

Connecting the UPS

This section provides information on what tools, materials and procedures are needed to connect the UPS.

Tools and Materials Required

The following list describes the tools and materials needed to connect the UPS.

- Slotted-tip screwdrivers for tightening screws on terminal blocks.
- AC/DC voltmeter.

Procedures

Complete the following steps.

Step 1: Wiring the Input and Output Connectors

1. Remove the two screws that secure the UPS cover.
2. Remove the UPS cover.



Figure 34 – Wire Input and Output Connectors



The UPS contains a vent on the upper right side of the case; do not remove this.

Step 2: Installing and Wiring the Batteries

1. Install Liquid-Tight Flexible Non-Metallic Conduit from the disconnect switch to the lower 1/2' conduit hole on the side of the UPS.
2. Install the black, white, and green wires through the conduit and terminate to the terminal block inside the UPS.

Powering ON the UPS

1. Install the DC cord grip in the upper 1/2" conduit hole on the side of the UPS; just above the conduit.
2. Route the open pigtail end of the DC power cable through the cord grip and terminate to the DC terminal block inside the UPS.
3. Tighten the DC cord grip using pliers or a wrench.
4. Attach the power cord to the bottom of the R450 RM DC.
5. Turn the UPS power switch on.
6. Re-install the UPS cover and secure it with the two screws.

Servicing the UPS

This section provides information on servicing the UPS.



CAUTION: Before attempting to service the UPS, verify that the disconnect device is turned OFF. Also verify that the UPS switch is turned OFF.

Checking UPS Status LEDs

This section provides information on checking and troubleshooting the UPS.

Complete the following steps to check the UPS status if the R450 RM DC will not power up.

1. Remove the power plug from the bottom of the R450 RM DC.
2. Measure between pin-1 (+) and pin-2 (-) on the plug.

The voltage should measure 13.5-14.4 VDC. See Figure 35.



Figure 35 – R450 RM DC Power Plug

If the voltage measures okay, then there is a problem with the R450 RM DC. Refer to "Potential R450 RM DC Problems" on page 46.

If the voltage is negative, there is a problem with the UPS wiring. Complete the following steps.

1. Remove the UPS cover .
2. Correct the wiring issue.
3. Recheck wiring.

If there is no voltage present or the voltage is low (< 10.5V DC), complete the following steps.

1. Remove the two screws that secure the UPS cover.
2. Remove the cover.
3. Verify the internal power switch is on.
4. Check the status LEDs inside the UPS. See Table 8 below.

Table 8 – UPS Status LEDs

LED Indicators	Description
Green	Solid on = AC okay
	Off = AC failure
Yellow	Solid on = battery fully charged
	Blinking slowly = battery charging
	Blinking rapidly = battery is discharging (possible AC input voltage failure)
Red	DC output is faulty (fuse may be blown)

5. Verify the UPS is producing the correct voltage at the output terminals by measuring across **DC+** (red) and **DC-** (black).

The voltage should measure 13.5-14.4 VDC.



This assumes the AC input voltage is present and the UPS internal switch is on (i.e., battery should be charging).

If the AC input is not present, then the voltage across **DC+** (red) and **DC-** (black) should measure 10.5-12.8 VDC.

If the voltage is less than 10.5 VDC, this indicates a fully discharged battery and must be recharged. Complete the following steps.

1. Measure the AC input voltage across **L1** and **N1**.

The voltage should measure 100-140 VAC.

2. Verify the UPS's internal switch is On.
3. Check the UPS status LEDs. See Table 8.

Checkup Complete

After the UPS diagnostics has been completed, perform the following steps.

1. Re-install the UPS cover.
2. Secure cover with two screws.

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Chapter 5: Troubleshooting

This section provides information for possible symptoms, areas of focus, and actions that can be taken to resolve problems that could arise with your R450 Rack Mount Data Collector (R450 RM DC).

Equipment Required

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

- Keys to access the site and open the R450 RM DC cabinet.
- Digital volt - Ohm multimeter
- Voltage Standing Wave Ration (VSWR) meter
- Socket and open-end wrenches to install/remove the R450 RM DC
- Small, medium, and large slot style screw drivers
- #1 and #2 Phillips Head screw drivers
- Electrical tape and wire ties
- Backup R450 RM DC, if one fails
- R450 RM DC configuration USB flash drive



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

- Anti-static wrist strap and ground lead with alligator clip for attaching wrist strap to the R450 RM DC cabinet
- MIU configured for site
- Magnet to swipe MIU
- R450 System Field Service Tool

PC Notebook Configuration

In order to use a notebook computer, consider the following.

- The CalAmp modem requires an Ethernet cable to connect to the network port of the computer.
- The CalAmp modem uses an online application for configuration. It does not require software to be installed to configure the modem. Refer to the cellular modem's *Quick Start Guide* for log on and setup instructions.



WARNING: Neptune does not recommend servicing an R450 RM DC during inclement weather.

Potential R450 RM DC Problems

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

Multiple R450 DCs Not Syncing with Host Database

Consider the following.

- 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 RM DC is not syncing with the host database.



Troubleshooting this problem requires going to the R450 RM DC site.

First Steps

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



For instructions on how to assess the health of the R450 RM DC, refer to "Using System Health" in the "System Health" chapter of the *N_SIGHT® R450 Online Help*.

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

Initial Site Activities

- Open the R450 RM DC 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 RM DC should be replaced with the spare and returned to Neptune's repair facility.



CAUTION: The ground wrist strap must be clipped to the box. Do not touch the computer circuit board or any of the components if you are not wearing the wrist strap. Failure to use the strap could cause damage to the computer due to static electricity.

Checking the General Health of Each of the Modules

Visual Check of CPU Board Power

There are three Ethernet Status Light Emitting Diodes (LEDs) to the left of the Ethernet RJ45 connector. The red LED closest to the connector should be lit if there is power being supplied to the CPU board. See Figure 36.



Figure 36 – Ethernet Status LED

Visual Check of Radio Power

The radio has several indicator LEDs on the front panel. The green Power indicator should be on. See Figure 37. If the amber ALM LED is on, the radio is malfunctioning.



Figure 37 – Radio LEDs on Front Panel

Visual Check of Backhaul Modem Power and Connectivity

Cal Amp Vanguard Modem

Look at the indicator lights on the modem to verify if the modem is working. See Figure 38.

- If the RSSI and SVC lights are on, this indicates that the modem is connected.
- If the RSSI and SVC lights are not on, this indicates that there is a power problem with the modem. Verify that the main power is on.
- If the SVC light is solid, the modem is connected to the cellular network. See Table 9 on the facing page.
- If the SVC light is flashing, the modem is trying to connect to the network. See Table 9 on the facing page.

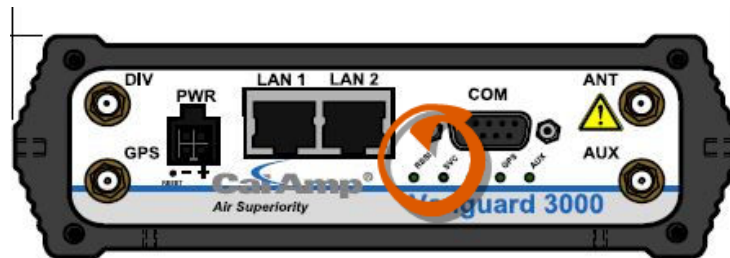


Figure 38 – Modem Indicator Lights



The LEDs behavior is different than the table below at boot. The sequence is: all read, all amber, all green, and all flash green

Table 9 – Modem Status LEDs

Function	Off	Green	Flash Green	Red	Flash Red	Amber	Flash Amber
RSSI		Strong		Weak/None		Medium	
SVC (cellular network connection)		3G/4G	3G/4G/NC		NC	2G	2G/NC
NET	No connectivity		Rx data		Tx data		Rx/Tx
GPS	Disabled	Fix	Search	no fix			
AUX	Disabled	Good		Failed			

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.

Verify 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 in the R450 RM DC, this must be checked.

- The circuit breaker should be in the ON position. Verify that it has not tripped.
- Using the voltmeter, verify that there is 120V AC on both the AC feed and the power supply sides of the circuit breaker.

- If voltage is not present on the AC feed side of the circuit breaker or is less than 110V, there is something wrong with the supply voltage. Repairing this is outside of the scope of this manual



The R450 RM DC is capable of functioning on voltages as low as 90V.

- If voltage is not present on the power supply side of the circuit breaker and the circuit breaker is not tripped, the breaker is damaged. If the circuit breaker is damaged, it is recommended that the R450 RM DC be returned for repair.

Verifying CPU Board Power

Neptune recommends checking the voltage levels going to the computer.

1. Put on your wrist strap and attach the alligator clip to the cabinet.
2. Turn off the circuit breaker.
3. Remove the 10-pin connector located in the upper left corner of the CPU Board. There is a locking tab on the bottom side of the connector.
4. Turn the circuit breaker back on.

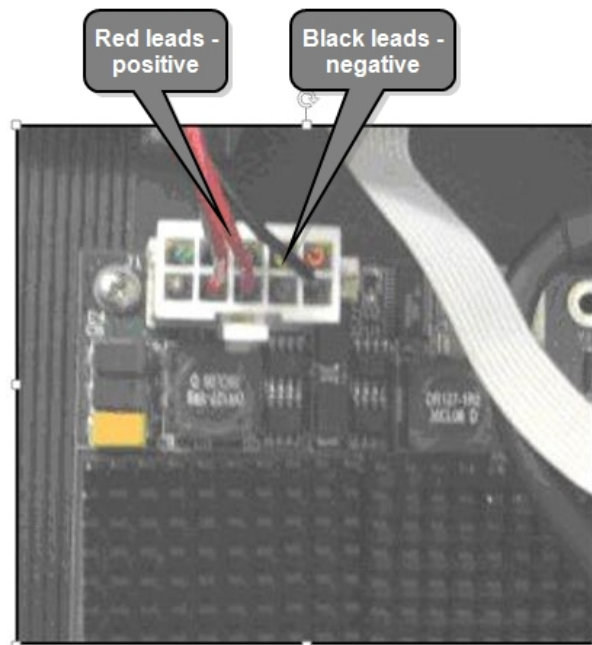


Figure 39 – Red and Black Leads

5. Use the Digital Volt-Ohm-Multimeter to measure the voltage. The red leads are positive; the black leads are negative.
6. The voltage must be between 4.9V and 5.2V. Turn off the R450 RM DC circuit breaker.



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

7. Reconnect CPU power.

Verifying Radio Power

1. Turn off the circuit breaker if it is not already off.
2. Remove the BATT connector on the radio. The locking ring unscrews.
3. Turn the circuit breaker back on.
4. On the power cable connector, measure the voltage across pins X and Y as shown.
5. The voltage should be between 14.5V and 15.5V. If the voltage is above or below these values, the power supply is defective and the R450 RM DC should be returned to Neptune's repair facility.
6. If the voltage is within specifications, turn the circuit breaker off and replace the connector. Make sure that the connector locking ring is finger tight.

Verifying Cellular Modem Power

Cal Amp Vanguard Modem

Approximately 12.0 V should be present between the two pins shown as illustrated in the following figure.



Figure 40 – Vanguard Three Wires

Verifying Cellular Modem Connectivity

Cal Amp Vanguard Modem

To verify connectivity and signal levels, complete the following.

1. Locate the RSSI LED light on the modem.
2. Identify how the light is lit.
 - Solid = indicates signal strength is strong
 - Blinking = indicates signal strength is medium
 - Off = indicates signal strength is poor or no signal at all

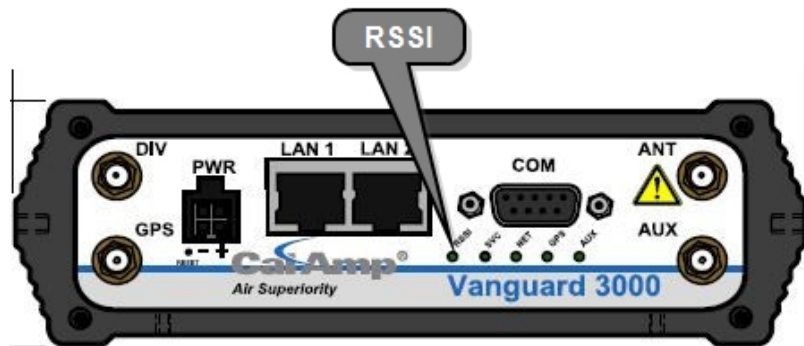


Figure 41 – CalAmp Vanguard Modem with RSSI LED

3. If the signal strength is poor or if there is no signal at all, there is something wrong with the antenna, or it is possible that the local cell service is not working.



For more detailed information on your wireless connection status, connect to the modems configuration application. Refer to "Securing the R450 RM DC" on page 27.

Ethernet

If Ethernet backhaul is used, then check the status lights on the CPU board. Refer to "Testing the Connections" on page 24.

Verifying Radio Functionality Using an MIU

To verify that the system is functioning properly, complete the following steps.



For this test to be valid, there must be regular time beacon transmissions sent by the R450 RM DC. This is indicated by the TX indicator flashing every ten seconds. See Figure 37 on page 48. If the R450 RM DC is not sending out time beacons, this test will automatically fail.

1. Obtain a magnet and an MIU.
2. Swipe the MIU with a magnet so that it will send out a configuration packet.
3. Watch for the radio's **Busy** light to turn on. This should happen within a minute of swiping the MIU.
 - If the **Busy** light turns on, it should be followed by an immediate flash of the **TX** indicator. See Figure 41 on page 52.
 - If the **Busy** indicator is not immediately followed by a flash of the **TX** indicator, then there is an internal problem with the R450 RM DC that may include its configuration, the radio, NTG modem, or the computer.

R450 RM DC is Syncing but Not Supplying MIU Data

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



Troubleshooting this problem requires going to the R450 RM DC site.

Initial Observations

After opening the cabinet, assess the following.

- The R450 RM DC sends out a time beacon every 10 seconds. The transmit light on the radio should flash every 10 seconds. See Figure 37 on page 48. Only the red transmit light should turn on. If the amber ALM indicator turns on at the same time, this indicates that there is a problem between the transmitter and the antenna.
- If the transmit indicator does not flash, this indicates that there is a potential problem with the modem or possibly the computer's serial port.

Transmitter Transmits but ALM Indicator Flashes

This requires measuring the Voltage Standing Wave Ratio of the antenna system. If the VSWR is greater than 1.5:1, that indicates that there is a problem with the feed line or the antenna.

Measuring the VSWR

To measure the VSWR (MFJ-269 SWR Analyzer), complete the following steps.

1. Make sure the red **Power** button is off. The red button is extended outward.
2. Press the **UHF** button to be sure it is extended outward.
3. Turn the **Frequency** knob fully counter-clockwise. This knob points to 114-170/UHF.
4. Connect the 2-inch long attenuator pad to the **Antenna Connector**. Leave the other end open.
5. Press and lock the red **Power** button and the black **UHF** button.
6. Adjust the Tune knob for desired frequencies. Sweep the entire **450 - 470 MHz** range.
7. Observe the indicated VSWR. It should read 3.0 ± 0.2

This indicates that the unit is calibrated correctly and the batteries are good.

- If the reading is outside this range, then try replacing the batteries (eight AA batteries).
 - If this does not improve the readings, the unit needs to be recalibrated.
8. Power off the unit.
 9. Remove the attenuator pad and connect the antenna from the bottom of the collector.
 10. Press and lock the red **Power** button and the black **UHF** button.
 11. Adjust the **Tune** knob for desired frequencies. Look at both the collector receive and transmit frequencies.
 12. Observe the indicated **VSWR**. The value should be 1.5 or less.

A value of 1.0 is ideal but not practical. Usually values are 1.1 or 1.2.



If a flashing **SLP** indication appears in the bottom-right corner of the display, this indicates **Sleep** mode. Simply turn the unit off and then on again.

13. When finished, power off the unit.

The Radio Never Transmits

The simplest test is to cycle power on the R450 RM DC to see if the radio starts transmitting.



It can take up to 10 minutes for the R450 RM DC to be fully functional.

- If radio 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 RM DC has an internal problem, either with the computer or the Neptune modem. It is recommended that you return the R450 RM DC for repair.

Reduction in Amount of Data Collected

If the R450 RM DC is not collecting as much data as before, but it is still collecting some MIU data, this usually indicates that there is a problem with the antenna and feedline system or possibly an internal problem. To determine the cause of the problem, complete the following steps.

1. Check all the system voltages as outlined above.
2. Check the VSWR of the system using the technique previously described.

If the VSWR is high, the feedline and antenna should be checked out and certified by qualified radio personnel.

3. Check the VSWR again, if the power output is low, by placing the wattmeter between the duplexer and the surge protector.

If the VSWR measures much higher before the surge suppressor, the suppressor may be damaged.

If the above tests pass, most likely there is a problem with the duplexer or radio, and it is recommended that you contact Customer Support

Contacting Customer Support

Within North America, Neptune Customer Support is available Monday through Friday, 7:00 AM to 5:00 PM Central Standard Time by telephone, email, or fax.

By Phone

To contact Neptune Customer Support by phone, complete the following steps.

1. Call **(800) 647-4832**.
2. Select one of the following options:
 - Press **1** if you have a Technical Support Personal Identification Number (PIN).
 - Press **2** if you do not have a Technical Support PIN number.
3. Enter the six-digit **PIN** number and press **#**.
4. Select one of the following options.
 - Press **2** for Technical Support.
 - Press **3** for maintenance contracts or renewals.
 - Press **4** for Return Material Authorization (RMA) for Canadian accounts.

You are directed to the appropriate team of Customer Support Specialists. The specialists are dedicated to you until the issue is resolved to your satisfaction. When you call, be prepared to give the following information.

- Your name and utility or company name.
- A description of what occurred and what you were doing at the time.
- A description of any actions taken to correct the issue.

By Fax

To contact Neptune 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 customer support specialist to contact you.

By Email

To contact Neptune Customer Support by email, send your message to support@neptunetg.com.

Appendix A: RF Antenna Installation

RF Antenna Overview

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

Mounting the Antenna

Consider the following when mounting the antenna.

1. Mount the antenna as high as possible 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. When mounting the antenna on a water tower, it is recommended that they be mounted on top as close to the center as possible.
 - When mounting the antenna on a traditional three-leg or four-leg tower, the standoff mount for the antenna must position the antenna at least five feet away from the tower to minimize coverage area problems.
2. Avoid making the R450 Data Collector's (R450 RM DC) antenna the tallest point in the surrounding area. This may be unavoidable but it increases the potential of the antenna being damaged by lightning.

Mounting the Antenna Mast

Consider the following.



CAUTION: The 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 antennas and antenna mast, it is important to maximize the line-of-sight relationship between the RF 450 MHz Antenna and R450 MIUs for optimum RF communications.



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



WARNING: Do not mount antennas on utility poles, electric service masts, or other structures carrying electric light or power wires. Coaxial cables must maintain clearance of at least 2 feet (.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 N.E.C., Article 810, C.E.C. Section 54.

Site Recommendations

The following are recommendations for sites with multiple transmitters, receivers, and antennas. These sites require extra care when determining a location to install the antenna.

- Avoid mounting the R450 RM DC 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 by at least 10 feet vertically. This will minimize the interference between the systems.
- The exception to the previous rule is for cellular antennas. As long as the R450 RM DC 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



CAUTION: 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

Consider the following.

- The 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.
- The feed line must be bonded at the top of the tower and at the base of the tower. Andrew grounding 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 bounded 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 RM DC and antenna connectors.
- Andrew provides installation instructions for Heliac Coaxial Cable. See Bulletin 17800B Revision C. Neptune can supply a PDF copy by request through Customer Support.

Cable Guidelines

Prepare the cable for installation and check for damage. You will need the following materials to install the cable.

Table 10 – Material Needed for Cable Installation

Action	Material Needed
Hoisting the Cable	<ul style="list-style-type: none"> • Hoist lines • Pulleys • Cable reel • Hoisting grips
Anchoring Cable	<ul style="list-style-type: none"> • Cable hangers (standard, snap-in) • 3 to 4 ft. intervals
Grounding	Coax ground kits (top, bottom, building entrance)
Horizontal Cable Runs	<ul style="list-style-type: none"> • Above ground - ice bridge • Buried cable - conduit or sand below the frost line or one meter
Cable Connections	<ul style="list-style-type: none"> • Connector installation instructions • Connector torque • Weatherizing kits
Measurements	<ul style="list-style-type: none"> • Return Loss (VSWR) • Distance to Fault (DTF)

Neptune Part Numbers

The following tables provides Neptune part numbers for cable and connectors.

Table 11 – Neptune Part Numbers for Cable and Connectors

Neptune Part Number	Andrew Part Number	Coax Diameter	Loss per 100'	Minimum Bend Radius	Weight per Foot	Maximum Length	Notes
10046-119	LDF4-50A	1/2"	1.45 dB	5"	0.15	150'	Recommended antenna cable for 150' cable runs or less
10046-118	AVA5-50	7/8"	0.74 dB	10"	0.30	400'	Recommended antenna cable for runs over 150'

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

Table 12 – Connectors and Accessories

Cable Type	Neptune Part Number	Andrew Part Number	Coax Diameter	Notes
FSJ4-50B				
	10046-117	F4A-PNMDM-6-USA	Pre-made Coax 6' Jumper DIN Male on one end, N Male on the other	Used as jumper from feed line to R450 RM DC or antenna
LDF4-50A				
	8138-200	L4TNM-PS	Coax Connector, N Male	Mates with R450 RM DC and antenna connectors
		SG12-12B2U	SureGround Grounding Kit for 1/2" coax	
AVA5-50				
	8138-190	ALDF-PS	Coax Connector, 7/16" DIN Female	Used to connect to FSJ4 jumper cable

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 supplied antenna are shown in the table below.

Neptune P/N	12896-001
Andrew P/N	DB636-C
Frequency Range	450-482MHz
Maximum Input Power (Watts)	500
Gain	8.1 dBi (6 dBd)
Bandwidth > 1.5VSWR	32 MHz
Vertical Beam Width (-3 db)	20 Degrees
Lightning Protection	Direct Ground
Termination	N Female
Overall Length	9.3 Feet
Element Housing Length	6.8 Feet
Support Pipe Diameter	2.5 inches
Support Pipe Length	26 Inches
Wind Load	1.61 Square Feet
Rated Wind Velocity	225 MPH
Weight	30 lbs
Mounting Hardware Included	DB365 Clamps

Requirements

- The antenna, if mounted on the side of a tower or other supporting structure, must be mounted so that it is at least five 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 RM DC 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 Andrews antenna supplied with the R450 RM DC is specified as having a VSWR of 1.5:1 or better over the 450 - 470 MHz range.

Measuring VSWR at the R450 RM DC must take into account losses in the feed line. For instructions, see “Measuring the VSWR” on page 68. The easiest approach is to use return loss instead of VSWR. The 1.5:1 VSWR translates into a return loss of 13.98dB. Refer to Table 13 below, Table 14 on the next page and Table 16 on page 70 to 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 13 – Power Measurement to Return Loss and VSWR Conversion Table -Part I

Input Power			Return Loss	VSWR
1W	5W	10W		
Reflected Power Reading			Return Loss	VSWR
0.001	0.005	0.01	30.0	1.07
0.002	0.010	0.02	27.0	1.09
0.003	0.015	0.03	25.2	1.12
0.004	0.020	0.04	24.0	1.14
0.005	0.025	0.05	23.0	1.15
0.006	0.030	0.06	22.2	1.17
0.007	0.035	0.07	21.5	1.18
0.008	0.040	0.08	21.0	1.20
0.009	0.045	0.09	20.5	1.21
0.010	0.050	0.10	20.0	1.22
0.020	0.100	0.20	17.0	1.33
0.030	0.150	0.30	15.2	1.42
0.040	0.200	0.40	14.0	1.50
0.050	0.250	0.50	13.0	1.58

Table 13 – Power Measurement to Return Loss and VSWR Conversion Table -Part I (continued)

Input Power			Return Loss	VSWR
1W	5W	10W		
Reflected Power Reading			Return Loss	VSWR
0.060	0.300	0.60	12.2	1.65
0.070	0.350	0.70	11.5	1.72
0.080	0.400	0.80	11.0	1.79
0.090	0.450	0.90	10.5	1.86
0.100	0.500	1.00	10.0	1.92
0.110	0.550	1.10	9.59	1.99
0.120	0.600	1.20	9.21	2.06
0.130	0.650	1.30	8.86	2.13
0.140	0.700	1.40	8.54	2.20
0.150	0.750	1.50	8.24	2.26
0.160	0.800	1.60	7.96	2.33
0.170	0.850	1.70	7.70	2.40
0.180	0.900	1.80	7.45	2.47
0.190	0.950	1.90	7.21	2.55
0.200	1.000	2.00	6.99	2.62

Table 14 – Power Measurement to Return Loss and VSWR Conversion Table -Part II

Input Power			Return Loss	VSWR
1W	5W	10W		
Reflected Power Reading			Return Loss	VSWR
0.20	1.05	2.10	6.78	2.69
0.22	1.10	2.20	6.58	2.77
0.23	1.15	2.30	6.38	2.84
0.24	1.20	2.40	6.20	2.92

Table 14 – Power Measurement to Return Loss and VSWR Conversion Table -Part II (continued)

Input Power			Return Loss	VSWR
1W	5W	10W		
Reflected Power Reading			Return Loss	VSWR
0.25	1.25	2.50	6.02	3.00
0.26	1.30	2.60	5.85	3.08
0.27	1.35	2.70	5.69	3.16
0.28	1.40	2.80	5.53	3.25
0.29	1.45	2.90	5.38	3.33
0.30	1.50	3.00	5.23	3.42
0.31	1.55	3.10	5.09	3.51
0.32	1.60	3.20	4.95	3.60
0.33	1.65	3.30	4.81	3.70
0.34	1.70	3.40	4.69	3.80
0.35	1.75	3.50	4.56	3.90
0.36	1.80	3.60	4.44	4.00
0.37	1.85	3.70	4.32	4.11
0.38	1.90	3.80	4.20	4.21
0.39	1.95	3.90	4.09	4.33
0.40	2.00	4.00	3.98	4.44
0.41	2.05	4.10	3.87	4.56
0.42	2.10	4.20	3.77	4.68
0.43	2.15	4.30	3.67	4.81
0.44	2.20	4.40	3.57	4.94
0.45	2.25	4.50	3.47	5.08
0.46	2.30	4.60	3.37	5.22
0.47	2.35	4.70	3.28	5.36
0.48	2.40	4.80	3.19	5.51
0.49	2.45	4.90	3.10	5.67

Coax Cable Loss

Table 15 – Coax Cable Loss Table

Coax Type	FSJ4-50B	LDF4-50A	AVA5-50
Loss 100 ft.	2.31 dB	1.45 dB	0.744 dB
Length (ft.)	Loss in dB		
10	0.231	0.145	0.074
20	0.462	0.290	0.149
30	0.693	0.435	1.223
40	0.924	0.580	0.298
50	1.155	0.725	0.372
60*	1.386	0.870	0.446
70*	1.617	1.015	0.521
80*	1.848	1.160	0.595
90*	2.079	1.305	0.670
100*	2.310	1.450	0.744
110	2.541	1.595	0.818
120	2.772	1.740	0.893
130	3.003	1.885	0.967
140	3.234	2.030	1.042
150	3.465	2.175	1.116
160	3.696	2.320	1.190
170	3.927	2.465	1.265
180	4.158	2.610	1.339
190	4.389	2.755	1.414
200	4.620	2.900	1.488

Coax Type	FSJ4-50B	LDF4-50A	AVA5-50
Loss 100 ft.	2.31 dB	1.45 dB	0.744 dB
Length (ft.)	Loss in dB		
210	4.851	3.045	1.562
220	5.082	3.190	1.637
230	5.313	3.335	1.711
240	5.544	3.480	1.786
250	5.775	3.625	1.860
260	6.006	3.770	1.934
270	6.237	3.915	2.009
280	6.468	4.060	2.083
290	6.699	4.205	2.158
300	6.930	4.350	2.232
310	7.161	4.495	2.306
320	7.392	4.640	2.381
330	7.623	4.785	2.455
340	7.854	4.930	2.530
350	8.085	5.075	2.604
360	8.316	5.220	2.678
370	8.547	5.365	2.753
380	8.778	5.510	2.827
390	9.009	5.655	2.902
400	9.240	5.800	2.976

* Acceptable Range

VSWR Calculation

Neptune recommends the following method of computing VSWR. Taking the reading at the R450 RM DC 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 450MHz Radio

The recommended procedure is to use a handheld commercial grade transceiver that is tuned to the R450 RM DC'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 steps to use a Wattmeter and handheld to calculate VSWR.

1. Connect the wattmeter and transceiver to the feed line in place of the R450 RM DC.
2. Measure both the forward and reflected power.
3. Find the return loss value using Table 13 on page 63 and Table 14 on page 64.
4. Find the loss attributed to the coax using Table 15 on the previous page based on the coax type and feed line length.

The adjusted return loss is calculated by the following formula.

Return Loss (from Table) - (2 x Cable Loss) = Corrected Return Loss

5. Find the VSWR using Table 13 on page 63 and Table 14 on page 64 using the Corrected Return Loss value.
6. Change the frequency on the handheld transceiver to the R450 RM DC's receive frequency.
7. Measure the power and calculate VSWR using the procedure just used for calculating transmitter VSWR.
8. 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. Set the value next to **WID** on the screen to **20** using the width buttons.
5. Set the reading to return loss by pressing **F1** three times. (Press it slowly; the unit should beep each time.)

Taking the Reading and Calculating VSWR

1. Connect the analyzer to the feed line in place of the R450 RM DC.
2. Configure the analyzer using the preceding procedure.



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.

3. Allow the analyzer reading to stabilize, between 10 and 20 seconds.
4. Press **EXAM PLOT** to freeze the display.
5. Move the cursor (the vertical line in the middle of the screen) using the **FREQ** arrows to approximately the R450 RM DC's frequency. (It moves to within 100KHz of a frequency.)
6. Read the value next to **RETL** on the display. This is the return loss value.
7. Find the loss attributed to the coax (based on the coax type and feed line length) using Table 15 on page 66.
8. Calculate the adjusted return loss using the following formula.
Return Loss (from Table 5) - (2 x Cable Loss) = Corrected Return Loss.
9. Find the VSWR (using the Corrected Return Loss value) Table 13 on page 63 or Table 14 on page 64

10. Move the cursor to within 100KHz of the R450 RM DC's receive frequency.
11. Calculate VSWR using the new return loss value.
12. 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 450 MHz antenna should be handled with care; however, no additional special handling is required.

After unpacking the RF 450 MHz antenna, inspect it for damage. If any parts of the R450 MHz 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 check while the antenna is on the ground than after it is installed.

RF Antenna Installation Kit

The RF 450 MHz antenna and the basic accessories are included with the R450 RM DC. The mounting brackets that are included 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. Neptune does not sell it.

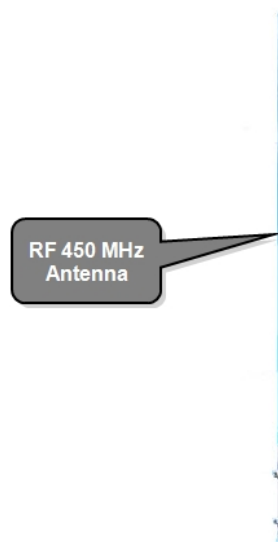


Figure 42 – RF 450 MHz Antenna

Tools and Materials

Table 16 shows the recommended tools and materials you need to successfully install the RF antenna.

Table 16 – Recommended Tools and Materials


Item	Description/Recommendation	Use
Tool Kit	Contains standard tools including: <ul style="list-style-type: none"> • Assorted screwdrivers (medium, flat head) • Cordless electric drill/assorted bits • Adjustable wrench • Standard socket wrench set • Standard box-end wrench set • Hammer • Channel locks 	Various installation procedures performed by the installer
UV-Stable Cable Ties	8" and 12" (20.32 cm and 30.48 cm)	Secure coax cable
Cable Clips	Various sizes	Securing coax cable
Weatherizing Kit	PolyPhasor P/N: WK-1 - or Times Microwave P/N: WK-S-2 - or Andrews P/N: 245171	Weatherproofing coax cable connections
Electrical Tape	Scotch® Heavy Duty Vinyl Electrical Tape 22 -or Scotch® Super 88	Weatherproofing coax cable connections and other connections as required


Installing the RF Antenna

This section contains the instructions for the RF antenna installation.

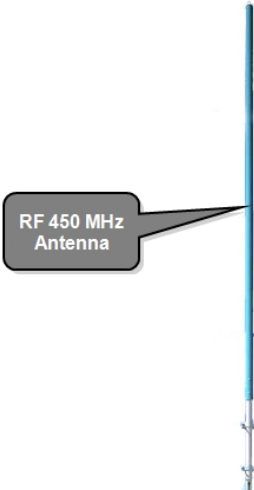
Mounting the RF 450 MHz Antenna

The RF 450 MHz antenna must be installed by professionals in accordance with the FCC site license before you begin the installation of the R450 RM DC.

 **WARNING: Mounting and wiring the RF 450 MHz antenna must be done by a trained professional. Be sure to subcontract this work, so it is completed properly.**

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

To mount the RF 450 MHz antenna, complete these steps.

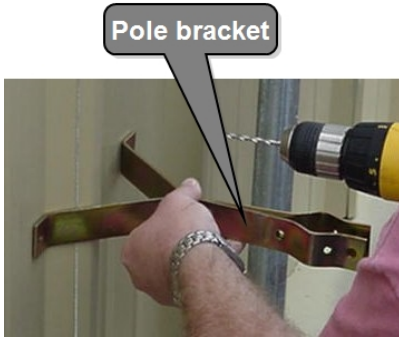


1. Assemble the RF 450 MHz antenna, per the instructions included with the antenna kit See Figure 43.
2. Use the mounting hardware included with the antenna to mount the antenna per the supplied instructions.
3. Install the antenna in accordance with the FCC site license (per the antenna mounting instructions contained in this appendix).
4. Weatherize the antenna coaxial connector using the weatherizing kit. See Table 16 on the previous page.

Figure 43 – RF 450 MHz Antenna to be Mounted

Mounting the Antenna Mast to the Building

With a wall-mount installation, it is necessary to mount the 450MHz and cellular antenna on the exterior of the building. Complete the following steps to mount the antenna mast to the building. Use manufacturer installation instructions provided with mounting hardware.



1. Use antenna pole brackets to install the pole to the building. See Appendix A.
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 wood screws rated at minimum of 20 pounds loading.
 - If mounting to sheet metal or masonry, use appropriate sheet metal screws or masonry anchors rated at a minimum of 20 pounds loading.

Figure 44 – Securing the Pole Bracket



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 (2') 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 Appendix A.
8. Secure the pole with the bolts provided.

Figure 45 – Lining Up Second Bracket

Attaching the RF 450 MHz Antenna Cable

To attach the RF 450 MHz antenna cable to the RF antenna R450 RM DC, complete the following steps.



1. Locate the RF 450 MHz antenna cable that extends from the RF 450 MHz antenna cable conduit. See Figure 46.
2. Connect the RF 450 MHz antenna cable to the RF 450 MHz antenna connector located on the bottom of the R450 RM DC. See Appendix A. Tighten the coaxial connector to:
 - **Type N:** 15 to 20 lbf in (1.7 - 2.3 N m)
 - **Type 7 - 16 DIN:** 220 - 265 lbf in (25 - 3 N m)

Figure 46 – RF 450 MHz Antenna Connection

WARNING: Special consideration should be given when the RF antenna R450 RM DC is installed inside a building.



The screen (shield) of the coaxial cable must be connected to the 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 Cable Connections

Complete the following instructions to weatherproof the cables with the Scotch Wireless Wk101 Kit or equivalent.



1. Using the weatherizing kit, start the tape at the top of the RF antenna connection as illustrated in Figure 47.
2. Wrap the tape around the connection several times; slowly work your way downward to weatherize your connection at the base.

Figure 47 – Weatherizing the RF Antenna Connection

Troubleshooting the RF Antenna

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 RF antenna.

Equipment Required

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

- Keys to access the site and open the R450 RM DC cabinet
- Digital volt - Ohm multimeter
- Socket and open-end wrenches to install and remove the R450 RM DC
- Small, medium, and large slot-style screw drivers
- #1 and #2 Phillips head screw drivers
- Electrical tape and wire ties
- Spare R450 RM DC in order to swap if one fails

- R450 RM DC configuration memory stick
- Anti-static wrist strap and ground lead with alligator clip for attaching wrist strap to the R450 RM DC cabinet
- MIU configured for the site
- Magnet to swipe the MIU

Conduct a test by hooking up the wattmeter to the coaxial connector at the R450 RM DC end to measure the VSWR for the antenna and feed line combined.

The R450 RM DC'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.

Appendix B: USB Flash Drive Configuration for R450 RM DC

Overview

This appendix provides information and the steps for creating an R450 Rack Mount Data Collector (R450 RM DC) and configuring the USB flash drive using the N_SIGHT PLUS host software.

Creating a Collector

The Collector tab in the N_SIGHT PLUS host software provides valuable information about the R450 RM DCs in your R450 System. On this tab you can search for or create a R450 RM DC.

Using the Collector tab, you can do the following:

- Create collector
- Search collectors

Creating a New Collector

To create a new R450 RM DC, complete the following steps.

1. Open the N_SIGHT PLUS host software on the PC.
2. Select the **Collector** tab, and click **Create Collector**.

The Create a New Collector window appears similar to Figure 48. All required fields display a red *.

The screenshot shows a window titled "Create a new Collector" with a close button in the top right corner. Below the title bar is a tabbed interface with two tabs: "Collector Details" (which is active) and "Collector Network Settings". The "Collector Details" tab contains several input fields, each with a red asterisk indicating it is a required field. The fields and their values are: Collector Id (0), Collector Name (empty), Host IP Address (empty), System Id # (0), Time Zone (0), Sync Interval (minutes) (0), Transmit Frequency (450), Receive Frequency (450), Latitude (0.00000), Longitude (0.00000), Power (0), Antenna Height (0), Daily Reboot (0), Start Time (15 : 26), and End Time (15 : 26). At the bottom of the window are three buttons: "Save", "Save & Close", and "Cancel".

Figure 48 – Create a New Collector Window

Table 17 – Collector Details

Field	Description
Collector ID	Indicates the unique identifier for the data collector which can be a street, location, or a neighborhood.
Collector Name	Indicates the name of the data collector, for example the street, neighborhood, tower name, and so forth.
Host IP Address	Displays the static IP address for the host database.
Time Zone	Indicates the unique identifier for the time zone in which the R450 RM DC is located; offset is from UTC: Atlantic Time is -4; Eastern Time is -5; and so forth.
Sync Interval (minutes)	Indicates, in number of minutes, the time between synchronizations between the collector and the database. Usually it is 60 minutes for cellular system, and 30 minutes for an Ethernet system.
Transmit Frequency	Indicates the frequency used to transmit data.
Receive Frequency	Indicates the frequency used to receive data.
Latitude	Indicates the actual latitude of the R450 RM DC.
Longitude	Indicates the actual longitude of the R450 RM DC.
Power	Indicates the power used by the R450 RM DC.
Antenna Height	Indicates the actual height of the RF antenna.
Daily Reboot	Indicates if the R450 RM DC requires a daily reboot.
Start Time	Displays the beginning time in hh:mm format for the quiet time period when the R450 RM DC is not transmitting or receiving.
End Time	Displays the ending time in hh:mm format for the quiet time period when the R450 RM DC is not transmitting or receiving.



On this tab, remember the following:

- All fields with an * are required.
- All white fields are available fields.
- All fields with gray text are read-only fields

3. Complete all the required and available information that applies, and click **Save**.

The Collector Network Settings tab appears similar to Figure 49.

Figure 49 – Collector Network Setting Tab

Table 18 – Collector Network Settings

Field	Description
WAN Connection Type	Indicates the type of Wide Area Network (WAN) used by the R450 RM DC. The options include the following: <ul style="list-style-type: none"> • Cellular • Cellular_Ethernet • Network_DHCP • Network_Static_IP • Mobile
NTP Server	Indicates a server that uses NTP (Network Time protocol). Its purpose is to keep the clock accurate.
Primary DNS Server	Indicates the primary server, the first DNS (Domain Name System) server queried when trying to resolve a server name. You can supply the name rather than the IP address, for example, Chicago rather than 10.10.10.10.
Secondary DNS Server	Indicates the secondary server, the second DNS (Domain Name System) server.

On this tab, remember the following:

- All fields with an * are required.
 - All white fields are available fields.
 - All fields with gray test are read-only fields.
4. Complete all the required and available information that applies, and click **Save**.

The R450 RM DC just created appears in the list of R450 DCs on the Collector tab, and the detail appears in the lower half of the page.

Editing Collector Information

To edit information for an R450 RM DC, complete the following steps.

1. On the **Collector** tab, select the R450 RM DC for which you want to edit the information.

The **Edit Collector** window appears with the existing information for the collector.

2. Edit and change the appropriate information on both the **Collector Details** tab and the **Collector Network Settings** tab.
3. When complete, click **Save** to display the new information for the collector.

The changes you made are saved for the selected collector.

Deleting a Collector

To delete a collector, complete the following steps.

1. On the **Collector** tab, select the collector you want to delete.
2. Click **Delete**.

A delete confirmation message appears similar to the following.

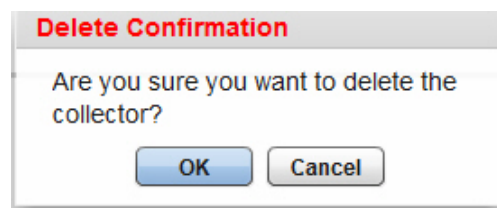


Figure 50 – Delete Confirmation Dialog Box

3. Click **OK**.

The R450 RM DC is now deleted from the list of collectors on the **Collector** tab.

Using Collector Search

To use the Search function to locate an R450 RM DC, complete the following steps.

1. Click **Search Collectors** on the **Collector** tab.

The following page appears.

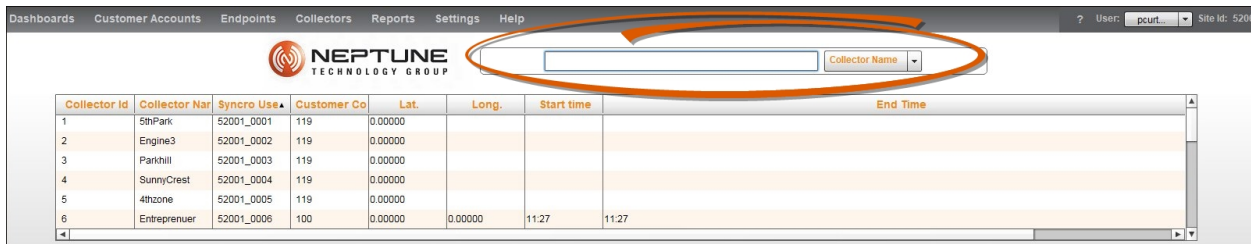


Figure 51 – Collector Search

On this page, there is a drop-down selection list for you to select how you want to search for the R450 RM DC.

- Collector Name
 - Syncro User
 - Collector ID
2. Type all or part of the search criteria you selected in the previous step in the search area provided. See Figure 51.

Everything matching your search criteria appears in the collector list on the **Collector** tab with the detailed information for the collector appearing in the lower-half of the page. See Figure 52 on page 80.

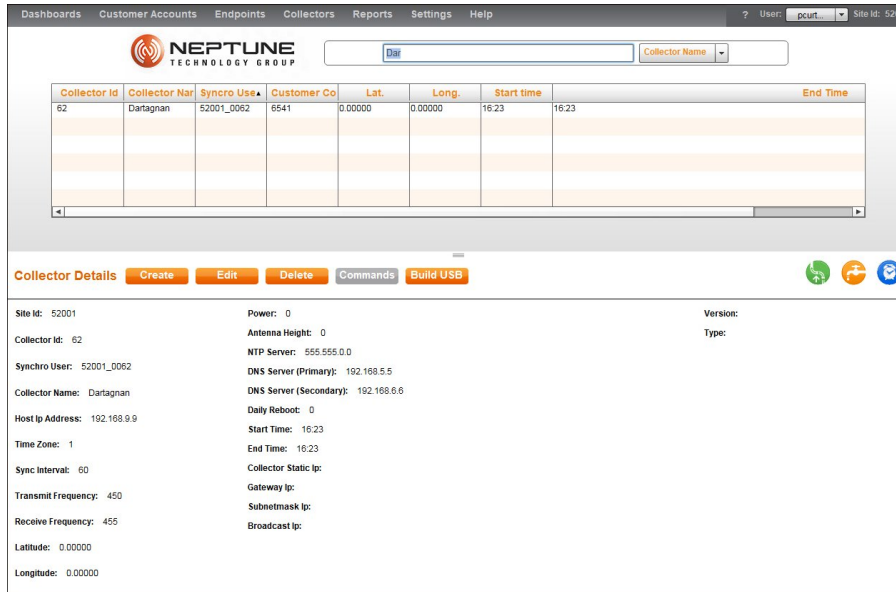


Figure 52 – Collector Search Results

3. Select one of the following options.
 - Create another R450 RM DC.
 - Edit information for the selected R450 RM DC.
 - Delete the selected R450 RM DC.
 - Build a USB drive for the R450 RM DC.

Building a USB Drive for Collector Configuration

This feature adds the ability to build a USB drive that can be inserted into a replacement collector for automatic configuration in order to mimic an old collector.

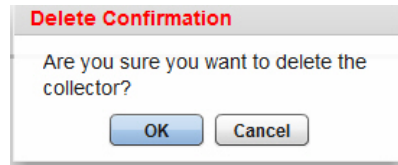


R450 Collector configuration application must be installed on a local PC to extract files to the USB drive. Make sure only the desired USB drive is on the computer.

Complete the following steps to add an USB drive.

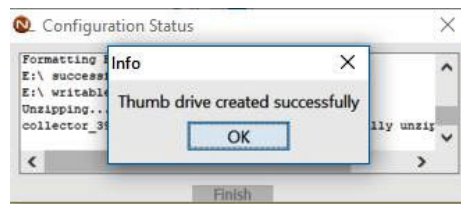
1. Select the R450 RM DC to upload data to the USB drive from the **Collector** tab
2. Click **Build USB**.

A confirmation message appears similar to the following.



3. Click **OK** to build the drive.
4. Double-click the downloaded file (*.ntg).

The application formats and extracts files to the USB drive. A message similar to the following will appear.



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Appendix C: Ethernet Termination

Straight-Through Ethernet Cable

For most installations, the Straight-Through Ethernet Cable is used. Terminate the Ethernet cable according to the diagram below using the T-568B wiring standard for both ends. One end should already be pre-terminated to the switch or hub.

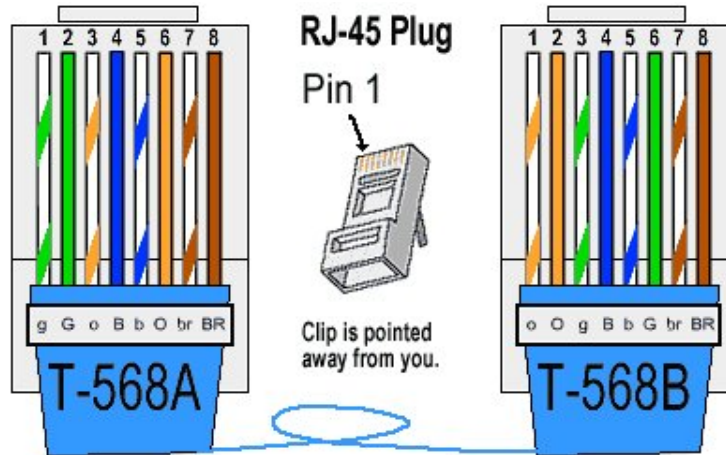


Figure 53 – Straight-Through Ethernet Cable

RJ-45 Crossover Ethernet Cable

On some occasions, a Crossover Ethernet Cable is required. If you require a cable to connect two Ethernet devices directly together without a hub or when you connect two hubs together, you will need to use a crossover cable instead.

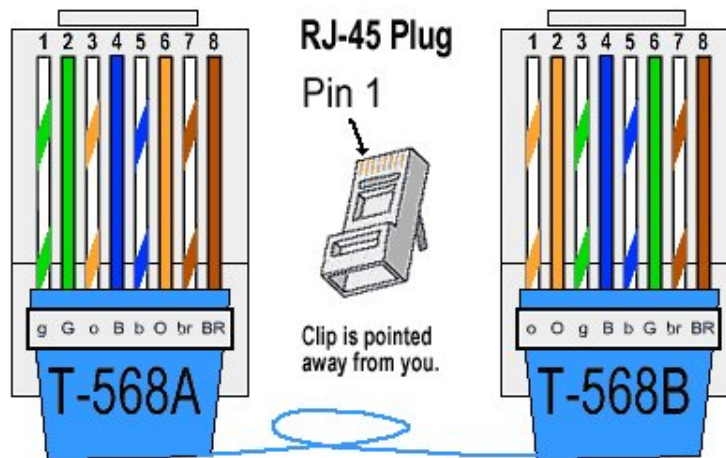


Figure 54 – RJ-45 Crossover Ethernet Cable

Determining if You Need a Crossover Cable

One method of determining if you need a crossover cable is to plug the Ethernet cable from the hub or modem into your laptop computer's Ethernet port. If the laptop computer can communicate through the Ethernet port, then the site probably requires a Crossover Ethernet Cable to be compatible with the R450 Data Collector (R450 RM DC).

Table 19 – Cable Color Code Table

Symbol	Wire Color
o	White with orange stripe
O	Solid orange
g	White with green stripe
B	Solid blue
b	White with blue
G	Solid green
br	White with brown stripe
BR	Solid brown

Glossary

A

ALM

Alarm indicator.

AMI

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.

AMR

Automatic Meter Reading. The automated process of reading meters.

APN

Access Point Name.

B

ballast

Heavy material used to secure the stability of the equipment stand. For the R450 System, concrete blocks are used for the ballast.

C

CDMA

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.

D

Data Collector

R450 Data Collector (R450 DC). The physical equipment that houses Neptune's N_SIGHT PLUS host software. The R450 DC is a device that collects meter reading data from Neptune's absolute encoder register interfacing with Neptune's R450 MIU and transmits the data for collection. This unit receives the data for collection. This unit receives the data and stores data to be downloaded through the host software.

DHCP

Dynamic Host Configuration Protocol.

I

IMEI

International Mobile Equipment Identifier.

L

LED

Light Emitting Diode.

M

MEID

Mobile Equipment Identifier.

MHz

Abbreviation for megahertz. One MHz represents one million cycles per second.

MIU

Meter Interface Unit.

R

R450 System

R450 System is a fixed network AMI system for targeted applications allowing a utility to conduct meter reading operations automatically ensuring maximum collection of the data.

S

serial number

A unique identification number given to each product at the factory.

V

VSWR

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.

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