Form A2-3: Compliance Verification Report for Type A Inverter Connected Power Generating Modules

This form should be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G99. The form can be used in a variety of ways as detailed below:

1. To obtain **Fully Type Tested** status (≤ 50 kW)

   The **Manufacturer** can use this form to obtain **Fully Type Tested** status for a **Power Generating Module** by registering this completed form with the Energy Networks Association (ENA) Type Test Verification Report Register. Tests 1 – 15 must all be completed and compliant for the **Power Generating Module** to be classified as **Fully Type Tested**.

2. To obtain **Type Tested** status for a product

   This form can be used by the **Manufacturer** to obtain **Type Tested** status for a product which is used in a **Power Generating Module** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Verification Report Register.
   Where the **Manufacturer** is seeking to obtain **Type Tested** status for an **Interface Protection** device the appropriate section of Form A2-4 should be used.

3. One-off Installation

   This form can be used by the **Manufacturer** or **Installer** to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99. This form shall be submitted to the **DNO** as part of the application.

A combination of (2) and (3) can be used as required, together with Form A2-4 where compliance of the **Interface Protection** is to be demonstrated on site.

Note:

Within this Form A2-3 the term **Power Park Module** will be used but its meaning can be interpreted within Form A2-3 to mean **Power Park Module**, **Generating Unit or Inverter** as appropriate for the context. However, note that compliance shall be demonstrated at the **Power Park Module** level.

If the **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Verification Report Register, the Installation Document (Form A3-1 or A3-2) should include the **Manufacturer's** reference number (the system reference), and this form does not need to be submitted.

Where the **Power Generating Module** is not registered with the ENA Type Test Verification Report Register or is not **Fully Type Tested** this form (all or in parts as applicable) needs to be completed and provided to the **DNO**, to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99.

PGM technology		Grid-tied photovoltaic inverter	
Manufacturer name		Rayleigh Instruments LTD.	
Address		1-5 Raytel House, Cutlers road, South Woodham Ferrers, Chelmsford,Essex. England.	
Tel	01245428500	Web site	www.Rayleigh.com
E:mail	Sales@rayleigh.com		
Registered Capacity		15kW	

Registered Capacity	17kW
Registered Capacity	20kW
Registered Capacity	25kW
Energy storage capacity for **Electricity Storage** devices	kWh

There are four options for Testing: (1) **Fully Type Tested**(≤ 50 kW), (2) **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. Type Tested product**	**3. One-off Manufacturers' Info.**	**4. Tested on Site at time of Commissioning**
0. **Fully Type Tested** - all tests detailed below completed and evidence attached to this submission		**N/A**	**N/A**	**N/A**
1. Operating Range	**N/A**			
2. PQ – Harmonics				
3. PQ – Voltage Fluctuation and Flicker				
4. PQ – DC Injection (**Power Park Module**s only)				
5. **Power Factor** (PF)				
6. Frequency protection trip and ride through tests				
7. Voltage protection trip and ride through tests				
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test				
9. **LFSM-O** Test				
10. Protection – Reconnection Timer				
11. Fault Level Contribution				
12. Self-monitoring Solid State Switch				

There are four options for Testing: (1) **Fully Type Tested**(≤ 50 kW), (2) **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. Type Tested product**	**3. One-off Manufacturers' Info.**	**4. Tested on Site at time of Commissioning**
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)				
14. Logic Interface (input port)				
15. Cyber security				

Manufacturer compliance declaration. - I certify that all products supplied by the company with the above **Type Tested Manufacturer**'s 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 **Modification**s are required to ensure that the product meets all the requirements of EREC G99.

Signed		On behalf of	Rayleigh Instruments Limited

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.

A2-3 Compliance Verification Report –Tests for Type A Inverter Connected Power Generating Modules – test record

1. Operating Range: Tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time.

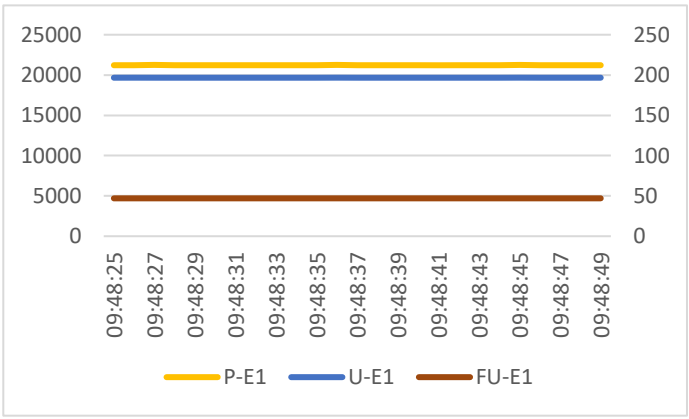
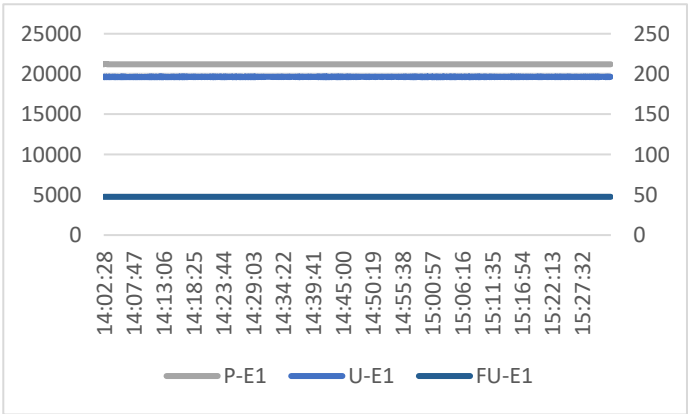
The **Interface Protection** shall be disabled during the tests.

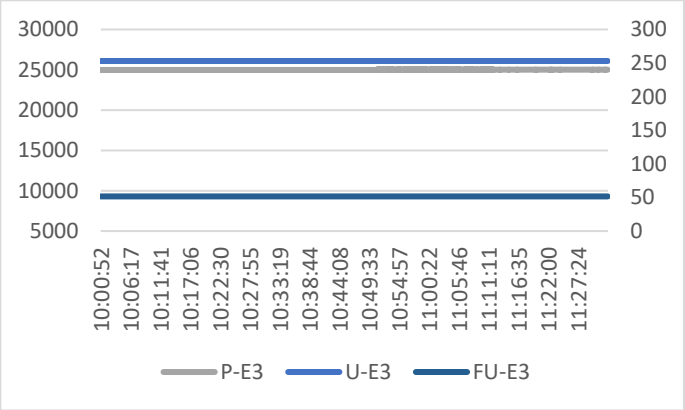
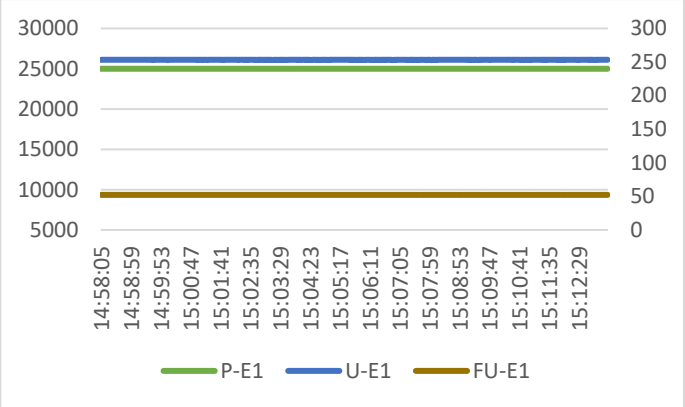
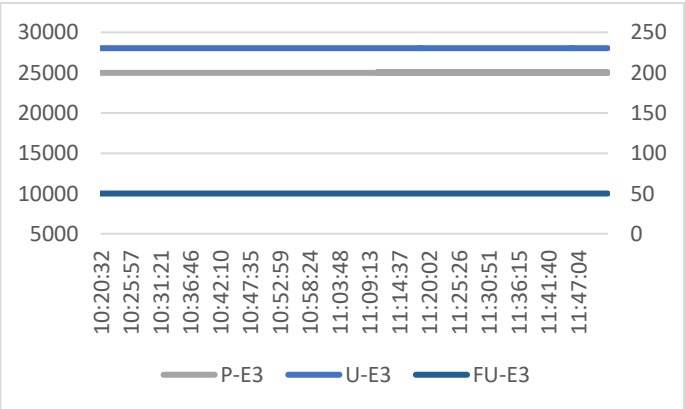
In case of a PV **Power Park Module** the PV primary source may be replaced by a DC source.

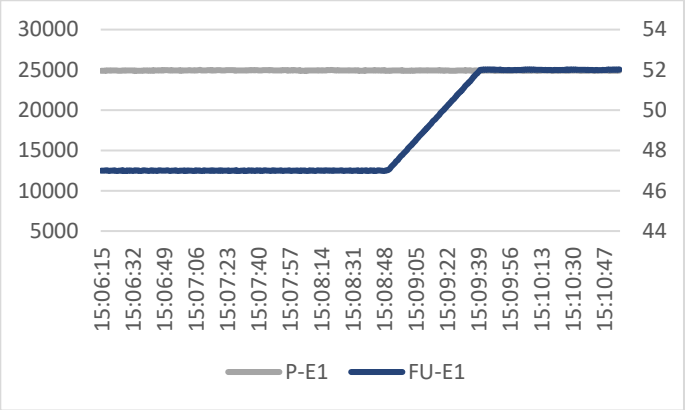
In case of a full converter **Power Park Module** (eg wind) the primary source and the prime mover I**nverter**/rectifier may be replaced by a DC source.

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.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Test results or chart to confirm operation  Pass
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation  Pass

Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation  Pass
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Test results or chart to confirm operation  Pass
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Test results or chart to confirm operation  Pass

Test 6 RoCoF withstand	Test results or chart to confirm operation
Confirm that the **Power Generating Module** 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. Note that this is not expected to be demonstrated on site.	 Pass

2. Power Quality – Harmonics:

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Module**s, measurements for all phases should be provided.
For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)			**5**		kVA		Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.1383	0.0970	0.0863	1.153	0.808	0.719	8%	8%
3	0.0233	0.0363	0.0175	0.194	0.303	0.146	21.6%	Not stated
4	0.0661	0.0782	0.0764	0.551	0.652	0.637	4%	4%
5	0.0710	0.0736	0.0735	0.592	0.613	0.613	10.7%	10.7%

6	0.0123	0.0074	0.0085	0.103	0.062	0.071	2.67%	2.67%
7	0.0313	0.0341	0.0308	0.261	0.284	0.257	7.2%	7.2%
8	0.0067	0.0099	0.0093	0.056	0.083	0.078	2%	2%
9	0.0046	0.0082	0.0057	0.038	0.068	0.048	3.8%	Not stated
10	0.0171	0.0137	0.0142	0.143	0.114	0.118	1.6%	1.6%
11	0.0312	0.0340	0.0345	0.260	0.283	0.288	3.1%	3.1%
12	0.0046	0.0027	0.0045	0.038	0.023	0.038	1.33%	1.33%
13	0.0528	0.0514	0.0532	0.440	0.428	0.443	2%	2%
THD[1]	0.2399	0.2189	0.2221	1.999	1.824	1.851	23%	13%
PWHD[2]	0.0536	0.0529	0.0529	0.447	0.441	0.441	23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.1583	0.1002	0.1505	0.660	0.418	0.627	8%	8%
3	0.0466	0.0532	0.0244	0.194	0.222	0.102	21.6%	Not stated
4	0.1367	0.1483	0.1322	0.570	0.618	0.551	4%	4%
5	0.2294	0.2377	0.2291	0.956	0.990	0.955	10.7%	10.7%
6	0.0167	0.0187	0.0067	0.070	0.078	0.028	2.67%	2.67%
7	0.1916	0.1832	0.1818	0.798	0.763	0.758	7.2%	7.2%
8	0.0125	0.0185	0.0131	0.052	0.077	0.055	2%	2%
9	0.0079	0.0108	0.0151	0.033	0.045	0.063	3.8%	Not stated
10	0.0226	0.0198	0.0181	0.094	0.083	0.075	1.6%	1.6%
11	0.0634	0.0734	0.0673	0.264	0.306	0.280	3.1%	3.1%
12	0.0089	0.0058	0.0059	0.037	0.024	0.025	1.33%	.33%
13	0.0593	0.0627	0.0677	0.247	0.261	0.282	2%	2%
THD[3]	0.4656	0.4598	0.4550	1.940	1.916	1.896	23%	13%

[1] THD = Total Harmonic Distortion
[2] PWHD = Partial Weighted Harmonic Distortion
[3] THD = Total Harmonic Distortion

PWHD[4]	0.1702	0.1728	0.1810	0.709	0.720	0.754	23%	22%
Power Generating Module rating per phase (rpp)				**5.66**		kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.031	0.032	0.03	0.230	0.237	0.222	8%	8%
3	0.01	0.009	0.008	0.074	0.067	0.059	21.6%	Not stated
4	0.028	0.024	0.024	0.207	0.178	0.178	4%	4%
5	0.06	0.06	0.049	0.444	0.444	0.363	10.7%	10.7%
6	0.002	0.001	0.001	0.015	0.007	0.007	2.67%	2.67%
7	0.05	0.054	0.047	0.370	0.400	0.348	7.2%	7.2%
8	0.006	0.001	0.003	0.044	0.007	0.022	2%	2%
9	0.006	0.001	0.003	0.044	0.007	0.022	3.8%	Not stated
10	0.008	0.003	0.004	0.059	0.022	0.030	1.6%	1.6%
11	0.043	0.04	0.045	0.319	0.296	0.333	3.1%	3.1%
12	0.006	0.001	0.007	0.044	0.007	0.052	1.33%	1.33%
13	0.049	0.052	0.045	0.363	0.385	0.333	2%	2%
THD[5]	0.1007	0.1004	0.0932	0.746	0.744	0.69	23%	13%
PWHD[6]	0.0323	0.0304	0.0325	0.239	0.225	0.241	23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.089	0.082	0.076	0.330	0.304	0.281	8%	8%

4 PWHD = Partial Weighted Harmonic Distortion
5 THD = Total Harmonic Distortion
6 PWHD = Partial Weighted Harmonic Distortion

3	0.01	0.006	0.008	0.037	0.022	0.030	21.6%	Not stated
4	0.068	0.061	0.06	0.252	0.226	0.222	4%	4%
5	0.055	0.049	0.049	0.204	0.181	0.181	10.7%	10.7%
6	0.001	0.003	0.003	0.004	0.011	0.011	2.67%	2.67%
7	0.02	0.022	0.023	0.074	0.081	0.085	7.2%	7.2%
8	0.014	0.009	0.006	0.052	0.033	0.022	2%	2%
9	0.011	0.004	0.008	0.041	0.015	0.030	3.8%	Not stated
10	0.003	0.008	0.01	0.011	0.030	0.037	1.6%	1.6%
11	0.084	0.015	0.048	0.311	0.056	0.178	3.1%	3.1%
12	0.002	0.011	0.005	0.007	0.041	0.019	1.33%	.33%
13	0.037	0.048	0.029	0.137	0.178	0.107	2%	2%
THD[7]	0.1941	0.1601	0.1612	0.719	0.593	0.597	23%	13%
PWHD[8]	0.1015	0.0926	0.0986	0.376	0.343	0.365	23%	22%
Power Generating Module rating per phase (rpp)				**6.66**		kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.033	0.036	0.043	0.213	0.232	0.277	8%	8%
3	0.003	0.007	0.008	0.019	0.045	0.052	21.6%	Not stated
4	0.024	0.031	0.029	0.155	0.200	0.187	4%	4%
5	0.058	0.059	0.059	0.374	0.381	0.381	10.7%	10.7%
6	0.002	0.002	0.004	0.013	0.013	0.026	2.67%	2.67%
7	0.049	0.051	0.054	0.316	0.329	0.348	7.2%	7.2%

[7] THD = Total Harmonic Distortion
[8] PWHD = Partial Weighted Harmonic Distortion

8	0.007	0.008	0.006	0.045	0.052	0.039	2%	2%
9	0.006	0.007	0.003	0.039	0.045	0.019	3.8%	Not stated
10	0.002	0.006	0.005	0.013	0.039	0.032	1.6%	1.6%
11	0.041	0.052	0.045	0.265	0.335	0.290	3.1%	3.1%
12	0.004	0.004	0.001	0.026	0.026	0.006	1.33%	1.33%
13	0.046	0.047	0.061	0.297	0.303	0.394	2%	2%
THD[9]	0.1114	0.1178	0.1237	0.719	0.760	0.798	23%	13%
PWHD[10]	0.0367	0.0322	0.0319	0.237	0.208	0.206	23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.091	0.085	0.070	0.294	0.274	0.226	8%	8%
3	0.009	0.006	0.009	0.029	0.019	0.029	21.6%	Not stated
4	0.065	0.062	0.053	0.210	0.200	0.171	4%	4%
5	0.051	0.053	0.052	0.165	0.171	0.168	10.7%	10.7%
6	0.002	0.001	0.005	0.006	0.003	0.016	2.67%	2.67%
7	0.025	0.027	0.022	0.081	0.087	0.071	7.2%	7.2%
8	0.011	0.010	0.010	0.035	0.032	0.032	2%	2%
9	0.002	0.013	0.005	0.006	0.042	0.016	3.8%	Not stated
10	0.007	0.006	0.008	0.023	0.019	0.026	1.6%	1.6%
11	0.029	0.076	0.027	0.094	0.245	0.087	3.1%	3.1%
12	0.004	0.008	0.007	0.013	0.026	0.023	1.33%	.33%
13	0.046	0.049	0.045	0.148	0.158	0.145	2%	2%
THD[11]	0.2006	0.2167	0.1810	0.647	0.699	0.584	23%	13%
PWHD[12]	0.1172	0.1172	0.1212	0.378	0.378	0.391	23%	22%

9 THD = Total Harmonic Distortion
10 PWHD = Partial Weighted Harmonic Distortion
11 THD = Total Harmonic Distortion
12 PWHD = Partial Weighted Harmonic Distortion

Power Generating Module rating per phase (rpp)				**8.33**		kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.0411	0.0480	0.0382	0.206	0.240	0.191	8%	8%
3	0.0038	0.0098	0.0097	0.019	0.049	0.049	21.6%	Not stated
4	0.0343	0.0333	0.0322	0.172	0.167	0.161	4%	4%
5	0.0618	0.0639	0.0626	0.309	0.320	0.313	10.7%	10.7%
6	0.0042	0.0016	0.0038	0.021	0.008	0.019	2.67%	2.67%
7	0.0450	0.0532	0.0506	0.225	0.266	0.253	7.2%	7.2%
8	0.0078	0.0110	0.0078	0.039	0.055	0.039	2%	2%
9	0.0058	0.0037	0.0067	0.029	0.019	0.034	3.8%	Not stated
10	0.0032	0.0036	0.0056	0.016	0.018	0.028	1.6%	1.6%
11	0.0263	0.0393	0.0497	0.132	0.197	0.249	3.1%	3.1%
12	0.0036	0.0048	0.0031	0.018	0.024	0.016	1.33%	1.33%
13	0.0636	0.0522	0.0517	0.318	0.261	0.259	2%	2%
THD[13]	0.1590	0.1620	0.1594	0.795	0.810	0.797	23%	13%
PWHD[14]	0.0398	0.0480	0.0488	0.199	0.240	0.244	23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.0178	0.0264	0.0247	0.045	0.066	0.062	8%	8%
3	0.0057	0.0065	0.0044	0.014	0.016	0.011	21.6%	Not stated

[13] THD = Total Harmonic Distortion
[14] PWHD = Partial Weighted Harmonic Distortion

4	0.0096	0.0120	0.0120	0.024	0.030	0.030	4%	4%
5	0.0660	0.0684	0.0602	0.165	0.171	0.151	10.7%	10.7%
6	0.0072	0.0029	0.0012	0.018	0.007	0.003	2.67%	2.67%
7	0.0543	0.0575	0.0485	0.136	0.144	0.121	7.2%	7.2%
8	0.0031	0.0067	0.0065	0.008	0.017	0.016	2%	2%
9	0.0101	0.0165	0.0112	0.025	0.041	0.028	3.8%	Not stated
10	0.0025	0.0099	0.0050	0.006	0.025	0.013	1.6%	1.6%
11	0.0419	0.0823	0.0305	0.105	0.206	0.076	3.1%	3.1%
12	0.0055	0.0146	0.0027	0.014	0.037	0.007	1.33%	.33%
13	0.0535	0.0250	0.0560	0.134	0.063	0.140	2%	2%
THD[15]	0.2688	0.2552	0.4248	0.672	0.638	1.062	23%	13%
PWHD[16]	0.1424	0.1480	0.1784	0.356	0.370	0.446	23%	22%

3. Power Quality – Voltage fluctuations and Flicker:

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC P28.

The standard test impedance is 0.4 Ω for a single phase **Power Generating Module** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Power Generating Module** (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	8 September.,2022	Test end date	8 September.,2022
Test location	Suzhou National Hi-Tech District, Suzhou, China.		

15 THD = Total Harmonic Distortion

16 PWHD = Partial Weighted Harmonic Distortion

	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	0.39	0.29	0	0.39	0.29	0	0.33	0.33
Normalised to standard impedance	0.39	0.29	0	0.39	0.29	0	0.33	0.33
Normalised to required maximum impedance	0.39	0.29	0	0.39	0.29	0	0.33	0.33
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	Xl	0.15	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	Xl	0.15 * 0.25 ^	Ω
Maximum Impedance	R	0.24	Ω	Xl	0.15	Ω

* Applies to three phase and split single phase **Power Generating Module**s. Delete as appropriate.

^ Applies to single phase **Power Generating Module** and **Power Generating Module**s using two phases on a three phase system. Delete as appropriate.

4. Power quality – DC injection: The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

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) / Vphase. The % DC injection should not be greater than 0.25%.

Test power level（15K）	10%	55%	100%
Recorded value in Amps	0.055	0.051	0.056
as % of rated AC current	0.23%	0.21%	0.23%
Limit	0.25%	0.25%	0.25%
Test power level（17K）	10%	55%	100%
Recorded value in Amps	0.06	0.061	0.06
as % of rated AC current	0.22%	0.23%	0.22%
Limit	0.25%	0.25%	0.25%
Test power level（20K）	10%	55%	100%
Recorded value in Amps	0.062	0.064	0.066
as % of rated AC current	0.19%	0.20%	0.21%
Limit	0.25%	0.25%	0.25%
Test power level（25K）	10%	55%	100%
Recorded value in Amps	0.062	0.064	0.066

as % of rated AC current	0.16%	0.16%	0.17%
Limit	0.25%	0.25%	0.25%

5. Power Factor: The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out 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. These tests should be undertaken in accordance with Annex A.7.1.4.2.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

15kW			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.9979	0.999	0.9982
Power Factor Limit	>0.95	>0.95	>0.95
17kW			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.9987	0.9992	0.9983
Power Factor Limit	>0.95	>0.95	>0.95
20kW			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.9986	0.9994	0.9985
Power Factor Limit	>0.95	>0.95	>0.95
25kW			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.9986	0.9987	0.9988
Power Factor Limit	>0.95	>0.95	>0.95

6. Protection – Frequency tests: These tests should be carried out in accordance with the Annex A.7.1.2.3. 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	47.41Hz	20.02s	47.7 Hz 30 s	No trip

U/F stage 2	47 Hz	0.5 s	46.91Hz	0.51s	47.2 Hz 19.5 s	No trip
					46.8 Hz 0.45 s	No trip
O/F	52 Hz	0.5 s	52.05Hz	0.52s	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 A.7.1.2.2. For trip tests, voltage and time delay should be stated. For "no trip tests", "no trip" can be stated.

Note that the value of voltage stated below assumes a **LV** connection This should be adjusted for **HV** taking account of the VT ratio as required.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s	183.2V	2.52s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	1.14 pu (262.2 V)	1.0 s	263.5V	1.01s	258.2 V 5.0 s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	274.5V	0.51s	269.7 V 0.95 s	No trip
					277.7 V 0.45 s	No trip
Ph2						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s	183V	2.511s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip

O/V stage 1	1.14 pu (262.2 V)	1.0 s	263.9V	1.01s	258.2 V 5.0 s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	274.8V	0.509s	269.7 V 0.95 s	No trip
					277.7 V 0.45 s	No trip
Ph3						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s	182.9V	2.515s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	1.14 pu (262.2 V)	1.0 s	263.8V	1.01s	258.2 V 5.0 s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	274.9V	0.51s	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: These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
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 0.5s[17]	367ms	395ms	441ms	355ms	374ms	408ms

Loss of Mains Protection, Vector Shift Stability test: This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.			
	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

Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** 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

9. Limited Frequency Sensitive Mode – Overfrequency test: The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. This test should be carried out in accordance with Annex A.7.1.3, which also contains the measurement tolerances.	
Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.	**Y/N**
Alternatively, test results should be noted below:	

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz	24986.5W	50Hz	630V/25800W	99.95%

[17] If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

Step b) 50.45Hz ±0.05Hz	24736.5W	50.45Hz		98.95%
Step c) 50.70Hz ±0.10Hz	23486.5W	50.7Hz		93.95%
Step d) 51.15Hz ±0.05Hz	21236.5W	51.15Hz		84.95%
Step e) 50.70Hz ±0.10Hz	23485W	50.7Hz		93.94%
Step f) 50.45Hz ±0.05Hz	24700W	50.45Hz		98.80%
Step g) 50.00Hz ±0.01Hz	25000W	50Hz		100.00%
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz	12490W	50Hz	630V/13000W	49.96%
Step b) 50.45Hz ±0.05Hz	12240W	50.45Hz		48.96%
Step c) 50.70Hz ±0.10Hz	10990W	50.7Hz		43.96%
Step d) 51.15Hz ±0.05Hz	8740W	51.15Hz		34.96%
Step e) 50.70Hz ±0.10Hz	11000W	50.7Hz		44.00%
Step f) 50.45Hz ±0.05Hz	12232.2W	50.45Hz		48.93%
Step g) 50.00Hz ±0.01Hz	12492W	50Hz		49.97%

10. Protection – 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 10.1. 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 **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
30S	65S	At 1.16 pu (266.2 V **LV** connection, 127.6 V **HV** connection assuming 110 V ph-ph VT)	At 0.78 pu (180.0 V **LV** connection, 85.8 V **HV** connection assuming 110 V ph-ph VT)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		not re-connect	not re-connect	not re-connect	not re-connect

11. Fault level contribution: These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms	97.8V	24.6A
100ms	34.2V	18.4A
250ms	57.3V	14.8A
500ms	34.2V	9.4A
Time to trip	0.14s	In seconds

12. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.6.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	NA

13. Wiring functional tests: If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	NA

14. Logic interface (input port)	
Confirm that an input port is provided and can be used to shut down the module	Yes

Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes
15. Cyber security	
Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7.	Yes
Additional comments.	
Logic Interface (input port): the logic interface will take the form of a simple binary output. When the switch is opened the Micro-generator can operate normally. When the switch is closed the Microgenerator will reduce its Active Power to zero within 5 s. The signal from the Microgenerator that is being switched is DC 5 V. **Cyber security:** We used a communication server with an SSL certificate,which complies with the latest cyber security requirements.	