Multi-application - $LiFePO_4$ Power

UE-1MW-1MWh Smart ESS Micro-Grid

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1. System Function Diagram

This Micro-Grid ESS (Energy Storage System) contains 0.5 MW - 1.2 MWh $LiFePO_4$ battery system, 1000 kW PCS, 1 set HVAC (Heating, Ventilation and Air Conditioning), 1 set Fire Fighting, lighting system, thunder-proof, AC& DC distributor, optional parts, and a SCADA (Supervisory Control And Data Acquisition) system to manager them. All of the above are designed in 1 40 ft standard container.

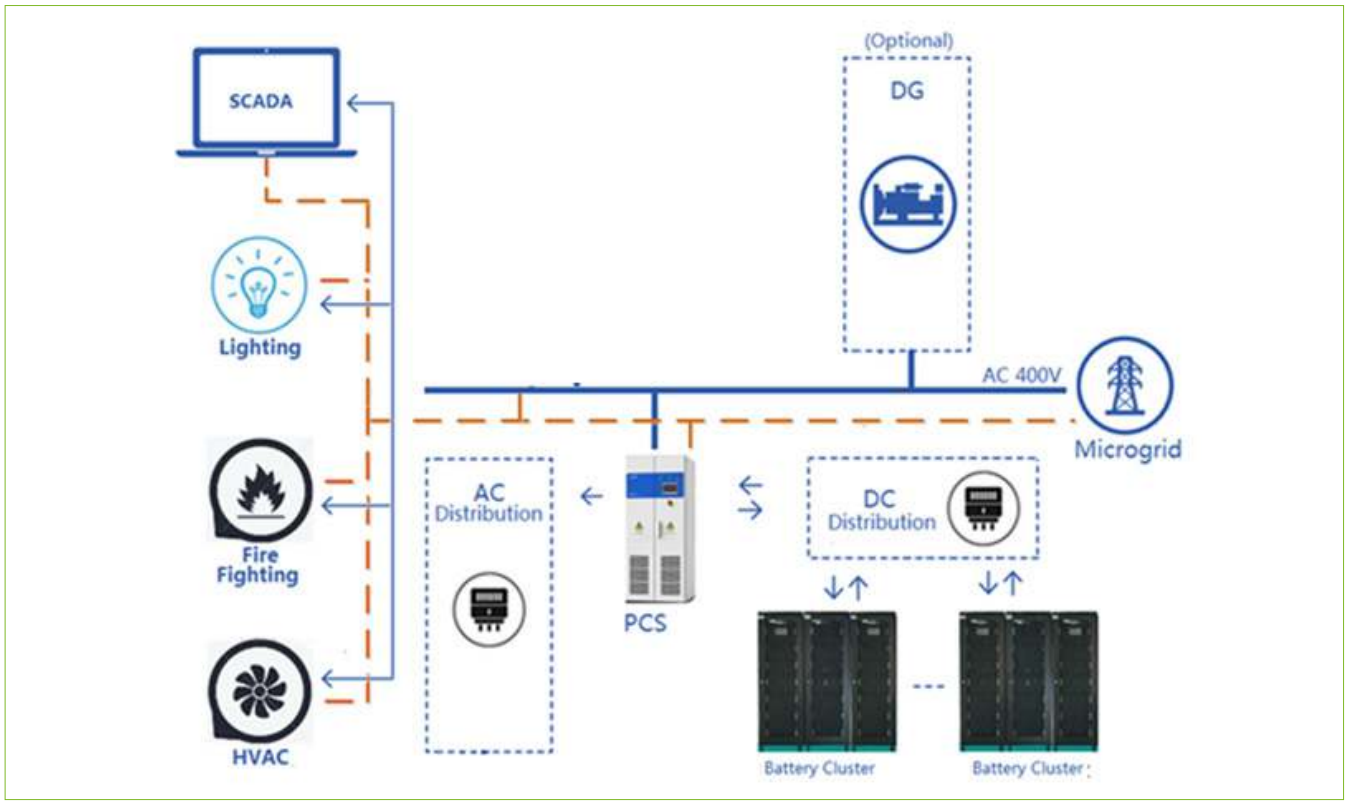

Diagram 1: System Block 1000kW / 1MWh Energy Storage System

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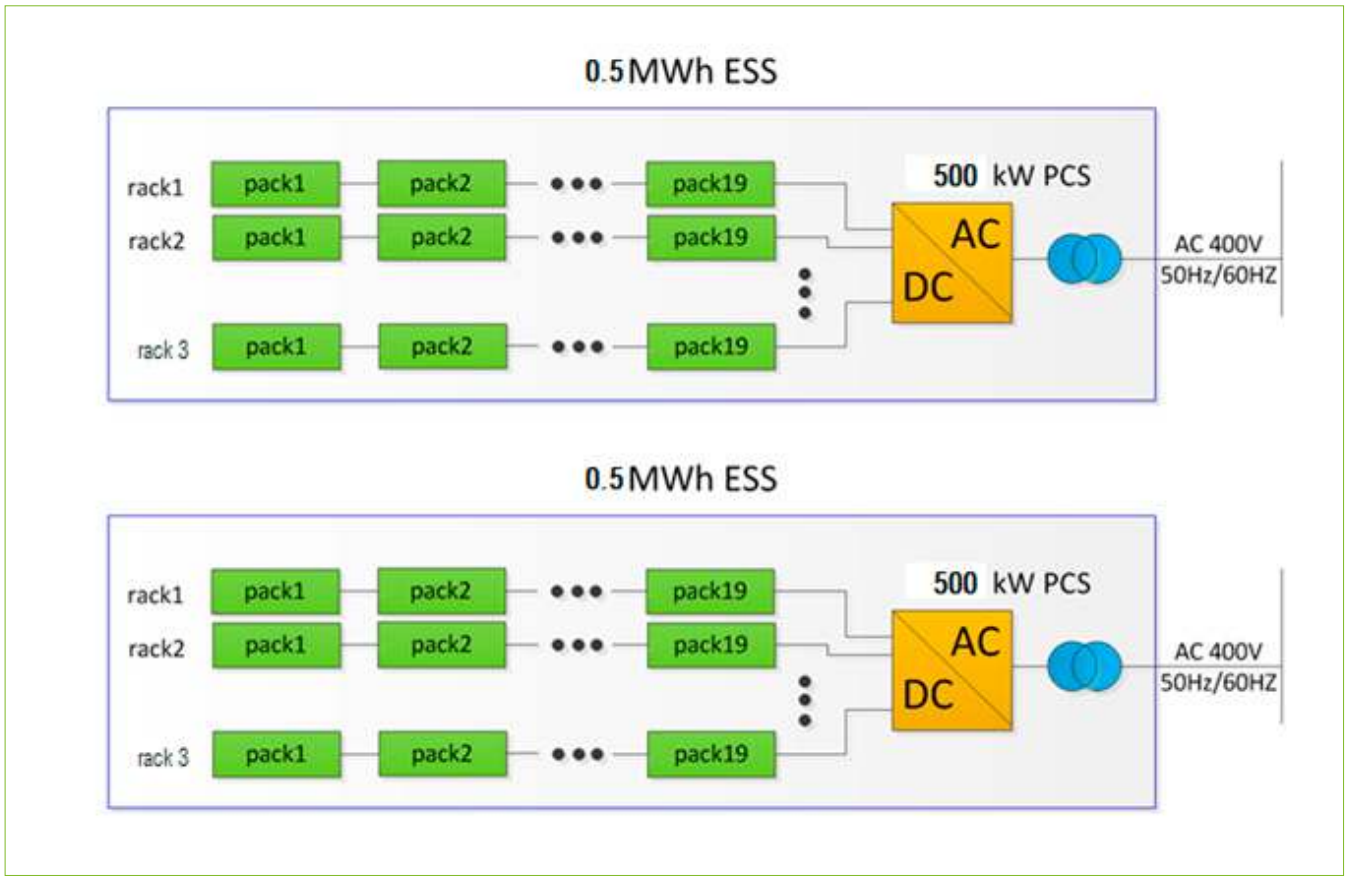

Diagram 2: (730V 1440Ah)

Energy Storage Systems Specification

NO.	Project description	Specifications	Remark
1	Energy storage system capacity	1050 KWh	
2	Rated discharge power	1000 KW	
3	Rated charge power	1000 KW	Not allowed
4	Rated output voltage	315 Vac	No transformer, suit for Asia, Europe, America
		400 Vac	With / no transformer, suit for Asia, Europe
5	Output voltage range	Rated voltage -20% / +15%	
6	Rated output frequency	50 Hz	Suit for Asia, Europe
		60 Hz	Suit for Asia
7	Frequency Range	47 Hz ~ 52 Hz	Suit for Asia, Europe
		57 Hz ~ 62 Hz	Suit for Asia, America

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8	System maximum efficiency		95%	Not with transformer
9	Total current aberration rate		< 3%	Rated power, Voltage aberration rate < 1% each hour
10	DC component		< 5%	Rated power
11	Power factor		-0.9 ~ 0.9	Adjustable
12	Charge and discharge conversion time		100 ms	
13	Communication system response time		2 S	
14	Output connection mode		Three-phase four-wire / three-phase five-wire	Not with transformer 3P + PE / with transformer 3P + N + PE
15	Working temperature		-15°C ~ 45°C	
16	Storage temperature		-15°C ~ 55°C	
17	Working relative humidity		0 ~ 95%	No dewing
18	Storage relative humidity		0 ~ 95%	No dewing
19	Altitude		≤ 2000 m	
20	System noise		< 75 dB	
21	Protection level		IP54 / NEMA 3R	
22	Pollution level		2 levels	
23	External Communication Port		Ethernet	MODBUS（TCP/IP）
24	Container Size		12192*2438*2839 mm	W*D*H
25	Container Weight		32 Ton	Not with transformer
			40 Ton	With transformer
26	Container Port	Power port	Path 1 / Path 2	315V / 380V
		Power distribution port	Path 1	230V
		Ground port	Path 2	PE
		Communication port	Path 1	MODBUS (TCP/IP)
27	Charge / discharge cycle life		> 2500	1C charge / discharge
28	Service life		10 years	Storage power drops to the initial 80%
29	Certification		No	American market, Europe market, Australia market, China
30	Transport requirements		No packaging	Satisfy the sea shipping

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2. Battery System

2.1 Features

- Using long lifetime (≥ 4000 cycles) high efficient (reach 98%) High safety LFP cells;
- Actively balance management, improve battery efficiency, maintain battery consistency, and increase the cycle life.
- Complete fault and operation log recording function, system.
- Info storage time last one month;
- Support RS485, Ethernet communication;
- Battery satisfied UL1973 certification.

Battery System Design

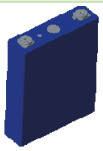
NO.	Project	Units topology	Nominal Voltage (V)	Nominal Capacity (Ah)	Storage energy (kWh)	Remark
1	Cells		3.2	120	0.384	$LiFePO_4$
2	Battery Box		38.4	240	9.216	Cells 2P12S
3	Battery RACK		730	240	175	Battery box 19 series
4	System		730	1440	1050	Battery 6 RACKS series

Diagram 3: Battery parameters

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PACK parameter table:

NO.	Project	Spec	Remark
1	Cells number (pcs)	24	Use Ecoline 3.2 V / 120 Ah cells
2	Cells parallel number (pcs)	1	
3	Battery series and parallel mode	2P 12S	
4	BMU number (pcs)	1	
5	Nominal voltage (V)	38.4 V	
6	Voltage scope (V)	30 ~ 43.8	
7	Nominal capacity (Ah)	240	
8	Battery energy (kWh)	9.216	
9	Battery module size W*D*H (mm)	482 mm *200 mm *650 mm	
10	Weight (Kg)	About 75	

Diagram 4: PACK parameters

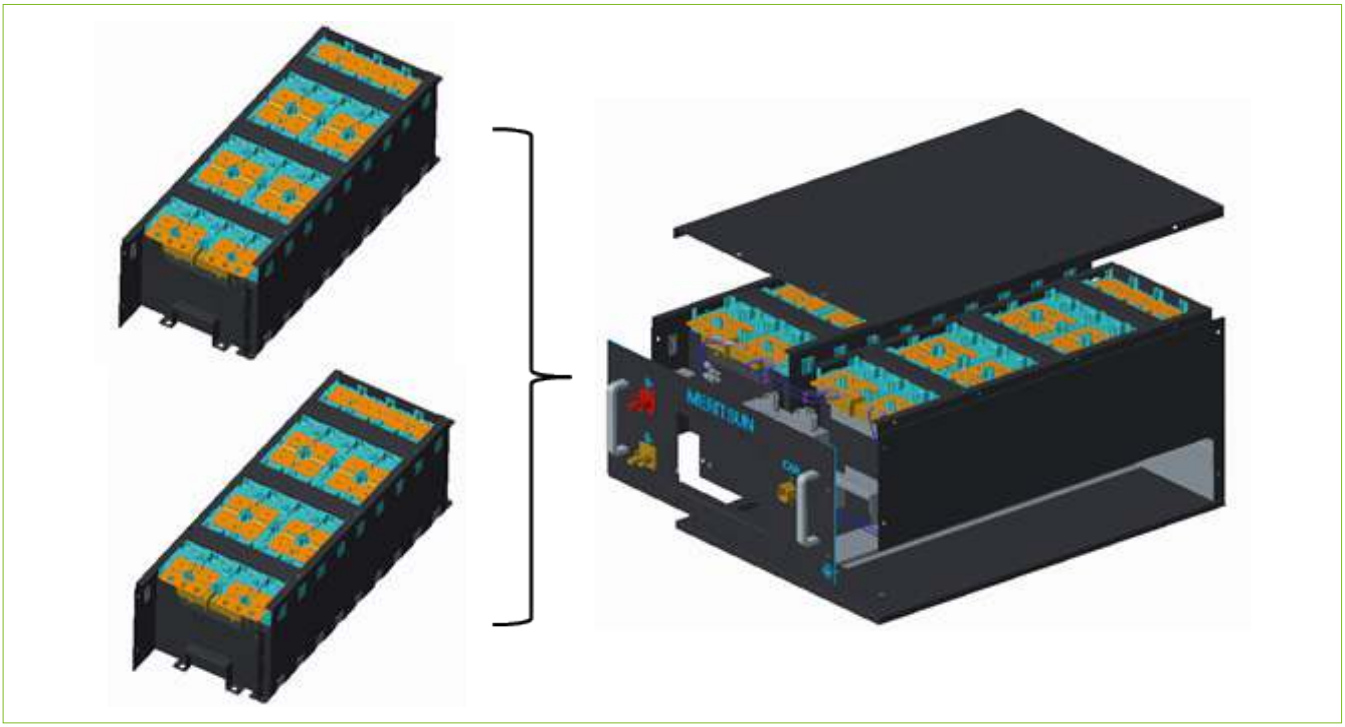

*Diagram 4: PACK (L*D*H=482mm*200mm*650mm)*

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2.2 Battery system introduction

The 1.2 MWh (730 V 1440 Ah) LFP battery system contains 6 Battery Clusters.
Each 175 KWh (730 V 240 Ah) Cluster is composed of 19 pcs battery modules, 1 pcs control modules.

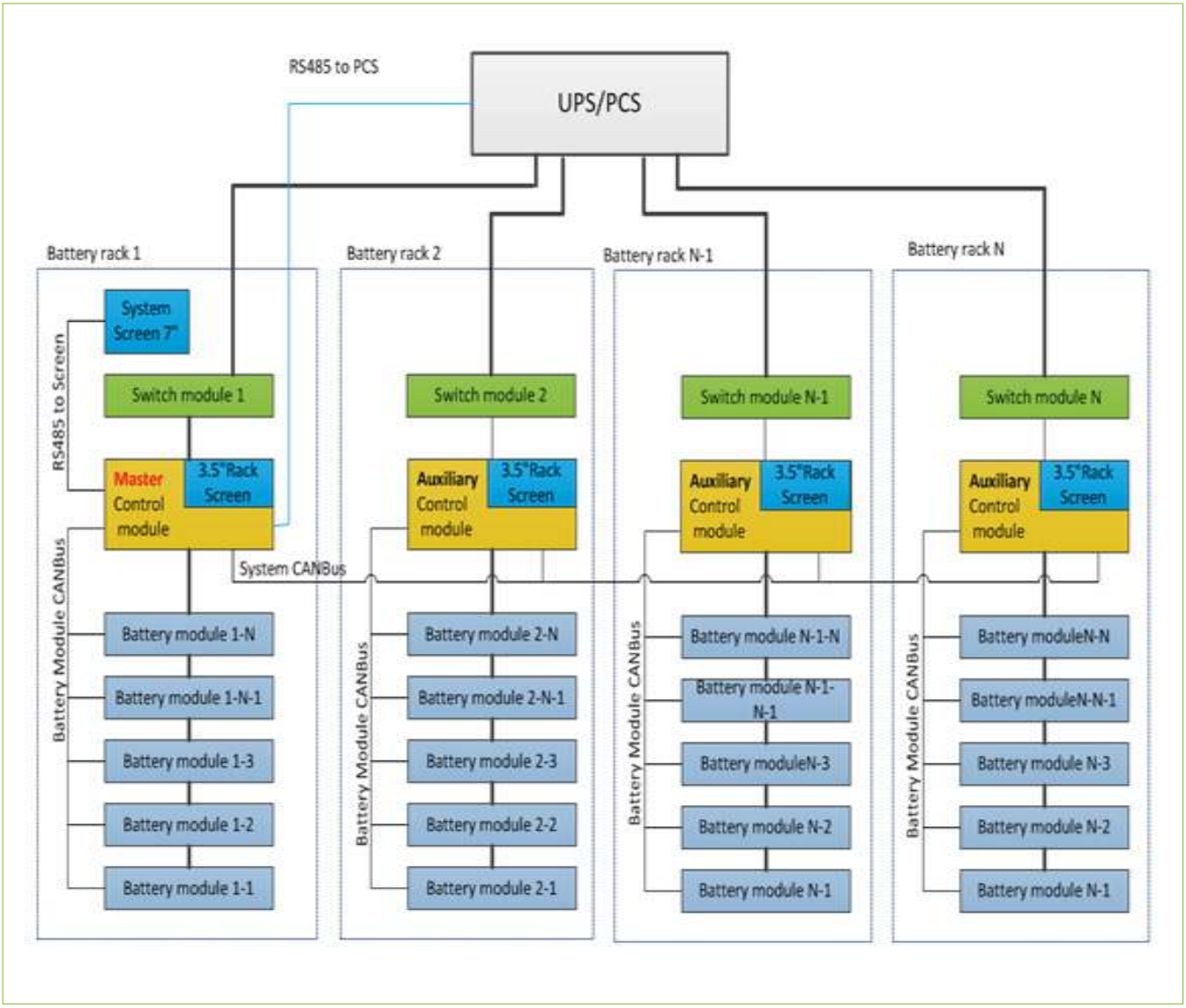

Diagram 5: 1MWh (730V1440Ah) Battery System Block

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Battery clusters spec:

NO.	Project	Spec	Remark
1	Battery module pack number	19	
2	Battery series and parallel mode	1P 19S	
3	BMU number (pcs)	18	
4	Nominal voltage (V)	730	
5	Voltage scope (V)	570 - 830	
6	Nominal capacity (Ah)	240 Ah	
7	Battery clusters energy (kWh)	175	
8	Battery clusters size W*D*H (mm)	1200*750*2200	
9	Weight (Kg)	About 2000	

Diagram 6: 729.6V240Ah Battery Cluster

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2.3 Battery system specification

Item	Spec
System topology	System = 7 Clusters = 7*19 Modules
Cell Type	$LiFePO_4$
Nominal Voltage	730 V
Nominal Capacity	Cluster: 240 Ah, System: 1680 Ah
Nominal Energy	Cluster: 0.175 MWh, System: 1 MWh
Working voltage range	570 ~ 830 V
Standard Charge Voltage	830 ± 8 V
Floating charge voltage	785 ± 8 V
Max charge current	1400 A
Max charge power	Subsystem: 1000 KW
Max discharge current	1600 A
Max discharge power	Subsystem: 1000 KW
Dimension (mm)	Module: 482W*650D*200H, Rack: (Customized)
Gross weight (Approx.)	Module: 80 kg, Rack (include modules): 2000 kg
Operating Temperature	Charging: 0 ~ 50°C, Discharging: -20 ~ 60°C
Cycle life	≥ 4000 cycles @80% DOD @0.25 C

2.4 BMS (Battery Manage System) function

1) Total voltage and total electric current sampling;

2) Insulation detection, real-time detect insulation resistance of high voltage positive and negative pole against the chassis;

3) Battery charge state (SOC, SOH) estimation function;

4) Each BMU module real-time monitoring of single voltage (real-time monitoring voltage of 16-24 cells in series) and 4-way temperature;

5) Equipped with two CAN communication function, divided into internal communication network, external communication network. Internal communication network is responsible for the host, from the machine communication and diagnostic system data, the external network is responsible for interaction with the PCS controller and other information.

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6) With fault diagnosis, including temperature, voltage, current, insulation, contactor status, fuses, sensors, communications and other fault diagnosis;

7) Battery system safety management functions, including overcharge, over discharge, overcurrent, insulation failure, overheating, voltage difference, temperature and other protection;

8) With a balanced function, balanced mode for the passive balance, the maximum equilibrium current of 30 mA.

9) With BootLoad function and CCP calibration function;

10) With remote monitoring function;

11) With fault, status record function;

12) With low power consumption, key switch wake-up function;

2.5 Battery Manage System performance

Performance	Index value
Operating voltage	18 ~ 32 V
SOC estimation accuracy	≤ 8%
Single voltage sampling accuracy	± 5 mV
Total voltage sampling accuracy	± 5 V
Current sampling accuracy	≤ 1% F.S
Temperature sampling accuracy	± 2°C
Standard Charge Voltage	840 ± 8 V
Floating charge voltage	814 ± 8 V
System power consumption	≤ 150 W / per Subsystem
Temperature Channels / per BMU	3
Communication surpport	RS485, CAN, Internet

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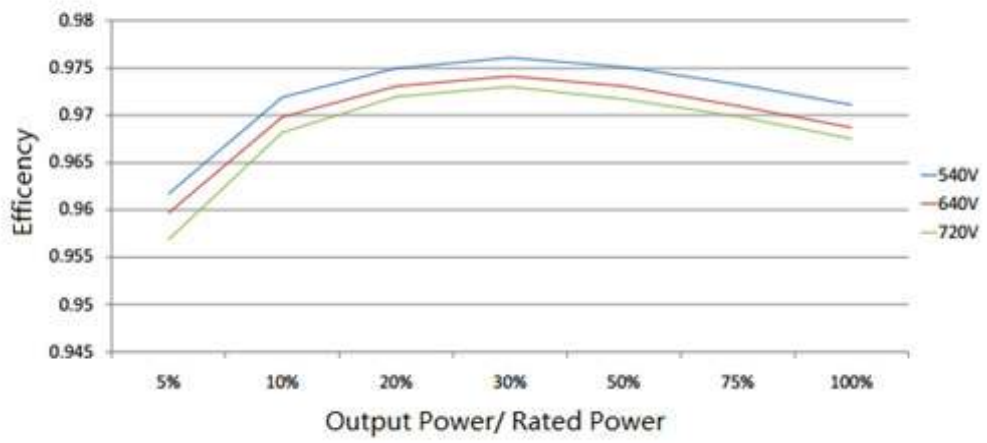
3. PCS

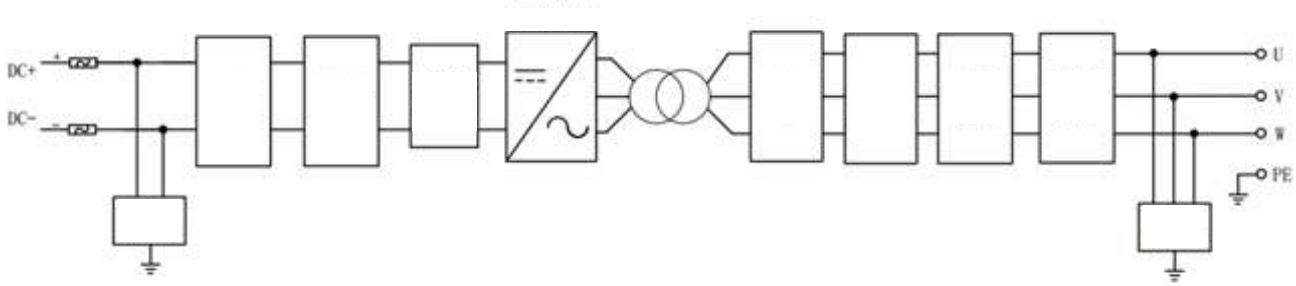
Product Features

- With bidirectional conversion, charging and discharging the battery.
- Charging with pre-charging, constant current charging, uniform charging, float charging mode.
- Built-in isolation transformer to ensure the electricity safety.
- Satisfied TUV. CE certifications.
- Advanced islanding detection technology.
- Low voltage enter, reactive power compensation.

BCS1000K-A Efficiency Curve



Function Block



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PCS Specification:

Item	Spec
DC	
Max. DC Power	500 KW
Max. DC Current	800 A
DC Voltage range	500 ~ 900 V
Adjustable current range	100 ~ 1000 A
DC Voltage Ripple	≤ 5%
Soft start function	Yes
MPPT Efficiency	99.90%
Grid Mode	
Phase Voltage range	90% UN ≤ U ≤ 110% UN (Adjustable)
Frequency range	49.5 Hz ~ 50.2 Hz (Adjustable)
Nominal AC Voltage	400 VAC
Power Factor (nominal power)	> 0.99
Max. Reactive power	± 250 kVar
THDi	< 3% (nominal power)
OFF-Grid Mode	
Rated voltage	380 V 50 Hz (Adjustable)
Output Voltage accuracy	± 1%
THDV	< 1% (Linear Load), < 5% (Non-Linear Load)
Resistive load over power	101% ~ 110% rated power 10 min protect, 110% rated power 10 s protect,
Power Factor (nominal power)	> 0.99
Output Voltage instability	± 5%
Parallel use	Support under OFF - Grid Mode
IP Grade	IP20
Altitude	5000 m (>2500 m derating)
Operating Environment	-35°C ~ 60°C, 0 ~ 95% (Non-condensation)
Rated AC Power	500 kW

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Others	
Dimensions (mm)	1000W*800D*2000H
Weight	1600 kg
IP Grade	IP20
Altitude	5000 m (> 2500 m derating)
Operating Environment	-25ºC ~ 55ºC, 0 ~ 95% (Non-condensation)

4. Fire extinguisher system

Fire system main features:

- The system can automaticlly detect fire, alarm and start the fire extinguishing system.
- Have three kinds of starting methods: automatic control, manual control and mechanical emergency operation.
- Independent emergency manual operating mechanism.
- Alarm bell and sound and light alarm.
- Self-test system, regular automatic inspection, monitoring faults and fault alarms.

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4.1 Automatic working mode

Control system is in automatic working state, automatically completes the whole process of fire detection, alarm, linkage control and fire extinguishing.

Steps:

Step 1: After a fire signal is detected by a detect circuit in the protection area, fire alarm controller activates the alarm bell in the protected zone and provides a fire pre-alarm signal.

Step 2: After the other detect system inside the same defence area defects the fire signal, the fire alarm control system activates the voice and light alarm from the defence, meanwhile, alert the people to escape. Then the airconditioner and airflow fan instruments will be cut off. The fire alarm system will enter into delayed period (0-30S).

Step 3: When the delay is over, fire alarm control system outputs active signal to activate the solenoid valve on the gas cylinder, and spray fire extinguishing agent into the protection area.
The fire alarm control system actives the deflation indicator of the protection area to remind the staff that on this protection area is spraying fire extinguishing agent and do not allow enter into.

4.2 Manual working mode

Emergency start
When the fire protection system is in the manual start state, fire alarm control system only sends out alarm signal, no output action signal. After the on-duty personnel confirm the fire alarm signal, press the emergency start button on the control panel of the fire alarm control system or the emergency start-stop button in the protection area to manually start the fire extinguishing device and spray the HFC-227EA fire extinguishing agent.

Emergency Stop
When the fire alarm control system into the 30s delayed period, if the on duty people confirms that it is a false alarm, can manually operate the emergency stop button on the control panel of the fire alarm control system or the emergency start-stop button in the protection area and stop spraying HFC-227EA fire extinguishing agent.

4.3 Mechanical emergency start mode

An emergency start is required only if both automatic and manual control fails or the system loses power. This moment can active the gas fire control system by operate the manual start device on the HFC-227EA fire extinguisher.

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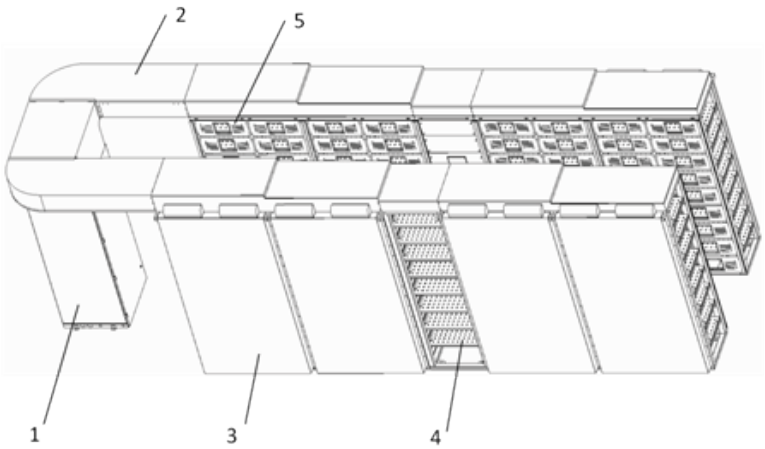
5. Temperature control system

In order to overcome the shortcomings of slow cooling and poor consistency of the existing battery compartment thermal management scheme, the utility model proposes a thermal management scheme using improved air ducts, wind walls and heat dissipation channels in the battery box to improve cooling efficiency and consistency.

The thermal management scheme of the energy storage container battery storehouse proposed by the utility model is that an industrial air conditioner is arranged at one end of the battery warehouse aisle, the maximum refrigeration capacity of the air conditioner is the same as the maximum heating power of all the batteries in the battery storehouse, the air supply and return mode of "top air supply and front air return" is adopted, the top air outlet of the air conditioner is connected with the air duct, and the air duct is installed above the battery rack along both sides of the aisle, and the air duct height is the direction decreases step by step. This design can make the air pressure of each outlet close to each other, and ensure the uniform outflow of cold air from each outlet. A wind wall is arranged between each battery rack and the wall of the warehouse. The upper part of the wind wall is connected with the air duct. The non blocked side of the wind wall is welded seamlessly at the edge and the battery rack. Its function is to guide the cold air flow from the air duct into each battery box evenly. Along the width direction of the battery box, a heat dissipation channel is arranged every two cores. The heat dissipation channel connects the wind wall and the walkway, enlarges the heat dissipation surface of the cores, and is conductive to uniform heat dissipation.

The utility model has the beneficial effects that the stepped air duct effectively equalizes the wind pressure, and realizes the even distribution of the cold air flow in each wind wall. The cold air is accurately guided to the heating electric core to realize efficient heat dissipation. The cold air is overflowed by the wind wall and evenly enter the heat dissipation channel of each battery box to improve the heat dissipation of the battery core.



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Industrial air conditioner

1. Placed at the end of the battery compartment aisle, on the air conditioning top is air supply and stepped air duct.

2. Connection: air duct outlets connected to the battery rack.

3. Wind wall.4. The unsealed side of the wind wall is seamlessly welded to the battery holder at the edge.

5. The battery box of the battery rack is placed horizontally, the front of the box is the battery compartment walkway, and the back is the wind wall.

6. 40ft container

The structural design of the mobile box energy storage power station is mainly composed of a 40-foot special container, with battery system, air conditioner cold system, fire protection system, bidirectional converter device, power distribution system, monitoring devices and thermal insulation devices.

Further description with the accompanying drawings

Diagram 1: Megawatt mobile box ESS structure oblique view.
Diagram 2: Schematic diagram of air-conditioned stepped structure air duct.
Diagram 3: Megawatt mobile box ESS structure assembly drawing.

As shown below:

1. air conditioning outdoor unit
2. air conditioning indoor unit
3. monitoring system cabinet
4. stepped air duct
5. fire protection system
6. bidirectional converter
7. sub-mother door
8. battery rack
9. main control frame
10. power distribution cabinet
11. battery rack air duct
12. double door
13. grid-type ventilation escape door
14. battery module
15. main control box.

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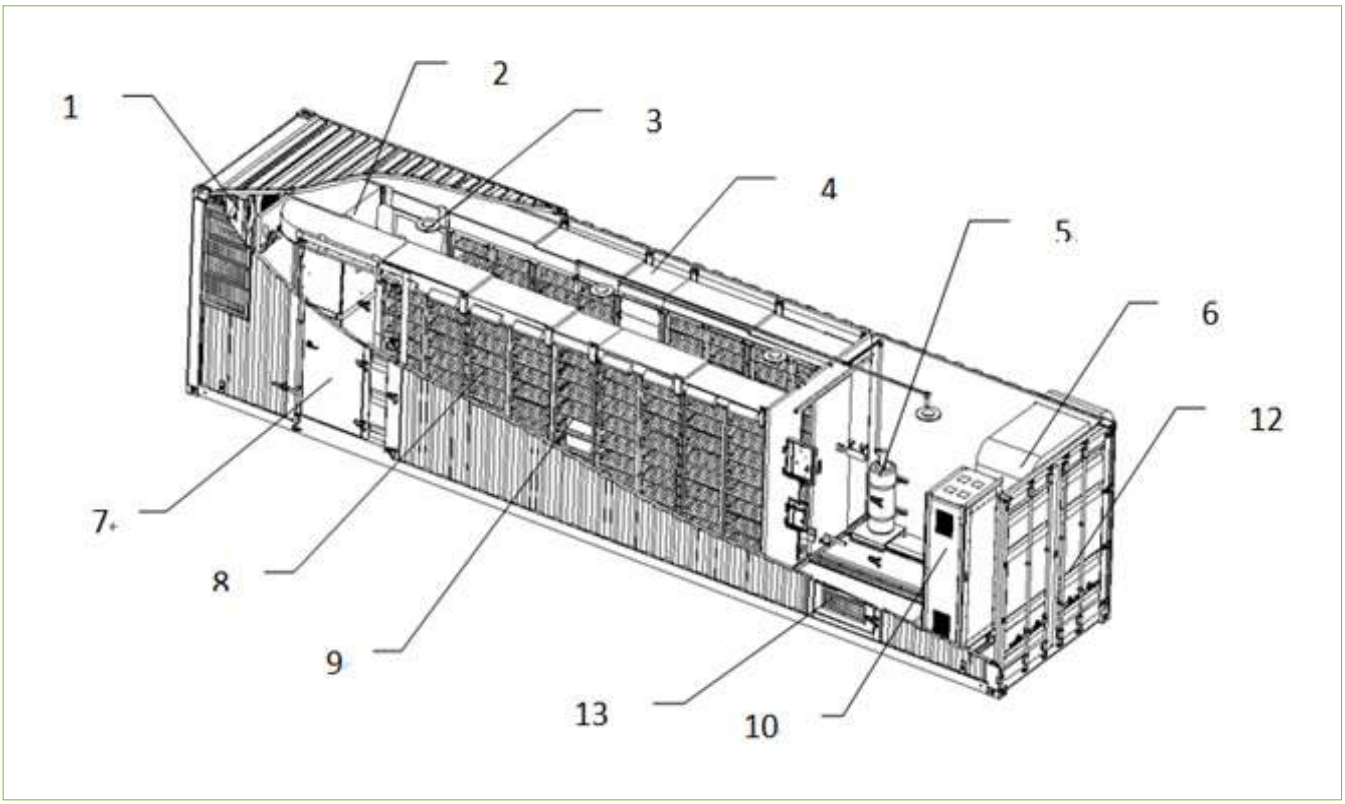

Diagram 1: Megawatt mobile box ESS structure oblique view

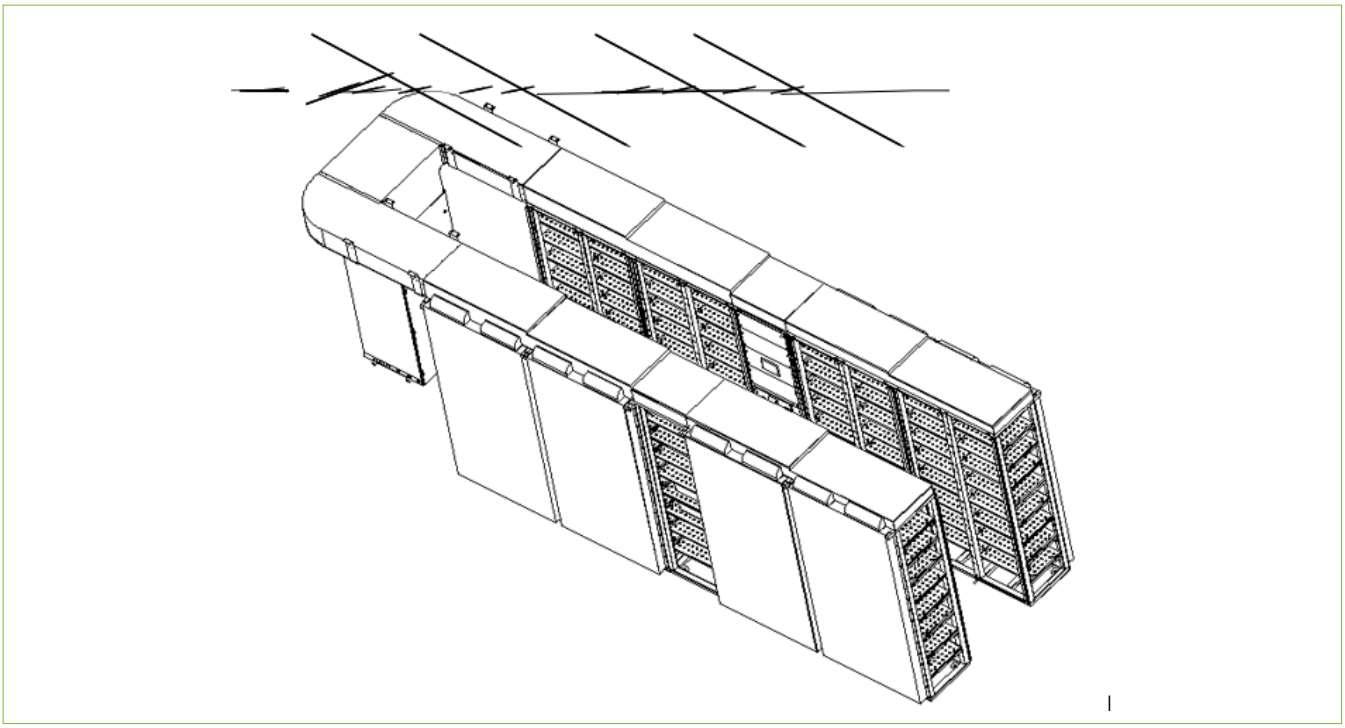

Diagram 2: Schematic diagram of air-conditioned stepped structure air duct

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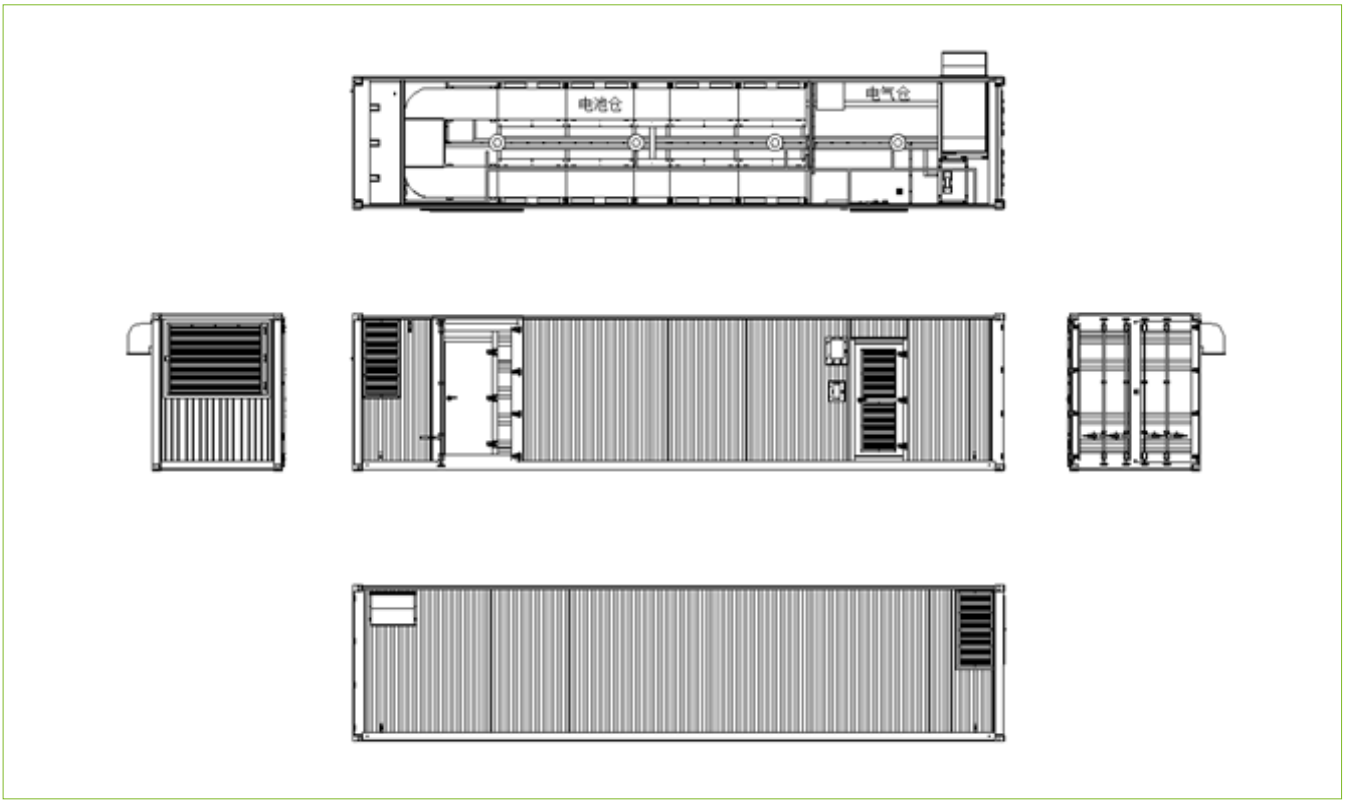

Diagram 3: Megawatt mobile box ESS structure assembly drawing

Diagram 4: Sample photo

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