



User's Manual

High Voltage MPPT Solar Charge Controller

CC-MPPT-HV-50

Systellar Innovations

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Introduction

Congratulations! You are the proud owner of one of the best MPPT charge controllers available in the market. CC-MPPT-HV series charge controllers are a range of high voltage MPPT solar charge controllers introduced by Systellar Innovations in the market after the spectacular success of other PWM and MPPT Solar Charge Controllers.

These Charge Controllers can work with Solar Photo Voltaic Panels with wide power and voltage ranges and offer a lot of advanced features for user convenience.

Salient Features:

Feature	Description
Works on High PV side voltage	Up to 750 volts open circuit solar panel voltage (V _{oc}).
Load output	A separate load output is provided where a DC load (typically inverter) up to 70A can be connected.
Prevention of excessive charging current to battery bank by sensing inverter load / charging current	This is a unique feature to sense inverter current to avoid charging the battery bank with excessive current. This allows a full 50 Amp from the solar panels if the inverter is in backup mode and is drawing current from the battery bank. However, if there is no load on the inverter, then the battery bank charging current is limited to say 20 Amp (programmable from 5A to 50A) by restricting the power output of the charge controller. Also in case the inverter is charging the battery bank, the output current from CC-MPPT-HV-50 will be appropriately reduced to prevent excessive battery bank current.
4-stage charging for maximum battery bank life	• Bulk mode charging. • Absorption mode charging (applicable only for LA battery bank). • Trickle mode charging. • Equalize Charging (applicable only for LA battery bank) — Equalize charging mode interval is user-programmable to periodically equalize charge in all battery bank cells in the battery bank.
Temperature compensation of all charging voltages	An external battery bank temperature sensor is supplied as a standard accessory for accurately measuring battery bank temperature.
User-programmable charging parameters	A whole range of charging and other operational parameters can be programmed by the user using the front panel keyboard and LCD.
Display	A large 24 char x 8 lines backlight LCD.
Keys	5 Keys (ESC, INCR, DECR, NEXT, SEL) are provided on the front panel to view / program various parameters.
Power Saver relay drive output	For driving a 12V relay of the Power Saver Accessory. This accessory disconnects Mains power to the Inverter during the daytime in case the battery bank is fully charged and automatically re-connects the mains at around 4 PM.
Fault indication relay	Potential free N/O and N/C contacts for connecting to an external alarm (Not Implemented).
Protections	Fuse protection (100A HRC fuse) on battery bank connection. Reverse PV connection protection, reverse current (from the battery bank to solar panels) flow protection during the night, battery bank overcharging & deep discharging protection, lightning protection.
Battery bank soft connect switch	A switch is provided which eliminates any sparking while inserting the battery bank fuse.
Optional accessories	Power saver relay (for 4KVA or 15 KVA Inverter) with control cable.

At present Systellar Innovations offers CC-MPPT-HV series charge controllers in the following models:

MODEL	Nominal Battery bank Voltage (user selectable)
CC-MPPT-HV-50-4872	48 / 72V
CC-MPPT-HV-50-96240	96 / 120 / 144 / 180 / 192 / 240V

This User Manual describes the installation and operation of both these models in detail. Please read this manual carefully before installing and operating the charge controller.

Product Description



Front View

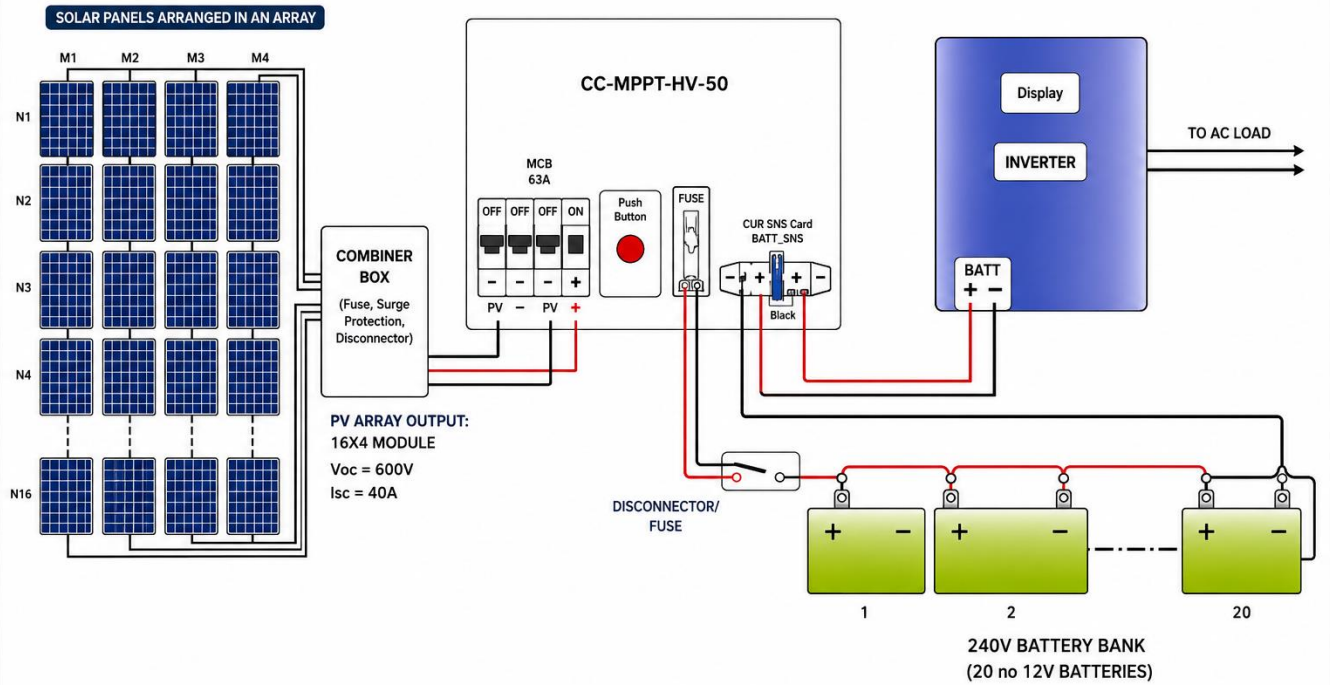


Inside Connection Panel View

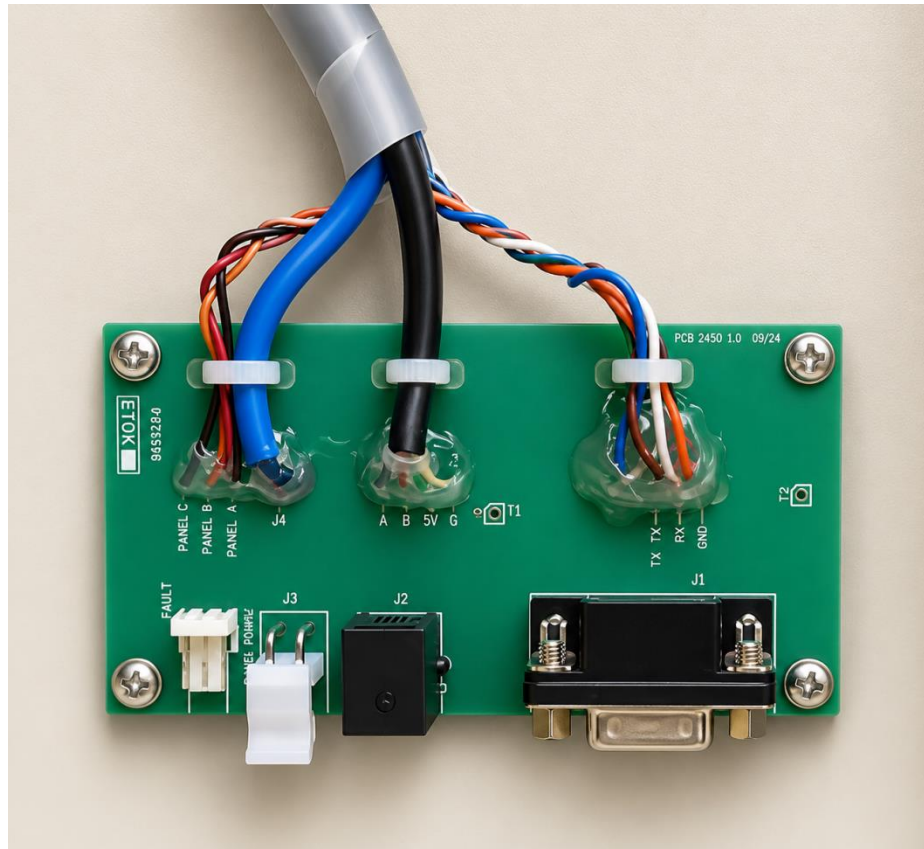
CONNECTION DIAGRAM

CC_MPPT_HV_50A_96240

With 240V Battery Bank



Connection Diagram — CC-MPPT-HV-50-96240 with 240V battery bank



Accessories connection panel (inside the cabinet on the right side of the main connection panel)

Recommended Number of Solar Panels for Each Battery Bank Voltage

The following table specifies the recommended solar panel configuration for 540Wp solar panels with 72 cells per panel. This table has been made to deliver 50A output charging current on a sunny day while keeping the maximum allowed V_{oc} to the Charge Controller in view.

Assumptions: Solar panel capacity: 540 Wp • Solar panel V_{oc} : 50 V • Expected SP Output: 70% of SPP capacity • Charge controller Efficiency: 95%

Sno.	Batt bank nominal voltage (V) LA	LiFePO4	End of charge (V) LA	LiFePO4	No. of panels	Strings in parallel	N per string	SPP array V_{oc} (V)	Total Wp	Output Power (W) / I_{cc_out} (A)
1	48	48	57.6	53.25	8	1	8	400	4,320	2,873 / 50
2	72	72	86.4	79.88	12	1	12	600	6,480	4,309 / 50
3	96	96	115.2	106.50	16	2	8	400	8,640	5,746 / 50
4	120	120	144.0	133.13	20	2	10	500	10,800	7,182 / 50
5	144	144	172.8	159.75	24	2	12	600	12,960	8,618 / 50
6	180	180	216.0	199.69	30	2	15	750	16,200	10,773 / 50
7	192	192	230.4	213.00	33	3	11	550	17,820	11,850 / 51
8	240	240	288.0	266.25	42	3	14	700	22,680	15,082 / 52
9	—	243.2	—	269.80	42	3	14	700	22,680	15,082 / 52

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 settings.
2. Earth the body of the charge controller before installation.
3. Check that the Battery bank negative terminal is properly earthed.
4. Check that all strings of solar panels are floating around Earth. This can be done by disconnecting the strings at both ends and measuring the voltage between each end of the string with respect to the earth. These voltages should be much less (about 1/10 of the string voltage).
5. Use 5m long 16 mm sq. copper cables for connecting the battery bank to the charge controller. First, connect the battery bank cable to the battery bank terminals then proceed as under.
6. **CAUTION: DANGEROUSLY HIGH VOLTAGES ARE PRESENT ON BATTERY BANKS AND SOLAR PANEL. ONLY TRAINED TECHNICIANS WITH DUE PRECAUTIONS SHOULD HANDLE THE CONNECTIONS.** Solar panel combiner box normally has a disconnecter. **KEEP IT IN OFF POSITION WHEN CONNECTIONS ARE BEING MADE. IT IS**

STRONGLY ADVISED TO HAVE TWO ADDITIONAL DISCONNECTORS (ONE EACH ON THE CC OUTPUT LINE AND INPUT LINE TO THE INVERTER) ON THE BATTERY BANK. KEEP THESE DISCONNECTORS IN DISCONNECTED STATE WHILE MAKING THE CONNECTIONS. Note that two disconnectors are necessary to ensure that inverter battery bank input connections always come directly from the battery bank terminals and never from the cc output alone.

7. Keep CC-MPPT-HV-50 Solar panel MCB in the off position. Remove the top portion of the battery bank fuse Kit Kat. Make all connections as per the connections diagram using at least 16 sq mm cable. Use Red for the positive line and black for the negative line. **CAUTION: MAKE ALL CONNECTIONS EXACTLY AS SHOWN IN THE CONNECTIONS DIAGRAM.**
8. **DOUBLE-CHECK THE POLARITY OF THE BATTERY BANK.**
9. Press 'Soft Start Switch' in the charge controller. A red light will glow on the soft start switch box and the display will turn on with a beep. **IN CASE THE LCD DISPLAY DOES NOT TURN ON WITH A BEEP, STOP, RELEASE THE SOFT START PUSH BUTTON AND CHECK BATTERY BANK POLARITY AGAIN.**
10. If the LCD turns on with a beep, keep the 'Soft Start Switch' pressed. The red LED on the Soft Start Switch Box will slowly turn off. Now insert the 100A fuse kit-kat top portion and release the 'Soft Start Switch'. This process ensures that there is no spark when a high-voltage and high capacity battery bank is suddenly connected to the discharged capacitor in the Charge controller.
11. When the battery bank is connected for the first time, the battery bank nominal voltage (one of the standard battery bank voltages mentioned in the solar panel table of this manual) is estimated from the voltage sensed at the battery bank terminal and presented to the user for confirmation on LCD. In case it is not correct the user may press the INCR / DECR buttons to correct it before pressing the SEL button.
12. Check the open circuit voltage of the solar panels. The maximum solar panel voltage should be less than 750 volts DC. **Note: Connecting higher solar panel voltage to the charge controller may damage it and will void warranty coverage.** Turn on Solar Panel MCB after properly making the connections.
13. If solar panel wires are connected in reverse polarity, the display will keep showing 'Night' and charging will not take place. Once solar panel connections are made in the correct polarity, if it is daytime, the display will show 'Dawn', then 'Waking up', and will then start charging the battery bank.
14. Connect the Temperature sensor to the side panel accessory connection panel and stick it with a double-sided tape on one of the batteries of the battery bank.
15. Whenever the user disconnects the battery bank from the CC and reconnects it, the Prog Params will be reset to their default values.

Charging Stages

CC-MPPT-HV-50 charge controller charges the battery bank in the following charging stages:

1. **Bulk Charging:** In this mode, the battery bank is charged with all the available power from the solar panel till the battery bank voltage reaches the 'End of charge' voltage set in programmable parameters. However, the battery bank charging current is limited to the 'Max Chg Cur' set in the programmable parameters.
2. **Absorption Charging:** (Applicable only for LA battery bank) The battery bank voltage is maintained at the 'End of charge' voltage for 'Absorption time'.
3. **Trickle Charging:** The battery bank voltage is maintained at 'Trickle voltage'.
4. **Equalize Charging:** (Applicable only for LA battery bank) It is useful to "overcharge" the Lead-acid battery bank for a limited period once every 15 days or a month or so. 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 Equalize charging.

In the Systellar CC-MPPT-HV-50 charge controller, for LA battery bank pressing **SEL** when "**Eq chg now?**" is displayed will set Equalize charging mode. In case the Equalize charging mode is already set, it will be reset. Equalize charging mode will remain set till the CC can take the battery bank 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 90 days. The default value is 30 i.e. battery bank will be put to equalizing charge every 30th day. If the Equalizing interval is set to 0, then equalizing is not done automatically and the user may set equalizing mode manually.

Note that when equalization mode is set, it does not go to equalization charging mode immediately. Equalization charging is the last leg of battery bank charging. In equalizing charging mode, instead of stopping the battery bank voltage at the "end of charge" voltage, the system will allow the battery bank to go up to "Equalizing Charge voltage" and it will maintain it there for Equalizing time (0 – 240 minutes (Default is 60 minutes)) as programmed in programmable parameters. Once this period is over, the battery bank will go into "Trickle charging mode" and equalizing mode will be automatically reset. When Equalizing charging is activated, if the battery bank voltage does not reach Equalizing voltage, Equalizing charge mode will carry over to the next day.

LED Indication

CC-MPPT-HV-50 has a green LED that indicates the charging status of the battery bank.

Condition	Indication
Night	One 50 msec blink at 2-second interval
Bulk charging mode (Charging current > 3 Amp)	Two 100 msec blinks with a gap of 200 msec after every 2 seconds
Absorption/Trickle Charging Mode (Battery bank fully charged)	Solid on

Beeper Indication

Condition	Indication
When the battery bank is first connected	One long (500 msec) beep
If a key is pressed which is not valid in the context or when the Menu options rollover from the last option to the first option	One short (100 msec) beep
While adjusting values in programming mode, if we try to go beyond allowed limits and exit from programming mode	One medium (250 msec) beep
Fault condition	Three medium (200 msec) beeps at 500 msec intervals
System Hardware Fault	Continuous long (500 msec) beeps at 1-second intervals with blank LCD

LCD Display Messages

CC-MPPT-HV-50 has a large 24 Char x 8 line liquid crystal display (LCD). During operation, the large display allows all operating parameters to be displayed simultaneously. This is a big convenience for the user.

Display messages during the day while charging the battery bank

Line	Description	Example
1	Displays the CC Mode of operation	MPPT Bulk Charging
2	Shows the PV voltage, PV Current & the power drawn from the solar panels. At the start of the day shows the state like Dawn / Waking up etc.	PV: 459V 20A 9180W
3	Shows Charge controller output current	CC Output curr: 35A
4	Shows the battery bank voltage & current (Charging / Discharging)	Batt: 252V Chg: 7A
5	Displays Inverter load (Inv Load) or charging current (Inv Chg) from inverter	Inv load: 28A
6	Shows the energy generated Today and the Total alternatively	Today: 15.45 KWHr
7	Shows Battery bank and Heat sink temperatures	Batt : 37 HS: 62 deg C
8	Shows Power Saver status	Power Saver: On

Display messages during the night

Line	Description	Example
1	Displays the status of the charge controller	Status OK
2	Night and the period since nightfall. After remaining in NIGHT mode for 30 minutes, it goes to SLEEP mode when it starts displaying 'Sleeping...'	Night 9:30M
3	Blank	
4	Shows the battery bank voltage & current (Charging / Discharging)	Batt: 252.5V Dischg:22A
5	Displays Inverter load (Inv Load) or charging current (Inv Chg) from inverter	Inv load: 22 A
6	Shows the energy generated Today and the Total alternatively	Total: 645.30 KWHr
7	Shows battery bank and heat sink temperatures	Batt : 32 HS:34 deg C
8	Shows Power Saver status	Power Saver: Off

Keyboard Commands

It is possible to control CC operation using the front panel keys and the LCD. To give a command, press the SEL key on the front panel for more than 1 second. It will display the following command messages in sequence:

CC-MPPT-HV-50 Top-level Menu

S No	Menu choice	Action
1	Program parms?	Press SELECT to program parameters.
2	Eq chg now?	(Applicable for LA battery bank) Press SELECT to start the Equalize charge cycle.
3	Re-start?	Press SELECT to re-start CC-MPPT-HV-50. It displays a start-up message and starts working with the earlier selected battery bank voltage.

Pressing the **SEL** key selects the displayed option. To go to the next command/option press **NEXT**.

Programmable Parameters

Pressing **SEL** when the "Prog Parm?" message is displayed on LCD, will start the Prog Parm command. These parameters are set in a multi-level menu-driven fashion. The following is the structure of the programmable parameter menu:

Menu	Sub-option	User entry
1. Set Charging?	1. Max chg current?	Value (Amp)
	2. Select Batt Type? (Applicable only for LA battery bank)	Flat plate? / Tubular? / SMF? — Yes (SEL) / No (NEXT)
	3. Chg V I Levels (per 12V battery): 1. End of Chg	Value (Volts)
	2. Absorption time (applicable for LA battery bank)	Value (Minutes)
	3. Trickle Voltage	Value (Volts)
	4. Rebulk Voltage	Value (Volts) (Note 7)
	5. Equalize Voltage (applicable for LA battery bank)	Value (Volts)
	6. Equalizing time (applicable for LA battery bank)	Value (Minutes)
	7. Equalizing interval (applicable for LA battery bank)	Value (Days)
2. Set P Saver?	1. P Saver On Voltage	Value (Volts)
	2. P Saver Off voltage	Value (Volts)
	3. Min time Psaver off	Value (Minutes)
3. Set Wake-up?	1. Wake-up delay	Value (Minutes)

Notes:

1. To choose an option, press SEL. To go to the next option, press NEXT.
2. Press INCR to increase the displayed value, DECR to decrease the value.
3. Pressing INCR or DECR continuously makes the displayed parameter increment/decrement automatically till its limit.
4. All voltages are in reference to each 12V battery in the battery bank i.e. for a 48V battery bank (4 12V batteries in series) if the end of charge voltage is set to 14.4V, it means $14.4 \times 4 = 57.6V$ for a 48V battery bank.
5. Pressing ESC will accept the displayed value and go one step up in the menu structure. When it comes out of top level menu, the modified parameters take effect.
6. The programmable parameters are stored in non-volatile memory inside the Charge controller. Even if the battery bank connections are removed, the values of programmed parameters are retained.
7. Rebulk voltage: If the battery bank voltage falls below this value then it will go to Bulk charging Mode (End of Chg).
8. To reset all programmable parameters to their factory default values and to reset the total energy harvested KWHr value remove solar panel and battery bank fuse. Then keep the INCR and DECR keys pressed while inserting the battery bank fuse again. After a few seconds "Default Parm's Restored" message will be displayed on the LCD and all parameters as well as all the stored data will be cleared.

Standard Accessories

1. Battery bank Temperature sensor



External Battery bank Temperature Sensor

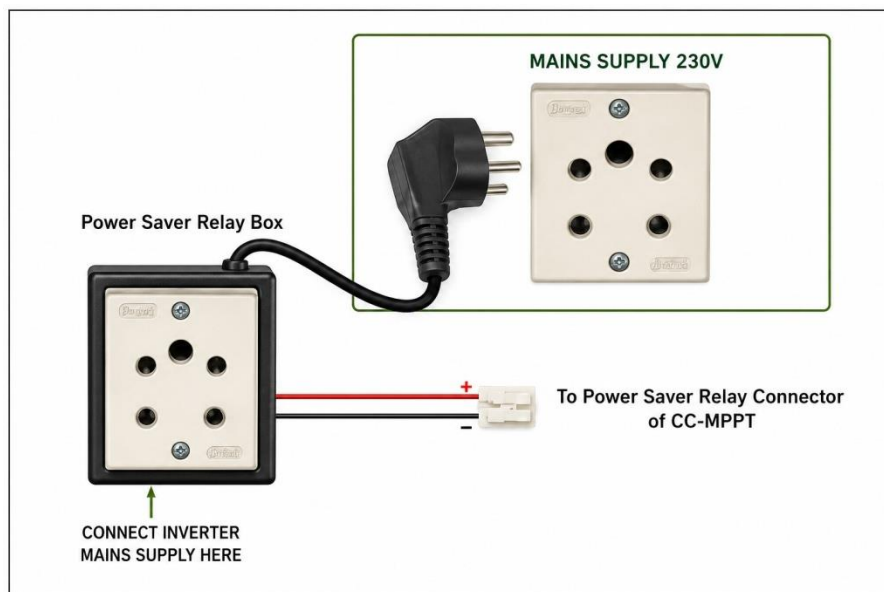
The battery bank temperature sensor is supplied as a standard accessory. Paste the temperature sensor on the battery bank side using double-sided tape. Insert the 4-pin RJ11 connector at the end of the temperature sensor cable in the socket provided on the left side of the charge controller.

Optional Accessories

1. Power Saver box



Power Saver Relay Box



Power Saver Connection Diagram

Inside the relay box, the tag going to the output socket comes from the N/C contact of the relay. This will cause the mains supply to the inverter to be cut when the relay is on.

The mains connections are made to the Mains terminal block and the inverter power connections are made to the Inverter terminal block on Power Saver. Ensure the Neutral, Live, and Earth connections are made properly on the terminal block.

Now during the daytime when solar power is available, if the battery bank charge voltage is more than the programmed 'Power Saver On' voltage, the relay will turn on. This will cut off the mains supply to the inverter and the batteries will be charged using only solar power. Note that in this condition, the load connected from the inverter will be driven by the battery bank while the battery bank is being charged by the solar panels. Thus electricity bill can be saved when the Power Saver box is used.

In case the battery bank voltage goes below the programmed 'Power Saver Off' voltage during the daytime, or two hours before sunset, the relay will be turned off and the mains will be connected to the inverter. Note that the Power saver will remain off for the 'Min PSaver Off' time programmed in the programmable parameters.

Troubleshooting

S No.	Symptoms	Cause / Remedy
1	Display is off	• Check the battery bank connection and polarity. • Battery bank voltage may be below 30V for Model CC-MPPT-HV-50-4872 or below 75V for Model CC-MPPT-HV-50-96240. In this case, the battery bank will have to be charged using an external charger to bring them to min. 36V / 80V to start CC-MPPT-HV-50 operation.
2	Not producing expected power	• Check PV connections. • Check PV panel conditions like dirty panels / clouds / partial shading on panels. • Connect an ammeter across PV panel connections to check the short circuit current. (This needs to be done carefully as the arc while breaking the connection takes a long time to extinguish.) • Check Max charging current setting in the programming menu. • Check that the battery bank is not in Absorption or trickle charge mode.
3	Not equalizing	• Not sufficient solar power to take the battery back to equalize voltage for an equalizing time. • High load on battery bank so that sufficient battery bank charging current is not available.
4	Always sleeping	• Check PV connections. • Check the PV voltage. It should be more than the battery bank voltage by 'Min Wakeup voltage'.
5	LCD scrambled	• Press the NEXT key to reset the LCD.
6	Any other error	• Call the dealer from whom it was purchased / Systellar Innovations helpline +91 121 434 2043. Keep the Model name and product serial number handy.

Technical Specifications

Parameter	Description
Battery Bank voltage	CC-MPPT-HV-50-4872: 48V, 72V Auto Select. CC-MPPT-HV-50-96240: 96V, 120V, 144V, 180V, 192V, 240V Auto Select.
Maximum charging current	50 Ampere
Maximum solar panel voltage	750 Volts DC
Maximum power point voltage range	(Battery bank voltage + 8) Volts to 600 Volts
Recommended solar panel capacity	See the 'Maximum Solar Panel Capacity' table below.
Idle current from the battery bank	Typical: 50 mA
Technology	IGBT Buck Converter
Microcontroller controlled	ARM-based 32-bit advanced microcontroller
Size	550 mm (H) x 440 mm (W) x 330 mm (D)
Weight	35 Kg

Maximum Solar Panel Capacity

Nom. Battery bank voltage	Max. Solar Panel Capacity
48V	4320 Wp
72V	6480 Wp
96V	8640 Wp
120V	10.8 KWp
144V	12.96 KWp
180V	16.2 KWp
192V	17.82 KWp
240V	22.68 KWp

Note: For product enhancement, product parameters can be changed without notice.

Ordering Information

Product model code:

CC – MPPT – HV – 750V – 48/72V – 50A

(Basic model name – Abs. Max. PV voltage – Battery nominal voltage – Maximum charging current)

Standard models are:

1. CC – MPPT – HV – 750V – 48/72V – 50A
2. CC – MPPT – HV – 750V – 96/120/144/180/192/240V – 50A

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