Product Manual

Power Supply

SP50-L, SP90-L, and SP370-L

Solar Panels

Revision: 09/2021

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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1. Introduction

Solar panels convert light energy to electricity, or specifically to direct current. The direct current produced is used to provide power to a system and to charge storage batteries. Solar panels operate in both direct and diffuse light, but not at night.

Each solar panel includes a 2-wire cable to attach the panel to a voltage regulator. The regulator and a rechargeable battery are purchased separately from the solar panel.

The Campbell Scientific CH201 and CH200 12V charging regulators are recommended for use with 12V sealed rechargeable batteries (BP12, BP24, and BP84). The CH201 or CH200 can easily be used with the BP84/PS84 battery when configured through Device Configuration Utility. Update the charging regulator operating system (OS) and Device Configuration Utility to the latest version at www.campbellsci.com.

The SP370-L requires the increased charging capacity of the CH201 or SunSaver MPPT™ to take full advantage of the higher power output from the solar panel.

The SunSaver™ SS-10-12V and SunSaver MPPT voltage regulators are also an option for these solar panels, and can be purchased from Campbell Scientific.

2. Specifications

The SP50-L, SP90-L, and SP370-L work with user-supplied deep cycle marine batteries, 12V sealed rechargeable batteries (BP12, BP24, or BP84), 12V rechargeable power supplies (PS84), and external voltage regulators (CH201, CH200, and MorningStar SunSaver regulators).

Table 2-1: Specifications

	SP50-L	SP90-L	SP370-L
Maximum peak power (Pp):	50 W	90 W	370 W
Voltage at peak power (Vpp) (voltage from solar panel before regulator):	17.5 V	17.9 V	38.3 V
Current at peak power (Ipp):	2.9 A	5.0 A	10.3 A
Temperature coefficent (Voc):	–0.45% / °C	–0.36% / °C	–0.28%/°C
Solar panel wire gauge:	16 AWG	16 AWG	10 AWG

Table 2-1: Specifications			
	SP50-L	SP90-L	SP370-L
Length:	83.9 cm (33.0 in)	120.9 cm (47.6 in)	179.5 cm (70.7 in)
Width:	53.7 cm (21.1in)	53.7 cm (21.1 in)	99 cm (39 in)
Depth:	5.0 cm (2.0 in)	5.0 cm (2 in)	3.8 cm (1.5 in)
Weight:	6 kg (13.2 lb)	7.7 kg (17.0 lb)	19 kg (42 lb)
Maximum allowable wind gust (extended mount):	58 m/s (130 mph)	50 m/s (112 mph)	Not rated

NOTE:
Solar panel characteristics assume a 1 kilowatt per square meter illumination and a solar panel temperature of 25 °C. Individual panels may vary up to 10%. The output panel voltage increases as the panel temperature decreases.

Table 2-2: Regulator specifications (purchased and shipped separately)				
Model	CH201	CH200	Morningstar SunSaver™ SS-10-12V	SunSaver MPPT™
Temperature compensation:	Variable, depending on battery manufacturer. Selectable in Device Configuration Utility.	Variable, depending on battery manufacturer. Selectable in Device Configuration Utility.	–28 mV / ºC	–5 mV/°C
Quiescent current:	300 µA	300 µA to 2 mA	6 to 10 mA	35 mA
Operating temperature:	–40 to 60 °C	–40 to 60 ºC	–40 to 85 ºC	–30 to 60 °C
Useable solar current:	10 A	2.8 to 4.3 A	10 A	15 A

Pairing the CH200 with the SP90-L allows the CH200 to operate at the maximum useable solar current of 4.3 A for longer periods of time than it would with a smaller panel. As the SP90-L output current increases above 4.3 A, the CH200 will continue to function at the maximum useable solar current of 4.3. It will remain at this level until the SP90-L output once again drops below 4.3 A. To take advantage of current levels above 4.3 A, the CH201 with a maximum current of 10 A must be used.

> **NOTE:**
> A second solar panel can be connected to the CH201 when additional power is required. One CH201 can handle two SP50-L or two SP90-L solar panels. FIGURE 2-1 (p. 3) shows how two solar panels are wired in parallel, leaving the second DC input terminal free for an alternate source of DC voltage.

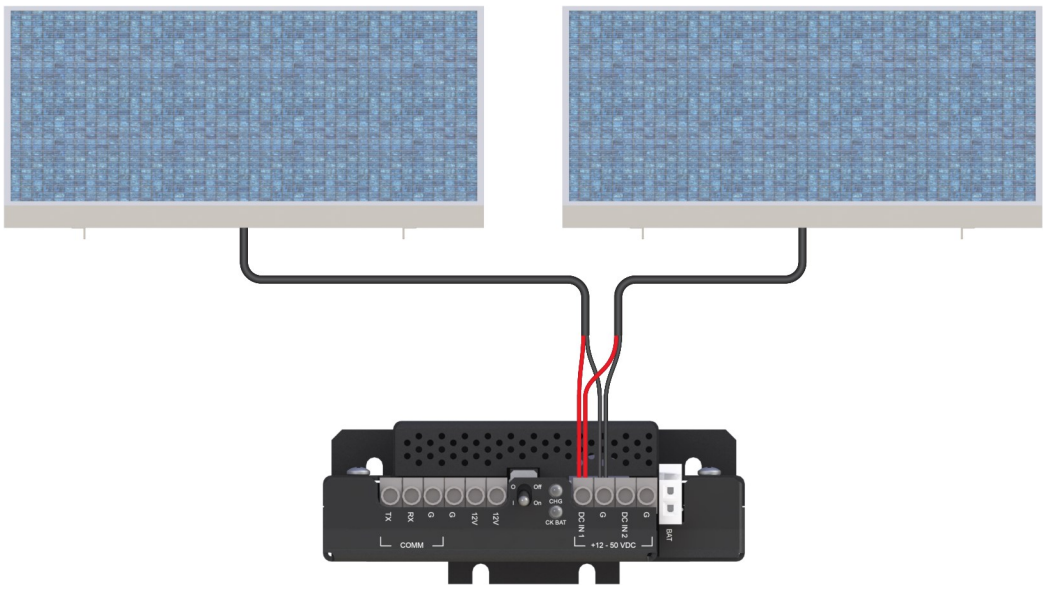

FIGURE 2-1. Wiring two solar panels to one controller (not to scale)

3. Installation

3.1 Tool list

- 1/2 in wrench (2)
- 7/16 in wrench
- Torpedo level
- Angle finder

3.2 SP50-L/SP90-L extended mount assembly

> NOTE:
> This procedure uses the SP50-L in the illustrations. However, the instructions given are also applicable to the SP90-L.

1. Spread a soft towel on a flat surface. Place the solar panel face down on the towel.
2. Place one of the extended mount brackets along the edge (FIGURE 3-1 (p. 5)) to determine which set of holes in the solar panel frame will be used to mount the arms. The correct holes will be just outside of the bracket. Set the bracket aside.

FIGURE 3-1. Determining the correct mounting holes

3. Determine which edge of the solar panel will be the bottom edge. Place one of the arms so the end with the attached struts is at the bottom (FIGURE 3-2 (p. 6)). Attach each arm with two bolts, washers, lock washers, and nuts. Do not fully tighten the nuts. Repeat for the second arm.

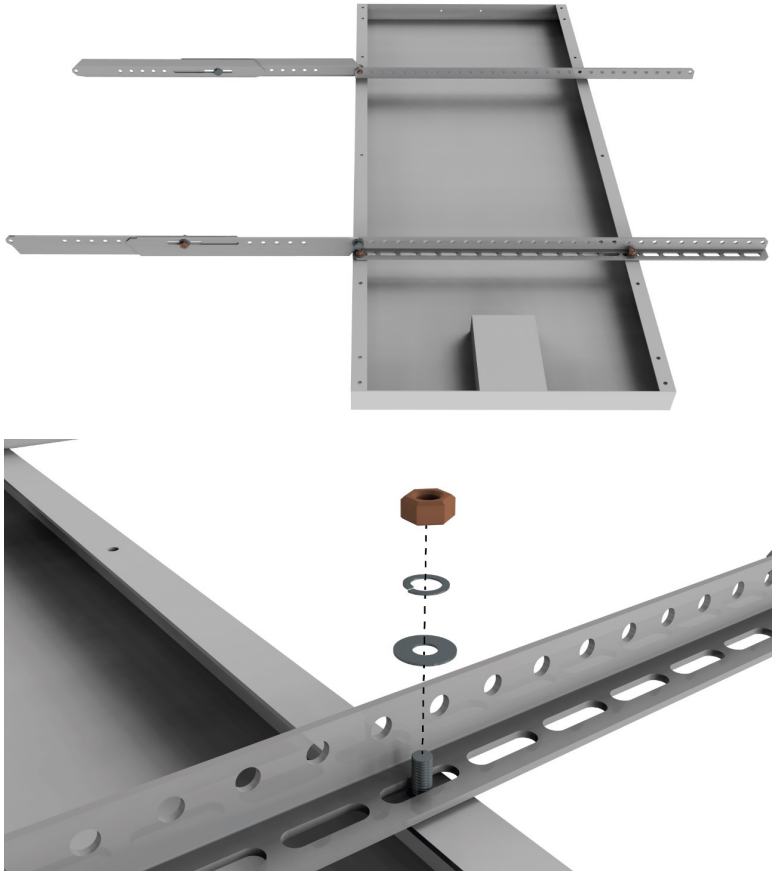

FIGURE 3-2. Attaching mounting arms

4. Locate the upper mount bracket with the angle decal on one end. Remove the nut, lock washer, and washer from each end of the bracket and orient the bracket as shown in FIGURE 3-3 (p. 7). Pass the bolts through the bracket and the last hole on each extended mount arm, and then replace the washer, lock washer, and nut on each bolt (see FIGURE 3-2 (p. 6)).

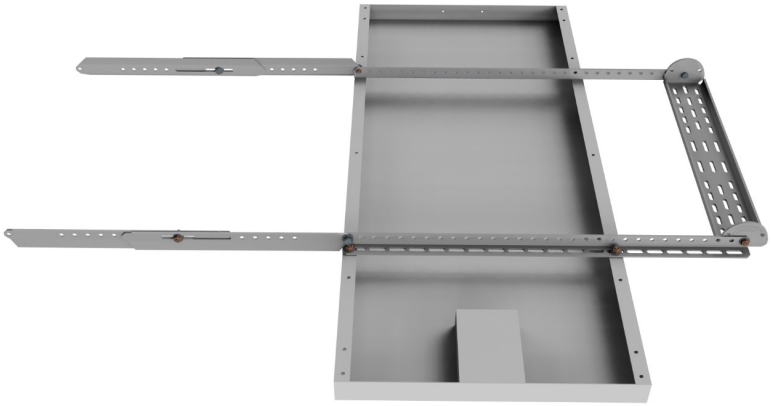

FIGURE 3-3. Attaching the upper mount bracket

5. Attach the bottom extended mount bracket to the extended mount struts as shown in FIGURE 3-4 (p. 7).

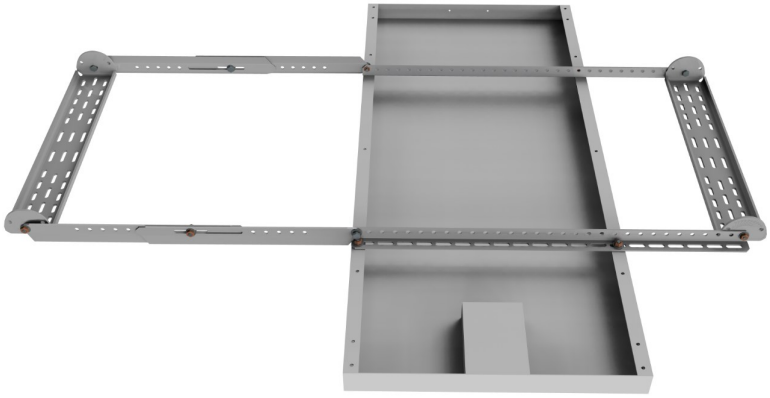

FIGURE 3-4. Attaching the lower mount bracket

6. (If mounting the solar panel on a tower, go to step 8.) With the help of a second person, hold the upper bracket against the tripod mast (FIGURE 3-5 (p. 8)). Use U-bolts, washers, lock washers, and nuts from the hardware bag labeled 'Tripod' to mount the bracket to the mast. Use a torpedo level to ensure the bracket is level. Fully tighten the nuts on both U-bolts.

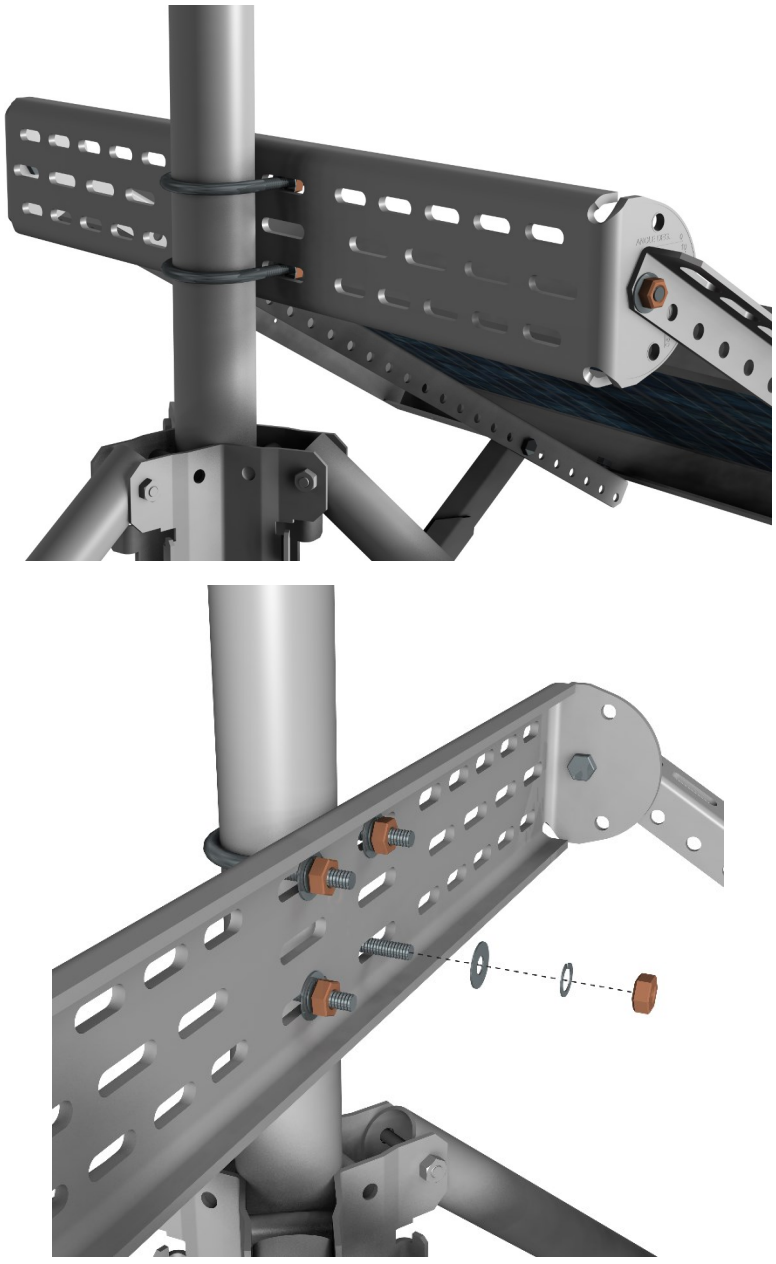

FIGURE 3-5. Attaching the upper mount bracket to the mast

7. Place the lower mount bracket against the tripod leg braces as shown (FIGURE 3-6 (p. 9)). Use U-bolts, washers, lock washers, and nuts from the hardware bag labeled 'Tripod' to mount the bracket on the tripod legs. It may be necessary to rotate the U-bolt so the ends of the bolt pass through holes on different rows in the lower mount bracket. Finger-tighten the nuts. Skip to Extended mount orientation (p. 20).

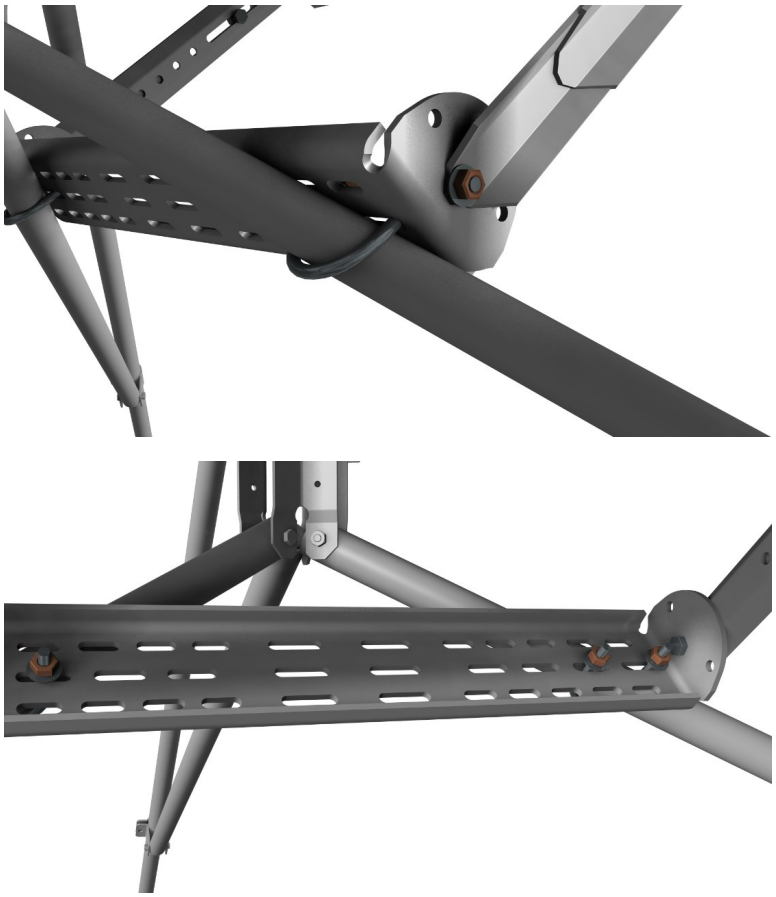

FIGURE 3-6. Attaching the lower mount bracket to the tripod legs

8. (Mounting on towers only.) With the help of a second person, secure the top bracket at the desired height on the tower using U-bolts, washers, lock washers, and nuts (FIGURE 3-7 (p. 10)). Raise the lower bracket until the angle decal on the upper bracket indicates the correct angle for the current latitude. Secure the lower bracket to the tower with U-bolts, washers, lock washers, and nuts. Fully tighten all nuts and bolts.

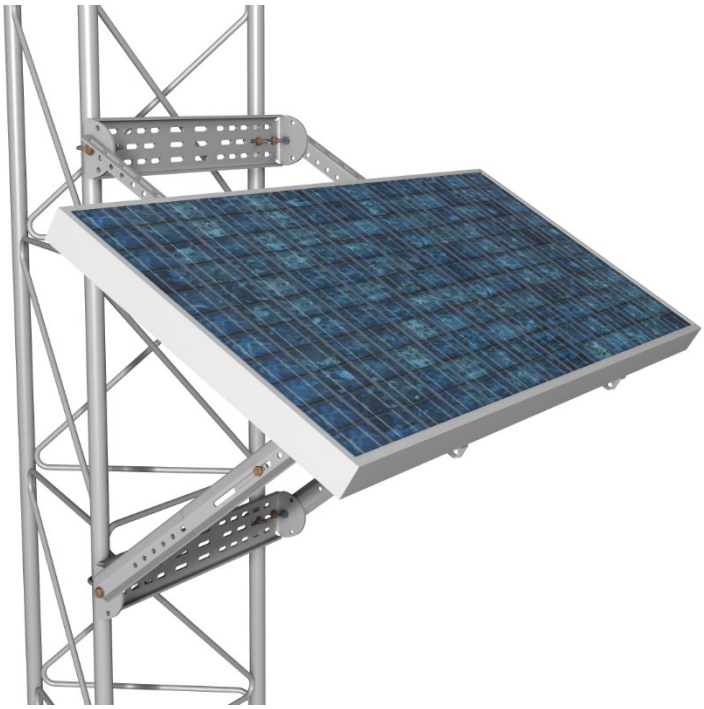

FIGURE 3-7. Extended mount tower installation

3.3 SP370-L mount assembly

For most tripod installations, the tripod is oriented with one leg pointing directly away from the equator. For most tower installations, the tower is positioned with one side oriented parallel to the equator.

Keep the solar panel covered during assembly to prevent voltage output during the assembly process.

1. Attach one mount bracket to the mast approximately 40 cm (16 in) above the tripod legs using two U-bolts, flat washers, lock washers, and nuts. Orient the mount bracket to face the equator. Use a level to ensure the mount bracket is level and fully tighten the nuts. For installation on a tower, the two U-bolts are used to attach the upper mount bracket to the tower legs closest to the equator.

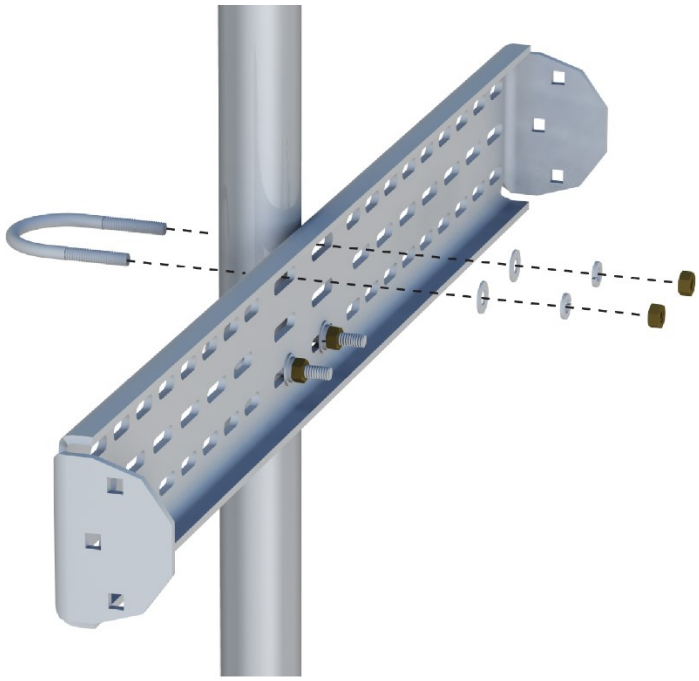

FIGURE 3-8. Attaching the upper mount bracket

2. Attach a mount arm to the top hole on either side of the mount bracket using a bolt, flat washer, lock washer, and nut. Do not fully tighten either nut.

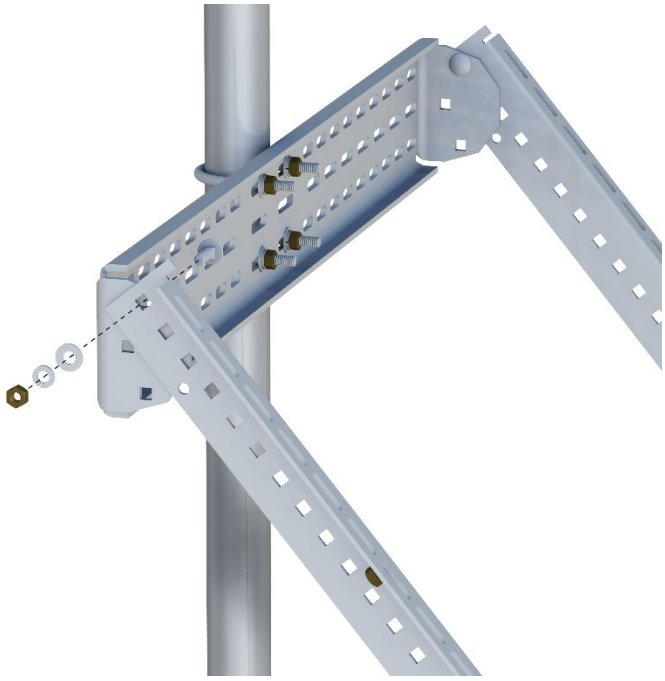

FIGURE 3-9. Attaching the mount arms

3. Place two support struts together, overlapping the large slot in each strut. Use two bolts, flat washers, lock washers, and nuts to attach the struts to each other. Do not fully tighten the nuts. Repeat for the remaining two support struts.

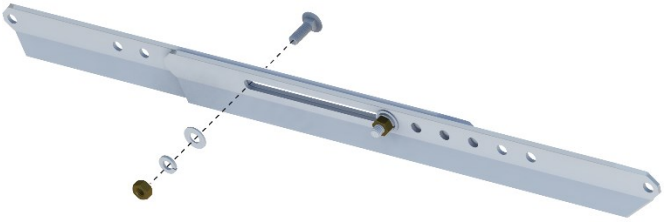

FIGURE 3-10. Assembling the support struts

4. Connect the end of a support strut assembly to the sixth hole from the bottom on one of the mount arms using a bolt, flat washer, lock washer, and nut. Connect the second support strut assembly to the sixth hole on the second mount arm. Do not fully tighten these nuts. The support struts may be moved to a different hole position when adjusting the mount angle in step 7.

FIGURE 3-11. Attaching the support struts to the mount arms

5. Place the second mount bracket on the ground between the two strut assemblies. Attach each strut assembly to the mount bracket in the hole shown with a bolt, flat washer, lock washer, and nut.

FIGURE 3-12. Attaching the lower mount bracket

6. Place the lower mount bracket on the lower supports of the two closest tripod legs. Center the mount bracket evenly between the two legs. Use a level to ensure the mount bracket is level. Secure the mount bracket in place with two U-bolts, flat washers, lock washers, and nuts. It may be necessary to rotate the U-bolt so the ends of the bolt pass through holes on different rows in the lower mount bracket. For tower assembly, use the two U-bolts to attach the lower mount bracket to the tower legs at the point that puts the angle of the mount arms at 45 degrees.

FIGURE 3-13. Attaching the lower mount bracket to the tripod legs

7. Determine the correct mounting angle for the location. Adjust the support strut length (blue arrows in FIGURE 3-14 (p. 16)) or change the mounting location of the support struts on the mount arms (yellow arrows in FIGURE 3-14 (p. 16)) to set the mount to the proper angle. Refer to Solar panel angle (p. 19) for correct angles and mount adjustments. For tower assembly, the lower mount bracket position may be adjusted up or down if needed. Fully tighten all the nuts and bolts used in the mount assembly.

FIGURE 3-14. Adjusting the mount angle

8. Attach the carabiner at the free end of one of the guy ropes to the hole shown on the lower end of the mount arm (A). Attach the second carabiner on the same guy rope to the opposite side of the lower mount bracket in the hole indicated (B). Repeat with the carabiners on the second guy rope, but on opposite sides of the mount, to form an 'X' with the two guy ropes (C).

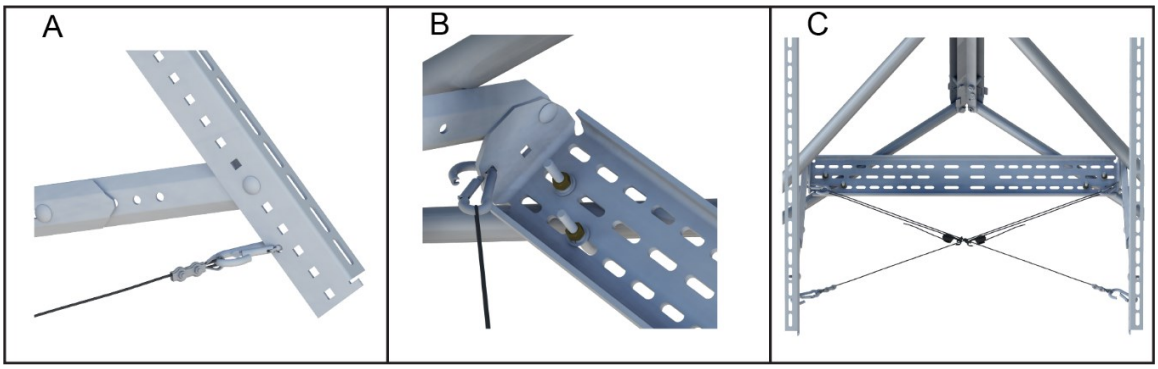

FIGURE 3-15. Attaching the guy ropes

9. Determine which edge of the solar panel will be the top. Gently set the solar panel onto the mount. Let the solar panel rest on the tabs at the end of each mount arm.

FIGURE 3-16. Installing the solar panel

10. Center the solar panel on the mount so the mounting holes on the back of the solar panel line up with the mounting holes on each mount arm. Insert a bolt through each of the four holes, first passing through the solar panel, then the mount arm. Secure each bolt with a flat washer, lock washer, and nut.

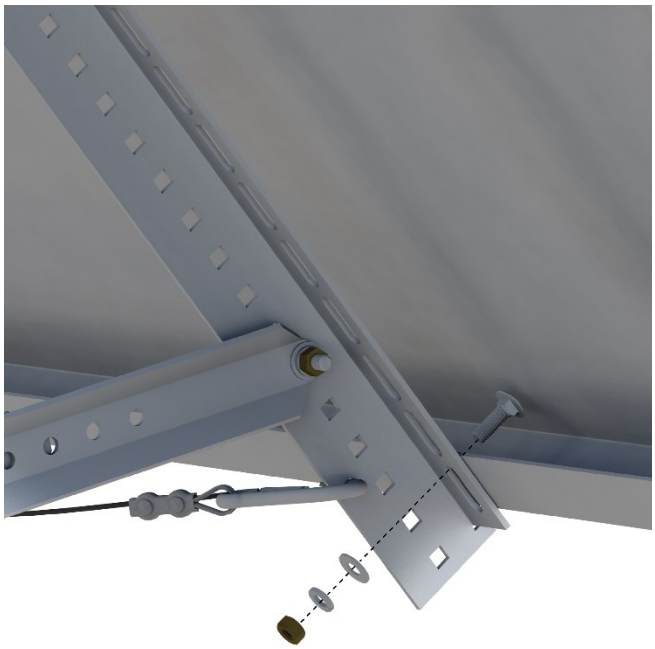

FIGURE 3-17. Attaching the solar panel

11. Remove any slack from the two guy ropes by pulling on the free end of each rope.

FIGURE 3-18. Removing guy rope slack

12. Connect the solar panel to the regulator and uncover the solar panel.

3.4 Solar panel angle

The solar panel should be oriented to receive maximum insolation (incident solar radiation) over the course of a year. Table 3-1 (p. 19) suggests optimal angles for the solar panel through a range of latitudes.

Table 3-1: Solar panel tilt angle[1]

Site latitude (N or S)	Tilt angle
0° - 10°	10°
11° - 20°	Latitude +5°
21° - 45°	Latitude +10°
46° - 65°	Latitude +15°
> 65°	80°

[1]From "Design Aids for Small PV Power Systems," Solorex Corp.

3.5 Extended mount orientation

FIGURE 3-19 (p. 20) shows how to configure the extended mount to achieve different mounting angles. Note that to reach angles greater than 50 degrees, one or both lower struts will need to be removed from the mount.

Refer to Table 3-1 (p. 19) to determine the proper angle for the installation site. Always check the angle of the solar panel to verify the correct angle before tightening the hardware on the extended mount.

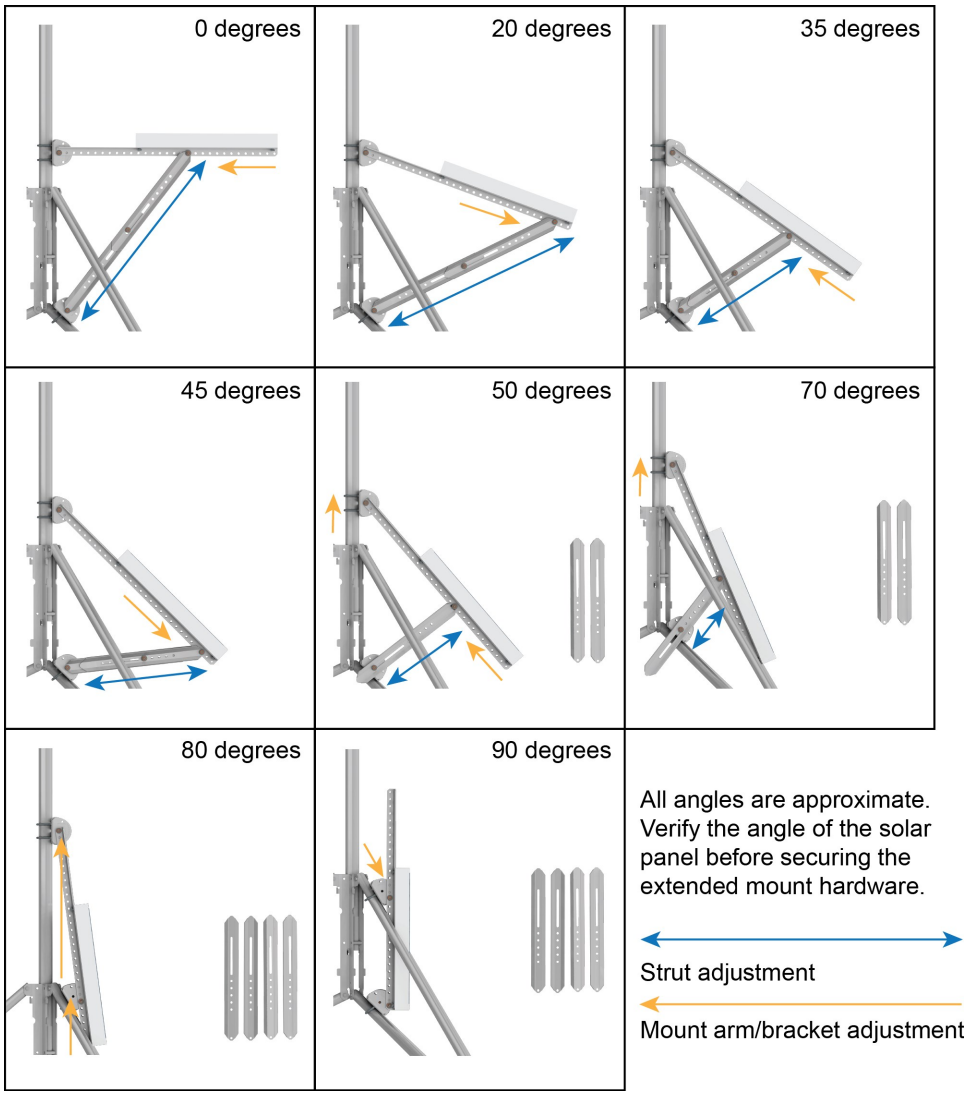

FIGURE 3-19. Extended mounting bracket configurations for different mounting angles

3.6 Installation of CH201 regulator

DANGER:
For safety reasons, completely cover the solar panel to limit output current and voltage. If nothing is available to cover the panel, be careful not to short solar panel (+) and (–) wires together.

1. Using the supplied mounting hardware, install the CH201 on the mounting plate of an environmental enclosure (see FIGURE 3-21 (p. 22)). Verify the On/Off switch is in the 'Off' position.
2. Plug the end of the wire that ships with the battery with the two-pin connector into the **BAT** terminal on the CH201 (the wire is an optional accessory for the BP84). Attach the red wire to the positive (+) terminal on the battery. Attach the black wire to the negative (–) terminal on the battery.

   The LED on the regulator labeled **CHG** should not be lit.

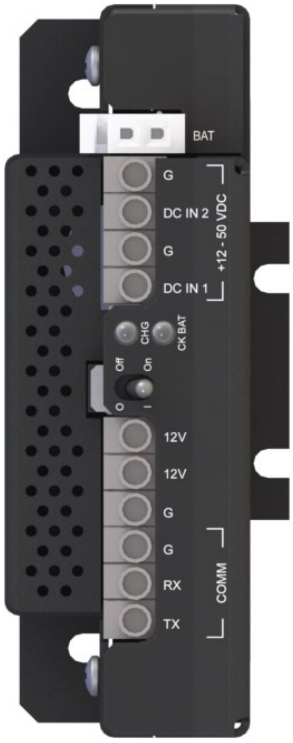

FIGURE 3-20. CH201 wire connections

3. Connect the black (–) wire from the solar panel cable to the **G** terminal on the regulator located between the **DC IN 1** and **DC IN 2** terminals. Connect the red (+) wire from the solar panel power cable to the terminal labeled **DC IN 1** on the regulator.
4. If charge current is available from the solar panel, the LED on the CH201 marked **CHG** will begin to flash green. This indicates the battery is charging and verifies proper operation and wiring of the regulator.
5. To supply power to the system, connect the red power wire from a data logger to either 12V terminal on the CH201. Attach the black power wire from the data logger to one of the two **G** terminals next to the **12V** terminals.

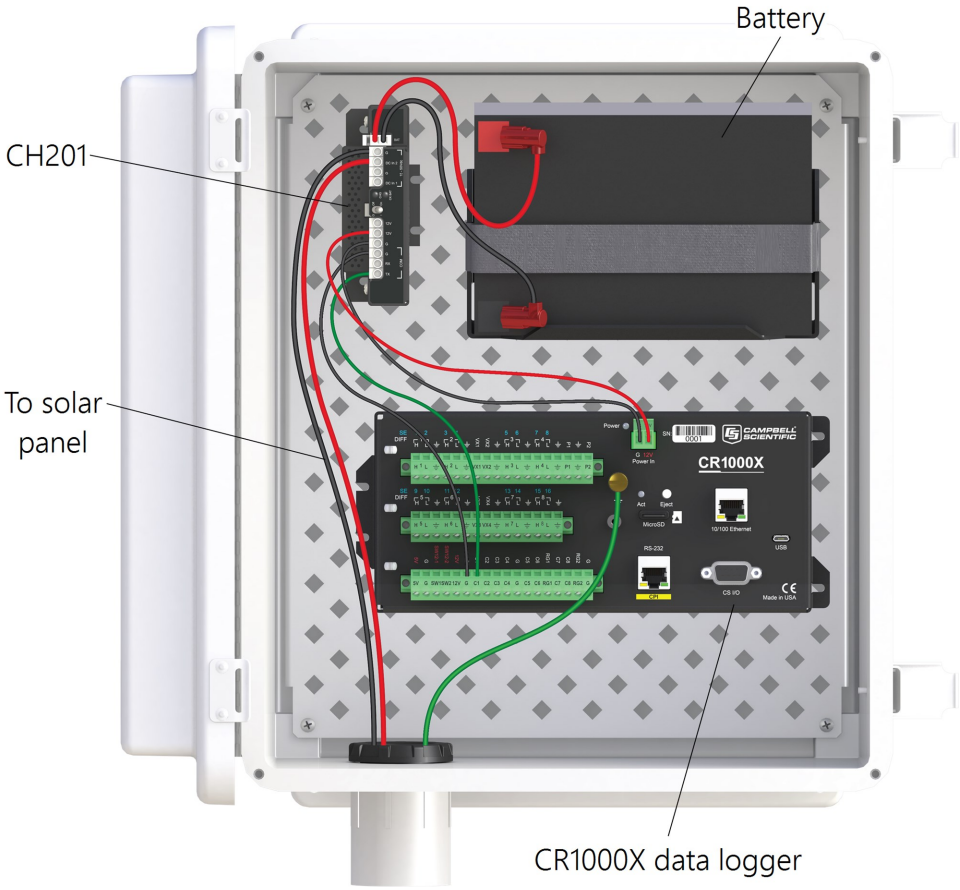

FIGURE 3-21. CH201 wired to solar panel, CR1000X, and battery

3.7 Installation of Morningstar SunSaver regulators

1. Using the supplied mounting hardware, install the Morningstar SunSaver regulator to the mounting plate of an environmental enclosure (see FIGURE 3-22 (p. 23)).

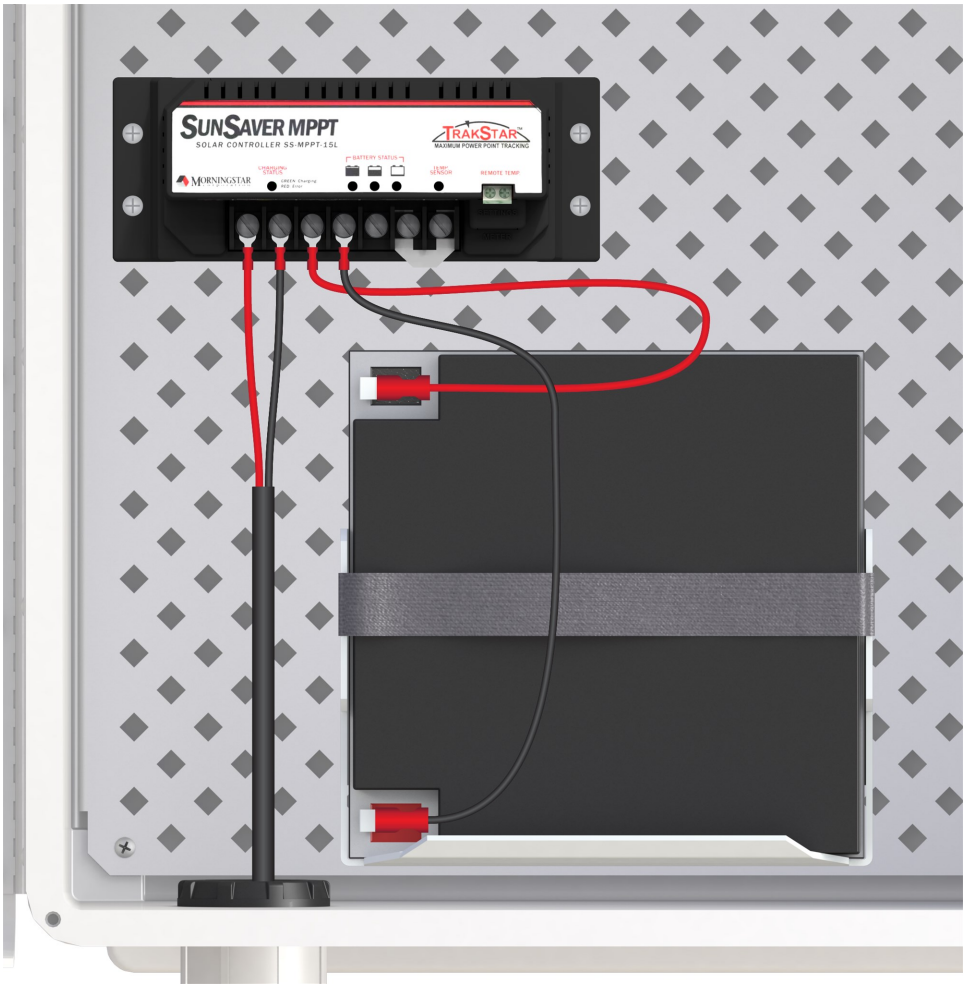

FIGURE 3-22. Morningstar's SunSaver™ SS-10-12V Regulator mounted on an enclosure backplate

2. If using deep cycle marine battery along with the SP50-L, SP90-L, or SP370-L solar panels, install a battery terminal bus on each terminal of the user-supplied deep cycle battery as shown in FIGURE 3-23 (p. 24).

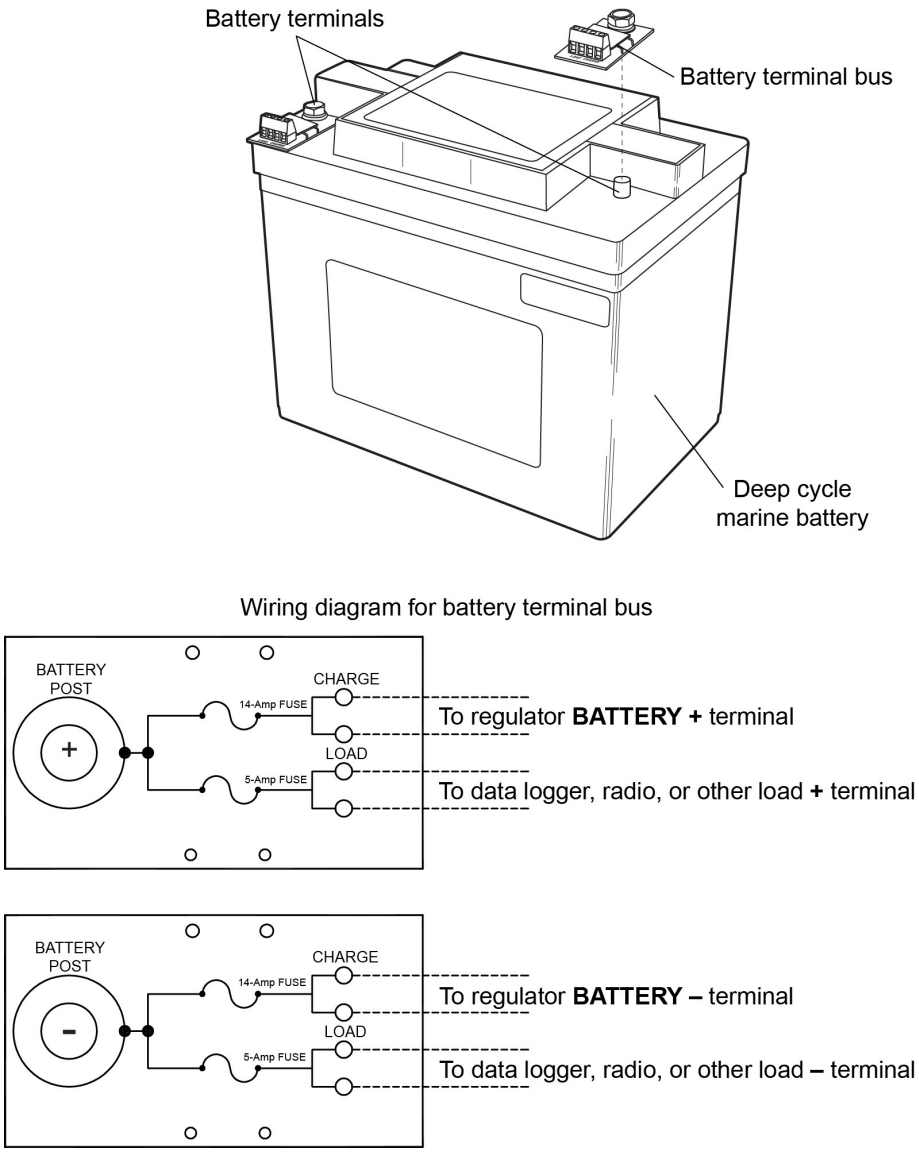

FIGURE 3-23. Installing the battery terminal bus kit

3. Using the spade terminated ends of the supplied red and black power wires, secure the black wire to the **BATTERY –** terminal on the regulator. Connect the other end of the black wire to the negative (–) battery terminal. If a deep cycle marine battery is being used, attach the black wire to the **CHARGE** terminal on the battery terminal bus attached to the negative (–) battery terminal instead.

Secure the red wire to the **BATTERY +** terminal on the regulator. Connect the other end of the red wire to the positive (+) battery terminal. If a deep cycle marine battery is being used, attach the red wire to the **CHARGE** terminal on the battery terminal bus attached to the positive (+) battery terminal instead.

With the battery connected and no solar panel input, the green LED on the regulator marked **CHARGING STATUS** should not be lit. A brief green flash every five seconds is okay.

4. Connect the black wire from the solar panel power cable to the **SOLAR –** terminal on the regulator. Connect the red wire from the solar panel power cable to the **SOLAR +** terminal on the regulator. Refer to the MorningStar SunSaver manual to determine if the jumper between the **LOAD –** and **Remove Jumper for Flooded Battery** terminals needs to be removed.
5. If charge current is available from the solar panel, the green LED on the regulator marked **GREEN: Charging** will light up. This verifies proper operation and wiring of the regulator.
6. To supply power to the system, connect the red wire from the data logger to the **LOAD +** terminal on the voltage regular and the black wire from the data logger to the **LOAD –** terminal on the voltage regulator. If a deep cycle marine battery is being used, connect the red wire from the data logger to the battery terminal bus **LOAD** terminal on the positive (+) battery terminal and connect the black wire from the data logger to the battery terminal bus **LOAD** terminal on the negative (–) battery terminal instead.

> **NOTE:**
> Morningstar SunSaver regulators ship with the jumper INSTALLED. Refer to the MorningStar SunSaver manual to determine if the jumper between the **LOAD –** and **Remove Jumper for Flooded Battery** terminals needs to be removed.

4. Maintenance

Occasional glass cleaning improves solar panel efficiency. Use a soft sponge and warm water with a small amount of dishwashing detergent to gently clean the solar panel of any dust, grime, or bird droppings. Use a soft, dry cloth or squeegee to remove any residual water from the panel.

If a problem with the solar panel is suspected, check the panel by measuring the voltage output. Check the voltage with a voltmeter connected between the two wires from the solar panel. There must be solar radiation incident on the panel and there must be a load connected to the solar panel. The load can be a data logger, other equipment, or a 75 ohm resistor capable of

dissipating solar panel power between the two wires. No voltage output implies a bad solar panel, or cable. The magnitude of the voltage output depends on the incident solar radiation.

5. Power considerations

5.1 Solar panel and storage batteries

The solar panel converts light energy to electricity, or specifically to direct current. The direct current produced is used to provide power to the system and to charge storage batteries.

The solar panel operates in both direct and diffuse light (cloudy days), but not at night.

The minimum battery size and solar panel output required depend on:

- The average current drain of the system
- The maximum time the battery must supply power to the system without being charged
- The location of the site

> NOTE:
> When some batteries are discharged below a specified voltage, the battery becomes damaged and cannot be recharged.

On average, the solar panel must be able to provide at least the amount of power necessary to operate the system for 24 hours. This means that the solar panel should not only be able to supply power to the system during the day, but it should also be able to provide power necessary to charge the battery for the power lost during the night. In addition, the battery must have enough capacity to power the system during times of no charging (night) and several days of low charging (cloudy and stormy days).

Campbell Scientific has developed an Excel power budget spreadsheet that estimates the solar panel size and battery required for a system based on the components in the system, scan interval, communications interval, and location.

This Excel spreadsheet may be downloaded from www.campbellsci.com/downloads/power-budget-spreadsheet.

A video demonstrating how to use the spreadsheet is also available. View it at www.campbellsci.com/videos/power-budgeting.

For additional help in computing the power budget for a specific system, please contact Campbell Scientific.

5.2 Voltage regulator

The solar panel must be regulated either with a Campbell Scientific regulator or a third-party regulator. The regulator has two basic functions:

- Blocking any current flow from the battery to the solar panel
- Limiting the source current to the battery

The solar panel must be connected to the voltage regulator, not direct to the storage battery.

Campbell Scientific voltage regulators include the CH201, GRANITE 6, CR6, CH200, CR300, and CH150. A separate battery is required for these regulators. The PS200 and PS150 regulators include a 7 Ah battery. The CR3000 has an optional rechargeable base. Two Morningstar SunSaver regulators are also available from Campbell Scientific.

Consult the product documentation to view the maximum charging current for each regulator.

The regulator and battery must be housed in an environmental enclosure. Mounting brackets are included with the regulator for attachment to an enclosure backplate.

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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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.

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Safety

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

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.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.

CAMPBELL SCIENTIFIC
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