User's Manual

Advanced MPPT Solar Charge Controller

CC-MPPT-6-200

Systellar Innovations

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Introduction

Congratulations! You are the proud owner of one of the best MPPT charge controllers available in India. CC-MPPT-6 has been introduced by Systellar Innovations in the market after the spectacular success of other Systellar PWM and MPPT Solar Charge Controllers.

CC-MPPT-6 is an advanced Solar Charge Controller for charging 12V / 24V / 36V / 48V / any custom nominal voltage batteries of the following chemistries:

- Lead-Acid (SMF / FLA / Tubular / Gel)
- Li-ion
- LiFePO4
- Ni-Cd

Battery bank configuration and cell chemistry are selectable at the time of installation. It is also possible to change cell settings like 'end of charge voltage', 'trickle charge voltage', etc as per user requirements.

For lead acid cell chemistry, there can be 1 / 2 / 3 / 4 batteries of 12V nominal rating (six 2V cells each) in the battery bank. For other cell chemistries, it is possible to have a programmable number of cells in the battery bank.

Main Features:

1. Maximum output current: 50A / 75A
2. Max input PV voltage for CC-MPPT-6-200 models:
    - With 12V nominal battery Bank voltage, Max allowed PV V_oc is 110V.
    - With 24V/36V/48V nominal battery Bank voltages, Max allowed PV V_oc is 175V.
3. DC Load output: DC load voltage same as battery voltage. Maximum 40A DC load current allowed
4. Power saver relay output (20A): To enable SMU (Solar Management Unit) feature to convert normal inverter into solar inverter.

CC-MPPT-6 tracks the maximum power point dynamically to extract the maximum possible power from the solar panels. A five-stage battery charging algorithm (Deep discharge, Bulk, Absorption, Trickle, and Equalization charge) is implemented which can charge the battery with precise current and voltage to achieve fast battery charging while ensuring long battery life.

Special charging mode for Lithium-ion batteries:

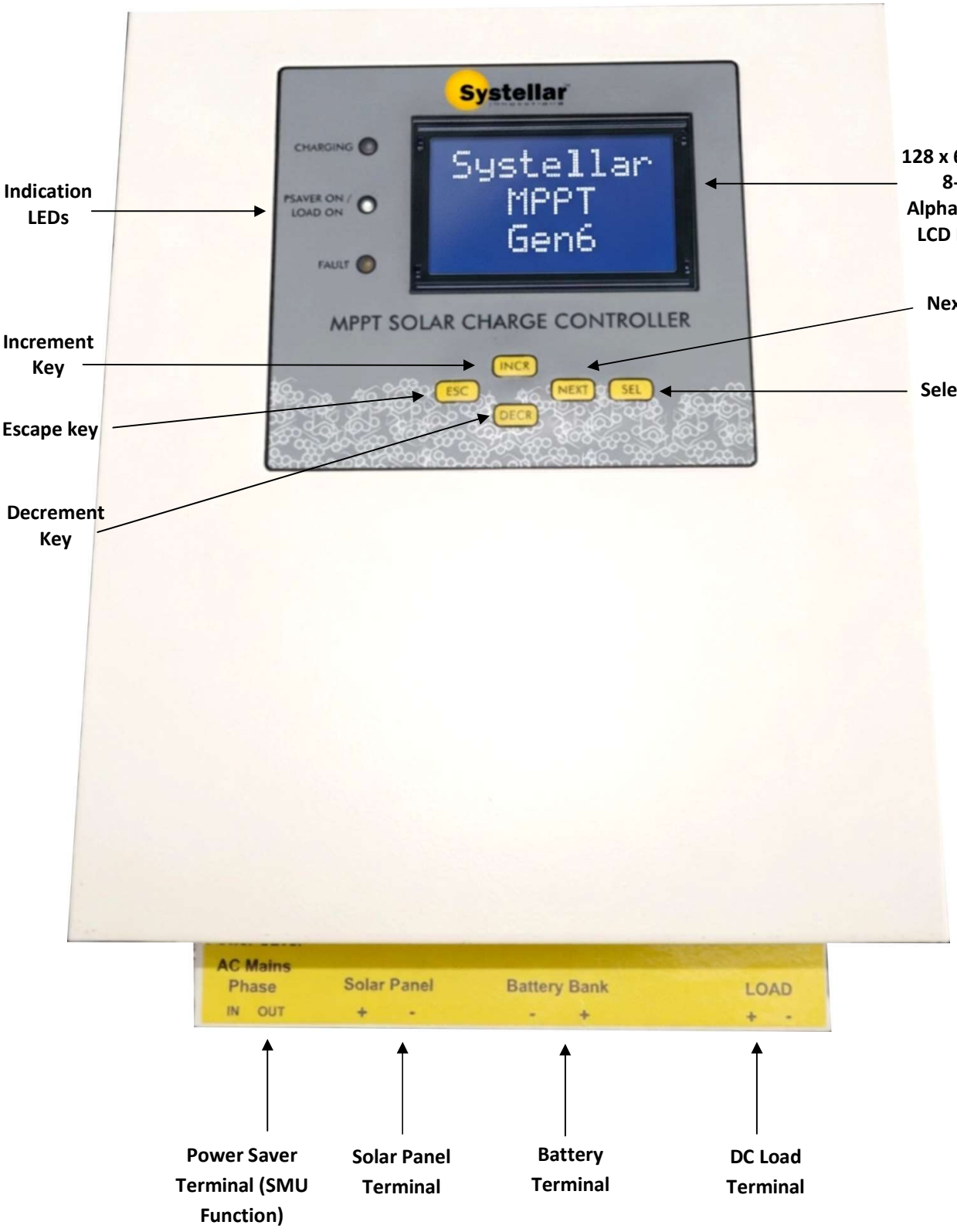
The deep discharge charging stage is only for Lithium-ion batteries to bring them out of the deep discharge state without damaging them. In this stage, the charging current is limited to 30% of the maximum current.

An equalizing charge for lead-acid batteries:

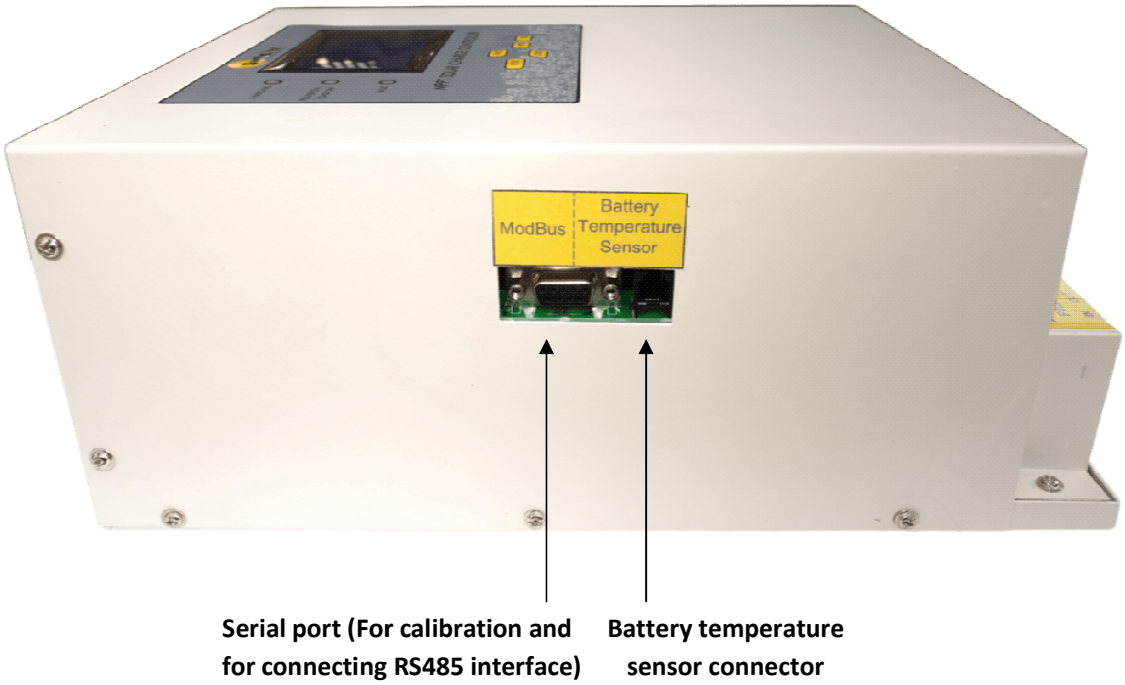
Lead-acid batteries may be put in an equalizing charging stage periodically (Either automatically after a pre-programmed number of days or manually).

This User Manual describes the installation and Operation of this Solar Charge Controller in detail. Please read this manual carefully before installing and operating the charge controller.

Front View



Side View



Installing the Charge Controller

1. Install the Charge Controller indoors near the battery bank at eye level. This will make it easy to read the LCD and make any changes in the settings.
2. The minimum cable cross-section for different models should be as under:
    a. 50 A 10 square mm
    b. 75 A 16 square mm
3. It is better to use a smaller length and thicker battery cable to reduce voltage drop and power loss in the cable (No compensation for voltage drop in the battery cables is provided in the software i.e. the voltages shown on the display are the voltages on the charge controller connectors). First, connect the battery cable to the charge controller. Check that the display starts working. Observe correct polarity while connecting wires from the battery. If battery wires are connected in the wrong polarity, a red LED indicator near the battery connections will light up and the display will not turn on. Correct the polarity before proceeding further. As soon as the battery cables are connected in the correct polarity, the LCD display will turn on.
4. When the battery is connected for the first time, the charge controller assumes that the battery chemistry is lead-acid (FLA). The battery nominal voltage is estimated from the voltage sensed at the battery terminal. This information is presented to the user for confirmation. Press SEL for a short duration to confirm it. In case it is not correct, the user should enter the battery configuration-editing mode by pressing the NEXT key. Set the

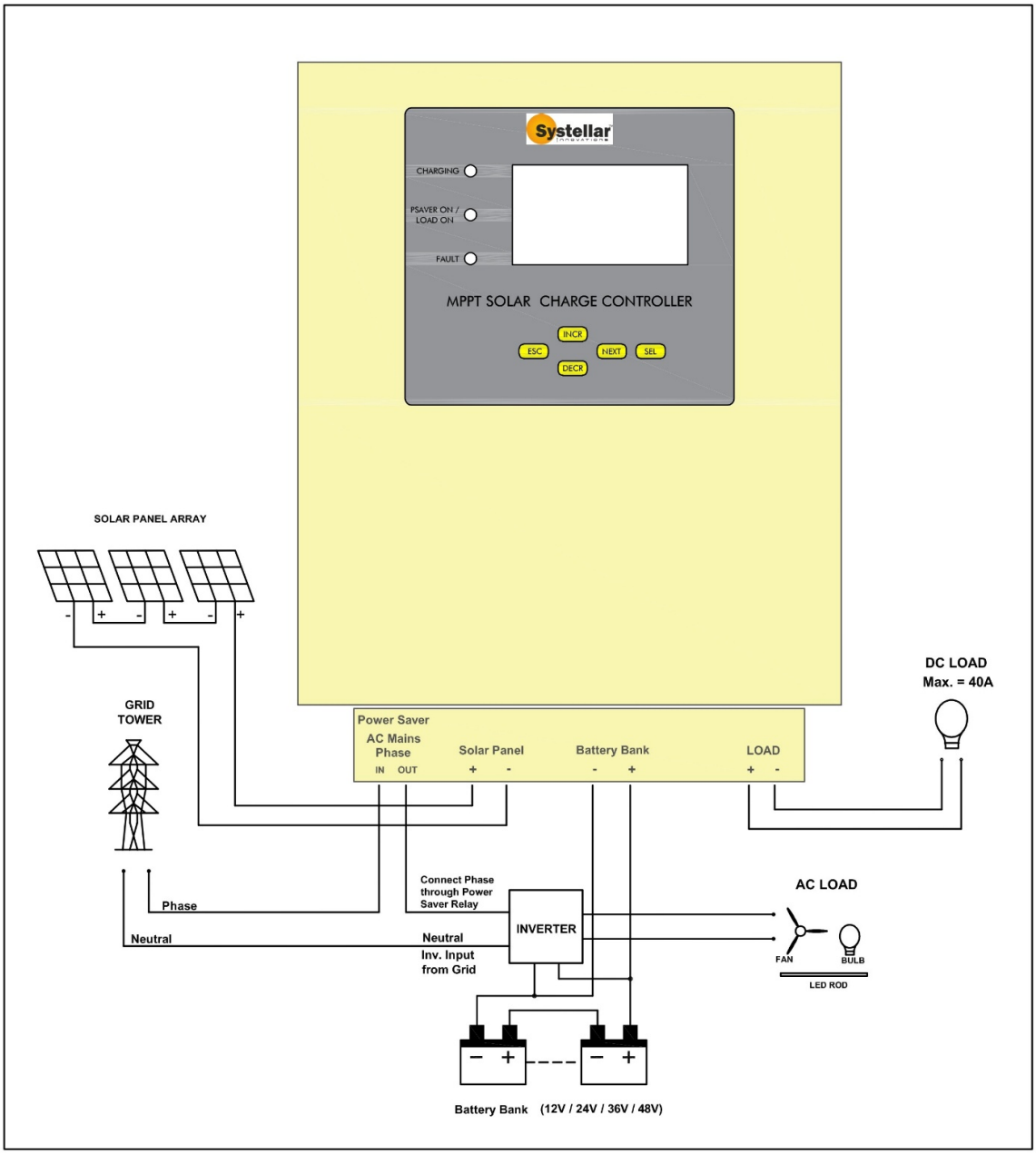
battery chemistry. If the battery chemistry is Lead-Acid, it is assumed that the battery bank consists of 1 / 2 / 3 / 4 batteries of 12V nominal voltage (Six cells of 2V nominal voltage). For other battery chemistries, the user has to enter the number of cells in the battery bank.

5. Check the open circuit voltage of the solar panels. The maximum solar panel voltage should 175 volts for MPPT-Gen6-200 model.
   *** **Note:** Connecting higher solar panel voltage to the charge controller may damage it and will void warranty coverage.
6. Connect the solar panel to the charge controller in the correct polarity. If solar panel wires are connected in reverse polarity, the PV reverse polarity LED will glow, the display will keep showing 'Night' and the charging will not take place.
   ***Note:** When the solar panel is connected in reverse, it is shorted through an internal protection diode and considerable heat may be generated in the charge controller. Do not let it remain connected in this condition for long.
7. Once solar panel connections have been made in the correct polarity, if it is daytime, the display will show 'Dawn VF' for approx. 5sec and will then start charging the battery.
   CAUTION: If the solar panel voltage is above 60 volts, take care not to touch the solar panel cable ends with a bare hand. It may give an electric shock.

Power Saver

This feature is for converting a normal inverter into solar inverter

In systems with an inverter, during the day when abundant sunlight is available, we do not want to use the mains power for the AC load at the inverter output or for charging the batteries. The power saver has a relay, which cuts the mains power to the inverter during the day. CC-MPPT-6 has the power saver relay inside the charge controller itself. The relay capacity is 250V AC, 20A that is sufficient for a 4KW load. Power saver connections are given on the next page.



Power Saver Connection Diagram

Common and the N/C contacts of the relay are available on a terminal block. N wire of the mains is to be connected directly to the inverter and the phase connection goes through the power saver relay contacts. When the power saver relay is on (Battery voltage above the '**power saver on threshold**' voltage), the phase connection is cut off from the inverter. This will ensure that only solar power is used to power the load and charge the battery. When the battery voltage falls below the '**power saver-off threshold**' voltage, the relay is turned off and the phase connection is also connected to the inverter. Now the battery connected to the inverter is charged from the main supply also.

For inverters that draw more than 20A current from the mains, the user should use an external power saver relay of the appropriate rating.

LED Indication:

CC-MPPT-6 has the following LED indicators:

S No	LED	Condition	Indication
1	Green	Night	Off
		Charging with current < 5A	One 100 msec blink at 2-second interval
		Charging current > 5 Amp	Two 100 msec blinks at 2 seconds interval
		Fully charged battery	(When the battery has attained the end of charge voltage and has gone to the Absorption stage / Trickle stage) Solid on
2	Red	Status OK	Off
		Battery discharged	One 100 msec blink at 2-second interval
		Overload (DC Load current exceeded 40A)	Two 100 msec blinks at a 2-second interval. (The system will try to turn on the load again after 1 minute)
		Battery voltage too high	Three 100 msec blinks at a 2-second interval
		PV voltage too high	Four 100 msec blinks at a 2-second interval
		Charge controller fault	Solid on

LCD Display Messages

CC-MPPT-6 has a 22 char x 8 row alphanumeric LCD display which displays the entire charging status without any interruption. The following information is displayed on the LCD:

Row	Display
1	Charging status
2	Charging stage
3	Battery bank voltage and charging current
4	Solar Panel voltage, Solar Panel current, and Solar Panel power
5	Energy harvested today and the total energy harvested till date

6	Battery and heat sink temperature
7	DC Load on/off status, Power Saver on/off status
8	Status messages

During power on, programming parameters, etc appropriate messages are displayed to guide the user.

Setting programmable parameters using keyboard commands

It is possible to enter programmable parameters mode using the front panel keys and the LCD.

To enter the menu, press the SELECT key on the front panel for more than 1 second.

CC-MPPT-6 Top level menu

The following menu is displayed with one of the choices highlighted. Pressing **SEL** selects that choice. Pressing **NEXT** highlights, the next choice.

S No	Menu choice	Action
1	Enter Prog Mode?	Press **SEL** to Enter Programming parameters mode. Press **NEXT** to go to the next menu choice.
2	Restart System?	Press **SEL** to Restart the system. Press **NEXT** to go to the next menu choice.
3	Restore Factory Setting?	Press **SEL** to reset edited programmable parameters (If any) and restart the system with default factory setting. Press **NEXT** to go to the next menu choice.
The following menu option is displayed only if the battery is lead-acid type		
4	Set Equalize Chg?	If the user wants that after achieving the end of charge voltage, the battery should keep getting charged to 'Equalize charge voltage', press **SEL**. Now equalization stage is set. Press **NEXT** to go to the first menu choice.
	Reset Equalize Chg?	If the Equalize charge is already set and the user does not want to equalize charge the battery, then Press **SEL** to reset the Equalize charge stage. Press **NEXT** to go to the first menu choice.

Programming Mode

Pressing **SEL** when the "Enter Prog Mode?" message is being highlighted will take you to the "Programming parameters mode" menu:

CC-MPPT-6 Prog level Menu

S No	Menu choice	Action
1	Edit Batt bank Config?	Press **SEL** to Edit battery bank parameters. Press **NEXT** to go to the next menu choice.
2	Edit Cell Settings?	Press **SEL** to Edit selected battery bank cell settings. Press **NEXT** to go to the next menu choice.
3	Edit Prog Parms?	Press **SEL** to Edit programmable parameters. Press **NEXT** to go to the first menu choice.

Battery Bank Configurations Editing

Pressing **SEL** when the "Edit Batt bank Config?" message is being displayed will take you to the 'Battery bank configuration' menu:

1. Battery Chemistry
    a. Lead-acid FLA
    b. Lead-acid SMF
    c. Lead-acid GEL
    d. Lead-acid Tubular
    e. Li-ion
    f. LiFePO4
    g. NiCad

If the battery chemistry is lead acid, you can choose a nominal battery voltage from 12V / 24V / 36V / 48V. For other battery chemistries, you can specify the number of cells in the battery.

Cell Settings

Pressing **SEL** when the "Edit Cell Settings?" message is being displayed will take you to the 'Cell settings' menu:

1. Battery end of charge voltage (end of Bulk charge stage, start of absorption charge stage).
2. Battery absorption charge stage period.
3. Battery trickle charge voltage (The voltage at which the battery voltage should be maintained after the end of the absorption charge stage)
4. Battery re-bulk voltage (If the battery voltage goes below this voltage, the charge controller will again go to the Bulk charging stage).
5. Battery Low cut enter voltage (If battery voltage goes below this voltage, the charge controller will display battery discharged fault)
6. Battery Equalize charge voltage (If the battery voltage goes above this voltage, the charge controller will go to the equalize charging Stage)
7. Equalizing charge interval (Only for lead-acid battery)

8. Temp Coefficient for selected Battery type (This is useful to calculate Battery bank EOC (Enf Of Charge) voltage as per the temperature variation)
9. Power saver turn-on threshold (Power saver will turn on if the battery voltage is above this value)
10. Power saver turn-off threshold (Power saver will turn off if the battery voltage is above this.

Programmable Parameters

Pressing **SEL** when the "Edit Prog Parms?" message is being displayed will take you to the 'Program Parameters' menu where the following programmable parameters can be set

1. Maximum charging current:
    a. Users can modify the maximum charge current as per the chosen model.
    b. For the 50Amp Model, It can be set in between 5 to 50 Amps.
    c. For the 75Amp Model, it can be set in between 5 to 75 Amps.
2. DC Load Ctrl code (LCC):
    a. Users can also modify the DC Load on/off timings by setting the Load ctrl code from 0 to 14.
    b. If LCC is 0: The load will always be on.
    c. If LCC is 1: The load will turn on at Night and turn off during the day.
    d. If LCC is 2-14: Load will turn on at Night for 2-14 hrs and turn off in the Day.

Notes (Also applicable for editing of cell settings & programmable parameters):

1. To choose an option, press **SEL**. To change the value on the screen press **INCR** / **DECR**. To go to the next option, press **NEXT**. To go to the previous menu level press **ESC**. If **ESC** is pressed when the run level menu is being displayed, then it comes out of the running menu.
2. Press **INCR** to increase the displayed value, and **DECR** to decrease the displayed value.
3. Pressing **INCR** or **DECR** continuously makes the displayed parameter increment/decrement automatically till its limit.
4. All voltages concern the complete battery bank voltage.
5. The programmable parameters are stored in non-volatile memory inside the Charge controller. Even if the battery connections are removed, the values of programmed parameters are retained.

Equalizing Charging

It is useful to "overcharge" the Lead Acid battery bank for a limited period once every 15 days or a month or so. This is especially helpful when several batteries are connected in series (like 24V, 36V, and 48V battery bank). It helps in equalizing the charge in all the cells of the battery bank by bringing them to full charge. The electrolyte in the batteries is also homogenized by agitation during gassing at the time of "overcharge".

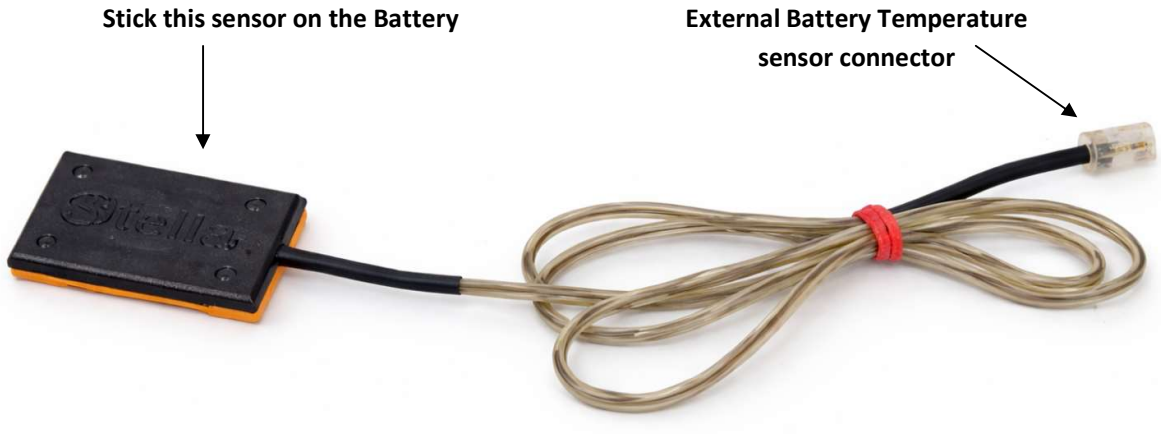
In the Systellar CC-MPPT-6 charge controller, pressing **SEL** when "**Equalize charge now?**" is displayed will set the Equalization charging stage. In case the Equalize charging stage is already set, it will be reset. The equalization charging stage will remain set till the CC can take the battery to

equalize voltage and keep it there for an equalizing time. **It is possible to automatically equalize the battery bank after a set number of days**. For this set equalizing interval from 1 to 60 days. The default value is 15 i.e. battery bank will be put to equalizing charge every 15th day. If the Equalizing interval is set to 0, then equalizing is not done automatically and the user may set equalizing stage manually.

Note that when the equalization stage is set, it does not go to the equalization charging stage immediately. Equalization charging is the last leg of battery charging. In the equalizing charging stage, instead of stopping the battery voltage at the "end of charge" voltage, the system will allow the battery to go up to "Equalizing Charge voltage" and it will maintain it there for Equalizing time a period of Default 60 minutes as programmed in programmable parameters. Once this period is over, the battery will go into the "Trickle charging stage" and the equalizing stage will be automatically reset. When Equalizing charging is activated, if the battery bank voltage does not reach Equalizing voltage, the Equalizing charge stage will carry over to the next day.

Optional Accessories

1. Battery Temperature sensor



External Battery Temperature Sensor

The battery temperature sensor is supplied as an accessory. Paste the temperature sensor on the battery side using double-sided tape. Insert the 4-pin RJ11 connector at the end of the temperature sensor cable in the Battery temperature sensor slot provided on the left side of the charge controller.

Troubleshooting:

S No.	Symptoms	Remedy
1	Display is off	• Check the battery connection and polarity. • Battery voltage below 9.2V may not power up the unit
2	Not producing expected power	• Check PV connections. • Check PV conditions like dirty panels/clouds / partial shading/panel very hot. • Connect an ammeter across PV panel connections to check the short circuit current. • Check Max charging current setting. • Check that the battery is not in the Absorption or trickle charge stage
3	Not equalizing	• Not sufficient solar power to take the battery to equalize voltage for an equalizing time • High load on battery so that sufficient charging current is not available to the battery
4	Always in Night mode	• Check PV connections • Check the PV voltage. It should be more than the battery bank voltage by 'Min Wakeup voltage'
5	LCD scrambled	• Press NEXT key
6	Any other error	• Call the dealer from whom the purchased / Systellar Innovations helpline +91 121 434 2043. Keep the Model name and product serial number handy.

Ordering information:

Product model code:

CC – MPPT - 6 - 200V - 12/24/36/48V - 75A - L1 – PS1
(Basic model name)

Max. PV voltage----------
Maximum charging current ----------
DC Load output: (Available) ----------
Power saver relay (Available) ----------

Standard models are:

1. CC – MPPT - 6 - 200V – 12/24/36/48V - 75A - L1 – PS1
2. CC – MPPT - 6 - 200V – 12/24/36/48V - 50A - L1 – PS1

Systellar MPPT Solar Charge Controller

CC-MPPT-Gen6

Detailed Technical specifications

<table>
<tr><th>S No</th><th>Item</th><th colspan="2">Description</th></tr>
<tr><td>1.</td><td>Battery voltage range</td><td colspan="2">200V model: 12/24/36/48V (nominal) Field programmable
(For Lead-acid batteries, number of 12V batteries can be specified. For other chemistries number of cells in the battery bank may be specified)
The maximum end-of-charge voltage for the battery bank can be up to 60V.</td></tr>
<tr><td>2.</td><td>Maximum V_oc (open circuit solar panel voltage)</td><td colspan="2">110V for 200V model if Selected battery bank nominal Voltage is 12V.
175V for 200V model if Selected battery bank nominal Voltages are 24/36/48V.</td></tr>
<tr><td>3.</td><td>Cell chemistries supported</td><td colspan="2">• Lead-Acid (SMF / FLA / Tubular / Gel)
• Li-ion
• LiFePO4
• Ni-Cd</td></tr>
<tr><td rowspan="9">4.</td><td rowspan="9">Maximum allowed solar panel capacity</td><td>Nominal Battery bank voltage</td><td>Max. Solar panel capacity</td></tr>
<tr><td>12V-50Amp</td><td>800 Wp</td></tr>
<tr><td>12V-75Amp</td><td>1200 Wp</td></tr>
<tr><td>24V-50Amp</td><td>1600 Wp</td></tr>
<tr><td>24V-75Amp</td><td>2400 Wp</td></tr>
<tr><td>36V-50Amp</td><td>2400 Wp</td></tr>
<tr><td>36V-75Amp</td><td>3600 Wp</td></tr>
<tr><td>48V-50Amp</td><td>3200 Wp</td></tr>
<tr><td>48V-75Amp</td><td>4800 Wp</td></tr>
<tr><td>5.</td><td>Load output</td><td colspan="2">DC output is equal to the battery voltage.
Maximum current: 40A</td></tr>
<tr><td>6.</td><td>Display:</td><td colspan="2">128x64 pixel back-lit graphic display which can display 8 rows of about 22 characters each for display of running parameters during operation and for programming various programmable parameters</td></tr>
<tr><td>7.</td><td>Keyboard</td><td colspan="2">5 Keys (INCR, DECR, NEXT, ESC & SEL) keyboard is provided on the front panel to view / program various parameters</td></tr>
</table>

8.	LED indicators	Green – The following indications are displayed:
		• Low charging (< 5A):
		  • Single 100ms Blink after every 2sec
		• High charging (> 5A):
		  • Double 100ms Blink after every 2sec
		• Battery fully charged:
		  • Solid ON
		Blue – User can control the LED blue indication mode (Either 0 or 1) by setting it through Keyboard.
		• 0: Led Blue displays status of Power Saver on/off
		• 1: Led Blue displays status of DC load on/off
		
		Red – The following faults are displayed:
		• Battery discharged (Load is disconnected):
		  ➢ Single 100ms Blink after every 2sec
		• Overload (Load is disconnected) :
		  ➢ Two 100ms Blink after every 2sec
		• Battery voltage too high (It can happen if an external charger is connected on the battery bank, Charging through CC-MPPT-Gen6 stops and the load is disconnected):
		  ➢ Three 100ms Blink after every 2sec
		• PV input too high (Charging is stopped):
		  ➢ Four 100ms blink after every 2sec

9.	User-programmable charging parameters	Using the above LCD display & keyboard, the following charging and other operational parameters can be programmed by the user. ● Battery end of charge voltage: End of Bulk charge stage, start of absorption charge stage. ● Battery absorption charge stage period ● Battery trickle charge voltage: The voltage at which the battery voltage should be maintained after the end of the absorption charge stage ● Battery re-bulk voltage: If the battery voltage goes below this voltage, the charge controller will again go to the Bulk charging stage. ● Battery Low cut enter voltage: If the battery voltage goes below this voltage, the charge controller will display battery discharged fault. ■ The minimum Low cut enter voltage for the battery bank must be equal to or greater than 10.0V for the below Cell types: * Lead Acid (SMF / FLA / Tubular / Gel) * LiFePO4 , * Li-ion , * Ni-Cd ■ (Battery Low cut exit voltage is equal to the

nominal battery bank voltage.)

- Battery Equalize charge voltage:
  - If the battery voltage goes above this voltage, the charge controller will go to the equalized charging Stage. Only for LA battery
- Equalizing charge interval (Only for LA battery)
- Temp Coefficient for selected Battery type:
  - Battery bank EOC voltage, trickle charge voltage and the equalization charge voltage is adjusted as per the Temp Coefficient and the sensed battery temperature.
- Power saver turn-on threshold:

  Power saver will turn on if the battery voltage is above this value. (When the power saver is ON, the mains supply to the inverter is cut-off and only the charge controller charges the battery).
- Power saver turn-off threshold:
  - The power saver will turn OFF if the battery voltage is above this voltage. (When the power saver is OFF, the mains supply to the inverter is connected and both the inverter and the charge controller charge the battery).
- Maximum charging current:
  - Users can modify the maximum charge current (Mainly to protect small capacity batteries).
  - For the 50Amp Model, It can be set in between 5 to 50 Amps.
  - For the 75Amp Model, it can be set in between 5 to 75 Amps.
- Load Ctrl code:
  - Users can turn on/off load as per their requirements

Load Control Code	Function
0	Load always on
1	Load on dusk to dawn
2 – 14	Load on for so many hours after dusk
- Led Blue indicator mode: User can adjust Led Blue indication as per their requirements. There are two Led Blue Indicator modes:
  - 0: Led Blue Display Power saver on/off status
  - 1: Led Blue Display DC Load on/off status

10.	5-stage charging for maximum battery care:	1. Deep discharge mode charging (For Li-ion battery only)
		2. Bulk mode charging,
		3. Absorption mode charging,
		4. Trickle mode charging,
		5. Equalizing Charging (For lead-acid batteries only) Programmable Equalizing charging mode interval to periodically equalize charge all batteries in the battery bank
11.	Temperature compensation of charging thresholds	With optional battery temperature sensor (For lead-acid batteries only)
12.	Heat sink temperature sense	Built-in heat sink temperature sensor stops charging in case of overheating of the heat sink
13.	Power saver relay	Built-in power saver relay. Common and N/C contacts are available for the connection of the input AC mains to the inverter. Relay capacity 250V AC 20A
14.	Idle current from the battery	Max: 60 mA
15.	Technology	Triple Interleaved Synchronous Buck Converters
16.	Microcontroller	ARM-based 32-bit advanced microcontroller
17.	Optional accessories:	
	1	Battery temperature sensor with 2 M cable
	2	RS-485 adapter card for transferring data over MODBUS (RTU protocol). (Requires special MODBUS firmware).

The above User Manual and Technical Specifications are for firmware version 2.00 onwards.

* For continuous product improvement, product specifications can change without notice.

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