SmartGen

MAKING CONTROL SMARTER

HEMS100/HEMS200

MICRO-GRID CONTROLLER

USER MANUAL

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Table 1 Software Version

Date	Version	Note
2024-03-03	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.

CONTENTS

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1 OVERVIEW

HEMS100/HEMS200 Micro-Grid Controller is developed based on Linux operation system that can make the power system work in intelligent and high efficiency way and expand intelligent components to realize more functions. The product can provide more powerful, user-friendly and convenient interface, support the management and real-time communication of PCS, rectifier, solar module, wind power module, inverter module, DC/DC module, diesel genset, lead-acid/lithium battery, liquid cooling/air cooling, intelligent breaker, ATS, AC energy meter, DC energy meter, collect important data of all communication substations, then control the whole system to operate orderly and reliably through the data acquisition, processing, analysis and logical operation of internal program. It can be widely applied for communication, energy, industrial park, communication base station of data center, port, shopping mall, finance, transportation, hotel, industrial and mining area, oil field, medical field, organs, school, military industry and other fields.

2 PERFORMANCE AND CHARACTERISTICS

— Equipment management;

— Battery management;

— Peak load shifting of industrial and commercial energy storage;

— Energy storage control (countercurrent protection, demand control, demand side response, load follow, green power utilization, etc.);

— PV + energy storage control;

— PV + energy storage + diesel genset control;

— PV + energy storage + charging pile control;

— Fault alarm and protection;

— Support cloud platform;

— With monitoring and management, "three remote" (remote control, remote measurement, remote communication) function;

— Support cloud upgrade of application program.

3 SPECIFICATION

Table 3 Performance Parameter

Item	HEMS100	HEMS200
Working Voltage	DC12V/DC24V	DC12V/DC24V
Overall Consumption	<4W	<12W
Processor	792MHz CPU	Multi-core 1.1GHz Cortex® A53
Memory	DDR3 512MB	DDR3L 2GB
Storage	eMMC 4GB	eMMC 8GB (can expand M.2 SSD externally)
Operation System	Linux	Linux
ADC	(0-20)mA, (0-10)V, 1%, 40sps sampling rate	(0-20)mA, (0-10)V, 1%, 40sps sampling rate
CAN	Isolated	Isolated
RS485	Isolated	Isolated
DI	8	18
DO	14	8
ADC	4	4
ETHERNET	2	4
RS232	1	3
RS485	4	8
CAN	3	3
USB	2	2
4G Module	●	●
WiFi Module	●	●
RTC	●	●
NTP	●	●
M.2 (SSD)	None	●
TF Card	●	●
IEC61850	●	●
IEC104	●	●
DLT645	●	●
Modbus-TCP	●	●
Modbus-RTU	●	●
Industrial and Commercial Energy Storage	●	●
PV + Energy Storage	●	●
PV + Energy Storage + Diesel Genset	●	●
PV + Energy Storage + Charging Pile	●	●
Cloud Platform	●	●
Overall Dimension	190mmx115mmx52.4mm	232mmx113mmx59mm
LCD	Power supply: DC12V; dimension: 10.1-inch; pixel: 1280*800	

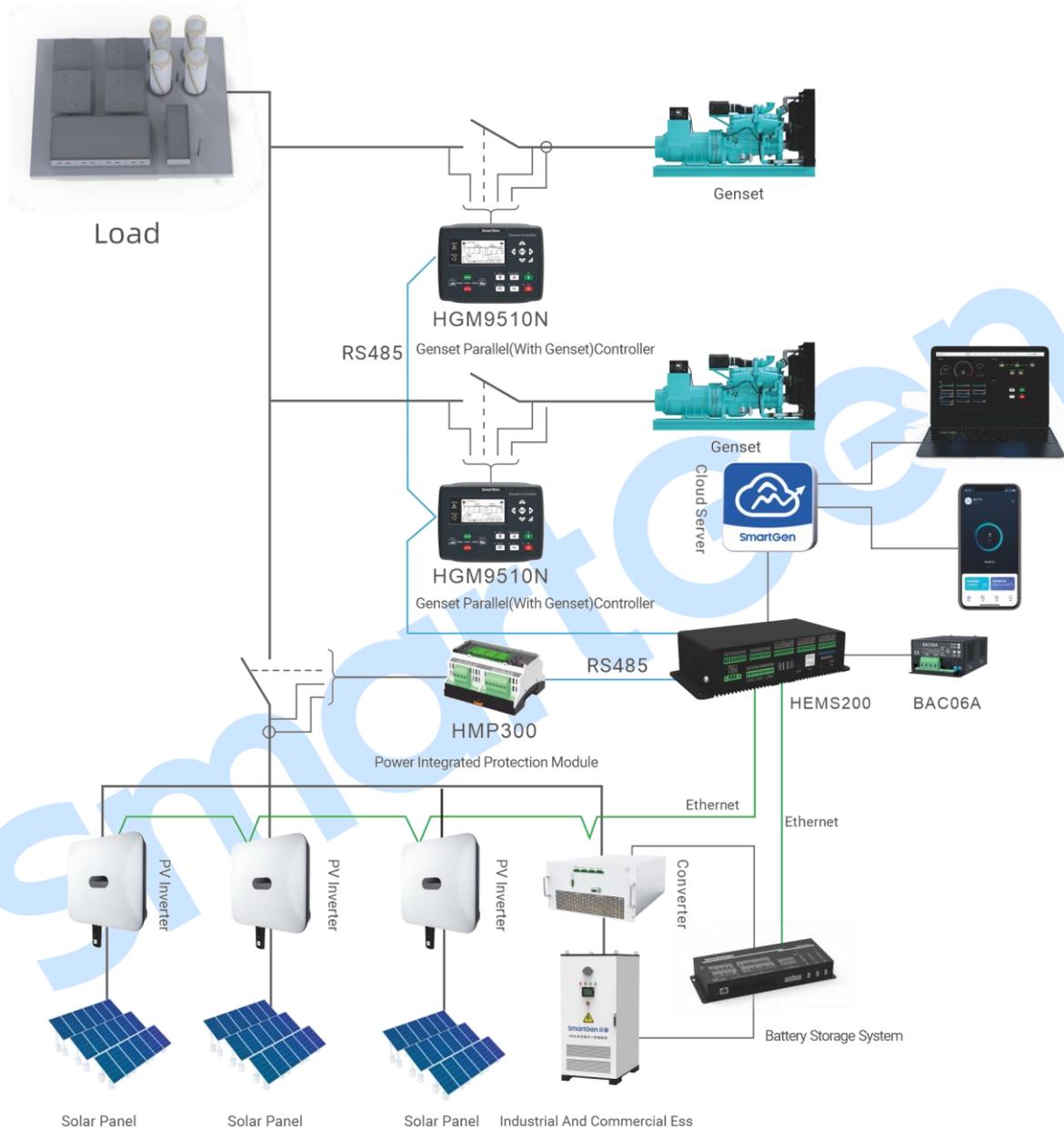| Item	HEMS100	HEMS200
Working Temperature	(-40~+60)°C	
Working Humidity	(5~95)%RH	

4   MICROGRID SYSTEM

Fig.1 Microgrid System

5 PRODUCT FUNCTION

5.1 EQUIPMENT MANAGEMENT AND MAINTENANCE

It can collect data of PCS, PV, genset, BMS (including cell data), energy meter, load, dynamic environment, air conditioner, firefighting, safety supervision, etc. accurately, comprehensively via various communication methods (Ethernet, RS485, CAN, etc.) in real time. The collected original data of the equipment is stored, the stored information includes remote measurement data, remote communication data, alarm information, operation log, events, etc. These stored data can be exported. The collected real-time, historical data of the equipment is transformed and processed in combination with parameters and control logic set by EMS system, then display data, statistic and alarm information are generated and reported to cloud platform of EMS system in real time. The controller can remotely control, configure, and conduct maintenance, make remote control, parameter setting, debugging, upgrade and other operations for PCS, EMS, PV, genset, dynamic environment, air conditioner, safety supervision, etc.

5.2 CONTROL AND PROTECTION

— Support linkage protection of firefighting system and energy storage system, and customized control logic.
— Support linkage protection of PCS and BMS, and customized control logic.
— Support PV generation protection, and customized control logic.
— Support genset protection, and customized control logic.
— Support linkage protection of other auxiliary system and energy storage system, and customized control logic.

5.3 SITE MANAGEMENT AND MAINTENANCE

— Support energy storage site system monitoring, energy scheduling, equipment management, running maintenance, data ayalysis and other functions of cloud platform.
— Support boot exclusive, local control, user interaction, which is simple and convenient.
— Support local storage backup of historical data of energy storage site system euqipment and cell, HEMS200 supports large capacity SSD, data sampling hisory storage, export and other functions of all site equipment and cell.
— Support site equipment configuration and data monitoring.

6 CONTROL STRATEGY

6.1 REVERSE POWER PROTECTION

Reverse power protection can prevent reverse power from being sent back to the grid. It is used for software protection, if reliable protection is required, reverse power protection device can be added to detect reverse power and trip immediately. It requires access to real-time power data from the meter on the low-voltage side of the transformer. When reverse power exceeds the limit, the system will automatically reduce or stop discharge. The reverse power limit is recommended to be set as max. transformer capacity * power factor (5%-10%), which continues for (5-10)s.

6.2 DEMAND CONTROL

Grid charges are divided into basic charges (transformer capacity charges) and electricity charges. The basic charges is reported in advance, and if it exceeds, the charge will be doubled, so the excess peak power consumption needs to be removed to save the basic charges. This strategy requires access to real-time power data from the meter on the low-voltage side of the transformer. When the power exceeds the limit, it will automatically start or increase energy storage discharge. The demand limit is active power (kW), which can be obtained by max. transformer capacity (kVA) * power factor.

6.3 DEMAND SIDE RESPONSE

The power enterprises apply for a demand side response through the relevant system, and execute the response after passing. The declared response load should be less than the approved capacity, and it is recommended not to exceed te average load of the baseline. After the response execution day, the system charges and discharges for energy storage according to the configuration period and load to complete the response.

6.4 GREEN POWER UTILIZATION

Green power utilization refers to PV generation utilization, that is, the surplus electric energy emitted by PV is dispatched to the load point with energy demand. In this system, when PV generation can meet the load demand, the excess power charges for the energy storage; after the energy storage is fully charged, the excess PV generation will be connected to the grid and utilized.

6.5 LOAD FOLLOW

The system can track the load power comsunption in real time, and schedule PV generation, energy storage generation, oil engine generation and other generation equipment reasonably and efficiently according to load power consumption.

6.6 LOAD FORECAST

The basic principle of energy storage load forecasting is to predict the energy storage load in the future period using mathematical models and algorithms through the analysis and processing of historical data, real-time data and external influencing factors. The predicted result can provide decision-making basis for charge, discharge strategy of energy storage system, so as to optimize the operation of the energy storage system and maximize the economic benefits.

6.7 GENERATION FORECAST

Through the weather forecast information of the Meteorological Bureau, historical meteorological information and power generation situation, the power generation of wind power and solar power in the short or ultra-short term is predicted, which provides a basis for energy optimization and scheduling, makes full use of distributed power generation to obtain greater economic and social benefits, and improves the realiability and economy of microgrid operation.

7 CLOUD PLATFORM

The cloud platform can display the information overview of all energy storage sites across the country through a large-screen map, realizing the overall distribution of all energy storage stations and the statistical functions of important business data. Specifically include the following:

— Basic data such as project numbers and maps

The number of hybrid energy stations and the location of the longitude and latitude of the station are displayed, and the EMS access network of the corresponding station is added to realize detailed data viewing and setting.

— Energy storage revenue display

Display the power and revenue data of all energy storage power stations on this platform.

— Charge and discharge efficiency display

Display the total charge and discharge capacity, efficiency and other data of all energy storage power stations on this platform.

— Site alarm and equipment alarm

Display the station alarm situation in the system and the alarm information in all energy storage stations.

— Hybrid energy control strategy issuance

Support the control and strategy issuance of commercial energy storage, PV + energy storage, PV + energy storage + diesel genset, PV + energy storage + charging piles.

8 TERMINAL DEFINITION

8.1 POWER INTERFACE

The whole HEMS200 is powered by DC (12V-24V/25W) power supply, please use it with a suitable power supply. The physical form of the interface is a green socket with 3Pin and a distance of 3.81mm. The socket has its own screw hole, as shown in the table below.

Table 4 Pin Definition of Power Interface

PIN	Name	Design No.	Note
1	Power Supply	12V-24V	System power input, stable operation under extreme working conditions (minimum 11V, maximum 30V), it does not power on below 9V.
2	Protection Ground	EARTH	Protection ground
3	Power Ground	GND	Power ground

8.2 DO INTERFACE

HEMS200 provides 8-channel relay-isolated passive DO interfaces, which can be used to control the on-off of external equipment or as a switch. The following table shows the DO interface signal description.

Table 5 DO Interface Signal

PIN	Name	Design No.	Note
1	DO1 Output	DO1	Normally open, contact resistive load 3A/5A 250VAC/30VDC
2	DO2 Output	DO2	Normally open, contact resistive load 3A/5A 250VAC/30VDC
3	DO3 Output	DO3	Normally open, contact resistive load 3A/5A 250VAC/30VDC
4	DO4 Output	DO4	Normally open, contact resistive load 3A/5A

PIN	Name	Design No.	Note
			250VAC/30VDC
5	DO5 Output	DO5	Normally open, contact resistive load 3A/5A 250VAC/30VDC
6	DO6 Output	DO6	Normally open, contact resistive load 3A/5A 250VAC/30VDC
7	DO7 Output	DO7	Normally open, contact resistive load 3A/5A 250VAC/30VDC
8	DO8 Output	DO8	Normally open, contact resistive load 3A/5A 250VAC/30VDC

8.3 DI INTERFACE

HEMS200 provides 18-channel opto-coupler-isolated DI interfaces, every 3 DI for a group share a common terminal (COM), a total of 6 groups (A...F), of which 12 channels from group A to group D are dry contact, and can be connected to passive switch acquisition and a variety of sensors switch inputs. The other 6 channels from group E to group F are wet contacts, which can be connected to +(9-24)V active switches as low-voltage trigger signals for controlling external devices on/off or as switch and trigger interrupt enable signals, etc. This maximizes the number of channels and ensures the independence of the signal inputs and general usability. The following table shows the DI interface signals of groups A and E, and the other groups of DI signals are similar.

Table 6 DI Interface Signal

| PIN	Name	Design No.	Note
1	DI1 Input	DIA1	Opto-coupler LED + pull-up 5V power supply (dry contact)
2	DI2 Input	DIA2	Opto-coupler LED + pull-up 5V power supply (dry contact)
3	DI3 Input	DIA3	Opto-coupler LED + pull-up 5V power supply (dry contact)
4	Group A DI Signal Ground	COMA	Three groups of dry contact common end
5	DI13 Input	DIE13	Wet contact, +(9 ~ 24)V
6	DI14 Input	DIE14	Wet contact, +(9 ~ 24)V
7	DI15 Input	DIE15	Wet contact, +(9 ~ 24)V
8	Group E DI Signal Ground	COME	Wet contact negative electrode
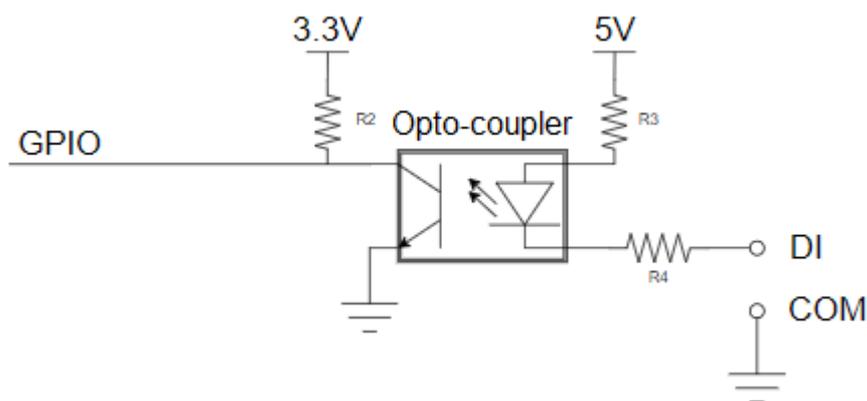
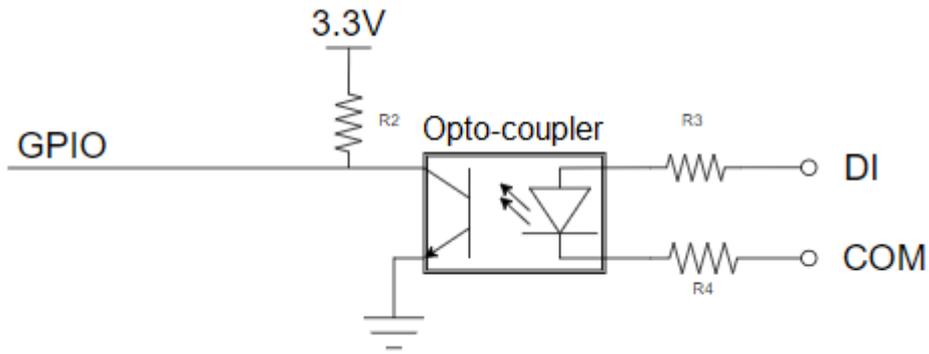**Fig.2 Circuit Principle Diagram of Dry Contact DI**

Fig.3 Circuit Principle Diagram of Wet Contact DI

8.4 CAN INTERFACE

HEMS200 has 3-channel CAN interfaces, of which the left two are native CAN interfaces and support CAN-FD; 1-channel on the right side is an expanded CAN interface, which does not support CAN-FD for the time being, as shown in the table below.

Table 7 Pin Definition of CAN Interface

PIN	Name	Design No.	Note
1	CAN1H	H1	Support CAN-FD
2	CAN1L	L1	Support CAN-FD
3	Ground	G1	CAN1 shielded ground
4	CAN2H	H2	Support CAN-FD
5	CAN2L	L2	Support CAN-FD
6	Ground	G2	CAN1 shielded ground
7	Reserved	Reserved	Reserved
8	CAN3H	H3	Support CAN-FD
9	CAN3L	L3	Support CAN-FD
10	Ground	G3	CAN1 shielded ground

8.5 RS-485 INTERFACE

HEMS200 provides 8-channel isolated RS-485 interfaces and uses four 3.81-6P blocks to lead out. Each 3.81-6P block has two sets of RS-485 signals. The following table lists the signals for one of the blocks, and the other three blocks are similar.

Table 8 Pin Signal Definition of RS-485

PIN	Name	Design No.	Note
1	1# RS-485 A-terminal Signal	A1	Isolated
2	1# RS-485 B-terminal Signal	B1	Isolated
3	1# RS-485 Signal Ground	G1	Shielded ground
4	2# RS-485 A-terminal Signal	A2	Isolated
5	2# RS-485 B-terminal Signal	B2	Isolated
6	2# RS-485 Signal Ground	G2	Shielded ground

8.6 RS-232 COMMUNICATION INTERFACE

The RS-232 interface of HEMS200 using 3.81-6pin block is two isolated communication interfaces, which can communicate with external RS-232 equipment through serial port, please see the following table for details.

Table 9 Pin Description of RS-232 Communication Interface

PIN	Name	Design No.	Note
1	TXD1	T1	Isolated
2	RXD1	R1	Isolated
3	GND1	G1	Shielded ground
4	TXD2	T2	Isolated
5	RXD2	R2	Isolated
6	GND2	G2	Shielded ground

8.7 ETHERNET INTERFACE

HEMS200 provides 4-channel Ethernet interfaces, the physical interface using RJ45, NET1 for the chip's native network port, NET2 and NET3, NET4 for the chip's PRG expansion of the network port, the factory firmware settings default 4-channel network ports support 10Mbps/100Mbps/1000Mbps self-adaptive, 1000Mbps operating mode is recommended for best performance. The distribution of network port numbers is shown in the following table.

Table 10 Channel Description

PIN	Name	Design No.	Note
1	RGMII Network Port 1	NET1	Chip native network port
2	RGMII Network Port 2	NET2	PRG2_PRU0 extended network port
3	RGMII Network Port 3	NET3	PRG2_PRU0 extended network port
4	RGMII Network Port 4	NET4	PRG2_PRU0 extended network port

8.8 ADC INTERFACE

HEMS200 provides 4-channel isolated ADC interfaces and uses a 3.5-8P block to lead out. Among them, AGND is the reference ground of ADC, and 4 ADCs share AGND. See the table below for the definition of block signal.

Table 11 Pin Signal Definition of ADC Block

PIN	Name	Design No.	Note
1	1# ADC Signal	ADC1	(0-20)mA, (0-10)V, 1%, sampling rate 40sps
2	ADC Reference Ground Signal	AGND	
3	2# ADC Signal	ADC2	(0-20)mA, (0-10)V, 1%, sampling rate 40sps
4	ADC Reference Ground Signal	AGND	
5	3# ADC Signal	ADC3	(0-20)mA, (0-10)V, 1%, sampling rate 40sps
6	ADC Reference Ground Signal	AGND	
7	4# ADC Signal	ADC4	(0-20)mA, (0-10)V, 1%, sampling rate 40sps
8	ADC Reference Ground Signal	AGND	

8.9 USB DOUBLE-LAYER SOCKET

The 2-channel USB2.0 signals in the USB double-layer socket are expanded from the USB1 of the main control through the USB Hub chip, and can be used to connect U disks and WiFi module of USB interface.

Table 12 USB Double-layer Socket

PIN	Name	Design No.	Note
1	USB2.0	USB1	Connect U disk or WiFi module of USB interface
2	USB2.0	USB2	

8.10 Nano SIM CARD SOCKET

HEMS200 provides a Nano SIM card socket, and the Nano SIM card socket can be matched when users use the internal MiniPCIe socket to expand 4G modules.

8.11 SD CARD SOCKET

HEMS200 provides a standard TF card socket, which can be used for system debugging, firmware burning, start and firmware upgrade. After the system starting, the user can read and write the TF card normally.

8.12 M.2 INTERFACE

HEMS200 provides an M.2 expansion interface, supports PCIe2.0 x1 channels, and can be used to expand peripherals such as M.22242 SSD that supports PCIe2.0 x1 channels. SSD (solid state drive) needs to support PCIe protocol, and the physical interface is M_KEY or B&M_KEY, as shown in the following figure.
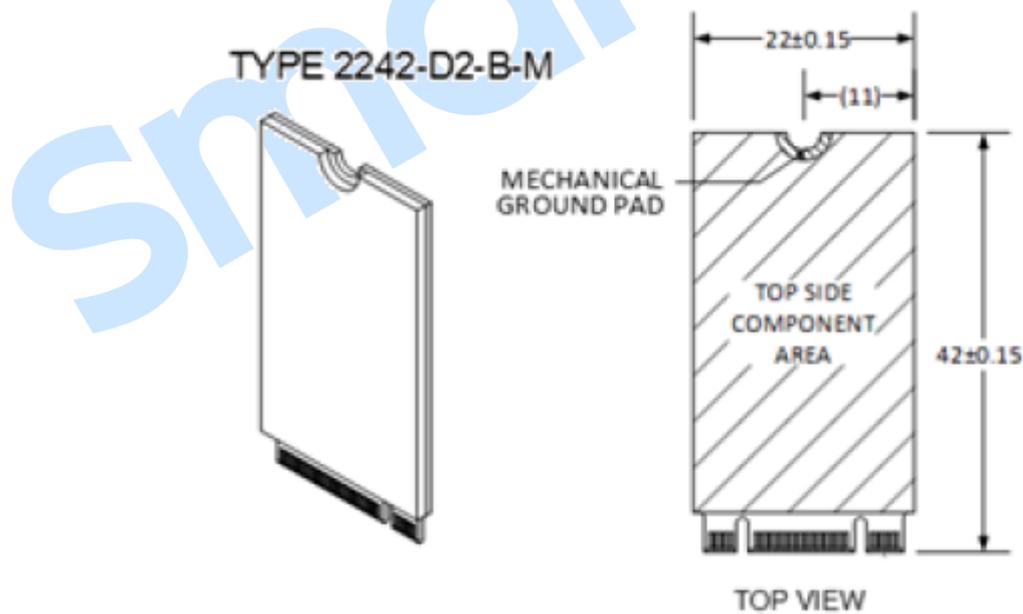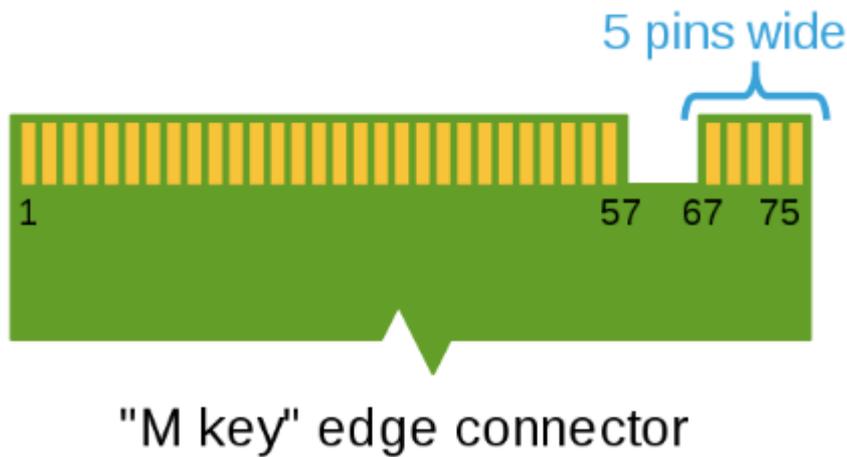

Fig.4 B&M_KEY 2242 SSD Size and Keys Diagram

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5 pins wide

"M key" edge connector

Fig.5 M_KEY Diagram

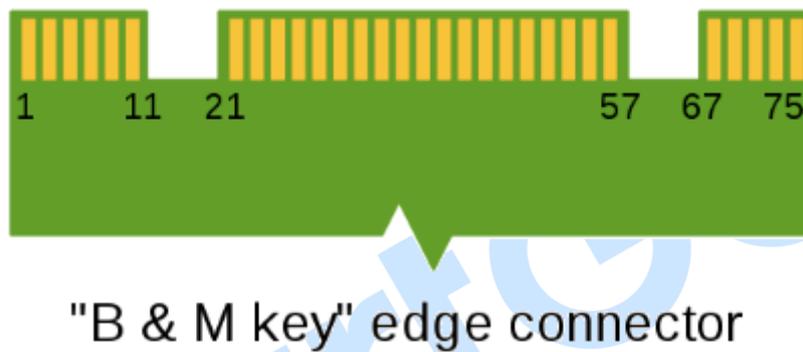"B & M key" edge connector

Fig.6 B&M_KEY Diagram

8.13   miniPCIe INTERFACE

HEMS200 provides a miniPCIe expansion interface, supports USB2.0 protocol, and can be used to expand communication peripherals such as 4G modules or WIFI modules that support USB2.0 protocol to support HEMS200 to realize wireless communication. The HEMS200 is preset with a Nano SIM card holder, which can be inserted into the Nano SIM card when expanding the 4G module.

8.14   INDICATORS

There are 8 indicators in HEMS200, namely power indicator, running indicator, error indicator, SSD indicator and 4 programmable indicators, which are convenient for understanding the operation status of the system in any case, as described in the table below.

Table 13 Indicator Description

PIN	Name	Design No.	Note
1	Power Indicator, Red	PWR	Light on: Normal power-on Light off: Power outage
2	Running Indicator, Green	RUN	Flash: Normal running Light on/off: System crashing
3	Error Indicator, Red	ERR	Light on: Running error Light off: Normal running
4	SSD Indicator, Green	SSD	Light on/flash: SSD normal/SSD data transfer

PIN	Name	Design No.	Note
			Light off: SSD not in position or abnormal
5	GPRS Indicator, Green	LED1	Flash: GPRS and cloud platform communicate normally Light off: Not connected to the cloud platform Light on: Synchronized with cloud platform data, TCP heartbeat communication failed
6	Wifi Indicator, Green	LED2	Flash: GPRS and cloud platform communicate normally Light off: Not connected to the cloud platform Light on: TCP heartbeat communication failed
7	Energy Storage Charge/Discharge Indicator, Green	LED3	Flash: Energy storage charging Light on: Energy storage discharging Light off: Energy storage not charge/discharge
8	Alarm Indicator, Green	LED4	Flash: Alarm occurred Light on: System failure Light off: Ok

8.15 OVERALL AND INSTALLATION DIMENSIONS
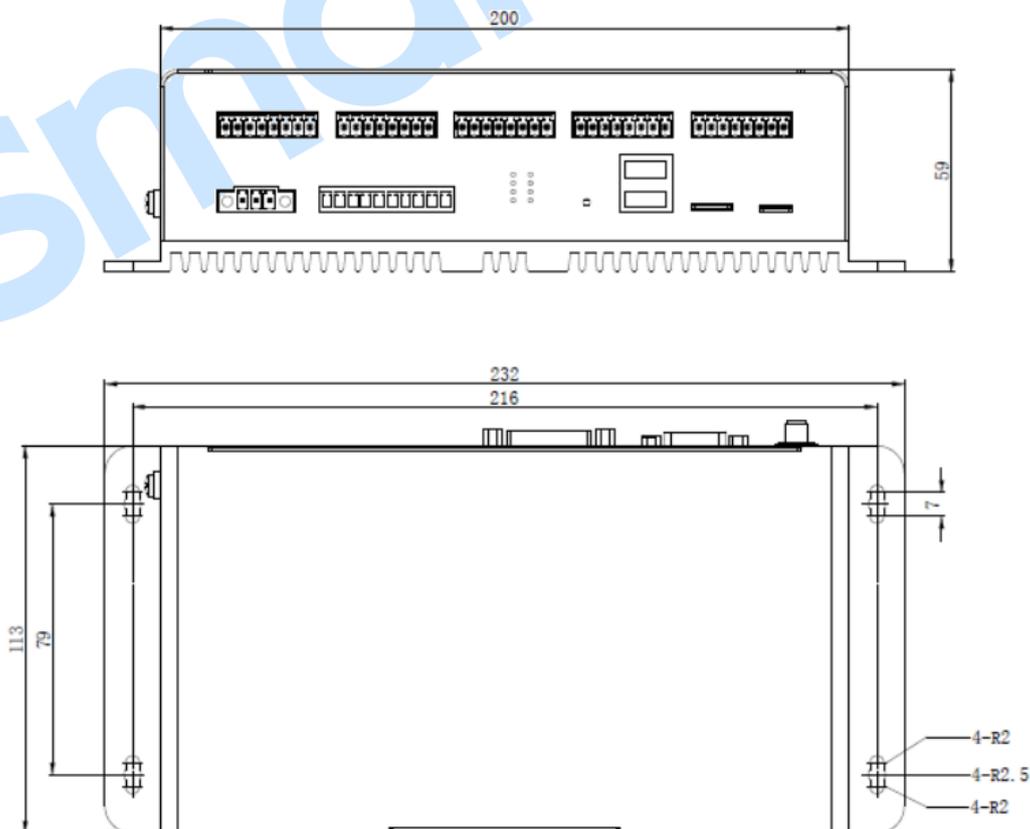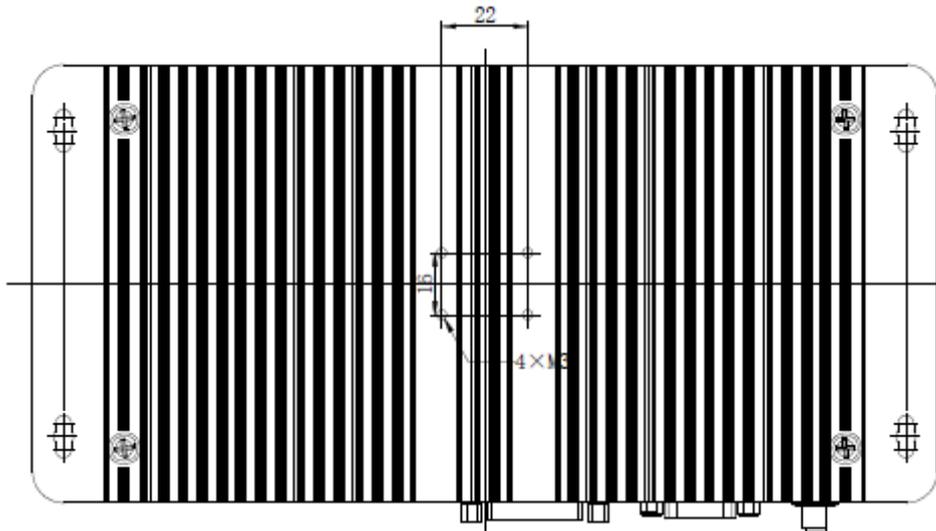
Unit: mm

Fig.7 HEMS200 Overall Dimensions

Fig.8 Installation Position Diagram of HEMS200 Guide Rail Buckle
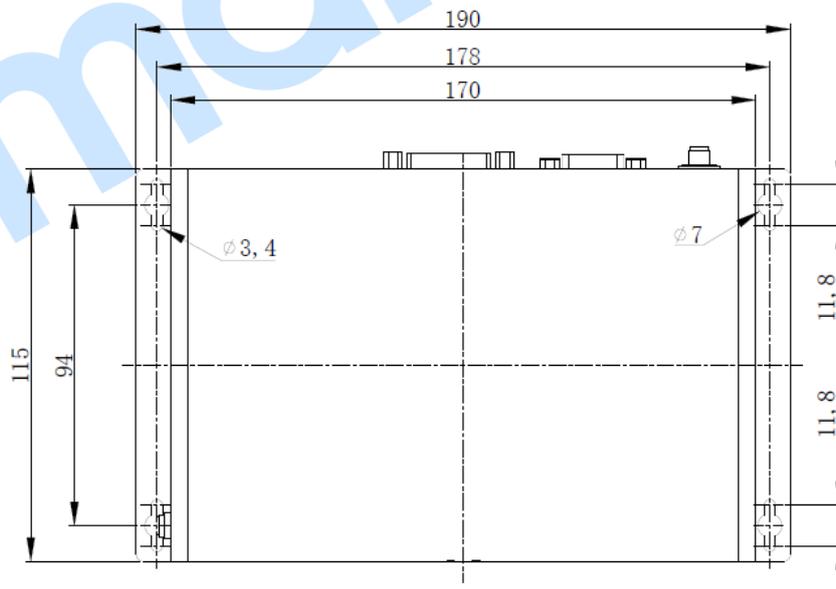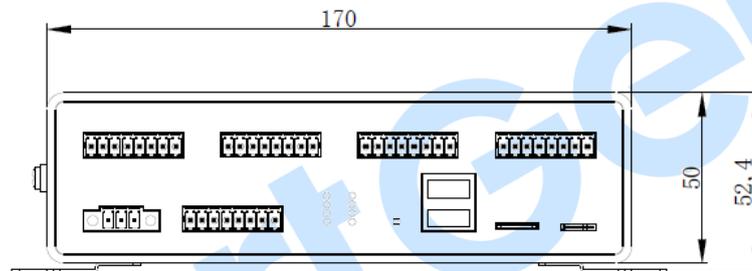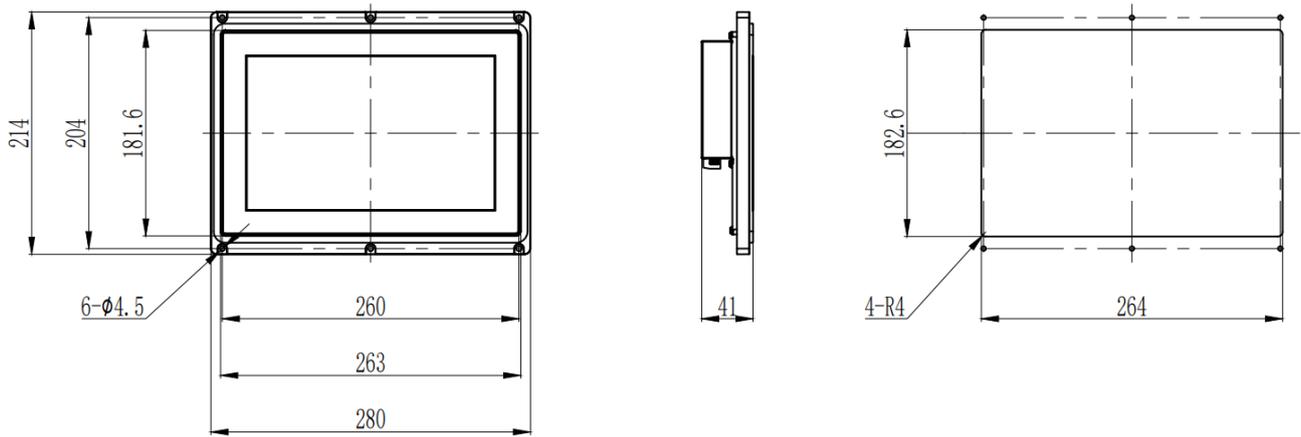

Fig.9 HEMS100 Overall Dimensions

(a) Overall Dimensions   (b) Recommended Cutout Size

Fig.10 Overall Dimensions and Recommended Cutout Size of 10.1-inch Screen

9   COMMISSIONING

Before running, the following checks are recommended:

— Check that all wirings are correct and the wire diameter is appropriate;

— Test whether each device is running and whether the uploaded data is correct;

If you have any other questions, please contact the service personnel of the company in time.

10   OPTIONAL ACCESSORY

Table 14 Optional Accessory

Accessory	Name
Display Screen	10.1-inch screen

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