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# AT920kW/1863kWh Outdoor Liquid Cooled ESS Container Specification

# Catalog

# 1 Product Appearance


# 2 Product Description

The liquid-cooled energy storage container system (all in one) has a capacity of 1863.68kWh (2h backup), rated charging and discharging power of 931.84kW, and integrated in a 20 foot container. This system adopt string solution, each cluster of battery capacity is 232.96kWh, connected to a 125kW string PCS (power conversion system), and 8 string PCS AC side are connected to the AC380V power grid after converging.

The system consists of liquid-cooled battery PACK, BMS system, power conversion system, temperature control system, fire protection system, lighting system, power distribution system, grounding system and EMS energy management system, etc.

This system used for power storage and release device, configured on the user side, which can not only realize the peak and valley price arbitrage of the power distribution system, cut peaks and fill valleys, and improve the power quality of power grid, but also can be used as a backup power source.

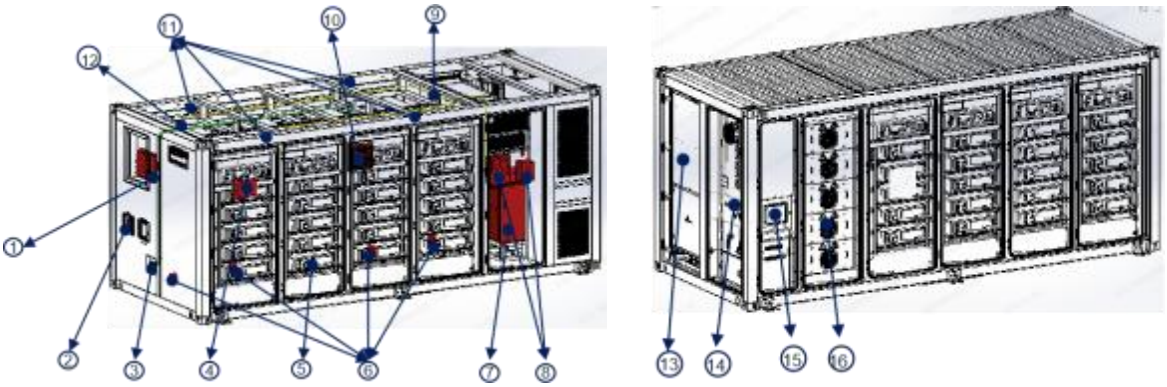
| Application Categorization | Application Name |
|---|---|
| **Common energy storage applications** | Peak shaving and valley filling, power supply and demand adjustment, capacity/demand management, peaking adjustment, standby power, distributed photovoltaic storage integration, micro-grids, etc. |
| **Grid-assisted applications** | Improve power supply reliability, ease transmission system congestion, and improve electric energy quality |

# 3 System Parameter

| No | Project Description | | Specification | Remark |
|---|---|---|---|---|
| 1 | **DC Side Parameters** | | | |
| 1.1 | Cell Type | | LFP 3.2V/280Ah | / |
| 1.2 | System Capacity | | 1863.68kWh | / |
| 1.3 | Rated DC Voltage | | 832V | / |
| 1.4 | Battery Voltage Range | | 728Vdc～936Vdc | Cell 2.8V~3.6V |
| 1.5 | DC Maximum Current | | 140A | / |
| 1.6 | Battery Pack Configuration | | 1P52S*5*8 | / |
| 1.7 | Rated Charge/Discharge Ratio | | ≤0.5P | / |
| 2 | **AC Side Parameters** | | | |
| 2.1 | Rated Output Voltage | | 380VAC | / |
| 2.2 | Grid Voltage Range | | -10%～15% | Settable |
| 2.3 | Rated Power-grid Frequency | | 50Hz/60Hz | / |
| 2.4 | Power-grid Frequency Range | | 45～55Hz | Settable |
| 2.5 | Rated Output Power | | 931.84kW | / |
| 2.6 | AC Input Way | | 3L+N/3L+N+PE | / |
| 2.7 | Power Factor Adjustment Range | | -1～1 | / |
| 2.8 | Adaptation To Power-grid Type | | TT/TN | / |
| 3 | **Efficiency** | | | |
| 3.1 | Maximum System Efficiency | | >90% | ＜0.5P |
| 4 | **Basic Parameters** | | | |
| 4.1 | Temperature Of Working Environment | | -30℃~55℃ | Automatic Derating Over 45℃ |
| 4.2 | Relative Humidity Of Working | | 0～95% | / |
| 4.3 | Maximum Working Altitude | | 4000m | Automatic Derating >2000m |
| 4.4 | Protective Class | | IP55 | / |
| 4.5 | Battery Heat Dissipation Method | | Intelligent Liquid Cooling | / |
| 4.6 | Size（W*H*D） | | 6058*2896*2438mm | / |
| 4.7 | Weight | | ＜30t | / |
| 4.8 | Fire-Fighting | | Perfluorohexanone/aerosol | / |
| 4.9 | External Communications Interface | | RS485/Ethernet/4G | / |
| 4.10 | Communications Protocol | | Modbus-RTU/TCP/TCP-IP | / |
| 4.11 | Display | | Touch Panel、Remote APP | / |
| 4.12 | Pollution Class | | 2 Level | / |
| 4.13 | Container | Power | 2 Way | A、B、C、N, 300-400mm2 Cable |
| | | Grounding | 4 pc | PE,120-240mm2 Cable |

| | | | | |
|---|---|---|---|---|
| | Interface | Communication | 1 Way | Ethernet,4G |
| | | Water Fire Protection | 1 Way | DN65 galvanized steel pipe |

# 4 Introduction of Main Components




| | | |
|---|---|---|
| 1.Explosion-proof fan | 2.Fire emergency stop | 3.Water fire interface |
| 4.Explosion vent window | 5.Battery Box | 6.Dehumidifier |
| 7.Erfluorohexanone/aerosol cylinder | 8.Fire host and fire fan control box | 9.Gas fire pipeline |
| 10.Electric blinds | 11.Composite sensor | 12.Water fire pipeline |
| 13.PCS Room | 14.Secondary equipment room | 15.Power distribution unit room |
| 16.Water Chiller | / | / |

## 4.1 Introduction of DC Systems

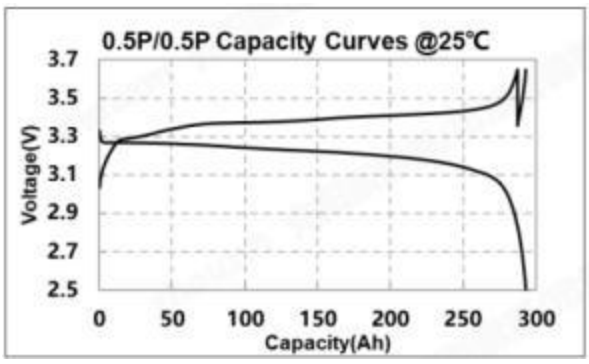
### 4.1.1 Cell

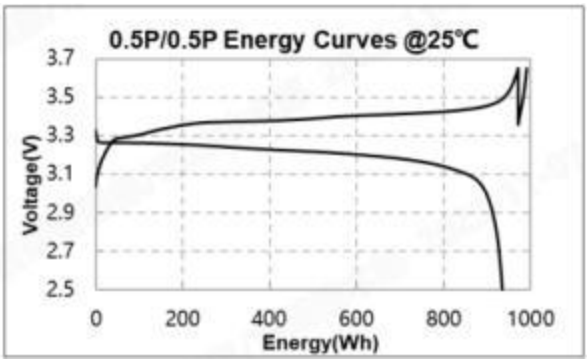
The DC side take CATL standard 280Ah Lithium Iron Phosphate (LFP) square aluminum cell, with a standard charging/discharging multiplier of 0.5P, featuring high sustained power, longer cycle life, reliable storage lifespan and high security.

| No | Project Title | Specification | Remark |
|---|---|---|---|
| 1 | Battery Type | Lithium Iron Phosphate | Aluminum Case |
| 2 | Nominal Voltage (V) | 3.2 | Rated Multiplier Discharge |
| 3 | Nominal Capacity（Ah） | 280 | 25±2℃，0.5P/0.5P Voltage Range 2.5～3.65V |
| 4 | Standard Charging Power | 0.5P | 25±2℃ |
| 5 | Maximum Continuous Charging Power | 0.5P | / |
| 6 | Standard Discharge Power | 0.5P | 25±2℃ |
| 7 | Maximum Continuous Discharge Power | 0.5P | / |
| 8 | Voltage Range（V） | 2.0-3.69 | Limit Range |
| 9 | | 2.8-3.65 | Recommended Range Of Use |
| 10 | Energy Efficiency | ≥94% | Rated Multiplier (Discharge Energy/Discharge Ah) / (Charge Energy/Charging Ah) |
| 11 | Size（W*H*T mm） | 173.93*207.2*71.65 | ±0.8 |
| 12 | Cycle life | ≥8000 cycles | 70%SOH，25℃、0.5C |
| 13 | Internal Resistance（mΩ）（1KHz） | 0.17±0.05 | New Battery Status（～30%SOC） |
| 14 | Weight（Kg） | 5.4±0.3 | / |
| 15 | Storage Temperature Range(℃) | -30℃~+60℃ | Storage Environment Humidity ≤85%ROH，no condensation |
| 16 | Working Temperature Range(℃) | -20～+60℃ | Charging temperature range:0～60℃，Discharging temperature range：-20~ 60℃ |
| 17 | Application Altitude（m） | <5000 | / |

（1）**Capacity & Energy Curve**

Testing Procedure: (1) 25℃, 0.5P constant power charge to 3.65V; (2)Stand for 5 minutes; (3) 0.1P constant power charge to 3.65V; (4)Stand for 30 minutes; (5) 0.5P constant power discharge to 2.5V; (6) Stand for 30 minutes.

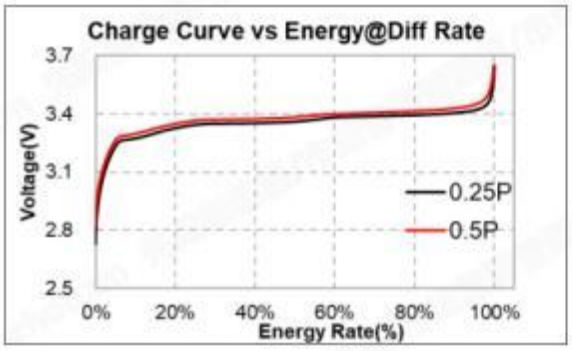


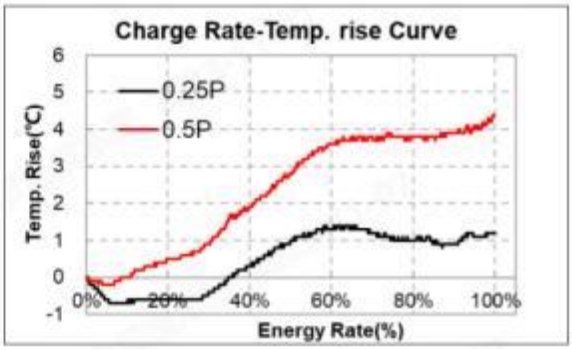




Conclusion: The minimum discharge capacity of the battery cell is 280Ah @25℃, 0.5P; the minimum discharge energy of the battery cell is 896Wh @25℃, 0.5P.

### （2）25°C Charge Multiplier Curve

Test Procedure: (1)Stand at 25°C for 30 minutes; (2) Charge n*P at constant power to 3.65V (n=0.25,0.5); (3)Stand for 5 minutes; (4) Discharge 0.5P at constant power to 2.5V; (5) Stand for 5 minutes; (6) Repeat Steps 2 to 5 until the test is completed.



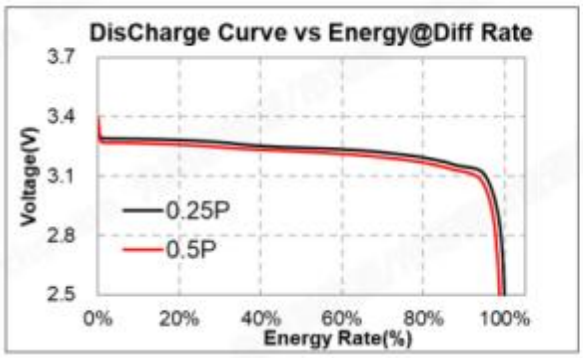



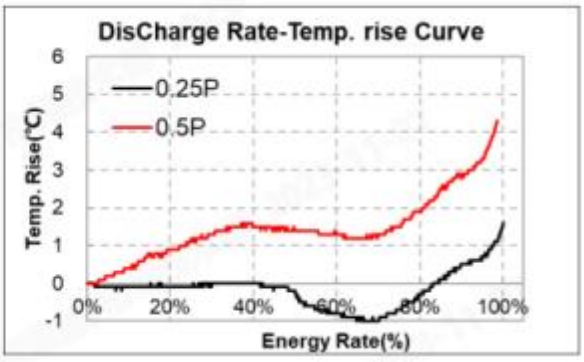

Conclusion:

| Rate DisCharge Performance | | |
|---|---|---|
| Rate | 0.25P | 0.5P |
| Energy Rate | 100.00% | 99.85% |
| Temp. Rise（℃） | 1.2 | 4.4 |

### （3）25°C Discharge Multiplication Curve

Test Procedure:(1) Stand at 25°C for 30 minutes; (2) 0.5P constant power charge to 3.65V; (3) Stand 5minutes; (4) 0.1Pconstant power charge to 3.65V; (5)Stand 5minutes; (6) n*P constant power discharge to 2.5V(n=0.167,0.25,0.5);(7)Stand 5minutes;(8)Repeat steps 2 to 7 until the test is complete.



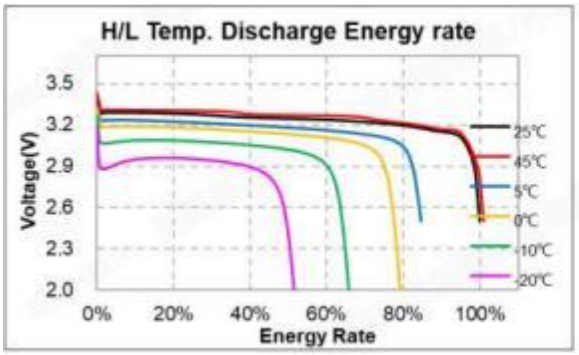



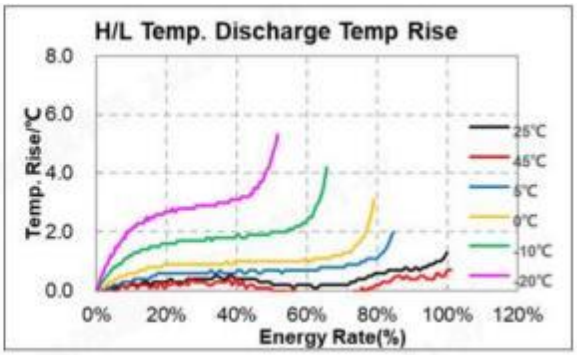

Conclusion:

| Rate DisCharge Performance | | |
|---|---|---|
| Rate | 0.25P | 0.5P |
| Energy Rate | 100.00% | 98.62% |
| Temp. Rise（℃） | 1.6 | 4.3 |

### （4）High And Low Temperature Discharge Curve

Test Procedure: (1) 25℃, 0.25P constant power charge to 3.65V; (2) XX℃ (XX=25,45,5,0,-10,-20), 0.25P constant power charge to 2.5V; (3) Repeat steps 1 to 2 until the test completed ; (4) Stand for 5 minutes.



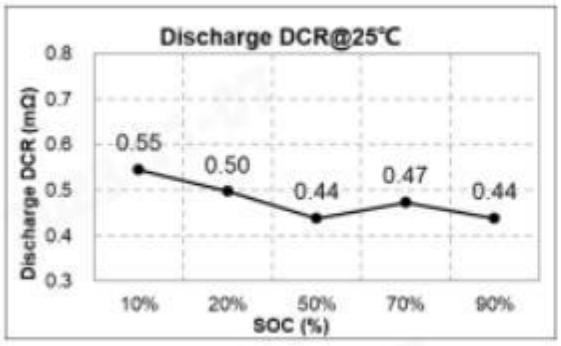



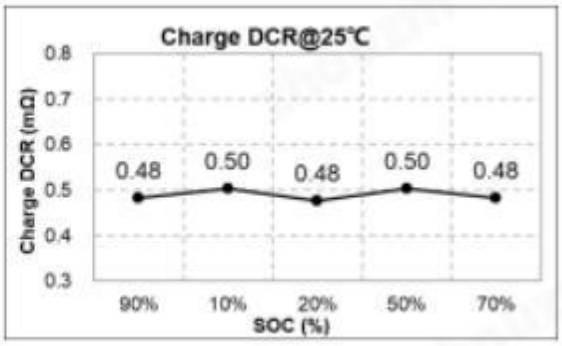

Conclusion:

| High/Low Temp Discharge Performance | | | | | | |
|---|---|---|---|---|---|---|
| Temp. （℃） | 25℃ | 45℃ | 5℃ | 0℃ | -10℃ | -20℃ |
| Energy Rate | 100.0% | 100.1% | 86.0% | 79.3% | 66.5% | 53.0% |
| Temp.Rise（℃） | 1.7 | 1.0 | 3.5 | 3.9 | 5.1 | 6.3 |

### （5）DCR

Test procedure: (1) 25℃, 560A constant current discharge for 30 seconds, cut off voltage ≥2.5V; (2) 25℃, 420A constant current charge for 30 seconds, cut-off voltage ≤3.65V.



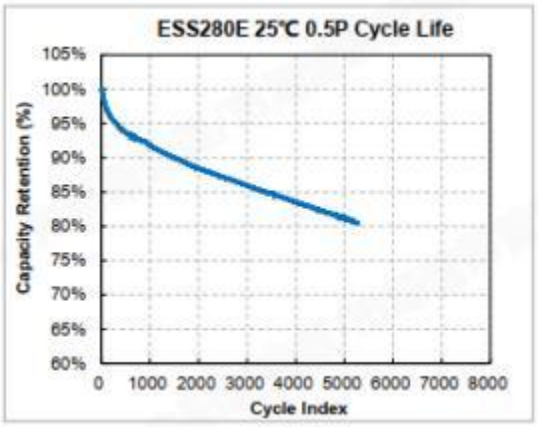



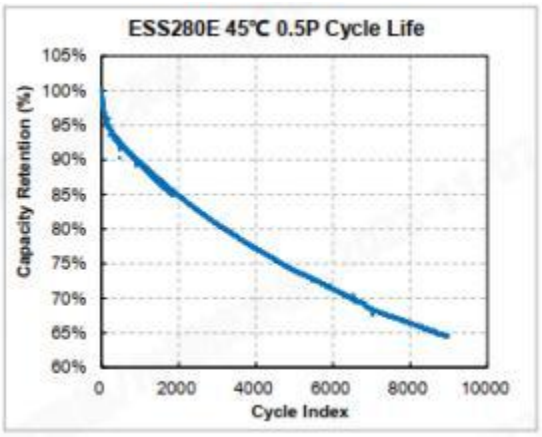

Conclusion:

| SOC | 10% | 20% | 50% | 70% | 90% |
|---|---|---|---|---|---|
| 放电 DCR mΩ | 0.55 | 0.50 | 0.44 | 0.47 | 0.44 |
| 充电 DCR mΩ | 0.48 | 0.50 | 0.48 | 0.50 | 0.448 |

（6）**Cycle Life Curve**

Test procedure: (1) 25℃, 2.5V~3.65V(100%DOD), 0.5P charging/0.5P discharging cycle; (2) 45℃, 2.5V~3.65V(100%DOD), 0.5P charging/0.5P discharging cycle.



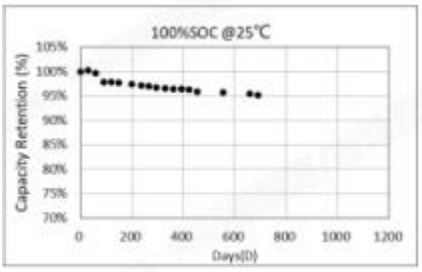

Conclusion:

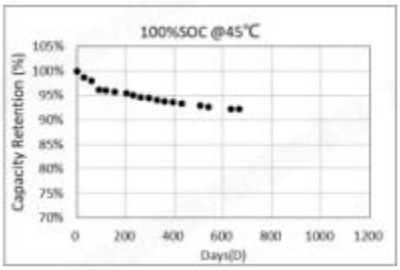
The environment temperature is 25℃, the multiplication rate is 0.5P, after predicted and analyzed, when the capacity retention rate of the battery cell is 80%, the number of 0.5P cycles is about 5200 times.

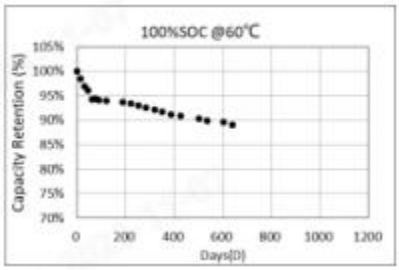
The environment temperature 45℃, multiplication rate 0.5P, after predicted and analyzed, when the capacity retention rate of the battery cell is 80%, the number of 0.5P cycles is about 3100 times.

（7）**Storage Life**

Test Procedure: (1) 25℃, 100% SOC storage, and monitor the reversible capacity retention rate; (2) 45℃, 100% SOC storage, and monitor the reversible capacity retention rate; (3) 60℃, 100% SOC storage, and monitor the reversible capacity retention rate.




Conclusion:

- ˜95% reversible capacity retention @ 25 ℃ ˜650days
- ˜92% reversible capacity retention @ 45 ℃ ˜650days
- ˜89% reversible capacity retention @ 60 ℃ ˜650days

## 4.1.2 Battery Box

The battery box contains 52 cells and a CSC, a battery box contains 8 NTC temperature sampling, the CSC is responsible for collecting the voltage, current and temperature of the cells inside the battery box.


The detailed parameters are shown in the table below:

| No. | Project Title | Specification | Remark |
|---|---|---|---|
| 1 | **Basic Parameters** | | |
| 1.1 | Battery Rated Energy Storage Capacity | 46.592kWh | / |
| 1.2 | Number of Battery cell | 52 | / |
| 1.3 | Voltage Range | 145.6～187.2V DC | Cell:2.8～3.6V |
| 1.4 | Rated Voltage | 166.4VDC | / |
| 1.5 | Rated Charge Multiplier | 0.5P/1P | / |
| 1.6 | Discharge Multiplier | 0.5P/1P | / |
| 1.7 | Maximum Continuous Current | 140A/280A | / |
| 1.8 | Passive Equilibrium | Full operating conditions, 24hours start-up equalization | / |
| 2 | **Working environment** | | |
| 2.1 | Working Temperature Range Of The Battery Box | Charge： 0～+55℃<br>Discharge： -30～+55℃ | / |
| 2.2 | Storage Temperature | -30～+60°C | / |
| 2.3 | Recommended Working Temperature | 21±3°C， average21°C | Optimum Working Temperature20～40℃ |
| 2.4 | Battery Box IP Protective Level | IP66 | |
| 3 | **Auxiliary power supply** | | |
| 3.1 | Control Loop-voltage Range | 20～26V DC | / |
| 3.2 | Control Loop-power (CSC power)（CSC power） | 2W | / |
| 4 | **Common Parameter** | | |
| 4.1 | Dimension(mm)(W*D*H) | 810*1152*243.4 (W*D*H) | / |
| 4.2 | Weight | 320(10kg) | / |
| 4.3 | IP Protective Level | IP66 | / |

| | | | |
|---|---|---|---|
| 4.4 | Cooling Method | Liquid Cooling | / |
| 4.5 | Communication Method | CAN | / |

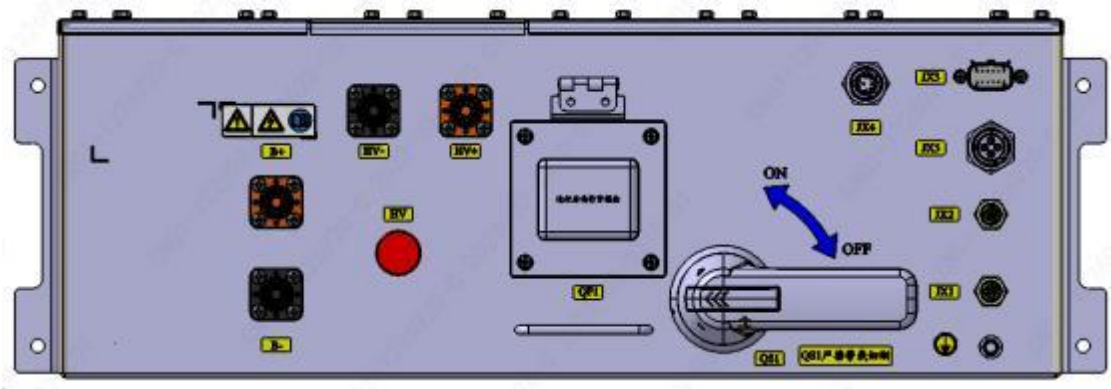
## 4.1.3 Battery Cluster

The battery cluster consists of 5 packs, connected in series with each other in the form of 1P260S. The battery modules are arranged from top to bottom in the storage cabinet and are connected via special connectors on the front panel.

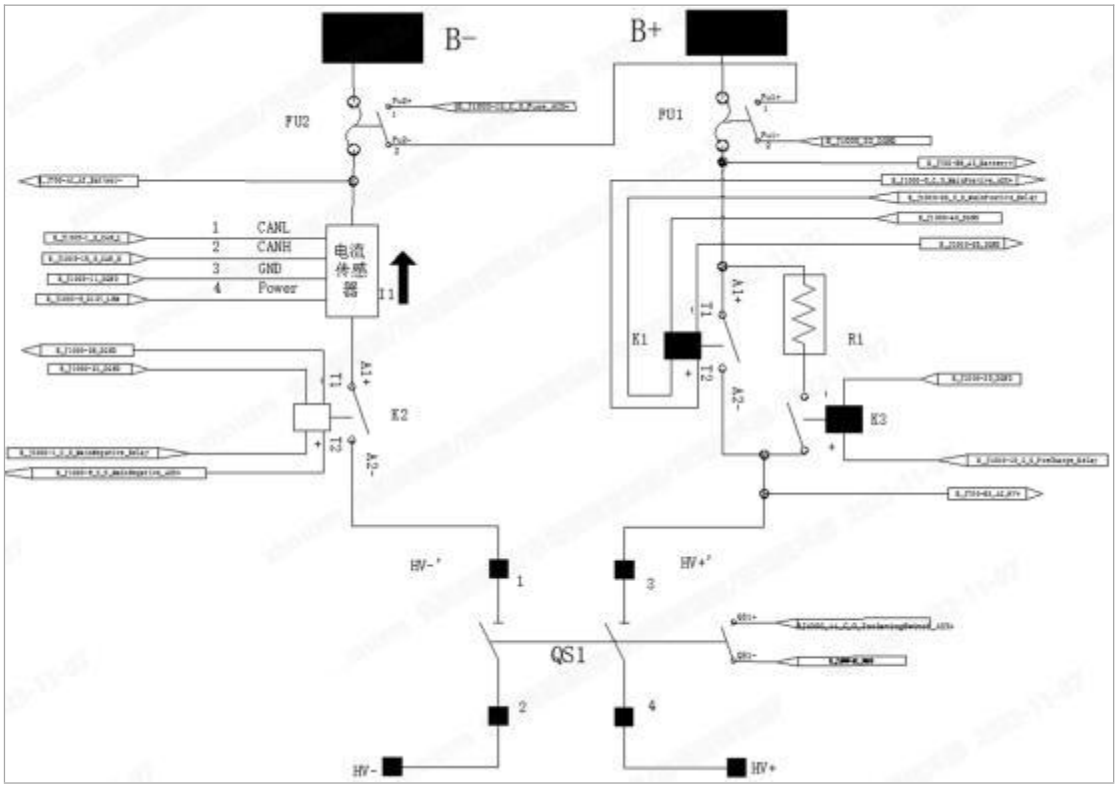
| No | Project Title | Specification | Remark |
|---|---|---|---|
| 1 | Nominal capacity | 280Ah | / |
| 2 | Nominal Voltage | 832V | / |
| 3 | Voltage Range | 728V～949V | Calculate according to 2.8～3.65V |
| 4 | Energy Storage | 232.96kWh | / |
| 5 | Structural dimensions | 836mm*1084mm*1315mm | W*D*H |
| 6 | Weight parameters | 1750kg | / |

## 4.1.4 High Voltage Box

The high voltage box is responsible for the connection between the battery string and PCS, monitoring the voltage, temperature, current and insulation of the battery string in real time, and collecting signals such as flooding and emergency stop button. The SBMU controls the start and stop of the electric water chiller according to the temperature of the battery cells, and uploads the information of the battery string to the EMS and PCS, and the high-voltage box is equipped with the protection functions of over-current, under-voltage, over-temperature, over-charging and discharging, etc




**Front view of high voltage box**



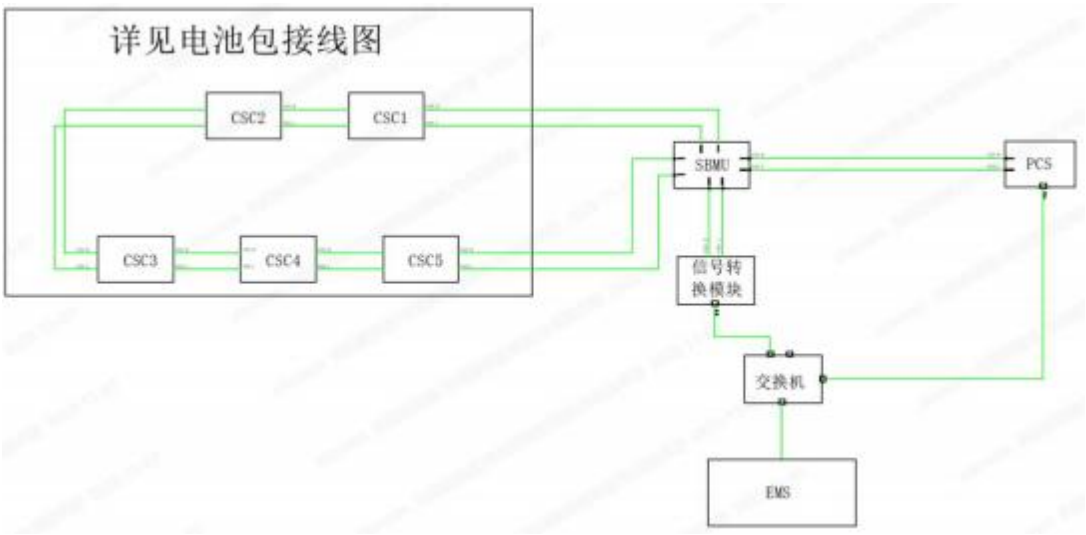

**Typical framework diagram**

High voltage box specification parameters:

| No | Project Title | Specification | Remark |
|---|---|---|---|
| 1 | Dimensions | 150.1*670*680.5mm | / |
| 2 | Weight | 60kg | / |
| 3 | Allowable Voltage Range | 800～1500V | / |
| 4 | Allowable Current Range | 0～320A | / |
| 5 | Allowable Environment Temperature | -30～55℃ | / |
| 6 | Allowable Relative Humidity | 95%RH | / |
| 7 | Allowable Altitude | 4000m | / |
| 8 | Cooling Method | Air Cooling | / |
| 9 | Protection Class | IP66 | / |
| 10 | External Communication Methods | CAN Bus Communication | / |

## 4.1.5 Battery Management System(BMS)

The BMS adopts a 2-stage architecture, with each Battery Module Management Unit CSC collecting parameters such as cell voltage and temperature from the battery module to the SBMU (Battery Cluster Management Unit) via the CAN bus, and the SBMU combining the other data collected (including fire alarm signals, water cooler status and other series of parameters such as battery status) to take equalization measures for the batteries and power control for the converter PCS. The SBMU, in combination with the other data collected (including fire action signals, water cooler status, battery status, and other series of parameters), takes measures to equalize the batteries and controls the power of the converter PCS.




**Typical System Diagram**

BMS Performance Parameters：

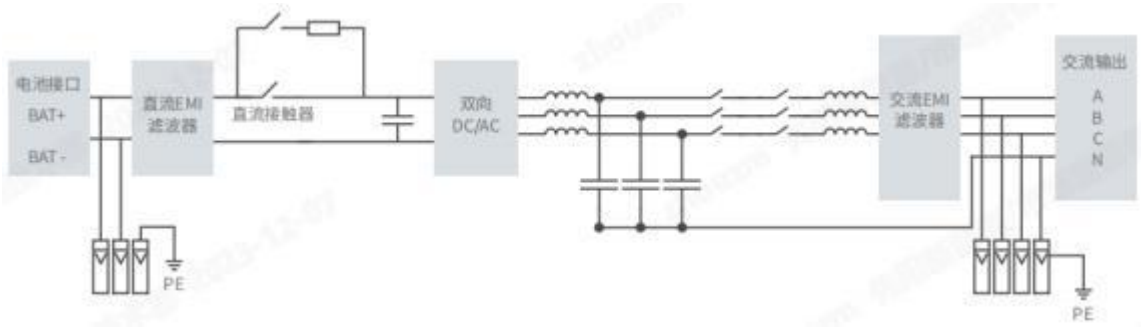
| No. | Performance Classification | Project | Performance Target |
|---|---|---|---|
| 1 | Basic Requirement | Operating Temperature Range | -30℃~65℃ |
| 2 | | Storage Temperature Range | -40℃~85℃ |
| 3 | Battery condition Monitoring accuracy and range | Individual Voltage Sampling Accuracy | ±5mV@0～60℃ |
| 4 | | Total voltage sampling accuracy | ≤0.5% FSR |
| 5 | | Total voltage detection range | 0V～1500V |
| 6 | | Current Sampling Accuracy | ≤0.5% FSR |
| 7 | | Current detection range | -500A～500A （Subject to actual conditions） |
| 8 | | Temperature sampling accuracy | ±1℃（-20℃~65℃;) |
| 9 | | Temperature Sampling Range | -40℃~85℃ |
| 10 | Battery status analysis accuracy | SOC SOC Estimation Accuracy | ≤5%@SOC≤30%ORSOC≥80%，8%@80%＞SOC＞30% |

## 4.2 Power Conversion System(PCS)

Power Conversion System (PCS) plays an executive role in the energy storage system. Its main function is to control the charging and discharging process of the energy storage battery pack, and to perform the conversion of AC and DC, which consists of a DC/AC bi-directional converter, a control unit, an auxiliary power supply, and a temperature control system.

PCS Appearance Photo

By communicating with BMS and EMS, PCS can realize active and reactive power adjustment, battery charging or discharging management, obtaining battery status information, and protecting battery charging and discharging.




**Power Conversion System Topological Diagram**

（1）PCS Specification Parameters：

| No. | Project Title | | Specification | Remark |
|---|---|---|---|---|
| 1 | Rated power | | 125kW | / |
| 2 | D.C. Input | Input power | 125kW | / |
| 3 | | Voltage range | Three-phase three-wire 600-1000Vdc<br>Three-phase four-wire 655-1000Vdc | / |
| 4 | | Maximum current | 233A (@45℃/1.1 times overload, three-phase three-wire)<br>213A (@45℃/1.1 times overload, three-phase four-wire) | / |
| 5 | | DC Slow Start Function | Possess | / |

Continued Table:

| No. | Project Title | | Specification | Remark |
|---|---|---|---|---|
| 6 | Grid-connection parameters | Rated power | 125kW | / |
| 7 | | Maximum power | 137.5kW | / |
| 8 | | Rated voltage | 400Vac | / |
| 9 | | Allowable Voltage Range | -20%～15%rated voltage(settable) | / |
| 10 | | Rated frequency | 50Hz OR 60Hz | / |
| 11 | | Allowable grid frequency | 45～55Hz(settable) | / |
| 12 | | Rated current（RMS） | 181A | / |
| 13 | | Maximum current（RMS） | 199A | / |
| 14 | | THDi | <3% | / |
| 15 | | Power factor adjustable range | -1～+1 | / |
| 16 | | Overload capacity | 110% | / |
| 17 | Off-grid parameters | Rated power | 125kW | / |
| 18 | | Maximum power | 137.5kW | / |
| 19 | | Rated Voltage | 400Vac | / |
| 20 | | Rated frequency | 50Hz OR 60Hz | / |
| 21 | | Output Voltage Accuracy | 1% | / |
| 22 | | Maximum inverter efficiency | 98.5% | / |
| 23 | | Voltage Scale | Three-phase four-wire OR Three-phase three-wire | / |

| | | | | |
|---|---|---|---|---|
| 24 | System | Isolation method | No | |
| 25 | | Communication method | RS485、Ethernet、CAN | / |
| 26 | | Communication protocol | Modbus-RTU / Modbus-TCP / CAN2.0B | / |
| 27 | | Display | LED | / |
| 28 | | Protection class | IP66 | / |
| 29 | | Size(W×D×H) | 998*800*275mm | / |
| 30 | | Weight | 98kg | / |
| 31 | | Operating temperature | -40℃~60℃ | Automatic derating when >45℃ |
| 32 | | Relative Humidity | 0～100%（No condensation） | / |
| 33 | | Altitude | 5000m | Automatic derating when >3000m |
| 34 | | Cooling method | Intelligent air cooling | / |
| 35 | | Installation Methods | Rack-mounted/Wall-mounted | / |
| 36 | | Maintenance methods | Pre-maintenance | / |

**（2）PCS Operating States and Their Transitions**

The operating states of the PCS include: down state, standby state, and running state.

**a.Shutdown Status**

The shutdown state is the state in which the PCS unit blocks the pulse and disconnects the contactors on the DC and AC sides simultaneously. It can be categorized into normal shutdown, emergency shutdown, and severe fault shutdown.

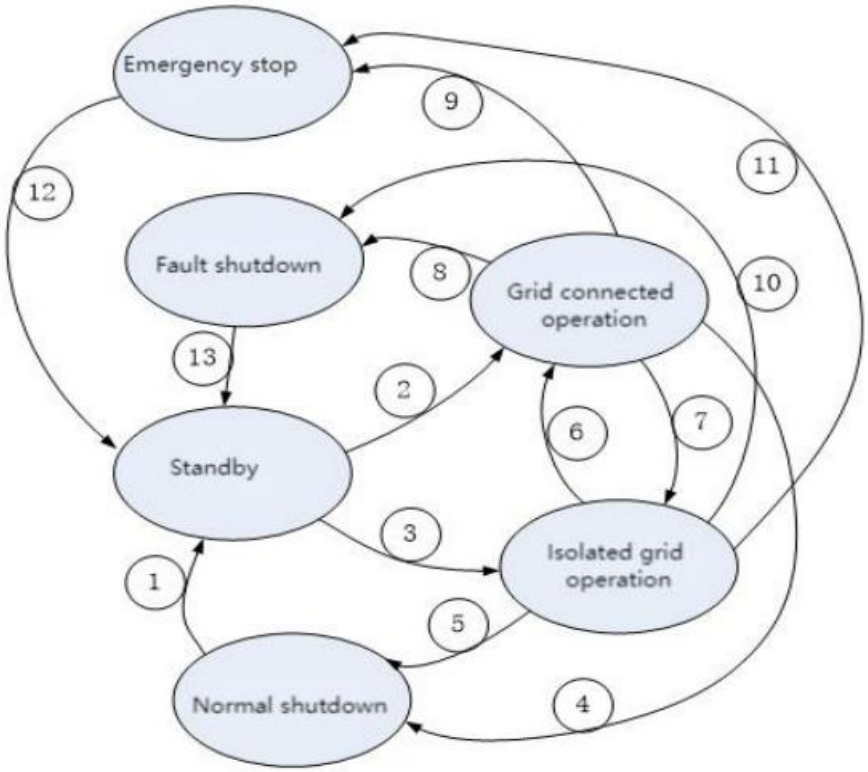
**b.Standby State**

The standby state refers to the hot standby state of the PCS device when it is ready to enter the working state or when a certain working state is completed. At initial power-up, when both the DC and AC sides are detected to be ready and the battery system reaches the working condition, the PCS unit enters the standby state and prepares to receive the operation mode and working state control commands.

**c.Operational Status**

The operation status is categorized into grid-connected and isolated grid operation status.

**d.State transitions**




**PCS State Transition Diagram**

Each state transition condition of PCS is as follows:

| No. | Instructions | No | Instructions |
|---|---|---|---|
| 1 | PCS receives a standby command from the monitoring system | 8 | PCS detects an internal or external fault |
| 2 | PCS receives a grid-connected operation command from the monitoring system. | 9 | PCS receives an emergency stop command from the monitoring system |
| 3 | PCS receives a command to run the isolated grid from the monitoring system | 10 | PCS detects an internal or external fault |
| 4,5 | PCS receives a shutdown command from the monitoring system | 11 | PCS receives an emergency stop command from the monitoring system |
| 6 | PCS receives a grid-connected operation command from the monitoring system. | 12 | PCS receives a standby command from the monitoring system |
| 7 | PCS receives an isolated grid command from the monitor | 13 | Receive standby command from monitoring system after fault elimination |

## 4.3 Monitoring System

The monitoring system mainly manages the metering meters of the distribution access system, the collection meters of the user load bus and the components of the energy storage system, and carries out adjustment and control and collection of relevant operating parameters.

Product Appearance

The integrated energy storage container monitoring system consists of an energy management system (EMS) controller and related communication accessories. It can interact with the PCS and BMS to control the charging or discharging of the energy storage system. Through RS485 or dry contact , water cooler, fire fighting, access control, flooding, security and other auxiliary systems work status.

（1）EMS is divided into equipment layer, communication layer and application layer

*Device layer: energy collection and conversion (PCS, BMS) is needed to support;

*Communication layer: mainly includes links, protocols, transmission and so on;

*Information layer: mainly includes cache middleware, database and server, of which the database system is responsible for data processing and data storage, recording real-time data and important historical data, and providing historical information query;

*Application layer: the forms of expression include APP, Web, etc, providing visualized monitoring and operation interface for management personnel, with specific functions covering energy conversion decision-making, energy data transmission and collection, real-time monitoring and control, operation and maintenance management and analysis, visual analysis of power/electricity, and remote real-time control.

（2）EMS Specification Parameters

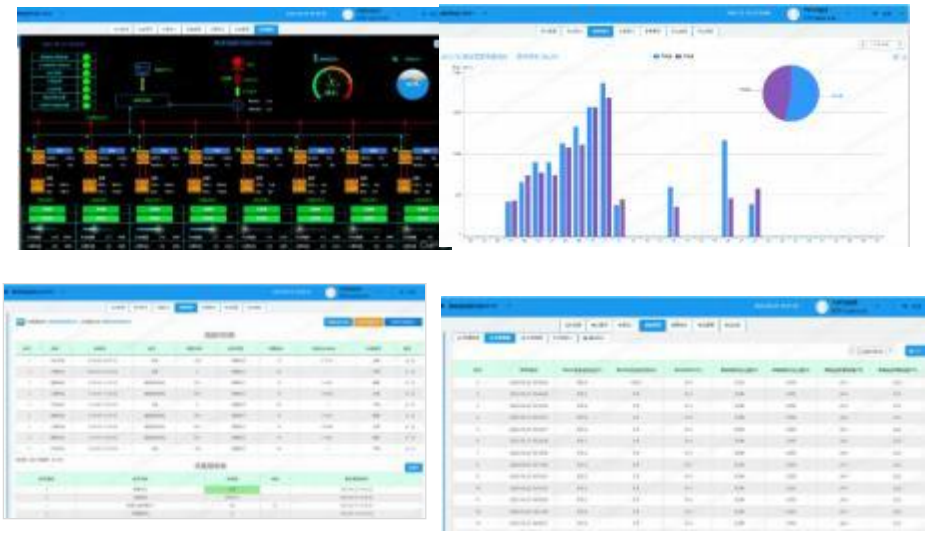
| Command | Description |
|---|---|
| Power Supply | Output VoltageAC220V |
| | Power Dissipation<19w |
| I0 Channel | 8-channel inputs supporting active (12V) and passive inputs, 4-channel outputs |
| Button | 1 FUN button for restoring the default IP address |
| Peripheral Interface | 1 USB HOST, 1 SD card slot |
| Communication Serial Port | 16 fully isolated RS485, using three levels of protection, support GB/T17626.5-2008 standard 4KV protection |
| | 2 fully isolated RS232; RS232 and RS485 are multiplexed |

Continued Table:

| Command | | Description |
|---|---|---|
| Network Interface | | 4 x 100M/10M Ethernet interface |
| | | Support embedded WEB, don't need to install any software that can browse the monitoring data |
| Wireless Configurable | WIFI | Compatible standard 802.11a/b/g , RF type DSSS/CCK/OFDM |
| | 4G Full Netcom | Quad-band TDD-LTE. Tri-band FDD-LTE |
| Computing Resource | CPU | 1.8GHz , Cortex-A72*2/Cortex-A53*4 |
| | Memory, FLASH | Default memory 2G, FLASH 8G, other capacity can be configured |
| Working Environment | Working Temperature | -20℃-55℃ |
| | Working humidity | 10%~90%RH，no condensation |
| | Storage Temperature | -30℃~+70℃ |
| | Atmospheric pressure | 70~106 kpa |
| Appearance Structure | Structure | High quality aluminum alloy |
| | Product Dimension | 440mm×280mm×44mm（L×W×H） |
| | Installation Method | Front or rear panel rack mounting |

（3）Mobile APP Interface:

（4）Web Interface:



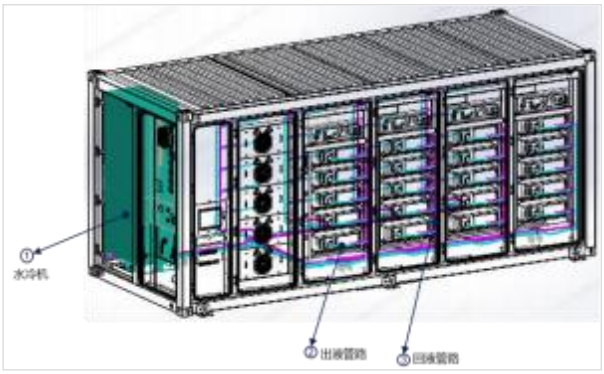
## 4.4 Thermal Management Systems

The liquid cooling system of the battery pack adopts the design of zone cooling, dividing the battery module into several independent cooling zones, each zone has its own cooling circuit, so as to better control the cooling effect of each zone, ensure the uniformity of the overall temperature of the battery pack, and effectively improve the comprehensive efficiency of the Pack.

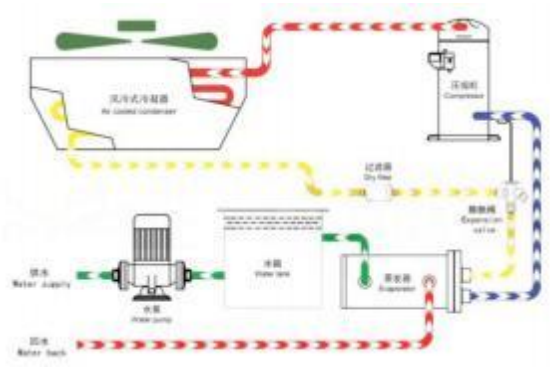
The temperature control system consists of a variable frequency liquid cooling system and its piping system to adjust the temperature of the cores in the energy storage system.

When the temperature of the battery cell is too high, the liquid cooling system delivers lower temperature heat transfer medium to the battery box to take away the excess heat to reduce the temperature of the battery cell; on the contrary, when the temperature of the battery cell is too low, the liquid cooling system delivers higher temperature heat transfer medium to the battery box to increase the temperature of the battery cell.In this way, the battery cells always work within the appropriate temperature range to maintain the optimal working condition of the system.

The thermal management system can control the core temperature within 35℃, and the temperature difference between the cores in the cluster does not exceed 3℃.




Temperature Control System Diagram



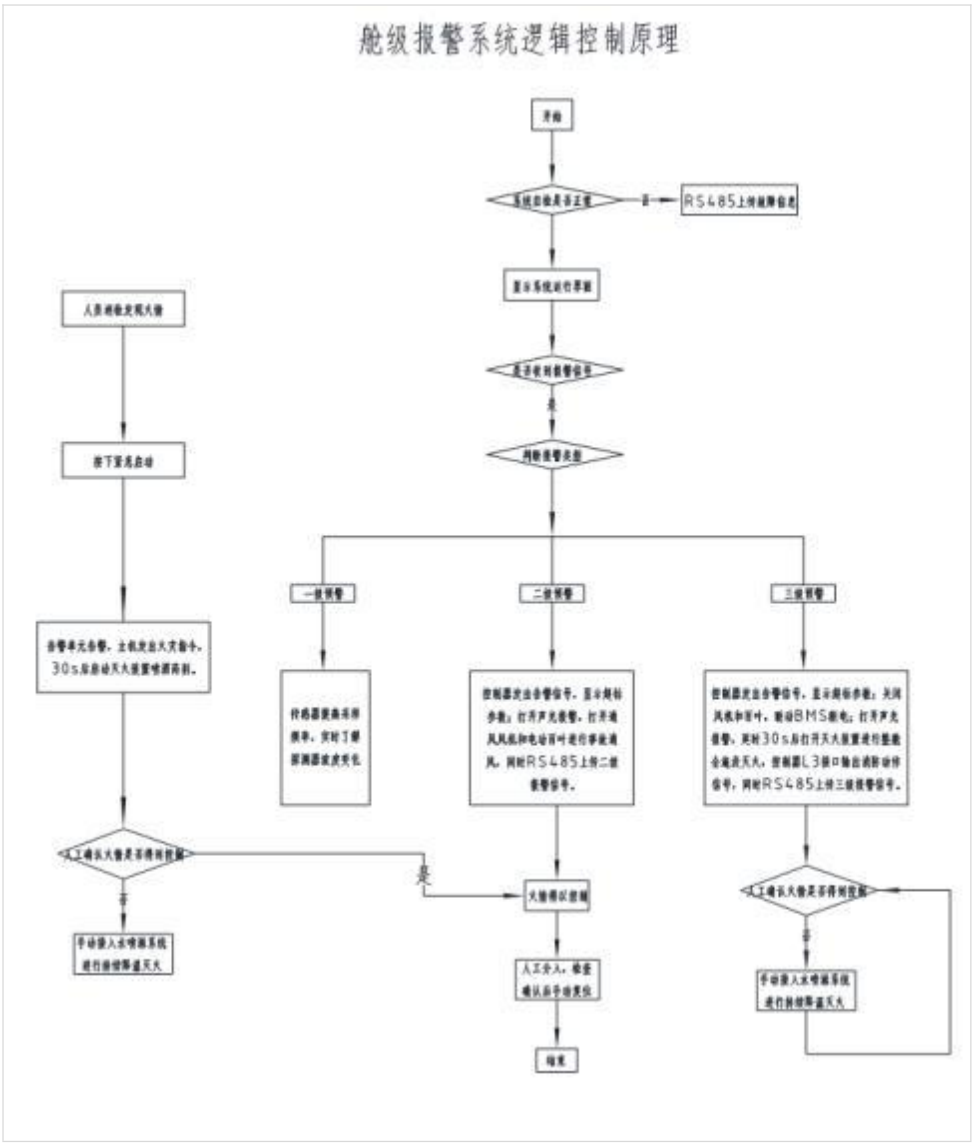
Cooler Working Diagram

## 4.5 Thermal Management System

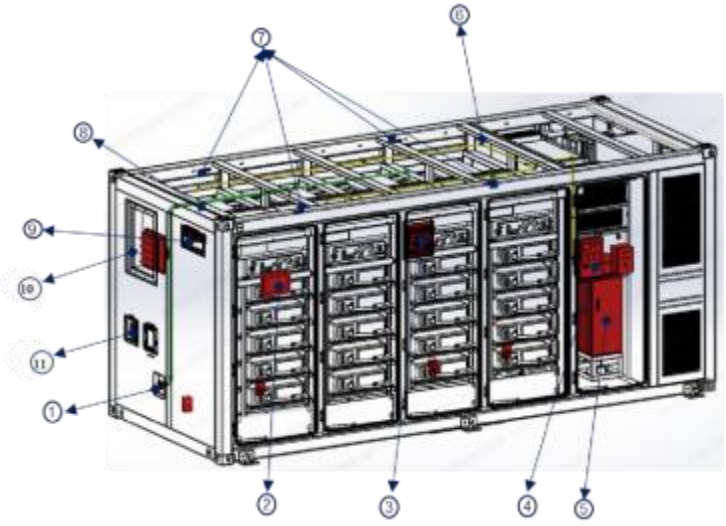
The electrochemical energy storage cabin fire suppression system mainly consists of three parts: thermal runaway detection and alarm system, perfluorohexanone/aerosol fire suppression system and water sprinkler fire extinguishing system.

Each battery compartment is a fire protection unit. The battery compartment contains 8 battery clusters. There are 4 composite fire detectors arranged on the top of each battery compartment. When any two detectors upload thermal runaway alarm signals at the same time (level three alarm) , the fire extinguishing device performs fire extinguishing actions. A set of perfluorohexanone/aerosol fire extinguishing device is installed inside the box. The outlet main pipe of the fire extinguishing device is divided into 2 branch pipes from the battery compartment and extends above the two rows of batteries, and 2 nozzles are arranged above each branch pipe, for a total of 4 nozzles. . This device is controlled by the fire alarm controller and opens when receiving a start signal, which can spray perfluorohexanone/aerosol to the thermally runaway battery cluster. When the device is released, it feeds back a signal to the host and turns on the deflation indicator light.

The water source of the water sprinkler system comes from the quick water fire fighting interface outside the cabin. A DN65 fire hydrant interface with cover plate is set on the external pipeline of the cabin as the inlet of the water sprinkler system. On both sides of the battery compartment, 2 water spray nozzles with K=80 are evenly arranged and connected to the hydrant interface outside the compartment through steel pipes. Two K=80 sprinkler heads are evenly arranged on both sides of the battery compartment and connected to the hydrant connection outside the compartment by steel pipes, which are made to be tapered inside the compartment according to the number of water sprinkler heads at the rear end.




Fire Protection System Action Diagram

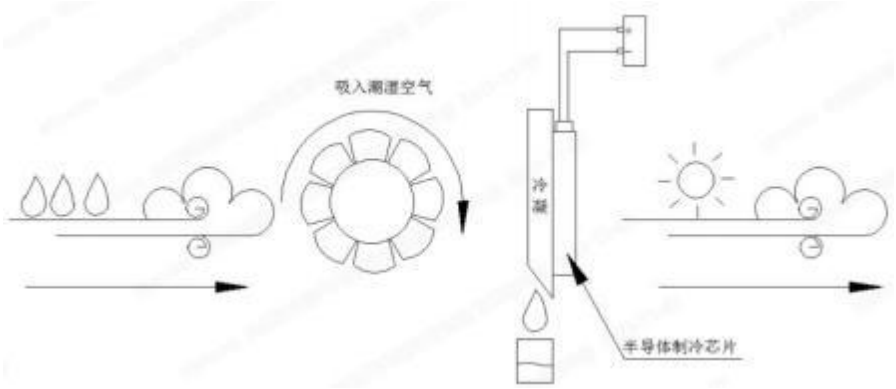



Fire-fighting System Diagram

## 4.6 Dehumidification System

For the power equipment such as mechanism box, terminal box, move-open and center-mounted switch gear, the inside of the cabinet is prone to creepage, flashover and accidents caused by condensation. The causes of these accidents mainly include humid climate, long term idling and so on. Therefore, the power system has a rigid demand for moisture-proof and condensation-proof cabinets.

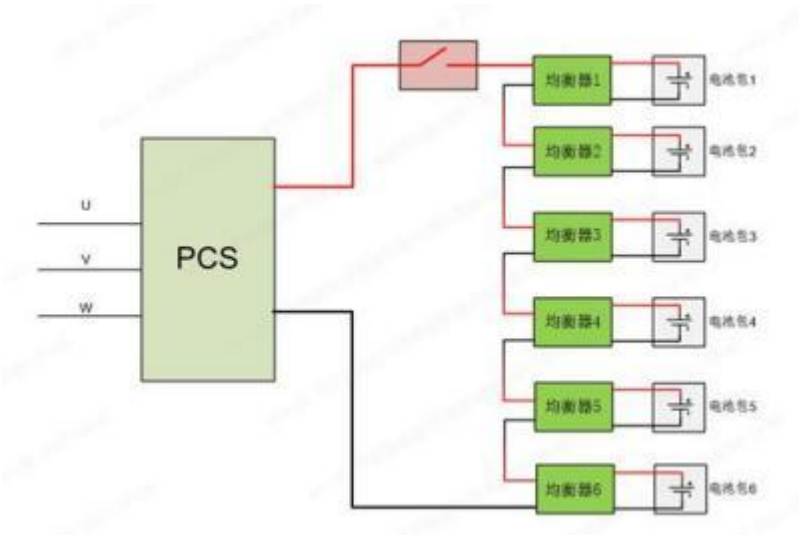
Intelligent dehumidifier can automatically draw the humid air in the confined space into the
dehumidification duct through the fan, and the water vapor in the air condenses into water after
passing through the semiconductor refrigeration components, and then discharged out of the cabinet through the conduit pipe, so as to make the small environment inside the cabinet to achieve good dehumidification effect. By actively guiding condensation, the device can effectively prevent the aging of the equipment inside the cabinet, the reduction of insulating strength, the breakdown of the secondary terminals, the mold and mildew of the materials and the corrosion of the steel structural parts and other safety hazards, so as to ensure the safe operation of the electrical circuits inside the cabinet.




How dehumidifiers work

## 4.7 Battery Pack Intelligent Equalizer (optional)

The three-phase power is output from the PCS to the high voltage DC, and several battery packs are connected in series, each with a battery pack intelligent equalizer. The following figure only lists 6 battery packs in series, the actual number of battery packs varies according to the system configuration, 8 or even more, each battery pack with an equalizer.




System Schematic diagram

Under normal circumstances, the Battery Pack Intelligent Equalizer is used in conjunction with the PCS. The Battery Pack Intelligent Equalizer is between the PCS and the battery packs, and can intelligently adjust the current through each battery pack according to the battery pack
capacity, so that the battery packs can be charged and discharged differently, and the capacity of
each battery pack can be balanced. Extends the life of the system with an estimated 10% increase
in discharge over the life of the system.

# 5 Optional System Configurations

The parameters in this specification are introduced for 931.84KW/1863.68KWh liquid-cooled integrated container, which is the standard ESS container configuration. Customers can make flexible choices and configurations according to the actual capacity demand situation, supporting up to 8 cluster of batteries. Product configuration list:

| No. | Configuration | Specification | Standard/ Optional | Remark |
|---|---|---|---|---|
| 1 | Battery clusters (with high voltage box) | 832Vdc/232.96kWh | Standard | The quantity is determined according to the project requirements, with a maximum of 8 clusters. |
| 2 | Constitute String Power Conversion System | 125kW | Standard | The quantity is determined according to the project requirements, with a maximum of 8 sets. |
| 3 | Water Chiller | | Standard | / |

| | | | | |
|---|---|---|---|---|
| 4 | Dehumidifying device | Dehumidification capacity＞230 ml/24h， Applicable space<3m³ | Standard | / |
| 5 | Fire Extinguishing Systems | Perfluorohexanone/aerosol | Standard | / |
| 6 | Distribution Cabinet | AC380V/1600A | Standard | Including total meter, auxiliary power distribution unit, grid-connected switch, etc. |
| 7 | Control Cabinet | / | Standard | Including EMS host, UPS, touch screen, etc. |
| 8 | Containers and their structural components | W*D*H:6058*2438*2896mm | Standard | Including water-cooling piping, grounding system, battery racks, etc. |
| 9 | Video Surveillance System | / | Standard | / |
| 10 | Battery Pack Intelligent Equalizer Confluence Cabinet | 1 per battery pack | Optional | / |

# 6 System Maintenance

## 6.1 Maintenance Considerations

When performing maintenance or overhaul of the energy storage system, the following procedures must be observed to ensure the safety of the operator:
1. Strictly observe the regulations in the maintenance manual, and do not operate with electricity.
2. Wear static electricity clothing, electrician's shoes, protective gloves, and insulated tools to protect yourself.
3. In the maintenance process, is strictly prohibited to wear metal rings, watches, earrings, and other metal equipment;
4. When maintenance work, contact with the wiring plug must use quality-qualified insulated tools, and take safety measures

## 6.2 Container Maintenance

| NO. | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance Matters** | | | |

| | | | |
|---|---|---|---|
| 1 | System Cleaning | Checking the cleanliness of the container and clean them. | 1 time per year |
| 2 | Grounding | Check for loose or rusted screws in the grounding copper drain. | Every 6 months to 1 year(depending on the environment of use) |
| 3 | Appearance | Checking for paint loss on all parts of the container, if any repainting is required. | 1 time per year |
| 4 | Protection | Checking for water leaks and conduct occasional inspections during the rainy season;<br><br>Checking the sealing of cavities to prevent the entry of small animals. | Once or more six months |
| **Maintenance Matters** | | | |
| 1 | Air Filters | Checking the container air filter and replace it if it is damaged, dusty, or dirty. | 1 time per quarter |
| 2 | Grounding | Replacement of corroded and broken screws and floor drains. | / |

## 6.3 Battery Cluster Maintenance

| No | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance** | | | |
| 1 | Temperature | Temperature sampling of the battery box observed through the monitoring system. | Everyday |
| 2 | Voltage | The voltage sampling of the battery box is observed by the monitoring system. | Everyday |
| 3 | Box Appearance | The surface is not stained, cracked, etc., battery box, High-voltage box parameter labels are clear, no peeling off phenomenon, whether the fasteners are loosened. | 1 time per quarter |
| 4 | Grounding | Check the battery box, high voltage box and battery rack for good grounding, loose or corroded ground rows and bolts. | Once per every 6 months to 1 year |
| 5 | Cable | Checking whether the power cable and communication cable connecting plugs are loose or burned. loose, detached, burned phenomenon, cable skin is cable skin is broken, burned site | once per every 6 months |

| | | | |
|---|---|---|---|
| 6 | Liquid Cooling | Check the liquid-cooling plate and liquid-cooling piping for corrosion, damage and leakage. | 1 time per quarter |
| **Repair** | | | |
| 1 | Battery box, high voltage box | Discovering battery cell, BMS failure, fuses, contactors, circuit breakers and other devices are damaged or burned. Fuses, contactors, circuit breakers and other devices are damaged or burned, liquid cooling panels are damaged or corroded. The battery box/high-voltage box is replaced in its entirety. Replace the battery box/high-voltage box as a whole | / |
| 2 | Cable | The battery box/high-voltage box as a whole<br><br>Replacement of the entire cable for problems found during the inspection | / |
| 3 | Tag | On-site production of paper labels, cable tags, etc. | / |
| 4 | Software Failures/ Program Upgrades | On-site troubleshooting and upgrading programs | / |
| 5 | SOC Calibration | Cycle at least once with a full charge | Quarterly (depending on operating conditions), EMS Automatic control of deep charging and discharging EMS automatically controls deep charging and discharging |

# 6.4 PCS Maintenance

| No | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance** | | | |
| 1 | Saving Software Data | Read data from the monitoring background software;<br>Save operation data, parameters and logs to the Relevant;<br>Saving operation data, parameters and logs to relevant files;<br>Check parameter settings; | Once a month |
| 2 | System Operational Status and Environment | Observe whether the PCS is damaged or deformed, and listen to the PCS for abnormal sounds;<br>Check the variables while the system is running;<br>Check whether the main components are normal;<br>Check whether the PCS shell temperature is normal, use the thermal imaging cameras to monitoring system temperature;<br>Observe whether the inlet and outlet air is normal;<br>Check the humidity and dust in the environment around the PCS;<br>Caution! The ventilation of the air inlet must be checked, otherwise, if the module can not be cooled, it will be malfaction due to overheating | 1 time every 6 months |
| 3 | PCS Cleanliness | Check the cleanliness of the circuit boards as well as the components;<br>Check the appearance of the heat sinks and dust, if necessary, use compressed air and turn on the fan to clean the module. | 1 time every 6 months to 1 year (depending on the dust content of the operating environment) |
| 4 | Cable | Check the power cable connections for looseness, detachment, and tightening; and<br>Check the power cables and control cables for damage, especially the skin in contact with metal surfaces;<br>Whether there are traces of cuts; and<br>Check whether the insulation tape of the power cable terminals has been detached. | Half a year after the first commissioning, and then every six months to one year. |
| 5 | Terminals, Rows of Wire Connections | Check the control terminal screws for looseness and tighten them with a Screwdriver;<br>Check main circuit terminals for poorcontact and screw locations for signs ofoverheating;<br>Check whether there is any color change in the wiring copper rows or screws, or terminals;<br>Visually check the connections of the equipment terminals and the distribution of the wiring | Once a year |

| | | | |
|---|---|---|---|
| 6 | Cooling Fans | Check the fan blades for cracks.<br>Listen to whether there is abnormal vibration sound when the fan is running If the fan has abnormal conditions, it should be replaced in time. | Once a year |
| 7 | Safety Function | Simulate a shutdown and check the shutdown signal communication;.<br>Check the warning labels and other equipment markings on the machine and replace them if they are obscured or damaged. | Once every six months to one year |
| 8 | Software Maintenance | Software upgrade; Check parameter settings | Once every six months to one year |
| **Repair** | | | |
| 1 | Cable | Replace the whole cable | / |
| 2 | PCS | Damage to case, power modules, boards, etc., overall PCS replacement | / |
| 3 | Draught Fan | Overall replacement | / |
| 4 | Software | Site survey, software upgrades. | / |

# 6.5 Gas Firefighting Maintenance

| No | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance** | | | |
| 1 | Composite Fire Detector | Turn off the tank, check that the green light on the detector is flashing properly, and use a heat gun or smoke (not both) to see if the control box produces the appropriate alarm. | 1 time every 6 months |
| 2 | Audible and visual alarms | Check whether the audible and visual alarms are activated when an alarm signal occurs. | 1 time every 6 months |
| 3 | Fire-fighting Tank | Check that the fire tank pressure gauge pointer is in the normal range (green range). | 1 time every 6 months |
| 4 | Fire protection pipeline network | Check for corroded lines and clogged nozzles. | 1 time every 6 months |
| **Repair** | | | |
| 1 | Composite Fire Detector | Overall replacement | / |
| 2 | Audible and visual alarms | Overall replacement | / |
| 3 | Fire-fighting Tank | Overall replacement | / |
| 4 | Fire protection pipeline network | Overall replacement | / |

# 6.6 UPS Maintenance

| No. | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance** | | | |
| 1 | Cable | Check for secure wiring, abnormal,<br>Check that the wiring is secure, that there is no abnormal heat or temperature buildup, that the skin is not damaged, that the insulation sheath is not damaged, and that the terminals are not damage, insulation sheath damage, terminal corrosion, heat Rust, heat phenomenon | 1 time per quarter |
| 2 | Tag | Whether the handwriting is clear, whether the label identification is complete | 1 time per quarter |
| 3 | UPS Host | Whether Panel, indicator lights are normal, the chassis whether there is a strange smell, noise, whether there is dust accumulation phenomenon;<br>Check whether the system by pass mode is correct;<br>Check the battery capacity and whether the backup time meets the requirements;<br>Check whether the voltage, current and other protection parameters are set incorrectly. | 1 time per quarter |
| 4 | Grounding | Check ground cable for tightness | 1 time a year |
| 5 | Battery | Check whether the connecting parts are firm and free of corrosion, and whether the shell is deformed and free of leakage.<br>Investigate the cause of abnormal battery operating temperature | 1 time per quarter |
| **Repair** | | | |
| 1 | Cable | Replace the whole cable | / |
| 2 | UPS Host | Damaged inverter module, rectifier module, static switch, batteries, etc. Replace the UPS. | / |
| 3 | Circuit breakers, sockets | Overall replacement | / |

# 6.7 Water Cooler Maintenance

| No. | Checking Content | Checking Method | Maintenance Cycle |
|---|---|---|---|
| **Maintenance** | | | |
| 1 | Appearance of the unit | Check the appearance of the unit for dirt, paint loss and corrosion, and clean and repaint the unit in time. | 1 time per quarter |
| 2 | Cable | Check the cable for looseness, aging, damage, abnormal heat and other abnormalities, and the terminals for whether there are traces of oxidization, overheating | 1 time per quarter |
| 3 | Air switch | Check whether there is any dirt on the shell, whether there is any strange odor, whether the operating handle can open/close the gate properly. odor, the operating handle can be normal opening/closing, connecting wire terminals are corrosion, traces of overheating | 1 time per quarter |
| 4 | Draught fan | Check the fan is free of dust and the air outlet is free of foreign matter. Use a brush to clean the dust of the fan. Clean foreign matter at the air outlet. Check that the fan blades are not damaged and that the fan rotates smoothly without abnormal noise. | 1 time per year |
| 5 | Condenser | Condenser free of dust and foreign matter blockage, use air gun Flush the condenser against the direction of air flow.<br>No serious bending and deformation of fins | 1 time per quarter |
| 6 | Coolant Liquid | Use a coolant tester to check that:<br>Concentration is within range, PH and electrolyte concentrations meet requirements. No dirt, deposits, algae, etc. | 1 time every 6 months |
| **Repair** | | | |
| 1 | Cable | Replace the whole cable | / |
| 2 | Air switch | Replace the whole cable | / |
| 3 | Draught fan | Replace the whole cable | / |
| 4 | Condenser | Fin deformation is corrected with a tool such as a fin comb. | / |
| 5 | Coolant Liquid | Replace | / |