

**ENA ER G100: 2016+Amd1 (2017)**

*Engineering recommendations G100, Issue 1 Amendment 1 2017*  
*Technical requirements for customer export limiting schemes*

**Report reference No.** .....: P2018092501

Tested by  
(printed name and signature) .....: Tops Oluboyede

Approved by  
(printed name and signature) .....: Daniel Keis

Date of issue .....: 27 September 2018




**Testing Laboratory Name** .....: EnTest Laboratories



All tests reported herein have been performed in accordance with  
the laboratory's scope of accreditation  
Accreditation number: 1273

Address .....: 1 Treffers Road, Wigram, Christchurch, New Zealand 8042

Testing location/procedure .....: NZL ☒

Other (please explain) .....

**Applicant's Name** .....: Enphase Energy

Address .....: 1420 North McDowell Boulevard, Petaluma, CA 94954, USA

**Test specification**

Standard .....: ENA ER G100: 2016+Amd1 (2017)

Test procedure .....: EnTest Laboratories

Non-standard test method .....

**Test Report Form No.** .....: ENA ER G100: 2016+Amd1 (2017)

TRF originator .....: EnTest Laboratories

Master TRF .....: Dated JULY 2018

This publication may be reproduced in whole or in part for non-commercial purposes as long as EnTest is acknowledged as copyright owner and source of the material. EnTest 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.

**Test item description** .....: Solar Micro Inverter

Trademark .....:  **ENPHASE.**

Manufacturer .....: Enphase Energy

Model and/or type reference .....: IQ7X-96-X-Y-Z

Rating(s) .....: See rating table

Copy of marking plate

Model: IQ7X-96-X-Y-Z

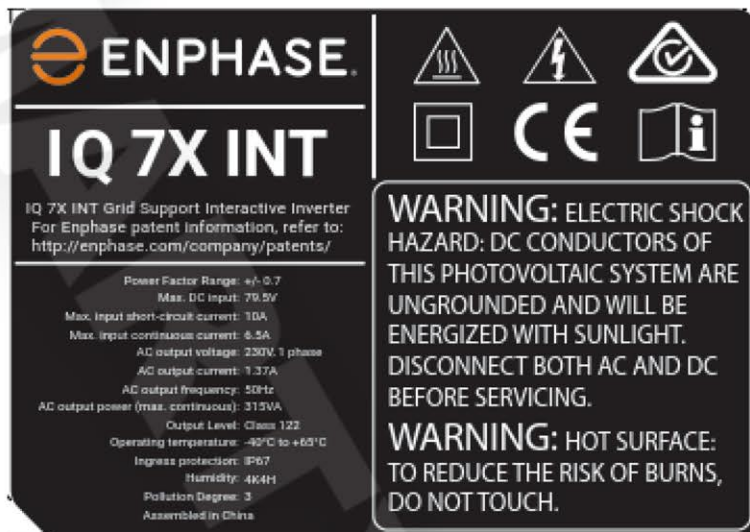


Figure 1: IQ7X marking plate

**SUMMARY OF COMPLIANCE WITH ENA ER G100: 2016+Amd1 (2017)**

All tests passed the requirements of the ENA ER G100: 2016+Amd1 (2017) standard within the required limits and within the equipment uncertainties.

The system consisting of Photovoltaic Micro-inverter, model number IQ7X-96-X-Y-Z **COMPLIED** with the tested clauses of ENA ER G100: 2016+Amd1 (2017).

**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)

**Testing** .....

Date of receipt of test item ..... : July 2018

Date (s) of performance of tests ..... : 25 September 2018

**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. EMC report:
  - a. E2018072501 including: BS EN 61000-6-2: 2005, BS EN 61000-6-3: 2007, BS EN 50065-1: 2011, BS EN 50065-2-2: 2003, BS EN 61000-3-2: 2014, BS EN 61000-3-3: 2013
7. Safety reports:
  - a. S2018080103 including: IEC BS/EN 62109-1
  - b. S2018080104 including: IEC BS/EN 62109-2

**General product information:**

The EUT (Equipment Under Test), known as Photovoltaic Micro-inverter, model number IQ7X was supplied for testing to ENA ER G100: 2016+Amd1 (2017) 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                                 | ±1,5 %                                 |
|                                            | 1kHz up to 5 kHz                            | ±2 %                                   |
|                                            | 5 kHz up to 20 kHz                          | ±3 %                                   |
|                                            | 20 kHz and above                            | ±5 %                                   |
| - 1000 V and above                         | dc up to 20 kHz                             | ±3 %                                   |
|                                            | 20 kHz and above                            | ±5 %                                   |
| <b>Current</b>                             |                                             |                                        |
| - Up to 5 A                                | up to 60 Hz                                 | ±1,5 %                                 |
|                                            | above 60 Hz up to 5 kHz                     | ±2,5 %                                 |
|                                            | 5 kHz up to 20 kHz                          | ±3,5 %                                 |
|                                            | 20 kHz and above                            | ±5 %                                   |
| - Above 5 A                                | up to 5 kHz                                 | ±2,5 %                                 |
|                                            | 5 kHz up to 20 kHz                          | ±3,5 %                                 |
|                                            | 20 kHz and above                            | ± %                                    |
| <b>Leakage (Touch) current<sup>1</sup></b> | 50 Hz up to 60 Hz                           | ±3,5 %                                 |
|                                            | greater 60 Hz up to 5 kHz                   | ±5 %                                   |
|                                            | greater 5 kHz up to 100 kHz                 | ±10 %                                  |
|                                            | greater 100 kHz up to 1 MHz                 | under consideration                    |
| <b>Power (50/60 Hz)</b>                    | up to 3 kW                                  | ±3 %                                   |
|                                            | above 3 kW                                  | ±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 | ±5 %                                   |
|                                            | above 1 TΩ                                  | ±10 %                                  |
|                                            | for all other cases                         | ±3 %                                   |
| <b>Temperature<sup>2,3</sup></b>           |                                             |                                        |
|                                            | - 35°C to below 100° C                      | ±2° C                                  |
|                                            | 100° C up to 500° C                         | ±3 %                                   |
|                                            | below - 35°C ± 3°C                          | ±3° C                                  |
| <b>Time</b>                                | 10 ms up to 200 ms                          | ±5 %                                   |
|                                            | 200 ms up to 1 s                            | ±10 ms                                 |
|                                            | 1 s and above                               | ±1 %                                   |
| <b>Linear dimensions</b>                   | up to 1 mm                                  | ±0,05 mm                               |
|                                            | 1 mm up to 25 mm                            | ±0,1 mm                                |
|                                            | 25 mm and above                             | ±0,5 %                                 |
| <b>Mass</b>                                | above 10 g and up to 100 g                  | ±1 %                                   |
|                                            | 100 g up to 5 kg                            | ±2 %                                   |
|                                            | 5 kg and above                              | ±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.

**Model rating table:**

| Specification                       | Units            | IQ7X         |
|-------------------------------------|------------------|--------------|
| Rated output active power           | W                | 315          |
| Output apparent power               | VA               | 315          |
| 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> | 1.37         |
| EN50530 efficiency                  | %                | 96.8         |
| Full power MPPT input voltage range | V                | 53-64        |
| Input operating range               | V                | 25-79.5      |
| Input current limit region          | V                | 25-53        |
| Input frequency                     | Hz               | DC           |
| Input maximum continuous current    | A                | 6.5          |
| DC short circuit input maximum      | A                | 10           |
| 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 IQ7X-96-X-Y-Z where

Suffix X = 2, 5 or B

2 = Multicontact PV connector

5 = Amphenol PV connector

B = Friends PV connector

Y = blank or ACM (X marking not required)

Z = blank or any letter for country of intended installation (eg: US for North America, INT for International)

The EUT AC connector was to be connected to a Q cable and connected to fixed-wiring in accordance with ENA ER G100: 2016+Amd1 (2017) and the National Wiring Rules.

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

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

Firmware version:

520-00082-r01-v02.14.02

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                            |          |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Results - Remark                                                                           | Verdict  |
| <b>5</b>                      | <b>REQUIREMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                            | <b>P</b> |
| <b>5.1</b>                    | <b>Export Limitation Scheme Design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                            | <b>P</b> |
|                               | An Export Limitation Scheme measures the Active Power at points within the Customer's installation and then uses this information to either restrict generation output and/or balance the Customers demand in order to prevent the export from the Distribution System from exceeding the Agreed Export Capacity.                                                                                                                                                                                                                                                                                                                                                                                                                | <i>Handled by the EnvoyS</i>                                                               | P        |
|                               | An ELS may include a secondary feature to restrict generation export when the voltage at the Connection Point exceeds the Statutory Voltage Limits. If this feature is required, the DNO shall specify this at the quotation / offer stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <i>Voltage limits and Volt Watt functions are propagated by the Envoy to the Inverters</i> | P        |
|                               | In order for the installation of an ELS to be an acceptable solution, the DNO must be satisfied that the control schemes will meet the requirements of section 5.6 under all circumstances.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                            | Noted    |
|                               | It should be noted that the Agreed Export Capacity is expressed as an Active Power value (in kW or MW). In addition to this Agreed Export Capacity, DNOs will specify an export Power Factor or Power Factor range at the Connection Point, as applicable. The ELS shall be designed to measure and limit the Active Power only since the Power Factor and hence the Apparent Power and Reactive Power should be controlled by the Customer to satisfy the requirements of the Connection Agreement.                                                                                                                                                                                                                             |                                                                                            | Noted    |
|                               | The ELS may be formed of discrete units, as shown in Appendix B, or integrated into a single packaged scheme. Where discrete units are used they should preferably be interconnected using metallic or fibre optic cables. Alternatively the units may be interconnected using secure radio links but where this is the case these links shall be licensed (by OFCOM) and have a planned availability of 99.9% or higher. Irrespective of the media used for interconnecting between the discrete units, if the communication path fails the generation output shall be reduced to a nominal value stipulated by the DNO within a set response time (see section 5.5) to prevent the Agreed Export Capacity from being exceeded. | <i>Power line communications is used between Envoy and inverters</i>                       | P        |
|                               | ELs installed at Power Stations with an aggregate Generating Unit capacity exceeding 16A (i.e. 3.68kW) per phase must be fail-safe and must ensure that the Agreed Export Limit is not exceeded if any single component, including the communication links between the discrete units, fail or lose their power supply.                                                                                                                                                                                                                                                                                                                                                                                                          | <i>Fail-safe passed testing</i>                                                            | P        |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                          |                                                                                  |              |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                     | Results - Remark                                                                 | Verdict      |
|                               | Once installed and commissioned, the scheme settings should not be capable of being readily altered by the Customer and shall only be changed with the written agreement of the DNO.                                                                                                                                                     | <i>Envoy setting as password protected and cannot be changed by the customer</i> | P            |
|                               | The exported power at the Connection Point may be managed by increasing the Customer's demand within the Customers installation; however the ELS must be able to turn down/reduce the generated power or disconnect one of more Generation Units if the demand is not available.                                                         | <i>This is handled by the export limiting function</i>                           | P            |
|                               | Additional reverse power protection shall be installed at all HV metered connections to back-up the ELS. See section 5.5 for further detail.                                                                                                                                                                                             | <i>Not HV</i>                                                                    | N/A          |
|                               | For LV Connection Points, a reverse power protection relay is only required if the DNO deems the ELS not to be fail-safe.                                                                                                                                                                                                                | <i>Fail-safe passed testing</i>                                                  | N/A          |
|                               | A description of the scheme, its settings, and a single line diagram shall be permanently displayed on site.                                                                                                                                                                                                                             |                                                                                  | Noted        |
| <b>5.2</b>                    | <b>Maximum Power Station Capacity</b>                                                                                                                                                                                                                                                                                                    |                                                                                  | <b>P</b>     |
|                               | An ELS will take a finite time (as specified in section 5.5.) to operate and restrict the site export. During this period the exported power may be above the Agreed Export Capacity which could cause equipment current ratings, over-current protection settings, fuse ratings or Statutory Voltage Limits to be temporarily exceeded. | <i>Power is limited within 5 seconds</i>                                         | P            |
|                               | The DNO will carry out an assessment at the design stage to determine the maximum acceptable Power Station Capacity above which either thermal limits, protection settings / fuse ratings or equipment voltage limits could be exceeded. Further guidance on these aspects is provided below.                                            |                                                                                  | Noted        |
| <b>5.2.1</b>                  | <b>Equipment Thermal Limit Assessment</b>                                                                                                                                                                                                                                                                                                |                                                                                  | <b>Noted</b> |
|                               | Plant and equipment (e.g. switchgear, transformers, cables and overhead lines etc.) is normally capable of withstanding short periods of moderate overloading. In most cases thermal limits will not be exceeded due to detection and operation of the ELS and, where fitted, the reverse power protection.                              |                                                                                  | Noted        |
| <b>5.2.2</b>                  | <b>Protection Assessment</b>                                                                                                                                                                                                                                                                                                             |                                                                                  | <b>Noted</b> |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                         |              |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                                 | Results - Remark                                        | Verdict      |
|                               | In order to prevent mal-operation of cut-out fuses and/or over-current protection and other protection equipment the Power Station Capacity shall typically be no greater than 1.25 x Agreed Import Capacity or 1.25 x Agreed Export Capacity, whichever is the higher. At some sites it may be possible for a DNO to agree a higher value depending upon the protection requirements and the Minimum Demand.                                        |                                                         | Noted        |
|                               | Where the site does not have an Agreed Import Capacity or Agreed Export Capacity the protection assessment shall be based on the DNO's cut-out fuse rating or the over-current protection settings applied to the metering circuit breaker (operating at Nominal Voltage). In the absence of other information, the DNOs cut-out fuse should be assumed to be 60A.                                                                                   |                                                         | Noted        |
| <b>5.2.3</b>                  | <b>Voltage Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         | <b>P</b>     |
|                               | The Power Station Capacity shall be restricted to prevent DNO equipment voltage ratings from being exceeded during the detection and operation time of the ELS. It is recommended that the highest network voltage is no greater than the Statutory Voltage Limit + 1% (of the Nominal Voltage) before the ELS operates.                                                                                                                             | <i>Statutory Voltage Limit will not be exceeded</i>     | P            |
|                               | For LV networks, the Declared Voltage is 230V (phase to neutral) and the DNO's upper Statutory Voltage Limit is = 230V + 10% = 253V. "Where a Power Station Capacity does not exceed 32A per phase and consists solely of Type Tested SSEGs a voltage assessment is not required. In all other circumstances the maximum Power Station Capacity should be restricted in order to prevent the network voltage exceeding 253V + (1% of 230V) = 255.3V. | <i>Inverters are type tested to G83/2-1 and G59/3-4</i> | P            |
|                               | For HV networks an upper voltage limit is defined by the DNO to ensure the voltage at LV Connection Points remains within Statutory Voltage Limits. For example, where a DNO specifies an upper voltage limit of 11.3kV (phase to phase) for an HV network, the maximum Power Station Capacity must be restricted to prevent the highest network voltage exceeding 11.3kV + (1% of 11kV) = 11.41kV.                                                  | <i>Not HV</i>                                           | N/A          |
| <b>5.2.4</b>                  | <b>Other Restrictions</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         | <b>Noted</b> |
|                               | It is possible that other factors may restrict the maximum Power Station Capacity at the site, for example fault level contribution, or possible transmission system related restrictions. Where this is the case the DNO shall notify the Customer of the reason for the restriction.                                                                                                                                                               |                                                         | Noted        |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                   |          |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Results - Remark                                  | Verdict  |
|                               | Examples of how the maximum Power Station Capacity is calculated are included Appendix D.                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                   | Noted    |
| <b>5.3</b>                    | <b>Maximum Capacity of Actively Controlled Demand</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                   | <b>P</b> |
|                               | Where the Agreed Export Capacity is limited by actively controlling flexible on-site demand the Agreed Import Capacity could be exceeded if the generation is suddenly disconnected (e.g. if the EREC G59 interface protection operates). This could potentially cause equipment thermal limits and / or rapid voltage change limits to be exceeded. In order to prevent these issues the maximum demand of the site, including the actively controlled demand, shall not exceed 1.25 x the Agreed Import Capacity of the site. | <i>Complies with Export limiting requirements</i> | P        |
|                               | Where a site with an LV Connection Point does not have an Agreed Import Capacity the rating of the cut-out fuse or the over-current protection settings applied to the metering circuit breaker (operating at Nominal Voltage) shall be used instead. In the absence of other data a 60A cut-out fuse shall be assumed.                                                                                                                                                                                                         |                                                   | Noted    |
| <b>5.4</b>                    | <b>Power Quality</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                   | <b>P</b> |
|                               | All installations must comply with the power quality requirements defined in                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <i>See general remarks 6 and 7</i>                | P        |
|                               | <ul style="list-style-type: none"> <li>• ENA Engineering Recommendation P28</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                          | <i>Flicker</i>                                    | P        |
|                               | <ul style="list-style-type: none"> <li>• ENA Engineering Recommendation P29</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                          | <i>Voltage unbalance</i>                          | P        |
|                               | <ul style="list-style-type: none"> <li>• ENA Engineering Recommendation G5</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           | <i>Harmonics</i>                                  | P        |
|                               | In accordance with the above documents, with BS7671 (The IET Wiring Regulations) and the Distribution Code, Customers shall discuss and agree the connection of any potentially disturbing equipment with the DNO.                                                                                                                                                                                                                                                                                                              |                                                   | Noted    |
|                               | In addition to the connected load and generation, the ELS may also create voltage disturbances and voltage distortion.                                                                                                                                                                                                                                                                                                                                                                                                          |                                                   | Noted    |
|                               | An ELS that quickly decreases or trips the generation or that quickly increases or decreases demand may give rise to rapid voltage changes and / or flicker. In such cases the Customer shall provide the DNO information on the maximum change in current or power, the characteristics of the change (e.g. step change, ramped change etc.). If the current is ramped up or down the maximum ramp rate and ramp duration shall also be provided. EREC P28 normally restricts rapid voltage changes to a maximum of 3%.        |                                                   | P        |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                               |          |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Results - Remark                              | Verdict  |
|                               | An ELS that relies on power electronics (e.g. converters etc.) to control the load shall also provide information demonstrating compliance with relevant harmonics standards (e.g. BSEN 61000-3-2 and/or BSEN 61000-3-12) or provide data on the harmonic current produced by the ELS in accordance with ENA EREC G5.                                                                                                                                                                                                                                                                            | <i>Harmonics passed as per G83 and G59</i>    | P        |
| <b>5.5</b>                    | <b>Accuracy and Response Rates</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               | <b>P</b> |
|                               | The overall accuracy of ELS with regard to measurement and control of Active Power and, where applicable, voltage, shall be determined by the manufacturer of the system and published within its operating manual. These tolerances shall, as far as possible, take account of sensing / measurement errors, processing errors, communication errors and control errors. Consideration shall also be given to environmental factors (e.g. the expected ambient temperature range).                                                                                                              | <i>Refer to product data sheets</i>           | P        |
|                               | The settings applied to the ELS shall take account of the published tolerances to ensure the required export limits and voltage limits are maintained. For example, if an ELS is required to limit the export to 100kW and it has an overall tolerance of +/-5% at this value, it shall be set to limit the Active Power to 95kW (i.e. 95% of the required value).                                                                                                                                                                                                                               |                                               | Noted    |
|                               | The ELS must detect an excursion and reduce the export to the Agreed Export Capacity or less within 5 seconds.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <i>See appendix A for results</i>             | P        |
|                               | Where communication delays (between the ELS and the Generating Units and actively controlled demand) mean that the 5 second operating time may not be satisfied, a back-up system shall be installed that detects an excursion and operates within 5 seconds. In such circumstances the back-up system should be programmed to act at the Agreed Export Capacity and the ELS at a lower value. This backup system should have an Active Power accuracy of +/-3% or better.                                                                                                                       | <i>Complied with the 5 second requirement</i> | P        |
|                               | For example, for a site with a nominal 50kW export limit, the ELS system could be set to 48kW, with a back-up disconnection device set at 50kW; under normal operation, the dynamic system will keep the site limited to 48kW export, but should the export peak over 50kW, the generation will be disconnected within 5 seconds by device back-up disconnection system. Where an ELS relies on a backup disconnection systems to achieve the 5 seconds limit the arrangement must satisfy the power quality requirements, including the EREC P28 rapid voltage change and flicker requirements. |                                               | Noted    |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                     |              |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                             | Results - Remark                                                                    | Verdict      |
|                               | For all High Voltage metered connections, protection (known as reverse power protection) shall disconnect the Generating Unit if the exported power exceeds the Agreed Export Capacity for more than 5 seconds. It shall be the responsibility of the Customer to specify and satisfy the relevant DNO that the protection meets this requirement.                                                                                               | Not HV                                                                              | N/A          |
| <b>5.6</b>                    | <b>Excursions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                     | <b>P</b>     |
|                               | The Active Power may, under abnormal conditions, temporarily exceed the Agreed Export Capacity. The ELS shall be designed so that under normal operating conditions the thermal limits and Statutory Voltage Limits are not exceeded.                                                                                                                                                                                                            | <i>Refer to general remarks 7</i>                                                   | P            |
|                               | In recognising that the ELS may have a delayed response under abnormal conditions, up to 5 seconds response time is assumed to allow the ELS to bring the export equal to, or below the Agreed Export Capacity. Where frequent excursions of the Agreed Export Capacity take place under normal operating conditions, the DNO may request that the Active Power thresholds are lowered to reduce the number and the magnitude of the excursions. | <i>Complies with 5 second response time and Inverters Frequency Watt capability</i> | P            |
|                               | The Connection Agreement may need to be amended in the event of an excursion to the Agreed Export Capacity.                                                                                                                                                                                                                                                                                                                                      |                                                                                     | Noted        |
|                               | Breeches of the Agreed Export Capacity may result in the Connection Agreement being withdrawn or further monitoring and/or remote control being installed at the Customers' cost.                                                                                                                                                                                                                                                                |                                                                                     | Noted        |
| <b>6</b>                      | <b>Application and Acceptance</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                     | <b>Noted</b> |
|                               | Customers shall provide information on the proposed ELS to enable DNOs to make an assessment on the risk to the network. A flowchart on the acceptability criteria is shown in Appendix C.                                                                                                                                                                                                                                                       |                                                                                     | Noted        |
|                               | The following information shall be provided with the ELS application:                                                                                                                                                                                                                                                                                                                                                                            |                                                                                     | Noted        |
|                               | <ul style="list-style-type: none"> <li>Single Line Diagram of ELS</li> </ul>                                                                                                                                                                                                                                                                                                                                                                     |                                                                                     | Noted        |
|                               | <ul style="list-style-type: none"> <li>Explanation of ELS operation</li> </ul>                                                                                                                                                                                                                                                                                                                                                                   |                                                                                     | Noted        |
|                               | <ul style="list-style-type: none"> <li>Description of any fail-safe functionality (interruption of sensor signals, disconnection of load, loss of power, internal fault detection etc.)</li> </ul>                                                                                                                                                                                                                                               |                                                                                     | Noted        |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                             |                                                                   |              |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                        | Results - Remark                                                  | Verdict      |
| <b>7</b>                      | <b>Witness Testing and Commissioning</b>                                                                                                                                                                                                                                                    |                                                                   | <b>P</b>     |
|                               | The following section only applies to ELSs at installations with an aggregate Generating Unit capacity exceeding 16A (3.68kW) per phase.                                                                                                                                                    |                                                                   | Noted        |
| <b>7.1</b>                    | <b>General</b>                                                                                                                                                                                                                                                                              |                                                                   | <b>Noted</b> |
|                               | The Customer is responsible for demonstrating that the ELS complies with the requirements detailed in this document.                                                                                                                                                                        |                                                                   | Noted        |
|                               | Where the ELS is used at a site with a combined on-site generation capacity of 50kW or less, the DNO may, at its discretion, not require to witness the Fail Safe operation. For larger installations DNOs normally witness the tests on the ELS.                                           |                                                                   | Noted        |
|                               | Where the ELS commissioning tests are witnessed by the DNO it is expected that this will be carried out in the same visit as the generation commissioning tests are witnessed.                                                                                                              |                                                                   | Noted        |
|                               | In order to safely and effectively test an ELS, it is necessary to be able to simulate instances where the ELS is expected to operate.                                                                                                                                                      |                                                                   | Noted        |
|                               | A means of ensuring the applied settings are tamper proof will need to be demonstrated. A copy of any additional settings associated with the ELS shall be displayed on site alongside any EREC G59 protection settings.                                                                    |                                                                   | Noted        |
| <b>7.2</b>                    | <b>Preventing the export limit being exceeded during setup/testing</b>                                                                                                                                                                                                                      |                                                                   | <b>P</b>     |
|                               | Care shall be taken whilst testing and commissioning the ELS so that the Agreed Export Capacity or the Agreed Import Capacity is not breached so as to not put the distribution network at risk. This may involve setting the export limit to a lower threshold for demonstration purposes. |                                                                   | P            |
|                               | A combination of the following measures should be considered to ensure that Agreed Export Capacity or the Agreed Import Capacity is not exceeded during setup/testing:                                                                                                                      |                                                                   | P            |
|                               | <ul style="list-style-type: none"> <li>Temporarily programming the export limit value to zero, or setting it to 50% (or less) than the true export limit</li> </ul>                                                                                                                         | <i>Zero export profile can be loaded for testing</i>              | P            |
|                               | <ul style="list-style-type: none"> <li>Restricting the maximum output of the generation (e.g. on a PV system with multiple inverters, turning off a number of the inverters)</li> </ul>                                                                                                     |                                                                   | P            |
|                               | <ul style="list-style-type: none"> <li>Operating a temporary load or load bank</li> </ul>                                                                                                                                                                                                   |                                                                   | P            |
|                               | If ELS settings need to be changed in order to demonstrate operation, then they must be restored and confirmed once testing is complete.                                                                                                                                                    | <i>Profile needs to be updated to agreed limits after testing</i> | Noted        |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                  |                             |              |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                             | Results - Remark            | Verdict      |
| <b>7.3</b>                    | <b>Commissioning Sequence</b>                                                                                                                                                                                                                                                                    |                             | <b>Noted</b> |
|                               | ELS commissioning should only be undertaken after the generation commissioning has been successfully completed.                                                                                                                                                                                  |                             | Noted        |
|                               | In order to ensure system safety, the following commissioning sequence shall be followed. This should be performed in the sequence indicated and the process should only proceed to the next stage once the preceding stage has been successfully undertaken:                                    |                             | Noted        |
|                               | The Customer shall provide all relevant scheme drawings and information to enable safe, informed commissioning of the ELS.                                                                                                                                                                       |                             | Noted        |
| <b>7.4</b>                    | <b>Fail-safe tests</b>                                                                                                                                                                                                                                                                           |                             | <b>P</b>     |
|                               | “Fail safe tests are not required at installations where all of the Generating Units are Type Tested SSEGs, with a Power Station Capacity of not more than 7.36kW per phase (i.e. 32A per phase at 230V) and an Export Capacity of not more than 3.68kW per phase (i.e. 16A per phase at 230V).” |                             | P            |
|                               | The purpose of the Fail-Safe tests is to ensure that should any part of the ELS fail, the Active Power exported across the Connection Point will drop to the Agreed Export Capacity or less within the specified time.                                                                           |                             | P            |
|                               | There are three potential options to reducing the Active Power.                                                                                                                                                                                                                                  |                             | P            |
|                               | 1. The Generation Units switches off completely                                                                                                                                                                                                                                                  | <i>Reduces power to 0 W</i> | P            |
|                               | 2. A section of the Generating Units may remain operating as long as the aggregate capacity of the Generating Units remaining operational is equal or less than the Agreed Export Capacity.                                                                                                      |                             | P            |
|                               | 3. All Generating Units may operate at a restricted output as long as the aggregate export from the Generating Units remaining operational is equal or less than the Agreed Export Capacity.                                                                                                     |                             | P            |
|                               | The Fail-Safe test process comprises a sequence of tests on each individual piece of equipment forming the ELS. Each piece of equipment needs to have, where relevant, its communication and its power supply cables removed as separate tests.                                                  |                             | P            |
|                               | At no time during the Fail-Safe test sequence should the Active Power rise above the programmed export limit for a duration longer than the specified reaction time.                                                                                                                             |                             | P            |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                           |                               |              |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                      | Results - Remark              | Verdict      |
|                               | NOTE: Some power supplies may take a short while to power down (due to power stored in capacitors). This will cause a slight delay in the response time of the system. In such cases the reaction time is measured from the point at which the unit powers down, not the point at which the power supply is disconnected. |                               | Noted        |
| <b>7.5</b>                    | <b>Test Sequence</b>                                                                                                                                                                                                                                                                                                      |                               | <b>Noted</b> |
|                               | The following table describes a typical test sequence. Not all systems will have all of the components listed and others may have additional components that need to be included in the list. An example can be found at Appendix B. The system shall be restored after each test below.                                  | <i>Removed power to Envoy</i> | Noted        |
| <b>7.6</b>                    | <b>Functional tests</b>                                                                                                                                                                                                                                                                                                   |                               | <b>P</b>     |
|                               | In order to safely and effectively test an ELS, it is necessary to be able to simulate instances where the ELS is expected to operate. Two different means may be employed to simulate system operation.                                                                                                                  |                               | Noted        |
|                               | 1. Manual control over the loads operating on the site; or                                                                                                                                                                                                                                                                |                               | P            |
|                               | 2. Injection testing using a calibrated test set                                                                                                                                                                                                                                                                          |                               | Noted        |
|                               | The method adopted will depend on the nature of the site. On larger sites with multiple distributed loads (e.g. an office, factory or school), injection testing will be the only practical option.                                                                                                                       |                               | Noted        |
|                               | Particular attention should be paid to the correct orientation of the PMU current monitoring connections (including CT orientation) during testing.                                                                                                                                                                       |                               | Noted        |
| <b>7.6.1</b>                  | <b>Functional testing – manual load control</b>                                                                                                                                                                                                                                                                           |                               | <b>P</b>     |
|                               | Three site factors can be adjusted and a generic test method could be:                                                                                                                                                                                                                                                    |                               | P            |
|                               | 1. The export limit is adjusted (set to zero or a percentage of the final figure)                                                                                                                                                                                                                                         |                               | P            |
|                               | 2. The site loads are manually increased / decreased                                                                                                                                                                                                                                                                      |                               | P            |
|                               | 3. The output from the Generation Units is manually increased / decreased                                                                                                                                                                                                                                                 |                               | P            |
|                               | Pass-Fail criteria: During the test sequence the power exported from the site does not rise above the programmed export capacity for a duration longer than the specified reaction time.                                                                                                                                  |                               | P            |
| <b>7.6.2</b>                  | <b>Functional testing – Injection testing</b>                                                                                                                                                                                                                                                                             |                               | <b>N/A</b>   |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |         |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|
| Clause                        | Requirements – Tests                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Results - Remark | Verdict |
|                               | Export limit conditions can be simulated by temporarily connecting the PMU to a calibrated injection test set.                                                                                                                                                                                                                                                                                                                                                        |                  | N/A     |
|                               | When using an injection test set, there is no feedback loop between the ELS and the injection test set. This has two significant implications for the test process:                                                                                                                                                                                                                                                                                                   |                  | N/A     |
|                               | 1. As soon as the ELS begins to operate, because it sees no corresponding decrease in export levels, the control loop will keep running until the Generation Units output is reduced to the programmed export capacity or below.                                                                                                                                                                                                                                      |                  | N/A     |
|                               | 2. To ensure that the ELS is reacting by the correct amount and within an acceptable time period, a step change needs be applied by the test set to the PMU.                                                                                                                                                                                                                                                                                                          |                  | N/A     |
|                               | The following test sequence should be performed: (Table 2)                                                                                                                                                                                                                                                                                                                                                                                                            |                  | N/A     |
|                               | The procedure for performing the test is as follows:                                                                                                                                                                                                                                                                                                                                                                                                                  |                  | N/A     |
|                               | <ul style="list-style-type: none"> <li>Initially apply 100% of nominal voltage and inject current (at unity power factor) to mimic an exported Active Power equivalent to 95% of the export limit setting. Check that the ELS does not operate.</li> </ul>                                                                                                                                                                                                            |                  | N/A     |
|                               | <ul style="list-style-type: none"> <li>Step up the current to give an export Active Power equivalent to 105% of the export Active Power limit (for Test A), Check that change in export level is "seen" by the PMU.</li> </ul>                                                                                                                                                                                                                                        |                  | N/A     |
|                               | <ul style="list-style-type: none"> <li>Check that the Active Power exported by the generation reduces to a value at least 5% below the export limit setting within the specified reaction time. The test shall be repeated at the maximum statutory voltage (i.e. at 110% of nominal voltage at LV connections or at 106% at HV connections) and also at the minimum statutory voltage limit (i.e. 94% of nominal voltage for both LV and HV connections).</li> </ul> |                  | N/A     |
|                               | <ul style="list-style-type: none"> <li>All the above tests shall also be repeated for step increases from 95% to 110% of the export limit and from 95% to 120% of the export limit as detailed in Table 2.</li> </ul>                                                                                                                                                                                                                                                 |                  | N/A     |
|                               | When injection testing is complete, the correct orientation of any current monitoring connections (including CT orientations) which may have removed for the test must be checked and verified as correct.                                                                                                                                                                                                                                                            |                  | N/A     |

| ENA ER G100: 2016+Amd1 (2017) |                                                                                                                                      |                  |              |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------|
| Clause                        | Requirements – Tests                                                                                                                 | Results - Remark | Verdict      |
|                               | If settings need to be changed in order to demonstrate operation, then they must be restored and confirmed once testing is complete. |                  | N/A          |
| <b>Appendix A</b>             | <b>Information Request</b>                                                                                                           |                  | <b>Noted</b> |
| <b>Appendix B</b>             | <b>Export Limitation Scheme Installation and Commissioning Tests</b>                                                                 |                  | <b>Noted</b> |
| <b>Appendix C</b>             | <b>Export Limitation Scheme Diagram</b>                                                                                              |                  | <b>Noted</b> |
| <b>Appendix D</b>             | <b>Export Limitation Scheme Application Flow Chart</b>                                                                               |                  | <b>Noted</b> |
| <b>Appendix E</b>             | <b>Power Station Capacity Examples</b>                                                                                               |                  | <b>Noted</b> |
| <b>Appendix F</b>             | <b>AC Power and Direction of Power Flow</b>                                                                                          |                  | <b>Noted</b> |

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

TABLE OF RESULTS

7.4

Fail-safe tests

P

The only requirement for fail-safe is if the Envoy (PMU) losses power:

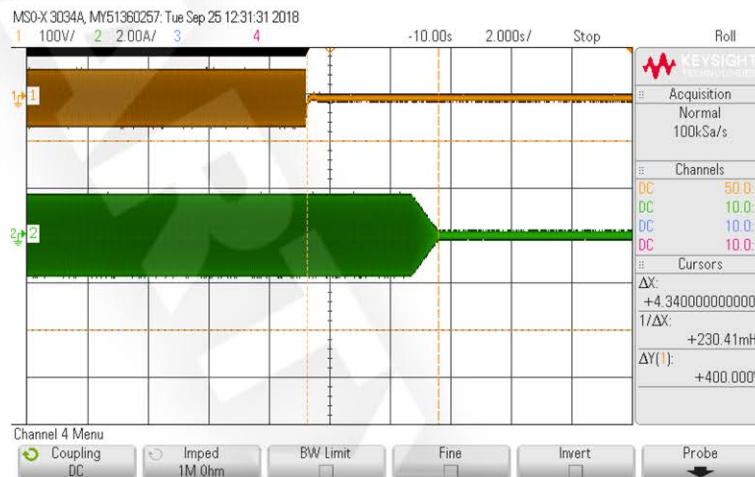


Figure 2: Fail-safe test on single phase system

Single phase system stops producing power within 5 seconds of Envoy losing power.  
Measured value = 4.34 seconds

Fail-safe verified on 1.2kW system:



Figure 3: Fail-safe test on 1.2kW single phase system

Single phase system stops producing power within 5 seconds of Envoy losing power.  
Measured value = 3.82 seconds

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

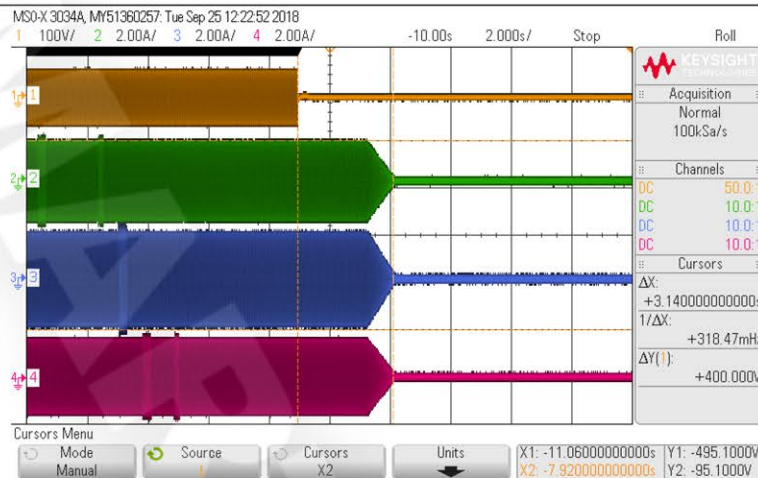
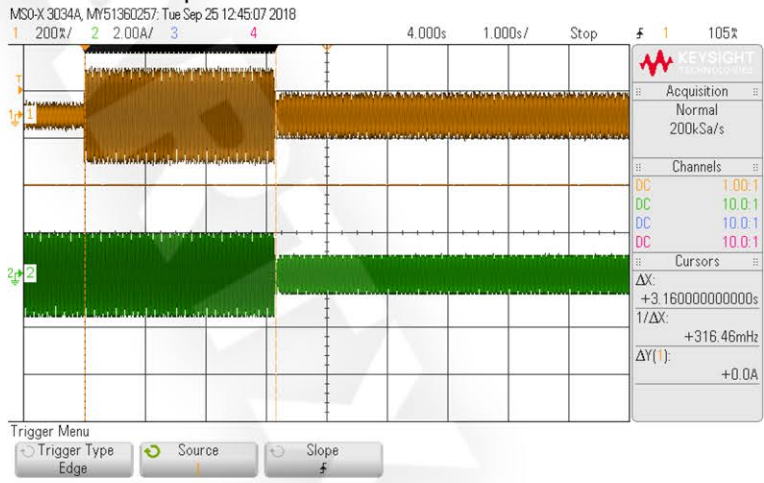


Figure 4: Fail safe on three phase system

Three phase system stops producing power within 5 seconds of Envoy losing power.  
Measured value = 3.14 seconds

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

| 7.6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Functional tests | P |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---|
| <p>Functional testing – manual load control used:</p> <ol style="list-style-type: none"> <li>1) Export limit was set to 114 W</li> <li>2) Resistive load was set to 300 W to allow full production of inverter.</li> <li>3) Resistive load was changed to 25 W and reaction time was measured:</li> <li>4) Power reduced to 100 W export</li> </ol>  <p>MSO-X 3034A, MY51360257: Tue Sep 25 12:45:07 2018</p> <p>1 200% / 2 2.00A / 3 4 4.000s 1.000s / Stop</p> <p>Trigger Menu: Trigger Type Edge, Source, Slope</p> <p>Channels: DC 1.00:1, DC 10.0:1, DC 10.0:1, DC 10.0:1</p> <p>Cursors: ΔX: +3.160000000000s, 1/ΔX: +316.46mHz, ΔY(1): +0.0A</p> <p>Figure 5: Functional test on single phase system</p> <p>Green waveform is inverter current<br/>Orange waveform is grid current<br/>Measured value = 3.16 seconds</p> |                  |   |
| <p>Export limiting tested on a 1.2kW system:</p>  <p>MSO-X 3034A, MY51360257: Tue Sep 25 13:42:21 2018</p> <p>1 500% / 2 5.00A / 3 4 4.000s 1.000s / Stop</p> <p>Trigger Menu: Trigger Type Edge, Source, Slope</p> <p>Channels: DC 1.00:1, DC 10.0:1, DC 10.0:1, DC 10.0:1</p> <p>Cursors: ΔX: +3.080000000000s, 1/ΔX: +324.68mHz, ΔY(1): +0.0A</p> <p>Figure 6: Functional test on 1.2kW single phase system</p> <p>Green waveform is combined inverter current<br/>Orange waveform is grid current<br/>Measured value = 3.08 seconds</p>                                                                                                                                                                                                                                                                                    |                  |   |

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

- 1) Export limit was set to 114 W
- 2) Resistive load was set to 300 W on all three phases to allow full production of inverter.
- 3) Resistive load was changed to 25 W on all three phases and reaction time was measured:

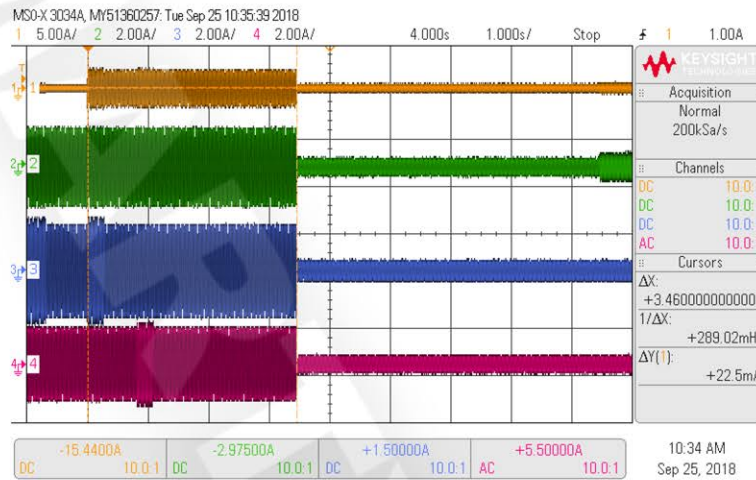


Figure 7: Functional test on three phase system adjusting all phases

Orange waveform is grid current.  
Green waveform is Phase 1 current.  
Blue waveform is Phase 2 current.  
Pink waveform is Phase 3 current.  
Measured value = 3.46 seconds

- 1) Export limit was set to 114 W
- 2) Resistive load was set to 300 W on all three phases to allow full production of inverter.
- 3) Resistive load was changed to 25 W on phase 1 and reaction time was measured:

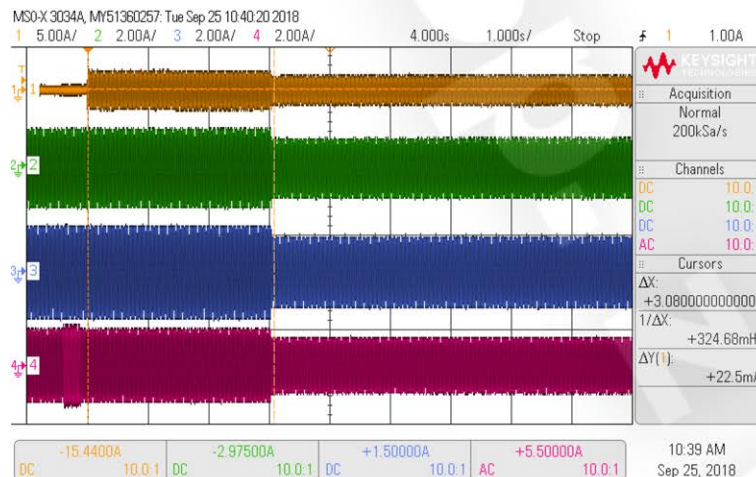


Figure 8: Functional test on three phase system adjusting phase 1

Orange waveform is Phase 1 grid current.  
Green waveform is Phase 1 current.  
Blue waveform is Phase 2 current.  
Pink waveform is Phase 3 current.  
Measured value = 3.08 seconds

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

- 1) Export limit was set to 114 W
- 2) Resistive load was set to 300 W on all three phases to allow full production of inverter.
- 3) Resistive load was changed to 25 W on phase 2 and reaction time was measured:

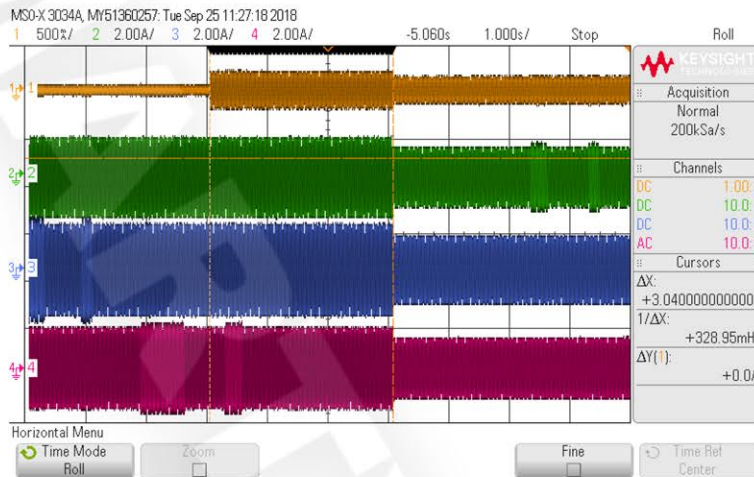


Figure 9: Functional test on three phase system adjusting phase 2

Orange waveform is Phase 2 grid current.  
 Green waveform is Phase 1 current.  
 Blue waveform is Phase 2 current.  
 Pink waveform is Phase 3 current.  
 Measured value = 3.04 seconds

- 1) Export limit was set to 114 W
- 2) Resistive load was set to 300 W on all three phases to allow full production of inverter.
- 3) Resistive load was changed to 25 W on phase 3 and reaction time was measured:

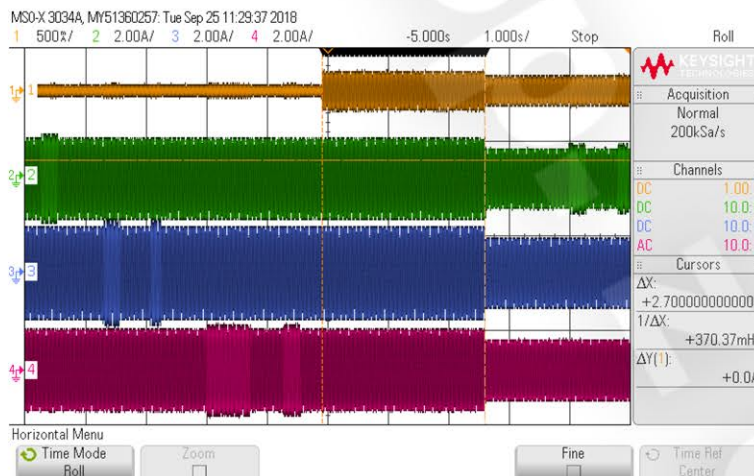


Figure 10: Functional test on three phase system adjusting phase 3

Orange waveform is Phase 3 grid current.  
 Green waveform is Phase 1 current.  
 Blue waveform is Phase 2 current.  
 Pink waveform is Phase 3 current.  
 Measured value = 2.70 seconds

ENA ER G100: 2016+Amd1 (2017)

APPENDIX A: Table of Results

- 1) Export limit was set to 114 W
- 2) Resistive load was set to 25 W on all three phases to show reduced production of inverter.
- 3) Resistive load was changed to 300 W on all three phases and ramp up reaction time was measured:

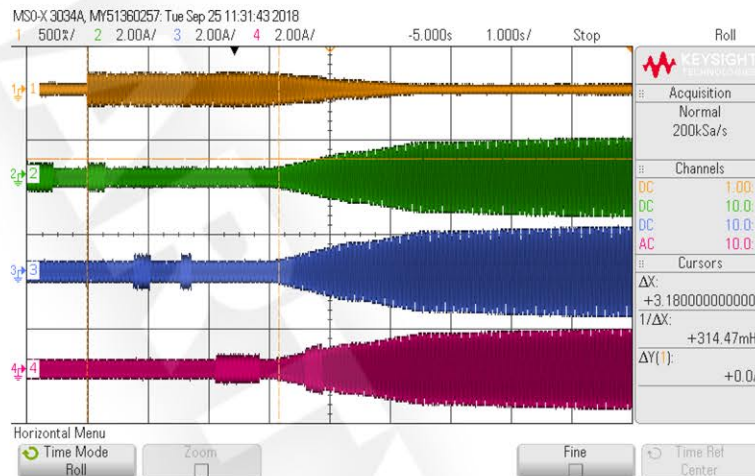


Figure 11: Return to full power after all loads are reengaged

Orange waveform is grid current.  
 Green waveform is Phase 1 current.  
 Blue waveform is Phase 2 current.  
 Pink waveform is Phase 3 current.  
 Measured value = 3.18 seconds before power ramps up.

**ENA ER G100: 2016+Amd1 (2017)**

**Appendix B: Photographic Record of Sample**

**Photographic Record of Sample**

IQ7X Photos:



*Figure 12: IQ7X general view*



*Figure 13: IQ7X bottom*

ENA ER G100: 2016+Amd1 (2017)

Appendix B: Photographic Record of Sample

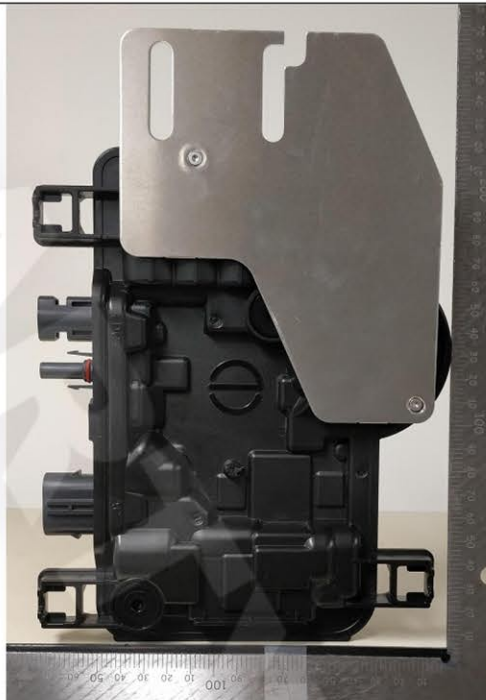


Figure 14: IQ7X top



Figure 15: IQ7X connector side



Figure 16: IQ7X right side



Figure 17: IQ7X label side

**ENA ER G100: 2016+Amd1 (2017)**

**Appendix B: Photographic Record of Sample**



*Figure 18: IQ7X mounting plate side*

**ENA ER G100: 2016+Amd1 (2017)**
**Appendix C: Equipment Calibration**
**List of measurement units used for investigation**

| Type                                                            | Model No       | Calibration date    | Expiration date     | Fixtures-No. |
|-----------------------------------------------------------------|----------------|---------------------|---------------------|--------------|
| 20 CH MULTIPLEXER CARD (with SAF-DAT-01)                        | 34901A         | 9/03/2018           | 9/03/2019           | SAF-MUX-02   |
| 20 CH MULTIPLEXER CARD (with SAF-DAT-01)                        | 34901A         | 9/03/2018           | 9/03/2019           | SAF-MUX-01   |
| 20 CH MULTIPLEXER CARD (with SAF-DAT-02)                        | 34901A         | 12/03/2018          | 12/03/2019          | SAF-MUX-04   |
| 20 CH MULTIPLEXER CARD (with SAF-DAT-02)                        | 34901A         | 12/03/2018          | 12/03/2019          | SAF-MUX-03   |
| AC POWER SOURCE                                                 | MX30           | NCR                 | NCR                 | SAF-PSU-02   |
| AC POWER SOURCE                                                 | MX30           | NCR                 | NCR                 | SAF-PSU-03   |
| AC Source                                                       | 320AMXT-UPC32E | NCR                 | NCR                 | SAF-PSU-01   |
| 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         | 6/03/2018           | 6/03/2019           | SAF-DAT-01   |
| DATA AQUISITION / SWITCH UNIT                                   | 34970A         | 12/03/2018          | 12/03/2019          | SAF-DAT-02   |
| DATA AQUISITION / SWITCH UNIT                                   | 34970A         | NCR                 | NCR                 | SAF-DAT-03   |
| Demand Response Enabling Device (AS/NZS 4777.2-2015 Appendix I) |                | NCR                 | NCR                 | SAF-DRD-01   |
| Digital Micrometer                                              | MDC-25SX       | 23/05/2017          | 23/05/2022          | SAF-MIC-01   |
| Digital Multimeter                                              | 34461A         | 19/02/2018          | 19/02/2019          | SAF-DMM-01   |
| Digital Multimeter                                              | 34461A         | 6/03/2018           | 6/03/2019           | SAF-DMM-02   |
| Handheld Digital Multimeter with current clamp                  | U1242C         | For indication only | For indication only | SAF-DMM-03   |
| Hi Pot Tester                                                   | 08256          | 26/02/2018          | 26/02/2019          | SAF-HPT-01   |
| Modular SAS Mainframe                                           | E4360A         | NCR                 | NCR                 | SAF-SAS-01   |
| 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   |
| Modular SAS Mainframe                                           | E4360A         | NCR                 | NCR                 | SAF-SAS-13   |
| Oscilloscope                                                    | TDS3034C       | 5/03/2018           | 5/03/2019           | SAF-OSC-01   |
| Oscilloscope                                                    | TDS3034C       | 5/03/2018           | 5/03/2019           | SAF-OSC-02   |
| Oscilloscope                                                    | DSO-X 3034A    | 11/05/2018          | 11/05/2019          | SAF-OSC-03   |
| Oscilloscope                                                    | MSO-X 3034A    | 13/08/2018          | 13/08/2019          | SAF-OSC-04   |
| Power Quality Analyzer                                          | WT3004E        | 19/01/2018          | 19/01/2019          | SAF-PQA-01   |
| Power Quality Analyzer                                          | WT1806         | 10/05/2018          | 10/05/2019          | SAF-PQA-02   |
| 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   |
| RLC Load for Anti-Islanding                                     | ACLT-3802H     | 18/06/2018          | 18/06/2019          | SAF-RLC-01   |
| Solar Array Simulator (in SAF-SAS-01)                           | E4361A         | NCR                 | NCR                 | SAF-SAS-02   |
| Solar Array Simulator (in SAF-SAS-01)                           | E4361A         | NCR                 | NCR                 | SAF-SAS-03   |
| 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         | 8/03/2018           | 8/03/2019           | SAF-SAS-11   |
| Solar Array Simulator (in SAF-SAS-10)                           | E4361A         | 8/03/2018           | 8/03/2019           | SAF-SAS-12   |
| Solar Array Simulator (in SAF-SAS-13)                           | E4361A         | NCR                 | NCR                 | SAF-SAS-14   |
| Solar Array Simulator (in SAF-SAS-13)                           | E4361A         | NCR                 | NCR                 | SAF-SAS-15   |
| Reference Impedance network                                     | IEC61000-3     | NCR                 | NCR                 | SAF-RIN-01   |

**End of report**