R450™ Mini Collector Installation and Maintenance Guide
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FCC Notice
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
• Reorient or relocate the receiving antenna.
• Increase the separation between the equipment and receiver.
• Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
• Consult the dealer or an experienced radio/TV technician for help.

RF Exposure Information
This equipment complies with the FCC RF radiation requirements for uncontrolled environments. To maintain compliance with these requirements, the antenna and any radiating elements should be installed to ensure that a minimum separation distance of 46cm is maintained from the general population.

CAUTION:
The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This device is approved with emissions having a source-based time-averaging duty factor not exceeding 50%.

Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.
Professional Installation

In accordance with Section 15.203 of the FCC rules and regulations, the R450 Mini Collector must be professionally installed by trained installers. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Industry Canada

This Class A digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Cet appareillage numérique de la classe A répond à toutes les exigences de l'interférence canadienne causant des règlements d'équipement. L'opération est sujette aux deux conditions suivantes: (1) ce dispositif peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue, y compris l'interférence qui peut causer l'opération peu désirée.

Important Safety Precautions

Review the following precautionary measures prior to installation.

Refer installation and service to qualified service personnel only.

• Review the following precautionary measures prior to installation. Connections to the AC mains must be performed by a licensed electrician. No user-installable parts inside.
• Installation must be done in accordance with the instructions contained in this manual.
• Installation must be done in accordance with the National Electrical Code (NEC), NFPA 70 or Canadian Electrical Code (CEC.), CSA C22.2, No. 1.
• In particular, installation must be done in accordance with NEC Article 810 or CEC Section 54.
• This unit is not intended to be powered directly from the Mains Distribution System.

Risk of explosion if battery is replaced by an incorrect type.
Dispose of used batteries according to the manufacturer's instructions.
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<td>Solar Power System Troubleshooting</td>
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<td>Battery Load Voltage by DOD</td>
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<td>79</td>
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</tbody>
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Notes:
1 Product Description

General Product Overview

This section provides a general description of the R450™ Mini Collector (R450 MC). The R450 MC receives, stores, and communicates meter reading data to the N_SIGHT™ R450 host software (version 1.6 or later) in the host computer. The R450 MC collects meter reading data from Neptune’s R450 meter interface unit (MIU) interfacing with Neptune’s absolute encoder register. This data can later be uploaded to the Customer Information System (CIS) and sent to the utility billing system for processing.

The R450 MC utilizes frequencies in the 450-470 MHz licensed band. An FCC license is required prior to installation of the system.

This chapter is designed to provide you with an introduction to the installation process. It explains the focus of the guide, the pre-installation personnel responsibilities, and general information on customer support.

Before you begin to install the R450 MC, it is important to become familiar with the unit and its components. This guide is intended for use by installers and is designed to help in the installation process. This guide contains information on the components and specifications, the site selection, and the actual installation of the unit.
Types of R450 MC Installations

There are three R450 MC variants depending upon the mounting option, power supply option, and backhaul communications required. Each type is powered by either 12VAC or 12VDC.

Neptune provides an installation kit for each type of installation. The standard configuration of the R450 MC backhaul is Ethernet or a cellular modem. Other available backhaul options include using an Ethernet connection.

Mounting Options

Supports:

• Existing light poles
• Towers
• Wall mount
• Rooftop mount

The R450 MC can be mounted on a wall, a pole, or a stand as shown in the illustrations on the following pages.

Power Supply Options

• AC transformer
• UPS
• Solar

Backhaul Communications Options

• Ethernet
• Cellular modem
Determining How to Install the R450 MC

For best performance of your R450 MC, mount the RF antenna at a minimum of 30 feet high, but no more than 75 feet high.

The following figure illustrates how the R450 MC can be installed.

![Diagram of R450 MC installation options]

**Figure 2  Mounting Options**

Depending upon the availability of communications, cellular or Ethernet modems can be used. Use site selection checklist before installing the R450 MC.
Mounting Configurations

**Street Light Pole Installation**

The pole installation is used for an outdoor free-standing pole. Refer to Figure 3 for how you can install the R450 MC on a pole.

![Figure 3 Pole Installation](image)

Depending upon the availability of communications, a cellular modem or Ethernet can be used.
**Tower Mount**

The tower mount installation is used for an outdoor tower. Refer to Figure 4 for how to install the R450 MC on a tower.

![Figure 4 Tower Mount Installation](image)

**Rooftop Installation**

The rooftop installation is used when the R450 MC is mounted in a high location, such as on a rooftop. Refer to Figure 5.

![Figure 5 Stand Installation](image)

Depending upon the availability of communications, a cellular modem or Ethernet can be used.
Wall Mount Installation

The wall-mounted installation can be installed outdoors. Refer to Figure 6 for how to mount the R450 MC to a wall.

Depending upon the availability of communications, Ethernet or cellular modems can be used.

Do not mount the R450 MC, antenna mast, or antenna to a pole or similar structure carrying open electric light, power wires, or trolley wires over 250 volts. See NEC, Article 810.

Always mount the R450 MC at least three feet above ground level.
Performance Considerations with the R450 System

This section addresses situations where the system is functioning but R450 MC or MIU communication is not performing as expected.

This discussion covers two situations.

- The first is getting the newly installed system to perform per specification.
- The second covers an installed system where the performance degrades suddenly or over time.

Optimizing the Performance of a New System

Before you install the system, Neptune uses computer software and other resources to predict the performance of the system and recommend a minimum number of R450 MCs to provide the desired performance. Each site has a survey performed that provides recommendations on antenna placement and looks for potential radio interference problems. These steps can identify many of the potential problems but may not be able to identify all the problems encountered during installation and maintaining the system.

If Neptune's propagation model is not followed, then the resulting performance may not meet expectations.

Owners of both licensed and unlicensed equipment are responsible for the proper operation of their equipment. If it is not operating within specifications, the owner is required to bring the systems into compliance or stop using it. This can be beyond the capability of most homeowners and small businesses, requiring a cooperative effort to solve.

It is possible for a piece of equipment to be functioning totally within its required specifications and still cause interference with the R450 System. The collaborative effort of all the affected parties is required to solve this type of problem.

During the initial installation of a site, Neptune advises using a receiver or high quality spectrum analyzer connected to the antenna to assure that the transmit and receive frequencies are free from interference. Additionally, be sure that there are no potentially interfering signals around the frequencies used by the R450 MC, both transmit or receive. The overall noise level could potentially reduce the sensitivity of the R450 MC or MIU receivers. A recommended receiver is the Icom IC-PCR1500 which includes a PC interface. A Rohde & Schwarz FSH3.03 or FSH3.23 spectrum analyzer is also acceptable.
Problems can occur from a number of sources. Some common problems include the following:

- Improper installation, for example, loose connectors. Refer to “Feed Line and Antenna Recommendations” on page 54 in Appendix A to confirm the correct installation procedures.

You must provide this appendix to antenna contractors prior to installation. Failure to follow these procedures can result in poor system performance.

- Local cable systems having leaks in the cables and amplifiers can degrade the performance of the R450 System.
- Local businesses and factories can have equipment that raises the ambient noise level, reducing the ability of the R450 MC to hear MIUs.
- Local residences and businesses can have equipment that interferes with the R450 System.

Site surveys often find these problems but cannot detect intermittent, factory shift related, or other time specific sources of interference.

Being in close proximity to a high power commercial broadcast antenna produces a unique set of problems. Loose or badly corroded hardware on or near the site can cause signals from the R450 MC or other transmitters near the site to combine with the broadcast signal and produce interfering signals. Incorrectly installed antennas and feed lines can also cause similar problems. The R450 MC and other local transmitters themselves can also be a source of re-radiated interference. Additional equipment that your installer can recommend can help control these issues.

Terrain and the types of buildings in the area can affect the performance of the R450 System. Hilly or rolling terrain as well as tall buildings can make it difficult to receive even local MIUs. Placement of the MIUs (wall mount and pit style) can be critical in some areas. Additional R450 MCs that can supplement the problem areas can be the best solution in these situations.

Maintaining the Performance of the R450 System

The first major activity is to be sure that you properly install all the R450 MIUs so that the R450 System can reliably receive their transmissions.

The troubleshooting section of this guide includes recommendations on how to verify that the R450 MC and antenna system are performing up to specification.

Storm activity can degrade the performance of the R450 MC. If this happens, the lightning arrestors should be checked and replaced if defective.

Running the surveys again using the radio receiver can identify new sources of interference. Problems related to specific time windows should have the surveys performed during those time periods.
R450 MC Kits

The following section describes the components for each of the R450 MC kits.

Cellular Modem

The R450 MC is mounted on either a pole, a wall, or a stand. The following list includes the parts needed for the R450 MC – cellular modem kit.

Table 1 Cellular Modem Parts List

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13071-000</td>
<td>R450 MC (cellular modem); includes pole/wall mounting bracket</td>
<td>1</td>
</tr>
<tr>
<td>13071-XXX</td>
<td>R450 MC Accessories</td>
<td>A/R</td>
</tr>
<tr>
<td>13025-001</td>
<td>R450 MC Installation and Maintenance Guide</td>
<td>1</td>
</tr>
</tbody>
</table>

Ethernet

The following list includes the parts needed for the R450 MC – Ethernet kit.

Table 2 Ethernet Parts List

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13071-100</td>
<td>R450 MC (Ethernet); includes pole/wall mounting bracket</td>
<td>1</td>
</tr>
<tr>
<td>13071-XXX</td>
<td>R450 MC Accessories</td>
<td>A/R</td>
</tr>
<tr>
<td>13025-001</td>
<td>R450 MC Installation and Maintenance Guide</td>
<td>1</td>
</tr>
</tbody>
</table>
## 2 General Installation Guidelines

This section describes the specifications for the R450 Mini Collector (R450 MC), storage, unpacking instructions, preliminary tests, tools, materials, site selection, and installation of the R450 MC.

### R450 MC Specifications

#### Electrical Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Power</td>
<td>12V AC, 0.66A nominal (2A peak)</td>
</tr>
<tr>
<td>DC Power</td>
<td>12V DC, 0.66A nominal (2A peak)</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>8 Watts</td>
</tr>
</tbody>
</table>

#### Environmental Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>-22° to 140°F (-30° to 60°C)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-40° to 185°F (-40° to 85°C)</td>
</tr>
<tr>
<td>Operating Humidity</td>
<td>0 to 95% Non-condensing</td>
</tr>
<tr>
<td>Environmental Rating</td>
<td>National Electrical Manufacturers Association (NEMA) 4X Enclosure</td>
</tr>
</tbody>
</table>

#### Mechanical Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Weight</td>
<td>24.0 lbs</td>
</tr>
<tr>
<td></td>
<td>10.9 kg</td>
</tr>
<tr>
<td>Dimensions</td>
<td>9.0 W x 13.0 H x 7.5 in. D</td>
</tr>
<tr>
<td></td>
<td>22.8 x 33 x 19 cm</td>
</tr>
</tbody>
</table>

#### R450 MC Footprint

<table>
<thead>
<tr>
<th>Stand Type</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>R450 MC Stand (Rohn)</td>
<td>5 ft Square, 1.5 ft</td>
</tr>
<tr>
<td></td>
<td>(1.54 x 1.5 m Square)</td>
</tr>
<tr>
<td>R450 MC Stand (Valmont)</td>
<td>8 ft Triangle, 2.4 ft</td>
</tr>
<tr>
<td></td>
<td>(2.4 x 2.4 m Triangle)</td>
</tr>
</tbody>
</table>
Storage

Upon receipt, inspect shipping containers for damage, and inspect the contents of any damaged cartons prior to storage.

Once the inspection is complete, store the cartons in a clean, dry environment. The temperature should remain between -40° and 185°F (-40° and 85°C).

Unpacking

As with all precision electronic instruments, the R450 MC should be handled with care; however, no special handling is required.

After unpacking the R450 MC, inspect it for damage. If any parts of the R450 MC appear to be damaged or prove to be defective upon installation, notify your Neptune sales representative. If the unit or item requires reshipment, use the original cardboard box and packing material.
R450 MC Installation Kits

The RF antenna and accessories are ordered separately from the R450 MC. The RF antenna, coax cables, and coax connectors must be ordered as accessories. See “RF Antenna Installation” on page 53 in Appendix A for a list of the antenna accessories and cables.

The pole/wall mounting bracket is included with the R450 MC.

Tools and Materials

Table 3 shows the recommended tools and materials you need to successfully install the R450 MC.

Some items may not apply to your specific installation or the list may not contain all required tools or materials depending on which installation method you use.
If you have R450 MIUs already installed, you can use these to test if the R450 MC is receiving readings from MIUs. However, it is recommended that you take an R450 MIU and Neptune magnet with you when you install the R450 MC. These items are needed to test the unit. See “Swiping the MIU” on page 32.

Be sure that the N_SIGHT R450 host software (version 1.6 or later) is running and that you have an R450 MIU and magnet with you when you install the R450 MC. You will use the R450 MIU to test the unit.
3 Installation of the R450 MC

This chapter contains sections detailing the installation instructions for the R450 Mini Collector (R450 MC) installation options:

• “Mounting the Battery Box” on page 16
• “Attaching the Solar Panel” on page 17
• “Mounting the R450 MC” on page 18
• “Installing a Large Pole Mount System” on page 23
• “Installing a Wall Mount System” on page 33
• “Troubleshooting” on page 38

Mounting RF Antenna to Pole or Stand

To mount the RF antenna to a pole or a stand, complete the following steps.

1. Assemble the stand per manufacturer's instructions.

   If mounting to a 2-inch round SCH40 steel pole, seat the pole per the recommendations from the solar-powered system's installation guide. The pole is to be seated against a firm, crushed-stone base, on firm, compacted soil a minimum of 6-inch below the frost line encased in reinforced concrete per ASTM standards. The pole is to be level and plumb.

2. Attach the antenna mounting brackets to pole. See Figure 9.

Figure 9 Antenna Mounting Brackets
3 Attach the coax cable to RF antenna. See Figure 10.

4 Weatherize the RF antenna connection using the weatherizing kit, Polyphasor Part No: WK-1. See Figure 11.

5 Mount the RF antenna to the antenna pole using antenna mounting brackets. See Figure 12.

6 Secure the coaxial cable every two feet along the pole using UV-stable wire ties. See Figure 12.
Mounting the R450 MC – Solar Configuration

Mounting the Battery Box

The following instructions are for the installation of the battery box needed for the solar panel of an R450 MC solar-powered system. If you are installing an AC-powered system, skip this step.

Prior to installing a solar-powered unit, choose a non-shaded location that faces true south. Determine true south by using a magnetic compass corrected for magnetic declination. Refer to the Installation Manual for the solar power system. In addition, refer to “Solar Power Information” on page 71 in Appendix C.

To mount the battery box, complete the following steps.

1. Install the brackets onto the pole using the U-bolts provided. Be sure the U-bolts are spaced 12.75 inches (32.39 cm) apart and face the brackets true south. See Figure 13.

2. Lift the battery box, then lower it so that the flange on the top rear of the box slides over the flange of the top bracket and locks in place.

   The square holes in the bottom bracket now line up with the holes in the bottom rear of the enclosure. See Figure 14.

3. Secure the box to the bottom bracket using the 5/16-inch carriage bolts.
4 Install the battery in the battery box leaving ventilation areas free of blockage.

5 Connect the $B^+$ wire to the positive battery terminal. Connect the $B^-$ wire to the negative battery terminal. See Figure 15.

6 Remove the two 1/2-inch knockouts in the rear of the battery box by lightly tapping them with a flathead screwdriver and hammer. See Figure 14 on page 16.

---

**Attaching the Solar Panel**

The following instructions are for the installation of the solar panel of an R450 MC solar-powered system. If you are installing an AC-powered system, skip this step.

The solar panel is mounted to the R450 MC stand or to a pole. See Figure 16. This panel allows the R450 MC to operate using energy generated by the sun.

It is important to install the solar panel so that it faces true south. The solar panel tilt angle should be set based on latitude. For latitude range between 25º and 60º, the solar panel tilt angle should be set for latitude plus 15º. It is recommended that the solar panel tilt be limited to 15º minimum angle and 60º for a maximum tilt angle.

To mount the solar panel, complete the following steps.

1 Attach the solar panel to the pole using the U-bolts or bands provided. See Figure 17.
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Installation of the R450 MC

2 Use a protractor to set the angle of the solar panel. For latitude range between 25º and 60º, set solar panel tilt angle for latitude plus 15º minimum angle and 60º for a maximum tilt angle. “Solar Power Information” on page 71.

You can find the latitude of your location by using a map, mapping software, or a Global Positioning System (GPS) device.

3 Tighten all the nuts and bolts.

Mounting the R450 MC

To mount the R450 MC to a pole or stand, complete the following steps.

The pole/wall mounting bracket is included with the R450 MC. The clamps are ordered as accessories.

1 Position the R450 MC so that the top of the box is approximately four inches above the battery box.
2 Attach the R450 MC to the pole using two stainless steel Snaplock clamps. See Figure 20.

3 Tighten the clamps with a nut-driver, as illustrated in Figure 20.

---

**Wiring the Solar Panel**

The following instructions are for the solar panel of an R450 MC solar-powered system. If you are installing an AC-powered system, skip this step. Proceed to "Wiring the R450 MC" on page 21.

Connect the solar panel to the battery box by completing the following steps.

1 Feed the flexible conduit wiring from the solar panel to the back of the battery box. See Figure 21.

2 Connect the **green GND** solar panel wire to the **green GND** lead in the battery box.

3 Connect the **red PV +** solar panel positive lead to the **red PV +** wire in the battery box.

4 Connect the **black PV -** solar panel negative lead to the **black PV -** wire in the battery box.
Installation of the R450 MC

Wiring the Battery Box

The following instructions are for wiring the battery box needed for the solar panel of an R450 MC solar-powered system. If you are installing an AC-powered system, skip this step.

Solar-Powered System

Connect the R450 MC to the battery box by completing the following steps.

1. Attach the 1/2-inch connector hub to the back of the battery box. See Figure 22.

2. Insert the DC power cable through the connector hub. Insert enough cable so that it can be terminated to the load terminals inside the battery box. See Figure 22.

3. Tighten the connector hub using a crescent wrench to secure the cable. See Figure 23.

4. Strip back the insulation 1/2-inch on red and black wires.

5. Attach the red (+) wire to the Load (+) terminal inside the battery box.
6. Attach the **black** (-) wire to the **Load** (-) terminal inside the battery box. See Figure 24.

### Wiring the R450 MC

Connect the wiring in the R450 MC by completing the following steps.

1. Attach the power plug to the R450 MC by pushing and rotating the circular power connector clockwise to engage it.

2. Secure the R450 MC cover with the tamper-resistant T27 Torx Pin-Head tool.

### Applying the Ballast to the Stand

*Install a roof pad between stand and rooftop to protect roof. See “R450 MC Stand” on page 69 in Appendix B.*

After the R450 MC is wired, the next stage is to secure the entire unit in its location by applying the ballast.

To apply the ballast to the stand, complete the following steps.

1. Refer to Appendix B to determine the adequate amount of ballast for your installation.

2. Evenly distribute the ballast to secure the stand in its position as illustrated in Figure 26.
Activating the R450 MC System

Once you have all the kit items in place, attached, and mounted, you can activate the R450 MC system.

Activating the Solar Power System

To activate the battery, complete the following steps.

1. Open the door of the battery box.
2. Turn the two breakers to the **ON** position.
3. Close the battery box with locking key.

   This should activate both the battery box and the R450 MC.

4. Open the R450 MC by removing the security Torx screws in the following pattern: 4, 3, 2, 1. See Figure 28.

   To close the R450 MC, replace the security Torx screws in the following pattern: 1, 2, 3, 4. See Figure 28.

5. Watch the LED located in the lower right corner of the radio module.

   There is approximately a 30-second delay before the LED activates.

6. Configure the GPRS modem. See “Configuring the R450 MC” on page 29.

   If the R450 MC is an Ethernet version, skip step 6.

7. Configure the USB flash drive using the N_SIGHT R450 host software (version 1.6 or later). If configuring multiple USB flash drives, be sure to label them accordingly.

8. Configure the R450 MC using the configured USB flash drive. See “Configuring the R450 MC” on page 29.

   The configured USB flash drive contains information that is unique to each R450 MC. Do not inadvertently switch them during R450 MC configuration.
Installing a Large Pole Mount System

This section presents a table to be used to mount the R450 MC system to a large pole.

The instructions to mount the R450 MC system to a large pole are very similar to the instructions for installing a stand system.

- Please refer to “Mounting the R450 MC to a Large Pole” on page 24.
- Please note that information bullets, such as these, are included in each section for special considerations added for the large pole installation.

To assemble and install the pole mount system, complete the instructions contained in the following sections of this manual.

Table 4 Installing the R450 MC Large Pole Mount System

<table>
<thead>
<tr>
<th>Complete</th>
<th>Steps for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“Mounting the RF Antenna to a Large Pole” on page 23</td>
</tr>
<tr>
<td>2</td>
<td>“Mounting the R450 MC to a Large Pole” on page 24</td>
</tr>
<tr>
<td>3</td>
<td>“Mounting the Battery Box to a Large Pole” on page 25</td>
</tr>
<tr>
<td>4</td>
<td>“Mounting the Solar Panel to a Large Pole” on page 26</td>
</tr>
</tbody>
</table>

Mounting the RF Antenna to a Large Pole

Mount the RF antenna to a 3-inch to 16-inch (7.62 cm to 40.64 cm) diameter pole by completing the following steps.

1. Mount the RF antenna to the pole the same as when mounting to a stand. See “Attaching the RF Antenna Cable” on page 27. However, use the 2-inch to 12-inch Snaplock clamps to mount the antenna bracket to the pole as shown in Figure 29.
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Installation of the R450 MC

When mounting the RF antenna to a tower or tall pole, always hoist the coax cable and antenna separately.

2 Attach the supplied coax cable to the base of the antenna.

3 Weatherize the antenna connection using the weatherization kit.

Mounting the R450 MC to a Large Pole

Mount the R450 MC to a 4-inch to 16-inch (10.16 cm to 40.64 cm) diameter pole by completing the following steps.

1 Mount the R450 MC to pole using two stainless steel Snaplock clamps (Neptune Part Number 13089-001).

The pole/wall mounting bracket is included with the R450 MC. Snaplock clamps must be ordered as accessories.

2 Insert clamps through the slots on the mounting bracket. See Figure 31.
Mounting the Battery Box to a Large Pole

Mount the battery box to a 3-inch to 16-inch (7.62 cm to 40.64 cm) diameter pole by completing the following steps.

1. Open the battery box and make sure the breakers are in the OFF position. See Figure 15 on page 17.

2. Mount the battery box to a large pole. However, use the Bolt-A-Band clamps as shown in Figure 32.

3. Install brackets onto the pole using the Bolt-A-Band clamps provided. Be sure that the brackets are spaced 12.75 inches (32.39 cm) apart. See Figure 33.

4. Lift the battery box then lower it so that the flange on the top rear of the box slides over the flange of the top bracket and locks in place. The square holes in the bottom bracket now line up with the holes in the bottom rear of the enclosure.

5. Secure the box to the bottom bracket using the 5/16-inch carriage bolts.

6. Center the battery in the battery box leaving ventilation areas free of blockage.

7. Close the door of the battery box with the locking key.

Prior to installing a solar unit, choose a location that faces true south. Use a magnetic compass to help determine the correct direction and location for your unit. You can determine true south by using a magnetic compass corrected for magnetic declination. (Refer to the installation, operations, and maintenance manual for the solar power system. In addition, refer to Appendix C.)
Mounting the Solar Panel to a Large Pole

Mount the solar panel to a 3-inch to 16-inch diameter pole by completing the following steps.

1. Attach the solar panel to the large pole using the Bolt-A-Band clamps provided. See Figure 35.
2. Install the solar panel so that it faces true south.
3. Set solar panel tilt angle based on latitude.

For latitude range between 25° and 60°, set solar panel tilt angle for latitude plus 15°. It is recommended that the solar panel be limited to 15° minimum angle and 60° for a maximum tilt angle. See Appendix C “Solar Power Information” on page 71.

4. Adjust the PV array mounting bracket to obtain the proper tilt angle. See Figure 36.

Mounting the R450 MC to a Large Pole

To mount the R450 MC to a large pole, complete the following steps.

The pole/wall mounting bracket is included with the R450 MC. Snaplock clamps must be ordered as accessories.

1. Attach the R450 MC to the large pole using two stainless steel Snaplock clamps. See Figure 37.
2. Position the R450 MC so that it is in close proximity with the battery box and the solar panel. See Figure 20 on page 19.
3 Tighten the Snaplock clamps. See Figure 38.

Attaching Cables for the R450 MC

The corresponding sections detail how to attach the following components:

- RF antenna cable
- Ground wire
- AC power source

Refer to the following sections for the steps to attach these items.

Attaching the RF Antenna Cable

Complete the following instructions to attach the RF antenna cable.

1 Locate the RF antenna cable that extends from the RF antenna.

2 Connect the RF antenna cable to the RF antenna connector located on the bottom of the R450 MC. See Figure 39.

3 Tighten the coaxial connector to 14 in-lb. (1.58 Nm.)

Special consideration should be given when the R450 MC is installed inside a building.

The screen (shield) of the coaxial cable must be connected to earth (grounded) at the entrance to the building. This should be done in accordance with applicable national electrical installation codes (Section 820.93 of the National Electrical Code, ANSI/NFPA 70).
Weatherizing the RF Antenna Connection

Complete the following instructions to weatherproof the RF antenna.

1. Weatherize the RF antenna port connection using the weatherizing kit, Polyphasor Part No. WK-1. See Figure 40.

2. Start the tape at the top of the RF antenna connection as illustrated in Figure 40.

3. Wrap the tape clockwise around the connection several times and slowly work your way downward to weatherize the RF antenna connection. Be sure to overlap the tape at least 1/4-inch.

When complete, the weatherized port should resemble Figure 41.

Attaching the Power Cable

To attach the power cable, complete the following step.

Attach the power plug to the R450 MC by pushing and rotating the circular power connector clockwise to engage it.

The power connector is weatherproof and doesn't require weatherization wrap. However, it is okay to do so.
Connecting the Ground Wire

To attach the ground wire, complete the following steps.

1. Locate the lightning protection system ground for the site.

2. Connect the external ground lug of the R450 MC to the lightning protection system ground for that site, as illustrated in Figure 43. Use #4 American Wire Gage (AWG) copper wire with a minimum temperature rating of 75º C.

3. Tighten with a flathead screwdriver. Torque to 35 in-lb. (4.0 Nm).

4. Configure the cellular modem. See "Configuring the Cellular Modem".

   If using a WiFi modem, refer to the user's manual for the WiFi modem.

Configuring the R450 MC

Complete the following steps to configure the R450 MC.

1. Remove the power plug from the R450 MC by rotating the circular power connector counterclockwise to disengage it.

2. Allow the R450 MC to power down; all lights on the radio module should be off.

3. Configure the USB flash drive for the appropriate R450 MC using the N_SIGHT R450 host software (version 1.6 or later). This is usually done at the host software location.

4. Insert the configured USB flash drive into the USB port on the R450 MC. See Figure 44.

5. Attach the power plug to the R450 MC by pushing and rotating the circular power connector clockwise to engage it.

6. Wait for the R450 MC to power up.

   This can take approximately 30 seconds; the radio module lights should then be active. The CPU boot-up status LED flashes once every 10 seconds after the main application has initialized.

7. Safely remove the USB flash drive from the USB port.

8. Close and secure the enclosure lid.
Connecting Power to the R450 MC

The integrity of the protective earthing should be ensured when installed.

The following section contains the instructions for connecting the AC power (12V AC) or DC power (12V DC) to the R450 MC.

Connect AC power wire to the transformer or UPS per the manufacturer’s instructions. Install the transformer or UPS only in a well-ventilated area that is free from explosive or corrosive gases, vapor, or excessive dust, dirt, and moisture. Ensure a free flow of air around the transformer or UPS.

Checking Cellular Modem Connectivity

Complete the following steps to check for modem connectivity.

1. There are LED lights located on the digital and RF board that should be lit as the unit is powered on. LED lights on the Ethernet connector (BF Ethernet J1003) should be flashing or steadily lit indicating that the Ethernet connection is good.

2. If any of the lights are not illuminated, check the Ethernet connection to the board. The LED lights on the cellular modem should be illuminated. See Table 5 on page 31. At power up, all LEDs light red, then amber, and then green. When the boot sequence is complete, RSSI will light steadily green and SVC will be flashing green.

   RSSI flashing green and SVC amber, indicating reduced RSSI and/or 2G cell coverage, is sufficient for normal operation.

3. If the lights are off, this indicates a power problem with the modem or the power source.

4. Verify that the cellular modem has a SIM card installed (if applicable) and has been configured.

   Certain cellular services, such as CDMA, do not require a SIM card to operate. However, some cellular services do require a SIM card, such as GSM (EDGE and GPRS). Verify with the cellular service provider.
5 Once you have verified that all of the steps have been completed and you are still having issues with the unit operating properly, please call Neptune Customer Support at (800) 647-4832 for assistance in further diagnosis. See “Contacting Customer Support” on page 52.

6 After the R450 MC has been powered up for five minutes, remove the USB flash drive.

<table>
<thead>
<tr>
<th>LED Function</th>
<th>Off</th>
<th>Green</th>
<th>Flash Green</th>
<th>Red</th>
<th>Flash Red</th>
<th>Amber</th>
<th>Flash Amber</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSSI</td>
<td></td>
<td>Strong</td>
<td></td>
<td>Weak/None</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVC</td>
<td>3G</td>
<td>3G/NC</td>
<td></td>
<td>NC</td>
<td>2G</td>
<td>2G/NC</td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>No Connectivity</td>
<td>RX Data</td>
<td>TX Data</td>
<td>RX/TX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS</td>
<td>Disabled</td>
<td>Fix</td>
<td>Search</td>
<td>No Fix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aux</td>
<td>Disabled</td>
<td>Good</td>
<td>Failed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Swiping the MIU

Before you can proceed with these steps, the R450 MC must be set up in the N_SIGHT R450 host software version 1.6 or later. See the N_SIGHT™ R450 Online Help for instructions for setting up the R450 MC in the host software.

To verify that the R450 MC can receive readings from MIUs and can synchronize with the N_SIGHT R450 host software, complete the following steps.

1. Wait about five minutes after you have powered on the R450 MC.
2. With an R450 MIU, position the Neptune magnet against the left side of the MIU directly in line with the Neptune logo, as shown in Figure 47.
3. Swipe the MIU bringing the magnet from the side and around the corner to the top. See Figure 47.
4. When swiped, an email will be sent to the email address that is set up in the host software. See the example in Figure 48.

- Make sure the email comes from the R450 MC that you are installing.
- If you do not receive an email, continue to the instructions outlined in "If No Email is Received".

If No Email is Received

If you do not receive an email, do the following:

- Check to see if the lights on the radio module are illuminated.
- If the light is not flashing, call Neptune Customer Support. Refer to “Contacting Customer Support” on page 52.
- If the radio module lights are illuminated and you do not receive readings, there is either a problem with the network connection or a problem with the N_SIGHT R450 host software.
- Check that N_SIGHT R450 host software is configured to send emails to the correct email address.
- Check the host software to ensure that R450 MC is synchronizing.
Installing a Wall Mount System

The following section contains the instructions needed to install a wall-mounted system.

<table>
<thead>
<tr>
<th>Complete</th>
<th>Instructions</th>
<th>Ethernet</th>
<th>Cellular Modem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“Mounting the R450 MC to a Wall” on page 33</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>2</td>
<td>“Mounting the RF Antenna and Antenna Mast” on page 35</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>3</td>
<td>“Troubleshooting” on page 38</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

Mounting the R450 MC to a Wall

To mount the R450 MC to a wall, as illustrated in Figure 49, complete the following step.

Secure the R450 MC to the wall in one of the following ways:

- If mounting to wood, use #14 stainless steel wood screws.
- If mounting to masonry, use 1 3/4-inch long, 3/16-inch diameter, corrosion-resistant masonry screws.
- If mounting to sheet metal, use #14 corrosion-resistant sheet metal screws.

Figure 49  R450 MC Mounted on Wall
Connecting the Cables to the R450 MC

The RF 450 MHz antenna and the communications antenna connect on the outside of the building to the R450 MC inside the building.

1. Attach the RF antenna cable to the bottom of the R450 MC. See Figure 50.

2. Weatherize the RF antenna connection using the weatherization kit. See Figure 51.

3. Attach the circular power connector to the R450 MC by pushing and rotating the connector clockwise to engage it. See Figure 52.

4. Figure 53 illustrates the completed R450 MC and transformer wall installation.
Mounting the RF Antenna and Antenna Mast

The RF antenna mast and stand must be grounded to the same grounding electrode used for the building's electrical system to ensure that all exposed, non-current-carrying metal parts are the same potential (refer to NEC Article 810).

When mounting the RF antenna and antenna mast, it is important to maximize the line-of-sight relationship between the RF antenna and R450 MIUs for optimum RF communications.

Antenna contact with high voltage wires may result in death. Watch for overhead electric power lines when erecting antenna and mast.

Do not mount antenna or R450 MC on utility poles, electric service mast, or other structures carrying electric light or power wires. Coaxial cables must maintain clearance of at least 2 feet (0.61 M) from power or light wires of less than 250V, or at least 10 feet (3.048 M) from power wires of more than 250V, per NEC Article 810, CEC Section 54.

Mounting the Antenna Mast

Mounting the Antenna Mast to the Building

With a wall mount installation, it is necessary to mount the RF antenna on the exterior of the building. Complete the following steps to mount the antenna mast to the building.

1  Use antenna-pole brackets to install the pole to the building. See Figure 54.

2  With a drill, pre-drill your holes for the first pole bracket.

3  Secure the pole bracket in one of the following ways:
   - If mounting to a wood-constructed wall, use corrosion-resistant wood screws rated at a minimum of 20 pounds loading.
   - If mounting to sheet metal or masonry, use appropriate sheet metal, corrosion-resistant screws, or masonry anchors rated at a minimum of 20 pounds loading.
4 Place the antenna mast pole within the bracket.

5 Using a level to make sure the pole is vertical, line up a second bracket a minimum of 2 feet from the bracket you just installed.

6 Secure the second bracket similarly to the first one following steps 2 and 3.

7 Line up the pole in the two brackets. See Figure 55.

8 Secure the pole with the bolts provided.

---

### Mounting RF Antenna to Antenna Mast

To mount the RF antenna to the antenna mast, complete the following steps.

1 Attach antenna mounting brackets to the mast. See Figure 56.

2 Attach the coax cable to the RF antenna. See Figure 57.
3  Weatherize RF antenna connection using the weatherizing kit, Polyphasor Part No: WK-1. See Figure 58.

4  Mount the RF antenna to the antenna mast using antenna mounting brackets. See Figure 59.

5  Secure the coaxial cable every two feet along the mast using UV-stable wire ties. See Figure 60.
4 Troubleshooting

This section provides a table of possible symptoms, areas of focus, and actions that can be taken to try to resolve problems that could arise with your R450 Mini Collector (R450 MC) and N_SIGHT R450 host software.

Equipment Required

The following items are required in order to troubleshoot the R450 MC.

- T27 Torx Pin-Head tool to open the R450 MC
- Digital volt - Ohm multimeter
- Voltage Standing Wave Ratio (VSWR) meter
- Socket and open-end wrenches to install / remove the R450 MC
- Small, medium, and large slot style screw drivers
- #1 and #2 Phillips Head screw drivers
- Electrical tape and wire ties
- Backup R450 MC (to swap if one fails)
- R450 MC configuration USB flash drive

The USB flash drive must be configured for the specific R450 MC.

- Anti-static wrist strap and ground lead with alligator clip for attaching wrist strap to the R450 MC cabinet
- MIU configured for site
- Magnet to swipe MIU
- R450 System Field Service Tool (FST)
R450 MC Troubleshooting

The following sections describe problems that can arise and how to handle these potential problems.

Multiple R450 MCs Not Syncing with Host Database

- Host database server is down or not connected to the Internet
- Remote Internet, phone, cable, or cell service provider is either down or experiencing degraded service
- Multiple power outages affecting several sites
- Storm damage affecting multiple sites

One R450 MC Not Syncing with the Host Database

Troubleshooting this problem requires going to the R450 MC site.

First Steps

Before leaving for the site, assess the health of the R450 MC using the host system.

For instructions on how to assess the health of the R450 MC, refer to “Using System Health” in the “System Health” chapter of the N_SIGHT R450 Online Help.

- If the R450 MC is offline, this indicates that the power, power supply, CPU, or backhaul modem may not be functioning.
- Some sites are configured so that an operator can log into the R450 MC remotely, look at the logs, and watch the system activity. If the R450 MC is offline but it is still possible to log into the system, this indicates that the computer and backhaul modem are both functional.

Initial Site Activities

- Open the R450 MC and inspect the equipment.
- Make sure that there is no obvious physical damage to the system, such as evidence of burned components or wires, which may indicate a lightning strike. If there is any evidence of physical damage, the R450 MC should be replaced with the spare and returned to Neptune's repair facility.
Troubleshooting

Checking the General Health of the R450 MC

Visual Check of Radio Module

The radio module has several indicator LEDs. See Figure 61. Watch for the following:

- The red power indicator should be on.
- The RDF light should flash every time an MIU packet is received.
- The HSD RX and HSD TX lights will flash when there is communication activity between the CPU and radio module.
- The TDF and TX Enable LED should flash every 10 seconds to indicate that the transmit beacon is working.

Additional Detail Checks

If any of the previous checks failed, the following detail checks should be performed.

Power supply voltage checks should be made one at a time so that a load remains on the power supply. This is especially true of the CPU and modem voltage checks. With no load on the power supply, erroneous values may be measured.

Do not touch the computer circuit board or any of the components on it if you are not wearing the ground wrist strap which must be clipped to the box. Failure to use the wrist strap could cause damage to the computer due to static electricity.
Verifying Main Power

Usually, it is a good practice to check the main power and make sure it is within specification. If there are no power indications on the R450 MC, this must be checked.

The R450 MC uses two different versions of the power cable depending on the power source:

- AC Power Cable (for transformer), Neptune P/N: 13064-000
- DC Power Cable (for solar or UPS), Neptune P/N: 13065-000

- Disconnect the power plug to the R450 MC. See Figure 62.

Figure 62 AC Power Plug Disconnected

- Using a voltmeter, verify that there is 12V AC between pins A and B on the power plug.

- If voltage is not present on the power plug or is less than 11V AC, there is something wrong with transformer or circuit breaker.

When checking power for a DC-powered R450 MC, such as solar or UPS, verify that +12V DC is between Pins C (+) and D (-).

Verifying Radio Module Power

Neptune recommends checking the voltage levels going to the radio module.

1. First, use the wrist strap. Put it on your wrist and attach the alligator clip to the cabinet.

2. Disconnect the power plug from the R450 MC.

3. Remove the 6-pin connector located in the lower right corner of the radio module. There is a locking tab on the bottom side of the connector.
4 Reconnect the power plug to the R450 MC and wait 30 seconds for the unit to power-up.

5 Use the Digital Volt-Ohm-Multimeter to measure the voltage on the 6-pin connector across the red and black wire; there should be 5VDC.

The red lead is positive; the black lead is negative (5V DC).

6 Be sure there is 12V DC between the orange (+) and black (-) wires.

If the voltage is above or below these values, it indicates that the power supply is defective. Return the R450 MC to Neptune’s repair facility.

Cellular Modem Overview

CalAmp’s Vanguard 3000 modem is designed for operation on both GSM and CDMA networks. It offers more choice and redundancy in carrier networks.

<p>| Table 7  CDMA Bands and Speeds Supported by Vanguard 3000 |</p>
<table>
<thead>
<tr>
<th>CDMA Technology</th>
<th>Bands</th>
<th>Downlink</th>
<th>Uplink</th>
</tr>
</thead>
</table>
| EVDO Rev A (IS-856-A) | • 800 MHz Cellular  
| | • 1900 MHz PCS  
| | • 2100 | 3.1 Mbps | 1.8 Mbps |
| 1xEVDO Rev 0 (IS-856) | • 800 MHz Cellular  
| | • 1900 MHz PCS  
| | • 2100 | 2.4 Mbps | 153.6 kbps |
| 1xRTT (IS-2000) | • 800 MHz Cellular  
| | • 1900 MHz PCS | 153.6 kbps | 153.6 kbps |
Configuring the Cellular Modem

You can configure CalAmp’s Vanguard 3000 modem to operate in either a GSM or CDMA network. To manually configure the cellular modem for the R450 MC, you need a Vanguard 3000 modem from CalAmp, and then complete the steps to configure it. Refer to the quick start guide for the Vanguard 3000 on CalAmp's website: http://www.calamp.com/images/WNmanualsquickstarts/qs_vanguard3000rev1.pdf.

Equipment Required

To configure the cellular modem, you need the following equipment:

- Laptop or PC with Ethernet network port
- Vanguard 3000 quick start guide
- Ethernet cable
- Cellular service provider, SIM card (if applicable), APN, and password (from the cellular service provider)

Certain cellular services, such as CDMA, do not require a SIM card to operate. However, some cellular services do require a SIM card, such as GSM (EDGE and GPRS). Verify with the cellular service provider.

Table 8  GSM Bands and Speeds Supported by Vanguard 3000

<table>
<thead>
<tr>
<th>GSM Technology</th>
<th>Bands</th>
<th>Downlink</th>
<th>Uplink</th>
</tr>
</thead>
</table>
| UMTS/HSPA      | Five-band:  
• 850 MHz  
• 900 MHz  
• 1900 MHz  
• 2100 MHz  
• AWS  | 7.2 Mbps | 2.0 Mbps |
| EDGE/GPRS      | Quad-band:  
• 850 MHz  
• 900 MHz  
• 1800 MHz  
• 1900 MHz  | 236 kbps | 236 kbps |

Table 9  Certifying Carriers by Nation

<table>
<thead>
<tr>
<th>United States</th>
<th>Canada</th>
<th>Mexico</th>
</tr>
</thead>
</table>
| • AT&T  
• Sprint  
• Verizon | • Rogers  
• Bell  
• Telus | TBD |

Troubleshooting
Configuring the Modem

The customer maintains the username, password, and APN information provided by the cellular service provider.

To configure the cellular modem, complete the following steps:

1. Insert the SIM card (if applicable) in the cellular modem’s SIM slot. For CalAmp Vanguard 3000, be sure to insert the SIM card facing gold side upward.

2. If you are configuring this cellular modem in the field, verify that the R450 MC is powered on.

3. Run the online configuration application for the modem by following the steps outlined in the quick start guide for the Vanguard 3000.

The Unit Status window appears.
4  Verify the service is operational by opening an Internet browser page on the laptop.

5  If you are able to successfully connect to a web page, then the service is operational.

   If the service is not operational, contact the service provider.

6  If you are unable to connect to a web page, refer to the Vanguard 3000 User Manual at: http://www.calamp.com/images/WNmanualsquickstarts/m_vanguard3000_rev0.pdf

Provisioning the Vanguard 3000 for GSM

1  To provision the Vanguard 3000 for GSM service, the username is admin, and the password is password.

2  Confirm the settings, and then click OTASP. The provisioning process could take up to 90 seconds.

3  When the modem is provisioned, click Reset, and then click Reboot.

4  When prompted to confirm reboot, click Yes.

5  Provisioning is completed after rebooting when the confirmation message displays, and then the PPP status is UP.

Modem Setup Troubleshooting

If you finish provisioning the modem and the main screen still displays empty fields, select the Cell Connection tab, then Carrier, and make sure that you have a primary carrier selected. Carrier APN must be populated with a number that you get from the carrier.

R450 MC is Syncing but Not Supplying MIU Data

If the R450 MC is online, this indicates that both the computer and the backhaul modem are working. If no readings are being collected by the R450 MC, this indicates that there is a potential problem with the radio and modem.

Troubleshooting this problem requires going to the R450 MC site.

Initial Observations

After opening the R450 MC, assess the following.
• The R450 MC sends a time beacon every 10 seconds. The transmit light (TX Enable) on the radio module should flash every 10 seconds. See Figure 61 on page 40.

• If the transmit indicator (TX Enable) does not flash, this indicates that there is a potential problem with the radio module or possibly the computer's serial port.

Transmitter Transmits but No MIU Readings

This requires measuring the Voltage Standing Wave Ratio (VSWR) of the antenna system. If the VSWR is greater than 1.5:1, this indicates a problem with the feedline or the antenna. Visually check for water ingress inside the coax connector. If water is detected, then the weatherproofing on the coax connections needs to be investigated and possibly redone.

Taking the Reading and Calculating VSWR

1  Connect the analyzer to the feed line in place of the R450 MC.
2  Configure the analyzer using the preceding procedure.
3  Be sure that there is not a vertical line running through the display in the plot area. If there is, press EXAM PLOT and it should go away.
4  Allow the analyzer reading to stabilize, between 10 and 20 seconds.
5  Press EXAM PLOT to freeze the display.
6  Using the FREQ arrows, move the cursor (the vertical line in the middle of the screen) to approximately the R450 MC’s frequency. (It moves to within 100KHz of a frequency.)
7  Read the value next to RETL on the display. This is the return loss value.
8  Based on the coax type and feed line length, find the loss attributed to the coax using Table 13 on page 60.
9  The adjusted return loss is calculated by the formula:
   \[ \text{Return Loss (from Table)} - (2 \times \text{Cable Loss}) = \text{Corrected Return Loss} \]
10 Using the Corrected Return Loss value, find the VSWR using Table 12 on page 59.
11 Move the cursor to within 100KHz of the R450 MC’s receive frequency.
12 Using the new return loss value, calculate VSWR.
13 Record both values. They must be less than 1.5:1 for the antenna and feed line to pass the test.
The Radio Module Never Transmits

The simplest test is to cycle power on the R450 MC and see if the radio module starts transmitting.

- If radio module starts transmitting, this indicates that there was a soft failure in one of the serial ports possibly related to the side effects of a storm.
- If this does not fix the problem, then the R450 MC has an internal problem, either with the computer or the radio module. It is recommended that the R450 MC be returned for repair.

R450 MC Not Collecting as Much Data as Before but Still Collecting Some MIU Data

This usually indicates that there is a problem with the RF antenna and feedline system or possibly an internal problem.

1. First, check all the system voltages as outlined above.
2. Check the VSWR of the system using the technique previously described.
3. If VSWR is high, the feedline and antenna should be checked out and certified by qualified radio personnel. Visually check for water ingress inside the coax connector. If water is detected, then the weatherproofing on the coax connections needs investigating and possible redoing.
4. If power output is low, a second VSWR check can be made by placing the wattmeter between the radio module and the surge protector.
5. If the VSWR is much higher measuring before the surge suppressor, the suppressor may be damaged.
6. If the above tests pass, most likely there is a problem with the radio module, and it is recommended that the R450 MC be returned for repair. See “Contacting Customer Support” on page 52.

Diagnostic Ports

You can obtain diagnostic information from the R450 MC using the three available diagnostic ports:

- Cellular modem serial port
- Microsoft Diagnostic (MSD)
- Field Service Tool (FST)
MSD Port

The MSD diagnostic port is used for software debugging only and is not recommended to be used during field diagnostics.

FST Port

The FST diagnostic port is the primary port used for troubleshooting. The following figure shows a null modem serial cable connected to the FST diagnostic port.

Figure 65   Null Modem Serial Cable Connected to FST Port

The communications program used to monitor the FST port is HyperTerminal. However, when using Windows 7 or Vista, use the communications program called "PuTTY". This is a free terminal emulator program.

Starting FST Diagnostics

Complete the following steps to start the FST diagnostics using HyperTerminal.

1  Connect a laptop computer to the FST diagnostic port using a null modem serial cable.

2  Start the HyperTerminal program on a laptop computer.
The following window appears.

![HyperTerminal Window](image)

**Figure 66 HyperTerminal Window**

3 Set up the laptop computer to use COM1 to connect. See Figure 66.

4 Set the COM1 port settings as illustrated in Figure 67.

![Port Settings](image)

**Figure 67 Port Settings**

Refer to the following:

- **Bits per second** = 115200
- **Data bits** = 8
- **Parity** = None
- **Stop bits** = 1
- **Flow control** = None
5 Using the keyboard type V.

The R450 MC starts sending data through the FST diagnostic port.

This command times out in 10 minutes and you must type it again to continue outputting serial data.

### CPU Boot-Up Status LED

The CPU boot-up status LED is located just under the Compact Flash (CF) card. It provides the status condition of the CPU board during and after powering up (boot-up). See Figure 80. The following is a list of the LED status conditions.

1 The LED is off while the operating system comes up and the R450 MC boot loader program runs.

2 The LED flashes twice per second while the main loader is running.

3 The LED flashes once per second while the main R450 MC application is initializing.

4 The LED flashes once every 10 seconds once the main application has initialized. At this time, it is safe to remove the USB flash drive from the USB port. See “Configuring the R450 MC” on page 29.

5 The LED flashes 4 times per second when shutting down. However, this usually takes less than a second, so there are only a few of these quick flashes.
Reset Switch

There is a reset switch adjacent to the CPU boot-up status LED. Pressing the switch momentarily resets the CPU board. See Figure 69.

![Reset Switch and CPU Boot-Up Status LED](image)

Figure 69  Reset Switch and CPU Boot-Up Status LED
Contacting Customer Support

Within North America, Neptune Customer Support is available Monday through Friday, 8:00 AM to 6:00 PM Eastern Standard Time by telephone, e-mail, or fax.

To contact Customer Support by phone, call (800) 647-4832. You are directed to the appropriate team of Support Specialists. These specialists are dedicated to you until the issue is resolved to your satisfaction. When you call, be prepared to give the following information:

- The exact wording of any message that appears on the R450 MC
- A description of what happened and what you were doing when the problem occurred
- A description of how you tried to solve the problem
- Your company’s end user name

You will be directed according to the options in Figure 70 on page 52.

To contact Customer Support by fax, send a description of your problem to (334) 283-7497. Please include on the fax cover sheet the best time of day for a support specialist to contact you.

To contact Customer Support by e-mail, send your message to the following address: hhsupp@neptunetg.com.
Appendix A: RF Antenna Installation

RF Antenna Overview

There are a number of critical items you must consider when placing and installing antennas. The following list contains items that can influence the antenna placement and installation.

Mounting the Antennas

Consider the following when mounting the antennas.

1. Mount the RF antenna at least 30 feet high with an unobstructed view of the coverage area.
   - The supporting structure, if the antenna is not mounted above it, can cause specific areas of limited coverage.
   - Water towers in particular can severely limit coverage where the signal must pass directly through the tank. It is recommended that when mounting antennas on a water tower they be mounted on the top, as close to the center, as is practical.

If the antenna must be mounted on the side of the water tower, then position it at least five feet away from the side of the water tower to minimize coverage area problems.

   - When mounting the antenna on a traditional three- or four-leg tower, the standoff mount for the antenna must position the antenna at least two feet away from the tower to minimize coverage area problems.

2. Avoid making the antenna for the R450 Mini Collector (R450 MC) the tallest point in the surrounding area. This may be unavoidable, but it increases the potential of the antenna being damaged by lightning.

Site Recommendations

The following are recommendations for selecting the site to install the antenna with multiple transmitters, receivers, and antennas.

Extra care is required when selecting these sites.

   - Avoid mounting the R450 MC antenna so that it is at the same height as another antenna on the site, regardless of the frequencies.
• For sites that have multiple antennas, if possible, mount the antennas one above the other, separating each from the other by several wavelengths of the lowest frequency antenna. This will minimize the interference between the systems.

Usually a 450 MHz wavelength is ~26-inches.

• The exception to the previous rule is for cellular antennas. As long as the R450 MC antenna is either above, below, or in the middle of the ring of cell antennas, the two systems can coexist without interference.

• Antenna sites that must share space with multiple transmitting systems may require additional equipment to protect the systems from interfering with each other. These sites may also require additional engineering to make them perform well.

• If there are radio systems at the site that are already operating on the 450 - 470 MHz band, it may be advantageous to combine the signals into one antenna system using the appropriate equipment. This often works better than attempting to protect the individual systems from interfering with each other.

• Managed antenna sites may require additional equipment and may dictate how an installation is to be performed. As long as the installation meets Neptune's minimum requirements, following the site's requirements is recommended.

Feed Line and Antenna Recommendations

Neptune recommends that you consult with a qualified installer on the design and installation of the antenna systems. If the installer is already familiar with the sites and the existing equipment, this can make the installation go more smoothly.

Feed Line

The feed line is a significant contributor to both good and poor system performance. A properly installed feed line is critical to optimal system performance. Testing the antenna while it is on the ground can ensure the system is working properly.

Installation of the connectors is best done with the proper tools and a trained installer. With the proper tools and jigs, installing coaxial (coax) connectors takes only a few minutes each. Not using the proper tools as recommended by the manufacturer could potentially cause problems, either immediately or after several years of apparently proper operation.
Feed Line Requirements

- The RF antenna and feed line system installation must be certified by the installer after it is completed to perform according to specifications.

- Maximum loss for the feed line and connectors must be less than 3 dB.

- For the antenna cable that runs 50 feet or less, the Times Microwave P/N: LMR-400-UF is an acceptable coax cable. It has a loss of 3.3dB/100' @ 450MHz. Pre-terminated coax cable assemblies can be purchased from companies such as Tessco Technologies, Talley Communications, and Custom Cable Assemblies. Each end must be terminated with an N-male type connector. For the antenna cable that runs over 50', see the following page for recommended coax cable.

- It may be necessary to use more than one type of coax in an installation. The FSJ4-50B cable is very flexible and may be used for the last section of a coax run to the R450 MC if the additional flexibility is required.

- The feed line must be bonded at the top of the tower and at the base of the tower. Andrews bonding kits and procedures should be used for all bonds.

- For towers over 150 feet tall, the feed line should be bonded at regular intervals down the tower. The general recommendation is that the feed line be bonded by a minimum of 200 feet. Site requirements and standard practices should dictate the configuration.

- An optional surge protector may be installed on the tower near the antenna to help protect the feed line but is not required.

- For the AVA5-50 cable, or larger, jumpers should be used to go between the larger cable and the R450 MC and antenna connectors.

- Andrews provides installation instructions for Heliax Coaxial Cable. See Bulletin 17800B Revision C. Neptune can supply a PDF copy on request through Customer Support.
Neptune Part Numbers

The following tables contain the Neptune part numbers for cable and connectors.

Table 10  Neptune Part Numbers for Cable and Connectors

<table>
<thead>
<tr>
<th>Neptune Part Number</th>
<th>Andrews Part Number</th>
<th>Coax Diameter</th>
<th>Loss per 100’ @ 450 MHz</th>
<th>Minimum Bend Radius</th>
<th>Weight per Foot</th>
<th>Maximum Length</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10046-116</td>
<td>FSJ4-50B</td>
<td>1/2-inch</td>
<td>2.31 dB</td>
<td>1.25-inch</td>
<td>0.14</td>
<td>100’</td>
<td>Should only be used for jumpers and short cable run</td>
</tr>
<tr>
<td>10046-119</td>
<td>LDF4-50A</td>
<td>1/2-inch</td>
<td>1.45 dB</td>
<td>5-inch</td>
<td>0.15</td>
<td>150’</td>
<td>Recommended antenna cable for 150’ cable runs or less</td>
</tr>
<tr>
<td>10046-118</td>
<td>AVA5-50</td>
<td>7/8-inch</td>
<td>0.74 dB</td>
<td>10-inch</td>
<td>0.30</td>
<td>400’</td>
<td>Recommended antenna cable for runs over 150’</td>
</tr>
</tbody>
</table>

The following tables contain the Neptune part numbers for cable and connectors.

Table 11  Connectors and Accessories

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Neptune Part Number</th>
<th>Andrews Part Number</th>
<th>Coax Diameter</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSJ4-50B</td>
<td>10046-117</td>
<td>F4A-PNMDM-6-USA</td>
<td>Premade coax 6-foot jumper DIN male on one end, N male on other</td>
<td>Used as a jumper cable from the feed line to the R450 MC or antenna</td>
</tr>
<tr>
<td></td>
<td>8138-198</td>
<td>F4PDMV2</td>
<td>Coax connector, 7/16-inch DIN male</td>
<td>Used to make a custom jumper using the FSJ4 cable</td>
</tr>
<tr>
<td></td>
<td>8138-189</td>
<td>F4PNMV2-HC</td>
<td>Coax connector, N male</td>
<td>Used to make a custom jumper using the FSJ4 cable</td>
</tr>
<tr>
<td>LDF4-50A</td>
<td>8138-199</td>
<td>L4TDF-PS</td>
<td>Coax connector, 7/16-inch DIN female</td>
<td>Used to connect to the FSJ4 jumper cable</td>
</tr>
<tr>
<td></td>
<td>8138-200</td>
<td>L4TNM-PS</td>
<td>Coax connector, N male</td>
<td>Mates with the R450 MC and antenna connectors</td>
</tr>
<tr>
<td></td>
<td>13014-001</td>
<td>SG12-12B2U</td>
<td>SureGround grounding kit for 1/2-inch coax</td>
<td></td>
</tr>
<tr>
<td>AVA5-50</td>
<td>8138-190</td>
<td>ALDF-PS</td>
<td>Coax connector, 7/16-inch DIN female</td>
<td>Used to connect to FSJ4 jumper cable</td>
</tr>
</tbody>
</table>

For the long-term protection of all RF connections, use the appropriate Andrews weatherproofing kit (Andrews P/N 245171) on all coaxial connectors.
### Antenna

General Specifications for the RF Antenna.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tr>
<td>Comtelco</td>
<td>BS450XL3-C</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>450-470 MHz</td>
</tr>
<tr>
<td>Maximum Input Power (Watts)</td>
<td>250W</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>Gain</td>
<td>3dBi</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt;2.0:1</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Vertical Beam Width</td>
<td>40 degrees</td>
</tr>
<tr>
<td>Lightning Protection</td>
<td>Direct ground</td>
</tr>
<tr>
<td>Termination</td>
<td>N Female</td>
</tr>
<tr>
<td>Overall Length</td>
<td>39 inches</td>
</tr>
<tr>
<td>Support Pipe Diameter</td>
<td>1.35 inches</td>
</tr>
<tr>
<td>Support Pipe Length</td>
<td>5 inches</td>
</tr>
<tr>
<td>Lateral Thrust</td>
<td>14.2 pounds</td>
</tr>
<tr>
<td>Flat Plate Area</td>
<td>0.21 square feet</td>
</tr>
<tr>
<td>Rated Wind Velocity</td>
<td>125 MPH</td>
</tr>
<tr>
<td>Weight</td>
<td>5 pounds</td>
</tr>
<tr>
<td>Mounting Hardware (ordered separately)</td>
<td>BSLMNT2</td>
</tr>
<tr>
<td>Standoff, 25-inch (ordered separately)</td>
<td>BSSMNT10-4</td>
</tr>
</tbody>
</table>
Requirements

- The RF antenna, if mounted on the side of a tower or other supporting structure, must be mounted so that it is at least 5 feet away from the structure. The components to offset the antenna are specific to the installation and are not included by Neptune with the R450 MC package.

- The antenna is large and care must be taken when hoisting it up a tower so that it is not damaged.

- The feed line should not be attached to the antenna while it is being hoisted up the tower or other supporting structure. The feed line should be attached after the antenna is in place.

- There have been reports of damage to the antenna's N connector where the center pin has become bent and shorts out the antenna system. Care must be taken not to damage the connector.

System Certification

The RF antenna supplied with the R450 MC is specified as having a VSWR of 1.5:1 or better over the 450 - 470 MHz range. Conduct a test by hooking up the wattmeter to the coaxial connector at the R450 MC end to measure the VSWR for the antenna and feed line combined.

The R450 MC’s transmitter cannot be used to certify the antenna system. The transmitter only transmits short packets approximately 50ms in length, so taking an accurate reading of forward or reflected power cannot be done with standard equipment.

Measuring VSWR at the R450 MC must take into account losses in the feed line. The easiest approach is to use return loss instead of VSWR. The 1.5:1 VSWR translates into a return loss of 13.98dB. The tables below will assist with the calculation.

It is recommended that the feed line be certified as a separate step. This is best performed by putting a known amount of power into one end of the cable and verifying that, after correcting for the cable losses, the correct amount of power is coming out the other end.
### Power Measurement

#### Table 12  Power Measurement to Return Loss and VSWR Conversion Table

<table>
<thead>
<tr>
<th>Input Power</th>
<th>1W</th>
<th>5W</th>
<th>10W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reflected Power Reading</strong></td>
<td><strong>Return Loss</strong></td>
<td><strong>VSWR</strong></td>
<td></td>
</tr>
<tr>
<td>0.001</td>
<td>0.05</td>
<td>0.01</td>
<td>30.0</td>
</tr>
<tr>
<td>0.002</td>
<td>0.10</td>
<td>0.02</td>
<td>27.0</td>
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<tr>
<td>0.003</td>
<td>0.15</td>
<td>0.03</td>
<td>25.2</td>
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<tr>
<td>0.004</td>
<td>0.20</td>
<td>0.04</td>
<td>24.0</td>
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<tr>
<td>0.005</td>
<td>0.25</td>
<td>0.05</td>
<td>23.0</td>
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<tr>
<td>0.006</td>
<td>0.30</td>
<td>0.06</td>
<td>22.2</td>
</tr>
<tr>
<td>0.007</td>
<td>0.35</td>
<td>0.07</td>
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<td>0.09</td>
<td>20.5</td>
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<td>0.10</td>
<td>20.0</td>
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<td>17.0</td>
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<td>0.40</td>
<td>14.0</td>
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<td>0.250</td>
<td>0.50</td>
<td>13.0</td>
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<tr>
<td>0.060</td>
<td>0.300</td>
<td>0.60</td>
<td>12.2</td>
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<tr>
<td>0.070</td>
<td>0.350</td>
<td>0.70</td>
<td>11.5</td>
</tr>
<tr>
<td>0.080</td>
<td>0.400</td>
<td>0.80</td>
<td>11.0</td>
</tr>
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<td>0.090</td>
<td>0.450</td>
<td>0.90</td>
<td>10.5</td>
</tr>
<tr>
<td>0.100</td>
<td>0.500</td>
<td>1.00</td>
<td>10.0</td>
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<td>0.550</td>
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<td>0.200</td>
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<td>6.99</td>
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</table>

#### Acceptable Range

<table>
<thead>
<tr>
<th>Input Power</th>
<th>1W</th>
<th>5W</th>
<th>10W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reflected Power Reading</strong></td>
<td><strong>Return Loss</strong></td>
<td><strong>VSWR</strong></td>
<td></td>
</tr>
<tr>
<td>0.20</td>
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<tr>
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<td>5.38</td>
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## Coax Cable Loss

<table>
<thead>
<tr>
<th>Length (ft.)</th>
<th>Loss in dB @ 450 MHz</th>
<th></th>
<th>Loss in dB @ 450 MHz</th>
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<td>10</td>
<td>0.231</td>
<td>0.145</td>
<td>0.074</td>
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<tr>
<td>20</td>
<td>0.462</td>
<td>0.290</td>
<td>0.149</td>
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<td>0.693</td>
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<td>40</td>
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<td>50</td>
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<td>60</td>
<td>1.386</td>
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<td>1.617</td>
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</tr>
<tr>
<td>370</td>
<td>8.547</td>
<td>5.365</td>
<td>2.753</td>
</tr>
<tr>
<td>380</td>
<td>8.778</td>
<td>5.510</td>
<td>2.827</td>
</tr>
<tr>
<td>390</td>
<td>9.009</td>
<td>5.655</td>
<td>2.902</td>
</tr>
<tr>
<td>400</td>
<td>9.240</td>
<td>5.800</td>
<td>2.976</td>
</tr>
</tbody>
</table>
VSWR Calculation

Neptune recommends the following method of computing VSWR. Taking the reading at the R450 MC end of the feed line without compensating for cabling losses may give a false impression of the antenna and feed line performance.

Using a Wattmeter and a Handheld 450 MHz Radio

The recommended procedure is to use a handheld commercial grade transceiver that is tuned to the R450 MC’s transmitter frequency and an inline wattmeter, such as a Bird Model 43 Wattmeter with the appropriate element (slug) for the frequency range and power output of the transceiver.

The Bird Model 43 Wattmeter uses elements to set the frequency and power ranges that the meter will read. The wattmeter element should be a 400 - 1000 MHz model sized so that the forward power reading is close to full scale. For a 5W output handheld, the Bird 5E element is recommended. If the radio puts out more than 5W, a Bird 10E or higher power element may be required.

Complete the following step to use a wattmeter and handheld to calculate VSWR.

1. Connect the wattmeter and transceiver to the feed line in place of the R450 MC.
2. Measure both the forward and reflected power.
3. Using the Power Measurement to Return Loss and VSWR Conversion Table on page 59, find the return loss value.
4. Based on the coax type and the feed line length, find the loss attributed to the coax using the Coax Cable Loss Table on page 60.
5. The adjusted return loss is calculated by the formula:
   \[
   \text{Return Loss (from Table)} - (2 \times \text{Cable Loss}) = \text{Corrected Return Loss}
   \]
6. Using the Corrected Return Loss value, find the VSWR using the Power Measurement to Return Loss and VSWR Conversion Table on page 59.
7. Change the frequency on the handheld transceiver to the R450 MC’s receive frequency.
8. Measure the power and calculate VSWR using the procedure just used for calculating transmitter VSWR.
9. Record both transmit and receive frequencies VSWR values. In order for the antenna system to pass, both readings must be less than 1.5:1.
Using the AEA 140-525 Antenna Analyzer

Complete the following steps to configure the analyzer:

- **This procedure assumes that the analyzer has not been configured prior to use.**

1. Turn the analyzer **ON**.
2. Type the frequency: **46000**.
3. Press **Enter**.
4. Using the width buttons, set the value next to **WID** on the screen to **20**.
5. Set the reading to return loss by pressing **F1** three times. (Press it slowly; the unit should beep each time.)

![Figure 71 AEA Antenna Analyzer](image)

Taking the Reading and Calculating VSWR

1. Connect the analyzer to the feed line in place of the R450 MC.
2. Configure the analyzer using the preceding procedure.
3. Be sure there is not a vertical line running through the display in the plot area. If there is, press **EXAM PLOT** and it should go away.
4. Allow the analyzer reading to stabilize, between 10 and 20 seconds.
5. Press **EXAM PLOT** to freeze the display.
6. Using the FREQ arrows, move the cursor (the vertical line in the middle of the screen) to approximately the R450 MC's frequency. (It moves to within 100KHz of a frequency.)
7. Read the value next to **RETL** on the display. This is the return loss value.
8. Based on the coax type and the feed line length, find the loss attributed to the coax using the Coax Cable Loss Table on page 60.
9. The adjusted return loss is calculated by the formula:
   
   \[
   \text{Return Loss (from Table)} - (2 \times \text{Cable Loss}) = \text{Corrected Return Loss}
   \]
10. Using the Corrected Return Loss value, find the VSWR using the Power Measurement to Return Loss and VSWR Conversion Table on page 59.
11. Move the cursor to within 100KHz of the R450 MC's receive frequency.
12 Using the new return loss value, calculate VSWR.

13 Record both values. They must be less than 1.5:1 for the antenna and feed line to pass the test.

General Installation Guidelines

Unpacking

As with all precision electronic instruments, the RF antenna should be handled with care; however, no additional special handling is required.

After unpacking the RF antenna, inspect it for damage. If any parts of the RF antenna appear to be damaged or prove to be defective upon installation, notify your Neptune sales representative. If the unit or item requires reshipment, use the original cardboard box and packing material.

In particular, check to be sure that the N connector at the base of the antenna is not damaged. This is much easier to deal with while the antenna is on the ground than after it is installed.

RF Antenna Installation Kit

The RF antenna, mounting brackets, coax cable, and standoff (if required), must be ordered as accessories. The antenna mounting brackets are designed to mount on the top of a mast or similar structure. If the installation requires offsetting the antenna from the supporting structure, this must be ordered separately. Antenna offsets can be ordered from companies such as Comtelco, Tessco, Talley, and Hutton Communications. Use a minimum of 24 inches of offset between the supporting structure and antenna. Neptune can provide a 25-inch offset that's compatible with ROHN 45 type towers—(Neptune P/N: 13135-001).
Table 14 shows the recommended tools and materials you need to successfully install the RF antenna.

Some items may not apply to your specific installation or the list may not contain all required tools or materials depending on which installation method you use.

Table 14  Recommended Tools and Materials for RF Antenna Installations

<table>
<thead>
<tr>
<th>Item</th>
<th>Description/ Recommendation</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool Kit</td>
<td>Contains standard tools including:</td>
<td>Various installation procedures performed by the installer</td>
</tr>
<tr>
<td></td>
<td>• Assorted screwdrivers (medium, flat head)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cordless electric drill/assorted bits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Adjustable wrench</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Standard socket wrench set</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Standard box-end wrench set</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hammer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Channel locks</td>
<td></td>
</tr>
<tr>
<td>UV-Stable Cable Ties</td>
<td>8-inch and 12-inch 20.32cm and 30.48cm</td>
<td>Securing coax cable</td>
</tr>
<tr>
<td>Cable Clips</td>
<td>Various sizes</td>
<td>Securing coax cable</td>
</tr>
<tr>
<td>Concrete Blocks</td>
<td>8-inch X 8-inch X 16-inch 20.32cm X 20.32cm X 40.64 cm</td>
<td>Ballast for the R450 MC stand</td>
</tr>
<tr>
<td>Weatherizing Kit</td>
<td>PolyPhasor P/N: WK-1 - or Andrews P/N 245171</td>
<td>Weatherproofing coax cable connections</td>
</tr>
<tr>
<td>Electrical Tape</td>
<td>Scotch® Heavy Duty Vinyl Electrical Tape 22 - or Scotch® Super 88</td>
<td>Weatherproofing coax cable connections and other connections as required</td>
</tr>
</tbody>
</table>
Installation of the RF Antenna

This section contains sections detailing the installation instructions for the RF antenna installation.

Locating the Site

Choose a location that does not interfere with any other wiring and is easily accessible. Once chosen, complete the following procedures.

The first step in securing the R450 MC pole in the ground is to locate where the RF antenna will be seated. Complete these instructions to locate the site for the pole.

1. Locate the conduit for the RF antenna cable and the trench where the cable for the RF antenna will be buried. See Figure 73.

2. Find a suitable spot close in this location to seat the 2-inch round SCH40 galvanized steel pole.

- The pole used to support the PV array must be designed per the local soil conditions to meet the following minimum requirements:
  - Solar panel array area based at tilted angle
  - Typical sustained wind speed per the recommended local building code.

- The pole is to be seated against a firm crushed stone base, on firm compacted soil a minimum of 6-inch below the frost line encased in reinforced concrete per ASTM standards.

- The pole is to be level and plumb.

- Pole diameter and wall thickness sized to withstand array forces without damage.
Mounting the RF Antenna

![RF Antenna](image1)

**The RF antenna must be installed by trained professionals in accordance with the FCC site license.**

**The cable, connectors, and the antenna installation must be checked with the VSWR meter.**

To mount the RF antenna, complete these steps.

1. Mount the RF antenna per the instructions included with the antenna kit. See Figure 74.
2. Use the mounting hardware (ordered as accessories) to mount the RF antenna per the supplied instructions.
3. Install the RF antenna in accordance with the FCC site license (per the antenna mounting instructions contained in this appendix).
4. Weatherize the antenna coaxial connector using the weatherizing kit. See Table 14 on page 64.

![RF Antenna to be Mounted](image2)

**Figure 74 RF Antenna to be Mounted**

Attaching the RF Antenna Cable

To attach the RF antenna cable to the R450 MC, complete the following steps.

1. Locate the RF antenna cable that extends from the RF antenna cable conduit. See Figure 75.
2. Connect the RF antenna cable to the RF antenna connector located on the bottom of the R450 MC. See Figure 75.
3. Tighten the coaxial connector to 14 in-lb. (1.58 Nm.)

![Antenna Connections](image3)

**Figure 75 Antenna Connections**
Weatherizing the Cable Connections

Special consideration should be given when the R450 MC is installed inside a building.

The screen (shield) of the coaxial cable must be connected to earth (grounded) at the entrance to the building. This should be done in accordance with applicable national electrical installation codes (Section 820.93 of the National Electrical Code, ANSI/NFPA 70).

Complete the following instructions to weatherproof the cables with the black tape.

1. Using the weatherizing kit, start the tape at the top of the RF antenna connection as illustrated in Figure 76.

2. Wrap the tape around the connection several times; slowly work your way downward to weatherize your connection at the base.
Appendix B: R450 MC Stand

Using the R450 MC Stand

Ballast Requirements vs. Wind Speed

The tables in this appendix demonstrate the requirements for a proper ballast for the R450 Mini Collector (R450 MC) stand.

For AC-powered systems, only eight (8) concrete blocks are required.

Ballast requirements are listed for the “Rohn Industries Stand – Part # JRM23855” on page 70. Be sure to evenly distribute the ballast to secure the stand in its position as illustrated in Figure 77.

Install a rubber pad beneath the stand to protect the roof surface.

- For Rohn stand, use Rohn P/N: JRMPAD
- For Valmont stand, use Valmont P/N: B1564

Ballast Considerations

If the stand you are installing is in a rooftop location, Neptune recommends using a ballast to secure the stand against high winds. Refer to the following section for ballast recommendations.

Applying the Ballast to the Stand

After the R450 MC is wired, the next stage is to secure the entire unit in its location by applying the ballast.

To apply the ballast to the stand, complete the following steps.

1. Refer to Table 15 on page 70 to determine the adequate amount of ballast for your installation.

2. Evenly distribute the ballast to secure the stand in its position as illustrated in Figure 77.

Figure 77   Stand with Concrete Block Ballast
Rohn Industries Stand – Part # JRM23855

The stand must be secured to the building structure before operation.

The following table shows the U.S. standard and metric requirements for the Rohn Industries Stand – Part # JRM23855.

Table 15  Rohn Industries Stand
Concrete Block Requirements

<table>
<thead>
<tr>
<th>Wind Speed (mph)</th>
<th>Ballast (lbs)</th>
<th>8-inch x 8-inch x 16-inch Concrete Block (27.5lbs. ea.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>250</td>
<td>9</td>
</tr>
<tr>
<td>68</td>
<td>350</td>
<td>13</td>
</tr>
<tr>
<td>77</td>
<td>450</td>
<td>16</td>
</tr>
<tr>
<td>86</td>
<td>550</td>
<td>20</td>
</tr>
<tr>
<td>93</td>
<td>650</td>
<td>24</td>
</tr>
<tr>
<td>100</td>
<td>750</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wind Speed (kph)</th>
<th>Ballast (kg)</th>
<th>20 x 20 x 20 cm Concrete Block (12.5 kg ea.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>113</td>
<td>9</td>
</tr>
<tr>
<td>109</td>
<td>159</td>
<td>13</td>
</tr>
<tr>
<td>124</td>
<td>204</td>
<td>16</td>
</tr>
<tr>
<td>138</td>
<td>249</td>
<td>20</td>
</tr>
<tr>
<td>150</td>
<td>295</td>
<td>24</td>
</tr>
<tr>
<td>161</td>
<td>340</td>
<td>27</td>
</tr>
</tbody>
</table>

This table assumes 10 ft.\(^2\) (.93 m\(^2\)) projected area with the centroid at 4 feet (1.22 M) up from roof.

Reference:

- JRM Allowable Antenna Areas
- Rohn Drawing #A981812

This table assumes 10 ft.\(^2\) (.93 m\(^2\)) projected area with the centroid at 4 ft. (1.22 m) up from roof.

Reference:
Appendix C: Solar Power Information

Magnetic Declination

Correction for Magnetic Declination and Array Tilt

Facing True South

For optimum performance, your PV array should face true south in the Northern Hemisphere (and true north in the Southern Hemisphere). However, when determining direction using a magnetic compass, indicated bearings will vary from true bearings because of the difference between the location of the true and magnetic north poles. This angular difference varies with location on the globe and is called the “declination.” Values of declination for the contiguous United States and portions of Mexico, Canada, and the Caribbean are shown on the map in Figure 79 on page 73. In order to correct for magnetic declination when sighting your PV array, proceed as follows:

• Locate your site on the map shown in Figure 79 on page 73. (Great accuracy is not critical.)

• Interpolate the value for magnetic declination in degrees based on the lines of constant declination (isogonic lines) shown above. For example, the declination for Washington, D.C., is approximately -11°; for Chicago, IL, -1°; and for Los Angeles, CA, +14°.

• Determine magnetic south at your site using a magnetic compass.

• If the local declination found in step 2 is negative, true south is that number of degrees added to magnetic south. For example, at Washington, D.C., true south is the same as 180° + 11° = 191° indicated. If the local declination found in step 2 is positive, true south is that number of degrees subtracted from magnetic south. For example, at Los Angeles, true south is the same as 180° – 14° = 166° indicated.

• Orient your array in the direction of true south (or north if applicable) as determined above.

• A declination chart for North America is provided below for assistance in determining the appropriate correction for other sites. Other suggested resources include World Aeronautical Charts (WAC), the World Wide Web, local airports, or government agencies. The Internet site www.ngdc.noaa.gov/cgi-bin/ will calculate magnetic variation from an input of altitude, latitude, and longitude.
Specific Tilt Angle

For optimum performance, your PV array should set to a specific tilt angle. To determine the desired tilt angle of the array, use an atlas to determine the latitude of the installation location.

To determine what your latitude is:

- Locate your site on the map. (Great accuracy is not critical.)
- Determine what latitude line closest intersects your region.

Take this value and add the factor based on the table below. This will provide the optimum worst case performance with the minimum amount of annual adjustment based on the winter months (Northern hemisphere). For example, if the solar panel location is at 32° latitude, take $32° + 15° = 47°$. In this example, the solar panel tilt angle would be set for 47°.

- Latitude range between 90 – 60° (Set to 60°)
- Latitude range between 60 – 25° (Set to latitude + 15°)
- Latitude range between 25 – 15° (Set to latitude + 5°)
- Latitude range between 15 – 0° (Set to 15°)

It is recommended that the array tilt be limited to 15° for a minimum angle and 60° for a maximum tilt angle.
Magnetic Declination for the United States

The following map of the United State illustrates the magnetic declination for the U.S.

Magnetic Declination for the U.S.
2004

Figure 79  Magnetic Declination U.S.

Selecting the Correct Solar Power System

Complete the following steps to select the correct solar power system for the R450 Mini Collector (R450 MC).

1. Determine the installation location.

2. Using Figure 80 on page 74, determine in which zone the site location is situated.
When a site location is close to a zone transition line, choose the larger size solar power system. For example, if the site location falls on or near transition line D and E, choose the Zone E solar power system recommendation.

3 Select the appropriate solar power system from the following table.

Table 17 Solar Power System Selection

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C, and D</td>
<td>150 W</td>
<td>26 x 58 in.</td>
<td>13068-200 (small pole/stand) 13068-400 (large pole)</td>
</tr>
<tr>
<td>E and Canada</td>
<td>220 W</td>
<td>52 x 48 in.</td>
<td>13068-300 (small pole/stand) 13068-500 (large pole)</td>
</tr>
</tbody>
</table>

- The small pole/stand version is for a 2-inch to 4-inch diameter schedule 40 galvanized steel pole or stand.
- The large pole version is for a 5-inch to 16-inch diameter pole.

4 Refer to the accessories drawing for the most current information.
# Troubleshooting the Solar Power System

The following table shows some probable causes of problems you could see with the solar power system.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Probable Cause</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Charging Power</td>
<td>Overload solar/load</td>
<td>Verify that the load is not exceeding the system capability.</td>
</tr>
<tr>
<td></td>
<td>High temperature disconnect</td>
<td>Allow the controller to cool down, and then verify continued operation.</td>
</tr>
<tr>
<td></td>
<td>Reverse polarity</td>
<td>Re-configure the wiring terminations to restore operation.</td>
</tr>
<tr>
<td></td>
<td>Battery select fault</td>
<td>Verify that the jumper settings are correct for the system configuration.</td>
</tr>
<tr>
<td></td>
<td>Solar module is shaded</td>
<td>Confirm that the solar module angle and direction are correct. Make sure there is no shade.</td>
</tr>
<tr>
<td>Load Disconnected</td>
<td>Load low voltage disconnect (LVD) trip on the load controller</td>
<td>Confirm that the battery voltage is above the LVD cutoff voltage. If not, allow the battery to fully charge.</td>
</tr>
<tr>
<td></td>
<td>Load overload or short circuit</td>
<td>Check the wire terminations for proper configuration.</td>
</tr>
<tr>
<td></td>
<td>LVD trip repeatedly</td>
<td>Verify that the load is not exceeding the system capability. Confirm that the battery depth of discharge (DOD) cycles have not exceeded the normal end of life.</td>
</tr>
<tr>
<td>Breaker Trip or Fuse Blown</td>
<td>Improper wiring</td>
<td>Confirm that wiring is correct and terminals are not corroded. Use an ohm meter to confirm the wire and terminal continuity.</td>
</tr>
<tr>
<td></td>
<td>Short circuit</td>
<td>Confirm that the load end of the circuit breaker does not have a short circuit.</td>
</tr>
<tr>
<td></td>
<td>Breaker damaged</td>
<td>Use an ohm meter to verify the breaker continuity out of circuit. Replace the breaker if necessary.</td>
</tr>
</tbody>
</table>
Troubleshooting the Solar Panel’s Load/Controller

You can measure load voltages at the designated terminal blocks.

- If the battery voltage is present at the load blocks, you can assume that the load fuse and the LVD are fully functional.

**LVD occurs at 11.5V. LVD reconnect occurs at 12.6V.**

- If the battery voltage is above 12.8 Vdc with the PV array on in the sunlight, and the load is attached and active, the controller is actively charging.

- No further troubleshooting of the controller is required

Troubleshooting the Solar Panel’s Battery

Table 19 lists the 120 hour load voltages during the discharge cycle from full charge to 100% discharge to 10.5V at 25°C (77°F). Please note that these voltages are averages and will vary slightly from battery to battery even of the same rating. However, they are a good indicator of state of charge for Concorde AGM batteries. This data is for newer batteries with relatively few cycles. An older battery will measure a lower voltage for a given depth of discharge (DOD).
You can measure the batteries both voltage open circuit (Voc) and voltage under charge (Vuc). The Vuc is a simple method to measure voltage without disabling the load or disabling the system from charging. Use Voc when the battery end of life is in question, and a more accurate means of measurement is required.

Batteries should be tested for end-of-life whenever a particular system begins to fall in a state-of-charge (SoC) below 80% repeatedly, or the system begins to exhibit LVD on a recurring basis. This may vary depending on load use, depth of discharge and temperature extremes, but can vary between 3–10 years.

To measure for battery end-of-life:

1. Disconnect the battery from the system.
2. Charge the battery with an appropriate three-stage battery charger.
3. After completion, allow the battery to settle for three hours with no charge or load attached.

The following table provides Voc and Vuc for SoC at 25°C.

<table>
<thead>
<tr>
<th>DOD (%)</th>
<th>120 hr. Rate (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12.69</td>
</tr>
<tr>
<td>20</td>
<td>12.58</td>
</tr>
<tr>
<td>30</td>
<td>12.45</td>
</tr>
<tr>
<td>40</td>
<td>12.32</td>
</tr>
<tr>
<td>50</td>
<td>12.18</td>
</tr>
<tr>
<td>60</td>
<td>12.05</td>
</tr>
<tr>
<td>70</td>
<td>11.88</td>
</tr>
<tr>
<td>80</td>
<td>11.65</td>
</tr>
<tr>
<td>90</td>
<td>11.40</td>
</tr>
<tr>
<td>100</td>
<td>10.50</td>
</tr>
</tbody>
</table>

These voltages are averages and will vary slightly from battery to battery even of the same rating. However, they are a good indicator of state of charge for Concorde AGM batteries. This data is for newer batteries with relatively few cycles. An older battery will measure a lower voltage for a given DOD.
• If an individual battery does not hold a voltage of at least 12.6VDC open circuit after a full charge and a three-hour wait period under no load, you may have a damaged cell and require a battery replacement.

• If battery voltage climbs very rapidly under charge, then falls rapidly after removing the charge, you may have a damaged cell and require a battery replacement.

### Table 20 Voltages for SoC at 25°C

<table>
<thead>
<tr>
<th>SoC (%)</th>
<th>Voc</th>
<th>Vuc</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>12.8</td>
<td>14.2</td>
</tr>
<tr>
<td>80</td>
<td>12.6</td>
<td>12.91</td>
</tr>
<tr>
<td>60</td>
<td>12.3</td>
<td>12.60</td>
</tr>
<tr>
<td>40</td>
<td>12.0</td>
<td>12.25</td>
</tr>
<tr>
<td>20</td>
<td>11.8</td>
<td>11.81</td>
</tr>
<tr>
<td>0</td>
<td>&lt;11.6</td>
<td>&lt;11.81</td>
</tr>
</tbody>
</table>
PV Array (Solar Panel) Troubleshooting

If the array is unobstructed, non-shaded, at the correct tilt angle, and in full light between 10am and 3pm, you can verify the module performance per the nameplate ratings for Voc and short circuit current (ISC) as follows:

1. Set the PV(+) breaker to OPEN (OFF) position.

2. Using a volt meter, measure the Voc voltage between the PV(+) and PV(-) terminal blocks. It should measure within 5% of the nameplate rating in LOW to HIGH sunlight.

3. Set the PV(+) breaker to CLOSED (ON) position.

4. Using an ammeter rated for a maximum system ISC value, measure the charging current through the PV(+) terminal. In LOW sunlight, it should measure approximately 30% or less of the rating shown on the nameplate; 60% or less of nameplate rating in MED sunlight; and 60% or greater in HIGH sunlight. The degree of sunlight is based on cloud cover and height on the horizon for that time of day in winter. Table 21 provides the degrees of sunlight at various times on a clear, sunny day in the winter:

Table 21  Sunlight by Time of Day in the Winter

<table>
<thead>
<tr>
<th>Degree of Sunlight</th>
<th>Time</th>
<th>Sun Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>7:00 a.m.-9:00 a.m.</td>
<td>10-30%</td>
</tr>
<tr>
<td>MED</td>
<td>9:00 a.m.-11:00 a.m.</td>
<td>30-60%</td>
</tr>
<tr>
<td>HIGH</td>
<td>11:00 a.m.-1:00 p.m.</td>
<td>60-100%</td>
</tr>
<tr>
<td>MED</td>
<td>1:00 p.m.-3:00 p.m.</td>
<td>30-60%</td>
</tr>
<tr>
<td>LOW</td>
<td>3:00 p.m.-5:00 p.m.</td>
<td>10-30%</td>
</tr>
</tbody>
</table>

Table 22 provides the degrees of sunlight at various times on a clear, sunny day in the summer:

Table 22  Sunlight by Time of Day in the Summer

<table>
<thead>
<tr>
<th>Degree of Sunlight</th>
<th>Time</th>
<th>Sun Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>7:00 a.m.-9:00 a.m.</td>
<td>10-30%</td>
</tr>
<tr>
<td>MED</td>
<td>9:00 a.m.-11:00 a.m.</td>
<td>30-60%</td>
</tr>
<tr>
<td>HIGH</td>
<td>11:00 a.m.-2:00 p.m.</td>
<td>60-100%</td>
</tr>
<tr>
<td>MED</td>
<td>2:00 p.m.-5:00 p.m.</td>
<td>30-60%</td>
</tr>
<tr>
<td>LOW</td>
<td>5:00 p.m.-8:00 p.m.</td>
<td>10-30%</td>
</tr>
</tbody>
</table>
## Glossary

<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>ALM</td>
<td>Alarm indicator</td>
</tr>
<tr>
<td>AMI</td>
<td>Advance Metering Infrastructure. System that captures, stores, and provides to the utility at frequent intervals detailed consumption and other information, such as, usage, leak, and flow status, in order to support advanced applications. These data can then be used to support a consumer portal. Furthermore, the mass of data generated by the system can feed an advanced analytics system to convert it into actionable information that supports the efficient management of the utility.</td>
</tr>
<tr>
<td>AMR</td>
<td>Automatic Meter Reading. The automated process of reading meters.</td>
</tr>
<tr>
<td>ballast</td>
<td>Heavy material used to secure the stability of the equipment stand. For the R450 System, concrete blocks are used for the ballast.</td>
</tr>
<tr>
<td>CDMA</td>
<td>Code Division Multiple Access. A channel-access method used by various radio communication technologies that allows multiple users to be connected over the same channel.</td>
</tr>
<tr>
<td>CEC</td>
<td>Canadian Electrical Code</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>Mini Collector</td>
<td>The R450 Mini Collector (R450 MC) is the physical equipment that houses Neptune’s N_SIGHT R450 host software. The R450 MC is a device that collects meter reading data from Neptune’s absolute encoder register interfacing with Neptune’s new R450 MIU and transmits the data for collection. This unit receives the data and stores data to be downloaded through host software.</td>
</tr>
<tr>
<td>MHz</td>
<td>Abbreviation for megahertz. One MHz represents one million cycles per second.</td>
</tr>
<tr>
<td>MIU</td>
<td>Meter Interface Unit</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>N_SIGHT R450</td>
<td>N_SIGHT R450 is a software tool for managing the daily tasks of your fixed network AMI operation by storing route and meter information from data collectors.</td>
</tr>
<tr>
<td><strong>serial number</strong></td>
<td>A unique identification number given to each product at the factory.</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>R450 System</strong></td>
<td>A fixed network AMI system for targeted applications allowing a utility to conduct meter reading operations automatically, ensuring maximum collection of the data.</td>
</tr>
<tr>
<td><strong>VSWR</strong></td>
<td>Voltage Standing Wave Ratio. The ratio of the amplitude of a partial standing wave at an antinode (maximum) to the amplitude at an adjacent node (minimum), in an electrical transmission line.</td>
</tr>
</tbody>
</table>
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