*ref. TRIO-27.6-TL-OUTD (UK G59/3 Type Verification Test Report)*

# *ENA Engineering Recommendation G59/3*
# *Type Verification Test Report*

| **Type Approval and manufacturer/supplier declaration of compliance with the requirements of Engineering Recommendation G59/3** | | | |
|---|---|---|---|
| Type Test reference number | TRIO-20.0-TL-OUTD-400; TRIO-20.0-TL-OUTD-S2-400; TRIO-20.0-TL-OUTD-S2X-400; TRIO-20.0-TL-OUTD-S2F-400; TRIO-20.0-TL-OUTD-S1J-400; TRIO-20.0-TL-OUTD-S2J-400; TRIO-27.6-TL-OUTD-400; TRIO-27.6-TL-OUTD-S2-400; TRIO-27.6-TL-OUTD-S2X-400; TRIO-27.6-TL-OUTD-S2F-400; TRIO-27.6-TL-OUTD-S1J-400; TRIO-27.6-TL-OUTD-S2J-400 TRIO-27.6-TL-OUTD-400-W; TRIO-20.0-TL-OUTD-400-W | | |
| Generating unit technology | PHOTOVOLTAIC / WIND<br>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 | | Web site | www.abb.com/solarinverters |

| Maximum / Nominal rated capacity | Connection Option | |
|---|---|---|
| | **30.0 / 27.6 kW** | kW single phase (for TRIO-27.6 series) |
| | **22.0 / 20.0 kW** | kW single phase (for TRIO-20.0 series) |

We, Power-One Italy S.p.A., as manufacturer/supplier of Generating Unit, certifies that all products manufactured/supplied by the company with the above Type Test reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the products meet all the requirements of G59/3.

Attachment:
Extract of Test Report Ref. **28106733 001**, Determination of Electrical Properties,
released by TUeV Rheinland

| | | |
|---|---|---|
| *(Manufacturer)* | **Phoenix, AZ**<br>*(Place)* | **2014 July 15**<br>*(Date)* |

Robert P. White Jr.
(Director Product Compliance)

**Extract of Test report**: **28106733 001**
**Engineering Recommendation G59 Issue 03 (September 2013)**
**13.1 Generating Unit Type Test Sheet**
**Type Tested Generating Unit (>16A per phase but ≤ 17 kW 1 phase)**



| | |
|---|---|
| **Type of System:** | 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 |
| **Reference test report**: | **28106733 001**<br>Issued by TÜV Rheinland Italia S.r.l.<br>on 14th July 2014 |
| **Measuring period:** | From 22Th May 2014 to 29Th May 2014 |
| **Type Test reference number:**<br><br>**Pacr / Pacmax**<br>*(Rated AC Power / Maximum AC output Power)* | See table below |
| **Software version:** | Bundle Firmware Update Version**:<br>**not less than 1422G** standard selection: **UK G59** |
| **Rated Voltage:** | 3-phase device<br>230 V (Phase/ Neutral) |

| Models * | Pacr / Pacmax |
|---|---|
| TRIO-20.0-TL-OUTD-400 | 27.6 / 30.0 |
| TRIO-20.0-TL-OUTD-S2-400 | |
| TRIO-20.0-TL-OUTD-S2X-400 | |
| TRIO-20.0-TL-OUTD-S2F-400 | |
| TRIO-20.0-TL-OUTD-S1J-400 | |
| TRIO-20.0-TL-OUTD-S2J-400 | |
| TRIO-20.0-TL-OUTD-400-W | |
| TRIO-27.6-TL-OUTD-400 | 22.0 / 20.0 |
| TRIO-27.6-TL-OUTD-S2-400 | |
| TRIO-27.6-TL-OUTD-S2X-400 | |
| TRIO-27.6-TL-OUTD-S2F-400 | |
| TRIO-27.6-TL-OUTD-S1J-400 | |
| TRIO-27.6-TL-OUTD-S2J-400 | |
| TRIO-27.6-TL-OUTD-400-W | |

**Remarks:**

**Note *:** test performed on models TRIO-27.6-TL-OUTD-400 and TRIO-20.0-TL-OUTD-400

All models have the same release firmware version, electronic control boards.
Hardware differences are managed by a flash memory installed during the manufacturing process.

Models with option “-S2”, “-S2X”, “-S2F”, “-S1J”, “-S2J” have got different wiring box .

Models with suffix “-W” are used for wind application.

Tested model indicated in **bold** characters.

**Note **:**

“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)

**Power Quality. Harmonics.**

MODELs: TRIO-27.6-TL-OUTD-400 and derived models

| Generating Unit rating per phase (rpp) | | | 9.2 | kVA | Harmonic % = Measured Value (Amps) x 23/rating per phase (kVA) | |
|---|---|---|---|---|---|---|
| Harmonic | At 45-55% of rated output | | 100% of rated output | | Limit in BS EN 61000-3-12 | |
| | Measured Value (MV) in Amps | % | Measured Value (MV) in Amps | % | 1 phase % | 3 phase % |
| 2 | 0.042 | 0.105 | 0.085 | 0.213 | 8.00 | 8.00 |
| 3 | 0.046 | 0.116 | 0.045 | 0.114 | 21.60 | Not stated |
| 4 | 0.013 | 0.033 | 0.031 | 0.077 | 4.00 | 4.00 |
| 5 | 0.089 | 0.222 | 0.095 | 0.237 | 10.70 | 10.70 |
| 6 | 0.008 | 0.019 | 0.018 | 0.046 | 2.67 | 2.67 |
| 7 | 0.086 | 0.214 | 0.093 | 0.232 | 7.20 | 7.20 |
| 8 | 0.007 | 0.017 | 0.017 | 0.043 | 2.00 | 2.00 |
| 9 | 0.019 | 0.048 | 0.020 | 0.051 | 3.80 | Not stated |
| 10 | 0.008 | 0.020 | 0.014 | 0.035 | 1.60 | 1.60 |
| 11 | 0.270 | 0.675 | 0.366 | 0.915 | 3.10 | 3.10 |
| 12 | 0.007 | 0.017 | 0.008 | 0.020 | 1.33 | 1.33 |
| 13 | 0.184 | 0.459 | 0.296 | 0.739 | 2.00 | 2.00 |
| THD | 1.816 | - | 1.415% | - | 23.00% | 13.00% |
| PWHD | 2.005% | - | 3.020% | - | 23.00% | 22.00% |

MODELs: TRIO-20.0-TL-OUTD-400 and derived models

| Generating Unit rating per phase (rpp) | | | 6.7 | kVA | Harmonic % = Measured Value (Amps) x 23/rating per phase (kVA) | |
|---|---|---|---|---|---|---|
| Harmonic | At 45-55% of rated output | | 100% of rated output | | Limit in BS EN 61000-3-12 | |
| | Measured Value (MV) in Amps | % | Measured Value (MV) in Amps | % | 1 phase % | 3 phase % |
| 2 | 0.075 | 0.258 | 0.110 | 0.380 | 8.00 | 8.00 |
| 3 | 0.024 | 0.083 | 0.024 | 0.084 | 21.60 | Not stated |
| 4 | 0.007 | 0.024 | 0.016 | 0.054 | 4.00 | 4.00 |
| 5 | 0.080 | 0.276 | 0.102 | 0.353 | 10.70 | 10.70 |
| 6 | 0.006 | 0.019 | 0.009 | 0.032 | 2.67 | 2.67 |
| 7 | 0.086 | 0.296 | 0.099 | 0.343 | 7.20 | 7.20 |
| 8 | 0.010 | 0.033 | 0.011 | 0.036 | 2.00 | 2.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | 0.013 | 0.043 | 0.015 | 0.051 | 3.80 | Not stated |
| 10 | 0.010 | 0.033 | 0.011 | 0.039 | 1.60 | 1.60 |
| 11 | 0.085 | 0.293 | 0.281 | 0.971 | 3.10 | 3.10 |
| 12 | 0.007 | 0.023 | 0.013 | 0.043 | 1.33 | 1.33 |
| 13 | 0.057 | 0.196 | 0.236 | 0.813 | 2.00 | 2.00 |
| THD | 1.386% | - | 1.560% | - | 23.00% | 13.00% |
| PWHD | 3.262% | - | 2.809% | - | 23.00% | 22.00% |

*In the table above, the worst case measure of the 3 phases is reported.*

**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**

MODELs: TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models)

| | Starting | | | Stopping | | | Running | |
|---|---|---|---|---|---|---|---|---|
| | dmax | dc | d(t) | dmax | dc | d(t) | Pst | Plt 2 hours |
| Measured Values | 1.945% | 1.143% | 0 | 1.945% | 1.143% | 0 | 0.583 | 0.315 |
| Normalised to standard impedance and 3.68kW for multiple units | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Limits set under BS EN 61000-3-2 | 4% | 3.30% | 3.3% 500ms | 4% | 3.30% | 3.3% 500ms | 1 | 0.65 |
| Test start date | 19th January 2012 | | | Test end date | | 10th April 2012 | | |
| Test location | AUSTEST Laboratories | | | | | | | |

*In the table above, the worst case measure of the 3 phases is reported.*

**Power quality. DC injection.**

MODELs: TRIO-27.6-TL-OUTD-400 and derived models

| Test power level | 10% | 55% | 100% |
|---|---|---|---|
| Recorded value | 12.0 mA | 12.0 mA | 23.0 mA |
| as % of rated AC current | 0.03 % | 0.03 % | 0.05 % |
| Limit | 0.25 % | 0.25 % | 0.25 % |

MODELs: TRIO-20.0-TL-OUTD-400 and derived models

| Test power level | 10% | 55% | 100% |
|---|---|---|---|
| Recorded value | 29.0 mA | 18.0 mA | 22.0 mA |
| as % of rated AC current | 0.09 % | 0.05 % | 0.07 % |
| Limit | 0.25 % | 0.25 % | 0.25 % |

*In the table above, the worst case measure of the 3 phases is reported.*

| **Power quality. Power Factor.** | | | | |
|---|---|---|---|---|
| MODELs: TRIO-27.6-TL-OUTD-400 and derived models | | | | |
| - | 216.4V | 230V | 253V | 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 | 0.9999 | 0.9999 | 0.9999 | |
| Limit | >0.95 | >0.95 | >0.95 | |
| MODELs: TRIO-20.0-TL-OUTD-400 and derived models | | | | |
| - | 216.3V | 230V | 253V | 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 | 0.9998 | 0.9999 | 0.9998 | |
| Limit | >0.95 | >0.95 | >0.95 | |

*In the table above, the worst case measure of the 3 phases is reported.*

| **Protection. Frequency tests.** | | | | | | |
|---|---|---|---|---|---|---|
| MODELs: TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models) | | | | | | |
| 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 | 47.50 Hz | 20.05s | 47,7Hz/ 25s | No Trip |
| U/F stage 2 | 47Hz | 0,55s | 47.0 Hz | 0.55s | 47,2Hz/ 19,98s | No Trip |
| | | | | | 46,8Hz/ 0,48s | No Trip |
| O/F stage 1 | 51,5Hz | 90,05s | 51.50 Hz | 90.03s | 51,3Hz/95s | No Trip |
| O/F stage 2 | 52Hz | 0,55s | 52.00 Hz | 0.55s | 51,8Hz/ 89,98s | No Trip |
| | | | | | 52,2Hz/ 0,48s | No Trip |

| **Protection. Voltage tests .** | | | | | | |
|---|---|---|---|---|---|---|
| MODELs: TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models) | | | | | | |
| Function | Setting | | Trip test | | "No trip tests" | |
| | Voltage | Time delay | Voltage | Time delay | Voltage/Time | Confirm no trip |
| U/V stage 1 | 200.1V | 2.50s | 199.80 | 2.55s | 204.1V/3.5s | No Trip |
| U/V stage 2 | 184V | 0.50s | 183.20 | 0.53s | 188V/2.48s | No Trip |
| | | | | | 180V/0.48s | No Trip |
| O/V stage 1 | 262.2V | 1.00s | 262.80V | 1.03s | 258.2V/2.0s | No Trip |
| O/V stage 2 | 273.7V | 0.50s | 273.50V | 0.52s | 269.7V/0.98s | No Trip |
| | | | | | 277.7V/0.48s | No Trip |

*In the table above, the worst case measure of the 3 phases is reported.*

**a) Protection. Loss of Mains test and single phase test.**

Note as an alternative, inverters can be tested to BS EN 62116. The following sub set of tests should be recorded in the following table.

TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models)

| Test Power and imbalance | 33% -5% Q Test 22 | 66% -5% Q Test 12 | 100% -5% P Test 5 | 33% +5% Q Test 31 | 66% +5% Q Test 21 | 100% +5% P Test 10 |
|---|---|---|---|---|---|---|
| Trip time. Limit is 1.0s | 0.634s | 0.615s | 0.666s | 0.642s | 0.617s | 0.485s |

Single phase test for multi phase Generating Units. Confirm that the removal of a single phase connection to the Generating Unit, with the remaining phases connected causes a disconnection ot the generating unit within a maximum of 1s.

| Ph 1 removed | Confirm Trip in: 0.309s | Ph2 removed | Confirm Trip in : 0.288s | Ph3 removed | Confirm Trip in: 0.238s |
|---|---|---|---|---|---|

**b) Protection. Frequency change, Stability test.**

TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models)

| | 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 |

**c) Protection. Re-connection timer.**

TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models)

| 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 | 25.48s | At 266.2V | At 196.1V | At 47.4Hz | At 51.6Hz |
| Confirmation that the SSEG does not re-connect. | | No reconnection | No reconnection | No reconnection | No reconnection |

**d) Fault level contribution.**

TRIO-27.6-TL-OUTD-400 and derived models (including TRIO-20.0 models)

For a Inverter SSEG

| Time after fault | Volts | Amps |
|---|---|---|
| 20ms | 49.42 | 33.59 |
| 100ms | 29.61 | 17.61 |
| 250ms | 24.62 | 11.31 |
| 500ms | 22.77 | 8.18 |
| Time to trip | >0.600 | In seconds |

| | |
|---|---|
| **e) Self-Monitoring solid state switching. The requirement is specified in section 5.3.1. no specified test requirements.** | N/A |
| Mechanical relay used. | |

This extract from the test report is only valid in conjunction with the test report no.: **28106733 001**

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