

BaroVUE™ 10

Digital Barometer



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1. Introduction

The BaroVUE™10 measures barometric pressure from 500 to 1100 hPa. This range is equivalent to a pressure measurement taken below sea level, such as in a mine, to a pressure measurement taken 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.
- An authorized technician shall verify that the installation and use of this product is in accordance with manufacturer 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. 16) for more information.

WARNING:

Failure to protect the sensor from condensation may result in permanent damage.

- DO NOT blow into the pressure tube/barb. 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.

- The sensor card is not a memory card. Although inserting the sensor 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:






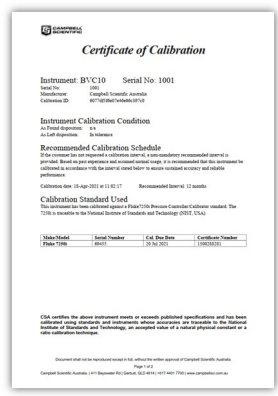
Improper wiring may damage the BaroVUE 10 beyond repair.

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

[Table 3-1](#) (p. 3) shows the components included with all BaroVUE 10 assemblies:

Table 3-1: BaroVUE 10 components

Component	Quantity	Description	Image
BaroVUE 10	1	Reads sensor card data and sends data to the data logger using SDI-12 or RS-232	
BVC10 ¹ sensor card	1	Contains barometric pressure sensors and calibration coefficients	
USB type A—micro B cable	1	Connects BaroVUE 10 to the computer	
BaroVUE10CBL data and power cable	1	Connects BaroVUE 10 to data logger	
#6-32 x .375 pan Phillips screws and grommets for #6 screws	2	Mounts BaroVUE 10 to enclosure backplate	
BV-CAL	1	Factory calibration sheet for BVC10 sensor card (see Note that follows)	

¹ The BCV10 is supplied inside the BaroVUE 10.

NOTE:

The calibration sheet supplied with the BaroVUE 10 applies to the sensor card (BVC10), NOT the serial number of the BaroVUE 10 main board located on the outside of the unit. To confirm you have the correct calibration sheet, you must open the device and check the serial number on the BVC10 sensor card.



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 down time and calibration costs.

The BaroVUE 10 is a fully digital sensor. Electronics within the BaroVUE 10 control measurements made by the sensor element, apply 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 a 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, which result in accurate and stable measurements with a built-in quality metric
- Field-interchangeable sensor card
- Individually calibrated sensor elements that require no further adjustment
- Low power consumption
- Digital SDI-12 or RS-232 output
- Compatible with Campbell Scientific data loggers: Granite-series, CR6, CR1000X, CR800-series, CR300-series

5. QuickStart

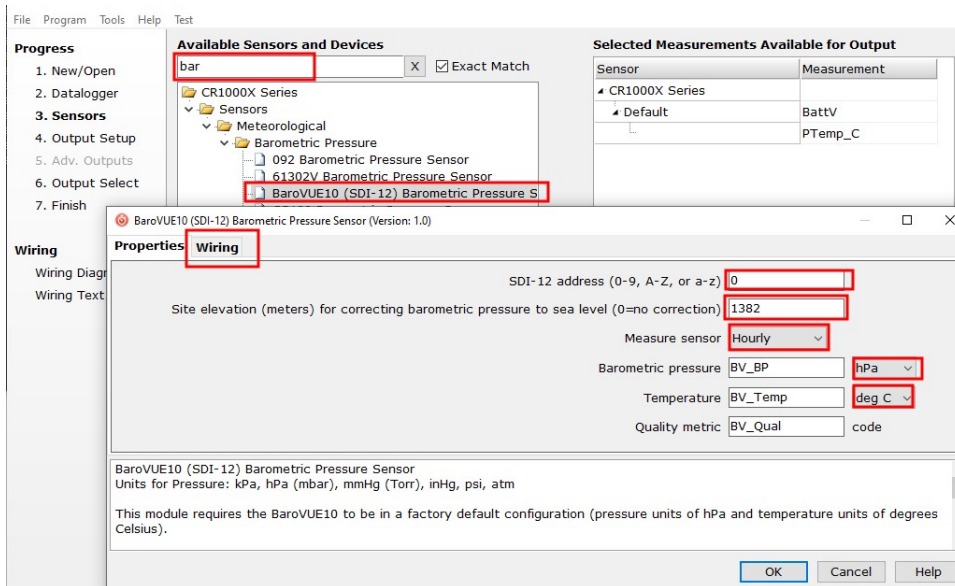
A video that describes data logger programming using *Short Cut* is available at:

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*.

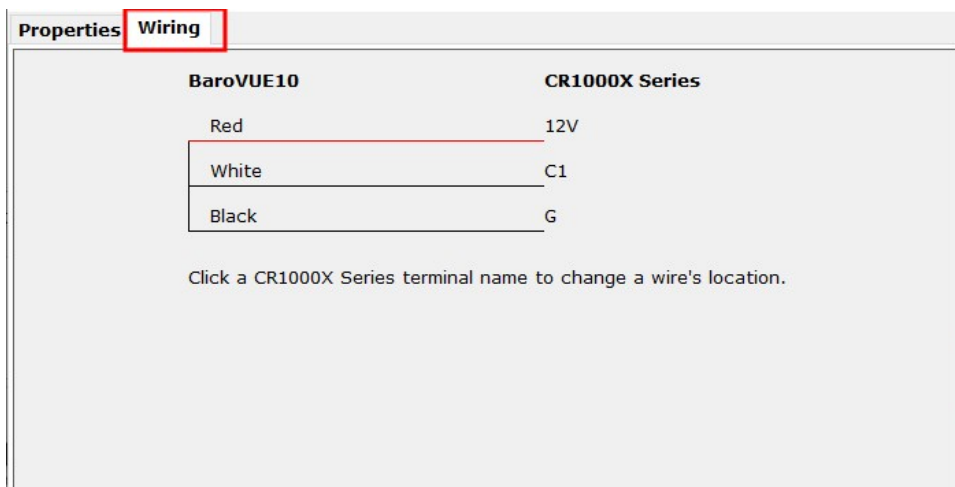
The following procedure also details how to use *Short Cut* to program the BaroVUE 10:

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

- 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.

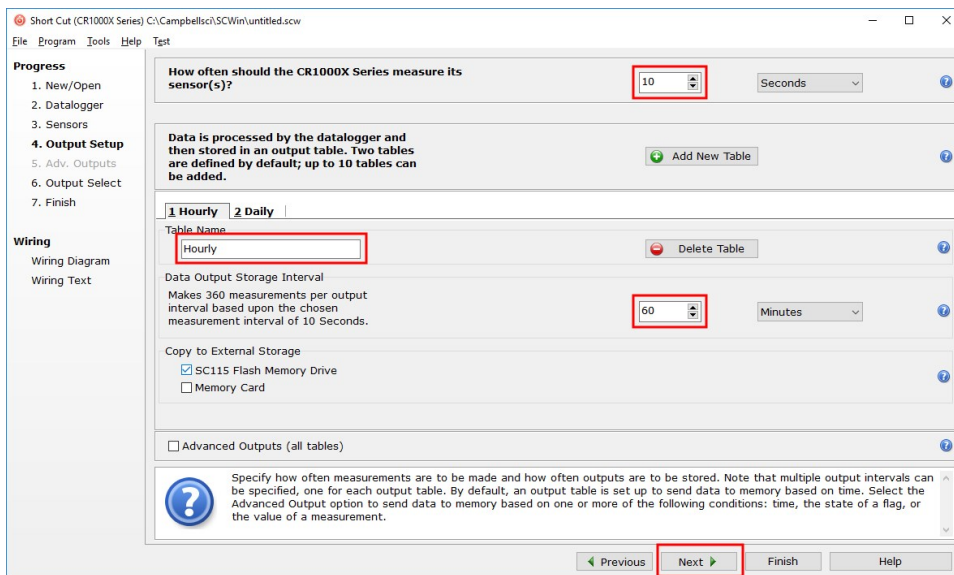


- Click the **Wiring** tab to see how the sensor is to be wired to the data logger. The default control terminal for SDI-12 is **C1**. To change to another terminal, click the terminal name and select another terminal. Click **OK** after wiring the sensor.

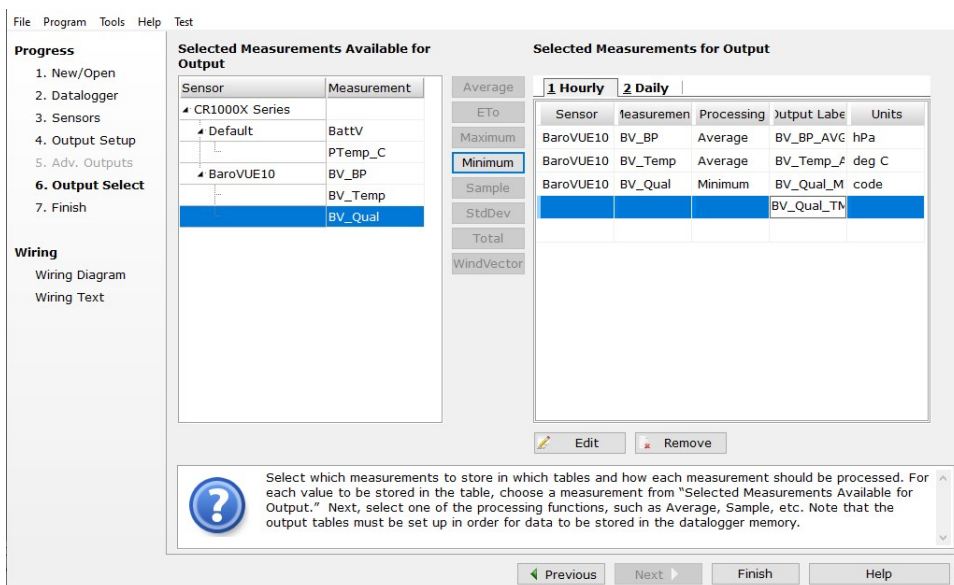


- Repeat steps three and four for other sensors you want to connect. Click **Next**.

- In **Output Setup**, type the scan rate, a **Table Name**, and **Data Output Storage Interval**. Click **Next**.



- Select the output options.




- Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
- 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

CAUTION:

Specifications assume the use of recommended desiccation. See [Venting, condensation, and mounting](#) (p. 13) for more information.

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 \equiv
Current consumption at 12 VDC	
Idle:	200 μ A; 350 μ A (RS-232 enabled)
Active:	<5 mA (sensor is active ~200 ms)
Housing material:	Polybutylene terephthalate (PBT) and polycarbonate (PC)
Internal chamber pressure rating with respect to ambient:	
	\pm 400 hPa
Pressure fitting:	1/8-in 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

¹Defined 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.



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. 31). Programming basics for *CRBasic* data loggers are provided in the following sections.

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. 18) 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 quotation marks (for example, "A"). Also enclose the **SDICommand** in quotation marks 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. 19).

FillNaN and **WaitonTimeout** are optional parameters (refer to *CRBasic Editor* help for more information).

A downloadable program is available at www.campbellsci.com/downloads/barovue10-example-program .

7.2.2 RS-232 programming—Polled Mode

SDI-12 is the default interface for measurement communication. However, the sensor can be configured to support measurement communication over RS-232. The RS-232 mode may be configured using [Device Configuration Utility](#) (p. 21) or the [Terminal menu](#) (p. 26).

When the RS-232 mode is set to **Polled Mode**, the BaroVUE 10 will accept a carriage-return terminated command to initiate and return measurements (see [Table 7-3](#) [p. 12] for the command list). The `SerialOut()` instruction is used to send a measurement request to the sensor. The `SerialIn()` instruction is used to capture the measurement values returned by the sensor. The `SplitStr()` instruction is used to parse the measurement values into an array of floating-point numbers.

The following is an example exchange, where <CR> is a carriage return and <LF> is a line feed. The values returned are separated by the sign of the value (+ or -).

Data logger transmit: `M0<CR>`

Data logger receive: `+123.45+67.8+6<CR><LF>`

CAUTION:

The carriage-return termination command must be issued outside of an active terminal menu session. Issue the command before entering the terminal menu or ensure that you have exited any active terminal menu session.

A downloadable program is available at www.campbellsci.com/downloads/barovue10-example-program.

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

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.

WARNING:

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. 16] 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.

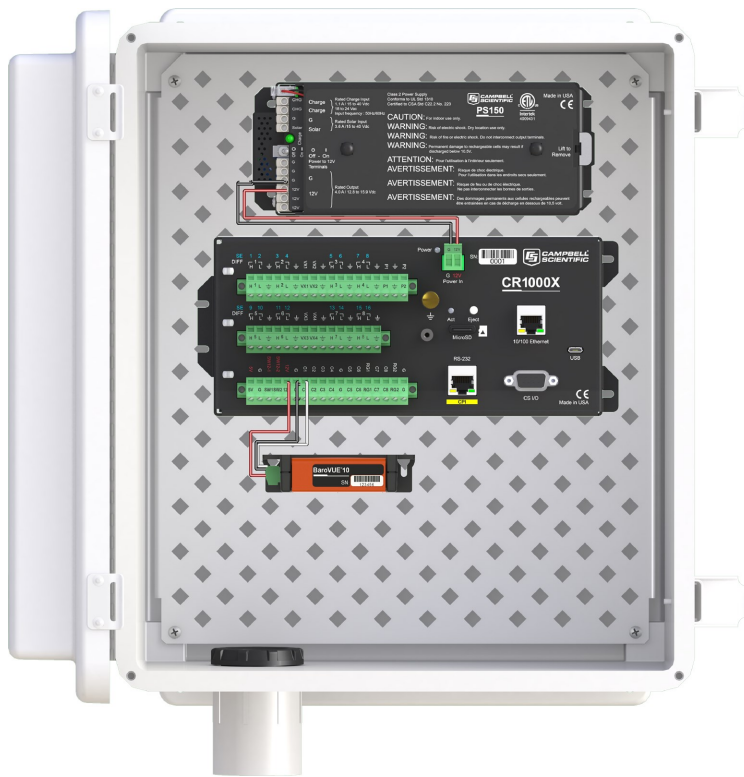


Figure 7-2. BaroVUE 10 mounted in a Campbell Scientific enclosure

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. 15]). 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. A small enclosure (ENC100) 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	
Description	Quantity
BaroVUE 10 DIN rail adapter plate	1
6 mm M3 Pozi-drive screws	2
DIN rail mount	1

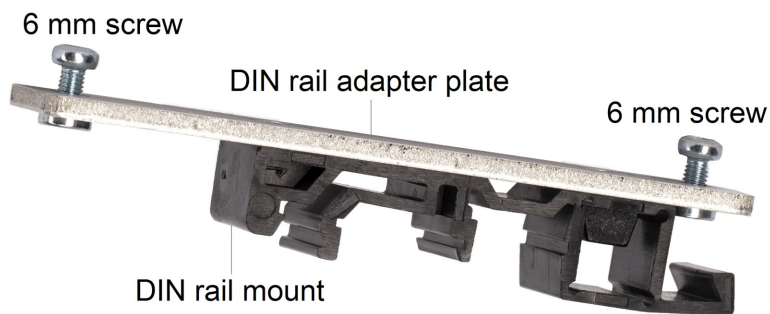


Figure 7-4. Din rail kit



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 the 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 port

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:

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8.5 Device Configuration Utility	21
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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. 19). 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, no offset errors are incurred with increasing cable length as seen with analog sensors. However, an increase in cable length does reach 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 such as **MC!**, which add a cyclic redundancy check [CRC], can significantly improve incorrect data issues.)

Table 8-2: BaroVUE 10 SDI-12 commands

SDI-12 command ¹	Values Returned or Function	Units
<i>aM!</i> , <i>aC!</i> , <i>aMC!</i> , or <i>aCC!</i>	<ol style="list-style-type: none"> 1. Pressure 2. Temperature 3. Quality metric 	<ol style="list-style-type: none"> 1. hPa (millibar) 2. °C 3. N/A
<i>aM1!</i> , <i>aC1!</i> , <i>aMC1!</i> , or <i>aCC1!</i>	<ol style="list-style-type: none"> 1. Pressure 2. Temperature 3. Quality metric 	<ol style="list-style-type: none"> 1. kPa 2. °C 3. N/A
<i>aM2!</i> , <i>aC2!</i> , <i>aMC2!</i> , or <i>aCC2!</i>	<ol style="list-style-type: none"> 1. Pressure 2. Temperature 3. Quality metric 	<ol style="list-style-type: none"> 1. in Hg 2. °F 3. N/A
<i>aM3!</i> , <i>aC3!</i> , <i>aMC3!</i> , or <i>aCC3!</i>	<ol style="list-style-type: none"> 1. Pressure 2. Temperature 3. Quality metric 	<ol style="list-style-type: none"> 1. mm Hg 2. °C 3. N/A
<i>aM4!</i> , <i>aC4!</i> , <i>aMC4!</i> , or <i>aCC4!</i>	<ol style="list-style-type: none"> 1. Pressure 2. Temperature 3. Quality metric 	<ol style="list-style-type: none"> 1. psia 2. °F 3. N/A
?!	Returns the SDI-12 address	

¹*a* is the SDI-12 address. In the [SDI12Recorder\(\)](#) CRBasic instruction, the command parameter does not include the SDI-12 address because the address is a separate parameter.

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:

QM range	Description	Comments
> 6	Sensor freshly calibrated	The sensor card was recently 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, sensor will need recalibration	The sensor card will soon need recalibration. Contact your local Campbell Scientific office for a replacement card.
0 to 3.99	Recalibrate sensor now	The sensor 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 and Hobbes 1977, 59-61¹).

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

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

Use the following equation to convert feet to meters:

$$E(m) = \frac{E(ft)}{3.281ft/m} \quad \text{Eq. 2}$$

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.

¹Wallace, J.M. and P.V. Hobbes. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press.

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.

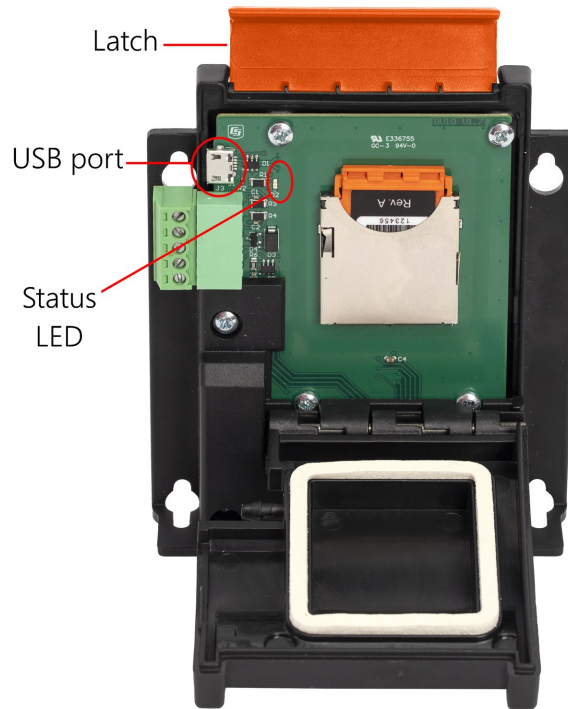
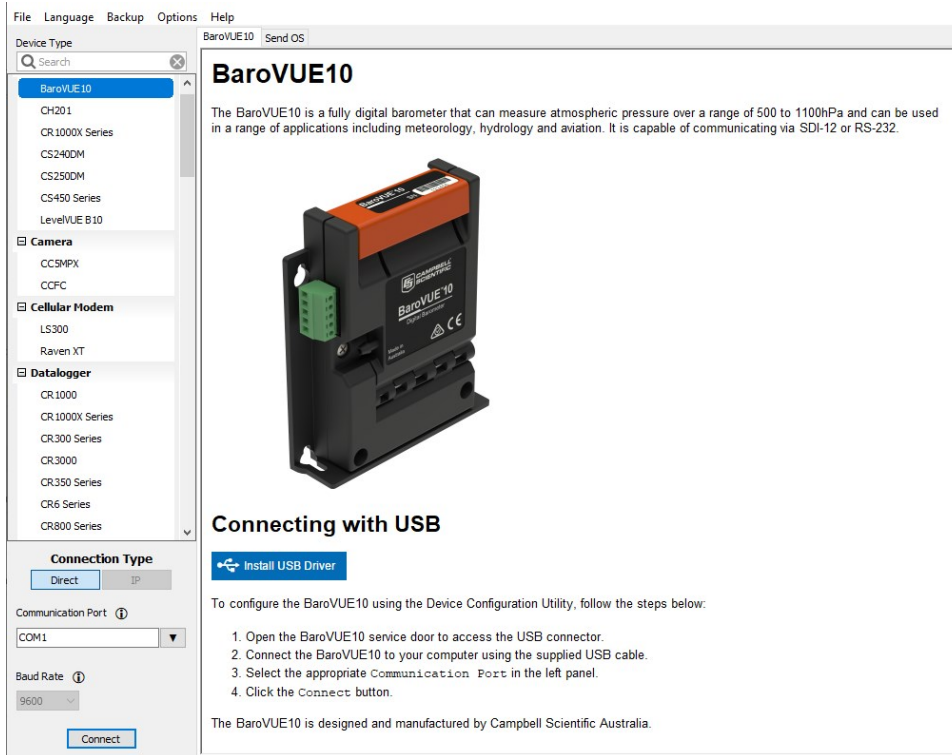


Figure 8-1. BaroVUE 10 with main door open

2. Open *Device Configuration Utility*.

3. Type BaroVUE10 in the **Device Type** box and click **BaroVUE10**.

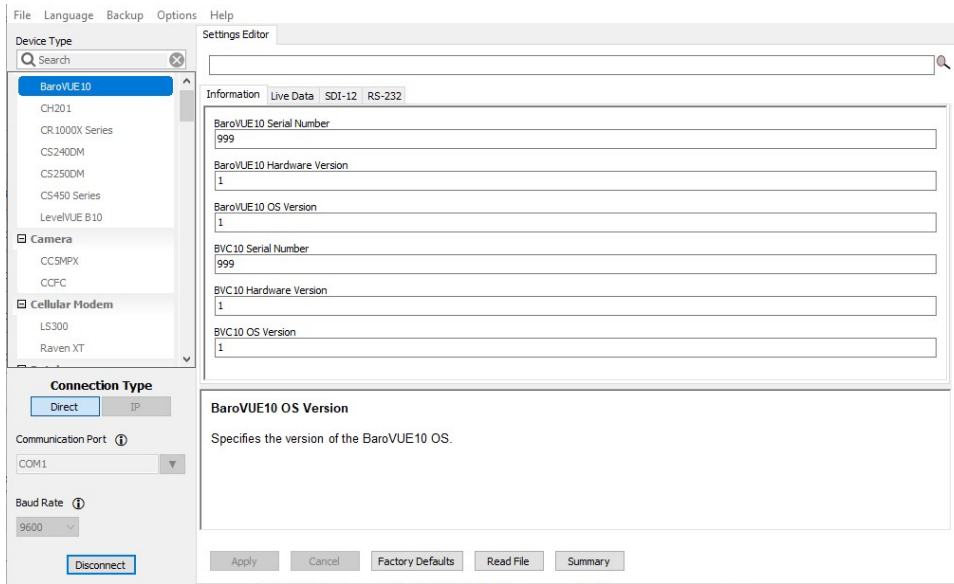


4. If this is the first time connecting the BaroVUE 10 to the computer, click **Install USB Driver** before connecting the cable to the computer.
5. Use the USB cable to connect the BaroVUE 10 USB port to a computer USB port. See [Figure 8-1](#) (p. 21).
6. Select the **Communication Port** in the left panel. **BaroVUE10** will appear in the selection dialog.

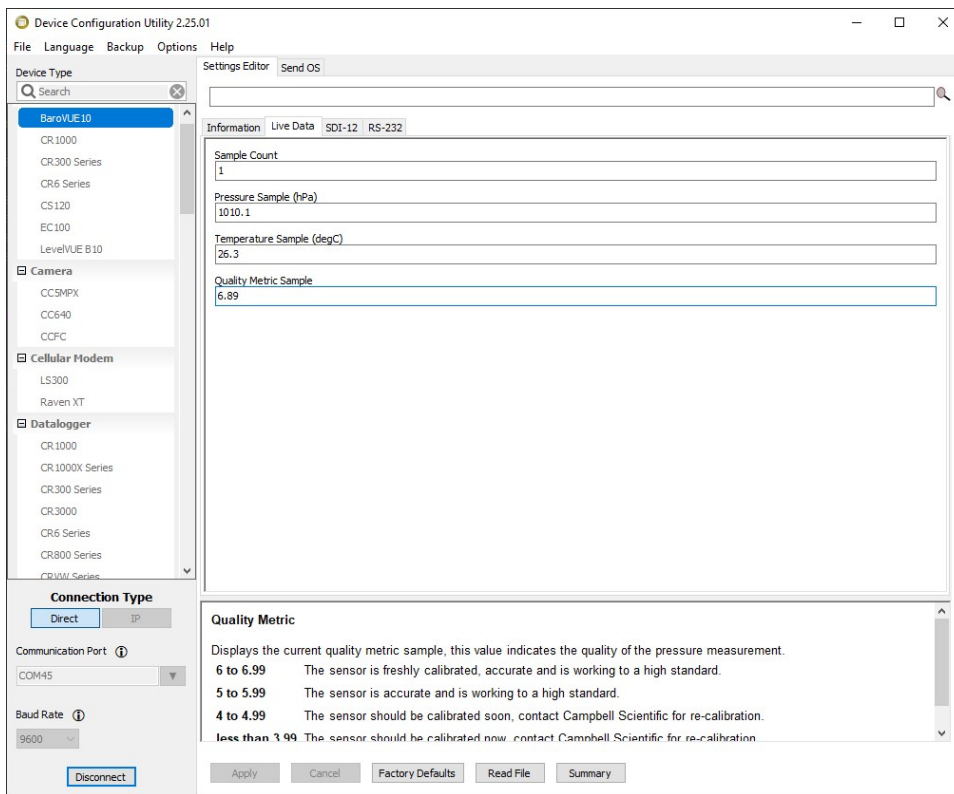
NOTE:

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 correctly installed as per Step 4.

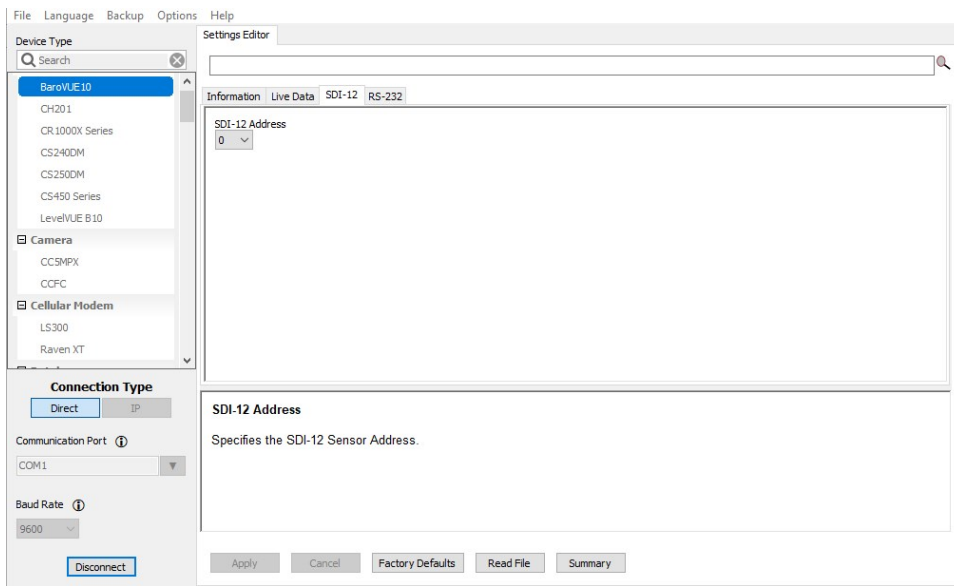
7. Click **Connect** to access the **Settings Editor**.



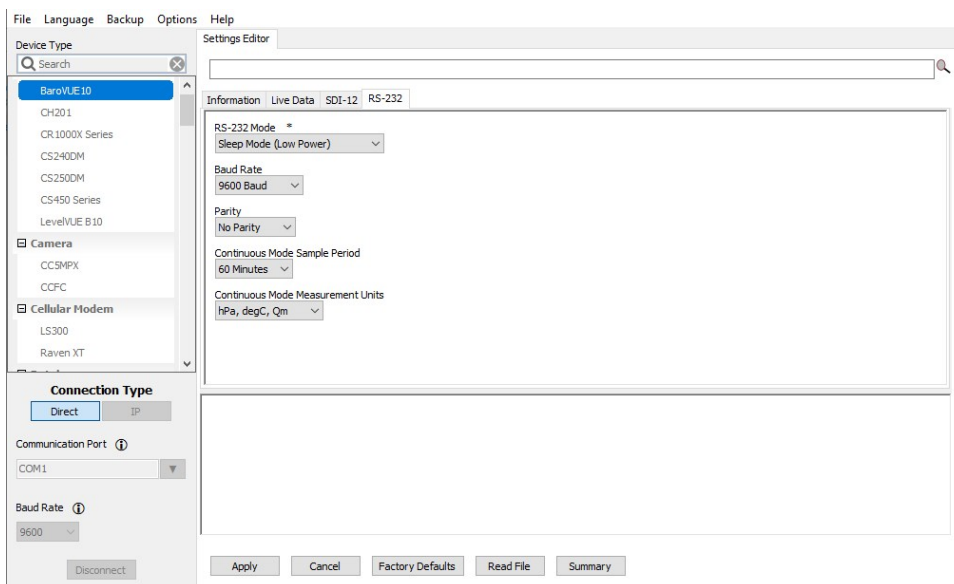
8. Click the **Live Data** tab to view real-time measurements.



9. To change the SDI-12 address, click the **SDI-12** tab, click the **SDI-12 Address** box, select a different value, then click **Apply**.



10. To change the RS-232 settings, click the **RS-232** tab. RS-232 settings that can be changed include the **RS-232 Mode**, **Baud Rate**, **Parity**, **Continuous Mode Sample Period**, and **Continuous Mode Measurement Units**. After changing settings, click **Apply**.

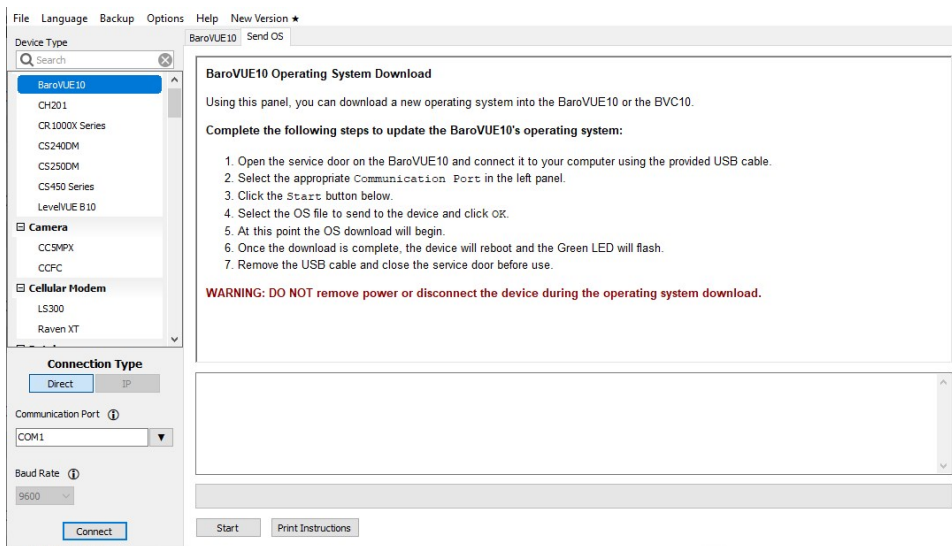


WARNING:

Remove the USB cable before closing the door.

8.5.1 Updating the 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. Use the USB cable to connect the BaroVUE 10 USB port to a computer USB port.
4. Access *Device Configuration Utility* (see [Device Configuration Utility](#) [p. 21]).
5. Click the **Send OS** tab.



6. Click **Start**.
7. Select the file. It will have an .srec extension.
8. 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.

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

8.6 Terminal menu

To access the main menu, do the following:

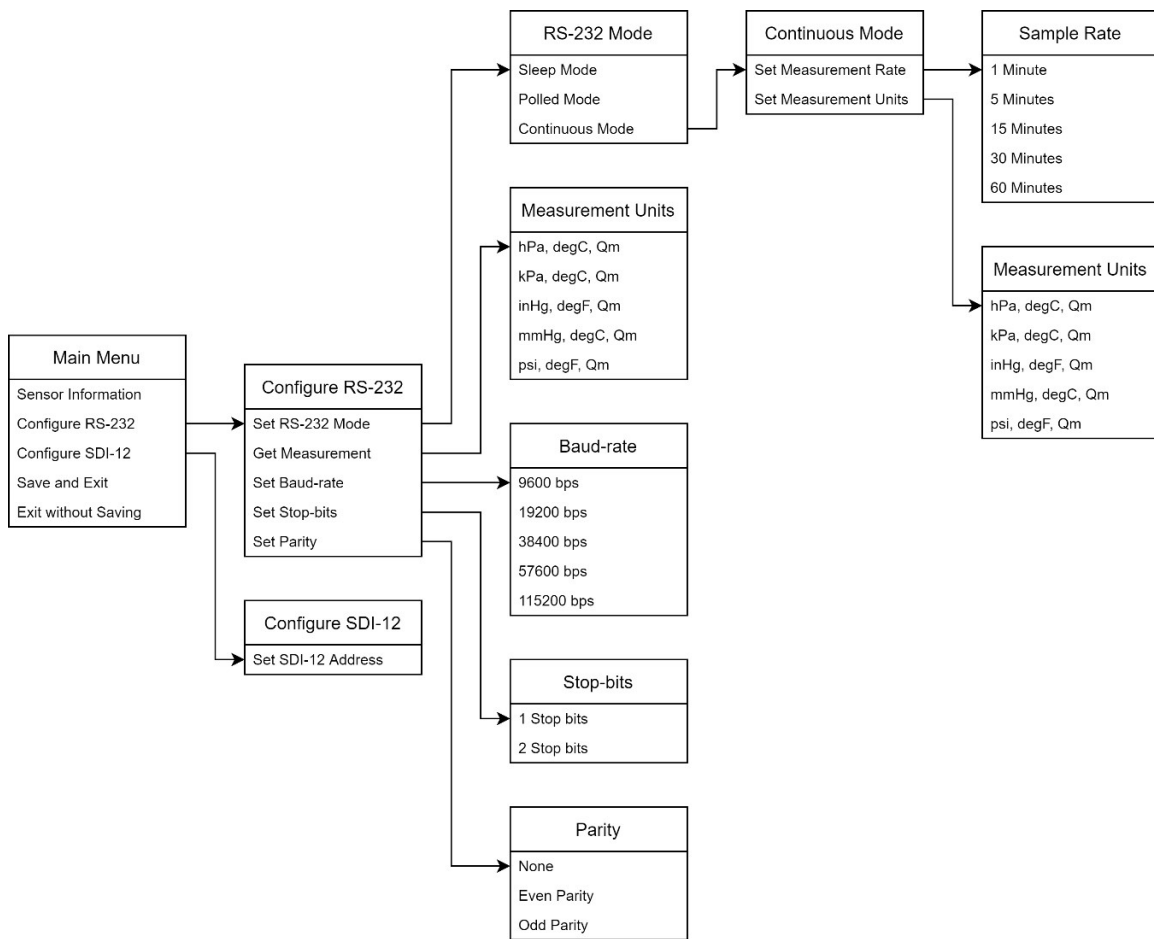
1. Connect your computer to the RS-232 interface, such as the A200 interface. One end of the A200 has a terminal block while the other end has a type B female USB port. The terminal block provides **12V**, **G**, **Tx**, and **Rx** terminals for connecting the sensor (see [Figure 8-2](#) [p. 26] and [Table 8-4](#) [p. 26]). The data cable shipped with the A200 has a USB type-A male connector that attaches to a computer USB port, and a type B male connector that attaches to the A200 USB port.



Figure 8-2. A200 Sensor-to-Computer Interface

Wire color	Wire function	A200 terminal
Red	Power	+12V
Black	Power ground	G
Blue	RS-232 TX	Tx
Yellow	RS-232 RX	Rx
White	SDI-12 signal	not connected

2. Connect the BaroVUE 10 to power.
3. Open a terminal program and set the communication settings to match the device. See [Table 8-1](#) (p. 18) for default settings.
4. Press **Enter** several times until **BaroVUE10>** appears (may take up to 10 presses).
5. Type **?** and press **Enter** to view the **Main Menu**.
6. 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:



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.

Recovery Mode:

If the RS-232 settings are unknown, the RS-232 menu can be accessed by setting your serial port to 9600 baud, 8 data bits, 1 stop bit, no parity, and pressing enter multiple times until the prompt is displayed. From here, the settings can be edited and saved as needed.

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 sensor card is inserted fully in its socket and in the correct orientation (see [Figure 9-1](#) [p. 29]).
- Verify that the white wire is connected to the terminal specified by the [SDI12Recorder\(\)](#) instruction.
- Verify that the red wire is connected to a **12V** terminal and that 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 non-switched **12V** terminal for test purposes.
- Verify that 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. 32) or by using the [Device Configuration Utility](#) (p. 21).

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. 19]). 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 be 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. When received, take this newly calibrated card with you to the site of the BaroVUE 10 installation.
2. Open the main case by unclipping the latch and opening the main door. See [Figure 8-1](#) (p. 21).
 - Sensor card plugs into the silver card socket mounted on the motherboard (see [Figure 9-1](#) [p. 29]).
 - Correct sensor-card orientation is with card notch facing down (towards the motherboard). The card revision number should be visible.

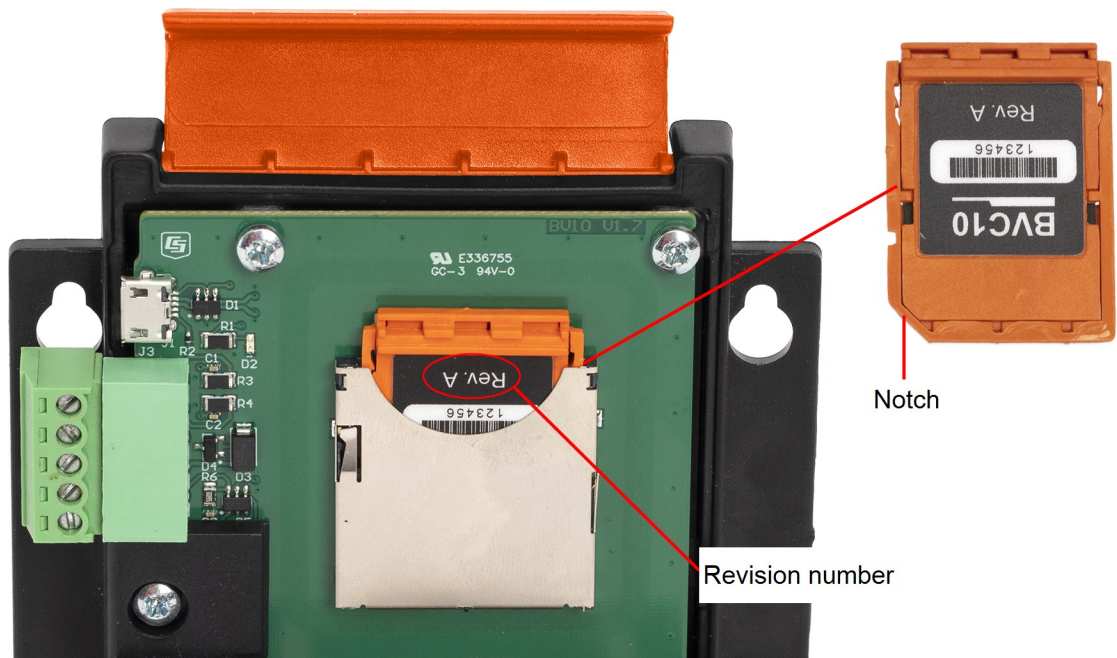


Figure 9-1. Card notch and correct orientation of the card.

CAUTION:

If the sensor card is oriented incorrectly, it will not insert fully. Do not force the card into the slot.

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

NOTE:

The sensor card can be safely removed while the BaroVUE 10 is connected to power.

4. Store the old sensor card in an electrostatic protective package and return it to Campbell Scientific for recalibration or general servicing.
5. Unpack the replacement sensor card, avoiding static discharges to the element by touching the package before touching the element.
6. Carefully align and insert the sensor card in the card socket on the motherboard.
7. Confirm the correct orientation and gently push the sensor card into the socket until it clicks into place.
8. Before closing the main case, double-check that the card is inserted in the correct orientation. Refer to [Figure 8-1](#) (p. 21).
9. 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. Failure to do this can damage the case, cables, and pressure tubes.

CAUTION:

Do not apply excessive 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 *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, then save it. Click the **Advanced** tab then the **CRBasic Editor** button. Your program file will open in CRBasic with a generic name. 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.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder. Copy the wiring information found at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information at the beginning of the program.
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

Serial Data Interface at 1200 baud (SDI-12) 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 (January 2019) 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. 32).

Name ¹	Command	Response
Acknowledge active	a!	a<CR><LF>
Send identification	aI!	allccccccmmmmmmvvvxxx...xx <CR><LF>
Start verification	aV!	atttn <CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response sets

Name ¹	Command	Response
Address query	?!	a<CR><LF>
Change address	aAb!	b<CR><LF>
Start measurement	aM! aM1! . . . aM9!	attn<CR> <LF>
Start measurement and request CRC	aMC! aMC1! . . . aMC9!	attn <CR> <LF>
Start concurrent measurement	aC! aC1! . . . aC9!	attnn<CR><LF>
Start concurrent measurement and request CRC	aCC! aCC1! . . . aCC9!	attnn<CR> <LF>
Send data	aD0! . . . aD9!	a<values><CR><LF> or a<values><CRC><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. Source: *SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors* (see [References](#) [p. 41]).

Command: aI!

Response: *llccccccmmmmmmvvvxxx...xx<CR><LF>*

Where

a = sensor address

ll = SDI-12 version number (indicates compatibility)

ccccccc = 8-character vendor identification

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

B.1.3 Start verification command (aV!)

The response to start verification (**aV!**) can include hardware diagnostics, but like the **aI!** command, the response is not standardized.

Command: **aV!**

Response: *atttn<CR><LF>*

Where

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

<CR><LF> = terminates the response

B.1.4 Address query command (?!)

Command **?!** requests an address of the connected sensor. The sensor responds 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 *attn*<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!** command is issued, the data logger pauses its operation and waits until either it receives 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. To avoid this, ensure that the scan interval is greater 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 concurrent measurement commands (aC!)

A concurrent measurement (**aC!**) command follows the same pattern as the **aM!** command with the exception that it does not require the data logger to pause its operation, and other SDI-12 sensors may take measurements at the same time. The sensor will not issue a service request to notify the data logger that the measurement is complete. The data logger will issue the **aD0!** command during the next scan after the measurement time reported by the sensor has expired. To use this command, the scan interval should be 10 seconds or less. The response to each command has the form *attn*<CR><LF>, where

a = the sensor address

ttt = time, in seconds, until the measurement data is available


nn = the number of values to be returned when one or more subsequent **D!** commands are issued.

See the following example. A data logger has three sensors wired into terminal **C1**. The sensors are addresses **X**, **Y**, and **Z**. The data logger will issue the following commands and receive the following responses:

Table B-3: Example aC! sequence	
XC!	The data logger makes a request to sensor X to start a concurrent measurement.
X03005<CR><LF>	Sensor X immediately indicates that it will have 5 (05) values ready for collection within the next 30 (030) seconds.
YC!	The data logger makes a request to sensor Y to start a concurrent measurement.
Y04006<CR><LF>	Sensor Y immediately indicates that it will have 6 (06) values ready for collection within the next 40 (040) seconds.
ZC!	The data logger makes a request to sensor Z to start a concurrent measurement.
Z02010<CR><LF>	Sensor Z immediately indicates that it will have 10 values ready for collection within the next 20 (020) seconds.
ZD0!	After 20 seconds have passed, the data logger starts the process of collecting the data by issuing the first D command to sensor Z.
Z+1+2+3+4+5+6+7+8+9+10<CR><LF>	Sensor Z immediately responds with the sensor address and the 10 values.
XD0!	10 seconds later, after a total of 30 seconds have passed, the data logger starts the process of collecting data from sensor X by issuing the first D command.
X+1+2+3+4+5<CR><LF>	The sensor immediately responds with the sensor address and the 5 values.

Table B-3: Example aC! sequence	
YD0!	Ten seconds later, after a total of 40 seconds have passed, the data logger starts the process of collecting data from sensor Y by issuing the first D command.
Y+1+2+3+4+5+6<CR><LF>	The sensor immediately responds with the sensor address and the 6 values.

B.1.8 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!** commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within three characters appended before the <CR><LF>. This code is not returned in the data table but is instead 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 version 1.4 (January 2019) available at www.sdi-12.org  to learn more about how the CRC code is developed.

B.1.9 Stopping a measurement command

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

B.1.10 Send data command (aD0! ... aD9!)

The send data command (**aD!**) 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 an **aD!** command that follows an **aM!** or **aMC!** command. A sensor may return up to 75 characters of data in response to a **aD!** command that follows an **aC!** or **aCC!** 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 through Campbell Scientific *Device Configuration Utility* software.

Watch [videos/sdi12-sensors-transparent-mode](#)  from our website.

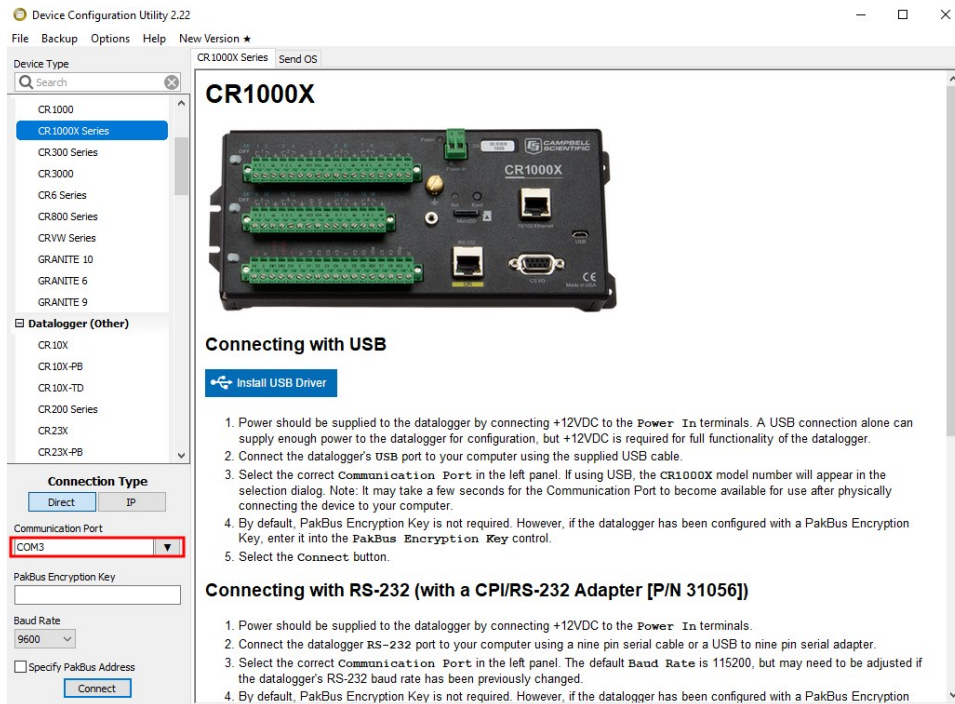
Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

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. 38) are used with most Campbell Scientific data loggers.

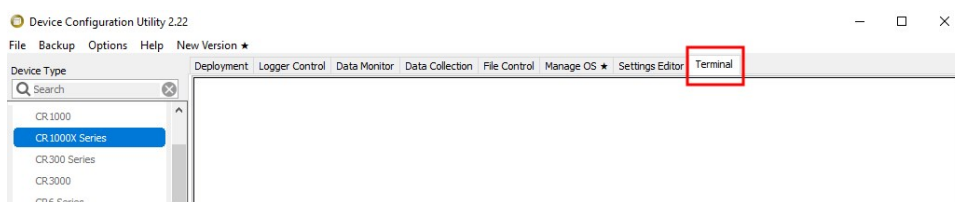
B.2.1 Changing an SDI-12 address

This example was done with a CR1000X, but the steps are only slightly different for Granite-series, CR6, CR800-series, CR300-series data loggers.

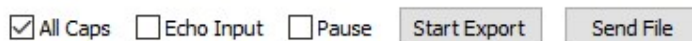
1. Connect an SDI-12 sensor to the CR1000X.
2. Open *Device Configuration Utility*.
3. Under **Device Type**, type the data logger model and double-click on the model type. This example uses a CR1000X directly connected to the computer USB port.
4. Select the correct **Communication Port** and click **Connect**.



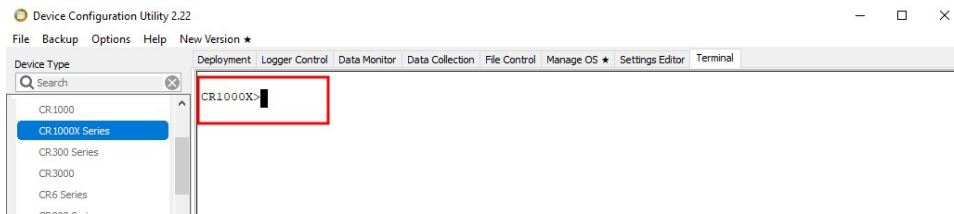
5. Click the **Terminal** tab.



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 Granite-series, CR6, CR3000, CR800-series, CR300-series data loggers is similar to that shown for the CR1000X.

B.3 References

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

Limited warranty

Products manufactured by Campbell Scientific are warranted by Campbell Scientific to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified on the corresponding product webpage. See Product Details on the Ordering Information pages at www.campbellsci.com[↗]. Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.


Refer to www.campbellsci.com/terms#warranty[↗] for more information.

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Assistance

Products may not be returned without prior authorization.

Products shipped to Campbell Scientific require a Returned Materials Authorization (RMA) or Repair Reference number and must be clean and uncontaminated by harmful substances, such as hazardous materials, chemicals, insects, and pests. Please complete the required forms prior to shipping equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page for the Global Sales and Support Network or visit www.campbellsci.com/contact  to determine which Campbell Scientific office serves your country.

To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

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.
- 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.

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.



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