

RainVUE-Series

SDI-12 Precipitation Sensors



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1. Introduction

The RainVUE-series rain sensors are an ideal solution for many hydrological or meteorological applications such as weather stations and flood warning systems. The models differ in their body material; the RainVUE™10 has a molded UV-stabilized plastic body and the RainVUE™20 has a rugged aluminum body. A microprocessor corrects for rainfall intensity and outputs an SDI-12 signal to communicate with any SDI-12 recorder including Campbell Scientific data loggers.

NOTE:

The RainVUE-series rain sensors are compatible with all data loggers that support SDI-12 communications. This manual focuses on Campbell Scientific CRBasic data loggers.

2. Precautions



- READ AND UNDERSTAND the [Safety](#) section at the back of this manual.
- RainVUE-series is a precision instrument that must be handled with care.
- Remove the piece of foam from under the tipping mechanism. This foam may be saved and used whenever the sensor is transported.
- Pull and remove the insulator tab used to prevent draining of the backup coin cell battery during shipping and storage. The tab extends from the bottom of the RainVUE-series interface inside the RainVUE-series.

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.
- Check model information against the shipping documents to ensure the expected products and the correct lengths of cable are received. Model numbers are found on each product. On cables and cabled items, the model number is usually found at the connection end of the cable. Report any shortages immediately to Campbell Scientific.

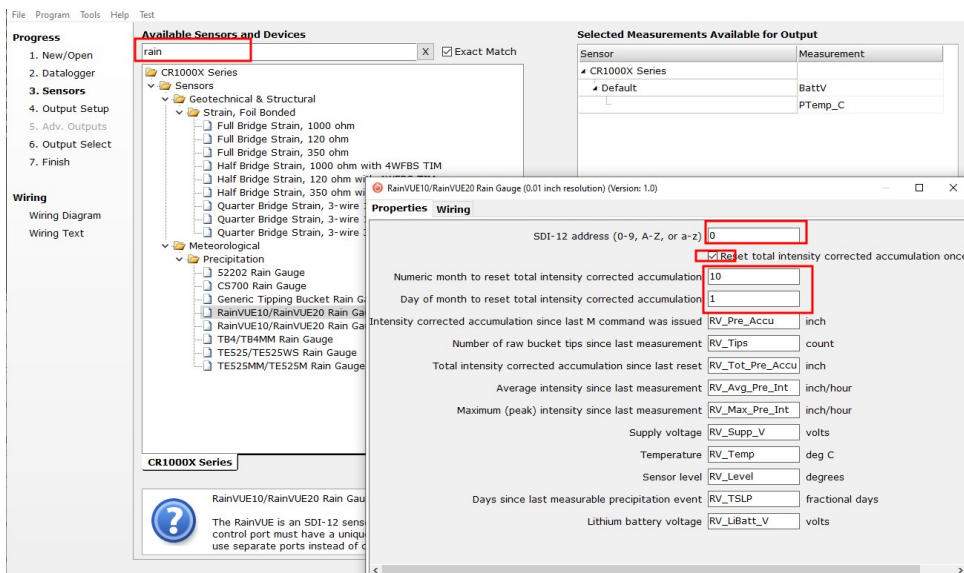
4. QuickStart

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

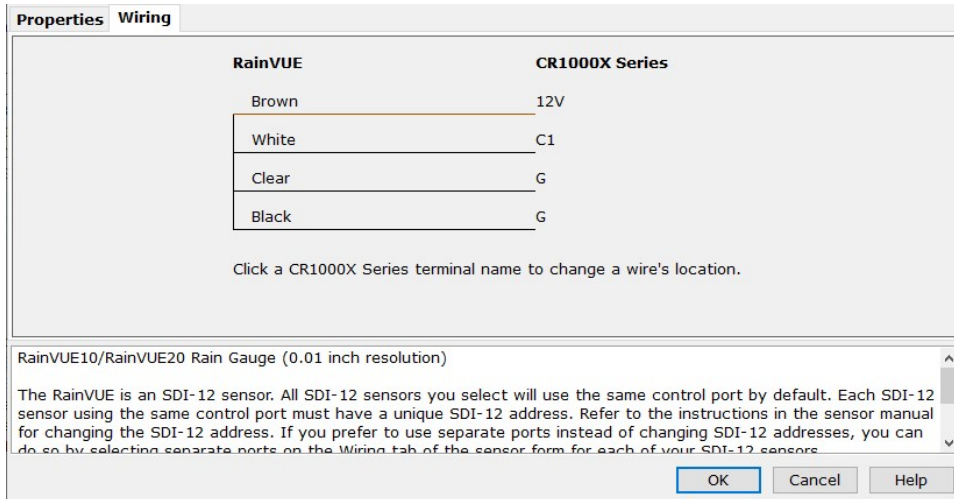
www.campbellsci.com/videos/cr1000x-data-logger-getting-started-program-part-3 . *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com . It is included in installations of *LoggerNet*,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

The following procedure also shows using *Short Cut* to program the RainVUE-series.

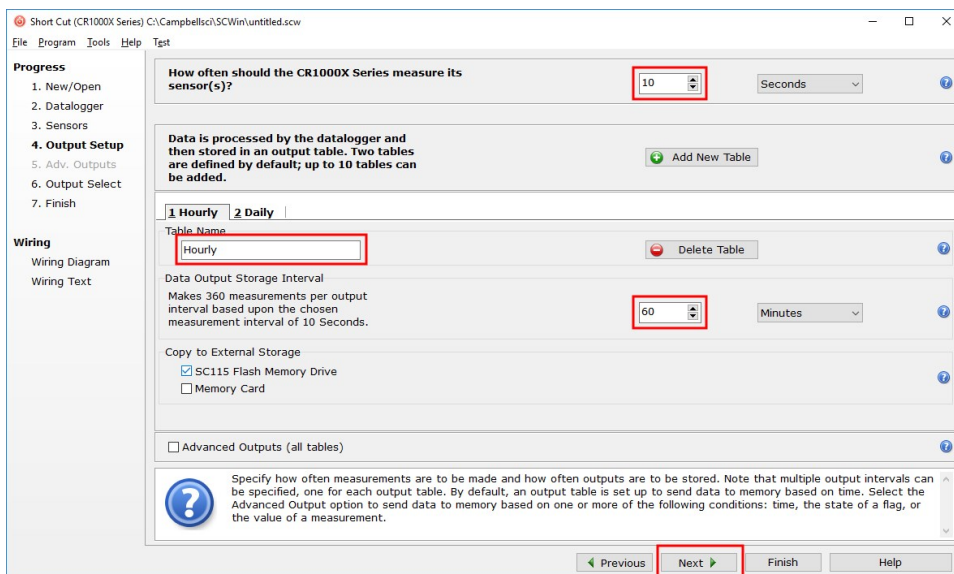
1. Open *Short Cut* and click **Create New Program**.
2. Double-click the data logger model.
3. In the **Available Sensors and Devices** box, type RainVUE or find the sensor in the **Sensors > Meteorological > Precipitation** folder, and double-click **RainVUE10/RainVUE20 Rain Gauge**. Enter the correct **SDI-12 Address** for the sensor if it has been changed from the factory-set default value. Type the numeric month and day for resetting the total accumulation if you want to do this. Otherwise, uncheck the **Reset total intensity corrected accumulation once a year** box.



- Click the **Wiring** tab. Click **OK** after wiring the sensor.



- Repeat steps three and four for other sensors you want to measure. Click **Next**.
- In **Output Setup**, type the scan rate, a **Table Name**, and **Data Output Storage Interval**. Click **Next**.



7. Select the output options.

The screenshot shows a software interface for configuring output options. On the left, a 'Progress' sidebar lists steps from 'New/Open' to 'Finish'. The main window is titled 'Selected Measurements Available for Output'. It features a tree view of sensors, with 'RainVUE' expanded to show various measurements. 'RV_Max_Pre_Int' is selected. A table on the right, 'Selected Measurements for Output', shows the configuration for 'RV_Max_Pre' with the 'Maximum' processing function. A help box at the bottom explains the selection process, and navigation buttons ('Previous', 'Next', 'Finish', 'Help') are at the bottom.

Sensor	Measurement	Processing	Output Label	Units
RainVUE	RV_Max_Pre	Maximum	RV_Max_Pre	inch/hour

- Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
- If the sensor is connected to the data logger, check the output of the sensor in the data display in *LoggerNet*, *RTDAQ*, or *PC400* to make sure it is making reasonable measurements.

5. Overview

The RainVUE-series funnels rainfall through a stainless-steel screen that traps debris, preventing it from impeding the flow of precipitation. Rainfall flows through a nozzle into one of two bucket halves. The internal tipping mechanism assembly rotates around a pivot point. The tipping mechanism tips when the first bucket fills to a fixed calibrated level, then the tipping mechanism moves the second bucket under the funnel. A magnet attached to the tipping mechanism actuates a reed switch as the bucket tips. The outgoing water drains through outlets.

The aerodynamic design of the RainVUE-series reduces the amount of rain that wind carries away from the collecting vessel. With traditional cylindrical tipping bucket rain sensors, wind can reduce the rainfall catch by up to 20%. The RainVUE-series also includes a microprocessor that corrects for rainfall intensity and outputs an SDI-12 signal. Refer to [Rainfall intensity correction](#) (p. 19) for more information.

Features:

- Suitable for nonfreezing precipitation and high intensity rain events
- Digital processing to correct for high-intensity precipitation errors (see [Specifications](#) (p. 5))
- Unique aerodynamic shape increases measurement accuracy in windy conditions
- Meets WMO recommendations for accuracy and funnel area
- Adjustable mounting feet to simplify leveling
- Tilt, internal temperature, and voltage measurement for remote diagnostics on the sensor
- Compatible CRBasic data loggers: GRANITE-series, CR6, CR3000, CR1000X, CR800-series, CR300-series, and CR1000

6. Specifications

Sensor type:	Tipping bucket with magnetic reed switch
Rainfall per tip:	0.01 in (0.254 mm) or 0.1 mm (0.004 in)
Output:	SDI-12 version 1.4
Response time:	0 s for M0! command and 1 s for M1! command
Accuracy	
Rainfall:	±1% at 0 to 500 mm/h (0 to 20 in/hr) intensity

NOTE:

Accuracy over the rain intensity range requires a mechanical calibration that is within 1% at a 1 in/h intensity. RainVUE-series sensors are calibrated at the factory to meet this specification but should be verified prior to deployment.

Tilt:	±1°
Temperature:	±0.25 °C (±0.45 °F)
Supply voltage:	±0.5 V
Operating temperature:	1 to 70 °C (34 to 158 °F)
Funnel diameter:	20.0 cm (7.87 in)
Height:	43.5 to 46.5 cm (17.1 to 18.3 in) with feet adjustment
Power:	6 to 18 VDC

Compliance documents: View at:

www.campbellsci.com/rainvue10

www.campbellsci.com/rainvue20

Specification	RainVUE 10	RainVUE 20
Maximum rainfall intensity	1000 mm/h (39.4 in/h)	1500 mm/h (60 in/h)
Material	White, ASA LI-911 plastic	Main collector body: 2-mm thick, powder-coated aluminum Base: LM6 marine-grade aluminum
Weight	2 kg (4.5 lb)	6 kg (13 lb)

7. Installation

If you are programming your data logger with *Short Cut*, skip [Wiring](#) (p. 6), and [Data logger programming](#) (p. 7). *Short Cut* does this work for you. See [QuickStart](#) (p. 2), for a *Short Cut* tutorial.

7.1 Wiring

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

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

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

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


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

7.2 Data logger 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. 2). If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in [Importing Short Cut code into CRBasic Editor](#) (p. 31). Programming basics for CRBasic data loggers are provided in the following sections. Downloadable example program is available at www.campbellsci.com/downloads/rainvue-example-program .

7.2.1 CRBasic programming

The `SDI12Recorder()` instruction is used to measure a RainVUE-series. This instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See [SDI-12 measurements](#) (p. 13) for more information.

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

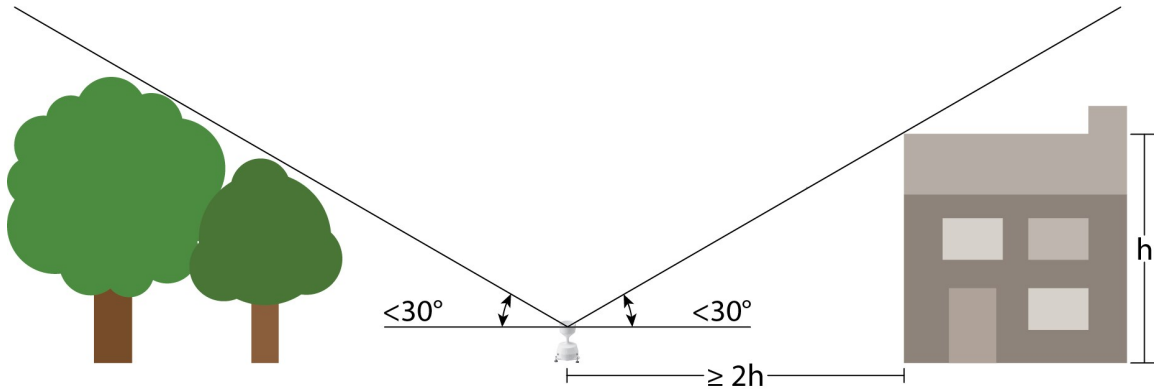
```
SDI12Recorder(Destination, SDIPort, SDIAddress, "SDICommand", Multiplier, Offset, FillNAN, WaitonTimeout)
```

For the `SDIAddress`, alphabetical characters need to be enclosed in quotes (for example, "A"). Also enclose the `SDICommand` in quotes as shown. The `Destination` parameter must be an array. The required number of values in the array depends on the command (see [Table 8-1](#) (p. 14)).

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

7.3 Siting

Mount the RainVUE-series in a relatively level location representative of the surrounding area. Ensure that the funnel is horizontal. Place the sensor away from objects that obstruct the wind. The distance should be at least 2 times the height of the obstruction. A concrete pad is recommended, but the RainVUE-series should not be installed over a large paved or concrete surface.



7.4 Mounting

The RainVUE-series has three equally-spaced leveling feet. Next to each leveling foot is a hole for securing the sensor to a flat surface. The CM241 mounting bracket offered by Campbell Scientific allows the RainVUE-series to be mounted on a CM300-series mounting pole or to a user-supplied 1.5 in. IPS (1.9 in. OD) unthreaded pipe.

Mounting poles are placed directly into a concrete foundation, attached to a concrete foundation with the J-bolts, or are self-supporting with three legs (see [FIGURE 7-1](#) (p. 9)).

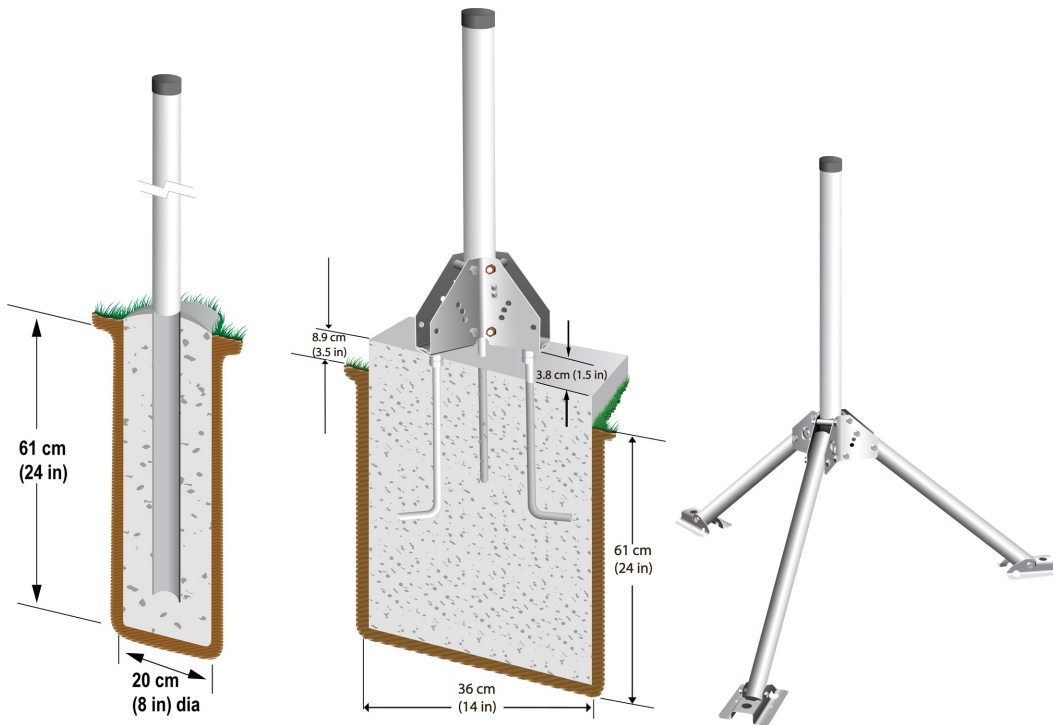


FIGURE 7-1. CM300-series mounting options

Procedure for mounting to a CM241 bracket and leveling the sensor:

1. Loosen and remove the three base thumb screws then lift the funnel upward.



FIGURE 7-2. Thumbscrew on RainVUE 20

2. Remove the wing nuts and washers from the CM241 mounting bracket.

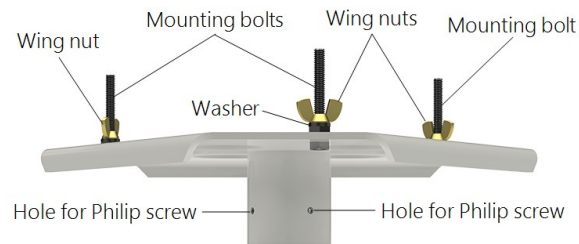
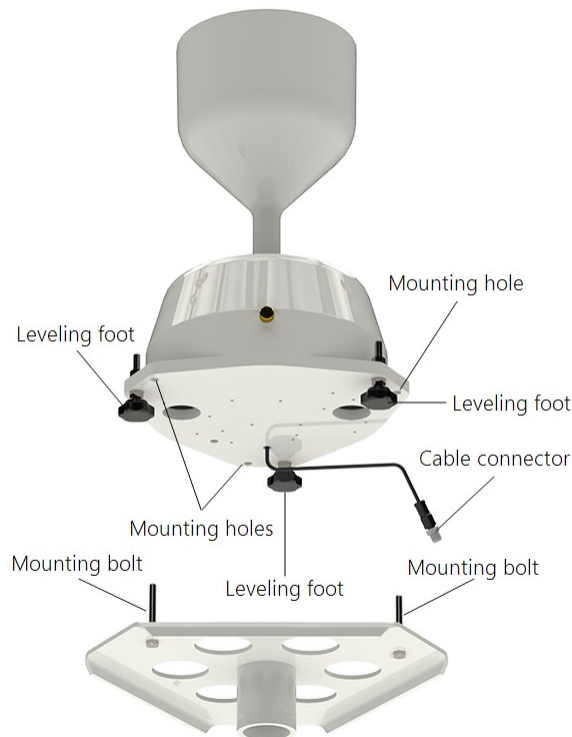


FIGURE 7-3. CM241 mounting bracket

3. Line up the RainVUE-series mounting holes over the CM241 mounting bolts and place the sensor on the bracket.



*FIGURE 7-4. Exploded view of RainVUE-series and CM241 bracket.
Wing nuts and pole not shown.*

4. Loosely secure the RainVUE-series to the CM241 using the washers and wing nuts.
5. Place the CM241 on the pole or pipe and secure it to the pole or pipe by tightening the screws with a Philips screwdriver (see [FIGURE 7-3](#) (p. 10) and [FIGURE 7-7](#) (p. 12)).

- Adjust the three leveling feet on the RainVUE-series to level the RainVUE-series. The RainVUE 10 has a bubble level next to a leveling foot. On the RainVUE 20, the funnel needs to be removed to view the bubble level. See [FIGURE 7-5](#) (p. 11).



FIGURE 7-5. Bubble levels on the RainVUE-series

- Once level, tighten the wing nuts by hand until hand-tight and recheck the level.
- Remove the piece of foam from under the tipping mechanism. This foam may be saved and used whenever the sensor is transported.
- Tip the tipping assembly several times to ensure the tipping mechanism is moving freely.

10. Pull and remove the insulator tab used to prevent draining of the backup coin cell battery during shipping and storage. The tab extends from the bottom of the RainVUE-series interface inside the RainVUE-series.



FIGURE 7-6. RainVUE-series interface and insulator tab

11. Replace the funnel and tighten the three base thumb screws to secure the funnel to the base.



FIGURE 7-7. RainVUE-series mounted on a pole

12. Mate the extension cable connector to the cable connector. Only hand tighten the connectors.

8. Operation

This section discusses the following:

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8.1 SDI-12 measurements

The RainVUE-series responds to the SDI-12 measurement commands shown in [Table 8-1](#) (p. 14). When the data logger issues an **M!** command, the sensor should respond immediately indicating how long it will take to perform the measurement. The data logger then waits that amount of time or if the sensor finishes sooner, it will send a service request to the data logger indicating data can be collected. After receiving the service request or waiting the indicated time, the data logger will send the **D!** command to collect the data.

The **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 retrieves the data with the **D!** command on the next scan through the program. Another measurement request is then sent so that data are ready on the next scan.

NOTE:


[SDI-12 sensor support](#) (p. 34) describes the SDI-12 commands. Additional SDI-12 information is available at www.sdi-12.org .

Table 8-1: SDI-12 measurement commands

SDI-12 command ¹	Values returned	Units	Comments
<i>aM!</i> , <i>aMC!</i> , <i>aC!</i> , <i>aCC!</i> , <i>aRO!</i> , <i>aRCO!</i>	<ol style="list-style-type: none"> Intensity corrected accumulation since last M, MC, C, CC, RO, or RCO command was issued. Number of raw bucket tips since last measurement Total intensity corrected accumulation since reset Average precipitation intensity since last measurement Maximum (peak) intensity since last measurement 	<ol style="list-style-type: none"> mm or inch Counts mm or inch mm/hr or in/hr mm/hr or in/hr 	Command resets accumulators
<i>aM1!</i>	<ol style="list-style-type: none"> Supply voltage Temperature Sensor level Time since last measurable precipitation event Lithium battery voltage 	<ol style="list-style-type: none"> VDC °C Degrees from normal, flat Days VDC 	
<i>aMC1!</i> , <i>aC1!</i> , <i>aCC1!</i> , <i>aRC1!</i>	<ol style="list-style-type: none"> Supply voltage Temperature Sensor level Time since last measurable precipitation event Lithium battery voltage 	<ol style="list-style-type: none"> VDC °C Degrees from normal, flat Days VDC 	Command resets accumulators

Table 8-1: SDI-12 measurement commands			
SDI-12 command ¹	Values returned	Units	Comments
<i>aR9!</i>	<ol style="list-style-type: none"> Intensity corrected accumulation since last M command was issued Number of raw bucket tips since last measurement Total intensity corrected accumulation since reset Average precipitation intensity since last measurement Maximum (peak) intensity since last measurement 	<ol style="list-style-type: none"> mm or inch Counts mm or inch mm/hr or in/hr mm/hr or in/hr 	Command does not reset accumulators
<i>aI!</i>	014CampbellMMMM100SN=xxxxxx Where, MMMM = RV20IN, RV20MM, RV10IN, or RV10MM xxxxxx = serial number	not applicable (NA)	
<i>aV!</i>	<ol style="list-style-type: none"> Hardware Revision starting at 1 Reset Code <ul style="list-style-type: none"> 2 = Power On 11=OS Update 12=Watchdog Timeout 	NA	

¹a is the sensor address.

8.2 SDI-12 extended commands

Enter the following SDI-12 extended commands using the transparent mode 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. Refer to [SDI-12 transparent mode](#) (p. 40) for more information.

Table 8-2: SDI-12 extended commands		
SDI-12 command ¹	Values returned or function	Comments
<i>aXRDT!</i>	Read sensor date and time.	
<i>aXWDT+MM/DD/YYYY hh:mm:ss!</i>	Write date and time.	
<i>aXWARA!</i>	The extended write adjusted rainfall accumulator command. Resets the total adjusted rain accumulator to 0.00.	Typically this command is issued on the start of the water year, which is normally October 1 or January 1.
<i>aXWA+xx.xx!</i> Where <i>xx.xx</i> = current rain value	Resets the total adjusted rain to a current value and returns the number of values. Follow this command with the <i>aDO!</i> command to get the new adjusted rain.	Used when replacing the RainVUE-series midway through a water year.
<i>aXWRESET!</i>	Resets all accumulators	
<i>aXWD!</i>	Resets RTC or 24 hour tick counter to midnight.	This command is a simple way for data loggers to sync the time clock without having to format the SDI-12 command.
<i>aXWTILT!</i>	Zero tilt sensor (XWTILT) status. Returns a status flag indicating the success of the leveling process. s = 0 Success s = 1 Error (cannot zero the sensor)	Mechanically balance the sensor, then issue this command.
<i>aXRTILT!</i>	Reads the tilt angle (degrees) of the tilt sensor.	When this command is issued right after the sensor is zeroed, it should return 0.00 degrees. This command verifies the RainVUE-series is level.

Table 8-2: SDI-12 extended commands		
SDI-12 command ¹	Values returned or function	Comments
<i>aXTEST!</i>	Returns two lines of header information, then returns updated data at every tip and every 2 seconds or until a break is detected with each line terminated with a <CR><LF>.	Command is only intended for testing and debugging the sensor.
<i>aXHELP!</i>	Lists the standard measurement and extended commands supported by the RainVUE-series.	Command is only intended for testing and debugging the sensor.

¹a is the sensor address.

8.3 SDI-12 version 1.4 identify measurement commands and responses

Version 1.4 compliant sensors must respond to identify commands for each type of measurement command and each parameter with a command. The broad identify commands return how many variables will be returned with a given measurement command and the time it will take the sensor to respond. The specific identify parameter commands will return a SHEF code, the measurement units, and the type of measurement (sample, count, or average). For more information see the SDI-12 version 1.4 specification.

(http://sdi-12.org/current_specification/SDI-12_version-1_4-Jan-10-2019.pdf)

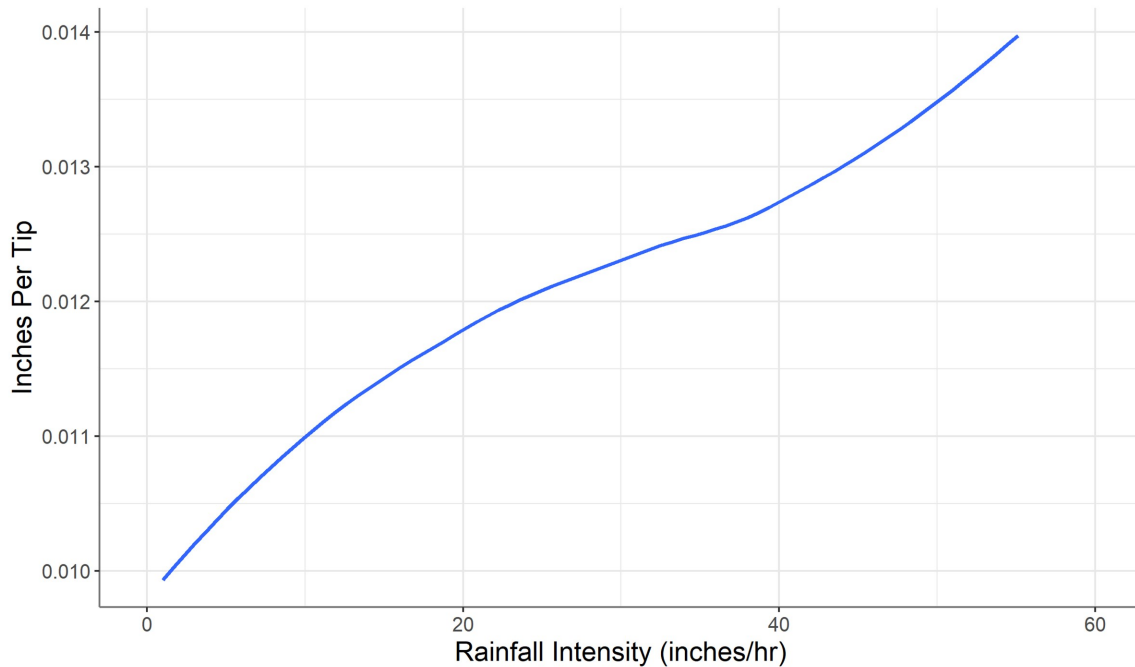
Table 8-3: Identify commands for the RainVUE-series			
Type of command	Command	Sensor response	Comment
Identify measurement for M commands	<i>aIM!</i> , <i>aIMC!</i> , <i>aM1!</i> , <i>aIMC1!</i>	atttn	ttn: response time (seconds) n: # of values returned
Identify measurement for C commands	<i>aIC!</i> , <i>aICC!</i> , <i>aIC1!</i> , <i>aICC1!</i>	atttnn	ttn: response time (seconds) nn: # of values returned

Table 8-3: Identify commands for the RainVUE-series

Type of command	Command	Sensor response	Comment
Identify measurement for the V command	<i>aIV!</i>	atttn	ttt: response time (seconds) n: # of values returned
Identify measurement for parameter 1 of M command	<i>aIM_001!</i>	aAdjRain, Inches or aAdjRain, mm	AdjRain: adjusted or intensity-corrected precipitation since last measurement Units: inches or mm
Identify measurement for parameter 2 of M command	<i>aIM_002!</i>	aRawTips, Tips	RawTips: number of raw bucket tips since last measurement (counts) Units: counts
Identify measurement for parameter 3 of M command	<i>aIM_003!</i>	aTotAdjRain, Inches or aTotAdjRain, mm	TotAdjRain: total adjusted or total intensity corrected precipitation since last reset Units: inches or mm
Identify measurement for parameter 4 of M command	<i>aIM_004!</i>	aAvgInt, Inches/Hour or aAvgInt, mm/Hour	AvgInt: average precipitation intensity since last measurement Units: inches/hour or mm/hour
Identify measurement for parameter 5 of M command	<i>aIM_005!</i>	aMaxInt, Inches/Hour or aMaxInt, mm/Hour	MaxInt: maximum peak precipitation intensity since last measurement Units: inches/hour or mm/hour

8.4 Rainfall intensity correction

During intense rainfall, extra water can accumulate in the bucket before the tipping mechanism tips. The following graph shows the relationship between bucket volume and rainfall rate. The RainVUE-series includes a microprocessor that corrects for the intensity sensitivity of the bucket mechanism. This correction adjusts the rainfall rate based on the time between bucket tips. An electronic timer precisely measures the time between tips.



8.5 *Device Configuration Utility*

Use *Device Configuration Utility* to change the SDI-12 address, view sensor measurements, collect data, and update an operating system (see [Updating operating system](#) (p. 28)).

1. Loosen and remove the three base thumb screws then lift the funnel upward.
2. Use a Philips screwdriver to remove the four screws on the RainVUE-series interface.

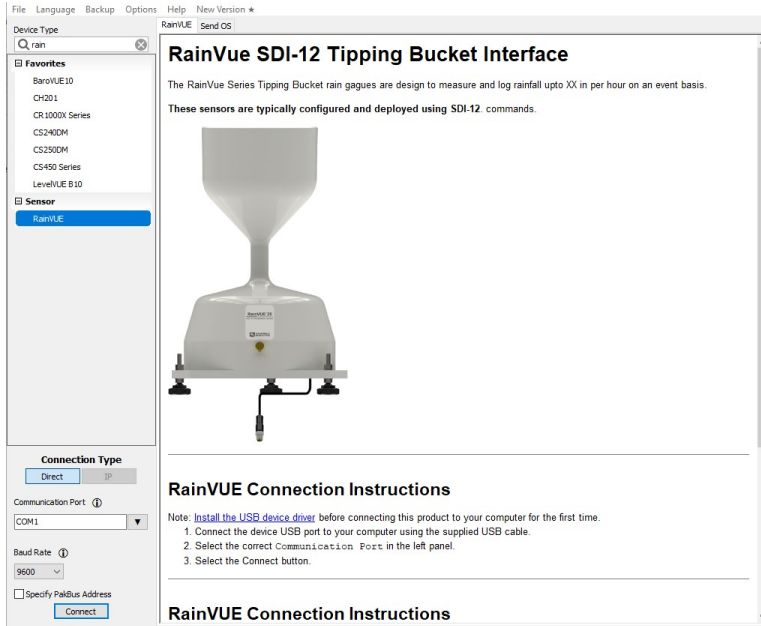


3. Remove the interface cover to access the USB port.



4. Open *Device Configuration Utility*.

5. Type RainVUE-series in the **Device Type** box and click RainVUE-series.



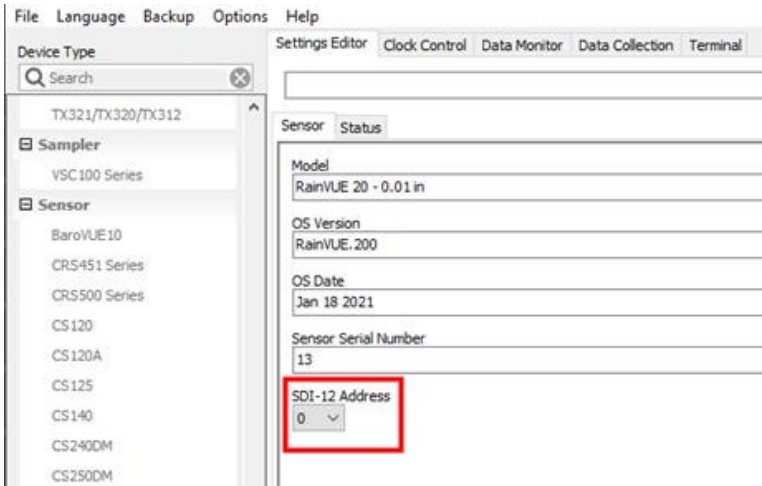
6. If this is the first time connecting the RainVUE-series to the computer, click **install USB driver for the RainVUE** before connecting the cable to the computer.
7. Use the supplied USB cable to connect the RainVUE-series USB port to a computer USB port.
8. Select the **Communication Port** in the left panel. **RAINVUE** will appear in the selection dialog.

NOTE:

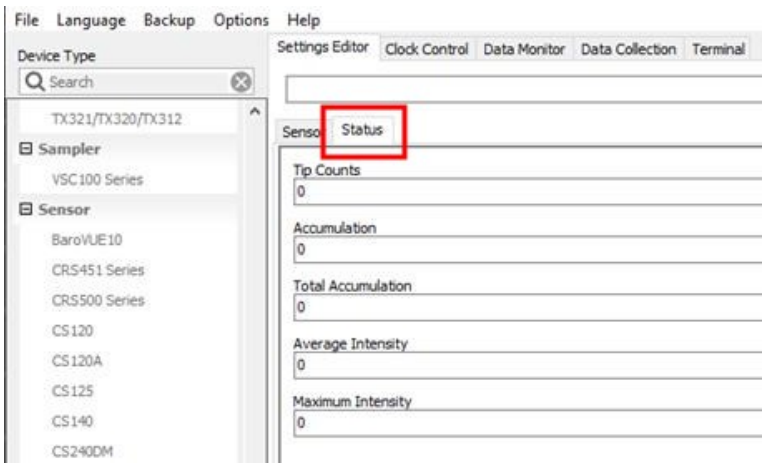
It may take a few seconds for the **Communication Port** to become available for use after physically connecting the RainVUE-series to the computer.

9. Click **Connect**.

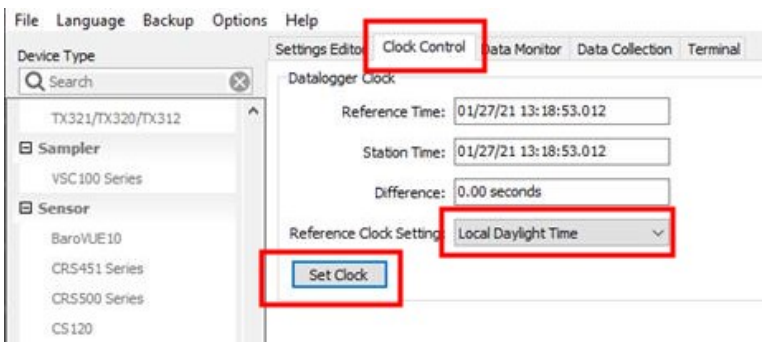
10. To change the SDI-12 address, click the **SDI-12 Address** box and select a different value.



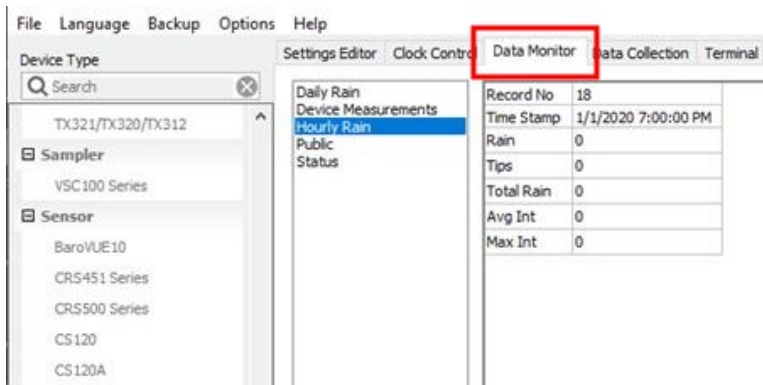
11. Click the **Status** tab to view tip counts, accumulation, and intensity information.



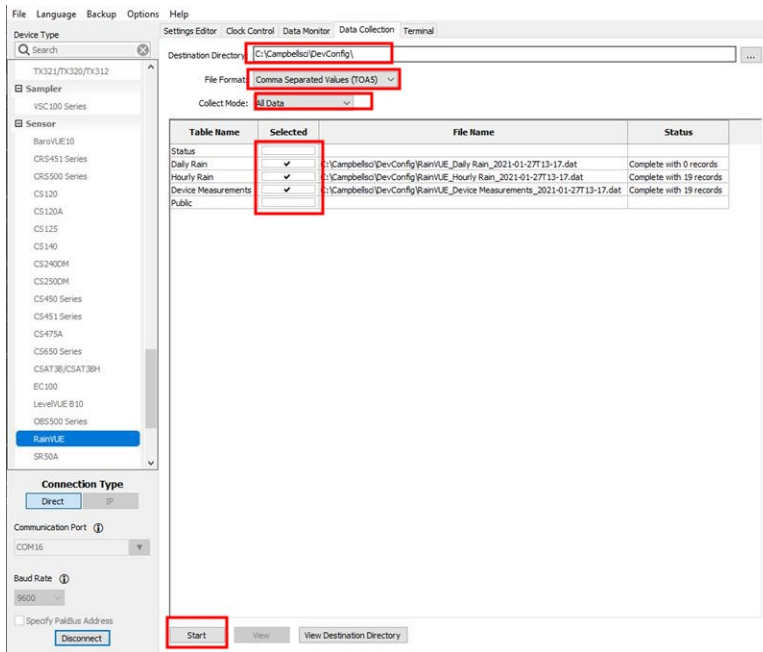
12. Click the **Clock Control** tab to change the **Reference Clock Setting**. Click **Set Clock** to manually initiate a clock check of the reference time and station time.



- Click the **Data Monitor** tab to view real-time data. From the list, select the table you want to display.



- Click the **Data Collection** tab to manually collect data. Check the **Destination Directory** and **File Format** to make sure the files are where you want them and in the right format. Select the **Collect Mode**, tables, then click **Start**.



The following shows data collected from an hourly rain table.

```
RainVUE_Hourly Rain_2021-02-17.dat - Notepad
File Edit Format View Help
"TOA5","RainVUE","201","200","RainVUE.201","RainVUE","58570","Hourly Rain"
"TIMESTAMP","RECORD","Rain","Tips","Total Rain","Avg Int","Max Int"
"TS","RN","Inches","Tips","Inches","In/Hr","In/Hr"
"","","Smp","Smp","Smp","Smp","Smp"
"2021-02-16 13:00:00",194,0.08018232,8,0.08018232,0.9281653,2.487704
"2021-02-16 14:00:00",195,1.405512,140,1.485694,1.436232,2.492251
"2021-02-16 15:00:00",196,1.199677,119,2.685371,1.779221,2.219253
"2021-02-16 16:00:00",197,0.6451383,64,3.330509,1.661599,4.781378
"2021-02-16 17:00:00",198,1.538052,153,4.868562,1.563827,2.793025
"2021-02-16 18:00:00",199,0.4801372,48,5.348699,1.203217,1.375089
"2021-02-16 19:00:00",200,0,0,5.348699,0,0
"2021-02-16 20:00:00",201,0,0,5.348699,0,0
"2021-02-16 21:00:00",202,0,0,5.348699,0,0
"2021-02-16 22:00:00",203,0,0,5.348699,0,0
"2021-02-16 23:00:00",204,0,0,5.348699,0,0
"2021-02-17 00:00:00",205,0,0,5.348699,0,0
"2021-02-17 01:00:00",206,0,0,5.348699,0,0
"2021-02-17 02:00:00",207,0,0,5.348699,0,0
"2021-02-17 03:00:00",208,0,0,5.348699,0,0
"2021-02-17 04:00:00",209,0,0,5.348699,0,0
"2021-02-17 05:00:00",210,0,0,5.348699,0,0
"2021-02-17 06:00:00",211,0,0,5.348699,0,0
"2021-02-17 07:00:00",212,0,0,5.348699,0,0
"2021-02-17 08:00:00",213,0,0,5.348699,0,0
"2021-02-17 09:00:00",214,0,0,5.348699,0,0
"2021-02-17 10:00:00",215,0,0,5.348699,0,0
"2021-02-17 11:00:00",216,0,0,5.348699,0,0
"2021-02-17 12:00:00",217,0.3263632,31,5.675062,5.540471,20.95949
"2021-02-17 13:00:00",218,0.2610095,26,5.936072,1.257819,2.204605
```

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.

This section discusses the following:

9.1 Maintenance	25
9.2 Troubleshooting	29

9.1 Maintenance

To ensure reliable and accurate measurements, Campbell Scientific recommends doing the following every month.

1. Check the integrity of the cable and data logger connections. Replace cable if damaged.
2. Inspect the funnel for any damage or blockage. To clear a blockage, remove the funnel from the base and remove debris.
3. Check and clean the filters (see the following section).
4. Level the RainVUE-series if necessary (see **aXWTILT!** and **aXRTILT!** command in [Table 8-2](#) (p. 16)). The RainVUE 10 has a bubble level next to a leveling foot. On the RainVUE 20, the funnel needs to be removed to view the bubble level.
5. Clean dirt from the tipping bucket. Avoid tipping the bucket if the RainVUE-series is still connected to the data logger.
6. If the data logger is disconnected, check the tipping mechanism for stiffness.
 - a. Try to balance the bucket in its center position. It should be extremely difficult or impossible to balance.
 - b. If the bucket balances easily, closely examine the tipping bucket assembly for dirt or wear on the pivot pin and bucket tubs.

9.1.1 Cleaning and replacing filters

The RainVUE-series has both a funnel filter and a stainless-steel, mesh-screen filter (see the following figures). The mesh screen should be regularly cleaned and both filters can be replaced if damaged or lost.

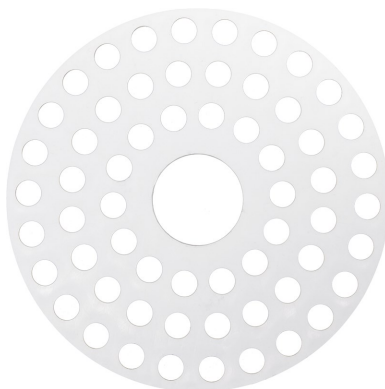


FIGURE 9-1. Funnel filter

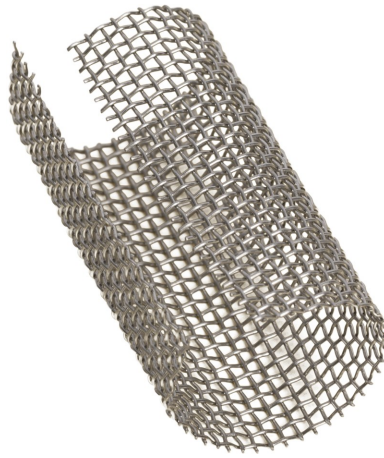
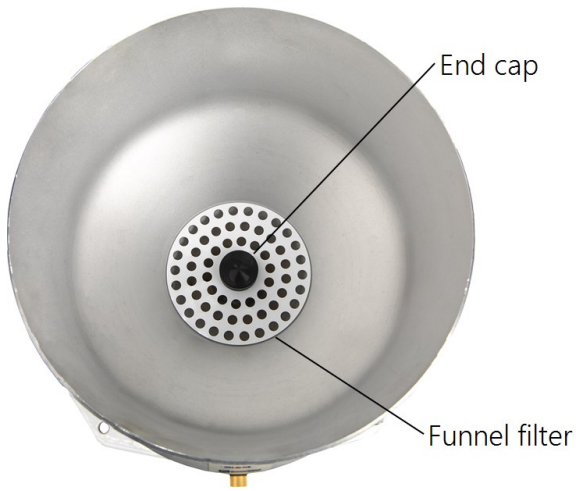


FIGURE 9-2. Stainless-steel mesh screen filter

Filter cleaning and replacement procedure:

1. Unscrew the end cap from the filter tube.



2. Remove the funnel filter.

3. Carefully, remove the stainless-steel mesh screen from the filter tube.



4. Gently clean mesh screen.
5. Place mesh screen in filter tube.
6. Place funnel filter in the funnel.
7. Screw on the end cap.

9.1.2 Internal lithium battery

An internal lithium coin cell battery powers the RainVUE-series during power loss of the main 12 V power source. The battery allows the RainVUE-series to capture rain events for 12 to 15 days depending on battery age, temperature, and frequency of rain detections and SDI-12 measurement request.

The **M1!** and **IM1_005!** SDI-12 commands report the lithium battery voltage (see [Table 8-1](#) (p. 14) and [Table 8-3](#) (p. 17)). Replace the battery when voltage is approximately 2.7 VDC.

Campbell Scientific recommends replacing the battery every 2 to 3 years and after each loss of power event. High temperature can reduce the battery life and low temperatures can decrease battery capacity lowering available power and sensor runtime.

Remove the backup battery when the sensor is removed from service. Replace the battery when the RainVUE-series is placed back in service.

Battery replacement procedure:

1. Loosen and remove the three base thumb screws then lift the funnel upward.
2. Use a Philips screwdriver to remove the four screws on the RainVUE-series interface.



3. Remove the interface cover.
4. Replace the old lithium battery with the new battery (3 V Coin Cell CR2032).

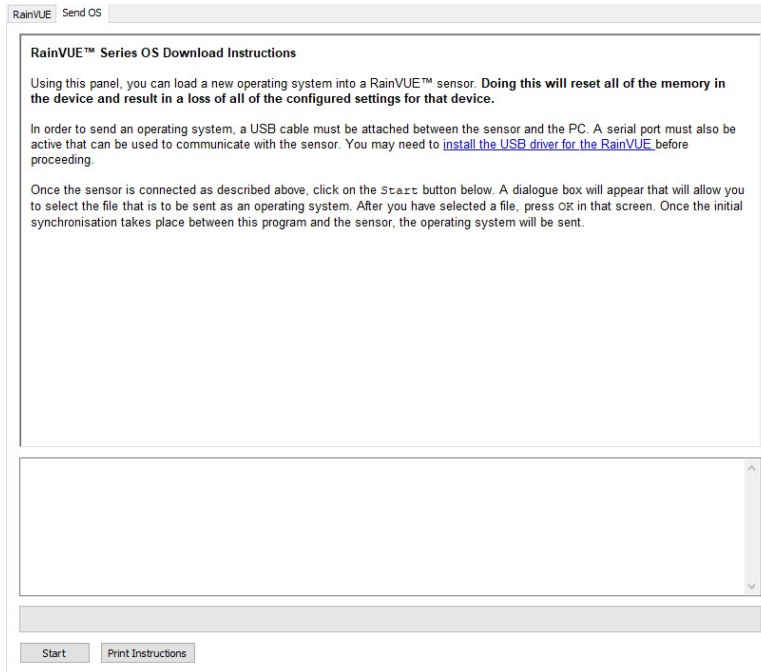


5. Place the interface cover on the interface and secure with the four screws.
6. Replace the funnel and tighten the three base thumb screws to secure the funnel to the base.

9.1.3 Updating operating system

1. Go to www.campbellsci.com/downloads/rainvue-os, click **Download Now**, and click **Save File**. This will download an .exe file on your computer.
2. Double-click the .exe file. This will save the operating system file in C:/Campbellsci/Lib/OperatingSystems.
3. Access *Device Configuration Utility* (see [Device Configuration Utility](#) (p. 19)).

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



5. Click **Start**
6. Select the file. It will have an .a43 extension.
7. Click **OK**.

9.2 Troubleshooting

Symptom:

On a CRBasic data logger, data values report NAN, or on a non-Campbell Scientific data logger, data values do not change when the tipping mechanism is activated and new measurement commands are issued.

Solution:

1. Verify the RainVUE-series is wired correctly ([Table 7-1](#) (p. 6)).

NOTE:

Connect the power wire to the data logger **12V** terminal and not the **SW12** terminal.

2. Verify the power to the RainVUE-series is in the appropriate range (6 to 18 VDC).
3. Verify the correct SDI-12 address is being used when communicating with the RainVUE-series. Use the transparent mode to verify the data logger can communicate with the it. For additional information, refer to [SDI-12 transparent mode](#) (p. 40).

Symptom:

Reported data values are lower than expected.

Solution:

1. Ensure that the filter is clean and allows water to flow through it.
2. Check that the tipping mechanism can move freely.
3. Use a voltmeter on the switch to verify the switch is activated as expected while transitioning from one side to the other. While the tipping mechanism is in its resting positions, the volt meter should read 3 to 5 V. When at the mid- point as it transitions from one side to the other side, the volt meter should read 0 V.
4. Ensure that the RainVUE-series is level. The RainVUE 10 has a bubble level next to a leveling foot. On the RainVUE 20, the funnel needs to be removed to view the bubble level.
5. Check the wires and connections between the switch and the interface are secure.
6. Verify no obstacles are preventing rain from entering the funnel.

Symptom:

Reported data values are higher than expected.

Solution:

1. Verify the tipping mechanism is not stuck near the center of its movement from one side to the other.
2. Verify that the wires and connections between the switch and the interface are secure.
3. Verify that the RainVUE-series is not under a structure that will drip into it.

For more information refer to:

www.campbellsci.com/videos/sdi12-sensors-transparent-mode 

www.campbellsci.com/videos/sdi12-sensors-watch-or-sniffer-mode 

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


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

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

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

NOTE:

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

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information into it.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the [CRBasic | Features](#) video .

Appendix B. XTEST! operation

Use the **XTEST!** SDI-12 command to validate the calibration. Enter this command in the transparent mode while the computer is communicating with the data logger through a terminal emulator program.

This command displays simulated rain fall data that does not affect rain accumulators used for the normal operation. It runs for 60 minutes then returns to normal operation. The **XTEST!** command can also be aborted by a break on the SDI-12 data line. Therefore, suspend the data logger program before you begin field calibration.

To validate the calibration, first run a fixed amount of water through the RainVUE-series, then use the **XTEST!** command and compare the results. A common amount of simulated rain is 946 ml which equates to 115 tips on the 0.01 inch rain gauge at a rate of 2 inches of rain per hour or slower.

Initially, the command sends the following header information.

Raw Tip	Corrected Rain Fall	Total Rain Fall	Balance
--------------------	--------------------------------	----------------------------	----------------

For each second or each tip detected, the command displays a new line of data, such as the following.

Raw Tip	Corrected Rain Fall	Total Rain Fall	Balance
0	0.000	0.000	0
0	0.000	0.000	0

Eventually, the numbers should start changing and the latest data should give an indication of how close the gauge is to calibration.

Raw Tip	Corrected Rain Fall	Total Rain Fall	Balance
0	0.000	0.000	0
0	0.000	0.000	0
1	0.010	0.010	33
2	0.011	0.021	68
3	0.011	0.032	51
4	0.012	0.044	50
5	0.010	0.054	51
6	0.011	0.065	49
8	0.023	0.088	51
110	0.011	1.180	51
111	0.011	1.191	50
112	0.011	1.202	51
113	0.012	1.214	51
114	0.010	1.224	51
114	0.000	1.224	51
114	0.000	1.224	51

The corrected rain fall and total rain fall values include intensity correction. When the simulated rain is ran through the gauge at a fast rate, the number of tips may be lower than expected, but the corrected rain fall should be close to the actual amount of simulated rain.

The balance value represents how balanced the tipping mechanism is as it tips from one side to the other. If the gauge needs to be adjusted, it is best to try to keep the balance as close to 50% as possible. The balance value is only valid if the simulated rain is being applied at a constant rate. It is best to look at this value after the test has been running for consistently for a few tips.

Appendix C. SDI-12 sensor support

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

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

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

C.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 C-1](#) (p. 34).

Name	Command	Response ¹
Acknowledge Active	a!	a<CR> <LF>
Send Identification	aI!	allccccccmmmmmmvvvxxx...xx <CR> <LF>
Start Verification	aV!	attn <CR> <LF>

Table C-1: Campbell Scientific sensor SDI-12 command and response set

Name	Command	Response ¹
Address Query	?!	a<CR><LF>
Change Address	aAb!	b<CR><LF>
Start Measurement	aM! aM1! . . . aM9!	attn<CR><LF>
Start Measurement and Request CRC	aMC! aMC1! . . . aMC9!	attn <CR><LF>
Start Concurrent Measurement	aC! aC1! . . . aC9!	attnn<CR><LF>
Start Concurrent Measurement and Request CRC	aCC! aCC1! . . . aCC9!	attnn<CR><LF>
Send Data	aD0! . . . aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
Continuous Measurement	aR0! . . . aR9!	a<values><CR><LF>
Continuous Measurement and Request CRC	aRC0! . . . aRC9!	a<values><CRC><CR><LF>
Extended Commands	aXNNN!	a<values><CR><LF>
¹ Information on each of these commands is given in the following sections.		

C.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.

C.1.2 Send identification command (aI!)

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

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

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

C.1.3 Start verification command (aV!)

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

Command: **aV!**

Response: *attn*<CR><LF>

a = sensor address

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

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

C.1.4 Address query command (?!)

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

C.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.

C.1.6 Start measurement commands (aM!)

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

a = sensor address

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

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

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

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

C.1.7 Start concurrent measurement commands (aC!)

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

a = the sensor address

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

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

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

Table C-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 C-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.

C.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** or **R** commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within 3 characters appended before the <CR><LF>. This code is not returned in the data table but checked by the data logger as it comes. The code returned is based on the SDI-12 protocol. See the SDI-12 communication specification for version 1.4 available at www.sdi-12.org to learn more about how the CRC code is developed.

C.1.9 Stopping a measurement command

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

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

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

The Send Data command requests data from the sensor. It is issued automatically with every type of measurement command (**aM!**, **aMC!**, **aC!**, **aCC!**). When the measurement command is **aM!** or **aMC!**, the data logger issues the **aD0!** command once a service request has been received from the sensor or the reported time has expired. When the data logger is issuing concurrent commands (**aC!** or **aCC!**), the Send Data command is issued after the required time has elapsed (no service request will be sent by the sensor). In transparent mode (see [SDI-12 transparent mode](#) (p. 40)), the user asserts this command to obtain data.

Depending on the type of data returned and the number of values a sensor returns, the data logger may need to issue **aD0!** up to **aD9!** to retrieve all data. A sensor may return up to 35

characters of data in response to a **D** command that follows an **M!** or **MC!** command. A sensor may return up to 75 characters of data in response to a **D** command that follows a **C!** or **CC!** command. Data values are separated by plus or minus signs.

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

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

where:

a = the sensor address

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

<CR><LF> = terminates the response

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

C.1.11 Continuous measurement command (aR0! ... aR9!)

Sensors that are able to continuously monitor the phenomena to be measured can be read directly with the **R** commands (**R0!** ... **R9!**). The response to the **R** commands mirrors the Send Data command (**aD0!**). A maximum of 75 characters can be returned in the *<values>* part of the response to the **R** command.

C.1.12 Extended commands

Many sensors support extended SDI-12 commands. An extended command is specific to a make of sensor and tells the sensor to perform a specific task. They have the following structure. Responses vary from unit to unit. See the sensor manual for specifics.

Command: **aXNNNN!**

The command will start with the sensor address (**a**), followed by an **X**, then a set of optional letters, and terminate with an exclamation point.

Response: *a<optional values><CR><LF>*

The response will start with the sensor address and end with a carriage return/line feed.

C.2 SDI-12 transparent mode

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

Transparent mode is entered while the computer is communicating with the data logger through a terminal emulator program. It is accessed through Campbell Scientific data logger support software or other terminal emulator programs. Data logger keyboards and displays cannot be used.

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

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

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

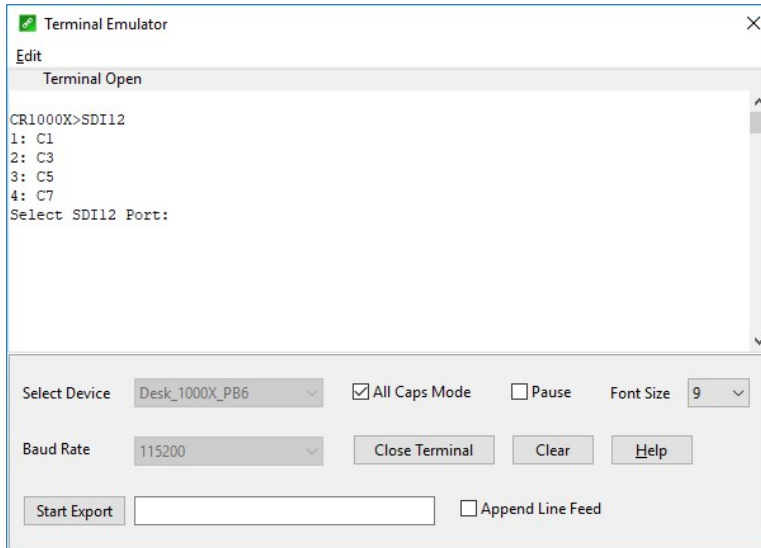
The following examples show how to enter transparent mode and change the SDI-12 address of an SDI-12 sensor. The steps shown in [Changing an SDI-12 address](#) (p. 41) are used with most Campbell Scientific data loggers.

C.2.1 Changing an SDI-12 address

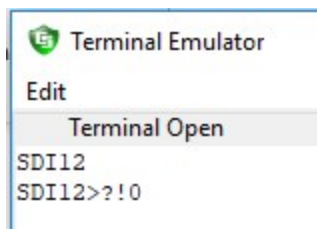
This example was done with a CR1000X, but the steps are only slightly different for CR6, CR3000, CR800-series, CR300-series, CR1000 data loggers.

1. Connect an SDI-12 sensor to the CR1000X.
2. In **LoggerNet Connect**, under **Datalogger**, click **Terminal Emulator**. The terminal emulator window opens.
3. Under **Select Device**, located in the lower left side of the window, select the **CR1000X**.
4. Click **Open Terminal**.
5. Select **All Caps Mode**.
6. Press Enter until the data logger responds with the **CR1000X>** prompt.

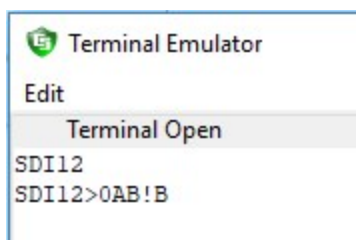
7. Type **SDI12** and press Enter.



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



10. 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.




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

NOTE:

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

C.3 References

SDI-12 Support Group. SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors – Version 1.4. River Heights, UT: SDI-12 Support Group, 2017. http://www.sdi-12.org/current_specification/SDI-12_version-1_4-Dec-1-2017.pdf .

Limited warranty

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


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

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Assistance

Products may not be returned without prior authorization.

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

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

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

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

Safety

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

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

General

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

Utility and Electrical

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

Elevated Work and Weather

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

Maintenance

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

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

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



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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.com
Website: www.campbellsci.com

France

Location: Vincennes, 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: Shepshed, 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