EnerX Battery Container

Operating Instruction and Maintenance Manual

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- CATL Confidential -

Revision History

Revision	Chapter	Description	Date
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1.1	All	Confirm clearance and operation/storage temperature	2024/5/11
1.2	All	Change the number of cable	2024/6/25
1.3	All	Update content	2024/7/25

Contents

1 Important Safety Instructions 5
1.1 Electrically Safe Working Condition 5
1.2 Qualified Person 5
1.3 Safety Symbols 5
1.4 Primary Risks Associated With BESS 7
1.4.1 Hazardous Voltage 7
1.4.2 Arc Fault 8
1.5 Arc Flash Hazard Boundary 8
1.6 Arc Flash Label 9
1.7 Personal Protective Equipment (PPE) 10
1.8 LOTO Procedure 11
2 Manual Overview 11
2.1 Applicable Scope 11
2.2 General 11
2.3 Manual Updates 12
2.4 Abbreviation 13
3 Product Introduction 14
3.1 Product Overview 14
3.2 Product Specification 31
3.3 BMS introduction 32
3.3.1 BMS system overview 33
3.3.2 BMS power on and off 33
3.3.3 Battery status monitoring 33
3.3.4 Charging/discharging management 34
3.3.5 Thermal management 34
3.3.6 Program update 34
3.3.7 High voltage safety monitoring 34
3.3.8 Fault diagnosis management 34
3.3.10 BMS system for four container parallel application 35
4 Transportation and Storage 36
4.1 Transportation process and requirements 36
4.2 Hoisting & lifting equipment 37
4.2.1 Container hoisting parameters of single-point crane 37
4.2.2 Container hoisting parameters of four points vertical crane 38
4.2.3 Precautions for hoisting 39
4.2.4 Risk identification for hoisting 40
4.2.5 Measures of hoisting safety 40
4.3 Storage 41
4.4 Ambient thermal insulation 41
5 Product Installation 42

5.1 Site and environment requirements 42
5.2 Foundation requirements 43
5.3 Installation procedure 45
5.4 Anti-vibration and anti-collision requirement for installation 46
5.5 Locking the container 46
5.6 Wiring 47
5.6.1 Connection interface 47
5.6.2 Removal and installation of metal covers between electrical compartment and copper busbar compartment 47
6 CATL Monitor Software 55
6.1 Commissioning Tool 55
6.2 Commissioning system hardware setup 55
6.3 Commissioning system software setup 56
6.4 Software configuration 57
6.5 CATL Real–time Monitoring System 60
7 Commissioning flow chart 68
7.1 Commissioning flow chart 68
7.2 System inspection before commissioning 68
7.3 Switch on auxiliary power supply 69
7.4 Switch on HV relays of battery control box 71
7.5 Startup PCS and Precharge DC capacitors 72
7.6 Switch on the connection between PCS and Container 72
7.7 EMS send command to PCS to start charge/discharge 72
7.8 E-Stop procedure 73
8 Diagnosis of common abnormal problems 74
8.1 System status word 74
8.2 Countermeasures of system alarm 75
8.3 Countermeasures of abnormal conditions 75
8.4 After-sales Service 78
9 Product Maintenance 79
9.1 Battery System Maintenance 84
9.1.1 Maintenance instructions for normal operating system 84
9.1.2 Maintenance instructions for long duration idle mode after COD date 84
9.1.3 Battery system inspection 86
9.2 Container enclosure maintenance 86
9.3 Maintenance requirements for Thermal Management System 88
9.3.1 Instructions of Chiller Maintenance: 88
9.3.2 Instructions of Coolant Maintenance: 88
9.4 Spare parts 89
9.5 Fastener type and torque requirement 90
10 System Decommissioning & Removal 92
11 Emergency Plan 92

1 Important Safety Instructions

SAVE THESE IMPORTANT SAFETY INSTRUCTIONS

Installation and service of the EnerX battery container requires knowledge of high voltage electricity and should only be performed by qualified persons. CATL assumes no liability for injury or property damage resulting from repairs attempted by unqualified individuals or a failure to properly follow these instructions. These warnings and cautions must be followed when using the EnerX product.

1.1 Electrically Safe Working Condition

A condition in which an electrical conductor or circuit component has been disconnected from BESS energized parts, LOTO procedures must be implemented, the isolation switches in this product must be locked and tagged, and the absence of voltage must be verified. If necessary, temporarily ground to protect personnel.

1.2 Qualified Person

A person who has demonstrated skills and knowledge related to the design, operation, and installation of BESS products and has received safety training to identify hazards and reduce associated risks.

Qualified persons shall be trained and knowledgeable in the operation of the battery system and specific work practices, and shall be trained to avoid the electrical hazards that are present. Such persons must be familiar with the proper use of precautionary techniques and PPE. Qualified person training shall include the following:

1. Skills and techniques to avoid the risk of electric shock:
    a) Between exposed energized surfaces, which may include temporarily insulating or guarding parts to allow the worker to work on exposed energized parts.
    b) Between exposed energized surfaces and grounded equipment, other grounded objects, or the earth itself, which may include temporarily insulating or guarding parts to allow the worker to work on exposed energized parts.
2. The method of determining the working limits of the battery system.

1.3 Safety Symbols

The following are some basic safety symbols and descriptions that apply to all BESS equipment.

	**DANGER** When energized, this equipment presents a potential hazard of electric shock, burn or death. Only authorized personnel who are thoroughly familiar with the equipment and adequately trained may install, operate or maintain this equipment. To prevent death, personal injury, or damage to equipment, follow all site safety procedures as indicated by HSE Plan. To minimize hazard of electrical shock, death and burns, approved grounding practices must be strictly followed.

	**WARNING** To prevent personal injury or damage to equipment, personnel shall adhere to site protocol regarding working at heights. To prevent personal injury or equipment damage by equipment malfunction, only adequately trained personnel should modify any programmable machine. Always ensure applicable standards and regulations are followed and only properly certified equipment is used as a critical component of the safety system. Never assume that critical-safety control loop is closed.

	**WARNING — Shock Hazard** Do not come into contact with system connectors or terminals. Do not open the enclosure doors unless appropriate LOTO procedures are followed, PPE and related training as required by local codes and regulations are part of the maintenance plan.

	**WARNING — Arc Flash Hazard** There is an arc flash hazard associated with all electrical equipment. There is an increased risk of arc flash with any equipment modification (e.g., open doors). Serious injuries can occur in arc flash incidents. Appropriate PPE and training as per local codes and regulations is required.

	**WARNING — Fire Hazard** Fire is possible under certain, extreme fault conditions.

	CAUTION
	Indicates a procedure, condition, or statement that, if not strictly observed, could result in damage to or destruction of equipment.

The following directives must be followed when working with or near the BESS equipment.

1. Safety parameters and procedures are site-specific, and therefore, must be developed by the customer.
2. Review and refer to all safety warnings contained in this manual before beginning operations. Follow all the safety procedures as prescribed be the supplier manufacturer published safety procedures for each equipment.
3. Establish a clear, permanent, restricted access around the system. Fire extinguishers must be readily available on-site.
4. The system requires a clean, mechanically stable operating environment, free from conductive contaminates, combustibles, moisture, liquids and gases and corrosive substances. The system may be operated only when the ambient temperature is between **-35°C to 55°C**. Do not tap, drill puncture or attach anything to the equipment enclosures. Ensure there is enough clearance on all sides of the enclosures to allow access to the system. Remove watches, jewellery, rings and other metallic objects and always use tools with insulated handles.
5. Follow all applicable Lock Out/Tag Out (LOTO) procedures always. If proper LOTO procedures are not followed, serious injury or death could result. With power applied to the equipment, hazardous voltages will be present on some components. To prevent accidental death or injury, do not touch any components within the enclosure unless specifically directed to do so. To reduce risk of electrical shock, verify that all equipment is properly grounded.
6. Strobes and alarms within the system for evacuation are activated by the FSS system.

	WARNING
	Only authorized, adequately trained energy storage personnel with proper Personal Protective Equipment (PPE) can access the system. Do not open the equipment access doors unless qualified person.

1.4 Primary Risks Associated With BESS

The primary risks associated with the BESS system are:

1.4.1 Hazardous Voltage

Hazardous Voltage
• High AC at MV Switchgear, Isolation transformer and Auxiliary Transformer. • High AC at PCS input, aux transformer input. • 1500 VDC at PCS output, Battery container.
Consequence
• Electrocution, Fire, Explosion.
Avoidance
• Only qualified and authorized person should only be allowed restricted access. • Equipment barriers must remain in place. • PPE must be appropriate for the task and equipment

1.4.2 Arc Fault

Arc fault
• When insulation breakdown or accidental contact between high voltage conductors, an arc fault will be happen through the air gap between conductors.
Consequence
• Arc fault creates an electrical explosion. • Light and heat emitted from the explosion is known as **arc flash**. • Pressure wave caused by the tremendous temperatures of the arc flash is known as **arc blast**.
Avoidance
• Only qualified and authorized person should only be allowed restricted access. • Restricted access. • Equipment barriers must remain in place. • PPE must be appropriate for the task and equipment.

1.5 Arc Flash Hazard Boundary

The US National Fire Protection Association (NFPA) has developed specific approach boundaries designed to protect employees while working on or near energized equipment. These boundaries are:

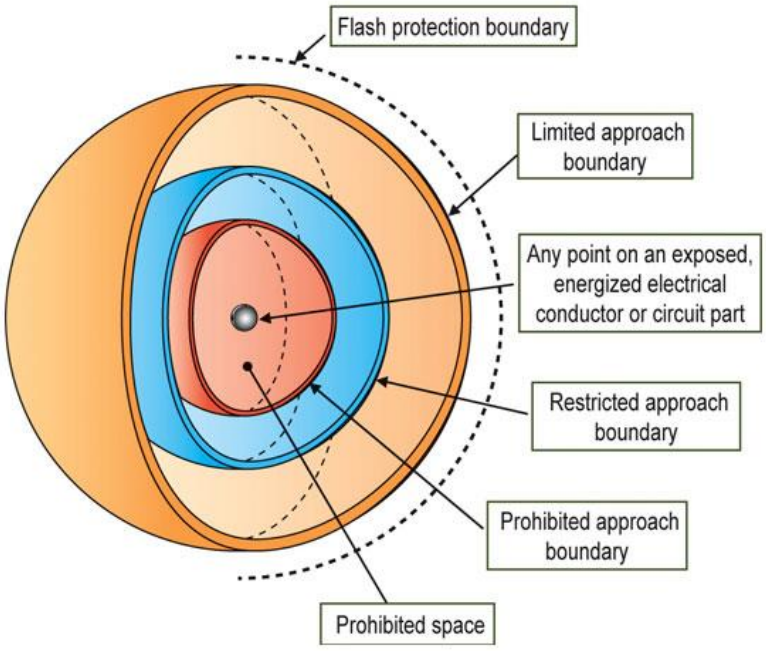


Figure 1-1 Arc Flash Boundaries

- Flash Protection boundary (outer boundary) – this is the furthest established boundary from the energy source. If an arc flash occurred, this boundary is where an employee exposed to a curable second-degree burn. The issue here is the heat generated from a flash that results in burn.
- Limited approach – An approach limit at a distance from an exposed live part where a shock hazard exists.
- Restricted approach – An approach limit at a distance from an exposed live part which there is an increased risk of shock.
- Prohibited approach (inner boundary) – A distance from an exposed part which is considered the same as making contact with the live part.

1.6 Arc Flash Label

According to “Maximum Power Method” in NFPA 70E, the estimated DC arc flash incident energy at the maximum power point can be calculated, and then the hazard boundary is defined as following figure.

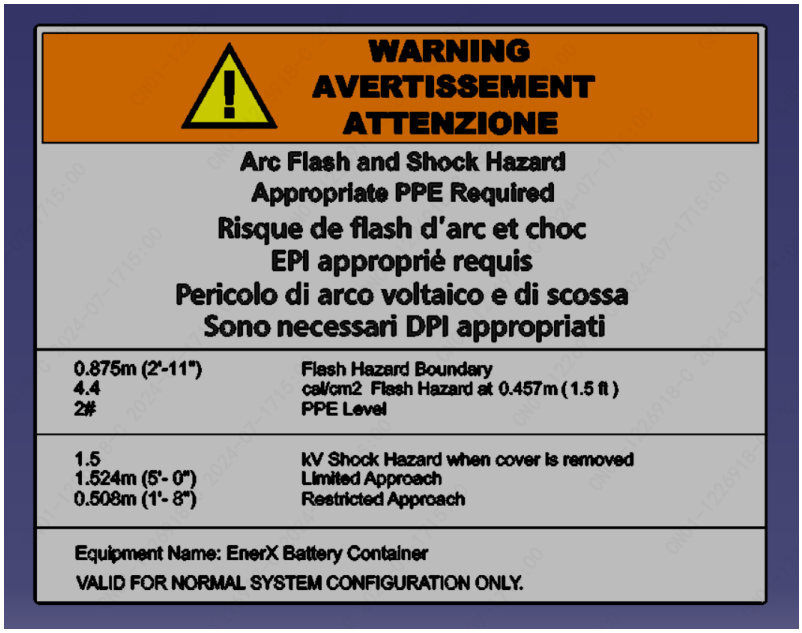


Figure 1-2 Arc Flash Label

1.7 Personal Protective Equipment (PPE)

The PPE is determined by the incident energy which is the temperature produced (in cal/cm²) at a distance (usually eighteen inches) from an arc flash.

PPE requirement for EnerX battery container operational precautions is category 2

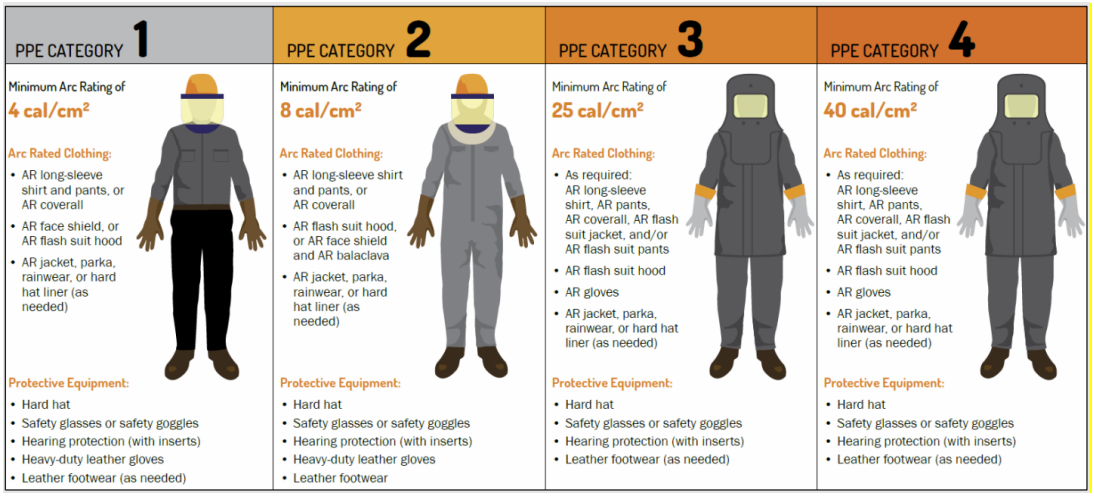


Figure 1-3 PPE Category

1.8 LOTO Procedure

1. The battery container needs to be powered off first. Check the status of PCS and battery containers from EMS, make sure that the circuit breakers/contactors of PCS DC side are all disconnected, and the HV contactors of all racks in the battery containers are disconnected.
2. PPE 2 is required for operator.
3. Turn off the AC circuit breaker QF1, QF2,QF3, QF4 , QF5, QF6(or QS),QF7 and QF8 inside the container distribution box that connect the external auxiliary power. Hang a LOTO warning sign on the door of the distribution box to prevent it from being turned back on.
4. Turn off the on-site AC circuit breaker which supplies the external auxiliary power of the battery containers. Apply a LOTO adapter and LOTO lock and tag to the circuit breaker handle to prevent it from being turned back on.
5. Check, with a multi-meter, that the 1,500 VDC bus bar reads 0 V.
6. Switch off the isolation switch of the rack to “OFF” state. Pull out the LOTO ring of the isolation switch handle and apply LOTO lock and tag to the LOTO ring to prevent it from being turned back on.
8. Install a safety ground clamp from the positive 1,500 VDC bus bar to the ground bar. Use a shotgun stick to make the initial contact between the positive 1,500 VDC bus bar and ground.
9. Install a safety ground clamp from the negative 1,500 VDC bus bar to the ground bar. Use a shotgun stick to make initial contact between the negative 1,500 VDC bus bar and ground.

2 Manual Overview

2.1 Applicable Scope

This manual is applicable to the EnerX battery container.

All references to “battery container” in this manual, unless specifically indicated here in, refer to the product series mentioned above.

2.2 General

This manual has been prepared primarily for Battery Energy Storage System (BESS) operators and service personnel and provides three essentials: operation, maintenance and parts information for the BESS. A distribution of text revisions when necessary will be made to all recipients of the Operations and Maintenance manual.

Personnel who practice good operating and maintenance procedures ensure BESS reliability. It is of vital importance that station personnel, trained or untrained in BESS operation, become thoroughly familiar with the information contained in this manual. Prior to BESS operation, a sound program of maintenance should be developed and instituted. Adherence to such a program will result in reduced operating costs, fewer outages, and shorter periods of downtime.

2.3 Manual Updates

An experienced staff from the best information available has compiled the manuals provided for this BESS equipment prior to the time of shipment. Due to your shipping requirements and our desire to meet manual delivery commitments, manuals may be shipped with missing information. All manuals in your hands should be updated as material is received from CATL Company. To assist you in revising and updating your manuals, we offer the following suggestions:

1. Identify those individuals or functions who will be using the sets of manuals.
2. Assign the manuals to each individual or function and number each set.
3. Maintain a log of manual sets and the associated owners.
4. If possible, assign a librarian to ensure all controlled (or numbered) sets of manuals are updated as material is received from CATL. If this is not possible, each owner must keep their set of manuals current.
5. Retain shortage/revision instructions sheet at the front of the appropriate volume. This acts as a log of updates received.
6. Follow instructions for insertion of new material exactly. If the material is not filed properly, it cannot be easily found.
7. Insert shortage/revision material in manuals as soon as received. Some updates are small and can be misplaced.
8. All other manuals left from installations, etc., should be clearly labelled as extras, spares, or not controlled copies.

2.4 Abbreviation

CATL	Contemporary Amperex Technology Limited
BMU	Battery Management Unit
BMS	Battery Management System
BESS	Battery Energy Storage System
EMS	Energy Management System
PCS	Power Conversion System
CSC	Cell Supervision Circuit
CSU	Current Sample Unit
ETH	Ethernet Module
FSS	Fire Suppression System
HV	High Voltage
LV	Low Voltage
LOTO	Lockout/Tagout
MBMU	Master battery management unit
SBMU	Slave Battery Management Unit
IMM	Insulation monitoring Module
CAN	Controller Area Network
ACAN	CAN between BMU and PCS
CCAN	AN between BMU and CSC
SCAN	CAN between BMU and CSU
DCAN	CAN for calibration
BOL	Begin of Life
EOL	End of Life
SOC	State of Charge
SOE	State Of Energy
SOH	State of Health
SOP	State Of Power
TMS	Thermal Management System

3 Product Introduction

3.1 Product Overview

EnerX Battery container is the core unit in the energy storage system and acts as the equipment for storing electrical energy. It can be applied to many applications including renewable energy integration, frequency regulation, and voltage regulation of the grid.

Battery container consists of battery system, battery management system (BMS), fire suppression system (FSS), thermal management system (TMS) and auxiliary distribution system.

Figure 3-1 battery container ---right side overview

Figure 3-2 battery container ---left side overview

The basic units for whole system is list as following:

Table 3-1 Components of battery container

System	Sub Components	Number	Remark
Battery Racks	20 Feet Container	1	2896mm(H)*2438mm(W)*6058mm(D)
	Battery Module	32	With CSC
BMS	Master Control Box	1	Including IMM, MBMU, ETH, fiber optic module
	Sub Control Box	4	Including SBMU, fuse, isolation switch and so on
TMS	Liquid Cooling Unit(Chiller)	1	Including compressor, pump, fan, heater and others
FSS	Fire Suppression System	1	Including fire control panel, smoke detectors, gas detectors, heat detectors, explosion-proof fan, aerosol(optional), dry pipe(optional), fiber optic networking card(optional)
Auxiliary Power Supply	Distribution Box	1	Including transformer, circuit breaker, UPS/24V power module, E-stop circuit, circuit protection and power supply on-off control circuit, type II SPD for AC power supply

3.1.1 Battery rack system overview

The battery system consists of 4 battery racks connected in parallel.

Figure 3-3 EnerX liquid-cooling energy storage container overview – inside

The battery system consists of 4 battery racks connected in parallel, each battery rack contains 8 battery modules, each battery module consists of 104S(2P52S) battery cells connected in series, so the battery system contains 3328 battery cells.

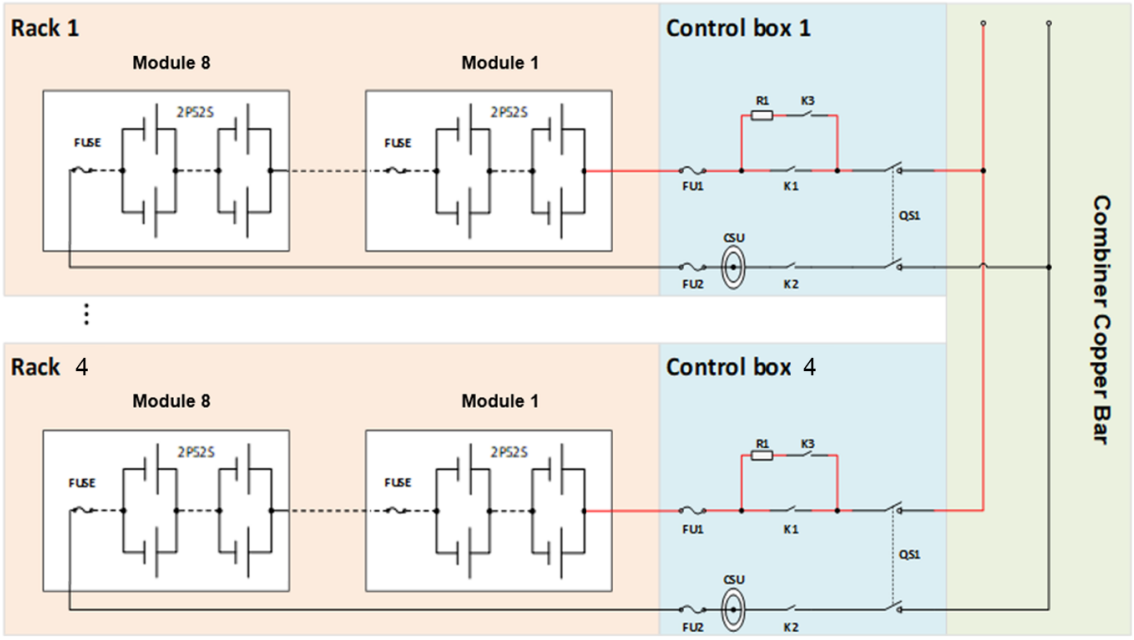


Figure 3-4 Circuit diagram of battery racks

3.1.2 Battery module overview

A total 104 (2P52S) lithium-iron cells (530Ah/3.2V) in series connection are used for each battery module. An internal high speed DC fuse is included for safety protection.

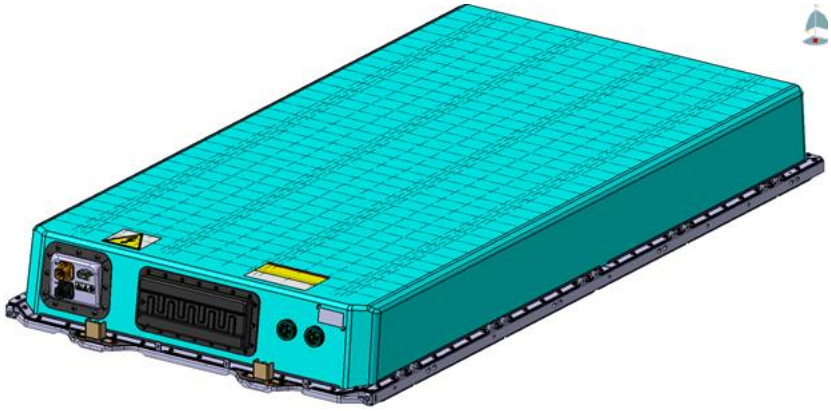


Figure 3-5 Battery module -- exterior overview

3.1.3 Master Control Box

The MBMU, IMM, ETH, fiber optic module are integrated to master control box together.

3.1.3.1 Functional Description of the Master Control Box

Table 3-2 Module Function of the Master Control Box

Module	Function
MBMU	1. Controlling system power on and off MBMU detects the state of system power button to switch state. When receive system power on command from EMS, MBMU can turn itself on from off; When receive system power off command, MBMU can turn itself off from on. 2. Synchronize time ● MBMU synchronizes the time via CAN communication. 3. CAN communication ● MBMU consists of 3 channels of CAN communication including MCAN, DCAN and ACAN： 1) MBMU communicates with SBMU, ETH, PC monitor via MCAN. 2) MBMU communicates with TMS (Thermal Management System) via DCAN. 3) MBMU communicates with ETH via ACAN. 4. Environment temperature detection ● MBMU contains 2 temperature detection inputs: - 40℃~85℃ range, ±3℃ accuracy. ● One temperature sensor is located on the fire control panel and one temperature sensor is located on the transformer T1 in the distribution box. ● MBMU gives a Level 1 alarm when the environment temperature exceeds 60 °C. 5. Addressing ● MBMU can address CAN and RS485. 6. System status upload ● MBMU can upload SOC, SOH, SOP and operation status of the system. 7. Contactor driver and auxiliary equipment power supply ● MBMU controls the rack HV relays to turn on or off when a PCS or EMS command is received via the SBMU.

Module	Function
	● MBMU has high-side outputs that can be used to drive a power supply relay for external devices or to supply power directly to auxiliary devices. High-side output also has fault diagnosis function. 8. Dry contact detection ● MBMU has dry contact detection, which is used for identifying the working states of SPD, UPS, FSS, auxiliary power supply and so on. 9. Insulation status judgment ● MBMU can calculate and determine the current insulation status of the system based on the insulation value provided by the current IMM test board, and send it by means of communication. 10. Relay split and combine commands ● MBMU can control SBMU to turn on and off the relay of single or all electrical cabinets according to control commands from PCS and EMS. 11. Ventilation fan status detection ● MBMU can detect the status of the ventilation fan, whether the fan is open or closed.
IMM	1. Insulation testing ● Support insulation detection function to measure insulation resistance between HV+ and case and between HV- and case. 2. CAN communication ● It has a CAN communication function to communicate with MBMU.
ETH	1. Ethernet communication: ● ETH communicates with PCS and EMS externally via RJ45 interface. Based on TCP/IP, the IP address allocation method can be configured as fixed IP or DHCP according to requirements. The Modbus protocol is now supported. 2. Remote update: ● ETH supports to remote update of the BMS system from client via Ethernet. 3. CAN communication:

Module	Function
	● ETH has two CAN interfaces, which receive the status information of the BMS system through MCAN, and can also receive and send PCS information through ACAN. 4. The ETH has an Ethernet interface
Fiber optic module	Convert Ethernet to optical signal.

3.1.3.2 Interface description of Master Control Box

Figure 3-6 Master Control box---Outside view

- JX1: A-CAN bus. The A-CAN bus can be connected to the PCS.
- JX2: RS485 bus. The RS485 bus can be connected to the PCS.
- JX3: Debug. This is an internal CAN bus for debugging.
- JX4: JX4 is an internal communication port.
- JX5: Emergency dry contact. Includes emergency dry contact to PCS and emergency dry contact from EMS.
- JX6: M-CAN bus. JX6 pin1 and 2 are the M-CAN bus for parallel containers communication. If you choose CAN bridge in the container, the M-CAN bus for parallel containers communication is the CAN bridge.

The definition for communication terminal JX1, JX2, JX3, JX4, JX5,JX6 see Table 3-3

Table 3-3 connector information of master control box

No.	Connector	Definition	Connector information	Remark
1	JX1-1	A-CAN-H	A-CAN Bus	Communicate with the PCS through CAN port
2	JX1-2	A-CAN-L		
3	JX1-3	GND_ACAN		
4	JX1-4	Reserve		
5	JX2-1	RS485A	485 Bus	Communication with the PCS through 485 port
6	JX2-2	RS485B		
7	JX2-3	GND		
8	JX3-1	D-CAN-H	Internal CAN bus for debugging	Debugging
9	JX3-2	D-CAN-L		
10	JX3-3	A-CAN-H		
11	JX3-4	A-CAN-L		
12	JX3-5	M-CAN-H		
13	JX3-6	M-CAN-L		
14	JX3-7…10	Reserve		
15	JX4-1	M-CAN-H	Internal communication. Installed by CATL in factory	Communication between SBMU and MBMU
16	JX4-2	M-CAN-L		
17	JX4-3	SBMU_Code_Out		
18	JX4-4…6	Reserve		
19	JX4-7	M-CAN-H		
20	JX4-8	M-CAN-L		
21	JX5-1	E_Stop_to_PCS+	Emergency dry contact	Emergency dry contact to PCS.
22	JX5-2	E_Stop_to_PCS-		
23	JX5-3	E_Stop_to_BMS+		Emergency dry contact to BMS
24	JX5-4	E_Stop_to_BMS-		
25	JX6-1	M-CAN-H	M-CAN bus for parallel containers communication.	M-CAN is used for parallel containers.
26	JX6-2	M-CAN-L		
27	JX6-3	MCAN_GND		
28	JX6-4	Reserve		
29	JX6-5	CAN bridge_24V+		

30	JX6-6	CAN bridge_24V-		
31	JX6-7	M-CAN-H		
32	JX6_8	M-CAN-L		

3.1.4 Sub control box

Sub control box integrates SBMU, HV contactors, precharge circuit, high breaking capacity and high speed DC fuses, which can control battery rack by SBMU and send battery status data to MBMU via CAN bus. A total of four sub control boxes are contained in one container, the panel diagram of which is shown in Figure 3-7.

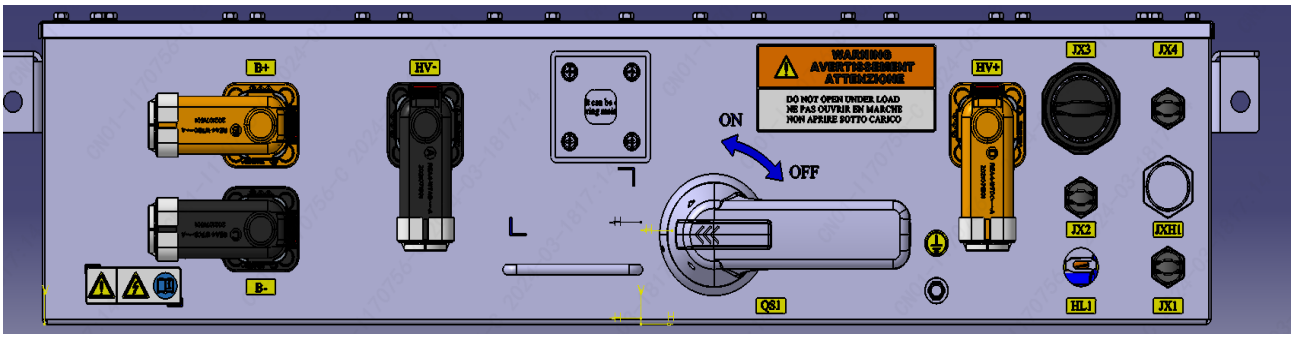


Figure 3-7 Sub Control box

Table 3-4 connector information of sub control box

No.	Connector	Definition	Remark
1	JX1-1	M-CAN-H_OUT	Connect to the next sub control box
2	JX1-2	M-CAN-L_OUT	
3	JX1-3	SBMU _Code _OUT	
4	JX1-4	Reserve	
5	JX2-1	M-CAN-H_IN	Connect to the previous sub control box
6	JX2-2	M-CAN-L_IN	
7	JX2-3	SBMU _Code _IN	
8	JX2-4	Reserve	
9	JX3	C-CAN	The physical connection of the 8 battery modules in the rack
10	JX4-1	M-CAN-H	Debug for commissioning
11	JX4-2	M-CAN-L	
12	JX4-3	C-CAN-H	
13	JX4-4	C-CAN-L	
14	JXH1-1	C_Box_24V+_OUT	Auxiliary power supply for the next sub control box
15	JXH1-2	C_Box_24V-_OUT	
16	JXH1-3	C_Box_24V+_IN	Auxiliary power supply for the previous sub control

17	JXH1-4	C_Box_24V-_IN	box
18	HV+	Positive output	Connect to high voltage
19	HV-	Negative output	
20	B+	Positive input	Connect to the battery module
21	B-	Negative input	

Table 3-5 Information of switch

No.	Switch	Name of switch	Function
1	QS1	Isolating switch	To turn the output of the battery system on and off. (Cannot operate under load)

3.1.5 FSS overview

As an outdoor non-walk-in battery energy storage system, EnerX provides a complete set of fire suppression system solutions with detection, explosion control and fire suppression functions. The fire suppression control strategy is divided into four levels:

- The first level: Alarm warning;
- The second level: Smoke exhaust ventilation system to prevent deflagration;
- The third level: Aerosol is released to extinguish the initial fire;
- The fourth level: Water spraying to control the spread of the fire.

The fire suppression system is divided into three parts: detection system, exhaust ventilation system and fire suppression system.

The main components are listed as follows.

Table 3-6 Main components of FSS

NO.	Category	Product name	Quantity	Configuration	Remark
1	Detection and alarm system	Fire control panel（ARC-100）	1	Standard	Receives detector signals and control fire suppression and smoke exhaust ventilation system, in the electrical compartment
		Fiber optic networking card（NCF-1000）	1	Optional	Converts the signal from the fire suppression control panel to a fiber optic signal. It is used for the signal between two network cards and the terminal host AFC-1000
2		H2 detector	1	Standard	Detection of hydrogen, in the battery compartment
		CO detector	1	Standard	Detection of CO, in the battery compartment

3		Heat detector	2	Standard	Detection of temperature, in the battery compartment
4		Smoke detector	3	Standard	Detection of smoke particles, two in the battery compartment, and one in the electrical compartment
5		Releasing circuit disable switch	1	Standard	In the electrical compartment
6		Horn and strobe	1	Standard	On the electrical compartment door
7		Two relay two input module	4	Standard	In the electrical compartment
8	Smoke exhaust and ventilation system	Explosion-proof exhaust fan	1	Standard	Adjacent to the thermal management system
9		Explosion-proof ventilation louver	2	Standard	On the battery compartment door
10		Fan emergency switch	1	Standard	On the electrical compartment door
11	Fire suppression system	Aerosol	12	Optional	In the battery compartment
12		Fire alarm pull station	1	Standard	On the electrical compartment door
13	Dry pipe system	Nozzle with rubber plug	8	Optional	In the battery compartment
14		Flange	1		Adjacent to the thermal management system

The information of the interactive interface of FSS is shown in the following Figure 3-8.

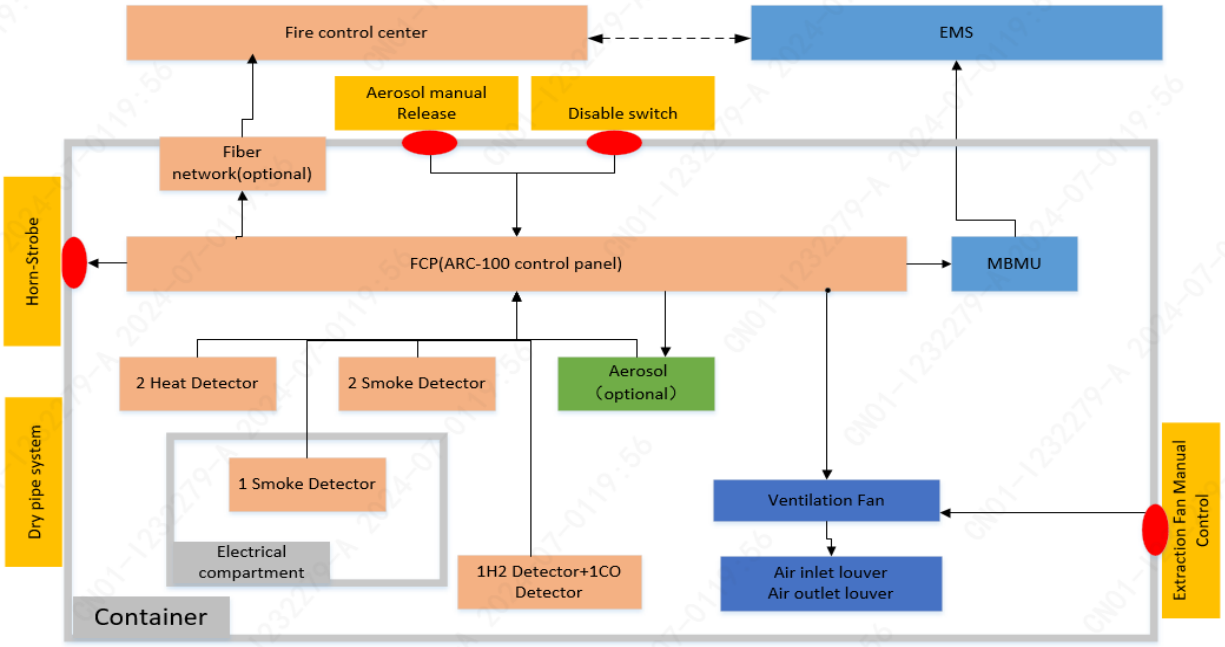


Figure 3-8 The interactive interface of FSS

The detection system has three types of detectors, the number and installation position of which are shown in Table 3-6 and Figure 3-9. All detection signals are received and processed by the fire suppression control panel.

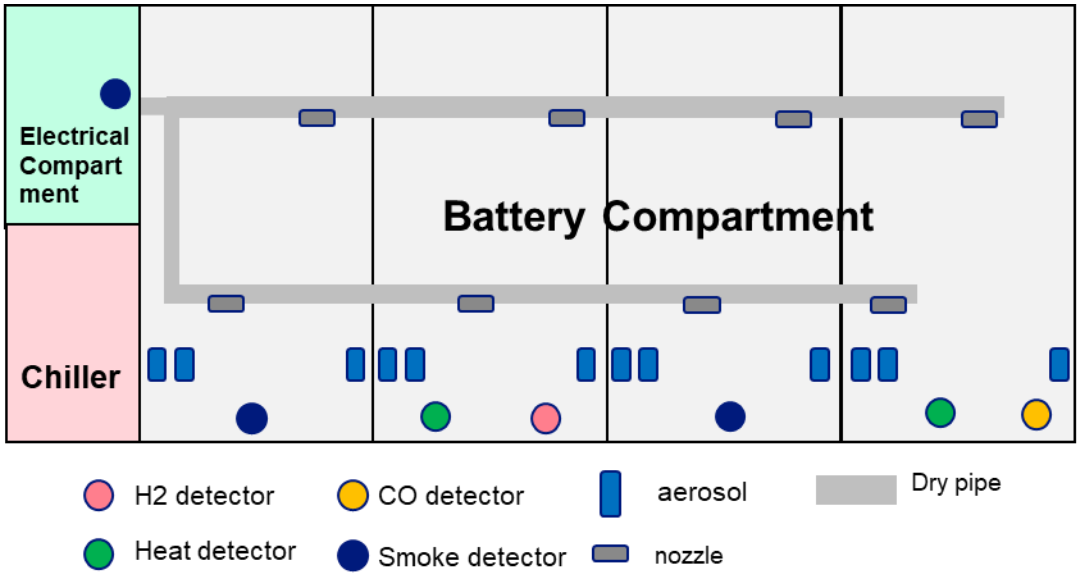


Figure 3-9 Type and location of detectors（Top view）

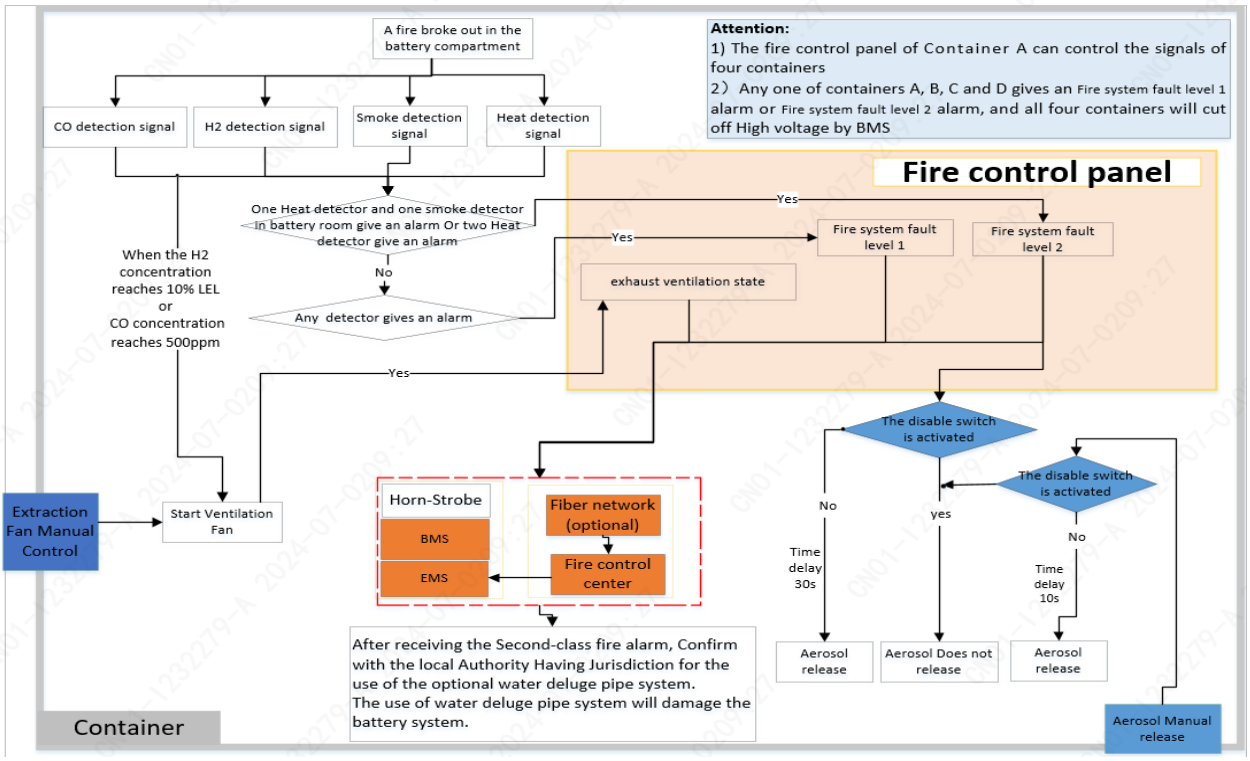


Figure 3-10 FSS control logic overview

3.1.5.1 Smoke exhaust ventilation system

Using Smoke exhaust ventilation system to meet NFPA69 standard. As shown in Figure 3-11.

Figure 3-11 The design of smoke exhaust ventilation system

The smoke exhaust ventilation system receives the alarm signal from the FCP after the FCP receives the

alarm signal sent by the H_2 detector or CO detector, then turns on the air electric louver and the explosion-proof fan, and discharges the combustible gas in the battery compartment. The explosion-proof exhaust fan doesn't turn off automatically after opening. The parameters of the smoke exhaust fan are shown in Table 3-8.

Table 3-8 The paraments of the smoke exhaust fan

Item	Specification
Rated power	128W
Supply voltage	230V AC
Maximum air volume	820±15%CFM

3.1.5.2 Fire extinguisher system

1) Aerosol fire extinguisher system（optional）

In the event of an initial fire in the battery compartment, a fire alarm signal will be emitted, and the fire extinguisher system will automatically control the release of the aerosol, which can also be triggered manually. The fixed position of the aerosol is shown in Figure 3-9.

2) Dry pipe system（optional）

The dry pipe system can effectively control the spread of the fire. As shown in Figure 3-12.

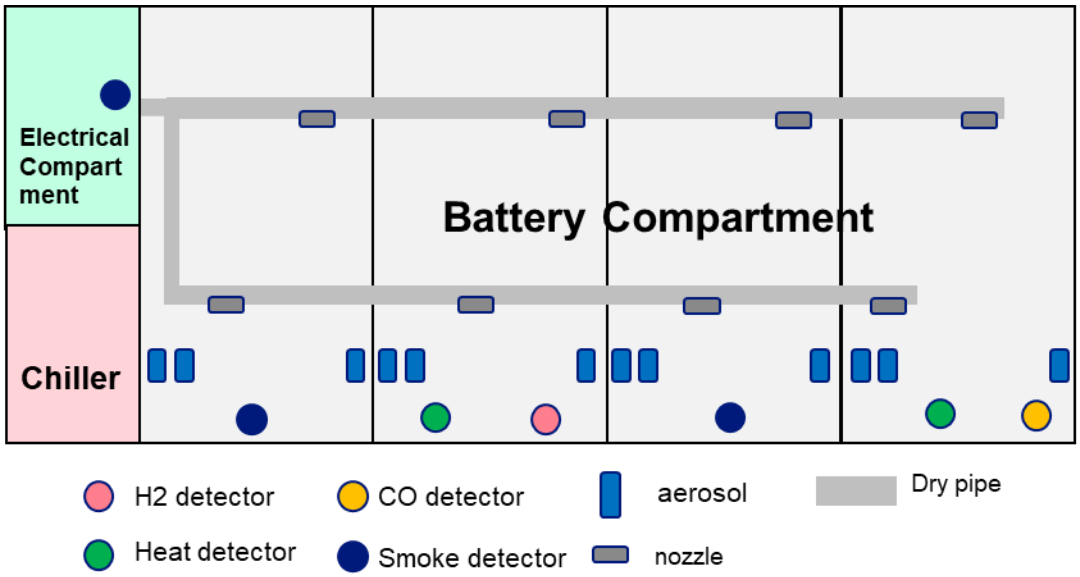


Figure 3-12 The design of dry pipe

The flange is installed at the entrance of the water fire protection system, for the connection between the pipes. The parameters of the flange are shown in Table 3-9.

Table 3-9 The paraments of the flange

Item	Specification
Model	NPS 2”
Standard	ASME B16.5
Material	ASTM A105
Class	Class 150
Flange type	Thread
Certificate	Integrate into rack

The Water Spray Nozzles are open type (non-automatic) nozzles with rubber plug, designed for directional spray application in fixed fire protection system. The parameters of the nozzle are shown in Table 3-10.

Table 3-10 The paraments of the nozzle

Item	Specification
Model	V2709
Type	Standard horizontal sidewall
Maximum working pressure	250 psi/1725 kPa
End connection	½ NPT

3.1.5.3 Instruction of UPS for FSS

In order to keep the FSS working normally for at least 24 hours standby and 2 hours alarm without external auxiliary power supply, an internal UPS has been incorporated into the FSS control panel, and two DC 12V batteries have been connected in series. For safety reasons, the battery connection must be disconnected during transportation process. The power supply of the explosion-proof system requires additional backup power from the customer.

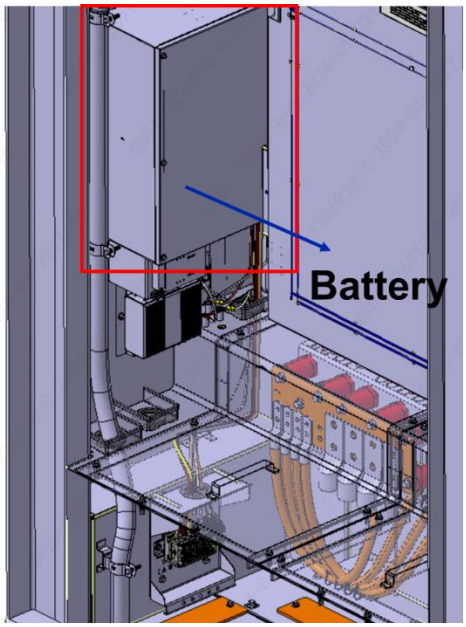


Figure 3-13 The UPS for Fire Control Panel

	CAUTION
	Note that overdischarge risk of UPS battery for FSS operation if long period without auxiliary power. If lost AC auxiliary power 24 hours above, please energize in external backup power to continuously enable FSS, or disconnect the battery connection to stop FSS operation to prevent over discharge.

3.1.6 TMS overview

The TMS is a liquid cooling system whose primary function is to maintain the temperature of the battery system within an acceptable operating temperature range. The following is the layout of the coolant pipes.

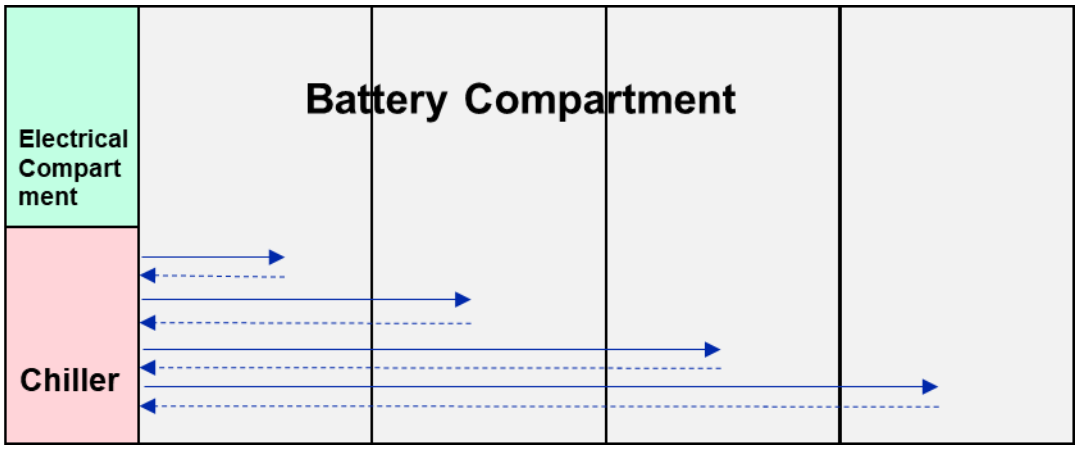


Figure 3-14 Pipe layout of TMS（Top view）

Table 3-11 Main feature of TMS

	✓ Coolant: 50% ethylene glycol+50% DI water ✓ Max. ambient temperature: 55 °C ✓ Power supply: 3AC 380DI…480V (external) ✓ 40kW cooling capacity for 0.25P system ✓ One unit of TMS (chiller) per container ✓ Cooling power is automatically adjusted according to ambient temperature & discharge/charge status ✓ The working status of the TMS system components depends on the target battery cell temperature controlled by BMS. In total, there are four operating states for TMS, which can be read by the bit 0- bit 1 via register address 0 x 0060

Table 3-12 Status of TMS components

Status	**Cooling** (bit 0 = 0, bit 1=1)	**Heating** (bit 0 = 1, bit 1=0)	**Self-circulation** (bit 0 = 1, bit 1=1)	**Sleeping** (bit 0 = 0, bit 1=0)
Compressor	Run	Stop	Stop	Stop
Pump	Run	Run	Run	Stop
Fan	Run	Stop	Stop	Stop
PTC Heater	Stop	Run	Stop	Stop

Table 3-13 Power Consumption of TMS

Type of EnerX	**0.25 P System**
Quantity of Cooling Unit	1
Refrigerating Capacity	1 x 40 kW
Maximum Heating Power	21.3 kW
Maximum Cooling Power	27.9 kW

Maximum Cooling current	50.1A
Maximum Heating current	31A
EER	⩾2.76 (18℃ TMS liquid , @35℃ ambient)

3.1.7 Auxiliary distribution box overview

The Auxiliary distribution box is for providing the auxiliary power for whole control system and liquid cooling system.

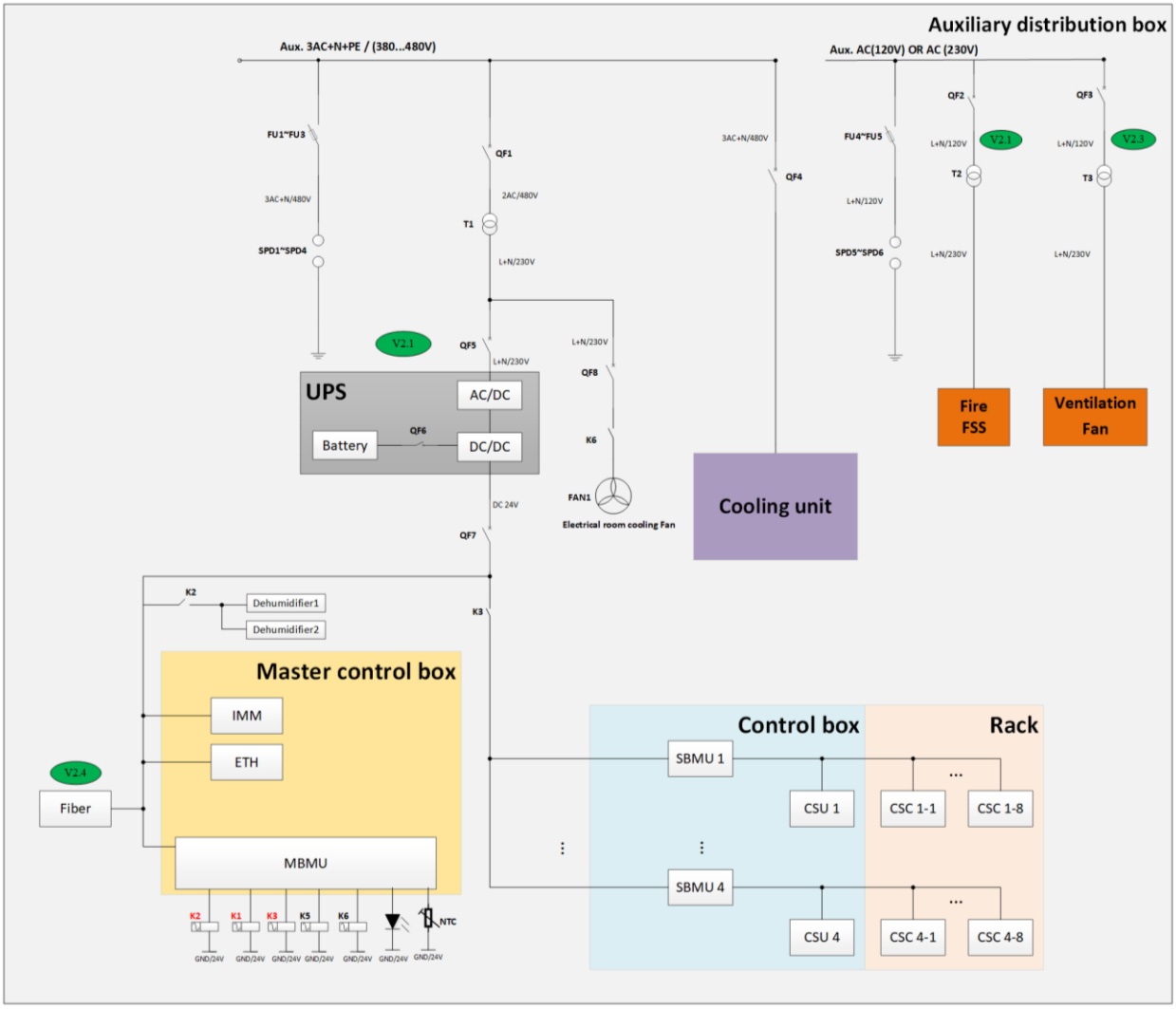


Figure 3-15 Single line graph for auxiliary power

Table 3-14 main feature of distribution box

- ✓ Auxiliary power supply input :

  3AC + N+PE 480V(380…480V)±10%, 50/60Hz & 1AC 230V(L+N+PE) ±10%, 50/60Hz
- ✓ Include DC24V power supply output & DC24V UPS for BMS system,
- ✓ Include 230V power supply output for FSS and Explosion-proof system,
- ✓ Include 380V power supply output for Chiller system ,
- ✓ Include E-stop circuit,
- ✓ Include circuit protection and power supply on-off control circuit,
- ✓ Include Type II SPD for AC Power supply.

3.2 Product Specification

EnerX liquid-cooled energy storage container				
Product model		**C06530P25L01**		
Product Type		**LFP battery bank**		
NO.	**Item**		**Specification**	**Remark**
1	Configuration		4P2P416S	
2	Rated Energy		5644.29kWh	
3	Rated Voltage		1331.2VDC	
4	Voltage Range		1040~1500VDC	
0.25 P System				
5	Charging Current (0.25 P)	Rated	1060A	
		Maximum	1357A/1 minute	
6	Charging Power (0.25P)	Rated	1411.07kW	
7	Discharging Current (0.25P)	Rated	1060A	
		Maximum	1357A/1 minute	
8	Discharging Power (0.25P)	Rated	1411.07kW	
9	Auxiliary power supply	Voltage range	3AC+N+PE 480V(380…480V)±10%, 50/60Hz&	

	(0.25P)		1AC 230(L+N+PE)±10% , 50Hz/60Hz	
		Power	Max. 35kW (3AC 380~480V±10%) Max. 0.5kW(1AC 230V ±10%)	
10	Operating Ambient Temperature	Charge	-35 ℃…+55℃	
		Discharge	-35 ℃…+55 ℃	
11	Environment condition	Storage temperature	-35 ℃…+60℃	
		Relative Humidity	0 ~ 95 % (non-condensing)	
		Application altitude	≤4000m	
12	General Parameters	Size	6058mm(W)*2438mm(D)*2896mm(H)	
		Weight	~45.0t (Metric Ton)	
		IP Level	IP55（Battery Room）	
			IP55（Electrical Room）	
		Cooling mode	Liquid Cooling	
		Communication agreement	CAN, RS485, TCP/IP	
		Power connection	Cable lug: 8 x M12	
		Communication connection	Fast plug	
		Aux power connection	Terminal	
		Coolant	50% Ethylene glycol+50% DI water	
13	Fulfill standard	Cell	UN38.3	
			UL1973	
			IEC62619	
			UL9540A	
		Container	UL1973	
			NFPA855	
			UL9540A	
			UL9540	
			IEC 62477	
			IEC 62619	
			IEC 62933-5-2	
			IEC 63056	
			IEC 61000-6-2/ IEC 61000-6-4	

3.3 BMS introduction

3.3.1 BMS system overview

BMS is used in conjunction with the energy storage system, which can monitor the battery voltage, current, temperature, manage energy absorption and release, thermal management, low voltage power supply, high voltage safety monitoring, fault diagnosis and management, external communication with PCS and EMS, ensure the stable operation of the energy storage system.

The BMS system is composed of 1 unit of MBMU, 1unit of IMM, 1 unit of ETH, 4 units of SBMU, 32 units of CSC.

	CAUTION
	Note that over discharge risk of UPS battery operating if long period without auxiliary power. please recharge the UPS within one week after the auxiliary power supply is cut off. For long-term storage, please recharge the UPS battery every three months.

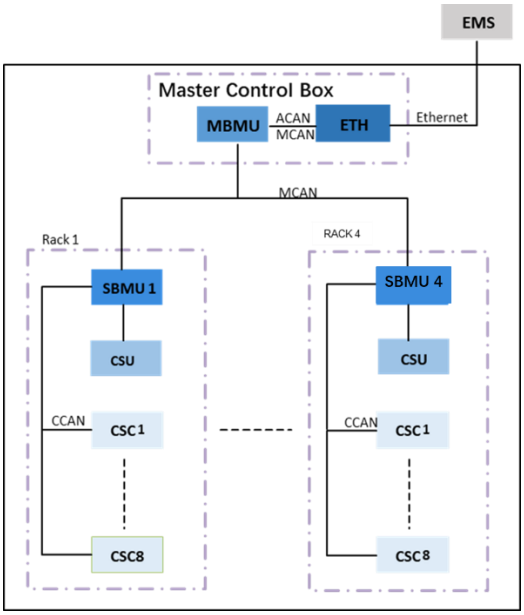


Figure 3-16 Three-level BMS architecture

3.3.2 BMS power on and off

The BMS does not have on/off button. Turn on the power supply to the BMS, then the BMS is turned on and operates normally; turn off the power supply to the BMS, then the BMS shut down.

3.3.3 Battery status monitoring

1. The BMS monitors battery parameters including cell voltage, module temperature, battery current and total battery voltage.

2. The BMS detects the battery status such as State of Charge (SOC) accurate to within 5%, SOH and the calculation of SOP.
3. The BMS functions as a safety management system in cases such as under-voltage, over-discharge, over-voltage, over-temperature, and over-current of the battery. In the event of a fault, the system alarms the supervisory equipment, limits the charge and discharge current or power, and delays the disconnection of all HV relays. This can protect the battery while maintaining the safety of the systems.
4. The BMS provides battery information including data recording and fault information recording to the EMS.

3.3.4 Charging/discharging management

1. The BMS controls and monitors HV relays, including the low voltage coils of the contactor and the high-voltage contact (auxiliary contact).
2. The BMS has precharge control within the parallel connection between racks.
3. The BMS works in charge and discharge management. It will calculate the charge and discharge power limit according to the existing status of the battery (temperature, SOC) and the actual performance of electrical components and then report to the EMS which has the function of controlling to these limits;
4. The BMS has the function of balance management to extend the operability of the battery system.

3.3.5 Thermal management

1. The BMS has the function of sampling the battery cell temperature and the chiller operating status.
2. The BMS controls the liquid cooled TMS based on the battery cell and the coolant temperature.

3.3.6 Program update

The BMS can flash programs on site, which supports flashing of MBMU, SBMU, IMM, CSC and ETH by using the host computer through MCAN.

3.3.7 High voltage safety monitoring

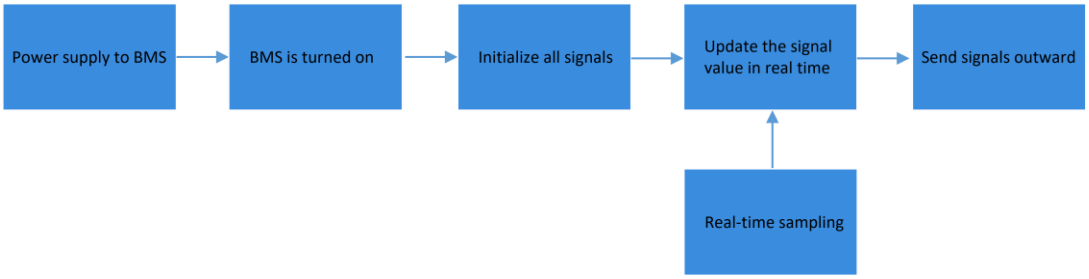
1. The BMS has the function of high voltage sampling (collecting data of the main positive voltage)
2. The BMS supports the detection of the dry contact of the fuse and switch, as well as the auxiliary contact of the primary loop relay.

3.3.8 Fault diagnosis management

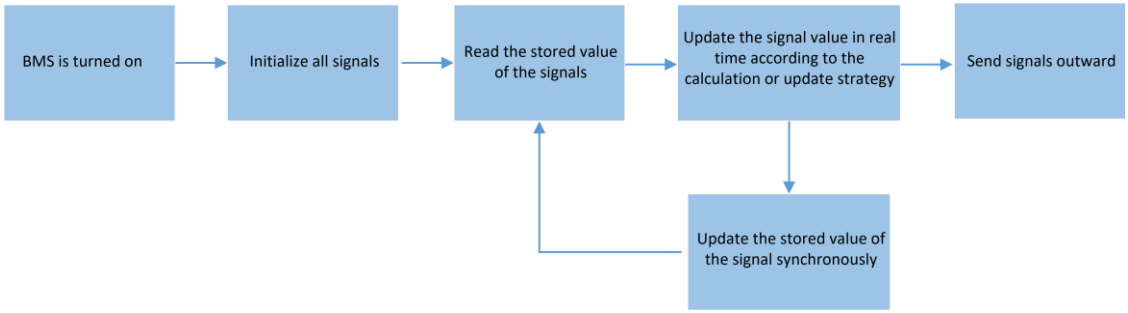
1. The BMS stores information such as operating parameters and historical alarms, which can be viewed by the ESS monitoring tool.
2. The BMS allows storage of recent alarms.

3.3.9 BMS data recovery function after abnormal power off

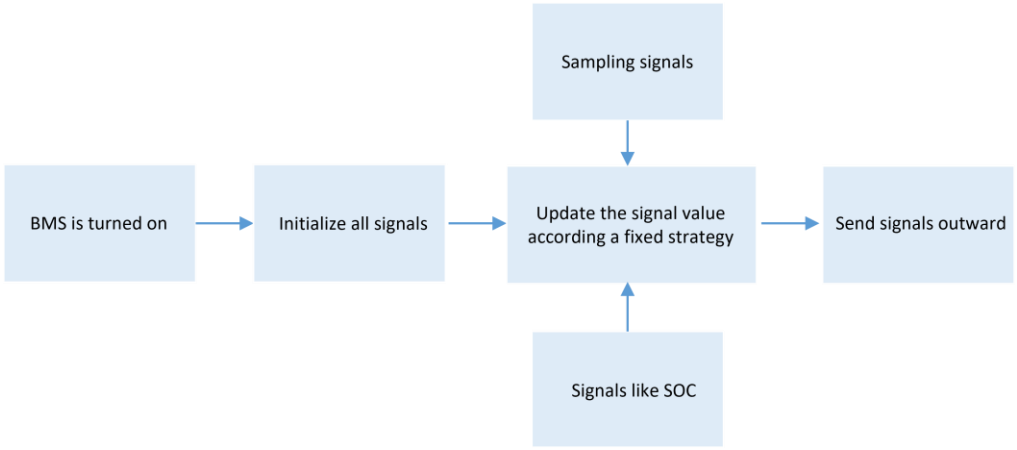
1) Real-time sampling signals, such as voltage, temperature, current, etc., are first initialized after the BMS is turned on. Then the signal value will be updated in real time with the sampled values.



2) Signals that need to be stored, such as SOC, SOH, SOE, etc., are also initialized when the BMS is turned on. These signals then read the stored value from the BMS once. After that, these data are updated in real time according to their update strategies, and their corresponding stored values will be updated synchronously.



3) Other types of signals are updated by the above two types of signals according to certain logical processing.



3.3.10 BMS system for four container parallel application

When four containers connect to the PCS at the same DC public connection point, these four containers must adopt the following communication architecture.

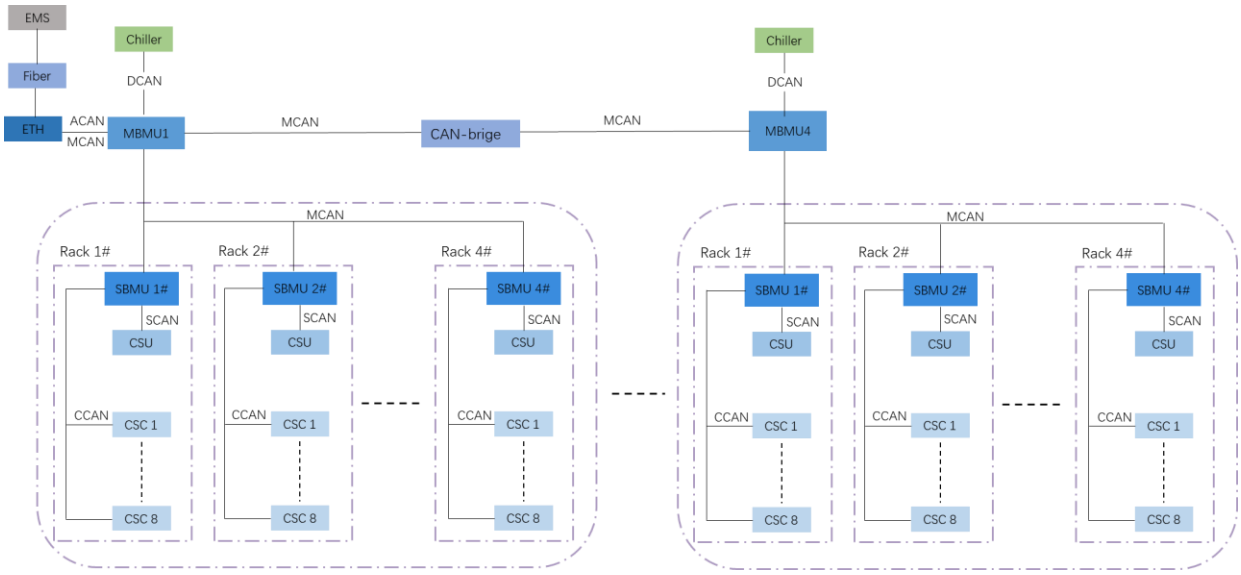


Figure 3-17 Communication circuit for four container parallel application

4 Transportation and Storage

4.1 Transportation process and requirements

Transportation methods: sea freight and land freight.

During loading and unloading, it should be handled with care to prevent throwing, rolling, and heavy pressure; during transportation, external mechanical impact should be avoided.

- Battery container transportation requirements for land freight
  1) The transportation scheme for bulky cargo must be evaluated in advance;
  2) The high-speed driving speed of the vehicle (truck) shall not exceed 100 km / hour & domestic legal requirement;
  3) It is forbidden to make sudden braking and sharp turns while driving;
  4) Keep the vehicle in good condition, check the vehicle's carrying status frequently, find and solve the problems in time.
- Battery container transportation requirement for sea freight

  Keep the vehicle in good condition, check the vehicle's carrying status frequently, find and solve the problems in a timely manner.

Requirements for Battery Container Transport

Based on battery features and with the purpose of maximizing battery performance, the transportation and storage of battery container should meet the following requirements:

- Allowable transport temperature: -35~+60℃.

- Humidity: ≤95% (no condensation).
- Take appropriate protective measures to keep the SOC level at about 23%, and make sure that no short circuit occurs, or no liquid is allowed to enter the battery container, or the battery container is soaked in liquids (e.g. water, oil, etc.).

4.2 Hoisting & lifting equipment

Equipment requirement

1) According to the site conditions and mechanical equipment, the selection of good performance of lifting equipment, rigging, shackle calculation selection; Ensure that the crane and rope meet the load-bearing requirements.
2) All kinds of lifting equipment, including sling, shackle, etc. should be checked in good condition before entering the site; before formal lifting, it should be reconfirmed that the specifications and quality meet the requirements of this lifting.
3) The lifting point is located at the top of the four terminal corners of the container.
4) When installing or removing a lifting device, do not drag the container. Otherwise, the container may be damaged.

4.2.1 Container hoisting parameters of single-point crane

Table 4-1 single point lifting

Preloaded weight	Cable length	Cable quantity	Acceleration
~45t(Metric Ton)	＞ 6.3m	4	≤0.5g

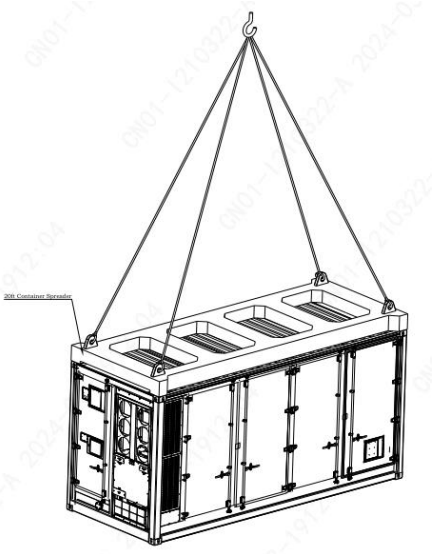


Figure 4-1 Single-point lifting

Note：Lifting equipment is provided by customer

	CAUTION
	The gravity center of the battery container must be kept stable during lifting process.

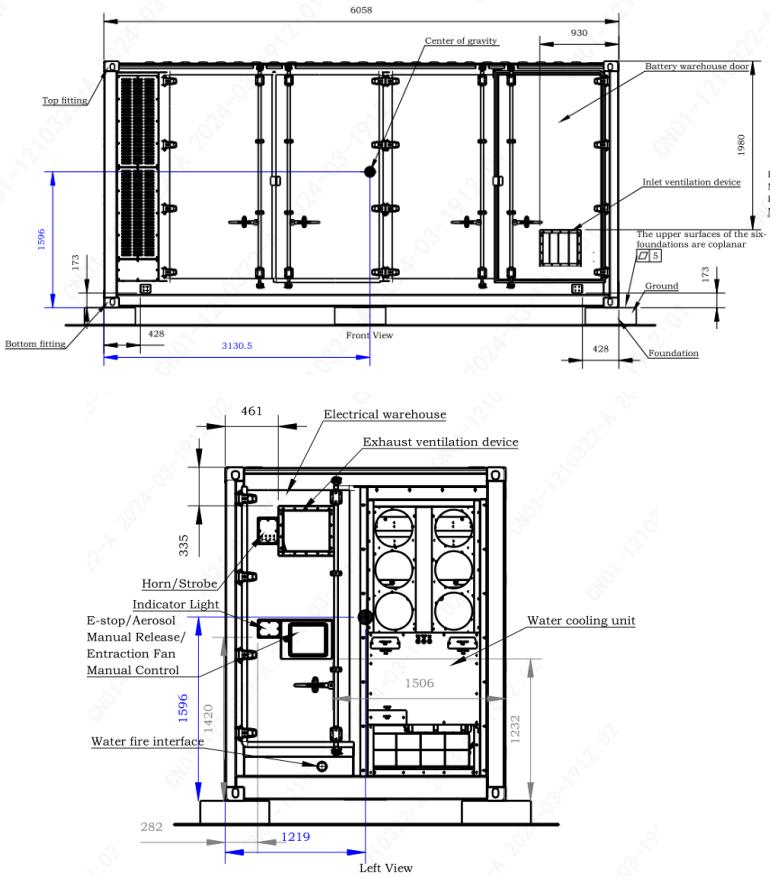


Figure 4-2 Gravity center of the battery container

4.2.2 Container hoisting parameters of four points vertical crane

Figure 4-3 Top lifting by four points vertical crane

4.2.3 Precautions for hoisting

Hoisting process	Precaution
Before lifting	The lifting capacity and working radius of the crane meet the requirements. If the onsite working conditions do not meet the requirements, seek professional evaluation.
	For outdoor use, you are advised to lift containers when the weather is clear and there is no wind & rain.
	Ensure that the crane and steel cable meet the requirements before hoisting.
	The doors of the container are all closed and locked.
	Ensure the cable connection is safe and reliable.
During lifting	It is strictly forbidden for irrelevant personnel to enter the lifting area, and it is strictly prohibited to stand under the lifting arm.
	Ensure that the crane is in a proper position, not long distance hoisting.
	Keep the container steady, and the diagonal inclination of the container is less than or equal to 5°.
	Hoisting gently, the box body should be slow and steady when falling, to avoid impact on internal equipment.
	When the container is in contact with the base, remove the steel hoisting cable after the base is evenly stressed.

	Containers can be hoisted only after they are secured.

4.2.4 Risk identification for hoisting

	WARNING
	To prevent personal injury or equipment damage, the risk identification must be done before hoisting

1) The crane in the operation of the human body caused by extrusion or impact;
2) The crane hook overloading fracture, lifting when the sling slip out of the hook;
3) Heavy objects fall in the lifting cause striking, heavy objects fall from the air to the ground and rebound wounding;
4) Accidental contact of spreader or sling with conductive slip line;
5) Truck crane working site ground is not smooth, support unstable, weight imbalance, heavy weight exceeds the rated lifting weight caused by crane overturning;
6) Excessive wind, illegal operation caused the crane overturned;
7) People standing under the boom and other dangerous areas;
8) A person standing or sitting on a hook;
9) When lifting, there is no command, there are people staying in the working area, and the spares and heavy objects of the crane in operation swing and strike pedestrians;
10) The crane and other operators do not wear safety helmet and other personal protective equipment;
11) The driver's cab glass is not cleaned, resulting in unclear vision;
12) The driver has poor communication with the commanding personnel, or misunderstands the hoisting signal;
13) The hanging method is not correct, causing heavy objects to fall out from the hook;
14) The sling used exceeds the safety factor;
15) The wire rope jumps out of the pulley groove;
16) Brake crack, friction gasket wear too much.

4.2.5 Measures of hoisting safety

	WARNING
	To prevent personal injury or equipment damage, the safety measure must be followed

1) Strengthen the management of the construction site, set up a warning area on the hoisting site, send full-time safety personnel to supervise and alert, non-operation personnel are strictly prohibited to enter;
2) Carefully do the preparatory work before lifting, according to the requirements of the plan to prepare machinery and heavy lifting rigging. Strictly implement the lifting equipment performance inspection, lifting rigging inspection, pre-lifting detection and lifting procedures to ensure the safe and reliable lifting operation;
3) Detailed technical disclosure shall be made to all personnel participating in the construction operation in advance, so that they must understand the essentials, procedures and requirements of the operation. After the crane enters the site, the crane driver will be introduced to the hoisting scheme in detail, and the unified command signal will be made clear.
4) Crane position operation and walking route should be carried out according to the requirements of the scheme, the outrigger pad must be safe and reliable. Special subgrade box cushion is used under the leg to expand the unit force surface. Crane lifting operation should be smooth, slow action, lifting operation should pay close attention to the settlement of the crane leg;
5) The contact between the site commander and the crane driver should be timely and reliable, and the command signal, flag language and gesture should be clear. If abnormal conditions are found, the commander in chief of the lifting site should be reported in time, so as to take effective measures as soon as possible;
6) When the wind is level 5 or above, it is strictly prohibited to lift in thunder, rain and fog days;
7) Construction personnel entering the hoisting operation site must strictly implement the safety rules and regulations of the site, wear labor protection clothing and safety helmet according to the provisions;
8) Hoisting operation should be unified command, operation personnel should do their duty, closely cooperate, so as to complete the hoisting operation safely and smoothly.

4.3 Storage

The battery container should be stored in a place without harmful gases, flammable or explosive products and corrosive chemicals nearby. Keep away from mechanical impact, heavy pressure and strong magnetic field. The distance to heat source should be far away.

4.4 Ambient thermal insulation

The battery system must operate within the range of optimum operating temperature, so that the service life of a battery can be extended, and the safety performance of a battery can be improved. The limitation

of temperature should completely comply with various definitions in the specification, the installation space of the battery system should be well-ventilated and be designed with the function of thermal insulation.

5 Product Installation

5.1 Site and environment requirements

EnerX battery container applies to general outdoor scenarios. In accordance with local laws and regulations, the site selection requirements are as follows:

1 The installation position of the node cannot be in a low-lying area, and the site level is higher than the highest historical water level in the area.

2 The soil condition is good and the ground is solid. No bad geological conditions such as rubber soil and soft soil layer are allowed. The ground that is easy to accumulate water and sink should be avoided.

3 Invest in a well-ventilated place.

4 Keep away from strong vibration, noise sources, and electromagnetic interference areas. Try to avoid places with existing underground facilities.

5 Keep away from places that produce dust, fume, harmful gases, and produce or store corrosive, flammable, and explosive materials. The distance from the airport, landfill, river bank, shore or dam should not be less than 500m.

6 Choose an open location according to the requirement of Figure 5-1, and ensure that there are no obstacles from the surrounding area.

7 Keep at least 50m away from residential areas to avoid noise pollution.

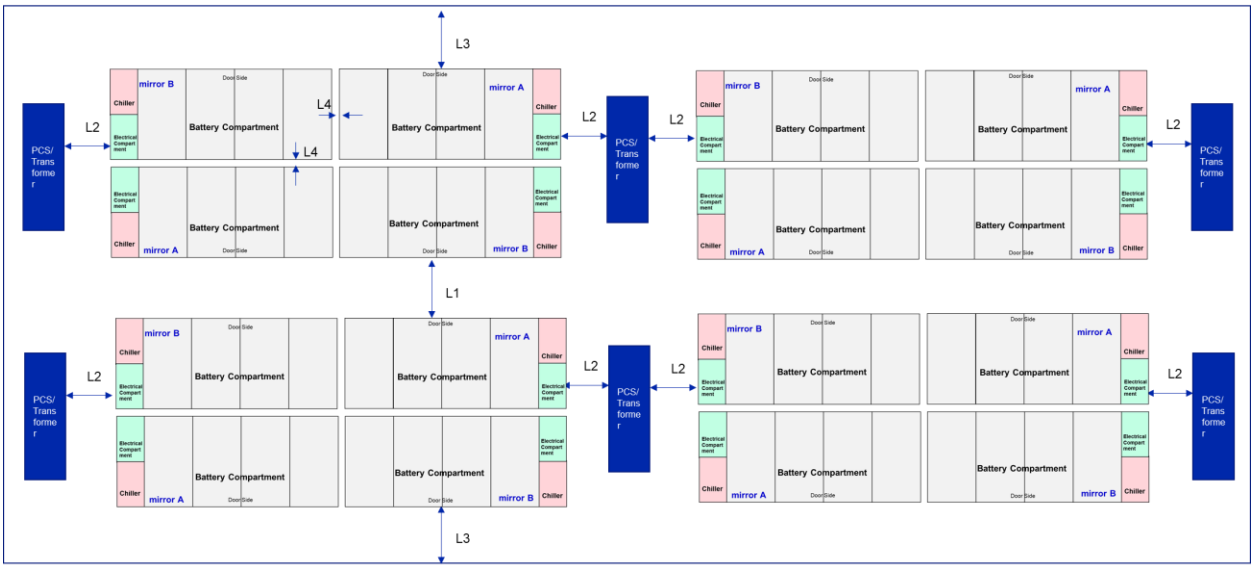


Figure 5-1 Clearance requirement

To avoid the hot air interaction for two containers, and to maintain the container, the minimum distance must be followed :

L1 : 3.5m

L2 : 3.0m

L3 : 3.5m

L4 : 0.3m

Note that back-to-back two containers have opposite wiring direction and need to control the length of the high-voltage cable to the PCS. The distance here refers to the road width, mainly considering the pass ability of maintenance tools. (Excluding mounting base dimensions)

5.2 Foundation requirements

Before installing this container, build the foundation and trench on the selected ground. The requirements for foundation construction are as follows:

1) The size of foundation meets the requirements of container installation and bearing capacity as following shown.

Table 5-1 Installation site requirement

Ground type	Condition requirements	Note
Concrete floor	Support at least six points in the Figure 5-2. The ground needs to be able to bear a static load of 45 tons, considering the seismic conditions, it should meet the requirements of the support reaction in the drawing	Ground should fulfill: ◆ Flatness deviation ≤5mm/6 foundations
Plain land surface		

2) Foundation requirement:

- At least six foundation points must be in place to support the container as shown in Figure 5-2.
- It is mandatory to fix four corner foundation points as shown in Figure 5-3
- Refer to Figure 5-4 for the spacing of the bottom foundation points of a container.
- Diameter for each foundation point is 500mm, the recommended height is 200mm （at least 50mm for bottom module maintenance）

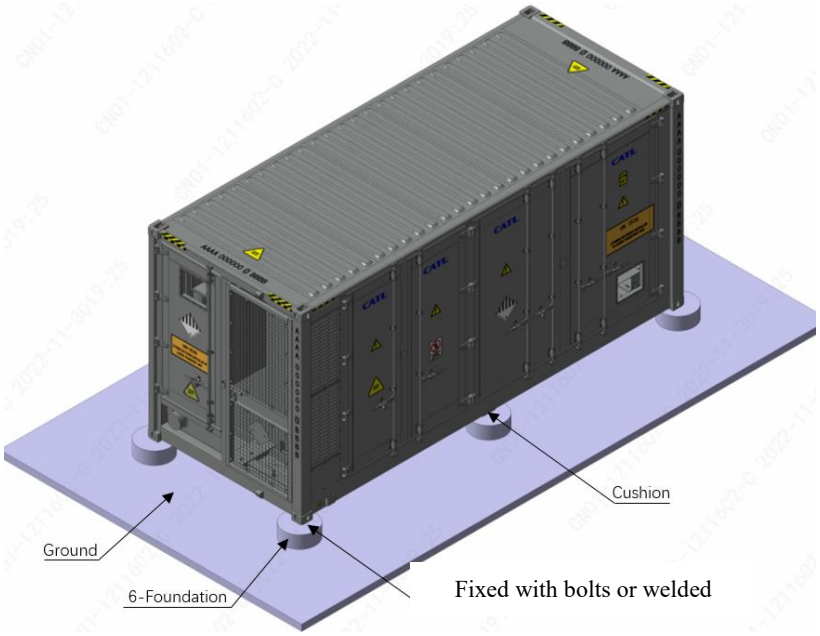


Figure 5-2 Installation site overview

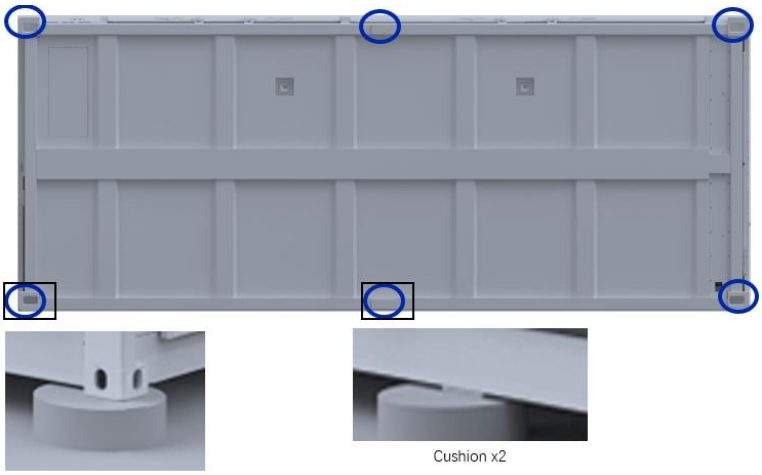


Figure 5-3 Bottom foundation points of a container

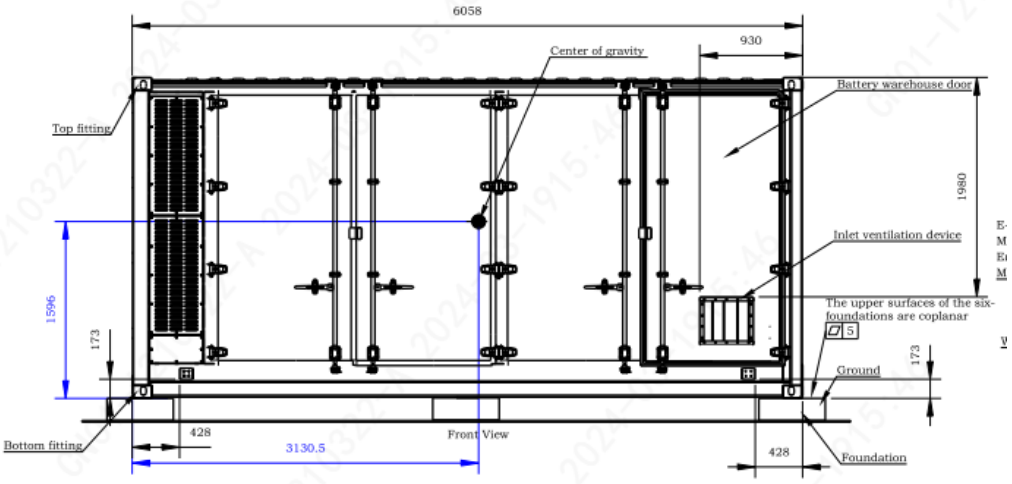


Figure 5-4 Spacing of the bottom foundation points of a container

1) Bury the ground grid and install a ground bar at the designated position of the container. Connect one end of the ground grid to the embedded ground grid and the other end to the container's ground point. When embedding the ground network, ensure you reserve enough length for the ground lug to connect to the container's ground point.
2) The grounding resistance of the container is less than or equal to 0.1Ω.
3) The containerized energy storage system uses underside cabling, so the cables must be buried under the power cabin in advance.
4) The inner diameter of the protective pipe should not be less than 1.5 times the outer diameter (including the protective layer) of the cable.
5) Foundation construction should meet the local historical maximum rainfall drainage requirements. The discharged water must be treated in accordance with local laws and regulations.

5.3 Installation procedure

Table 5-2 Installation procedure

Step	Procedure
1	Determine the position for installing containers based on the foundation design diagram;
2	Measure the support points of foundation containers fulfilling the requirement of chapter 5.2
3	Use a crane to lift containers according to chapter 4.2
4	Adjust the container and level the container using washers to ensure that the support points at the bottom are evenly supported. Note: The washer has been packed with the box and placed at the protective cover of the water pipe in the electrical cabin

5	Open and close all side doors and the electrical cabin doors. There is no lag in operation and no rigid contact between the side door and the cabin body. If there is interference between the door and cabin, washer should be added in the corresponding position
6	Remove the lifting rope and release the crane after the side door and electrical cabin door meet requirements
7	Secure the container.

5.4 Anti-vibration and anti-collision requirement for installation

Inside the battery container, battery racks are connected in parallel, the management system and a variety of sensors are installed. The entire battery system must be installed firmly and reliably without loosening or shaking. An anti-collision device with sufficient strength must be installed at the periphery of the installation space of battery system so as to ensure that no safety accident (e.g. direct short circuit, overheating and combustion) will be caused by general collision which will not directly harm the battery system and batteries.

5.5 Locking the container

After securing the container, it is recommended that the side and end doors of the container be locked by padlock (as shown in the figure below) to prevent unauthorized access.

Figure 5-5 Lock of battery container

The regular maintenance and inspection of the padlock should be conducted regularly.

5.6 Wiring

5.6.1 Connection interface

The battery container has four main connection interfaces: DC power cable connection, AC auxiliary power connection, communication interface, and FSS communication interface.

5.6.2 Removal and installation of metal covers between electrical compartment and copper busbar compartment

There are two metal covers between the electrical compartment and the copper busbar compartment to reduce the effects of condensation in the electrical compartment.

Each metal cover is fastened with 12 M6*16 bolts

Before connecting the high-voltage wiring harness, auxiliary power wiring harness, and other external wiring in the field, you must use tools to remove the bolts and open the metal covers.

After the external wiring is completed, the metal covers must be installed before the container is officially commissioned.

Bolts：M6*16

Torque：10±0.5N.m

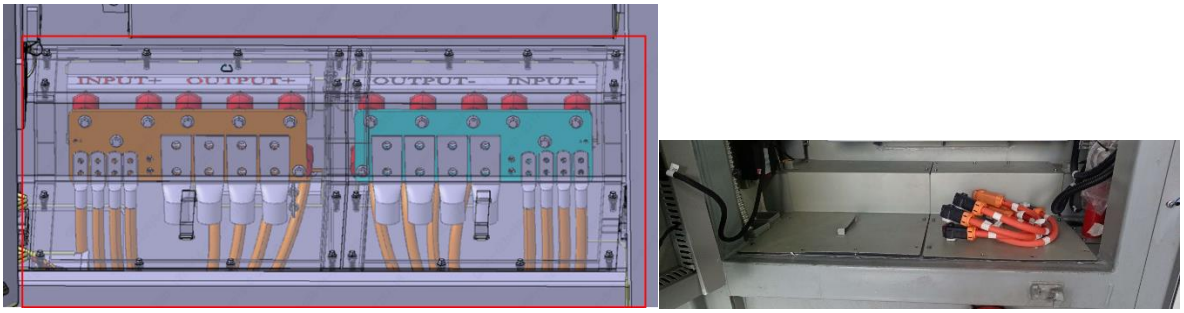


Figure 5-6 Photos of Metal Covers

5.6.2.1 DC power cable connection

As Figure 5-6 shown, The DC power cable connection of the battery container is located in the busbar of the electrical room. The positive and negative copper bar each have 4 x double M12 holes for connection.

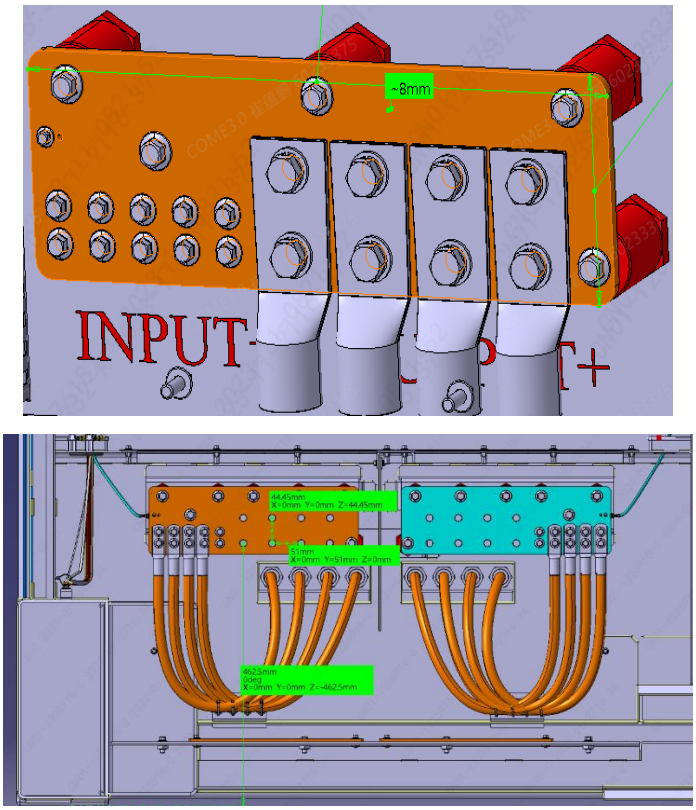


Figure 5-7 DC power cable connection interface

It is recommended to use a dual hole cable lug as shown in Figure 5-7 for the external HV cable connection, and the bolt assembly should follow the scheme shown in Figure 5-8 .

Figure 5-8 External DC power cable lug

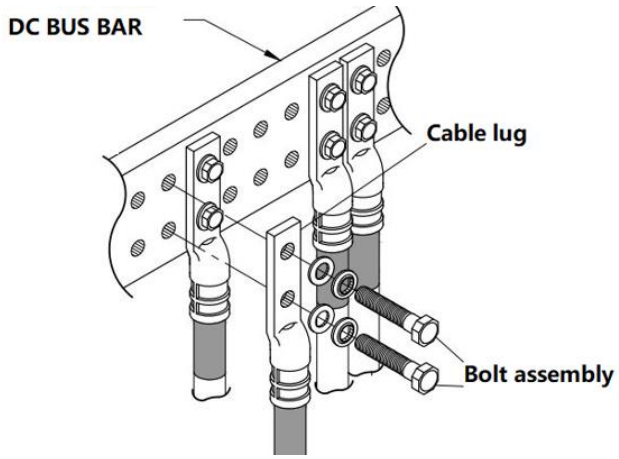


Figure 5-9 External DC power cable connection

Table 5-3 Description of DC power cable connection interface

Pole	Connection	Requirement
HV+	➢ Cable type: copper ➢ Cable lug :4 *M12, ➢ Recommend cable cross-section(copper conductor): 4 *150 mm² or 4 *AWG 300 ➢ Screw: M12 * 35 ➢ Torque: 50 N·m	1. The terminal is a double-hole terminal, the center-line distance between the two holes is about 45mm; 2. The connecting cables should meet the following service requirements: the rated voltage is 1500V DC and the continuous current is 1220A, the maximum current is 1560A; 3. Route as shown in Figure 5-6 DC power cable connection interface. 4. After the external wiring of the container is completed, it is necessary to fill the gap between the threading opening and the wiring harness with fireproof mud and other materials for sealing. It is required that the filling be uniform, tight, seamless, and the beautiful in appearance.
HV-	➢ Cable type: Copper ➢ Cable lug :4 *M12, ➢ Recommend cable cross-section(copper conductor): 4 x 150 mm² or 4x AWG 300 ➢ Screw: M12 x 35 ➢ Torque: 50 N·m	

5.6.2.2 Auxiliary power cable connection

Auxiliary Power：3AC+N+PE，1AC+N+PE

As shown in Figure 5-9, the auxiliary power cable connection can be accessed at the bottom of electrical room.

Auxiliary power cable connection (3AC 380~480V)

The connection requirements of auxiliary power supply (3AC+N+PE):

1) The 3AC 380V…480V , 50/60 Hz power supply can be connected to the XT8 terminals;
2) Be sure to connect the U/V/W/N/PE (A/B/C/N/PE) terminals in the correct order;
3) Use flexible or hard wires with cold-pressed tube terminals: Locking torque requirement: 3.2~3.7N·m;
4) 25mm² is recommended for single wire.

Auxiliary power cable connection (Ventilation Fan AC230V)

The connection requirements of auxiliary power supply (L+N+PE):

1) The AC230V 50/60Hz power supply can be connected to the XT10 terminals;
2) Be sure to connect the L/N/PE terminals in the correct order;
3) Use flexible or hard wires with cold-pressed tube terminals. Locking torque requirement: 1.5~1.8 N·m;
4) Continuous current 5A（AC 120/230V). 2.5mm² for single wire is recommended.

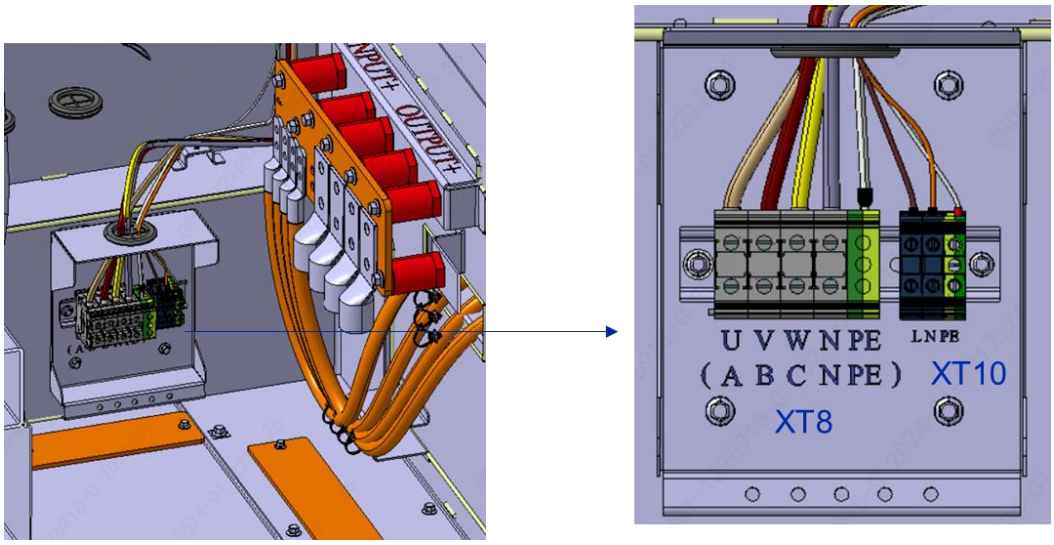


Figure 5-10 AC auxiliary power cable connection interface

Table 5-4 Auxiliary power cable connection interface

XT1 Terminal	For 3AC 380~480V	Power capacity requirement	Cross-section
XT8-1	U/A	Max: 37.5kW	

XT8-2	V/B		Type: Copper Recommend: 25mm² Torque： 3.2-3.7N·m
XT8-3	W/C		
XT8-4	N		
XT8-5	PE		
XT10 Terminal	For AC230V	Power capacity requirement	Cross-section
XT10-1	L	Max: 0.8kW	Type: Copper, Recommend: 2.5mm² Torque： 1.5-1.8N·m
XT10-2	N		
XT10-3	PE		

5.6.2.3 Grounding connection

As shown in Figure 3-2 and Figure 3-3, there are two grounding connection points for the EnerX container.

The minimum cross-section of the earthing conductors must meet the following requirement.

Figure 5-11 Grounding connection point

Table 5-4 Earthing cable requirement

Cross-section S of line phase conductor	Minimum cross-section of earthing conductors
S ≤ 16 mm^2	≥ S
16 mm^2 < S ≤ 35 mm^2	≥ 16 mm^2
S > 35 mm^2	≥ 0.5 * S
Recommend earthing cable cross-section for 0.5P system: 3x 150mm^2 or 3 x AWG 300	

Using M12x35 combination hexagon bolt. The torque is 50N·m .

The resistance of grounding connection point should be ≤0.1Ω.

5.6.2.4 Communication cable connection

For optic fiber connection, the optic fiber conversion module is contained in the electrical room, which can convert TCP/IP to fiber signal, and the single mode ST port is used

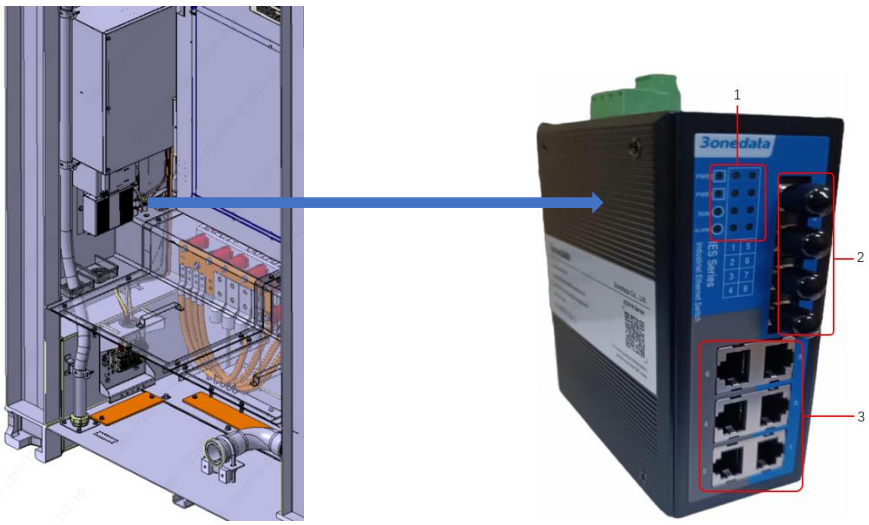


Figure 5-12 Interface of optic fiber conversion module

Figure 5-13 Type of fiber optic connector: **ST**

Table 5-1 Fiber optic conversion module connector information

No.	Item	Connector information
1	Led indicator	Power/Alarm/Working indicator
2	ST port	Two ST (single mode) ports
3	ETH port	Six RJ45 ports.

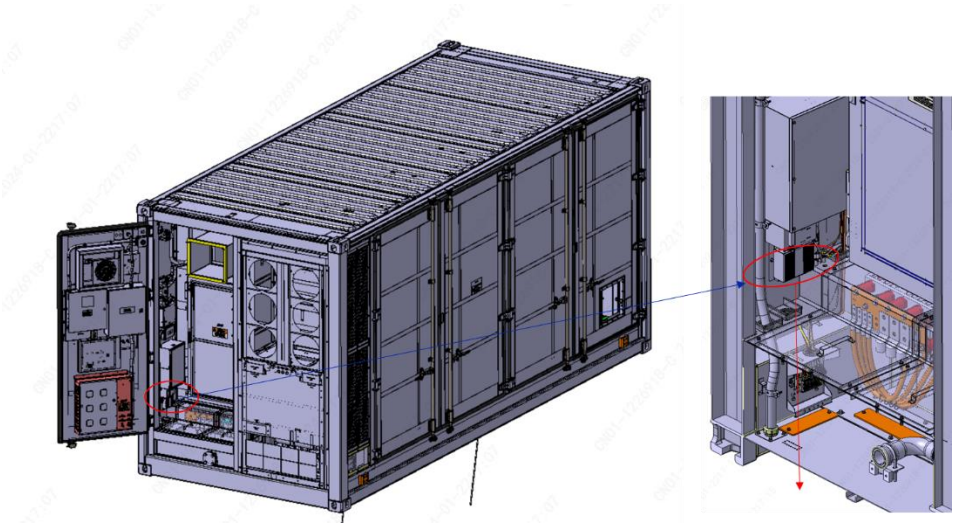


Figure 5-14 Schematic diagram of fiber optic routing

5.6.2.5 The configuration instructions of the terminal resistance

The configuration instructions of the terminal resistance:

- The MCAN terminal resistors are installed on the ETH and MBMU boards, and the terminal resistors can be accessed by shorting the corresponding ports on the board.
- In the MCAN communication circuit, use one of MBMU or ETH as a communication terminal resistance.
- The SBMU board and IMM board are not equipped with MCAN terminal resistance. Generally, the terminal resistance is configured on the MCAN interface of the electrical cabinet where the last SBMU is located.
- The whole MCAN loop has two 120Ω terminal resistors in parallel, equivalent to 60Ω resistance. Use multi-meter to measure the resistance of any MCAN loop interface.

5.6.2.6 FSS dry contact interface

- There are five dry contact interfaces in FSS.
  - Fire system fault level 1
  - Fire system fault level 2
  - Exhaust ventilation state
  - Exhaust ventilation body warning
  - Fire system failure warning
- **FSS dry contact**

Fault name	Function	Dry contact status	External FSS or EMS action
Fire system fault level 1	To indicate that any one sensor of FSS is in alarm.	Close	No action
		Open	Cut off PCS power by EMS and check the detail fault information on the FCP.
Fire system fault level 2	To indicate that one heat detector and one smoke detector in battery room give an alarm or two heat detectors give an alarm	Close	No action
		Open	Cut off PCS power by EMS and check the detail fault information on the FCP.
Exhaust ventilation state	To indicate that the ventilation fan is open	Close	No action
		Open	Cut off PCS power by EMS and check the detail fault information on the FCP.
Exhaust ventilation body warning	To indicate that fan or louver can't operate when exhaust ventilation fan is turned on	Close	No action
		Open	Check the detail fault information on the FCP
Fire system failure warning	To indicate the fault of FSS in battery container.	Close	No action
		Open	Check the detail fault information on the FCP

5.6.3 Wiring quality requirements

1. Inspect whether the polarity of DC cables is correct, nuts are installed properly, and cable signs are correct.
2. Inspect whether the phase sequence of AC cables is correct, wiring terminals are secured properly, and cable signs are correct.
3. Inspect whether the insulation impedance of all racks meet the requirements.
4. Inspect whether the positive and negative poles of DC racks are short-circuited, and terminals U, V, W, N and PE of AC cables are short-circuited.
5. Inspect whether grounding conduction of grounding wires is good.
6. Before power on, check the connection cable of the whole system, and make sure that the cable connection is reliable without aging fracture and insulation damage.
7. Check whether all communication wires and cables and sub connections at the connection end are tight and reliable;

6 CATL Monitor Software

As the LFP battery energy storage running monitor, CATL Real–time Monitoring System can realize following fundamental functions, and the installation process and instruction can refer to follow chapters

1) Data monitoring and recording
2) Rack numbering
3) CSC numbering
4) Rack on-off controlling
5) Fault Alarm checking and analyzing

6.1 Commissioning Tool

For LFP Battery Energy Storage Running Monitor System Installation, following commissioning tools need be installed.

Table 6-1 Commissioning tool

Tool	Description	Overview
ZLGCAN II /ValueCAN4	ZLGCAN tools and ValueCAN4 tools provide connections between CATL BESS and the real time monitoring system (computer). Flashing and configuring are both done by these tools.	
DB9 connector	DB9 connector and rack connectors are used for connection between CAN tools and BESS.	

6.2 Commissioning system hardware setup

As the debug interface, JX3 terminal in EnerX Master Control box can be used for external commissioning

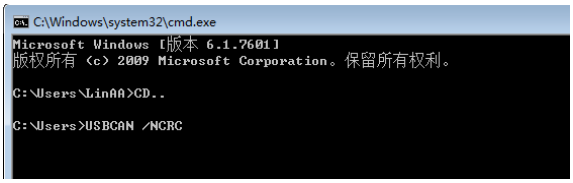
Ener X Master Control Box
JX3 MCAN interface

ZLGCAN II

Commissioning PC

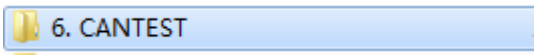
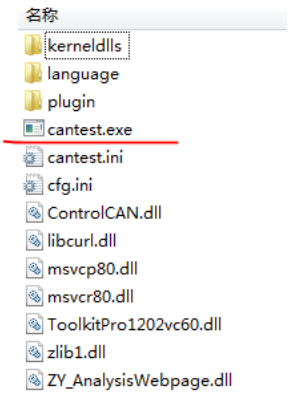
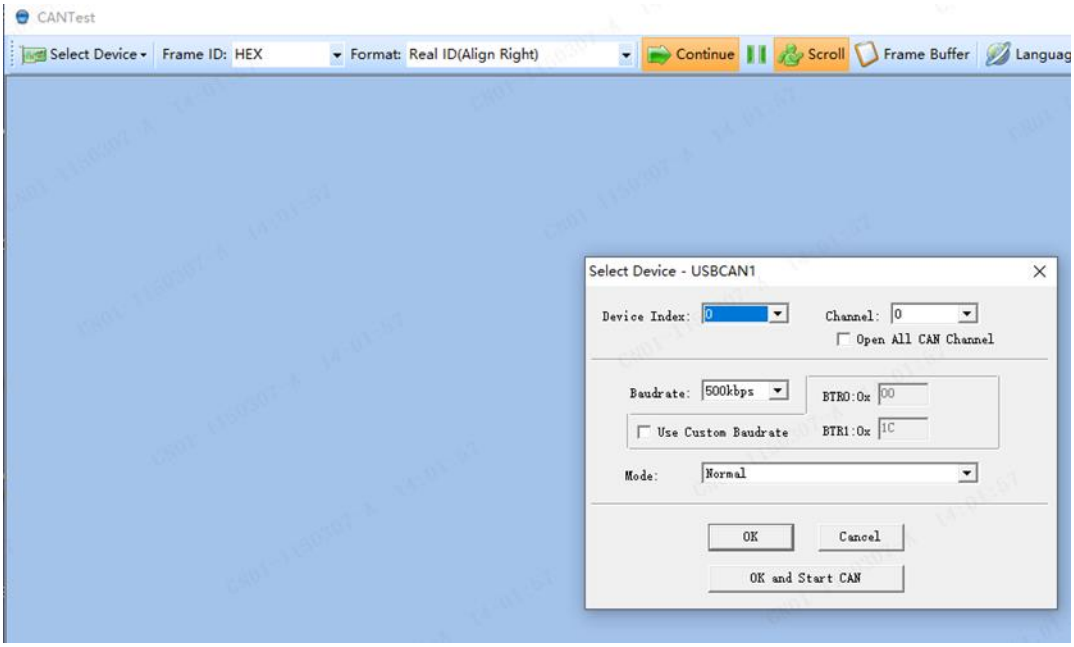
6.3 Commissioning system software setup

1) ZLGCAN Ⅱ driver installation

Step	Solution 1	Solution 2
1	Extract the diver USBCAN_I_II_2A_drive.rar → 【驱动程序】USBCAN-I_I+_II_II+_2A_I-MINI windows驱动安装 → USBCAN_AllInOne_x86_x64_2.0.0.1.exe	Extract the diver USBCAN_I_II_2A_drive.rar → 【驱动程序】USBCAN-I_I+_II_II+_2A_I-MINI windows驱动安装 → USBCAN_AllInOne_x86_x64_2.0.0.1.exe
2	Install the driver. USBCAN_AllInOne_x86_x64_2.0.0.1.exe	Rename the document as 'USBCAN.exe' and save it to the folder 'user' in Disk C
3	End	Open CMD command in folder 'user' 
4		Input 'USBCAN /NCRC' and press 'enter' to start the installation of the driver. 
5		End

2) CANTEST Usage

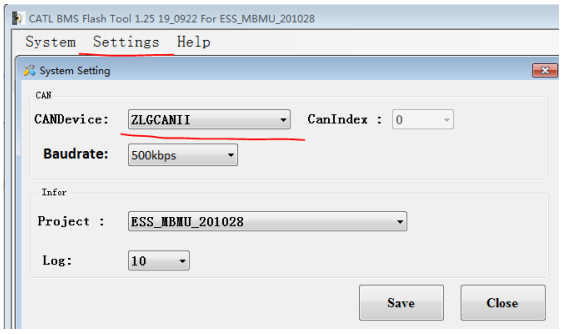
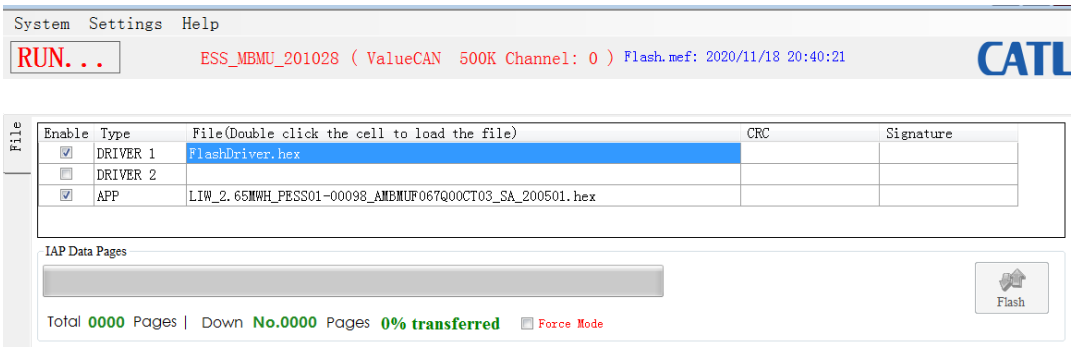
Step	Solution

1	Extract CANTEST software in any folder of the computer. 
2	After connecting the ZLG, open CANTEST.EXE. 
3	Choose 500kbps， click ‘ok and start CAN’. 

6.4 Software configuration

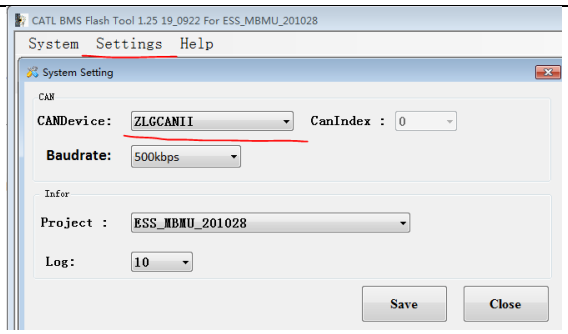
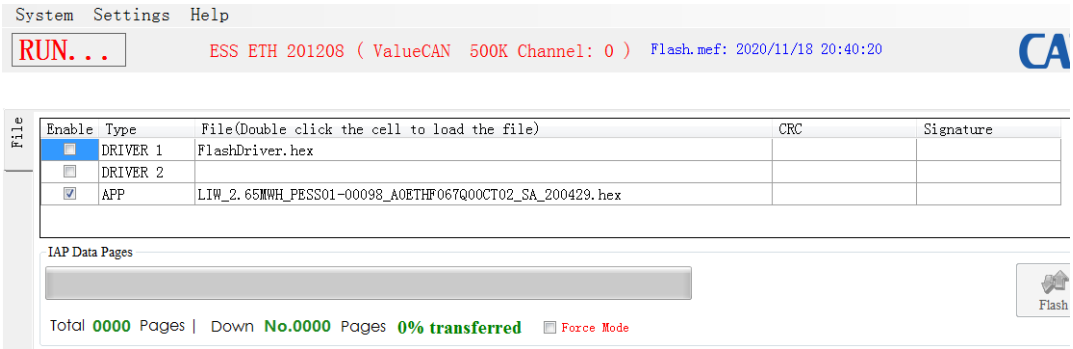
Switch on aux power supply, if the green indicator of master control box lights up, it means the 24V power supply of MBMU, ETH and fiber conversion module is ok, then, use CANTest software to verify the MCAN log. After getting normal log, start verification and flashing MBMU and ETH software, and then configuring ETH IP according to following steps:

1) MBMU software flashing

Step	Description
1	Open MBMU/ETH flash tool CATL BMS Flash Tool.exe
2	Select 'setting', 'ZLGCANⅡ', and click 'save' 
3	Select driver path in source file configuration \CATL_BMS_Flash_Tool 1.25 For ESS MBMU 201208\Configuration\ESS_MBMU_201028\FlashDriver
4	Select 'APP path', and select MBMU hex file (configured project by project) Such as: AMBMUF067Q00CT03_SA_200501.hex 
5	Select 'system', click 'run'.
6	Click 'flash' and wait until 100% done.

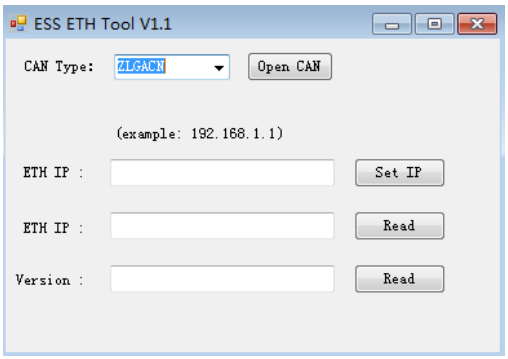
2) ETH software flashing

Step	Description
1	Open MBMU/ETH flash tool CATL BMS Flash Tool.exe
2	Select 'setting', 'ZLGCANⅡ', and click 'save'

	
3	Select driver path in source file configuration \CATL_BMS_Flash_Tool 1.25 For ESS ETH 201208\Configuration\ESS ETH 201208\FlashDriver
e4	Select 'APP path', and select MBMU hex file (configured project by project) Such as: A0ETHF067Q00CT02_SA_200429.hex 
5	Select 'system', click 'run'.
6	Click 'flash' and wait until 100% done.

3) ETH status verification

a) Open ETH IP setting tool, select ZLGCAN, press open CAN, type in the IP address at ETH IP, press set IP, and then it should show 'successful' after completion. If failed, please check CAN loop and retry. After 'successful' notification appears, Ping IP address and check the connection.



If not able to set IP:

i. Use CANtest to read the log

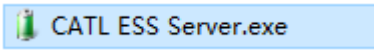
ii. Check ETH power supply and CAN_H/CAN_L loop connection.

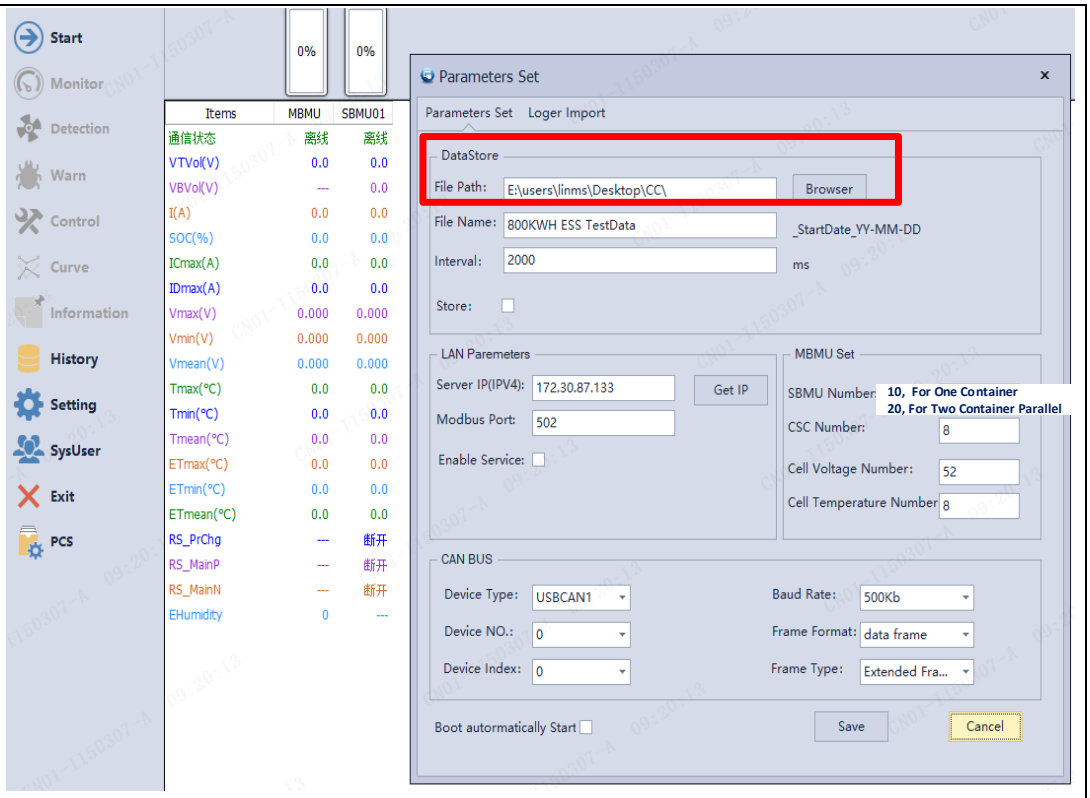
iii. Only turn on the ETH power supply and configure IP.

b) After verifying the version, configure IP using setting tools (if the version is wrong, flash the ETH software first.)

6.5 CATL Real–time Monitoring System

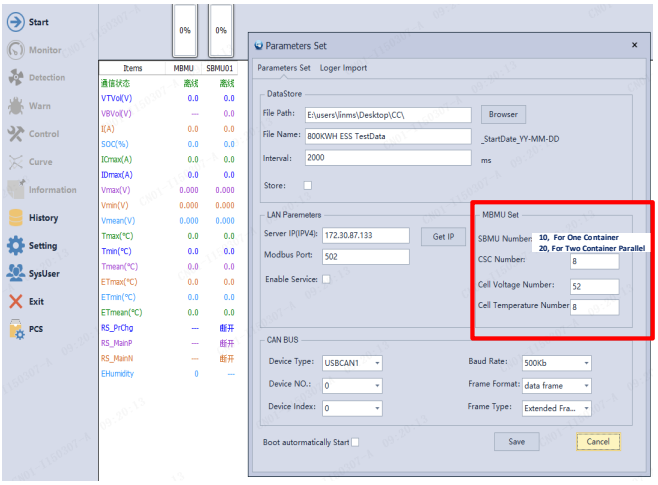
Table 6-2 CATL Real–time Monitoring System Overview

Step	Description
1	**CATL Real–time Monitoring System installation** ● After connecting CAN tools to the computer, open the real-time monitoring system 
2	**Data Store file path setting** ● Set up the real-time monitoring system by choosing the data storage place, check the Store option below, after that, all shown data on the monitoring system will be stored on the path.

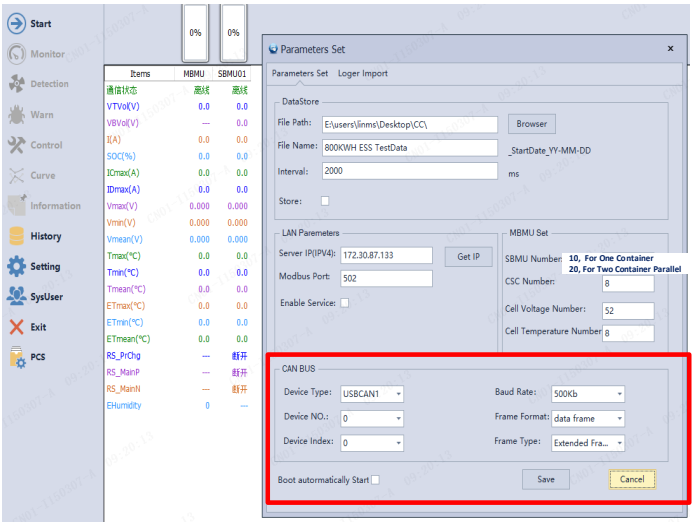
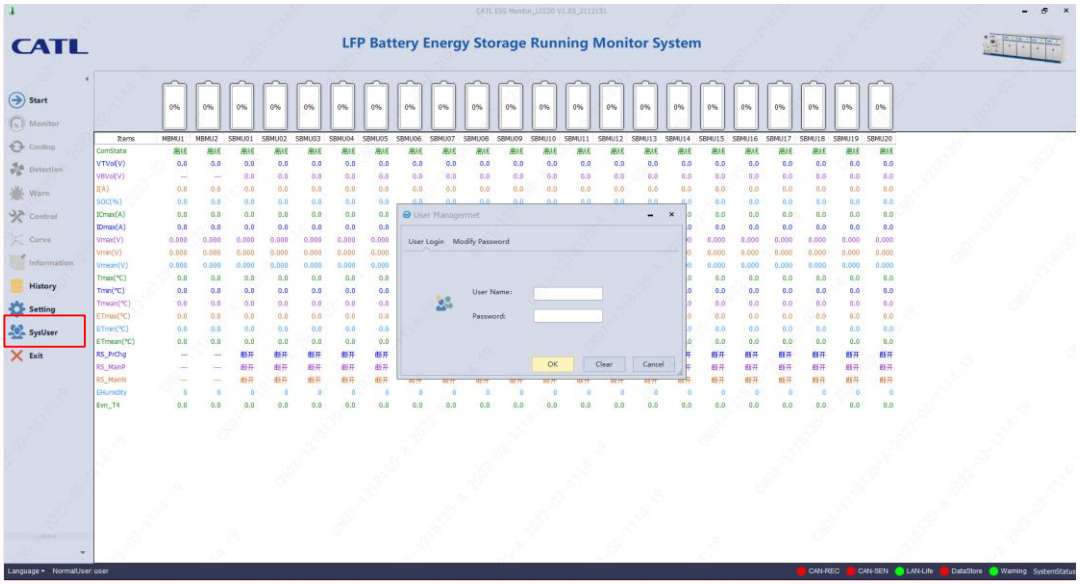


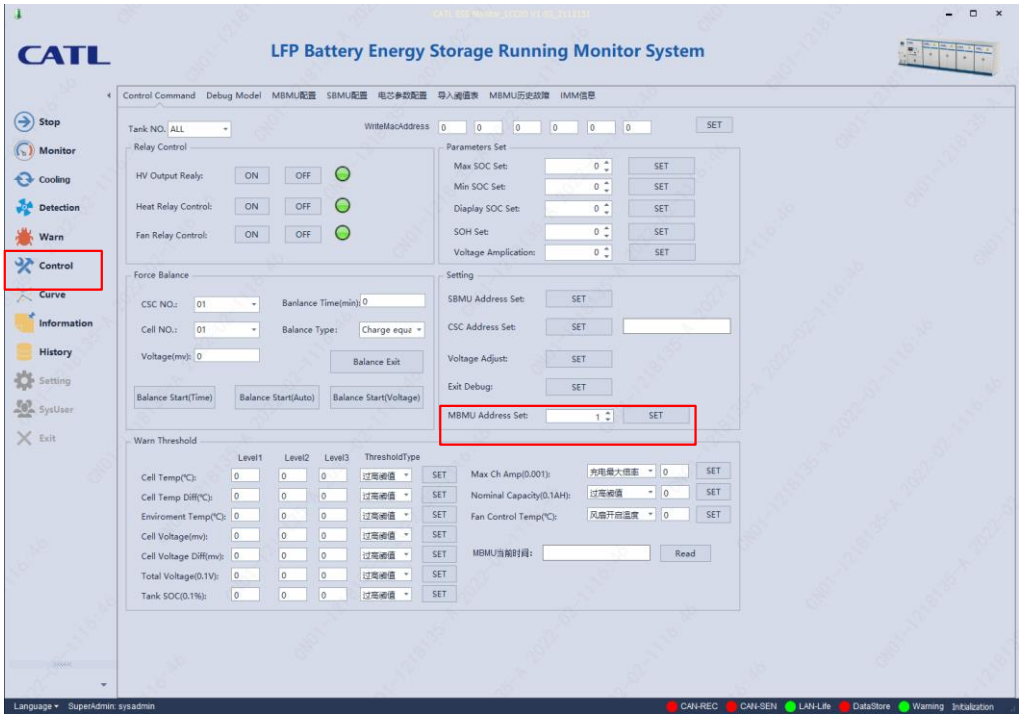
3

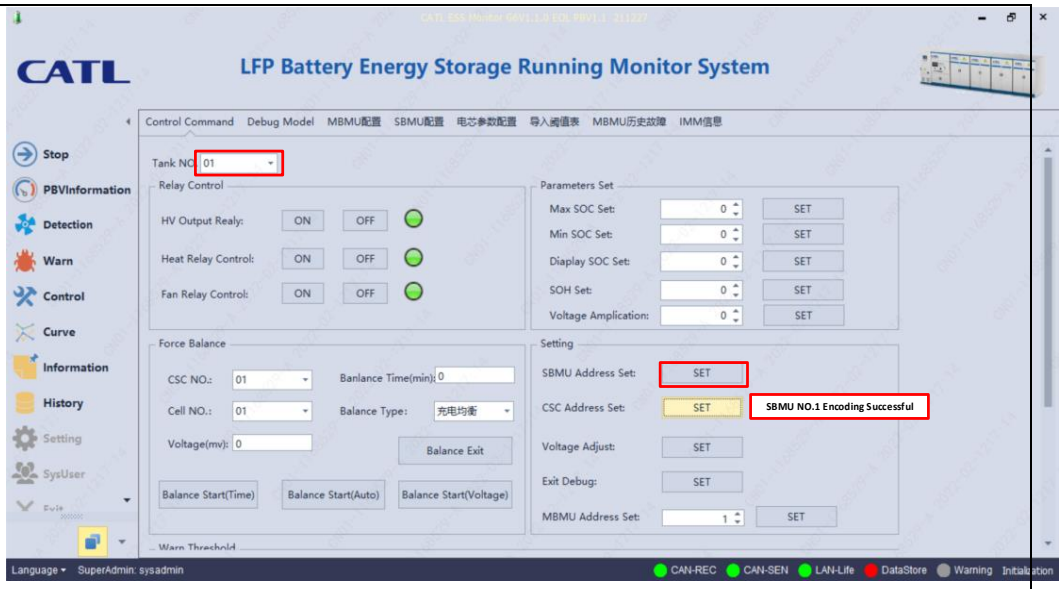
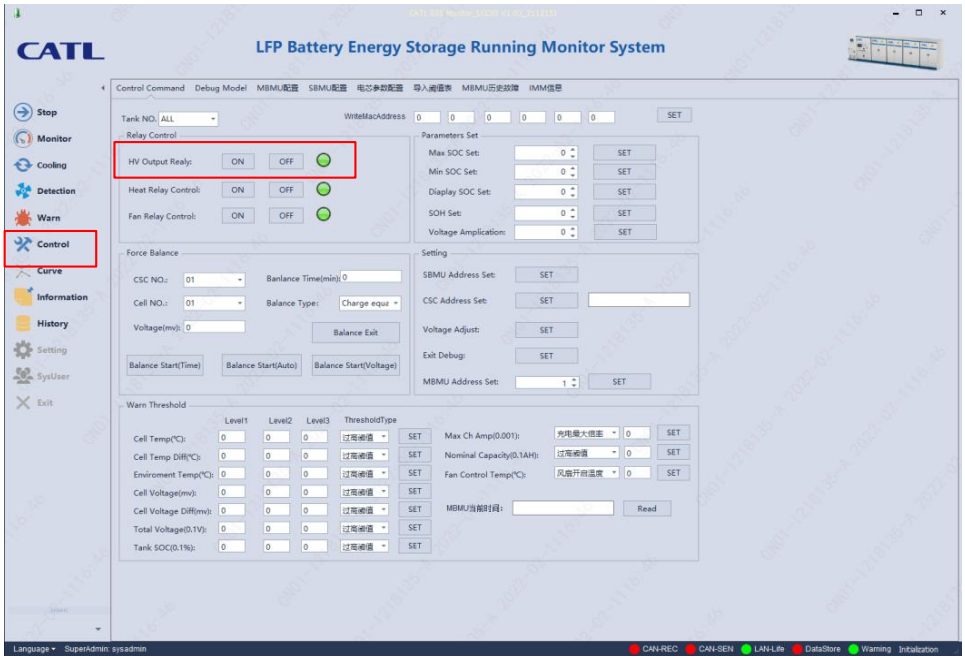
MBMU Setting:

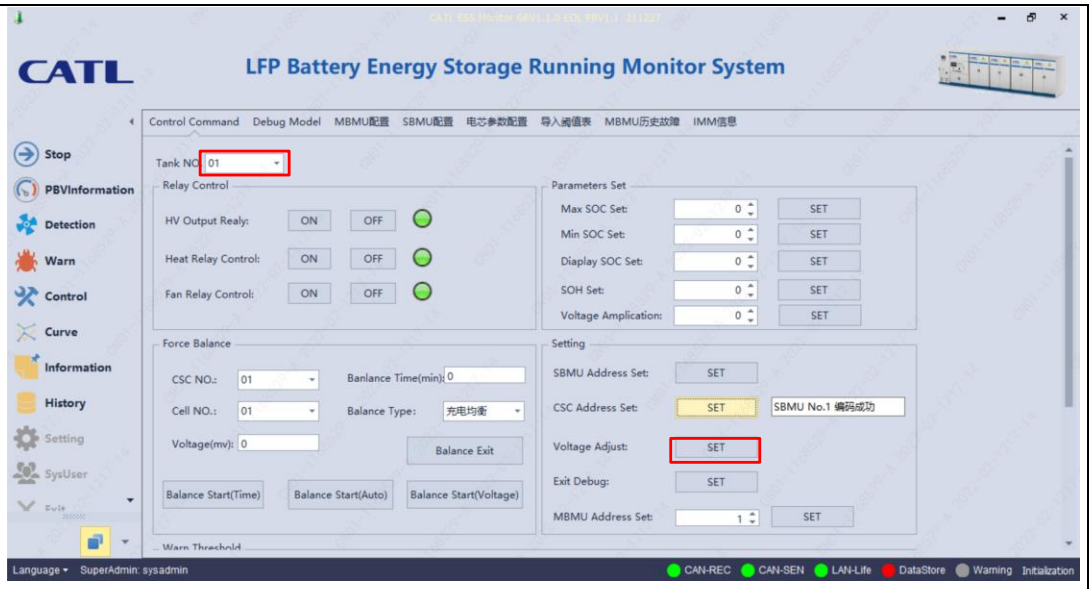
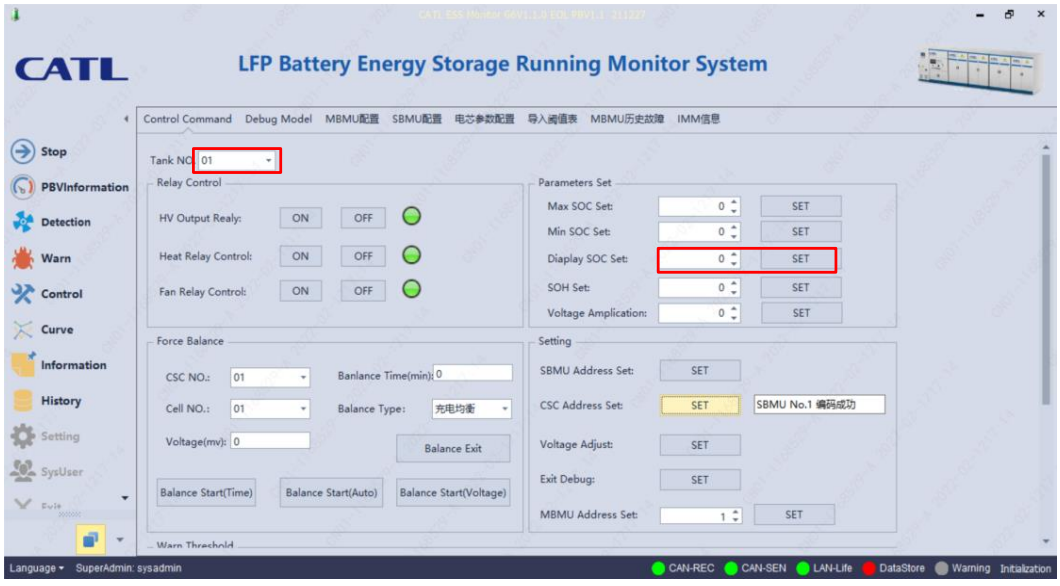


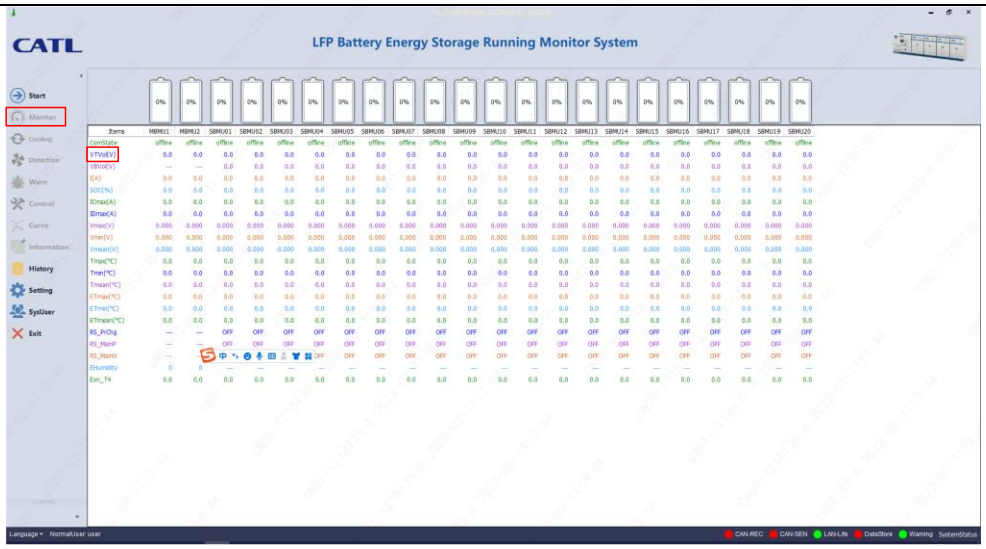
- SBMU number: the number of racks on the same CAN circuit, for single container, SBMU number is 4 for two container parallel connection, the number must be updated to 8;
- CSC number: 8, the number of modules in a single rack;
- Cell voltage number: 52, the number of cell in a single module 104 (2P52S);
- Cell temperature number: 11, the number of temperature test points in a single module.

4	**Interface setting:** ● Regarding device type, usually, choose USBCAN1 if using ZLGCAN (ZLGCAN has two interface, CAN1 and CAN2). If using ValueCAN tool, then choose ValueCAN. ● Regarding Baud Rate and data type, leave them as the default value. Click 'save', and the monitoring system will restart automatically. If others Baud Rate setting is required, the definition is according to the type of CAN, the value of ACAN is 250k, CCAN, MCAN, SCAN need chose 500K. 
5	**User login interface setting** ● Click the menu SysUser， the user login interface will pop up. The User Name is sysadmin, the password is 1234567890111. Then click the OK. 

6	**MBMU Encoding** ● Click the menu 'Control', enter encoding interface. When encoding the first MBMU, the MBMU address must be set to '1'. If have two container parallel connection, the second MBMU address must be set to '2'. 
7	**SBMU&CSC Encoding** ● When encoding the first SBMU, set the Tank NO. to "1", and then click the "SBMU Address Set", after that, click "CSC address set". If encoding successful, following message "SBMU No.1 encoding successful" will be got. ● Others SBMU&CSC encoding follow same process

	
8	**Rack on-off controlling** ● After confirming that the condition for closing High Voltage relays is fulfilled, click ‘ON’. Then all the racks will be powered on. 
9	**internal voltage calibration** ● After closing high voltage relay, BMS will measure system voltage and accumulative voltage of single cell. For limiting these two voltage difference smaller than 2V, the internal voltage calibration need be done. ● Firstly, choose the Tank No. correctly, and then click the ‘set’ in voltage adjust.

<table>
<tr><td></td><td> 
</td></tr>
<tr><td>10</td><td>SOC calibration
● Firstly, choose the Tank No. correctly, and then set the “Display SOC State” to the value you want.
 
</td></tr>
<tr><td>11</td><td>Operating status Monitor
● Select “monitor”， check if all the batteries are on closed state, and check VTVOL to see if there is voltage data.</td></tr>
</table>



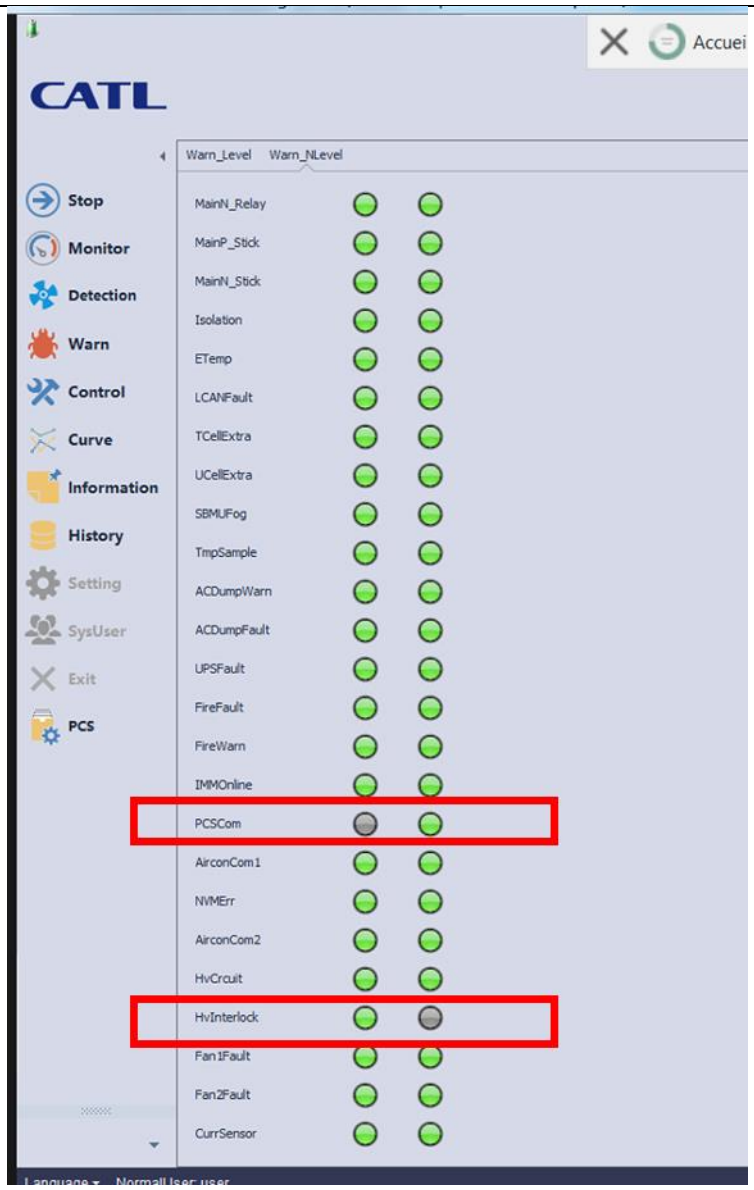
- Check if allowable charging/discharging current appears. If so, it means that the system can charge and discharge normally.

Items	MBMU	SBMU01
ComState	normal	normal
VTVol(V)	---	0.0
VBVol(V)	---	1028.9
I(A)	0.0	0.0
SOC(%)	39.4	39.4
ICmax(A)	0.0	-116.0
IDmax(A)	0.0	181.3
Vmax(V)	3.300	3.300
Vmin(V)	3.297	3.297
Vmean(V)	3.297	3.297
Tmax(°C)	20.0	20.0
Tmin(°C)	19.0	19.0
Tmean(°C)	19.0	19.0
ETmax(°C)	204.0	203.0
ETmin(°C)	204.0	21.0
ETmean(°C)	204.0	203.0
RS_PrChg	---	OFF
RS_MainP	---	OFF
RS_MainN	---	OFF
EHumidity	0	---

12

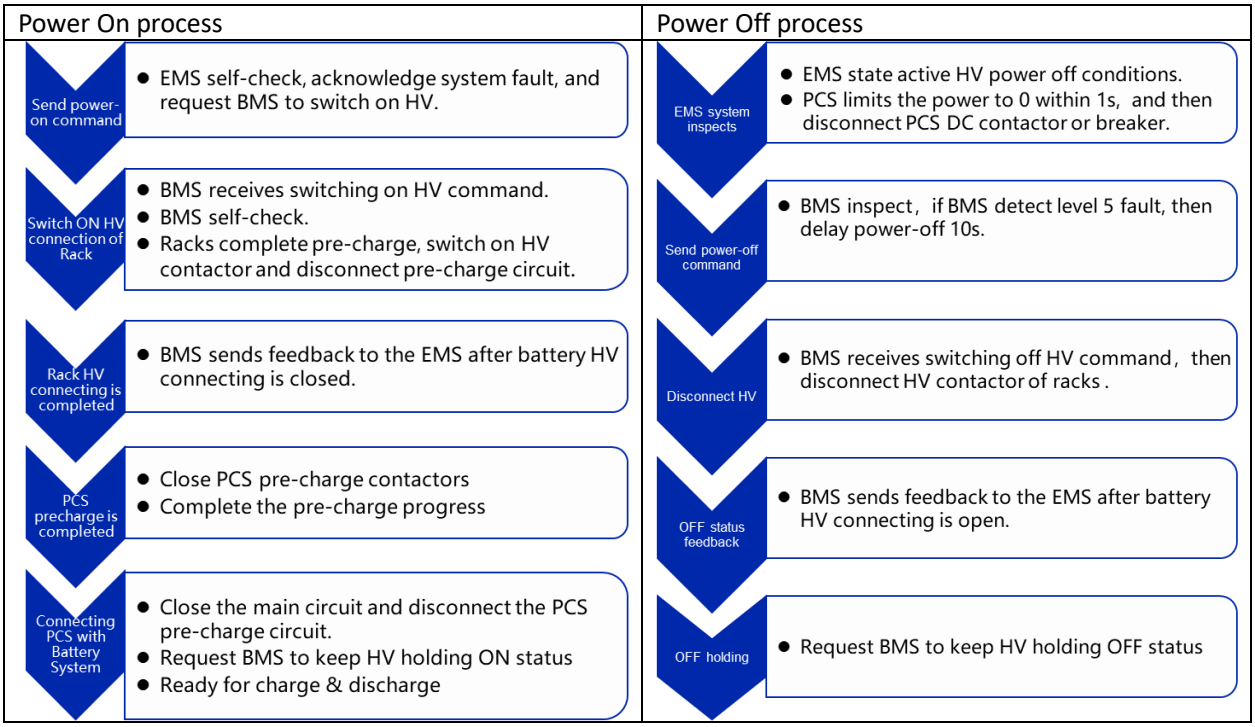
Warning status Monitor

- Select ‘warn’. Alarm status can be found here. Based on the alarm status, figure out the corresponding problems and do the analysis.


Accuei
CATL
Warn_Level
Warn_NLevel
Stop
Monitor
Detection
Warn
Control
Curve
Information
History
Setting
SysUser
Exit
PCS
MainN_Relay
MainP_Stick
MainN_Stick
Isolation
ETemp
LCANFault
TCellExtra
UCellExtra
SBMUFog
TmpSample
ACDumpWarn
ACDumpFault
UPSFault
FireFault
FireWarn
IMMOnline
PCSCom
AirconCom1
NVMErr
AirconCom2
HvCrcuit
HvInterlock
Fan1Fault
Fan2Fault
CurrSensor

7 Commissioning flow chart

7.1 Commissioning flow chart



7.2 System inspection before commissioning

In accordance with the requirements in the system instructions, patrol inspection should be performed for the system and execution and recording should be carried out as per the following table.

Table 7-1 Checklist of system inspection

No	Test item	Description	Result	
1	Appearance Inspection	The appearance of product has no damage and deformation; paint coating has no raise and damage	OK□	NG□
			OK□	NG□
			OK□	NG□
2	Check bolts	Whether bolts get damaged or loosed	OK□	NG□
3	Check HV disconnection	Use the multimeter to test open voltage = 0V;	OK□	NG□
		Use the multimeter to test the resistance	OK□	NG□

		between positive and negative poles is = ∞.		
4	Check LV cable connection	Whether cable connection is correct according to chapter 5.6	OK□	NG□
5	Check AC voltage level of 3AC Auxiliary power supply	Be sure the primary terminals of transformer inside of LV box can match the voltage level 380V…480V of 3AC Auxiliary power supply. Default setting: 3AC 480V.	OK□	NG□

	WARNING
	In the battery system, all power connections must ensure that a sufficient number of protective measures for insulation will be taken, the positive and negative poles of a battery will in no way contact the outer box to lead to leakage of electricity and a short circuit, and the positive and negative poles of the battery system will not be short-circuited in any case; otherwise, a major safety accident and an electric shock might be caused.

7.3 Switch on auxiliary power supply

Connect 3AC 380…480V and 1AC 120…230V auxiliary power and power on according to the following table, make sure the U/V/W/N/PE terminals connection correctly, then check that the green indicator light is on.

Table 7-2 Auxiliary distribution box(UPS configuration)

Auxiliary distribution box	**Operating**

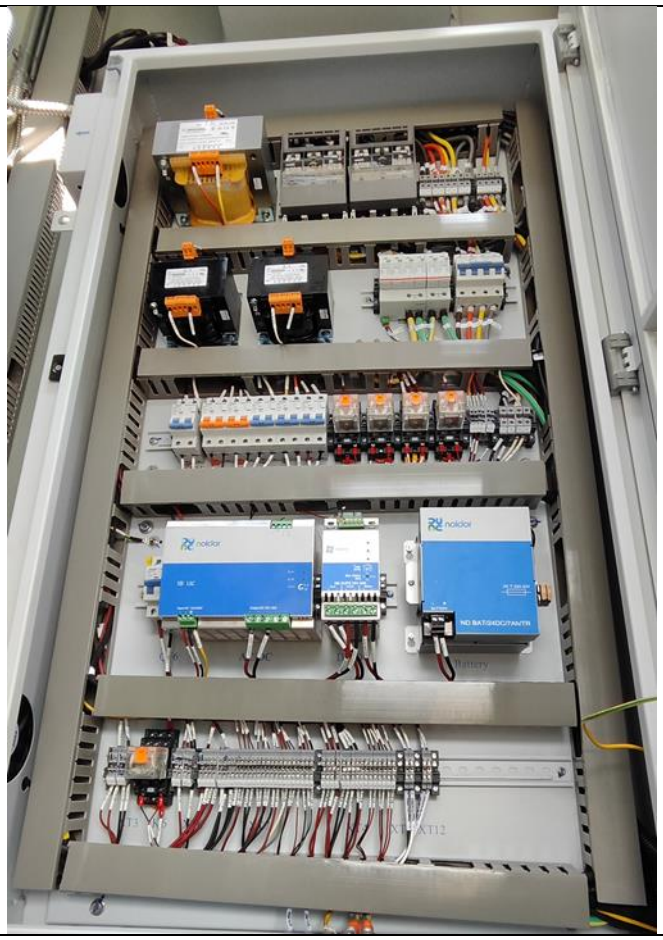
	1. Switch on the external 3AC 380V~480V auxiliary power supply and 1AC 120~230V FSS power supply. 2. Close the main circuit breaker QF1 in the 3AC480V power supply. 3. Close the circuit breaker QF2and QF3 in the power supply of the Fire system and Explosion proof . 4. Close the circuit breaker QF4 in the power supply of the cooling unit system. 5. Close the circuit breaker QF5,QF7 & QF8 6. Close the circuit breaker QF6in the UPS battery.. 7. Check the indicator of K1 K2 K3 K5 & K6 relay: **Lighting**

Table 7-2 Auxiliary distribution box(24V power module configuration)

Auxiliary distribution box	**Operating**

1. Switch on the external 3AC 380V~480V auxiliary power supply and 1AC 120~230V FSS power supply.
2. Close the main circuit breaker QF1 in the 3AC480V power supply.
3. Close the circuit breaker QF2and QF3 in the power supply of the Fire system and Explosion proof .
4. Close the circuit breaker QF4 in the power supply of the cooling unit system.
5. Close the circuit breaker QF5,QF7 & QF8
6. Turn on the QS in the 24V power module.
7. Check the indicator of K1 K2 K3 K5 & K6 relay: **Lighting**

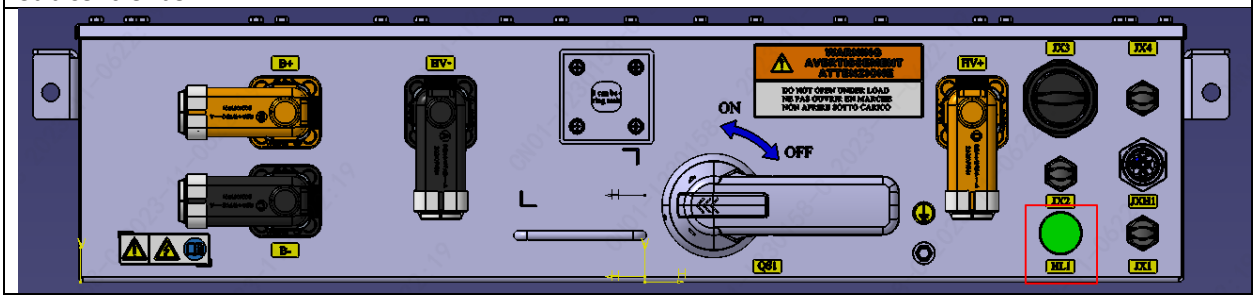
Table 7-3 Definition of indication lights

System state	Indicators status for the HV circuit ●	Indicators status for the LV circuit ●	Alarm indicator light ●
Power OFF	Green light is OFF	Red light is OFF	Yellow light is OFF
Failure	Green light is ON	Red light is OFF	Yellow light is ON
Power ON	Green light is ON	Red light is OFF	Yellow light is OFF
Power up of Primary Circuit	Green light is ON	Red light is ON	Yellow light is OFF
Charge/Discharge	Green light is ON	Red light is ON	Yellow light is OFF

7.4 Switch on HV relays of battery control box

Switch on insolation switches of four control box.

Table 7-4 Sub control box overview

Sub control box


Switch on HV relays

After the auxiliary power supply is switching on, use the close HV relays command to close the HV relays according to communication protocol. At this moment, the positive and negative output ends of the battery racks will generate about 1040V~1500V DC high voltage. The light will correspond to the following state:

Table 7-5 Indicator light: High voltage power supply

System state	Indicator light for the LV circuit●
low voltage power supply	Green light is on

7.5 Startup PCS and Precharge DC capacitors

Due to PCS include DC capacitors for filter function, the precharging process is always mandatory, it's recommend that PCS precharging is realized by PCS itself instead of DC battery system.

7.6 Switch on the connection between PCS and Container

For EnerX container, high current will be conducted to PCS during charge/discharge process, for line protection and controlling function, a DC breaker with motorized controlling need be used for switching on/off the connection between PCS and EnerX container.

After startup PCS and prechaging of DC capacitors, then switch on DC connection.

7.7 EMS send command to PCS to start charge/discharge

7.7.1 Charging of Battery System

When the connection is closed between PCS and EnerX container, enable PCS (EMS) working in constant power control model and start charging, the BMS detects the charging current, and the battery system is charged, at this time, the combination of the on and off of each indicator will correspond to the state as Table 7-5.

7.7.2 Discharging of Battery System

When the battery system is charged at high voltage, if the battery system detects the discharging current, the battery system will enter the discharging state and the battery system will start discharging. At this moment, the combination of lights on and off will correspond to the state as Table 7-5.

7.8 E-Stop procedure

As Figure 7-1 shown, there is an E-stop button on the door, which is used for power off in case of Emergency.

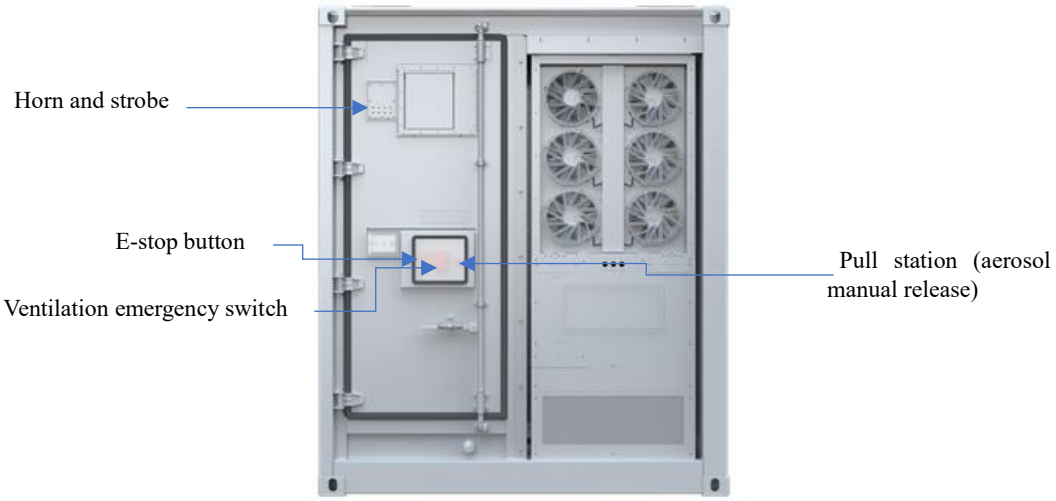


Figure 7-1 E-stop button

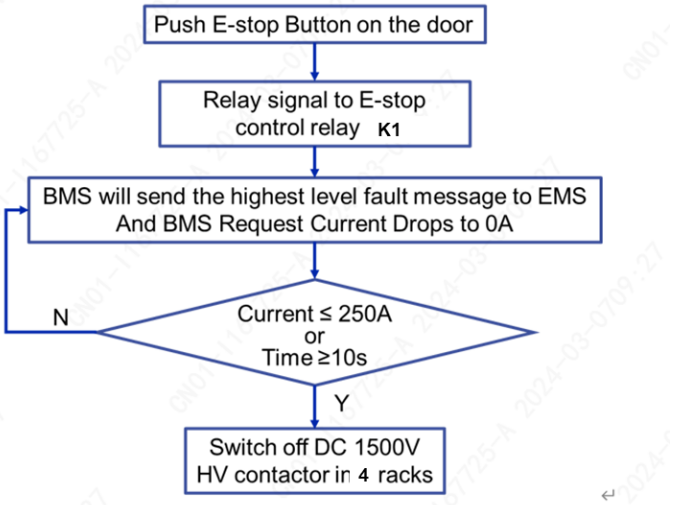


Figure 7-2 E-stop by push button

8 Diagnosis of common abnormal problems

8.1 System status word

The system status can be read by BMS via register address.

Table 6-1 System level fault message

Level	Fault	Register	(Value =0, normal; Value ≠0, abnormal)
MBMU	Single cell overvoltage warning	0x0000	Bit0-Bit2
MBMU	Single cell under voltage warning		Bit3-Bit5
MBMU	Cell extreme over voltage warning		Bit6
MBMU	Cell extreme under voltage warning		Bit7
MBMU	Single cabinet over voltage warning		Bit8-Bit9
MBMU	Single cabinet under voltage warning		Bit10-Bit11
MBMU	Warning for big voltage difference of single cell		Bit12
MBMU	Cell voltage Invalid warning		Bit13
MBMU	Single cell under voltage Report for exchange warning		Bit14
MBMU	Single cell over voltage Report for exchange warning		Bit15
MBMU	Platform Reserved signal	0x0001	Bit0-Bit1
MBMU	Discharge over current warning		Bit2-Bit5
MBMU	Charge over current warning		Bit6-Bit9
MBMU	Current sensor warning		Bit10
MBMU	Platform Reserved signal		Bit11-Bit13
MBMU	Single cell over temperature warning		Bit14-Bit15
MBMU	Single cell over temperature warning	0x0002	Bit0-Bit1
MBMU	Single cell Under temperature warning		Bit2-Bit4
MBMU	Big voltage difference of single cell Warning		Bit5-Bit7
MBMU	SBMU master control box Over temperature warning		Bit8-Bit11
MBMU	SBMU master control box under temperature warning		Bit12-Bit14
MBMU	Single temperature sampling abnormal warning		Bit15
MBMU	Multiple temperature sampling abnormal warning	0x0003	Bit0
MBMU	Platform Reserved signal		Bit1-Bit4
MBMU	Main positive relay drive Short power supply warning		Bit5
MBMU	Main positive relay drive Short Ground warning		Bit6
MBMU	Main negative relay drive Short power supply warning		Bit7
MBMU	Main negative relay drive Short Ground warning		Bit8
MBMU	Pre-charge relay drive Short power supply warning		Bit9
MBMU	Pre-charge relay drive Short Ground warning		Bit10
MBMU	CSC Power Supply Drive Short Power Supply warning		Bit11
MBMU	CSC Power Supply Drive Short Ground warning		Bit12

MBMU	CSC Coded Drive Short Power Supply warning		Bit13
MBMU	Platform Reserved signal		Bit14
MBMU	SBMU Coded Drive Short Power Supply warning		Bit15
MBMU	SBMU Coded Drive Short Ground warning	0x0004	

8.2 Countermeasures of system alarm

If system failure mode is detected, the abnormal status will be divided into 5 level to distinguish the severity of failure, and then the system will automatically switching to a safety operating model according to following definition.

Table 8 2 Treatment measures of failure at different levels

Failure level	Severity degree	Alarm to EMS	BMS failure dry contact	HV Contactor response
CAT 1	Very Low	Report	close	No action
CAT 2	Low	Report	close	No action
CAT 3	Low	Report	close	No action
CAT 4	Medium	Report	close	Outage of failure single rack after 10s
CAT 5	High	Report	close	Outage of failure single rack immediately
CAT 6	High	Report	open	Outage of all battery racks after 10s
CAT 7	Very High	Report	open	Outage of all battery racks immediately

8.3 Countermeasures of abnormal conditions

When enable the battery rack, if it cannot work normally, please check the potential cause according to **错误!未找到引用源。** 8-3. At the same time, pay attention to check whether it is caused by external environment, such as temperature, noncompliant humidity or load overload. If the maintenance or replacement of spare parts is involved, the after-sales service procedure should be followed. Meanwhile, the disassembly and installation are not allowed without authorization.

This chapter contains only a few simple failure diagnosis procedures. If the answer to the diagnosis is not very unequivocal, or the information obtained is not enough to settle the problem, please contact the local office or distributor of the CATL.

Table 8-3 List of Failure diagnosis procedures

S/N	Failure or alarm phenomena	Possible cause of failure	Troubleshooting scheme
1	The green indicator light of the battery rack is not on	1. Poor contact of wiring harness	Check indicator light wiring harness
		2. SBMU failure	Replacement of SBMU
		3. Breakdown of indicator	Replacement of indicator light
2	The yellow indicator light of the battery rack is not on	1. Poor contact of wiring harness	Check indicator light wiring harness
		2. SBMU failure	Replacement of SBMU
		3. Breakdown of indicator	Replacement of indicator light
3	The red indicator light of the battery rack is not on	1. Poor contact of wiring harness	Check indicator light wiring harness
		2. SBMU failure	Replacement of SBMU
		3. Breakdown of indicator	Replacement of indicator light
4	Pre-charge relay cannot be closed	1. Poor connection of relay wiring harness	Check wiring harness connection
		2. Relay failure	Replacement of pre-charge relay
		3. SBMU failure	Replacement of SBMU
5	Main positive DC-contactor cannot be closed	1.Poor connection of main positive DC-contactor wiring harness	Check wiring harness connection
		2. Main DC-contactor failure	Replacement of main DC-contactor
		3. SBMU failure	Replacement of SBMU
6	Main negative DC-contactor cannot be closed	1. Poor connection of main negative DC-contactor wiring harness	Check wiring harness connection
		2. Main negative DC-contactor failure	Replacement of main negative DC-contactor
		3. SBMU failure	Replacement of SBMU
7	Adhesion of main positive DC-contactor	1. Damage of main positive DC-contactor	Replacement of main positive DC-contactor
8	Adhesion of main negative DC-contactor	1. Damage of main negative DC-contactor	Replacement of main negative DC-contactor
9	Abnormal power down of CSC	1. Abnormal CSC power supply wiring harness	Check CSC power supply wiring harness
		2. CSC failure	Replacement of CSC
10	Abnormal cell voltage detection	1. Poor connection of voltage detection wiring harness	Check wiring harness connection
		2. CSC failure	Replacement of CSC

S/N	Failure or alarm phenomena	Possible cause of failure	Troubleshooting scheme
11	Abnormal NTC temperature detection	1. Poor connection of temperature detection wiring harness	Check wiring harness connection
		2. Temperature sensor failure	Replacement of temperature sensor
		3. CSC failure	Replacement of CSC
12	Abnormal total voltage detection	1. Poor connection of total voltage detection wiring harness	Check wiring harness connection
		2. SBMU failure	Replacement of SBMU
13	Internal communication anomaly	1. Poor connection of internal CAN wires	Check CAN connecting wires by pluck and insertion
14	Anomaly caused by unconfigured system parameters	1. Unconfigured battery system parameters	Configure system parameters
15	Current sensor anomaly	1. Poor connection of 12V power harness wiring	Check wiring harness
		2. Poor connection of SCAN communication wires	Check wiring harness
		3. SBMU power generation anomaly	Replacement of SBMU
16	SBMU automatic shutdown	1. Poor connection of MBMU wake-up signal wires	Check wiring harness
		2. MBMU failure	Replacement of MBMU
17	cell over-voltage alarm	1. Poor equalization	Stop charging and standby equalization
		2. System overcharge	Stop charging
18	cell under-voltage alarm	1. Poor equalization	Stop discharge and standby equalization
		2. System over-discharge	Stop discharge
19	NTC over-temperature alarm	1. Excessive temperature of individual NTC	Check whether the air conditioner is in operation
		Excessive charging-discharge current	Appropriately reduce charging and discharge current
20	NTC under-temperature alarm	1. Lower temperature of individual cores	Check whether the heating function is on (if the equipment cabinet has heating function)
		2. Lower ambient temperature	No charging
21	Charging over-current alarm	1. Excessive current of system	Reduce charging power

S/N	Failure or alarm phenomena	Possible cause of failure	Troubleshooting scheme
		charging	
22	Discharge over-current alarm	1.Excessive current of system discharge	Reduce system load
23	Alarm of higher SOC	1.The system power is full (overcharged)	Stop system charging
24	Alarm of lower SOC	1.The system power is too low (over-discharge)	Stop system discharge
25	Alarm of higher monomer temperature difference	1.Non-uniform heat dissipation of equipment cabinet	Check whether the air conditioner is on
		2. Temperature sensor failure	Replacement of temperature sensor
26	Alarm of higher monomer voltage difference	1.Excessive difference of cell capacity	Battery system can be charged to over 80% SOC, with standby equalization
27	SOC difference alarm	1. The electric quantity difference of different battery racks is too large	—— ——
28	Abnormal alarm of equalization circuit	1. Equalization abnormal CSC board	Replacement of CSC board

8.4 After-sales Service

CATL will provide clients with a full range of technical support and after-sales service. Users can gain services by dialing our service number. Service Number: 86 **400-918-0889**

Please refer to the contract for the free warranty service information.

- The following circumstances are not within the scope of our free warranty service:

1. System damage or failure caused by not following the user manual.
2. Damage or failure caused by not following the relevant electrical safety specifications for wiring and power supply or caused by poor site environment.
3. System damage or failure caused by users' private modification.
4. System damage or failure caused by irresistible natural factors, such as typhoon, earthquake, flood, fire or harsh environment (high temperature, low temperature, high humidity, acid rain, etc.).

After the failure occurs, the user fails to maintain the initial failure state, fails to timely notify the manufacturer and handles without authorization, thus causing it is unable to make a practical fault identification of the failure causes.

9 Product Maintenance

During whole product lifecycle, abnormal operating must be avoid, regular maintenance in Table 8-1 is mandatory to ensure safe and reliable operation and acquire an optimal performance for system.

Table 8-1 Product maintenance category

No.	Components	Checking items	Description	Frequency
1	Container	Coating （*）	Check whether the surface coating of the container is warped, cracked, peeled, rusted, etc.	Annual
2		Label & nameplate	Check whether the labels and nameplates have abnormal phenomena such as falling off, blurring and tilting.	Annual
3		Water traces	Check whether there is obvious water ingress or water ingress in the container.	Semi-Annual
4		Biological invasion	Check whether there are any living things (rodents) in the air conditioner, water-cooled unit compartment, electrical compartment, and battery compartment.	Semi-Annual
5		Battery compartment	Check the dust situation inside the container. If the pollution is particularly serious, it is necessary to find the location from where the dust enters.	Semi-Annual
6		Abnormal odor （*）	Check whether there is a pungent odor or burning paste odor in the container (short cycle inspection does not require opening the	Semi-Annual

			container door).	
7		Battery compartment door	Check whether the battery compartment door limit lever functions normally and whether there is any deformation damage.	Annual
8		Corrosion of parts	Check whether there is corrosion of structural parts, frames, etc. caused by water accumulation inside the container.	Semi-Annual
9		Floor drain	Check whether the floor drain function is normal.	Semi-Annual
10		Abnormal sounds （*）	Check whether there is a crackling sound during system operation (short cycle inspection does not require opening the container door).	Semi-Annual
11		Internal identification	Check whether labels such as master control box, subcontrol box, ditribution box have any abnormal phenomena such as falling off, not being able to see clearly, and cocking.	Annual
12		Door seals	Check whether the sealing strip of each door of the container is dirty, broken, falling off, or not installed in place.	Annual
13		Ambient temperature and humidity	Check whether the ambient temperature and humidity record and check whether the temperature and humidity is within the allowable range.	Semi-Annual
14		Indicator （*）	Check whether the indicators are normal or not.	Semi-Annual

15	Fire suppression system	Gas detector	Check whether the gas detectors are normal or not.	Annual (or refer to local rules)
16		Smoke detector	Check whether the smoke detectors are normal or not.	Annual (or refer to local rules)
17		Temperature detector	Check whether the temperature detectors are normal or not.	Annual (or refer to local rules)
18		Smoke&gas trigger	Check whether the alarm function is normal when the smoke and gas detector triggered at the same time.	Annual (or refer to local rules)
19		Temperature&smoke trigger	Check whether the alarm function is normal when the temperature and smoke detector triggered at the same time.	Annual (or refer to local rules)
20		Connectors	Check whether the smoke and temperature sense are installed and tightened, and the wiring harness connection is normal.	Annual (or refer to local rules)
21		Aerosol	Check whether the aerosol starting line is damaged, the aerosol is installed firmly, the appearance is damaged, the aerosol reaches the service life.	Annual (or refer to local rules)
22	Chiller	Filter	Check whether the air inlet filter is blocked	Semi-Annual
23		Ventilation hood	Check whether there is dust in the ventilation hood.	Semi-Annual
24		Heating mode function	Check whether the heating mode function is normal.	Semi-Annual
25		Cooling mode function	Check whether the cooling mode function is normal.	Semi-Annual

26		Sleeping mode function	Check whether the sleeping mode function is normal.	Semi-Annual
27		Interface	Check whether there are obvious liquid leakage marks at each interface position of the unit and water cooling pipe.	Semi-Annual
28		Abnormal sounds （*）	Check whether the chiller has abnormal noise during operation (mechanical impact sound/whistle sound).	Semi-Annual
29		Operational status monitoring	1. Check the operation process. Judged by the operation status TMS_RunState in the Cooling interface of the BMS monitor, Cooling is refrigeration, Hot is heating, Cycling is self-circulation, and Stop is shutdown. 2. Check the TMS outlet pressure and return pressure in Cooling interface when the unit is running for 5 minutes without shutdown, and meet the pressure value ⩾x bar.	Semi-Annual
30		Fault monitoring	Check the chiller's working condition based on BMS.	Semi-Annual
31		Water pressure and temperature monitoring	The BMS monitor reads the inlet and outlet temperature and water pressure to check whether it is within the normal range.	Semi-Annual
32	High and low voltage wiring harnesses	Harness appearance	Check whether the wiring harness is damaged, ablated or aged.	Semi-Annual
33	High and low voltage	Connector appearance	Check whether the connector is yellowing, blacking or even ablated.	Semi-Annual

34	connectors	Connector connection reliability	Shake the connector plug to see if the connector interface is loose.	Semi-Annual
35	Energy storage system	Common-mode voltage troubleshooting--spot check, one for each project	The waveforms of DC-to GND and DC +to GND under five working conditions (standby/shutdown, zero-power floating charge, full-power charge, full-power discharge, standby-to-charge) were collected and analyzed by oscilloscope. PCS terminal AC A-to-ground, B-to-ground waveform.	Annual
36		Equipotential connecting wire	Check whether the equipotential connecting wire of the electric cabinet is complete.	Semi-Annual
37		Equipotential detection	Measure the resistance of the electric box shell to the equipotential site of the electric cabinet.	Semi-Annual
38		Insulation test	Insulation detection with a multimeter.	Semi-Annual
39		BMS monitor inspection	Read voltage difference by BMS monitor.	Semi-Annual
40		Historical data collection	Collect local 6-month operation data for analysis.	Semi-Annual
41		SOH statue analysis	Refer to the collected data, analyze the SOC consistency, historical failure, voltage difference and other information of the battery.	Semi-Annual

Note:

1.This is a general about CATL preventive maintenance services, for details, please contact CATL service email: S-CustomerCenter@catl.com

2.CATL provide paid preventive maintenance services during warranty period.

3.Service call center：GSS-CustomerCenter@catl.com

3.Maintenance items with asterisks (*） mean that the customer can perform them themselves and will not be counted into the preventive maintenance hours.

4.It is the minimum requirement that an overall annual preventive maintenance shall be carried out to the ESS.

5.It is recommended that ESS preventive maintenance be conducted twice a year, one basic semi-annual inspection and one overall annual checklist.

6.Preventive Maintenance shall be scheduled and carried out as required by CATL ESS User Manuals. Where laws and regulations provide otherwise provisions on the preventive maintenance, such provisions shall prevail.

9.1 Battery System Maintenance

9.1.1 Maintenance instructions for normal operating system

Perform battery maintenance according to following plan on the system every twelve months to prevent battery damage.

1) **Plan 1 (This plan is applicable when SOC of the battery system is low)**

- Discharge the battery system to the cut-off condition (the lowest voltage<2.5V), then stop discharging, standing for 1 hour.
- Full charging automatically to the battery system (The highest voltage>3.65V), after charging, standing for 1 hour.
- Discharge the battery system to 23% and stop.

2) Plan 2 (This plan is applicable when SOC of the battery system is high)

- Full charging automatically to the battery system (The highest voltage>3.65V), after charging, standing for 1 hour.
- Discharge the battery system to the cut-off condition (the lowest voltage<2.5V), then stop discharging, standing for 1 hour.
- Charge the battery system to 23% and stop.

	CAUTION
	1. Check to ensure environmental safety, system safety, no alarm, no fault before performing maintenance operations. 2. After the battery maintenance of ESS is completed, it's suggested to notify CATL after-sales engineer to perform data analysis for free.

9.1.2 Maintenance instructions for long duration idle mode after COD date

- Suggested SOC range of battery storage: 30%~60%.
- If the battery system keep on idle mode more than 90 days, the battery is suggested to have SOC equal or above 50%. 3.2V shall in any case be considered as a minimum voltage level for per cell, in case that this voltage level is reached, battery system must be recharged immediately.
- Battery capacity test about 100% SOC charge and 0% SOC discharge must be conducted every 12 months.
- When recover the system from idle mode over 90 days to discharge/charge mode, the battery system must perform SOC calibration applying one of the possible methods, including:
  - Static Calibration
  - Dynamic Calibration
  - High Voltage Calibration

	CAUTION
	If the energy storage system keep on idle mode for a long time, it will cause irreversible damage to the battery. Please perform regular maintenance. 1. The minimum cell voltage (Static voltage) should not be less than 3.2 V for a long idle state; 2. The minimum cell voltage (Static voltage) should not be less than 2.5 V in any case; otherwise, the warranty will be invalid. 3. The minimum cell voltage (Static voltage)should not be less than 2.0 V in any case; otherwise, the battery will be over-discharged and may not be able to be repaired.

Spare Batteries are shipped out from CATL at SOC=23%

- The initial maintenance of the spare battery needs to be conducted after 12 months period. Charge the battery to 50% SOC (Equipment used: Pack-level charge and discharge machine)
- After the initial recharge, charge the battery once a year. Charge the battery to 50% SOC. (Equipment used: Pack-level charge and discharge machine)
- The spare parts should be maintained as follows before use.

  First discharge the battery until the minimum cell voltage is 2.5V; evaluate the battery consistency according to the OCV curve table, if the SOC imbalance (that is, the SOC corresponded to average voltage – the SOC corresponded to the lowest cell voltage)> 5%, you need to perform balanced maintenance first. (Equipment used: Pack-level charge and discharge machine、Equalization

equipment)

Remark:

Charging duration (h) = (target SOC - current SOC)*nominated capacity (Ah)/machine constant charging current (A)

Discharging duration (h) = (current SOC - target SOC)*nominated capacity (Ah)/machine constant discharging current (A)

9.1.3 Battery system inspection

Conduct an inspection of ESS every 12 months and make inspection record.

9.2 Container enclosure maintenance

	CAUTION
	The enclosure is not allowed to have rust, bend structure during whole product lifecycle

Conduct an inspection of Container every twelve months and make inspection record, if the paint on the surface have following damage scenarios, repaint it according to the following steps.

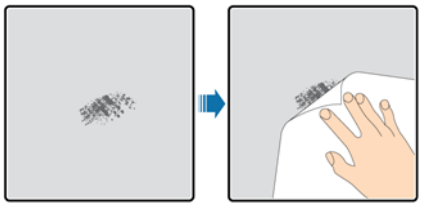
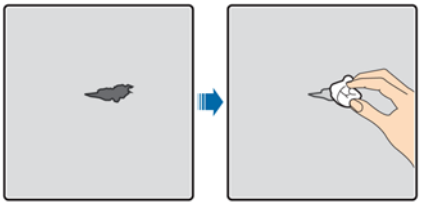
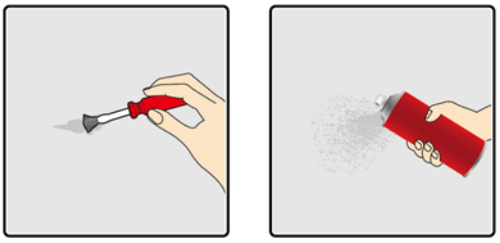
- Shallow scratch (not exposed steel substrate)
- A stain or rust that cannot be wiped
- Deep scratch (damage of primer, exposure of steel substrate)

➢ **Precondition**

- In the outdoor environment without shelter, it is strictly forbidden to repaint in bad weather。
- Prepare the corresponding paint with the same color of the container surface.
- Visually inspect the severity of the surface paint damage of the container, prepare corresponding tools and materials, and evaluate the quantity of materials on site based on the repainting situation.
- Paint that meets requirements has been prepared based on the paint surface color number **RAL7042** of containers.
- The exterior of the container should be intact. If the paint on the surface of the container is damaged or broken, repaint it immediately.
- Tools and Materials: Hand spray paint or paint, brush (for painting a small area), fine sand paper, anhydrous ethanol, cotton cloth, and spray gun

➢ **Procedure**

Step	Procedure

1	Gently polish the damaged area with fine sandpaper to remove dirt or rust. 
2	Moisten the cotton cloth with anhydrous ethanol, wipe the polished area or area to be repaired, remove dirt and dust, and wipe dry with a clean cotton cloth. 
4	According to the damage degree of the paint, evenly apply paint to the damaged coating by using one of the following methods until no damage is visible: 1. A small number of scratches and small area of stains, rust recommended to use hand spray paint or brush paint. 2. A large number of scratches and large areas of stains and rust should be sprayed with a paint spray gun. 
5	Leave the paint on for 30 minutes, and then observe whether the repainting area meets requirements.

	CAUTION
	If the substrate is exposed in the area to be repaired, paint primer until the substrate is not exposed after the paint dries, and then apply middle layer paint and polyurethane topcoat. Use primer or polyurethane top coat of the corresponding color.

	CAUTION

	Note that the paint film should be as thin and even as possible. The paint film should not be droplet shape and the surface should be smooth. If there are different colors on the box body pattern, use adhesive tape and white paper to cover the parts of other colors except the damaged paint before painting, so as to avoid contamination of the parts of other colors during painting repair.

	CAUTION
	The paint patch area should be consistent with the color of the surrounding area, without obvious boundaries, obvious bumps, damage marks, and paint peeling phenomenon. If the user want to spray paint, it's advised to spray it three times and then check whether it meets the requirements. If not, repeat until the requirements are met.

9.3 Maintenance requirements for Thermal Management System

9.3.1 Instructions of Chiller Maintenance:

- It is strictly forbidden to let the unit work when there is no coolant in the waterway;
- It is strictly forbidden to operate the unit under the condition of soaking in water;
- It is strictly forbidden for personnel to touch the unit while the unit is running;
- It is strictly forbidden to disassemble by non-professionals
- It is strictly forbidden for the unit to be squeezed by heavy objects
- Use a vacuum cleaner to clean the condenser, radiator and air inlet and outlet of the unit every three months (no water).

9.3.2 Instructions of Coolant Maintenance:

Replace the coolant every five years or the coolant is degraded below any of the following levels.

- PH value < 6.5 or PH value > 9.5
- Chloride concentration > 60ppm
- Appearance: turbid coolant with impurities such as precipitated particles or flocculent impurities that are easily seen as shown below:

Turbid coolant:	**Normal coolant:**

If coolant has not degraded below any of the conditions described above by YAE, existing coolant can be used until the next scheduled inspection (every 5 years).

The coolant element is EC-45, only following approved supplier & type can be used

Table 8-2 Coolant element

Coolant	Supplier	Supplier type	Mark
EC-45	BASF	G30-45	
	SINOPEC	CNSH OEVC-45	
	Lopal Tech	**JSLP L70-45**	**Default type**

	CAUTION
	Mixed coolant from different supplier or type is not allowed, otherwise, the cooling capacity will be lost.

	CAUTION
	Any damage to the relevant parts of the battery compartment caused by using other coolants which are not recommended or approved by CATL is not covered by the warranty.

9.4 Spare parts

The detail spare parts list can be provided order by order, the range of spare parts is pre-defined as following：

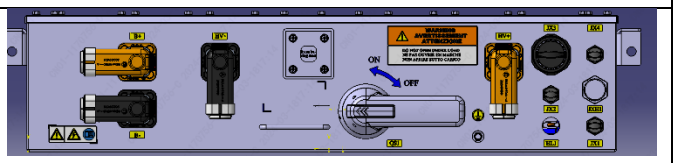
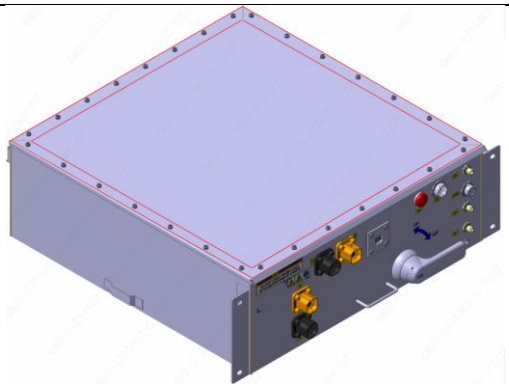
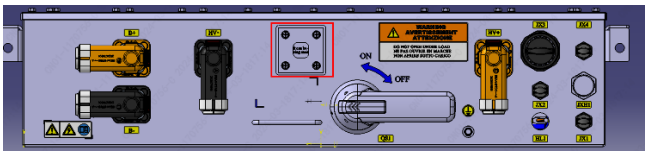
- Master control box and its sub components
- Sub control box and its sub components
- Battery module and CSC module
- Fire Suppression System components

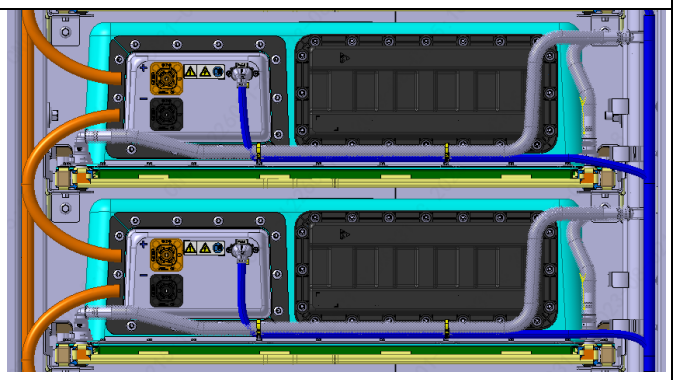
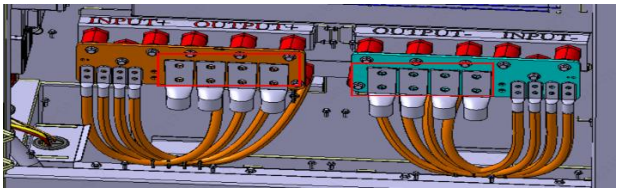
- Thermal Management System components
- LV components of distribution box
- Enclosure

9.5 Fastener type and torque requirement

Any assembly and disassembly maintenance, following fastener type and torque requirement must be followed.

Table 8-3 Fastener type and torque requirement

Module	Screw type	Torque	Fixed point
Sub control box	M6x16, Hexagon bolt with flange	8N.m	
Cover plate of Sub control box	M5x17, Hexagon bolt with flange	5N.m	
Cover Plate of air tightness test in sub control box	M5x17, Hexagon bolt with flange	5N.m	

Module	Screw type	Torque	Fixed point
Battery module	M8x20, Hexagon bolt with flange	25N.m	
HV Connection of DC Combiner	M12x35, Combination Hexagon bolt	50N.m	
Earthing point	M12x35, Combination Hexagon bolt	50N.m	
Cover Plate of Master control box	M4x12, Cross recessed hexagon bolt	2N.m	

10 System Decommissioning & Removal

Contact CATL Service before attempting to decommission or remove a system. CATL equipment is designed for end-of-life management through recycling and materials reclamation, tasks which are normally handled by CATL-qualified partners. CATL Energy Storage can supply a list of qualified partners in your area to help ensure proper disposal of retired equipment.

11 Emergency Plan

After anomalies and accidents occur in battery system, correct and effective treatment measures shall be taken in time to deal with the problems in order to eliminate further damage and enlarged losses. The detail emergency plan can be separated provided.

Appendix 1：Inspection Checklist

No.	Inspection Items	Inspection Methods and Criteria	Tools	Type of Inspection	Inspection Results
1	Common-mode voltage check	Collect the DC- to GND and DC+ to GND waveforms under five operating conditions (standby/shutdown, zero-power floating charge, full power charge, full power discharge, and standby to charge) with an oscilloscope for analysis. Refer to the SOP for Common-Mode Voltage Check Oscilloscope for ESS Products.	Oscilloscope/isolating probe/multimeter, etc.	First maintenance	
2	Historical data collection	Collect local operating data in the last one month and upload it to the cloud storage; name the folder as assembly PN + collection time.	USB flash drive	First maintenance	
3	Rack tightness check	Visually check whether the sealing strip of the rack door comes off or is damaged.	Visual check	Routine inspection	
4	Inspection of the labels and nameplates	Visually check whether the label and the nameplate come off and take photos.	Visual check	Routine inspection	
5	Condensate check	Check whether there are traces of condensate and water flow on the inner wall, the top and other visible areas of the container, and take photos if any.	Visual check	Routine inspection	
6	Cabinet body check	Check whether the surface of the electrical cabinet is deformed, rusted, damaged or peeling off.	Visual check	Routine inspection	

7	Cabinet insulation test	Test the insulation resistance of the DC terminal with PCS, ≥10MΩ; Test condition: test the insulation under 1,500V DC voltage and check whether the stable insulation resistance is ≥20MΩ.	Insulating meter	In-depth inspection	
8	Confirmation of equipotential bonding and grounding of the system	1. Visually check whether the equipotential bonding wire and grounding wire of the system are intact. 2. In the container/cabinet, measure the resistance of the pack housing to the equipotential point of the cabinet, with the value <0.1 Ω as the acceptable one;	Visual check/multimeter	Routine inspection	
9	Fixing bolts of the pack	Check whether the bolts are loose or fall off, and tighten or reinstall them if yes.	Visual check/wrench	Routine inspection	
10	Spill check	Check whether there is any irritating smell in the cabinet.	Smelling	Routine inspection	
11	Harness (HV connector/HV harness in the control cabinet)	1. No missing parts, interference, damage or dirt 2. No looseness, with reliable connection and installation 3. No ablation or damages caused by squeezing 4. Consistency of the line markings, without damage or falling off.	Visual check	Routine inspection	
12	Harness (HV connector/HV harness in the control cabinet)	With the system in operation, use a handheld thermal imaging camera to measure the temperature of the first three cabinets of the system and take photos; check whether the temperature rise exceeds 50°C (temperature measured by the thermal imaging camera minus the room temperature);	Thermal images	In-depth inspection	
13	Electrical parts check	Check whether there is any crackle or burning smell during the operation of the system	Visual check/smelling/listening	Routine inspection	
14	Water cooling pipes	Whether the water cooling pipes are damaged.	Visual check	Routine inspection	
15	BMS monitor inspection	1. Read the software version 2. Check whether there is any alarm in the system. 3. Check whether the cell voltage difference is ≤300 mV (dynamic, full range) or the cell voltage difference is ≤100 mV (dynamic, 30%-80% SOC) 4. Read the net outlet temperature and	BMS monitor	Routine inspection	

		pressure with the BMS monitor to confirm whether they are within the normal ranges. 5. Check whether the disk space of the IPC is full, and back up the data of the past year.			
16	Historical data collection and analysis	Collect local operating data in the last. Upload the data to the cloud storage if no portable servicer is available; name the folder as assembly PN + collection time. Carry out the local analysis with a portable servicer if it is available.	USB flash drive, portable servicer	In-depth inspection	
17	Capacity testing	By project, perform the capacity testing using the capacity test method provided by SC (capacity test requirements in the acceptance report).	/	In-depth inspection	
18	Ambient environment	1. Ensure the channels/pipes are not blocked2. Check whether the plant and the container leak and check the humidity	Visual check	Routine inspection	
19	Fire protection system	1. Obtain a list of firefighting facilities from the energy storage power station and confirm whether the firefighting facilities are complete 2. Confirm whether there is a third-party fire safety inspection record	Visual check	Routine inspection	
20	Fire protection system	Check whether a third party has performed a professional inspection over the fire protection system and maintained an inspection record.	/	In-depth inspection	
21	UPS power supply	Check whether the UPS indicator and the UPS battery work.	Visual check	Routine inspection	

Appendix 2：Maintenance Tools and Equipment List

Number	Name	Photo	Specification	Recommend Brand
1	Insulated gloves		Insulation grade ≥1500V	Tianjin ShuangAn
2	Insulated shoes		Insulation grade ≥1500V	Shida
3	Protective mask or glasses		S200A-普通型 L ordinary typeL	Honeywell

			(GB14866-2006)	
4	Insulated socket wrench		Insulation grade ≥1500V 09267-20 pieces 12.5MM series VDE Insulating sleeve kit	Shida
5	Auto repair full set of special tools		120+1 pieces 6.3*10*12.5MM series	Shida
6	ZLG		ZLG-USBCAN-II	ZLG
7	ValueCAN4		2Can FD channel 64 bit timestamp accuracy reaches 25 nanoseconds	Intrepid
8	Lifting forklift	TBD	**TBD**	TBD
9	数显扭力扳手 Digital torque wrench		examination range 1.5N.M-30N.M accuracy 4% Recommended model: WE2-030	WIZTANK
10	Multimeter		DC voltage range can reach 1500V Recommended model: HD-160C	Fluke
11	Insulation meter/megger		Insulation test voltage level 2500V Recommended model: F1535	Fluke

12	Clamp flow meter		DC current range 600A Accuracy 1%+4 Recommended model: Fluke-317	Fluke
13	Portable airtight tester		Detecting pressure: 0～500Kpa Balance time: 0～999.9s Differential pressure measurement range: -990Pa～+990Pa testing time: 0～999.9s Leakage measurement range: 0～999.9mL/h Resolution: 1Pa	Gu Heng
14	Pack-level charge and discharge machine		Charge/discharge voltage: 2-260V Charge/discharge current: 0~80A Recommended model:FCF-651CT	Fu Guang
15	Equalization equipment		Balanced constant current: 0~5A; Current control accuracy: ±0.1A; Current acquisition accuracy: ±3mA; 2 channels and 12 channels Recommended model: ACTM-5201	Fu Guang

16	Coolant injection and discharge tool	 	It consists of control panel， air exhaust tool ,coolant injection tool and coolant discharge tool.	Air-internat ional Schlemmer