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1 SmartPVMS Product Description

1.1 Positioning and Features

1.1.1 Positioning

Hosting Cloud

The SmartPVMS is a software system for monitoring and O&M of PV power systems. It aims to display the current and historical running status of PV plants in a more real-time and comprehensive manner. In addition, the SmartPVMS provides functions such as intelligent alarming, analysis, diagnosis, and O&M to help customers improve the power generation efficiency and lower the O&M cost, achieving refined management and improved profitability.

With the rapid development of PV, PV has expanded to millions of power plants 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 more and more 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, which is described as follows:

- The smart PV cloud platform provides intelligent, high-quality, maintenance-free, and low-cost plant status monitoring and intelligent O&M services. Users do not need to deploy hardware devices or arrange professional maintenance personnel.
- The basic functions of the smart PV cloud platform, such as status monitoring, PV plant management, intelligent O&M, and data reports, are free of charge. Value-added features such as Smart I-V Curve Diagnosis are charged on demand.
- The smart PV cloud provides high-precision and reliable data transmission, open northbound data interfaces, and a SmartLogger with the data recovery function to ensure that PV plant data is always available.

1.1.2 Benefits

Simple Management and Monitoring Platform for All Scenarios

- Applies to all scenarios, including residential, commercial and industrial, and utility PV plants.
- Supports cloud-based and server-based deployment to meet customers' installation requirements.
- Uses the multi-layer user architecture, which is applicable to distributed scenarios, simplifying management.
- Defines multiple roles for proper permission assignment to user accounts.

Full-lifetime Management Allows You to Learn the Plant Operating 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 learning the plant running status.

Intelligent and Efficient O&M

- Simple and efficient centralized O&M and monitoring.
- Real-time alarm push and troubleshooting suggestions, enabling 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 PV plants.

Targeted Poverty Alleviation

- Display of comprehensive poverty alleviation achievements
- Refined poverty alleviation information management
- Integrated poverty alleviation and plant management

1.1.3 Distributed Hosting Center

Centralized Monitoring of Plant Information

- Real-time fault reporting and accurate alarm information
- Big data analysis and mining, discovering potential device risks
- Clear PV plant operating status and efficiency

Remote PV Plant Health Check

The one-click PV plant inspection function enables one-click acquisition of plant health data, ensuring long-term stable running of the plant.

Intelligent System Analysis and Inspection

String-level intelligent analysis and inspection of inverters and PV strings, implementing refined O&M and improving energy yield revenues.

1.2 Product Architecture

1.2.1 Hardware Components

1.2.2 2288X V5 Server

The 2288X V5 server is a new-generation Huawei data center server that integrates patented technologies such as Dynamic Energy Management Technology (DEMT) and fault diagnosis & management (FDM). It features efficient computing, high security and reliability, and an open ecosystem. Suitable for efficient acceleration of applications such as big data, distributed storage, native applications, high-performance computing, and databases, the server aims to meet the requirements of diversified computing and green computing in data centers.

Figure 1-1 2288X V5 server interface diagram

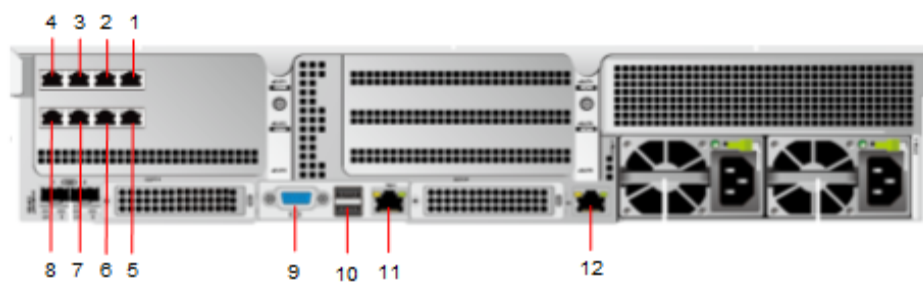


Table 1-1 2288X V5 server interface description

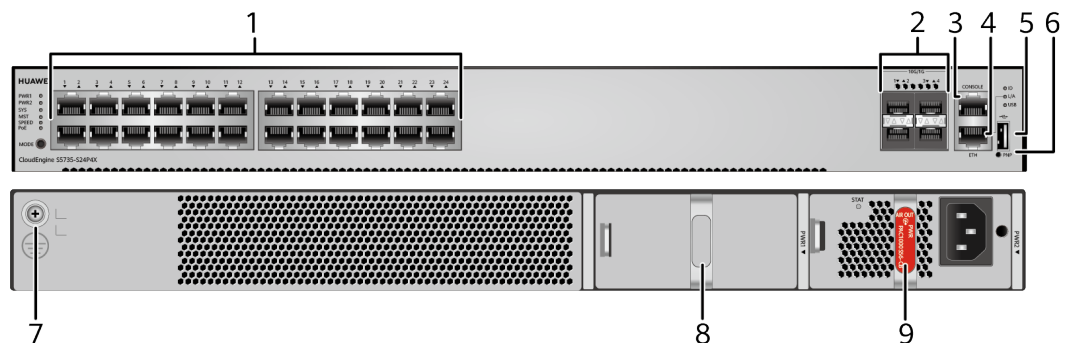
No.	Interface Type	Function
1	eth0 GE interface	Used for connecting to the LAN switch. eth0 and eth1 comprise a bond, eth2 and eth3 comprise a bond, which is used for providing external services.
2	eth1 GE interface	
3	eth2 GE interface	

No.	Interface Type	Function
4	eth3 GE interface	
5	eth4 GE interface	
6	eth5 GE interface	
7	eth6 GE interface	Reserved.
8	eth7 GE interface	
9	VGA interface	Used for connecting to the monitor.
10	USB interface	Used for connecting to the mobile storage device.
11	iBMC remote management interface	Used for connecting to the PC computer to manage the 2288X V5 server.
12	Server serial interface	Reserved.

1.2.3 S5735-S24P4X LAN Switch

Appearance and Structure

Figure 1-2 S5735-S24P4X appearance



1	Twenty-four PoE + 10/100/1000BASE-T ports	2	Four 10GE SFP+ ports Applicable modules and cables: <ul style="list-style-type: none"> • GE optical module • GE-CWDM optical module • GE-DWDM optical module • GE copper module (100M/1000M auto-sensing) • 10GE SFP+ optical module (OSXD22N00 not supported) • 10GE-CWDM optical module • 10GE-DWDM optical module • 1 m and 3 m SFP+ high-speed copper cables • 3 m and 10 m SFP+ AOC cables • 0.5 m and 1.5 m SFP+ dedicated stack copper cables (used for zero-configuration stacking)
3	One console port	4	One ETH management port
5	One USB port	6	One PNP button NOTICE To restore the factory settings and reset the switch, hold down the button for at least 6 seconds. To reset the switch, press the button. Resetting the switch will cause service interruption. Exercise caution when you press the PNP button.
7	Ground screw NOTE It is used with a ground cable.	8	Jack for AC power cable locking strap NOTE Applicable power module: 1000 W AC PoE Power Module (PAC1000S56-CB)
9	AC socket NOTE Applicable power module: 1000 W AC PoE Power Module (PAC1000S56-CB)	-	-

Technical Specifications

Table 1-2 lists technical specifications of the S5735-S24P4X.

Table 1-2 Technical specifications

Item	Description
Memory (RAM)	1 GB
Flash	512 MB in total. To view the available flash memory size, run the display version command.
Mean time between failures (MTBF)	59.88 years
Mean time to repair (MTTR)	2 hours
Availability	> 0.99999
Service port surge protection	Common mode: ± 7 kV
Power supply surge protection	± 6 kV in differential mode, ± 6 kV in common mode
Dimensions (H x W x D)	<ul style="list-style-type: none"> Basic dimensions (excluding the parts protruding from the body): 43.6 mm x 442.0 mm x 420.0 mm (1.72 in. x 17.4 in. x 16.5 in.) Maximum dimensions (the depth is the distance from ports on the front panel to the handle on the rear panel): 43.6 mm x 442.0 mm x 444.2 mm (1.72 in. x 17.4 in. x 17.49 in.)
Weight (with packaging)	7.39 kg (16.29 lb)
Stack ports	Any 10/100/1000BASE-T ports or 10GE SFP+ ports
RTC	Supported
RPS	Not supported
PoE	supported
Rated voltage range	<ul style="list-style-type: none"> AC input: 100 V AC to 240 V AC, 50/60 Hz High-Voltage DC input: 240 V DC
Maximum voltage range	<ul style="list-style-type: none"> AC input: 90 V AC to 290 V AC, 45 Hz to 65 Hz High-Voltage DC input: 190 V DC to 290 V DC
Maximum power consumption (100% throughput, full speed of fans)	<ul style="list-style-type: none"> Not providing the PoE function: 65 W 100% PoE loads: 847 W (PoE: 720 W)

Item	Description
Typical power consumption (30% of traffic load) <ul style="list-style-type: none"> • Tested according to ATIS standard • EEE enabled • No PoE power consumption 	51 W
Operating temperature	-5°C to +50°C (23°F to 122°F) at an altitude of 0-1800 m (0-5906 ft.) <p>NOTE</p> When the altitude is 1800-5000 m (5906-16404 ft.), the highest operating temperature reduces by 1°C (1.8°F) every time the altitude increases by 220 m (722 ft.). The switch cannot be started when the ambient temperature is lower than 0°C (32°F).
Short-term operating temperature	-5°C to +55°C (23°F to 131°F) at an altitude of 0-1800 m (0-5906 ft.) <p>NOTE</p> When the altitude is 1800-5000 m (5906-16404 ft.), the highest operating temperature reduces by 1°C (1.8°F) every time the altitude increases by 220 m (722 ft.). The equipment can operate beyond the normal operating temperature range for a short-term period, but the following conditions must be met: <ul style="list-style-type: none"> • The equipment operates at a temperature of over 45°C (113°F) consecutively for at most 96 hours in one year. • The equipment operates at a temperature of over 45°C (113°F) for a total of no more than 360 hours in one year. • The equipment operates at a temperature of over 45°C (113°F) for no more in 15 times in one year. The equipment may be damaged or experience unexpected exceptions if any of the preceding limits is exceeded. The equipment cannot start when the temperature is lower than 0°C (32°F). The maximum distance of optical modules used in these conditions cannot exceed 10 km.
Storage temperature	-40°C to +70°C (-40°F to +158°F)
Noise under normal temperature (27°C, sound power)	< 58.9 dB(A)
Relative humidity	5% to 95%, noncondensing

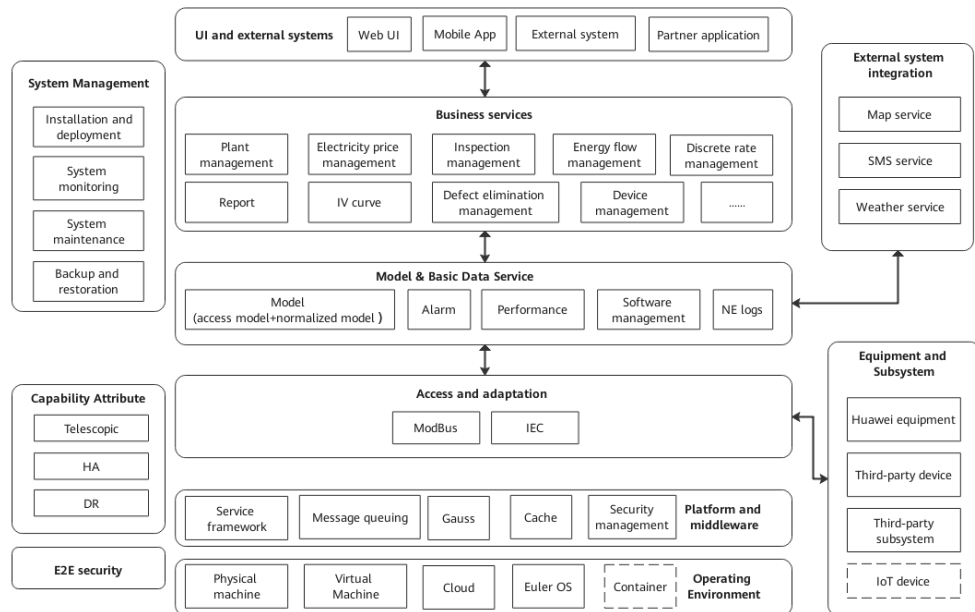
Item	Description
Operating altitude	0-5000 m (0-16404 ft.)
Certification	<ul style="list-style-type: none"> • EMC certification • Safety certification • Manufacturing certification
Part number	98010940

1.2.4 Software Architecture

The SmartPVMS software adopts the B/S architecture and consists of the access, public framework, application and service, and UI layers. It runs on the Euler OS operating system. Users can access the server in web mode on the Windows operating system (OS). To ensure data transmission security, the SmartPVMS supports encrypted transmission.

Figure 1-3 shows the SmartPVMS software architecture.

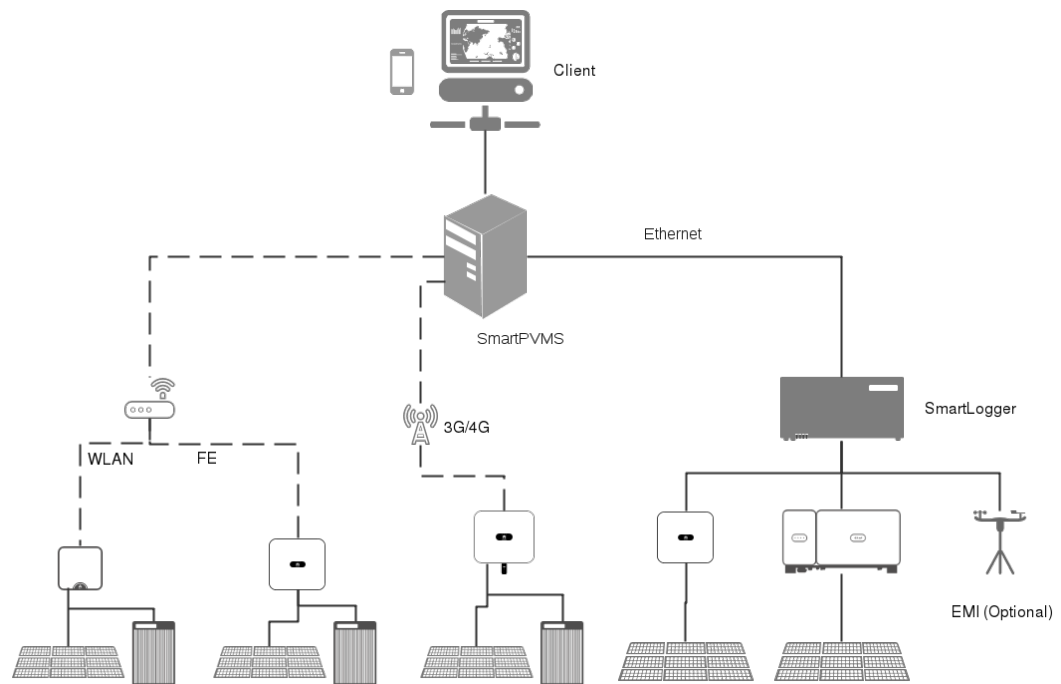
Figure 1-3 SmartPVMS software architecture



1.2.5 System Networking

The SmartPVMS is used to monitor residential and distributed PV plants. Figure 1-4 shows the system networking.

Figure 1-4 System networking



The entire system incorporates the SmartPVMS, service provider, PV equipment, third-party service, and client through the Internet.

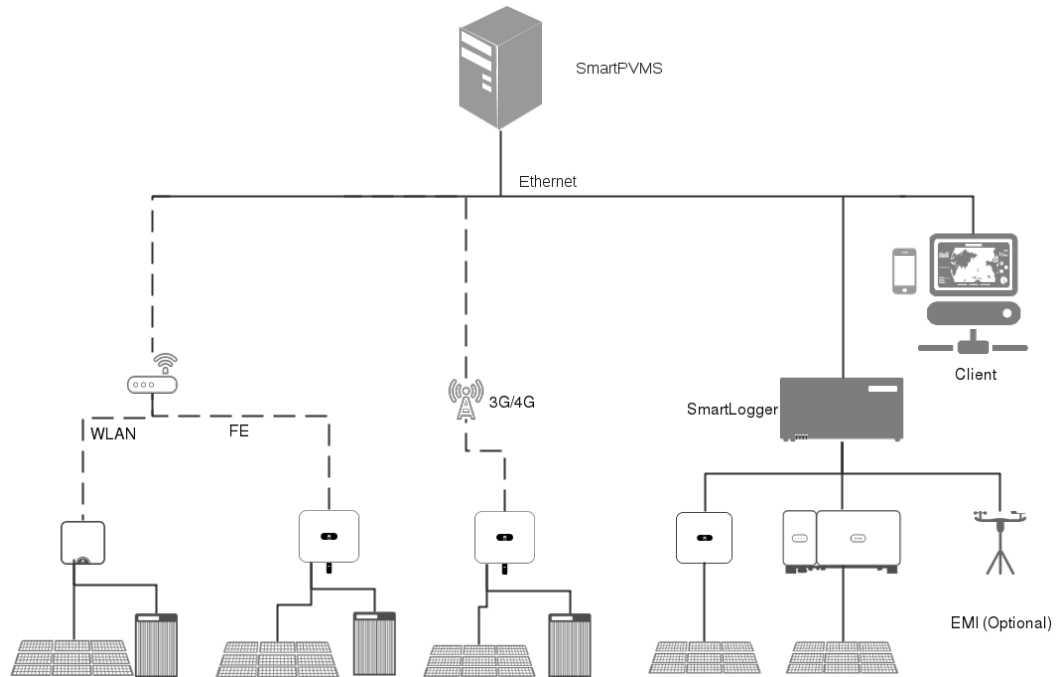
- The system supports inverters, power sensor, optimizers, environmental monitoring instruments (EMIs), and batteries.
- The SmartLogger can connect to multiple inverters or inverters through the Dongle communications module.
- The SmartPVMS uses a firewall as the primary protection.
- Service providers mainly consist of DNS, email, weather, and map service providers.
- Clients mainly consist of user PC servers and smart phones.

1.2.6 Single-Server Deployment Solution

The SmartPVMS can be deployed on a physical server to form a SmartPVMS single-node system. The SmartPVMS supports basic configuration and standard configuration.

Figure 1-5 shows the single-node system networking.

Figure 1-5 Single-node system networking

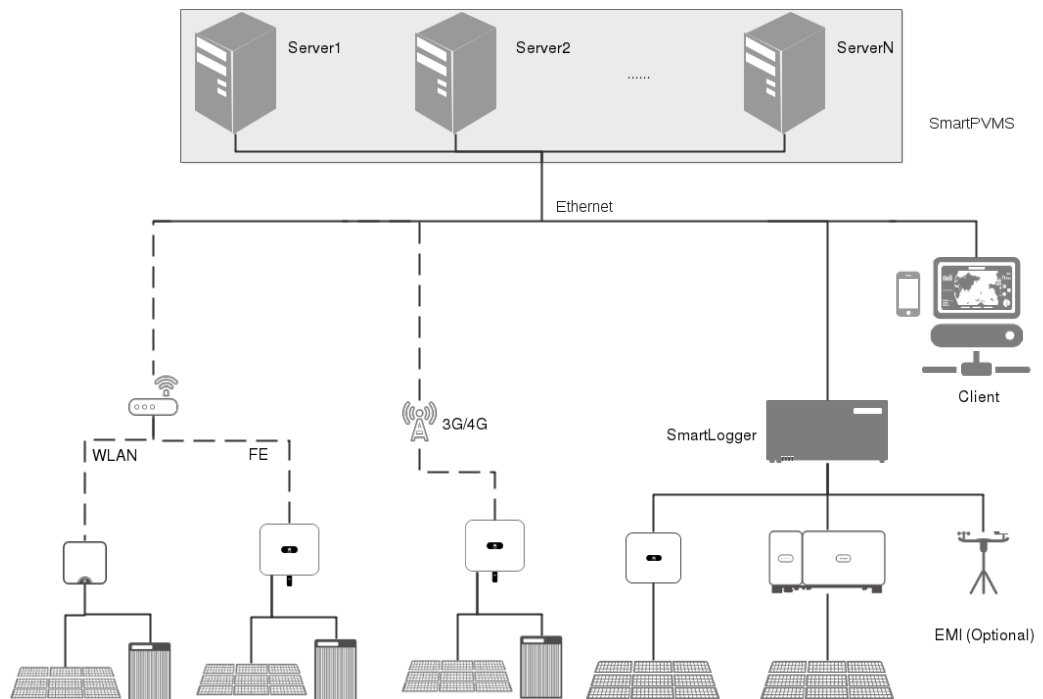


1.2.7 Distributed Cluster Deployment Solution

The SmartPVMS supports a distributed cluster system consisting of seven, eight, nine, or ten physical servers or HUAWEI CLOUD hosts.

Figure 1-6 shows the networking of distributed cluster deployment.

Figure 1-6 Distributed cluster networking



1.3 Product Functions and Application Scenarios

1.3.1 Product Functions

System requirement

- Multi-language support
Supports a group's plants to be connected around the world. Allows users to change languages based on their language habits, resolving the problem that plants cannot be effectively managed due to language restrictions. Supports global hosting using a unified domain name.
- Security and reliability
Hardens the security of the system in terms of web security, data integrity, transmission security, operating systems, third-party components, security logs, sensitive data protection, and privacy protection, ensuring the reliable running of the system.
- Front-end and back-end concurrency and access volume
Supports access of a large number of devices and concurrent PV requests to unify the device data center and monitoring management.
- Message push
Supports email and terminal message push in alarm, fault, and O&M management to improve O&M efficiency in mobile offices.
- Compatibility
Adapts to mainstream browsers (You are advised to use the latest Chrome browser (Stable Channel version) or Firefox browser (ESR version).) and supports the lowest resolution (1366 x 768) , ensuring that users can monitor plants in real time without changing office hardware.
- License management
Supports system scenario, capacity, and user management to meet diversified access requirements.
- Access from self-built platforms
Supports self-built platforms and does not need to be deployed on the cloud, which allow customers to purchase and deploy the system without using the cloud hosting mode.
- Third-party interface
Supports interconnection with third-party systems, sharing of different service data, and overall service collection.
- Scheduled report push
Sends daily, monthly, and yearly plant reports, solar inverter reports, and battery reports to users' mailboxes.
- Dual-FTP cluster
Supports dual FTP channels and allows a SmartLogger to be upgraded in FTP mode.

- I-V license
Dongle 1.0, Dongle 2.0, and SmartLogger support IV license data obtaining and delivery.

Plant management (access and manage a group's plants)

- Plant access configuration
Supports distributed plant and residential plant management, such as plant information configuration and plant equipment configuration, meeting the customers' requirements for diversified PV plant access in one system.
- One-click PV plant deployment
Allows inverters to be deployed in one-click mode and rapidly connected to the system.
- Time-of-use pricing
Calculates the revenue in different periods using different electricity prices, which makes the revenue calculation more accurate.
- Independent page for a plant
Displays the data of a single plant on an independent page, which achieves comprehensive real-time monitoring for the plant.

Plant counters and analysis (manage a group's power generation)

- Group KPI analysis
Obtains analysis data from each plant, including the installed capacity, energy yield, O&M work order quantity, and planning data, analyzes and calculates common KPIs, and displays the KPIs in graphics. Displays key energy yield counters of a managed plant on one screen, facilitating monitoring and management.
- Multi-plant KPI analysis
Allows users to compare the real-time power, energy yield, and utilization hours to identify excellent plants and improve poor plants.
- Plant KPI analysis
Collects statistics on energy yield KPIs and environment KPIs. Allows users to view the level-one counters in the intelligent cloud center and click the counter interface of a certain plant to view the specific counters of the plant.
- Historical device data
Allows users to view the 5-minute historical data of each device.
- Device analysis report
Displays device analysis reports to help users effectively view the running KPIs of solar inverters.

Visualized monitoring

- Real-time device monitoring
Collects device data to implement real-time monitoring, enabling plant monitoring personnel to monitor the overall and detailed situations of the entire PV plant.
- Device control

Allows monitoring personnel to remotely and quickly control devices.

- O&M monitoring
Combines real-time monitoring and O&M management to monitor O&M processes and trace completed O&M processes.
- Device configuration information display
Supports graphical display of data of solar inverters, PV modules, and optimizers; Displays the physical and logical views synchronously on the SmartPVMS app.

O&M management

- Device alarm management
Traces active and historical alarms in real time.
- Defect elimination management
Creates, modifies, and operates defect elimination processes to register, track, and monitor faults or defects that have occurred, and archive the results after the defect elimination and acceptance.
- Mobile preventive maintenance inspection (PMI)
Supports mobile O&M based on terminals and GIS to help customers implement mobile O&M.
- Diagnosis warning
Analyzes devices and generates alarms to notify users.
- Repair suggestion knowledge base
Allows users to customize or update alarm clearance suggestions.
- Power generation information comparison
Compares plants in the same environment to evaluate the advantages of the plants.
- I-V curve
Starts I-V curve scanning for PV strings, analyzes and collects statistics on faulty PV strings, and displays detailed scanning results by plant.

User management

- User management
Supports user rights and resource management, creates accounts with different permissions, and specifies different work scopes.
- Role management
Assigns different function permissions to users of different roles.
- Company information management
Supports customization of company logos and names.
- Password retrieval
Allows users to retrieve their passwords by mailbox to ensure the long-term stability of user accounts.

Dashboard display

Displays O&M and centralized monitoring information on the dashboard by company and plant. The information displayed varies with application scenarios.

Device management

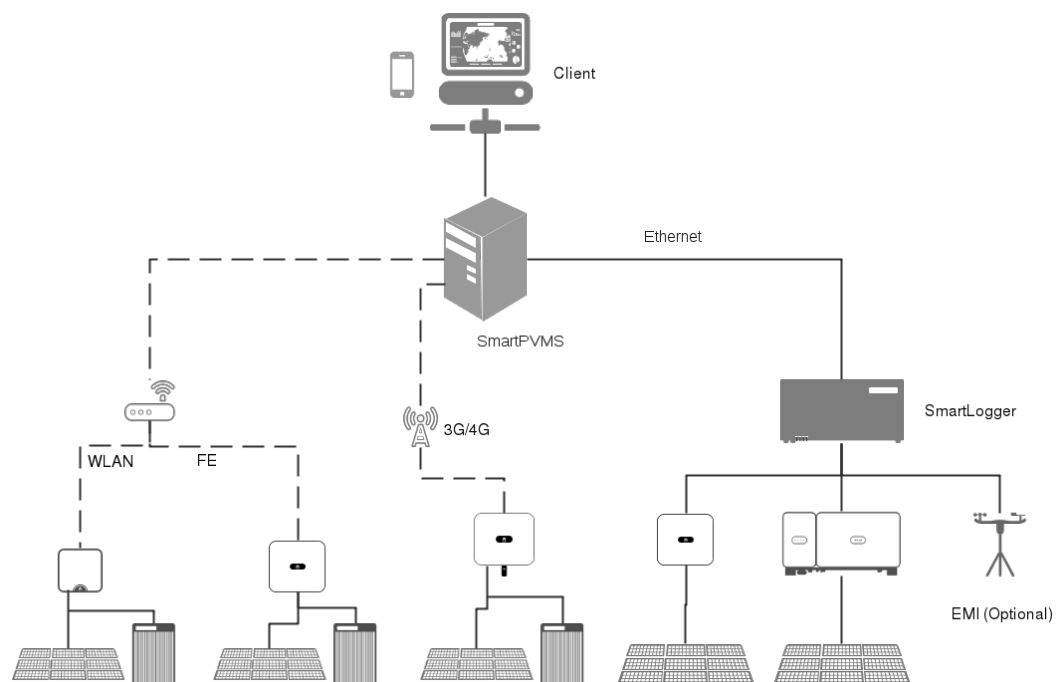
- Device management
Manages all user devices in a unified manner, including the PV area and step-up station devices.
- Device upgrade
Allows users to upgrade devices remotely and quickly.
- Device log management
Allows users to export and save device running logs to quickly locate device faults.
- Data re-collection
After the communication between the data collector and the system recovers, the system can initiate a data supplementary collection request in automatic or manual mode to ensure the integrity of plant data.

1.3.2 Application Scenarios

Distributed deployment

Huawei residential inverters can be connected to the system through Wi-Fi or 4G-dongle access. [Figure 1-7](#) shows the networking.

Figure 1-7 Networking of the Distributed Deployment



1.4 Configuration

1.4.1 Hardware Configuration

This section describes the hardware and configuration requirements of the system in a self-built scenario.

Table 1-3 lists hardware configuration requirements.

Table 1-3 Hardware configuration requirements

Hardware	Configuration Requirements	Description
2288X V5 Server	<ul style="list-style-type: none">● Basic configuration<ul style="list-style-type: none">– CPU: 2 x Intel 4208-8Core, 2.1GHz– Memory: 2 x 32GB– Hard disk: 2 x 1200 GB– Operating system: EulerOS V2.0 SP5● Standard configuration<ul style="list-style-type: none">– CPU: 2 x Intel 5218-16Core, 2.3GHz– Memory: 4 x 32GB– Hard disk: 2 x 1200 GB + 8 x 1800 GB– Operating system: EulerOS V2.0 SP5	Used for installing the operating system
Firewall	<ul style="list-style-type: none">● Network layer: protection for layers 2 to 7● VPN: SSL VPN, L2TP VPN, GRE VPN, and IPSec/IKE● Network security: authentication, authorization, and auditing (AAA) service, firewall, antivirus, intrusion prevention, URL filtering, security log and statistics, and network address translation (NAT)● Defense against DoS/DDoS attacks● Support for buffer overflow and SQL injection● Defense against attacks such as IDS/IPS evasion● Identification and control of peer-to-peer (P2P) and instant messaging (IM) traffic, such as BitTorrent (BT)	Used for system entry security protection
LAN switch	<ul style="list-style-type: none">● Application layer: three layers● Transmission rate: 1000 Mbit/s● Port description: 100/1000Base-T/X Ethernet port	Used for communicating with IT devices

Hardware	Configuration Requirements	Description
Client	<ul style="list-style-type: none"> • CPU: Intel quad-core CPU of 2.6 GHz or higher • Memory: 4 GB or larger • Hard disk: free space of 40 GB or more after the OS installation • Resolution: The optimal resolution is 1920 x 1080 pixels. • Operating system: mainstream operating systems • Browser: You are advised to use the latest Chrome browser (Stable Channel version) or Firefox browser (ESR version). 	Used for accessing the system server and web client

1.4.2 Cloud Resource Configuration

This section describes the cloud resource configuration requirements for the system in public cloud scenarios.

Table 1-4 describes the cloud resource configuration requirements.

Table 1-4 Cloud resource configuration requirements and name planning

Resource type	Configuration requirements	ECS Name (Example)	Description
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-master01	Northbound network cloud host, which is used to deploy the SmartPVMS and PowerEcho services. Huawei technical support engineers must evaluate the data disk space and provide a proper space to prevent data migration failures.

Resource type	Configuration requirements	ECS Name (Example)	Description
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-master02	
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-db01	<p>Storage network cloud host, which is used to deploy database services.</p> <p>Huawei technical support engineers must evaluate the data disk space and provide a proper space to prevent data migration failures.</p>
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-db02	
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-disb01	<p>Southbound network cloud host, which is used to deploy southbound access and distributed services.</p> <p>Huawei technical support engineers must evaluate the data disk space and provide a proper space to prevent data migration failures.</p>

Resource type	Configuration requirements	ECS Name (Example)	Description
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> ● vCPU: 32 ● Memory: 64GB ● system disk: 100GB ● CPU Architecture: x86 ● operating system: EulerOS 	ecs-smartpvms-disb02	
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> ● vCPU: 32 ● Memory: 64GB ● system disk: 100GB ● CPU Architecture: x86 ● operating system: EulerOS 	ecs-smartpvms-disb03	
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> ● vCPU: 32 ● Memory: 64GB ● system disk: 100GB ● CPU Architecture: x86 ● operating system: EulerOS 	ecs-smartpvms-disb04	
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> ● vCPU: 32 ● Memory: 64GB ● system disk: 100GB ● CPU Architecture: x86 ● operating system: EulerOS 	ecs-smartpvms-disb05	

Resource type	Configuration requirements	ECS Name (Example)	Description
Elastic Cloud Server(ECS)	<ul style="list-style-type: none"> • vCPU: 32 • Memory: 64GB • system disk: 100GB • CPU Architecture: x86 • operating system: EulerOS 	ecs-smartpvms-disb06	

1.4.3 Mobile Device Configuration

Mobile devices used to install apps must meet certain requirements for installing and accessing the system.

Table 1-5 lists mobile device configuration requirements.

Table 1-5 Mobile device configuration requirements

System Type	Configuration Requirements
Android	<ul style="list-style-type: none"> • CPU: quad-core CPU of 1 GHz or higher • Version: 5.0 or later • Screen: 1080p or higher

1.5 Technical Specifications

1.5.1 Performance Specifications

1.5.1.1 Management Capability

Table 1-6 lists the management capabilities of IP devices and Modbus-RTU connected devices supported by the SmartPVMS in single-server configuration.

Table 1-6 SmartPVMS Server Configuration Management Capability

Server Model	Number of Servers	Deployment Mode	Number of Devices	Number of Concurrently Connected Clients
basic configuration	1	Single-node system	10000	1000
standard configuration	1	Single-node system	30000	3000

 **NOTE**

The preceding management capability of the large-configuration server is evaluated based on the current SmartPVMS delivery models.

1.5.1.2 Bandwidth Requirements

The bandwidth between the SmartPVMS server and the client depending on the number of inverters managed by the SmartPVMS server. [Table 1 Outbound bandwidth requirements of the SmartPVMS server](#) lists the requirements for the outbound bandwidth of the SmartPVMS server.

It is recommended that the bandwidth between the client and the SmartPVMS server be at least 10 Mbit/s

Table 1-7 Outbound bandwidth requirements of the SmartPVMS server

Number of Inverters	50,000	
Bandwidth Required (Mbit/s)	Access Bandwidth	Sampling Bandwidth
	50	5

1.5.2 System Specifications

[Table 1-8](#) and [Table 1-9](#) lists the SmartPVMS server specifications.

2288X V5 Server

Table 1-8 Basic configuration server specifications

Item	Specifications	
Server dimension	Height	86.1 mm (2 U)

Item	Specifications	
	Depth	748mm
	Width	447 mm
Server weight	29 kg	

Table 1-9 Standard configuration server specifications

Item	Specifications	
Server dimension	Height	86.1 mm (2 U)
	Depth	748mm
	Width	447 mm
Server weight	30 kg	

Table 1-10 lists the power consumption of each device in the SmartPVMS system.

Table 1-10 Power consumption of each device in the SmartPVMS system

Device	Power Supply	Power Consumption	System BTU Per Hour
Basic configuration server	2*900W	280W	945.43 BTU/hour
Standard configuration server	2*900 W	500W	1669.14 BTU/hour

 **NOTE**

Workloads have a great impact on power consumption. That is, the power consumption of the same CPU usage may vary significantly in different workloads. Therefore, the data may be slightly different. The power consumption values in the preceding table are for reference only. You are advised to measure the power consumption values in actual environments and loads.

1.6 Standards Compliance

1.6.1 Safety Standards

The SmartPVMS complies with the following safety specifications and standards:

- IEC 60950-1

- IEC/EN41003
- EN 60950-1
- UL 60950-1
- CSA C22.2 No 60950-1
- AS/NZS 60950-1
- BS EN 60950-1
- IS 13252
- GB4943

1.6.2 EMC Standards

The SmartPVMS complies with the following electromagnetic compatibility (EMC) standards:

- CISPR22 Class A
- EN55022 Class A
- EN50024
- ETSI EN 300 386 Serial Class A
- ETSI EN 301 489 Class A
- ICES 003 Class A
- AS/NZS CISPR22 Class A
- GB9254 Class A
- VCCI Class A
- CNS 13438 Class A

1.6.3 Environment Standards

The environmental requirements of the SmartPVMS involve three types of environments: storage environment, shipping environment, and operating environment. The SmartPVMS complies with the following specifications:

- GB 4798 Application environmental conditions of electric and electronic products
- ETS 300019 Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment
- IEC 60721 Classification of environmental conditions

1.6.4 Storage Environment

1.6.4.1 Climatic Requirements

Table 1-11 Climatic requirements

Item	Value Range
Temperature	0-40°C

Temperature change rate	≤ 1°C/min
Relative humidity	10%–90%
Altitude	≤ 5000 m
Atmospheric pressure	70–106 kPa
Solar radiation	≤ 1120 W/s ²
Heat radiation	≤ 600 W/s ²
Wind speed	≤ 30 m/s

1.6.4.2 Waterproof Requirements

- Field equipment must be stored indoors.
 - Water does not accumulate on the ground or fall on the package.
 - The equipment is kept away from water sources such as a hydrant and air-conditioner.
- In the case of outdoor storage, the following requirements must be met:
 - The package is intact.
 - Waterproof measures are taken to prevent water penetration.
 - Water does not accumulate on the ground or fall on the package.
 - The package is not exposed directly to sunlight.

1.6.4.3 Biological Requirements

- The environment should not be conducive to the growth of fungus or mildew.
- There should be no rodents such as rats.

1.6.4.4 Air Purity Requirements

- The air must be free of explosive, conductive, magnetic conductive, or corrosive dust.
- The density of physically active materials must comply with the requirements listed in [Table 1-12](#).

Table 1-12 Requirements for the density of physically active materials

Physically Active Material	Unit	Density
Suspended dust	mg/m ³	≤ 5.00
Deposited dust	mg/m ² ·h	≤ 20.0
Sand	mg/m ³	≤ 300

Physically Active Material	Unit	Density
NOTE		
<ul style="list-style-type: none"> Suspended dust: diameter $\leq 75 \mu\text{m}$ Deposited dust: $75 \mu\text{m} \leq \text{diameter} \leq 150 \mu\text{m}$ Sand: $150 \mu\text{m} \leq \text{diameter} \leq 1000 \mu\text{m}$ 		

- The density of chemically active materials must comply with the requirements listed in [Table 1-13](#).

Table 1-13 Requirements for the density of chemically active materials

Chemically Active Material	Unit	Density
SO ₂	mg/m ³	≤ 0.30
H ₂ S	mg/m ³	≤ 0.10
NO ₂	mg/m ³	≤ 0.50
NH ₃	mg/m ³	≤ 1.00
Cl ₂	mg/m ³	≤ 0.10
HCl	mg/m ³	≤ 0.10
HF	mg/m ³	≤ 0.01
O ₃	mg/m ³	≤ 0.05

1.6.4.5 Mechanical Stress Requirements

Table 1-14 Mechanical stress requirements

Item	Sub-Item	Value Range	
Sinusoidal vibration	Offset	$\leq 7.0 \text{ mm}$	-
	Accelerated speed	-	$\leq 20.0 \text{ m/s}^2$
	Frequency range	2–9 Hz	9–200 Hz
Unsteady impact	Impact response spectrum II	$\leq 250 \text{ m/s}^2$	
	Static payload	$\leq 5 \text{ kPa}$	

<p>NOTE</p> <ul style="list-style-type: none"> • Impact response spectrum: Refers to the maximum acceleration response curve generated by the equipment under specified impact excitation. Impact response spectrum II means that the duration of semi-sine impact response spectrum is 6 ms. • Static payload: Refers to the capability of the equipment in package to bear the pressure from the top in normal pile-up method.

1.6.5 Shipping Environment

1.6.5.1 Climatic Requirements

Table 1-15 Climatic requirements

Item	Value Range
Temperature	0–40°C
Temperature change rate	≤ 3°C/min
Relative humidity	5%–100%
Altitude	≤ 5000 m
Atmospheric pressure	70–106 kPa
Solar radiation	≤ 1120 W/m ²
Heat radiation	≤ 600 W/m ²
Wind speed	≤ 30 m/s

1.6.5.2 Waterproof Requirements

Before shipping the equipment, ensure that the following requirements are met:

- The package is intact.
- Waterproof measures are taken to prevent water penetration.
- No water is accumulated inside the shipping vehicle.

1.6.5.3 Biological Requirements

- The environment should not be conducive to the growth of fungus or mildew.
- There should be no rodents such as rats.

1.6.5.4 Air Purity Requirements

- The air must be free of explosive, conductive, magnetic conductive, or corrosive dust.
- The density of physically active materials must comply with the requirements listed in [Table 1-16](#).

Table 1-16 Requirements for the density of physically active materials

Physically Active Material	Unit	Density
Suspended dust	mg/m ³	-
Deposited dust	mg/m ² ·h	≤ 3.0
Sand	mg/m ³	≤ 100
NOTE		
<ul style="list-style-type: none"> • Suspended dust: diameter ≤ 75 μm • Deposited dust: 75 μm ≤ diameter ≤ 150 μm • Sand: 150 μm ≤ diameter ≤ 1000 μm 		

- The density of chemically active materials must comply with the requirements listed in [Table 1-17](#).

Table 1-17 Requirements for the density of chemically active materials

Chemically Active Material	Unit	Density
SO ₂	mg/m ³	≤ 0.30
H ₂ S	mg/m ³	≤ 0.10
NO ₂	mg/m ³	≤ 0.50
NH ₃	mg/m ³	≤ 1.00
Cl ₂	mg/m ³	≤ 0.10
HCl	mg/m ³	≤ 0.10
HF	mg/m ³	≤ 0.01
O ₃	mg/m ³	≤ 0.05

1.6.5.5 Mechanical Stress Requirements

Table 1-18 Mechanical stress requirements

Item	Sub-Item	Value Range		
Sinusoidal vibration	Offset	≤ 7.5 mm	-	-
	Accelerated speed	-	≤ 20.0 m/s ²	≤ 40.0 m/s ²

Item	Sub-Item	Value Range		
	Frequency range	2-9 Hz	9-200 Hz	200-500 Hz
Random vibration	Spectrum density of accelerated speed	10 m ² /s ³	3 m ² /s ³	1 m ² /s ³
	Frequency range	2-9 Hz	9-200 Hz	200-500 Hz
Unsteady impact	Impact response spectrum II	≤ 300 m/s ²		
	Static payload	≤ 10 kPa		
NOTE <ul style="list-style-type: none"> Impact response spectrum: Refers to the maximum acceleration response curve generated by the equipment under specified impact excitation. Impact response spectrum II means that the duration of semi-sine impact response spectrum is 6 ms. Static payload: Refers to the capability of the equipment in package to bear the pressure from the top in normal pile-up method. 				

1.6.6 Operating Environment

Table 1-19 Temperature and humidity requirements for operation

Temperature		Relative Humidity	
Long term	Short term	Long term	Short term
15-30°C	0-40°C	20%-80%	20%-90%
NOTE <ul style="list-style-type: none"> The values are measured 1.5 m above the floor and 0.4 m in front of the equipment, without protective panels in front of or behind the cabinet. Short-term operation means that the continuous working hours are shorter than 48 and the total working days per year are fewer than 15 days. 			

Table 1-20 Other climatic requirements for operation

Item	Value Range
Altitude	≤ 4000 m
Atmospheric pressure	70-106 kPa
Temperature change rate	≤ 3°C/min

Item	Value Range
Solar radiation	$\leq 700 \text{ W/m}^2$
Heat radiation	$\leq 600 \text{ W/m}^2$
Wind speed	$\leq 1 \text{ m/s}$

1.7 Acronyms and Abbreviations

Abbreviation	Full Name
DB	Database
KPI	Key Performance Indicators
OS	Operating System
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SSO	Single Sign On
TCP/IP	Transmission Control Protocol/Internet Protocol