4.179MWh Liquid Cooling Container with 2P52S Module (ESS-ES4179A-LP71173207) Product Specification

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Revision Record

Rev.	Description of Revision	Author	Date
0	First release	Ziye Jiang	20240826
1	Update the cycle life of cell, module, etc.	Ziye Jiang	20240905
2	Update the model of air conditioners.	Ziye Jiang	20240913
3	Update the model of liquid cooling unit.	Ziye Jiang	20241011

Content

Definitions

ESS	Energy Storage System
BOL	Begin of Life
EOL	End of Life
DOD	Depth of Discharge
SOC	State of Charge
SOE	State of Energy
SOH	State of Health
SOP	State of Power
BPU	Battery Protection Unit
BMS	Battery Management System
CAN	Controller Area Network
ESBMM	Energy Storage Battery Management Module (ESBMM), the local battery management unit monitors parameters such as cell voltage and temperature within a single module, as well as cell balance management.
ESBCM	Energy Storage Battery Control Module (ESBCM) is for rack-level control and responsible for managing a rack/cluster of battery modules, communicating with all ESBMM and ESMU, receiving and processing all battery information uploaded by ESBMM, and uploading alarm information to ESMU. It can also receive and respond to commands transmitted by ESMU.
ESMU	Energy Storage Management Unit (ESMU) manages all battery modules and battery protection units under its jurisdiction as well as communicating with the remote monitoring system and PCS.

Referenced Industry Standards

No.	Standard	Description
1	GB/T36276-2018	Lithium-ion battery for electrical energy storage.
2	GB/T36558-2018	General technical requirements for electrochemical energy storage system in power system.
3	GB/T 34131-2017	Technical standard for battery management system of electrochemical energy storage station.
4	T/CEC 373-2020	Technical specification for fire protection of lithium iron phosphate battery energy storage power station based on prefabricated cabin.
5	NB/T 42091-2016	Technical specification for lithium-ion batteries of electrochemical energy storage station.
6	GB/T 191-2008	Packaging-pictorial marking for handling of goods.
7	GB 16806-2006	Automatic control system for fire protection.
8	GB 50370-2005	Code for design of gas fire extinguishing systems.
9	GB 50263-2007	Code for installation and acceptance of gas extinguishing systems.
10	GB 50116-2019	Code for design of automatic fire alarm system.
11	GB 50166-2019	Standard for installation and acceptance of fire alarm system.
12	GB 15322.1-2019	Point-type combustible gas detectors for industrial & commercial use.
13	GB 16806-2006	Automatic control system for fire protection.
14	GB 15322.1-2019	Point-type combustible gas detectors for industrial and commercial use.
15	DB 37/T 3642-2019	Code for design, installation, and commissioning of fire extinguishing systems.
16	UL–Underwriter's Laboratories	UL9540A, UL9540, UL1973.
17	IEC62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
18	IEC63056	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
19	IEC 62933-5-2	Safety requirements for grid-integrated - Electrochemical-based ESS system.
20	NFPA 855/68/69	NFPA – National Fire Protection Association.

21	UN3536, UN38.3	Lithium Batteries Installed in Cargo Transport Unit.
22	IEC 61850	General standard in the field of power system automation.
23	IEC 104	Communication protocol
24	IEC 60529	Ingress Protection (IP Code) certification to rate the enclosures of electric and electronic devices against the intrusion of dust and liquids.
25	IEC60730-1	automatic electrical controls for use in, on, or in association with equipment for household appliance and similar use.
26	ROHS	Cell meets the requirements. Container products are the ROHS exempt products.
27	IS17387	General Safety and Performance Requirements of Battery Management Systems (Self Declaration _Compliance)
28	IS17092	Electrical energy storage systems: safety requirements (Self Declaration _Compliance)

1. Product Specification

Table 1 Key Parameters for the 4.179 MWh Liquid Cooling Container

Product Model	ESS-ES4179A-LP71173207	
No.	Description	Parameter Value
1	Rated Energy	4.179MWh
2	Rated Voltage	1331.2V
3	Operation Voltage Range	1123.2V~1497.6V
4	Cell	314Ah
	Battery Module	2P52S
	Battery Rack	2P416S
	System	10P416S
5	Rated Discharge Power	2.08MW (0.5P_1)
6	Rated Charge Power	2.08MW (0.5P_1)
7	RTE	≥94% (0.5P_1)
8	Cooling Mode	Liquid Cooling
9	Operating Ambient Temperature	-20°C-50°C
10	Storage Temperature	-30°C~45°C
11	Fire Protection System	Condensed Aerosol Fire Extinguishing System + Water Fire Protection System
12	Environmental Monitoring	Temperature, Humidity, Water logging
13	IP Level	IP55
14	Certifications	UL1973, UL9540A, UL9540, UN3536, IEC62933-5-2, IEC62933-2-1, Zone-4, IEC60529 (IP55), CCS
15	Dimension (20-Foot)	6058mm×2438mm×2896mm (±10mm)
16	Weight	37t ±1t

2. Introduction of the BESS Container

The 4.179MWh Liquid Cooling Battery Energy Storage System (BESS) Container is an integrated system with high energy density, consisting of battery racks, battery management system, fire protection system, thermal management system, and electrical system.

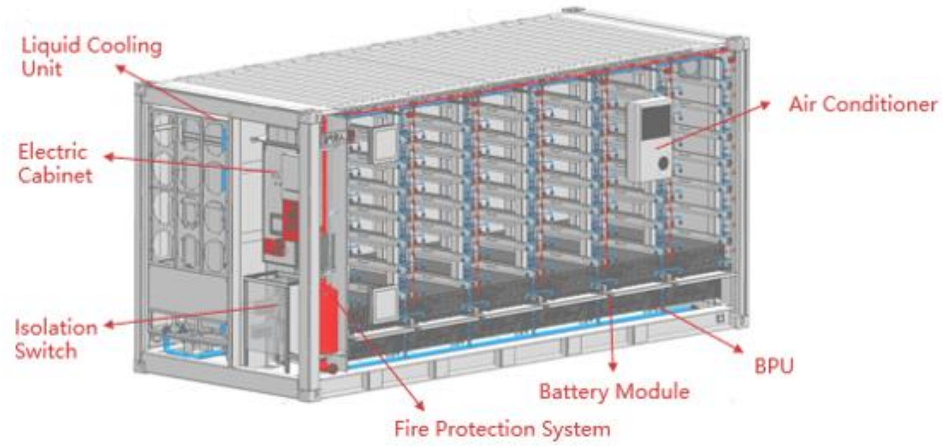


Figure 1 4.179MWh Liquid Cooling Battery Energy Storage Container Diagram

Table 2 Key Components of the 4.179 MWh Liquid Cooling BESS Container

No.	Component	Quantity	Remark
Cell	314Ah	4160	T×W×H: 71.5mm×173.8mm×207.2mm (±0.5mm). Weight: 5.6kg±0.3kg.
Battery Module	2P52S	40	W×D×H: 792mm×2200mm×250mm(±4mm). Weight: 686kg ± 5kg. The battery module consists of 104 cells, in addition to the cells, wiring cable and structural parts, there is also one Module BMS.
Battery Protection Unit (BPU)		5	Composed of Rack BMS, wiring cable, wiring terminal and related structural parts, etc. Designed with external HVDC power interface, CAN interface, isolation switch, power input interface, etc.
Battery Rack	2P416S	5	W×D×H: 969mm×2250mm×2480mm (±3mm). Weight: 5760kg±50kg.
Electrical Cabin		1	Composed of isolation switch, secondary lightning protection device, battery stack management unit, switching power supply, and UPS.

Power Distribution Cabinet (PDC)		1	Power distribution of liquid cooling units, air conditioner system, lighting system, ventilation system, communication system and others.
Battery Management System (BMS)		1	The BMS consists of three-level architecture of ESMU, ESBCM, ESBMM and the corresponding cables. IEC 61850, IEC 104 compliance.
Thermal Management System	Liquid Cooling Unit	1	60kW liquid cooling unit, liquid cooling pipeline, coolant, including compressor, water pump, air blower, heater, etc. ETL, CE compliance.
	Air Conditioner	2	Two 3kW air conditioners in battery cabin and electric cabin. UL and CE compliance.
Fire Protection System	Gas Fire Extinguishing Device	12	Condensed aerosol fire extinguishing devices. UL2775 compliance.
	Gas Fire Extinguishing Controller	1	Located in the electrical control chamber next to the electrical cabin. UL864 compliance.
	Fire Detector	4	2 Smoke Detectors. UL268 compliance. 2 Temperature/heat Detectors. UL521 compliance.
	Alarm Device	2	1 Audible and visual alarm. UL464&UL1638 compliance. 1 Alarm Bell. UL464 compliance.
	Manual Start-stop Device	2	1 Emergency stop button. UL864 compliance. 1 Manual release of the pull station. UL38 compliance.
Explosion Proof & Exhaust System		2	Combustible Gas detector. UL1203 compliance.
		1	Automatic Ventilation Window. CAS C22.2 NO.113-18 compliance.
		2	Explosion-proof fan. CAS C22.2 NO.113-18 compliance.
Explosion Relief Plate (for explosion vent)		5	Reference NFPA 68. ATEX compliance. 5 plates with total effective area of 3.65m^2.
Cable (communication & power)		Group	Meet the standard UL3817.
20ft Container	10P416S	1	L×W×H: 6058mm×2438mm×2896mm (±10mm)

2.1. System Specification

Table 3 summarizes the 4.179MWh Liquid Cooling BESS from cell to container

Name	Type	Minimum Voltage(V)	Maximum Voltage(V)	Rated Voltage(V)	Capacity (Ah)	Energy （kWh)	Quantity
Cell	LP71173207	2.7	3.6	3.2	314	1.0048	4160
Module	2P52S	140.4	187.2	166.4	628	104.4992	40
Battery Cluster/rack	2P416S	1123.2	1497.6	1331.2	628	835.9936	5
Energy Storage System Container	10P416S	1123.2	1497.6	1331.2	3140	4179.968	1

Table 4　Overview of 4.179 MWh Liquid Cooling BESS Container

System Information	
Product Model	ESS-ES4179A-LP71173207
Rated Energy	4.179MWh
Rated Voltage	1331.2V
Operation Voltage Range	1123.2V~1497.6V
Configuration	10P416S
Cell Information	
Cell Chemistry	Lithium Iron Phosphate (LFP)
Typical Capacity	314Ah
Protection and Safety Devices	
Short Circuit Protection	Yes
Lightning Protection	Yes
Over-charge/Over-discharge Protection	Yes
Over-temperature Protection	Yes

Fire Detection	Yes
Emergency Switch	Yes
UPS	Yes
Operating Environment	
IP Level	IP55
Operating Ambient Temperature	-20℃-50℃
Storage Temperature	-30℃~45℃
Relative Humidity	0~95% (No condensation)
Operating Altitude	≤2000m (>2000m derating)
General Information	
Fire Protection System	Condensed Aerosol Fire Extinguishing System + Water Fire Protection System
Communication Mode	RS485/ Ethernet /CAN2.0
Balancing Mode	Passive Balancing, Balancing Current 100mA
Dimension	L×W×H: 6058mm×2438mm×2896mm (±10mm)
Weight	37t ±1t

2.2. Cell

The system uses 314Ah lithium iron phosphate cell, with high energy density, long cycle life, safety, reliability, and other performance characteristics. Single cell key parameters are shown in the following table.

Table 5 Key Parameters for **Single Cell**

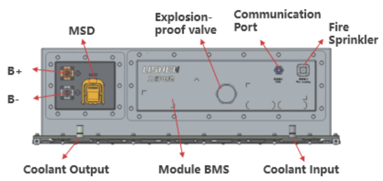
No.	Description	Parameter Value	Remarks
1	Cell Model	LP71173207	
2	Typical Capacity	314Ah (25℃，0.5P_1)	
3	Typical Voltage	3.2V	

5	Standard charge/Discharge Rate	0.5P_1	
6	Cycle Life	≥8800(25℃±2℃, 0.5P_1, 65%SOH)	
7	Grading Criteria Ah	A1- 325Ah-328A (<=3.0AH) A2-328Ah-331Ah (<=3.0AH) A3- 331Ah-334A (<=3.0AH) A4-334Ah-337Ah (<=3.0AH)	
8	Vdc	Δ 5mV	
9	ACIR	0.17 mΩ +-0.05mΩ	
10	Dimension (T×W×H)	71.5mm×173.8mm×207.2mm (±0. 5mm)	
11	Weight	5.6kg ± 0.3kg	

2.3. Battery Module

The battery module contains 104 cells with 2 cells in parallel first and then 52 of them in series configuration (2P52S) and one battery module management unit. The positive and negative terminals of the battery module are clearly marked for easy connection, visual inspection, and maintenance. The battery module is also equipped with manual maintenance switch MSD, which can cut off the battery circuit during maintenance and protect the safety of personnel.

Table 6 Key Parameters for **Battery Module**

No.	Description	Parameter Value	Remarks
1	Battery Module Model	ESS-EM104.4A-2P52S-LP71173207	
2	Cell Model	LP71173207	
3	Cell Configuration	2P52S	
4	Rated Energy	104.499kWh@100%DOD, 0.5P_1, 25±2℃(ambient temperature), 18±2℃, 10L/min (coolant inlet temperature & flow rate)	

5	Rated Voltage	166.4V	
6	Rated Capacity	628Ah@100%DOD, 0.5P_1, 25±2°C(ambient temperature), 18±2°C, 10L/min (coolant inlet temperature & flow rate)	
7	Operating Voltage Range	130V~189.8V	
8	Rated Charge/ Discharge Power	52.2kW @100%DOD, 0.5P_1, 25±2°C(ambient temperature), 18±2°C, 10L/min (coolant inlet temperature & flow rate)	
9	Rated Charging and Discharging Current	314A @100%DOD, 0.5P_1, 25±2°C(ambient temperature), 18±2°C, 10L/min (coolant inlet temperature & flow rate)	
10	RTE BOL	0.25 P_1: 95% 0.5 P_1: 94%	
11	Self-discharge Rate/Month	2.5%@25±2°C, 35%SOC, 3 months after battery production	
12	ACIR (30%SOC, BOL)	≤15mΩ@25±2°C,1kHz	
13	Insulation Resistance	≥50MΩ	
14	MSD	1500V, 380A	
15	IP Level	IP67	
16	Communication Interface & Protocol	ISO SPI	
17	Restriction Using Requirements	RoHS	
18	Weight	686kg ± 5kg	
19	Dimension (W×D×H)	792mm×2200mm×250mm (±4mm)	
20	Number of Sampling Points	Temperature Sampling 32	
21		Voltage Sampling 52	

**Note: Insulation resistance testing method.

Testing voltage：2500VDC.
Testing environment：The test should be conducted under an environment of relative humidity ≤ 90% and an atmospheric pressure of 86kPa~106kPa.
Test method: Measure the insulation resistance between the positive terminal of the battery module and the external exposed conductive part, and between the negative terminal of the battery module and the external exposed conductivepart.

2.4. Battery Rack

The battery system consists of 5 battery racks in parallel. The layout of battery racks in a container is shown in the following figure.

Each battery rack is designed with nine slots for eight battery modules and one BPU. BPU is located at the bottom of the rack and all cable connections are placed on the front side of the rack for easy installation and maintenance.

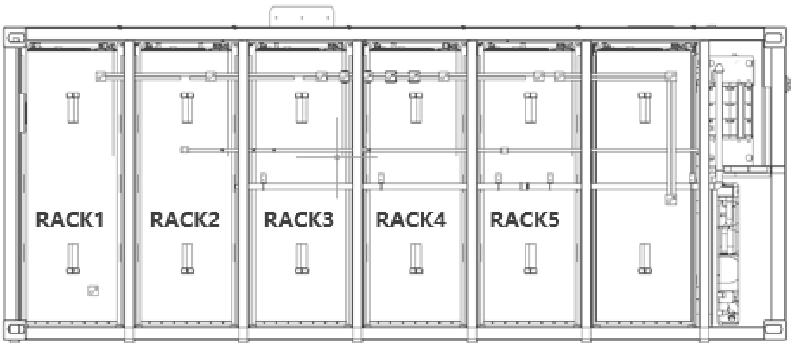
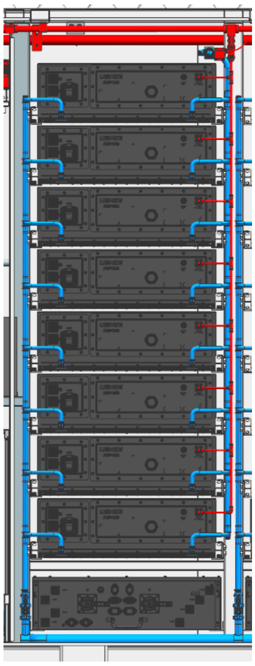


Figure 2 **Battery Rack** Layout inside the 4.179MWh Liquid Cooling BESS Container (Top View)

Table 7 Key Parameters for **Battery Rack**

No.	Description	Parameter Value	Remarks
1	Battery Rack Model	ESS-ER835.994kWh-LP71173207	
2	Battery Module Model	ESS-EM104.4A-2P52S-LP71173207	
3	Arrangement	9 Layers (8 battery modules and 1 BPU) in one column	
4	Cell Configuration	2P416S	
5	Rated Energy	835.994kWh	

6	Rated Voltage	1331.2V	
7	Voltage Range	1123.2V~1497.6V	
8	Rated Capacity	314Ah	
9	Rated Charge/ Discharge Power	417.996kW@100%DOD, 0.5P1, 25±2℃ (ambient temperature), 18±2℃, 10L/min (coolant inlet temperature & flow rate)	
10	Short-circuit Current	6.640kA@100%DOD, 0.5P1, 25±2℃(ambient temperature), 18±2℃, 10L/min (coolant inlet temperature & flow rate)	
11	Cooling Mode	Liquid Cooling	
12	Dimension(W×D×H)	969mm×2250mm×2480mm(±3 mm)	
13	Weight	5760kg ± 5kg	

2.5. Battery Protection Unit

The Battery Protection Unit (BPU) is a high voltage power loop management unit. It has the functions of battery rack voltage/current collection, battery rack loop contactor control/protection, etc. BPU is equipped with circuit breakers, contactors, fuses, pre-charged control circuits, current sensors, battery rack management unit, switching power supplies, etc. The appearance of BPU is shown in the following figure.

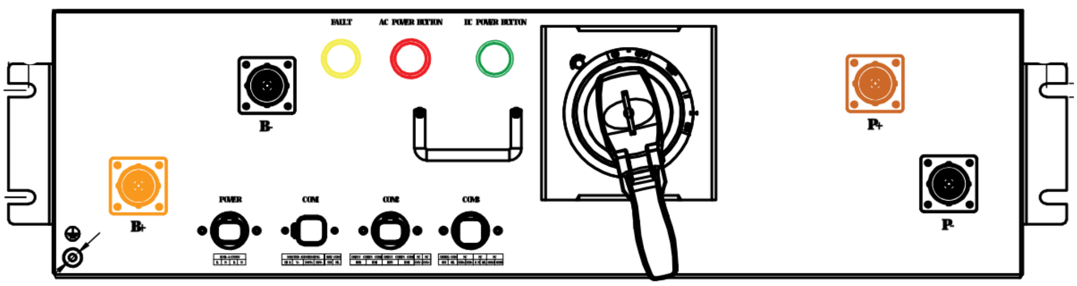


Figure 3 Appearance of **BPU**

Table 8 Key Parameters for **BPU**

No.	Description	Parameter Value
1	Rated Voltage	DC1500V
2	Rated Current	314A
3	Communication	CAN、ISOSPI
4	IP Level	IP65
5	Dimension(W×D×H)	724mm×800mm×200mm (±0.8mm)
6	Weight	40kg

Table 9 Interface Definition of **BPU**

No.	Interface	Function Description	Remark
1	B +	Battery Rack Input+	Connect the positive terminal of the battery rack. Connector: FSPC22112P-M10A1. Cable: AWG4/0. 350A/1500VDC. UL4128 compliance (the cables' model depend on the connector wiring requirements).
2	B -	Battery Rack Input-	Connect the negative terminal of the battery rack. Connector: FSPC22112Q-M10B1. Determine cables based on connector wiring requirements. Cable: AWG4/0. 350A/1500VDC. UL4128 compliance (the cables' model depend on the connector wiring requirements).
3	P +	Battery Rack Output+	Connect the PCS positive terminal. Connector: FSPC22112P-M10A1. Determine cables based on connector wiring requirements. Cable: AWG4/0. 350A/1500VDC. UL4128 compliance (the cables' model depend on the connector wiring requirements).
4	P -	Battery Rack Output-	Connect the PCS negative terminal. Connector: FSPC22112Q-M10B1. Determine cables based on connector wiring requirements. Cable: AWG4/0. 350A/1500VDC. UL4128 compliance (the cables' model depend on the connector wiring requirements).

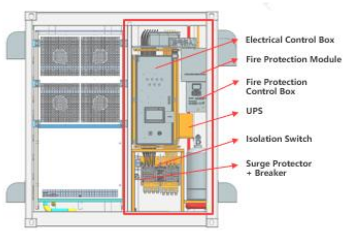
5	ON/OFF	Power Button Switch	Control BMS power on and off.
6	QF	Battery Rack Switch	Manually control the high voltage output of the battery rack (circuit breaker handle).
7	POWER	Power Input	AC220V power input.
8	COM1	Power, Communication Input/Output Interface	Module BMS power supply; CAN/ ISO SPI communication.
9	COM2	Power, Communication Input/Output Interface	Address assignment input/output; CAN communication between Rack BMS and System BMS.
10	COM3	Power, Communication Input/Output Interface	Debugging port; CAN, RS485-2

2.6. Electrical Cabin

The electrical cabin is a DC high voltage power circuit pile level management unit, which is the intermediate unit connecting the battery pile and the energy storage converter PCS. It has the functions of battery rack pile level bus, battery power circuit breaker control and protection. A circuit isolation switch, fuse, secondary surge protection device, System BMS, switching power supply, and uninterruptible power supply UPS are installed in the electrical cabin.

The design of the electrical cabin has fully considered the electrical characteristics of each component, heat dissipation performance, safety performance and operable maintenance, reasonable space layout, flexible configuration, safe and reliable, size standards and other characteristics.

Table 10 Key Parameters for **Electrical Cabin**

No.	Description	Parameter Value	Remarks
1	Rated Voltage	DC1500V	
2	Rated Current	2500A	
3	Communication	CAN、RS485、LAN	
4	Number of Racks	5	

5	Cooling Mode	Air Cooling	
6	UPS	220VAC/3kVA/Long Delay	
7	Communication	To EMS: MODBUS TCP(IP), IEC61850; TO PCS: CAN/RS485/ MODBUS TCP(IP)	
8	Emergency Switch	With Key Locking	

2.7. Power Distribution Cabinet (PDC)

The Power Distribution Cabinet (PDC) is used in the BESS system to assist power distribution and control power distribution equipment. It plays a critical role in protecting the normal operation of the whole BESS system.

The PDC provides auxiliary power for:

- Battery management system
- Fire protection system
- Air conditioner
- Liquid cooling unit
- Socket
- Other auxiliary power supplies

2.8. Battery Management System (BMS)

BMS Architecture

The BMS consists of three-level architecture of ESMU, ESBCM，ESBMM and the corresponding cables. The system is characterized by wide functional coverage, small size, strong anti-interference performance, safety, and reliability.

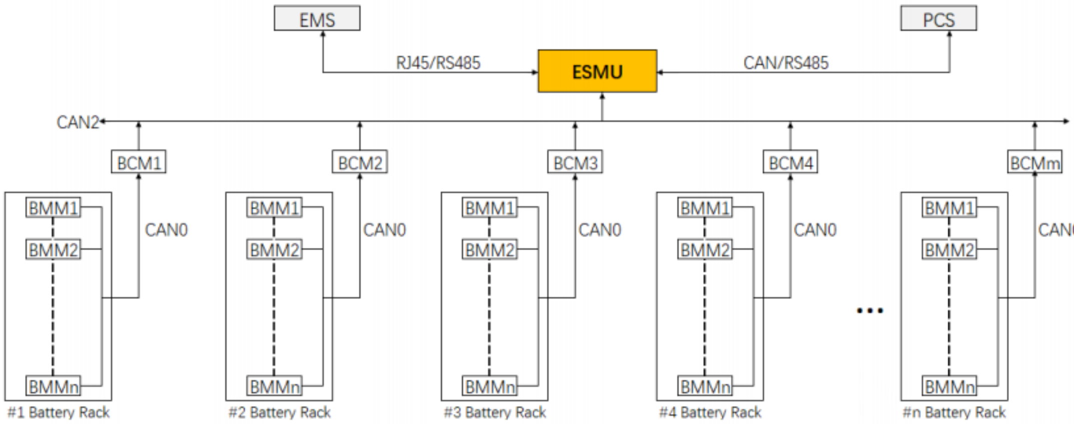


Figure 4 **BMS** System Architecture Diagram

Energy Storage Management Unit (ESMU) – Container Level BMS

ESMU has feature in monitoring and managing the battery energy storage system. It is responsible for analyzing and storing real-time data uploaded by ESBCMs and ESBMMs. Then it implements calculation, performance analysis, alarm processing and recording. In addition, it could be connected to PCS and EMS for external control and operation, such as generating strategies for load control and optimization according to output power and SOC of every rack to ensure a safe and efficient system.

Table 11 Key Parameters for **ESMU**(Container Level BMS)

Description	Parameter Value
CPU	ARM, 4-core, 2.0GHz
RAM	4GB LPDDR4
OS	Linux
Storage	16GB Emmc 240G-256G SSD, Standard 256G 32G SD card (optional)
Number of Cells Can Manage	Max. 450 cells x 20 racks
LCD	10.1" TFT
Data Record Interval	≤ 1s
Event Log Database	More than 100,000 events recorded, including types, time and protections
Inquiry Method	Local inquiry, remote inquiry, data download and output

Alarm Method	Sound-light alarm, alarm content display, fault point output
Communication Interface	3×LAN, LAN0/LAN1: 100M/1000Mbps; LAN2: 10M/100Mbps 3×CAN (Isolated), 250Kbps-500Kbps, 1500Vac 5×RS485 (Isolated), 96000bps-19200bps, 1500Vac 2×USB
DO/DI	6×IO input (DIH) with photoelectric isolation, 9-32V effective,1500Vac 6×IO input (DIL) with photoelectric isolation, 0-0.7V effective,1500Vac 12×IO input/output, relay dry contact, 2A/30Vdc or 2A.250Vac (use as AC output, adjacent ports could not be used), 1500Vac 1×AC power loss detection, range 220Vac±30%
Supply Power	DC 9-32V
Power Consumption	≤ 10W
Working Conditions	Environmental temperature: -10-+60℃ Relative humidity (non-condensing): <95% Environmental magnetic: <400A/m No erosive, flammable chemical, and combustible gas around

Energy Storage Battery Control Module (ESBCM) – Rack Level BMS

ESBCM manages the battery rack and is generally placed in BPU of the battery racks. It is mainly responsible for collecting voltage and current of battery racks, summarizing voltage and temperature information of individual batteries in the rack, calculating SOC/SOH status of battery racks, performing balancing strategy judgment and battery fault diagnosis functions, and implementing local protection and relay control of battery racks based on battery fault information.

Table 12 Key Parameters for **ESBCM** (Rack Level BMS)

Item Name	**Description**	**Min.**	**Typical**	**Max.**	**Unit**	**Remark**
Rated Voltage	Working voltage	9	24	32	V	
Rated Power Consumption	Rated power consumption	-	-	3	W	No external load
Voltage Sampling	Range	0	-	1500	V	
	Accuracy	-	±0.1%FS	±0.5%FS		
Current Sampling	Range	-500	-	500	A	Hall Sensor
	Accuracy	-	±0.1%	0.5%		
Temperature Sampling	Channel	-	-	4		

	Range	-40	-	125	℃	
	Accuracy	-	±1	-	℃	±1℃@-25℃~65℃; ±2℃@-40℃~25℃ or 65℃~125℃
Insulation Resistance	Range	0	-	10	MΩ	
	Accuracy		15%			
CAN	Baud	125	250	1000	Kb/s	Channel: 3
LAN	Baud	-	10/100		Mb/s	Channel: 1
RS485	Baud	1200	9600	115200	bps	Channel: 1

Energy Storage Battery Management Module (ESBMM) –Module Level BMS

ESBMM can provides real-time monitoring of cell voltage and temperature, thermal management, and passive equalization capabilities. It can communicate with ESBCM via ISO SPI.

Table 13 Key Parameters for **ESBMM** (Module Level BMS)

Description		**Min.**	**Typical**	**Max.**	**Unit**	**Remark**
Single Cell Voltage	Channel	32	-	64	Channel	At least connected with 8 cells and pack voltage should be above 16V
	Range	0	-	5.0	V	
	Sampling Accuracy	-	±3	±5	mV	
Single Cell Temperature	Channel	-	-	64	Channel	
	Range	-40	-	125	℃	
	Sampling Accuracy	-	±1	-	℃	±1℃@-25℃~65℃; ±2℃@-40℃~25℃ or 65℃~125℃
Passive Balancing	Current		100		mA	

2.9. Thermal Management System

Considering the operating environment of the battery system, to ensure the long-term reliable operation of the battery, the fire insulation layer is set on the inner wall of the container. The fire protection grade is A, and the fire resistance limit is 2hrs, so that the system has the functions of heat storage, heat insulation and flame retardant.

In addition, to meet the requirements of the battery for temperature adaptability, the temperature in the container needs to be maintained in a certain range, not only to supplement the heat loss of the container in the low temperature environment at night, but also to balance the heat accumulation in the container in the extreme high temperature environment. According to the comprehensive consideration of the external environment temperature, container heat loss, battery charging and discharging, the container uses an industrial liquid cooling unit (battery cabin) with a cooling power of 60kW, two 3kW dehumidification air conditioners.

2.9.1. Liquid Cooling Unit (Chiller)

The liquid cooling unit (chiller) is a refrigeration product developed for the battery system heat dissipation to maintain required temperature for the BESS internal cells that are sensitive to environmental temperature, etc., and to protect the service life of the battery system.

The industrial liquid cooling unit is installed at one end side of the container. The cooling power is 60kW and the cooling/heating mode is changed according to the ambient temperature in the container. The liquid cooling unit uniformly adjusts the temperature of each battery rack through the liquid cooling pipeline to ensure the uniform battery temperature. This product integrates the communication and alarm functions of the upper computer and is highly reliable. Adopting an intelligent thermal management system and reasonable liquid cooling pipeline design, the module temperature difference within the BESS is controlled within 3 ℃.

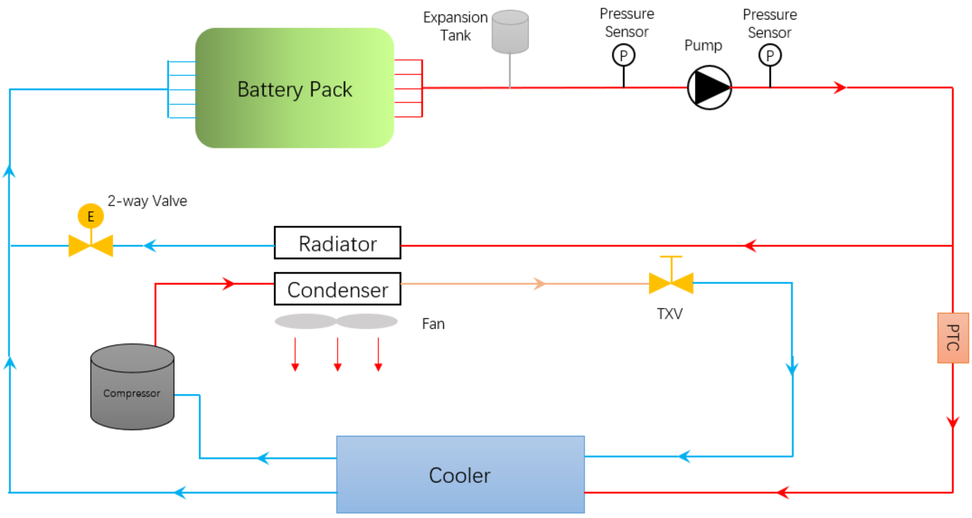


Figure 5 Appearance of the Liquid Cooling Unit

Table 14 Key Parameters for **Liquid Cooling Unit** (Chiller)

Cooling Unit (Chiller): EMW600HCNC1C		
Dimensions (H × W × D)	mm	1200×440×2400
Weight (without coolant)	kg	≤500
Installation Method	/	Floor Mounted
Application	/	Outdoor
Working Temperature Range	℃	-30 ~ +55
Storage Temperature Range	℃	-40 ~ +70
Working Altitude	m	0~4000m (When the value exceeds 1000m, the derated value is reduced by5% for every 1000m)
Noise Level	dB(A)	＜85
IP Level (for our-door side)	/	IPX5
Refrigerant	/	R410A (ROHS)
Coolant	/	50% Glycol Solution
RoHS 2.0 Compliant	/	Yes
CE	/	Yes
Cooling Capacity@W18/L45	kW	60
Heating Capacity @Tu=10℃	kW	25

Outlet Coolant Temperature	℃	18
Cooling Input Power@W18/L45	kW	33.4
Heating Input Power@Tu=10℃	kW	27
Self-cycling Mode (only pump operation) Power	kW	1.2
Max. Power Consumption	kW	35
Rated Circulating Flow	L/min	500@150kPa
Power Supply		
Rated Voltage	V, Hz	380V-415V, 3~, 50/60Hz
Power Supply Range	V, Hz	380-415V ± 10%V, 3~, 50/60±3Hz
Max. Operating Current	A	75

2.9.2. Air Conditioner

Two 3kW air conditioners are equipped with the dehumidification function to ensure the temperature and humidity environmental parameters in the electrical cabin and the battery cabin.

Table 15 Key Parameters for **Air Conditioner**

External Dimensions (H×W×D)	mm	1300×500×250
External Dimensions (H×W ×D) With Flange	mm	1350×550×250
Weight	kg	62
Mounting Method	/	Door Mounted
Application	/	Outdoor
Working Ambient Temperature Range	℃	-40 ~ +55
IP Level	/	IPX5
Refrigerant	/	R134a (ROHS)
RoHS Compliant	/	Yes
Cooling Capacity@L35/L35 50Hz	kW	3
Heating Capacity @ Tu=10℃	kW	2.5

Power Consumption@L35/L35 50Hz	W	1100
Current@L35/L35	A	9.0
Internal Airflow	m^3/h	700
Power Supply		
Power Supply Range	V, Hz	220±15%,50
Rated Operating Voltage - Controller	V, Hz	220, 50
Rated Operating Voltage - Cooling/Heating System	V, Hz	220, 50
Max. Current	A	12.0

2.10. Fire Protection System

A fire protection system is installed in the container. When the fire occurs in the very early stage, the combustible gas detector opens the fan according to the concentration of combustible gas in the protection area to reduce the concentration to prevent deflagration; When the smoke detector and heat detector in the protection area simultaneously detect the fire or manual emergency release button is pressed at the door, the audible and visual alarm and alarm bell in the protection area will immediately start to prompt the evacuation of the scene personnel: after a delay of 30 seconds, 24V electrical signal will be sent to the fire extinguishing device, and the fire extinguishing device will start to implement the fire extinguishing. If the abort switch at the door is pressed constantly during the 30-second delay period, the gas spraying operation will be suspended until manual intervention arrives and the system is reset.

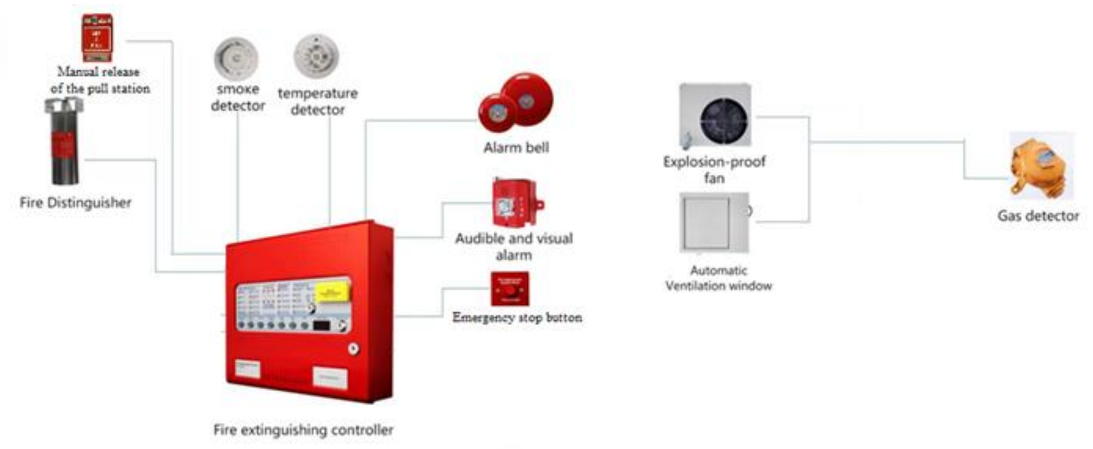


Figure 6 Fire Pipeline Layout

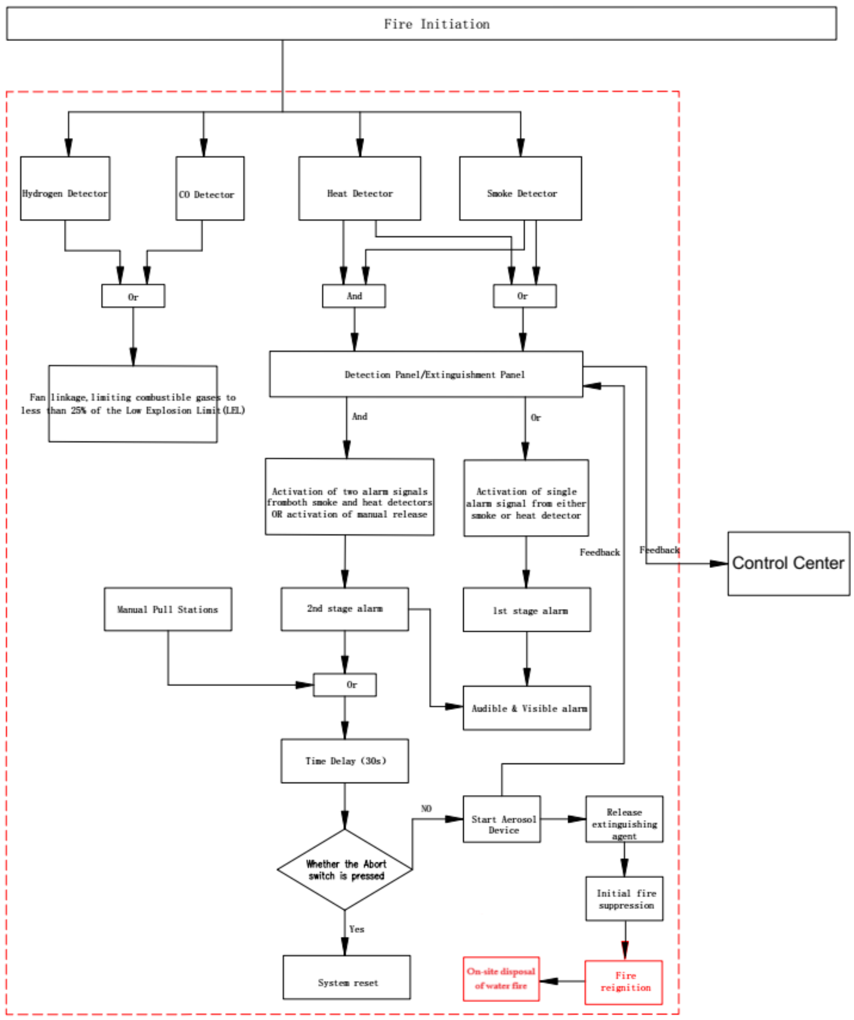


Figure 7 Fire Pipeline Control Logic

**Note: The fire pipeline layout and control logic are subject to the final implementation design.

A standard water inlet interface is designed outside the container. Fire truck, fire hydrant can be connected quickly to deliver water to the battery compartment in the case of severe fire within the BESS container. Water is considered the last line of defense for energy storage fire to prevent fire spread and reduce loss.

2.11.Container

2.11.1. Container Enclosure Design

(1) Enclosure Structure

In order to ensure sufficient strength and BESS project life requirements, the container enclosure adopts hot-rolled or cold-rolled high-weathering steel plates with an effective thickness of not less than 2.0 mm, and the mechanical collision performance should not be lower than the IK10. When the roof load reaches the concentrated load of 3kN / 0.18m^2 and the average load of 3kN / m^2, there should be no plastic deformation or damage; the corrosion resistance of the container enclosure surface meets the requirements of C4.

(2) Environmental Adaptability Requirements of the Enclosure

Containers must have good anti-corrosion, fire prevention, waterproof, anti-condensation, dust prevention (wind and sand), anti-ultraviolet, anti-theft, and other functions.

The waterproof function must ensure that the top of the box does not accumulate water, does not seep water, does not leak water, does not rain on the side of the box, and does not seep water at the bottom of the box.

Dust prevention (sand prevention) function must ensure that the container can effectively prevent dust from entering the container in the event of strong wind and sand weather, and this function must have long-term effectiveness.

The anti-ultraviolet function must ensure that the properties of the materials inside and outside the container will not deteriorate due to ultraviolet radiation, and will not absorb ultraviolet heat.

2.11.2. Container Layout Design

The energy storage system adopts integrated design, and integrates the energy storage battery cabinet, power distribution cabinet, liquid cooling unit, temperature control system, fire protection system and so on into a 20-foot container. The container has an independent power distribution system, thermal management system, fire alarm system, fire protection system and other automatic control and security system. The container corner hole size is designed according to the 20-foot container, which is convenient for transportation.

Considering the construction, commissioning, maintenance and repair of the battery energy storage system device, the container adopts the method of external maintenance, and opens the door at the equipment on both sides and the end to facilitate the daily maintenance and management of the battery system.

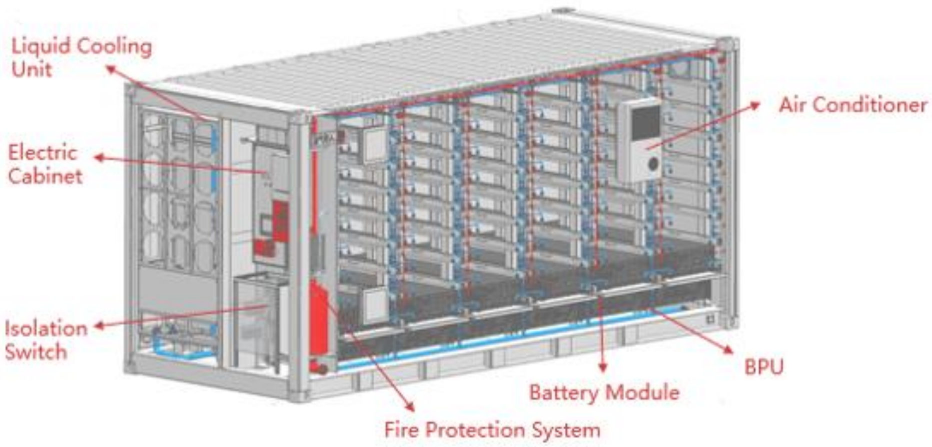


Figure 8 Container Layout Design Diagram

2.11.3. Container Wiring Design

(1) The installation of battery racks in the container and the routing between racks are neat and reliable, and the layout is reasonable.

(2) The power cable in the container is placed separately from the secondary control cable and the communication cable, which is orderly and avoids interference.

(3) The power cable in the container is arranged to the disconnector through the bridge frame at the bottom of the container.

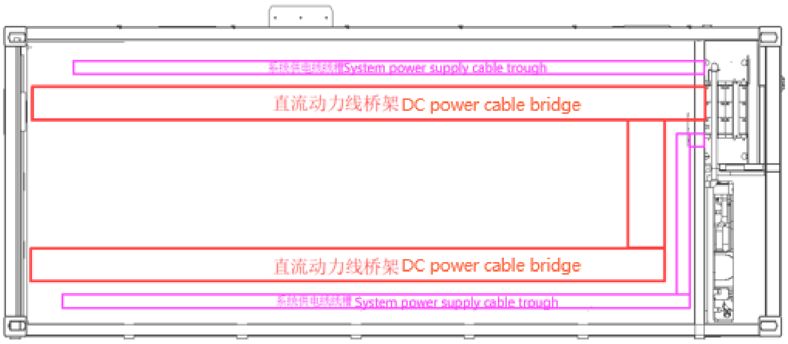


Fig 9   Container Wiring Diagram

**Note: the red is the DC power cable bridge; the purple is the system power supply cable trough.

2.11.4. Container Grounding Design

The container provides two grounding points arranged along the diagonal line, and the electric container with independent secondary equipment provides two grounding points arranged along the diagonal line. Independent secondary equipment equipotential grounding terminals are set up, and obvious grounding signs are set up. The effective cross-sectional area in the grounding system is ≥250mm^2.

The resistance of the contactable conductive component connected to the external protection grounding electrode through equipotential protection is ≤1Ω.

The output port of the battery compartment should be equipped with a surge protector.

There is a grounding row inside the container, and the grounding wires such as power distribution cabinet and control cabinet are connected to the internal grounding row.
The front end of the container and one side of the side wall are equipped with a lightning protection grounding point, which is connected to the embedded iron bar at the

installation site, as shown in the following figure.

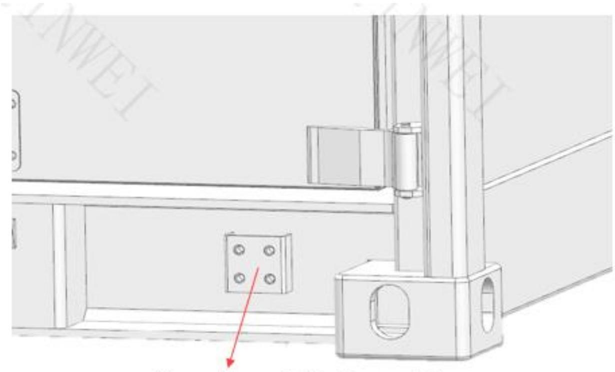


Fig 10 Container Grounding Diagram

2.11.5. Container Lighting

The container lighting adopts four explosion-proof LED lights (20W) with good seismic performance, and the power supply of the device is connected by the distribution box. The positions of all luminaires should be sufficiently spaced from the surrounding live equipment and are easy to maintain.

3. Container Installation Specification

3.1. Container Assembly

3.1.1. System Layout

According to the energy and capacity configuration, the system considers the convenience of equipment installation, maintenance, and overhaul under the premise of fully utilizing the space in the cabin and fully ensuring the stable operation of the system. The energy storage system equipment is arranged in the container according to the following figure.

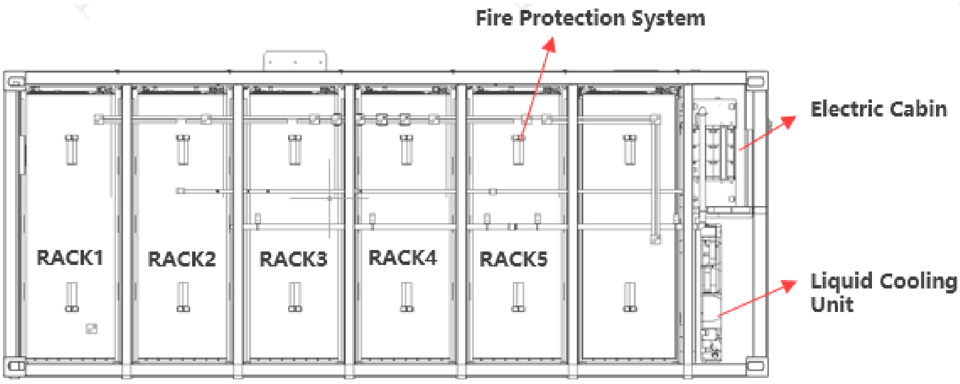


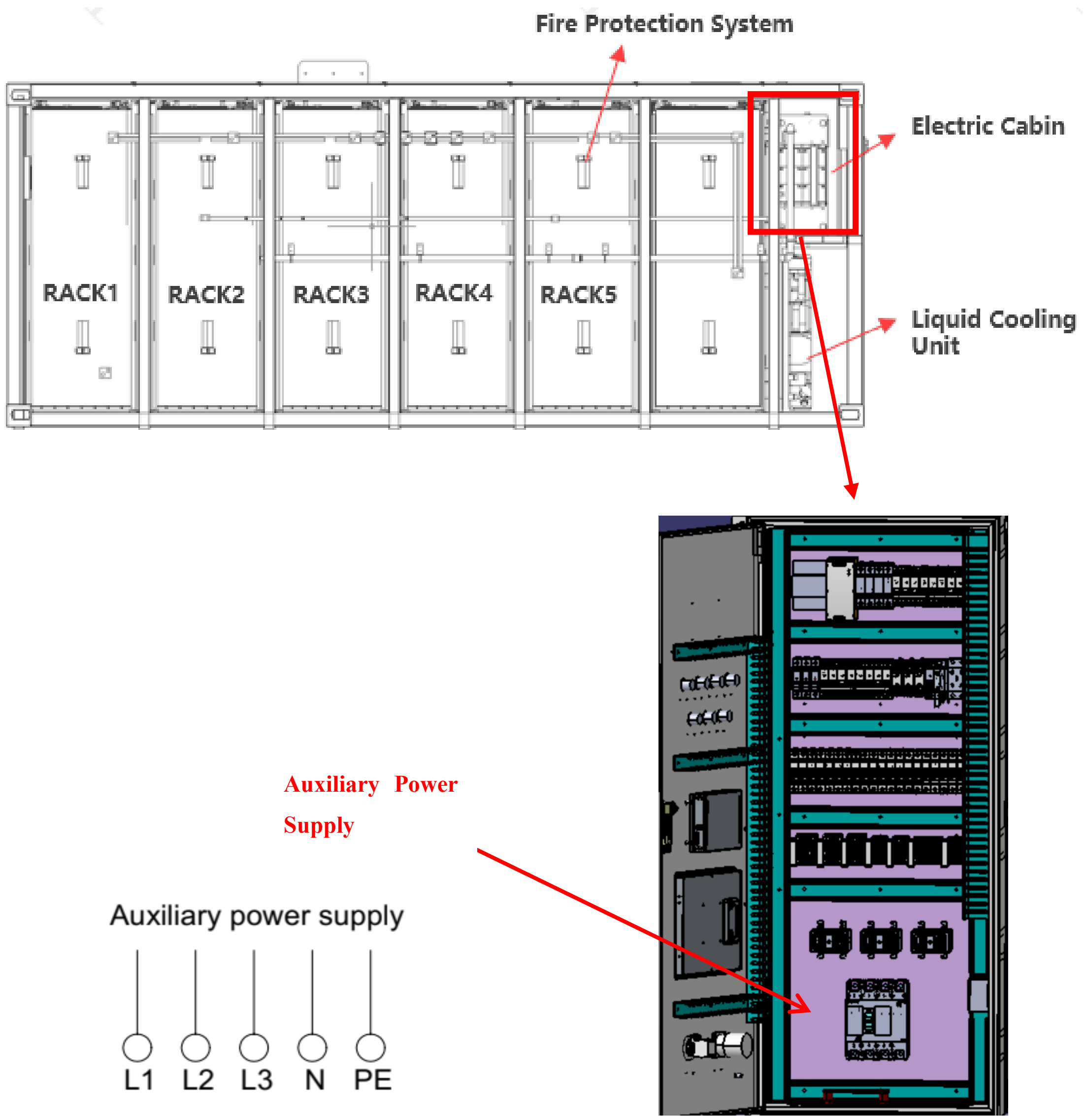
Figure 11 Battery Energy Storage System Container Layout (Top View)

3.1.2. Container Cable Connection

The high-voltage cables used in the system includes high-voltage cables between battery modules and high-voltage cables between battery rack and electrical cabin. The two terminals of the high-voltage cables between the battery modules are fast plug connectors, and the cables has the function of anti-stale. One terminal of the battery rack - electrical cabin high-voltage cable is connected by a quick plug connector, and the other terminal is connected by an M8 terminal to the bus bar in the bus bar cabinet.

Table 16 Key Parameters for the Cable Within Container

No.	Description	Parameter Value	Remarks
1	High Voltage Cable Between Battery Modules	UL3817	
2	High Voltage Cable Between Battery Rack and Electrical Cabin	UL3817	



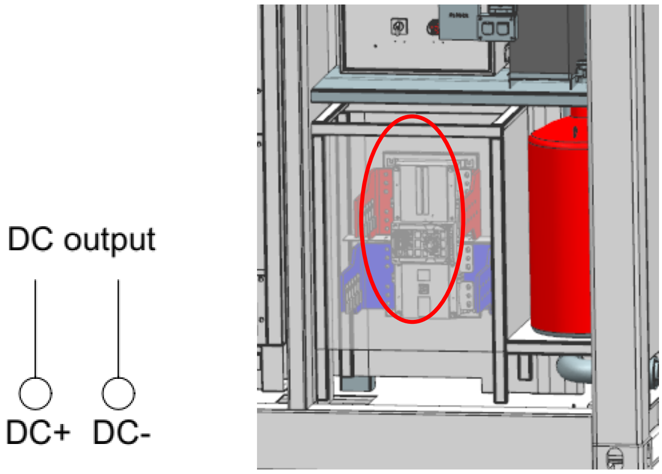


Figure 12 External Wiring Diagram

**Note: The final design position shall be agreed with customer's real project site conditions.

3.2. Container Installation

3.2.1. Preparation and Inspection Before Unloading

After the container arrives at the scene, first unload the container, and place it on the foundation. Before unloading, check the following items:

- Whether the construction of container foundation has been completed;
- The container foundation should be cementing ground, the height should be ≥ 300mm, and the ground bearing strength should not be less than 3T / M^2;
- Whether the container lifting vehicle (meet the requirements of ≥100 tons of lifting) has been in place;
- At least one qualified supervisor responsible for industrial safety was present.

3.2.2. Unloading Precautions

- All items need to be taken lightly, according to the container's safety identification operation;
- Unloading in rainy weather should be avoided.

3.2.3. Unloading Requirements

The unloading shall be supervised by the representative of the tenderer and the bidder.

3.2.4. Installation Steps

(1) Container Lifting:

According to the relevant container hoisting and transportation scheme, the container hoisting work is completed, and the container is arranged at the place of use, and the container number and orientation should be paid attention to. The equipment spacing should meet the needs of equipment transportation and maintenance. The long-side spacing of the lithium-ion battery prefabricated cabin is recommended to be no less than 3m, and the short-side spacing is recommended to be no less than 3m. The distance between the battery prefabricated cabin equipment and the road (roadside) in the station is recommended to be no less than 1m.
(In the case of no relevant special requirements of the fire station of the project, the long side spacing can be 4 Meter on one side & 0.1 Meter on another side.)

(2) Container Installation & Fixing:

The container is installed and fixed according to the site conditions. The bottom of the container must have a concrete foundation with sufficient strength; the surface of the foundation is flat without protrusions, and there will be no wave ups and downs after placing the container. The container installation reference the NFPA855" Standard for the Installation of Stationary Energy Storage Systems".

When the container is installed, the four corners of the container and the bottom side beam need to have sufficient support. The total weight of the container is about 37t, and the overall flatness of the container support surface is less than 5mm.

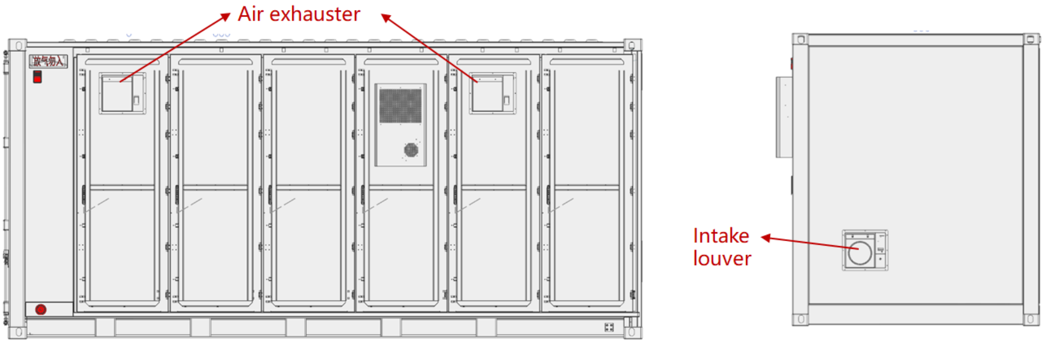


Fig.13 Scheme of Container Attachment Location

**Note: The above installation pictures are for reference only, details will be based on the final design agreement with customer.

The container should be fixed by welding or bolt connection (customers can choose according to the field situation). The four corners at the bottom of the container are directly welded and fixed with the embedded steel plate. The fixed method is as follows.

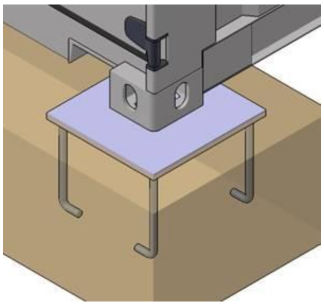


Fig 14 Schematic Diagram of Container Welding Fixation

4. Product Identification

Table 17 Product Identification

UL9540 certification label will be placed by certification agency.

	**This indicates that the product contains high voltage with risk of electric shock.**
	**This indicates the PE end and should be securely grounded to ensure safety of operators.**
	**This means a risk of danger.**
	**This means a risk of explosion.**
	**This means a risk of corrosion.**
	**This indicates that the product cannot be discarded with domestic waste.**
	**This indicates that fire and flammable materials are prohibited close to the product.**
	**This indicates that if contact with eyes, immediately use flowing water or saline to rinse, and seek medical treatment timely.**
	**This indicates that goggles and appropriate personnel protection is required.**
	**This identification indicates that read the product specifications before doing anything with the product.**
	**This indicates that the product is classified as Class 9 dangerous goods.**
UN 3536	**This indicates that the product meets the overall shipping requirements.**

5. Product Precautions and Warnings

This system is a high-voltage energy storage system. Please read the product specification carefully before use, and use the product according to the specification. The warning signs on the equipment contain important information on the safe operation of the energy storage system. It is strictly prohibited to tear or damage the product labels and warning signs, and any damage should be repaired in time.

5.1. Personnel Protection Requirements

The lifting, transportation, installation, wiring, operation and maintenance of the battery energy storage containers must be carried out by authorized professional and technical personnel wearing appropriate personnel protection equipment (PPE) following the operation & maintenance manual and in accordance with local operating procedures. Operators need to meet the following basic requirements:

- Knowledge of Lithium-ion battery, electronics, electrical wiring and mechanical expertise, familiar with electrical and mechanical schematics;
- Familiar with the components and working principle of Lithium-ion battery energy storage container.
- Received professional training related to BESS electrical equipment installation and commissioning.
- Capable of seeking emergency response in case of danger or emergency during installation or commissioning.
- Familiar with the relevant standards and operating procedures of the local country / region where the project is located.

5.2. Electrical Safety

There is a deadly high voltage inside the BESS equipment! Please pay attention to and comply with the warning signs on the product! Avoid danger during operation.

- There will be a risk of electric shock if you touch the power supply or the contact points and terminals connected to it inside the BESS container.
- Voltage may be generated on the battery container side or at the grid side. Before touching, be sure to wear appropriate personnel protection equipment such as insulation gloves and shoes. Use a voltmeter to confirm that there is no voltage.
- When disconnecting the BESS DC side power supply, the battery will not be powered off immediately, be sure to wait for 10 minutes to ensure that the equipment is completely uncharged before operation.
- When operate the BESS product the first time, if the container enclosure is found to be severely damaged, smelly and other abnormal phenomena, stop use the product and contact the manufacturer.
- In the process of installation, routine maintenance, overhaul, and other operations, in order to prevent mis operation or accidents caused by the proximity of unrelated personnel, obvious signs should be erected at the front and rear switches of the energy storage system to prevent accidents. Set up warning signs or safety warning tapes near the operation area;
- Any maintenance work on the BESS system should be carried out by at least two people at the same time, and all personnel are equipped with necessary safety protection measures, such as insulation gloves, insulation shoes, etc. It is strictly prohibited to conduct any maintenance work when the BESS equipment is in operation.
- The electrical connection should be carried out by trained personnel. It is strictly prohibited to reverse and short-circuit the battery modules. It is strictly prohibited to disassemble all components, especially the battery modules inside the BESS container. There are protection mechanisms and protection circuits inside battery modules. Improper disassembly and assembly will damage the protection functions, causing battery to heat, smoke, deform or burn, resulting in fire or safety accidents.

5.3. Product Safety

In order to use the BESS product safely, please read carefully and comply with the following safety requirements. Any product function abnormality, battery or component damages, personal safety accident, property loss and so on caused by the following reasons are not within the scope of Lishen's responsibility.

- Failure to charge the battery for more than 6 months due to customer reasons, causing capacity loss or irreversible damage to the battery;
- Improper handling or failure to operate the battery as required per specification and Operation & Maintenance manual;
- Battery damage caused by over discharge to less than 2.5V due to customer failure to power on in time;
- Improper charging and discharging due to customer reasons;
- Improper customer maintenance, frequent battery over-discharge, customer onsite capacity expansion or long-term failure to be fully charged, etc.;
- Incorrect operating parameters set up by customer;
- On-site operating environment failed to meet the specified environmental requirements for normal operation;
- Change the battery usage scenario due to customer reasons, including but not limited to: connect the battery to additional load on its own;
- Failed to carry out required maintenance correctly according to the Operation & Maintenance manual;
- Use the BESS container beyond warranty period;
- Use defective or deformed batteries;
- Mixing batteries provided by Lishen with other batteries, including but not limited to: mixing with other brands of batteries, mixing with batteries with different rated capacities, etc.;
- Store or install BESS or batteries together with flammable / explosive materials;
- Battery-related operations performed by non-authorized personnel.
- Failed to wear required personnel protective equipment (PPE) during installation,

commissioning, maintenance and any operation on the BESS product;

- Eating, drinking, smoking, and other behaviors near the BESS product;
- Stolen accident.

5.4. Product Storage

- From the date of delivery, the installation and commissioning of the BESS product should be completed within 6 months, and a charge and discharge maintenance work should be carried out during this time. If the battery is not charged during this period, there will be additional battery capacity loss;
- During storage, be sure to charge the battery to 30%~50% state of charge (SOC). The BESS container storage temperature should meet the specified -30℃ to 45℃, the humidity should be less than 75% and no condensation (The temperature and humidity inside the container can be guaranteed by turning on the dehumidification air conditioner within the BESS container). No dust and foreign debris are allowed inside the container;
- Flammable and explosive objects cannot be placed around the BESS container, and there must be no heat source at least 3 meters around the container.

5.5. Product Disposal & Recycling

When the whole BESS container or internal individual component needs to be disposed, please contact Lishen after-sales department to verify the status of the equipment and arrange for product recycle after consultation and agreement with customer.

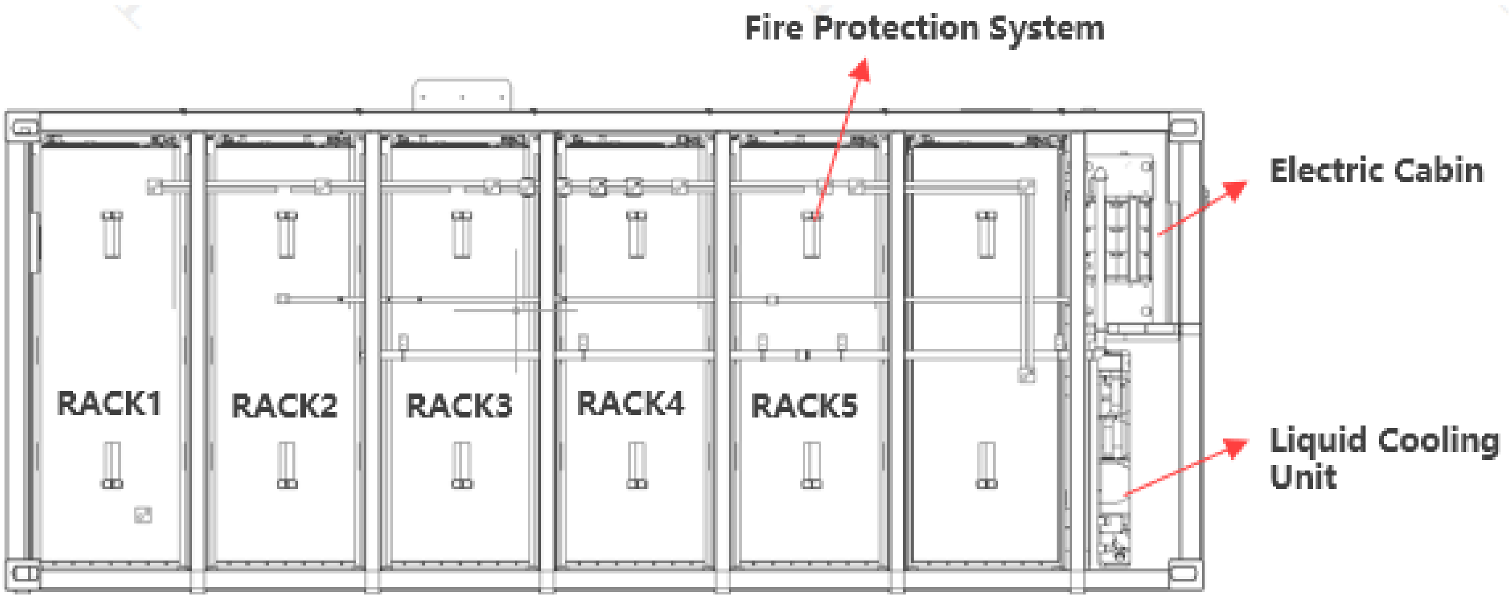
Annex 1 - List of Key Electrical Components

No.	Description		Parameter Value	Standard
1	Battery Module	Manual Service Disconnect (MSD)	1500V 380A	UL4128, EN61948
2		FUSE	1500V 630A	IEC60269, UL248
3	Battery Protection Unit (BPU)	DC Switch	1500V 550A	UL489, IEC60947-1
4		DC Relay	1500V 500A	IEC60947-4-1, UL60947-4-1
5		Precharge Relay	1500V 50A	IEC60947-4-1, UL60947-4-1
6		FUSE	1500V 550A	IEC60269.4, UL248-1
7		HALL	500A	EN IEC61326-1, EN IEC61000-3-2, EN IEC61000-3-3, CSA C22.2
8		Power Plug Socket	1500V 350A	UL4128, IEC 60512, IEC 61984, IEC 60068, IEC 60695
9	Battery Connection Panel (Electrical Cabin)	Isolator	1500V 3200A	UL489B, EN IEC60947-3
10		FUSE	1500V 3000A	EN60269, UL248
11		Surge Protective Device (SPD)	1500V 40kA	EN50539-11, UL1449
12		Uninterruptible Power Supply (UPS)	3kVA	UL1778 IEC62040-1

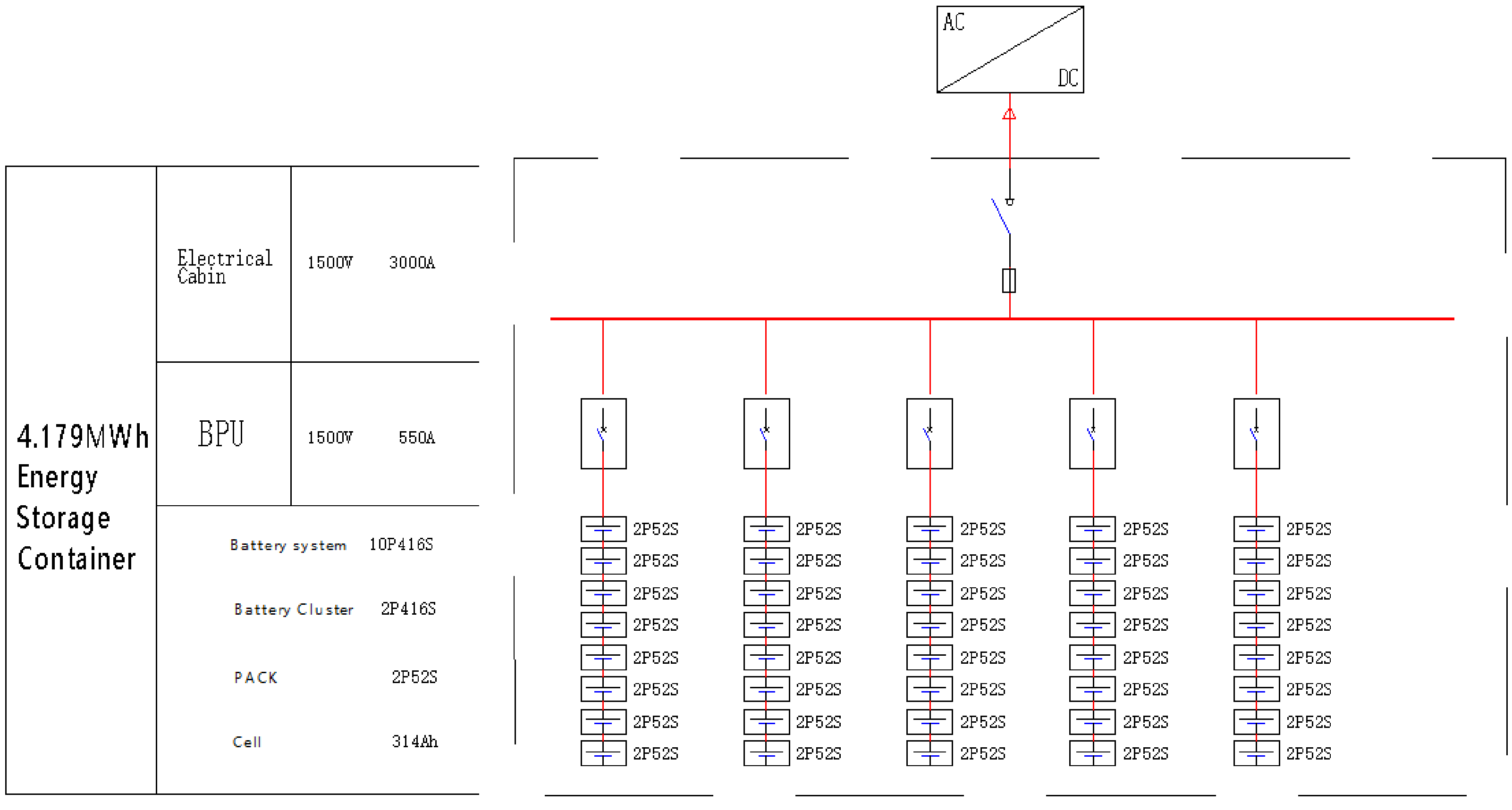
Annex 2 - List of Auxiliary Power Consumption

No.	Equipment	Standby	Operation			Max
		Consumption(kW)	Consumption(kW) @ 35℃ Ambient	Consumption(kW) @ 45℃ Ambient	Consumption(kW) @ 50℃ Ambient	Consumption(kW)
1	Liquid Cooling Unit	1.20	26.0	33.40	26.50	35.0
2	UPS (including the electrical cabin、BPU、BMS、Fire Protection System)	0.70	0.70	0.70	0.70	1.20
3	Lightings	0	0.10	0.10	0.10	0.10
4	Air Conditioner 1	0.10	1.10	1.10	1.10	2.64
5	Air Conditioner 2	0.10	1.10	1.10	1.10	2.64
Total		2.10	29.0	36.40	29.50	41.58

Annex 3 – 4.179MWh Liquid Cooling BESS Container Layout



Annex 4 - Container Electric Primary Diagram



Annex 5 - Container Power Distribution Diagram