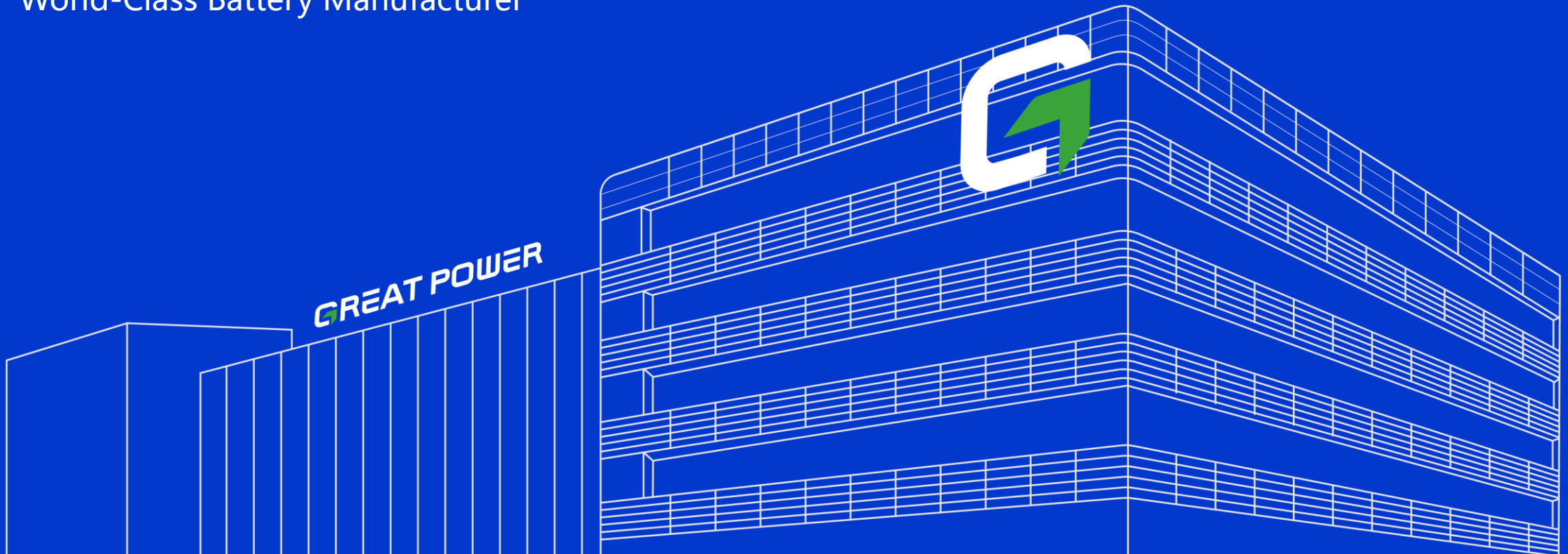


GREAT POWER

373kWh DC Outdoor Cabinet

World-Class Battery Manufacturer



CONTENTS

- Dc cabinet specification
- Advantage
- Safety design
- Product structure
- Main component
 - Fire protection system
 - Liquid cooling system
 - Battery management system
 - Battery pack
 - Electrical communication system
- Process flow
- Certificate
- Matching PCS model



Spec of 373kWh DC Cabinet



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产品类型	Magna-UTL-373
Product category	DC liquid-cooling outdoor cabinet energy storage solution
Rated capacity	372.736kWh@0.5C
Rated output power	180kW
Rated voltage	900-1500Vd.c.
Cell capacity	280Ah
Cell type	LFP
Disposition	1P416S
Maximum discharge current	173A
Maximum charging current	173A
Charging temperature	0~50℃
Discharge temperature	-20~50℃
Communication interface	485/CAN
Cooling mode	Liquid cooling
Waterproof class	IP55
Functional safety	ASIL B
Product weight	≈3850kg
dimension	W1300*D1300*H2373.5mm
Application field	Utility, grid, C&I

Advantage

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High security

- Active safety fire protection system
- Complies with UL 9540A
- Complies with NFPA68

Long-life

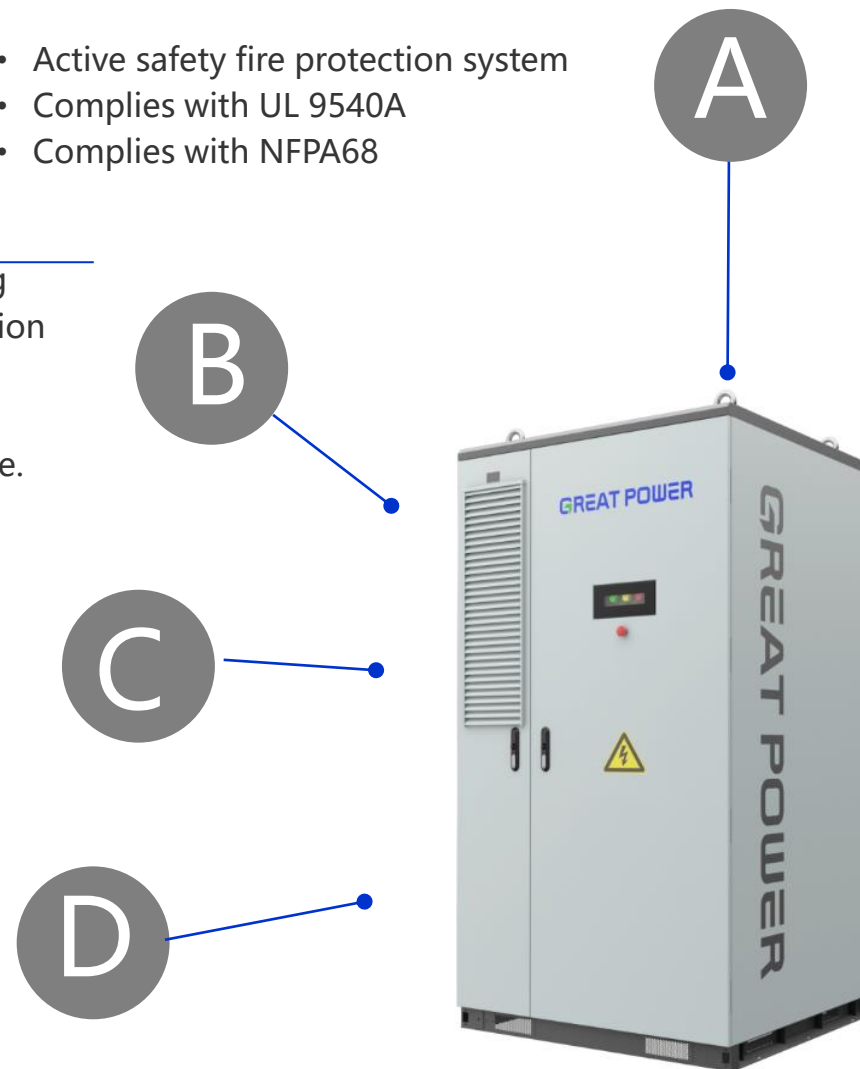
Combined with intelligent liquid cooling control system, of uniform heat dissipation & small battery temperature difference, which guarantees operation in the best temperature range, to extend battery life.

Extend easily

Intelligent management system, compatible with different converters for a variety of energy storage scenarios

High integration

Integrated design, integral transportation, plug&play



Safety Design-LFP cell

- High safety LFP system of optimized stability of the anode structure ;
- Optimize the ratio of electrolyte to reduce the IR, temperature rise, and the side effects ;
- Long life graphite without dendrites to maintain safety performance ;
- High adhesion and stability, low resistance and temperature rise, safety and long-term performance ;
- High temperature tolerance, thermal runaway performance and puncture tolerance;
- Optimized VC/FEC to improve the stability of anode;
- Adjusted LiDFOB/LiPFO2 to improve the safety at high and low temperature.
- Optimize the ratio of solvent and lithium salt to improve the stability and safety of electrolyte.

Cathode

Anode

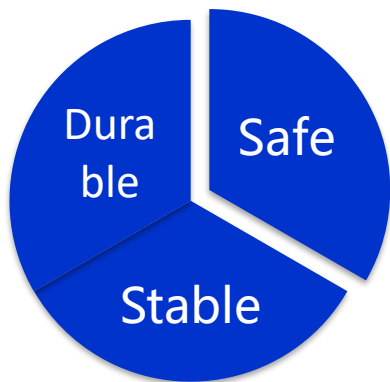
Foil coated with carbon

Seperator

Eletrolyte



◆ **Material chain**



◆ **Technology design**

Area density

NP ratio

High quality pressing

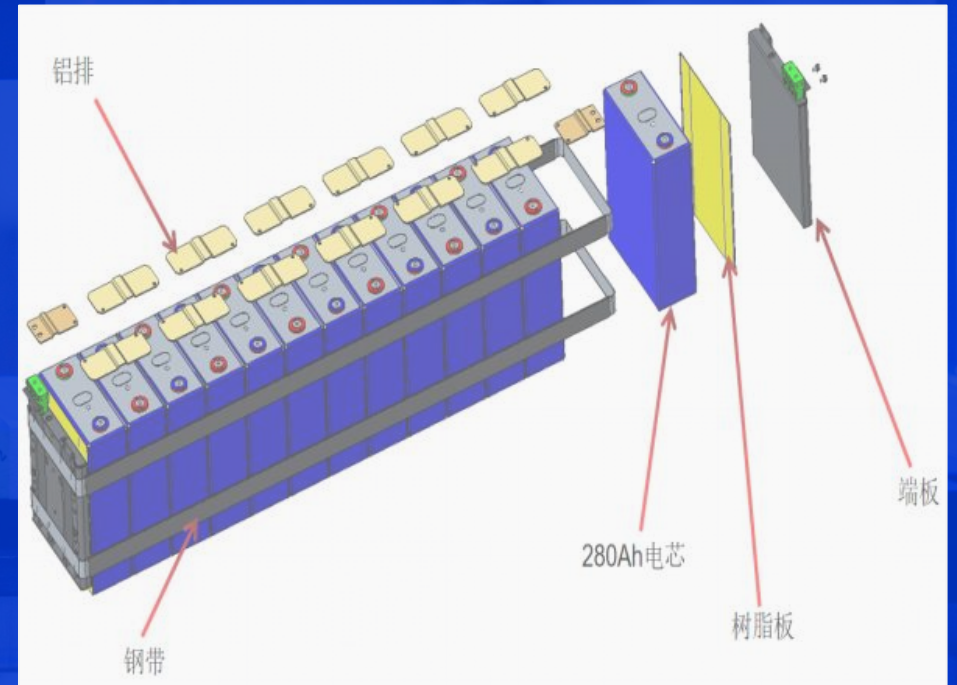
Jelly-roll

Cell plate buffer

- Reduce the electrode coating area density to lower IR, reduce the temperature rise, and improve safety
- Improve the NP ratio to eliminate the cathode lithium precipitation, and to improve safety and extend the cycle life.
- Reduce the pressing density of electrodes to inhibit the battery inflation, and to improve the long-term stability and safety.
- Optimize jelly-roll, Avoid battery bulges or excessive resistance, ensure the stability and consistency of the battery cell
- Increase the buffer of the cathode and the separator, to reduce misalignment short circuit, and the safety performance

Safety Design-Pack & System

- The use of insulation materials avoids large areas of heat transfer, to effectively reduce the risk of heat spread.
- Use a resettable pressure relief valve to reduce the risk of overpressure & explosion of the battery pack and prevent excessive air.
- The sampling line is wrapped in a heat-resistant material to reduce the risk of secondary short circuits.
- Three level fire suppression system(FSS) design :
 - Battery Pack - Aerosol
 - Container –NOVEC1230/FM200
 - Backup water sprinkler fire system



Exploded View



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**Horn & Strobe
alarm device**

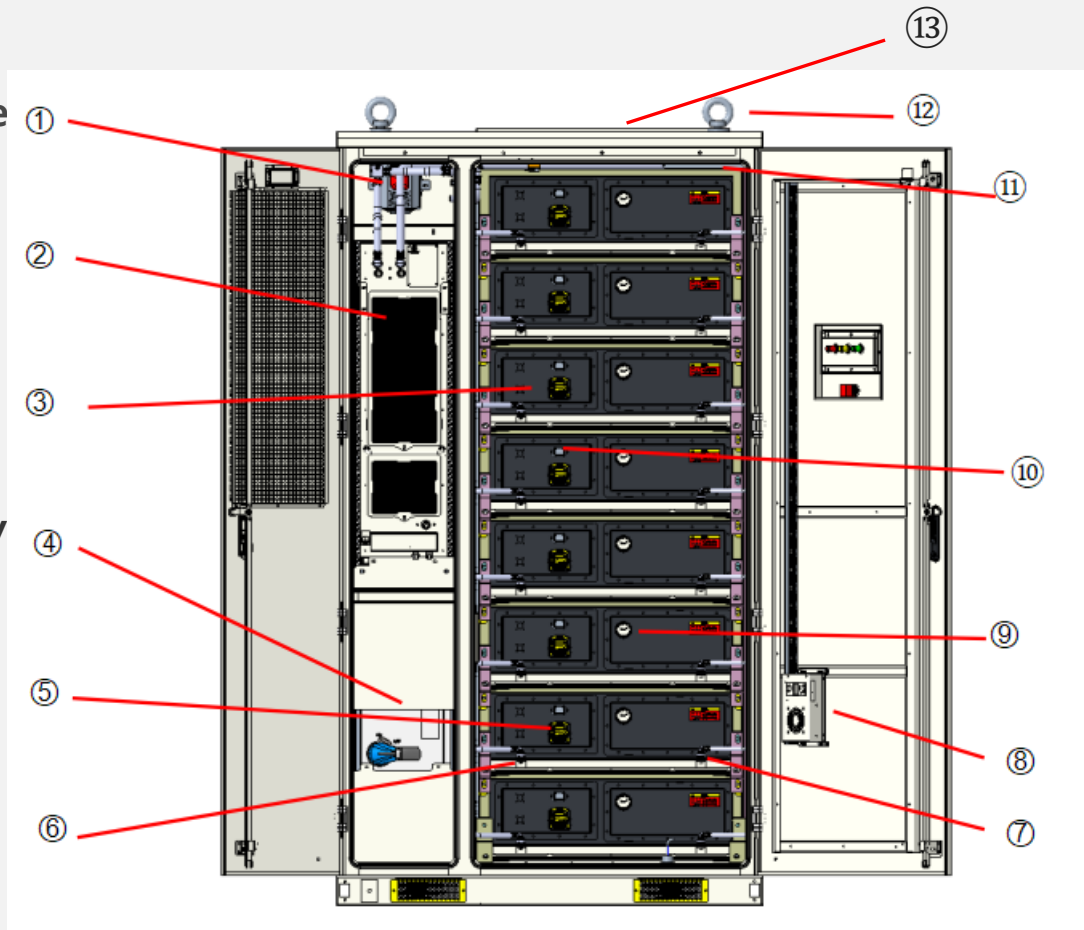
**Industrial
Chiller**

Battery Pack

**HV Box/
BPU**

MSD

**Hot water
outlet**



Deflagration Plate

Lifting Ring

**Gas fire Extinguisher
(Optional)**

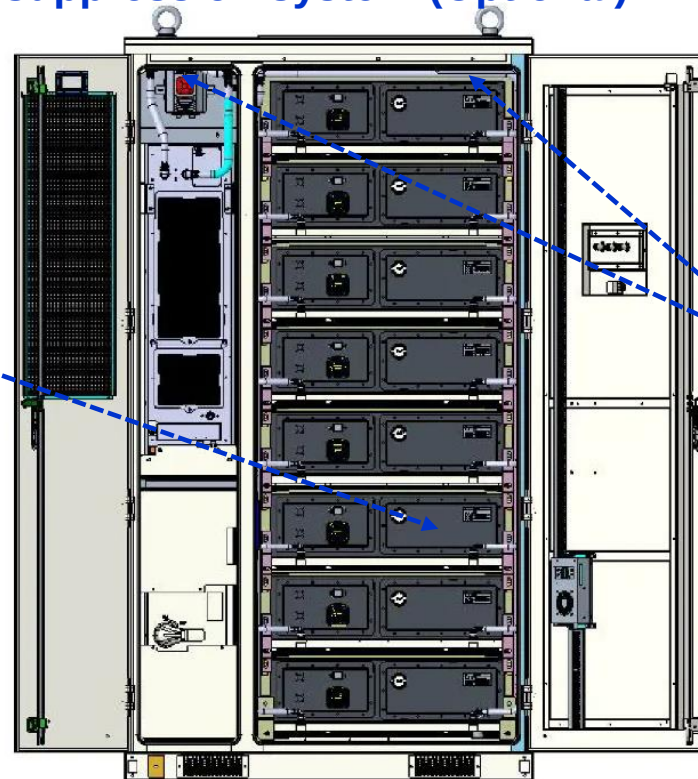
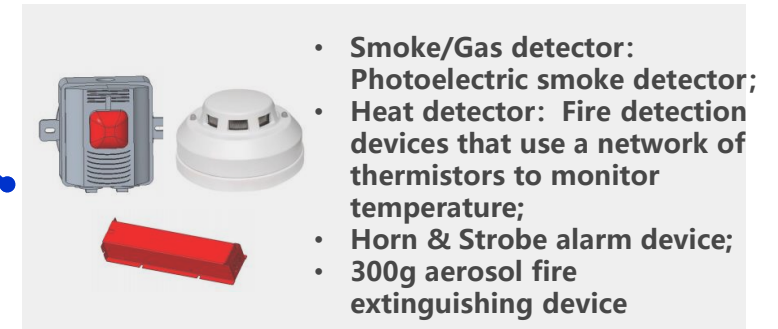
**Communication
Port**

Pressure Relief Valve

Dehumidifier

Cooling water inlet

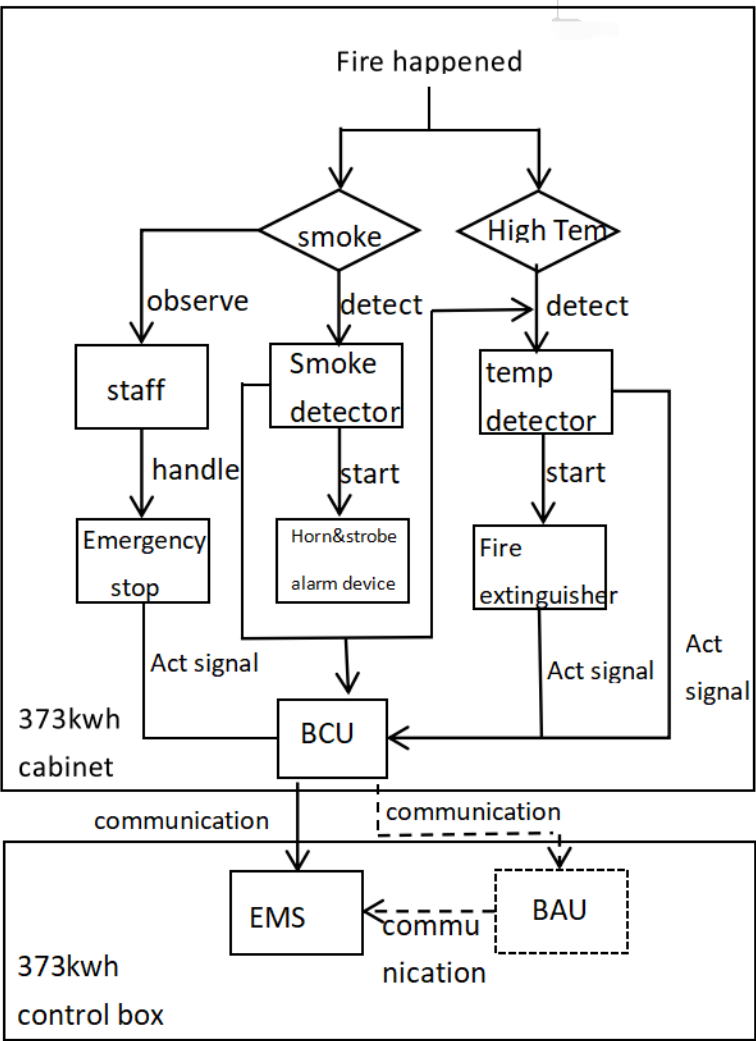
Aerosol Pack(Default) or Gas (Optional, FM 200 / Novec 1230) and water pipe fire suppression system (Optional)



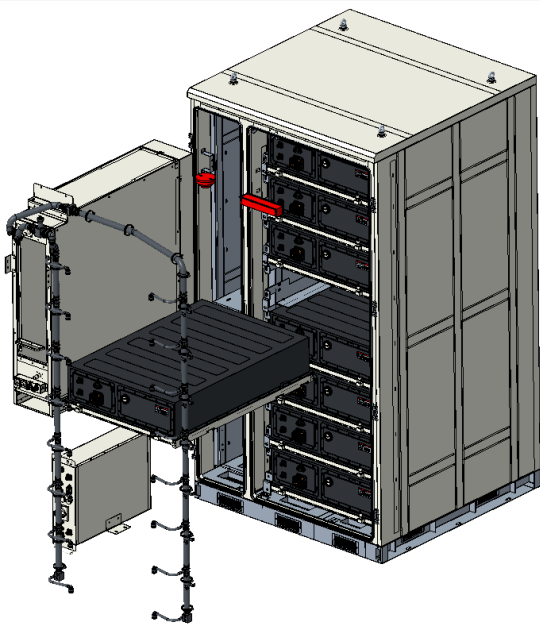
FSS-Main Components

No.	Main components
1	Smoke/Gas detector: Photoelectric smoke detector
2	Heat detector: Fire detection devices that use a network of thermistors to monitor temperature
3	Horn & Strobe alarm device
4	Pressure-Releasing system: valve plate
5	300g aerosol fire extinguishing device
6	Aerosol fire extinguishing device bulid in battery pack

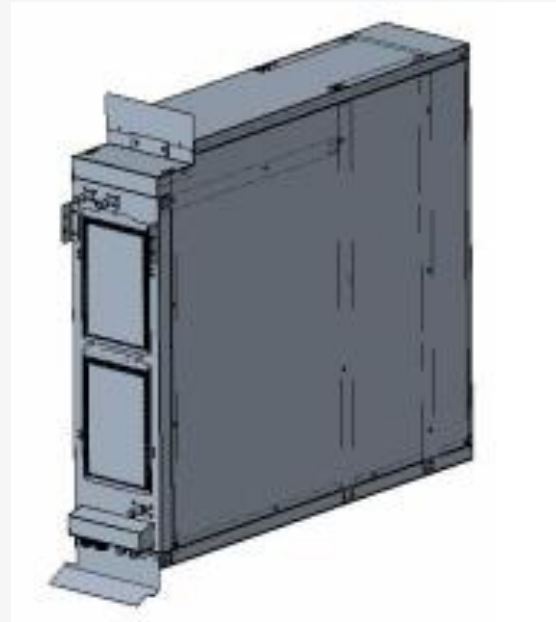
FSS Control Strategy



Liquid cooling system-layout



Piping for cooling system

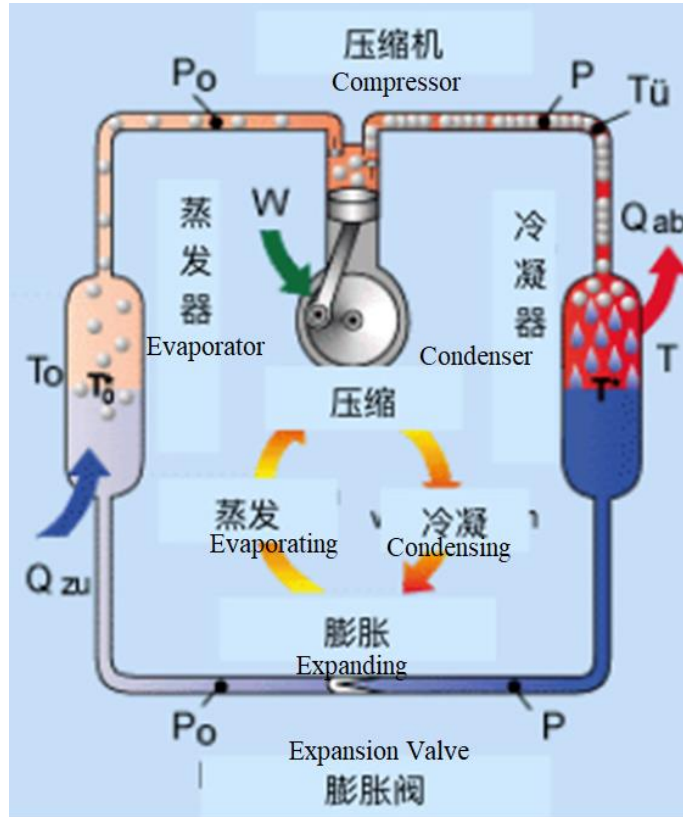


Industrial Chiller

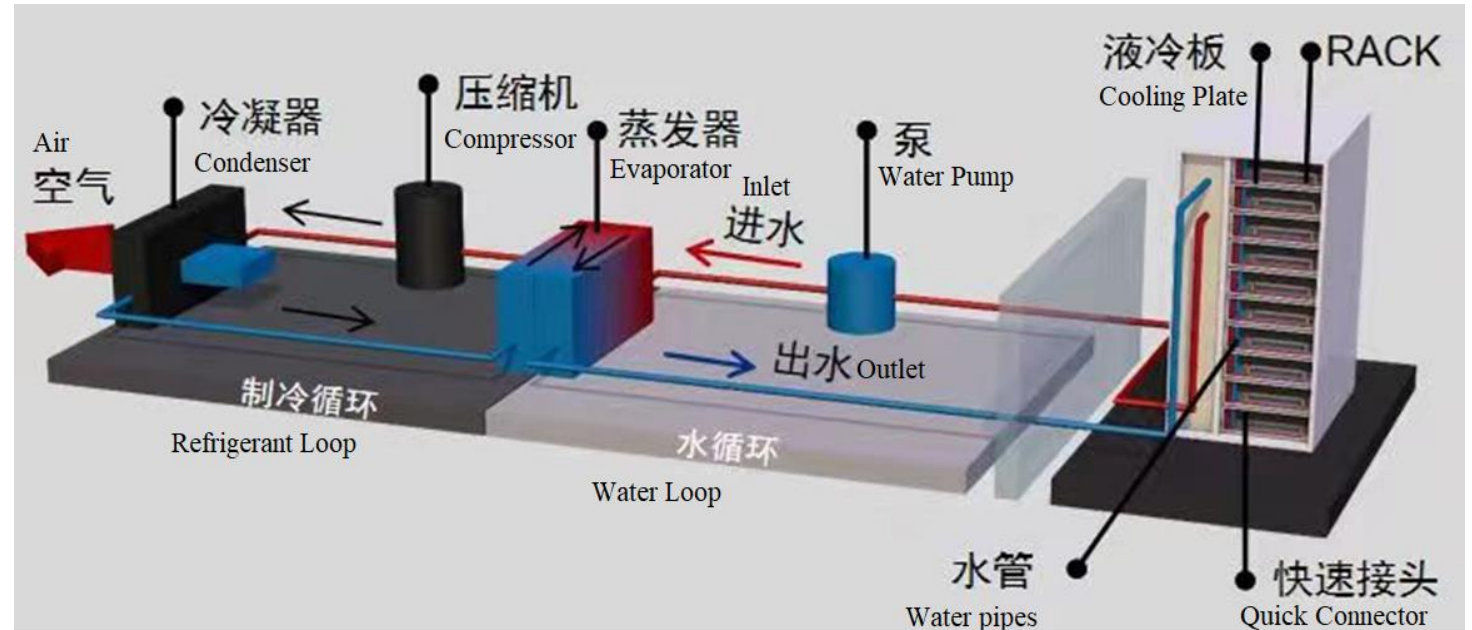
- Temperature difference is well controlled within 3°C among cells;
- The temperature rise of charge and discharge shall not exceed 4°C;
- Refrigeration capacity: 8kW
Cooling power: 4.5kW
- Heating capacity: 2.5kW
Heating power: 3.5kW

Liquid chiller Working diagram

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Refrigerant Loop



Water Loop

Liquid Cooling System-Function

The Chiller consists mainly of a compressor, condenser, throttling component, evaporator, water pump, PTC liquid heater and the necessary control components. The Chiller is used to regulate the temperature of the battery pack in the energy storage system to ensure that it always works within the right temperature range in order to maintain the best working conditions of the system, with the following functions:

- Precise measurement and monitoring of the coolant temperature.
- Effective heat dissipation when the battery pack temperature is high to prevent thermal runaway accidents.
- Pre-heating is working when the battery temperature is low, to raise the battery temperature and ensure charging and discharging performance and safety at low temperatures.

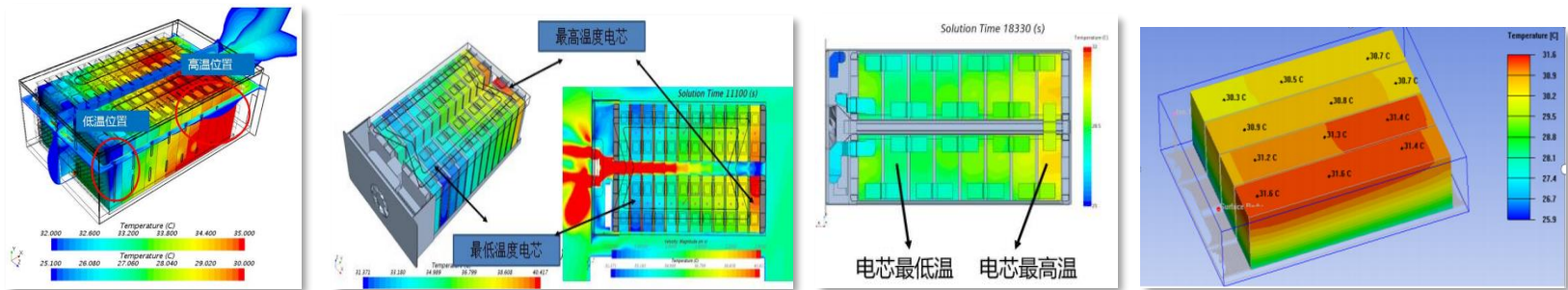
Control strategy of liquid cooling system



No.	Working mode	Judgment logic	Cut-off condition	remark
1	Cooling mode	Discharge condition: Cooling is activated when NTC monitoring cell Tmax≥32°C&Tvag≥30°C.	Discharge condition: NTC monitoring cell Tmax≤30°C & Tvag≤28°C , Cooling will stop.	After receiving the cooling request sent by BMS, TMS will start the pump within 20 seconds, and start the compressor to enter the cooling mode after 30 seconds. The set target temperature of the compressor to start is T=20±1°C@ the environment is 25°C±2°C, and the compressor power will be adjusted according to the water temperature.
		Charging condition: Cooling is activated when NTC monitoring cell Tmax≥32°C&Tvag≥30°C.	Charging condition: NTC monitoring cell Tmax≤30°C & Tvag≤28°C .	
2	Heating mode	Discharge condition: When NTC monitors cell unit Tmin≤-10°C Tvag≤-5°C, turn on the heating and allow small current discharge	Discharge condition: NTC monitoring cell monomer Tmin≥20°C&Tvag≥25°C, turn off the heating.	PTC heating is regulated by TMS. In heating mode, TMS monitors the cooling liquid heating target temperature T=30°C.
		Charging condition: When NTC monitors cell monomer Tmin≤5°C Tvag≤10°C, turn on heating and prohibit charging;	Charging condition: NTC monitors the cell mono Tmin≥20°C & Tvag≥25°C, turns off the heating and allows charging.	
3	Standby mode	Do not start cooling and heating.		
4	Work mode judgment and description	The cooling and heating modes have the highest priority and are executed first when they conflict with other modes. When there is a conflict between the cooling and heating modes, the self-circulation mode is executed.		
5	Fault tolerant processing of TMS control strategy	1. When the communication between BMS and TMS is interrupted, delay 5M, TMS sends alarm code, and automatically enters standby mode, BMS sends level 1 alarm (without cutting off the main loop relay, the power will be properly reduced, and maintenance processing is requested); 2. When the Chiller fails in the heating and cooling mode, exit and automatically enter the self-cycle mode.		

Liquid Cooling System

-Thermal Simulation



Ambient temperature 25℃	The highest temperature(℃)	Temperature rise(℃)	Temperature difference(℃)
(Air cooling) 2P12S-150Ah-0.5CP	37.3	12.3	3
(Air cooling) 1P24S-150Ah-1CP	39.8	14.8	7.1
(Air cooling) 1P16S-280Ah-0.5CP	33.9	8.9	3.3
(Liquid cooling) 1P52S-280Ah-0.5CP	31.7	6.7	2.9

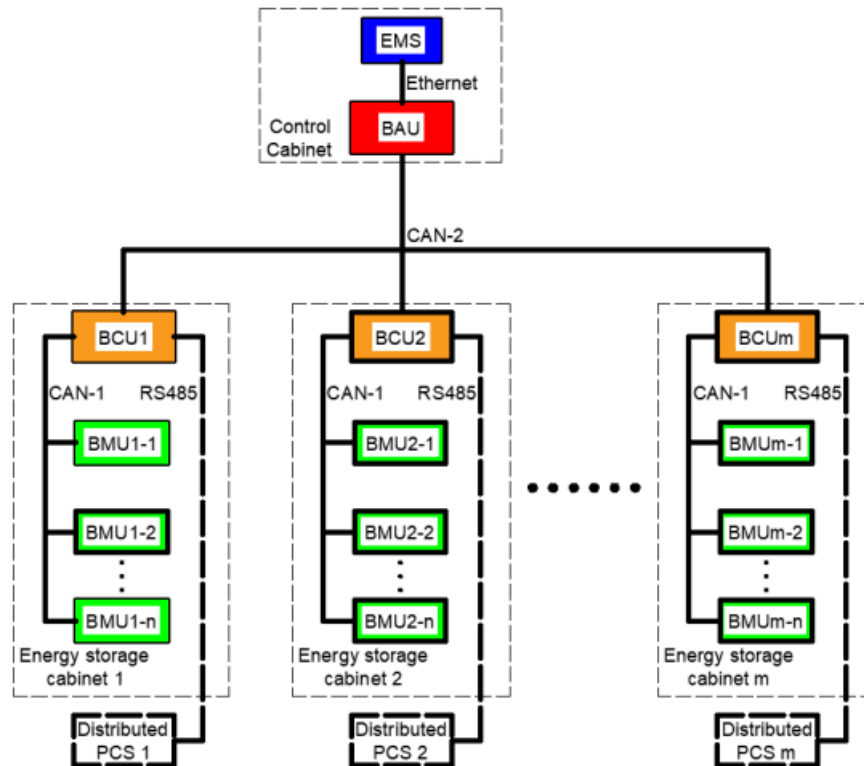
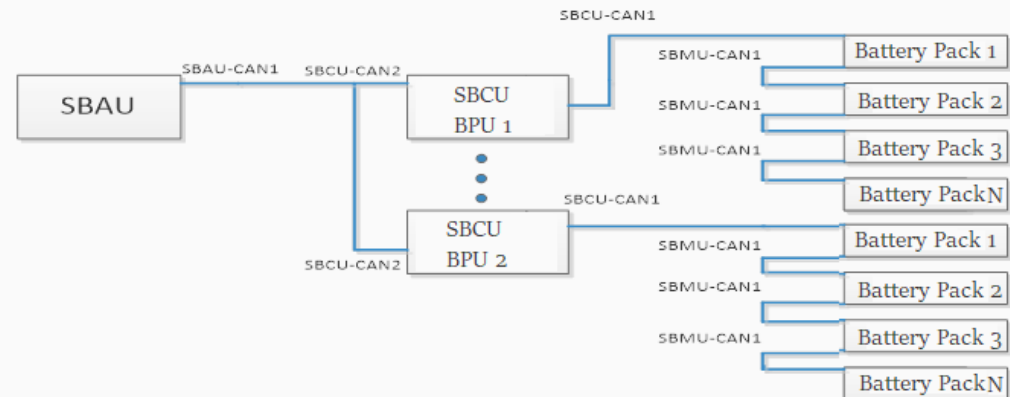
BMS-Topology

Battery Management System (BMS)

- Sub-system- **BAU**
monitoring & control BCU and other equipment, charge and discharge management
- Sub-system- **BCU**
monitoring & control BMU, & monitoring current & voltage of battery rack
- Sub-system- **BMU**
monitoring cell operating data (voltage/temperature)

BMS Internal communication protocol: CAN

BMS to EMS/PCS communication protocol: Modbus, IEC61850, IEC104



Component	Function
SBMU	Monitoring the voltage and temperature of single cells in the battery module. Providing data for the battery system control of equalization management.
SBCU	<p>Management of SBMUs for battery voltage and temperature and detection of the discharge current and charging current of the batteries in the same rack.</p> <p>Triggering the protection when current, OCV, Temp etc. exceeds the threshold values by cutting off the relays and reporting to SBAU through CAN bus.</p> <p>Control of the main relay, sampling and processing of current sensor signals, sampling of auxiliary contact feedback signals of the main relay, and leakage detection.</p> <p>Calculation of the SOC and SOH of the battery rack.</p>
SBAU	Connect with the SBCUs and communicate with the PCS and the monitoring screen, including obtaining voltage, temperature, current, insulation, and relay status reported by SBCUs through internal CAN bus, displaying the BESS status in real-time on the monitoring screen after being connected to it with debugging CAN bus, and communicating with PCS for control of charge and discharge through the external CAN bus. One SBAU (Master *1) will manages the battery information provided by multi SBCUs (slaves*N).

BMS-The advantages of the design scheme

Safety

- Improvement of the system failure detection, to reduce the possibility of BMS's own malfunction, and reach ASILB level;
- Failure diagnosis of broken wires, over-temperature and so on is carried out for the BPU, battery pack and wiring harness, with timely warning and treatment.

Reliability

- The DC bus is equipped with "controllable DC circuit breaker", for safe disconnection of the system in case of failure;
- Monitoring of the temperature of B-/B+ of the battery pack, and shutdown of the system in event of the abnormal change of temperature in time;
- Software follows the Autosar architecture, greatly reducing the development & optimization cycle.

Intelligence

- Intelligent address assignment, which improves the efficiency of on-site commissioning and after-sales;
- Intelligent high-voltage management, minimizing the input of after-sales personnel while ensuring safety
- Intelligent equalization at battery packs, racks and system to ensure the consistency and maximize the efficiency of the battery system;
- Combined with EMS, PCS and backend system to enable battery remote diagnosis, remote control, remote operation and maintenance.

Maintenance

- Complete system diagnostic information and operation and maintenance tips for easy operation and maintenance.

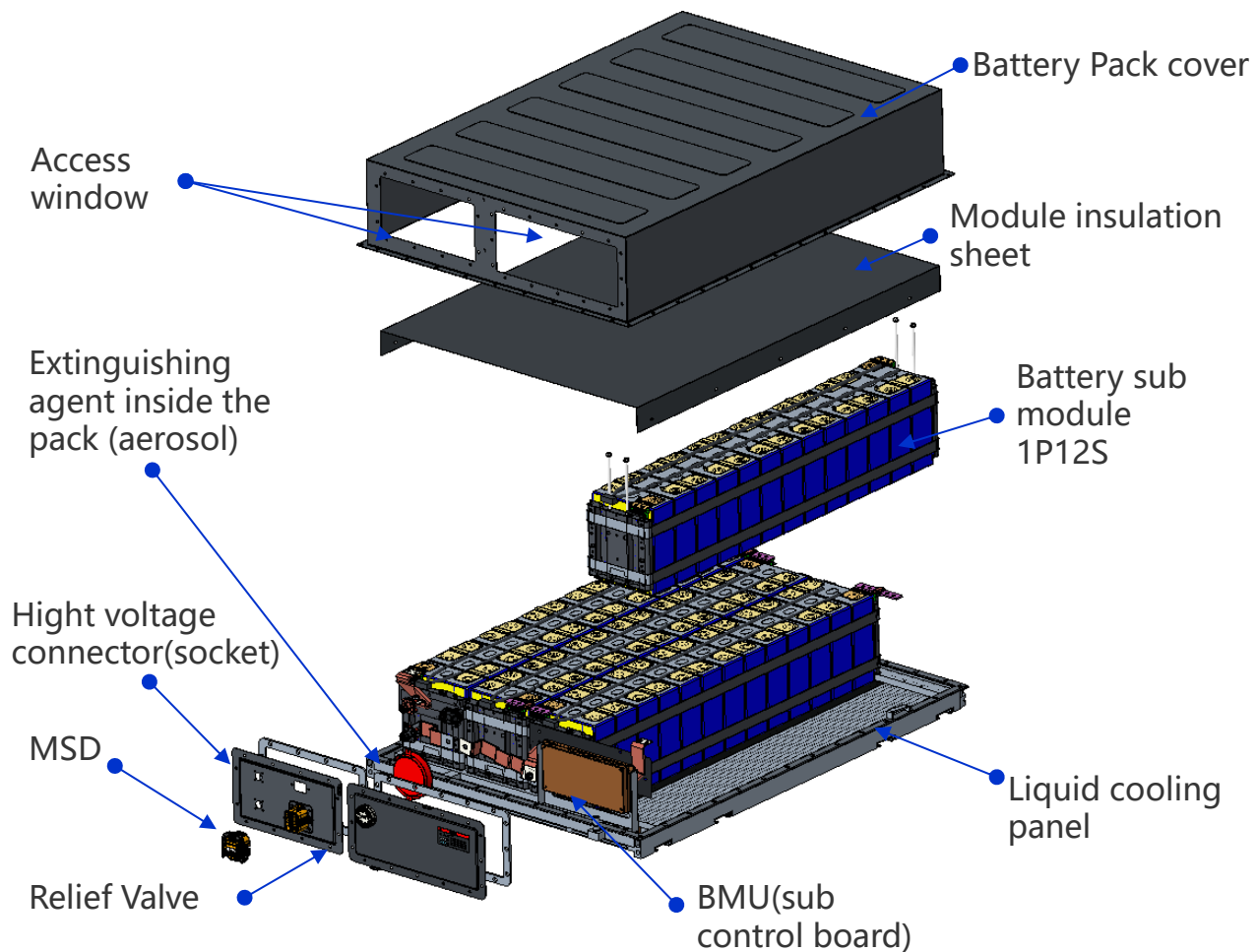
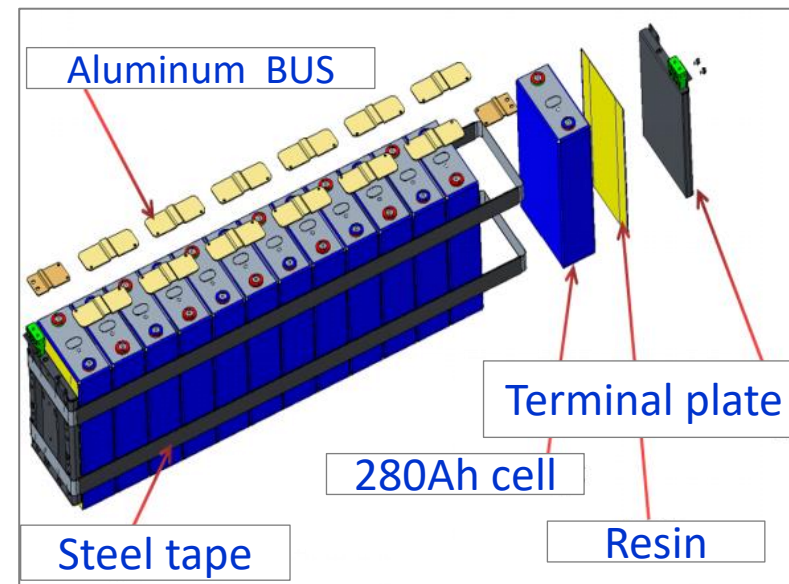
Battery Pack- Specification



No.	Items	Specification parameter
1	Cell specification	280Ah
2	System group mode	1P52S
3	Rated capacity	280Ah
4	Application voltage level	1500V
5	Rated energy	46.592kWh
6	IP protection level	IP67
7	Dimension	D1138*W786*H250mm
8	Weight	Apprx 360kg
9	Application	Standard Battery Pack, outdoor cabinet

Battery Pack-Structure

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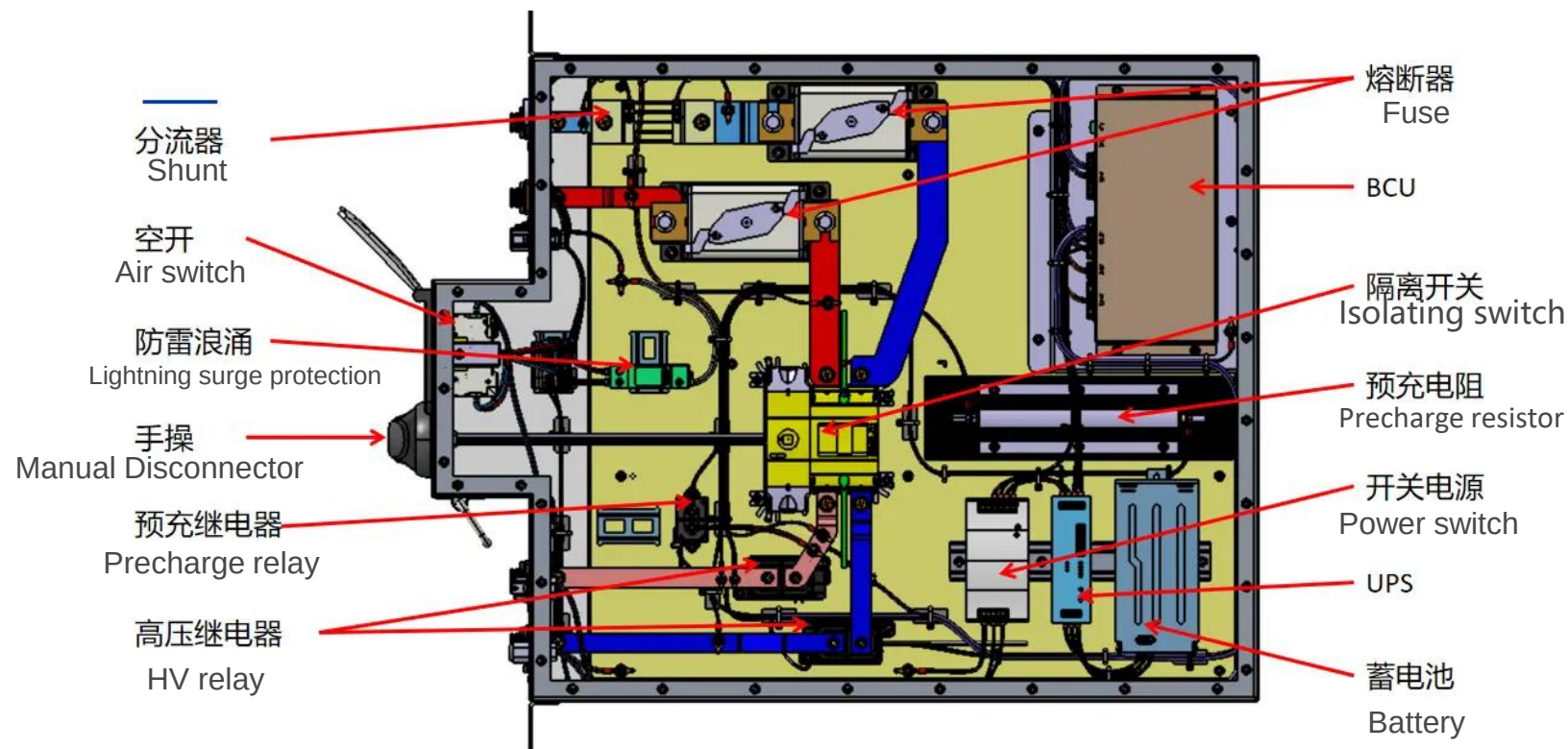


HV Box



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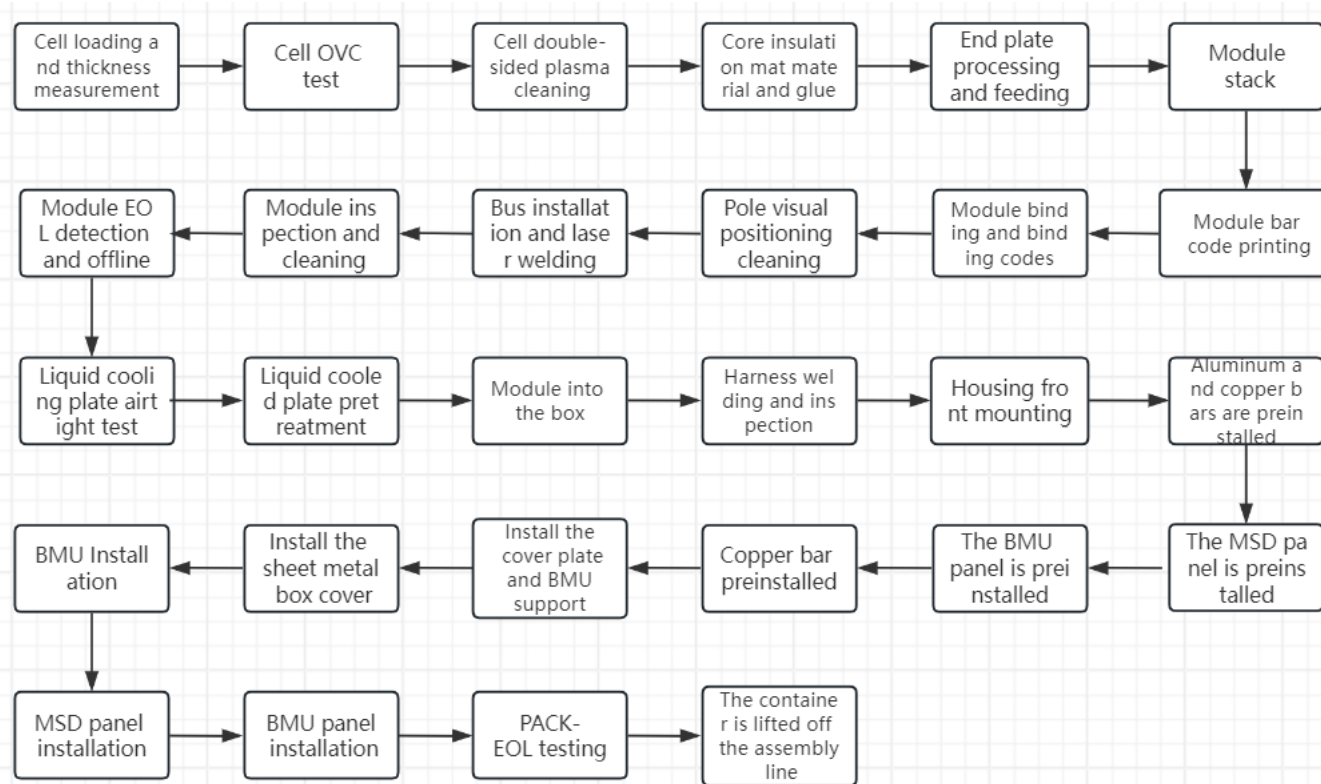
- BCU
- Isolating switch
- Lightning protector
- UPS & Battery(lead-acid)
- HV relay
-



Factory acceptance tests are designed to test the functionality and integrity of the entire system to ensure that all components and modules are working correctly to achieve the performance of the system. FAT mainly includes the following test items:

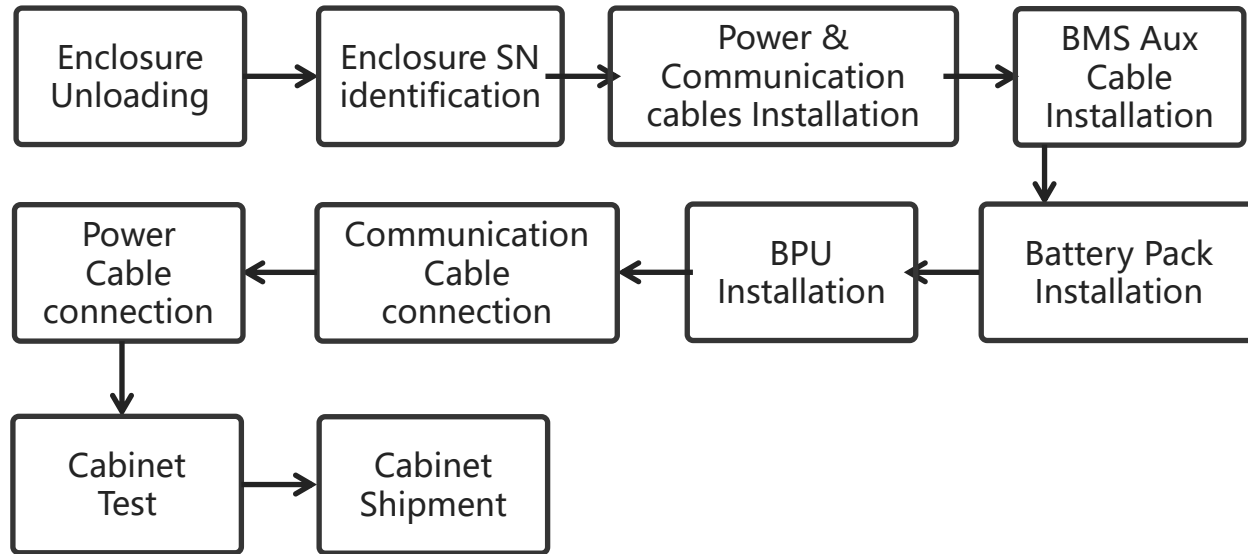
- **Dimensional check**
- **Torque and tension test**
- **Ground resistance test**
- **Withstand voltage/ Hi-POT test**
- **Charge, discharge and capacity test**
- **Communication function test**
- **HVAC/TMS function test**
- **FSS function test**
- **Waterproofing test**
- **.....**

Process flow chart



Procedure 1: Pack assembly (see paper CP file for details)

Process flow chart



Step 2: Battery rack installation and system testing (see paper CP file for details)



ESS global certificate list

Items	North America					Europe				Australia		transport
Standard	GB/T 36276	UL9540A (2019)	UL9540 (2023)	UL1973 (2022)	NFPA855 (NFPA68)	IEC62619 (FS IEC 60730-1)	IEC62477 & IEC62040	EMC (IEC61000)	IEC62933	AS3000	AS5139	UN38.3
Cell	PASS	PASS	/	PASS	/	PASS	/	/	/	/	/	PASS
Battery Module	24/03	PASS	/	/	/	/	/	/	/	/	/	PASS
Rack	PASS	/	/	/	/	PASS	/	PASS	/	/	/	/
Cabinet	/	PASS	PASS	PASS	comply	PASS	PASS	PASS	comply	comply	comply	PASS

Compatible PCS

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C Rate	PCS		Dc side		Ac side			Applicability		
	Name of manufacturer	Model number	Battery voltage range	Cabinet No. at Max C rate	Rated AC power	Rated AC voltage	Rated frequency	Safety certification	Grid-connected certification	Applicable country
0.5C/0.33C/ 0.25C	INDRIVITEC	FC1440ML	1120 - 1500 V	8	1440KW	690V	50/60Hz	EN61000-6-2, EN61000-6-4, EN62477-1, IEC62103	Eu EN 50530, EN 50549-2, Italy CEI 0-16, Germany VDE-AR-N 4120, VDE-AR-N 4110, UK G99,	Most of Europe
		FC2160ML	1120 - 1500 V	12	2160KW					
		FC2880ML	1120 - 1500 V	16	2880KW					
		FC3600ML	1120 - 1500 V	20	3600KW					
		FC4320ML	1120 - 1500 V	20 (Short-circuit current TBC)	4320KW					

Compatible PCS

 GREAT POWER

C Rate	PCS		Dc side		Ac side			Applicability		
	Name of manufacturer	Model number	Battery voltage range	Battery Cluster No. at Max C rate	Rated AC power	Rated AC voltage	Rated frequency	Safety certification	Grid-connected certification	Applicable country
0.5C/ 0.33C /0.25 C	KACO	Gridsave 92.0 TL3-S	668 - 1315 V	1	92KW	400V	50/60Hz	IEC 62477-1:2012, IEC 62109-1/2	/	EU
	DYNAPOWER	DYNAPOWER MPS125	730V-1500V	1	125KW	480V	60Hz	UL1741 SA\NFPA70\IEEE519	IEEE 1547.1:2020	USA

THANKS



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