


Form C: Type Test Verification Report

Type Approval and **Manufacturer** declaration of compliance with the requirements of G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA).

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA **Type Test Verification Report** Register, the **Installation Document** should include the **Manufacturer's** Reference Number (the Product ID), and this form does not need to be submitted.

Where the **Micro-generator** is not registered with the ENA **Type Test Verification Report** Register this form needs to be completed and provided to the **DNO**, to confirm that the **Micro-generator** has been tested to satisfy the requirements of this EREC G98.

Manufacturer's reference number		MOD10000TL3-X	
Micro-generator technology		MOD 3000TL3-X, MOD 4000TL3-X, MOD 5000TL3-X , MOD 6000TL3-X, MOD 7000TL3-X , MOD 8000TL3-X , MOD 9000TL3-X , MOD 10KTL3-X.	
Manufacturer name		Shenzhen Growatt New Energy Co., Ltd.	
Address		4-13th Floor, Building A, Sino-German Europe Industrial Demonstration Park, No. 1, Hangcheng Avenue, Bao'an District, Shenzhen, Guangdong, China.	
Tel	+86 755 2951 5888	Fax	+86 755 2747 2131
E-mail	Peng.zhu@growatt.com	Web site	www.ginverter.com
Registered Capacity , use separate sheet if more than one connection option.	Connection Option		
	N/A	kW single phase, single, split or three phase system	
	3-10	kW three phase	
	N/A	kW two phases in three phase system	
	N/A	kW two phases split phase system	
Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above Type Tested reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.			
Signed		On behalf of	Shenzhen Growatt New Energy Co., Ltd.
Note that testing can be done by the Manufacturer of an individual component or by an external test house.			

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.Operating Range: This test should be carried out as specified in EN 50438 D.3.1.

Active Power shall be recorded every second. The tests will verify that the **Micro-generator** can operate within the required ranges for the specified period of time.

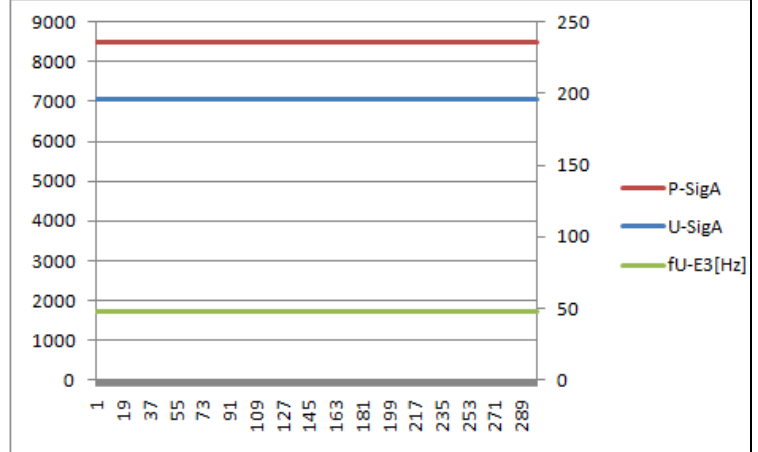
The **Interface Protection** shall be disabled during the tests.

In case of a PV **Micro-generator** the PV primary source may be replaced by a **DC** source.

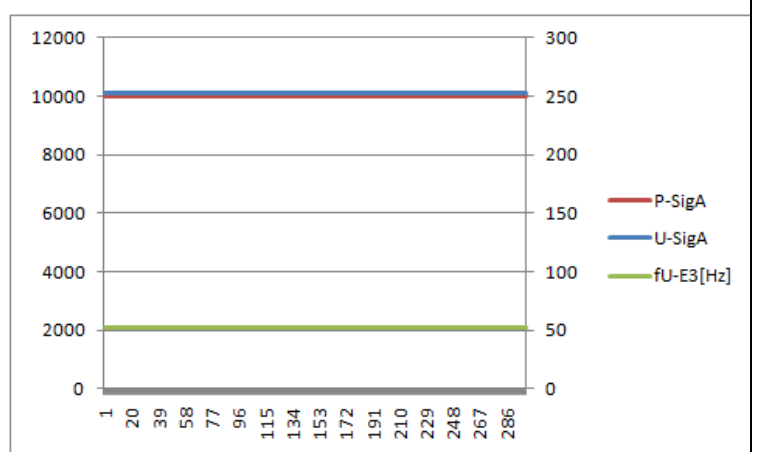
In case of a full converter **Micro-generator** (eg wind) the primary source and the prime mover **Inverter/rectifier** may be replaced by a **DC** source.

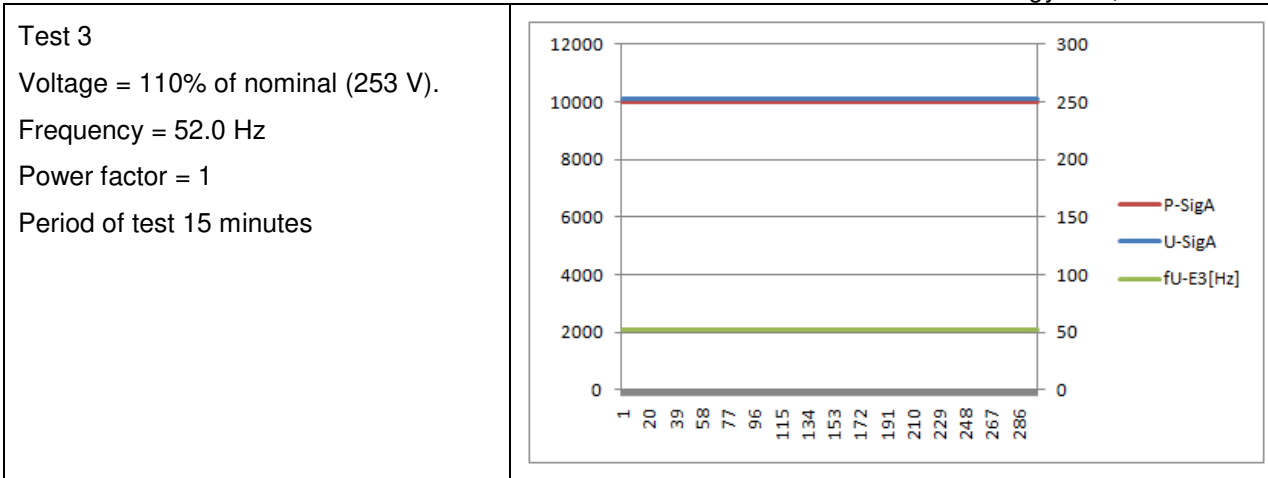
In case of a DFIG **Micro-generator** the mechanical drive system may be replaced by a test bench motor.

Test 1
 Voltage = 85% of nominal (195.5 V)
 Frequency = 47.5 Hz
 Power factor = 1
 Period of test 90 minutes



Test 2
 Voltage = 110% of nominal (253 V).
 Frequency = 51.5 Hz
 Power factor = 1
 Period of test 90 minutes





2.Power Quality – Harmonics: These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of Registered Capacity. The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).

Micro-generator tested to BS EN 61000-3-2

Micro-generator rating per phase (rpp)	3.33	kW	NV=MV*3.68/rpp
Harmonic	At 45-55% of Registered Capacity	100% of Registered Capacity	

Average harmonic current results – Phase 1						
	Measured Value MV in Amps	Normalised Value (NV) in Amps	Measured Value MV in Amps	Normalised Value (NV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.020	0.022	0.024	0.027	1.080	
3	0.040	0.045	0.046	0.051	2.300	
4	0.031	0.035	0.051	0.056	0.430	
5	0.190	0.210	0.248	0.274	1.140	
6	0.018	0.020	0.024	0.027	0.300	
7	0.114	0.126	0.140	0.155	0.770	
8	0.014	0.015	0.021	0.023	0.230	
9	0.021	0.023	0.022	0.024	0.400	



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10	0.010	0.011	0.014	0.015	0.184	
11	0.039	0.043	0.054	0.060	0.330	
12	0.006	0.007	0.006	0.007	0.153	
13	0.035	0.038	0.045	0.050	0.210	
14	0.005	0.006	0.007	0.008	0.131	
15	0.010	0.011	0.010	0.011	0.150	
16	0.004	0.004	0.005	0.006	0.115	
17	0.021	0.023	0.033	0.036	0.132	
18	0.009	0.010	0.014	0.015	0.102	
19	0.015	0.017	0.025	0.028	0.118	
20	0.007	0.007	0.012	0.013	0.092	
21	0.004	0.004	0.004	0.004	0.107	0.160
22	0.003	0.003	0.004	0.004	0.084	
23	0.008	0.009	0.016	0.018	0.098	0.147
24	0.002	0.002	0.002	0.002	0.077	
25	0.006	0.006	0.012	0.013	0.090	0.135
26	0.002	0.002	0.002	0.002	0.071	
27	0.003	0.003	0.003	0.003	0.083	0.124
28	0.002	0.002	0.002	0.002	0.066	
29	0.005	0.005	0.008	0.009	0.078	0.117
30	0.001	0.001	0.002	0.002	0.061	
31	0.004	0.004	0.006	0.007	0.073	0.109
32	0.002	0.002	0.002	0.002	0.058	
33	0.001	0.001	0.002	0.002	0.068	0.102
34	0.001	0.001	0.001	0.001	0.054	
35	0.003	0.003	0.004	0.004	0.064	0.096

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36	0.001	0.002	0.002	0.002	0.051	
37	0.003	0.004	0.004	0.004	0.061	0.091
38	0.001	0.001	0.001	0.001	0.048	
39	0.002	0.002	0.001	0.001	0.058	0.087
40	0.001	0.001	0.001	0.001	0.046	

Average harmonic current results – Phase 2						
	Measured Value MV in Amps	Normalised Value (NV) in Amps	Measured Value MV in Amps	Normalised Value (NV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.178	0.197	0.212	0.234	1.080	
3	0.065	0.072	0.073	0.081	2.300	
4	0.040	0.045	0.063	0.070	0.430	
5	0.174	0.193	0.236	0.261	1.140	
6	0.028	0.030	0.033	0.036	0.300	
7	0.123	0.136	0.158	0.175	0.770	
8	0.016	0.018	0.020	0.022	0.230	
9	0.035	0.039	0.031	0.034	0.400	
10	0.017	0.019	0.021	0.023	0.184	
11	0.042	0.047	0.058	0.064	0.330	
12	0.012	0.014	0.014	0.015	0.153	
13	0.034	0.038	0.044	0.049	0.210	
14	0.014	0.015	0.018	0.020	0.131	
15	0.016	0.018	0.017	0.019	0.150	
16	0.006	0.007	0.006	0.007	0.115	
17	0.019	0.021	0.033	0.036	0.132	

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18	0.007	0.007	0.012	0.013	0.102	
19	0.015	0.017	0.026	0.029	0.118	
20	0.008	0.008	0.012	0.013	0.092	
21	0.004	0.005	0.004	0.004	0.107	0.160
22	0.004	0.004	0.004	0.004	0.084	
23	0.008	0.008	0.016	0.018	0.098	0.147
24	0.004	0.004	0.004	0.004	0.077	
25	0.006	0.006	0.012	0.013	0.090	0.135
26	0.004	0.005	0.007	0.008	0.071	
27	0.004	0.004	0.005	0.006	0.083	0.124
28	0.003	0.004	0.003	0.003	0.066	
29	0.004	0.005	0.008	0.009	0.078	0.117
30	0.003	0.003	0.003	0.003	0.061	
31	0.004	0.004	0.006	0.007	0.073	0.109
32	0.002	0.003	0.003	0.003	0.058	
33	0.002	0.002	0.002	0.002	0.068	0.102
34	0.002	0.003	0.002	0.002	0.054	
35	0.003	0.003	0.004	0.004	0.064	0.096
36	0.002	0.003	0.003	0.003	0.051	
37	0.003	0.003	0.004	0.004	0.061	0.091
38	0.002	0.002	0.001	0.001	0.048	
39	0.002	0.002	0.002	0.002	0.058	0.087
40	0.002	0.003	0.003	0.003	0.046	

Average harmonic current results – Phase 3						
	Measured Value MV in	Normalised Value	Measured Value MV in	Normalised Value	Limit in BS EN 61000-	Higher limit for odd harmonics 21 and above

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	Amps	(NV) in Amps	Amps	(NV) in Amps	3-2 in Amps	
2	0.179	0.198	0.216	0.239	1.080	
3	0.033	0.036	0.035	0.039	2.300	
4	0.030	0.033	0.053	0.059	0.430	
5	0.203	0.224	0.264	0.292	1.140	
6	0.021	0.024	0.018	0.020	0.300	
7	0.104	0.115	0.138	0.153	0.770	
8	0.015	0.017	0.021	0.023	0.230	
9	0.018	0.020	0.019	0.021	0.400	
10	0.013	0.015	0.013	0.014	0.184	
11	0.049	0.055	0.064	0.071	0.330	
12	0.014	0.016	0.015	0.017	0.153	
13	0.031	0.035	0.043	0.048	0.210	
14	0.013	0.014	0.016	0.018	0.131	
15	0.007	0.008	0.008	0.009	0.150	
16	0.006	0.007	0.005	0.006	0.115	
17	0.022	0.024	0.035	0.039	0.132	
18	0.011	0.012	0.013	0.014	0.102	
19	0.014	0.015	0.024	0.027	0.118	
20	0.008	0.009	0.013	0.014	0.092	
21	0.003	0.003	0.003	0.003	0.107	0.160
22	0.005	0.005	0.004	0.004	0.084	
23	0.008	0.009	0.016	0.018	0.098	0.147
24	0.004	0.005	0.004	0.004	0.077	
25	0.005	0.006	0.010	0.011	0.090	0.135
26	0.005	0.005	0.008	0.009	0.071	

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27	0.002	0.002	0.002	0.002	0.083	0.124
28	0.004	0.004	0.004	0.004	0.066	
29	0.005	0.005	0.008	0.009	0.078	0.117
30	0.003	0.003	0.002	0.002	0.061	
31	0.003	0.004	0.005	0.006	0.073	0.109
32	0.003	0.003	0.004	0.004	0.058	
33	0.001	0.001	0.001	0.001	0.068	0.102
34	0.002	0.003	0.003	0.003	0.054	
35	0.003	0.004	0.004	0.004	0.064	0.096
36	0.002	0.002	0.001	0.001	0.051	
37	0.003	0.003	0.003	0.003	0.061	0.091
38	0.002	0.002	0.002	0.002	0.048	
39	0.001	0.001	0.001	0.001	0.058	0.087
40	0.002	0.003	0.003	0.003	0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

3.Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (**Inverter** connected) or Annex A2 A.2.3.3 (Synchronous).

	Starting			Stopping			Running	
	d max	d c	d(t)	d max	d c	d(t)	P _{st}	P _{lt} 2 hours
Measured Values at	0.20	0.10	0	0.20	0.10	0	0.31	0.40

test impedance								
Normalised to standard impedance	0.20	0.10	0	0.20	0.10	0	0.31	0.40
Normalised to required maximum impedance	--	--	--	--	--	--	--	--
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65
Test Impedance	R	0.24	Ω	X	0.15	Ω		
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω		
Maximum Impedance	R	-	Ω	X	-	Ω		
<p>Applies to three phase and split single phase Micro-generators.</p> <p>^ Applies to single phase Micro-generators and Micro-generators using two phases on a three phase system.</p> <p>For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation output is 0.98 or above.</p> <p>Normalised value = Measured value*reference source resistance/measured source resistance at test point.</p> <p>Single phase units reference source resistance is 0.4 Ω</p> <p>Two phase units in a three phase system reference source resistance is 0.4 Ω.</p> <p>Two phase units in a split phase system reference source resistance is 0.24 Ω.</p> <p>Three phase units reference source resistance is 0.24 Ω.</p> <p>Where the power factor of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the Standard Impedance.</p> <p>The stopping test should be a trip from full load operation.</p> <p>The duration of these tests need to conform to the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below.</p>								
Test start date	November 5, 2021			Test end date	November 5, 2021			
Test location	Growatt certified testing laboratory							

4. Power quality – DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10				
Test power level (10K)	20%	50%	75%	100%
Recorded value in Amps	18.6mA/17.5mA/ 19.6mA	17.5mA/16.6mA/ 16.6mA	15.4mA/14.6mA/ 14.2mA	12.1mA/13.6mA/ 12.6mA
as % of rated AC current	0.12%/0.11%/0.14%	0.11%/0.10%/0.11%	0.11%/0.10%/0.10%	0.08%/0.08%/0.08%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (9K)	20%	50%	75%	100%
Recorded value in Amps	16.6mA/15.5mA/ 17.1mA	16.4mA/15.7mA/ 17.4mA	16.1mA/16.5mA/ 17.3mA	16.2mA/15.9mA/ 17.0mA
as % of rated AC current	0.11%/0.10%/0.11%	0.11%/0.10%/0.11%	0.11%/0.10%/0.12%	0.11%/0.10%/0.11%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (8K)	20%	50%	75%	100%
Recorded value in Amps	18.2mA/17.5mA/ 18.1mA	18.1mA/16.8mA/ 17.1mA	17.6mA/16.5mA/ 17.2mA	16.6mA/16.1mA/ 17.1mA
as % of rated AC current	0.14%/0.13%/0.14%	0.14%/0.13%/0.13%	0.14%/0.12%/0.13%	0.13%/0.12%/0.14%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (7K)	20%	50%	75%	100%
Recorded value in Amps	18.0mA/17.2mA/ 17.8mA	18.3mA/17.6mA/ 18.5mA	18.5mA/17.9mA/ 18.5mA	18.7mA/17.8mA/ 18.3mA

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as % of rated AC current	0.14%/0.13%/0.14%	0.14%/0.13%/0.13%	0.14%/0.12%/0.13%	0.13%/0.12%/0.14%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (6K)	20%	50%	75%	100%
Recorded value in Amps	16.1mA/15.2mA/16.3mA	16.6mA/15.2mA/16.4mA	16.7mA/16.0mA/17.1mA	17.2mA/15.9mA/17.0mA
as % of rated AC current	0.16%/0.15%/0.16%	0.16%/0.15%/0.16%	0.16%/0.16%/0.17%	0.17%/0.16%/0.17%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (5K)	20%	50%	75%	100%
Recorded value in Amps	15.1mA/15.3mA/15.6mA	14.8mA/14.5mA/15.1mA	15.1mA/14.3mA/15.3mA	14.2mA/14.9mA/15.1mA
as % of rated AC current	0.18%/0.18%/0.18%	0.18%/0.17%/0.18%	0.18%/0.17%/0.18%	0.17%/0.18%/0.18%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (4K)	20%	50%	75%	100%
Recorded value in Amps	13.1mA/13.3mA/13.6mA	13.0mA/12.4mA/13.2mA	12.9mA/13.0mA/12.6mA	13.3mA/12.6mA/12.3mA
as % of rated AC current	0.19%/0.19%/0.19%	0.19%/0.18%/0.19%	0.19%/0.19%/0.19%	0.19%/0.19%/0.18%
Limit	0.25%	0.25%	0.25%	0.25%
Test power level (3K)	20%	50%	75%	100%

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Recorded value in Amps	10.1mA/9.3mA/9.6mA	10.3mA/9.8mA/9.2mA	10.1mA/10.6mA/9.8mA	10.0mA/9.4mA/9.6mA
as % of rated AC current	0.20%/0.19%/0.19%	0.20%/0.20%/0.19%	0.20%/0.20%/0.20%	0.20%/0.19%/0.19%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: This test shall be carried out in accordance with EN 50548 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.

	216.2 V	230 V	253 V
20% of Registered Capacity	0.9918	0.9912	0.9897
50% of Registered Capacity	0.9956	0.9961	0.9965
75% of Registered Capacity	0.9955	0.9960	0.9965
100% of Registered Capacity	0.9952	0.9958	0.9962
Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A.1.2.3 (**Inverter** connected) or Annex A2 A.2.2.3 (Synchronous)

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.51Hz	20.05s	47.7 Hz 25 s	No Trip
U/F stage 2	47 Hz	0.5 s	47.01Hz	0.548s	47.2 Hz 19.98 s	No Trip
					46.8 Hz 0.48 s	No Trip
O/F stage	52 Hz	0.5 s	52.00Hz	0.64s	51.8 Hz	No Trip

1					89.98 s	
					52.2 Hz 0.48 s	No Trip

Note. For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the protection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

7. Protection – Voltage tests: These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98 Annex A1 A.1.2.2 (**Inverter** connected) or Annex A2 A.2.2.2 (Synchronous)

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	184.5V	2.596 s	188 V 3.50 s	No Trip
					180 V 2.48 s	No Trip
O/V stage 1	262.2 V	1.0 s	262.38V	1.062s	258.2 V 2.0 s	No Trip
O/V stage 2	273.7 V	0.5 s	273.9V	0.574s	269.7 V 0.98 s	No Trip
					277.7 V 0.48 s	No Trip

Note for Voltage tests the Voltage required to trip is the setting ± 3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ± 4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

8. Protection – Loss of Mains test: For PV Inverters shall be tested in accordance with BS EN 62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Limit is 0.5 s	0.301s	0.372s	0.324s	0.269s	0.326 s	0.389 s

For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.

Test Power	10%	55%	100%	10%	55%	100%
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Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph1 fuse removed	0.291 s	0.324 s	0.356 s	0.302 s	0.317 s	0.358 s
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph2 fuse removed	0.301 s	0.378 s	0.354 s	0.321 s	0.358 s	0.347 s
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph3 fuse removed	0.345 s	0.374 s	0.358 s	0.367 s	0.315 s	0.306 s
<p>Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.</p>						
Indicate additional shut down time included in above results.					0.3ms	
<p>For Inverters tested to BS EN 62116 the following sub set of tests should be recorded in the following table.</p>						
Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5 s	0.294	0.367	0.342	0.298	0.347	0.389
<p>9.Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).</p>						
	Start Frequency	Change	Confirm no trip			
Positive Vector Shift	49.0 Hz	+50 degrees	No Trip			
Negative Vector Shift	50.0 Hz	- 50 degrees	No Trip			

10. Protection – Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).				
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip	
49.0 Hz to 51.0 Hz	+0.95 Hzs ⁻¹	2.1 s	No Trip	
51.0 Hz to 49.0 Hz	-0.95 Hzs ⁻¹	2.1 s	No Trip	
11. Limited Frequency Sensitive Mode – Overfrequency test: This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and Droop of 10%.				
Test sequence at Registered Capacity >80%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	9777.38W	50Hz	10035W	-
Step b) 50.45 Hz ±0.05 Hz	9679.71W	50.452Hz		-
Step c) 50.70 Hz ±0.10 Hz	9205.03W	50.699Hz		-
Step d) 51.15 Hz ±0.05 Hz	8338.59W	51.154Hz		-
Step e) 50.70 Hz ±0.10 Hz	9212.98W	50.699Hz		-
Step f) 50.45 Hz ±0.05 Hz	9675.33W	50.452Hz		-
Step g) 50.00 Hz ±0.01 Hz	9775.69W	50Hz		
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	4887.82W	50Hz	4979.67W	-
Step b) 50.45 Hz ±0.05 Hz	4840.54W	50.453Hz		-
Step c) 50.70 Hz ±0.10 Hz	4593.42W	50.702Hz		-
Step d) 51.15 Hz ±0.05 Hz	4145.35W	51.151Hz		-
Step e) 50.70 Hz ±0.10 Hz	4584.01W	50.701Hz		-
Step f) 50.45 Hz ±0.05 Hz	4838.99W	50.451Hz		-
Step g) 50.00 Hz ±0.01 Hz	4886.20W	50Hz		
Steps as defined in EN 50438				
12. Power output with falling frequency test: This test should be carried out in accordance with EN				

50438 Annex D.3.2 active power feed-in at under-frequency.						
Test sequence	Measured Active Power Output	Frequency	Primary power source			
Test a) 50 Hz ± 0.01 Hz	9881.74 W	49.998 Hz	10187.36 W			
Test b) Point between 49.5 Hz and 49.6 Hz	9876.61W	49.499 Hz	10182.72 W			
Test c) Point between 47.5 Hz and 47.6 Hz	9860.9W	47.498 Hz	10165.88 W			
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes						
13.Re-connection timer.						
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2.						
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.				
20s	36.5	At 266.2 V	At 196.1 V	At 47.4 Hz	At 52.1 Hz	
Confirmation that the Micro-generator does not re-connect.		Yes	Yes	Yes	Yes	
14.Fault level contribution: These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (Inverter connected) and Annex A2 A.2.3.4 (Synchronous).						
For machines with electro-magnetic output			For Inverter output			
Parameter	Symbol	Value	Time after fault	Volts	Amps	
Peak Short Circuit current	i_p	--	20 ms	98.4V	26.8A	
Initial Value of aperiodic current	A	--	100 ms	42.1V	15.7	
Initial symmetrical short-circuit current*	I_k	--	250 ms	61.4V	16.7	
Decaying (aperiodic) component of short circuit current*	i_{DC}	--	500 ms	46.5V	10.8	
Reactance/Resistance Ratio of source*	X/R	--	Time to trip	0.14	In seconds	
For rotating machines and linear piston machines the test should produce a 0 s – 2 s plot of the short circuit current as seen at the Micro-generator terminals.						

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot	
15.Logic Interface.	Yes
16.Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (Inverter connected).	Yes/or NA
It has been verified that in the event of the solid state switching device failing to disconnect the Micro-generator , the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s.	
Additional comments	