PRODUCT MANUAL

Communications Device

RF407-series

Spread Spectrum Radios

Revision: 07/2024

RELIABLE MONITORING SINCE 1974

Campbell SCIENTIFIC®

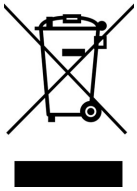
Please read first

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. Radio communications

The RF407-series frequency-hopping spread-spectrum (FHSS) radio options include the RF407, RF412, RF422, and RF427. RF407-series are designed for license-free use in several countries:

- The RF407 option has a 902 to 928 MHz operating-frequency range appropriate for use in the United States and Canada (FCC / IC compliant).
- The RF412 option has a 915 to 928 MHz operating-frequency range appropriate for use in Australia and New Zealand (ACMA compliant).
- The RF422 option has an 863 to 873 MHz operating-frequency range appropriate for use in most of Europe and some of Asia (ETSI compliant).
- The RF427 option has a 902 to 907.5 MHz/915 to 928 MHz operating-frequency range appropriate for use in Brazil.

NOTE:
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his or her own expense.

CAUTION:
Radio options cannot be mixed within a network. An RF407 can only be used with other RF407-type radios, an RF412 can only be used with other RF412-type radios, an RF422 can only be used with other RF422-type radios, RF427 can only be used with other RF427-type radios.

Throughout these instructions, RF407-series represents each of the RF407, RF412, RF422, and RF427 radio options, unless otherwise noted.

See also Specifications (p. 9).

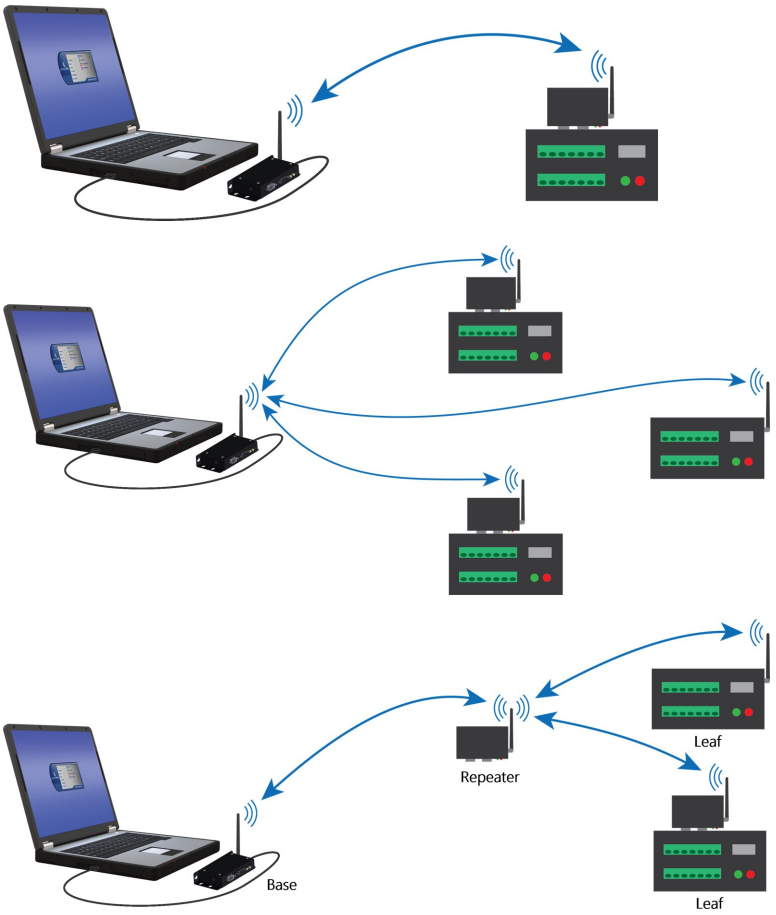
1.1 Overview

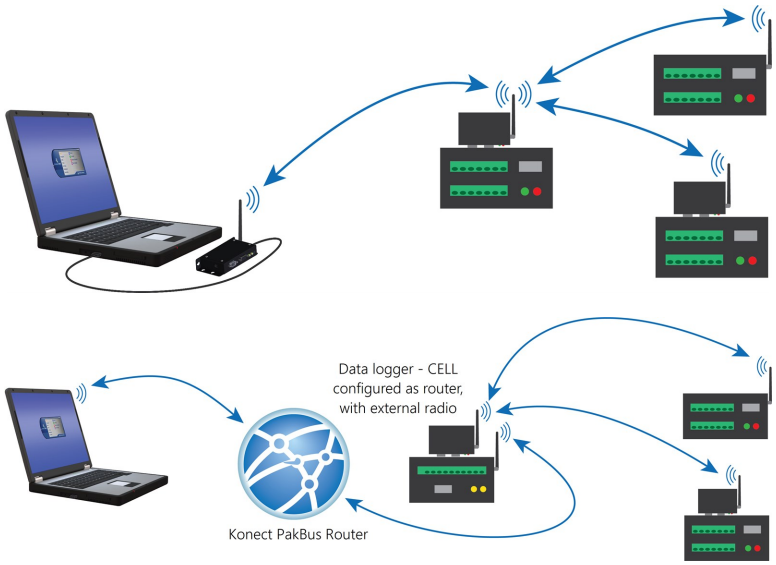
Spread-spectrum radios spread the normally narrowband information signal over a relatively wide band of frequencies. This allows the communications to be more immune to noise and interference from RF sources such as pagers, cellular phones, and multipath signals. The RF407-series radios reduce susceptibility to RF interference from other spread-spectrum devices by providing user-selectable frequency-hopping patterns.

The RF407-series radios can provide up to three mile transmission range with an inexpensive whip antenna. The radios can provide greater than 16 mile transmission range when using a higher-gain directional antenna at ideal conditions.

1.2 Configuration options

The following images show the most frequently used configurations with the RF-series data logger and RF-series radio:





2. Precautions

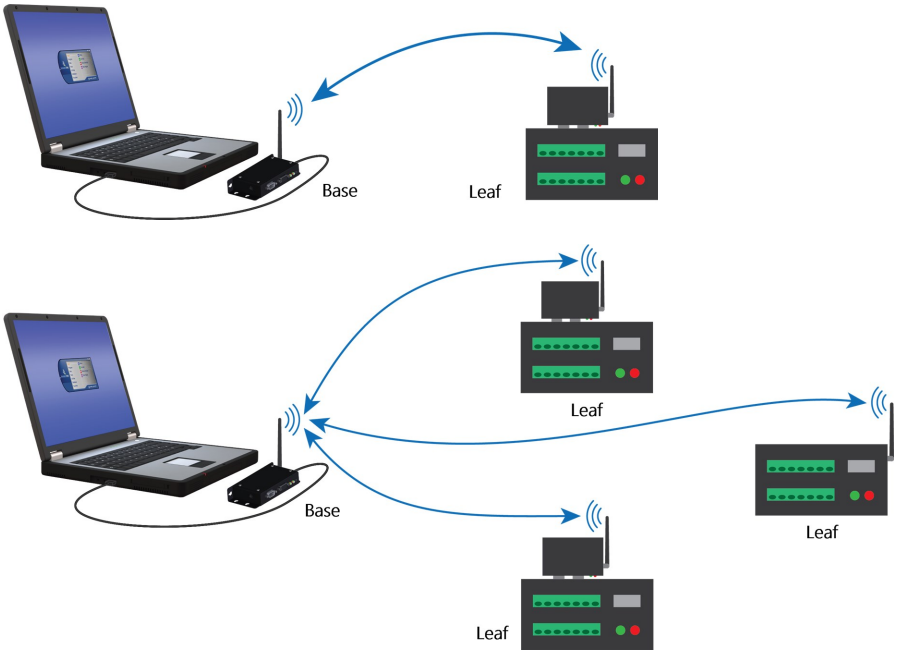
- This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. See Part 15 FCC compliance warning (p. 46) for more information.
- It is recommended that the RF422 868 MHz radio be installed at least 200 meters from any 4G LTE cellular transmitter including towers and cellular modems/gateways.
- Ensure maximum protection against surges. Use coaxial (antenna) surge protection. Keep RS-232, CS I/O, and USB connections short or use protective isolation and surge protection when appropriate.
- A Campbell Scientific wall charger is recommended when AC power is used. Any other AC adapter used must have a DC output not exceeding 16 volts measured without a load to avoid damage to the radio. Over-voltage damage is not covered by factory warranty.
- Line-of-sight obstructions and RF interference will affect the transmission distance. See Line of Sight Technical Paper and Link Budget Technical Paper for a discussion of antenna gain and other factors affecting distance.

3. Initial inspection

- Upon receipt of the RF407-series radio, inspect the packaging and contents for damage. File damage claims with the shipping company.
- Immediately check package contents against shipping documentation. Thoroughly check all packaging material for product that may be trapped. Contact Campbell Scientific immediately about any discrepancies. Model numbers are found on each product. On cables, the model number is often found at the connection end of the cable.

4. QuickStart – Basic networks

> NOTE:
> This procedure assumes the RF407-series devices are using factory default settings.



4.1 Configure the base RF407-series radio

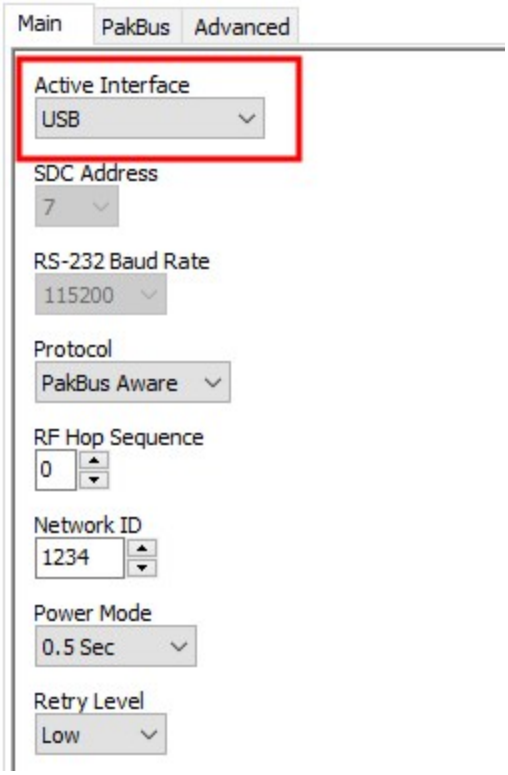
Configure the RF407-series radio that is connected to the computer. This is sometimes referred to as the base radio.

1. Ensure that an antenna is connected to the RF407-series radio.
2. If connecting via USB for the first time, you must first install USB drivers using ***Device Configuration Utility*** (select your radio, then on the main page, click **Install USB Driver**).

3. Connect the **USB** port on your RF407-series radio to your computer.

4. Using ***Device Configuration Utility***, select the **Communication Port** used for your radio and connect to the RF407-series radio.

5. On the **Main** tab, set the **Active Interface** to **USB** or **RS-232** (depending on how your computer will be connected to the RF407-series radio).



6. **Apply** to save your changes.
7. Close *Device Configuration Utility*.
8. The **TX/PWR** and **RX** LEDs flash once, after which the **TX/PWR** LED returns to blinking at the **Power Mode** interval (0.5 sec, by default).
9. Leave the radio connected to the computer.

   If the **Active Interface** was set to RS-232, disconnect the USB cable. Use a serial cable to connect the computer RS-232 port to the RF407 **RS-232** port.

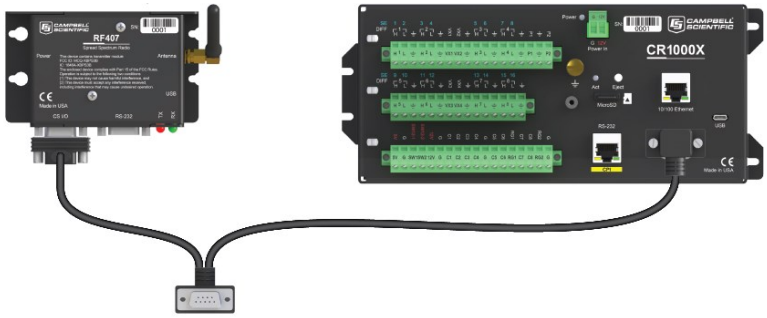
4.2 Configure the remote RF407-series data logger(s)

Follow these instructions multiple times to set up multiple data loggers. In this case, each data logger must be given a unique PakBus address. For more complicated networks, it is recommended that you use Network Planner.

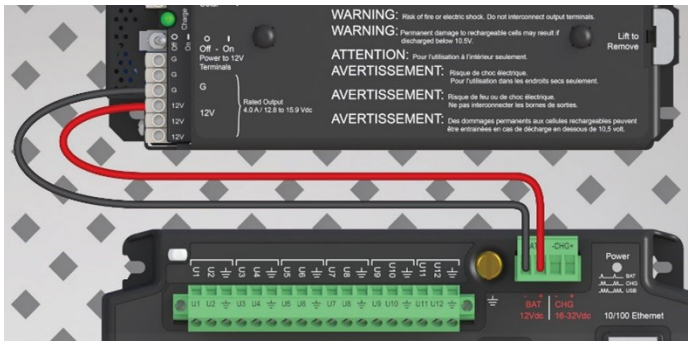
NOTE:
Most Campbell Scientific devices come from the factory with a default PakBus address of 1. For this reason, it is best not to assign PakBus address 1 to any device in the network. Then, if a new device with default settings is added to the system, it will not create a conflict.

1. Ensure the antenna is connected.

2. For data loggers with an external radio, connect the radio and data logger **CS I/O** ports using an SC12 cable.

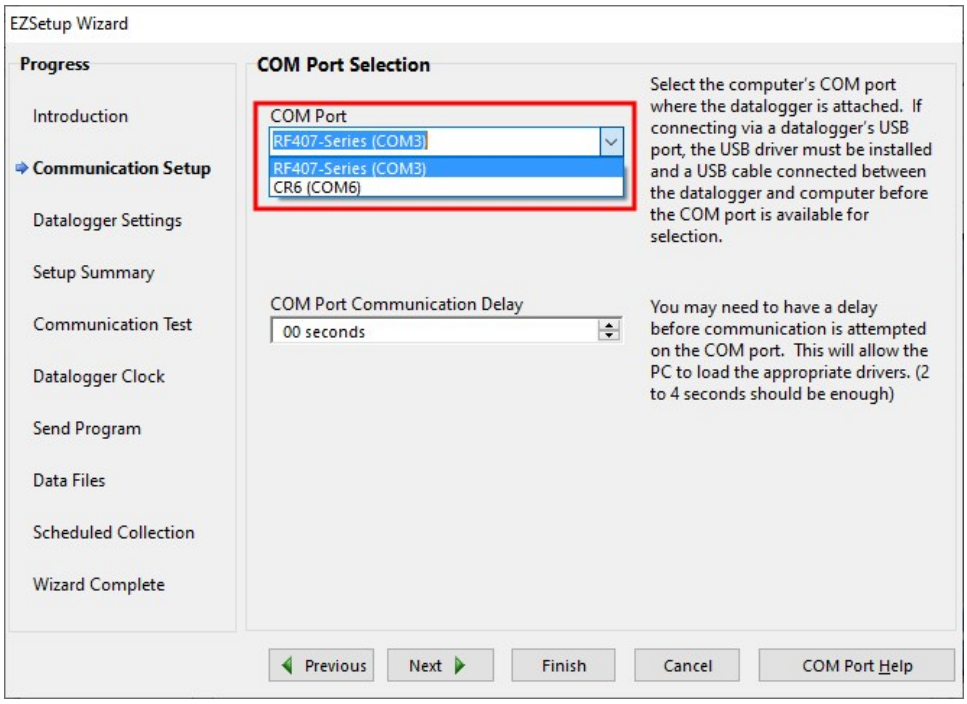


3. Supply 12 VDC power to the data logger.
    - connect 12 VDC at the green **BAT** terminals
    - or connect 16 to 32 VDC at the **CHG** terminals



4. Using data logger support software, launch the EZSetup Wizard.
    - *LoggerNet* users, from the *Main* category click **Setup** and select the **View** menu to ensure you are in the **EZ (Simplified)** view, then click **Add**.
    - *PC400* users, click **Add Datalogger**.
5. Click **Next**.
6. Select your data logger from the list, type a meaningful name for your data logger (for example, a site identifier or project name), and click **Next**.
7. Select the **Direct Connect** connection type and click **Next**.
8. Select the communications port used to communicate with the RF407-series radio from the **COM Port** list. It should be listed as **RF407-Series (COMX)**.

> **TIP:**
> If the **RF407-Series (COMX)** is not in the list ensure your RF407 is connected to your computer.



9. Accept the default value of **00 seconds** in the **COM Port Communication Delay** - this box is used to allow time for hardware devices to "wake up" and negotiate a communications link. Click **Next**.

10. In Configure the base RF407-series radio (p. 4) you selected an active interface option of USB or RS-232. If you selected USB as the active interface for the radio, you do not need to select a baud rate. If you selected RS-232, set the baud rate to the one chosen during that step. The radio default baud rate is 115200. The PakBus address must match the hardware settings for your data logger. The default **PakBus Address** is **1**.
11. Click **Next**.
12. By default, the data logger does not use a security code or a PakBus encryption key. Therefore, the **Security Code** can be set to **0**, and the **PakBus Encryption Key** can be left blank. If either setting has been changed, enter the new code or key.
13. Click **Next**.
14. Review the **Setup Summary**. If you need to make changes, click **Previous** to return to a previous window and change the settings.

Setup is now complete. The EZSetup Wizard allows you to **Finish**, or you may click **Next** to test communications, set the data logger clock, and send a program to the data logger.

> NOTE:
> The RF407-series radio to RF407-series data logger link is not indicated in the ***LoggerNet*** Setup Standard View.

If you experience network communications problems, see Troubleshooting (p. 39) for assistance.

5. Specifications

Antenna Connector: Reverse Polarity SMA (RPSMA) jack (female)

Radio Type

- **RF407, RF412**, and **RF427**: Frequency-Hopping Spread-Spectrum (FHSS)
- **RF422**: SRD860 Radio with Listen Before Talk (LBT) and Automatic Frequency Agility (AFA)

Frequency

- **RF407**: 902 to 928 MHz (US, Canada)
- **RF412**: 915 to 928 MHz (Australia, New Zealand)
- **RF422**: 863 to 870 MHz (Europe, Middle East, and Africa)
- **RF427**: 902 to 907.5 MHz/915 to 928 MHz (Brazil)

Transmit Power Output (software selectable)

- **RF407** and **RF412**: 5 to 250 mW
- **RF422**: 2 to 25 mW
- **RF427**: 5 to 250 mW

Channel Capacity

- **RF407**: Eight 25-channel hop sequences sharing 64 available channels.
- **RF412**: Eight 25-channel hop sequences sharing 31 available channels.
- **RF422**: Ten 30-channel hop sequences (default), software configurable to meet local regulations; 10 sequences for reducing interference through channel hop.
- **RF427**: Eight 25-channel hop sequences sharing 43 available channels.

Receive Sensitivity

- **RF407**, **RF412**, and **RF427**: –101 dBm
- **RF422**: –106 dBm

RF Data Rate

- **RF407**, **RF412**, and **RF427**: 200 kbps
- **RF422**: 10 kbps

General

- Dimensions: 11.1 x 6.9 x 2.7 cm (4.4 x 2.7 x 1.1 in)
- Weight: 136 g (4.8 oz)
- Two-piece aluminum case, black anodized

Current required

- Average transmit
    - **RF407**, **RF412**, and **RF427**: < 80 mA (250 mW TX power)
    - **RF422**: < 25 mA (25 mW TX power)
- Receive
    - 15 mA
- Idle
    - <0.5 mA (depending on power-saving mode)

RF422: LBT + AFA compliance and performance

- Complies with ETSI duty cycle requirements. Radio communications effective duty cycle = (number of channels × 100) / 3600.
- Channel spacing: 100 kHz
- Receiver bandwidth: 150 kHz
- Modulation bandwidth: < 300 kHz
- LBT threshold: < –88 dBm
- TX on time: < 1 s

Power

- Powered over CS I/O or 2.5 mm DC power jack
- Input voltage: 9 to 16 VDC

Maximum nodes in network

- RF407, RF412, and RF427: 50
- RF422: 20

Connections

- USB:
    - USB Type-B jack
    - Can draw enough power for normal operation from standard USB host
- RS-232:
    - 9-pin, socket (female)
    - 1200, 4800, 9600, 19200, 38400, 57600, and 115200 baud rates supported
- CS I/O:
    - 9-pin, pin (male)
    - Provides power connection from data logger for normal operation
    - Supports SDC (7, 8, 10, 11) and modem enable (ME) master communications modes
    - Does not support ME peripheral mode

Diagnostics

- LEDs: TX/PWR (transmit/power), RX (receive)
- Received signal strength indicator (RSSI) for last packet

Operating temperature

- Standard: –40 to 70 °C

Configuration

- *Device Configuration Utility* via USB

Compliance

- RF407:
  - United States FCC Part 15.247: MCQ-XB900HP

    View the Declaration of Conformity at www.campbellsci.com/rf407
  - Industry Canada (IC): 1846A-XB900HP
  - Mexico Federal Telecommunications Institute
  - IFT# RCPDIXB15-0672-A1
- RF412:
  - ACMA RCM
  - United States FCC Part 15.247: MCQ-XB900HP
  - Industry Canada (IC): 1846A-XB900HP
- RF422:
  - View the Declarations of Conformity at www.campbellsci.com/rf422
- RF427:
  - This device complies with Brazil ANATEL standards in Resolution No. 506. The operating frequencies are 902 MHz to 907 MHz and 915 MHz to 928 MHz. View the Certificate of Conformity at www.campbellsci.com/rf427.

6. Product description

The following sections describe specific hardware components.

6.1 Mounting

The mounting holes are designed to align with a one-inch-on-center hole pattern and provide for either vertical or horizontal mounting. #6-32 x 0.375-inch stainless steel Phillips head screws and nylon grommets are supplied for securing the radio to the backplate of a Campbell Scientific enclosure.

6.2 Power

There are three ways the radio may be powered for operation. The radio may be powered via CS I/O, USB, or the 2.5 mm DC power jack.

The **Power** connector is most commonly used to supply power to the radio when the radio is used as a standalone PakBus® router / RF repeater or when the **RS-232** port is used to interconnect with another device. Either a Campbell Scientific Field Power Cable or AC to DC power adapter can be used for supplying 12 VDC to the power connector.

The power connector of the radio uses the inner conductor for positive (+) voltage and the outer/sleeve conductor for ground (–).

CAUTION:
There are many AC adapters available with barrel connectors that will fit the RF407-series radios. Damage that occurs from the use of an AC adapter that is not the recommended AC to DC power adapter will not be covered by warranty. If using a different AC adapter, be sure that the adapter "no load" voltage is below the 16 VDC; measure the output with a DC voltmeter while the AC adapter is plugged into the outlet but not powering anything.

6.3 USB

The radio has a USB Type-B jack that can be connected to your computer by using a USB cable. The connection is used for power, configuration, and data transfer.

NOTE:
INSTALL the DEVICE DRIVER BEFORE connecting the radio to your computer via USB for the first time. You will need the device driver properly installed before you can connect to the radio via USB. To install the device driver, download the latest version of ***Device Configuration Utility*** from our website. Under **Device Type**, select **Radio** > **RF407 Series**. Click **Install USB Driver** and follow the prompts.

Most host USB ports will supply a sufficient amount of voltage and current for all normal operations. When used as a base radio, an external power supply is generally not required. When sourcing operational power from the computer USB port, connect the radio directly to the computer or to an externally powered USB hub.

When the radio is connected to the computer, a virtual COM port will be added to the list of available ports. It will be descriptively labeled, for example "RF407 Series (COM10)", where COM10 denotes the COM port enumerated by the Windows® operating system.

Regardless of the Active Interface radio setting, the **USB** port can always be used for connecting with ***Device Configuration Utility*** for radio configuration.

The USB interface is only available for operational, network communications when the radio **Active Interface** setting is set as **USB**.

6.4 CS I/O

The **CS I/O** port is a 9-pin (male) connector that is typically connected to a Campbell Scientific data logger by using the supplied SC12 cable. See Table 6-1 (p. 15) for the pinout.

The **CS I/O** port is not a typical RS-232 connection and is specific to Campbell Scientific products. **CS I/O** cannot be used for radio configuration using ***Device Configuration Utility***.

For a typical remote radio site, the radio only needs to be connected to the data logger **CS I/O** port by using the supplied SC12 cable. This connection supplies operational power to the radio and serves as the data connection between the radio the data logger. The **Active Interface** setting must be set to **CS I/O SDC**.

An alternative, but much less common, use of CS I/O is connection to another communications peripheral through an A100 CS I/O null modem adapter. This is typically only used when creating a "phone to RF base" configuration. The radio **Active Interface** setting must be set to **CS I/O ME Master** and the other device (for example COM220) must be capable of being configured as a modem enabled (ME) peripheral.

Table 6-1: CS I/O Pinout

Pin	Function	I/O	Description
1	5V	I	Sources 5 VDC to power peripherals
2	GND		GND for pin 1 and signals
3	Ring	O	Raised by modem to put data logger into telecommunications mode
4	RX	O	Serial data receive line
5	Modem Enable	I	Raised when data logger determines that associated modem raised the ring line
6	Synchronous device enable	I	Used by data logger to address synchronous devices; can be used as a printer enable
7	CLK/handshake	I/O	Used by data logger with SDE and TX lines to transfer data to synchronous devices
8	12V supplied by data logger	PWR	Sources 12 VDC to power peripherals
9	TX	I	Serial data transmit line

I = Signal into the radio, O = Signal out of the radio

6.5 RS-232

The **RS-232** port is a DCE (data communications equipment), 9-pin socket (female) connector used to connect the radio to the **RS-232** port of a data logger, computer, or another RS-232 device. This connection is most commonly used when connecting the radio to a device without a **CS I/O** port or when linking two communications peripherals; for example, directly connecting the radio to an Ethernet serial server. See Table 6-2 (p. 16) for the RS-232 port pinout.

The **RS-232** port can be connected to a DTE (data terminal equipment) device, such as a computer or NL201, by using a 9-pin serial data cable. The **RS-232** port can be connected to another DCE device, such as a data logger RS-232 port, MD485, or cellular modem, by using a 9-pin null-modem serial cable.

When using RS-232, supply 12 VDC power to the **Power** connector by using a Campbell Scientific Field Power Cable or AC power adapter. The **Active Interface** setting must be set to **RS-232**, and the **RS-232** port configuration, like baud rate, should match the device the radio is connected to.

RS-232 cannot be used for radio configuration using *Device Configuration Utility*.

Table 6-2: RS-232 pinout

Pin	I/O	Description
1		
2	O	TX
3	I	RX
4		
5		GND
6		
7		
8	O	CTS
9		

I = Signal into the radio, O = Signal out of the radio

6.6 LEDs

The radios have a red LED labeled **TX/PWR** and a green LED labeled **RX**. When 12V power is applied, both LEDs turn on for about one second.

The red LED indicates when the receiver is actively listening. It will flash in correlation with the **Power Mode**; that is, Always On, 0.5 Sec, 1 Sec, or 4 Sec. When the radio is transmitting, the red LED will flash (it will not be on solid).

Green LED activity indicates that there is an RF signal being received.

6.7 Antenna

The radio has a reverse polarity SMA (RPSMA) jack (female) antenna connection. It is important to note the distinction between RPSMA and SMA connectors when selecting a compatible antenna or antenna cable. See www.campbellsci.com/blog/ins-outs-rf-connectors for more information.

6.7.1 Compatible antennas

Campbell Scientific offers antennas to satisfy the needs for various base station and remote station requirements. All antennas (or antenna cables) that attach directly to the radio have an RPSMA plug connector. The use of an unauthorized antenna could cause transmitted field strengths in excess of FCC rules, interfere with licensed services, and result in FCC sanctions against the user.

> CAUTION:
> An FCC authorized antenna is a required component.

> CAUTION:
> In order to comply with the FCC RF exposure requirements, the RF407-series radios may be used only with approved antennas that have been tested with these radios. Maintain a minimum 20 cm separation distance between the antenna and any nearby persons.

6.7.2 Electrostatic issues and surge protection

Many radio installations are outdoors and therefore susceptible to lightning damage, especially via the antenna system. Also, depending on climate and location, electrostatically-charged wind can damage sensitive electronics if sufficient electric charge is allowed to accumulate on the antenna and cable.

To protect against electrostatic damage, the antenna connector of the radio is connected to the radio case which should be tied to a good earth ground for discharge of electrostatic build up.

Also, to protect against electrostatic damage, Campbell Scientific offers an Antenna Surge Protection Kit. The surge protection kit includes a PolyPhaser® surge protector, coax jumper for connecting the RF407-series radio to the PolyPhaser, ground wire, and mounting hardware. The PolyPhaser has Type-N jack connectors on both ends; one for connection to a COAXNTN-L cable and the other for connection to the 18-inch length of COAXRPSMA cable included in the kit. The surge protection kit can be pre-installed by Campbell Scientific (bulkhead-mounted through the enclosure wall).

6.7.3 Antenna cables

Some antennas require an additional antenna cable to connect to the radio directly or to an interconnected surge protector.

COAXRPSMA-L is an LMR195 coaxial cable terminated with a Type-N plug on one end and an RPSMA plug on the other. The COAXRPSMA-L can be used to connect antennas with a Type-N jack connector directly to the RF407-series radios.

COAXNTN-L is an RG8/U coax cable terminated with a Type-N plug on both ends. The COAXNTN-L is typically used to connect antennas with a Type-N jack connector to an inline surge protector, or to a bulk head Type-N jack.

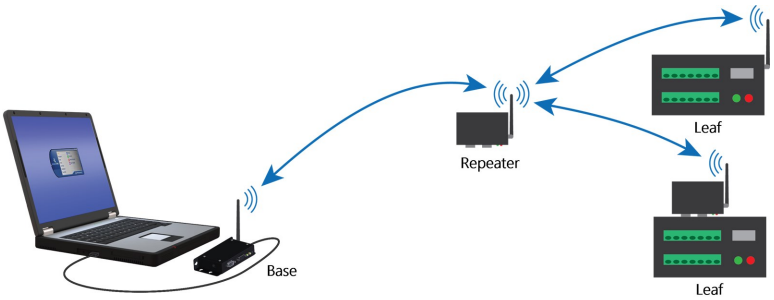
See www.campbellsci.com/blog/ins-outs-rf-connectors for more information.

7. Network examples

The following sections describe frequently used configurations with the RF407-series.

7.1 Using the RF407-series as a stand-alone repeater (router)

The RF407-series radio can be used as a stand-alone repeater in your network. This type of network configuration is useful for communicating around an obstacle, such as a hill or building, or to reach longer distances.

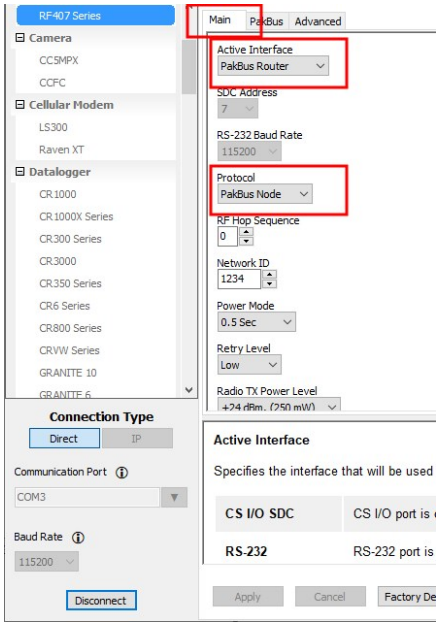


7.1.1 Configure stand-alone repeater radio

1. Ensure that an antenna is connected to the RF407-series radio.
2. If connecting via USB for the first time, you must first install USB drivers using ***Device Configuration Utility*** (select your radio, then on the main page, click **Install USB Driver**).

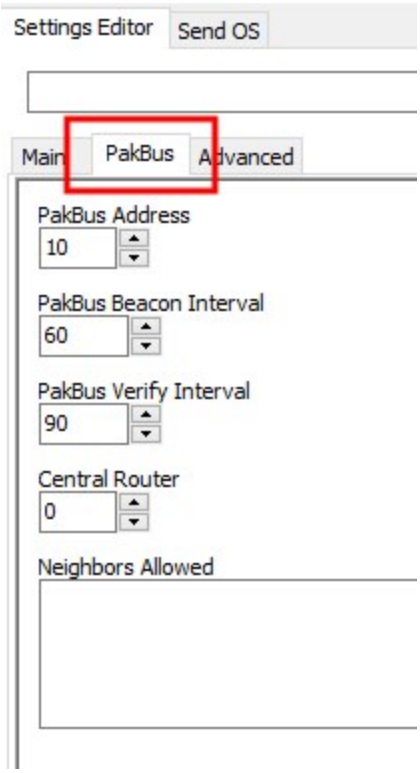
3. Connect the **USB** port on your RF407-series radio to your computer.

4. Using ***Device Configuration Utility***, select the **Communication Port** used for your radio and connect to the RF407-series radio.
5. On the **Main** tab, set the **Active Interface** to **PakBus Router** and **Protocol** to **PakBus Node**. Leave the remaining settings as their defaults.



6. On the **PakBus** tab assign a unique PakBus address. Set the **Beacon Interval** to **60** seconds (or the amount of time you are willing to wait for the leaf data loggers in the network to be discovered). A beacon is a packet broadcast at a specified interval intended to discover neighbor devices. Set the **Verify Interval** to something slightly greater than the expected communications interval between the router and the other (leaf) data loggers in the network (for example, 90 seconds).

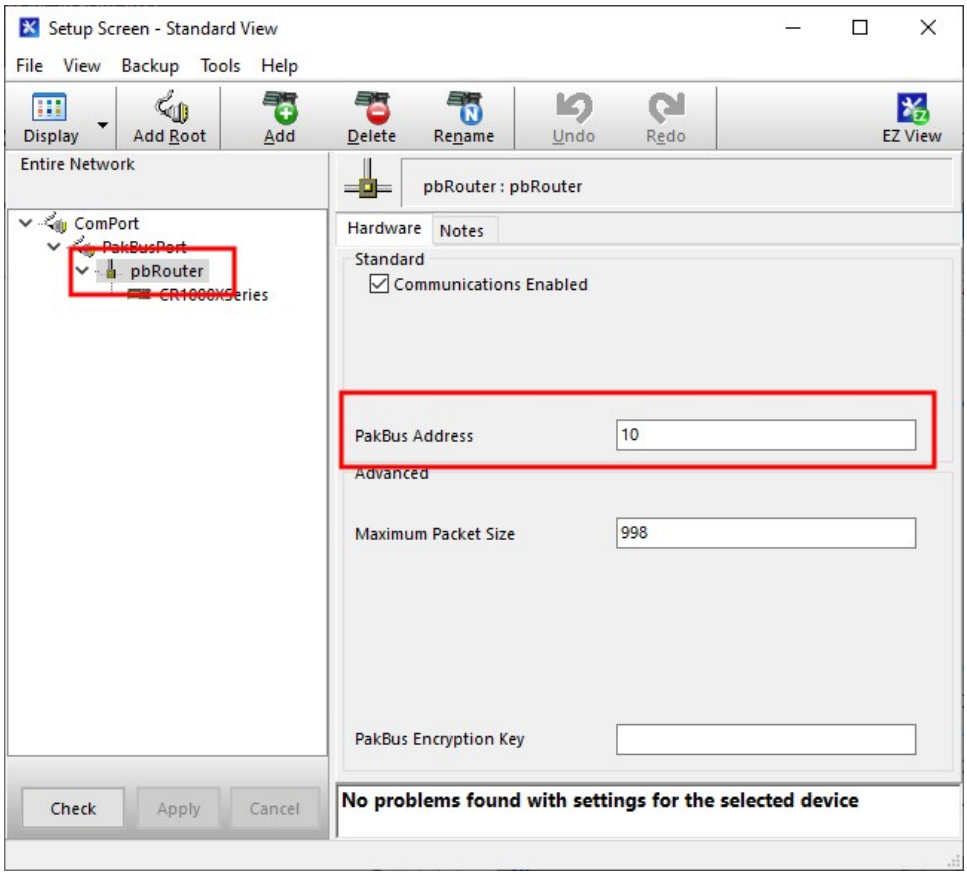
NOTE:
Most Campbell Scientific devices come from the factory with a default PakBus address of 1. For this reason, it is best not to assign PakBus address 1 to any device in the network. Then, if a new device with default settings is added to the system, it will not create a conflict.



7. **Apply** to save your changes.

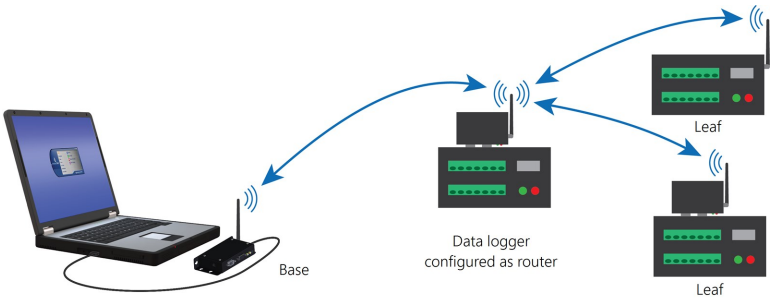
7.1.2 Add stand-alone repeater to *LoggerNet*

Enter the stand-alone repeater into the ***LoggerNet* Setup** screen. Add a **pbRouter** device with the PakBus address of the RF407-series radio in the **PakBus Address** field. If the repeater is the first hop from ***LoggerNet***, it should always be shown in the network map. This will force routes to go through the repeater. If the repeater is further down the network, it may still be helpful to display it in the network map. However, it does not force routes to go through the repeater.



7.2 Communications with multiple data loggers through a data logger router

This type of network configuration is useful for communicating around an obstacle, such as a hill or building, or to reach longer distances.



NOTE:
Most Campbell Scientific devices come from the factory with a default PakBus address of 1. For this reason, it is best not to assign PakBus address 1 to any device in the network. Then, if a new device with default settings is added to the system, it will not create a conflict.

7.2.1 Configure the RF407-series base radio

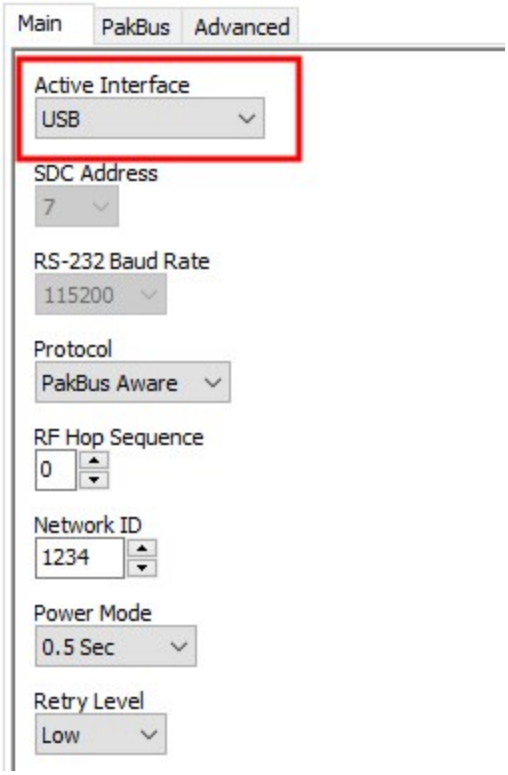
Configure the base radio. This is the RF407-series radio that is connected to the computer (see previous image for reference).

1. Ensure that an antenna is connected to the RF407-series radio.
2. If connecting via USB for the first time, you must first install USB drivers using ***Device Configuration Utility*** (select your radio, then on the main page, click **Install USB Driver**).

3. Connect the **USB** port on your RF407-series radio to your computer.

4. Using ***Device Configuration Utility***, select the **Communication Port** used for your radio and connect to the RF407-series radio.

5. On the **Main** tab, set the **Active Interface** to **USB** or **RS-232** (depending on how your computer will be connected to the RF407-series radio).

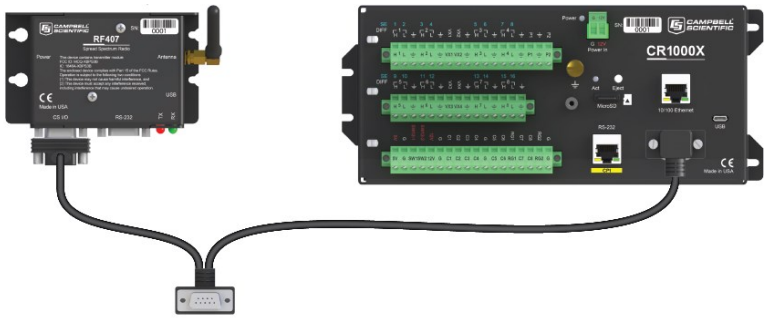


6. **Apply** to save your changes.
7. The **TX/PWR** and **RX** LEDs flash once, after which the **TX/PWR** LED returns to blinking at the **Power Mode** interval (0.5 sec, by default).

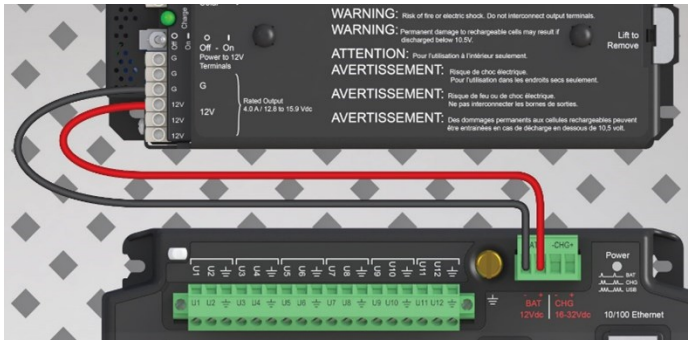
7.2.2 Configure the data logger acting as a router

1. Ensure the antenna is connected.

2. For data loggers with an external radio, connect the radio and data logger **CS I/O** ports using an SC12 cable.



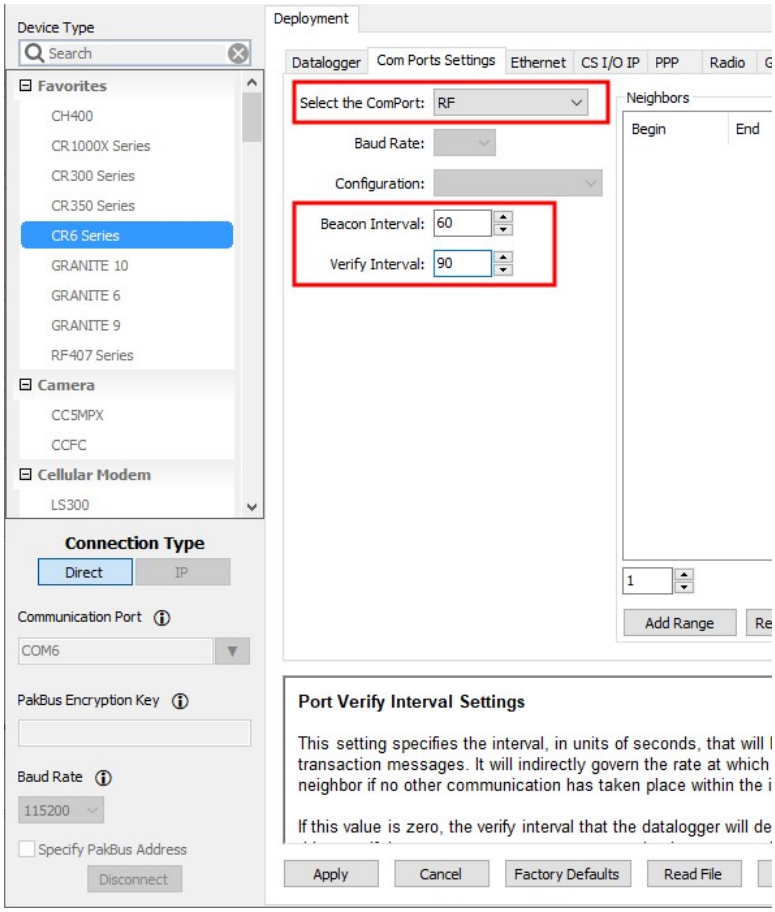
3. Supply 12 VDC power to the data logger.
    - connect 12 VDC at the green **BAT** terminals
    - or connect 16 to 32 VDC at the **CHG** terminals



4. If connecting via USB for the first time, you must first install USB drivers using ***Device Configuration Utility*** (select your radio, then on the main page, click **Install USB Driver**).

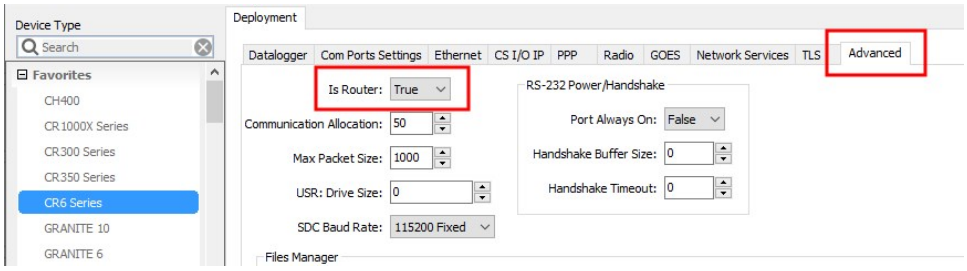
5. Using ***Device Configuration Utility***, connect to the data logger that will serve as a router.
6. On the **Deployment** > **Datalogger** tab, assign a unique PakBus address.
7. On the **Deployment** tab, click the **Com Ports Settings** sub-tab.
8. From the **Select the ComPort** list, select **RF**.
9. Set the **Beacon Interval** to **60** seconds (or the amount of time you are willing to wait for the leaf data loggers in the network to be discovered).

> **NOTE:**
> A beacon is a packet broadcast at a specified interval intended to discover neighbor devices.



10. Set the **Verify Interval** to something slightly greater than the expected communications interval between the router and the other (leaf) data loggers in the network (for example, 90 seconds).

11. Click the **Advanced** sub-tab and set **Is Router** to **True**.



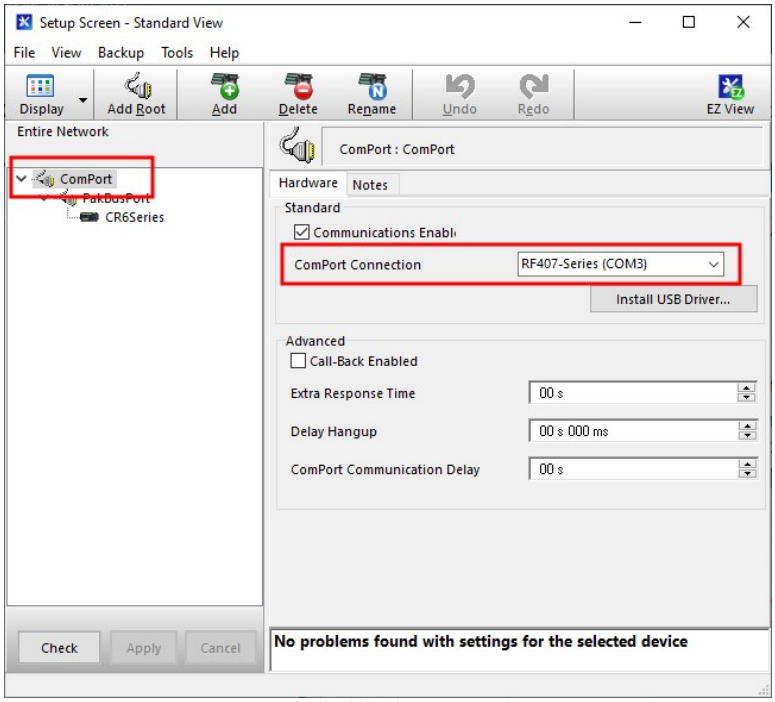
12. **Apply** to save your changes.

CAUTION:
Typically only the base data logger is configured as a router. Configuring multiple data loggers as routers may create unnecessary network traffic.

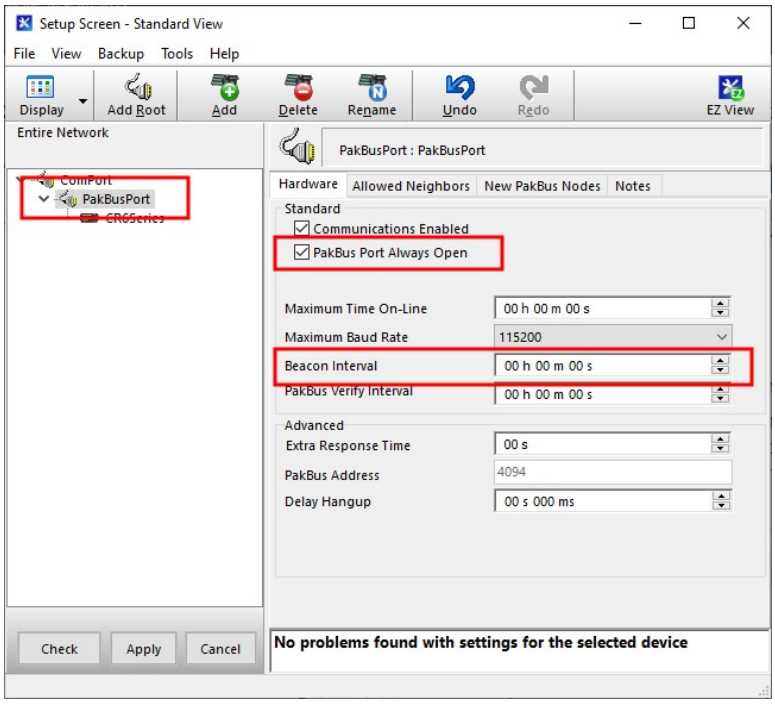
7.2.2.1 Add routing data logger to *LoggerNet* network

1. Using ***LoggerNet***, click **Setup** and click the **View** menu to ensure you are in the **Standard** view.
2. Click **Add Root**.
3. Click **ComPort**, then **PakBusPort (PakBus Loggers)**, then your data logger model.
4. Click **Close**.
5. In the Entire Network pane on the left side of the window, select the **ComPort**.

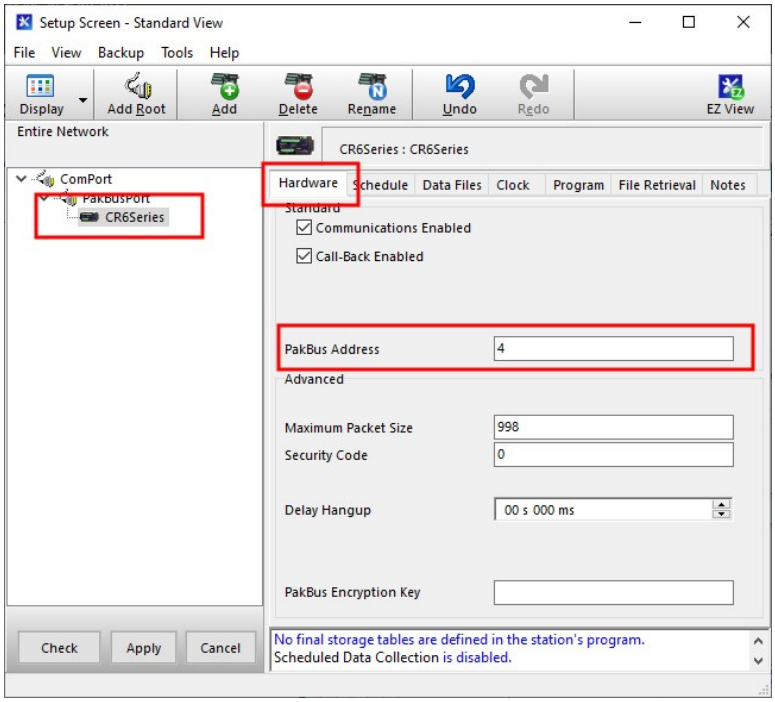
6. On the **Hardware** tab on the right, click the **ComPort Connection** list and select the communications port assigned to the RF407-series radio.



7. In the Entire Network pane on the left side of the window, select **PakBusPort**.
8. On the **Hardware** tab on the right, select the **PakBus Port Always Open** check box.
    - If you would like to prevent the possibility of ***LoggerNet*** communicating directly with any other data loggers in the network without going through the router, set the **Beacon Interval** to **00 h 00 m 00s**.



9. In the Entire Network pane on the left side of the window, select the router data logger from the list.
10. On the **Hardware** tab on the right, type the **PakBus Address** you assigned to the router data logger in *Device Configuration Utility*.



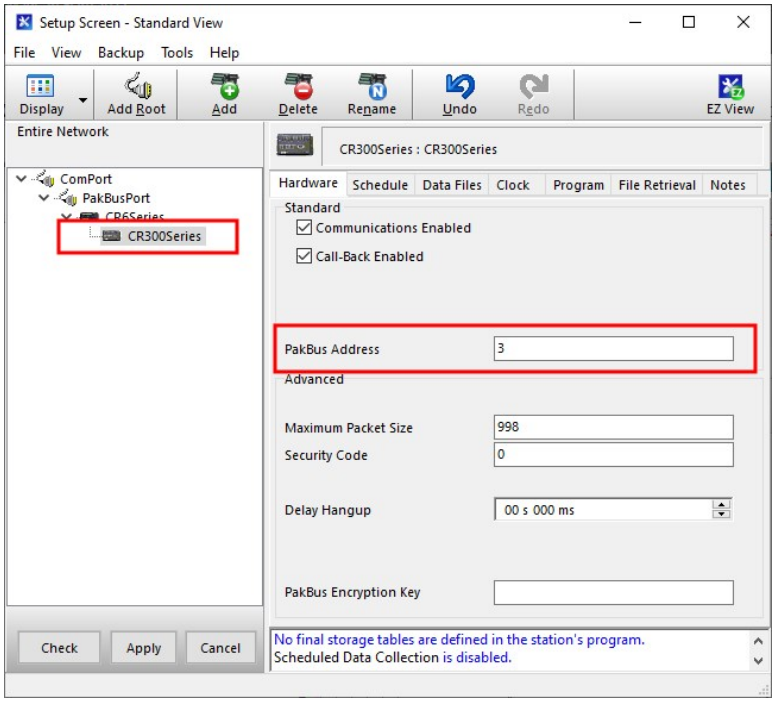
11. Click **Rename** to provide the data logger a descriptive name.
12. **Apply** to save your changes.

7.2.3 Configure remote (leaf) data loggers

Follow steps 1 – 6 in Configure the data logger acting as a router (p. 24) to assign a unique PakBus address to each leaf data logger. Do not configure leaf data loggers as routers.

7.2.3.1 Add leaf data loggers to the network

1. In the ***LoggerNet* Standard Setup** view (click the **Setup** option and click the **View** menu to ensure you are in the **Standard** view), right-click on the router data logger in the Entire Network pane on the left side of the window and select your data logger.
2. With the newly added data logger selected in the **Entire Network** pane, set the **PakBus Address** to the address that was assigned to the leaf data logger in ***Device Configuration Utility***.

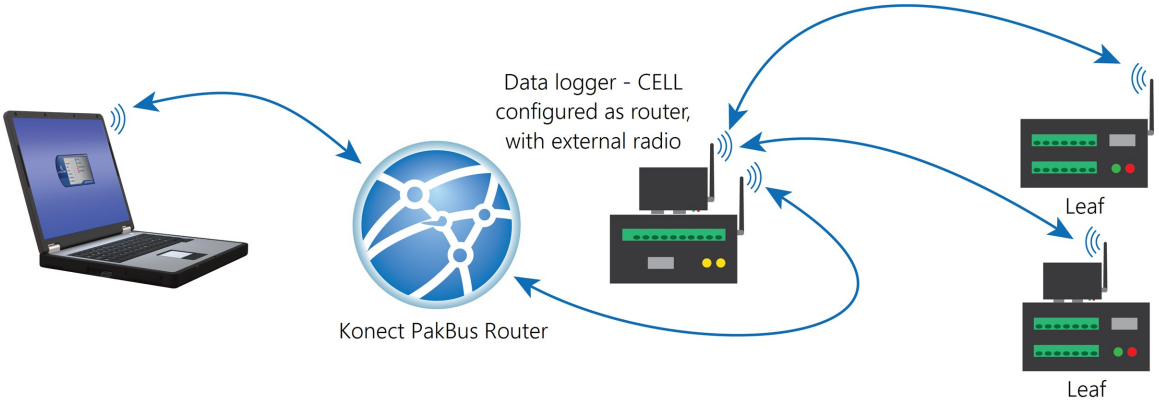


3. Click **Rename** to provide the data logger a descriptive name.
4. **Apply** to save your changes.
5. Repeat these steps for each leaf data logger in the network.

If you experience problems with network communications, see Troubleshooting (p. 39) for assistance.

7.3 Using additional communications methods

Using similar instructions, a RF407-series data logger can be used in a system with additional communications methods. For example, in the following image, the router RF407-series data logger communicates with ***LoggerNet*** through Konect PakBus Router. The router RF407-series data logger communicates with the leaf RF407-series data loggers over RF.

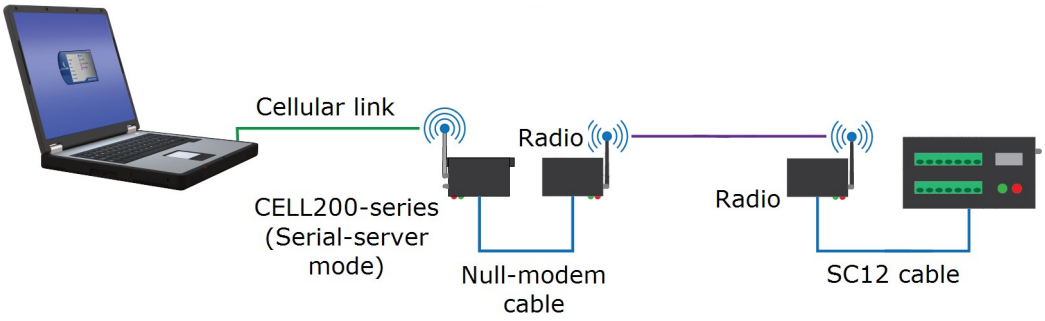


The RF portion of this network requires no changes to the hardware settings described in the previous procedure.

See the Konect Pakbus Router Getting Started Guide for more information on setting up that part of the network.

7.4 CELL200-series to RF

This type of network is useful when a single data logger is not located close enough to a reliable cellular signal. To overcome this distance, use radios to establish connectivity with the cellular network.



7.4.1 CELL200-series physical setup

1. Connect the CELL200-series and radio RS-232 ports using an RS-232 pin-to-pin null-modem cable.
2. Connect the cellular and radio antennas, if they are not already connected.
3. Apply DC power to the CELL200-series and radio.

7.4.2 Configure the CELL200-series as a serial server

1. Connect a USB cable between a USB port on your computer and the **USB** port on the CELL200 series.
2. Starting with the default settings, open a web browser and go to: **cell.linktodevice.com**.

   > NOTE:
   > Cellular service must be setup before configuring the CELL200-series.

3. If the data logger has been assigned a **public static IP address**, on the **Settings** > **General** tab:
   a. Enter the **APN** as assigned by your service provider.
   b. Change **Mode** from PPP to **Serial Server**.
   c. Click **Apply** to save the changes and then close the browser tab.
4. If the data logger has been assigned a **private dynamic IP address** and you are using the **Konect PakBus Router** service, on the **Settings** tab:
   a. **General** tab > Enter the **APN** as assigned by your service provider.
   b. **General** tab > Change **Mode** from PPP to **Serial Server/Client**.
   c. **Serial Mode Setup** > **URL** > Enter the Konect PakBus Router address.
   d. **Serial Mode Setup** > **Port Number** > Enter the Konect PakBus Router port number.

   > NOTE:
   > *Konect PakBus Route*r connections through a CELL200 series modem do not support a TCP Password. Contact Campbell Scientific support for more information.

7.4.3 Configure radio connected to the CELL200-series

Connect a USB cable between a USB port on your computer and the **USB** port on the radio that will be connected to the CELL200 series. Either RF407-series or RF451/452 radios can be used. See those product manuals for additional details.

7.4.3.1 RF407-series

1. Connect to the radio in *Device Configuration Utility*.
2. Click the **Factory Defaults** button at the bottom of the Deployment window.
3. On the **Main** tab set **Active Interface** to **RS-232**.
4. Click **Apply** to save the changes.

7.4.4 Configure radio connected to the data logger

1. Using an SC12 cable connect the data logger **CS I/O** port to the radio **CS I/O** port.
2. Connect a USB cable between a USB port on your computer and the radio **USB** port.

7.4.4.1 RF407-series

1. Connect to the radio in *Device Configuration Utility*.
2. Click the **Factory Defaults** button at the bottom of the Deployment window.
3. Click **Apply** to save the changes.

7.4.5 Configure the data logger

1. Connect a USB cable between a USB port on your computer and the data logger **USB** port.
2. Connect to the data logger in *Device Configuration Utility*.
3. Click the **Factory Defaults** button at the bottom of the Deployment window.
4. On the **Datalogger** tab verify or change the PakBus address.
    - Default address is **1**.
    - If using *Konect PakBus Router*, verify the address assigned here matches the address you setup for the data logger in **Konect PakBus Router**.

5. On the **Com Ports Settings** tab set:
    a. **ComPort** to **CS I/O SDC7**
    b. **Beacon Interval** to **60** (seconds)
6. Click **Apply** to save the changes and then close ***Device Configuration Utility***.

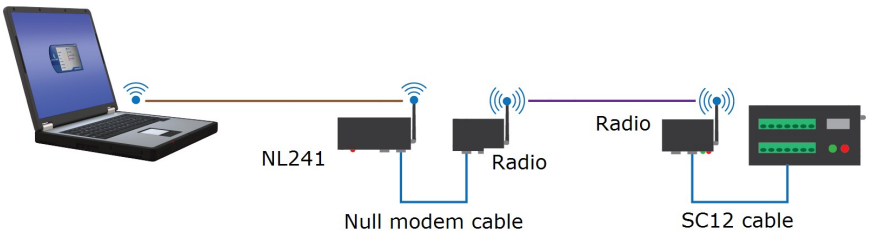
7.4.6 Setup *LoggerNet*

1. In the ***LoggerNet*** Setup screen, click **Add Root** and select **IPPort**. Enter the CELL200-series IP address and port number. The IP address and port number are input on the same line separated by a colon. IPv6 addresses will need to be enclosed in square brackets when specifying a port number. An IPv4 address may look like 192.168.1.100:3001. An IPv6 address may look like [2001:db8::1234:5678]:3001. A fully qualified host name entry may look like yourlogger.com:3001. In serial server mode, the default port number is **3001**.

    If you are using a ***Konect PakBus Router*** use the address of the ***Konect PakBus Router*** followed by a colon and the port number of the PakBus router.
2. Add **PakBusPort (PakBus Loggers)**.
3. Add a PakBus Router (**pbRouter**). The default PakBus address for the ***Konect PakBus Router*** is **4070**. Click **Close**.
4. Add the data logger and enter its PakBus address. If using a ***Konect PakBus Router*** ensure that the PakBus address matches both that of the data logger and the configuration you setup with your ***Konect PakBus Router***.
5. Click **Apply** to save the changes.
6. You are now ready to connect to your data logger using ***LoggerNet***. Select **Main** and **Connect** on the ***LoggerNet*** toolbar, select the data logger from the **Stations** list, then **Connect**. From there, you can view and collect data, or manage data logger settings.

7.5 NL241 with radio network

This type of network is useful when the data logger is not located close enough to a Wi-Fi network. To overcome this distance, use spread-spectrum radios to establish connectivity with the Wi-Fi network.



7.5.1 Configure the NL241 as a PakBus router

Out of the box, the NL241 is configured for operation as a PakBus router. You may not need to make any changes. The following steps provide information about these default settings.

1. Connect to the NL241 in *Device Configuration Utility*.
2. On the **NL241** tab, set **Bridge Mode** to **disable**.
3. If a dynamic address is to be used, the network information acquired via DHCP can be seen on the NL241 tab under **Status**. The **Status** box also displays the MAC address of the NL241.
4. To enter a static IP address, select **disable** in the **Use DHCP** field. Then input the **IP Address**, **Network Mask**, and **Default Gateway**. These values can be provided by your network administrator.
5. On the **RS-232** tab:
    a. Set **Configuration** to **PakBus**.
    b. Set **Baud Rate** to baud rate of attached radio. Generally this is **115200** (default).
    c. Set **Beacon Interval** to **60** (seconds) and **Verify Interval** to **0**. If you want to restrict communications paths, use the **PakBus Neighbors Allowed** setting to specify allowed neighbor addresses.
6. On the **Network Services** tab, make note of the **PakBus/TCP Service Port**. The default **PakBus/TCP Service Port** is **6785**. Unless firewall issues exist, it is not necessary to change the port from its default value. This port number must match the port number entered in LoggerNet Setup after the IP address. See Setup LoggerNet (p. 36).

7.5.2 Configure radio connected to the NL241

Using a USB cable, connect to the radio that will be connected to the NL241. Either an RF407-series or RF451/452 can be used. See those product manuals for additional details.

7.5.2.1 RF407-series

1. Connect to the radio in *Device Configuration Utility*.
2. Click the **Factory Defaults** button at the bottom of the Deployment window.
3. On the **Main** tab set **Active Interface** to **RS-232**.
4. Click **Apply** to save the changes.

7.5.3 Configure radio connected to the data logger

1. Using an SC12 cable, connect the data logger **CS I/O** port to the radio **CS I/O** port.
2. Connect a USB cable between a USB port on your computer and the radio **USB** port.

7.5.3.1 RF407-series

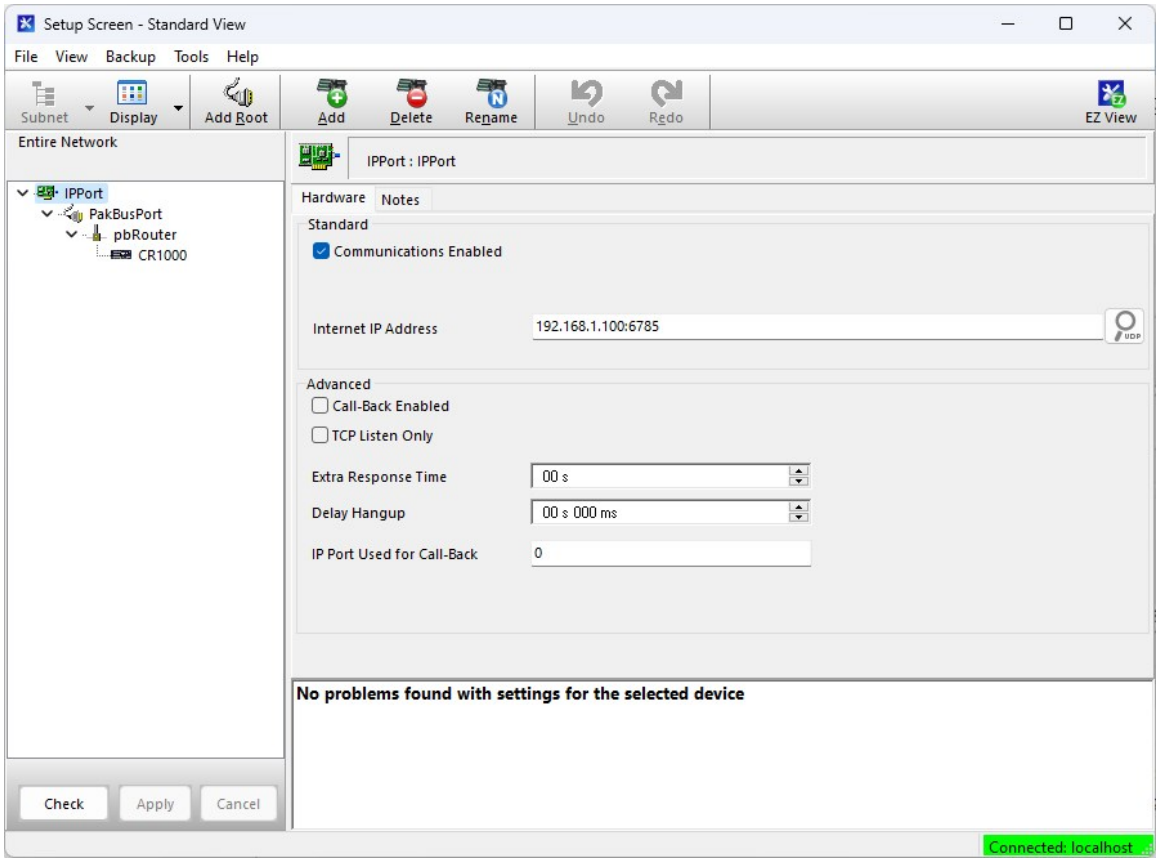
1. Connect to the radio in *Device Configuration Utility*.
2. Click the **Factory Defaults** button at the bottom of the Deployment window.
3. Click **Apply** to save the changes.

7.5.4 Configure the data logger

1. Connect to the data logger in *Device Configuration Utility*.
2. Click the **Factory Defaults** button at the bottom of the Deployment window.
3. On the **Com Ports Settings** tab set:
   a. **ComPort** to **CS I/O SDC7**
   b. **Beacon Interval** to **60** (seconds)
4. Click **Apply** to save the changes and then close *Device Configuration Utility*.

7.5.5 Setup *LoggerNet*

1. In the *LoggerNet* Setup screen, click **Add Root** and select **IPPort**. Enter the NL241 IP address and port number. The IP address and port number are input on the same line separated by a colon. IPv6 addresses will need to be enclosed in square brackets when specifying a port number. An IPv4 address may look like 192.168.1.100:6785. An IPv6 address may look like [2001:db8::1234:5678]:6785. A fully qualified host name entry may look like yourlogger.com:6785.
2. Add **PakBusPort (PakBus Loggers)**.
3. Add a PakBus Router (**pbRouter**). Enter the PakBus address of the NL241. The NL241 default PakBus address is **678**. Click **Close**.
4. Add the data logger and enter its PakBus address.
5. Click **Apply** to save the changes.



6. You are now ready to connect to your data logger using ***LoggerNet***. Select **Main** and **Connect** on the ***LoggerNet*** toolbar, select the data logger from the **Stations** list, then **Connect**. From there, you can view and collect data, or manage data logger settings.

8. Installation best practices

The following sections provide installation guidelines.

8.1 Avoiding interference

Attempt to avoid locating radios and antennas near other transmitters or transmitting through areas where commercial communications towers are locationed. In-band interference within range of either radio in a link can significantly degrade communications. Additionally, a powerful signal of almost any frequency at very close range can simply overwhelm a receiver. Test such a site with a representative setup before committing to it. Campbell Scientific offers a Radio Test Kit (www.campbellsci.com/21107). Contact Campbell Scientific for more information.

Relocating an antenna by a few feet vertically or horizontally or constraining the radiation pattern with a directional antenna may make a significant difference. Keep in mind that commercial tower sites and urban areas tend to evolve over time which may result in new sources of interference.

8.2 Antenna selection, placement, and mounting

Antenna selection and placement can play a large role in system performance. Often directional antennas are preferred over omnidirectional antennas when possible, as RF energy can be more selectively directed and received. Also, higher gains can be realized without the consumption of additional power. Additionally, it is good practice to place antennas as high as possible. Placing an antenna at a higher elevation often increases the line-of-sight distance it can transmit and receive. Sometimes performance can be improved by even slightly changing the horizontal or vertical position of the antenna. See Line of Sight Technical Paper on our website for more information on line-of-sight obstructions.

8.3 Antenna cables

- Installation
  - Install all conductors and cables in a neat, orderly fashion. Avoid placing them directly over or across system components.
  - Avoid installing conductors carrying low level analog signals in close proximity and parallel to conductors carrying digital signals or switched voltage levels.
- Bend Radius
  - The RF cable used to connect the radio and antenna has a specified minimum bend radius. Exceeding it will lead to a degradation of system performance such as increased signal losses, and high VSWR (voltage standing wave ratio).

- Strain Relief
    - Avoid cable chaffing and connector fatigue by providing strain relief to all conductors and cables that span a distance of more than 30 cm (12 inches) or have a potential for relative motion due to vibration or wind.
- Connectors
    - All exposed RF connectors should be weatherproofed. A good method is to apply overlapping wraps of a good quality mastic tape, extending several inches beyond either side of the connection, then cover the mastic tape with tight, overlapping wraps of a good quality vinyl tape.
    - Keep electrical connectors clean and corrosion free by periodic application of a good quality aerosol-based contact cleaner.

8.4 Troubleshooting

Intermittent communications problems when connecting via radio, may indicate there is another network in the area causing interference. To help remove the interference, use ***Device Configuration Utility*** to change the **Network ID** and **RF Hop Sequence** in all RF407, RF412, and RF422 radios within a network (standalone or included in a data logger) to another value. Each of these settings must have the same value in all radios and dataloggers within a network. For example, the **Network ID** in all devices could be set to **1726**, and the **RF Hop Sequence** in all devices could be set to **1**. The **Network ID** can be any number between 0 and 32767. The **RF Hop Sequence** can be any number between 0 and 7 in an RF407 or RF412 network; it can be any number between 0 and 9 in an RF422 network.

> **NOTE:**
> Radio options cannot be mixed within a network. An RF407 can only be used with other RF407-type radios, an RF412 can only be used with other RF412-type radios, an RF422 can only be used with other RF422-type radios, RF427 can only be used with other RF427-type radios.

For specifications information, see Specifications (p. 9).

See also: Troubleshooting large networks paper.

9. RF407-series radio settings

Access RF407-series radio settings, using *Device Configuration Utility*. Clicking on a setting in *Device Configuration Utility* also provides information about that setting. These settings are available for RF407-series data loggers.

> NOTE:
> A list of **Settings** fieldnames is also available from the data logger terminal mode using command **F**.

9.1 RadioAvailFreq

Displays the bitfield of the frequencies that are available in the module's region of operation.

- String data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Available Frequencies**

9.2 RadioChanMask

The channel mask allows channels to be selectively enabled or disabled. This allows you to avoid using frequencies that experience unacceptable levels of RF interference.

- String data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio Channel Mask**

9.3 RadioEnable

Global control for the internal radio module.

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio Enable**

9.4 RadioHopSeq

Specifies the radio channel hop sequence. This setting must match in all radios in the same RF network. This setting can also be used to prevent radios in one RF network from listening to transmissions of another.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > RF Hop Sequence**

9.5 RadioMAC

Radio serial number.

- String data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio MAC Address**

9.6 RadioModel

Reports the model of the internal radio module.

- String data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio Model**

9.7 RadioModuleVer

Radio hardware version.

- Long data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio Hardware Version**

9.8 RadioNetID

The RadioNetID specifies the identifier for the RF network. The radio will ignore any packets received that do not use this network identifier - therefore, all radios in the network must use the same value. Valid entries are between **0** and **32767**.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Network ID**

9.9 RadioProtocol

Specifies the protocol mode that will be used by the radio.

PakBus Aware: This is the most commonly used protocol setting for PakBus networks. The radio will automatically inherit an RF identifier equal to the PakBus address of the device to which it is serially attached. In this mode, the radio will be capable of performing RF level retries and acknowledgments and provide a more reliable link than **Transparent** mode used for broadcast messaging. You do not need to manually set a unique RF Radio Address or a unique PakBus Address. This device will not appear in PakBus Graph.

PakBus Node: Similar to **PakBus Aware**, but requires the device to have a unique PakBus Address specified. Because the radio is PakBus addressable status information, such as RSSI, can be queried through a `GetVariables()` transaction. Additionally, if the radio is connected to a PakBus router it will also be viewable in PakBus Graph and accessible by other remote PakBus devices. If attached to a PakBus router, network overhead will increase due the increase in number of PakBus nodes in the network. If **Active Interface** is also set to PakBus Router, this mode will allow the device to function as a standalone RF repeater. This setting must be used if Active Interface is set as PakBus Router. This setting is most commonly used when a user wants to a) use the device as a standalone PakBus repeater, b) make the device available remotely for viewing and editing settings, or c) attach more than one radio to a single data logger.

Transparent: Provides a transparent link with no interpretation of the data packet. This mode is most commonly used with array based data loggers, and it must be used when communicating with other transparent devices such as the stand alone and built-in RF407-series radios. This mode is also used for non-PakBus protocols like Modbus. When used this way, **Retry Level** must be set to **None**.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Protocol**

9.10 RadioPwrMode

This setting governs the duty cycle that the radio will use for powering its receiver circuit. As such, it governs the amortized current drain for the radio. This setting should be set the same for all radios in the same network. Power Modes include:

Always On: The radio is always on and does not transmit a wakeup header.

0.5 Second: The radio wakes every 0.5 seconds for a 100 msec interval to listen for RF activity. It will transmit a 700 msec wakeup header with the first transmission following a period of RF inactivity.

1 Second: The radio wakes every 1 second for a 100 msec interval to listen for RF activity. It will transmit a 1200 msec wakeup header with the first transmission following a period of RF inactivity.

4 Second: The radio wakes every 4 seconds for a 100 msec interval to listen for RF activity. It will transmit a 4200 msec wakeup header with the first transmission following a period of RF inactivity.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Power Mode**

9.11 RadioRetries

Specifies the level to which the radio should retry to deliver an unacknowledged RF packet transmission. When an RF packet fails to be acknowledged by the destination, the radio will resend the packet again. A receiving radio responds to the sending radio with an ACK packet for every radio packet that it receives that is addressed to it and has a valid CRC. Retry levels and counts:

- **None**: 0
- **Low**: 2
- **Medium**: 4
- **High**: 6

Set **Retry Level** to **None** when the **Protocol** setting is set to **Transparent** for the purpose of communicating with other RF407-series radios.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Retry Level**

9.12 RadioRSSI

Indicates the signal strength of the last packet received by this radio.

The units of the RSSI are dBm; –40 is a stronger signal than –70. Because the received signal strength can vary due to multipath signals, interference, or other environmental effects; this setting may not give a true indication of communications performance or range. However, received signal strength can be useful for activities such as:

- Determining the optimal direction to aim a Yagi antenna
- Determining the effects of antenna height and location
- Trying alternate (reflective) paths
- Seeing the effect of vegetation and weather over time

- Long data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > RFSignalLevel** (first number)

9.13 RadioRSSIAddr

Indicates the PakBus address of the **RadioRSSI** signal radio.

- Long data type
- Read only

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > RFSignalLevel** (second number)

9.14 RadioStats

Provides performance statistics for the data logger integrated radio. The data logger will maintain a radio routing table for each PakBus neighbor accessed using the integrated radio and this setting is generated from that table. The fields reported for this setting are as follows:

- **PakBus Address**: Specifies the PakBus address of the neighbor reached through an integrated radio link.
- **Sent Packets**: Reports the number of radio packets that have been transmitted to the PakBus neighbor using the integrated radio link.
- **Received Packets**: Reports the number of radio packets that have been received from the PakBus neighbor using the integrated radio link.
- **Packet Retries**: Reports the number of radio packet transmissions to the PakBus neighbor using the integrated radio link that had to be retransmitted by the radio module.
- **Packet Failures**: Reports the number of radio packet transmissions to the PakBus neighbor that were never acknowledged.
- String data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio Performance Statistics**

9.15 RadioTxPwr

Specifies the power level at which the RF module transmits.

Levels are approximate. It is very important that the TX power level selected and the gain of the attached antenna do not exceed the maximum allowed ERP permitted by local laws. These rules vary from region to region.

- Long data type

Where to find:

- **Settings Editor** tab in *Device Configuration Utility*: **Radio > Radio TX Power Level**

Appendix A. Part 15 FCC compliance warning

Changes or modifications to the RF407-series radio systems not expressly approved by Campbell Scientific, Inc. could void the user's authority to operate this product.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

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

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.

Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

CAMPBELL SCIENTIFIC EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF

MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Campbell Scientific hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the products, whether express, implied, or statutory, other than those expressly provided herein.

Campbell Scientific will, as a default, return warranted equipment by surface carrier prepaid. However, the method of return shipment is at Campbell Scientific's sole discretion. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty and the Company's obligation thereunder is in lieu of all other

warranties, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

In the event of any conflict or inconsistency between the provisions of this Warranty and the provisions of Campbell Scientific's Terms, the provisions of Campbell Scientific's Terms shall prevail. Furthermore, Campbell Scientific's Terms are hereby incorporated by reference into this Warranty. To view Terms and conditions that apply to Campbell Scientific, Logan, UT, USA, see Terms and Conditions. To view terms and conditions that apply to Campbell Scientific offices outside of the United States, contact the regional office that serves your country.

Assistance

Products may not be returned without prior authorization. Please inform us before returning equipment and obtain a **return material authorization (RMA) number** whether the repair is under warranty/guarantee or not. See Limited warranty for information on covered equipment.

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.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

Global Sales and Support Network

A worldwide network to help meet your needs

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