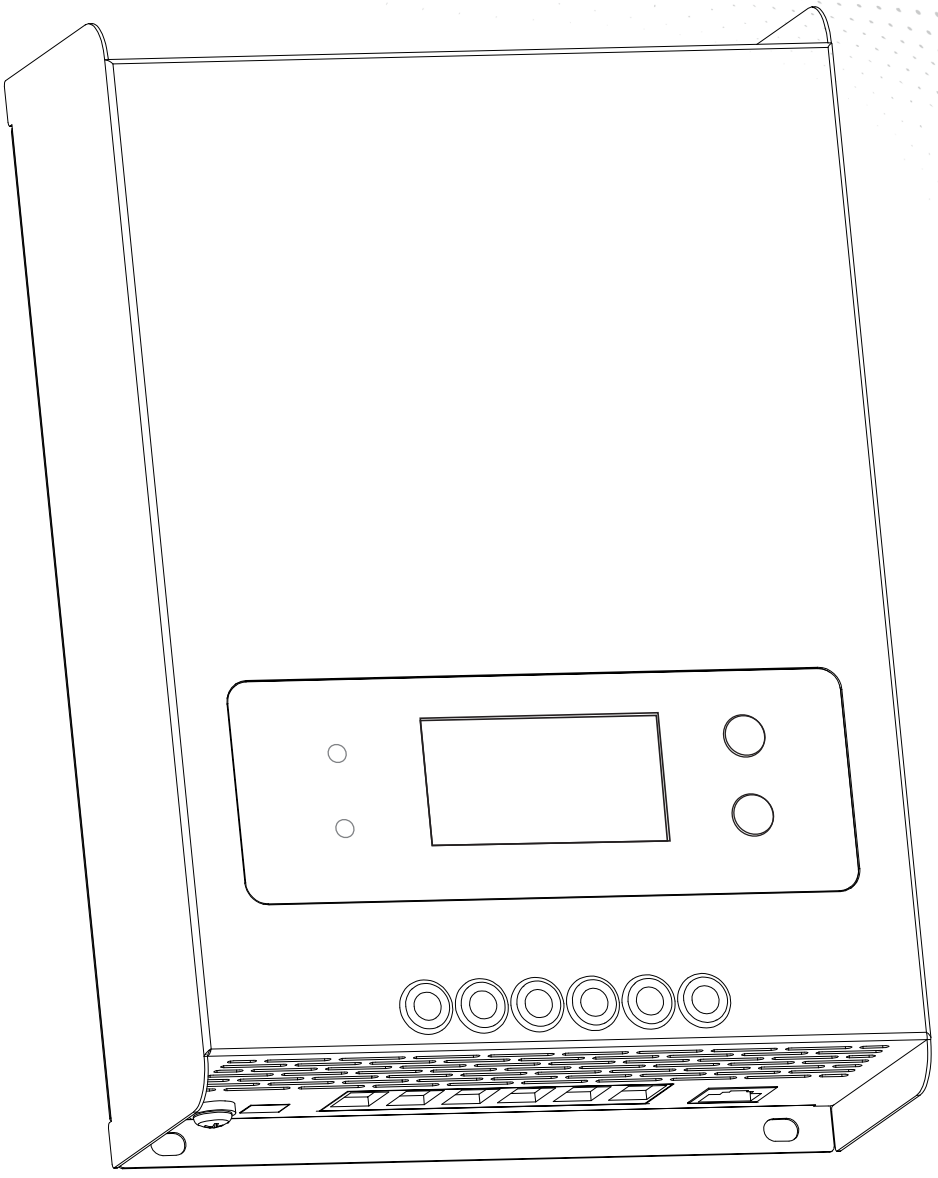
User manual

MPPT



INTELLIGENT
PHOTOVOLTAIC MPPT CONTROLLER

- Please read this user manual carefully before use and keep it properly.
- Please refer to the actual product, the picture is for reference only.

V3.1

CONTENT

1.0 Important safety instructions

1.1 Acknowledgement

Thank you for buying our products and for your trust and support.
In this product manual, we are committed to providing you with accurate and clear usage guidelines and relevant information to help you better understand and use our products.

1.2 Notice to Operation

Before using this product, please read this manual thoroughly to understand the correct and safe operation methods. By using this product, you agree to and fully read and understand all contents of this manual. Do not use this product before carefully reading the instructions and understanding the performance of this product; We are not responsible for any financial loss or personal injury arising from operations that do not comply with the provisions of this Manual. In order to continuously optimize our products, we reserve the right to adjust the content of the manual. It also retains all relevant intellectual and industrial property rights, including Copyrights, patents, trademarks and designs. This manual will be updated from time to time without prior notice. If you find any conflict between your product and this manual, or have any questions about the product or this manual, please contact us for consultation and modification. We reserve the right of final interpretation of this manual.

1.3 Safety warning note

We take safety very seriously and recommend that anyone who is in close contact with our products, such as installing, operating, maintaining or servicing this product, use caution, follow common sense, and follow the safety information on this manual and machine installation stickers to ensure the safety of people and products and reduce safety risks.
The following information is displayed on the instructions or product labels: A hazard or warning label indicates a potentially hazardous or hazardous situation which, if not avoided, will result in death or serious injury. Extra care and attention should be paid to the safety of you or the product.

	**Reminder:** Indicates suggestions and prompts to the operator.
	**Note:** Indicates that this operation is destructive.
	**Warning:** Indicates that this operation is dangerous. Make safety preparations before performing this operation.

2.0 Product introduction

2.1 Product overview

This product can detect the power generation of solar panels in real time, and track the maximum voltage current value (VI), so that the system can charge the battery at the maximum power output. It is used in off-grid photovoltaic system to coordinate the work of solar panels, batteries and loads, and is the core control component of off-grid photovoltaic system.

This product can touch the key operation and setting, but also through the Bluetooth or RJ45 communication interface connected to the upper computer and other devices to view the operating parameters, controller logs, historical parameters, control parameters, remote control, etc., and can modify the controller parameters as required to meet different system requirements.

The controller adopts standard Modbus communication protocol, which is convenient for users to carry out secondary development according to application scenarios. At the same time, the company provides free monitoring software to view and modify the parameters of the system.

The controller has a comprehensive electronic fault self-test function and powerful electronic protection function, which can avoid the damage of product components due to installation errors and system failures to the greatest extent.

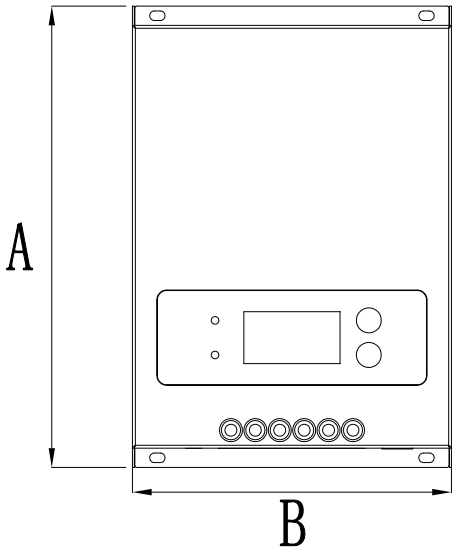
2.2 Product characteristics

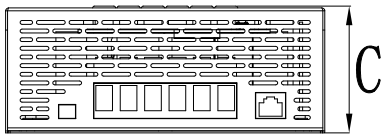
- Advanced dual-peak or multi-peak tracking technology, when the panel is shaded or part of the panel is damaged, the I-V curve will appear multiple peaks, the controller can still accurately track the maximum power point;
- The built-in maximum power tracking algorithm can significantly improve the energy utilization rate of the photovoltaic system, which is about 15%~20% higher than the traditional PWM charging efficiency.
- The combination of various tracking algorithms can accurately track the best working point of I-V curve in a very short time.
- MPPT tracking efficiency up to 99.9%;
- Using advanced digital power technology, the circuit energy conversion efficiency is as high as 98%;
- Support colloidal battery, sealed battery, open battery, user-defined and other different types of battery charging procedures;
- With current limiting charging mode, when the power of the panel is too large and the charging current is greater than the rated current, the controller automatically reduces the charging power to make it work at the rated charging current;
- Can support capacitive load instant high current start;
- Support battery voltage automatic identification;
- With fault LED indication, easy to determine the system fault;
- Support standard modbus protocol, to meet the communication needs of different occasions;
- Built-in overtemperature protection mechanism, when the temperature exceeds the device set value, the charging current decreases linearly with the temperature to avoid high temperature damage to the controller;
- With temperature compensation function, automatic adjustment of charge and discharge parameters, improve battery life;
- With the battery overtemperature protection function, the external battery temperature exceeds the set value will shut down the charge and discharge, so as to avoid excessive temperature damage to the equipment;

2.3 Packing list

1	MPPT controller*1	3	User manual*1
2	Certificate of conformity*1		

2.4 Product size

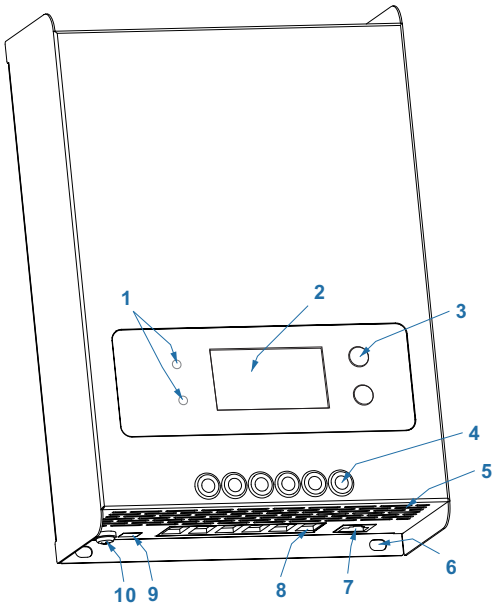




Model number	A		B		C	
	in	mm	in	mm	in	mm
TS-SC48-50P-MPPT	9.45	240	6.63	166	2.56	65
TS-SC48-60P-MPPT	9.45	240	6.63	166	2.56	65
TS-SC48-80P-MPPT	12	305	7.9	200	4.9	85
TS-SC48-100P-MPPT	12	305	7.9	200	4.9	85

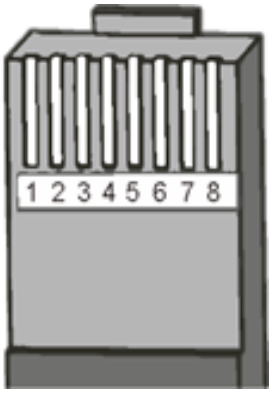
2.5 Structure introduction

1	Charging status and fault indicator
2	LCD display
3	Operating key
4	Cable screw holes
5	Heat dissipation hole
6	Mounting hole position
7	RJ45 Serial communication port
8	Input and output interfaces
9	Temperature sensing wire interface
10	Ground connection



No. "7" RJ45 Port Definition:

No.	DEFINITION
1	RS485-A
2	RS485-B
3	-
4	-
5	GND
6	GND
7	+5V
8	+5V



Note: The pin definition applies to this product only.

2.6 Specification parameter

Model number	TS-SC48-50P-MPPT	TS-SC48-60P-MPPT	TS-SC48-80P-MPPT	TS-SC48-100P-MPPT
MPPT efficiency	≥99.5%			
No-load static loss	1W~1.2W			
system voltage	12V/24V/36V/48V Auto			
Cooling method	Fan cooling			
PV Maximum Open Circuit Voltage (VOC)*	200Vdc		250Vdc	
Turn on the charging voltage point	3V higher than battery voltage			
Input low voltage protection point	2V higher than the current battery voltage			
Input overvoltage protection point	200Vdc		250Vdc	
Rated input power 12V system**	650W	780W	1040W	1300W
Rated input power 24V system**	1300W	1560W	2080W	2600W
Rated input power 36V system**	1950W	2340W	3120W	3900W
Rated input power 48V system**	2600W	3120W	4160W	5200W
Applicable battery type	Lead-acid battery / Li-ion battery			
Lithium battery activation function	Optional			
Charge rated current	50A	60A	80A	100A
Charging method	Lead-acid battery: fast charge, equal charge, floating charge; lithium battery: fast charge, equal charge			
load voltage	same battery voltage			
Rated load current	30A		50A	
Load control method	Normally open and normally closed mode / dual period control mode / light control mode / light control-fixed time control mode			
Display method	High-definition LCD segment code backlight display			
communication method	8-pin RJ45 interface / RS485 / support host computer monitoring / support external Bluetooth, WIFI module expansion to realize app cloud monitoring / support external monitoring header			
Protective function	Input and output over-voltage protection, anti-reverse connection protection, battery drop protection, etc.			
Working temperature	-20℃ ~+55℃			
Storage temperature	-40℃ ~+70℃			
IP protection class	IP21			
Maximum wire size	$20mm^2$		$25mm^2$	
Net weight (kg)	1.7		3.4	
Gross weight (kg)	2.1		4	
Product size (mm)	240*166*65		305*200*85	
Packaging size (mm)	292*204*67		382*245*129	

*The voltage of the PV array cannot exceed this limit.

**These power limits refer to the maximum power that the MPPT controller can handle. High power arrays can be used without damaging the controller.

3.0 Install

3.1 Precautions before installation

➢ Installation position

- Install the controller in a dry, ventilated location that is convenient for disassembly and maintenance.
- Do not install on flammable building materials; Do not install on highly flammable materials; Do not install in hazardous areas where there is a risk of explosion.
- Do not expose the equipment to harsh environments such as damp, flammable and explosive, or large accumulation of dust.
- Never install the controller in a case with an open/liquid-rich battery.
- The temperature of the heat sink of the controller may exceed 40 ° C during operation. Install the controller in a place that is not accessible to children and the elderly.
- Ensure adequate ventilation when installing the controller in the chassis. Installation in a sealed case can result in overheating, reduced power operation and shortened product life.

➢ Safety information

- Wear insulation tools for installation.
- Disconnect all power to the controller before installing or maintaining the MPPT.
- Do not operate or install alone, in case of an accident, ask someone nearby to assist.
- MPPT controllers must be installed by qualified technicians or personnel trained in safety installation in accordance with the electrical regulations of the country in which they are located.

➢ Proper use

- This MPPT controller is only used for solar power generation. Connecting to any other type of power source (such as a wind turbine or generator) may void the warranty.
- There are no user repairable parts in the MPPT, do not disassemble or attempt to repair the controller.
- In normal use of the circuit, a device capable of disconnecting all power supply electrodes connected to the MPPT must be installed.

3.2 Cable specification

2% Voltage Drop Charts for 75°C Stranded Copper Wire

1-Way Wire Distance (feet), 12 Volt System									
Wire Size(AWG)	**100A**	**80A**	**60A**	**55A**	**50A**	**45A**	**40A**	**35A**	**30A**
2/0*	13.5	16.8	22.4	24.4	26.9	29.9	33.6	38.4	44.8
1/0*	10.6	23.3	17.7	19.3	21.3	23.6	26.6	30.4	35.5
2	6.7	8.4	11.2	12.2	13.4	14.9	16.8	19.2	22.4
4	4.3	5.3	7.1	7.7	8.5	9.4	10.6	12.1	14.1
6	2.7	3.3	4.4	4.8	5.3	5.9	6.6	7.5	8.8
8	1.7	2.1	2.8	3.1	3.4	3.7	4.2	4.8	5.6
10	1.1	1.3	1.7	1.9	2.1	2.3	2.6	3.0	3.5

1-Way Wire Distance (meters), 12 Volt System									
Wire Size (mm2)	**100A**	**80A**	**60A**	**55A**	**50A**	**45A**	**40A**	**35A**	**30A**
70*	4.1	5.1	6.8	7.4	8.2	9.1	10.2	11.7	13.7
50*	3.3	4.1	5.4	5.9	6.5	7.2	8.1	9.3	10.8
35*	2.1	2.6	3.4	3.7	4.1	4.5	5.1	5.8	6.8
25	1.3	1.6	2.1	2.3	2.6	2.9	3.2	3.7	4.3
16	0.8	1	1.3	1.5	1.6	1.8	2.0	2.3	2.7
10	0.5	0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.7
6	0.3	0.4	0.5	0.6	0.6	0.8	0.8	0.9	1.1

2% Voltage Drop Charts for 75°C Solid Copper Wire

1-Way Wire Distance (feet), 12 Volt System									
Wire Size(AWG)	**100A**	**80A**	**60A**	**55A**	**50A**	**45A**	**40A**	**35A**	**30A**
2/0*	13.5	16.8	22.4	24.4	26.9	29.9	33.6	38.4	44.8
1/0*	10.6	23.3	17.7	19.3	21.3	23.6	26.6	30.4	35.5
2	6.7	8.4	11.2	12.2	13.4	14.9	16.8	19.2	22.4
4	4.3	5.3	7.1	7.7	8.5	9.4	10.6	12.1	14.1
6	2.7	3.3	4.4	4.8	5.3	5.9	6.6	7.5	8.8
8	1.7	2.1	2.8	3.1	3.4	3.7	4.2	4.8	5.6
10	1.1	1.3	1.7	1.9	2.1	2.3	2.6	3.0	3.5
1-Way Wire Distance (meters), 12 Volt System									
Wire Size (mm2)	**100A**	**80A**	**60A**	**55A**	**50A**	**45A**	**40A**	**35A**	**30A**
70*	5.1	6.4	8.5	9.2	10.2	11.3	12.7	14.5	16.9
50*	4.1	5.1	6.7	7.3	8.1	9.0	10.1	11.5	13.4
35*	2.6	3.2	4.2	4.6	5.1	5.6	6.3	7.2	8.5
25	1.6	2	2.7	2.9	3.2	3.5	4.0	4.6	5.3
16	1	1.3	1.7	1.8	2.0	2.2	2.5	2.9	3.3
10	0.7	0.8	1.1	1.1	1.3	1.4	1.6	1.8	2.1
6	0.4	0.5	0.7	0.7	0.8	0.9	1.0	1.1	1.3

Attention: Wires larger than 4 AWG (25 mm^2) must be terminated at the bus box outside the MPPT. Connect the MPPT to the bus box using 4 AWG (25 mm^2) or smaller wires.

Note: The specified wire length applies to a pair of wires (one-way distance) from the solar or battery power supply to the controller.
- For a 24-volt system, multiply the length in the table by 2;
- For a 36-volt system, multiply the length in the table by 3;
- For a 48-volt system, multiply the length in the table by 4;

3.3 Installation procedure

➢ Step 1: Unpack and check

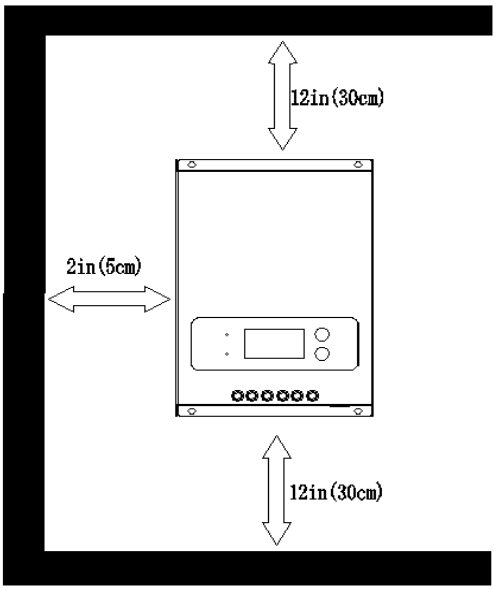
Check the controller for transport damage and bumps; Check whether the specifications are consistent with the order.

➢ Step 2: Check the controller parameter limits

Ensure that the solar array open circuit voltage (Voc) under the maximum temperature compensation state does not exceed the MPPT rated voltage value of the model. Multiple controllers can be mounted in parallel on the same battery pack for greater charging current. Each MPPT in parallel must be connected to an independent solar panel.

➢ Step 3: Determine the installation space

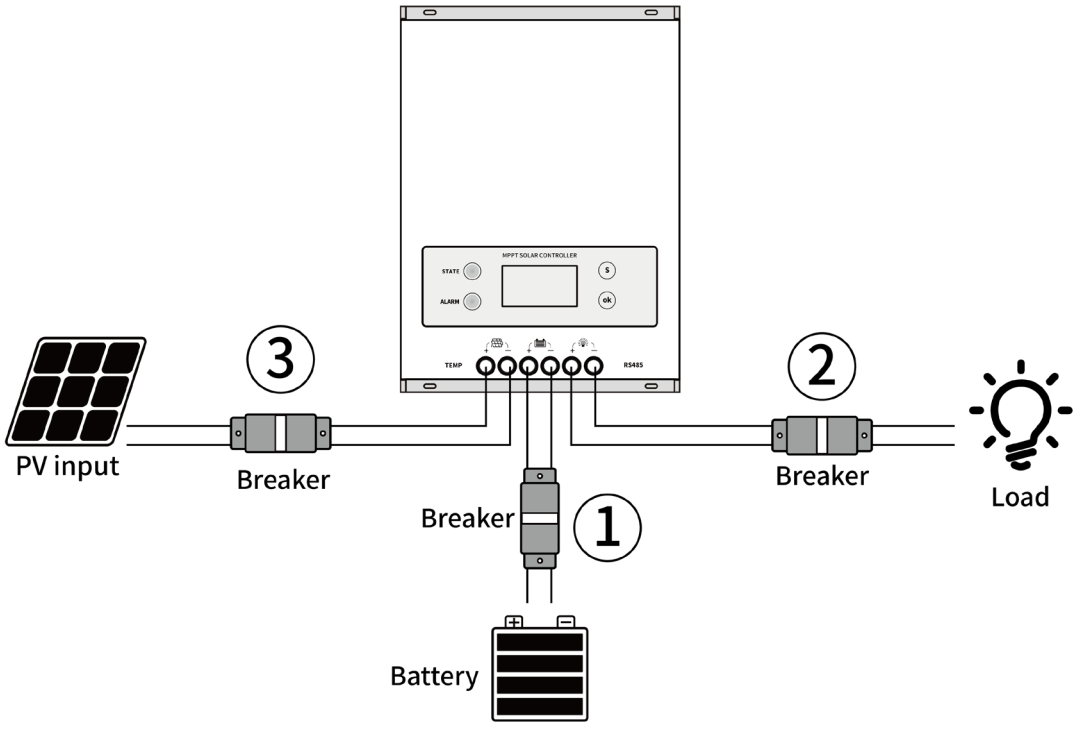
To ensure room for air circulation, leave at least 30 cm (12 in) above and below the controller, and 5 cm (2 in) on the side, and do not install it in a closed box. As shown in the figure.



⚠	**Note:** Leave enough space between the top and bottom for the fan to dissipate heat.

➢ Step 4: Wiring sequence

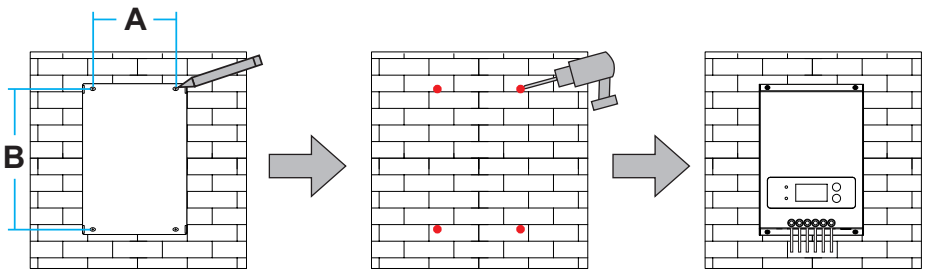
Connect the input and output cables connected to the circuit breakers to their corresponding positions on the controller in sequence. Ensure that the circuit breaker is off before connecting the cables. As shown below.



➢ Step 5: Secure the controller

Measure and mark the distance on the wall, drill four holes with a diameter of 6mm, fill the four holes with plastic expansion particles, fix the controller to the mounting wall using M4 self-tapping screws and tighten the screws.

	A	B
ESF48L50	140mm	230mm
ESF48L60		
ESF48H50		
ESF48H60		
ESF48H80	155mm	295mm
ESF48H100		



➢ Step 6: Power on the device

Ensure that all cables are securely connected before powering on the device.

1, first close the circuit breaker connected to the battery ① , ensure that the controller is connected to the battery (the controller LCD will display the content), then you can set the battery type (see);

2, if you need DC output control load, then first set the output control mode, and then open the DC output circuit breakerv ② ;

3, and then connect to open the solar panel PV input circuit breaker ③ , if the PV input voltage in the controller charging working range, then the controller will enter the charging state;

Reminder: ① After the No. 1 circuit breaker is connected, the controller fails to turn on, which may be a battery loss;

After closing the circuit breaker ③ , it will be powered on normally by the input of the solar panel.

Reminder: This MPPT controller prevents reverse current leakage at night, so serial diodes are not required in the system.

Note: Before connecting the battery, measure the open circuit voltage of the battery and must exceed 10 volts to start the controller.

Note: The photovoltaic input should not be incorrectly connected to the output power line of the controller when wiring, otherwise the internal circuit of the controller may be damaged and the warranty will be invalid.

Note: Installation must comply with electrical code requirements.Select appropriate specifications for circuit breakers and fuses based on application requirements.

Warning: Ensure that the cable is securely connected and secured with cable clips to prevent the cable from rocking in the mobile application environment and overheating.

Warning: Risk of electric shock. Before contact, test the impedance between all terminals and ground.Grounding according to local codes and regulations.

3.4 Power off

Please disconnect serial number 3 circuit breaker, then disconnect serial number 2 circuit breaker, and finally disconnect serial number 1 circuit breaker connection;

Note: If possible, disconnect the battery from the MPPT after the solar input is disconnected. If the battery is removed during the MPPT charging process, there is a low chance of damage to the controller.

Note: Please switch on and off the power supply in strict accordance with the sequence of operations, otherwise the equipment is abnormal or damaged, you will not enjoy the warranty service.

4.0 Display and operation

4.1 Number of PV modules in series reference table

Voc * N = PV input < 150dc												
System Voltage	Voc<23V		Voc<31V		Voc<34V		Voc<38V		Voc<46V		Voc<62V	
	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum
12V	6	2	4	1	4	1	3	1	3	1	2	1
24V	6	3	4	2	4	2	3	2	3	2	2	1
36V	6	4	4	3	4	3	3	3	3	2	2	1
48V	6	5	4	4	4	3	3	3	3	2	2	2

Voc * N = PV input < 200Vdc												
System Voltage	Voc<23V		Voc<31V		Voc<34V		Voc<38V		Voc<46V		Voc<62V	
	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum
12V	8	2	6	1	5	1	5	1	4	1	3	1
24V	8	3	6	2	5	2	5	2	4	2	3	1
36V	8	4	6	3	5	3	5	3	4	2	3	1
48V	8	5	6	4	5	3	5	3	4	2	3	2

Voc * N = PV input < 250Vdc												
System Voltage	Voc<23V		Voc<31V		Voc<34V		Voc<38V		Voc<46V		Voc<62V	
	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum	maximum	optimum
12V	10	5	8	4	7	3	6	3	5	2	4	2
24V	10	7	8	5	7	5	6	4	5	4	4	3
36V	10	7	8	5	7	5	6	4	5	4	4	3
48V	10	9	8	7	7	6	6	6	5	5	4	3

Attention: N in the table represents the number of series, the data is for reference only.

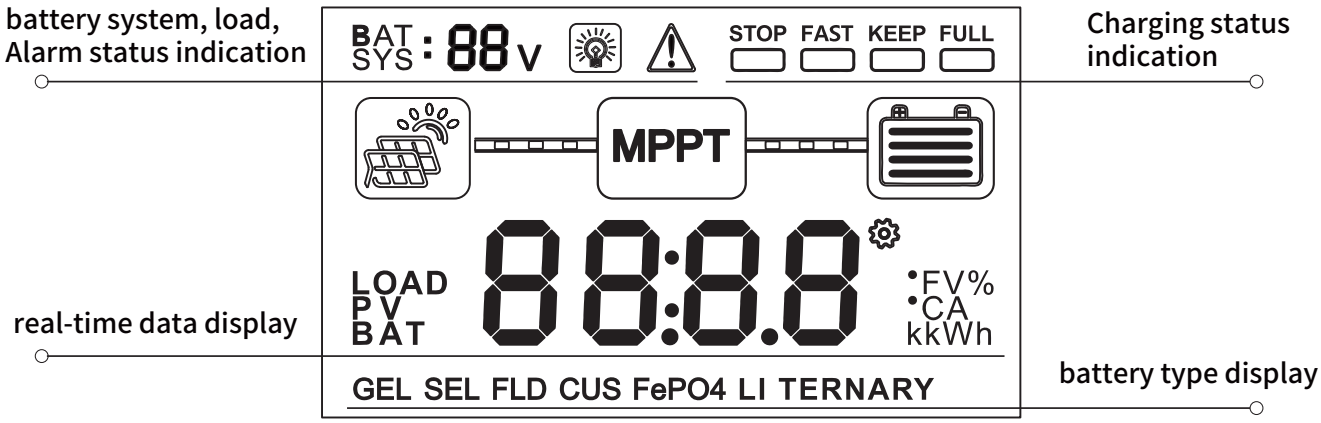
4.2 Status light

Indicator color	Graphical	Indicator status	Controller state
green		Steady lighting	Floating charge state (CF) or standby mode
		Fast flicker	Fast Charge mode (CC mode)
		Slow flash	Constant voltage charging (CV mode)
Red light		Steady lighting	Out of order

4.3 Screen wake up

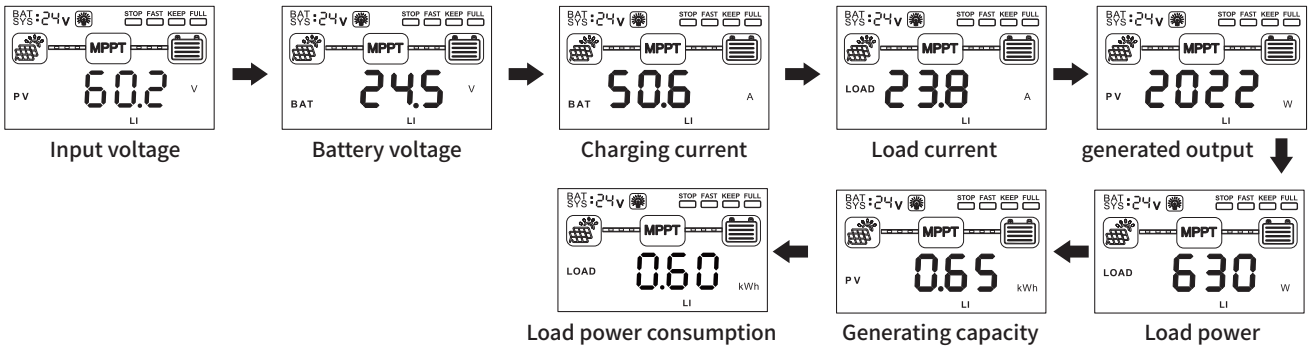
The default screen backlight duration is 30 seconds (the time can be set on other devices), and the backlight display can be awakened by pressing a key or touching the device.

4.4 Interface introduction

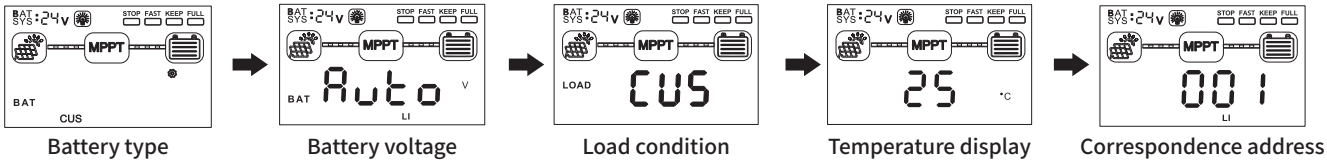


4.5 menu

First-level menu: real-time data display interface -- press "S" to switch the interface;



Level 1 menu: Set the main menu -- press the "OK" key to switch the interface;



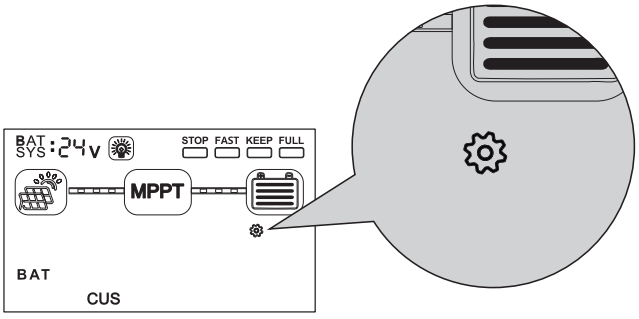
4.6 Key operation

factory data reset

Press the "OK" and "S" keys for 6 seconds at the same time to restore factory Settings.

Other Settings

Select the level-1 menu Set Main Menu and hold down the OK key for 3 seconds. After entering the setting state, it will be displayed on the screen The " ⚙ " icon blinks. Press the "S" key and "OK" to scroll up and down when placing an order in the setting state;



Long press the "S" key for 3 seconds to exit editing;
Hold down the "OK" key for 3 seconds to save the current option.

Set item	Optional parameter	introduce	Step size
Battery type setting	GEL; SEL; FLD; CUS; FePo4; TeRNAPY; LI;	Set the type of battery to be connected;	
Battery voltage system Settings	12V; 24V; 36V; 48V; AUTO;	The lead-acid battery can be set to 12V. 24V; 36V; 48V; Lithium battery status Do not need to set the voltage, the system is AUTO (automatic identification) state;	
Load setting	ON; OFF; CUS;	Can be set to: on, off, custom, status; Custom (CUS) items can be set through the host computer or APP;	
Load setting	℉ ; ℃ ;	The display mode can be set to: Fahrenheit, Celsius;	
Correspondence address	001~247	The controller address number can be set;	±1

Note: If you need to customize additional parameters, you can do so through optional attachments.

4.7 Charging status and parameters

4.7.1 The controller charges the lead-acid battery

The MPPT controller has a 4-stage battery charging algorithm for fast, efficient and safe charging of lead-acid batteries.
1 - CC State (Constant Current Charging): Fast Charging Phase - FAST
2 - CV state (constant voltage charging): regulated charging phase - KEEP
3 - CF Status (Float Charging): Prevents the battery from being overcharged for a long time. And make up for the loss of self-discharge. -FULL
4 – Boost charging: activate battery chemistry, desulphurization effect

4.7.2 The controller charges the lithium-ion battery

The MPPT controller will charge according to the specifications of the lithium-ion battery, mainly in two stages. In the first stage, when the battery voltage is lower than the saturation voltage, it will rapidly charge according to the maximum power point that is tracked; in the second stage, when the battery voltage is equal to the saturation voltage, it will charge at a constant voltage, and the charging current will gradually decrease to 0.

4.7.3 Charging parameter settings

The charging parameters of commonly used lead-acid battery. All voltage settings listed are for standard 12 volt batteries. Example: For a 24 volt battery, multiply the voltage setting by 2.

Battery Type	Constant pressure	Float charg	Equalization voltage	Equalization charging time	Undervoltage protection	Brownout Recovery
Gel (GEL)	14.2V	13.8V	14.2V	30 points user-defined	11.1V	12.6V
Sealed (SEL)	14.4V	13.8V	14.6V	30 points user-defined	11.1V	12.6V
Flooded (FLD)	14.6V	13.8V	14.8V	30 points user-defined	11.1V	12.6V
Custom (CUS)	user-defined	user-defined	user-defined	30 points user-defined	user-defined	user-defined

The charging parameters of commonly used lithium-ion batteries.

Battery Type	Standard Voltage	Saturation voltage	Discharge cut-off voltage	cut-off recovery voltage
LiFePO4-12V (4 strings of lithium iron phosphate)	12.8V	14.4V	10.8V	12.4V
LiFePO4-24V (8 strings of lithium iron phosphate)	25.6V	28.8V	21.6V	24.8V
LiFePO4-48V (15 strings of lithium iron phosphate)	48V	54V	40.5V	46.5V
Ternary-12V (3 strings of ternary lithium)	11.1V	12.6V	9.6V	10.5V
Ternary-24V (6 strings of ternary lithium)	22.2V	25.2V	19.2V	21.0V
Ternary-48V (13 strings of ternary lithium)	48.1V	54.6V	41.6V	45.5V
user-defined	user-defined	user-defined	user-defined	user-defined

Note: These Settings are a general guide for user use. MPPT can be set to meet a variety of charging parameters. Consult the battery manufacturer for the best battery charging Settings.

4.8 Load Control

The main purpose of the load control function is to disconnect the system load when the battery is discharged to a low voltage state and reconnect the system load when the battery is charged back to a certain level. System loads can be lamps, DC appliances, or other electronic equipment. The total current of all loads must not exceed the MPPT maximum load rating.

Reminder: Risk of Equipment Damage
Do not connect any AC inverter to the load terminals of the MPPT. The load control circuit may be damaged. The inverter should be connected to the battery. If any other load may sometimes exceed the maximum voltage or current limit, the device should be connected directly to the battery or battery pack.

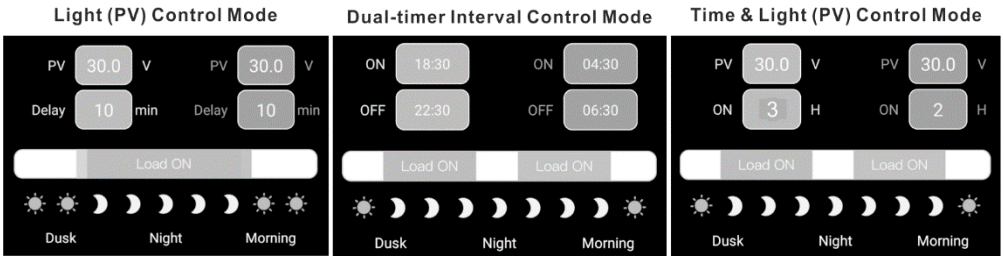
➢ **Brief description of load control:**

- Do not connect multiple MPPT load outputs in parallel to power supply dc loads that consume more than 30A current, depending on the MPPT model used.
- Be careful when connecting loads with specific polarities to controller load terminals. Reverse polarity connections may damage the load. Be sure to check the load connection carefully before powering on.
- The load output voltage of the controller is the same as that of the battery string. For example, when the battery voltage is 25.2V, the load output voltage is also 25.2V.
- When the load output current is lower than the rated load current, the system provides stable power to the load.
- When the load output current exceeds the preset load current and lasts for 5 minutes in the range of 100% to 120%, the load output is shut down and switches to the normal off mode.
- When the load output current is detected to exceed 120% of the rated load current, the load output will be shut down immediately and switch to the normal off mode.

Attention: When the Load switches to normal off mode, in order to restart the Load, the user needs to reset the Load to "ON" mode ON the controller or reset the Load mode through the mobile APP, upper computer, and meter header.

➢ **Load Control Mode:**

1 - Normal on/Normal Off mode: The load output state is on or off.
2 - Optical control mode: The load output is turned on or off according to whether there is light (input voltage limit). Refer to the following diagram for the working mechanism.
3 - Dual-period timing control mode: The load switch of two different periods is controlled according to two timers. Refer to the following diagram for the working mechanism.
4 - Fixed time light control mode: according to whether there is light (input voltage limit), the load output is controlled to turn on or off in hourly units.



Attention: Only the normal ON/normal OFF mode can be set on the controller panel. Other modes need to be set through other optional accessories.

4.9 communication

4.9.1 Apply

All operations of this series of controllers can be done via Bluetooth /wifi modules. Users can search for "SolarMate" in the AppStore or GooglePlay to download and install the app, or obtain the installation package directly from the website. When the Bluetooth function of the mobile phone is enabled, you can use the App to interact with the controller through Bluetooth.

IOS download	google download	Android web download	PC download

Note: Users can also monitor the controller through other optional accessories.

5.0 Common faults and handling

5.1 Common fault

1.The LCD screen doesn't light up, and the controller doesn't seem to be powered on.
Solution:
Use a multimeter to check the voltage of the battery terminals on the MPPT. The battery voltage must be 10 VDC or higher. If the voltage on the controller battery terminal is between 10 and 60 VDC and no indicator light is on, contact the authorized distributor for repair. If the voltage is not measured, check the wiring, fuses, and circuit breakers.

2.The controller is not charging.
Solution:
Check fuses, circuit breakers, and wiring connections in power wiring. Using a multimeter, check the array voltage directly on the MPPT solar input terminals. Before starting charging, the input voltage must be greater than the battery voltage. Check whether the battery voltage displayed on the LCD screen is within the recognition range of the controller system.

3.The battery has been in a low or dead state for a long time.
Solution:
Possible reasons:
1. There are too few solar panels to generate enough energy to meet the system use, and the solar panel array can be increased appropriately.
2. The battery capacity is too small to store enough energy for the system to use, and the capacity of the battery pack can be appropriately increased.

	**Warning:** Inputs and outputs are not electrically isolated and may be energized using dangerous solar voltages. Under certain fault conditions, the battery may be overcharged. Before contact, take protective insulation measures.

	**Warning:** Devices must be installed to disconnect all power supply electrodes, and these disconnections must be included in the fixed wiring. Before maintaining or removing controller connections, disconnect all power devices.

6.0 Product protection function and system maintenance

6.1 Protection function description

- **Waterproof and dustproof protection：IP21**
  Waterproof grade: 2, dust grade: 1
- **Battery reverse protection**
  After the positive and negative terminals of the battery are reversed, the system does not work and will not burn out the controller.

	**Note:** When the photovoltaic input is connected and running, it is not allowed to reverse the battery, otherwise the equipment is abnormal or damaged, you will not enjoy the warranty service.

- **Photovoltaic input short circuit protection**
  When the input end of the photovoltaic array is short circuited, the controller disconnects the charging. When the short circuit is cleared, the charging will automatically resume.
- **Photovoltaic input reverse protection**
  When the photovoltaic array polarity is reversed, the controller will not be damaged, and will continue to work normally after correcting the wiring error.
- **Internal overtemperature protection**
  When the internal temperature of the controller reaches the specified threshold, the power is automatically reduced.
- **Radiator temperature limit**
  When the heat sink temperature exceeds the maximum threshold, the controller automatically power off and stops running.
- **Battery drop protection**
  When the battery is in the overcharge state, the charging circuit will automatically fall off and disconnect, preventing overcharge and extending the battery life.

	**Note:** There is no GFDI (Ground fault detection device) inside the controller.

6.2 System maintenance

- In order to maintain the best performance, it is recommended to inspect the project more than twice a year.
- Make sure the airflow around the controller is not blocked and remove any dirt or debris from the radiator Check all exposed wires for insulation damage caused by sun exposure, friction with other objects around, dry rot, insects or rodents. Wires need to be repaired or replaced as necessary.
- Verify that the indicator is consistent with the device operation. Please note any faults or errors displayed and take corrective action if necessary.
- Check all terminals for signs of corrosion, insulation damage, high temperature, or burning/ discoloration, and tighten the terminal screws.
- Check for dirt, nesting insects and corrosion and clean as required.

	**Warning:** Electric shock danger! When performing the above operations, ensure that all power supplies of the controller are disconnected, and then perform the corresponding check or operation!