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

   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.

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 Product ID), 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		AC/AC full converter for hydroelectric plants, wind turbines, CHP	
Manufacturer name		Elpower s.r.l.	
Address		Via Beggiato, 23 36025 - Noventa Vicentina (VI) Italy	
Tel	+39 0444 787882	Web site	http://www.elpower.it/
Fax	+39 0444 787758		
E:mail	info@elpower.it		

Model	CLEANVERTER 30 TL	CLEANVERTER 60 TL	CLEANVERTER 80 TL	CLEANVERTER 100 TL	CLEANVERTER 150 TL	CLEANVERTER 200 TL	CLEANVERTER 250 TL
Inverter type	Three-phase transformer less	Three-phase transformer less	Three-phase transformer less	Three-phase transformer less	Three-phase transformer less	Three-phase transformer less	Three-phase transformer less
Output power [kW]	32	60	80	100	150	200	250
Firmware version	401	401	401	401	401	401	401

CLEANVERTER 100 TL was tested as representative model of the product family.

Test report are issued by:

Testing laboratory	:	CREIVEN S.c.a.r.l.
Site of test	:	Corso Spagna, 12 - 35127 Padova (PD) Corso Stati Uniti, 4 - 35127 Padova (PD)
Test report		351/20/00525/ER
Test reference		1. Operating Range 4. PQ – DC Injection 5. Power Factor (PF) 6. Frequency protection trip and ride through tests 7. Voltage protection trip and ride through tests 8. Protection – LoM Test, VS and RoCoF Stability Test 9. LFSM-O Test 14. Logic Interface (input port)
Date(s) of performance of test	:	From 27/10/2020 to 18/11/2020
Test performed and compiled by	:	Giuseppe Silecchia, Mauro Majolo
Approved by	:	Alessandro Zuccato
Test report		153263LP
Test reference		3. PQ – Voltage Fluctuation and Flicker
Date(s) of performance of test	:	From 19/11/2015 to 20/11/2015
Test performed and compiled by	:	Daniele Montanari, Mattia Dal Corso
Approved by	:	Alessandro Zuccato

Testing laboratory	:	Wtlab Srl
Site of test	:	Via Mantegna, 3 - 35020 Tribano (PD)
Test report		15WC022001
Test reference		2. PQ – Harmonics 11. Fault Level Contribution
Date(s) of performance of test	:	From 18/03/2015 to 22/06/2015
Test performed and compiled by	:	Andrea Sartorato
Approved by	:	Roberto Bolzonaro

There are four options for Testing: (1) **Fully Type Tested**, (2) Partially **Type Tested**, (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).
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. Partially Type Tested**	**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		✓		

There are four options for Testing: (1) **Fully Type Tested**, (2) Partially **Type Tested**, (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).
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. Partially Type Tested**	**3. One-off Manufacturers'. Info.**	**4. Tested on Site at time of Commissioning**
12. Self-monitoring Solid State Switch		NA		
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)		NA		
14. Logic Interface (input port)		✓		

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	ELPOWER S.r.l.

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 organization 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: Five 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.

Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Confirmed by test – no trip
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Confirmed by test – no trip
Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Confirmed by test – no trip
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Confirmed by test – no trip
Test 5 RoCoF withstand 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.	Confirmed by test – no trip

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 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 **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.

Power Generating Module tested to BS EN 61000-3-12			
Power Generating Module rating per phase (rpp)	33.33	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)

Generating Unit tested to BS EN 61000-3-12							
Generating Unit rating three phase			100		kVA		
Harmonic	100% of rated output						Limit in BS EN 61000-3-12
	Measured Value MV in Amps			%			
No.	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**	**3 phase**
1	143,12	143,67	142,63	99%	100%	99%	-
2	0,3668	0,5760	0,2424	0,254%	0,399%	0,168%	8,0%
3	0,6104	0,3661	0,4664	0,423%	0,254%	0,323%	-
4	0,1475	0,4409	0,5558	0,102%	0,306%	0,385%	4,0%
5	3,2903	3,3117	3,2594	2,282%	2,297%	2,260%	10,7%
6	0,2324	0,2501	0,1022	0,161%	0,173%	0,071%	2,67%
7	1,9677	1,9189	1,8170	1,365%	1,331%	1,260%	7,2%
8	0,1720	0,1174	0,0745	0,119%	0,081%	0,052%	2%
9	0,0315	0,0312	0,0364	0,022%	0,022%	0,025%	-
10	0,0729	0,0365	0,0244	0,051%	0,025%	0,017%	1,6%
11	0,1123	0,1056	0,1160	0,078%	0,073%	0,080%	3,1%
12	0,0129	0,0127	0,0134	0,009%	0,009%	0,009%	1,33%
13	0,0781	0,0835	0,0759	0,054%	0,058%	0,053%	2,0%
14	0,0320	0,0275	0,0201	0,022%	0,019%	0,014%	-
15	0,0109	0,0117	0,0138	0,008%	0,008%	0,010%	-
16	0,0241	0,0262	0,0316	0,017%	0,018%	0,022%	-
17	0,2603	0,2564	0,2617	0,181%	0,178%	0,181%	-
18	0,0959	0,1066	0,1021	0,066%	0,074%	0,071%	-
19	0,0634	0,0530	0,0391	0,044%	0,037%	0,027%	-
20	0,0081	0,0087	0,0073	0,006%	0,006%	0,005%	-

No.	L1	L2	L3	L1	L2	L3	
21	0,0047	0,0047	0,0048	0,003%	0,003%	0,003%	-
22	0,0043	0,0043	0,0045	0,003%	0,003%	0,003%	-
23	0,0796	0,0688	0,0963	0,055%	0,048%	0,067%	-
24	0,0052	0,0050	0,0051	0,004%	0,003%	0,004%	-
25	0,3315	0,2978	0,2846	0,230%	0,207%	0,197%	-
26	0,0049	0,0047	0,0047	0,003%	0,003%	0,003%	-
27	0,0036	0,0035	0,0036	0,002%	0,002%	0,002%	-
28	0,0033	0,0033	0,0033	0,002%	0,002%	0,002%	-
29	0,0030	0,0030	0,0030	0,002%	0,002%	0,002%	-
30	0,0032	0,0032	0,0033	0,002%	0,002%	0,002%	-
31	0,0027	0,0027	0,0027	0,002%	0,002%	0,002%	-
32	0,0030	0,0030	0,0031	0,002%	0,002%	0,002%	-
33	0,0028	0,0027	0,0028	0,002%	0,002%	0,002%	-
34	0,0027	0,0027	0,0028	0,002%	0,002%	0,002%	-
35	0,0029	0,0029	0,0029	0,002%	0,002%	0,002%	-
36	0,0025	0,0025	0,0025	0,002%	0,002%	0,002%	-
37	0,0029	0,0029	0,0029	0,002%	0,002%	0,002%	-
38	0,0025	0,0025	0,0025	0,002%	0,002%	0,002%	-
39	0,0027	0,0027	0,0028	0,002%	0,002%	0,002%	-
40	0,0026	0,0027	0,0027	0,002%	0,002%	0,002%	-
41	0,0025	0,0025	0,0025	0,002%	0,002%	0,002%	-
42	0,0027	0,0028	0,0028	0,002%	0,002%	0,002%	-
43	0,0025	0,0024	0,0025	0,002%	0,002%	0,002%	-
44	0,0027	0,0027	0,0028	0,002%	0,002%	0,002%	-
45	0,0025	0,0025	0,0026	0,002%	0,002%	0,002%	-
46	0,0026	0,0026	0,0026	0,002%	0,002%	0,002%	-
47	0,0026	0,0027	0,0027	0,002%	0,002%	0,002%	-
48	0,0026	0,0025	0,0026	0,002%	0,002%	0,002%	-
49	0,0027	0,0027	0,0027	0,002%	0,002%	0,002%	-
50	0,0026	0,0026	0,0026	0,002%	0,002%	0,002%	-
THD	0,0275	0,0275	0,0269	2,75%	2,75%	2,69%	13%
PWHD	0,0145	0,0134	0,0134	1,45%	1,34%	1,34%	22%

Generating Unit rating three phase	100		kVA			
Harmonic	45 - 55% of rated output					Limit in BS EN 61000-3-12
	Measured Value MV in Amps			%		
No.	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**	**3 phase**
1	73,99	74,07	73,92	51%	51%	51%	-
2	0,7567	0,9010	0,2781	0,525%	0,625%	0,193%	8,0%
3	0,2154	0,3892	0,3839	0,149%	0,270%	0,266%	-
4	0,5899	0,5516	0,7606	0,409%	0,383%	0,527%	4,0%
5	3,1766	3,1212	3,2054	2,203%	2,165%	2,223%	10,7%
6	0,1624	0,1375	0,1206	0,113%	0,095%	0,084%	2,67%
7	0,7491	0,7577	0,6738	0,519%	0,525%	0,467%	7,2%
8	0,1762	0,1607	0,1415	0,122%	0,111%	0,098%	2%
9	0,0476	0,0820	0,0791	0,033%	0,057%	0,055%	-
10	0,0986	0,0677	0,1068	0,068%	0,047%	0,074%	1,6%
11	0,2998	0,2261	0,2754	0,208%	0,157%	0,191%	3,1%
12	0,0277	0,0245	0,0267	0,019%	0,017%	0,018%	1,33%
13	0,2547	0,2426	0,2502	0,177%	0,168%	0,174%	2,0%
14	0,0469	0,0576	0,0661	0,033%	0,040%	0,046%	-
15	0,0291	0,0258	0,0277	0,020%	0,018%	0,019%	-
16	0,0539	0,0499	0,0798	0,037%	0,035%	0,055%	-
17	0,5328	0,5538	0,5728	0,369%	0,384%	0,397%	-
18	0,1362	0,1289	0,1304	0,094%	0,089%	0,090%	-
19	0,2157	0,1769	0,1740	0,150%	0,123%	0,121%	-
20	0,0307	0,0255	0,0274	0,021%	0,018%	0,019%	-
21	0,0079	0,0077	0,0079	0,005%	0,005%	0,005%	-
22	0,0065	0,0064	0,0064	0,005%	0,004%	0,004%	-
23	0,0059	0,0058	0,0058	0,004%	0,004%	0,004%	-
24	0,0056	0,0055	0,0055	0,004%	0,004%	0,004%	-
25	0,0840	0,0856	0,0766	0,058%	0,059%	0,053%	-
26	0,0260	0,0274	0,0467	0,018%	0,019%	0,032%	-
27	0,0045	0,0045	0,0045	0,003%	0,003%	0,003%	-
28	0,0041	0,0041	0,0041	0,003%	0,003%	0,003%	-
29	0,0038	0,0038	0,0039	0,003%	0,003%	0,003%	-
30	0,0036	0,0036	0,0036	0,002%	0,002%	0,002%	-

No.	L1	L2	L3	L1	L2	L3	
31	0,0033	0,0034	0,0034	0,002%	0,002%	0,002%	-
32	0,0032	0,0032	0,0032	0,002%	0,002%	0,002%	-
33	0,0031	0,0031	0,0031	0,002%	0,002%	0,002%	-
34	0,0031	0,0031	0,0031	0,002%	0,002%	0,002%	-
35	0,0031	0,0031	0,0031	0,002%	0,002%	0,002%	-
36	0,0032	0,0032	0,0032	0,002%	0,002%	0,002%	-
37	0,0032	0,0033	0,0032	0,002%	0,002%	0,002%	-
38	0,0033	0,0033	0,0033	0,002%	0,002%	0,002%	-
39	0,0033	0,0034	0,0033	0,002%	0,002%	0,002%	-
40	0,0033	0,0034	0,0033	0,002%	0,002%	0,002%	-
41	0,0033	0,0034	0,0033	0,002%	0,002%	0,002%	-
42	0,0033	0,0033	0,0033	0,002%	0,002%	0,002%	-
43	0,0032	0,0033	0,0032	0,002%	0,002%	0,002%	-
44	0,0032	0,0032	0,0032	0,002%	0,002%	0,002%	-
45	0,0031	0,0032	0,0031	0,002%	0,002%	0,002%	-
46	0,0030	0,0031	0,0031	0,002%	0,002%	0,002%	-
47	0,0030	0,0031	0,0030	0,002%	0,002%	0,002%	-
48	0,0030	0,0031	0,0030	0,002%	0,002%	0,002%	-
49	0,0030	0,0031	0,0030	0,002%	0,002%	0,002%	-
50	0,0031	0,0031	0,0031	0,002%	0,002%	0,002%	-
THD	0,0472	0,047	0,0471	4,72%	4,70%	4,71%	13%
PWHD	0,0341	0,0342	0,0354	3,41%	3,42%	3,54%	22%

[17] THD = Total Harmonic Distortion

[18] PWHD = Partial Weighted Harmonic Distortion

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.

Sk,fic/Sn		20							
Power [%S_n]		**Ψ_k=30°**		**Ψ_k=50°**		**Ψ_k=70°**		**Ψ_k=85°**	
		P_{st}	**$c(\Psi_k)$**	**P_{st}**	**$c(\Psi_k)$**	**P_{st}**	**$c(\Psi_k)$**	**P_{st}**	**$c(\Psi_k)$**
100 ± 5	Phase 1	0,120017	2,400337	0,090299	1,80598	0,049555	0,991097	0,016242	0,324838
	Phase 2	0,119025	2,38051	0,089549	1,790977	0,049125	0,982505	0,016083	0,321659
	Phase 3	0,120064	2,401277	0,090331	1,80662	0,049511	0,990226	0,01615	0,323004
90 ± 5	Phase 1	0,130071	2,601423	0,097615	1,952291	0,053173	1,063467	0,016902	0,338037
	Phase 2	0,127094	2,541878	0,095381	1,907612	0,052072	1,041445	0,01663	0,332602
	Phase 3	0,130432	2,608643	0,097909	1,958173	0,053435	1,068703	0,017009	0,340179
80 ± 5	Phase 1	0,13133	2,626608	0,098481	1,96962	0,053604	1,072076	0,016907	0,33813
	Phase 2	0,130035	2,600703	0,097483	1,949665	0,053083	1,061652	0,016772	0,335434
	Phase 3	0,131935	2,638705	0,09894	1,97879	0,053871	1,077415	0,016982	0,339632
70 ± 5	Phase 1	0,136972	2,739433	0,102492	2,049831	0,055572	1,111444	0,017145	0,342907
	Phase 2	0,137001	2,74001	0,102544	2,050876	0,055708	1,114162	0,017302	0,346038
	Phase 3	0,137965	2,759307	0,103293	2,065868	0,056119	1,122372	0,017473	0,34946
60 ± 5	Phase 1	0,136972	2,739433	0,102492	2,049831	0,055572	1,111444	0,017145	0,342907
	Phase 2	0,137001	2,74001	0,102544	2,050876	0,055708	1,114162	0,017302	0,346038
	Phase 3	0,137965	2,759307	0,103293	2,065868	0,056119	1,122372	0,017473	0,34946
50 ± 5	Phase 1	0,138724	2,77448	0,103664	2,073286	0,056032	1,120642	0,017135	0,342694
	Phase 2	0,139082	2,781636	0,103952	2,079048	0,05632	1,126396	0,017293	0,345861
	Phase 3	0,140249	2,804974	0,104826	2,096521	0,056768	1,135356	0,017433	0,348669
40 ± 5	Phase 1	0,154573	3,091457	0,115427	2,30854	0,0623	1,246007	0,018522	0,370433
	Phase 2	0,153693	3,073862	0,114809	2,296186	0,062072	1,241441	0,018572	0,371442
	Phase 3	0,153033	3,060651	0,114331	2,286613	0,061837	1,236744	0,01858	0,371605
30 ± 5	Phase 1	0,152142	3,042831	0,113462	2,269245	0,061192	1,223833	0,018438	0,368751
	Phase 2	0,14884	2,976799	0,111016	2,220324	0,059949	1,198972	0,018205	0,364098
	Phase 3	0,149785	2,9957	0,111719	2,234374	0,060311	1,206214	0,018242	0,364833
20 ± 5	Phase 1	0,020826	0,416519	0,017126	0,342523	0,013375	0,267507	0,012005	0,240096
	Phase 2	0,020513	0,410256	0,016979	0,339585	0,013369	0,267373	0,01193	0,238602
	Phase 3	0,019958	0,399152	0,016379	0,327573	0,012675	0,253499	0,011328	0,226554
10 ± 5	Phase 1	0,160435	3,208705	0,11937	2,387403	0,064134	1,28269	0,019234	0,384685
	Phase 2	0,160477	3,209546	0,119439	2,388772	0,064257	1,285137	0,019333	0,386656
	Phase 3	0,156712	3,134236	0,116657	2,333149	0,062756	1,255129	0,018846	0,376926
0 ± 5	Phase 1	0,149712	2,994236	0,111363	2,22726	0,059889	1,197775	0,018243	0,364865
	Phase 2	0,153985	3,079693	0,114566	2,291319	0,061641	1,232822	0,018706	0,374113
	Phase 3	0,149707	2,994137	0,111399	2,227974	0,059986	1,19972	0,018324	0,366473

Sk,fic/Sn	20

Operation type: start-up at Sn

Phase	Ψ_k=30°			Ψ_k=50°			Ψ_k=70°			Ψ_k=85°		
	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$
Op. condition	No reactive power											
Phase 1	1,008185	1,160608	0,955621	1,006062	1,158164	0,71193	1,004126	1,155935	0,439653	1,003421	1,155124	0,371347
Phase 2	1,007924	1,160307	0,953244	1,005842	1,15791	0,709244	1,003924	1,155703	0,40839	1,003233	1,154907	0,446214
Phase 3	1,008048	1,16045	0,943811	1,005965	1,158052	0,702158	1,004057	1,155856	0,376543	1,003367	1,155062	0,100617
K_{imax}	≈1											

Operation type: start-up at 10%Sn

Phase	Ψ_k=30°			Ψ_k=50°			Ψ_k=70°			Ψ_k=85°		
	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$
Op. condition	Test 1 No reactive power											
Phase 1	0,143218	0,16487	0,186536	0,106602	0,122718	0,140853	0,057378	0,066053	0,080651	0,017503	0,020149	0,029592
Phase 2	0,14091	0,162213	0,189624	0,104912	0,120773	0,143082	0,056547	0,065096	0,080316	0,017452	0,020091	0,027181
Phase 3	0,137982	0,158843	0,604054	0,102707	0,118235	0,59272	0,055349	0,063717	0,577551	0,017049	0,019627	0,564666
K_{imax}	≈1											
Op. condition	Test 2 No reactive power											
Phase 1	0,145839	0,167888	0,559134	0,108503	0,124907	0,550658	0,058349	0,067171	0,53923	0,01766	0,02033	0,530556
Phase 2	0,143924	0,165683	1,071017	0,107131	0,123327	1,042331	0,057711	0,066436	1,004225	0,017688	0,020362	0,972078
Phase 3	0,143416	0,165098	0,19592	0,106744	0,122882	0,147265	0,057467	0,066155	0,081565	0,017541	0,020193	0,025853
K_{imax}	≈1											
Op. condition	Test 3 No reactive power											
Phase 1	0,155051	0,178492	0,556536	0,115366	0,132808	0,548915	0,06202	0,071396	0,538636	0,018421	0,021206	0,530331
Phase 2	0,15444	0,177789	1,082334	0,11498	0,132363	1,052235	0,061853	0,071204	1,011944	0,01854	0,021343	0,977878
Phase 3	0,150645	0,173421	0,198785	0,112144	0,129099	0,148623	0,060365	0,069492	0,081025	0,01817	0,020917	0,02404
K_{imax}	≈1											

Operation type: shut-down

Phase	Ψ_k=30°			Ψ_k=50°			Ψ_k=70°			Ψ_k=85°		
	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$	P_{st}	$k_f(\Psi_k)$	$K_u(\Psi_k)$
Op. condition	No reactive power											
Phase 1	1,080706	1,244093	1,009423	1,061202	1,22164	0,751651	1,031726	1,187708	0,452022	1,004619	1,156502	0,373904
Phase 2	1,081543	1,245057	0,999149	1,060946	1,221345	0,741938	1,031445	1,187385	0,406731	1,004394	1,156244	0,443803
Phase 3	1,080935	1,244357	1,00811	1,060633	1,220986	0,751292	1,031721	1,187702	0,404938	1,004555	1,156429	0,111428
K_{imax}	≈1											

Note	N_{10m}=10 and N_{120m}=120 has been considered

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.			
Test power level	10%	55%	100%
Recorded value in Amps	L1 = 47.2 mA L2 = 26.3 mA L3 = 39.1 mA	L1 = 97.3 mA L2 = 62.6 mA L3 = 51.7 mA	L1 = 207.3 mA L2 = 142.6 mA L3 = 101.7 mA
as % of rated AC current	L1 = 0.03% L2 = 0.02% L3 = 0.02%	L1 = 0.06% L2 = 0.04% L3 = 0.03%	L1 = 0.13% L2 = 0.09% L3 = 0.06%
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**. 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.			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	1.00	1.00	1.00
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.

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	47.507	20.1	47.7 Hz 30 s	Confirmed
U/F stage 2	47 Hz	0.5 s	47.003	0.590	47.2 Hz 19.5 s	Confirmed
					46.8 Hz 0.45 s	Confirmed

O/F	52 Hz	0.5 s	52.02	0.591	51.8 Hz 120.0 s	Confirmed
					52.2 Hz 0.45 s	Confirmed

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.

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	184.21	2.603	188 V 5.0 s	Confirmed
					180 V 2.45 s	Confirmed
O/V stage 1	1.14 pu (262.2 V)	1.0 s	262.81	1.111	258.2 V 5.0 s	Confirmed
O/V stage 2	1.19 pu (273.7 V)	0.5 s	274.45	0.606	269.7 V 0.95 s	Confirmed
					277.7 V 0.45 s	Confirmed

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	44 ms	158 ms	345 ms	61 ms	425 ms	442 ms

Loss of Mains Protection, Vector Shift Stability test. This test should be carried out in accordance with Annex A.7.1.2.6.

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 H z	+50 degrees	Confirmed no trip
Negative Vector Shift	50.5 H z	- 50 degrees	Confirmed no trip

Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6.			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	Confirmed no trip
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	Confirmed no trip

9. Limited Frequency Sensitive Mode – Over frequency 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.	
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	97496	49.9987	100000	-
Step b) 50.45Hz ±0.05Hz	92791	50.4519		-
Step c) 50.70Hz ±0.10Hz	69113	50.6996		-
Step d) 51.15Hz ±0.05Hz	25114	51.1532		-
Step e) 50.70Hz ±0.10Hz	69108	50699		-
Step f) 50.45Hz ±0.05Hz	92783	50.4528		-
Step g) 50.00Hz ±0.01Hz	97426	49.9984		29.65% s^{-1}

Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz	48214	49.9986	50000	-
Step b) 50.45Hz ±0.05Hz	46064	50.4509		-
Step c) 50.70Hz ±0.10Hz	34226	50.6993		-
Step d) 51.15Hz ±0.05Hz	12885	51.1528		-
Step e) 50.70Hz ±0.10Hz	34566	50.6998		-
Step f) 50.45Hz ±0.05Hz	46301	50.451		65.93% s^{-1}
Step g) 50.00Hz ±0.01Hz	48181	49.9985		43.21% s^{-1}

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.

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.			
20	23.102	At 1.16 pu (266.2 V)	At 0.78 pu (180.0 V)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		Confirmed no reconnect	Confirmed no reconnect	Confirmed no reconnect	Confirmed no reconnect

11. Fault level contribution: These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5.

For **Inverter** output

Time after fault	Volts	Amps
20ms	L1 = 337.2V L2 = 349.4V L3 = 327.7V	L1 = 160.2A L2 = 166.1A L3 = 152.2A
100ms	L1 = 15.6V L2 = 27.9V L3 = 29.3V	L1 = 1.59A L2 = 1.07A L3 = 1.08A
250ms	L1 = 15.6V L2 = 27.9V L3 = 28.3V	L1 = 1.58A L2 = 1.07A L3 = 1.08A
500ms	L1 = 15.6V L2 = 27.9V L3 = 28.3V	L1 = 1.59A L2 = 1.07A L3 = 1.08A
Time to trip	0.08	In seconds

12. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.7.	
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
Additional comments.	