# LVD TEST REPORT

## EN 62109-1:2010

Safety of power converters for use in photovoltaic power systems
Part 1: General requirements

## EN 62109-2:2011

Safety of power converters for use in photovoltaic power systems
Part 2: Particular requirements for inverters

For

**Magnizon power systems FZE**

JAFZA LB11,1st floor, Office 32,Jebel Ali Free Zone, Dubai-U.A.E

**Series Model:**
APS-1024SW-M40、APS-2024SW-M60、APS-3024SW-M60、
APS-4048SW-M60、APS-5048SW-M60、APS-6048SW-M120、
APS-8048SW-M120、APS-10K48SW-M120、APS-12K48SW-M120

July 18, 2018

| This Report Concerns: | Equipment Type: |
|---|---|
| ☒ Original Report | **Inverter** |

| | |
|---|---|
| **Test Engineer:** | Eric/ Eric |
| **Report Number:** | TH18GR-871S |
| **Test Date:** | July 11~18, 2018 |
| **Reviewed By:** | Prince / Prince |
| **Approved By:** | Prince / Prince |
| **Prepared By:** | **Shenzhen Tian Hai Test Technology Co.,Ltd.**<br>4F, A3 BLDG, The Silicon Valley Power intelligent terminal industrial park, Guanlan street, Longhua district, Shenzhen<br>Tel : 86-755-86615100<br>Fax: 86-755-86615105 |

**Note:** This test report is limited to the above client company and the product model only. It may not be duplicated without prior written consent of Shenzhen Tian Hai Test Technology Co,.Ltd.

# TEST REPORT

## EN 62109-1:2010

Safety of power converters for use in photovoltaic power systems

Part 1: General requirements

## EN 62109-2:2011

Safety of power converters for use in photovoltaic power systems

Part 2: Particular requirements for inverters

| | | |
|---|---|---|
| Report | | |
| Report reference No. | : | TH18GR-871S |
| Tested by (+signature) | : | Eric |
| Reviewed by (+signature) | : | Prince |
| Approved by (+signature) | : | Prince |
| Date of issue | : | July 18, 2018 |
| Testing laboratory | | |
| Name | : | **Shenzhen Tian Hai Test Technology Co.,Ltd.** |
| Address | : | 4F, A3 BLDG, The Silicon Valley Power intelligent terminal industrial park, Guan Lan street, Longhua district, Shenzhen |
| Test location | : | Same as above |
| Client | | |
| Name | : | **Magnizon power systems FZE** |
| Address | : | JAFZA LB11,1st floor, Office 32,Jebel Ali Free Zone, Dubai-U.A.E |
| Test specification | | |
| Standards | : | EN 62109-1:2010; EN 62109-2:2011 |
| Non-standard test method | : | N.A. |
| Test item | | |
| Description | : | **Inverter** |
| Serise Model and or type reference | : | APS-1024SW-M40、APS-2024SW-M60、APS-3024SW-M60、APS-4048SW-M60、APS-5048SW-M60、APS-6048SW-M120、APS-8048SW-M120、APS-10K48SW-M120、APS-12K48SW-M120 |
| Trademark | : | MAGNIZON |
| Rating | : | Input: 230V AC, 50/60Hz, 72A, 12kW; Solar charger parameter: 48V DC(system voltage), 60A, 3500W, 145V DC(VOC) |
| Manufacturer | : | **Magnizon power systems FZE** |
| Address | : | JAFZA LB11,1st floor, Office 32,Jebel Ali Free Zone, Dubai-U.A.E |
| Note | : | All of test performed on the model: APS-12K48SW-M120. |



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| | | |
|---|---|---|
| Test case verdicts | | |
| Test case does not apply to the test object | : | N(Not applicable) |
| Test item does meet the requirement | : | P(pass) |
| Test item does not meet the requirement | : | F(fail) |

General remarks:

""See remark #)""refers to a remark appended to the report.
""See appended table)""refers to a table appended to the report.
Throughout this report a comma is used as the decimal separator.
The test results presented in this report relate only to the object tested.
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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| **4** | **General testing requirements** | | P |
| 4.1 | Compliance with the requirements of this standard is checked by carrying out all applicable tests in this standard, except that a test may be omitted if examination of the equipment demonstrates conclusively that the equipment would pass the test. | Complied | P |
| 4.2 | General conditions for testing | Complied | P |
| 4.3 | Thermal testing | | P |
| 4.3.1 | General | | P |
| | This subclause specifies requirements intended to prevent hazards due to: | | P |
| | – touchable parts exceeding safe temperatures; and | Complied | P |
| | – components, parts, insulation and plastic materials exceeding temperatures which may degrade safety-related electrical, mechanical, or other properties during normal use over the expected life of the equipment; and | Complied | P |
| | – structures and mounting surfaces exceeding temperatures which may degrade the materials over the expected life of the equipment. | Complied | P |
| 4.3.2 | Maximum temperatures | | P |
| 4.3.2.1 | General | | |
| | Materials and components shall be selected so that under the most severe rated operating conditions, the temperatures do not exceed the temperature limits. | Complied | P |
| 4.3.2.2 | Touch temperatures | | P |
| | In order to limit the touch temperatures of accessible parts of PCE, the maximum temperature for accessible parts of the PCE shall be in compliance with Table 3. | Complied | P |
| 4.3.2.3 | Temperature limits for mounting surfaces | | P |
| | In order to protect against long-term degradation of building materials, surfaces of the PCE that will be in contact with the mounting surface shall not exceed a maximum total temperature of 90 °C. | Complied | P |
| 4.4 | Testing in single fault condition | | P |
| 4.4.1 | General | | P |
| | Testing in single fault condition is done to determine that no hazards result from reasonably expected fault conditions that may arise in normal service or from reasonably expected misuse. | Complied | P |
| 4.4.4.15 | Fault-tolerance of protection for grid-interactive inverters**(EN 62109-2)** | | P |
| 4.4.4.15.1 | Fault-tolerance of residual current monitoring | | P |
| | Where protection against hazardous residual currents according to 4.8.3.5 is required, the residual current monitoring system must be able to operate properly with a single fault applied, or must detect the fault or loss of operability and cause the inverter to indicate a fault in accordance with 13.9, and disconnect from, or not connect to, the mains, no later than the next attempted re-start. | Complied | |
| 4.4.4.15.2 | Fault-tolerance of automatic disconnecting means | | P |
| 4.4.4.15.2.1 | General | | P |
| | The means provided for automatic disconnection of a grid-interactive inverter from the mains shall: | | P |
| | – disconnect all grounded and ungrounded current-carrying conductors from the mains, and | Complied | P |



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| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | – be such that with a single fault applied to the disconnection means or to any other location in the inverter, at least basic insulation or simple separation is maintained between the PV array and the mains when the disconnecting means is intended to be in the open state. | Complied | P |
| 4.4.4.15.2.2 | Design of insulation or separation | | P |
| | The design of the basic insulation or simple separation referred to in 4.4.4.15.2.1 shall comply with the following: | | P |
| | – the basic insulation or simple separation shall be based on the PV circuit working voltage,impulse withstand voltage, and temporary over-voltage, in accordance with 7.3.7 of Part 1; | Complied | P |
| | – the mains shall be assumed to be disconnected; | Complied | 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, and where required by 7.3.7.1.2 of Part 1, monitoring of such means; | Complied | 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. | Complied | P |
| 4.4.4.15.2.3 | Automatic checking of the disconnect means | | N |
| | For a non-isolated inverter, the isolation provided by the automatic disconnection means shall be automatically checked before the inverter starts operation. After the isolation check, if the check fails, any still-functional disconnection means shall be left in the open position, at least basic insulation or simple separation shall be maintained between the PV input and the mains, the inverter shall not start operation, and the inverter shall indicate a fault in accordance with 13.9. | | N |
| | In all cases, the non-isolated grid-interactive inverter shall comply with the requirements for basic insulation or simple separation between the mains and the PV input following application of the fault. | | N |
| 4.4.4.16 | Stand-alone inverters – Load transfer test**(EN 62109-2)** | | P |
| | A stand-alone inverter with a transfer switch to transfer AC loads from the mains or other AC bypass source to the inverter output shall continue to operate normally and shall not present a risk of fire or shock as the result of an out-of-phase transfer. | Complied | P |
| 4.4.4.17 | Cooling system failure – Blanketing test**(EN 62109-2)** | | P |
| | In addition to the applicable tests of subclause 4.4.4.8 of Part 1, inadvertent obstruction of the airflow over an exposed external heatsink shall be one of the fault conditions considered. No hazards according to the criteria of subclause 4.4.3 of Part 1 shall result from blanketing the inverter in accordance with the test below. | Complied | P |
| 4.5 | Humidity preconditioning**(EN 62109-2)** | Complied | P |
| 4.6 | Backfeed voltage protection**(EN 62109-2)** | Complied | P |
| | Under normal and single-fault conditions, hazardous voltage or energy shall not be present on the terminals of each source, with that source de-energized or disconnected. | | P |
| 4.7 | Electrical ratings tests**(EN 62109-2)** | | P |
| 4.7.1 | Input ratings | | P |
| | While operating under the reference test conditions of 4.2.2, the measured continuous input current or power, as applicable, shall not exceed the marked input ratings by more than 10 %. | 230Vac,50/60Hz,72A, 12KW | P |
| 4.7.2 | Output ratings | | P |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | While operating under the reference test conditions of 4.2.2, each output port of the PCE shall be capable of providing its marked output power or current ratings, as applicable, without overcurrent protective devices operating and without shutdown due to operation of over temperature protection systems. The measured continuous output current or power, as applicable, shall not exceed the marked output ratings by more than 10 %. | 48V DC | P |
| 4.7.3 | Measurement requirements for AC output ports for stand-alone inverters | | P |
| | Measurements of the AC output voltage and current on a stand-alone inverter shall be made with a meter that indicates the true RMS value. | Complied | P |
| 4.7.4 | Stand-alone Inverter AC output voltage and frequency | | N |
| 4.7.4.1 | General | | N |
| | 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. | Solar Hybrid Inverters | N |
| 4.7.4.2 | Steady state output voltage at nominal DC input | | N |
| | 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 |
| 4.7.4.3 | Steady state output voltage across the DC input range | | N |
| | 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 |
| 4.7.4.4 | Load step response of the output voltage at nominal DC input | | N |
| | 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 |
| 4.7.4.5 | Steady state output frequency | | N |
| | The steady-state AC output frequency shall not vary from the nominal value by more than+4 % or –6 %. | | N |
| 4.7.5 | Stand-alone inverter output voltage waveform | | N |
| 4.7.5.1 | General | | N |
| | 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 |
| 4.7.5.2 | Sinusoidal output voltage waveform requirements | | N |
| | 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 |
| 4.7.5.3 | Non-sinusoidal output waveform requirements | | N |
| 4.7.5.3.1 | General | | N |
| | 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 |
| 4.7.5.3.2 | Total harmonic distortion | | N |
| | The total harmonic distortion (THD) of the voltage waveform shall not exceed 40 %. | | N |
| 4.7.5.3.3 | Waveform slope | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The slope of the rising and falling edges of the positive and negative half-cycles of the voltage waveform shall not exceed 10 V/μs measured between the points at which the waveform has a voltage of 10 % and 90 % of the peak voltage for that half-cycle. | | N |
| 4.7.5.3.4 | Peak voltage | | N |
| | 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 |
| 4.7.5.4 | Information requirements for non-sinusoidal waveforms | | N |
| | 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 |
| 4.7.5.5 | Output voltage waveform requirements for inverters for dedicated loads | | N |
| | For an inverter that is intended only for use with a known dedicated load, the following requirements may be used as an alternative to the waveform requirements in 4.7.5.2 to 4.7.5.3. | | N |
| | 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 |
| 4.8 | Additional tests for grid-interactive inverters**(EN 62109-2)** | | N |
| 4.8.1 | General requirements regarding inverter isolation and array grounding | | N |
| | 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. | Solar Hybrid Inverters | N |
| 4.8.2 | Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays | | N |
| 4.8.2.1 | Array insulation resistance detection for inverters for ungrounded arrays | | N |
| | 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, or shall be provided with installation instructions in accordance with 5.3.2.11. | | N |
| | If the insulation resistance is less than R = (V MAX PV /30 mA) ohms, the inverter: | | N |
| | – 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; | | N |
| | – 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. | | N |
| | The measurement circuit shall be capable of detecting insulation resistance below the limit above, under normal conditions and with a ground fault in the PV array. | | N |
| 4.8.2.2 | Array insulation resistance detection for inverters for functionally grounded arrays | | N |
| | Inverters that functionally ground the array through an intentional resistance integral to the inverter, shall meet the requirements in a) and c), or b) and c) below: | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **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 mA) ohms. The expected insulation resistance of the array to ground shall be calculated based on an array insulation resistance of 40 MΩ per m 2 , with the surface area of the panels either known, or calculated based on the inverter power rating and the efficiency of the worst-case panels that the inverter is designed to be used with. | | N |
| | 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 networks (for example measurement networks) 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 |
| | c) The inverter shall have means to measure the DC insulation resistance from the PV input to ground before starting operation, in accordance with 4.8.2.1. | | N |
| 4.8.3 | Array residual current detection | | N |
| 4.8.3.1 | General | | N |
| | Ungrounded arrays operating at DVC-B and DVC-C voltages can create a shock hazard if live parts are contacted and a return path for touch current exists. In a non-isolated inverter, or an inverter with isolation that does not adequately limit the available touch current, the connection of the mains to earth (i.e. the earthed neutral) provides a return path for touch current if personnel inadvertently contact live parts of the array and earth at the same time.The requirements in this section provide additional protection against this shock hazard through the application of residual current detectors (RCD's) per 4.8.3.4 or by monitoring for sudden changes in residual current per 4.8.3.5, except neither is required in an isolated inverter where the isolation provided limits the available touch current to less than 30 mA when tested in accordance with 4.8.3.2. | | N |
| | Ungrounded and grounded arrays can create a fire hazard if a ground fault occurs that allows excessive current to flow on conductive parts or structures that are not intended to carry current. The requirements in this section provide additional protection against this fire hazard by application of RCD's per 4.8.3.4 or by monitoring for continuous excessive residual current per 4.8.3.5, except neither is required in an isolated inverter where the isolation provided limits the available current to less than: | | N |
| | – 300 mA RMS for inverters with rated continuous output power ≤ 30 kVA, or | | N |
| | – 10 mA RMS per kVA of rated continuous output power for inverters with rated continuous output power rating > 30 kVA. | | N |
| 4.8.3.2 | 30 mA touch current type test for isolated inverters | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Compliance with the 30 mA limit in 4.8.3.1 is tested with the inverter connected and operating under reference test conditions, except that the DC supply to the inverter must not have any connection to earth, and the mains supply to the inverter must have one pole earthed. It is acceptable (and may be necessary) to defeat array insulation resistance detection functions during this test. The touch current measurement circuit of IEC 60990, Figure 4 is connected from each terminal of the array to ground, one at a time. The resulting touch current is recorded and compared to the 30 mA limit, to determine the requirements for array ground insulation resistance and array residual current detection in Table 30. | | N |
| 4.8.3.3 | Fire hazard residual current type test for isolated inverters | | N |
| | 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, except that the DC supply to the inverter must not have any connection to earth, and the mains supply to the inverter must have one pole earthed. It is acceptable (and may be necessary) to defeat array insulation resistance detection functions during this test. An ammeter is connected from each PV input terminal of the inverter to ground, one at a time. The ammeter used shall be an RMS meter that responds to both the AC and DC components of the current, with a bandwidth of at least 2 kHz. | | N |
| 4.8.3.4 | Protection by application of RCD's | | N |
| | The requirement for additional protection in 4.8.3.1 can be met by provision of an RCD with a residual current setting of 30 mA, located between the inverter and the mains. The selection of the RCD type to ensure compatibility with the inverter must be made according to rules for RCD selection in Part 1. The RCD may be provided integral to the inverter, or may be provided by the installer if details of the rating, type, and location for the RCD are given in the installation instructions per 5.3.2.9. | | N |
| 4.8.3.5 | Protection by residual current monitoring | | N |
| 4.8.3.5.1 | General | | N |
| | 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. The residual current monitoring means shall measure the total (both a.c. and d.c. components) RMS current. | | N |
| | As indicated in Table 30 for different inverter types, array types, and inverter isolation levels,detection may be required for excessive continuous residual current, excessive sudden changes in residual current, or both, according to the following limits: | | N |
| | a) Continuous residual current: The inverter shall disconnect within 0,3 s and indicate a fault in accordance with 13.9 if the continuous residual current exceeds: | | N |
| | – maximum 300 mA for inverters with continuous output power rating ≤ 30 kVA; | | N |
| | – maximum 10 mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA. | | N |
| | b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31 and indicate a fault in accordance with 13.9, if a sudden increase in the RMS residual current is detected exceeding the value in the table. | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | **Table 31 – Response time limits for sudden changes in residual current**<br>Residual current sudden change: 30 mA — Max time to inverter disconnection from the mains: 0,3 s<br>60 mA — 0,15 s<br>150 mA — 0,04 s | | N |
| | – monitoring for the continuous condition in a) is not required for an inverter with isolation complying with 4.8.3.3; | | N |
| | – monitoring for the sudden changes in b) is not required for an inverter with isolation complying with 4.8.3.2. | | N |
| 4.8.3.5.2 | Test for detection of excessive continuous residual current | | N |
| | An external adjustable resistance is connected from ground to one PV input terminal of the inverter. The resistance shall be steadily lowered in an attempt to exceed the residual current limit in a) above, until the inverter disconnects. This determines the actual trip level of the sample under test, which shall be less than or equal to the continuous residual current limit above. To test the trip time, the test resistance is then adjusted to set the residual current to a value approximately 10 mA below the actual trip level. A second external resistance, adjusted to cause approximately 20 mA of residual current to flow, is connected through a switch from ground to the same PV input terminal as the first resistance. The switch is closed, increasing the residual current to a level above the trip level determined above. The time shall be measured from the moment the second resistance is connected until the moment the inverter disconnects from the mains, as determined by observing the inverter output current and measuring the time until the current drops to zero. | | N |
| | This test shall be repeated 5 times, and for all 5 tests the time to disconnect shall not exceed 0,3 s. | | N |
| 4.8.3.5.3 | Test for detection of sudden changes in residual current | | N |
| | This test shows that the residual current sudden change function operates within the limits for residual current and trip time, even when the sudden change is superimposed over a pre-existing baseline level of continuous residual current. | | N |
| | a) Setting the pre-existing baseline level of continuous residual current: An adjustable capacitance is connected to one PV terminal. This capacitance is slowly increased until the inverter disconnects by means of the continuous residual current detection function. The capacitance is then lowered such that the continuous residual current is reduced below that disconnection level, by an amount equal to approximately 150 % of the first residual current sudden change value in 4.8.3.5.1 b) to be tested (e.g. 45 mA for the 30 mA test) and the inverter is re-started. | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | b) Applying the sudden change in residual current: An external resistance, pre-adjusted to cause 30 mA of residual current to flow, is connected through a switch from ground to the same PV input terminal as the capacitance in step a) above. The time shall be measured from the moment the switch is closed (i.e. connecting the resistance and applying the residual current sudden change) until the moment the inverter disconnects from the grid, as determined by observing the inverter output current and measuring the time until the current drops to zero. This test shall be repeated 5 times, and all 5 results shall not exceed the time limit indicated in the 30 mA row of Table 31. | | N |
| 4.8.3.6 | Systems located in closed electrical operating areas | | N |
| | 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) is not required if the installation information provided with the inverter indicates the restriction for use in a closed electrical operating area, and indicates what forms of shock hazard protection are and are not provided integral to the inverter, in accordance with 5.3.2.7. The inverter shall be marked as in 5.2.2.6. | | N |
| **5** | **Marking and documentation** | | P |
| 5.1 | Marking | | P |
| 5.1.1 | General | | P |
| | Equipment shall bear markings as specified in 5.1 and 5.2. | Complied | P |
| 5.1.2 | Durability of markings | | P |
| | Markings required by this clause to be located on the PCE shall remain clear and legible under conditions of normal use and resist the effects of cleaning agents specified by the manufacturer | Complied | P |
| 5.1.3 | Identification | | P |
| | The equipment shall, as a minimum, be permanently marked with: | | P |
| | a) the name or trade mark of the manufacturer or supplier; | MAGNIZON GREEN ENERGY | P |
| | b) a model number, name or other means to identify the equipment, | APS-12K48SW-M120 | P |
| | c) a serial number, code or other marking allowing identification of manufacturing location and the manufacturing batch or date within a three month time period. | | P |
| 5.1.4 | Equipment ratings**(EN 62109-2)** | | P |
| | In addition to the markings required in other clauses of Part 1 and elsewhere in this Part 2,the ratings in Table 32 shall be plainly and permanently marked on the inverter, where it is readily visible after installation. Only those ratings that are applicable based on the type of inverter are required | Complied | P |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Table 32 – Inverter ratings – Marking requirements | | |

| Rating | Units |
|---|---|
| PV input ratings: | |
| Vmax PV[a] (absolute maximum) | d.c. V |
| Isc PV[a] (absolute maximum) | d.c. A |
| a.c. output ratings: | |
| Voltage (nominal or range) | a.c. V |
| Current (maximum continuous) | a.c. A |
| Frequency (nominal or range) | Hz |
| Power (maximum continuous) | W or VA |
| Power factor range | |
| a.c. input ratings: | |
| Voltage (nominal or range) | a.c. V |
| Current (maximum continuous) | a.c. A |
| Frequency (nominal or range) | Hz |
| d.c. input (other than PV) ratings: | |
| Voltage (nominal or range) | d.c. V |
| Current (maximum continuous) | d.c. A |
| d.c. output ratings: | |
| Voltage (nominal or range) | d.c. V |
| Current (maximum continuous) | d.c. A |
| Protective class[a] (I, II, or III) | |
| Ingress protection[a] (IP) rating per Part 1 | |
| [a] These terms are defined in Clause 3 of Part 1. | |

| | | | |
|---|---|---|---|
| | An inverter that is adjustable for more than one nominal output voltage shall be marked to indicate the particular voltage for which it is set when shipped from the factory. It is acceptable for this marking to be in the form of a removable tag or other non-permanent method. | Complied | P |
| 5.1.5 | Fuse identification | | P |
| | Marking shall be located adjacent to each fuse or fuseholder, or on the fuseholder, or in another location provided that it is obvious to which fuse the marking applies, giving the fuse current rating and, where fuses of different voltage rating value could be fitted, the fuse voltage rating. | Complied | P |
| 5.1.6 | Terminals, connections and controls | | P |
| | If necessary for safety, an indication shall be given of the purpose of terminals, connectors,controls, and indicators, and their various positions, including any connections for coolant fluids such as water and drainage. | Complied | P |
| 5.1.7 | Switches and circuit-breakers | | P |
| | The on and off-positions of switches and circuit breakers shall be clearly marked. | Complied | P |
| 5.1.8 | Class II equipment | | N |
| | Equipment using Class II protective means throughout shall be marked with symbol 12 of Annex C. Equipment which is only partially protected by double insulation or reinforced insulation shall not bear symbol 12 of Annex C. | Class I | N |
| 5.1.9 | Terminal boxes for external connections | | P |
| | Where required by note 1 of Table 2 as a result of high temperatures of terminals or parts in the wiring compartment, there shall be a marking, visible beside the terminal before connection, of either: | | P |
| | a) the minimum temperature rating and size of the cable to be connected to the terminals; or | | P |
| | b) a marking to warn the installer to consult the installation instructions. Symbol 9 of Annex C is an acceptable marking. | | N |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| 5.2 | Warning markings | | P |
| 5.2.1 | Visibility and legibility requirements for warning markings | | P |
| | Warning markings shall be visible when the equipment is installed and ready for normal use. If a warning applies to a particular part of the equipment, the marking shall be placed on, or near to, this part. | Complied | P |
| | Warning markings shall be legible, and shall have minimum dimensions as follows: | Complied | P |
| | – Printed symbols shall be at least 2,75 mm high. | Complied | P |
| | – Printed text characters shall be at least 1,5 mm high, whether upper case or lower case, and shall contrast in colour with the background. | Complied | P |
| | – Symbols or text that are moulded, stamped or engraved in a material shall have a character height of at least 2,0 mm, whether upper case or lower case, and if not contrasting in colour from the background, shall have a depth or raised height of at least 0,5 mm | Complied | P |
| | If it is necessary to refer to the instruction manual to preserve the protection afforded by the equipment, the equipment shall be marked with symbol 9 of Annex C. | | N |
| 5.2.2 | Content for warning markings | | P |
| 5.2.2.1 | Ungrounded heatsinks and similar parts | | P |
| | An ungrounded heat sink or other part that may be mistaken for a grounded part and involves a risk of electric shock in accordance with 7.3 shall be marked with symbol 13 of Annex C, or equivalent. The marking may be on or adjacent to the heatsink and shall be clearly visible when the PCE is disassembled to the extent that a risk of contact with the heatsink exists. | Complied | P |
| 5.2.2.2 | Hot surfaces | | P |
| | A part of the PCE that exceeds the temperature limits specified in 4.3.2 shall be marked with symbol 14 of Annex C. | Complied | P |
| 5.2.2.3 | Coolant | | N |
| | A unit containing coolant that exceeds 70 °C shall be legibly marked externally where readily visible after installation with symbol 15 of Annex C. The documentation shall provide a warning regarding the risk of burns from hot coolant, and either: | No Coolant | N |
| | a) a statement that coolant system servicing is to be done only by service personnel, or | | N |
| | b) instructions for safe venting, draining, or otherwise working on the cooling system, if these operations can be performed without operator access to hazards internal to the equipment | | N |
| 5.2.2.4 | Stored energy | | P |
| | Where required by 7.3.9.2 or 7.4.2 the PCE shall be marked with Symbol 21 of Annex C and the time to discharge capacitors to safe voltage and energy levels shall accompany the symbol. | Complied | P |
| 5.2.2.5 | Motor guarding | | P |
| | Where required by 8.2 a marking shall be provided where it is visible to service personnel before removal of a guard, warning of the hazard and giving instructions for safe servicing (for example disconnection of the source before removing the guard). | Complied | P |
| 5.2.2.6 | Inverters for closed electrical operating areas**(EN 62109-2)** | | P |
| | 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. | Complied | P |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| 5.2.3 | Sonic hazard markings and instructions | | P |
| | If required by 10.2.1 a PCE shall: | | P |
| | a) be marked to warn the operator of the sonic pressure hazard; or | Complied | P |
| | b) be provided with installation instructions that specify how the installer can ensure that the sound pressure level from equipment, at its point of use after installation, will not reach a value, which could cause a hazard. These instructions shall include the measured sound pressure level, and shall identify readily available and practicable protective materials or measures which may be used. | Complied | P |
| 5.2.4 | Equipment with multiple sources of supply | | N |
| | A PCE with connections for multiple energy sources shall be marked with symbol 13 of Annex C and the manual shall contain the information required in 5.3.4. | One source of supply | N |
| | The symbol shall be located on the outside of the unit or shall be prominently visible behind any cover giving access to hazardous parts. | | N |
| 5.2.5 | Excessive touch current | | P |
| | Where required by 7.3.6.3.7 the PCE shall be marked with symbol 15 of Annex C. See also 5.3.2 for information to be provided in the installation manual. | Complied | P |
| 5.3 | Documentation | | P |
| 5.3.1 | General | | P |
| | The documentation provided with the PCE shall provide the information needed for the safe operation, installation, and (where applicable) maintenance of the equipment. The documentation shall include the items required in 5.3.2 through 5.3.4, and the following: | | P |
| | a) explanations of equipment markings, including symbols used; | Complied | P |
| | b) location and function of terminals and controls; | Complied | P |
| | c) all ratings or specifications that are necessary to safely install and operate the PCE, including the following environmental ratings along with an explanation of their meaning and any resulting installation requirements: | Complied | P |
| | – Environmental category as per 6.1 | Complied | P |
| | – Wet locations classification as per 6.1 | Complied | P |
| | – Pollution degree classification for the intended external environment as per 6.2 | Complied | P |
| | – Ingress protection rating as per 6.3 | Complied | P |
| | – Ambient temperature and relative humidity ratings | Complied | P |
| | – Maximum altitude rating | Complied | P |
| | – Overvoltage category assigned to each input and output port as per 7.3.7.1.2, accompanied by guidance regarding how to ensure that the installation complies with the required overvoltage categories; | Complied | P |
| | d) a warning that when the photovoltaic array is exposed to light, it supplies a d.c. voltage to the PCE. | Complied | P |
| 5.3.1.1 | Language | | P |
| | Instructions related to safety shall be in a language that is acceptable in the country where the equipment is to be installed. | Complied | P |
| 5.3.1.2 | Format | | P |
| | In general, the documentation shall be provided in printed form and is to be delivered with the equipment. | Complied | P |
| | For equipment which requires the use of a computer for both installation and operation, documentation may be provided in electronic format without accompanying printed format. | Complied | P |
| 5.3.2 | Information related to installation | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The documentation shall include installation and where applicable, specific commissioning instructions and, if necessary for safety, warnings against hazards which could arise during installation or commissioning of the equipment. The information provided shall include: | Complied | P |
| | a) assembly, location, and mounting requirements; | Complied | P |
| | b) ratings and means of connection to each source of supply and any requirements related to wiring and external controls, colour coding of leads, disconnection means, or overcurrent protection needed, including instructions that the installation position shall not prevent access to the disconnection means; | Complied | P |
| | c) ratings and means of connection of any outputs from the PCE, and any requirements related to wiring and external controls, colour coding of leads, or overcurrent protection needed; | Complied | P |
| | d) explanation of the pin-out of connectors for external connections, unless the connector is used for a standard purpose (e.g. RS 232); | Complied | P |
| | e) ventilation requirements; | Complied | P |
| | f) requirements for special services, for example cooling liquid; | Complied | P |
| | g) instructions and information relating to sound pressure level if required by 10.2.1; | Complied | P |
| | h) where required by 14.8.1.3, instructions for the adequate ventilation of the room or location in which PCE containing vented or valve-regulated batteries is located, to prevent the accumulation of hazardous gases; | Complied | P |
| | i) tightening torque to be applied to wiring terminals; | Complied | P |
| | j) values of backfeed short-circuit currents available from the PCE on input and output conductors under fault conditions, if those currents exceed the max. rated current of the circuit, as per 4.4.4.6; | Complied | P |
| | k) for each input to the PCE, the maximum value of short-circuit current available from the source, for which the PCE is designed; and | Complied | P |
| | l) compatibility with RCD and RCM; | Complied | P |
| | m) instructions for protective earthing of the PCE, including the information required by 7.3.6.3.7 if a second protective earthing conductor is to be installed; | Complied | P |
| | n) where required by 7.3.8, the installation instructions shall include the following or equivalent wording:<br>"This product can cause current with a d.c. component. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product." | Complied | P |
| | o) for PCE intended to charge batteries, the battery nominal voltage rating, size, and type; | Complied | P |
| | p) PV array configuration information, such as ratings, whether the array is to be grounded or floating, any external protection devices needed, etc. | Complied | P |
| 5.3.2.1 | Ratings**(EN 62109-2)** | | P |
| 5.3.2.2 | Grid-interactive inverter setpoints**(EN 62109-2)** | | N |
| | For a grid-interactive unit 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. | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| 5.3.2.3 | Transformers and isolation**(EN 62109-2)** | | |
| | 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 (functional, basic,reinforced, or double) is provided by that transformer. 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. | Complied | P |
| 5.3.2.4 | Transformers required but not provided**(EN 62109-2)** | | N |
| | 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 transformer with which it is intended to be used. | Provided | N |
| 5.3.2.5 | PV modules for non-isolated inverters**(EN 62109-2)** | | N |
| | Non-isolated inverters shall be provided with installation instructions that require PV modules that have an IEC 61730 Class A rating. 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. | Isolated | N |
| 5.3.2.6 | Non-sinusoidal output waveform information**(EN 62109-2)** | | N |
| | 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, that some loads may experience increased heating, and that the user should consult the manufacturers of the intended load equipment before operating that load with the inverter. The inverter manufacturer shall provide information regarding what types of loads may experience increased heating, recommendations for maximum operating times with such loads, and shall specify the THD, slope, and peak voltage of the waveforms as determined by the testing in 4.7.5.3.2 through 4.7.5.3.4 | DC | N |
| 5.3.2.7 | Systems located in closed electrical operating areas**(EN 62109-2)** | | P |
| | 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, and indicating which forms of shock hazard protection are and are not provided integral to the inverter (for example the RCD, isolation transformer complying with the 30 mA touch current limit, or residual current monitoring for sudden changes). | Complied | P |
| 5.3.2.8 | Stand-alone inverter output circuit bonding**(EN 62109-2)** | | P |
| | Where required by 7.3.10, the documentation for an inverter shall include the following: | | P |
| | – if output circuit bonding is required but is not provided integral to the inverter, the required means shall be described in the installation instructions, including which conductor is to be bonded and the required current carrying capability or cross-section of the bonding means; | | N |
| | – if the output circuit is intended to be floating, the documentation for the inverter shall indicate that the output is floating. | Complied | P |
| 5.3.2.9 | Protection by application of RCD's**(EN 62109-2)** | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | 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. | Complied | P |
| 5.3.2.10 | Remote indication of faults**(EN 62109-2)** | | P |
| | The installation instructions shall include an explanation of how to properly make connections to (where applicable), and use, the electrical or electronic fault indication required by 13.9. | Complied | P |
| 5.3.2.11 | External array insulation resistance measurement and response**(EN 62109-2)** | | P |
| | 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: | Complied | P |
| | – for isolated inverters, an explanation of what aspects of array insulation resistance measurement and response are not provided, and an instruction to consult local regulations to determine if any additional functions are required or not; | Complied | P |
| | – for non-isolated inverters: | | N |
| | • an explanation of what external equipment must be provided in the system, and | | N |
| | • what the setpoints and response implemented by that equipment must be, and | | N |
| | • how that equipment is to be interfaced with the rest of the system. | | N |
| 5.3.2.12 | Array functional grounding information**(EN 62109-2)** | | P |
| | Where approach a) of 4.8.2.2 is used, the installation instructions for the inverter shall include all of the following: | Complied | P |
| | a) the value of the total resistance between the PV circuit and ground integral to the inverter; | Complied | P |
| | 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; | Complied | P |
| | c) the minimum value of the total resistance R = V MAX PV /30 mA that the system must meet, with an explanation of how to calculate the total; | Complied | P |
| | d) a warning that there is a risk of shock hazard if the total minimum resistance requirement is not met. | Complied | P |
| 5.3.2.13 | Stand-alone inverters for dedicated loads**(EN 62109-2)** | | P |
| | 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. | Complied | P |
| 5.3.2.14 | Identification of firmware version(s)**(EN 62109-2)** | | 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. | Complied | P |
| 5.3.3 | Information related to operation | | P |
| | Instructions for use shall include any operating instructions necessary to ensure safe operation, including the following, as applicable: | | P |
| | – instructions for adjustment of controls including the effects of adjustment; | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | – instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials; | Complied | P |
| | – warnings regarding the risk of burns from surfaces permitted to exceed the temperature limits of 4.3.2 and required operator actions to reduce the risk; and | Complied | P |
| | – instructions that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. | Complied | P |
| 5.3.4 | Information related to maintenance | | P |
| | Maintenance instructions shall include the following: | | P |
| | – intervals and instructions for any preventive maintenance that is required to maintain safety (for example air filter replacement or periodic re-tightening of terminals); | Complied | P |
| | – instructions for accessing operator access areas, if any are present, including a warning not to enter other areas of the equipment; | Complied | P |
| | – part numbers and instructions for obtaining any required operator replaceable parts; | Complied | P |
| | – instructions for safe cleaning (if recommended); | Complied | P |
| | – where there is more than one source of supply energizing the PCE, information shall be provided in the manual to indicate which disconnect device or devices are required to be operated in order to completely isolate the equipment. | Complied | P |
| 5.3.4.1 | Battery maintenance | | P |
| | Where required by 14.8.5, the documentation shall include the applicable items from the following list of instructions regarding maintenance of batteries: | Complied | P |
| | – Servicing of batteries should be performed or supervised by personnel knowledgeable about batteries and the required precautions. | | P |
| | – When replacing batteries, replace with the same type and number of batteries or battery packs. | | P |
| | – General instructions regarding removal and installation of batteries. | | P |
| | – CAUTION: Do not dispose of batteries in a fire. The batteries may explode. | | P |
| | – CAUTION: Do not open or damage batteries. Released electrolyte is harmful to the skin and eyes. It may be toxic. | | P |
| | – CAUTION: A battery can present a risk of electrical shock and high short-circuit current. The following precautions should be observed when working on batteries: | | P |
| | a) Remove watches, rings, or other metal objects. | | N |
| | b) Use tools with insulated handles. | | P |
| | c) Wear rubber gloves and boots. | | N |
| | d) Do not lay tools or metal parts on top of batteries. | | P |
| | e) Disconnect charging source prior to connecting or disconnecting battery terminals. | | P |
| | f) Determine if battery is inadvertently grounded. If inadvertently grounded, remove source from ground. Contact with any part of a grounded battery can result in electrical shock. The likelihood of such shock can be reduced if such grounds are removed during installation and maintenance (applicable to equipment and remote battery supplies not having a grounded supply circuit). | | N |
| **6** | **Environmental requirements and conditions** | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The manufacturer shall rate the PCE for the following environmental conditions: | | P |
| | – Environmental category, as in 6.1 below | Complied | P |
| | – Suitability for wet locations or not | Complied | P |
| | – Pollution degree rating, as in 6.2 below | Complied | P |
| | – Ingress protection (IP) rating, as in 6.3 below | Complied | P |
| | – Ultraviolet (UV) exposure rating, as in 6.4 below | Complied | P |
| | – Ambient temperature and relative humidity ratings, as in 6.5 below | | P |
| | The documentation provided with the PCE shall include these ratings as per 5.3.1. In addition, the rating, as in 6.3 below shall be marked on the equipment as per 5.1.4. | Complied | P |
| | These parameters are subject to minimum requirements, test, and examination, as given in the following clauses and in Table 4. | Complied | P |
| 6.1 | Environmental categories and minimum environmental conditions | | P |
| | The PCE environmental categories are defined as follows: | Complied | P |
| 6.1.1 | Outdoor | | N |
| | The PCE is fully or partly exposed to direct rain, sun, wind, dust, fungus, ice, condensation,radiation to the cold night sky, etc., and to the full range of outdoor temperature and humidity.Wet location requirements apply. | | N |
| 6.1.2 | Indoor, unconditioned | | N |
| | The PCE is fully covered by a building or enclosure to protect it from direct rain, sun, wind-blown dust, fungus, and radiation to the cold night sky, etc., but the building or enclosure is not conditioned in terms of temperature, humidity or air filtration, and the equipment may experience condensation. If the PCE is not rated for and evaluated for wet location use, then the installation instructions shall specify that the installation location must be dry, except for condensation. | | N |
| 6.1.3 | Indoor, conditioned | | P |
| | The PCE is fully covered by a building or enclosure to fully protect it from rain, sun, wind-blown dust, fungus, and radiation to the cold night sky, etc., and the building or enclosure is generally conditioned in terms of temperature, humidity and air filtration. Condensation is not expected. If the PCE is not rated for and evaluated for wet location use, then the installation instructions shall specify that the installation location must be dry, including no expected condensation. | Complied | P |
| 6.2 | Pollution degree | | P |
| | The manufacturer's stated pollution degree rating shall be used when determining the required creepage and clearance distances in 7.3.7. The stated pollution degree rating shall comply with above and with the definitions in 3.60 through 3.63. | Complied | P |
| 6.3 | Ingress protection | | P |
| | The manufacturer's stated ingress protection rating shall comply with Table 4 and shall be verified in accordance with IEC 60529. | Complied | P |
| 6.4 | UV exposure | | P |
| | External plastic parts of equipment for outdoor service shall not be degraded by exposure to UV light to the extent that protection against hazards is reduced below levels given in 13.6.4. If required by Table 4, the polymeric material shall have been evaluated for ultraviolet (UV) radiation resistance as determined in accordance with 13.6.4. If degradation of the parts could not affect the protection provided, this requirement is waived. | Complied | P |



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<table>
<tr><th colspan="4">EN 62109-1&-2</th></tr>
<tr><th>Clause</th><th>Requirement ~Test</th><th>Result</th><th>Verdict</th></tr>
<tr><td>6.5</td><td>Temperature and humidity</td><td></td><td>P</td></tr>
<tr><td></td><td>The manufacturer’s stated ranges of ambient temperature and relative humidity are used elsewhere in this standard to determine preconditioning and test parameters.</td><td>Complied</td><td>P</td></tr>
<tr><td>7</td><td>Protection against electric shock and energy hazards</td><td></td><td>P</td></tr>
<tr><td>7.1</td><td>General</td><td></td><td>P</td></tr>
<tr><td></td><td>This clause 7 defines the minimum requirements for the design and construction of PCE for protection against shock and energy hazards during installation, operation, and maintenance, under normal and single fault conditions, for the expected lifetime of the PCE. Consideration is also given to minimizing hazards resulting from reasonably foreseeable misuse.</td><td>Complied</td><td>P</td></tr>
<tr><td>7.2</td><td>Fault conditions</td><td></td><td>P</td></tr>
<tr><td></td><td>Protection against electric shock and energy hazards shall be maintained under normal and single fault conditions.</td><td>Complied</td><td>P</td></tr>
<tr><td>7.3</td><td>Protection against electric shock</td><td></td><td>P</td></tr>
<tr><td>7.3.1</td><td>General</td><td></td><td>P</td></tr>
<tr><td></td><td>Each circuit under evaluation shall be compliant with Figure 1, which presents a summary of possible design solutions with regard to protection against electric shock arising from direct and indirect contact.</td><td>Complied</td><td>P</td></tr>
<tr><td>7.3.2</td><td>Decisive voltage classification</td><td></td><td>P</td></tr>
<tr><td>7.3.2.1</td><td>Use of decisive voltage class (DVC)</td><td></td><td>P</td></tr>
<tr><td></td><td>Protective measures against electric shock depend on the decisive voltage classification of the circuit, which is determined from Table 6 and 7.3.2.4. The decisive voltage classification for a circuit is the least severe classification for which both of the following are complied with:</td><td>Complied</td><td>P</td></tr>
<tr><td></td><td>– the working voltage limits of Table 6, and</td><td>Complied</td><td>P</td></tr>
<tr><td></td><td>– the applicable protective measures of 7.3.2.4.</td><td>Complied</td><td>P</td></tr>
<tr><td>7.3.2.2</td><td>Limits of DVC</td><td>Complied</td><td>P</td></tr>
<tr><td></td><td>The voltage limits for each DVC level are given in Table 6.<br><br>Table 6 – Summary of the limits of the decisive voltage classes<br><table><tr><th rowspan="2">Decisive voltage Classification (DVC)</th><th colspan="3">Limits of working voltage V</th></tr><tr><th>a.c. voltage r.m.s. $U_{ACL}$</th><th>a.c. voltage peak $U_{ACPL}$</th><th>d.c. voltage mean $U_{DCL}$</th></tr><tr><td>A*</td><td>≤25<br>(16)</td><td>≤35,4<br>(22,6)</td><td>≤60<br>(35)</td></tr><tr><td>B</td><td>50<br>(33)</td><td>71<br>(46,7)</td><td>120<br>(70)</td></tr><tr><td>C</td><td>>50<br>(>33)</td><td>>71<br>(>46,7)</td><td>>120<br>(>70)</td></tr><tr><td colspan="4">The table values in parentheses are to be used for PCE or portions of PCEs rated for installation in wet locations as addressed in 6.1 for environmental categories and minimum environmental conditions.<br>*DVC-A circuits are allowed under fault conditions to have voltages up to the DVC-B limits, for maximum 0,2 s.</td></tr></table></td><td>Complied</td><td>P</td></tr>
<tr><td>7.3.2.3</td><td>Short-term limits of accessible voltages under fault conditions</td><td></td><td>P</td></tr>
<tr><td></td><td>The non-recurring voltage allowable on accessible live or conductive parts under fault conditions shall not exceed DVC-A limits, except that voltages up to the DVC-B limits are allowed if the duration for which the voltage exceeds DVC-A levels does not exceed 0.2 s.</td><td><0.2s</td><td>P</td></tr>
<tr><td>7.3.2.4</td><td>Requirements for protection</td><td></td><td>P</td></tr>
</table>



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Protection shall be provided that ensures that no single fault, including faults to functional, basic, or supplemental insulation, can result in a voltage higher than the DVC-A limits appearing on an accessible circuit or accessible conductive part. | Complied | P |
| 7.3.2.5 | Connection to PELV and SELV circuits | | N |
| | If it is intended to connect signal, communication, or control ports of the PCE to external PELV or SELV devices or circuits, the compatibility of the different systems shall be determined, such that: | Not PELV or SELV | N |
| | – the PELV or SELV classification of the external circuit is not changed, and | | N |
| | – the DVC classification of the external port of the PCE is not changed. | | N |
| 7.3.2.6 | Working voltage and DVC | | P |
| 7.3.2.6.1 | General | | P |
| | The working voltage used in determining the decisive voltage classification of a given circuit is evaluated by the method set out below. | | P |
| | Working voltage shall be based on operation of the PCE under the worst case combination of highest and lowest rated voltages for each port, and under worst-case normal operating conditions. | | P |
| 7.3.2.6.2 | AC working voltage | | P |
| 7.3.2.6.3 | DC working voltage | | N |
| 7.3.2.6.4 | Pulsating working voltage | | N |
| 7.3.3 | Protective separation | | P |
| | Protective separation shall be achieved by: | | P |
| | • double or reinforced insulation,or | | P |
| | • protective screening, i.e. by a conductive screen connected to earth by protective bonding in the PCE, or connected to the protective earth conductor itself, whereby the screen is separated from live parts by at least basic insulation,or | | N |
| | • protective impedance comprising limitation of current per 7.3.5.3.1 and of discharged energy per 7.3.5.3.2,or | | N |
| | • limitation of voltage according to 7.3.5.4. | | N |
| | The protective separation shall be fully and effectively maintained under all conditions of intended use of the PCE. | | P |
| 7.3.4 | Protection against direct contact | | P |
| 7.3.4.1 | General | | P |
| | Protection against direct contact is employed to prevent persons from touching live parts that do not meet the requirements of 7.3.5 and shall be provided by one or more of the measures given in 7.3.4.2 (enclosures and barriers) and 7.3.4.3 (insulation). | | P |
| 7.3.4.2 | Protection by means of enclosures and barriers | | P |
| | The following requirements apply where protection against contact with live parts is provided by enclosures or barriers, not by insulation in accordance with 7.3.4.3. | | P |
| 7.3.5 | Protection in case of direct contact | | P |
| 7.3.5.1 | General | | P |
| | Protection in case of direct contact is required to ensure that contact with live parts does not produce a shock hazard. | Complied | P |
| | Protection against direct contact according to 7.3.4 is not required if the accessible circuit | | N |
| | • is of DVC-A and complies with 7.3.5.2, or | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | • is provided with protective impedance in accordance with 7.3.5.3, or | | N |
| | • is limited in voltage according to 7.3.5.4. | | N |
| 7.3.6 | Protection against indirect contact | | P |
| 7.3.6.1 | General | | P |
| | Protection against indirect contact is required to prevent shock-hazardous currents being accessible from conductive parts during an insulation failure. This protection shall comply with the requirements for protective class I (basic insulation plus protective earthing), protective class II (double or reinforced insulation) or protective class III (limitation of voltages). | Complied | P |
| 7.3.6.2 | Insulation between live parts and accessible conductive parts | | P |
| | Accessible conductive parts of equipment shall be separated from live parts by insulation meeting the requirements of Table 7 or by clearances as specified in 7.3.7.4 and creepages as specified in 7.3.7.5. | Complied | P |
| 7.3.6.3 | Protective class I - Protective bonding and earthing | | P |
| 7.3.6.3.1 | General | | P |
| | Equipment of protective class I shall be provided with protective earthing, and with protective bonding to ensure electrical contact between accessible conductive parts and the means of connection for the external protective earthing conductor, except bonding is not required for: | Complied | P |
| | a) accessible conductive parts that are protected by one of the measures in 7.3.5.2 to 7.3.5.4, or | Complied | P |
| | b) accessible conductive parts that are separated from live parts of DVC-B or -C using double or reinforced insulation. | Complied | P |
| 7.3.6.3.2 | Requirements for protective bonding | | P |
| | Electrical contact with the means of connection of the external protective earthing conductor shall be achieved by one or more of the following means: | | P |
| | a) through direct metallic contact; | | P |
| | b) through other conductive parts which are not removed when the PCE or sub-units are used as intended; | | P |
| | c) through dedicated protective bonding conductors; | | N |
| | d) through other metallic components of the PCE. | | N |
| 7.3.6.3.3 | Rating of protective bonding | | P |
| | Protective bonding shall withstand the highest thermal and dynamic stresses that can occur to the PCE item(s) concerned when they are subjected to a fault connecting live parts to accessible conductive parts. | Complied | P |
| | The protective bonding shall remain effective for as long as a fault to the accessible conductive parts persists or until an upstream protective device removes power from the part. | Complied | P |
| | Protective bonding shall meet following requirements: | | P |
| | a) For PCE with an overcurrent protective device rating of 16 A or less, the impedance of the protective bonding means shall not exceed 0,1 Ω during or at the end of the test below. | | N |
| | b) For PCE with an overcurrent protective device rating of more than 16 A, the voltage drop in the protective bonding test shall not exceed 2,5 V during or at the end of the test below. | 72A | P |
| 7.3.6.3.4 | Protective bonding impedance (routine test) | | P |



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| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | If the continuity of the protective bonding is achieved at any point by a single means only (for example a single conductor or single fastener), or if the PCE is assembled at the installation location, then the impedance of the protective bonding shall also be tested as a routine test. | Complied | P |
| | The test shall be as in 7.3.6.3.3, except for the following: | | P |
| | • the test current may be reduced to any convenient value greater than 10 A sufficient to allow measurement or calculation of the impedance of the protective bonding means; | 72A | P |
| | • the test duration may be reduced to no less than 2 s | >2s | P |
| | For equipment subject to the type test in 7.3.6.3.3.1a), the impedance during the routine test shall not exceed 0,1 Ω. | <0,1 Ω. | P |
| | For equipment subject to the type test in 7.3.6.3.3.1b) the impedance during the routine test shall not exceed 2,5 V divided by the test current required by 7.3.6.3.3.1b). | <2,5 V | P |
| 7.3.6.3.5 | External protective earthing conductor | | P |
| | A protective earthing conductor shall be connected at all times when power is supplied to PCE of protective class I. Unless local wiring regulations state otherwise, the protective earthing conductor cross-sectional area shall be determined from Table 11 or by calculation according to IEC 60364-5-54. | Complied | P |
| 7.3.6.3.6 | Means of connection for the external protective earthing conductor | | P |
| 7.3.6.3.6.1 | General | | P |
| | The means of connection for the external protective earthing conductor shall be located near the terminals for the respective live conductors. The means of connection shall be corrosion-resistant and shall be suitable for the connection of cables according to 7.3.6.3.5. | Complied | P |
| | The means of connection for the protective earthing conductor shall not be used as a part of the mechanical assembly of the equipment or for other connections. | Complied | P |
| | A separate means of connection shall be provided for each external protective earthing conductor. | Complied | P |
| | Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and/or conductors of aluminium or aluminium alloys are used, particular attention should be given to the problems of electrolytic corrosion. | Complied | P |
| | The means of connection for the protective earthing conductor shall be permanently marked with: | | P |
| | – symbol 7 of Annex C; or | Complied | P |
| | – the colour coding green-yellow. | Complied | P |
| | Marking shall not be done on easily changeable parts such as screws. | Complied | P |
| 7.3.6.3.7 | Touch current in case of failure of the protective earthing conductor | | P |
| | The requirements of this subclause shall be satisfied to maintain safety in case of damage to or disconnection of the protective earthing conductor. | Complied | P |
| | For pluggable equipment type A , the touch current measured in accordance with 7.5.4 shall not exceed 3,5 mA a.c. or 10 mA d.c. | Complied | P |
| | For all other PCE, one or more of the following measures shall be applied, unless the touch current measured in accordance with 7.5.4 does not exceed 3,5 mA a.c. or 10 mA d.c. | | N |
| | a) Permanently connected wiring, and: | Complied | P |



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| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | • a cross-section of the protective earthing conductor of at least 10 mm 2 if copper, or 16 mm 2 if aluminum;or | | P |
| | • automatic disconnection of the supply in case of discontinuity of the protective earthing conductor; or | | P |
| | • provision of an additional terminal for a second protective earthing conductor of the same cross-sectional area as the original protective earthing conductor and installation instructions requiring a second protective earthing conductor to be installed. | | P |
| | b) Connection with an industrial connector according to IEC 60309 and a minimum protective earthing conductor cross-section of 2,5 mm 2 as part of a multi-conductor power cable.Adequate strain relief shall be provided. | | P |
| | In addition, the caution symbol 15 of Annex C shall be fixed to the product and the installation manual shall provide details of the protective earthing measures required in the installation as required in 5.3.2. | | P |
| | When it is intended and allowed to connect two or more PCEs in parallel using one common protective earthing conductor, the above touch current requirements apply to the maximum number of PCEs to be connected in parallel, unless one of the measures in a) or b) above is used. The maximum number of parallel PCEs is used in the testing and has to be stated in the installation manual. | | P |
| 7.3.6.4 | Protective class II - Double or reinforced insulation | | N |
| | Equipment or parts of equipment designed for protective class II shall have insulation between live parts and accessible surfaces in accordance with 7.3.4.3. The following requirements also apply: | | N |
| | • equipment designed to protective class II shall not have means of connection for the external protective earthing conductor. However this does not apply if the external protective earthing conductor is passed through the equipment to equipment series-connected beyond it. In the latter event, the external protective earthing conductor and its means for connection shall be insulated with basic insulation from the accessible surface of the equipment and from circuits that employ protective separation, extra-low voltage, protective impedance and limited discharging energy, according to 7.3.5. This basic insulation shall correspond to the rated voltage of the series-connected equipment; | | N |
| | • metal-encased equipment of protective class II may have provision on its enclosure for the connection of an equipotential bonding conductor; | | N |
| | • equipment of protective class II may have provision for the connection of an earthing conductor for functional reasons or for the damping of overvoltages; it shall, however, be insulated as though it is a live part; | | N |
| | • equipment employing protective class II shall be marked according to 5.1.8. | | N |
| 7.3.7 | Insulation including clearance and creepage distances | | P |
| 7.3.7.1 | General | | P |
| | This subclause gives minimum requirements for insulation, based on the principles of IEC 60664 | Complied | P |
| 7.3.7.1.1 | Pollution degree | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Insulation, especially when provided by clearances and creepage distances, is affected by pollution that occurs during the expected lifetime of the PCE. The pollution degree rating of the PCE or section of the PCE to be used in judging the requirements of this section shall be the pollution degree determined according to 6.1 and 6.2. | Complied | P |
| 7.3.7.1.2 | Overvoltage category and Impulse withstand voltage rating | | P |
| | The concept of overvoltage categories is applied to each separate circuit in the PCE, including mains circuits, PV circuits, and other circuits, whether connected to or isolated from the mains and PV circuits, as follows: | Complied | P |
| | a) For equipment or circuits energized from the mains, four categories are considered: | Complied | P |
| | • category IV applies to equipment permanently connected at the origin of an installation (upstream of the main distribution board). Examples are electricity meters, primary overcurrent protection equipment and other equipment connected directly to outdoor open lines | | N |
| | • category III applies to fixed equipment downstream of, and including, the main distribution board. Examples are switchgear and other equipment in an industrial installation; | | N |
| | • category II applies to equipment not permanently connected to the installation.Examples are appliances, portable tools and other plug-connected equipment; | | N |
| | • category I applies to equipment connected to a circuit where measures have been taken to reduce transient overvoltages to a low level. | Complied | P |
| | b) For PV circuits in general, Overvoltage Category II is assumed, and impulse withstand voltage ratings for the PV circuit are assigned based on the PV system voltage as in 7.3.7.1.4, but the minimum impulse voltage to be used is 2 500 V. | Complied | P |
| | c) For PCE with galvanic isolation between the mains and PV circuits, the impulse voltage withstand ratings of the mains and PV circuits are determined as in a) and b) above, and then the effect of reduction of OVC across the isolation is evaluated as follows: | Complied | P |
| | – The magnitude of impulses from the mains circuit on the PV circuit is determined by reducing the OVC of the mains circuit by one level, and determining the resulting impulse voltage withstand rating based on mains system voltage. | Complied | P |
| | – The rating to be used on the PV circuit is the higher of the value in b) and the value calculated above. | Complied | P |
| | – The magnitude of impulses from the PV circuit on the mains circuit is determined by reducing the OVC of the PV circuit by one level, and determining the resulting impulse voltage withstand rating based on PV system voltage. | Complied | P |
| | – The rating to be used on the mains circuit is the higher of the value in a) and the value calculated above. | Complied | P |
| | d) For PCE not providing galvanic isolation between the mains and PV circuits, the impulse withstand voltage ratings of the mains and PV circuits are determined as in a) and b) above, and the higher of the two impulse withstand voltage ratings is used for the entire combined circuit. For circuits connected to the combined circuit without galvanic isolation,the impulse withstand voltage rating of the combined circuit applies. | | N |



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| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | e) For other circuits the impulse withstand voltage rating is the most severe rating determined by the relationship of the circuit under consideration to the PV and mains circuits, according to the following: | | N |
| | • for circuits connected to the mains without galvanic isolation, the impulse withstand voltage rating of the mains circuit applies; | | N |
| | • for circuits connected to the PV circuit without galvanic isolation, the impulse withstand voltage rating of the PV circuit applies; | | N |
| | • where isolation is provided by means of isolation transformers, optocouplers, or similar galvanic isolation devices, between a considered circuit and an adjacent mains or PV circuit, the impulse withstand voltage rating of the considered circuit is reduced by one level from that of the adjacent circuit; if more than one adjacent circuit is involved, the highest resulting impulse withstand voltage rating applies. | | N |
| | f) The overvoltage categories determined as above apply from circuits to earth. The overvoltage category that applies to functional insulation within each circuit is one category lower (less severe) than the overvoltage category that applies from the circuit to earth. | Complied | P |
| | g) Application of means to reduce impulse voltages: For basic and functional insulation, if transient reduction means are provided which reduce impulses to lower values, insulation may be designed for the reduced impulse levels. The reduced values to be used are the highest impulses occurring in the testing of 7.5.1. | Complied | P |
| | If such devices are used to reduce the values for design of Basic insulation, and the devices can be damaged by overvoltages or repeated impulses, thus decreasing their ability to reduce impulses, they shall be monitored and an indication of their status provided. | | N |
| | The requirements for double or reinforced insulation shall not be reduced when measures to reduce impulses are provided. | Complied | P |
| 7.3.7.1.3 | Supply earthing systems | | P |
| | Three basic types of earthing system are described in IEC 60364-1. They are: | Complied | P |
| | • TN system: has one point directly earthed, the accessible conductive parts of the installation being connected to that point by protective conductors. Three types of TN system, TN-C, TN-S and TN-C-S, are defined according to the arrangement of the neutral and protective conductors; | Complied | P |
| | • TT system: has one point directly earthed, the accessible conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the power system; | | N |
| | • IT system: has all live parts isolated from earth or one point connected to earth through an impedance, the accessible conductive parts of the installation being earthed independently or collectively to the earthing system. | | N |
| 7.3.7.1.4 | Insulation voltages | | P |
| | Table 12 makes use of the circuit system voltage and overvoltage category to define the impulse withstand voltage and the temporary overvoltage. | Complied | P |



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| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |

**Table 12 – Insulation voltage for low voltage circuits**

| Column 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| System voltage (7.3.7.2) V | Impulse withstand voltage V | | | | Mains circuit Temporary overvoltage (peak / r.m.s.) (see note 5) V |
| | Overvoltage category | | | | |
| | I | II | III | IV | |
| 50 V rms or 71 V dc | 330 | 500 | 800 | 1 500 | 1 770 / 1 250 |
| 100 V rms or 141 V dc | 500 | 800 | 1 500 | 2 500 | 1 840 / 1 300 |
| 150 V rms or 213 V dc | 800 | 1 500 | 2 500 | 4 000 | 1 910 / 1 350 |
| 300 V rms or 424 V dc | 1 500 | 2 500 | 4 000 | 6 000 | 2 120 / 1 500 |
| 600 V rms or 849 V dc | 2 500 | 4 000 | 6 000 | 8 000 | 2 550 / 1 800 |
| 1 000 V rms or 1 500 V dc | 4 000 | 6 000 | 8 000 | 12 000 | 3 110 / 2 200 |

NOTE 1 Interpolation is not permitted in mains circuits, but is permitted in other circuits.

NOTE 2 The last row only applies to single-phase systems, or to the phase-to-phase voltage in three-phase systems.

NOTE 3 Column 6, temporary overvoltages, only applies to mains circuits.

NOTE 4 PV circuits are in general OVCII with a minimum impulse voltage of 2 500 V - see 7.3.7.1.2b).

NOTE 5 These values are derived using the formula (1 200 V + system voltage) from IEC 60664-1.

| | | | |
|---|---|---|---|
| 7.3.7.2 | Insulation between a circuit and its surroundings | | P |
| 7.3.7.2.1 | General | | P |
| | Basic, supplementary, and reinforced insulation between a circuit and its surroundings shall be designed according to: | Complied | P |
| | • the impulse voltage; or | | P |
| | • the temporary overvoltage; or | | P |
| | • the working voltage of the circuit. | | P |
| | For creepage distances, the r.m.s. value of the working voltage is used. | | P |
| | For clearance distances and solid insulation the voltage used is as described in 7.3.7.2.2 to 7.3.7.2.4. | Complied | P |
| 7.3.7.2.2 | Circuits connected directly to the mains | | P |
| | Clearances and solid insulation between circuits connected directly to the mains and their surroundings shall be designed according to the impulse voltage, temporary overvoltage, or working voltage, whichever gives the most severe requirement. | Complied | P |
| 7.3.7.2.3 | Circuits other than mains circuits | | P |
| | Clearances and solid insulation between circuits other than the mains and their surroundings shall be designed according to impulse voltage and recurring peak voltage, according to the following: | Complied | P |
| | – the system voltage is | | P |
| | –for PV circuits, the max rated PV open circuit voltage; | | P |
| | –for other circuits, the working voltage; | | P |
| | – the impulse voltage is determined from Table 12, using the system voltage above and according to 7.3.7.1.2; | | P |
| | – the working voltage or the impulse voltage, whichever gives the more severe requirement, determines the design of the clearances and solid insulation. | | P |
| 7.3.7.2.4 | Insulation between circuits | | P |
| | Insulation between two circuits shall be designed according to the following: | Complied | P |
| | a) for clearances and insulation, the requirements are determined by the circuit having the higher impulse voltages; | | P |
| | b) for creepages, r.m.s. working voltage across the insulation determines the requirements. | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| 7.3.7.3 | Functional insulation | | P |
| | For insulation within a circuit and for other cases where functional insulation is permitted, the voltage used for insulation requirements is determined as follows: | Complied | P |
| | The overvoltage category shall be determined as in 7.3.7.1.2. | | P |
| | For parts or circuits in overvoltage category I, functional insulation shall be designed according to the working voltage across the insulation. | | P |
| | For parts or circuits in overvoltage category II, III, or IV, functional insulation shall be designed according to the applicable impulse voltage as determined by 7.3.7.1.4. | | P |
| 7.3.7.4 | Clearance distances | | P |
| 7.3.7.4.1 | Determination | | P |
| | Table 13 defines the minimum clearance distances required to provide functional, basic, or supplementary insulation (see Annex A for examples of clearance distances). | Complied | P |
| | **Table 13 – Clearance distances** | | |

| Column 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Impulse voltage (Table 12 and 7.3.7.1.4) | Temporary overvoltage (peak value) for determining insulation between circuits and their surroundings or Working voltage (recurring peak) for determining functional insulation | Working voltage (recurring peak) for determining insulation between circuits and their surroundings | Minimum clearance mm | | |
| | | | Pollution degree | | |
| V | V | V | 1 | 2 | 3 |
| N/A | ≤ 110 | ≤ 71 | 0,01 | 0,20 [a] | 0,80 |
| N/A | 225 | 141 | 0,01 | 0,20 | 0,80 |
| 330 | 340 | 212 | 0,01 | 0,20 | 0,80 |
| 500 | 530 | 330 | 0,04 | 0,20 | 0,80 |
| 800 | 700 | 440 | 0,10 | 0,20 | 0,80 |
| 1 500 | 960 | 600 | 0,50 | 0,50 | 0,80 |
| 2 500 | 1 600 | 1 000 | 1,5 | | |
| 4 000 | 2 600 | 1 600 | 3,0 | | |
| 6 000 | 3 700 | 2 300 | 5,5 | | |
| 8 000 | 4 800 | 3 000 | 8,0 | | |
| 12 000 | 7 400 | 4 600 | 14,0 | | |

NOTE 1 Interpolation is permitted.

NOTE 2 Examples of clearance distances are given in Annex A.

NOTE 3 Clearances for Temporary overvoltage and Working voltage have been derived from Table A.1 of IEC 60664-1. In column 2, the voltage is approximately 80 % of the withstand voltage; in column 3, the voltage is approximately 50 % of the withstand voltage.

[a] 0,1 mm on PWB.

| | | | |
|---|---|---|---|
| 7.3.7.4.2 | Electric field homogeneity | | P |
| | The dimensions in Table 13 correspond to the requirements of an inhomogeneous electric field distribution across the clearance, which are the conditions normally experienced in practice. If a homogeneous electric field distribution is known to exist, and the impulse voltage is equal to or greater than 6 000 V for a circuit connected directly to the mains or 4 000 V within a circuit, the clearance may be reduced to not less than that required by Table F.2 Case B of IEC 60664-1. In this case, however, the impulse voltage test of 7.5.1 shall be performed on the clearance. | Complied | P |
| 7.3.7.4.3 | Clearance to conductive enclosures | | P |
| | The clearance between any non-insulated live part and the walls of a metal enclosure shall be in accordance with 7.3.7.4.1 following the deformation tests of 13.7. | Complied | P |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | If the design clearance is at least 12,7 mm and the clearance required by 7.3.7.4.1 does not exceed 8 mm, the deformation tests may be omitted. | Complied | P |
| 7.3.7.5 | Creepage distances | | P |
| 7.3.7.5.1 | General | | P |
| | Creepage distances shall be large enough to prevent long-term degradation of the surface of solid insulators, according to Table 14. | Complied | P |
| 7.3.7.5.2 | Voltage | | P |
| | The voltage in column 1 of Table 14 is the r.m.s. value of the working voltage across the creepage distance. Interpolation is permitted. | Complied | P |
| 7.3.7.5.3 | Materials | | P |
| | Insulating materials are classified into four groups corresponding to their comparative tracking index (CTI) when tested according to 6.2 of IEC 60112: | | P |
| | • Insulating material group I CTI ≥ 600; | | N |
| | • Insulating material group II 600 > CTI ≥ 400; | | N |
| | • Insulating material group IIIa 400 > CTI ≥ 175; | | N |
| | • Insulating material group IIIb 175 > CTI ≥ 100. | | P |
| | Creepage distances on printed wiring boards (PWBs) exposed to pollution degree 3 environmental conditions shall be determined based on Table 14 Pollution degree 3 under"Other insulators". | Complied | P |
| | Table 14 – Creepage distances (mm) | | |
| 7.3.7.6 | Coating | | P |

| Column 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PWBs [a] | | Other insulators | | | | | | | | |
| RMS Working Voltage (7.3.7.5.2) | Pollution degree | | Pollution degree | | | | | | | | |
| | 1 | 2 | 1 | 2 | | | | 3 | | | |
| | | | | Insulating material group | | | | Insulating material group | | | |
| V | [b] | [c] | [b] | I | II | IIIa | IIIb | I | II | IIIa | IIIb |
| ≤ 2 | 0,025 | 0,04 | 0,056 | 0,35 | 0,35 | 0,35 | | 0,87 | 0,87 | 0,87 | |
| 5 | 0,025 | 0,04 | 0,065 | 0,37 | 0,37 | 0,37 | | 0,92 | 0,92 | 0,92 | |
| 10 | 0,025 | 0,04 | 0,08 | 0,40 | 0,40 | 0,40 | | 1,0 | 1,0 | 1,0 | |
| 25 | 0,025 | 0,04 | 0,125 | 0,50 | 0,50 | 0,50 | | 1,25 | 1,25 | 1,25 | |
| 32 | 0,025 | 0,04 | 0,14 | 0,53 | 0,53 | 0,53 | | 1,3 | 1,3 | 1,3 | |
| 40 | 0,025 | 0,04 | 0,16 | 0,56 | 0,80 | 1,1 | | 1,4 | 1,6 | 1,8 | |
| 50 | 0,025 | 0,04 | 0,18 | 0,60 | 0,85 | 1,20 | | 1,5 | 1,7 | 1,9 | |
| 63 | 0,04 | 0,063 | 0,20 | 0,63 | 0,90 | 1,25 | | 1,6 | 1,8 | 2,0 | |
| 80 | 0,063 | 0,10 | 0,22 | 0,67 | 0,95 | 1,3 | | 1,7 | 1,9 | 2,1 | |
| 100 | 0,10 | 0,16 | 0,25 | 0,71 | 1,0 | 1,4 | | 1,8 | 2,0 | 2,2 | |
| 125 | 0,16 | 0,25 | 0,28 | 0,75 | 1,05 | 1,5 | | 1,9 | 2,1 | 2,4 | |
| 160 | 0,25 | 0,40 | 0,32 | 0,80 | 1,1 | 1,6 | | 2,0 | 2,2 | 2,5 | |
| 200 | 0,40 | 0,63 | 0,42 | 1,0 | 1,4 | 2,0 | | 2,5 | 2,8 | 3,2 | |
| 250 | 0,56 | 1,0 | 0,56 | 1,25 | 1,8 | 2,5 | | 3,2 | 3,6 | 4,0 | |
| 320 | 0,75 | 1,6 | 0,75 | 1,6 | 2,2 | 3,2 | | 4,0 | 4,5 | 5,0 | |
| 400 | 1,0 | 2,0 | 1,0 | 2,0 | 2,8 | 4,0 | | 5,0 | 5,6 | 6,3 | |
| 500 | 1,3 | 2,5 | 1,3 | 2,5 | 3,6 | 5,0 | | 6,3 | 7,1 | 8,0 | |
| 630 | 1,8 | 3,2 | 1,8 | 3,2 | 4,5 | 6,3 | | 8,0 | 9,0 | 10,0 | |
| 800 | 2,4 | 4,0 | 2,4 | 4,0 | 5,6 | 8,0 | | 10,0 | 11 | 12,5 | [d] |
| 1 000 | 3,2 | 5,0 | 3,2 | 5,0 | 7,1 | 10,0 | | 12,5 | 14 | 16 | |
| 1 250 | 4,2 | 6,3 | 4,2 | 6,3 | 9 | 12,5 | | 16 | 18 | 20 | |
| 1 600 | [e] | [e] | 5,6 | 8,0 | 11 | 16 | | 20 | 22 | 25 | |
| 2 000 | | | 7,5 | 10,0 | 14 | 20 | | 25 | 28 | 32 | |
| 2 500 | | | 10,0 | 12,5 | 18 | 25 | | 32 | 36 | 40 | |
| 3 200 | | | 12,5 | 16 | 22 | 32 | | 40 | 45 | 50 | |
| 4 000 | | | 16 | 20 | 28 | 40 | | 50 | 56 | 63 | |
| 5 000 | | | 20 | 25 | 36 | 50 | | 63 | 71 | 80 | |
| 6 300 | | | 25 | 32 | 45 | 63 | | 80 | 90 | 100 | |
| 8 000 | | | 32 | 40 | 56 | 81 | | 100 | 110 | 125 | |
| 10 000 | | | 40 | 50 | 71 | 100 | | 125 | 140 | 160 | |

[a] These columns also apply to components and parts on PWBs, and to other creepage distances with a comparable control of tolerances.
[b] All material groups.
[c] All material groups except IIIb.
[d] Insulating materials of group IIIb are not normally recommended for pollution degree 3 above 630 V.
[e] Above 1 250 V use the values from columns 4 to 11, as appropriate.
NOTE Interpolation is permitted.



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | A coating may be used to provide insulation, to protect a surface against pollution, and to allow a reduction in creepage and clearance distances (see 7.3.7.8.4.2 and 7.3.7.8.6). | Complied | P |
| 7.3.7.7 | PWB spacings for functional insulation | | P |
| | Spacings for functional insulation on a PWB which do not comply with 7.3.7.4 and 7.3.7.5 are permitted when all the following are satisfied: | Complied | P |
| | • the PWB has flammability rating of V-0 (see IEC 60695-11-10); and | | P |
| | • the PWB base material has a minimum CTI of 175; and | | P |
| | • the equipment complies with the PWB short-circuit test (see 4.4.4.14). | | P |
| 7.3.7.8 | Solid insulation | | P |
| 7.3.7.8.1 | General | | P |
| | Materials selected for solid insulation shall be able to withstand the stresses occurring in the application. These include mechanical, electrical, thermal and climatic stresses which are to be expected in normal use. Insulation materials shall also be resistant to ageing during the expected lifetime of the PCE. | Complied | P |
| 7.3.7.8.2 | Requirements for electrical withstand capability of solid insulation | | P |
| 7.3.7.8.2.1 | Basic, supplemental, reinforced, and double insulation | | P |
| | Solid insulation shall withstand the applicable impulse withstand voltage test according to 7.5.1 and the a.c. or d.c. voltage test according to 7.5.2. | ac | P |
| | In addition, double and reinforced insulation shall withstand the partial discharge test according to 7.5.3, if the recurring peak working voltage across the insulation is greater than 700 V and the voltage stress on the insulation is greater than 1 kV/mm. | Complied | P |
| 7.3.7.8.2.2 | Functional insulation | | P |
| | Functional insulation shall comply with the requirements of 7.3.7.3. Testing is not required. | Complied | P |
| 7.3.7.8.3 | Thin sheet or tape material | | P |
| 7.3.7.8.3.1 | General | | P |
| | This section applies to the use of thin sheet or tape materials in assemblies such as wound components and bus-bars. | Complied | P |
| 7.3.7.8.3.2 | Material thickness not less than 0,2 mm | | P |
| | • Basic or supplementary insulation shall consist of at least one layer of material, and shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic or supplementary insulation. | Complied | P |
| | • Double insulation shall consist of at least two layers of material. Each layer shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic insulation, and the partial discharge requirements of 7.3.7.8.2.1. The two or more layers together shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for double insulation. | Complied | P |
| | • Reinforced insulation shall consist of a single layer of material, which will meet the impulse, a.c. or d.c. voltage, and partial discharge test requirements 7.3.7.8.2.1 for reinforced insulation. | Complied | P |
| 7.3.7.8.3.3 | Material thickness less than 0.2 mm | | N |
| | • Basic or supplementary insulation shall consist of at least one layer of material, and shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic or supplementary insulation. | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | • Double insulation shall consist of at least three layers of material. Each layer shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic insulation.Any two layers together shall meet the impulse, a.c. or d.c. voltage, and partial discharge test requirements of 7.3.7.8.2.1 for double insulation. | | N |
| | • Reinforced insulation consisting of a single layer of material less than 0,2 mm thick is not permitted. | | N |
| 7.3.7.8.4 | Printed wiring boards (PWBs) | | P |
| 7.3.7.8.4.1 | General | | P |
| | Insulation between conductor layers in double-sided single-layer PWBs, multi-layer PWBs and metal core PWBs, shall meet the requirements for solid insulation in 7.3.7.8. | Complied | P |
| 7.3.7.8.4.2 | Use of coating materials | | P |
| | A coating material used to provide a microenvironment or to provide functional, basic,supplementary and reinforced insulation shall meet the requirement as specified below. | Complied | P |
| | Type 1 protection (as defined in IEC 60664-3) improves the microenvironment (Pollution Degree) of the parts under protection. The clearance and creepage distance of Table 13 and Table 14 for pollution degree 1 apply under the protection. Between two conductive parts, it is a requirement that one or both conductive parts, together with all the spacing between them, are covered by the protection. | Complied | P |
| | Type 2 protection is considered to be similar to solid insulation. Under the protection, the requirements for solid insulation specified in 7.3.7.8 are applicable and spacings shall not be less than those specified in Table 1 of IEC 60664-3. The requirements for clearance and creepage in Table 13 and Table 14 do not apply. Between two conductive parts, it is a requirement that both conductive parts, together with the spacing between them, are covered by the protection so that no airgap exists between the protective material, the conductive parts and the printed wiring boards. | Complied | P |
| 7.3.7.8.5 | Wound components | | N |
| | Varnish or enamel insulation of wires shall not be used for basic, supplementary, double or reinforced insulation. | | N |
| | Wound components shall meet the requirements of 7.3.7.8.1 and 7.3.7.8.2. | | N |
| | The component itself shall pass the requirements given in 7.3.7.8.1 and 7.3.7.8.2. If the component has reinforced or double insulation, the voltage test in 7.5.2 shall be performed as a routine test. | | N |
| 7.3.7.8.6 | Potting materials | | N |
| | A potting material may be used to provide solid insulation or to act as a coating to protect against pollution. If used as solid insulation, it shall comply with the requirements of 7.3.7.8.1 and 7.3.7.8.2. If used to protect against pollution, the requirements for Type 1 protection in 7.3.7.8.4.2 apply. | | N |
| 7.3.7.9 | Insulation requirements above 30 kHz | | N |
| | Where voltages across insulation have fundamental frequencies greater than 30 kHz, further considerations apply. Requirements for this are provided in IEC 60664-4, and the more severe of these and the requirements of 7.3.7.1 to 7.3.7.8 shall be applied. | | N |
| 7.3.8 | Residual Current Detection (RCD) or Monitoring (RCM) device compatibility | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | RCD and RCM devices are used to provide protection against insulation faults in a.c. supply circuits in some domestic and industrial installations, in addition to any protection provided by the installed equipment. | | P |
| 7.3.9 | Protection against shock hazard due to stored energy | | P |
| 7.3.9.1 | Operator access area | | P |
| | Equipment shall be so designed that there is no risk of electric shock in operator access areas from stored charge after disconnection of the PCE | Complied | P |
| | In the case of plugs, connectors, or similar devices that can be disconnected without the use of a tool, the withdrawal of which results in the exposure of conductors (e.g. pins), the discharge time to reduce the voltage to DVC A (see 7.3.2.2) or, for capacitors, to a stored charge level below the limits specified in 7.3.5.3.2, shall not exceed 1 s. | <1s | P |
| 7.3.9.2 | Service access areas | | P |
| | Capacitors and other energy storage devices located behind panels that are removable for servicing, installation, or disconnection shall present no risk of electric shock or energy hazard from stored charge after disconnection of the PCE. | Complied | P |
| | Capacitors within a PCE shall be discharged to a voltage less than DVC A (see 7.3.2.2), or an energy level below the limits specified in 7.3.5.3.2, within 10 s after the removal of power from the PCE. If this requirement is not achievable for functional or other reasons, the warning symbol 21 of Annex C and an indication of the discharge time shall be placed in a clearly visible position on the enclosure, the capacitor protective barrier, or at a point close to the capacitor(s) concerned (depending on the construction) (see 5.2.2.4). | Complied | P |
| | For energy storage devices (such as batteries or ultracapacitors) the intended function of which is to maintain charge even with the PCE off and disconnected from external sources, a barrier or insulation shall be provided so that unintentional contact with hazardous live parts is prevented. The warning symbol 21 of Annex C shall be placed in a clearly visible position on or adjacent to the barrier or insulation, where it will be seen before removal of the barrier or insulation. | Complied | P |
| 7.3.10 | Additional requirements for stand-alone inverters**(EN 62109-2)** | | P |
| | 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. | Complied | P |
| | The means used to bond the grounded conductor to protective earth may be provided within the inverter or as part of the installation. If not provided integral to the inverter, the required means shall be described in the installation instructions as per 5.3.2.8. | Complied | P |
| | The means used to bond the grounded conductor to protective earth shall comply with the requirements for protective bonding in Part 1, except that if the bond can only ever carry fault currents in stand-alone mode, the maximum current for the bond is determined by the inverter maximum output fault current. | Complied | P |
| | Output circuit bonding arrangements shall ensure that in any mode of operation, the system only has the grounded circuit conductor bonded to earth in one place at a time. Switching arrangements may be used, in which case the switching device used is to be subjected to the bond impedance test along with the rest of the bonding path. | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Inverters intended to have a circuit conductor bonded to earth shall not impose any normal current on the bond except for leakage current. | Complied | P |
| | Outputs that are intentionally floating with no circuit conductor bonded to ground, must not have any voltages with respect to ground that are a shock hazard in accordance with Clause 7 of Parts 1 and 2. The documentation for the inverter shall indicate that the output is floating as per 5.3.2.8. | Complied | P |
| 7.3.11 | Functionally grounded arrays**(EN 62109-2)** | | P |
| | All PV conductors in a functionally grounded array shall be treated as being live parts with respect to protection against electric shock. | Complied | P |
| 7.4 | Protection against energy hazards | | P |
| 7.4.1 | Determination of hazardous energy level | | P |
| | A hazardous energy level is considered to exist if: | | N |
| | a) the voltage is 2 V or more, and power available after 60 s exceeds 240 VA. | | N |
| | b) the stored energy in a capacitor is at a voltage, U of 2 V or more, and the stored energy,E, calculated from the following equation, exceeds 20 J: | | N |
| 7.4.2 | Operator access areas | | P |
| | Equipment shall be so designed that there is no risk of energy hazard in operator access areas from accessible circuits. | Complied | P |
| 7.4.3 | Service access areas | | P |
| | Energy storage devices located behind panels that are removable for servicing, installation, or disconnection shall present no risk of electric energy hazard from charge stored after disconnection of the PCE. | No such devices | N |
| | Energy storage devices within a PCE shall be discharged to an energy level less than 20 J, as in 7.4.1, within 10 s after the removal of power from the PCE. | Complied | P |
| | For energy storage devices (such as batteries or ultracapacitors) the intended function of which is to maintain charge even with the PCE off and disconnected from external sources, a barrier or insulation shall be provided so that unintentional contact with parts at a hazardous energy level is prevented. | Complied | P |
| 7.5 | Electrical tests related to shock hazard | | P |
| 7.5.1 | Impulse voltage test (type test) | | P |
| | The impulse voltage test is performed with a voltage having a 1,2/50 µs waveform (see Figure 6 of IEC 60060-1) and is intended to simulate overvoltages induced by lightning or due to switching of equipment. See Table 15 for conditions of the impulse voltage test. | Complied | P |
| 7.5.2 | Voltage test (dielectric strength test) (type test and routine test) | | P |
| 7.5.2.1 | Purpose of test | | P |
| | The test is used to verify that the clearances and solid insulation of components and of assembled PCE has adequate dielectric strength to resist overvoltage conditions. Routine tests are performed to verify that clearances and solid insulation have not been omitted, reduced, or damaged during the manufacturing operations. | Complied | P |
| 7.5.2.3 | Humidity pre-conditioning | | P |
| | For type tests on PCE for which wet locations requirements apply, according to 6.1, the humidity pre-conditioning of 4.5 shall be performed immediately prior to the voltage test. | Complied | P |
| 7.5.2.4 | Performing the voltage test | Complied | P |
| 7.5.2.5 | Duration of the a.c. or d.c. voltage test | AC | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| 7.5.2.6 | Verification of the a.c. or d.c. voltage test | AC | P |
| 7.5.3 | Partial discharge test (type test or sample test) | | P |
| 7.5.4 | Touch current measurement (type test) | | P |
| 7.5.5 | Equipment with multiple sources of supply | | P |
| **8** | **Protection against mechanical hazards** | | P |
| 8.1 | General | | P |
| | Operation shall not lead to a mechanical hazard in normal condition or single fault condition. | Complied | P |
| | Edges, projections, corners, openings, guards, handles and the like, that are accessible to the operator shall be smooth and rounded so as not to cause injury during normal use of the equipment. | Complied | P |
| 8.2 | Moving parts | | N |
| | Moving parts shall not be able to crush, cut or pierce parts of the body of an operator likely to contact them, nor severely pinch the operator's skin. Hazardous moving parts of equipment, that is moving parts which have the potential to cause injury, shall be so arranged, enclosed or guarded as to provide adequate protection against the risk of personal injury. | No moving parts | N |
| | If, during routine maintenance outside normal use, it is unavoidable for technical reasons that an operator has to perform a function, such as adjustment, which requires access to moving parts, which could cause a hazard, access is permitted if all of the following precautions have been taken: | | N |
| | a) access is not possible without the use of a tool; | | N |
| | b) the instructions for the responsible body include a statement that operators must be trained before being allowed to perform the hazardous operation; | | N |
| | c) there are warning markings (see 5.2) on any covers or parts which have to be removed to obtain access, prohibiting access by untrained operators. | | N |
| | Automatic reset thermal cut-outs or overcurrent protection devices, automatic timer starting, etc., shall not be incorporated if unexpected resetting might create a hazard. | | N |
| 8.2.1 | Protection of service persons | | N |
| | Protection shall be provided such that unintentional contact with hazardous moving parts is unlikely during servicing operations. If a guard over a hazardous moving part may need to be removed for servicing, the marking of symbol 15 of Annex C shall be applied on or near the guard. | | N |
| 8.3 | Stability | | P |
| | Equipment and assemblies of equipment not secured to the building structure before operation shall be physically stable in normal use. | Complied | P |
| | If means are provided to ensure that stability is maintained after the opening of drawers, etc. by an operator, either these means shall be automatic or there shall be a warning marking (see 5.2). | Complied | P |
| 8.4 | Provisions for lifting and carrying | | N |
| | If carrying handles or grips are fitted to, or supplied with, the equipment, they shall be capable of withstanding a force of four times the weight of the equipment. | No such Provisions | N |
| | Equipment or parts having a mass of 18 kg or more shall be provided with a means for lifting and carrying or directions shall be given in the manufacturer's documentation. | | N |
| 8.5 | Wall mounting | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Mounting brackets on equipment intended to be mounted on a wall or ceiling shall withstand a force of four times the weight of the equipment. | Complied | P |
| 8.6 | Expelled parts | | P |
| | Equipment shall contain or limit the energy of parts that could cause a hazard if expelled in the event of a fault. | Complied | P |
| | The means of protection against expelled parts shall not be removable without the aid of a tool. | Complied | P |
| **9** | **Protection against fire hazards** | | P |
| 9.1 | Resistance to fire | | P |
| | This subclause specifies requirements intended to reduce the risk of ignition and the spread of flame, both within the equipment and to the outside, by the appropriate use of materials and components and by suitable construction. | Complied | P |
| 9.1.1 | Reducing the risk of ignition and spread of flame | | P |
| | For equipment or a portion of equipment, there are two alternative methods of providing protection against ignition and spread of flame that could affect materials, wiring, wound components and electronic components such as integrated circuits, transistors, thyristors,diodes, resistors and capacitors. | Complied | P |
| | Method 1 – Selection and application of components, wiring and materials that reduce the possibility of ignition and spread of flame and, where necessary, by the use of a fire enclosure. The appropriate requirements are detailed in 9.1.2 and 9.1.3. In addition, the simulated faults of 4.4.4.1 a) and b) are applied, when using this method. | Complied | P |
| | Method 2 – Application of all of the simulated fault tests in 4.4.4.1 a), b), and c). A fire enclosure is not required for equipment or that portion of equipment for which only Method 2 is used if the fault testing does not result in ignition of components, temperatures that could be sufficient for ignition, or other indication of a risk of fire. | | N |
| 9.1.2 | Conditions for a fire enclosure | | N |
| | A fire enclosure is required for equipment or parts of equipment for which Method 2 is not fully applied and complied with. | Method 1 | N |
| 9.1.3 | Materials requirements for protection against fire hazard | | P |
| 9.1.3.1 | General | | P |
| | Enclosures, components and other parts shall be so constructed, or shall make use of such materials, that the propagation of fire is limited. | Complied | P |
| | Materials of flammability classes VTM-0, VTM-1 and VTM-2 are considered to be equivalent to materials of FLAMMABILITY classes V-0, V -1 and V-2, respectively, for their flammability properties. Their electrical and mechanical properties are not necessarily equivalent. | V-2 | P |
| 9.1.3.2 | Materials for fire enclosures | | P |
| | If an enclosure material is not classified as specified below, a test may be performed on the final enclosure or part of the enclosure, in which case the material shall additionally be subjected to periodic sample testing. | classified as specified | P |
| | The material of a fire enclosure, in the thinnest significant wall thickness used, shall be classified as flammability class 5VB according to IEC 60695-11-20 or shall pass the 5VB test in the end product. Whether classified or tested, the test result shall comply with all of the following: | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | a) the sample shall not release either flaming drops or particles capable of igniting the surgical cotton, and | Complied | P |
| | b) the sample shall not continue to burn for more than 1 min after the fifth application of the test flame, and | Complied | P |
| | c) there shall be no openings greater than 25 mm after the test. | Complied | P |
| | Materials for components that fill an opening in a fire enclosure shall: | No such materials | N |
| | - be of at least V-1 class material and no larger than 100 mm in any dimension; or | | N |
| | - be of at least V-2 class material and either | | N |
| | -no larger than 25 mm in any dimension, or | | N |
| | -no larger than 100 mm in any dimension and located at least 100 mm from any part that is a source of fire hazard, or | | N |
| | -be of at least V-2 class material and there is a barrier or device(s) that forms a barrier made of a V-10 class material between the part and a source of fire hazard, or | | N |
| | -comply with a relevant IEC component standard that includes flammability requirements for components that are intended to form part of, or fill openings in, a fire enclosure | | N |
| | Plastic materials of a fire enclosure shall be located more than 13 mm through air from parts that arc under normal conditions such as unenclosed commutators and unenclosed switch contacts. | | N |
| | Plastic materials of a fire enclosure located less than 13 mm through air from non-arcing parts which, under any condition of normal or abnormal operation, could attain a temperature sufficient to ignite the material, shall be capable of passing the hot-wire ignitability test of IEC 60695-2-20. If a sample melts through without igniting, the dimensions of the hole shall comply with the requirements elsewhere in this standard. | | N |
| | Metals, ceramic materials and glass shall be considered to comply without test. | | N |
| 9.1.3.3 | Materials for components and other parts inside fire enclosures | | P |
| | Inside fire enclosures, materials for components and other parts, (including mechanical and electrical enclosures located inside fire enclosures), shall comply with one of the following: | | P |
| | – be of flammability class V-2 or flammability class HF-2; or | V-2 | P |
| | – meet the flammability requirements of a relevant IEC component standard which includes such requirements. | Complied | P |
| 9.1.3.4 | Materials for air filter assemblies | | N |
| | Air filter assemblies shall be constructed of materials of flammability class V-2, or flammability class HF-2. | No such materials | N |
| 9.1.4 | Openings in fire enclosures | | N |
| 9.1.4.1 | General | | N |
| | For equipment that is intended to be used or installed in more than one orientation as specified in the product documentation, the following requirements apply in each orientation. | One orientation | N |
| | These requirements are in addition to those in the following sections: | | N |
| | – 7.3.4, Protection against direct contact; | | N |
| | – 7.4, Protection against energy hazards; | | N |
| | – 13.5, Openings in enclosures. | | N |
| 9.1.4.2 | Side openings treated as bottom openings | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Where a portion of the side of a fire enclosure falls within the area traced out by the 5° angle in Figure 14, the limitations in 9.1.4.3 regarding openings in bottoms of fire enclosures also apply to this portion of the side. | | N |
| 9.1.4.3 | Openings in the bottom of a fire enclosure | | N |
| | The bottom of a fire enclosure or individual barriers, shall provide protection against emission of flaming or molten material under all internal parts | | N |
| | The location and size of the bottom or barrier shall cover area D in Figure 14 and shall be horizontal, lipped or otherwise shaped to provide equivalent protection. The area shall be free of openings, except for those protected by a baffle, screen or other means so that molten metal and burning material are unlikely to fall outside the fire enclosure. | | N |
| 9.1.4.4 | Equipment for use in a closed electrical operating area | | N |
| | The requirements of 9.1.4.3 do not apply to fixed equipment intended only for use in a closed electrical operating area and to be mounted on a concrete floor or other non-combustible surface. Such equipment shall be marked as follows:<br>WARNING: FIRE HAZARD. SUITABLE FOR MOUNTING ON CONCRETE OR OTHER<br>NON-COMBUSTIBLE SURFACE ONLY | | N |
| 9.1.4.5 | Doors or covers in fire enclosures | | N |
| | If part of a fire enclosure consists of a door or cover leading to an operator access area, it shall comply with one of the following requirements: | | N |
| | – the door or cover shall be provided with a safety interlock; or | | N |
| | – a door or cover, intended to be routinely opened by the user, shall comply with both of the following conditions: | | N |
| | • it shall not be removable from other parts of the fire enclosure by the user; and | | N |
| | • it shall be provided with a means to keep it closed during normal operation. | | N |
| 9.1.4.6 | Additional requirements for openings in transportable equipment | | N |
| | The risk of ignition caused by small metallic objects, moving around inside transportable equipment during transportation shall be reduced by measures to minimize the likelihood of such objects entering the equipment and bridging bare conductive parts between which the power is not limited in accordance with 9.2. | | N |
| | The bottom of the fire enclosure or individual barriers shall also provide protection against emission of flaming or molten material under all internal parts, including partially enclosed components or assemblies, for which Method 2 of 9.1.1 has not been fully applied and complied with. | | N |
| 9.2 | Limited power sources | | P |
| 9.2.1 | General | | P |
| | This clause provides requirements for evaluating limited power sources, as referred to in clause 9.1. A limited power source shall comply with one of the following: | 230V AC, 50/60Hz, 72A, 12kW | |
| | – the output is inherently limited in conformity with Table 22; or | Complied | P |
| | – an impedance limits the output in conformity with Table 22. If a positive temperature coefficient device is used, it shall pass the tests specified in IEC 60730-1, clauses 15,17, J.15 and J.17; or | Not used | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | – an overcurrent protective device is used and the output is limited in conformity with Table 23; or | Complied | P |
| | – a regulating network limits the output in conformity with Table 22, both under normal operating conditions and after any single fault in the regulating network (open circuit or short circuit); or | Complied | P |
| | – a regulating network limits the output in conformity with Table 22 under normal operating conditions, and one of the above protective means is used in addition to limit the output under single fault conditions. | | N |
| | Where an overcurrent protective device is used to meet the limits for a limited power source, it shall be a fuse or a non-adjustable, non-autoreset, electromechanical device. | Complied | P |
| 9.3 | Short-circuit and overcurrent protection | | P |
| 9.3.1 | General | | P |
| | The PCE shall not present a hazard, under short-circuit or overcurrent conditions at any port, including phase-to-phase, phase-to-earth and phase-to-neutral, and adequate information shall be provided to allow proper selection of external wiring and external protective devices. | Complied | P |
| 9.3.2 | Number and location of overcurrent protective devices | | P |
| | Protection against short-circuits and overcurrents shall be provided for all input circuits, and for output circuits that do not comply with the requirements for limited power sources in 9.2, except for circuits in which no overcurrent hazard is presented by short-circuits and overloads. | Complied | P |
| | If a protective device interrupts a neutral conductor, it shall also simultaneously interrupt all ungrounded conductors of the same circuit. | | N |
| 9.3.3 | Short-circuit co-ordination (backup protection) | | P |
| | Protective devices provided or specified shall have adequate breaking capacity to interrupt the maximum short circuit current specified for the port to which they are connected. If protection that is provided integral to the PCE for an input port is not rated for the short-circuit current of the circuit in which it is used, the installation instructions shall specify that an upstream protective device, rated for the prospective short-circuit current of that port, shall be used to provide backup protection. | Complied | P |
| | For pluggable equipment type A, the building installation is considered as providing short circuit backup protection. | Complied | P |
| 9.3.4 | Inverter backfeed current onto the array **(EN 62109-2)** | | P |
| | 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. Faults to be considered include shorting all or part of the array, and any faults in the inverter that would allow energy from another source (for example the mains or a battery) to impress currents on the PV array wiring. The current measurement is not required to include any current transients that result from applying the short circuit, if such transients result from discharging storage elements other than batteries. | Complied | P |
| | This inverter backfeed current value shall be provided in the installation instructions regardless of the value of the current, in accordance with Table 33. | Complied | P |
| **10** | **Protection against sonic pressure hazards** | | N |
| 10.1 | General | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The equipment shall provide protection against the effects of sonic pressure. Conformity tests are carried out if the equipment is likely to cause such hazards. | No sonic pressure | N |
| 10.2 | Sonic pressure and sound level | | N |
| 10.2.1 | Hazardous noise levels | | N |
| | If equipment produces noise at a level that could cause a hazard, the noise shall be measured to determine the maximum sound pressure level that the equipment can produce | | N |
| **11** | **Protection against liquid hazards** | | N |
| 11.1 | Liquid containment, pressure and leakage | | N |
| | The liquid containment system components shall be compatible with the liquid to be used.There shall be no leakage of liquid onto live parts as a result of: | No liquid | N |
| | a) Normal operation, including condensation; | | N |
| | b) Servicing of the equipment; or | | N |
| | c) Inadvertent loosening or detachment of hoses or other cooling system parts over time. | | N |
| | The instruction manual for a PCE that includes a liquid containment system, shall include procedures to prevent the wetting live parts during servicing. | | N |
| | If a reservoir is part of the liquid containment system, a live part shall be located or protected so that it is not subject to dripping during the filling of the reservoir or if the reservoir fails. | | N |
| 11.2 | Fluid pressure and leakage | | N |
| 11.2.1 | Maximum pressure | | N |
| | The maximum pressure to which a part of the equipment can be subjected in normal use or single fault condition shall not exceed the rated maximum working pressure for the part. | | N |
| 11.2.2 | Leakage from parts | | N |
| | Leakage from liquid containing parts shall not cause a hazard. | | N |
| 11.2.3 | Overpressure safety device | | N |
| | A closed liquid containment system shall be provided with an overpressure safety device that shall not operate in normal use. The over pressure safety device shall: | | N |
| | a) be connected as close as possible to the liquid-containing parts of the system that it is intended to protect; | | N |
| | b) be installed so as to provide easy access for inspection,maintenance and repair; | | N |
| | c) only be adjustable via the use of a tool; | | N |
| | d) have its discharge opening so located and directed that the released material is not directed towards any person; | | N |
| | e) have its discharge opening so located and directed that operation of the device will not deposit liquid on parts that may cause a hazard; | | N |
| | f) have adequate discharge capacity to ensure that, in the event of a failure of the supply pressure control, the pressure does not exceed the rated maximum working pressure of the system; | | N |
| | g) have no shut-off valve between it and the parts that it is intended to protect. | | N |
| 11.3 | Oil and grease | | N |
| | Where internal wiring, windings, commutators, slip-rings and the like, and insulation in general, are exposed to oil, grease or similar substances, the insulation shall have adequate properties to resist deterioration under these conditions. | | N |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| **12** | **Chemical hazards** | | P |
| 12.1 | General | | P |
| | Means shall be provided to reduce the risk of injury resulting from contact with or exposure to hazardous chemicals or from inhalation of their vapours and fumes. | Complied | P |
| **13** | **Physical requirements** | | P |
| 13.1 | Handles and manual controls | | N |
| | Handles, knobs, grips, levers and the like shall be reliably fixed so that they will not work loose in normal use, if this might result in a hazard. | No such compenents | N |
| | Sealing compounds and the like, other than self-hardening resins, shall not be used to prevent loosening. | | N |
| | If handles, knobs and the like are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this might result in a hazard. | | N |
| 13.1.1 | Adjustable controls | | N |
| | Equipment shall be so constructed that manual adjustment of a control device, such as a device for selection of different supply voltages, requires the use of a tool if incorrect setting or inadvertent adjustment might create a hazard. | | N |
| 13.2 | Securing of parts | | P |
| | Screws, nuts, washers, springs or similar parts shall be secured so as to withstand mechanical stresses occurring in normal use if loosening would create a hazard, or if clearances or creepage distances over supplementary insulation or reinforced insulation would be reduced to less than the values specified in 7.3.7.4 and 7.3.7.5. | Complied | P |
| 13.3 | Provisions for external connections | | P |
| 13.3.1 | General | | P |
| | Provisions for external connections made during installation, shall comply with the following basic principles: | | P |
| | – connection means shall be of a type or so located as to comply with the requirements of this standard for protection against fire hazard, shock hazard, and energy hazard; | Complied | P |
| | – wiring in DVC B and C circuits shall be separated from wiring and bare live parts in DVC A circuits if a shock hazard could result from insulation failure; | Complied | P |
| | – wiring and flexible cables shall be securely terminated and provided with strain relief to prevent the transmission of stress to the connections; | Complied | P |
| | – provisions for permanently connected wiring shall be rated for and suitable for the size and type of wiring that will be required to be used in the installation; | Complied | P |
| | – disconnecting means shall be provided for each supply circuit in the equipment or be specified in the installation instructions, unless connectors are provided that are rated for disconnection under load; and | Complied | P |
| | – wiring space shall be sufficient for connections to be made and inspected, and shall provide sufficient space for the required size and type of conductors to be installed without risk of damage or reduction of separation from other circuits. | Complied | P |
| 13.3.2 | Connection to an a.c. mains supply | | P |
| 13.3.2.1 | General | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | For safe and reliable connection to a mains supply, equipment shall be provided with one of the following: | Complied | P |
| | – terminals or leads or a non-detachable power supply cord for permanent connection to the supply; or | Complied | P |
| | – a non-detachable power supply cord for connection to the supply by means of a plug; or | Complied | P |
| | – an appliance inlet for connection of a detachable power supply cord; or | Complied | P |
| | – a mains plug that is part of direct plug-in equipment as in 13.3.8. | | P |
| 13.3.2.2 | Permanently connected equipment | | P |
| | Permanently connected equipment shall be provided with either: | | P |
| | – a set of terminals as specified in 13.3.3 for connection of supply wires; or | Complied | P |
| | – a set of leads suitable for connection to supply wires using standard means such as wire nuts or splicing connectors, or | Complied | P |
| | – a non-detachable power supply cord for permanent connection to the source. | | N |
| | Permanently connected equipment having a set of terminals or leads shall: | | P |
| | – permit the connection of the supply wires after the equipment has been fixed to its support; and | Complied | P |
| | – be provided with cable entries, conduit entries, knock-outs or glands, which allow connection of the appropriate sizes and types of cables or conduits. | Complied | P |
| | Conduit and cable entries and knock-outs for supply connections shall: | | P |
| | – not be located on covers that need to be removed to access or inspect wiring; | Complied | P |
| | – be so designed or located that the introduction of the conduit and cable does not affect the protection against electric shock, or reduce clearances and creepage distances below the values specified in clause 7.3.7.4 and 7.3.7.5. | Complied | P |
| | Leads provided for connection to supply wiring shall be sized according to Table 24 and shall be located in wiring space according to 13.3.4. | Complied | P |
| 13.3.2.3 | Appliance inlets | | P |
| | Appliance inlets shall meet all of the following: | | P |
| | – be so located or enclosed that parts at hazardous voltage are not accessible during insertion or removal of the connector (appliance inlets complying with IEC 60309 or with the IEC 60320 series are considered to comply with this requirement); and | Complied | P |
| | – be so located that the connector can be inserted without difficulty; and | Complied | P |
| | – be so located that, after insertion of the connector, the equipment is not supported by the connector for any position of normal use on a flat surface. | Complied | P |
| 13.3.2.4 | Power supply cords | | P |
| | A power supply cord for connection to the a.c. mains shall comply with all of the following, as appropriate: | | P |
| | – if rubber insulated, be of synthetic rubber and not of a lighter grade than ordinary tough rubber sheathed flexible cord according to IEC 60245-1 (designation 60245 IEC 53); and | Complied | P |
| | – if PVC insulated: | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | • for equipment provided with a non-detachable power supply cord and having a mass not exceeding 3 kg, be not of a lighter grade than light PVC sheathed flexible cord according to IEC 60227-1 (designation 60227 IEC 52); | | N |
| | • for equipment provided with a non-detachable power supply cord and having a mass exceeding 3 kg, be not of a lighter grade than ordinary PVC sheathed flexible cord according to IEC 60227-1 (designation 60227 IEC 53); | | N |
| | • for equipment provided with a detachable power supply cord, be not of a lighter grade than light PVC sheathed flexible cord according to IEC 60227-1 (designation 60227 IEC 52); | Complied | P |
| | – include, for equipment required to have protective earthing, a protective earthing conductor having green-and-yellow insulation; and | Complied | P |
| | – have conductors with cross-sectional areas not less than those specified in Table 24. | Complied | P |
| | **Table 24 – Sizes of conductors** | | |
| 13.3.2.5 | Cord anchorages and strain relief | | N |
| | For equipment with a non-detachable power supply cord, a cord anchorage shall be supplied such that: | | N |
| | – the connecting points of the cord conductors are relieved from strain; and | | N |
| | – the outer covering of the cord is protected from abrasion. | | N |
| | It shall not be possible to push the cord back into the equipment to such an extent that the cord or its conductors, or both, could be damaged or internal parts of the equipment could be displaced. | | N |
| | For non-detachable power supply cords containing a protective earthing conductor, the construction shall be such that if the cord should slip in its anchorage, placing a strain on conductors, the protective earthing conductor will be the last to take the strain. | | N |

| Rated current of equipment A | Minimum conductor sizes | | | |
|---|---|---|---|---|
| | Nominal cross-sectional area mm² | | AWG or kcmil [cross-sectional area in mm²] see note 2 | |
| Up to and including 6 | | 0,75 [1] | 18 | [0,8] |
| Over 6 up to and including 10 | (0,75) [2] | 1,00 | 16 | [1,3] |
| Over 10 up to and including 13 | (1,0) [3] | 1,25 | 16 | [1,3] |
| Over 13 up to and including 16 | (1,0) [3] | 1,5 | 14 | [2] |
| Over 16 up to and including 25 | | 2,5 | 12 | [3] |
| Over 25 up to and including 32 | | 4,0 | 10 | [5] |
| Over 32 up to and including 40 | | 6,0 | 8 | [8] |
| Over 40 up to and including 63 | | 10 | 6 | [13] |
| Over 63 up to and including 80 | | 16 | 4 | [21] |
| Over 80 up to and including 100 | | 25 | 2 | [33] |
| Over 100 up to and including 125 | | 35 | 1 | [42] |
| Over 125 up to and including 160 | | 50 | 0 | [53] |
| Over 160 up to and including 190 | | 70 | 000 | [85] |
| Over 190 up to and including 230 | | 95 | 0000 | [107] |
| Over 230 up to and including 260 | | 120 | 250 kcmil | [126] |
| Over 260 up to and including 300 | | 150 | 300 kcmil | [152] |
| Over 300 up to and including 340 | | 185 | 400 kcmil | [202] |
| Over 340 up to and including 400 | | 240 | 500 kcmil | [253] |
| Over 400 up to and including 460 | | 300 | 600 kcmil | [304] |

1) For rated current up to 3 A, a nominal cross-sectional area of 0,5 mm² is permitted in some countries provided the length of cord does not exceed 2 m.

2) The value in parentheses applies to detachable power supply cords fitted with the connectors rated 10 A in accordance with IEC 60320 (types C13, C15, C15A, and C17) provided that the length of the cord does not exceed 2 m.

3) The value in parentheses applies to detachable power supply cords fitted with the connectors rated 16 A in accordance with IEC 60320 (types C19, C21, and C23) provided that the length of the cord does not exceed 2 m.

NOTE 1 IEC 60320 specifies acceptable combinations of appliance couplers and flexible cords, including those covered by items 1), 2), and 3). However, a number of countries have indicated that they do not accept all of the values listed in table 3B, particularly those covered by conditions 1), 2), and 3).

NOTE 2 AWG and kcmil sizes are provided for information only. The associated cross-sectional areas, in square brackets, have been rounded to show significant figures only. AWG refers to the American Wire Gage and the term "cmil" refers to circular mils where one circular mil is equal to the area of a circle having a diameter of one mil (one thousandth of an inch). These terms are commonly used to designate wire sizes in North America.



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The cord anchorage shall either be made of insulating material or have a lining of insulating material complying with the requirements for supplementary insulation. However, where the cord anchorage is a bushing that includes the electrical connection to the screen of a screened power cord, this requirement shall not apply. | | N |
| | The construction of the cord anchorage shall be such that: | | N |
| | – cord replacement does not impair the safety of the equipment; and | | N |
| | – for ordinary replacement cords, it is clear how relief from strain is to be obtained; and | | N |
| | – the cord is not clamped by a screw which bears directly on the cord, unless the cord anchorage, including the screw, is made of insulating material and the screw is of comparable size to the diameter of the cord being clamped; and | | N |
| | – methods such as tying the cord into a knot or tying the cord with a string are not used; and | | N |
| | – the cord cannot rotate in relation to the body of the equipment to such an extent that mechanical strain is imposed on the electrical connections. | | N |
| 13.3.2.6 | Protection against mechanical damage | | P |
| | Power supply cords shall not be exposed to sharp points or cutting edges within or on the surface of the equipment, or at the inlet opening or inlet bushing. | Complied | P |
| | The overall sheath of a non-detachable power supply cord shall continue into the equipment through any inlet bushing or cord guard and shall extend by at least half the cord diameter beyond the clamp of the cord anchorage. | Complied | P |
| | Inlet bushings, where used, shall: | | P |
| | – be reliably fixed; and | Complied | P |
| | – not be removable without the use of a tool. | Complied | P |
| | A metallic inlet bushing shall not be used in a non-metallic enclosure. | Complied | P |
| | An inlet bushing or cord guard secured to a conductive part that is not protectively earthed shall meet the requirements for supplementary insulation. | Complied | P |
| 13.3.3 | Wiring terminals for connection of external conductors | | P |
| 13.3.3.1 | Wiring terminals | | P |
| | Permanently connected equipment and equipment with non-detachable power supply cords shall be provided with terminals in which connection is made by means of screws, nuts or equally effective devices (see also 7.3.6.3.6). | Complied | P |
| 13.3.3.2 | Screw terminals | | P |
| | Screws and nuts which clamp external supply conductors shall have a thread conforming to ISO 261 or ISO 262, or a thread comparable in pitch and mechanical strength (for example, unified threads). The screws and nuts shall not serve to fix any other component, except that they are permitted also to clamp internal conductors provided that the internal conductors are so arranged that they are unlikely to be displaced when fitting the supply conductors. | Complied | P |
| | The terminals of a component (for example, a switch) built into the equipment are permitted for use as terminals for external mains supply conductors, provided that they comply with the requirements of this section. | Complied | P |
| 13.3.3.3 | Wiring terminal sizes | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Terminals shall be provided which accommodate the conductors specified in the installation documentation provided (see 5.3.1) and in the wiring rules applicable at the installation. The terminals shall meet the temperature rise test of 4.3 when connected using wire sizes as specified in the documentation or in Table 24, whichever is smaller. | Complied | P |
| 13.3.3.4 | Wiring terminal design | | P |
| | Wiring terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor. | Complied | P |
| | Terminals shall be so designed or located that the conductor cannot slip out when the clamping screws or nuts are tightened. | Complied | P |
| | Terminals shall be provided with appropriate fixing hardware for the conductors (for example,nuts and washers). | Complied | P |
| | Terminals shall be so fixed that, when the means of clamping the conductor is tightened or loosened: | Complied | P |
| | – the terminal itself does not work loose; and | Complied | P |
| | – internal wiring is not subjected to stress; and | Complied | P |
| | – clearance and creepage distances are not reduced below the values specified in 7.3.7.4 and 7.3.7.5. | Complied | P |
| 13.3.3.5 | Grouping of wiring terminals | | P |
| | Terminals associated with a particular input or output circuit shall be located in proximity to each other. In addition, terminals for connection to the mains supply circuit shall be located in proximity to the protective earthing terminal, if any. | Complied | P |
| 13.3.3.6 | Stranded wire | | P |
| | Terminals shall be designed, located, guarded or insulated so that, should a strand of a stranded conductor escape when the conductor is fitted, there is no likelihood of accidental contact between such a strand and other parts if a shock, energy, or fire hazard could result. | Complied | P |
| 13.3.4 | Supply wiring space | | P |
| | The supply wiring space provided inside, or as part of, the equipment for permanent connection or for connection of a non-detachable power supply cord shall be designed: | Complied | P |
| | – to allow the conductors to be introduced and connected easily; and | Complied | P |
| | – so that the uninsulated end of a conductor is unlikely to become free from its terminal, or, should it do so, cannot come into contact with: | Complied | P |
| | • an accessible conductive part that is not protectively earthed; or | Complied | P |
| | • an accessible conductive part of hand-held equipment; and | Complied | P |
| | – to permit checking before fitting the cover, if any, that the conductors are correctly connected and positioned; and | Complied | P |
| | – so that covers, if any, can be fitted without risk of damage to the supply conductors or their insulation; and | Complied | P |
| | – so that covers, if any, giving access to the terminals can be removed with a commonly available tool. | Complied | P |
| 13.3.5 | Wire bending space for wires 10 mm 2 and greater | | P |
| | The distance between a terminal for connection to external wiring and an obstruction toward which the wire is directed upon leaving the terminal shall be at least that specified in Table 26. | Complied | P |



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| EN 62109-1&-2 | | | |
|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Table 26 – Wire bending space from terminals to obstructions<br>Size of wire mm²: 10 – 16 / 25 / 35 / 50 / 70 / 95 / 120 / 150 / 185 / 240 / 300 / 350 / 400 / 450<br>Minimum bending space, terminal to obstruction mm<br>Wires per terminal 1: 40 / 50 / 65 / 80 / 90 / 105 / 205 / 255 / 305 / 305 / 355 / 355 / 455 / 455<br>Wires per terminal 2: - / - / - / 125 / 150 / 180 / 205 / 230 / 255 / 305 / 305 / 405 / 405 / 485 / 485<br>Wires per terminal 3: - / - / - / 180 / 190 / 205 / 230 / 280 / 330 / 380 / 455 / 510 / 560 / 610 | | |
| 13.3.6 | Disconnection from supply sources | | P |
| | To enable servicing, a disconnect device or devices shall be provided to disconnect the equipment from each source of supply that has a hazardous live voltage or exceeds the values for hazardous energy or from which a hazardous live voltage or energy is derived. As an alternative, the installation instructions shall instruct that a disconnect device for each source of supply be provided as part of the installation, and shall indicate the required type and ratings for the device(s). | Plug | P |
| 13.3.7 | Connectors, plugs and sockets | | P |
| | Connectors, plugs and sockets shall not be employed in a manner likely to create a hazard due to misconnection. | | P |
| | Where connectors are used it shall not be possible to connect them misaligned or with reverse polarity if a hazard would result. | Complied | P |
| | Use of a connector with a standardized purpose in a circuit type other than that for which it is intended (for example use of an a.c. mains socket for d.c. connections) shall not result in a hazard. | Complied | P |
| | If connectors can be separated without the use of a tool, no hazard shall result from or be exposed, during and after separating the connector parts. | Complied | P |
| 13.3.8 | Direct plug-in equipment | | N |
| | Direct plug-in equipment shall not impose undue stress on the socket-outlet. The mains plug part shall comply with the standard for the relevant mains plug. | | N |
| 13.9 | Fault indication**(EN 62109-2)** | | P |
| | Where this Part 2 requires the inverter to indicate a fault, both of the following shall be provided: | Complied | P |
| | a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and | Complied | P |
| | b) an electrical or electronic indication that can be remotely accessed and used. | Complied | P |
| | The installation instructions shall include information regarding how to properly make connections (where applicable) and use the electrical or electronic means in b) above, in accordance with 5.3.2.10. | Complied | P |
| 13.4 | Internal wiring and connections | | P |
| 13.4.1 | General | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The wiring and connections between parts of the equipment and within each part shall be protected from mechanical damage during installation. | Complied | P |
| | The insulation, conductors and routing of all wires of the equipment shall be suitable for the electrical, mechanical, thermal and environmental conditions of use. | Complied | P |
| | Conductors which are able to contact each other or bare live parts shall be provided with insulation rated for the highest possible working voltage present. | Complied | P |
| 13.4.2 | Routing | | P |
| | A hole through which insulated wires pass in a conductive wall within the enclosure of the equipment shall be provided with a smooth, well-rounded bushing or grommet or shall have smooth, well-rounded surfaces upon which the wires bear to reduce the risk of abrasion of the insulation. | Complied | P |
| | Wires shall be routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and similar parts, which could abrade the wire insulation. | Complied | P |
| | The minimum bend radius specified by the wire manufacturer shall not be violated. | Complied | P |
| | Clamps and guides, either metallic or non-metallic, used for routing internal wiring shall be provided with smooth, well-rounded edges. The clamping action and bearing surface shall be such that abrasion or cold flow of the insulation does not occur. If a metal clamp is used for conductors having thermoplastic insulation less than 0,8 mm thick, non-conducting mechanical protection shall be provided. | Complied | P |
| 13.4.3 | Colour coding | | P |
| | Insulated conductors, other than those which are integral to ribbon cable or multi-cord signal cable, identified by the colour green with or without one or more yellow stripes shall not be used other than for protective bonding. | Complied | P |
| 13.4.4 | Splices and connections | | P |
| | All splices and connections shall be mechanically secure and shall provide electrical continuity. | Complied | P |
| | Electrical connections shall be soldered, welded, crimped, or otherwise securely connected. A soldered joint, other than a component on a PWB, shall additionally be mechanically secured. | Complied | P |
| | When stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands of wire do not contact: | | P |
| | • other uninsulated live parts not always of the same potential as the wire; or | Complied | P |
| | • de-energized metal parts. | Complied | P |
| | When screw terminal connections are used, the resulting connections may require routine maintenance (tightening). Appropriate reference shall be made in the maintenance manual (see 5.3.4). | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The end of a stranded conductor shall not be consolidated by soft soldering at places where the conductor is subject to contact pressure unless the method of clamping is designed so as to reduce the likelihood of a bad contact due to cold flow of the solder. Spring terminals that compensate for the cold flow are deemed to satisfy this requirement. Preventing the clamping screws from rotating is not considered to be adequate. | Complied | P |
| 13.4.5 | Interconnections between parts of the PCE | | P |
| | In addition to complying with the requirements given in 13.4.1 to 13.4.4, the means provided for the interconnection between parts of the PCE shall comply with the following requirements: | Complied | P |
| | Cable assemblies and flexible cords provided for interconnection between sections of equipment or between units of a system shall be suitable for the service or use involved.Cables shall be protected from physical damage as they leave the enclosure and shall be provided with mechanical strain relief. | Complied | P |
| | Misalignment of male and female connectors, insertion of a multipin connector in a connector other than the one intended to receive it, reverse polarity connection, and other manipulations of parts which are accessible without the use of a tool shall not result in mechanical damage or a risk of thermal hazards, electric shock, or injury to persons. | Complied | P |
| 13.5 | Openings in enclosures | | P |
| | For equipment intended to be used in more than one orientation, the requirements of this clause apply in each orientation. | Complied | P |
| 13.5.1 | Top and side openings | | P |
| | Openings in the top and sides of enclosures shall be so located or constructed that it is unlikely that objects will enter the openings and create hazards by contacting bare conductive parts. | Complied | P |
| 13.6 | Polymeric materials | | P |
| 13.6.1 | General | | P |
| | Polymeric materials shall comply with 9.1.3 regarding materials selection for fire enclosures and for protection against fire hazard, with the thermal index or capability requirements in 13.6.1.1, and with the applicable requirements in 13.6.2, 13.6.3, and 13.6.4 as follows: | | P |
| | – section 13.6.2 for polymers serving as enclosures or barriers to provide protection against access to hazards (for example protection against direct contact according to 7.3.4.2 or protection against moving parts according to 8.2); | Complied | P |
| | – section 13.6.3 for polymers serving as solid insulation; | Complied | P |
| | – section 13.6.4 for resistance of polymeric parts to UVexposure. | Complied | P |
| | A polymeric material or part that serves more than one of the above functions shall comply with all applicable requirements. | Complied | P |
| 13.6.1.1 | Thermal index or capability | | P |
| | All polymeric materials relied upon for compliance with this standard shall have a thermal index or capability (electrical and mechanical) at least as high as the maximum measured operating temperature of the material in the application, as measured during the temperature test of 4.3. | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | The thermal index or capability shall be in accordance with at least one of the following: thermal index (TI), relative thermal index (RTI), relative thermal endurance index (RTE) or relative thermal capability (RTC) in accordance with at least one of the following standards; IEC 60216-1, IEC 60216-2, IEC 60216-3, IEC 60216-5, IEC 60216-6, ANSI UL746B or UL ANSI UL 746C. | Complied | P |
| 13.6.2 | Polymers serving as enclosures or barriers preventing access to hazards | | P |
| | A polymeric material serving as an enclosure or barrier to prevent access to a hazard shall comply with the following requirements. | Complied | P |
| 13.6.2.1 | Stress relief test | | P |
| | Enclosures of moulded or formed thermoplastic materials shall be so constructed that any shrinkage or distortion of the material due to release of internal stresses caused by the moulding or forming operation does not result in the exposure of hazardous parts or in the reduction of creepage distances or clearances below the minimum required. | Complied | P |
| 13.6.3 | Polymers serving as solid insulation | | P |
| | A polymeric material serving as solid insulation shall comply with the requirements of 7.3.7.8,and the following. | Complied | P |
| 13.6.3.1 | Resistance to arcing | | P |
| | A polymeric material located inside the fire enclosure and closer than 13 mm from unenclosed parts that arc under normal conditions, such as switch contacts, shall have a high-ampere arc ignition (HAI) rating in accordance with ANSI UL 746C. The HAI rating shall be 15 or better for material with a flammability rating of V-0 or better, and the HAI rating shall be 30 or better for material with a flammability rating of V-1 or better. | Complied | P |
| 13.6.4 | UV resistance | | P |
| | Polymeric parts of an outdoor enclosure required for compliance with this standard shall be sufficiently resistant to degradation by ultra-violet (UV) radiation. | Complied | P |
| 13.7 | Mechanical resistance to deflection, impact, or drop | | P |
| 13.7.1 | General | | P |
| | The mechanical deflection, impact, or drop likely to occur in normal use shall not result in a hazard or reduction of protection provided in the PCE. Equipment shall have adequate mechanical strength, components shall be reliably secured, and electrical connections shall be secure. | Complied | P |
| | Compliance is checked by the following tests, as applicable: | | P |
| | – the 250 N deflection test of 13.7.2 - applies to PCE with metal enclosures, except for direct plug-in, handheld, and transportable equipment; | Complied | P |
| | – the 7 J impact test of 13.7.3 - applies to PCE with polymeric enclosures, except for direct plug-in, handheld, and transportable equipment; | | N |
| | – the drop test of 13.7.4 - applies to direct plug-in, handheld, and transportable equipment. | Complied | P |
| | At the conclusion of the applicable test, the PCE shall pass the voltage test of 7.5.2 and shall be inspected to check that: | | P |
| | – live parts have not become accessible; | Complied | P |
| | – enclosures show no cracks or openings which could cause a hazard; | Complied | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | – clearances are not less than their minimum permitted values and other insulation is undamaged; clearances are to be verified using the impulse test of 7.5.1 unless they can be inspected and determined not to have been reduced; | Complied | P |
| | – barriers have not been damaged or loosened; | Complied | P |
| | – no moving parts which could cause a hazard are exposed. | Complied | P |
| 13.7.2 | 250 N deflection test for metal enclosures | | P |
| | The enclosure shall be held firmly against a rigid support and subjected to a steady force of 250 N applied for 5 s through the end of a rod having a 12,7 mm by 12,7 mm square, flat steel face. | Complied | P |
| 13.7.3 | 7J impact test for polymeric enclosures | | N |
| | A sample consisting of the enclosure or a portion thereof representing the largest non-reinforced area shall be supported in its normal position. | | N |
| 13.7.4 | Drop test | | P |
| | The drop test applies to hand-held, direct plug-in, and transportable equipment. | Complied | P |
| 13.8 | Thickness requirements for metal enclosures | | P |
| 13.8.1 | General | | P |
| | Metal enclosures shall have a thickness as specified in 13.8.2 or 13.8.3. This does not apply to enclosures that comply with the applicable tests of 13.7. | | P |
| 13.8.2 | Cast metal | | P |
| | Die-cast metal, except at threaded holes for conduit, where a minimum of 6,4 mm is required,shall be: | | P |
| | – not less than 2,0 mm thick for an area larger than 155 $cm^2$ or having any dimension larger than 150 mm; | Complied | P |
| | – not less than 1,2 mm thick for an area of 155 cm 2 or less and having no dimension larger than 150 mm. | Complied | P |
| | Malleable iron or permanent-mould cast aluminium, brass, bronze, or zinc shall be: | | P |
| | – at least 2,4 mm thick for an area greater than 155cm 2 or having any dimension more than 150 mm; and | Complied | P |
| | – at least 1,5 mm thick for an area of 155 cm 2 or less having no dimension more than150 mm; and | Complied | P |
| | – at least 6,4 mm thick at threaded holes for conduit. | Complied | P |
| | A sand-cast metal enclosure shall be a minimum of 3,0 mm thick except at locations for threaded holes for conduit, where a minimum of 6,4 mm is required. | Complied | P |
| 13.8.3 | Sheet metal | | P |
| | The thickness of a sheet-metal enclosure at points to which a wiring system is to be connected shall be not less than 0,8 mm thick for uncoated steel, 0,9 mm thick for zinc-coated steel, and 1,2 mm thick for non-ferrous metal. | Complied | P |
| **14** | **Components** | | P |
| 14.1 | General | | P |
| | Where safety is involved, components shall be used in accordance with their specified ratings unless a specific exception is made. They shall conform to one of the following: | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | a) applicable safety requirements of a relevant IEC standard. Conformity with other requirements of the component standard is not required. If necessary for the application,components shall be subjected to the tests of this standard, except that it is not necessary to carry out identical or equivalent tests already performed to check conformity with the component standard; | Complied | P |
| | b) the requirements of this standard and, where necessary for the application, any additional applicable safety requirements of the relevant IEC component standard; | Complied | P |
| | c) if there is no relevant IEC standard, the requirements of this standard; | Complied | P |
| | d) applicable safety requirements of a non-IEC standard which are at least as high as those of the applicable IEC standard, provided that the component has been approved to the non-IEC standard by a recognized testing authority. | Complied | P |
| | Components such as optocouplers, capacitors, transformers, and relays connected across basic, supplemental, reinforced, or double insulation shall comply with the requirements applicable for the grade of insulation being bridged, and if not previously certified to the applicable component safety standard shall be subjected to the voltage test of 7.5.2 as a routine test. | Complied | P |
| 14.2 | Motor overtemperature protection | | P |
| | Motors which, when stopped or prevented from starting (see 4.4.4.3), would present an electric shock hazard, a temperature hazard, or a fire hazard, shall be protected by an overtemperature or thermal protection device meeting the requirements of 14.3. | Complied | P |
| 14.3 | Overtemperature protection devices | | P |
| | Overtemperature protection devices are devices operating in single fault condition and shall meet all of the following requirements: | | P |
| | a) be constructed so that reliable function is ensured; | Complied | P |
| | b) be rated to interrupt the maximum voltage and current of the circuit in which they are employed; | Complied | P |
| | c) not operate in normal use. | Complied | P |
| 14.4 | Fuse holders | | P |
| | Fuse holders with fuses intended to be replaceable by an operator shall not permit access to parts that are hazardous live during fuse replacement. | Complied | P |
| 14.5 | Mains voltage selecting devices | | P |
| | Devices shall be constructed so that a change from one voltage or one type of supply to another cannot occur accidentally. The markings of voltage selecting devices are specified in 5.1.4 and 5.1.6. | Complied | P |
| 14.6 | Printed circuit boards | | P |
| | Printed circuit boards shall be made of material with a flammability classification of V-1 or better. | Complied | P |
| 14.7 | Circuits or components used as transient overvoltage limiting devices | | P |
| | If control of transient overvoltage is employed in the equipment, any overvoltage limiting component or circuit shall be tested with the applicable impulse withstand voltage of Table 16 using the test method from 7.5.1 except 10 positive and 10 negative impulses are to be applied and may be spaced up to 1 min apart. | Complied | P |
| 14.8 | Batteries | | P |



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|---|---|---|---|
| **Clause** | **Requirement ~Test** | **Result** | **Verdict** |
| | Equipment containing batteries shall be designed to reduce the risk of fire, explosion and chemical leaks under normal conditions and after a single fault in the equipment including a fault in circuitry within the equipment battery pack. | Complied | P |
| 14.8.1 | Battery enclosure ventilation | Complied | P |
| 14.8.2 | Battery mounting | Complied | P |
| 14.8.3 | Electrolyte spillage | Complied | P |
| 14.8.4 | Battery connections | Complied | P |
| 14.8.5 | Battery maintenance instructions | Complied | P |
| 14.8.6 | Battery accessibility and maintainability | Complied | P |
| **15** | **Software and firmware performing safety functions** | | P |
| | Firmware or software used in or with PCE, that performs one or more safety functions the failure of which could result in a risk of fire, electric shock or other hazard as specified by this standard, shall be evaluated in accordance with Annex B. | Complied | P |
| Annex A | Measurement of clearances and creepage distances | | |
| Annex B | Programmable equipment | | |
| Annex C | Symbols to be used in equipment markings | | |
| Annex D | Test probes for determining access | | |
| Annex E | RCDs | | |
| Annex F | Altitude correction for clearances | | |
| Annex G | Clearance and creepage distance determination for frequencies greater than 30 kHz | | |
| Annex H | Measuring instrument for touch current measurements(see 7.5.4) | | |
| Annex I | Examples of protection, insulation, and overvoltage category requirements for PCE | | |
| Annex J | Ultraviolet light conditioning test | | |



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**Appendix for equipment photo**



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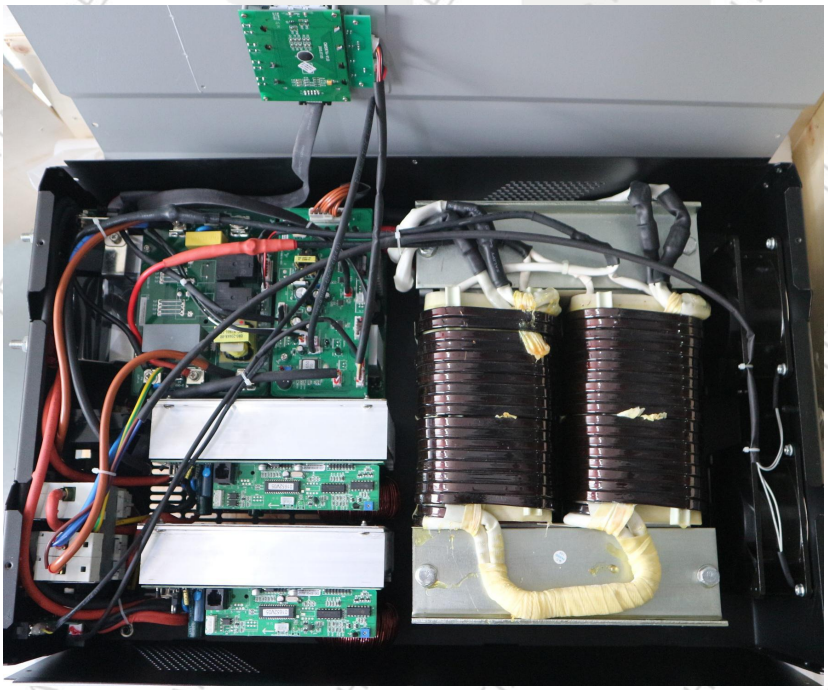



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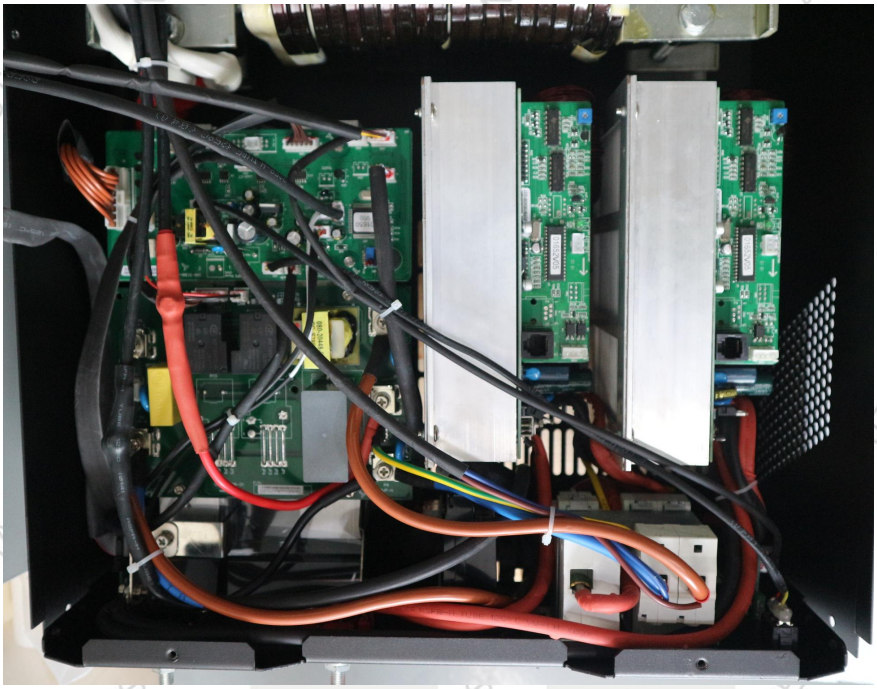

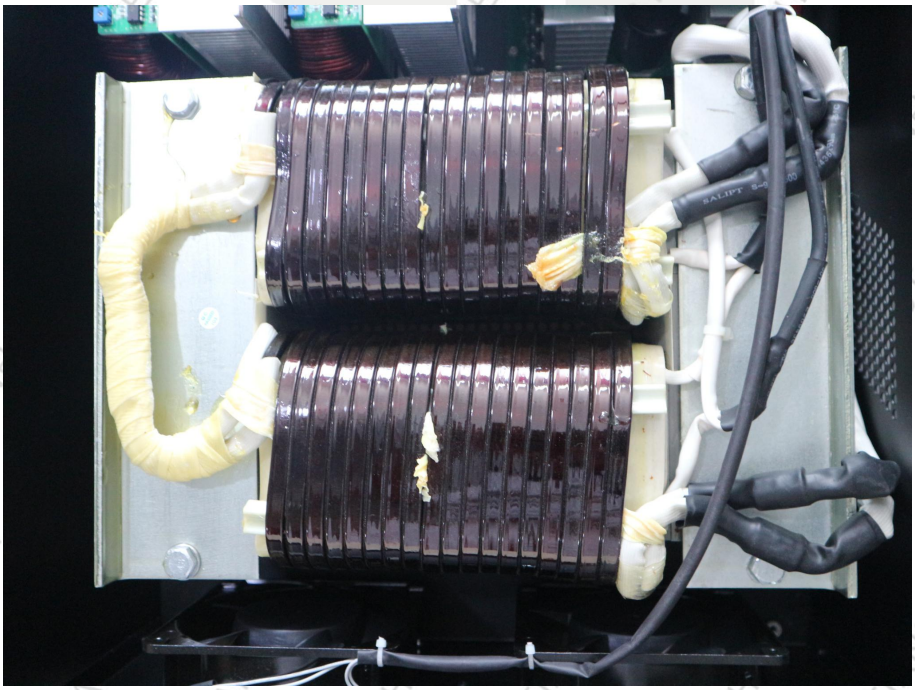



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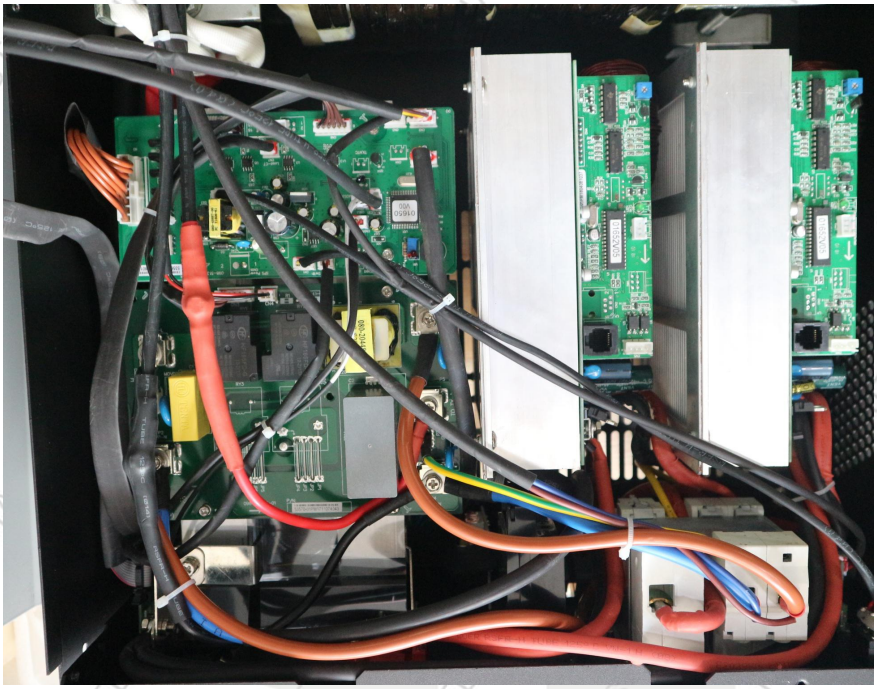

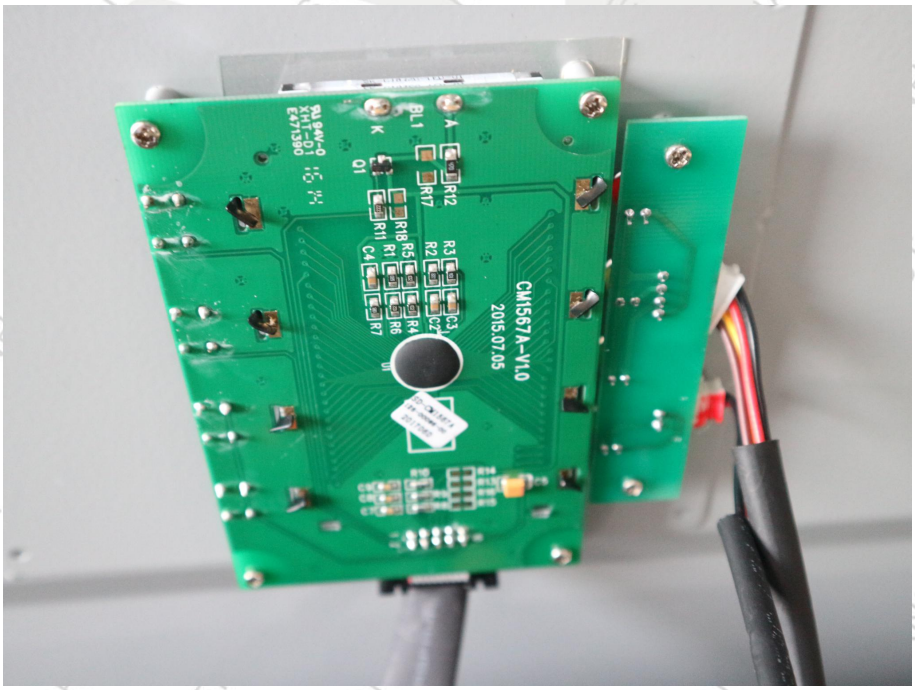


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China National Accreditation Service for Conformity Assessment

# LABORATORY ACCREDITATION CERTIFICATE

**(Registration No. CNAS L5885 )**

## Shenzhen Tianhai Test Technology Co., Ltd.

1/F., East Building, Yalian Haoshida Industrial Zone, No.5022, Wuhe Road, Bantian Street, Longgang District, Shenzhen, Guangdong, China

***is accredited in accordance with ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories(CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence to undertake testing service as described in the schedule attached to this certificate.***

***The scope of accreditation is detailed in the attached schedule bearing the same registration number as above. The schedule form an integral part of this certificate.***

**Date of Issue: 2015-12-14**

**Date of Expiry: 2018-12-13**

**Date of Initial Accreditation: 2012-10-29**

**Signed on behalf of China National Accreditation Service for Conformity Assessment**

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