

Manufacture Declaration for Denmark

Micro-generator Type reference	X1-Hybrid-3.0-D-C X1-Hybrid-3.0-D-E X1-Hybrid-3.0-N-C X1-Hybrid-3.0-N-E	X1-Hybrid-3.7-D-C X1-Hybrid-3.7-D-E X1-Hybrid-3.7-N-C X1-Hybrid-3.7-N-E X1-Fit-3.7C, X1-Fit-3.7E	X1-Hybrid-4.6-D-C X1-Hybrid-4.6-D-E X1-Hybrid-4.6-N-C X1-Hybrid-4.6-N-E X1-Fit-4.6C, X1-Fit-4.6E	X1-Hybrid-5.0-D-C X1-Hybrid-5.0-D-E X1-Hybrid-5.0-N-C X1-Hybrid-5.0-N-E X1-Fit-5.0C, X1-Fit-5.0E
Maximum continuous rating	3000VA	3680VA	3680VA	3680VA
Manufacturer	SolaX Power Network Technology (Zhe jiang) Co. , Ltd.			
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Web site	www.solaxpower.com			
standard	Technical regulation 3.3.1 for electrical energy storage facilities			
Signed	<i>Guo Huawei</i>			
On behalf of	SolaX Power Network Technology (Zhejiang) Co. , Ltd.			

the generating unit manufacturer/supplier declaration.

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.

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	47.50Hz	0.181s
O/F stage 1	51.5Hz	0.2s	51.52Hz	0.113s

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	195.5V	49.62s	184.0V	0.176s

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	253.1V	59.82s	264.6V	0.150s

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

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)	230.9	15.9	49.99	3680.0	PV generator
Test b)	230.8	15.9	49.50	3675.1	PV generator
Test c)	231.0	15.9	49.00	3678.7	PV generator
Test d)	230.8	15.9	48.50	3674.5	PV generator
Test e)	230.8	15.9	48.00	3674.4	PV generator
Test f)	230.8	15.9	47.50	3674.3	PV generator

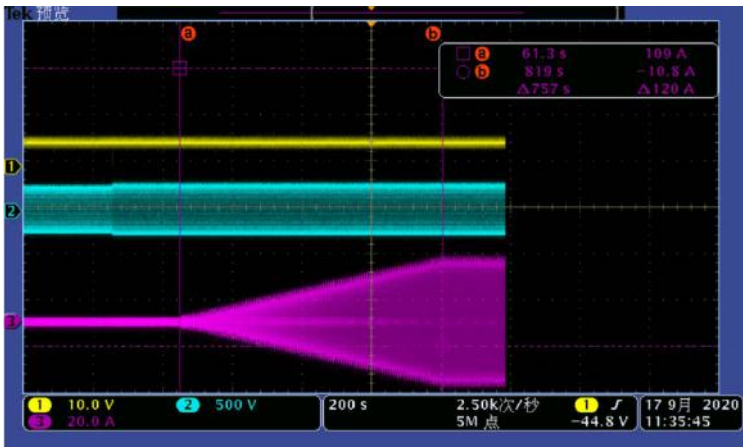
Supplementary information: During the test, under-frequency protection is disabled.

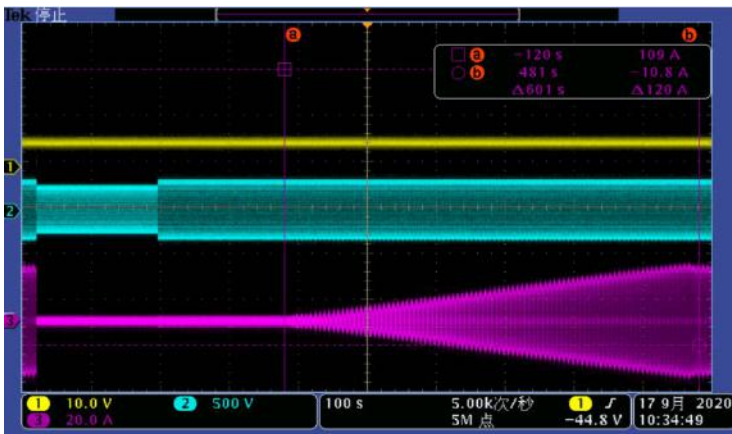
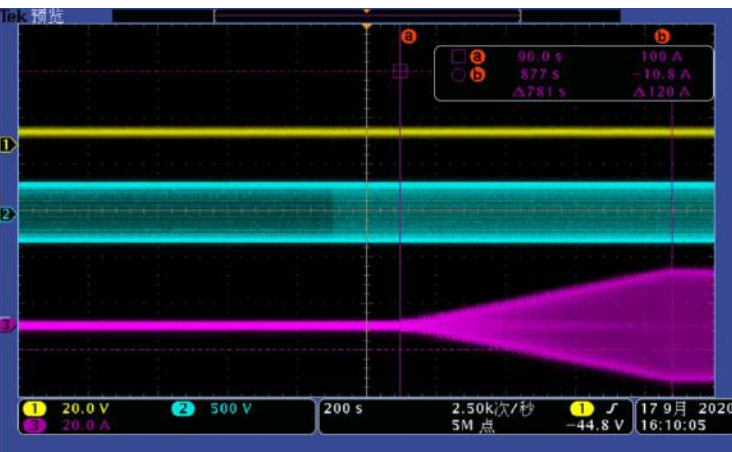
c) Transient voltage phase jumps

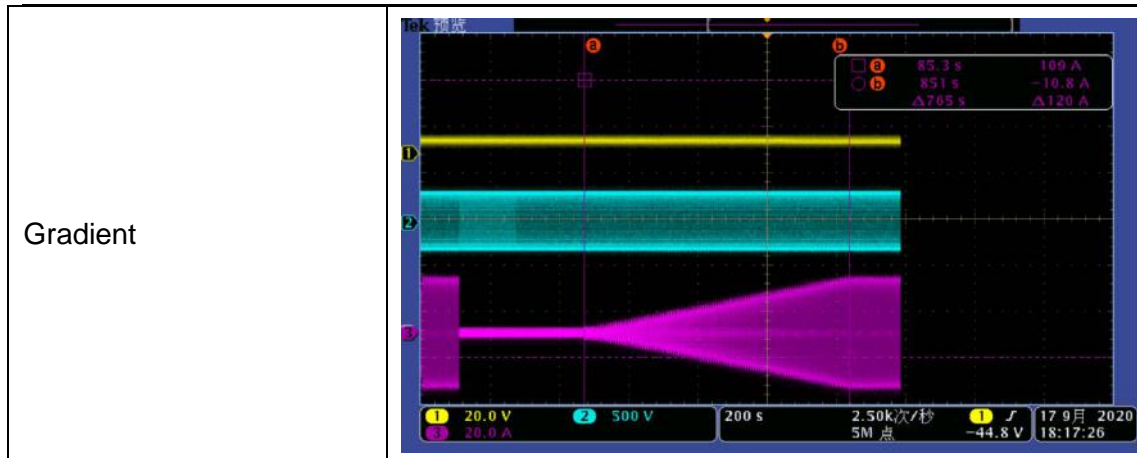
Transient voltage phase jumps			P
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+20 degrees	No trip
Negative Vector Shift	50.5 Hz	-20 degrees	No trip

3、 Start-up and reconnection

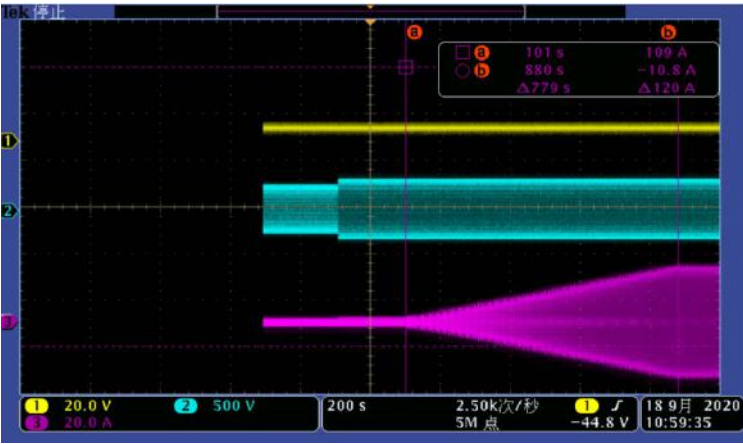
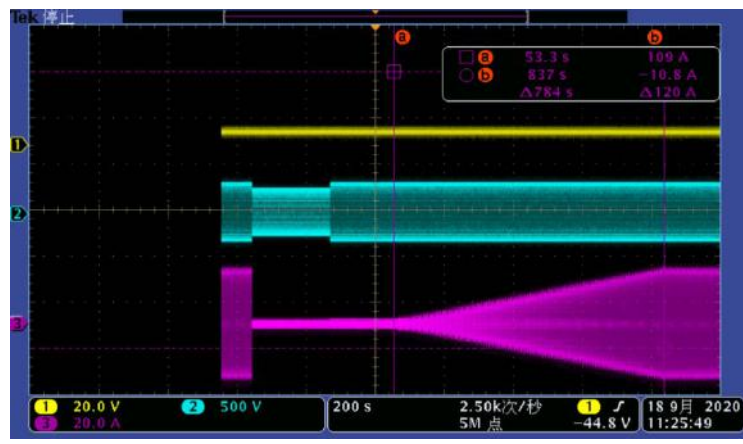
a) Eastern Denmark

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	49.9Hz
	Max.Frequency for connected to grid	50.1Hz
	Observation time (180s)	180s
Test:		
	Voltage conditions	
a) start up for voltage range	< 85%U _n for twice of setting observation time	> 110%U _n for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) in voltage range at start up	□ ≥ 85%U _n within twice of setting observation time	□ ≤ 110%U _n within twice of setting observation time
Reconnection time[s]	187s	189s
Limit:	Reconnection after setting observation time(180s)	
Gradient		
c) In voltage range after voltage failure	≥ 85%U _n for twice of setting observation time	≤ 110%U _n for twice of setting observation time
Reconnection time[s]	200s	184s
Limit:	Reconnection after setting observation time(≥180s)	

Gradient		
Frequency conditions		
d) start up for frequency range	$< 49.9\text{Hz}$ for twice of setting observation time	$> 50.1\text{Hz}$ for twice of setting observation time
Connection	No connection	No connection
Limit	No connection allowed	
e) in frequency range at start up	$\geq 49.9\text{Hz}$ within twice of setting observation time	$\leq 50.1\text{Hz}$ within twice of setting observation time
Reconnection time[s]	192s	195s
Limit:	Reconnection after setting observation time($\geq 180\text{s}$)	
Gradient		
f) In frequency range after frequency failure	$\square 49.9\text{Hz}$ for twice of setting observation time	$\square 50.1\text{Hz}$ for twice of setting observation time
Reconnection time[s]	192s	195s
Limit:	Reconnection after setting observation time($\geq 180\text{s}$)	


b) Western Denmark

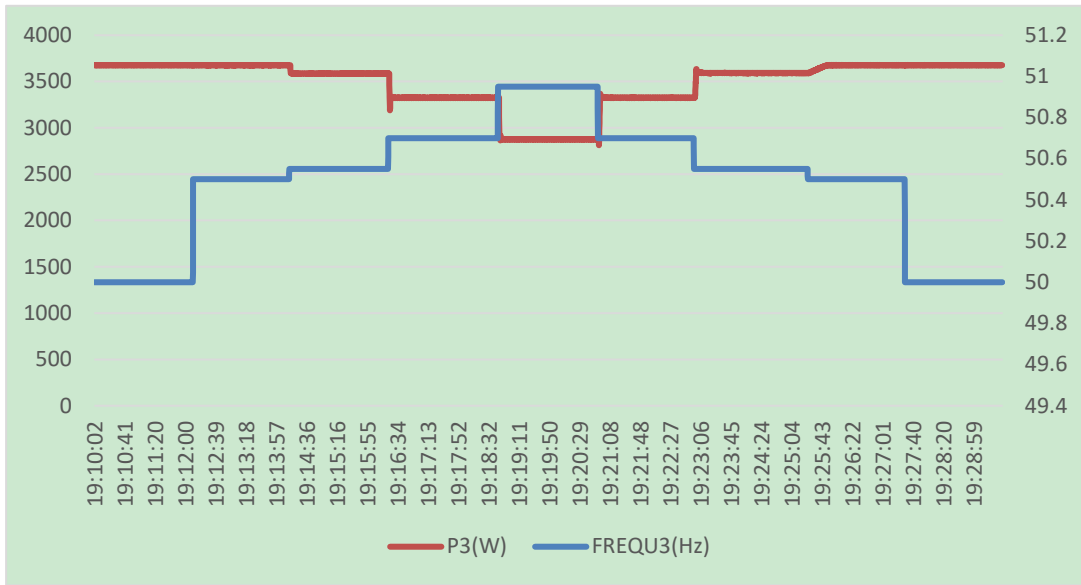
Starting to generate electrical power Automatic reconnection after tripping		P
Setting values	Min.voltage for connected to grid	195.5V
	Max.voltage for connected to grid	253.0 V
	Min.Frequency for connected to grid	49.8Hz
	Max.Frequency for connected to grid	50.2Hz
	Observation time (180s)	180s
Test:		
	Voltage conditions	
a) start up for voltage range	< 85%U _N for twice of setting observation time	> 110%U _N for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) in voltage range at start up	□ ≥ 85%U _N within twice of setting observation time	□ ≤ 110%U _N within twice of setting observation time
Reconnection time[s]	187s	189s
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]	184s	187s
Limit:	Reconnection after setting observation time($\geq 180s$)	
Gradient		
Frequency conditions		
d) start up for frequency range	$< 49.8\text{Hz}$ 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	$\geq 49.8\text{Hz}$ within twice of setting observation time	$\leq 50.2\text{Hz}$ within twice of setting observation time
Reconnection time[s]	184s	187s
Limit:	Reconnection after setting observation time($\geq 180s$)	

<p>Gradient</p>		
<p>f) In frequency range after frequency faulture</p>	<p>≥49.8Hz for twice of setting observation time</p>	<p>≤50.2Hz for twice of setting observation time</p>
<p>Reconnection time[s]</p>	<p>184s</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 %		
Test:						
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}						
						

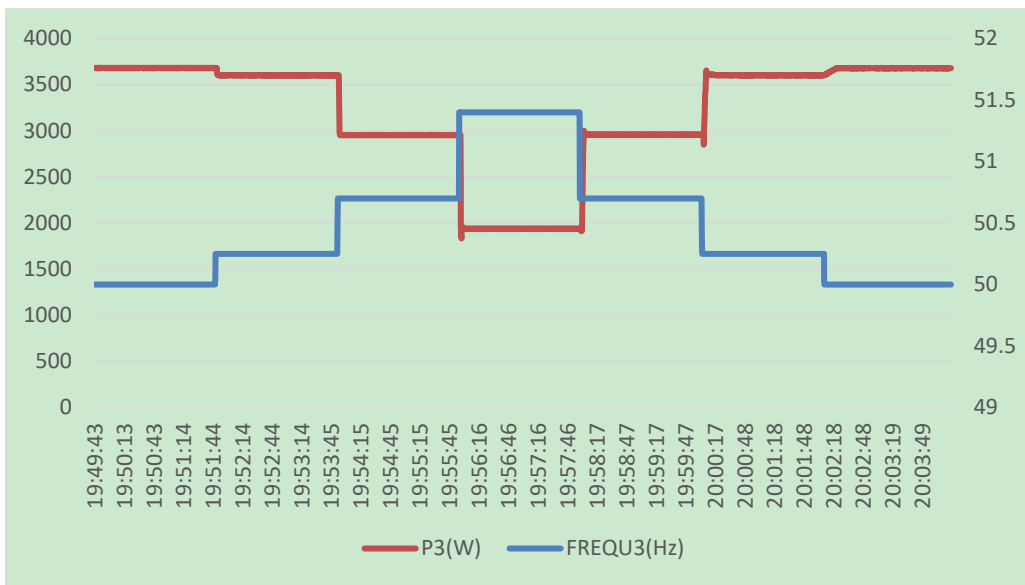
b) Western Denmark

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) 51.40Hz	e) 50.70Hz	f) 50.25Hz	g) 50.00Hz

Graph of Measurement a) to g) : Active power output > 80% $P_{E_{max}}$



5、 Reactive power control

Reactive power control						P
Test 1: Power Factor control						
Cos ϕ set=0.9 (inductive)						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos ϕ]	Δ Cos ϕ	LIMIT Δ cos ϕ _max
10%	337.4	374.5	-163.0	0.9006	0.0006	\pm 0.01
20%	731.2	815.0	-360.0	0.8972	-0.0028	\pm 0.01
30%	1107.4	1228.6	-532.5	0.9012	0.0012	\pm 0.01
40%	1476.6	1648.4	-732.7	0.8958	-0.0042	\pm 0.01
50%	1845.6	2054.1	-901.6	0.8985	-0.0015	\pm 0.01
60%	2211.9	2457.5	-1071.2	0.9000	0.0000	\pm 0.01
70%	2575.9	2860.4	-1243.7	0.9005	0.0005	\pm 0.01
80%	2943.1	3266.5	-1417.1	0.9010	0.0010	\pm 0.01
90%	3308.7	3670.7	-1589.2	0.9014	0.0014	\pm 0.01
100%	3315.8	3677.7	-1591.0	0.9016	0.0016	\pm 0.01
Cos ϕ set=0.9 (capacitive)						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos ϕ]	Δ Cos ϕ	LIMIT Δ cos ϕ _max
10%	369.2	410.9	180.4	0.8985	-0.0015	\pm 0.01
20%	740.3	823.4	360.3	0.8992	-0.0008	\pm 0.01
30%	1106.5	1239.8	559.3	0.8924	-0.0076	\pm 0.01
40%	1471.4	1639.0	722.0	0.8978	-0.0022	\pm 0.01
50%	1845.7	2049.2	890.3	0.9007	0.0007	\pm 0.01
60%	2215.5	2454.6	1056.7	0.9026	0.0026	\pm 0.01
70%	2575.7	2849.6	1219.0	0.9039	0.0039	\pm 0.01
80%	2943.1	3251.9	1383.4	0.9050	0.0050	\pm 0.01
90%	3296.6	3634.5	1530.1	0.9070	0.0070	\pm 0.01
100%	3306.9	3644.7	1532.1	0.9074	0.0074	\pm 0.01
Cos ϕ set=1.0						
Power - Bin (P/Sn)	Active power [W]	Apparent power [VA]	Reactive power [Var]	Power factor [cos ϕ]	Δ Cos ϕ	LIMIT Δ cos ϕ _max

10%	366.4	367.5	-28.0	0.9971	-0.0029	±0.01
20%	735.9	736.3	-25.0	0.9994	-0.0006	±0.01
30%	1101.7	1102.0	-25.0	0.9997	-0.0003	±0.01
40%	1474.2	1484.8	-176.8	0.9929	-0.0071	±0.01
50%	1844.6	1853.2	-178.0	0.9954	-0.0046	±0.01
60%	2208.1	2215.4	-179.2	0.9967	-0.0033	±0.01
70%	2572.4	2578.7	-179.5	0.9976	-0.0024	±0.01
80%	2958.5	2965.7	-207.0	0.9976	-0.0024	±0.01
90%	3316.8	3322.9	-200.3	0.9982	-0.0018	±0.01
100%	3679.9	3685.5	-200.5	0.9985	-0.0015	±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	416.5	11.3%	1.02	-27.0	0.9979	1.00	-0.0021	±0.01
20	783.0	21.3%	1.02	-24.0	0.9995	1.00	-0.0005	±0.01
30	1149.6	31.2%	1.02	-23.3	0.9998	1.00	-0.0002	±0.01
50	1878.7	51.1%	1.02	-26.0	0.9999	1.00	-0.0001	±0.01
60	2242.4	60.9%	1.02	-30.0	0.9999	1.00	-0.0001	±0.01
60	2244.3	61.0%	1.06	-454.0	0.9801	0.98	0.0001	±0.01
75	2787.6	75.8%	1.06	-898.7	0.9518	0.95	0.0018	±0.01
90	3328.4	90.4%	1.06	-1388.8	0.9229	0.92	0.0029	±0.01
100	3675.9	99.9%	0.98	-62.8	0.9999	1.00	-0.0001	±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 _{max} , cosφ=1.0	0.9997	779.5	779.6	-20.1	--	--
50% P _{max} , cosφ=1.0	0.9999	1875.2	1875.4	-26.3	--	--
90% P _{max} , cosφ=0.92	0.9229	3328.7	3606.7	-1388.7	3.4	10

90% P _{max} , cosφ=0.92	0.9229	3328.6	3606.6	-1388.6	--	--
50% P _{max} , cosφ=1.0	0.9999	1864.7	1865.0	-25.6	2.2	10
20% P _{max} , cosφ=1.0	0.9997	776.6	777.1	-20.1	--	--

Test 3: Q control

$$Q=Q_{cmax} \quad (Q_{cmax}=43.6\% \text{ Sn})$$

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%	403.5	1658.0	1608.2	43.7%	43.6%	0.1%	+/-2%
20%	768.7	1784.0	1610.0	43.7%	43.6%	0.1%	+/-2%
30%	1133.8	1968.5	1609.0	43.7%	43.6%	0.1%	+/-2%
40%	1499.7	2198.7	1607.8	43.7%	43.6%	0.1%	+/-2%
50%	1866.1	2461.7	1605.2	43.6%	43.6%	0.0%	+/-2%
60%	2228.6	2743.7	1600.5	43.5%	43.6%	-0.1%	+/-2%
70%	2589.7	3041.1	1594.1	43.3%	43.6%	-0.3%	+/-2%
80%	2950.8	3350.7	1587.4	43.1%	43.6%	-0.5%	+/-2%
90%	3275.6	3636.7	1580.0	42.9%	43.6%	-0.7%	+/-2%
100%	3275.4	3636.5	1580.0	42.9%	43.6%	-0.7%	+/-2%

$$Q=Q_{Lmax} \quad (Q_{Lmax} = -43.6\% \text{ Sn})$$

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%	433.8	1652.9	-1595.0	-43.3%	-43.6%	-0.3%	+/-2%
20%	795.5	1782.9	-1596.0	-43.4%	-43.6%	-0.2%	+/-2%
30%	1159.6	1974.0	-1598.0	-43.4%	-43.6%	-0.2%	+/-2%
40%	1525.8	2211.7	-1601.0	-43.5%	-43.6%	-0.1%	+/-2%
50%	1892.5	2480.8	-1604.2	-43.6%	-43.6%	0.0%	+/-2%
60%	2249.9	2763.6	-1604.3	-43.6%	-43.6%	0.0%	+/-2%
70%	2612.3	3067.8	-1608.9	-43.7%	-43.6%	0.1%	+/-2%
80%	2972.7	3382.2	-1613.3	-43.8%	-43.6%	0.2%	+/-2%
90%	3303.0	3677.8	-1617.9	-44.0%	-43.6%	0.4%	+/-2%
100%	3303.3	3678.1	-1618.0	-44.0%	-43.6%	0.4%	+/-2%

6、 Control functions

Control functions				P
Test 1: Absolute power constraint				
P _{nl} is the designation for rated power supplied by an energy storage facility.				
P _{no} denotes the nominal power absorbed by an energy storage facility.				
Set-point P/ P _{nl} [%]	Set-point P [W]	Measured P [W]	Accuracy [%]	Required accuracy of Set-point P [%]
10%	368	363.8	-1.14%	±5%
20%	736	742.9	0.94%	±5%
30%	1104	1124.9	1.89%	±5%
40%	1472	1506.2	2.32%	±5%
50%	1840	1881.0	2.23%	±5%
60%	2208	2259.0	2.31%	±5%
70%	2576	2634.1	2.26%	±5%
80%	2944	3006.9	2.14%	±5%
90%	3312	3377.6	1.98%	±5%
100%	3680	3692.3	0.33%	±5%
Note:				
Accuracy of the control performed and of the set point must not deviate by more than ±5% of the set point value or ±0.5% of rated power, depending which yields the highest tolerance.				
Set-point P/ P _{no} [%]	Set-point P [W]	Measured P [W]	Accuracy [%]	Required accuracy of Set-point P [%]
10%	-368	-374.3	1.71%	±5%
20%	-736	-730.3	-0.77%	±5%
30%	-1104	-1087.7	-1.48%	±5%
40%	-1472	-1445.6	-1.79%	±5%
50%	-1840	-1803.3	-1.99%	±5%
60%	-2208	-2163.5	-2.02%	±5%
70%	-2576	-2522.6	-2.07%	±5%
80%	-2944	-2886.5	-1.95%	±5%
90%	-3312	-3248.7	-1.91%	±5%
100%	-3680	-3609.9	-1.90%	±5%

Test 2: Ramp rate constraint function					
Test sequence	Measured stable active power of start point P[W]	Measured stable active power of end point P[W]	Time elapsed [s] (from start to time for output power last entered 5% tolerance band around the set-point)	Power gradient [%P _n /min]	Ramp rate limit[%P _n /min]
100% P _{nl} to 5% P _{nl}	3691.4	177.1	504	11.4	≥1% and ≤20%
5% P _{nl} to 100% P _{nl}	181.6	3692.3	572	10.0	≥1% and ≤20%
100% P _{no} to 5% P _{no}	-3609.1	-185.4	456	12.2	≥1% and ≤20%
5% P _{no} to 100% P _{no}	-189.1	-3611.7	520	10.7	≥1% and ≤20%