Product Manual

BaroVUE™10

Digital Barometer

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC®

Table of contents

1. Introduction

The BaroVUE™10 measures barometric pressure between 500 to 1100 hPa. This range is equivalent to a pressure measurement taken below sea level such as in a mine to over 4,570 m above sea level. The BaroVUE 10 is designed for use in environmental applications and is compatible with all Campbell Scientific data loggers.

> **NOTE:**
> This manual provides information for CRBasic data loggers only.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.

- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.

- Authorized technician shall verify that the installation and use of this product is in accordance to the manufacturer's instructions, recommendations, and intended use.

- Although the BaroVUE 10 is rugged, it should be handled as a precision scientific instrument.

- To prevent condensation, install the sensor in an environmentally protected enclosure, complete with desiccant. Change the desiccant at regular intervals.

- If the BaroVUE 10 uses an external pressure port, the pressure port inlet tubing must be connected to a suitable desiccant chamber. See External pressure port (p. 15) for more information.

  > **WARNING:**
  > Failure to protect the sensor from condensation may result in permanent damage.

- DO NOT blow into the pressure tube/barb. The human lungs are capable of creating a pressure of approximately 150 hPa above ambient, which can damage the pressure sensors or cause loss of calibration.

- Sensor card is not a memory card. Although inserting the card into a computer slot will not damage the card, it will not appear as external storage or be shown in the computer device manager.

- Do not submerge the sensor card or the motherboard in water.

- Temperatures beyond the operating temperature range may damage the electronics and cause loss of calibration (see Specifications [p. 8]).

- Unnecessary forces applied to the sensor card can cause loss of calibration.

> **WARNING:**
> Improper wiring may damage the BaroVUE 10 beyond repair.

3. Initial inspection

- Upon receipt of the BaroVUE 10, inspect the packaging and contents for damage. If any damage during transport has occurred, file damage claims with the sensor provider.

- Immediately check package contents against the shipping documentation. Contact Campbell Scientific about any discrepancies.

The following components are included with all BaroVUE 10 assemblies:
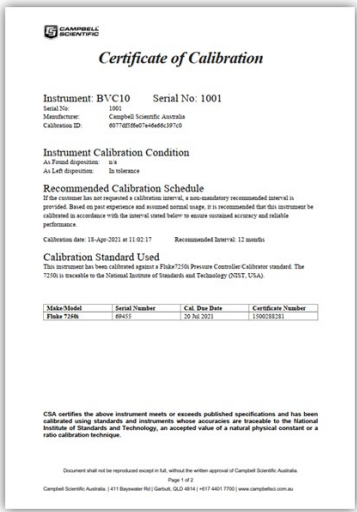
Table 3-1: BaroVUE 10 components			
Quantity	Component	Description	Image
1	BaroVUE 10	Reads sensor card data and sends data to the data logger using SDI-12 or RS-232	
1	BVC10[1] sensor card	Contains barometric pressure sensors and calibration coefficients	

Table 3-1: BaroVUE 10 components			
Quantity	Component	Description	Image
1	USB Type A - Micro B cable	Connects BaroVUE 10 to the computer	
1	BaroVUE10CBL Data and Power cable	Connects BaroVUE 10 to data logger	
2	#6-32 x .375 Pan Phillips Screws and Grommets for #6 screws	Used to mount BaroVUE 10 to an enclosure backplate	
1	BV-CAL	Factory calibration sheet for the BVC10 sensor card (see Note that follows)	
[1] The BCV10 is supplied inside the BaroVUE 10.			

4. Overview

The BaroVUE 10 uses a set of silicon pressure elements. Each element is individually calibrated with the calibration corrections stored on the chip. An out-of calibration sensor card can be returned to Campbell Scientific for recalibration. The sensor card is easily changed in the field, reducing downtime and calibration costs.

The BaroVUE 10 is a fully digital sensor. Electronics within the BaroVUE 10 control the measurement made by the sensor element, apply the calibration coefficients, average the readings, and output the data using SDI-12 or RS-232 protocol to a data logger. The BaroVUE 10 also includes built-in outlier detection and quality metric with each measurement ensuring a reliable and accurate pressure sample. This barometer is encased in a plastic housing designed to

withstand the operating temperature range. The case is fitted with an intake valve and a sealed pressure chamber to allow for remote pressure sensing.

In most applications, the BaroVUE 10 idle current is insignificant compared to the data logger and other power draws, allowing the BaroVUE 10 to be powered continuously. See Specifications (p. 8) for more information.

Features

- Multiple sensor elements result in accurate and stable measurements with built-in quality metric
- Field-interchangeable sensor card
- Individually calibrated sensor elements that require no further adjustment
- Low power consumption
- Digital SDI-12 and RS-232 output
- Compatible with Campbell Scientific data loggers: Granite-series, CR6, CR3000, CR1000X, CR800-series, CR300-series, CR1000

5. QuickStart

A video that describes data logger programming using *Short Cut* is available at: www.campbellsci.com/videos/cr1000x-data logger-getting-started-program-part-3 ▶. *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com ↗. It is included in installations of *LoggerNet*, *RTDAQ*, and *PC400*.

The following procedure also shows using *Short Cut* to program the BaroVUE 10.

1. Open *Short Cut* and click **Create New Program**.
2. Double-click the data logger model.

3. In the **Available Sensors and Devices** box, type BaroVUE10 or find the sensor in the **Sensors > Meteorological > Barometric Pressure** folder, and double-click **BaroVUE10 (SDI-12) Barometric Pressure Sensor**. **SDI-12 Address** defaults to **0**. Enter the correct **SDI-12 Address** for the sensor if it has been changed from the factory default value. Type the elevation in meters. Choose whether to measure the sensor every hour or every scan. The **Barometric pressure** and **Temperature** default to **hPa** and **deg C**, respectively. These can be changed by clicking the **Barometric pressure** or **Temperature** box and selecting another option.
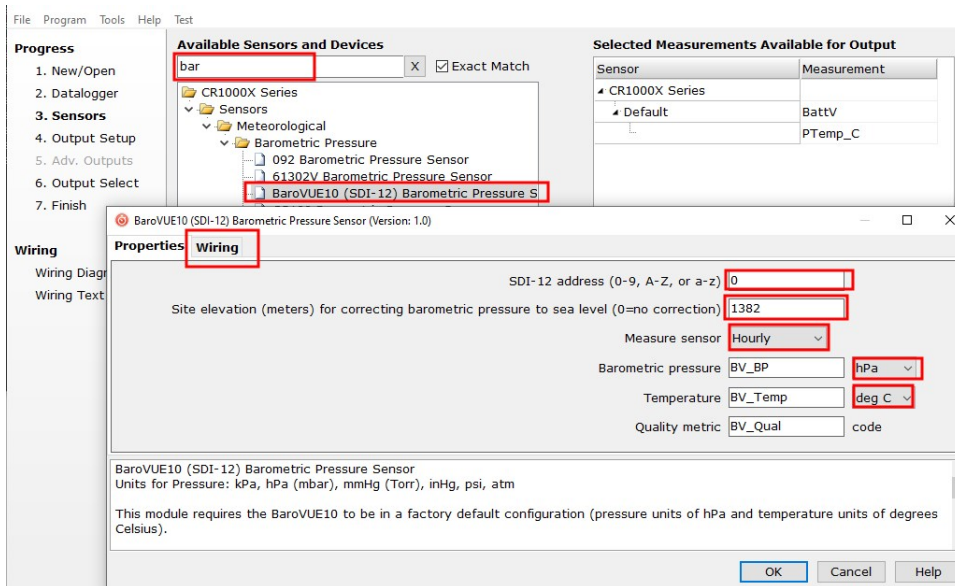
4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. The default control terminal for SDI-12 is **C1**. To change to another terminal, click the terminal name and select another terminal. Click **OK** after wiring the sensor.
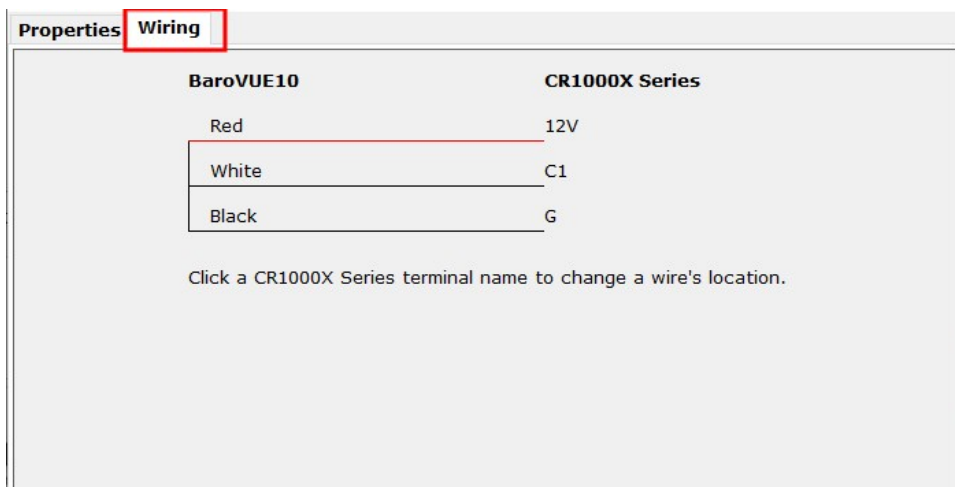
5. Repeat steps three and four for other sensors you want to measure. Click **Next**.

6. In **Output Setup**, type the scan rate, a **Table Name**, and **Data Output Storage Interval**. Click **Next**.
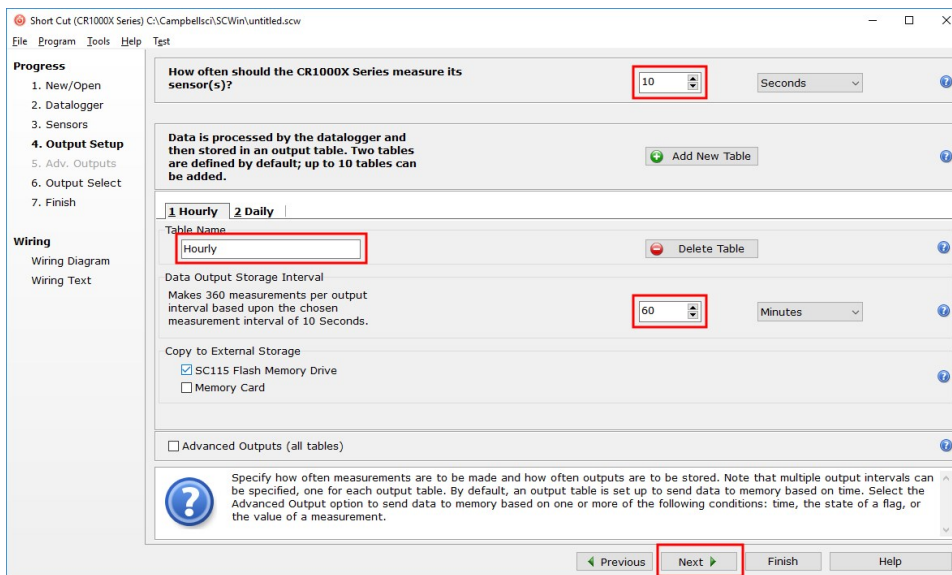
7. Select the output options.
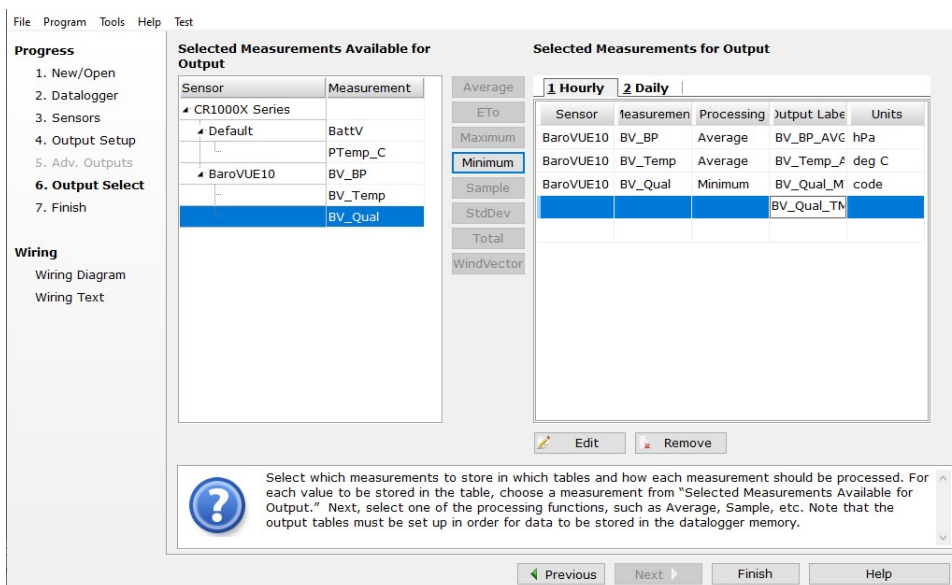
8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

9. If the sensor is connected to the data logger, check the output of the sensor in the data display in *LoggerNet*, *RTDAQ*, or *PC400* to make sure it is making reasonable measurements.

6. Specifications

Digital output:	SDI-12, RS-232 serial
Response time:	1 s for the M! SDI-12 command
Default configuration	
SDI-12:	Default SDI-12 address is 0
RS-232:	9600 baud rate, eight data bits, no parity, one stop bit
Operating range	
Pressure:	500 to 1100 hPa
Temperature:	–40 to 60 °C
Humidity:	0 to 97%, non-condensing
Supply voltage:	9 to 28 VDC ⎓
Current consumption at 12 VDC	
Idle:	200 µA; 350 µA (RS-232 enabled)
Active:	<5 mA
Housing material:	Polybutylene terephthalate (PBT) and polycarbonate (PC)
Internal chamber pressure rating with respect to ambient:	±400 hPa
Pressure fitting:	⅛ inch barb
Maximum cable length:	3 m (10 ft)
Dimensions:	2.1 x 9.0 x 10.2 cm (0.8 x 3.5 x 4.0 in)
Weight:	135 g (4.8 oz)
Compliance:	View documents at: www.campbellsci.com/barovue10 ⧉

6.1 Accuracy

Calibration Uncertainty:[1]   ±0.15 hPa at 20 °C

Uncertainty: ±0.3 hPa at 20 °C

Total uncertainty: ±0.5 hPa at –40 to 60 °C

Long-term stability: ±0.1 hPa per year

Power supply rejection: >30 dB

Measurement noise: 0.05 hPa (RMS)

Resolution: 0.1 hPa

[1]Defined as ±2 standard deviation limits of inaccuracy of the working standard at 1000 hPa in comparison to international standards (NIST)

7. Installation

If you are programming your data logger with *Short Cut*, skip Wiring (p. 9) and Programming (p. 11). *Short Cut* does this work for you. See QuickStart (p. 5) for a tutorial.

7.1 Wiring

The BaroVUE 10 does not support communications through SDI-12 and RS-232 simultaneously. The data logger connects to the BaroVUE 10 with a 5-pin screw terminal plug connector. This connector is removable and may be replaced.

RS-232 RX (yellow)
RS-232 TX (blue)
G (black)
12V (red)
SDI12 (white)

Figure 7-1. 5-pin screw terminal plug connector and connections

7.1.1 SDI-12 data logger connections

Connect the wires in the order shown in the following table.

Table 7-1: Wire color, function, and data logger connection		
Wire color	Wire function	Data logger connection
White	SDI-12 signal	**C**, **SDI-12**, or **U** configured for SDI-12[1]
Red	Power	**12V**, **Battery+**
Black	Power ground	**G**
Blue	RS-232 TX	not connected
Yellow	RS-232 RX	not connected
[1]**U** and **C** terminals are automatically configured by the measurement instruction.		

If multiple SDI-12 sensors are connected to a data logger, Campbell Scientific recommends using separate terminals when possible. However, multiple SDI-12 sensors can connect to the same data logger control or **U** terminal. Each must have a unique SDI-12 address. Valid addresses are 0 through 9, a through z, and A through Z.

For CR6 and CR1000X data loggers, triggering conflicts may occur when a companion terminal is used for a triggering instruction such as `TimerInput()`, `PulseCount()`, or `WaitDigTrig()`. For example, if this product is connected to **C3** on a CR1000X, **C4** cannot be used in the `TimerInput()`, `PulseCount()`, or `WaitDigTrig()` instructions.

7.1.2 RS-232 connections

Table 7-2: Wire color, function, and data logger connection		
Wire color	Wire function	Data logger connection
Yellow	RS-232 RX	**C** (odd numbered)
Blue	RS-232 TX	**C** (even numbered)
Black	Power ground	**G**
Red	Power	**12V**, **Battery+**
White	SDI-12 signal	not connected
[1]**U** and **C** terminals are automatically configured by the measurement instruction.		

7.2 Programming

Short Cut is the best source for up-to-date programming code for Campbell Scientific data loggers. If your data acquisition requirements are simple, you can probably create and maintain a data logger program exclusively with **Short Cut**. If your data acquisition needs are more complex, the files that **Short Cut** creates are a great source for programming code to start a new program or add to an existing custom program.

> **NOTE:**
> **Short Cut** cannot edit programs after they are imported and edited in **CRBasic Editor**.

A **Short Cut** tutorial is available in QuickStart (p. 5). If you wish to import **Short Cut** code into **CRBasic Editor** to create or add to a customized program, follow the procedure in Importing Short Cut code into CRBasic Editor (p. 33). Programming basics for CRBasic data loggers are provided in the following sections. A downloadable program is available at www.campbellsci.com/downloads/barovue10-example-program ⬀.

7.2.1 SDI-12 programming

The `SDI12Recorder()` instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See SDI-12 commands (p. 17) for more information.

For most data loggers, the `SDI12Recorder()` instruction has the following syntax:

```
SDI12Recorder(Destination, SDIPort, SDIAddress, "SDICommand", Multiplier, Offset,
FillNAN, WaitonTimeout)
```

Valid values for the `SDIAddress` are 0 through 9, A through Z, and a through z; alphabetical characters need to be enclosed in quotes (for example, **"A"**). Also enclose the `SDICommand` in quotes as shown. The `Destination` parameter must be an array. The required number of values in the array depends on the command (see Table 8-2 [p. 18]).

`FillNAN` and `WaitonTimeout` are optional parameters (refer to CRBasic Help for more information).

7.2.2 RS-232 programming

The RS-232 instructions are shown in Table 7-3 (p. 12).

Table 7-3: Serial instructions

Instruction	Function
`SerialFlush()`	Clears the buffer.
`Scan()`	Establish a scan rate.
`SerialOut()`	Send command to the sensor.
`SerialIn()`	Set up the COM port to receive the incoming serial data. Note that in the beginning of the CRBasic program, the variable used in the `SerialIn()` instruction needs to be declared as an ASCII string format.
`SplitStr()`	Split out digital count value from the input string.

7.3 Venting, condensation, and mounting

To prevent condensation, install the sensor in an environmentally protected enclosure, complete with desiccant. Change the desiccant at regular intervals. If the BaroVUE 10 uses an external pressure port, the pressure port inlet tubing must be connected to a suitable desiccant chamber.

> **CAUTION:**
> Failure to protect the sensor from condensation may result in permanent damage.

For the sensor to detect the external ambient pressure, the enclosure must vent to the atmosphere (not be hermetically sealed), which may require the addition of a vent hole on the outer wall. An external pressure port can reduce errors caused by wind (see External pressure port [p. 15] for more information).

7.3.1 Typical mounting

The BaroVUE 10 is typically mounted in a Campbell Scientific enclosure next to the data logger. Secure the BaroVUE 10 to an enclosure backplate by inserting screws through the mounting holes in the BaroVUE 10 and into the grommets. The enclosure must include desiccant and a desiccant indicator card.
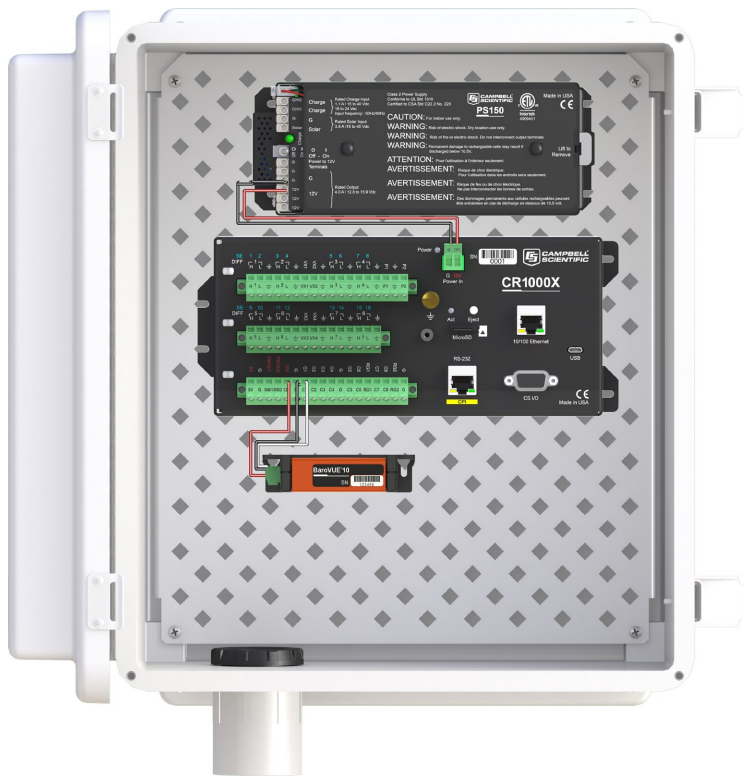
Figure 7-2. BaroVUE 10 mounted in a Campbell Scientific enclosure

7.3.2 ENC100 mounting

Campbell Scientific offers the ENC100 for situations where it is desirable to house the BaroVUE 10 in its own enclosure (see Figure 7-3 [p. 14]). The ENC100 is a small enclosure with dimensions of 17 x 14 x 10 cm (6.7 x 5.5 x 3.9 in). It includes a compression fitting for cable entry, a vent for equalization with the atmosphere, a backplate for mounting the BaroVUE 10, and hardware for mounting the ENC100 to a tripod, tower, or pole.

Figure 7-3. ENC100 is a small enclosure that can house one BaroVUE 10

7.3.3 DIN-rail mounting

The BaroVUE 10 can also be mounted to a DIN Rail using the DIN Rail mounting kit (purchased separately). The DIN Rail mounting kit contains the following parts:

Table 7-4: DIN-rail components	
Quantity	Description
1	BaroVUE 10 DIN rail adapter plate
2	6 mm M3 Pozi-drive screws
3	DIN rail mount
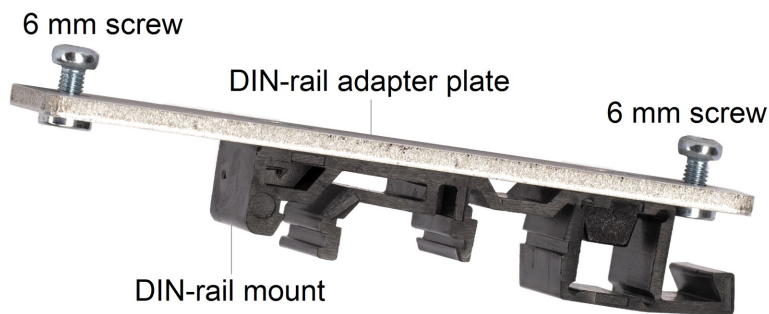
Figure 7-4. Din-rail kit
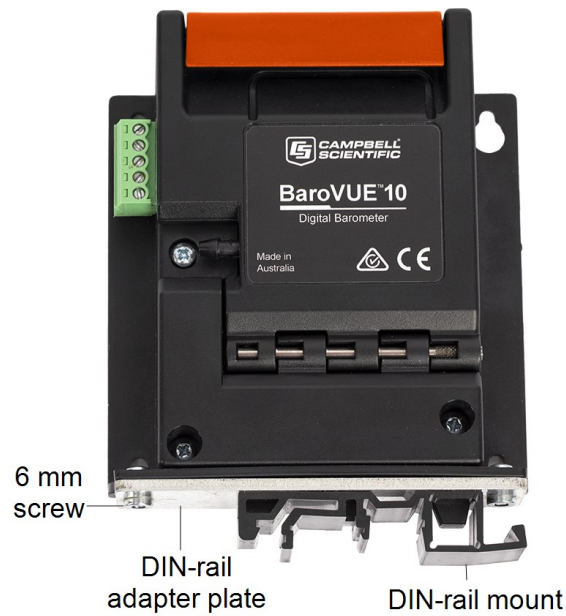
Figure 7-5. BaroVUE 10 with optional DIN Rail mounting kit

7.3.4 External pressure port

A two plate pressure port such as the RM Young 61002 can minimize dynamic pressure errors due to wind. Wind at the barometer inlet can impair measurement performance of remote barometers. Ambient wind of 20 meters/second (45 mph) blowing over a typical barometer inlet tube can cause dynamic pressure errors as high as 3 hPa. These errors can make atmospheric pressure data unsuitable for research and forecast purposes. The pressure port reduces dynamic pressure errors to a minimum level. The design of the pressure port effectively slows air velocity at the pressure inlet. An internal baffle system creates a barrier to water and snow intrusion into the barometer.

Figure 7-6. Zero wind pressure plate

Mount the sensor with the pneumatic connector pointing vertically downwards to prevent condensation collecting in the pressure cavity, and also to ensure that water cannot enter the sensor.

To prevent water vapor from entering the inner cavity of the sensor, terminate the intake/vent tube opening inside a suitable desiccant tube. The desiccant tube must always be attached to the BaroVUE 10.

8. Operation

This section discusses the following:

8.1 Factory settings

Table 8-1: Factory Settings	
Parameter	Setting
SDI-12 Address	0
RS-232 Data Bits	8
RS-232 Stop Bits	1
RS-232 Parity	None
RS-232 Baud Rate	9600
Pressure Units	hPa
Temperature Units	Celsius

8.2 SDI-12 commands

The BaroVUE 10 supports the commands listed in Table 8-2 (p. 18). When using an M! command, the data logger waits for the time specified by the sensor, sends the D! command, pauses its operation, and waits until either it receives the data from the sensor or the sensor timeout expires. If the data logger receives no response, it will send the command a total of three times, with three retries for each attempt, or until a response is received.

A C! command follows the same pattern as an M! command with the exception that it does not require the data logger to pause its operation until the values are ready. Rather, the data logger picks up the data with the D! command on the next pass through the program. Another measurement request is then sent so that data is ready on the next scan.

As measurement data is transferred between the BaroVUE 10 and data logger digitally, there are no offset errors incurred with increasing cable length as seen with analog sensors. However, with increasing cable length, there is still a point when digital communications break down, resulting in either no response or excessive SDI-12 retries and incorrect data due to noise problems. (Using SDI-12 commands like MC!, which adds a cyclic redundancy check (CRC), can significantly improve incorrect data issues.)

Table 8-2: BaroVUE 10 SDI-12 commands		
SDI-12 command (a is the sensor address)	Values Returned or Function	Units
*a*M!, *a*C!, *a*MC!, or *a*CC!	1. Pressure 2. Temperature 3. Quality Metric	1. hPa (millibar) 2. °C 3. N/A
*a*M1!, *a*C1!, *a*MC1!, or *a*CC1!	1. Pressure 2. Temperature 3. Quality Metric	1. kPa 2. °C 3. N/A
*a*M2!, *a*C2!, *a*MC2!, or *a*CC2!	1. Pressure 2. Temperature 3. Quality Metric	1. in Hg 2. °F 3. N/A
*a*M3!, *a*C3!, *a*MC3!, or *a*CC3!	1. Pressure 2. Temperature 3. Quality Metric	1. mm Hg 2. °C 3. N/A
*a*M4!, *a*C4!, *a*MC4!, or *a*CC4!	1. Pressure 2. Temperature 3. Quality Metric	1. psia 2. °F 3. N/A
?!	Returns the SDI-12 address	

8.3 Quality metric

For each pressure value, the BaroVUE 10 can output a number known as the quality metric (QM). The QM indicates the quality in the pressure measurement. For more information about the QM, refer to the following table.

Table 8-3: Quality metric numbers		
QM range	Description	Comments
> 6	Sensor freshly calibrated	
5 to 5.99	Sensor working well	The sensor card is working well. All elements agree to a high level.
4 to 4.99	In two to three months, this sensor will need to be recalibrated.	The BaroVUE 10 card will soon need recalibration. Contact your local Campbell Scientific office for a replacement card.
0 to 3.99	Recalibrate the sensor now.	The BV10 BaroVUE 10 card is out of calibration or has a fault. Contact your local Campbell Scientific office for a replacement card.

8.4 Correcting pressure to sea level

The weather service, most airports, radio stations, and television stations adjust the atmospheric pressure to a common reference (sea level). Use the following equation to find the difference (dP) in pressure between the sea level and the site. This equation assumes U. S. Standard Atmosphere and dry air (Wallace, J. M. and P. V. Hobbes, 1977: Atmospheric Science: An Introductory Survey, Academic Press, pp. 59-61).

$$dP = 1013.25 \left\{ 1 - \left(1 - \frac{E}{44307.69231} \right)^{5.25328} \right\}$$

Eq. 1

The value dP is in hPA and the site elevation, E, is in meters. Add dP value to the offset in the measurement instruction.

Use the following equation to convert feet to meters.

$$E(m) = \frac{E(ft)}{3.281ft/m}$$

Eq. 2

The corrections involved can be significant. For example, at 1000 hPa and 20 °C, barometric pressure decreases by 1.1 hPa for every 10 m increase in elevation.

8.5 *Device Configuration Utility*

Use *Device Configuration Utility* software to change the SDI-12 address, view sensor measurements, and update an operating system.

1. Open the main case by unclipping the latch and opening the main door.

Figure 8-1. BaroVUE 10 with main door open

2. Open *Device Configuration Utility*.

3. Type BaroVUE 10 in the **Device Type** box and click BaroVUE 10.
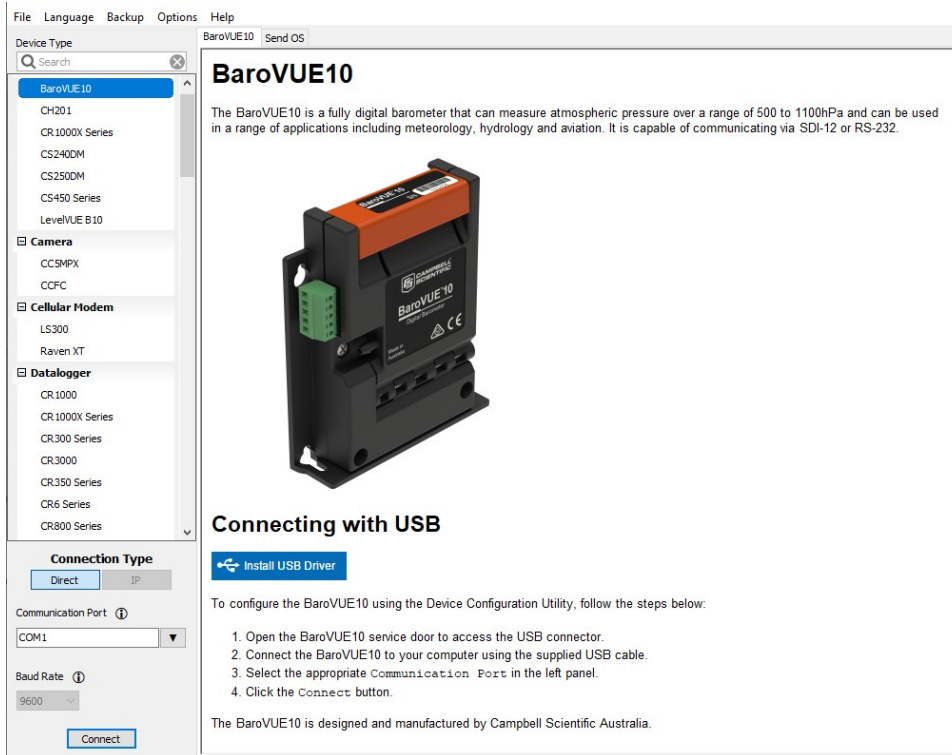
4. If this is the first time connecting the BaroVUE 10 to the computer, click **Install USBDriver before** connecting the cable to the computer.

5. Use the USB cable to connect the BaroVUE 10 USB port to a computer USB port. See Figure 8-1 (p. 20).

6. Select the **Communication Port** in the left panel. **BaroVUE10** will appear in the selection dialog.

> **NOTE:**
> It may take a few seconds for the **Communication Port** to become available for use after physically connecting the BaroVUE 10 to the computer. If you don't see a BaroVUE 10 device listed, check that the USB cable is correctly inserted and that the USB driver was installed in step 4.

7. Click **Connect** to access the **Settings Editor**.
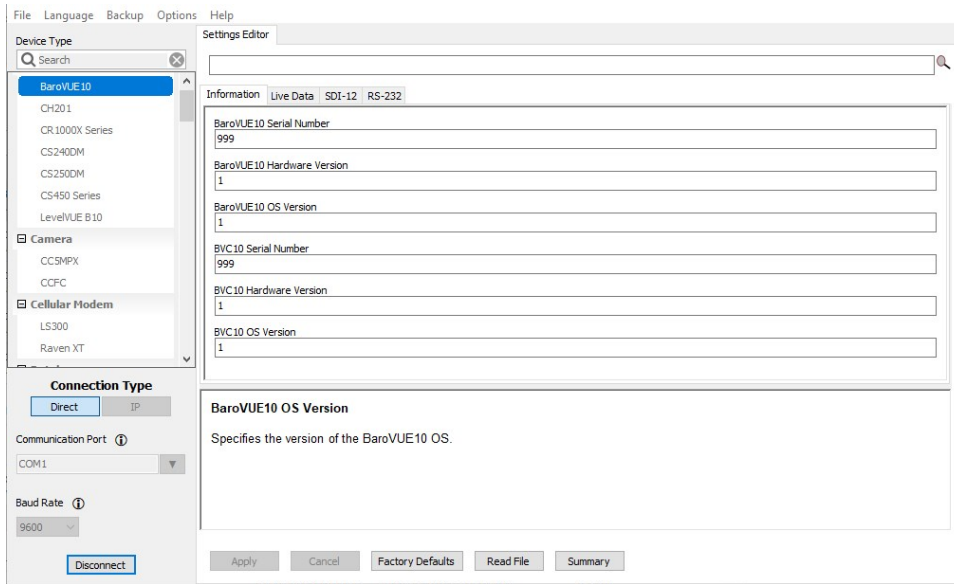
8. Click the **Live Data** tab to view real-time measurements. The Quality Metric Sample value should be greater than 5 (see Quality metric [p. 18]).
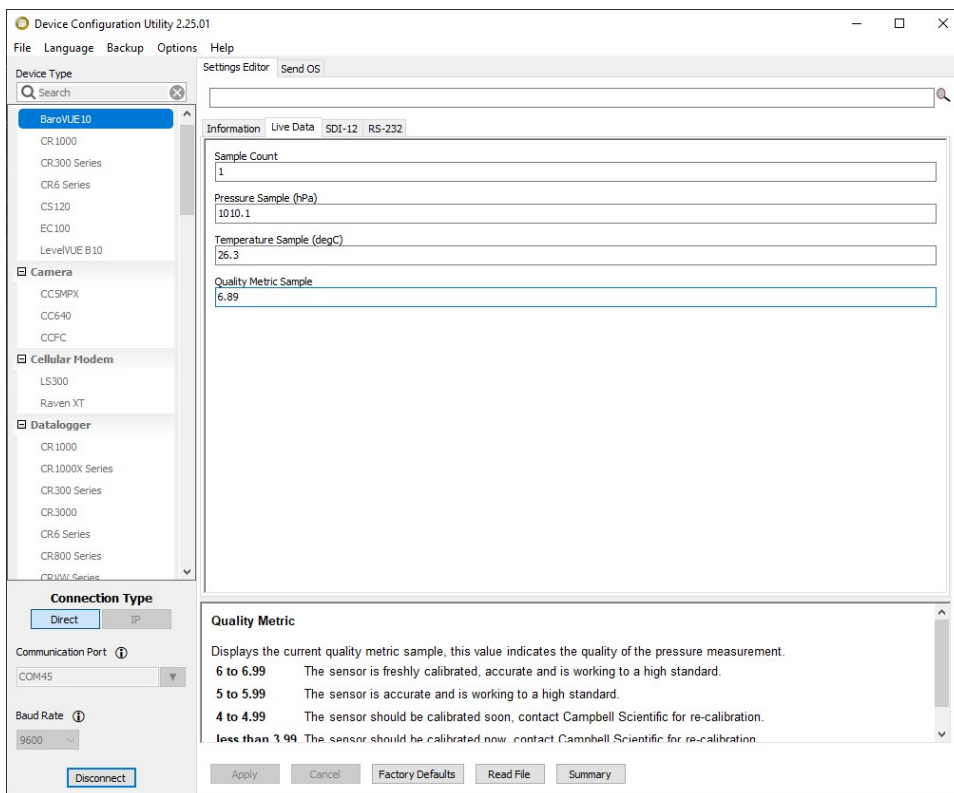
9. To change the SDI-12 address, click the **SDI-12** tab, click the **SDI-12** box, select a different value, then click **Apply**.
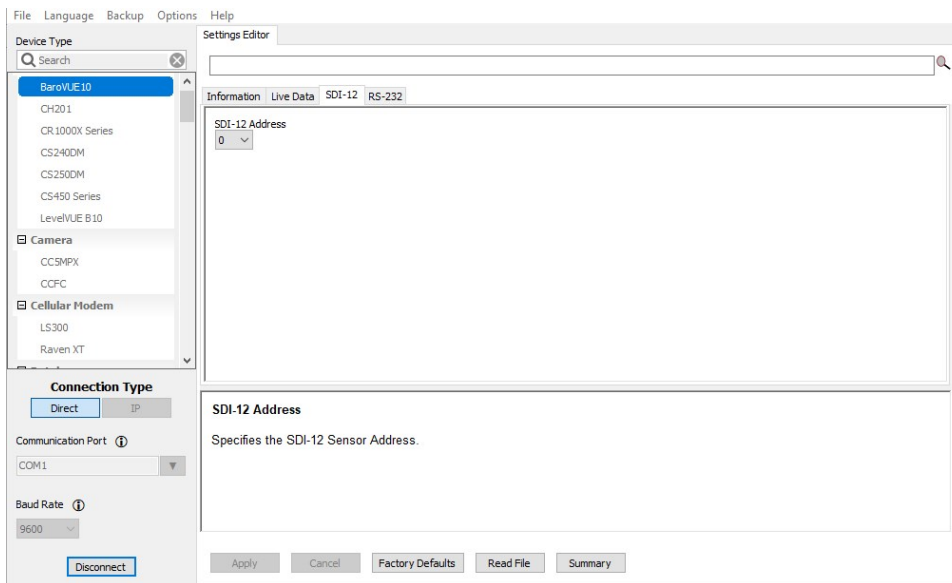
10. Click the **RS-232** tab to change the **RS-232 Mode**, **Baud Rate**, **Parity**, **Continuous Mode Sample Period**, and **Continuous Mode Measurement Units**. After changing settings, click **Apply**.
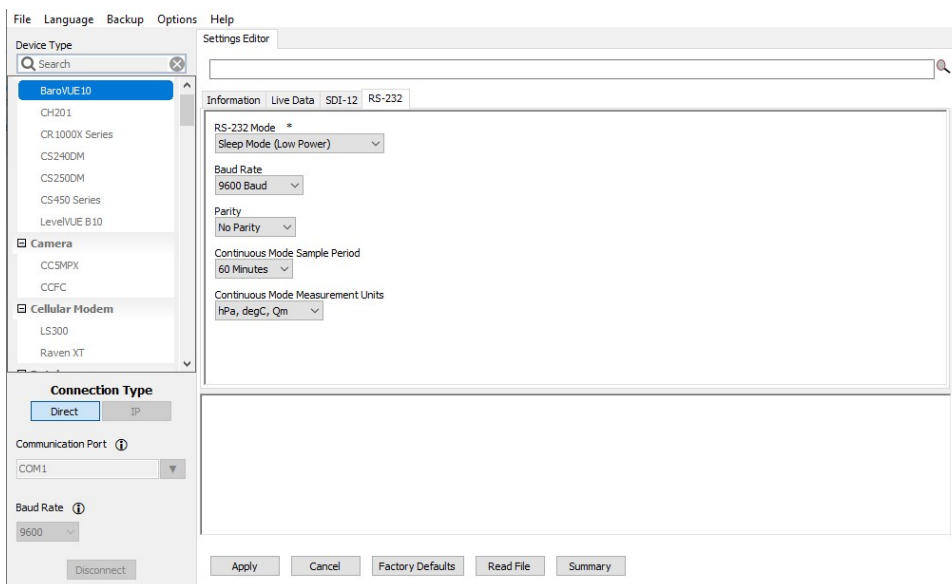
> **WARNING:**
> Remove the USB cable before closing the door.

8.5.1 Updating operating system

1. Find the BaroVUE 10 operating system at www.campbellsci.com/downloads ⬀, click **Download Now**, and click **Save File**. This will download an .exe file on your computer.

2. Double-click the .exe file. This will save the operating system file in C:/Campbellsci/Lib/OperatingSystems.

3. Access *Device Configuration Utility* (see Device Configuration Utility [p. 20]).

4. Click the **Send OS** tab.
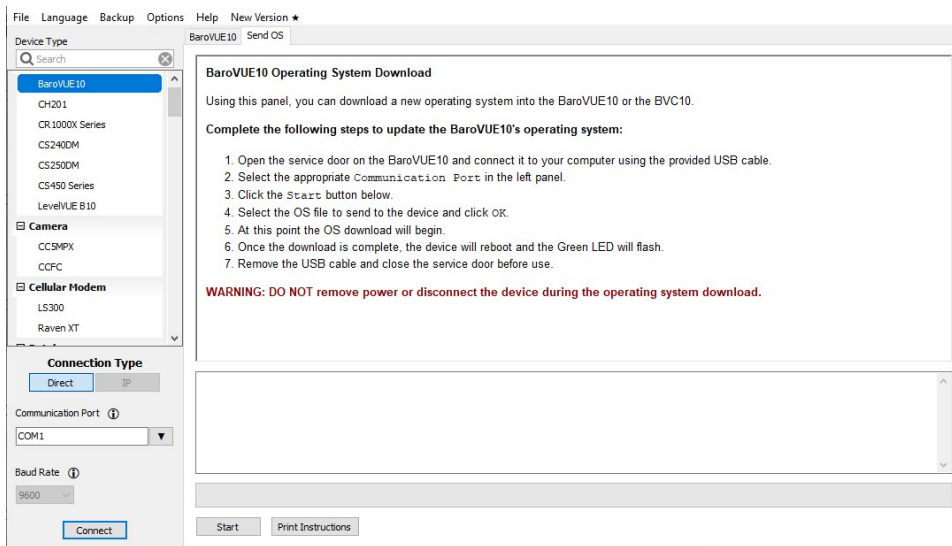
5. Click **Start**

6. Select the file. It will have an .a43 extension.

7. Click **OK**. The operating system will start downloading. When download is complete, the BaroVUE 10 will restart and the green LED will flash.

> **WARNING:**
> Do not remove power or disconnect the device during the operating system download.

8. Remove the USB cable and close the door before use.

8.6 Main menu

To access the main menu:

1. Open the main case by unclipping the latch and opening the main door.

USB port

Figure 8-2. BaroVUE 10 with main door open

2. Connect the BaroVUE 10 to power.

3. Use the USB cable to connect the BaroVUE 10 USB port to a computer USB port.

4. Open a terminal program and set the communication settings to match the device. If the device settings are unknown, use the recovery mode to reconfigure the device settings (see Recovery mode [p. 27]).

5. Press enter several times until **BaroVUE10>** appears (may take up to 10 presses).

6. Type **?** and press enter to view the **Main Menu**.

7. To navigate the menu, type the character associated with the menu option and press enter. To return to the previous menu, type **?** and press enter. The following shows the complete menu structure.

Main Menu

Sensor Information
Configure RS-232
Configure SDI-12
Save and Exit
Exit without Saving

Configure RS-232

Set RS-232 Mode
Get Measurement
Set Baud-rate
Set Stop-bits
Set Parity

Configure SDI-12

Set SDI-12 Address

RS-232 Mode

Sleep Mode
Polled Mode
Continuous Mode

Continuous Mode

Set Measurement Rate
Set Measurement Units

Sample Rate

1 Minute
5 Minutes
15 Minutes
30 Minutes
60 Minutes

Measurement Units

hPa, degC, Qm
kPa, degC, Qm
inHg, degF, Qm
mmHg, degC, Qm
psi, degF, Qm

Measurement Units

hPa, degC, Qm
kPa, degC, Qm
inHg, degF, Qm
mmHg, degC, Qm
psi, degF, Qm

Baud-rate

9600 bps
19200 bps
38400 bps
57600 bps
115200 bps

Stop-bits

1 Stop bits
2 Stop bits

Parity

None
Even Parity
Odd Parity

Updating device settings:

- **>** indicates the currently active settings.
- To change a setting, type the character associated with the menu option and press enter.
- To save changes, navigate to the main menu, type **+**, and press enter.
- To exit without saving changes, navigate to the main menu, type **–**, and press enter.

> **CAUTION:**
> The menu times out after 30 seconds and unsaved changes are lost.

8.6.1 RS-232 polled mode commands

Polled mode allows measurements to be requested at any time.

1. Access the Main menu (p. 25).
2. Select **Polled Mode**.

3. Type a command from Table 8-4 (p. 27).

4. Press enter to make the measurement.

Table 8-4: RS-232 command list		
Command	Values returned	Units
M0	1. Pressure 2. Temperature 3. Quality Metric	1. hPa 2. °C 3. not applicable (N/A)
M1	1. Pressure 2. Temperature 3. Quality Metric	1. kPa 2. °C 3. N/A
M2	1. Pressure 2. Temperature 3. Quality Metric	1. inHg 2. °F 3. N/A
M3	1. Pressure 2. Temperature 3. Quality Metric	1. mmHg 2. °C 3. N/A
M4	1. Pressure 2. Temperature 3. Quality Metric	1. psia 2. °F 3. N/A

8.6.2 Recovery mode

Recovery mode allows the device to be re-configured if the device's communication settings have been lost.
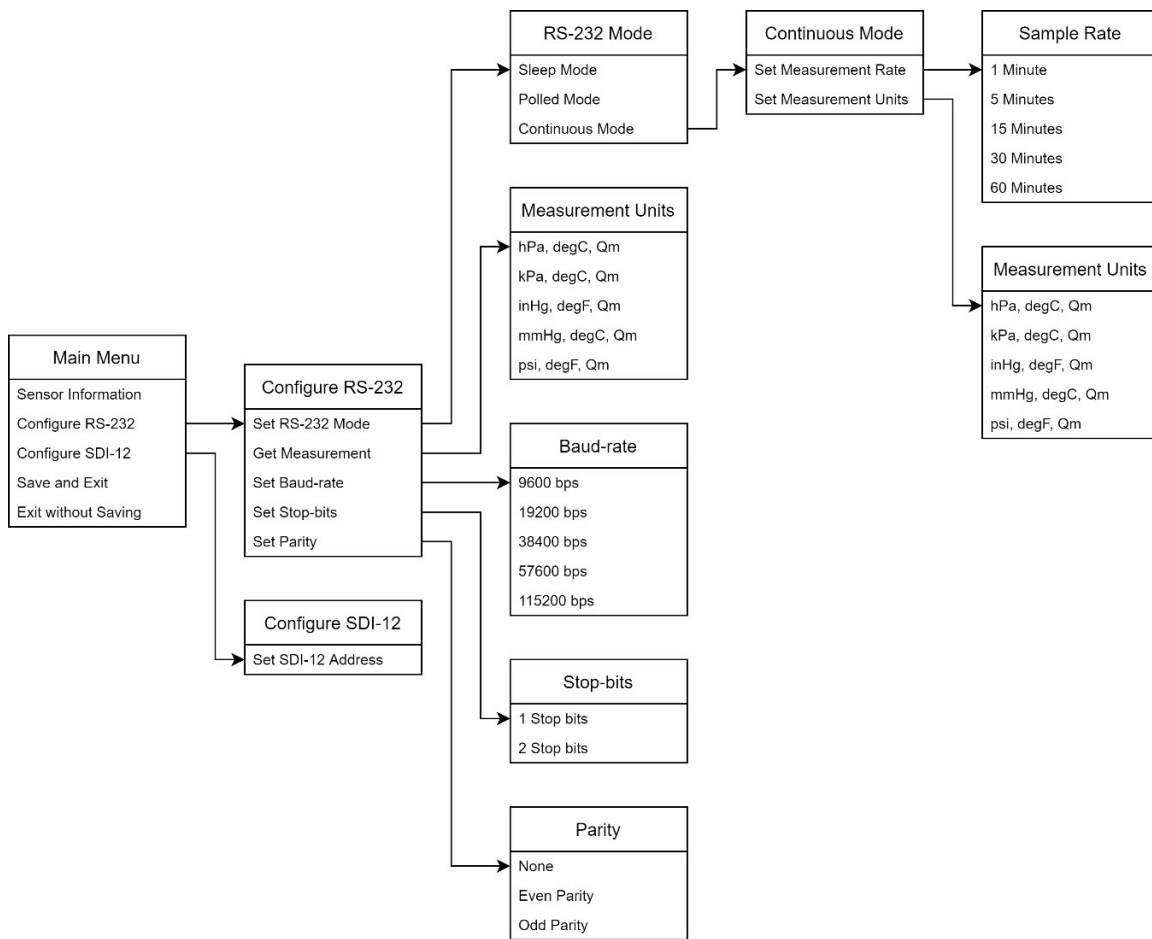
To access the main menu:

1. Open the main case by unclipping the latch and opening the main door.

USB port

Figure 8-3. BaroVUE 10 with main door open

2. Connect the BaroVUE 10 to power.

3. Use the USB cable to connect the BaroVUE 10 USB port to a computer USB port.

4. Open a terminal program and set the communication settings to the factory defaults
   (Factory settings [p. 17]).

5. Continue to press enter until **BaroVUE10>** appears.

6. Type **?** and press enter to view the main menu in recovery mode. The communication
   settings can now be changed. To save any changes, navigate to the main menu, type **+** and
   press enter.

> **CAUTION:**
> The menu times out after 30 seconds and unsaved changes are lost.

9. Troubleshooting and maintenance

> **NOTE:**
> All factory repairs and recalibrations require a returned material authorization (RMA) and completion of the "Statement of Product Cleanliness and Decontamination" form. Refer to the Assistance page at the end of this manual for more information.

9.1 Troubleshooting

Symptom: Pressure and temperature values are returned as NAN.

- Check that the card is inserted fully in its socket and in the correct orientation (see Figure 9-2 [p. 31]).
- Verify the white wire is connected to the terminal specified by the `SDI12Recorder()` instruction.
- Verify the red wire is connected to a **12V** terminal and the black wire is connected to the **G** terminal.
- Use a digital voltage meter to check the voltage to the sensor. If a switched **12V** terminal is used, temporarily connect the red wire to a **12V** terminal (non-switched) for test purposes.
- Verify the BaroVUE 10 SDI-12 address matches the address entered for the `SDI12Recorder()` instruction. The default address is 0. The address can be verified or changed with the commands described in SDI-12 command basics (p. 34).

9.2 Maintenance

Required maintenance includes regularly changing the desiccant and recalibrating the sensor card. When the Enclosure Accessory Humidity Indicator Card changes from blue to pink, replace the desiccant in the enclosure and, if applicable, the desiccant chamber.

The BaroVUE 10 calculates information about the quality of the measurement (see Quality metric [p. 18]). The quality metric gives information about the reliability of the data; a poor quality metric may mean the data is unreliable and the device should be sent to the factory for calibration. However, it is recommended that the sensor card is sent to Campbell Scientific for calibration

every 12 months regardless of the value of the quality metric. Refer to Assistance for more information.

9.2.1 Sensor card replacement procedure

> **CAUTION:**
> The BaroVUE 10 is sensitive to static when the main case is opened. To avoid damage, take adequate anti-static measures when handling.

1. Contact Campbell Scientific for your replacement sensor card and take this newly calibrated card with you to the site of the BaroVUE 10 installation.

   > **CAUTION:**
   > Before handling the BaroVUE 10, wash hands and wear gloves to avoid getting dirt or grease on the element.

2. Open the main case by unclipping the latch and opening the main door.

Figure 9-1. BaroVUE 10 with main door open

3.

- Sensor card plugs into the silver card socket mounted on the motherboard.

- Correct sensor-card orientation is with card notch facing down (towards the motherboard).

Figure 9-2. Card notch in top right corner

- Figure 9-1 (p. 30) shows the correct orientation of the card. The card revision number should be visible.

4. To remove the sensor card, push the card in towards the socket then release. Spring tension pushes the sensor card out of the socket.

5. Once the sensor card is protruding from the socket, hold the motherboard body with one hand and with the other hand, clasp the card body between your fingertips and pull the card out of the socket.

6. Store the old sensor card in an electrostatic protective package and return it to Campbell Scientific for recalibration or general servicing.

7. With the old sensor card removed, check the socket and use a damp cloth to clean dirt, corrosion, or salt on the socket.

8. Unpack the replacement sensor card, avoiding static discharges to the element by touching the package before touching the element.

9. Either hold the new sensor card by the top of the package (the other end to the gold pins) or use a pair of fine nosed pliers or tweezers to grip the sensor card.

10. Carefully align and insert the sensor card in the card socket on the motherboard

11. Confirm the correct orientation and gently push the sensor card into the socket until it will not go any further.

12. Before closing the main case, double-check that the card is inserted in the correct orientation. Refer to Figure 9-1 (p. 30).

13. Close the main case and secure it by pressing down on the latch and clipping it into position.

> **CAUTION:**
> Ensure that cables and pressure tubes are clear of the case and not pinched when closing the lid and tightening the case. This can damage the case, cables, and pressure tubes.

> **CAUTION:**
> Do not apply extreme force when closing the lid. The main case should close with ease. If difficulty is experienced, check for an obstruction.

Appendix A. Importing *Short Cut* code into *CRBasic Editor*

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the *CRBasic Editor*. By default, these files reside in the C:\campbellsci\SCWin folder.

Import *Short Cut* program file and wiring information into *CRBasic Editor*:

1. Create the *Short Cut* program. After saving the *Short Cut* program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > **NOTE:**
   > Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the program it created.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.

3. Go into the CRBasic program and paste the wiring information into it.

4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video ▶.

Appendix B. SDI-12 sensor support

SDI-12, Serial Data Interface at 1200 baud, is a protocol developed to simplify sensor and data logger compatibility. Only three wires are necessary — serial data, ground, and 12 V. With unique addresses, multiple SDI-12 sensors can connect to a single SDI-12 terminal on a Campbell Scientific data logger.

This appendix discusses the structure of SDI-12 commands and the process of querying SDI-12 sensors. For more detailed information, refer to version 1.4 of the SDI-12 protocol, available at www.sdi-12.org ☐.

For additional information, refer to the SDI-12 Sensors | Transparent Mode and SDI-12 Sensors | Watch or Sniffer Mode videos.

B.1 SDI-12 command basics

SDI-12 commands have three components:

- **Sensor address (a)** – a single character and the first character of the command. Use the default address of zero (0) unless multiple sensors are connected to the same port.

- **Command body** – an upper case letter (the "command"), optionally followed by one or more alphanumeric qualifiers.

- **Command termination (!)** – an exclamation mark.

An active sensor responds to each command. Responses have several standard forms and always terminate with <CR><LF> (carriage return and line feed). Standard SDI-12 commands are listed in Table B-1 (p. 34).

Table B-1: Campbell Scientific sensor SDI-12 command and response set		
Name	Command	Response[1]
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	allccccccccmmmmmmvvvxxx...xx <CR><LF>
Start Verification	aV!	atttn <CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response set		
Name	**Command**	**Response[1]**
Address Query	`?!`	a<CR><LF>
Change Address	`aAb!`	b<CR><LF>
Start Measurement	`aM!` `aM1!...aM9!`	atttn<CR><LF>
Start Measurement and Request CRC	`aMC!` `aMC1!...aMC9!`	atttn <CR><LF>
Start Concurrent Measurement	`aC!` `aC1!...aC9!`	atttnn<CR><LF>
Start Concurrent Measurement and Request CRC	`aCC!` `aCC1!...aCC9!`	atttnn<CR><LF>
Send Data	`aD0!...aD9!`	a<values><CR><LF> or a<values><CRC><CR><LF>
Continuous Measurement	`aR0!...aR9!`	a<values><CR><LF>
Continuous Measurement and Request CRC	`aRC0!...aRC9!`	a<values><CRC><CR><LF>
Extended Commands	`aXNNN!`	a<values><CR><LF>

[1] Information on each of these commands is given in the following sections.

B.1.1 Acknowledge active command (a!)

The Acknowledge Active command (`a!`) is used to test a sensor on the SDI-12 bus. An active sensor responds with its address.

B.1.2 Send identification command (aI!)

Sensor identifiers are requested by issuing command `aI!`. The reply is defined by the sensor manufacturer but usually includes the sensor address, SDI-12 version, manufacturer's name, and sensor model information. Serial number or other sensor specific information may also be included.

`aI!`	allccccccccmmmmmmvvvxxx...xx<CR><LF>
a	Sensor SDI-12 address
ll	SDI-12 version number (indicates compatibility)

cccccccc	8-character vendor identification
mmmmmm	6 characters specifying the sensor model
vvv	3 characters specifying the sensor version (operating system)
xxx...xx	Up to 13 optional characters used for a serial number or other specific sensor information that is not relevant for operation of the data logger
<CR><LF>	Terminates the response
Source: *SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors* (see References).	

B.1.3 Start verification command (aV!)

The response to a Start Verification command can include hardware diagnostics, but like the `aI!` command, the response is not standardized.

Command: `aV!`

Response: *atttn<CR><LF>*

a = sensor address

ttt = time, in seconds, until verification information is available

n = the number of values to be returned when one or more subsequent `D!` commands are issued

B.1.4 Address query command (?!)

Command `?!` requests the address of the connected sensor. The sensor replies to the query with the address, *a*. This command should only be used with one sensor on the SDI-12 bus at a time.

B.1.5 Change address command (aAb!)

Multiple SDI-12 sensors can connect to a single SDI-12 terminal on a data logger. Each device on a single terminal must have a unique address.

A sensor address is changed with command **aAb!**, where *a* is the current address and *b* is the new address. For example, to change an address from *0* to *2*, the command is **0A2!**. The sensor responds with the new address *b*, which in this case is 2.

> **NOTE:**
> Only one sensor should be connected to a particular terminal at a time when changing addresses.

B.1.6 Start measurement commands (aM!)

A measurement is initiated with the **M!** command. The response to each command has the form *atttn<CR><LF>*, where

a = sensor address

ttt = time, in seconds, until measurement data is available. When the data is ready, the sensor notifies the data logger, and the data logger begins issuing **D** commands.

n = the number of values returned when one or more subsequent **D** commands are issued. For the **aM!** command, n is an integer from 0 to 9.

When the **aM!** is issued, the data logger pauses its operation and waits until either it receives the data from the sensor or the time, *ttt*, expires. Depending on the scan interval of the data logger program and the response time of the sensor, this may cause skipped scans to occur. In this case make sure your scan interval is longer than the longest measurement time (*ttt*).

Table B-2: Example aM! sequence	
0M!	The data logger makes a request to sensor 0 to start a measurement.
00352<CR><LF>	Sensor 0 immediately indicates that it will return two values within the next 35 seconds.
0<CR><LF>	Within 35 seconds, sensor 0 indicates that it has completed the measurement by sending a service request to the data logger.
0D0!	The data logger immediately issues the first **D** command to collect data from the sensor.
0+.859+3.54<CR><LF>	The sensor immediately responds with the sensor address and the two values.

B.1.7 Start measurement commands with cyclic redundancy check (aMC! and aCC!)

Error checking is done by using measurement commands with cyclic redundancy checks (**aMC!** or **aCC!**). This is most commonly implemented when long cable lengths or electronic noise may impact measurement transmission to the data logger. When these commands are used, the data returned in response to **D** or **R** commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within 3 characters appended before the <CR><LF>. This code is not returned in the data table but checked by the data logger as it comes. The code returned is based on the SDI-12 protocol. See the SDI-12 communication specification for version 1.4 available at www.sdi-12.org ⬈ to learn more about how the CRC code is developed.

B.1.8 Stopping a measurement command

A measurement command (M!) is stopped if it detects a break signal before the measurement is complete. A break signal is sent by the data logger before most commands.

A concurrent measurement command (C!) is aborted when another valid command is sent to the sensor before the measurement time has elapsed.

B.1.9 Send data command (aD0! ... aD9!)

The Send Data command requests data from the sensor. It is issued automatically with every type of measurement command (aM!, aMC!, aC!, aCC!). When the measurement command is aM! or aMC!, the data logger issues the aD0! command once a service request has been received from the sensor or the reported time has expired. When the data logger is issuing concurrent commands (aC! or aCC!), the Send Data command is issued after the required time has elapsed (no service request will be sent by the sensor). In transparent mode (see SDI-12 transparent mode [p. 38]), the user asserts this command to obtain data.

Depending on the type of data returned and the number of values a sensor returns, the data logger may need to issue aD0! up to aD9! to retrieve all data. A sensor may return up to 35 characters of data in response to a D command that follows an M! or MC! command. A sensor may return up to 75 characters of data in response to a D command that follows a C! or CC! command. Data values are separated by plus or minus signs.

Command: aD0! (aD1! ... aD9!)

Response: *a<values><CR><LF>* or *a<values><CRC><CR><LF>*

where:

a = the sensor address

<values> = values returned with a polarity sign (+ or –)

<CR><LF> = terminates the response

<CRC> = 16-bit CRC code appended if data was requested with aMC! or aCC!.

B.2 SDI-12 transparent mode

System operators can manually interrogate and enter settings in probes using transparent mode. Transparent mode is useful in troubleshooting SDI-12 systems because it allows direct communication with probes. Data logger security may need to be unlocked before activating the transparent mode.

Transparent mode is entered while the computer is communicating with the data logger through a terminal emulator program. It is accessed through Campbell Scientific data logger support

software or other terminal emulator programs. Data logger keyboards and displays cannot be used.

The terminal emulator is accessed by navigating to the **Tools** list in *PC400* or the **Datalogger** list in the **Connect** screen of *LoggerNet*.

Watch videos/sdi12-sensors-transparent-mode ▶ from our website.

Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

The following examples show how to enter transparent mode and change the SDI-12 address of an SDI-12 sensor. The steps shown in Changing an SDI-12 address (p. 39) are used with most Campbell Scientific data loggers.

B.2.1 Changing an SDI-12 address

This example was done with a CR1000X, but the steps are only slightly different for CR6, CR3000, CR800-series, CR300-series, CR1000 data loggers.
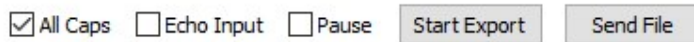
1. Connect an SDI-12 sensor to the CR1000X.

2. Open *Device Configuration* utility.

3. Under **Device Type**, type the data logger model and double-click on the model type. This example uses a CR1000X directly connected to the computer USB port.

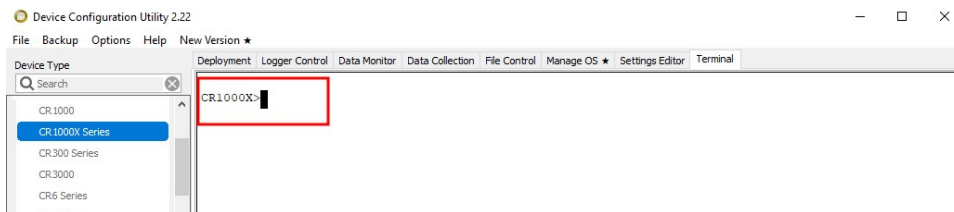4. Select the correct **Communication Port** and click **Connect**.
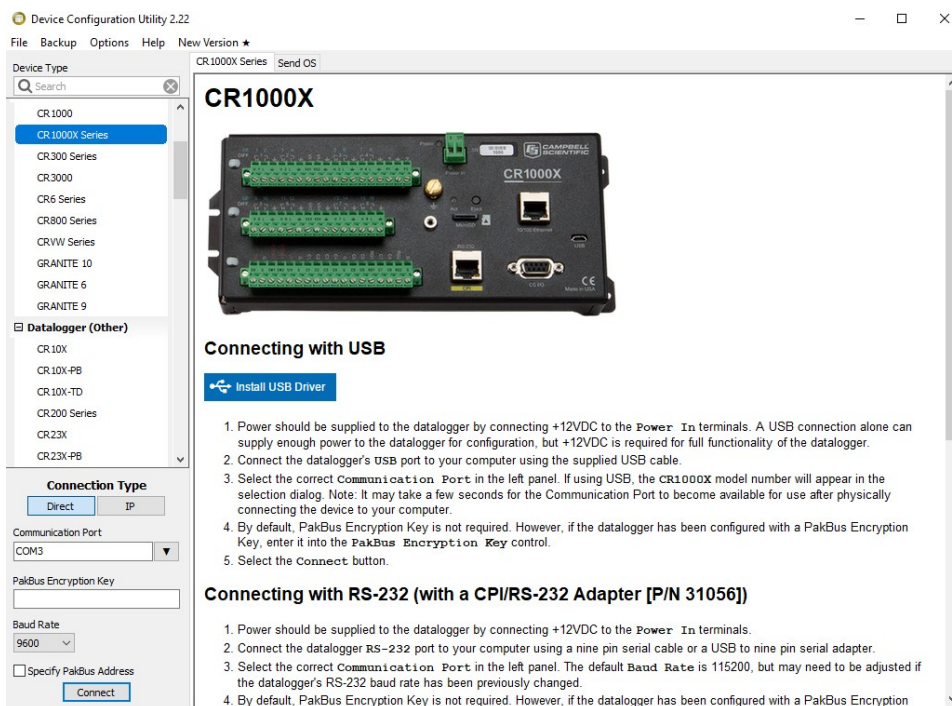
5. Click the **Terminal** tab.
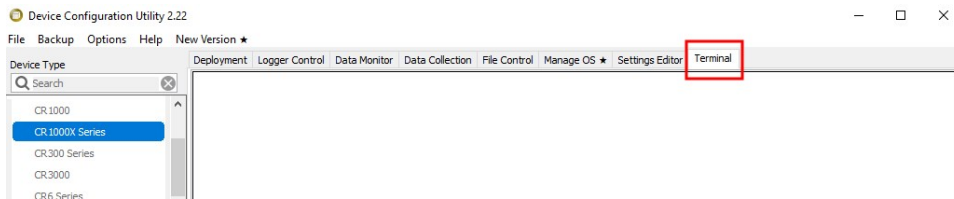
6. Select **All Caps Mode**.

7. Press Enter until the data logger responds with the data logger (**CR1000X>**) prompt.

8. Type **SDI12** and press Enter.

9. At the **Select SDI12 Port** prompt, type the number corresponding to the control port where the sensor is connected and press Enter. In this example the sensor is connected to C3. The response **Entering SDI12 Terminal** indicates that the sensor is ready to accept SDI-12 commands.

```
CR1000X>
CR1000X>SDI12
1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 2
```

10. To query the sensor for its current SDI-12 address, type **?!** and press Enter. The sensor responds with its SDI-12 address. If no characters are typed within 60 seconds, the mode is exited. In that case, simply type **SDI12** again, press Enter, and type the correct control port number when prompted.

```
?!
0
```

11. To change the SDI-12 address, type **aAb!**, where **a** is the current address from the previous step and **b** is the new address. Press **Enter**. The sensor changes its address and responds with the new address. In the following example, the sensor address is changed from 0 to B.

```
SDI12
SDI12>0AB!B
```

12. To exit SDI-12 transparent mode, click **Close Terminal**.

> **NOTE:**
> The transparent mode for the CR6, CR3000, CR800-series, CR300-series, and CR1000 data loggers is similar to that shown for the CR1000X.

B.3 References

SDI-12 Support Group. SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors – Version 1.4. River Heights, UT: SDI-12 Support Group, 2017. https://sdi-12.org/specification ⬀.

Limited warranty

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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.
- 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.

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.

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.

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Website: www.campbellsci.de

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Website: www.campbellsci.in

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Location: Stellenbosch, South Africa
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Email: sales@campbellsci.co.za
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Phone: 44.0.1509.601141
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Website: www.campbellsci.co.uk

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Location: Logan, UT USA
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