

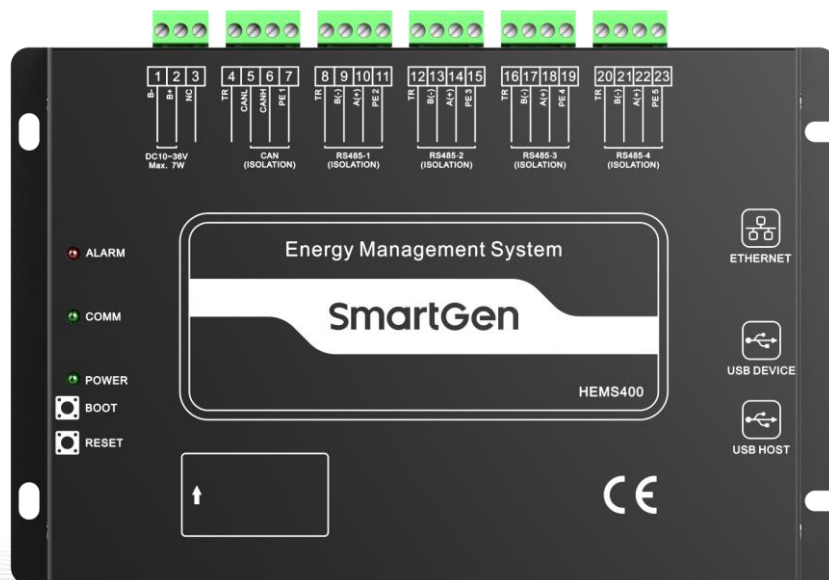
SmartGen

MAKING CONTROL SMARTER

HEMS400

HYBRID ENERGY MANAGEMET SYSTEM

USER MANUAL



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Table 1 Software Version

Date	Version	Note
2024-07-01	1.0	Original release.

Table 2 Symbol Instruction

Symbol	Instruction
 NOTE	Highlights an essential element of a procedure to ensure correctness.
 CAUTION	Indicates a procedure or practice, which, if not strictly observed, could result in damage or destruction of equipment.
 WARNING	Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.

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1 OVERVIEW

HEMS400 Hybrid Energy Management System is used for hybrid energy system consists of solar energy, wind energy, energy storage battery, hydrogen fuel cell, mains supply and diesel genset. It can read and display the data and status of various energies, control the power distribution, customize the control policy and support multiple control modes. The communication protocol is customized by PC, supporting the Modbus or CAN protocol to collect data, and supporting the Modbus slave service to output data. The operation policy or control logic can be written by using the built-in PLC. It is suitable for hybrid energy systems with flexible configuration and easy operation.

2 PERFORMANCE AND CHARACTERISTICS

Its main characteristics are as follows:

- With 4-way RS485 communication port, 1-way CAN port, 1-way Ethernet port;
- The logic programming is available by the built-in PLC, operation mode and scheduling method can be changed;
- Customized communication protocols for PV inverter, energy storage converter and BMS;
- Customized communication protocols when connecting to power expansion module, genset controller and low voltage distribution controller;
- The previous data monitoring can be realized via Ethernet port;
- With USB device port and host port;
- The controller is fixed with metal clips;
- Modular design, pluggable wiring terminals, built-in mounting, compact structure with easy installation.

3 SPECIFICATION

Table 3 Performance Parameter

Item	Content
Working Voltage	DC10.0V~DC36.0V continuous power supply
Overall Consumption	Up to 7W
RS485	4-way RS485 ports adopt MODBUS-RTU communication protocol, isolated, half-duplex, baud rate can be set
Ethernet	Self-adaption 10M/100M/1000Mbps
CAN	Isolated, the maximum communication length is 250m, using Belden 9841 cable or equivalent
Vibration	Frequency Range: 5Hz~8Hz, displacement: $\pm 7.5\text{mm}$ Frequency Range: 8Hz~500Hz, a: $\pm 2\text{g}$ IEC 60068-2-6
Shock	Peak acceleration: 50g, pulse time: 11ms, pulse waveform: half-sine, complete shock test from three directions, and 18 times shock for each test IEC 60068-2-27
Bump	Peak acceleration: 20g, pulse time: 16ms, pulse waveform: half-sine
Production Compliance	According to EN 61010-1 installation category (over voltage category) III, 300V, pollution class 2, altitude 3000m
Overall Dimensions	224mm x 156mm x 41mm
Panel Cutout	The hole spacing is 213mm x 100mm, and the aperture is $\Phi 5.5\text{mm}$
Working Temperature	$(-25\sim+70)^{\circ}\text{C}$
Working Humidity	$(20\sim95)\%\text{RH}$
Storage Temperature	$(-30\sim+80)^{\circ}\text{C}$
Protection Level	Front Panel: IP20
Weight	1.02kg

4 CONFIGURATION AND OPERATION

4.1 QUICKSTART

4.1.1 SOFTWARE DOWNLOAD

Please download and install the configuration software of HEMS400 by SmartGen official website.

4.1.2 CONNECTION SETTING

Using network cable to connect HEMS400 (slave computer) with PC (host computer), click "Setting" of PC, set the IP as "192.168.0.111", and the port number as "8080".

NOTE: The IP addresses of PC network card and the slave computer must be on the same network segment, for example, 192.168.0.10, subnet mask: 255.255.255.0, gateway: 192.168.0.1.

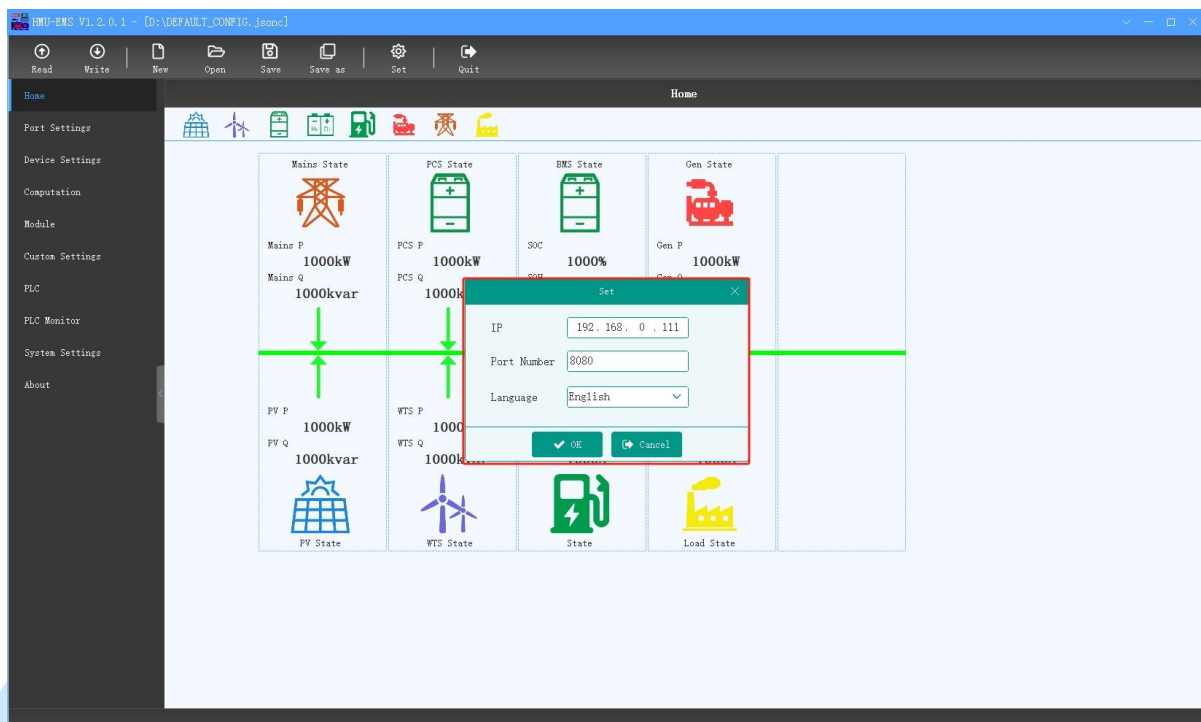


Fig.1 Connection Setting

Click “Read” of PC, it will display “ Read Configuration Completely”, which means that the communication between PC and slave computer is successful.

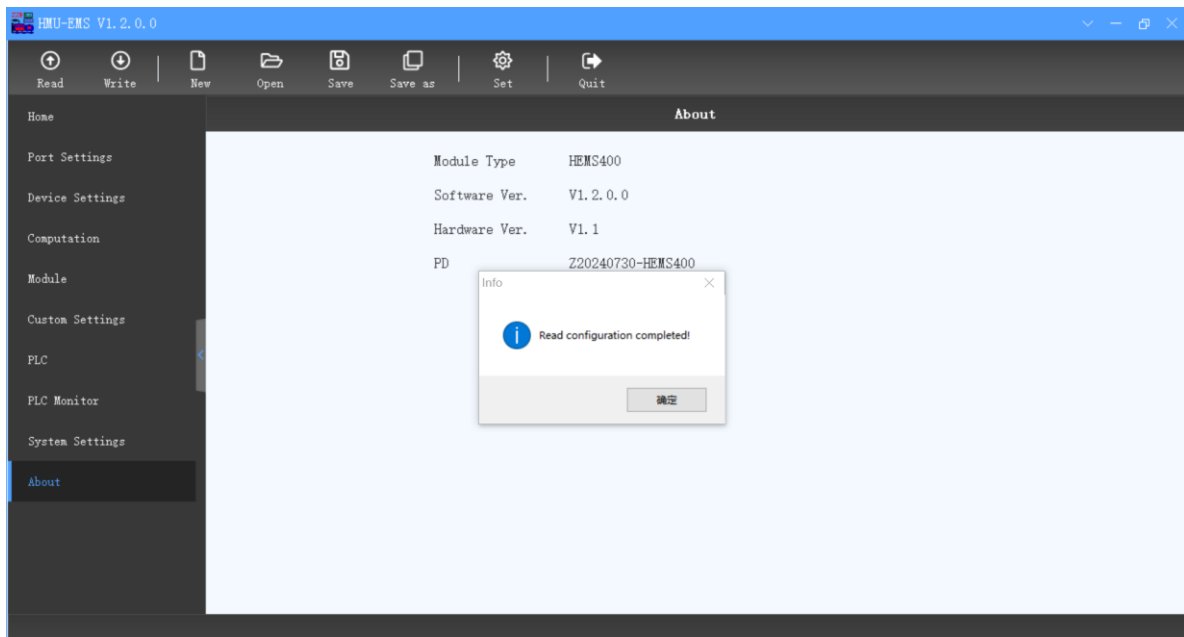


Fig.2 Successful Communication

4.2 PORT SETTING

Modify the port parameters via PC and write the configuration into slave computer, it will take effect.

4.2.1 RS485 PORT SETTING

Enable Status: the port communication is able to be opened and closed.

Baud Rate: 1200bps, 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps are optional, the default is 9600bps.

Data Bit: 8-bit.

Parity Bit: None, odd parity and even parity, default is None.

Stop Bit: 1-bit, 2-bit are optional, default is 1-bit.

Each port can set its baud rate, stop bit and parity bit separately.

4.2.2 ETHERNET PORT SETTING

Eable Status: the port communication is able to be opened and closed.

The default IP address is 192.168.0.111, subnet mask is 255.255.255.0, gateway is 192.168.0.1. They can be modified through PC and take effect after restart.

4.2.3 CAN PORT SETTING

Enable Status: the port communication is able to be opened and closed.

Baud Rate: 10kbps, 20kbps, 50kbps, 100kbps, 125kbps, 250kbps, 500kbps, 800kbps, 1000kbps are optional, the default is 125kbps.

4.3 EXTERNAL DEVICE MANAGEMENT

Each device here corresponds to a real device, which may be photovoltaic inverter, energy storage converter, genset controller, etc. By setting its port, communication address and message, the system

can obtain the real-time data automatically, such as working status, alarm information of the device. At the same time, according to the self-defined PLC logic, the slave computer is able to control the working status of each device, for instance, the power distribution and the start/stop of energy device, closing/opening of circuit breaker, so as to realize the centralized management of whole system.

This section will describe how to configure each external device by wizard mode.

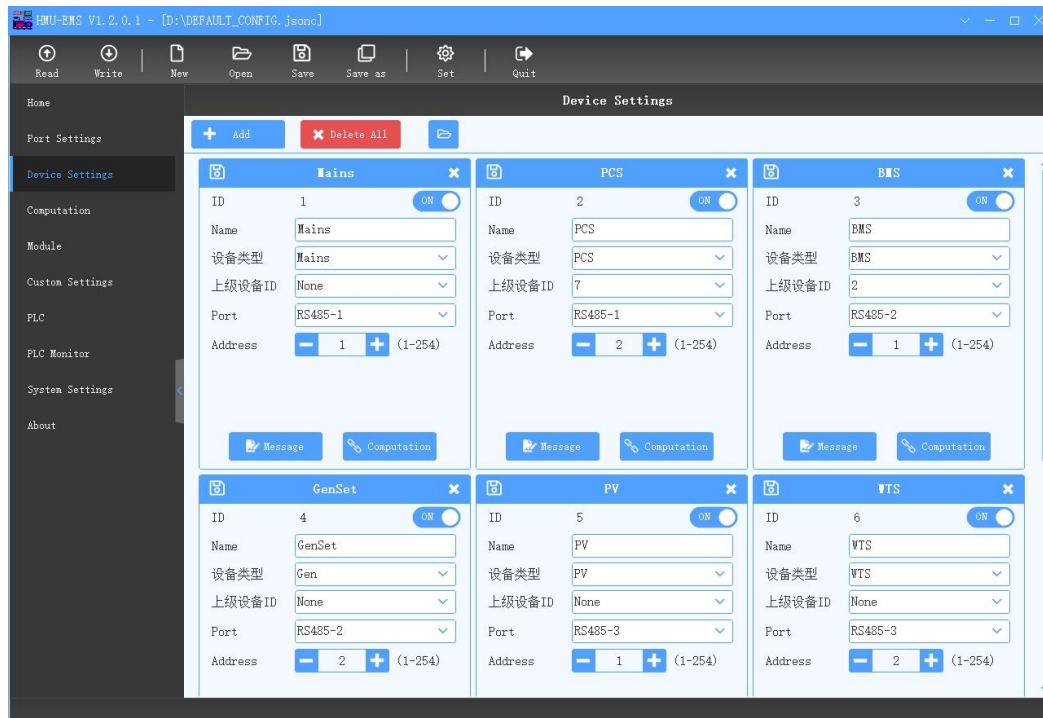


Fig.3 Device Management

4.3.1 ADD DEVICE

Click **+ Add** to add a new device, which may be photovoltaic inverter, energy storage converter, genset controller, etc. Please name each device properly.

Enable Status: the communication of device is able to be opened and closed.

Device Name: You may customize the display name to distinguish different devices.

Device Type: Mains, oil engine, fan, PV, PCS, BMS, load, meter, air conditioner, bus cabinet, liquid cooling, fire control, EMS, expansion input/output port, dehumidifier, etc. are optional.

Upper-level Device ID: ID of the parent device.

Communication Port: Select the communication ports, and the options are: RS485-1, RS485-2, RS485-3, RS485-4, Ethernet port and CAN port.

Module Address: 1-254 is available.

IP: the IP address of the Ethernet port needs to be set and should be on the same network segment as the slave computer.

Port No.: the Ethernet device needs to be set its port number, the default value is 502.

NOTE: Baud rate, data bit, parity bit and stop bit of all devices with same RS485 port must be consistent, while the module address can't be same.

4.3.2 MESSAGE SETTING

Click  to display all polling message of the device. When HEMS400 is running, it will automatically poll to obtain the real-time data of external device based on the message setting.



Fig.4 Message Management

Click  to add polling message for external device, include the function code, communication type (only for Modbus-RTU protocol), register start address, register number and timeout interval.

The polling duration depends on the total number of messages on the access device. When adding messages, minimum polling message (includes all required data bits) is recommended. In this way, the polling interval is reduced and the data real-time is enhanced.

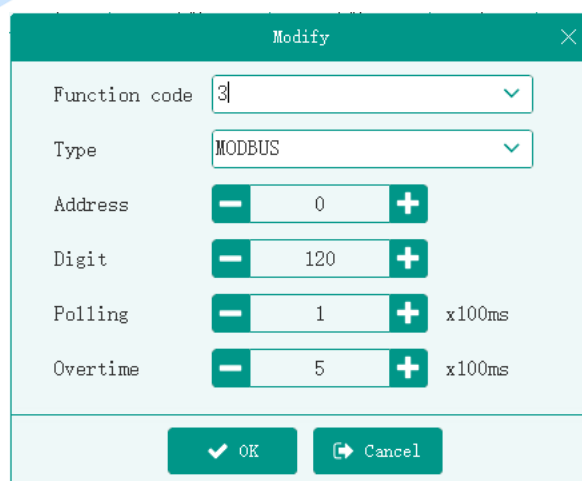


Fig.5 Message Setting

The following is the polling sequence diagram for all devices on the same port:

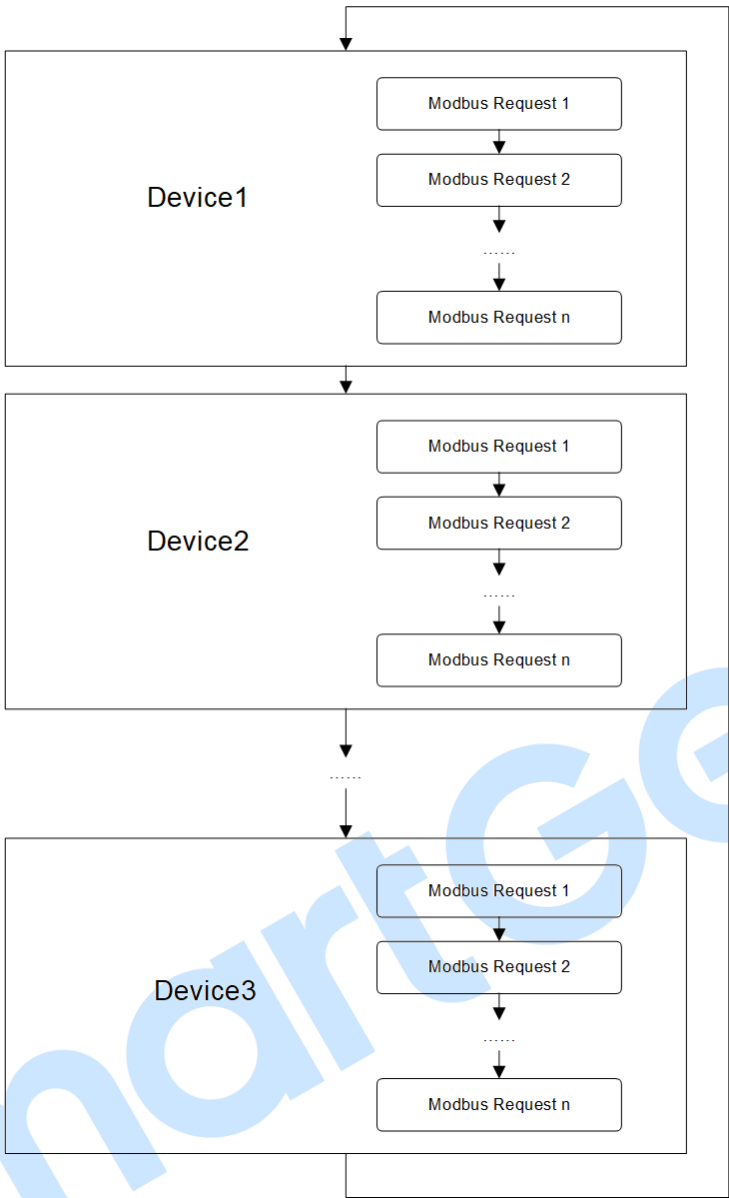


Fig.6 Polling Sequence Diagram

4.3.3 BINDING COMPUTATION

Click [Computation](#) to display all computations bound to the device. Please see more details about the computation in next section.

+ Add ✖ Unbind All												
	Computation	Type	Value	String	Method	Func. code	Address	Start	Digit	Rate	Edit	Unbind
▶	[1]-PV State	String(...)	400	Display	NONE					1	Edit	Unbind
	[2]-PV Alarms	String(...)	0	Display	BOOLEANS_BITS_AB	03	0	0	0	1	Edit	Unbind
	[3]-PV Warnings	String(...)	0	Display	BOOLEANS_BITS_AB	03	0	0	0	1	Edit	Unbind
	[4]-PV Running	Float	0		UINT_BITS_AB	03	0	0	0	1	Edit	Unbind
	[5]-PV Common Alarm	Float	0		UINT_BITS_AB	03	0	0	0	1	Edit	Unbind
	[6]-PV Common Warning	Float	0		UINT_BITS_AB	03	0	0	0	1	Edit	Unbind
	[8]-PV Direction	Float	0		UINT_BITS_AB	03	0	0	0	1	Edit	Unbind
	[9]-PV Stopped	Float	0		UINT_BITS_AB	03	0	0	0	1	Edit	Unbind
	[10]-PV Generation Today	Float	0		UINT32_ABCD	03	0			1	Edit	Unbind
	[11]-PV Total Power Generation	Float	0		UINT32_ABCD	03	0			1	Edit	Unbind
	[12]-PV Active Power	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[13]-PV Reactive Power	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[14]-PV Power Factor	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[15]-PV DC1 Voltage	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[16]-PV DC1 Current	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[17]-PV DC1 Power	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[18]-PV DC2 Voltage	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[19]-PV DC2 Current	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[20]-PV DC2 Power	Float	0		INT16_AB	03	0			1	Edit	Unbind
	[21]-PV AC-L1 Voltage	Float	0		INT16_AB	03	0			1	Edit	Unbind

✓ OK

Fig.7 Device Computation

Click

+ Add

 to add a computation to be bound with the device, only the computations that are not bound to any device can be selected.

ID	Name	Type	Value	String	Method	Func. code	Address	Start	Digit	Rate	Binding device
▶ 1	PV State	String(...)	400	Display	NONE					1	PV
2	PV Alarms	String(...)	0	Display	BOOLEANS_BITS_AB	03	0	0	0	1	PV
3	PV Warnings	String(...)	0	Display	BOOLEANS_BITS_AB	03	0	0	0	1	PV
4	PV Running	Float	0		UINT_BITS_AB	03	0	0	0	1	PV
5	PV Common Alarm	Float	0		UINT_BITS_AB	03	0	0	0	1	PV
6	PV Common Warning	Float	0		UINT_BITS_AB	03	0	0	0	1	PV
8	PV Direction	Float	0		UINT_BITS_AB	03	0	0	0	1	PV
9	PV Stopped	Float	0		UINT_BITS_AB	03	0	0	0	1	PV
10	PV Generation Today	Float	0		UINT32_ABCD	03	0			1	PV
11	PV Total Power Genera...	Float	0		UINT32_ABCD	03	0			1	PV
12	PV Active Power	Float	0		INT16_AB	03	0			1	PV
13	PV Reactive Power	Float	0		INT16_AB	03	0			1	PV
14	PV Power Factor	Float	0		INT16_AB	03	0			1	PV
15	PV DC1 Voltage	Float	0		INT16_AB	03	0			1	PV
16	PV DC1 Current	Float	0		INT16_AB	03	0			1	PV
17	PV DC1 Power	Float	0		INT16_AB	03	0			1	PV
18	PV DC2 Voltage	Float	0		INT16_AB	03	0			1	PV
19	PV DC2 Current	Float	0		INT16_AB	03	0			1	PV
20	PV DC2 Power	Float	0		INT16_AB	03	0			1	PV
21	PV AC-L1 Voltage	Float	0		INT16_AB	03	0			1	PV
22	PV AC-L2 Voltage	Float	0		INT16_AB	03	0			1	PV

✓ Select

✖ Cancel

Fig.8 Computation Selection

After binding, the value of the computation can be obtained through the real-time data calculation of the device according to the set calculation method, or through the mutual calculation among the computation, settings and internal variables according to the internal PLC logic.

The relationship among external device, real-time data and computation is shown as follows:

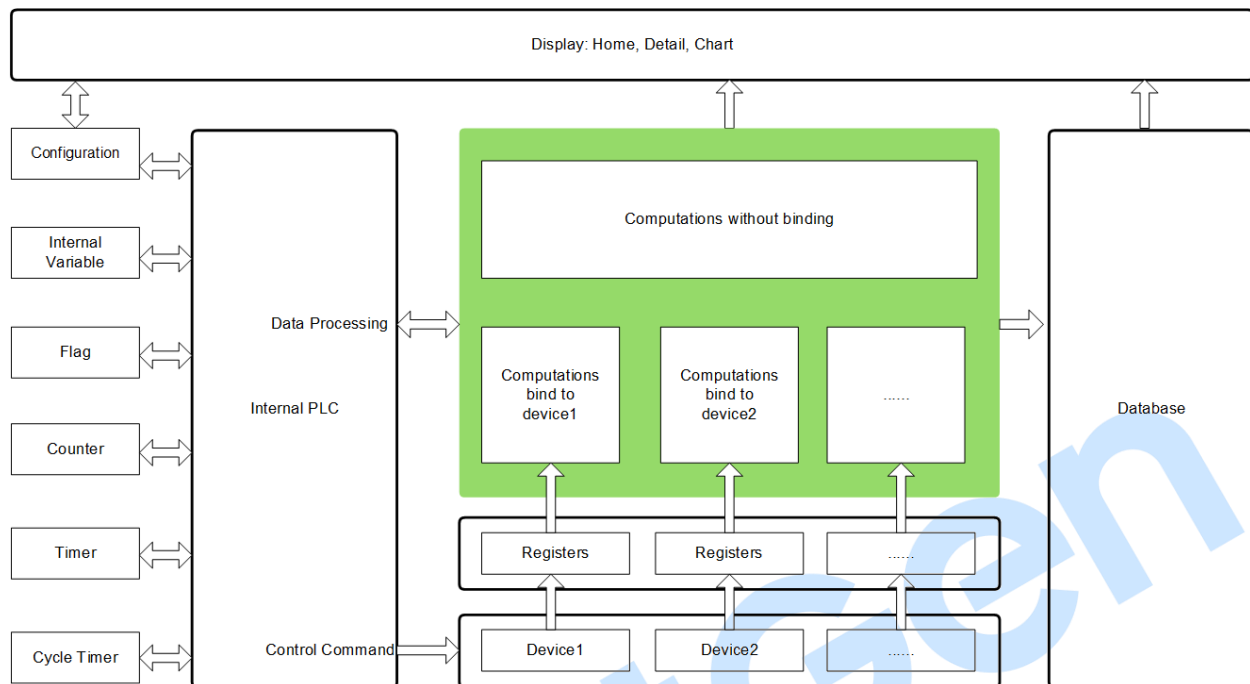


Fig.9 Software Frame

4.4 COMPUTATION MANAGEMENT

4.4.1 ILLUSTRATION

As a bridge between external device and HEMS400, computation is the data mapping of external physical device, the data source of HEMS400, and the data center of the whole energy management system.

According to the binding relationship between computation and the device, the related configuration of computation, the computation can be calculated and assigned by the real-time data of the device or by the internal PLC logic calculation. The computation may not involved in any calculations. The value can be output externally via the Modbus slave service, or participate in the PLC logic calculation, or provide data source for database.

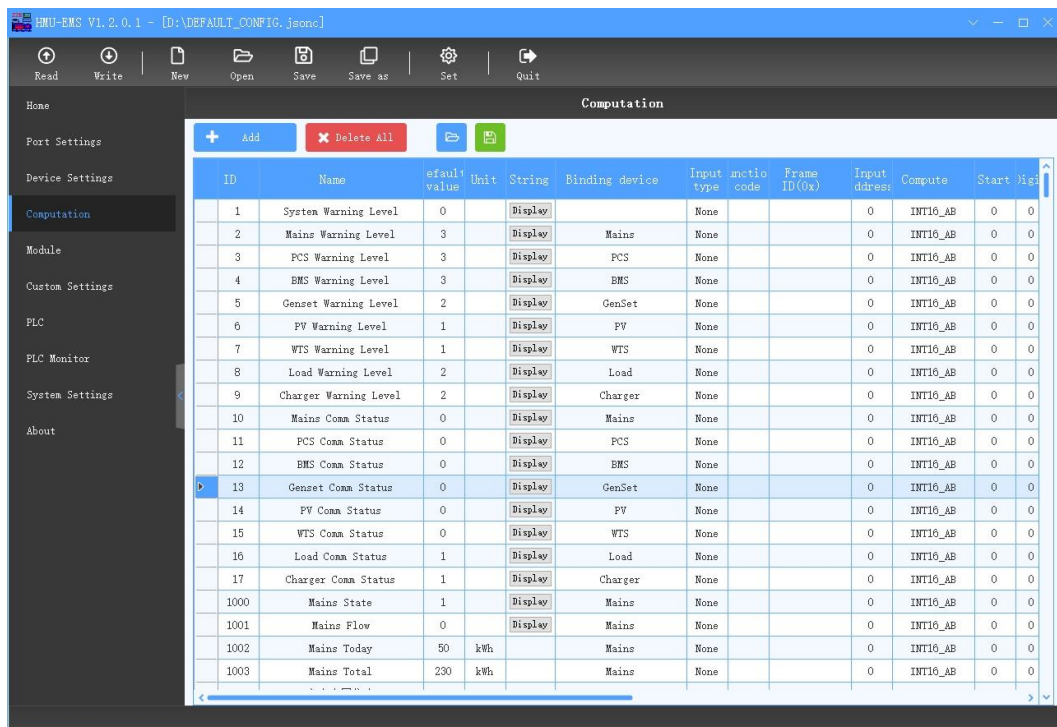


Fig.10 Computation Management

4.4.2 ADD COMPUTATION

Click **+ Add** to add computation, the system will assign a unique serial number automatically. Click "Edit" to modify the computation name (Both Chinese and English), type, default value, calculation method, address (decimalism), etc. Click "Delete" to delete the computation, and the serial number of the computation can't be used again.

The name of the computation must be unique. In addition, the type and calculation method of the computation should be correctly configured. Otherwise, the correct value cannot be calculated. For more details of the configuration about the type and calculation method, see the following section.

Fig.11 Add Computation

4.4.3 COMPUTATION INPUT TYPE

It is the internal computation when the input type is None, and assigned by internal PLC. If the input type is Modbus, the computation is collected by Modbus protocol; while the computation is collected by CAN communication for CAN type. The calculation method is shown as the table below:

Table 4 Calculation Method

Method	Description	Example
UINT_BITS_AB	Get an unsigned 16-bit integer of multiple bits	Hexadecimal: 0xFEFC Binary: MSB 1111 1110 1111 1100 LSB Cut 3 bits from the first bit 0x110 => 6
UINT_BITS_BA	Get an unsigned 16-bit integer of multiple bits	Hexadecimal: 0xFCFE Binary: MSB 1111 1110 1111 1100 LSB Cut 3 bits from the first bit 0x110 => 6
INT8_A_AB	Get a signed 8-bit integer of pre-byte	"FEFC" ==> -2
INT8_B_AB	Get a signed 8-bit integer of post-byte	"FEFC" ==> -4
UINT8_A_AB	Get a signed 8-bit integer of pre-byte	"FEFC" ==> 254
UINT8_B_AB	Get a signed 8-bit integer of post-byte	"FEFC" ==> 252
INT16_AB	Get a signed 16-bit integer of AB	"FEFC" ==> -260

Method	Description	Example
	sequence	
INT16_BA	Get a signed 16-bit integer of BA sequence	"FEFC" ==> -770
UINT16_AB	Get an unsigned 16-bit integer of AB sequence	"FEFC" ==> 65276
UINT16_BA	Get an unsigned 16-bit integer of BA sequence	"FEFC" ==> 64766
INT32_ABCD	Get a signed 32-bit integer of ABCD sequence	"FEDCBAFF" => -19088641
INT32_DCBA	Get a signed 32-bit integer of DCBA sequence	"FEDCBAFF" => -4530946
INT32_BADC	Get a signed 32-bit integer of BADC sequence	"FEDCBAFF" => -587268166
INT32_CDAB	Get a signed 32-bit integer of CDAB sequence	"FEDCBAFF" => -1157628196
UINT32_ABCD	Get an unsigned 32-bit integer of ABCD sequence	"FEDCBAFF" => 4275878655
UINT32_DCBA	Get an unsigned 32-bit integer of DCBA sequence	"FEDCBAFF" => 4290436350
UINT32_BADC	Get an unsigned 32-bit integer of BADC sequence	"FEDCBAFF" => 3707699130
UINT32_CDAB	Get an unsigned 32-bit integer of CDAB sequence	"FEDCBAFF" => 313733910
FLOAT32_ABCD	Get 32-bit floating-point number of ABCD sequence	"FEDCBAFF" => -1.4670055E38
FLOAT32_DCBA	Get 32-bit floating-point number of DCBA sequence	"0080C842" => 100.25
FLOAT32_BADC	Get 32-bit floating-point number of BADC sequence	"FEDCBAFF" => -5.7420655E17
FLOAT32_CDAB	Get 32-bit floating-point number of CDAB sequence	"FEDCBAFF" => -0.001953091

4.4.4 COMPUTATION OUTPUT TYPE

The output type can be selected as required. -1 indicates no output, and 0~65535 indicates the output address.

If the computation value or setting value is 150, the output rate is 0.1 and the offset is -30, then the external host reads the register as $[150 - (-30)] / 0.1 = 1800$.

If the input rate is 1 and the offset is 0, while the output rate is 1 and the offset is 0, the data is transparent transmission, and the accuracy of the original data is not lost.

4.5 SETTING MANAGEMENT

Settings are the supplement to the computation, the values can be saved after a power failure, which can be used to save the coefficient, threshold, status, etc. It can take part in the PLC logic operation and output by Modbus slave service.

The functional-related settings can be put in the same group when adding. Click “Edit” to modify the name, type, default value, permission, unit of the settings, and click “Delete” to delete the computation.

The setting value can be assigned by PLC logic operation, or modified by PC. The figure of PC setting screen is shown as follows:

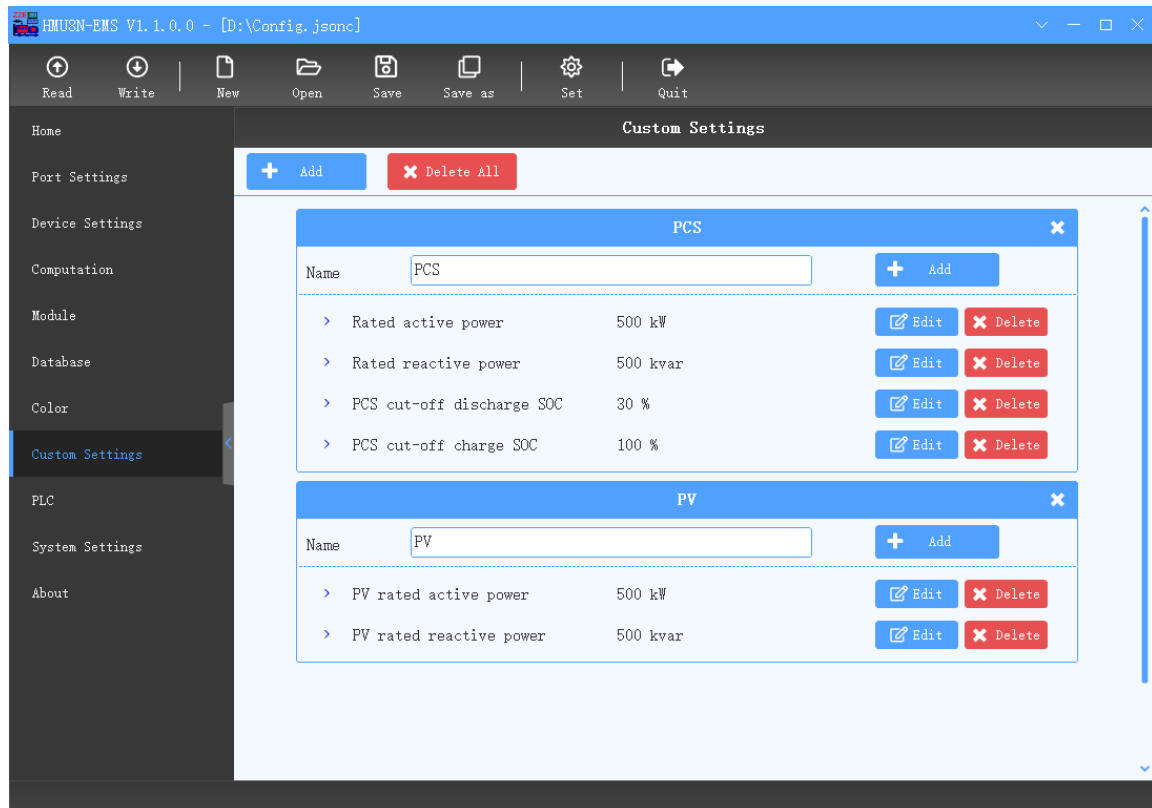


Fig.12 Setting Management (PC)

4.5.1 ALARM SETTING

1. Either of the computation or settings can be configured with string list;
2. The string list can add multiple items and each item can be configured alarm names, RMS, levels;
3. When the values of computation or settings are equal to the RMS, the configured alarm will be active and the setting level is the alarm level;
4. If the level is not set or the level is set to 0, this item is not an alarm.

4.6 PLC INTRODUCTION

4.6.1 ILLUSTRATION

As the introduction of the above section, after the communication establishment between PC and external device, the real-time data is obtained continuously, including various parameters, running status, alarm information, etc, which is converted into the computation and displayed on slave computer to realized the remote monitoring of the external device.

Through the PLC logic operation, the computation, internal variables and settings can be converted to each other to control the display of the slave computer, and can send to the external device the Modbus request to realize the remote control of external device, which is more flexible and convenient to meet the business requirements.

4.6.2 PLC EDITING INTERFACE

PLC editing interface is divided into condition area, action area, setting area and logic editing area, as shown below:

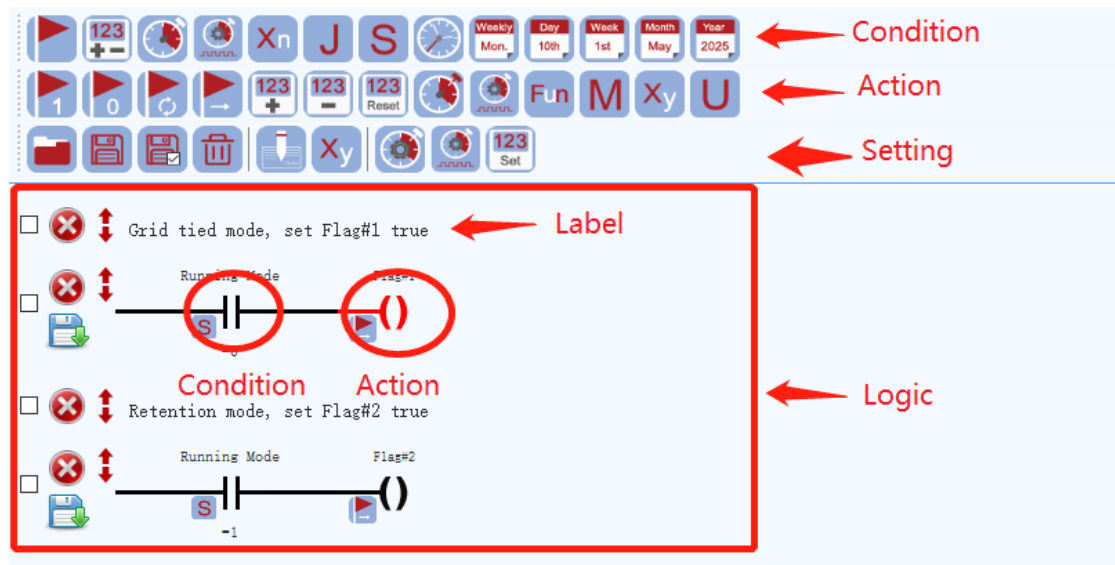
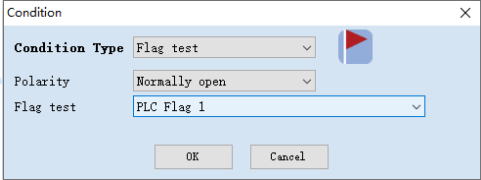
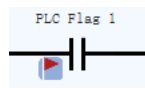
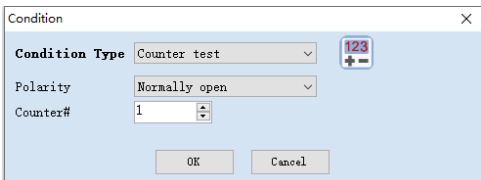
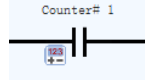
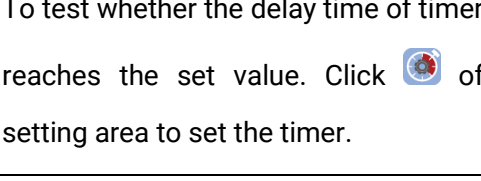
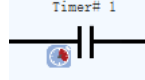


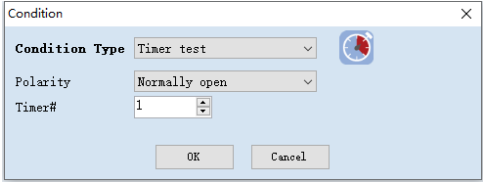
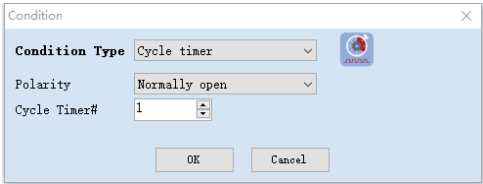
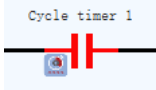
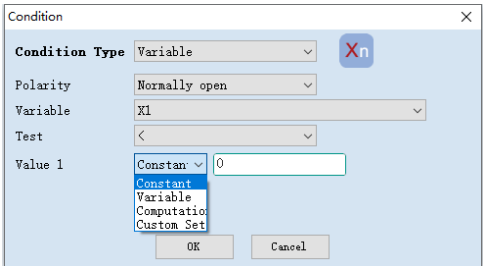
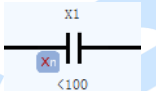
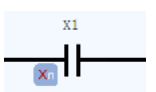
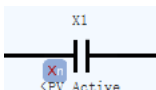
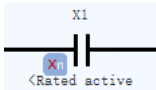
Fig.13 PLC Editing Interface

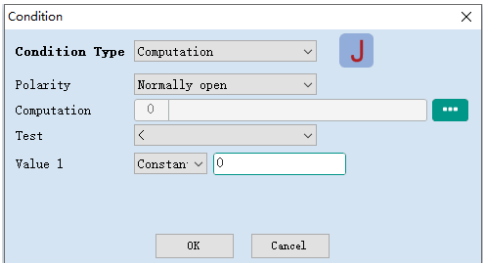
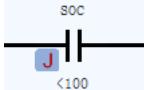
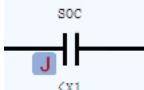
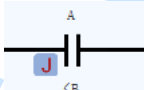
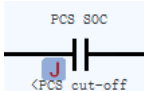
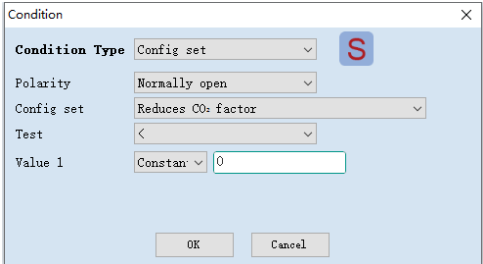
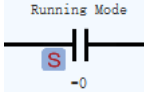
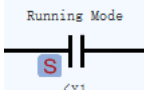
4.6.3 CONDITION AREA ELEMENTS

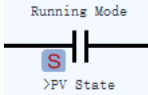
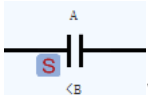
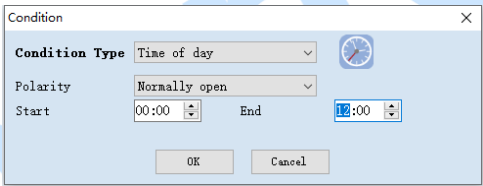
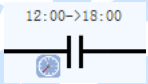
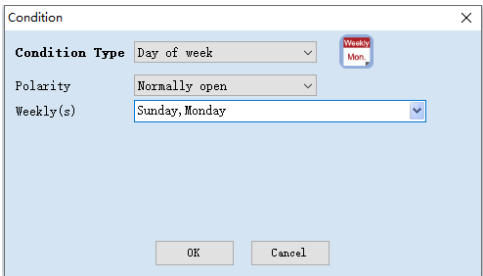
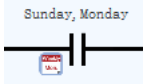
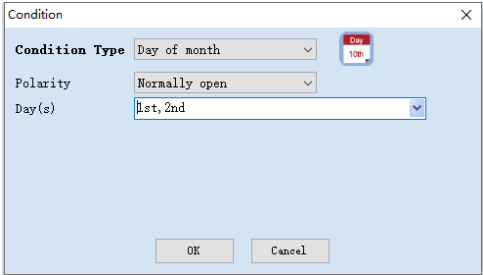
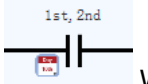
Drag the corresponding condition icon to the logic editing area for logical editing. The elements of condition area are shown as the following table:

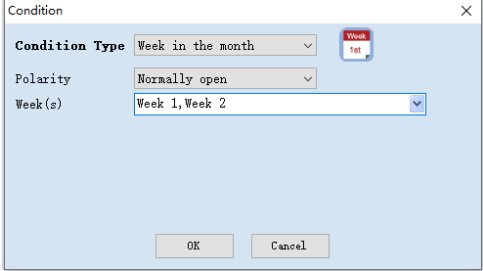
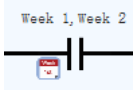
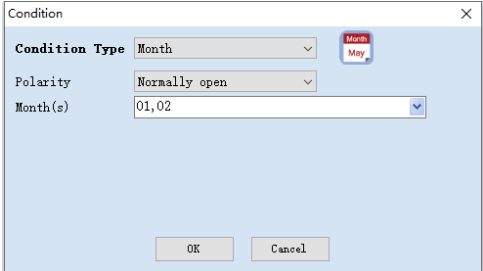
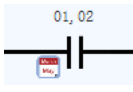
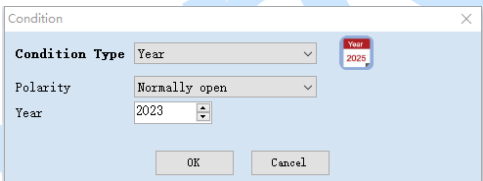
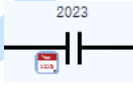
Table 5 Elements of PLC Condition Area

Icon	Condition Name	Description	Example
	Flag	To test whether the flag is valid. 	 When Flag 1 is true, condition is valid; otherwise the condition is invalid.
	Counter	To test whether the counter value reaches the set value. Click  of the setting area to set the counter. 	 When the value of Counter 1 reaches the set value, condition is valid; otherwise the condition is invalid.
	Timer	To test whether the delay time of timer reaches the set value. Click  of setting area to set the timer. 	 When the delay time of Timer 1 reaches the set value, condition is valid,

Icon	Condition Name	Description	Example
			otherwise the condition is invalid.
	Cycle Timer	To test whether the cycle timer and positive pulse reach the set value. Click  of setting area to set the value of cycle timer. 	 When the delay time of Cycle Timer 1 is less than the set value of positive pulse time, condition is valid; otherwise the condition is invalid.
	Internal Variable	To test whether the internal variable meets the set conditions, and can be compared with the internal variable, settings, computation, constant in pairs. 	 When internal variable X1 is less than constant 100, condition is valid; otherwise condition is invalid.  When internal variable X1 is less than the value of X2, condition is valid; otherwise the condition is invalid.  When internal variable X1 is less than the total active power value of computation, condition is valid; otherwise the condition is invalid.  When internal variable X1 is less than the charging power value of custom setting, condition is valid; otherwise the condition is invalid.

Icon	Condition Name	Description	Example
	Computation	To test whether the computation meets the set conditions, floating-point type and string (value) type are supported, and can be compared with the internal variable, settings, computation, constant in pairs. 	 When the value of computation SOC is less than the constant 100, condition is valid; otherwise the condition is invalid.  When the value of computation SOC is less than the value of internal variable X1, condition is valid; otherwise the condition is invalid.  When the value of computation A is less than the value of computation B, condition is valid; otherwise the condition is invalid.  When the value of computation SOC is less than charge SOC value, condition is valid; otherwise the condition is invalid.
	Setting	To test whether the setting is meet the set conditions, and can be compared with the internal variable, settings, computation, constant in pairs. 	 When the value of running mode is equal to the constant value 0, condition is valid; otherwise the condition is invalid.  When the value of running mode is less than the value of internal variable X1, condition is valid; otherwise the condition is invalid.

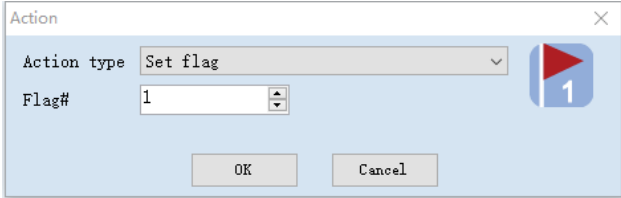
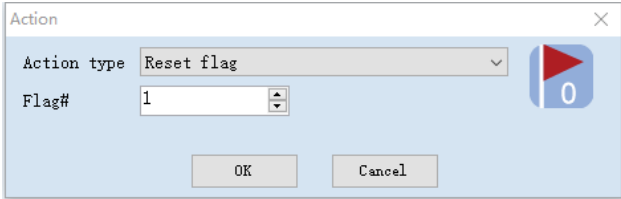
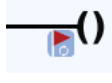
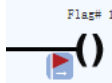
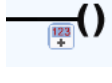
Icon	Condition Name	Description	Example
			 When the value of running mode is greater than the value of genset status, condition is valid; otherwise the condition is invalid.  When the value of setting A is less than the value of setting B, condition is valid; otherwise the condition is invalid.
	Time	To test whether the current time meets the specific time period of setting, including start time, but not the end time. The start time should be earlier than the end time, and both of them should be on the same day. 	 When the time of slave computer is between 12:00 and 18:00, condition is valid; otherwise the condition is invalid.
	Week	To test whether the time of the day meets the condition of the specific day. 	 When the day of slave computer is Sunday or Monday, condition is valid; otherwise the condition is invalid.
	Date	To test whether the current date meets the condition of specific date. 	 When the date of slave computer is the first or second day of each month, condition is valid; otherwise the condition is invalid.

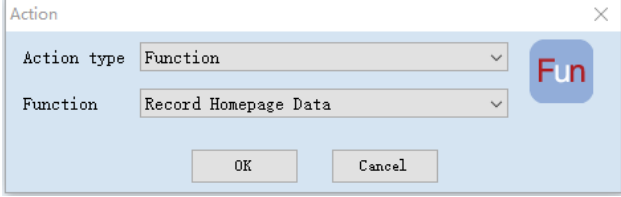
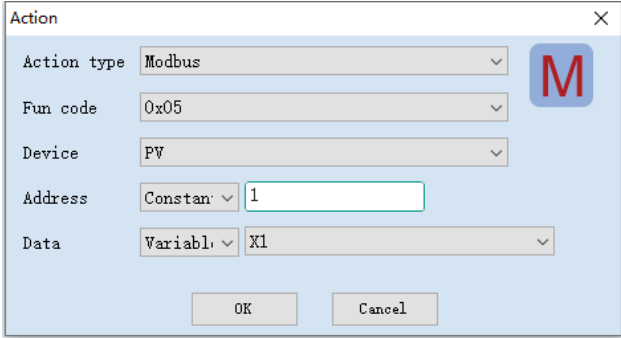
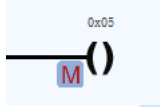
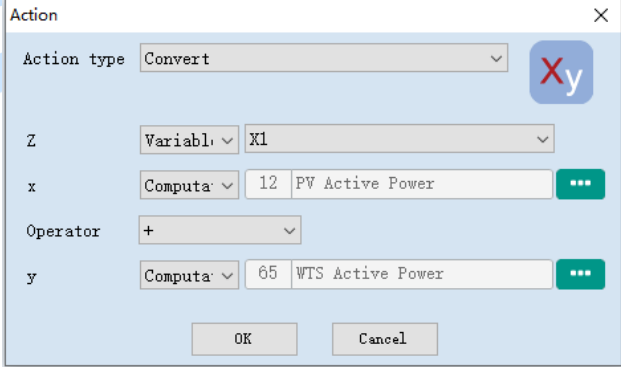
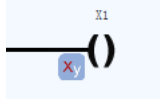
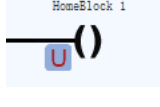
Icon	Condition Name	Description	Example
	Week No.	To test whether the number of current week of a month meets the set number condition. 	 When the date of slave computer is the first or second week of each month, condition is valid; otherwise the condition is invalid.
	Month	To test whether the current month meets the set month condition. 	 When the month of slave computer is Jan. or Feb., condition is valid; otherwise the condition is invalid.
	Year	To test whether the current year meets the set year condition. 	 When the year of slave computer is 2023, condition is valid; otherwise the condition is invalid.

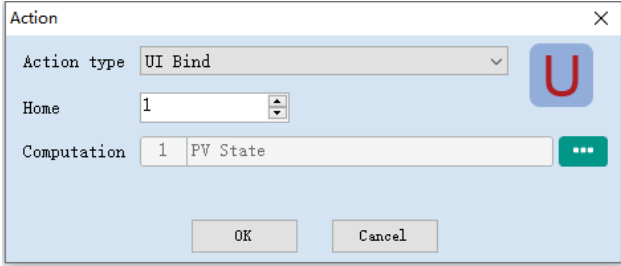
4.6.4 ACTION AREA ELEMENTS

Drag the corresponding action icon to the logic editing area for logical editing. The logic condition can have multiple logic actions.

Table 6 Elements of PLC Action Area

Icon	Action Description	Example
	Action: Set flag to 1. Trigger Mode: Triggered when condition is valid. 	 Act when condition is valid: set flag to 1; act when condition is invalid: flag keeps the original state.
	Action: Set flag to 0. Trigger Mode: Triggered when condition is valid. 	 Act when condition is valid: set flag to 0; act when condition is invalid: flag keeps the original state.
	Action: Toggle flag (if the original flag is 1, it turns to 0; if the original flag is 0, it turns to 1.). Trigger Mode: Triggered when condition changes from invalid to valid (edge trigger). 	 Act when condition changes from invalid to valid: toggle flag.
	Action: Drive flag (set flag to 1 when condition is active; set flag to 0 when condition is invalid). Trigger Mode: Triggered when condition are valid and invalid. 	 Act when condition is valid: set flag to 1; act when condition is invalid: set flag to 0.
	Action: Add 1 to the counter. Trigger Mode: Triggered when condition changes from invalid to valid (edge trigger).	 Act when condition changes from invalid to valid: counter increases by 1.

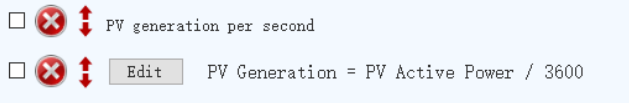
Icon	Action Description	Example
		function when condition is valid. Optional functions include: 1)Record the homepage data, and the minimum recording interval is 500ms 2)Turn on the buzzer and the alarm indicator is flashing 3) Turn off the buzzer and the alarm indicator is distinguished.
	Action: Send the Modbus request to external device. Trigger Mode: Triggered when condition changes from invalid to valid(edge trigger).  Optional Function Code: 0x05, 0x06, 0x10. Address and data can be filled in constant, or use the computation, settings , internal variable value (floating-point is strongly converted to integer).	 Send the Modbus request to external device when condition changes from invalid to valid.
	Action: numerical conversion and conversions among computation, internal variable and settings in pairs. Trigger Mode: Triggered when condition is valid.  X, Y are parameters, Z is the output value, X, Y, Z are floating-point types.	 Conversions among computation, internal variable and settings in pairs when condition is valid.
	Action: Interface binding, to change the computation bound to the homepage energy flow. Trigger Mode: Triggered when condition is valid.	 Change the computation bound to the energy flow of homepage when the condition is

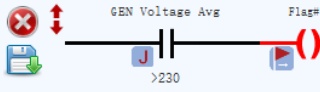
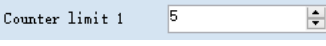
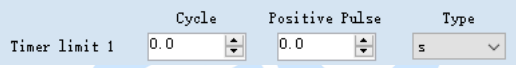
Icon	Action Description	Example
	 The homepage is the sequence number of energy flow, see section 4.2.7.3.	valid.

4.6.5 SETTING AREA ELEMENTS

It can open, save, delete the PLC configuration, add label and variable change, set counter, timer and cycle timer.

Table 7 Elements of PLC Setting Area

Icon	Description	Example
	Open: Click the icon to open the edited PLC file.	
	Save: Save all the logic editing areas to PLC file.	
	Selected Save Save the selected logic code to PLC file.	
	Clear: Clear the logic editing area.	
	Save the Single Line: Save the PLC logic of the line to PLC file.	
	Move: Drag up and down to change the position of the PLC logic in the whole PLC logic.	
	Delete: Delete the line.	
	Label: Drag the icon to logic editing area for labeling. Save the comments or notes about the PLC logic in this section.	 As shown in the red box.

Icon	Description	Example
	Numerical Conversion: Drag the icon to logic editing area for adding the conversions among computation, internal variable and settings in pairs.	☐   $X1 = \text{GEN AC-L1 Voltage} + \text{GEN AC-L2 Voltage}$ ☐   $X2 = X1 + \text{GEN AC-L3 Voltage}$ ☐   $\text{GEN Voltage Avg} = X2 / 3$  X1 and X2 are internal variables, Gen Ua, Gen Ub, Gen Uc and average voltage are computations.
	Counter Setting: Click icon to set the counter, and there are 100 built-in counters.	 Set the upper limit times of Counter 1 is 5.
	Timmer Setting: Click the icon to set the timer, and there are 100 built-in timers, the type can be s or min.	 Set the delay time of Time 1 as 10.0s.
	Cycle Timer Setting: Click the icon to set the cycle timer, there are 100 built-in cycle timers, the type can be s or min.	 Set the cycle time of the timer as 10.0s, and the positive pulse as 1s.

4.6.6 LOGIC INTRODUCTION

4.6.6.1 "OR" LOGIC

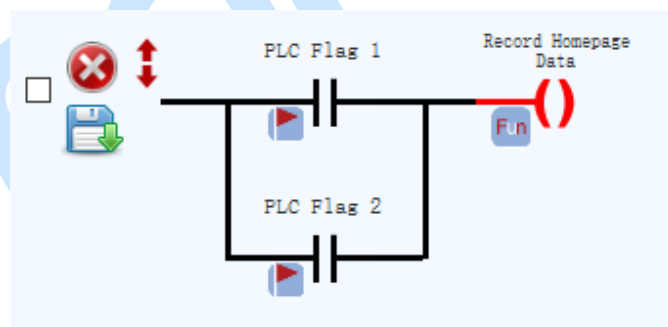


Fig.14 "OR" Logic

When flag 1 is true or flag 2 is true, perform the function.

4.6.6.2 "AND" LOGIC

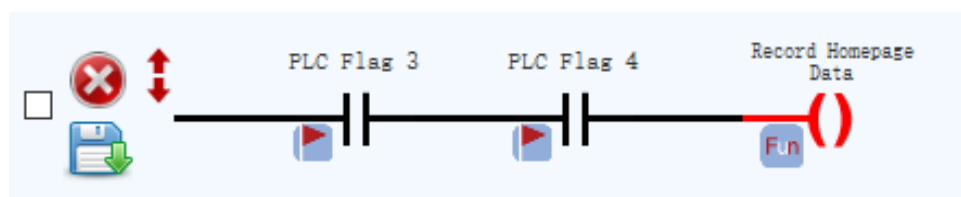


Fig.15 "AND" Logic

When flag 3 is true and flag 4 is true, perform the function.

4.6.6.3 "NOT" LOGIC



Fig.16 "Not" Logic

When flag 5 is false, perform this function.

4.6.6.4 COMBINATION LOGIC

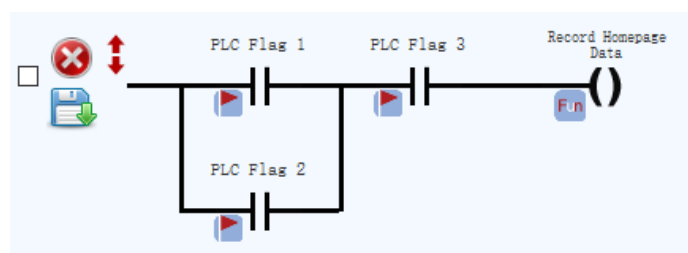


Fig.17 Combination Logic

In the state when flag 3 is true, flag 1 is true or flag 2 is true, perform this function.

4.6.7 APPLICATION EXAMPLES

Suppose the service logic is as follows: system is composed of PV1, PCS1, BMS1, Mains 1, Wind 1, Load 1.

Grid-tied Running

In grid-tied operation, PV and wind energy are always at the highest power generation.

Safety Power Running Mode

The goal is to make the energy storage as the backup power supply, which could support a maximum power supply time during the whole micro-grid is in off-grid running mode due to the failure of external power grid.

Table 8 Safety Power Mode

SOC $\geq$ 98%	SOC $<$ 95%
PCS stop charging	PCS start charging

Zero-carbon Economy Running Mode

The goal is to use PV, wind, storage energy as the clear energy to the fullest and to supply power for load at the demand.

If the total output of the three energy sources is less than the load, the differential load will be supplied by external grid. Meanwhile, considering the sharp, peak, valley and flat hours of the power price, the charge and discharge of energy storage will be economically scheduled to realize the zero-carbon economy running of the system.

Table 9 Zero-carbon Economy Mode

	PV + Wind Energy >= Load		PV + Wind Energy < Load	
	SOC >= 95%	SOC < 95%	SOC > 10%	SOC <= 10%
Valley Power 2:00-4:00 11:00-17:00	Excess power is connected to the grid.	Charging: The charging power is the excess power.	Discharging: The discharging power is the load power – PV power – wind power	No charging and discharging.
Flat Power 0:00-2:00 4:00-7:00 10:00-11:00 17:00-18:00				
Peak Power 7:00-10:00 18:00-24:00				
Uniform Recharge 16:00-17:00				
	SOC < 40%, full power 100kW charge; SOC >= 40%, No recharge.			

Off-grid Running

The off-grid mode operation only happens during special circumstances (such as trips of external grid maintenance power failure, overcurrent, short circuit, voltage loss protection)

Table 10 Off-grid Mode

PV + Wind Energy $\geq$ Load		PV + Wind Energy < Load	
SOC $\geq$ 98%	SOC < 98%	SOC > 10%	SOC $\leq$ 10%
Limited power generation, first to limit the wind energy, then to limit the PV.	Charging: Full power generation of PV and wind energy	Discharging: Full power generation of PV and wind energy	Storage energy at rest, and the whole system is power off.

The PLC logic figure is shown as below:

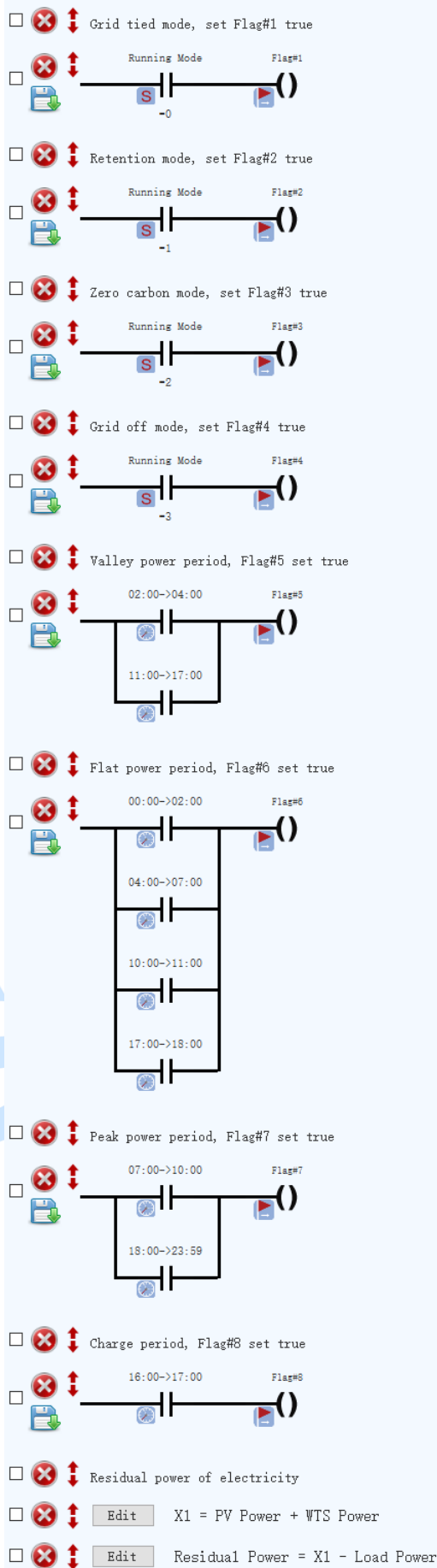


Fig.18 PLC Logic Example (Part 1)

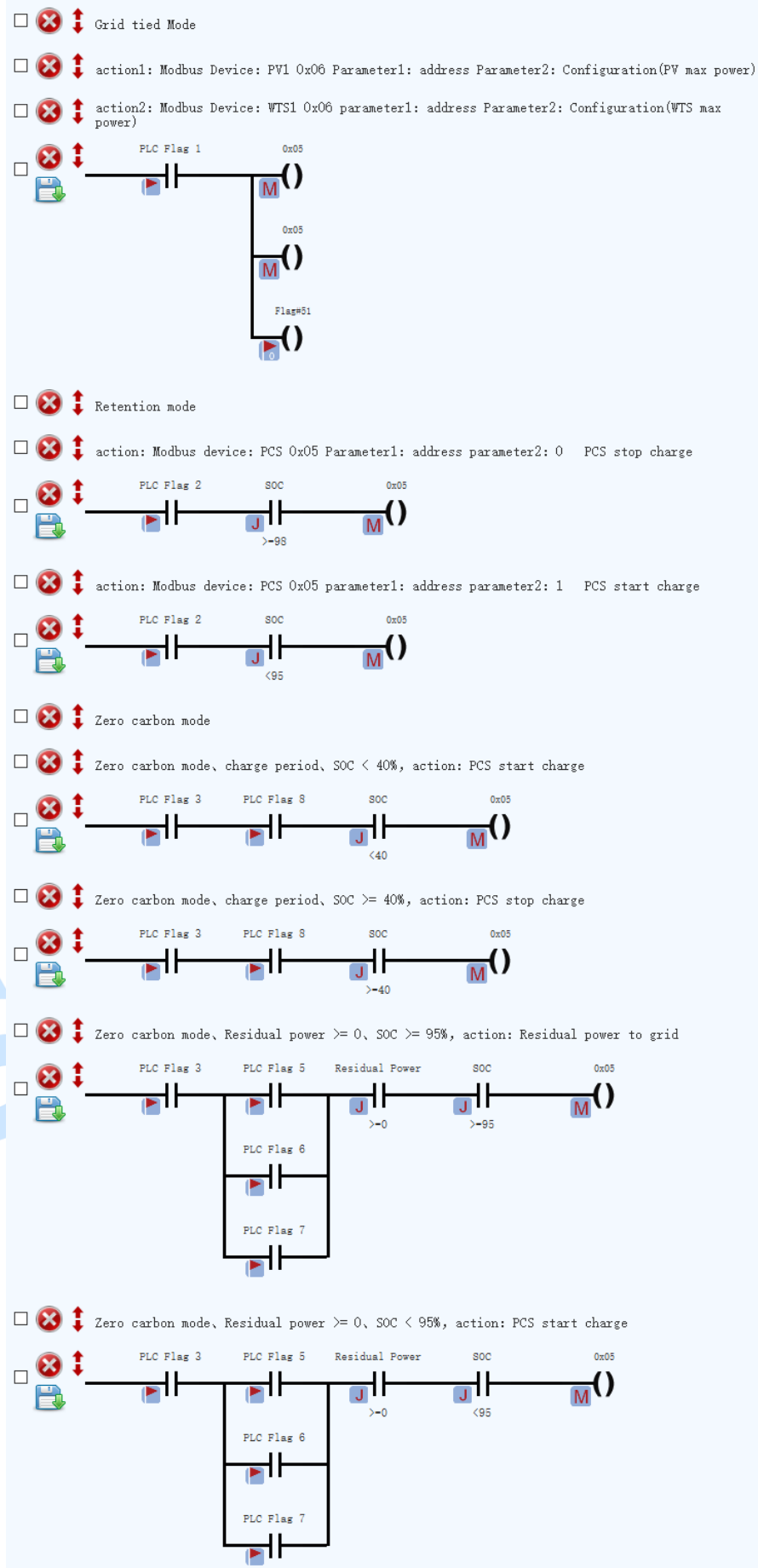


Fig.19 PLC Logic Example (Part 2)

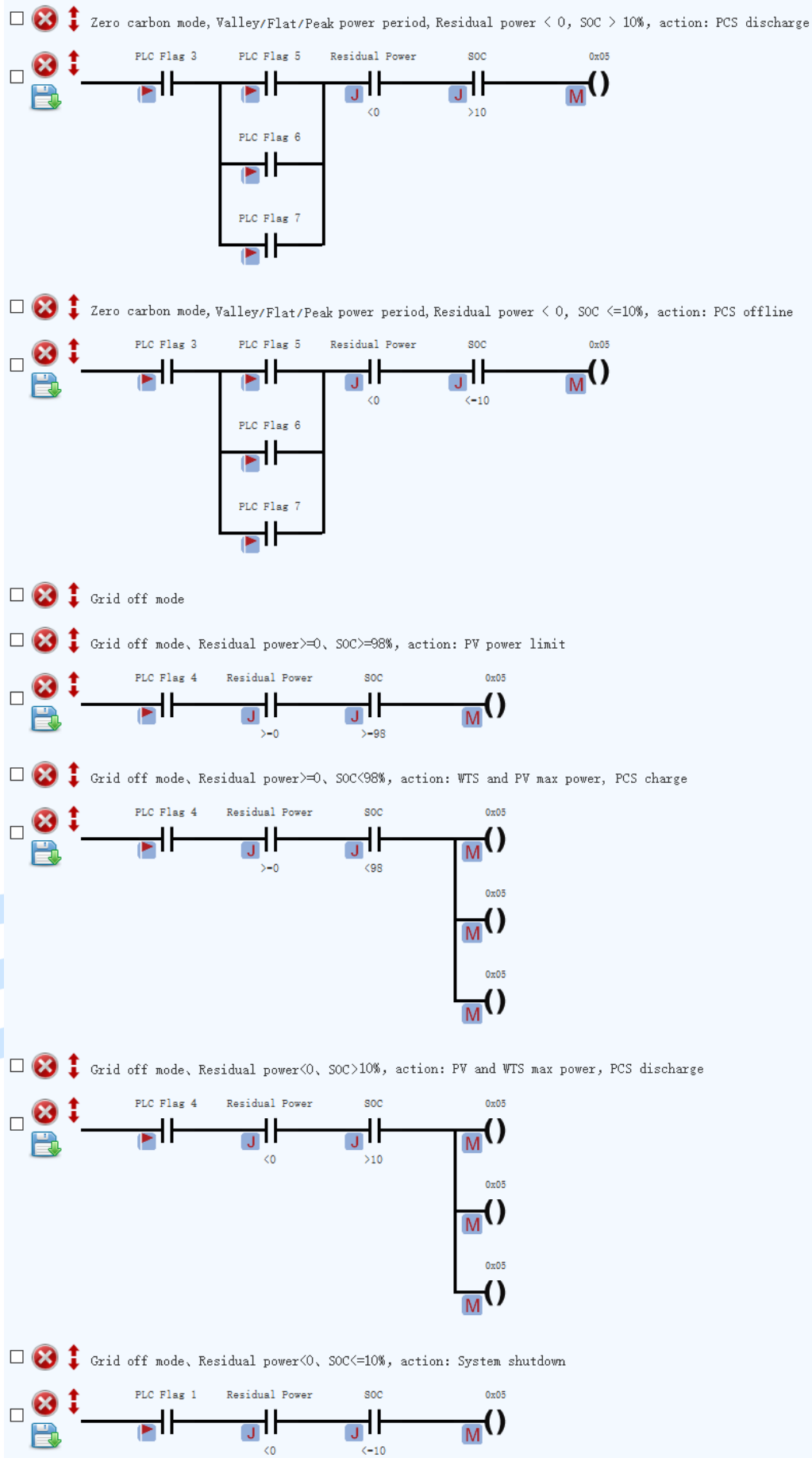


Fig.20 PLC Logic Example (Part 3)

5 WIRING CONNECTION

The back panel of HEMS400 is as follows:

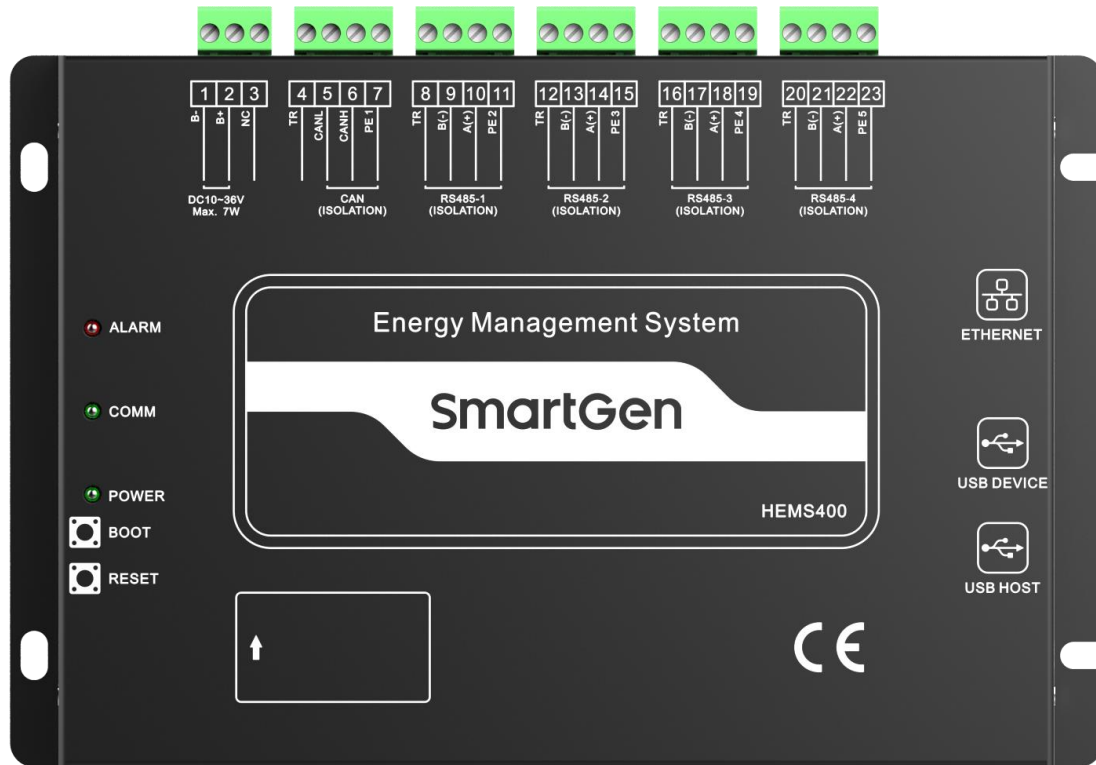


Fig.21 Back Panel Drawing

Table 11 Indicators Description

Indicator	Description
Alarm	Flashes when alarm occurs.
Communication	Always illuminated when communication of all external devices is normal; Flashes when communication of partial external devices is abnormal; Extinguished when communication of all external devices is abnormal.
Power	Always illuminated when power on, extinguished when power off.

Table 12 Terminal Connection Description

No.	Function	Cable Size	Description
1	B-	1.0 mm ²	Connect to battery negative.
2	B+	1.0 mm ²	Connect to battery positive.
3	PE	/	
4	Terminal Matching Resistance (120Ω)	/	Impedance-120Ω shielding wire is recommended and its single end grounded.
5	CAN H	0.5 mm ²	
6	CAN L	0.5 mm ²	
7	PE1	/	
8	Terminal Matching Resistance (120Ω)	/	Impedance-120Ω shielding wire is recommended and its single end grounded.

No.	Function	Cable Size	Description
9	RS485A-1(-)	0.5 mm ²	
10	RS485B-1(+)	0.5 mm ²	
11	PE2	/	
12	Terminal Matching Resistance (120Ω)	/	Impedance-120Ω shielding wire is recommended and its single end grounded.
13	RS485A-2(-)	0.5 mm ²	
14	RS485B-2(+)	0.5 mm ²	
15	PE3	/	
16	Terminal Matching Resistance (120Ω)	/	Impedance-120Ω shielding wire is recommended and its single end grounded.
17	RS485A-3(-)	0.5 mm ²	
18	RS485B-3(+)	0.5 mm ²	
19	PE4	/	
20	Terminal Matching Resistance (120Ω)	/	Impedance-120Ω shielding wire is recommended and its single end grounded.
21	RS485B-4(-)	0.5 mm ²	
22	RS485A-4(+)	0.5 mm ²	
23	PE5	/	

NOTE1: ETHERNET port can be directly connected to controller via network cable, or multiple controllers via a switch. The default IP address of HEMS400 is 192.168.0.111, and the IP address of controller must be in the same network segment but different from that of large screen.

NOTE2: USB-HOST is used for rapid upgrade and data export of the USB flash drive. The partition table of the USB flash drive must be in the MBR format and the file system must be in FAT32 format.

NOTE3: USB-DEVICE port is used to connect PC to upgrade the firmware. The upgrade steps are as follows:

1. Power on the monitoring screen;
2. Press the BOOT key;
3. Press the RESET key;
4. Release the RESET key;
5. Release the BOOT key, and then the touch screen enters the burning mode;
6. Connect to PC via USB-DEVICE of the large screen;
7. Decompress the upgrade package, and double-click the file of "mftool2.vbs";
8. If "HID-compliant vendor-defined device" appears, it indicates a successful identification.

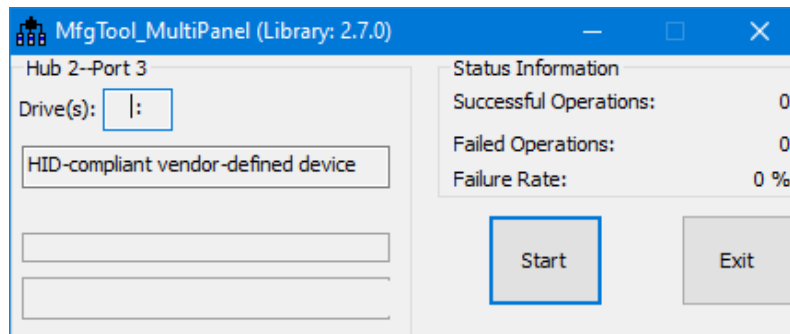


Fig.22 Burn Mode

9. Click "Start" button to start burning the image, click "Stop" to stop burning after successful burning, and click "Exit" to exit the burning software;

10. Disconnect the large screen from the PC, press the RESET key and release it to restart the large screen.

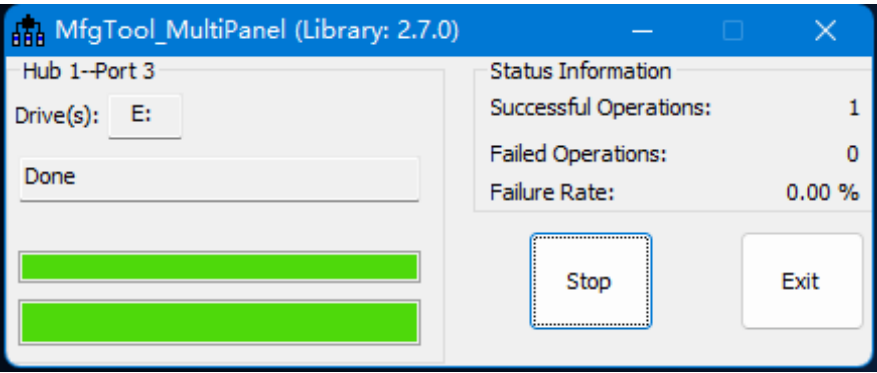


Fig.23 Successful Firmware Upgrade

6 TYPICAL APPLICATION

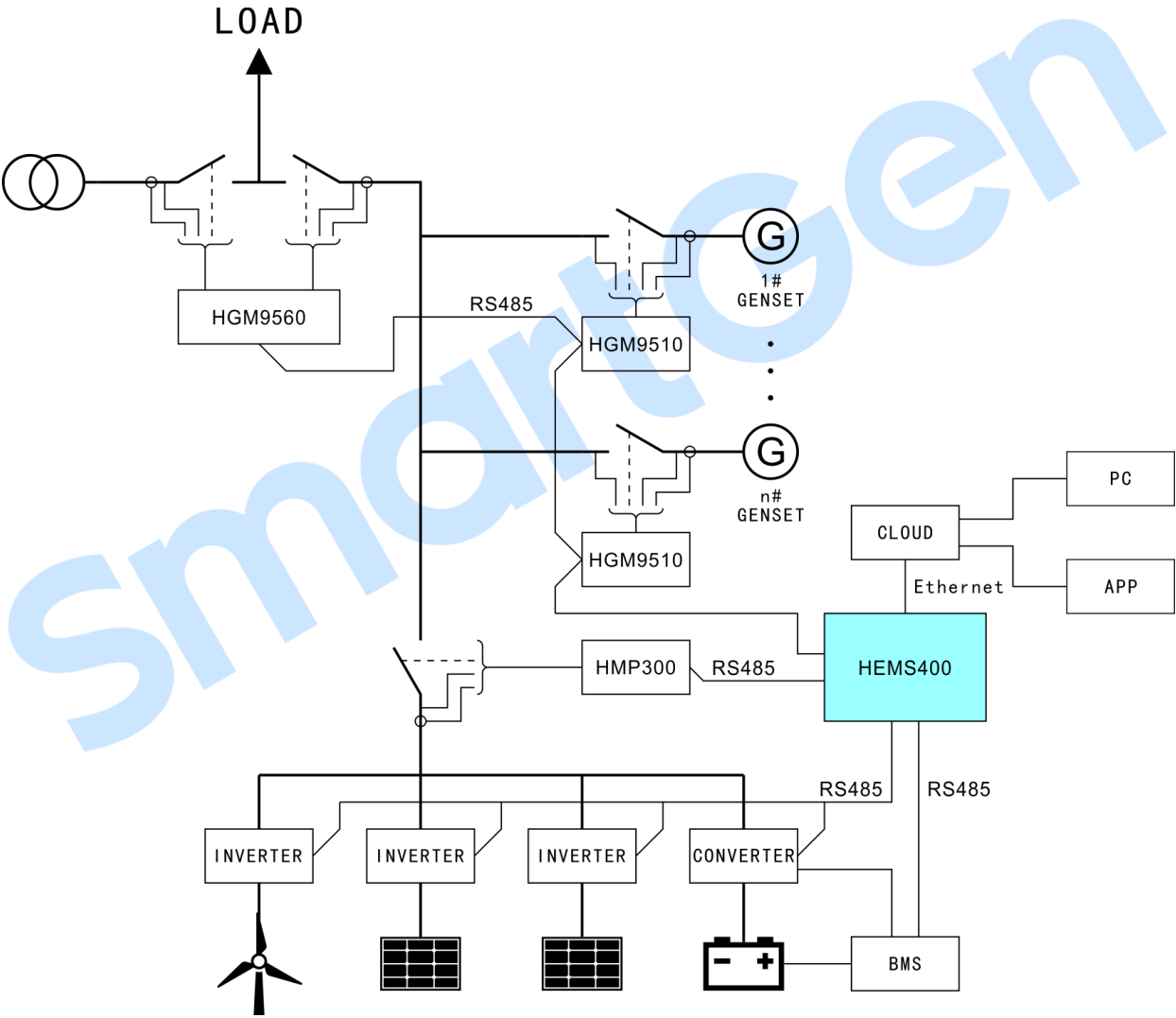


Fig.24 Typical Application Diagram

7 OVERALL DIMENSIONS AND PANEL CUTOUT

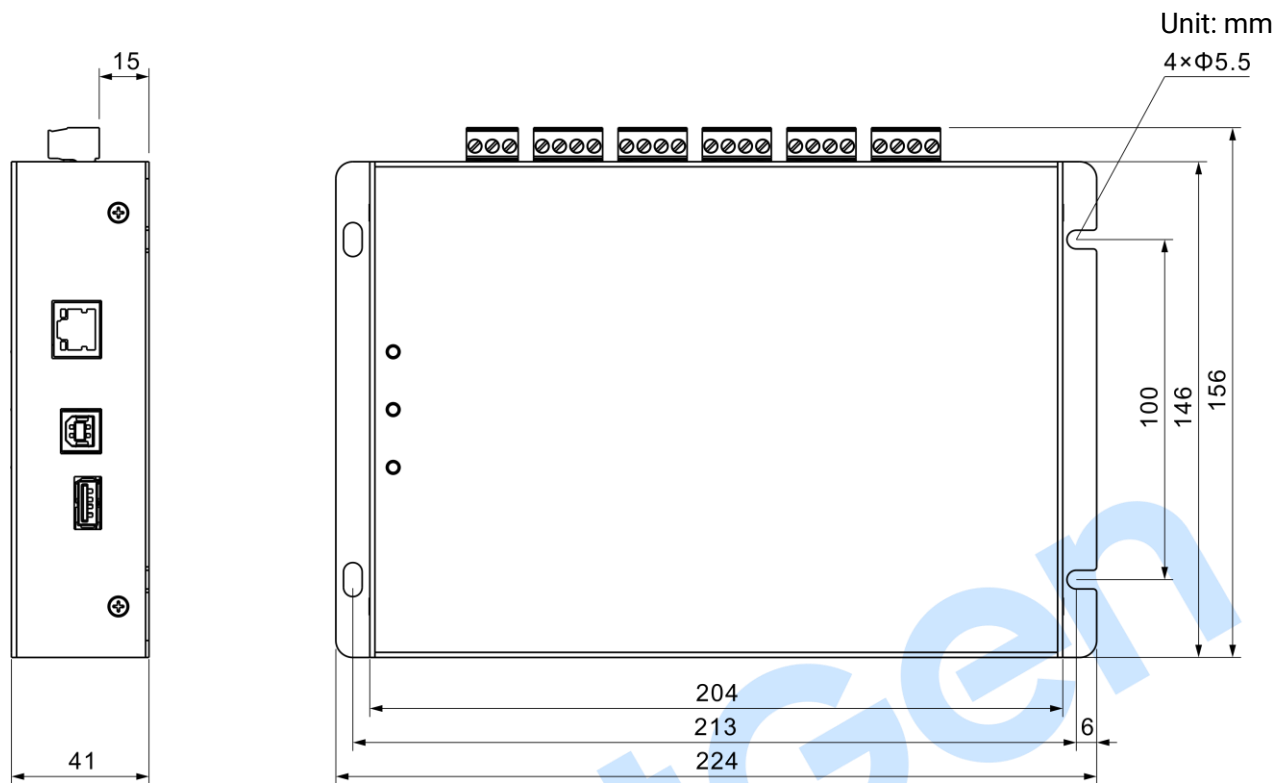


Fig.25 Overall Dimensions and Panel Cutout

8 TROUBLESHOOTING

Table 13 Troubleshooting

Symptoms	Possible Solutions
PC read/write configuration failure	Check whether the PC network and HEMS400 are on the same network segment.
PC read/write configuration failure	Check whether the IP address and port set by PC are the same with HEMS400.
Comm. failure of external device	Check whether the baud rate, stop bit, parity bit of RS485 port are correct.
Failed to obtain external device data	Check whether the register address, number and timeout period of the device message are correct.
Failed to obtain external device data	Check whether the communication address and calculation method of the computation are correct.
Comm. failure of external device	Ensure that all cable connectors are firmly connected to HEMS400.