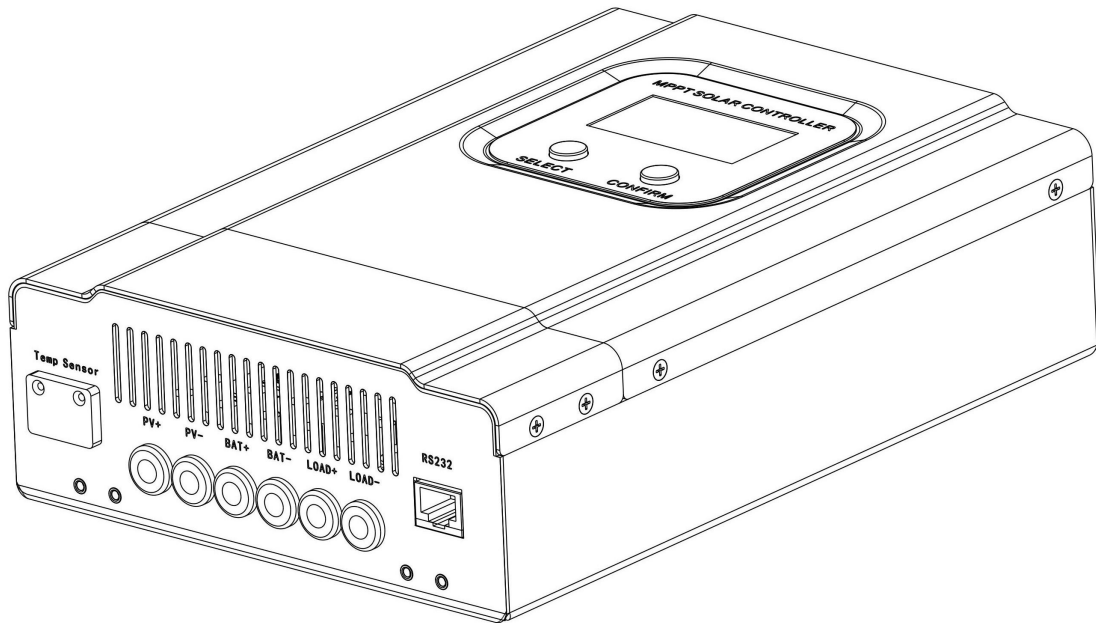# User Manual of MPPT Solar Charge Controller

eSmart2-20A/30A/40A

Maximum PV input voltage(VOC):100V

Important Safety Instructions

Please reserve this manual for future review.
This manual contains all instructions of safety, installation and operation for Maximum Power Point Tracking (MPPT) controller in eSmart2 series ("the controller" is referred in this manual).

General Safety Information

➢ Please read carefully all the instructions and warnings in the manual before installation.
➢ Mount the controller indoors. Prevent exposure to the elements and do not allow wet or water to enter the controller.
➢ Install the controller in well ventilated places, the controller's case temperature may become very hot during operation.
➢ Suggested to install appropriate external breakers.
➢ Power connections must remain tight to avoid excessive heating from a loose connection.

# Contents

1. MPPT Controller General Information

1.1 Overview

Appreciate you for choosing MPPT solar charge controller. I-P-eSmart2 series is the second generation of eSmart mppt controller, based on eSmart series mppt controller, we update the display with LCD, control method, connect way, internal structure etc. It features an efficient MPPT control algorithm to track the maximum power point of the PV array. Greatly improve the utilization of solar panel. Its intelligent LCD and upper PC display, mostly convenient for customers checking, records and parameter setting. It widely used in off-grid solar system, communication base station solar system,household solar systems, street light solar systems, field monitoring and other fields etc.
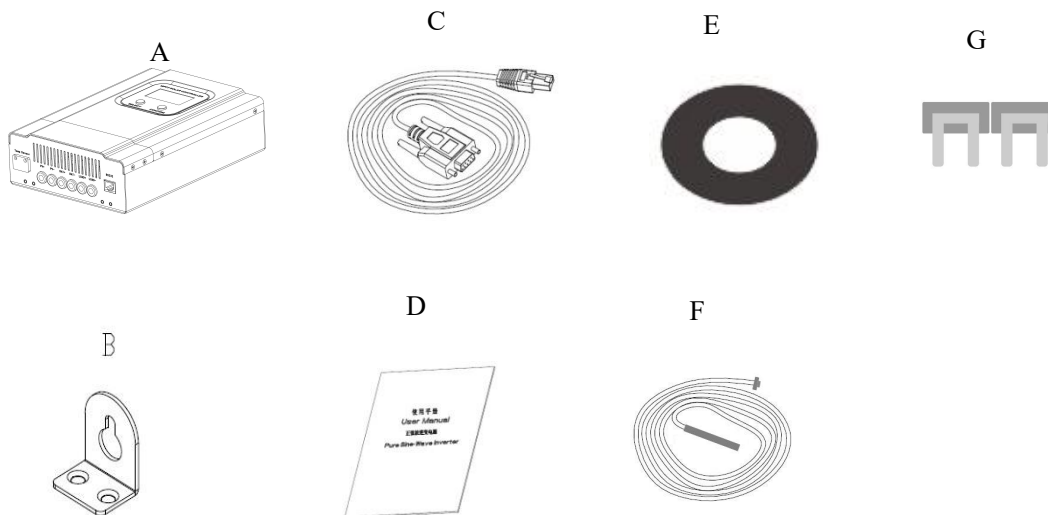
Features:

◆ High efficiency MPPT control algorithm, MPPT efficiency ≥99.5%, whole machine conversion efficiency upto 98%;

◆ 12V/24V/36V/48V system Automatic Recognition, users can use it in different system conveniently.

◆ Maximum PV input voltage: 100VDC

◆ Charge mode: three stages (fast charge, constant charge, floating charge). It prolongs service life of the batteries.

◆ Discharge mode: ON/OFF mode, PV voltage control mode.

◆ Recommended battery types: Sealed lead acid, Vented, Gel, NiCd battery. Other types of the batteries can also be defined.

◆ Most information could be provide by LCD like: model No., PV input voltage, battery type, battery voltage, charging current, charging power, working status and so on. Also customer's information like company name, website and logo can be added into Solar Eagle software.

◆ RS232 communication, we can offer communication protocol also, it's convenient for user's integration management.

◆ CE, RoHS, FCC certifications approved. We can help clients to approve other certifications.

◆ 2 years warranty. And 3~10 years extended warranty service also can be provided.

1.2 Characteristics
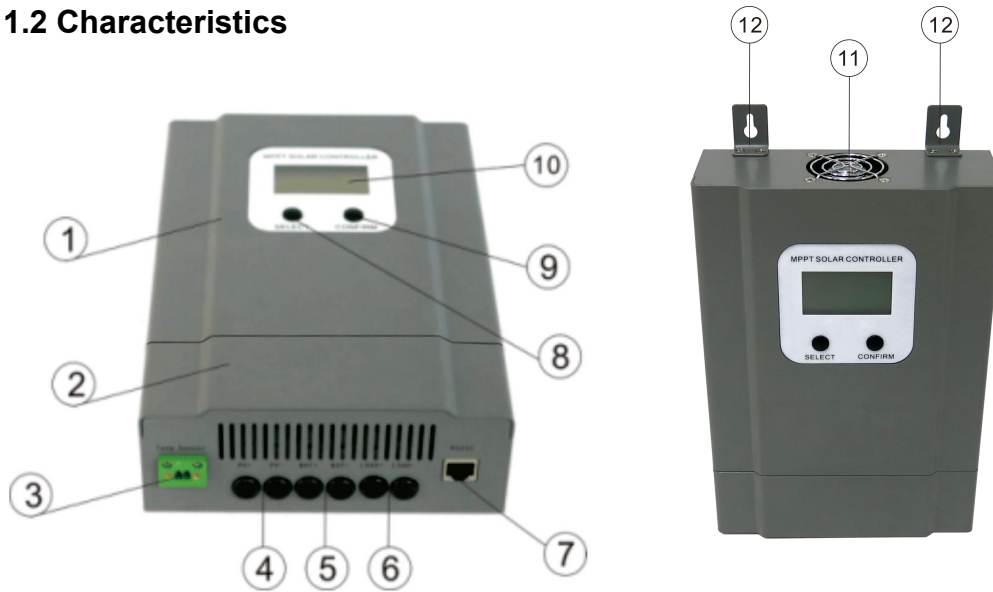
Item	Name	Item	Name
①	Case	⑦	RS232 port
②	Terminal Cover	⑧	Select Button
③	Bat. Temp Sensor	⑨	Confirm Button
④	PV Terminals	⑩	LCD Display
⑤	Battery Terminals	⑪	Cooling Fan
⑥	Load Terminals	⑫	Hang Bracket

1.3 Accessories Instruction

MPPT Solar Charge Controller Accessories Diagram

Object	Quantity	Description
A	1 unit	MPPT solar charge Controller

B	2 pcs	Hang Bracket
C	1 pcs	RS232 Communication Port
D	1 pcs	User Manual
E	1 pcs	CD (PC Software)
F	1 pcs	Temperature sensing wire
G	2 pcs	Fuse

If there is any part missing, please contact your dealer.

1.4 Maximum Power Point Tracking Technology

Due to the nonlinear characteristics of solar array, there is a maximum energy output point (Max Power Point) on its curve. eSmart2 series solar charge controller with Maximum Power Point Tracking (MPPT) Technology can lock on the point to harvest the maximum energy and deliver it to the battery. Traditional controllers, with switch charging technology and PWM charging technology, can't charge the battery at the maximum power point, so can't harvest the maximum energy available from PV array.

The MPPT algorithm of eSmart2 series continuously compares and adjusts the operating points to attempt to locate the maximum power point of the array. The tracking process is fully automatic and does not need user adjustment.

As the Figure shown below, the curve is also the characteristic curve of the array, the MPPT technology will "boost" the battery charge current through tracking the MPP(Max. Power Point). Assuming 100% conversion efficiency of the solar system, in that way, the following formula is established:

Controller Input Power (PV input power) (P_{PV})   =Controller Output Power (P_{Bat})

⇓

Input Voltage(V_{Mpp})* Input Current (I_{PV})=Battery Voltage (V_{Bat})*Battery Current (I_{Bat})

Normally, the V_{Mpp} is always higher than $V_{Bat,}$ Due to the principle of conservation of energy, the I_{Bat} is always higher than $I_{PV.}$ The greater the discrepancy between V_{Mpp} &$V_{Bat,}$ the greater the discrepancy between I_{PV}&$I_{Bat.}$ The greater the discrepancy between array and battery. This is also the simplest way to distinguish whether the real MPPT controller.

As the Figure shown below, is the maximum power point curve, the shaded area is charging range of traditional solar charge controller (PWM Charging Mode), it can obviously diagnose that the MPPT mode can improve the usage of the solar energy resource. According to our test, the MPPT controller can raise 20%-60% efficiency compared to the PWM controller. (The efficiency may be change due to the different use environment background.)
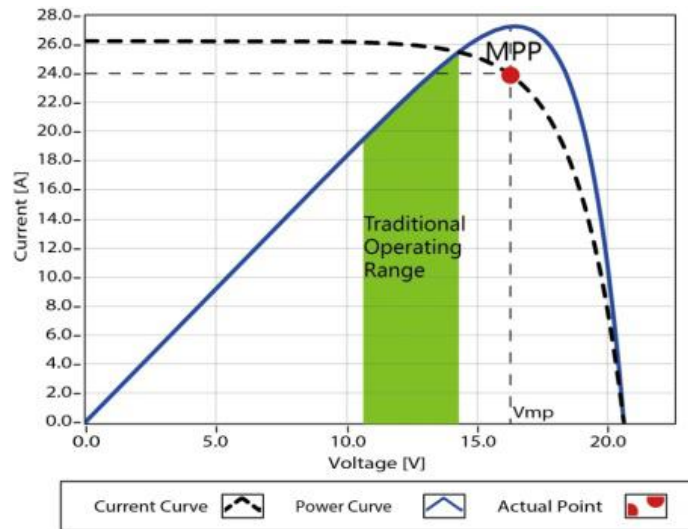
Maximum Power Point Curve

In actual application, as shading from cloud, tree and snow, the panel maybe appear Multi-MPP, but in actually there is only one real Maximum Power Point. As the below Figure shows:
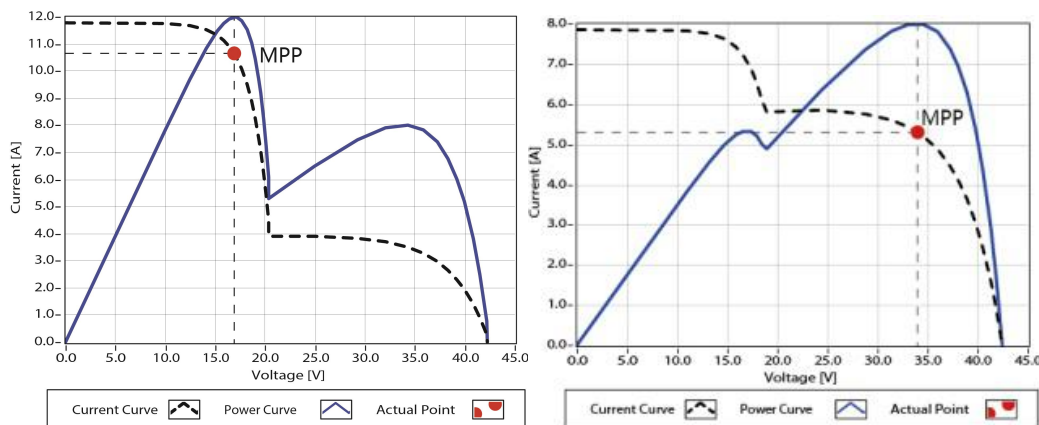
Mutil-MPP Curve

If the program works improperly after appearing Multi-MPP, the system will not work on the real max power point, which with low conversion efficiency. The typical MPPT algorithm, designed by our company, can track the real MPP quickly and accurately, improve the utilization rate of the array and avoid the waste of resources.

1.5 Battery Charging Stage
The controller have 3 stages charge mode, Constant Current Charging(Bulk Charging), Constant Voltage Charging(CV) and Floating Charging(CF) for rapid, efficient, and safe battery charging.
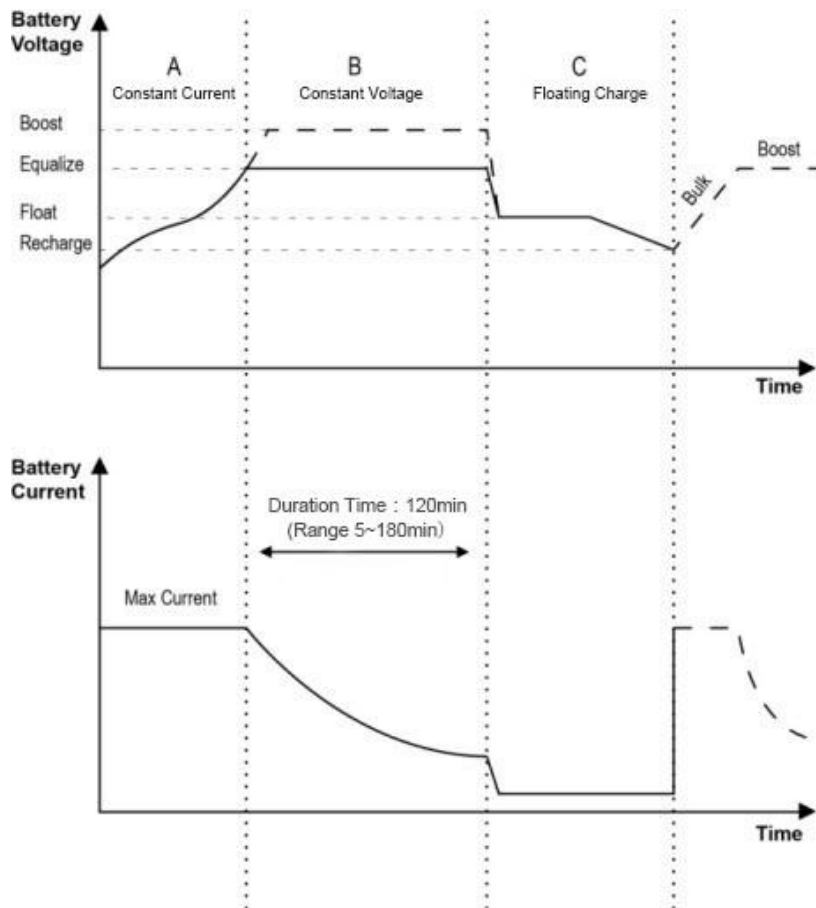
Battery Changing Stage Curve

a) Constant Current Charging_CC(Bulk Charging)

In this stage, the battery voltage has not yet reached constant voltage (Equalize or Boost Voltage), the controller operates in constant current mode, delivering its maximum current to the batteries (MPPT Charging).

b) Constant Voltage Charging_CV(Equalize and Boost Charging)

When the battery voltage reaches the constant voltage set point, the controller will start to operate in constant voltage charging mode, this process the charging current will drop gradually. The Constant Charging has 2 stages, equalize and boost. These two stages are not carried out constantly in a full charge process, and its boost charging is start at 25th of each month.

c) Floating Charging_CF

After the constant voltage stage, the controller will reduce charging current to maintaining the battery voltage on the Floating Voltage set point. Charging the battery with a smaller current and voltage on Floating Voltage stage, while maintaining full battery storage capacity.

In Floating charging stage, loads are able to obtain almost all power from solar panel. If loads exceed the power, the controller will no longer be able to maintain battery

voltage in Floating charging stage. If the battery voltage remains below the Recharge Voltage, the system will leave Floating charging stage and return to Bulk charging stage.

2. Installation Instructions

2.1 Operator
Professional Technical Personnel;

2.2 Selecting the Mounting Location

Danger:
Danger to life due to fire or explosion.
The charge controller enclosure will be hot during operation.
• Do not mount the charge controller on flammable construction material.
• Do not mount the charge controller near highly flammable materials.
• Do not mount the charge controller in potentially explosive areas.
• Do not expose the charge controller to direct sunlight to avoid power
  loss due to overheating.

Caution:
Danger of burn injuries due to hot enclosure parts.
• Mount the charge controller in such a way that it cannot be touched
  inadvertently during operation.

The mounting location must be suitable for the weight and dimensions.
• Mount on a solid surface.
• The mounting location must be accessible at all times.
• The charge controller must be easy to remove from the mounting
  location at any time.
• The ambient temperature should be between -20 °C ~ +60 °C to
  guarantee optimal operation.
• Do not expose the charge controller to direct sunlight to avoid power
  losses due to overheating.

2.3 Dimensions and Weight (Unit: MM)
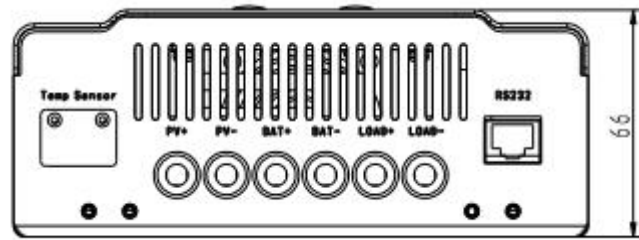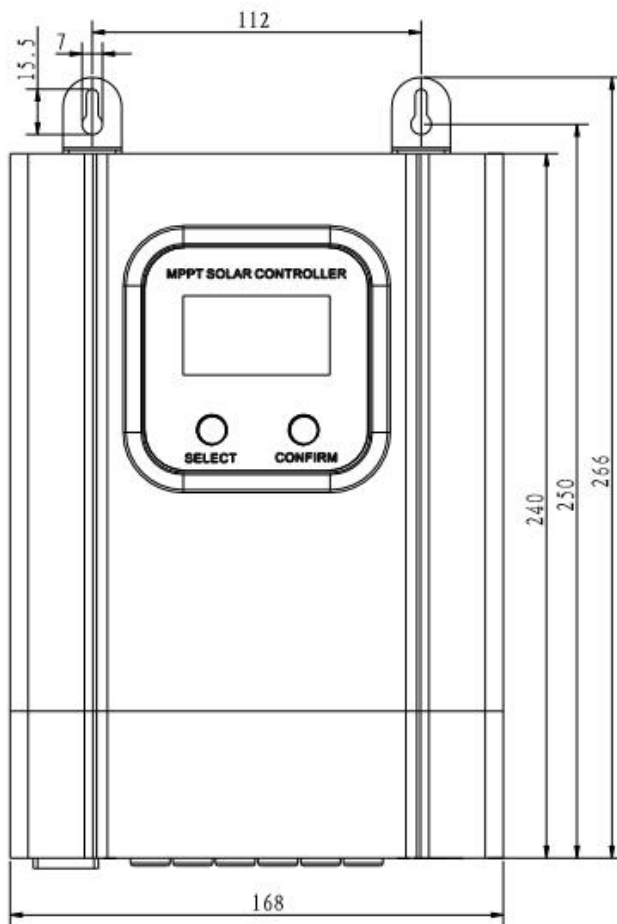
eSmart2 20A/30A/40A

Controller Net Weight: 2.3KG

2.4 Safety Distance

Direction	Safety Distance
Left-Right direction	>20cm
Up-Down direction	>30cm
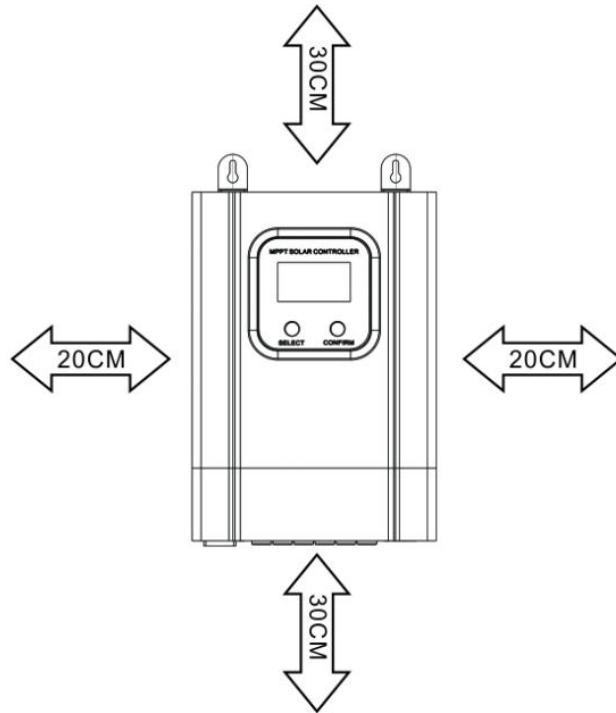
Controller Safety Distance

3. MPPT Controller Connection

3.1 Safety

Danger!
Danger to life due to high voltage in the solar charge controller.
• Disconnect the PV array using a circuit breaker and secure it against accidental reactivation.
• Disconnect the circuit breaker and ensure that it cannot be reconnected.
• Ensure that no voltage is present in the system.

Warning:
Electrostatic discharge can damage the charging controller
• Please connect the ground wire, after the location of the fixed controller.

Warning:
Over voltage can damage the system.
• Use an external over voltage protector in areas with an increased risk of thunderstorm and lightning.

3.2 Connection of the PV Power System

PV Power System Connection Diagram

3.3 Serial connection (string) of PV modules

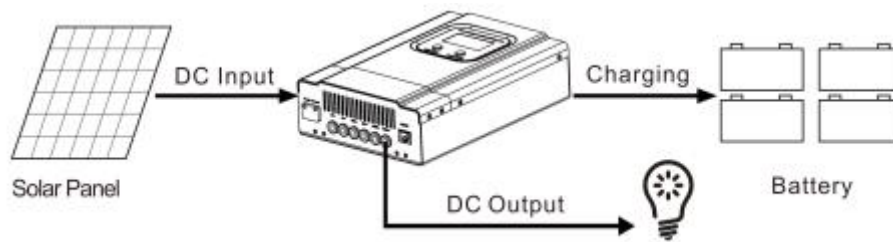As the core component of PV system, controller could be suitable for various types of PV modules and maximize converting solar energy into electrical energy. According to the open circuit voltage (V_{oc}) and the maximum power point voltage(V_{Mpp}) of the MPPT controller, the series number of different types PV modules can be calculated. The below table is for reference only.

eSmart2-20A/30A/40A :

PV$_{input}$ <DC 100V Prohibit the total input voltage greater than 100V								
System Voltage	36cell Voc<23V		48cell Voc<31V		54cell Voc<34V		60cell Voc<38V	
	Max.	Best	Max.	Best	Max.	Best	Max.	Best
12V	4	2	3	1	2	1	2	1
24V	4	3	3	2	2	2	2	2
36V	4	3	3	3	2	2	2	2
48V	4	4	3	3	\	\	\	\

PV$_{input}$ <DC 100V Prohibit the total input voltage greater than 100V						
System Voltage	72cell Voc<46V		96cell Voc<62V		Thin-Fim Module 80V<Voc<100V	
	Max.	Best	Max.	Best	Max.	Best
12V	2	1	1	1	1	1
24V	2	1	1	1	1	1
36V	2	2	1	1	1	1
48V	2	2	\	\	1	1

NOTE: The above parameter values are calculated under standard test conditions (STC (Standard Test Condition): Irradiance 1000W/m², Module Temperature 25℃, Air Mass 1.5)

3.4 PV Array Input Total Power

This MPPT controller has a limiting function of charging current, the charging current will be limited within rated range. Therefore, the controller will charge the battery with the rated charging power even if the input power at the PV exceeds. Such as: for 12V Solar System with 30A controller, no matter how many solar panels input, the charging current will not exceeds 30A.

The actual operation power of the PV array conforms to the conditions below

  1) PV array actual power ≤ controller rated charge power, the controller charge battery at actual maximum power point.

  2) PV array actual power > controller rated power, the controller charge battery at rated power. If the PV array higher than rated power, the charging time at rated power to battery will be longer, more energy to battery yields. Meanwhile, it will waste the power under the fierce sunshine due to the limitation of current.

As following is the Rated Power and Max. Power of mppt solar controller

Rated Current / Battery System	20A		30A		40A	
	Rated Input Power	Max. Input Power	Rated Input power	Max. Input Power	Rated Input power	Max. Input Power
12V system	260W	520W	390W	780W	520W	1080W
24V system	520W	1040W	780W	1560W	1040W	2080W
36V system	780W	1560W	1170W	2340W	1560W	3120W
48V system	1040W	2080W	1560W	3120W	2080W	4160W

In order to make full use of solar energy, and to extend the life of the controller, PV array power lower than controller rated power will be better. It forbid anybody to make the PV array power higher than Max input power.

3.5 System Voltage and Battery Type.

1) This controller can charge in DC12V, DC24V, DC36V and DC48V battery systems. Controller automatic recognized the battery voltage based on the first connection, power re-identification after power off and restart. So when the controller start, please check the system voltage displayed in LCD, if the controller automatic recognized the system voltage is different as your connect, you need to recheck the battery voltage.

System Voltage	12V system	DC9V~DC15V
	24V system	DC18V~DC30V
	36V system	DC32V~DC40V
	48V system	DC42V~DC60V

2) The controller has been pre-programmed, it can optional 4 kinds of battery types. If need to set other battery type, please set via PC software. (parameters is in 12V system at 25℃, please use double value in 24V, use three times value in 36V and use four times value in 48V.)

LCD display	Battery type	Constant voltage	Floating voltage
01	Vented	14.6V	13.5V
02	Sealed	14.4V	13.7V
03	Gel	14.2V	13.7V
04	NiCd	14.3V	13.7V
00	customer (Setting)	C(10V~15V)	F(10V~15V)

3.6 DC Load Output Voltage and Max. Discharge Current
The controller with DC load output function, the range of output voltage based on battery system. Such as battery system is 48V, so the DC load output voltage in the range of 48V, Max. Discharge Current 40A.

3.7 Specifications for Cables and Breakers
The wiring and installation methods must conform to all national and local electrical code requirements.

PV array specification of Wiring
Since PV array output can vary due to the PV module size, connection method or sunlight angle, the minimum wire can be calculated by the Isc of PV array. Please refer to the value of Isc in PV module specification. When the PV modules connect in series, the Isc is equal to the PV module's Isc. When the PV modules connect in parallels, the Isc is equal to the sum of PV module's Isc.

In order to easy to operation, please connect with breaker,as follows is the cable and breaker models for reference:

Model	Rated charge current	Rated discharge current	Battery wire (mm2/AWG)	Load wire (mm2/AWG)	Breaker
eSmart2 20A	20A	40A	6/10	16/6	>63A
eSmart2 30A	30A	40A	10/8	16/6	>63A
eSmart2 40A	40A	40A	16/6	16/6	>63A

Breaker should be installed to the controller and connection PV wire. Please check the below picture . (Please noted: external connect breaker not be provided)

Before you connect the wire, please open the product case. After done it, please close and locked them, it is helpful to protect the connection port.

3.8 Steps of Switch on and off
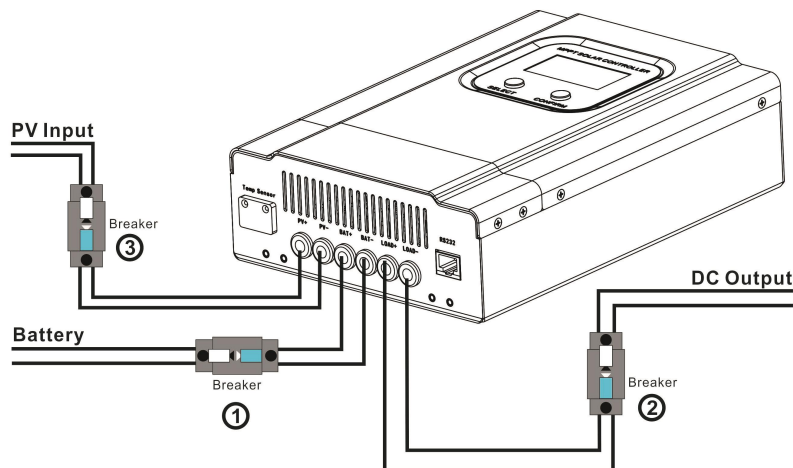
Make sure that the controller is installed and connected as above

☞ Please noted: If not under the right operation, controller easy be damaged

Step 1:

Switch on

Please open the breaker of battery ①, ensure the controller is right connect with the battery (controller LCD display will show information)

Step 2: If used DC output to control and manage the load, please set the output control mode, and then open the Breaker of DC load output ②;

Step 3: The last step is open the breaker of PV array input ③, If the Input voltage in the range of controller working range, it will start to charging.

If you need to connect with inverter, please let the input port of inverter connect with battery directly.
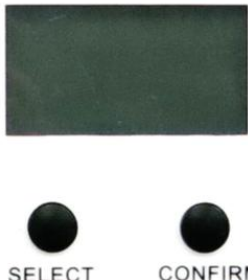
> ⚠ **Warning**
> If the controller in working, not allowed to switch off the breaker of battery before switch off PV input. Otherwise it will cause an unrecoverable failure to controller, this failure is not covered by the warranty;

Once you need to switch off the solar system please do as follow steps:

Step ③②①

4. Operation

4.1 Button Function

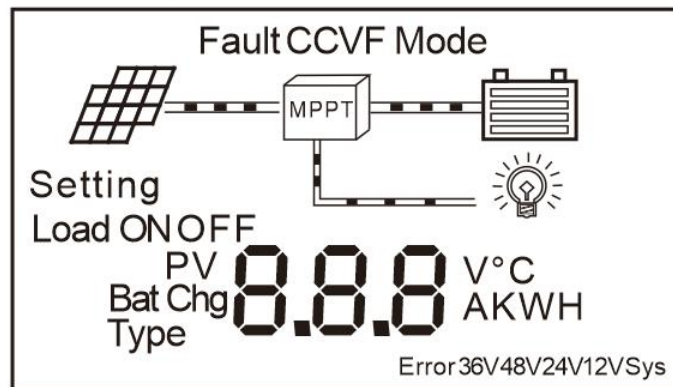| MPPT SOLAR CONTROLLER	Mode	Remark
	Browse mode	Press SELECT Button
	Setting mode	Press CONFIRM button go into setting mode, short press SELECT button to set the parameter, Short press CONFIRM button to ensure, Exceed to 5s it will exit the setting mode.

4.2 LCD Display

Figure LCD

◆ **Status Description**

Item	Icon	Status
Charge mode	Fault CCVF Mode	Fault Mode CC Mode CV Mode CF Mode
Charge status		No charging
		Charging
Discharge status		No discharge
		Discharge working
Working parameter	PV 88.8 V	PV input voltage
	Bat Chg 88.8 V°C AKWH	Battery charge voltage, current, power KW/H, Charge power, Temperature
System information	Error36V48V24V12VSys	Controller auto recognition the system Error

◆ **Browse Interface**
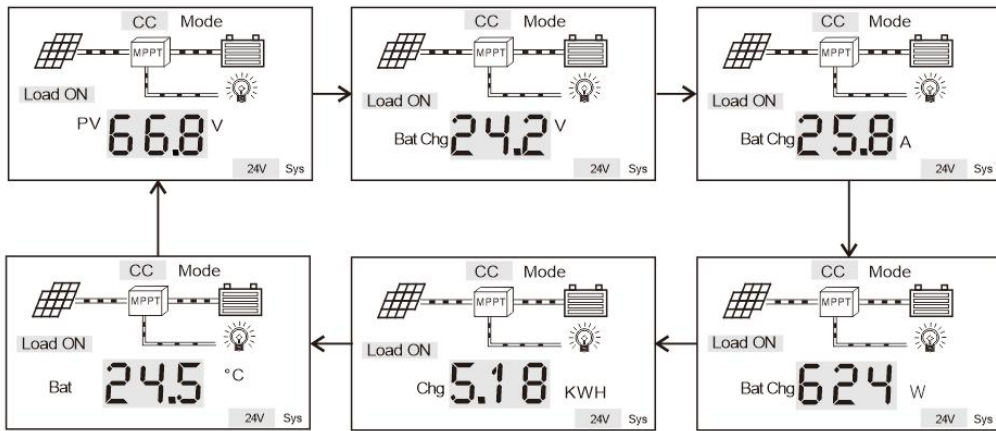
◆ **Setting Interface (Press CONFIRM button)**
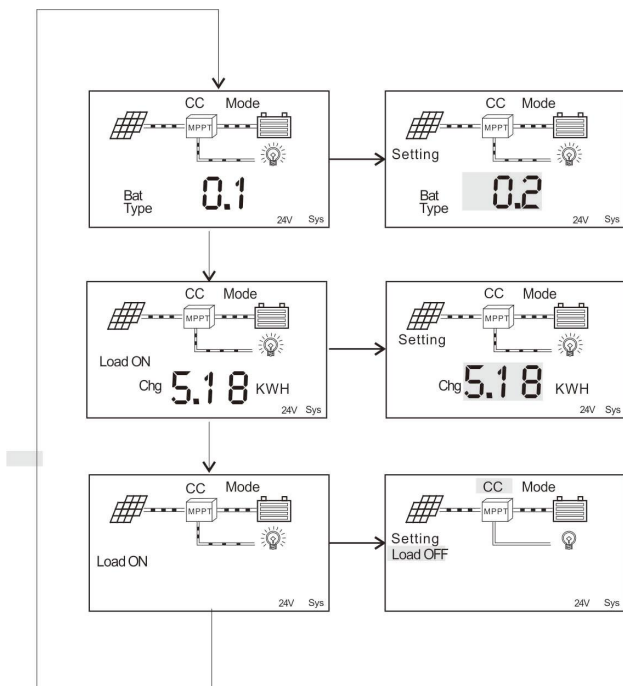
Press CONFIRM button one time, you could browse the parameter.
Under the related setting information, press CONFIRM button for 3s, you will enter into the setting mode, please select the parameter you like via SELECT button. After set it, press CONFIRM button to save and exit.

Battery Type & Parameter:

LCD display No.	Battery Type	Constant voltage	Floating charge
01	Vented	14.6V	13.5V
02	Sealed	14.4V	13.7V
03	Gel	14.2V	13.7V
04	NiCd	14.3V	13.7V
00	Others (set)	C(10V~15V)	F(10V~15V)

Please press CONFIRM button for 3s, it will display the mode of battery type (00,01,02,03,04), Press SELECT button to select, after choose the right type, please press CONFIRM button again.

Remark: The default set is 03 (Gel battery type).

Please noted:

00 mode value is same with 03 mode Gel battery C=14.2V, F=13.7V;

Others C and F value of 00 mode, please set it via PC software, and meet the logic of C > F.

◆ **DC Load setting**

Controller can be set the DC load output on or off mode. For the PV control mode, please set it via PC software.

Power generation is cleared.

Please find the Energy Restore Option,choose Apply butten, then type the password, that the total power will be 0 W/H, and recalculate. Like picture as below:
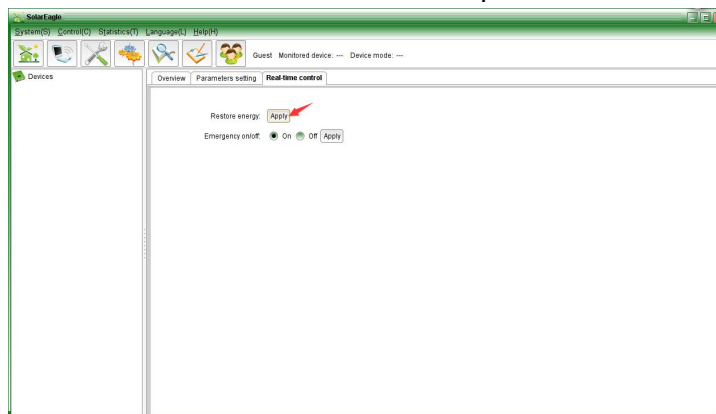
5. Controller and PC connection
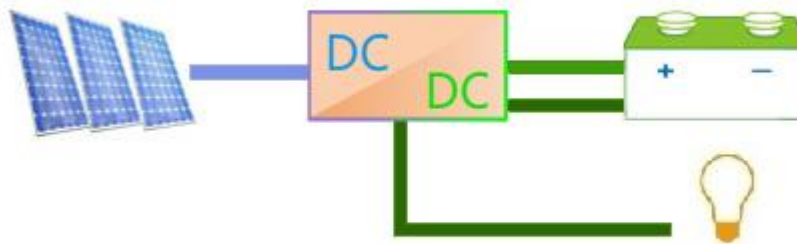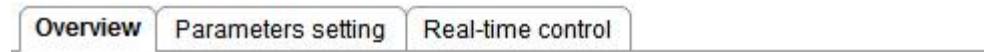
5.1 Software Introduction (Solar Eagle)

We have developed PC operational software, easy for customer to check the whole PV system information and set parameters. And if authorized by our company, it also can be modified its related custom parameters. As below picture:
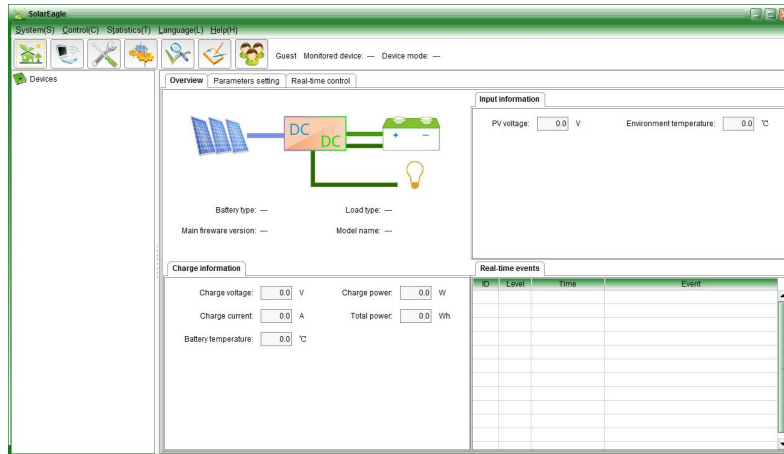
Solar Eagle overview

Overview: Access main interface as following;

Battery type: ---   Load type: ---

Main fireware version: ---   Model name: ---

Com Setting (Com): Get into Set the connection of Solar Eagle and PC **please noted, this series of controller have COM (RS232) connection way only.**

Setting: Get into battery type set and load control set interface

Remarks: 1) this series controller have DC output and users can only set On mode, Off mode and PV voltage control mode.

2) Others battery type please set the parameter as 12V system, the controller can automatic recognition working in double value in 24V, working three times value in 36V and working four times value in 48V.

For all setting please meet the logic 10V < Floating charge voltage < Buck charge Voltage < 15V

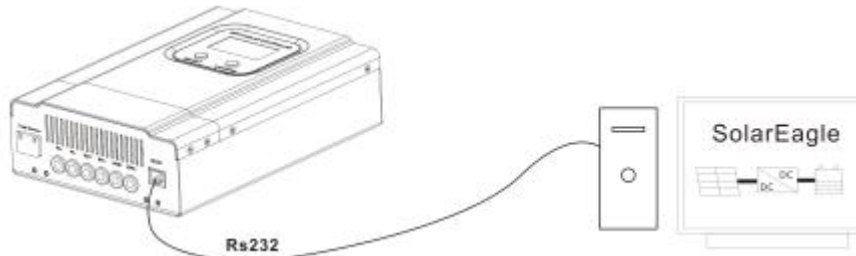 Login: Some parameters setting need administrator's password.

Battery type: ---   Load type: ---

Main fireware version: ---   Model name: ---
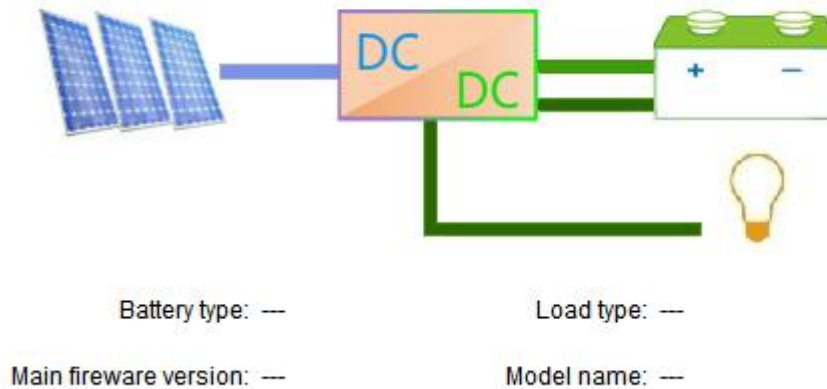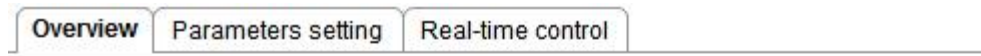
5.2 Connection of MPPT with Software

1) Customer's PC with RS232 connector, as below:

Step 1: Please install solar Eagle software to PC, for details please check install steps;

Step 2: Once software is installed and controller is connected properly, ensure controller in boot (connected controller to battery will automatically start)

Step 3: Connected PC and controller with RS232 and PC will notice the communication, at this time the PC will default to COM1

Step 4: Open the software as administrator (WIN 7 or 8), then press to choose COM communication and enter. It will automatically connect within 10s.

Step 5: After succeed to connect, user can check the related parameter. If set the parameter, it must be authorized by our company.

2) NO RS232 port?

　　If you do not have an RS232 port, then you need to prepare a USB to RS232 connector, such as below:
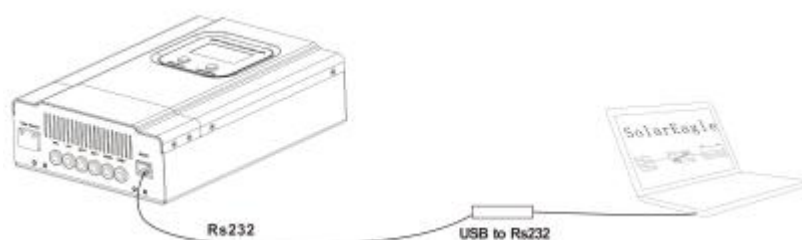

Step1: Please install Solar Eagle software on PC, please check the above Step. And then please install USB to RS232 driver software and make sure it's communicating. The other steps are the same as above.

6. Parameters

MPPT controller eSmart2-12V/24V/36V/48V-series		20A	30A	40A
Charge mode	MPPT(maximum power point tracking)			
Charge method	Three stages: constant current(MPPT), constant voltage,floating charge			
System type	DC12V/24V/36V/48V	Automatic recognition		
System voltage	12V system	DC9V~DC15V		
	24V system	DC18V~DC30V		
	36V system	DC32V~DC40V		
	48V system	DC42V~DC60V		
MPPT efficiency	≥99.5%			
Input Characteristics				
Max. PV input voltage(VOC)	12V/24V/36V/48V system	DC100V		
Start the charge voltage point	12V/24V/36V/48V system	Higher than current battery voltage 3V		
Low input voltage protection point	12V/24V/36V/48V system	Higher than current battery voltage 1V		

Over voltage protection point	12V/24V/36V/48V system	DC100V		
High voltage recovery point	12V/24V/36V/48V system	DC95V		
Rated PV power	12V system	260W	390W	520W
	24V system	520W	780W	1040W
	36V system	780W	1170W	1560W
	48V system	1040W	1560W	2080W
Charge Characteristics				
Selectable Battery Types (Default Gel battery)	12V/24V/36V/48V system	Sealed lead acid, Vented, Gel, NiCd battery (Other types of the batteries also can be defined)		
Constant Voltage	12V/24V/36V/48V system	Please check the charge voltage according to the battery type form.		
Floating Voltage	12V/24V/36V/48V system			
Rated charge Current	12V/24V/36V/48V system	20A	30A	40A
Current-limit Protection	12V/24V/36V/48V system	25A	34A	45A
Temperature Factor	12V/24V/36V/48V system	±0.02%/℃		
Temperature Compensation	12V/24V/36V/48V system	-3mV/℃/2V (default)		
Output Ripples(peak)	12V/24V/36V/48V system	200mV		
Output Voltage Stability Precision	12V/24V/36V/48V system	≤±1.5%		
Output Discharge Characteristics				
Output voltage		Base on battery voltage		
Low voltage output Protection point		Default 10.5V; Recovery 11V; It can be adjustable.		
Max. DC load current		40A		
The output control		On mode, Off mode, PV voltage control mode		
Output control set mode		Controller button or PC software		

| Display	
LCD display	System type, PV voltage, Charge voltage, Charge current, Charge power, temperature etc.
PC software	RS232
Protection	
Low voltage input protection	yes
Over voltage input protection	yes
Over charge power protection	yes
Low voltage output protection	yes
Rated output current protection	yes
Temperature protection	yes
Other Parameters	
Noise	≤40dB
Thermal heat-dissipating method	Fans cooling
Components	Brand
Certification	CE\FCC\RoHS
Physical	
Measurement DxWxH(mm)	240*168*66
Package size DxWxH(mm)	289*204*101
N.W.(kg)	2.3
G.W.(kg)	2.8
Mechanical Protection	IP25
Environment	
Humidity	0~90%RH (no condense)
Altitude	0~3000m
Operating Temperature	-20℃ ~ +50℃
Storage Temperature	-40℃ ~ +75℃
Atmospheric Pressure	70~106kPa

7. Maintenance and Cleanliness

7.1 Replacing the Thermal Fuses

Using incorrect thermal fuses may irreparably damage the solar charge controller.

Only use the thermal fuses included in the scope of delivery.

1. Open the solar charge controller as described in section "Opening the solar charge controller"
2. Remove the broken thermal fuses from the sockets
3. Insert new thermal fuses (included in the scope of delivery).

4. Close the solar charge controller as described in section "Closing the solar charge controller".

5. Remember always connect the batteries before the solar panels or you will permanently damage the controller. Internal picture as below:
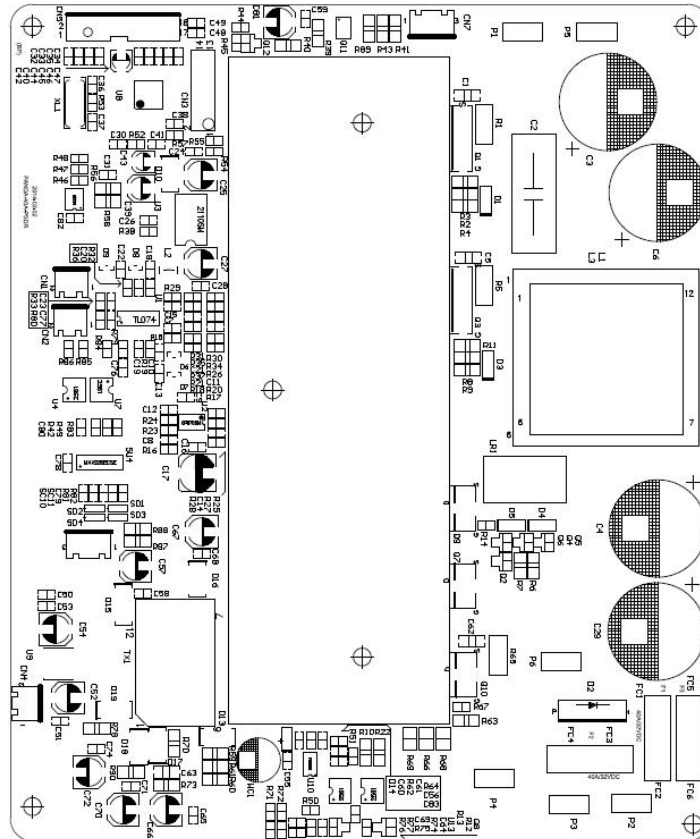
7.2 Clean the Cooling Fan

Clean the Fan air vents and internal cooling fan regularly by using a dry or slightly damp cloth to wipe.

Attention:

• Liquid detergent or corrosive solvent cleaning are forbidden.

• Liquid is not allowed in the device.

• Clear the air vent passage.

• Carefully remove dirt with a suitable soft brush if deemed necessary.

8. Storage and Waste Disposal

8.1 Store the charge controller in a dry place with ambient temperatures between -40 °C and +75 °C.

8.2 Disposal

Dispose of the solar charge controller at the end of its service life in accordance with the disposal regulations for electronic waste at the installation site at that time.

9. Warranty and Repair

9. 1 Repair

When the controller malfunctions, please check the following questions and contact our customer service representative if you need assistance.

9.1.1 Controller Failure Mode

Please check the fault tips in the failure mode, and then proceed to the appropriate troubleshooting;

9.1.2　When the controller does not start properly:

a. Check the controller external solar panels with the correct polarity.

b. Check Battery Connection;

c. Check Battery if working fine;

d. Check circuit breaker;

e. Check internal fuse;

If the problem persists, please contact customer service；

Please offer the following information：Equipment information: Model, Order No., serial-number (Stickers on the rear plate); Detailed description of the problem

(Type of system, occasionally/frequent problems, indicator light, data display, and so on).

9.2 Warranty

Within the warranty period, it is free to repair for the non-human fault. Otherwise, should charge the cost of repairs. When you send back to agent, please packed the equipment properly to avoid damage to the equipment during transport.