Sól Dual Voltage Buck Boost Solar Charge Controller Connection & Operation V3.xx & V4.xx

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 12.5 volts, Night shutdown 9.75 volts. **Do NOT Over Tighten Connections. Non Oxidation grease is also a good idea to prevent corrosion over time.**
2) Connect wires to Battery side and then to the breaker / fuse rated at 20 Amps. Connect to Battery and Turn on Breaker / install fuse.
3) **Verify LCD display comes on—this indicates proper Polarity.**
4) Software version and serial number displays then "b12" or "b24" indicating battery voltage. Controller will enter night mode.
5) **Connect solar panel** wires to the Panel Input and then to the Solar Panel. **Important to ALLWAYS connect battery first.**
6) Controller will enter DAY mode and begin charging the battery if the battery is below 13.5 / 27 volts otherwise the controller will enter night mode display sequence.
7) Re-install cover and screws. You can now mount to a panel.
8) Controller must have a battery to work properly.
9) 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.
10) When disconnecting **ALLWAYS disconnect panel first then battery** to prevent possible transient voltage damage to the controller. Transient voltage damage is not covered under warranty.

"**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. 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 (>12.5 Volts VOC).

Maximum Solar power (54 volt Limit)
12 Volt output = 350 Watts STC Rating
24 Volt output = 700 Watts STC Rating
See Page 3 for Details

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

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 0.00085 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.

PAn	**Solar Input Voltage**
bAt	**Battery Voltage**
A	**Output Current in Amps**
Out	**Output Power in Watts**
P-P	**Peak Power in Watts**
A-H	**Amp Hours Today**
b-t	**Board Temperature Deg. F**
b12	**Battery Detected** b24

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. 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.

LCD Display Information

Night display sequence /
Battery > 13.45 / 26.9 Volts

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

Battery Wake-up or
No Battery detected

Error Codes:

001 = Solar Panel Over 54 volts input
002 = Temperature Sensing Error out of range
003 = Current Sensing Amplifier Error
004 = MOSFET Driver Voltage out of range

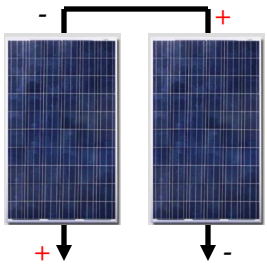
Hot Flashing indicates thermal shutdown due to excessive heat (Charger OFF)

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.

Solar Panel Connection Examples

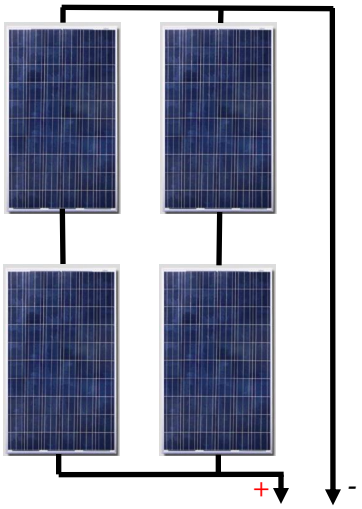
12 Volt Output

One Large Panel
36-80 Cells
Up to 350 Watts



Two Smaller 36 Cell
Panels—Matched Pair
Up to 175 Watts Each
Series Connected

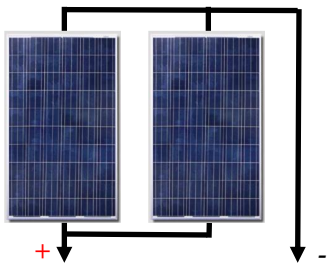
Up to 350 Watts Total



Four Small 36 cell Panels
In a series / parallel array 2 x 2
** Series Pairs Must Be Matched**
2 panels at 70 watts in series combined
with 2 panels at 100 watts in series
OR 4 panels at up to 85 Watts
Up to 350 Watts Total

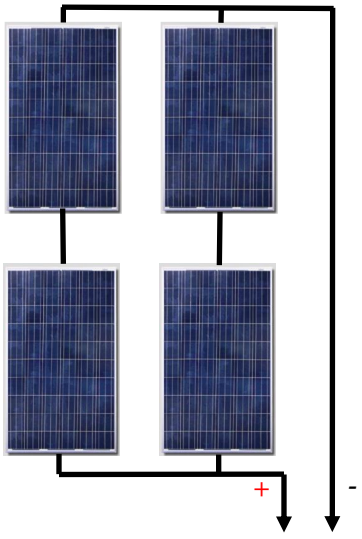
24 Volt Output (2x Power)

One Large Panel
60 to 80 Cells **
Up to 700 Watts



Two Panels—Matched
Pair 60 to 80 Cells **
Up to 350 Watts Each
Parallel Connected

Up to 700 Watts Total



Four 36 cell Panels at up to 175 Watts
each In a series / parallel array 2 x 2
Panels should be matched in type and
size. Up to 700 Watts Total

Because SóL is a Buck-Boost design any panel can be used for 12 or 24 volt batteries however maximum power is achieved with 60-80 cells for 24 volt systems. If using only 36 cells (Boost 16 volts to 28.8 volts) the input is limited to 20 amps so maximum Power is about 350 watts STC due to input current limit.

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).

Solar Positive (+)

Solar Negative (-)

Use RF Ferrite if Transmitter is nearby

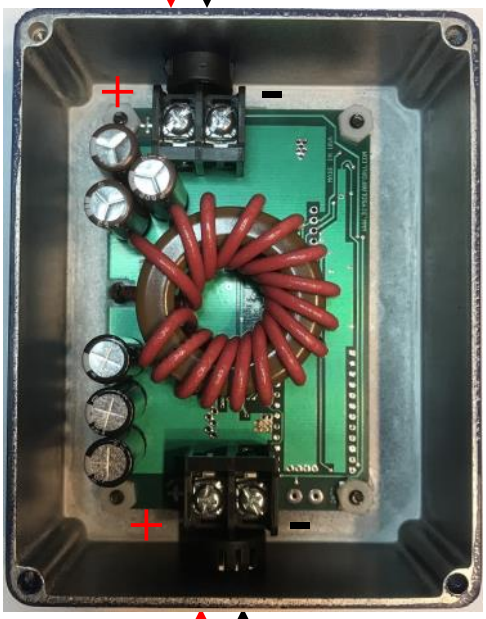
36 to 80 Cell Solar Panel

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



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.

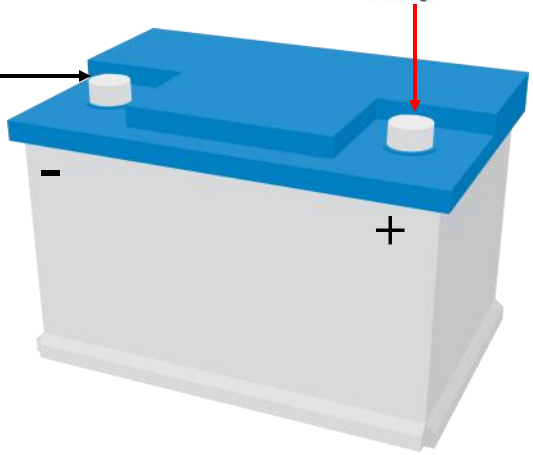
Power DC-AC Inverter if used is connected to the Battery and can be fed from a larger amperage circuit breaker.

Positive output to Breaker (+)

Use 20 Amp Circuit Breaker or Fuse

Breaker output to Battery (+)

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



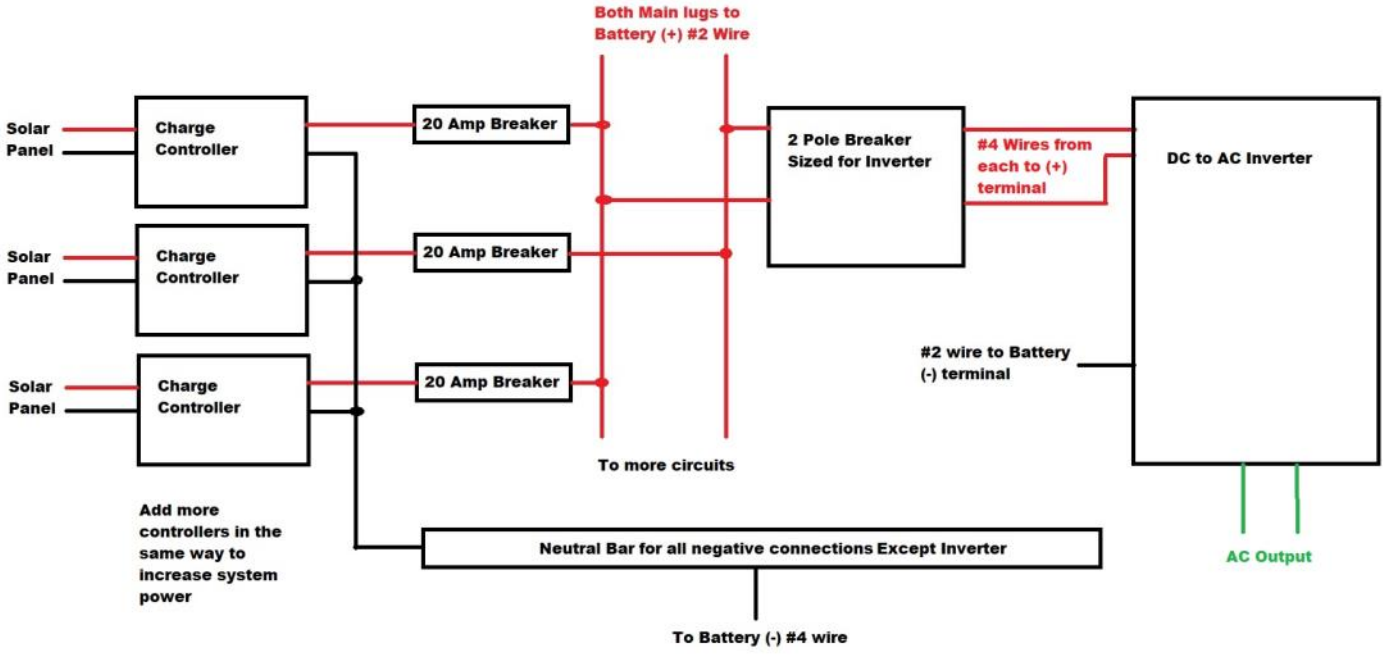
A Multiple Charger Board System could use a 100 Amp or 200 Amp Home Breaker Panel as a DC Power Distribution Box. The 100/200 Amp Main Breaker would connect to the Battery Bank (+) and the Neutral to the Battery Bank (-). Size your wire for the maximum current of your system and check your Electrical Codes for wire sizing.

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. 24 volt systems double the power … 800 watts = 20 amp 2 Pole Breaker.

System DC Connection Diagram
Power Distribution Box using off the shelf Breaker Box

Black is Negative wire
Red is Positive Wire

For use with Breaker Box with Main Lugs
100 or 200 amp typical ratings
6 or more “SPACES” for Breakers



Theory of Operation

At the heart of the DIY Solar Charge Controller is a very efficient DC-DC Power converter which transfers over 99% 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 288 / 576 Watts of Output (350 / 700 Maximum Watt STC rated Solar Panel). With 24 Volt Systems use 2 same type 60-80 cell panels in parallel at up to 350 Watts STC each 700 Watts total. No Adjustments are needed as the board is fully automatic and will adapt to any panel within the specification limits. Sól 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. The Buck Boost power converter has extended operation 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 **218% MORE Power that a PWM charge controller would deliver with the same Solar Panel.**

Cheaper PWM Controllers DO NOT DO DC to DC POWER CONVERSION.

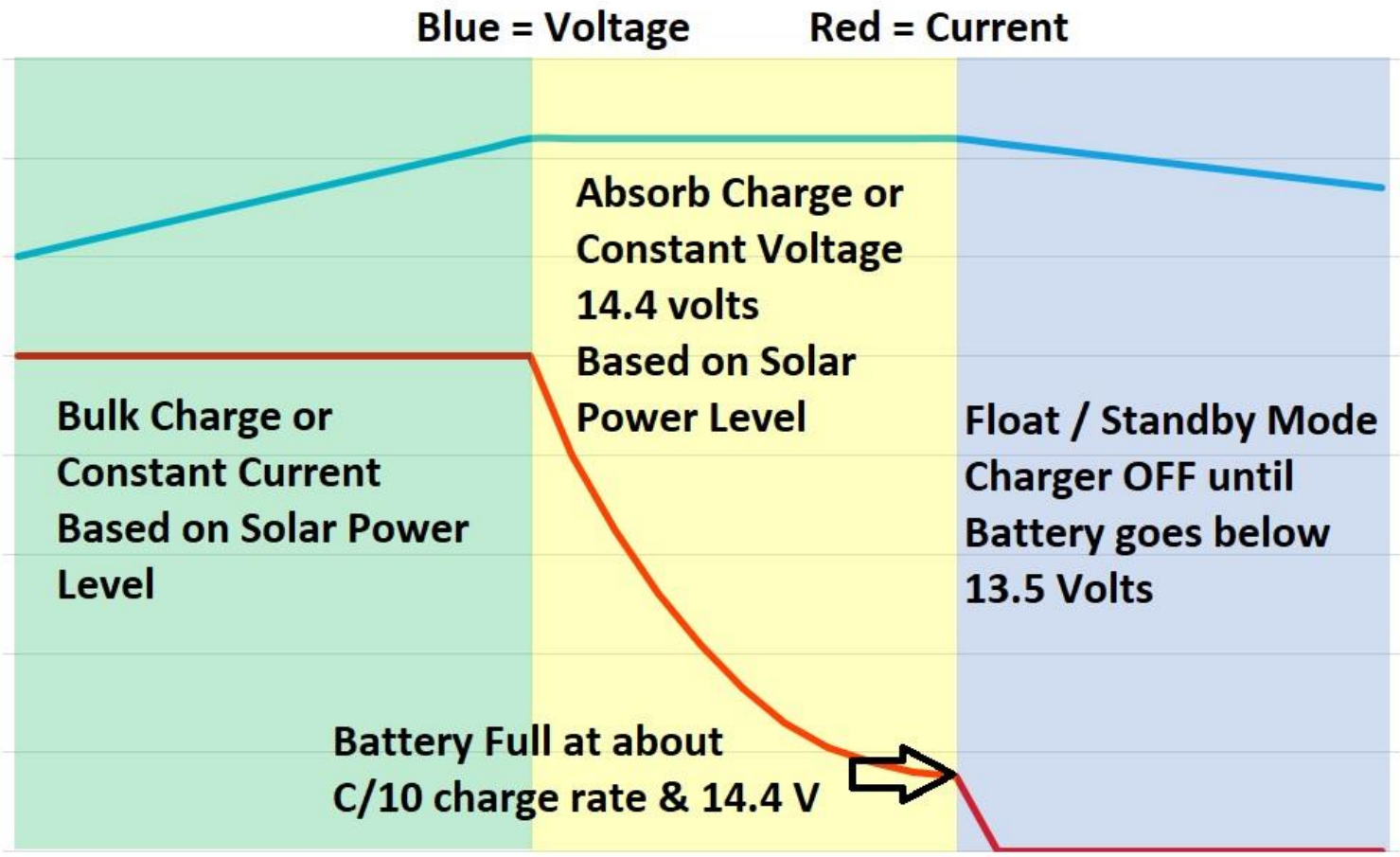
When the solar input voltage exceeds 12.5 volts at sunrise the Solar Charge Controller switches from NIGHT mode to DAY mode and transfers the previous day's totals to memory. The Power Stage is turned on and Solar energy begins to charge the system battery. The LCD display cycles through the daytime 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 below **13.5 (27.0) 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 9.75 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 or transients over 60 volts**. Above 54 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 with common **33, 36, 54, 60 and 72** cell count Solar Panels. **96 Cell Panasonic / Sanyo panels have too much voltage DO NOT USE**. Do not use panels with a Open Circuit Voltage rating over about 49 volts to allow for cold weather operation in used in a cold climate because voltage increases when colder.

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

3 Stage Charging Profile 12 volt Example



For 24 volt systems charging stops at 28.8 Volts and starts when battery is below 27.0 volts

Sól Buck Boost Comparison to Apollo

Comparision	Apollo	Sól
36 Cell Solar Panel	12 Volts Only	12 and 24 Volts
Shading Tolerance	Up to 2 Cells	**Up to 10 Cells**
60 Cell Solar Panel	12 Volt, Limited 24 Volts	12 and 24 Volts
Shading Tolarance	24 Cells @ 12V, **0 Cells @ 24V**	**Up to 30 Cells**
72 Cell Solar Panel	12 and 24 Volts	12 and 24 Volts
Shading Tolerance	22 Cells @ 12V, 5 Cells @ 24V	**Up to 48 Cells**
Start Voltage	18 Volts	12.5 Volts
Minimum Operating	15 Volts for 14.4 Volts Output	10 Volts
Maximum Operating	50 Volts	54 Volts
Power Conversion	> 98.5%	> 99%
Maximum Solar STC No Limiting of Power	280 Watts / 560 Watts	350 Watts / 700 Watts
Maximum current	16 amps	**20 Amps**

New in Version 1.04

Now operates down to –40 Degrees F / C

Increased Power to 20 amps (350 / 700 Watts STC Solar) from 18 amps

Software optimizations to improve CPU performance

New in Version 1.1x

Data output for Remote Display added—single wire interface

New in Version 2.xx

Improved MPPT performance in partial shading conditions.

New in Version 3.xx

Code updates for improved performance
System Data Master Compatible version with CRC error checking on DATA
Added voltage control adjustment for use with System Data Master and cell balancing.

New in Version 4.xx

High Precision Resistors on battery monitoring for improved voltage accuracy.

New in Version 4.10

Smart Battery Detection using EEPROM and minor bug fixes / improvements.