

Solarmate charger controller user manual



Contents

Important safety instructions	6
1. Product description	8
1.1 General description.....	8
1.2 Features	8
1.3 Maximum setting point voltage limit.....	9
1.4 Temperature and output power	9
1.5 Maximum power point tracking (MPPT).....	9
1.6 How MPPT works	9
1.7 Over voltage / reverse polarity protection	9
1.8 Electrostatic handling precautions	10
1.9 Solar charger controller setup	10
1.9.1 Factory default settings.....	10
1.10 Three stage charge control	10
1.10.1 Bulk charge	10
1.10.2 Absorption charge.....	10
1.10.3 Float charge	11
1.11 Battery temperature sensor (BTS).....	11
1.12 Equalization charge	11
1.12.1 Photovoltaic charge and load controller.....	11
1.12.2 Automatic PV array night disconnect.....	12
1.12.3 Solar charger controller load control.....	12
1.12.4 Low voltage disconnect.....	12
1.12.5 Low voltage reconnect.....	12
1.13 Optional accessories.....	13
2. Installation	14
2.1 Pre-Installation.....	14
2.2 Removing the top cover	14
2.3 Mounting the solar charger controller	14
2.3.1 Mount the solar charge controller.....	15
2.4 Configuring the solar charge controller.....	16
2.4.1 Battery type selector can apply different charger method	16
2.5 Temperature compensation	17
2.5.1 Automatic battery temperature compensation	18
2.6 Grounding.....	19
2.7 DC terminal connector locations.....	19
2.8 Wire Size and over-current protection requirements	19
2.8.1 Current rating	19
2.8.2 Surge protection	20
2.8.3 Over-current protection.....	20
2.9 PV Charge and load control mode wiring.....	20
2.10 Easily install in parallel connection	21
2.11 Battery type selector	22
2.12 Installing optional accessories.....	23
2.13 Reinstalling the faceplate	23
3. Operation	25
3.1 Basic operation.....	25
3.2 LED status indicator.....	25
3.2.1 Charge control indications	25
4. Troubleshooting	27
5. Specifications	28
5.1 Specifications	28
5.2 Environmental.....	28
5.2.1 Temperature	28
5.3 Safety and EMC.....	28
5.3.2 European market: CE	29
5.4 Humidity	29
5.4.1 Operating humidity	29
5.4.2 Non-operating humidity.....	29
5.5 Mechanical features.....	29
5.6 Detailed dimension drawing	30

6. Batteries	31
6.1 Battery types.....	31
6.2 Automotive batteries	31
6.3 Maintenance-free batteries.....	31
6.4 Deep-cycle batteries	31
6.5 Sealed batteries.....	31
6.6 Battery sizing	31
6.7 Equalization charging.....	31
6.8 Equalization setting points (non-sealed batteries only)	32

Tables

Table 1 – 1: Factory shipping settings	10
Table 1 – 2: Battery type selector switch settings.....	16
Table 1 – 3: Temperature compensation calculation.....	18
Table 1 – 4: Battery compensation coefficient.....	18
Table 1 – 5: Minimum wire size	20
Table 1 – 6: The LED indicators	26
Table 1 – 7: Troubleshooting list	27
Table 1 – 8: Electrical specification.....	28
Table 1 – 9: Mechanical specification	29
Table 1 – 10: Battery equalization	32

Figures

Figure 1 – 1: Bulk charge curve.....	10
Figure 1 – 2: PV charge and load controller.....	12
Figure 1 – 3: Load controller	12
Figure 1 – 4: Removing the topcover.....	14
Figure 1 – 5: Mounting the solar charge controller	15
Figure 1 – 6: Battery type selector (B.SEL).....	16
Figure 1 – 7: Safety (earth) ground.....	19
Figure 1 – 8: DC terminal connector locations	19
Figure 1 – 9: PV charge control mode wiring	20
Figure 1 – 10: Parallel connection	21
Figure 1 – 11: battery type selector	22
Figure 1 – 12: Install BTS.....	23
Figure 1 – 13: Reinstalling the faceplate.....	24
Figure 1 – 14: LED status indicator	25
Figure 1 – 15: Solar charger controller dimension drawing	30

About manual

Purpose

The purpose of this manual is to provide explanations and procedures for installing, operating, maintaining, and troubleshooting solar charge controller.

Scope

This manual provides safety guidelines, detailed planning and setup information, procedures for installing solar charger controller, as well as information about operating and troubleshooting the unit. It does not provide details about particular brands of batteries. You need to consult individual battery manufacturers for this information.

Audience

This manual is intended for anyone who needs to install and operate solar charger controller. Installers should be certified technicians or electricians.

Organization

This manual is organized into six chapters.

Chapter 1 Product description

Chapter 2 Installation

Chapter 3 Operation

Chapter 4 Troubleshooting

Chapter 5 Specification

Chapter 6 Battery

Important safety instructions

Save these instructions

This manual contains important instructions for solar charger controller that shall be followed during installation and maintenance.

General

1. Refer installation and servicing to qualified service personnel. Incorrect installation or use may result in risk of fire. No user serviceable parts in this unit.

2. Remove all sources of power, photovoltaic and battery before servicing or installing.

3. Warning – risk of explosive gases

(1) When solar charger controller is working, please DO NOT touch it because temperature is too high.

(2) Working in vicinity of lead-acid batteries is dangerous. Batteries produce explosive gasses during normal battery operation.

(3) To reduce risk of battery explosion, follow these instructions and those published by battery manufacturer and manufacturer of any equipment you intend to use in vicinity of battery.

4. Personal precautions

(1) Someone should be within range of your voice or close enough to come to your aid when you work near a lead-acid battery.

(2) Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing or eyes.

(3) Wear complete eye protection and clothing protection. Avoid touching eyes while working near battery.

(4) If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 10 minutes and get medical attention immediately.

(5) NEVER smoke or allow a spark or flame in vicinity of battery.

(6) Be extra cautious to reduce risk of dropping metal tool onto battery. It might spark or short circuit battery or other electrical part that may cause explosion.

(7) Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a lead-acid battery. A lead-acid battery can produce a short circuit current high enough to weld a ring or the like to metal, causing a severe burn.

5. Preparing to charge

(1) Never charge a frozen battery.

(2) Be sure battery is mounted in a well-ventilated compartment.

(3) Add distilled water in each cell until battery acid reaches level specified by battery manufacturer. This helps purge excessive gas from cells. Do not overfill. For a battery without cell caps, carefully follow manufacturers charging instructions.

6. Charger location & installation

(1) Controller employs components that tend to produce arcs or sparks. NEVER install in battery compartment or in presence of explosive gases.

(2) Protect all wiring from physical damage, vibration and excessive heat.

(3) Insure that controller is properly setup for battery being charged.

(4) Do not expose controller to rain or snow.

(5) Insure all terminating connections are clean and tight to prevent arcing and overheating.

(6) Charging system must be properly installed as described in these instructions prior to operation.

(7) Do not connect to a PV array capable of producing greater than 40 amps of short circuit current @ 25°C.

(8) Do not connect input to DC source directly with load, solar charger controller need to be powered by solar panel.

(9) Do not short-circuit DC output port, it will damage solar charger controller.

Symbol



--Warning



--Dangerous Voltage



--Alternative Current



--Direct Current



--Protective Earth



--ESD

Abbreviations and Acronyms

BTS	Battery temperature sensor
DC	Direct current
LED	Light emitting diode
LVD	Low voltage disconnect
LVR	Low voltage reconnect
B.SELECT	Battery type selector
CHG.MODE	Charge mode
PV	Photovoltaic
MPPT	Maximum power point tracking
PWM	Pulse width modulation
RE	Renewable energy

1. Product description

1.1 General description

Solar charger controller is a 40 amp 12/24 voltage maximum power point tracking (MPPT) photovoltaic (PV) battery charge controller. Through use of MPPT technology, solar charger controller can increase charge current up to 30% or more compared to conventional controllers. Solar charger controller's sophisticated three stage charge control system can be configured to optimize charge parameters to precise battery requirements. The unit is fully protected against voltage transients, over temperature, over current, reverse battery and reverse PV connections. An automatic current limit feature allows use of full 40 amp capability without worrying about overload from excessive current, voltage or amp-hour based load control.

Solarmate passes pulse width modulation (PWM) charge voltage control combined with a multistage charge control algorithm leads to superior charging and enhanced battery performance. Filtered PWM power control system uses highly efficient and reliable power MOSFET transistors. MOSFET's are turned on and off at high frequency to precisely control charge voltage and MPPT.

Fully automatic temperature compensation of charge voltage is available to further improve charge control and battery performance. Optional battery temperature sensor is built for long term reliability. The sensor element is environmentally sealed and encapsulated into a plastic lug which adheres to directly to battery terminal and by RJ11 port connect with the unit, and solar charger controller also includes an isolated RS232 port for connection to a PC computer for data logging and system monitoring.

Solar charger controller can easily install in parallel connection of output, so it also suitable for large system current application condition.

1.2 Features

1. A DC Load output port
2. An optional battery temperature sensor ensures precise battery charging
3. LED displays to indicate the status of charge
4. Lightning protection
5. Reverse current at night
6. Three-stage battery charging (bulk, absorption, and float) with optional temperature compensation
7. Automatic overload protection
8. Microprocessor controlled
9. Silent, pulse width modulated (PWM), high efficiency operation

1.3 Maximum setting point voltage limit

Very cold batteries combined with high charge voltage setting points can produce voltages high enough to disrupt or damage other equipment connected to battery. To minimize possible damage a maximum voltage setting point limit feature is provided. Factory defaults can be adjustable using software. Regardless of what setting point values result from temperature compensation, solar charger controller will never attempt to apply a charge voltage greater than the maximum voltage setting point limit value.

1.4 Temperature and output power

Over temperature protection is provided to protect the unit from damage due to high output power at high ambient temperatures. When mounted vertically as described in installation section, the unit can deliver full output in a temperature of up to 40°C, and the unit will de-rate output in 40-60°C. While operating in charge mode, controller will decrease charge current to reduce transistor temperature and the green led will be blinking green, reducing average power delivery to within safe limits. During thermal shutdown charge status indicator will display an "Off" condition. Over temperature shutdown occurs when ambient temperature reaches 60°C.

1.5 Maximum power point tracking (MPPT)

MPPT and associated current boost operation is fully automatic and will function whenever sufficient PV voltage and current are available. Percent increase in output charge current relative to PV current is variable, and will change with operating conditions. When conditions are such that insufficient PV power is available to produce an increase in output current, the unit will stop its internal DC-DC power conversion and operate as a series pass PWM controller with very low forward voltage drop.

Principal operating conditions which affect current boost performance are PV array temperature and battery voltage. At constant solar intensity available PV power changes with PV temperature. A PV array's power vs. temperature characteristic is such that a cool PV array can produce a higher voltage and more power, than a hot PV array. When PV voltage is sufficiently high for MPPT to operate, a constant power output is delivered to battery. Since output power is constant while MPPT is operating, a decrease in battery voltage produces corresponding increase in charge current. This means that the greatest current increase occurs with a combination of cool ambient temperature and low battery voltage. The unit delivers the greatest charge current increase when you need it most, in cold weather with a discharged battery. Additionally, anything that can be done to lower PV array temperature will also lead to increased charge current by increasing PV power production. In cool/comfortable temperatures and typical battery states of charge, most systems see about 10-20% increase. Charge current increase can go to zero in hot temperatures, whereas charge current increase can easily exceed 30% with a discharged battery and freezing temperatures.

1.6 How MPPT works

A PV module is a constant current type device. As shown on a typical PV module voltage vs. current curve, current remains relatively constant over a wide range of voltage. A typical 75 watt module is specified to deliver 4.45 amps @ 17 volts @ 25 C cell temperature. Conventional PV controllers essentially connect PV array directly to battery when battery is discharged. When a 75 watt module is connected directly to a battery charging at 12 volts, module still provides approximately the same current. But, because output voltage is now at 12 volts rather than 17 volts, module power production is artificially limited and 75W module only delivers 53 watts. This wastes 22 watts of available power.

Solar charger controller's MPPT technology operates in a very different fashion. Under these conditions solar charger controller calculates the maximum power voltage (V) at which PV module delivers maximum power, in this case 17 volts. It then MPPT operates module 17 volts which extracts maximum available power from module. Solar charger controller continually recalculates the maximum power voltage as operating conditions change. Input power from the maximum power tracking controller, in this case 75 watts, feeds a switching type power converter which reduces the 17 volt input to battery voltage at output. The full 75 watts which is now being delivered at 12 volts would produce a current of 6.25 amps. A charge current increase of 1.8 amps or 40% is achieved by converting the 22 watts that would have been wasted into useable charge current. Note that this example assumes 100% efficiency to illustrate principal of operation. In actual operation, boost will be somewhat less.

1.7 Over voltage/reverse polarity protection

Solar charger controller is fully protected against reverse polarity and high voltage transients for both PV and battery connections. If battery is connected reverse polarity, solar charger controller will be protected by inner fuse and fuse will be open. If PV array is connected reverse polarity charge control system will not turn on.

1.8 Electrostatic handling precautions

All electronic circuits may be damaged by static electricity. To minimize likelihood of electrostatic damage, discharge yourself by touching a water faucet or other electrical ground prior to handling the unit and avoid touching components on circuit boards. Risk of electrostatic damage is the highest when relative humidity is below 40%.

1.9 Solar charger controller setup

1.9.1 Factory default settings

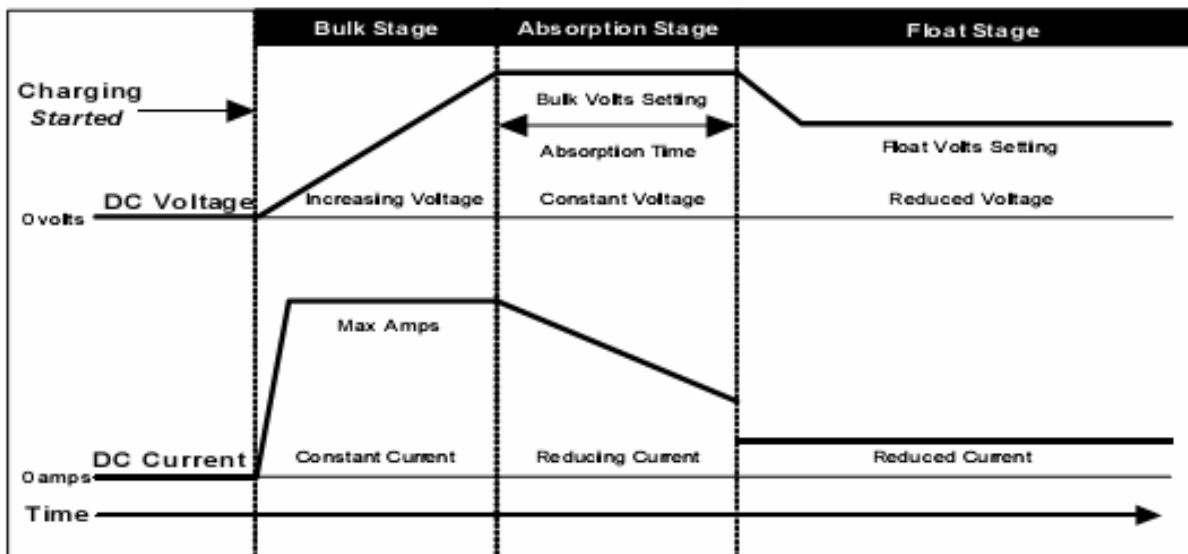
Table 1-1: Factory shipping settings

Basic settings	
Charge mode	3 stage
Absorption voltage	14.4/28.8V
Bulk voltage	14.6/29.2V
Float voltage	13.4/26.8V
Equalize	14/28V

1.10 Three stage charge control

Solar charger controller is typically configured for a three stage charging process, bulk, absorption and float. The three stage charge process provides a somewhat higher charge voltage to charge the battery quickly and safely. Once battery is fully charged a somewhat lower voltage is applied maintain battery in a fully charged state without excessive water loss. The three stage charge process charges battery as quickly as possible while minimizing battery water loss and maintenance.

Figure 1 – 1: Bulk charge curve



1.10.1 Bulk charge

When charge starts solar charger controller attempts to apply bulk charge voltage to battery. The system will switch to bulk charge if battery is sufficiently discharged and/or insufficient charge current is available to drive battery up to bulk voltage setting point. During bulk charge stage the unit delivers as much charge current as possible to rapidly recharge battery. Once charge control system enters absorption or float, the unit will again switch to bulk charge if battery voltage drops below the present charge voltage setting point.

1.10.2 Absorption charge

During this stage, the unit changes to a constant voltage mode where absorption voltage is applied to battery.

When charge current decreases to float transition current setting, battery is fully charged and the unit switches to the float stage.

1.10.3 Float charge

During this stage, float voltage is applied to battery to maintain it in a fully charged state. When battery voltage drops below float setting for a cumulative period, a new bulk cycle will be triggered.

1.11 Battery temperature sensor (BTS)

Charge voltage required by batteries changes with battery temperature. Temperature compensation of charge voltage enhances battery performance and life, and decreases battery maintenance. Automatic temperature compensation can be provided through use of optional battery temperature sensor. The following table describes approximately how much voltage may vary depending on temperature of batteries.

1.12 Equalization charge

Equalize charging is a special mode of battery charging. During use, battery's cells can become unequal in voltage and current they can deliver. This is due to a buildup of sulfate on plates as well as stratified electrolyte. Sulfate prevents cells from receiving or delivering full power. If sulfate is left on plates, it will harden, and permanently reduce battery's capacity. Stratification separates heavier acid from water, and concentrated acid remains at lower portion of plates, eventually corroding them. Equalizing batteries every month or two (depending on usage) prolongs life of batteries and provides better battery performance.

To set the equalize charge:

1. Remove all DC loads connected to batteries.
2. Remove all battery vent caps.
3. Check battery water level, it should be just over the top of plates (do not over fill). Use only distilled water for filling batteries.
4. Set BATTERY TYPE SELECTOR switch to position "0" or "1"(position "1" is reserved).
5. Reset BATTERY TYPE SELECTOR potentiometer to an appropriate setting for system batteries when equalize charge has completed.

1.12.1 Photovoltaic charge and load controller

Solar charger controller can operate as a PV charge controller. It can regulate up to 40amps of continuous photovoltaic (PV) array current at 12 / 24-volts DC for charging batteries, at the same time solar charger controller can provide the maximum 15Amp current to DC load ,but the rating 40Amp current is shared battery with DC load.

When PV voltage is lower, battery will provide power to DC load, In load control condition, solar charger controller controls when to remove load from system when an over-discharge or over-load situation occurs. Solar charger controller uses software setting points to determine when to disconnect or reconnect loads depending on battery voltage. Solar charger controller prevents damage to battery from over-discharge during periods of poor weather or excessive loads. Solar charger controller can charge batteries when in this function.

Figure 1-2: PV charge and load controller



1.12.2 Automatic PV array night disconnect

When using PV charge control mode, PV array is automatically disconnected from battery at night to prevent reverse leakage of power and protect PV.

1.12.3 Solar charger controller load control

Solar charger controller can operate as a low voltage disconnect (LVD) for DC loads to prevent over-discharge to batteries during periods of poor charging or excessive loads. Solar charger controller uses software setting points to determine when to disconnect or reconnect loads depending on battery voltage.

1.12.4 Low voltage disconnect

When configured as a load controller, solar charger controller will disconnect load from batteries when it reaches LVD setting. There will be a 1-minute delay after voltage drops below low voltage disconnect (LVD) setting before controller actually disconnects load.

1.12.5 Low voltage reconnection

It can also provide automatic reconnection of loads at the low voltage reconnect (LVR) setting. Reconnection of load is allowed once battery voltage has exceeded low voltage reconnect (LVR) setting. Loads are either automatically when battery voltage exceeds low voltage reconnect (LVR) setting for 1 minutes.

Figure 1-3: Load controller



Important: When using solar charger controller load control:

1. Do not temperature-compensate these settings.

2. Do not install optional battery temperature compensation sensor.

1.13 Optional accessories

The follow accessories can be purchased for use with solar charger controller:

Battery temperature sensor (BTS): BTS is installed on the side of battery and attaches to RS232 port inside solar charger controller. It provides accurate sensing of battery temperature and uses this reading to control charging. Using this accessory can extend battery life and improve overall charging.

2. Installation

2.1 Pre-installation

The instructions that follow are applicable to typical installation. For special applications, consult a qualified electrician or your certified dealer. Installation procedures will vary according to your specific application.

- ² Important: Installations should meet all local codes and standards. Installations of this equipment should only be performed by skilled personnel such as qualified electricians and certified renewable energy (RE) system installers.

2.2 Removing top cover

1. Access inside of solar charger controller by removing the four screws M3*6 on cover of the unit.
2. Remove top cover of solar charger controller.

Figure 1 – 4: Removing top cover



Remove these screws M3*6 (*4) from top cover to access heat sink of controller



Remove top cover

2.3 Mounting solar charge controller

Solar charge controller is designed for indoor mounting. Care should be taken in selecting a location and when mounting enclosure. Avoid mounting it in direct sunlight to prevent heating of enclosure. Enclosure should be mounted vertically on a wall. In outdoor installations, solar charge controller must be installed in a rainproof enclosure to eliminate exposure to rain, mist or water-spray.

- ² Caution: Damage to solar charge controller, install solar charge controller in a dry, protected location away from sources of high temperature, moisture, and vibration. Exposure to saltwater is particularly destructive. Corrosion is not covered by warranty.

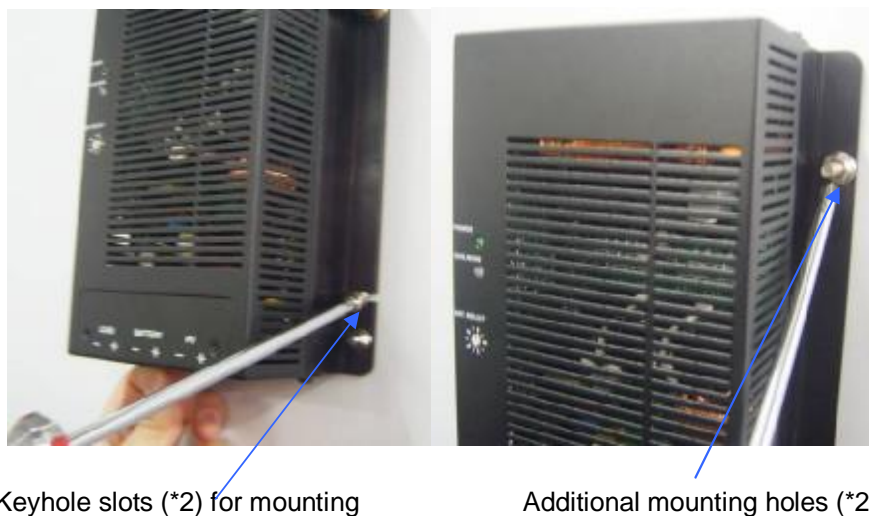
2.3.1 Mount solar charge controller

1. Place controller on desired mounting surface and mark location of keyhole slots on wall.
2. Move controller out of way, and secure two mounting screws in the locations marked. Leave screw heads backed out approximately 1/4inch (6 mm) or less.
3. Place controller onto the screws and pull it down into the keyhole slots.
4. Then insert the two screws provided to secure enclosure onto the wall.

- ² Warning: Explosion/corrosion hazard and don't mount solar charge controller on flammable wall (for example: wooden all and so on).

Do not locate solar charge controller in a sealed compartment with batteries. Batteries can vent hydrogen-sulfide gas, which is corrosive to electronic equipment. Batteries also generate hydrogen and oxygen gas that can explode when exposed to a spark.

Figure 1-5: Mounting solar charge controller



2.4 Configuring the solar charge controller

Before making any wiring connections to solar charge controller, it must be configured for desired mode of operation. The following sections describe how to configure the unit for desired application and function.

2.4.1 Battery type selector can apply different charger method

Battery type selector is a 10 position rotary switch used to set solar charger controller for proper float and bulk voltage levels. These levels are selected depending on type of batteries used. Refer to the table below for charge voltages in various switch positions. Consult battery manufacturer for optimum battery voltage charging settings.

Figure 1-6: Battery type selector (B.SEL)

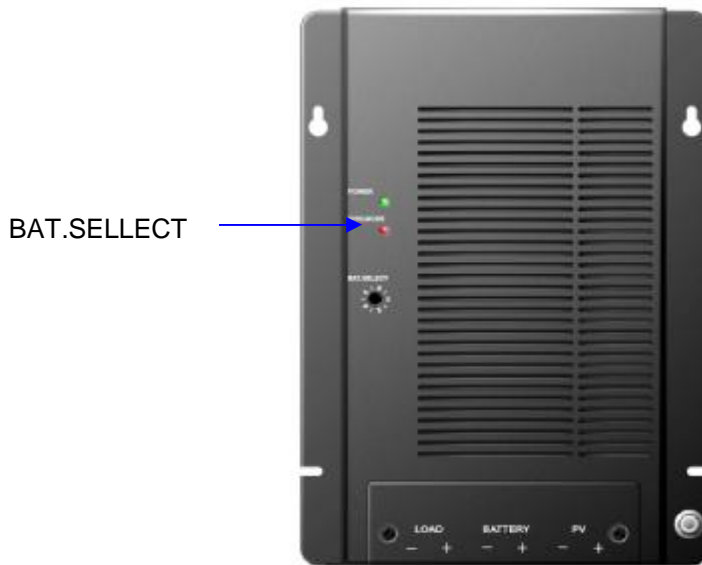


Table 1 – 2: Battery type selector switch settings

Switch position	Description	12-volt		24-volt		Charge function	
		Float voltage (V)	Bulk/equalize voltage (V)	Float voltage (V)	Bulk/equalize voltage (V)	Equalize charge rate	Equalize time
0	Equalize 1 - equalizes at a rate equal to the battery bank capacity (in amp hours) divided by 40.	13.2	*15	26.4	*30	Max 40Amp	Depend on battery capacity
1	Equalize 2 –depend on customer reset	Reserved	Reserved	Reserved	Reserved		

2	Deep cell lead acid 2	13.3	15	26.6	30	Provides an additional float and bulk settings for deep cycle, lead acid batteries. Refer to battery manufacturer recommendation for float and bulk settings.
3	Not specified	13.6	14.3	27.2	28.6	Provides an additional setting of bulk and float voltages.
4	GEL cell 2	13.7	14.4	27.4	28.8	Recommended for GEL cell batteries that specify high float voltages. Check with battery manufacturer.
5	GEL cell 1	13.5	14.1	27	28.2	Typical gel cell setting.
6	PcCa-lead calcium	13.2	14.3	26.4	28.6	Use this setting for sealed type car batteries.
7	Deep cycle lead acid 1 (default setting)	13.4	14.6	26.8	29.2	Factory setting for typical deep cycle lead acid batteries.
8	NiCad 1	14	16	28	32	Use for NiCad battery systems.
9	NiCad 2	14.5	16	29	32	Recommended for use with nickel iron batteries.

² Important:

1. Switch positions "0" and "1" are for monthly battery maintenance only. Equalize voltages are displayed in the table with an asterisk (*) – Switch positions "0" and "1" only.
2. Switch position "7" is default values as shipped from factory.
3. Always refer to battery manufacturer's specifications for equalization.

2.5 Temperature compensation

For optimal battery charging, bulk and float charge rates should be adjusted according to temperature of battery. When battery charging voltages are compensated based on temperature, charge voltage will vary depending on temperature around batteries.

2.5.1 Temperature compensation based on battery type

Charge voltage required by batteries changes with battery temperature. Temperature compensation of charge voltage enhances battery performance and life, and decreases battery maintenance. Automatic temperature compensation can be provided through use of optional battery temperature sensor. The following table describes approximately how much voltage may vary depending on temperature of the batteries. Temperature compensation is based on battery type-5mv /cell for lead acid type batteries and 2mv/cell for alkaline type batteries (NiCad or NiFe). Temperature compensation calculations are derived from the following table.

Table 1 – 3: Temperature compensation calculation

Battery type	12 -volt	24-volt
Lead acid	0.03 volts (30mv) per degree Celsius	0.06 volts (60mv) per degree Celsius
NiCad	0.02 volts (20mv) per degree Celsius	0.04 volts (40mv) per degree Celsius

2.5.2 Automatic battery temperature compensation

Temperature compensation can be accomplished automatically by using a battery temperature sensor (BTS). The sensor attaches directly to the side of one of batteries in bank and provides precise battery temperature. See “Installing the battery temperature sensor” for detailed instructions on how and where to install BTS. If a BTS is installed, charge controlling process will be automatically adjusted for battery temperature. When using a BTS, set bulk and float voltage for a battery at normal room temperature for 25 °C.

Table 1 – 4: Battery compensation coefficient

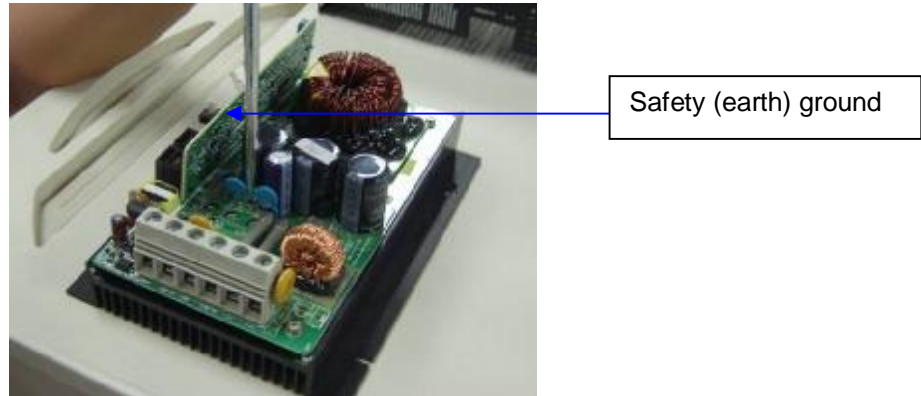
Temperature (around the BTS)		12-volt		24-volt	
Celsius	Fahrenheit	Lead acid (6 cells)	NiCad (10 cells)	Lead acid (12 cells)	NiCad (20 cells)
60	140	-1.05	-0.7	-2.1	-1.4
55	131	-0.9	-0.6	-1.8	-1.2
50	122	-0.75	-0.5	-1.5	-1
45	113	-0.6	-0.4	-1.2	-0.8
40	104	-0.45	-0.3	-0.9	-0.6
35	95	-0.3	-0.2	-0.6	-0.4
30	86	-0.15	-0.1	-0.3	-0.2
25	77	0	0	0	0
20	68	0.15	0.1	0.3	0.2
15	59	0.3	0.2	0.6	0.4
10	50	0.45	0.3	0.9	0.6
5	41	0.6	0.4	1.2	0.8
0	32	0.75	0.5	1.5	1
-5	23	0.9	0.6	1.8	1.2
-10	14	1.05	0.7	2.1	1.4
-15	5	1.2	0.8	2.4	1.6
-20	-4	1.35	0.9	2.7	1.8
-25	-13	1.5	1	3	2
-30	-22	1.65	1.1	3.3	2.2
-35	-31	1.8	1.2	3.6	2.4
-40	-40	1.95	1.3	3.9	2.6

If using a BTS, when battery temperature drops below 25 °C, regulation voltage setting automatically increases. When temperature rises above 25°C, regulation battery voltage setting automatically decreases.

2.6 Grounding

Solar charge controller is designed to work with grounded electrical systems. In solar charge controller ground is not connected to input terminal and output terminal so customer can connect ground to battery + or battery -. But don't connect battery terminal and PV output terminal with ground at same time.

Figure 1-7: Safety (earth) ground



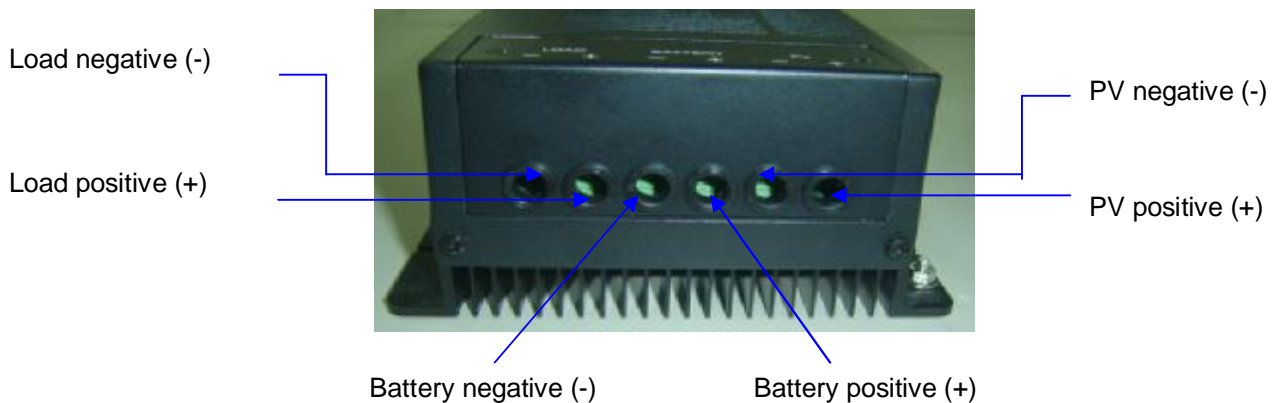
2.7 DC terminal connector locations

Terminal connectors for DC wiring are located on the lower edge of circuit board.

Terminal torque requirements:

Once wires have been installed, torque terminals as follows. Be careful not to over tighten.

Figure 1-8: DC terminal connector locations



2.8 Wire size and over-current protection requirements

The wiring, over-current protection devices (fuses), and installation methods used must conform to all national and local electrical code requirements. Wiring should be protected from physical damage with conduit or a strain relief clamp.

2.8.1 Current rating

Solar charge controller is rated for a rating continuous current of 40 amps. Since PV outputs can vary due to array size or sunlight striking it, the safe minimum wire size should be based on the maximum current ratings.

2.8.2 Surge protection

Since PV arrays are often mounted on an elevated structure and thus are more susceptible to lightning strikes, protection from lightning-induced power surges and other transient power disturbances between PV array and solar charge controller are strongly recommended. Because solar charge controller has wider input voltage range 15-55VDC.

2.8.3 Over-current protection

If controller detects an overload, it will automatically resets over current protection system every 6 minutes. If the default is still present, controller will shut off and wait another 6 minutes. This will occur continuously until the problem is corrected.

Table 1-5: Minimum wire size

Controller	Minimum wire size
12/24VDC	#8AWG

2.9 PV charge and load control mode wiring

The procedure below is illustrated in Figure 1-9

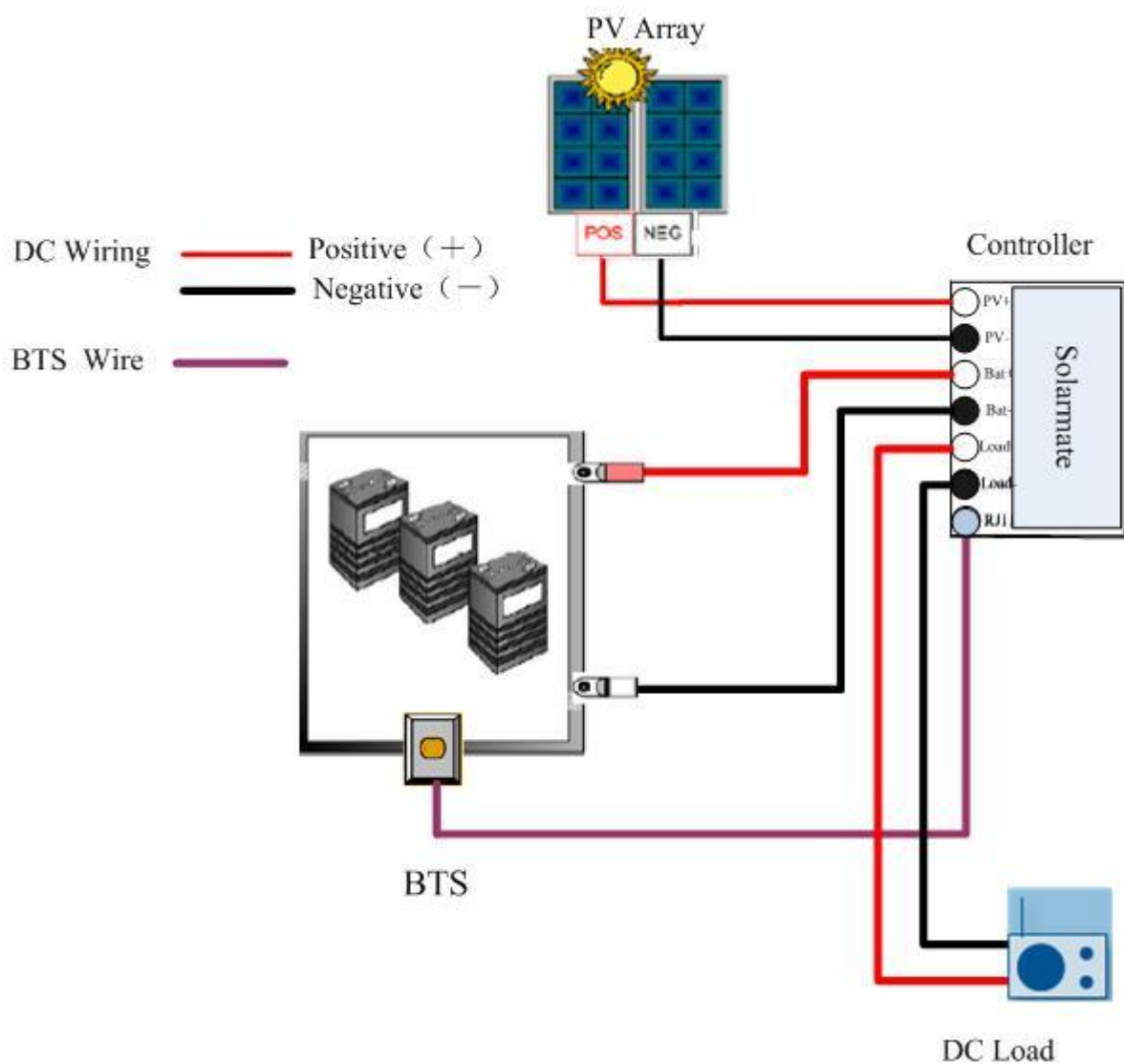
⚠ WARNING: Shock hazard

PV arrays generate voltage whenever light strikes surface of array. Before connecting solar charge controller, cover or disconnect array to prevent any current from being generated.

1. Connect the PV array's positive (+) output to the terminal marked PV positive (+) on solar charge controller and tighten the screws.
2. Connect the PV array's negative (-) output to the terminal marked PV negative (-) on solar charge controller and tighten the screws.
3. Connect the terminal marked battery negative (-) on solar charge controller to the negative (-) battery terminal and tighten the screws.
4. Connect the terminal marked battery positive (+) on solar charge controller to the positive (+) battery terminal and tighten the screws.
5. Connect the terminal marked load negative (-) on solar charge controller to the negative (-) load terminal and tighten the screws.
6. Connect the terminal marked load positive (+) on solar charger controller to the positive (+) battery terminal and tighten the screws.
7. Connect a cable from controller's other terminal marked load negative (-) to the negative terminal of your DC load and tighten the screws.
8. Connect a cable from controller's other terminal marked load positive (+) to the positive terminal of your DC load and tighten the screws.

Figure 1 – 9: PV charge control mode wiring

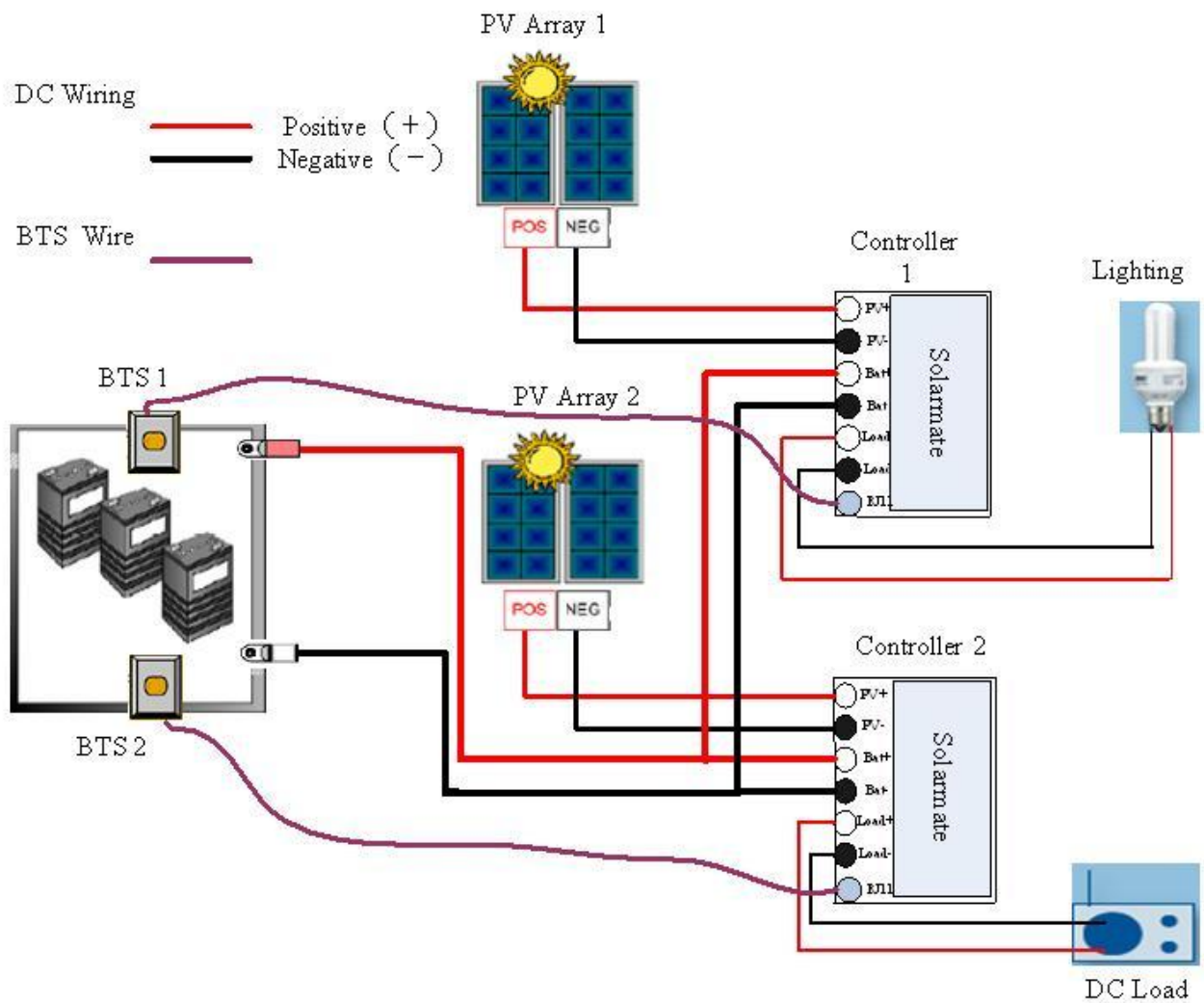




2.10 Easily install in parallel connection

In order to get more than 40A charge current, Output of solar charger controller can be connected in parallel. For example, connecting 2 solar charger controller in parallel can get 80A charger current, and connecting 3 solar charger controller in parallel can get 120A charger current.

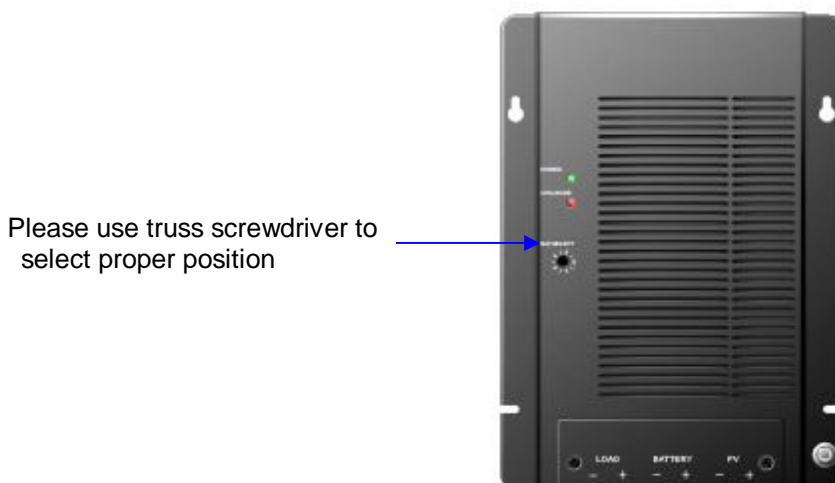
Figure 1-10: Parallel connection



2.11 Battery type selector

Please see 2.5.1 section, which you find the different one of 10 positions stand for different battery types specified. You can select solar charger controller for proper float and bulk voltage levels. These levels are selected depending on type of batteries used. Refer to the table below for charge voltages in various switch positions. Consult battery manufacturer for optimum battery voltage charging settings.

Figure 1-11: Battery type selector



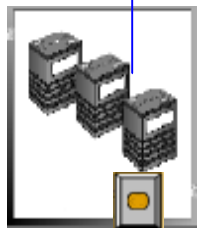
2.12 Installing optional accessories

The following sections describe how to install optional accessories available for solar charge controller.

To install battery temperature sensor (BTS)

1. Install BTS on the side of battery below electrolyte level. It is best to place the sensor between batteries and place batteries in an insulated box to reduce influence of ambient temperature outside battery enclosure.
2. Insert RJ-11 plug on the other end of the BTS into BTS port on solar charge controller.

Figure 1-12: Install BTS



RJ-11 Port

Accept BTS to the side of the battery

2.13 Reinstalling the faceplate

To reinstall the faceplate on solar charge controller:

1. Align top cover so that two screw holes in corners line up.
2. Insert screws into screw holes and tighten.

Figure 1-13: Reinstalling the faceplate



Align these screw holes, replace the screw to secure the top cover

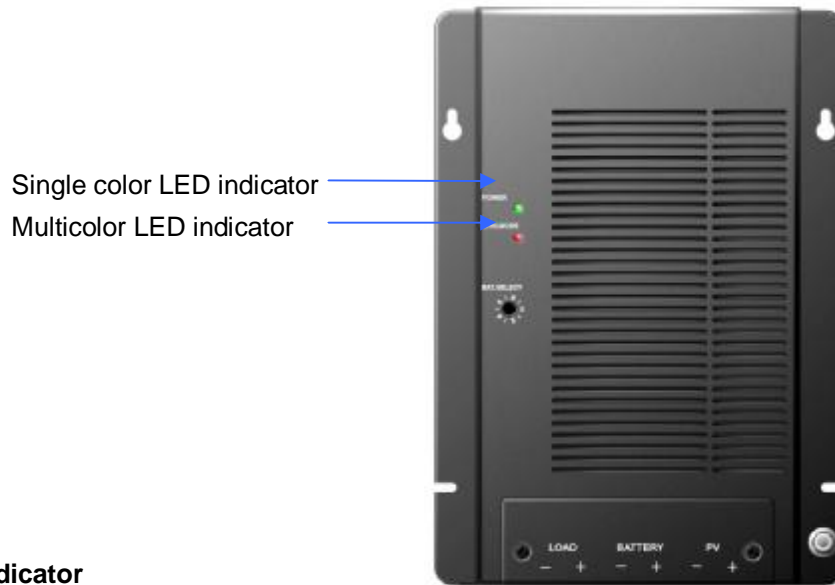
3. Operation

Chapter 3 contains information about operation of solar charge controller.

3.1 Basic Operation

Solar charge controller has one blue and multicolor LED status indicator, one battery type selector.

Figure 1-14: LED status indicator



3.2 LED Status Indicator

Solar charger controller has one multicolor LED and one green LED to indicate operating status. The green LED indicates whether charging source is functioning properly when it display solid green or type of fault when it flash. And the multi color LED indicates particular operating mode and batteries capacity level.

3.2.1 Charge control indications

	LED1			LED2			Description	Operation mode
	State	On	Off	State	On	Off		
1	Solid green	All	0	Solid red	All	0	Charge ON(PV>BV), BAT<LVD	Normal
2	Solid green	All	0	Solid orange	All	0	Charge ON(PV>BV), LVD<BAT<LVR	
3	Solid green	All	0	Solid green	All	0	Charge ON(PV>BV), BAT>LVR	
4	Solid green	All	0	Blink red	1s	1s	Charge ON(PV>BV), BAT<LVD	Derated
5	Solid green	All	0	Blink orange	1s	1s	Charge ON(PV>BV), LVD<BAT<LVR	
6	Solid green	All	0	Blink green	1s	1s	Charge ON(PV>BV), BAT>LVR	
7	Off	0	all	Blink orange	1s	6s	BAT under voltage	Fault
8	Blink green	3s	6s	Off	0	all	DC load over current or dc load voltage out of the range	
9	Blink green	2s	6s	Off	0	all	Over temperature	
10	Blink green	1s	1s	Blink red	1s	1s	PV over voltage	
11	Blink green	1s	1s	Blink orange	1s	1s	PV under voltage	
12	Blink green	1s	6s	Blink red	0	all	BAT over voltage	

13	Blink green	All	0	Blink red	0	all	when solar charger controller starts, wait for 3s; if the start time is over 3s, then mean that the BAT voltage is out of the range
----	-------------	-----	---	-----------	---	-----	---

Table 1-6: The LED indicators

NOTE:

When solar charger controller is charging, the green LED will be solid green.

1. Low voltage disconnect

When connected with DC load, if voltage remains below low voltage disconnect setting, controller will disconnect after a 1-minute delay period. And controller waits until voltage rises above low voltage recovery setting.

2. Over voltage of load

If controller detects an over voltage of load, it will disconnect load.

3. Over temperature

Temperature of the controller's transistors is continuously monitored. This protects charge controller from damage in high temperature environments if excessive temperatures are detected. While operating in charge mode, controller will decrease charge current to reduce transistor temperature and the green led will be solid green. If solar charger controller connected with DC load, load is disconnected before transistors reach an excessive temperature and the green LED flashes. Once temperature has dropped, loads are reconnected.

4. Over current of load

If controller detects an overload or short circuit of load, it will automatically resets over current protection system every 6 minutes. If the default is still present, controller will shut off and wait another 6 minutes. This will occur continuously until the problem is corrected.

4. Troubleshooting

Table 1-7: Troubleshooting list

Symptom	Probable cause	Items to examine or correct
Completely dead, no display	No battery power	Battery disconnected, overly discharged, or connected reversely, no display polarity. Battery powers system, not PV.
Unit will not turn on(charge status LED off), display if attached is OK	PV disconnected PV reverse polarity PV- connected to BAT- external to controller	PV disconnected PV must supply at least 0.25Amp at 3V more than battery voltage to begin charge. PV reverse polarity, reverse polarity PV will cause heat sink to heat. PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts inside the solar charger controller which internally connect PV- to BAT-. External connection prevents proper operation of internal shunts and current measurement system. Battery voltage is determined automatically when the unit first receives power. Voltage must be less than 30VDC for 12VDC battery, or greater than 30VDC for 24VDC battery. Apply battery quickly and crisply.
Charge status LED on, but no output charge current	Battery voltage greater than charge voltage setting point. Battery voltage too low	This is normal operation. Output is off due to high battery voltage which may be caused by other charging systems. Battery voltage must be at least 9VDC for the unit to operate.
Charge current is lower than expected, PV current may be low as well	Battery is highly charged Worn out PV modules Low isolation PV- connected to BAT- Nominal PV voltage has changed from 24VDC to 12VDC	Normal operation, current is reduced if battery voltage is at setting point Replace, or use as it. Atmospheric haze, PV's dirty, sun low on horizon, etc. PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts inside the Solar charger controller which internally connect PV- to BAT-. External connection prevents proper operation of internal shunts and current measurement system. If PV voltage is changed from 24VDC to 12VDC, battery and PV power must be removed momentarily to reboot the unit and load initial 12VDC PV control values. The unit considers PV's to 24VDC if PV voltage ever goes above 30VDC.
Charge OFF at high temperature	System temporarily shuts down due to high heat sink temperature	Improve ventilation or reduce PV power. Sufficient ventilation to prevent over temperature shut down

5. Specifications

Specifications provide specification for solar charge controller.

5.1 Specifications

Table 1 – 8: Electrical specification

Rated voltage	12/24VDC	
Rated charge current(include load current)	40Amp	
Load current	15Amp	
Input voltage range	15-55VDC	
Max. PV open circuit array voltage	55VDC	
Overload protection(DC load)	2.0 * Inom>5s 1.5 * Inom >20s 1.25 * Inom temperature controlled	
Typical idle consumption	At idle < 10mA	
Bulk charge	14.6VDC(default)	29.2VDC(default)
Floating charge	13.4VDC(default)	26.8VDC(default)
Equalization charge	14.0VDC(default)	28.0Vdc (default)
Over charge disconnection	14.8VDC	29.6VDC
Over charge recovery	13.6VDC	27.2VDC
Over discharge disconnection	10.8VDC(default)	21.6VDC(default)
Over discharge reconnection	12.3VDC	24.6VDC
Temperature compensation	-13.2mV/°C	-26.4mV/°C
Lead acid battery settings	Adjustable	
NiCad battery settings	Adjustable	
Load control mode	1. Low voltage reconnect (LVR): adjustable 2. Low voltage disconnect (LVD): automatic disconnection 3. Reconnection: includes warning flash before disconnect and reconnection	
Low voltage reconnect	12.0-14.0VDC	24.0-28.0VDC
Low voltage disconnect	10.5-12.5VDC	21.0-25.0VDC
Ambient temperature	0-40°C (full load), 40-60°C (de-rating)	
Altitude	Operating 5000 m, Non-operating 16000 m	
Protection class	IP21	
Battery temperature sensor	BTS-optional remote battery temperature sensor for increased charging precision	
Terminal size(fine/single wire)	#8AWG	

5.2 Environmental

5.2.1 Temperature

5.2.1.1 Operating Temperature

0°C to 40°C (40°C to 60°C (de-rating))

5.2.1.2 Transit temperature

25°C to +70°C

5.2.1.3 Storage temperature

-25°C to +70°C

5.3 Safety and EMC

5.3.2 European market: CE

5.3.2.1 Compliant with EN 60335-1

5.3.2.2 Compliant with EN61000-6-1:2001

5.3.2.3 Compliant with EN61000-6-3:2001

5.4 Humidity

5.4.1 Operating humidity

20 to 80% relative humidity (non-condensing)

5.4.2 Non-operating humidity

5 to 95% relative humidity, 38.7°C maximum wet bulb temperature with no cosmetic damage

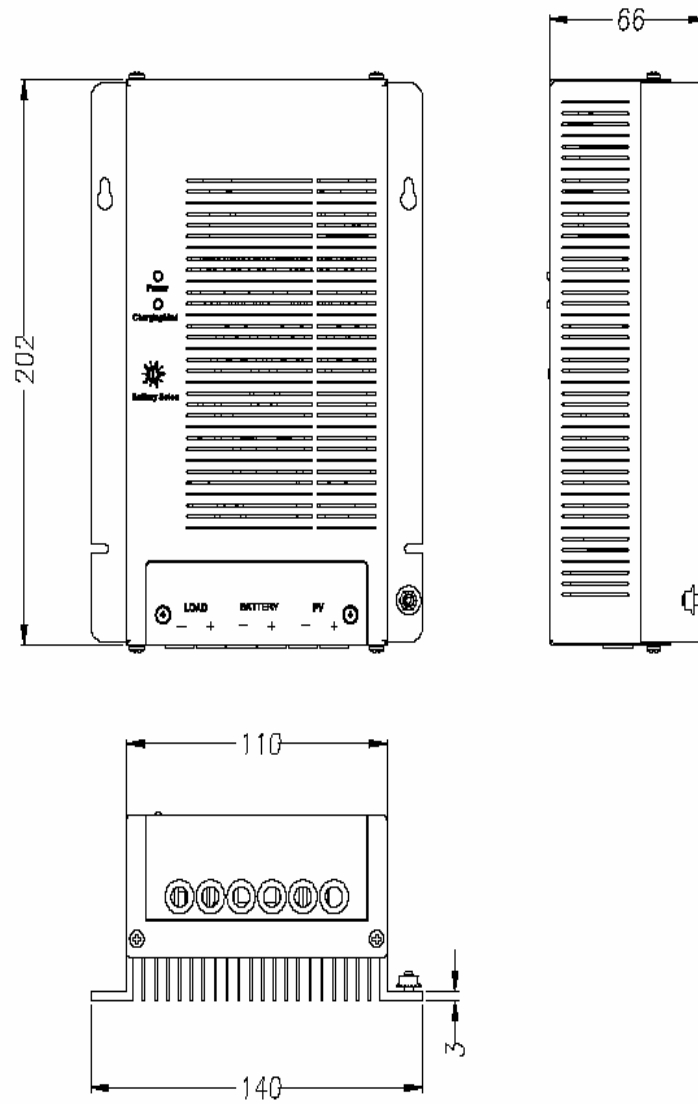
5.5 Mechanical features

Table 1-9: Mechanical specification

Items	Specification
Dimension (H x W x D)	Depth: ≤ 202 mm Height: ≤ 66 mm Width: ≤ 140 mm
Unit weight	1.4Kg
Warranty	2 years
Mounting	Vertical wall mount - indoor only
Cooling	Natural cooling

5.6 Detailed dimension drawing

Figure 1-15: Solar charger controller dimension drawing



6. Batteries

6.1 Battery Types

Batteries come in different sizes, types, amp-hour capacity, voltages and chemistries. Here are a few guidelines that will help in battery selection, and ensure that the batteries are properly maintained. The best source of the most appropriate settings for solar charger controller will be from manufacturer or supplier of the batteries.

6.2 Automotive batteries

Automotive and truck batteries are designed for high cranking power—not deep-cycling. Do not use them unless no other battery type is available. They simply will not last long in a cycling application.

6.3 Maintenance-free batteries

This type of battery is often sold as a RV or marine battery, but is rarely appropriate for use with a PV system. They typically have an additional reserve of electrolyte, but are vented. This is not the same as a sealed battery.

6.4 Deep-cycle batteries

Best suited for use with PV systems, this type of battery is designed to be more deeply discharged before being recharged. Deep-cycle batteries are available in many sizes and types. The most common is vented liquid electrolyte battery. Vented batteries usually have battery caps. The caps may appear to be sealed, but are not. The caps should be removed periodically to check level of electrolyte. When a cell is low, distilled water should be added after battery is fully charged. If level is extremely low, add only enough distilled water to cover plates before recharging. Electrolyte volume increases during charging process and battery will overflow if it is filled all of way up before recharging. Use only distilled water because impurities will reduce battery performance. A popular and inexpensive deep-cycle battery is “golf cart” battery. It is a 6-volt design, typically rated at 220amp-hours. RV and marine deep-cycle batteries are also popular for small systems. They are usually referred to as group 24 or group 27 batteries and are rated at 80 to 100 amp-hours at 12volts. Many larger systems use L16 batteries, which are usually rated at 350amp-hours at 6-volts each. They are 17 inches high and weigh about 130pounds. 8D batteries are available with either cranking or deep-cycle construction. Purchase only deep-cycle version. 8D is typically rated at 220 amp hours at 12 volts.

6.5 Sealed batteries

Another type of battery construction is sealed gel cell. They do not use battery caps. Electrolyte is in form of a gel rather than a liquid, which allows batteries to be mounted in any position. The advantages are no maintenance, long life (800 cycles claimed) and low self-discharge. Absorbed glass mat (AGM) electrolyte batteries are also acceptable. Their electrolyte is contained in mats between battery plates. Sealed batteries reduce maintenance requirements for system and are good for remote applications. They are much more sensitive to charging process and can be ruined in as little as a day of overcharging.

6.6 Battery sizing

Batteries are fuel tank of system. The larger the batteries, the longer the system can operate before recharging is necessary. An undersized battery bank results in short battery life and disappointing system performance. To determine proper battery bank size, compute number of amp-hours that will be used between charging cycles. Once required amp hours are known, size batteries at approximately twice this amount. Doubling expected amp-hour usage ensures that batteries will not be overly discharged and will extend battery life.

6.7 Equalization charging

Approximately every month, some batteries may need to be “equalized.” Since individual cells of battery are not identical, some cells may not be fully charged when charging process is completed. If batteries have been left in a discharged condition for long periods of time, plates will have sulfates on them from electrolyte. If sulfate remains on plates for an extended period of time, it will harden and seal off a percentage of plate area, reducing capacity of battery. By equalizing batteries before sulfate hardens, the sulfate is removed from plates. Batteries with liquid electrolyte may become stratified. Stratification concentrates sulfuric acid into the bottom of cell while the top becomes diluted. This corrodes lower portion of plates, reducing battery life. Mixing of

electrolyte by formation of gas bubbles during equalization process reduces stratification. Two methods can be used to determine if a battery needs to be equalized. If possible, measure voltage of each individual cell while battery is at rest (not being charged or discharged). A variation of 0.05 volts between cells indicates an imbalance exists. If battery construction prevents measurement of individual cell voltages, use a hydrometer. A variation of 0.020 in specific gravity between cells is considered significant. Both conditions can be corrected by an equalization charge. A proper equalization charge will not damage a vented, liquid electrolyte type battery. It may, however, cause significant electrolyte usage and require that battery be refilled with distilled water to correct level. This may be a problem with unattended systems in remote areas which do not receive regular maintenance. Consult battery manufacturer for their recommendations.

6.8 Equalization setting points (non-sealed batteries only)

Table 1-10: Battery equalization

Battery type	Bulk volts	Float volts	Equalizing charge
Default settings	14.0VDC	13.5VDC	Disabled
Sealed GEL battery	14.1VDC	13.6VDC	Not recommended, consult battery manufacturer
AGM lead acid battery	14.4VDC	13.4VDC	Charge to 15.5VDC or per manufacturer
Maintenance-free RV/marine	14.4VDC	13.4VDC	Limited appropriateness if water level can be checked
Deep-cycle, liquid electrolyte lead antimony battery	14.6VDC	13.4VDC	Charge to 15.5VDC or per antimony battery manufacturer
NiCad or NiFe alkaline battery	16.0VDC	14.5VDC	Not recommended, consult battery manufacturer