

# MH Series

MH60 MPPT Integrated Constant-Current Charge Controller for Lithium Batteries of Solar Street Lights

12V/60W

# Instruction Manual

Version: 1.03

The above information is subject to change without prior notice.

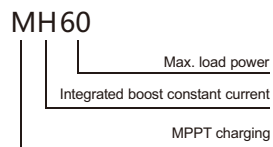


## Main Features

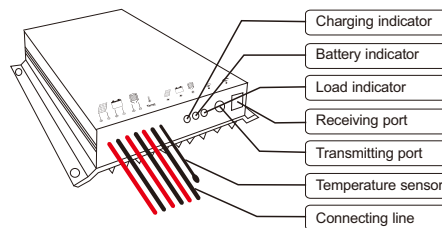
- Dedicated MPPT controller for lithium batteries; applicable to ternary-material lithium, lithium iron phosphate, lithium cobalt oxide and other types of lithium batteries.
- Supporting 12 V lithium batteries; able to activate the batteries automatically.
- Adopting the MPPT solar charging technology, with a max. solar panel open-circuit voltage  $V_{oc} \leq 40$  V and a max. solar panel power  $P_m \leq 100$  W.
- Providing lithium battery low-temperature charging protection function. When the ambient temperature falls below the freezing point, charging is halted to protect the battery.
- Featuring load boost constant-current output; able to directly power a maximum of 12 light bulbs in series, with a max. load power  $P_{led} \leq 60$  W.
- Boasting the design of load triple-stage brightness adjustment and morning light, with operating duration adjustable from 0 to 15 hours and power settable from 0 to 100%.
- Featuring system status log function; able to record system status for a maximum of 7 days; comprehensively and effectively monitoring the system's conditions.
- Data communication adopts a multiple-time two-way handshake protocol and a data compression algorithm, realizing precise and fast data transmission.
- Providing intelligent power mode, which can extend the battery's life to its top limit by adjusting the load power automatically according to the remaining battery capacity.
- True constant current rather than current-limiting control ensures smooth and stable output current, effectively reducing LED light attenuation and extending LED service life.
- With infrared remote control function, operations including setting parameters, reading status and viewing historical data can be performed.
- A metal case and an IP68 waterproof level enable the device to operate in various tough conditions.
- The overheat protection function enables the device to scale down or shut off the load completely when its temperature exceeds certain point.
- A range of protection measures such as battery reverse-connection protection, LED short-circuit protection and open-circuit protection place the system under comprehensive protection.

## Exterior and Wiring

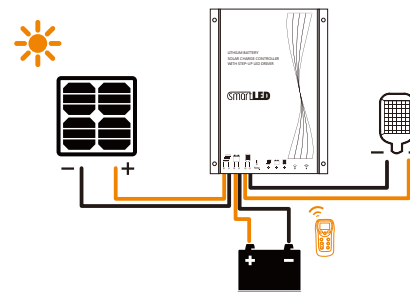
### 1. Model recognition



### 2. Exterior

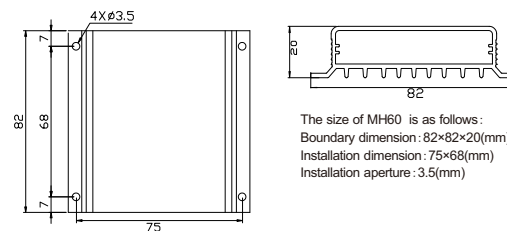


## 3. Wiring diagram



### 4. Wiring sequence: connect the load, battery, and solar panel successively.

## Installation Dimension



## LED Load Connection

- 1) With a built-in boost type constant current source, MH60 provides a max. output voltage of 40 V, which is able to power up to 12 LED light bulbs.
- 2) This controller is of the boost type. When LED load is connected, be sure to connect the correct number of LED lights in series.

The number of connected LED lights is recommended as follows:

System voltage	Recommended minimum No. of serially connected LEDs	Load output voltage $V_{out}$
12V	$n \geq 5$	$V_{out} \geq 15V$

- 3) In practical use, make sure you correctly connect the LED lights before switching on the load.

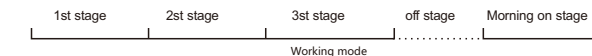
**Warning: If a wrong number of LED lights are connected in series, the LED load or controller may be damaged. Always bear this in mind**

## State Indicators

LED light	Indicated content	State	Meaning
	Charging	Steady on	Solar panel voltage higher than light control voltage
		Off	Solar panel voltage lower than light control voltage
		Slow flashing	Charging in process
		Quick flashing	System overvoltage
	Battery	Steady on	Normal battery function
		Off	Battery not connected
		Quick flashing	Battery over discharged
	Load	Steady on	Load turned on
		Slow flashing	Open-circuit LED load
		Quick flashing	Short-circuit LED load
		Off	Load turned off

## Load Working Modes

Controlled by the MH60 controller, the load's working time can be divided into 3 stages plus the stage of morning on. The operating duration and power of each stage can be freely adjusted, with different combinations achieving different control modes.



- A. Normal working mode: operates according to time and power settings in sequence.
- B. Delay on mode: For example, if the 1st-stage operating duration is set to 4 hours and power to 0%, the system will delay switching on the lights by 4 hours.
- C. Morning on mode: The controller automatically calculates the length of the night and intelligently adjusts the time point for switching on the lights in the morning, thereby making the morning on time more precise.
- D. Test mode: In daily use, the controller works in the light control + time control mode. However, when test is needed during installation, you can use the remote control to switch on the load, and the LED load will change its power according to the remote control settings. The test mode lasts for 1 minute, and after that, the system will automatically restore the normal working mode.

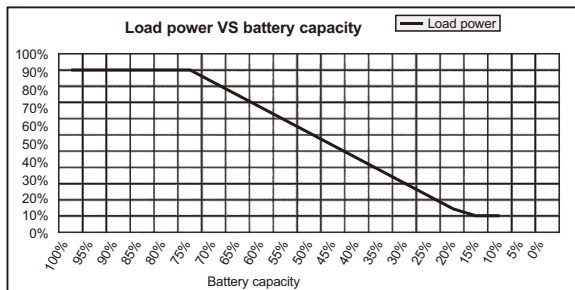
Adjustment item	Value	Default
1st-stage operating duration	0 to 15 hours	4
1st-stage operating power	0 to 100%	100%
2nd-stage operating duration	0 to 15 hours	0
2nd-stage operating power	0 to 100%	70%
3rd-stage operating duration	0 to 15 hours	4
3rd-stage operating power	0 to 100%	50%
Morning on operating duration	0 to 15 hours	0
Morning on operating power	0 to 100%	30%

## Intelligent LED Power Control

When the controller's "intelligent power" mode is activated by the user, the LED load's power can be automatically adjusted according to battery capacity. If the operating duration and load power set by the user are still valid, the system chooses the smaller one from between the automatically adjusted power and power set by the user as the load output power.

For example: When the remaining battery capacity is 50% and load power calculated in the intelligent power mode is 60%, and if the load power set by the user is 100%, the final load power is 60%. However, if the load power set by the user is 20% instead, the final load power will also be 20% accordingly.

The typical curve of intelligent power is shown below:



## Parameter Read and Modification

The MH60 controller can be used to set parameters, including parameters about load operating duration, load operating power, light control delay and charging voltage, etc. When completing settings through the remote control, aim it at the controller and press the "send" key to save the settings. Besides, current parameter settings in the controller can also be viewed to make sure the settings are correct.

## Charging and Discharging Control

### 1) MPPT charging technology

MPPT, short for Maximum Power Point Tracking, is an advanced charging method. The MPPT controller can keep monitoring the solar panel's generating power and tracking the highest voltage and current values (V), enabling the system to charge the battery in optimum efficiency. Compared with conventional PWM controllers, the MPPT controller can make the most of the solar panel's max. power and therefore provide larger charging current. Generally, the latter raises energy utilization ratio by 15% to 20% in contrast with the former.

### 2) Freezing point charging protection

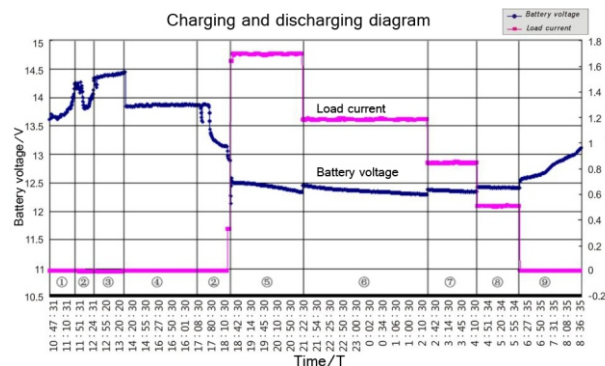
Temperature has a substantial bearing on lithium batteries' performance. When the ambient temperature falls below 0 °C, the lithium battery's properties change significantly and its capacity decreases rapidly, making charging no longer feasible. With the freezing point charging protection function enabled, when an ambient temperature below 0 °C is detected, the controller stops charging the battery to avoid damaging it.

## 3) Charging and discharging cases

A. The parameters of the controller in this case are set as follows:

Item set in this case	Set value	Item set in this case	Set value
1st-stage operating duration	3 hours	Morning on operating duration	2 hours
1st-stage operating power	100%	Morning on operating power	30%
2nd-stage operating duration	5 hours	Load current	1.74 A
2nd-stage operating power	70%	Overcharge voltage	14.6 V
3rd-stage operating duration	2 hours	Overcharge recovery voltage	13.6 V
3rd-stage operating power	50%	Light control voltage	8 V
		Light control delay	5 min

B. Diagram of charging and discharging in a day



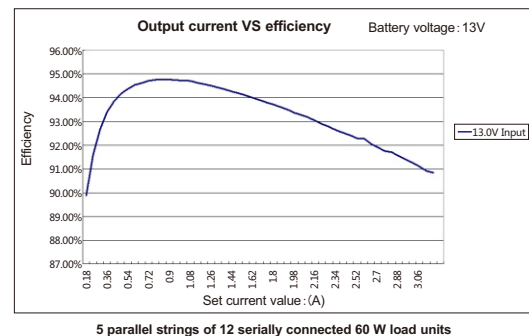
C. Operating stage description

Stage	Description
1	Daytime: With the light intensity strengthened, the charging current keeps growing, making the battery voltage rise again.
2	Daytime: Changes of light intensity put battery voltage in an unstable condition.
3	Daytime: stable charging.
4	Nighttime: The solar panel voltage falls to lower than the light control voltage, and after a time delay, the load is switched on. At the 1st stage, the load power starts at 100%.
5	Nighttime: At the 2nd stage, the load power becomes 70%.
6	Nighttime: At the 3rd stage, the load power falls to 50%.
7	Nighttime: The 4th stage is morning on stage, and load power at this stage is 30%. Note: Since the preset total duration (12 hours) exceeds the length of the night at the given time of the year, the load is not shut off in the process, but keeps operating all the night.
8	Daytime: The solar panel voltage becomes higher than the light control voltage, and after a time delay, the load is shut off and the battery's voltage rises again as battery charging begins.

## System Status Logs

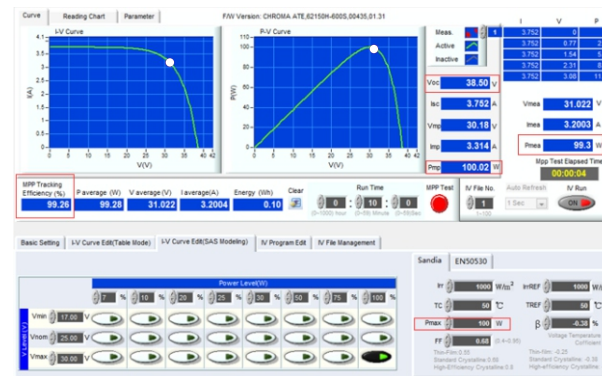
The MH60 controller can record the operating status of the whole system, including operating days, over-dischargings, full-chargings, etc. Moreover, it can keep a record of battery voltage changes in a week, enabling the user to have a clear understanding of the system and conduct better analysis on it. The user needs to use the remote control to read the system's operating status, and when the reading is successful, the parameters are recorded in the remote control.

## Constant Current Source Efficiency Curve



5 parallel strings of 12 serially connected 60 W load units

## Typical MPPT Tracking Efficiency Test



12 V lithium battery, solar panel Voc = 38.5 V and Pm = 100 W, tracking efficiency 99.26%

## Parameters

Parameter	Value	Whether adjustable	Default
Model	MH60		
System voltage	12V		
Output power	60 W/ 12 V		
Output current	0.15 A to 3.3 A	√	330mA
Static power consumption	12.5 mA/ 12 V		
Rated charging current	8 A		
Solar panel power	≤ 100 W		
Solar panel open-circuit voltage	< 40 V		
MPPT tracking efficiency	99%		
Typical constant current source efficiency	90% to 96%		
Overvoltage protection	Overcharge voltage + 2 V		16.6V
Charging voltage limit	Overcharge voltage + 1 V		15.6V
Overcharge voltage	8.0 V to 17.0 V	√	14.6V
Overcharge recovery voltage	8.0 V to 17.0 V	√	13.6V
Over-discharge voltage	8.0 V to 17.0 V	√	10.0V
Over-discharge recovery voltage	8.0 V to 17.0 V	√	12.0V
Current accuracy	±3% (load current > 300 mA)		
Load output voltage	< 40 V		
Over-temperature protection	Ambient temperature: 85 °C (load downrating power)		
Light control voltage	5 V to 11 V	√	5V
Light control delay	1 min to 50 min	√	1min
Operating temperature	-35 °C to +65 °C;		
Protection degree	IP68		
Weight	200g		
Dimensions (mm)	82*82*20		

Note: Parameter setting shall comply with the following rule, i.e. overcharge voltage > overcharge recovery voltage > over-discharge recovery voltage > over-discharge voltage.

## Common Abnormalities and Solutions

Symptoms	Causes and solutions
There is no output after the open-circuit load is reconnected.	Check whether connection is correct and reliable. A maximum of 10s is needed for the load to get started again when reconnection is correct.
There is no output after the short-circuit load problem is resolved.	The load will restart following a time delay of 1s after a short-circuit event.
The battery indicator is flashing quickly, and there is no output.	The battery is over-discharged, and will recover automatically when recharged to the over-discharge recovery point.
While sunlight is present, the solar panel indicator does not light up.	Check whether the solar panel is correctly connected and whether it is blocked.
None of the controller's 3 indicators lights up.	Check whether the battery is correctly connected and whether the lithium battery is under over-discharge protection.
The load current does not reach the preset value.	Check whether the current value exceeds the max. current allowed by the controller.

Note: For detailed parameter and status information, refer to the CU-ALL Instruction Manual.