Form C: Type Test Verification Report

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

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.

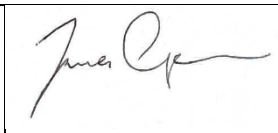
Where the **Micro-generator** is not registered with the ENA **Type Test Verification Report** Register this form needs to be completed and provided to NIE Networks, to confirm that the **Micro-generator** has been tested to satisfy the requirements of this EREC G98/NI.

Manufacturer's reference number	LIBBI-HS3680
Micro-generator technology	Transfomerless
Manufacturer name	Myenergi Ltd
Address	Pioneer Business Park, Faraday Way, Grimsby, DN418FF, UNITED KINGDOM

Tel	0333300 1303	Fax	
E:mail	james.chapman@myenergi.com	Web site	www.myenergi.com

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	3.68	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

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/NI.

Signed		On behalf of	myenergi 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	Measured Voltage(V):196.271 Measured Frequency(Hz):47.503 Measured Power(W): 3150.52 Measured Factor: 0.99981 Period of test: 90 minutes Confirm normal operation: YES
Test 2 Voltage = 110% of nominal (253 V) Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Measured Voltage(V): 253.941 Measured Frequency(Hz): 51.497 Measured Power(W): 3682.34 Measured Factor: 0.99964 Period of test: 90 minutes Confirm normal operation: YES
Test 3 Voltage = 110% of nominal (253 V) Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Measured Voltage(V): 254.269 Measured Frequency(Hz): 52.004 Measured Power(W): 3681.01 Measured Factor: 0.99909 Period of test: 15 minutes Confirm normal operation: YES

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)			3.68	kW		
Harmonic	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	0.020		0.005		1.080	
3	0.088		0.181		2.300	
4	0.003		0.003		0.430	
5	0.046		0.058		1.140	
6	0.003		0.010		0.300	
7	0.036		0.047		0.770	
8	0.005		0.013		0.230	
9	0.039		0.076		0.400	
10	0.006		0.018		0.184	
11	0.029		0.072		0.330	
12	0.008		0.011		0.153	
13	0.026		0.053		0.210	
14	0.003		0.008		0.131	
15	0.024		0.048		0.150	
16	0.006		0.003		0.115	
17	0.010		0.050		0.132	
18	0.002		0.004		0.102	
19	0.010		0.035		0.118	
20	0.006		0.011		0.092	
21	0.013		0.018		0.107	0.160

22	0.002		0.011		0.084	
23	0.006		0.013		0.098	0.147
24	0.003		0.006		0.077	
25	0.007		0.021		0.090	0.135
26	0.002		0.006		0.071	
27	0.005		0.005		0.083	0.124
28	0.006		0.010		0.066	
29	0.003		0.013		0.078	0.117
30	0.003		0.004		0.061	
31	0.009		0.011		0.073	0.109
32	0.002		0.004		0.058	
33	0.003		0.003		0.068	0.102
34	0.005		0.003		0.054	
35	0.001		0.007		0.064	0.096
36	0.003		0.003		0.051	
37	0.006		0.007		0.061	0.091
38	0.001		0.004		0.048	
39	0.005		0.007		0.058	0.087
40	0.001		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.

Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with EREC G98/NI 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 test impedance	0.343 %	0.295 %	0%	0%	0%	0.344%	0.182	0.136
Normalised to standard impedance	--	--	--	--	--	--	--	--
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	0.4	Ω	X	0.25	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**.

^ 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		24.May.2021	Test end date	28.May.2021
Test location		**CCIC Southern Testing Co., Ltd**, Electronic Testing Building, No. 43 Shahe Road, Xili Jiedao, Nanshan District, Shenzhen, Guangdong, China		
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	0.0079A	0.0106A	0.0371A	0.0295A
as % of rated AC current	0.049%	0.07%	0.23%	0.18%
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 ±1.5% of the stated level during the test.				
	216.2 V		230 V	253 V
20% of **Registered Capacity**	0.9882		0.9878	0.9865
50% of **Registered Capacity**	0.9980		0.9979	0.9976
75% of **Registered Capacity**	0.9985		0.9987	0.9984
100% of **Registered Capacity**	0.9986		0.9987	0.9988
Power Factor Limit - leading	>0.95		>0.95	>0.95
Power Factor Limit – lagging	>0.98		>0.98	>0.98
Protection – Frequency tests: These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98/NI 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	48.0 Hz	0.5 s	48.0 Hz	0.49s	48.2 Hz 25 s	NO TRIP
					47.8 Hz 0.45 s	NO TRIP
O/F	52 Hz	1.0 s	52 Hz	0.98s	51.8 Hz 120 s	NO TRIP
					52.2 Hz 0.98 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.						
Protection – Voltage tests: These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98/NI 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 stage 1	195.5 V	3 s	194.5 V	2.98 s	199.5 V 5 s	NO TRIP
U/V stage 2	138 V	2 s	137V	1.98 s	142 V 2.5 s	NO TRIP
					134 V 1.98 s	NO TRIP
O/V	253 V	0.5 s	254 V	0.49 s	249 V 5.0 s	NO TRIP
					257 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.						
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	93.6ms	90.8ms	280.2ms	96.0ms	95.0ms	334.8ms
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.			0ms			

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	0.0936	0.0908	0.2802	0.0960	0.0950	0.3448

Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98/NI 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	49.5 Hz	+50 degrees	NO TRIP
Negative Vector Shift	50.5 Hz	- 50 degrees	NO TRIP

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

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 50.2 Hz and **Droop** of 4%.

Note: Droop = 4%, threshold frequency 50.2Hz

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	3672W	50.00Hz	3730W	-
Step b) 50.25 Hz ±0.05 Hz	3582W	50.25 Hz		-
Step c) 50.70 Hz ±0.10 Hz	2758W	50.70 Hz		-
Step d) 51.15 Hz ±0.05 Hz	1917W	51.15 Hz		-
Step e) 50.70 Hz ±0.10 Hz	2756W	50.7 Hz		-
Step f) 50.25 Hz ±0.05 Hz	3583W	50.25 Hz		-
Step g) 50.00 Hz ±0.01 Hz	3671W	50.00 Hz		-

Note: Droop = 4%, threshold frequency 50.2Hz				
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	1836W	50.00 Hz	1904W	-
Step b) 50.25 Hz ±0.05 Hz	1791W	50.25 Hz		-
Step c) 50.70 Hz ±0.10 Hz	1058W	50.70 Hz		-
Step d) 51.15 Hz ±0.05 Hz	250W	51.15 Hz		-
Step e) 50.70 Hz ±0.10 Hz	469W	50.7 Hz		-
Step f) 50.25 Hz ±0.05 Hz	1792W	50.25 Hz		-
Step g) 50.00 Hz ±0.01 Hz	1836W	50.00 Hz		-
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 and under steady state conditions.			
Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	3680.70W	50.00Hz	3685W
Test b) Point between 49.5 Hz and 49.6 Hz	3680.52W	49.55 Hz	3685W
Test c) Point between 47.5 Hz and 47.6 Hz	3669.97W	47.55 Hz	3685W
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 60 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.			
60s	72.3s		At 257.0 V	At 191.5 V	At 47.9 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			NO RE-CONNECT	NO RE-CONNECT	NO RE-CONNECT	NO RE-CONNECT

Fault level contribution: These tests shall be carried out in accordance with EREC G98/NI 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	Volts	Amps

			fault		
Peak Short Circuit current	i_p	--	20 ms	0 V	9A
Initial Value of aperiodic current	A	--	100 ms	0 V	0A
Initial symmetrical short-circuit current*	I_k	--	250 ms	0 V	0A
Decaying (aperiodic) component of short circuit current*	i_{DC}	--	500 ms	0 V	0A
Reactance/Resistance Ratio of source*	$^X/_R$	--	Time to trip	0.0304s	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					
Logic Interface.					Yes
The inverter incorporates a high level potential on pin 2 of the DRM port. The active power of the inverter decreases to zero, in accordance with the EREC G98 requirements. Additionally, the inverter incorporates a serial communication link (RS485), which is used to reduce the active power output to zero, in accordance with the EREC G98 requirements.					
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98/NI 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					