Fusion SolarCI V800R024C00 C&I ESS On-Grid Solution Technical Proposal

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HUAWEI TECHNOLOGIES CO., LTD.

Huawei Technologies Co., Ltd.

Address:	Huawei Industrial Base Bantian, Longgang Shenzhen 518129 People's Republic of China
Website:	https://www.huawei.com/
Email:	support@huawei.com

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Contents

1 About This Document

Purpose

This document describes the commercial and industrial (C&I) on-grid energy storage system (ESS) solution in terms of its composition, main devices, communications networking in various scenarios, and device list.

Intended Audience

The document is intended for:

- Installation and commissioning engineers
- Onsite maintenance engineers
- Product delivery engineers
- System maintenance engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Supplements the important information in the main text.

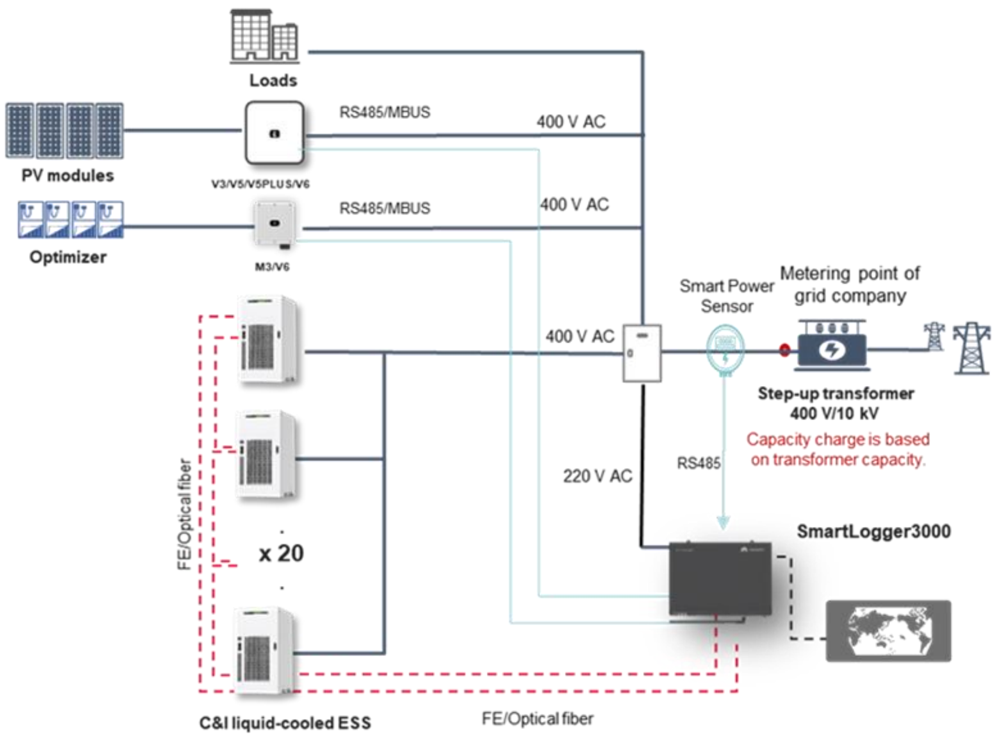
Symbol	Description
	NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

2 Architecture and Features of the C&I ESS Solution

2.1 Architecture

The C&I ESS system is connected to the grid using AC coupling. The solution consists of the following devices:

Figure 2-1 C&I ESS solution panorama



- Smart String ESS
- Smart Module (optimizer)
- Smart PV Controller
- SmartLogger
- Smart Power Sensor (power meter at the grid connection point)
- Smart PV Management System (SmartPVMS)

2.2 Features

Customer Benefits	Key Performance	Feature Description
C2C electrical and thermal safety	C2C electrical safety	Short circuit prevention and isolation: dual-level intelligent cell monitoring, strong insulation on six sides of a battery pack, five-level system protection, and round-the-clock consumption assurance
	C2C thermal safety	Fire mitigation and suppression: cell-level thermal suppression, pack-level exhaust, system-level fire suppression, and top-mounted explosion vent
Lower LCOS	More dischargeable energy	Refined management and smart algorithms: ultimate efficiency, maximum RTE ≥ 91.3%, pack-level optimization 2.0, real-time active balancing, 2% more throughput, and phase-level control to support 100% imbalanced three-phase output
	Lower CAPEX	Three-sided cabinet layout, saving space and improving energy density per unit area by 8%; transported with prefabricated components in a 20-foot container, reducing the transportation cost by 20%; no trenching or external auxiliary power cable, reducing installation costs; transformerless in off-grid scenarios, reducing system investment by 5%
	Lower OPEX	Pack-level automatic SOC calibration, eliminating the need for manual site visits; no need of coolant change for 10 years, reducing labor costs and leakage risks
	Smart air and liquid	Low energy consumption:

Customer Benefits	Key Performance	Feature Description
	cooling	intelligent cooling router for intelligent multi-mode switching, reducing energy consumption by 30%; slow degradation: triple cooling techniques for reducing system degradation speed; high reliability: automotive-grade liquid cooling system, full-range anti-condensation, failure rate reduced by 60%
One for all	Intelligent O&M	Four-layer refined monitoring is implemented from the cell level to the PV+ESS system level to clearly locate faults. Early warning on 13 types of faults, SOH analysis, and cell voltage/temperature/SOC consistency analysis help users identify abnormal cell units in seconds.
	Smart design	SmartDesign 2.0, optimal solution design within 1 minute, and hour-level accurate benefit analysis: Minute-level optimal design: The smart design algorithm recommends an optimal PV+ESS capacity solution within 1 minute. Hour-level investment analysis: Annual hour-level PV energy yield prediction is used with ESS operation policies to allow for accurate project ROI calculation.

3 Introduction to Devices in the C&I ESS Solution

3.1 Smart String ESS Configuration

The configurations of the Smart String ESS (ESS for short) vary with the power grid voltage level and fire suppression requirements. The following models are available: LUNA2000-215-2S10, LUNA2000-161-2S11, and LUNA2000-107-1S11. For details, see the following table.

Model	LUNA2000-215-2S10	LUNA2000-161-2S11	LUNA2000-107-1S11
Overview	0.5C, without DCDC, 380/400/415 V AC output	0.67C, with DCDC, 380/400/415/420/440/480 V AC output	1C, with DCDC, 380/400/415/420/440/480 V AC output
Nominal energy of a battery rack (kWh)	215.0	161.3	107.5
Rated charge/discharge rate of a battery rack (C)	0.5	0.67	1
Battery pack model	LUNA2000-54-2E1	LUNA2000-54-1E1	LUNA2000-54-1E1
Rated battery capacity (Ah)	280.0	280.0	280.0
Battery rack configuration	(1P60S)4S	(1P60S)3S	(1P60S)2S
Rated power grid voltage (V)	380/400/415	380/400/415/420/440/480	380/400/415/420/440/480

DCDC configuration of a battery rack	0	1	1
PCS configuration of a battery rack	1	1	1
Rack control module (RCM) disconnector	0	0	0
Pack-level optimization 2.0	4	3	2
GTM region	Global	Outside China	Outside China
Aerosol	1	1	1
Explosion vent	Top-mounted explosion vent	Top-mounted explosion vent	Top-mounted explosion vent
EMC level	Class B	Class B	Class B
Certification standards	GB/T 36276-2018, IEC 62619, IEC 62477-1, etc.	IEC 62619, IEC 62477-1, etc.	IEC 62619, IEC 62477-1, etc.

- The LUNA2000-215-2S10 manufactured in and before December 2024 does not support the on/off-grid function or the phase-level zero power control function.
- Currently, LUNA2000-107-1S11 and LUNA2000-161-2S11 support only the on-grid solution.

3.2 Overview of Devices in the C&I ESS Solution

3.2.1 Smart String ESS

The LUNA2000-215-2S10, LUNA2000-161-2S11, and LUNA2000-107-1S11 Smart String ESSs (ESS for short) can be charged from or discharge energy to an external grid through the rectification of a Smart PCS to support the maximum self-consumption of PV power, time-of-use (TOU) arbitrage, and reduction of the capacity charge.

The ESS is a prefabricated all-in-one energy storage system that integrates the prefabricated modular structure system, power supply and distribution system, monitoring system, environment control system, fire suppression system, and integrated cabling system. It features high safety and reliability, fast deployment, low cost, high efficiency, and intelligent management.

Figure 3-1 LUNA2000-215-2S10, LUNA2000-161-2S11, and LUNA2000-107-1S11 Smart String ESSs

3.2.1.1 System Architecture Design

The C&I Smart String ESS supports rack-level management, pack-level active balancing, intelligent temperature control, independent ventilation duct, top-mounted explosion vent, and centralized fire suppression (optional). The ESS supports three-sided cabinet layout. The battery packs and power modules are installed in different cabins. The Liquid Thermal Management System (LTMS) is mounted on the door. The ESS has an all-in-one architecture. Only AC output power cables and communications cables need to be installed onsite.

The following figures show the physical layout of modules such as the battery packs, main power DCDC, main power PCS, RCM, power distribution unit, LTMS, sensor, and fire suppression system.

Figure 3-2 ESS AC coupling 0.5C: 4-pack physical architecture

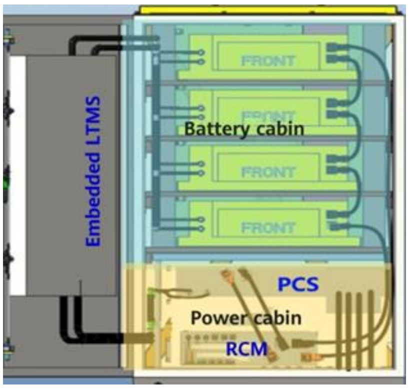


Figure 3-3 ESS AC coupling 0.67C: 3-pack physical architecture

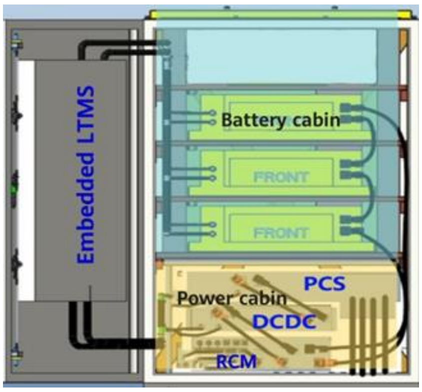
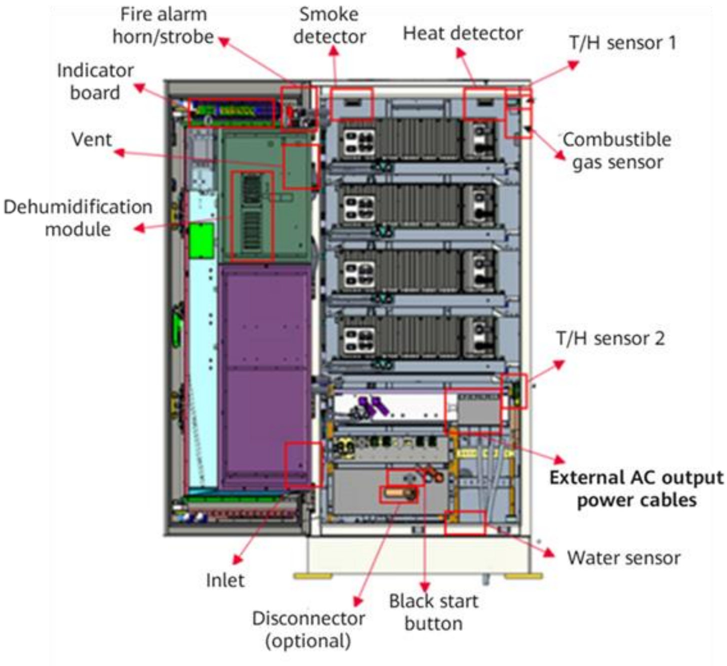


Figure 3-4 ESS interior



3.2.1.2 Module Functions

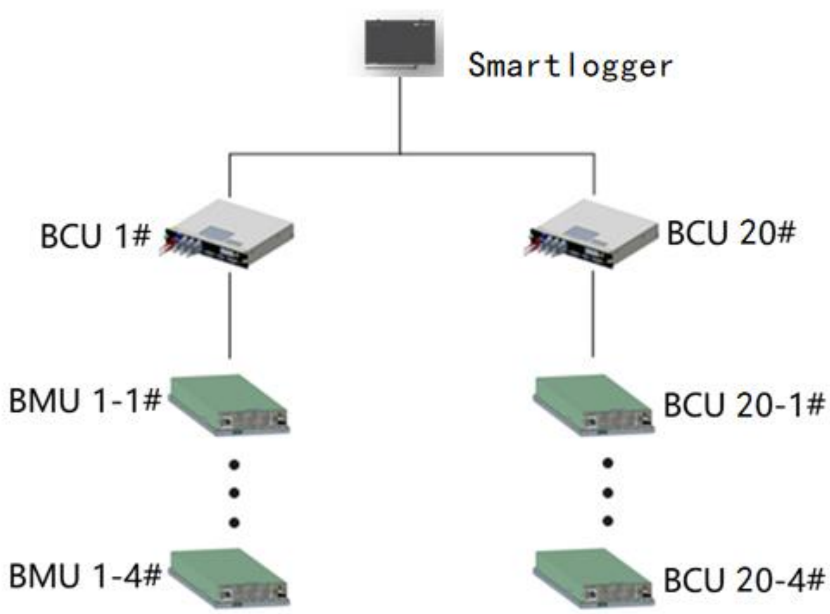
1. RCM: consists of the battery control unit (BCU), rack power control board (RPCB), contactor, fuse, power copper bar, and heat dissipation fan. The RPCB contains the low-voltage auxiliary power supply for the ESS and provides two 12 V DC power supplies, one for the LTMS and the other for low-voltage electrical devices. The BCU is the main control unit of the ESS. It communicates with external devices in the northbound direction and controls and manages internal devices in the southbound direction. The RCM also provides an independent 220 V AC power supply for air conditioners, which is controlled by a circuit breaker.
2. Main power PCS: converts 648–864 V DC voltage into 380–480 V AC voltage, supports 3-phase 4-wire and 100% imbalanced loads, uses CAN FD for communication, and supports hardware rapid shutdown.
3. Main power DCDC: converts the DC voltage of the battery racks into stable 760 V DC voltage (adjusted as required) to match the PCS, uses CAN for communication, and supports hardware rapid shutdown.
4. Battery pack: is composed of cells connected in series and parallel (1P60S in this solution). It is the minimum energy storage unit that stores or provides energy. Data such as the battery voltage, battery current, and battery temperature is reported.
5. LTMS: includes a highly integrated thermal management module developed by Huawei. It ensures the optimal operating temperature for each module of the ESS and optimal temperature and humidity inside the cabinet through adaptive adjustment and control.
6. General power distribution unit: adopts 1000 V DC high-voltage DC design for fault isolation or power-off maintenance

3.2.1.3 Monitoring System

The internal monitoring unit of the ESS consists of the BCU and battery monitoring unit (BMU). The external monitoring unit of the ESS is the SmartLogger. In the single-cabinet scenario, the SmartLogger can be placed inside or outside the ESS.

Level	Function
Level 1: battery monitoring unit (BMU)	1. Monitors cell voltage and temperature, and aggregates and reports the collected data. 2. Checks the sampling circuit in real time, ensuring sampling reliability. 3. Activates the active balancing module in the pack.
Level 2: battery control unit (BCU)	1. Receives the cell voltage and temperature reported by the BMU through daisy chain communication. 2. Controls the active balancing module in the pack through CAN communication and balancing capabilities between packs. 3. Receives the total rack voltage and current reported by the RPCB and calculates the SOC. 4. Calculates the battery rack SOH. 5. Manages the normal operation and alarm information of batteries in the rack, controls the charge and discharge currents of the battery rack based on control requirements, and delivers balancing commands based on the battery status in the rack. 6. Connects to the environment management system and fire suppression system in the southbound direction to monitor the operating environment and fire protection status of the ESS. 7. Obtains the alarms and protection status of the ESS to ensure the safe operation of the system.

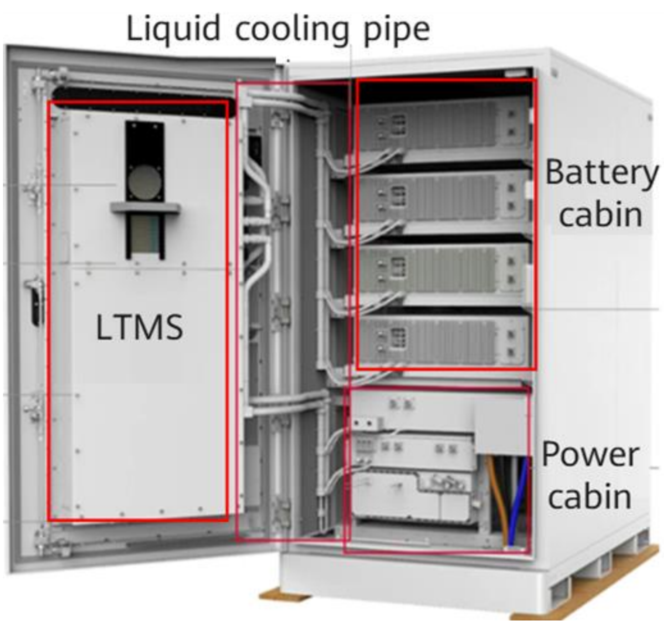
Figure 3-5 Monitoring unit networking



3.2.1.4 Temperature Control System

The C&I liquid-cooled ESS consists of a battery cabin and a power cabin. The LTMS is embedded in the ESS to improve space utilization. The LTMS provides cold or hot coolant (with a 50% volume concentration of ethylene glycol solution). The circulating pump in the LTMS transmits the cold or hot coolant to the battery cabin. The coolant exchanges heat with the cold plate at the bottom of the battery pack to keep the pack temperature within a constant range.

Figure 3-6 Embedded LTMS

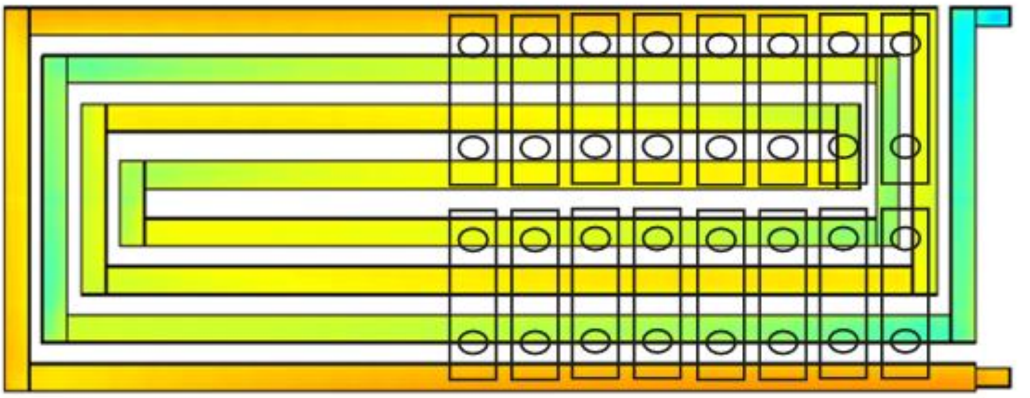


The Huawei-developed LTMS consists of the compressor, fan, heating pump, heat exchanger, and multi-way valve. It automatically adjusts the eight-way valve and control module to meet different cooling requirements, allowing the ESS to operate properly in different outdoor environments. The LTMS includes a highly integrated thermal management module developed by Huawei. It ensures the optimal operating temperature for each module of the ESS and optimal temperature and humidity inside the cabinet through adaptive adjustment and control. The LTMS can intelligently select a cooling or heating mode. There are six modes:

- Active liquid cooling: When the ambient temperature outside the cabinet is high, the system switches to the active liquid cooling mode and provides cold coolant (with a 50% volume concentration of ethylene glycol solution) through the compressor. The pump transmits the low-temperature cold coolant to the battery pack cold plate to cool the battery pack, and transmits the cold coolant with a relatively high temperature to the PCS cold plate to cool the PCS.
- Natural air cooling: When the ambient temperature outside the cabinet is relatively low, the coolant exchanges heat with the external air through the heat sink to provide cold coolant for the heat generation modules (battery packs and PCSs). Under the same conditions, natural air cooling reduces the auxiliary power consumption of the ESS by about 50% compared with compressor cooling. When the ambient temperature is relatively low, the system preferentially switches to the natural air cooling mode. This reduces the auxiliary power consumption and improves the cycle efficiency and 24-hour comprehensive energy efficiency of the ESS.
- Electric heating: When the ambient temperature outside the cabinet is lower than –5°C and the battery temperature needs to be raised, the system automatically selects the electric heating mode and enables the PTC electric heater to provide hot coolant with the required temperature for the battery pack. When the battery temperature reaches the heating stop threshold, the PTC electric heater stops running.
- Heating through heat pump: When the ambient temperature outside the cabinet is higher than –5°C and the battery temperature needs to be raised, the system automatically enables the heat pump to provide hot coolant with the required temperature for the battery pack. When the battery temperature reaches the heating stop threshold, the heat pump stops running. Compared with the electric heater, the heat pump mode consumes less auxiliary power.
- Waste heat recovery: When the ambient temperature outside the cabinet is low, the battery pack needs to be heated, and the PCS generates heat during operation, the system automatically switches to this mode. By switching the mode inside the coolant pipe system, the system transfers the heat in the PCS to the battery pack with coolant as the carrier, making full use of the waste heat in the power cabin.
- Intra-cabinet intelligent dehumidification and cooling: When the air humidity inside the cabinet is high, the system automatically starts the intelligent dehumidification module in the LTMS to dehumidify the air till the specified dehumidification stop threshold. When the temperature inside the cabinet is high, the system starts the compressor and fan of the LTMS to supply low-temperature dry air to the cabinet. This scheme can effectively reduce the humidity and temperature inside the cabinet to improve system reliability. It does not require an additional dehumidification system, which is mandatory in other vendors' solutions, and makes the software control logic more intelligent. In addition, the liquid-cooled ESS can transmit cold air to control the temperature inside the cabinet.

The bottom cold plate of the pack adopts the multi-homocentric flow path design that implements single-pipe flow and ultra-low flow resistance. The jet impingement cooling inside the pipe produces good cooling effect. The inlet and outlet are located at the same position, offering better temperature uniformity compared with the traditional U-shaped flow path.

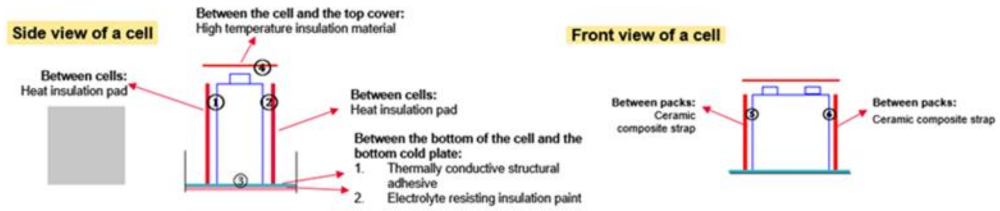
Figure 3-7 Multi-homocentric flow path of the bottom cold plate of the pack



3.2.1.5 Electrical Safety Design

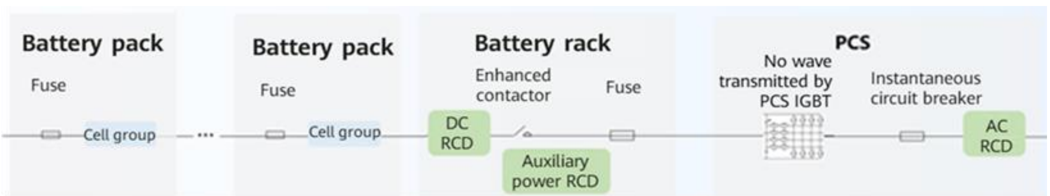
3.2.1.5.1 Battery Pack Insulation & Heat Insulation Design

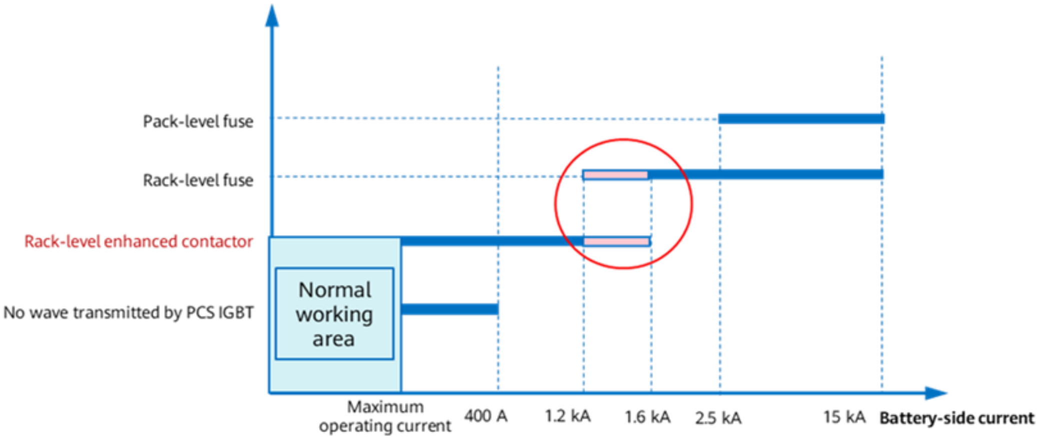
The system provides six-side all-round protection for cells inside the battery pack. Enhanced insulation materials are used at the bottom and top of a cell. Ceramic composite straps are added on both sides of a cell to prevent enclosure breakdown by arc and cell short circuits. Heat insulation pads are used between cells to prevent thermal runaway of a cell from spreading to neighboring cells.



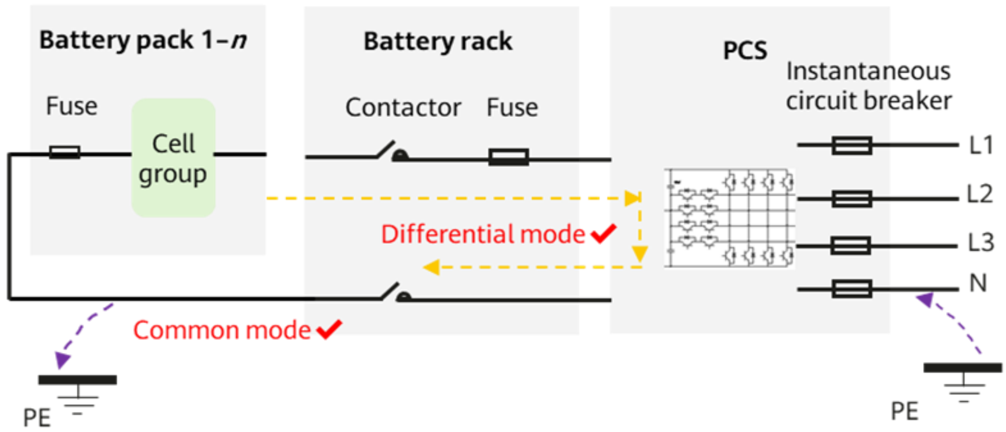
3.2.1.5.2 System-Level Electrical Protection

The system adopts five-level full-range overcurrent protection (pack-level fuse + rack-level enhanced fuse + rack-level enhanced contactor + PCS-level IGBT disconnector + PCS-level instantaneous circuit breaker), covering the AC/DC protection blind spot between 1200 A and 1600 A in conventional systems.





Unique millisecond-level cell-to-ground short-circuit protection allows for rapid shutdown within 5 ms through the instantaneous circuit breaker.



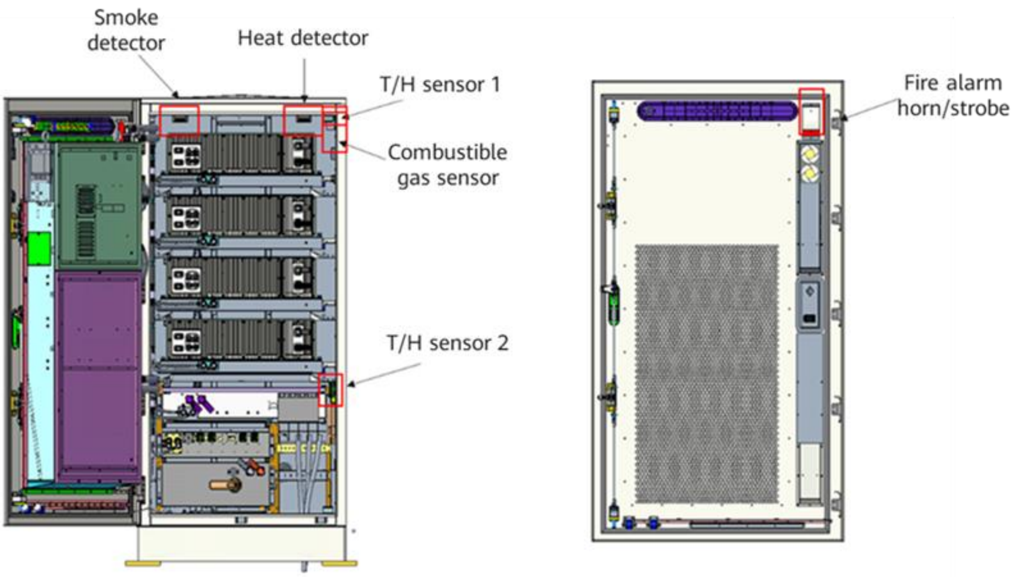
3.2.1.6 Thermal Runaway Suppression Device (TRSD)

3.2.1.6.1 Thermal Runaway Detection

Detection by System Sensors

Smoke and fire can be detected within minutes for the pack, power component, power distribution unit, and LTMS inside the cabinet. After detecting a fire, the cabinet generates an audible and visual alarm. One smoke sensor, one temperature sensor, one CO sensor, and two temperature and humidity sensors are installed inside the cabinet. One fire alarm horn/strobe is installed outside the cabinet.

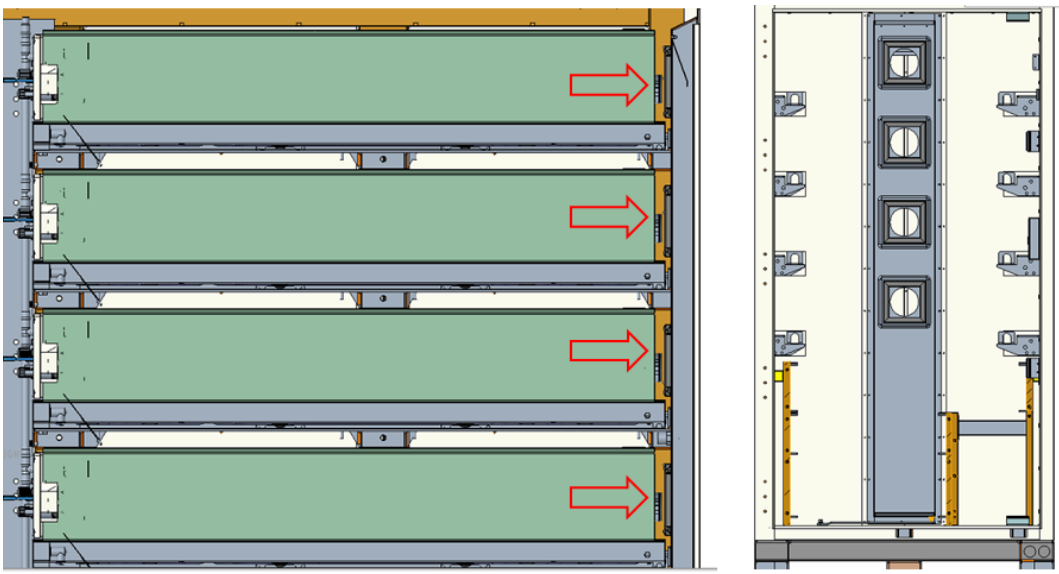
Installation diagram



3.2.1.6.2 Safety Guarantee Design

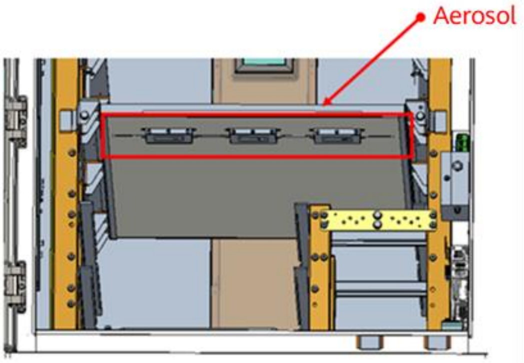
(1) Directional smoke exhaust

When a large amount of gas is generated due to thermal runaway of a battery pack, the combustible gas is directly discharged to the outside of the system through the explosion-proof valve, ventilation duct, and smoke outlet. This prevents a large amount of combustible gas from accumulating inside the cabinet and causing explosion risks.



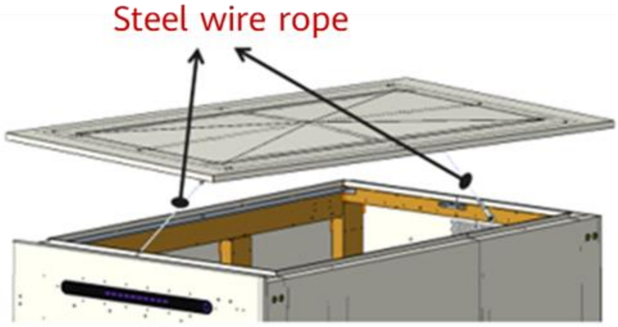
(2) Aerosol fire suppression

When an electrical fire occurs in the power cabin, the aerosol module detects the temperature and releases a large amount of aerosol dust. The power cabin is fully covered by aerosol dust and the fire is quickly suppressed. The aerosol module is passively triggered by temperature. The trigger temperature is 185±15°C.



(3) Top-mounted explosion vent

When the positive pressure oxygen blocking for battery packs and ventilation duct capability reach the limit or fail, the explosion is discharged from the top of the cabinet. After the explosion relief, the rupture disks on the top are broken. The panel will be open but will not disconnect because it is secured by the stranded cable.

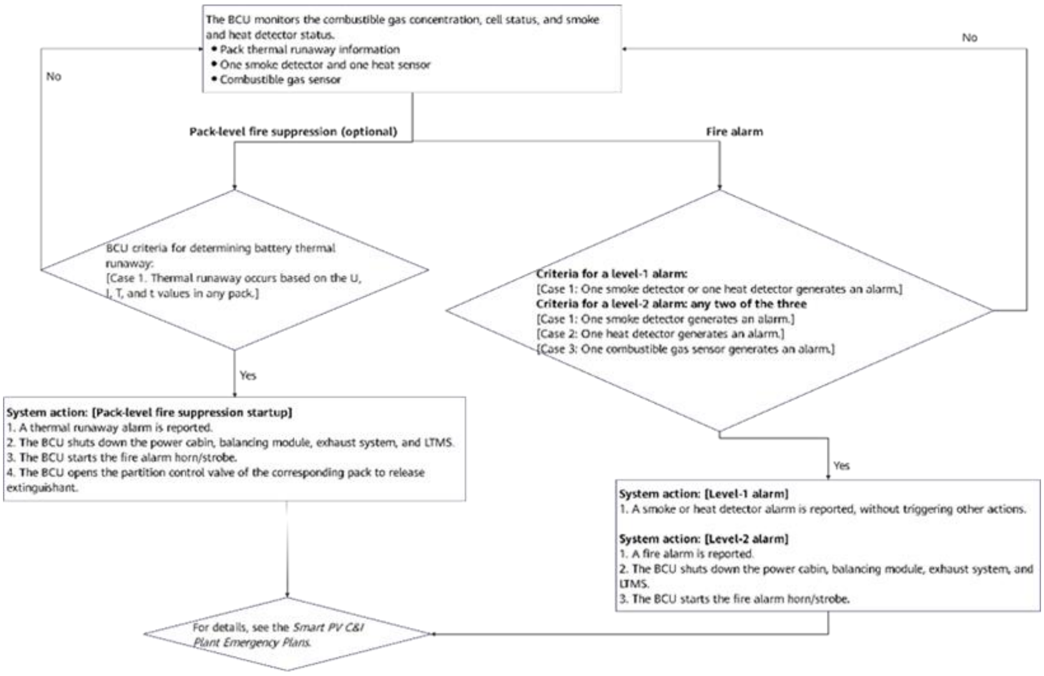


3.2.1.6.3 Thermal Runaway Suppression Logic

When thermal runaway occurs in any pack, the ESS is powered off, air exhaust is disabled, and the LTMS is powered off. The BCU opens the partition control valve of the corresponding pack to release extinguishant. The fire alarm horn/strobe is started at the same time.

When a cabinet-level fire occurs, the ESS is powered off, air exhaust is disabled, the LTMS is powered off, and the fire alarm horn/strobe is started.

Figure 3-8



3.2.2 SmartLogger

The SmartLogger3000 is recommended for the C&I PV+ESS system networking. The SmartLogger3000C comes standard with two optical ports, one WAN port, one LAN port, and three RS485 ports. The SmartModule provides four LAN ports and three RS485 ports.

For PV+ESS scenarios outside China, the PV side supports RS485/MBUS networking, and FE ring networking is recommended for the ESS. The ESS also supports fiber ring networking.

The SmartLogger3000 supports FE or optical fiber networking in the northbound direction.

The power meter at the grid connection point is connected to the RS485 port on the SmartLogger3000 through an RS485 communications cable.

The SmartLogger monitors and manages PV+ESS system. It converges ports, converts protocols, collects and stores data, and centrally monitors and maintains the equipment in PV+ESS system. The SmartLogger has the following features:

- Intelligent and flexible: Connects to the inverter, ESS, and optimizer, and supports one-click commissioning.
- Easy to use: Supports wizard-based settings, facilitating parameter settings and device connection.

Figure 3-9 SmartLogger appearance and technical specifications

Item	Technical Specifications
Power adapter	AC input: 100–240 V, 50/60 Hz
	DC output: 12 V DC/2 A
DC power supply	24 V, 0.8 A
Power consumption	SmartLogger3000C (typical): 8 W
	SmartLogger3000C + SmartModule1000A (typical): 10 W
	Maximum: 15 W
Dimensions (W x H x D)	Including mounting ears: 259 mm x 160 mm x 59 mm
	Excluding mounting ears: 225 mm x 160 mm x 44 mm
Net weight	2 kg
Operating temperature	–40°C to +60°C
Storage temperature	–40°C to +70°C
Relative humidity	5%–95% RH
IP rating	IP20
Installation mode	Installed on a wall or guide rail
Maximum operating altitude	4000 m
Pollution degree	2
Corrosion level	B
Ethernet ports (WAN and LAN)	Two 10M/100M/1000M auto-sensing ports
Ethernet optical ports (SFP)	Two ports, supporting 100M/1000M SFP/eSFP optical modules
MBUS ports	One port, supporting a maximum AC input voltage of 800 V
RS485 (COM)	Three ports; supported baud rates: 1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps, 115200 bps

Item	Technical Specifications
USB	USB 2.0
Power output port	One port; DC output: 12 V, 0.1 A
Digital input (DI) port	Four ports; supports only the access from relay dry contacts
Digital output (DO) port	Two ports; relay dry contact outputs, with NO or NC contacts; 12 V/0.5 A signal voltage
Analog input (AI) port	Four inputs; AI1: supports 0–10 V voltage (passive); AI2–AI4: support 4–20 mA or 0–20 mA input current (passive)
4G antenna port (4G)	One port; SMA-K (external screw inner hole) port, used with an antenna that has the SMA-J (internal screw inner pin) port

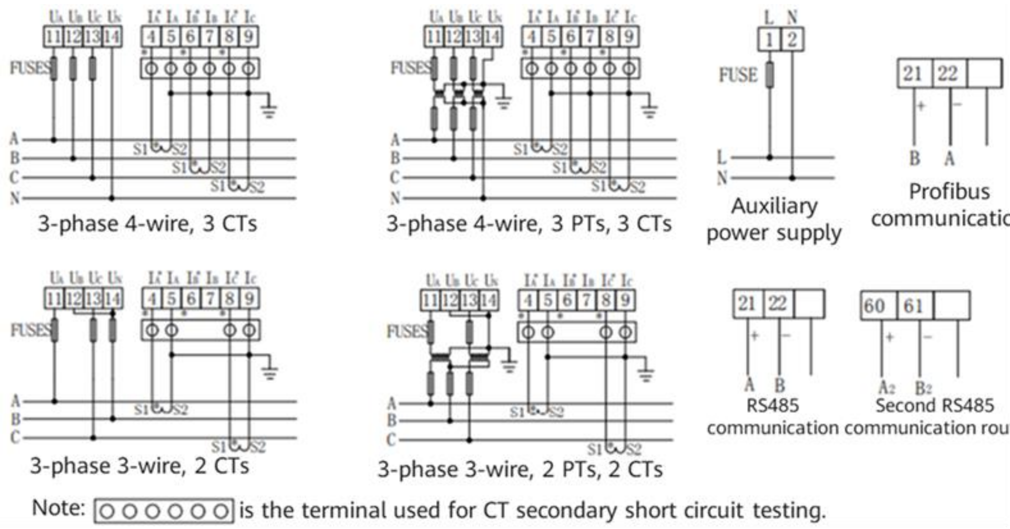
3.2.3 Smart Power Sensor

For collaborative control of the PV+ESS system, a Smart Power Sensor (power meter at the grid connection point) is required. Currently, the SmartPS-80AI-T0 (DTSU666-HW and YDS60-80) has been verified. For other meter models, submit a verification application to the RAT.

In the 10 kV on-grid scenario, a 10 kV/100 V PT with a minimum sampling precision of 0.5s is required.

The current on the secondary side of the current transformer (CT) is 1 A or 5 A. The minimum CT sampling precision is 0.5s.

Figure 3-10 Smart Power Sensor wiring diagram (For details, see the *Commercial and Industrial On-Grid Energy Storage Solution Quick Guide*.)



4 C&I ESS Solution Design

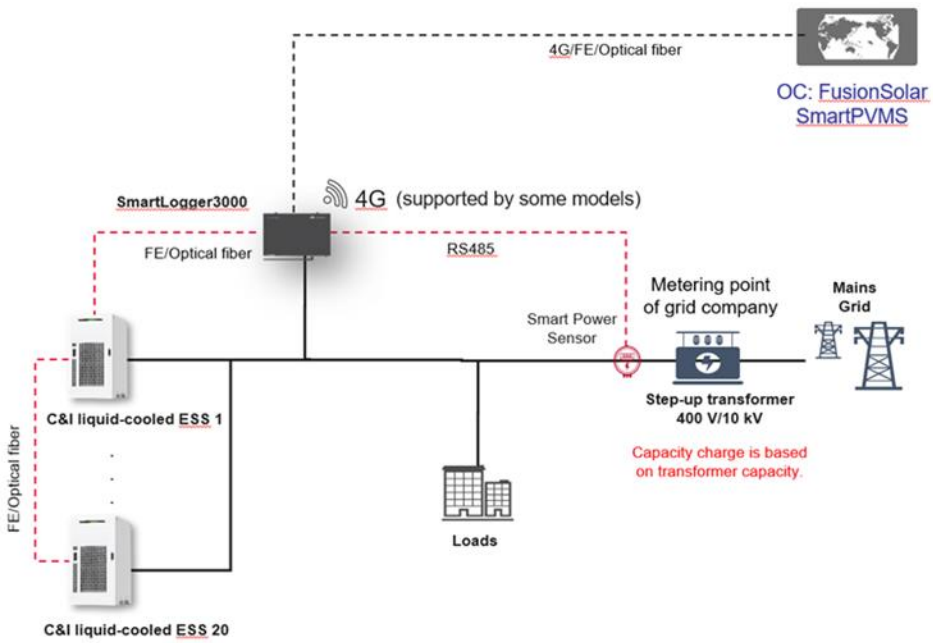
4.1 On-Grid Scenarios

4.1.1 Low-Voltage Grid Connection Through AC Coupling in ESS-Only Scenarios

In small- and medium-sized ESS-only scenarios, the ESS is mainly used for TOU arbitrage, charge/discharge based on dispatch, peak shaving, and power boost.

The C&I Smart String ESSs LUNA2000-215-2S10, LUNA2000-161-2S11 and LUNA2000-107-1S11 are used.

Figure 4-1 Low-voltage grid connection through AC coupling in ESS-only scenarios



Solution scenario characteristics:

Typical scenario: 0.5C ESS charge/discharge rate; 2-hour power backup. In scenarios where ESSs are discharged at a rate of 1C, all parallel ESSs shall be 107 kWh ESSs. For details about the 1C charge/discharge capability, see the SOC charge/discharge power curve.

The ESS-only system supports only one SmartLogger and one grid connection point. One transformer supports a maximum of 50 ESSs running in parallel, and one SmartLogger can connect to a maximum of 20 ESSs.

At the grid connection point, only Huawei C&I meters are supported (SmartPS-80AI-T0). Customers need to purchase CTs (XXX A/5 A or 1 A) with a minimum precision of 0.5s.

The 215 kWh, 161 kWh, and 107 kWh ESSs can be used together. The **Maximize energy** or **Maximize power** mode can be used. Mixed use is not supported in the frequency regulation scenario.

Dispatching Mode	Description
Maximize energy	**Maximize energy**: If ESSs with different C-rates are used together in C&I scenarios, the power is allocated based on the minimum C-rate of all ESSs in the array. If LUNA2000-107-1S11 (charge/discharge rate: 1C) and LUNA2000-215-2S10 (charge/discharge rate: 0.5C) are used together, the charge/discharge power of the array does not exceed 162 kW.
Maximize power	**Maximize power**: If ESSs with different C-rates are used together in C&I scenarios, the power is allocated based on the C-rate of each ESS.

Dispatching Mode	Description
	If LUNA2000-107-1S11 (charge/discharge rate: 1C) and LUNA2000-215-2S10 (charge/discharge rate: 0.5C) are used together, the charge/discharge power of the array does not exceed 216 kW, the power of LUNA2000-107KWH-1H1 may be completely discharged first, and the charge/discharge power of the array may decrease. In addition, the system might collapse in off-grid operation.

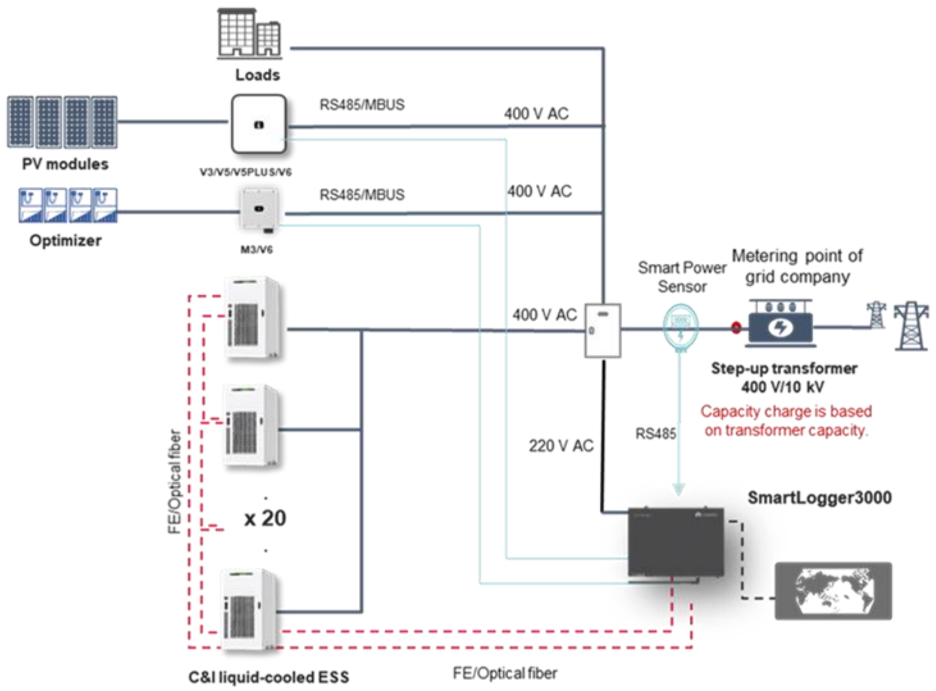
4.1.2 Low-Voltage Grid Connection Through AC Coupling in PV+ESS Scenarios

In this scenario, the ESS is mainly used for maximum self-consumption of PV power, TOU arbitrage, charge/discharge based on dispatch, peak shaving, and power boost.

PV inverters: M3, V3-C, V5, V5+, and V6. The M3 can work with 1-to-1 and 1-to-2 optimizers, and the V6 can work with 1-to-2 optimizers.

The C&I Smart String ESSs LUNA2000-215-2S10, LUNA2000-161-2S11 and LUNA2000-107-1S11 are used.

Figure 4-2 Low-voltage grid connection through AC coupling in PV+ESS scenarios



Solution scenario characteristics:

Typical scenario: 0.5C ESS charge/discharge rate; 2-hour power backup. In scenarios where ESSs are discharged at a rate of 1C, all parallel ESSs shall be 107 kWh ESSs. For details about the 1C charge/discharge capability, see the SOC charge/discharge power curve.

In the PV+ESS on-grid scenario, only one SmartLogger and one grid connection point are supported. A maximum of 20 ESSs and 30 PV inverters (V3-C/M3/V5/V5+/V6 series inverters) are supported.

The 215 kWh, 161 kWh, and 107 kWh ESSs can be used together. The **Maximize energy** or **Maximize power** mode can be used. Mixed use is not supported in the frequency regulation scenario.

At the grid connection point, only Huawei C&I meters are supported (SmartPS-80AI-T0). Customers need to purchase CTs (XXX A/5 A or 1 A) with a minimum precision of 0.5s.

MBUS networking: applicable only to medium-voltage on-grid scenarios or non-low-voltage utility grid scenarios (on-grid; industrial environment). For details, see the inverter user manual.

If Huawei C&I ESSs are connected in parallel with non-V3/M3/V5/V5+/V6 inverters (including third-party inverters) in low-voltage coupling mode, circulating current and resonance may occur, causing ESS derating or faults. In addition, when the external power grid experiences power outage, inverter overvoltage may occur, which may cause the auxiliary power supply module of the ESS to fail. If the customer uses this solution, the customer shall accept the potential risks. The Company is not liable for any consequences caused by the risks. The customer is advised to add magnetic rings or auxiliary isolation transformer to mitigate or avoid the risks.

4.2 Communication Networking

The SmartLogger3000 is recommended for the C&I PV+ESS system networking. The SmartLogger3000A/B/C comes standard with two optical ports, one WAN port, one LAN port, and three RS485 ports. The SmartModule provides four LAN ports and three RS485 ports. In outdoor scenarios, the SmartACU2000D-D-08 can be configured. The ports of SmartACU2000D-D-08 are the same as those of the SmartLogger3000. The SmartLogger3000 shall be upgraded to the C&I SmartLogger software version before June 30, 2025.

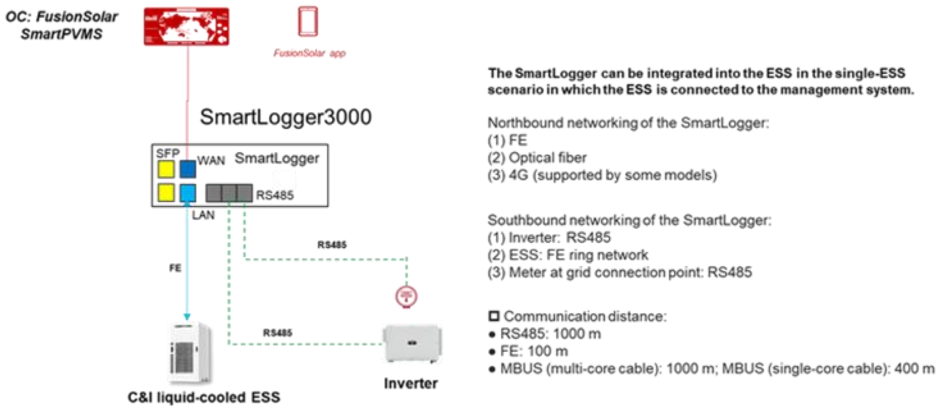
For PV+ESS scenarios outside China, the PV side supports RS485/MBUS networking, and FE ring networking is recommended for the ESS. The ESS also supports fiber ring networking.

The SmartLogger3000 supports FE or optical fiber networking in the northbound direction.

The power meter at the grid connection point is connected to the RS485 port on the SmartLogger3000 through an RS485 communications cable.

4.2.1 Communication Networking of a Single ESS

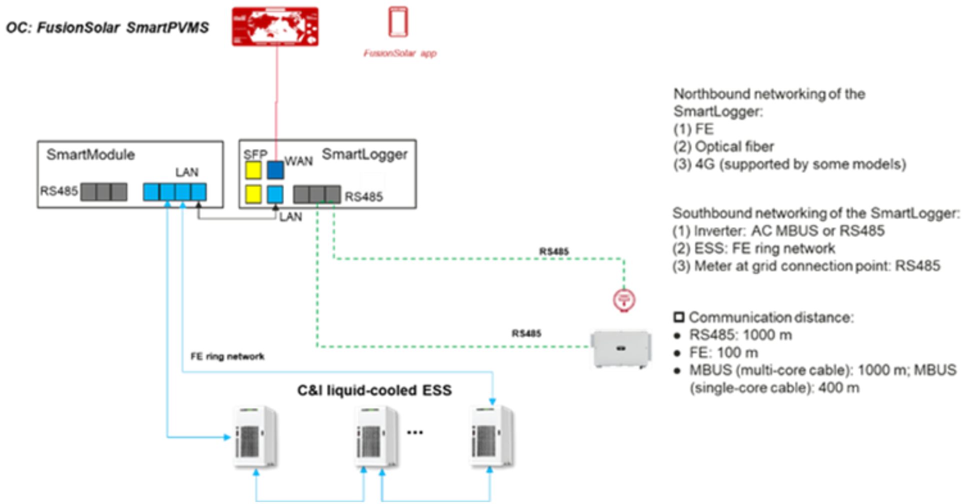
In the single ESS scenario, the SmartLogger can be installed in the ESS and must be connected to the FusionSolar SmartPVMS.



4.2.2 FE Communication Networking of 2–20 ESSs

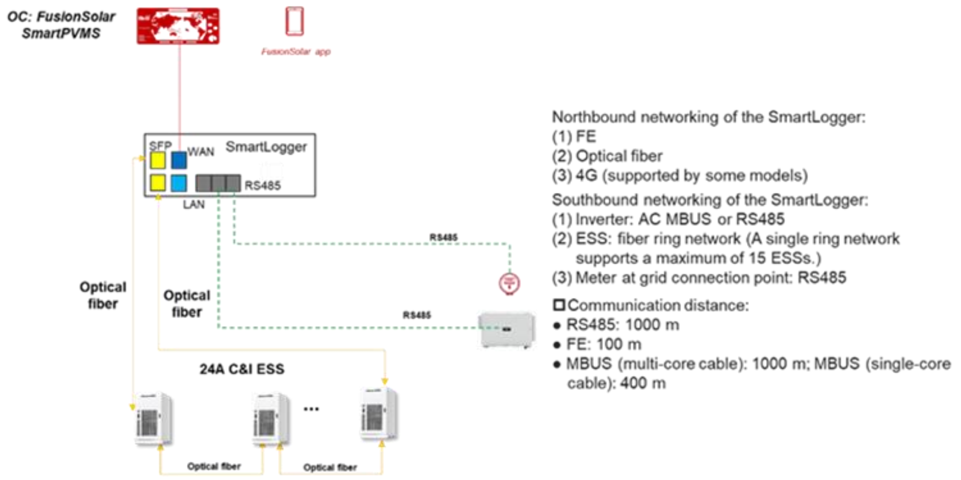
Application scenario: A single array contains 2 to 20 ESSs.

Figure 4-3 FE ring network topology for the ESSs



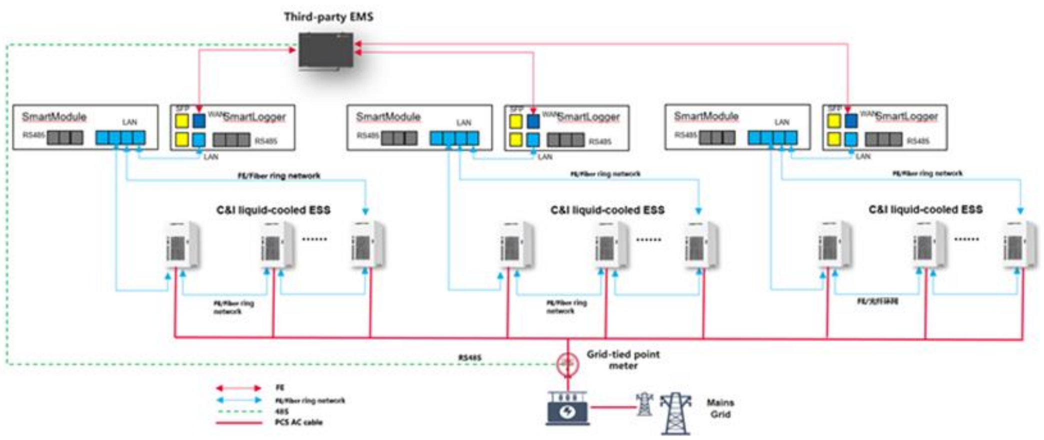
4.2.3 Optical Fiber Communication Networking

The ESS can use the optical fiber communication networking, which supports a maximum of 20 ESSs.



4.2.4 Communication Networking of More Than 20 ESSs

In the networking scenario with more than 20 ESSs, a single SmartLogger supports a maximum of 20 ESSs. If there are more than 20 ESSs, multiple SmartLoggers are used and they are controlled by a third-party controller. A third-party EMS implements functions such as 2s zero feed-in, maximum self-consumption, TOU, and peak shaving. The third-party EMS shall be able to connect to multiple SmartLoggers and communicate with the SmartLoggers over IEC 104 and Modbus.



4.3 ESS Array Design

4.3.1 Solution Design Key Points

Key Design Point	Description
Requirements for connection power distribution	**The protection setting value of the circuit breakers on the high- and low-voltage sides of the transformer shall be greater than the maximum overload current of the transformer or the sum of the maximum load current**

Key Design Point	Description
	and the ESS charging current.
Requirements for the PDC	Each ESS is connected to one power distribution switch. The recommended rated current for each power distribution switch is 250 A. When the leakage current is greater than 1 A, a surge protection device (SPD) can be configured for the PDC connected to the ESS. When the auxiliary power supply cables are connected to the PCS terminal, set the three-phase current imbalance of the power distribution switch on the customer side to ≥ 22 A. (This operation is optional. Skip this step for a power distribution switch without the current imbalance monitoring function.) Breaking capacity of the power distribution switch > Short-circuit current on the low-voltage side of the user. For example, if the rated capacity of the transformer at the grid connection point is 200 kVA and the short-circuit impedance is 4%, the short-circuit current (I_{cc}) on the low-voltage side is about 8.357 kA.
Requirements for the external auxiliary power supply	You are advised to use the utility power or a reliable power source as the auxiliary power supply for the ESS. Do not obtain power from the AC side of the PV inverter. The voltage of the auxiliary AC power supply can fluctuate (±20%) and ranges from 176 V AC to 300 V AC. L+N or L+N+PE is used. The frequency is 50 Hz/60 Hz. An auxiliary transformer is required for the IT system and 420/440/480 V power grid to convert the power grid voltage into 220 V single-phase power.
Capacity requirements for the external auxiliary power supply	Calculate the power distribution capacity based on the number and specifications of the Smart String ESSs (5 kVA).
Requirements for the short-circuit current of the external auxiliary power supply	The calculated short-circuit current of the AC input port of the auxiliary power supply shall be less than or equal to 10 kA. The current of the auxiliary power supply shall not exceed 10 kA. It is recommended that a 40 A 10 kA 2P miniature circuit breaker (MCB) be used.
Power supply requirements for the monitoring system	One single-phase power switch needs to be reserved to supply 220 V AC power to devices such as SmartLogger and PoE power supply. The power is 110 W.
Layout requirements for the foundation and surrounding areas	The foundation must be properly designed based on the foundation reference diagram and cable connection diagram. The ground around the foundation (see the layout diagram sheet) must be flat to facilitate installation and O&M using a forklift (see the foundation diagram).
Earthing system	TN-S, TN-C, TN-C-S, TT, and IT
Grounding	The ground terminal of the ESS must be grounded through

Key Design Point	Description
requirements	a cable or hot-dip zinc-coated flat steel sheet.
Storage requirements	Storage temperature: –35°C to +60°C (The recommended range is 0°C to 30°C. If the ESS is stored at a temperature higher than 40°C for extended periods, the battery performance and service life may be deteriorated.) Relative humidity: 5%–95% RH
Mapping relationship	Huawei SmartLogger3000 shall be used.
Prefabrication before transportation	Prefabrication before transportation is supported.
Fire suppression equipment	It is recommended that the project site be equipped with two to five dry powder fire extinguishers for each ESS, which shall be stored next to the ESS.
Requirements for the auxiliary power supply	It is recommended that the auxiliary power supply be connected to the customer's PDC. For the 380 V, 400 V, or 415 V power grid, the auxiliary power can be obtained through the PCS port in the cabinet. The cable is delivered with the cabinet and connected to phase C and phase N of the PCS port. The power meter on the customer side displays phase C power imbalance.
Cable selection	Three-core, four-core, or five-core outdoor copper, copper-clad aluminum, or aluminum alloy cable with a cross-sectional area of 50–300 mm^2
Charging requirements	Ensure that the ESS is powered on within 7 months after delivery. If the ESS might not be powered on and connected to the power grid within 7 months, notify Huawei in advance.
System configuration	A grid connection point corresponds to one SmartLogger and one power meter.
ESS control mode	1. Maximum self-consumption (PV+ESS scenario) 2. TOU (PV+ESS or ESS-only scenario in which the electricity prices in peak and off-peak hours are different and a power meter is available) 3. TOU (fixed power) (PV+ESS scenario or ESS-only scenario in which the electricity prices in peak and off-peak hours are different and no power meter is available) 4. Charge/Discharge based on dispatch (third-party controller scenario) 5. Peak shaving (This mode can be used together with modes 1 and 2 to limit the load demand. Alternatively, this mode needs to be used with other modes when the sum of the load power and ESS charge power may exceed the transformer capacity.)

Key Design Point	Description
	6. **Power boost (This mode is used in transformer capacity expansion scenarios where the transformer capacity is less than the load power.)**
Fitting bag for fiber ring switching	If the fiber ring network is used, the fitting bag for fiber ring switching must be configured, including pigtails and optical modules. Gigabit single-mode optical modules must be used at the central site (central control room or management system site). Four-core or eight-core single-mode armored optical cables with a transmission wavelength of 1310 nm and an outer diameter less than 18 mm must be used.
Scenario in which the SmartLogger is integrated into the ESS	Applicable only to the single-ESS scenario in which the ESS is connected to the management system. Otherwise, the SmartLogger cannot be integrated into the ESS to achieve the safety black box function. In this scenario, the SmartLogger, 4G antenna (if 4G networking is required), and SmartLogger cables need to be connected.
ESS networking solution	FE networking is recommended for the ESSs. Optical fiber networking is also supported.
Maximum number of devices that can be connected to the system	The maximum numbers of C&I ESSs that can be connected are as follows: A single SmartLogger supports a maximum of 20 ESSs and 30 PV-only inverters. Each M3 inverter can connect to a maximum of 100 optimizers, and each V6 inverter can connect to a maximum of 240 optimizers. (The number of optimizers to be connected depends on the configuration principles for connecting inverters of different models to optimizers.)
Restrictions on communication networking	When FE networking is used, the communication distance between two points is less than or equal to 100 m. An FE or fiber ring network supports a maximum of 20 ESSs.
Adding devices to be connected	Consult the product SE.
Environment adaptability	Region: (Use the smaller value after confirmation by the SE of each component.) Specifications provided by the MO Operating temperature: –30°C to +55°C (derated when the temperature is higher than 50°C) Altitude: ≤ 4000 m
Application scenario	The ESS is protected to IP55 and fit for outdoor deployment.
Maximum number of parallel ESSs	**In the ESS-only scenario, a maximum of 50 ESSs can be connected in parallel on the AC side. (The 50 ESSs can connect to the low-voltage side of the same transformer.) In the PV+ESS scenario, a maximum of 20 ESSs and 30 inverters can be connected in parallel on**

Key Design Point	Description
	the AC side.
Requirements on mixing ESSs of different C-rates	**The 215 kWh, 161 kWh, and 107 kWh ESSs can be used together. The "Maximize energy" or "Maximize power" mode can be used. Mixed use is not supported in the frequency regulation scenario. In the 1C discharge scenario, all parallel ESSs must be 107 kWh ESSs. For details about the output power, see the SOC-charge/discharge power curve.**
Restrictions on low-voltage AC coupling between ESSs and inverters	To prevent the circulating current of the parallel system from exceeding the threshold, the cables from the PCSs and inverters (V3-C, M3, V5, V5+, and V6) to the parallel connection points on the power distribution cabinet must be at least 5 m long.
Installation requirements	The minimum clearance is 2500 mm in front of the ESS, 400 mm behind the ESS, 750 mm on the left side, and 100 mm on the right side. In the case of 3-sided layout, the minimum clearance is 100 mm from side to side and 300 mm from back to back.
Overall layout requirements	For details about the typical layout, see the user manual and solution technical proposal. Layout principles: 1. For the fire safety and maintenance passage, the minimum clearance is 2500 mm in front of the ESS, 400 mm behind the ESS, 750 mm on the left side, and 100 mm on the right side. In the case of 3-sided layout, the minimum clearance is 100 mm from side to side and 300 mm from back to back. 2. A maximum of 50 ESSs can be configured in a site. 3. A maximum of 12 ESSs connected in parallel can be deployed in a row. 4. If two rows of ESSs are deployed back to back or multiple rows of ESSs are deployed in the same direction, a maximum of 12 ESSs can be deployed in each row. If ESSs are deployed face to face, 12 ESSs shall be deployed as a group (6+6 cabinets face to face). If there are more than 12 ESSs, they shall be equally divided into two groups. The distance between groups shall be greater than or equal to 1 m and a maximum of 12 ESSs can be deployed in a row. In this case, the outdoor ambient temperature required for fully loaded ESSs is 40°C@0 m (passive derating). 5. When the layout is face-to-face, it is recommended that the customer increase the face-to-face distance to alleviate the heat cascading issue.
Zero feed-in requirements	Only the SUN2000-V3/M3/V5/V5+/V6 inverters can be connected to the ESSs in parallel, and **2s zero feed-in is**

Key Design Point	Description
	supported.
Solution design	The overall solution must be designed or reviewed by trained product managers or solution design engineers.
Import feasibility assessment	Some countries have special qualification or license requirements for the import of equipment containing dangerous chemicals. In some countries, it is difficult or time-consuming to obtain the permit. Due to changing policies in different countries, if chemicals such as refrigerant and fire suppression agents need to be injected before delivery: If the import is handled by a subsidiary: Confirm with the supply chain of the rep office whether the customs clearance is feasible for the import before signing the contract. If the import is handled by a channel partner: It is recommended that the channel partner be informed of the types and quantities of chemicals in advance to make preparation in advance. In some countries, it is prohibited to fill refrigerant or extinguishant in advance. You need to find other solutions such as local filling.
Others	1. Before sales and shipment, check whether vehicles/mechanical tools can be used for project delivery and whether they can support forklifts with a load-bearing capacity of more than 5 tons. 2. The cartons are used only for preventing dust and dirt. If a carton is damaged but the ESS is intact, the customer's goods acceptance shall not be affected.

NOTICE

This section describes the key points of design and boundary conditions that customers must comply with before using Huawei C&I Smart String ESS Solution. In the case of any nonconforming items, the system design may be incorrect, the solution may fail to work, or the project operation may be affected.

4.3.2 Typical Array Design

The following describes the system configurations and primary wiring diagrams of ESS arrays with different C-rates and power values.

Note:

1. The typical design is based on an ambient temperature of 40°C. For areas where the ambient temperature is higher than 40°C, the PCS power will be derated. Therefore, the derating needs to be considered in the design.
2. The typical design is based on the altitude below 4000 m.

3. Full load is supported in the following conditions: altitude of 0 m, temperature not higher than 50°C; altitude of 2000 m, temperature not higher than 40°C; altitude of 4000 m, temperature not higher than 30°C.

Table 4-1 1.08 MW/2.15 MWh typical 0.5C array (BOQ)

No.	Device	Model	Unit	Qty.	Supplier	Remarks
1	Smart String ESS	LUNA2000-215-2S10	pcs	10	Huawei	
2	SACU/SmartLogger	SmartLogger3000	pcs	1	Huawei	
3	SmartModule	SmartModule	pcs	1	Huawei	
4	Three-phase meter	SmartPS-80AI-T0	pcs	1	Huawei	
5	AC power cable for the Smart String ESS	ZC-0.6/1 kV-YJV22-4 x 95 mm² + 1 x 50 mm²	m	xx	Separately purchased by the customer	-
6	Auxiliary power cable for the Smart String ESS	ZC-0.6/1 kV-YJV22-3 x 6 mm²	m	xx	Separately purchased by the customer	-

Table 4-2 1.08 MW/1.07 MWh typical 1C array (BOQ)

No.	Device	Model	Unit	Qty.	Supplier	Remarks
1	Smart String ESS	LUNA2000-107-2S11	pcs	10	Huawei	
2	SACU/SmartLogger	SmartLogger3000	pcs	1	Huawei	
3	SmartModule	SmartModule	pcs	1	Huawei	
4	Three-phase meter	SmartPS-80AI-T0	pcs	1	Huawei	
5	AC power cable for the Smart String ESS	ZC-0.6/1 kV-YJV22-4 x 95 mm² + 1 x 50 mm²	m	xx	Separately purchased by the customer	-
6	Auxiliary power cable for the Smart String ESS	ZC-0.6/1 kV-YJV22-3 x 6 mm²	m	xx	Separately purchased by the customer	-

4.3.3 Typical Layout of a C&I ESS Array

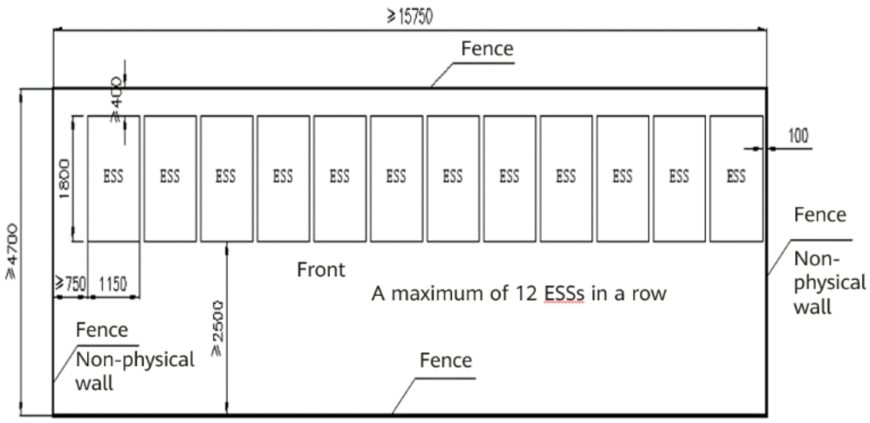
4.3.3.1 Typical Array Layout

Array Deployment Principles

1. For the fire safety and maintenance passage, the minimum clearance is 2500 mm in front of the ESS, 400 mm behind the ESS, 750 mm on the left side, and 100 mm on the right side. In the case of 3-sided layout, the minimum clearance is 100 mm from side to side and 300 mm from back to back.
2. A maximum of 50 ESSs can be configured in a site.
3. A maximum of 12 ESSs connected in parallel can be deployed in a row.
4. If two rows of ESSs are deployed back to back or multiple rows of ESSs are deployed in the same direction, a maximum of 12 ESSs can be deployed in each row.

   If ESSs are deployed face to face, 12 ESSs shall be deployed as a group (6+6 cabinets face to face). If there are more than 12 ESSs, they shall be equally divided into two groups. The distance between groups shall be greater than or equal to 1 m and a maximum of 12 ESSs can be deployed in a row. In this case, the outdoor ambient temperature required for fully loaded ESSs is 40°C@0 m (passive derating).
5. When the layout is face-to-face, it is recommended that the customer increase the face-to-face distance to alleviate the heat cascading issue.

Figure 4-4 Typical array layout (single row in the same direction)



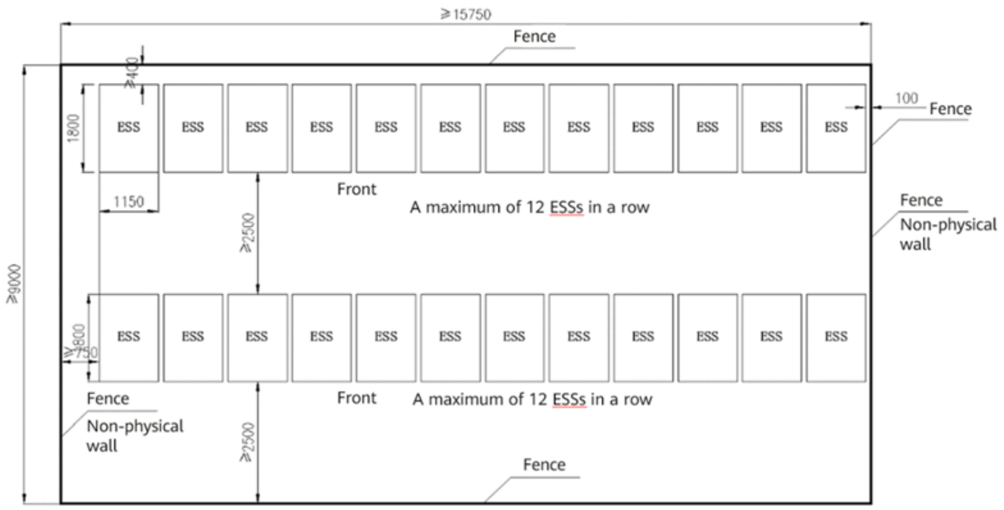


Figure 4-5 Typical array layout (dual-row back-to-back)

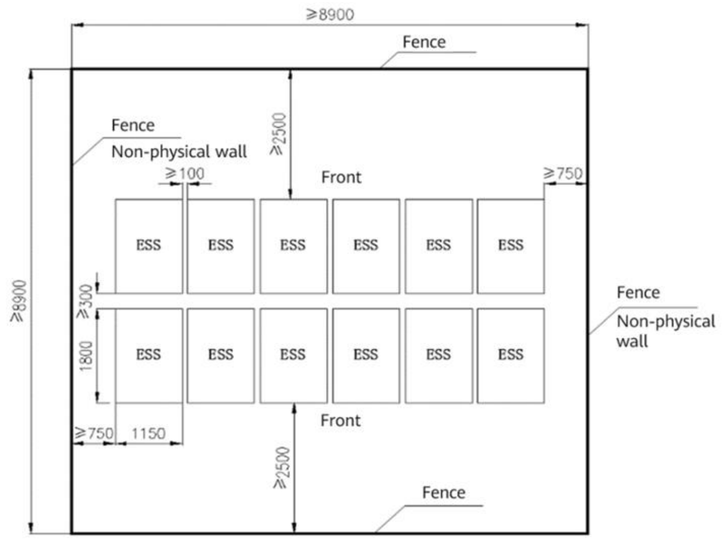
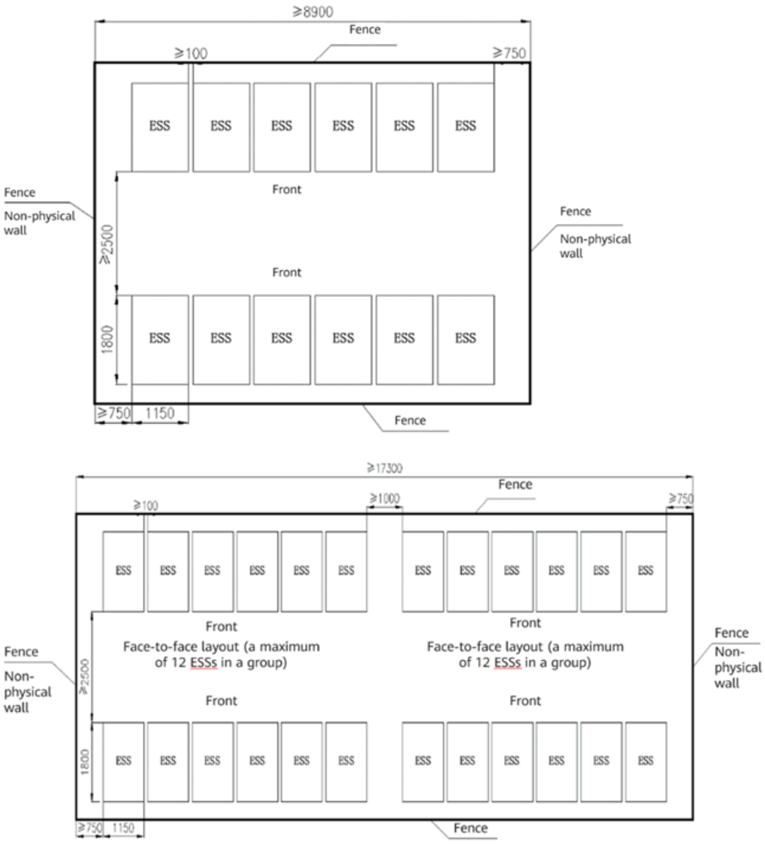


Figure 4-6 Typical array layout (dual-row face-to-face)



4.3.4 Charge Solution

Material Delivery Check

There must be a battery charge label on the packing case of the ESS. The charge label must specify the latest charge time and the next charge time.

Storage Requirements

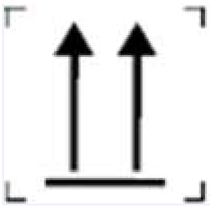
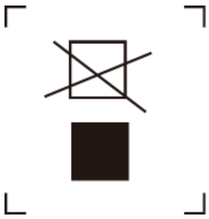
⚠ WARNING

- Store the ESS in a dry, clean, and ventilated indoor environment that is free from sources of strong infrared or other radiations, organic solvents, corrosive gases, and conductive metal dust. Do not expose the ESS to direct sunlight or rain. Keep the ESS far away from sources of heat and fire.
- Store the ESS separately to avoid mixing with other equipment. The site must be equipped with qualified fire suppression facilities, such as fire sand and fire extinguishers.

CAUTION

It is recommended that the ESS be used soon after being deployed onsite. The ESS that has been stored for an extended period shall be charged periodically. Otherwise, the ESS may be damaged.

- Place the ESS correctly according to the signs on the packing case during storage. Do not place the ESS upside down, lay it on one side, or tilt it.
- The ESS packaging signs are described as follows.

ID	Symbol	Description
Up		The package shall be kept upright during transportation and storage.
Fragile		The package contains fragile objects and shall be handled with care.
Keep dry		The package shall be protected against rain, and rainproof measures shall be taken during transportation and storage.
Do not roll		The package shall not be rolled during transportation.
Do not stack		The package shall not be stacked.

- Storage environment requirements:
  - Ambient temperature: –35°C to +60°C (0°C to 30°C are recommended. If the ESS is stored at a temperature higher than 40°C for extended periods, the battery performance and service life may be deteriorated.)
  - Ambient temperature: –30°C to +55°C

  - Relative humidity outside the cabinet: 0–100% RH; relative humidity inside the cabinet: 5%–95% RH
  - Store batteries in a dry, clean, and well-ventilated place.
  - Away from corrosive organic solvents and gases
  - Away from direct sunlight
  - At least 2 m away from heat sources
- The ESS must be disconnected from external equipment during storage, and the ESS indicators must be off.
- The storage duration starts from the latest charge time labeled on the ESS packaging. If the ESS is qualified after charge, update the latest charge time (recommended format: *YYYY-MM-DD HH:MM*) and the next charge time (Next charge time = Latest charge time + Charge interval) on the label.
- The following table lists the maximum ESS charge intervals. Charge the ESS promptly and calibrate the SOC to at least 50%. Otherwise, the battery performance and service life may be deteriorated.

Storage Temperature (T)	Maximum Charge Interval[a]
–35°C < T ≤ +30°C	15 months
30°C < T ≤ 40°C	11 months
40°C < T < 60°C	7 months
Note a: The interval starts from the latest charge time labeled on the ESS packaging.	

- When stored in low SOC, the ESS must be charged within the maximum interval corresponding to the SOC when the batteries are powered off. If the ESS is not charged within the specified interval, the batteries may be damaged due to overdischarge.

Power-Off SOC Before Storage	Maximum Charge Interval
SOC ≥ 50%	Refer to the charge intervals for batteries delivered separately.
5% ≤ SOC < 50%	20 days
SOC < 5%	48 hours

- Do not remove the packaging from the ESS. If charging is necessary, the ESS must be charged by professionals as required and then returned to their original packaging after charging.
- The warehouse keeper shall collect the ESS storage information every month and periodically report the ESS inventory information. The ESS in long-term storage must be charged promptly.

CAUTION

- Only trained and qualified personnel are allowed to recharge batteries. Wear insulated gloves and use dedicated insulated tools during the operation.
- Observe onsite during charge and handle any exceptions in a timely manner.
- If a battery experiences an abnormality such as bulging or smoke during charging, stop charging immediately and dispose of it.

- AC mains input voltage requirements for charging:
  - 220 V (three-phase 380–480 V AC and single-phase 176–300 V AC)
  - AC input power cables used for charging the ESS in the warehouse must have a through-current capacity greater than 60 A.
- If the ESS has been stored for longer than allowed, promptly report the condition to the person in charge.
- Ensure that the ESSs are delivered on a "first-in, first-out" basis.
- Handle the ESS with care to prevent damage.

Maximum ESS Storage Periods

- Do not store the ESS for extended periods.
- The following table lists the maximum ESS charge intervals. Charge the ESS promptly and calibrate the SOC to at least 50%. Otherwise, the battery performance and service life may be deteriorated.

Storage Temperature (T)	Maximum Charge Interval[a]
–35°C < T ≤ +30°C	15 months
30°C < T ≤ 40°C	11 months
40°C < T < 60°C	7 months
Note a: The interval starts from the latest charge time labeled on the battery packaging.	

- If the ESS has been stored for longer than allowed, promptly report the condition to the person in charge.
- Dispose of a deformed, damaged, or leaking ESS directly irrespective of how long it has been stored.
- The storage duration starts from the latest charge time labeled on the ESS packaging. If the ESS is qualified after charge, update the latest charge time (recommended format: *YYYY-MM-DD HH:MM*) and the next charge time (Next charge time = Latest charge time + Charge interval) on the label.
- Batteries can be charged for a maximum of three times during storage. Dispose of batteries if the maximum charge times are exceeded.

Preparing Charging Devices

- Multimeter
- Clamp meter
- Insulated torque socket wrench

Checking the ESS Before Charging

1. Check the ESS exterior to ensure that the ESS is qualified before charging.
2. The ESS is qualified if it is free from the following symptoms:
   - Deformation
   - Enclosure damage
   - Leakage

Full Charge Strategy

The charging ambient temperature ranges from 15°C to 40°C.

Charging Procedure

NOTE

Prepare the ESS that is qualified for charging.

Step 1 Remove the ESS packaging and open the ESS door.

Step 2 Connect the PCS port of the ESS to the 380–480 V AC power grid.

Step 3 Connect the ESS auxiliary power supply to the single-phase 176–264 V power distribution cabinet.

Step 4 Connect the general BAT+ and BAT– cables of battery packs to the BAT+ and BAT– terminals of the RCM.

Step 5 (Optional) Turn on the RCM disconnector.

Step 6 Turn on the general power circuit breaker of the power distribution cabinet outside the ESS.

Step 7 Turn on the auxiliary power circuit breaker of the power distribution cabinet outside the ESS.

Step 8 (Optional) Turn on the auxiliary power circuit breakers QF1 and QF2 of the RCM (applicable when the UPS is used).

Step 9 Press the WiFi button on the ESS door for more than 3 seconds, and connect to the ESS on the FusionSolar app.

Step 10 Log in to the FusionSolar app and perform charging operations.

----End

4.4 ESS Safety Requirements

NOTICE

The ESS site selection and fire safety must comply with local laws and regulations. Reference standards include but are not limited to the *NFPA 855 Standard for the Installation of Stationary Energy Storage Systems*.

The safety site selection requirements of the ESS shall meet the requirements in the user manual (the final requirements are subject to the user manual: https://support.huawei.com/enterprise/en/doc/EDOC1100394281). Check whether the following requirements are met:

- There must be no combustible materials within 3 m of the ESS or the site to prevent fire from spreading. (Exemption: Single specimens of trees, shrubbery, or cultivated ground cover such as green grass, ivy, succulents, or similar plants used as ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire.)
- You are advised not to add any overhead structure above the ESS. If an overhead structure is necessary in special scenarios, the following conditions must be met: The distance between the overhead structure and the top of the ESS shall be greater than 3 m. The overhead structure shall be non-combustible.

  Outside China:
- The ESS located outdoors must be at least 10 ft (3.048 m) away from lot lines, public ways, buildings, combustible materials, hazardous materials, high-piled stock, parking spaces, and other exposure hazards not associated with electrical grid infrastructure.
- If either of the following conditions is met, the distance between the ESS and the production building shall be permitted to be reduced to 3.28 ft (1 m). In addition, clearance requirements for equipment transportation, installation, and maintenance shall be considered.
- There are 1-hour freestanding fire walls, extending 5 ft (1.5 m) above and extending 5 ft (1.5 m) beyond the physical boundary of the ESS installation.
- Non-combustible exterior walls with no openings or combustible overhangs are provided on the walls adjacent to the ESS and the fire resistance rating of the exterior walls complies with 2-hour fire resistance rating of ASTM E119 or UL 263.
- The distance between the exhaust device of an ESS and the heating and ventilation vents, air intake vents of air conditioners, windows, doors, unloading platforms, and fire sources of other buildings or facilities must be greater than 4.6 m.

5 SmartPVMS (Plant)

5.1 Introduction

With the rapid development of PV, millions of PV plants have been established around the world. As the scale of PV plants keeps increasing, problems of traditional PV plants, such as high OPEX, inability to share data, and inability to evaluate the plant operational quality, become increasingly prominent. Higher requirements are posed in terms of automatic monitoring and production management, operation evaluation and maintenance, networking, and system reliability of PV plants. Based on the preceding PV plant development trends and customers' requirements, Huawei launched the SmartPVMS.

The SmartPVMS (Plant) provides the monitoring software and value-added features for Huawei PV inverters.

The SmartPVMS (Plant) mainly works with the SUN2000, SUN5000, and LUNA2000 as well as other devices, such as SmartLoggers, Smart Dongles, optimizers, batteries, power meters, and environmental monitoring instruments (EMIs). You can log in to the SmartPVMS (Plant) using a web browser to monitor the performance data and alarms of Huawei grid-tied PV inverters in real time, and remotely control and manage the PV inverters. This achieves centralized management and remote O&M of grid-tied PV inverters.

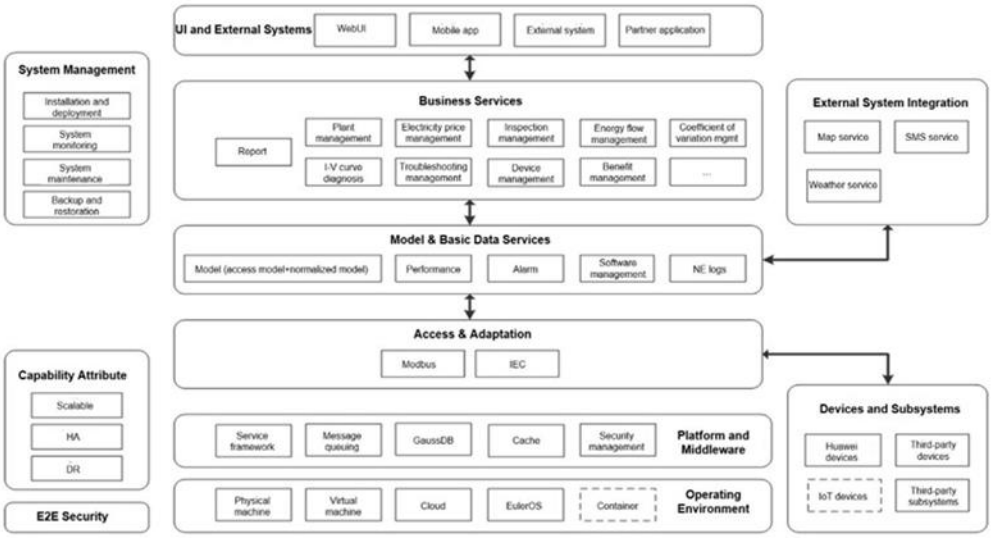
The system allows you to configure value-added features such as Smart I-V Curve Diagnosis and SDS and displays their results.

The SDS can be configured and started through the SmartLogger. However, the SmartPVMS (Plant) is required to start Smart I-V Curve Diagnosis and display the energy yield comparison. For details about the mapping between features and the SmartPVMS (Plant), see the user manual of the corresponding device.

The SmartPVMS software uses the B/S architecture, consists of the access, common framework, application and service, and UI layers, and runs on the EulerOS. Users can access the server through the WebUI on a device that runs the Windows operating system. The SmartPVMS supports encrypted transmission to ensure data transmission security.

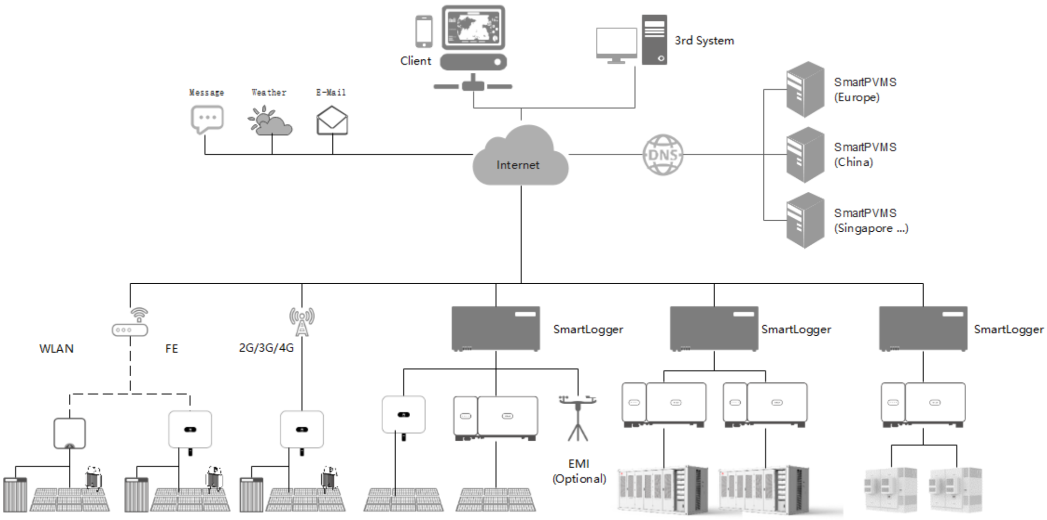
The following figure shows the SmartPVMS software architecture.

Figure 5-1 SmartPVMS software architecture



The SmartPVMS monitors Huawei PV devices and their auxiliary devices. The following figures show the system networking diagrams.

Figure 5-2 SmartPVMS networking



The system consists of the SmartPVMS server, PV devices, third-party services, and clients, which are connected through the Internet.

- The system supports devices such as inverters/PCSs, power meters, optimizers, EMIs, residential ESSs, utility-scale ESSs, and C&I ESSs.
- The SmartLogger can connect to multiple inverters, and inverters can connect to the system through the Dongle.

- The SmartPVMS uses a firewall as the primary protection.
- Services such as the DNS, email, weather forecast, and map mainly rely on third-party providers.
- Clients mainly include user PCs and smartphones.

5.2 Features

Simple Management and Monitoring Platform for All Scenarios

- Applies to all scenarios, including the residential, C&I, and utility-scale scenarios.
- The multi-layer user architecture is used, which is applicable to distributed scenarios, facilitating user management.
- Defines multiple roles for proper permission assignment to user accounts.

Lifetime Management for a Full Knowledge of the Plant Status

- PV plant information on one screen, facilitating management
- Real-time monitoring of plant-level, device-level, and module-level running data
- Traceable and presentable plant-level and device-level historical data of multiple types
- Real-time display of fault alarms, facilitating quick response and troubleshooting
- Report and alarm push and subscription for visibility into plant operation

Intelligent and Efficient O&M

- Simple and efficient centralized O&M and monitoring
- Real-time alarm push and troubleshooting suggestions for quick response
- Accurate locating of arc faults, reducing the onsite troubleshooting time (full optimizer configuration required)
- Intelligent diagnosis and warning, detecting device exceptions in advance
- Mobile O&M/Electronic tickets, delivering simple and efficient O&M
- Remote health check and proactive optimization, ensuring the healthy and stable operation of plants

6 Appendix A: Technical Specifications

For details, see the *C&I ESS 215 kWh Series Technical Specifications*.

7 Appendix B: Model Mapping for the PV+ESS Solution

For details, see the *C&I ESS 215 kWh Device Model Matrix for PV+ESS Solution*.