SUN2000 Smart PV Optimizer

User Manual

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About This Document

Purpose

This document describes the functions, electrical specifications, and structure of the smart photovoltaic (PV) optimizer.

Figures provided in this document are for reference only.

Intended Audience

This document is intended for:

- Sales engineers
- Technical support engineers
- Maintenance engineers

Symbol Conventions

The symbols that may be found in this guide 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 potential hazard 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	Description
NOTE	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 (2021-10-30)

This issue is the first official release.

Contents

1 Safety Precautions

General Safety

- Follow the precautions and special safety instructions provided by Huawei when operating this product. Installation or maintenance personnel must be well trained, fully understand all safety precautions, and be able to correctly perform all operations. Huawei will not be liable for any consequences that may arise due to violations of general safety requirements or safety standards concerning the usage of the equipment.

- Before performing operations, read through the safety precautions to prevent accidents. The information provided under the "NOTICE", "CAUTION", "WARNING", and "DANGER" headings within this manual is not intended to cover all applicable safety policies, and instead acts as a supplement to the comprehensive safety information provided.

- Follow local laws and regulations when operating the equipment. The safety instructions in this document are considered supplementary to local laws and regulations.

- Do not operate the equipment or cables during thunderstorms.

- Before operating the product, remove any conductors such as jewelry or watches.

- Use insulated tools during operations.

- Tighten screws using a torque wrench, and mark them in red and blue for double-check. Installation personnel should mark tightened screws in blue. Inspection personnel should confirm that the screws are tightened and then mark them in red. If screws or bolts used to secure the equipment are not tightened to the required torque, the equipment may fall off the mounting kits.

- Follow specified procedures during installation and maintenance. Do not modify the equipment structure or the recommended installation procedures without prior consent from the manufacturer.

- Install the product in strict accordance with the quick guide.

Declaration

Huawei will not be liable for any consequences in any of the following circumstances:

- Damage during transportation
- Storage conditions that do not meet the requirements specified in this document
- Incorrect installation or use
- Installation or use by unqualified personnel
- Failure to follow the operation instructions and safety precautions on the product and in this document
- Operation beyond the conditions specified in this document
- Operation beyond the specified parameter ranges
- Unauthorized modifications to the product or software code or removal of the product
- Equipment damage due to force majeure (such as lightning, fire, and storms)
- Warranty expired and not extended
- Installation or use in environments which are not specified in relevant international standards

Personnel Requirements

Only qualified electricians are allowed to install, connect cables for, maintain, troubleshoot, and replace the optimizer.

- Receive professional training.
- Read through this document and understand all safety precautions.
- Get familiar with the safety specifications about the electrical system.
- Understand the composition and working principles of the grid-tied PV power system and local regulations.
- Wear proper personal protective equipment (PPE).

Label Protection

- Do not scrawl or damage any warning labels on the optimizer because these labels contain important information about safe operation.
- Do not scrawl or damage the nameplate on the back of the optimizer because it contains important product information.

System Installation

- Ensure that the optimizer is not powered on during the installation.
- Reserve appropriate clearances around the optimizer for installation and heat dissipation.

Electrical Connections

⚠ **DANGER**

Before connecting cables, ensure that the optimizer is not damaged. Otherwise, electric shocks or fire may occur.

- Ensure that all electrical connections comply with local electrical standards.
- Ensure that the cables used in a grid-tied PV power system are properly connected and insulated and meet specifications.
- The output wiring terminals of the optimizer are not hot-swappable. If the terminals are hot-swapped, the optimizer may be damaged.

Operation

⚠ **DANGER**

High voltage from the optimizer in operation may cause an electric shock, resulting in serious property damage, injury, or death. Strictly comply with the safety precautions in this document and other related documents when operating the optimizer.

- Do not touch the optimizer in operation as its surface temperature is high and may cause burning.
- When operating the equipment, comply with local laws and regulations.

Maintenance and Replacement

⚠ **DANGER**

High voltage from the optimizer in operation may cause an electric shock, resulting in serious property damage, injury, or death. Before maintenance, power off the optimizer and strictly comply with the safety precautions in this document and other related documents when operating the optimizer.

- Maintain the optimizer with proper understanding of this document and appropriate tools and testing equipment.
- Place temporary warning signs or erect fences to prevent unauthorized access to the maintenance site.
- The optimizer can be powered on only after all faults are rectified. Otherwise, faults may escalate or equipment may be damaged.
- Observe ESD precautions and wear ESD gloves during maintenance.

2 Product Introduction

2.1 Overview

The smart PV optimizer is a DC to DC converter which implements maximum power point tracking (MPPT) of each PV module to improve the energy yield of the PV system. It enables module-level shutdown and monitoring, and supports long-string design.

Functions and Features

- Module-level MPPT: Implements maximum power point tracking of each PV module to improve the energy yield of the PV system.
- Module-level shutdown: Adjusts the module output voltage to a safe range when the output is disconnected or the inverter shuts down.
- Module-level monitoring: Monitors the operating status of each PV module.
- Long PV string supported: If all PV modules are configured with optimizers, a PV string can contain more PV modules than conventional PV strings.

Model

This document involves the following product models:

- SUN2000-600W-P
- SUN2000-450W-P

Figure 2-1 Model description (The SUN2000-600W-P optimizer is used as an example)

SUN2000-600W-P
— Smart PV optimizer
— Maximum input power: 600W
— Product series
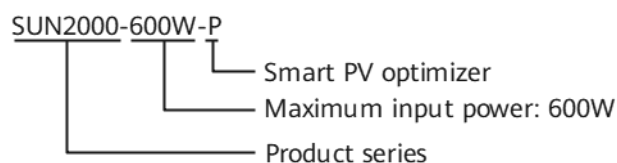
Output Power Cable Requirements for PV Modules

The length of the input power cable delivered with the optimizer is 150 mm. Select PV modules with appropriate cable length to ensure that the optimizer can connect to PV modules.

Typical scenario 1: For modules whose power ranges from 530 W to 550 W (182 mm silicon wafers), the recommended output cable length is 1.3 m.
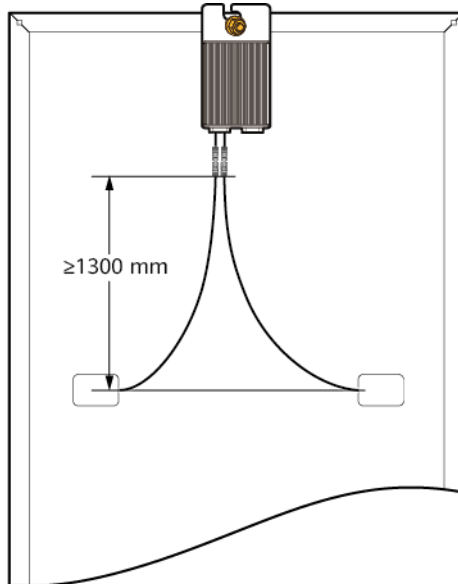
IV05I30015

Typical scenario 2: For modules whose power ranges from 400 W to 415 W (166/182 mm silicon wafers), the recommended output cable length is 1.2 m.
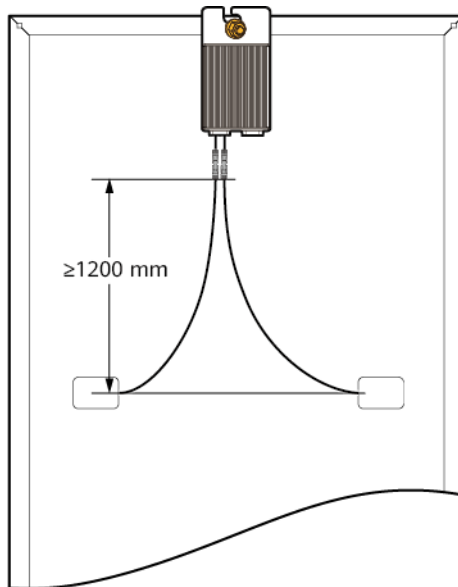
IV05I30016

2.2 Application Scenarios

Optimizers configured for all PV modules

All PV modules are connected to optimizers.

In this scenario, the MPPT function, module-level shutdown and monitoring, and long-string design are supported.

Figure 2-2 Optimizers configured for all PV modules
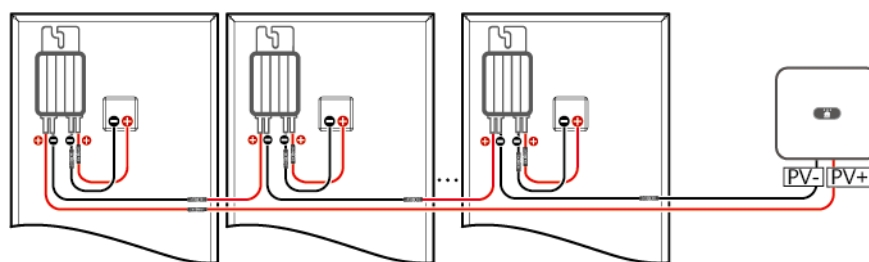
IV05I30013

Optimizers configured for some PV modules

Some PV modules are connected to optimizers.

In this scenario, the MPPT function and module-level management through communications with the inverter are supported. Module-level shutdown, disconnection detection, and long-string design are not supported.

Figure 2-3 Optimizers configured for some PV modules
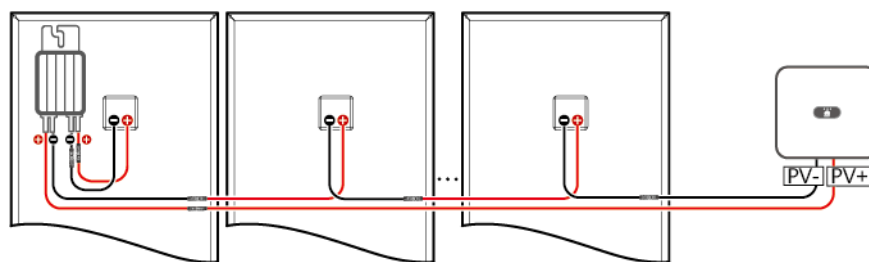
IV05I30014

2.3 Configuration Principles

The optimizer models supported by different inverters may vary, and different optimizers may be configured for the same inverter. Select the optimizer model as required.

Configuration Principles

The number of optimizers supported in a PV string, the upper limit of the string power, and requirements for connecting PV strings in parallel vary according to the

inverter model. The configuration principles for different inverter models are as follows:

◘ NOTE

If two strings are connected in parallel to the inverter under the same MPPT circuit, the restrictions for configuring optimizers are as follows:

● The PV strings connecting to the same MPPT should contain the same number and model of PV modules and optimizers.

● All PV modules in the two strings must have the same orientation and tilt angle.

You are advised to use long strings instead of Y-shaped terminals.

Table 2-1 SUN2000-600W-P configuration principles

Supported Inverter Models	Maximum Number of Optimizers Supported in a String	String Power Upper Limit
SUN2000-2/3/3.68/4/4.6/5/6KTL-L1	4 to 25	5 kW
SUN2000-3/4/5/6/8/10KTL-M1	6 to 35	10 kW
SUN2000-8/10/12/15/17/20KTL-M2	6 to 35	10 kW
SUN2000-29.9/30/36/40KTL-M3	6 to 25	10 kW
SUN2000-20KTL-M3 (Brazil and Japan)	6 to 25	7 kW
SUN2000-4.95KTL-JPL1	4 to 25	5 kW
SUN2000-4.95KTL-NHL2	4 to 25	5 kW

Table 2-2 SUN2000-450W-P configuration principles

Supported Inverter Models	Number of Optimizers Supported in the String	String Power Upper Limit
SUN2000-2/3/3.68/4/4.6/5/6KTL-L1	4 to 25	5 kW
SUN2000-3/4/5/6/8/10KTL-M1	6 to 35	10 kW
SUN2000-8/10/12/15/17/20KTL-M2	6 to 35	10 kW
SUN2000-29.9/30/36/40KTL-M3	6 to 25	10 kW

Supported Inverter Models	Number of Optimizers Supported in the String	String Power Upper Limit
SUN2000-20KTL-M3 (Brazil)	6 to 25	7 kW

Optimizers supported by Inverters

The optimizer models supported by different inverters may vary, as described in the following table.

📖 **NOTE**

"√" indicates supported. "×" indicates not supported.

Inverter Model	SUN2000-450 W-P	SUN2000-600 W-P
SUN2000-2/3/3.68/4/4.6/5/6KTL-L1	√	√
SUN2000-3/4/5/6/8/10KTL-M1	√	√
SUN2000-8/10/12/15/17/20KTL-M2	√	√
SUN2000-29.9/30/36/40KTL-M3	√	√
SUN2000-4.95KTL-JPL1	×	√
SUN2000-4.95KTL-NHL2	×	√
SUN2000-20KTL-M3 (Brazil)	√	√
SUN2000-20KTL-M3 (Japan)	×	√

Compatibility Between Optimizers

Different models of optimizers can be used in the same string. The compatibility between different optimizers is described in the following table.

📖 **NOTE**

"√" indicates mixed use supported. "×" indicates mixed use not supported.

Optimizer Compatibility	SUN2000-450W-P	SUN2000-600W-P
SUN2000-450W-P	√	√
SUN2000-600W-P	√	√

2.4 Structure

Optimizer Ports

Figure 2-4 Ports

IV05W00007
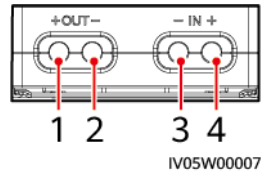
(1) Output port (positive)	(2) Output port (negative)
(3) Input port (negative)	(4) Input port (positive)

Optimizer Dimensions

Figure 2-5 SUN2000-600W-P dimensions

74.4 mm   27.7 mm

139.2 mm
95 mm

150 mm

1300 mm

IV05W00005
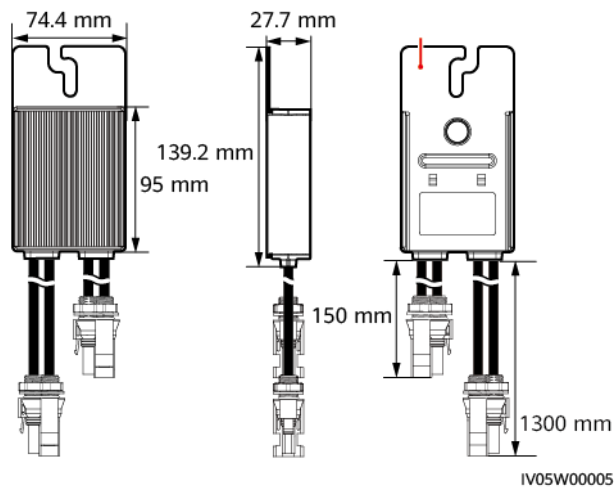
Figure 2-6 SUN2000-450W-P dimensions
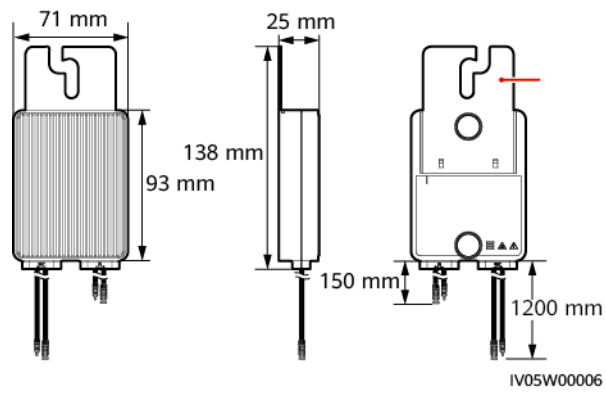
3 Smart PV Solution Documentation

Quick Guide

Quick installation guides for different optimizers are:

- SUN2000-600W-P: **SUN2000-600W-P Smart PV Optimizer Quick Guide**
- SUN2000-450W-P: **SUN2000-450W-P Smart PV Optimizer Quick Guide**

Optimizer Installation Video

See **Smart PV Optimizer Installation Video**.

You can also scan the QR code below to obtain the installation video:

4 System Maintenance

4.1 Setting the Physical Layout of the Smart PV Optimizers

You can view the position of each optimizer in the physical layout to facilitate subsequent commissioning and maintenance. If an optimizer is faulty, you can quickly locate and replace it based on the physical layout.

📖 NOTE

- If smart PV optimizers are configured for PV strings, ensure that the smart PV optimizers have been successfully connected to the inverter before performing the operations in this section.
- Check that the SN labels of smart PV optimizers are correctly attached to the physical layout template.
- Take and save a photo of the physical layout template. Keep your phone parallel to the template and take a photo in landscape mode. Ensure that the four positioning points in the corners are in the frame. Ensure that each QR code is attached within the frame.
- For details about the physical layout of smart PV optimizers, see **FusionSolar App Quick Guide**. During the FusionSolar app upgrade, scan the QR code to download the corresponding quick guide according to the downloaded app version.

Scenario 1: Setting on the FusionSolar Server Side (Inverter Connected to the Management System)

Step 1 Log in to the FusionSolar app and tap the plant name on the **Home** screen to access the plant screen. Choose **Layout** > **Physical Layout**, tap 🖼, and upload the physical layout template photo as prompted.


Figure 4-1 Uploading the physical layout template photo (app)

NOTE

You can also upload the physical layout template photo on the WebUI as follows: Log in to https://intl.fusionsolar.huawei.com to access the WebUI of the FusionSolar Smart PV Management System. On the **Home** page, click the plant name to go to the plant page. Choose **Layout**, click **Click to Upload**, and upload the physical layout template photo.

Figure 4-2 Uploading the physical layout template photo (WebUI)
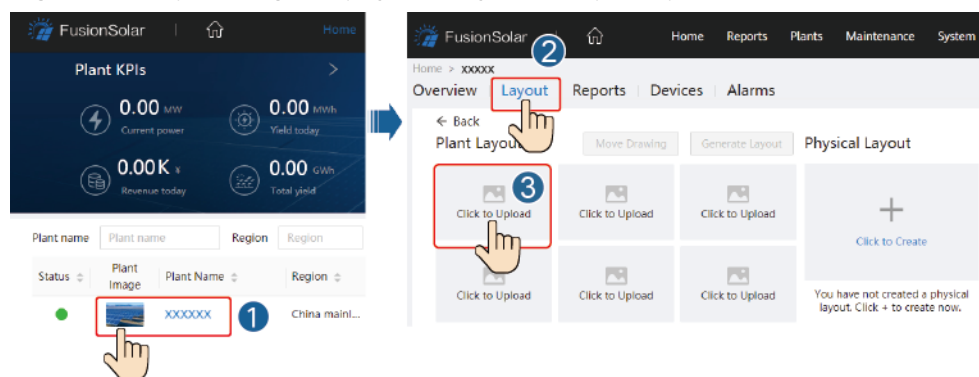
Step 2 Log in to https://intl.fusionsolar.huawei.com to access the WebUI of the FusionSolar Smart PV Management System. On the **Home** page, click the plant name to go to the plant page. Select **Layout**. Click **Generate Layout**, and create a physical layout as prompted. You can also manually create a physical layout.

Figure 4-3 Physical layout design of PV modules
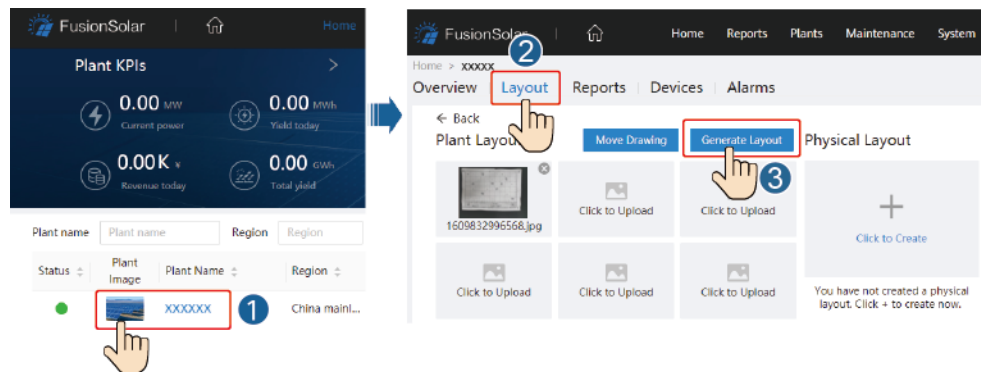
----**End**

Scenario 2: Setting on the Inverter Side (Inverter Not Connected to the Management System)

**Step 1** If the FusionSolar Smart PV Management System is not connected, access the **Device Commissioning** screen on the FusionSolar app to set the physical layout of optimizers.

1. Log in to the FusionSolar app. On the **Device Commissioning** screen, choose **Maintenance > Optimizer layout**. The **Optimizer layout** screen is displayed.

2. Tap the blank area. The **Identify image** and **Add PV modules** buttons are displayed. You can use either of the following methods to perform operations as prompted:

   – Method 1: Tap **Identify image** and upload the physical layout template photo to complete the optimizer layout. (The optimizers that fail to be identified need to be manually bound.)

   – Method 2: Tap **Add PV modules** to manually add PV modules and bind the optimizers to the PV modules.

**Figure 4-4** Physical layout design of PV modules
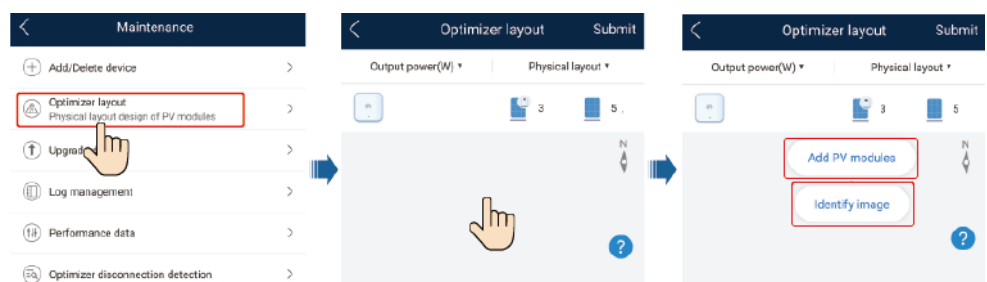
----**End**

4.2 Configuring Optimizer Disconnection Detection

The optimizer disconnection detection function can accurately locate the disconnected cables between optimizers or between optimizers and the inverter.

Log in to the FusionSolar app, on the **Device Commissioning** screen, choose **Maintenance** > **Optimizer disconnection detection**, tap the detection button, and rectify the fault based on the detection result.

Figure 4-5 Optimizer disconnection detection
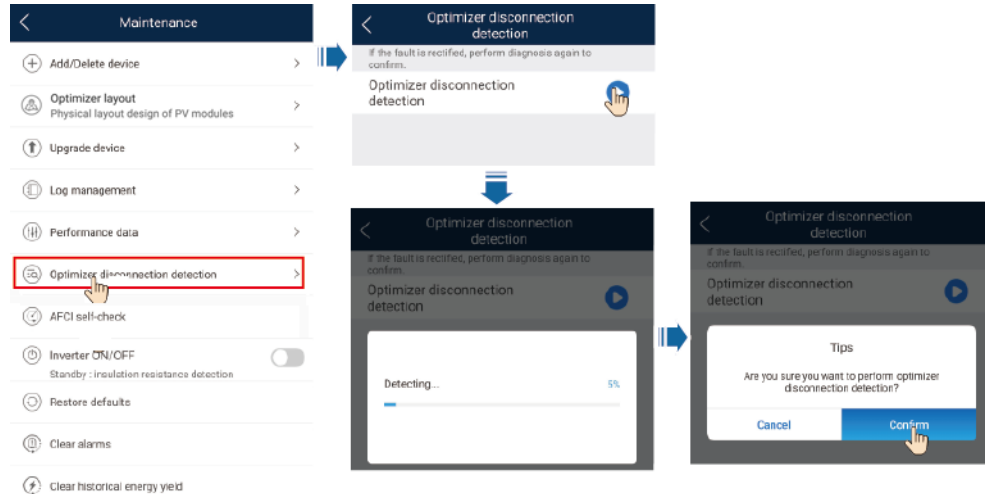
4.3 Rapid Shutdown

When the output is disconnected or the inverter shuts down, the optimizer can adjust the module output voltage to a safe range to ensure the safety of the construction and O&M personnel as well as firefighters.

◫ NOTE

- The rapid shutdown function is not supported if optimizers are configured for some PV modules.
- You are advised to periodically check whether the rapid shutdown function is normal.

If optimizers are configured for all PV modules, the PV system can perform a rapid shutdown to decrease the output voltage to below 120 V within 15s and to below 30 V within 30s.

Perform the following steps to trigger a rapid shutdown:

- Method 1: Turn off the AC switch between the inverter and the power grid.
- Method 2: Connect a switch to the DI and GND ports of the inverter to form a circuit. (For details about the DI port, see the corresponding inverter user manual.) The switch is turned on by default. Turn off the switch to trigger a rapid shutdown.

4.4 Troubleshooting

Table 4-1 Common alarms and troubleshooting measures

Alarm Name	Cause	Suggestions
Input overvoltage	Optimizer input overvoltage occurred.	Check whether the open-circuit voltage of the PV module connected to the optimizer exceeds 80 V.
Overtemperature	The optimizer internal temperature is too high.	1. Check the ventilation and ambient temperature at the optimizer installation position. If the ventilation is poor or the ambient temperature exceeds the upper threshold, improve the ventilation and heat dissipation. 2. If the ventilation and ambient temperature are normal, contact the installation contractor.
Internal hardware fault	An internal fault occurred in an optimizer.	Contact the installation contractor.
Output backfeed	Optimizer output backfeed occurred.	1. Check whether PV modules are shaded when PV strings are connected in parallel. 2. If the fault persists, contact the installation contractor.
Abnormal output voltage	The optimizer output voltage is abnormal.	1. When the sunlight is normal, perform optimizer search again. 2. Check whether the optimizer output extension cable is correctly prepared (positive connector at one end and negative connector at the other). 3. Check whether the PV string is correctly connected to the inverter or whether there is a breakpoint in the PV string. 4. If the fault persists, contact the installation contractor.
Upgrade failed	The optimizer software upgrade failed.	1. When the sunlight is normal, perform the optimizer upgrade again. 2. If the fault persists, contact the installation contractor.

☐ **NOTE**

> Contact the service provider if all suggested measures listed above are completed and the fault still exists.

4.5 Replacing an Optimizer

Prerequisites

- Use dedicated insulation tools, and wear insulation shoes and protective gloves before performing operations.
- A new smart PV optimizer is available.

Procedure

Step 1 Put on the protective gloves.

Step 2 Power off the inverter.

Step 3 Disconnect the input terminals of the optimizer.

Step 4 Remove the old optimizer.

1. Record the cable connection positions on the optimizer and disconnect the cables.

2. Loosen the bolt that secures the optimizer and remove the optimizer.

Step 5 Install a new optimizer.

1. Secure the new optimizer to the corresponding bolt and tighten the bolt.

2. Connect the cables to the new optimizer based on the recorded information.

☐ **NOTE**

> If multiple optimizers need to be replaced, record the mapping information.

Step 6 Power on the inverter. On the **Device Commissioning** screen, choose **Maintenance** > **Subdevice management**, and tap **Auto search** to add the new optimizer.
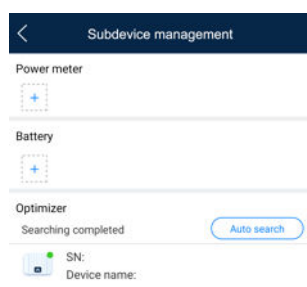
Step 7 On the **Device Commissioning** screen, choose **Maintenance** > **Optimizer layout**, select the corresponding PV module, and bind the new optimizer according to the recorded mapping information. Tap **Submit**.
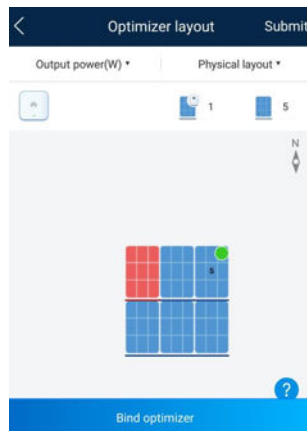
Step 8 Remove the protective gloves.

----End

Follow-up Procedure

Pack the faulty component and return it to the local Huawei warehouse.

5 Technical Specifications

5.1 SUN2000-600W-P Technical Specifications

Efficiency

Technical Specifications	SUN2000-600W-P
Maximum efficiency	99.5%
European weighted efficiency	99.0%

Input

Technical Specifications	SUN2000-600W-P
Rated PV module power	600 W
Maximum PV module power	630 W
Maximum input voltage	80 V
MPPT voltage range	10–80 V
Maximum short-circuit current	14.5 A
Overvoltage level	II

Output

Technical Specifications	SUN2000-600W-P
Rated output power	600 W
Output voltage	0–80 V
Maximum output current	15 A
Output bypass	Yes
Shutdown output voltage/impedance	0 V/1 kΩ (±10%)

General Specifications

Technical Specifications	SUN2000-600W-P
Dimensions (H x W x D)	145 mm x 75 mm x 28 mm
Net weight	≤ 600 g
DC input and output terminals	Staubli MC4
Operating temperature	–40°C to +85°C
Storage temperature	–40°C to +70°C
Operating humidity	0–100% RH
Maximum operating altitude	4000 m
IP rating	IP68
Installation mode	● PV module support installation ● PV module frame installation

5.2 SUN2000-450W-P Technical Specifications

Efficiency

Technical Specifications	SUN2000-450W-P
Maximum efficiency	99.5%
European weighted efficiency	99.0%

Input

Technical Specifications	SUN2000-450W-P
Rated PV module power	450 W
Maximum PV module power	472.5 W
Maximum input voltage	80 V
MPPT voltage range	8–80 V
Maximum short-circuit current	13 A
Overvoltage level	II

Output

Technical Specifications	SUN2000-450W-P
Rated output power	450 W
Output voltage	4–80 V
Maximum output current	15 A
Output bypass	Yes
Shutdown output voltage/impedance	0 V/1 kΩ (±10%)

General Specifications

Technical Specifications	SUN2000-450W-P
Dimensions (H x W x D)	138 mm x 71 mm x 25 mm
Net weight	≤ 550 g
DC input and output terminals	Staubli MC4
Operating temperature	–40°C to +85°C
Storage temperature	–40°C to +70°C
Operating humidity	0–100% RH
Maximum operating altitude	4000 m
IP rating	IP68
Installation mode	● PV module support installation ● PV module frame installation

A Acronyms and Abbreviations

D

DC   direct current

E

EFT   electrical fast transient

EMI   electromagnetic interference

EMS   electromagnetic susceptibility

ESD   electrostatic discharge

M

MPPT   maximum power point tracking

R

RE   radiated emission

RS   radiated susceptibility