Form C: Type Test Verification Report

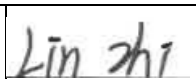
All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

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

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

Manufacturer's reference number		DC2301-01-MHS-3~3.6K-G98	
Micro-generator technology		HYBRID INVERTER	
Inverter Mode		MHS-3K-30, MHS-3.6K-30	
Manufacturer name		Wuxi Solinteg Power Co., Ltd.	
Address		Building H1-1001, No. 6 Jingxian Road, Xinwu District, 214135 Wuxi, Jiangsu Province, China	
Tel	+86 4001858909	Fax	
E-mail	info@solinteg.com	Web site	www.solinteg.com
Registered Capacity		Connection Option	
		3.0	kW single phase
		3.6	kW single phase
Energy storage capacity for **Electricity Storage** devices		5.12---20.48	kWh

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully 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.

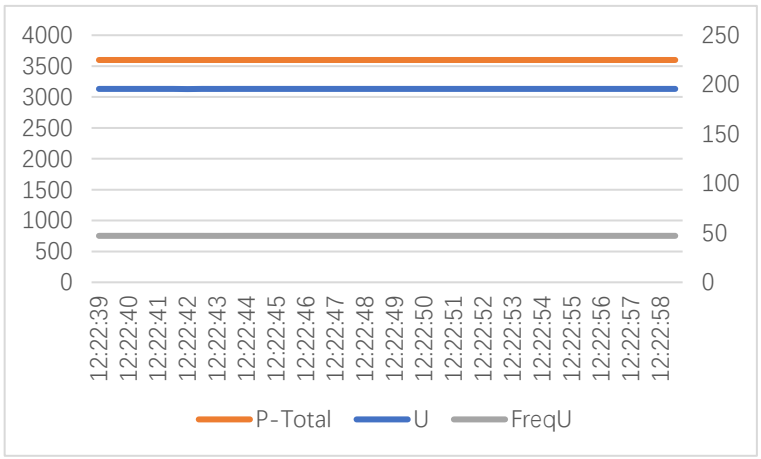
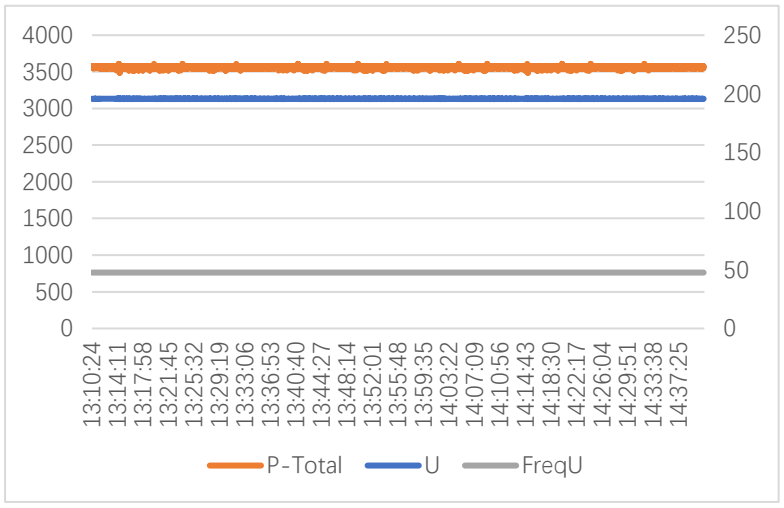
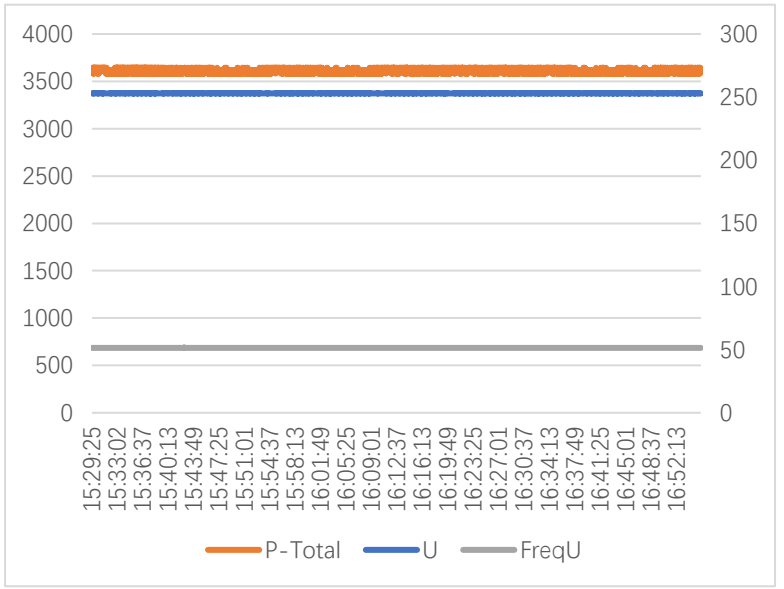
Signed		On behalf of	Wuxi Solinteg Power Co., Ltd.

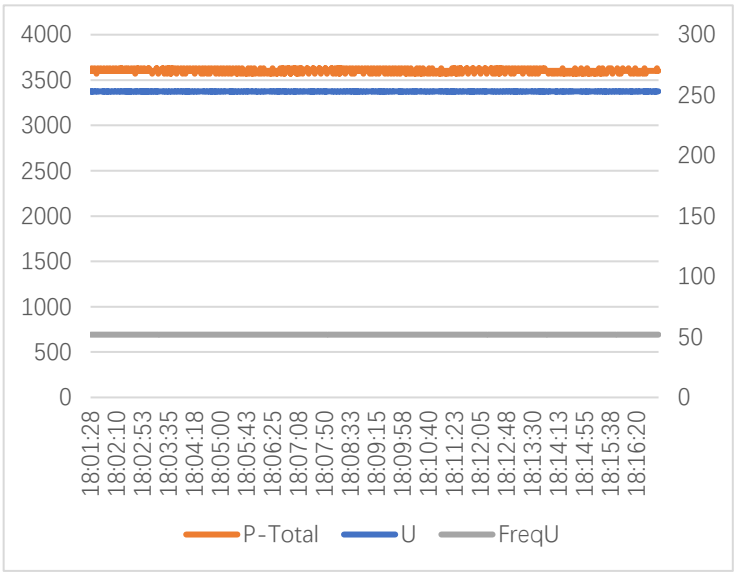
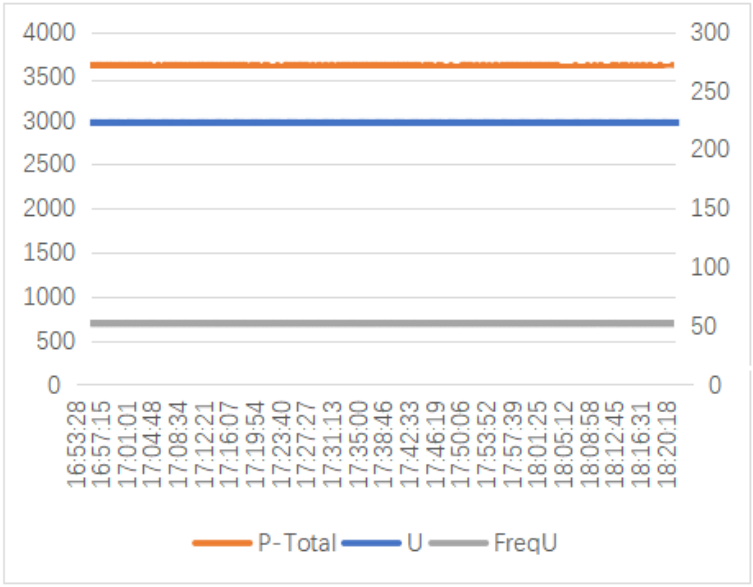
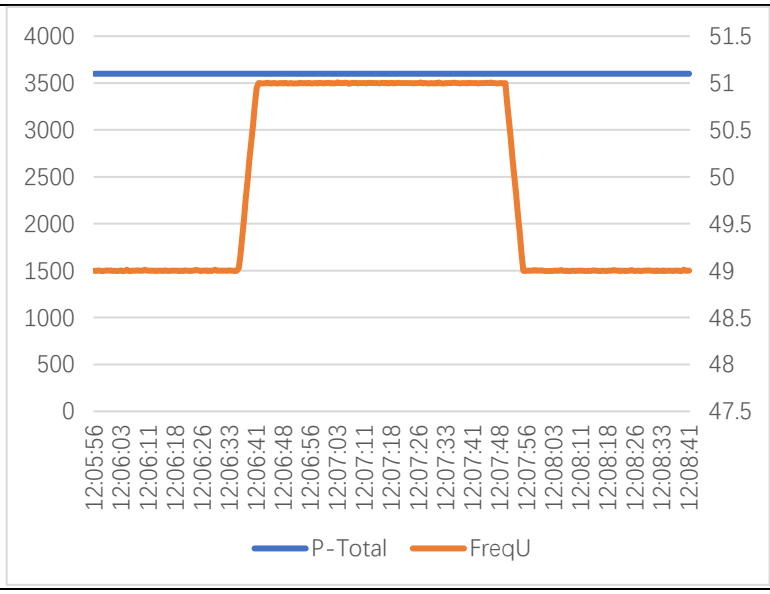
Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

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 A.1.2.10.

Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred.

Test 1 Voltage = 85% of nominal (195.5 V) Frequency = 47.0 Hz Power factor = 1 Period of test 20 seconds	
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	

Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	
Test 6 Confirm that the **Micro-Generating Plant** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms.	

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	kW	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).		Single phase	

Harmonic	Measured Value (MV) in Amps							
Harmonic	At 45-55% of **Registered Capacity**			At 100% of **Registered Capacity**				
	L1	L2	L3	L1	L2	L3	Limit in BS EN 61000-3-2	Higher limit for odd harmonics 21 and above
2	0.039	-	-	0.079	-	-	1.080	-
3	0.158	-	-	0.173	-	-	2.300	-
4	0.004	-	-	0.007	-	-	0.430	-
5	0.049	-	-	0.074	-	-	1.140	-
6	0.002	-	-	0.004	-	-	0.300	-
7	0.036	-	-	0.069	-	-	0.770	-
8	0.020	-	-	0.004	-	-	0.230	-
9	0.031	-	-	0.061	-	-	0.400	-
10	0.003	-	-	0.005	-	-	0.184	-
11	0.030	-	-	0.053	-	-	0.330	-
12	0.005	-	-	0.007	-	-	0.153	-
13	0.028	-	-	0.046	-	-	0.210	-
14	0.004	-	-	0.005	-	-	0.131	-
15	0.025	-	-	0.042	-	-	0.150	-
16	0.007	-	-	0.007	-	-	0.115	-
17	0.015	-	-	0.033	-	-	0.132	-
18	0.006	-	-	0.007	-	-	0.102	-
19	0.008	-	-	0.025	-	-	0.118	-

20	0.004	-	-	0.006	-	-	0.092	-
21	0.006	-	-	0.020	-	-	0.107	0.160
22	0.005	-	-	0.006	-	-	0.084	-
23	0.005	-	-	0.015	-	-	0.098	0.147
24	0.004	-	-	0.004	-	-	0.077	-
25	0.004	-	-	0.011	-	-	0.090	0.135
26	0.003	-	-	0.004	-	-	0.071	-
27	0.004	-	-	0.009	-	-	0.083	0.124
28	0.004	-	-	0.004	-	-	0.066	-
29	0.004	-	-	0.009	-	-	0.078	0.117
30	0.003	-	-	0.004	-	-	0.061	-
31	0.003	-	-	0.006	-	-	0.073	0.109
32	0.003	-	-	0.004	-	-	0.058	-
33	0.003	-	-	0.005	-	-	0.068	0.102
34	0.003	-	-	0.004	-	-	0.054	-
35	0.004	-	-	0.006	-	-	0.064	0.096
36	0.003	-	-	0.004	-	-	0.051	-
37	0.004	-	-	0.005	-	-	0.061	0.091
38	0.003	-	-	0.004	-	-	0.048	-
39	0.005	-	-	0.006	-	-	0.058	0.087
40	0.003	-	-	0.004	-	-	0.046	-

Micro-generator rating per phase (rpp)	3.6	kW	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).		Single phase	

Harmonic	Measured Value (MV) in Amps							
Harmonic	At 45-55% of **Registered Capacity**			At 100% of **Registered Capacity**				
	L1	L2	L3	L1	L2	L3	Limit in BS EN 61000-3-12	Higher limit for odd harmonics 21 and above
2	0.044	-	-	0.082	-	-	1.080	-
3	0.157	-	-	0.192	-	-	2.300	-

4	0.005	-	-	0.007	-	-	0.430	-
5	0.053	-	-	0.103	-	-	1.140	-
6	0.003	-	-	0.005	-	-	0.300	-
7	0.042	-	-	0.086	-	-	0.770	-
8	0.004	-	-	0.005	-	-	0.230	-
9	0.036	-	-	0.079	-	-	0.400	-
10	0.003	-	-	0.004	-	-	0.184	-
11	0.028	-	-	0.067	-	-	0.330	-
12	0.006	-	-	0.008	-	-	0.153	-
13	0.024	-	-	0.059	-	-	0.210	-
14	0.004	-	-	0.007	-	-	0.131	-
15	0.025	-	-	0.050	-	-	0.150	-
16	0.006	-	-	0.011	-	-	0.115	-
17	0.21	-	-	0.037	-	-	0.132	-
18	0.006	-	-	0.009	-	-	0.102	-
19	0.021	-	-	0.029	-	-	0.118	-
20	0.006	-	-	0.006	-	-	0.092	-
21	0.017	-	-	0.025	-	-	0.107	0.160
22	0.007	-	-	0.008	-	-	0.084	-
23	0.011	-	-	0.018	-	-	0.098	0.147
24	0.005	-	-	0.004	-	-	0.077	-
25	0.005	-	-	0.013	-	-	0.090	0.135
26	0.004	-	-	0.004	-	-	0.071	-
27	0.005	-	-	0.012	-	-	0.083	0.124
28	0.004	-	-	0.004	-	-	0.066	-
29	0.004	-	-	0.009	-	-	0.078	0.117
30	0.004	-	-	0.003	-	-	0.061	-
31	0.004	-	-	0.007	-	-	0.073	0.109
32	0.004	-	-	0.003	-	-	0.058	-
33	0.004	-	-	0.006	-	-	0.068	0.102
34	0.003	-	-	0.004	-	-	0.054	-

35	0.005	-	-	0.006	-	-	0.064	0.096
36	0.003	-	-	0.004	-	-	0.051	-
37	0.005	-	-	0.005	-	-	0.061	0.091
38	0.003	-	-	0.004	-	-	0.048	-
39	0.005	-	-	0.006	-	-	0.058	0.087
40	0.003	-	-	0.004	-	-	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).

The standard test impedance is 0.4 Ω for a single phase **Micro-generating Plant** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Micro-generating Plant** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

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.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date	2022/12/27			Test end date			2022/12/27	
Test location	Building H1-1001, No. 6 Jingxian Road, Xinwu District, 214135 Wuxi, Jiangsu Province, China							
	Starting			Stopping			Running	
	d(max)	d(c)	d(t)	d(max)	d(c)	d(t)	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	0.30	0.25	0	0.52	0.48	0	0.10	0.08
Normalised to standard impedance	0.30	0.25	0	0.52	0.48	0	0.10	0.08

Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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

*Applies to three phase and split single phase **Micro-generators**. Delete as appropriate.

^ Applies to single phase **Micro-generators** and **Micro-generators** using two phases on a three phase system. Delete as appropriate.

4.Power quality – DC injection: This test should be carried out in accordance with A 1.3.4 as applicable. The % **DC** injection ("as % of rated AC current" below) is calculated as follows:

% **DC** injection = Recorded **DC** value in Amps / base current

where the base current is the **Registered Capacity** (W) / 230 V. The % **DC** injection should not be greater than 0.25%.

3KW				
Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.030	0.024	0.019	0.027
as % of rated AC current	0.231%	0.185%	0.146%	0.208%
Limit	0.25%	0.25%	0.25%	0.25%
3.6KW				
Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.026	0.028	0.027	0.030
as % of rated AC current	0.166%	0.178%	0.172%	0.191%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: This test shall be carried out in accordance with A.1.3.2 and A.2.3.2 at three voltage levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test.

3 KW			
	216.2 V	230 V	253 V
20% of **Registered Capacity**	0.971	0.974	0.980
50% of **Registered Capacity**	0.997	0.998	0.998
75% of **Registered Capacity**	0.999	0.999	0.998
100% of **Registered Capacity**	0.999	0.999	0.999
Power Factor Limit	>0.95	>0.95	>0.95
3.6KW			
	216.2 V	230 V	253 V
20% of **Registered Capacity**	0.973	0.976	0.981
50% of **Registered Capacity**	0.997	0.998	0.998
75% of **Registered Capacity**	0.999	0.999	0.999
100% of **Registered Capacity**	0.999	0.999	0.999
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: These tests should be carried out in accordance with Annex A1 A.1.2.3 (**Inverter** connected) or Annex A2 A.2.2.3 (Synchronous). For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.

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	47.49 Hz	20.30s	47.7 Hz 30 s	No trip
U/F stage 2	47 Hz	0.5 s	47.00 Hz	0.516s	47.2 Hz 19.5 s	No trip
					46.8 Hz 0.45 s	No trip
O/F stage 1	52 Hz	0.5 s	52.01Hz	0.525s	51.8 Hz 120.0 s	No trip
					52.2 Hz 0.45 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 projection 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 Annex A1 A.1.2.2 (**Inverter** connected) or Annex A2 A.2.2.2 (Synchronous). For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

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	183.4V	2.52s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	262 V	1.0 s	262V	1.02s	258.2 V 5.0 s	No trip
O/V stage 2	273.7 V	0.5 s	273.9V	0.52s	269.7 V 0.95 s	No trip
					277.7 V 0.45 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 **Inverter**s shall be tested in accordance with BS EN 62116. Other **Micro-generator**s should be tested in accordance with A.2.2.4 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	0.125s	0.134s	0.197s	0.131s	0.145s	0.164s
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%
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	-	-	-	-	-	-
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	-	-	-	-	-	-
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	-	-	-	-	-	-
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.						
Indicate additional shut down time included in above results.				--		
Additional comments:						

For **Inverter**s tested to BS EN 62116 the following sub set of tests should be recorded in the following table.						
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	0.127s	0.131s	0.193s	0.135s	0.142s	0.168s

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). Confirmation is required that the **Micro-generating Plant** does not trip under positive / negative vector shift.

	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). Confirmation is required that the **Micro-generating Plant** does not trip for the duration of the ramp up and ramp down test.

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 A.1.2.8. The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. The measurement tolerances are contained in A.1.2.8.

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output(W)	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	3618	50.00	PV simulator (100%Pn)	-
Step b) 50.45 Hz ±0.05 Hz	3568	50.45		-
Step c) 50.70 Hz ±0.10 Hz	3390	50.70		-
Step d) 51.15 Hz ±0.05 Hz	3056	51.15		-

Step e) 50.70 Hz ±0.10 Hz	3389	50.70		-
Step f) 50.45 Hz ±0.05 Hz	3566	50.45		-
Step g) 50.00 Hz ±0.01 Hz	3619	50.00		-
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output(W)	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	1806	50.00	PV simulator (50%Pn)	-
Step b) 50.45 Hz ±0.05 Hz	1765	50.45		-
Step c) 50.70 Hz ±0.10 Hz	1588	50.70		-
Step d) 51.15 Hz ±0.05 Hz	1269	51.15		-
Step e) 50.70 Hz ±0.10 Hz	1585	50.70		-
Step f) 50.45 Hz ±0.05 Hz	1768	50.45		-
Step g) 50.00 Hz ±0.01 Hz	1809	50.00		-

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.			
Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	3604W	50.00Hz	3726W
Test b) Point between 49.5 Hz and 49.6 Hz	3603W	49.55Hz	3723W
Test c) Point between 47.5 Hz and 47.6 Hz	3602W	47.55Hz	3722W
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. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Micro-generating Plant** does not reconnect at the voltage and frequency settings below; a statement of “no reconnection” can be made.					
Time delay setting(s)	Measured delay(s)	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.			
60s	65s	At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz

Confirmation that the **Micro-generator** does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

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). Please complete each entry, even if the fault contribution is zero.					
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	49.9V	17.9A
Initial Value of aperiodic current	A		100 ms	49.7V	17.4A
Initial symmetrical short-circuit current*	I_k		250 ms	48.4V	0A
Decaying (aperiodic) component of short circuit current*	i_{DC}		500 ms	48.3V	0A
Reactance/Resistance Ratio of source*	X/R		Time to trip	0.11s	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 (input port)	
Confirm that an input port is provided and can be used to shut down the module.	Yes
16.Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	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	
By default the DNO logic interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the Power Generating Module can operate normally. When the switch is opened the Power Generating Module will fast stop within 1s.	