BridgeWave
COMMUNICATIONS

Making connections in a high-speed world

AR60X Wireless Ethernet Links

Installation Manual

P/N 580-00517
Revision B
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This publication has been prepared for professional and properly trained personnel, and the customer assumes full responsibility when using the information herein.

Export Control

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Product Compatibility

While every effort has been made to verify operation of this product with many different communications products and networks, BridgeWave makes no claim of compatibility between its products and other vendors' equipment. It is assumed that users have thoroughly evaluated this product's performance in the communications environment in which it will be used.

Safety

CAUTION, WARNING, and DANGER statements have been strategically placed in the text to alert personnel of possible hazards. These statements must be closely observed.

The following general safety precautions must be observed during all phases of operation and service of the products covered in this manual. Failure to comply with these precautions or with specific warnings elsewhere in this manual willfully violates standards of design, manufacture, and intended use of the product. BridgeWave assumes no liability for the customer's failure to comply with these requirements.

- *These BridgeWave radios meet all applicable FCC safety requirements for general population exposure to radio frequency emissions; however, it is best to avoid prolonged, unnecessary exposure to the front of the radio while it is operating.*
- *The outdoor equipment must be properly grounded to provide some protection against voltage surges and built-up static charges. In the event of a short circuit, grounding reduces the risk of electrical shock.*

  For installations in the U.S.A., refer to Articles 810830 of the National Electrical Code, ANSI/NFPA No. 70, for information with respect to proper grounding and applicable lightning protection for DC cables. The installer must also follow any additional local building and electrical code regulations.

  For installations in all other countries, implement protection in accordance with the safety standards and regulatory requirements of the country where the equipment is to be installed.
- *Do not install or operate this equipment in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.*
- *Do not install substitute parts or perform any unauthorized modification to the equipment. Changes or modifications not expressly approved by BridgeWave can void the user's authority to operate the equipment.*

Regulatory Information

This device complies with FCC Part 15.255 and Industry Canada RSS-210.

Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and,
(2) This device must accept any interference that may cause undesired operation.

Equipment Precautions

Water and Moisture - All AR 60X links are designed to withstand weather conditions typically encountered when installed outdoors.

Power Sources - This product should only be operated with the type of power source provided by BridgeWave Communications Inc.

Table of Contents

1 Introduction

1.1 Purpose of Manual

The information in this manual is directed to persons who must perform or coordinate the tasks associated with the process of installing wireless communication devices, and planning communication network applications.

1.2 Prior Knowledge

This manual assumes the operator has at least basic experience with and an understanding of wireless technology and some familiarity with configuring and operating networking equipment. Preferably, the person installing this equipment fully understands the information covered in this manual prior to attempting these procedures.

DANGER, WARNING and **NOTE** statements have been placed in various sections throughout this document to alert personnel of possible traffic affecting issues and to provide additional tips and helpful information. These statements should be closely observed.

Symbol	Description
 **Danger**	*Indicates that personal injury can result if the user does not comply with the given instruction.* *A DANGER statement will describe the potential hazard, its possible consequences, and the steps to perform to avoid personal injury.*
 **Warning**	*Indicates that equipment damage, process failure and/or loss of data can result if the user does not comply with the given instructions.* *A WARNING statement will describe the potential hazard, its possible consequences, and the steps to perform to avoid serious equipment damage.*
 **Note**	*Provides supplementary information to emphasize a point or procedure, or provides a tip for easier operation.*

1.3 Contact Information

Technical Assistance and Customer Service
BridgeWave distributors are authorized local service providers and are responsible for immediate customer support. If problems are not resolved, contact BridgeWave Customer Service for assistance:

Santa Clara, CA USA
Tel: 408.567.6906
Fax: 408.567.0775
Email: support@bridgewave.com

Return Material Authorization (RMA)

Should BridgeWave equipment have to be returned for repair or replacement, an RMA number must be obtained from BridgeWave or the local BridgeWave distributor. When returning equipment, be sure to write the RMA number on the outside of the shipping carton.

BridgeWave Sales

E-mail: sales@bridgewave.com
Inside Sales: +1.866.577.6908

2 Site Planning

2.1 General

Before the start of an installation a survey should be conducted of the proposed area of the site(s). The survey personnel should be fully familiar with the details required to install the BridgeWave radio system.

2.2 Equipment Checklist

The survey team will need at least the following equipment:

- Binoculars
- GPS Navigation Device
- Tape Measure
- Site Survey Report Form
- Level

2.3 Line of Sight (LOS)

BridgeWave Wireless links require line-of-sight for proper operation. Fortunately, the links are relatively short and obstructions in the path can easily be identified. Binoculars can ease viewing in poor light conditions.

The planning should include an investigation into future building plans that could block the LOS path, and other long-term incremental obstructions such as trees. Intermittent obstructions such as aircraft at a nearby airport should also be considered.

The following table details the minimum clearance needed from obstacles near the path in order to ensure the radios will operate properly.

Path Length (meters)	Minimum Clearance (meters)
250	0.56
500	0.79
750	0.97
1000	1.12
1500	1.37
2000	1.58

Table 2-1: Minimum Clearance at Link Midpoint for various Path Lengths

2.4 Link Distance

Measurement of the link distance is important in estimating the link availability and calculating expected Receive Signal Level (RSL). This measurement can be performed using the Latitude and Longitude readings from a Global Positioning System (GPS) device, which is placed near the proposed locations of the antennas, or using a range finder device.

The Minimum Link Distances are as follows:

- AR/GE/FE 60: 65 feet (20 meters)
- AR60X: 330 feet (100 meters)

To estimate maximum distances and availabilities for a given product and region, BridgeWave's Path Availability Calculator can be used. To obtain the latest version of BridgeWave's Path Availability Calculator, contact BridgeWave's Customer Service or search the eService center knowledgebase

2.5 Antenna Location

The optimum location for the antennas must be determined. The ideal location should provide for ease of erecting and mounting the antenna, as well as unimpeded Line-Of-Sight (LOS) to the other site. The following factors should be taken into account:

- Type of mounting—fixed or roof-safe pole mounting
- Location where the fiber and DC power wiring will enter/exit the building
- Length of cable runs
- Grounding connection points
- Obstructions (LOS)
- Accessibility of mounting location
- Access to building after regular working hours

2.6 Cabling

The installation site should be inspected to determine the run paths for the fiber cable and power cable from the radio equipment to the termination point. Locations for roof penetration should be identified. The routing and securing of all cables should conform to all applicable codes and requirements. Depending on the likelihood of damage due to foot traffic or equipment movement, cabling conduit may be required. The maximum cable run length as specified for the equipment being installed must not be exceeded.

The radio requires an LC type connectors on a pair of simplex multi-mode fibers to properly connect to the radio and the users network equipment. Single-mode fiber is **not** a current option supported by the radio. The network equipment end of the fibers should be terminated with connectors that match the network equipment fiber interface.

Fiber Cable Length	Cable Type
Up to 270 meters	62.5/125 µm
Up to 500 meters	50/125 µm

Table 2-5: Fiber Cable Types

Each radio includes a 100-240 VAC power adaptor suitable for indoor operation that converts the AC voltage from the standard electrical outlet in the wall to DC voltage. The radio requires a minimum of 15.0 VDC (24.0 VDC maximum) via the power cable to the radio to function properly. When planning the cable run from the indoor mounted AC power adaptor to the radio unit, it is critical to use the cable gauge (AWG) indicated below to ensure adequate voltage at the radio. The electrical cable that is used outside the building must be outdoor rated (i.e., weather-protected) providing a single pair of wires necessary to power the equipment. The required DC power cable is 12 or14 gauge, 2 wire (i.e., 12/2 or 14/2) rated for outdoor use.

	Minimum Cable Size	
DC Cable Length	Outside Diameter of DC Cable Jacket (min-max)*	Conductor size
Up to 125 meters	0.14 – 0.36 inches (3.6 – 9.2mm)	14 AWG ($2.5mm^2$)
Up to 200 meters	0.17 – 0.45 inches (4.3 – 11.9mm)	12 AWG ($4mm^2$)

Table 2-6: Minimum DC Cable Size

Note	*The DC cable must comply with local building and/or electrical codes in your area.*

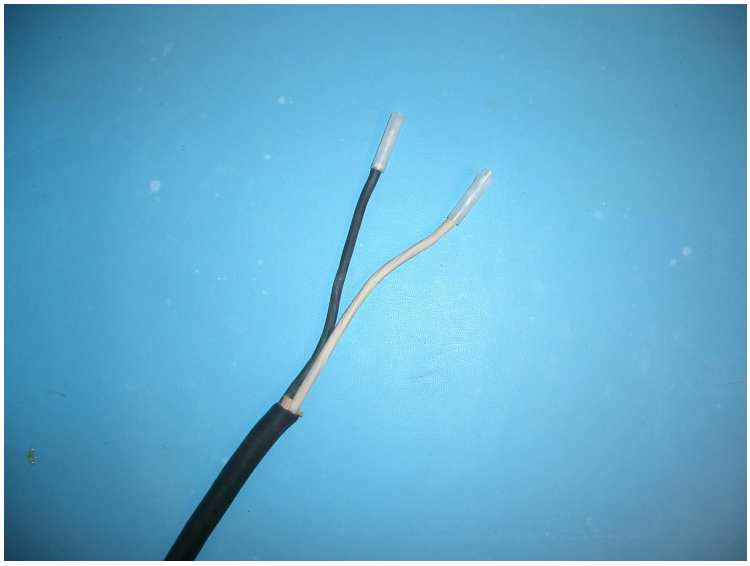


Figure 2-3 (left) details a standard 14-gauge wire that has been fitted with the power connectors (provided) for the radio's internal power supply necessary to mate with the provided power cord. A standard crimping/splicing tool (not provided) is required to terminate the power connectors onto the 14-gauge cable required for use with the unit.

Figure 2-3: 14-gauge DC power cable with crimp connectors

In addition to grounding the equipment, **BridgeWave strongly recommends,** and local building codes may require, that the power cable be protected from lightning strikes. If a copper Cat5 Ethernet cable is used for Network Management access, it is also necessary to install surge suppressors at each end of this cable. A surge suppressor must be placed within the radio enclosure (to protect the radio electronics) and at the building exit/entrance (to protect the indoor equipment). BridgeWave recommends the Dehn Patch DPA M CAT6 RJ45S 48.

2.7 Grounding & Lightning

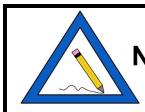
Danger	*Proper grounding of the outdoor equipment reduces electromagnetic interference, provides lightning protection, and protects against electrical discharge.* *Using improper techniques in lightning prone geographic areas may pose a danger to local personnel.* *The source and connection points for the building-to-earth ground in the vicinity of the antenna location should be determined.*

It is recommended to integrate the radio ground into the building ground utilizing the pole mount hardware. For wall or ungrounded pole mounts connect a grounding wire to the grounding point on the radio. Select the size of the ground wire based on the National Electrical Code.

In addition to grounding the equipment, **BridgeWave strongly recommends,** and local building codes may require, that the DC electrical cable be protected from lightning strikes with a surge

suppressor. The surge suppressor must be installed at the point where the DC electrical cable exits/enters the building, however, the use of a surge suppressor at the radio unit is optional since power cable surge suppression is built into the unit.

If a copper Cat5 Ethernet cable is permanently installed, it is necessary to install surge suppressors **at both ends** of this cable. A surge suppressor must be placed within the radio enclosure (to protect the radio electronics) and at the building exit/entrance (to protect the indoor equipment).

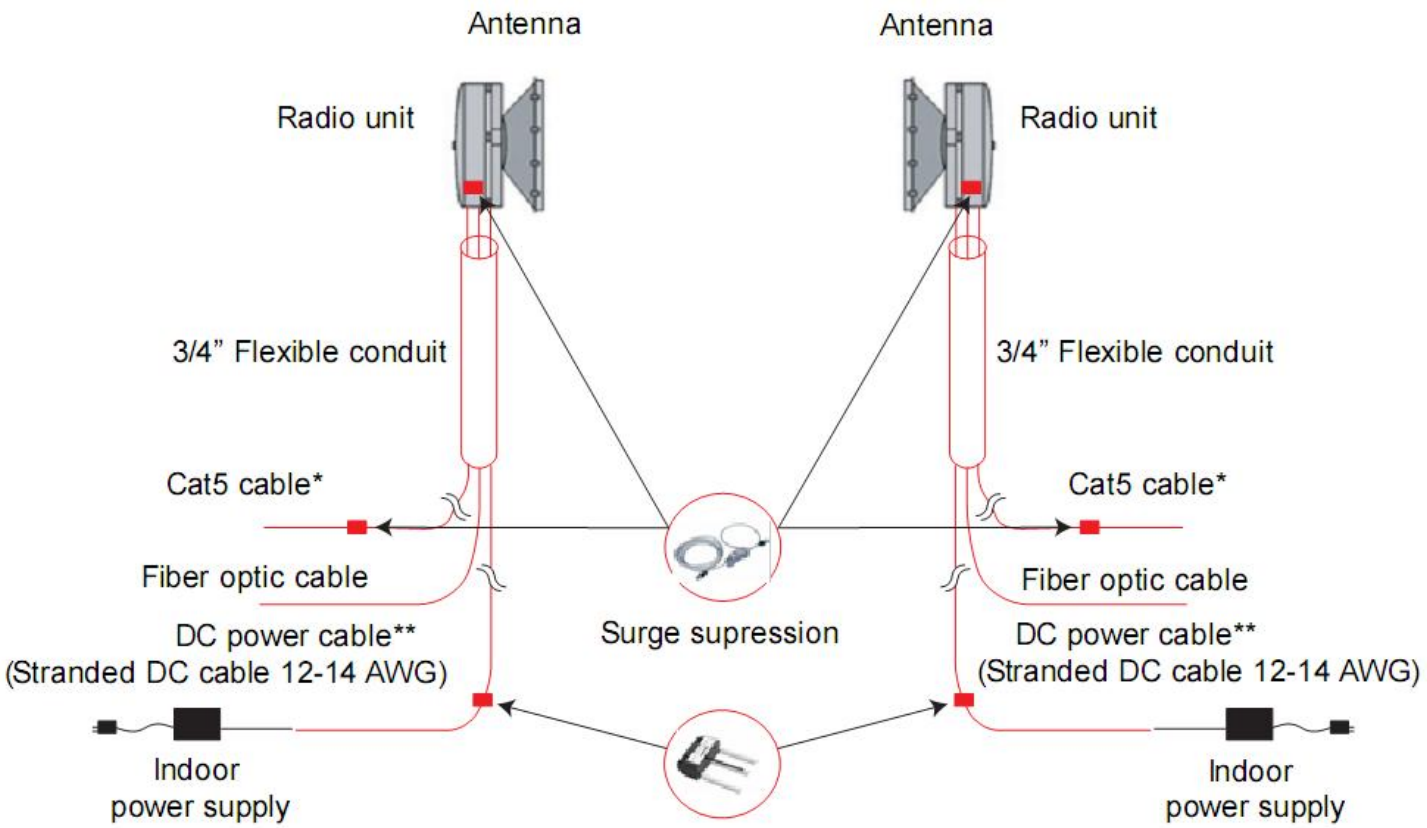
 **Note**	*For more information on recommended accessory devices and kits, contact BridgeWave Sales*

2.8 Environmental

The structure to which the equipment will be mounted must be adequate to bear all wind and weather conditions. The wind load at high wind velocities can exceed 100 ft/lb of torque, BridgeWave highly recommends pole diameters of 3” or more. The environmental conditions at the location must conform to the operating environment specified for the equipment.

2.9 Cabling Diagram

Following is a diagram detailing the equipment and cabling found on a typical installation of BridgeWave's 60GHz radio equipment.



3 Installation

3.1 General

It is recommended that installation personnel read this section in its entirety prior to installing the BridgeWave System. During a particular phase of installation, the user may refer directly to the applicable subsection.

The Installation section is comprised of seven subsections covering the procedures and guidelines for installing the BridgeWave Radio System.

Subsections 3 through *3.4* contain information necessary to prepare for the equipment installation.

Subsections 3.5 through *3.8* covers equipment installation procedures.

Subsections 3.9 and *3.10* contains information necessary for aligning the antennas.

3.2 Equipment Unpacking

The radio system equipment will arrive in two boxes—one box for the low band radio and one box for the high band radio. Locate the correct box (low band or high band) before beginning installation by checking the label on the outside of the box or on the radio itself. It is recommended that the shipping cartons and packing materials be retained in the event that it is necessary to return any equipment.

Note	*Unpacked radios can be identified by the color of their labels found on their front faces or inside the unit after removing the plastic back weather cover. The blue color label indicates a high band radio and the red color label indicates a low band radio. See Figure 3-5 for further details.*

3.3 Equipment Inventory

Each carton is accompanied by a packing list. Verify the contents of the carton against the packing list. Following are inventory lists for a typical system.

Qty ***Description***

2 ea. AR60X radios (1 low-band & 1 high-band)

2 ea. Standard Power Supply (Indoor rated, 100-240VAC input to 24VDC output)

2 ea. Pole mount kits

1 ea. CD with Manuals (1 CD provided per pair of radios)

2 ea. DC power connection set. (Includes 2-prong DC plug and 2 ea slip fit plugs/receptacles)

2 ea. Antennas (radios are attached to back of antenna in vertical polarization)

1 ea. Hard reset box

AR60X Antenna and Mount Kit Parts List

Item	Description	Qty.
1	Antenna	1
2	Lower Pole mount assembly	1
3	Upper Pole mount assembly	1
4	Antenna mounting plate	1
5	3/8 bolts	2
6	3/8 lock washers	2
7	3/8 flat washer	2
8	3/8 nylon washer	2

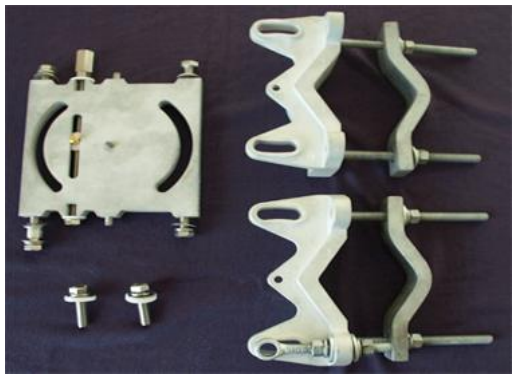


Figure 3-1

Warning	*The radio is sealed at the factory warranty stickers on the inner (metal) cover of the radio. There is no need to open this cover in the field. Tampering with these seals will void the warranty.*

3.4 Installation Tools

The following tools, not provided by BridgeWave, are required for installing the radio and the antenna:

Screwdriver, slotted 0.1 inch (2.5mm) wide

Open-end wrench 11/32 (9mm)

Open-end wrench 9/16 (14mm), 2 ea.

Open-end wrench 1/2 (13mm)

Ratchet with 6 inch (15cm) extension and 9/16 inch (14mm) deep socket

Wire stripper/cutter/crimp tool (10-16 gauge)

Electrical tape

Fish tape for pulling cable

Cable tie wraps

Level

Hand-held DVM (digital voltmeter) with standard banana plug receptacles

3.5 Antenna Mount Installation

Warning	*1. Read these instructions before beginning installation. Caution should be used. Qualified persons experienced with antenna assembly and installation are required for installation.* *2. BridgeWave Communications Inc. disclaims any responsibility or liability for damage or injury resulting from incorrect or unsafe installation practices.* *3. The antenna has been formed to a very close tolerance parabolic shape. Careful handling and assembly is required to avoid denting the reflector, which would degrade antenna performance.*

1. Attach the upper pole mount.

Confirm that the Mount is centered as shown.
Tighten bolts Securely

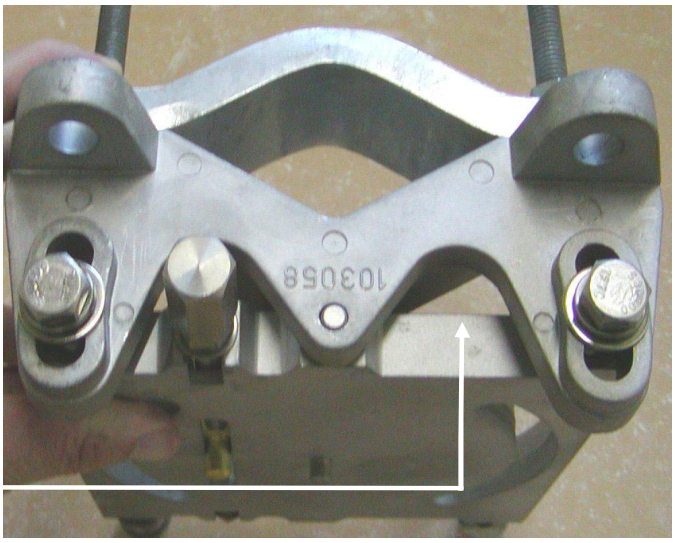


Figure 3-2

2. Attach the lower pole mount as shown.

Hardware: Flat washer, bushing (inside eye), flat washer, lock washer, bolt.

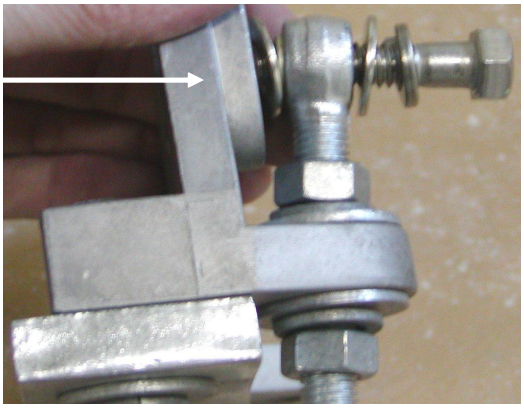
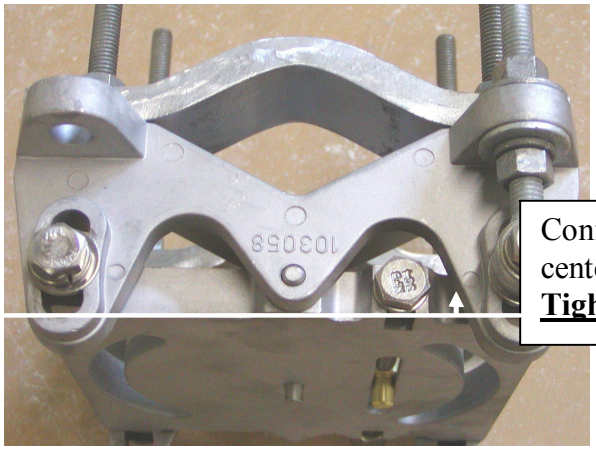


Figure 3-3



Confirm that the Mount is centered as shown.
Tighten bolts securely

Figure 3-4

3. Completed installation of pole mount with right hand offset for the antenna.

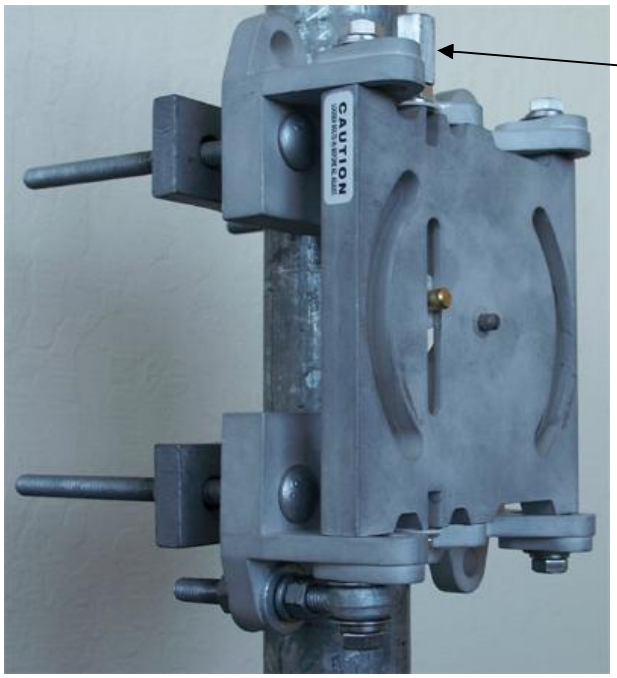


Figure 3-5

4. Optional left hand antenna offset mount preparation.

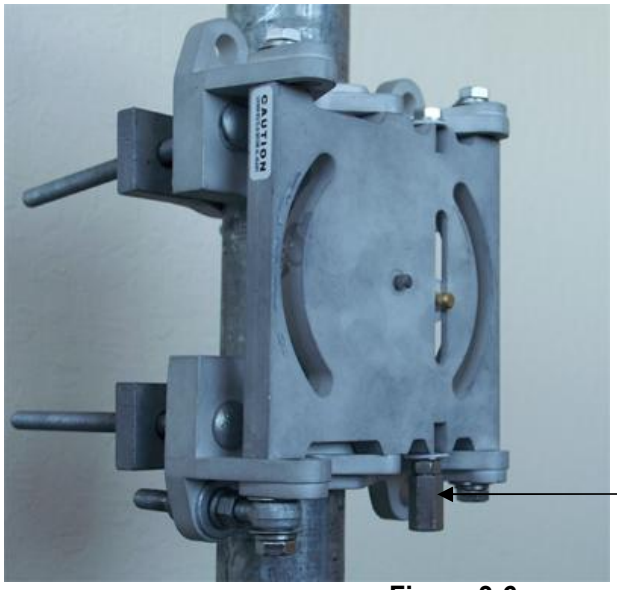


Figure 3-6

Warning	When using the left side radio mount position, the antenna drain plugs must be rotated to the top drain holes and the bottom holes must be open to allow for proper drainage.

3.6 Antenna and Radio Installation

5. Install – Antenna

Slip antenna over pivot pin, ensuring that the elevation adjust pin is engaged with slot in adaptor plate.

Secure the antenna with two (2) x 3/8-16 bolts, lock washer, flat washer and nylon washers attach antenna to the alignment plate.

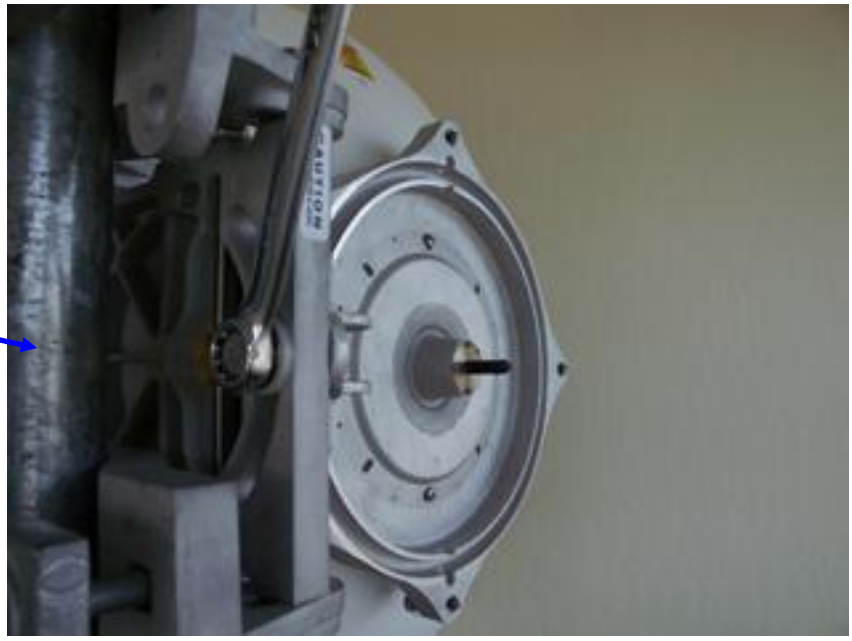


Figure 3-7

When the radios come from the factory, they are mounted on the back of the antenna in the vertical polarization position, that is, the diamond marking (see figure 3-8 below) on the front of the radio housing is to the right when viewed from the front of the radio. For horizontal polarization, the radio needs to be removed from the antenna and rotated so the diamond is at the top when viewed from the front.

Figure 3-8: Polarization diamond orientations: vertical (left) and horizontal (right)

Note	*The blue color label indicates a high band radio and the red color label indicates a low band radio*

Warning	*It is critically important during installation to ensure the radios on each side of the link are in the same polarization (horizontal-horizontal or vertical-vertical). A link that has a radio on one side of the link set in the horizontal polarization and the other side of the link set in the vertical polarization will not operate properly.* *It is also critically important that a high-band radio is paired with a low-band radio to ensure the system will operate properly. Prior to installation check each radio to verify one is a high-band and the other is a low-band version. The label on the radio will indicate the band (blue for high or red for low).*

6. Verify that the four (4) captive 3/8-16 bolts with lock and flat washer are in place. A ½ inch open-end wrench is required to tighten them. It is important that all four screws are tightened evenly (hand tight, 1 to 2 turns each and finally until the lock washer is flattened)

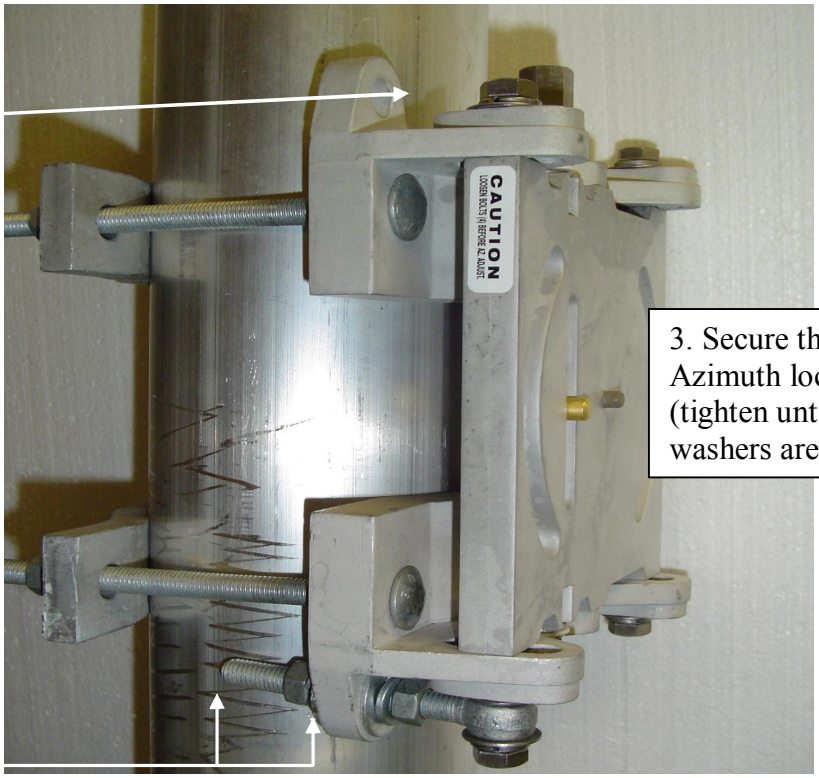
Figure 3-9 Captive radio bolt detail

7. Attach the radio to the back of the antenna and tighten the four (4) bolts. See 6. for details.

Figure 3-10 Attaching the radio to the back of the antenna

8.Adjust azimuth (Side to Side)

1. Loosen the 4 Azimuth lock bolts



3. Secure the 4 Azimuth lock bolts (tighten until lock washers are flattened)

2. Adjust eyebolt length using a 9/16 open-end wrench to required location

Figure 3-11 Azimuth (right/left) alignment

Warning	*It is very important that the azimuth bolts are tightened before any elevation adjustment is done. The very narrow beamwidth of this antenna (0.6°) makes it necessary to completely tighten the bolts of the azimuth adjustment while adjusting the elevation and vice versa.*

8. Adjust elevation (up - down)

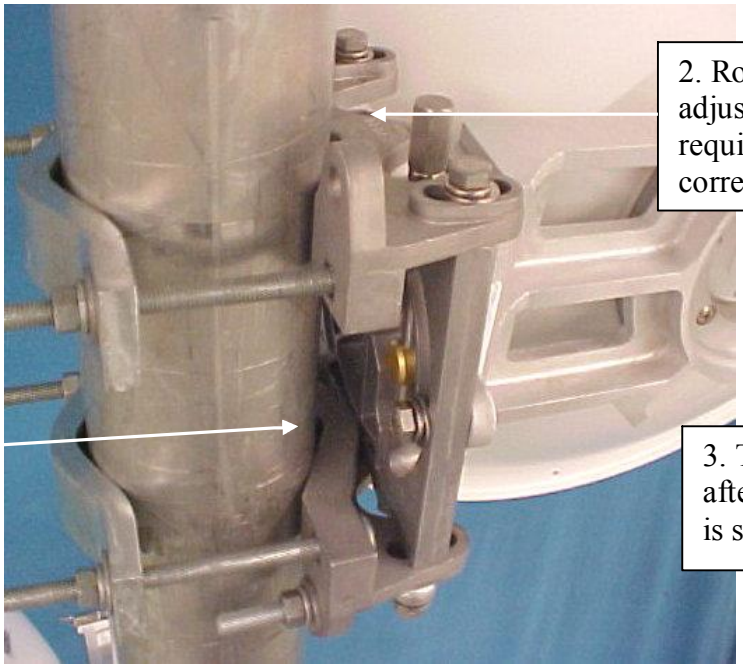


Figure 3-12 Elevation (up/down) adjustment

Note	*Begin the alignment process with the antenna in a level attitude. When adjusting elevation, it is better to start in a low attitude and raise the antenna to the proper position than to start high and work towards a low elevation setting.*

3.7 Cable Installation

Fiber Cabling

1. Install a pair of multi-mode fibers (850nm) from the radio to the network termination equipment (switch or router with 1000Base-X port). The cable should be looped around the inside of the enclosure to provide strain-relief. Do not connect the fibers to the radio's fiber ports at this time.

   The connectors on the radio end of the fibers require **simplex** LC connectors; the connectors on the switch/router end should be chosen to correctly mate to the network equipment sockets.

 **Note**	*The simplex LC connectors for the radio need to be inserted individually through the slip-fit connectors on the radio, as there is not sufficient room for both to fit through at the same time. If you have a duplex hood joining the LC connections, it should be temporarily removed during this process.*

2. Connect fibers at the network equipment.

 **Warning**	*It is important not to connect the fibers to the radio until after aligning the radio as the radio performs an automatic calibration once the fiber is inserted into the radio and this calibration will not operate properly if the radio is not properly aligned. If this inadvertently occurs while the radio is powered on, unplug the fibers and power cycle the radio.*

Power Cabling

1. Select indoor location for the AC power adaptor, with easy cable routing to the radio. Normally it is convenient, but not required, to place the adaptor near the network termination equipment.
2. Ensure the DC wire used is 14-gauge type and no longer than 125 meters; or 12-gauge and no longer then 200 meters.
3. Connect the provided DC Connectors onto the 14-guage wire using a splicing/crimping tool. For the use of 12-gauge wire it may be necessary to trim a few strands from the ends of thicker stranded cables to more easily fit the crimp connectors.
4. Install the DC power cable and attach to the AC adaptor using the supplied crimp connectors. Do not connect the power jack to the radio at this time.

 **Note**	*Be sure to first connect the DC power connectors before inserting the power plug into the power jack in the radio. Minor electrical sparks may be noticed if the sequence above is not followed; however, these sparks are normally harmless.*

Optional Copper Ethernet Cabling

Normally, only the fiber cable is used to carry network traffic to the indoor network equipment. In special cases, it may be necessary to use a 10/100Base-T copper connection to the indoor equipment (or other outdoor network equipment), in which case special care must be taken to protect both the radio unit and the indoor equipment from electrical surges. Surge suppressors are not needed for temporary connections while installing or troubleshooting a link when lightning is not a risk.

1. Install a Cat5 type Ethernet cable from the radio to the network termination equipment (switch or router with 10/100Base-T port). The cable should be looped around the inside of the enclosure to provide strain-relief. Connect the Ethernet cable to the surge suppressor placed **within** the radio housing and then connect a cable from the other end of the surge suppressor to the radio's 10/100Base-T port.

Note	*The RJ45 connector for the radio needs to be inserted separately from the fiber and DC cable through the ¾-inch conduit fitting on the radio, as there is insufficient room for all to fit through at the same time.*

2. Install a second surge suppressor at the building entrance/exit. This may require the use of RJ45 Female/Female couplers. Connect Ethernet cable to the network equipment used for network management.

Figure 3-13: Back view of vertically polarized unit.

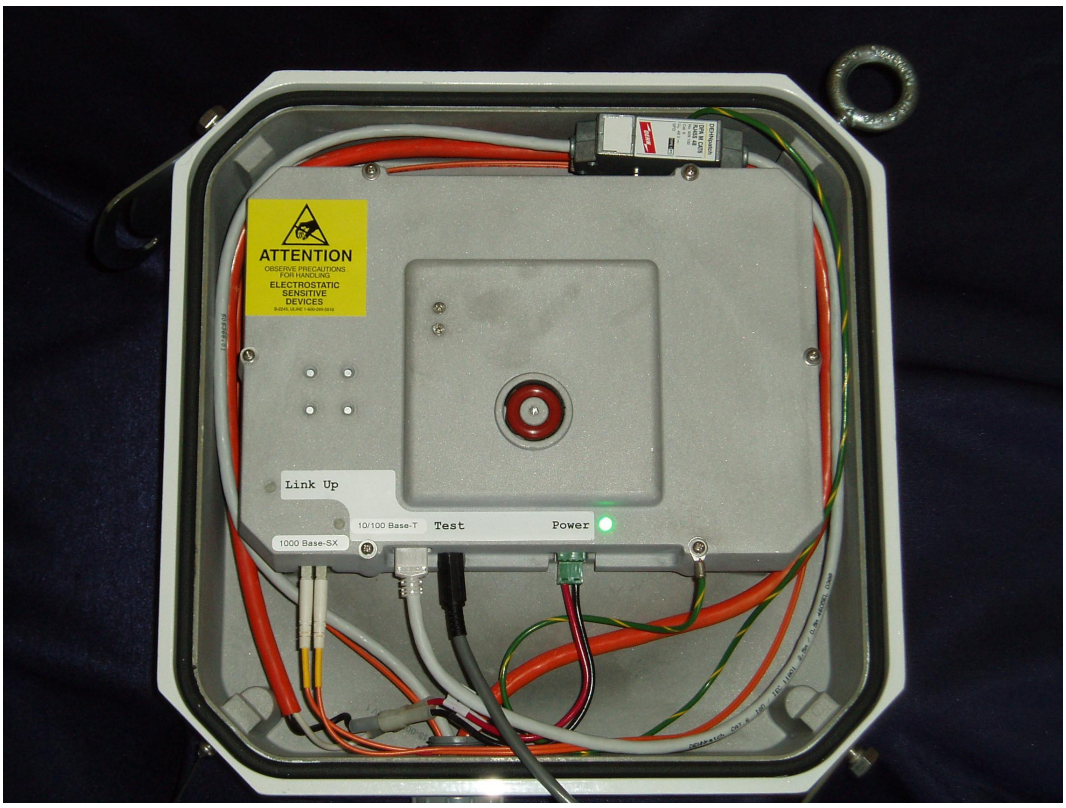


Figure 3-14: Inside view of fiber, power and Cat 5 cable connected

Note	*The fiber cable is inserted through the fitting before the conduit is connected to the fitting. Ensure that the cables do not get pinched when the conduit is pushed onto the fitting. Both the cables have been looped around the inside of the enclosure to minimize tension on the cables when connected to the radio and to maintain proper bend-radius of the fiber cable.*

Ground Cabling

The preferred method for grounding the radio unit is to ground the mast (or wall-mount bracket) to a ground source, since this provides the largest grounding surface contact possible. If this is not possible, then use the following procedure:

1. Attach the lug of the ground cable (not provided) with the radio to one of the two #8 holes at the bottom of the radio using a #8-32 x ½" long bolt, #8 lock washer and #8 flat washers (not provided).

2. Connect other end of the ground cable to a nearby building exterior ground location.

3.8 Ice Shield Canopy Installation

Note	*The Ice Shield assembly is an optional item and can be ordered in kit form through a BridgeWave distributor.*

3.8.1 Introduction

In northern climates, the buildup of ice or snow on antennas can be a problem for millimeter wave radio installations. These problems are twofold: the electrical effect of snow and ice built up on the antenna's radome; and the mechanical impact of the additional weight of the snow or ice on the antenna and supporting structure.

The formation of ice or snow on the antennas radome can cause attenuation of the signal to the point where the link may become severely degraded or unusable. Uneven ice buildup can cause scattering of the signal, which in turn results in standing waves.

Ice layers are not likely to exist for extended periods, as ice tends to melt. In cold climates when the radome is below freezing temperature, ice does not stick to it, thus there is no issue. However in mixed rain-snow-ice storms, ice can stick to the radome, causing the link to operate at less than its optimal design.

Once the ice has hardened and freezes, the added weight of the ice on the antenna increases the wind load on the tower or mast, which may cause premature failure of the mounting structure. As ice breaks apart due to melting, or via its own weight, these large and heavy sheets falling down a tower or mast can cause damage to antennas or other objects mounted below.

BridgeWave provides an ice shield kit, designed to combat the buildup of ice on BridgeWave's wireless bridges. These inexpensive ice shields are easily fitted on the radios during the installation process.

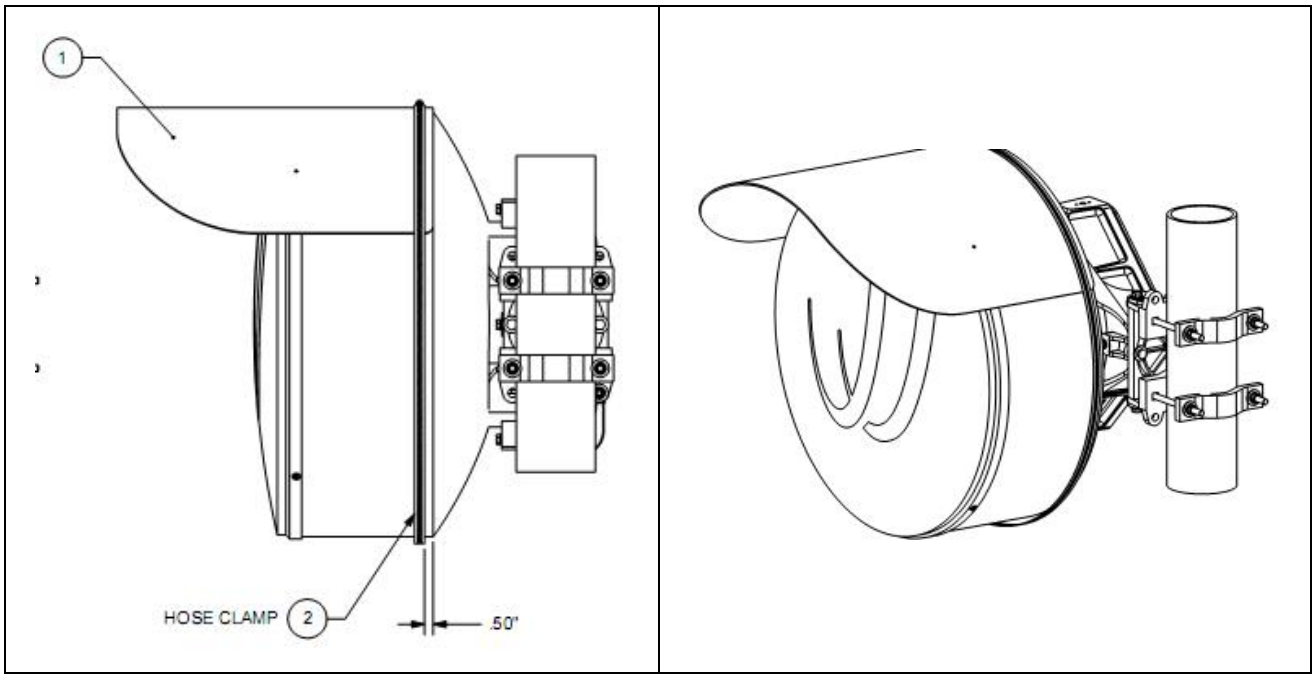


Figure 3.8.1-1: 60X Ice Shield

3.8.2 Optional Kit

The part number for this kit is 515-00529 (Available through Sales, see contact information section)

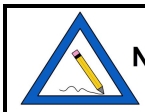
Refer to the table below for the kit required for your particular application. Each kit contains the necessary materials for the installation of the ice shield on one radio. Two kits are required per link.

Qty:	Description:
1 ea.	Ice Shield Canopy
1 ea.	Ice Shield Clamp, 6’

3.8.3 Installation Instructions

1. Remove the protective liner from the plastic canopy.
2. Use a screwdriver or 5/16” nut driver to set the hose clamp to the end of its range for maximum opening.
3. Slip the hose clamp over the radome so that it loosely sits in approximately the middle of the radome.
4. Slide one end of the plastic canopy under the clamp and slowly bend it around the canopy and work it under the rest of the clamp.

5. Align the canopy to the back edge of the radome and position the clamp 1 to 3” away from the edge.
6. Tighten the clamp until snug. (*Do Not Overtighten*)

 **Note**	*Remove canopy when its not snowing to reduce antenna wind loading*

3.9 Antenna Alignment

1. Finish the installation as described in Chapter 3.6 and 3.7
2. Ensure fiber cables are still disconnected!
3. Connect DC power to the radio.
4. Verify that the Power LED is lit. If the Power LED is not lit, use voltmeter to verify correct voltage and polarity at radio. To reverse the power polarity, unplug the power jack and swap the two conductors.
5. Repeat steps 1 through 4 on other side of the link.
6. Connect QUAL and RSL test cable to the radio.
7. Slightly rotate each antenna up/down and left/right to find the maximum RSL voltage reading. To ensure that the antennas are not aligned on a side-lobe, they must be rotated at least ten degrees on each side of the visually-perceived alignment center to ensure that the true maximum RSL voltage is found; note that the width of the center beam is only 0.6 degrees and the first side-lobe beam is only 1.5 degrees off from center. Set the antenna in the position that results in the highest RSL voltage reading. ***See Section 3.9 to determine the proper use of the supplied test cable in order to read the RSL voltage.***

Note	*Verify that the RSL voltage falls within the expected range based on the graph in Appendix B.*

8. Ensure all bolts are tightened securely and the RSL voltage remains unchanged during tightening. Keep in mind that it is very important that the azimuth bolts are tightened before any adjustment on the elevation is done. The very narrow beamwidth of this antenna (0.6º) makes it necessary to completely tighten the bolts of the azimuth adjustment while adjusting the elevation and vice versa.
9. Connect the fiber cable to one of the radios at a time. The fibers should already be connected to active network equipment. If the unit is not to be connected using fiber cabling, a temporary loopback fiber must be used to perform this operation.
10. Verify the Fiber LED's on each radio are illuminated solid.

Note	*The fiber integrity indication on the network equipment could show up or down independent of the link status. Once the radio link is up and network equipment connected on both sides of the link the network equipment should indicate fiber integrity.*

11. Once the fiber is connected to the radio, the radio will begin an internal link calibration. During this time the Link Up LED will blink for approximately 120 seconds for the AR60X.

12. Wait until the Link Up LED is lit solid on both radios.

13. Verify the Link Quality voltage is 3.3V (i.e., error free). Repeat steps 10-13 for the second radio.

 **Note**	*When a radio is power cycled, it will execute a limited version of the calibration process. After this time, the link should be functioning. This limited automatic calibration process is also activated if the link is down for more than 5minutes .*

14. Remove the test cable from the radio, replace the rear plastic cover and use a wrench to tighten the back cover nut to the point where the back cover stops (i.e., when it hits the metal ring on the back metal plate). The installation is now complete.

Auto Calibration States

State	Description
Unit powered up no fiber connected	Unit will be in alignment mode, there will be no automatic calibration event started until the fiber is connected
Unit powered up then fiber cable connected for the first time	The radio will perform a single calibration scan and will then go into normal operation mode, regardless of the results of the scan. (Link up or down status has no influence on the scan)
Normal operation mode	Disconnecting and reconnecting the fiber cables will not cause a recalibration. A recalibration will only happen if the link is down for more then 50 seconds.
Forced Recalibration	Power cycling the radio and disconnecting then reconnecting the fiber to the powered up radio will start the auto calibration routine again. If the fiber cables stay disconnected the radio will go back into alignment mode.

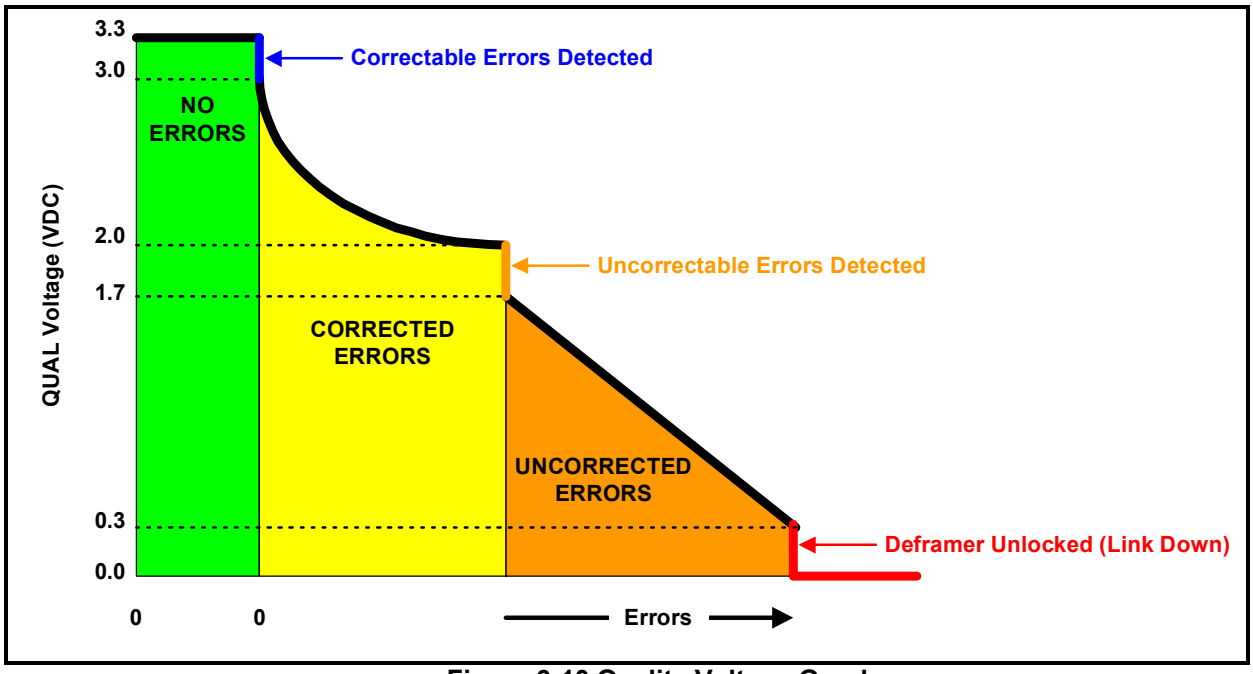


Figure 3-10 Quality Voltage Graph

- Quality Voltages between 3.0V and 3.3V indicate an error-free wireless link.
- Quality Voltages between 1.5V and 3.0V indicate a low rate of errors, that the forward error correction will correct. The lower the voltage, the more errors are being corrected.
- Quality Voltages between 0.5V and 1.0V indicate excessive errors in the wireless link that can not be corrected by the FEC. To indicate this change in error performance, the quality voltage will drop from 1.5V to 1.0V in a single step.
- Quality Voltages below 0.5V indicate an unlocked deframer condition. This will be recognized as a link-down condition.

3.10 QUAL and RSL Test Cable

The alignment procedure is optimized through the use of the provided test cable. This test cable is designed for use with a digital voltmeter (not provided) to read the Link Quality and Receive Signal Level (RSL) voltage generated by the radio's receiver.

1. To read the RSL value of the radio, insert GND (ground) and RSL banana plugs into the voltmeter. Note the RSL voltage. The voltage may be fluctuating; in this case, note the maximum value seen.

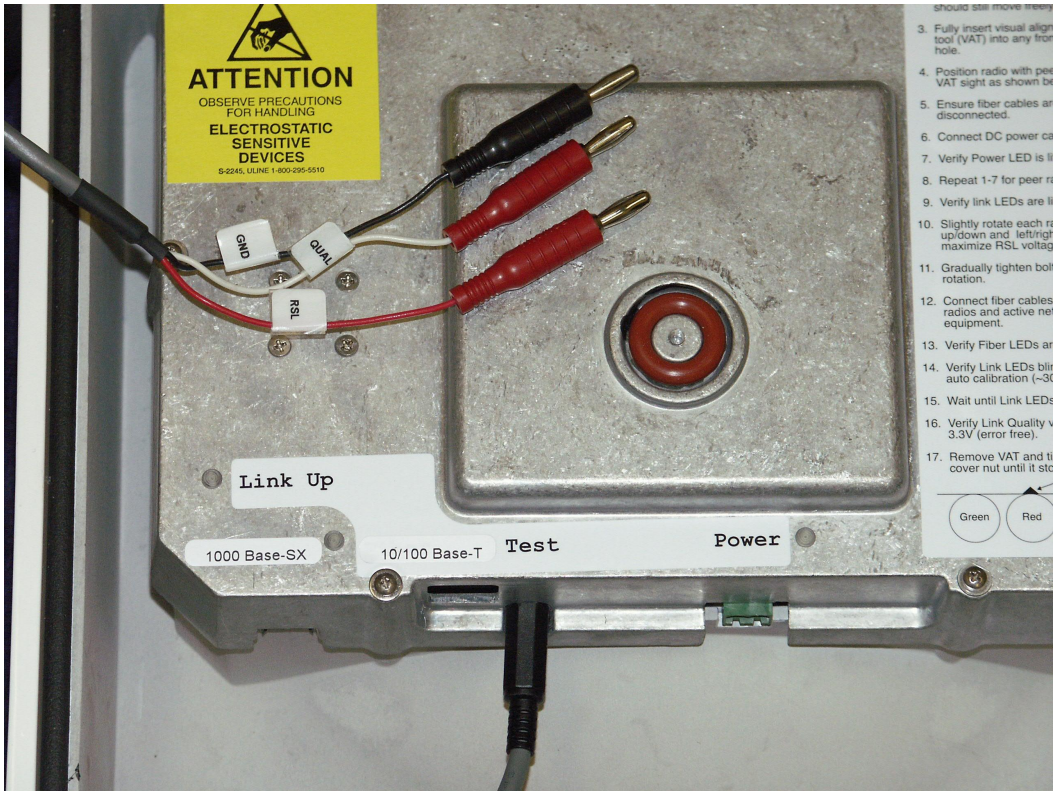


Figure 3-15: Top view of test cable provided to check Link Quality & Receive Signal level

2. To read the Link Quality value of the radio, insert GND (ground) and QUAL banana plugs into the voltmeter. Note the Link Quality voltage. After the radios have performed an auto calibration the quality voltage should read 3.3V if the link is aligned on the main antenna beam and there are no obstructions (i.e., trees, buildings, etc…) in the path, the link distance is within the operating parameters of the radio (see Section 2.4 above), and it is not raining heavily. AR radios may have less than 3.3V Quality in 1000 Mbps mode and still operate normally; this would indicate that the AR link is operating near the distance limit for Gigabit Ethernet performance.

4 Radio Link Status Indicators

During normal operation, the following conditions should exist at the radio:

- The power LED should be lit—solid green;
- The fiber LED should be lit—solid green;
- The Link Up LED should be lit—solid green;
- The Link Quality BER voltage should be 3.3V, although dips in voltage are acceptable during periods of precipitation.
- 10/100Base-T LEDs (each side next to socket opening); left should be green if connected (link up) and right flashing yellow indicates activity

Figure 4-1: Link Up, Fiber and Power LED's indicating link is up and operating

The radios do not require periodic maintenance. However, each end of the link should be periodically inspected for visible damage or excessive accumulation of dirt on the antenna's radome.

5 Connecting Network Equipment

The user networking equipment that is connected to the radio should be checked to ensure it operates properly over a wired connection. Once this has been confirmed this will save troubleshooting steps after the radio is installed and connected to the network equipment.

We recommend the network equipment on both sides of the link be configured as follows:

- 1000 Mbps full-duplex
- Port auto-negotiation and flow control enabled
- Port configured to not enter *error-disable* state due to link up/down transitions (since these may occur during periods of very heavy rain)

 **Note**	*It is possible to disable auto-negotiation on the radio's fiber interface by use of the built-in Network Management interface. The radio's 10/100Base-T port is permanently set to auto-negotiate.*

5.1 Network Port Statistics

In the event the network equipment connected to the AR60X offers the capability below, we recommend you verify the following on the network equipment:

- Link integrity
- There are no receive errors on the link
- Network traffic is flowing in both directions.

 **Note**	*The radios support all standard Ethernet frame sizes, up to 1632 bytes for un-tagged or 802.1q VLAN-tagged frames.*

Appendix A: Troubleshooting

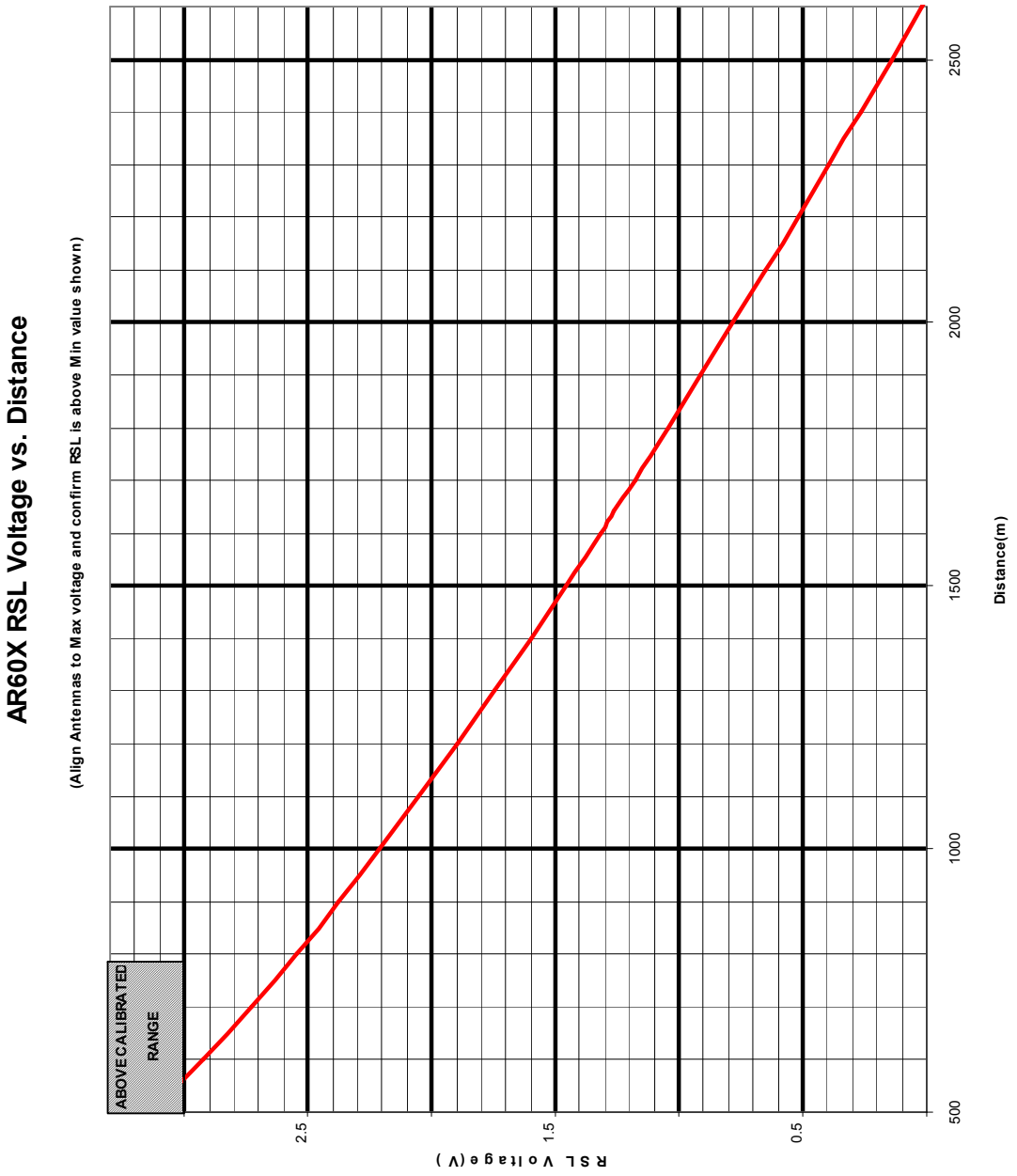
The following table provides a summary of possible problems you might encounter while installing a BridgeWave AR60X link, along with possible causes and their solutions.

Note	*Extensive troubleshooting support and knowledgebase articles are available at the BridgeWave eSupport knowledgebase online at: http://bridgewave.com/support/kbrma.htm Contact BridgeWave support to obtain a login account.*

Problem	Possible Cause	Resolution
No power to radio	Wrong polarity of supply voltage	Use a DVM to determine the polarity and voltage on the DC cable. (See Section 2.6)
	The supply voltage measured at the radio (when connected) is below 15Vdc	The cable run is too long or the cable gauge is too small. Shorten the length of the cable or use larger gauge cable. (See Section 2.6)
Fiber light lit at radio but not on network equipment	LSP is enabled and radio link is down.	This is normal behavior.
	TX and RX fibers are swapped.	Try swapping the TX and RX fibers at one/both ends of the connection.
	Error in the configuration of the networking equipment.	Verify the configuration of the network equipment is consistent with radio unit's fiber port settings (auto-negotiation and flow control).
	One or both of the fibers have been damaged or is not connected at both ends.	Use a loopback connector at the radio to verify the radio is OK, repeat at the networking equipment. Visually inspect the fiber cable.
Cannot establish the wireless link	Units are not properly aligned	The two units are not set to the same polarization. Verify and if necessary correct the polarization setting. (See Section 3.6)
	Obstacle in link	Verify the line of sight conditions and check for required clearance (See Section 2.3).

RSL voltage lower then expected	Incorrect calculation of link distance	Verify that the calculation tool used and the GPS used both use the same annotation system (degree hours minutes seconds or degree with a decimal value)
	Antennas aligned on side lobes	Realign antenna to main lobe. Keep in mind that the side lobe is only 1 degree from the main lobe.
	Antennas set to different polarizations	Verify that both radios are set to the same polarization. (see Section 3.6)
	Installed two high or low band radios in one link	Verify that one end of the link is high and the other end is a low band radio (see Section 3.6)
	Link exceeds maximum specified range	Verify that maximum path length has not been exceeded
Low link quality voltage		
	Antennas are not aligned for maximum RSL	Verify antenna alignment, using instructions provided in section 3.6.
	Auto-calibration not completed	Power cycle units to force auto calibration cycles. (see Section 3.8)
	Interference	Check for possible interference by turning off the radio at the other end of the link and verify the RSL voltage on the local side drops below 0.2V
Wireless link established but no data transfer over the link	Network equipment configuration and radio configuration incompatible	Verify settings on network equipment to be consistent with radio units fiber port settings. Verify network equipment port configured to not enter *error-disable* state due to link up/down transitions (see Section 4.1)

Appendix B: RSL Voltage vs. Distance



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