PV HUB EMS

Balcony Photovoltaic

Energy Storage Controller

User Manual

V1.0301

Foreword

Thank you for purchasing PV HUB EMS balcony photovoltaic energy storage controller（PV HUB EMS for short）.

The PV HUB EMS products described in this manual mainly provide solutions for the balcony photovoltaic energy storage. This user manual introduces how to use PV HUB EMS balcony photovoltaic energy storage controller correctly. The PV HUB EMS system is composed as follows:

- Power module 1;
- Power module 2;
- Control part of photovoltaic panel path 1;
- Control part of photovoltaic panel path 2;
- The control part of micro inverter path 1;
- The control part of micro inverter path 2;
- Wireless communication module;
- Auxiliary power supply part.

Before using (installation, debugging, operation, maintenance and inspection), please read the instruction manual carefully.

Precautions:

1. The illustrations in this manual are for illustration only and may be different from the products you ordered.
2. Due to product upgrade or change, and in order to improve the convenience and accuracy of the manual, the contents of this manual will be changed in time.
3. If you need to order the instruction manual due to damage or loss, please contact our regional agents or directly contact our customer service.
4. If you still have some unclear problems in use, please contact our customer service center.

Safety Precautions:

1. Before installation:Please check the materials carefully. If there are any missing or damaged materials, please do not install them dangerously.
2. Before installation:Be sure to read the operation manual carefully before operation.
3. When installing: strictly observe the installation sequence.
4. All modules can be powered on only after they are properly connected, and plugging and unplugging is prohibited when they are powered on, otherwise there is a risk of electric shock or burning out modules.
5. Non-professionals are not allowed to disassemble the module shell, and they are not allowed to touch the internal circuit board to avoid electric shock accidents.
6. It is forbidden to modify or use this system on other projects without the confirmation of the manufacturer's technicians, so as to avoid serious accidents.

Data version: V1.0301

Advantages of the Product

PV HUB EMS balcony photovoltaic energy storage controller, independently developed by our company, includes hardware device with photovoltaic intelligent charging and discharging management strategy and mobile platform for visual monitoring operation, which intelligently realizes the adaptive balance among solar energy, battery power and energy consumption of household appliances.

Intelligent photovoltaic charge and discharge management strategy and hardware device:

The strategy effectively controls the coordinated operation of four parts: battery charging and discharging, output power of micro-inverters, photovoltaic panel charging to batteries, and PV HUB EMS discharging to micro inverters through the power hardware platform.

The hardware platform realizes the flexible collocation of two photovoltaic panels, two micro inverters and energy storage batteries for power control, including two photovoltaic panels discharging to two micro inverters at the same time, charging the battery, discharging while charging, and discharging the battery to the micro inverter.

Visual monitoring operation mobile platform:

The platform adopts IoT technology, which can set the operation mode of device in real time, monitor the operation status of device and household electricity consumption, and support remote upgrade.

Catalogue

Chapter 1 Overview of the system

Balcony photovoltaic energy storage controller (referred to as PV HUB EMS) is an electrical system that enables photovoltaic panels to output more electric energy by adjusting the working state of electrical modules. It is a bridge between solar energy and lithium batteries and the outside world. It can effectively store the direct current emitted by solar panels in the battery, and connect it with the power load and power grid through the micro inverter, effectively solving the key technical problems such as safety, availability, ease of use and service life in the photovoltaic energy storage system, and providing clean energy efficiently without causing environmental pollution.

1.1 Application Mode

This product can be applied to balcony photovoltaic energy storage system.

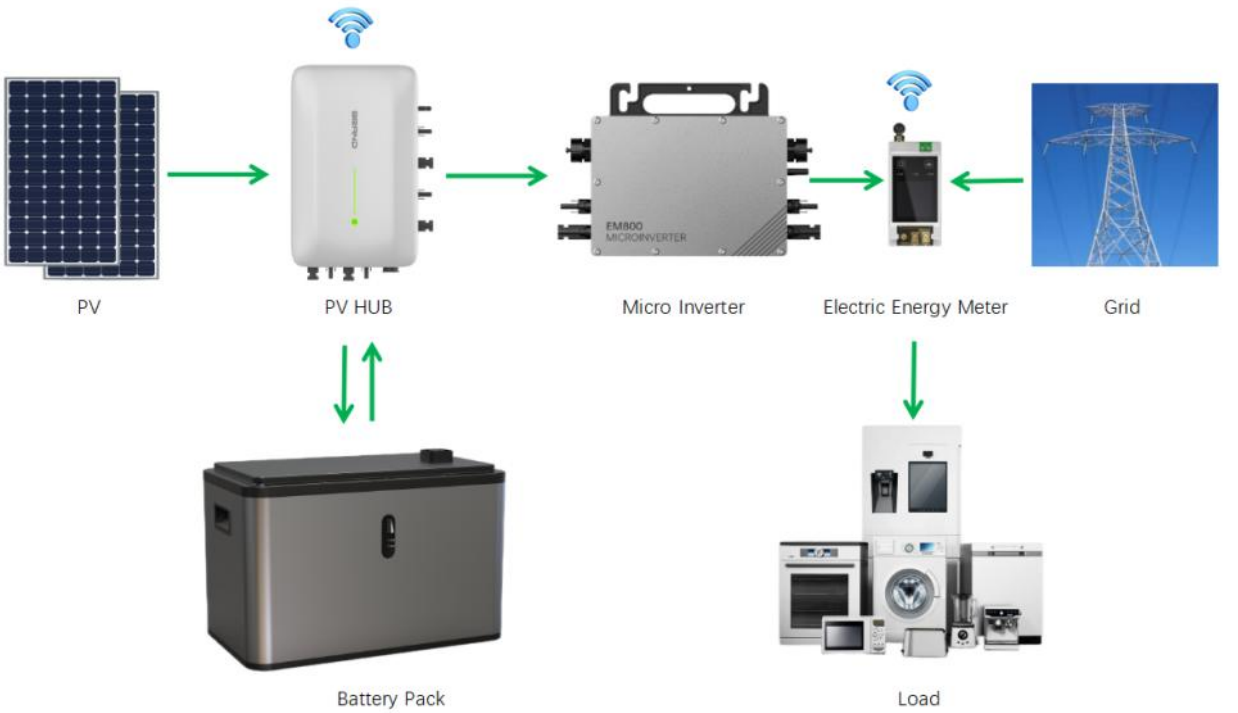


Figure 1-1 Separate Vertical Balcony Photovoltaic Energy Storage System

1.2 Application Scenarios

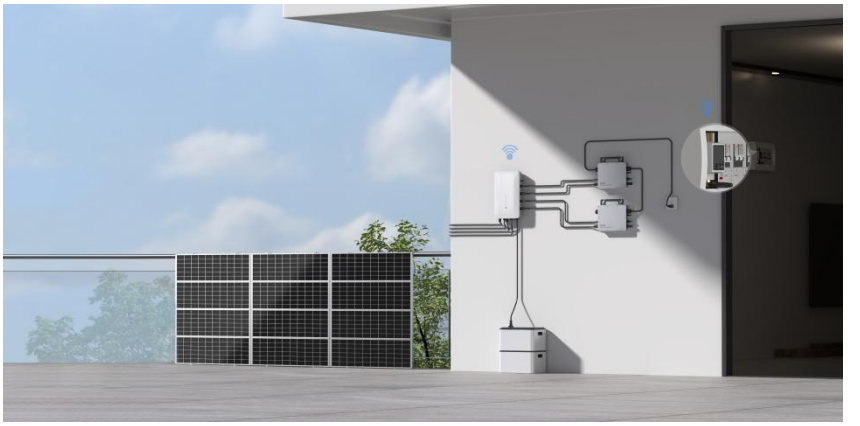


Figure 1-2-1 Balcony Photovoltaic Energy Storage System

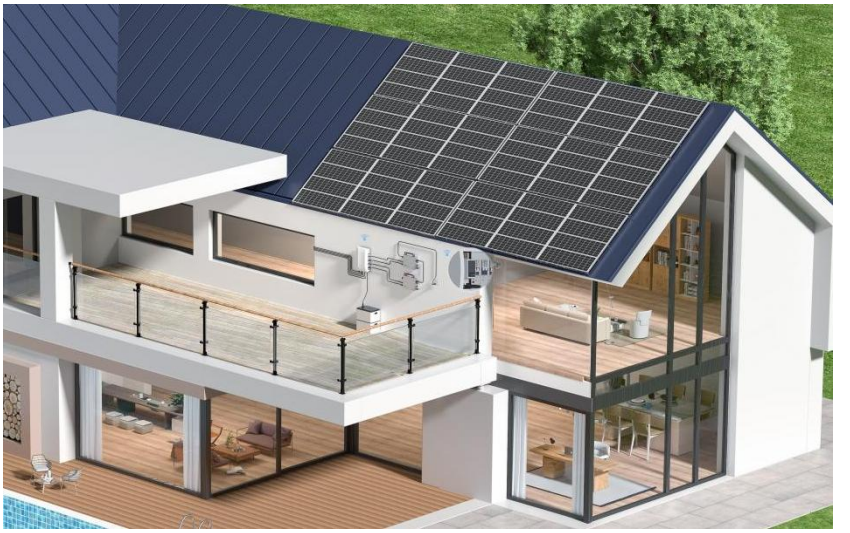


Figure 1-2-2 Rooftop Photovoltaic Energy Storage System

Figure 1-2-3 Courtyard Photovoltaic Energy Storage System

1.3 Function Introduction

The series of PV HUB EMS products not only have basic functions such as power quantification and flow path control, Wi-Fi communication control, temperature collection, current collection, maximum power point tracking of photovoltaic panels, system self-inspection, but also innovatively configure advanced functions such as multi-battery pack parallel strategy, cloud monitoring, capacity management, charging management and power distribution management.

1.4 System Block Diagram

The system consists of main control module MCU, drive control module, power conversion part, auxiliary power supply module, Wi-Fi module, current sampling and voltage sampling module. MCU, the main control module, identifies the access and load supply states of photovoltaic panel and battery and micro inverter through voltage and current sampling, runs the algorithm to enable the driving module, and then controls the DCDC conversion power. The device allows users to set and adjust the power flow path and power size through the mobile phone APP. (PV HUB EMS realizes information interaction control with BMS of battery pack through RS485 communication module, and realizes the interaction between cloud data uploaded by Wi-Fi module and control information of mobile phone.)

The PV HUB EMS system is as shown in the figure:

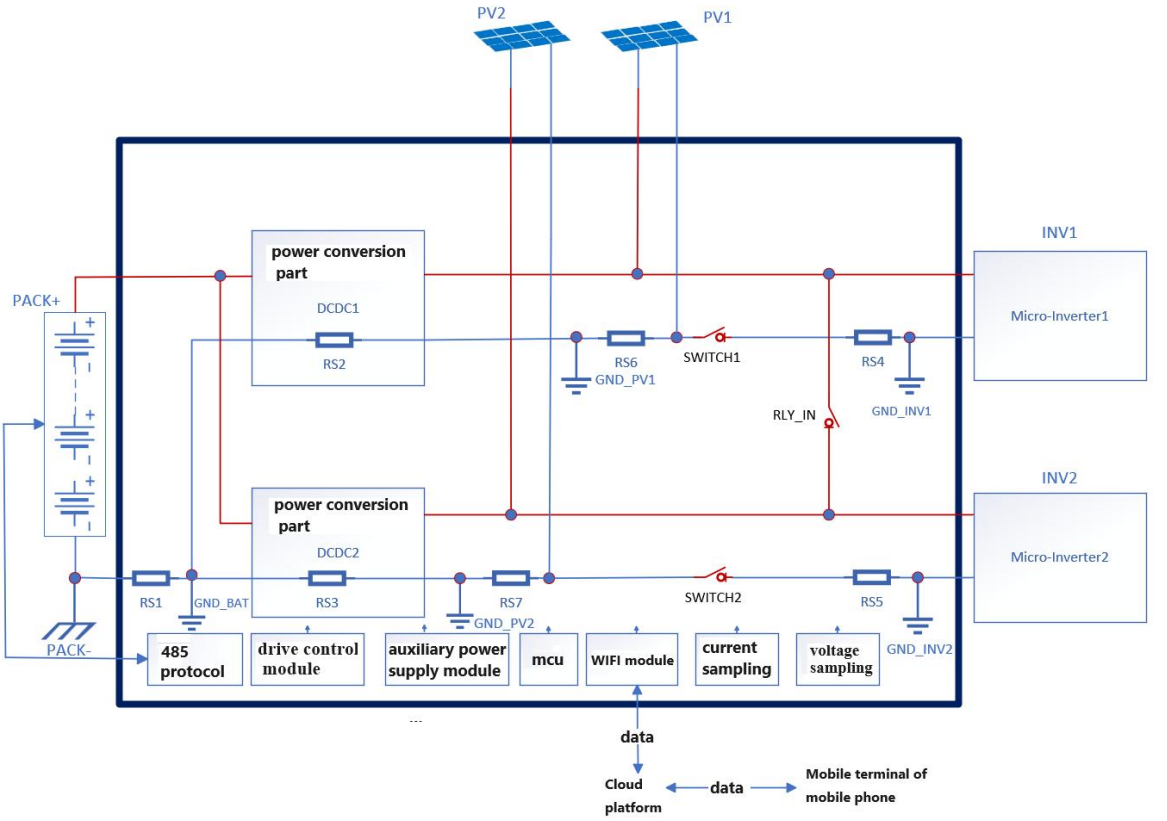


Figure 1-4 Block Diagram of PV HUB EMS System

1.5 System Parameters

Table 1-4 Parameter List of PV HUB EMS System

PV input voltage range	12V-60V	peak efficiency	98%
PV input power	800W×2 Max	MPPT tracking efficiency	99%
output voltage range	18V-55V	battery short-circuit protection current	66A
output rating	800W×2 Max	operating ambient temperature	-20°C~65°C
battery voltage range	40V-58.4V	the protection grades	IP65
battery charging power	1600W Max	RS485 and CAN	support
EMC grade	CLASS-B	Wi-Fi communication	support
weight	≈3.2kg	size	320×200×65mm

Chapter 2 Module Introduction

2.1 Model Description

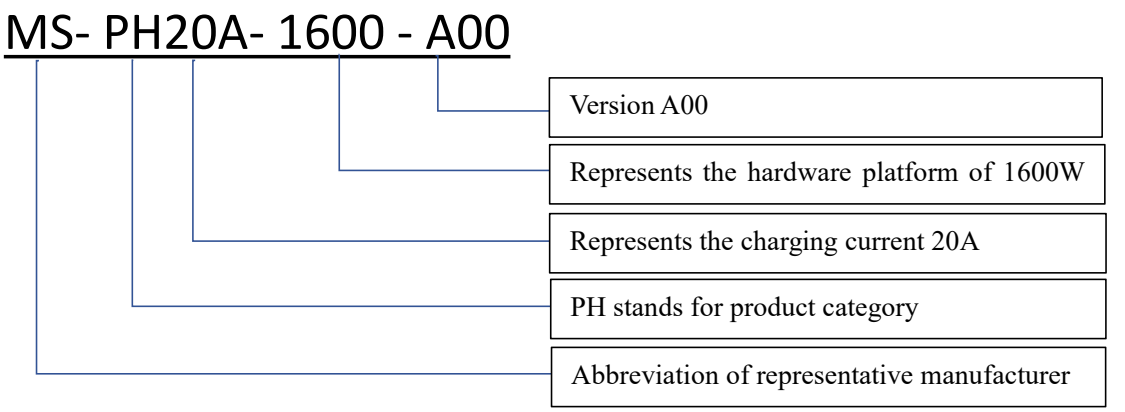


Figure 2-1 Description of PV HUB EMS

2.2 Interface Definition

PV HUB EMS has many external interfaces, which can meet the application requirements of various occasions. These interfaces include:

Battery pack interface, communication interface (RS485, CAN, Wi-Fi), two photovoltaic panel power interfaces (which can support the maximum power of each photovoltaic panel of 800W), and two micro inverters interfaces (which can support the maximum power of each micro inverter output of 800W).

As shown in Figure 2-2-1, the PV HUB EMS is electrically connected with solar photovoltaic panel and micro inverter through MC4 connectors. The outgoing line of the solar photovoltaic panel and the micro inverter must refer to the connector type shown in Figure 2-2-1, otherwise the connection cannot be realized.

Figure 2-2-1 Schematic Diagram of Interface of PV HUB EMS

The interface signal definitions for the PV HUB EMS control module are shown in Table 2-2-1.

Table 2-2-1 Communication Interface Description Table

interface	**definition**
PV1+	PV input+,input voltage range 12-60V (photovoltaic panel No.1+)
PV1-	PV input-,input voltage range 12-60V (photovoltaic panel No.1-)
PV2+	PV input+,input voltage range 12-60V (photovoltaic panel No.2+)
PV2-	PV input-,input voltage range 12-60V (photovoltaic panel No.2-)
INV1+	Output+,connected to micro inverter A input.
INV1-	Output-,connected to micro inverter A input
INV2+	Output+,connected to the micro inverter B input.
INV2-	Output-,connected to the micro inverter B input
BAT+	Battery pack+
BAT-	Battery pack-
Wi-Fi	Connecting seat of Wi-Fi antenna and built-in Wi-Fi module
CANH	H end of CAN communication
CANL	L end of CAN communication
RS485A	RS485 communication (communication with BMS of battery pack)
RS485B	RS485 communication (communication with BMS of battery pack)

2.3 Structure and Dimensions:

The overall structure dimensions of the PV HUB EMS with its casing are 340×213×67mm, as shown in Figure 2-3.

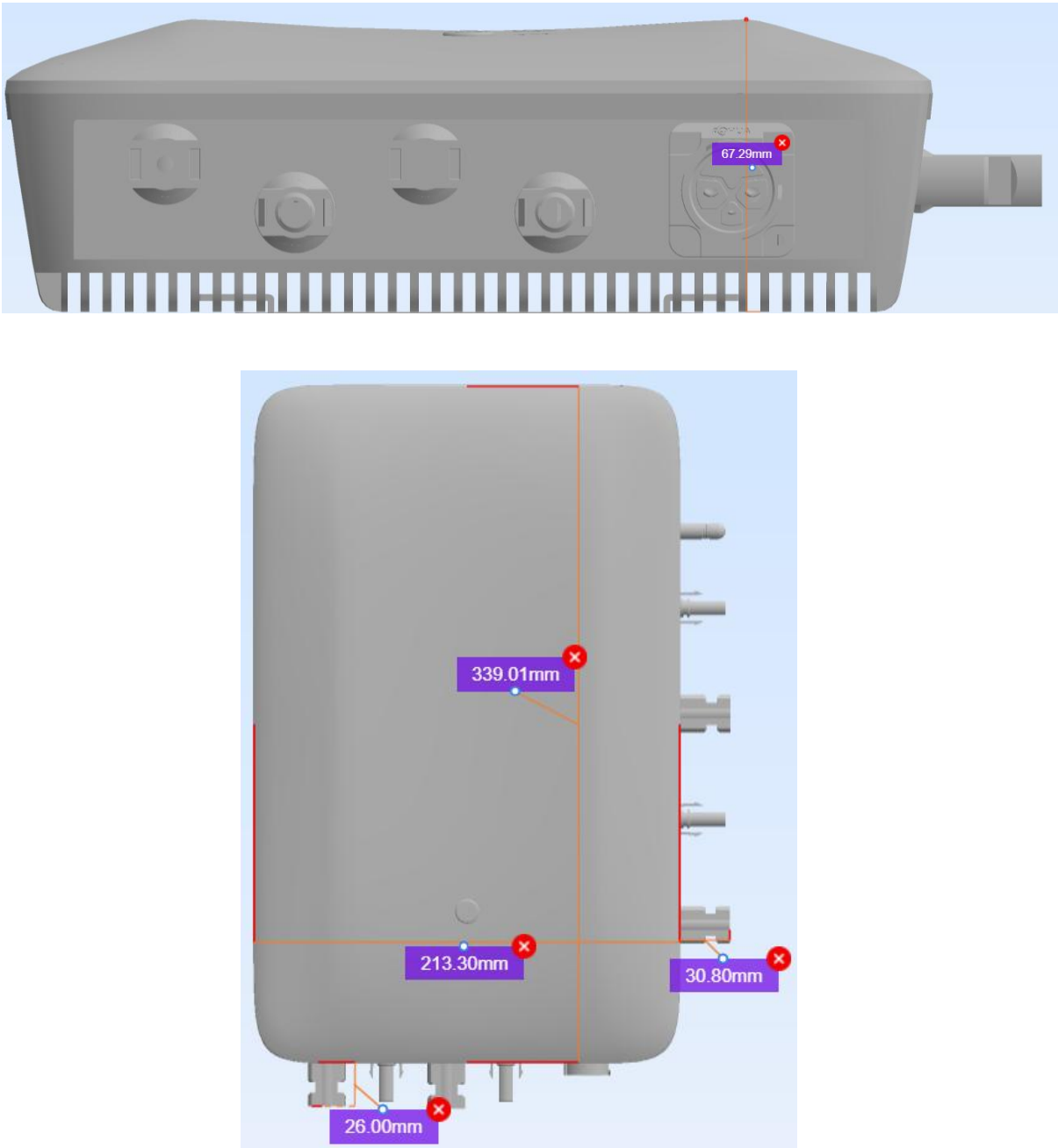


Figure 2-3 Overall dimensions of PV HUB EMS

Note: Overall assembly dimensions have a tolerance of ±0.5mm, and the approximate weight of the assembly is 3.2kg.

2.4 Connector Specifications and Parameters:

The PV HUB EMS is connected to the PV panel and micro-inverter with MC4 PV connectors. The specific parameters of the MC4 connector are as follows:

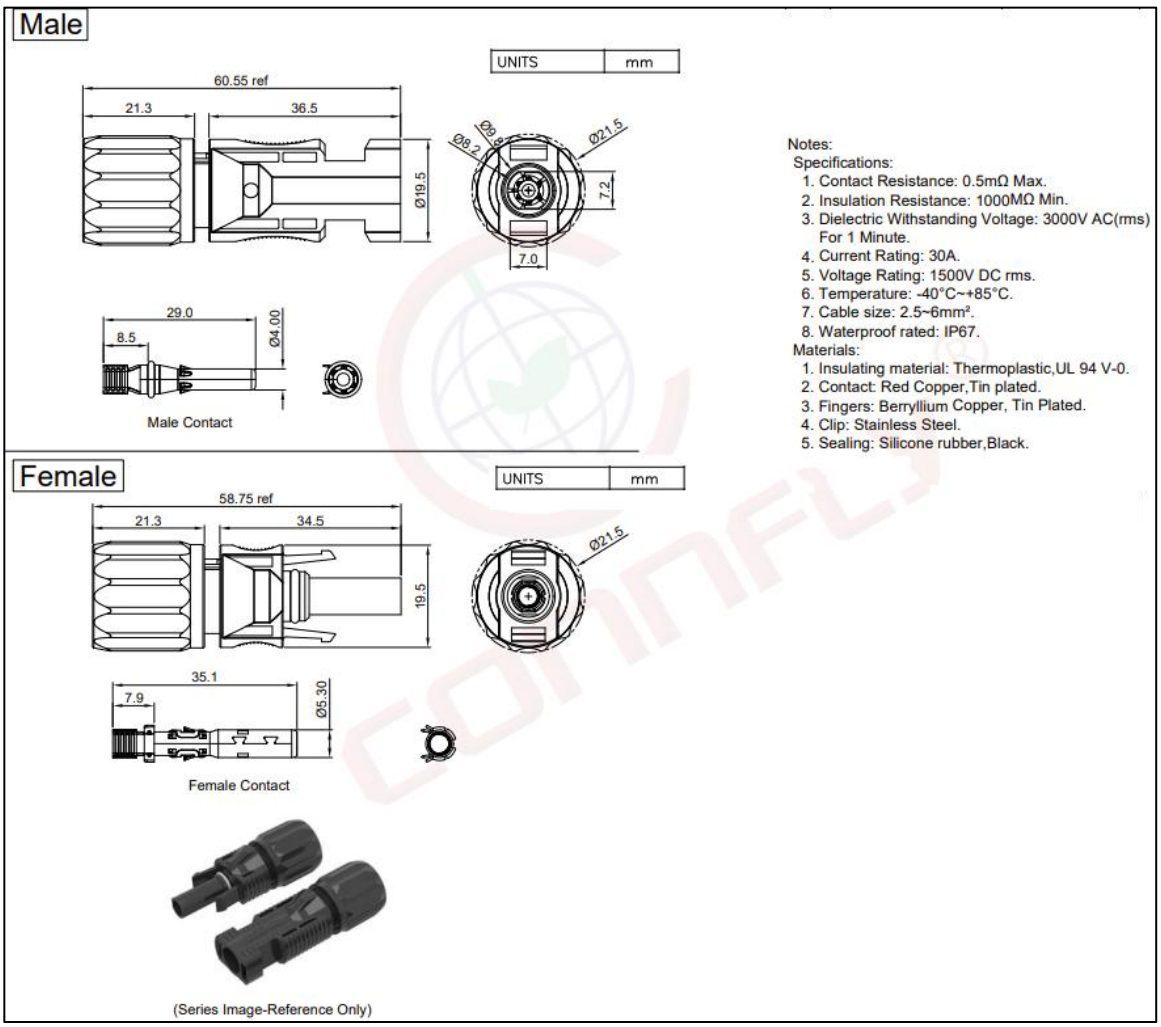


Figure 2-4-1 Schematic Diagram of MC4 Connector

The connection between PV HUB EMS and the battery pack is made through an aviation plug connector. The pin numbering and location of the connector are shown in Figure 2-4-1. The pin definitions for the aviation plug connector are provided in Table 2-4. The physical appearance of the aviation plug connector is shown in Figure 2-4-3.

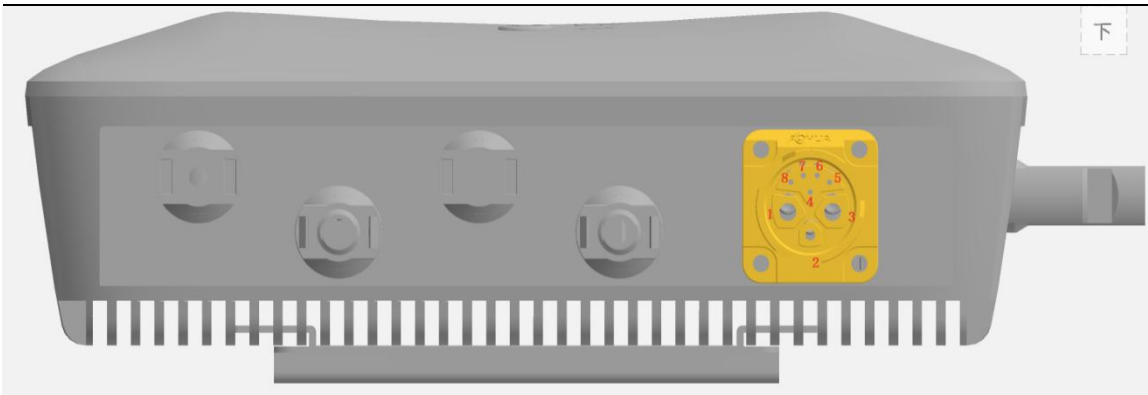


Figure 2-4-2 Schematic Diagram of Pin Number of Aviation Plug Connector

Table 2-4 Pin Definition of Aviation Plug Connector

pin number	meaning	pin number	meaning
1	Battery power negative line	2,6,7,8	NC
3	Battery power positive line		
4	RS485-A/CAN-H		
5	RS485-B/CAN-L		

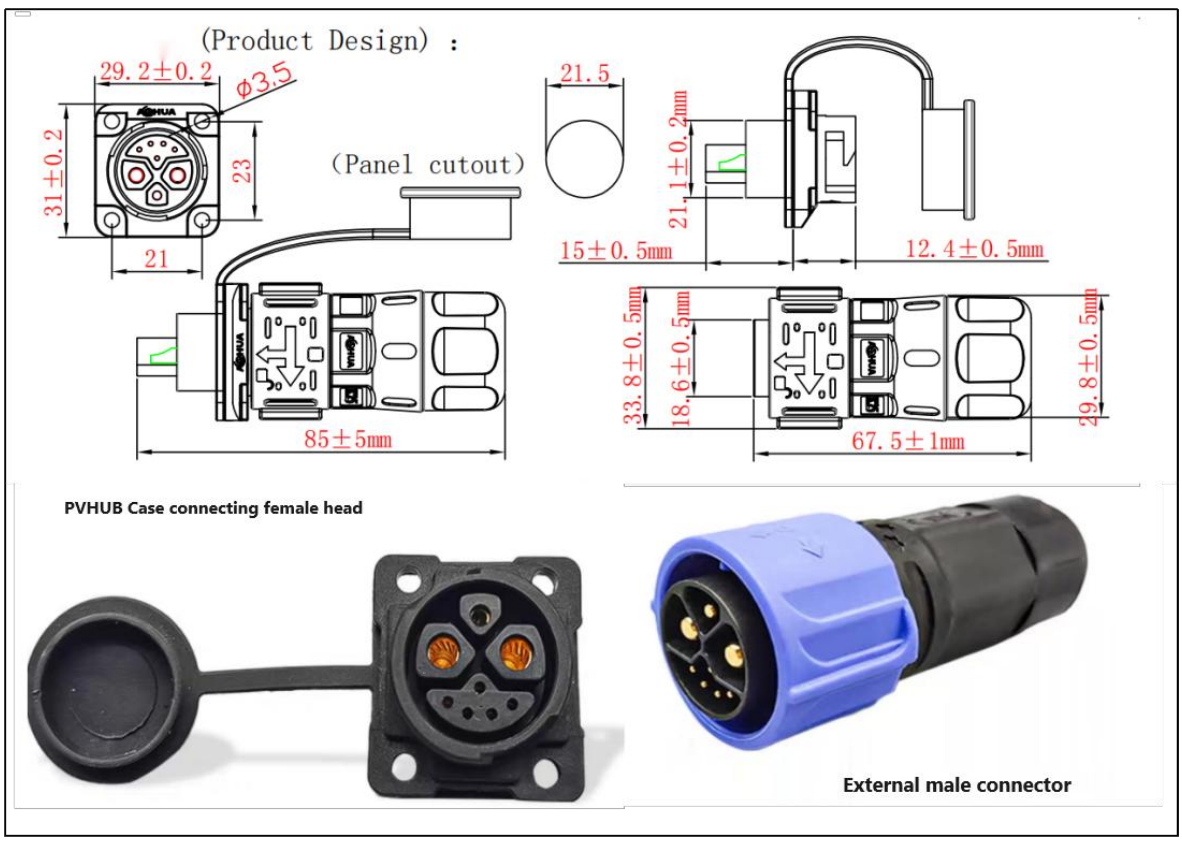


Figure 2-4-3 Physical Schematic Diagram of Aviation Plug

2.5 Wi-Fi Antenna Configuration

PV HUB EMS has a built-in WIFI module, which adopts a hexahedral all-metal metal seal structure. Antenna size is shown below:

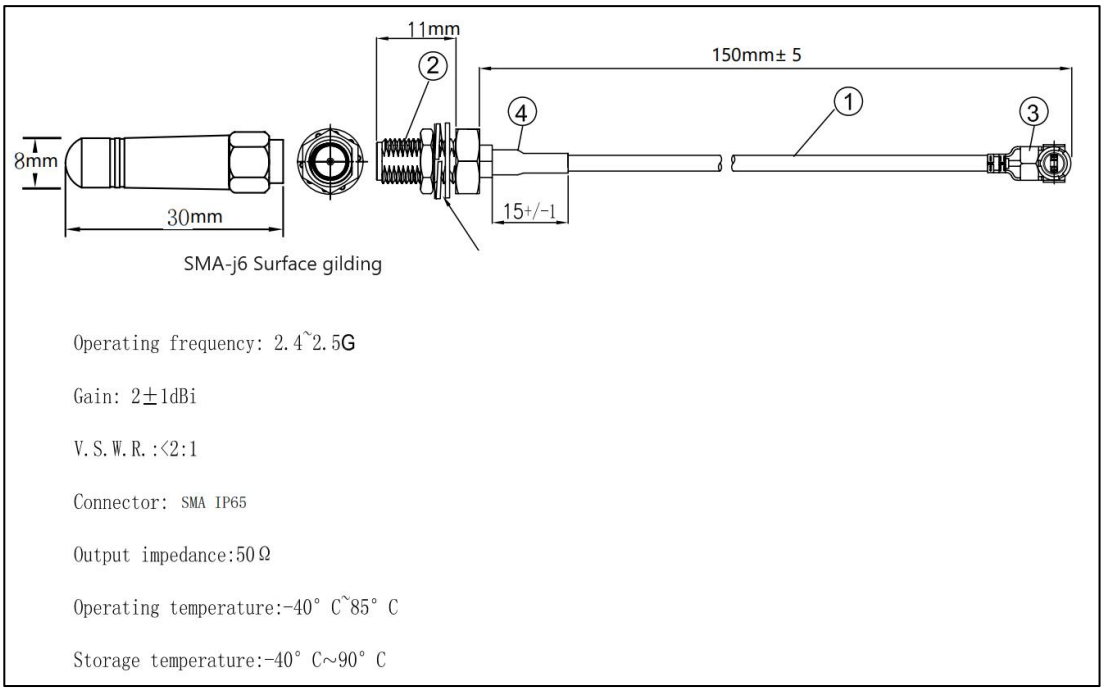


Figure 3-1-4 Schematic Diagram of Wi-Fi Antenna

Chapter 3 Instructions for Using the System

3.1 Wiring Introduction

3.1.1 Wiring between Photovoltaic Panel and PV HUB EMS

In general, the balcony energy storage system consists of battery packs, PV HUB EMSs, photovoltaic panels, and micro-inverters, as shown in Figure 1-1. Users can customize the parameters of the balcony energy storage system according to different types of micro inverters and battery packs.

Before connecting the PV panel to the PV HUB EMS, ensure that the PV panel functions properly. Note the following before wiring:

Table 3-1-1 Precautions for connecting photovoltaic panels and PV HUB EMS

1	The maximum voltage of a single photovoltaic panel should not exceed 60 V
2	The polarity and model of photovoltaic panel outlet terminals shall match PV HUB EMS, refer to Section 2.2-Interface Definition;
3	Photovoltaic panels cannot be input in parallel, that is, PVA+ and PVB- cannot be directly connected with PVA+ and PVB-.

3.1.2 Wiring between Micro Inverter and PV HUB EMS

The following precautions should be confirmed before the micro inverter is connected:

Table 3-1-2 List of precautions to be confirmed before micro inverter access

1	The micro inverter works properly. Check the input voltage and power by referring to Table 2-2-1 Description of communication ports;
2	The polarity and model of the outlet terminal of the micro inverter shall refer to Section 2.2-Interface Definition;
3	Never connect or disconnect the wiring terminal between the micro inverter and the PV HUB EMS artificially when the PV HUB EMS is turned on;
4	When the AC plug of micro inverter is connected to the power grid, it is necessary to ensure that the ground terminal in the AC plug is reliably grounded, otherwise the communication between PV HUB EMS and battery pack will be affected, resulting in abnormal system operation.

3.1.3 Connection between Battery Pack and PV HUB EMS

See section 2.2-Interface Definition for details of the wiring description between battery pack and PV HUB EMS. Pay attention to the following items before connecting the battery to PV HUB EMS:

Table 3-1-3 Precautions for connecting battery packs to PV HUB EMS

1	The function of the battery pack is intact, and the battery pack comes with BMS, and the communication protocol of BMS has been docked with PV HUB EMS in advance;
2	Refer to Chapter 2.2 for interface definition and connector selection of power outlet and signal outlet of battery pack, which should be consistent with the physical schematic diagram of aviation plug;
3	The parameters of battery pack, charging and discharging power and so on conform to the parameter table of PV HUB EMS system;
4	Never directly connect or disconnect the terminal between the battery pack and the PV HUB EMS when the PV HUB EMS is turned on.

3.2 System Installation Sequence

1. Connect the battery with PV HUB EMS by using the battery matching cable;
2. First connect the micro inverter to the INV1 and INV2 ports of the PV HUB;
3. Connect the grid plug of the micro inverter to the the household socket;
4. Connect the solar panel to the PV1 and PV2 ports of the PV HUB EMS;
5. Press the battery switch to start the system;

Note: When the solar panel is connected, if the battery switch is not turned on for more than 1 minute, the system will output PV1 to INV1 by-pass and output PV2 to INV2 by-pass. The system will not start to operate normally until the battery switch is turned on.

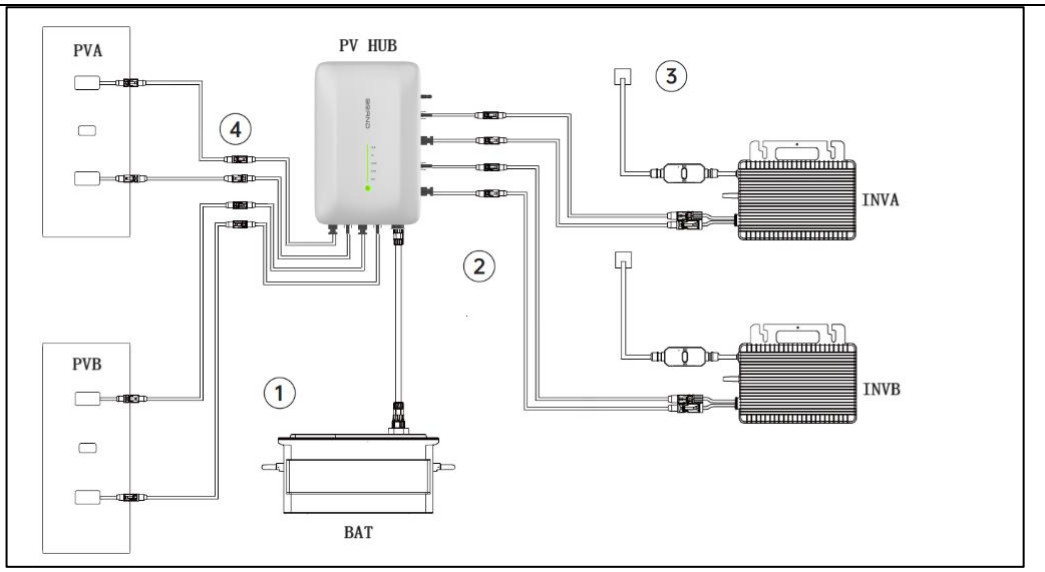


Figure 3-2 System Installation Schematic Diagram

3.3 System Disassembly Sequence

1. Turn off the battery pack and PV HUB (keep pressing the button on the PV HUB panel for 3 seconds or use the on-off control on the APP to turn it off).
2. Disconnect the home power grid and unplug the inverter and household appliances.
3. Disconnect the solar panels, and unplug the cables of two solar panels and PV HUB EMS.
4. Disconnect the battery and unplug the cable connecting the battery pack with PV HUB EMS.
5. Disconnect the micro inverter, unplug the cable connecting the micro inverter with PV HUB EMS.

Tips: Take good care of all components for reinstallation.

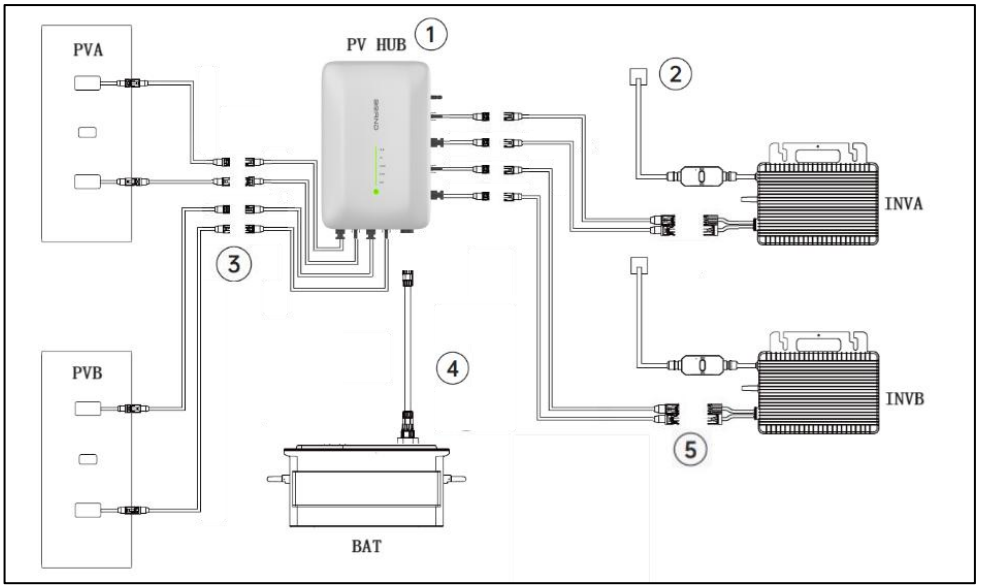


Figure 3-3 System Disassembly Schematic Diagram

3.4 System Operation Instructions

3.4.1 System Startup

①When the device is powered on for the first time or re-runs, if the battery is connected normally, it will immediately enter the self-check state; If the battery connection is not detected within one minute, the PV is output to the micro inverter through bypass;

②After entering the self-test state, the device will detect the PV and micro inverter access and the maximum power of the micro inverter. Ensure that the micro inverter is connected to the grid properly. The maximum self-test time is about 150 seconds;

③After the self-check is completed, it operates normally according to the battery capacity and working mode;

④At 9:30 and 21:30 every day, the device temporarily stops charging and discharging, and then detects the access of PV for about 5 seconds. After the detection is completed, it will resume the running state before suspension.

3.4.2 Mode Description

①. Charging priority mode

When users select the charging priority mode, they need to set the discharge time period and discharge power.

Before the discharge time, the battery is not fully charged, and all the energy of PV will be used to charge the battery. After the battery is fully charged, the PV will directly supply power to the micro inverter.

When the discharge time arrives, the device will discharge according to the power preset by the user. If the PV energy is surplus, the battery will be charged. After the battery is fully charged, all the PV energy will be delivered to the micro inverter. When the PV energy is not surplus, it will be supplied by the battery until the battery stops discharging due to the loss;

This mode is more suitable for the situation that electricity needs to be concentrated in a certain period of time, and the situation that the photovoltaic panel has low open-circuit voltage and low power and needs to be charged first and then discharged.

②. Discharge priority mode

When the user selects the discharge priority mode, the user only needs to select the power to be discharged. The device will discharge according to the preset power of the user. If the PV energy is surplus, the battery will be charged. After the battery is fully charged, all the PV energy is delivered to the micro inverter. When the PV energy is not surplus, it will be supplied by the battery until the battery stops discharging due to the loss;

This mode is suitable for the case that the photovoltaic panel has strong ability and the micro inverter can't completely use up the energy of PV.

3.5 Indicator Light Signal

The PV HUB EMS control module provides 5 LED indicators to indicate the current operating status of PV HUB EMS. The indications are defined as follows:

Table 3-5 Indicators on the PV HUB EMS

Indicator Light	Condition	Description	Solution
ALM	light up	System failure/Protection	Turn off the device first, and then turn it on to see if it can be restored. If it cannot be recovered, the system will be powered off and restarted. If the restart cannot be resumed, please contact after-sales technical support.
	slow flash	Alarm	The device automatically recovers under normal circumstances. If the device can't recover automatically, turn off the device first, and then turn it on, so that it can return to normal.
	light off	No alarm or fault	
PV	light up	There is PV charging power.	
	slow flash	PV self-test	
	light off	No PV output power	
LOAD	light up	There is micro inverter output power.	
	slow flash	Micro inverter self-test	
	light off	No micro inverter output power	
WIFI	light up	Distribution network succeeded.	
	slow flash	The device is not connected to the network and is in STA mode.	
	double flash	The device is not connected to the network and is in AP mode.	
BAT	light up	The battery is normally connected.	
	light off	The battery is not connected.	
RUN	light up	Power supply is normal.	
	light off	Power off.	

3.6 Button Control

The PV HUB EMS has a control button, which can achieve different control effects through different triggering methods. The specific definition is shown in the following table:

Table 3-6 Button Functions

button	ontrol mode	description
power button	Long press for 3S or more.	Device power on/off
	Press for 5 times or more.	Clear Wi-Fi pairing information
	Press for 3 times or more.	Switch to Wi-Fi and network paired mode (effective in unpaired mode)

3.7 Status Information

The PV HUB EMS periodically reports the operating status of the system to the APP, including the operating status of the device itself, photovoltaic power generation, home power supply, and battery pack.See the table below for details:

Table 3-7 List of Status Information Submitted by PV HUB EMS

module	status messages	unit
photovoltaic power generation	PV1 voltage	V
	PV1 current	A
	PV1 power	W
	PV2 voltage	V
	PV2 current	A
	PV2 power	W
	Total PV power	W
home power supply	INV1 voltage	V
	INV1 current	A
	INV1 power	W
	INV2 voltage	V
	INV2 current	A
	INV2 power	W
	Total INV power	W
battery pack	battery voltage	V
	Battery current	A
	Battery charging and discharging power	W
	Battery capacity	%
device	device switch	--
	device temperature	℃
	device alarm	--

3.8 Alarm Threshold

Table 3-8 PV HUB EMS preset protection alarm parameter list

alarm type	trigger condition	protective action	recovery condition	alarm delay (100ms)
battery overvoltage	> 58V	turn off charging	< 57V	10
battery undervoltage	< 48V	turn off discharge	> 49V	10
PV overvoltage	> 60V	turn off charging and discharging	< 58V	10
environmental overheating	> 65℃	turn off charging and discharging	< 63℃	10
battery overvoltage protection	> 60V	turn off charging and discharging	< 60V	/
battery short circuit protection	> 66A	turn off charging and discharging	beyond retrieve	/
DCDC inductor overcurrent protection	> 46A	turn off charging and discharging	beyond retrieve	/
output overcurrent protection	> 78A	turn off discharge	Automatic recovery after 1ms. Triggered 3 times within 10ms, it cannot be recovered again.	/

Chapter 4 How to Use the APP

4.1 APP Download and Installation

Login https://www.pgyer.com/JS0qa2 to download and install the latest version of the APP. When the downloading is completed, click on the Install option. After the installation is completed, login the APP and enter the startup interface. There will be two connection modes for you to choose from:

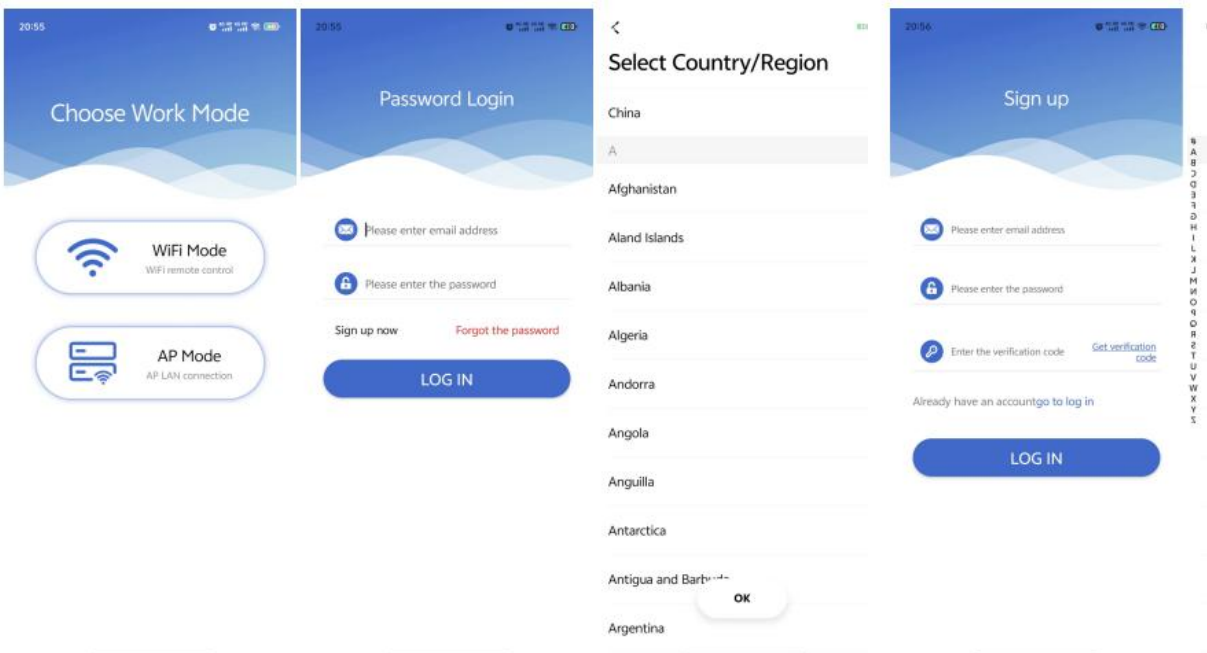
Wi-Fi mode: It is suitable for families with Wi-Fi, and can be shared with multiple family members to check the running status of the device;

AP mode: When there is no Wi-Fi in the family, the Wi-Fi module in the device can be used as an AP hotspot for direct connection to the phone.In this mode, the user can connect the device to check the running status. In this mode, only one mobile phone can be connected.

The default setting is Wi-Fi mode. To select AP mode, press the button to clear the pairing information between WiFi and the network to set the device to AP mode.Please refer to Section 3.5-Indicator Light Signal and Section 3.6-Button Control for how to clear Wi-Fi pairing information with the network and switch the distribution mode.

4.2 Wi-Fi Mode

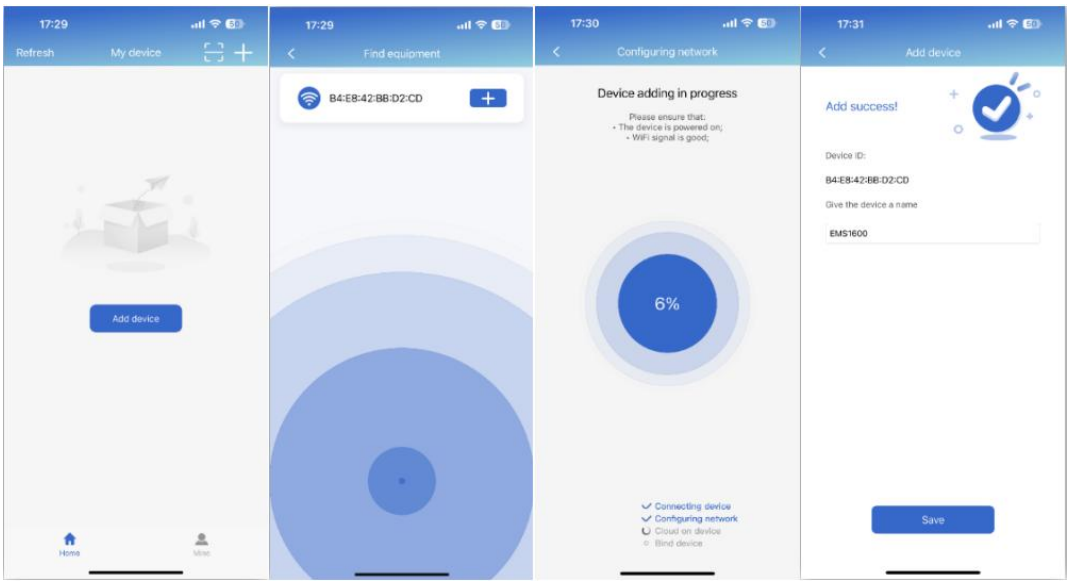
4.2.1 Login/Register an Account



4.2.2 Add the device

Before adding the device, make sure that it has been powered on normally. The operation steps of adding the device are as follows:

First of all, ensure that the device works properly after powering on, click "Add device", and then turn on the mobile phone Wi-Fi and Bluetooth for auxiliary network distribution according to the instructions. Under normal circumstances, wait about 20 seconds, the APP can discover the device. Click the "+" sign to add, and enter the router's Wi-Fi name and Wi-Fi password as instructed. Click Next and wait until the network configuration is completed.



4.3 AP mode

4.3.1 Not in AP mode

Out of the AP mode, if the device has been connected to the network, you need to press the button for 5 consecutive times to clear the network information, and observe the status of the Wi-Fi indicator:

The slow flashing of the Wi-Fi indicator indicates that the device is currently in the Wi-Fi mode, and you need to press the button for 3 consecutive times to enter the AP mode; If the Wi-Fi indicator flashes twice quickly and periodically, it means that the device is currently in AP mode.

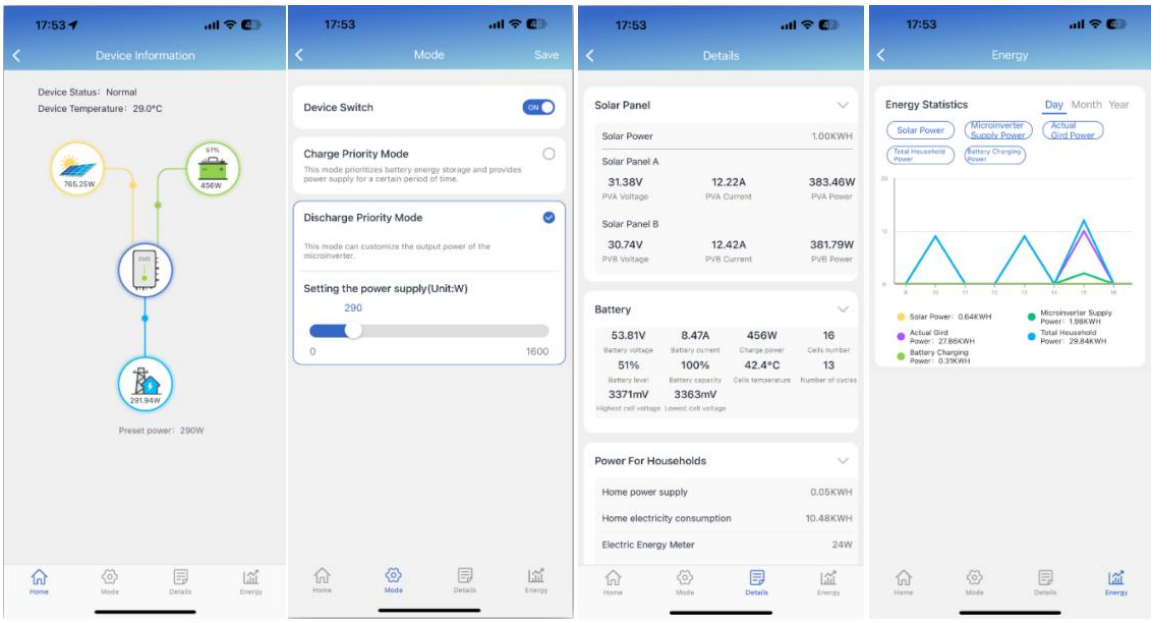
4.3.2 In AP mode

When the device is in AP mode, you can find the AP hotspot named SR-xxx opened by the device through the mobile phone, and the password is 12345678. After connecting this Wi-Fi, you can return to the APP and click to select AP mode to enter AP mode.

4.4 APP Operation Interface

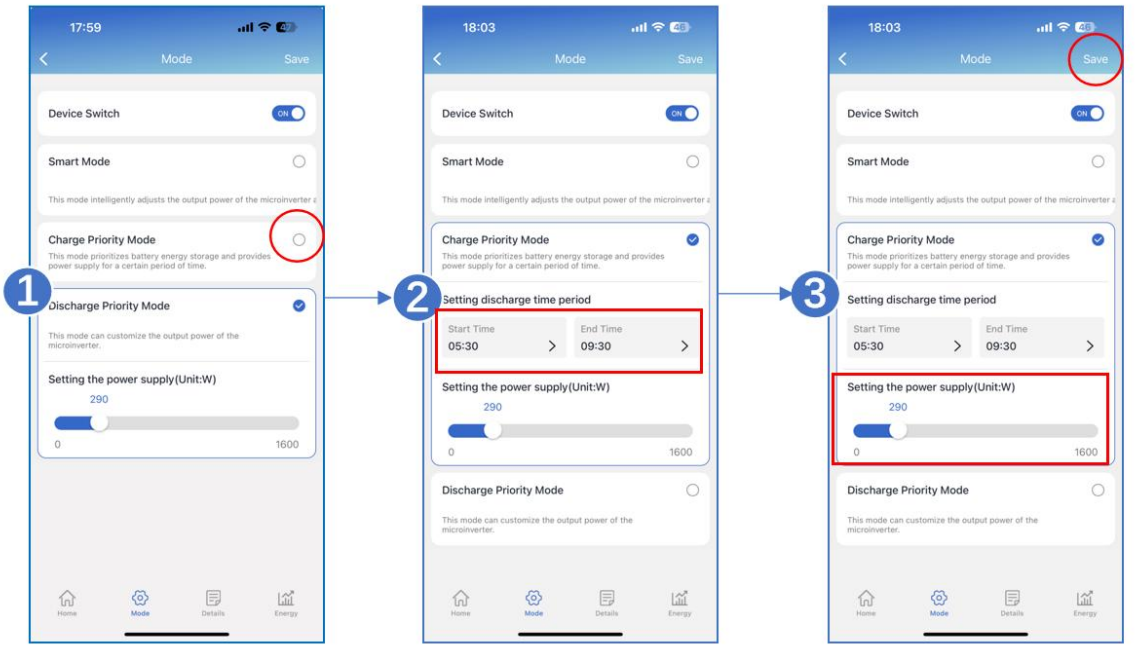
4.4.1 Device Status Checking

Click the online device and enter the "Home page" to check the running status and energy flow of the device; Click "Mode" to enter the device mode setting interface, you can see the device operating mode and discharge power on this interface. Click "Details" to check the detailed information of each component of the device. Click "Energy" to check the statistics of device energy.



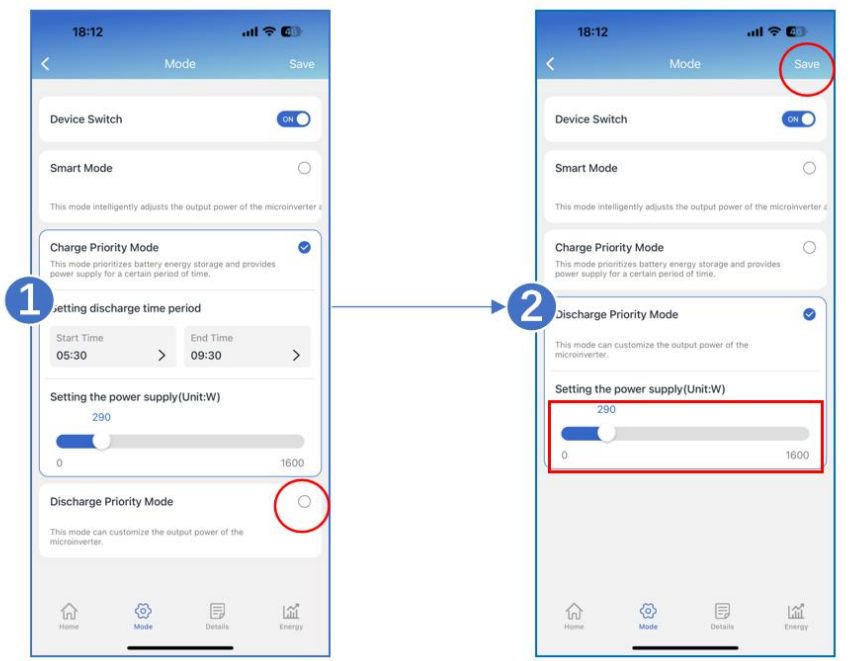
4.4.2 Charging Priority Mode Setting

Click the small circle to the right of the charging priority mode to enter the charging priority mode. Set the discharge start time.Set the discharge end time. Set the discharge power and click “Save” to complete the setting.



4.4.3 Discharge Priority Mode Setting

Click the small circle on the right of the discharge priority mode to enter the discharge priority mode. Select the discharge power and click "Save" to complete the Settings.

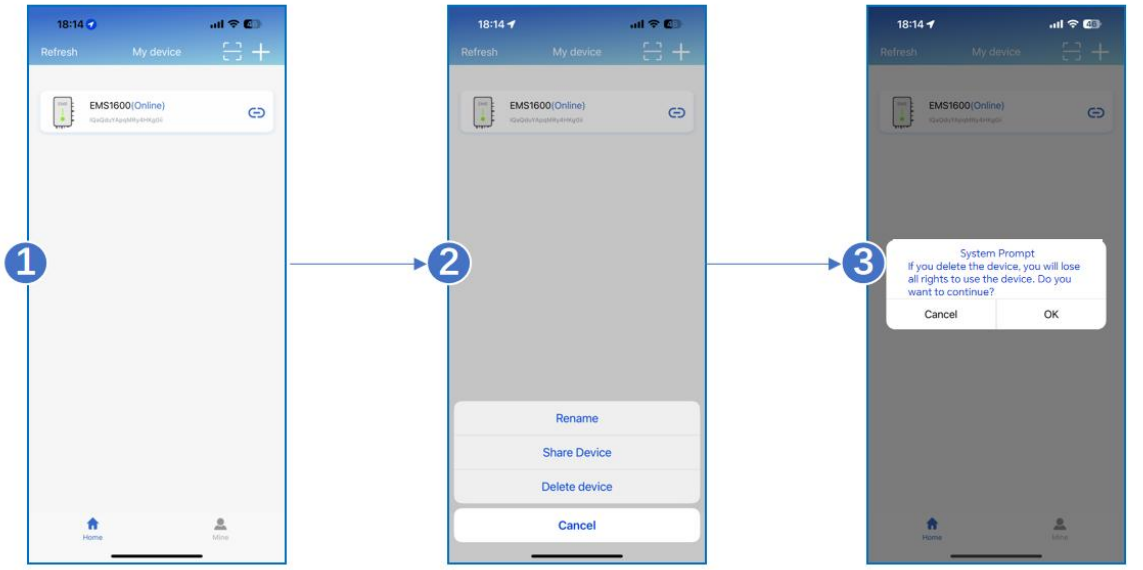


4.4.4 Device Deleting

Press and hold an added device.

Select “Delete Device”.

Click OK. The device will be successfully deleted.



Chapter 5 Countermeasures for Common Faults

The abnormal working state and solutions of PV HUB EMS are shown in the following table:

Table 5-1 List of Abnormal Phenomena and Solutions of PV HUB EMS

phenomenon	probable cause	solution
Red light alarm, micro inverter can not be output.	Battery short circuit protection; DCDC inductor overcurrent protection; Output overcurrent protection;	Press the physical button or use the APP to turn off and restart the PV HUB EMS. If it cannot be solved, please contact the after-sales technicians.
Unable to boot	Cannot start after PV is connected.	Check whether the wiring harness is properly connected.

After the PV is connected, it cannot be charged and discharged, and the battery indicator light does not light up.	Poor contact of power line and abnormal communication of battery pack	Check whether the wiring harness is properly connected.
After the PV is connected, it cannot be charged and discharged immediately, and the battery indicator light is on.	After the PV HUB EMS is activated, it will last for 150 seconds to check the photovoltaic panel and the micro inverter access status.	If the system is connected correctly, wait for 150 seconds.
Query that there is no such device	Exception in querying Wi-Fi device.	Check the mobile phone network and the device, whether it has been bound by other devices.

---------- ----**The End** ----------