# *ENA Engineering Recommendation G83/2-1*
# *Appendix 4*
# *Type Verification Test Report*

| **Type Approval and manufacturer/supplier declaration of compliance with the requirements of Engineering Recommendation G83/2-1** | | | |
|---|---|---|---|
| SSEG (Small-Scale Embedded Generator) Type reference number | **REACT2-UNO-3.6-TL** | | |
| SSEG Type | SOLAR GRID TIED INVERTER | | |
| System Supplier name | Power-One Italy S.p.A. | | |
| Address | Via S. Giorgio, 642<br>52028 Terranuova Bracciolini<br>Arezzo – Italy | | |
| Tel. | +39-055-91951 | Fax | +39-055-9195248 |
| E:mail | servicer.solarinverters@it.abb.com | Web site | www.abb.com/solarinverters<br>www.abb.com |
| Nominal / Maximum rated capacity | Connection Option | | |
| | **3.6 kW / 3.6 kW** | kW single phase | |

We, Power-One Italy S.p.A., as manufacturer/supplier of Small Scale Embedded Generators, certifies that all products manufactured/supplied by the company with the above SSEG Type reference number will be manufactured and tested to ensure that they perform as stated in this Type Verification Test Report, prior to shipment to site and that no site modifications are required to ensure that the products meet all the requirements of G83/2.

Attachment:
Extract of Test Report Ref. **28111587 026,** Determination of Electrical Properties, released by TUeV Rheinland.

Terranuova B.ni, 2018 October 24

Alessandro Rossi
( Project Manager )

Paolo Casini
( GPG R&D Manager )

**Extract of Test report**: **28111587 026**
**"Determination of electrical properties"**



Appendix 4 Type Verification Test Report (G83/2)

| | |
|---|---|
| **Type of System:** | Solar Grid tied inverter |
| **System Manufacturer:**<br>**Manufacturer data:** | **Power-One Italy S.p.A.**<br>Via S. Giorgio 642, 52028<br>Terranuova Bracciolini (AR) - Italy |
| **0eference test report**: | **28111587 026**<br>Issued by TÜV Rheinland Italia S.r.l. on 03/10/2018 |
| **Measuring period:** | From 17/09/2018 to 28/09/2018 |
| **Pacr:**<br>*(Rated AC Power)*<br>**Pacmax:**<br>*(Maximum AC output Power)* | |

| | **REACT2-UNO-3.6-TL** | **REACT2-UNO-5.0-TL** |
|---|---|---|
| **$P_{acr}$ [W] @cosφ=1** | 3600 | 5000 |
| **$P_{acmax}$ [W] @cosφ=1** | 3600 | 5000 |

| | |
|---|---|
| **Software version** | Bundle Firmware Update Version (2):<br>**not less than 1840C** (3) with standard selection**: UK G83** |
| **Rated Voltage:** | Single-phase device<br>230 V (Phase/ Neutral) |

**Remarks:**

(1) Model designation of the product:

**Energy Storage System "Inverter+Battery Unit":**

| Model Designation: | Description |
|---|---|
| REACT2-5.0-TL-OUTD | System composed by up to 3 REACT2-BATT and REACT2-UNO-5.0-TL hybrid PV inverter |
| REACT2-3.6-TL-OUTD | System composed by up to 3 REACT2-BATT and REACT2-UNO-3.6-TL hybrid PV inverter |

**"Hybrid" PV Inverter:**

| Model Designation | Description |
|---|---|
| REACT2-UNO-5.0-TL | 5.0 KW 230V hybrid PV inverter. Hybrid means there is a PV DC input and a DC battery input |
| REACT2-UNO-3.6-TL | 3.6 KW 230V hybrid PV inverter. Hybrid means there is a PV DC input and a DC battery input |

**Battery Unit:**

| Model Designation: | Description: |
|---|---|
| REACT2-BATT | 4 KWh battery system. Up to 3 units per system |

Models REACT2-UNO-5.0-TL and REACT2-UNO-3.6-TL are identical in construction and they have the same release firmware version. They only differ in current/power limits controlled by software parameter setting.

The possible configurations for the Energy Storage System REACT2-5.0-TL-OUTD and REACT2-3.6-TL-OUTD are the following:

Nr. 1 REACT2-UNO-5.0-TL + Nr. 1 REACT2-BATT
Nr. 1 REACT2-UNO-5.0-TL + Nr. 2 REACT2-BATT
Nr. 1 REACT2-UNO-5.0-TL + Nr. 3 REACT2-BATT
Nr. 1 REACT2-UNO-3.6-TL + Nr. 1 REACT2-BATT
Nr. 1 REACT2-UNO-3.6-TL + Nr. 2 REACT2-BATT
Nr. 1 REACT2-UNO-3.6-TL + Nr. 3 REACT2-BATT

Tested Item composed by the following items:

| **Item Number** | **Model Designation** | **Serial number** |
|---|---|---|
| 3P819900000A | REACT2–UNO-5.0-TL | 000002 (prototype selected by the customer) |
| 3P889900000A | REACT2–UNO-3.6-TL | 000002 (prototype selected by the customer) |
| 3P729900000A | REACT2-BATT | 000001 (prototype selected by the customer) |

(2) "Update version" identifies the Bundle Firmware Features by a sequential code: xxxxy where:

- xxxx is a number indicates Year (two digits) and Week (two digits)
- y is a letter from A to G indicates Day (form Sunday = A to Saturday=G)

(3) Not less than: MICRO (Supervisor): C.2.3.8; Booster (DC-DC): A.0.1.5; Inverter (DC-AC): B.0.1.3 CHARGER (DC-DC): H1.0.2

**Power Quality. Harmonics. The requirement is specified in section 5.4.1, test procedure in Annex A or B 1.4.1**

| **SSEG rating per phase (rpp)** | | | **5.0 kW** | | | |
|---|---|---|---|---|---|---|
| **Harmonic** | **At 45-55% of rated output** | | **100% of rated output** | | **Mono Phase** | |
| | **Measured Value (MV) in Amps** | **Normalised Value (NV) in Amps** | **Measured Value (MV) in Amps** | **Normalised Value (NV) in Amps** | **Limit in BS EN 61000-3-2 in Amps** | **Higher limit for odd harmonics 21 and above** |
| **2** | 0.0140 | 0.00129 | 0.0190 | 0.0009 | 1.080 | |
| **3** | 0.1330 | 0.01224 | 0.1480 | 0.0068 | 2.300 | |
| **4** | 0.0020 | 0.00018 | 0.0030 | 0.0001 | 0.430 | |
| **5** | 0.0660 | 0.00607 | 0.0650 | 0.0030 | 1.140 | |
| **6** | 0.0030 | 0.00028 | 0.0020 | 0.0001 | 0.300 | |
| **7** | 0.0190 | 0.00175 | 0.0250 | 0.0011 | 0.770 | |
| **8** | 0.0020 | 0.00018 | 0.0010 | 0.0000 | 0.230 | |
| **9** | 0.0160 | 0.00147 | 0.0130 | 0.0006 | 0.400 | |
| **10** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.184 | |
| **11** | 0.0130 | 0.00120 | 0.0100 | 0.0005 | 0.330 | |
| **12** | 0.0020 | 0.00018 | 0.0010 | 0.0000 | 0.153 | |
| **13** | 0.0120 | 0.00110 | 0.0080 | 0.0004 | 0.210 | |
| **14** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.131 | |
| **15** | 0.0100 | 0.00092 | 0.0080 | 0.0004 | 0.150 | |
| **16** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.115 | |
| **17** | 0.0090 | 0.00083 | 0.0050 | 0.0002 | 0.132 | |
| **18** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.102 | |
| **19** | 0.0060 | 0.00055 | 0.0040 | 0.0002 | 0.118 | |
| **20** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.092 | |
| **21** | 0.0060 | 0.00055 | 0.0030 | 0.0001 | 0.107 | |
| **22** | 0.0000 | 0.00000 | 0.0010 | 0.0000 | 0.084 | |
| **23** | 0.0030 | 0.00028 | 0.0020 | 0.0001 | 0.098 | 0.147 |
| **24** | 0.0000 | 0.00000 | 0.0010 | 0.0000 | 0.077 | |
| **25** | 0.0030 | 0.00028 | 0.0010 | 0.0000 | 0.090 | 0.135 |
| **26** | 0.0000 | 0.00000 | 0.0010 | 0.0000 | 0.071 | |
| **27** | 0.0040 | 0.00037 | 0.0020 | 0.0001 | 0.083 | 0.124 |
| **28** | 0.0010 | 0.00009 | 0.0000 | 0.0000 | 0.066 | |
| **29** | 0.0020 | 0.00018 | 0.0010 | 0.0000 | 0.078 | 0.117 |
| **30** | 0.0010 | 0.00009 | 0.0000 | 0.0000 | 0.061 | |
| **31** | 0.0030 | 0.00028 | 0.0020 | 0.0001 | 0.073 | 0.109 |
| **32** | 0.0010 | 0.00009 | 0.0000 | 0.0000 | 0.058 | |
| **33** | 0.0020 | 0.00018 | 0.0010 | 0.0000 | 0.068 | 0.102 |
| **34** | 0.0000 | 0.00000 | 0.0010 | 0.0000 | 0.054 | |
| **35** | 0.0020 | 0.00018 | 0.0020 | 0.0001 | 0.064 | 0.096 |
| **36** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.051 | |
| **37** | 0.0010 | 0.00009 | 0.0010 | 0.0000 | 0.061 | 0.091 |
| **38** | 0.0000 | 0.00000 | 0.0000 | 0.0000 | 0.048 | |
| **39** | 0.0020 | 0.00018 | 0.0030 | 0.0001 | 0.058 | 0.087 |
| **40** | 0.0020 | 0.00018 | 0.0020 | 0.0001 | 0.046 | |

| **Power Quality. Voltage fluctuations and Flicker. The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3** | | | |
|---|---|---|---|
| Parameter | Measured Value | Limit | Verdict |
| $P_{st}$ | 0.070 | 1.00 | P |
| $P_{lt}$ | 0.070 | 0.65 | P |
| $d_c$ [%] | 0.024 | 3.30 | P |
| $d_{max}$ [%] | 0.098 | 4.00 | P |
| dt [s] | 0.000 | 0.50 | P |

| | |
|---|---|
| Standard used: | EN/IEC 61000-3-3 Flicker |
| Short time (Pst): | 10 min |
| Observation time: | 120 min (12 Flicker measurements) |
| Flickermeter: | 230V / 50Hz according IEC 61000-4-15 Ed.2 |
| Flicker Impedance: | Zref (IEC 60725) |

| **Power quality. DC injection. The requirement is specified in section 5.5, test procedure in Annex A or B 1.4.4 (of reference document G83/2)** | | | |
|---|---|---|---|
| Test power level | 10% | 55% | 100% |
| Recorded value | 0.008A | 0.018A | 0.025A |
| as % of rated AC current | 0.036 % | 0.082 % | 0.11 % |
| Limit | 0.25 % | 0.25 % | 0.25 % |

| **Power quality. Power Factor The requirement is specified in section 5.6, test procedure in Annex A or B 1.4.2** | | | | |
|---|---|---|---|---|
| **Nominal Values:** | See General Product Information | | | |
| Ambient temperature (°C) .....: | 25°C ± 5°C | | | |
| Humidity (RH %) .....: | 65%RH | | | |
| Instrumentation list.....: | See table "Measurement equipment and instrumentation" | | | |
| | 216.3V | 230.1V | 253.2V | Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test. |
| Measured value | 0.999 | 0.999 | 0.999 | |
| Limit | >0.95 | >0.95 | >0.95 | |

| **Protection. Voltage tests The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.2** | | | | | | |
|---|---|---|---|---|---|---|
| Function | Setting | | Trip test | | "No trip tests" | |
| | Voltage | Time delay | Voltage | Time delay | Voltage/Time | Confirm no trip |
| **U/V stage 1** | 200.1V | 2.55s | 200.13 | 2.558 | 204.1V/3.5s | No Trip |
| **U/V stage 2** | 184V | 0.55s | 183.53 | 0.552 | 188V/2.48s | No Trip |
| | | | | | 180V/0.48s | No Trip |
| **O/V stage 1** | 262.2V | 1.0s | 262.16 | 1.044 | 258.2V/2.0s | No Trip |
| **O/V stage 2** | 273.7V | 0.5s | 273.69 | 0.541 | 269.7V/0.98s | No Trip |
| | | | | | 277.7V/ 0.48s | No Trip |

| **Protection. Frequency tests The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.3** | | | | | | |
|---|---|---|---|---|---|---|
| **Protection. Frequency tests.** | | | | | | |
| Function | Setting | | Trip test | | "No trip tests" | |
| | Frequency | Time delay | Frequency | Time delay | Frequency /time | Confirm no trip |
| **U/F stage 1** | 47.5Hz | 20.05s | 47.45 | 20.096 | 47.7Hz/ 25s | No Trip |
| **U/F stage 2** | 47Hz | 0.55s | 46.95 | 0.565 | 47.2Hz/ 19.98s | No Trip |
| | | | | | 46.8Hz/ 0.48s | No Trip |
| **O/F stage 1** | 51.5Hz | 90.05s | 51.55 | 90.047 | 51.3Hz/95s | No Trip |
| **O/F stage 2** | 52Hz | 0.55s | 52.05 | 0.542 | 51.8Hz/ 89.98s | No Trip |
| | | | | | 52.2Hz/ 0.48s | No Trip |

**Protection. Loss of Mains test. The requirement is specified in section 5.3.2, test procedure in Annex A or B 1.3.4**

| No. | $P_{EUT}$ 1) (% of EUT rating) | Reactive load (% of $Q_L$ in 6.1.d)1) | $P_{AC}$ 2) (% of nominal) | $Q_{AC}$ 3) (% of nominal) | Run on time (ms)** | $P_{EUT}$ (W) | $V_{DC}$ (V) | Remarks 4) | Verdict |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 100 | 0 | 0 | 769.6 | 5000 | 439 | Test A at BL | P |
| 2 | 66 | 66 | 0 | 0 | 807.6 | 3300 | 328 | Test B at BL | P |
| 3 | 33 | 33 | 0 | 0 | 795.6 | 1188 | 216 | Test C at BL | P |
| 4 | 100 | 100 | -5 | -5 | 715.6 | 5000 | 439 | Test A at IB | P |
| 5 | 100 | 100 | -5 | 0 | 687.6 | 5000 | 439 | Test A at IB | P |
| 6 | 100 | 100 | -5 | +5 | 623.6 | 5000 | 439 | Test A at IB | P |
| 7 | 100 | 100 | 0 | -5 | 715.6 | 5000 | 439 | Test A at IB | P |
| 8 | 100 | 100 | 0 | +5 | 613.6 | 5000 | 439 | Test A at IB | P |
| 9 | 100 | 100 | +5 | -5 | 699.6 | 5000 | 439 | Test A at IB | P |
| 10 | 100 | 100 | +5 | 0 | 891.6 | 5000 | 439 | Test A at IB | P |
| 11 | 100 | 100 | +5 | +5 | 609.6 | 5000 | 439 | Test A at IB | P |
| 12 | 66 | 66 | 0 | -5 | 639.6 | 3300 | 328 | Test B at IB | P |
| 13 | 66 | 66 | 0 | -4 | 701.6 | 3300 | 328 | Test B at IB | P |
| 14 | 66 | 66 | 0 | -3 | 731.6 | 3300 | 328 | Test B at IB | P |
| 15 | 66 | 66 | 0 | -2 | 651.6 | 3300 | 328 | Test B at IB | P |
| 16 | 66 | 66 | 0 | -1 | 737.6 | 3300 | 328 | Test B at IB | P |
| 17 | 66 | 66 | 0 | 1 | 673.6 | 3300 | 328 | Test B at IB | P |
| 18 | 66 | 66 | 0 | 2 | 647.6 | 3300 | 328 | Test B at IB | P |
| 19 | 66 | 66 | 0 | 3 | 641.6 | 3300 | 328 | Test B at IB | P |
| 20 | 66 | 66 | 0 | 4 | 623.6 | 3300 | 328 | Test B at IB | P |
| 21 | 66 | 66 | 0 | 5 | 619.6 | 3300 | 328 | Test B at IB | P |
| 22 | 33 | 33 | 0 | -5 | 647.6 | 1188 | 216 | Test C at IB | P |
| 23 | 33 | 33 | 0 | -4 | 675.6 | 1188 | 216 | Test C at IB | P |
| 24 | 33 | 33 | 0 | -3 | 677.6 | 1188 | 216 | Test C at IB | P |
| 25 | 33 | 33 | 0 | -2 | 695.6 | 1188 | 216 | Test C at IB | P |
| 26 | 33 | 33 | 0 | -1 | 697.6 | 1188 | 216 | Test C at IB | P |
| 27 | 33 | 33 | 0 | 1 | 727.6 | 1188 | 216 | Test C at IB | P |
| 28 | 33 | 33 | 0 | 2 | 673.6 | 1188 | 216 | Test C at IB | P |
| 29 | 33 | 33 | 0 | 3 | 667.6 | 1188 | 216 | Test C at IB | P |
| 30 | 33 | 33 | 0 | 4 | 641.6 | 1188 | 216 | Test C at IB | P |
| 31 | 33 | 33 | 0 | 5 | 651.6 | 1188 | 216 | Test C at IB | P |
| 32 | 100 | 100 | -10 | -10 | 617.6 | 5000 | 439 | Test A at IB | P |
| 33 | 100 | 100 | -10 | -5 | 709.6 | 5000 | 439 | Test A at IB | P |
| 34 | 100 | 100 | -10 | 0 | 709.6 | 5000 | 439 | Test A at IB | P |
| 35 | 100 | 100 | -10 | +5 | 615.6 | 5000 | 439 | Test A at IB | P |
| 36 | 100 | 100 | -10 | +10 | 603.6 | 5000 | 439 | Test A at IB | P |
| 37 | 100 | 100 | -5 | +10 | 603.6 | 5000 | 439 | Test A at IB | P |

**Protection. Loss of Mains test. The requirement is specified in section 5.3.2, test procedure in Annex A or B 1.3.4**

| No. | $P_{EUT}$ [1] (% of EUT rating) | Reactive load (% of $Q_L$ in 6.1.d)1) | $P_{AC}$ [2] (% of nominal) | $Q_{AC}$ [3] (% of nominal) | Run on time (ms)** | $P_{EUT}$ (W) | $V_{DC}$ (V) | Remarks [4] | Verdict |
|---|---|---|---|---|---|---|---|---|---|
| 38 | 100 | 100 | 0 | +10 | 597.6 | 5000 | 439 | Test A at IB | P |
| 39 | 100 | 100 | +5 | +10 | 583.6 | 5000 | 439 | Test A at IB | P |
| 40 | 100 | 100 | -5 | -10 | 617.6 | 5000 | 439 | Test A at IB | P |
| 41 | 100 | 100 | 0 | -10 | 593.6 | 5000 | 439 | Test A at IB | P |
| 42 | 100 | 100 | +5 | -10 | 597.6 | 5000 | 439 | Test A at IB | P |
| 43 | 100 | 100 | +10 | -10 | 601.6 | 5000 | 439 | Test A at IB | P |
| 44 | 100 | 100 | +10 | -5 | 691.6 | 5000 | 439 | Test A at IB | P |
| 45 | 100 | 100 | +10 | 0 | 843.6 | 5000 | 439 | Test A at IB | P |
| 46 | 100 | 100 | +10 | +5 | 625.6 | 5000 | 439 | Test A at IB | P |
| 47 | 100 | 100 | +10 | +10 | 589.6 | 5000 | 439 | Test A at IB | P |

[1] $P_{EUT}$: EUT output power
[2] $P_{AC}$: Real power flow at S1 as in Figure 1. Positive value means the power from EUT to utility. Nominal value is the 0% test condition value.
[3] $Q_{AC}$: Reactive power flow at S1 as in Figure 1. Positive value means the power from EUT to utility. Nominal value is the 0% test condition value
[4] BL: Balance condition, IB: Imbalance condition
*: Needs to be measured if any of the recorded run-on times at imbalanced condition are longer than the one recorded for the rated balance condition at test condition A
** "Run on time" must be < 2s
The filled out switch-off time values the highest among the three phase

| **Protection. Re-connection timer. The requirement is specified in section 5.3.4, test procedure in Annex A or B 1.3.5 (of reference document G83/2)** | | | | | |
|---|---|---|---|---|---|
| Time delay setting | Measured delay | Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1. | | | |
| 20s | 24s | At 254.7V | At 196.2V | At 47.6Hz | At 51.4Hz |
| Confirmation that the SSEG does not re-connect. | | No reconnection | No reconnection | No reconnection | No reconnection |

| **Protection. Frequency change, Stability test The requirement is specified in section 5.3.3, test procedure in Annex A or B 1.3.6 (of reference document G83/2)** | | | | |
|---|---|---|---|---|
| | Start Frequency | Change | End Frequency | Confirm no trip |
| Positive Vector Shift | 49.5Hz | +9 degrees | | No trip |
| Negative Vector Shift | 50.5Hz | - 9 degrees | | No trip |
| Positive Frequency drift | 49.5Hz | +0.19Hz/sec | 51.5Hz | No trip |
| Negative Frequency drift | 50.5Hz | -0.19Hz/sec | 47.5Hz | No trip |

| **Fault level contribution. The requirement is specified in section 5.7, test procedure in Annex A or B 1.4.6 (of reference document G83/2)** | | |
|---|---|---|
| Time after fault | Volts | Amps (rms) |
| 20ms | 20.02 | 21.72 |
| 60ms | 10.65 | 10.81 |
| 100ms | 7.59 | 6.78 |
| 1000ms | 4.56 | 4.12 |
| Time to trip | <1 | In seconds |

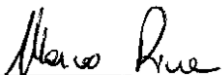
**Extract of Test report**: **28111587 026**
**"Determination of electrical properties"**



Appendix 4 Type Verification Test Report (G83/2)

This extract from the test report is only valid in conjunction with the test report no.: **28111587 026**

**Reviewed by:**

| 03.10.2018 | Marco Piva / BFM |  |
|---|---|---|
| **Datum**<br>*Date* | **Name/Stellung**<br>*Name/Position* | **Unterschrift**<br>*Signature* |