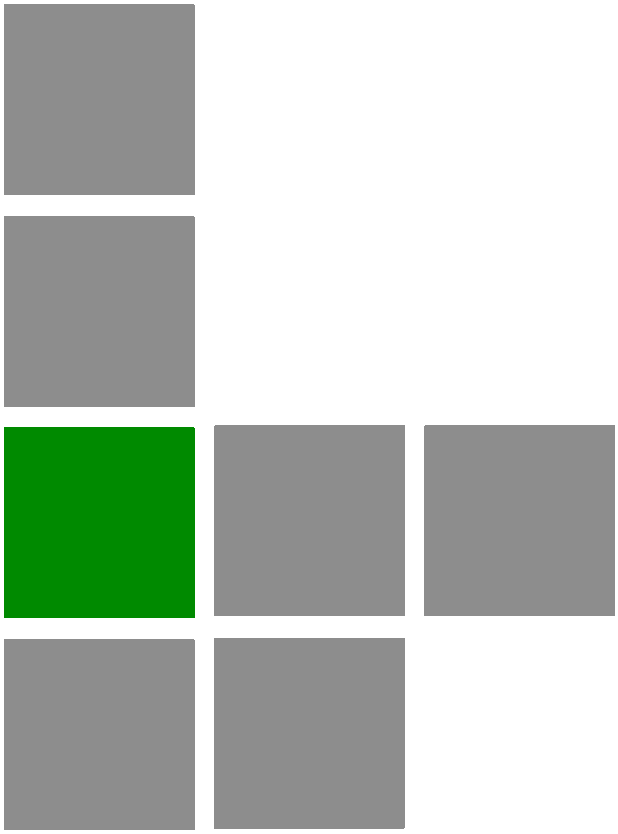
4Motion® Installation Procedure



Reference Guide

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Disposal of Electronic and Electrical Waste

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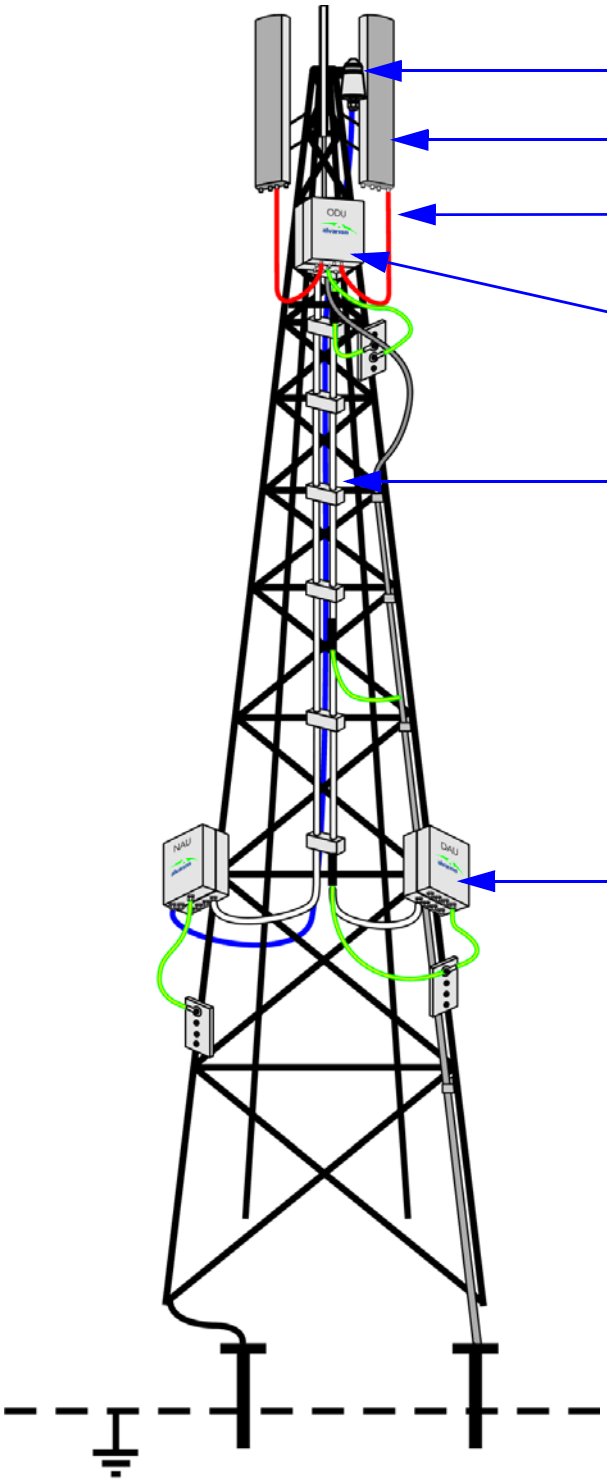


"GPS" on page 2

"Antenna" on page 3

"RF Cable Connection" on page 4

"ODU" on page 8

"IF Cable Connection" on page 9

"BTS" on page 15

List of Appendixes:

1. Introduction

This handbook provides general guideline for the physical installation and inspection of a basic site. The handbook describes the requirements from a proper installation.

It is assumed that professional radio and site surveys have been conducted. This is highly recommended in order to avoid radio, space, electricity, and other environmental issues.

This handbook is intended for professional installers.

Referenced manuals:

- *4Motion Installation Manual* - downloadable from the web.

2. General Prerequisites

For best installation results, installers must first complete the official Alvarion's CAIT or CASS course training.

3. Site Construction and Inspection

Make sure that the site can be accessed by Alvarion employees/sub-contractors and their equipment.

Make sure that there is safe entrance, exit, and parking available.

When building a site from scratch, prepare reports after each construction phase. When the site is ready for installation, make sure you have at least one of the following reports available for inspection:

- Civil engineering report: includes information on building strength, approach roads, aviation safety, water, sewage, electricity lines etc. Check that the report was approved by a civil engineer before using the site.
- As built report: including tests of tower/pole/mast strength and approval to add the extra equipment in the required height.
- Soil measurements report: with soil resistance per meter used for calculating the grounding resistance.
- Electrician report: including the approval of the electrician for the grounding systems. Verify that the resistance is under 10Ω.

- Operator report: including all the information on the site infrastructure and approvals.

When installing on an existing infrastructure (tower, pole, mast) with existing grounding, obtain the documentation for inspection before beginning the installation.

4. Installation

4.1 GPS

4.1.1 Requirements

Before starting the GPS installation, make sure you have the following:

- Deployment instructions detailing the type and positioning of the GPS (obtained from the Project Manager)
- GPS - verify that you have the correct GPS types according to the deployment instructions
- Mounting kit
- Grounding cables with termination according to connection type
- Lightning surge arrestor
- Cat.5E Ethernet cable
- Installation tools and materials, including means for installing the GPS (Phillips screwdriver, tools for connector installation (see Appendix C), etc.)
- Sealing materials (see Appendix A).

4.1.2 Installation

1. Install the GPS in the locations detailed in the deployment instructions.
2. Install the GPS and connect the GPS cable to the BTS according to the instructions in the *4Motion Installation Manual*.
3. Ground the GPS according to the instructions in the *4Motion Installation Manual*.

4 Connect the GPS to the lightning surge arrestor as instructed in the documentation provided by the manufacturer with the lighting arrestor. If no instructions are provided, see Appendix B.

5 Seal the connector according to Appendix A “Sealing and Weather-proofing” on page 18.

4.1.3 Inspection

1 Check that the GPS is oriented parallel to the horizon.

2 Check that there are no obstacles, such as vegetation and buildings, blocking the view of the GPS antenna.

3 Check that all nuts and bolts are firmly connected and are not loose.

4 Check that the GPS is properly grounded.

5 Check that the GPS is properly protected by a lightning arrestor.

4.2 Antenna

4.2.1 Requirements

Make sure that you have the following:

- Radio Network Planning document - make sure you have the most recent version with the correct azimuth, tilt, and height.
- The documentation provided by the antenna manufacturer
- Antennas, including mounting kit (fixed and adjustable downtilt).
- Installation tools: digital compass, binoculars, GPS, inclinometer.

4.2.2 Installation

1 Check that there are no obstacles, such as vegetation and buildings, blocking the planned azimuth of the antenna.

2 Install the antenna according to the documentation provided by the antenna manufacturer.

3 Check the azimuth and tilt of the antenna against the Radio Network Planning document:

» Check the azimuth from the center of the antenna

- » If more than one antenna are used, check the azimuth from the exact center point between the antennas
- » Use an inclinometer to check the tilt.

4.2.3 Inspection

1 Check that the antennas are installed according to the Radio Network Planning document.

2 Verify that there are no obstacles, such as vegetation and buildings, blocking the planned azimuth of the antenna.

4.3 RF Cable Connection

4.3.1 Requirements

Before starting the RF cable installation make sure you have the following:

- Proper RF cable in terms of length and condition
- The right installation tools
- Sealing materials (see Appendix A)

4.3.2 RF Cable Installation

1 Connect the RF cable to the antenna port.

- » Apply torque of 1.7 [N*m]/15.00 [Lbf*in].
- » Do not over-tighten so as not to damage the connector.
- » Check that the connector is firmly closed.

2 Seal the connector according to Appendix A “Sealing and Weather-proofing” on page 18.

3 Connect the RF cable to the ODU port.

- » Make sure you connect the right ODU port to the correct polarization antenna element.
- » Apply torque of 1.7 [N*m]/15.00 [Lbf*in].
- » Do not over-tighten so as not to damage the connector.
- » Check that the connector is firmly closed.

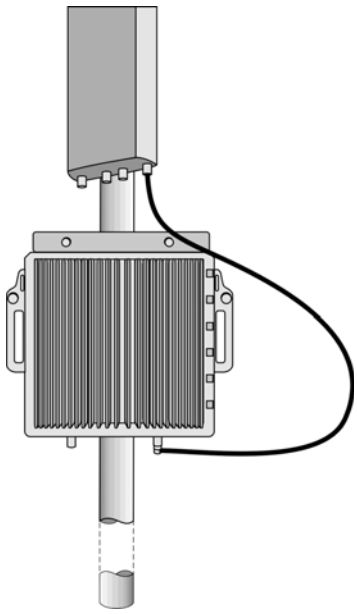


Figure 1: Antenna RF Cable Connection to 2x2/4x2 ODU

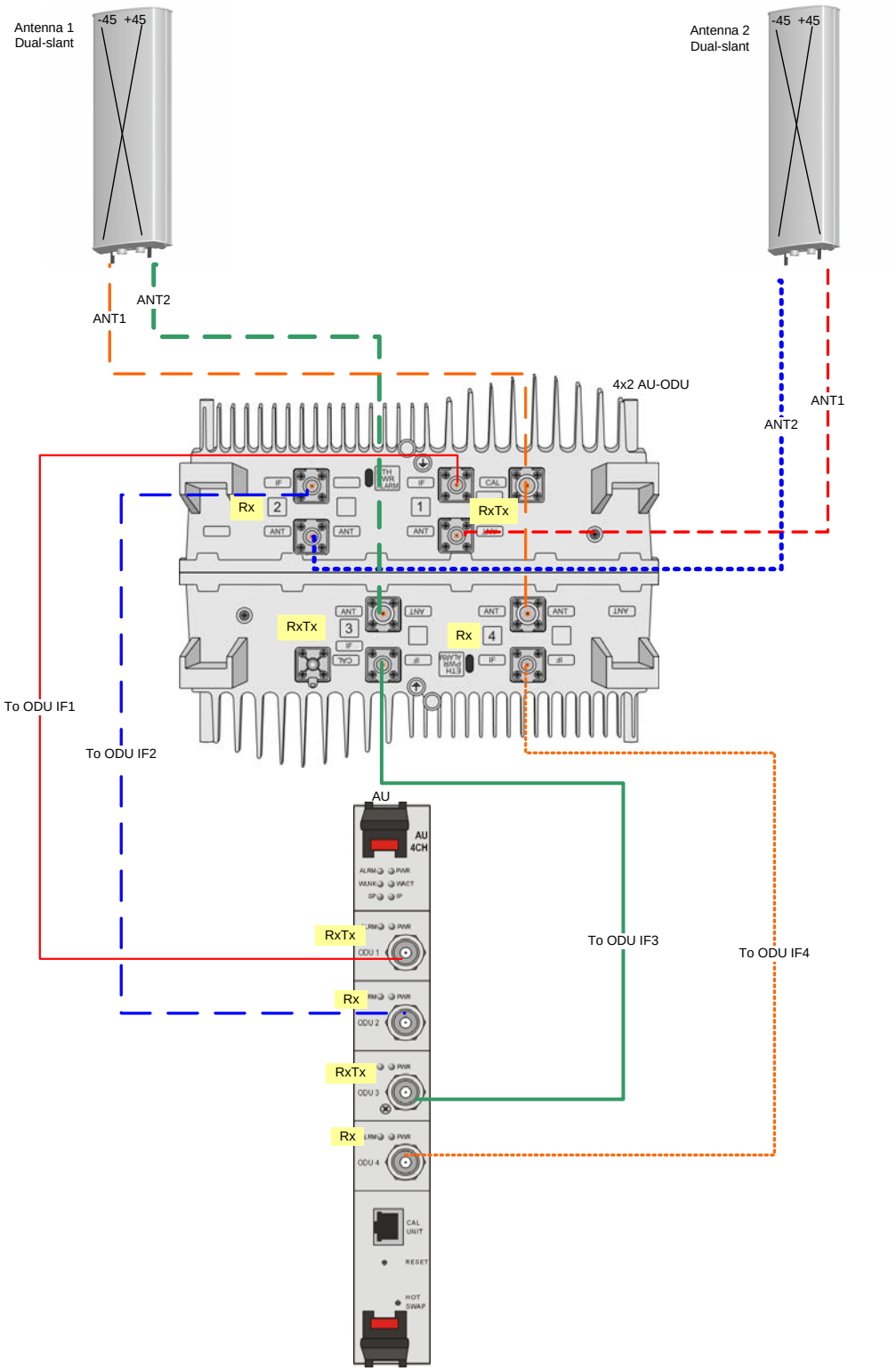


Figure 2: Antenna Connection Diagram (4x2 ODU)

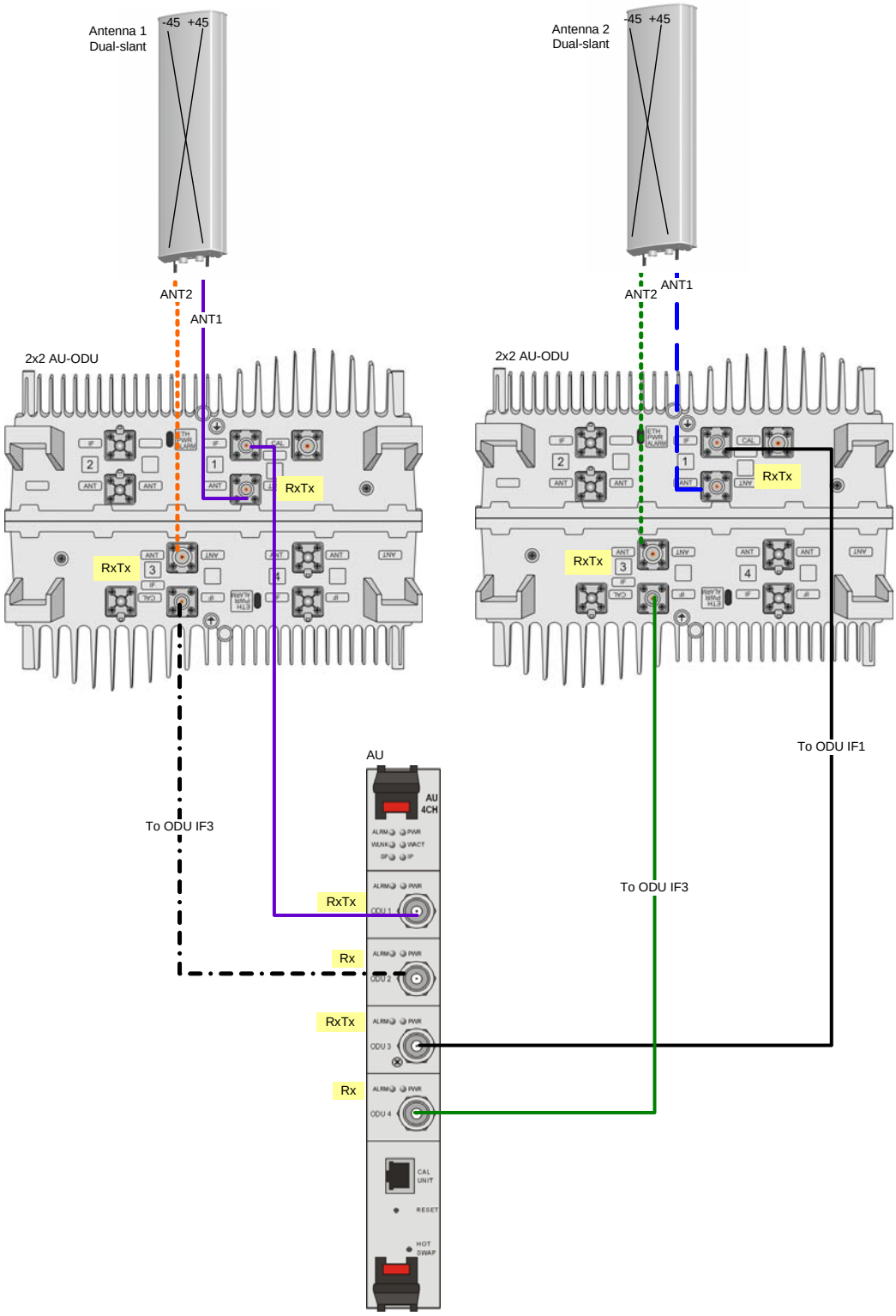


Figure 3: Antenna Connection Diagram (2x2 ODU)

4 Seal the connector according to Appendix A “Sealing and Weather-proofing” on page 18.

5 Fix the RF cable onto the pole using Velcro® wide adjustable straps.

» If possible, use additional straps to route the cable such that water can accumulate on the cable bends, away from the unit.

» When routing the cable, do not exceed the minimum bending radius in the cable specifications.

4.3.3 Inspection

1 Check that all the connectors are firmly connected and are not loose.

2 Check that all connectors are properly sealed, according to “Sealing and Weather-proofing” on page 18.

3 Check that water can accumulate on the cable bends, away from the unit.

4 Check that the cable passes a pull test according to the connector’s specifications.

4.4 ODU

4.4.1 Requirements

Make sure that you have the following:

- Deployment instructions detailing the type and positioning of each ODU (obtained from the Project Manager)
- ODUs - verify that you have the correct ODU types and sub-bands according to the ODU deployment instructions
- Mounting kits (for one, two, or three ODUs, and also for round, or L-shaped poles/masts)
- Grounding cables with terminations according to connection type
- Installation tools and materials, including means for installing the ODU (a harness for lifting the ODUs, wrenches, etc.)
- Sealing materials (see Appendix A)
- Anti oxidant protective grease

4.4.2 ODU Installation

1. Apply protective grease on all nuts, bolts, and lugs for additional protection against corrosion.
2. Install the ODUs in the locations detailed in the deployment instructions.
3. Install each ODU according to the instructions in the *4Motion Installation Manual*.
4. Ground each ODU according to the instructions in the *4Motion Installation Manual*.

4.4.3 Inspection

1. Check that all nuts and bolts are firmly connected and are not loose.
2. Check that the ODU is not blocking the antenna as this might cause reflections.
3. Check that the distance between the ODU and other components is sufficient to allow easy and effective connection and sealing of the IF and RF cables.
4. Check that all nuts and bolts are properly greased.

4.5 IF Cable Connection

4.5.1 Requirements

Before starting the IF cable installation make sure you have the following:

- Ready-made IF cables in the correct lengths and requirements (see Table 1). Use only ready-made LMR-400 double shielded cables.

Table 1: IF Cable Requirements

Item	Description
Screening Effectiveness	90 dB minimum in the 10-300 MHz band.
IF cable Impedance	50 Ohm
Maximum IF cable Attenuation	■ 10 dB @ 240 MHz ■ 7.5 dB @ 140 MHz ■ 8 dB @ 64 MHz
Maximum IF cable DC Resistance	1.5 Ohm
Maximum IF cable Return Loss	20 dB in the 10-300 MHz band

- The right installation tools
- Grounding kits for LMR 400 IF cables.

Figure 4: LMR 400 Grounding Kit

- The installation instructions for the grounding kits and the required tools
- Sealing materials (see Appendix A).

4.5.2 IF Cable Installation

1. Measure the exact length of the IF cable to be used taking into account the height at which the ODU is installed and the distance to the base band unit (whether indoor AU card, or NAU/SAU/DAU). In case of a macro indoor unit, take into account also the distance to the shelter and inside the shelter to the rack.
2. Test the cable before connecting it to the ODU and base band units using designated equipment, such as a reflectometer and a strength field meter, to assure proper cable assembly. Verify that the return loss is less than 20 dB.
3. Connect the IF cable to the ODU port.
   - » Do not over-tighten so as not to damage the connector
   - » Check that the connector is firmly closed.

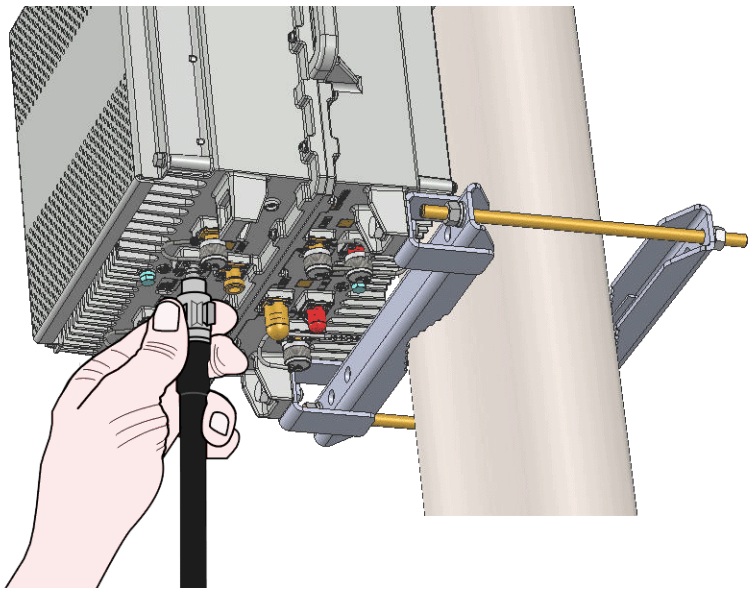
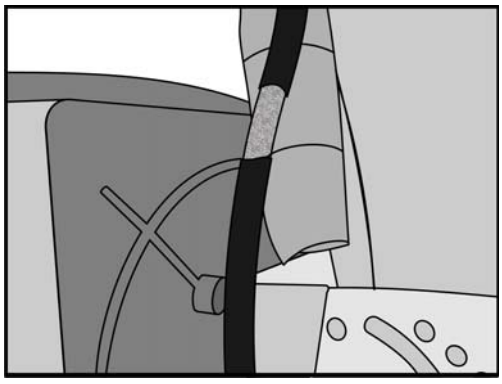


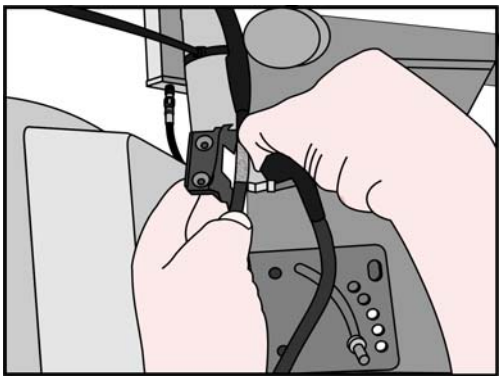
Figure 5: Connecting the IF Cable

4 Use the grounding kit to ground the cable at the top near the ODU. If the cable is longer than 60m (200 ft), ground the cable also at mid point and at another point before curving of the IF cable towards the base band unit/shelter (see Figure 6 for an illustration of the grounding points). The following are instructions for grounding the cable.

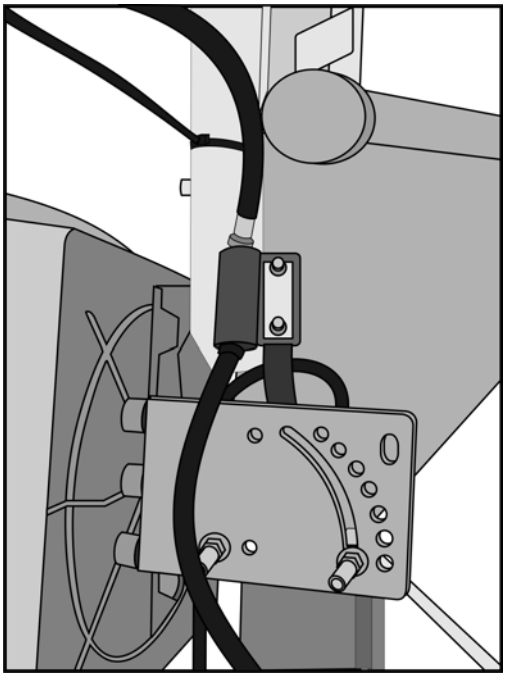
1 Use the strip tool to strip away about 40 mm of the outer plastic.



2 Clamp the grounding kit on the stripped section of cable. Ensure that the metal sections are sealed properly.



3 Tighten the screws on the grounding kit and connect the grounding wire to a good earth connection.



4 Connect the IF cable to the lighting surge arrestor as instructed in the documentation provided by the manufacturer with the lighting arrestor. If no instructions are provided, see Appendix B.

5 Fix the IF cable onto the pole/tower/mast using Velcro® wide adjustable straps.

- Use additional straps to route the cable such that water can accumulate on the cable bends, away from the unit.
- When routing the cable, do not exceed the minimum bending radius in the cable specifications.

6 For a Macro Indoor installation, ground the cable also at the entry to the shelter:

- On the exterior side to the exterior grounding system
- On the interior side to the interior grounding system.

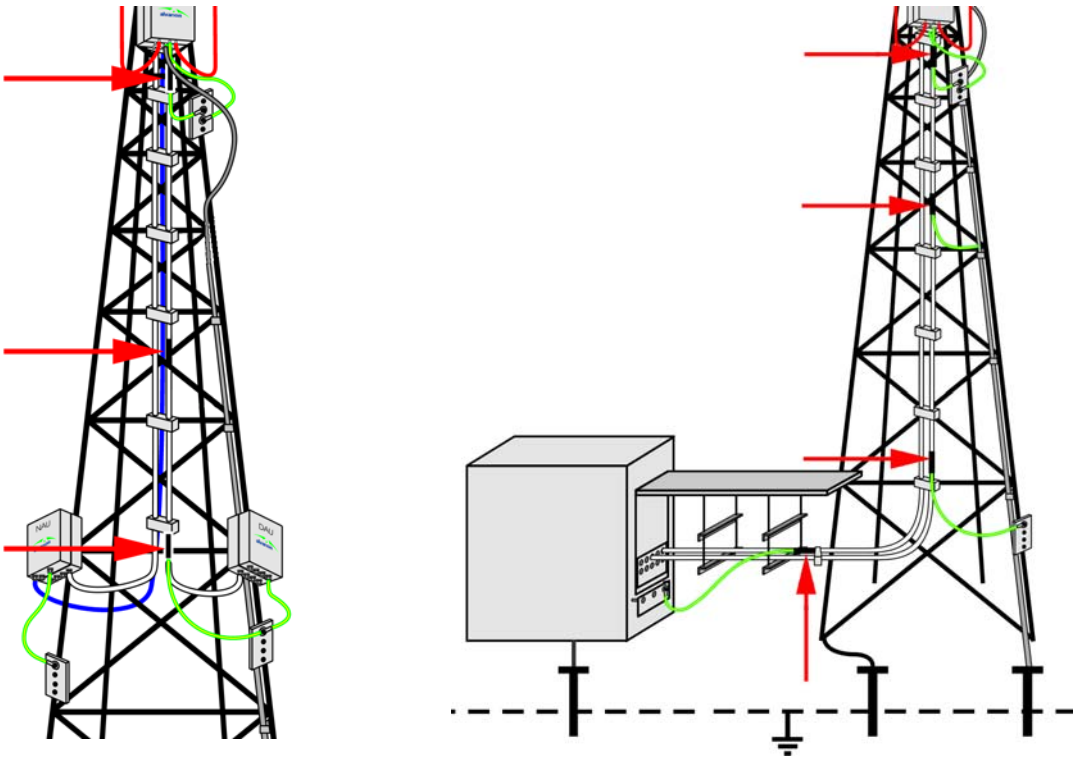


Figure 6: IF Cable Grounding Points: Macro Outdoor (Left) and Macro Indoor (Right)

7 Mark the IF cables as follows:

- Use different tape colors for different sectors.
- Attach one to four tapes to each cable according to the connection number. For example: Attach one red tape on both ends of the IF1 cable, two red tapes on both ends of the IF2 cable, and so on. See Figure 7.

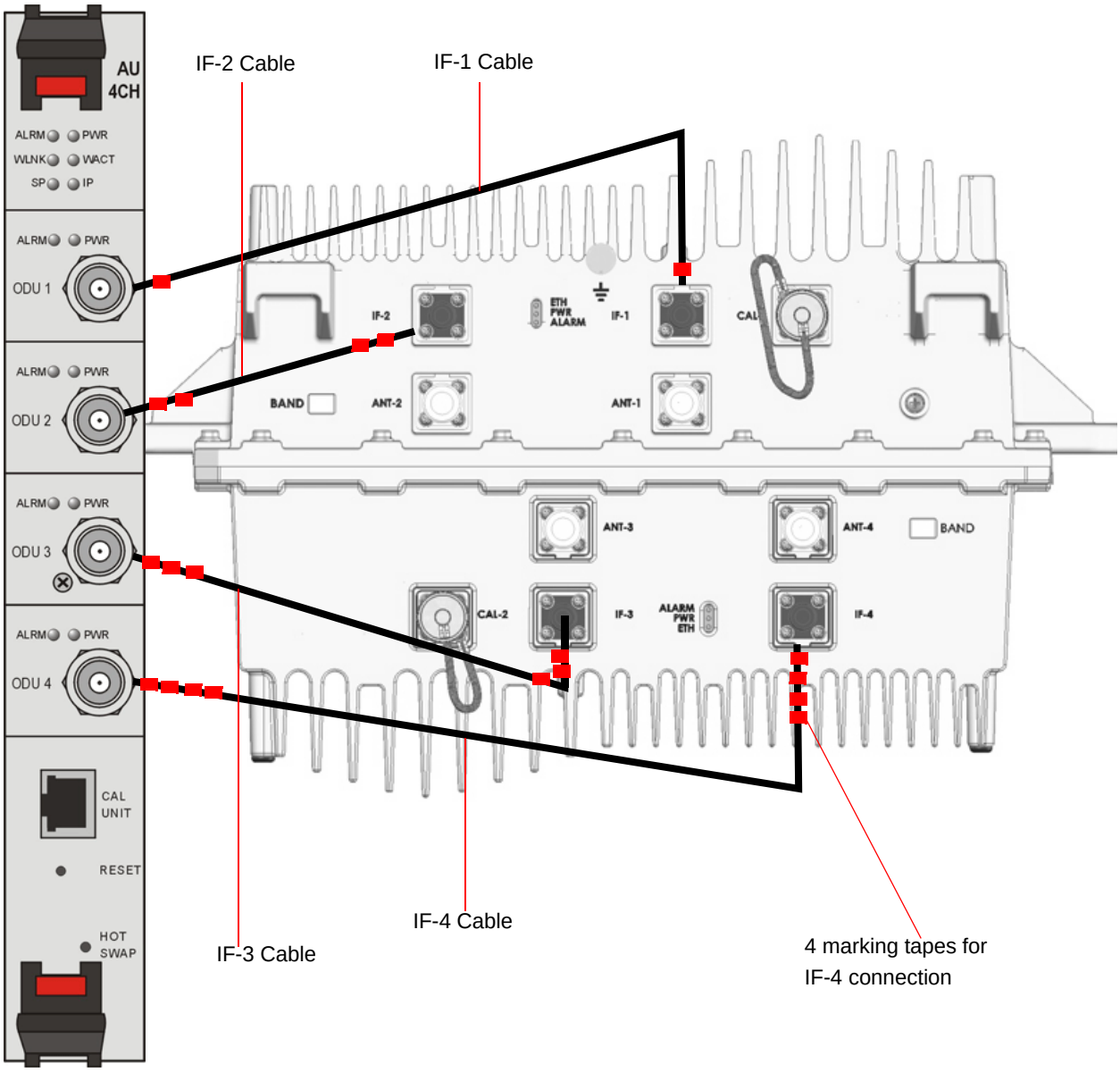


Figure 7: Example of IF Cables Color Coding

8 Connect the IF cable to the base band unit.

» Make sure that the cables are connected according to the marking.

» Do not over-tighten so as not to damage the connector.

» Check that the connector is firmly closed.

9 Seal the outdoor connectors and grounding points according to Appendix A “Sealing and Weather-proofing” on page 18.

4.5.3 Inspection

1. Check that all connectors are firmly connected and are not loose.
2. Check that all connectors are properly sealed, according to "Sealing and Weather-proofing" on page 18.
3. Check that water can accumulate on the cable bends, away from the unit.
4. Check that the IF cables are grounded to the tower/pole/mast at the top and bottom of the tower/pole/mast.
5. If the tower is taller than 60m (200 ft), check that the cable is grounded also at midpoint.
6. For a structure that has a coaxial cable entrance plate, check that the entrance plate is fixed to both the interior and the exterior of the structure's ground ring.
7. Check that the coaxial shield is also fixed to the exterior and interior of the metallic entrance plate.
8. Check that the coaxial cable is protected by a lightning surge arrestor.
9. Check that the lightning arrestor is fixed to the exterior ground electrode system.
10. Verify that the IF cables have passed the return loss test and that the return loss is less than 20 dB.

4.6 BTS

4.6.1 Requirements

Before starting the BTS installation, make sure you have the following:

- Deployment instructions detailing the type and positioning of each BTS (obtained from the Project Manager)
- BTSs - verify that you have the correct BTS types according to the BTS deployment instructions
- Mounting kits for outdoor BTSs (according to installation type)
- Grounding cables with terminations according to connection type
- Installation tools and materials, including means for installing the BTS (a harness for lifting the BTS, screwdrivers, wrenches, etc.)

4.6.2 Installation

1 Apply protective grease on all outdoor nuts, bolts, and lugs for additional protection against corrosion.

2 Install the BTS in the locations detailed in the deployment instructions.

3 Install each BTS according to the instructions in the *4Motion Installation Manual*.

4 To prepare a power cable, follow the instructions in Section C.2.4. See also the *4Motion Installation Manual*.

5 Connect the power cable to the power supply.

- **a** Connect the black wires to the RTN connector(s) on the power supply.
- **b** Connect the red wires to the +48V connector(s) on the power supply.

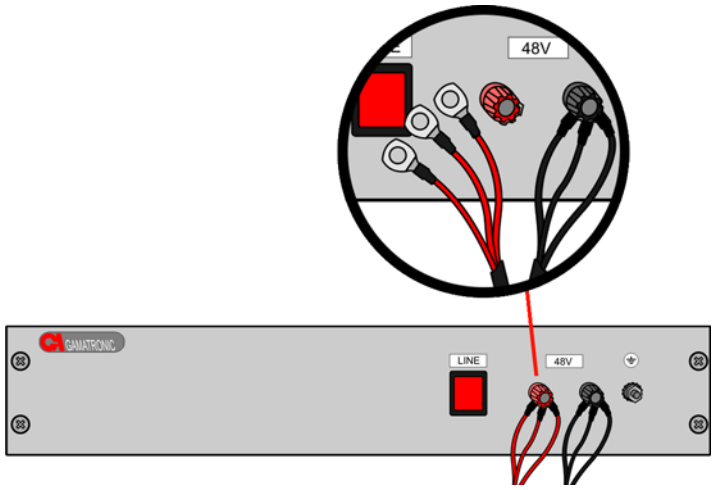


Figure 8: Connection to Power Supply

6 To connect the power cable to a circuit breaker, follow the block diagram example in Figure 9.

7 Ground each BTS according to the instructions in the *4Motion Installation Manual*.

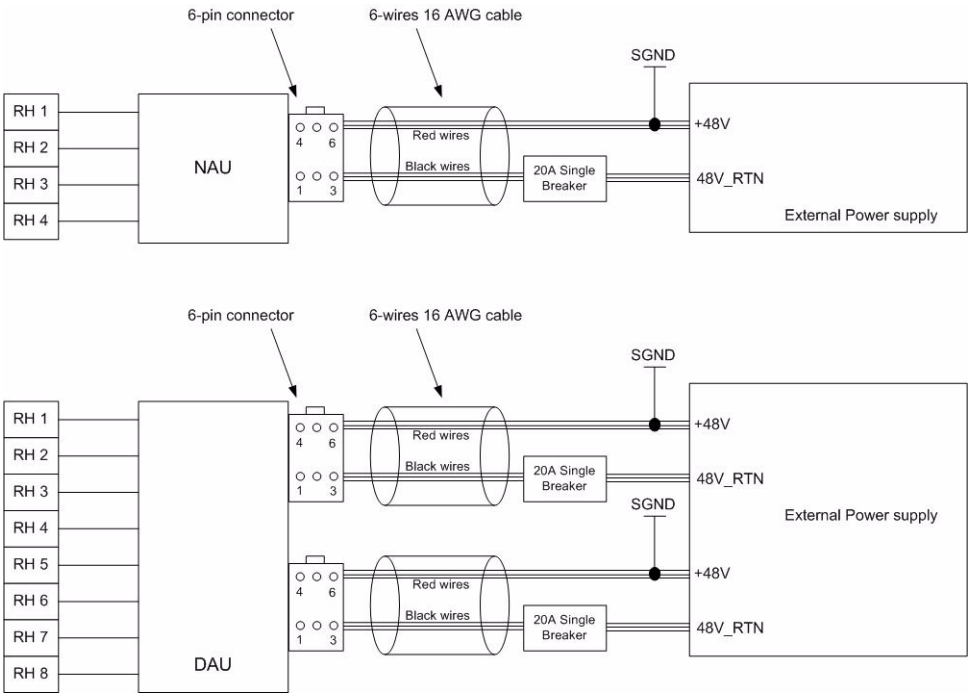


Figure 9: Connecting to a Circuit Breaker

4.6.3 Inspection

1 Check that all nuts and bolts are firmly connected and are not loose.

2 Check that all nuts and bolts are properly greased.

3 Measure the return loss of the IF cables. Check that it is less than 20 dB.

Appendix A: Sealing and Weather-proofing

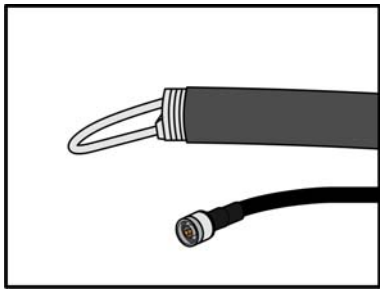
A.1 Requirements

- All sealings and weather-proofing must comply with the IP-67 standard.
- Seal all outdoor connectors that are not supplied with sealing glands to protect against rain and moisture.
- Seal all grounding points on the IF cables.
- Use high quality sealing material such as Scotchfil™ Electrical Insulation Putty from 3M (or equivalent) over-wrapped with a UV resistant outdoor rated tape (e.g. Super 33+ or Super 88 vinyl Electrical Tape).
- Use high quality cold shrink sleeves to seal connectors.

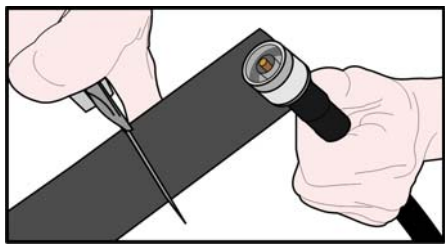
Figure 10: Sealing Materials

A.2 Sealing Instructions

A.2.1 Connectors



1 Cut the cold shrink sleeve to size. Take into account the size of the unit's connector and additional 2.5 cm (0.5 in.).

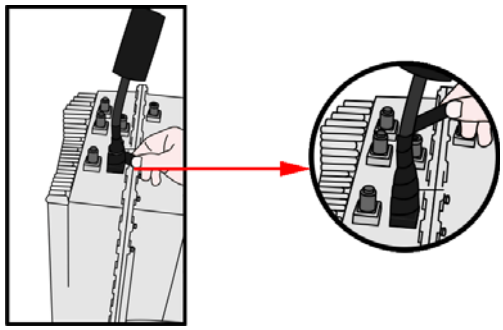


2 Slide the cold shrink sleeve onto the cable before connecting the cable.

3 Connect the cable.

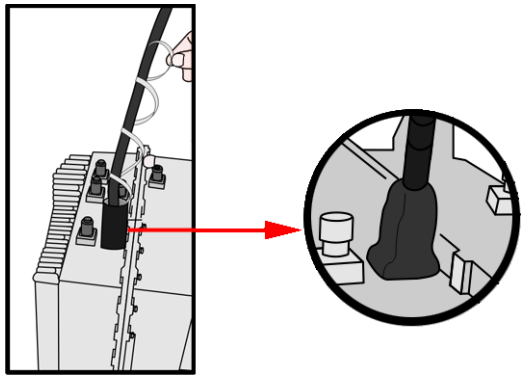
4 Attach the mastic tape (Scotchfil™ Electrical Insulation Putty) and wrap it around the connector butting up against the connector. Do not over stretch.

5 Squeeze to tighten the mastic sealer. Make sure there are no air bubbles.

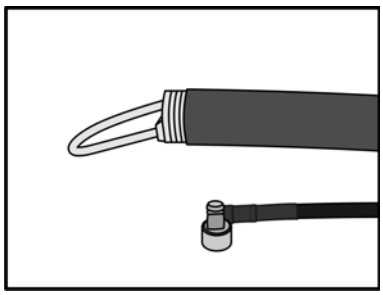


6 Slide the cold shrink sleeve on top of the connector. Make sure that the sleeve covers both cable connector and unit connector.

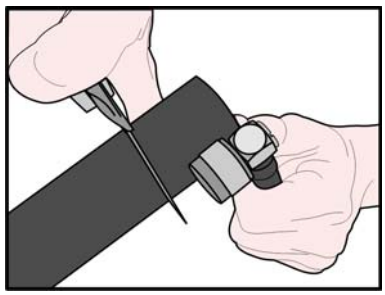
7 Pull the cord slowly to shrink the sleeve.



A.2.2 Angled Connectors

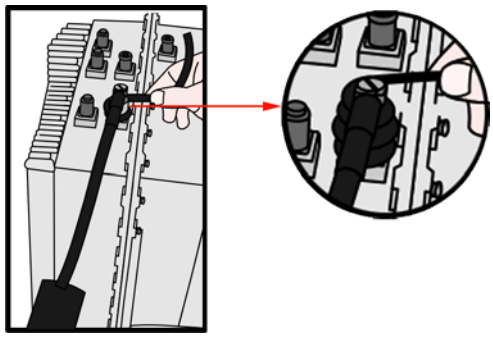


1 Cut the cold shrink sleeve to size. Take into account the size of the unit's connector.



2 Slide the cold shrink sleeve onto the cable before connecting the cable.

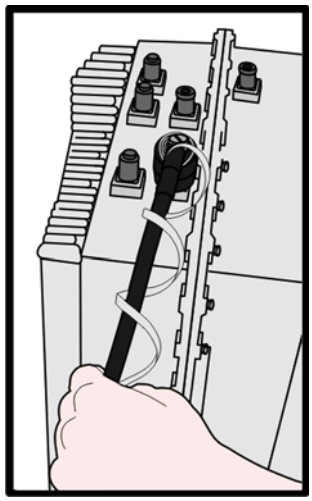
3 Connect the cable.



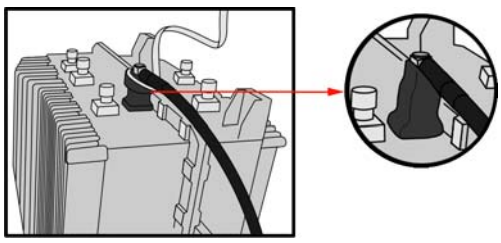
4 Attach the mastic tape (Scotchfil™ Electrical Insulation Putty) and wrap it around the connector butting up against the connector. Do not over stretch.

5 Squeeze to tighten the mastic sealer. Make sure there are no air bubbles.

6 Slide the cold shrink sleeve on top of the connector. Make sure that the sleeve covers both cable connector and unit connector.

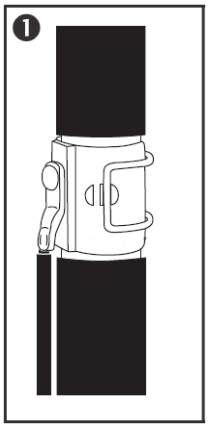


7 Pull the cord slowly to shrink the sleeve.

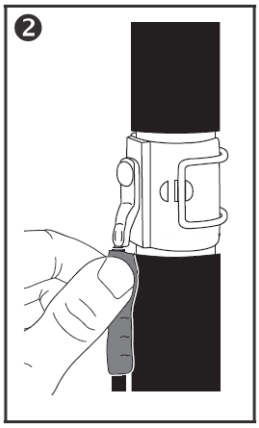


A.2.3 Cable Grounding Points

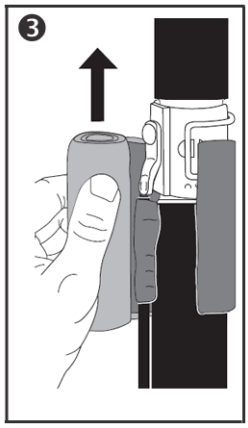
Use mastic band and vinyl tape to seal and weather-proof all grounding points:



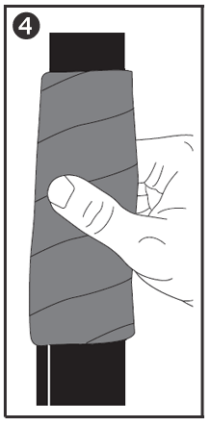
1 Ground the cable according to the instructions provided with the grounding kit.



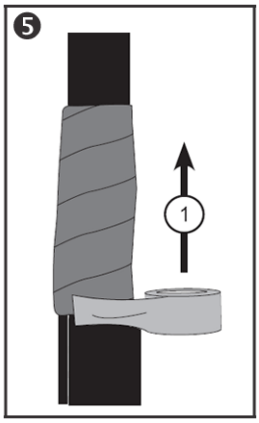
2 Apply some mastic (Scotchfil™ Electrical Insulation Putty, or equivalent) to the grounding cable



3 Attach the mastic band and wrap it around the grounding point. Do not over stretch.

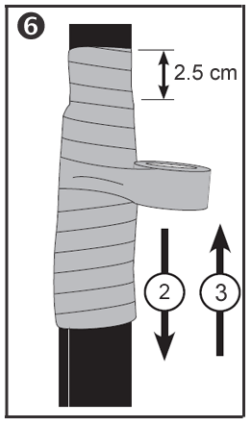


4 Squeeze to tighten the mastic band. Make sure there are no air bubbles



5 Weather-proof the connection using the vinyl tape.

Wrap the connection starting from the bottom up. Begin about 2.5 cm (1”) below the mastic band. Do not overtighten to avoid the mastic from squeezing through.



6 Apply a second wrap from the top down (without cutting the tape). Stretch the vinyl tape tightly.

Do the last wrap from bottom up to allow water to flow off.

Appendix B: Lightning Arrestor Installation

B.1 Requirements

- Install a lightning arrestor on each GPS and electronic equipment, and at the building entrance. Use a PolyPhaser® lightning arrestors according to the frequency of the protected equipment.
- Installation tools
- Dow Corning RTV-3145 adhesive/sealant or equivalent thixotropic silicone

Figure 11: Dow Corning RTV-3145 Adhesive/Sealer

- Additional sealing materials (see Appendix A)

Figure 12: Example of PolyPhaser Lightning Arrestor

B.2 Installation

1 Install the Polyphaser 90-degrees oriented (horizontal) on the feed bracket using the self-locking screws. The assembly orientation direction is essential to prevent water from accumulating on the sealing interfaces. The surface of

the bracket must be clean metal with no contamination, in order to allow solid electrical contact to the Polyphaser.

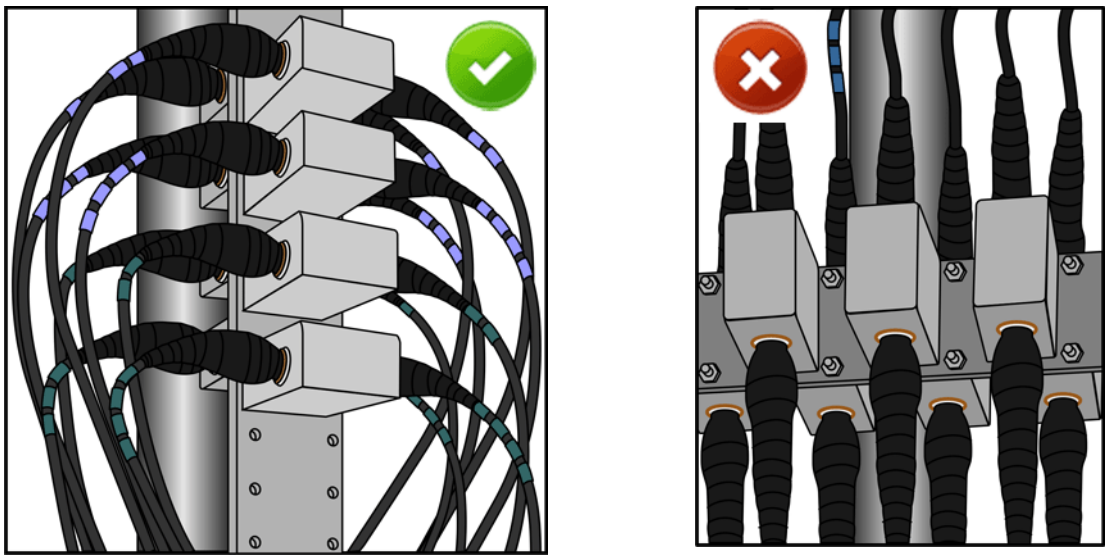


Figure 13: Polyphaser Correct and Wrong Installations

2 Cut the IDU/ODU cables to length, install RF connectors, and attach to the Polyphaser.

3 Pay special attention to ensure that the ODU cable is supported within 0.6m (2 ft.) of the Polyphasers. The cable must not be run in a manner that unduly stresses the mechanical interface of the Polyphaser to the ODU connector even though the bracket in itself provides rigidity and strain relief.

4 Apply a layer of RTV around the RF connector to fill the groove by using nozzle. This operation will prevent water penetration between the connector and the case. Wait 2-4 hours for the silicone to cure.

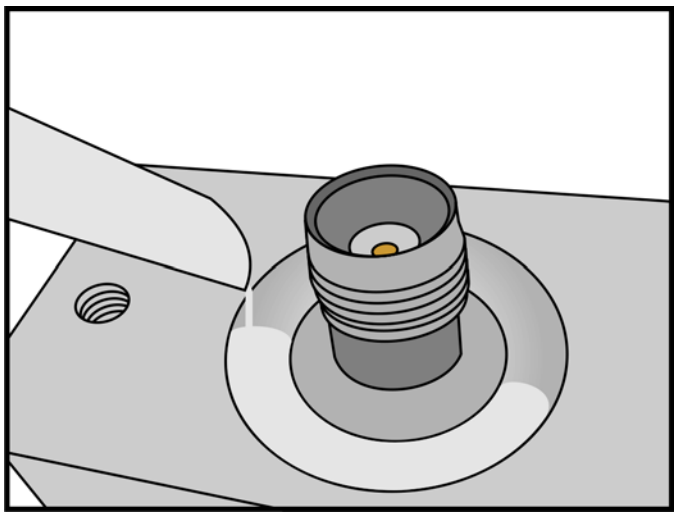


Figure 14: Applying Silicone to the Groove of the RF Connector

5 Apply the mastic tape extending at least 50 mm (2”) onto the cable sheath and also cover the connectors bolt body interface.

6 Wrap a vinyl tape to provide UV and abrasion protection for the mastic tape. The vinyl tape must extend 50mm (2”) beyond the end of the mastic tape along the sheath of the cable. Do not stretch the final few turns to avoid wind-back. Firmly smooth over to ensure a good bond.

7 The wrapping direction should be in parallel to the connector bolt closing direction. See Figure 15 for the final result.

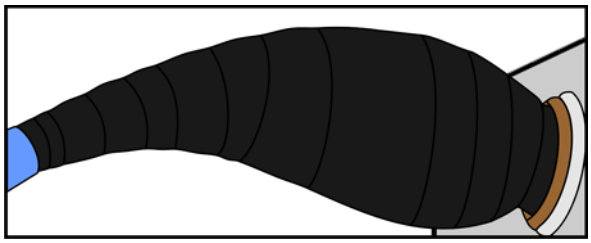


Figure 15: Polyphaser Sealing

B.3 Inspection

1 Check that all external radio units are protected with a lightning arrestor.

2 Check that the lightning arrestor is suitable for the frequency of the equipment it protects.

3 Check that all the protected units are suitably grounded.

4 Check that all lightning arrestors are suitably grounded.

5 Check that all the connections on the lightning arrestors are properly sealed.

Appendix C: Connector Installation

C.1 Requirements

- Use PPC compression connectors for coaxial cables. Consult with the project manager before using other connectors.
- Use only proper installation tools for installing connectors:

Crimp tool

Cutting tool

Deburring tool

Strip tool

Compression tool

This section provides instructions for installing the following types of connectors:

- “Crimping Coaxial Connectors” on page 27
- “Assembling Compression Connectors” on page 29
- “Crimping RJ-45 Connectors” on page 30
- “Crimping the Macro Outdoor Power Cable with Mini-fit Connector” on page 31
- “Assembling Threaded Connectors” on page 32

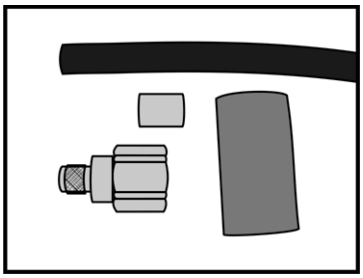
Figure 16: Assembled Connector (TNC)

C.2 Installation Guidelines

C.2.1 Crimping Coaxial Connectors

Alvarion recommends using compression connectors. Consult with the project manager before using crimped connectors.

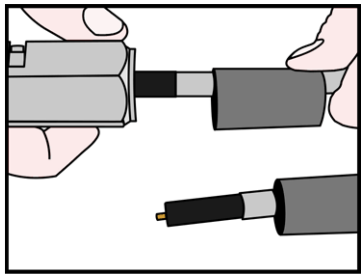
1 Flush cut the cable squarely using the cutting tool.



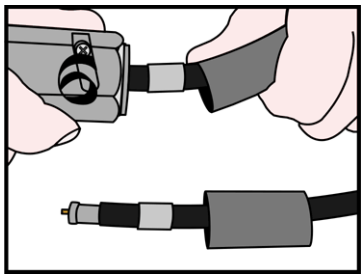
2 Slide the cold shrink sleeve and crimp ring onto the cable.

3 Strip the cable-end using a strip tool by inserting the cable into one end and rotating the tool.

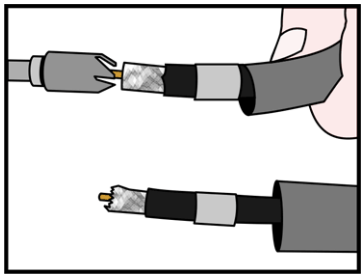
4 Remove any residual dielectric material from the center conductor.



5 Insert the cable into the other end of the tool and rotate the tool to remove the plastic jacket



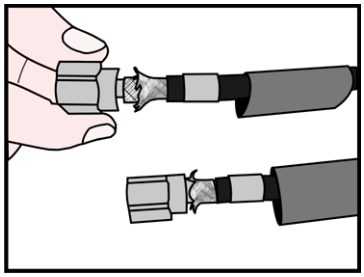
6 Deburr the center conductor using the deburring tool



7 Flare the braid slightly.

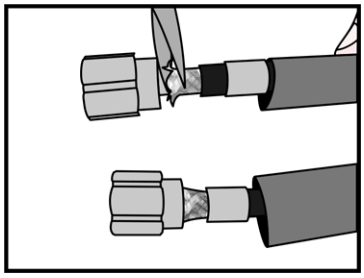
8 Push the connector body onto the cable until the connector snaps into place.

9 Slide the crimp ring forward, creasing the braid.



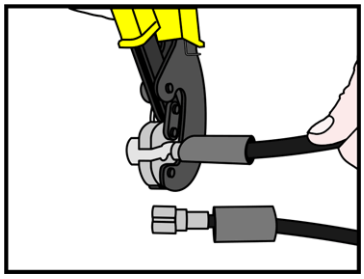
10 Temporarily slide the crimp ring back and remove the connector body from the cable to trim the excess braid at the crease line.

11 Remount the connector and slide the crimp ring forward until it butts up against the connector body.



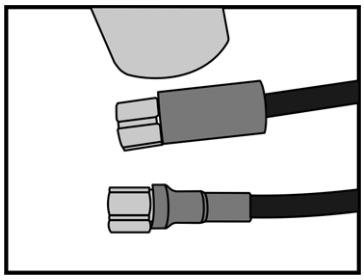
12 Position the crimp tool with the dies directly behind and adjacent to the connector body.

13 Crimp the connector. The crimp tool automatically releases when the crimp is complete.



14 Position the heat shrink sleeve as far forward on the connector body as possible, without interfering with the coupling nut.

15 Use a heat gun to form a weather tight seal.



C.2.2 Assembling Compression Connectors

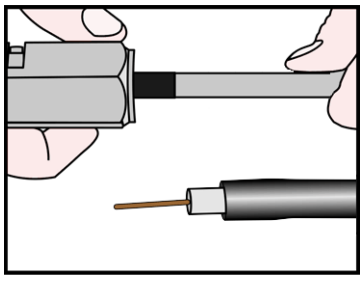
Alvarion recommends using PPC compression connectors.

1 Flush cut the cable squarely using the cutting tool.

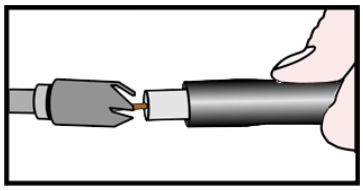
2 Strip the cable-end using the strip tool by inserting the cable into one end and rotating the tool.

3 Remove any residual dielectric material from the center conductor.

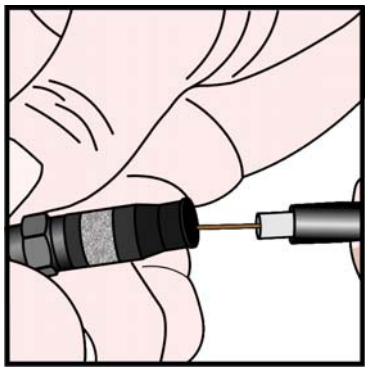
4 Insert the cable into the other end of the tool and rotate the tool to remove the plastic jacket.



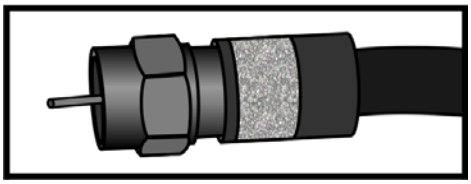
5 Deburr the center conductor using the deburring tool

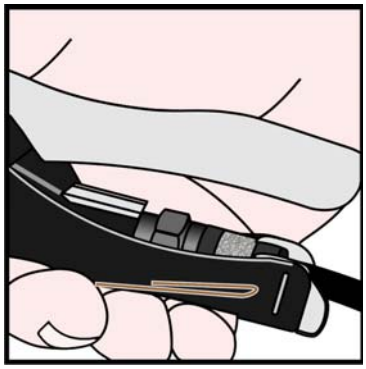


6 Push the connector body onto the cable until the connector snaps into place.



7 Position cable with the connector in the compression tool and squeeze the tool's handle.



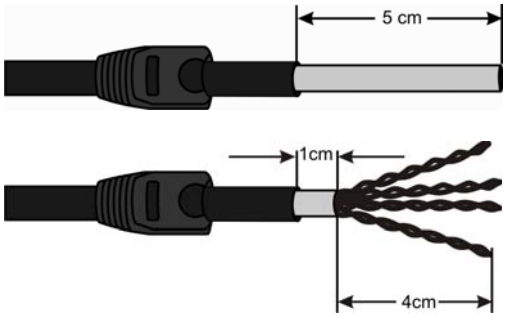


C.2.3 Crimping RJ-45 Connectors

1 Thread the RJ-45 plastic cover on the cable.

2 Reveal 5 cm of outer sleeve.

3 Reveal 4 cm of the inner sleeve.

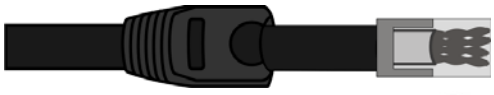


4 Release all wires and arrange them in order.

5 Cut the wires to 1 cm length each.

6 Insert the wires into the connector.

7 Press the connector using a crimp tool.



8 Solder the shield drain wire to the connector.

Refer to Figure 17 for Pin assignment.

Wire color	Pin
Orange/white	1
Orange	2
Brown/white	3
Brown	4
Blue	5
Blue/white	6
Green	7
Green/white	8

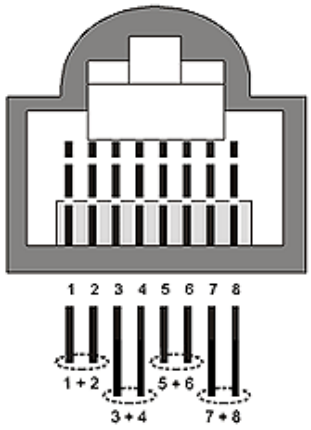
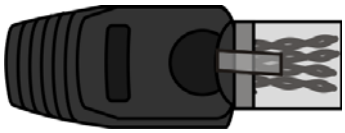


Figure 17: Pin Assignment

9 Push the plastic cover into place.



C.2.4 Crimping the Macro Outdoor Power Cable with Mini-fit Connector

Alvarion recommends using the Pressmaster® DRB-0115 crimp tool.

1. Insert the cable through the sealing gland.
2. Remove as small a length as possible of the cable's external jacket to expose the wires.
3. Insert a terminal into the crimper slot.
4. Insert the wire into the terminal within the slot and squeeze the tool's handles to crimp the terminal.
5. Repeat steps 3 and 4 for each of the six wires.
6. Connect the wires to the mini-fit connector as follows (see Figure 18):
   - Pin 1 (RTN) - to 1A: Black (min. 16 AWG wire)
   - Pin 2 (RTN) - to 2A: Black (min. 16 AWG wire)
   - Pin 3 (RTN) - to 3A: Black (min. 16 AWG wire)
   - Pin 4 (+48V) - to 4A: Red (min. 16 AWG wire)

» Pin 5 (+48V) - to 5A: Red (min. 16 AWG wire)

» Pin 6 (+48V) - to 6A: Red (min. 16 AWG wire)

7 Attach suitable terminal rings (lugs) to the side that connects to the power source.

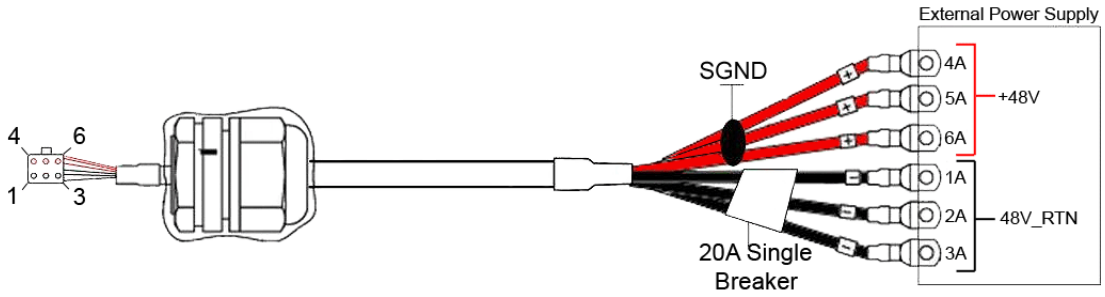
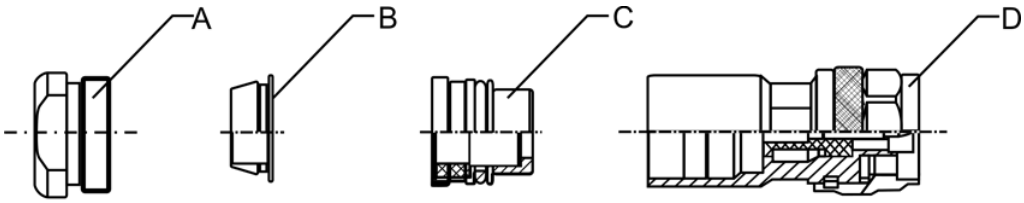


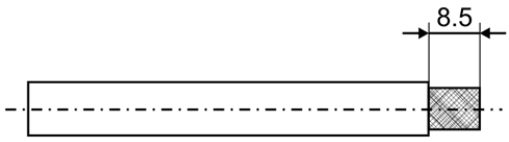
Figure 18: Power Cable Diagram

C.2.5 Assembling Threaded Connectors

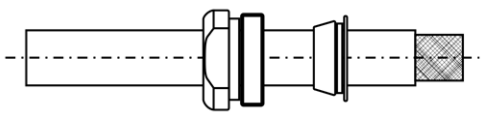
Alvarion recommends using compression connectors. Consult with the project manager before using threaded connectors.



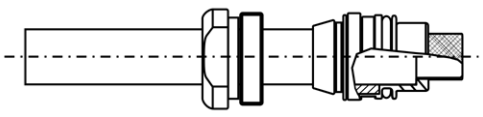
1 Remove 8.5 mm of the jacket.



2 Slide screw "A" and assemble "B" onto the cable.



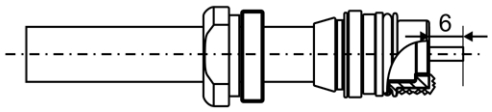
3 Slide assembly "C" onto the cable until it reaches “B”.



4 Stripe braid backwards.

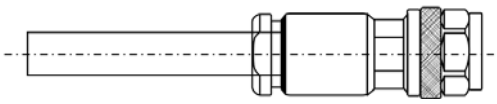
5 Strip 6 mm of the cable-dialectric

6 Chamfer center pin.



7 Assemble body "D" and tighten screw "A".

Apply torque 8 Nm.



Appendix D: Transportation Guidelines

The following are the storage and transportation guidelines for the handling of Alvarion products.

D.1 Packing

- All goods must be packed using original cartons only
- All cartons must have the appropriate symbols printed ("This side up", “Fragile”, etc.)
- Cartons must be arranged with all labels facing outwards.
- Cartons must be packed such that the heavier and larger cartons are at the bottom.
- Maximum height for pallets: 1.60m

D.2 Warehouse

- Goods must be stored in a closed and secured warehouse
- The warehouse must be waterproofed against rain
- The warehouse must comply with local safety regulations
- The warehouse must have a full and comprehensive insurance policy
- All goods must be stored on wooden pallets
- Stacking of pallets is not permitted

D.3 Transport

- Vehicles used for transporting must be:
  - Big enough to carry all needed
  - Closed/sealed (rain-protected)
  - Dry

- Not used for transporting animals, food, chemicals, or liquids

- Transport will be insured in accordance with the goods being shipped
- Suitable loading/offloading equipment (i.e. forklifts) must be used.
  - Forklift drivers must have required training and permits
- Maximum height of pallets during transit must not exceed 1.60m
- The vehicle/transportation process must comply with local safety regulations.

D.4 On-site Storage

If during installation there is a need to store the equipment on site, a waterproof shelter is mandatory.

Appendix E: ATP Sweep Testing Procedure

This appendix applies to all RF and IF feedlines and connectors, antennas, surge suppressors, and Polyphasers. Repeated testing has shown that equipment failure is often the result of improperly installed and sealed connectors, used in conjunction with the LMR400 coaxial cable.

All the cables and connectors must be tested for proper operation before installation. The tests check the following:

- Cable loss
- Connector integrity
- Cable imperfections
- Antenna bandwidth
- Antenna Center Frequency

IMPORTANT

- All components must be tested individually on the ground to ensure that only working components are being installed.
- All components must be tested on the ground as a complete system before any tower work begins.

The tests described in this appendix:

- Identify cables with bad connectors or workmanship in the assembly of the connector-to-cable junction.
- Confirm that new cables are made correctly and tested fully before the new cables are weatherproof sealed.

E.1 Component Operation

The WiMAX radio system consists of five main components, with a coaxial cable used to interconnect these components:

- “Indoor Radio Unit” on page 37
- “Outdoor Radio Unit” on page 37

There are two independent systems at each WiMAX site:

- WiMAX Radio Site Access Point
- Microwave Radio Backhaul system to a central high speed internet Gateway.

E.1.1 Indoor Radio Unit

The Indoor Radio Unit (IDU) has the following sub-sections:

- Power supply
- Baseband multiplex transmitter and intermediate frequency upconverter
- Baseband de-multiplexer receiver and intermediate frequency decoder

E.1.2 Outdoor Radio Unit

The Outdoor Radio Unit (ODU) has separate cables for the transmitter IF (IDU to ODU) and receiver IF (ODU to IDU). The DC power for the ODU is carried on both cables from the IDU power supply to the voltage regulator on the ODU.

E.1.3 Inter-connecting IF Cables and Power Cables

The IF cable carries the intermediate IF power (100 MHz to 250 MHz) and signals from the IDU to the ODU:

- IF transmitter signal from the IDU to the ODU
- IF receiver signal from the ODU to the IDU
- Power from the IDU to the ODU
- Confirmation that the connectors can carry the IF signal and the DC power between the IDU and the ODU

IMPORTANT

Because of the currents involved, and the minimum amount of cable current capacity, there must be no defect in the cable or foil shield.

E.1.4 Lightning Arrestor

1. Sweep the Lightning Arrestor at the IF frequency for proper **Return Loss** (RL).
2. Ensure that the DC resistance for carrying the power from the IDU to the ODU is correct.

E.1.5 WiMAX Sector Antennas

1. Test the WiMAX Sector Antennas to ensure that the frequency band of the Antenna is correct.
2. Ensure that there is a good 50 Ohm match between the antenna and the coaxial connector at the back of the antenna.
3. Perform a **Return Loss** Line Sweep for each antenna on the site.

E.2 Reflectometer

Use a reflectometer to test the cables before connecting them to the radio units. Calibrate the tool before each frequency change. It is recommended to sweep all of the cables for each calibration setting, rather than to do all sweeps for one cable before moving on to the next cable.

Follow the instructions provided with the reflectometer in order to operate and calibrate it.

CAUTION

Handle the phase stable cable and the open-short-load calibration tee with care. Dropping them may cause them damage.Ensure that any cable being tested has no power from the IDU before attaching the calibration tee from the reflectometer. Any amount of DC power or radio energy will destroy the calibrated load part of the tee, and the calibrated short will damage the IDU power supply if that section is connected while under power.

E.3 Equipment Sweep Tests

Use the supplied Installation Manual to wire up the cables and hardware, and for mounting both the IDU and the ODU.

Pre-measure the LMR400 RF cables needed to connect the IDU to the ODU and cut to the required length.

Use only PPC connectors and an LMR400 cable for this purpose.

When making the connectors, do not nick or cut the foil shield or the strands of ground wire that are part of the shield.

IMPORTANT

The loss of even a small part of the shield will cause a failure of the Radio ODU .

E.3.1 Cables

The cables used at the IF and RF frequencies must be installed properly, and the shields must be fully intact. The test setups and sweeps are used to confirm that the cables are properly made and that the braid of the cable shields is not cut or nicked.

NOTE

All cables must be labeled according to the Alvarion labeling standards:

- Access point cables: IF and RF cables
- Microwave backhaul cables

E.3.1.1 Cable Nomenclature

The diagram below demonstrates location designation and labeling for sector feedlines when multiple paths are installed on a tower.

1. Mark the first sector installation at, or nearest to 0 (zero) degrees with one red ring of tape (R1).
2. Mark each additional sector installation in clockwise order with an additional red ring of tape (R2, R3, etc.)
3. If a specific antenna carries more than one Radio Unit, requiring multiple IF coaxial cables installed, mark each additional coaxial cable with a blue ring of tape.
4. The third sector cables must be marked in green rings of tape, with the first cable marked with one green ring of tape, and each additional cable with an additional green ring of tape

IMPORTANT

There can never be more than four cables per antenna.

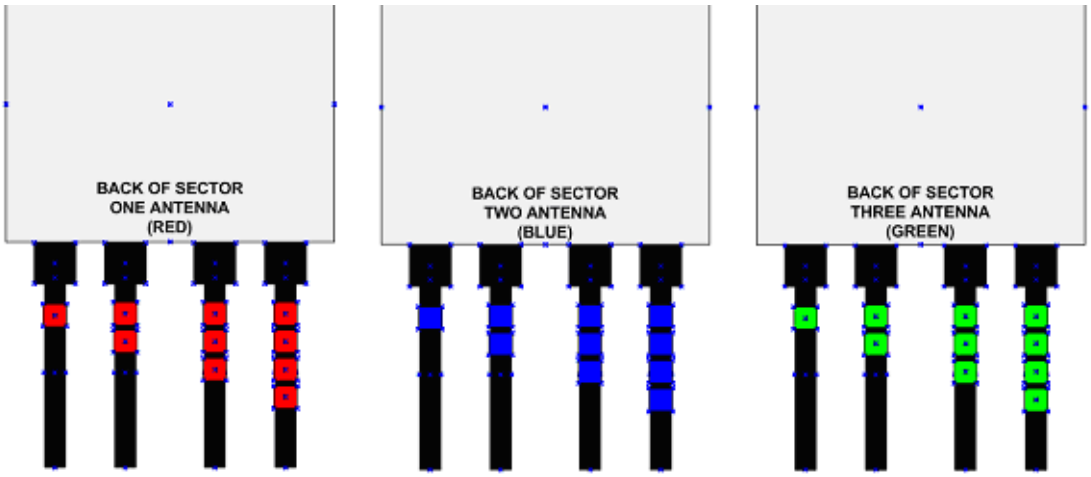


Figure 19: Designation and Labeling for Microwave Feed Lines

E.3.1.2 Jumper Cables

Perform the same tests that are performed for the long IF cables for jumper cables from the IDU to the Polyphaser lightning arrestors.

E.3.1.3 IF Cables - Sweep 1: 100 MHz - 250 MHz

1. Calibrate the analysis tool.
2. Perform this test for the first time by connecting the cable to the 50 Ohm calibrated load.
3. Sweep each IF cable in **Return Loss** (RL) mode with the following settings:
   - F1 = 100 MHz
   - F2 = 250 MHz
   - Amplitude Top = 0 dB
   - Amplitude Bottom = -60 dB
   - Limit Line = -20 dB

4 To ensure that the cable and connectors function properly for the IF signal, perform the test for each IF cable and record the results.

NOTE

This frequency sweep shows how the cable reacts to the IF signal.

5 To discover a loss of the IF signal as it passes through the IF cable, perform the same test into a calibrated short.

6 Perform the test for each IF cable and record the results.

E.3.1.4 IF cables - Sweep 2: 100 MHz - 250 MHz

1 Perform this test for the first time by connecting the cable to the 50 Ohm calibrated load.

2 Sweep each IF cable in the **Distance to Fault** (DTF) mode at the following settings:

- F1 = 100 MHz
- F2 = 250 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -20 dB
- Cable Type = LMR400
- D1 = 0 feet
- D2 = xxx feet (xxx is the length of the cable plus an extra 50%. For example, if the cable length is 100 feet, then xxx is 150 feet.

3 To ensure that the cable and connectors function properly for the IF signal, perform the test for each IF cable and record the results.

4 To discover the loss of the IF signal as it passes through the IF cable, perform the same test into a calibrated short.

5 Perform the test for each IF cable and record the results.

E.3.1.5 IF cables - Sweep 3: 800 MHz - 1000 MHz

1 Calibrate the analysis tool.

2 Perform this test for the first time by connecting the cable to the 50 Ohm calibrated load.

3 Sweep each IF cable in the **Return Loss** (RL) mode at the following settings:

- F1 = 800 MHz
- F2 = 1000 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -20 dB

4 To ensure that the cable and connectors function properly for the DC power, perform the test for each IF cable and record the results.

NOTE

This frequency sweep shows how the cable and connectors react to the DC signal. If the shield is damaged in any way, this high frequency sweep will discover the problem before cable installation.

E.3.1.6 IF cables - Sweep 4: 800 MHz - 1000 MHz

1 Perform this test for the first time by connecting the cable to the 50 Ohm calibrated load.

2 Sweep each IF cable in the **Distance To Fault** (DTF) mode at the following settings:

- F1 = 800 MHz
- F2 = 1000 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -20 dB
- Cable Type = LMR400
- D1 = 0 Feet
- D2 = xxx feet, xxx is the length of the cable plus an extra 50%. For example, if the cable length is 100 feet, then xxx is 150 feet.)

3 To ensure that the cable and connectors function properly for the DC power, perform the test for each IF cable and record the results.

NOTE

This frequency sweep shows how the connectors react to the DC signal.

E.3.1.7 RF cables - Sweep 1: Bandwidth According to the ODU

1 Calibrate the analysis tool.

2 Connect the analysis tool to one end of the cable and the 50 Ohm precision load to the other end.

3 Sweep each IF cable in **Return Loss** (RL) mode at the following settings:

- F1
  - For ODUs with a 2300 MHz bandwidth, F1= 2200 MHz
  - For ODUs with a 2500 MHz bandwidth, F1= 2400 MHz
  - For ODUs with a 3500 MHz bandwidth, F1= 3400 MHz
- F2
  - For ODUs with a 2300 MHz bandwidth, F2= 2400 MHz
  - For ODUs with a 2500 MHz bandwidth, F2= 2600 MHz
  - For ODUs with a 3500 MHz bandwidth, F2= 3600 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -20 dB

4 Perform the test for each RF cable and record the results.

NOTE

This frequency sweep shows how the cable and connectors react to the Microwave signal. If the shield is damaged in any way, this high frequency sweep will discover the problem before cable installation.

5 To record signal loss of the RF cable at the Microwave frequency, substitute the calibrated short for the 50 Ohm load, and run the RL sweep a second time.

6 Perform the test for each RF cable and record the results.

E.3.1.8 RF cables - Sweep 2: Bandwidth According to the ODU

1 Calibrate the analysis tool.

2 Connect the analysis tool to one end of the cable and the 50 Ohm precision load to the other end.

3 Sweep each IF cable in **Distance To fault** (DTF) mode at the following settings:

- F1
  - For ODUs with a 2300 MHz bandwidth, F1= 2200 MHz
  - For ODUs with a 2500 MHz bandwidth, F1= 2400 MHz
  - For ODUs with a 3500 MHz bandwidth, F1= 3400 MHz
- F2
  - For ODUs with a 2300 MHz bandwidth, F2= 2400 MHz
  - For ODUs with a 2500 MHz bandwidth, F2= 2600 MHz
  - For ODUs with a 3500 MHz bandwidth, F2= 3600 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -20 dB

4 Perform the test for each RF cable and record the results.

E.3.2 Lightning Arrestor

E.3.2.1 100 MHz - 250 MHz Sweep

1 Calibrate the analysis tool.

2 Put the 50 ohm load at the antenna side of the Lightning Protector and the analysis tool phase stable cable on the equipment side of the Lightning Protector.

3 Sweep each Lightning Protector in **Return Loss** (RL) mode at the following settings:

- F1=100 MHz
- F2=250 MHz
- Amplitude Top = 0 dB
- Amplitude Bottom = -60 dB
- Limit Line = -25 dB

4 Perform this test for each Lightning Protector cable and record the results.

NOTE

This frequency sweep shows how the Lightning Protector reacts to the IF signal.

E.3.3 Microwave Antennas

All working antennas exhibit a region in the frequency band in which there is an increase capabilities (a good match with 50 Ohm) and a decrease in their capabilities (no match with 50 Ohm).

E.3.3.1 Return Loss Sweeps

To discover locations of proper antenna functioning:

1 Sweep an antenna at an out-of-range frequency mentioned in the antenna specifications.

2 Sweep an antenna below resonance frequency mentioned in the antenna specifications.

3 Sweep an antenna through the resonant range and back out of range above the antenna design mentioned in the antenna specifications.

CAUTION

Every antenna must be swept with a **Return Loss** sweep to ensure that it is operating at the frequency for which it is cut and labeled.

IMPORTANT

When performing a Line Sweep, there must be no objects or people within a 5 foot distance of the antenna.

E.4 Section Orientation

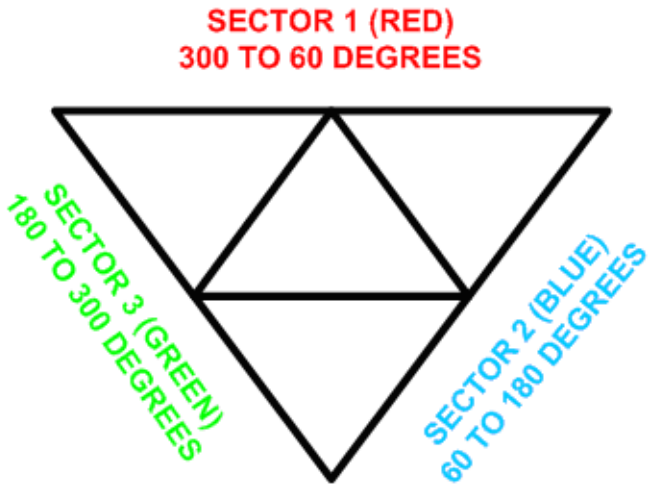


Figure 20: Section Orientation

E.5 Equipment Sweep Test Results Interpretation

E.5.1 Cables

E.5.1.1 IF Cables- Results: 100 - 250 MHz Return Loss

A **Return Loss** sweep made at a frequency range of 100 - 250 MHz into a short or an open shows the Insertion Loss of the cable x 2.
The IF signal travels from the analysis tool and then back from the end of the cable to the analysis tool.

To receive the Insertion Loss of one direction, divide the loss reading by 2.

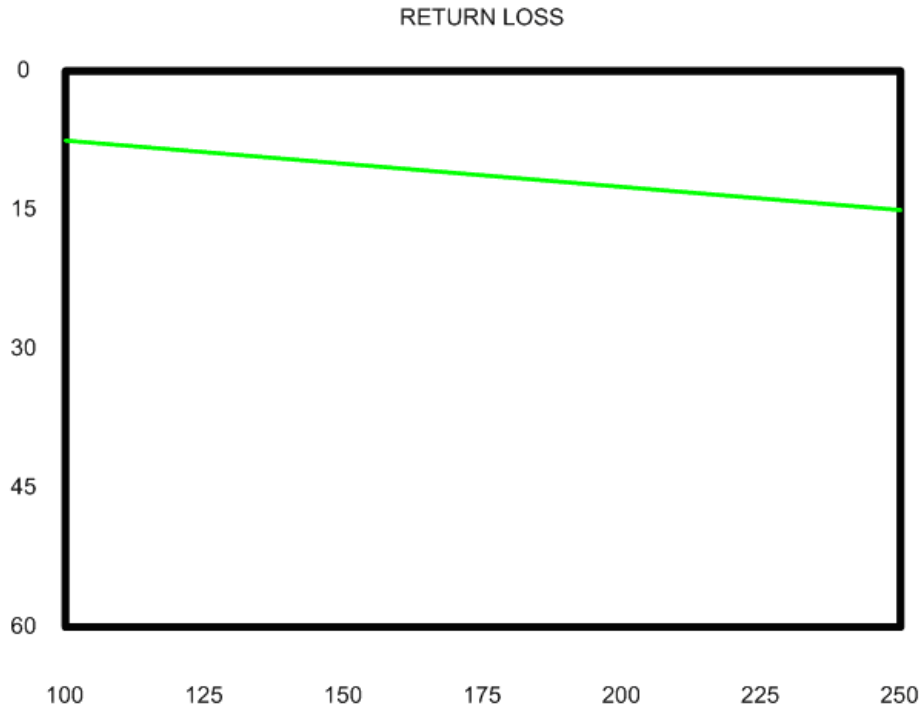
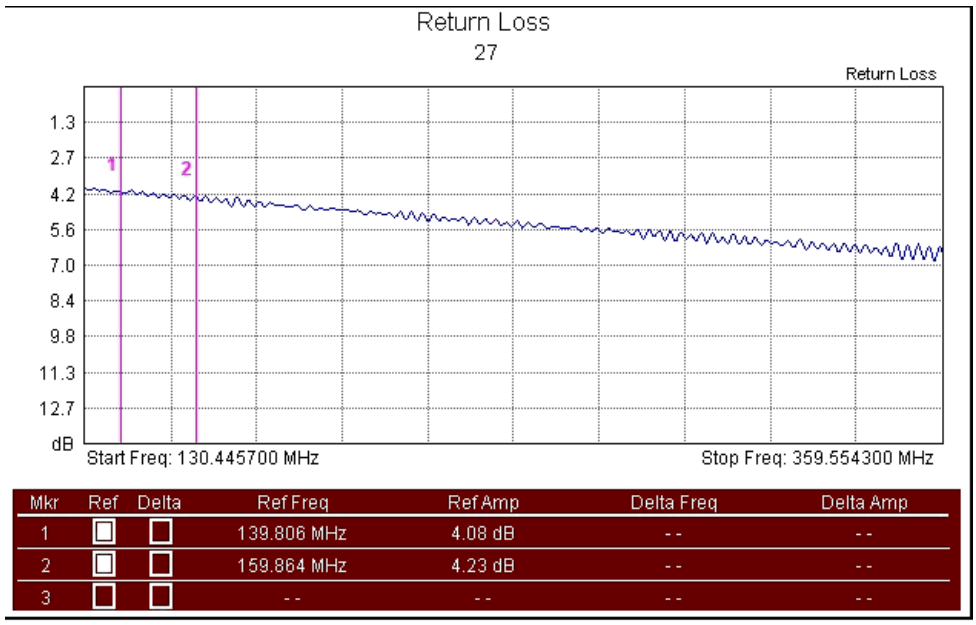


Figure 21: Return Loss



Measurement Parameters

Cal Status	On	Fixed CW On/Off	Off
Data Points	517	Serial Number	751082
Date	8/19/2010	Firmware Version	V5.32
Time	5:46:11 AM	Model	S331D

Figure 22: Return Loss 2

E.5.1.2 IF Cables- Results: 100 - 250 MHz Return Loss - Calibrated Load Termination

To receive a **Return Loss** of -25 dB or better, connect a calibrated 50 Ohm load to the end of the cable. If the shield is partially missing, the expected results for a **Return Loss** sweep at these low frequencies is shown in the following graphs.

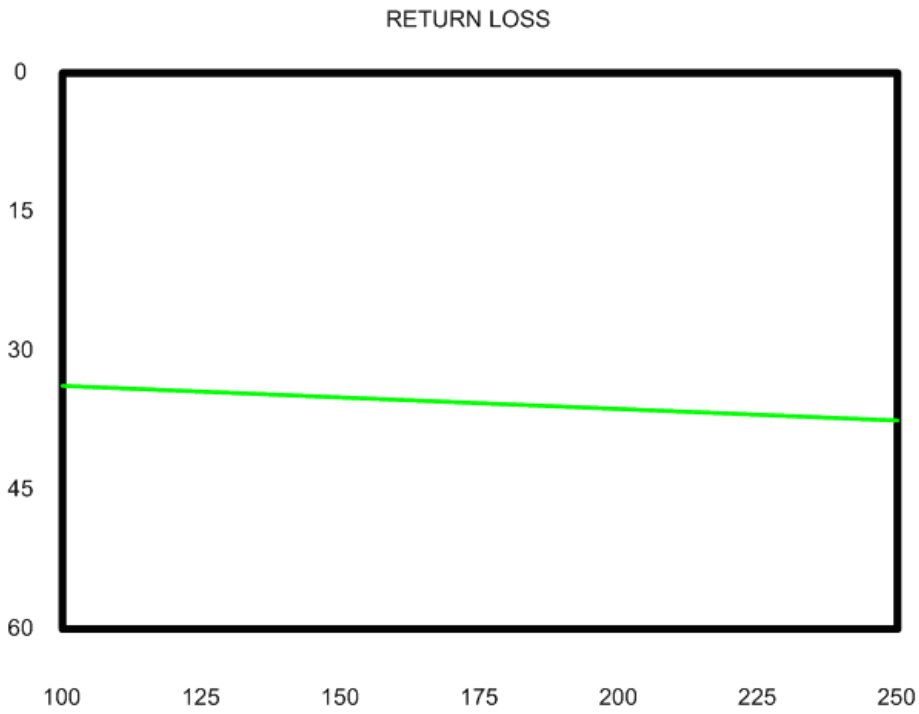
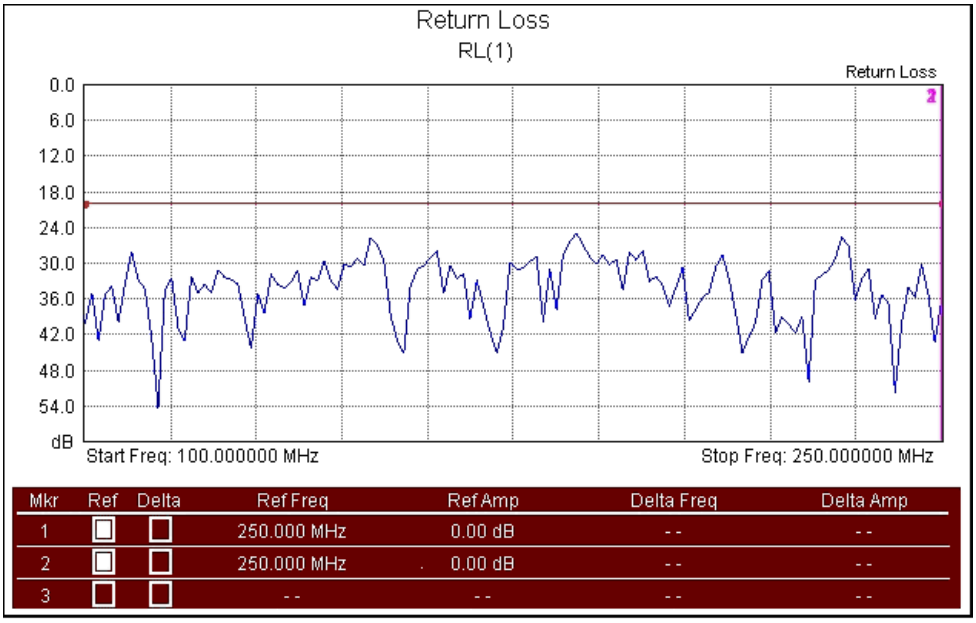


Figure 23: Return Loss: Calibrated Load Termination



Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	130	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	1:33:51 PM	Model	S331D

Figure 24: Return Loss: Calibrated Load Termination 2

E.5.1.3 IF Cables- Results: 100 - 250 MHz Return Loss - Poorly Made Connector

When the shield is partially open, it will show a higher **Return Loss**, even though a calibrated 50 Ohm termination is at the far end connection.

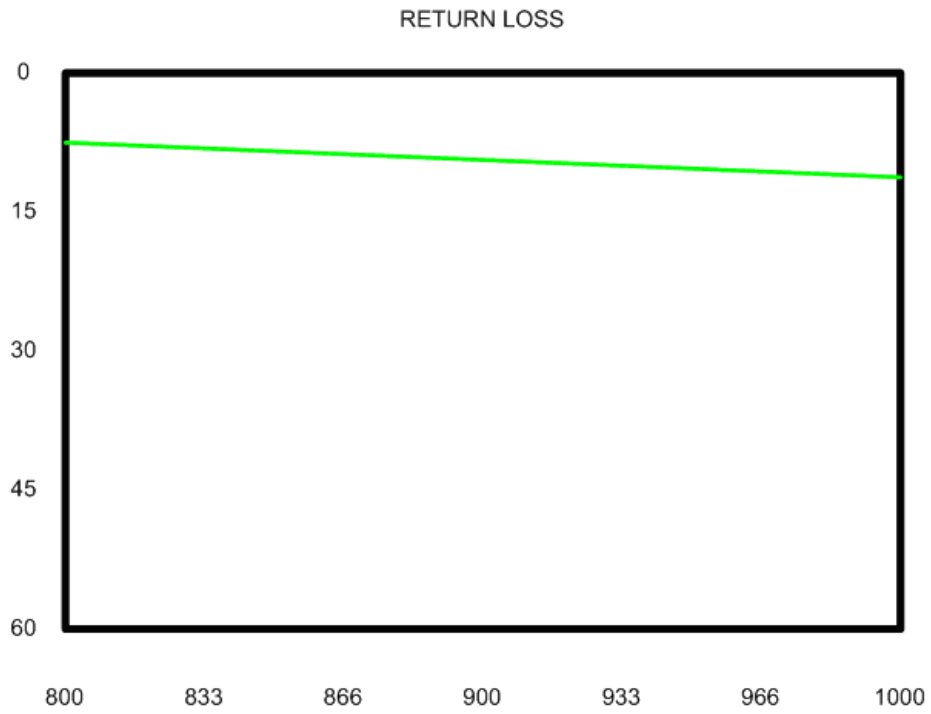
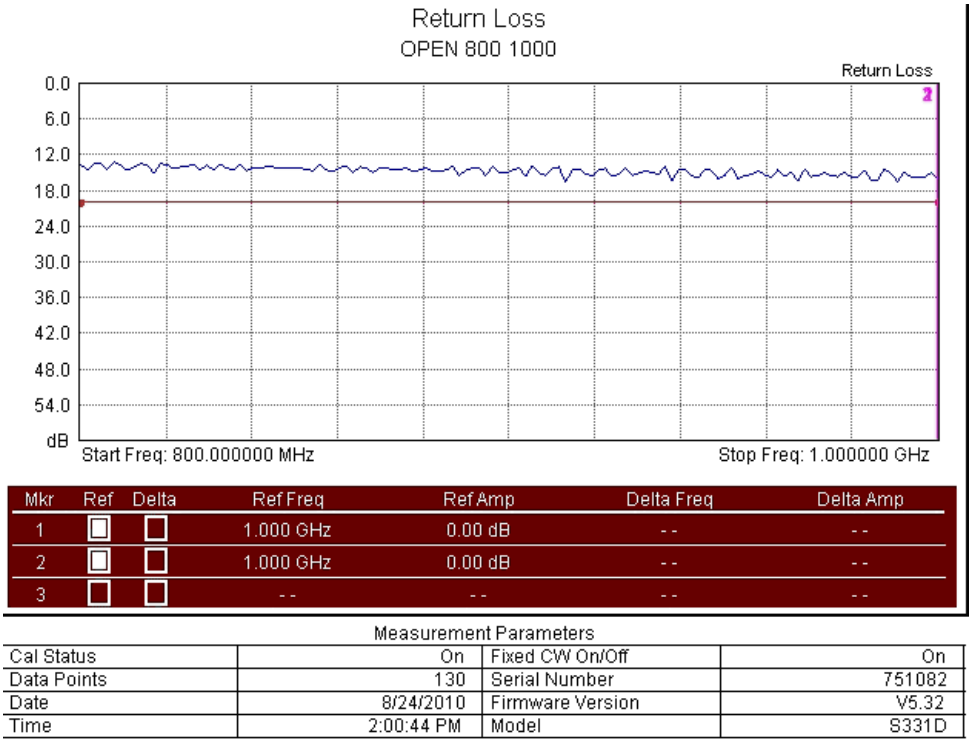


Figure 25: Return Loss: Poorly Made Connector



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1			1.000 GHz	0.00 dB	- -	- -
2			1.000 GHz	0.00 dB	- -	- -
3			- -	- -	- -	- -

Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	130	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	2:00:44 PM	Model	S331D

Figure 26: Return Loss: Poorly Made Connector 2

E.5.1.4 IF Cables- Results: 100 - 250 MHz Return Loss - Good Connector

When a cable is connected to a 50 Ohm calibrated load, the following results are expected:

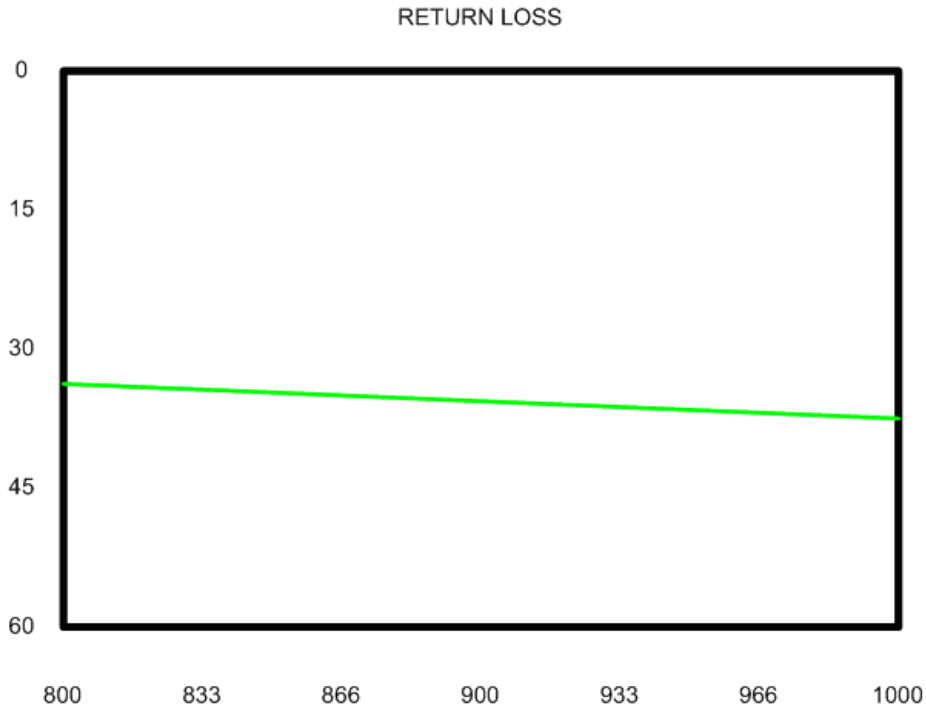
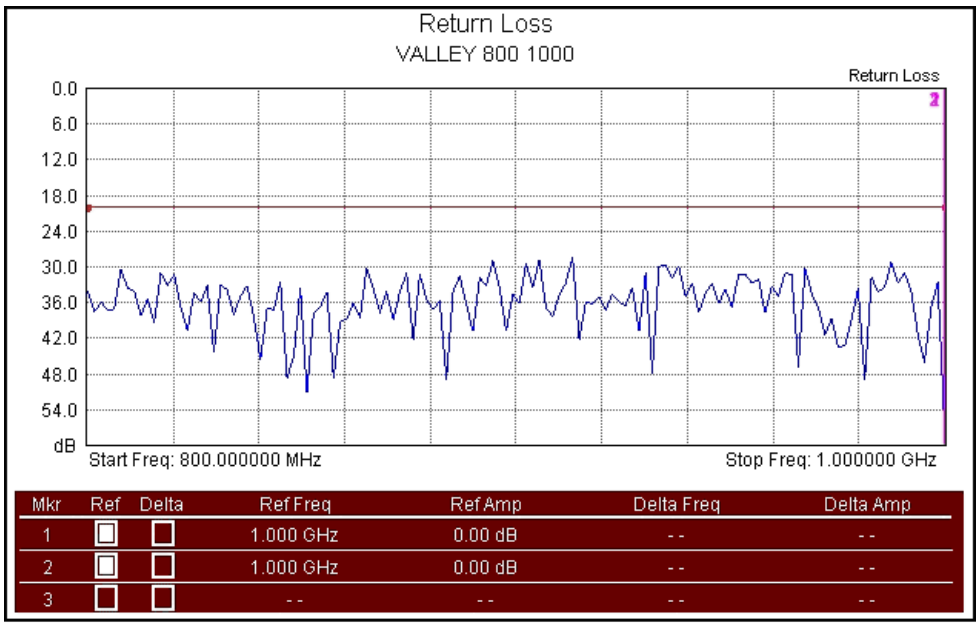


Figure 27: Return Loss: Good Connector



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	1.000 GHz	0.00 dB	- -	- -
2	☐	☐	1.000 GHz	0.00 dB	- -	- -
3	☐	☐	- -	- -	- -	- -

Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	130	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	2:03:33 PM	Model	S331D

Figure 28: Return Loss: Good Connector 2

E.5.1.5 IF Cables- Results: 100 - 250 MHz Distance to Fault

To discover cable inconsistencies and severe cable damage, sweep the IF cable at the frequency range of 100-250 MHz.

IMPORTANT

At this frequency, The sweep will show expected results even for poorly made connections.

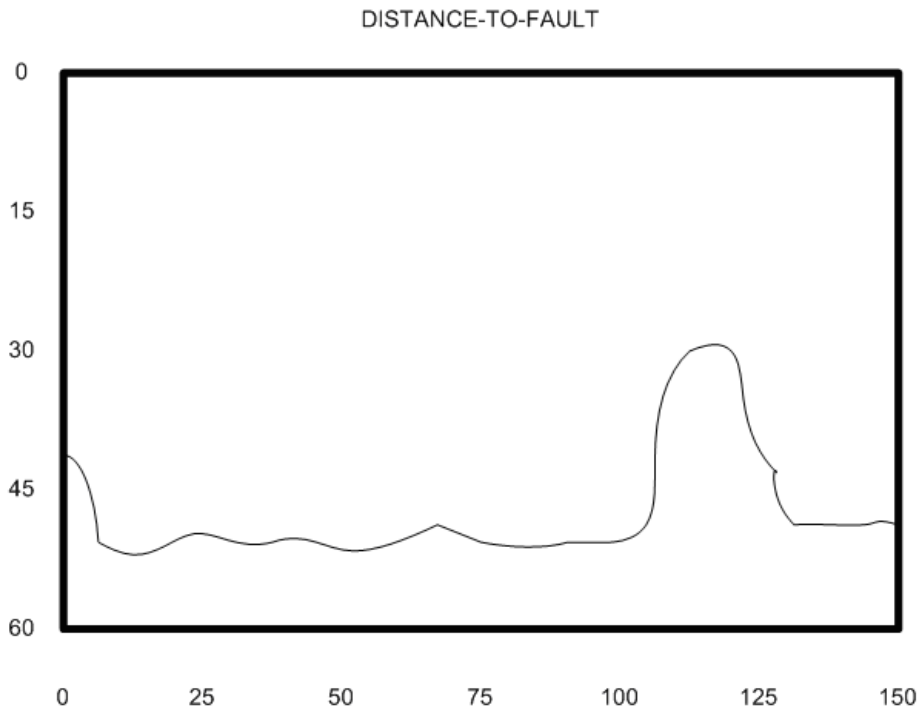
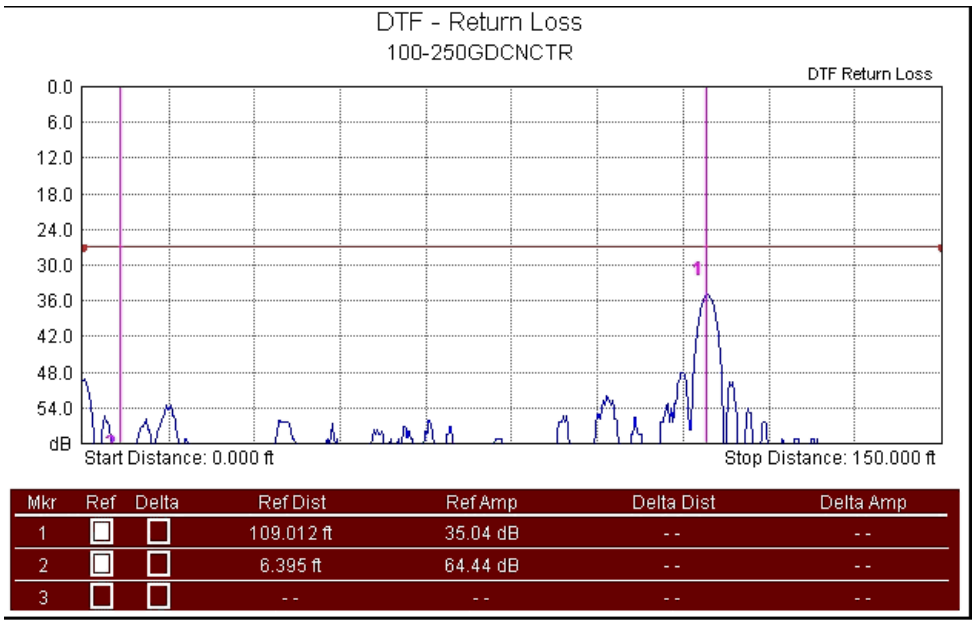


Figure 29: DTF



Mkr	Ref	Delta	Ref Dist	Ref Amp	Delta Dist	Delta Amp
1	☐	☐	109.012 ft	35.04 dB	--	--
2	☐	☐	6.395 ft	64.44 dB	--	--
3	☐	☐	--	--	--	--

Measurement Parameters

Data Points	517	Fixed CW On/Off	Off
Date	9/15/2010	Cable Loss	0.041 dB/m
Time	8:15:35 PM	Prop. Velocity	0.850
Model	S331D	Start Freq	100.000000 MHz
Cal Status	On	Stop Freq	250.000000 MHz
Serial Number	805149	Firmware Version	V5.10

Figure 30: DTF 2

E.5.1.6 IF Cables- Results: 800 MHz - 1000 MHz Distance to Fault - Poor Connector

A DTF sweep at this frequency discovers poor connectivity because the **Return Loss** at the end is higher than the rest of the system average level.

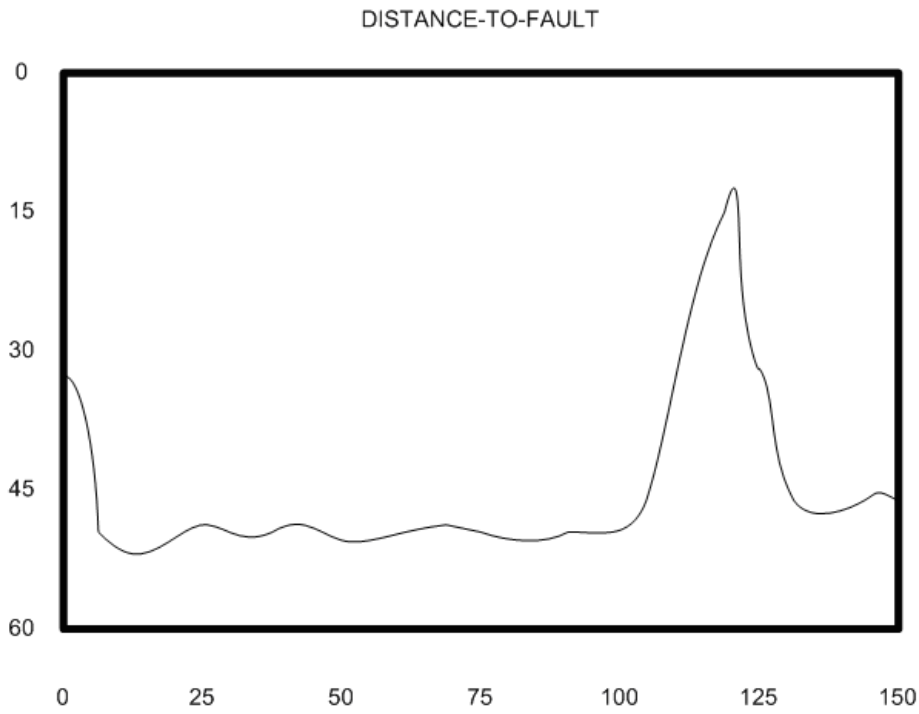
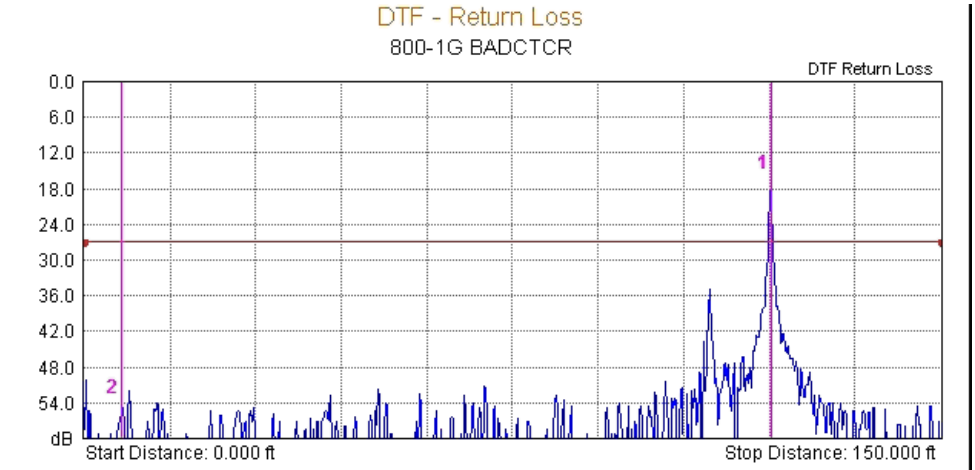


Figure 31: DTF: Poor Connector



Mkr	Ref	Delta	Ref Dist	Ref Amp	Delta Dist	Delta Amp
1	☐	☐	120.349 ft	18.04 dB	--	--
2	☐	☐	6.395 ft	55.92 dB	--	--
3	☐	☐	--	--	--	--

Measurement Parameters

Data Points	517	Fixed CW On/Off	Off
Date	9/15/2010	Cable Loss	0.041 dB/m
Time	8:24:36 PM	Prop. Velocity	0.850
Model	S331D	Start Freq	100.000000 MHz
Cal Status	On	Stop Freq	1.000000 GHz
Serial Number	805149	Firmware Version	V5.10

Figure 32: DTF: Poor Connector 2

E.5.1.7 IF Cables- Results: 800 MHz - 1000 MHz Distance to Fault - Poor Shield Connection Closest to Analysis Tool

The following graphs are the results received for a DTF sweep carried out at the frequency range of 800 MHz - 1000 MHz on an IF cable with a poor shield connection located at the end closest to the analysis tool.

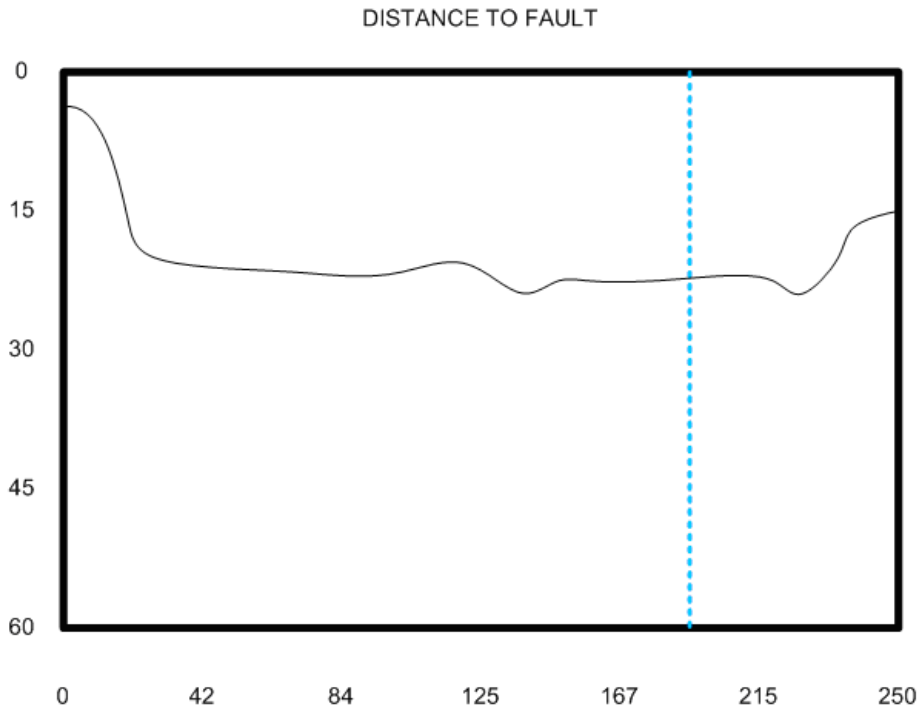
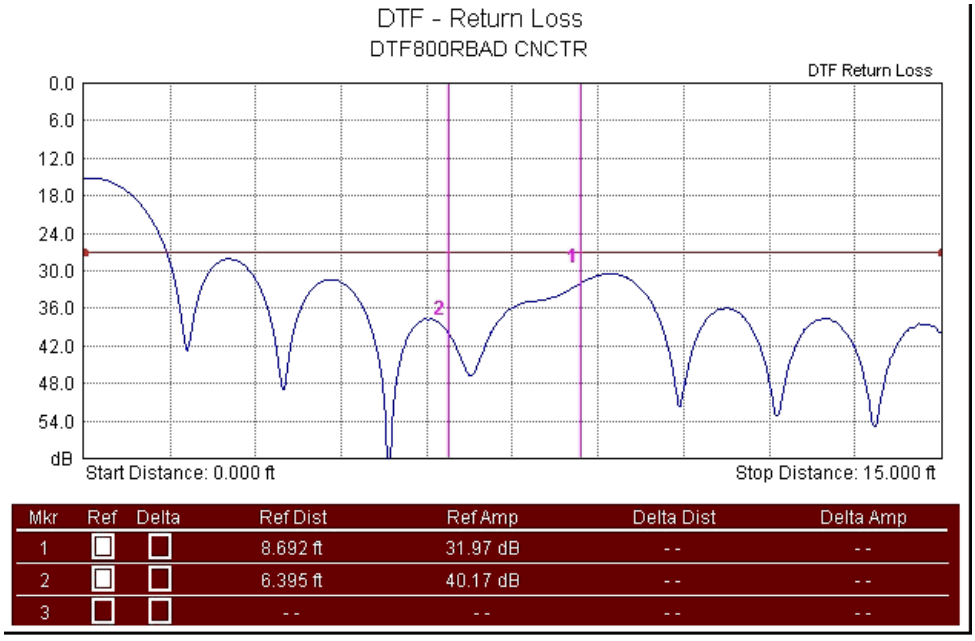


Figure 33: DTF - Poor Shield Connection Closest to the Site Master



Mkr	Ref	Delta	Ref Dist	Ref Amp	Delta Dist	Delta Amp
1	☐	☐	8.692 ft	31.97 dB	--	--
2	☐	☐	6.395 ft	40.17 dB	--	--
3	☐	☐	--	--	--	--

Measurement Parameters

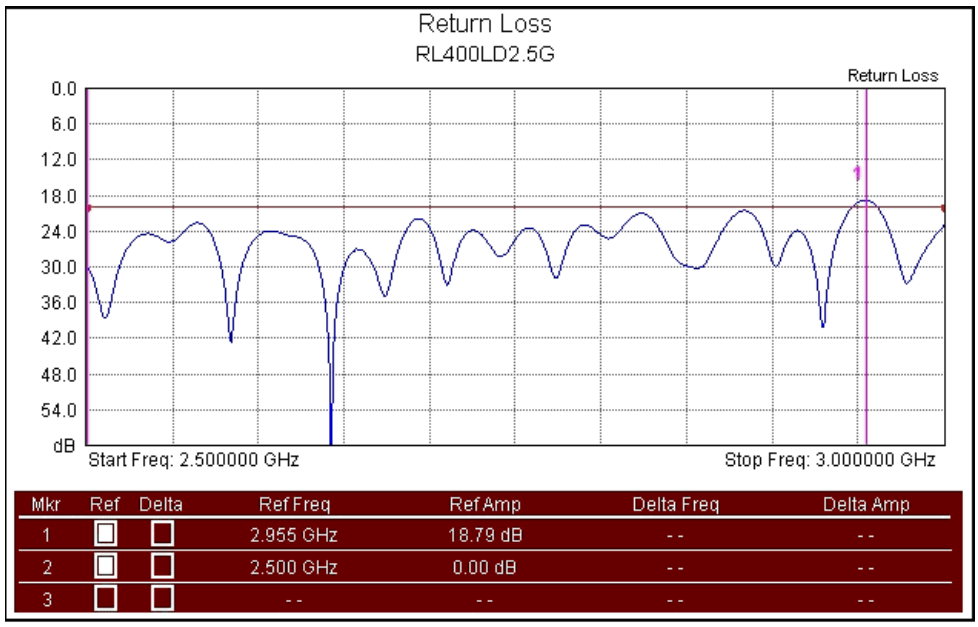
Data Points	517	Fixed CW On/Off	Off
Date	9/15/2010	Cable Loss	0.131 dB/m
Time	5:42:56 PM	Prop. Velocity	0.700
Model	S331D	Start Freq	800.000000 MHz
Cal Status	On	Stop Freq	1.000000 GHz
Serial Number	805149	Firmware Version	V5.10

Poor Shield Connection Closest to the Site Master 2

E.5.1.8 RF Cables - Return Loss Results: Bandwidth According to the ODU

The LMR400 Cables that operate at the bandwidth according to the ODU exhibit a **Return Loss** of around 30 dB.

Figure 34: RF: Return Loss



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	2.955 GHz	18.79 dB	--	--
2	☐	☐	2.500 GHz	0.00 dB	--	--
3	☐	☐	--	--	--	--

Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	517	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	3:43:25 PM	Model	S331D

Figure 35: RF: Return Loss 2

E.5.1.9 RF Cables - Distance to Fault Results: Bandwidth According to the ODU

Properly made, short RF connectors (6-10 feet long) have a small rise in the **Return Loss** at the coaxial cable termination from the radio into the antenna.

NOTE

At frequencies above 1000 MHz, the connectors and cable terminations have a higher Return Loss. At these high frequencies disturbances are amplified.

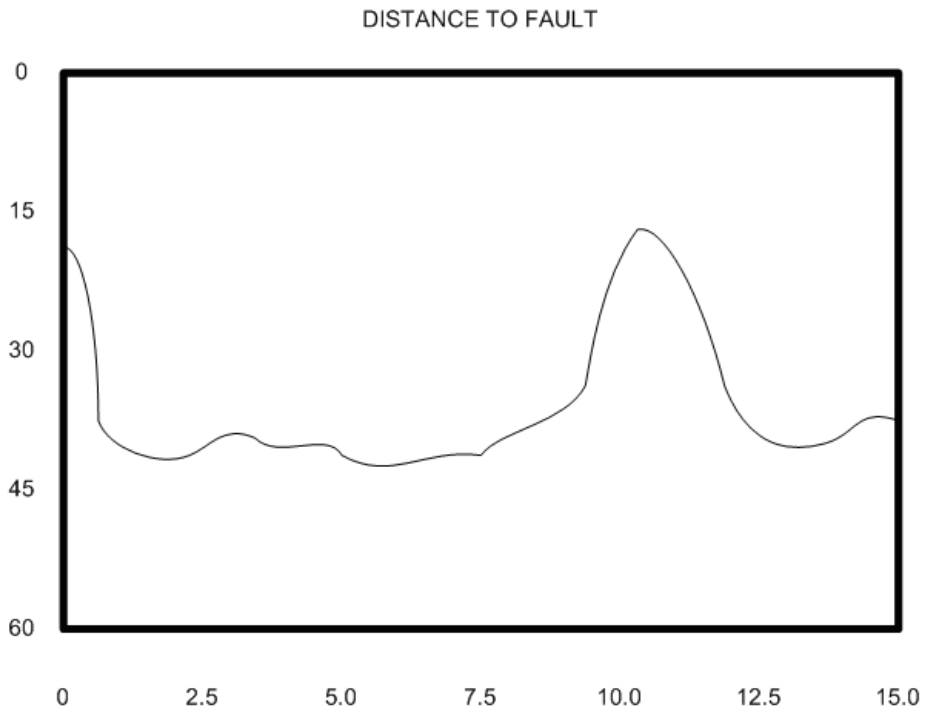
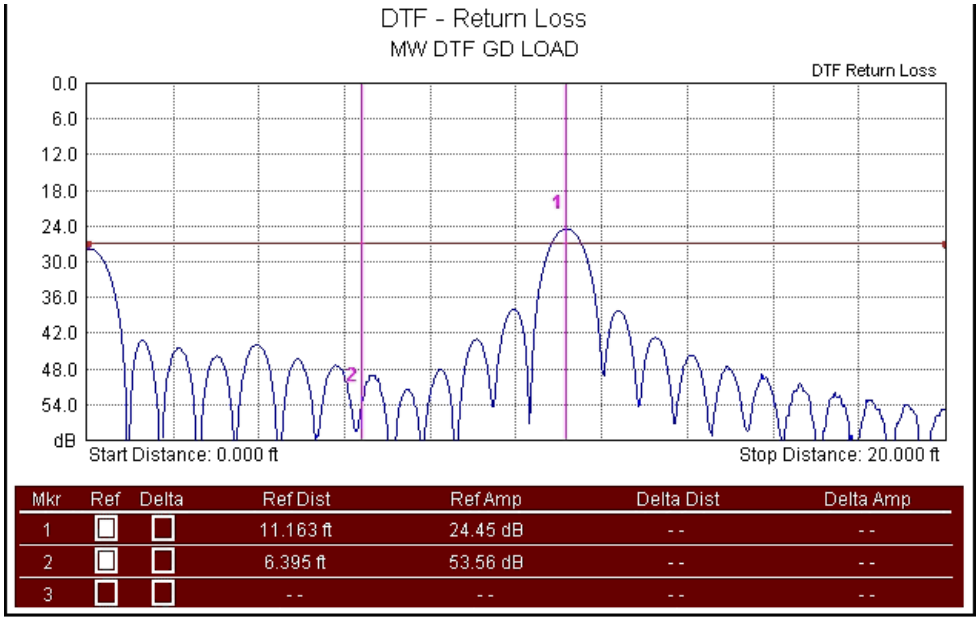


Figure 36: RF Cables - DTF: Frequencies Above 1000 MHz



Mkr	Ref	Delta	Ref Dist	Ref Amp	Delta Dist	Delta Amp
1	☐	☐	11.163 ft	24.45 dB	--	--
2	☐	☐	6.395 ft	53.56 dB	--	--
3	☐	☐	--	--	--	--

Measurement Parameters

Data Points	517	Fixed CW On/Off	Off
Date	9/15/2010	Cable Loss	0.068 dB/m
Time	8:32:34 PM	Prop. Velocity	0.850
Model	S331D	Start Freq	2.500000 GHz
Cal Status	On	Stop Freq	3.000000 GHz
Serial Number	805149	Firmware Version	V5.10

Figure 37: RF Cables - DTF: Frequencies Above 1000 MHz 2

E.5.2 Lightning Arrestor

E.5.2.1 100 MHz - 250 MHz Return Loss

Polyphaser manufactures a special Lightning Protector that passes the Downlink and Uplink Intermediate Frequencies (IF), but also passes Direct Current for powering the ODU Radio Unit. The Lightning Protector also provides the required protection against the voltage surges of a near hit lightning strike.

IMPORTANT

No device can protect the ODU against a **direct** lightning strike.

A good Lightning Protector has a higher than 25 dB **Return Loss** across the operational band of the Lightning Protector equipment.

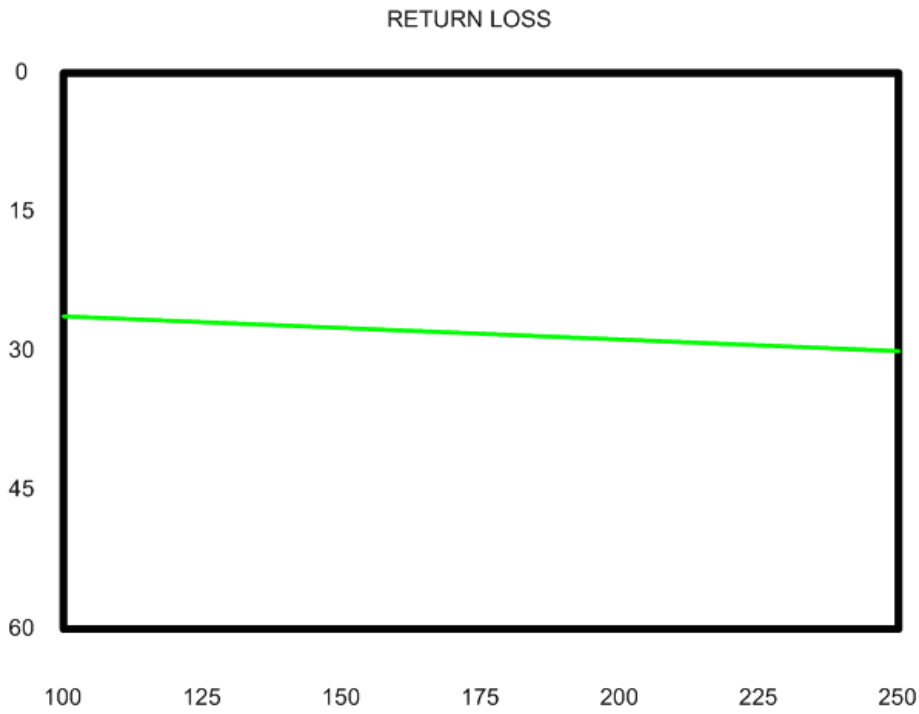
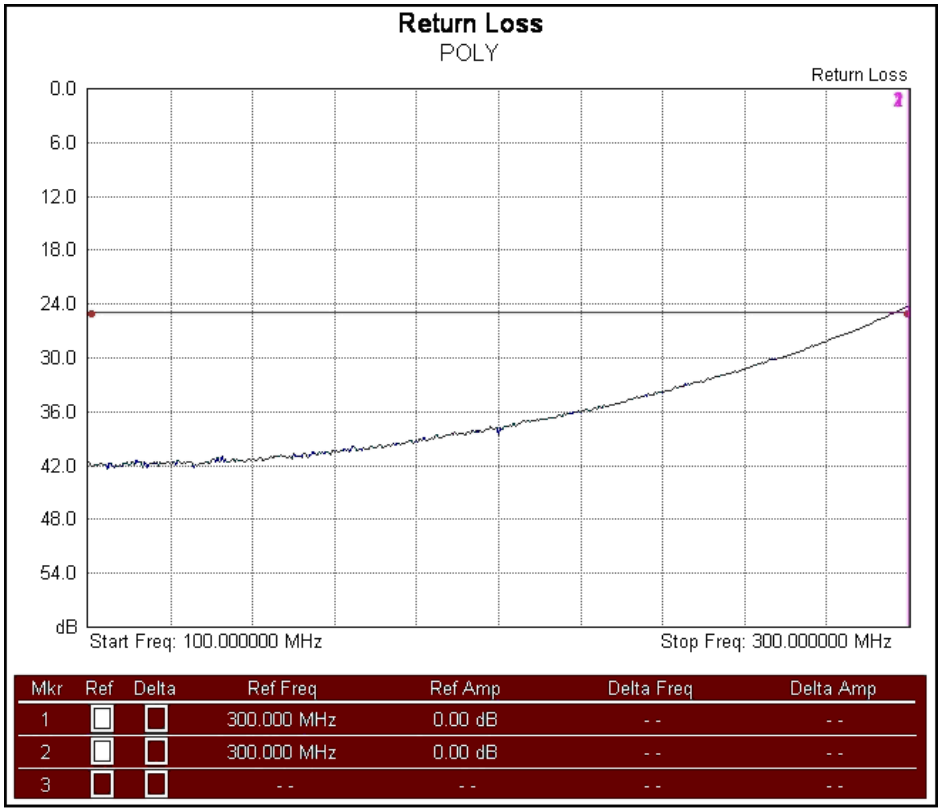


Figure 38: Lightning Protector - Return Loss



Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	517	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	4:00:44 PM	Model	S331D

Figure 39: Lightning Arrestor - Return Loss 2

E.5.3 Microwave Antennas

E.5.3.1 Return Loss

All antennas should show a poor **Return Loss** at points that are outside the resonant frequency of the antenna and a good **Return Loss** within the specified and published specifications of the resonant frequency bands of the antenna.

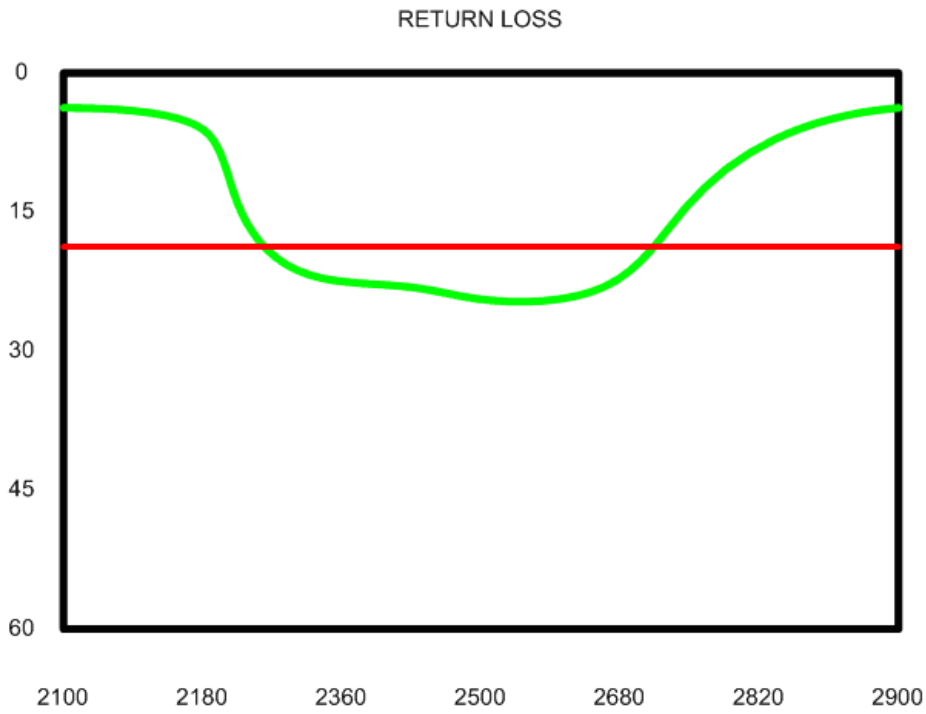
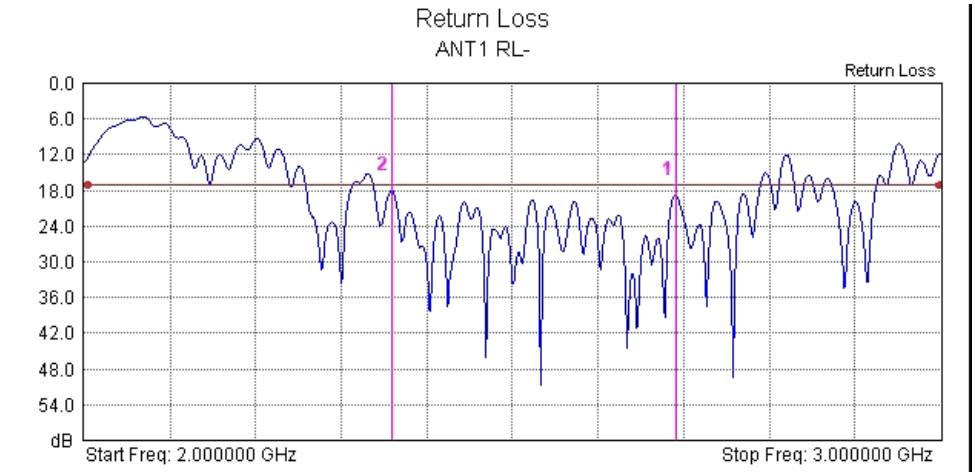


Figure 40: Antenna - Return Loss



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	2.691 GHz	18.76 dB	- -	- -
2	☐	☐	2.360 GHz	18.15 dB	- -	- -
3	☐	☐	- -	- -	- -	- -

Measurement Parameters

Cal Status	On	Fixed CW On/Off	On
Data Points	517	Serial Number	751082
Date	8/24/2010	Firmware Version	V5.32
Time	3:53:39 PM	Model	S331D

Figure 41: Antenna - Return Loss 2