

# Ra V2 MPPT Buck—Boost Charge Controller

## Connection Instructions

Connect wires from sides and tighten with a small  
Screwdriver thru the bottom access holes.

Do NOT Over Tighten Connections

- 1) Solar Start up 12 volts, Night shutdown 10 volts . Connect wires to Controller and then to the breaker / fuse rated at 4 to 5 Amps. Connect to Battery and Turn on Breaker / install fuse.
- 2) **Verify LCD display comes on—this indicates proper Polarity.**
- 3) Software version and serial number displays. Controller will then enter night mode.
- 4) **Turn OFF breaker / remove fuse and then connect solar panel wires to the Ra Controller and then to the panel.**
- 5) **LCD should start indicating proper polarity.**
- 6) After polarity has been verified turn on the breaker / install fuse and Ra will enter DAY mode and begin charging the battery.
- 7) Mounting with side tabs to a panel is optional.
- 8) 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.



### **\*\*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 (35 volt Limit)  
12 Volt output = 60 Watts STC Rating

4 to 5 Amp Output Fuse or Circuit Breaker is required to prevent a fire from abnormal operation and meet Safety Standards.

**\*DISASSEMBLY WILL VOID WARRANTY\***

## LCD Display Information

The LCD Display scrolls through the items about every 15 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 0.001 amps on a 12 volt Battery.

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 1 Watt to about 2% at 50 Watts.

Voltage accuracy is typically +/- 0.1 volts on Battery and +/- 0.2 volts on the Solar Input.

Note: Daily Totals are lost if Battery voltage lost with no Solar input present (Night for example).

**WARRANTY:** DIY Solar warranties the charge controller against defects in materials or workmanship for a period of FIVE YEARS from the date of purchase. DIY Solar's only remedy is to repair or replace at our discretion a defective product. User must obtain an RMA by contacting us at: [diysolarforu@gmail.com](mailto: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 with safety over current fuse or circuit breaker. This Warranty does NOT cover misuse, neglect, Acts of God, Modifications, Disassembly, Tampering, or accidental damage of any kind. Warranty is void if taken apart.

### Daytime Charge Sequence

	Solar Input Voltage
	Battery Voltage
	Output Current in Amps
	Output Power in Watts
	Peak Power in Watts
	Amp Hours Today
	Board Temperature Deg. F

# 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 Small Phillips Screwdriver or small flat screwdriver.

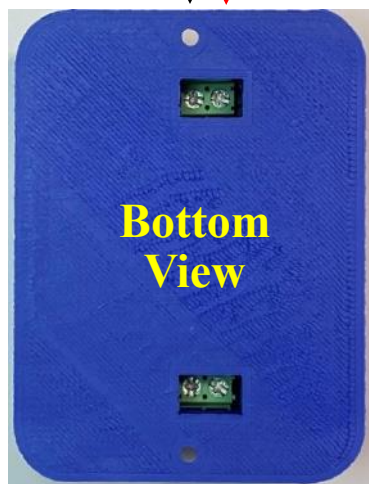
Verify Correct Polarity to prevent damage by following the procedure on

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

Solar Panel V.O.C  
14 to 32 Volts Max

Solar Positive (+)

Solar Negative (-)



Use #18 to #14 Wire Size for minimal Power Loss.  
Low Voltage Landscape Lighting Wire works well.

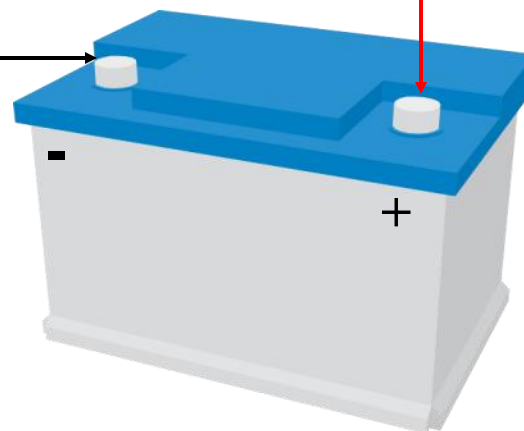
Tin the leads with solder for best performance (Stranded) Wire or use Solid wire.

Positive output to Breaker (+)

Use 4 to 5 Amp Circuit Breaker or

Fuse output to Battery (+)

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



# LCD Display Information

## Night display sequence

 Panel Voltage

 Battery Voltage

 All Time Peak Power

 Amp Hours Today

 Amp Hours 2 Days Ago

 Amp Hours 3 Days Ago

 Amp Hours 4 Days Ago

 Amp Hours 5 Days Ago

 Amp Hours 6 Days Ago

 Amp Hours 7 Days Ago

## Battery Full Sequence





 Battery Charged Voltage

 Amp Hours Today



 Over Temperature Shutdown — Flashing

 Error Code

## Error Codes:

001 = Solar Panel Over 35 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. Controller will automatically wake up a battery with over - discharge protection.

# Theory of Operation

At the heart of the DIY Solar Charge Controller is a very efficient DC-DC Power converter which transfers over 96.5% 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 50 Watts of Output (60 Watt Maximum STC rated Solar Panel). No Adjustments are needed as the board is fully automatic and will adapt to any panel within the specification limits. Ra V2.00 is for 12 Volt Battery Systems only— SLA, Deep Cycle, AGM and Lithium Iron Phosphate or LFP.

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 and waste a lot of available power.**

When the solar input voltage exceeds 12 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, and Board Temperature. If the system Battery is at **14.4 volts AND the current is less than 0.5 amps for one minute** then the charger shuts off until the Battery drops below **13.5 volts**. The LCD Display will indicate **"Bat"** **"Full"** and display the voltage and amp hours input for the current day. See charging profile graph on the next page.

After Sunset when the panel voltage drops below 10 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 under 0.001 amps.

The Solar Charge Controller is designed for many years of reliable operation using parts rated for High Temperature Operation assuring long operating life. The 3D Printed case is made from Automotive Grade ASA filament and can withstand 105 degrees C or about 230 Degrees F. It is also UV / Sunlight tolerant however dark colors in Sunlight heat up so its best to operate in the shade to prevent thermal limiting or shutdown. 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 35 volts "Err" then 001 will display. Do Not Connect a panel with more than 50 cells or a combination of series connected panels that exceeds 50 cells. The Solar Charge Controller will work well with most smaller solar panels up to 60 Watts STC Rating.

# 3 Stage Charging Profile 12 volt Example

Blue = Voltage

Red = Current

