

Procedure of setting Reactive Power Compensation at Night with SmartLogger3000



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01	m00598297	26.03.2021	Reactive Power

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1. Reason of Reactive Power Consumption at Night

All inverters have an output EMI filter that prevents high frequency EMI interference inside the inverter from feeding into the grid.

During nighttime, inverter does not work, output relay is disconnected, but the capacitors of EMI filter are permanently connected to grid, which causing capacitive reactive power consumption.

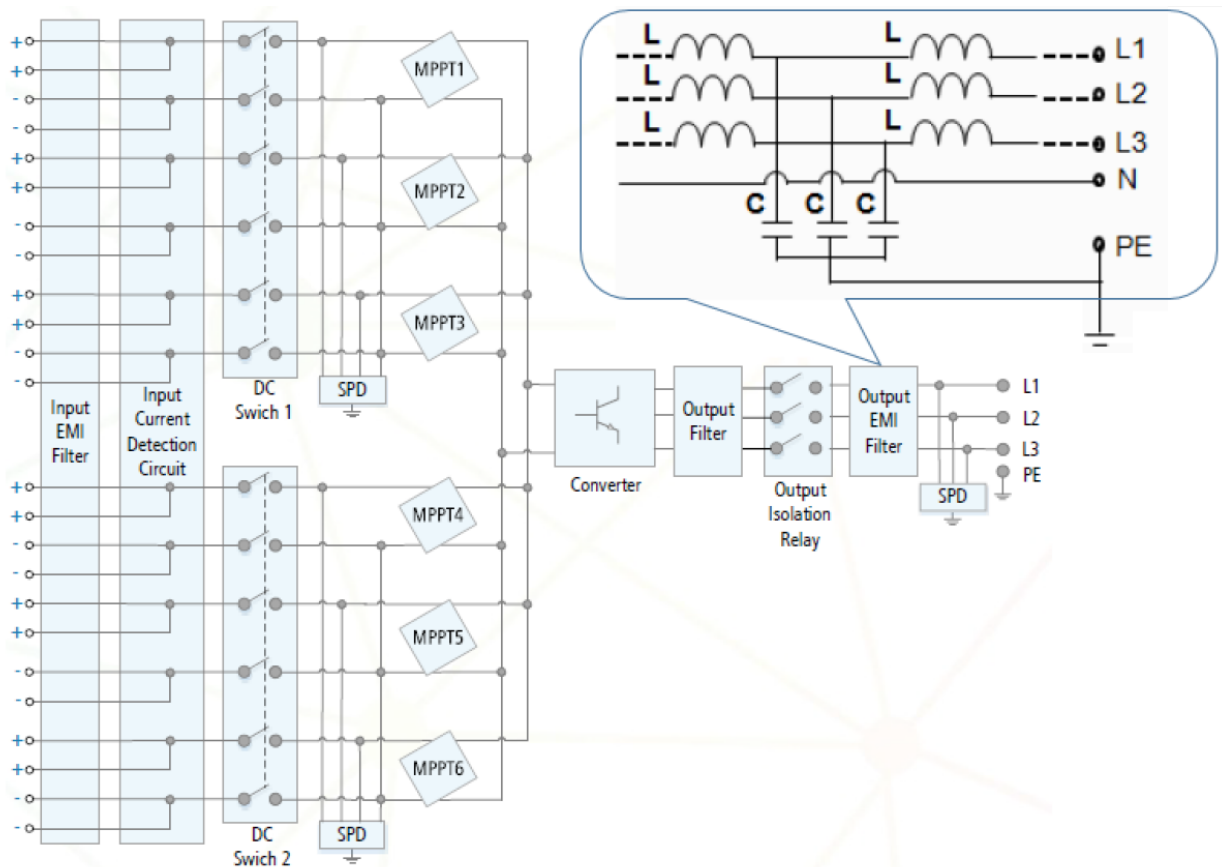


Fig. 1 Circuit Diagram of SUN2000 inverters

The formula to calculate reactive power is as below:

$$S = 3UI = 3 \frac{U^2}{X_c}$$

$$X_c = \frac{1}{2\pi f c}$$

Where U is the grid voltage, U=462V for medium voltage grid connection (800V), U=230V for low voltage grid connection (400V).

According to above formula, for SUN2000 series inverters, the reactive power consumed by each inverter during nighttime is as below.

Model	Capacity(μF)	q-ty of capacitors per phase (pcs)	Output Voltage (V)	Reactive Power (var)
SUN2000-36KTL	1.93	3	400	291
SUN2000-50/60KTL	1.8	3	400	271
SUN2000-105KTL	2.2	1	800	442
SUN2000-185KTL	0.12	1	800	24
SUN2000-215KTL	XXX	XXX	800	XXX

2. Inverter capabilities to generate reactive power

Inverter as current source working on grid voltage can supply current with any phase shift, and generate active, reactive or both types of power parallel. Additionally inverter can be power from either DC or AC side, which means it can generate reactive power also during the night.

Direct working range is described in document called Output Characteristic Curve, with characteristic curve called PQ. It describes inverter ability to generate active/reactive power vs. grid voltage, and in cross-section with horizontal axis describes ability to generate only reactive power. For 105KTL range is from 69.6 KVar inductive to 69.9KVar capacitive reactive power to be supplied to grid by one inverter during day and night.

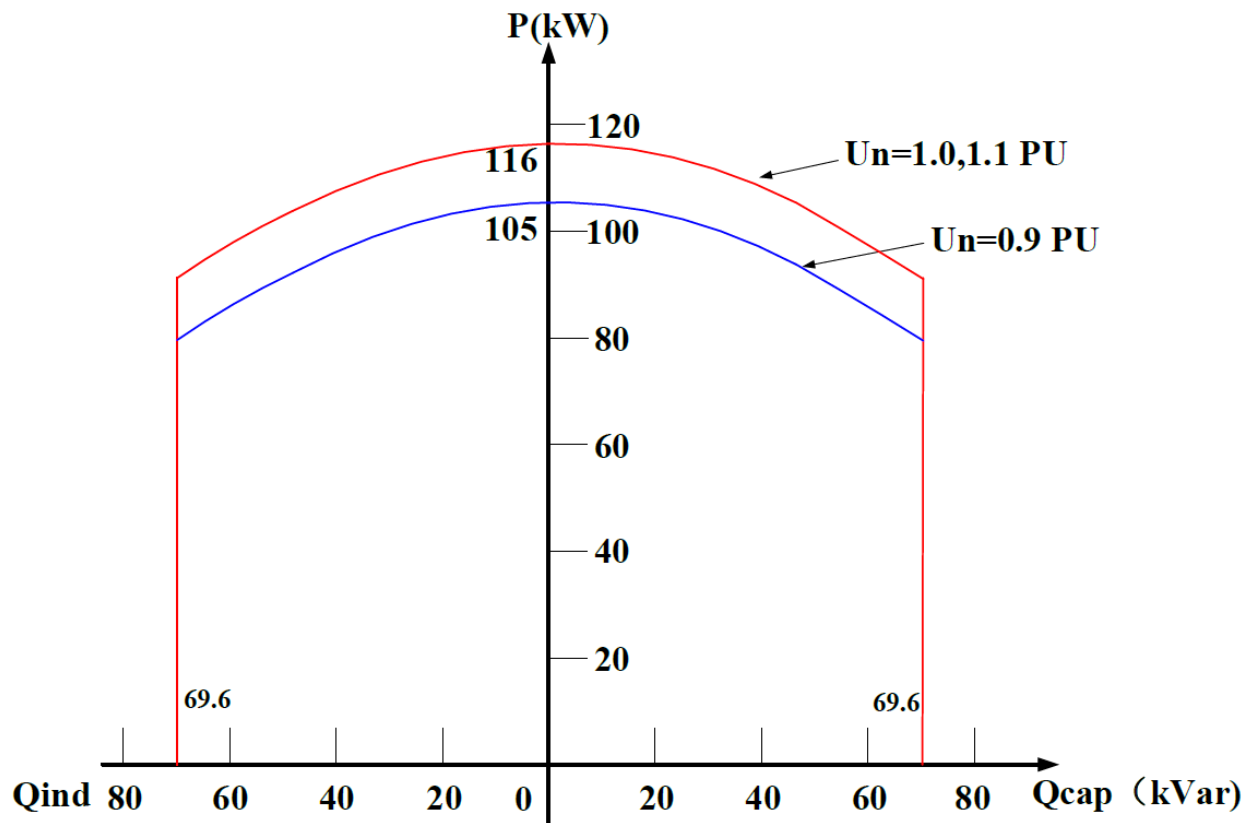


Fig2. PQ curve for 105KTL-H1 inverter

For other inverter in SUN2000 family reactive power capability is as below:

105 – 69.6 KVar

185 – 110 KVar

215 – 129 KVar

3. Case study for 1MWp installation

Reactive Power calculation for typical 1MWp PV plant:

In example: 7 inverters 105KTL connected to 1MVA transformer.

The no-load current of transformer $I_o\%$ is 0.2, and the inductive reactive power of transformer is $Q_o = 2\text{KVar}$, when there is no load during the night.

The capacitive reactive power produced by 7pcs 105KTL inverters at night is $7 \times 442 = 3094\text{var}$

Then the capacitive reactive power of entire 1MVA block is $3.094 - 2 = 1.094\text{KVar}$ needs to be compensated.

Reactive Power real case scenario typical 1MWp PV plant:

In example: 15 inverters 60KTL connected to 1MVA transformer and 10km SN line to SN connection point.

Night time reactive power consumption in connection point rises to 215KVar, reasoning high penalty fees.

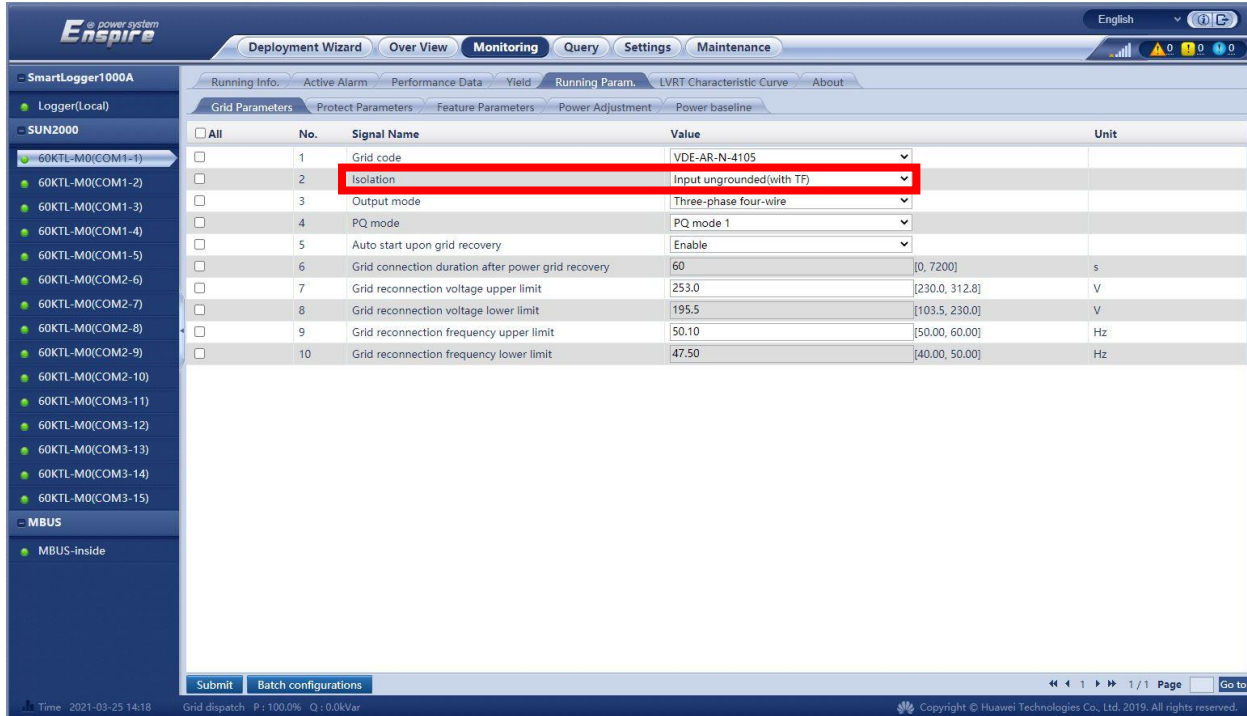


Fig3. Reactive Power at night in connection point 215KVar

4. Setting reactive power compensation at Night

In order to compensate reactive power first some settings needs to be Enabled. Place of each parameter can differ according to Smart Logger type, software version and inverter type connected.

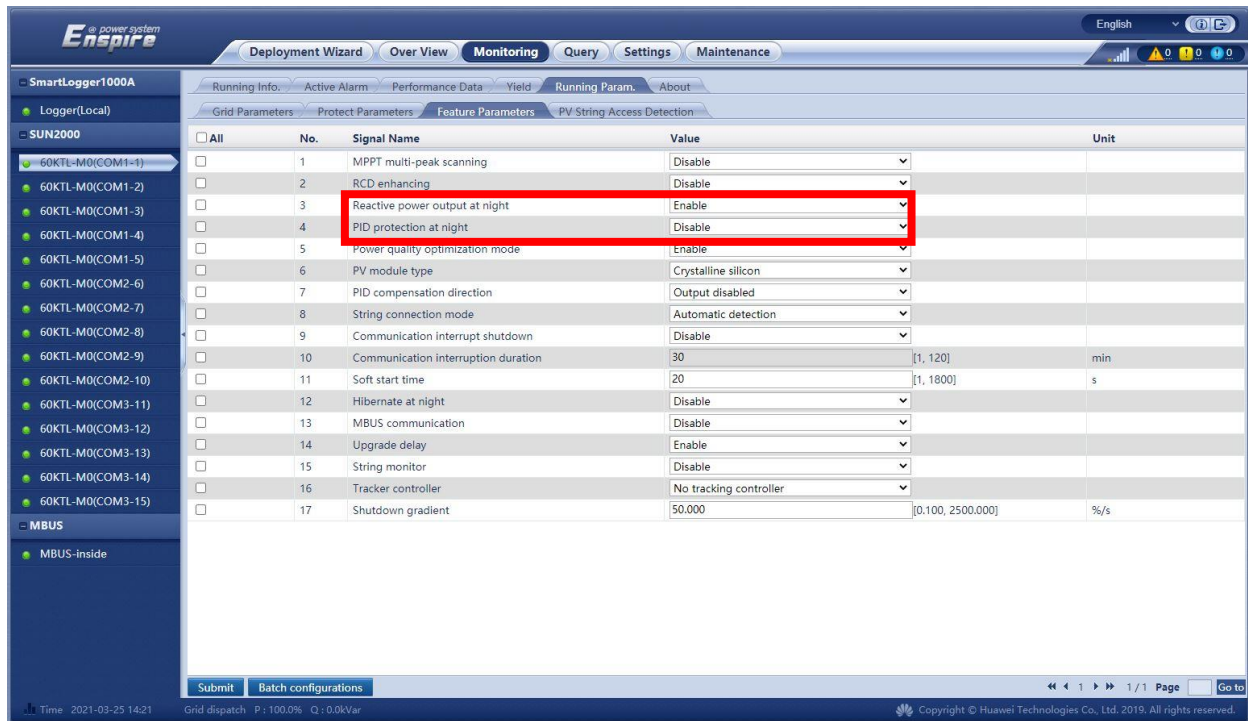
Set Insolation Input ungrounded (withTF)



No.	Signal Name	Value	Unit
1	Grid code	VDE-AR-N-4105	
2	Isolation	Input ungrounded(with TF)	
3	Output mode	Three-phase four-wire	
4	PQ mode	PQ mode 1	
5	Auto start upon grid recovery	Enable	
6	Grid connection duration after power grid recovery	60	s
7	Grid reconnection voltage upper limit	253.0	V
8	Grid reconnection voltage lower limit	195.5	V
9	Grid reconnection frequency upper limit	50.10	Hz
10	Grid reconnection frequency lower limit	47.50	Hz

Reactive power output at night Enable

PID protection at night Disable



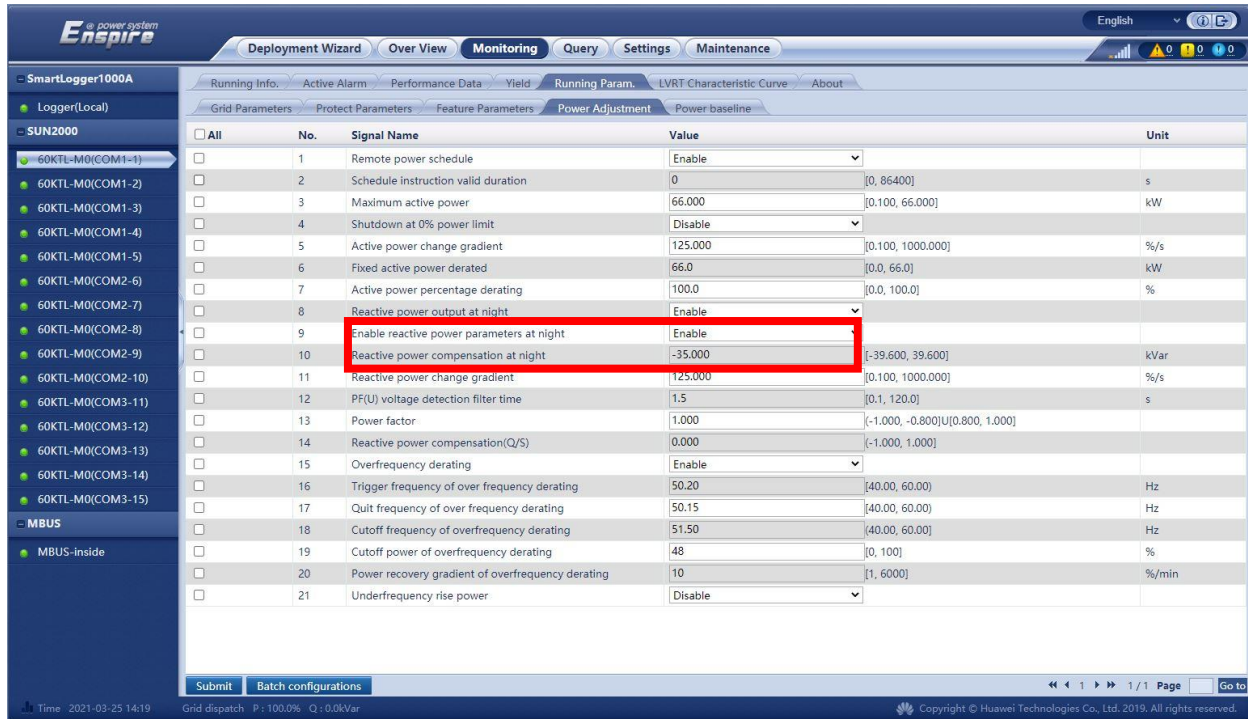
The screenshot shows the Huawei Enspire SmartLogger1000A web interface. The left sidebar lists the system components, including SUN2000 inverters. The main area displays the 'Feature Parameters' configuration for the selected inverter. The 'Reactive power output at night' and 'PID protection at night' settings are highlighted with a red box.

All	No.	Signal Name	Value	Unit
<input type="checkbox"/>	1	MPPT multi-peak scanning	Disable	
<input type="checkbox"/>	2	RCD enhancing	Disable	
<input type="checkbox"/>	3	Reactive power output at night	Enable	
<input type="checkbox"/>	4	PID protection at night	Disable	
<input type="checkbox"/>	5	Power quality optimization mode	Enable	
<input type="checkbox"/>	6	PV module type	Crystalline silicon	
<input type="checkbox"/>	7	PID compensation direction	Output disabled	
<input type="checkbox"/>	8	String connection mode	Automatic detection	
<input type="checkbox"/>	9	Communication interrupt shutdown	Disable	
<input type="checkbox"/>	10	Communication interruption duration	30	[1, 120] min
<input type="checkbox"/>	11	Soft start time	20	[1, 1800] s
<input type="checkbox"/>	12	Hibernate at night	Disable	
<input type="checkbox"/>	13	MBUS communication	Disable	
<input type="checkbox"/>	14	Upgrade delay	Enable	
<input type="checkbox"/>	15	String monitor	Disable	
<input type="checkbox"/>	16	Tracker controller	No tracking controller	
<input type="checkbox"/>	17	Shutdown gradient	50.000	[0.100, 2500.000] %/s

Time: 2021-03-25 14:21 Grid dispatch P: 100.0% Q: 0.0kVar Copyright © Huawei Technologies Co., Ltd. 2019. All rights reserved.

Enable reactive power parameters at night

Set Range of Reactive Power compensation at night



The screenshot shows the Enspire power system monitoring interface. The left sidebar lists various components, including 60KTL-M0(COM1-1) through 60KTL-M0(COM3-15) and MBUS. The main panel displays the 'Monitoring' tab with a table of parameters. A red box highlights the 'Reactive power compensation at night' parameter (No. 10), which is set to '-35.000' with a range of '[-39.600, 39.600]'. Other parameters include 'Reactive power output at night' (No. 8, set to 'Enable') and 'Enable reactive power parameters at night' (No. 9, set to 'Enable').

No.	Signal Name	Value	Unit
1	Remote power schedule	Enable	
2	Schedule instruction valid duration	0	s
3	Maximum active power	66.000	kW
4	Shutdown at 0% power limit	Disable	
5	Active power change gradient	125.000	%/s
6	Fixed active power derated	66.0	kW
7	Active power percentage derating	100.0	%
8	Reactive power output at night	Enable	
9	Enable reactive power parameters at night	Enable	
10	Reactive power compensation at night	-35.000	kVar
11	Reactive power change gradient	125.000	%/s
12	PF(U) voltage detection filter time	1.5	s
13	Power factor	1.000	
14	Reactive power compensation(Q/S)	0.000	
15	Overfrequency derating	Enable	
16	Trigger frequency of over frequency derating	50.20	Hz
17	Quit frequency of over frequency derating	50.15	Hz
18	Cutoff frequency of overfrequency derating	51.50	Hz
19	Cutoff power of overfrequency derating	48	%
20	Power recovery gradient of overfrequency derating	10	%/min
21	Underfrequency rise power	Disable	

5. Reactive Power Control

FusionSolar Distributed Reactive Power Compensation Solution offers different type of plant management according to reactive power setting. Full list of options below.



Fig. 5 Full list of available options to control reactive power.

More information's according Reactive Power Control can be found in links

SmartLogger Manual

<https://support.huawei.com/enterprise/en/doc/EDOC1100108365/fdf170ec/setting-reactive-power-control>

FusionSolar Distributed Reactive Power Compensation Solution

<https://support.huawei.com/enterprise/en/doc/EDOC1100154247>

Youtube Channel FusionSolar Service

<https://www.youtube.com/watch?v=DPSIsSCvyuw>

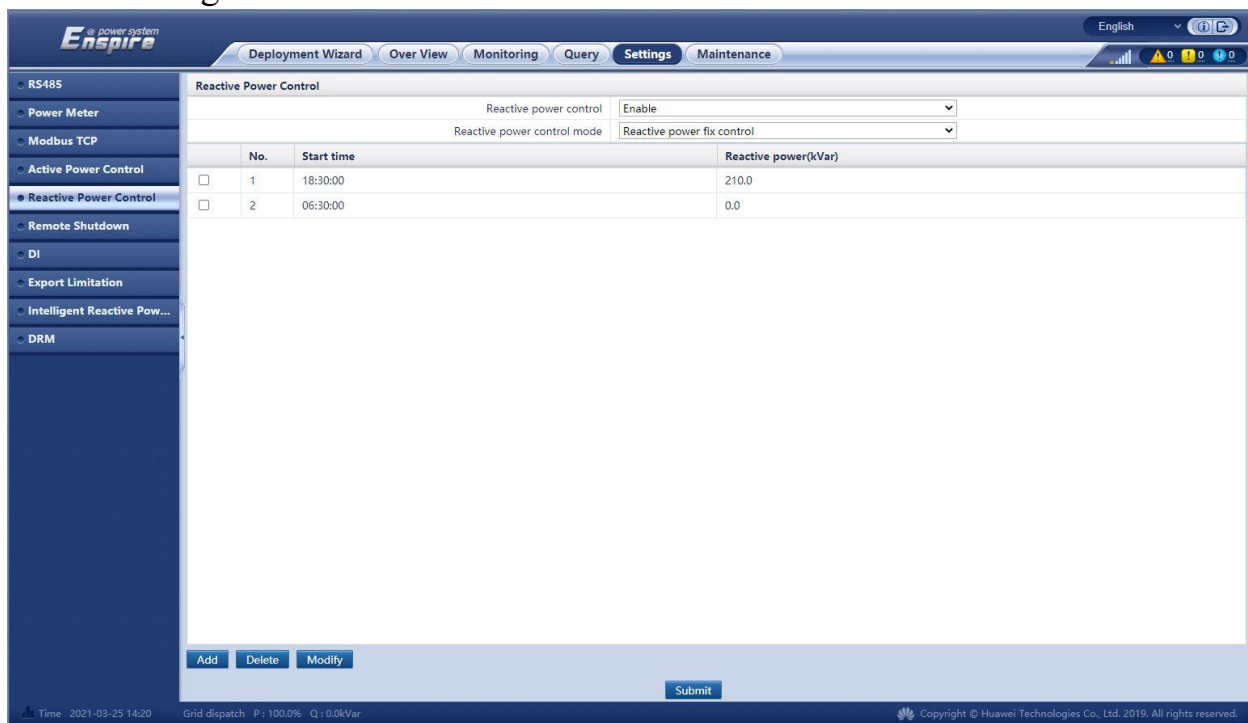
<https://www.youtube.com/watch?v=iUeKh7GTKcc>

6. 215 KVar compensation scenario

In example: 15 inverters 60KTL connected to 1MVA transformer and 10km SN line to SN connection point.

Night time reactive power consumption in connection point rises to 215KVar, reasoning high penalty fees.

For this real case scenario client used **Reactive power fixed control** set for 210 KVar working between 18.30 and 6.30.

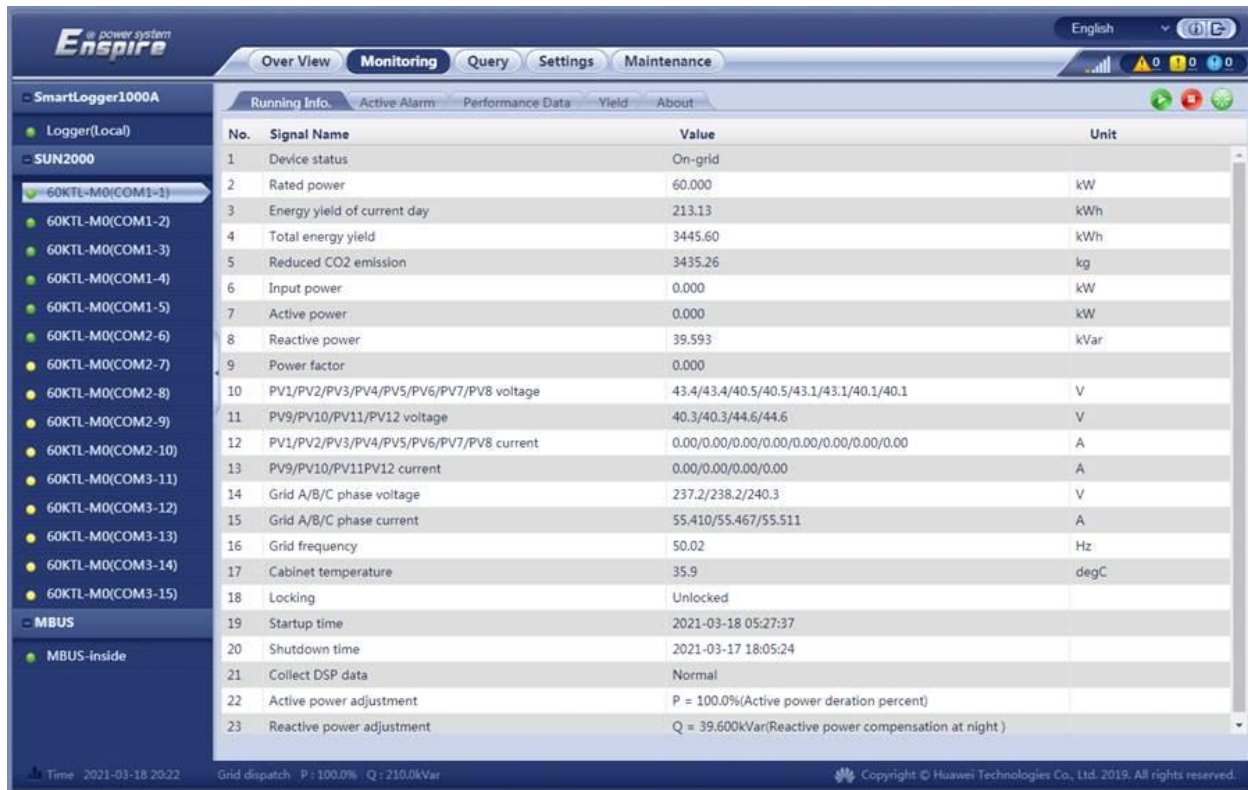


The screenshot shows the 'Enspire' power system management interface. The 'Settings' tab is active, and the 'Reactive Power Control' section is selected in the left sidebar. The main panel displays the configuration for reactive power control, including a table with two rows for different time periods.

No.	Start time	Reactive power(kVar)
1	18:30:00	210.0
2	06:30:00	0.0

At the bottom of the interface, there are buttons for 'Add', 'Delete', 'Modify', and 'Submit'. The status bar at the very bottom shows the time as 2021-03-25 14:20 and grid dispatch statistics: P: 100.0%, Q: 0.0kVar.

In SmartLogger 6 inverters was set to work during nighttime according to presented suggestion in instruction. Those devices were visible during night with green dot and Reactive power production around 36kVar.



No.	Signal Name	Value	Unit
1	Device status	On-grid	
2	Rated power	60.000	kW
3	Energy yield of current day	213.13	kWh
4	Total energy yield	3445.60	kWh
5	Reduced CO2 emission	3435.26	kg
6	Input power	0.000	kW
7	Active power	0.000	kW
8	Reactive power	39.593	kVar
9	Power factor	0.000	
10	PV1/PV2/PV3/PV4/PV5/PV6/PV7/PV8 voltage	43.4/43.4/40.5/40.5/43.1/43.1/40.1/40.1	V
11	PV9/PV10/PV11/PV12 voltage	40.3/40.3/44.6/44.6	V
12	PV1/PV2/PV3/PV4/PV5/PV6/PV7/PV8 current	0.00/0.00/0.00/0.00/0.00/0.00/0.00/0.00	A
13	PV9/PV10/PV11/PV12 current	0.00/0.00/0.00/0.00	A
14	Grid A/B/C phase voltage	237.2/238.2/240.3	V
15	Grid A/B/C phase current	55.410/55.467/55.511	A
16	Grid frequency	50.02	Hz
17	Cabinet temperature	35.9	degC
18	Locking	Unlocked	
19	Startup time	2021-03-18 05:27:37	
20	Shutdown time	2021-03-17 18:05:24	
21	Collect DSP data	Normal	
22	Active power adjustment	P = 100.0%(Active power deration percent)	
23	Reactive power adjustment	Q = 39.600kVar(Reactive power compensation at night)	

According to customer measurement active compensation increased reactive power at first night due to incorrect positive compensation sign. After changing sign value to negative next night decrease of reactive power consumption was observed.

Needles in picture represents time between end of inverters work to start compensation. In future compensation values will be set automatically by customer SCADA system in closed loop with measured parameters in connection point.



For simple cases we suggest to use Power Factor Close-loop Control (old policy) option which measures Power Factor at connection point and automatically set inverter to keep constant value.

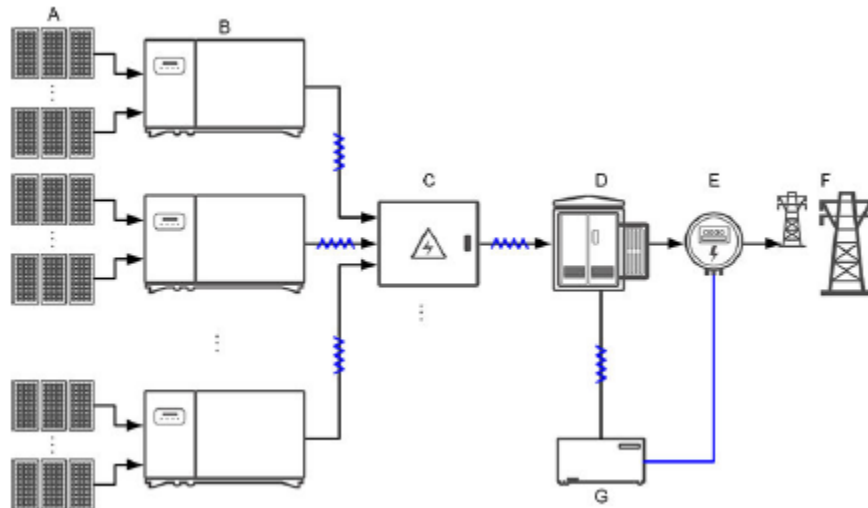


Fig. 6 Closed loop control scenario