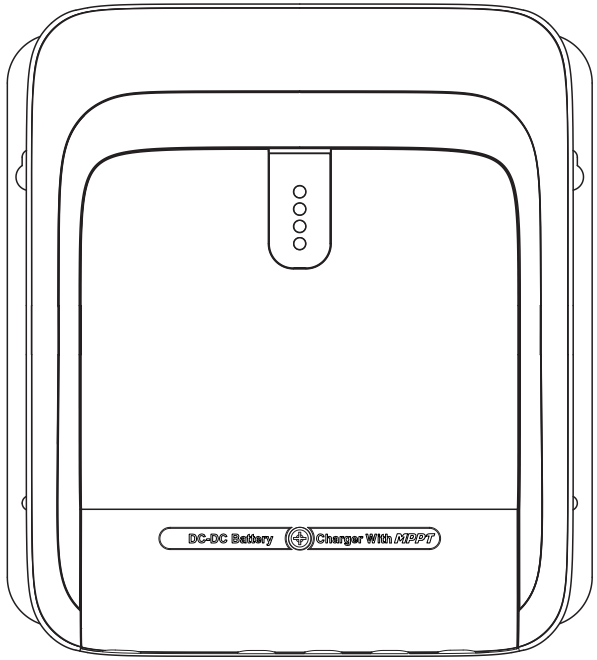
User Manual of MPPT DC Charge Controller for Solar Energy and Generator



Code: 108260

Manual version: V1.02 Subject to change without notice

Dear users:

Thank you for choosing our products!

Safety Instructions

1. Since the applicable voltage of the controller exceeds the safety limit of human body, please read the manual carefully before operation and operate it only after the safety operation is trained.
2. Since no part is required to be maintained or repaired inside the controller, please do not disassemble and repair the controller.
3. Please install the controller indoors to avoid exposure of components and keep water away from the controller.
4. Since the cooling fin will be very hot during operation, please mount the controller in a well-ventilated place.
5. Suitable fuse or circuit breaker is recommended to be equipped outside the controller.
6. Before installing and adjusting the wiring of the controller, be sure to disconnect the wiring of the photovoltaic array and the fuse or circuit breaker near the accumulator battery terminals.
7. After installation, check whether all wiring is tightly connected to avoid the danger of heat accumulation due to loose connection.

Warning: Indicating dangerous operation, and safety preparation is required before operating.

Attention: Indicating destructive operation.

Tips: Indicating suggestions and tips to the operator.

Contents

1. Product Introduction

1.1 Product overview

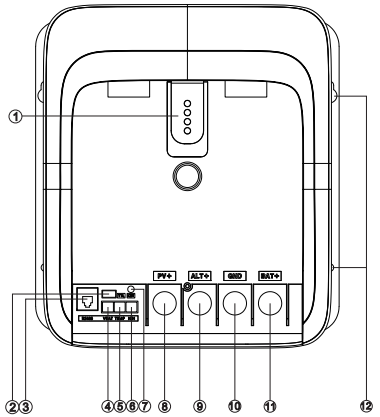
Based on multi-phase synchronous rectification technology and advanced MPPT control algorithm, the MD Series MPPT DC charge controller for solar energy and generator adopts fully digital and intelligent design. Thus, it achieves advantages such as great response speed and reliability and reaches high industrialization standards. The multi-phase synchronous rectification technology ensures super conversion efficiency at any charging power, significantly improving the energy utilization of the system. The PowerCatcher maximum power point tracking technology leads the industry and achieves the maximum energy tracking of solar panels. That makes it possible for the panel to rapidly and precisely track the maximum power point of solar battery in any condition and obtain the maximum energy of solar panels in real-time.

The product belongs to the DC/DC intelligent charger that applies to vehicle or ship systems. It is applied to a dual battery system integrating the respective advantages of generator and photovoltaic power generation. In this case, the system adopts the combination of charging methods with ingenious design, which effectively ensures enough power at any time. The backup battery could be charged by either or both of the solar energy and generator.

1.2 Product features

- Applied with the PowerCatcher maximum power point tracking technology, the controller could still track the maximum power point of the solar battery in complex conditions. Compared with traditional MPPT technology, it has better response speed and tracking efficiency, and its efficiency could reach up to 99.9%.
- Applied with the design of multi-phase synchronous rectification for step-up/down circuitry, the controller owns great DC/DC conversion efficiency whether in high/low power, which could reach up to 98%.
- Various types of backup batteries are supported such as sealed, gel, flooded, lithium, and custom.
- Various types of generators are supported such as intelligent and traditional generators, and the controller could automatically identify the generator types by the ignition signal.
- Applied with various charging modes such as photovoltaic charging the backup battery individually, generator charging the backup battery individually, and photovoltaic and generator charging the backup battery at the same time.
- Applied with cable drop compensation for charging voltage of the backup battery, so that the controller controls the charging voltage in a more accurate way.
- Applied with temperature sampling for the backup battery, and temperature compensation for the lead-acid battery, effectively extending the service life of batteries.
- Applied with automatic derating while charging in high temperature.
- Applied with TTL communication, providing technical support of communication protocol to facilitate applications for secondary development.
- The parameters could be monitored and set via mobile APP and PC monitoring and setting applications.
- Applied with potting of smidahk, the controller has IP65 grade of protection, which ensures reliable and efficient operation in various working conditions.
- Applied with high-quality aluminum radiator and high-temperature derating technology, which ensures reliable and efficient operation in various working conditions.

1.3 Interface description

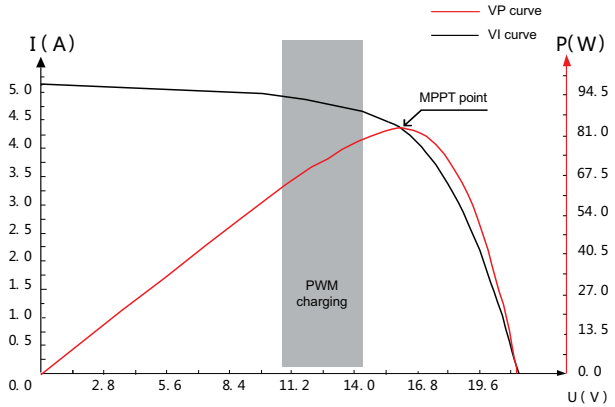


No.	Name	No.	Name
①	LED indicator light	⑦	Operating button
②	TTL communication interface	⑧	Positive interface for solar battery
③	CAN and RS485 communication interfaces	⑨	Positive interface for generator (startup battery)
④	Voltage sampling interface for backup battery	⑩	Common negative interface
⑤	Temperature sampling interface for backup battery	⑪	Positive interface for backup battery
⑥	Ignition signal interface	⑫	fixed hole

1. The solar battery, generator (startup battery), and backup battery adopt the common negative pole design.
2. See the description below for the definitions of the indicator light and interface, button function, interface description, etc.

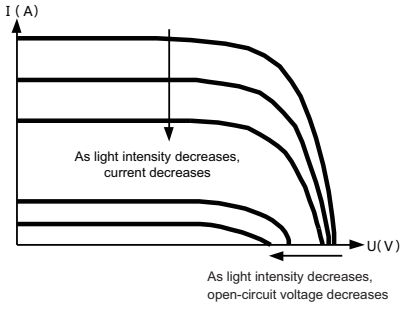
1.4 Introduction of maximum power point tracking

The MPPT (Maximum Power Point Tracking) system is an advanced charging technology, which achieves more energy output from the solar batteries by adjusting the operating state of the electrical modules. Due to the nonlinearity of the solar battery array, there is a maximum energy output point (maximum power point) on its curve. The traditional controller (switching charging technology and PWM charging technology) cannot charge the battery continuously at the point, so it cannot obtain the maximum energy of the solar panel. Instead, the solar controller with MPPT can always track the maximum power point of the array, so as to charge the battery with the maximum energy. For example, for the 12V solar system, since the peak-to-peak voltage (Vpp) of the solar battery is about 17V, while the battery voltage is about 12V, therefore, when the charge controller is charging the battery, the voltage of the solar battery is generally about 12V, that is, the solar battery does not fully exert its maximum power. The MPPT controller can overcome the problem. It could adjust the input voltage and current of the solar panel in real-time to reach the maximum input power. Compared with the traditional PWM controller, the MPPT controller can exert the maximum power of the solar battery, so it can provide a larger charging current. Generally, the MPPT controller can improve the energy utilization rate by 15%~20% more than the PWM controller.

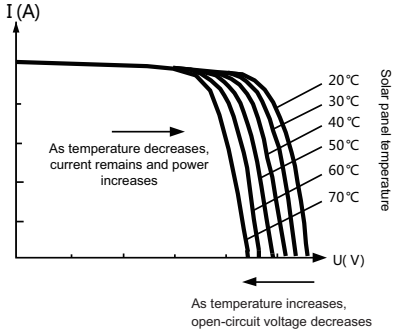


Output characteristic curve of battery panel

Due to the different ambient temperature and lighting conditions, the maximum power point often changes. And our MPPT controller could adjust the parameters in real-time under different conditions, thus making the system status always near the maximum operating point. The whole process is completely automatic without any adjustment.



Relationship between output characteristic of battery panel and light intensity

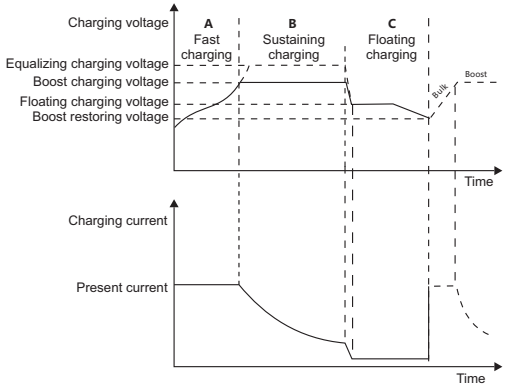


Relationship between output characteristic of battery panel and temperature

1.5 Introduction of charging stage

1.5.1 Charging for lead-acid battery

The controller charges the backup battery for lead-acid type in three stages. A complete charging process consists of: fast charging (BULK), sustaining charging (EQUALIZE/BOOST), and floating charging (FLOAT). The charging curve is as down below:



Charging curve of lead-acid battery

➢ **Fast charging (BULK)**

During the fast charging stage, when the battery voltage has not yet reached the setting value (i.e. equalizing/boost voltage) of full voltage, the controller will perform MPPT to charge the battery with the maximum solar power. When the battery voltage reaches the default value, constant-voltage charging will be applied.

➢ **Sustaining charging (EQUALIZE/BOOST)**

When the battery voltage reaches the setting value of the sustaining voltage, the controller will perform constant-voltage charging. In this process, the MPPT charging will not work, meanwhile, the charging current gradually decreases over time. The sustaining charging consists of equalizing charging and boost charging, which are not repeated during one complete charging process. And the equalizing charging is performed once a month (30 days) (default).

➢ **Equalizing charging (EQUALIZE)**

Regular equalizing charging is applied in certain types of batteries, which could stir up the electrolyte and balance the battery voltage to complete the chemical reaction. During the equalizing charging stage, the charging voltage is increased beyond the standard complement voltage, which could gasify the electrolyte. This stage will last for 120 minutes (default). Equalizing charging and boost charging are not repeated during a single full charging process to avoid excessive gas evolution or overheating of the battery.

➢ Equalizing charging

Warning: Explosion risk!

The gas could be generated during the equalizing charging stage. So the battery compartment shall be well ventilated and not be covered by foreign objects.

Attention: Device damage!

Excess charging and gas evolution may damage the battery panel, resulting in falling off of the active substances on the battery panel. Over voltage of equalizing charging or too long duration of this stage will damage the battery. Please carefully and strictly follow the technical specifications of the battery.

➢ Boost charging (BOOST)

Generally, the default duration of the boost charging stage is 2h, while customers could also adjust the duration and the default value of boost voltage point according to actual needs. When the duration reaches the setting value, the system will be switched to floating charging.

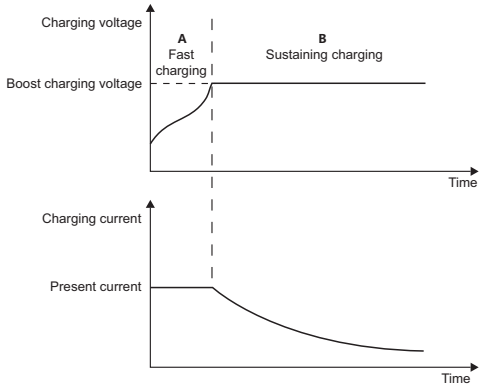
➢ Floating charging (FLOAT)

This stage could maintain the battery voltage near the floating charging voltage. In this stage, the battery is charged with a very weak current to maintain the battery in a fully-charged state.

During the stages of equalizing charging, boost charging, and float charging, when the battery voltage drops to “boost recovery voltage”, the system will exit the current stage and re-enter the BULK fast charging stage. Then, the battery voltage slowly increases and the current drops as the charging goes, the system will enter the constant-voltage stage again.

1.5.2 Charging for lithium battery

The controller charges the backup battery of lithium type in two stages. The first one is the fast charging (BULK) stage, which maximizes the utilization of solar energy and generator energy with the limited maximum charging current, and rapidly increases the battery voltage to the setting value of charging. Then, it switches to the second stage, constant-voltage charging, until the battery is fully charged. And, the charging current gradually drops during this stage.



Schematic diagram for charging stages of lithium battery

2. Product Applications

2.1 Specification and parameter

Product model		MD4830N06
System voltage of backup battery		12/24/48V
Voltage range of backup battery		9~60V DC
Back up battery types		Sealed, gel, flooded, lithium iron phosphate, and custom battery
Rated charging current		30A
Maximum PV input voltage		60V DC
Maximum power point voltage range		17~42V
Maximum PV input current		100A
Charging method for solar panel		Step-down MPPT, step-up MPPT, step-up/down MPPT
MPPT tracking efficiency		> 99%
Maximum PV input power	12 V backup battery	400W
	24 V backup battery	800W
	48 V backup battery	1600W
System voltage of generator (startup battery)		12/24/48V
Type of startup battery		Lead-acid battery
Maximum input voltage of generator		60V DC
Maximum input current of generator		120A
Voltage range of generator	Traditional generator	13.2~16 V (*2/24 V generator; *4/48 V generator)
	Intelligent (EURO 6) generator	12~16 V DC (*2/24 V generator; *4/48 V generator)
Charging method for generator		boost，buck，boost-buck
Maximum input power of generator	12 V backup battery	400W
	24 V backup battery	800W
	48 V backup battery	1600W
No-load loss		< 19mA
Maximum charging conversion efficiency		98%
Temperature compensation factor		-3 mV/°C/2 V (default, while it could be set for lead-acid battery). No temperature compensation for lithium battery
Communication method		TTL、RS485、CAN、BLE
Protection function		Overcharge protection, overcurrent protection, overtemperature protection, reverse connection protection of generator, reverse connection protection of solar panel, reverse charging protection at night. No reverse connection protection for backup battery (external fuse is needed)
Operating temperature		-35°C ~ 65°C
Altitude		≤3000 meters
Protection grade		IP65
Net weight		5.3kg
Product dimensions		233*262*100mm

2.2 Default parameters of battery type

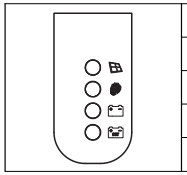
Default parameters of battery types

Parameter \ Battery type	Sealed lead-acid battery SLD (default)	Gel lead-acid battery, GEL	Flooded lead-acid battery, FLD	Lithium iron phosphate battery, LFP	Custom battery default	Custom battery USER (SLD default)
Overvoltage disconnect voltage	16.0V	16.0V	16.0V	16.0V	16.0V	9.0 ~ 17.0V
Overvoltage recovery voltage	15.0V	15.0V	15.0V	15.0V	15.0V	——
Equalizing voltage	14.6V	——	14.8V	——	14.6V	9.0 ~ 17.0V
Boost voltage	14.4V	14.2V	14.6V	14.4V	14.4V	9.0 ~ 17.0V
Boost voltage	13.8V	13.8V	13.8V	——	13.8V	9.0 ~ 17.0V
Boost restoring voltage	13.2V	13.2V	13.2V	13.2V	13.2V	9.0 ~ 17.0V
Over-discharge restoring voltage	12.6V	12.6V	12.6V	12.6V	12.6V	9.0 ~ 17.0V
Undervoltage recovery voltage	12.2V	12.2V	12.2V	12.3V	12.2V	——
Undervoltage alarming voltage	12.0V	12.0V	12.0V	12.1V	12.0V	9.0 ~ 17.0V
Over-discharge voltage	11.1V	11.1V	11.1V	11.1V	11.1V	9.0 ~ 17.0V
Boost charging duration	120 minutes	120 minutes	120 minutes	——	120 minutes	10~600 minutes
Equalizing charging duration	120 minutes	——	120 minutes	——	120 minutes	0~600 minutes
Equalizing charging interval	30 days	——	30 days	——	30 days	0~250 days
Temperature compensation mV/°C/2V	-3	-3	-3	0	-3	0、-3、-4、-5

Note: Please strictly follow the technical specifications and the safety recommendations from the battery manufacturer for setting relevant parameters

2.3 Definition and description of indicator lights

2.3.1 Status description of indicator lights



No.	Definition of indicator light
①	Indicator light of solar panel
②	Indicator light of generator
③	Indicator light of backup battery
④	Indicator light of backup battery types

2.3.2 Indicator light of solar panel

Color of indicator light	Indicating method	Description
Red	Normal ON	MPPT charging
	Slow flash	Boost charging
	Single flash	Floating charging
	Fast flash	Equalizing charging
	Double flash	Current-limited charging
	OFF	Not in charging

2.3.3 Indicator light of generator

Color of indicator light	Indicating method	Description
Red	Normal ON	Backup battery charged by generator
	Fast flash	Generator over-voltage
	OFF	Not in charging

2.3.4 Indicator light of backup battery

Color of indicator light	Indicating method	Description
Green	Normal ON	Battery fully charged
Yellow	Normal ON	Normal battery voltage (>12.0 V)
Red	Normal ON	Battery undervoltage (<12.0 V)
	Slow flash	Battery over-discharge (<11.1 V)
	Fast flash	Battery overvoltage (>16.0 V)/ battery over-temperature

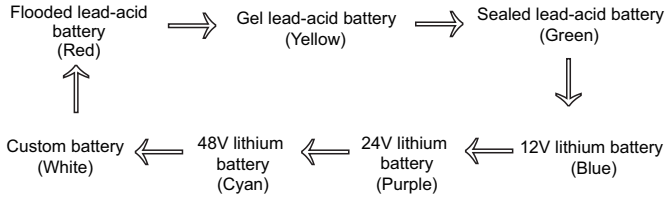
2.3.5 Indicator light of backup battery types

Color of indicator light	Indicating method	Description
Red	Normal ON	Flooded lead-acid battery, FLD
Yellow	Normal ON	Gel lead-acid battery, GEL
Green	Normal ON	Sealed lead-acid battery, SLD (default)
Blue	Normal ON	12 V lithium battery, LI (default lithium iron phosphate)
Purple	Normal ON	24 V lithium battery, LI (default lithium iron phosphate)
Cyan	Normal ON	48 V lithium battery, LI (default lithium iron phosphate)
White	Normal ON	Custom (default 12 V sealed lead-acid)

2.4 Button

Button function I: set battery type

Hold down the button for 8 seconds, and the indicator light of battery type starts to flash (the controller turns off charging now). In this situation, each press switches the color of the indicator, indicating a battery type. When the battery type is set, hold down for 3 seconds or no operation for 10 seconds, and the controller will automatically save the current battery type, cancel the setting mode, and perform the normal working mode.

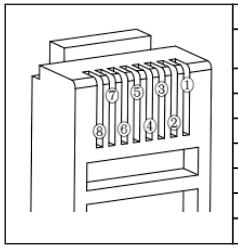


Button function II: restore to factory defaults

Hold down the button for 20 second, and the four red indicator lights start to flash, and the factory defaults are restored.

2.5 RS485 communication

(1) Default baud rate: 9,600 bps, check bit: none, data bit: 8 bit, stop bit: 1 bit
(2) Interface type: RJ45, communication power supply output specification: 5VDC/200mA
(3) RS485 communication line sequence is defined as follows, and the interface integrates CAN communication interface.



S/N	Definition
①	The isolated power supply is positive 5.0VDC
②	D+
③	D-
④	Power ground
⑤	-
⑥	-
⑦	CANH
⑧	CANL

2.6 CAN communication interface

It is an isolated CAN communication interface. According to the communication protocol, the user can make customized development for controller data monitoring, parameter setting, and other operation.

2.7 Bluetooth communication

Built-in Bluetooth communication function, real-time monitoring of the controller's operating data, fault status, and adjustment of the controller's operating parameters through the mobile APP.

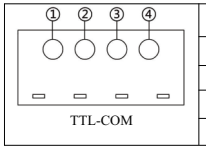
2.8 CAN communication

Built-in CAN communication function, RV-C protocol, real-time monitoring of the controller's operating data, fault status, adjustment of the controller's operating parameters, etc. See 2.5 for the pin definition of CAN communication interface.

2.9 TTL communication interface

Users can use the Modbus protocol for controller data monitoring, parameter setting, and other operation through this port.

The interface is defined as follows:

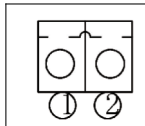


No.	Definition
①	Output voltage+14.8V
②	Controller receiver (RX)
③	Controller sender (TX)
④	GND

2.10 Voltage compensation interface of backup battery

With large charging power and small wire diameter, the collected voltage by the controller is higher than the battery voltage, causing the battery to be undercharged. The battery voltage sampling wire can collect the battery voltage more accurately, so as to compensate the output voltage difference in time to get a more reasonable charging voltage. Connect the battery positive and negative electrodes to the corresponding position of the battery voltage sampling terminals ④ by the voltage compensation wire. The positive electrode is on the left and the negative electrode is on the right.

The interface is defined as follows:



No.	Definition
①	+
②	-

2.11 Temperature sampling interface of backup battery

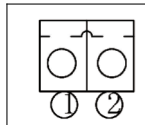
Connect the temperature sensor to the interface ⑤ to sample the real-time temperature of the battery. The default temperature is 25℃ when the temperature probe is not connected. When a temperature sensor is connected, by sampling battery temperature, it can provide high/low temperature protection for batteries or temperature compensation for lead-acid battery charging voltage.

Wiring method: connect the temperature sensor terminal to interface ⑤ and fix the temperature sensor on the battery surface.

2.12 Ignition signal interface

The charging voltages of the smart generator and general generator are different. If using a smart generator, the ignition signal wire should be connected to the IGN terminal. When using general generator, the charging voltage is 13.2V. When using smart generator, the charging voltage is 12.0V. It is also allowed to connect only one wire on the positive electrode.

The interface is defined as follows:



No.	Definition
①	+
②	-

3. Common Problems and Solutions

Phenomenon	Possible reasons	Troubleshooting
Power the backup battery, the indicator does not light.	A. Incorrect or loose wiring of backup battery B. Lithium battery protection	A1. Please check whether the connection wire of the backup battery is correct. B1. Connect the solar panel or generator to activate the lithium battery by charging.
The backup battery cannot be charged by the solar panel through the controller in the daytime.	A. Incorrect or loose wiring of solar panel B. The solar panels are blocked C. The voltage class of the backup battery system is set incorrectly	A1. Please check whether the connection wire of the solar panel is correct. B1. Ensure that the solar panels are not blocked. C1. The system voltage class set by the controller is consistent with the actual battery voltage class in use.
The backup battery cannot be charged by the generator while driving.	A. Incorrect or loose wiring of generator B. The voltage class of the backup battery system is set incorrectly	A1. Please check whether the connection wire of the generator is correct. B1. The system voltage class set by the controller is consistent with the actual battery voltage class in use.

4. Product Installation

4.1 Installation precautions

- Be careful when installing battery. Wear protective goggles when installing a flooded lead-acid battery. Once in contact with the battery acid, please rinse with water immediately.
- Stay away from metal objects to prevent battery short-circuit.
- The battery may produce acid gas when charging. Ensure the ambient environment is well ventilated.
- The battery may produce combustible gas. Stay away from sparks.
- When installing outdoors, avoid direct sunlight and rain seeping.
- The false connection and corroded cables may produce extreme heat to melt the cable insulation and burn surrounding materials, even causing a fire. Make sure that the connections are tightened. The cables are fixed with ties to avoid loose connection when wobbled in transportation.
- When connecting the system, the output voltage of the components may exceed the human body safety voltage, therefore, use insulated tools and keep your hands dry.
- The battery terminals on the controller can be connected either to a single battery or a battery pack. The subsequent instructions are for a single battery, but they are also applicable to systems with a battery pack.
- Please follow the safety recommendations of the battery manufacturer.
- The current density of the system connection wire should be no more than 4A/mm2.
- Ground the ground terminal of the controller.
- When installing the battery, it is forbidden to reverse the battery connection, which may cause irreversible damage.

4.2 Reference for wire and fuse selection

Wiring and installation must meet the requirements of national and local electrical codes.

The wiring specifications of PV(Photovoltaic), generator and battery shall be selected y as per their rated current. Please refer to the table below for wire and fuse specifications:

Voltage of PV at the maximum power point (Vmp)	System voltage of generator (V)	System voltage of backup battery (V)	Maximum input current of PV (A)	Wire diameter of PV (mm²/ AWG)	Fuse specification of PV (A)	Maximum input current of generator (A)	Wire diameter of generator terminal (mm²/ AWG)	Fuse specification of generator (A)	Current of backup battery (A)	Wire diameter of backup battery terminal (mm²/AWG)	Fuse specification of backup battery (A)
17	12	12	25	6/9	40~50	30	8/8	50~60	30	8/8	50~60
		24	50	12/6	75~100	60	15/5	90-120			
		48	100	25/3	150~200	120	30/2	180-240			
	24	12	25	6/9	40~50	17	4/11	26-34			
		24	50	12/6	75~100	34	9/7	51-68			
		48	100	25/3	150~200	68	17/5	102-136			
	48	12	25	6/9	40~50	9	2/14	14-18			
		24	50	12/6	75~100	18	5/10	27-36			
		48	100	25/3	150~200	36	9/7	54-72			

1. The data above is only part of the application of the controller and the actual application differs from the site configuration;
2. The current density of wire should be around 4A/mm²;
3. The specification of the fuse at the input terminal should be 1,5 to 2 times of the actual maximum current

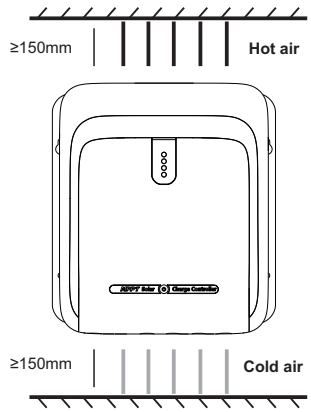
4.3 Installation and wiring

Warning: Danger of explosion! Never install the controller and the flooded battery in the same confined space or a place where battery gas may be accumulated.

Warning: Danger of high voltage! The PV array may generate high open-circuit voltage. Disconnect the circuit breaker or fuse before wiring, and be careful during wiring.

Warning: Danger of electric shock! We strongly recommend that fuses or circuit breakers should be connected to the PV array, generator and battery terminals.

Note: When installing the controller, make sure that there is enough air to flow through the cooling fins of the controller, and leave at least 150mm space above and below the controller to ensure natural convection heat dissipation. If the controller is installed in a sealed box, the heat dissipation of the controller shall be reliable.



Installation and heat dissipation

Step 1: Select an installation location

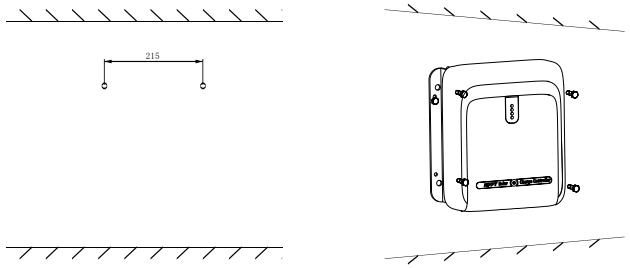
Do not install the controller in a place with direct sunlight, high temperature, or where water can easily enter, and make sure the controller is well ventilated.

Step 2: Fix suspension screws

According to the mounting dimensions of the controller, mark the mounting positions, then drill two mounting holes of suitable size at the two marks and fix the screws on them.

Step 3: Fix the controller

Align the controller fixing holes with the two pre-fixed screws to hang the controller up, and then fix the two screws below.



Fix the controller

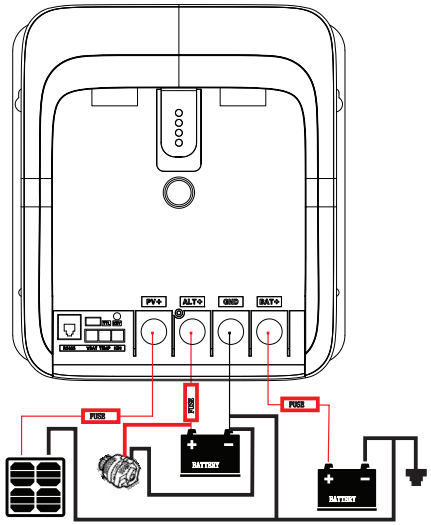
Step 4: Wiring

4.4.1 Crimping. According to the system configuration, select the proper wire specification and fix one wire end to the standard copper tip SC35-8 with a professional crimping tool;

4.4.2 Wiring. Connect the wiring hole of copper terminal SC35-8 to the corresponding bolt of the controller, and fasten the M8 mounting nut with a hexagon socket. The size of the hexagon socket is 14mm.

Wiring terminals	Cross-sectional area 35mm² Diameter of crimping hole 8,5mm	
Wiring tool	Hexagon socket with 14mm diameter of the opposite side	

4.4.3 The specific wiring method is shown in the system wiring diagram:



wiring diagram

Warning: Danger of electric shock! We strongly recommend that fuses or circuit breakers should be connected to the PV array, loading and battery terminals to prevent the risk of electric shock during wiring or misoperation, and make sure that the fuse or circuit breaker is disconnected before wiring.

Warning: Danger of high voltage! The PV array may generate high open-circuit voltage. Disconnect the circuit breaker or fuse before wiring, and be careful during wiring.

Warning: Danger of explosion! Once the positive and negative battery terminals and the connected wires are short-circuited, it will cause fire or explosion. Please be careful when operating.

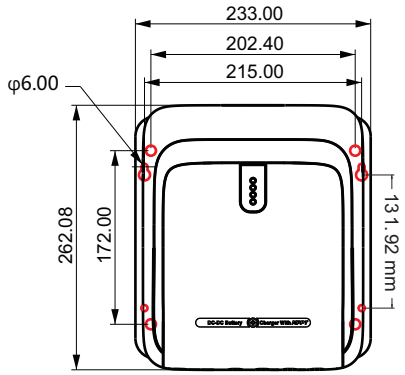
Connect the battery first, then the solar panel and finally the load. Please connect the positive electrode first when wiring.

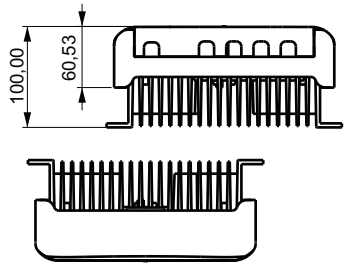
When all power lines are connected firmly and reliably, check again whether the wiring is correct and make sure that the positive and negative electrodes are not reversed. After confirming, connect the battery fuse or circuit breaker first, then observe whether the LED indicator lights up. If not, please immediately cut off the fuse or circuit breaker and check whether the wire is well-connected.

After the battery is normally energized and then connected to the solar panel, the charging indicator of the controller will always light or blink and start charging the battery if there is enough sunlight.

Notice: the installation position of the battery fuse should be close to the controller, and the recommended installation distance is no more than 150 mm.

5. Product Dimensions





Product dimensions: 233*262*100mm
Mounting dimension: 215*132mm
Fixing hole position: φ6mm