# MPPT Solar Charge Controller

## User Manual

**Model：**

**Tracer4215BN**

EN

# Contents

# Important Safety Instructions

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

### General Safety Information

- Read all the instructions and warnings carefully in the manual before installation.
- No user-serviceable component exists inside the controller. DO NOT disassemble or attempt to repair the controller.
- Mount the controller indoors. Prevent exposure to the elements and do not allow water to enter the controller.
- Install the controller in well-ventilated places. The controller's heat sink may become very hot during operation.
- Install appropriate external fast-acting fuses/breakers.
- Disconnect all PV array connections and fast-acting fuses/breakers close to the battery before controller installation and adjustment.
- Power connections must remain tight to avoid excessive heating from a loose connection.

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|---|---|
|  **WARNING** | Do not install the controller in humid, salt spray, corrosion, greasy, flammable, explosive, dust accumulative, or other severe environments. |

# 1 General Information

## 1.1 Overview

Appreciate you for choosing MPPT solar charge controller, the Tracer BN series. Based on a common negative design and advanced MPPT control algorithm, with a die-cast aluminum design for heat dissipation, products in this series are artistic, economical, and practical.

With the MPPT control algorithm, products of this series can fast and accurately track the photovoltaic array's best maximum power point (MPP). Obtain the maximum solar energy in time, which remarkably improves energy efficiency. With the Modbus communication interface, it is convenient for customers to expand applications and monitor various fields. Such as telecommunication base stations, household systems, caravan systems, street lighting systems, wilderness monitoring systems, etc.

All-round electronic fault self-test and enhanced electronic protection functions could prevent damage to system components from installation errors or system failures.

**Feature:**

- Advanced Maximum Power Point Tracking (MPPT) technology, with no less than 99.5% efficiency.
- High-quality components, perfecting system performance, with a maximum conversion efficiency of 98%.
- Ultra-fast tracking speed and guaranteed tracking efficiency.
- Accurately recognizing and tracking of multiple power points.
- Reliable automatic limit function of maximum PV input power, ensuring no overload.
- Wide MPP operating voltage range.

- Die-cast aluminum design, ensuring excellent heat dissipation characteristics.
- 12/24VDC automatically voltage-identifying system or user-defined working voltage.
- LED indicators showing system status, simple and clear.
- Multiple load control modes: manual control, light ON/OFF, light On+Timer, and time control.
- Support multiple battery types, including lithium batteries
- Battery temperature compensation function.
- Real-time energy statistics function.
- The RS485 communication bus interface and Modbus communication protocol allow it to meet various communication requirements in different situations.
- Available for PC monitoring and external display unit connecting like MT50 and so on, realizing real-time data checking and parameter setting.

## 1.2 Characteristics

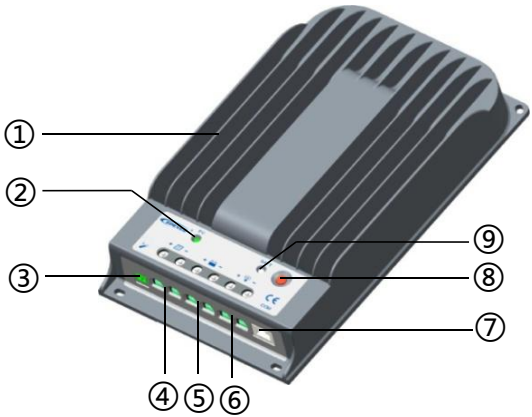


Figure 1-1 Tracer BN Series Characteristics

| Item | Name | Item | Name |
|---|---|---|---|
| ① | Heat Sink | ⑥ | Load Terminal |
| ② | Charging LED indicator | ⑦ | RS485 Port (Isolated RJ45 port) |
| ③ | RTS① Port | ⑧ | Button |
| ④ | Solar Terminal | ⑨ | Battery LED indicator |
| ⑤ | Battery Terminal | | |

**Explanation:**

① Connect an RTS (Remote Temperature Sensor) to detect battery temperature remotely.

## 1.3 Maximum Power Point Tracking Technology

Due to the nonlinear characteristics of the solar array, there is a maximum energy output point (Max Power Point) on its curve. Traditional controllers, adopting the switch charging technology and PWM charging technology, can't charge the battery at the maximum power point. They can't harvest the maximum energy available from the PV array. In comparison, the 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.

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

As shown in Figures 1-2, the curve is the characteristic curve of the array. The MPPT technology will boost the battery charge current by tracking the MPP. Assuming the conversion efficiency of the solar system is 100%, the following formula is established:

Input power ($P_{PV}$)= 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 energy conservation, 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 the PV array and battery, the bigger the reduction of the system's conversion efficiency. Thus the controller's conversion efficiency is particularly important in the PV system.

Figure 1-2 is the maximum power point curve, and the shaded area is the charging range of a traditional solar charge controller (PWM Charging Mode). It can diagnose

that the MPPT mode can improve the usage of solar energy resources. According to our test, the MPPT controller can raise 20%-30% efficiency compared to the PWM controller. (Value may fluctuate due to the ambient circumstance's influence and energy loss.)

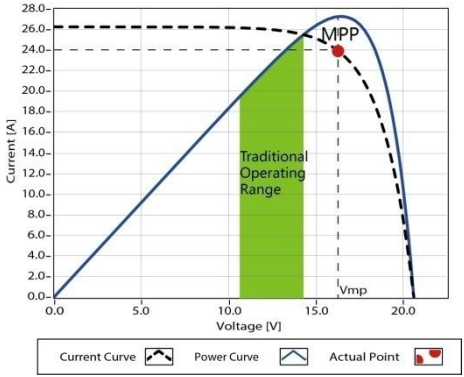


Figure 1-2 Maximum Power Point Curve

The panel may appear Multi-MPP as shading from clouds, trees, or snow in actual application. However, there is only one real Maximum Power Point. As Figure 1-3 show:

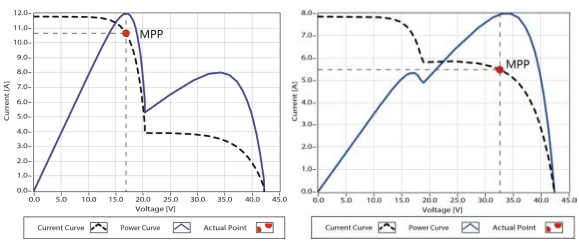


Figure 1-3 Mutil-MPP Curve

If the program works improperly after appearing Multi-MPP, the system will not work on the real max. power point. It may waste most solar energy resources and affect the system's normal operation. The typical MPPT algorithm, designed by our company, can track the real MPP quickly and accurately, improve the array's utilization rate and avoid wasting resources.

## 1.4 Battery Charging Stage

The controller has a three-stage battery charging algorithm (Bulk Charging, Constant Charging, and Float Charging) for rapid, efficient, and safe battery charging.

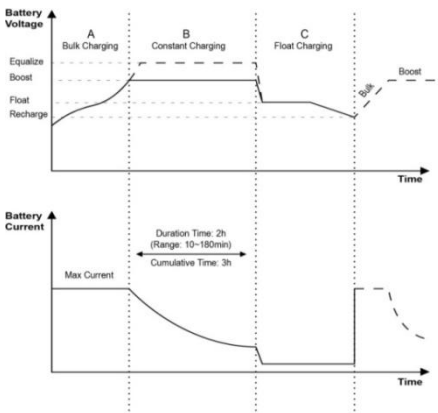


Figure 1-4 Battery changing stage Curve

**A) 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 Charging**

When the battery voltage reaches the constant voltage set point, the controller will start to operate in constant charging mode. This process is no longer MPPT charging. In the meantime, the charging current will drop gradually. The process is not the MPPT charging. Constant charging has two stages, equalize and boost. These two stages are not carried out constantly in a full charge process to avoid too much gas precipitation or overheating of the battery.

- **Boost Charging**

The Boost stage maintains 2 hours in default. Users can adjust the constant time and preset value of boost voltage according to demand.

The stage is used to prevent heating and excessive battery gassing.

- **Equalize Charging**

| | |
|---|---|
|  **WARNING** | **Explosive Risk!** Equalizing flooded batteries would produce explosive gases, so well ventilation of the battery box is recommended. |
|  **CAUTION** | **Equipment damage!**<br>• Equalization may increase battery voltage to the level that damages sensitive DC loads. Verify that all load allowable input voltages are 11%greater than the equalizing charging set point voltage.<br>• Over-charging and excessive gas precipitation may damage the battery plates and activate material shedding on them. Too high an equalizing charge or for too long may cause damage. Please carefully review the specific requirements of the battery used in the system. |

Some batteries benefit from equalizing charge regularly, which can stir electrolytes, balance battery voltage, and accomplish chemical reactions. Equalizing charge

increases battery voltage, higher than the standard complement voltage, which gasifies the battery electrolyte.

The controller will equalize the battery on the 28th of each month. The constant equalization period is 0~180 minutes. Suppose the equalization isn't accomplished at one-time. In that case, the equalization recharge time will be accumulated until the set time is finished. Equalize and boost charges are not carried out constantly in a full charge process to avoid too much gas precipitation or overheating of the battery.

**NOTE:**

**1) The battery voltage can't be steady in constant voltage due to ambient circumstances or load working. The controller will accumulate and calculate the time of constant voltage working. When the accumulated time reaches 3 hours, the charging mode will turn to Float Charging.**

**2) If the controller time is not adjusted, the controller will charge the battery in equalized charging mode once a month following the inner time.**

**C) Float Charging**

After the Constant voltage stage, the controller will reduce the charging current to the Float Voltage set point. This stage has no more chemical reactions, and all the charge current transforms into heat and gas at this time. Then the controller reduces the voltage to the floating stage, charging with a smaller voltage and current. It will reduce the battery's temperature and prevent the battery's gassing and charging simultaneously. The Float stage is to offset the power consumption caused by self-consumption and small loads while maintaining full battery storage capacity.

In the Float charging stage, loads can obtain almost all power from solar panels. If loads exceed the power, the controller can no longer maintain battery voltage in the Float charging stage. Suppose the battery voltage remains below the Recharge Voltage. In that case, the system will leave the Float charging stage and return to the

Bulk charging stage.

# 2 Installation Instructions

## 2.1 General Installation Notes

- Be very careful when installing the batteries, especially flooded lead-acid batteries. Please wear an eye protector, and have fresh water available to wash and clean any contact with battery acid.
- Keep the battery away from any metal objects, which may cause a short circuit of the battery.
- Explosive battery gases may come out from the battery during charging, ensure the ventilation condition is good.
- The controllers are intended for indoor use only. Prevent exposure to the elements and do not allow water to enter the controller.
- Ventilation is highly recommended if mounted in an enclosure. Never install the controller in a sealed enclosure with flooded batteries! Battery fumes from vented batteries will corrode and destroy the controller circuits.
- Loose power connections and corroded wires may produce high heat that can melt wire insulation, burn surrounding materials, or even cause a fire. Ensure tight connections, use cable clamps to secure cables, and prevent them from swaying in mobile applications.
- Only lead-acid and lithium batteries that meet the controller requirement can be charged.
- Multiple models of controllers can be installed in parallel on the same battery bank to achieve a higher charging current. Each controller must have its solar module(s).
- Select the system cables according to 5A/mm$^2$ or less current density following Article 690 of the National Electrical Code, NFPA 70.

## 2.2 PV Array Requirements

**Serial connection (string) of PV modules**

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

| 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 | 2 | 1 |

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

## 2.3 Wire Size

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

- **PV Wire Size**

Since the PV array output varies with the PV module size, connection method, or sunlight angle. The PV array $I_{SC}$ can calculate the minimum PV wire size. Please

refer to the value of $I_{SC}$ in the PV module specification. When the PV modules are connected in series, the $I_{SC}$ equals any PV module's $I_{SC}$. When the PV modules are connected in parallel, the $I_{SC}$ equals the sum of the PV module's $I_{SC}$. The PV array $I_{SC}$ must not exceed the maximum PV input current. Please refer to the table below:

| Model | Max. PV input current | Max. PV wire size (mm²/AWG) |
|---|---|---|
| Tracer4215BN | 40A | 16/6 |

**NOTE:** When the PV modules are connected in series, the open-circuit voltage of the PV array must not exceed 138V (25℃).

- **Battery and Load Wire Size**

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

| Model | Rated charge current | Rated discharge current | Battery wire size (mm²/AWG) | Load wire size (mm²/AWG) |
|---|---|---|---|---|
| Tracer4215BN | 40A | 40A | 16/6 | 6/10 |

**NOTE:** 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 can be used to reduce the voltage drop and improve performance.

## 2.4 Mounting

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|---|---|
| **WARNING** | **Explosive Risk!**<br>Never install the controller in a sealed enclosure with flooded batteries! Do not install in a confined area where battery gas can accumulate.<br>**Risk of electric shock!**<br>Exercise caution when handling solar wiring. The solar PV array can produce open-circuit voltages over 150V when in sunlight. |

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

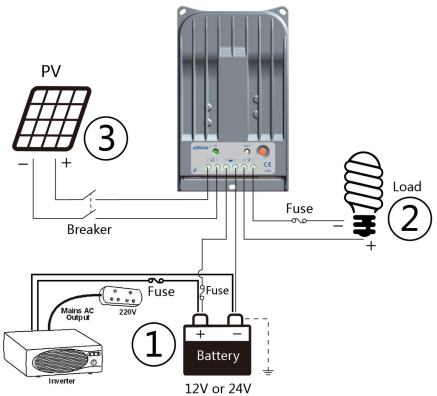


Figure 2-1 Mounting

1) Connect components to the charge controller in the sequence "① > ② > ③" shown above and ensure that the electrode polarity is connected correctly. Please don't connect the fast-acting fuse during the installation. When disconnecting the system, the order will be reserved.

2) After installation, power the controller and check the battery indicator on the controller; it will be green. If it's not green, please refer to chapter 4. Always connect the battery first to allow the controller to recognize the system voltage.

3) The fast-acting fuse should be installed as close to the battery. The suggested distance is within 150mm.

4) The Tracer BN series is a negative ground controller. Any negative solar, load, or battery connection can be earth grounded as required.

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|  **CAUTION** | • Unplug the RTS, and the battery's temperature will be 25 ºC.<br>• Please connect the inverter to the battery rather than to the controller if the inverter is necessary.<br>• The RS485 and RTS ports are not SELV circuits; they must have isolation between the port and where the end-user can access them directly. |

# 3 Operation

## 3.1 LED Indication

| LED Indication | Color | Indicator | Status |
|---|---|---|---|
|  | Green | On Solid | PV charges the battery with a low current |
| | Green | Slowly Flashing(1Hz) | Normal charging |
| | Green | OFF | 1. No sunlight<br>2. Connection Error<br>3. Low PV voltage |
|  | Green | On Solid | Normal |
| | Green | Slowly Flashing(1Hz) | Full |
| | Green | Fast Flashing(4Hz) | Overvoltage |
| | Orange | On Solid | Under voltage |
| | Red | On Solid | Over-discharge |
| | Red | Flashing | Battery Overheating |
| Load Status LED indicator | Red | On Solid | Load ON |
| | Red | OFF | Load OFF |
| | Red | Fast Flashing(4Hz) | Load Short Circuit |
| | Red | Slowly Flashing(1Hz) | Load Overload |
| Charging(green), battery (orange), and load(red) indicators flash simultaneously | | | System voltage error |
| Charging(green) and battery indicator(orange) flash | | | Controller overheating |

| | |
|---|---|
| simultaneously | |

## 3.2 Setting Operation

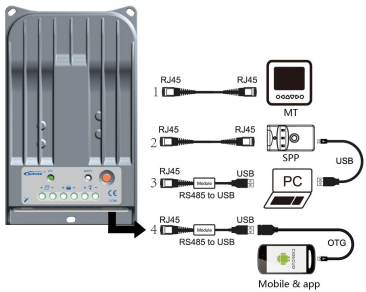


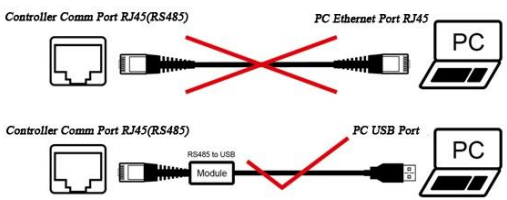

Figure 3-1 Setting operation

Four methods to configure the controller:

**1–Remote meter, MT50**

**2–Super parameter programmer, SPP-02**

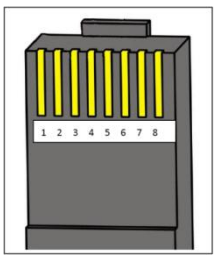
**3–PC monitoring software "Solar Station Monitor"**



| | |
|---|---|
| **WARNING** | DO NOT communicate with the PC using the Ethernet cable. Otherwise, the components of the controller will be damaged. For detailed communication cable, refer to the “Tracer-BN Accessories” file. |

➢ **The RJ45 interface pin definition is shown below:**

| Pins | Define |
|---|---|
| 1 | +5VDC |
| 2 | +5VDC |
| 3 | RS485-B |
| 4 | RS485-B |
| 5 | RS485-A |
| 6 | RS485-A |
| 7 | GND |
| 8 | GND |




| | |
|---|---|
| **WARNING** | The RJ45 interface is only allowed to connect with our company products or operated by a qualified engineer. (The RJ45 interface voltage is 5V, and the current is 200mA). |

**4–Mobile APP**

## 3.3 Battery Parameters

**1. Supported battery types**

| | | |
|---|---|---|
| **1** | **Battery** | Sealed(default) |
| | | Gel |
| | | Flooded |
| **2** | **Lithium battery** | LiFePO4(4S/8S) |
| | | Li(NiCoMn)O2 (3S/6S/7S) |
| **3** | **User** | |

**2. Battery voltage parameters**

**Measure the parameters in the condition of 12V/25ºC. Please double the values in the 24V system.**

| Battery parameters \ Battery type | Sealed | GEL | FLD | User |
|---|---|---|---|---|
| Over voltage disconnect voltage | 16.0V | 16.0V | 16.0V | 9~17V |
| Charging limit voltage | 15.0V | 15.0V | 15.0V | 9~15.5V |
| Over voltage reconnect voltage | 15.0V | 15.0V | 15.0V | 9~15.5V |
| Equalize charging voltage | 14.6V | —— | 14.8V | 9~15.5V |
| Boost charging voltage | 14.4V | 14.2V | 14.6V | 9~15.5V |
| Float charging voltage | 13.8V | 13.8V | 13.8V | 9~15.5V |
| Boost voltage reconnect voltage | 13.2V | 13.2V | 13.2V | 9~15.5V |
| Low voltage reconnect voltage | 12.6V | 12.6V | 12.6V | 9~15.5V |
| Under voltage warning recover voltage | 12.2V | 12.2V | 12.2V | 9~15.5V |
| Under voltage warning voltage | 12.0V | 12.0V | 12.0V | 9~15.5V |
| Low voltage disconnect voltage | 11.1V | 11.1V | 11.1V | 9~15.5V |
| Discharging limit voltage | 10.6V | 10.6V | 10.6V | 9~15.5V |
| Equalize Duration | 120 minutes | -- | 120 minutes | 0~180 minutes |
| Boost Duration | 120 minutes | 120 minutes | 120 minutes | 10~180 minutes |

**NOTE:**

1) When the battery type is sealed, gel, or flooded, the equalize duration is 0 to 180 minutes, and the boost duration is 10 to 180 minutes.

2) The following rules must be observed when modifying the parameter's value in the user battery type (the factory default value is the same as the sealed type):

a) Over Voltage Disconnect Voltage > Charging Limit Voltage ≥ Equalize Charging Voltage ≥ Boost Charging Voltage ≥ Float Charging Voltage > Boost Voltage Reconnect 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 Recover Voltage > Under Voltage Warning Voltage ≥ Discharging Limit Voltage.

e) Boost Voltage Reconnect Voltage > Low Voltage Reconnect Voltage.

**3. Lithium Battery voltage parameters**

| Battery type / Battery parameters | LFP | | | |
|---|---|---|---|---|
| | **LFP4S** | **User** | **LFP8S** | **User** |
| Over voltage disconnect voltage | 14.8V | 9~17V | 29.6 V | 18~34V |
| Charging limit voltage | 14.6 V | 9~15.5V | 29.2 V | 18~31V |
| Over voltage reconnect voltage | 14.6 V | 9~15.5V | 29.2 V | 18~31V |
| Equalize charging voltage | 14.5 V | 9~15.5V | 29 .0 V | 18~31V |
| Boost charging voltage | 14.5 V | 9~15.5V | 29.0 V | 18~31V |
| Float charging voltage | 13.8 V | 9~15.5V | 27.6 V | 18~31V |
| Boost voltage reconnect voltage | 13.2 V | 9~15.5V | 26.4 V | 18~31V |
| Low voltage reconnect voltage | 12.8 V | 9~15.5V | 25.6 V | 18~31V |
| Under voltage warning recover voltage | 12.2 V | 9~15.5V | 24.4 V | 18~31V |
| Under voltage warning voltage | 12.0 V | 9~15.5V | 24.0 V | 18~31V |
| Low voltage disconnect voltage | 11.1 V | 9~15.5V | 22.2 V | 18~31V |
| Discharging limit voltage | 11.0 V | 9~15.5V | 22.0 V | 18~31V |

**Note: LFP4S is for the 12V system, and LFP8S is for the 24V system.**

| Battery type / Battery parameters | LNCM | | | | |
|---|---|---|---|---|---|
| | LNCM 3S | User | LNCM 6S | LNCM 7S | User |
| Over voltage disconnect voltage | 12.8 V | 9~17V | 25.6 V | 29.8 V | 18~34V |
| Charging limit voltage | 12.6 V | 9~15.5V | 25.2 V | 29.4 V | 18~31V |
| Over voltage reconnect voltage | 12.5 V | 9~15.5V | 25.0 V | 29.1 V | 18~31V |
| Equalize charging voltage | 12.5 V | 9~15.5V | 25.0 V | 29.1 V | 18~31V |
| Boost charging voltage | 12.5 V | 9~15.5V | 25.0 V | 29.1 V | 18~31V |
| Float charging voltage | 12.2 V | 9~15.5V | 24.4 V | 28.4 V | 18~31V |
| Boost voltage reconnect voltage | 12.1 V | 9~15.5V | 24.2 V | 28.2 V | 18~31V |
| Low voltage reconnect voltage | 10.5 V | 9~15.5V | 21.0 V | 24.5 V | 18~31V |
| Under voltage warning recover voltage | 12.2 V | 9~15.5V | 24.4 V | 28.4 V | 18~31V |
| Under voltage warning voltage | 10.5 V | 9~15.5V | 21.0 V | 24.5 V | 18~31V |
| Low voltage disconnect voltage | 9.3 V | 9~15.5V | 18.6 V | 21.7 V | 18~31V |
| Discharging limit voltage | 9.3 V | 9~15.5V | 18.6 V | 21.7 V | 18~31V |

**Note: LNCM3S is for the 12V system, LNCM6S and LNCM7S are for the 24V system.**

- **When the battery type is "USE," the Lithium battery voltage parameters follow the following logic:**

  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 Voltage Reconnect Voltage;

c) Low Voltage Reconnect Voltage > Low Voltage Disconnect Voltage ≥ Discharging Limit Voltage.

d) Under Voltage Warning Recover Voltage > Under Voltage Warning Voltage ≥ Discharging Limit Voltage;

e) Boost Voltage Reconnect voltage > Low Voltage Reconnect Voltage;

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

| | |
|---|---|
| **CAUTION** | The required accuracy of BMS is no higher than 0.2V. We will not assume responsibility for the abnormal when the accuracy of BMS is higher than 0.2V. |

| | |
|---|---|
| **CAUTION** | Please refer to the user guide or contact the sales for the setting operation details. |

## 3.4 Load Set Mode

**1. Manual Control (default)**

A button or remote control command can switch the load.

**2. Light ON/Off**

- **12V system:**

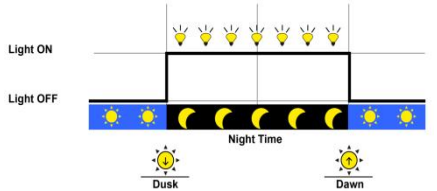
Turn-on voltage (adjustable): 5V, delay 10 minutes.

Turn-off voltage (adjustable): 6V, delay 10 minutes.

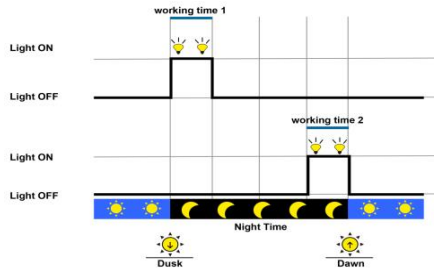
- **24V system:**

Turn-on voltage (adjustable): 10V, delay 10 minutes.

Turn-off voltage (adjustable): 12V, delay 10 minutes.




**3. Light ON+ Timer**




**4. Time Control**

Control the load on/off time by setting the real-time clock.

# 4 Others

## 4.1 Protection

- **PV Over Current**

The controller will limit the battery charging current to the Maximum Battery Current rating. Therefore an oversized solar array will not operate at peak power.

- **PV Short Circuit**

When PV short circuit occurs, the controller will stop charging. Clear it to resume normal operation.

- **PV Reverse Polarity**

Fully protected against PV reverse polarity, no damage to the controller will result. Correct the mis-wire to resume normal operation.

| | |
|---|---|
|  **WARNING** | The controller will be damaged when the PV array is reversed, and the actual PV array power is 1.5 times greater than the rated charge power! |

- **Battery Reverse Polarity**

Fully protected against battery reverse polarity, no damage to the controller will result. Correct the mis-wire to resume normal operation.

| | |
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|  **WARNING** | The controller, limited to the lithium battery characteristic, will be damaged when the PV connection is correct and the lithium battery connection is reversed. |

- **Battery Over Voltage**

When the battery voltage reaches the Over Voltage Disconnect Voltage, the controller stops charging the battery to prevent the battery's overcharging.

- **Battery Over-discharge**

When the battery voltage reaches the Low Voltage Disconnect Voltage, the controller stops discharging the battery to protect the battery over-discharged.

- **Battery Overheating**

The controller detects the battery temperature through the external temperature sensor. If the battery temperature exceeds 65ºC, the controller will automatically start the overheating protection to stop working and recover below 50 ºC.

- **Load Overload**

If the load current exceeds the maximum load current rating 1.05 times, the controller will disconnect the load. Overloading must be cleared up by reducing the load and restarting the controller.

- **Load Short Circuit**

Fully protected against load wiring short-circuit. Once the load shorts (more than quadruple the rated current), the short circuit protection will start automatically. After five automatic load reconnecting attempts, the fault must be cleared by restarting the controller.

- **Damaged Remote Temperature Sensor**

Suppose the temperature sensor is short-circuited or damaged. In that case, the controller will charge or discharge at 25℃ to prevent the battery from being damaged.

- **Controller Overheating**

If the temperature of the controller heat sinks exceeds 85℃, the controller will automatically start the overheating protection and recover below 75℃.

- **High Voltage Transients**

PV is protected against small high surge voltage. In lightning-prone areas, additional external suppression is recommended.

## 4.2 Troubleshooting

| Faults | Possible reasons | Troubleshooting |
|---|---|---|
| The charging LED is off during the daytime when sunshine properly falls on the PV. | PV array disconnection. | Confirm that the PV and battery wire connections are correct and tight. |
| The wire connection is correct, while the indicators are off. | 1. Battery voltage is lower than 9V.<br>2. PV voltage is less than the battery voltage. | 1. Please check the battery voltage. At least 9V to activate the controller.<br>2. Check the PV input voltage, which should be higher than the battery. |
| Battery LED flashes green fast. | Battery voltage is higher than over voltage disconnect voltage(OVD). | Check if the battery voltage is too high, and disconnect the solar module. |
| The battery LED flashes orange. | Battery under-voltage. | The load output is normal, and the charging LED indicator will return to green automatically when fully charged. |
| The battery LED flashes red. | Battery low voltage disconnect. | The controller will cut off the output automatically, and the LED indicator will return to green when fully charged. |
| All the LED indicators flash (battery indicator | Too high controller temperature. | When the heat sink of the controller exceeds 85℃, the controller will automatically cut |

| | | |
|---|---|---|
| flashes orange). | | the input and output circuit. When the temperature is below 75℃, the controller will resume working. |
| All the LED indicators flash (battery indicator flashes red). | System voltage error. | Check whether the battery voltage matches the controller's working voltage. Please change to a suitable battery or reset the working voltage. Remove all faults and click the button to resume working. |
| Load terminals have no output. | Overload or Short circuit. | Remove or reduce the load and press the button; the controller will resume working after 3 seconds. |

### 4.3 Maintenance

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

- Make sure the controller is firmly installed in a clean and dry ambient.
- 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 serious solarization, frictional wear, dryness, insects or rats, etc. Repair or replace some wires if necessary.
- Tighten all the terminals. Inspect for loose, broken, or burnt wire connections.
- Check and confirm that LED is consistent with what is required. Pay attention to any troubleshooting or error indication. Take corrective action if necessary.

- Confirm that all the system components are ground-connected tightly and correctly.
- Confirm that all the terminals have no corrosion, insulation damage, high temperature, or burnt/discolored sign. Tighten terminal screws to the suggested torque.
- Check for dirt, nesting insects, and corrosion. If so, clear up in time.
- Check and confirm that the lightning arrester is in good condition. Replace a new one 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 Technical Specifications

| Item | Tracer4215BN |
|---|---|
| **Electrical Parameters** | |
| Rated system voltage | 12/24VDC Auto |
| Rated charge current | 40A |
| Rated discharge current | 40A |
| Battery working voltage range | 8V～32V |
| Max. PV open circuit voltage | 150V(at minimum operating environment temperature)<br>138V(at 25℃ environment temperature) |
| MPP voltage range | Battery voltage+2V～108V |
| Max. PV input power | 520W(12V); 1040W(24V) |
| Self-consumption | ≤15mA(12V); ≤9mA(24V) |
| Discharge circuit voltage drop | ≤0.2V |
| Temperature compensate coefficient | -3mV/ºC/2V(Default) |
| Communication | RS485(RJ45 interface) |
| Grounding | Common negative |
| **Environmental Parameters** | |
| Work temperature range★ | -35℃～+55℃ |
| Storage temperature range | -35℃～+80℃ |
| Humidity | ≤95% (N.C.) |
| Enclosure | IP30 |
| **Mechanical Parameters** | |
| Mechanical | Tracer4215BN |
| Dimension (L x W x H) | 302.5mm x 182.7mm x 63.5mm |

| | |
|---|---|
| Mounting size (L x W) | 170mm x 290mm |
| Mounting hole size | Φ4.7mm |
| Power cable | 4AWG(25mm$^2$) |
| Weight | 2.9kg |

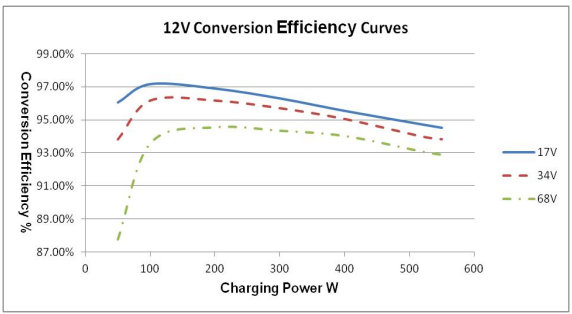
★ Please operate the controller at a proper environment temperature. If the actual temperature exceeds the permissible temperature range, the charging and load power will be reduced appropriately; full-load working is not supported.

# Annex I Conversion Efficiency Curve

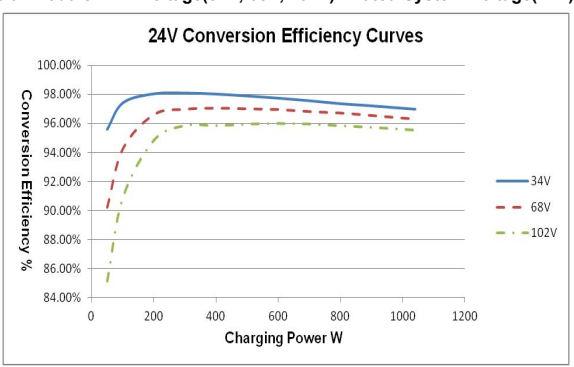
**Illumination Intensity: 1000W/m² Temp: 25ºC**

- **Model: Tracer4215BN**

**1. Solar Module MPP Voltage(17V, 34V, 68V) / Rated System Voltage(12V)**

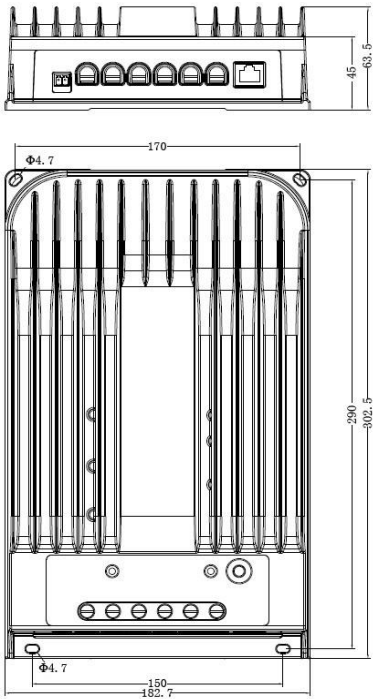



**2. Solar Module MPP Voltage(34V, 68V, 102V) / Rated System Voltage(24V)**



# Annex II Dimensions

- **Tracer4215BN Dimensions in Millimeters**




**Any changes without prior notice! Version number: V1.0**

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