V3.2

TBB POWER

E4 User Manual

1. Product Introduction

This document serves as a user manual for the operation of E4. With this document we aim to provide detailed instructions on the E4 hardware configuration and the system functions, to aid in the understanding of each function module and setting item of the system for users.

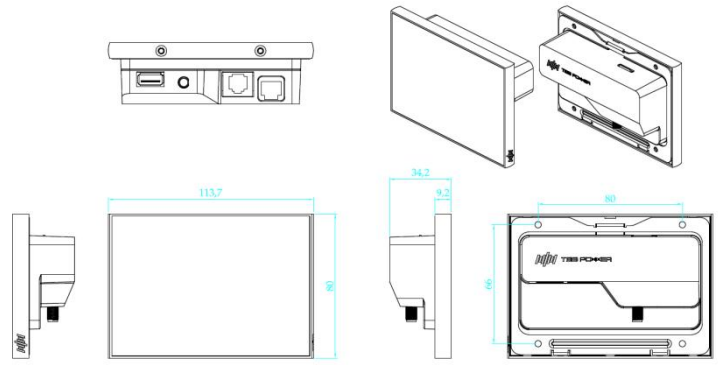
1.1 Hardware Configuration

E4 LCD Monitor (E4) is a 4.3-inch display & control screen developed by TBB POWER. Based on GD32 microcontroller, E4 is a fully intelligent central LCD touch monitor, providing intuitive, real-time and local control and monitoring for TBB systems. It supports monitoring and configurations for the following TBB products: Apollo Matrix, CK, RiiO Sun II, Tyrann, RiiO Sun II SP,LS50, LS75, ES100, Solar mate, Raython Model1&Model2.

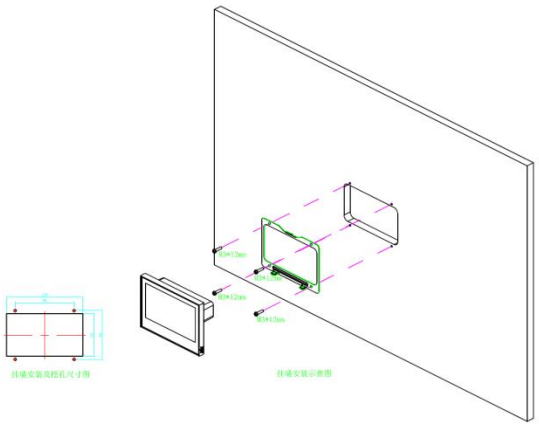
E4 is designed with multiple interfaces: 1 x CAN communication, 3 x RS485 communication, supporting USB host or USB device, supporting GPRS communication. Featuring high performance at moderate cost, E4 adopts ARM Cortex M4 core integrated circuit with the bus frequency up to 200MHz and integrated with rich interfaces, perfectly satisfying the demands for data display. Its hardware configuration parameters are as follows:

Component	Specification	Note
Microcontroller	GD32F450 Series	
Max Operating Frequency	200MHz	
Flash	2048KB	
SRAM	512KB	
Core	ARM Cortex M4	

1.2 Appearance and Dimensions

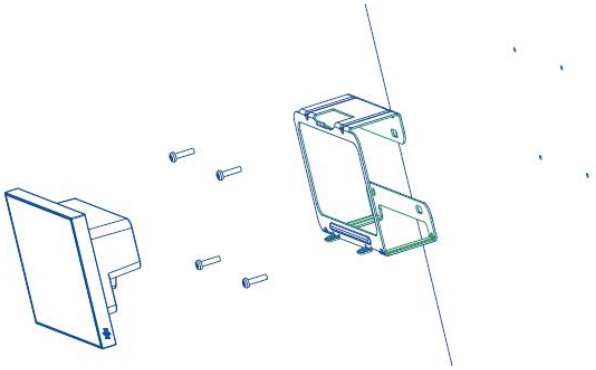


Structure dimensions



Embedded Installation Diagram

Cut a hole in the wall to lock the bracket onto the wall, then mount the screen onto the bracket, and finally secure the screen to the bracket with the bottom screws.



Surface Mount Diagram

Product rendering

1.3 E4 Interface Explanation

① An interface for connecting the Wi-Fi signal antenna

② USB interface for real-time data storage and firmware upgrade.

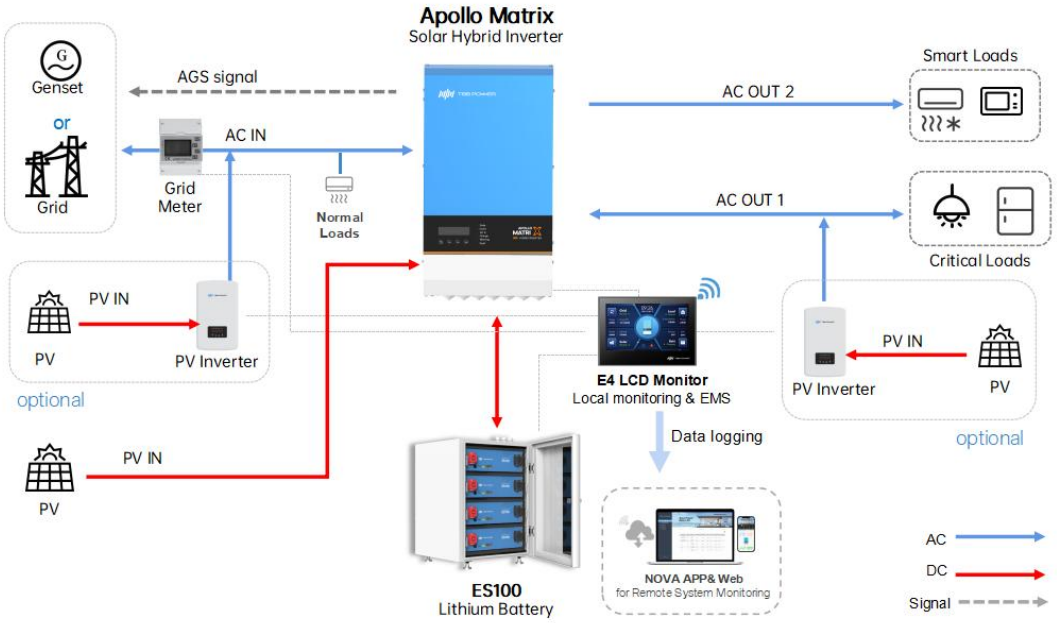
③ Integrated interface for power supply and communication with the inverter.

④ For communication with the battery, grid meter and PV inverter.

1.4 Application Scenarios

As the core component of the system, E4 plays an important role in human-machine interaction and system energy dispatching control. Through RS485 or CAN communication, E4 can establish communication with the solar hybrid inverter, battery, meter and other components in the system. Thanks to its software management mechanism, E4 ensures high stability and robustness of the entire electrical system.

AC+DC Coupled PV System with ESS Functionality



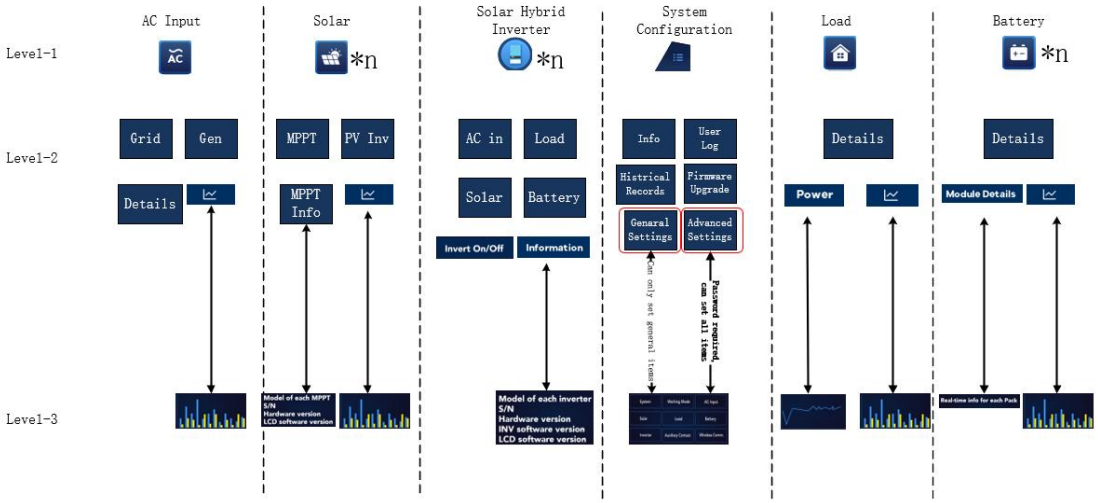
The system supports up to 9 inverters, 6 MPPTs (including the inverter's built-in MPPT) and 4 PV inverters. PV inverters differentiate between the front end (AC in side of the inverter) and the back end (AC out side of the inverter). The front-end PV inverters operate according to the status of the utility power, ceasing operation when the utility power is out.

2. Levels of User Interface

The whole system is designed based on the general principle of “system + subsystem”, and each subsystem is in modular design and is independent from each other to ensure a quick respond to the users’ needs as well as smooth evolution of the system.

- The brand-new interface design provides various setting items. During the system installation, the system can be easily and individually configured to further improve the installation efficiency of the system.
- With fault detection and recording function, it can quickly locate where a fault is, providing sufficient technical guidance for after-sales service.
- Integrated with Wi-Fi functionality, it supports uploading real-time data to NOVA App & Web and remote control via NOVA App & Web.

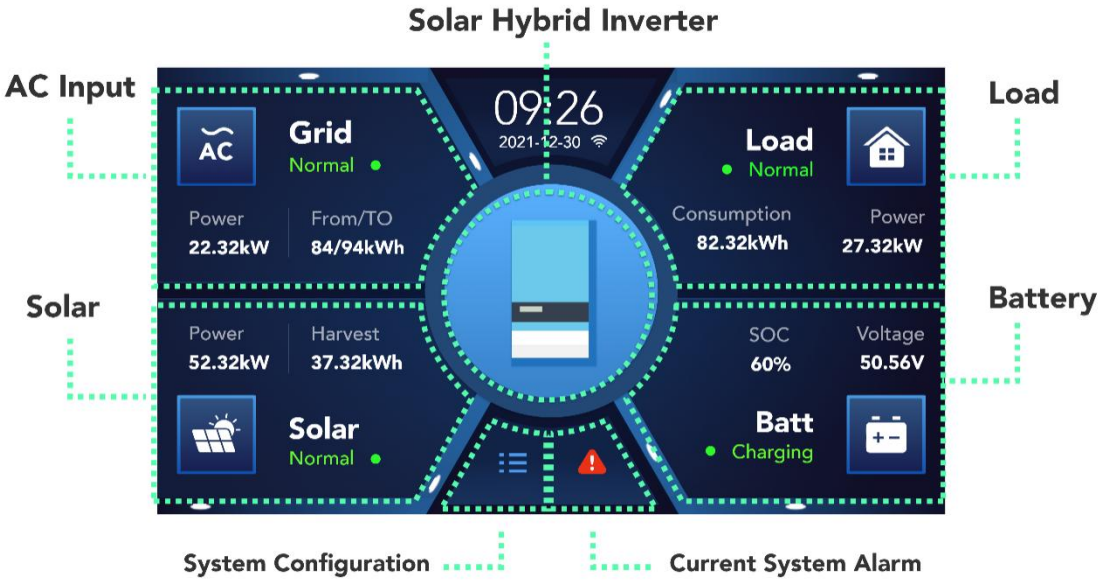
The first, second and third level interfaces are shown as below:



3. Function

3.1 Main Interface

The main interface displays basic information of the four major subsystems: AC in, battery, solar and load. It also visually and vividly displays the energy flow in the form of animation.



AC in Module Explanation:

a) The "Normal" indicates that its running status is normal. When the module is faulty or disconnected, the running status will be indicated as "Abnormal" in red font.

Definition of abnormal AC in: "Abnormal" will show up when the inverter reports an AC in fault or when the Grid Meter is disconnected in non-To Load mode;

b) Grid: Indicates that the current AC source is from the grid. It is possible to switch between Grid or Generator by setting. When E4 is connected to RiiO Sun II or Tyrann (2kW-8kW), the Smart Port can be used to connect to a generator. When the AC IN source is GEN and connected, it displays Gen1; when Smart Port is set to GEN connection and the front-end AC input is disconnected, it displays Gen2.

Currently, the system does not support automatic identification of the AC source. It requires manual configuration on the E4 to record the operating time for grid or generator. Grid operating time accumulates once it is set to the grid mode, while generator operating time begins to accumulate when it is set to generator mode.

c) Power indicates the current power.

d) From Grid/To Grid: This indicates the energy input from the grid and the energy fed back to the grid, with the data alternating every 2 seconds. For readings up to 1000 kWh, the unit is displayed as 0.1 kWh; for readings above 1000 kWh, the unit shifts to 0.01 MWh.

Solar Module Explanation:

a) The "Normal" indicates that the running status is normal, indicated in green font under normal operation 

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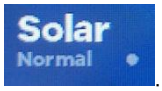
The "Normal" is indicated in gray font in standby status (When MPPT + PVINV output power = 0) 

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When the module is faulty or disconnected, the status will be indicated as "Abnormal" in red font.

b) Power indicates the current power.

c) Harvest indicates today's power generation.

Battery Module Explanation:

a) The "Normal" indicates that its running status is normal.. When the module is faulty or disconnected, the running status will be indicated as "Abnormal" in red font.

b) Voltage indicates the current voltage of the battery bank.

c) SOC indicates the remaining amount of energy available in the battery bank. If the lithium battery is disconnected, SOC displays "--";

Load Module Explanation:

a) The "Normal" indicates that its running status is normal. When the inverter reports a load fault, the status becomes Abnormal, and the font turns red;

b) Consumption indicates today's power consumption.

c) Power indicates the current power.

Showing the date, time and the current Wi-Fi connection status.


Access to detail page of the solar hybrid inverter.


Access to system settings.


Current system alarm. When a new alarm occurs to the system, the exclamation mark will turn red  , and the user will also be reminded by the buzzer. The alarms that will not cause fatal damage to the system are classified as general alarms, and the buzzer will beep slowly and disappear automatically after one minute. When a serious fault such as short circuit or communication interruption occurs, the buzzer will beep rapidly so as to attract the attention of the user and remind the user to attend to the fault.

3.2 AC in Subsystem

Items on the left include Total From Grid (total consumption of the grid), Total To Grid (total energy exported to the grid), Running Time (Daily operating duration), Total Running Time. Items on the right include the voltage, current, frequency, active power and apparent power of each phase.

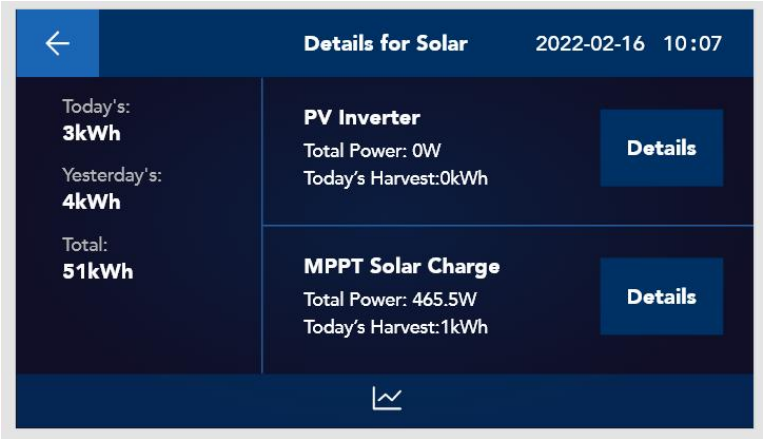
3.3 Battery Subsystem

Items on the left include voltage, current, SOC, and the current working status (which could be either charging, discharging or idle) of the battery.

Items on the right include the number of battery modules, average cell temperature, total battery capacity, firmware version, voltage and address of high-voltage cell, voltage and address of low-voltage cell, temperature and address of high-temperature cell, temperature and address of low-temperature cell.

Letter C stands for cell and P for pack, indicating the highest temperature value and the address of the cell with the highest temperature.

3.4 Solar Subsystem

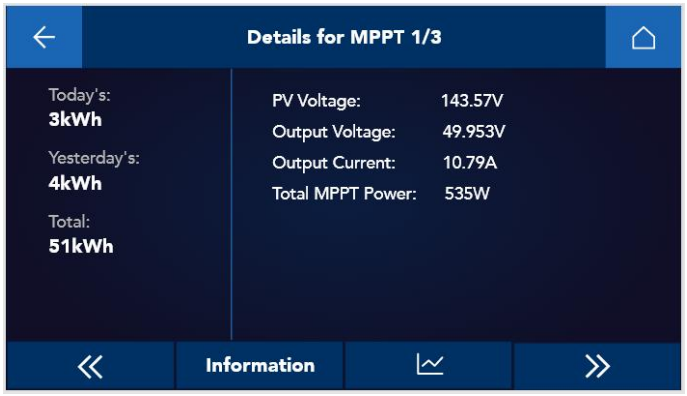


The solar subsystem includes two parts: PV inverter and MPPT.

Items on the left include today's power generation, yesterday's power generation and total power generation; Items on the right include access to the detail page of PV inverter and MPPT.

Click the 

button for the MPPT Solar Charge Controller to access its detail page. This page lists all the information for MPPTs, with the RiiO Sun II model displaying two PV inputs and two PV voltages, while other models show one PV voltage



a) 

The quantity, serial number, hardware version and software version of the MPPT module.

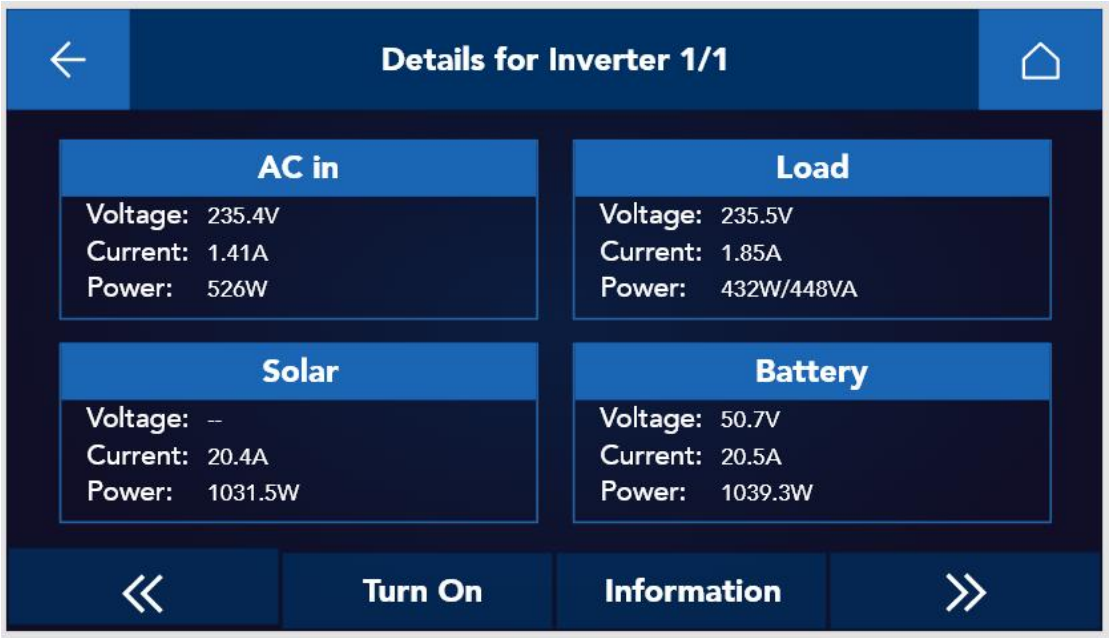
b)  Chart.

3.5 Load Subsystem

The user can select the Critical Load, Normal Load,Smart Load or Total by clicking the drop-down button. ▼

Items on the right include the real-time data of voltage, frequency, current power and total power of each phase.

3.6 Solar Hybrid Inverter

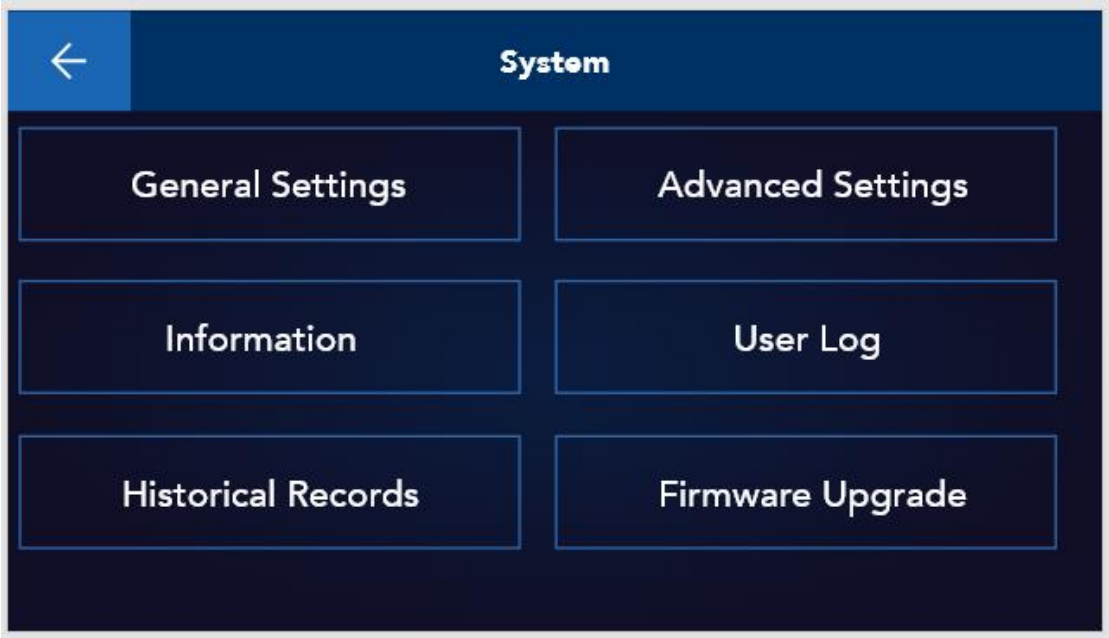


After entering the detail page of the solar hybrid inverter, the user can find the current status of the AC in, the load, the solar (If there is no built-in MPPT, display "—". The CK, Tyrann, and RiiO models do not have built-in MPPT, while other models are equipped with built-in MPPT) and the battery, with their real-time voltage, current and power displayed. When there are multiple units in parallel, the user can view the detailed data of each unit by clicking the page up and down buttons « ».

With the Turn On button, the user can easily switch on/off of the inverting function. This action applies to all inverters.

The user can view the model number, serial number, hardware version and software version of each inverter by clicking the Information button.

4. Menu



This menu covers 6 major modules: General Settings, Advanced Settings, Information, User Log, Historical Records and Firmware Upgrade. The Information module records the serial number and firmware version of the E4. The User Log module records all operation logs, and each page displays 5 pieces of records. The Historical Records module records the alarms and faults arising out of the system, and each page displays 5 pieces of records.

All setting items are classified into two categories: General Settings and Advanced Settings. The content and quantity of the setting items are the same for both categories. Their difference is: the General Settings do not allow the user to change all settings and the items that cannot be set are shown in gray and marked with an asterisk, while on the Advanced Settings page, the user is able to make changes to all setting items. To enter the Advanced Settings page, the user needs to enter a password, which is a four-digit number "1000".

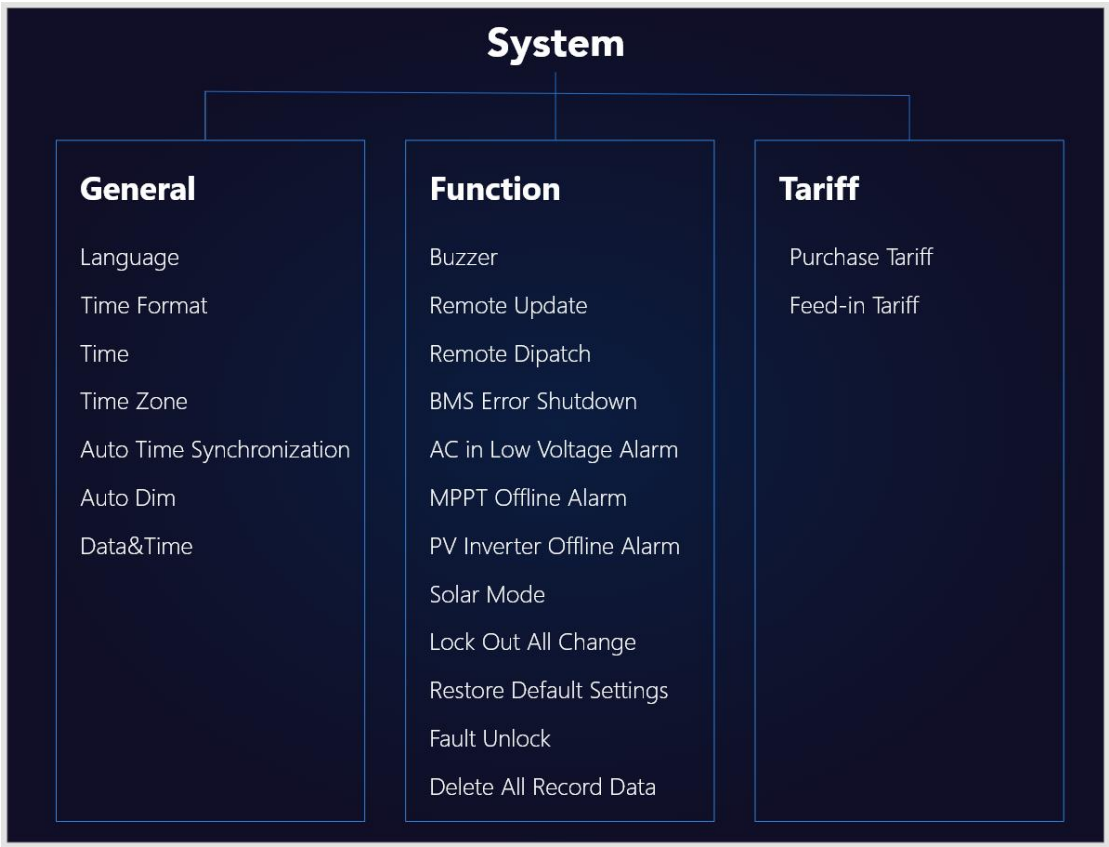
The setting items are divided into 9 parts as shown below. Full explanations to these setting items are provided in the following chapter.


System
Working Mode
AC Input
Solar
Load
Battery
Inverter
Auxiliary Contact
Wireless Comm.

4.1 Setting Item Explanation

1. System Setting

The system settings are divided into three parts: general settings, function settings and electricity price settings. The contents of each sub-item, when expanded, are as follows:



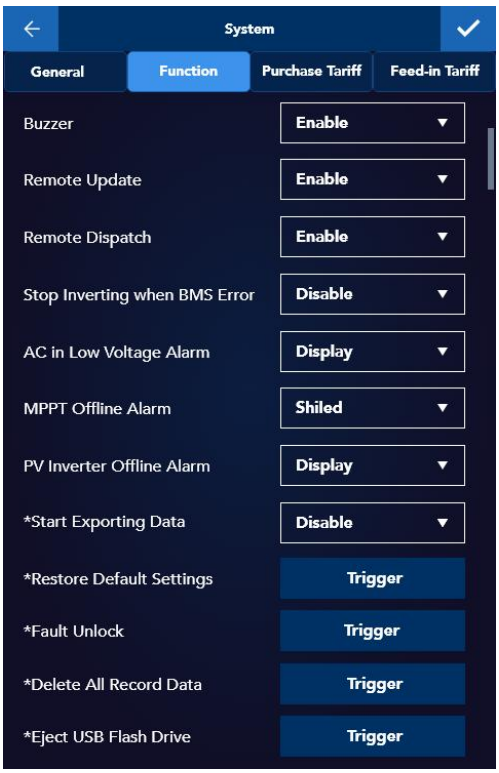
1) General Setting Page

The user can make basic settings on this page.

Supports the following languages: Chinese, English, and Spanish;

The screen-on time of the E4 cannot be set to be permanently on, and the maximum screen-on time is up to 999 seconds.

2) Function Setting Page



a) Buzzer switch. used to alert users through a buzzer in case of system faults;

b) Remote Update. Enabling it will allow the user to remotely update the firmware version of E4 and other components of the system.

c) Remote Dispatch. Enabling it will allow the user to set parameters via Nova Web or APP.

d) Stop Inverting when BMS Error. Enabling it will shut down the system in the event of a BMS error.

e) AC in Low Voltage Alarm switch.

f) MPPT Offline Alarm switch.

g) PV Inverter Offline Alarm switch.

h) Data export: when Enable is set, the data of AC input, load, battery, and PV modules will be stored in the U disk in real time.

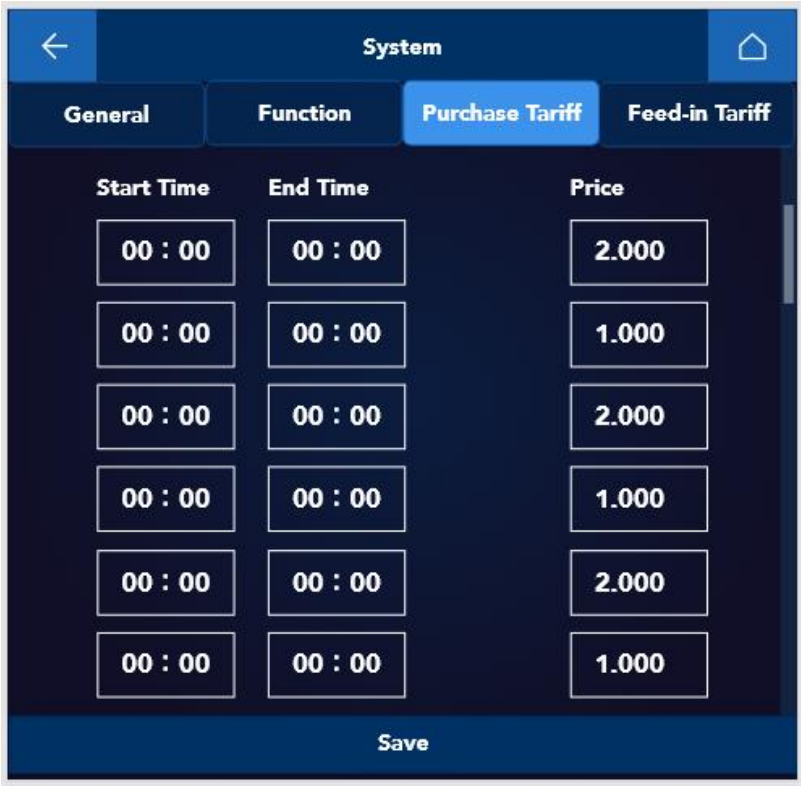
i) Restore Default setting: Clicking this item will delete all running data of the system and restore all setting items. Please proceed with caution.

j) Fault Unlock: Some inverter faults, such as overload, short circuit or over temperature will lead to lock of the inverter. Its normal operation can be restored only after the user clicks the fault unlock button.

k) Delete All Record Data: Clicking this item will delete all running data.

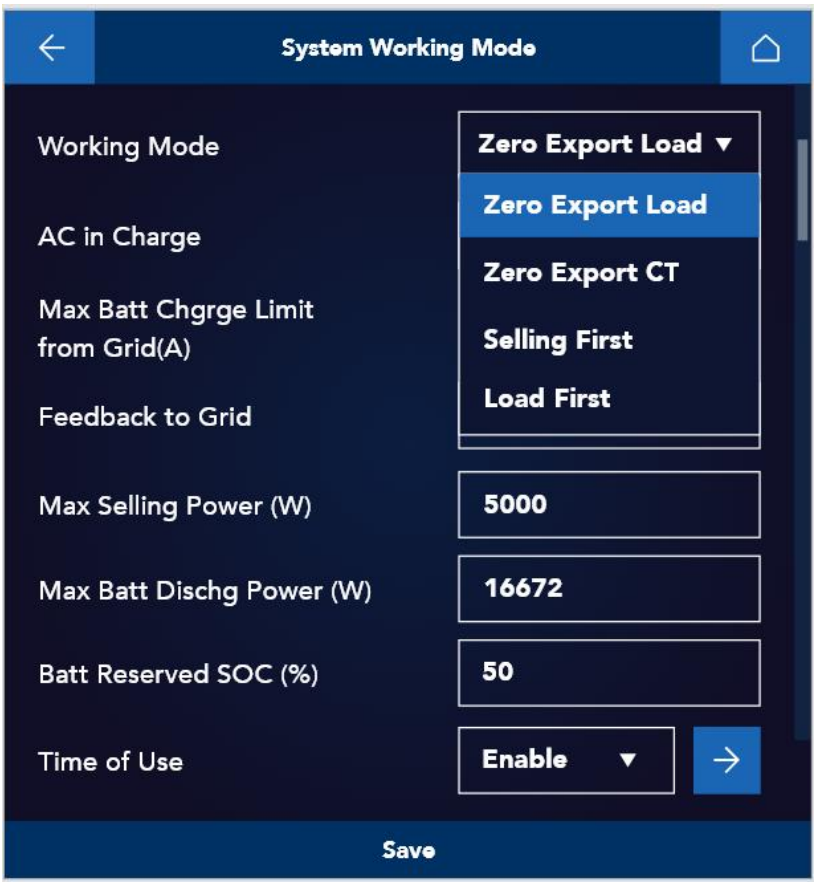
l) USB ejection: upon activation, it will stop writing data to the USB drive and safely eject the USB drive from E4;

3）System - Electricity Price Setting



Set the electricity purchase tariff and feed-in tariff for each time range. 8 time ranges are available for setting.

2. System Working Mode



a) Selection of working mode;

① Zero Export To CT: In this mode, the PV and battery will be preferentially used to supply power to the loads, and the grid will be used to supply power to the loads only when the battery SOC (voltage) reaches its reserved capacity threshold. The battery energy is used to power the loads, including the Critical Load and Smart Load on the AC outputs and Normal Load on the AC input. The battery energy is not allowed to be fed back into the grid. The excess PV energy can be fed back into the grid, and the selling (export) power is available for selection.

② Zero Export To Load: In this mode, the PV and battery will be prioritized to power the Critical Load until the battery SOC (voltage) reaches its reserved capacity threshold, at which point the grid will assist the PV in supplying power to the Critical Load on the AC output. Normal loads on the AC input will be powered by the grid first. The battery energy is used to power the Critical Load and Smart Load on the AC outputs, and it is not allowed to be fed back to the AC input port, including the grid and generator. The excess PV energy can be fed back to the grid, and the selling (export) power is available for selection.

③ Selling First: In this mode, the PV will power the loads first before exported to the grid, and the battery will assist PV in powering the loads and its energy will be

exported to the grid until the battery SOC (voltage) reaches its reserved capacity threshold, at which point only the PV will supply power to the loads and export energy to the grid. When the PV is insufficient, the selling (export) power will be decreased even to a degree that the grid will provide power to the loads together with the PV. In this mode, the battery energy is allowed to be fed back to the grid.

④ Load First: In this mode, charging the battery from the grid is disabled. PV prioritizes powering the load, then charges the battery. If the grid feed-in is allowed, then feeds the surplus into the grid. This mode does not prioritize charging the battery up to the threshold.

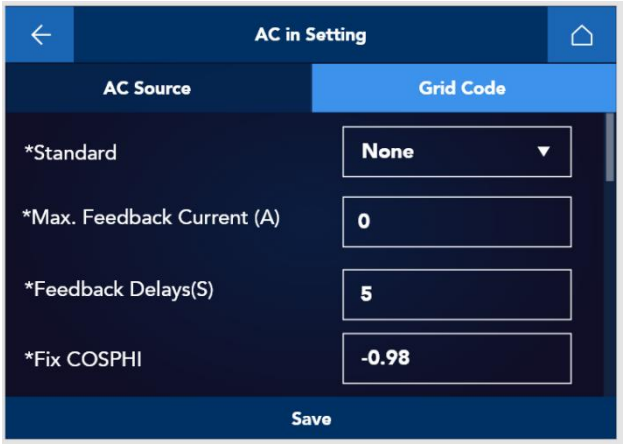
b) AC in Charge, can be set as enabled or disabled;
c) Maximum AC charging current: This setting limits the energy obtained from the utility power to reduce pressure on the grid;
d) Feedback to Grid, can be set as enabled or disabled;
e) Maximum Selling Power;
f) Maximum battery discharge power;
g) Battery Reserved SOC value;
h) Energy Management Matrix(Time of Use). The user can customize 8 time ranges to manage battery charge and discharge. For each time range, the following setting items can be separately configured: using grid to charge battery or not, battery maximum discharge power and battery reserved SOC (or voltage if lead-acid batteries are used).

3. AC in Setting

The current system does not support automatic recognition of AC input sources. It distinguishes between grid and generator operations through manual AC Source Selection;

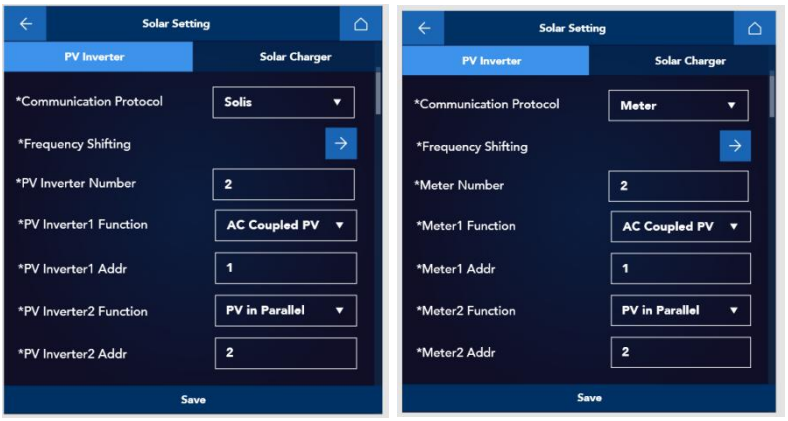
Allowed Max. AC Input Current: This setting limits the maximum AC input current for each phase;

When the Allowed Low Quality AC Source item is set to Weak Grid, the AC in harmonic adaptation mode will be activated. In case of high AC in harmonic, selecting the Weak Grid will ensure the inverter to perform charging in a more stable way.



With regard to grid code, the grid connection standards can be selected through the Grid Code submenu. Currently, only the NRS2017 protocol is available for selection.

4. Solar Setting



Two communication protocols are supported with the PV inverter: Solis and Meter. In this page, the user can set the installation location and function of each PV inverter. When the communication protocol is selected as meter, these settings will apply to meter accordingly. Furthermore, user-defined start value, stop value and disconnect value with regard to the frequency shifting are supported to adapt to the frequency shifting of different PV inverter models.

5. Load Setting

The AC OUT 2 on/off can be programmed based on the following setting items. The setting items include:

1. AC OUT2 configuration logic: it can be configured as Smart Load or PV Inverter, which means it can be connected to smart load or PV inverter;

2. Switch on Grid Only: if enable this setting, it means the AC OUT 2 will be automatically switched on when the grid power is available

3. SOC Control: if enable this setting, it means the AC OUT 2 can be switched on/off based on battery SOC

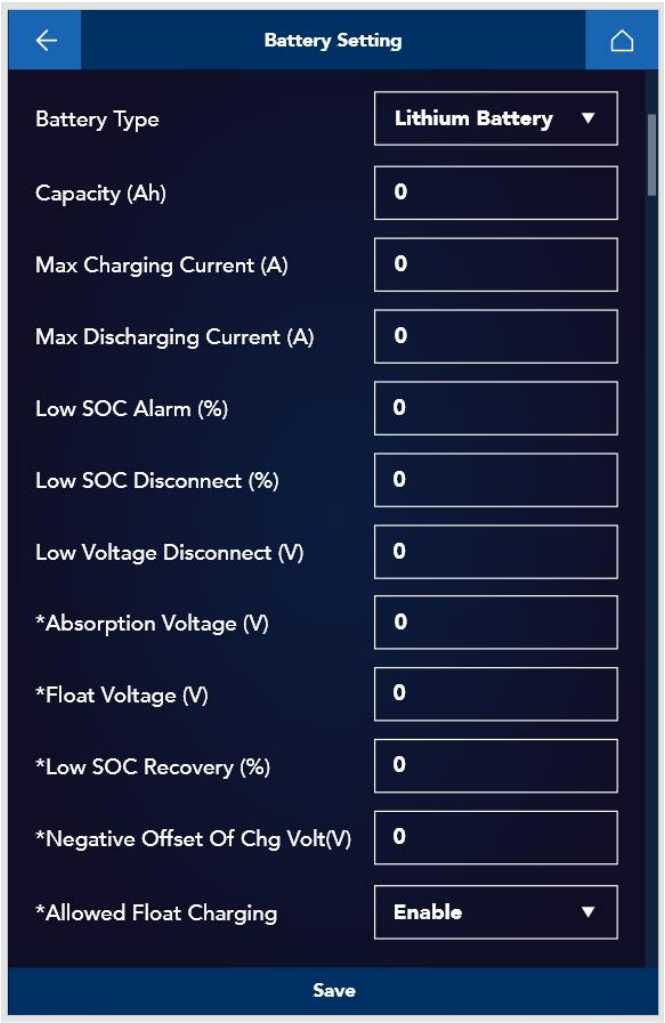
4. Switch on SOC>(%) and Switch off SOC <(%): Set the SOC value to trigger the on/off of AC OUT2

5. PV power control: if enable this setting, it means the AC OUT2 can be switched on/off based on the PV power

6. Switch on PV power>(W) and Switch off PV power <(W): Set the PV power value to trigger the on/off of AC OUT2 .

7. Besides, Time Control option is also available, which allows the user to customize the time range during which the AC OUT 2 will be switched on.

6. Battery Setting



Battery setting page, where the battery type can be selected.

When the battery type is set as the Lithium Battery, its battery capacity is measured and reported by the battery BMS and it is unavailable for setting.

Here we need to explain two important technical items: the Negative Offset of Charge Voltage as for the lithium battery and the Temperature Compensation Coefficient as for the lead-acid battery:

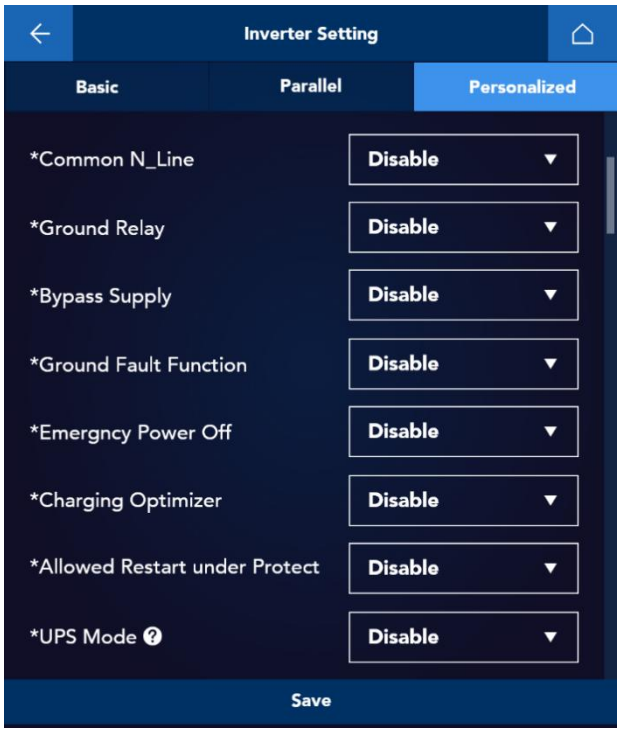
1) Negative Offset of Charge Voltage: if the battery communication protocol supports TBB SUPER-L, this functionality will allow the user to reduce the charging voltage.
2) Temperature compensation coefficient: When the lead-acid battery is being charged, the intensity of the battery's chemical reaction is affected by ambient

temperature. Generally, higher battery temperature will lead to more active chemical reaction, while lower battery temperature will lead to less active chemical reaction in the battery. Therefore, when the battery is in high temperature, the float voltage needs to be decreased to slow down the chemical reaction due to the intensified chemical reaction of the battery; when the battery is in low temperature, as the chemical reaction slows down, the float voltage needs to be increased to speed up the chemical reaction, so as to ensure normal energy conversion.

7. Inverter Setting

There are three types of parallel connection methods available for selection: Stand-alone, Parallel and Three-Phase. Users should choose one of them based on the system's installation method;

Number of units in parallel: set the quantity based on the actual number of inverters deployed in the system.



Inverter personalization settings

a) Common N Line: to enable or disable the input and output to share the same neutral wire.

b) Ground Relay: neutral grounding setting on the output of the inverter. This setting will take effect only when the input and output do not share the same neutral wire.

c) Bypass Supply: when it is enabled, the system will switch to pure bypass operation in case the inverter fails during a grid-connected operation. When it is disabled, the protection will be otherwise triggered.

d) Ground Fault Detection: voltage detection between the neutral wire and the ground wire.

e) EPO: Emergency power off.

f) Battery Charging Optimizer: to optimize the battery charging current on the DC side by optimizing the inverter charging waveform.

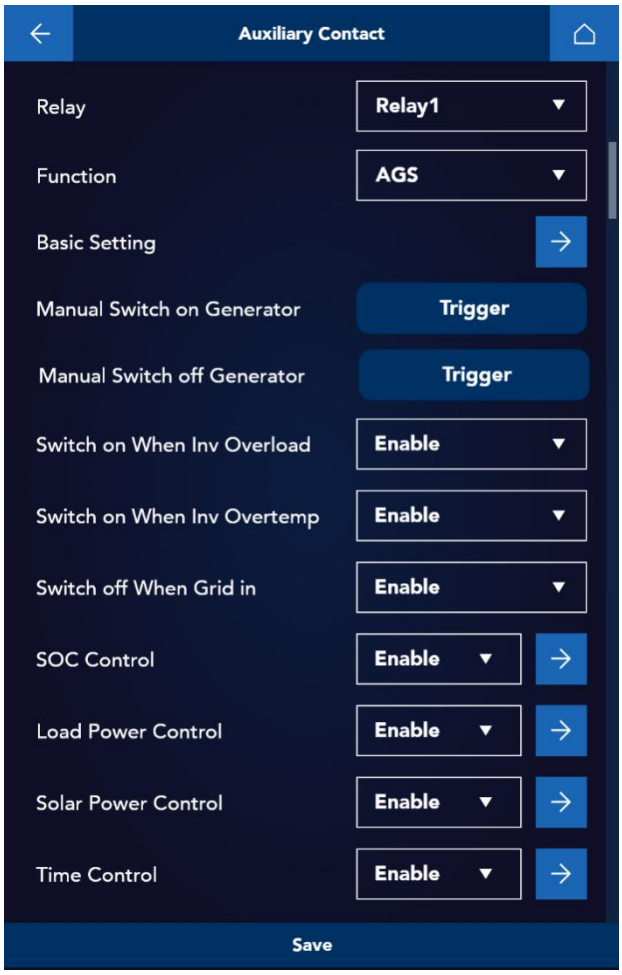
g) Restart under Protect: to enable or disable the restart after the fault is removed.

h) UPS mode: When enabled, the system seamlessly transitions to inverter mode in the event of an abrupt AC input cut-off, ensuring continuous power to devices on the output side. When disabled, the transition to inverter mode takes longer. Note: If the system has a small-capacity battery and battery protection is activated during a power outage, the UPS function should be disabled.

*The RiiO Sun II system only has Common N_line, Ground Relay, Bypass Supply, and UPS Mode functions

8. Relay Setting

With multiple relays built in the inverter, the AGS function can be realized through the switch on/off of the relays based on the set conditions. This chapter addresses the AGS function, including its setting conditions and result.



Relay1 represents the dry contact 1 of all inverters in the system. Individual dry contact settings for each inverter are not supported at this time. This setting is effective for all inverters.

① Switch off When Grid in: Disable the AGS when the grid is available. If the grid is unavailable, assess further before deciding whether to enable AGS.

② Solar Power Control: When enabled, turn off AGS if PV output power exceeds (load power + 200W) for over a minute.

③ Switch on When Inv Overload: When enabled, AGS activation is controlled by the alarm status

④ Switch on When Inv Overtemp: When enabled, AGS activation is controlled by the alarm status

⑤ SOC Control: When enabled, AGS activation is controlled by the SOC value

⑥ Load power Control: When enabled, AGS activation is controlled by the load power.

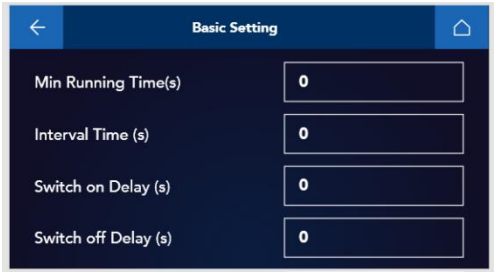
⑦ Time Control: Two time periods can be configured.

Priority: Conditions ①-② take precedence over conditions ③-⑦. No further evaluation needed if one of the conditions ①-② is met. Otherwise, conditions 3 to 7 are judged.

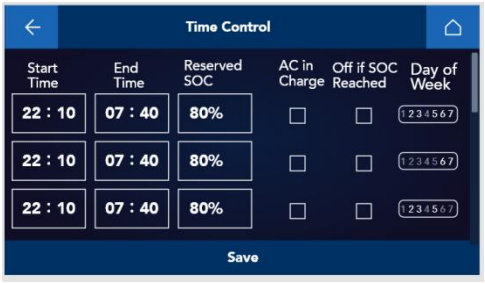
For conditions ③-⑦, AGS will be activated if any condition is met when enabled, otherwise, it will remain deactivated.

1) Basic Setting

The minimum running time of the generator, the minimum interval for starting the generator, the switch on delay and the switch off delay are available for setting, to prevent the generator being started frequently due to the fluctuation of the battery SOC (voltage) or load power, and thus to achieve the more economical and efficient use of the generator.



2) Time Control



Reserved SOC: SOC threshold within the time range.;
AC in Charge: whether to charge the battery within the time range.
Off if SOC Reached: whether to turn off the generator after the battery reaches its high threshold. If not selected, the generator will not be turned off until the end of the time range.
Day of Week: Number 1 to 7 stands for Monday to Sunday respectively. The number highlighted indicates it is selected while the number in gray indicates it is not selected.

AGS is automatically activated at the start time when the grid is unavailable and the Solar Power Control does not meet the criteria for deactivation.

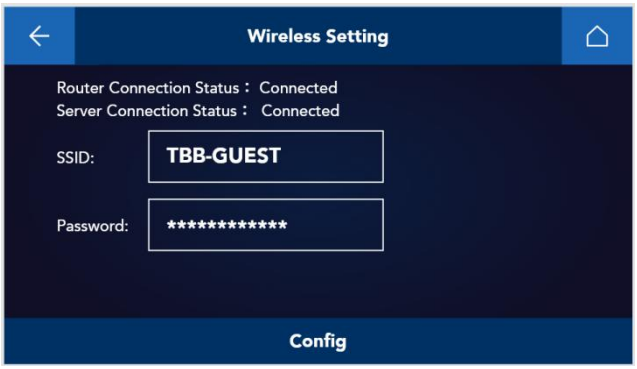
AGS is deactivated at the end time unless other activation conditions are present.

9. Wireless Setting

Through the Wi-Fi configuration, the user can connect to a Wi-Fi network for data exchange between local data and Nova Web & APP.

The E4 screen can automatically search and identify nearby wireless network signals, making Wi-Fi configuration via the E4 significantly convenient.

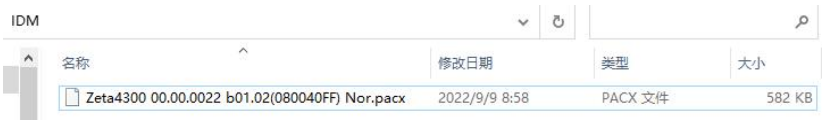
After selecting the SSID and inputting the password, click 'Config'. The wireless network is successfully configured once the router connection status displays 'Connected'.



4.2. Firmware Upgrade

Through E4, you can easily update the firmwares of most system devices via USB, including the inverter's internal DSP, LCD, MPPT modules, as well as the E4's own firmware. Currently, firmware updates for external SPs are not supported. Detailed steps for the firmware updating process are as follows

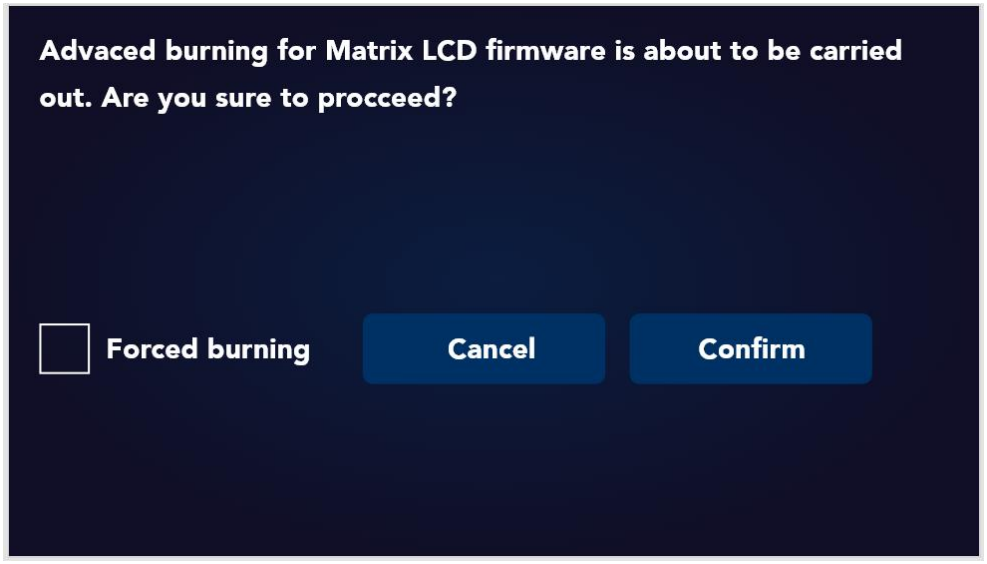
1) Create the [IDM] folder in the root directory of the USB flash drive, and then put the firmware file in the [IDM] folder.



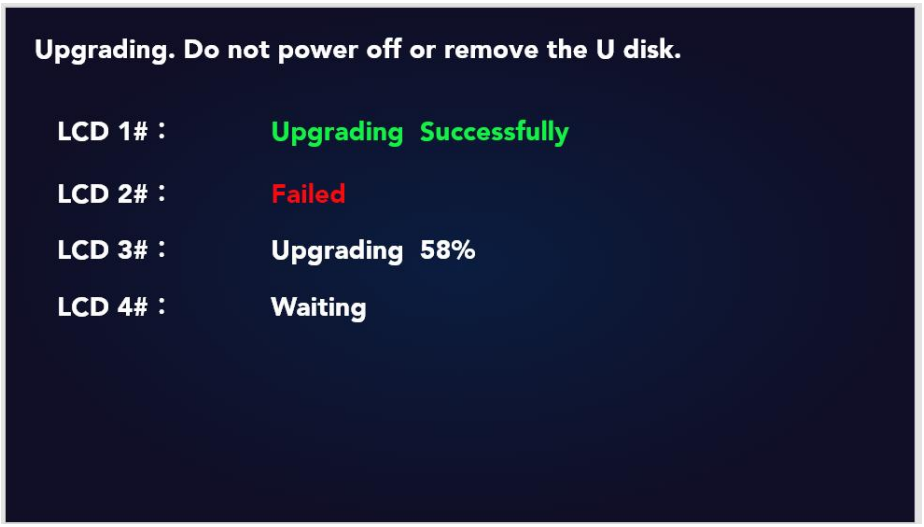
2) Insert the USB flash drive into the USB interface of E4. Hot swapping is supported.

3) After clicking the “Firmware Upgrade” button on the E4 screen, the screen will pop

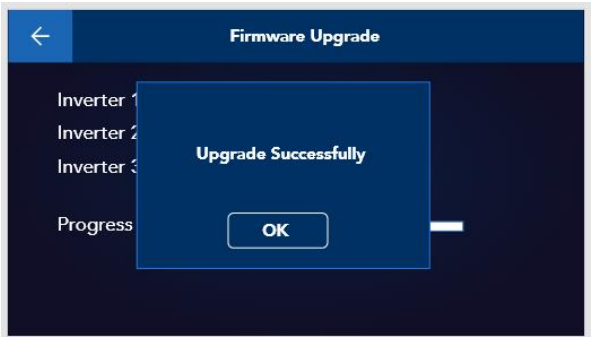
up everything that can be recognized by E4 under the [IDM] folder of the USB flash drive. Select the firmware to be upgraded. Firmware updates are categorized into 'Normal' and 'Advanced.' As illustrated, firmware names containing 'Nor' denote Normal updates, while 'Adv' signifies Advanced updates. When performing an advanced update, the option "Forced Burning" can be selected.



4) Taking the firmware updating of inverter LCDs as an example, this operation will apply to the LCDs of all inverters in the system. The updating progress for each inverter will be displayed on the screen. If the updating task fails, a "Failed" message will appear highlighted in red.



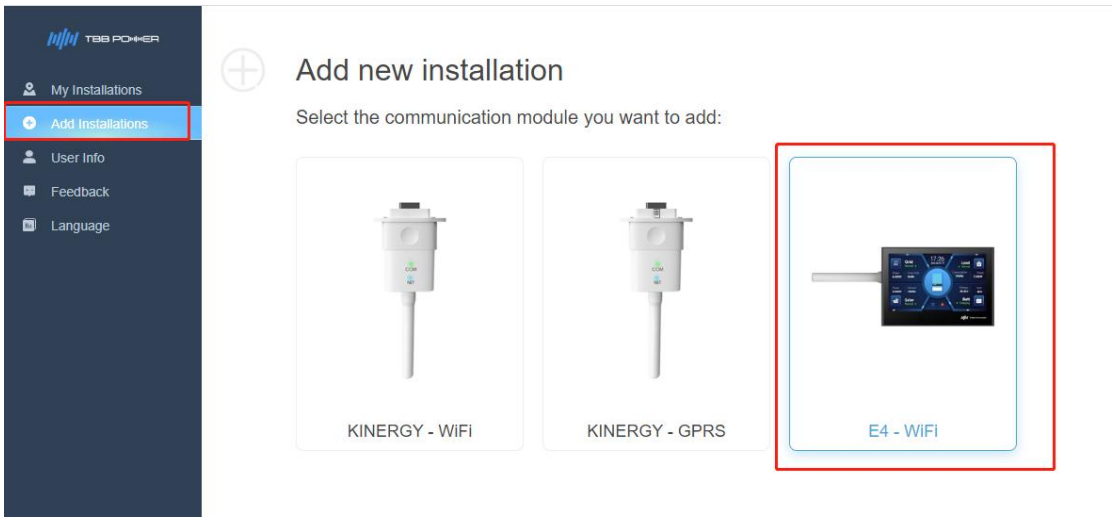
5) A popup window will show up once the upgrade is successfully completed.



5、Nova Connection

After successfully configuring the wireless network for E4, you can proceed with site creation on NOVA Web.

1) Log into NOVA Web, at https://nova.tbbrenewable.com. Click “Add Installations” on the left navigation bar to enter the site creation page. Choose “E4-WiFi” as the communication module;



2) Enter E4's serial number (System Settings->Information->SN)

3) After entering the site name, geographical location, and other information, the site creation will be completed.