



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 **FullyType 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		Q1907054-01	
Micro-generator technology		Solis-mini-3600-4G	
Manufacturer name		Ningbo Ginlong Technologies Co., Ltd.	
Address		No. 57 Jintong Road, Seafront (Binhai) Industrial Park, Xiangshan, Ningbo, Zhejiang, 315712, P.R.China	
Tel	(+86) 574 6580 3377	Fax	(+86) 574 6578 1606
E-mail	kun.zhang@ginlong.com	Web site	www.ginlong.com
Registered Capacity , use separate sheet if more than one connection option.	Connection Option		
	3.6	kW single phase, single, split or three phase system	
		kW three phase	
		kW two phases in three phase system	
		kW two phases split phase system	
ManufacturerType 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	<i>Zhang Kun</i> 09.July.2019	On behalf of Manufacturer stamp	宁波锦浪新能源科技有限公司 NINGBO GINLONG TECHNOLOGIES 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.			
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	Tested with the specified conditions, in the 90 minutes period of time, the inverters operate normally
Test 2 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Tested with the specified conditions, in the 90 minutes period of time, the inverters operate normally
Test 3 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Tested with the specified conditions, in the 15 minutes period of time, the inverters operate normally

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 A1A.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)			3.6	kW	NV=MV*3.68/rpp	
Harmoni c	At 45-55% of Registered Capacity		100% of Registered Capacity			
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.019	0.119	0.046	0.288	1.08	
3	0.076	0.475	0.265	1.656	2.3	

Engineering Recommendation G98 Form C



4	0.011	0.069	0.026	0.163	0.43	
5	0.059	0.369	0.136	0.85	1.14	
6	0.019	0.119	0.018	0.113	0.3	
7	0.045	0.281	0.095	0.594	0.77	
8	0.012	0.075	0.019	0.119	0.23	
9	0.038	0.238	0.062	0.388	0.4	
10	0.011	0.069	0.018	0.113	0.184	
11	0.03	0.188	0.06	0.375	0.33	
12	0.009	0.056	0.021	0.131	0.153	
13	0.024	0.15	0.042	0.263	0.21	
14	0.007	0.044	0.022	0.138	0.131	
15	0.027	0.169	0.027	0.169	0.15	
16	0.013	0.081	0.012	0.075	0.115	
17	0.007	0.044	0.029	0.181	0.132	
18	0.016	0.1	0.013	0.081	0.102	
19	0.024	0.15	0.029	0.181	0.118	
20	0.007	0.044	0.021	0.131	0.092	
21	0.011	0.069	0.017	0.106	0.107	0.160
22	0.008	0.05	0.022	0.138	0.084	
23	0.006	0.038	0.022	0.138	0.098	0.147
24	0.016	0.1	0.019	0.119	0.077	
25	0.017	0.106	0.01	0.063	0.09	0.135
26	0.002	0.013	0.027	0.169	0.071	
27	0.009	0.056	0.024	0.15	0.083	0.124



28	0.011	0.069	0.021	0.131	0.066	
29	0.011	0.069	0.013	0.081	0.078	0.117
30	0.009	0.056	0.019	0.119	0.061	
31	0.009	0.056	0.032	0.2	0.073	0.109
32	0.023	0.144	0.043	0.269	0.058	
33	0.02	0.125	0.011	0.069	0.068	0.102
34	0.003	0.019	0.035	0.219	0.054	
35	0.009	0.056	0.02	0.125	0.064	0.096
36	0.01	0.063	0.019	0.119	0.051	
37	0.007	0.044	0.006	0.038	0.061	0.091
38	0.01	0.063	0.027	0.169	0.048	
39	0.021	0.131	0.029	0.181	0.058	0.087
40	0.004	0.025	0.008	0.05	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.

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 _{ft} 2 hours
Measured Values at test impedance	0.42	0.36	0	0.37	0	0	0.05	0.07
Normalised to standard impedance	0.42	0.36	0	0.37	0	0	0.05	0.07
Normalised to required maximum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A



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 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω		
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω		
Maximum Impedance	R	N/A	Ω	X	N/A	Ω		

Applies to three phase and split single phase **Micro-generators**.
 ^ Applies to single phase **Micro-generators** and **Micro-generators** using two phases on a three phase system.
 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.
 Normalised value = Measured value*reference source resistance/measured source resistance at test point.
 Single phase units reference source resistance is 0.4 Ω
 Two phase units in a three phase system reference source resistance is 0.4 Ω.
 Two phase units in a split phase system reference source resistance is 0.24 Ω.
 Three phase units reference source resistance is 0.24 Ω.
 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 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.

Test start date	10.June.2019	Test end date	17.June.2019
Test location	Ningbo Ginlong electrical R&D LAB		

Power quality – DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10

Test power level	20%	50%	75%	100%
Recorded value in Amps	9.6mA	12.4mA	19.4mA	18.5mA
as % of rated AC current	0.061%	0.079%	0.124%	0.121%
Limit	0.25%	0.25%	0.25%	0.25%



Power Quality – Power factor: This test shall be carried out in accordance with EN 50538 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	0.995	0.994	0.992
50% of Registered Capacity	0.996	0.995	0.991
75% of Registered Capacity	0.997	0.998	0.998
100% of Registered Capacity	0.998	0.999	0.998
Limit	>0.95	>0.95	>0.95

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	47.47Hz	20.045s	47.7 Hz 25.3s	Yes
U/F stage 2	47 Hz	0.5 s	46.95Hz	0.542s	47.2 Hz 19.98 s	Yes
					46.8 Hz 0.48 s	Yes
O/F stage 1	52 Hz	0.5 s	52.03Hz	0.537s	51.8 Hz 89.98 s	Yes
					52.2 Hz 0.48 s	Yes

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.

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	183.5 V	2.534s	186 V 3.60 s	Yes
					182 V 2.48 s	Yes



O/V stage 1	262.2 V	1.0 s	262.5 V	1.048 s	260.2 V 2.0 s	Yes
O/V stage 2	273.7 V	0.5 s	274.0 V	0.546 s	269.7 V 0.98 s	Yes
					277.7 V 0.48 s	Yes

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.

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	0.28s	0.37s	0.16s	0.41s	0.26s	0.36s

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.					--ms	
For Inverters 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	0.30s	0.36s	0.25s	0.30s	0.25s	0.34s
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).						
	Start Frequency	Change	Confirm no trip			
Positive Vector Shift	49.0 Hz	+50 degrees	Yes			
Negative Vector Shift	50.0 Hz	- 50 degrees	Yes			
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	Yes			
51.0 Hz to 49.0 Hz	-0.95 Hzs ⁻¹	2.1 s	Yes			
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 Source	Power	Active Power Gradient	
Step a) 50.00 Hz ±0.01 Hz	3660W	50.00Hz	3755W		–	
Step b) 50.45 Hz ±0.05 Hz	3621W	50.45Hz			–	
Step c) 50.70 Hz ±0.10 Hz	3444W	50.70Hz			–	
Step d) 51.15 Hz ±0.05 Hz	3116W	51.15Hz			–	
Step e) 50.70 Hz ±0.10 Hz	3445W	50.70Hz			–	
Step f) 50.45 Hz ±0.05 Hz	3631W	50.45Hz			–	



Step g) 50.00 Hz ±0.01 Hz	3664W	50.00Hz		21.6kW/min
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency	Primary Source Power	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	1890W	50.00Hz	1942W	-
Step b) 50.45 Hz ±0.05 Hz	1862W	50.45Hz		-
Step c) 50.70 Hz ±0.10 Hz	1774W	50.70Hz		-
Step d) 51.15 Hz ±0.05 Hz	1615W	51.15Hz		-
Step e) 50.70 Hz ±0.10 Hz	1775W	50.70Hz		-
Step f) 50.45 Hz ±0.05 Hz	1863W	50.45Hz		-
Step g) 50.00 Hz ±0.01 Hz	1900W	50.00Hz		21.6kW/min
Steps as defined in EN 50438				
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	3620W	50.00Hz	3711W	
Test b) Point between 49.5 Hz and 49.6 Hz	3617W	49.55Hz	3709W	
Test c) Point between 47.5 Hz and 47.6 Hz	3613W	47.55Hz	3708W	
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes				
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.		
30s	32s	At 266.2 V	At 179.4 V	At 47.4 Hz
				At 52.1 Hz
Confirmation that the Micro-generator does not re-connect.	Yes	Yes	Yes	Yes
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	51.2V	20.2A
Initial Value of aperiodic current	A	--	100 ms	50.8V	0
Initial symmetrical short-circuit current*	I_k	--	250 ms	50.5V	0
Decaying (aperiodic) component of short circuit current*	i_{DC}	--	500 ms	50.5V	0
Reactance/Resistance Ratio of source*	X/R	--	Time to trip	0.055s	In seconds
<p>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.</p> <p>* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot</p>					
Logic Interface.			Yes		
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.			N/A (Solid state switch means electronic switch, Solis inverter uses mechanical dual relay protection with relay checks, which drops the voltage below 50V in 0.5s)		
Additional comments					