EnerC+ 306 Container Product Specification

Version	Date	Changes
1.0	Nov. 30, 2022	First Release
1.1	Apr. 24, 2023	Updated some descriptions

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1 General Introduction

1.1 Confidentiality

This product specification is intended to be seen only by persons directly involved in this project. Transfer to other parties, especially to partners without the approval of CATL, has to be coordinated by the person in charge of this project in CATL and is governed by declarations relating confidentiality in the development contract.

1.2 Purpose of Document

This document is a product specification formulated by Contemporary Amperex Technology Company Limited (CATL) for Battery Energy Storage System developed by CATL. It describes and stipulates the performance index, basic functions, interface and communication, key parameters, safety characteristics, this product, as well as matters needing attention of users and relevant legal statements.

The specifications and parameters of the products are provided in this document. If the contract parties find any inadequacies, they shall inform us so as to develop better products.

CATL possesses the right to update and clarify this document.

1.3 Definitions and Abbreviations

1.3.1 Definitions

BESS: Battery Energy Storage System, using electrochemical cells to storage electrical energy.

Frequency Modulation: The grid should work under stable frequency while other uncontrol events will disturb the frequency. So, the active power shall be supplied to modulate the frequency of grid. The BESS shall provide the active power for the grid.

Voltage Modulation: The grid should work under stable voltage while other uncontrol events, especially the inductive load and capacitive load will disturb the voltage. So, the reactive power shall be supplied to modulate the voltage of grid. The BESS shall provide the reactive power for the grid.

Peak shaving and Valley filling: When the power plants generate more energy than the demand, the containers shall absorb the excess energy which called peak shaving. When the power plants generate less energy than the demand, the containers shall release the lack of energy which called Valley filling.

PV: Photovoltaic power generation.

Wind power: Power get from the rotation blade driven by wind.

Modbus TCP: The Modbus protocol including three kinds of messages: ASCII, RTU, TCP. Modbus TCP is a kind of communication protocol which is widely used in the industrial field.

Container: The container for the battery energy storage system.

Module: A mechanically integrated arrangement of cells connected in series and/or parallel, complete with packaging, thermal management, output DC connections, and associated cell sensing.

Cell: The smallest non-divisible component of the EnerC+ System, assembled into a battery module in series and parallel arrays.

RTE: Round-trip Efficiency, defined as discharging of the system from 100% SOC to 0% SOC at kWp immediately followed by charging the system from 0% SOC to 100% SOC at kWp. The Round-trip DC-DC energy efficiency shall be measured at the DC terminals of the container.

1.3.2 Abbreviations

BMS: Battery Management System.

TMS: Thermal Management System.

CAN: Controller Area Communication.

FSS: Fire Suppression System.

PCS: Power Conversion System.

BOL: Beginning of Life.

EOL: End of Life.

SOC: State of Charge.

SOH: State of Health.

CSC: Cell Supervision Circuit， the base unit of battery management.

SBMU: Slave Battery Management Unit, collects and analyses the data from CSC, and uploads to the MBMU.

MBMU: Main Battery Management Unit. The core control unit of the container.

EMS: Energy Management System. Monitoring and manage the charge and discharge of the BESS.

Sub Control Box: Including the SBMU fuse isolation switch and other components.

Master Control Box: Including the IMM, MBMU ETH fiber conversion module.

Distribution Box: Including auxiliary power system, UPS and other components.

2 System Description

2.1 Application

The EnerC+ container is a modular fully integrated product , consisting of rechargeable lithium-ion batteries, with the characteristics of high energy density, long service life, high efficiency. It can provide stable energy release for 2H or 4H when the batteries are fully charged. The EnerC+ Energy Storage product is capable of various on-grid applications, such as frequency regulation, voltage regulation, arbitrage, peak shaving and valley filling, and demand response. Furthermore, the EnerC+ container can be used for PV storage integration and Wind storage integration. The system can also operate as a microgrid to support backup and islanded systems.

2.2 Overview

The overview of the container is shown in Figure 1. The detailed information can be found in the following chapters.

Figure 1 EnerC+ Liquid Cooling Energy Storage Container – Sideview

Figure 2 EnerC+ Liquid Cooling Energy Storage Container – Sideview Without Door

The EnerC+ container consists of following parts: batteries, BMS, FSS and TMS, which are integrated together to keep the normal working of the container.

2.2.1 Battery

The capacity of cell is 306Ah, 2P52S cells integrated in one module, 8 modules integrated into one rack, 5 racks integrated into one container. As the core of the energy storage system, the battery releases and stores energy.

2.2.2 BMS

BMS adopts the distributed scheme, through the three-level (CSC--SBMU--MBMU) architecture to control the BESS, to ensure the stable operation of the energy storage system. It can manage energy absorption and release, the thermal management system and low voltage power supply according to the detected information: battery voltage, current and temperature. It can monitor high voltage DC/AC security, diagnosis and analysis faults according information from various detectors and dry-contacts. And it can keep communication with PCS and EMS through CAN. The BMS is the most important control unit of EnerC+ container. The BMS possesses the UPS to keep normal function when facing the temporary out of power.

2.2.3 FSS

FSS consists of smoke detectors, heat detectors (optional), H2 detectors, the fire control panel, the aerosol (optional), the dry pipe(optional), the explosion-proof fan and the UPS. FSS undertakes functions : monitor the thermal run-away risks of container through the detectors, extinguish the thermal run away, especially the flame fire, control the loss to minimum. The control panel will control and record information for the fire suppression system. The FSS is independent with any other system and it is the security guard of EnerC+ container.

2.2.4 TMS

TMS consists of one powerful chiller, the PTC heater and the liquid cooling pipe distributed in each battery module. The TMS will control and keep the temperature of battery within reasonable range. The battery will work at best state and reach longest life under the thermal management system.

2.3 Advantages

Our EnerC+ container possesses the advantages below:

1) **Standard design.** The 20ft design is very convenient for the transportation. The standard design can be installed one-stop.

2) **New generation Cell.** EnerC+ container integrates the LFP 306Ah cells from CATL, with more capacity, slow degradation, longer service life and higher efficiency.

3) **High integrated.** The cell to pack and modular design will increase significantly the energy density of the same area. The system is highly integrated, and the area energy density is over 270 kWh/m^2.

4) **Extreme safety.** The system supports three levels of safety:

   Firstly, the cell safety, the highly stable lithium iron phosphate is used in the EnerC+ container. LFP is a kind of safety material especially for the BESS.

   Secondly, the electrical safety: a) E-Stop design; b)multiple fuse protection design; c) insulation monitor voltage monitor; d) multi-channel isolation design; e) lightning protection design.

   Thirdly, the fire protection design, CATL has four-level fire control strategy. The first-level is the alarm. The second-level is ventilation and smoke exhausting to prevent deflagration. The third-level is aerosol to extinguish initial fire, and the fourth-level is the dry pipe sprinkle fire protection to prevent fire spread.

5) **Adaptive thermal management.** EnerC+ integrated single-cluster water pump, temperature control

strategy automatically adjusted with battery status, prolonging battery life.

6) **Easy extension.** It is very convenient for the augmentation of containers or racks. Furthermore, the EnerC+ support one PCS connected to 2 containers; this will decrease the covered area significantly.

7) **Independent UPS.** EnerC+ container have integrated two UPS system, one is for FSS which available capacity is 24 hours, another one is for BMS which available capacity is 10 minutes

3 System Specifications

In this chapter, the systems specifications will be introduced in detail. For the BESS, the system specifications included the power and energy, electrical specifications, the environmental specifications, the mechanical specifications and certification standards. The product model is C02306P05L01.

3.1 Power and Energy

Table 1 Power and Energy of EnerC+

DC Side Data		
Product Model	**C02306P05L01**	**Remark**
P-Rate	0.5P	
Cell		
Cell type	LFP	
Cell capacity	306Ah	
Cell Voltage range	2.5-3.65V	
Cell rated Energy	979.2Wh	
System		
Configuration	5P2P416S	
Rated Energy	4073.47kWh	
Rated Voltage	1331.2VDC	
Voltage Range	1040 ~ 1500VDC	
Rated Charging Current	1530A	
Maximum Charging Current	1883A	For 1 minites
Rated Charging Power	2036.73kW	
Rated Discharging Current	1530A	
Maximum Discharging Current	1883A	For 1 minites
Rated Discharging Power	2036.73kW	

3.2 Electrical Specifications

For the auxiliary power supply, the standard configuration is 2 auxiliary power circuit. Auxiliary 1 and auxiliary 2 is listed in Table 2. The UPS for the BMS components is include in the auxiliary power circuit. The optional configuration is 1 auxiliary power circuit and the detailed configurations can be consulted to CATL.

Table 2 Electrical specifications of EnerC+

Auxiliary Power & Communication		
Product Model	**C02306P05L01**	**Remark**
P-Rate	0.5P	

Auxiliary Power 1	**Voltage Range**	3AC+N+PE 380V~480V ±10%，50/60HZ	
	Power	Max. 36.7kW	
	Inrush Current	≤65A， ＜5S	
Auxiliary Power 2	**Voltage Range**	AC+PE 230 V±10%，50/60HZ	
	Power	Max. 0.8kW (Continuous)	
	Inrush Current	5A	
UPS	**Capacity**	DC24V. 7Ah capacity.@25℃	The UPS is only used to supply power to BMS components. The UPS is included in the Aux power supply
Communication Protocol		CAN, Modbus/TCP	

3.3 Mechanical Specifications

Table 3 Mechanical Data of EnerC+

Mechanical Data		
Product Model	**C02306P05L01**	**Remark**
Transportation	Land or sea transportation	
Size	2896mm(H)*2438mm(D)*6058mm(W)	
Weight	~36t	
Color	RAL7042	
IP Level	IP55 (Battery Room)	
	IPX5 (Electrical Room)	
	IPX5(Cooling unit)	

3.4 Environmental Specifications

Table 4 Environmental Specifications of EnerC+

Environment condition		
Specifications	**Range**	**Remark**
Charge Temperature Range	-25℃…+55 ℃	It is necessary to inform CATL for professional evaluation if temperature beyond range
Discharge Temperature Range	-25℃…+55 ℃	
Storage Temperature Range	-30℃…+60℃	
Application Altitude	≤2000m（no derating）	

Relative Humidity	0 ~ 95 % (non-condensing)	
Degree of Anti-corrosion of Battery Unit	C4, (optional C5)	
Seismic Level	IEEE 693-2018 Moderate design level	

3.5 Certification Standard

Table 5 Certification Standard

Standards & Certificates		
Cell	UN38.3	UN Transportation Testing for Lithium Batteries
	UL1973	Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
	IEC62619	Safety requirements for secondary lithium cells and batteries, for use in industrial applications
	UL9540A	Energy Storage Systems and Equipment
Container	UL1973	Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
	NFPA855	Standard for the Installation of Stationary Energy Storage Systems
	UL9540A	Energy Storage Systems and Equipment
	IEC 62477	Safety requirements for power electronic converter systems and equipment – Part 1: General
	IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
	IEC 62933-5-2	Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems

	IEC 61000-4 IEC 61000-6	Generic standards – Emission standard for industrial environments
	IEC61000-4-6	Electromagnetic compatibility (EMC) –Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields

4 Battery Management System(BMS)

4.1 BMS Overview

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

4.2 BMS Architecture

BMS includes three-level constructure, composed of 1 unit of MBMU, 1 unit of IMM, 1 unit of ETH, 1 unit of media converter (optional), 5 units of SBMUs, 40 units of CSCs. This is the architecture that one PCS connected to one container (Figure 3). What's more, the system can also support one PCS match 2 containers (Figure 4).

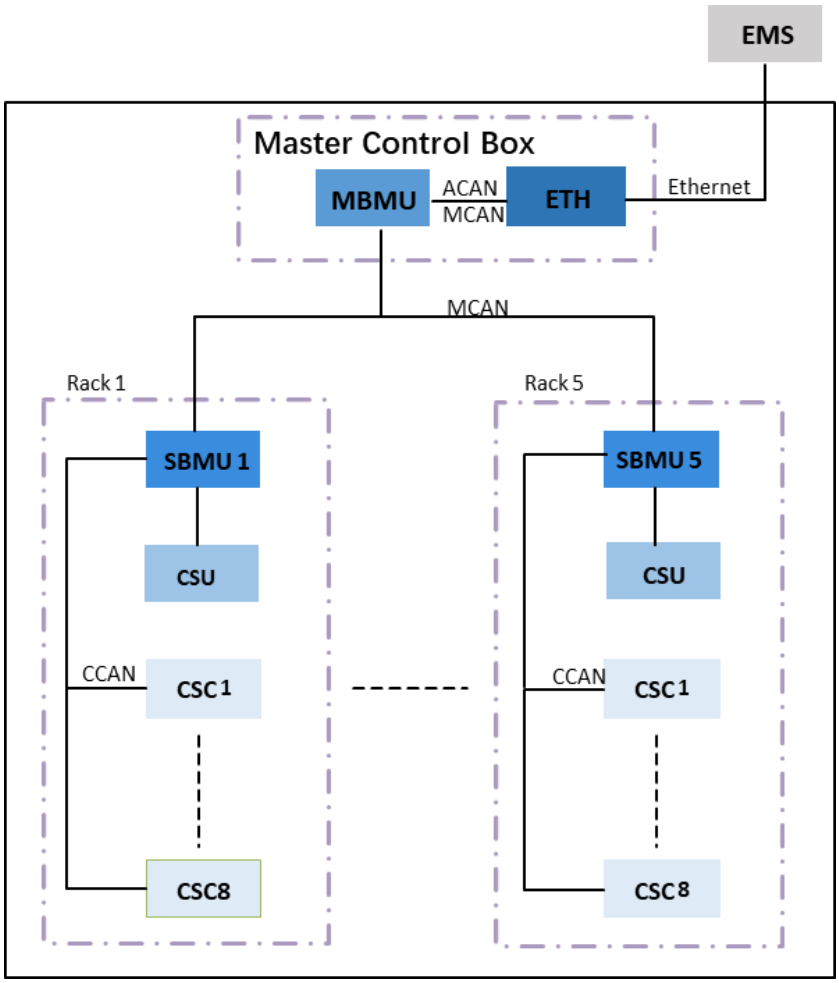

Figure 3 Three-Level BMS Architecture for One Container in Parallel

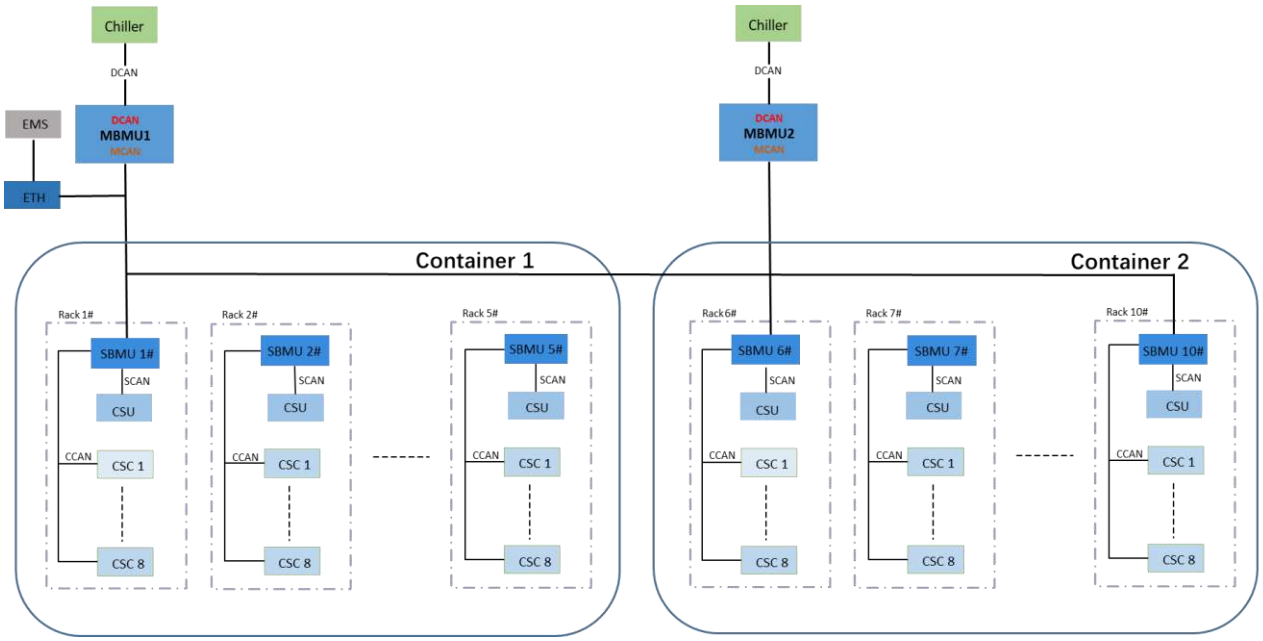

Figure 4 Three-level BMS Architecture for Two Containers in Parallel

4.3 BMS Function

The detailed information of BMS can be seen in Table 6. The parameters including: Cell voltage sampling, Cell temperature sampling, Current sampling, HV sampling, Ambient temperature detection, Insulation detection and other important parameters.

Table 6 Detailed Performance Parameters of BMS

Item	Performance Parameters	Value	Note
Working voltage	Range	20V~26V	
Cell voltage sampling	Range	1V~4.85V	
	Accuracy	±5mV	0℃ ~ +60℃
		±10mV	-40℃ ~ 0℃or60℃ ~ 85℃
Cell temperature sampling	Range	-40℃ ~ +125℃	
	Accuracy	±2℃	-20℃ ~+60℃
		±3℃	-40℃~-20℃&+60℃~+85℃
Current sampling	Range	± 500A	
	Accuracy	<1%FSR	-40℃ ~ 85℃
HV sampling	Range	0V ~ 1500V	
	Accuracy	1%FSR	
Cell balance	Current	100mA@3.2V	Opened in all channels

SOC	Accuracy	＜± 5%	LFP, according to specific conditions
SOH	Accuracy	＜± 5%	After calibratio
Ambient temperature detection	Range	-40℃ ~ +85℃	
	Range	±3℃	
Insulation detection	Range	0 ~ 10MΩ	
	Accuracy	-30% ~ 0%	
	Detection Time	≤10s	Y capacitor<0.47μF (for single side)

4.3.1 Battery Status Monitoring

1) BMS monitors the battery's parameters, including cell voltage, module temperature, battery module current and total battery module voltage.

2) BMS detects the battery status such as State of Charge (SOC) accurate to within 5%, SOH and the accurate to within 5%.

3) BMS functions as a safety management system in such cases as under voltage, over discharge, over voltage, over temperature, and over current of the battery. In case of failure, the system will give an alarm to the supervisory equipment, limit the charge and discharge current or power, and control the disconnection of all HV contactors. This can protect the battery while safeguarding the power systems security.

4) BMS shall provide battery information (including data recording and fault waveform recording) to EMS.

4.3.2 Charging/Discharging Management

1) BMS controls and monitors the high voltage main contactors, auxiliary relays and low voltage coils.

2) BMS has pre-charge control within the parallel connection among racks.

3) BMS works in the management of charge and discharge. It will calculate the charge and discharge power limit according to the existing status of the battery (temperature, SOC) and actual performance of electrical components and then report to EMS which has the function of controlling to these limits.

4) BMS has the function of balance management to extend the reliability of the battery system.

4.3.3 Thermal Management

1) BMS has the function of sample collecting of battery cell temperature and chiller operating status.
2) BMS controls the liquid cooling TMS system based on cell & coolant's temperature.

4.3.4 Program Refreshing

BMS can flash programs on site, which supports the flashing of MBMU, SBMU, IMM, CSC and ETH by using the host computer through MCAN. BMS has the function of remote software flash, which enables to update BMS from a remote client via Ethernet. Furthermore, the system supports the BMS program refreshing through EMS.

4.3.5 High Voltage Safety Monitoring

1) BMS has the function of system insulation detection.
2) BMS has the function of high voltage sampling (collecting data of the main positive voltage).
3) BMS supports the detection of the dry contact of MSD, Fuse and Switch, as well as the auxiliary contact of the primary loop contactor.

4.3.6 Peripheral Monitoring and Control Management

1) BMS has the function of ambient temperature sampling and humidity sampling, which matches according to project requirements
2) BMS has multiple high-side drivers and can drive and control peripheral devices according to project requirements.
3) BMS has multiple dry contact interfaces and can monitor external signals according to project requirements.

4.3.7 Fault Diagnosis Management

1) BMS stores information such as operational parameters and historical alarms that can be viewed by ESS host computer.
2) BMS enables storage of latest historical alarms.

5 Fire Suppression System(FSS)

5.1 FSS Overview

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

- **First level, alarm warning;**
- **Second level, ventilation and smoke exhaust to prevent deflagration;**
- **Third level, aerosol is released to extinguish the initial fire;**
- **Fourth level, dry pipe spraying to control the spread of fire.**

5.2 FSS Function

The fire suppression system is divided into three parts: detection system, explosion-proof system and fire extinguishing system. The information of the interactive interface is shown in the following Figure 5.

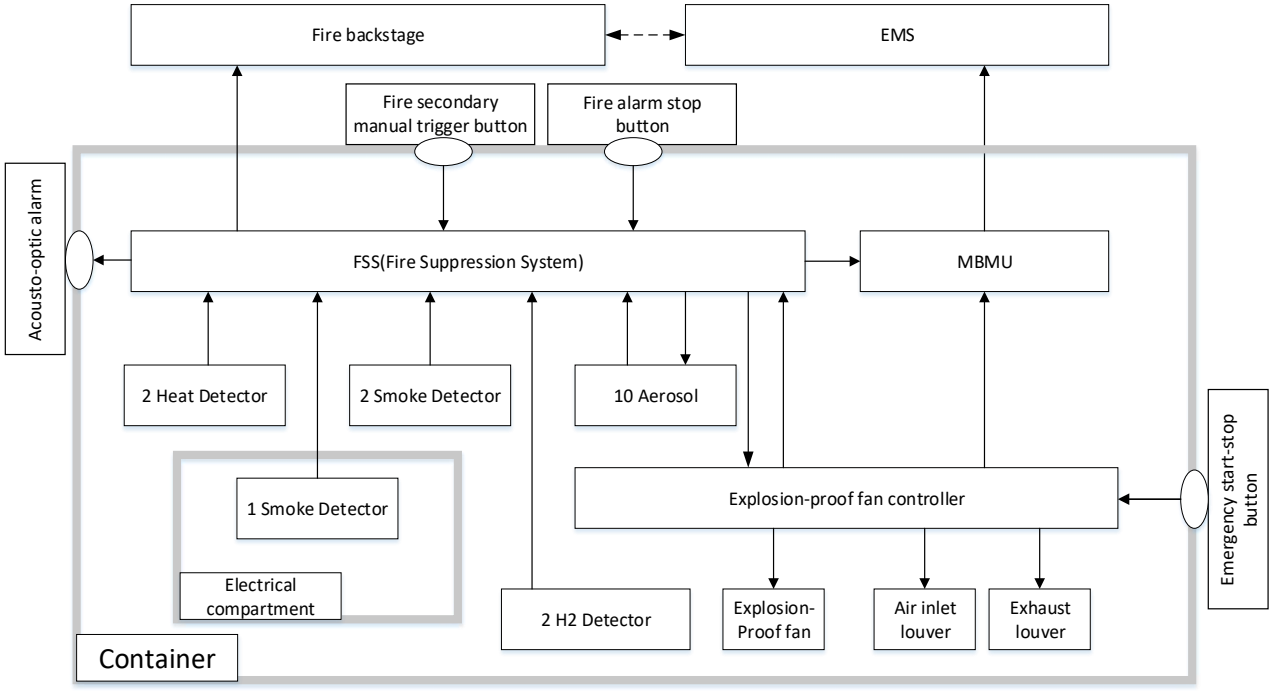

Figure 5 The Interactive Interface of FSS

5.2.1 Detection System

The detection system has three types of detectors, the number and installation position of which are shown in Table 7 and Figure 6. All detection signals are received and processed by the fire control panel, and the hydrogen(H_2) detector can be linked with the explosion-proof fan system.

Table 7 Detector Type and Position Description

No	type	quantity	Configuration	remarks
1	Heat detector	2	Optional	Detection of temperature, in the battery room
2	Smoke detector	2+1	standard	Detection of smoke particles, two in the battery room, and one in the electrical room
3	H_2 detector	2	standard	Detection of H_2, in the battery room
4	CO detector	2	optional	Detection of CO, in the battery compartment
5	Fire control panel	1	standard	Receive detector signals and control fire extinguishing system and explosion-proof system, in the electrical room

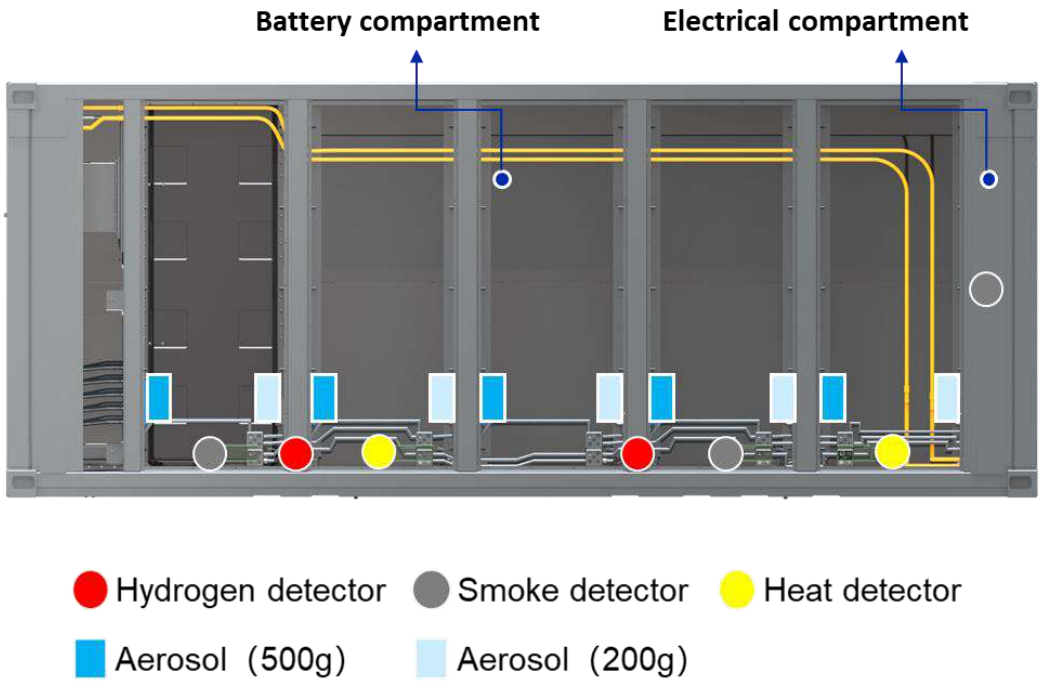

Figure 6 Type and Location of Detectors

5.2.2 Explosion-Proof System

Explosion-proof fan system meets NFPA855 (NFPA 69) standard and has the ATEX certification, which is shown in Figure 7

Figure 7 Explosion-Proof Fan System

The air inlet electric louver receives the alarm signal sent by the hydrogen(H_2) detector and opens the electric louver. When one of these two signals is received, the air inlet electric louver automatically closes. One signal comes from the hydrogen (H2) detector, indicating that the combustible gas concentration is within a reasonable threshold range, and the other signal is a secondary alarm signal. The parameters of the Inlet are shown in Table 8.

Table 8 The Parameters of the Inlet

Item	Specification
Supply voltage	24V DC
Rated power	60W
Inrush power	85W
Position	Integrate in Rack
Certification	In the process of ATEX certification

The air outlet electric louver will turn on the explosion-proof fan and releases the combustible gas in the battery room after receives the alarm signal from the hydrogen(H_2) detector. The explosion-proof exhaust fan will automatically turn off when the concentration of combustible gas falls within the reasonable threshold. The parameters of the exhaust port are shown in Table 9.

Table 9 The Parameters of the Exhaust Port

Item	Specification
Supply voltage	230V AC
Rated power	72W
Inrush power	102W
Position	Integrate in Rack
Maximum air volume	820CFM
Certification	ATEX

5.2.3 Fire Extinguishing System

5.2.3.1 Aerosol

When an initial fire occurs in the battery room, a fire alarm signal will occur, and the fire extinguishing system will automatically control the release of aerosol, which can also be triggered manually. The fixed position of aerosol is shown in Figure 6.

5.2.3.2 Dry pipe

As the last line of defense, the dry pipe system can effectively control the spread of fire, which is shown in Figure 8.

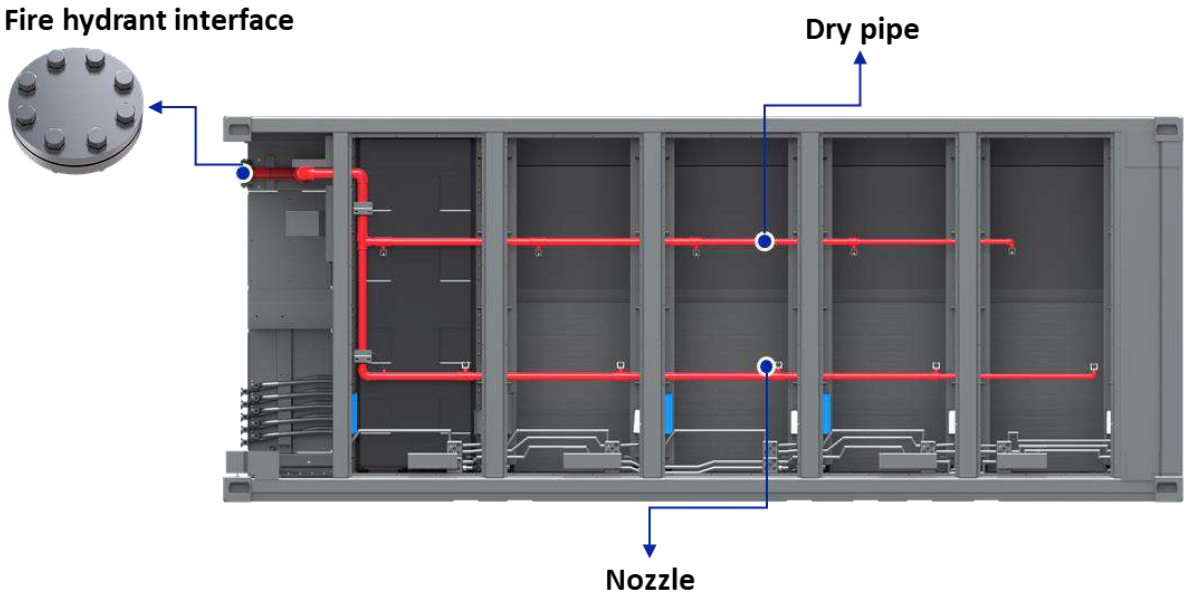

Figure 8 Dry Pipe System

The flange is installed at the entrance of the dry pipe fire protection system, for the connection between the pipes. The parameters of the flange are shown in Table 10.

Table 10 The Paraments of The Flange

Item	Specification
Model	DN65
Standard	EN1092-1
Material	ASTM A105
Class	PN 16
Flange type	TYPE 01 Plate flange for welding TYPE 05 Blind flange
Certificate	PED 4.3 for material
End connection	Integrate in Rack

The HD Medium Velocity 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 11.

Table 11 The Parameters of the Nozzle

Item	Specification
Model	MV-A Brass Material
Type	MV-A
Maximum working pressure	12bar（175 psi）
End connection	½ BSPT
Heat Sensor Position	Integrate in Rack

6 Thermal Management System(TMS)

6.1 TMS Overview

The TMS system of EnerC+ is liquid cooling, which main function is to maintain the temperature of the battery system to an allowable operating temperature range. Thus, the battery shall work at the best conditions, adsorb and release the maximum energy, slow degradation the SOH and maintain the longest life.

The Thermal management system is composed with the high-efficiency liquid cooling unit, the liquid cooling pipe under the bottom of battery and the PTC heater. The TMS works under the control of BMS. BMS sends the start up or shut down signals to the cooling unit, then the cooling unit and the PTC heater will work together to change the temperature of circulating coolant liquid for heat exchange in the cooling pipe. The circulating liquid will exchange the heat with the battery through the pipe. Thus, the temperature of battery will increase or decrease into appropriate range.

For example, the cooling unit will be started if the BMS detect the battery temperature over the setting value. The cooling mode will be activated to decrease the temperature of circulating liquid until reaching the setting value. When the BMS detects the battery temperature less than the setting value, the heat mode will be activated to increase the temperature of circulating liquid until the setting value. Detailed information will be described below.

6.2 TMS architecture

Figure 9 Overview of the cooling unit of EnerC+

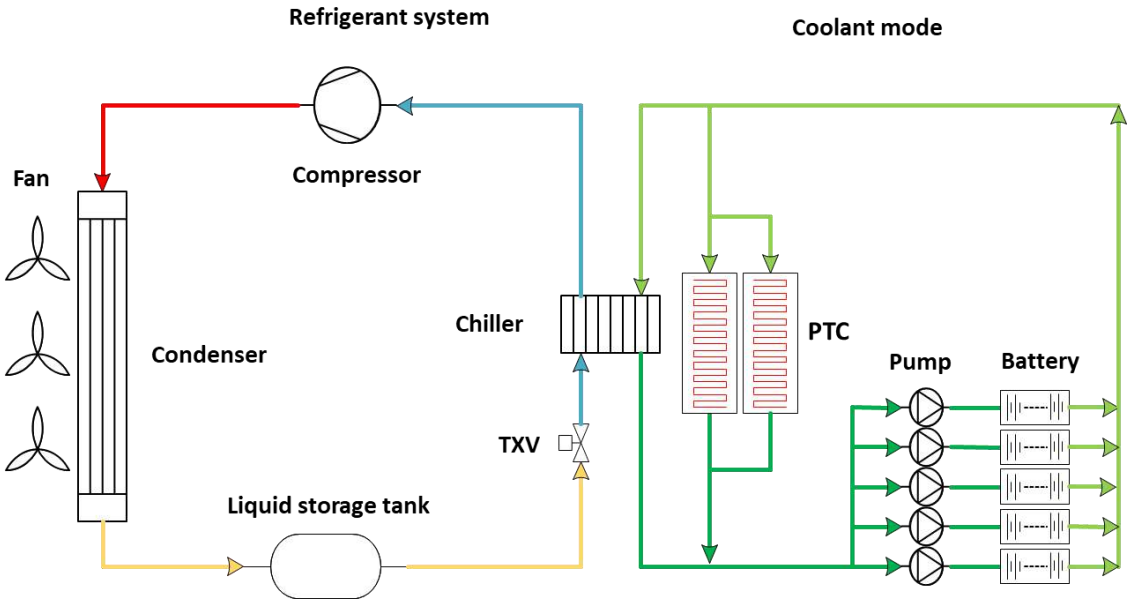

Figure 10 Architecture of Thermal Management System

The overview of cooling unit has been listed in Figure 9. EnerC+ own one high power cooling unit at the side of the container. TMS architecture can be described above (Figure 10). The composites parts are listed below:

a) **Compressor.** The function of compressor is to compress the low temperature and low pressure refrigerant gas into high temperature and high pressure refrigerant gas. Then the gas flow to the condenser through the pipe.

b) **Condenser.** The function of condenser is condensing the high temperature and high pressure refrigerant gas into ambient temperature and high pressure refrigerant liquid. Excess liquefaction heat will be taken away by the fan. Then the liquid flow to the chiller through the pipe.

c) **Chiller.** The function of chiller is to exchange the heat from the refrigerant liquid with the coolant. The ambient temperature and high pressure refrigerant liquid will evaporate into low temperature and low pressure refrigerant gas. The heat will transfer from the coolant to the refrigerant liquid. The low temperature coolant will flow to the cooling plate to cool the batteries while the refrigerant gas return to the compressor. The circle process will continue and the heat of battery will be taken away.

d) **PTC Heater**. The positive temperature co-efficiency resistance. The PTC will heat the coolant when the TMS get signals that the temperature of coolant is below the setting value. Then the coolant will be heated until the temperature increases to the setting value. The battery will be warmed up by the coolant.

e) **Pump.** The pump will force the coolant into circulating in the pipe.

6.3 TMS Specification

Table 12 Main Feature of Thermal Management System

	Coolant: 50%Ethylene glycol,50% Deionized water
	Max. ambient temperature: 55°C
	Power supply: 3AC 380…480V
	40kW Cooling capacity for 0.5P System
	Cooling capacity is auto-adjustable according to ambient temperature & discharge/charge status

The main features of TMS are listed above, which is shown in Table 12. The TMS will work under the ambient temperature range from -25℃ to 55℃. The cooling power is auto-adjustable according to ambient temperature & discharge/charge status. There are four operating modes for the TMS, including shutdown mode, cooling mode, heating mode and self-circulation mode.

Table 13 Power Consumption of Thermal Management System

Type of EnerC+	**0.5P System**
Cooling Capacity	40kW
Maximum Heating Power	17.6kW
Maximum Cooling Power	27.54kW
EER	≥2.6(18℃@35℃)

7 User Interface

7.1 PCS Requirements

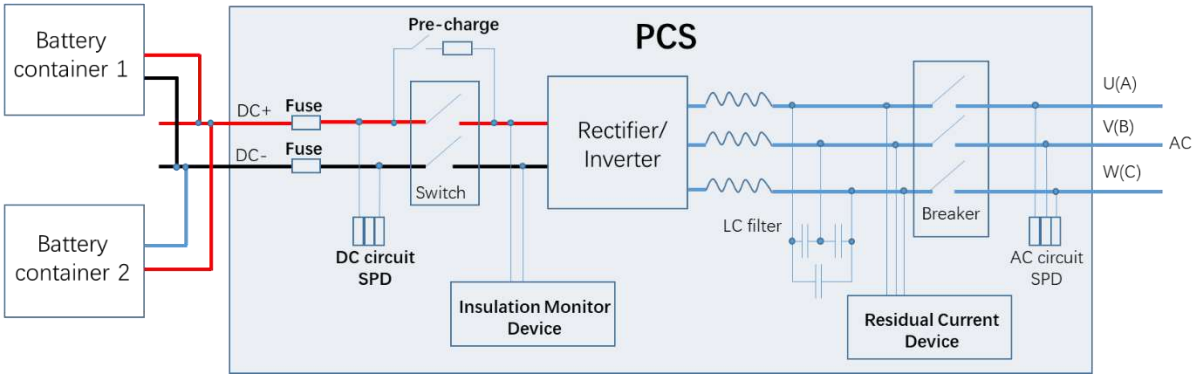

Figure 11 PCS Matching

- Please make sure to use one single copper Busbar for two parallel battery containers cable connection for positive or negative pole in PCS side.
- Please make sure to use Fuse(F) for DC circuit in PCS. The Fuse breaking time in PCS should less than the breaking time of fuse in battery container when short circuit occurs.
- Please make sure PCS have pre-charge circuit.
- Please make sure the PCS has a main circuit switch on the DC side .
- One PCS can match up to 2 battery containers.
- PCS should have SPD in DC high voltage bus.
- PCS should have SPD in AC side.
- PCS should have insulation monitor device. BMS monitor the insulation of DC bus before battery DC relay is closed. PCS monitor the insulation of DC bus after battery DC relay is closed.
- PCS should have residual current device to monitor the leakage current on AC side.
- When the battery is in a low SOC state after discharge, the grid cannot charge the battery in time and needs short-term storage. In this scenario, it is necessary to ensure that PCS is disconnected from the battery to prevent the battery from being over discharged.

7.2 Fuse Matching

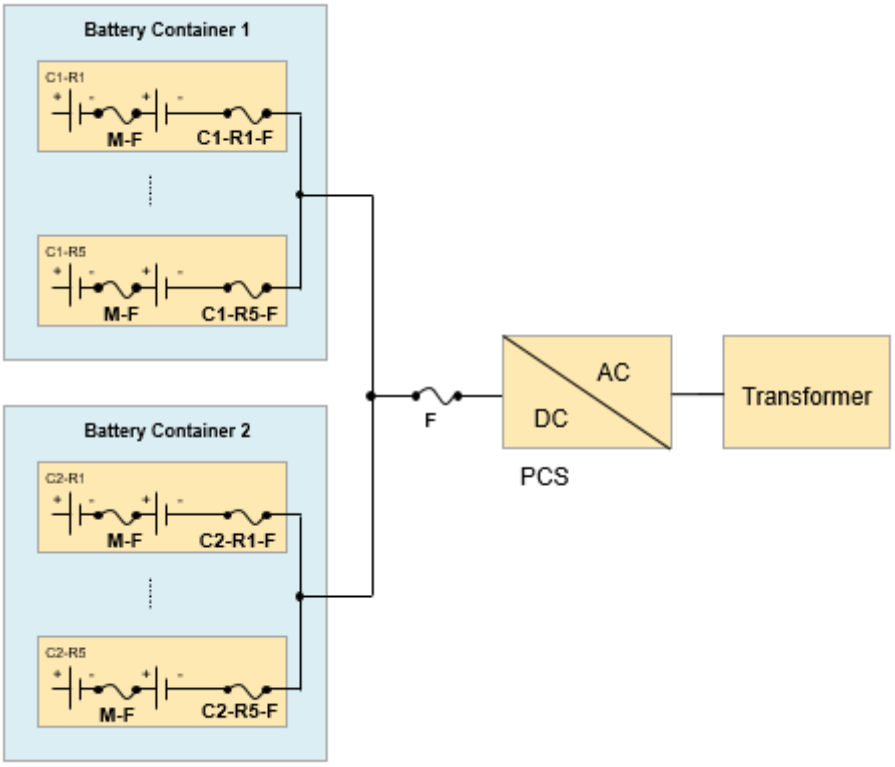

Figure 12 Fuse Matching

- The principle of fuse matching：
- Fuse Breaking Time: F<C-R-F<M-F. the F fuse means the fuses at the DC side of PCS. The C-R-F fuses means the fuses installed in the main control boxes. The M-F fuses means the fuses installed in the packs. The breaking time of F fuse is the minimum value of these three.
- Voltage Level： 1500V
- **One Container Fuse F Breaking ability：＞72.72kA**
- **Two Container Fuse F Breaking ability：＞145.44kA**

1. One PCS can connect two battery containers. Every container has 5 racks .
2. One rack short circuit current is 14.544kA.
3. PCS DC side fuse is **Fuse F**.
4. Battery rack fuse is C-R-F.
5. Module fuse is M-F.

7.3 Common Mode Voltage

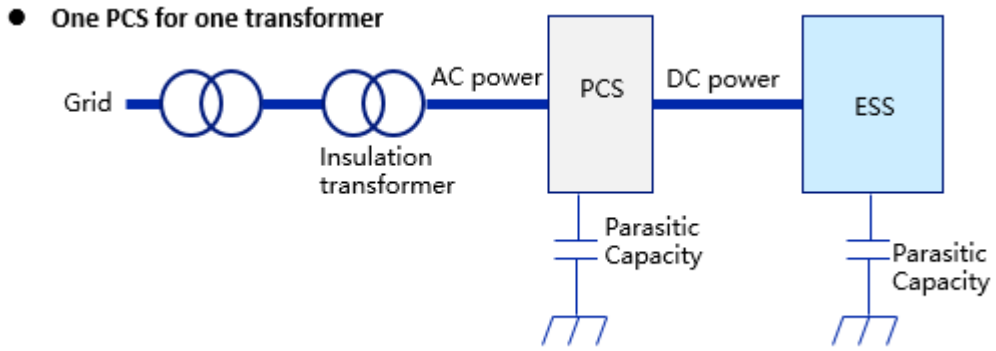

Figure 13 One PCS for One Transformer

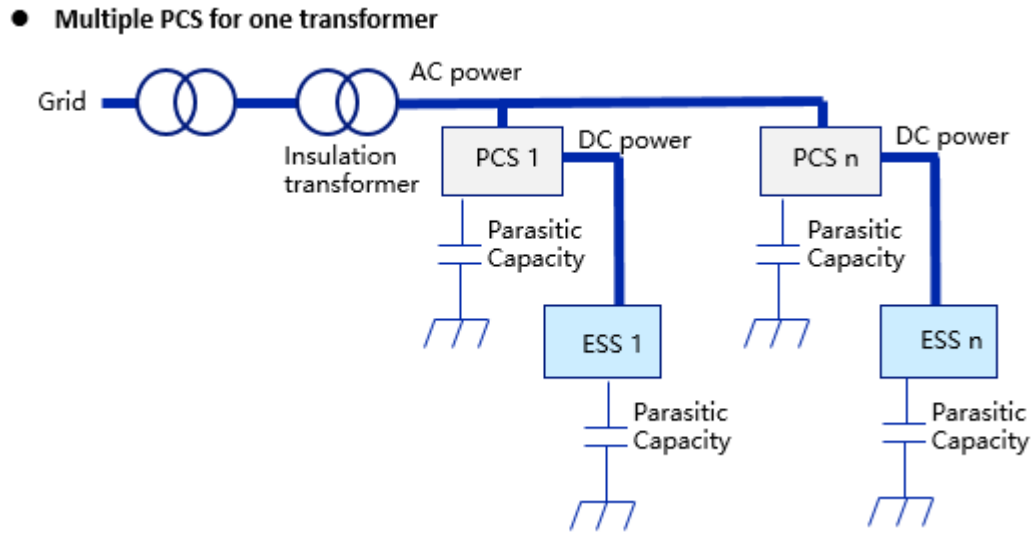

Figure 14 Multiple PCSs for One Transformer

The common mode voltage or current will affect the BESS reliability and personal safety. PCS will generate the common mode voltage and current due to the converter theory. Due to parasitic capacitance, the PCS should improve the insulation resistance isolation.And it is recommended to use insulation transformer. When multiple PCS are parallel connected, make sure that the switching of IGBT inside each PCS will not affect the other PCS to reduce the common mode voltage. The carrier synchronization should be considered in PCS control.

Common mode voltage value in DC side <100VAC, <15kHz

Make sure not to mix the AC and DC power cables, not to mix input and output cables, not to mix power cables and control cables.

7.4 Communication

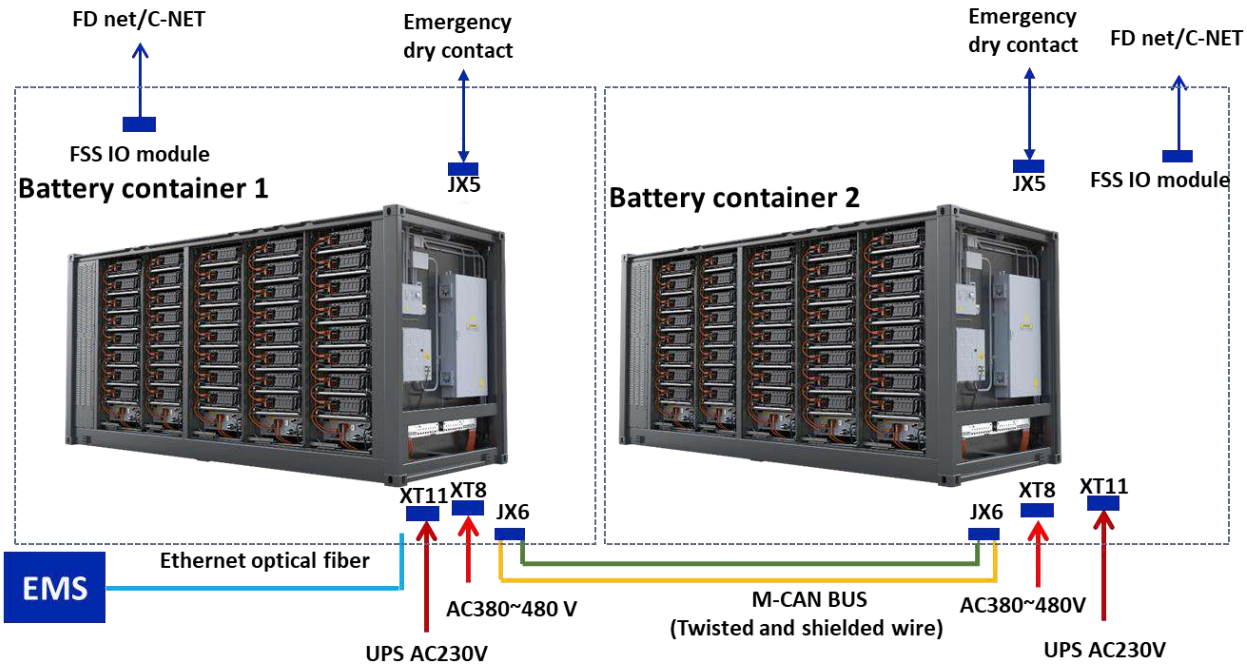

Figure 15 The Communication Architecture of the System

PCS should respond within 1s after BMS sending out the requirement.

PCS should respond within 1s after BMS sending out the emergency requirement by emergency dry contact.

PCS operation power should not exceed battery power limitation.

PCS should derating power to 0 W within 2s once receiving BMS limit to ZERO current requirement.

When the length of CAN communication loop exceeds to 30m, it is necessary to add CAN bridge to enhance communication signal.

It is recommended to use Ethernet optical fiber to communicating with EMS.

The A-CAN Bus or 485 Bus can be optional. If using the A-CAN Bus or 485 Bus, the Ethernet optical fiber will be not used.

8 Appendix

The attached is the triple view and the dimensions of EnerC+. The front view, the side view, the top view. The detailed installation information can be found in the users' manual.

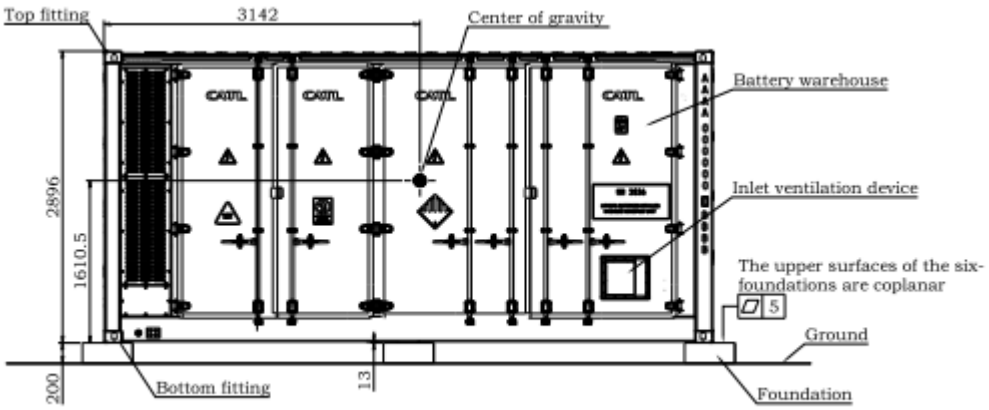

Figure 16 The Front View and Dimensions of EnerC+

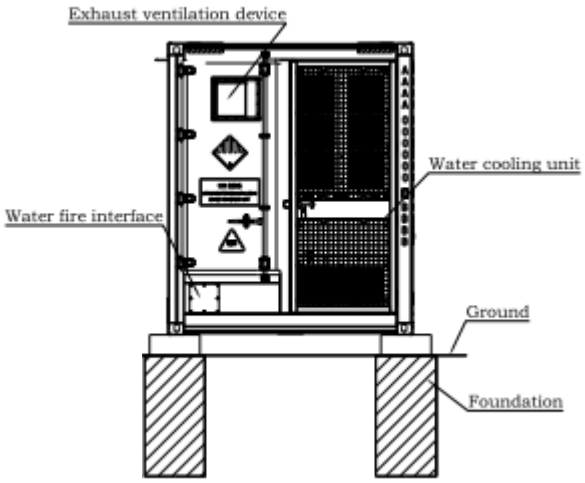

Figure 17 The Side View and Dimensions of EnerC+

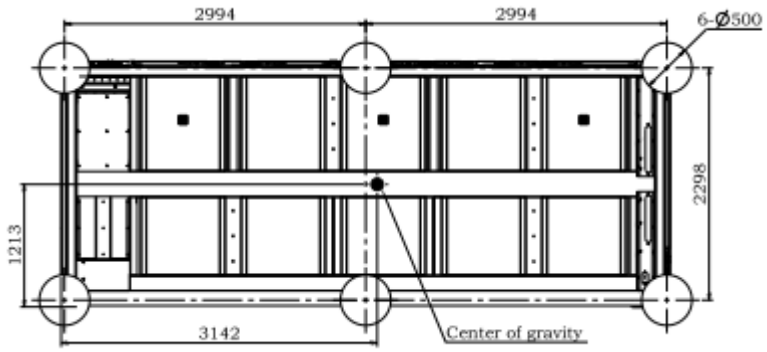

Figure 18 The Top View and Dimensions of EnerC+

There are two kinds of installation layout recommended. First case layout is listed below at Figure 19. Second Case layout is listed below at Figure 20.

For case 1. to avoid the hot air interaction for two containers ,and to maintain the container, the minimum distance must be followed :

L1 : 3.0m

L2 : 3.0m

L3 : 3.00m （Recommend 3.5m）

L4 : 0.90m（C5 or above），0.20m（C4 or below）

L5 : 3.00m （Recommend 3.5m）

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.

For case 2. to avoid the hot air interaction for two containers ,and to maintain the container， the minimum distance must be followed :

L1 : 3.00m （Recommend 3.5m）

L2 : 3.00m

L3 : 3.00m（Recommend 3.5m）

L4: 1.10m （Recommend 1.5m）

L5 : 3.00m （Recommend 3.5m）

Note: Orientation of water cooling unit and door in the drawing.

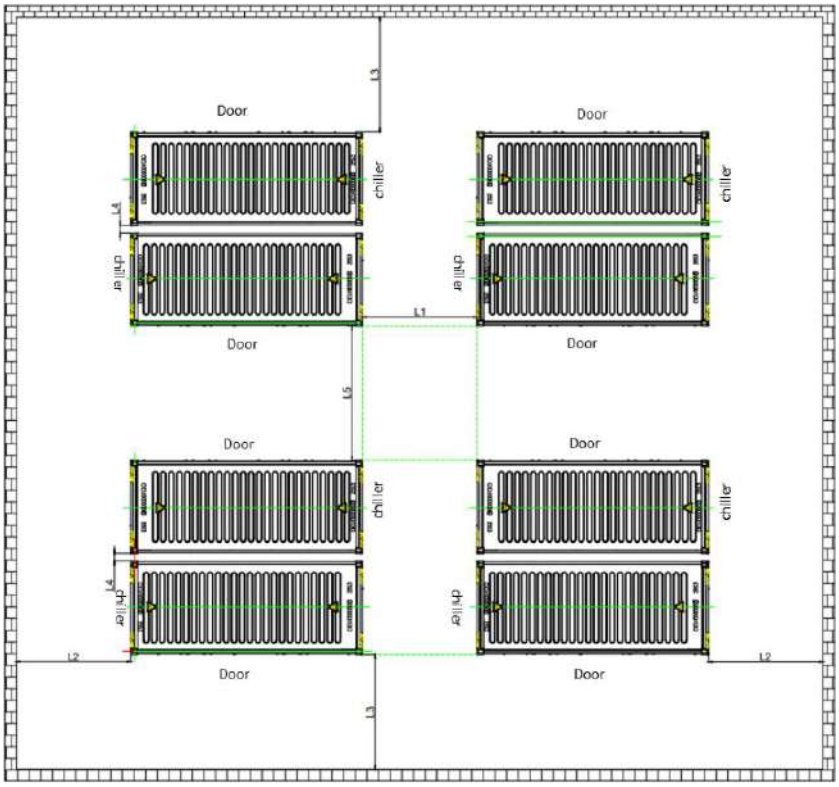

Figure 19 Case1 containers installation layout

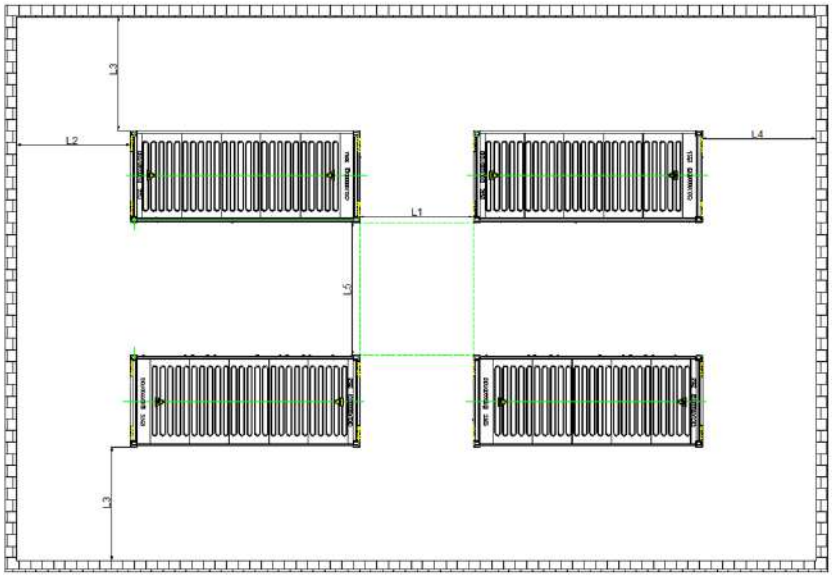

Figure 20 case 2 containers installatiuon layout

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