# SmartPVMS Smart I-V Curve Diagnosis

# **User Manual**

 Issue
 01

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 2021-08-20





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# **About This Document**

### Purpose

This document describes the Smart I-V Curve Diagnosis function of the Smart PV Management System (SmartPVMS), and provides solutions to common faults.

## **Intended Audience**

This document is intended for photovoltaic (PV) plant operating personnel and qualified electricians.

## **Symbol Conventions**

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

Symbol	Remarks
	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
	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.

Symbol	Remarks
	Supplements the important information in the main text.
	NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

# **Change History**

Changes between document issues are cumulative. The latest document issue contains all updates made in previous issues.

#### Issue 01 (2021-08-20)

This issue is used for first office application (FOA).

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# Function Description

#### Functions

Smart I-V Curve Diagnosis allows Huawei inverters to scan PV strings and generate an I-V curve, which is then analyzed simultaneously in the Smart PV Management System (SmartPVMS) to diagnose PV strings and generate alarms for faulty PV modules.

A large number of PV plant statistics show that PV module quality and faults are important factors that affect energy yields. As the PV industry is becoming mature, how to identify faulty PV modules in a convenient and efficient way and how to take appropriate measures to rectify faults are the key to increasing energy yields and decreasing investment risks, and are also the development trend of operation and maintenance (O&M).

Smart I-V Curve Diagnosis helps scan and diagnose the PV strings connected to an inverter or in an entire PV plant to detect faults and risks and ensure plant safety. In addition, the operation wizard makes O&M easier and faster.

#### Features

- Promptly detecting faults and risks of PV modules
  - All PV modules in a PV plant are scanned periodically through annual inspection, which helps promptly detect faulty PV modules. Timely processing of faulty PV modules helps improve energy yields and prevents faults from escalating.
  - PV strings are scanned in real time for any output exceptions to detect faults and risks.
  - SmartPVMS analyzes the data simultaneously, which has little impact on energy yields and ensures high reliability.
- Improving the O&M efficiency
  - Wizard-based remote operation is supported.
  - I-V curves are analyzed automatically.
  - Reports are generated automatically.
  - Rectification suggestions are provided for located faults to improve O&M quality and efficiency.

#### **Key Performance Indicator**

- Huawei inverter I-V scanning duration (string open circuit to short circuit) < 1s
- Huawei inverter I-V scanning resolution: 128 data points
- Huawei inverter I-V scanning voltage precision: 0.5%
- Huawei inverter I-V scanning current precision: 0.5%
- Scanning of a single inverter does not require the inverter to be shut down, so energy yields will barely be affected.

# **2** Smart I-V Curve Diagnosis License Management

# 2.1 License Description

#### Description

Smart I-V Curve Diagnosis can be used only after a license is purchased. The license file for Smart I-V Curve Diagnosis is stored in a Huawei inverter. The inverter SN uniquely maps to the license.

The license for Smart I-V Curve Diagnosis is a fixed-term license. When the license goes beyond **License Deadline**, the system provides a warning asking the customer to replace it with a new license.

The license can still be used for 60 days (grace period) after the **License Deadline**. After the **Grace period** expires, the Smart I-V Curve Diagnosis function will be disabled.

#### NOTICE

- The SmartPVMS can be used to manage licenses for all inverters in multiple PV plants.
- The SmartLogger can be used to manage licenses for all inverters in a PV array.
- The FusionSolar app or SUN2000 app can be used to manage the license for a single Huawei commercial inverter.

#### **License Application Procedure**

- 1. The customer exports a license application file and sends it to a technical service engineer.
- 2. The technical service engineer transfers the obtained license file to the customer.

3. The customer imports and loads the license file to an inverter, thereby obtaining the permission to use the Smart I-V Curve Diagnosis function.

## 2.2 License Management on the SmartPVMS.

#### Prerequisites

- You have logged in to the SmartPVMS as an installer.
- You have created a PV plant and added devices to the PV plant. The devices are running properly.

#### **NOTE**

The software version corresponding to the user interface (UI) snapshots in this section is SmartPVMS V500R007C00CP1308. The UIs could vary with software versions and are for reference only.

#### Procedure

#### **Step 1** Choose **Plants > Device License Management**.



Figure 2-1 Device license management

#### **Step 2** Perform operations according to **Table 2-1**.

Task Name	Task Description	Procedure
Viewing license informati on	For routine O&M, the license validity and function usage are queried routinely to check whether the license is about to expire and solve the problems in a time manner. In this way, the device can function properly.	<ol> <li>Click License Information tab to view the license information about the target device.</li> <li>Click Export All or select the target device (multiple devices can be selected) and click Export Selected, and save the license information to the PC.</li> </ol>
Exporting the license applicati on file	The license application file contains the content required for applying the device license. Export the license application file to apply for a new device license if the license has expired.	<ol> <li>Click the License Application tab and export the license application file.</li> <li>Click Export All or select the target device (multiple devices can be selected) and click Export Selected, and save the license information to the PC.</li> </ol>
Loading a device license	If the license has not been loaded for the device or the license is about to expire, you need to load a new license file to the device so that the device functions properly.	<ol> <li>Click the License Loading tab.</li> <li>Click Upload License. Select the license to be uploaded and click Upload.</li> <li>Click Load All, or select the target device (multiple devices can be selected) and click Load Selected</li> <li>(Optional) To stop license loading, click Stop Loading</li> <li>NOTE A license file uniquely maps to a device SN. The license can be successfully loaded only if the license file uniquely maps to the device SN.</li> </ol>

Table 2-1 Operations related to license management

Task Name	Task Description	Procedure
Revoking a license	Before a device is replaced, the current device license needs to be revoked so that the revocation code can be generated and used for applying for a new device license. After the device is replaced, you can load the new license file to the device, and then the device functions properly.	<ol> <li>Select the License Revocation tab.</li> <li>Select the target device (multiple devices can be selected) and click Revoke License</li> <li>Enter the user password and click OK.</li> <li>Click Export All Revocation Codes or select the target device (multiple devices can be selected) and click Export Selected Revocation Code.</li> <li>NOTE         If you export revocation codes of devices whose License Status is Normal, the following message is displayed: The license revocation code cannot be exported because the license is not in revocation state.     </li> </ol>

----End

# 2.3 License Management Through the SmartLogger

#### Prerequisites

- You have logged in to the SmartLogger WebUI.
- Devices have been added to the SmartLogger and operate normally.
- You have logged in as an advanced user, a special user, or the admin user.

#### 

The software version corresponding to the user interface (UI) snapshots in this section is SmartLogger3000 V300R001C00SPC060. The UIs could vary with software versions and are for reference only.

#### Procedure

**Step 1** Choose **Maintenance** > **License Management** on the main menu.

e power system						English	~ (0F)
Enspire		Deploym	ent Wizard Over View Moni	toring Query S	Settings Maintenance		<u>10 🕛 🔮 1</u>
<ul> <li>Software Upgrade</li> </ul>	Lic	ense info	ormation License application Lice	ense loading 🗡 License i	revocation	To	tal Device Qty. : 2
<ul> <li>Product Information</li> </ul>	Auti	norized F	unction: All	Number of auth	orized devices: Smart I-V Curve Diagnosi 🗸	Authorized: 0 Unauthor	ized: 1 ( Help
<ul> <li>Security Settings</li> </ul>		No.	Device 🗢	Device status 🗘	Authorized Function 🗘	License Status 🌣	License SN 🗘
<ul> <li>System Maint.</li> </ul>		1	4.125KTL-JP(COM1-2)	•	Smart I-V Curve Diagnosis	No license	
- Device Log		2	Logger(Local)	•	Smart tracking algorithm	Grace period	LIC20210425U
<ul> <li>Onsite Test</li> </ul>	0	3	Logger(Local)	•	Smart reactive power compensation (102.000kVar)	Grace period	LIC20210425L
License Management							
Device Mgmt.	•						
Connect Device	1						
SmartModule							
Device List							
Export Param.							
Clear Alarm							
Data Re-collection							
Adjust total energy yield							
							+
	Expo	rt Details					

Figure 2-2 License management

**Step 2** Perform operations according to **Table 2-2**.

Task Name	Task Description	Procedure
Querying license informati on	For routine O&M, the license validity and function usage are queried routinely to check whether the license is about to expire and solve the problems in a time manner. In this way, the device can function properly.	<ol> <li>Choose License information to view the license information about the target device.</li> <li>Select the target device and click Export Details to save the license information about the target device to the PC.</li> </ol>
Exporting the license applicati on file	The license application file contains the content required for applying the device license. Export the license application file to apply for a new device license if the license has expired.	<ol> <li>Choose License application.</li> <li>Select the target device (multiple devices can be selected) and click Export License Appli File.</li> </ol>

Table 2-2 Operations related to license management

Task Name	Task Description	Procedure
Loading a device license	If the license has not been imported for the device or the license is about to expire, you need to import the new license file to the device, ensuring that the device functions properly.	<ol> <li>Choose License loading.</li> <li>Click Upload License and select the license file to be imported.</li> <li>Select the target device (multiple devices can be selected) and click Load License to load the device license.</li> <li>NOTE         A license file uniquely maps to a device SN. The license can be successfully loaded only if the license file uniquely maps to the device SN.     </li> </ol>
Revoking a license	Before a device is replaced, the current device license needs to be revoked so that the revocation code can be generated and used for applying for a new device license. After the device is replaced, you can import the new license file to the device, and then the device functions properly.	<ol> <li>Click License revocation.</li> <li>Select the target device (multiple devices can be selected) whose license needs to be revoked.</li> <li>Click Revoke License.</li> <li>Enter the user password and click Submit.</li> <li>Click Export Revo Code File.</li> <li>NOTE         If you export revocation codes of devices whose License Status is Normal, the system will prompt you to re-select devices.     </li> </ol>

----End

# 2.4 License Management on the FusionSolar App or SUN2000 App

#### Prerequisites

- The solar inverter has been connected to the mobile phone installed with the FusionSolar app or SUN2000 app.
- You have logged in to the app as an advanced user or an installer user.
- The FusionSolar app or SUN2000 app can be used to manage the license for a single inverter at a time.

#### **NOTE**

The software version corresponding to the user interface (UI) snapshots in this section is FusionSolar 5.7.011 and SUN2000 3.2.00.014. The UIs could vary with software versions and are for reference only.

#### Procedure

**Step 1** Choose **Maintenance** > **License management** on the main menu.



Step 2 Tap

in the upper right corner of the screen.

#### Figure 2-3 License management

agement 🗮
Load
NA NA
NA
NA
None

Step 3 Tap Load license.

**Step 4** Select the license file to be loaded and confirm the loading.

----End

#### **Follow-up Procedure**

Before a device is replaced, the current device license needs to be revoked so that the revocation code can be generated and used for applying for a new device license.

Step 1 Tap Revoke license.

C License ma	nagement 🗮
License status	Load
License SN	Revoke license
License load time	21-Mar-2021 16:10:37
License expiration time	20-Jun-2021 23:59:59
Authorized function	Smart I-V curve diagnosis

#### Figure 2-4 Revoke license

Step 2 Tap Export revocation code.

----End

# **3** Smart I-V Curve Diagnosis

# 3.1 Smart I-V Curve Diagnosis on the SmartPVMS

#### Prerequisites

- You have logged in to the SmartPVMS as an installer.
- The Smart I-V Curve Diagnosis license has been loaded and is valid.

#### **NOTE**

The software version corresponding to the user interface (UI) snapshots in this section is SmartPVMS V500R007C00CP1308. The UIs could vary with software versions and are for reference only.

#### Setting the String Capacity

**Step 1** Choose **Maintenance** > **Smart Diagnosis**.

Figure 3-1 Smart diagnosis





#### Figure 3-2 String management

🎢 FusionSolar 🛛	ŵ	Home Report	s Plants N	laintenance V	alue-Added Services	System	Q 🕜 English	0	(i) (?	)
Real-Time Status   Alarm	Management	Task Management   S	smart Diagnosis	Smart Track	king					
Smart Diagnosis	Task name:	Check ti	me: Start date	→ End date	🗄 Search	Reset				
Module Library Manageme							Configure String	s Ad	d Diagnosis Ta	ask
		Task Name	Faulty Units	Total Units	Check Time	Scanni	ing Progress		Operation	
	+	12	22	28	2021-08-20 16:16:34		🗕 🥑 🛛 Time used: (	00:10:26	View Details	\$

- **Step 3** (Optional) Set filter criteria such as Task name and Check time, and click **Search**. The device list that meets the search criteria is displayed.
- **Step 4** Select the target device (multiple devices can be selected) and click **Configure String Details**.

#### **NOTE**

You can select and configure devices of the same type in batches. A maximum of 400 devices can be configured at a time.

#### Figure 3-3 Configure string details

Configure Strings								×
Enter a keyword	Q	Inverter ty	pe: All 🗸	Inverter name:	Configuration state:	All v		
▼ □ 🗈 Root						Search	Configure String Details	J
<ul> <li>Im testCompany</li> <li>Im testShareCompany</li> </ul>			Plant Name	Inverter Type	Inverter Name	SN	Configuration State	
			shareplant	Residential inverter	rwzzzaa	rwzzzaa	Unconfigured	•

#### **Step 5** Configure the parameters.

#### **NOTE**

- String capacity = Rated power of a PV module x Number of PV modules in a PV string
- Click **Parameter Description** to view parameter details.

#### Figure 3-4 Configuring the parameters

Configure String Details								×
Batch apply String quantity 12						А	dd Template	Parameter Description
String *Module Quar	nti 2-in-1 St *Mod	ule Manufacturer	Mode	ule Model	*Module Type	*Max. Module	Powe	String Capacity (Wp)
E PV1	Us	er-defined V	User-	-defined V	Polycrystalline V	User-define	d ~	9615.3846
*Max. module power (Pmax) (W)		*Optimal module op	perating voltage		*Optimal module opera	ating current		
*Module open-circuit voltage (Voc) (		*Module short-circu	it current (lsc) (A)		*Maximum power (Pma	x) temperatu	-0.41	
*Open-circuit voltage (Voc) tempera	-0.31	*Short-circuit curren	it (lsc) temperat	0.053	*Module type		Polycrystalli	ne v
*Module manufacturer		*Cell quantity (PCS/	module)	60	*Grid connection date		Select date	8
*Module degradation rate in first ye	2.5	*Module degradatio	in rate from sec	0.7	Module model			
Fill factor (%)		Nominal module eff	iciency (%)					

----End

#### Set the Smart I-V Curve Diagnosis Task.

Step 1 On the Smart Diagnosis page, click Add Diagnosis Task and set task parameters.

Х

#### NOTICE

Read the I-V Curve Diagnosis **Operation Suggestions** carefully and ensure that the conditions are met before setting parameters.

#### Figure 3-5 Setting diagnosis task parameters

Add I-V Curve Diagnosis Task

		Operation Suggestions				
Requirements for I-V curve diagnosis: 1. Cleaning status of the strings must be consistent diagnosis. 2. The solar irradiance must be above the lower lim during I-V curve diagnosis.	t during hit (400 W/m²)	uggestions for string diagnosis: A maximum of 200 inverters can be diagnosed at a time. It is recommended that strings be cleaned before diagnosis to reveal the actual status of e diagnosed modules. You are advised to perform diagnosis between 11:00 am and 13:00 pm. Ensure that the				
<ol> <li>String configuration information must be correct</li> </ol>		front and roar rows of the strings are not blocked				
Task name						
Select device	Enter a keywo	rd Selected devices: 0 Q ttompany ttshareCompany				
String cleaning	<ul> <li>Cleaned ()</li> </ul>	Not cleaned				
Environmental parameters	<ul> <li>Auto</li> <li>Manually se</li> </ul>	tting				
		Cancel Start Scanning				

Table 3-1 Diagnosis task parameters

Parameter	Description			
Task name	Enter a task name.			
Select device	Inverter-Level Health Check: Checks the health status of P strings connected to the inverter.			
String cleaning	Choose <b>Cleaned</b> or <b>Not Cleaned</b> according to the actual conditions.			
Environmental parameters	<ul> <li>Auto: The system automatically calculates PV module plane and Module back surface temperature.</li> </ul>			
	<ul> <li>Manually setting: Manually enter the values of PV module plane (The recommended value is greater than or equal to 400 W/m<sup>2</sup>) and Module back surface temperature (The recommended value is 25°C).</li> </ul>			

#### Step 2 Click Start Scanning.

#### **NOTE**

If an error message dialog box is displayed when you attempt to start the diagnosis, rectify the fault and then start the diagnosis.

----End

#### View Diagnosis Results.

**Step 1** On the **Smart Diagnosis** page, locate the target task and click **View Details** in the **Operation** column.

Figure 3-6 Viewing the diagnosis task status

🎢 FusionSolar 🛛	ŵ	Home Reports	i Plants 🕨	Maintenance Va	alue-Added Services	System C	ک 🛞 English	8	i ?
Real-Time Status   Alarm	Management	Task Management   S	mart Diagnosis	Smart Track	king				
Smart Diagnosis	Task name:	Check tir	ne: Start date	e → End date	📋 Search	Reset			
I-V Curve									
Module Library Manageme							Configure String	s Ado	d Diagnosis Task
		Task Name	Faulty Units	Total Units	Check Time	Scanning	Progress		Operation
		12	22	28	2021-08-20 16:16:34		O Time used: 0	0:10:26	View Details

**Step 2** Click + before the task to view the **Fault List** and the diagnosis report.

Figure	3-7	Fault	list
--------	-----	-------	------

🎢 FusionSolar 🛛 🕤	ທີ	Hom	e Report	s Plants	Maintenance V	alue-Add	ed Services Sy	ystem		Q 🛞 English	8	(i) (	?
Real-Time Status   Alarm Management   Task Management   Smart Diagnosis   Smart Tracking													
Smart Diagnosis	Task n	ame:	Check ti	me: Start da	te → End date	e 🖻	Search	Reset					
I-V Curve													
Module Library Manageme										Configure String	js A	dd Diagnosis	Task
		Task Nam	e	Faulty Unit	ts Total Units	C	heck Time		Scannir	ng Progress		Operatio	'n
		12		22	28	2021-	08-20 16:16:34			- 🥑 Time used:	00:10:26	View Deta	ails
Fault List ivTest1									✓ Experimentary Experiment	ort			
		Plant Name	Plant	address	Inverter Na	me	Inverter	SN	String	Fault Descripti	on	Suggestion	1
		ivTest1	Dąbie, P	rawobrzeż	SUN2000-50KT 001	L-M0-	SUN2000-50 001	KTL-M0-	1	String open circuit	(the	View	

#### Figure 3-8 Diagnosis report

🎢 FusionSolar 🛛	ŵ	н	ome Reports	Plants N	laintenance	Value-Ad	lded Servi	ces Syste	m	d	2 ®	English ,	å	0 7
Real-Time Status   Alarm M	Managem	nent   Task Mana	gement   Sm	hart Diagnosis	Smart Tr	acking								
Smart Diagnosis	Task	k name:	Check time	e: Start date	→ End da		Sea	arch Re	set					
I-V Curve														
Module Library Manageme										l.	Configu	ure Strings	Add	Diagnosis Task
		Task Na	ime	Faulty Units	Total Unit	ts	Check Tir	ne		Scanning	Progress			Operation
	- 12 22 28 2021-08-20 16:16:34 -				🛛 Tim	ne used: 00::	10:26	View Details						
		Fault List ivTest1												<ul> <li>✓ Export</li> </ul>
								Fault Type	Fault Count	Ratio (%)	Fa	ult Descripti	ion	Suggestion
		(21.43%)						<b>1</b> 0002	18	64.29	String	open circuit	t (the	View
×				<b>1</b> 0012 4				4	14.29	Missin	g string con	nfigur	View	
		(14.28%)						Normal	6	21.43		Normal		
				(04.29%)										
		Fault Type	Inverter 1	Name 🌲	String	Voc (V)	lsc (A)	FF	Pmax (W)	Vm (V)	lm (A)	Vm/Voc	lm/lso	c Details 👔
	Г	Normal	SUN2000-50	KTL-M0-001	PV8	1218.9	10.98	0.7742	10361	1017.8	10.18	0.84	0.93	View
			Mean	value	PV3	1229.2	11.04	0.7622	10343	1017.2	10.17	0.83	0.92	

• Click **View** (as shown in **Figure 3-8** 1) to view the I-V curve data of the strings.

0

#### Figure 3-9 I-V curve

,							
Basic Information	n						
Inverter name:	SUN2000-50K	Inverter rated power (kW):	50.000	String Voc (V):	1218.9	String Pm (W):	10361
Inverter model	: SUN2000-50K	Check time:	2021-08-20 16	String Isc (A):	10.98	String Vm/Voc:	0.84
Inverter SN:	SUN2000-50K	Total yield (kWh):	5111.15	String Vm (V):	1017.8	String Im/Isc:	0.93
Version:	V100	Fill factor (FF) %:	77.42%	String Im (A):	10.18	String degradation rate:	0.60
I-V curve							
I-V curve			- <b>-</b> - IV	- <b>-</b> - PV			
I-V curve			- <b>-</b> - IV	- <b>-</b> - PV			
I-V curve			- <b>-</b> - IV	- <b>-</b> - PV			Power (kW)
I-V curve			- <b>-</b> - IV	• PV			Power (kW) 12,0 10,0
I-V curve			IV	● PV			Power (kW) 12,0 10,0 8,00
I-V curve			- 17	• PV	~		Power (kW) 12,0 10,0 8,00 6,00 4,00

• Select the mean value string and another string (as shown in Figure 3-8 (2)) to view the comparative analysis of the selected strings.

Voltage (V)

#### Figure 3-10 I-V curve comparative analysis

400

I-V Curv	e Comparative Analy	sis (for Max. 10 Strir	igs)				
			_				
			- <b>-</b> - SUN200	00-50KTL-M0-001-PV8	Mean value-PV3		
	Current (A)						
12							
10							
8							
6						\	
4						····· \\	
						N N	
2 -							
0							//
0	) 20	00 40	0 6	00 Veltaga 0.0	300 1,0	000 1,20	00 1,400
				vorage (v)			

#### 

0

- Mean value refers to the median power of the strings connected to an inverter. (For example, in the case of 20 W, 30 W, 40 W, 50 W, and 60 W strings, the I-V curve of the 40 W string is the mean value curve.)
- Click **Exported** to export **Fault List** and diagnosis report for viewing or archiving.

#### ----End

# **3.2 Smart I-V Curve Diagnosis Results and Troubleshooting Suggestions**

Fault ID	Fault Type	Troubleshooting Suggestion
1000 2	String open circuit	1. Check whether the string is correctly connected to the inverter on site.
		2. If the string is connected to the inverter, shut down the inverter and remove the cable connectors from the string and the inverter. Then use a multimeter to check the open-circuit voltage of the string.
		3. If the open-circuit voltage of the string is normal, check the connectors between the string and the inverter. If they are intact, check the inverter interior for open circuits.
		<ol> <li>If the open-circuit voltage of the string is abnormal, check the string for open circuits.</li> </ol>
		5. If the open-circuit voltage of the string is normal, use a multimeter to test whether the string current is normal. If the string current is less than 0.5 A, restart the IV scanning when the irradiation meets the requirements.
1000 3	Incorrect string configuration	<ol> <li>If 2In1 flag is selected for the current string, check whether this string is connected in 2In1 mode.</li> </ol>
	(incorrect 2In1 flag configuration and/or some	<ol> <li>If 2In1 identity is selected for the current string and this string is connected in 2In1 mode, check whether some 2In1 strings are not configured or the string current is abnormal due to other reasons (such as dust blocking, direction, and aging attenuation).</li> </ol>
	configured)	3. If 2In1 flag is not selected for the current string, check if the current string supports 2In1.
1000 5	Current mismatch in the string (shade/ dust/	<ol> <li>Check to see if scanning was conducted on a sunny day. The fast changes in irradiation may cause current mismatch in the string.</li> <li>Observe the string for shade. If there is shade, eliminate the shade and measure again.</li> </ol>
	inconsistent	3. If there is no shade, check whether the string has been cleaned.
	current)	4. If not, clean it and measure again after the component surface is dry.
		5. If the string has been cleaned, test the IV curve of each component to locate the component with low short-circuit current or mixed component.

Fault ID	Fault Type	Troubleshooting Suggestion
1000 6	Abnormal component	1. Observe the string for shade on site. If there is shade, eliminate the shade and measure again.
	current output (due to shading, glass breakage,	<ol><li>If there is no shade, check for foreign matter on the surface of components in the string. If yes, clear the foreign matter and then measure again.</li></ol>
	or hidden cracks)	3. If no foreign matter is found, check whether the glass panel of the string component is broken. If yes, replace the component with one of the same model.
		<ol> <li>If no component has a broken glass panel, check whether the string has been cleaned. If not, clean it and measure again after the component surface is dry.</li> </ol>
		5. If the string has been cleaned, scan the string using an infrared thermal imager to locate the abnormal component.
		<ol><li>If no abnormal component is found using the infrared thermal imager, test the IV curve for each component on site to locate the component with abnormal output current.</li></ol>
1000 8	Abnormal string voltage (diode	1. Check whether the number of components connected to the string is correct.
	short circuit/ component failure)	2. Observe whether there are traces of burning at the interconnection strip, backsheet, and wiring box. If so, replace the component with the same model.
		3. Check whether there is a component with diode short circuits or broken interconnection strip by using the infrared thermal image.
		4. If no abnormal component is found using the infrared thermal imager, use a voltmeter to test the voltages of the strings (two strings on the same route of MPPT) on site to check whether the string voltage is very low. If so, use a thermometer to check the temperature distribution between components of this string and other normal strings and check whether there is an abnormal temperature.
1000 9	Low string short-circuit	1. Check to see if the string direction differs greatly from the direction of other strings.
	current	2. Check whether the string has been cleaned.
	orientation/ dust/component	3. If not, clean the string and then measure again after the component surface is dry.
	degradation)	<ol> <li>If yes, check the string area for shade which will greatly decrease the string short-circuit current.</li> </ol>
		5. If there is no shade, check the string direction.
		6. If the string direction is normal, check the string for material deterioration (yellowing).

Fault ID	Fault Type	Troubleshooting Suggestion
1001 0	Low string power	1. Check to see if the string direction differs greatly from the direction of other strings.
	(abnormal	2. Check whether the string has been cleaned.
	dust/component degradation)	<ol><li>If the string has not been cleaned, clean the string and then measure again after the component surface is dry.</li></ol>
	, ,	4. Check the string direction.
		5. If the direction is correct, check the string for material deterioration (such as yellowing) that causes high component attenuation.
		<ol><li>If no component has material deterioration, check whether the abnormal string output is caused by high temperature.</li></ol>
1001 1	String not connected	-
1001 6	Excessively low string parallel	1. Check to see if scanning was conducted on a sunny day. The fast changes in irradiation may cause abnormal IV curve of the string.
	attenuation/	2. Observe the string for shade. If there is shade, eliminate the shade.
	dust/uneven	3. If there is no shade, check whether the string has been cleaned.
	component irradiation)	<ol><li>If the string has not been cleaned, clean the string and then measure again after the component surface is dry.</li></ol>
		5. If the string has been cleaned, test the IV or EL curve for each component on site to locate the component with PID attenuation.
1001 8	Slight current mismatch in the string (dust/	<ol> <li>Check to see if scanning was conducted on a sunny day. The fast changes in irradiation may cause slight current mismatch in the string.</li> </ol>
	slight shade)	<ol><li>Observe whether a component is blocked by shade or foreign matter. If so, eliminate the shade or foreign matter.</li></ol>
		3. If not, check whether the string has been cleaned.
		<ol><li>If the string has not been cleaned, clean the string and then measure again after the component surface is dry.</li></ol>
		<ol><li>If the string has been cleaned, check whether any cell of a component has an abnormal temperature by using an infrared thermal imager.</li></ol>
		6. If no abnormal component is found using the infrared thermal imager, test the IV curve for each component on site to locate the component with abnormal output current.
1002 0	Excessively high string series	1. Check to see if scanning was conducted on a sunny day. The fast changes in irradiation may cause abnormal IV curve of the string.
	resistance (high cable resistance/	2. Scan the string using an infrared thermal imager to locate the abnormal component.
	internal resistance of the component)	3. If no abnormal component is found using the infrared thermal imager, test the IV curve for each component on site to locate the component with abnormal series resistance.

Fault ID	Fault Type	Troubleshooting Suggestion
1000 0	Normal	-
1111 1	Low irradiation during diagnosis	Scan again when the irradiation meets the requirements.
9999 9	Invalid scanning data (caused by environmental factors)	Scan again when the irradiation meets the requirements.

# **4** License Fault Management Table

No.	Fault Symptom	Cause Analysis	Troubleshooting Methods
1	Device License Management is not displayed on the SmartPVMS WebUI.	The SmartPVMS software version does not support the license management function.	Upgrade the SmartPVMS.
2	Failed to export the license application file from the SmartPVMS.	<ol> <li>Communication between the SmartPVMS client and server is abnormal.</li> <li>The SmartPVMS server is abnormal.</li> </ol>	<ol> <li>Fix the communication between the SmartPVMS client and server.</li> <li>Fix the SmartPVMS server.</li> </ol>
3	The device list in the license application file exported from the SmartPVMS is incorrect.	The target device is incorrectly selected for exporting the license application file.	Select the correct target device and export the license application file again.
4	Failed to upload the license file to the SmartPVMS.	<ol> <li>Communication between the SmartPVMS client and server is abnormal.</li> <li>The SmartPVMS server is abnormal.</li> </ol>	<ol> <li>Fix the communication between the SmartPVMS client and server.</li> <li>Fix the SmartPVMS server.</li> </ol>

No.	Fault Symptom	Cause Analysis	Troubleshooting Methods
5	Failed to load the license file on the SmartPVMS.	<ol> <li>The communication between the SmartLogger and the inverter is disconnected.</li> <li>The communication between the SmartLogger and the SmartPVMS is disconnected.</li> <li>The license file does not match the inverter SN.</li> <li>The inverter software version does not support the license management function.</li> <li>The SmartLogger software version does not support the license management function.</li> </ol>	<ol> <li>Fix the communication between the SmartLogger and the inverter.</li> <li>Fix the communication between the SmartLogger and the SmartPVMS.</li> <li>Contact the supplier or Huawei customer service center and purchase the Smart I-V Curve Diagnosis function or apply for a license.</li> <li>Upgrade the inverter.</li> <li>Upgrade the SmartLogger.</li> </ol>
6	Failed to revoke the license on the SmartPVMS.	<ol> <li>The communication between the SmartLogger and the inverter is disconnected.</li> <li>The communication between the SmartLogger and the SmartPVMS is disconnected.</li> </ol>	<ol> <li>Fix the communication between the SmartLogger and the inverter.</li> <li>Fix the communication between the SmartLogger and the SmartPVMS.</li> </ol>
7	Failed to export the license revocation code file from the SmartPVMS.	<ol> <li>Communication between the SmartPVMS client and server is abnormal.</li> <li>The SmartPVMS server is abnormal.</li> </ol>	<ol> <li>Fix the communication between the SmartPVMS client and server.</li> <li>Fix the SmartPVMS server.</li> </ol>
8	The device list in the license revocation code file exported from the SmartPVMS is incorrect.	The target device is incorrectly selected for exporting the license revocation code file.	Select the correct target device and export the license revocation code file again.
9	Failed to export the license information code file from the SmartPVMS.	<ol> <li>Communication between the SmartPVMS client and server is abnormal.</li> <li>The SmartPVMS server is abnormal.</li> </ol>	<ol> <li>Fix the communication between the SmartPVMS client and server.</li> <li>Fix the SmartPVMS server.</li> </ol>

No.	Fault Symptom	Cause Analysis	Troubleshooting Methods
10	The device list in the license information file exported from the SmartPVMS is incorrect.	The target device is incorrectly selected for exporting the license information file.	Select the correct target device and export the license information file again.
11	Device License Management is not displayed on the SmartPVMS WebUI.	The SmartLogger software version does not support the license management function.	Upgrade the SmartLogger.
12	Failed to export the license application file from the SmartLogger.	The SmartLogger is abnormal.	Fix the SmartLogger.
13	The device list in the license application file exported from the SmartLogger is incorrect.	The target device is incorrectly selected for exporting the license application file.	Select the correct target device and export the license application file again.
14	Failed to upload the license file on the SmartLogger.	<ul> <li>The SmartLogger is abnormal.</li> <li>The license file (package) name or format is abnormal.</li> </ul>	<ul> <li>Fix the SmartLogger.</li> <li>Contact the supplier or Huawei customer service center to obtain the license file (package).</li> </ul>
15	Failed to load the license file on the SmartLogger.	<ol> <li>The communication between the SmartLogger and the inverter is disconnected.</li> <li>The license file does not match the inverter SN.</li> <li>The inverter software version does not support the license management function.</li> <li>The SmartLogger software version does not support the license management function.</li> </ol>	<ol> <li>Fix the communication between the SmartLogger and the inverter.</li> <li>Contact the supplier or Huawei customer service center and purchase the Smart I-V Curve Diagnosis function or apply for a license.</li> <li>Upgrade the inverter.</li> <li>Upgrade the SmartLogger.</li> </ol>
16	Failed to revoke the license on the SmartLogger.	The communication between the SmartLogger and the inverter is disconnected.	Fix the communication between the SmartLogger and the inverter.
17	Failed to export the license revocation code file from the SmartLogger.	The SmartLogger is abnormal.	Fix the SmartLogger.

No.	Fault Symptom	Cause Analysis	Troubleshooting Methods
18	The device list in the license revocation code file exported from the SmartLogger is incorrect.	The target device is incorrectly selected for exporting the license revocation code file.	Select the correct target device and export the license revocation code file again.
19	Failed to export the license information file from the SmartLogger.	The SmartLogger is abnormal.	Fix the SmartLogger.
20	The device list in the license information file exported from the SmartLogger is incorrect.	The target device is incorrectly selected for exporting the license information file.	Select the correct target device and export the license information file again.
21	Failed to load the license file on the app.	<ol> <li>The inverter SN does not match the license file.</li> <li>Communication between the app and inverter is disconnected.</li> </ol>	<ol> <li>Load the license file that matches the inverter SN.</li> <li>Fix the communication between the app and inverter.</li> </ol>
22	Failed to revoke the license file on the app.	<ol> <li>The paired inverter is incorrect.</li> <li>Communication between the app and inverter is disconnected.</li> </ol>	<ol> <li>Select the correct inverter for pairing.</li> <li>Fix the communication between the app and inverter.</li> </ol>