PRODUCT MANUAL

Sensor

CMP10

Pyranometer

Revision: 10/2024

RELIABLE MONITORING SINCE 1974

Campbell Scientific®

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 CMP10 is designed for continuous outdoor monitoring of solar radiation intensity. A flat spectral sensitivity from 285 to 2800 nm enables accurate measurements in natural sunlight, under plant canopies, and in green houses or buildings. When inverted, the pyranometer can measure reflected solar radiation. Applications include monitoring global horizontal irradiance (GHI) and plane-of-array irradiance (POA). Diffuse sky radiation can also be measured with the use of a shade mechanism.

> NOTE:
> This manual provides information only for CRBasic data loggers. For Edlog data logger support, see a retired manual at www.campbellsci.com\old-manuals.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Although the CMP10 is rugged, it should be handled as a precision scientific instrument.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.
- Pyranometers purchased from Campbell Scientific have different wiring than pyranometers purchased directly from Kipp & Zonen.

3. Initial inspection

- Upon receipt of the CMP10, inspect the packaging and contents for damage. File damage claims with the shipping company.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the correct product and cable length are received.

3.1 Calibration certificate

The pyranometer is shipped with an instruction manual provided by Kipp & Zonen that contains information concerning its construction, spectral sensitivity, cosine response, and a simple sensor check out procedure. Included with the sensor and manual is a calibration certificate with the sensor sensitivity value and serial number.

> NOTE:
> Cross check this serial number against the serial number on your pyranometer to ensure that the given sensitivity value corresponds to your sensor.

4. QuickStart

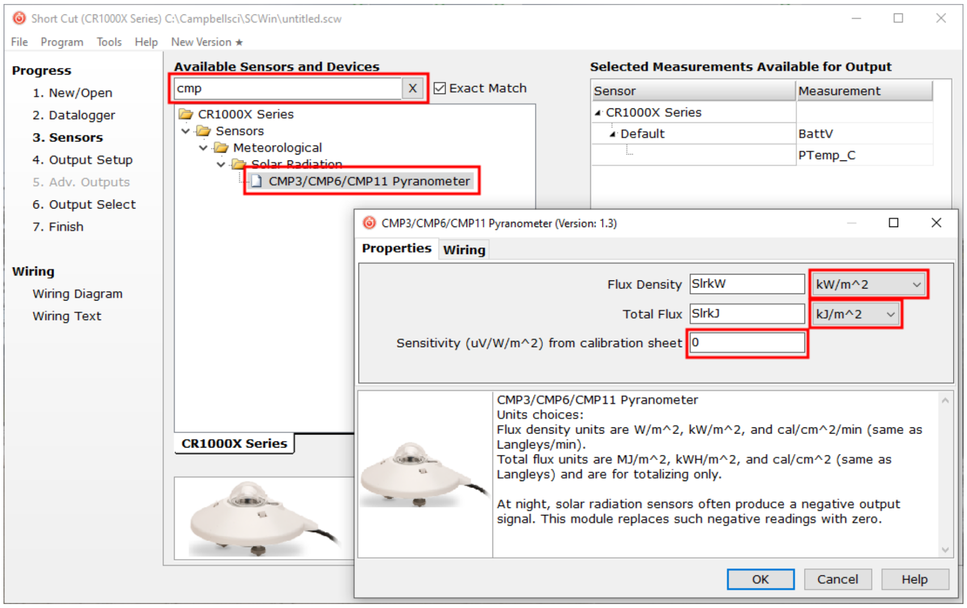
A video that describes data logger programming using ***Short Cut*** is available at: www.campbellsci.com/videos/cr1000x-datalogger-getting-started-program-part-3. ***Short Cut*** is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. ***Short Cut***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

The following procedure also describes using ***Short Cut*** to program the pyranometer.

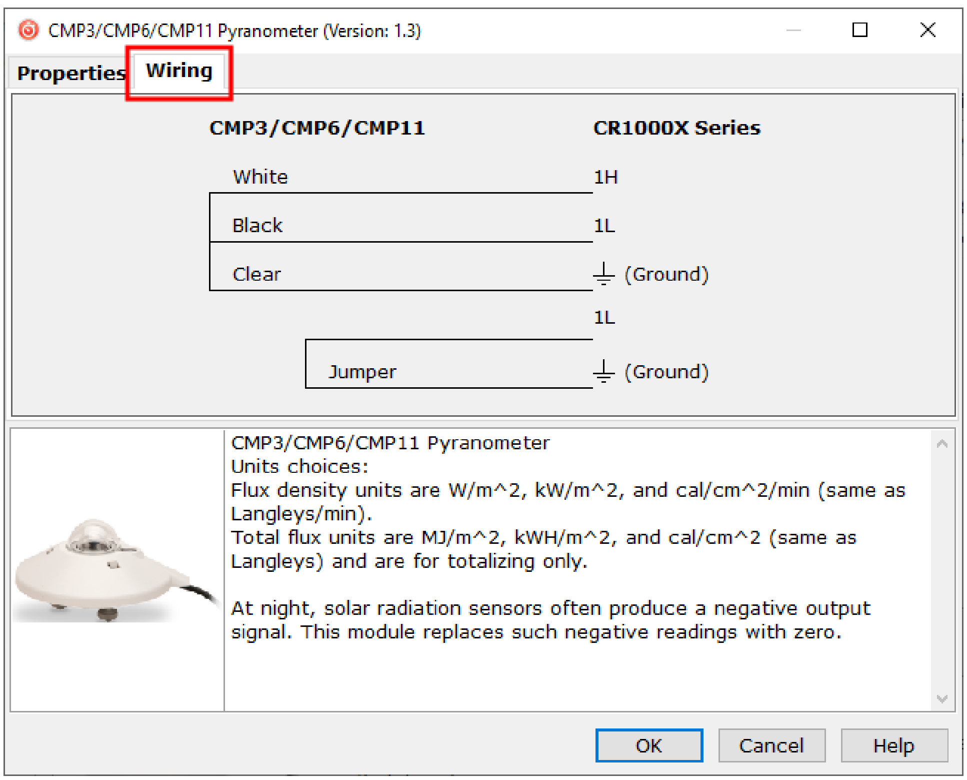
1. Open ***Short Cut*** and click **Create New Program**.
2. Double-click the data logger model.
3. In the **Available Sensors and Devices** box, type CMP, or locate the sensor in the **Sensors** > **Meteorological** > **Solar Radiation** folder. Double-click **CMP3/CMP6/CMP11 Pyranometer**.

   > NOTE:
   > The CMP10 is not included in the sensor list. However, the CMP10 is programmed the same as the CMP3/CMP6/CMP11, and therefore a ***Short Cut*** program can be created for the CMP10 by selecting the **CMP3/CMP6/CMP11 Pyranometer**.

   Default units are kW/m^2 for flux density units and kJ/ m^2 for total flux. These can be changed by clicking the **Flux Density** and **Total Flux** boxes and selecting different values. A sensitivity value needs to be entered. This value is unique to each sensor and is listed on the calibration sheet that is included with the sensor.

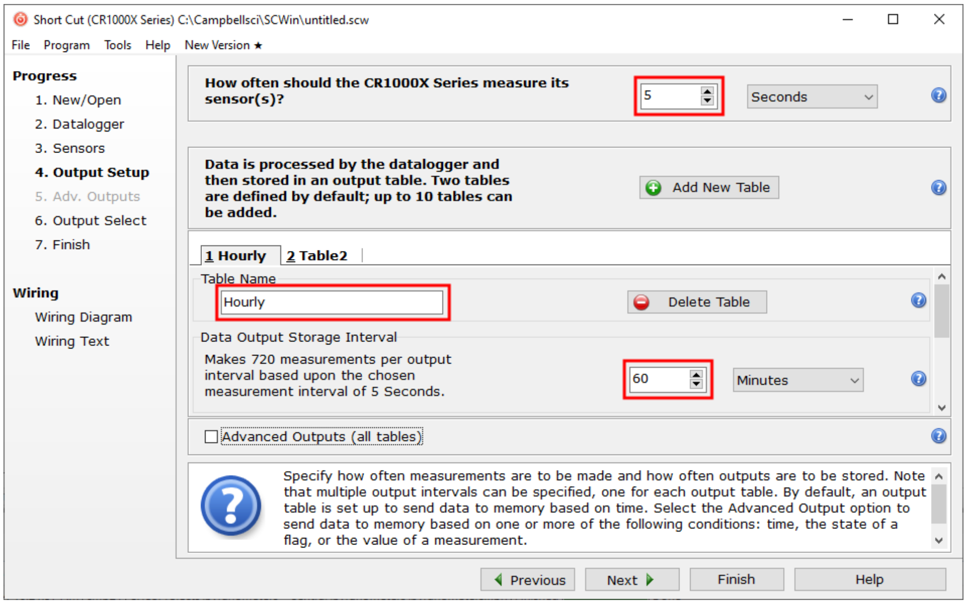


4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

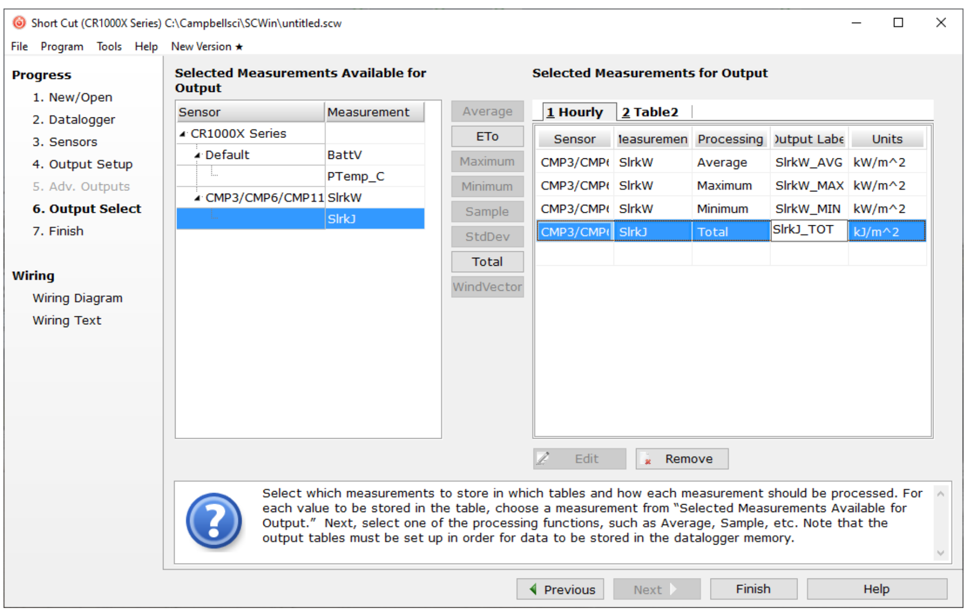


5. Repeat steps three and four for other sensors.

6. In **Output Setup**, type the scan rate, meaningful table names, and the **Data Output Storage Interval**.



7. Select the measurement and its associated output options.



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

9. If the sensor is connected to the data logger, check the output of the sensor in the data logger support software data display in ***LoggerNet***, ***RTDAQ***, or ***PC400*** to make sure it is making reasonable measurements.

NOTE:
Short Cut uses the execution interval to make total flux calculations (Table 7-2 [p. 10]). This needs to be taken into account while editing the **Short Cut** program.

5. Overview

The pyranometer consists of a thermopile sensor, housing, two glass domes, and cable. The thermopile is coated with a black absorbent coating. The paint absorbs the radiation and converts it to heat. The resultant temperature difference is converted to a voltage by the copper-constantan thermopile. The thermopile is encapsulated in the housing in such a way that it has a field of view of 180 degrees and the angular characteristics needed to fulfill the cosine response requirements.

The pyranometer is compatible with the optional CVF4 Heater/Ventilator Unit, which can keep their dome free from ice and dew (see CVF4 ventilation unit [p. 21]). In some applications, the CVF4 may also reduce the deposition of dust on the dome, and therefore reduce the cleaning interval frequency.

Features:

- Double glass dome
- Integrated bubble level is visible without removing sun shield
- Measures reflected solar radiation when inverted
- The CMP10 has an internal drying cartridge that will last for at least ten years if the housing is not opened. This significantly minimizes maintenance.
- Provides measurements in direct sunlight, under plant canopies, when the sky is cloudy, and in artificial light
- Compatible with Campbell Scientific CRBasic data loggers: CR6 series, CR1000X series, CR800 series, CR350 series, CR300 series, CR3000, and CR1000

6. Specifications

6.1 Pyranometer

Dimensions are shown in Figure 6-1 (p. 6).

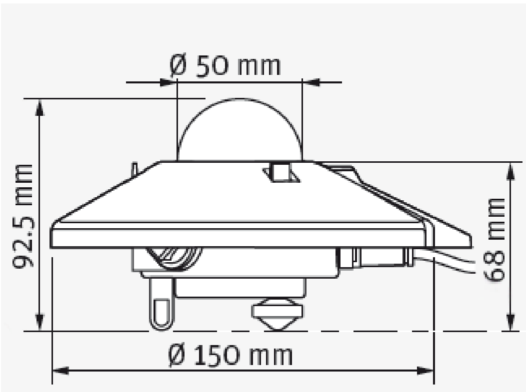


Figure 6-1. Dimensions

ISO classification:	Secondary Standard
Maximum irradiance:	4000 W/m^2
Spectral range (50% points):	285 to 2800 nm
Response time (95 %):	<5 s
Expected daily uncertainty:	<2%
Zero offset due to thermal radiation (200 W/m^2):	<7 W/m^2
Zero offset due to temperature change (5 K/hr):	<2 W/m^2
Non-stability (change/year):	<0.5%
Non-linearity (0 to 1000 W/m^2):	<0.2%
Directional error (up to 80° with 1000 W/m^2 beam):	<10 W/m^2
Tilt error (at 1000 W/m^2):	<0.2%

Level accuracy:	0.1°
Operating temperature:	–40 to 80 °C
Temperature dependence of sensitivity:	<1% (–10 to 40 °C)
Sensitivity:	7 to 14 µV / W/m^2
Typical signal output for atmospheric applications:	0 to 15 mV
Weight:	0.6 kg (1.3 lb) without cable; 0.9 kg (2 lb) with 10 m (33 ft) cable
Impedance[1]:	10 to 100 Ω
EU Declaration of Conformity:	View at: www.campbellsci.com/cmp10-l

[1] Impedance is defined as the total electrical impedance at the radiometer output connector fitted to the housing. It arises from the electrical resistance in the thermal junctions, wires, and passive electronics within the radiometer.

6.2 CVF4 ventilation unit

Power supply:	12 VDC, 0.9 A (with 5.5 W heater)
Operating temperature range:	–40 to 70 °C
Ventilation power:	5 W continuously
Heating power:	5.5 W
Heater induced offset:	<1 W/m^2
Weight without cable:	1.6 kg (3.5 lb)
Height:	12.95 cm (5.1 in)
Length:	35.5 cm (14.0 in)
Width:	23.0 cm (9.1 in)
EU Declaration of Conformity:	View at: www.campbellsci.com/cvf4-l

7. Installation

If you are programming the data logger with ***Short Cut***, skip Wiring (p. 8) and Programming (p. 9). ***Short Cut*** does this work for you. See QuickStart (p. 2) for a tutorial.

7.1 Wiring

NOTE:
Pyranometers purchased from Campbell Scientific have different wiring than pyranometers purchased directly from Kipp & Zonen.

Figure 7-1 (p. 8) provides a schematic of the thermopile contained in the pyranometer.

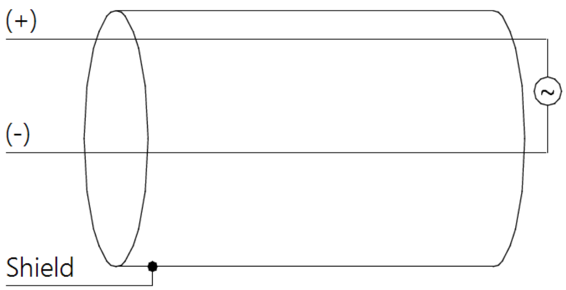


Figure 7-1. Thermopile detector schematic

Connections to Campbell Scientific data loggers are given in Table 7-1 (p. 8). Solar radiation can be measured by using either differential or single-ended analog terminals. The differential measurement has better noise rejection and is therefore recommended. For differential measurements, a user-supplied jumper wire needs to be connected between the low side of the differential input and ground to keep the signal in common mode range.

Table 7-1: CMP10 wire color, function, and data logger connection

Wire color	Wire function	Differential data logger connection terminal	Single-ended data logger connection terminal
White	Signal high	**U** configured for differential input[1], **DIFF H** (differential high, analog-voltage input)	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
Black	Signal reference	**U** configured for differential input[1, 2], **DIFF L** (differential low, analog-voltage input)[2]	⏚ (analog ground)
Clear	Shield	⏚ (analog ground)	⏚ (analog ground)

[1] **U** terminals are automatically configured by the measurement instruction.

[2] Jumper to ⏚ with a user-supplied wire.

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. 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. 18). Programming basics for CRBasic data loggers are provided in the following sections. A complete program example for a select CRBasic data logger can be found in Example program for measuring a CMP10 (p. 19).

7.2.1 Solar radiation measurements

Solar radiation can be reported as an average flux density (W/m^2) or daily total flux density (MJ/m^2). The appropriate multipliers are listed in Table 7-2 (p. 10). Programming examples are given for both average and daily total solar radiation.

The pyranometer outputs a low-level voltage ranging from 0 to a maximum of up to 20 mV, in natural light, depending on the calibration factor and radiation level.

This voltage output is measured by using either the `VoltDiff()` CRBasic instruction or `VoltSE()` CRBasic instruction.

> CAUTION:
> Nearby AC power lines, electric pumps, or motors can be a source of electrical noise. If the sensor or data logger is located in an electrically noisy environment, the measurement should be made with the 60 or 50 Hz rejection integration option as shown in the example programs.

7.2.1.1 Input range

The output voltage is usually between 5 and 20 mV per 1000 W/m^2. When estimating the maximum likely value of sensor output, a maximum value of solar radiation of 1100 W/m^2 can be used for field measurements on a horizontal surface. Plane-of-array irradiances can exceed 1500 W/m^2.

Select the input range as follows:

1. Estimate the maximum expected input voltage by multiplying the maximum expected irradiance (in W/m^2) by the calibration factor (in µV / W/m^2). Divide the answer by 1000 to give the maximum in millivolt units.
2. Select the smallest input range that is greater than the maximum expected input voltage. The exact range will depend on the sensitivity of your individual sensor and the maximum expected reading. With some data loggers, an autorange option can be used if measurement time is not critical.

7.2.1.2 Multiplier

The multiplier converts the millivolt reading to engineering units. The sensitivity value supplied by the manufacturer gives the output of the sensor as µV (micro-volts) / W/m^2. As the data logger voltage measurement instructions give a default output in mV, the following equation should be used to calculate the multiplier to give the readings in W/m^2:

$$M = 1000/c$$

Where,
M = multiplier
c = sensor output in µV / W/m^2

Other units can be used by adjusting the multiplier as shown in Table 7-2 (p. 10).

Table 7-2: Multipliers required for flux density and total fluxes

Units	Multiplier	Output processing
W/m^2	M	Average
MJ/m^2	M • t • 0.000001	Totalize
kJ/m^2	M • t • 0.001	Totalize
cal/cm^2	M • t • 0.0239 • 0.001	Totalize
$cal/cm^2/min$	M • 1.434 • 0.001	Average
$W \cdot hr/m^2$	M • t / 3600	Totalize

M = calibration factor with units of W/m^2 / mV
t = data logger program execution interval in seconds

7.2.1.3 Offset

The offset will normally be fixed at zero as the sensor should output no significant signal in dark conditions. In practice, because of the nature of thermopile detector sensors, there will be some offset in dark conditions; sometimes this offset can give negative light readings. This offset varies with factors, such as rate of change of sensor temperature, so it cannot be removed with a fixed offset. Some users remove small negative readings by including code after the measurement instructions that sets negative readings to zero.

7.2.1.4 Output format considerations

Over-ranging may be an issue if the measurement values are totalized. Over-ranging can be prevented by storing the data in the IEEE4 format.

7.3 Siting

The pyranometer is usually installed horizontally for global horizontal measurements. However, the pyranometer can be installed at any angle for POA measurements and in the inverted position for reflected measurements. In all cases it will measure the solar flux incident on the sensor surface.

Site the pyranometer to allow easy access for maintenance while ideally avoiding any obstructions or reflections above the plane of the sensing element. It is important to mount the pyranometer such that a shadow or reflection will not be cast on it at any time.

If this is not possible, try to choose a site where any obstruction over the azimuth range between earliest sunrise and latest sunset has an elevation not exceeding 5°. Diffuse solar radiation is less influenced by obstructions near the horizon. For instance, an obstruction with an elevation of 5° over the whole azimuth range of 360° decreases the downward diffuse solar radiation by only 0.8%.

The sensor should be mounted with the cable pointing towards the nearest magnetic pole. For example, in the Northern Hemisphere, point the cable toward the North Pole (Figure 7-2 [p. 12] through Figure 7-5 [p. 13]).

> **NOTE:**
> CVF4 ventilation unit (p. 21) provides the mounting information for the CVF4 ventilation unit.

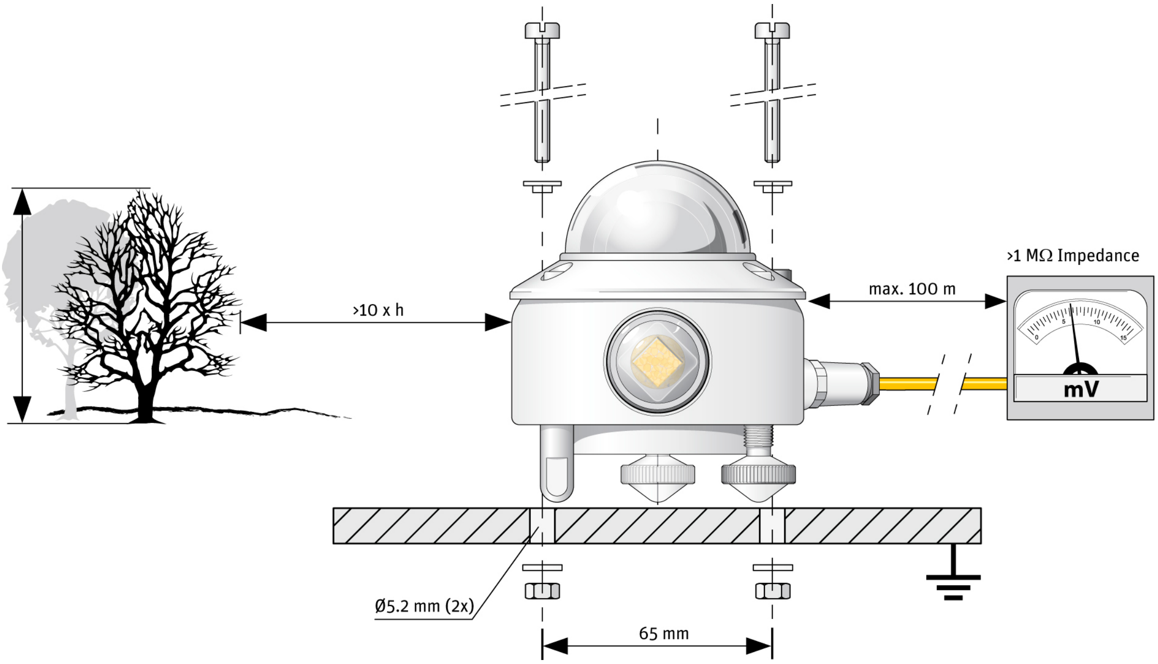


Figure 7-2. Pyranometer installation

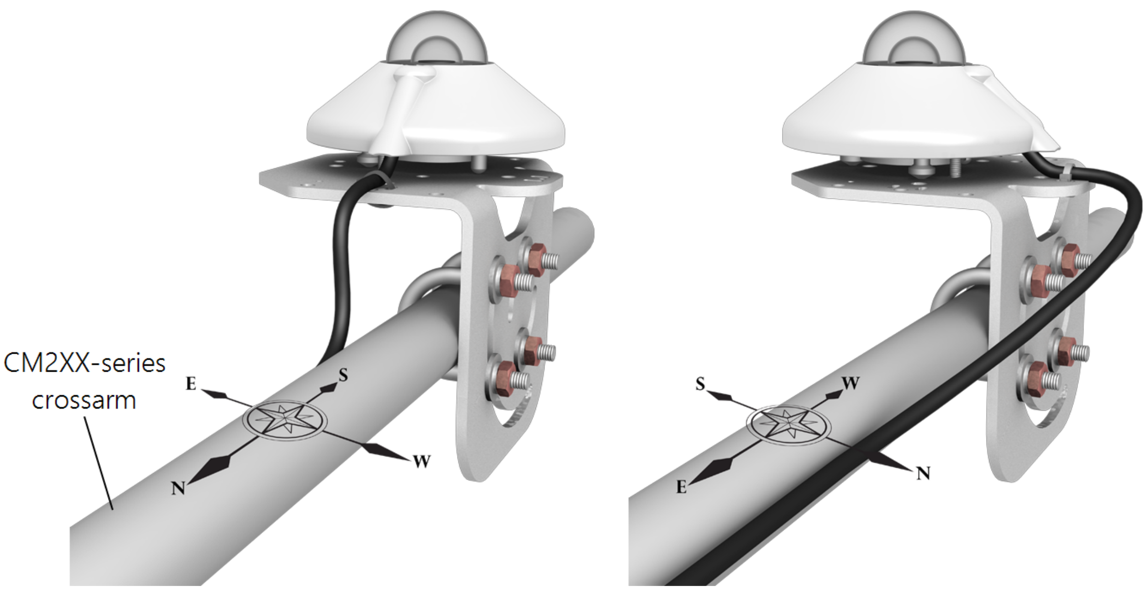


Figure 7-3. Pyranometer mounted horizontally for the Northern Hemisphere (left) and Southern Hemisphere (right)

Figure 7-4. Two views of a pyranometer mounted at an angle for the Northern Hemisphere

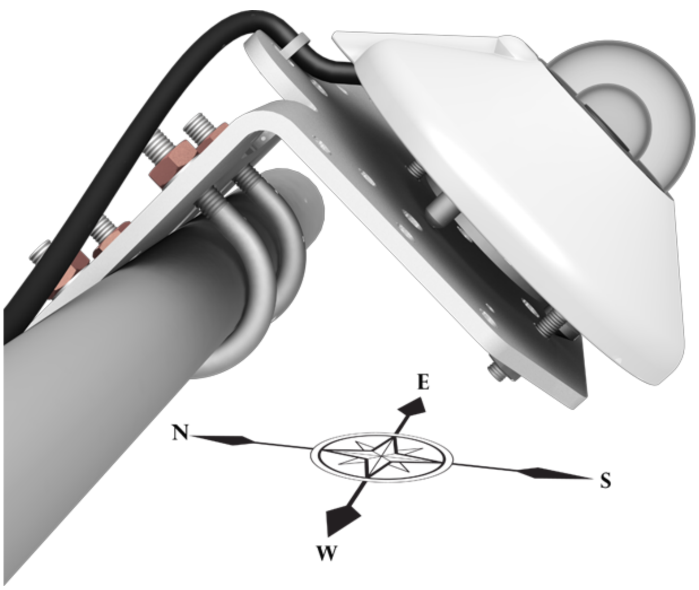


Figure 7-5. Pyranometer mounted at an angle for the Southern Hemisphere

7.4 Mounting to a tripod or tower

Tools required for installation on a tripod or tower:

- 4 mm (5/32-inch) Allen wrench
- 8 mm (5/16-inch) open-end wrench for U-bolt nuts
- Tape measure

- UV-resistant wire ties
- Side-cut pliers
- Compass
- Step ladder

The pyranometer includes a bubble level and two leveling screws, which allows it to be leveled horizontally without using a leveling base. It typically mounts to a crossarm via the CM255 or CM255LS Mounting Stand.

> **NOTE:**
> The CM255 and CM255LS are not compatible with a pyranometer housed in a CVF4 Ventilation Unit. The CVF4 mounts to a tripod or tower by using the CVF4 Mounting Stand and either the CM220 Right-Angle Mount or the 1-inch-by-1-inch Nu-Rail Crossover Fitting. Refer to CVF4 ventilation unit (p. 21) for more information.

The CM255 and CM255LS can be adjusted to any angle from horizontal to vertical. If mounting the pyranometer at an angle, ensure that the crossarm is leveled horizontally before placing the bracket at its proper angle. Refer to the Solar Radiation Sensor Mounts manual for more information.

Do the following to level the pyranometer horizontally (Figure 7-6 [p. 15]):

1. Attach the mounting stand to the crossarm.
2. Loosely mount the pyranometer on the mounting stand. Do not fully tighten the two mounting screws.
3. Turn the leveling screws as required to bring the bubble of the level within the ring.
4. Use the Allen wrench to tighten the mounting screws and secure the assembly in its final position. Check that the pyranometer is still correctly leveled and adjust as necessary.
5. Attach the white plastic sun screen to the pyranometer.
6. Route the sensor cable along the underside of the crossarm to the tower/tripod mast, and to the instrument enclosure.
7. Secure the sensor cable to the crossarm and mast by using cable ties.

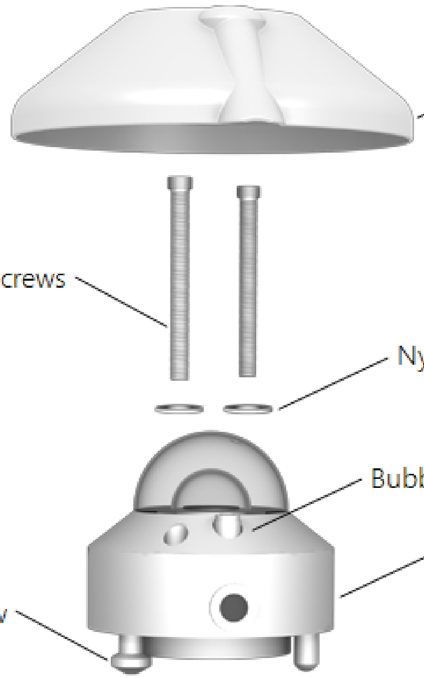


Figure 7-6. Exploded view of the pyranometer

8. Maintenance and troubleshooting

8.1 Maintenance

Every week, physically inspect the pyranometer to ensure that:

- Dome is free of dirt, condensation, and ice. Remove accumulated dust, condensation, or ice from the dome and pyranometer body by using a soft cloth dampened with water or alcohol (Figure 8-1 [p. 16]).
- Mounting is secure.
- Pyranometer is level or is at the correct angle.
- Cables are in good condition.

Figure 8-1. Reading is reduced if dome is not dry or clean

8.1.1 Check sensor output

Check the data returned from the sensor as it will show the first indication of a fault. However, several expected phenomena can cause strange measurements. In particular, on clear, windless nights the outer dome temperature of horizontally placed pyranometers can fall as low as the dew point temperature of the air, due to infrared radiation exchange with the cold sky. (The effective sky temperature can be 30 °C lower than the ground temperature, which results in an infrared emission of –150 W/m^2). If this happens, dew, glazed frost or hoar frost can form on the top of the outer dome and can stay there for several hours in the morning. An ice cap on the dome is a strong diffuser and can increase the pyranometer signal by up to 50% in the first hours after sunrise.

8.2 Recalibration

The calibration of the pyranometer may drift with time and exposure to radiation. Campbell Scientific recommends recalibrating every two years. The sensor should be returned to Campbell Scientific for recalibration. Refer to the Assistance page for information on returning the pyranometer to Campbell Scientific for recalibration.

8.3 Troubleshooting

Symptom: NAN, –9999, or radiation values around 0

1. Check that the sensor is wired to the differential terminal specified by the measurement instruction.
2. Verify that the range code is correct for the data logger type.
3. Measure the impedance across the white and black sensor wires. This should be around 100 ohms plus the cable resistance (typically 0.1 ohm•m^{-1}). If the resistance is low, there may be a short circuit (check the wiring). Resistances somewhat lower than expected could be due to water ingress into the sensor or enclosure connectors. If the resistance is infinite,

there is a broken connection (check the wiring).

4. Disconnect the sensor cable and check the voltage output from the sensor. With the sensor located 8 inches below a 60 W incandescent light bulb the voltage should be approximately 2.5 mV. No voltage indicates a problem with the sensor.

Symptom: sensor signal is unrealistically high or low

1. Check that the right calibration factor has been properly entered into the data logger program. Please note that each sensor has its own individual calibration factor.
2. Check the condition of the sensor cable.

Symptom: sensor signal shows unexpected variations

1. Check for the presence of strong sources of electromagnetic radiation, such as radar or radio interference.
2. Check the condition and the connection of the sensor shield wire.
3. Check the condition of the sensor cable.

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

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

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

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

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

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

Appendix B. Example program for measuring a CMP10

> **NOTE:**
> For an example program for using the CVF4 ventilator, see CVF4 ventilation unit (p. 21).

Although this example is for the CR1000X, other CRBasic data loggers are programmed similarly. The following program measures the CMP10 every second and converts the millivolt output to W/m^2. A sensor calibration of 8.55 µV / W/m^2 is used for the example program. Every 10 minutes, the program outputs the average and standard deviation of the flux (W/m^2) measurements.

Wiring for this example is given in Table B-1 (p. 19).

Table B-1: CR1000X wiring for CMP10 example program

Wire color	Description	CR1000X	Jumper[1]
White	Solar signal (+)	**2H**	
Black	Solar signal (–)	**2L**	
Clear	Shield	⏚	

[1] Jumper **2L** to ⏚ with user-supplied 26 AWG or larger wire.

CRBasic Example 1: CR1000X example program for measuring a CMP10

```
'CR1000X Series Data Logger

Public PTemp
Public Batt_Volt
Public CMP10_Irr

Units CMP10_Irr = W/m2

DataTable (TenMin,1,-1)
  DataInterval (0,10,Min,10)
  Minimum (1,Batt_Volt,FP2,0,False)
  Sample (1,PTemp,FP2)
  Average (1,CMP10_Irr,IEEE4,False)
  StdDev (1,CMP10_Irr,IEEE4,False)
EndTable

BeginProg
  Scan (1,Sec,0,0)

    'Measure the Battery Voltage and Panel Temperature
    PanelTemp (PTemp,60)
    Battery (Batt_Volt)

    'Measure the CMP10. Multiplier (M) = 1000/c where c = 8.55.
    VoltDiff (CMP10_Irr,1,mV200C,2,True ,10000,60,1000/8.55,0)

    CallTable TenMin

  NextScan
EndProg
```

Appendix C. CVF4 ventilation unit

Ventilation of radiometers improves the reliability and accuracy of the measurement by reducing dust, raindrops and dew on the dome. With thermopile-based instruments ventilation stabilizes the temperature of the radiometer and suppresses thermal offsets. The integrated heater can be used to disperse precipitation and melt frost, or even melt snow and ice in cold climates.

CVF4 is a low power, low maintenance ventilation unit. The only part that needs maintenance is the removable air inlet filter, which should be checked at regular intervals and cleaned or replaced when necessary.

The flow that the CVF4 creates is unique. At the top of the pyranometer dome the flow is high and it swirls to improve the air distribution over the dome. The position of the heaters and the cover material ensure only half the heating power is needed to melt frost and snow compared to older ventilation units.

CVF4 is designed to be used with Kipp & Zonen:

- CMP / SMP pyranometers
- CGR 4 pyrgeometer
- CUV 5 total UV radiometer

CVF4 can be mounted on the 2AP and SOLYS 2 sun trackers.

CVF4 replaces the successful and widely used CVF3 ventilation unit.

The CVF4 is meant to run continuously. The heater can either be powered on continuously for cold regions or be switched on by a Campbell Scientific data logger to remove dew in the morning and be switched off afterwards. In that case, the heater could operate for a period of time before and after sunrise. This saves power in situations where power is limited, such as PV operated systems.

> **NOTE:**
> The CVF4 is manufactured by Kipp & Zonen and cabled by Campbell Scientific. The wiring of a CVF4 purchased from Campbell Scientific is different than the wiring of a CVF4 purchased directly from Kipp & Zonen.

C.1 CVF4 components

Figure C-1 (p. 22) and CVF4 components (bottom view) (p. 23) show the components of the CVF4. It is shipped with a cover, power cable, eight washers, four screws, Allen wrench, and five spare filters (Figure C-3 [p. 23]).

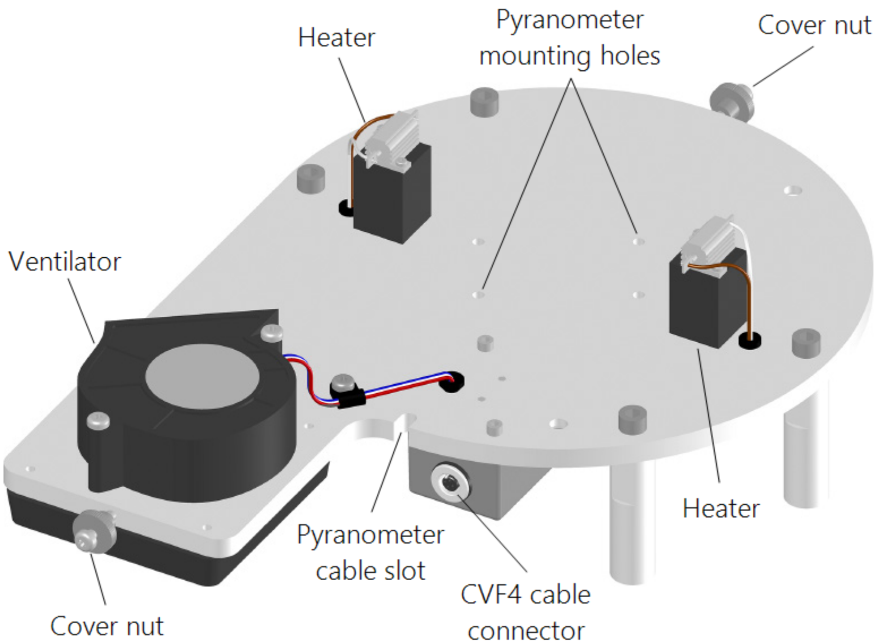


Figure C-1. CVF4 components (top view, no cover)

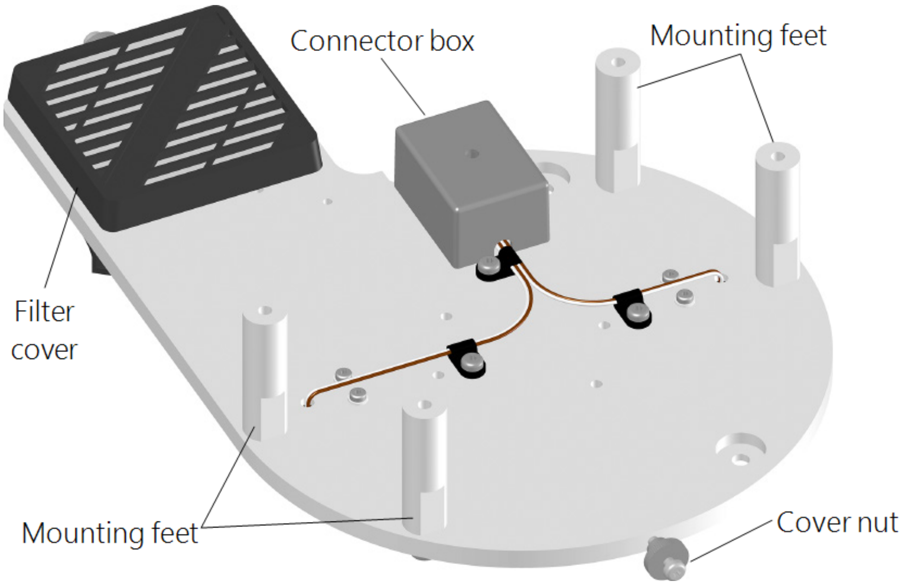


Figure C-2. CVF4 components (bottom view)

Figure C-3. CVF4 ventilation unit and ships with kit

C.2 CVF4 installation

Siting information provided in Siting (p. 11) is pertinent when using the CVF4 heater/ventilation.

CVF4 heater/ventilator unit includes the heater/ventilator unit, white cover, cable, and mounting hardware. The CVF4 is mounted to a crossarm by using the CVF4 Mounting Stand and either the CM220 Right-Angle Mounting Bracket or the 1-inch-by-1-inch Nu-Rail Crossover Fitting.

> **NOTE:**
> Refer to the Kipp & Zonen Instruction Manual if mounting the CVF4 to a SOLYS 2 Solar Tracker or to a CM 121C Shadow Ring.

Tools required for mounting to a tripod or tower are:

- Allen wrench supplied with the CVF4
- 8 mm (5/16-inch) open-end wrench for U-bolt nuts
- Tape measure
- UV-resistant wire ties
- Side-cut pliers
- Stepladder

To install, do the following:

1. Mount the crossarm to the tripod or tower (Figure C-4 [p. 24]).

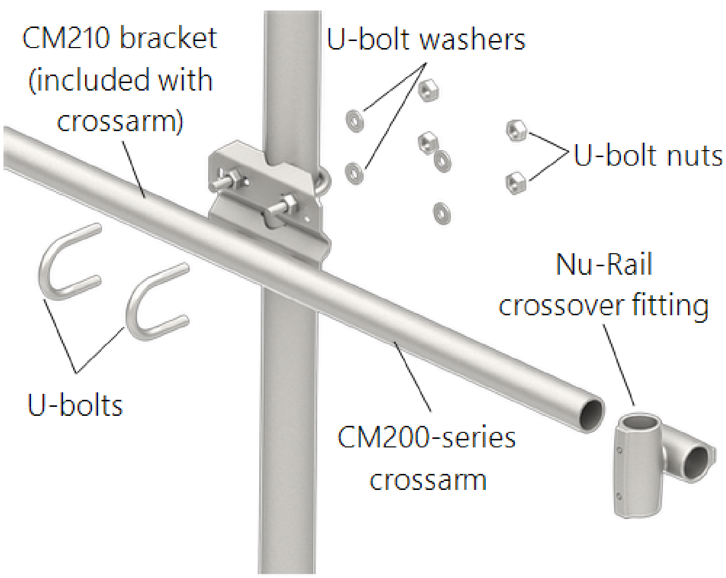


Figure C-4. Crossarm and Nu-Rail crossover fitting mounted to mast (exploded view)

2. Attach the CM220 Right-Angle Mounting Bracket (Figure C-5 [p. 25]) or a 1 inch-by-1-inch Nu-Rail Crossover Fitting (Figure C-4 [p. 24]) to the crossarm.

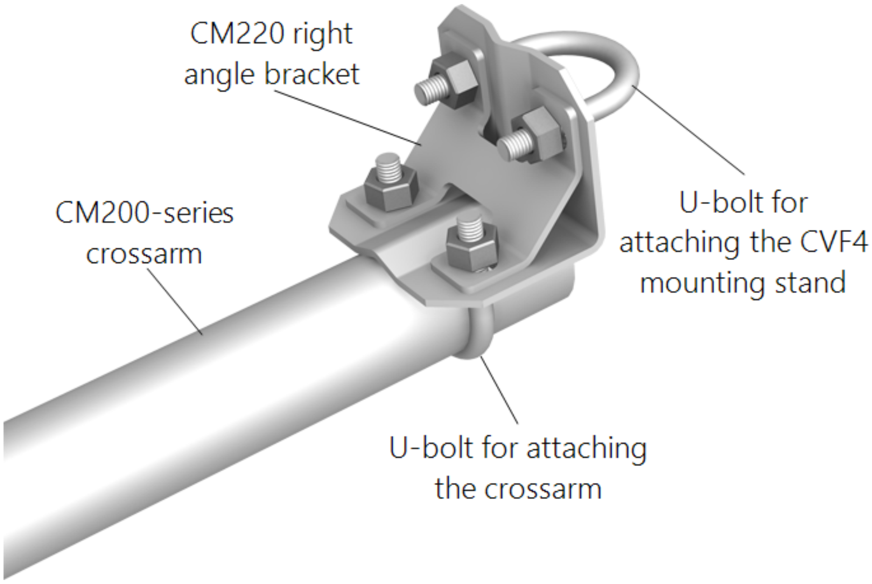


Figure C-5. CM220 right-angle mounting bracket attached to CM200-series crossarm

3. Place the CVF4 (without the white plastic cover) on the CVF4 Mounting Stand with the fan hanging over the edge of the plate and with the mounting feet lined up with the mounting holes.

4. Fasten the CVF4 feet to the mounting stand by using the supplied washers and screws (Figure C-6 [p. 26]).

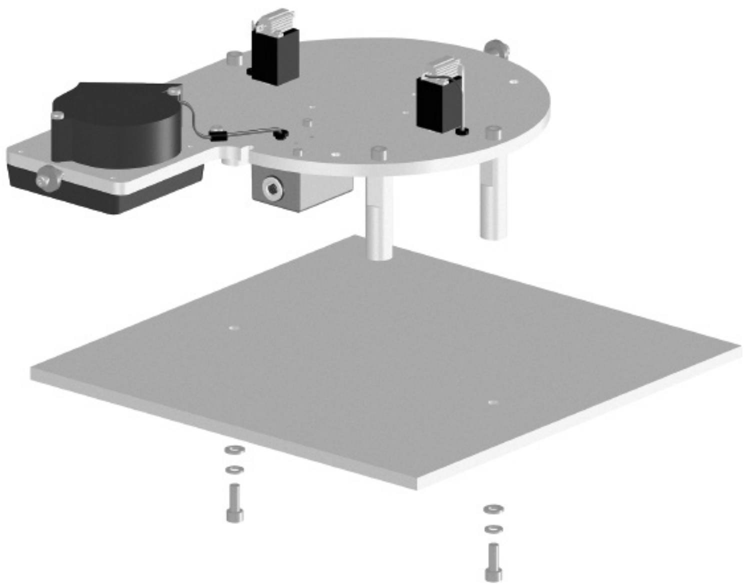


Figure C-6. Mounting CVF4 feet to a mounting stand

5. Loosely mount the pyranometer on the CVF4 by using the mounting screws and washers. Do not fully tighten the pyranometer two mounting screws (Figure C-7 [p. 26]).

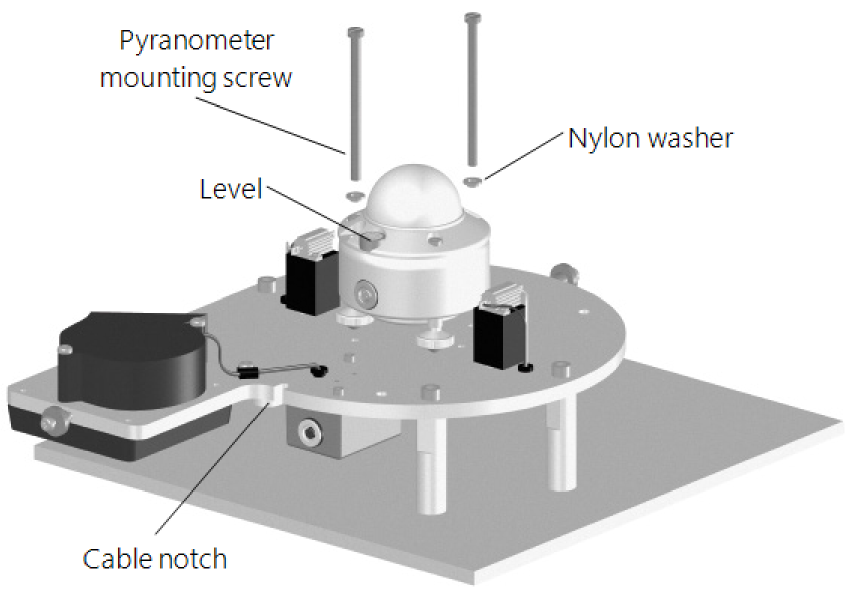


Figure C-7. Mounting the pyranometer to the CVF4

6. Turn the pyranometer leveling screws as required to bring the bubble of the level within the ring.
7. Tighten the pyranometer mounting screws to secure the assembly in its final position. Check that the pyranometer is still correctly leveled and adjust as necessary.
8. Route the pyranometer cable through the cable notch.
9. Fit the white cover onto the CVF4 and secure it with the cover nuts (see Figure C-8 [p. 27]).

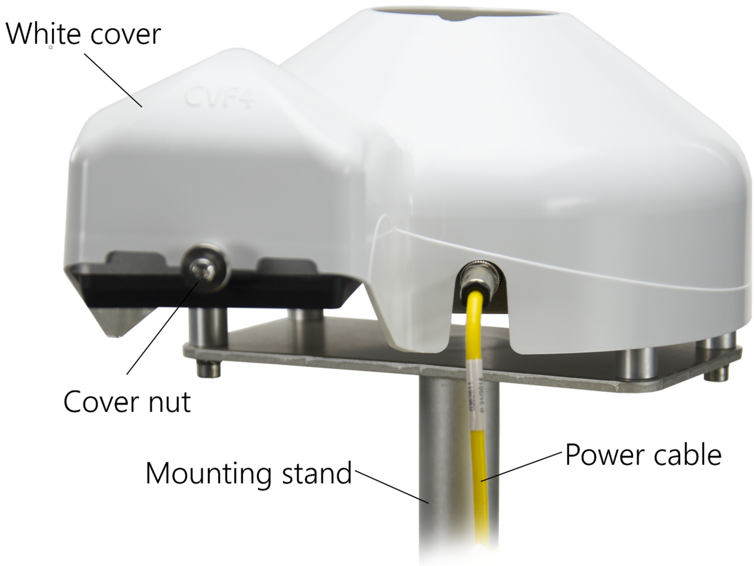


Figure C-8. CVF4 mounted to CVF4 mounting stand (pyranometer not shown)

10. Attach the power cable to the CVF4 connector.
11. Route the cables along the underside of the crossarm to the tower/tripod mast, and to the instrument enclosure.
12. Secure the cables to the crossarm and mast by using cable ties.

C.3 Wiring

Wiring of the CVF4 is shown in Table C-1 (p. 28) and Table C-2 (p. 28). Refer to Wiring (p. 8) for information about wiring the pyranometer.

Table C-1: CVF4 8-pin wiring			
Wire color	**Description**	**Power supply connection**	**Data logger connection**
Brown	Ventilator power	**+12V**	--
Blue	Heater power	**+12V**	--
Black	Power ground	**G**	--
White	Tachometer signal	--	**U** configured for pulse input[1], **P** (pulse input), **C** (control port) or **P_SW** (pulse, switch closure input)
Clear	Shield	--	⏚ (analog ground)
[1]**U** and **C** terminals are automatically configured by the measurement instruction.			

Table C-2: CVF4 4-pin wiring			
Wire color	**Description**	**Power supply connection**	**Data logger connection**
Red	Ventilator power	**+12V**	--
White	Heater power	**+12V**	--
Black	Power ground	**G**	--
Green	Tachometer signal	--	**U** configured for pulse input[1], **P** (pulse input), **C** (control port) or **P_SW** (pulse, switch closure input)
Clear	Shield	--	⏚ (analog ground)
[1]**U** and **C** terminals are automatically configured by the measurement instruction.			

C.3.1 Schematics

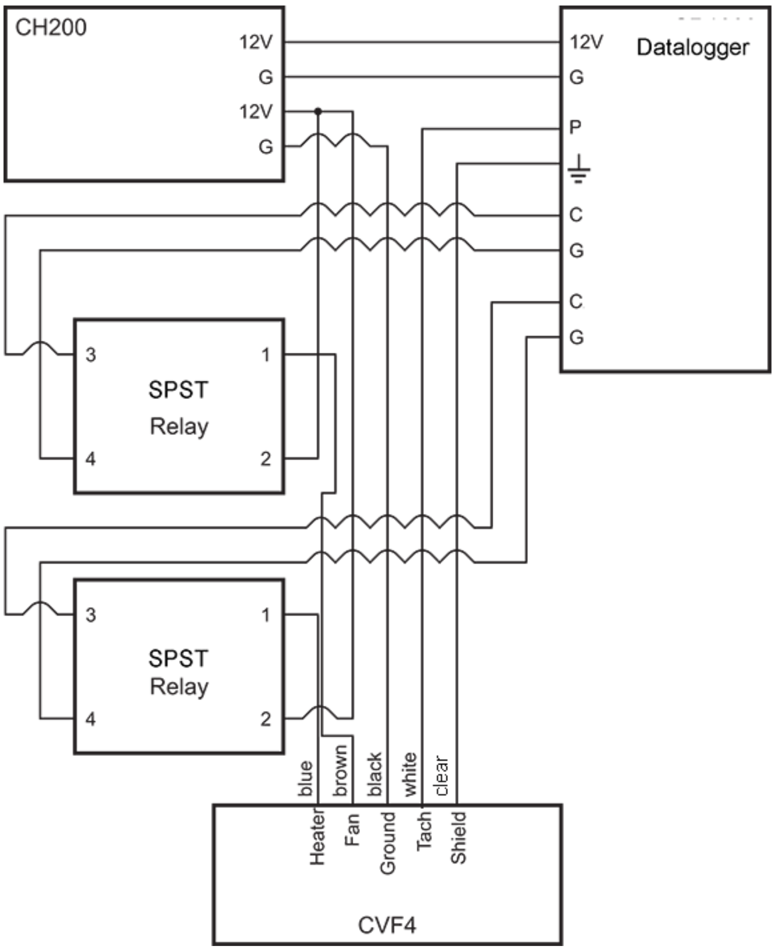


Figure C-9. 8-pin schematic

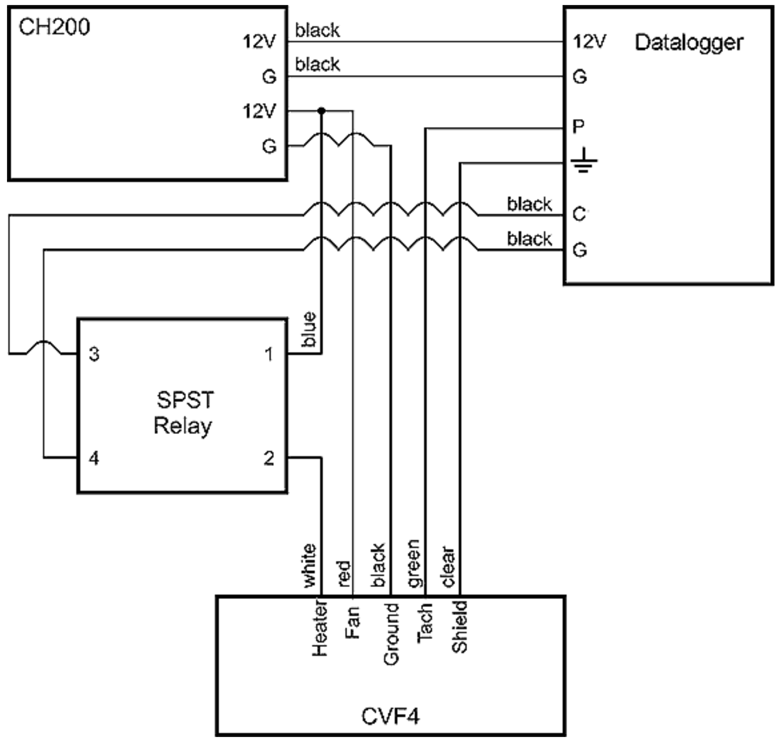


Figure C-10. 4-pin schematic

C.4 CVF4 example program

In the example program, the CVF4 heater is controlled based on the solar position. The 109 temperature sensor provides the temperature measurement used in the solar position instruction. The CVF4 fan is continuously on. Power to the CVF4 heater is switched using one SPST Single-Channel Solid-State Relay (Figure C-10 [p. 30]). In the beginning of the program, the sensitivity of the CMP10 is entered as a constant. Wiring for the example is shown in Table C-3 (p. 31).

Table C-3: Wiring for program controlling CVF4 heater						
Function	CMP10 wire color	109 wire color	CVF4 wire color	Relay	Power supply terminal	CR1000X terminal
CMP10 signal high	White					1H
CMP10 signal reference	Black					1L
Clear	Shield					⏚
109 signal		Black				VX1
109 excitation		Red				SE3
109 signal ground		Purple				⏚
109 shield		Shield				⏚
CVF4 ventilator power			Red		12V	
CVF4 heater power			White	2		
CVF4 power ground			Black		G	
CVF4 tachometer signal			Green			P1
CVF4 shield			Clear			⏚
Relay control				3		C1
Relay ground				4		G
Relay power				1	12V	
Data logger power					12V	12V
Data logger power ground					G	G

CRBasic Example 2: CVF4 example program

```
'CR1000X Series Data Logger
'Example program for CVF4

'Declare Public Variables
Public PTemp, batt_volt
Public GH_Irradiance_CMP11
Public CVF4_Tach
Public SolarPos(5)
Public Airtemp
Public TimeArray(9)

'Declare Constants
Const CMP11_Sensitivity = 12.5
Const Latitude = 41.767561
Const Longitude = -111.85592
Const Altitude = 1358

'Define Aliases
Alias SolarPos(1) = SolarAzimuth
Alias SolarPos(2) = SunElevation
Alias SolarPos(3) = HourAngle
Alias SolarPos(4) = Declination
Alias SolarPos(5) = AirMass

'Define Data Tables
DataTable (Ten_Min,1,-1)
  DataInterval (0,10,Min,10)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
  Average (1,GH_Irradiance_CMP11,IEEE4,False)
  StdDev (1,GH_Irradiance_CMP11,IEEE4,False)
  Average (1,CVF4_Tach,IEEE4,False)
EndTable

'Main Program
BeginProg
  Scan (1,Sec,0,0)
    PanelTemp (PTemp,60) 'Measure wire panel temperature
    Battery (batt_volt) 'Measure battery voltage

    'Retrieve the current time for use in the Solar Position Calculation
    '---------------------------------------------------------------------------
    RealTime (TimeArray())
    '---------------------------------------------------------------------------

    'Measure Air Temperature
    '---------------------------------------------------------------------------
```

CRBasic Example 2: CVF4 example program

```
    Therm109 (Airtemp,1,3,Vx1,0,60,1.0,0)
    '---------------------------------------------------------------------------

    'Calculate the Solar Position
    '---------------------------------------------------------------------------
    SolarPosition (SolarPos(),TimeArray,0,Latitude,Longitude,Altitude,-1,Airtemp)
    '---------------------------------------------------------------------------

    'Measure GH Irradiance with CMP11 Pyranometer
    '---------------------------------------------------------------------------
    VoltDiff (GH_Irradiance_CMP11,1,mV200,1,True,0,60,1000/CMP11_Sensitivity,0)
    '---------------------------------------------------------------------------

    'Measure CVF4 Tachometer Output
    '---------------------------------------------------------------------------
    PulseCount (CVF4_Tach,1,P1,3,1,1.0,0)
    CVF4_Tach = CVF4_Tach*(60/2) 'convert to RPM, CVF4 outputs two pulses per
                                 'revolution
    '---------------------------------------------------------------------------

    'Control the CVF4 Heater
    '---------------------------------------------------------------------------
    If SunElevation > -10 AND SunElevation < 10 Then
      PortSet (C1,1)
    Else
      PortSet (C1,0)
    EndIf
    '---------------------------------------------------------------------------
    CallTable Ten_Min
  NextScan
EndProg
```

C.5 CVF4 heater/ventilator maintenance

1. Refer to Maintenance (p. 15) for the pyranometer maintenance.
2. Inspect the area directly under the fan to ensure that it is free from leaves, snow, or other obstructions that can inhibit air flow.
3. Regularly inspect the fan inlet by unclipping the cover. For optimal air flow, make sure the diagonal line on the filter cover is in line with the diagonal line on the ventilator (Figure C-11 [p. 34]). The filter cover clicks back on the ventilator.

4. Clean or replace filters typically every 6 months.

> **NOTE:**
> The filters may need to be cleaned or replaced more frequently depending on the site and air pollution.

5. If desired, clean the plastic cover by using water and a brush or cloth.

> **NOTE:**
> Discoloration of the plastic cover does not affect the operation of the CVF4. The cover only needs to be cleaned for aesthetic reasons.

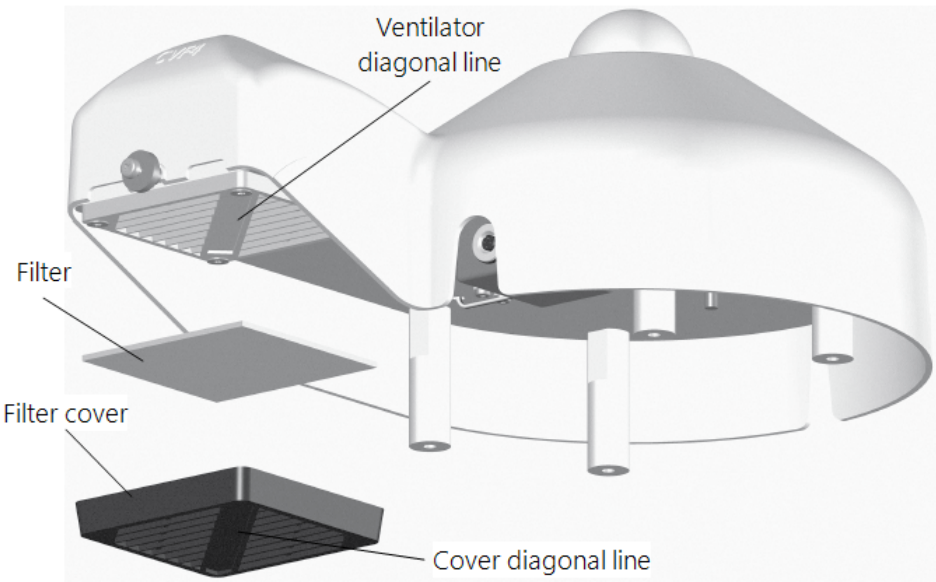


Figure C-11. CVF4 filter replacement

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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Campbell Scientific will, as a default, return warranted equipment by surface carrier prepaid. However, the method of return shipment is at Campbell Scientific's sole discretion. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty and the Company’s obligation thereunder is in lieu of all other warranties, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

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

Assistance

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

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

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

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

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

Safety

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

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

General

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

Utility and Electrical

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

Elevated Work and Weather

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

Internal Battery

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

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

Use and disposal of batteries

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

Avoiding unnecessary exposure to radio transmitter radiation

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

Maintenance

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

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

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