Form A2-3: Compliance Verification Report for 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.

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 must 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 must 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) 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.

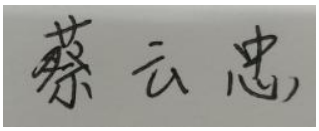
PGM technology		Growatt SPH4000，Growatt SPH4600，Growatt SPH5000，Growatt SPH6000	
Manufacturer name		Growatt New Energy Technology Co., Ltd.	
Address		1st East & 3rd Floor of Building A,Building B,Jiayu Industrial Park,#28,GuangHui Road,LongTeng Community,Shiyan Street,Baoan,District,Shenzhen, P.R.China	
Tel	+86 755 2951 5888	Web site	www.ginverter.com
E:mail	yunzhong.cai@growatt.com		
Registered Capacity		6kW	

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 PGMs** tests marked with * may be carried out at the time of commissioning (Form A4).

Tested option:	**1. Fully Type Tested**	**2. Partially Type Tested**	**3. One-off Man. Info.**	**4. Tested on Site at time of Commission-ing**
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 Modules** 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				
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)*				
14. Logic Interface (input port)*				

* may be carried out at the time of commissioning (Form A.2-4).

Document reference(s) for **Manufacturers' Information:**

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 **Modifications** are required to ensure that the product meets all the requirements of EREC G99.			
Signed		On behalf of	Growatt New Energy Technology Co., Ltd.
Note that testing can be done by the **Manufacturer** of an individual component or by an external test house. Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.			

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

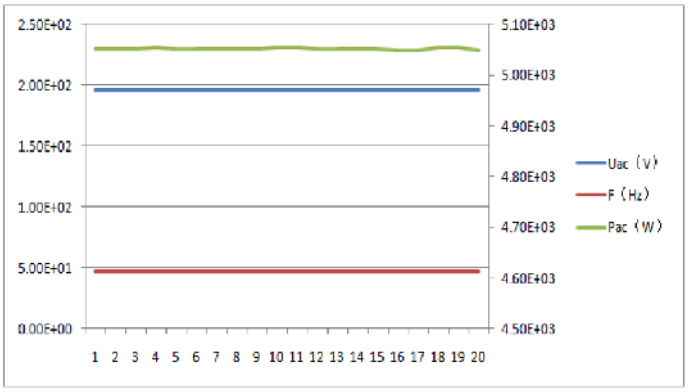
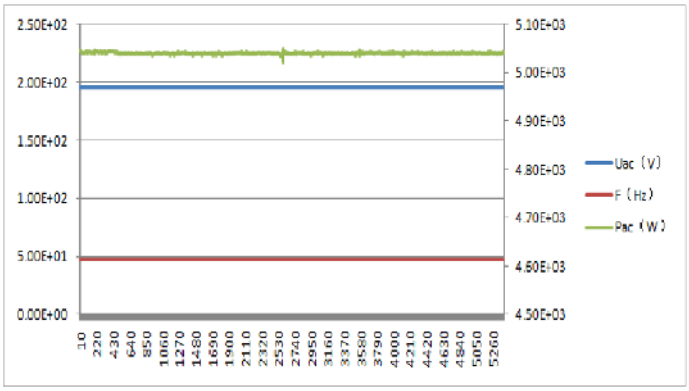
1. Operating Range: Two tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the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

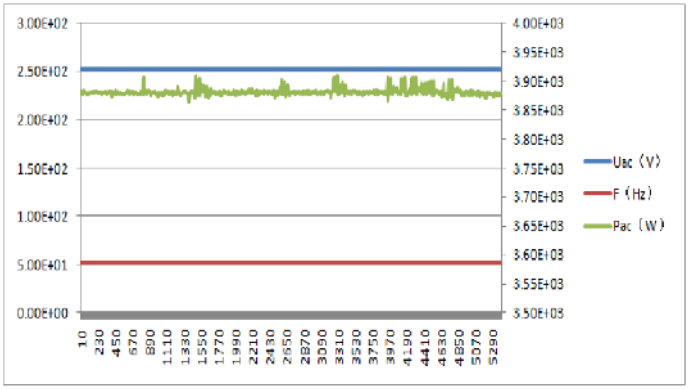
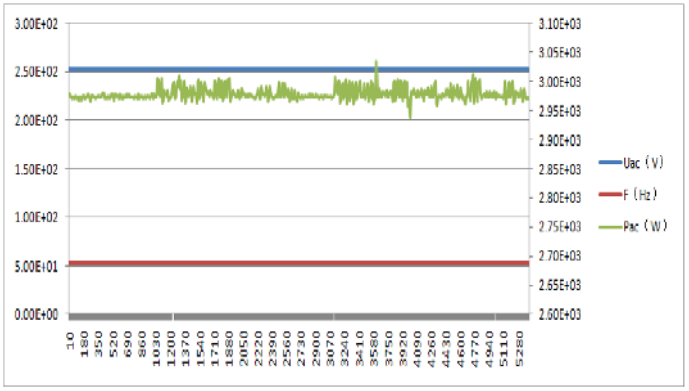
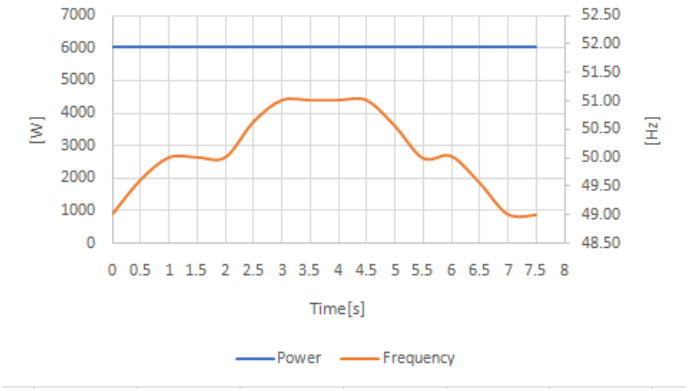
Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time.

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	
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	

Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	
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.	
2. Power Quality – Harmonics: For **Power Generating Modules** 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. **Power Generating Modules** with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the **Power Generating Module** in order to accept the connection to a **Distribution Network.** For **Power Generating Modules** of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.	
Power Generating Module tested to BS EN 61000-3-12	

Power Generating Module rating per phase (rpp)			4	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.0224	0.129	0.0284	0.163	8%	8%
3	0.0819	0.471	0.0828	0.476	21.6%	Not stated
4	0.0135	0.078	0.0121	0.070	4%	4%
5	0.0199	0.114	0.042	0.242	10.7%	10.7%
6	0.0102	0.059	0.007	0.040	2.67%	2.67%
7	0.0383	0.220	0.0418	0.240	7.2%	7.2%
8	0.0068	0.039	0.0162	0.093	2%	2%
9	0.0371	0.213	0.0209	0.120	3.8%	Not stated
10	0.0165	0.095	0.0216	0.124	1.6%	1.6%
11	0.0317	0.182	0.0373	0.214	3.1%	3.1%
12	0.0125	0.072	0.0211	0.121	1.33%	1.33%
13	0.0278	0.160	0.0377	0.217	2%	2%
THD[1]	-	1.524	-	1.318	23%	13%
PWHD[2]	-	1.791	-	1.643	23%	22%
Power Generating Module rating per phase (rpp)			4.6	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.0239	0.120	0.0297	0.149	8%	8%

[1] THD = Total Harmonic Distortion

[2] PWHD = Partial Weighted Harmonic Distortion

3	0.0706	0.353	0.1120	0.560	21.6%	Not stated
4	0.0092	0.046	0.0183	0.092	4%	4%
5	0.0207	0.104	0.0449	0.225	10.7%	10.7%
6	0.0126	0.063	0.0155	0.078	2.67%	2.67%
7	0.0348	0.174	0.0347	0.174	7.2%	7.2%
8	0.0271	0.136	0.0182	0.091	2%	2%
9	0.0428	0.214	0.0369	0.185	3.8%	Not stated
10	0.0111	0.056	0.0151	0.076	1.6%	1.6%
11	0.0339	0.170	0.0381	0.191	3.1%	3.1%
12	0.0134	0.067	0.0168	0.084	1.33%	1.33%
13	0.0284	0.142	0.0428	0.214	2%	2%
THD[1]	-	1.483	-	1.353	23%	13%
PWHD[2]	-	1.745	-	1.610	23%	22%
Power Generating Module rating per phase (rpp)			5	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.0137	0.063	0.0237	0.109	8%	8%
3	0.0707	0.325	0.1054	0.485	21.6%	Not stated
4	0.0174	0.080	0.0093	0.043	4%	4%
5	0.0218	0.100	0.0495	0.228	10.7%	10.7%
6	0.0086	0.040	0.0163	0.075	2.67%	2.67%
7	0.0328	0.151	0.0433	0.199	7.2%	7.2%
8	0.0113	0.052	0.0147	0.068	2%	2%
9	0.0398	0.183	0.0387	0.178	3.8%	Not stated
10	0.0144	0.066	0.0147	0.068	1.6%	1.6%

11	0.0382	0.176	0.0359	0.165	3.1%	3.1%
12	0.0142	0.065	0.0223	0.103	1.33%	1.33%
13	0.0387	0.178	0.0542	0.249	2%	2%
THD[1]	-	1.517	-	1.266	23%	13%
PWHD[2]	-	1.805	-	1.495	23%	22%
Power Generating Module rating per phase (rpp)			6	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.0210	0.081	0.0368	0.141	8%	8%
3	0.0187	0.072	0.1277	0.490	21.6%	Not stated
4	0.0134	0.051	0.0170	0.065	4%	4%
5	0.0242	0.093	0.0300	0.115	10.7%	10.7%
6	0.0056	0.021	0.0091	0.035	2.67%	2.67%
7	0.0458	0.176	0.0410	0.157	7.2%	7.2%
8	0.0218	0.084	0.0062	0.024	2%	2%
9	0.0405	0.155	0.0369	0.141	3.8%	Not stated
10	0.0130	0.050	0.0227	0.087	1.6%	1.6%
11	0.0322	0.123	0.0341	0.131	3.1%	3.1%
12	0.0124	0.048	0.0049	0.019	1.33%	1.33%
13	0.0364	0.140	0.0345	0.132	2%	2%
THD[1]	-	1.392	-	0.963	23%	13%
PWHD[2]	-	1.663	-	1.280	23%	22%

3. Power Quality – Voltage fluctuations and Flicker:

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

	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	1.079%	0.15%	0	1.08%	0.15%	0	0.271	0.17
Normalised to standard impedance	1.079%	0.15%	0	1.08%	0.15%	0	0.271	0.17
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	Xl	0.25	Ω
Standard Impedance	R	0.4 ^	Ω	Xl	0.25 ^	Ω
Maximum Impedance	R	-	Ω	Xl	-	Ω

* Applies to three phase and split single phase **Power Generating Modules.**

^ Applies to single phase **Power Generating Module** and **Power Generating Modules** 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 x 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 XI 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 comply with 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	21. June.2020	Test end date	21. June.2020
Test location	Growatt R&D Test Lab		
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（4K）	10%	55%	100%
Recorded value in Amps	33.1mA	31.4mA	19.1mA
as % of rated AC current	0.19%	0.18%	0.11%
Limit	0.25%	0.25%	0.25%

Test power level（4.6K）	10%	55%	100%
Recorded value in Amps	25.4mA	24.1mA	22.8mA
as % of rated AC current	0.13%	0.12%	0.11%
Limit	0.25%	0.25%	0.25%

Test power level（5K）	10%	55%	100%
Recorded value in Amps	36.3mA	33.7mA	31.3mA
as % of rated AC current	0.17%	0.16%	0.14%
Limit	0.25%	0.25%	0.25%

Test power level（6K）	10%	55%	100%
Recorded value in Amps	40.2mA	35.9mA	46mA
as % of rated AC current	0.15%	0.14%	0.18%

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	0.99754	0.99759	0.99676
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	47.49Hz	20.138s	47.7 Hz 30 s	No trip
U/F stage 2	47 Hz	0.5 s	46.98Hz	0.541s	47.2 Hz 19.95 s	No trip
					46.8 Hz 0.45 s	No trip
O/F	52 Hz	0.5 s	52.04Hz	0.562s	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.

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	2.576s	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	263V	1.028s	258.2 V 5.0 s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	274V	0.519s	269.7 V 0.95s	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	0.271s	0.268s	0.218s	0.253s	0.26s	0.208s

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 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.			
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 – 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, simulation 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	5981.71W	50.001Hz	6197.87W	-
Step b) 50.45Hz ±0.05Hz	5920.45W	50.45Hz		-
Step c) 50.70Hz ±0.10Hz	5630.24W	50.701Hz		-
Step d) 51.15Hz ±0.05Hz	5090.76W	51.151Hz		-
Step e) 50.70Hz ±0.10Hz	5640.24W	50.7Hz		-
Step f) 50.45Hz ±0.05Hz	5918.65W	50.451Hz		-

Step g) 50.00Hz ±0.01Hz	5981.75W	50Hz		
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz	2965.31W	50Hz	3071.68W	-
Step b) 50.45Hz ±0.05Hz	2930.3W	50.451Hz		-
Step c) 50.70Hz ±0.10Hz	2785.27W	50.701Hz		-
Step d) 51.15Hz ±0.05Hz	2511.22W	51.15Hz		-
Step e) 50.70Hz ±0.10Hz	2783.4W	50.701Hz		-
Step f) 50.45Hz ±0.05Hz	2930.7W	50.451Hz		
Step g) 50.00Hz ±0.01Hz	2955.32W	50Hz		

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.			
20s	20s	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.		yes	yes	yes	yes

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	81.2V	28A
100ms	77.3V	22.5A

250ms	76.9V	16.5A
500ms	73.5V	8.9A
Time to trip	0.2s	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.		
This equipment is equipped with RJ45 terminal for logic interface that being received the signal from the DNO, the connection should be installed per installation manual, and the signal should be a simple binary output that captured by RJ45 terminal(PIN 5 and 1 for detecting the signal). Once the signal actived, the inverter will reduce its active power to zero within 5s.		