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	-
Micro-generator technology	**Moixa V3C (Energy Storage System)**
Manufacturer name	**Moixa Technology Ltd**
Address	Moixa Technology Ltd Ground Floor, 29-31 Saffron Hill, London, EC1N 8FH

Tel	+44 (0)207 734 1511	Fax	-
E-mail	chris.wright@moixa.com	Web site	www.moixa.com

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	0.43	kW single phase, single, split or three phase system
	N/A	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 Moixa Technology Ltd	Chris Wright, CTO.

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	**Result**
Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Pass; unit remains connected for 90 minutes under listed characteristics while interface protection is disabled.

Test 2	**Result**
Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Pass; unit remains connected for 90 minutes under listed characteristics while interface protection is disabled.

Test 3	**Result**
Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Pass; unit remains connected for 15 minutes under listed characteristics while interface protection is disabled.

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)	0.43	kW

Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**			
	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	0.004	0.00377	0.005	0.00471	1.080	
3	0.169	0.15936	0.195	0.18387	2.300	
4	0.003	0.00283	0.002	0.00189	0.430	
5	0.061	0.05752	0.06	0.05657	1.140	
6	0.002	0.00189	0.004	0.00377	0.300	
7	0.038	0.03583	0.004	0.00377	0.770	
8	0.002	0.00189	0.002	0.00189	0.230	
9	0.055	0.05186	0.042	0.03960	0.400	
10	0.001	0.00094	0.004	0.00377	0.184	
11	0.037	0.03489	0.04	0.03772	0.330	
12	0.003	0.00283	0.004	0.00377	0.153	
13	0.024	0.02263	0.028	0.02640	0.210	
14	0.002	0.00189	0.003	0.00283	0.131	
15	0.038	0.03583	0.037	0.03489	0.150	
16	0.004	0.00377	0.005	0.00471	0.115	
17	0.066	0.06223	0.055	0.05186	0.132	

18	0.004	0.00377	0.004	0.00377	0.102	
19	0.07	0.06601	0.097	0.09146	0.118	
20	0.005	0.00471	0.005	0.00471	0.092	
21	0.035	0.03300	0.041	0.03866	0.107	0.160
22	0.006	0.00566	0.006	0.00566	0.084	
23	0.038	0.03583	0.031	0.02923	0.098	0.147
24	0.007	0.00660	0.007	0.00660	0.077	
25	0.037	0.03489	0.04	0.03772	0.090	0.135
26	0.006	0.00566	0.007	0.00660	0.071	
27	0.008	0.00754	0.014	0.01320	0.083	0.124
28	0.005	0.00471	0.006	0.00566	0.066	
29	0.028	0.02640	0.032	0.03017	0.078	0.117
30	0.003	0.00283	0.004	0.00377	0.061	
31	0.032	0.03017	0.03	0.02829	0.073	0.109
32	0.004	0.00377	0.004	0.00377	0.058	
33	0.006	0.00566	0.014	0.01320	0.068	0.102
34	0.005	0.00471	0.005	0.00471	0.054	
35	0.005	0.03017	0.033	0.03112	0.064	0.096
36	0.006	0.00566	0.004	0.00377	0.051	
37	0.021	0.01980	0.027	0.02546	0.061	0.091
38	0.007	0.00660	0.004	0.00377	0.048	
39	0.036	0.03395	0.03	0.02829	0.058	0.087
40	0.005	0.00471	0.003	0.00283	0.046	

Note higher limits for odd harmonics 21 and above are only allowable under certain conditions and are not requried for the Moixa V3C Smart Battery.

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 test impedance	0.18	0.14	0.0	0.18	0.14	0.0	0.08	0.07
Normalised to standard impedance	0.17	0.13	0.0	0.17	0.13	0.0	0.08	0.07
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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	N/A	Ω	X	N/A	Ω

Test start date	2015-02-17	**Test end date**	2015-02-17
Test location	**1400 North McDowell Blvd, Petaluma, CA USA**		

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	< 0.0017 A	< 0.0026 A	< 0.0039 A	< 0.005 A
as % of rated AC current	< 0.25%	< 0.25%	< 0.25%	< 0.25%
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**	0.99	0.99	0.99
50% of **Registered Capacity**	0.99	0.99	0.99
75% of **Registered Capacity**	0.99	0.99	0.99
100% of **Registered Capacity**	1.0	0.999	0.999
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	47.5Hz	20.09s	47.7 Hz 25 s	No trip
U/F stage 2	47 Hz	0.5 s	47.05Hz	0.73s	47.2 Hz 19.98 s	No trip
					46.8 Hz 0.48 s	No trip
O/F stage 1	52 Hz	0.5 s	51.95Hz	0.74s	51.8 Hz 89.98 s	No trip
					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 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	183.2V	>2.5s	188 V 3.50 s	No trip
					180 V 2.48 s	No trip
O/V stage 1	262.2 V	1.0 s	264.15V	1.09s	258.2 V 2.0 s	No trip
O/V stage 2	273.7 V	0.5 s	274.64V	0.79s	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.

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 **RegisteredCapacity**	95% of **RegisteredCapacity**	95% of **RegisteredCapacity**	105% of **RegisteredCapacity**	105% of **RegisteredCapacity**	105% of **RegisteredCapacity**
Trip time. Limit is 0.5s	0.032 s	0.024 s	0.304 s	0.016 s	0.016 s	0.304 s

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	No trip
Negative Vector Shift	50.0 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 50.4 Hz and **Droop** of 10%.
Note: As stated in Appendex 1 of EREC G98 the requirements listed in clause 9.3 as **"LFSM-O"** are not applicable for **Energy Storage Systems**.

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.
Note: As stated in Appendix 1 of EREC G98 the requirements listed in clause 9.4.2 "**Power output with falling frequency**" are not applicable for **Energy Storage Systems**.

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	24s		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

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	15	20 ms	0	0
Initial Value of aperiodic current	A	15	100 ms	0	0
Initial symmetrical short-circuit current*	I_k	17.9	250 ms	0	0
Decaying (aperiodic) component of short circuit current*	i_{DC}	0	500 ms	0	0
Reactance/Resistance Ratio of source*	X/R	2.5	Time to trip	0.014	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.	N/A. Note: As stated in Appendix 1 of EREC G98, requirements listed in clause 9.4.3 "**Logic Interface**" are not applicable for **Energy Storage Systems**.

Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	N/A
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

Additional comments
System operates as an Energy Storage System (ESS) and is therefore exempt from clauses 9.3, 9.4.2 and 9.4.3.