PRODUCT MANUAL

Sensor

SnowVue™10

Digital Snow-Depth Sensor

Revision: 08/2024
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Campbell Scientific, Inc.

RELIABLE MONITORING SINCE 1974

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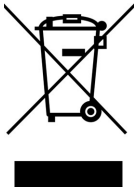
Please read first

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.

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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 back 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

> NOTE:
> The *SnowVue 10 Patch for Short Cut v4.4 v.1.0* is required for ShortCut versions 4.4 and older. This patch is available at www.campbellsci.com/snowvue10.

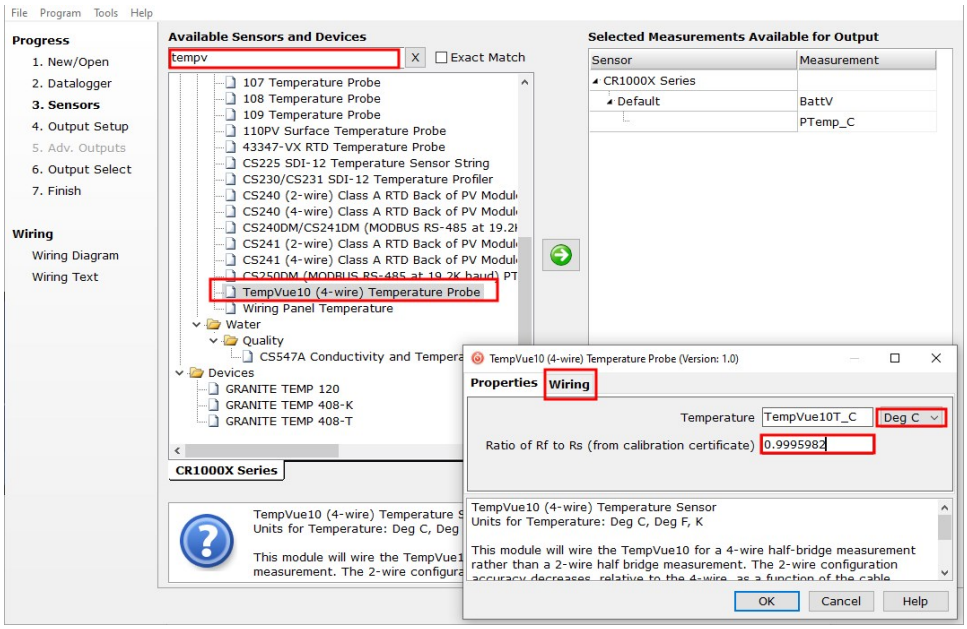
A video that describes data logger programming using ***Short Cut*** is available at: www.campbellsci.com/videos/cr1000x-data logger-getting-started-program-part-3. ***Short Cut*** is an easy way to program your data logger to measure the sensor and assign data logger

wiring terminals. ***Short Cut*** is available as a download on www.campbellsci.com. It is included in installations of ***LoggerNet***, ***RTDAQ***, and ***PC400***.

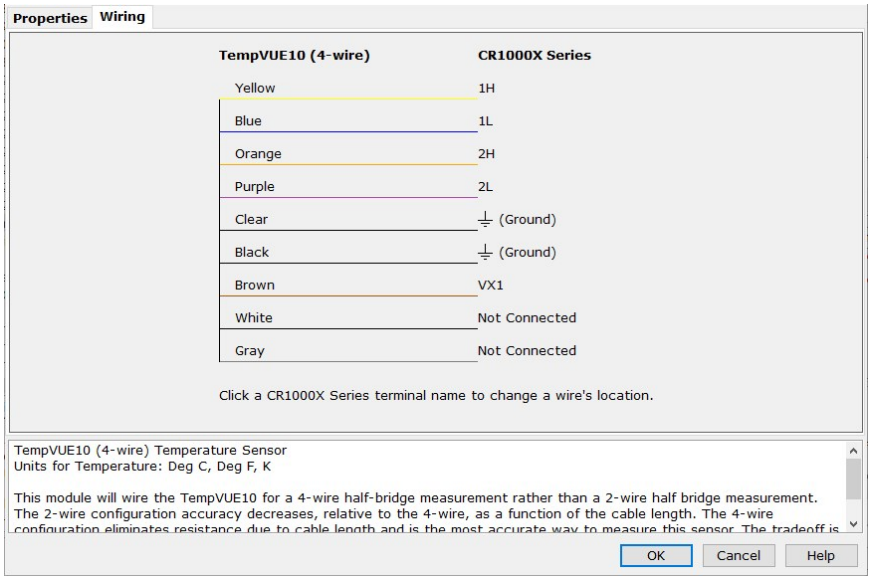
1. Open ***Short Cut*** and click **Create New Program**.
2. Double-click the data logger model.

> **NOTE:**
> A reference temperature measurement is required to compensate the distance for temperature. This example uses the TempVue 10 temperature probe.

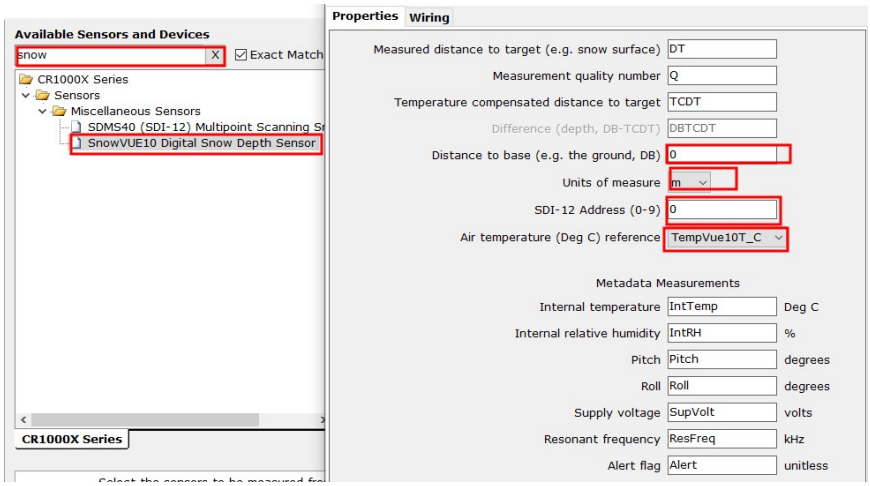
3. In the **Available Sensors and Devices** box, type TempVue10 or find the TempVue 10 in the **Sensors** > **Temperature** folder. Double-click **TempVue10 Temperature Probe**. Under the **Properties** tab, use the default of **Deg C**. Type the **Ratio of Rf to Rs** value provided in the calibration certificate that was shipped with the sensor.



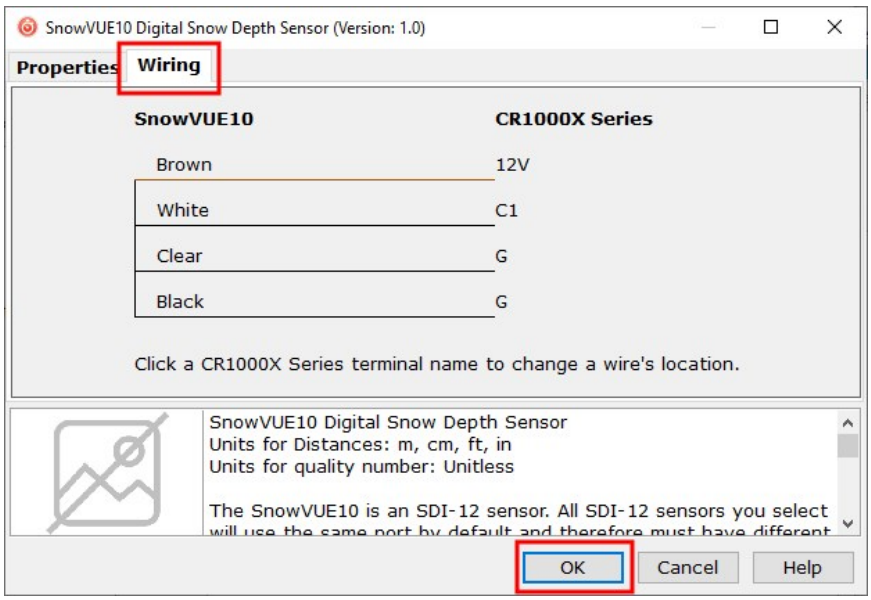
4. Click the **Wiring** tab to see how the temperature probe is to be wired to the data logger. Wire the probe accordingly, then click **OK**.



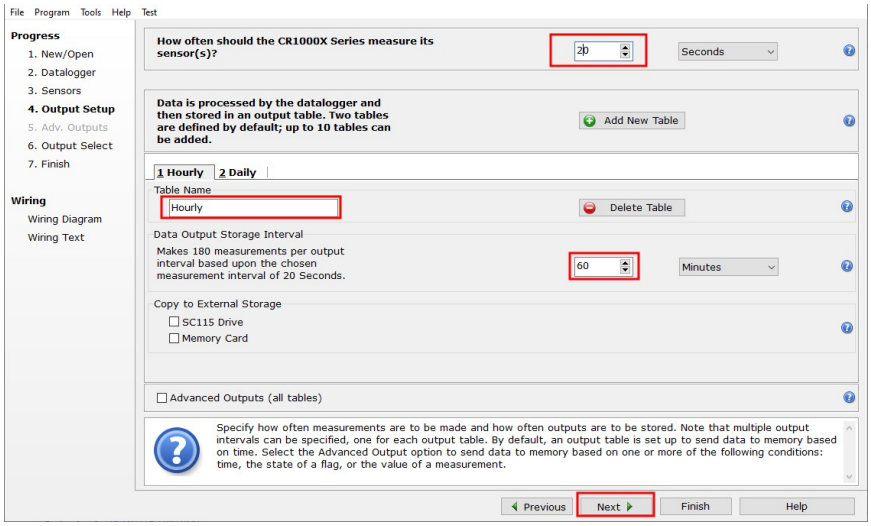
5. In the **Available Sensors and Devices** box, type SnowVue 10 or locate the sensor in the **Sensors** > **Miscellaneous Sensors** folder. Double-click **SnowVUE10 Digital Snow Depth Sensor**. Under the **Properties** tab, type the **Distance to base**, which is the distance from the wire mesh face 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, TempVue10T_C). Click **OK**.



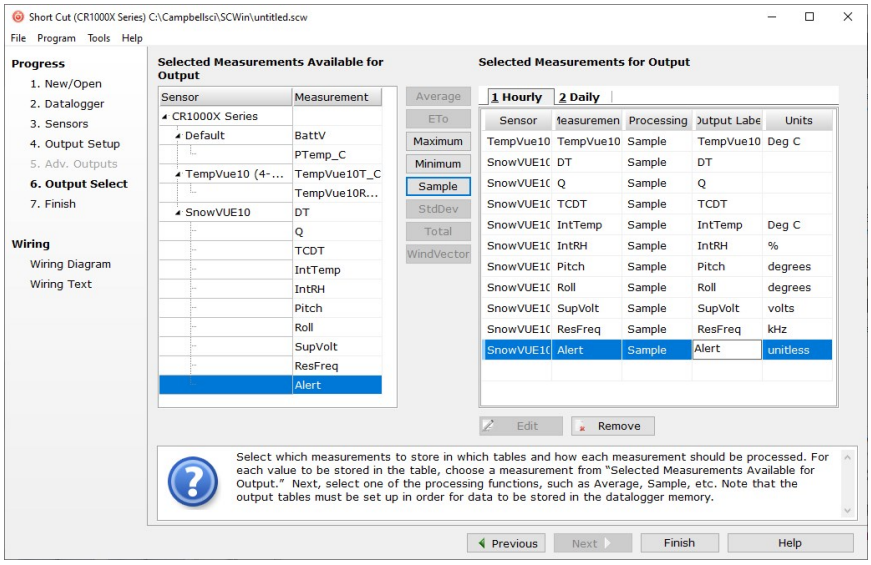
6. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Wire the sensor accordingly, then click **OK**.



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 a measurement rate between 20 and 60 seconds.



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, nominal) 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 TempVue 10, to provide the measurement. The temperature sensor needs to be housed in a radiation shield.

> **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, the distance values will not be accurate for temperatures other than 0 °C.

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 aluminum 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 the Aspen 10 Edge Device
- Compatible with SDI-12 controllers including Campbell Scientific GRANITE-series, CR6, CR1000X, CR350-series, CR300-series, CR1000, and CR800-series,data loggers

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
Warmup time:	2 s
Output:	SDI-12 (version 1.4)

Measurement range	
Distance from sensor:	0.4 to 10 m (1.3 to 32.8 ft)
Snow depth:	0 to 9.6 m
Accuracy:	0.2% of distance to target Accuracy specification is for still air with uniform temperature between the sensor and a flat, solid target. Air movement, temperature gradient along the sonic path, snow density, and differences between actual and measured temperature can affect the accuracy. Temperature corrections for the speed of sound must be applied to the readings; for more information, see Temperature compensation (p. 16). This specification excludes errors in the temperature compensation.
	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, 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
Survivability temperature range:	–55 to 80 °C
Humidity range:	0 to 100% non-condensing
Sensor connector type:	M12, 5-pole, A-coded, pin connector (will resume normal operation when sensor returns to operational temperatures)
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 aluminum
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.com/snowvue10

7. Installation

If you are programming your data logger with ***Short Cut*** or using the Aspen 10 Edge Device, skip Wiring (p. 8) and Programming (p. 9). See QuickStart (p. 1) 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 SnowVue 10.

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 color and function and data logger connection		
Wire color	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. 26).

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. 17) for more information.

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

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

Valid values for the **SDIAddress** are 0 through 9, a through z, and A through Z; alphabetical characters need to be enclosed in 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. 17].

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, the distance values will not be accurate for temperatures other than 0 °C.

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

> **NOTE:**
> For this sensor, Campbell Scientific recommends a measurement rate between 20 and 60 seconds.

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. 11).

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 $CONE_{height}$

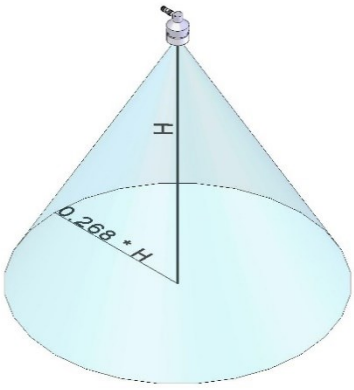


Figure 7-1. Beam angle clearance

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. 12]) 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. 13) 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. 14]), 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 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. 16]); roll occurs when the sensor rotates side to side around the axis of the vent and connector (y-axis).

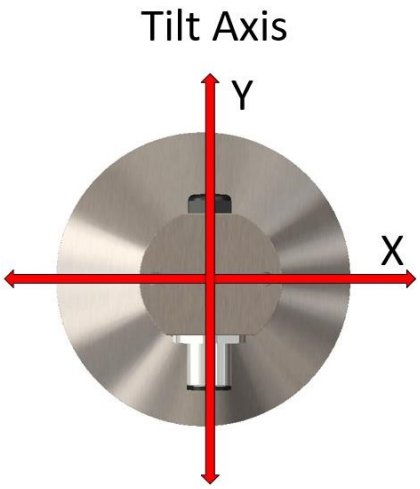


Figure 8-1. Tilt axis, with the black vent on the y-axis representing the front of the sensor

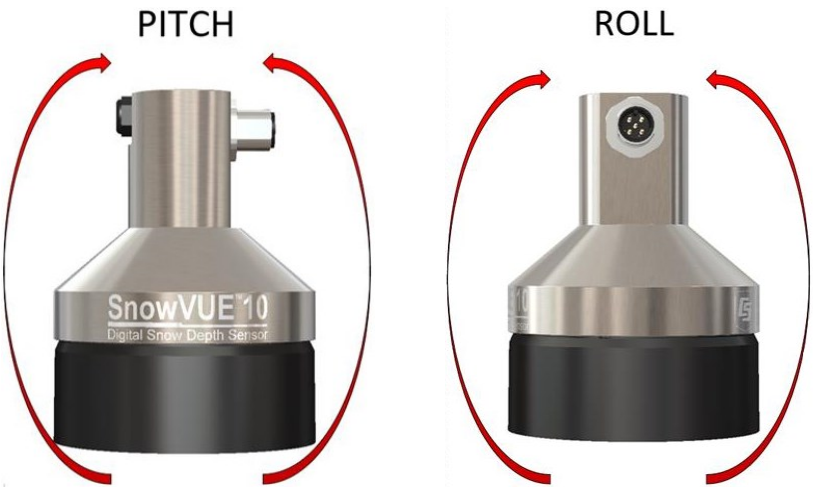


Figure 8-2. Pitch and roll diagram

8.3 Temperature compensation

Temperature corrections for the speed of sound must be applied to the readings by using temperature measurements from a reliable and accurate temperature sensor, such as the TempVue 10. The data logger program can use the following equation to apply temperature compensation to the SnowVue 10 output:

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

The SnowVUE_Sample.CRB example program (available at www.campbellsci.com/downloads/snowvue10-example-programs) uses the following expression to apply the temperature compensation to the distance measurement :

```
'Distance corrected for speed of sound due to air temperature
TCDT=DT*SQR((AirTC+273.15)/273.15)
```

Where,

TCDT is the temperature corrected distance value.

DT is the variable containing the distance measurement.

AirTC is the variable containing the temperature measurement used to temperature compensate the distance measurement.

The SnowVue 10 can also internally apply temperature compensation by using the *a***XWT+CC.C!** extended command (Table 8-2 [p. 17]). To do this, the CRBasic program needs to convert the temperature measurement to a formatted string by using the **Sprintf()** instruction and then set the reference temperature measurement in the sensor by using the *a***XWT+CC.C!** command. The SnowVUE_Sprintf_Example.CRB example program (available at

www.campbellsci.com/downloads/snowvue10-example-programs) uses this method to apply the temperature compensation.

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, 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. 17).

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)	Response time
*a*M!, *a*C!	Distance (m)	5 s typical, 20 s maximum
*a*M1!, *a*C1!	1. Distance (m) 2. Quality number	5 s typical, 20 s maximum
*a*M2!, *a*C2!	1. Distance (m) 2. Reference temperature (° C)[2]	5 s typical, 20 s maximum
*a*M3!, *a*C3!	1. Distance 2. Quality number 3. Reference temperature (° C)[2]	5 s typical, 20 s maximum
*a*M4!, *a*C4!	1. Snow depth (m) 2. Quality number 3. Reference temperature (° C)[2]	5 s typical, 20 s maximum

Table 8-2: SDI-12 commands

SDI-12[1] command	Values returned or function (units)	Response time
*a*M9!, *a*C9!	1. Reference temperature (° C)[2] 2. Internal temperature (° C)[3] 3. Internal RH (%)[3] 4. Pitch (°) 5. Roll (°) 6. Supply voltage (V) 7. Resonant frequency (kHz). Should be 40 to 60 kHz. 8. Alert flag 0 = good 1 = transducer outside of normal operating range	3 s maximum
*a*R3!	Returns the CPU temperature (° C)	
*a*I!	a14CampbellSnowVU10 SN=nnnnn SDI-12 address: a SDI-12 version: 14 vendor: Campbell model: SnowVU10 SN = Serial number (5 digits)	
*a*V!	1. Operating system (OS) version 2. Hardware version 3. Watchdog errors 4. Uptime (s)	
?!	SDI-12 address	
*a*A*b*! where *b* = new address	Change address command	
*a*XRM!	Returns the distance to ground setting, in meters; it returns four decimal places	

Table 8-2: SDI-12 commands

SDI-12[1] command	Values returned or function (units)	Response time
*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	
*a*XRT!	Returns the reference temperature (° C)[2], which is 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.	
*a*XWT+*CC.C*! where *CC.C* = temperature in °C	Sets reference temperature (° C)[2], when having the SnowVue 10 apply temperature compensation internally.	
*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) using XLOADOS SDI-12 command (p. 20)	

[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.

[2]The reference temperature is the temperature value used to temperature compensate the distance measurement. This temperature value is provided by an external temperature sensor. Refer to Temperature compensation (p. 16) for more information.

[3]The circuit board has a built-in temperature/RH sensor that monitors the sensor environmental conditions. The RH is helpful for customers to determine when they need to perform maintenance on the sensor and replace the desiccant. The RH sensor is neither replaceable nor calibratable.

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. Because of the datalogger functionality for this command, it is 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) 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:

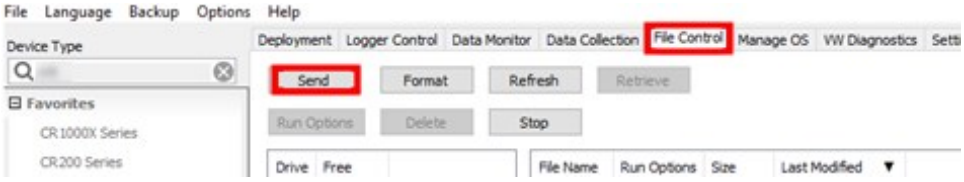
- CR6: OS 11 or newer
- CR1000X: OS 5.0 or newer
- CR300 series: OS 10.05 or newer

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.

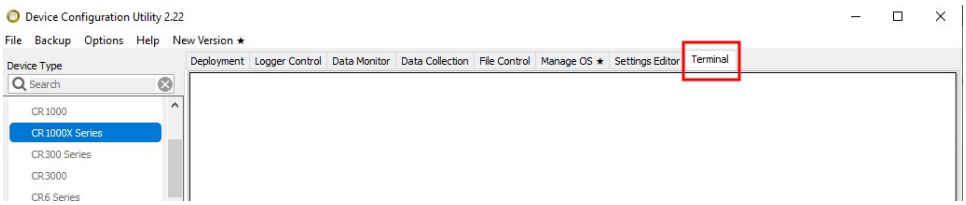
1. Download the update file from the Campbell Scientific website and run the self-extracting executable. The extraction takes only a moment, and a dialog box will indicate that the OS file has been saved on the computer in the C:\Campbellsci\Lib\OperatingSystems directory.
2. Upload the OS to the data 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 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:

```
<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

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. 24) 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

Table 9-1: Data filtering example	
Consecutive snow-depth values	Values sorted from low to high
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.

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.

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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.

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