

# INSTRUCTION MANUAL



## PS150/CH150 12 V Charging Regulators

6/14



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# Precautions

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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.

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](http://www.campbellsci.com) or by telephoning 435-227-9000 (USA). 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.



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# ***PS150/CH150 12 V Charging Regulators***

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## **1. Introduction**

The PS150 is a 12 Vdc power supply that includes a rechargeable 7 Ah valve-regulated lead-acid (VRLA) battery and charging regulator. The CH150 is a charging regulator for an external rechargeable 12 V VRLA battery such as the BP12 or BP24 offered by Campbell Scientific. Charging power for these charging regulators is typically supplied by an unregulated solar panel, AC/AC transformer, or AC/DC converter.

The PS150/CH150 are smart chargers that provide charging with temperature compensation for optimal charging and battery life. A maximum power point tracking algorithm is incorporated for solar inputs to maximize available solar charging resources.

The PS150/CH150 are compatible with the A100 null-modem adapter and the A105 adapter for additional 12 V output terminals. The A100 Null Modem Adapter connects and powers two Campbell Scientific peripherals via two CS I/O 9-pin connectors configured as a null modem. This is useful in linking different communications technologies; e.g., telephone to radio, at sites that do not have a datalogger. The A105 adapter may be used to provide additional 12 V and ground terminals where the power supply is used to power several devices.

The PS150/CH150 charging regulators are termed series regulators, because the regulators are placed in series between the charging source and the load. As batteries become closer to fully charged, series regulators reduce the current drawn from the charging source, to where the charging source may be completely unloaded if full-charge is reached. While this unloading of the charging source is acceptable for solar panels, AC/AC transformers and AC/DC converters, it is undesirable for wind turbines because of the resulting free spinning when unloaded. Consequently, series charging regulators, including the PS150/CH150, should not be used to regulate the output of wind turbines without the inclusion of a way to load the turbine when the batteries require little or no charging current.

The PS150/CH150 chargers have several safety features intended to protect the charging source, battery, charger, and load devices. Both the SOLAR – G and CHARGE – CHARGE input terminals incorporate hardware current limits and polarity reversal protection. There is a 5 A fuse in series with the CHARGE – CHARGE inputs in the event of a catastrophic AC/AC or AC/DC charging source failure. There is a 4.7 A solid-state breaker in series with the 12 V output terminals of the charger in the event of an output load fault. The PS150/CH150 incorporate battery reversal protection, which is catastrophic for most chargers. ESD and surge protection are incorporated on all inputs and outputs of the PS150/CH150.

## 2. Precautions and Tips

<b>CAUTION</b>	For indoor use only.
<b>WARNING</b>	<b>Risk of electric shock. Dry location use only.</b>
<b>WARNING</b>	<b>Risk of fire or electric shock. Do not interconnect output terminals.</b>
<b>WARNING</b>	<b>Permanent damage to rechargeable cells may result if discharged below 10.5 V.</b>

Under normal charging conditions with sealed VRLA batteries, hydrogen and oxygen gasses are produced in relatively small quantities, most of which later recombines back into water. Aggressive overcharging produces excess hydrogen and oxygen gasses, resulting in gas venting by means of a pressure activated valve. Hydrogen gas emitted from VRLA batteries must not be allowed to accumulate, as it could form an explosive mixture. Fortunately, hydrogen gas is difficult to contain in anything but a metal or glass enclosure.

<b>WARNING</b>	<b>Never put VRLA batteries in an enclosure that does not allow emitted hydrogen gas to be dispersed.</b>
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VRLA batteries are capable of providing high surge currents. The 12 V output terminals of the PS150/CH150 are fused with a 4 A self-resettable thermal fuse, but there is no fusing for inadvertent bridging of the battery terminals. Accidental shorting of battery terminals by metallic objects, such as watchbands, can cause severe burns due to rapid heating and is also a fire hazard.

VRLA battery manufacturers state that “Heat Kills Batteries”. While the PS150/CH150 can operate from  $-40^{\circ}$  to  $+60^{\circ}\text{C}$ , optimum battery life is achieved with battery operating temperatures ranging from  $5^{\circ}$  to  $35^{\circ}\text{C}$ <sup>i</sup>, per manufacturer’s recommendations<sup>1</sup>. The PS150/CH150 offer temperature compensation of the battery charging voltage based on a temperature measurement inside the PS150/CH150 cases. The CH150 internal temperature measurement likely will not accurately represent battery temperature for charge voltage compensation unless the battery is in close proximity to the CH150.

With rechargeable batteries, a charge → discharge → re-charge event is termed a cycle. In general the most important factor for the service life of a battery is depth of discharge<sup>1</sup>. For example, decreasing the depth of each discharge from

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<sup>i</sup> Genesis Application Manual – Genesis NP and NPX Series US-NP-AM-002, June 2006.

100% to 50% approximately doubles the number of useful cycles available from the battery<sup>1</sup>.

**CAUTION**

Leaving a lead-acid battery in a discharged state for prolonged periods of time results in the undesirable growth of large sulfate crystals (sulfation) that are detrimental to battery performance.

VRLA batteries self-discharge at approximately 3% of rated capacity per month at room temperature<sup>1</sup>. A 3% of rated capacity per month self-discharge results in 100% discharge in approximately 33 months ( $\approx$  3 years) for a battery stored at room temperature. Self-discharge increasing with increasing storage temperature.

**NOTE**

Periodic recharging of stored batteries every few months is recommended to prevent irreversible sulfation due to prolonged time in a discharged state.

### 3. Quick Start

The PS150/CH150 modules are designed to handle extreme conditions. The modules have been designed with mounting holes on one inch centers for mounting to a standard Campbell Scientific enclosure back plate — see the enclosure manual for mounting suggestions. See FIGURE 3-1 through FIGURE 3-3 for typical enclosure installations using a PS150/CH150.

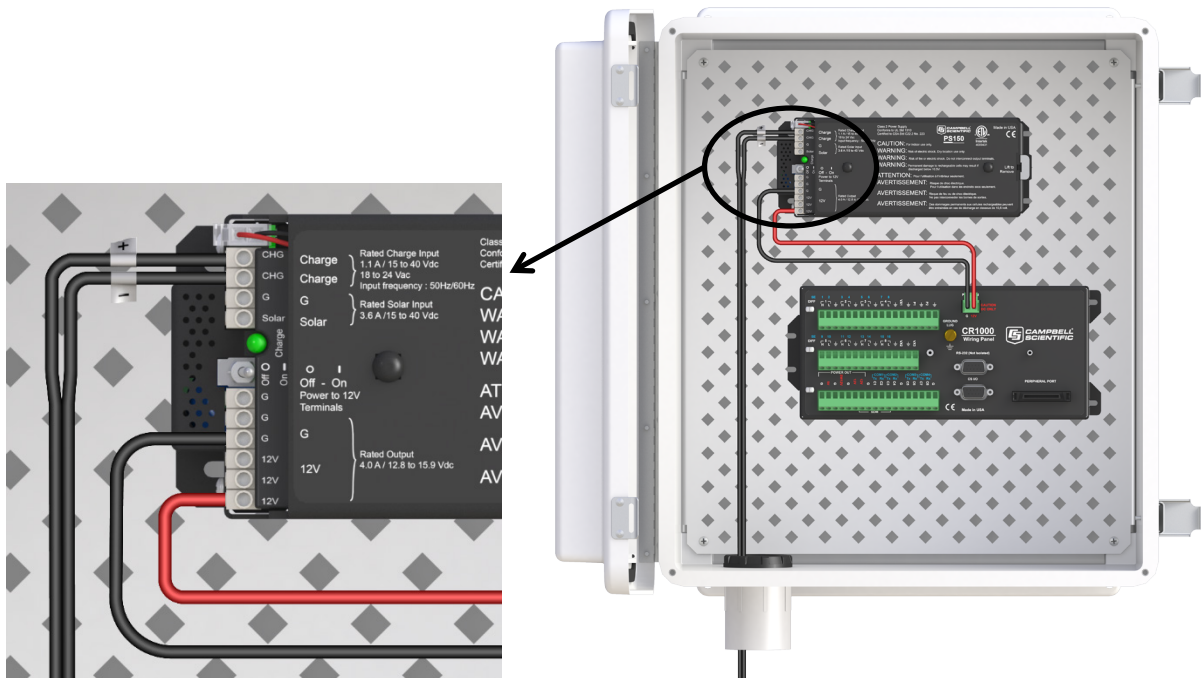


FIGURE 3-1. The PS150 connected to a CR1000 and AC power

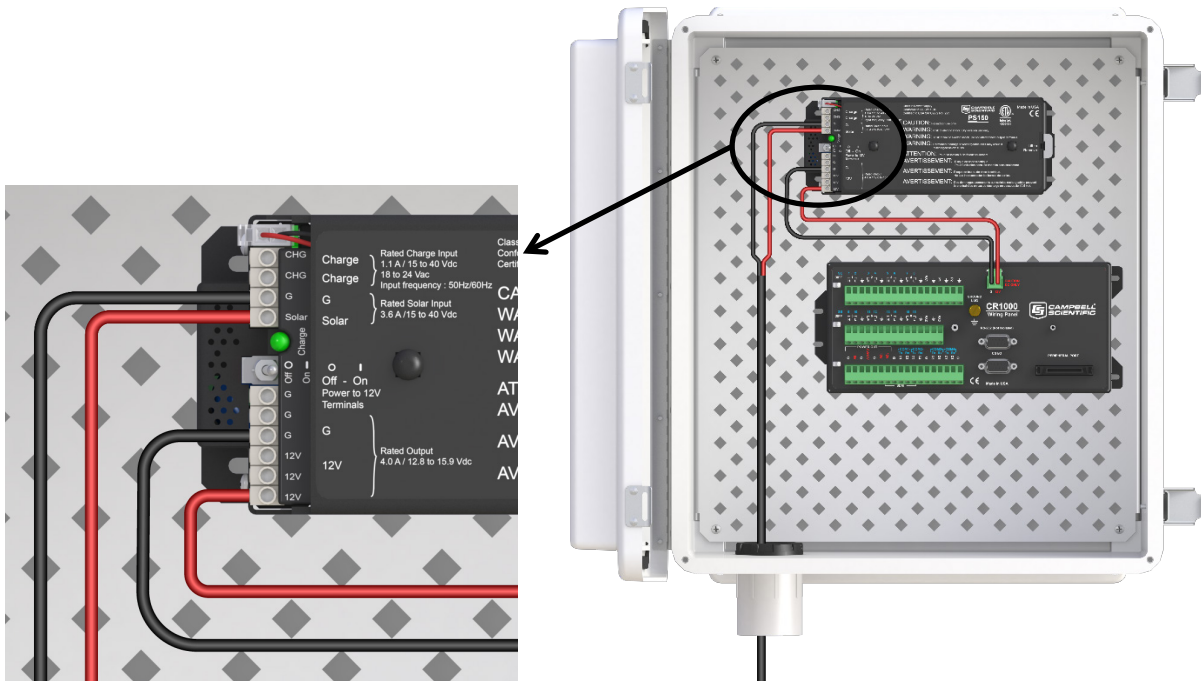


FIGURE 3-2. The PS150 connected to a CR1000 and solar panel

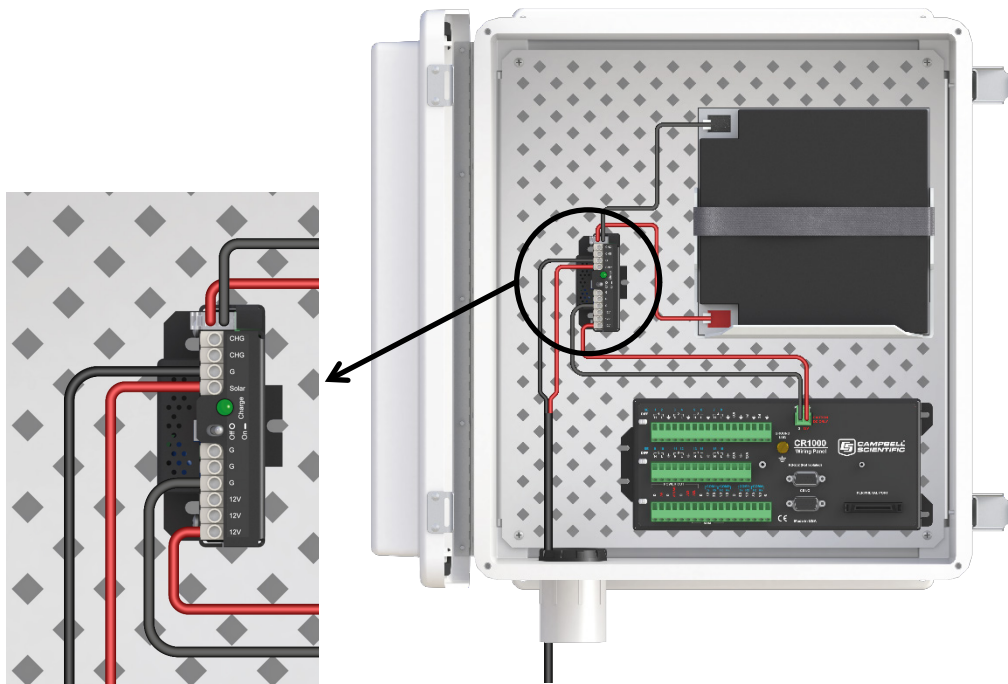


FIGURE 3-3. CH150 connected to BP24 battery pack and CR1000



### 3.1.2 AC/DC Power

Double check the input voltages coming in to the charger/regulator with a volt meter.

AC Input Voltage: 14 to 24 VAC RMS

DC Input Voltage: 15 to 40 VDC

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**WARNING** Exceeding the voltages listed above will damage the power supply.

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Disconnect the primary side of the AC/DC power before connecting wires to the PS150.

Connect the secondary power supply leads to the two terminal blocks marked “CHG”. There is no polarity on the “CHG” terminal blocks, so it does not matter which wire goes to which “CHG” terminal block, but make sure there is only ONE wire per block. See FIGURE 3-5.

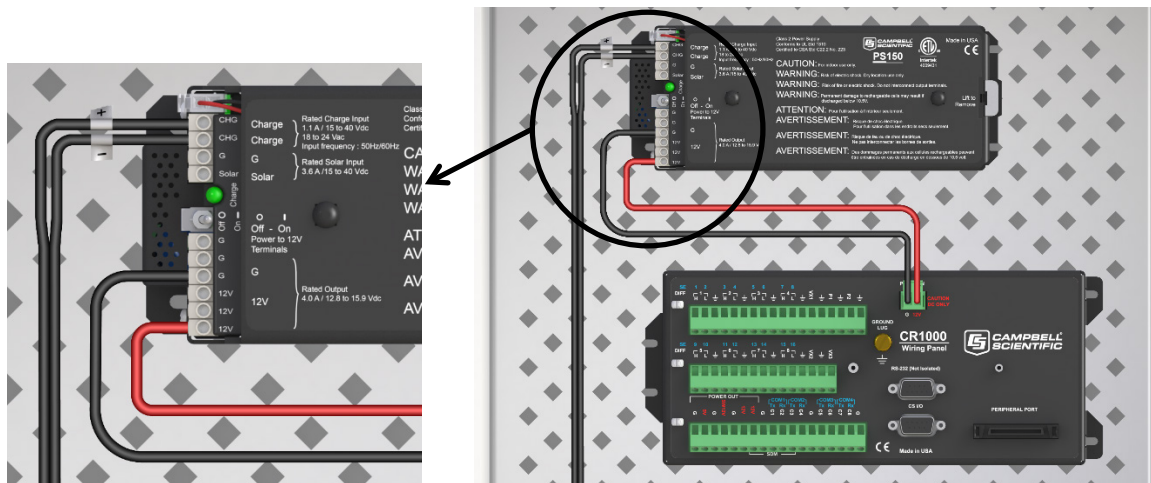


FIGURE 3-5. AC power connections on PS150

### 3.2 Plug In the Battery

The battery used with the PS150 is shipped inside of the PS150 case if the power supply is NOT installed inside an enclosure. If the PS150 is mounted inside an enclosure then the battery will be located separately packed in one of the packing boxes. This is done to minimize any damage that could occur if the power supply should get loose from its mounts inside the enclosure during shipment. The battery will NOT be plugged into the PS150. This is done to minimize discharging the battery.

To remove the lid from the PS150, pull up on the PS150 lid latch and slide the lid off as shown in FIGURE 3-6 and FIGURE 3-7.

**WARNING**

Do not remove the tape holding the battery wiring harness to the top of the battery! The tape is used to keep the battery wiring harness out of the way of the rubber bumpers on the inside of the lid.

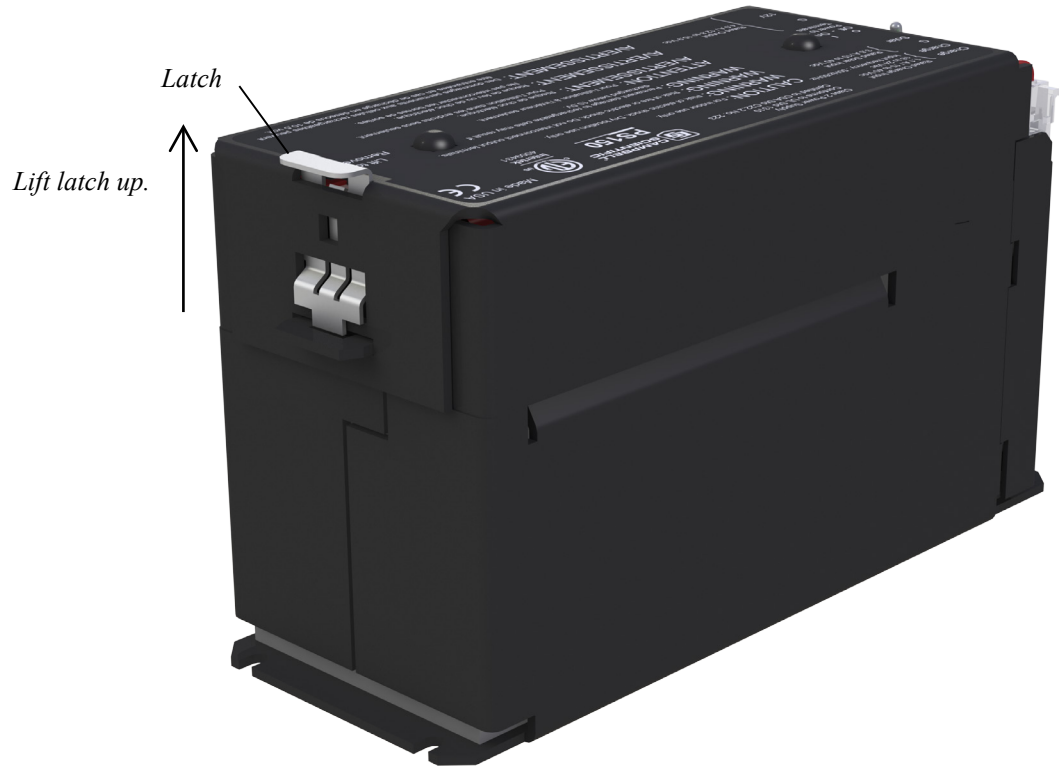


FIGURE 3-6. Lift latch up on PS150

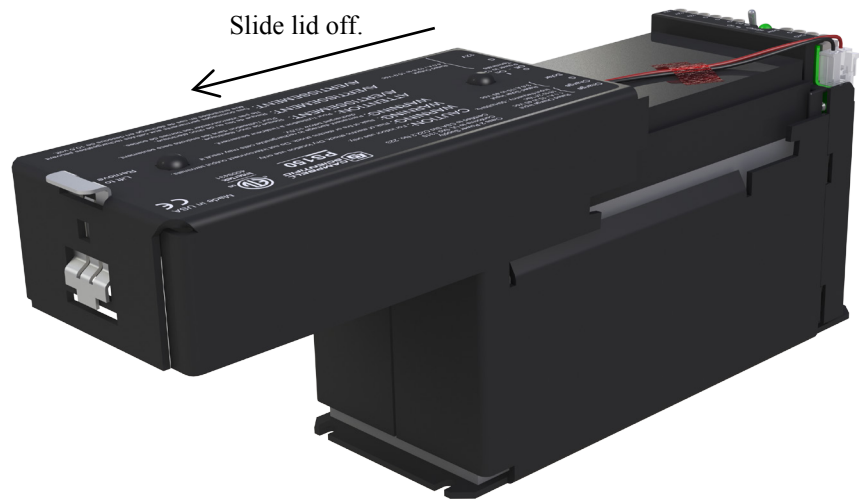
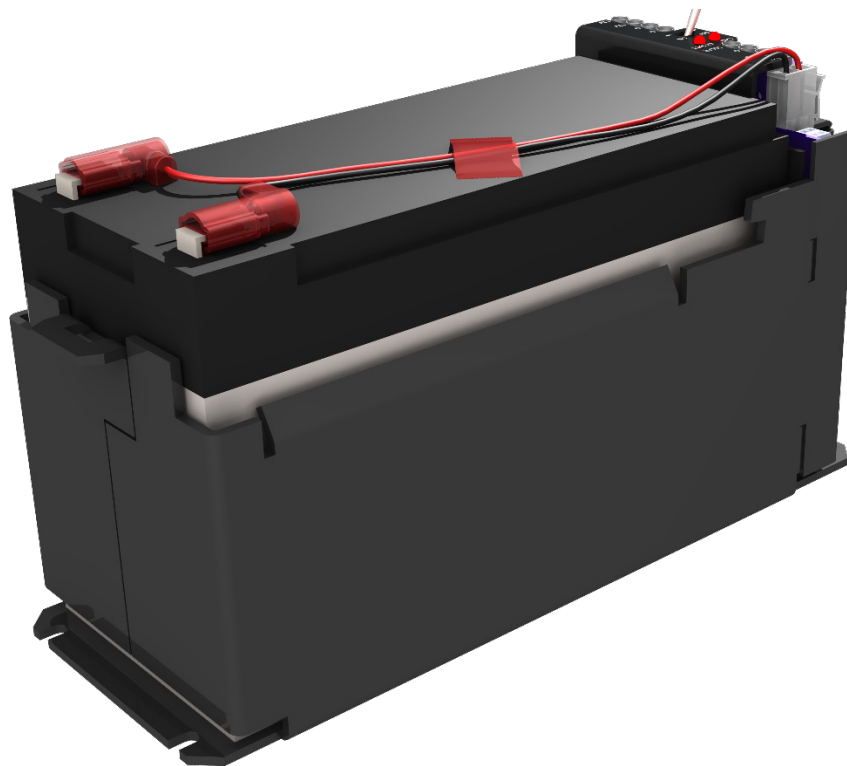


FIGURE 3-7. Slide PS150 lid off

Plug the battery into the connector marked “BATT”. This connector is polarized and will only allow the mating connector to be plugged in one way. Push the connector all the way in until it locks in place.



*FIGURE 3-8. Wiring harness plugged into battery connector*

### **3.3 Hook Up Power to Datalogger**

Both the PS150 and the CH150 come with a 1 foot black wire attached to one of the **G** terminal blocks and a 1 foot red wire attached to one of the **12V** terminal blocks. Attach the red wire from the power supply to the datalogger Power terminal block marked 12V (Campbell Scientific part number 3768). Attach the black wire from the power supply to the datalogger Power terminal block marked “G”.

### **3.4 Turn On the Charging Source**

Turn on the power going to the charging source or uncover the solar panel. The green “Charge” LED will flash approximately once a second if all incoming connections are correct and there is an adequate charging voltage present.

### **3.5 Turn On Power to the Datalogger**

Flip the switch on the PS150/CH150 supply to “On”. Verify voltage to the datalogger with a volt meter, or use a key pad display, or connect to the datalogger with a laptop or PDA to make sure the datalogger is running correctly.



### 3.6 LED Indicator

The green “Charge” LED will flash approximately once a second if all incoming connections are correct and there is an adequate charging voltage present.

## 4. Specifications

### 4.1 Specifications

<b>(CHARGE - CHARGE terminals) AC or DC Source:</b>	AC – (18 to 24) VRMS internally limited to 1.2 ARMS DC – (16 to 40) Vdc internally limited to 0.85 A DC
<b>(SOLAR - <math>\frac{\perp}{\perp}</math> terminals) Solar Panel or Other DC Source<sup>1</sup>:</b>	15 to 40 Vdc Maximum Charging Current: 4.0 ADC typical 3.2 ADC to 4.8 ADC depending on individual DC voltage source
<b>Battery Charging</b>	FLOAT Charging: $V_{batt}(T) = 13.65 - (24 \text{ mV}) \cdot (T - 25) + (0.24 \text{ mV}) \cdot (T - 25)^2$ $\pm 1\%$ Accuracy on charging voltage over $-40^\circ$ to $+60^\circ\text{C}$ range
<b>Operational Temperature Range<sup>2</sup>:</b>	$-40^\circ$ to $+60^\circ\text{C}$
<b>Power Out (+12 terminals)</b>	
<b>Voltage:</b>	Unregulated 12 V from Battery 4.65 A solid-state circuit breaker
<b>Quiescent Current</b>	
<b>No Charge Source Present:</b>	160 $\mu\text{A}$ at 13.7 Vdc
<b>No Battery Connected:</b>	930 $\mu\text{A}$ at 30 volt input voltage (ac or dc)
<b>Rated UL Class 2 Power Supply</b>	
<b>Physical Specifications</b>	
<b>PS150:</b>	10.6 cm (4.2 in) tall, 19.3 cm (7.5 in) long, 7.6 cm (3 in) wide
<b>CH150:</b>	10.0 cm (3.9 in) tall, 7.5 cm (3 in) long, 3.7 cm (1.5 in) wide

1. Battery voltages below 8.7 V may result in  $< 3.0$  A current limit because of foldback current limit.
2. VRLA battery manufacturers state that “heat kills batteries” and recommend operating batteries  $\leq 50^\circ\text{C}$ .

## 4.2 Battery Packs

Battery Pack Model	Amp-Hour Capacity (Ah)	*Operating Temperature Range (°C)	Battery Family
PS150	7	Charge: -15 to +50 Discharge: -20 to +60	EnerSys/Genesis
BP12	12	Charge: -15 to +50 Discharge: -20 to +60	EnerSys/Genesis
BP24	24	Charge: -15 to +50 Discharge: -20 to +60	EnerSys/Genesis
BP84	84	-40 to +71	Concorde Sun Xtender
* Battery specifications shown are from the manufacturer. The PS150/CH150 contains charging algorithms that optimize battery charging over the range of -40°C to +50°C. Battery usage outside of manufacturer specifications could have unknown effects on the life of the battery.			

### WARNING

**Battery life is shortened if the battery is allowed to discharge below 11.5 V.**

## 4.3 Charging Sources

Campbell Scientific Solar Panels			
	SP10	SP20	SP50
Peak Power	10 W	20 W	50 W
Voltage @ Peak Power	16.8 V	16.8 V	17.5 V
Current @ Peak Power	0.59 A	1.19 A	3.9 A

Notes:

- Specifications assume a 1 kilowatt per square meter illumination and a solar panel temperature of 25°C (77°F).
- Individual panels may vary up to 10%.
- The output panel voltage increases as the panel temperature decreases, which is in the same direction as the recommended VRLA battery charging voltage change with temperature.
- Higher latitudes and less sun hours during winter months might require a larger panel than what is required to keep the battery charged during the summer.

**AC/DC Transformer with Interchangeable Blades: Campbell Scientific Model No. 29796-US**

<b>Input Voltage:</b>	100 – 240 Vac
<b>Input Frequency:</b>	47 – 63 Hz
<b>Output Voltage:</b>	24 Vdc
<b>Output Current (max):</b>	1.67 A
<b>Protection:</b>	Unit will auto-recover upon removal of fault.
<b>UL Approval:</b>	UL60950-1 2 <sup>nd</sup> Edition

Unit has interchangeable blades. Unit ships with US/Canada plug installed.

For international orders select option 29798 –IP for international blades. International blade selection contains blades for Australia/New Zealand, UK, Europe/South America, Korea, Argentina, China, & India/South Africa.

**AC/DC DIN Rail Mount Power Adapter: Campbell Scientific Model No. 28370**

<b>Input Voltage:</b>	85 – 240 Vac or 90 – 350 Vdc
<b>Input Frequency:</b>	45 – 65 Hz
<b>Output Voltage:</b>	24 Vdc
<b>Output Current:</b>	3.8A (–25° to +70°C)
<b>Protection:</b>	3.15A internal slow-blow fuse
<b>Approval:</b>	ETL Listed for US and Canada

**NOTE**

Both of the recommended chargers have dc voltage output which can be used on either the CHARGE/CHARGE or SOLAR/G terminal blocks. Maximum input charging current on the CHARGE/CHARGE terminal blocks is limited to 1.1 Adc. Maximum input charging current on the SOLAR/G terminal blocks is limited to 3.6 Adc.

CHARGE/CHARGE terminal blocks have no polarity. Power wires from the charging source can be connected in any fashion. The PS150/CH150 will only float charge a battery with power connected to the CHARGE/CHARGE terminal blocks which is fine when using an AC/DC charging source.

SOLAR/G terminal blocks do have a polarity that must be followed when wiring up either of the AC/DC devices. Positive wire goes to the terminal block marked SOLAR. Negative wire goes to the terminal block marked G. Higher power throughput makes this an attractive option. It will float charge a battery but it will also try to quick charge as well depending on the needs of the battery.

## 5. Operational Overview

A 12-V 7Amp-hr rechargeable battery is included with the PS150, whereas the user provides the rechargeable battery, such as the BP12 or BP24 offered by Campbell Scientific, Inc., for the CH150. See Section 4.2, *Battery Packs*, for rechargeable batteries offered for the CH150 by Campbell Scientific.

Charging power for the PS150/CH150 is typically supplied by an unregulated solar panel, AC/AC transformer, or AC/DC converter. The CHARGE – CHARGE terminals are connected to a diode bridge, accommodating either AC or DC voltages from a charge source. Because of the diode bridge, polarity does not matter when connecting sources to the CHARGE – CHARGE input terminals. In order to protect AC/AC or AC/DC sources when charging discharged batteries, the CHARGE – CHARGE input terminals offer an approximately 1.1 amps DC (1.2 A RMS) current limit. The SOLAR – G input terminals are intended for connection to solar panels, or other high-current DC sources. Polarity definitely matters on the DC only SOLAR – G input terminals, with positive connected to SOLAR and the return or negative connected to G, with reversal protection included. The SOLAR – G input terminals have an input current limit of approximately 3.6 amps, making the PS150/CH150 well suited for 70 watt or smaller solar panels. The PS150/CH150 can be simultaneously powered from both the CHARGE – CHARGE and SOLAR – G input terminals, as the internal diodes will route power from the source with the highest input voltage. This allows for an AC mains powered application with a solar panel for back-up. If the reverse is needed – solar power as the primary supply and AC as the secondary supply – then a solar panel should be used with a 24 vdc output and an AC, or AC to DC, source with a voltage output less than the solar panel voltage.

An AC/DC converter charge source could be connected to either the CHARGE – CHARGE input terminals or the SOLAR - G input terminals. The best input terminals to use with a given AC/DC converter should be based on the converters output current capability. For example, the CHARGE – CHARGE input terminals provide a current limit of 1.1 A DC on the charging source.. Whereas the SOLAR - G input terminals have a fixed 3.6 A DC typical current limit, providing faster battery charging for a charge source that can deliver up to 3.6 A DC current without damage.

The SOLAR – G terminals are optimal for solar panels because of the high-current charging capability when solar resources are available. A Maximum Power Point Tracking algorithm is also utilized when the PS150/CH150 detects the charging source is connected to the SOLAR input.

The +12 V output terminals are intended to power a datalogger and any peripherals. Power to these output terminals is controlled by a toggle switch, with the total output current limited by a 4.65 A solid-state circuit breaker (see Section 4.1, *Specifications*). The A105 Additional 12 V Terminals Adapter may be used to provide extra 12 V and ground terminals where the power supply is used to power several devices, noting that the hold current limit on the 4.65 A solid-state circuit breaker still applies.

## 6. Charging Details

### 6.1 Charging Algorithm

The PS150/CH150 offers both Continuous and Solar charging inputs. The Continuous charging input has a maximum value of 1.1 A DC to help protect AC/AC transformers and AC/DC converters. The 3.6 ADC typical current limit of the PS150/CH150 Solar charging input is well suited for 70 W solar panels. Typical Continuous charging inputs would be AC/AC transformers or AC/DC converters in which a charge voltage is continuously applied except for line power outages.

The PS150/CH150 uses a float charging algorithm for either the Continuous or Solar charging inputs. This charging method can charge a battery indefinitely without overcharging a battery.

### 6.2 Maximum Power Point Tracking

The current and power versus voltage for a 70 W solar panel are illustrated in FIGURE 6-1. As can be seen from the figure, a Maximum Power Point of operation exists for solar panels. Adjusting the load on the solar panel so it operates at this Maximum Power Point is referred to as Maximum Power Point Tracking (MPPT). MPPT is beneficial when insufficient power is available from the charge source, which is the case during current limited charging. The somewhat noisy charging current and voltage during the initial current limited charging stage is due to the MPPT algorithm of the PS150/CH150 searching for the maximum power point of the associated solar panel.

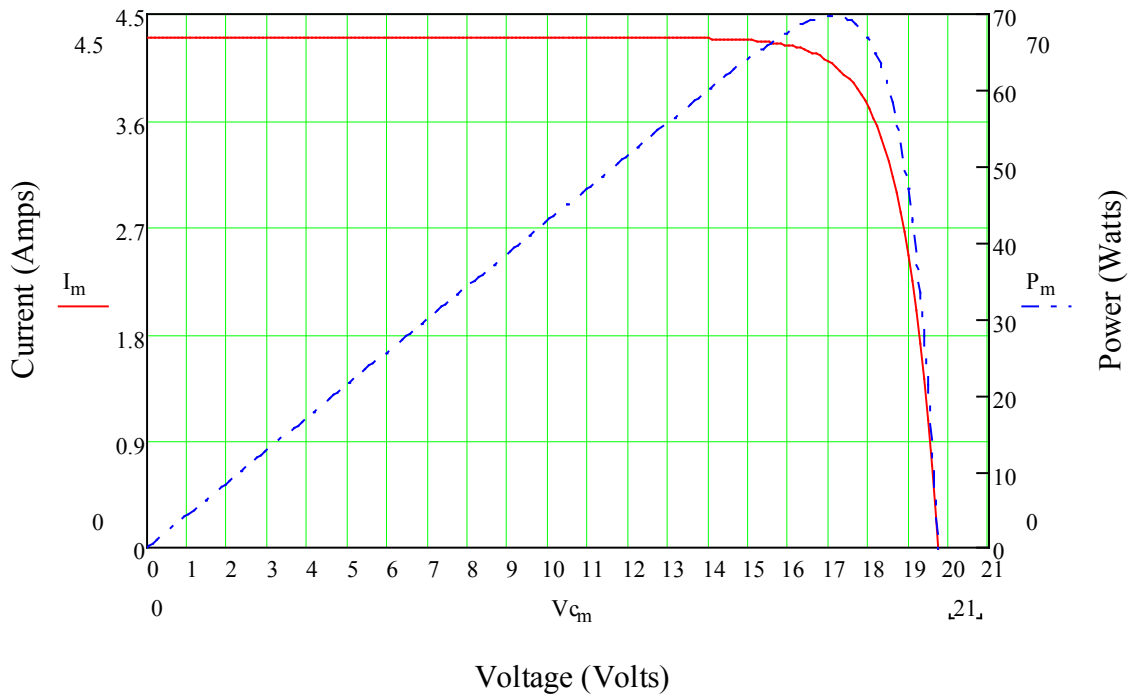


FIGURE 6-1. 70 W solar panel I – V and power characteristics

## 7. A100 Null Modem Adapter

The A100 adapter has two 9-pin CS I/O ports with a null modem between them. The ports are used to connect two 9-pin devices (e.g., modems or RF radios) that would normally be connected to the CS I/O port of a Campbell datalogger. The charger supplies 12 Vdc and 5 Vdc to the appropriate pins on the connector for powering the connected devices. This functionality is required in a station where a datalogger will not be present, such as a phone-to-RF base station. The A100 cannot be used as a null modem between two RS-232 devices.



FIGURE 7-1. Null modem connections

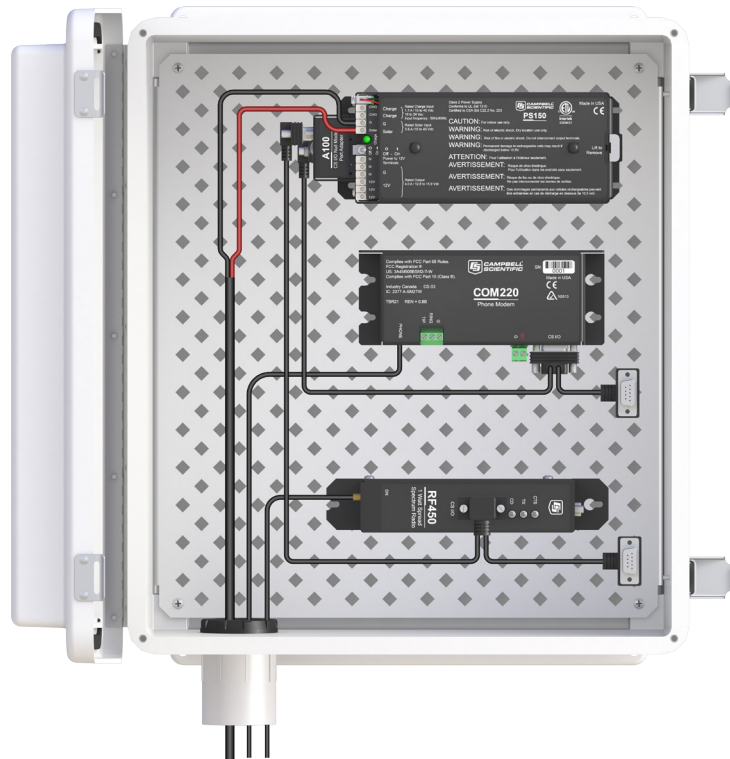


FIGURE 7-2. PS150 with A100 module using a COM220 and RF450

## 8. A105 Additional 12 V Terminals Adapter

The A105 adapter adds four 12 V terminals and four ground terminals to a PS150/CH150 charging regulator. The extra terminals make it easier to wire multiple continuously powered 12 Vdc devices to the power supply.



FIGURE 8-1. A105 adapter

## 9. References

1 – Genesis Application Manual – Genesis NP and NPX Series US-NP-AM-002, June 2006.







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