# PRODUCT MANUAL

Communications Device

# MD485

## RS-485 Multidrop Interface


Revision: 09/2024


RELIABLE MONITORING SINCE 1974

Campbell SCIENTIFIC®

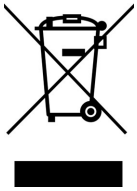
# Please read first

## About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country*.

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered.

## Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility, per The Waste Electrical and Electronic Equipment (WEEE) Regulations 2012/19/EU. Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

# Table of contents

# 1. Introduction

The MD485 is an intelligent RS-485 interface. It is configurable to use any two of its three interface ports (RS-485, RS-232 and CS I/O) at a time.

The primary function of the MD485 device is to provide a connection to an RS-485 network (using CS I/O or RS-232). It can also be used to provide an RS-232 connection to a data logger CS I/O port (SDC or ME).

MD485s may be networked, thereby permitting a computer to address and communicate with multiple data loggers. There are two RS-485 terminals to allow for easy networking. Both are connected to the same port internally, so either may be used for an RS-485 connection. For networking, one may be used for input and the other for output. Total cable length may be up to 4000 feet.

With the communications link initiated and controlled by a computer using Campbell Scientific *LoggerNet* or similar software, the operation of the MD485 in the system is transparent to the user.

# 2. Specifications

| | |
|---|---|
| **Size:** | 15.88 x 6.35 x 1.91 cm (6.25 x 2.5 x .75 in) |
| **Weight:** | 127.6 g (4.5 oz) |
| **Accessories:** | RS-232 cable, SC12 cable, 3-pin terminal block (2) |
| **Voltage:** | 12 Volts from data logger or wall transformer |
| **Current** | |
| **Standby:** | 1.2 mA |
| **Communicating:** | 2-7 mA |
| **Power** | |
| **Standby:** | 14.4 mW |
| **Communicating:** | 24-84 mW |

| | |
|---|---|
| ESD | |
| Air Discharge: | Complies with IEC61000-4-2, test level 4 (±15 kV) |
| Contact Discharge: | Complies with IEC61000-4-2, test level 4 (±8 kV) |
| Surge: | Complies with IEC61000-4-5, test level 3 (±2 kV, 2 ohms coupling impedance) |
| Temperature range: | –25 to +50°C |
| Baud rates: | 115.2K, 57.6K, 38.4K, 19.2K, 9600, 1200 |
| Communications cable: | CABLE2TP-L two-twisted-pair cable |

# 3. System components



## 3.1 MD485 ground lug

The MD485 has a GND lug (see Figure 3-1 [p. 3]). Connect this GND lug to earth ground with 8 AWG wire. This connection should be as short as possible.

## 3.2 MD485 indicator LEDs

The MD485 has two red LEDs. When 12V power is applied, the LEDs light for one second. The LEDs then begin flashing once every two seconds, while there is no activity on the ports.

When the RS-485 port is an active port, the LED nearest that connector (labeled B in Figure 3-1 [p. 3]) indicates traffic on the RS-485 port, and the other LED (labeled A) indicates traffic on the other active port (CS I/O or RS-232). When CS I/O and RS-232 are the active ports, the LED between the CS I/O connector and the RS-232 connector (A) indicates activity on the CS I/O port, and the other LED (B) indicates traffic on the RS-232 port. When data is being received and transmitted, the LEDs will flash. The LED for the port that is transmitting will be on more than the LED for the receiving port.

The LED nearest the RS-485 (B) connector will blink twice a second to indicate an RS-485 receiving error. This most likely indicates a wiring problem between the RS-485 ports of the base and remote MD485s.

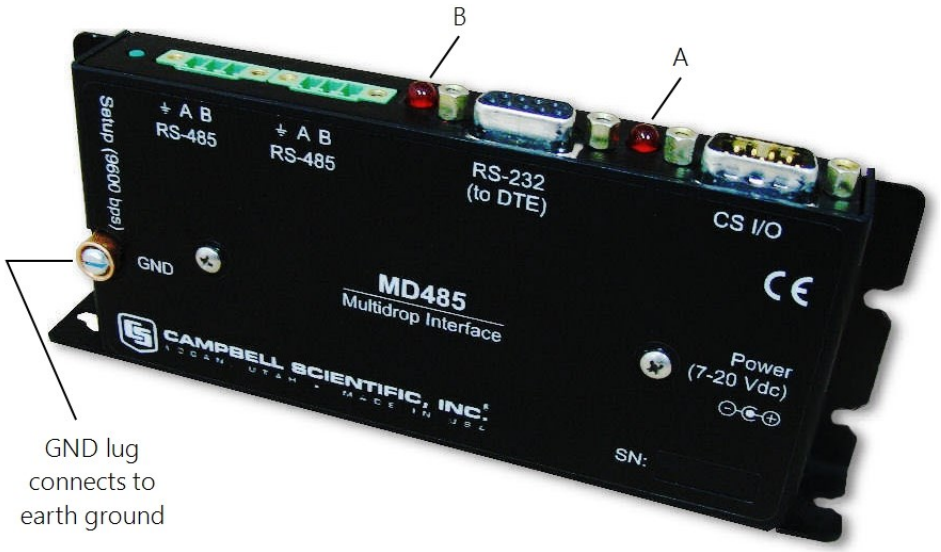



*Figure 3-1. The MD485 has a ground lug that should be attached to earth ground, and LEDs that indicate traffic on the ports.*

# 3.3 Power supplies

The typical base station MD485 connected directly to a computer uses a wall transformer to supply 12 VDC power. You can order the optional wall transformer that accepts inputs from 90 to 260 VAC at 47 to 63 Hz, then outputs 12 VDC at 880 mA. In a phone to MD485 base station configuration (without data logger) the MD485 can obtain power from a PS150 Power Supply with an A100 Null Modem Adapter.

The typical remote MD485 will be connected to a data logger CS I/O port and get its 12 V power from there. Campbell Scientific also offers a wall transformer that supports 120 VAC.

A 12 V supply may connect to either the MD485 **DC Pwr** jack or CS I/O pin 8 (or both, since there is diode isolation between supply inputs). The 12 V supply inputs are diode protected against the application of reverse polarity power.

# 3.4 RS-485 cable

The connection between MD485s is made with a CABLE2TP-L two-twisted-pair cable with shield and Santoprene jacket. Insulation colors of the twisted pair are red/black and green/white. One pair is used for the differential data ("A" connects to "A"; "B" connects to "B"), and one line of the

other twisted pair is used for the signal ground (third connection on the MD485 terminal block). This is shown in Figure 3-2 (p. 4). The cable shield should be connected to a chassis or earth ground (NOT the signal ground).

When connecting to equipment that uses – and + terminal markings, the MD485 **A** terminal is connected to the – terminal and the MD485 **B** terminal is connected to the + terminal.

If an application requires both the maximum distance (4000 ft) and the highest data rate (115k) for the MD485, a better quality cable, such as a polyethylene data cable, is recommended.

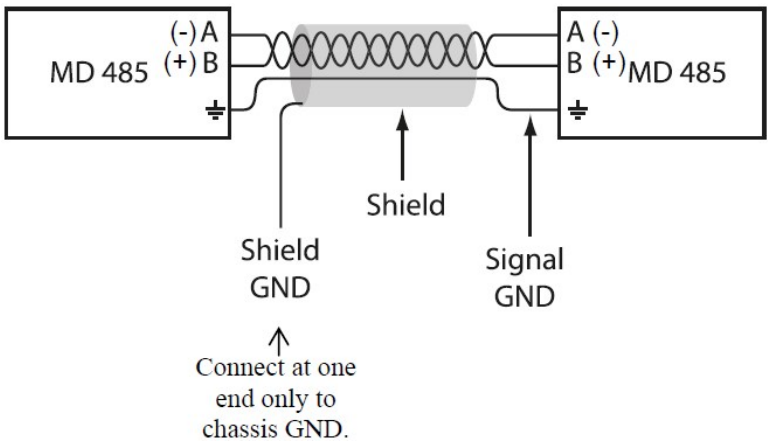



*Figure 3-2. RS-485 connections and grounding*

## 3.5 Serial cables

In an MD485 base station, a straight-through DB9M/DB9F RS-232 cable will connect from the MD485 **RS-232** port to the computer **COM** port. This cable is included with the MD485.

A remote MD485 normally uses the included SC12 cable to connect the MD485 **CS I/O** port to the data logger **CS I/O** port.

A remote MD485 can be connected to a data logger 9-pin **RS-232** port with a Null Modem DB9M/DB9M Cable.

# 4. QuickStart

This section is intended to serve as a "primer" enabling you to quickly build a simple system and see how it operates. This section describes in five steps how to set up a pair of MD485s in a direct connect, point-to-point network. We recommend completing this step before beginning field installation.

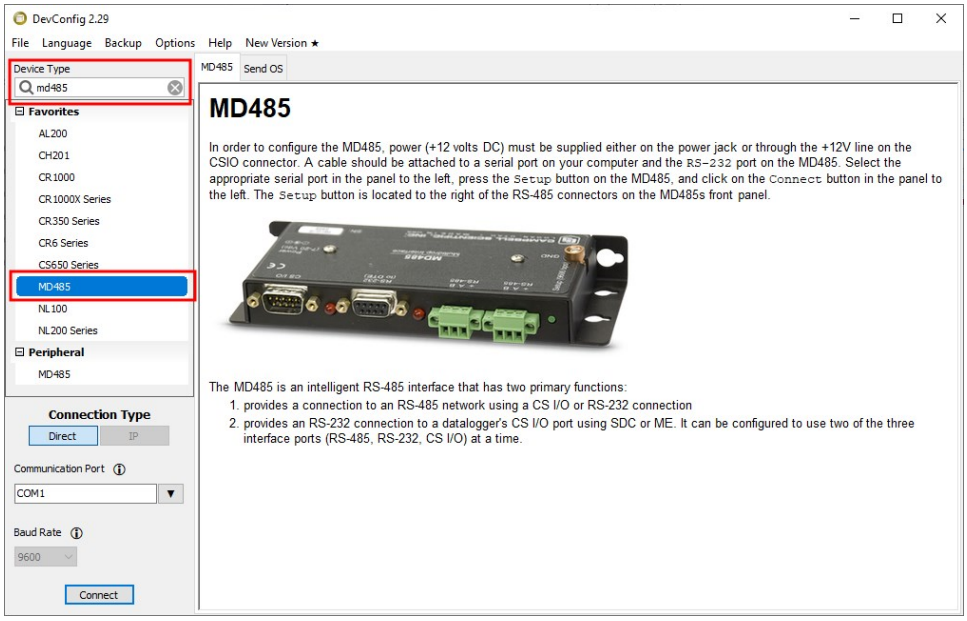
For this system you will need the following hardware or the equivalent:

- Two MD485s
- Wall transformer
- Serial cable for computer COM port to MD485 RS-232 port (included with MD485)
- SC12 cable (included with MD485)
- Campbell Scientific data logger
- CABLE2TP-L 2-twisted-pair cable with shield and Santoprene jacket

You will also need:

- A computer with one available COM port
- ***LoggerNet*** or ***PC400*** installed

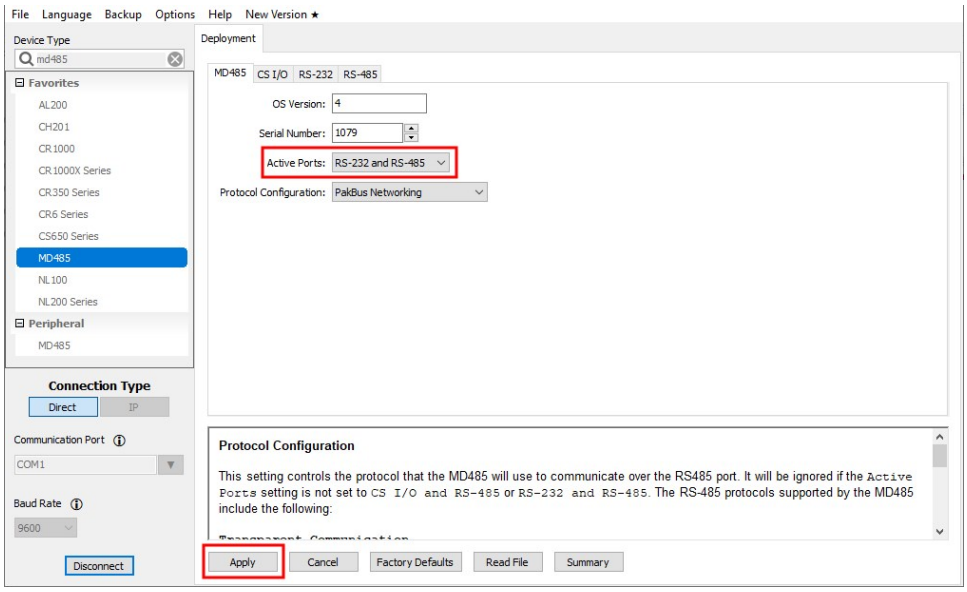
1. Set up base MD485
    a. Connect serial cable from computer **COM** port to base MD485 **RS-232** port.
    b. Plug transformer into AC outlet and plug barrel connector into base MD485 **DC Pwr** jack. You will see both red LEDs light immediately for 1 second. Both LEDs then begin to flash once every 2 seconds.
    c. Open ***Device Configuration Utility***.
    d. Type MD485 in the **Device Type** box and click **MD485**.




    e. Select the **Communication Port** in the left panel.

f. Click **Connect**.

g. Change **Active Ports** to **RS-232 and RS485**, then click **Apply**.



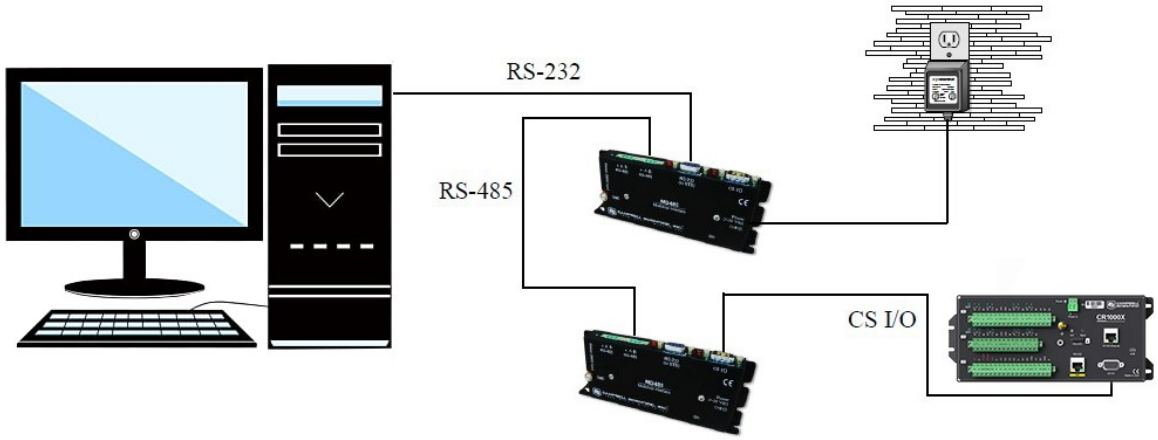




*Figure 4-1. MD485 basic point-to-point network*

2. Set up remote MD485

   a. Connect SC12 cable from data logger **CS I/O** port to remote MD485 **CS I/O** port. Current data logger/wiring panel CS I/O ports apply power to the remote MD485.

   b. Open ***Device Configuration Utility***.

   c. Type MD485 in the **Device Type** box and click **MD485**.

   d. Select the **Communication Port** in the left panel.

e. Click **Connect**.

f. Change **Active Ports** to **CS I/O and RS-485**, then click **Apply**.

3. Connect the CABLE2TP cable from the 3-pin terminal block on the base MD485 to the 3-pin terminal block on the remote MD485 as described in RS-485 cable (p. 3).

4. Set up ***PC400*/*LoggerNet***

   a. Run ***PC400*/*LoggerNet*** and configure it to connect to the data logger via the MD485 point-to-point network you have set up. The MD485 in a point-to-point network can operate transparent to ***PC400*/*LoggerNet***. Using the **EZSetup Wizard** in ***PC400*** or ***LoggerNet***, transparent communications is set up as if it is a direct connect. If not using the **EZSetup Wizard**, simply add a data logger to a COM port in the **Device Map**.

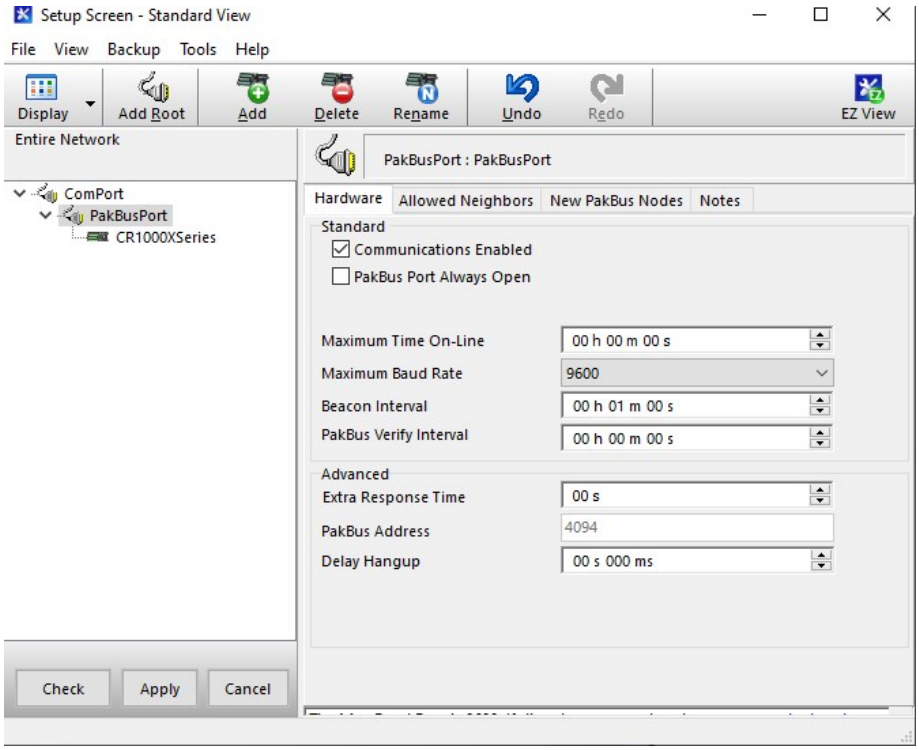



*Figure 4-2. Point-to-point **LoggerNet** network map*

   b. Set the **Maximum Baud Rate** to 9600 baud which is the rate at which the MD485 communicates by default. The data logger **Extra Response Time** can be left at 0.

5. Connect to your data logger using ***PC400*** or ***LoggerNet*** **Connect** screen.

   Data logger program transfer and data collection are now possible.

# 5. System configuration

The block diagram in Figure 5-1 (p. 8) depicts the connection of a computer to a network of Campbell Scientific data loggers using MD485s.

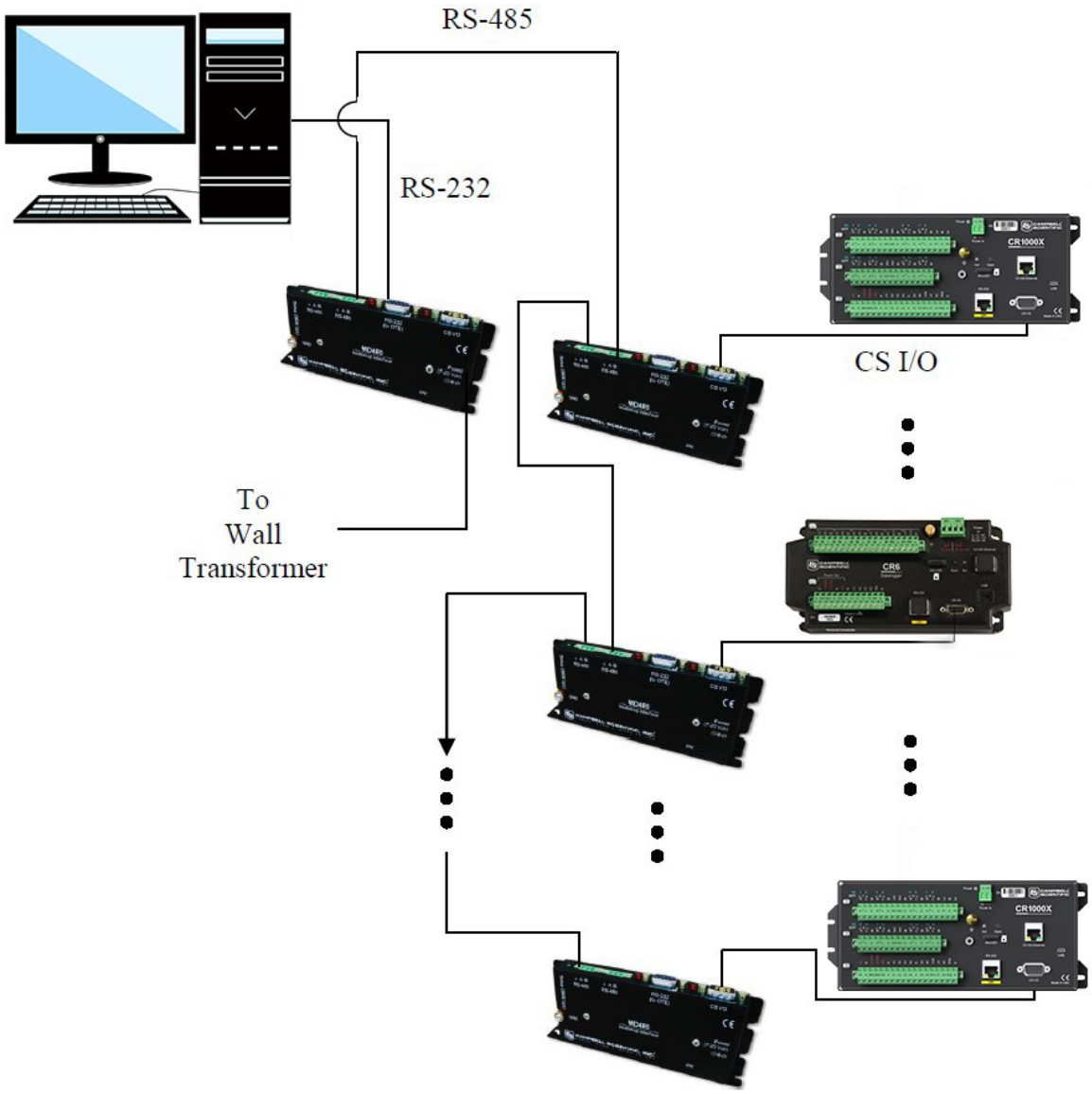



*Figure 5-1. MD485 point-to-multipoint network*

The base MD485 is connected to the computer **COM** port with a serial cable. A transformer supplies +12 VDC power to the MD485.

The MD485 at the computer is connected to one or more remote MD485s with the CABLE2TP cable.

The MD485 at the data logger is connected via an SC12 cable (supplied with the MD485) and is powered from the data logger **CS I/O** port.

Each MD485 includes (2) green 3-pin terminal blocks to allow for cable connections.

# 5.1 MD485 configuration

The MD485 is typically configured using ***Device Configuration Utility***, which is included with ***PC400*** and ***LoggerNet*** and can be downloaded at no charge from our web site. Using the ***Device Configuration Utility***, you can select and configure the active ports and choose the communications mode (see Figure 5-2 [p. 10]). Changed settings are saved in Flash memory.

Alternatively, a **Setup Menu** can be accessed by connecting the MD485 RS-232 port to a computer running a terminal program such as HyperTerminal™ or Procomm™ (always 9600 baud, 8-N-1) and pressing the **Setup** button on the MD485. Changed settings are saved in flash memory by selecting menu item **7** as you exit the **Setup Menu**. If left idle, the **Setup Menu** will time out 2 minutes after the last received character and exit without saving any parameter changes with the message **Setup Timeout**.

> NOTE:
> A data logger can remain connected to the CS I/O port while setting MD485 parameters on the RS-232 port, although CS I/O communications would be inactive until exiting ***Device Configuration Utility*** or the **Setup Menu**.

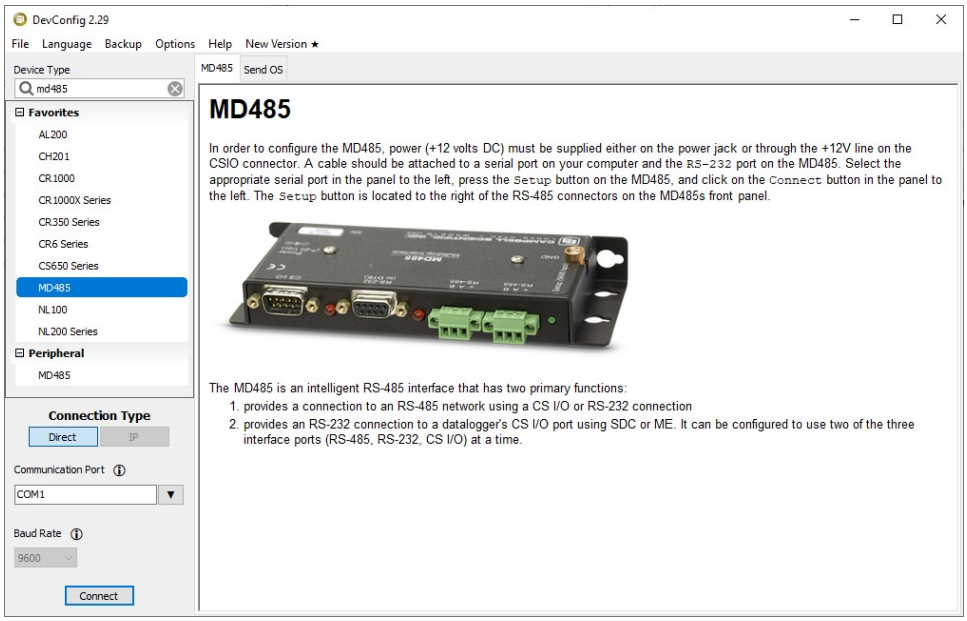



*Figure 5-2. MD485 setup using* ***Device Configuration Utility***

> **NOTE:**
> The baud rate for each port is set independently, so they can be different. However, in some instances, mismatched baud rates can cause an MD485 buffer overflow and create communications failures. Regardless of the baud rates set on other interface ports, the RS-485 ports of all MD485s in a system must be set to the same baud rate.

# 5.2 Transparent communications

When configured as a transparent device, the MD485 simply passes serial data from one interface to the other as quickly as possible without translation. If communications rates are different, the MD485 can buffer up to 1000 bytes.

Functioning as a transparent device, the MD485 becomes somewhat protocol independent. It acts as a way to get from one physical interface to another. In this mode the MD485 uses what is called "send-data" transmit control. The 485 transceiver is normally set to receive. When data needs to be transmitted on the RS-485 link, the driver is enabled, and stays enabled for 1 character tone after the last byte is sent. After this time, the transceiver switches back to receiving.

When using the **EZSetup Wizard** provided in ***PC400*** and ***LoggerNet***, select **Direct Connect** for the **Connection Type**. In transparent mode, the MD485 does not need to be represented in the network map of ***LoggerNet***.

Figure 5-3 (p. 11) shows an MD485 being used as an RS-232 to CS I/O interface converter. The MD485 is powered by the data logger through the CS I/O interface. In the ***Device Configuration Utility***, set the **Active Port** to **RS-232 and CS I/O** and the **Protocol Configuration** to **Transparent Communication**.


*Figure 5-3. RS-232 to CS I/O conversion*

Figure 5-4 (p. 11) would allow the longer cables supported by RS-485, while providing an RS-232 interface for the computer and using the CS I/O interface on the data logger. A transformer is required to power the MD485 closest to the computer. The base MD485 has **RS-232** and **RS-485** chosen as active ports, while the remote MD485 has the active ports set to **RS-485** and **CS I/O**.

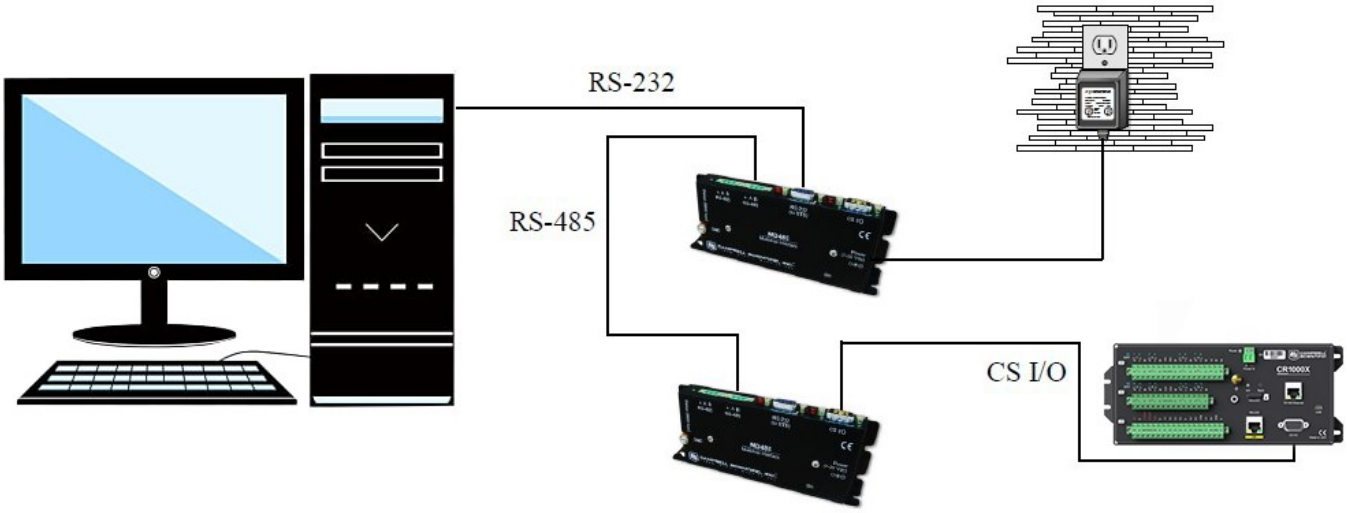



*Figure 5-4. Long distance RS-232 to CS I/O conversion*

Figure 5-5 (p. 12) shows the MD485 used in a transparent point-to-multipoint configuration. Modbus, which is commonly used in the SCADA industry, uses this configuration.

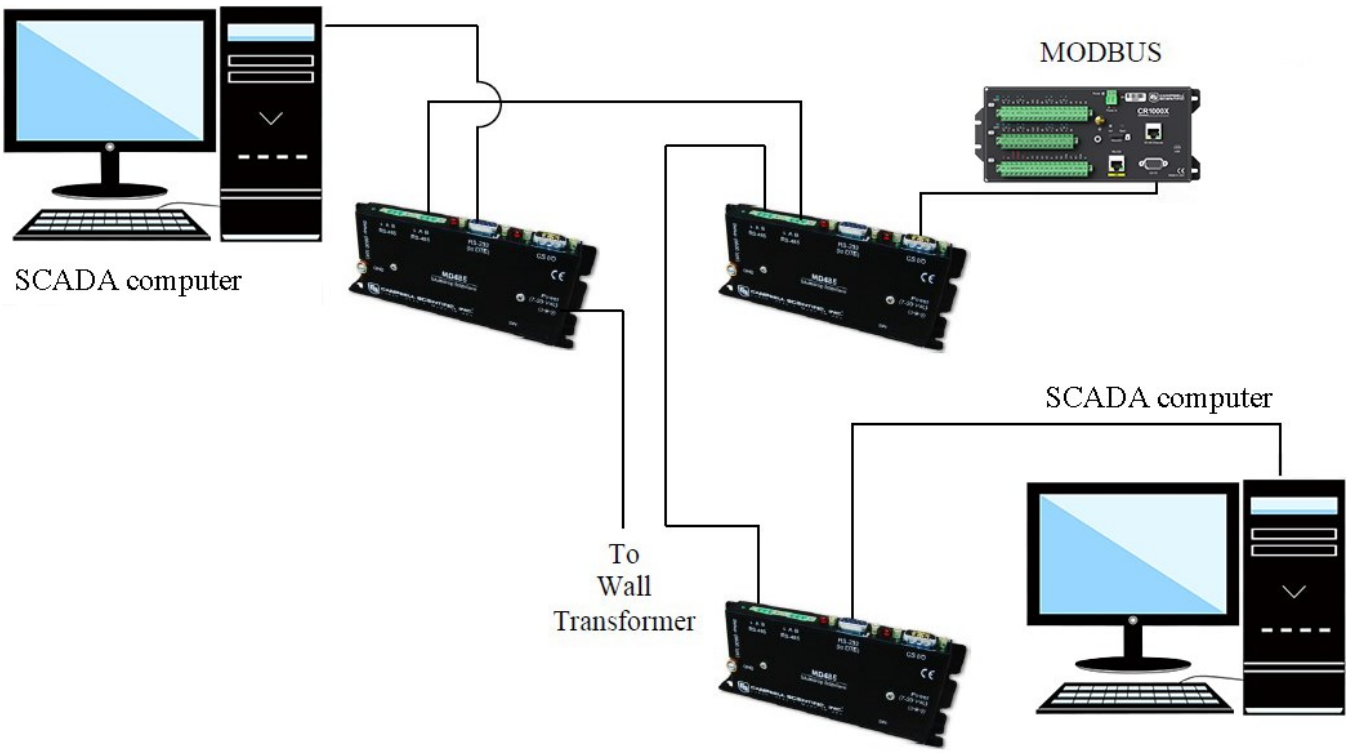



*Figure 5-5. Transparent point-to-multipoint network*

# 5.3 PakBus networking

When configured to use PakBus protocol, the MD485 makes use of the PakBus/Mdrop protocol on the RS-485 side. This allows reliable peer-to-peer networking of multiple devices over the three-wire RS-485 interface.

When the communications mode is set to **PakBus Networking**, the MD485 does not need to be represented in the device map of ***LoggerNet***. The data loggers are simply attached to a PakBusPort.

When using **PakBus Networking**, data loggers must be set up with PakBus addresses. They must also have beacons or neighbor filters set up as appropriate. (Beaconing is used for most applications. Networks with RF401As use neighbor filters.)

In **PakBus Networking** mode, data logger-to-data logger communications is possible.

# 6. Combining with other devices

Besides the direct to computer communications described in QuickStart (p. 4) and System configuration (p. 8), it is possible to combine methods in data logger communications.

Some combined communications examples:

- Phone to MD485: computer to external modem to COM220 to PS150 with A100 to MD485 to MD485 to data logger (see Phone to MD485 network [p. 16])
- RF401A to MD485: computer to RF401As then through null modem cable (or PS150 with A100) to MD485s to data logger (see RF401A to MD485 network [p. 20])
- MD485 to RF401A: computer to MD485s then through null modem cable (or PS150 with A100) to RF401As to data logger (see MD485 to RF401A network [p. 27])

# 7. Wiring considerations



## 7.1 RS-485 line length

The EIA/TIA RS-485 communications standard, an upgrade of RS-422, supports 32 devices (driver/receiver pairs) in a party line or multi-drop mode, on a cable of up to 4,000 feet.

The standard specifies that each device has a "unit load" of not more than 12k ohm. It does not specify cable type or data rate.

The MD485 has a 1/8-unit-load receiver input impedance (96k ohm) that allows up to 256 transceivers on the bus. Practical network design will be more of a limitation than the electrical load limit of 256 nodes for the MD485.

The RS-485 data transceivers used in the MD485 feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted. Because of this no

"biasing resistors" need to be used. They also feature reduced slew-rate drivers that minimize EMI and reduce reflections. Because of this, termination resistors do not need to be used for most applications.

## 7.2 Grounding

The MD485 has a ground lug. Connect this ground lug to earth ground with an 8 AWG wire. This connection should be as short as possible.

The differential signaling of RS-485 does not require a signal ground to communicate. The standard allows for a common-mode voltage (Vcm) of -7 to +12 V. As long as the MD485 local grounds do not exceed this common-mode voltage limit, the RS-485 communications will work fine.

Over a distance of hundreds or thousand of feet, there can be significant differences in the voltage level of "ground"; it can easily extend beyond the common-mode voltage limits of RS-485. The signal ground wire serves to tie the signal ground of each node to one common ground, which is within the common-mode voltage of the RS-485 specification.

The RS-485 specification also recommends connecting a 100 ohm resistor of at least 0.5 W in series between each node signal ground and the network ground wire. This resistor is in the MD485, between the terminal block connection marked with the ground symbol and the MD485 power ground. This way, if the ground potentials of two nodes vary, the resistors limit the current in the ground wire.

See Figure 3-1 (p. 3), Figure 3-2 (p. 4), and RS-485 cable (p. 3) for more information on ground connections.

## 7.3 Protection and isolation

The MD485 incorporates gas tubes and multilayer varistors on the RS-485 port for protection against ESD and surge. The MD485 passes IEC61000-4-2, test level 4 for both contact and air discharge. It also passes IEC61000-4-5, test level 3 for surge immunity.

If large ground potentials exist, optical isolation may be desired. One recommended optical isolator is B&B's Model 485OP, which provides 2 kV isolation. If most of the nodes in the network close together (limited ground differences), and one node is located at a distance (large ground difference), then a single optical isolator can be located on the distant node. If all of the nodes are distant from each other, optical isolation will be needed at every node.

The Model 485OP can also be used as a repeater to extend the network.

## 7.4 Termination

The RS-485 spec says to use termination. For high baud rates (>115k) and long cable runs, this is true.

In most equipment though, with maximum speeds of 115 kbit, it is unnecessary. Adding termination dramatically increases power consumption, and complicates system design. It rarely solves problems when used in the kilobit data range.

If power is not a concern, and signal integrity is questioned, the network can be terminated with a 120 ohm resistor at the extreme ends of the line. There should be no more than two terminations in a system that does not use repeaters.

## 7.5 Summary

- Use CABLE2TP-L 2-twisted-pair cable with shield and Santoprene jacket for most installations.
- Connect the MD485 ground lug to earth ground with an 8 AWG wire. This connection should be as short as possible.
- Connect the signal ground wire between MD485s.
- Ground the shield at one end only (to earth ground).
- In most instances, no termination is required.
- If large ground potentials exist, use optical isolation. (B&B's Model 4850P)
- Electrically, 256 MD485s can be connected, but that may be an unmanageable network.

# Appendix A. Phone to MD485 network

It is possible to access an MD485 network via telephone when the network is miles from the computer. See Figure A-1 (p. 17).

A Campbell Scientific Model COM220 Telephone Modem is used in conjunction with a Model PS150 Power Supply and A100 Null Modem Adapter to communicate with an MD485. The COM220 and the MD485 are both supplied with a 9 pin SC12 cable suitable for connection to the A100. The PS150 provides 5 and 12 volts for system operation and the A100 performs the function of a null modem (the COM220 and MD485 are both "modem" devices).

> **NOTE:**
> The telephone to MD485 Network using a PS150 with A100 may be done with Transparent Communications, but is not possible with PakBus networking. Connection to a single PakBus Data logger is still possible with Transparent Communications. PakBus networking can be done by using a data logger in place of the PS150/A100 for routing.

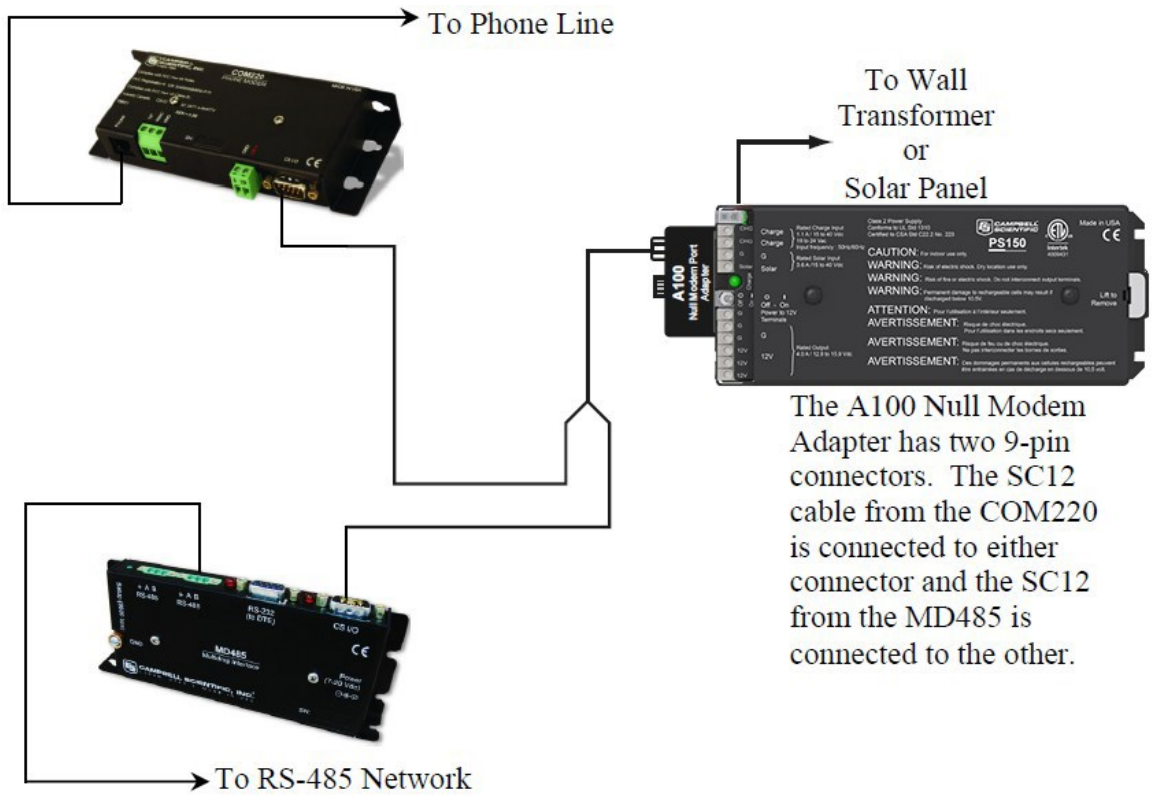



*Figure A-1. Telephone to MD485 conversion*

Where a phone to MD485 base is desired, the following configurations will provide point-to-point or point-to-multipoint communications.

1. HARDWARE REQUIREMENTS
    a. MD485s
    b. COM220
    c. PS150 with A100
    d. Transformer or solar panel
    e. Three SC12 cables (one included with each MD485 and one with COM220)
    f. CABLE2TP cable
2. TRANSPARENT COMMUNICATIONS (POINT-TO-POINT)

    Computer-Modem---COM220-PS150 with A100-MD485---MD485-DL

*LoggerNet* Setup

a. Setup:

   ComPort_1

     PhoneBase

       PhoneRemote

         PakBus Port

       CR1000X

b. ComPort_1 – default settings

c. PhoneBase

   i. Modem Type – specify computer phone modem

   ii. Maximum Baud Rate – 9600

   iii. Extra Response Time – 0 s

d. PhoneRemote – input base site phone number

e. PakBus Port – defaults

f. CR1000X – default settings, schedule collections as desired

MD485 Configuration

a. Base MD485

   i. Active Ports – CS I/O and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. CS I/O Mode – ME Master

   iv. RS-485 Port Configuration – Desired baud rate

b. Remote MD485

   i. Active Ports – CS I/O and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. CS I/O Mode – Modem Enable

   iv. RS-485 Port Configuration – Desired baud rate

3. HARDWARE

After configuring ***LoggerNet*** and the MD485s, you are ready to set up hardware. The A100 null modem connectors (it's not important which connector goes to which unit) connect

using SC12 cables to the COM220 and the base MD485 CS I/O port. Connect the site phone line to COM220. Connect power to PS150. When you turn on the PS150 supply, the MD485 receives 12 V power and you will see the LEDs light in their power-up sequence.

Remote MD485s normally connect to data logger CS I/O ports via SC12 cables. Powering up the data logger will start the MD485 operating. Connect the CABLE2TP cable between the RS-485 ports of the base and remote MD485s and you are ready to connect to the data logger.

# Appendix B. RF401A to MD485 network

Where an RF401A to MD485 network is desired, the following configurations will provide access to an MD485 network via RF401As.

The connection between the remote RF401A and the base MD485 can be made in two different ways. 1) Using a Campbell Scientific PS150 Power Supply with A100 Null Modem Adapter. The PS150 provides 5 and 12 volts for system operation and the A100 performs the function of a null modem (the RF401A and MD485 are both "modem" devices). 2) Using a null modem cable and transformers to provide power to the RF401A and the MD485.

The following sections will describe how to set up the RF401A to MD485 network using each of these two methods for each communications mode.

## B.1 Connection using a PS150 with A100

Figure B-1 (p. 21) shows an RF401A to MD485 network using a PS150 with A100. The following configurations will provide communications in transparent mode. Connection to a single PakBus data logger is possible with transparent communications. PakBus networking is not possible using the PS150/A100, but can be done using a data logger in place of the PS150/A100 for routing.

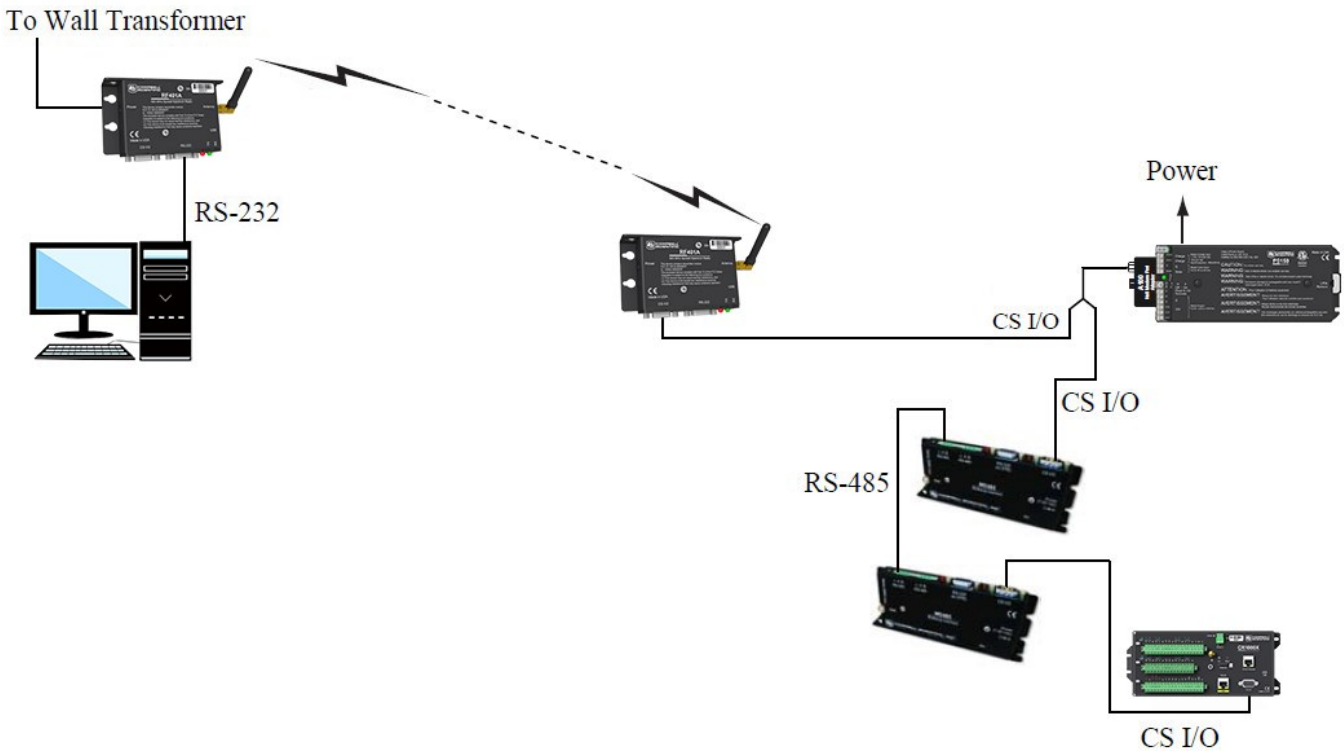



*Figure B-1. RF401A to MD485 conversion*

1. HARDWARE REQUIREMENTS
    a. MD485s
    b. RF401As
    c. PS150 with A100
    d. Transformer for base RF401A
    e. Transformer or solar panel for PS150
    f. Three SC12 cables (one included with each MD485 and one with RF401A)
    g. CABLE2TP
2. TRANSPARENT COMMUNICATIONS (POINT-TO-POINT)

    Computer-RF401A---RF401A-PS150 with A100-MD485---MD485-DL

*LoggerNet* Setup

a. Setup:

   ComPort_1

   PakBus Port (PakBus data loggers only)

   CR1000X

b. ComPort_1 – default settings

c. PakBus Port – defaults (PakBus data loggers only)

d. CR1000X – default settings, schedule collections as desired

MD485 Configuration

a. Base MD485

   i. Active Ports – CS I/O and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. CS I/O Mode – ME Master

   iv. RS-485 Port Configuration – Desired baud rate

b. Remote MD485

   i. Active Ports – CS I/O and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. CS I/O Mode – Modem Enable

   iv. RS-485 Port Configuration – Desired baud rate

RF401A Configuration

The RF401As may be left in their default settings. However, if there is a neighboring RF401A network, you should change the RF Hopping Sequence of base and remote RF401As to a new setting to avoid interference.

3. HARDWARE

After configuring ***LoggerNet***, the RF401As, and the MD485s, you are ready to set up hardware. Connect the base RF401A RS-232 port to the computer COM port. The A100 null modem connectors (it's not important which connector goes to which unit) connect via SC12 cables to the CS I/O ports of the remote RF401A and the base MD485. Connect power to the PS150. When you turn on the PS150 supply, the MD485 receives 12 V power and you will see the LEDs light in their power-up sequence.

Remote MD485s normally connect to data logger **CS I/O** ports via SC12 cables. Powering up the data logger will start the MD485 operating. Connect the CABLE2TP cable between the **RS-485** ports of the base and remote MD485s and you are ready to connect to the data logger.

# B.2 Connection using a null modem cable

The RF401A to MD485 conversion can be done using a null modem cable in place of the PS150/A100. The following configurations will provide communications in transparent mode or PakBus networking.

1. HARDWARE REQUIREMENTS
    a. MD485s
    b. RF401As
    c. Three transformers
    d. Null modem cable
    e. Three SC12 cables (one included with each MD485 and one with RF401A)
    f. CABLE2TP
2. TRANSPARENT COMMUNICATIONS (POINT-TO-POINT)

    Computer-RF401A---RF401A---null modem---MD485---MD485-DL

    *LoggerNet* Setup

    a. Setup:

        ComPort_1

            PakBus Port (PakBus data loggers only)

                CR1000X

    b. ComPort_1 – default settings
    c. PakBus Port – defaults (PakBus data loggers only)
    d. CR1000X – corresponding PakBus address (PakBus data loggers only), other settings default, schedule collections as desired

### MD485 Configuration

a. Base MD485
    i. **Active Ports** – **RS-232 and RS-485**
    ii. **Protocol Configuration** – **Transparent Communications**
    iii. RS-232 Port Configuration – Desired baud rate
    iv. RS-485 Port Configuration – Desired baud rate
b. Remote MD485
    i. **Active Ports** – **CS I/O and RS-485**
    ii. **Protocol Configuration** – **Transparent Communications**
    iii. **CS I/O Mode** – **Modem Enable**
    iv. RS-485 Port Configuration – Desired baud rate

### RF401A Configuration

The RF401As may be left in their default settings. However, if there is a neighboring RF401A network, you should change the **RF Hopping Sequence** of base and remote RF401As to a new setting to avoid interference.

3. **PAKBUS NETWORKING**

```
Computer-RF401A---RF401A---null modem---MD485  ---MD485-DL1
                                               ---MD485-DL2
```

### *LoggerNet* Setup

a. Setup:

    ComPort_1

      PakBus Port

        CR1000X

        CR1000X_2

b. ComPort_1 – default settings
c. PakBus Port – defaults
d. Data loggers – corresponding PakBus address, other setting default, schedule collections as desired

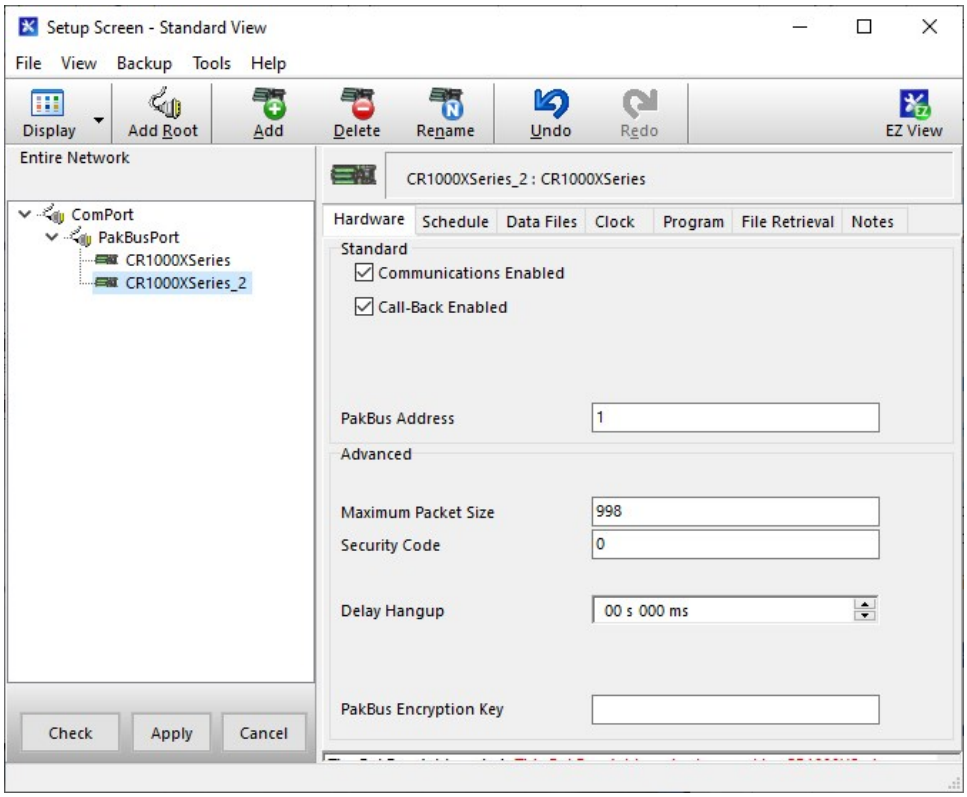



*Figure B-2.* ***LoggerNet*** *PakBus networking setup*

## MD485 Configuration

a. Base MD485
   i. **Active Ports** – **RS-232 and RS-485**
   ii. **Protocol Configuration** – **PakBus Networking**
   iii. RS-232 Port Configuration – Desired baud rate
   iv. RS-485 Port Configuration – Desired baud rate

b. Remote MD485s
   i. **Active Ports** – **CS I/O and RS-485**
   ii. **Protocol Configuration** – **PakBus Networking**
   iii. **CS I/O Mode** – **SDC Address 7** or **SDC Address 8**
   iv. RS-485 Port Configuration – Desired baud rate

### RF401A Configuration

The RF401As may be left in their default settings. However, if there is a neighboring RF401A network, you should change the **RF Hopping Sequence** of base and remote RF401As to a new setting to avoid interference.

4. **HARDWARE**

After configuring ***LoggerNet***, the RF401As and the MD485s you are ready to set up hardware. Connect the base RF401A **RS-232** port to the computer **COM** port. Attach the null modem cable to the **RS-232** ports of the remote RF401A and the base MD485. Attach transformers to the **DC Pwr** jack of each RF401A and the base MD485.

Remote MD485s normally connect to data logger **CS I/O** ports via SC12 cables. Powering up the data logger will start the MD485 operating. Connect the CABLE2TP cable between the **RS-485** ports of the base and remote MD485s and you are ready to connect to the data logger.

# Appendix C. MD485 to RF401A network

Where an MD485 to RF401A network is desired, the following configurations will provide access to an RF401A network via MD485s.

The connection between the remote MD485 and the base RF401A can be made in two different ways. 1) Using a Campbell Scientific PS150 Power Supply with A100 Null Modem Adapter. The PS150 provides 5 and 12 volts for system operation and the A100 performs the function of a null modem (the RF401A and MD485 are both "modem" devices). 2) Using a null modem cable and transformers to provide power to the RF401A and the MD485.

The following sections will describe how to set up the MD485 to RF401A network using each of these two methods for each communications mode.

## C.1 Connection using a PS150 with A100

Figure C-1 (p. 28) shows an MD485 to RF401A network using a PS150 with A100. The following configurations will provide communications in transparent mode. Connection to a single PakBus data logger is possible with transparent communications. PakBus networking is not possible using the PS150/A100, but can be done using a data logger in place of the PS150/A100 for routing.

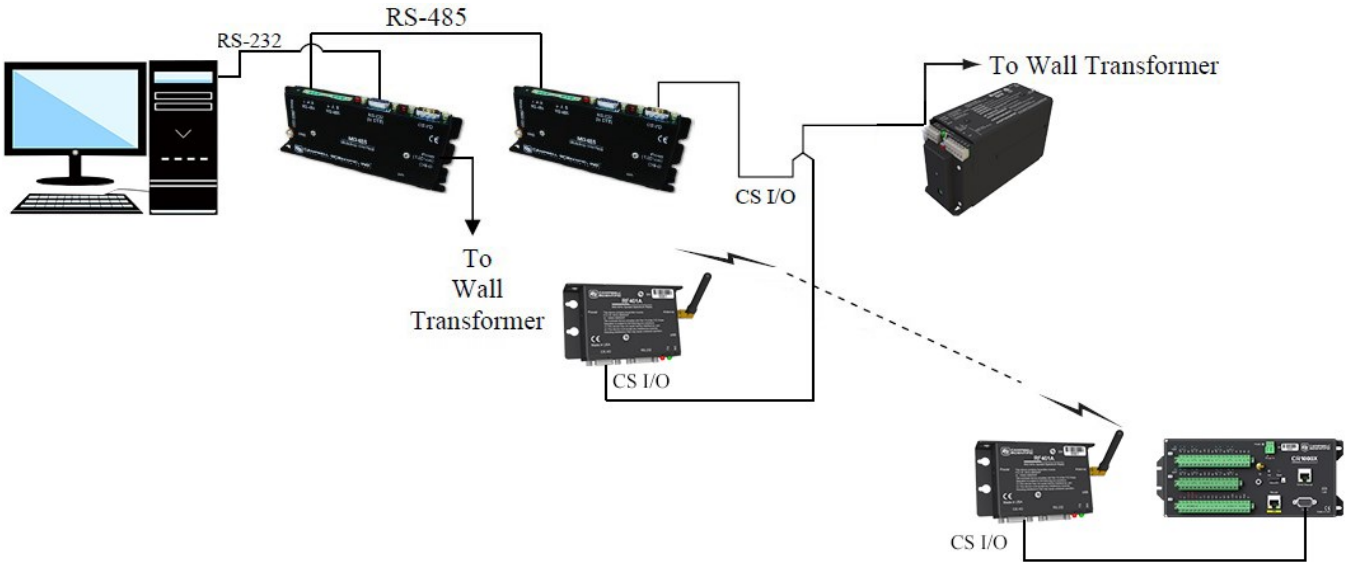



*Figure C-1. MD485 to RF401A conversion*

1. HARDWARE REQUIREMENTS
    a. MD485s
    b. RF401As
    c. PS150 with A100
    d. Transformer for base MD485
    e. Transformer for solar panel for PS150
    f. Three SC12 cables (one included with MD485 and one with each RF401A)
    g. CABLE2TP cable
2. TRANSPARENT COMMUNICATIONS (POINT-TO-POINT)

    Computer-MD485---MD485-PS150 with A100-RF401A---RF401A-DL

    *LoggerNet* Setup

    a. Setup:

        ComPort_1

            PakBus Port (PakBus data loggers only)

                CR1000X

    b. ComPort_1 – default settings

c. PakBus Port – defaults (PakBus data loggers only)

d. CR1000X – default settings, schedule collections as desired

MD485 Configuration

a. Base MD485

   i. Active Ports – RS-232 and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. RS-232 Port Configuration – Desired baud rate

   iv. RS-485 Port Configuration – Desired baud rate

b. Remote MD485

   i. Active Ports – CS I/O and RS-485

   ii. Protocol Configuration – Transparent Communications

   iii. CS I/O Mode – Modem Enable

   iv. RS-485 Port Configuration – Desired baud rate

RF401A Configuration

The active interface of the base RF401A should be set to **CS I/O ME Master**. All other RF401A settings maybe left in their default state. However, if there is a neighboring RF401A network, you should change the **RF Hopping Sequence** of base and remote RF401As to a new setting to avoid interference.

3. HARDWARE

After configuring ***LoggerNet***, the RF401As and the MD485s you are ready to set up hardware. Connect the base MD485 **RS-232** port to the computer **COM** port. Attach a transformer to the **DC Pwr** jack of the base MD485. The A100 null modem connectors (it's not important which connector goes to which unit) connect via SC12 cables to the **CS I/O** ports of the remote MD485 and the base RF401A. Connect power to the PS150. When you turn on the PS150 supply, the MD485 and the RF401A receive 12 V power and you will see the LEDs light in their power-up sequence.

The remote RF401A connects to data logger **CS I/O** port via an SC12 cable. Powering up the data logger will start the RF401A operating.

Connect the two twisted pair, shielded cable between the **RS-485** ports of the base and remote MD485s and you are ready to connect to the data logger.

# C.2 Connection using a null modem cable

The MD485 to RF401A conversion can be done using a null modem cable in place of the PS150/A100. The following configurations will provide communications in transparent mode or PakBus networking.

1. HARDWARE REQUIREMENTS
    a. MD485s
    b. RF401As
    c. Three transformers
    d. Null modem cable
    e. Three SC12 cables (one included with each RF401A and one with MD485)
    f. CABLE2TP cable
2. TRANSPARENT COMMUNICATIONS (POINT-TO-POINT)

    Computer-MD485---MD485---null modem---RF401A---RF401A-DL

    *LoggerNet* Setup

    a. Setup:

        ComPort_1

            PakBus Port (PakBus data loggers only)

                CR1000X

    b. ComPort_1 – default settings
    c. PakBus Port – defaults (PakBus data loggers only)
    d. CR1000X – default settings, schedule collections as desired

    MD485 Configuration

    a. Base MD485
        i. Active Ports – RS-232 and RS-485
        ii. Protocol Configuration – Transparent Communications
        iii. RS-232 Port Configuration – Desired baud rate
        iv. RS-485 Port Configuration – Desired baud rate

b. Remote MD485

   i. **Active Ports** – **RS-232 and RS-485**

   ii. **Protocol Configuration** – **Transparent Communications**

   iii. RS-232 Port Configuration – Desired baud rate

   iv. RS-485 Port Configuration – Desired baud rate

### RF401A Configuration

The RF401As may be left in their default settings. However, if there is a neighboring RF401A network, you should change the **RF Hopping Sequence** of base and remote RF401As to a new setting to avoid interference.

3. **PAKBUS NETWORKING**

Computer-MD485---MD485---null modem---RF401A---RF401A-DL

### *LoggerNet* Setup

a. Setup:

ComPort_1

PakBus Port

CR1000X

b. ComPort_1 – default settings

c. PakBus Port – defaults

d. Data loggers – corresponding PakBus address, other setting default, schedule collections as desired

### MD485 Configuration

a. Base MD485

   i. **Active Ports** – **RS-232 and RS-485**

   ii. **Protocol Configuration** – **PakBus Networking**

b. Remote MD485s

   i. **Active Ports** – **RS-232 and RS-485**

   ii. **Protocol Configuration** – **PakBus Networking**

### RF401A Configuration

The RF401As may be left in their default settings. However, if there is a neighboring RF401A network, you should change the **RF Hopping Sequence** of base and remote RF401As to a new setting to avoid interference.

4. **HARDWARE**

   After configuring ***LoggerNet***, the RF401As and the MD485s you are ready to set up hardware. Connect the base MD485 **RS-232** port to the computer **COM** port. Attach the null modem cable to the **RS-232** ports of the remote MD485 and the base RF401A. Attach transformers to the **DC Pwr** jack of each MD485 and the base RF401A.

   Remote MD485s normally connect to data logger **CS I/O** ports via SC12 cables. Powering up the data logger will start the MD485 operating. Connect the CABLE2TP cable between the **RS-485** ports of the base and remote MD485s and you are ready to connect to the data logger.

# Appendix D. MD485 port pin descriptions

### CS I/O Port

The CS I/O port is Campbell Scientific's input/output port. It is not a standard RS-232 pin-out. The following table provides pin-out information on the port when connected to a data logger.

Table D-1: CS I/O connector, 9-pin D-sub male

| Pin | I/O | Function | Description |
|---|---|---|---|
| 1 | NC | 5 V supplied by data logger | Data logger sources 5 VDC to power peripherals |
| 2 | GND | GND | GND |
| 3 | O | Ring | Raised by modem to put data logger into telecommunications mode |
| 4 | O | RX | Serial data receive line |
| 5 | I | Modem enable | Raised when data logger determines that associated modem raised the ring line |
| 6 | I | Synchronous device enable | Used by data logger to address synchronous devices; can be used as a printer enable |
| 7 | I | CLK/Handshake | Used by data logger with SDE and TX lines to transfer data to synchronous devices |
| 8 | PWR | 12 V supplied by data logger | Data logger sources 12 VDC to power peripherals |
| 9 | I | TX | Serial data transmit line |
| I = Signal into the MD485, O = Signal out of the MD485, NC = No connection | | | |

### RS-232 Port

The RS-232 port is a partial implementation of RS-232C. It is configured as Data Communications Equipment (DCE) for direct cable connection to Data Terminal Equipment (DTE) such as a computer serial port.

Table D-2: RS-232 connector, 9-pin D-sub female

| Pin | I/O | Function |
|---|---|---|
| 1 | +5V | DCD |
| 2 | O | RXD |
| 3 | I | TXD |
| 4 | NC | DTR |
| 5 | GND | GND |
| 6 | +5V | DSR |
| 7 | NC | RTS |
| 8 | O | CTS |
| 9 | NC | RI |
| I = Signal into the MD485, O = Signal out of the MD485, NC = No connection | | |

### RS-485 Port

Table D-3: RS-485 connector, 3-pin terminal block

| Pin | I/O | Function |
|---|---|---|
| 1 | GND | Signal ground |
| 2 | I/O | 485_IO- (A) |
| 3 | I/O | 485_IO+ (B) |
| I = Signal into the MD485, O = Signal out of the MD485 | | |

# Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.

2. The defect cannot be the result of misuse.

3. The defect must have occurred within a specified period of time; and

4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.

2. Batteries; and

3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country. For directions on how to return equipment, see Assistance.

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Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country.

When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a "Declaration of Hazardous Material and Decontamination" form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. For details on decontamination standards specific to your country, please reach out to your regional Campbell Scientific office.

> NOTE:
> All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your regional Campbell Scientific office for details.

# Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.

- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

- Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

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