

## Manufacture Declaration for Denmark

Micro-generator Type reference	X1-0.7-S-D(L) X1-0.7-S-N(L)	X1-1.1-S-D(L) X1-1.1-S-N(L)	X1-1.5-S-D(L) X1-1.5-S-N(L)	X1-2.0-S-D(L) X1-2.0-S-N(L)
Maximum continuous rating	700VA	1100VA	1500VA	2000VA
Manufacturer	SolaX Power Network Technology (Zhe jiang) Co. , Ltd.			
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standard	Guide for connection of power-generating plants to the low-voltage grid ( $\leq 1$ kV) Type A and B December 2019 Version 1.1			
Signed	<i>Guo Huawei</i>			
On behalf of	SolaX Power Network Technology (Zhe jiang) Co. , Ltd.			
<p>the generating unit manufacturer/supplier declaration.</p> <p>I certify on behalf of the company named above as a manufacturer/supplier of generating units, that all products manufactured/supplied by the company with the above generating unit Type reference number will be manufactured and tested to ensure that they perform as stated in this Type Verification Test Report, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of 'standard' as above.</p>				

## 1、 Voltage and frequency protection

Protection. Frequency tests				P
Function	Default setting		Trip test	
	Frequency	Disconnection time limit	Frequency	Disconnection time
U/F stage 1	47.5Hz	0.2s	47.51Hz	0.162s
O/F stage 1	51.5Hz	0.2s	51.51Hz	0.144s

Protection. Under Voltage				P
Parameter	Voltage	Disconnection time limit	Voltage	Disconnection time limit
Protection limit	0.85Un	50s	0.80Un	0.2s
Actual Setting	195.5V	50s	184.0V	0.2s
Trip test	Voltage	Disconnection time	Voltage	Disconnection time
L1	195.9V	49.8s	184.7V	0.169s

Protection.Over Voltage				P
Parameter	Voltage	Disconnection time limit	Voltage	Disconnection time limit
Protection limit	1.10Un	60s	1.15Un	0.2s
Actual Setting	253.0V	60s	264.5V	0.2s
Trip test	Voltage	Disconnection time	Voltage	Disconnection time
L1	254.3V	60.0s	265.7V	0.196s

## 2、Tolerance of frequency deviations

### a) Frequency Change

Rate of change of frequency (ROCOF) immunity					P
	Frequency		Change	Result (disconnect or not)	Requirement
	Begin	End			
a)	49.0 Hz	51.0 Hz	+ 2Hz/s	Stay connected	Stay connected
b)	51.0 Hz	49.0 Hz	- 2Hz/s	Stay connected	Stay connected

Note:  
The ROCOF immunity is defined with a sliding measurement window of 500 ms.

### b) Power response to under-frequency

Active power at under-frequency					P
Test sequence	Voltage (V)	Current (A)	Frequency (Hz)	Active Power (W)	Primary source
Test a)	230.6	8.7	50.00	2000.2	PV generator
Test b)	230.5	8.7	49.50	1994.5	PV generator
Test c)	230.5	8.6	49.00	1991.5	PV generator
Test d)	230.5	8.6	48.50	1993.7	PV generator
Test e)	230.5	8.6	48.00	1991.9	PV generator
Test f)	230.5	8.7	47.50	1998.3	PV generator

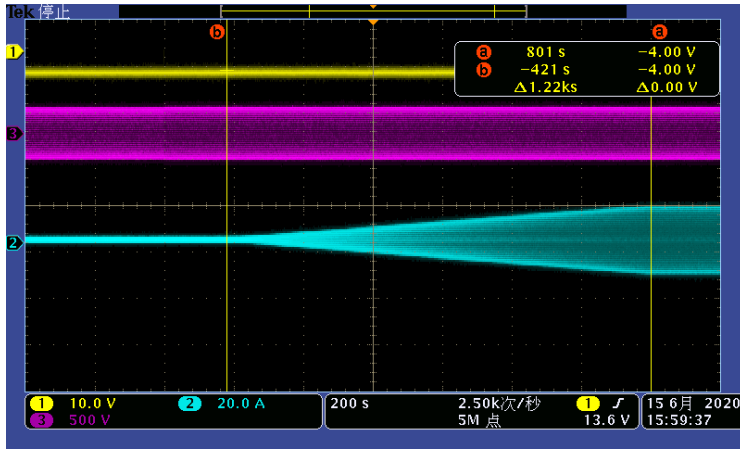
Supplementary information: During the test, under-frequency protection is disabled.

### c) Transient voltage phase jumps

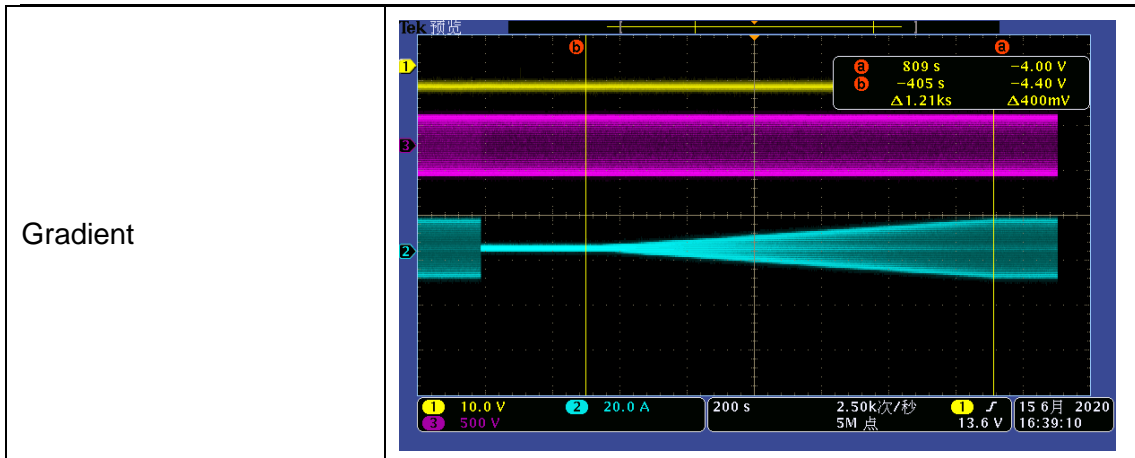
Transient voltage phase jumps			P
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+20 degrees	Stay connected
Negative Vector Shift	50.5 Hz	-20 degrees	Stay connected

### 3、 Start-up and reconnection

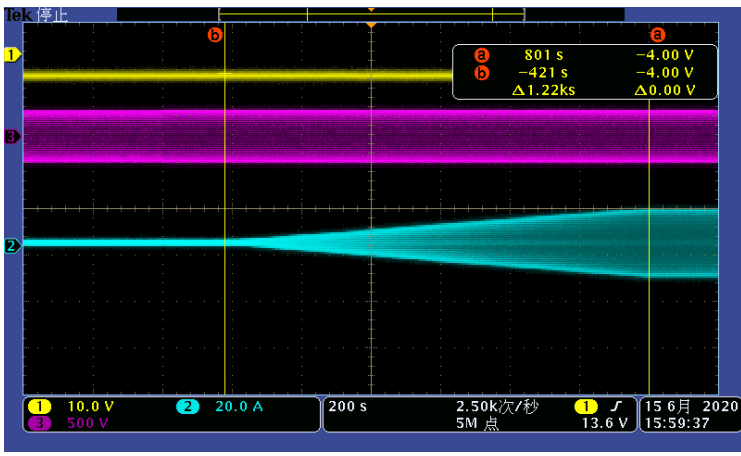
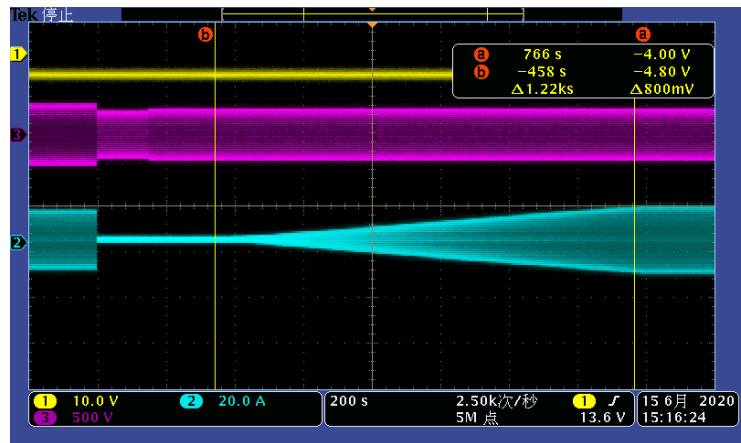
#### a) Eastern Denmark

Starting to generate electrical power Automatic reconnection after tripping		P
Setting values	Min.voltage for connected to grid	195.5V
	Max.voltage for connected to grid	253.0 V
	Min.Frequency for connected to grid	47.5Hz
	Max.Frequency for connected to grid	50.5Hz
	Observation time (180s)	180s
<b>Test:</b>		
	<b>Voltage conditions</b>	
a) start up for voltage range	< 85%U <sub>n</sub> for twice of setting observation time	> 110%U <sub>n</sub> for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) in voltage range at start up	≥ 85%U <sub>n</sub> within twice of setting observation time	□ ≤ 110%U <sub>n</sub> within twice of setting observation time
Reconnection time[s]	189s	190s
Limit:	Reconnection after setting observation time(180s)	
Gradient		
c) In voltage range after voltage failure	≥ 85%U <sub>n</sub> for twice of setting observation time	≤ 110%U <sub>n</sub> for twice of setting observation time
Reconnection time[s]	192s	190s
Limit:	Reconnection after setting observation time(≥180s)	

Gradient		
<b>Frequency conditions</b>		
d) start up for frequency range	$< 47.5\text{Hz}$ for twice of setting observation time	$> 50.5\text{Hz}$ for twice of setting observation time
Connection	No connection	No connection
Limit	No connection allowed	
e) in frequency range at start up	$\geq 47.5\text{Hz}$ within twice of setting observation time	$\leq 50.5\text{Hz}$ within twice of setting observation time
Reconnection time[s]	184s	187s
Limit:	Reconnection after setting observation time( $\geq 180\text{s}$ )	
Gradient		
f) In frequency range after frequency failure	$\geq 47.5\text{Hz}$ for twice of setting observation time	$\leq 50.5\text{Hz}$ for twice of setting observation time
Reconnection time[s]	189s	180s
Limit:	Reconnection after setting observation time( $\geq 180\text{s}$ )	


**b) Western Denmark**

Starting to generate electrical power Automatic reconnection after tripping		P
Setting values	Min.voltage for connected to grid	195.5V
	Max.voltage for connected to grid	253.0 V
	Min.Frequency for connected to grid	47.5Hz
	Max.Frequency for connected to grid	50.2Hz
	Observation time (180s)	180s
<b>Test:</b>		
	<b>Voltage conditions</b>	
a) start up for voltage range	<85%U <sub>n</sub> for twice of setting observation time	>110%U <sub>n</sub> for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) in voltage range at start up	<input type="checkbox"/> ≥85%U <sub>n</sub> within twice of setting observation time	<input type="checkbox"/> ≤110%U <sub>n</sub> within twice of setting observation time
Reconnection time[s]	189s	190s
Limit:	Reconnection after setting observation time(180s)	

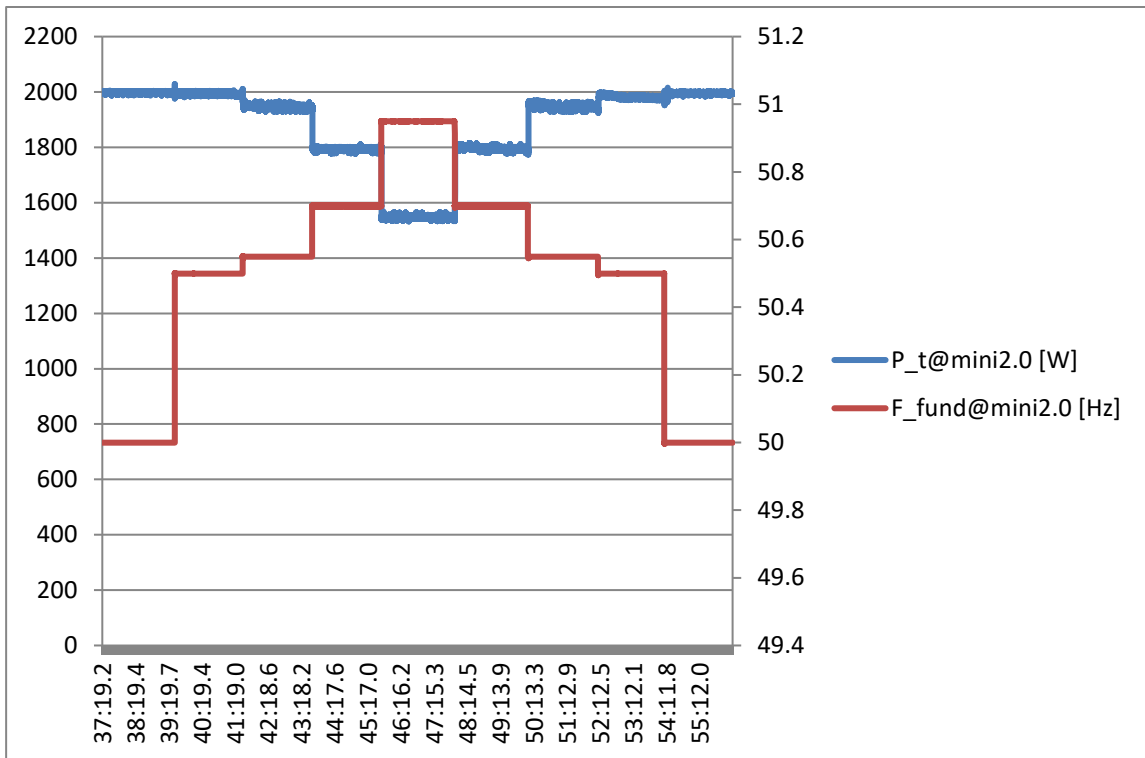
Gradient		
c) In voltage range after voltage failure	$\geq 85\%U_n$ for twice of setting observation time	$\leq 110\%U_n$ for twice of setting observation time
Reconnection time[s]	192s	190s
Limit:	Reconnection after setting observation time( $\geq 180s$ )	
Gradient		
<b>Frequency conditions</b>		
d) start up for frequency range	$< 47.5\text{Hz}$ for twice of setting observation time	$> 50.2\text{Hz}$ for twice of setting observation time
Connection	No connection	No connection
Limit	No connection allowed	
e) in frequency range at start up	$\geq 47.5\text{Hz}$ within twice of setting observation time	$\leq 50.2\text{Hz}$ within twice of setting observation time
Reconnection time[s]	188s	183s
Limit:	Reconnection after setting observation time( $\geq 180s$ )	

<p>Gradient</p>		
<p>f) In frequency range after frequency faulture</p>	<p>≥47.5Hz for twice of setting observation time</p>	<p>≤50.2Hz for twice of setting observation time</p>
<p>Reconnection time[s]</p>	<p>183s</p>	<p>184s</p>
<p>Limit:</p>	<p>Reconnection after setting observation time(≥180s)</p>	
<p>Gradient</p>		



## 4、 power response to overfrequency

### a) Eastern Denmark

Power response to overfrequency						P
Setting values	Parameter		Range		Default setting	
	Threshold frequency $f_{RO}$		50.2 Hz to 50.5 Hz		50.5 Hz	
	Droop		2 % to 12 %		4 %	
<b>Test:</b>						
2-min mean value	a) 50.00Hz	b) 50.50Hz	c) 50.55Hz	d) 50.70Hz	e) 50.95Hz	f) 50.70Hz
	g) 50.55Hz		H) 50.50Hz		i) 50.00Hz	
Graph of Measurement a) to i) : Active power output >80% $P_{Emax}$						
						

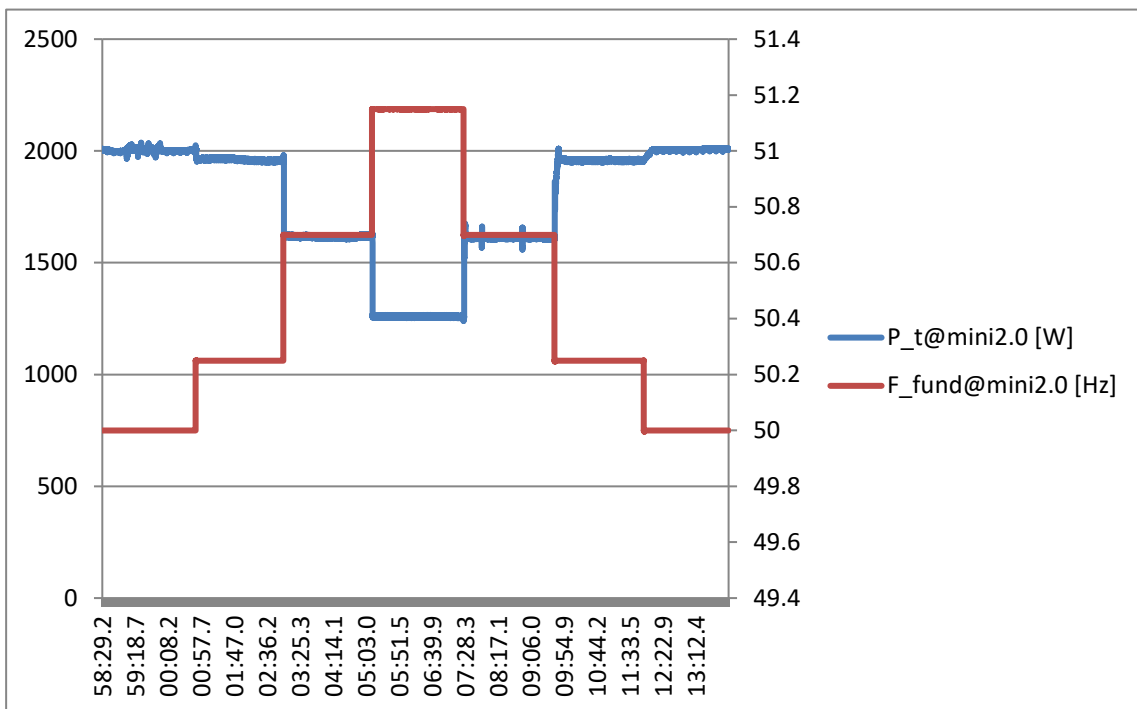
**b) Western Denmark**

Power response to overfrequency			P
Setting values	Parameter	Range	Default setting
	Threshold frequency $f_{RO}$	50.2 Hz to 50.5 Hz	50.2 Hz
	Droop	2 % to 12 %	5 %

**Test:**

2-min mean value	a) 50.00Hz	b) 50.25Hz	c) 50.70Hz	d) 51.15Hz	e) 50.70Hz	f) 50.25Hz	g) 50.00Hz
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Graph of Measurement a) to g) : Active power output >80% $P_{Emax}$



## 5、 Reactive power control

Reactive power control						P
Test 1 : Power Factor control						
Cos $\phi$ set=0.9 (inductive)						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos $\phi$ ]	$\Delta$ Cos $\phi$	LIMIT $\Delta$ cos $\phi$ _max
10%	200.5	222.2	-95.8	0.902	0.002	$\pm$ 0.01
20%	403.9	447.3	-192.1	0.903	0.003	$\pm$ 0.01
30%	608.9	674.0	-289.0	0.903	0.003	$\pm$ 0.01
40%	805.5	892.7	-384.8	0.902	0.002	$\pm$ 0.01
50%	1007.4	1116.1	-480.6	0.903	0.003	$\pm$ 0.01
60%	1210.9	1342.2	-579.0	0.902	0.002	$\pm$ 0.01
70%	1412.4	1565.7	-675.6	0.902	0.002	$\pm$ 0.01
80%	1610.1	1785.2	-771.0	0.902	0.002	$\pm$ 0.01
90%	1808.1	2005.2	-867.1	0.902	0.002	$\pm$ 0.01
100%	1885.8	2090.2	-901.6	0.902	0.002	$\pm$ 0.01
Cos $\phi$ set=0.9 (capacitive)						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos $\phi$ ]	$\Delta$ Cos $\phi$	LIMIT $\Delta$ cos $\phi$ _max
10%	201.3	221.8	93.1	0.908	0.008	$\pm$ 0.01
20%	401.1	445.5	193.7	0.900	0.000	$\pm$ 0.01
30%	603.7	671.7	294.6	0.899	-0.001	$\pm$ 0.01
40%	803.2	895.1	395.1	0.897	-0.003	$\pm$ 0.01
50%	1004.7	1120.1	495.1	0.897	-0.003	$\pm$ 0.01
60%	1201.1	1341.3	596.2	0.896	-0.004	$\pm$ 0.01
70%	1396.9	1559.5	693.5	0.896	-0.004	$\pm$ 0.01
80%	1594.2	1780.3	792.4	0.895	-0.005	$\pm$ 0.01
90%	1791.3	2001.5	893.0	0.895	-0.005	$\pm$ 0.01
100%	1889.2	2109.9	939.3	0.895	-0.005	$\pm$ 0.01
Cos $\phi$ set=1.0						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos $\phi$ ]	$\Delta$ Cos $\phi$	LIMIT $\Delta$ cos $\phi$ _max

10%	201.9	202.5	15.9	0.996	-0.004	±0.01
20%	406.2	407.7	35.5	0.996	-0.004	±0.01
30%	608.1	609.0	35.2	0.998	-0.002	±0.01
40%	809.7	810.4	35.0	0.999	-0.001	±0.01
50%	1010.1	1010.7	34.7	0.999	-0.001	±0.01
60%	1210.4	1210.9	34.9	0.999	-0.001	±0.01
70%	1410.7	1411.2	34.7	0.999	-0.001	±0.01
80%	1608.4	1608.8	34.6	0.999	-0.001	±0.01
90%	1805.4	1805.7	34.6	0.999	-0.001	±0.01
100%	1998.1	1998.4	36.0	0.999	-0.001	±0.01

**Test 2 : Automatic Power Factor control**

Lock-in: 1.05Vn (Vn and 1.1 Vn with steps of 0.01)

Lock-out: 1.00Vn (0.9 Vn and Vn with steps of 0.01)

P/Pn[%] setpoint	P[W]	P/Pn [%]	Vout/Vn	Q[Var]	Cosφ measured	Cosφ Set-point	ΔCosφ	LIMIT Δcosφ_max
10	200.9	10.0	1.02	18.0	0.996	1.00	-0.004	±0.01
20	404.1	20.2	1.02	19.1	0.999	1.00	-0.001	±0.01
30	601.7	30.1	1.02	22.0	0.999	1.00	-0.001	±0.01
50	1003.6	50.2	1.02	28.7	0.999	1.00	-0.001	±0.01
60	1204.3	60.2	1.02	31.3	0.999	1.00	-0.001	±0.01
60	1204.0	60.2	1.06	-211.7	0.985	0.98	0.005	±0.01
75	1509.4	75.4	1.06	-462.1	0.956	0.95	0.006	±0.01
100	1908.5	95.4	1.06	-846.3	0.914	0.90	0.014	±0.01
100	2002.7	100.1	0.98	34.9	0.999	1.00	-0.001	±0.01

Response time measurement: Standard characteristic curve for cos φ (P)

Power step under applied cosφ(P)-curve setted through control panel	Measured cosφ	Active Power [W]	Apparent Power [VA]	Reactive Power [Var]	Response time to new reactive power set value [s]	Settling time limit [s]
20% P <sub>max</sub> , cosφ=1.0	0.999	403.3	403.9	20.7	--	--
50% P <sub>max</sub> , cosφ=1.0	0.999	1002.2	1002.6	29.6	--	--
90% P <sub>max</sub> , cosφ=0.92	0.928	1803.6	1942.3	-720.9	2.94	10

90% P <sub>max</sub> , cosφ=0.92	0.928	1802.9	1941.6	-720.7	--	--	
50% P <sub>max</sub> , cosφ=1.0	0.999	1001.7	1002.2	28.8	1.94	10	
20% P <sub>max</sub> , cosφ=1.0	0.999	403.5	404.0	19.9	--	--	
<b>Test 3 : Q control</b>							
<b>Q=Q<sub>cmax</sub> (Q<sub>cmax</sub>=43.6% Sn)</b>							
Power-Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive Power [VAr]	Reactive Power/Sn	Reactive Power/Sn setpoint	Deviation [%]	ΔQ/Sn limit [%]
10%	186.2	909.7	890.4	44.5%	43.6%	0.9%	+/-2%
20%	390.0	973.1	891.7	44.6%	43.6%	1.0%	+/-2%
30%	593.3	1071.3	892.0	44.6%	43.6%	1.0%	+/-2%
40%	797.4	1196.3	891.7	44.6%	43.6%	1.0%	+/-2%
50%	996.0	1337.5	892.7	44.6%	43.6%	1.0%	+/-2%
60%	1191.9	1487.6	890.3	44.5%	43.6%	0.9%	+/-2%
70%	1387.7	1649.2	891.2	44.6%	43.6%	1.0%	+/-2%
80%	1590.8	1824.2	892.8	44.6%	43.6%	1.0%	+/-2%
90%	1783.9	1995.3	894.0	44.7%	43.6%	1.1%	+/-2%
100%	1942.8	2139.6	896.4	44.8%	43.6%	1.2%	+/-2%
<b>Q= Q<sub>Lmax</sub> (Q<sub>Lmax</sub> = -43.6% Sn)</b>							
Power-Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive Power [VAr]	Reactive Power/Sn	Reactive Power/Sn setpoint	Deviation [%]	ΔQ/Sn limit [%]
10%	202.5	918.9	-896.3	-44.8%	-43.6%	1.2%	+/-2%
20%	402.7	977.7	-890.0	-44.5%	-43.6%	0.9%	+/-2%
30%	610.3	1076.4	-886.7	-44.4%	-43.6%	0.8%	+/-2%
40%	812.4	1202.4	-886.4	-44.3%	-43.6%	0.7%	+/-2%
50%	1013.5	1344.0	-882.8	-44.1%	-43.6%	0.5%	+/-2%
60%	1209.0	1494.2	-878.2	-43.9%	-43.6%	0.3%	+/-2%
70%	1406.3	1655.7	-873.8	-43.7%	-43.6%	0.1%	+/-2%
80%	1609.0	1828.9	-869.6	-43.5%	-43.6%	-0.1%	+/-2%
90%	1803.8	2001.9	-868.3	-43.4%	-43.6%	-0.2%	+/-2%
100%	1896.5	2085.3	-867.1	-43.4%	-43.6%	-0.2%	+/-2%