EPEVER®

MPPT Solar Charge Controller

User Manual

MSC2210N
MSC3210N
MSC4210N
MSC4215N

EN

Contents

Important Safety Instructions

Please reserve this manual for future review.

This manual contains all safety, installation, and operation instructions for the MSC-N series Security Monitoring Maximum Power Point Tracking (MPPT) solar controller ("controller" as referred to in this manual).

1. Explanation of symbols

Please read related literature accompanying symbols to enable users to use the product efficiently and ensure personal and property safety.

Symbol	Definition
TIP	Indicate any practical advice for reference.
	**IMPORTANT:** Indicates a critical tip during the operation, if ignored, may cause the device to run in error.
	**CAUTION:** Indicates potential hazards that may cause the device to be damaged if not avoided.
	**WARNING:** Indicates the danger of electric shock, if not avoided, would cause casualties.
	**WARNING HOT SURFACE:** Indicates the risk of high temperature, if not avoided, would cause scalds.
	Read the user manual carefully before any operation.

 **WARNING**	The entire system should be installed by professional and technical personnel.

2. Requirements for professional and technical personnel

- Professionally trained;
- Familiar with related safety specifications for the electrical system;
- Read this manual carefully and master related safety cautions.

3. Professional and technical personnel is allowed to do

- Install the controller to a specified location;
- Conduct trial operations for the controller;
- Operate and maintain the controller

4. Safety cautions before installation

IMPORTANT	When you receive the controller, check whether any damage occurred in transportation. Contact the transportation company or our company in time for any problem.
CAUTION	• When storing or moving the controller, follow the instructions in the manual. • When installing the controller, evaluate whether the operation area has any arc danger.
WARNING	Keep the controller out of reach of children.

5. Safety cautions for mechanical installation

WARNING	• Before installation, make sure the controller has no electrical connection. • Ensure enough heat dissipation space for the controller before installation. Do not install the controller in humid, salt spray, corrosion, greasy, flammable, explosive, dust accumulative, or other severe environments.

6. Safety cautions for electrical connection

CAUTION	Check whether all the wiring connections are tight to avoid the danger of heat accumulation due to loose connections.
WARNING	The PV input is a high voltage, do not touch the wiring connection to avoid electric shock.

7. Safety cautions for controller operation:

CAUTION	When the controller is running, please do not open the cabinet.

 **WARNING HOT SURFACE**	When the controller runs, the heat sink will generate heat, and the temperature will be very high; please do not touch it.

8. Dangerous operations which would cause an electric arc, fire, or explosion

- Touch the wire end that hasn't been insulation treated and may be electriferous.
- Touch the wiring copper row, terminals, or internal modules of the controller that may be electriferous.
- Screw or other spare parts inadvertently falls into the controller.
- Improper operations are taken by untrained non-professional personnel.

 **WARNING**	Once an accident occurs, it must be handled by professional and technical personnel. Improper operations would cause more serious accidents.

9. Safety cautions for stopping the controller

- After the controller stop running for five minutes, the internal conductive modules can be touched;
- The controller is allowed to restart after removing the faults affecting the controller's safety performance.
- There are no serviceable parts inside. If any maintenance service is required, please contact our service personnel.

10. Safety cautions for controller maintenance

- It is recommended to check the controller with testing equipment to ensure there is no voltage and current at all;
- When conducting electrical connection and maintenance, must post temporary warning signs or put up barriers to prevent unrelated personnel from entering the electrical connection or maintenance area;
- An improper operation of the controller may cause personal injury or equipment damage;
- To prevent electrostatic damage, please wear an antistatic wrist strap or avoid unnecessary contact with the circuit board.

1 General Information

1.1 Overview

MSC-N series is a new generation of solar controllers with a two-way load output. An enable switch allows the two-way load output voltage to switch to 12V or 24V DC. According to the battery voltage, the two-way load output voltage can be turned off in stages to ensure the main load output. The two-way load output adopts a high-efficiency buck-boost conversion circuit, which greatly reduces the battery's invalid loss and improves the battery's service time.

The MPPT charging technology can fast track the max power point of solar panels in any situation and obtain the maximum energy in real-time. It can increase the utilization ratio of solar energy by 20%-30% compared with the PWM charging method. Charging current limit, charging power limit, and high temperature charging automatic power reduction fully ensure the system stability of access to excess PV modules and high temperature running. Adaptive three-stage charging mode and comprehensive electronic protections such as over-charge, over-discharge, PV & battery reverse polarity, etc., effectively ensure the power supply is safer, more stable, and more durable. MSC-N series controllers are most suitable for applications in the field of security monitoring, RV, household system, etc.

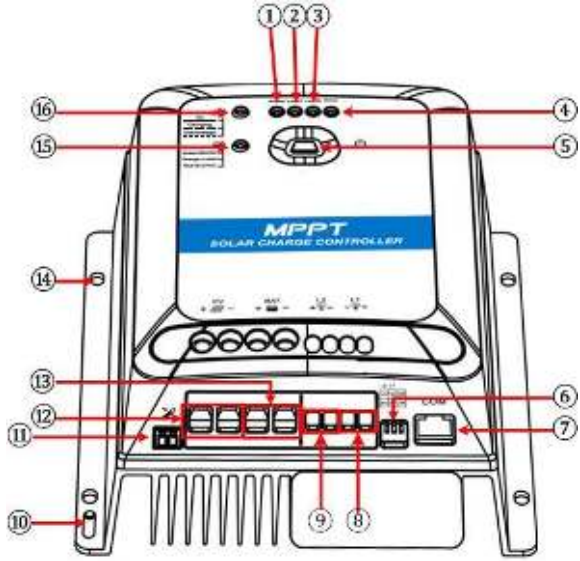
Features

- High quality and low failure rate components of ST or IR to ensure the service life
- Advanced MPPT technology & ultra-fast tracking speed guarantee tracking efficiency up to 99.5%
- Maximum DC/DC transfer efficiency up to 98.6%, full load efficiency up to 96.6 %

- Accurate recognizing and tracking technology of multi-peaks maximum power point
- Wider MPP running voltage to increase the utilization ratio of PV modules
- Support the lead-acid and lithium batteries, programmable temperature compensation
- High temperature charging automatic power reduction function
- The freely set voltage level of the two-way load output especially suitable for voltage-sensitive loads
- Configurable cut-off voltage value for the two-way load output
- Support no-battery mode, PV array powers the load directly ①
- High-efficiency buck-boost control chip and power device, conversion efficiency up to 98.9%
- Optional charging prior mode and load prior mode
- Effectively prolong the running time of load one by the discontinuous power supply in load prior mode
- Customized the load two output according to the actual requirement
- Common negative design, used in a negative grounded system
- Real-time monitor controller by an external remote meter, BT module, Wifi module, or PC software
- Comprehensive electronic protections

① **Set the rated voltage level of the battery to auto recognition mode through the PC software or the remote meter, and the controller will be in no-battery mode.**

1.2 Appearance



①	Power Indicator	⑨	Load 2 Terminals
②	Load 1 indicator	⑩	Grounding terminal
③	Load 2 indicator	⑪	Temperature sensor interface②
④	Error codes	⑫	PV Terminals
⑤	Load ON/OFF and setting button	⑬	Battery Terminals
⑥	Load 1/Load 2/Prior Mode enable switch	⑭	Mounting Hole *4
⑦	RS485 communication port①	⑮	Battery indicator
⑧	Load 1 Terminals	⑯	PV Indicator

① Pin definition for the RS485 communication port

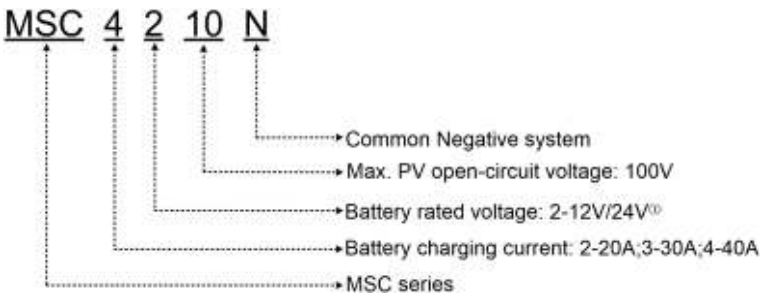
RJ45  crystal head 

Pin	Definition	Instruction
1/2	+5VDC	5V/200mA
3/4	RS485-B	RS485-B
5/6	RS485-A	RS485-A
7/8	GND	Power GND

WARNING	Do not short circuit the positive and negative pins of the RS485 communication port; otherwise, it will damage the controller.

② If the remote temperature sensor is not connected to the controller or damaged, the controller will charge or discharge the battery at the default temperature setting of 25℃ (no temperature compensation).

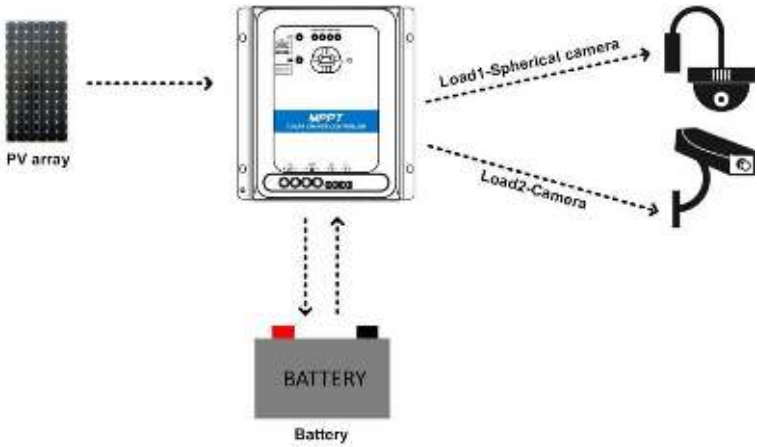
1.3 Naming rules



① For MSC4210N and MSC4215N, the rated voltage of the battery supports 24V only. For other MSC-N types, the battery's rated voltage supports 12V and 24V.

1.4 Connection diagram

1.4.1 Battery mode



1.4.2 No-battery mode

The PV array will provide power for the load in the no-battery mode. The operating processes of setting the no-battery way by the controller button are shown below:

Step1: Press the controller button for 5s until the indicator blinks orange slowly. Enter the battery type setting mode.

Step2: Click the controller button to switch the battery type to "24V Sealed" the

indicator blinks green slowly.

Step3: Press the controller button for 5s to confirm.

Step4: Switch the "Prior Mode enable switch" to the "LPM" side.

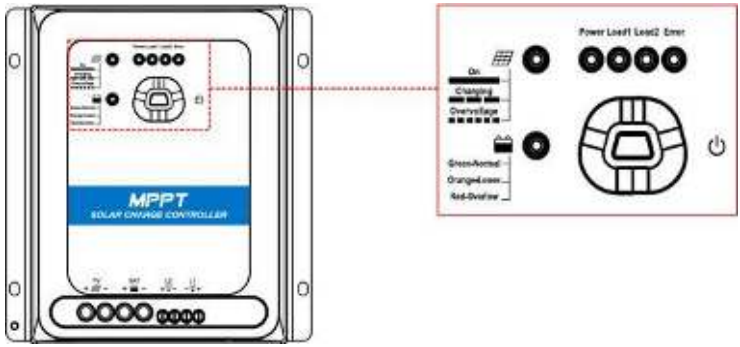
Then the controller enters the no-battery mode, with no output at the battery side.

CAUTION	• Only when the PV power goes greater than the total load power, which cannot surge drastically, and the PV input voltage exceeds

	30V, will the load work normally. • In the condition of a two-way load, when the power of the PV array is lower than the total power of the loads but can meet the power of load 2, the output of load 2 is given priority. Load 1 will be turned off and restarted every 30 minutes until it can work normally.

2 Interface

2.1 Indicator



Indicator	Color	Status	Definition
	Green	ON solid	PV charges the battery with a low current
	Green	OFF	1. No sunlight 2. Connection error 3. Low PV voltage
	Green	Slowly Flashing(1Hz)	Normal charging
	Red	Fast Flashing (4Hz)	PV over voltage
	Green	ON solid	Battery normal
	Green	Slowly Flashing(1Hz)	Battery full
	Green	Fast Flashing (4Hz)	Battery over voltage
	Orange	ON solid	Battery under voltage
	Orange	Slowly Flashing	Battery type set

	Red	ON solid	Battery over discharged
	Red	Slowly Flashing(1Hz)	Battery over temperature
	Red	Fast Flashing (4Hz)	Lithium battery low temperature①
Power 	Green	ON solid	Controller normal Battery type: 12V Sealed
		Slowly Flashing	Battery type: 24V Sealed
Load1 	Green	ON solid	Load 1 ON Battery type: 12V Gel
		Slowly Flashing	Battery type: 24V Gel
Load2 	Green	ON solid	Load 2 ON Battery type: 12V LFP
		Slowly Flashing	Battery type: 24V LFP
Error 	Red	ON solid	Controller over temperature/fault Load over current/short circuit Battery type: 12V LNCM
		Slowly Flashing	Battery type: 24V LNCM
All Indicators keep ON solid			Battery type: User
All Indicators fast flashing			System voltage error②

① When a lead-acid battery is used, the controller doesn't have low-temperature protection.

② When a lithium-ion battery is used, the system voltage can't be identified automatically.

2.2 Button

Click	**1. Control the load ON/OFF** First: Load 1 OFF, Second: Load 2 OFF; Third: Load 1 ON; Forth: Load 2 ON. **2 Select battery type （refer to 2.1 Indicator)**

Press for 5s	Enter the Battery type setting interface

2.3 Battery type

① Supported battery types

1	**Lead-acid battery**	Sealed (default, 12V Sealed/24V Sealed)
		Gel (12V Gel/24V Gel)
2	**Lithium battery**	LiFePO4 (12V LFP/24V LFP)
		Li(NiCoMn)O2 (12V LNCM/24V LNCM)
3	**User**	

② Setting the battery type by the controller button

Step1: Press the controller button for 5s until the  indicator blinks orange slowly. Enter the battery type setting mode.

Step2: Click the controller button to switch the battery type. The battery type is cycled in the following sequence:

"12V Sealed → 12V Gel → 12V LFP → 12V LNCM → 24V Sealed → 24V Gel → 24V LFP → 24V LNCM → User → 12V Sealed → ……".

Distinguish the battery type by observing the indicators' status.

Step3: Press the controller button for 5s to confirm.

2.4 Battery voltage control parameters

Set the battery type as "User" by the controller button, remote meter, or the PC software. Then the voltage control parameters can be modified.

◆ **Battery parameters**

Below values are measured in the 12V/25 ºC system; please double the values in the 24V system.

Battery type / Voltage parameters	Sealed	GEL	User
Over Voltage Disconnect Voltage	16.0V	16.0V	9~17V
Charging Limit Voltage	15.0V	15.0V	9~17V
Over Voltage Reconnect Voltage	15.0V	15.0V	9~17V
Equalize Charging Voltage	14.6V	--	9~17V
Boost Charging Voltage	14.4V	14.2V	9~17V
Float Charging Voltage	13.8V	13.8V	9~17V
Boost Reconnect Charging Voltage	13.2V	13.2V	9~17V
VLVR （Low voltage reconnect voltage）	12.6V	12.6V	9~17V
Under Voltage Warning Reconnect Voltage	12.2V	12.2V	9~17V
Under Voltage Warning Voltage	12.0V	12.0V	9~17V
VLVD （Low Voltage Disconnect Voltage）	11.1V	11.1V	9~17V
Discharging Limit Voltage	10.6V	10.6V	9~17V
Equalize Duration	120 minutes	--	0～180 minutes
Boost Duration	120 minutes	120 minutes	10～180 minutes

- **The following rules must be observed when modifying the parameter values in User for a lead-acid battery.**

A. Over Voltage Disconnect Voltage > Charging Limit Voltage ≥ Equalize Charging Voltage ≥ Boost Charging Voltage ≥ Float Charging Voltage > Boost Reconnect

Charging Voltage.

B. Over Voltage Disconnect Voltage > Over Voltage Reconnect Voltage

C. Low Voltage Reconnect Voltage > Low Voltage Disconnect Voltage ≥ Discharging Limit Voltage.

D. Under Voltage Warning Reconnect Voltage>Under Voltage Warning Voltage≥ Discharging Limit Voltage;

E. Boost Reconnect Charging voltage >Low Voltage Reconnect Voltage.

◆ **Lithium battery parameters**

Below values are measured in the 12V/25 ºC system; please double the values in the 24V system.

Battery type / Voltage control parameters	LFP	Li(NiCoMn)O2	User
Over Voltage Disconnect Voltage	15.6V	13.5V	9~17V
Charging Limit Voltage	14.6V	12.6V	9~17V
Over Voltage Reconnect Voltage	14.7V	12.7V	9~17V
Equalize Charging Voltage	14.5V	12.5V	9~17V
Boost Charging Voltage	14.5V	12.5V	9~17V
Float Charging Voltage	13.8V	12.2V	9~17V
Boost Reconnect Charging Voltage	13.2V	12.1V	9~17V
VLVR （Low voltage reconnect voltage）	12.8V	10.5V	9~17V
Under Voltage Warning Reconnect Voltage	12.8V	11.0V	9~17V
Under Voltage Warning Voltage	12.0V	10.5V	9~17V
VLVD （Low Voltage Disconnect Voltage）	11.1V	9.3V	9~17V
Discharging Limit Voltage	10.6V	9.3V	9~17V

- **The following rules must be followed when modifying the parameter values in User for a lithium battery.**

A. Over Voltage Disconnect Voltage>Over Charging Protection Voltage(Protection Circuit Modules(BMS))+0.2V;

B. Over Voltage Disconnect Voltage>Over Voltage Reconnect Voltage＝Charging Limit Voltage ≥ Equalize Charging Voltage＝Boost Charging Voltage ≥ Float Charging Voltage>Boost Reconnect Charging Voltage;

C. Low Voltage Reconnect Voltage > Low Voltage Disconnect Voltage ≥ Discharging Limit Voltage.

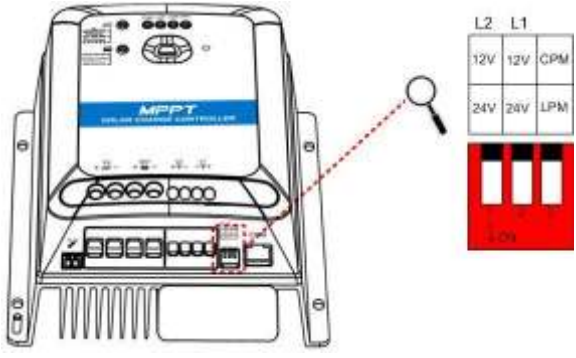
D. Under Voltage Warning Reconnect Voltage>Under Voltage Warning Voltage≥ Discharging Limit Voltage;

E. Boost Reconnect Charging voltage> Low Voltage Reconnect Voltage;

F. Low Voltage Disconnect Voltage ≥ Over Discharging Protection Voltage (BMS)+0.2V

WARNING	• The voltage parameters of a lithium battery can be set according to the voltage parameters of the lithium battery BMS. • The required accuracy of BMS shall be no higher than 0.2V. We will not assume any responsibility for the system abnormal when the accuracy of BMS is higher than 0.2 v.

2.5 Load output voltage and priority setting



L2	Load 2 Output voltage	Set to OFF	Output 12V
		Set to ON	Output 24V
L1	Load 1	Set to OFF	Output 12V

	Output voltage	Set to ON	Output 24V
CPM/LPM	Load working Modes (only valid for load 2)	Set to OFF	CPM(Charging Prior Mode) (Default)
		Set to ON	LPM(Load prior mode①)

① **The load prior mode will be enabled when the battery voltage reaches the low voltage disconnect voltage and the PV array charging current reaches more than 7A for 10 minutes.**

WARNING	Before connecting loads, ensure the voltage level of the load is equal to the output voltage level corresponding to the DIP switch. The load may be damaged if the output voltage level is higher than the load voltage.

2.6 Load operation mode

Load	Working modes	Definition
Load 1	Manual mode(Default load ON)	The load output will be turned off when the battery voltage reaches the Under Voltage Warning Voltage (UVW). The load output will resume when the battery voltage reaches the Under Voltage Warning Reconnect Voltage (UVR).
Load 2	Manual mode(Default load ON)	✦ **Set enable switch to CPM(default)** The load output will be turned off when the battery voltage reaches the Low Voltage Disconnect Voltage (LVD). The load output will resume when the battery voltage reaches the Low Voltage Reconnect Voltage (LVR). ✦ **Set the enable switch to LPM①** Mode 1: The load output will discontinue when the battery voltage reaches the Low Voltage Disconnect Voltage and the PV array's charging current reaches more than 7A for 10 minutes. It will be turned on for

		five minutes and then turned off for ten minutes. The load output will resume when the battery voltage reaches the Low Voltage Reconnect Voltage. Mode 2: The load output will be turned off when the battery voltage reaches the Low Voltage Disconnect Voltage. The load output will resume when the battery voltage reaches the Low Voltage Reconnect Voltage.

① **Check or set the mode 1/2 by the PC software or remote meter only.**

3 Installation

3.1 Attentions

- Be very careful when installing the batteries. Please wear eye protection when installing the open-type lead-acid battery, and rinse with clean water in time for any contact with battery acid.
- Keep the battery away from any metal objects, which may cause a short circuit of the battery.
- Acid gas may be generated when the battery is charged. Ensure that the surrounding environment is well ventilated.
- Avoid direct sunlight and rain infiltration when installing it outdoor. Do not install the controller in humid, salt spray, corrosion, greasy, flammable, explosive, dust accumulative, or other severe environments.
- Loose connectors and corroded wires may produce high heat that can melt wire insulation, burn surrounding materials, or even cause a fire. Ensure tight connections and secure cables with cable clamps to prevent them from swaying in moving equipment.
- Only charge the lead-acid and lithium-ion batteries within the control range of this controller.
- The battery connector may be wired to another battery or a bank of batteries. The following instructions are for the use of a single battery. Still, they are also applicable to systems with a group of batteries.
- Select the system cables according to 5A/mm^2 or less current density.

3.2 PV requirements

Serial connection (string) of PV modules

As the core component of the solar system, the controller needs to suit various types of PV modules and maximize the conversion of solar energy into electricity. According to the open-circuit voltage (VOC) and the maximum power point voltage (VMPP) of the MPPT controller, the serial connection of PV modules suitable for different controllers can be calculated. The below table is for reference only.

MSC2210N/MSC3210N/MSC4210N:

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	2	1	2	1	2	1
24V	4	3	2	2	2	2	2	2

System voltage	72cell Voc< 46V		96cell Voc< 62V		Thin-Film Module Voc> 80V
	Max.	Best	Max.	Best	
12V	2	1	1	1	1
24V	2	1	1	1	1

NOTE: The above parameters are calculated under standard test conditions (STC (Standard Test Condition): Module Temperature 25℃, Air Mass1.5, Irradiance 1000W/m^2.)

MSC4215N

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	2	1	2	1	2	1
24V	6	3	4	2	4	2	3	2

System voltage	72cell Voc< 46V		96cell Voc< 62V		Thin-Film Module Voc> 80V
	Max.	Best	Max.	Best	
12V	2	1	1	1	1
24V	3	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 Mass1.5.)

3.3 Wire size

The wiring and installation methods must conform to the national and local electrical code requirements.

- **PV wire size**

The PV array output varies with the PV module's size, connection method, and sunlight angle. The PV array's short circuit current(ISC) can calculate the minimum PV wire size. Please refer to the value of ISC in the PV module specification. When PV modules are connected in series, the total ISC equals any PV module's ISC. When PV modules are connected in parallel, the total ISC equals the sum of all PV modules' ISC. The ISC of the PV array must not exceed the controller's maximum PV input current.

Please refer to the table below:

Model	Max. PV input current	Max. PV wire size *
MSC2210N	20A	6mm^2/10AWG
MSC3210N	30A	10mm^2/8AWG
MSC4210N MSC4215N	40A	16mm^2/6AWG

WARNING	The total voltage must not exceed the max PV open circuit voltage when the PV modules are connected in series. PV open circuit voltage 92V (MSC**10N), or 138V (MSC**15N) at 25℃ environment temperature.

- **Battery wire size**

The battery and load wire size must conform to the rated charge current; the reference size as below:

Model	Rated charge current	Battery wire size
MSC2210N	20A	6mm²/10AWG
MSC3210N	30A	10mm²/8AWG
MSC4210N MSC4215N	40A	16mm²/6AWG

CAUTION	• The wire size is only for reference. Suppose there is a long distance between the PV array, the controller, and the battery. In that case, larger wires shall be used to reduce the voltage drop and improve the system performance. • The recommended battery wire is selected when the battery terminals are not connected to any additional inverter.

➢ **Load wire size**

Load 1

Output voltage	Output power	Max. output current	Recommended wire
12VDC	100W	8.33A	2.5mm²/13AWG
24VDC	100W	4.17A	1.5mm²/15AWG

Load 2

Output voltage	Output power	Max. output current	Recommended wire
12VDC	36W	3A	1mm²/16AWG
24VDC	36W	1.5A	0.5mm²/20AWG

3.4 Mounting

WARNING	• Risk of explosion! Never install the controller in a sealed enclose with flooded batteries! Do not install the controller in a confined area where battery gas can accumulate. • Risk of electric shock! When wiring the solar modules, the PV array may generate a high open-circuit voltage, so disconnect the breaker before wiring and be careful.

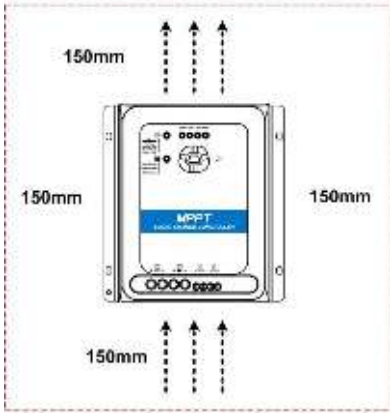
CAUTION	The controller requires at least 150mm of clearance above and below for proper airflow. Ventilation is highly recommended if mounted in an enclosure.

Installation Procedure:

Step 1: Determine the installation location and heat-dissipation space

The controller requires at least 150mm of clearance above and below for proper airflow, as shown below.

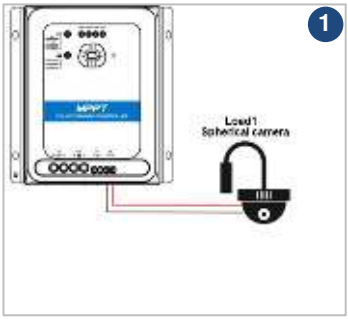
Air outlet

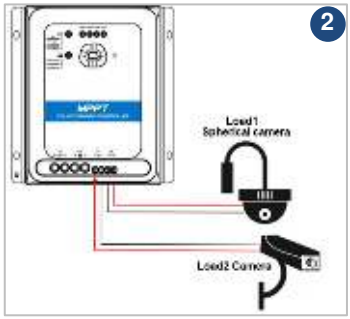


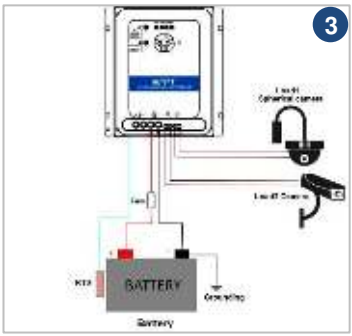
Air inlet

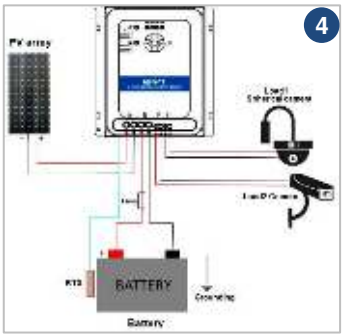
CAUTION	Suppose the controller is to be installed in an enclosed box. In that case, ensuring reliable heat-dissipation through the box is important.

Step 2: Connect wires according to the sequence of ① load 1-- ② load 2-- ③ battery -- ④ PV array.









Note: Disconnect the system in the reverse order. Namely, disconnect the system in the order of ④ PV array -- ③ battery -- ② load 2-- ① load 1.

⚠ **CAUTION**	• When wiring the controller, please do not connect the circuit breaker or fast-acting fuse. Ensure that the electrode polarity is correctly connected. • A fast-acting fuse, whose current is 1.25 to 2 times the rated current of the controller, must be installed on the battery side with a distance from the battery no longer than 150 mm. • Suppose the controller is to be used in frequent lightning strikes or unsupervised areas. In that case, an external surge arrester must be installed on the input side of the PV array. • Suppose an inverter is to be connected to the system. In that case, you must connect the inverter directly to the battery, not to the load side of the controller.

Step 3：Grounding

MSC-N series are common-negative controllers; all the negative terminals can be grounded simultaneously, or anyone is grounded. However, according to the practical application, the negative terminals of the PV array, battery, and load can also be ungrounded. Still, the grounding terminal on the shell must be grounded. It effectively shields the electromagnetic interference from the outside and prevents some electric shock to the human body.

CAUTION	A common-negative controller for a common-negative system, such as the RV system, is recommended. The controller may be damaged if a common-positive controller is used and the positive electrode is grounded in the common-negative system.

Step 4：Connect the remote temperature sensor

Connect the remote temperature sensor to interface ⑪ and place the other end close to the battery.

Included Accessory:
(Model: RT-MF58R47K3.81A)

Optional Accessory:
(Model: RTS300R47K3.81A)

CAUTION	Suppose the remote temperature sensor is not connected to the controller or is damaged. In that case, the controller will charge or discharge the battery at the default temperature of 25℃ (no temperature compensation).

Step 5：Power on the controller

Connect the battery fast-acting fuse to power the controller. Check the status of the battery indicator (green ON solid of the indicator states controller is operating normally). Connect the fast-acting fuse and circuit breaker of the load and PV array; the system will work in preprogrammed mode.

CAUTION	If the controller cannot work properly or the battery indicator shows an abnormality, please refer to **4.2 Troubleshooting**.

4 Others

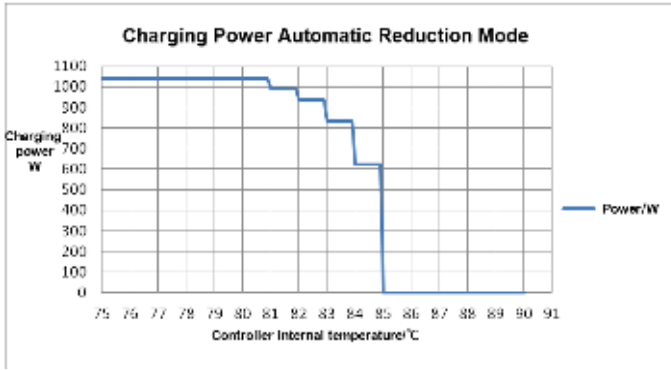
4.1 Protection

Protection	Instruction
PV limit Current/limit power protection	When the charging current/power of the PV array exceeds the rated charging current/power, the PV array will charge the battery as per the rated charging current/power.
PV short circuit protection	When not in the PV charging state, the controller will not be damaged in the case of a short-circuiting in the PV array.
PV reverse polarity protection	When the polarity of the PV array is reversed, the controller may not be damaged and resume normal operation after the mis-wiring is corrected. **NOTE: If the PV array is reversed and the actual power is 1.5 times the rated power of the controller, the controller will be damaged.**
Night reverse charging protection	Prevent the battery from discharging to the PV module at night.
Battery reverse protection	When the polarity of the battery is reversed, the controller may not be damaged and resume normal operation after the mis-wiring is corrected. **NOTE: The controller, limited to the lithium battery characteristic, will be damaged when the PV array connection is right and the battery connection is reversed.**
Battery over-voltage protection	When the battery voltage reaches the over voltage disconnect voltage, the PV array will automatically stop charging the battery to prevent battery damage due to overcharging.
Battery over-discharging protection	When the battery voltage reaches the low voltage disconnect voltage, battery discharging will automatically stop to prevent the battery from damaging due to over-discharging.

Battery overheating protection	The controller detects the battery temperature through an external temperature sensor. The battery will stop working when its temperature exceeds 65 °C and will resume when it is below 55 °C.
Lithium battery low-temperature protection	When the detected temperature is lower than the Low Temperature Protection Threshold (LTPT), the controller automatically stops charging and discharging. When the detected temperature is higher than the LTPT, the controller will work automatically (The LTPT is 0 °C by default and can be set within 10 ~ -40 °C).
Load short circuit protection	When the load is short-circuited, the controller will cut off the output and resume the output when the short circuit is released.
Overload protection	If the load current exceeds 1.05 times the controller's rating current, the controller will cut off the output after 30 seconds delay. In case of overload, the controller is restarted at intervals of 5 seconds, 10 seconds, 15 seconds, 20 seconds, 25 seconds, 30 seconds, and 1 hour until the power of all the loads is reduced to the rated power.
Device overheating protection	An internal temperature sensor can detect the internal temperature of the controller. The controller stops working when the internal temperature exceeds 85 °C and resumes work when the internal temperature is below 75 °C.
TVS high voltage transients protection	The internal circuitry of the controller is designed with Transient Voltage Suppressors (TVS), which can only protect against high-voltage surge pulses with less energy. Suppose the controller is to be used in an area with frequent lightning strikes. In that case, it is recommended to install an external surge arrester.

When the internal temperature of the controller reaches 81℃, the charging power automatic reduction function will be enabled. With every increase of 1℃, the charging power will be reduced by 5%, 10%, 20%, and 40%. If the internal temperature exceeds 85℃, the controller will stop charging the battery. When the internal temperature of the controller declines to 75 ºC or lower, the controller will resume.

For example MSC4215N 24V system:



4.2 Troubleshooting

Faults	Possible reasons	Solutions
Charging LED is OFF during daytime when sunshine falls on PV array properly	PV array open circuit	Confirm whether the PV array connection is correct and tight
The wire connection is correct; the controller is not working.	Battery voltage is lower than 8V	Please check the battery's voltage (at least 8V to activate the controller).
Charging indicator Green fast flashing	Battery over voltage	Check whether the battery voltage is higher than OVD (over-voltage disconnect voltage), and disconnect the PV array connection.
The battery indicator is in red on solid	Battery over discharged	① Automatically restore load output after the battery is fully charged. ②Other ways to recharge the battery.

The battery indicator flashes red slowly	Battery overheating	While the temperature declines below 55 ºC, the controller will resume.
The fault indicator is ON. PV and battery Indicators flash orange fast	Controller overheating	When the heat sink of the controller exceeds 85℃, the controller will automatically cut off the input and output circuit. When the temperature is below 75℃, the controller will resume work.
	System voltage error	① Check whether the current battery voltage matches the system voltage set by the controller. ② Please change a suitable battery or reset the system voltage.
Fault indicator on solid, load off.	Over load①	① Please reduce the number of electric equipment. ② Restart the controller or press the button to clear faults.
Fault indicator on solid, load off.	Load short circuit	①Check carefully load connection, and clear the fault. ②Restart the controller, or press the button to clear faults.

① If the load current exceeds 1.05 times the controller's rating current, the controller will cut off the output after 30 seconds delay. In case of overload, the controller is restarted at intervals of 5 seconds, 10 seconds, 15 seconds, 20 seconds, 25 seconds, 30 seconds, and 1 hour until the power of all the loads is reduced to the rated power.

4.3 Maintenance

The following inspections and maintenance tasks are recommended at least twice yearly for the best performance.

- Make sure no block on airflow around the controller. Clear up any dirt and fragments on the radiator.
- Check all the naked wires to ensure insulation is not damaged by sun exposure, frictional wear, dryness, insects or rats, etc. Repair or replace some wires if necessary.
- Verify that the indicator display is consistent with the actual operation. Pay attention to any troubleshooting or error indication. Take corrective action if necessary.
- Confirm that all terminals have no corrosion, insulation damaged, high temperature, or burnt/discolored sign, tighten terminal screws to the suggested torque.
- Clear up dirt, nesting insects, and corrosion in time.
- Replace a new surge arrester in time to avoid damaging the controller and other equipment.

 **WARNING**	Risk of electric shock! Ensure all the power is turned off before the above operations, and then follow the corresponding inspections and operations.

5 Specifications

Electrical Parameters

Model	MSC2210N	MSC3210N	MSC4210N	MSC4215N
Battery rated voltage	12/24VDC Auto-recognition①		24VDC	24VDC
Rated charging current	20A	30A	40A	40A
Controller working voltage range	8~32V	8~32V	16~32V	16~32V
Max. PV open circuit voltage	100V(At minimum operating environment temperature) 92V(At 25℃ environment temperature)			150V(At minimum operating environment temperature) 138V(At 25℃ environment temperature)
MPPT voltage range	(Battery voltage +2V)~72V			(Battery voltage +2V)~108V
Rated charging power	260W/12V 520W/24V	390W/12V 780W/24V	1040W/24V	
Max. conversion efficiency	98.3%	98.6%	98.6%	
Full load efficiency	96.4%	96.6%	96.5%	
Self-consumption	≤35mA(12V) ≤22mA(24V)			
Load 1/2 constant-voltage output voltage	DC 12V/24V (configurable)			

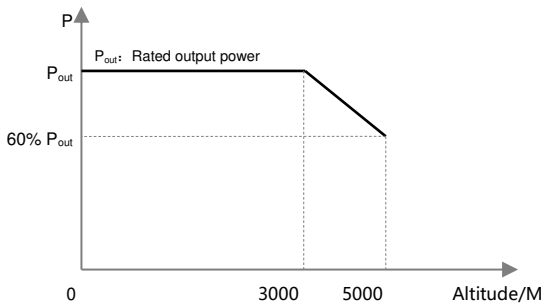
Load rated power	Load 1: 100W Load 2: 36W
Load output protection voltage	Load 1: Under Voltage Warning Voltage (it can be set when the battery type is "USER.") Load 2: Low Voltage disconnect Voltage (it can be set when the battery type is "USER.")
Max. load conversion efficiency	Load 1 98.9% Load 2 97.1%
Full load conversion efficiency	Load 1 97.4% Load 2 96.0%
No battery mode	Support
Load output voltage accuracy	12VDC --load 1: ≤0.4%; load 2: ≤ 0.1% 24VDC --load 1: ≤0.9%; load 2: ≤ 1.1%
Load ripple voltage	100mV
Load ripple current	200mA
Load adjustment rate	≤1%
LINEAR adjustment rate	＜0.5%
Temperature compensate coefficient②	-3mV/℃/2V (Default)
Grounding Type	Common negative
Communication port	RS485
Altitude③	≤5000 (when the height exceeds 3000M, the load power will be reduced appropriately; working of full load is not supported.)

Protections	PV limit current/ limit power/short circuit/reverse /night reverse charging protection Lithium Battery reverse/over voltage/over-discharging/overheating/low temperature charging and discharging protection Load short circuit/overload protection, controller overheating protection, against transient

① When an LFP or LNCM battery is used, the system voltage can't be identified automatically. Please confirm the system voltage before operating.

② When an LFP or LNCM battery is used, the temperature compensation coefficient will be 0 and can't be changed.

③ Under 3000M, All loads working at the same time is supported. When the altitude exceeds 3000M, the load power is reduced appropriately. The load power variation curve with height is shown in the figure below:

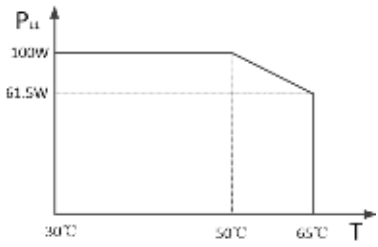


Environmental Parameters

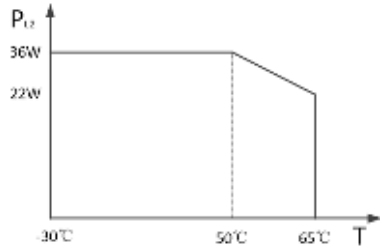
Environment temperature④	-30℃～+65℃ (when the working temperature reaches 50℃, the load power is reduced appropriately; working of full load is not supported.)
Storage temperature	-30℃ ~ +70℃
Relative humidity	< 95% (N.C.)
Enclosure	IP30

④ During -30℃～+50℃, all loads can work at the same time. When the internal temperature of the controller exceeds 81℃, the charging power automatic reduction function is

enabled. Details refer to 4.1 protection. When the environment temperature exceeds 50°C, the actual load power needs to be derated. With every increase of 1°C, the actual load power needs to be reduced by 2.57% of the rated load power. For example, when the environment temperature reaches 60℃, the actual rated power for load 1 is [100W-0.0257*（60-50）*100=74.3W]. The load power variation curve with temperature is shown in the figure below:



Load 1 Power reduction curve



Load 2 Power reduction curve

Mechanical parameters

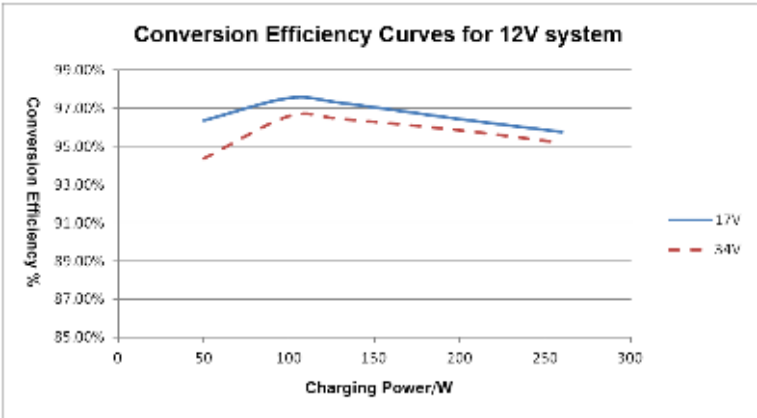
Model	MSC2210N	MSC3210N	MSC4210N	MSC4215N
Dimension (L x W x H)	173×158×77.1mm	178×162×80.1mm	213.2×192×96.6mm	
Mounting size (L x W)	120×149mm	120×153mm	150×182mm	
Mounting hole size	Φ5mm			
Grounding terminal	RNB14-5			
Recommended grounding cable	8AWG ($10mm^2$)	8AWG ($10mm^2$)	6AWG ($16mm^2$)	6AWG ($16mm^2$)
Net Weight	1.2kg	1.4kg	2.4kg	2.4kg

Annex I PV Conversion Efficiency Curves

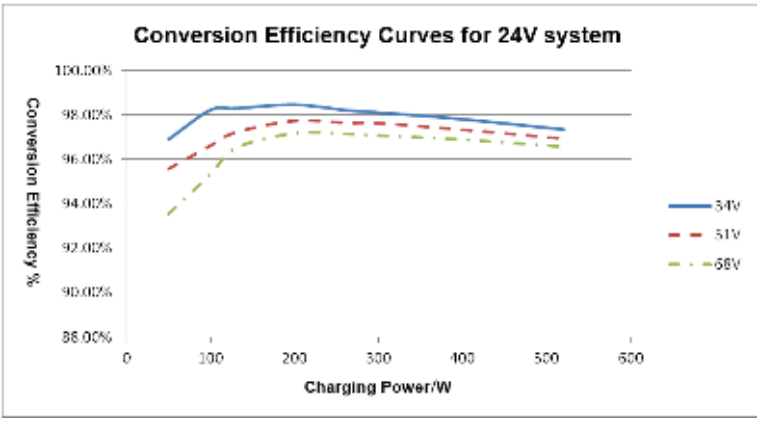
Test condition: Illumination Intensity: 1000W/m^2 Temperature: 25℃

◆ **Model: MSC2210N**

1. PV array Max. power point voltage(17V, 34V)/system voltage(12V)

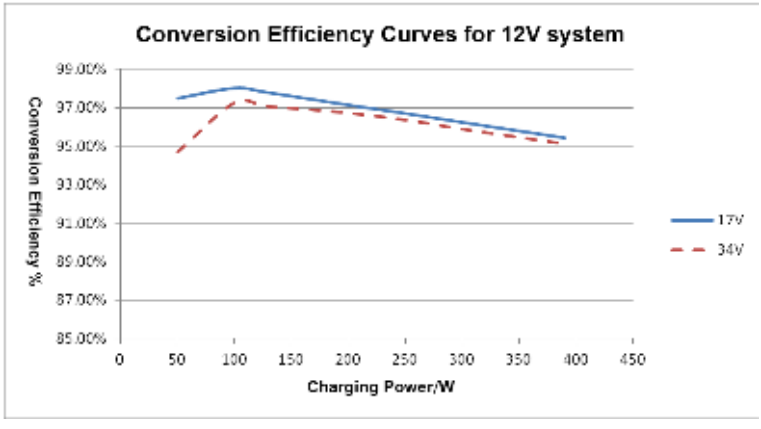


2. PV array Max. power point voltage(34V, 51V, 68V)/system voltage(24V)

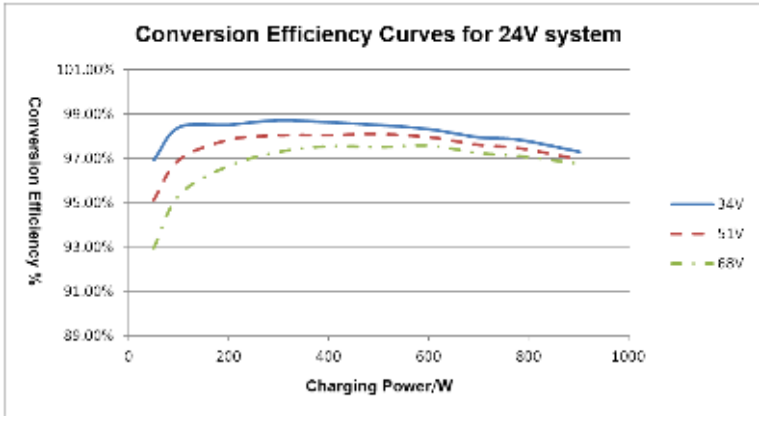


◆ **Model: MSC3210N**

1. PV array Max. power point voltage(17V, 34V)/system voltage(12V)

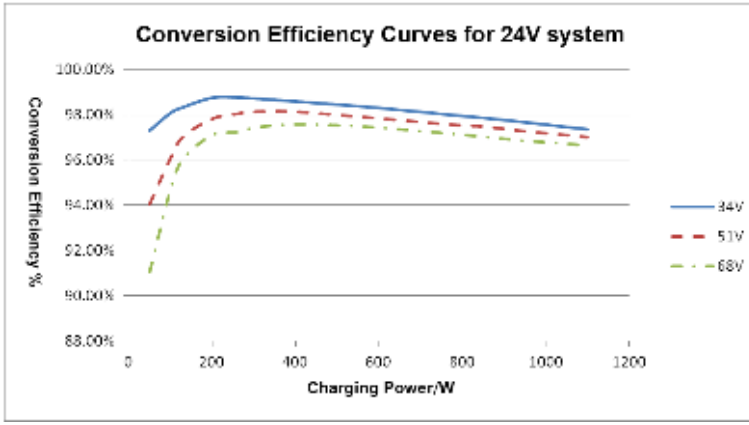


2. PV array Max. power point voltage(34V, 51V, 68V)/system voltage(24V)



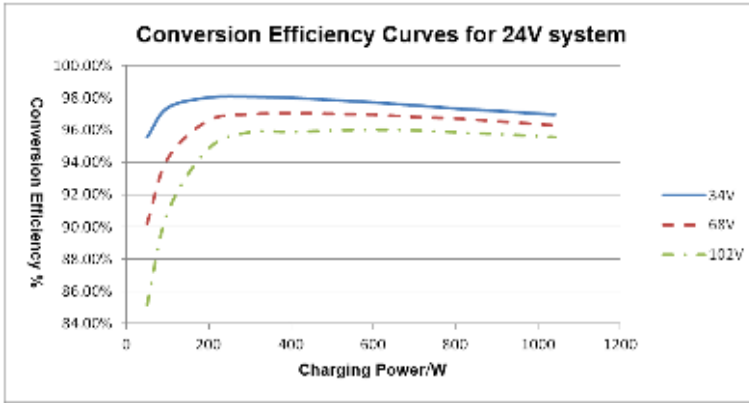
◆ **Model: MSC4210N**

PV array Max. power point voltage(34V, 51V, 68V)/system voltage(24V)

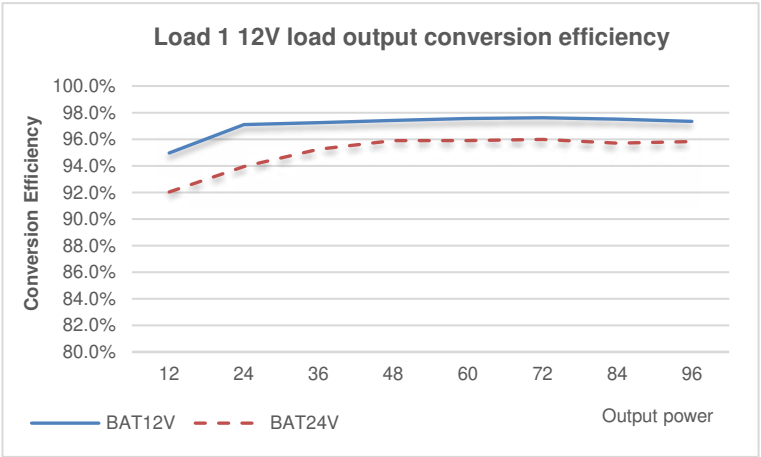


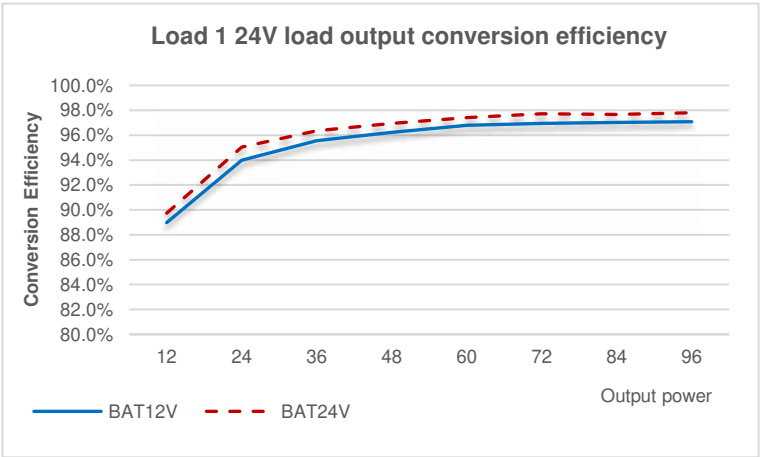
◆ **Model MSC4215N**

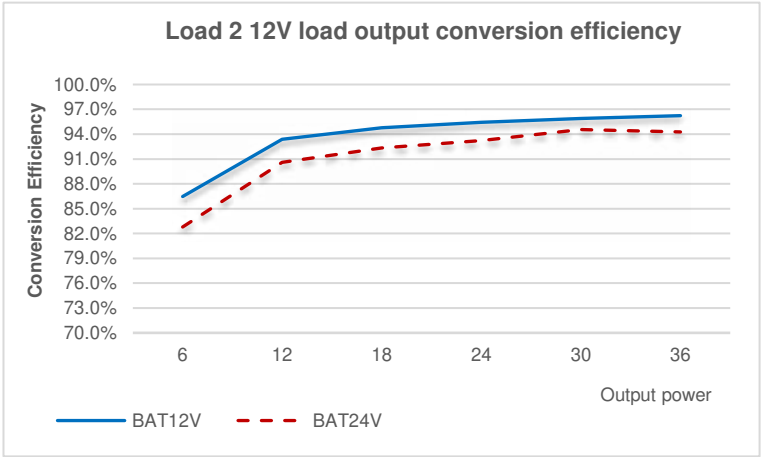
PV array Max. power point voltage(34V, 68V, 102V)/system voltage(24V)

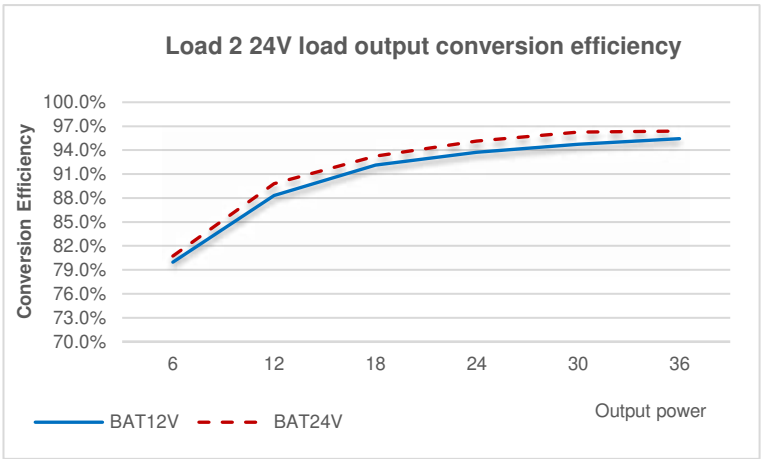


Annex 2 Load Conversion Efficiency Curves









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