



TempVue™ 20 SDI-12

PT-100 RTD Class A Precision,
Digital Air Temperature Sensor



Please read first

About this manual

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

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

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



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

Table of contents

1. Introduction	1
2. Precautions	1
3. Initial inspection	2
4. QuickStart	3
5. Overview	6
6. Specifications	7
7. Installation	8
7.1 Wiring	8
7.2 Programming	9
7.2.1 CRBasic programming	9
7.3 Siting	10
7.4 Installation in a radiation shield	11
7.5 Mount the shield	12
8. Operations	14
8.1 SDI-12 sensor measurements	14
8.2 Updating the operation system (OS) using XLOADOS SDI-12 command	16
9. Maintenance and troubleshooting	18
9.1 Maintenance	18
9.2 Troubleshooting	19
10. References	19
Appendix A. Importing Short Cut code into CRBasic Editor	20
Appendix B. SDI-12 sensor support	21
B.1 SDI-12 command basics	21
B.1.1 Acknowledge active command (a!)	22
B.1.2 Send identification command (al!)	22
B.1.3 Start verification command (aV!)	23
B.1.4 Address query command (?!)	23



B.1.5 Change address command (aAb!)	23
B.1.6 Start measurement commands (aM!)	24
B.1.7 Start concurrent measurement commands (aC!)	24
B.1.8 Start measurement commands with cyclic redundancy check (aMC! and aCC!)	26
B.1.9 Stopping a measurement command	26
B.1.10 Send data command (aD0! ... aD9!)	26
B.2 SDI-12 transparent mode	27
B.2.1 Changing an SDI-12 address	28
B.3 References	30

1. Introduction

The TempVue™20 represents the next generation of air-temperature measurement sensors, meeting all relevant World Meteorological Organization (WMO¹) temperature recommendations.

Designed with the customer in mind, the TempVue 20 SDI-12 easily interfaces with Campbell Scientific or third-party data loggers and fits a wide range of active and passive solar radiation shields. The sensor comes with a short, attached cable and terminates with an M12 connector, which provides exceptional convenience, environmental protection, and data integrity for use in a variety of applications. The TempVue 20 SDI-12 communicates with a data logger or RTU using the SDI-12 protocol.





2. Precautions

- READ AND UNDERSTAND the [Safety](#) section at the back of this manual.
- When opening the shipping package, do not damage or cut the cable jacket. If damage to the cable is suspected, consult with a Campbell Scientific support engineer.
- Although rugged, the TempVue 20 SDI-12 should be handled as a precision scientific instrument.
- Do not bend or damage the measurement tip of the TempVue 20 SDI-12 because this can affect the measurement quality and potentially damage the sensor.
- Do not modify or attempt to repair the TempVue 20 SDI-12 unit without consulting Campbell Scientific.
- This temperature probe meets UKCA and EU declarations of conformity, citing international standards applicable to the product.
- The TempVue 20 SDI-12 should not be buried in soil or submerged in water. Refer to www.campbellsci.com/soil-temperature  or www.campbellsci.com/water-temperature  for a list of sensors that are appropriate for soil, road surface, or water temperature applications.

¹WMO, 2008. See [References](#) (p. 19).

3. Initial inspection

- Upon receipt of the TempVue 20 SDI-12, inspect the packaging and contents for damage. 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. 2) shows the components typically shipped with the TempVue 20 SDI-12.

Component	Quantity	Description	Image
TempVue 20 SDI-12	1	Measures air temperature	
Extension cable (ordered as an option)	1	Connects the sensor to a data logger. Not required when using an Aspen 10 Edge Device.	
Quick deploy guide	1	Provides siting, mounting, and wiring information	
Shield extender	1	Allows sensor to be housed in a 10-plate or 14-plate radiation shield.	

- [Figure 3-1](#) (p. 3) shows the TempVue 20 SDI-12 and shield extender.





Figure 3-1. TempVue 20 SDI-12 and shield extender.

- Refer to [Installation in a radiation shield](#) (p. 11) for instructions about attaching the extender tube to the TempVue 20 SDI-12 for use in longer radiation shields.
- Accessories and replacement parts are listed on the web site product page (see www.campbellsci.com/tempvue20).

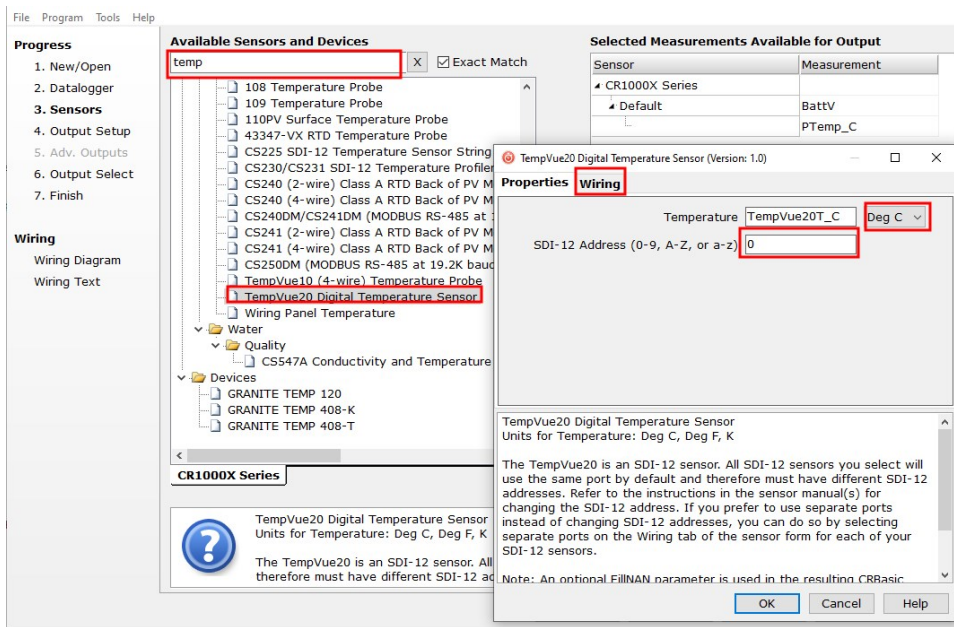
4. QuickStart

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

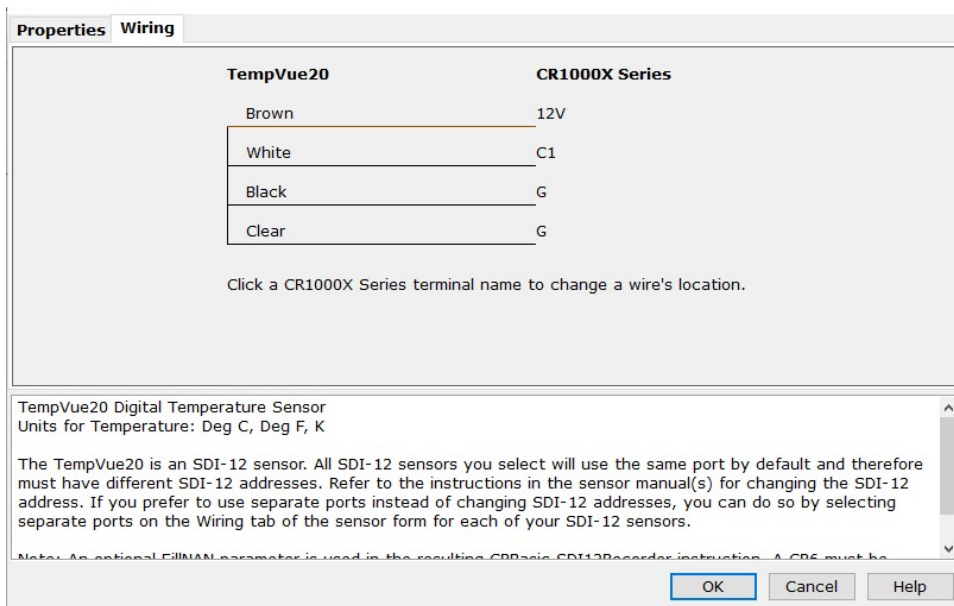
www.campbellsci.com/videos/cr1000x-data-logger-getting-started-program-part-3 . *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com . It is included in installations of *LoggerNet*,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

The following procedure shows using *Short Cut* to program the TempVue 20 SDI-12.

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 TempVue 20 SDI-12. You can also locate the sensor in the **Sensors > Temperature** folder. Double click the sensor model. **SDI-12 Address** defaults to 0. Enter the correct **SDI-12 Address** for the TempVue 20 SDI-12 if it has been changed from the factory-set default value. The temperature defaults to degree C. This can be changed by clicking the **Temperature** box and selecting one of the other options.

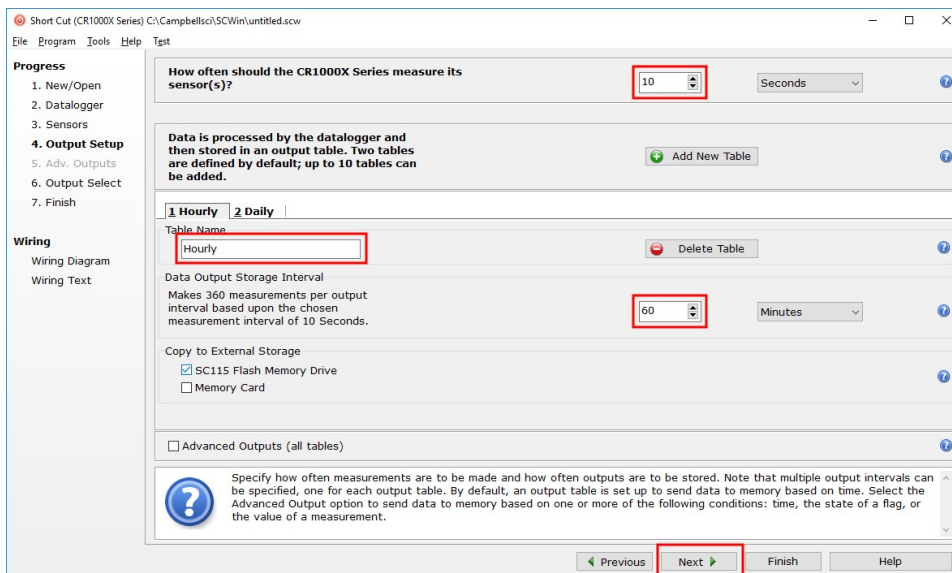


4. Click on the **Wiring** tab. The default control terminal for SDI-12 is **C1**. To change to another terminal, click the terminal name and select another terminal. Click **OK** after wiring the sensor.

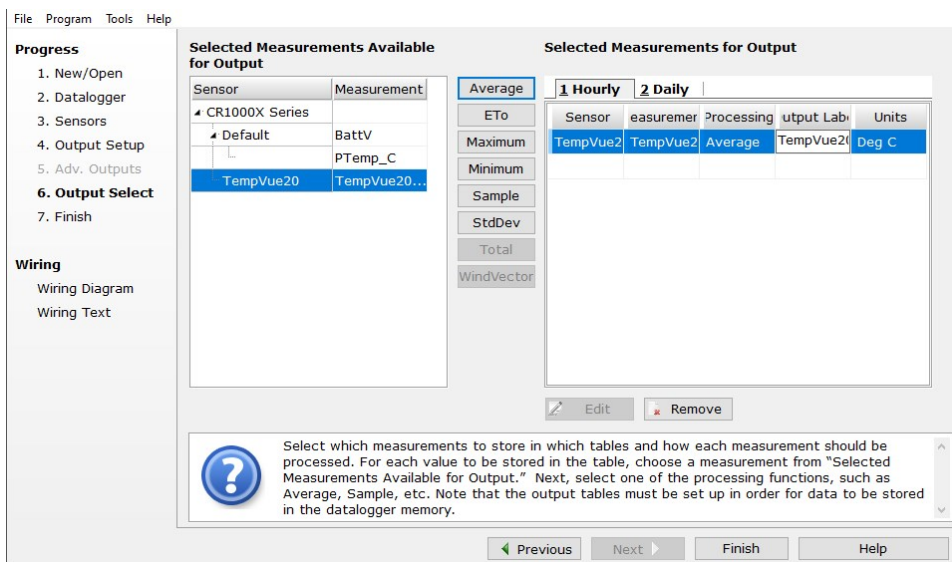


5. Repeat steps three and four for other sensors you want to measure. Click **Next**.

- In **Output Setup**, type the scan rate, a meaningful table name, and the **Data Output Storage Interval**.



- Select the measurement and its associated output option.



- Click **Finish** and save the program. If the data logger is connected to the computer, send the program just created to the data logger.
- 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.

5. Overview

The sensor consists of a wire-wrapped, four-wire Pt100 Resistance Temperature Detector (RTD) element encapsulated in an epoxy-filled, stainless-steel housing. The thin yet robust housing, combined with the Pt100 sensing element, provide the first true WMO-compliant sensor to meet the 20-second step response time with an ambient wind speed of only 1 m/s (3.3 ft/s).

The TempVue 20 SDI-12 has a maximum measurement uncertainty of only 0.3 K over the entire measurement range of -60 to $+60$ °C, with only 0.1 Kelvin (K) over the most common temperature range of -40 to $+40$ °C.

When exposed to environments with high wind, sun, or precipitation levels, the TempVue 20 SDI-12 must be housed in a radiation shield, such as the RAD06 6-plate shield.

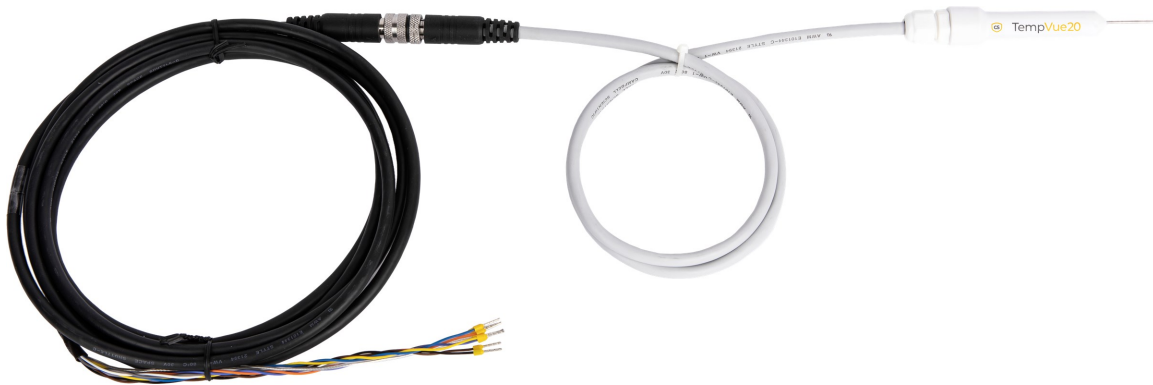



Figure 5-1. TempVue 20 SDI-12 with the extension cable attached

Features:

- Meets WMO step change response time at 1 m/s (3.28 ft/s)
- Maintains high measurement stability over both time and temperature
- Incredibly easy to install or remove for calibration checks
- Highly durable, providing sensor element protection in even the harshest environmental conditions
- Connects directly to a Campbell Scientific Aspen 10 Edge Device.
- Compatible with any SDI-12 data logger/controller including Campbell Scientific GRANITE-series, CR6, CR3000, CR1000X, CR800-series, CR300-series, and CR1000
- Allows for cable length adjustments without the need for calibration changes

6. Specifications

Sensor description:	100 ohm Class A platinum (PT100) ¹
Measurement uncertainty²:	±0.1 K over –40 to +40 °C (–40 to +104 °F) range ±0.3 K over –60 to 60 °C (–76 ° to +140 °F) range
Temperature measurement range:	–60 to 60 °C (–76 ° to +140 °F)
Time constant in air:	20 seconds to 63% of step change in 1 m/s wind
Resolution:	Two decimal places (0.01 °C)
Voltage range:	6 to 16 VDC
Average current:	150 µA
Connector type:	M12 (to extend beyond 1 m [3 ft] standard cable length)
Signal type/output:	Digital output SDI-12 version 1.4
SDI-12 version:	1.4
Default SDI-12 address:	0
Probe diameter:	1.9 cm (0.75 in) maximum
Probe length:	12.1 cm (4.75 in) tip to end of cable gland
Extended probe length:	18.1 cm (7.125 in) tip to end of shield extender
Weight:	70 g (0.15 lb) for probe with shield extender, including standard 1 m (3 ft) cable with M12 connector
Compliance:	View documents at: www.campbellsci.com/tempvue20 

¹Class A refers to ISO 60751:2008 class A standards and the corresponding ASTM E1137 Class A standards.

²Kelvin is the SI unit (International System of Units) for temperature, and used for uncertainty measurements, whereas the range of the product is in Celsius and therefore both are used in these specifications. The WMO guide to Instruments and Observations, Guide no. 8, also uses both Kelvin and Celsius in their recommendation. Regarding resolution of the unit, 1 Kelvin = 1 °Celsius.

7. Installation

If you are programming your data logger with *Short Cut* or are using the Aspen 10 Edge Device, skip [Wiring](#) (p. 8) and [Programming](#) (p. 9). See [QuickStart](#) (p. 3) for a *Short Cut* tutorial. Refer to the Aspen 10 manual, available at www.campbellsci.com/aspen10, for information about using the Aspen 10 with the TempVue 20.

7.1 Wiring

Campbell Scientific offers extension cables in lengths up to 10 m, which connect to the TempVue 20 M12 connector. Contact Campbell Scientific if a longer cable is required.

[Table 7-1](#) (p. 8) provides connections to Campbell Scientific data loggers. Connect the wires in the order shown in the table.

Wire color	Wire function	Data logger connection
White	SDI-12 signal	C, SDI-12, or CR6 U terminal configured for SDI-12 ¹
Brown	Power	12V
Black	Power ground	G
Clear	Shield	G
Gray	Aspen detect signal	G
Other colors	N/A	not used ²

¹U and C terminals are automatically configured by the measurement instruction.

²Individually isolate the unused wires with electrical tape or wire caps.

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 (C) or universal (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.

7.2 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. 3). 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. 20). Programming basics for CRBasic data loggers are provided in the following section.

7.2.1 CRBasic programming

Downloadable example programs are available at www.campbellsci.com/downloads/tempvue20-sdi12-example-program.

The [SDI12Recorder\(\)](#) instruction is used to measure a TempVue 20 SDI-12. The [SDI12Recorder\(\)](#) instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See [SDI-12 sensor measurements](#) (p. 14) 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 8-1](#) [p. 15].

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

7.3 Siting

The TempVue 20 SDI-12 is intended for air temperature measurements only. The general EPA guidance for standard meteorological stations is to locate the sensor over an open, level area at least 9 m (29.5 ft) in diameter. The surface should be covered by short grass or the natural earth surface where grass does not grow. Sensors should be protected from thermal radiation and adequately ventilated. Protect the filter at the top of the sensor from exposure to liquid water.

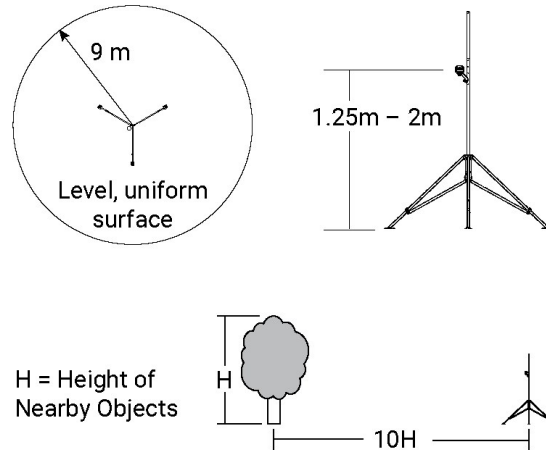


Figure 7-1. Clearances

The sensor should be installed at a standard measurement height which varies depending on the guides being used:

- 1.5 m (4.92 ft) (AASC)
- 1.25 to 2.0 m (4.1 to 6.5 ft) (WMO)
- 2.0 m (6.5 ft) (EPA)

See [References](#) (p. 19) for a list of references that discuss temperature sensors.

When used in the field, the TempVue 20 SDI-12 must be housed in a radiation shield. Compatible radiation shields include the RAD06, RAD10E, and RAD14 unventilated radiation shields and the TS100SS fan-aspirated radiation shield. The white color of these shields reflects solar radiation.

The unventilated radiation shields have a louvered construction that allows air to pass freely though, thereby keeping the sensor at or near ambient temperature. The RAD06, RAD10E, and RAD14 have a double-louvered design that offers improved sensor protection from insect intrusion and driving rain and snow. In addition, compared to shields of a similar appearance, the RAD shields have lower self-heating in bright sunlight combined with low wind speeds giving a

better measurement. The RAD shields attach to a crossarm, mast, or user-supplied pipe with a 2.5 to 5.3 cm (1.0 to 2.1 inch) outer diameter.

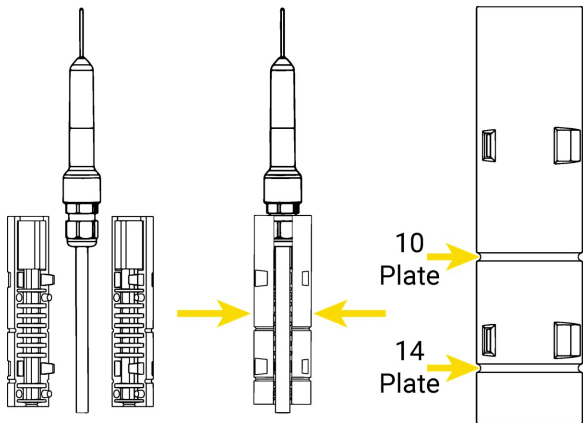
The Apogee Instruments aspirated TS100SS shield can also be used where minimal solar errors and a fast speed of response is desired. It mounts on a crossarm or horizontal pipe (1-1/4 inch to 2 inch IPS).

Tools required for installing a radiation shield to a tripod or tower include:

- adjustable wrench (to suit 12 mm (1/2 in) nuts)
- small screwdriver provided with data logger
- small Phillips screwdriver
- UV-resistant cable ties
- small pair of diagonal-cutting pliers
- adjustable wrench with a minimum 50 mm (2 in) jaw size.

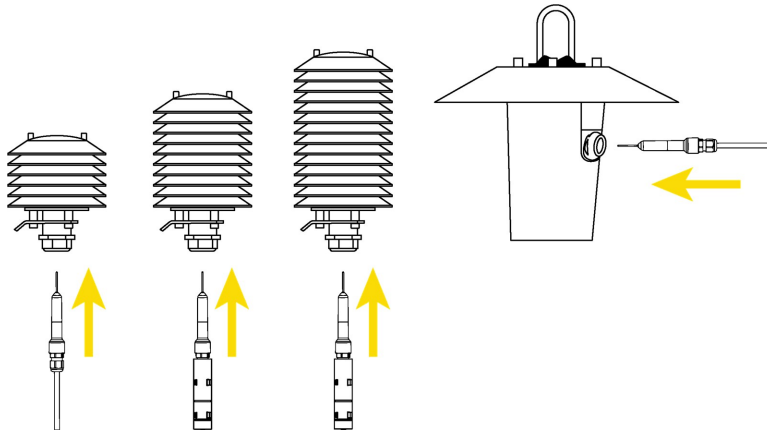
7.4 Installation in a radiation shield

1. If using a 10- or 14-plate shield, attach the shield extender.



2. If using a RAD06, RAD10E, or RAD14 shield, loosen the nut on the entry gland at the bottom of the shield.

3. Insert the sensor into the gland.



4. If using an unventilated shield, first tighten, by hand, the nut on the radiation shield gland until the sensor is held firmly in place. Then use the large adjustable wrench to further tighten the gland by 1/2 to 1 turn. Do not overtighten the nut as you risk damaging the sensor body and also making service of the sensor more difficult in the future.



Figure 7-2. Cut away view shows TempVue 20 SDI-12 insertion in a RAD shield

7.5 Mount the shield

1. Attach the radiation shield to the tripod mast, crossarm, or tower leg using the supplied U-bolt or band clamp. See [7.4](#) (p. 11) and [Figure 7-3](#) (p. 13).
2. Connect the cable to the sensor, if using an extension cable.

3. Route the cable to the data logger or Aspen 10, and secure the cable to the mounting structure using cable ties.

CAUTION:

Failure to secure the cable can lead to breakage of the wires due to fatigue caused by blowing back and forth in the wind.



Figure 7-3. Cutaway view of a TempVue 20 SDI-12 installed in a RAD10E radiation shield on a pole with an Aspen 10 Edge Device

8. Operations

8.1 SDI-12 sensor measurements

The TempVue 20 SDI-12 responds to the SDI-12 commands shown in [Table 8-1](#) (p. 15). The most recent 5760 measurements (one day worth) are stored in memory to be used to return statistical data. The memory buffer is emptied at power up. All temperatures are returned with two decimal places. Because of the internal measurement frequency, Campbell Scientific recommends measurement scans of 15 seconds or more.

The Campbell Scientific data logger follows the SDI-12 protocol and pauses its operation after sending the **M!** command then waits until either it receives a response from the sensor, or the sensor timeout expires. 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. The **R0!** command directly reads the sensor measurements and outputs all of its values.

NOTE:

[SDI-12 sensor support](#) (p. 21) describes the SDI-12 commands. Additional SDI-12 information is available at www.sdi-12.org .

Table 8-1: SDI-12 command list

Commands ¹	Values returned or function
<i>aR0!</i> , <i>aM!</i> , or <i>aC!</i>	Temperature (°C)
<i>aR1!</i> , <i>aM1!</i> , or <i>aC1!</i>	Temperature (°F)
<i>aM2!</i> , or <i>aC2!</i>	<ol style="list-style-type: none"> 1. Temperature (°C) 2. 60 s average temperature (°C) 3. Minimum temperature (°C)² 4. Maximum temperature (°C)² 5. Average temperature (°C)² 6. Measurement period (sec) 7. Error flag, where 0 = No error 1 = Suspect reading 2 = Error reading 4 = Sensor stuck 8 = Sensor error
<i>aM3!</i> , or <i>aC3!</i>	<ol style="list-style-type: none"> 1. Temperature (°F) 2. 60 s average temperature (°F) 3. Minimum temperature (°F)² 4. Maximum temperature (°F)² 5. Average temperature (°F)² 6. Measurement period (sec) 7. Error flag, where 0 = No error 1 = Suspect reading 2 = Error reading 4 = Sensor stuck 8 = Sensor error
<i>aI!</i>	<i>a14CampbellTempVu20 SN=nnnnn</i> Where, <i>nnnnn</i> = serial number
<i>aV!</i>	<ol style="list-style-type: none"> 1. Hardware revision 2. Software revision 3. Uptime in seconds 4. Supply voltage

Table 8-1: SDI-12 command list	
Commands ¹	Values returned or function
<p><i>a</i>XLOADOS <i>rrrrr</i> CPU: TEMPVUE_OS_Vn.nn.xobj! where <i>rrrrr</i>= baud rate; valid baud rates are 1200, 2400, 4800, and 9600 TEMPVUE_OS_Vn.nn.xobj = OS name</p>	<p>Sends the new OS to the sensor; refer to Updating the operation system (OS) using XLOADOS SDI-12 command (p. 16)</p>
<i>a</i> XHELP	Display a helpful description of the SDI-12 commands
<p>¹<i>a</i> is the SDI-12 address. In the SDI12Recorder (C) CRBasic instruction, the command parameter does not include the SDI-12 address because the address is a separate parameter.</p> <p>²The minimum, maximum, and average temperature values are over the measurement period.</p>	

8.2 Updating the operation system (OS) using XLOADOS SDI-12 command

The SDI-12 extended command XLOADOS ! sends the new operating system (OS) to the sensor.

NOTE:

Only the CR6, CR1000X, and CR300-series data loggers are compatible with the XLOADOS ! functionality.

Verify that the data logger has been updated to the latest OS to ensure compatibility.

If a compatible data logger is not available to update the sensor, send the sensor to the factory to have Campbell Scientific update the OS. A returned material authorization (RMA) and completion of the “Statement of Product Cleanliness and Decontamination” form are required. Refer to the page near the end of this manual for more information.

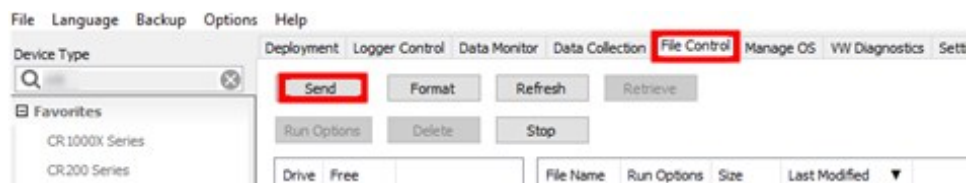
The data loggers need the following OS versions:

- CR6: OS 11 or newer
- CR1000X: OS 5.0 or newer
- CR300 series: OS 10.05 or newer

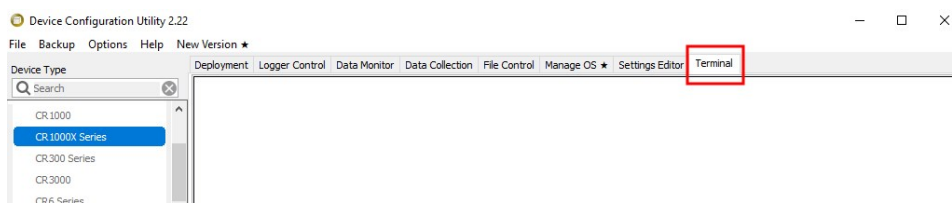
The XLOADOS ! OS update process requires access to the data logger terminal. Campbell Scientific *Device Configuration Utility* is recommended.

Although this update may be performed remotely, if the sensor is not communicating with the data logger, it must first be power cycled to regain communication and accept the new OS.

1. Download the update file from the Campbell Scientific website and run the self-extracting executable. The extraction takes only a moment, and a dialog box will indicate that the OS file has been saved on the computer in the C:\Campbellsci\Lib\OperatingSystems directory.
2. Upload the OS to the data logger CPU drive using *Device Configuration Utility*.
 - a. Connect to the data logger.
 - b. Open the **File Control** tab.
 - c. Click **Send** and select the OS file from the C:\Campbellsci\Lib\OperatingSystems directory. File type may need to be changed to **All Files (*.*)** for the OS file to show up on the list.



- d. Verify that the file is now on the data logger CPU drive.
3. Connect the sensor to the data logger digital and power terminals. Note the terminal to which the sensor is connected.
 4. Open a terminal interface to the data logger. Press Enter twice within the terminal window to get a command prompt.



5. Within the terminal, run the following commands:
 - a. Type **SDI12** at the prompt and then enter the corresponding number assigned to the digital terminal to which the sensor is connected.
 - b. Identify the SDI-12 address of the sensor by typing **?!** at the prompt.
 - c. Verify that the responding sensor is the TempVue 20 SDI-12 that you want to update by using the SDI-12 verify command **aI!**.

6. Send the OS to the sensor with the **XLOADOS!** extended command in the following format:
`<SDI-12 address>XLOADOS <baud rate> CPU:<OS name>!`

NOTE:

A baud rate of 9600 is typically used. CR300-series data loggers are case sensitive, and the file name must match the name used in the command. The **All Caps** checkbox on the bottom will need to be unchecked to allow lowercase letters.

7. When the OS update is complete, the file size, bytes sent, and the word **SUCCESS** are displayed. For example:
`file size 117500, bytes sent 117304SUCCESS`
8. Verify that the OS was updated with the verify command **aV!**, followed by the **aD0!** command to read the results.

9. Maintenance and troubleshooting

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 Maintenance

The TempVue 20 SDI-12 requires minimal maintenance. Periodically check cabling for proper connections, signs of damage, and possible moisture intrusion.

Check the radiation shield monthly to make sure it is free from dust and debris. To clean the shield, first remove the sensor. Dismount the shield. Brush all loose dirt off. If more effort is needed, use warm, soapy water and a soft cloth or brush to thoroughly clean the shield. Allow the shield to dry before remounting.

Ensure the TempVue 20 SDI-12 probe is clean and free of dirt or any soiling by wiping carefully with a lint free cloth and warm soapy water.

9.2 Troubleshooting

Symptom: Temperature is NAN, -INF, -9999, -273

Verify wiring of sensor to the data logger; cross-reference data logger program or the measurement system wiring diagram.

Symptom: Incorrect Temperature

Check the cable for signs of damage and possible moisture intrusion.

Symptom: Unstable Temperature

Make sure the shield and ground wires are connected to data logger ground, and the data logger is properly grounded.

10. References

WMO, 2008. *Guide to Meteorological Instruments and Methods of Observation*. World Meteorological Organization No. 8, 7th edition, Geneva, Switzerland.

WMO, 2021. *Instruments and Observing Methods, Generic Automatic Weather Station (AWS) Tender Specifications*. World Meteorological Organization, Report 136, Geneva, Switzerland.

AASC, 1985: The State Climatologist (1985) Publication of the American Association of State Climatologists: *Heights and Exposure Standards for Sensors on Automated Weather Stations*, v. 9, No. 4 October, 1985. (www.stateclimate.org/publications/state-climatologist/NOAA-NCY-SCBOOKS-SC77097/00000029.pdf)

EPA, 2008: *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. IV, Meteorological Measurements, Ver. 2.0, EPA-454/B-08-002 (revised 2008). Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

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. 21).

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

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

Name ¹	Command	Response
Start verification	aV!	atttn <CR> <LF>
Address query	?!	a<CR> <LF>
Change address	aAb!	b<CR> <LF>
Start measurement	aM! aM1! . . . aM9!	atttn<CR> <LF>
Start concurrent measurement	aC! aC1! . . . aC9!	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>
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. 30]).

Command: aI!

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

Where

a = sensor address

ll = SDI-12 version number (indicates compatibility)

ccccccc = 8-character vendor identification

mmmmmm = 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

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 *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!** 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*).

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 *atttn*<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. 27]), 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.

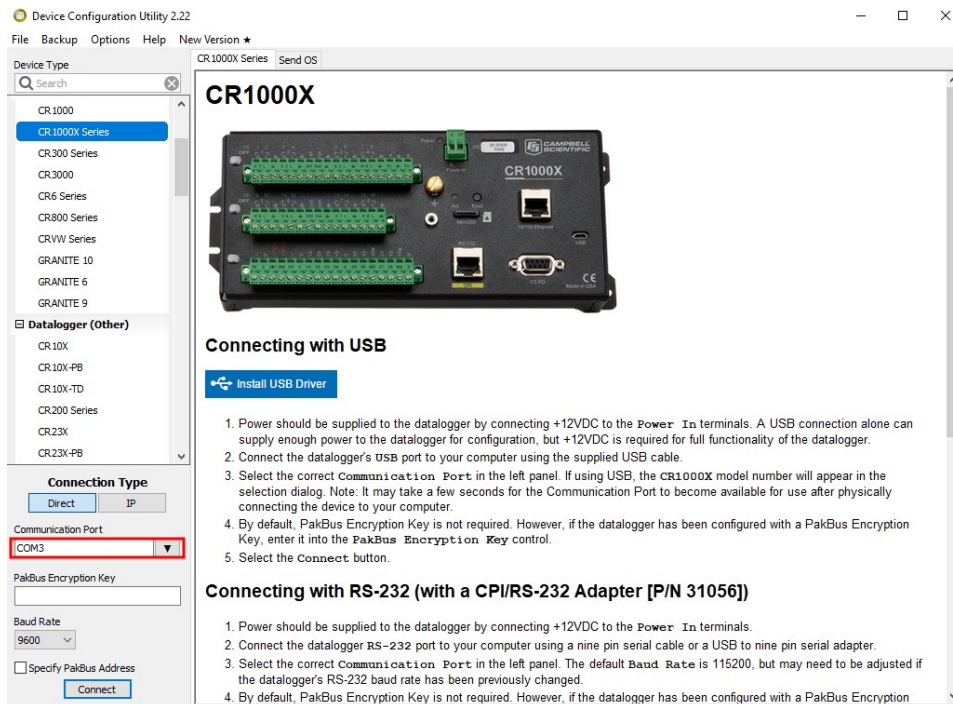
Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

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

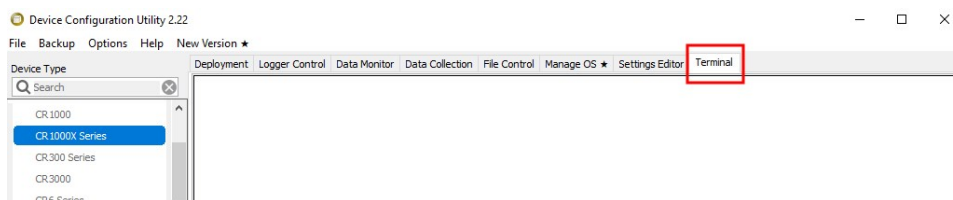
B.2.1 Changing an SDI-12 address

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

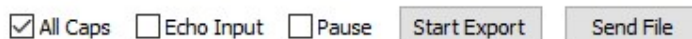
1. Connect an SDI-12 sensor to the CR1000X.
2. Open *Device Configuration Utility*.
3. Under **Device Type**, type the data logger model and double-click on the model type. This example uses a CR1000X directly connected to the computer USB port.
4. Select the correct **Communication Port** and click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



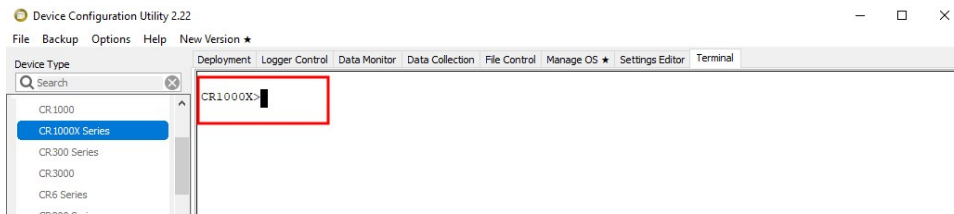
5. Click the **Terminal** tab.



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

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

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.
2. The defect cannot be the result of misuse.
3. The defect must have occurred within a specified period of time; and
4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.
2. Batteries; and
3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.


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

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

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


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

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

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

Assistance

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

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

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

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

NOTE:

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

Safety

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

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

General

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

Utility and Electrical

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

Elevated Work and Weather

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

Internal Battery

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

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

Use and disposal of batteries

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

Avoiding unnecessary exposure to radio transmitter radiation

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

Maintenance

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

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

Global Sales and Support Network

A worldwide network to help meet your needs



Campbell Scientific Regional Offices

Australia

Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Montrouge, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

India

Location: New Delhi, DL India
Phone: 91.11.46500481.482
Email: info@campbellsci.in
Website: www.campbellsci.in

South Africa

Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Spain

Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

Thailand

Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: info@campbellsci.asia
Website: www.campbellsci.asia

UK

Location: Shephed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA

Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com