

Technical Note

How to set Hoymiles 3Gen Grid Profile?

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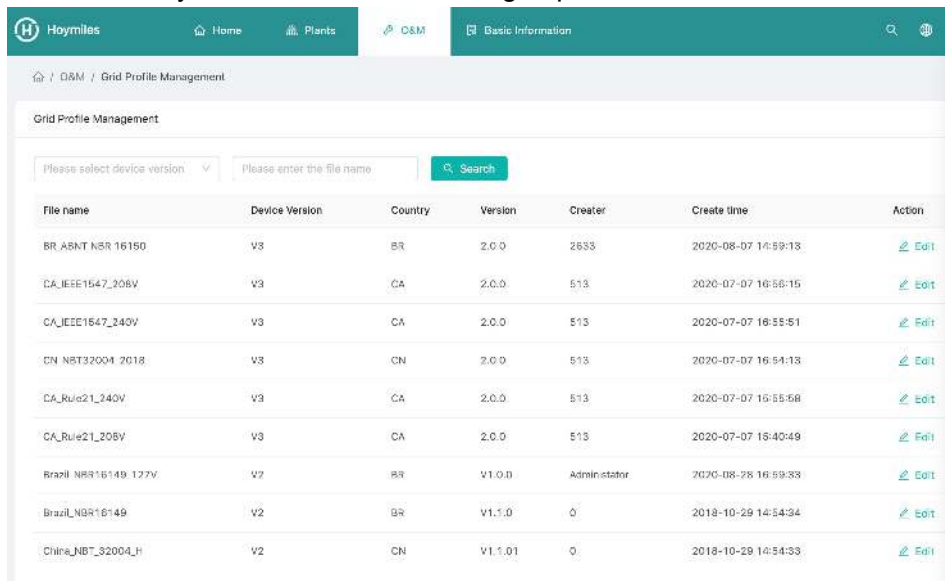
1. Introduction

When PV inverters are connected to the grid, local electric utility usually requires that these inverters must be compliant with relevant regulations to avoid impact on the stability of the grid. For Hoymiles microinverters, these compliance requirements are defined in the grid profiles, in which there are a series of settings for grid voltage, grid frequency, output power, etc.

For PV system installations in many countries around the world, the grid profiles are preset at the factory, and generally do not need to be adjusted. Also, these grid profiles can be found on Hoymiles Monitoring Platform. However, if these grid profiles cannot meet the local regulations, you need to set a specific grid profile on the platform and then send to the microinverters.

2. How to update the grid profile to the microinverters?

The grid profile can be found on Hoymiles Monitoring Platform and modified according to local electric regulation. When logging in the platform, enter the “Grid Profile Management” of the “O&M”. Then you can see the list of the grid profiles shown as below.



File name	Device Version	Country	Version	Creator	Create time	Action
BR_ABNT_NBR_16150	V3	BR	2.0.0	2633	2020-08-07 14:59:13	Edit
CA_IEEE1547_206V	V3	CA	2.0.0	513	2020-07-07 16:56:15	Edit
CA_IEEE1547_240V	V3	CA	2.0.0	513	2020-07-07 16:55:51	Edit
CN_NBT32004_2018	V3	CN	2.0.0	513	2020-07-07 16:54:13	Edit
CA_Rule21_240V	V3	CA	2.0.0	513	2020-07-07 16:55:56	Edit
CA_Rule21_206V	V3	CA	2.0.0	513	2020-07-07 16:40:49	Edit
Brazil_NRR16149_127V	V2	BR	V1.0.0	Administrator	2020-08-28 16:59:33	Edit
Brazil_NBR16149	V2	BR	V1.1.0	0	2018-10-29 14:54:34	Edit
China_NBT_32004_H	V2	CN	V1.1.01	0	2018-10-29 14:54:33	Edit

Figure 1 “Grid Profile Management” of the “O&M”

You can edit the grid profile, then created a new one. Go to the PV plant that you want to change, then go to “Devices”-“Device maintenance”-“Grid profile update” and select the one you just modified and click “OK” to send the grid profile to the PV microinverters.

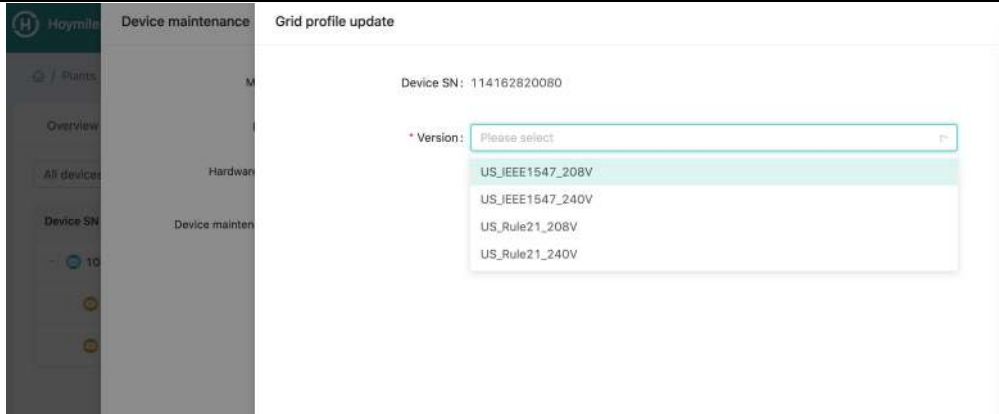


Fig. 2 How to update the grid profile?

3. How to understand Hoymiles grid profile?

The grid profile contains all the requirements for specific standard, which are for PV inverters for the injection of electric power through a PV installation into the grid. Next, taking the latest European standard EN 50549-1:2019 as an example, every module and parameter of the grid profile will be further explained.

There are twelve modules in the EN 50549-1:2019 grid profile, which are High-voltage/Low-voltage Ride Through (H/LVRT), High-frequency/Low-frequency Ride Through (H/LFRT), Islanding (ID), Reconnection, Ramp Rate (RR), Frequency Watt (FW), Volt Watt (VW), Volt Var (VV), Specified Power Factor (SPF), Watt Power Factor (WPF), Active Power Control (APC), Reactive Power Control (RPC).

3.1 High-voltage/Low-voltage Ride Through (H/LVRT)

The generating plant shall be capable not to disconnect due to grid voltage when the voltage at the point of connection stays within the range of $0.85 \cdot U_n$ to $1.1 \cdot U_n$. At the same time, the plant should be capable of remaining connected to the distribution network within the required time even if the grid voltage is beyond the range of $0.85 \cdot U_n$ to $1.1 \cdot U_n$. This required time is defined as “Maximum Trip Time” and the range of grid voltage is defined as “Low Voltage” or “High Voltage” shown as below. And if the trip time and the range of grid voltage are both exceeded, the plant, in other words, all inverters in this PV plant should be disconnect from the network.

Local electric utilities in different regions may have different requirements, but usually they can be met by using the parameter settings similar to the following table. And Hoymiles has already created the corresponding framework in advance for different requirements on the monitoring platform.

Table 1 H/LVRT Module

H/LVRT			
Parameter	Value	Unit	Range(min-max)
Nominal Voltage (NV)	230	V	
Low Voltage 1 (LV1)	195.5	V	170~195.5

Maximum Trip Time (MTT)	1.5	s	
High Voltage 1 (HV1)	253	V	253~264
Maximum Trip Time (MTT)	3	s	
Low Voltage 2 (LV2)	161	V	140~161
Maximum Trip Time (MTT)	0.2	s	
High Voltage 2 (HV2)	264.5	V	264~275
Maximum Trip Time (MTT)	0.16	s	
High Voltage 3 (LV3)	276	V	275~280
Maximum Trip Time (MTT)	0.1	s	
10mins Average High Voltage (AHV)	253	V	245~253

3.2 High-frequency/Low-frequency Ride Through (H/LFRT)

The generating plant shall be capable of operating continuously when the grid frequency at the point of connection stays within the range of 48Hz to 51Hz. And in the frequency range of 47.5Hz to 52Hz, the plant should be capable of operating until the interface protection trips. Similar to the H/LVRT module, the required time is defined as “Maximum Trip Time” and the range of grid frequency is defined as “Low Frequency” or “High Frequency” shown as below. And if the trip time and the range of grid frequency are both exceeded, all inverters in this PV plant should be disconnect from the network.

Table 2 H/LFRT Module

H/LFRT			
Parameter	Value	Unit	Range(min-max)
Nominal Frequency (NF)	50	Hz	
Low Frequency 1 (LF1)	48	Hz	48~49.9
Maximum Trip Time (MTT)	2	s	
High Frequency 1 (HF1)	51	Hz	50.1~51
Maximum Trip Time (MTT)	2	s	
Low Frequency 2 (LF2)	47.5	Hz	47.5~47.9
Maximum Trip Time (MTT)	0.5	s	
High Frequency 2 (HF2)	52	Hz	51.1~52
Maximum Trip Time (MTT)	0.5	s	

3.3 Islanding (ID)

Islanding is a situation where a section of the electricity network, containing the PV plant, becomes physically disconnected from the public distribution network and the generating plants may produce power to the isolated section of the network. The inverters shall be capable of detecting this islanding situation and then stop generating. This function is sometimes called Loss of Mains (LoM) detection.

Table 3 Islanding Module

Islanding (ID)			
Parameter	Value	Unit	Range(min-max)

Function Activated	1	/	0: Disable 1: Enable
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3.4 Reconnection

When the grid voltage and frequency are abnormal, the PV inverters should not be generating. But connection and starting to generate electrical power is allowed after the grid voltage and frequency are within the allowed range for at least the specified time. The setting of the connections can be set in the Reconnection module and Ramp Rate module, in which the settings depend on whether the connection is due to a normal operational start-up or an automatic reconnection after tripping of the interface protection.

The frequency range, the voltage range, the reconnection time and the power gradient can be modified in the grid profile. The default settings for the reconnection after tripping of the interface protection are shown as follows. Please note that settings of the power gradient are in the Ramp Rate module in which “Normal Ramp up Rate (RUR_NM)” is for the normal operational start-up while “Soft Start Ramp up Rate (RUR_SS)” is for the automatic reconnection after tripping of the interface protection.

Table 4 Reconnection Module

Reconnection (RT)			
Parameter	Value	Unit	Range(min-max)
Reconnection Time (RT)	60	s	10~300
Reconnect High Voltage (RHV)	253	V	240~253
Reconnect Low Voltage (RLV)	195.5	V	195.5~210
Reconnect High Frequency (RHF)	50.2	Hz	50.1~50.9
Reconnect Low Frequency (RLF)	49.5	Hz	49~49.9

3.5 Ramp Rate (RR)

The settings of the power gradient are shown as follows.

Table 5 Ramp Rate Module

Reconnection (RT)			
Parameter	Value	Unit	Range(min-max)
Normal Ramp up Rate (RUR_NM)	20	Rated%/s	10~100
Soft Start Ramp up Rate (RUR_SS)	0.16	Rated%/s	0.1~10

3.6 Frequency Watt (FW)

Frequency Watt module is designed for the regulation about the active power response to over-frequency. The PV plant shall be capable of activating active power response to over-frequency at a programmable frequency threshold f_{start} with a programmable droop. Taking the regulations in EN 50549-1:2019 as an example shown as Fig.1 and Table 6, the start frequency is 50.2Hz, the power droop gradient is 40%Rated/Hz. The Recovery Ramp Rate means the rising speed of the active power while the grid frequency is going

down when the grid frequency is higher than 50.2Hz and the power is drooping. The setting time is related to the change of the active power and usually does not need to be modified.

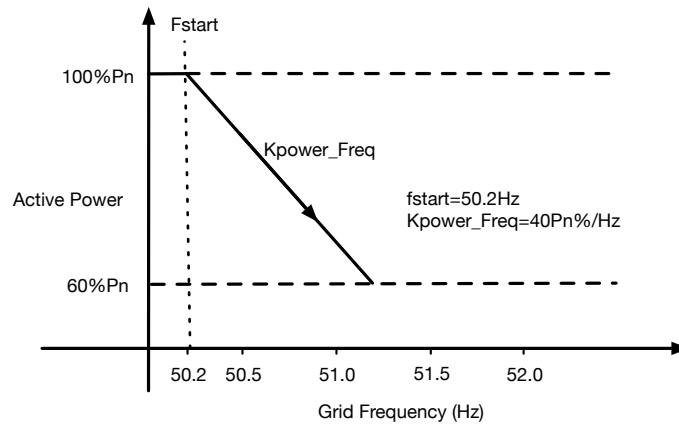


Figure 3 Example of active power response to over-frequency

Table 6 Frequency Watt Module

Frequency Watt (FW)			
Parameter	Value	Unit	Range(min-max)
Function Activated	1	/	0: Disable 1: Enable
Start of Frequency Watt Droop (Fstart)	50.2	Hz	50.2~52
Droop Slope (Kpower_Freq)	40	Pn%/Hz	16.7~100
Recovery Ramp Rate (RRR)	0.16	Pn%/s	0.1~50
Settling Time (Tr).	0	s	0~2

3.7 Volt Watt (VW)

The Volt Watt module varies the output power of the inverter in response to the voltage at the point of connection. When the grid voltage is higher than Vstart, output power goes down at the Droop Slope shown as below.

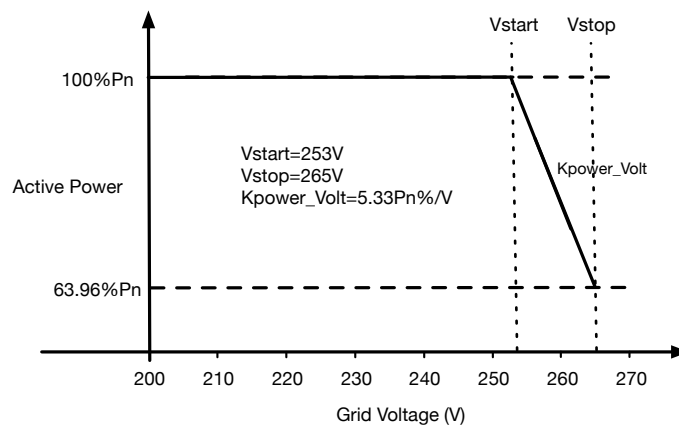


Figure 4 Example of Volt Watt response mode

Table 7 Volt Watt Module

Volt Watt (VW)			
Parameter	Value	Unit	Range(min-max)
Function Activated	1	/	0: Disable 1: Enable
Start of Voltage Watt Droop (Vstart)	253	V	
End of Voltage Watt Droop (Vend)	265	V	
Droop Slope (Kpower_Volt)	5.33	Pn%/V	

3.8 Volt Var (VV)

HoyMiles new generation microinverters, HM and HMT series, are capable of reactive power control, including the Volt Var, SPF, WPF RPC, etc. These modules shall be disabled by default and only one of them can be enabled at a time.

The Volt Var response mode varies the output reactive power of the inverter in response to the voltage at the grid-interactive port. The response curve required for the Volt Var module is shown as below. The default values are listed in Table 8 and shown in Figure 3.

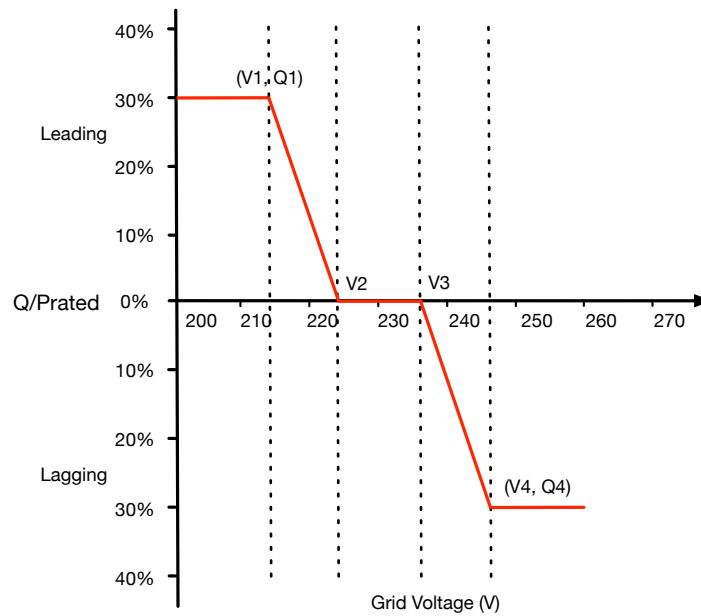


Figure 5 Example of Volt Var response mode

Table 8 Volt Var Module

Volt Var (VV)			
Parameter	Value	Unit	Range(min-max)
Function Activated	0	/	0: Disable 1: Enable
Voltage Set Point V1	213.9	V	
Reactive Set Point Q1	30	%Pn	0~50
Voltage Set Point V2	223.1	V	
Voltage Set Point V3	236.9	V	
Voltage Set Point V4	246.1	V	

Reactive Set Point Q4	30	%Pn	0~50
Setting Time (Tr)	10	s	

3.9 Specified Power Factor (SPF)

The specified power factor mode is required in some situations by the electric utility to meet the local requirements. The minimum range of the setting of the fixed power factor is 0.8 leading to 0.8 lagging.

Note1: Power factor is ratio of the absolute value of the active power P to the apparent power S under periodic conditions.

Note2: Lagging power factor is defined to be when the inverter acts as an inductive load from the perspective of the grid. Leading power factor is defined to be when the inverter acts as a capacitive load from the perspective of the grid.

Note3: As shown in the table below, if the input value of power factor is positive, the leading power factor will be set while if the input value of power factor is negative, the lagging power factor will be set.

Table 9 Specified Power Factor Module

Specified Power Factor (SPF)			
Parameter	Value	Unit	Range(min-max)
Function Activated	0	/	0: Disable 1: Enable
Power Factor (PF)	0.95	/	-0.9~0.9

3.10 Watt Power Factor (WPF)

The characteristic power factor curve for Watt Power Factor module varies the displacement power factor of the output of the inverter in response to changes in the output power of the inverter.

The response curve required for the Watt Power Factor module is shown as below.

Note: As shown in the table below, if the input value of power factor is positive, the leading power factor will be set while if the input value of power factor is negative, the lagging power factor will be set.

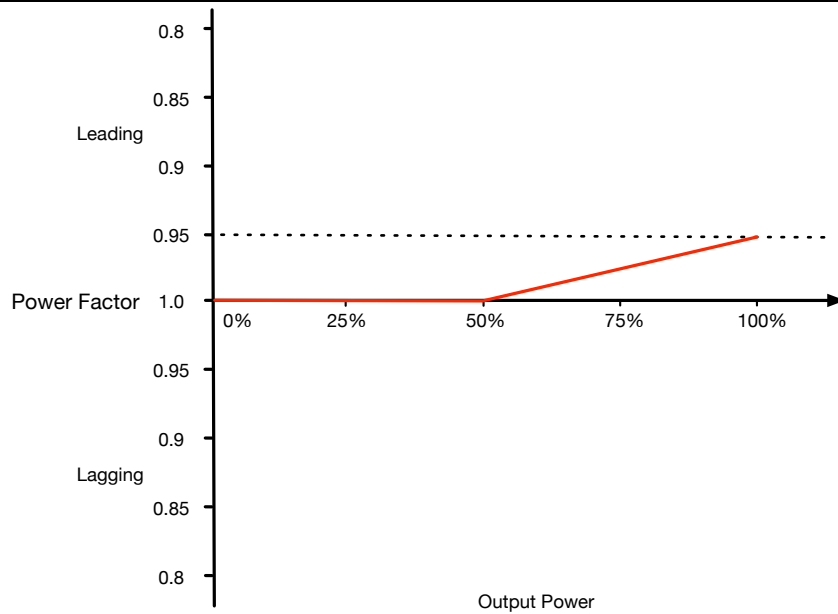


Figure 6 Example of Watt Power Factor module

Table 10 Watt Power Factor Module

Watt Power Factor (WPF)			
Parameter	Value	Unit	Range(min-max)
Function Activated	0	/	0: Disable 1: Enable
Start of Power of WPF (Pstart)	50	%Pn	
Power Factor at Rated Power (PFRP)	0.95	/	-0.9~0.9

3.11 Active Power Control (APC)

The output active power can be directly limited by the command from the platform and this function is enabled in the table as below by default. The change rate of the output power can be also modified in this module.

Table 11 Active Power Control Module

Active Power Control (APC)			
Parameter	Value	Unit	Range(min-max)
Function Activated	1	/	0: Disable 1: Enable
Power Ramp Rate (PRR)	0.5	%Pn/s	0.33~0.66

3.12 Reactive Power Control (RPC)

The output reactive power can be directly limited by making this function being enabled shown as below.

Note: As shown in the table below, if the input value of reactive power is positive, the leading reactive power will be set while if the input value of reactive power is negative, the lagging reactive power will be set.

Table 12 Reactive Power Control Module

Reactive Power Control (RPC)			
Parameter	Value	Unit	Range(min-max)
Function Activated	0	/	0: Disable 1: Enable
Reactive Power (VAR)	0	%Sn	-50~50