

Dual Voltage Solar Power Charge Controller Connection & Operation V2.20

Connection Instructions

Remove Bottom 4 cover to attach wires to terminal blocks then attach cover and flip over for mounting to a panel or wall.

*****DO NOT LOOSEN 4 SCREWS ON FRONT FACE*****

Warranty is void if the board mounting is tampered with

- 1) Solar Start up 18 volts, Night shutdown 14.5 volts for 12 Volts. For 24 volt output then its 36 and 29 volts respectively.
- 2) **Do NOT Over Tighten Connections . Non Oxidation grease is also a good idea to prevent corrosion over time.**
- 3) Connect wires to Apollo and then to the breaker / fuse rated at 20 Amps. Connect to Battery and Turn on Breaker / install fuse.
- 4) **Verify LCD display comes on—this indicates proper Polarity.**
- 5) Software version and serial number displays then “b12” or “b24” indicating battery voltage. Controller will enter night mode.
- 6) **Turn OFF breaker / remove fuse and then connect solar panel wires to the Apollo and to the panel.**
- 7) **LCD should start indicating proper polarity.**
- 8) After polarity has been verified turn on the breaker / install fuse and Apollo will enter DAY mode and begin charging the battery.
- 9) Re-install cover and screws. You can now mount to a panel.
- 10) Apollo must have a battery to work properly.
- 11) Multiple Charge Controller boards can be parallel output connected to increase system power. There is no limit to how many can be used. Each should have its own Fuse or Breaker.

“Hot” Flashing indicates thermal protection is active as the board is over **170 Degrees F**. Too much solar input, or too hot of ambient air around the board can cause this to occur. Soft limit occurs at 165 F and will reduce output to keep below 170 F. Error codes are described on the last page of this document.

LCD Display Information

The LCD Display scrolls through the items every 30 seconds. Title is displayed, then the number follows. Last 7 days totals display after sunset and until the next daylight. At night the CPU slows to conserve power and minimize battery drain below 0.00085 amps (850 microamps typical for 12 volts).

The LCD Display is not a high precision meter however it's designed to show relative levels so the user can determine how well the system is working at any given time. Accuracy is better at higher power levels and ranges from about 10% at 10 Watts to about 2% at 200 Watts.

Note: Totals are lost if Battery connection removed.

WARRANTY: DIY Solar warranties the board against defects for a period of TWO YEARS from the date of purchase. This warranty covers defects in materials or workmanship only. DIY Solar's only remedy is to repair or replace at our discretion any defective board. User must obtain an RMA by contacting us at: diysolarforu@gmail.com. User assumes all risks associated with the use of this product and agrees to hold harmless DIY Solar for U. It's up to the user to properly install and use the product. This Warranty does NOT cover misuse, neglect, or accidental damage of any kind.



****IMPORTANT****

Use a Voltmeter and be certain of the Polarity PRIOR to connection

DO NOT GROUND solar panel wires as they MUST remain floating. Frame can be Grounded

Panel open circuit voltage must be high enough to start charging based on battery voltage.

**Maximum Solar power (50 volt Limit)
12 Volt output = 280 Watts STC Rating
24 Volt output = 560 Watts STC Rating
See Page 2 for Details**

20 amp Output Fuse or Circuit Breaker is required to prevent a fire from abnormal operation and meet Safety Standards.

P A N

Solar Input Voltage

b A t

Battery Voltage

A

Output Current in Amps

O u t

Output Power in Watts

P - P

Peak Power in Watts

A - H

Amp Hours Today

b - t

Board Temperature Deg. F

b 1 2

Battery Detected

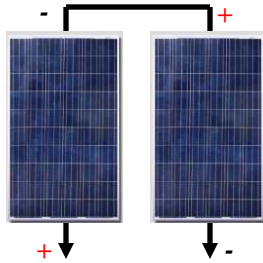
b 2 4

Solar Panel Connection Examples

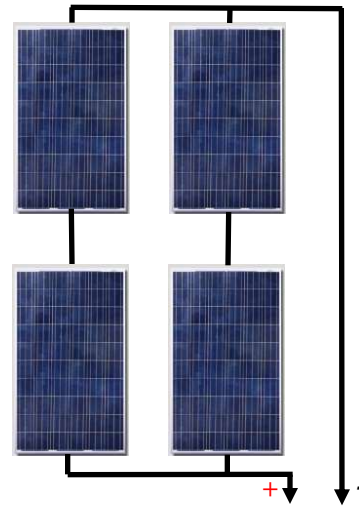
12 Volt Output



One Large Panel
36-80 Cells
Up to 280 Watts



Two Smaller 36 Cell
Panels—Matched Pair
Up to 140 Watts Each
Series Connected
Up to 280 Watts Total

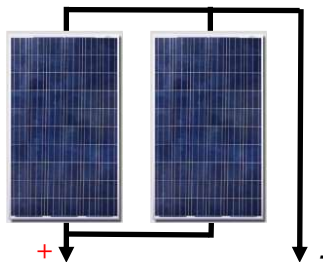


Four Small 36 cell Panels
In a series / parallel array 2 x 2
** Series Pairs Must Be Matched**
2 panels at 50 watts in series combined
with 2 panels at 75 watts in series
OR 4 panels at up to 70 Watts
Up to 280 Watts Total

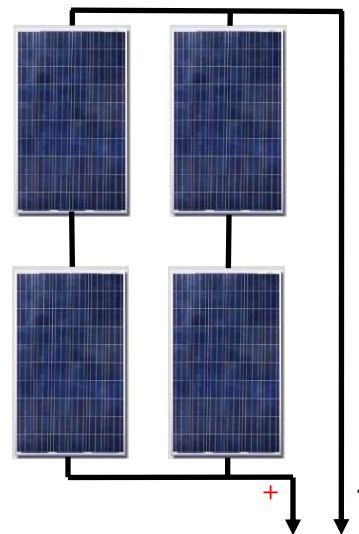
24 Volt Output (2x Power)



One Large Panel
72 to 80 Cells **
Up to 560 Watts



Two Panels—Matched
Pair 72 to 80 Cells **
Up to 280 Watts Each
Parallel Connected
Up to 560 Watts Total



Four 36 cell Panels at up to 140 Watts
each In a series / parallel array 2 x 2
Panels should be matched in type and
size. Up to 560 Watts Total

**** For 24 volt systems 72 total cells are required to produce enough voltage to Start and Charge a 24 volt battery to its recommended 28.8 volts. 72 to 80 cell panels will produce this voltage. Two 36 cell panels in series will also work.**

System Connection Diagram

IMPORTANT:

Do NOT Ground solar panel wires—Frame only can be tied to Earth Ground
Each Solar Input MUST be electrically Isolated. Tie the Battery (-) to Earth Ground and Solar Panel Frame to Earth Ground only.

Each Charge controller input should be connected to its own solar panel (s).

IMPORTANT:

Board contains Ceramic SMD capacitors that can crack / short circuit if too much flexing of the board occurs.

When connecting DO NOT BEND the board by using excessive downward force to prevent capacitor failure.

Tighten with a #2 Phillips Screwdriver

Verify Correct Polarity to prevent damage by following the procedure on Page #1



Solar Positive (+)

Solar Negative (-)

Use RF Ferrite if Transmitter is nearby

36 to 80 Cell Solar Panel



Use #12 Wire Size for minimal Power Loss. Low Voltage Landscape Lighting Wire works well.

Tin the leads with solder for best performance (Stranded) Wire

Use Non-Oxidation Grease to Prevent corrosion

Connect Additional Charge Controllers in the same manner using one circuit breaker for each. Breaker output from each connects to Battery (+) Terminal.

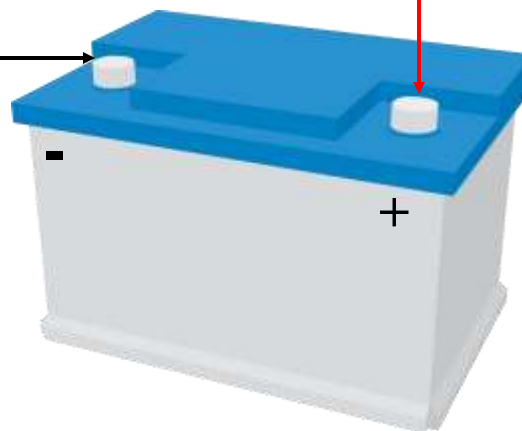
Power DC-AC Inverter if used is connected to the Battery and can be fed from a larger amperage circuit breaker.

Positive output to Breaker (+)

Use 20 Amp Circuit Breaker or Fuse

Breaker output to Battery (+)

Negative output to Battery (-)
This is System Ground (GND)



A Multiple Charger Board System could use a 100 Amp or 200 Amp Home Breaker Panel as a DC Power Distribution Box. The 100/200 Amp Main Breaker would connect to the Battery Bank (+) and the Neutral to the Battery Bank (-). **Use #2 wire size for battery.**

Each Charge Controller would connect to a 20 Amp Breaker. Inverter can use 2 Pole Breakers to feed their (+) Terminal. 20 to 100 Amp 2 Pole breakers sized to match inverter power with BOTH wires used. A good rule is 5 amps per 100 watts inverter power... 400 Watts = 20 Amp 2 pole.

Theory of Operation

At the heart of the DIY Solar Charge Controller is a very efficient DC-DC Power converter which transfers over 98% of the Panels energy to the system. The Power Converter is controlled by a Microprocessor which performs the Maximum Power Tracking, collects and tabulates data, and drives the LCD display. The Solar Charge controller works from below 1 Watt to 230 / 460 Watts of Output (280 / 560 Maximum Watt STC rated Solar Panel). With 24 Volt Systems use 2 same type 72 cell panels in parallel at up to 280 Watts STC each 560 Watts total. No Adjustments are needed as the board is fully automatic and will adapt to any panel within the specification limits. Apollo V2.10 now includes Automatic 12 / 24 volt Battery detection.

Our customized Maximum Power Tracking routine adjusts the power transfer about **6000 times per second** to yield maximum performance even in partial shading of the Solar Panels from shadows (Trees, Utility Poles ect.). Rapid Sunlight changes on a partly sunny day are not a problem either. The Microprocessor monitors input and output parameters while always seeking the maximum power possible. There are 2 control loops working together to get every last watt of power from the Solar Panel resulting in up to **2 TIMES** the Power that a PWM charge controller would deliver with the same Solar Panel. **Simple Cheap PWM Controllers DO NOT DO DC POWER CONVERSION.**

When the solar input voltage exceeds 18 (36 for 24 volt output) volts at sunrise the Solar Charge Controller switches from NIGHT mode to DAY mode and transfers the previous day's totals to memory. The Power Stage is turned on and Solar energy begins to charge the system battery. The LCD display cycles through the daytime parameters... Battery Voltage, Panel Voltage, Amps output, Power Output, Peak Power, Amp Hours, Board Temperature, and Battery Detected. If the system Battery is at **14.4 (28.8) volts AND the current is less than 1.5 amps** then the charger shuts off until the Battery drops to **13.5 volts**. The LCD Display will indicate **"Bat"** **"Full"** and display the voltage and amp hours input for the current day.

After Sunset when the panel voltage drops below 14.5 (29 for 24 volt output) volts the Power Stage is turned off and the LCD Display switches to NIGHT mode. The LCD Display cycles through the Panel Voltage, Battery Voltage, all time MAX Power (P.P.1), and the last 7 Days Amp Hour Totals. The Processor slows to keep Battery Drain to minimum.

The Solar Charge Controller is designed for many years of reliable operation using parts rated for High Temperature Operation assuring long operating life. The Board is protected from reverse battery, input short circuit, reverse power flow, over current, over temperature, and reversed Solar Panel connections. **It is NOT however protected from excessive input voltage over 60 volts** open circuit voltage. Above 50 volts "Err" then 001 will display. Do Not Connect a panel with more than 80 cells or a combination of series connected panels that exceeds 80 cells. The Solar Charge Controller will work well from 36 to 72 cells with very high performance. **36, 54, 60 and 72** cell count Solar Panels are common and will work well with the Charge Controller. **** 24 volt output should use 72 cells for best performance.****

Do NOT connect a solar panel until battery polarity is verified correct by LCD operation.

New Features V2.xx

Software Version 2.xx has come with significant code enhancements and also a hardware upgrade. The List is below.

- 1) New larger input and output connectors rated at 25 amps
- 2) Lower loss power inductor and MOSFETS for increased Efficiency
- 3) Dual Source Microcontroller Power for re-charge of a protected Battery
- 4) Diagnostic routines added to meet USA and International Safety Standards
- 5) 4x FASTER MPPT control for better dynamic Tracking
- 6) Improved Spread Spectrum for even lower RF emissions
- 7) Added Display items listed Below
- 8) Automatic Battery Voltage Detection 12 / 24 Volt

Added "b12" or "b24" to daytime loop and on startup to indicate battery voltage

Added Panel Voltage to nighttime loop display

Added Error Codes for Diagnostics "Err" followed by the number

001 = Solar Panel Over 50 volts input

002 = Temperature Sensing Error out of range

003 = Current Sensing Amplifier Error

Hot Flashing indicates thermal shutdown due to excessive heat (Charger OFF)

Constant cycling thru Serial number and version indicates not enough power present to operate (No Battery and Low Solar Voltage). If your battery pack has built in over-discharge protection and it cuts off the battery this display pattern can happen until there is enough Solar Power present to operate and begin charging the battery again. "tst" will display during battery wake up and detection or if no battery is connected but solar is present.

V2.11 Minor bug fix for over 40 volts input start-up

V2.12 Changes Start-up to 18 / 36 Volts

V2.20 Increased Power control resolution and changed power stage operation to 148 KHz nominal. Efficiency increased to 99% peak. Added thermal margin of about 10 degrees for full power operation.