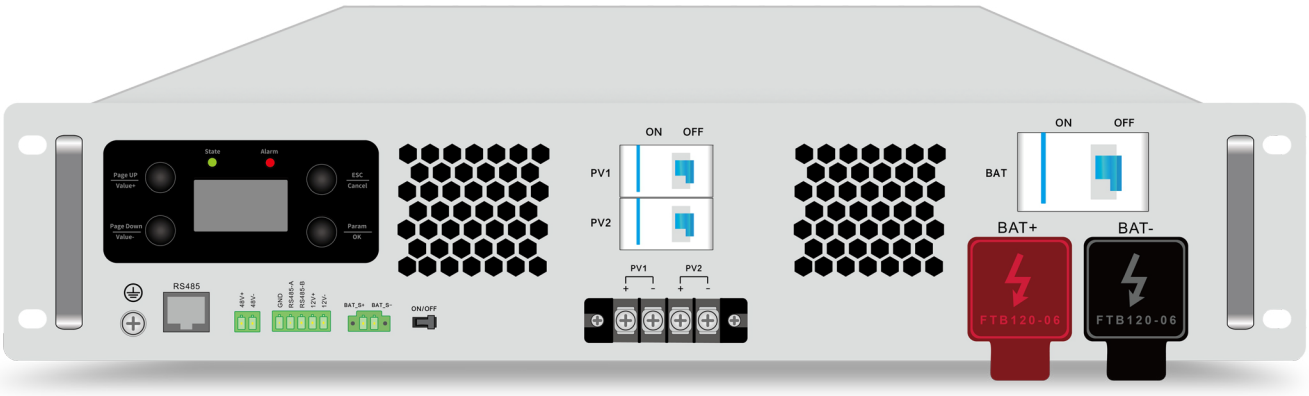
IPANDEE

INSTRUCTION MANUAL



COMMUNICATION BASE STATION PHOTOVOLTAIC SMART MPPT CONTROLLER

- Please read this user manual carefully before use and keep it properly.
- The product in kind shall prevail. The picture is for reference only.

V2.0

CONTENT

1.0 Important safety instructions

1.1 Acknowledgement

We sincerely thank you for purchasing our products and for your trust and support.
In this product manual, we are committed to providing you with accurate and clear instructions and related information to help you better understand and use our products.

1.2 Usage and notice

Before using this product, please read this manual fully for proper and safe operation. Use of this product indicates that you have agreed to and fully read and understood all the contents of this manual. Do not use this product until you have carefully read the manual and understand the performance of this product; we are not responsible for any economic loss or personal injury resulting from operation not in accordance with this manual. In order to continuously optimize our products, the Company reserves the right to adjust the contents of the manual. It also reserves all related intellectual and industrial property rights, including copyrights, patents, trademarks and designs. This manual will be updated from time to time and newer versions will be available without 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 advice and modifications. We reserve the right of final interpretation of this manual.

1.3 Safety Warning Notes

We take safety very seriously and recommend that anyone who is in close contact with our products, such as those installing, operating, maintaining or servicing this product, exercise caution, follow common sense, and follow the safety information in this manual and on the machine's installation sticker, to ensure the safety of people and objects and to minimize safety risks.
The following informational symbols appear in the instruction manual or on the product labeling sticker: DANGER or WARNING symbols indicate a potential hazard or a high risk situation that, if not avoided, could result in death or serious personal injury. Extreme caution and attention should be paid to the safety of you or the product.

	**Reminder:** Indicates advice and tips for the operator.
	**Note:** Indicates that this operation is destructive.
	**Warning:** Indicates that this operation is dangerous and that safety preparations must be made before operation.

2.0 Product introduction

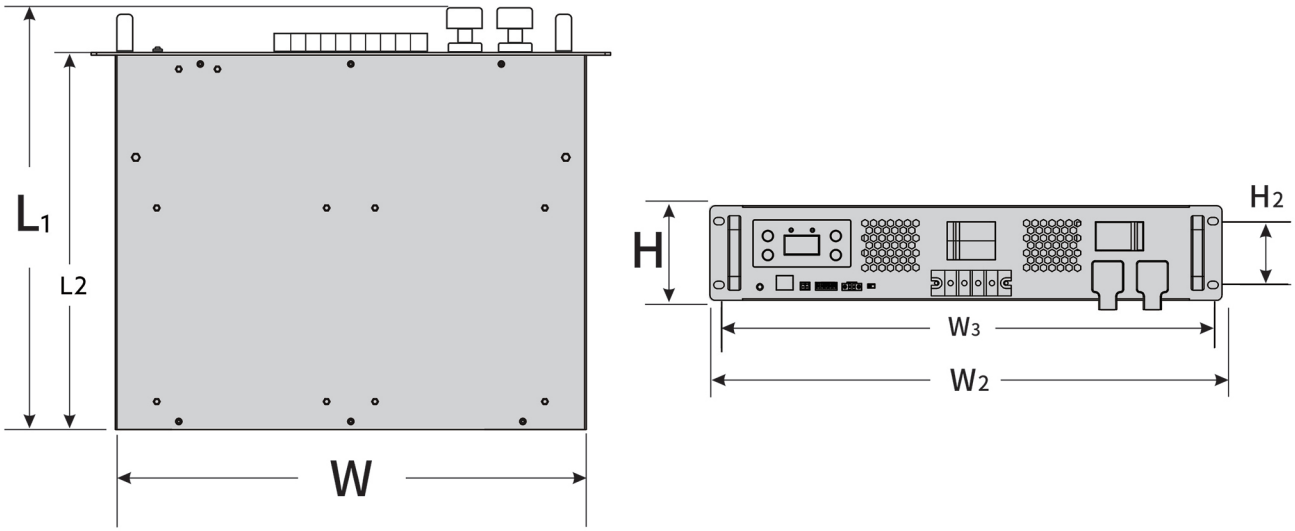
2.1 Product overview

Thank you for choosing this series of MPPT solar charge controllers!
This series of products has the function of current limiting charging. When the user's PV panel power is too large, the controller automatically maintains the charging power, and the charging current will not exceed the rated value.
This series of products in the design of the system stability as the core under the premise of maintaining a high energy conversion efficiency, DSP as the control core with excellent algorithms and operating logic so that the product has a super high MPPT tracking efficiency.
This series of products support all kinds of battery storage system solar charging application needs. This series of products support the external WIFI cloud module of our company, and support the operation and maintenance of PC monitoring software with serial communication.
This series of products adopts RS485 bus external communication mode, users can according to the communication protocol for unified integration and management.

2.2 Product List

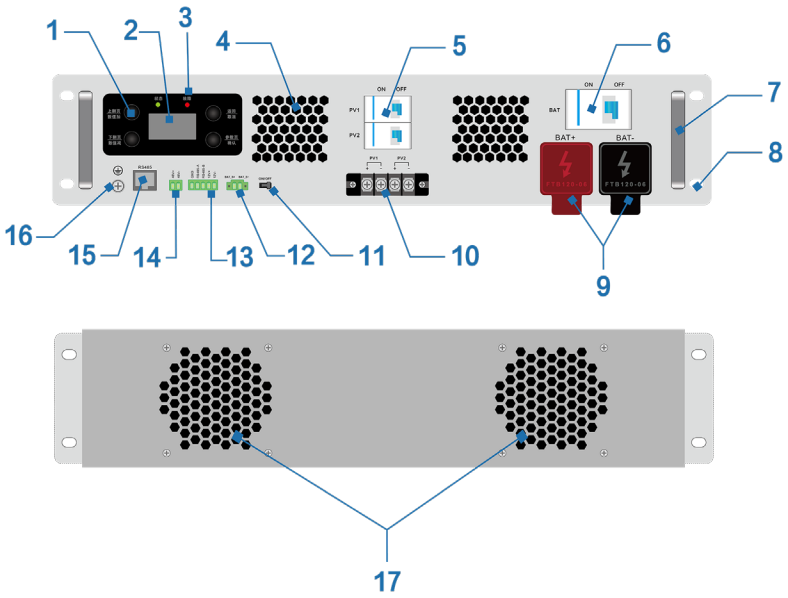
1	2P small signal terminal *1ps	4	OT type battery wiring copper terminals *2ps
2	5P small signal terminal *1ps	5	Instruction manual *1
3	Fork type photovoltaic wiring copper terminal *4ps	6	

2.3 Product Size



	L1	L2	W	W2	W3	H	H2
Sizes	383mm	350mm	423mm	482mm	466mm	89mm	60mm

2.4 Structural description



Serial number	Name (of a thing)	Serial number	Name (of a thing)
1	Operating key	10	2 Controller PV Input Terminal Block
2	Display	11*	Battery external sampling switch (remote compensation)
3	Status light	12*	Battery external sampling output port
4	Cooling air intake holes	13	Small Signal Terminal Blocks
5	2 Controller PV Input Switches	14	48V output port (reserved)
6	Battery switch	15	RJ45 port
7	Grips	16	Grounding screw
8	Mounting hole	17	Heat dissipation hole
9	Battery terminal block		

⚠	Note: When the controller does not use external sampling, the switch is "OFF" (factory default: OFF). When the controller uses external compensation sampling, the switch needs to be turned to "ON".

2.5 Electrical parameters

Model number	EMPPT4860	EMPPT4880	EMPPT48100	EMPPT48120
MPPT efficiency	≥99%			
Whole machine conversion Efficiency	≥97%			
Installation	Cabinet Installation			
Heat dissipation method	Air cooling			
Input operating voltage range *	65~250VDC (Recommended 120V~250V)			
Start charging Vstart-pv	Vbat+3V			
Low voltage protection Vlow-pv	Vbat+2V			
Input Protection Voltage	250Vdc			
Input Protection Recovery Voltage	245Vdc			
Rated input power**	3360W	4480W	5600W	6720W
Component Access	Supports 2 equal accesses			
Output DC voltage range	Output range: 42V to 60VDC (Factory default output: 56VDC)			
Battery management	Output charging parameters and protection parameters can be set			
Output DC current	0~60A(Adjustable)	0~80A（Adjustable）	0~100A(Adjustable)	0~120A(Adjustable)
Output Voltage Setting	Setting of equalizing voltage, floating voltage			
Electricity measurement	1. Built-in DC meter function; 2. Controller comes with metering;			
Communication method	Standard Modbus protocol			
Monitoring Methods	Remote monitoring with 4G module or PC software			
Photovoltaic input protection	Input over-voltage and under-voltage protection, reverse connection protection, anti-reverse current protection			
Output protection	Voltage regulator protection, battery reverse connection protection, battery disconnection protection and over-under-voltage protection, etc.			
General Protection	Thermal over-temperature protection and over-temperature load reduction operation, environmental over-temperature protection, etc.			
Product Size	482*350*89mm （2U）			
Product weight (kg)	5.4	6.7		
Operating Temperature	-20℃ ~+50℃			
IP Protection Rating	IP21			
Altitude	≤3000m			

*The PV array voltage shall not exceed this limit.

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

2.6 Maximum power point tracking technology

Due to the non linearity of the solar array and the influence of the light environment, there exists a maximum energy output point (maximum power point) of the array on its power curve, this series of controllers have MPPT control technology, which can always track to the maximum power point of the array in order to obtain the maximum energy for battery charging, while the traditional controllers (switching charging and PWM charging technology) can't maintain the charging of the battery at this point. Traditional controllers (switching charging and PWM charging) cannot maintain the battery at this point, and therefore cannot capture the maximum energy of the battery panels.

As shown in the figure below, which is also the characteristic curve of the array, MPPT technology "boosts" the system charge current by tracking the maximum power point of the array. Assuming 100% system charge conversion efficiency, the following equation holds:

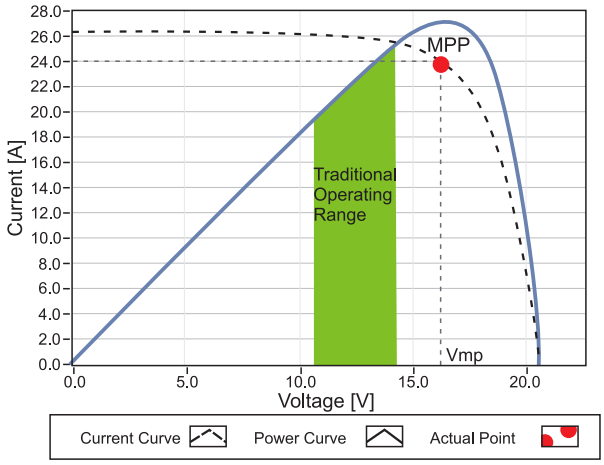
Controller input power (Solar panel input power) (P_{PV}) = Controller output power (P_{Bat})

⇓

Input voltage (V_{Mpp}) *Input Current(I_{PV}) = Charging voltage (V_{Bat}) *Charging current (I_{Bat})

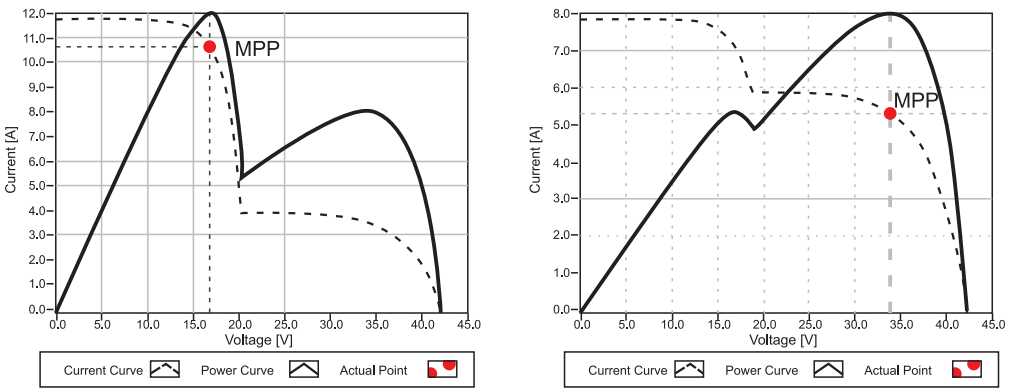
Under normal circumstances, the VMpp of an array is always greater than the VBat, and because of the principle of conservation of energy, the IBat is always greater than the IPV. if the difference between the VMp and the VBat is greater, then the difference between the IPV and the IBat is greater, which is the easiest way to tell if it is an MPPT controller or not.

As shown in the figure below, the maximum power point tracking curve of our products, in which the shaded part is the working range of the traditional controller, it can be clearly judged from the figure that the MPPT algorithm can effectively improve the utilization rate of solar arrays. According to the test comparison, our company's MPPT controller than PWM controller can enhance the utilization efficiency of solar arrays by 20% to 60%. (according to different use of environmental background, the efficiency varies)



Maximum power point tracking curve

In practice, multiple MPPT points may appear in the array due to cloud cover, tree branches, or snow cover, but only one of these MPPT points is the actual maximum power point, as shown in the following figure:



Maximum power point tracking bimodal plot

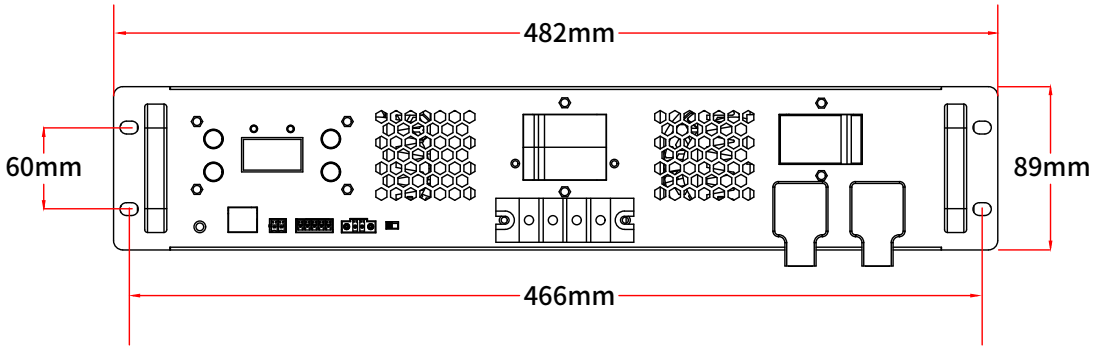
When there are multiple MPPT points, if the MPPT algorithm is not handled properly, it will lead to working on non-MPPT points, in this case the conversion efficiency is low. The maximum power point tracking algorithm of the controller designed by our company is able to quickly and accurately track to the actual MPP points, improve the utilization rate of the array energy, and avoid wasting resources.

3.0 Installation

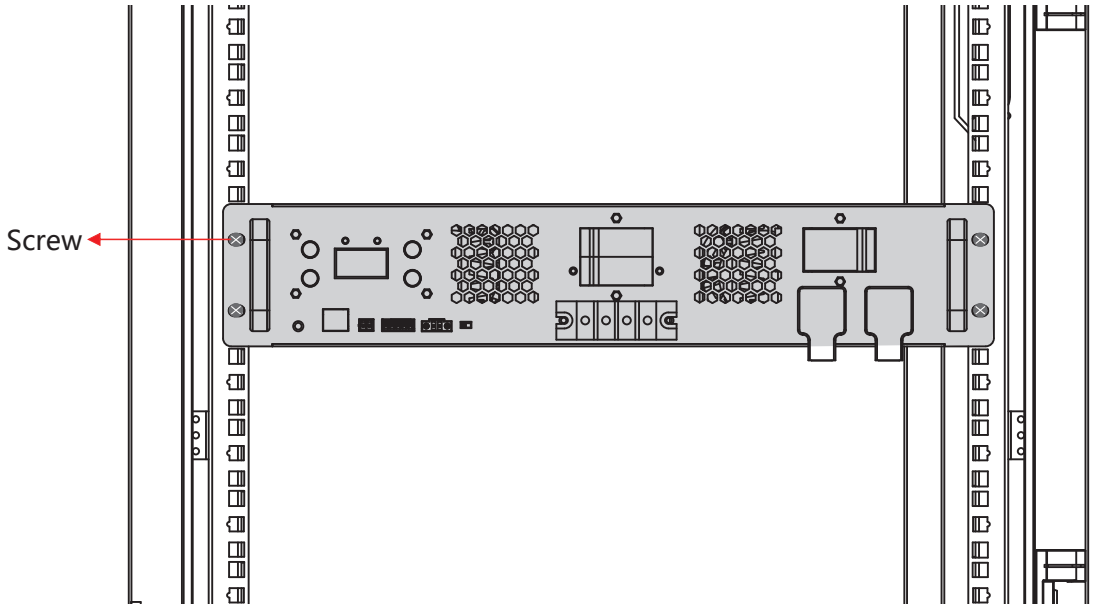
3.1 Mounting Types

➢ **Racked-mount**

- Dimensions:

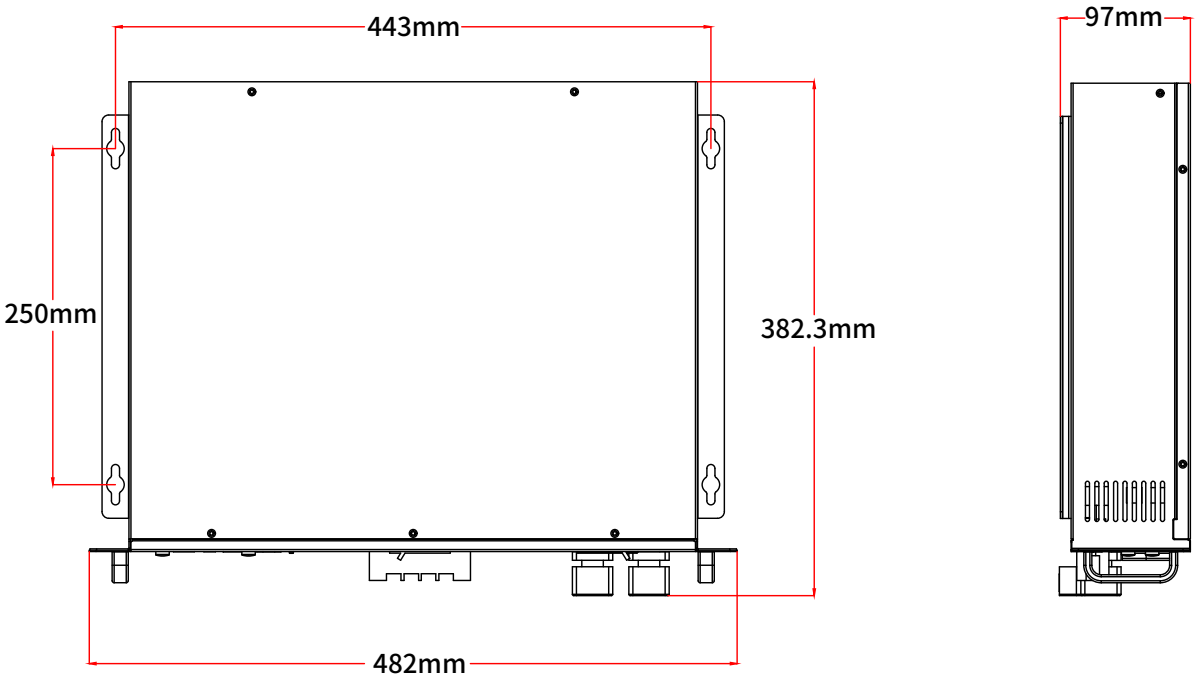


- Installation Diagram:

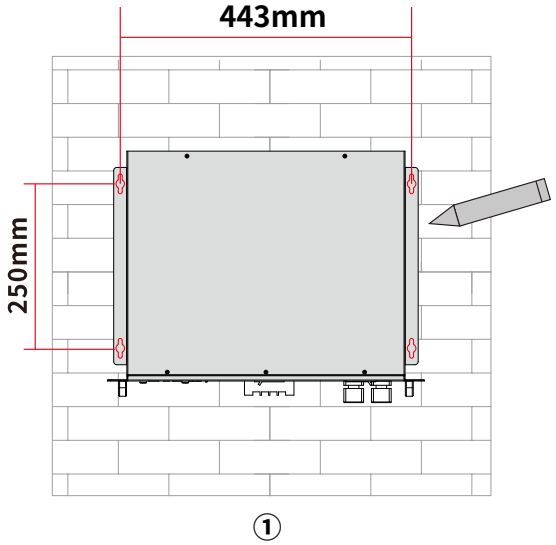


➢ Wall-mount

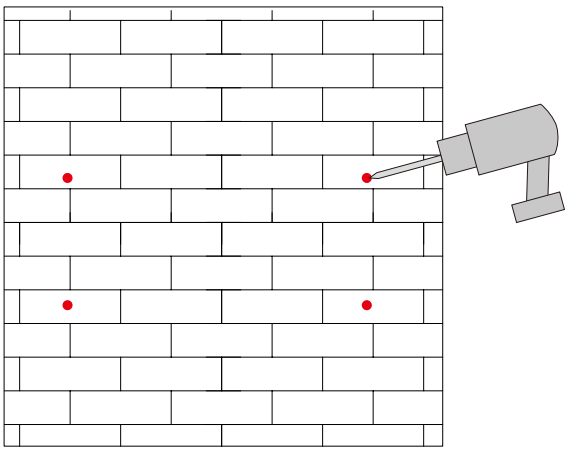
- Dimensions:



- Installation Diagram:



①



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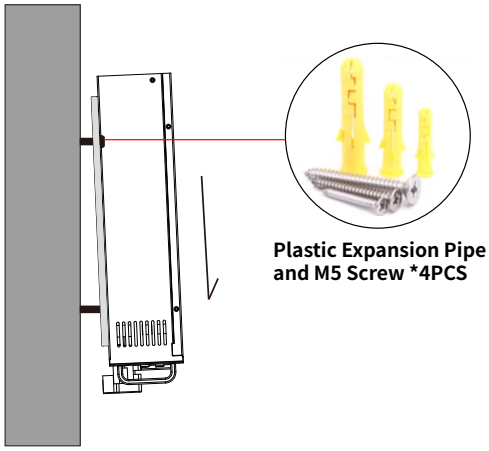


③

3.2 Precautions before installation

➢ Installation position

- To install the controller, choose a dry and ventilated location that is easy to remove and service.
- Do not install on flammable and 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 moisture, flammable and explosive or large concentrations of dust.
- The temperature of the controller may exceed 40°C during operation, so install the controller in a location that is not easily accessible to non-professionals.
- Do not install in direct sunlight, direct sunlight causes the body temperature to rise, affecting the product's own heat dissipation effect, resulting in product damage.

➢ Safety information

- Wear insulated tools for installation.
- Disconnect all power to the controller before installing or adjusting the controller.
- It is recommended that 2 or more people operate and install the unit, and in the event of an accident, ask someone nearby to assist.
- The controller must be installed by a qualified technician or a person trained in safe installation in accordance with the electrical code of the country in which it is located.

➢ Proper use

- This controller is intended for solar power only. Connecting to any other type of power source (such as a wind turbine or generator) may void the warranty.
- There are no user-serviceable parts inside the controller; do not disassemble or attempt to repair the controller.
- When servicing the product, disconnect the product's internal circuit breaker before proceeding.

3.3 Installation and power-On Procedure

➢ Step 1: Unpacking Inspection

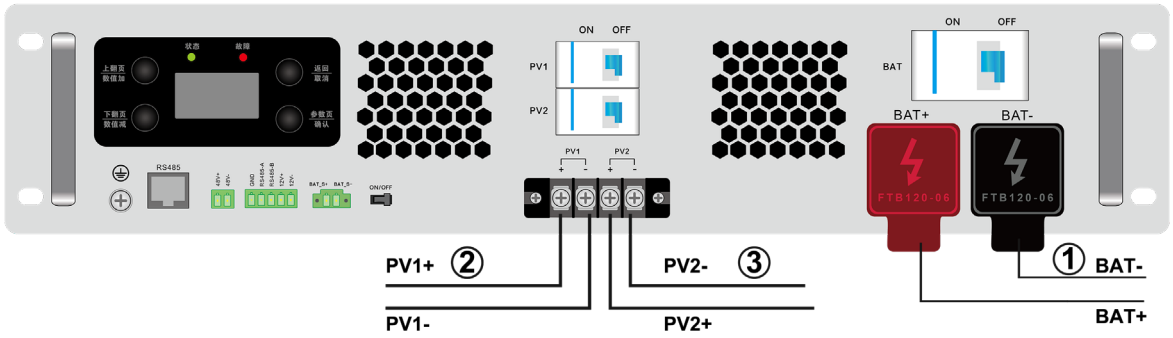
Check the controller for transportation damage and bumps; check whether the specification parameters are consistent with the order.

➢ Step 2: Check Controller Parameter Limits

Ensure that the solar array open circuit voltage (Voc) at the lowest temperature compensated condition of operation does not exceed the rated voltage value of this model controller. Multiple controllers can be mounted in parallel on the same battery bank for greater charging current, each controller in parallel must be connected to a separate solar panel.

➢ Step 3: Sequence of connection

After connecting the cable to the terminals, connect the corresponding positive and negative terminal positions on the controller according to the serial number sequence, and the circuit breaker is in the disconnected state before wiring. The following diagram.



➢ **Step 4: Power on**

Check to make sure all cables and terminals are securely connected before powering on;

1. Close the circuit breaker for the battery connection ① , and make sure the controller is connected to the battery (the controller OLED will display contents), at this time you can set the output operating parameters ;

2. Turn on the circuit breaker of the PV input of the solar panel ② , if the voltage of the PV input is within the charging operating range of the controller, then the controller will enter the charging state;

	Reminder: After ① circuit breaker is connected, the controller fails to turn on, may be the battery loss of power to connect the reverse or not firmly connected, please check the battery circuit; it will power up with PV input after turn off the ② circuit breaker
	Reminder: This controller prevents reverse current leakage during the night, so diodes do not need to be connected in series in the system.
	Note: Before closing the circuit breaker, please measure the open circuit voltage of the battery to make sure the positive and negative terminals are correct; the voltage must exceed 40V for the controller to operate.
	Note: Avoid incorrectly connecting the PV input to the controller's output power cable when wiring, otherwise may damage the controller's internal circuitry and void the warranty.
	Note: Installation must comply with electrical code requirements. This controller has built-in circuit breakers, If external circuit breakers and fuses are required, select the appropriate specifications according to the application requirements.
	Warning: Ensure that the connection is secure and that the cable is held in place with a cable clamp to prevent the cable from swaying and overheating dangerously in mobile applications.
	Warning: Risk of electric shock. Before contact, test the impedance between all terminals and ground.
	Warning: The positive power terminal of the controller is connected (common positive). If necessary, it must be grounded in accordance with instructions, local codes and regulatory requirements.

3.4 Power off

Disconnect the No. ② circuit breaker for serial and then Disconnect the I No. ① circuit breaker to ensure that the controller is powered off before carrying out maintenance or other operations on the controller.

4.0 Setup and Operation

4.1 PV module series connection rules

Due to the different types of photovoltaic modules on the market, the controller, as a core component in the photovoltaic system, can be suitable for various types of photovoltaic modules and can maximize the conversion of solar energy into electricity is particularly important, so according to the controller's open-circuit voltage(VOC) and voltage at maximum power point (VMPP) can be calculated to fit the number of PV modules in series for different types.
For series programming, the total open circuit voltage (VOC) in series should be less than the controller's calibrated maximum input voltage of 250V and the total theoretical maximum power point voltage (VMPP) in series should be greater than 65V.

4.2 Total PV module input power

This series of controllers have the function of charging current limitation, i.e., the controller can limit the charging current within the rated charging current of the controller, and the controller can get the maximum power which is not greater than the rated charging current of the controller, therefore, even if the power inputted into the PV side of the controller is more than the rated charging power of the controller, the controller will charge the batteries in accordance with the rated charging current of the controller. For example, if the rated power is 60A and the controller is used in 48V system, the charging current will not exceed 60A no matter how big the solar panel is input.
The actual operating power of the PV array meets the following conditions:
1) When the actual power of the PV array ≤ the rated charging power of the controller, the maximum charging power of the controller is the actual power of the PV array.
2) When the actual power of the PV array > the rated charging power of the controller, the controller works according to the power of the rated charging current. If the power of the PV array is greater than the rated charging power of the controller,then the charging time with the rated charging current will be extended, so that more energy can be obtained to charge the battery, and at the same time in the case of strong sunlight, because of the current limiting effect, which also results in the waste of solar panels.

Reminder: Please refer to the parameter table for the rated power of different models!

4.3 Total PV module input power

Wiring and installation methods must comply with national and local electrical code requirements. Since the output current of a PV array is affected by the type of PV module, connection method, and light, the minimum wire diameter of a PV array is calculated based on the short-circuit current of the PV array. Please refer to the PV module data sheet for the short-circuit current value (short-circuit current is unchanged when PV modules are connected in series; when connected in parallel, the short-circuit current is the sum of short-circuit currents of all modules connected in parallel).

4.4 Controller On and Off Procedure

Wiring and installation methods must comply with national and local electrical code requirements. Since the output current of a PV array is affected by the type of PV module,
connection method, and light, the minimum wire diameter of a PV array is calculated based on the short-circuit current of the PV array. Please refer to the PV module data sheet for the short-circuit

current value (short-circuit current is unchanged when PV modules are connected in series; when connected in parallel, the short-circuit current is the sum of short-circuit currents of all modules connected in parallel).

➢ **Step 1:**

Secure the controller in the desired mounting location;

➢ **Step 2:**

Crimp and insulate the UT copper terminals supplied with the kit for the PV input cables, and crimp and insulate the OT copper terminals supplied with the kit for the battery cables;

➢ **Step 3:**

Use a multi-meter to measure the voltage at the positive and negative terminals of each cable, and after ensuring that the voltage is normal, install the cables on the corresponding marked terminal blocks, organize the cables and check to ensure that the wiring is tight;

➢ **Step 4:**

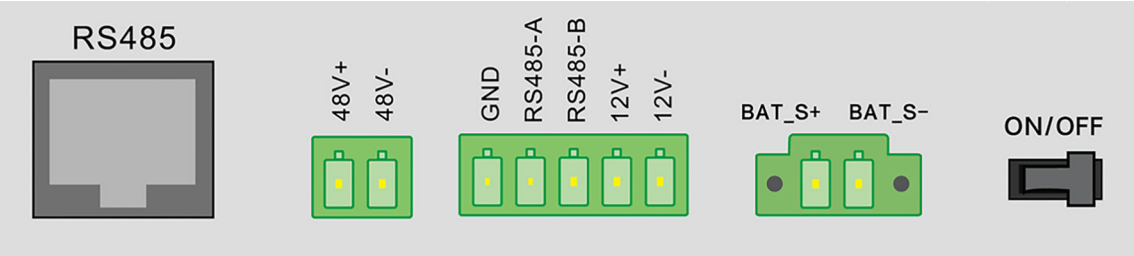
When powering up, you can turn on the battery switch first, and continue to turn on the switch of PV input only after the display lights up normally!

⚠	**Note:** For maintenance without power, follow this sequence: Disconnect all PV input switches -> Disconnect the battery switch.

⚠	**Warning:** Do not disconnect the battery while the controller is in the normal charging state as this may damage the DC loads and the resulting damage to the controller will not be covered by the warranty.

4.5 Controller Small Signal Cable Bar Description

The small signal wiring row area shown below:



48V+/48V-: This port is connected to the battery port inside the device, and can be used by the user for battery voltage sampling or auxiliary power supply of other 48V small power devices (less than 1A);

RS485-A/RS485-B: This port is the signal port for the RS485 communication bus of the controller;

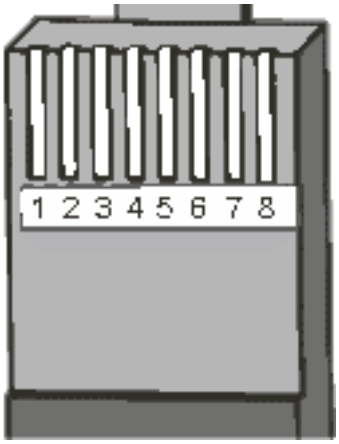
12V+/12-: This port is used for auxiliary power supply of some communication modules with 12V power supply (rated current less than 0.5A) BAT_S+/BAT_S-: Battery Sampling Port. (BAT_S+/_ S-(plotting*Note: When the controller does not use-external sampling, the switch is "OFF"(out). (Factory default: OFF); when the controller uses external compensation sampling, the switch needs to be turned to the "ON" state.)

⚠	**Note:** 2U device can be integrated with two controller modules, the default address is left 1 and right 2, users need to integrate management data, you can read the data of each controller module through the RS485 communication port by time sharing (if for one controller module, the address is 1 by default).

4.6 RS485 Wire Sequence Definitions for RJ45 Interface:

The communication port is a standard 8-wire RJ45 interface with the following pin definitions:

Pin	RJ45 Port	Pin	RJ45 port
1	RS485-A	5	GND
2	RS485-B	6	
3	Dry contact A (passive)* Option	7	5V
4	Dry contact B (passive)* Option	8	



4.7 Status indicator

Indicator light color	Icon	Indicator status	Controller Status
Green		Off	Indicates that all modules are on standby
		Flicker	Indicates that at least one module is charging the output
Red		Off	Indicates no faults
		Flicker	Indicates that there are multiple internal modules and at least one of them is working properly
		Steady lighting	Indicates that all modules are malfunctioning

4.8 Error code

When the device is running normally, the fault code information will show "Normal", when there is a malfunction or warning will be prompted in the form of a code, the specific malfunctions or warnings can be referred to the following table description:

left to right	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
1	IGBT Fault	Battery overvoltage	Photov oltaic over voltage	Charging over current	Environ mental over heating	Thermal over heating	Battery under voltage	Battery overvoltage (hardware)	command shutdown
0	No related faults or warnings								

4.9 Configurable items

Outputs the value of the parameter setting:

Settings item	Function	Operation	Value
Battery overvoltage	System output overvoltage protection point (corresponding to lithium battery parameter overvoltage protection)	Press the scroll up/down key after moving the cursor. Adjust the values	Adjustment step: ±1V, ±0.1V Range: 48.0~60.0V
Ove r-voltage recovery	Shows the recovery point after system overvoltage protection(overvoltage recovery corresponding to lithium battery parameters)		Adjustment steps are: ±1V, ±0.1V Range: 48.0~ Battery overvoltage -0.2V
Equalize charge voltage	System output target voltage (corresponding to lithium battery parameter saturation charging voltage)		Adjustment step: ±1V, ±0.1V Range: 32.0~ Battery over-voltage -0.2V

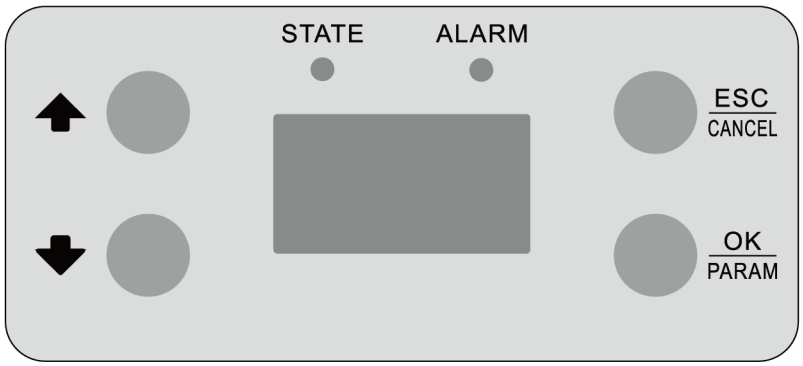
Float Charge Voltage	System float voltage, no practical use in software (corresponds to nominal voltage of Li-ion battery parameters)	Press the scroll up/down key after moving the cursor. Adjust the values	Adjustment step: ±1V, ±0.1V Range: 32.0~ Charge Voltage

System parameter setting values:

Settings item	Function	Operation	Value
Number of modules	Number of modules inside the system	Press the scroll up/down key after moving the cursor. Adjust the values	Range: 1~4
Maximu m current	Maximum system charging current		Adjustment step is:±1A Range: 10~60* Number of modules
Local number	System external communication address number		Setting range: 1~247
Battery capacity	System configuration battery capacity		Adjustment steps ±100, ±10, ±1 Range:0~2000AH

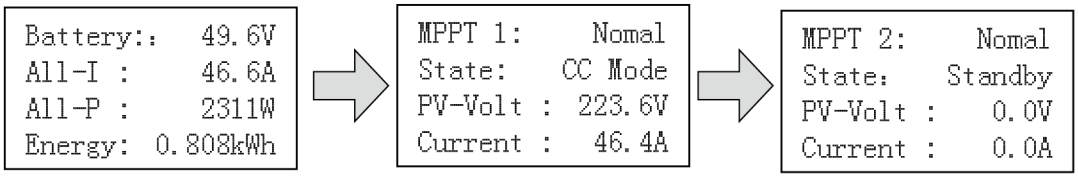
4.10 Operation Setting

Operation panel

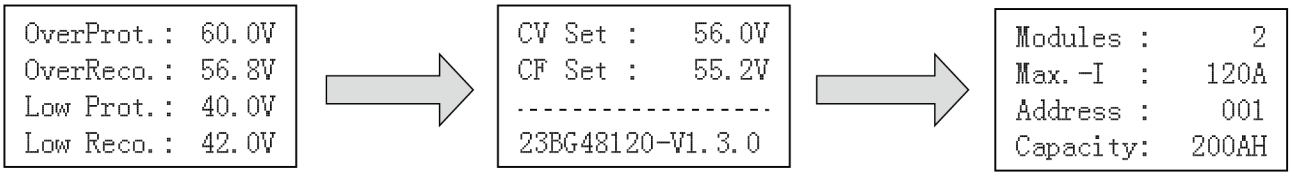


User interface

Default Home Screen Press"⬇⬆"bey to switch the main interface,check the state of modules;

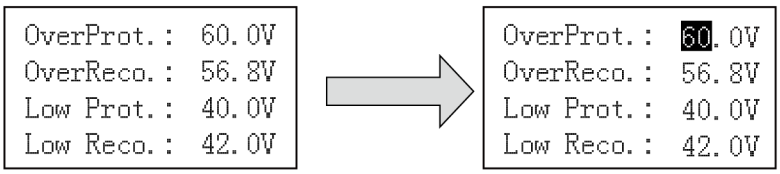


Parameter Press the "Param"Continu ously and switch to parameter interface;



Parameter Setting

Switch to the interface of parameter setting,Press and hold “OK”key for 3 seconds to enter the paraneter setting.



* Press “⬇⬆”to adjust the Value,then press “OK”to Save the value it will shows setting successfully;
* Press “ESC/Cancel”to cacel the current setting and return to the parameter screen;
* 20 seconds withour any operation,it will return to normal page;
* Modules statuss will be shown sperately,but setted together。

5.0 Common Failures and Troubleshooting

5.1 Common Failures

Unable to charge troubleshooting:

Check that the solar panels are good contacted and that the array is not shaded or damaged;
Check that the controller input voltage is normal and ensure that the controller is wired correctly;
Check the battery status and replace if necessary.

Display troubleshooting:

Try rebooting the controller and observe if it returns to normal;
If the display is damaged, contact the manufacturer for replacement or repair;
If the internal circuitry of the controller is damaged, contact the manufacturer for replacement or repair.

Communication troubleshooting:

Check whether the data cable is damaged, contact the manufacturer for replacement or repair;
Ensure that the communication interface is connected correctly without looseness or damage;
Verify the communication protocol settings to ensure that they match other devices.

	**Warning:** There are no user-serviceable parts inside the controller; do not disassemble or attempt to repair the controller yourself.

	**Warning:** Inputs and outputs are not electrically isolated and may be energized with hazardous solar voltages. Batteries may be overcharged under certain fault conditions. Take protective insulation measures before touching.

6.0 Product Protection Functions and System Maintenance

6.1 Introduction to Protection Functions

- **Waterproof and dust proof protection:IP21**
  EMPPT4860~EMPPT48120 Dust proof grade: Grade 2, Waterproof grade: Grade 1 ; Dust proof grade: Grade 2, Waterproof grade: Grade 1
- **Battery reverse connection protection**
  The system does not work when the positive and negative terminals of the battery are reversed and will not burn out the controller.
- **Short-circuit protection for photovoltaic inputs**
  The controller disconnects charging after a short circuit at the PV array input, and charging resumes automatically when the short circuit condition is cleared.
- **Photovoltaic input reverse connection protection**
  The controller will not be damaged when the polarity of the PV array is reversed and will continue to operate normally after correcting the wiring error.
- **Internal over-temperature protection**
  When the internal temperature of the controller reaches a limited threshold, it automatically operates with reduced power.
- **Heat sink temperature limit**
  When the radiator temperature exceeds the maximum tolerance threshold, the controller automatically cuts off power to stop operation.
- **Battery dropout protection**
  The charging circuit is automatically disconnected when the battery is overcharged, preventing overcharging and prolonging the service life of the battery.

	**Note:** There is no GFDI (Ground Fault Detection Device) inside the controller.

6.2 System maintenance

- To maintain optimal work performance, it is recommended that the program be inspected more than twice a year.
- Verify that airflow around the controller is not blocked by removing dust and blockages from the chassis ventilation holes.
- Inspect all exposed conductors for damage to insulation due to sunlight, friction with other surrounding objects, dry rot, insect or rodent damage, etc. Repair or replace wires as necessary.
- Verify that the indicators are consistent with the operation of the unit. Note any malfunctions or error indications Take corrective action if necessary.
- Inspect all terminals for signs of corrosion, insulation damage, heat or burning/discoloration, tighten terminal screws.
- Check for dirt, nesting insects and corrosion and clean as required.

	**Warning:** Danger of electric shock! Always make sure that all power to the controller is disconnected before carrying out any checks or operations!