Address: Economic Development Zone of Hangbu town, Shucheng County, Lu'an, China

Tel:+86-0564-8030526 | Post Code:231300 | Web: www.lvwo-energy.com

100kW/215kWh
All-In-One Cabinet Liquid-Cooling Energy Storage System Specification

Prepared By	Checked By	Approved By
Zhang Hongjiang	Zhou Youbing	Li Pai

Customer Approved	**Signature:**
	Date:
	Company Name: （Company Stamp）

CONTENT

I. Scope of Application

This specification is suitable for the 100kW/215kWh industrial and commercial energy storage system developed by Anhui Lvwo Recycling Energy Technology Co., Ltd. and describes its external dimensions, performance indexes, battery management system parameter settings, the appearance of the battery pack marking, the use of the environment and the requirements of storage and transportation, as well as the precautions for use.

II. Battery System Design Reference Technical Documents

GB/T 191-2008 Packaging, Storage and Transportation Graphic Marking
GB/T 2423.1-2008 Environmental Tests for Electrical and Electronic Products Part 2: Test Methods Test A: Low Temperature
GB/T 2423.2-2008 Environmental Tests for Electrical and Electronic Products Part 2: Test Methods Test B: High Temperature
GB/T 2423.3-2006 Environmental test for electrical and electronic products Part 2: Test method Cab:Constant humidity and heat test
GB/T 2423.2008 Environmental test for electrical and electronic products Part 2: Test method Test Db: Alternating humidity and heat (12h+12h cycle)
GB/T 2900.33-2004 Electrician's Terminology Power Electronics
GB/T 3859.1-1993 Specification of basic requirements for semiconductor converters
GB/T 3859.2-1993 Semiconductor converter application guidelines
GB/T 3859.3-1993 Semiconductor converter transformers and reactors
GB/T 4208-2008 Enclosure protection class (IP code)
GB/T 5226.1-2008 Mechanical and Electrical Safety Mechanical and Electrical Equipment Part 1: General Technical Conditions
GB/T 7947-2006 Basic and safety rules for HMI logo marking Conductor color or number marking
GB/T 12325-2008 Power quality supply voltage deviation
GB/T 12326-2008 Power quality voltage fluctuations and flicker
GB/T 13382008 General Technical Conditions for Packaging of Electromechanical Products GB/T 13422-2013 Electrical test methods for semiconductor power converters
GB/T 14048.1-2006 Low-voltage switchgear and controlgear Part 1: General provisions
GB/T 14549-1993 Power quality utility grid harmonics
GB/T 15543-2008 Power quality Permissible unbalance of three-phase voltage
GB/T 14598.27-2008 Measurement relays and protective devices Part 27: Product safety requirements
GB/T 15543-2008 Power quality three-phase voltage imbalance
GB/T 15945-2008 Power quality Permissible deviation of power system frequency
GB/T 17626 -2006 Electromagnetic compatibility test and measurement techniques

GB/T 17799.2012 General Standard for Electromagnetic Compatibility Emission Standards in Industrial Environments

GB/T 50062014 Specification for overvoltage protection and insulation fit design of alternating current electrical installations

GB/T 50065-2011 Code of practice for the grounding of AC electrical installations

GB 51048-2014 Design Code for Electrochemical Energy Storage Station

GB/T-36549-2018 Operational indicators and evaluation of electrochemical energy storage power plants

GB/T-36558-2018 General Technical Conditions for Electrochemical Energy Storage Systems for Power Systems

GB/T 36547-2018 Technical regulations for grid connection of electrochemical energy storage systems

GB/T 34133-2017 Technical Specification for Energy Storage Converter Testing

GB/T 34120-2017 Technical Specification for Energy Storage Converters for Electrochemical Energy Storage Systems

GB/T-36545-2018 Technical requirements for mobile electrochemical energy storage systems

GB/T-36548-2018 Test specification for grid access of electrochemical energy storage systems

NB/T-1815-2018 Reliability Evaluation Protocol for Electrochemical Energy Storage Power Plant Equipment

III. Supply List

No.	Name	Unit	Quantity	Notes
1	100kW/215kWh Energy Storage System	set	1	
2	Product Brochure	pcs	1	
3	Certificate	pcs	1	

IV. Product Performance Technical Indicators

This energy storage product has three unique advantages: safe and reliable, intelligent and efficient, and streamlined and flexible. In terms of safety, the system has six safety designs: body safety, design safety, structural safety, system safety, management safety, and fire safety, and there is no omission in safety precautions. It can accurately locate each abnormal battery, accurately detect faults, and efficiently carry out fire protection and operation and maintenance; adopt the design concept of explosion-proof + fire protection, and comprehensively protect the safety of the power station system from multiple dimensions at the cell level, pack level, and cabinet system level; realize triple insulation monitoring and protection, that is, DC insulation inside the battery system, and DC and AC insulation between the battery and PCS.

This energy storage system adopts a liquid-cooled thermal management solution, with a nominal capacity of 215kWh and an output power of 100kW; it consists of 5 sets of 153.6V280Ah lithium iron phosphate battery packs, using certified lithium iron phosphate ion cells, as well as 1 set of BMS battery management system, 1 set of EMS energy management system, 1 set of high-voltage control box, 1 set of 8kW energy storage liquid cooling unit, 1 set of fire protection system, and 1 set of 100kW PCS in 1 set of customized cabins.

4.1 Product Configuration List

Table 4-1 System configuration list

No.	Name	Specifications	Quantity	Unit	Brand	Notes
1	Energy Storage System	100kW/215kWh	**1**	set		details refer to 1.1 ~ 1.11
1.1	Battery Module	280-1P48S 43.008kWh	5	set	Anhui Lvwo	
1.2	High voltage box	768V High voltage box	1	set	Anhui Lvwo	
1.3	Cell	3.2V280Ah	240	pcs		
1.4	Thermal Management System	8kW energy storage liquid cooling unit	1	set	Liangsheng	
1.5	Fire Fighting System	Perfluorohexanone fire extinguishing system	1	set	ZHUO AN	
1.6	BMS	1 master, 15 Slaves	1	set	Anhui Lvwo	
1.7	EMS	Energy Management System	1	set	zoneyet	
1.8	PCS	100kW	1	set	inpower	
1.9	Cabinet	Customization	1	set	Anhui Lvwo	
1.10	Cables	/	1	set		
1.11	Other accessories	Lighting, circuit breakers, surge, switching power lights, etc.	1	set		
1.12	STS	STSZ/400KVA0.4KV	1	set	inpower	

4.2 Features

(1) Reliable charging and discharging. Efficient charging and discharging through lithium iron phosphate ion battery, long service life and high reliability.

(2) Battery pack overvoltage and undervoltage protection, cell overvoltage and undervoltage protection;
Over-voltage and under-voltage protection for the battery pack as a whole, and over-Charge/discharge over-temperature protection;
Charge/discharge overcurrent protection;

◇ Charge and discharge temperature over-temperature protection;
◇ Short circuit protection;
◇ Adoption of perfluoroacetone fire extinguishing device;

(3) Protection release mode. When the battery pack or cell is under overcharge protection, the voltage returns to the overcharge reset voltage value, and the alarm is automatically lifted.

(4) Battery equalization function. According to each battery voltage equalization control, energy transfer type equalization mode (reserved).

(5) Charging and discharging with the same port, support charging and discharging 140A, with 485/CAN communication function.

4.3 Indicators of Technical Specifications

No	Items	Parameters		Notes
Cells parameters				
1	Battery type	Lithium Iron Phosphate Battery		**LiFePO4 280A**
2	Rated voltage/capacity	3.2V/280Ah		
3	Cell voltage range	2.80V-3.60V		
4	Cell weight	5.34±0.05kg		
5	Dimension	Width	173.7±0.5mm	
		Thickness	71.7±0.5mm	
		Height (overall height)	205.1±0.5mm	
		Height (main body)	200.5±0.5mm	
		Pole center distance	90±0.3mm	
6	Working temperature	Charging temperature	0℃～60℃	
		Discharging temperature	-20℃～60℃	
7	Power retention capability	97%（25℃,30days）		
8	Cycles	More than 6000 times（0.2Ccycle．Normal temperature．Capacity retention rate: 80%）		
Battery Pack Parameters				
1	Rated voltage	153.6V		48 series
2	Pack voltage range	134.4～172.8V		According to single cell 2.8V-3.6V
3	Rated capacity	280Ah		
4	Total energy	43.008kWh		
5	Series-parallel connection	48S1P		

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6	SOC Range	20%-100%	
7	Charge and discharge capacity efficiency	≥95%	
8	Maximum continuous charging current (A)	280	
9	Overcurrent protection (A)	300	
10	Maximum continuous discharge current (A)	280	
11	Total weight	275KG（estimation）	
12	Ambient relative humidity	10%-90%	
13	Ingress Protection	IP55	
14	Ambient temperature	Charging and discharging-20℃-60℃	
15	PACK dimension		
Energy storage system parameters			
1	Rated voltage	768V	240 strings
2	Battery pack voltage range	672～864V	cells: 2.8V-3.6V
3	Rated capacity	280Ah	
4	Total energy	215.04kWh	
5	Series-parallel connection	240S1P	15 51.2V280Ah battery packs are connected in series
6	Number of battery boxes	5	
7	Inverter	100kW	
8	Cycle life	More than 6000 times（0.2C cycle, room temperature, capacity retention rate: 80%）	
9	Working temperature	Charging temperature: 0℃～60℃	
		Discharging temperature: -20℃～60℃	
10	Maximum charging power	100kW	
11	Maximum discharging power	100kW	
12	Rated frequency	50/60Hz	
13	Maximum output power	110kW	
14	Shipped Product Charge	30%-50% power delivery	

15	Communication method	CAN0/RS485	
16	Cabinet Dimension	1850*1390*2190mm	
17	Ingress Protection	IP55	
18	Battery box weight	2.3 tons (estimation)	
19	Packaging material	Pallet	

4.4 Environmental Characterization

(Charge according to the standard, after fully charged, leave it for 0.5h to do the following tests)

ambient temperature	discharge current	Battery Capacity Requirements
25℃	1.0I1A	The measured capacity of the discharged battery is not less than 100% of the nominal capacity, and the appearance of no deformation and no rupture
0℃	1.0I1A	The measured capacity of the discharged battery is not less than 90% of the nominal capacity, and the appearance is not deformed or cracked.
-10℃	1.0I1A	The measured capacity of the discharged battery is not less than 75% of the nominal capacity, and the appearance of no deformation and no rupture
55℃	1.0I1A	The measured capacity of the discharged battery is not less than 95% of the nominal capacity, and the appearance of no deformation and no rupture

4.5 Security Characteristics

items	Specification	Notes
Insulate electricity	≥10MΩ	With insulation resistance tester DC 500V test voltage, the battery positive and negative terminal interface (terminal) were tested on the battery pack metal case, insulation resistance value ≥ 10MΩ.
Insulating strength	No breakdowns, no flying arcs	Battery positive and negative terminal interface respectively on the battery pack metal casing can withstand 50Hz, RMS 500V AC voltage (leakage current ≤ 10mA) or 710V DC voltage 1min, no breakdown, no flying arc
Anti-immersion	No leaks, smoke, fire or explosion	The fully charged battery pack will be immersed in 3.5% NaCl solution, the depth of water completely over the battery pack, keep it for 2h, take it out, and then place it under the ambient temperature of 15℃~35℃, relative humidity of 25%~85%, and atmospheric pressure of 86kPa~106kPa for 4h.
Drop resistance	No obvious damage, no leakage, shell rupture, fire or explosion, and no displacement of the battery pack and each position when shaken up and down.	The battery pack is fully charged, and 6 angles are selected arbitrarily, and the battery pack is dropped to the concrete floor once from the highest point of the set height (0.8 meters to 1.8 meters).

Constant humidity	No obvious deformation, corrosion, smoke or explosion, and its capacity should not be less than 90% of the measured base capacity.	After the battery is fully charged, when there is BMS, put it into the constant temperature and humidity box of 60℃±2℃ and relative humidity of 90%~95% for 12h, then take it out and let it stand for 2h under the condition of ambient temperature of 25℃±2℃, visually inspect its appearance, and then discharge it to the termination voltage with the current of 1.0I1A.
Vibro-meter	No explosion, no fire, no deformation, no shedding of parts, no abnormal voltage, no sharp change in discharge current	After the battery pack is fully charged, it is fixed on the vibration table in the direction of the large side, and the amplitude of the battery pack is applied to the battery pack as 5mm, the maximum stroke is 10mm, and the vibration frequency is from 10Hz to 55Hz. Vibration test is carried out in the x, y, and z direction of the battery pack respectively, and the test time of sweeping cycle between the frequency of 10Hz to 55Hz in each direction is 90min±5min, and the battery pack is set aside for 1h after the end of the test. The test time was 90min±5min for each direction of frequency sweep from 10Hz to 55Hz.

4.6 Perfluoroacetone Fire Extinguishing Equipment

4.6.1 Product Introduction

Perfluorohexanone fire extinguishing device (rechargeable type) (built-in or external type) consists of fire extinguishing agent storage bottle, perfluorohexanone agent, spray nozzle, gas generator device, thermal initiation start line (can choose mechanical temperature-sensitive start or electric initiation start) and so on. This device integrates automatic fire detection and fire extinguishing functions, automatic start, rapid fire extinguishing, and can quickly and effectively extinguish battery fires.

Non-pressure storage perfluorohexanone fire extinguishing device consists of fire extinguishing agent storage bottle, perfluorohexanone agent, spray nozzle, piston cylinder (push type), gas generator device, thermal initiation start line (mechanical temperature-sensitive start or electrical initiation start is optional) and other components. This device integrates automatic fire detection and fire extinguishing functions, automatic start, rapid fire extinguishing, and can quickly and effectively extinguish battery fires.

Thermal start When the temperature reaches 175±5°C, the perfluorohexanone fire extinguishing device senses the temperature rise, and reaches the specified sensing temperature device automatically sprays the agent to achieve rapid cooling and rapid fire extinguishing.

Mechanical temperature sensing start with mechanical temperature sensing start device, when the temperature reaches 93°C, perfluorohexanone fire extinguishing device senses the temperature rise, and reaches the specified sensing temperature device automatically sprays the agent to achieve rapid cooling and quick fire extinguishing.

The start-up contains start-up device, feedback device, controller, display, composite fire detector (optional) and other components. According to the equipment will detectors, arranged in the PACK inside, in the battery thermal runaway, high-precision composite detector through the multi-data composite judgment, to the non-storage pressure automatic fire extinguishing device output 24V start-up voltage and open the corresponding PACK extinguishers, and at the same time to the control of the host reported thermal runaway signals, extinguishant through the nozzle high-speed spray, rapid fire extinguishing. It is a kind of early fire extinguishing system, with fast and accurate response, more timely release of extinguishing agent and better targeting, which can quickly and effectively detect early thermal runaway and extinguish the early fire, and achieve long time suppression of thermal runaway of the battery through repeated spraying, so as to minimize the loss.

4.6.2 Firefighting Programs

PACK suppression of fire: each pack is equipped with a set of built-in perfluorohexanone fire extinguishing device (rechargeable type), through the thermal initiation of the start line for temperature monitoring, when the temperature reaches the expected temperature, the fire extinguishing device is automatically sprayed to cool down or extinguish the fire.

- Cluster-level suppression of fire: each cluster is equipped with two sets of non-storage pressure perfluorohexanone fire extinguishing devices, through the thermal initiation of the start line or mechanical temperature sensing start device for temperature monitoring, when the temperature reaches the expected temperature, the fire extinguishing device is automatically sprayed to cool down or extinguish the fire.

4.7 100 KW PCS

4.7.1 PCS Technical Parameters

DC Side Parameters		
Number of channels	1	
DC voltage range	DC600V ~ 900V	
DC maximum current	192A	
Rated DC power	100kW	
Voltage stabilization accuracy	≤±2%	
Stabilization accuracy	≤±5%	
Pressure Limiting Characteristics	Equipped with	
Current Limiting Characteristics	Equipped with	
AC side parameters		
Rated output power	100kW	
Overload capacity	1.1x long term, 1.2x 1min	

Rated voltage	AC 400V	
Rated output current	145A	
AC access method	Three-phase four-wire	
Isolation method	None	
Grid voltage range	400V(-20%～+15%)	
Grid frequency range	50Hz/60Hz±2.5Hz	
Current total harmonic distortion rate	≤3%(full load)	
Power factor	-0.99～+0.99	
DC component of current	≤0.5%	
Charging and discharging conversion time	＜100ms	
AC off-grid parameters		
AC off-grid voltage	AC400V	
AC voltage range	AC400V±3%	
AC off-grid frequency	50Hz/60Hz	
Off-grid THDU output	≤3%(Linear load)	
Unbalanced load capacity	100%	
Other parameters		
Maximum conversion efficiency	≥98%	
Allowable ambient temperature	-20℃～50℃(＞45℃Derating required)	
Allowable relative humidity	≤95%	
Noise	≤75dB	
Ingress Protection	IP20	
Altitude	Greater than 2000 meters, derating is required.	
Dimension	W480mm×H186mm×D620mm	
PCS module structure and heat dissipation	Primary terminals rear panel, secondary terminals front panel, front inlet and rear outlet;	
Ventilation of PCS modules	467(CFM)	
Minimum effective air inlet area of PCS module	43232(mm^2)	Effective ventilation area without shutters and with air inlet and outlet facing the module
Minimum effective air outlet area of PCS module	69171(mm^2)	
Weight	50KG	
Cooling method	Forced air cooling	

Multi-module networking mode	DC side separate - AC side parallel/AC/DC dual parallel	
Emergency stop function	The module's IO receives the emergency stop switch command	
Human-computer interaction	The module does not have an LCD screen and requires an external 7-inch configuration screen	
BMS communication interface	CAN	
EMS communication interface	Network port	
Communication between modules	Fiber optic	
Communication with the screen	Network port	

4.7.2 PCS Appearance Picture

4.8 Thermal Management System

4.8.1 Liquid Cooling Product Parameters

Product Name	8kW Energy storage chiller unit

Product Model	LSE-08A
Operating Ambient Temperature	-30~+55℃（cooling）
Storage Temperature	-40~+80℃
Type of coolant	50% water /50% ethylene glycol
Refrigerant Type	R410a
power supply	220VAC(176~274VAC), 50 & 60, L-N
communication	CAN 2.0B B a u d r a t e 500 kbps
Refrigerating capacity	≥8.0kW @18℃Water temp& 45℃Ambient temp
heating capacity	≥2.5kW @40℃Water temp
refrigeration COP	≥2.2 @35℃
power factor	≥90%
Electric power of refrigeration	≤4.5kW
Electric power for heating	≤3.5kW
Self cycle electrical power	≤0.3kW
Static power	≤30w
Coolant flow rate	≥50 L/min @ 90kpa@18℃Water temp
Noise level	≤78 dB(A)
Protection grade	IPX7（Electrical parts）
Case material	Steel
Appearance of the color	Rhine White
Total quality	136kg±5kg
Overall dimensions	H1050mm*L1150mm*W275mm
Installation	Retaining bolt installation
Outer diameter of inlet pipe	Φ25 mm
Outer diameter of outlet pipe	Φ25 mm
Ac power supply port	1×C10514W1-02-3-1 G002
Communication interface	1×GR71208SN
Withstand voltage	2500Vdc, 60s, <20mA
Insulation properties	1000Vdc, 60s, >100MΩ
Ground resistance	＜0.1Ω
Pollution levels	Class IV
Over voltage level	Class III
Work at an altitude of	≤4000m
EMC	IEC61000-6-2 & IEC61000-6-4 3 level
Vibration	GB/T 4798.2-2008
Environmental protection	GB/T 30512-2014
Corrosion protection	Coating C4
Terminal resistance	NO (Without terminal resistor)

4.8.2 Liquid Cooler Dimensions

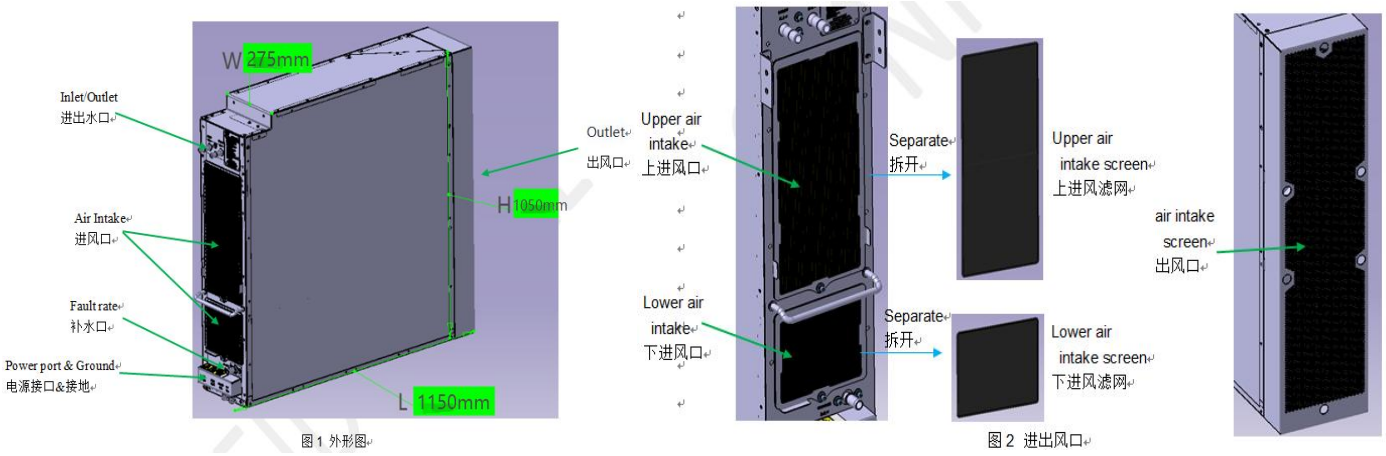
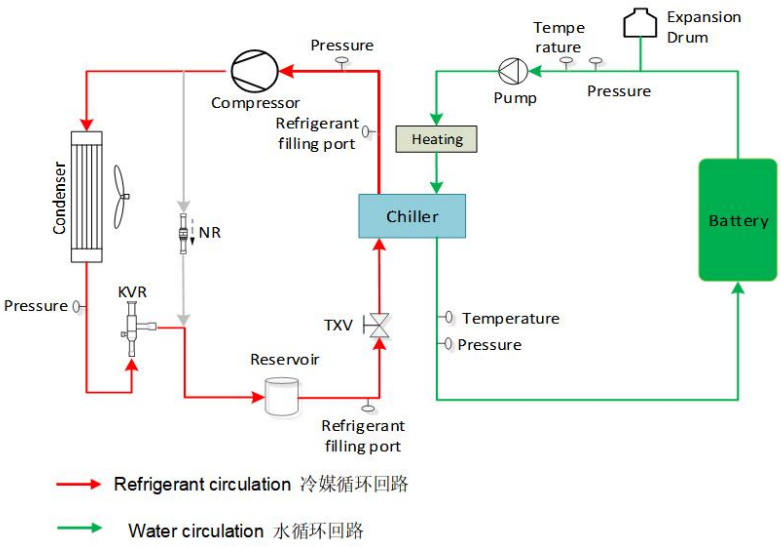


图 1 外形图

图 2 进出风口

4.8.3 Liquid Cooling Unit Operation Principle Diagram



4.9 BMS

4.9.1 BMS System Architecture

The energy storage battery management system (BMS) secondary architecture system is a battery energy management architecture suitable for small energy storage systems with a voltage of 1500V and below. The energy storage system architecture can monitor and manage energy storage battery parameters in real time, including high-precision SOx (SOH/SOC) estimation, insulation detection, bootloader online upgrade, thermal management, fault diagnosis, charge and discharge management, balancing and other functions, and interact with the screen control device or remote server through Ethernet or RS485 bus to ensure efficient, reliable and safe operation of the energy storage system.

The battery management system (BMS) of this project has a two-level architecture: including BMU and BAU.

4.9.2 BMS Function Description

- Supports voltage monitoring of up to 54 cells in a single cluster
- Supports temperature monitoring of up to 27 cells in a single cluster

- Charge and discharge management
- Photovoltaic and energy storage collaborative management
- Energy storage arbitrage management
- DC side current detection
- DC side voltage detection
- Insulation resistance detection
- Multi-level (cell, pack, cluster) SOx estimation
- Relay control
- CAN communication
- RS485 communication
- Ethernet communication
- Three-level fault diagnosis function
- Fault recording function
- Thermal management
- Online program upgrade
- Passive balancing execution
- Line break diagnosis function and temperature sensing fault diagnosis

4.9.3 Slave Control BMU

The energy storage battery management system (BMS) slave control BMU product is a slave control acquisition product suitable for energy storage systems with voltages of 1500V and below. The product is installed in the battery pack and can sample the single cell voltage and temperature information of the battery, and can realize the voltage and temperature acquisition harness status. In addition, this product can also realize the information collection of fan control and fire protection in the pack and transmit the data to the master control BCU through CAN communication. The picture is shown in Figure 7-1.

BMU has the following characteristics based on system requirements:

- ✧ Relay control
- ✧ CAN communication
- ✧ Thermal management
- ✧ Online program upgrade
- ✧ Battery cell temperature monitoring
- ✧ Battery cell voltage monitoring
- ✧ Passive balancing execution

BMU Parameter Table

Primary BMS – Slave BMU		
Working voltage	12V DC～36V DC（External power supply/self-powered）	
Working ambient temperature	-20℃～50℃	
Working humidity	5%～90%	
Power supply	DC12V/24V	
Digital signal detection	4 channel	
Digital signal output	4 channel	
Voltage acquisition	Number of acquisition channels	Maximum 54 channels, and backward compatible
	Acquisition Scope	1V～5V
	Acquisition accuracy	inaccuracies：±5mV
	Acquisition cycle	≤100ms
Temperature acquisition	Number of acquisition channels	Maximum 18 channels
	Acquisition Scope	-40℃～+125℃
	Acquisition accuracy	-40℃～-30℃．inaccuracies：±2℃
		-30℃～+60℃．inaccuracies：±1℃
		+60℃～+125℃．inaccuracies：±2℃
	Acquisition cycle	≤100ms
Equalization	Starting conditions	Follow the strategy
	Equalization current	100mA
Relay control number	Control channel number	4 channels (3 active, 1 passive)
	Driving voltage	24V DC
	Drive capability	1A

Optocoupler control channels	1 active output, no load capacity, only DO signal output	
CAN communication	Communication channels	1 channel (communication with secondary BMS)

4.9.4 Master BAU

The energy storage battery management system (BMS) smart control unit is a battery management control unit product suitable for three-level energy storage architecture. The product summarizes and displays the data of cells, battery packs and battery clusters of ≤5WMH energy storage systems; calculates SOx for battery stacks; realizes information monitoring and control with PCS, environmental control system, and fire protection system; supports universal power protocols and remote dispatch; supports large-capacity data storage and supports EMS energy management of local systems according to the system architecture.

According to the functional requirements, the design features of BAU are:

Charge and discharge management

Photovoltaic storage collaborative management

Energy storage arbitrage management

Four-level (cell, pack, cluster, stack) state of charge estimation (SOC)

Four-level (cell, pack, cluster, stack) life state estimation (SOH)

Four-level (cell, pack, cluster, stack) nominal capacity estimation

Relay control

CAN communication

RS485 communication

Ethernet communication

4G/GNSS communication (optional)

DTU communication

Four-level fault diagnosis function

Fault recording function

Online program upgrade

Battery health diagnosis

Smart operation and maintenance (optional)

Support for general power protocols such as IEC61850 and IEC104 (optional)

Specific parameters are shown in the table.

BAU Specific Parameters

Energy storage intelligent control unit BAU

Working voltage	12V DC～36V DC （External power supply）	
Working temperature	-20℃～50℃	
Working humidity	5%～90%	
Power supply	DC12V/24V	
Digital signal detection	16 channels	
Digital output	16 channels	
Communication Interface	RS485	4 channels (with isolation)
	RS232	1 channel (with isolation)
	Ethernet	2 channels
	CAN	2 channels
	4G	1 channel
Human-computer interaction	10.1 inch capacitive screen	
Mass storage	128GB	

4.10 EMS (Energy Management System)

4.10.1 Energy Management System Software Functions

1) Monitoring and control functions

The energy management system monitors the operation of the main equipment in the energy storage station, including:

A. The main equipment of the energy storage system, the power converter (PCS) and the battery management system (BMS), are monitored in real time. The monitoring parameters include the main power parameters of the PCS, the stack data and series data of the battery management system, as well as the single cell voltage, current, SOC data, and the fault and alarm data during equipment operation.

B. The auxiliary monitoring equipment of the energy storage system includes the fire protection system and the temperature control system. The energy management system is linked according to the signal provided by the fire protection system. When the fire alarm is activated, the system stops the operation of all equipment. The energy management system monitors the operating temperature in the cabinet through the liquid cooling system and controls the operation according to the temperature conditions.

In the normal operation mode of the system, automatic operation mode and manual operation mode are adopted. In the automatic operation mode, the PCS is automatically controlled according to the operation strategy, and the manual operation interface is closed. In the manual operation mode, the manual operation interface of the equipment is provided to accept manual setting control.
The system workstation provides a visual monitoring and operation interface. The system displays all measurement information in a variety of ways, including topological diagrams, equipment data lists, curve graphs,

bar graphs, distribution graphs, etc. The system operation interface is simple, convenient and efficient.

2) Alarm and fault prompt function

The system provides graded alarm and fault prompt functions, and supports setting the alarm type, level and alarm method according to user needs and equipment manufacturer requirements.

The alarm signals supported by the system include: alarm information provided by the equipment itself, and system operation alarm information provided by the energy management system master station.

Supports multiple alarm methods such as text, voice, and flashing. Supports manual and automatic confirmation and deletion of alarm information. Supports historical alarm information query by type and alarm source classification.

The system provides historical storage of all event alarm information.

3) Historical data query

The system stores all the original operation data of all equipment and the historical operation data of the system according to the collection time interval, including: equipment data, alarm data, system operation data, operation control data, etc. The system supports a variety of relational databases, and users can choose the database according to the system situation.

The system provides a friendly and convenient human-computer interface to complete the query and display of historical data, historical warnings and fault information, and operation event records. It supports query by date, type, and equipment number, and displays the query historical instantaneous data records, real-time statistical data, and historical statistical data in the form of tables, curves, bar charts, etc.

For real-time data, historical storage can save at least the real-time data of the last two years (configure appropriate physical storage devices according to the dimension of the stored data and the storage interval).

4) Statistical analysis function

The system's analysis and statistics functions include statistics on the operation of the energy storage system, including the charge and discharge capacity, maximum and minimum power, and charge and discharge cycle statistics of each energy storage unit, which can provide data comparison between various energy storage units.

At the same time, it also includes statistics on the operation of a single device, including the number of failures, the cumulative safe operation time, and other information.

5) Reporting function

The system's reporting functions include: report making, report display, report publishing, and report printing. The reporting subsystem can generate daily, monthly, and annual reports very conveniently and flexibly.

The data that can be displayed in the report include: various statistical values and maximum and minimum values such as the charge and discharge capacity and charge and discharge power of the energy storage system.

4.10.2 Energy Management System Operation Indicators

Table 1 Energy Management System Operation Indicators

No.	Technical parameter name	Parameters
1	Current and voltage measurement errors	≤0.2%
2	Active power and reactive power measurement error	≤0.5%

3	Station Event Sequence Recording Resolution(SOE)	≤2ms
4	Real-time data refresh cycle	≤2s
5	Grid frequency measurement error	≤1Hz
6	Analog over-deadband transmission of the set minimum value, and point-by-point adjustable	≥0.1％
7	Analog over-deadband transfer time (to station control level)	≤2s
8	Status variable transmission time (to station control level)	≤1s
9	Analog message response time (from I/O input to remote communication device outlet)	≤3s
10	State quantity change response time(from I/O input to remote communication device outlet)	≤2s
11	Control the time from command generation to output	≤1s
12	Control operation correctness	=100%
13	Correct rate of remote control maneuvers	=100%
14	Remote control test pass rate	=100%
15	Annual correct action rate of telemetry at the time of the accident	≥99%
16	System availability	≥99.9%
17	System Mean Time Between Failures (MTBF) which I/O unit module MTBF ≥ 50000h	≥20000h
18	Mean Time Between Failures (MTBF) for Interlayer Measurement and Control Units (IMCUs)	≥40000h
19	The average CPU load factor for each workstation:	
	Normal (within any 30 min)	≤30%
	In case of power system failure (within 10s)	≤50%
20	Monitor the average network load factor of the system:	
	Normal (within any 30 min)	≤30%
	In case of power system failure (within 10s)	≤50%
21	History curve sampling interval	1min~30min adjustable
22	Historical curve daily and monthly report storage time	≥1 year
23	Accident Memories:	
	Pre-accident	1min
	Post-accident	2min
24	Dual host switchover time:	≤30s
25	System capacity:	
	Number of access stations	≥1024
	Number of states	≥500000
	Number of Analogs	≥600000
	Number of meters	≥200000
	Number of Remote Controls	≥20000
	Number of remote control adjustments	≥20000

4.11 High Voltage Box

The high voltage box integrates contactors, circuit breakers, fuses, current sensors, pre-charging resistors, battery pack management unit, high voltage management unit and so on. The high voltage box is the protection and control unit for the DC side of the battery cluster connected to the back-end power electronic equipment, which is equipped with the functions of current detection, synchronized control and isolated output, short-circuit protection, over-current protection, cell over-charging and over-discharging protection, cell over-temperature protection, communication abnormality protection, high-voltage detection, insulation impedance detection, and SOC calculation of the battery pack, and at the same time, it also carries out the monitoring, management and diagnosis of the battery module.

This project has a total of 1 high-voltage box, the use of Xie Neng 300A/1000V standard high-voltage box. The parameters of the high voltage box are shown in the table.

Table 7-3 Technical Parameters of High Voltage Box

No.	Performance indicators	Specification	Notes
1	Maximum voltage （V DC）	1000	
2	Maximum current （A）	300	
3	Communication interface	CAN、RS485	
4	dimension （W*D*H,mm）	420×220×500	
5	Weight （kg）	TBD	

4.12 STS On-Grid and Off-Grid Switching Device

4.12.1 Product performance

- Quick disconnection from the grid: The switching time between grid and off-grid is less than 20ms, and the grid and microgrid can be quickly disconnected and connected.
- Active on-grid and off-grid switching: When the PCS detects that the voltage on the grid side is abnormal, it controls the STS to cut off, and at the same time, the PCS provides voltage support to the microgrid, and the system operates in island mode; when the PCS detects that the grid voltage returns to normal, the microgrid system synchronizes the grid voltage, and closes the STS to connect to the grid to achieve grid-connected operation.
- Passive on-grid and off-grid switching: When PCS receives an island operation command, PCS controls STS to cut off, and PCS provides voltage support to the microgrid, and the system operates in island mode. When PCS receives an exit island operation command, the microgrid system synchronizes the grid voltage, closes STS and connects to the grid, and realizes on-grid operation.
- Equipped with bypass maintenance function: Equipped with bypass maintenance switch to ensure uninterrupted power supply to important loads.

4.12.2 Product Application Scenarios

(1)User-side energy storage system

(2)Small microgrids operating on or off the grid

(3)Emergency power supply systems such as data centers and vehicles

(4)Other high-reliability power supply systems

4.12.3 Protection function

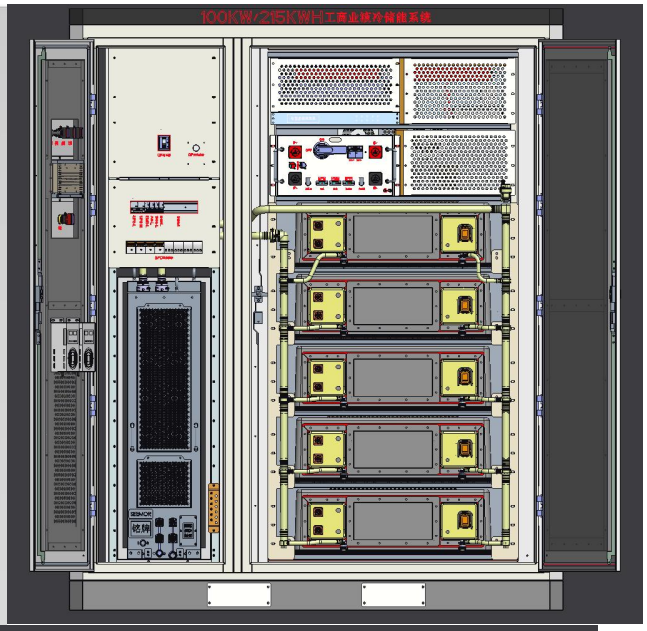
- Thyristor over-temperature protection
- Thyristor fault protection
- Grid-side switch overload, short-circuit protection Load-side switch overload, short-circuit protection

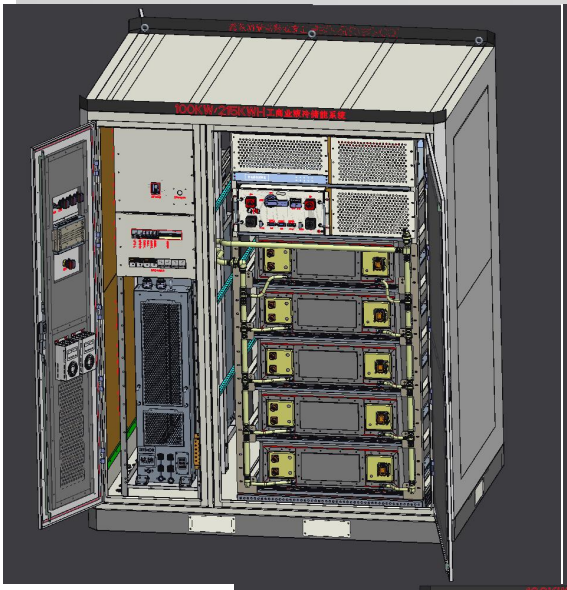
4.12.4 Technical parameters

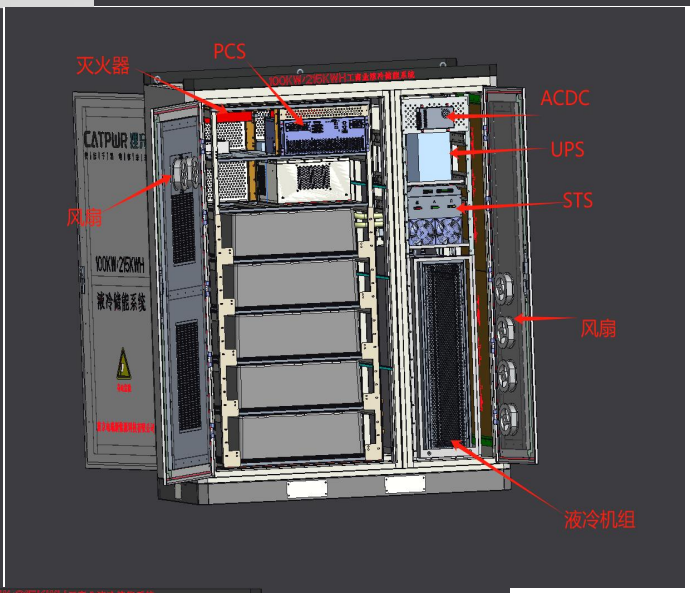
Rated voltage	0.4kV	
Rated current	290A	
Rated power	200KVA	
Rated frequency	50HZ	
On-grid and off-grid switching time	≤20ms	
Grid side switch	400A	
Load side switch	200A	
Bypass maintenance switch	200A	
Protection level	IP20	
Dimension	500*1000*2200	W*D*H
Weight		
Primary interface	Grid-side interface: A/B/C/N; Load-side interface: A/B/C/N; AC-side interface for PCS: A/B/C/N;	
Secondary Interface Input	External DC 24V input signal; thyristor switch trigger signal;	
Secondary Interface Output	Thyristor over-temperature feedback output; grid-side voltage signal; AC control power supply output;	
Rated voltage	0.4kV	
Rated current	580A	
Rated power	400KVA	
Rated frequency	50HZ	
On-grid and off-grid switching time	≤20ms	
Grid side switch	800A	
Load side switch	400A	
Bypass maintenance switch	400A	
Protection level	IP20	
Dimension	500*1000*2200	W*D*H
Weight		
Primary interface	Grid-side interface: A/B/C/N; Load-side interface: A/B/C/N; AC-side interface of PCS: A/B/C/N;	
Secondary interface	External DC 24V input signal; thyristor switch trigger signal;	
Communication Interface	Thyristor over-temperature feedback output; grid-side voltage signal; AC control power supply output;	

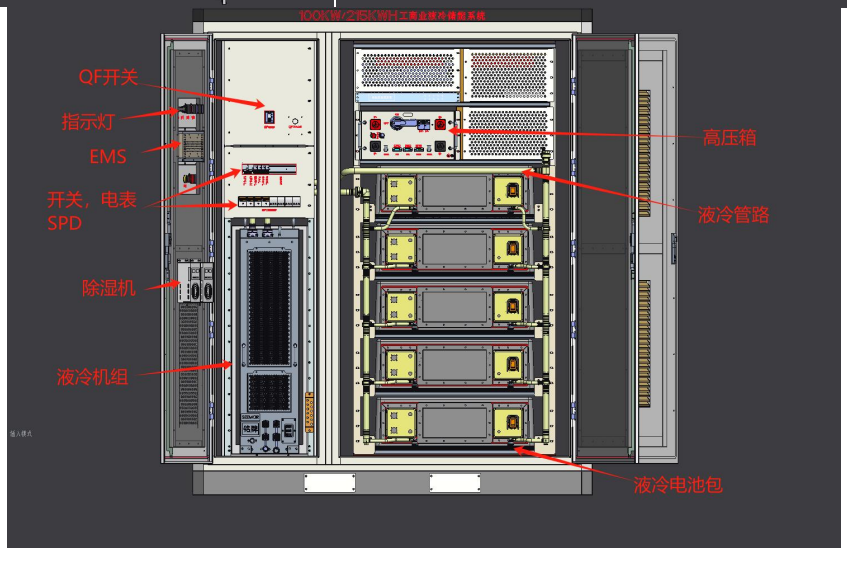
V. Product Schematic

5.1 Energy Storage System Appearance and Dimensions

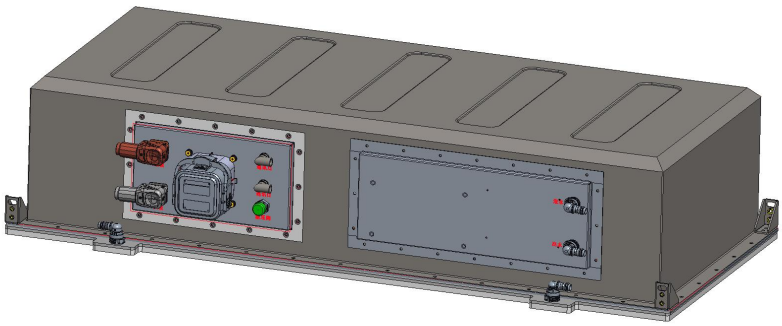






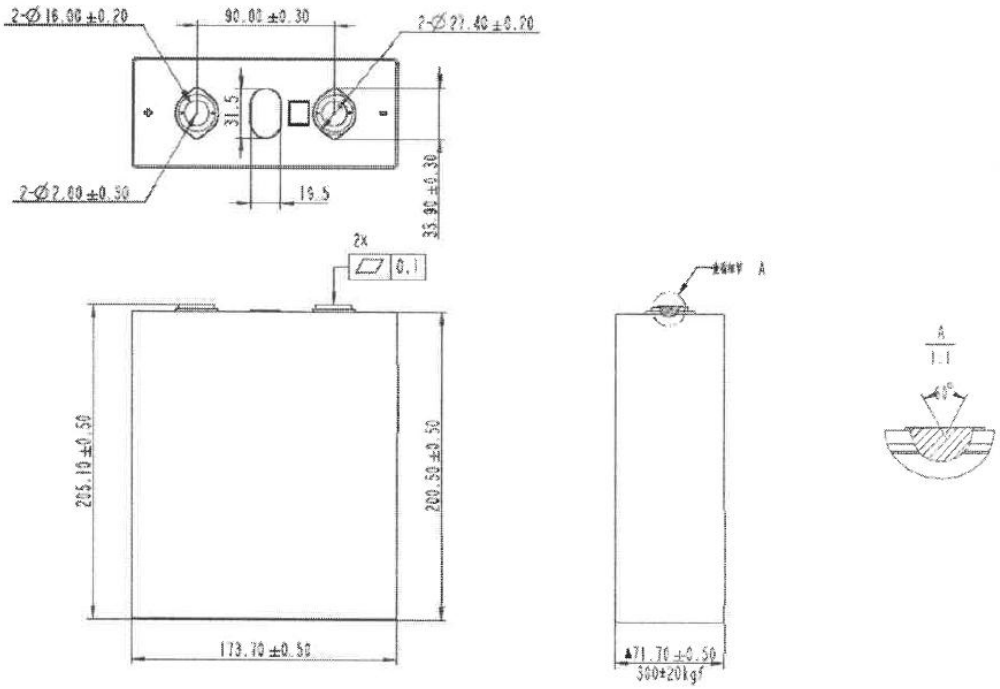


5.2 Battery Module Schematic



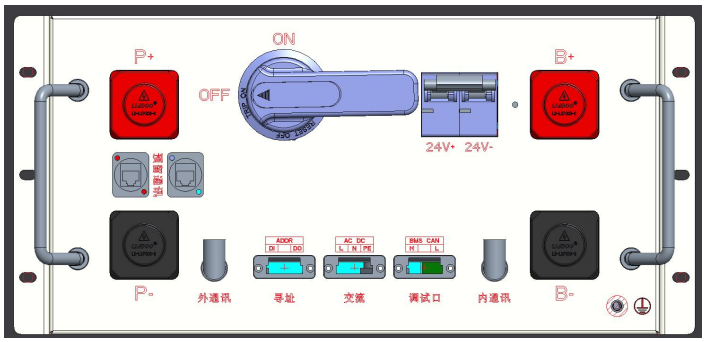
5.3 Battery Cell Dimensions

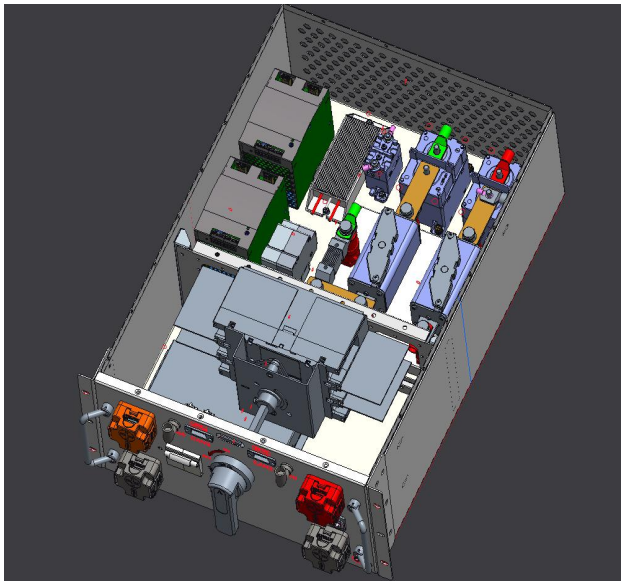
- The battery cells are mature standard A-grade 280Ah lithium iron phosphate (LFP) square aluminum shell cells produced by fully automatic production lines. This cell has high continuous power, high cycle life, high storage life and high safety. (As shown in the picture)



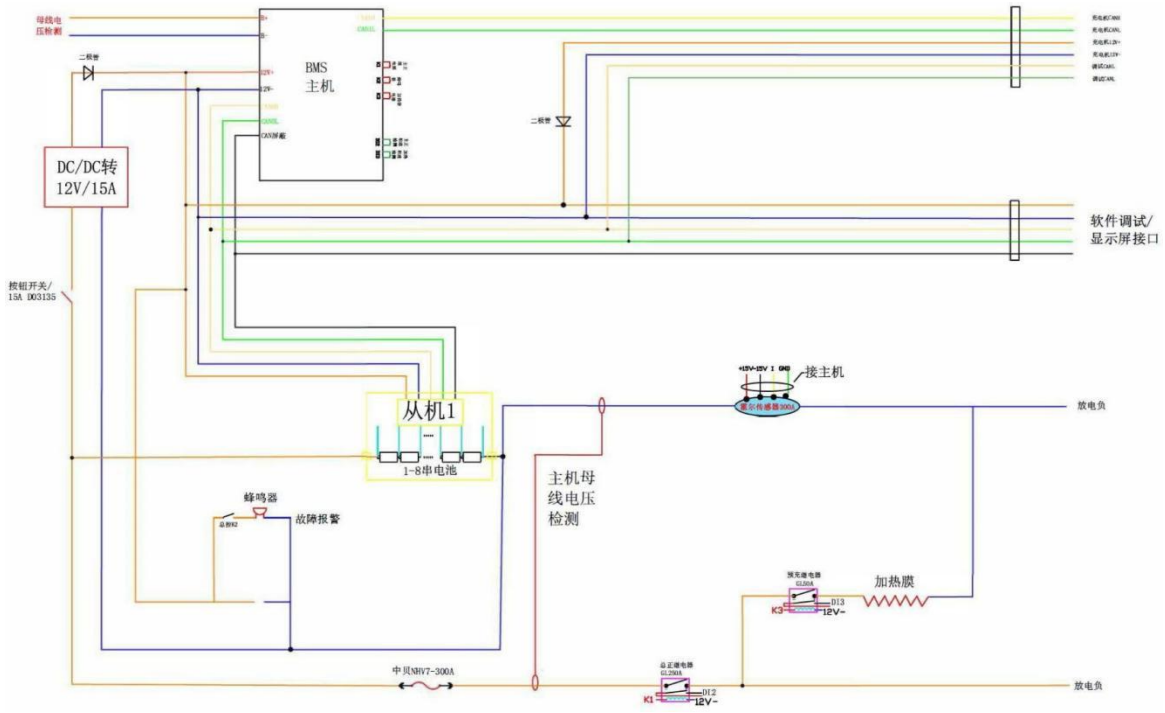
Battery Dimensions

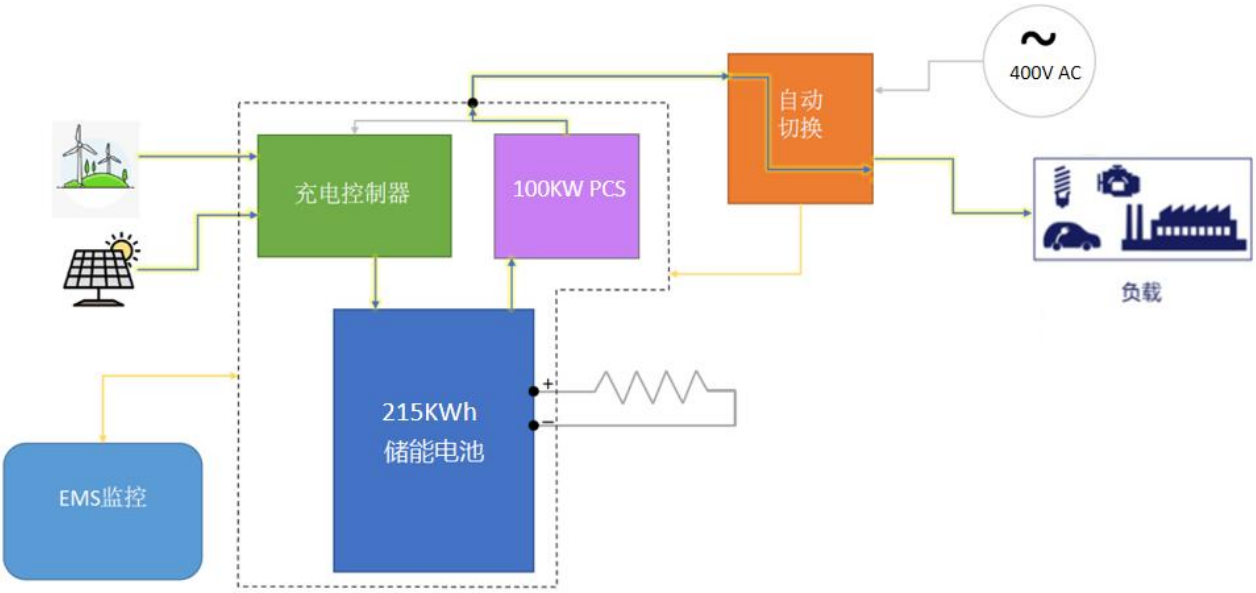
5.4 High Voltage Box Schematic Diagram





VI. Battery Electrical Principle and Working Principle Diagram of Energy Storage System





VII. Conditions of Use

7.1 Packaging

7.1.1 Method: □ Neutral carton (domestic) □ Dangerous goods carton (export) Wooden pallet (bulk container export).

7.1.2 Each battery pack should have an outer packaging, and should be accompanied by a product manual and certificate of conformity. Packaged products should be placed in dry, dust-proof and moisture-proof packaging boxes. The product name, model, voltage, capacity, quantity, gross weight/net weight, LOGO, battery serial number, etc. should be marked on the outside of the dangerous goods packaging box. The neutral packaging box does not contain the above content. There should be necessary signs such as "Handle with care", "Afraid of moisture", "Upward", "Afraid of fire", etc.

7.1.3 Materials accompanying the goods: Shipping inspection report, product manual, host computer software, communication protocol (electronic file), etc.

7.1.4 Anti-vibration and anti-pressure measures: Both sides (upper and lower) of the battery module need to be filled with anti-vibration materials.

7.1.5 Waterproof, anti-scattering, and handling: The battery module is covered with a nylon bag, tightened with strapping, and palletized.

7.2 Transportation

Battery packs should be packed into boxes for transportation, and should be prevented from violent vibration, impact or extrusion during transportation, and prevented from sunlight and rain, and can be transported by cars, trains, ships, airplanes and other means of transportation.

7.3 Storage

7.3.1 Batteries are usually stored in a clean, dry, ventilated and rain- and snow-proof room with an ambient temperature of -5℃ to 35℃ and a relative humidity of not more than 75% in a 20% to 40%

charged state, and should be placed flat on the floor and cushioned from the ground with a distance of not less than 100MM;

7.3.2 Batteries must not be stored with reactive chemicals or dusty materials;

7.3.3 The battery should not be subjected to any mechanical impact or heavy pressure;

7.3.4 Batteries should be kept out of direct sunlight, away from sources of ignition, and not less than 2M from sources of heat;

7.3.5 From the date of manufacture, the battery should be recharged for 30-60min every 3 months at 0.2-0.5C current, and the temperature range is 25℃±5℃.

VIII. User Responsibility Letter

Users must use the battery in accordance with the instructions on the battery label or this battery specification sheet of Anhui Lvwo Recycling Energy Technology Co., Ltd. If the power system overheats or even catches fire or explodes due to improper use by the user, the company will not bear any responsibility for the damage caused.

IX. Dangerous Matters

Failure to read the following carefully may cause battery leakage, explosion or fire.

(1) Do not put the battery into water or get it wet;

(2) Do not use or store the battery near a heat source (such as a fire or heater);

(3) Do not connect the positive and negative poles in reverse;

(4) Do not connect the battery directly to a wall socket or a car cigarette lighter socket;

(5) Do not throw the battery into fire or heat the battery;

(6) Do not short-circuit the positive and negative poles of the battery with wires or other metal objects, and do not transport or store the battery together with necklaces, hairpins or other metal objects;

(7) Do not hit, throw or subject the battery to mechanical vibration;

(8) Do not pierce the battery shell with nails or other sharp objects, and do not hammer or step on the battery;

(9) Do not disassemble the battery in any way;

(10) Do not charge the battery under fire or extreme heat conditions.

(11) Do not place the battery in a microwave oven or pressure container;

(12) Do not use the battery in combination with primary batteries (such as dry batteries) or batteries of different capacities, models, or types;

(13) Do not use the battery if it emits an odor, becomes hot, deforms, changes color, or exhibits any other abnormality; if the battery is being used or charged, remove it from the appliance or charging device immediately and stop using it;

(14) Batteries should be kept out of the reach of children;

(15) If a battery leaks or emits an odor, it should be immediately removed from open flames; leaking electrolyte may cause fire or explosion;

(16) If the electrolyte leaks from the battery and enters your eyes, do not rub them but rinse with water and seek medical help immediately. If not treated promptly, your eyes may be damaged.

X. Precautions

(1) Please strictly follow the instructions to use the lithium battery pack. If the battery leaks and the electrolyte gets on your skin or clothes, wash the affected area immediately with running water, otherwise it may cause skin inflammation

(2) Read the instructions of the device using the battery and install and remove the battery correctly

(3) If the terminals of the battery pack become dirty, wipe them clean with a dry cloth before use. Otherwise, the battery pack will have poor contact, causing energy loss or failure to charge.

(4) It is strictly forbidden to disassemble or repair the battery system without professional treatment.

(5) It must be charged with a charger specially matched for this battery system.

(6) It is strictly forbidden to immerse the power system in water or salt water. Please keep the battery in a cool and dry environment when not in use.

(7) If the power system emits an odor, heats up, changes color or deforms, or becomes abnormal in any way during charging or discharging, stop the operation immediately and find a professional to handle it.

(8) When the battery catches fire, use dry sand or nitrogen fire extinguisher to put out the fire.

(9) Never put the battery system into fire or heat source.

(10) When installing or using the battery, please remove metal jewelry or other metal objects, and be careful when handling the battery, especially when placing it in a metal container.