

MERC Smart PV Optimizer

User Manual

Issue 04
Date 2023-02-10



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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
	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.
	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 04 (2023-02-10)

- Updated [2.4 Application Scenarios](#).
- Updated [3.1 Setting the Physical Layout of the Smart PV Optimizers](#).

Issue 03 (2022-11-30)

- Updated [2.2 Structure](#).
- Updated [2.3 Configuration Principles](#).
- Updated [2.4 Application Scenarios](#).
- Updated [3.1 Setting the Physical Layout of the Smart PV Optimizers](#).
- Updated [3.2 Detecting Optimizer Disconnection](#).
- Updated [3.5 Replacing an Optimizer](#).

Issue 02 (2022-09-20)

- Updated [2.3 Configuration Principles](#).
- Updated [3.4 Troubleshooting](#).
- Updated [4 Technical Specifications](#).

Issue 01 (2022-08-30)

This issue is the first official release.

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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



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

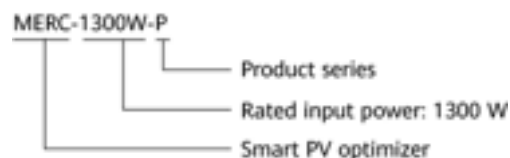
- Module-level MPPT: Implements maximum power point tracking of each PV module to improve the energy yield of the PV system.
- Module-level shutdown: Adjusts the module output voltage to a safe range when the output is disconnected or the inverter shuts down.
- Module-level monitoring: Monitors the operating 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:

- MERC-1300W-P
- MERC-1100W-P

Figure 2-1 Model description (MERC-1300W-P optimizer is used as an example)

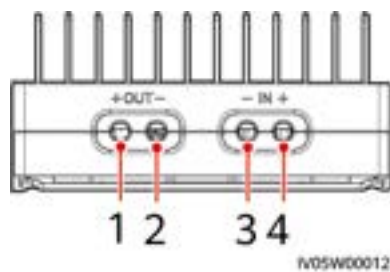


Optimizer Model	Part No.	Rated Input Power	Input Cable Length	Output Cable Length
MERC-1300W-P (Short input power cables)	02314APY	1300 W	0.1 m	5.1 m (negative) +0.1 m (positive)
MERC-1300W-P (Long input power cables)	02314AQB	1300 W	1.3 m	2.9 m (negative) +0.1 m (positive)
MERC-1100W-P (Short input power cables)	02314APY-001	1100 W	0.1 m	5.1 m (negative) +0.1 m (positive)
MERC-1100W-P (Long input power cables)	02314AQB-001	1100 W	1.3 m	2.9 m (negative) +0.1 m (positive)

2.2 Structure

Optimizer Ports

Figure 2-2 Ports



(1) Output port (positive)

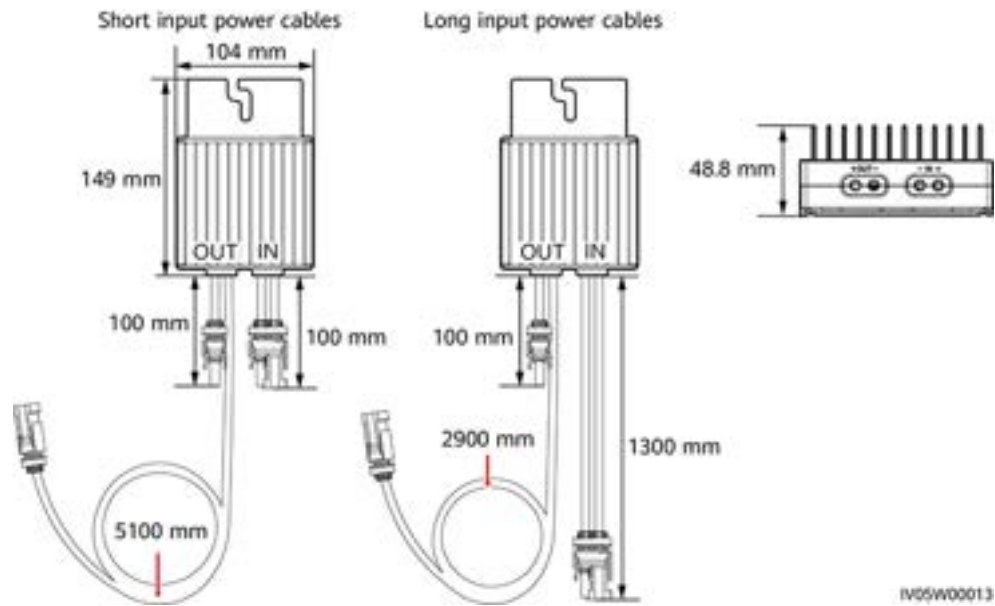
(2) Output port (negative)

(3) Input port (negative)

(4) Input port (positive)

Optimizer Dimensions

Figure 2-3 Optimizer dimensions



2.3 Configuration Principles

The SUN2000-(600W-P, 450W-P2) cannot be used together with the MERC-(1300W, 1100W)-P.

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

- Optimizers are not supported in off-grid scenarios.
- For the MERC-(1300W, 1100W)-P optimizers, one MPPT of the inverter can connect to only one PV string.
- The capacity difference between PV strings connected to the same inverter must be less than or equal to 2 kW.
- Partial configuration is not allowed. All PV modules must be connected to optimizers. Otherwise, serious consequences may occur, and the resulting device damage is not covered by the warranty.

Table 2-1 Configuration principles

Supported Inverter Models	Recommended String Quantity	String Power Upper Limit	Number of Optimizers Supported in the String	Capacity Ratio Corresponding to String Quantity				Version
				1	2	3	4	
SUN2000-8 KTL-M2	1	20 kW	6-25	0.8-2.0	-	N/A	N/A	<ul style="list-style-type: none"> • SUN2000MA V100R001C00S PC147 or later (M2) • SUN2000MB V200R002C10S PC100 or later (M5/ZHM5)
SUN2000-1 0KTL-M2	1	20 kW	6-25	0.8-2.0	-	N/A	N/A	
SUN2000-1 2KTL-M2/M5	1	20 kW	6-25	0.8-1.6	1.6-2.0	N/A	N/A	
SUN2000-1 5KTL-M2/M5/ZHM5	2	20 kW	6-25	0.8-1.0	1.0-2.0	N/A	N/A	
SUN2000-1 7KTL-M2/M5/ZHM5	2	20 kW	6-25	0.8-0.9	0.9-2.0	N/A	N/A	
SUN2000-2 0KTL-M2/M5/ZHM5	2	20 kW	6-25	-	0.8-2.0	N/A	N/A	
SUN2000-2 5KTL-M5/ZHM5	2	20 kW	6-25	-	0.8-1.6	N/A	N/A	
SUN2000-2 0KTL-M3 (Brazil & Japan)	4	8 kW	6-25	-	-	0.8-1.0	1.0-1.6	SUN2000 MA V100R001 C20SPC118 or later
SUN2000-2 9.9/30KTL-M3	3	20 kW	6-25	-	0.8-1.0	1.0-2.0	-	
SUN2000-3 6KTL-M3	3	20 kW	6-25	-	0.8-0.9	0.9-1.6	1.6-2.0	
SUN2000-4 0KTL-M3	4	20 kW	6-25	-	-	0.8-1.0	1.0-2.0	

Supported Inverter Models	Recommended String Quantity	String Power Upper Limit	Number of Optimizers Supported in the String	Capacity Ratio Corresponding to String Quantity				Version
				1	2	3	4	
SUN2000-5 OKTL- ZHM3/M3/ NHM3	4	20 kW	6-20	-	-	0.8-0.9	0.9-1.6	SUN2000 MC V200R023 C00SPC10 0 or later

2.4 Application Scenarios

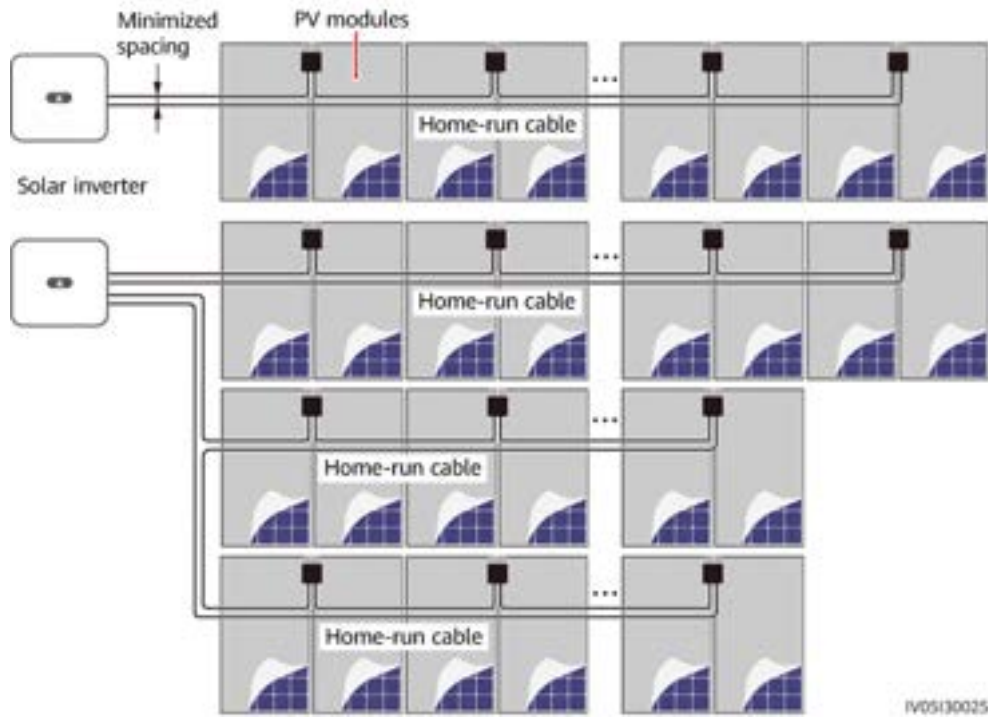
Full configuration: All PV modules are connected to optimizers.

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

NOTE

- An optimizer is delivered with two types of input power cables: long (1300 mm) or short (100 mm) cables. For PV modules with long cables, select optimizers with short cables; for PV modules with short cables, select optimizers with long cables.
- The SUN2000-(600W-P, 450W-P2) cannot be used together with the MERC-(1300W, 1100W)-P.
- To ensure reliable communication between the inverter and optimizers, the AC and DC power cables must be routed in different troughs or pipes with a minimum of 10 cm spacing in between.
- To reduce EMC impact, route the home-run cable next to the cables between the PV modules (keeping the positive and negative cables close to one another or twisting them together) as shown in the following figure for either a single string installation or a multi-string installation.

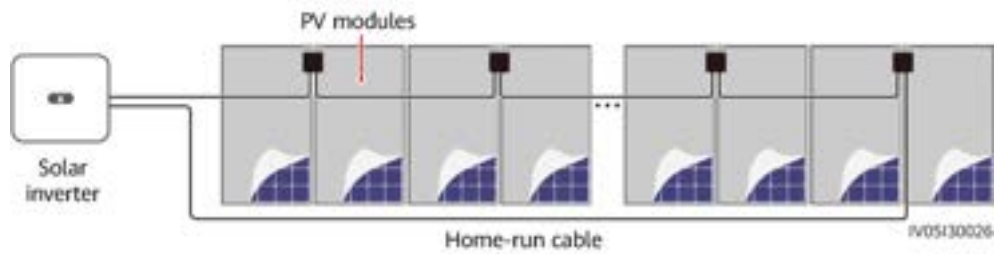
Figure 2-4 Required routing



NOTE

The figure shows only the output (OUT) cables.

Figure 2-5 Prohibited routing



3 System Maintenance

3.1 Setting the Physical Layout of the Smart PV Optimizers

NOTE

- If smart PV optimizers are configured for PV strings, ensure that the smart PV optimizers have been successfully connected to the SUN2000 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.

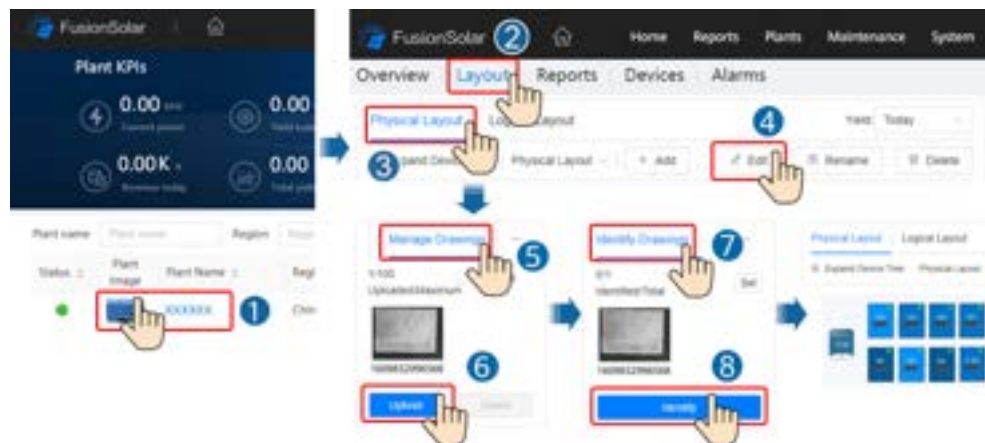
Method 1: Setting on the FusionSolar WebUI

NOTE

- If you have uploaded the physical layout template photo on the FusionSolar app, skip the steps of **Manage Drawings > Upload**.

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 access the plant page. Choose **Layout > Edit > Manage Drawings > Upload > Identify Drawings > Identify** to create a physical layout as prompted. You can also manually create a physical layout.

Figure 3-1 Physical layout design of PV modules



Method 2: Uploading the physical layout template photo on the FusionSolar app

NOTE

- If there are more than 16 photos, upload them on the FusionSolar WebUI.
- If the number of PV modules in the physical layout exceeds 200, edit the physical layout on the FusionSolar WebUI.
- For some unidentified QR codes, log in to the FusionSolar WebUI to manually bind them
- For details about the physical layout of smart PV optimizers, see [FusionSolar App Quick Guide](#). You can scan the QR code to download the quick guide.




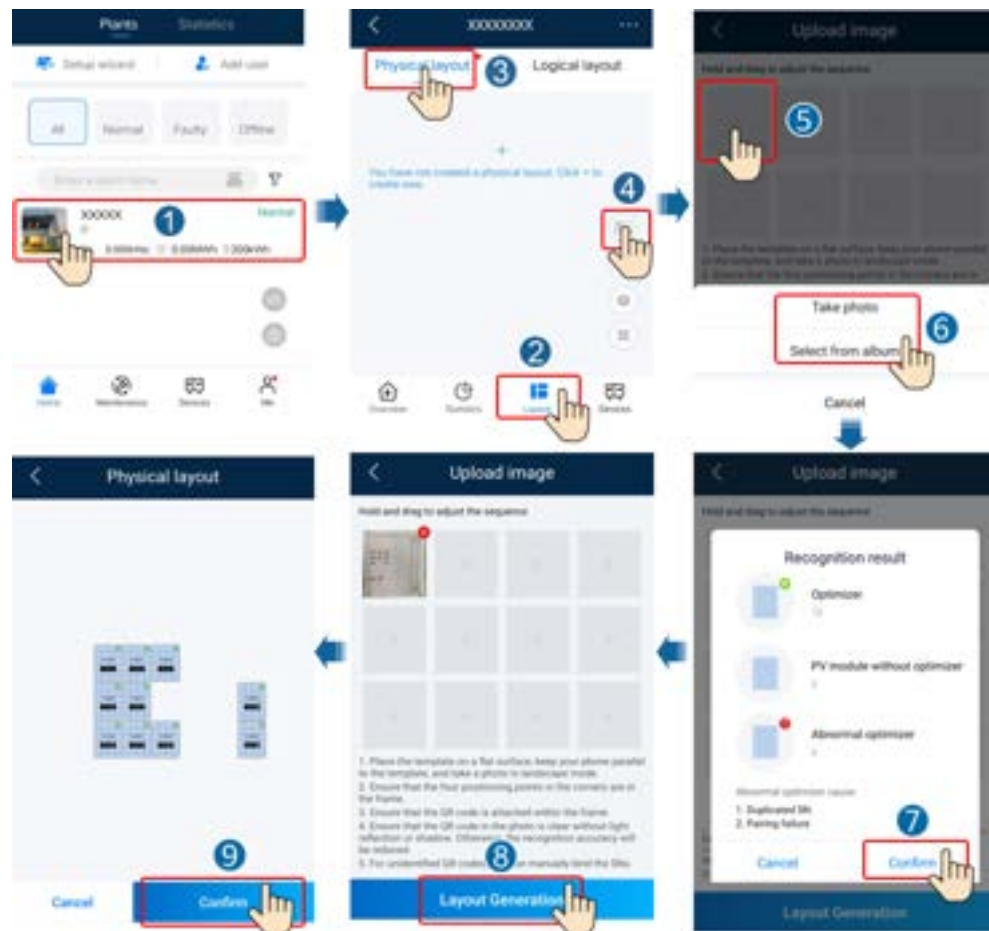
To upload the physical layout template photo on the FusionSolar app, log in to the app and tap the plant name on the **Home** screen to access the plant screen. Select **Layout**, tap , and upload the physical layout template photo as prompted. After the upload is complete, tap **Confirm** > **Layout Generation** > **Confirm** to create a physical layout as prompted. You can also manually create a physical layout.

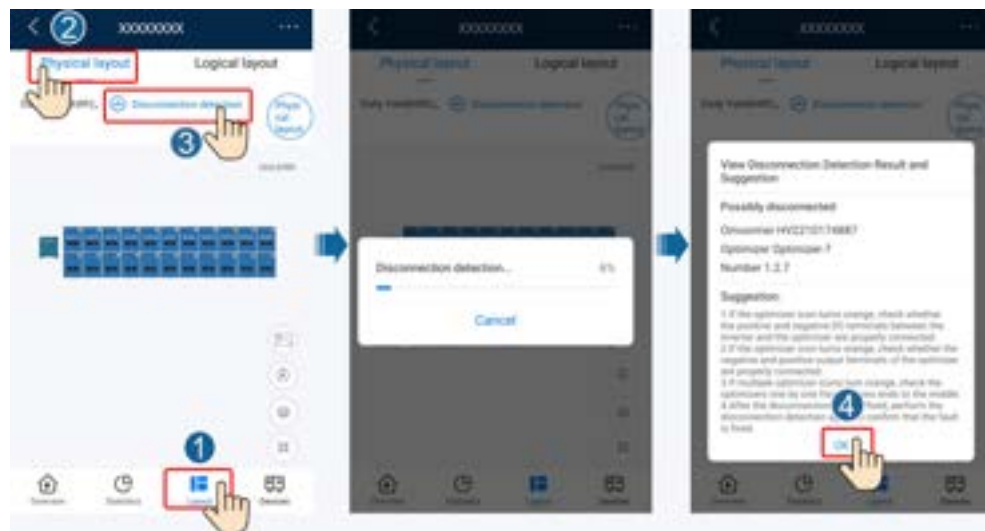
Figure 3-2 Uploading the physical layout template photo on the FusionSolar app



3.2 Detecting Optimizer Disconnection

- Log in to the FusionSolar app and tap the plant name on the **Home** screen to access the plant screen. Choose **Layout**, tap **Disconnection detection** to check optimizer disconnection, and rectify the fault based on the result.

Figure 3-3 Detect optimizer disconnection



- 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 access the plant page. Choose **Layout**, tap **Disconnection detection** to check optimizer disconnection, and rectify the fault based on the result.

Figure 3-4 Detect optimizer disconnection



3.3 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.

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: Turn off the DC switch on the inverter.
- Method 3: 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.

3.4 Troubleshooting

Table 3-1 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 exceeds the maximum input voltage of the optimizer.
Overtemperature	The optimizer internal temperature is too high.	<ol style="list-style-type: none"> 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 your installer.
Internal hardware fault	An internal fault occurred in an optimizer.	Contact your installer.
Output terminal overtemperature	The output terminal temperature of some optimizers is abnormal.	Contact your installer to replace the faulty optimizer and the optimizer connected to the short output cables of the faulty optimizer.
Output backfeed	Optimizer output backfeed occurred.	<ol style="list-style-type: none"> 1. Check whether PV modules are shaded when PV strings are connected in parallel. 2. If the fault persists, contact your installer.

Alarm Name	Cause	Suggestions
Abnormal output voltage	The optimizer output voltage is abnormal.	<ol style="list-style-type: none"> 1. When the sunlight is normal, perform optimizer search again. 2. Check the voltage of the corresponding PV string. If the voltage is greater than 0 V, power off the system and check whether the extension cable of the abnormal optimizer is correctly connected. 3. Check the voltage of the corresponding PV string. If the voltage is 0 V, power off the system and check the cable connection of the PV string. If there is an open circuit, rectify the cable connection of the PV string. If the polarity is incorrect, reconnect the PV string in the correct polarity. After the open circuit or reverse polarity is rectified, power on the system and perform an optimizer search again. If the alarm persists, check whether the extension cable of the abnormal optimizer is correctly connected. 4. If the fault persists, contact your installer. Note: The polarity at both ends of the extension cable must be opposite (one end is a positive connector, and the other is a negative connector). To determine the PV string polarity, see "3 Installing the Optimizer Cables" in the optimizer quick guide.
Upgrade failed	The optimizer software upgrade failed.	<ol style="list-style-type: none"> 1. When the sunlight is normal, perform the optimizer upgrade again. 2. If the fault persists, contact your installer.

 **NOTE**

If the fault persists after all suggested measures listed above are completed, contact your installer.

3.5 Replacing an Optimizer

Prerequisites

- Use dedicated insulation tools, and wear insulation shoes and insulated gloves before performing operations.

- A new smart PV optimizer is available.

Procedure

Step 1 Put on the insulated 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.

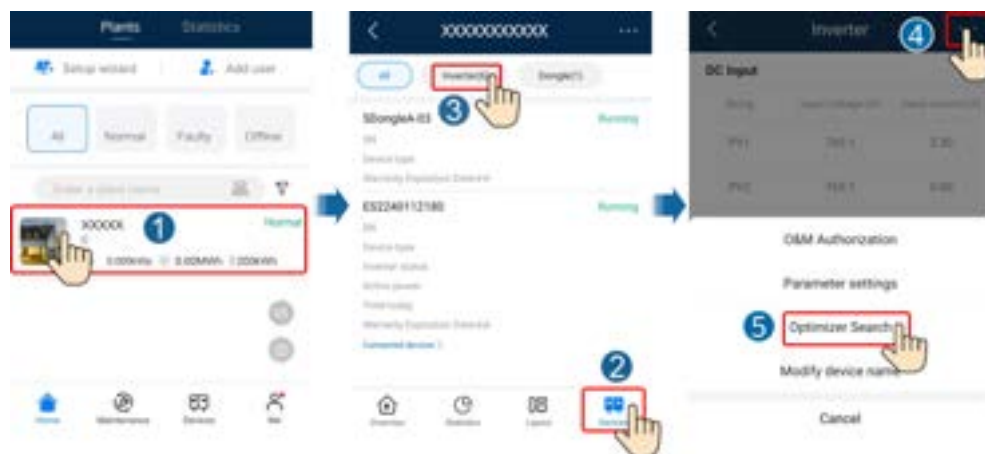
Step 5 Install a new optimizer.

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 optimizer numbers.

Step 6 Power on the solar inverter. Log in to the FusionSolar app and tap the plant name on the **Home** screen to access the plant screen. Choose **Devices > Inverter**, select the inverter corresponding to the faulty optimizer, tap **Optimizer Search**, and perform operations as prompted to search for optimizers.



Step 7 Choose **Devices > Connected devices > Optimizer**, tap **Optimizer No.**, select the faulty optimizer, tap **Device Replacement**, and replace the optimizer as prompted.

NOTE

- If N optimizers need to be replaced, perform the preceding procedure for N times.
- After the optimizer is replaced, the new optimizer automatically inherits the energy yield, physical layout, and logical layout of the faulty optimizer.



----End

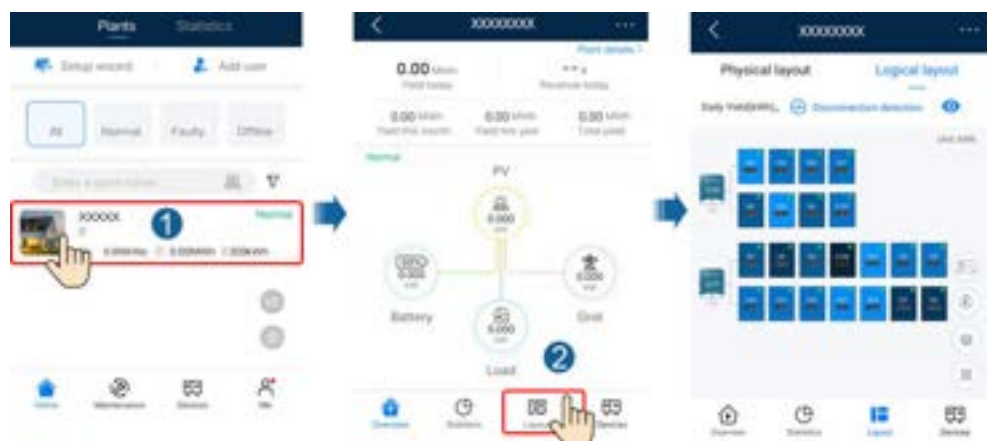
Follow-up Procedure

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

3.6 Maintaining PV Modules

Log in to the FusionSolar app and tap the plant name on the **Home** screen to access the plant screen. Select **Layout** and quickly identify inefficient PV modules by color in the physical or logical layout.







Figure 3-5 Maintaining PV modules



NOTE

- When the power of PV modules under normal irradiance is the same and the colors of PV modules in the layout are similar, the PV modules are normal.
- When the power of PV modules under normal irradiance is the same but the colors of some PV modules are darker than those of the other PV modules in the layout, PV modules with darker colors may be inefficient PV modules if the module surfaces are clean and there is no shading.
- When the power of PV modules under normal irradiance is the same and a 1-to-2 optimizer is connected to only one PV module, the color of this PV module is darker than that of other PV modules.

Table 3-2 PV module colors

Ratio Range (Optimizer Output Power/Optimizer Rated Power)	PV Module Color	Description
0%–20%		PV module power ratio = Optimizer output power/ Optimizer rated power. The color of a PV module depends on the power ratio range. A darker color indicates a smaller power ratio, and vice versa.
20%–40%		
40%–60%		
60%–80%		
80%–100%		
Default color		The rated power of the optimizer cannot be reported or obtained. As a result, the calculation fails.

4 Technical Specifications

Efficiency

Technical Specifications	MERC-1300W-P	MERC-1100W-P
Maximum efficiency	99.5%	
European weighted efficiency	99.0%	

Input

Technical Specifications	MERC-1300W-P	MERC-1100W-P
Rated PV module power	1300 W	1100 W
Maximum PV module power	1365 W	1155 W
Maximum input voltage	125 V	
MPPT voltage range	12.5-105 V	
Maximum short-circuit current	20 A	
Overvoltage level	II	

Output

Technical Specifications	MERC-1300W-P	MERC-1100W-P
Rated output power	1300 W	1100 W
Output voltage	2-80 V	
Maximum output current	22 A	
Output bypass	Yes	
Safe output voltage	Typical value: 1 V	

General Specifications

Technical Specifications	MERC-1300W-P	MERC-1100W-P
Dimensions (H x W x D)	149 mm x 104 mm x 48.8 mm	
Net weight	≤ 1050 g	
DC input and output terminals	Staubli MC4	
Operating temperature ^a	-40°C to +85°C	
Storage temperature	-40°C to +70°C	
Operating humidity	0-100% RH	
Storage humidity	5-95% RH	
Maximum operating altitude	4000 m	
IP rating	IP68	
Installation mode	<ul style="list-style-type: none"> ● PV module support installation ● PV module frame installation 	
<p>Note a: When the operating temperature of the optimizer ranges from 70°C to 85°C, the optimizer may shut down for overtemperature protection and report an overtemperature alarm. After the operating temperature decreases, the optimizer automatically recovers with no risk of damage.</p>		

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