Form A2-1: Compliance Verification Report for Synchronous and Asynchronous (non inverter) Power Generating Modules up to and including 50 kW

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. Tests 1 – 14 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 productwhich 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:

If the **Power Generating Module** is **FullyType 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 Limited	
Address		1-5 Raytel House, Cutlers road, South Woodham Ferrers, Chelmsford,Essex. England	
Tel.	01245428560	Web site	www.rayleigh.com
E:mail	t.hawkins@rayleigh.com		
Registered Capacity		4kW - 6kW	

There are four options for Testing: (1) **Fully Type Tested**, (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 TestedPGM**s tests may be carried out at the time of commissioning (Form A2-4).
Include reference(s) for **Manufacturers' Information** including the ENA Type Test Verification Report Registersystem reference number where applicable.

Tested option:	**1. Fully Type Tested**	**2. Type Tested product**	**3. One-Off Manufactures' 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. **Power Factor** (PF)				
5. Frequency protection trip and ride through tests				
6. Voltage protection trip and ride through tests				
7. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test				
8. **LFSM-O** Test				
9. Power Output with Falling Frequency Test				
10. Protection – Reconnection Timer				
11. Fault Level Contribution				

There are four options for Testing: (1) **Fully Type Tested**, (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 TestedPGM**s tests may be carried out at the time of commissioning (Form A2-4).
Include reference(s) for **Manufacturers' Information** including the ENA Type Test Verification Report Registersystem reference number where applicable.

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

Manufacturer compliance declaration - I certify that all products supplied by the company with the above **Type TestedManufacturer**'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 (ie product) 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.

A2-1 Compliance Verification Report –Tests for Type A Synchronous Power Generating Modules up to and including 50 kW – test record

1. Operating Range: Tests should be carried with the **Power Generating Module** operating at **RegisteredCapacity** and connected to a suitable test supply, grid simulation set or load bank. 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. 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.

Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz**,** **Power Factor** = 1, Period of test 20 s	Measured Voltage(V): 196.6 Measured Frequency(Hz):47 Measured Power(W): 5136 Measured Factor:1 Confirm normal operation: YES
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Measured Voltage(V): 196.8 Measured Frequency(Hz):47.5 Measured Power(W): 5157 Measured Factor:1 Confirm normal operation: YES
Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Measured Voltage(V): 254.3 Measured Frequency(Hz):51.5 Measured Power(W): 6029 Measured Factor:1 Confirm normal operation: YES
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Measured Voltage(V): 254.3 Measured Frequency(Hz):52 Measured Power(W): 6024 Measured Factor:1 Confirm normal operation: YES
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Measured Voltage(V): 230.00 Measured Frequency(Hz): 50.00 Measured Power(W): 4980 Measured Factor:1 Confirm normal operation:YES
Test 6 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.	Measured Voltage(V): 230 Measured Frequency(Hz): 50 Measured Power(W): 5000 Measured Factor: 1 Confirm normal operation YES

2. Power Quality – Harmonics: The test requirements are specified in A.7.2.5. 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.

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)	4/4.6/5 & 6	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**[1]						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	0.0148			0.0566			8%	8%
3	0.1922			0.7367			21.6%	Not stated
4	0.0126			0.0481			4%	4%
5	0.0498			0.1909			10.7%	10.7%
6	0.0100			0.0385			2.67%	2.67%
7	0.0385			0.1477			7.2%	7.2%
8	0.0151			0.0579			2%	2%
9	0.0133			0.0509			3.8%	Not stated
10	0.0093			0.0357			1.6%	1.6%
11	0.0109			0.0419			3.1%	3.1%
12	0.0106			0.0405			1.33%	.33%
13	0.0128			0.0490			2%	2%

[1] See the note in A.7.2.5.1 if 45-55% of **Registered Capacity** is below the **Minimum Stable Operating Level**. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated in the box at the end of this section.

THD[2]				1.956			23%	13%
PWHD[3]				2.158			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	0.0443			0.1696			8%	8%
3	0.6096			2.3366			21.6%	Not stated
4	0.0186			0.0711			4%	4%
5	0.0522			0.2000			10.7%	10.7%
6	0.0136			0.0522			2.67%	2.67%
7	0.0415			0.1591			7.2%	7.2%
8	0.0223			0.0855			2%	2%
9	0.0166			0.0638			3.8%	Not stated
10	0.0148			0.0568			1.6%	1.6%
11	0.0144			0.0550			3.1%	3.1%
12	0.0160			0.0615			1.33%	.33%
13	0.0197			0.0757			2%	2%
THD[4]				1.399			23%	13%
PWHD[5]				1.411			23%	22%
Reason for not testing at 45-55% **Registered Capacity** (if applicable):								

2 THD = Total Harmonic Distortion
3 PWHD = Partial Weighted Harmonic Distortion
4 THD = Total Harmonic Distortion
5 PWHD = Partial Weighted Harmonic Distortion

3. Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with Annex A.7.2.5.3. 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.

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 maxnormalised 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				Test end date				
Test location								
	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	0	0	0	0	0	0.1328	0.1339
Normalised to standard impedance	0	0	0	0	0	0	0.1328	0.1339
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R	0.4	Ω	X		Ω
Standard Impedance	R	0.24 *0.4 ^	Ω	X	0.15 *0.25 ^	Ω
Maximum Impedance	R		Ω	X		Ω

* Applies to three phase and split single phase **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 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.7.2.5.2.

Voltage	0.94 pu (216.2 V)	1.0 pu (230 V)	1.1 pu (253 V)
Measured value	0.9981	0.9982	0.9996
Power Factor Limit	>0.95	>0.95	>0.95

5. Protection – Frequency tests: These tests should be carried out in accordance with Annex A.7.2.2.3. 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	47.49 Hz	20.03s	47.7 Hz 30 s	No trip
					47.2 Hz 19.5 s	No trip
U/F stage 2	47 Hz	0.5 s	46.95 Hz	0.54s	46.8 Hz 0.45 s	No trip
O/F	52 Hz	0.5 s	52.01Hz	0.52s	51.8 Hz 120 s	No trip
					52.2 Hz 0.45 s	No trip

6. Protection – Voltage tests: These tests should be carried out in accordance with Annex A.7.2.2.2. For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

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	183.1 V	2.549s	188 V 5.00 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	1.14 pu (262.2 V)	1.0 s	263.4V	1.044s	258.2 V 5.0 s	No trip
					269.7 V 0.95s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	278.5V	0.225s	277.7 V 0.45s	No trip

7. Protection – Loss of Mains test: The tests are to be carried out at three output power levels ±5%. These tests should be carried out in accordance with Annex A.7.2.2.4.						
To be carried out at three output power levels with a tolerance of ± 5% in Test Power levels.[6]						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Limit is 0.5 s	76.4ms	92.3ms	172.5ms	122.3ms	89.9ms	144.2ms
For Multi phase**Power Generating Module**s confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph1 fuse removed						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph2 fuse removed						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph3 fuse removed						
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.						ms
Reason for not testing at suggested loading levels (if applicable):						

[6] See the note in A.7.2.2.4 if the suggested loading levels are below the **Minimum Stable Operating Level**. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated in the box at the end of this section.

Loss of Mains Protection, Vector Shift Stability test: This test should be carried out in accordance with Annex A.7.2.2.6. 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.7.2.2.6. 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
49.0Hz to 51.0Hz	+0.95 Hzs^{-1}	2.1 s	No trip
51.0Hz to 49.0Hz	-0.95 Hzs^{-1}	2.1 s	No trip
8. 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.7.2.4.			
Active Power response to rising frequency/time plots are attached			**Y/N**
9. Power output with falling frequency test			
Tests should prove that the **Power Generating Module** does not reduce output power as the frequency falls. These tests should be carried out in accordance with Annex A.7.2.3.			
Test sequence	Measured **Active Power** Output	Acceptable **Active Power**	Primary power source (if applicable)
49.5 Hz for 5 minutes	5996	100% **Registered Capacity**	6223
49.0 Hz for 5 minutes	5994	99% **Registered Capacity**	6223
48.0 Hz for 5 minutes	5991	97% **Registered Capacity**	6222
47.6 Hz for 5 minutes	2989	96.2% **Registered Capacity**	6221
47.1 Hz for 20 s	5988	95% **Registered Capacity**	6222

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.			
		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.		No reconnection	No reconnection	No reconnection	No reconnection

11. Fault level contribution: **Manufacturers'Information** in respect of the fault level contribution shall be provided.

12. Wiring functional tests: If required by para 15.2.1,

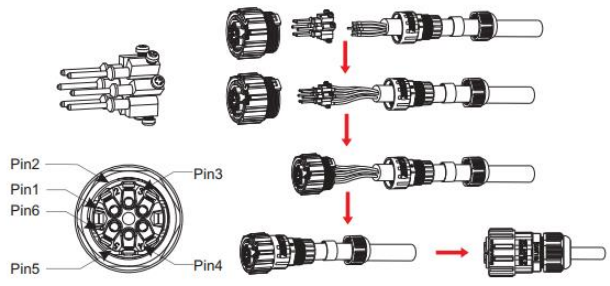
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	Yes / NA

13. 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, eg details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes / NA

Pin	Description	Pin	Description
1	DRM 1/5	4	DRM 4/8
2	DRM 2/6	5	RefGen
3	DRM 3/7	6	Com/DRM 0

Please follow below figure to assemble DRM connector.



Mode	Requirement
DRM0	
DRM1	
DRM2	

DRM3	When the inverter receives high level potential on pin 3 of the DRM port, the active power of the inverter decreases to 0W within 5s.	
DRM4		
DRM5		

14. Cyber security	
Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7.	Yes / NA
Additional comments	