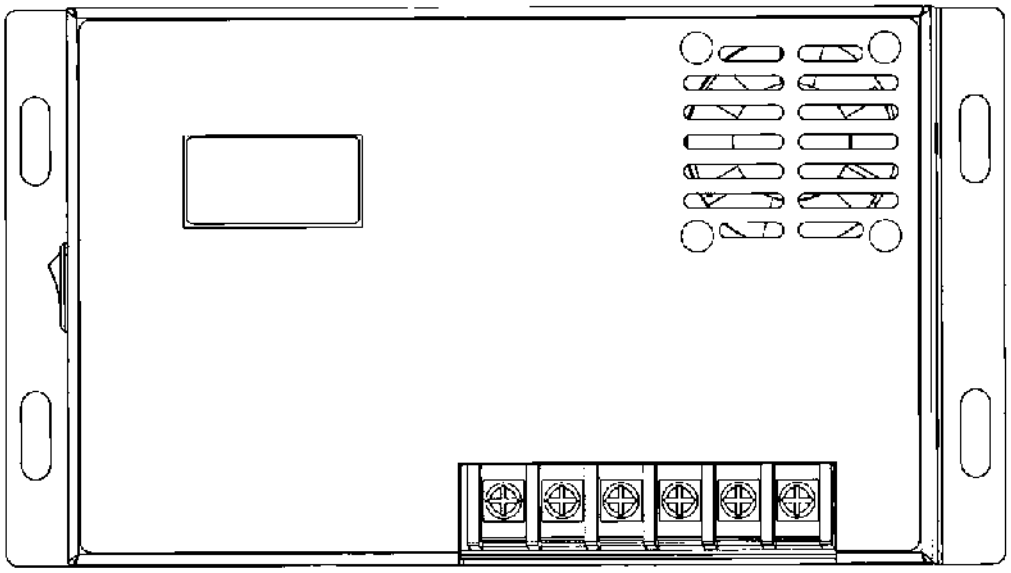
MPPT Solar Charging Controller User Manual

M24HB Model

Applicable to 12V/24V platform batteries (ternary, lithium iron, lead-acid, custom) step-down version



Manual Version: V1.0 Changes may occur without prior notice; please contact sales for the latest electronic documentation

Thank you very much for choosing our products!

1. Since the operating voltage of this controller exceeds the safe voltage for the human body, please read the manual carefully and ensure that safety operation training is completed before operating this controller.

2. There are no components inside the controller that require maintenance or repair; users should not disassemble or repair the controller themselves.

3. Please install the controller indoors to avoid exposure of components and prevent water from entering the interior of the controller.

4. Please install the controller in a well-ventilated area, as the temperature of the heat sink can be very high during operation.

5. It is recommended to install a suitable fuse or circuit breaker on the outside of the controller.

6. Before installing and adjusting the wiring of the controller, be sure to disconnect the photovoltaic array connection and the fuse or circuit breaker near the battery terminals.

7. After installation, check that all wiring connections are secure to avoid the risk of heat buildup due to loose connections.

Warning: This operation is dangerous; make sure to prepare for safety before proceeding.

Note: Indicates that this operation is destructive.

Tip: Indicates suggestions and prompts for the operator.

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1. Product Introduction

1.1 Product Overview

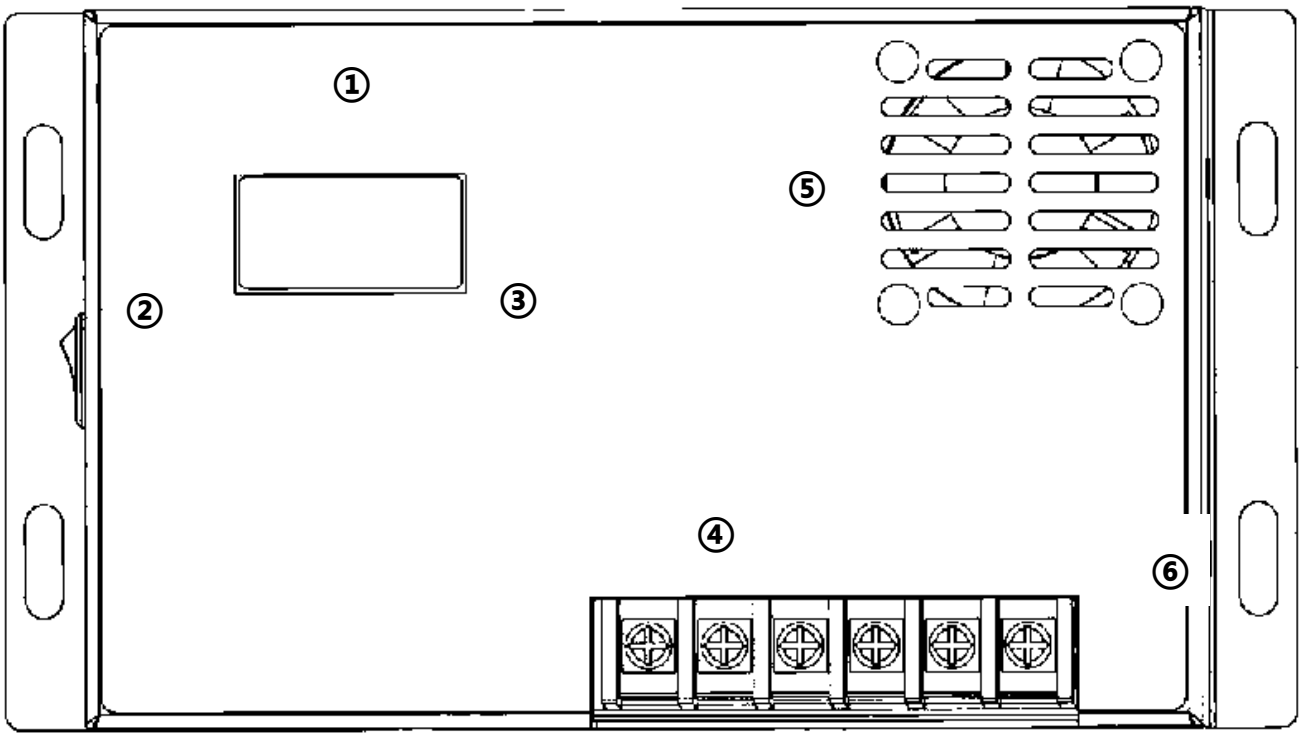
The M24HB controller adopts industry-leading MPPT (Maximum Power Point Tracking) technology to achieve maximum energy tracking of solar panels, allowing it to quickly and accurately track the maximum power point of solar cells in various environments. It real-time captures the maximum energy from solar panels, significantly improving the energy utilization rate of solar systems. It is widely used in off-grid photovoltaic systems to manage the operation of solar panels, batteries, and loads, serving as the core control component of off-grid photovoltaic systems. The controller features comprehensive software and hardware fault detection and protection functions, minimizing the risk of damage to product components due to installation errors and system failures.

1.2 Product Features

- Utilizes MPPT maximum power tracking technology, with a tracking efficiency of up to 99.9%.
- Supports simultaneous full-power charging and discharging.
- Supports various battery types including sealed, gel, open, lithium, and custom batteries.
- Supports activation of lithium and lead-acid batteries.
- Support for charging current settings.
- Support for full charge settings.
- Support for temperature compensation function.
- Support for parallel charging.
- Support for multiple load operating modes.
- Support for starting capacitive and inductive loads.
- Support for saving historical data.
- Support for RS485 communication with standard Modbus protocol, with fixed baud rate.
- Support for TTL communication with standard Modbus protocol, with fixed baud rate.
- Support for Bluetooth and Ethernet communication functions (optional).
- Equipped with comprehensive protection mechanisms for over-voltage, over-current, overload, over-temperature, and short-circuit during charging and discharging.
- Using high-quality aluminum heat sinks, air cooling, and high-temperature derating treatment to ensure reliable and efficient operation in various working environments.

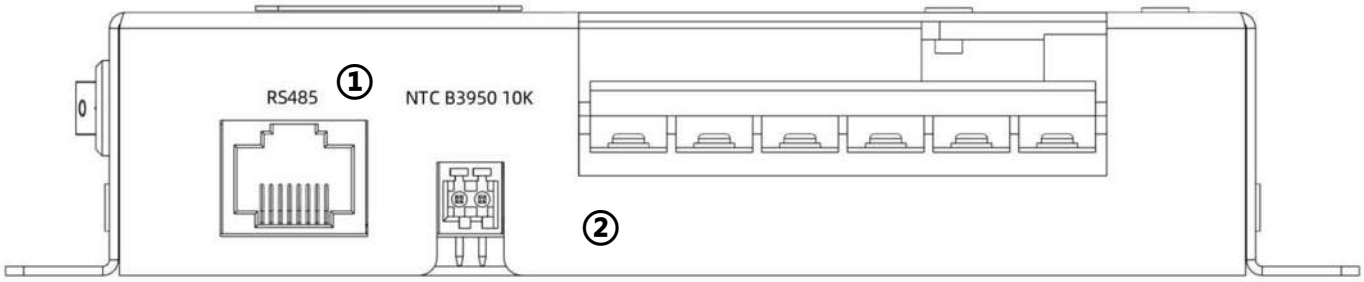
1.3 Appearance and Interface Description

Front Interface Introduction



Serial Number	Function Description	Notes
①	Battery type selection, Chinese and English switching, interface switch using a toggle switch	See the toggle switch section for details
②	Start button	Side boat-shaped switch
③	Display screen interface	
④	Load interface; battery interface; photovoltaic input interface	Interface KF2EDGR
⑤	Fan outlet	Do not block
⑥	Ground screw hole position	

Side interface introduction



Serial Number	Function Description	Notes
①	RS485 communication interface	See other sections for pin definitions
②	Battery temperature monitoring interface, external NTC B3950 10K temperature sensor battery	No Battery Temperature Monitoring

1.4 Introduction to Maximum Power Point Tracking Technology

The M24HB series Maximum Power Point Tracking (MPPT) system is an advanced charging technology that adjusts the operating state of the electrical module to enable solar panels to output more electrical energy. Due to the nonlinear characteristics of solar panel arrays, there exists a maximum power point on their curve. Traditional PWM charging technology cannot maintain charging at this point, thus failing to capture the maximum energy from the solar panels. However, solar controllers with MPPT technology can continuously track the maximum power point of the array to obtain the maximum energy for charging the batteries. For example, in a 12V system, the peak voltage (Vpp) of the solar panel is approximately 18V, while the battery voltage is around 12V. General charging controllers operate at around 12V during charging, which does not fully utilize the maximum power.

MPPT controllers can overcome this issue by dynamically adjusting the input voltage and current of the solar panels to achieve maximum input power. Compared to traditional PWM controllers, MPPT controllers can harness the maximum power of solar panels, thus providing a larger charging current. Generally, MPPT can improve energy utilization by 20% to 30% compared to PWM controllers.

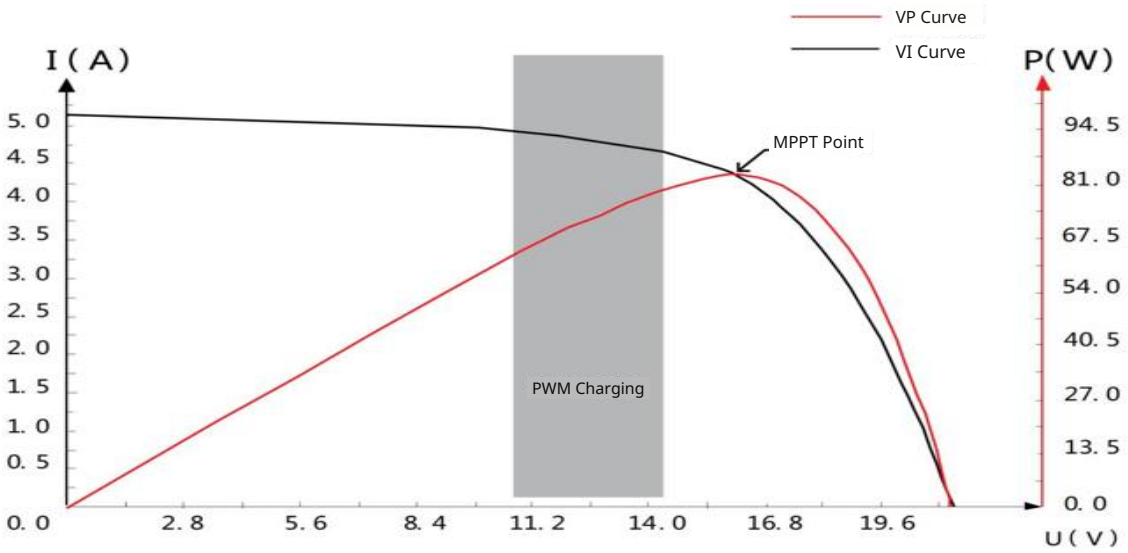


Figure 1-2 Battery Panel Output Characteristic Curve

Due to varying environmental temperatures and lighting conditions, the maximum power point frequently changes. Our company's MPPT controller can adjust parameters in real-time based on different conditions to keep the system near the maximum operating point at all times. The entire process is fully automated, requiring no adjustments from the user.

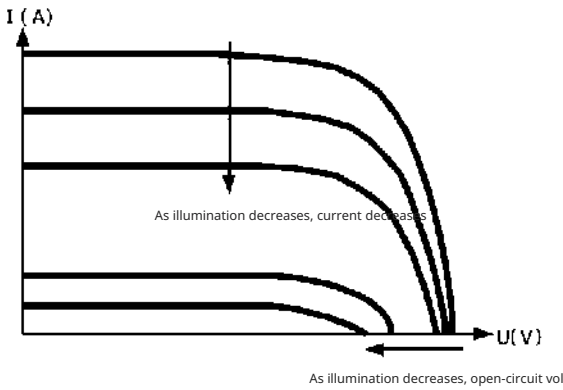


Figure 1-3 Relationship between solar panel output characteristics and illumination

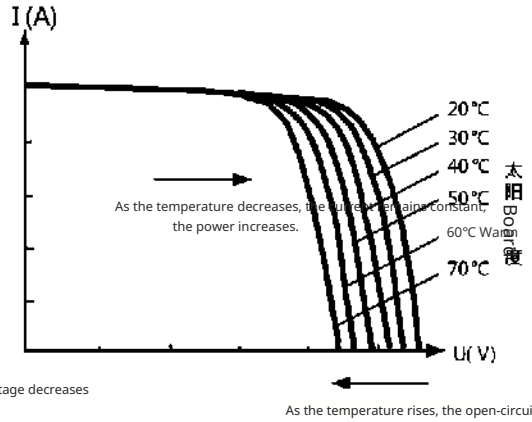


Figure 1-4 Relationship between solar panel output characteristics and temperature

2. Technical Parameters

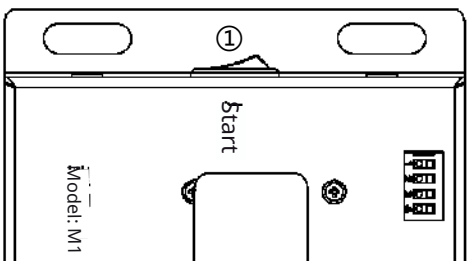
Product Model	**M24HB**	
Static Power Consumption	≤30mA	
Battery Type	Three-way/Lithium Iron/Lead Acid/Colloidal/Other Batteries (Users can configure independently based on the upper computer)	
Battery Voltage	12V Platform	24V Platform
System Mode	Step-down	
Rated Battery Charging Current	20A	
Maximum PV Input Current	18A	
Maximum Solar Panel Power	300W	600W
Max: PV Open Circuit Voltage (Voc)	56V	56V
Recommended PV Power Point Voltage (Vmp)	16V~36V (Recommended)	24V~42V (Recommended)
Maximum System Voltage	63V (±2%) Overvoltage will damage the system	
MPPT Tracking Efficiency	99.9%	
MPPT Tracking Rate	<1ms	
Charging Conversion Efficiency	>96%	
Rated Load Current	20A	
Load Operating Mode	Manual Mode, Automatic Mode (User can configure independently via the upper computer)	
Charging Operating Mode	Trickle/Constant Current/Constant Voltage	
Battery Charging Temperature Control Adjustable	√	
Temperature Protection	√	
Activate Battery	√	
Load Overload/Short Circuit Protection	√	
TTL Communication	√	
RS485 Communication	√	
External 12V Power Supply (<150mA)	√	
Display Screen	√	
Supports SOC Display	√	
Charging Power Adjustable	√	
The number of battery model strings can be configured.	√	
Supports Bluetooth (optional external accessory)	√	
Supports Ethernet (optional external accessory)	√	
Set auto-save	√	
Supported baud rate types	4800/9600/14400/19200/38400/56000/57600 Default 9600 (change requires host computer configuration)	
Backlight function	Default backlight always on	
Protection function	PV over-voltage protection, PV reverse connection protection, PV short-circuit protection, night reverse charging protection, input power limit protection, over-temperature protection, load short-circuit protection, load overload protection, battery over-voltage/over-discharge protection, battery reverse connection protection (Start activation function prohibits reverse connection)	
Operating temperature range	- 35℃~65℃ (within 45℃ under good ventilation without derating)	
Protection level	IP32	
Cooling method	Natural convection, air cooling	
Dimensions	Length x Width x Height 94.5x170x34mm	
Weight	0.55kg	
Lithium iron phosphate battery support	4 String	8 String
Support for lithium ternary batteries	3 String	6 String
Support for lead-acid/gel batteries	1 String	2 String
Other batteries	Users can set undervoltage and overvoltage points themselves (set via the host computer 9V~30V)	

3. Dip switch and power on/off instructions

3.1 Dip switch usage instructions (please select the battery type carefully from the front)

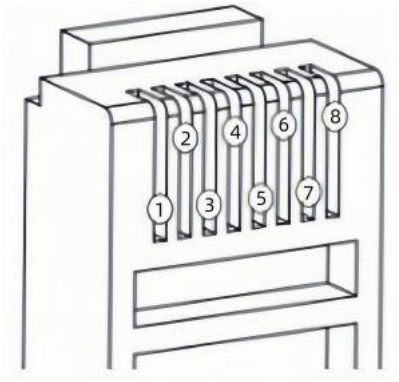
Dip switch selection (ON:1) (switch up is 1, down is 0)					Type	Overvoltage Protection	Undervoltage Protection	Full Charge Recovery	Load Recovery
1	2	3	4	5					
0	1	0	1	X	Ternary	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					3string	12.6V	9.0V	12.3V	9.6V
		1	0	X	Lithium Iron	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					4string	14.4	11.2V	13.6V	12.4V
		1	1	X	Lead Acid	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					3string	14.4	10.5V	13.4V	11.5V
		0	0	X	Colloid	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					3string	13.8	10.5V	13.2V	11.5V
1	0	0	1	X	Ternary	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					6string	25.2V	18.0V	24.6V	19.2V
		1	0	X	Lithium Iron	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					8string	28.8	22.4V	27.2V	24.8V
		1	1	X	Lead Acid	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					6string	28.8V	21.0V	26.8V	23.0V
		0	0	X	Colloid	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					6string	27.6	21.0V	26.4V	23.0V
0	0	0	0	X	Custom	Overvoltage	Undervoltage	Full Charge Recovery	Load Recovery
					Custom	User Setting	User Setting	User Setting	User Setting
X	X	X	X	0	Do not activate the battery				
X	X	X	X	1	Automatically activate the battery (set to activate the battery, the battery must not be reversed)				

3.2 Device Startup Switch Usage Instructions



① To start the device, switch left to off, right to on

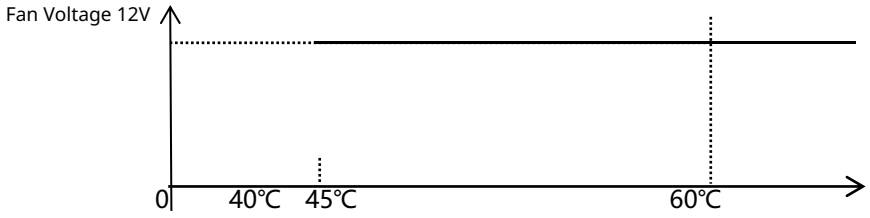
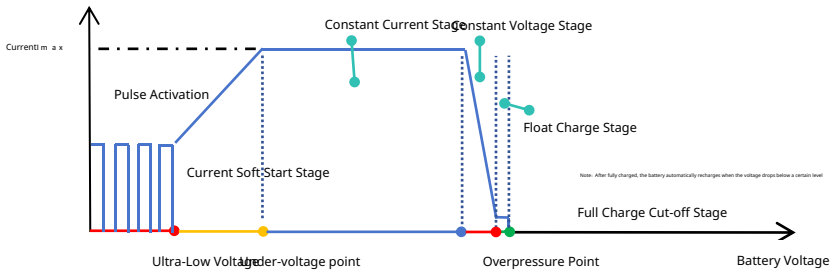
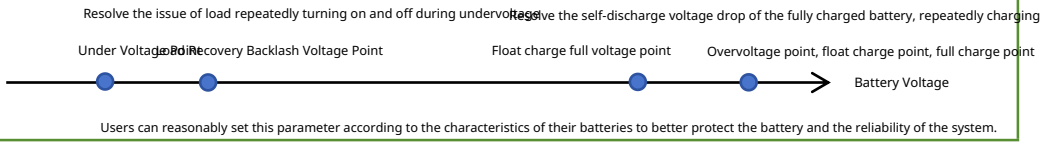
4. TTL Communication, RS485 Communication, External 12V Output Interface Pin Definitions



Serial Number	Definition
①	485-A
②	485-B
③	12V
④	GND
⑤	Unused
⑥	Unused
⑦	TTL-TXD
⑧	TTL-RXD

Note: 12V can provide a maximum current of 300mA; exceeding this may damage the interface with a certain probability.

5. Fan Temperature Control

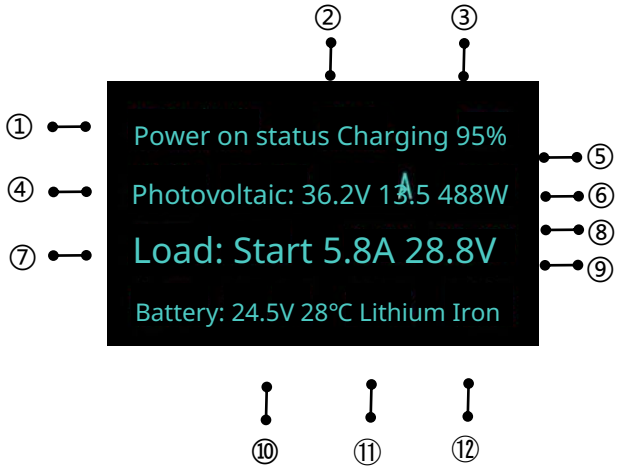
Serial Number	Fan Start Logic Diagram
When PV Charging	
When PV is not charging, discharge load current starts	
Six-Stage Current Charging	
Custom Settings	 Users can reasonably set this parameter according to the characteristics of their batteries to better protect the battery and the reliability of the system.

6. Common problems and solutions

Phenomenon	Method of Handling
Indicator light and LCD screen not lit	Check if the connections of the battery and solar panel are correct
Solar panel has voltage, but no voltage output at the battery terminal	Disconnect the battery to check if it has voltage; if there is no voltage, activate the battery in the system settings. (The battery is in an activated state, and the system does not support reverse polarity protection for the battery)
Battery type and series cannot be modified while MPPT is in operation	Changing the battery type will alter the over-voltage and under-voltage protection points!
Charging power does not reach the rated value	The system uses current limiting and constant temperature control; Check if the system has reset the charging power;
The load cannot start some loads.	You can set the short circuit load time through the upper computer to accommodate different external loads.
Other issues or difficult-to-solve exceptions.	Go to the settings interface to initiate a factory reset. After setting the factory settings, reconfigure the relevant parameters according to the sys Please proceed with caution!
No response when the battery is connected.	1. Check if the fuse is damaged; if so, replace the fuse or contact the manufacturer for repair.
The fan does not rotate.	1. Check if there are any foreign objects blocking the fan and clean the air duct regularly. 2. If the fan still does not rotate after cleaning, please contact customer service for fan replacement.

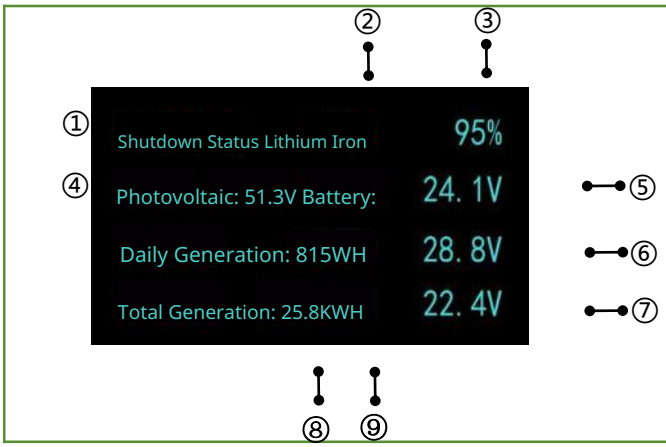
7. Display interface introduction

7.1 Startup System Display Interface



① Power On Status Display
② The system is in charging state (charging, discharging, protection)
③ SOC (State of Charge) display
④ Display photovoltaic voltage value
⑤ Display photovoltaic charging current size
⑥ Display photovoltaic charging power size
⑦ Load startup status display
⑧ Display load output current size
⑨ Display load output power size
⑩ Display battery voltage size
⑪ Battery temperature display (not connected to NTC, not displayed)
Display battery selection type (ternary, lithium iron, lead-acid, other)

7.2 Close System Display Interface



① Represents the current shutdown status
② Represents the current battery selection as ternary type
③ Displays battery state of charge (SOC)
④ Displays photovoltaic voltage value
⑤ Displays battery voltage value
⑥ Current battery over-voltage protection set point
⑦ Current battery under-voltage protection set point
⑧ Displays today's power generation
⑨ Displays historical power generation

8. Product Installation

8.1 Installation Precautions

- Be very careful when installing batteries. When installing open lead-acid batteries, wear protective goggles. If you come into contact with battery acid, rinse it off with clean water immediately.
- Avoid placing metal objects near the battery to prevent short circuits.
- Charging the battery may produce acidic gases, so ensure the surrounding environment is well-ventilated.
- The battery may produce flammable gases, so keep away from sparks.
- When installing outdoors, avoid direct sunlight and rainwater infiltration.
- Loose connections and corroded wires can cause excessive heat, melting the wire insulation, burning surrounding materials, and even causing fires. Therefore, ensure all connections are tight, and it is best to secure the wires with zip ties to prevent them from moving and loosening during use.
- When connecting the system, the output voltage of the components may exceed the safe voltage for the human body. When operating, be sure to use insulated tools and keep your hands dry.
- The battery terminals on the controller can be connected to either a single battery or a group of batteries. The subsequent instructions in the manual are for single battery use, but they also apply to a system of multiple batteries.
- Please follow the safety recommendations of the battery manufacturer.
- Ground the controller's grounding terminal.
- During installation, reverse connection of the battery is prohibited, as it can cause irreversible damage.

8.2 Installation Steps

The wiring and installation methods must comply with national and local electrical code requirements. The wiring specifications must be selected according to the rated current, generally at 5A/mm².

Step 1: Choose the installation location

Avoid installing the controller in direct sunlight, high temperatures, or areas prone to water ingress, and ensure good ventilation around the controller.

Step 2: Secure the mounting screws

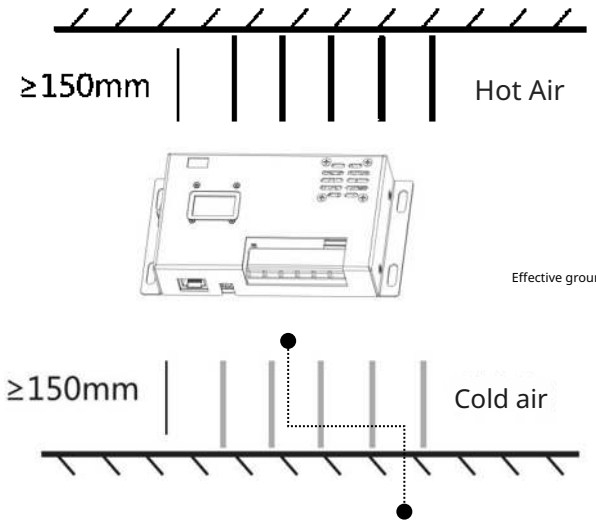
Mark the installation position according to the controller's installation dimensions, drill two appropriately sized mounting holes at the marked points, and secure the screws in the two mounting holes.

Step 3: Secure the controller

Align the controller's mounting holes with the two pre-secured screws and hang it up, then secure the two screws at the bottom.

Step 4: Secure the grounding wire

Lock one wire to the side screw of the controller, and connect the other end effectively to the ground (it can be tied to a metal block for burial) to direct leakage, static electricity, and lightning currents into the ground.



Effective grounding of the equipment

9. Protection Functions

- Overtemperature protection for the equipment

  When the internal temperature of the controller exceeds the set value, the charging power will automatically reduce or even shut down during charging, thereby further slowing the rise in internal temperature of the controller.

- Overtemperature protection for the battery

  The battery overtemperature protection requires an external battery temperature sampling sensor. When the battery temperature is detected to be too high, charging will stop. When the battery temperature drops to 5 degrees lower than the set value for 2 seconds, charging will automatically resume.

- Input overpower protection

  When the power of the solar panel exceeds the rated power, the controller will limit the charging power within the rated power range to prevent excessive current from damaging the controller, and the controller will enter current-limiting charging.

- Excessive voltage at the photovoltaic input terminal

  If the voltage at the photovoltaic array input terminal is too high, the controller will automatically disconnect the photovoltaic input.

- Photovoltaic input reverse connection protection

  When the polarity of the photovoltaic array is reversed, the controller will not be damaged and will continue to operate normally after correcting the wiring error.

- Nighttime reverse discharge protection

  Prevents the battery from discharging through the solar panel at night. Special note: There is no reverse connection protection function for the battery.

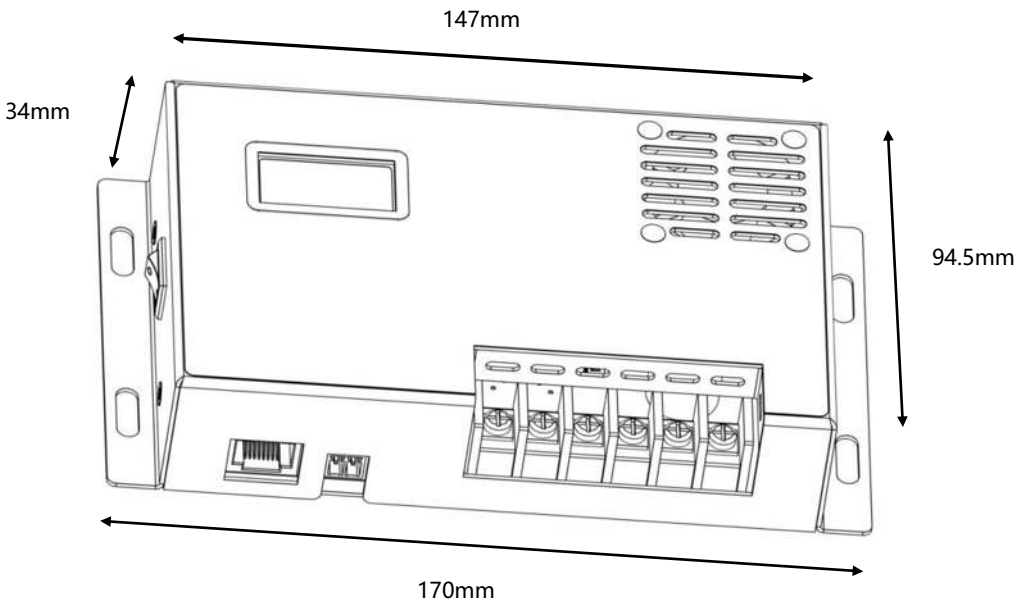
10. System Maintenance

To ensure that the controller maintains optimal working performance for a long time, it is recommended to regularly check the following items.

- If any abnormal faults or error messages are found, corrective measures should be taken promptly.
- Check for corrosion, insulation damage, high temperature, or signs of burning/discoloration at the terminal connections, as well as any deformation of the casing, and carry out timely repairs or replacements.
- Wires that are exposed, damaged, or have deteriorated insulation should be repaired or replaced promptly.
- Check for dirt, nesting insects, and corrosion, and clean them promptly.

Warning: Risk of electric shock! Ensure that all power to the controller is disconnected before performing the above checks or operations! Non-professionals, please do not operate without authorization.

11. Product Size Diagram



12. Communication Protocol

12.1 Basic communication configuration

Transmission mode	RTU	Protocol standard/function code	0x02 Read one or more input states	Bitwise read
Baud rate	Default is 9600bps	This communication protocol is based on <Standard MODBUS Protocol>, where the master cyclically requests data from the slave, and the slave receives the request command and responds with the data.	0x03 Read Holding Registers	Read as 16-bit words
Checksum	No checksum		0x04 Read a Register	Read as 16-bit words
Data bits	8bit		0x05 Write a Coil Status	Write bit by bit
Stop Position	1bit		0x06 Write a holding register	Write by 16-bit words
Frame Interval	Not less than 3.5 byte times		0x10 Write multiple holding registers	Write by 16-bit words
Frame Length	200 bytes	When the communication module detects errors other than CRC code errors, it must send back information to the host, with the highest bit of the function code set to 1; 01 illegal function code, 02 illegal da		
Maximum response time of the slave	350 Byte time			
Minimum polling interval of the master	400 Byte time	03 Illegal data value 04 service failure		

12.2 Information address

Register address table, read corresponding function code 0x03, set corresponding function code 0x06. The addresses in the table below are the same as those in the actual information frame, and no offset or other conversion is needed.

Address (Decimal)	Meaning	Byte	Read/Write	Example	Explanation
40000	Device Model	2	R	52482	M24HB Model
40001	Software Version	2	R	10	V1.2
40002	Hardware Version	2	R	10	V1.0
40003	Maximum Power Support	2	R	600	600W
40004	Maximum Input and Output Current	2	R	2020	PV:20A, BAT:20A
40005	Photovoltaic step-down heat sink temperature	2	R	25	Current system temperature 25 degrees Celsius
40006	PV NTC Status	2	R	0	0~7
40007	BAT NTC Status	2	R	0	0~7
40008	Reserved	2	R	Unused	Reserved
40009	Reserved	2	R	Unused	Reserved
40010	Charging Stage	2	R	3	1: Activation, 2: Trickle, 3: Constant Current, 4: Constant Voltage
40011	Charging Status	2	R	1	0: Not Charged, 1: Charging
40012	Fully Charged Status	2	R	1	0: Not Fully Charged, 1: Fully Charged
40013	Current Load Status	2	R	1	1: Starting, 0: Shutting Down
40014	BUCK Heatsink Temperature	2	R	50	50℃
40015	Reserved	2	R	Unused	Reserved
40016	Reserved	2	R	Unused	Reserved
40017	Reserved	2	R	Unused	Reserved
40018	Reserved	2	R	Unused	Reserved
40019	Reserved	2	R	Unused	Reserved
40020	Photovoltaic input voltage	2	R	4550	45.5V (accuracy 0.01V)
40021	Photovoltaic input current	2	R	111	1.11A (Accuracy 0.01A)
40022	Photovoltaic Input Power	2	R	256	256W (Accuracy 1W)
40023	Photovoltaic Radiator Temperature	2	R	20	20℃ (Accuracy 1℃)
40024	Photovoltaic fault code	2	R	0	See Fault Table 1
40025	Battery Output Voltage	2	R	2412	24.12V (Accuracy 0.01V)
40026	Battery Output Current	2	R	0	None (See Load Current)
40027	Battery Output Power	2	R	0	No (see load power)
40028	Battery radiator temperature	2	R	25	25℃ (accuracy 1℃)

40029	Battery fault code	2	R	See fault table 2	See fault table 2
40030	Load output current	2	R	18	1.8A
40031	Load output power	2	R	125	125W
40032	Fan Startup Status	2	R	0	0: Off 1: On
40033	Historical System ChargingW High Value	2	R	H+L (Unit: WH)	Historical Total Power Generation WH
40034	Historical System ChargingW Low Value	2	R		
40035	CurrentS O value	2	R	982	98.2%
40036	Reserved	2	R	Unused	Reserved
40037	Today's power generation	2	R	855	855WH
40038	M P P working mode	2	R	0	See Table 2
40039	Remote Load Switch	2	R/W	0	1: Load On; 0: Load Off
40040	Maximum Voltage Setting for Photovoltaic Access	2	R	560	56.0V
40041	Minimum Voltage Setting for Photovoltaic Access	2	R	20	20.0V
40042	User-defined maximum charging power	2	R/W	200	200W (limit maximum photovoltaic power)
40043	Current battery full charge recovery offset	2	R	2380	23.8V (recovery offset voltage)
40044	Photovoltaic stop working temperature setting	2	R/W	70	70℃
40045	Current photovoltaic fan start temperature	2	R	40	40℃ fan start
40046	Device address	2	R/W	01	Communication address: 01H
40047	Battery charging maximum voltage setting	2	R	2520	25.2V
40048	Battery discharging minimum voltage setting	2	R	1740	17.4V
40049	Current battery undervoltage hysteresis value	2	R	2170	21.7V (load recovery hysteresis value)
40050	Current battery discharge high temperature setting	2	R/W	60	>60℃ stop load output
40051	Current battery discharge low temperature setting	2	R/W	-10	<-10℃ stop load output
40052	Current battery charging high temperature setting	2	R/W	45	Stop charging the battery at 45℃
40053	Current low temperature charging setting for the battery	2	R/W	0	Stop charging the battery at <0
40054	Reserved	2	R/W	Unused	Reserved
40055	Set battery type	2	R	0	0: Ternary lithium, see Function Table 1
40056	Set the number of battery strings	2	R	7	Three-Element Lithium 7 Series
40057	Power On	2	R	1	0: Disable generation, 1: Start generation
40058	Battery activation setting	2	R	0	0: Disable activation (default), 1: Activate
40059	Baud rate	2	R/W	0	1: 9600 (default) 0~8
40060	Backlight time	2	R/W	60	M24HB does not support
40061	Lock screen	2	R/W	0	M24HB does not support
40062	Reserved	2	R/W	Unused	Reserved
40063	User-defined battery overvoltage value	2	R/W	2520	25.2V
40064	User-defined battery undervoltage value	2	R/W	1740	17.4V
40065	User-defined load short-circuit time	2	R/W	500	500*20(us)
40066	Reserved	2	R/W	Unused	Reserved
40067	Reserved	2	R/W	Unused	Reserved
40068	Load shutdown hysteresis voltage setting	2	R/W	1000	1000mV (Hysteresis start voltage setting after load shutdown)
40069	Full charge return voltage difference setting	2	R/W	1000	1000mV (Voltage difference setting for recharging after full charge voltage drops during float char
40070	Reserved	2	R/W	Unused	Reserved

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Appendix Detailed Table

Function Table

Function Table I (Decimal)		
NMC Battery	Nickel Manganese Cobalt Battery	0
LFP Battery	Lithium Iron Phosphate Battery	1
PAB Battery	Lead Acid Battery	2
GEL Battery	Colloidal Battery	3
OTH Battery	Other Batteries	5
ERR	Error Configuration	8

Function Table II (Decimal)		
MPPT->BAT	Solar Panel to Battery Charging	0

Fault Table

Fault Table One (Decimal)					
OV	Solar Panel Over Voltage	1	SC	Solar panel short circuit	128
UV	Solar panel undervoltage	2			
OT	System over temperature	4			
TF	Temperature sensor failure	8			
OC	Solar panel overcurrent	16			
OP	Solar Panel Overload	32			
SF	Current Sensor Fault	64			

Fault Table II (Decimal)					
OV	Battery Overvoltage	1	SF	Battery Current Sensor Fault	128
UV	Battery undervoltage	2	SC	Battery short circuit	256
OT	Battery over temperature	4	LOC1	Load level 1 over current	512
UT	Battery low temperature	8	LOC2	Load level 2 over current	1024
TF	Temperature sensor failure	16	LSC	Load Short Circuit	2048
OC	Battery Overcurrent	32	LSF	Load Current Sensor Fault	5096
OP	Battery Overload	64	PF	Battery Configuration Abnormality	10192
DPF	Charging Dial Fault Code	20384			

Application Wiring Diagram