Product Manual

Sensor

SnowVUE™10

Digital Snow Depth Sensor

Revision: 01/23

CSL I.D - 1380

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. 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 a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.

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About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area: 1 in^2 (square inch) = 645 mm^2

Length: 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

Mass: 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

Pressure: 1 psi (lb/in^2) = 68.95 mb

Volume: 1 UK pint = 568.3 ml
1 UK gallon = 4.546 litres
1 US gallon = 3.785 litres

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 it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials 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. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a "#" symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

Recycling information

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.

Campbell Scientific Ltd 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 advice or support, please contact Campbell Scientific Ltd, or your local agent.

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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.eu or by telephoning +44(0) 1509 828 888 (UK). 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

- 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, or 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.

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.

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.

Table of contents

1. Introduction

The SnowVUE™10 sonic ranging sensor provides a non-contact method for measuring snow depth. The sensor emits an ultrasonic pulse and measures the elapsed time between emission and return of that pulse, then uses this measurement to determine snow depth. An independent air temperature measurement is required to correct for variations of the speed of sound in air.

2. Precautions

- READ AND UNDERSTAND the Safety section at the front of this manual.
- Never open the sensor while it is connected to power or any other device.
- Always disconnect the sensor either by unplugging the connector or by disconnecting the cable wires from their termination points.
- Follow local regulations (see Compliance in Specifications [p. 6]).

3. Initial inspection

Check the packaging and contents of the shipment. If damage occurred during transport, immediately file a claim with the carrier. Contact Campbell Scientific to facilitate repair or replacement.

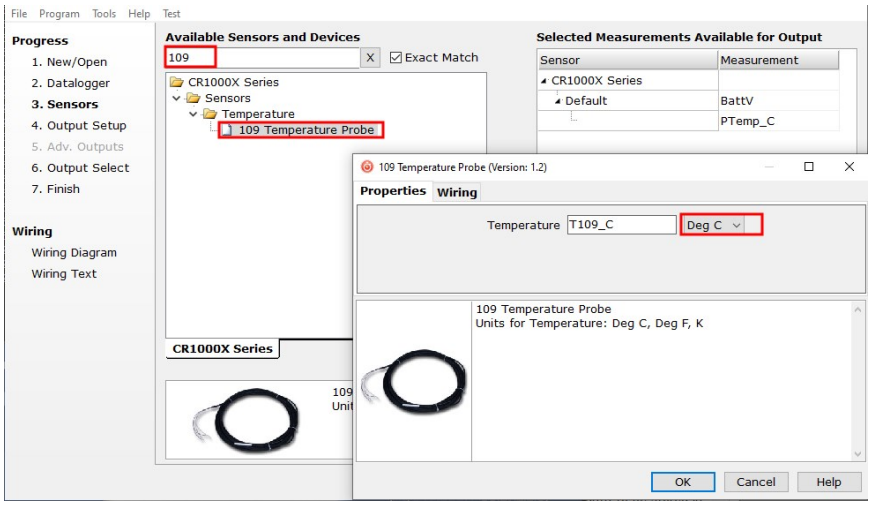
4. QuickStart

A video that describes data logger programming using ***Short Cut*** is available at: www.campbellsci.eu/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.eu. It is included in installations of ***LoggerNet***, ***RTDAQ***, and ***PC400***.

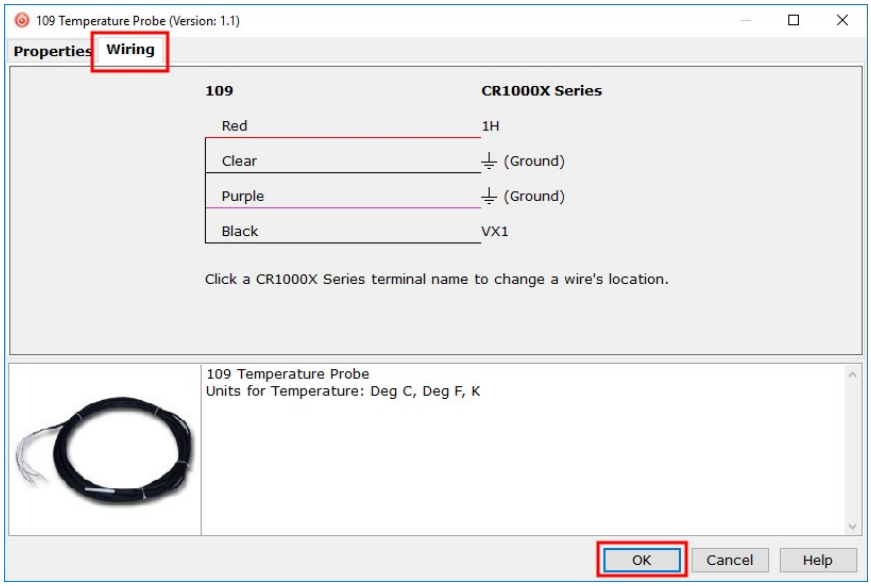
1. Open ***Short Cut*** and click **Create New Program**.
2. Double-click the data logger model.

> **NOTE:**
> A reference temperature measurement is required for accurate readings. This example uses the 109 temperature probe.

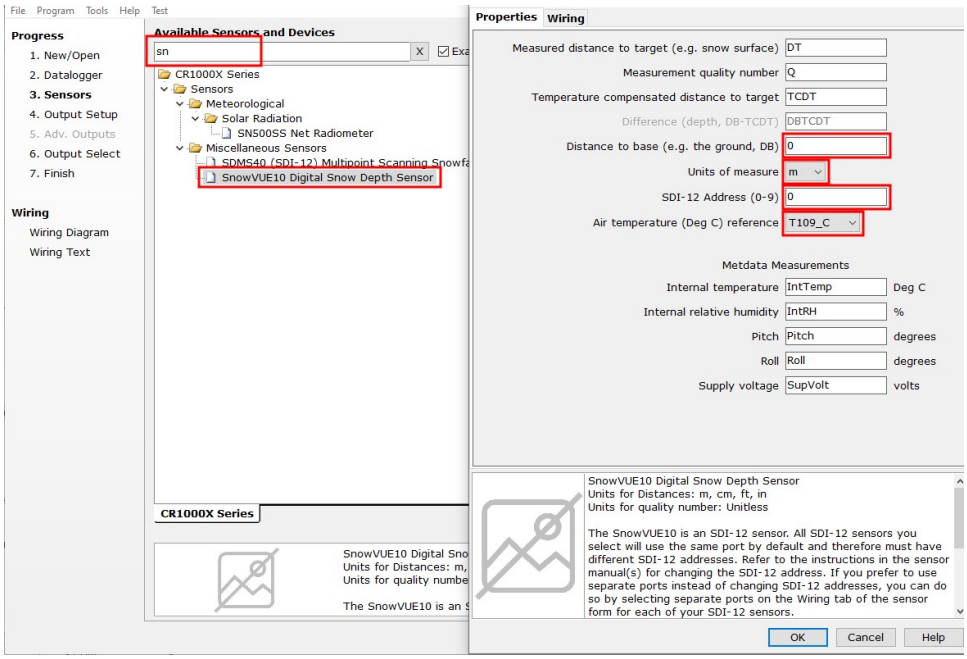
3. In the **Available Sensors and Devices** box, type 109 or find the 109 in the **Sensors** > **Temperature** folder. Double-click **109 Temperature Probe**. Under the **Properties** tab, use the default of **Deg C**.



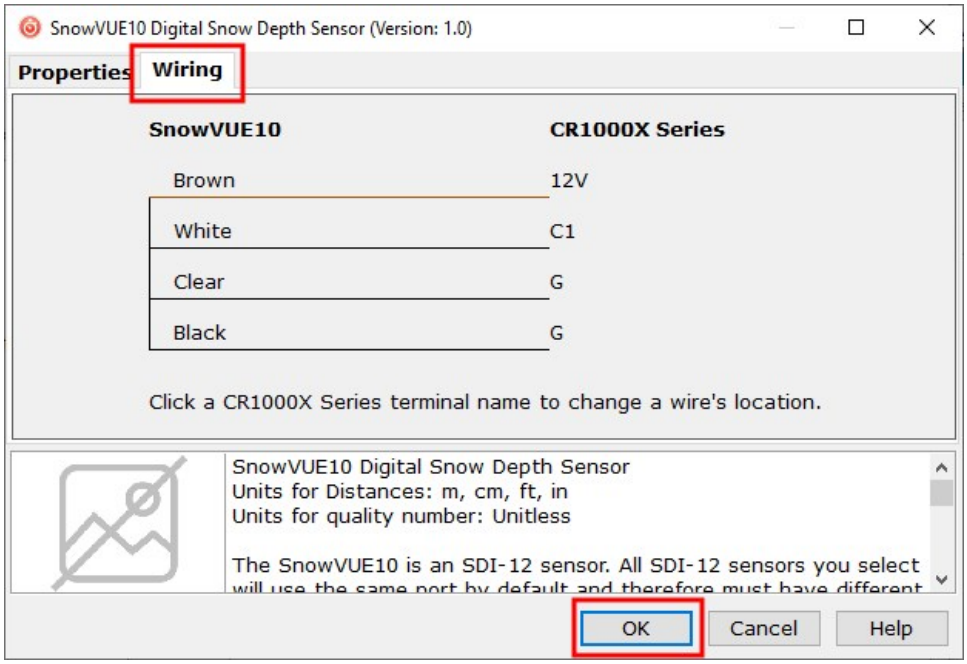
4. Click the **Wiring** tab to see how the temperature probe is to be wired to the data logger. Wire the probe accordingly, then click **OK**.



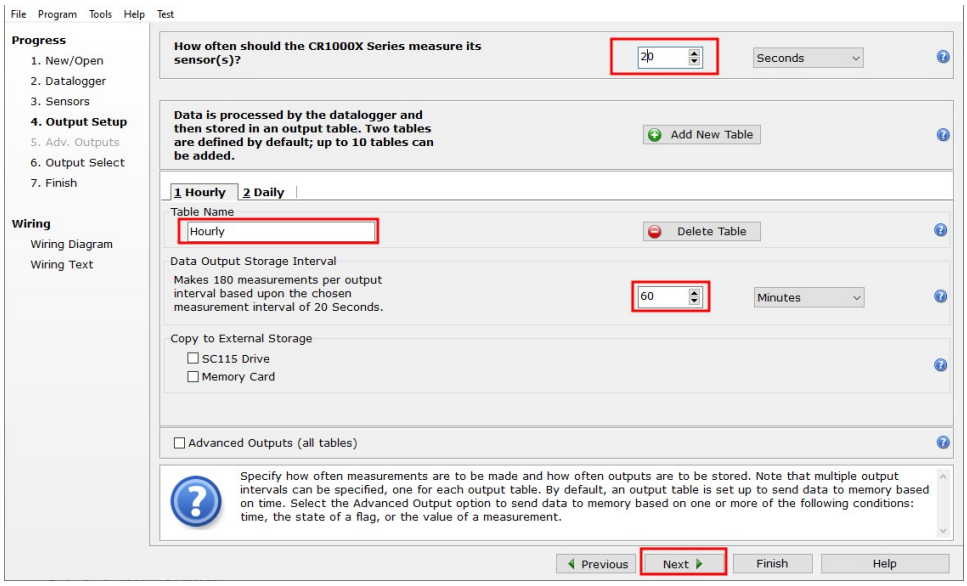
5. In the **Available Sensors and Devices** box, type SnowVUE10. You can also find the sensor in the **Sensors** > **Miscellaneous Sensors** folder. Double-click **SnowVUE10 Digital Snow Depth Sensor**. Under the **Properties** tab, type the **Distance to base**, which is the distance from the wire mesh face to the ground; this value should be in the same units as the **Units of measure**. The default for **Units of measure** is **m**; this can be changed by clicking the **Units of measure** box and selecting another value. **SDI-12 Address** defaults to 0. Type the correct **SDI-12 Address** if it has been changed from the factory-set default value. Click the **Air temperature (Deg C) reference** box and select the reference temperature variable (in this example, T109_C). Click **OK**.



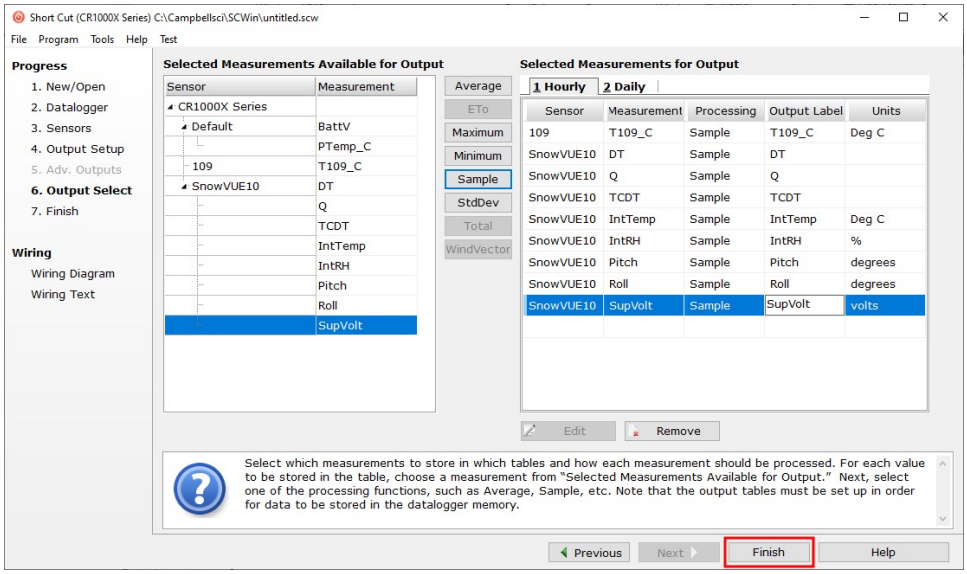
6. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Wire the sensor accordingly, then click **OK**.



7. Repeat steps five and six for other sensors, if necessary. Click **Next**.
8. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**. Click **Next**. For this sensor, Campbell Scientific recommends measurement scans of 15 seconds or more.



9. Select the desired output options.



10. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
11. 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 SnowVUE 10 measures the distance from the sensor to a target. It determines this distance by sending ultrasonic pulses (50 kHz) and listening for the returning echoes reflected from that target. The time from pulse transmission to echo return is the basis for obtaining the distance measurement.

Since the speed of sound in air varies with temperature, an independent temperature measurement is required to compensate the distance reading. The SnowVUE 10 requires an external temperature sensor, such as the 109, to provide the measurement.

The SnowVUE 10 is designed for extreme cold and corrosive environments, and it meets the stringent requirements of snow depth measurement. Its type III anodized aluminium chassis with a rugged transducer withstands many environments. Combined, these features make the SnowVUE 10 well suited for a wide range of applications.

Figure 5-1. An anodized chassis protects the SnowVUE 10

Features:

- Wide operating temperature range
- Use of a multiple echo processing algorithm to facilitate measurement reliability
- Ability to output a data value indicative of measurement quality (Quality numbers [p. 14])
- Compatible with Campbell Scientific CRBasic data loggers: GRANITE series, CR6, CR1000X, CR800 series, CR300 series, CR3000, and CR1000

6. Specifications

Power requirements:	9 to 18 VDC
Quiescent current consumption:	<300 µA
Active current consumption:	210 mA peak, 14 mA average @ 20 °C
Measurement time:	5 s typical, 20 s maximum
Output:	SDI-12 (version 1.4)
Measurement range:	0.4 to 10 m (1.3 to 32.8 ft)
Accuracy:	0.2% of distance to target Accuracy specification excludes errors in the temperature compensation. External temperature compensation is required; for more information, see Temperature compensation (p. 16).

> **CAUTION:**
> The SnowVUE 10 calculates distance readings using the speed of sound at 0 °C (331.4 m/s). If the temperature compensation formula is not applied or manually specified using the **XWT!** command, the distance values will not be accurate for temperatures other than 0 °C.

Resolution:	0.1 mm
Required beam angle clearance:	30°
Operating temperature range:	–45 to 50 °C
Sensor connector type:	M12, 5-pole, A-coded, pin connector
Maximum cable length:	60 m (197 ft)
Cable type:	3-conductor, polyurethane sheathed, screened cable, 4.8 mm (0.19 in) nominal diameter
Chassis type:	Corrosion-resistant, type III anodized aluminium
Sensor length:	9.9 cm (3.9 in)
Sensor diameter:	7.6 cm (3.0 in)
Sensor weight without cable:	293 g (10.3 oz)
Cable weight (15 ft):	250 g (8.2 oz)
IP rating	
Electrical housing:	IP67
Transducer:	IP64
Compliance:	This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions: 1. This device may not cause harmful interference. 2. This device must accept any interference received, including interference that may cause undesired operation.
Compliance documents:	View at www.campbellsci.eu/snowvue10

7. Installation

If you are programming your data logger with ***Short Cut***, skip Wiring (p. 8) and Programming (p. 9), as ***Short Cut*** does this work for you. See QuickStart (p. 1) for a ***Short Cut*** tutorial.

7.1 Wiring

The following table provides wiring information for the SnowVUE 10.

> **CAUTION:**
> Power down your system before wiring the sensor. Never operate the sensor with the shield wire disconnected. The shield wire plays an important role in noise emissions and susceptibility as well as transient protection.

Table 7-1: Wire colour and function and data logger connection

Wire colour	Wire function	Data logger connection terminal
Black	Power ground	G
Brown	Power	12V
White	SDI-12 signal	C[1] or U configured for SDI-12[1]
Clear	Shield	G

[1] C and U terminals are automatically configured by the `SDI12Recorder()` instruction.

To use more than one sensor per data logger, either connect the different sensors to different terminals on the data logger or change the SDI-12 addresses so that each sensor has a unique SDI-12 address. Using unique SDI-12 addresses reduces the number of terminals used on the data logger and allows sensors to be connected in a daisy chain that can minimize cable runs in some applications.

For the GRANITE-series, 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 the SnowVUE 10 is connected to C3 on a CR1000X, C4 cannot be used in the `TimerInput()`, `PulseCount()`, or `WaitDigTrig()` instructions.

Regardless of the data logger, if enough terminals are available, avoid using the companion terminal for another device.

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. 1). 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. 27).

Programming basics for CRBasic data loggers are provided in the following section.

7.2.1 CRBasic 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 measurements (p. 16) 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. 16).

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

The CRBasic program also needs to measure a temperature sensor. This measurement is used to compensate for the speed-of-sound variations in air temperature; refer to Temperature compensation (p. 16) for more information.

CAUTION:
The SnowVUE 10 calculates distance readings using the speed of sound at 0 °C (331.4 m/s). If the temperature compensation formula is not applied or manually specified using the **XWT!** command, the distance values will not be accurate for temperatures other than 0 °C.

Downloadable example programs are available at
www.campbellsci.eu/downloads/snowvue10-example-programs

7.3 Beam angle

When mounting the SnowVUE 10, the beam angle needs to be considered. Mount the SnowVUE 10 so that the face of the transducer is perpendicular to the intended target surface. The SnowVUE 10 has a beam angle of approximately 30 degrees, which means that objects outside this 30-degree beam will neither be detected nor interfere with the intended target. Any unwanted target must be outside the 30-degree beam angle.

Determine the required clearance for the beam angle using the following formula and Figure 7-1 (p. 10).

Clearance radius formula:

$CONE_{radius} = 0.268(CONE_{height})$

where

$CONE_{height}$ = distance from ground surface to base (Reference point [p. 11])

$CONE_{radius}$ = clearance radius in the same measurement units as the $CONE_{height}$

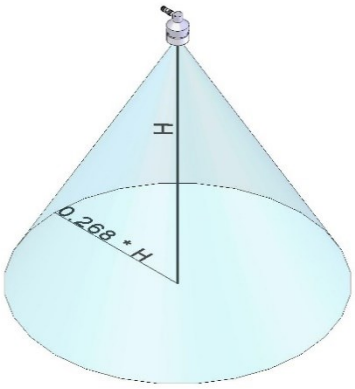


Figure 7-1. Beam angle clearance

7.4 Mounting height

Mount the SnowVUE 10 so that the face of the transducer is at least 70 cm (27.5 in) away from the target. However, mounting the sensor too far from the target can increase the absolute error. For example, if your sensor is measuring snow depth in an area that will likely not exceed 1.25 m (4.1 ft), then a good height to mount the sensor could be 2.0 to 2.2 m (6.56 to 7.22 ft). Mounting the sensor at a 4 m (13.1 ft) height could result in larger snow depth errors.

7.4.1 Reference point

The front grill on the ultrasonic transducer is used as the reference for distance values. Because of the difficulty of measuring from the grill itself, most users measure the distance from the target to the outer edge of the plastic transducer housing (Figure 7-2 [p. 11]) and then add 8 mm (0.3 in) to the measured distance.

Figure 7-2. Depth of space from edge of transducer housing to grill

7.5 Mounting

To achieve an unobstructed view for the beam, the SnowVUE 10 is typically mounted to a tripod mast, tower leg, or user-supplied pole, using a CM206 6-ft crossarm or pipe with an outer

diameter of 1 to 1.75 inches. The SnowVUE 10 mounting kit attaches directly to the crossarm or pipe. Figure 7-3 (p. 12) shows the SnowVUE 10 mounted to a crossarm using the mounting kit. A U-bolt mounts the bracket to the crossarm, and two screws fasten the SnowVUE 10 securely to the bracket.

The SnowVUE 10 mounting stem (Figure 7-4 [p. 13]) attaches to the crossarm using the 1-inch × 1-inch Nu-Rail fitting (Figure 7-5 [p. 13]), CM221 right-angle mount, CM230 adjustable-angle mount, or CM230XL extended adjustable-angle mount. Use the CM230 or CM230XL if the ground surface is at an angle.

Figure 7-3. Crossarm installation using the SnowVUE 10 mounting kit

Figure 7-4. SnowVUE 10 mounting stem

Figure 7-5. SnowVUE 10 mounted to a crossarm using the mounting stem and a 1-inch × 1-inch Nu-Rail fitting

8. Operation

The SnowVUE 10 bases every measurement on several readings and applies an algorithm to improve measurement reliability. The distance-to-target readings that are obtained from the sensor are referenced from the metal mesh on the face of the transducer. The SnowVUE 10 transmits an ultrasonic beam that detects objects within a 30-degree field of view (see Beam angle [p. 10]).

The SnowVUE 10 completes a measurement and outputs the data typically in 10 to 15 seconds, depending on the target distance, target type, and noise in the environment.

The SnowVUE 10 may reject readings from a moving target. If the SnowVUE 10 rejects a reading or detects no target, 0 will be output for the distance to target and for the quality number.

8.1 Quality numbers

The following table describes the measurement quality numbers provided in the output data. These numbers indicate the measurement certainty. The quality number is calculated as the standard deviation of multiple readings used to return one distance value. A 0 indicates that the reading was not obtained. Numbers greater than 300 indicate a degree of uncertainty in the measurement. Causes of high numbers include:

- sensor is not perpendicular to the target surface
- target is small and reflects little sound
- target surface is rough or uneven
- target surface is a poor reflector of sound (for example, extremely low-density snow)

Table 8-1: Quality number description

Quality number range	Quality range description
0	Unable to read distance
1 to 100	Good measurement quality numbers
100 to 300	Reduced echo signal strength
300 to 600	High measurement uncertainty

Although not necessary, quality numbers provide useful information such as surface density in snow monitoring applications. Please note that quality number values may increase during snowfall events consisting of low-density snow.

8.2 Pitch, roll, and tilt axis

The SnowVUE 10 reports pitch and roll to ensure that the sensor is mounted to be perpendicular to the intended target surface. The front of the sensor is the face with the vent on it (opposite the connector, see Figure 8-1 [p. 15]). The etchings are considered to be on the sides of the sensor, with the product model name on one side and the company logo on the other. Pitch occurs when the vent tilts forward or backward around the x-axis (Figure 8-2 [p. 15]); roll occurs when the sensor rotates side to side around the axis of the vent and connector (y-axis).

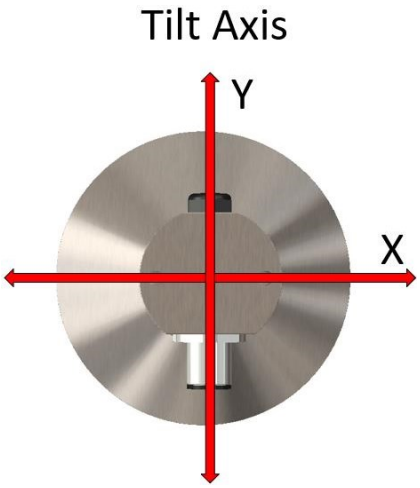


Figure 8-1. Tilt axis, with the black vent on the y-axis representing the front of the sensor

Figure 8-2. Pitch and roll diagram

8.3 Temperature compensation

Temperature corrections for the speed of sound must be applied to the readings by using measurements from a reliable and accurate temperature sensor, such as the 109. The temperature sensor needs to be housed in a radiation shield. Temperature compensation is applied to the SnowVUE 10 output using either the following formula or the *a*XWT+CC.C! extended command (Table 8-2 [p. 16]).

$$DISTANCE = READING_{\text{SnowVUE10}} \sqrt{\frac{T^{\circ}KELVIN}{273.15}}$$

CAUTION:
The SnowVUE 10 calculates distance readings using the speed of sound at 0 °C (331.4 m/s). If the temperature compensation formula is not applied or manually specified using the XWT! command, the distance values will not be accurate for temperatures other than 0 °C.

8.4 SDI-12 measurements

The SDI-12 protocol supports the SDI-12 commands listed in Table 8-2 (p. 16).

NOTE:
The SnowVUE 10 needs to be powered for at least 1.5 s before it can receive an SDI-12 command.

The different commands are entered as options in the SDI-12 recorder instruction. If the SnowVUE 10 is unable to detect a proper echo for a measurement, the sensor will return a 0 for the distance-to-target value.

Table 8-2: SDI-12 commands

SDI-12[1] command	Values returned or function	Units	Max. sensor response time
*a*M!, *a*C!	Distance	m	20 sec
*a*M1!, *a*C1!	1. Distance 2. Quality number	1. m 2. N/A (not applicable)	20 sec
*a*M2!, *a*C2!	1. Distance 2. Reference temperature	1. m 2. ° C	20 sec

Table 8-2: SDI-12 commands

SDI-12[1] command	Values returned or function	Units	Max. sensor response time
*a*M3!, *a*C3!	1. Distance 2. Quality number 3. Reference temperature	1. m 2. N/A 3. ° C	20 sec
*a*M4!, *a*C4!	1. Snow depth 2. Quality number 3. Reference temperature	1. m 2. N/A 3. ° C	20 sec
*a*M9!, *a*C9!	1. External temperature 2. Internal temperature 3. Internal RH 4. Pitch 5. Roll 6. Supply voltage 7. Resonant frequency (should be 50 kHz) 8. Alert flag 0 = good 1 = transducer outside of normal operating range	1. ° C 2. ° C 3. % 4. ° 5. ° 6. V 7. kHz 8. N/A	3 sec
*a*R3!	Returns the CPU temperature	° C	
*a*I!	a14CampbellSnow10SN=nnnnn SDI-12 address: a SDI-12 version: 14 vendor: Campbell model: Snow10 SN = Serial number (5 digits)		
*a*V!	1. Operating system (OS) version 2. Hardware version 3. Watchdog errors 4. Uptime	1. N/A 2. N/A 3. N/A 4. sec	
?!	SDI-12 address		

Table 8-2: SDI-12 commands

SDI-12[1] command	Values returned or function	Units	Max. sensor response time
*a*A*b*! where *b* = new address	Change address command		
*a*XRM!	Returns the distance to ground setting; it returns four decimal places	m	
*a*XWM+*D.DD*! where *D.DD* = distance in meters	Extended command that sets the distance-to-ground parameter, in meters, in the SnowVUE 10; the distance must be no more than four decimal places	m	
*a*XRT!	Returns the reference temperature with a value that remains the same unless power is cycled or a new temperature value is sent; the default value on power up is 0 °C.	° C	
*a*XWT+*CC.C*! where *CC.C* = temperature in degrees Celsius	Sets reference temperature, which must be a maximum of one decimal place	° C	
*a*XLOADOS *rrrrr SNOWVUE_nnn.xobj*! where *rrrrr*= baud rate *SNOWVUE_nnn.xobj* = OS name	Sends the new OS to the sensor; refer to Updating the operation system (OS) (p. 19)		

[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.

When using the **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. Because of the delays this command requires, it is only recommended in measurement scans of 20 seconds or more.

The **C!** command follows the same pattern as the **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 data is ready on the next scan.

8.5 Updating the operation system (OS)

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 About this manual page at the front of this manual for more information.

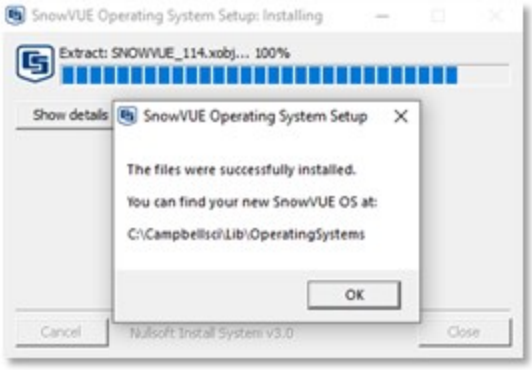
The data loggers need the following OS versions:

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

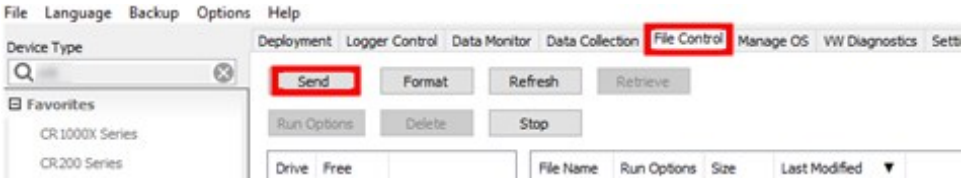
The **XLOADOS!** OS update process requires access to the data logger terminal. Campbell Scientific ***Device Configuration Utility*** is recommended.

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 to the computer. Take note of the directory where the SnowVUE 10 OS is saved on the computer: C:\Campbellsci\Lib\OperatingSystems.

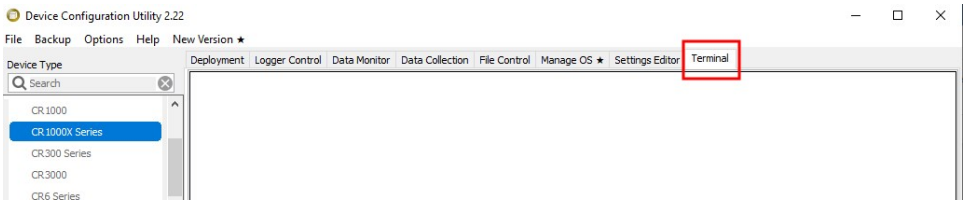


2. Upload the OS to the data logger CPU drive using ***Device Configuration Utility***.
    - Connect to the data logger.
    - Open the **File Control** tab.
    - Click **Send** and select the **SNOWVUE_114.xobj** file from the **C:\Campbellsci\Lib\OperatingSystems** directory. File type needs to be changed to **All Files (*.*)** for the .xobj file to show up on the list.



    - Verify that the .xobj 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.
    - Brown: **12V**
    - White: Odd numbered **C** or **U** terminal, for example **C1** or **U3**.
    - Black: **G**

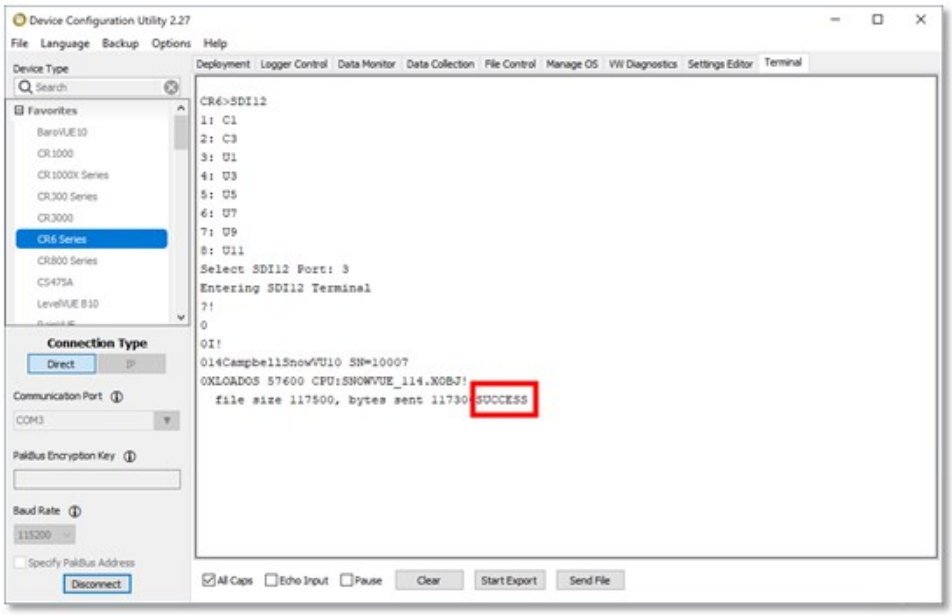
4. Open a terminal interface to the data logger. Press Enter twice within the terminal window to get a command prompt.



5. Within the terminal, run the following commands:
   - Type `SDI12` at the prompt and then enter the corresponding number assigned to the digital terminal to which the sensor is connected.
   - Identify the SDI-12 address of the sensor by typing `?!` at the prompt.
   - Verify that the responding sensor is the SnowVUE 10 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:
   - `<address>XLOADOS <baud rate> <OS name>!`
   - For example, this update would be entered as:
     `0XLOADOS 57600 CPU:SNOWVUE_114.XOBJ!`

> **NOTE:**
> 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 word **SUCCESS** is displayed.



8. Verify that the OS was updated with the verify command **aV!**, followed by the **aD0!** command to read the results.

```
Entering SDI12 Terminal
?!
0
0I!
014CampbellSnowVU10 SN=10007
0V!
00004
secs remaining until ready: 000
 0D0!
0+114+1+0+467
```

9. Maintenance and troubleshooting

Replace the transducer housing assembly every three years if it is not in a humid environment and every year if it is in a humid environment.

9.1 Disassembly/assembly procedures

The following figures show the procedure for disassembling the SnowVUE 10. Disassembly is required to change the transducer.

> CAUTION:
> Before proceeding with any maintenance, always retrieve the data first. Campbell Scientific also recommends saving the data logger program.

> CAUTION:
> Always disconnect the SnowVUE 10 from the data logger or the connector before disassembling.

1. Disconnect cable from the sensor.
2. Remove six screws from the transducer housing.

Figure 9-1. Transducer screws

3. Remove transducer housing and disconnect wires.

Figure 9-2. Disassembled SnowVUE 10

4. When it is time to reassemble the sensor, carefully do so in reverse order.

9.2 Data interpretation

Although not common, the SnowVUE 10 can output invalid-reading indicators if unable to obtain a measurement. For invalid distance-to-target values, 0 is returned to indicate an error. For snow depth outputs and temperature reading outputs, the error indicator value is –999. Invalid readings can easily be filtered out when analyzing the data. Invalid readings should be detected and discarded in control-type applications.

9.3 Data filtering

The following scenarios can produce values with higher than expected errors:

1. Low-density snow, which results in weak echos returned to the sensor.
2. Weak signal, as indicated by an increased number of echo-quality numbers returned to the sensor.

Under these circumstances, a SnowVUE 10 can underestimate or overestimate snow depth. If the signal is too weak, the sensor will output a value of 0 for the distance to target. When the echoes are weak, the sensor automatically increases sensitivity, which makes the sensor prone to erroneous readings from flying debris, drifting snow, or obstruction near the beam angle.

Averaging the values is discouraged because high-error values can skew the average. The recommended method is to take the median value, so as to minimize errors and filter out high-error readings. This technique also helps to automatically filter out readings of 0.

Table 9-1 (p. 26) shows a station that reads the SnowVUE 10 every 5 seconds for 1 minute and takes the median value from the readings.

Table 9-1: Data filtering example	
Consecutive snow-depth values	Values sorted from low to high
0.33	–1.1
0.34	0.10
0.35	0.28
–1.1 (erroneous reading)	0.32
2.0 (erroneous reading)	0.33
0.37	0.33
0.28	0.34
0.36	0.35
0.10 (high-error reading)	0.36
0.33	0.37
0.32	2.0

The best course of action would be to ignore the five lowest and five highest values and use the sixth (median) value of 0.33.

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.

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