

<p><b>ENA ERAC G98/1-3:2019</b></p> <p><i>Requirements for the connection of Fully Type Tested Micro-generators                  (up to and including 16 A per phase)                  in parallel with public Low Voltage Distribution Networks on or after 27 April 2019</i></p>	
<p><b>Report reference No.</b> .....</p> <p>Tested by                  (printed name and signature) .....</p> <p>Approved by                  (printed name and signature) .....</p> <p>Date of issue .....</p>	<p>P2019031202</p> <p>Daniel Keis </p> <p>Manuel Shimasaki </p> <p>12 April 2019</p>
<p><b>Testing Laboratory Name</b> :</p> <p> <b>IANZ</b>                  ACCREDITED LABORATORY</p> <p>Address .....</p> <p>Testing location/procedure .....</p> <p>Other (please explain) .....</p>	<p>EnTEST Laboratories</p> <p>Tests indicated as traceable only are outside of the laboratory's scope of accreditation                  Accreditation number: 1273</p> <p>1 Treffers Road, Wigram, Christchurch 8042, New Zealand</p> <p>NZ <input checked="" type="checkbox"/></p>
<p><b>Applicant's Name</b> .....</p> <p>Address .....</p>	<p>Enphase Energy</p> <p>1420 North McDowell Boulevard, Petaluma, CA 94954, USA</p>
<p><b>Test specification</b></p> <p>Standard .....</p> <p>Test procedure .....</p> <p>Non-standard test method .....</p>	<p>ENA ERAC G98/1-3:2019</p> <p>EnTEST Laboratories</p>
<p><b>Test Report Form No.</b> .....</p> <p>TRF originator. ....</p> <p>Non-standard test method .....</p> <p>This publication may be reproduced in whole or in part for non-commercial purposes as long as the EnTEST Laboratories is acknowledged as copyright owner and source of the material. EnTEST Laboratories takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.</p>	<p>ENA ERAC G98/1-3:2019</p> <p>EnTEST Laboratories</p>
<p><b>Test item description</b> .....</p> <p>Trademark .....</p> <p>Manufacturer .....</p> <p>Model and/or type reference .....</p> <p>Rating(s) .....</p>	<p>Solar Micro-inverter</p> <p> <b>ENPHASE.</b></p> <p>Enphase Energy Inc.</p> <p>IQ7PLUS-72-X-Y-Z</p> <p>See rating table</p>

**Model rating table:**

Specification	Units	IQ7PLUS
Rated output active power	W	290
Output apparent power	VA	290
Nominal output voltage	V <sub>rms</sub>	230
Output voltage range	V <sub>rms</sub>	184-276
Nominal output frequency	Hz	50
Output frequency range	Hz	45-55
AC output current	A <sub>rms</sub>	1.26
EN50530 efficiency	%	96.5
Full power MPPT input voltage range	V	27-45
Input operating range	V	16-60
Input current limit region	V	16-27
Input frequency	Hz	DC
Input maximum continuous current	A	12
DC short circuit input maximum	A	15
Ingress protection		IP67
Environmental category		Outdoor
Wet locations		suitable
Pollution degree		PD3
Ambient temperature		-40C to +65C
Relative humidity		4K4H
Maximum altitude		< 2000m
Overvoltage category		OVC III

Models IQ7PLUS-72-X-Y-Z nomenclature details:

Suffix X = 2, 5 or B

2 = Multicontact PV connector

5 = Amphenol PV connector

B = Bulkhead PV connector

Y = blank or ACM (X marking not required)

Z = blank or any letter for country of intended installation e.g.:

INT = International

FR = France

NL = Netherlands

DE = Germany

Mode and control of the inverter can be performed via PLC (Power Line Communication) with an external control gateway named Envoy.

There was reinforced isolation between the SELV DC input and the hazardous voltage AC output.

Firmware version:

520-00082-r01- v02.14.02



**Copy of marking plate**

Model: IQ7PLUS-72-X-Y-Z

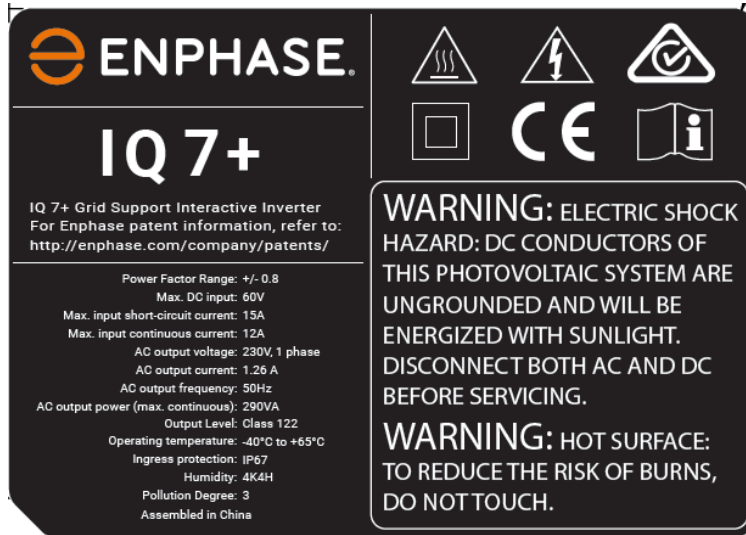


Figure 1: IQ7PLUS marking plate

Model: IQ7PLUS-ACM-INT

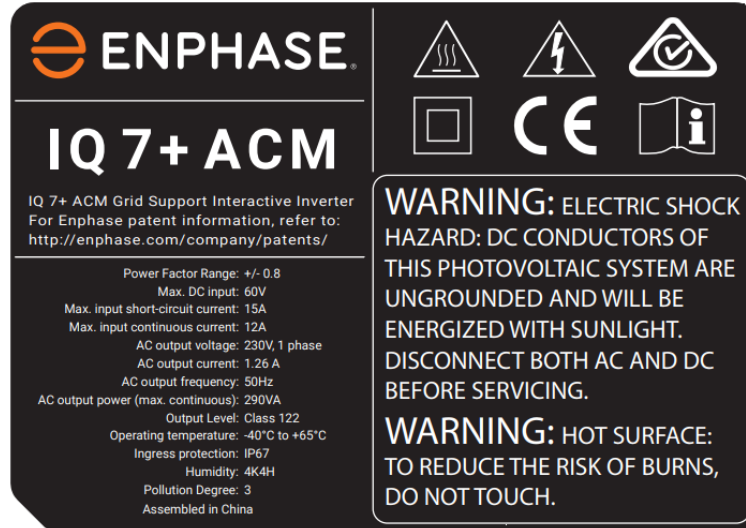


Figure 2: IQ7+ACM marking plate

**SUMMARY OF COMPLIANCE WITH ENA ERAC G98/1-3:2019**

All tests passed the requirements of the ENA ERAC G98/1-3:2019 standard within the required limits and within the equipment uncertainties.

The system, consisting of Photovoltaic Micro-inverters model number IQ7PLUS-72-X-Y-Z **COMPLIED** with the tested clauses of ENA ERAC G98/1-3:2019.

**Possible test case verdicts:**

- test case does not apply to the test object ..... : N/A
- test object does meet the requirement ..... : P(Pass)
- test object does not meet the requirement..... : F(Fail)
- informative information only ..... : Noted

**Testing**

Date of receipt of test item.....: May 2018  
Date (s) of completion of tests.....: March - April 2019

**General remarks:**

1. The test results presented in this report relate only to the object tested.
2. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
3. If the measured result complies up to the limit of acceptance, the result shall be reported along with our uncertainty of measurement. e.g. results to state window of uncertainty.
4. "(see Enclosure #)" refers to additional information appended to the report.
5. "(see appended table)" refers to a table appended to the report.
6. This report supersedes P2018062801 as G83/2-1 has been superseded by G98/1-3:2019 and firmware has been upgraded from 520-00082-r01-v02.12.02 to 520-00082-r01-v02.14.02.
7. New tests include
  - a. Operating range,
  - b. Updated power quality, DC injection and power factor tests,
  - c. Removal of stage 1 over frequency and stage 1 under voltage tests,
  - d. adding of LFSM over frequency test,
  - e. adding Power output with falling frequency test

**General product information:**

The EUT (Equipment Under Test), known as Photovoltaic Micro-inverters, model number IQ7PLUS was supplied for testing to ENA ERAC G98/1-3:2019 by Enphase Energy Inc of 1420 North McDowell Boulevard, Petaluma, CA 94954, USA.



**Worst case uncertainty of Measurements**

Parameter	Range	Instrument accuracy of Measuring Range
<b>Voltage</b>		
- Up to 1000 V	up to 1 kHz 1kHz up to 5 kHz 5 kHz up to 20 kHz 20 kHz and above	±1,5 % ±2 % ±3 % ±5 %
- 1000 V and above	dc up to 20 kHz 20 kHz and above	±3 % ±5 %
<b>Current</b>		
- Up to 5 A	up to 60 Hz above 60 Hz up to 5 kHz 5 kHz up to 20 kHz 20 kHz and above	±1,5 % ±2,5 % ±3,5 % ±5 %
- Above 5 A	up to 5 kHz 5 kHz up to 20 kHz 20 kHz and above	±2,5 % ±3,5 % ± %
<b>Leakage (Touch) current<sup>1</sup></b>	50 Hz up to 60 Hz greater 60 Hz up to 5 kHz greater 5 kHz up to 100 kHz greater 100 kHz up to 1 MHz	±3,5 % ±5 % ±10 % under consideration
<b>Power (50/60 Hz)</b>	up to 3 kW above 3 kW	±3 % ±5 %
<b>Power Factor (50/60 Hz)</b>		±0,05
<b>Frequency</b>	up to 10 kHz	±0,2 %
<b>Resistance</b>	1 mW up to 100 mΩ and above 1 MΩ up to 1 TΩ above 1 TΩ for all other cases	±5 % ±10 % ±3 %
<b>Temperature<sup>2,3</sup></b>	- 35°C to below 100° C 100° C up to 500° C below - 35°C	±2° C ±3° C ±3° C
<b>Time</b>	10 ms up to 200 ms 200 ms up to 1 s 1 s and above	±5 % ±10 ms ±1 %
<b>Linear dimensions</b>	up to 1 mm 1 mm up to 25 mm 25 mm and above	±0,05 mm ±0,1 mm ±0,5 %
<b>Mass</b>	above 10 g and up to 100 g 100 g up to 5 kg 5 kg and above	±1 % ±2 % ±5 %
<b>Force</b>	for all values	±6 %
<b>Mechanical energy</b>	for all values ± 10%	±10 %
<b>Torque</b>		±10%
<b>Angles</b>		±1 degree
<b>Relative humidity</b>	30% to 95% RH	±6% RH
<b>Barometric air pressure</b>		±10 kPa

1. The stated tolerances apply to the total tolerance of the leakage (touch) current circuit and metering Instrument.
2. Thermocouple not included in the Instrument accuracy of measuring range. Thermocouples type "T" premium grade, are recommended.
3. Not for measurements related to relative humidity.



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<b><u>TABLE OF RESULTS</u></b>

**Form C: Type Test Verification Report**

Type Approval and **Manufacturer** declaration of compliance with the requirements of G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA).

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA **Type Test Verification Report** Register, the **Installation Document** should include the **Manufacturer's** Reference Number (the Product ID), and this form does not need to be submitted.


Where the **Micro-generator** is not registered with the ENA **Type Test Verification Report** Register this form needs to be completed and provided to the **DNO**, to confirm that the **Micro-generator** has been tested to satisfy the requirements of this EREC G98.

<b>Manufacturer's</b> reference number	IQ7PLUS-72-X-Y-Z
<b>Micro-generator</b> technology	Micro-Inverter
<b>Manufacturer</b> name	Enphase Energy Inc
Address	1420 North McDowell Boulevard, Petaluma, CA 94954, USA

Tel		Fax	
E-mail		Web site	Enphase.com

<b>Registered Capacity</b> , use separate sheet if more than one connection option.	Connection Option	
	0.29 kW	kW single phase, single, split or three phase system
		kW three phase
		kW two phases in three phase system
		kW two phases split phase system

**Manufacturer Type Test** declaration. - I certify that all products supplied by the company with the above **Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed		On behalf of	Enphase Energy
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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.



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**TABLE OF RESULTS**

**Operating Range:** This test should be carried out as specified in EN 50438 D.3.1.

**Active Power** shall be recorded every second. The tests will verify that the **Micro-generator** can operate within the required ranges for the specified period of time.

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

In case of a PV **Micro-generator** the PV primary source may be replaced by a **DC** source.

In case of a full converter **Micro-generator** (eg wind) the primary source and the prime mover **Inverter/rectifier** may be replaced by a **DC** source.

In case of a DFIG **Micro-generator** the mechanical drive system may be replaced by a test bench motor.

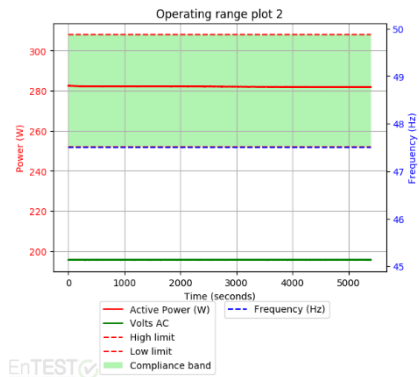
**Test 1**

Voltage = 85% of nominal (195.5 V)

Frequency = 47.5 Hz

Power factor = 1

Period of test 90 minutes



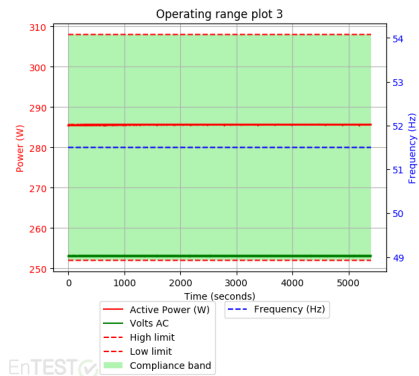
**Test 2**

Voltage = 110% of nominal (253 V).

Frequency = 51.5 Hz

Power factor = 1

Period of test 90 minutes



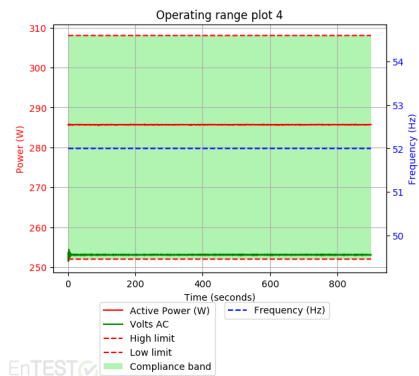
**Test 3**

Voltage = 110% of nominal (253 V).

Frequency = 52.0 Hz

Power factor = 1

Period of test 15 minutes



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<b><u>TABLE OF RESULTS</u></b>

**Power Quality – Harmonics:** These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of **Registered Capacity**. The test requirements are specified in Annex A1 A.1.3.1 (**Inverter** connected) or Annex A2 A.2.3.1 (Synchronous).

Micro-generator tested to BS EN 61000-3-2						
Micro-generator rating per phase (rpp)			2.109 kW			
Harmonic	At 45-55% of <b>Registered Capacity</b>		100% of <b>Registered Capacity</b>		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
	Measured Value in Amps		Measured Value in Amps			
2	0.0034	0.0059	0.0071	0.0124	1.080	
3	0.0241	0.0421	0.0237	0.0414	2.300	
4	0.0003	0.0005	0.0003	0.0005	0.430	
5	0.1059	0.1848	0.2278	0.3975	1.140	
6	0.0002	0.0003	0.0004	0.0007	0.300	
7	0.0008	0.0014	0.0021	0.0037	0.770	
8	0.0003	0.0005	0.0003	0.0005	0.230	
9	0.0031	0.0054	0.0011	0.0019	0.400	
10	0.0002	0.0003	0.0003	0.0005	0.184	
11	0.0100	0.0174	0.0039	0.0068	0.330	
12	0.0004	0.0007	0.0005	0.0009	0.153	
13	0.0107	0.0187	0.0033	0.0058	0.210	
14	0.0003	0.0005	0.0004	0.0007	0.131	
15	0.0102	0.0178	0.0034	0.0059	0.150	
16	0.0004	0.0007	0.0006	0.0010	0.115	
17	0.0068	0.0119	0.0037	0.0065	0.132	
18	0.0004	0.0007	0.0003	0.0005	0.102	





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19	0.0036	0.0063	0.0029	0.0051	0.118	
20	0.0006	0.0010	0.0007	0.0012	0.092	
21	0.0025	0.0044	0.0062	0.0108	0.107	0.160
22	0.0005	0.0009	0.0003	0.0005	0.084	
23	0.0003	0.0005	0.0041	0.0072	0.098	0.147
24	0.0003	0.0005	0.0004	0.0007	0.077	
25	0.0015	0.0026	0.0059	0.0103	0.090	0.135
26	0.0003	0.0005	0.0005	0.0009	0.071	
27	0.0020	0.0035	0.0064	0.0112	0.083	0.124
28	0.0003	0.0005	0.0004	0.0007	0.066	
29	0.0019	0.0033	0.0058	0.0101	0.078	0.117
30	0.0003	0.0005	0.0004	0.0007	0.061	
31	0.0031	0.0054	0.0065	0.0113	0.073	0.109
32	0.0003	0.0005	0.0005	0.0009	0.058	
33	0.0010	0.0017	0.0053	0.0092	0.068	0.102
34	0.0005	0.0009	0.0004	0.0007	0.054	
35	0.0012	0.0021	0.0036	0.0063	0.064	0.096
36	0.0004	0.0007	0.0004	0.0007	0.051	
37	0.0032	0.0056	0.0047	0.0082	0.061	0.091
38	0.0004	0.0007	0.0004	0.0007	0.048	
39	0.0040	0.0070	0.0020	0.0035	0.058	0.087
40	0.0015	0.0026	0.0016	0.0028	0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.



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<b><u>TABLE OF RESULTS</u></b>

**Power Quality – Voltage fluctuations and Flicker:** These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (**Inverter** connected) or Annex A2 A.2.3.3 (Synchronous).

	Starting			Stopping			Running	
	d max	d c	d(t)	d max	d c	d(t)	P <sub>st</sub>	P <sub>it</sub> 2 hours
Measured Values at test impedance	0	0	0	0	0	0	0.29	0.14
Normalised to standard impedance	0	0	0	0	0	0	0.17	0.08
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65
Test Impedance	R	0.4	Ω	X	0.25	Ω		
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω		
Maximum Impedance	R	N/A	Ω	X	N/A	Ω		



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<b><u>TABLE OF RESULTS</u></b>

\* Applies to three phase and split single phase **Micro-generators**.

^ Applies to single phase **Micro-generators** and **Micro-generators** 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\*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 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 need to conform to 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	11-May-2018	Test end date	11-May-2018
Test location	1 Treffers Rd, Wigram, Christchurch, NZ		



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<b><u>TABLE OF RESULTS</u></b>

<b>Power quality – DC injection:</b> This test should be carried out in accordance with EN 50438 Annex D.3.10				
Test power level	20%	50%	75%	100%
Recorded value in milli Amps	0.078 mA	0.074 mA	0.073 mA	0.030 mA
as % of rated AC current	0.0064 %	0.0061 %	0.0061 %	0.0025 %
Limit	0.25%	0.25%	0.25%	0.25%
<b>Power Quality – Power factor:</b> This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.				
	216.2 V	230 V	253 V	
20% of <b>Registered Capacity</b>	0.96	0.95	0.93*	
50% of <b>Registered Capacity</b>	1.00	1.00	0.99	
75% of <b>Registered Capacity</b>	1.00	1.00	1.00	
100% of <b>Registered Capacity</b>	1.00	1.00	1.00	
Limit	>0.95	>0.95	>0.95	

\* Note: At 253 V a power factor of 0.95 was achieved at 24% power due to output capacitors and burst mode operation.



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**TABLE OF RESULTS**

**Protection – Frequency tests:** These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A.1.2.3 (**Inverter** connected) or Annex A2 A.2.2.3 (Synchronous)

Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.52 Hz	20.3 s	47.7 Hz 25 s	Confirmed
U/F stage 2	47 Hz	0.5 s	47.02 Hz	0.62 s	47.2 Hz 19.98 s	Confirmed
					46.8 Hz 0.48 s	Confirmed
O/F stage 1	52 Hz	0.5 s	51.98 Hz	0.61 s	51.8 Hz 89.98 s	Confirmed
					52.2 Hz 0.48 s	Confirmed

Note. For frequency trip tests the frequency required to trip is the setting  $\pm 0.1$  Hz. In order to measure the time delay a larger deviation than the minimum required to operate the protection can be used. The “No trip tests” need to be carried out at the setting  $\pm 0.2$  Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

**Protection – Voltage tests:** These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98 Annex A1 A.1.2.2 (**Inverter** connected) or Annex A2 A.2.2.2 (Synchronous)

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	182.1 V	2.56 S	188 V 3.50 s	Confirmed
					180 V 2.48 s	Confirmed
O/V stage 1	262.2 V	1.0 s	261.5 V	1.06 s	258.2 V 2.0 s	Confirmed
O/V stage 2	273.7 V	0.5 s	271.0 V	0.56 s	269.7 V 0.98 s	Confirmed
					277.7 V 0.48 s	Confirmed

Note for Voltage tests the Voltage required to trip is the setting  $\pm 3.45$  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  $\pm 4$  V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

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<b><u>TABLE OF RESULTS</u></b>

**Protection – Loss of Mains test:** For PV Inverters shall be tested in accordance with BS EN 62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Limit is 0.5 s						

For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph1 fuse removed						

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph2 fuse removed						

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
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
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<b><u>Type Test Verification Report</u></b>

For **Inverters** tested to BS EN 62116 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 0.5 s	94 ms	165 ms	159 ms	101 ms	111 ms	169 ms

**Protection – Frequency change, Vector Shift Stability test:** This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous).

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.0 Hz	+50 degrees	Confirmed
Negative Vector Shift	50.0 Hz	- 50 degrees	Confirmed

**Protection – Frequency change, RoCoF Stability test:** The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous).

Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs <sup>-1</sup>	2.1 s	Confirmed
51.0 Hz to 49.0 Hz	-0.95 Hzs <sup>-1</sup>	2.1 s	Confirmed

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<b><u>Type Test Verification Report</u></b>

<b>Limited Frequency Sensitive Mode – Overfrequency test:</b> This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and <b>Droop</b> of 10%.				
Test sequence at <b>Registered Capacity</b> >80%	Measured <b>Active Power</b> Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	284.7 W	50.00 Hz	DC Supply	-
Step b) 50.45 Hz ±0.05 Hz	284.3 W	50.45 Hz		-
Step c) 50.70 Hz ±0.10 Hz	270.1 W	50.70 Hz		-
Step d) 51.15 Hz ±0.05 Hz	244.5 W	51.15 Hz		-
Step e) 50.70 Hz ±0.10 Hz	270.0 W	50.70 Hz		-
Step f) 50.45 Hz ±0.05 Hz	284.4 W	50.45 Hz		-
Step g) 50.00 Hz ±0.01 Hz	285.5 W	50.00 Hz		0.6 %/s
Test sequence at <b>Registered Capacity</b> 40% - 60%	Measured <b>Active Power</b> Output	Frequency		Primary Power Source
Step a) 50.00 Hz ±0.01 Hz	142.6 W	50.00 Hz	DC Supply	-
Step b) 50.45 Hz ±0.05 Hz	142.5 W	50.45 Hz		-
Step c) 50.70 Hz ±0.10 Hz	135.3 W	50.70 Hz		-
Step d) 51.15 Hz ±0.05 Hz	122.2 W	51.15 Hz		-
Step e) 50.70 Hz ±0.10 Hz	135.2 W	50.70 Hz		-
Step f) 50.45 Hz ±0.05 Hz	142.4 W	50.45 Hz		-
Step g) 50.00 Hz ±0.01 Hz	285.6 W	50.0 Hz		0.6 %/s
Steps as defined in EN 50438				



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<b><u>Type Test Verification Report</u></b>

<b>Power output with falling frequency test:</b> This test should be carried out in accordance with EN 50438 Annex D.3.2 active power feed-in at under-frequency.						
Test sequence	Measured <b>Active Power</b> Output	Frequency	Primary power source			
Test a) 50 Hz ± 0.01 Hz	284.0 W	50 Hz	DC supply			
Test b) Point between 49.5 Hz and 49.6 Hz	284.1 W	49.55 Hz	DC supply			
Test c) Point between 47.5 Hz and 47.6 Hz	284.1 W	47.55 Hz	DC supply			
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes						
<b>Re-connection timer.</b>						
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2.						
Time delay setting	Measured delay		Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.			
20 s	24 – 32 s		At 266.2 V	At 196.1 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the <b>Micro-generator</b> does not re-connect.			Confirmed	Confirmed	Confirmed	Confirmed

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<b>Fault level contribution:</b> These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 ( <b>Inverter</b> connected) and Annex A2 A.2.3.4 (Synchronous).					
For machines with electro-magnetic output			For <b>Inverter</b> output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	$i_p$	6.76	20 ms	0	0
Initial Value of aperiodic current	$A$	3.76	100 ms	0	0
Initial symmetrical short-circuit current*	$I_k$	3	250 ms	0	0
Decaying (aperiodic) component of short circuit current*	$i_{DC}$	0	500 ms	0	0
Reactance/Resistance Ratio of source*	$X/R$	2.5	Time to trip	0.01	In seconds
<p>For rotating machines and linear piston machines the test should produce a 0 s – 2 s plot of the short circuit current as seen at the <b>Micro-generator</b> terminals.</p> <p>* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot</p>					
<b>Logic Interface.</b>					Yes
<b>Self-Monitoring solid state switching:</b> No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 ( <b>Inverter</b> connected).					
It has been verified that in the event of the solid state switching device failing to disconnect the <b>Micro-generator</b> , the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s.					Yes
Additional comments					

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<b><u>Test Equipment calibration</u></b>

Type	Model No	Calibration date	Expiration date	Fixtures-No.
AC POWER SOURCE	MX30	NCR	NCR	SAF-PSU-02
Current Probe	TCP303	20/03/2017	19/03/2020	SAF-TCP-01
Current Probe	TCP303	17/03/2017	16/03/2020	SAF-TCP-02
Current Probe	TCP202A	5/03/2018	4/03/2021	SAF-TCP-03
Current Probe	N2783B	8/08/2017	7/08/2020	SAF-TCP-05
Current Probe	1147A	8/08/2017	7/08/2020	SAF-TCP-07
Current Probe	1147A	9/08/2017	8/08/2020	SAF-TCP-08
Current Probe	N2783B	NCR	NCR	SAF-TCP-04
Current Probe	1147A	NCR	NCR	SAF-TCP-06
Current Probe Power Supply	N2779A	NCR	NCR	SAF-CPA-03
Current Probe Power Supply	N2779A	NCR	NCR	SAF-CPA-04
DATA AQUISITION / SWITCH UNIT	34970A	6/03/2019	5/03/2020	SAF-DAT-01
Digital Multimeter	34461A	14/02/2019	14/02/2020	SAF-DMM-01
Digital Multimeter	34461A	6/03/2019	5/03/2020	SAF-DMM-02
Modular SAS Mainframe	E4360A	NCR	NCR	SAF-SAS-04
Modular SAS Mainframe	E4360A	NCR	NCR	SAF-SAS-07
Modular SAS Mainframe	E4360A	NCR	NCR	SAF-SAS-10
Oscilloscope	TDS3034C	1/03/2019	29/02/2020	SAF-OSC-01
Oscilloscope	TDS3034C	18/03/2019	17/03/2020	SAF-OSC-02
Oscilloscope	DSO-X 3034A	11/05/2018	11/05/2019	SAF-OSC-03
Oscilloscope	DSO-X 3034T	27/02/2019	27/02/2020	SAF-OSC-05
Power Quality Analyzer	WT1800	1/06/2018	1/06/2019	SAF-PQA-03
Power Quality Analyzer	WT3000	15/06/2018	15/06/2019	SAF-PQA-04
Power Quality Analyzer	WT3000E	7/2/2019	7/2/2020	SAF-PQA-05
Power Quality Analyzer	WT3000E	7/2/2019	7/2/2020	SAF-PQA-06
RLC Load for Anti-Islanding	ACLT-3802H	18/06/2018	18/06/2019	SAF-RLC-01
Solar Array Simulator (in SAF-SAS-04)	E4361A	NCR	NCR	SAF-SAS-05
Solar Array Simulator (in SAF-SAS-04)	E4361A	NCR	NCR	SAF-SAS-06
Solar Array Simulator (in SAF-SAS-07)	E4361A	NCR	NCR	SAF-SAS-08
Solar Array Simulator (in SAF-SAS-07)	E4361A	NCR	NCR	SAF-SAS-09
Solar Array Simulator (in SAF-SAS-10)	E4361A	13/03/2019	12/03/2020	SAF-SAS-11
Solar Array Simulator (in SAF-SAS-10)	E4361A	13/03/2019	12/03/2020	SAF-SAS-12

**ENA ERAC G98/1-3:2019**  
**Photographic Record of Test Sample**

IQ7PLUS Photos:

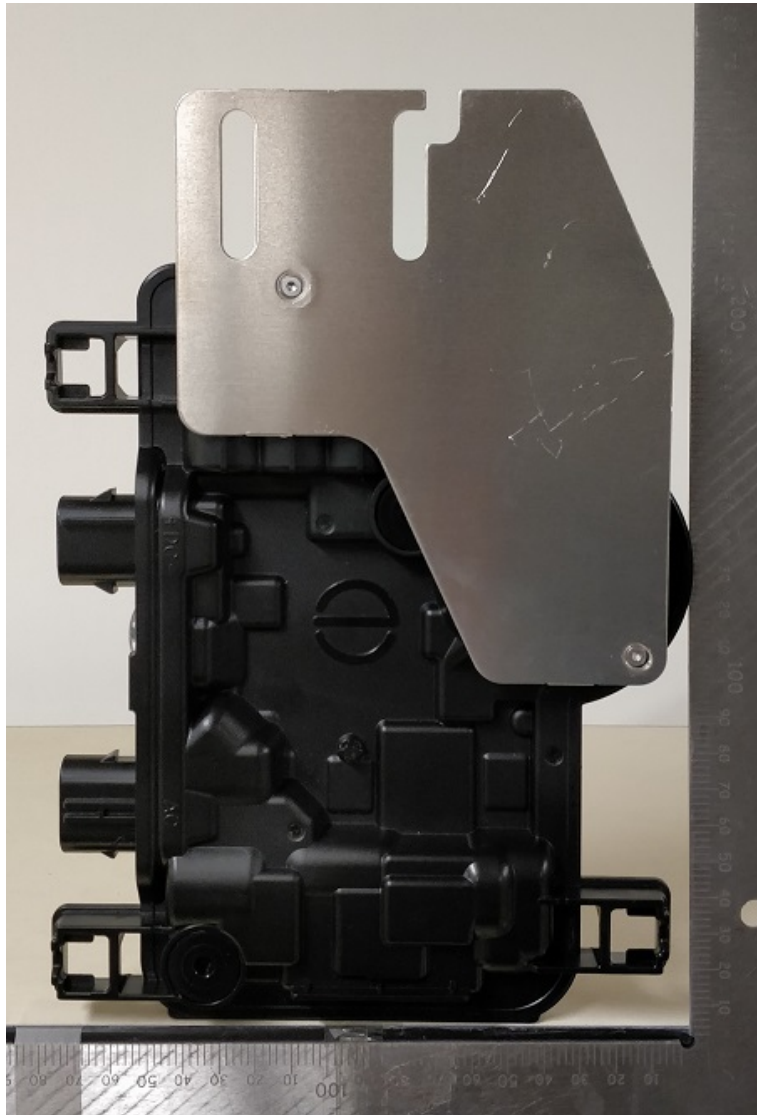


*Figure 3: IQ7PLUS general view*



*Figure 4: IQ7PLUS Bottom*

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<b>Photographic Record of Test Sample</b>



*Figure 5: IQ7PLUS Top*



*Figure 6: IQ7PLUS Connector side*

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<b>Photographic Record of Test Sample</b>



*Figure 7: IQ7PLUS Right side*



*Figure 8: IQ7PLUS Barcode side*



*Figure 9: IQ7PLUS Mounting plate side*

**End of report**