



Open Energy For All

Technical Note

Output Power Parameter Interpretation
and Control Instructions for Hoymiles
Microinverter

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0 Introduction

Intending to increase grid stability, many electric utilities are implementing grid restriction policies to require users to control the active and reactive power of inverters.

All Hoymiles HMS, HMT, and HM series microinverters are currently available with active and reactive power control capabilities. And all related parameters can be seen in their datasheet. However, as noted in the datasheet, the nominal output power is measured in Volt Ampere (VA), which is the unit of measurement for apparent power; the default power factor is >0.99 and can be adjusted between the range of 0.8 leading to 0.8 lagging.

Therefore, three questions are frequently asked of Hoymiles technical support team: Why the nominal output is measured in VA instead of Watts (W)? What is the power factor? How to understand the parameter 'Power factor adjustable range: 0.8 leading ... 0.8 lagging'?

Here, a brief description of active, reactive, and apparent power is given in this document, which will clear up these confusions.

1 Power Terminology

Before we proceed, let us briefly discuss the definition of the following power terminology.

1.1 Definitions

There are three types of power, active power, reactive power, and apparent power, all of which lead to the introduction of 'power factor' effectiveness in an AC circuit.

- **Active power** – Active power is the actual power that runs the electric devices to perform real work. It also refers to the useful power which can be converted into other forms of energy like heat energy, light energy, etc. A grid's active power represents the portion of the energy that can be used to perform useful work. It is denoted by P and measured in W .
- **Reactive power** – Reactive power is the electrical power which helps to produce the interaction between the electric and magnetic fields. It is also used to establish and maintain the electrical power of the magnetic field in electrical equipment. Reactive power does not do the work of electricity. It is denoted by Q and measured in Volt-Ampere Reactive (Var).
- **Apparent power** – The combination of active power and reactive power is called apparent power. Apparent power is the product of a circuit's voltage and current, regardless of phase angle. It is denoted by S and measured in VA.
- **Power factor** – Power factor is the ratio of active power that is used to do work to apparent power that is supplied to the circuit.

1.2 What is the Relation between the Three Types of Power?

A power triangle can be used to describe how these three types of power relate to one another. As Figure 1 demonstrates, active, reactive, and apparent power are trigonometrically related to each other. The active power is along the horizontal axis, the reactive power is along the vertical axis, and the apparent power is along the hypotenuse.

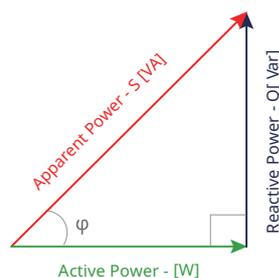


Figure 1. Power Triangle

Look at the power triangle, the formula of active, reactive, and apparent power can be written as,

$$S = \sqrt{(P^2 + Q^2)}$$

Usually, inverter apparent power capacity is measured in VA. When the Power factor is less than one, the active power is the product of apparent power times power factor:

$$P = S \times \cos \Phi = U \times I \times \cos \Phi$$

But, when the inverter operates with a power factor of one, apparent power rating is equal to the voltage U times the current I.

$$P = S = U \times I$$

Note that the reactive power isn't equal to the active power subtracted from the apparent power, instead, it is based on these formulas:

$$Q = \sqrt{(S^2 - P^2)}$$

also,

$$Q = S \times \sin \Phi = P \times \tan \Phi$$

1.3 What is the Positive and Negative Power Factor ?

Generally, the polarity sign of power factor represents the phase relationship between voltage and current. To illustrate this, the following will use the grid and microinverter as examples.

1.3.1 Grid

In the grid, the current charges direction periodically, and the voltage also periodically reverses because the current changes direction. The value of power factor is different based on the phase difference between voltage and current.

Current in Phase with the Voltage

When the voltage and current are in the same phase, both the current and voltage curves peak, and reach zero at the same time. In this case, the phase angle between the voltage and current is zero, meaning there is no reactive power flow in the circuit. Thus, the value of power factor is one.

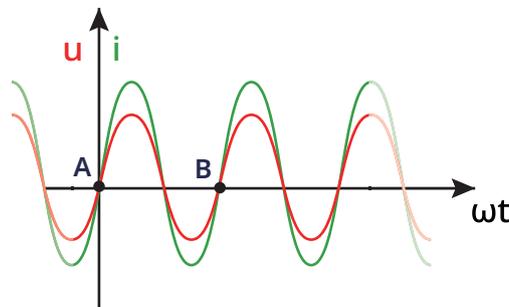


Figure 2. Visualization of in Phase Current

Current Lags the Voltage

When the current lags voltage in an ac circuit, in the interval [A, B], the current curve encounters the zero crossings of the time axis after the voltage curve. Thereby giving rise to a lagging power factor, and the value of power factor lies between 0 and 1.

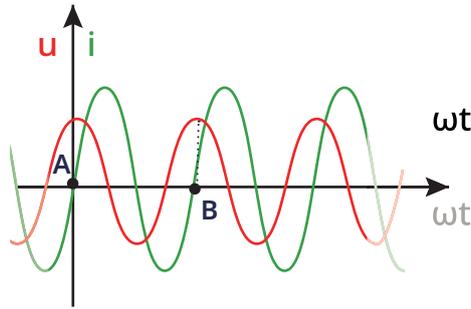


Figure 3. Current Lags the Voltage

Current Leads the Voltage

When the current leads voltage in an ac circuit, in the interval [A, B], the current curve encounters the zero crossings of the time axis earlier than that of voltage curve. This is called leading power factor, and the value of power factor lies between -1 and 0.

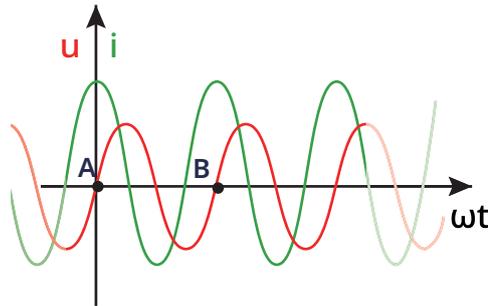


Figure 4. Current Leads the Voltage

1.3.2 For Microinverter

When it comes to the microinverter, the polarity sign of power factor also represents the phase relationship between voltage and current. But, a more straightforward interpretation of the polarity sign of power factor is that the polarity represents the direction in which reactive power is transferred.

We define that the reactive power is **absorbed** when the power factor is **negative**, whereas the reactive power is **generated** when the power factor is **positive**.

2 Example

Adjusting the value of power factor can control the active power output and reactive power output. To illustrate it, this chapter provides an example.

Here, we can take Hoymiles HMS-2000-4T as an example, and the following are some technical data of HMS-2000-4T:

Model	Rated output power (VA)	Power factor (adjustable)
HMS-2000-4T	2000	>0.99 default 0.8 leading ... 0.8 lagging

Among the parameters, the default power factor is greater than 0.99, indicating the apparent power is almost equal to the active power rating (W). In this case, all of the power is delivered and dissipated in the load.

If the microinverter operates using the default 0.99 power factor setting, then,

$$P = S = 2000 \text{ W}$$

If the microinverter operates using the 0.8 power factor setting, then,

$$P = 2000 \text{ VA} \times 0.8 = 1600 \text{ W};$$

$$Q = \sqrt{2000^2 - 1600^2} = 1200 \text{ Var}$$

From above, it is easy to see that a larger value for power factor, leads to an increase in reactive power, which ultimately results in a decrease of active power.



What does a power factor of -0.8 mean and why is it negative?

To begin with, we need to address that the sign just indicates the leading and lagging nature of the power factor.

In this example, the negative (-) sign before 0.8 means the current phase leads the voltage phase. And the number 0.8 means that, out of 100%, the system is consuming 80% active power. For example, if the power factor is 0.8 and the nominal output power is 2 kVA at this case, then the active power is 1.6 kW, while the reactive power is 1.2 kVar ($\sqrt{2^2 - 1.6^2} = 1.2$)

Generally, when the power factor of microinverter is 0.8, the microinverter **generates** active and reactive power to the system, to meet the needs of the power grid for reactive power; If the power factor becomes -0.8, the microinverter **absorbs** reactive power.

To put it in a nutshell, when the power factor is negative, the microinverter **absorbs** reactive power; when the power factor is positive, the microinverter **generates** reactive power.

3 Adjusting Active Power, Reactive Power and Power Factor

There are two ways to adjust the value of power factor, active power output and reactive power output through S-Miles Cloud (<https://global.hoymiles.com/platform>).

3.1 Editing Grid Profile via the S-Miles Cloud

The steps of editing grid profile can be summarized as the following steps:

1. Log into the **S-Miles Cloud** and search for the grid profile that you want to change.
2. Navigate to the grid profile, then edit the page and change the related parameters.
3. Save the new grid profile.
4. Search for the plant where you want to change the grid profile.
5. Executing the **Grid Profile Updating** operation .
6. Select and apply the **changed grid profile** to the microinverters.

Each of the steps is described below in more detail.

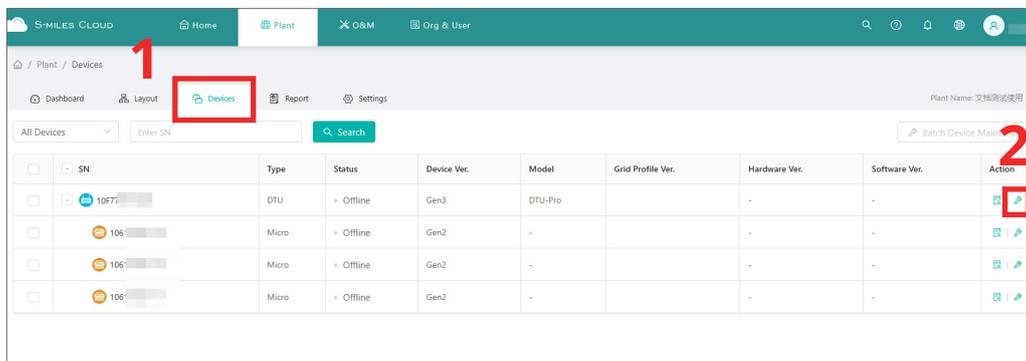
Step 1. Viewing the applied grid profile details.

1. Log into S-Miles Cloud using your credentials.

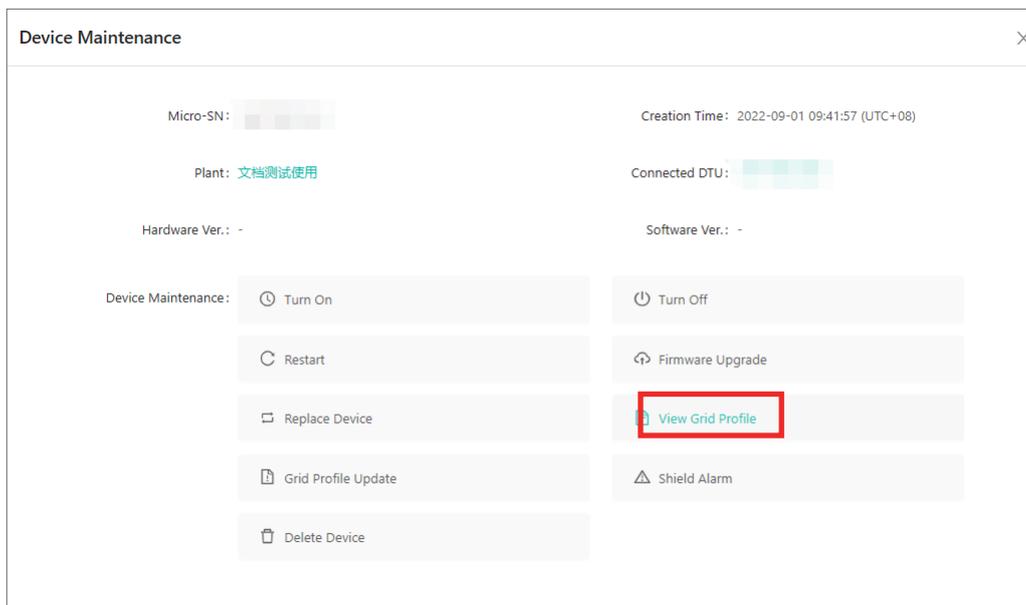
2. Select the **Plant** tab. Then search for the plant where you want to change the grid profile. Click on this site name to move to plant page.



3. Click on **Devices > Device Maintenance**.



4. Click on **View Grid Profile**.



5. The pop-up window displays the name of the grid profile and a list of settings by microinverter model for that grid profile.

View Grid Profile

SN: [REDACTED]

Grid Profile:

Name	Value	Unit
CN [REDACTED] 8		-
CountryStd		-
Version	8193	-
H/LVRT		-
H/LVRT F&C Code	3	
Nominal Voltage (NV)	230	V
Low Voltage 1 (LV1)	195.5	V
LV1 Maximum Trip Time (MTT)	1.6	s
High Voltage 1 (HV1)	270	V
HV1 Maximum Trip Time (MTT)	1.6	s

Step 2. Editing the grid profile.

6. Back to the main page. Click on the **O&M** tab and select **Grid Profile Management** from the O&M dropdown.

S-MILES CLOUD

Home Plant **O&M** Org & User

Power Generation

Energy This Month: 362.92 MWh
Lifetime Energy: 101.32 GWh
Total Reduction: 101,019 ton
Carbon Emission Offset: 5,520,210 Trees

Plant Sta Device List
Alarm Query
Report Query
Grid Profile Management

All Devices
59677 Total
Micro: 56448
DTU: 3229
Inverter: 0

Historical data
Month Year Total
2022-12

7. Search for the grid profile you want to change. Then click on the **Edit** button.

O&M / Grid Profile Management

Grid Profile Management

China Device Ver. Alias File Name Search

File Name	Alias	Device Ver.	Country	Version No.	Creation Time	Action
CN_N [REDACTED]_2018		Gen3	China	2.0.0	2020-07-07 16:54:13	Edit
LN_5C [REDACTED]		Gen2	China	1.1.0	2018-10-29 14:54:34	Edit
LN_5C [REDACTED]		Gen2	China	1.1.1	2022-10-19 08:21:39	Edit Alias Delete

- Adjusting Active Power Control

Scroll down to the **Active Power Control (APC)** section, and enter the value you want to adjust in the blanks. Click on the **Save and generate new profile** button.

55	Active Power Control (APC)			
56	APC Function Activated	<input type="text" value="1"/>		0-1
57	Power Ramp Rate (PRR)	<input type="text" value="100"/>	Pn%/s	0.33-100
58	Reactive Power Control (RPC)			
59	RPC Function Activated	<input type="text" value="0"/>		0-1
60	Reactive Power (VAR)	Leading <input type="text" value="0"/>	%Sn	0-50
		<input type="button" value="Cancel"/>	<input type="button" value="Save and generate new profile"/>	

- Adjusting Reactive Power Control

Scroll down to the **Reactive Power Control (RPC)** section, and enter the value you want to adjust in the blanks. Click on the **Save and generate new profile** button.

56	APC Function Activated	<input type="text" value="1"/>		0-1
57	Power Ramp Rate (PRR)	<input type="text" value="100"/>	Pn%/s	0.33-100
58	Reactive Power Control (RPC)			
59	RPC Function Activated	<input type="text" value="0"/>		0-1
60	Reactive Power (VAR)	Leading <input type="text" value="0"/>	%Sn	0-50
		<input type="button" value="Cancel"/>	<input type="button" value="Save and generate new profile"/>	

- Adjusting Power Factor

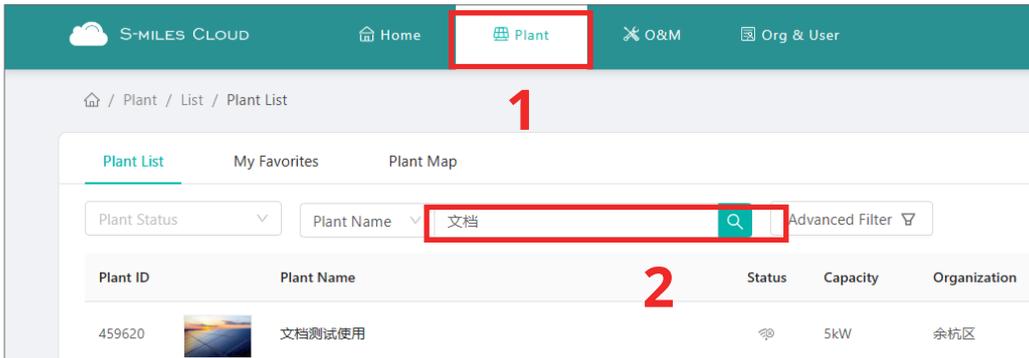
Scroll down to the **Specified Power Factor (SPF)** or **Watt Power Factor** section, and enter the data you want to adjust in the blanks. Click on the **Save and generate new profile** button.

48	Specified Power Factor (SPF)			
49	SPF Function Activated	<input type="text" value="1"/>		0-1
50	Power Factor (PF)	Leading <input type="text" value="1"/>		0.9-1
51	Watt Power Factor (WPF)			
52	WPF Function Activated	<input type="text" value="0"/>		0-1
53	Start of Power of WPF (Pstart)	<input type="text" value="50"/>	%Pn	~
54	Power Factor at Rated Power (PFRP)	<input type="text" value="0.95"/>		0.8-1
55	Active Power Control (APC)			
56	APC Function Activated	<input type="text" value="1"/>		0-1
57	Power Ramp Rate (PRR)	<input type="text" value="100"/>	Pn%/s	0.33-100
58	Reactive Power Control (RPC)			
59	RPC Function Activated	<input type="text" value="0"/>		0-1
60	Reactive Power (VAR)	Leading <input type="text" value="0"/>	%Sn	0-50
		<input type="button" value="Cancel"/>	<input type="button" value="Save and generate new profile"/>	

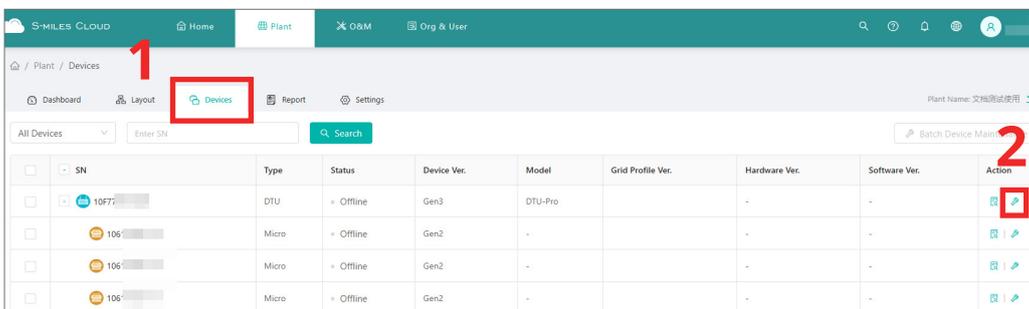
Note:
 The SPF, WPF and RPC modules are all related to the Reactive Power Control. For the microinverter which supports Reactive Power Control, all these modules will be disabled by default and only one of them can be enabled at a time.

Step 3. Applying the grid profile.

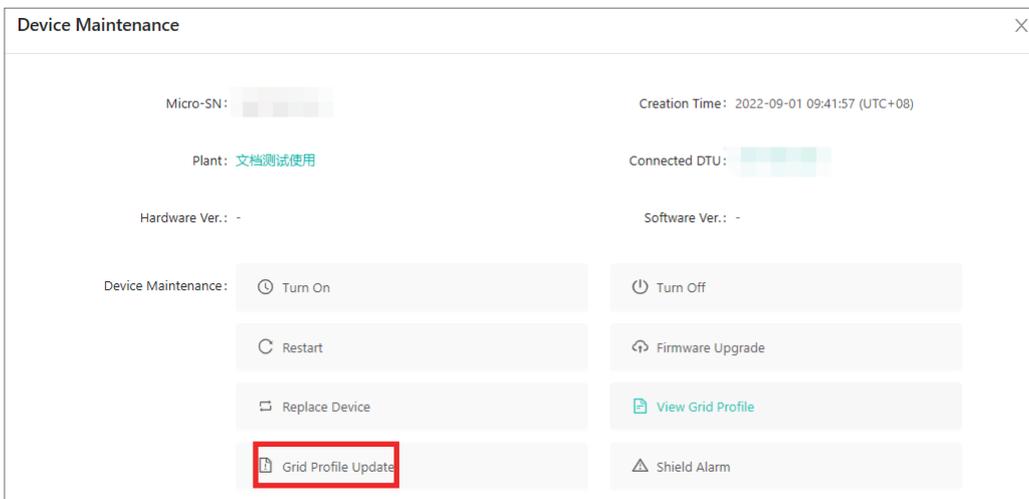
8. Select the **Plant** tab. Then search for the plant where you want to change the grid profile. Click on this site name to move to plant page.



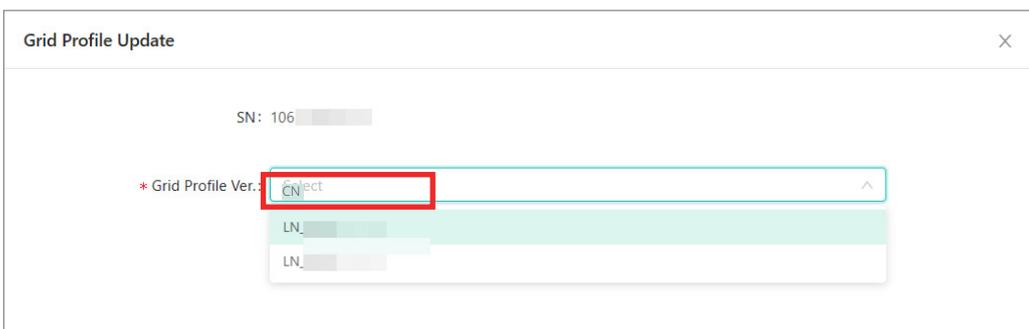
9. Click on **Devices > Device Maintenance**.



10. Click on **View Grid Profile**.



11. From the grid profile drop-down, select the grid profile you want to apply. Then click the **Confirm** button



3.2 Enabling the Power Adjustment Function

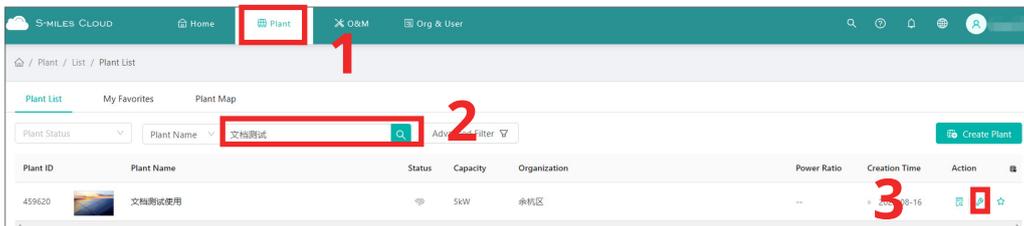
The steps of editing grid profile can be summarized as the following steps:

1. Log into S-Miles Cloud and search for the plant where you want to enable the Power Adjustment function.
2. Navigate to the **O&M** page of this plant.
3. Enabling the **Power Adjustment Function**.
4. In the Power Adjustment section, adjust the related parameters.
5. Save and issue the commission.

Each of the steps is described below in more detail.

1. Log in to S-Miles Cloud using your credentials.

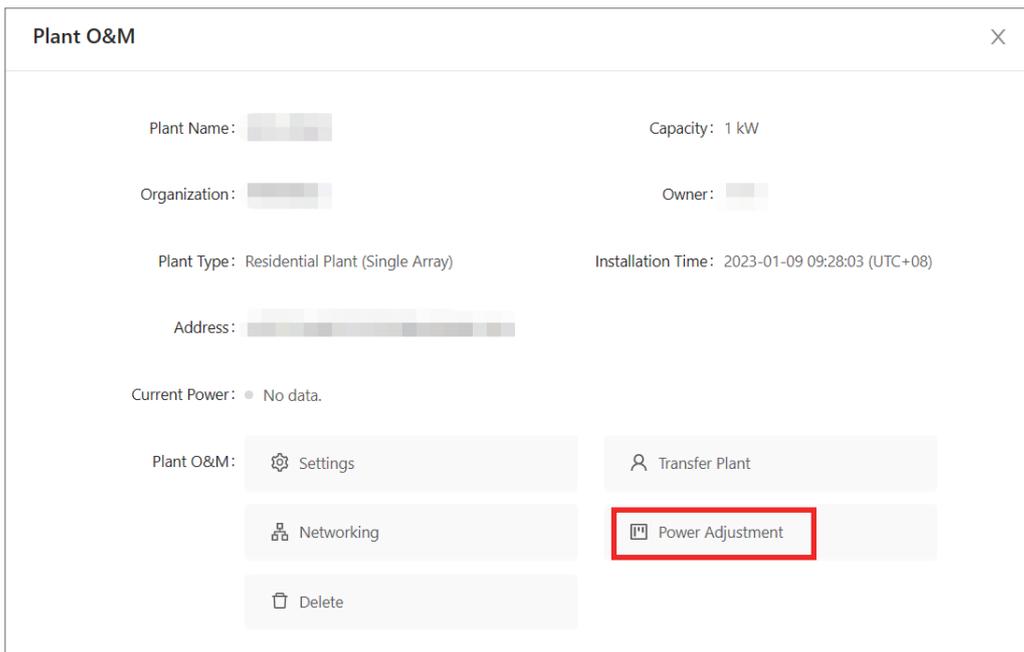
2. Select the **Plant** tab. Then search for the plant where you want to change the grid profile. Click the "O&M" icon to move to the **Plant O&M** pop-up window.



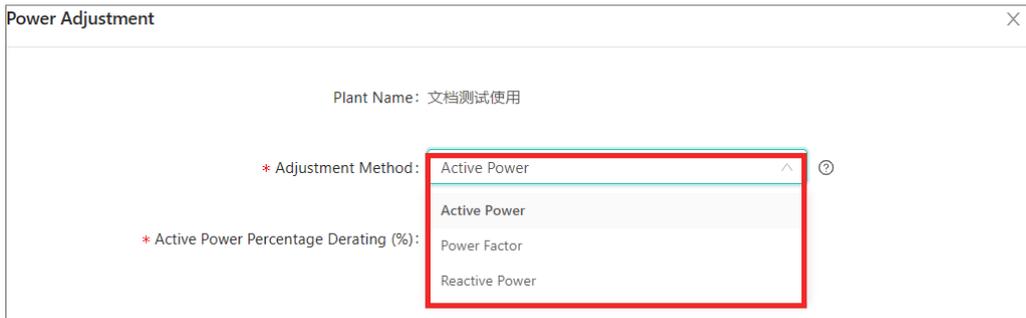
Note:

- To modify the parameters, make sure that the Power Adjustment Function has been enabled in the grid profile of this micro-inverter.
- Note that each power adjustment module has an option of xxx Function Activated. Here, 1 is the enable state, while 0 is the disable state.

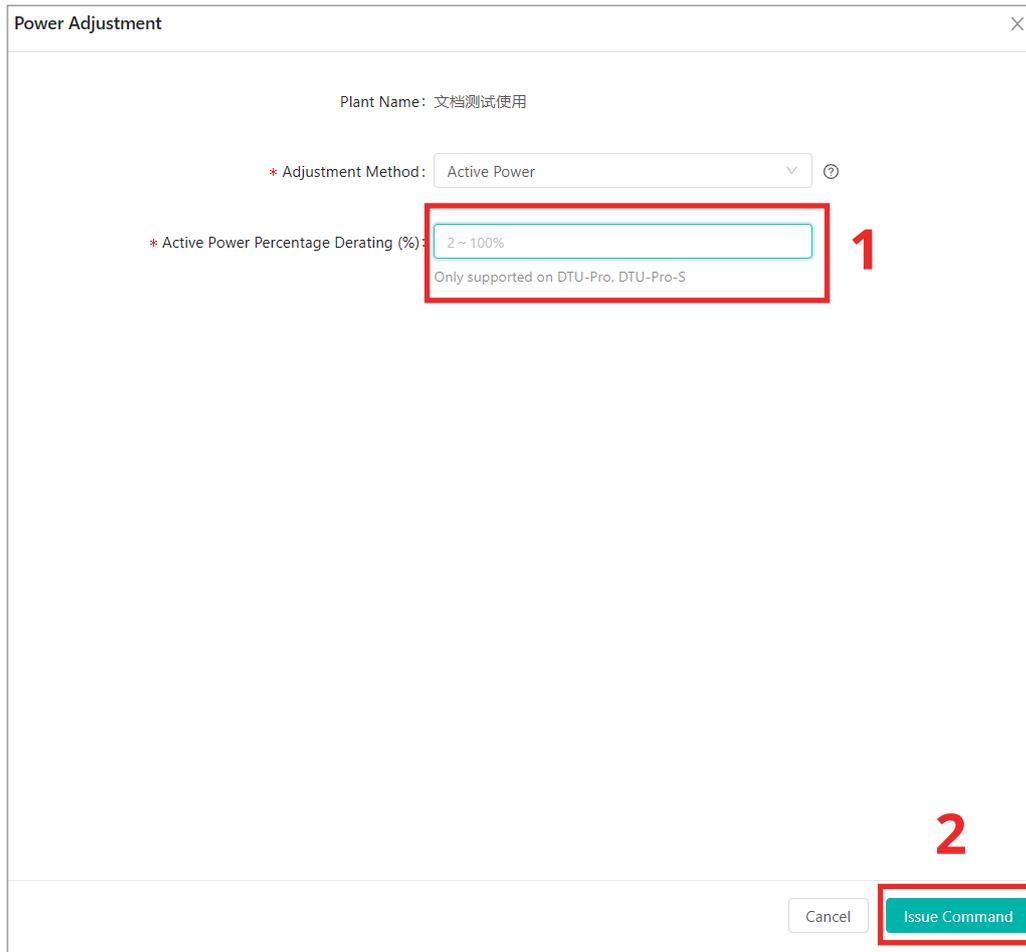
3. On the **Plant O&M** pop-up window, click on the **Power Adjustment** button.



4. From the **Adjustment Method** drop-down, select the parameter name you want to modify.



5. After that, enter the data into the blank, then click on the **Issue Command** button.



4 Conclusion

This document discusses how apparent power, active power, and reactive power relate, and how the power factor can be adjusted to control the amount of active and reactive power output.

To summarize, when the microinverter is not requested for the reactive power, it will generate power using the default power factor setting. If the reactive power generation is required, users can adjust the power factor through S-Miles Cloud according to the grid requirements or their own energy needs.