



**BUREAU
VERITAS**

TEST REPORT

IEC 62109-2

**Safety of power converters for use in photovoltaic power system -
Part 2: Particular requirements for inverters**

Report reference number: 18TH0412-IEC62109-2_KR_0

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Testing laboratory name.....: Bureau Veritas Consumer Products Services Germany GmbH

Address: Businesspark A96; D-86842 Türkheim

Accreditation.....:



Deutsche
Akkreditierungsstelle
D-PL-12024-03-03

Applicant's name.....: KACO new energy GmbH

Address: Werner-von-Siemens-Allee 1, 74172 Neckarsulm, Germany

Test specification

Standard.....: IEC 62109-2:2011, EN 62109-2:2011, DIN EN 62109-2:2012

Certificate.....: Certificate of compliance

Test report form number.....: IEC62109-2_8

Master TRF.....: Bureau Veritas Consumer Products Services Germany GmbH

Test item description: Grid-tied photovoltaic inverter

Trademark:

K A C O



new energy.

Model / Type.....: KACO blueplanet 100 TL3 M1 WM OD KRFX



| | | | | |
|---|--|----|----|----|
| Ratings | KACO blueplanet 100 TL3 M1 WM OD KRFX | -- | -- | -- |
| Input DC voltage range [V] | 563 – 1500 | -- | -- | -- |
| MPP DC voltage range [V] | 563 – 1200 | -- | -- | -- |
| Input DC current [A] | 183 | -- | -- | -- |
| Output AC voltage [V] | 3 x 380 / PE | -- | -- | -- |
| Output AC current [A] | 3 x 152 | -- | -- | -- |
| Initial short-current AC current I_K [A] .: | 150,8 | -- | -- | -- |
| Output power [VA] | 100000 | -- | -- | -- |



Testing Location.....: Bureau Veritas Consumer Products Services Germany GmbH

Address: Businesspark A96, 86842 Türkheim, Germany

Tested by Stefan Gerstmeyr
(name, function and signature): Project Manager – Energy Systems El. Safety

Approved by Domenik Koll
(name, function and signature): Manager – Energy Systems El. Safety

Manufacturer's name: KACO new energy GmbH

Factory address.....: Werner-von-Siemens-Allee 1, 74172 Neckarsulm, Germany

Document History

| Date | Internal reference | Modification / Change / Status | Revision |
|------------|--------------------|--------------------------------|----------|
| 2021-11-11 | SG | Initial report was written | 0 |

Supplementary information:

**Test item particulars**

Classification of installation and use: operator access area

Equipment mobility: ☐ movable ☐ hand-held ☐ stationary
☒ fixed ☐ transportable ☐ for building-in

Connection to the mains: ☐ pluggable equipment ☐ direct plug-in
☒ permanent/lockable connection
☐ for building-in

Connection to PV: ☐ pluggable equipment ☐ direct plug-in
☒ permanent/lockable connection
☐ for building-in

Environmental category: ☒ outdoor ☒ indoor unconditional ☒ indoor conditional

Over voltage category Mains.....: ☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV

Over voltage category PV.....: ☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV

Operating condition.....: ☒ Continuous ☐ Short-time

Mains supply tolerance (%): According to the specification:
operating range: 380Vac

Tested for IT power systems: N/A

IT testing, phase-phase voltage (V): N/A

Class of equipment: ☒ Class I ☐ Class II ☐ Class III
☐ Not classified

Mass of equipment (kg): 78

Pollution degree: ext. 3, int. 2

Protection against ingress of water: IP66 according to IEC 60529

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.....: 2018-08-27

Date (s) of performance of tests.....: 2018-10-01 to 2018-12-18



General remarks

The test results presented in this report relate only to the object tested.

This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

"(see Enclosure #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

Throughout this report a ☒ comma / ☐ point is used as the decimal separator.





Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed.





This Test Report consists of the following documents and/or enclosures:

| | |
|---|----|
| Test Results | 21 |
| Fault-tolerance of automatic disconnecting means | 22 |
| Cooling system failure – Blanketing test | 24 |
| Array insulation resistance detection for inverters for ungrounded arrays | 25 |
| TABLE: Protection by residual current monitoring | 26 |
| Annex No. 1 Pictures of the Unit | 28 |
| Annex No. 2 Test Equipment list | 32 |
| End of Test Report | 34 |

Copy of marking plate

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

| | | | |
|--|----------------------|---|---------------------|
| <div>   </div> <div> The Green Energy Company  </div> | | | |
| KACO blueplanet 100 TL3 M1 WM OD KRFX | | | |
| Serial | | | |
|  | KS표번호 | KS C 8565 | |
| | KS표준명 | 중대형 태양광발전용 인버터 | |
| 모델코드 | | 인증일자 | |
| 제조연월일 | | 인증기관명 | 한국에너지공단 신재생에너지센터 |
| MPP 전압범위 | 563 - 1200 V | 최대개방전압 | 1500 V |
| 정격 출력 | 100 kVA | 정격출력전압 | 380 V |
| 정격 주파수 | 60 Hz | 정격출력전류 | 152 A |
| 제조사 | KACO new energy GmbH | 연락처(A/S) | +49 7132 896-1000 |
| | 사무소 | Werner-von-Siemens-Allee 1, 74172 Neckarsulm, Germany | |
| | 공장 | Werner-von-Siemens-Allee 1, 74172 Neckarsulm, Germany | |
| 수입자 / 판매자 | OCI Power(주) | 연락처(A/S) | 1544-9633 |
| | 사무소 | 전라북도 군산시 자유무역2길 15, 5동 1,2층(오식도동) | |

| | | | |
|--|---------------------------------------|--|-----------------------|
| <div>   </div> <div> KACO new energy Werner-von-Siemens-Allee 1 74172 Neckarsulm Made in Germany </div> | | KACO blueplanet 100 TL3 M1 WM OD KRFX | |
| Part number | 1001950 | Serial number | 100TL0XXXXXX |
| Year | Q2 / 21 |  | |
| Input | Vmax PV / Isc PV (max) / Inom PV | 1500 V / 300 A / 183 A | |
| | V-MPP at Pnom / V- range | 563V - 1200V / 563V - 1450V | |
| Output | Nominal voltage | 380 V (3P+PE) | |
| | Voltage range continuous operation | 300 V - 437 V (Ph-Ph) | |
| | Current (maximum continuous) | 3 x 152 A | |
| | Frequency range | 45 Hz - 65 Hz | |
| Output Power | Snom at 380 V Unom | 100 000 VA | |
| | Smax at 380 V Unom | 100 000 VA | |
| | Reactive power | 0-100% Snom | cos phi 0,3-1 ind/cap |
| Environment | Temperature range | - 25...+60°C / -13...+140 °F | |
| | Protection class / Ingress protection | I / IP66 / NEMA 4X | |
| No galvanic separation / Ungrounded Arrays Only | | Max. Backfeed Current | 0 A |
| Grid Support Interactive Inverter | | ARC fault circuit protection | none |
| Interface protection according to country specific requirements, details see manual | | | |
|  | | | |

Copy of warning marks







DANGER: 1500V

CAUTION:
 ▶ Read IMPORTANT SAFETY INSTRUCTIONS before Use.

WARNING:
Risk of Electric Shock
 Both AC and DC voltage sources are terminated inside this equipment. The DC conductors of this photovoltaic system are ungrounded and may be energized when the photovoltaic array is exposed to light.
 ▶ Before removing cover, each circuit must be individually disconnected.
 ▶ Do Not Remove Cover. No User Serviceable Parts Inside.
 ▶ Refer Servicing To Qualified Service Personnel.

WARNING:
Risk of Electric Shock from Stored Energy in Capacitor
 ▶ Do not remove cover until 5min after disconnecting all sources of supply.

CAUTION: Hot Surface
 ▶ To reduce the risk of burns - Do not touch.

CAUTION:
Ingress of Water may Damage the Electronic
 ▶ Do not open unit when it rains.

Enclosure and user interface:

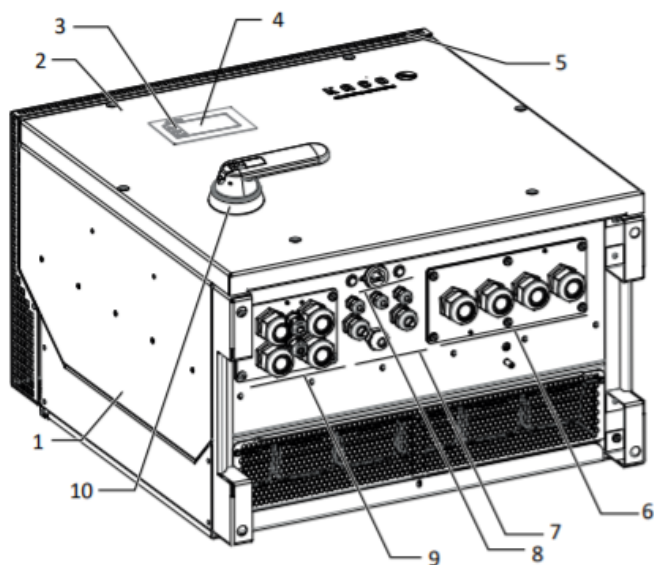


Fig. 3: Device diagrams - XL - Version

Key

| | |
|--------------------------------------|---|
| 1 Housing | 6 Interface / cable feed-through |
| 2 Cover | 7 Communication - button / USB port |
| 3 Status indicator | 8 DC connection / cable feed-through |
| 4 Upper cover | 9 DC isolator switch (not present in S version) |
| 5 AC connection / cable feed-through | |

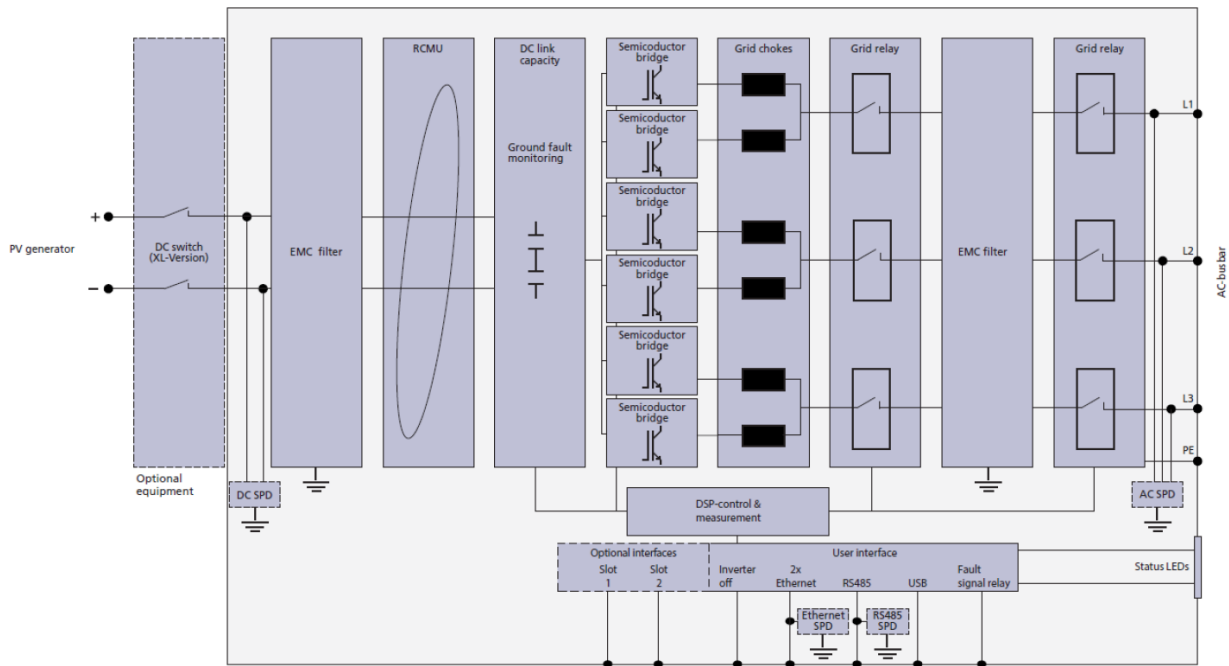
General product information:

The Solar Inverter converts DC voltage into AC voltage.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformer). The output is switched off redundant by the high-power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.

Software version: PKT: v3.50

Block diagram of the utility interactive inverter:



| IEC 62109-2 | | | |
|--------------|---|---|----------|
| Clause | Requirement + Test | | Verdict |
| 4 | General testing requirements The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | | P |
| 4.4 | Testing in single fault condition | | P |
| 4.4.4 | Single fault conditions to be applied | | P |
| 4.4.4.15 | Fault-tolerance of protection for grid-interactive inverters | | P |
| 4.4.4.15.1 | Fault-tolerance of residual current monitoring | The residual current monitoring device provides a test winding which is used to inject a defined current before each start-up. In case of a fault in the sensor, measuring circuit or microcontroller, the inverter will not connect to the grid. | P |
| | Protection required by 4.8.3.5 | | P |
| | a) the inverter ceases to operate, or | | N/A |
| | b) the inverter continues to operate, passes testing in accordance with 4.8.3, or | | N/A |
| | c) the inverter continues to operate, regardless of loss of residual current monitoring functionality, but does not re-connect after any sequence of removing and reconnecting PV power, AC power, or both. | See appended table. | P |
| 4.4.4.15.2 | Fault-tolerance of automatic disconnecting means | | P |
| 4.4.4.15.2.1 | General | | P |
| | –...disconnect all grounded and ungrounded current-carrying conductors from the mains | L and N connections are disconnected by two relays in series. | P |
| | –...single fault-tolerant | The inverter provides a watchdog for monitoring the main CPU. In case of a fault of the main CPU, the watchdog can disconnect the relays independent. See also appended table. | P |
| 4.4.4.15.2.2 | Design of insulation or separation | See appended table. | P |
| | –...the basic insulation or simple separation shall be based on the PV circuit working voltage, impulse withstand voltage, and temporary over-voltage | | P |
| | –...the mains shall be assumed to be disconnected | | P |
| | –...the provisions of 7.3.7.1.2 g) of Part 1 may be applied if the design incorporates means to reduce impulse voltages | | P |
| | –...in determining the clearance based on working voltage in 7.3.7 of Part 1, the values of column 3 of Table 13 of Part 1 shall be used | | P |

| IEC 62109-2 | | | |
|--------------|--|---|---------|
| Clause | Requirement + Test | | Verdict |
| 4.4.4.15.2.3 | Automatic checking of the disconnect means | | P |
| | For a non-isolated inverter, the isolation provided by the automatic disconnection means shall be automatically checked before the inverter starts operation | | P |
| | Single faults are to be applied to the automatic disconnection means or to other relevant parts of the inverter, fulfilling at least basic insulation or simple separation between mains and PV. | See appended table. | P |
| 4.4.4.16 | Stand-alone inverters – Load transfer test | Inverter is able only to feed into the mains. | N/A |
| | The bypass a.c. source is to be displaced 180° from the a.c. output of a single-phase inverter and 120° for a 3-phase supply | | N/A |
| | For an inverter employing a bypass switch having a control preventing switching between two a.c. sources out of synchronization, the test is to be conducted under the condition of a component malfunction | | N/A |
| 4.4.4.17 | Cooling system failure – Blanketing test | See appended table. | P |
| | This test is not required for inverters restricted to use only in closed electrical operating areas. | | N/A |
| | The inverter shall be mounted in accordance with the manufacturer's installation instructions. The entire inverter including any external heatsink provided shall be covered in surgical cotton with an uncompressed thickness of minimum 2 cm, covering all heatsink fins and air channels. | The relevant note is placed in the user manual. | P |
| | Duration of minimum of 7 h except thermal equilibrium is reached. | | P |
| | Maximum reached surface temperature: | 66,7 °C | P |
| 4.7 | Electrical ratings tests | Inverter is a grid interactive inverter. | N/A |
| 4.7.3 | Measurement requirements for AC output ports for stand-alone inverters | | N/A |
| 4.7.4 | Stand-alone Inverter AC output voltage and frequency | | N/A |
| 4.7.4.1 | General | | N/A |
| | The AC output voltage and frequency of a stand-alone inverter, or multi-mode inverter operating in stand-alone mode, shall comply with the requirements of 4.7.4.2 to 4.7.4.5. | | N/A |
| 4.7.4.2 | Steady state output voltage at nominal DC input | | N/A |
| | The steady-state AC output voltage shall not be less than 90 % or more than 110 % of the rated nominal voltage with the inverter supplied with its nominal value of DC input voltage. | | N/A |
| 4.7.4.3 | Steady state output voltage across the DC input range | | N/A |

| IEC 62109-2 | | | |
|-------------|--|--------------------------|---------|
| Clause | Requirement + Test | | Verdict |
| | The steady-state AC output voltage shall not be less than 85 % or more than 110 % of the rated nominal voltage with the inverter supplied with any value within the rated range of DC input voltage. | | N/A |
| 4.7.4.4 | Load step response of the output voltage at nominal DC input | No stand-alone inverter. | N/A |
| | The AC output voltage shall not be less than 85 % or more than 110 % of the rated nominal voltage for more than 1,5 s after application or removal of a resistive load equal to the inverter's rated maximum continuous output power in stand-alone mode, with the inverter supplied with its nominal value of DC input voltage. | | N/A |
| 4.7.4.5 | Steady state output frequency | | N/A |
| | The steady-state AC output frequency shall not vary from the nominal value by more than +4 % or -6 %. | | N/A |
| 4.7.5 | Stand-alone inverter output voltage waveform | | N/A |
| 4.7.5.1 | General | | N/A |
| | The AC output voltage waveform of a stand-alone inverter, or multi-mode inverter operating in stand-alone mode, shall comply with the requirements in 4.7.5.2 for sinusoidal outputs, or 4.7.5.3 and 4.7.5.4 for intentionally non-sinusoidal outputs, or with the dedicated load requirements in 4.7.5.5. | | N/A |
| 4.7.5.2 | Sinusoidal output voltage waveform requirements | | N/A |
| | The AC output waveform of a sinusoidal output stand-alone inverter shall have a total harmonic distortion (THD) not exceeding of 10 % and no individual harmonic at a level exceeding 6 %. | | N/A |
| 4.7.5.3 | Non-sinusoidal output waveform requirements | | N/A |
| 4.7.5.3.1 | General | | N/A |
| | The AC output voltage waveform of a non-sinusoidal output stand-alone inverter shall comply with the requirements of 4.7.5.3.2 to 4.7.5.3.4. | | N/A |
| 4.7.5.3.2 | Total harmonic distortion | | N/A |
| | The total harmonic distortion (THD) of the voltage waveform shall not exceed 40 %. | | N/A |
| 4.7.5.3.3 | Waveform slope | | N/A |
| | The slope of the rising and falling edges of the positive and negative half-cycles of the voltage waveform shall not exceed 10 V/ μ s measured between the points at which the waveform has a voltage of 10 % and 90 % of the peak voltage for that half-cycle. | | N/A |
| 4.7.5.3.4 | Peak voltage | | N/A |

| IEC 62109-2 | | | |
|-------------|--|--|---------|
| Clause | Requirement + Test | | Verdict |
| | The absolute value of the peak voltage of the positive and negative half-cycles of the waveform shall not exceed 1,414 times 110 % of the RMS value of the rated nominal AC output voltage. | | N/A |
| 4.7.5.4 | Information requirements for non-sinusoidal waveforms | | N/A |
| | The instructions provided with a stand-alone inverter not complying with 4.7.5.2 shall include the information in 5.3.2.6. | | N/A |
| 4.7.5.5 | Output voltage waveform requirements for inverters for dedicated loads | Inverter is not for dedicated loads only. | N/A |
| | The combination of the inverter and dedicated load shall be evaluated to ensure that the output waveform does not cause any hazards in the load equipment and inverter, or cause the load equipment to fail to comply with the applicable product safety standards. | | N/A |
| 4.8 | Additional tests for grid-interactive inverters | | P |
| 4.8.1 | General requirements regarding inverter isolation and array grounding | | P |
| | Inverters may or may not provide galvanic isolation from the mains to the PV array, and the array may or may not have one side of the circuit grounded. Inverters shall comply with the requirements in Table 30 for the applicable combination of inverter isolation and array grounding. | Inverter is transformer-less and therefore no grounded arrays are allowed. | N/A |
| 4.8.2 | Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays | | P |
| 4.8.2.1 | Array insulation resistance detection for inverters for ungrounded arrays | See appended table. | P |
| | Inverters for use with ungrounded arrays shall have means to measure the DC insulation resistance from the PV input (array) to ground before starting operation | | P |
| | –...for isolated inverters, shall indicate a fault (operation is allowed) | | N/A |
| | –...for non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, shall indicate a fault in accordance with 13.9, and shall not connect to the mains | | P |
| 4.8.2.2 | Array insulation resistance detection for inverters for functionally grounded arrays | | N/A |
| | Inverters that functionally ground the array through an intentional resistance integral to the inverter, shall meet the requirements below: | | N/A |

| IEC 62109-2 | | | |
|-------------|---|---|---------|
| Clause | Requirement + Test | | Verdict |
| | a) The value of the total resistance, including the intentional resistance for array functional grounding, the expected insulation resistance of the array to ground, and the resistance of any other networks connected to ground (for example measurement networks) must not be lower than $R = (V_{MAX} PV/30 \text{ mA})$ ohms | | N/A |
| | b) As an alternative to a), or if a resistor value lower than in a) is used, the inverter shall incorporate means to detect, during operation, if the total current through the resistor and any in parallel with it, exceeds the residual current values and times in Table 31 and shall either disconnect the resistor or limit the current by other means. If the inverter is a non-isolated inverter, or has isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, it shall also disconnect from the mains. | | N/A |
| | c) The inverter shall have means to measure the DC insulation resistance from the PV input to ground before starting operation | | N/A |
| 4.8.3 | Array residual current detection | | P |
| 4.8.3.1 | General | | P |
| 4.8.3.2 | 30 mA touch current type test for isolated inverters | Transformer-less inverter. | N/A |
| | Compliance with the 30 mA limit in 4.8.3.1 is tested with the inverter connected and operating under reference test conditions | | N/A |
| | The touch current measurement circuit of IEC 60990, Figure 4 is required. | | N/A |
| 4.8.3.3 | Fire hazard residual current type test for isolated inverters | Transformer-less inverter. | N/A |
| | Compliance with the 300 mA or 10 mA per kVA limit in 4.8.3.1 is tested with the inverter connected and operating under reference test conditions | | N/A |
| 4.8.3.4 | Protection by application of RCD's | External RCD Type A is allowed. See manual. | P |
| | Integral RCD provided | | P |
| | Instructions per 5.3.2.9 are given in the manual. | | P |
| 4.8.3.5 | Protection by residual current monitoring | | P |
| 4.8.3.5.1 | General | See appended table. | P |
| | Where required by Table 30, the inverter shall provide residual current monitoring that functions whenever the inverter is connected to the mains with the automatic disconnection means closed | | P |
| | a) Continuous residual current: The inverter shall disconnect within 0,3 s and indicate a fault if the residual current exceeds the limit. | | P |

| IEC 62109-2 | | | |
|-------------|---|---|---------|
| Clause | Requirement + Test | | Verdict |
| | b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31 and indicate a fault if a sudden increase in the RMS residual current is detected | | P |
| | Compliance with a) and b) is checked by the tests of 4.8.3.5.2 and 4.8.3.5.3 respectively. | | P |
| 4.8.3.5.2 | Test for detection of excessive continuous residual current | See appended table. | P |
| 4.8.3.5.3 | Test for detection of sudden changes in residual current | See appended table. | P |
| | For inverters with high power ratings a very large amount of capacitance may be needed to perform this test. In cases where this is impractical, it is allowable to use resistance in place of or in addition to the capacitance. | | P |
| 4.8.3.6 | Systems located in closed electrical operating areas | The inverter can be installed in operator access areas. | N/A |
| | For systems in which the inverter and a DVC-B or DVC-C PV array are located in closed electrical operating areas, the protection against shock hazard on the PV array in subclauses 4.8.2.1, 4.8.2.2, 4.8.3.2, 4.8.3.4, and 4.8.3.5.1 b). | | P |

| | | | |
|----------|--|----------------------|----------|
| 5 | Marking and documentation | | P |
| | The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | | |
| 5.1 | Marking | Refer to type label. | P |
| 5.1.4 | Equipment ratings | | P |
| | PV input ratings: | | P |
| | —...Vmax PV (absolute maximum) (d.c. V) | | P |
| | —...Isc PV (absolute maximum) (d.c. A) | | P |
| | a.c. output ratings: | | P |
| | —...Voltage (nominal or range) (a.c. V) | | P |
| | —...Current (maximum continuous) (a.c. A) | | P |
| | —...Frequency (nominal or range) (Hz) | | P |
| | —...Power (maximum continuous) (W or VA) | | P |
| | —...Power factor range | | P |
| | a.c input ratings: | | N/A |
| | —...Voltage (nominal or range) (a.c. V) | | N/A |
| | —...Current (maximum continuous) (a.c. A) | | N/A |
| | —...Frequency (nominal or range) (Hz) | | N/A |
| | d.c input (other than PV) ratings: | | P |
| | —...Voltage (nominal or range) (d.c. V) | | P |

| IEC 62109-2 | | | |
|-------------|---|---|---------|
| Clause | Requirement + Test | | Verdict |
| | –...Current (maximum continuous) (d.c. A) | | P |
| | d.c. output ratings: | | N/A |
| | –...Voltage (nominal or range) (d.c. V) | | N/A |
| | –...Current (maximum continuous) (d.c. A) | | N/A |
| | Protective class (I or II or III) | Inverter is class I | P |
| | Ingress protection (IP) rating per part 1 | IP66 | P |
| 5.2 | Warning markings | | P |
| 5.2.2 | Content for warning markings | | P |
| 5.2.2.6 | Inverters for closed electrical operating area | EUT is intended for user accessible area. | N/A |
| | Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be marked with a warning that the inverter is only for use in a closed electrical operating area, and referring to the installation instructions. | | N/A |
| 5.3 | Documentation | Refer to documentation. | P |
| 5.3.2 | Information related to installation | | P |
| 5.3.2.1 | Ratings: | | P |
| | PV input quantities : | | P |
| | –...Vmax PV (absolute maximum) (d.c. V) | | P |
| | –...PV input operating voltage range (d.c. V) | | P |
| | –...Maximum operating PV input current (d.c. A) | | P |
| | –...Isc PV (absolute maximum) (d.c. A) | | P |
| | –...Max. inverter backfeed current to the array (a.c. or d.c. A) | | N/A |
| | a.c. output quantities: | | P |
| | –...Voltage (nominal or range) (a.c. V) | | P |
| | –...Current (maximum continuous) (a.c. A) | | P |
| | –...Current (inrush) (a.c. A, peak and duration) | | |
| | –...Frequency (nominal or range) (Hz) | | P |
| | –...Power (maximum continuous) (W or VA) | | P |
| | –...Power factor range | | P |
| | –...Maximum output fault current (a.c. A, peak and duration or RMS) | | P |
| | –...Maximum output overcurrent protection (a.c. A) | 250A | P |
| | a.c. input quantities: | | N/A |
| | –...Voltage (nominal or range) (a.c. V) | | N/A |
| | –...Current (maximum continuous) (a.c. A) | | N/A |
| | –...Current (inrush) (a.c. A, peak and duration) | | N/A |
| | –...Frequency (nominal or range) (Hz) | | N/A |

| IEC 62109-2 | | | |
|-------------|---|---|---------|
| Clause | Requirement + Test | | Verdict |
| | d.c input (other than PV) quantities: | | N/A |
| | –...Voltage (nominal or range) (d.c. V) | | N/A |
| | –...Nominal battery voltage (d.c. V) | | N/A |
| | –...Current (maximum continuous) (d.c. A) | | N/A |
| | –...d.c. output quantities: | | N/A |
| | –...Voltage (nominal or range) (d.c. V) | | N/A |
| | –...Nominal battery voltage (d.c. V) | | N/A |
| | –...Current (maximum continuous) (d.c. A) | | N/A |
| | Protective class (I or II or III) | Inverter is class I | P |
| | Ingress protection (IP) rating per part 1 | IP66 | P |
| 5.3.2.2 | Grid-interactive inverter setpoints | | P |
| | with field adjustable trip points, trip times, or reconnect times, the presence of such controls, the means for adjustment, the factory default values, and the limits of the ranges of adjustability shall be provided in the documentation for the PCE or in other format such as on a website. | | P |
| | The settings of field adjustable setpoints shall be accessible from the PCE , for example on a display panel, user interface, or communications port. | | P |
| 5.3.2.3 | Transformers and isolation | Transformer-less inverter. | N/A |
| | An inverter shall be provided with information to the installer regarding whether an internal isolation transformer is provided, and if so, what level of insulation is provided | | N/A |
| | The instructions shall also indicate what the resulting installation requirements are regarding such things as earthing or not earthing the array, providing external residual current detection devices, requiring an external isolation transformer, etc. | | N/A |
| 5.3.2.4 | Transformers required but not provided | Transformer-less inverter. | N/A |
| | An inverter that requires an external isolation transformer not provided with the unit, shall be provided with instructions that specify the configuration type, electrical ratings, and environmental ratings for the external isolation | | N/A |
| 5.3.2.5 | PV modules for non-isolated inverters | | P |
| | Non-isolated inverters shall be provided with installation instructions that require PV modules that have an IEC 61730 Class A rating. | A relevant note is placed in the the user manual. | P |
| | If the maximum AC mains operating voltage is higher than the PV array maximum system voltage then the instructions shall require PV modules that have a maximum system voltage rating based upon the AC mains voltage | | N/A |

| IEC 62109-2 | | | |
|-------------|--|--|---------|
| Clause | Requirement + Test | | Verdict |
| 5.3.2.6 | Non-sinusoidal output waveform information | No stand-alone inverter. | N/A |
| | The instruction manual for a stand-alone inverter not complying with 4.7.5.2 shall include a warning that the waveform is not sinusoidal | | N/A |
| | –...THD | | N/A |
| | –...Peak voltage | | N/A |
| | –...Wave form | | N/A |
| 5.3.2.7 | Systems located in closed electrical operating areas | The inverter can be installed in operator access areas. | N/A |
| | Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be provided with installation instructions requiring that the inverter and the array must be installed in closed electrical operating areas | | N/A |
| | Indication witch forms of shock hazard protection are and are not provided integral to the inverter. | | N/A |
| 5.3.2.8 | Stand-alone inverter output circuit bonding | No stand-alone inverter. | N/A |
| | Where required by 7.3.10, the documentation for an inverter shall include the following: | | N/A |
| | –...if output circuit bonding is required but is not provided integral to the inverter, the required means shall be described in the installation instructions | | N/A |
| | –...if the output circuit is intended to be floating, the documentation for the inverter shall indicate that the output is floating | | N/A |
| 5.3.2.9 | Protection by application of RCD's | An external RCD type A is required fulfilling the requirements of this standard. | P |
| | Where the requirement for additional protection in 4.8.3.1 is met by requiring an RCD that is not provided integral to the inverter, as allowed by 4.8.3.4, the installation instructions shall state the need for the RCD, and shall specify its rating, type, and required circuit location. | | P |
| 5.3.2.10 | Remote indication of faults | A relevant note is placed in the user manual. | P |
| | The installation instructions shall include an explanation of how to properly make connections. | | P |
| 5.3.2.11 | External array insulation resistance measurement and response | The inverter fulfills the requirements of 4.8.2.1. | N/A |
| | The installation instructions for an inverter for use with ungrounded arrays that does not incorporate all the aspects of the insulation resistance measurement and response requirements in 4.8.2.1, must include | | N/A |

| IEC 62109-2 | | | |
|-------------|--|---|---------|
| Clause | Requirement + Test | | Verdict |
| | –...for isolated inverters, an explanation of what aspects of array insulation resistance measurement and response are not provided | | N/A |
| | –...for non-isolated inverters: | | N/A |
| | <ul style="list-style-type: none"> an explanation of what external equipment must be provided in the system, and | | N/A |
| | <ul style="list-style-type: none"> what the setpoints and response implemented by that equipment must be, and | | N/A |
| | <ul style="list-style-type: none"> how that equipment is to be interfaced with the rest of the system. | | N/A |
| 5.3.2.12 | Array functional grounding information | Transformer-less inverter. | N/A |
| | Where approach a) of 4.8.2.2 is used, the installation instructions for the inverter shall include all of the following: | | N/A |
| | a) the value of the total resistance between the PV circuit and ground integral to the inverter; | | N/A |
| | b) the minimum array insulation resistance to ground that system designer or installer must meet when selecting the PV panel and system design, based on the minimum value that the design of the PV functional grounding in the inverter was based on; | | N/A |
| | c) the minimum value of the total resistance $R = V_{MAX} PV/30 \text{ mA}$ that the system must meet, with an explanation of how to calculate the total; | | N/A |
| | d) a warning that there is a risk of shock hazard if the total minimum resistance requirement is not met. | | N/A |
| 5.3.2.13 | Stand-alone inverters for dedicated loads | No stand-alone inverter. | N/A |
| | Where the approach of 4.7.5.5 is used, the installation instructions for the inverter shall include a warning that the inverter is only to be used with the dedicated load for which it was evaluated, and shall specify the dedicated load. | | N/A |
| 5.3.2.14 | Identification of firmware version(s) | Firmware version of the inverter is visible in the web-browser of the inverter. | P |
| | An inverter utilizing firmware for any protective functions shall provide means to identify the firmware version. This can be a marking, but the information can also be provided by a display panel, communications port or any other type of user interface. | | P |

| IEC 62109-2 | | |
|-------------|--|---------|
| Clause | Requirement + Test | Verdict |
| 6 | Environmental requirements and conditions The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |

| | | |
|--------|--|---------------------------------|
| 7 | Protection against electric shock and energy hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| 7.3 | Protection against electric shock | P |
| 7.3.10 | Additional requirements for stand-alone inverters | No stand-alone inverter. N/A |
| | Depending on the supply earthing system that a stand-alone inverter is intended to be used with or to create, the output circuit may be required to have one circuit conductor bonded to earth to create a grounded conductor and an earthed system. | N/A |
| 7.3.11 | Functionally grounded arrays | N/A |
| | All PV conductors in a functionally grounded array shall be treated as being live parts with respect to protection against electric shock. | N/A |

| | | |
|---|--|---|
| 8 | Protection against mechanical hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
|---|--|---|

| | | |
|-------|--|--|
| 9 | Protection against fire hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| 9.3 | Short-circuit and overcurrent protection | P |
| 9.3.4 | Inverter backfeed current onto the array | No backfeed current from the mains to the PV array is possible due to the construction of the inverter. N/A |
| | Testing shall be performed to determine the current that can flow out of the inverter PV input terminals with a fault applied on inverter or on the PV input wiring | N/A |
| | This inverter backfeed current value shall be provided in the installation instructions regardless of the value of the current, in accordance with Table 33. | N/A |

| IEC 62109-2 | | |
|-------------|--|---------|
| Clause | Requirement + Test | Verdict |
| 10 | Protection against sonic pressure hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| 11 | Protection against liquid hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | N/A |
| 12 | Chemical hazards The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | N/A |
| 13 | Physical requirements The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| 13.9 | Fault indication | P |
| | Where this Part 2 requires the inverter to indicate a fault, both of the following shall be provided: | P |
| | a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and | P |
| | b) an electrical or electronic indication that can be remotely accessed and used. | P |
| 14 | Components The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| 15 | Software and firmware performing safety functions The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |
| Annex | Annex A to Annex J The subclauses are covered by the respective IEC62109-1 report. The clause of Part-1 of IEC62109 is applicable except as follows (replacements and additional subclauses): | P |

TEST RESULTS

| 4.4.4 | TABLE: Single fault condition to be applied | | | | | P |
|---|---|---------------------------|------------------|---------------|-------------------------|--|
| | Ambient temperature (°C): 24,9 | | | | | — |
| 4.4.4.15.2 | Fault-tolerance of automatic disconnecting means | | | | | |
| Component No. | Fault | Supply voltage (V) | Test time | Fuse # | Fuse current (A) | Observation |
| K201A – LP394C AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| K202A – LP394C AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| K203A – LP394C AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| K100A – LP392D AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| K102A – LP392D AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| K104A – LP392D AC relay defect | short PIN 3 to PIN 4 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 0Aac 0Adc | Unit did not start. Error message is shown on terminal. No hazard. No defect. |
| Current measurement L1 defect - LP392D | open CS200 Pin 1,2,3 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 134,0Aac 85,4Adc | Unit shutdown immediately. No hazard. No defect. |
| Current measurement L2 defect - LP392D | open CS201 Pin 1,2,3 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 134,0Aac 85,4Adc | Unit shutdown immediately. No hazard. No defect. |
| Current measurement L3 defect - LP392D | open CS202 Pin 1,2,3 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 134,0Aac 85,4Adc | Unit shutdown immediately. No hazard. No defect. |
| Current measurement L1 defect ref. - LP392D | short C209 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 134,0Aac 85,4Adc | Unit shutdown immediately. No hazard. No defect. |
| Current measurement L2 defect ref. - LP392D | short C210 | 400Vac 1100Vdc | 1 min. | ext. 250 A gG | 134,0Aac 85,4Adc | Unit shutdown immediately. No hazard. No defect. |



| | | | | | | |
|---|------------|-----------------------|--------|------------------|-----------------------------|---|
| Current measurement L3 defect ref. - LP392D | short C211 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L1 defect – LP394C | short R106 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L2 defect – LP394C | short R120 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L3 defect – LP394C | short R126 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L1 defect – LP394C | short R103 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L2 defect – LP394C | short R117 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Voltage monitoring L3 defect – LP394C | short R123 | 400Vac 1100Vd c | 1 min. | ext. 250 A gG | 134,0A ac 85,4Ad c | Unit shutdown immediately. No hazard. No defect. |
| Check that the relays fulfil the basic insulation or simple separation based on the PV circuit working voltage. | | | | | | Pass |
| Each active phase can be switched. (L and N) | | | | | | Pass |

| | | | |
|--|---|--------|-----------------------|
| 4.4.4.17 | Cooling system failure – Blanketing test | | P |
| | Test voltage (Vdc) | 1300 | — |
| | Test current (Idc) | 76,9 | — |
| | Test voltage (Vac) | 380 | — |
| | Test current (Iac) | 151,5 | — |
| | t _{amb1} (°C) | 60,0 | — |
| | t _{amb2} (°C) | 60,0 | — |
| maximum temperature T of part/at:: | | T (°C) | T _{max} (°C) |
| 1. | Enclosure top | 59,4 | 70 |
| 2. | Enclosure side | 63,2 | 70 |
| 3. | Enclosure front | 58,4 | 70 |
| 4. | Enclosure bottom | 66,2 | 70 |
| 5. | Heatsink | 66,7 | 70 |
| 6. | Enclosure top | 59,4 | 90 |
| Comment: The measured temperature values never reach the limit of 90°C. | | | |

| | | | | | |
|--|--|---|---|---|---|
| 4.8.2 | TABLE: Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays | | | | P |
| 4.8.2.1 | Array insulation resistance detection for inverters for ungrounded arrays | | | | P |
| DC Voltage below minimum operating voltage (V) | DC Voltage for inverter begin operation (V) | Resistance between ground and PV input terminal (Ω) | Required Insulation resistance R = (V _{MAX PV} / 30mA) (Ω) | Result | |
| DC+ | | | | | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| DC- | | | | | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| 500 | 900 | 225k | 250k | Inverter displays fault and does not start. | |
| Note: | | | | | |
| For isolated inverters, shall indicate a fault in accordance with 13.9 (operation is allowed); the fault indication shall be maintained until the array insulation resistance has recovered to a value higher than the limit above | | | | | |
| For non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, shall indicate a fault in accordance with 13.9, and shall not connect to the mains; the inverter may continue to make the measurement, may stop indicating a fault and may connect to the mains if the array insulation resistance has recovered to a value higher than the limit above. | | | | | |
| It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel. | | | | | |
| Supplementary information: | | | | | |

| | | | |
|---|---|-----------------------------|----------|
| 4.8.3.5 | TABLE: Protection by residual current monitoring | | P |
| Test conditions: | Output power: 100 kVA V_{DC} : 1300 Frequency: 50Hz V_N : 380 | | |
| 4.8.3.5.2 | Test for detection of excessive continuous residual current | | P |
| Fault Current (mA) | | Disconnection time (ms) | |
| Measured Fault Current | Limit 300mA for output power \leq 30 kVA 10mA per kVA for output power > 30 kVA | Measured Disconnection time | Limit |
| + PV to N: | | | |
| 931 | 1000 | 258 | 300 |
| 931 | 1000 | 256 | 300 |
| 931 | 1000 | 253 | 300 |
| 931 | 1000 | 258 | 300 |
| 931 | 1000 | 260 | 300 |
| - PV to N: | | | |
| 921 | 1000 | 260 | 300 |
| 923 | 1000 | 249 | 300 |
| 922 | 1000 | 249 | 300 |
| 922 | 1000 | 257 | 300 |
| 922 | 1000 | 260 | 300 |
| Note: – maximum 300mA for inverters with continuous output power rating \leq 30 kVA; – maximum 10mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA. This test shall be repeated 5 times, and for all 5 tests the time to disconnect shall not exceed 0,3s. The test is repeated for each PV input terminal. It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel. | | | |
| Supplementary information: | | | |

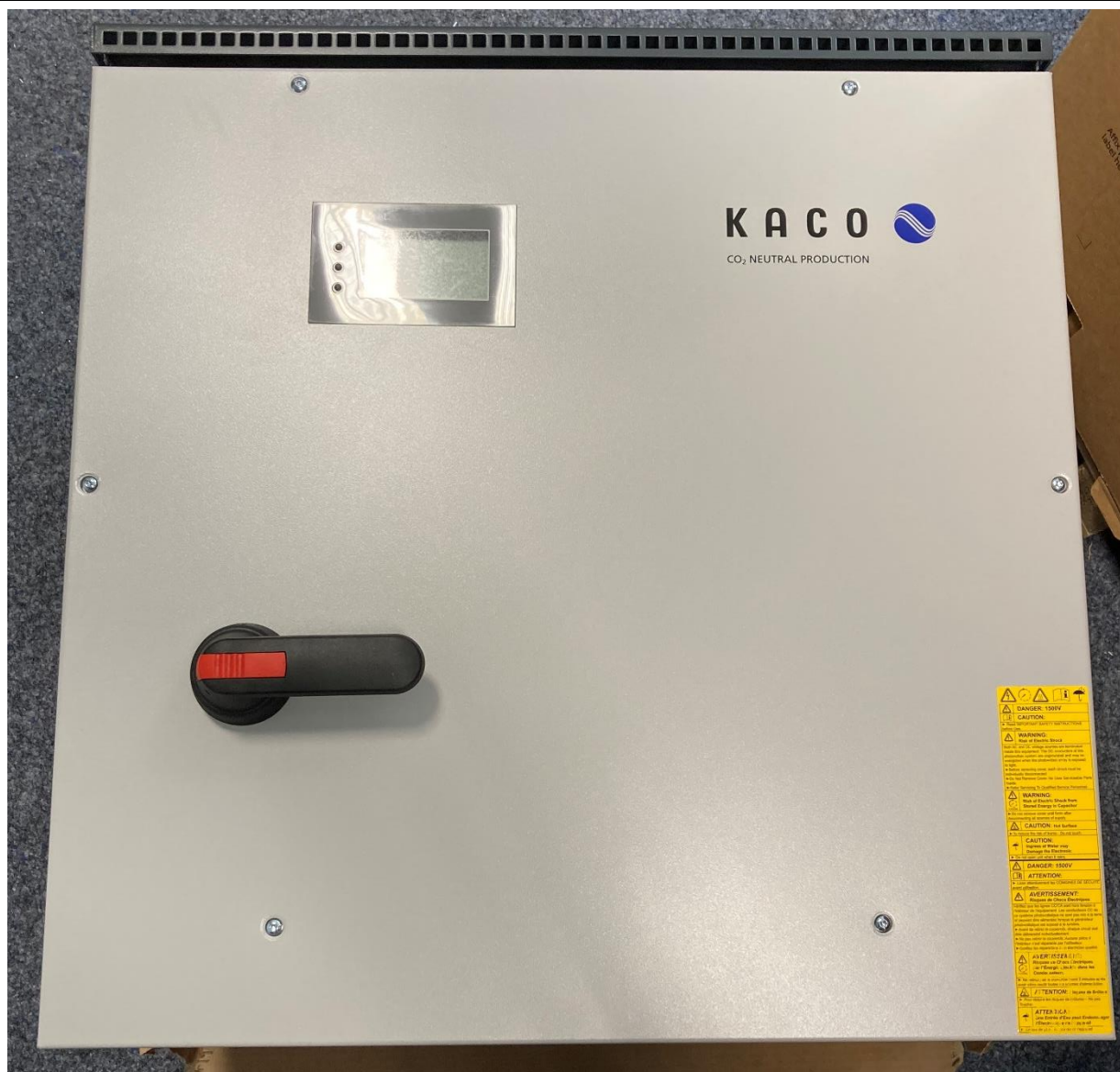


| | | | |
|---|---|------------|---|
| 4.8.3.5.3 | TABLE: Test for detection of sudden changes in residual current | | P |
| +PV to N | | | |
| Limit (mA) | U _N | Limit (ms) | |
| | Disconnection time (ms) | | |
| 30 | 260 | 300 | |
| 30 | 256 | 300 | |
| 30 | 252 | 300 | |
| 30 | 257 | 300 | |
| 30 | 256 | 300 | |
| | | | |
| 60 | 123 | 150 | |
| 60 | 118 | 150 | |
| 60 | 127 | 150 | |
| 60 | 118 | 150 | |
| 60 | 128 | 150 | |
| | | | |
| 150 | 15 | 40 | |
| 150 | 12 | 40 | |
| 150 | 16 | 40 | |
| 150 | 12 | 40 | |
| 150 | 15 | 40 | |
| -PV to N | | | |
| Limit (mA) | U _N | Limit (ms) | |
| | Disconnection time (ms) | | |
| 30 | 262 | 300 | |
| 30 | 253 | 300 | |
| 30 | 256 | 300 | |
| 30 | 256 | 300 | |
| 30 | 256 | 300 | |
| | | | |
| 60 | 129 | 150 | |
| 60 | 127 | 150 | |
| 60 | 133 | 150 | |
| 60 | 120 | 150 | |
| 60 | 122 | 150 | |
| | | | |
| 150 | 17 | 40 | |
| 150 | 13 | 40 | |
| 150 | 13 | 40 | |
| 150 | 15 | 40 | |
| 150 | 13 | 40 | |
| Note: | | | |
| The capacitive current is risen until disconnection. | | | |
| Test condition: I _c + 30/60/150mA <= I _{cmax} . R ₁ is set that 30/60/150mA Flow and switch S is closed. | | | |
| Supplementary information: | | | |

ANNEX NO. 1

PICTURES OF THE UNIT

Enclosure front



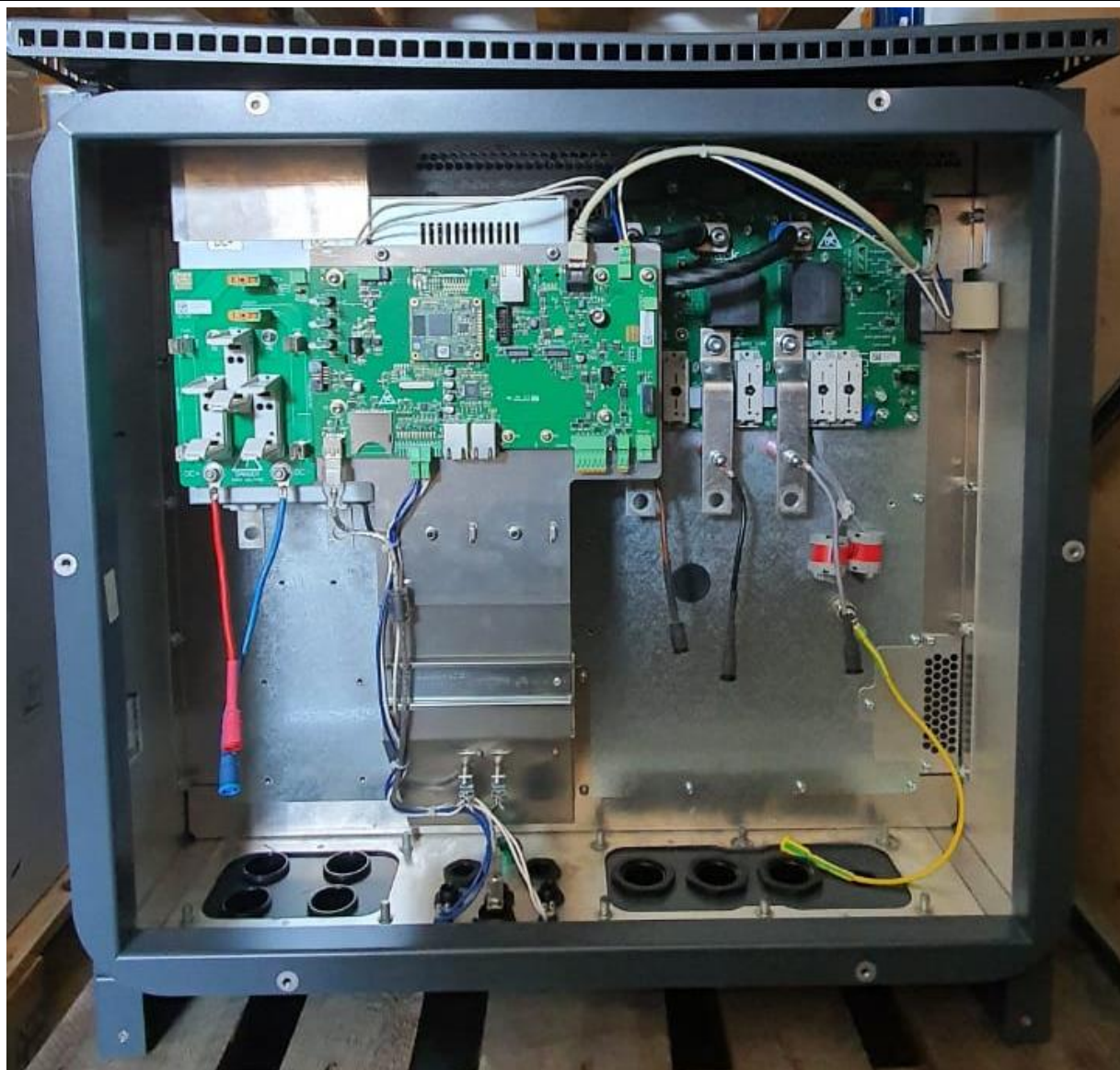
Enclosure bottom (connectors)



Enclosure right side



Enclosure open



ANNEX NO. 2

TEST EQUIPMENT LIST



Date (s) of performance of tests: 2018-10-01 to 2018-12-18

| Equipment | Internal No. | Manufacturer | Type | Serial No. | Last Calibration |
|--|--------------|-----------------------------|--|------------|------------------|
| Multimeter | 329 | Keithley | 2701/E | 1092554 | N/A |
| Channel Multiplexer 20 (Slide-In Module for Keithley no. 329) | 329.1 | Keithley | 7700 | 1205896 | Feb-20 |
| Channel Multiplexer 20 (Slide-In Module for Keithley no. 329) | 329.2 | Keithley | 7700 | 1091738 | Feb-20 |
| Variable Resistor | 380 | Ruhstrat | 20kOhm 0,1A | - | |
| Variable Resistor | 381 | Ruhstrat | 14,9kOhm 0,13A | - | |
| Variable Resistor | 382 | Ruhstrat | 14,9kOhm 0,13A | - | |
| Variable Resistor | 383 | Ruhstrat | 8030 Ohm 0,2A | - | |
| Capacitors | 594 | Innova | 0-4,0μF | - | |
| 3phase Transformer | 620 | Ruhstrat | 8229517901 | - | |
| Power Meter | 948 | ZES Zimmer Electronic Syst. | LMG 500-3 | 2441006 | Aug-20 |
| Oscilloscope | 984 | Yokogawa | DLM2022 | 91L512341 | Feb-20 |
| Differential Probe | 1051 | TESTEC | SI-9002 | 118136 | Feb-20 |
| DC- source | 1058 | Regatron | Model T.C.P. 32.1000.400.PV.H MI | 1239CC622 | N/A |
| Hygro- /Thermo- /Barometer | 1073 | Greisinger | GFTB 100 | 90258040 | Mar-20 |

END OF TEST REPORT