

MS-80

Secondary Standard Pyranometer



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1. MS-80 introduction

The MS-80, manufactured by EKO Instruments, is an innovative, next-generation secondary standard pyranometer inspired by the combination of latest technologies and state-of-the-art thermopile sensor with an unprecedented low zero-offset behavior; fast sensor response; and a five-year warranty and recalibration interval.

The MS-80 features a compact design with internal desiccation, single dome, isolated thermopile detector, quartz diffusor, immunity to offsets, ultra-low temperature dependency, and exceptional non-linearity characteristics. EKO instruments is the only ISO 17025 accredited pyranometer manufacturer in the world, enabling highest-quality calibration, compliant to international standards (ISO/IEC 17025/9847).

For a similar pyranometer with RS-485 Modbus communications, refer to the MS-80M:
www.campbellsci.com/ms-80m-l.

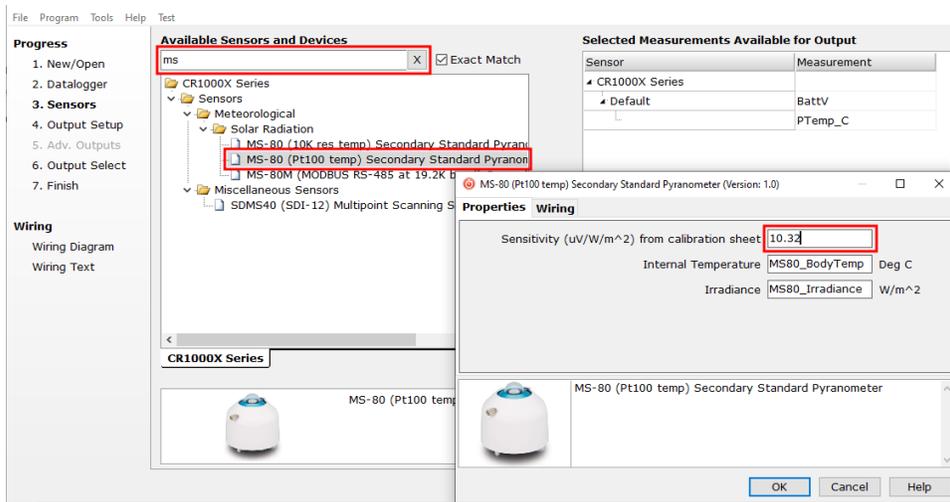
2. QuickStart

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*, *PC400*, or *PC200W*.

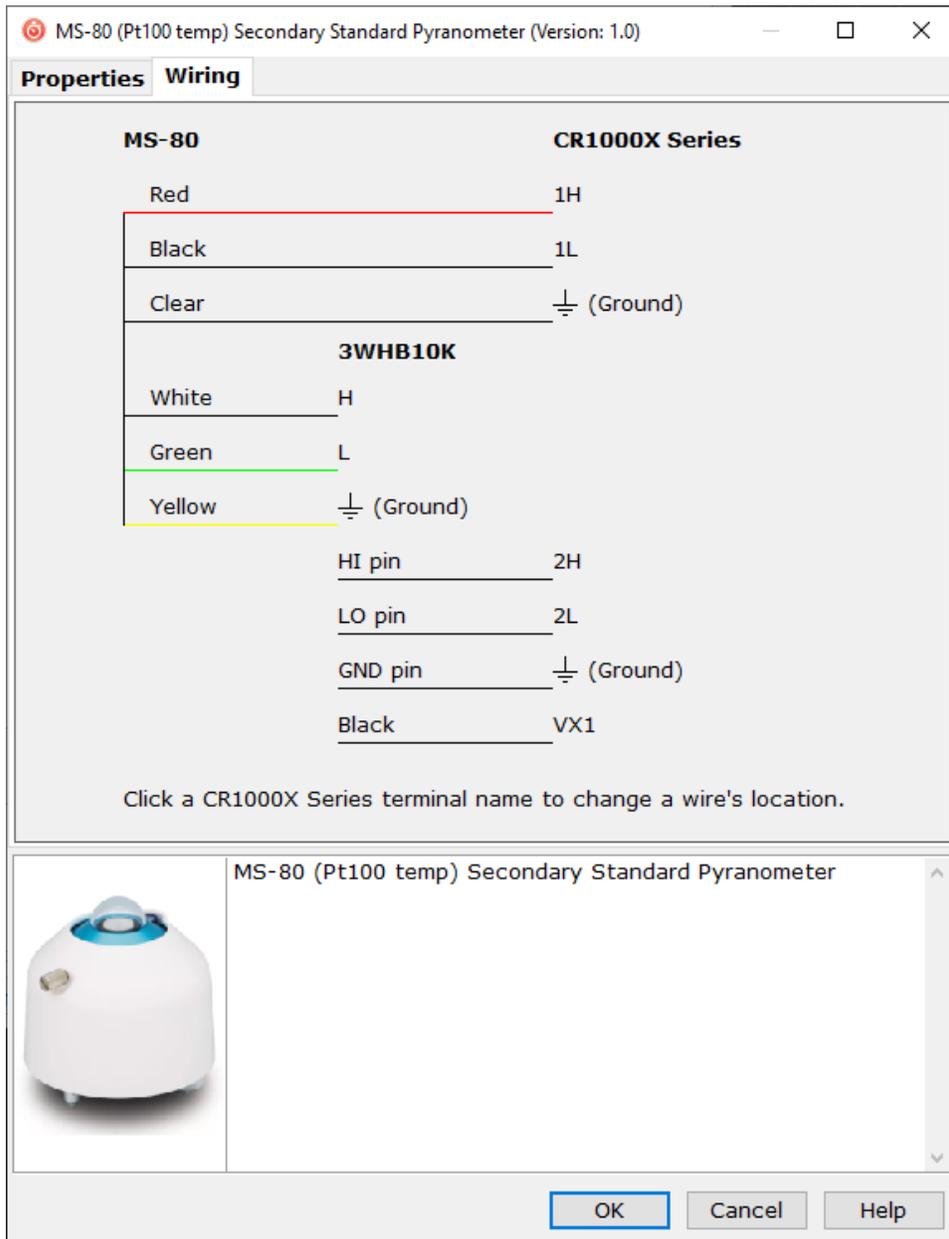
The following procedure also shows using *Short Cut* to program the sensor.

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 MS-80 or locate the sensor in the **Sensors > Meteorological > Solar Radiation** folder. Double-click the **MS-80 (Pt100 temp) Secondary Standard Pyranometer**. Type the **Sensitivity (uV/W/m^2)** from calibration sheet. This value is unique for each MS-80.

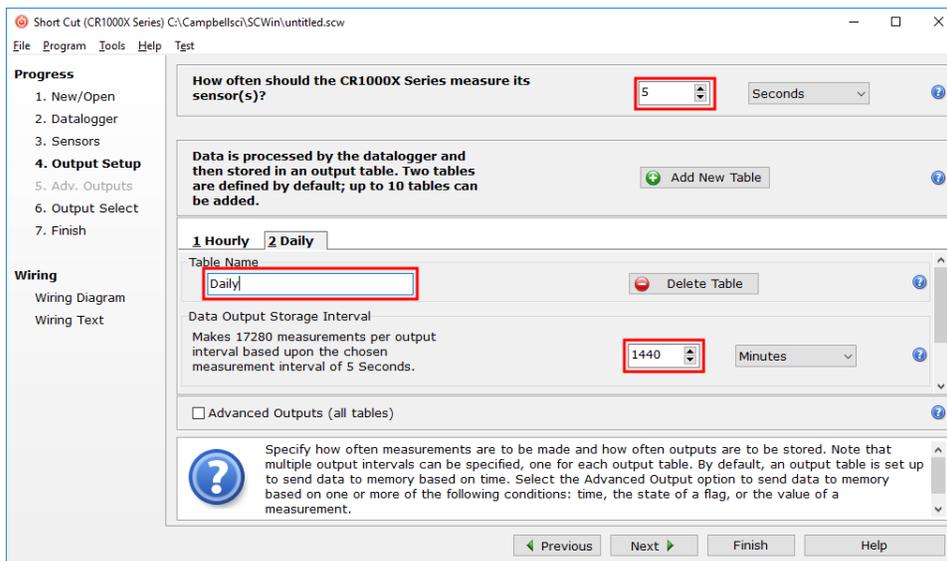


- Click the **Wiring** tab to see how the sensor is to be wired to the data logger and 3WHB10K; a completion resistor such as the 3WHB10K is required to connect the MS-80 to a data logger. Click **OK** after wiring the sensor.

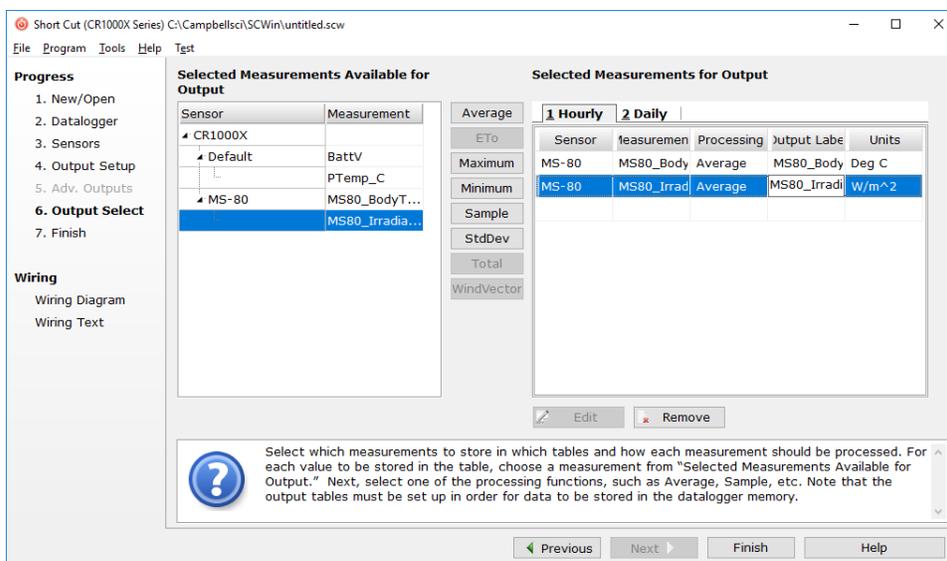


- Repeat steps three and four for other sensors.

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



- Select the measurement and its associated output option.



- 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 logger support software data display in **LoggerNet**, **PC400**, **RTDAQ**, or **PC200W** to make sure it is making reasonable measurements.

3. MS-80 specifications

ISO 9060 classification:	Secondary standard
Output:	Analog (mV)
Response time 95%:	< 0.5 s
Zero offset A:	< 1 W/m ² (response to 200 W/m ² net thermal radiation)
Zero offset B:	±1 W/m ² (5 K/hr)
Non-stability:	±0.5% change in 5 years
Non-linearity:	±0.2% (1000 W/m ²)
Directional response:	±10 W/m ² (1000 W/m ²)
Spectral selectivity:	±3% (0.35 to 1.5 μm)
Spectral range:	285 to 3000 nm
Operating temperature range:	-40 to 80 °C
Temperature response:	< 0.8% (-10 to 40 °C), < 1% (-20 to 50 °C)
Tilt response:	±0.2% (1000 W/m ²)
Sensitivity:	~10 μV/W/m ²
Impedance:	< 45000 Ω
Irradiance range:	0 to 4000 W/m ²
Compliance documents:	View at: www.campbellsci.com/ms-80-l

4. Siting

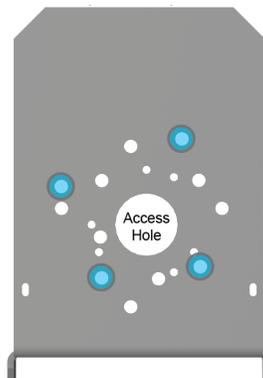
The solar radiation sensor is usually installed horizontally, but can also be installed at any angle including an inverted position. Site the sensor to allow easy access for maintenance while ideally avoiding any obstructions or reflections above the plane of the sensing element. It is important to mount the sensor such that a shadow or a 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. 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.

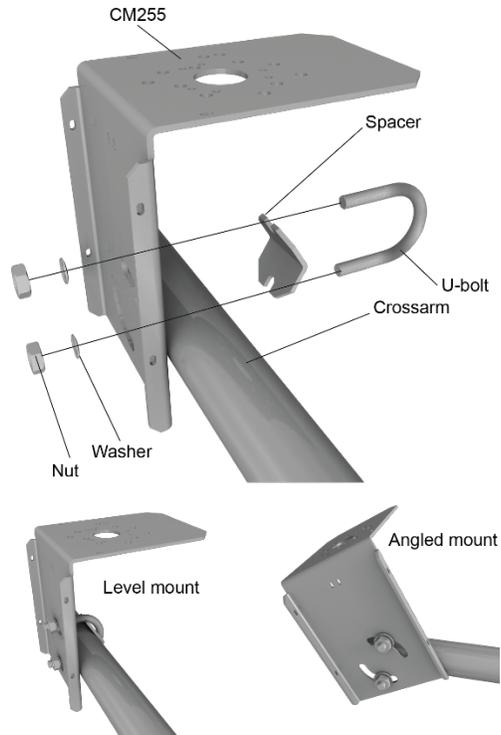
5. Mounting procedure

Required tools:

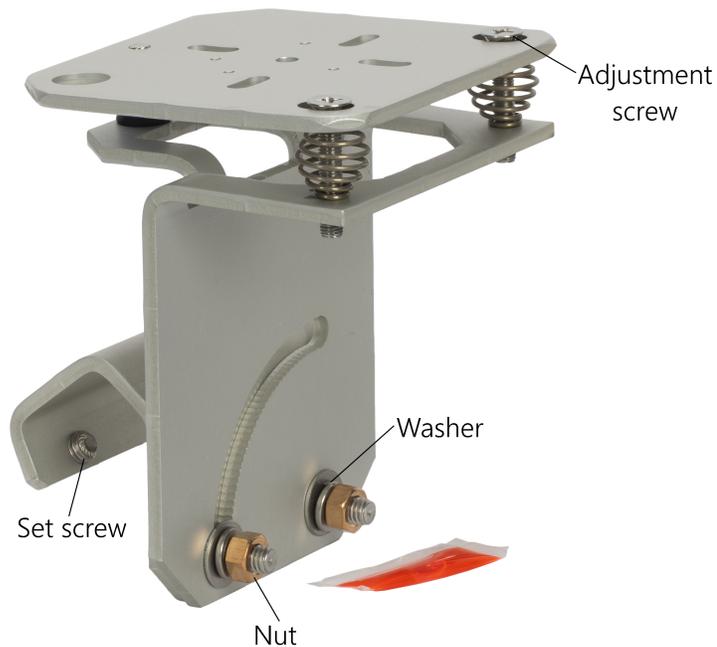
- Diopter
 - Solar compass
 - 8 mm (5/16-inch) open-end wrench for U-bolt nuts
1. On a level surface, level the solar radiation sensor using the leveling feet on the sensor. Alternatively, remove the sensor leveling feet to allow it to be mounted directly to the mounting bracket.
 2. Secure the solar radiation sensor to the mounting bracket. The blue dots in the following figure indicate the mounting holes used for this pyranometer.



3. Using a diopter in combination with a solar compass, install and orient the crossarm on the tripod or the mast. If installing the mounting bracket on a vertical pole, ensure the pole is truly vertical.
4. Secure the mounting bracket to the crossarm or vertical pole using the hardware included with the mounting bracket. The CM255 uses one U-bolt, nuts, flat washers, and lock washers to mount the bracket, as shown in the following figure.



- For the CM256 bracket, use the two set screws to secure the bracket to the crossarm or pole as shown in the following figure. For pyranometers mounted horizontally, ensure the mounting bracket is horizontal in two dimensions. For pyranometers mounted at an angle, set the mounting bracket angle to the desired angle prior to tightening the mounting hardware.



- Verify mounting hardware is firmly tightened, and that the mounting bracket is at the desired angle.

6. MS-80 wiring

The MS-80 requires a completion resistor such as the 3WHB10K to measure the internal PT100 sensor. [Table 6-1](#) (p. 8) shows the wiring to the data logger and 3WHB10K.

Wire color	Pin-out	Function	Data logger connection	3WHB10K connection
Red	1	Pyranometer signal high	U configured for differential input ¹ , DIFF H (differential high, analog-voltage input)	
Black	2	Pyranometer signal reference	U configured for differential input ¹ , DIFF L (differential low, analog-voltage input)	
Clear	N/C	Shield (tied to connector, body of sensor)	⏏ (analog ground)	
White	3	PT100 voltage excitation		H
Green	4	PT100 signal		L
Yellow	5	PT100 ground		⏏
			U configured for differential input ¹ , DIFF H (differential high, analog-voltage input)	HI pin
			U configured for differential input ¹ , DIFF L (differential low, analog-voltage input)	LO pin

Table 6-1: Pin-out, wire color, function, and connections of data logger and 3WHB10K

Wire color	Pin-out	Function	Data logger connection	3WHB10K connection
			⏏ (analog ground)	GND pin
			U configured for voltage excitation ¹ , EX, VX (voltage excitation)	Black wire

¹ U channels are automatically configured by the measurement instruction.

7. Solar radiation programming

The pyranometer outputs a low level voltage that is measured using either the `VolDiff()` 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.

If measurement time is not critical, the autorange option can be used in the `VolDiff()` or `VoltsE()` instruction; the autorange adds a few milliseconds to the measurement time. Otherwise, select the input range as follows:

1. Estimate the maximum expected input voltage by multiplying the maximum expected irradiance (in $W \times m^{-2}$) by the calibration factor (in $\mu V / W \times m^{-2}$). 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.

If electromagnetic radiation can be a problem, use an f_{N1} of 50 or 60 Hz. Select 60 Hz Noise Rejection for North America and areas using 60 Hz AC voltage. Select 50 Hz Noise Rejection for most of the Eastern Hemisphere and areas that operate at 50 Hz. The multiplier converts the millivolt reading to engineering units. [Table 7-1](#) (p. 10) provides the calculations required for the various units. The offset will normally be fixed at zero (see [MS-80 example program](#) (p. 13)).

Units	Multiplier	Output processing
$W \times m^{-2}$	M	Average
$MJ \times m^{-2}$	$M \times t \times 0.000001$	Totalize
$kJ \times m^{-2}$	$M \times t \times 0.001$	Totalize
$cal \times cm^{-2}$	$M \times t \times 0.0239 \times 0.001$	Totalize
$cal \times cm^{-2} \times min^{-1}$	$M \times 1.434 \times 0.001$	Average
$W \times hr \times m^{-2}$	$M \times t / 3600$	Totalize

$M = 1000/c$, where c is the sensor output in $\mu V / W \times m^{-2}$
t = data logger program execution interval in seconds

8. Internal PT100 programming

Measure the PT100 resistance using the `BrHalF3W()` CRBasic instruction, then convert the resistance by using the `PRT()` instruction. A typical `BrHalF3W()` instruction is:

```
BrHalF3W (Rs,1,mV200,3,Vx1,1,2500,True,0,60,100,0)
```

This assumes the 3WHB10K is connected to the **SE3**, **SE4**, and **VX1** data logger terminals.

A typical `PRT()` instruction is:

```
PRT (Sensor_Temp,1,Rs,1.0,0)
```

9. Maintenance and troubleshooting

The MS-80 has no service items requiring scheduled replacement. There is no accessible desiccant cartridge to maintain. Use pure alcohol or distilled water and a lint-free cloth to clean the dome, removing smears and deposits. Local conditions and application dictate cleaning interval. Sophisticated research applications require daily cleaning. For typical PV applications, clean once per week, bi-monthly, or monthly. The MS-80 should be recalibrated following industry standard best practices such as ASTM G167, ISO 9846, ASTM E824 or ASTM G207 by an

accredited lab. The recommended recalibration interval is two years. Contact Campbell Scientific for more information.

Unexpected results typically occur because of improper wiring or programming, electromagnetic radiation, or damaged cables. Ensure that the data logger program includes the correct parameters for the measurement instructions. Check for the presence of strong sources of electromagnetic radiation and use the 50 or 60 Hz integration option in the data logger program if electromagnetic radiation can be a problem. Check the cable for damage and ensure that it is properly connected to the data logger.

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. MS-80 example program

Table B-1 (p. 13) provides wiring for the example program. The MS-80 requires a completion resistor such as the 3WHB10K to connect to the data logger. Although this program is for the CR1000X, other CRBasic data loggers are programmed similarly.

Programming tips are provided at: www.campbellsci.com/videos/datalogger-programming.

Table B-1: Wiring for example program			
Wire color	Function	CR1000X connection	3WHB10K connection
Red	Pyranometer signal high	1H	
Black	Pyranometer signal reference	1L	
Clear	Shield	⏏ (analog ground)	
White	PT100 voltage excitation		H
Green	PT100 signal		L
Yellow	PT100 ground		⏏
		2H	HI pin
		2L	LO pin
		⏏ (analog ground)	GND pin
		VX1	Black wire

CRBasic Example 1: CR1000X program that measures the MS-80

```
'CR1000X Series
'MS-80-L with PT100

'SENS is sensitivity value from the calibration sheet.
'It is unique for each sensor.
Const SENS = 10.26 'uV/W/m^2

Public IRR
Public Rs
Public Sensor_Temp
Units IRR = W/m^2
Units Sensor_Temp = DegC

DataTable (MS80,1,-1 )
  DataInterval (0,1,Min,10)
  Average (1,IRR,IEEE4,False)
  Average (1,Sensor_Temp, FP2, False)

EndTable
BeginProg
  Scan (1,Sec,3,0)
    'Measure the irradiance
    VoltDiff (IRR,1,mV200,1,True,3000,60,1000/SENS,0)

    'Measure the PT100 PRT Temperature Sensor(3WHB10K)
    BrHalf3W (Rs,1,mV200,3,Vx1,1,2500,True,0,60,100,0)
    PRT (Sensor_Temp,1,Rs,1.0,0)

  CallTable MS80
  NextScan
EndProg
```

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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.

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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.

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