Product Manual

Power Supply

# Solar Panels

10/2020

CSL I.D - 060

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

# Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. 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 a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.


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# About this manual

**Some useful conversion factors:**

**Area:** 1 $in^2$ (square inch) = 645 $mm^2$

**Length:** 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

**Mass:** 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

**Pressure:** 1 psi ($lb/in^2$) = 68.95 mb

**Volume:** 1 UK pint = 568.3 ml
1 UK gallon = 4.546 litres
1 US gallon = 3.785 litres

## Recycling information

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.

Campbell Scientific Ltd 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 advice or support, please contact Campbell Scientific Ltd, or your local agent.

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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.eu or by telephoning +44(0) 1509 828 888 (UK). 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**

- 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, or 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.

**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.

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.

# Contents



## *Figures*

# *Solar Panels*

*Campbell Scientific has a range of solar panels of 5W to 100W nominal power output. The SP5, SP10 and SP30 have no shunt regulator whereas models SP10R and SP30R are supplied complete with a shunt regulator. The general description and specifications given in this manual for the SP10 and SP30 also apply to the SP10R and SP30R (see Table 1). The differences between the types are clearly stated. Larger panels are supplied with higher power regulators to suit the application.*

*The SP5 is normally only used with CR300 dataloggers.*

*In most climates the SP10 generates enough power to maintain a float charge on a lead-acid battery for many applications, allowing the datalogger to be powered continuously. The capacity of the battery used depends on the application – battery capacities of 2.5, 5 and 7Ah are commonly used. The SP30 can be used where climatic conditions are less favourable or where the extra output is needed, e.g. for GPRS communications. Where current drain is higher a large battery is often used such as the BP17 or BP24.*

*If the datalogger is to be used with ancillary equipment which consumes a significant amount of power (e.g. an Eddy Covariance system), the SP60 or SP100 panel is normally specified. Under these conditions, the battery capacity should also be increased to suit e.g. using a leisure battery of 70-100 Ah.*

# 1. Specifications

| | **SP5** | **SP10** | **SP30** | **SP60** | **SP100** |
|---|---|---|---|---|---|
| Typical maximum power (W) | 4.5(±10%) | 10(±10%) | 35(+/-5%) | 70(+/-5%) | 110(+/-5%) |
| Voltage at peak power** | 16.5 | 16.8 | 18.1 | 18.1 | 17.6 |
| Current at peak power (A) | 0.27 | 0.57 | 1.94 | 3.87 | 6.25 |
| Short circuit current (A) | 0.30 | 0.6 | 2.1 | 4.2 | 6.8 |
| Open circuit voltage** | 20.5 | 21.0 | 21.7 | 21.7 | 21.1 |
| Dimensions (excluding bracket) | 251 x 269 mm | 420 x 269 mm | 415 x 510 mm | 535 x 734 mm | 1037 x 527 mm |
| Weight (excluding bracket and cable) | 0.9 kg | 1.9 kg | 2.95 kg | 5.8 kg | 7.4 kg |
| Temp. coeff. of voltage (mV/°C) | -80 | -72 | -63 | -61 | -61 |
| Temp. coeff. of power (%/°C) | -0.5 | -0.37 | -0.38 | -0.38 | -0.38 |
| Cable *** termination | Fixed 4.5 m lead | Fixed 4.5 m lead | 0.9 m lead with MC4 connectors | 0.9 m lead with MC4 connectors | 0.9 m lead with MC4 connectors |

*Power ratings are obtained under standard test conditions of 10000 $Wm^{-2}$ and 25°C cell temperature.

**These are voltages at the panel surface. If an external regulator or long cables are used the apparent output voltage will be lower.

***Larger panels have two separate output leads fitted with MC4 connectors. A single dual-core extension cable is supplied with mating connectors to make the standard total cable length 5 m.

**Common Specifications**

Maximum temperature range: -40 to +85°C

Maximum system voltage: 50 V

Warranty on power output (90% of initial power): 10 years

# 2. Mounting

*Figure 1 General View of SP5 /SP10 with its Mounting Bracket*

A hinged bracket is provided which allows the angle of the panel to be altered. Attach the bracket to a section of vertical pipework of the SPM2, the CM10 tripod or other mounting structure using the `V' bolt clamp provided. The panel should face due South (North in the southern hemisphere) and the angle of the panel should generally be adjusted according to the following considerations:

- For best performance in short term installations the panel can be set perpendicular to the solar beam at midday.
- For longer term use over many months the optimum angle from the horizontal is the latitude of the site plus 15°.
- Where snow or dust is likely, the angle of the panel may have to be increased further to encourage the snow/dust to fall off the panel.
- Make sure that shadows do not fall on the panel, making an allowance for low sun angles in the winter.

**NOTE** It is also possible to mount the panel on the leg of a tripod, but this may limit the range of angles at which the panel can be set.

The SP5/SP10 bracket is not fitted to the Solar Panel before shipping and should be attached as follows (see Figure 2):

1. Assemble the M8 bolts through the bracket, and through the holes in the side of the Solar Panel.

   The panels have slotted side-channels. Slide the head of the bolt into the channel, spring open the bracket to let the bolt come out through the hole in the bracket and fit the nuts outside the bracket. Use the washers in the same order.

2. Fit the bracket to the mast using the M8 'V' bolts and fasteners.
3. Position the Solar Panel at the desired angle and tighten. It is advisable to use a thread locking compound on the M8 nuts if extreme weather conditions may be encountered.

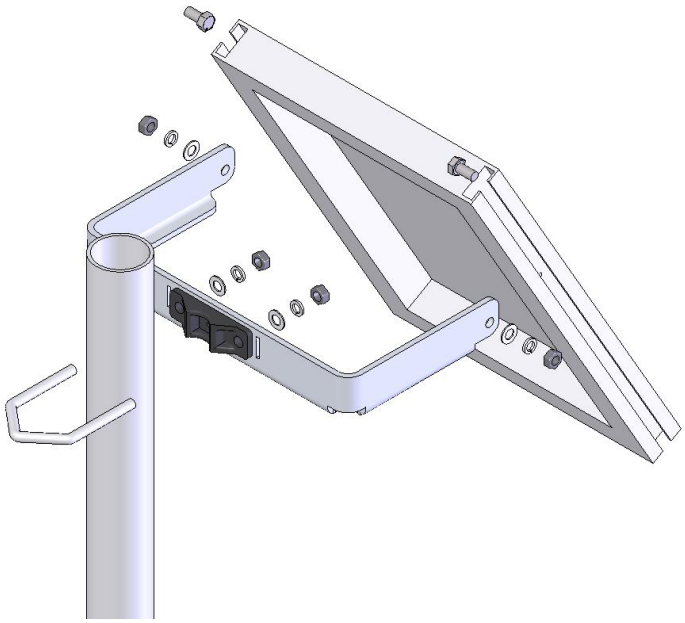

*Figure 2. Assembly details of bracket for the SP5 and SP10*

The SP30 and larger standard panels are supplied with a Solar Panel Multi-Fit bracket (Part number 006607). This is a substantial bracket that fits many different sizes of panels using small clamps fitted under the rear lip of the frame at either side of the panel (it works with panels up to 500 mm internal width). This allows easy exchange of the panel in the field, e.g. to upgrade to a larger size panel.

One bracket is supplied as standard with each panel which is suitable for mounting the SP30 panel on poles, tripods or towers in most applications. A single bracket may also be adequate with larger panels in sheltered sites where the lower edge of the panel rests on the ground or on the tripod legs. For exposed windy sites, especially with the larger panels, e.g. the SP60 or SP100, a second bracket should be ordered to allow the panel to be mounted on two vertical tubes rather than one. Those tubes could be the two sides of a larger tower or user supplied poles which are fixed into the ground.

Each bracket has two `V' bolt fittings for poles in the range of 25-54 mm diameter. Optional band clamps are available to allow the brackets to be fitted to larger poles up to 120 mm in diameter. Larger poles can be catered for to special order. The panel angle can be adjusted in one of six steps from 0-90 degrees relative to the pole. The bracket is supplied preassembled but needs to be mounted on the back of the panel as shown in Figure 3.

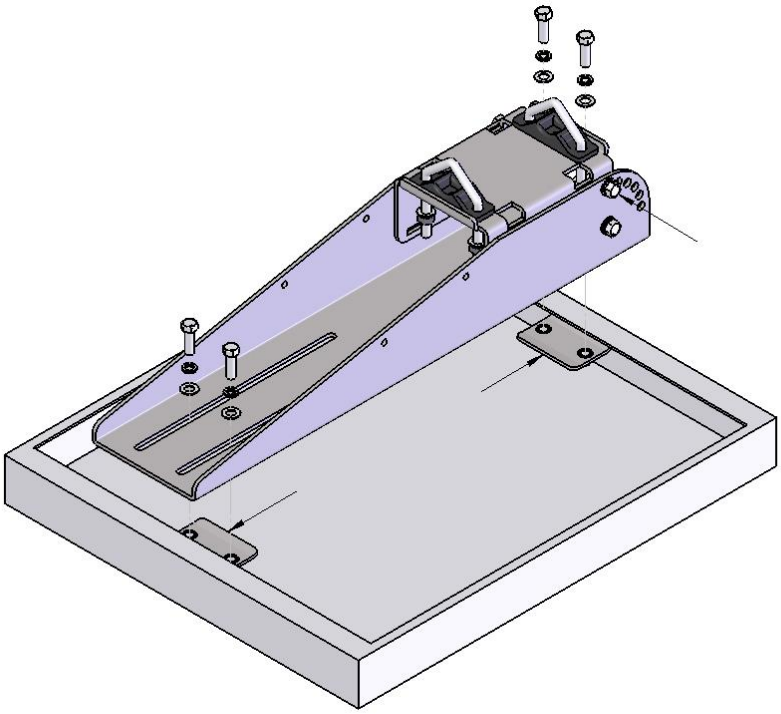

*Figure 3a. Assembly drawing for fitting the multi-mount bracket to a larger panel*

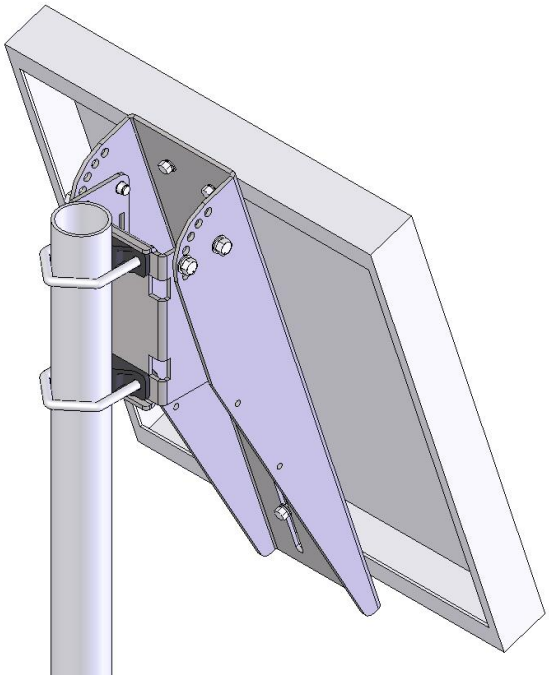

*Figure 3b. Solar panel mounted on pole using the multi-mount bracket*

If using band clamps the `V' bolts are removed and a band clamp fed through the slots at either side of the bracket close to the holes where the `V' bolts feed through. Two clamps are normally used, one top and one bottom. For very large poles (150 mm up), the body of the bracket (which holds the `V' bolts), can be detached from the longer main section of the assembly and then reversed. The band clamps can then be fed through the alternative slots near the open end of the bracket. The open end of the bracket is then the point of contact with the pole. See Figure 4.

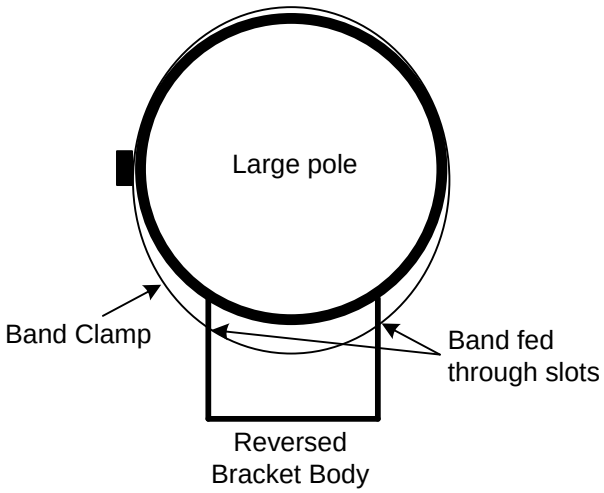


*Figure 4. How to attach the multi-fit bracket to larger poles using a band clamp*

The multi-fit bracket has a double locking mechanism to prevent the panel rotating at high wind speeds. For adjustment, the two locking screws must be removed to allow the panel to rotate. At the chosen angle replace the screws making sure to use the spring washers under the screw heads (refer to Figure 3).

# 3. Connections

The method by which the wire is connected to the solar panels will vary with the model and make of panel supplied. Smaller panels, such as the SOP5, are fitted with a flying lead that is moulded into the back of the panel. Larger panels have junction boxes on the back of the panel to which Campbell Scientific will normally fit a two core lead.

Newer designs of panels have a junction box which is fitted with industry standard single core leads with MC4 solar panel connectors. Where MC4 connectors are fitted a two core extension lead, with matching connectors on one end, will be supplied to join onto the shorter wires. The MC4 connectors are waterproof and keyed. They can only be mated into the correct matching halves on the extension cable. Ignore any polarity indicators on the moulded connector. Make sure the cable on either side of the mated connector is adequately cable tied to the mounting bracket or tower to avoid the cable pulling apart after installation. If there is a need to join panels in parallel, standard MC4 joining connectors can be used for this purpose.

There are two types of colour coding that may be used with the solar panels which are easily identified. Traditional US colour coded wires use red for the positive (+) wire and black for the negative (-) wire. Larger panels may use IEC wiring where brown indicates positive (+) and blue negative (-).

The SP10R and SP30R panels are supplied with shunt regulators suitable for 12V lead-acid batteries. The connection is normally made at the battery terminals.

In contrast, the SP10 and SP30 are designed to connect to the terminals of the battery charging circuit of the type fitted to the rechargeable CR300, CR3000 and CR6 dataloggers and the CH/PS series power supplies. The SP30 can also be used with these dataloggers and power supplies (see Section 3.3) in some applications.

**CAUTION** It is essential to ensure that the wires from the solar panel are fixed to the structure of the tower or tripod. This is to prevent the wire moving in the wind which can cause premature failure of the system.

The SP60 and SP100 are usually supplied with a separate Morningstar regulator. Please refer to the instructions supplied with that regulator for wiring and configuration instructions.

## 3.1 Connecting the SP10R or SP30R

The SP10R are supplied with loose shunt regulators which have to be wired into cables connecting the panel to the battery. The wires of the shunt regulators are clearly identified. Connect the shunt regulator as shown in Figure 5.

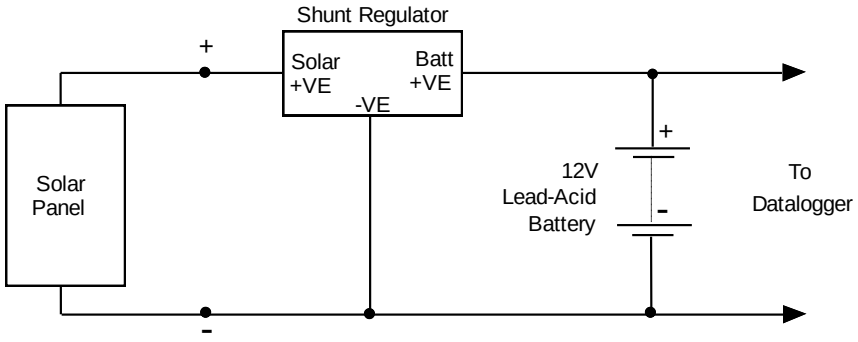


*Figure 5. Connection of Shunt Regulator for SP10R Panels*

**CAUTION** Observe the correct polarity when making connections to the shunt regulator. Failure to do so may damage the regulator beyond repair.

The shunt regulator operates by detecting the battery voltage on its output. When this voltage reaches a defined limit (nominally 14.6V) the shunt regulator effectively shorts out the solar panel preventing further charging. (A diode in the regulator prevents reverse discharge from the battery.)

With the panel shorted out, the battery voltage slowly drops to a point when the regulator re-enables the solar panel input. This results in cyclic on/off charging: as the battery becomes charged the regulator shorts out the panel for a greater proportion of the time.

Recent versions of the shunt regulator are fitted with a small green LED which protrudes from the regulator case close to the point where the wires emerge. This LED comes on when the regulator has shorted the solar panel. The LED can be used to check operation of the panel and as an indication of the state of charge of the battery.

As an initial test of operation of the panel, connect the regulator as shown, but do not connect the battery; leave the battery lead from the regulator disconnected. When the panel is exposed to sunlight the LED on the regulator should flash on and off indicating the panel is giving out a voltage with the correct polarity.

With the regulator connected to the battery and the panel exposed to sunlight the LED should start to flash on and off as the battery comes near to being fully charged.

**NOTE** The regulator supplied consumes about 5 mA of power all the time.

## 3.2 Connecting the SP5 or SP10 to the Rechargeable CR300 series, CR3000 and CR6 Dataloggers and the CH200, CH201, PS200, CH150 and PS150 series Power Supplies

Solar panels can be connected directly to the charging circuits of the rechargeable CR300, CR3000 and CR6 dataloggers, and the CH200, CH201, PS200, CH150 and PS150 series power supplies as indicated below.

The red LED built into the appropriate charging circuit comes on when enough light falls on the panel. Please see the CH200/CH201/PS200 and CR6 manuals regarding their LED indicators. The CR300 does not have an LED.

**NOTE** The LED only indicates that a voltage is being generated by the panel; it does *not* necessarily indicate that the batteries are being adequately charged.

### 3.2.1 Dataloggers with built in chargers: the CR300, CR3000 and CR6

Any of the smaller solar panels can be connected directly to the built in charging circuit of the dataloggers. See below if using the SP30 panel with these dataloggers.

Connect the wires from the panel to the charging circuit connector on *the right-hand side* of the rechargeable CR3000 base. *Do not connect to the 12V Power Input plug on the top of the datalogger.* Polarity of the leads to the connector is not critical.

### 3.2.2 CH200, CH201, PS200, CH150 and PS150 series Chargers

Connect the wires to the solar charging circuit connectors on the power supplies – observing the polarity. See below if using the SP30 with these power supplies.

## 3.3 Using the SP30 with systems containing smaller lead acid batteries

The SP30 can be used with smaller (7 Ah) lead-acid batteries in many circumstances – for example in less favourable climatic conditions, and in high latitude installations, where solar radiation can be low. It can also be used in some high current applications, but it should be noted that the reserve capacity of the internal battery may be a limiting factor. Current limits in the charger circuit will prevent the maximum amount of energy passing from the panel into the battery during sunny conditions.

If used in a high current application, although there is no risk of overcharging the battery, the charger may get hot, especially when solar radiation is very high. This

can be minimised by mounting the panel at less than its optimum Summer angle, or even turning the panel to its Winter setting (see Sections 2 and 4).

**NOTE**

The SP30, when connected to the CR3000, CR6 datalogger or the PS150 series chargers, must *not* be used to charge a large external battery, connected in parallel with the internal battery.

It is also important to note that the SP30R (with shunt regulator) should *not* be connected to any of the power supply chargers or to the rechargeable CR3000/CR6 charging circuit.

## 3.4 Using solar panels with the CH150, CH200 and CH201 chargers

Any of the solar panels which do not have built-in or secondary regulators can be used with the CH150, CH200 and CH201, with the exception of the SP100 which requires a high current charger.

Please refer to the manual for these chargers which can accommodate two charge sources, larger panels and larger batteries.

## 3.5 Using solar panels with Morningstar regulators

SP60 and SP100 panels will often be supplied with high current regulators. Please refer to the instruction supplied with those regulators. Please note that the quiescent consumption of the regulator may be quite high, e.g. 8-10 mA. Please note the fuse warning below.

# 4. Optimum Battery Size

The batteries fitted inside the rechargeable CR3000, and the 'PS' power supplies and the BP7 have a capacity of 7Ah. These batteries are suitable for operation with solar panels at most sites for many applications with slow to medium power requirements.

However, the power consumption of a logging system can vary a great deal; factors such as high logging frequencies, external sensors, communications interfaces and multiplexers will all add to the power requirement. Very low temperatures can also reduce the effective capacity of the battery and the geographical location of the installation can greatly affect how much energy the panel can capture.

It is essential to analyse all the power requirements and to try to arrive at a figure for the total power consumed over a daily period, normally estimated in ampère-hours. The following general rules can then be used to estimate the size of panel and battery capacity required for reliable operation:

- When the solar panel is set at the optimum winter angle (latitude plus 15 degrees from horizontal), the average power it can capture in mid-winter should be equal to your estimate of the average power needed by the data-logger. Please contact Campbell Scientific for further details of the efficiency of the panels. To work out this figure the details of the exact site of installation are required. This is because the amount of energy that can be captured varies with latitude and local climate.

- It is generally advisable to have at least one month's capacity in the battery, assuming that the panel provides no power. This allows for periods of bad weather, which apart from causing less solar radiation might also result in snow or ice build-up on the panel surface, thus reducing the panel output further.

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.

**NOTE** When estimating the battery capacity, remember to allow for any reduction caused by low temperatures.

It is possible to deviate from these rules in many circumstances, e.g. a smaller panel might be used if only operating in the summer months. In some circumstances it is also more cost effective to opt for a much larger battery to cover several months in the winter than to buy a much larger panel to give positive charging at all times.

If a larger battery is to be used with an existing power supply system (e.g. a PS power supply), either disconnect the existing supply altogether or connect the external battery to the existing supply using a diode/resistor connection technique (see Figure 6). This gives some protection against reverse polarity connection and also guards against excessive current flowing when the external battery is first connected to the internal battery.

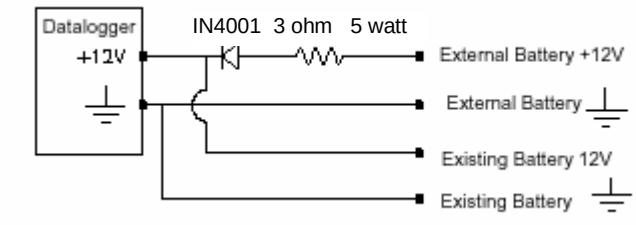


*Figure 6. Connecting to External Power Supply*

If using this connection it is essential to connect the solar panel and shunt regulator directly across the external battery. The battery voltage monitored by the logger will be 0.7V lower than the voltage on the external battery.

**WARNING**

**When using external lead acid batteries it is good practice (and sometimes a legal requirement) to fit a fuse in the leads coming from the battery so the accidental shorting of the leads does not lead to overheating of the cables or a fire.**

**NOTE**

Campbell Scientific does not recommend using the chargers built into the rechargeable CR3000/CR6 dataloggers, or the PS150 series power supplies to charge large external batteries. It is also generally inadvisable to connect panels with a greater output than the SP30 (i.e. 30W) to these chargers without first seeking the advice of Campbell Scientific.

# 5. Precautions

1. Although the solar panel is unlikely to be damaged by a short-circuit, the panel leads should be kept separate when not connected to a datalogger or battery pack.

   When using panels of 60W or 100W the potential current output on the panel can cause sparking or even a fire if connected incorrectly.

2. It is important to match panel output to battery capacity and current drain. Although an incorrect choice of components can lead to undercharging of the batteries in overcast conditions, there is little danger of overcharging, even if a large panel is used with low capacity batteries at very low current drain. Some care may, however, be needed to prevent the battery cell temperature from rising if this combination is operated in a climate which is particularly hot and sunny. The charging circuits built into all Campbell Scientific power supplies incorporating temperature compensation which will help to prevent overheating.

# 6. Maintenance

Visit the site at regular intervals to clean any dirt from the surface of the panel. The frequency of visits will be site-dependent and may also vary with time of year, e.g. in the autumn, leaves can fall and stick to the panel.

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***Other Locations:*** Sales and support are provided in many other locations through an extensive network of international reps. For the full list, please visit ***www.campbellsci.com/contact#dir***.