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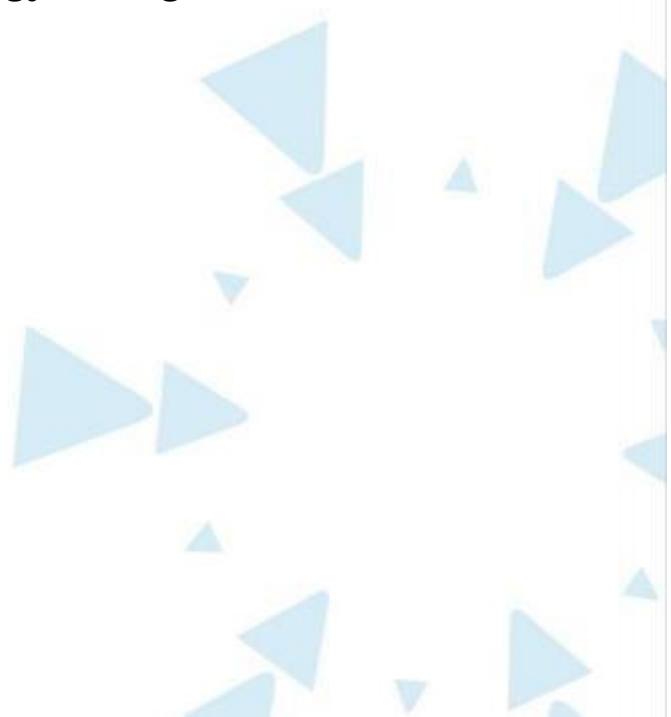
100 kW/233 kWh All-in-One Energy Storage Cabinet

Technical Specification

Product model:

100 kW/233 kWh All-in-One Energy Storage Cabinet

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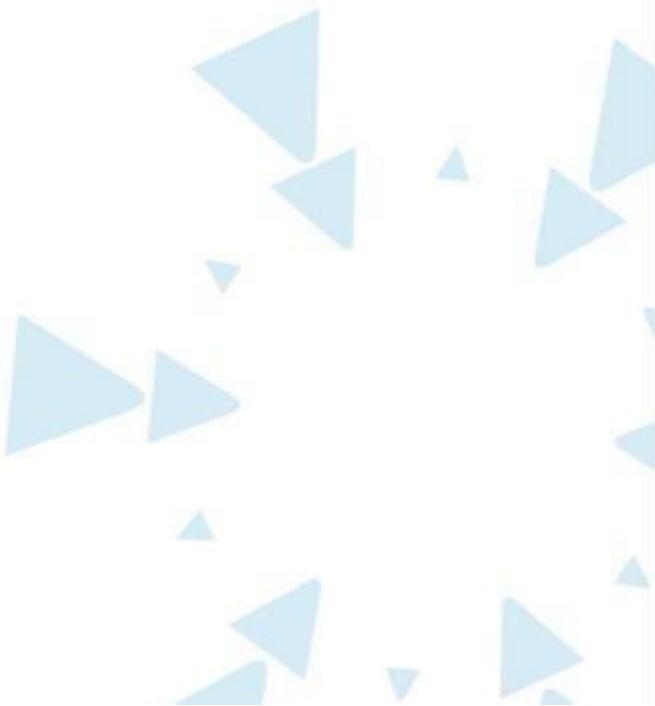
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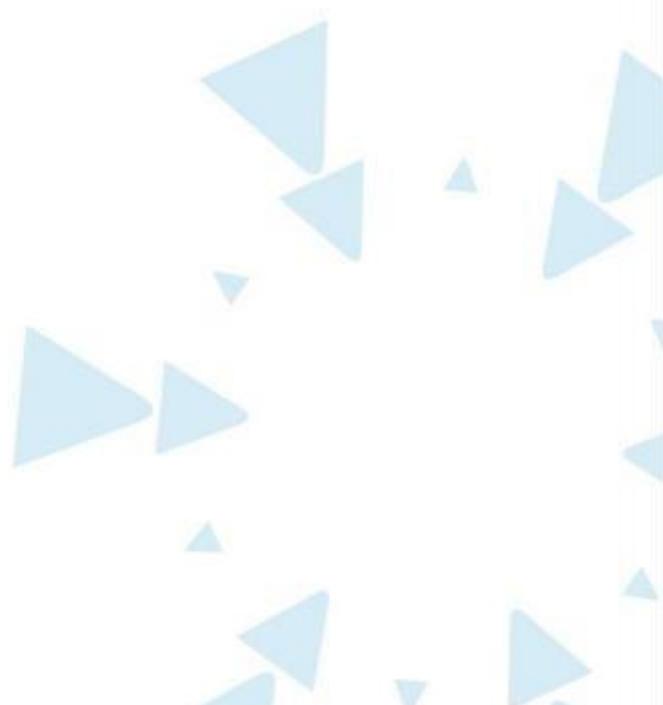
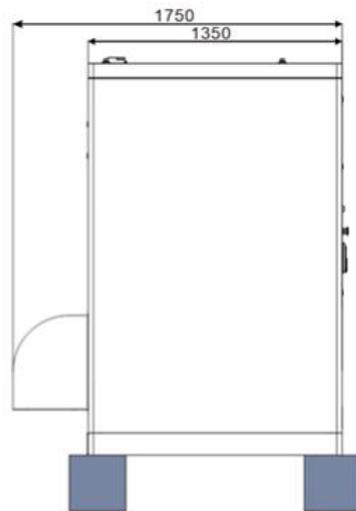
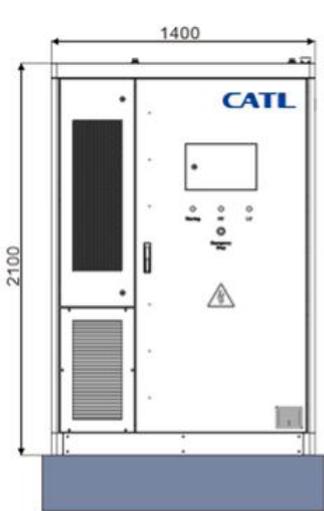
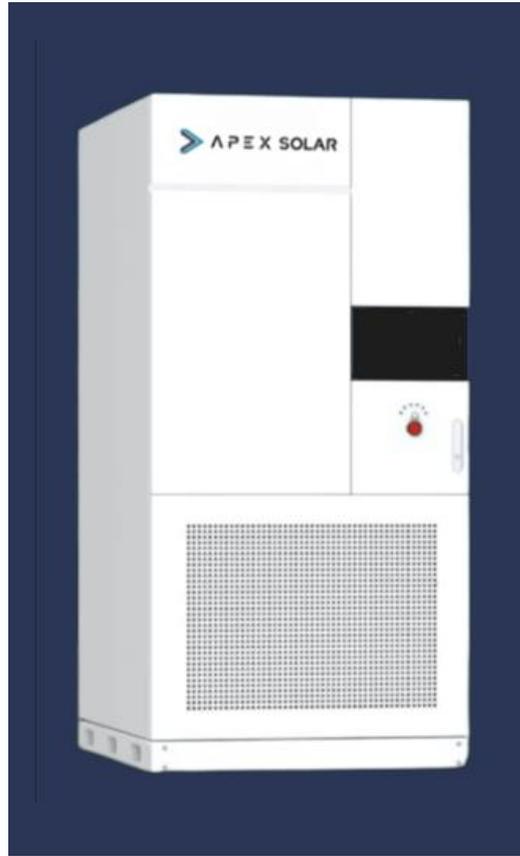
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Appearance





Appearance and dimensions

Notes: For foundation requirements, refer to the description in the construction drawing, which is available from the Product Manager of the Company on request.

The all-in-one energy storage cabinet selects 3.2 V/280 Ah LFP batteries (single module capacity of 46.6 kWh) for energy storage. The 1P5S battery configuration is used for a single cabinet (battery rack) with rated capacity

of 233 kWh. With two 50 kW power conversion systems (PCS) and operating in liquid cooling mode, the system can charge and discharge the energy storage battery system automatically in response to different application scenarios and meet technical requirements such as quality of electric energy, response to commands, and power control. The battery management system (BMS) works in a three-level control mode, that is, CSC, SBMU, and MBMU, and monitors and controls cell and system performance in real time. The energy management system (EMS), as the management center of the energy storage system, implements core functions including signal acquisition, communication management, logic control, and multi-level protection, in addition to querying operating incomes from energy storage systems, monitoring real-time system operation status, recording events, and generating alarm information.

Technical Specifications

Model	WH-TIANWU-100-233B
Battery Parameters	
Rated capacity (kWh)	233
Rated voltage (VDC)	832
Voltage range (VDC)	728-936
Battery type	LFP(LiFePO4)
Cell specification	3.2V/280Ah
Model specification	1P260S
AC Parameters (On-grid)	
Rated power (kW)	100
Max. power (kW)	110
Rated voltage (V)	400
Connection method	3W+PE

Frequency (Hz)	50/60
Power factor at nominal power/Adjustable power factor range	>0.99/1 lead – 1 lag
Adjustable reactive power range	-100 % – 100 %
THD THD	< 3% (nominal power)
Auxiliary supply voltage (V)/Max. power (kW)	230V,50/60Hz (L-N)/6
Basic Parameters	
Ingress protection	IP54
Isolation mode	Without transformer
Operating temperature	-20°C to 55°C (derating when the temperature is greater than 45°C)
Cooling method	Air cooling (PCS), liquid cooling (battery)
Max. operating altitude	Max. 2000 m
Communication interface	Modbus TCP/IP
Noise	<75dB
Size (W*D*H)	1100*2300*1300mm
Weight (kg) including battery	~<3000
Certificates and approvals (more information is available on request)	IEC62477,IEC62109,IEC61000-6-2/4, VDE4105,CEI-021

Functions and Features

Functions

The TIANWU-100-233-B energy storage system can run on grid or off grid.

On-grid mode

The AC side of the energy storage system is connected to the power grid and the DC side is internally connected to the battery pack. The product can be applied in power expansion, photovoltaic power

generation, energy storage, and charging power consumers, as well as peak-load shifting. The product can charge or discharge lithium batteries at constant voltage, current, and power according to the selected operation mode.

Off-grid mode

When connected to the power grid, the energy storage system can output three-phase AC voltage with fixed frequency and RMS. When used with a transformer, the system continuously supplies power to the loads on the AC side. When used with STS, the system can seamlessly switch between on-grid mode and off-grid mode.

Features

The energy storage system integrates the power supply and distribution system, monitoring system, environmental

control system, and fire suppression system, and features high safety and reliability, rapid deployment, low cost of ownership, high energy efficiency, and intelligent management.

Racks are optimized individually and energy is managed at the rack level to avoid parallel loop of battery racks.

Standard modules can be spliced as needed for easy maintenance and scaling up.

Liquid cooling, high energy density, low footprint, and highly consistent cell temperature

Cabinets can be connected in parallel.

Parts

Energy Storage Battery System

Taking into full account technology maturity, battery life, energy conversion efficiency, and energy density, this project selected CATL's 3.2 V, 280 Ah LFP batteries. The high battery consistency, world-leading BMS, and liquid cooling control technology guarantee the safety and reliability of batteries.

Battery

A battery pack contains 52 cells in series connection and one cell supervision circuit (CSC). A battery pack contains

eight NTC temperature sampling circuits and the cell supervision circuit collects cell voltage, current, and temperature inside the battery pack.

No.	Item	Specification	Notes	
1	Basic Parameter	Nominal Capacity (kWh)	46.59kWh	
2		Cell Number	52	
3		Cell Self-discharge Rate/month	≤3.5%	25°C, 30%SOC, 3□ months after new battery produced
4		Voltage Range (VDC)	145.6~187.2	CELL:2.8V~3.6V
5		Nominal Voltage (VDC)	166.4VDC	
6		Rated charging rate	0.5P	
7		Rated discharging rate	0.5P	
8		Maximum continuous current	160A 1min	
9		Equalization way	Passive equalization	
10	working environment	Charge/Discharge Temperature (°C)	Charging : 0~55°C Discharging : -20~55°C	
11		Storage Temperature(°C)	-30~60°C	
12		Recommended operating temperature	21±3°C , average21°C	
13	Auxiliary power supply	Voltage range	20~26V DC	
14		Power(CSC power)	2W	
15	General parameter	Dimension (W*D*H)(mm)	810mm(W)*1152mm(D)*243.4mm(H)	

16		Weight (kg)	330±10kg
17		IP code	IP66
18		Cooling mode	Liquid cooling
19		Communication	CAN
20	Test & Certification	Battery module	UN38.3
21			UL9540A(V3)

HV Box

Inside the HV box, secondary SBMU, DC fan, circuit breaker, fuse, and 24 V power supply are integrated.

The main features include the followings:

Battery rack current acquisition and total voltage acquisition

Power-off protection upon battery fault

Under the management of BMS, the module can separately implement capacity calibration and SOC calibration as the basis for subsequent charge and discharge management

The module acquires CSC information through CCAN and delivers the information to MBMU through MCAN.

Model	HVBX-A-140-01
Application scenario	Outdoors
DC rated voltage	DC1500V

DC rated current	140A
Max. power of auxiliary power supply	150W
Rated voltage of auxiliary power supply	220V , 50Hz
Communication protocol	CAN
Size (W*D*H)	664.54*749.49*221.5mm
Weight (approximate)	30kg

Battery Management System (BMS)

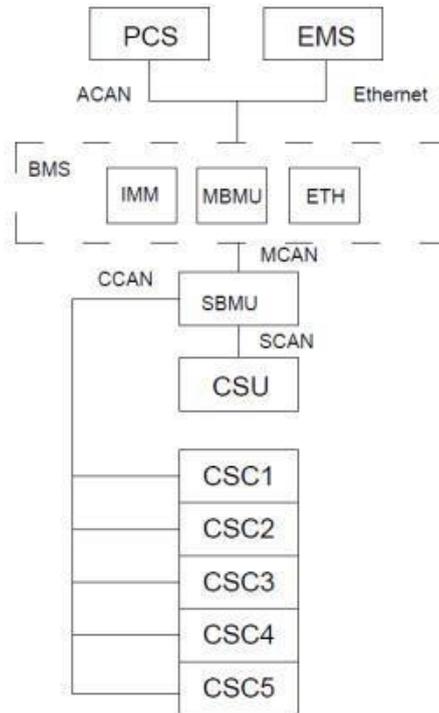
The battery management system (BMS) works in a three-level control mode, and each level implements the functionality as follows:

(1) The CSC in level 1 monitors the voltage and temperature of a single cell and the total voltage of a battery box, delivers the above information to the SBMU in level 2 over the CAN protocol or other bus communication protocol, a single cell.

(2) The SBMU in level 2 detects the total voltage and total current of the complete set of batteries, and delivers the above information to the MBMS in level 3 over the CAN protocol or other bus communication protocol. The SBMU can also display the capacity and health status of batteries when charging and discharging, predict the power, calculate the internal resistance, and control the equalization of unit voltage at the board level.

collects the information from the SBMU in level 2, estimates the remaining battery capacity in real time, predicts the power, calculates the internal resistance, controls the relay switch, and communicates with the upper and external systems over RS-485 or Modbus- TCP/IP.

Systemtopology



Item	Performance Parameter	Value	Note
Storage temperature	Range	-40°C ~ +85°C	
Operating temperature	Range	-40°C ~ +60°C	
Operating voltage	Range	20V~26V	All BMSs function well

Item	Performance Parameter	Value	Note
IP rating	Ingress protection	IP40D	

Item	Performance Parameter	Value	Note
Single-cell voltage sampling	Range	1V~4.85V	
	Accuracy	±5mV	0°C ~ +60°C
		±10mV	-40°C ~ 0°C or 60°C ~ 85°C
Number of single-cell voltage sampling channels	52/56	Up to 56 channels, configured as needed	
In-module cell temperature sampling	Range	-40°C ~ +125°C	
	Accuracy	±2°C	-20°C~+60°C
		±3°C	-40°C~-20°C&+60°C~+85°C
Number of temperature sampling channels	4+4+4+4	Up to 16 channels are supported for a single CSC	
Current sampling	Range	±500A	
	Period	10ms	
	Accuracy	<1%FSR	-40°C ~ 85°C
HV sampling	Range	0V ~ 1500V	
	Accuracy	1%FSR	
Equalizing	Equalizing current	100mA@3.2V	Can be enabled for all channels
SOC	Accuracy	<±5%	LFP,determinedby specificworking conditions
SOH	Accuracy	<±5%	
Ambient temperature detection	Range	-40°C ~ +85°C	
	Accuracy	±3°C	

Item	Performance Parameter	Value	Note
Insulation detection	Detection range	0 ~ 10MΩ	
	Accuracy	-30% ~ 0%	
	Detection time	≤10s	Single-sided Y capacitance < 0.47 μf

Local Controller (EMS-100)

EMS-100 is a master controller for the energy storage battery management system. It collects real-time data and fault information on the battery pack and implements fault protection and pick-up control. It also collects real-time operation data of the PCS and implements power control and fault protection. EMS-100 can be used with a chiller unit and a firefighting unit, and you can configure multiple control policies to guarantee the stable operation of the system.

Item Name	Parameter Description
CPU	ARM master controller, Cortex A7 kernel
Memory	512MB DDR3
Storage	4GB eMMC
Operating system	Linux
Interface	Ethernet: 2 ways, 10/100 Mbps, supporting Modbus TCP protocol

Item Name	Parameter Description
	<p>RS485: 4 ways, Modbus RTU</p> <p>CAN:2 ways</p> <p>DI: 4 ways, passive dry contact and wet contact (24 V\9 V)</p> <p>AI: 2 ways, current (4 mAto 20 mA), voltage (0 V to 5 V, 0 V to 10 V), resistance (for example, 0 k to 10 kor resistor type temperature-humidity sensor)</p> <p>DO: 4 ways, relay output (5 A@250 VAC/30 VDC)</p>
Power supply	200~240Vac
Operating temperature	-30~60°C
Storage temperature	-40~85°C
Operating temperature range	0 to 95% (without condensation)
Ingress protection	IP20
Anti-corrosion grade	C1
Size (WxHxD)	2U
Installation method	Rack-mounted or wall mounted

Power Conversion System (PCS)

The power conversion system features bidirectional conversion and has a series special properties and functions to charge and discharge the battery system in different application scenarios. The PCS operates automatically and the operation data is highly visualized. The display screen is used as the HMI, and users can view operation data, failure data, and failure history in real time on the touchscreen or by operating buttons. The PCS can operate in both on-grid and off-grid modes and two power conversion systems can be configured in one cabinet.

Model	WH-BEC-50AC
Rated power	50kW
Max. power	55kW
DC operating voltage range	500V~950V
DC-side full-load voltage range	600V~950V
Max. DC current	110A
Rated AC voltage	400Vac 3W+PE
Rated frequency	50/60Hz (±5Hz)
Rated alternating current	72A
Overload capacity	normal operation at 110% of rated load, and one minute at 120% of rated load
Current distortion	< 3% (rated power)
Power factor adjusting range	-1 lead to +1 lag
Unbalanced loading capacity	100%

Model	WH-BEC-50AC
Applicable batteries	Lithium battery/lead-acid battery/photovoltaic module/DC bus
Charging method	As instructed by the BMS/three-sectional/MPPT
Operation mode	Constant current, constant power, MPPT, AC voltage source
Max. efficiency	98.5%
Size (W*D*H)	483 (444 when the mounting lug is excluded)*600*150 mm
Weight (approximate value)	35 kg
Isolation mode	Non-isolation
Ingress protection	IP21
Operating temperature	-25°C to 55°C (derating when the temperature is greater than 45°C)
Relative humidity	0 to 95% (without condensation)
Cooling method	Smart air cooling
Noise	<70dB
Altitude	3000 m (derating when the altitude is higher than 3000 m)
Communication interface	CAN

Liquid Cooling System

The liquid cooling unit is an integrated design with all components encapsulated in a casing and can be easily installed. Featuring modular design and compact structure, the unit can be easily embedded in the customer's machine frame to save space. The chiller unit is used to adjust the temperature of the battery pack in the energy

storage system to ensure that the battery pack always works within the appropriate temperature range to maintain the best working condition of the system.

The main features include the followings:

I. Smart refrigeration

The chiller unit monitors the temperature at the liquid outlet in real-time, and makes intelligent adjustments according to the target temperature setting, so that the operating temperature of the battery in the container keeps stable within the appropriate range.

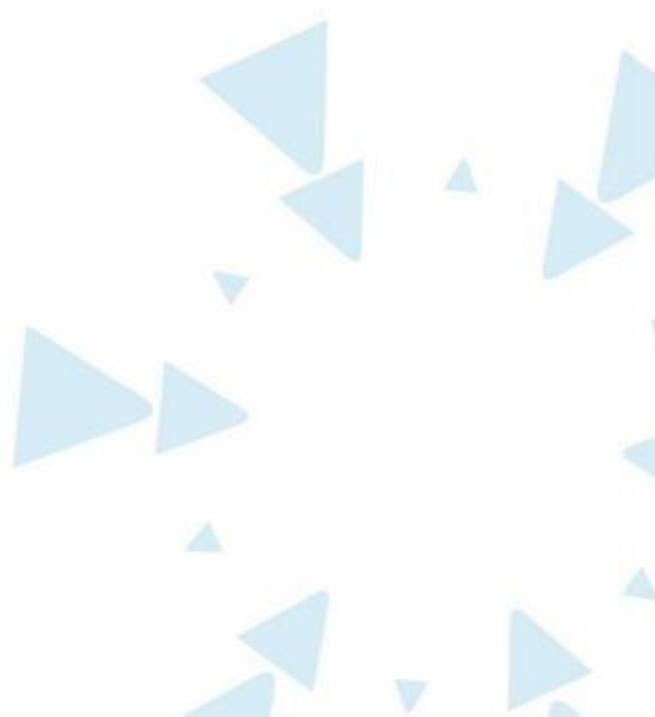
When the temperature at the liquid outlet is higher than the refrigeration setpoint and the refrigeration enabling condition is met, the air-cooled chiller unit starts refrigeration and outputs different cooling capacities according to the actual temperature.

When the temperature at the liquid outlet is lower than the refrigeration setpoint, the air-cooled chiller unit saves energy by shutting down the compressor and reducing the speed of the circulating water pump.

II. Electric heating

In a low-temperature environment, the coolant temperature is low when the batteries in the container are not charged or discharged. When the temperature at the liquid outlet is lower than the heating setpoint and the heating enabling condition is met, the chiller unit starts heating to ensure that the batteries are within the appropriate temperature range.

III. Remote monitoring



The chiller unit communicates with the host computer over Modbus/CAN protocol through RS485/CAN interface. On the host computer, users can remotely turn on or off the chiller unit, query the running status of parts of the air conditioning unit, and set control parameters through message interaction.

IV. Replenishment

Connect the chiller unit to the replenishment tooling. The replenishing pump in the replenishment tooling automatically pumps the coolant stored in the water tank into the circulation system to realize rapid replenishment.

Specification	Value
Operating voltage range	200~240VAC±10% , 50/60Hz 200 to 240 VAC ± 10%, 50/60 Hz (Supporting dual live line inputs, 110 VAC , 60 Hz)
Operatin ambient temperature range	-30°C ~ +55°C
Operating relative humidity range	5% ~ 95%
Storage temperature range	-40°C ~ +70°C
Storage humidityrange	5% ~ 95%
Transport	Land transport, air transport, and sea transport
Operating altitude	0 m to 4000 m Performance degraded for every increase of 1000m from 1000m to 4000m altitude 3%.
Size (WxDxH)	275mmx1185mmx1074mm

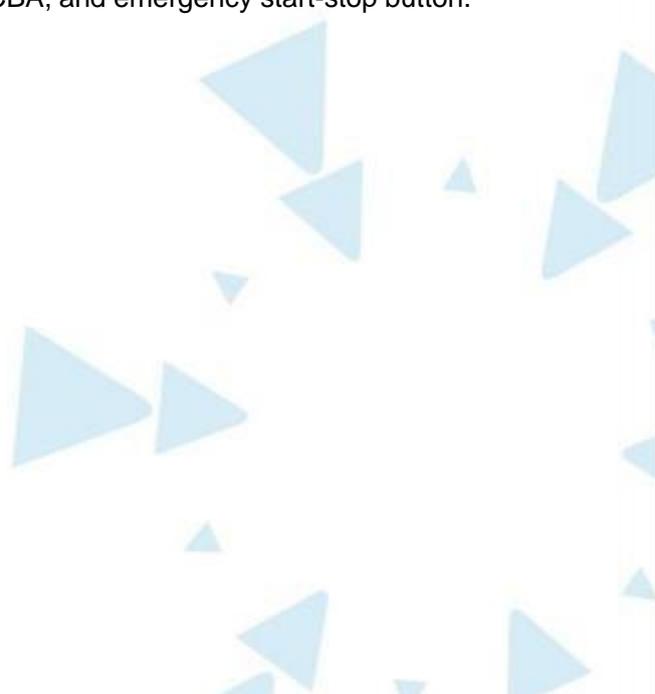
Fire Control System

The detector integrates a variety of detection sensors such as temperature, smoke, CO and electrolyte volatile gas and can detect various conditions of thermal runaway of batteries. The detector detects fire hazards in the battery pack and smartly identifies and suppresses incipient fire, and features early warning of thermal runaway, automatic extinguishing, and automatic start of fire extinguishing. There are four alarm levels, corresponding to incubation period, early warning period, alarm period, and open flame period throughout the fire development.

The QRR0.3G/S-Q condensed aerosol fire suppression device is a new and world-leading type of highly efficient environment-friendly fire suppression product that is domestically pioneered in China. When the QRR0.1G/S-Q condensed aerosol fire suppression device receives the start signal, the aerosol generator in the cartridge will be activated to decompose the chemical coolant on the upper layer so that the aerosol generator and the coolant work together to suppress a fire.

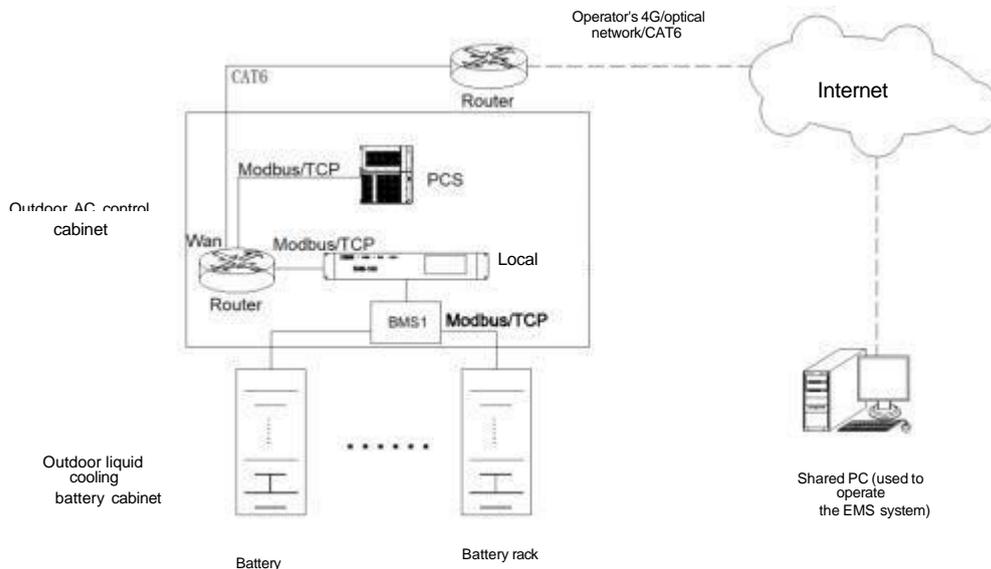
As the main fire control system in the cabinet, the fire alarm control panel features detector data acquisition, fire extinguisher startup, audible and visual alarm control, and in-station control system linkage communication.

This emergency start-stop switch integrates auto and manual control, forced start, emergency stop, and fire alarm indicators, and consists of casing, backplate, PCBA, and emergency start-stop button.



Energy Management System (EMS)

Communication Architecture



Communication architecture diagram

The PANGU EMS (Cloud version) uses a hierarchical communication architecture. Inside the cabinet, PCS, BMS, fire control system, liquid cooling unit, electricity meter, and other equipment are directly connected to the local controller over the TCP protocol to execute core communication instructions in the cabinet, maximizing the communication quality and control effect.

The PANGU EMS system (Cloud version) communicates with the local controller inside the cabinet over the MODBUS TCP protocol and only adjusts related power instructions, monitors metric data and executes necessary calculations, offering a user-friendly operation interface for maintenance staff. The local controller EMS-100 can keep the control system inside the cabinet alive when the PANGU system experiences network exception for some reason.

Smart Management

Features

Priority

The EMS power scheduling priorities are sorted from high to low as follows:

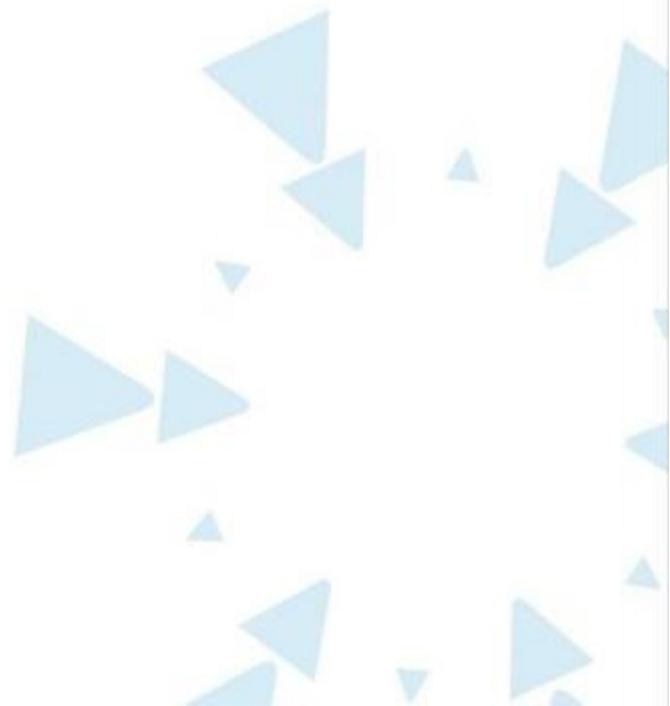
- Battery power limit boundary given by the BMS
- SoC discharge lower limit
- Output capacity limit on the electricity meter side
- Reverse current prevention limit on the electricity side
- Set point for real-time charge & discharge control

Control Boundary Limitations

Battery power limit boundary given by the BMS

When the battery is at high or low temperature or is fully charged or discharged, or the voltage is too high or too low, the BMS will give a charge and discharge current limit value allowed by the manufacturer for the current BMS.

This limit value is generally the safety boundary of the battery and should not be exceeded.



SoC discharge lower limit

This lower limit, for example, 10%, indicates the minimum capacity that the battery can discharge to as set by the user. The battery will stop discharging when the battery capacity is lower than this value to extend the battery life.

Output capacity limit on the electricity meter side

The output capacity limit or demand power limit on the electricity meter side represents the maximum power value output from the transformer. This power should not be exceeded. Otherwise, tripping will occur.

Reverse current prevention limit on the electricity side

Discharging to the power grid is generally not allowed. The EMS Kernel will schedule the charge and discharge process according to this value. If reverse current to the power grid exists, the battery will be charged to prevent energy from returning to the power grid.

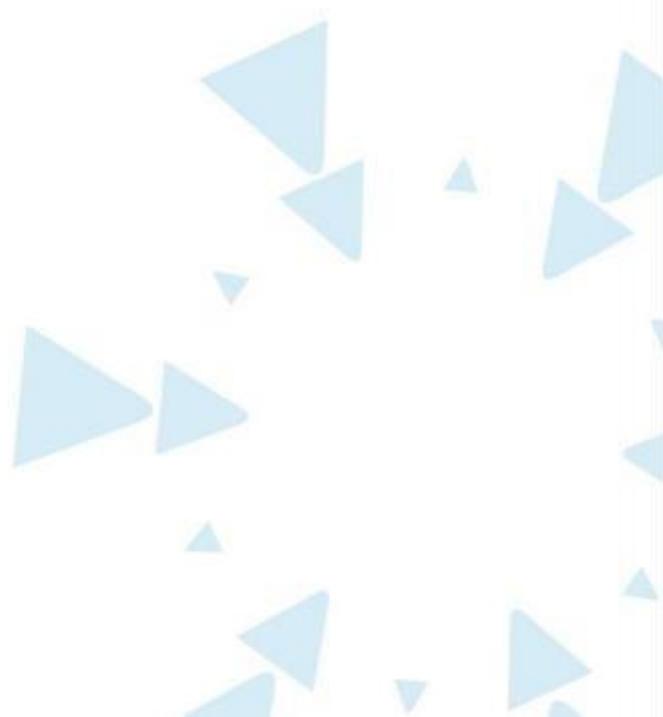
This option is usually used in self-consumption scenarios where a PV system is connected.

Set point for real-time charge & discharge control

The EMS Kernel supports time-sharing container power instruction settings for configuring up to 24 policies per day, seven days a week.

Introductions to Features

Calculation of operating incomes from energy storage systems



Query the operating incomes from energy storage systems by segments: Including incomes from charge and discharge processes of energy storage systems, from demand control, and from PV power generation. Users can export income reports.

Users can adjust electricity prices by configuring electricity prices/time periods to guarantee the accuracy of income data.

Real-time metric monitoring

Metric monitoring of PCS: Operating status, operating data, charge and discharge power curve, analog I/O and other metrics.

Metric monitoring of BMS: Operating status, SOC/SOH, operating data, battery rack data, and cell data.

Metric monitoring of AC and fire control system: Data of AC (humidity and temperature), operating status of AC and fire control system.

Alarms & events

Alarms: Users can record all alarms of the energy storage system in realtime, and can also query alarms by time range, alarm name, alarm ID, confirmed/unconfirmed, alarm type (warning or failure), and identify alarm information manually.

Events: Users can record all events of the energy storage system, and query events by time range and event priority.

Reports

Users can display data in daily report, monthly report, or yearly report, and can also export all data in reports.

Data in reports includes total PV generation, total power drew from grid, power generation capacity fed to grid, direct power draw, battery charge and discharge capacity, alarm count, and fault count.

History curve

Users can query history curves by time range, including charge power curve, original demand curve, actual demand curve, BMS-SOC curve, BMS-voltage curve, and single-cell voltage & temperature curve. Users can also export all curves.

System configuration

Forced start/stop is supported.

The system status is displayed.

Accountpermissionmanagemet

Users can edit their accounts, including addition, deletion, and modification.

Users can edit role permissions, including addition, deletion, and modification.

Setting

Users can change account passwords.

Active Safety Protection

Communication breakdown: When communication breakdown occurs in subsystems, load shedding or protection mechanism can be automatically triggered as appropriate.

Fire control system: The fire control system stops when an exception occurs.

Liquid cooling unit: Power off when an exception occurs.

PCS: Power off when an exception occurs.

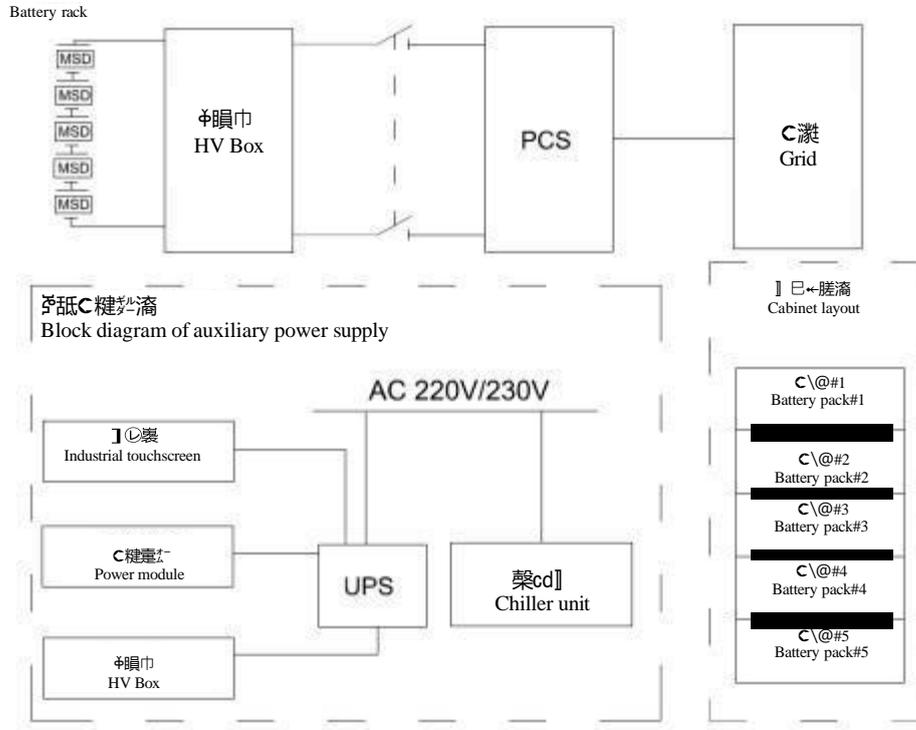
BMS: Power off when an exception occurs.

Power outage: Power off with the UPS operating.

Duplex communication.

System schematic diagram

System schematic diagram



Equipment States

There are five states for the energy storage system including running, shutdown, fault, standby, and offline.

Equipment States	Description
Running	The energy storage system stores external direct current into battery packs or discharges battery packs' electric energy to outside units.
Shutdown	The energy storage system stops charging and discharging and powers off battery packs.
Fault	The equipment is faulty when a fault is detected.
Standby	The equipment is in standby mode.
Offline	The EMS is disconnected from the display screen.