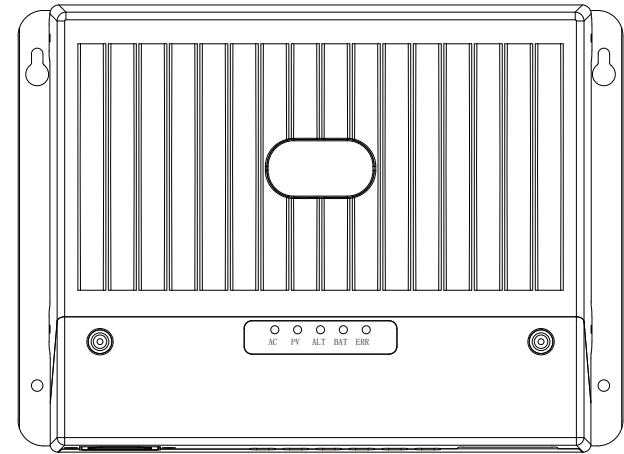


SAA Series AC, PV, and Alternator Charge Controller User Manual



Dear users:

Thank you for choosing our products!

Safety Instructions

- 1. Since the applicable voltage of the controller exceeds the safety limit of the human body, please read the manual carefully before operation and operate the controller only after the safety operation training is completed.
- 2. Since no part is required to be maintained or repaired inside the controller, please do not disassemble and repair the controller by yourself.
- 3. Please install the controller indoors to keep water away from the controller.
- 4. Since the cooling fin will be very hot during operation, please install the controller in a well-ventilated place. Additionally, do not touch it and keep away from materials or equipment affected by high temperatures.
- 5. Please install a suitable fuse or circuit breaker outside the controller.
- 6. Before installing and adjusting the wiring of the controller, make sure to disconnect the wiring of the PV panel and the fuse or circuit breaker near the battery terminals.
- 7. After installation, check whether all wiring is tightly connected to avoid the danger of heat accumulation due to loose connections.
- 8. To ensure personal and property safety during the operation of the controller, please read the contents indicated with the following symbols carefully.

 **Warning:** Indicates that this operation is dangerous and safety preparations must be made before operation.

 **Attention:** Indicates destructive operation.

 **Tip:** Indicates suggestions and tips to the operator.

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1. Product Introduction

1.1 Product overview

Based on multiphase synchronous rectification technology and advanced MPPT control algorithm, the SAA series AC, MPPT PV, and alternator charge controller adopts a fully digital and intelligent design. Thus, it achieves advantages such as fast response speed and great reliability and reaches high industrialization standards. The multiphase synchronous rectification technology ensures extremely high conversion efficiency at any charging power, significantly improving the energy utilization of the system. The leading Power Catcher maximum power point tracking technology achieves the maximum energy tracking of PV panels, which makes it possible to rapidly and precisely track the maximum power point of PV panels in any condition and obtain the maximum energy of PV panels in real time.

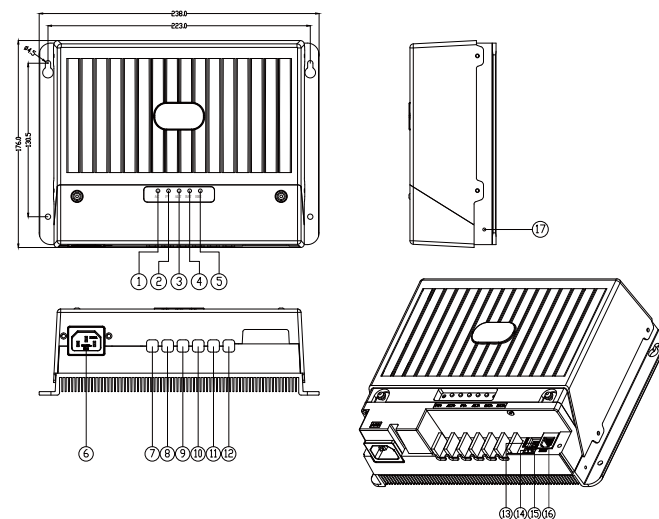
It is a 3-in-1 smart charge controller for RV systems. Thanks to the smart charge controller, the dual battery system integrates the advantages of alternator and PV power generation, and supports various charge control modes of AC, PV, and alternator, effectively keeping the dual battery system always at sufficient capacity. The PV, alternator, or AC can charge the house battery simultaneously or independently, while the PV can charge the starter battery under certain conditions.

When the starter battery voltage is too low to start the vehicle, the house battery can be forced to charge the starter battery through the communication setting.

1.2 Product features

- ◆ Adopt the Power Catcher maximum power point tracking technology to track the maximum power point of PV panels in complex conditions, with a tracking efficiency of up to 99.9%, which has better response speed and tracking efficiency compared with traditional MPPT technology.
- ◆ Adopt the multiphase synchronous rectifier and buck-boost circuit to obtain a high DC/DC conversion efficiency of up to 96% whether in high or low power.
- ◆ Support multiple types of house batteries such as sealed battery, gel battery, flooded battery, lithium battery, and user-defined battery.
- ◆ Support intelligent alternators and traditional alternators.
- ◆ Support the charge via AC, MPPT PV, and alternator.
- ◆ Support hybrid charge via AC and MPPT PV or MPPT PV and alternator.
- ◆ Support a wide range of AC voltage inputs.
- ◆ Possess the cable drop compensation for the house battery charge to control the battery charging voltage more accurately.
- ◆ Possess the temperature sampling for house batteries and temperature compensation for lead-acid batteries, effectively extending the service life of batteries.
- ◆ Possess automatic derating while charging at high temperatures.
- ◆ Support RS485 and TTL communication.
- ◆ With built-in Bluetooth, support the view of the running state, real-time data, fault state, and set parameters through the APP.
- ◆ Support CANbus communication (RV-C protocol).
- ◆ Adopt high-quality aluminum radiator and high-temperature derating technology to ensure reliable and efficient operation in various working conditions.

1.3 Interface description



No.	Name	No.	Name
①	AC charge indicator	⑩	Negative interface for alternator (starter battery)
②	PV charge indicator	⑪	Negative interface for house battery
③	ALT charge indicator	⑫	Positive interface for house battery
④	BAT charge indicator	⑬	TTL communication interface
⑤	ERR indicator	⑭	Voltage sampling interface for house battery
⑥	AC input interface	⑮	Temperature sampling interface for house battery
⑦	Positive interface for PV panel	⑯	RS485 communication interface
⑧	Positive interface for alternator (starter battery)	⑰	Grounding screw
⑨	Negative interface for PV panel		

1. The PV panel, alternator (starter battery), and house battery share the common negative pole.
2. The indicator definition, interface definition, interface description, etc. are shown below.

1.4 Introduction of maximum power point tracking

The maximum power point tracking (MPPT) system is an advanced charge technology with more energy output from the PV panel by adjusting the operating state of the electrical modules. Due to the nonlinearity of the PV array, there is a maximum energy output point (maximum power point) on its curve. The traditional controller (switching charge technology and PWM charge technology) cannot charge the battery continuously at the point, so it cannot obtain the maximum energy of the PV panel. Instead, the PV charge controller with MPPT can always track the maximum power point of the array, so as to charge the battery with the maximum energy.

Taking the 12V system as an example, and assuming that the peak voltage (V_{pp}) is 17V for the PV panel and 12V for the battery, through the non-MPPT charge controller, the PV panel voltage is about 12V, in this case, its maximum energy is unavailable. However, the MPPT controller maximizes the input power by adjusting the input voltage and current of the PV panel in real time. Compared with the traditional PWM controller, the MPPT controller exerts the maximum power of the PV panel and provides a larger charging current. Generally, the MPPT controller improves the energy utilization rate by 15%–20% higher than the PWM controller.

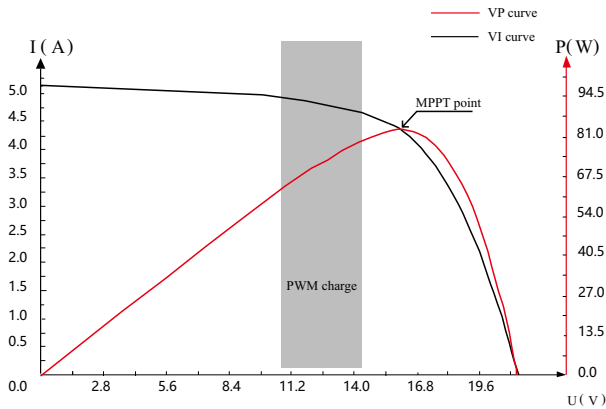


Figure 1-2 PV panel output characteristic curve

The maximum power point often changes due to the different ambient temperature and lighting conditions. However, our MPPT controller adjusts the parameters in real time under different conditions, thus making the system always operate near the maximum power point. The whole process is completely automatic without any adjustment.

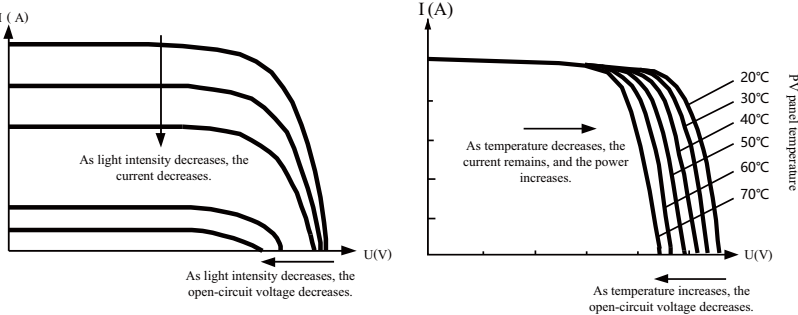


Figure 1-3 Relationship between PV panel output characteristic and light intensity

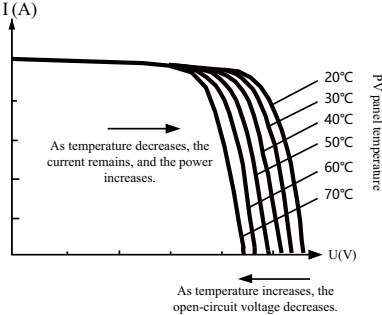
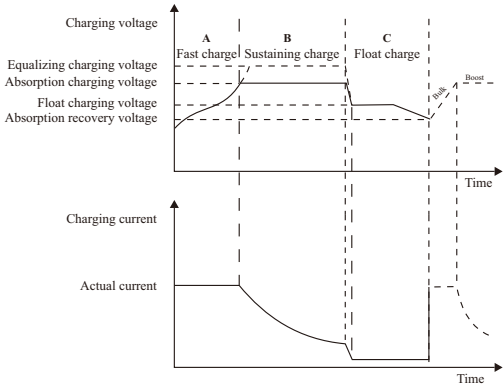


Figure 1-4 Relationship between PV panel output characteristic and temperature

1.5 Introduction of charge stage

1.5.1 Charging for lead-acid battery

The controller charges the lead-acid house battery in three stages, including fast charge (bulk/MPPT), sustaining charge (equalizing/absorption), and float charge. The charging curve is drawn as below:



Charging curve of lead-acid battery

➤ Fast charge (bulk)

During the fast charge, if the battery voltage does not reach the set full voltage (equalizing/absorption voltage), the controller will perform a bulk charge. If the battery voltage reaches the set value, the constant voltage charge will be started.

➤ Sustaining charge (equalizing/absorption)

When the battery voltage reaches the set sustaining voltage, the controller will perform a constant voltage charge. In this process, the bulk charge will not work, and the charging current will gradually decrease over time. The sustaining charge includes the equalizing charge and absorption charge, which are not repeated during one complete charging process. The equalizing charge is performed once every 30 days (default).

➤ Equalizing charge

The periodic equalizing charge is applied in certain types of batteries, which stirs up the electrolyte and balances the storage battery voltage to complete the chemical reaction. During the equalizing charge, the charging voltage is increased beyond the standard complement voltage to gasify the electrolyte. This stage will last for 120 min (default). Both equalizing charge and absorption charge are not repeated during a full charging process to avoid excessive gas evolution or battery overheating.

➤ Equalizing charge



Warning: Explosion risk!

The gas could be generated during the equalizing charge. So the battery compartment must be well-ventilated and protected from being covered by foreign objects.



Attention: Device damage!

Overcharge and gas evolution may damage the battery plate, resulting in falling off of the active substances on the battery plate. Overvoltage or long duration of equalizing charge will damage the battery. Please carefully and strictly follow the technical specifications of batteries.

➤ Absorption charge

The duration of the absorption charge is 2 h (default). When the duration reaches the set value, the system will switch to float charge.

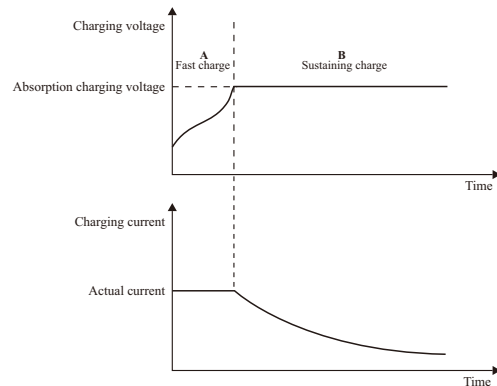
➤ Float charge

The float charge maintains the battery voltage near the float charging voltage. The battery is charged with low current to maintain it in a fully charged state.

During the stages of equalizing charge, absorption charge, and float charge, when the battery voltage drops to "absorption recovery voltage", the system will exit the current stage and re-enter the bulk charge stage. Then, the battery voltage slowly increases and the current drops as the charge goes, and the system will enter the constant voltage charge stage again.

1.5.2 Charging for lithium battery

The controller charges the lithium house battery in two stages. The first one is the fast charge (bulk) stage, which maximizes the utilization of AC, PV, and alternator energy with a limited maximum charging current, and rapidly increases the battery voltage to the set value. Then, it switches to the second stage, namely constant voltage charge, until the battery is fully charged. Meanwhile, the charging current gradually drops during this stage.



Charging curve of lithium battery

2. Product Application

2.1 Electrical parameters

Parameter		Value			
Model		SAA1230	SAA1240	SAA1250	SAA1260
System voltage of house battery		12V/24V/AUTO			
Voltage range of house battery		9~32VDC			
Type of house battery		Sealed lead-acid battery, gel lead-acid battery, flooded lead-acid battery, lithium iron phosphate battery, and user-defined battery			
PV Rated charging current		30A	40A	50A	60A
AC Rated charging current		House battery 12V 30A House battery 24V 15A	House battery 12V 40A House battery 24V 20A	House battery 12V 50A House battery 24V 25A	House battery 12V 60A House battery 24V 30A
ALT Rated charging current		House battery 12V House battery 24V House battery 12V/24V	Starter battery12V 40A Starter battery12V 20A Starter battery24V 40A	House battery 12V House battery 24V House battery 12V/24V	Starter battery12V 60A Starter battery12V 30A Starter battery24V 60A
Maximum PV input voltage		65VDC			
Maximum power point voltage range		15~50VDC			
Maximum PV input current		30A	40A	50A	60A
PV charge mode		Buck MPPT			
MPPT tracking efficiency		> 99%			
Maximum PV input power		12V 450W 24V 900W	12V 600W 24V 1200W	12V 750W 24V 1500W	12V 900W 24V 1800W
AC input voltage range		90-265VAC			
AC input frequency range		45-65Hz			
Power factor		≥0.99			
System voltage of alternator (starter battery)		12V/24V/AUTO			
Type of starter battery		Lead-acid battery			
Maximum input voltage of alternator		32VDC			
Voltage range of alternator	Traditional alternator	13.2-16VDC/26.4-32VDC			
	Intelligent alternator	12-16VDC/24-32VDC			
	User-defined	Adjustable between 11 and 14VDC (x2 24V alternator systems)			
Maximum input current of alternator		50A		65A	
Alternator charge mode		Buck and Boost			
Maximum input power of alternator		Starter battery12V 600W Starter battery24V 1200W		Starter battery12V 900W Starter battery24V 1800W	
Charge of starter battery via PV or backup battery	Charging voltage	Alternator starter charging voltage -0.2VDC			
	Charging current	≤10A(12V); ≤5A(24V)			
No-load loss		≤55mA			
Maximum charging conversion efficiency		96%			
Temperature compensation factor (lead-acid battery)		-3mV/°C/2V by default (adjustable)			
Communication mode		TTL、RS485、CAN(RV-C)、BLE			
Protection function		Overcharge protection, overcurrent protection, overtemperature protection, generator reverse-connection protection, solar panel reverse-connection protection, backup battery reverse-connection protection, and nighttime anti-backflow protection.			
Operating temperature		-35°C ~ 65°C			
Altitude		≤3,000m			
Protection grade		Electronic components: IP43; terminal: IP22			
Net weight		3.0kg		4.5kg	
Product dimensions(h*w*d)		238*176*74mm		255*196*90mm	

2.2 Default parameters of batteries

Default parameter table of batteries

Battery type Parameter	Sealed lead-acid battery SLD/AGM (default)	Gel lead-acid battery (GEL)	Flooded lead-acid battery (FLD)	Lithium iron phosphate battery (LFP)	User-defined battery (SLD by default)
Overvoltage turn-off voltage	16.0V	16.0V	16.0V	16.0V	9.0 -17.0V
Overvoltage recovery voltage	15.0V	15.0V	15.0V	15.0V	—
Equalizing charging voltage	14.6V	—	14.8V	—	9.0 -17.0V
Absorption charging voltage	14.4V	14.2V	14.6V	14.4V	9.0 -17.0V
Float charging voltage	13.8V	13.8V	13.8V	—	9.0 -17.0V
Absorption recovery voltage	13.2V	13.2V	13.2V	13.2V	9.0 -17.0V
Over-discharge recovery voltage	12.6V	12.6V	12.6V	12.6V	9.0 -17.0V
Undervoltage recovery voltage	12.2V	12.2V	12.2V	12.2V	—
Undervoltage alarming voltage	12.0V	12.0V	12.0V	12.0V	9.0 -17.0V
Over-discharge voltage	11.1V	11.1V	11.1V	11.1V	9.0 -17.0V
Absorption charge duration	120 min	120 min	120 min	—	10 min-600 min
Equalizing charge duration	120 min	—	120 min	—	0 min-600 min
Equalizing charge interval	30 d	—	30 d	—	0 d-250 d
Temperature compensation mV/°C/2 V	-3	-3	-3	0	-5-0

Note: 24V system voltage point *2, the actual control value is obtained.

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

3.Indicator State Description

	Indicator definition
	AC charge indicator
	PV charge indicator
	ALT charge indicator
	BAT charge indicator
	ERR indicator

3.1 AC charge indicator

Indicator color	Indicating state	Description
White	Normal ON	Charge of the house battery via AC
	OFF	Uncharged

3.2 PV charge indicator

Indicator color	Indicating state	Description
White	Normal ON	MPPT charge
	Slow flash	Absorption charge
	Single flash	Float charge
	Fast flash	Equalizing charge
	Double flash	Current-limited charge
	OFF	Uncharged

3.3 ALT charge indicator

Indicator color	Indicating state	Description
White	Normal ON	Charge of the backup battery via alternator
	Slow flash	Charge of the starter battery via PV panel
	Single flash	Charge of the starter battery via backup battery
	Fast flash	Alternator over-voltage
	OFF	Uncharged

3.4 BAT charge indicator

Indicator color	Indicating state	Description
White	Normal ON	Normal battery voltage
	Slow flash	Battery over-discharge
	Fast flash	Battery overvoltage

3.5 ERR indicator

Indicator color	Indicating state	Description
White	OFF	Normal system
	Fast flash	System fault

4.TTL communication interface

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

- 1) Default baud rate: 9,600 bps; check bit: none; data bit: 8 bit; stop bit: 1 bit
- 2) Communication power output: (12 V±2 V)/100 mA

The interface is defined as follows:

No.	Definition
①	VCC communication power output
②	RX controller data receiving terminal
③	TX controller data transmitting terminal
④	GND

5. RS485 and CAN Communication

1) RS485 communication:

Interface type: RJ45, communication power output specification: 5V/200mA, and matching resistance is 120R.

Default baud rate: 9,600 bps; parity bit: none; data bit: 8 bit; stop bit: 1 bit

2) CAN communication:

CAN 2.0B mode, extended frame, baud rate of 250Kbps, support RV-C protocol, and there is no terminal resistance inside the controller.

3) RJ45 interface communication line sequence definition:

No.	Definition
①	CAN_L
②	CAN_H
③	NC
④	NC
⑤	Power ground/signal ground
⑥	B/D-
⑦	A/D+
⑧	Positive pole

6. Bluetooth Communication

With the Bluetooth 4.0BLE module integrated inside the controller, users can scan the QR code below to download and install, as well as monitor and set the parameters of the controller through the APP.



7. House Battery Temperature Sampling

By referring to the 1.3 Interface description, it is required to connect the temperature sensor terminal to the interface ⑥ and fix the temperature sensor on the battery surface. The controller will compensate the charging temperature of the battery according to the collected temperature and protect the battery from high and low temperatures.

Note: If the temperature sensor is not connected, the default temperature is 25°C

8. House Battery Voltage Compensation

Due to configuration reasons, the charging power is large, and the wire diameter from the battery to the controller is small. As a result, the battery voltage collected by the controller is higher than the actual battery voltage, resulting in insufficient battery charging. However, the battery voltage sampling line collects accurate battery voltage, and the voltage compensation is output in time to keep the battery under reasonable charging voltage.

Wiring method: By referring to 1.3 Interface Description, connect the positive and negative poles of the battery respectively to the positive and negative sampling terminals ⑦ of the battery voltage through the voltage compensation line. Note that the line sequence is positive at the left and negative at the right.

The interface is defined as follows:

No.	Definition
①	Connected to the battery positive pole
②	Connected to the battery negative pole

VBAT

9. Common Faults and Troubleshooting

Fault	Possible reasons	Troubleshooting
After the house battery is connected, the indicator does not light.	A. Incorrect or loose wiring of house battery B. Lithium battery protection	A1. Please check whether the connection of house battery cable is correct and reliable; B1. Connect the PV panel or alternator to activate the lithium battery by charging.
The house battery cannot be charged by the PV panel through the controller in the daytime.	A. Incorrect or loose wiring of PV panel B. PV panels blocked C. Wrong voltage grade of the house battery system D. Battery fully charged	A1. Check whether the wiring of the PV panel is correct and secure. B1. Ensure that the PV panels are not blocked. C1. Ensure that the system voltage grade set by the controller is consistent with the actual battery voltage grade. D1. Note that the battery will automatically resume charge if the battery voltage is lower than the absorption charge recovery voltage.
The house battery cannot be charged by the alternator while driving.	A. Incorrect or loose wiring of alternator B. Wrong voltage grade of the house battery system	A1. Check whether the wiring of the alternator is correct and secure. B1. Ensure that the system voltage grade set by the controller is consistent with the actual battery voltage grade.

10. Installation

10.1 Installation precautions

- ◆ Be careful when installing the battery. Wear protective goggles when installing a flooded lead-acid battery. Once in contact with the battery acid, rinse with water immediately.
- ◆ Keep the battery away from metal objects to prevent short circuits.
- ◆ Ensure good ventilation, because the battery may produce acid gas when charging.
- ◆ Keep the battery away from sparks since it may produce combustible gases.
- ◆ During outdoor installation, avoid direct sunlight and rainwater infiltration.
- ◆ As false connections and corroded cables may cause extreme heat to melt the cable insulation, burn surrounding materials, and even cause a fire, ensure that the connections are tightened, and the cables are fixed with ties to avoid loose connections due to shaking of cable on the move.
- ◆ When connecting the system, the output voltage of the components may exceed the safety limit of the body, therefore, use insulating tools and keep your hands dry.
- ◆ Note that the battery terminals on the controller can be connected to either a single battery or a battery pack. The subsequent instructions are for a single battery in the manual, but they are also applicable to systems with a battery pack.
- ◆ Follow the safety recommendations of the battery manufacturer.
- ◆ Select the system connection cables with a current density of $\leq 4 \text{ A/mm}^2$.
- ◆ Ground the controller.

10.2 Wire and fuse selection

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

The wiring specifications of the AC , PV, alternator , and battery shall be selected as per their rated current. Please refer to the table below for wire and fuse specifications:

Model	Maximum input current of AC (A)	Wire diameter of AC(mm ² /AWG)	Maximum input current of PV (A)	Wire diameter of PV (mm ² /AWG)	Fuse capacity of PV (A)	Maximum input current of alternator (A)
SAA1230	10A	2.5mm ² /13AWG	30A	8mm ² /8AWG	40-50A	50A
SAA1240	10A	2.5mm ² /13AWG	40A	10mm ² /7AWG	50-60A	50A
SAA1250	10A	2.5mm ² /13AWG	50A	13mm ² /6AWG	60-70A	65A
SAA1260	10A	2.5mm ² /13AWG	60A	17mm ² /5AWG	70-80A	65A

Model	Wire diameter of alternator(mm ² /AWG)	Fuse capacity of alternator (A)	Current of house battery (A)	Wire diameter of house battery (mm ² /AWG)	Fuse capacity of house battery (A)
SAA1230	13mm ² /6AWG	60-70A	40A	10mm ² /7AWG	50-60A
SAA1240	13mm ² /6AWG	60-70A	40A	10mm ² /7AWG	50-60A
SAA1250	17mm ² /5AWG	80-90A	60A	13mm ² /6AWG	60-70A
SAA1260	17mm ² /5AWG	80-90A	60A	17mm ² /5AWG	70-80A

10.3 Installation and wiring

-  Warning: Danger of explosion! Never install the controller and flooded battery in the same confined space or a place where battery gas may accumulate.
-  Warning: Danger of high voltage! Since 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! Be sure to connect the fuses or circuit breakers with the PV array, alternator, and battery to prevent electric shock during wiring or misoperation, and make sure that the fuse or circuit breaker is disconnected before wiring.
-  Warning: Danger of high voltage! Since 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! Since the short circuit of positive and negative battery terminals and connected wires will cause fire or explosion, be careful when operating.

Connect the battery first, then the PV panel, and finally the load. Please connect the positive (+) first and then the negative (-) 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 poles are not reversed. After confirming, connect the battery fuse or circuit breaker first, then observe whether the LED indicator lights up. If not, immediately cut off the fuse or circuit breaker and check whether the wiring is correct.

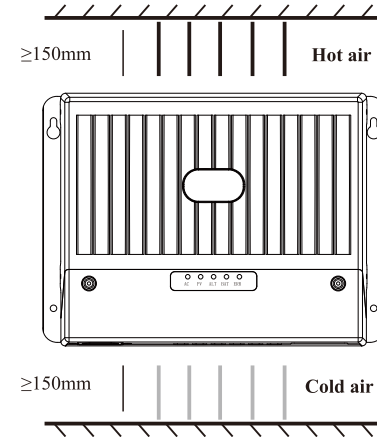
After the battery is turned on and connected to the PV panel, the charge indicator of the controller will always light or flash, and the battery will be charged if there is enough sunlight.

-  Attention: When installing the controller, make sure enough air flowing through the cooling fins of the controller, and leave at least 150mm space above and below the controller to ensure natural convection and heat dissipation. If the controller is installed in a sealed box, ensure a heat dissipation of the controller.
-  Attention: For the AC wiring, if the power cord is damaged, replace it with a special cord or special component obtained from the manufacturer or its service organization.
-  Attention: Install the battery fuse as close as possible to the battery, with a distance below 150 mm.

10.4 Installation diagram

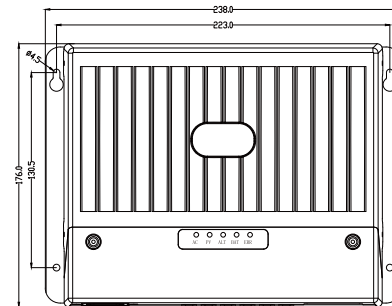
Step 1: Select an installation location

Install the controller in a place without direct sunlight, high temperature, or water inflow, but with good ventilation.



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.

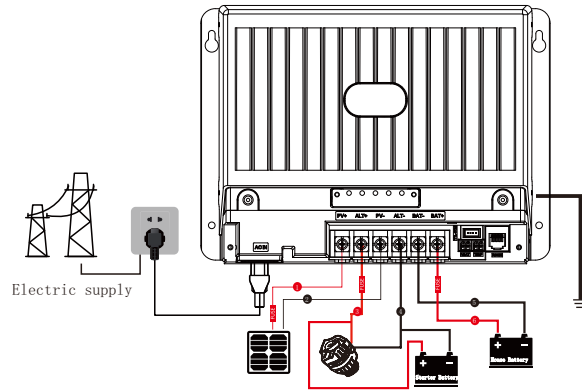


Step 3: Fix the controller

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

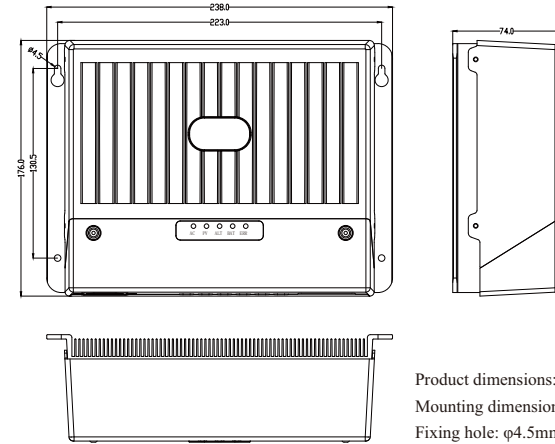
Step 4: Wiring

- 4.1 Crimping: According to the system configuration, select the proper wire and fix one wire end to the standard copper terminal with a professional crimping tool.
- 4.2 Wiring: Connect the wiring hole of the copper terminal to the wiring interface on the controller.
- Step 1: Unscrew the screw and remove the black front cover;
- Step 2: Connect to the terminal to the corresponding interface according to the mark, and avoid reverse connection.
- Step 3: Arrange the wire and push it into the black front cover of terminals.
- 4.3 The specific wiring method is shown in the system wiring diagram:



11. Product Dimensions

11.1 SAA1230&SAA1240 dimensional drawing



11.2 SAA1250&SAA1260 dimensional drawing

