



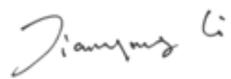
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<p>TEST REPORT IEC 62109-2 Safety of Power Converter for use in Photovoltaic Power Systems Part 2: Particular requirements for inverters</p>	
Report Number.....	50409240013128-00 part 2 of 4
Date of issue.....	2024-12-17
Total number of pages.....	32
Name of testing laboratory preparing the report.....	TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., LTD.
Applicant's name	Pylon Technologies Co., Ltd.
Address.....	No.300, Miaoqiao Road, Kangqiao Town, Pudong New Area, 201315 Shanghai, PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard.....	IEC 62109-2:2011
Test procedure	EESS approval scheme
Non-standard test method.....	N/A
Test Report Form No.	IEC62109_2B
Test Report Form(s) Originator	LCIE - Laboratoire Central des Industries Electriques
Master TRF.....	Dated 2016-11
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Test item description :	Energy Storage System (Force H3X Energy storage system)
Trade Mark :	
Manufacturer	Pylon Technologies Co., Ltd. No.300, Miaoqiao Road, Kangqiao Town, Pudong New Area, 201315 Shanghai, PEOPLE'S REPUBLIC OF CHINA
Model/Type reference :	FH3X-3.6K-HY-1P-5, FH3X-3.6K-HY-1P-10, FH3X-3.6K-HY-1P-15, FH3X-3.6K-HY-1P-20, FH3X-5K-HY-1P-5, FH3X-5K-HY-1P-10, FH3X-5K-HY-1P-15, FH3X-5K-HY-1P-20, FH3X-6K-HY-1P-5, FH3X-6K-HY-1P-10, FH3X-6K-HY-1P-15, FH3X-6K-HY-1P-20, FH3X-8K-HY-1P-5, FH3X-8K-HY-1P-10, FH3X-8K-HY-1P-15, FH3X-8K-HY-1P-20
Ratings :	See IEC 62109-1 test report.

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input checked="" type="checkbox"/>	Name of Testing Laboratory preparing the report:	TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.
	Location/ address	Building A, No.15 Factory, Jintong International Industrial Park, No.8 Xihu Road, Wujin National Hi-tech Industrial Development Zone, Changzhou City, Jiangsu Province, P.R. China
	Tested by (name, function, signature) :	Jianyong Li <i>Project handler</i> 
	Approved by (name, function, signature) .. :	Kai Zhao <i>Designated reviewer</i>

**List of Attachments (including a total number of pages in each attachment):**

See IEC 62109-1 test report.

Summary of testing:

Family design products, all tests were conducted on representative model FH3X-8K-HY-1P-20 except that electrical ratings test was conducted on models FH3X-8K-HY-1P-5, FH3X-8K-HY-1P-10, FH3X-8K-HY-1P-15, FH3X-8K-HY-1P-20, FH3X-3.6K-HY-1P-5, FH3X-3.6K-HY-1P-20. All tests were conducted at test voltage: 1/N/PE~ 230Va.c. and test frequency: 50Hz if not specified.

All the test results are confirmed to the requirements of the standard.

This part 2 test report can only be used together with part 1 test report.

Tests performed (name of test and test clause):

- Fault-tolerance of residual current monitoring – clause 4.4.4.15.1;
- Fault-tolerance of automatic disconnecting means – clause 4.4.4.15.2;
- Cooling system failure – Blanketing test – clause 4.4.4.17;
- Measurement requirements for AC output ports for stand-alone inverters – clause 4.7.3;
- Stand-alone Inverter AC output voltage and frequency – 4.7.4;
- Stand-alone inverter output voltage waveform – clause 4.7.5;
- Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays – clause 4.8.2;
- Array residual current detection – clause 4.8.3;
- Inverter backfeed current onto the array – clause 9.3.4 as combined with clause 4.4 in IEC 62109-1:2010.

Testing location:

TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.

Building A, No.15 Factory, Jintong International Industrial Park, No.8 Xihu Road, Wujin National Hi-tech Industrial Development Zone, Changzhou City, Jiangsu Province, P.R. China

Summary of compliance with National Differences (List of countries addressed):

All tests were carried out according to IEC 62109-2:2011.

- The product fulfils the requirements of IEC 62109-2:2011.**

Copy of marking plate:

Refer to IEC 62109-1 test report.



Test item particulars..... :	
Equipment mobility	<input type="checkbox"/> movable <input type="checkbox"/> hand-held <input type="checkbox"/> stationary <input checked="" type="checkbox"/> fixed <input type="checkbox"/> transportable <input type="checkbox"/> for building-in
Connection to the mains..... :	<input checked="" type="checkbox"/> pluggable equipment <input type="checkbox"/> direct plug-in <input type="checkbox"/> permanent connection <input type="checkbox"/> for building-in
Environmental category	<input checked="" type="checkbox"/> outdoor <input type="checkbox"/> indoor unconditional <input type="checkbox"/> indoor conditional
Over voltage category Mains	<input type="checkbox"/> OVC I <input type="checkbox"/> OVC II <input checked="" type="checkbox"/> OVC III <input type="checkbox"/> OVC IV
Over voltage category PV	<input type="checkbox"/> OVC I <input checked="" type="checkbox"/> OVC II <input type="checkbox"/> OVC III <input type="checkbox"/> OVC IV
Mains supply tolerance (%)	±10 %
Tested for power systems	TN-C-S
IT testing, phase-phase voltage (V)	---
Class of equipment	<input checked="" type="checkbox"/> Class I <input type="checkbox"/> Class II <input type="checkbox"/> Class III <input type="checkbox"/> Not classified
Mass of equipment (kg)	Refer to IEC 62109-1 test report.
Pollution degree	3(external environment), 2(internal environment)
IP protection class.....	IP 55
..... :	
Possible test case verdicts:	
- test case does not apply to the test object..... : N/A	
- test object does meet the requirement..... : P (Pass)	
- test object does not meet the requirement..... : F (Fail)	
Testing..... :	
Date of receipt of test item	2024-10-18
Date (s) of performance of tests	2024-10-18 to 2024-12-04



General remarks:	
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report.	
Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.	
Manufacturer's Declaration per sub-clause 4.2.5 of IEC 62109-1:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies) : Jiangsu Pylon Battery Co., Ltd. No. 7 Keyan 3rd Road, Yizheng Economic Development Zone, 211400 Yangzhou, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA	
General product information: Refer to IEC 62109-1 test report.	

IEC 62109-2

Clause	Requirement + Test	Result - Remark	Verdict
4	GENERAL TESTING REQUIREMENTS		P
4.4.4	Single fault conditions to be applied		P
4.4.4.15	Fault-tolerance of protection for grid-interactive inverters		P
4.4.4.15.1	Fault-tolerance of residual current monitoring according to 4.8.3.5: the residual current monitoring system operates properly	Residual current monitoring is met by provision of RCMU integrated in inverter, the protective system including a self-diagnostic test to check if RCMU is Ok(within the specified accuracy) before the next attempted re-start because it is considered highly unlikely that a fault in the monitoring system would happen on the same day a person coming into contact with normally enclosed hazardous live parts of the PV system. See appended table 4.4.4.15.1	P
	a) .- The inverter ceases to operate		P
	- Indicates a fault in accordance with §13.9		P
	- Disconnect from the mains		P
	- not re-connect after any sequence of removing and reconnecting PV power		P
	- not re-connect after any sequence of removing and reconnecting AC power		P
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		P
	b) .- The inverter continues to operate		N/A
	- the residual current monitoring system operates properly under single fault condition		N/A
	- Indicates a fault in accordance with §13.9		N/A
	c) The inverter continues to operate regardless of loss of residual current monitoring functionality		P
	- not re-connect after any sequence of removing and reconnecting PV power		P
	- not re-connect after any sequence of removing and reconnecting AC power		P
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		P
	- Indicates a fault in accordance with §13.9		P
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		P
4.4.4.15.	The means provided for automatic		P

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Clause	Requirement + Test	Result - Remark	Verdict
2.1	disconnection of a grid-interactive inverter from the mains shall:		
	- disconnect all grounded current-carrying conductors from the mains		P
	- disconnect all ungrounded current-carrying conductors from the mains	Approved series relays used for all active conductors.	P
	- 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.	See appended table 4.4.4.15.2 Fault-tolerance of automatic disconnecting	P
4.4.4.15.2.2	Design of insulation or separation complies with requirements of 7.3.7 of Part 1: report here Part 1 comment and verdict.		P
4.4.4.15.2.3	For non-isolated inverter, automatic checking of the isolation provided by a disconnect means after single fault.	See appended test table 4.4.4.15.2 Fault-tolerance of automatic disconnecting.	P
	If the check fail:		P
	- any still-functional disconnection means shall be left in the open position		P
	- at least basic or simple separation shall be maintained between the PV input and the mains		P
	- the inverter shall not start operation		P
	- the inverter shall indicate a fault in accordance with 13.9		P
4.4.4.16	A stand-alone inverter with a transfer switch to transfer AC loads from the mains or other AC bypass source to the inverter output:		P
	- shall continue to operate normally		P
	- shall not present a risk of fire as the result of an out-of-phase transfer		P
	- shall not present a risk of shock as the result of an out-of-phase transfer		P
	- And having control preventing switching: components for malfunctioning		P
4.4.4.17	Cooling system failure – Blanketing test No hazards according to the criteria of sub-clause 4.4.3 of Part 1 shall result from blanketing the inverter This test is not required for inverters restricted to use only in closed electrical operating areas.	See appended test table Cooling system failure – Blanketing test	P
	Test stop condition: time duration value or stabilized temperature	Stabilize without external surface of the inverter exceed 90 °C	P
4.7	ELECTRICAL RATINGS TESTS		P
4.7.4	Stand-alone Inverter AC output voltage and frequency		P

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Clause	Requirement + Test	Result - Remark	Verdict
4.7.4.1	General	See appended test table 4.7.4	P
4.7.4.2	Steady state output voltage at nominal DC input 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.		P
4.7.4.3	Steady state output voltage across the DC input range 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.		P
4.7.4.4	Load step response of the output voltage at nominal DC input 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.		P
4.7.4.5	Steady state output frequency The steady-state AC output frequency shall not vary from the nominal value by more than +4 % or -6 %.		P
4.7.5	Stand-alone inverter output voltage waveform		P
4.7.5.1	General	See appended test table 4.7.5	P
4.7.5.2	The AC output voltage 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 %.		P
4.7.5.3	Non-sinusoidal output waveform requirements	Sinusoidal output waveform	N/A
4.7.5.3.1	General		N/A
4.7.5.3.2	The total harmonic distortion (THD) of the voltage waveform shall not exceed 40 %.		N/A
4.7.5.3.3	The slope of the rising and falling edges of the positive and negative half-cycles of the voltage waveform shall not exceed 10 V/ μ s measured between the points at which the waveform has a voltage of 10 % and 90 % of the peak voltage for that half-cycle.		N/A
4.7.5.3.4	The absolute value of the peak voltage of the positive and negative half-cycles of the waveform shall not exceed 1,414 times 110 % of the RMS value of the rated nominal AC output voltage.		N/A
4.7.5.4	Information requirements for non-sinusoidal waveforms The instructions provided with a stand-alone inverter not complying with 4.7.5.2 shall include the information in 5.3.2.6.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
4.7.5.5	Output voltage waveform requirements for inverters for dedicated loads. 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/A
	The combination of the inverter and dedicated load shall be evaluated to ensure that the output waveform does not cause any hazards in the load equipment and inverter, or cause the load equipment to fail to comply with the applicable product safety standards.		N/A
	The inverter shall be marked with symbols 9 and 15 of Table C.1 of Part 1.		N/A
	The installation instructions provided with the inverter shall include the information in 5.3.2.13.		N/A
4.8	ADDITIONAL TESTS FOR GRID-INTERACTIVE INVERTERS		P
4.8.1	General requirements regarding inverter isolation and array grounding	Inverter isolation: transformer-less solar inverter, without galvanic isolation from the MAINS and PV array. PV Array grounding: Ungrounded with warning substance in manufacturer's manual. Array ground insulation resistance measurement: Before starting operation, per 4.8.2.1 for ungrounded arrays; Action on fault: signal the fault and do not connect to the MAINS; Array residual current detection: monitoring for both continuous excessive residual current per 4.8.3.5.2 and excessive sudden changes per 4.8.3.5.3 by RCMU integrated in inverter; Action on fault: shut down the inverter, disconnect from the MAINS, indicate the fault	P
	- Type of Array grounding supported	Ungrounded array	P
	- Inverter isolation	Inverter does not have internal isolated transformer between the mains and PV circuit.	P
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays	(See attached table)	P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays	Minimum Insulation Resistance before connection to the MAINS: 600V/30mA=20kΩ For safety and accuracy consideration, factory setting for array insulation resistance detection: @200kohms;	P

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Clause	Requirement + Test	Result - Remark	Verdict
	Inverter shall have means to measure DC insulation resistance from PV input (array) to ground before starting operation		P
	Or Inverter shall be provided with instruction in accordance with 5.3.2.11.	The expected insulation resistance of the array to ground shall be calculated based on an array insulation resistance of 40 MΩ per m ² either known according to 61730, calculate the practice PV system resistance with the surface area of the parallel and series panels and the set value maybe adjusted with agreement of authority agency.	P
	Measured DC insulation resistance:	200kΩ x 0.9=180kΩ 200kΩ x 1.1=220kΩ	P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value $R = V_{max}/30mA$ under normal conditions		P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value $R = V_{max}/30mA$ with ground fault in the PV array		P
	Isolated inverters shall indicate a fault if the insulation resistance is less than the limit value		N/A
	Isolated inverter fault indication maintained until insulation resistance has recovered to a value higher than the limit value		N/A
	Non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30:		P
	- shall indicate a fault in accordance with 13.9		P
	- shall not connect to the mains		P
4.8.2.2	Array insulation resistance detection for inverters for functionally grounded arrays	Not for functionally grounded arrays	N/A
	a-1) 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.		N/A
	a-2) The installation instructions shall include the information required in 5.3.2.12.		N/A
	b-1) 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,		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	exceeds the residual current values and times in Table 31		
	b-2) Inverter shall either disconnect the resistor or limit the current by other means		N/A
	b-3) If the inverter is a non-isolated inverter, or has isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, it shall also disconnect from the mains.		N/A
	c) The inverter shall have means to measure the DC insulation resistance from the PV input to ground before starting operation, in accordance with 4.8.2.1.		N/A
4.8.3	Array residual current detection		P
4.8.3.1	General		P
4.8.3.2	30 mA touch current type test for isolated inverters	Not isolated inverters	N/A
4.8.3.3	Fire hazard residual current type test for isolated inverters	Not isolated inverters	N/A
4.8.3.4	Protection by application of RCD's		N/A
	- 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.	RCMU used for monitoring the residual current, additional RCD may be required in end-use application between inverter and grid for safety consideration if required by local code	N/A
	- The selection of the RCD type to ensure compatibility with the inverter must be made according to rules for RCD selection in Part 1.		N/A
	- The RCD provided integral to the inverter, or		N/A
	- The RDC 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/A
4.8.3.5	Protection by residual current monitoring		P
4.8.3.5.1	General		P
	Where required by Table 30, the inverter shall provide residual current monitoring that functions whenever the inverter is connected to the mains with the automatic disconnection means closed.		P
	The residual current monitoring means shall measure the total (both a.c. and d.c. components) RMS current.		P
	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		P

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Clause	Requirement + Test	Result - Remark	Verdict
	limits:		
	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:		P
	- maximum 300 mA for inverters with continuous output power rating ≤ 30 kVA;	80mA@160ms	P
	- maximum 10 mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA.		N/A
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		P
	b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31		P
	The inverter indicates a fault in accordance with 13.9, if a sudden increase in the RMS residual current is detected exceeding the value in the table.		P
	- 30mA@0,3s	25mA@100ms	P
	- 60mA@0,15s	55mA@80ms	P
	- 150mA@0,04s	110mA@20ms	P
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		P
4.8.3.5.2	Test for detection of excessive continuous residual current: test repeated 5 times and time to disconnect shall not exceed 0,3 s.	See appended test table 4.8.3.5.2 Test for detection of excessive continuous residual current	P
4.8.3.5.3	Test for detection of sudden changes in residual current repeated 5 times and each of the 5 results shall not exceed the time limit indicated in for each row (30mA, 60mA and 150mA) of Table 31.	See appended test table 4.8.3.5.3 Test for detection of sudden changes in residual current	P
4.8.3.6	Systems located in closed electrical operating areas	Outdoor use not limited to be located in closed electrical operating areas.	N/A
	The protection against shock hazard is not required if the installation information provided with the inverter indicates the restriction for use in a closed electrical operating area, and		N/A
	Installation information indicates what forms of shock hazard protection are and are not provided integral to the inverter, in accordance with 5.3.2.7.		N/A
	The inverter shall be marked as in 5.2.2.6.		N/A
5	MARKING AND DOCUMENTATION		P
5.1	Marking		P
5.1.4	Equipment ratings		P
	PV input ratings:	See rating labels	P
	- V_{max} PV (absolute maximum) (d.c. V)		P

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Clause	Requirement + Test	Result - Remark	Verdict
	- Isc PV (absolute maximum) (d.c. A)		P
	a.c. output ratings:	See rating labels	P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	a.c input ratings:	See rating labels	P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	d.c. output ratings:		N/A
	- Voltage (nominal or range) (d.c. V)		N/A
	- Current (maximum continuous) (d.c. A)		N/A
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP 55	P
	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.		P
5.2	Warning markings		N/A
5.2.2	Content for warning markings		N/A
5.2.2.6	Inverters for closed electrical operating areas		N/A
	Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be marked with a warning that the inverter is only for use in a closed electrical operating area, and referring to the installation instructions.		N/A
5.3	Documentation		P
5.3.2	Information related to installation		P
5.3.2.1	Ratings. Subclause 5.3.2 of Part 1 requires the documentation to include ratings information for each input and output. For inverters this information shall be as in Table 33 below. Only those ratings that are applicable based on the type of inverter are required.		P
	PV input quantities:	See user manual	P
	- Vmax PV (absolute maximum) (d.c. V)		P
	- PV input operating voltage range (d.c. V)		P
	- Maximum operating PV input current (d.c. A)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	- Max. inverter backfeed current to the array (a.c. or d.c. A)	Maximum inverter backfeed current from grid to the array is 0A based on test/circuit topology analysis.	P
	a.c. output quantities:	See user manual	P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P



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Clause	Requirement + Test	Result - Remark	Verdict
	- Current (inrush) (a.c. A, peak and duration)	Max. 46.0A peak @278.0us	P
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	- Maximum output fault current (a.c. A, peak and duration or RMS)	The PCE max. output short-circuit current is 94.0A peak impulse (42.7ms duration)	P
	- Maximum output overcurrent protection (a.c. A)		P
	a.c. input quantities:	See user manual	P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Current (inrush) (a.c. A, peak and duration)		P
	- Frequency (nominal or range) (Hz)		P
	d.c input (other than PV) quantities:		N/A
	- Voltage (nominal or range) (d.c. V)		N/A
	- Nominal battery voltage (d.c. V)		N/A
	- Current (maximum continuous) (d.c. A)		N/A
	d.c. output quantities:		N/A
	- Voltage (nominal or range) (d.c. V)		N/A
	- Nominal battery voltage (d.c. V)		N/A
	- Current (maximum continuous) (d.c. A)		N/A
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP 55	P
5.3.2.2	Grid-interactive inverter setpoints		N/A
	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. Provided solution:		N/A
	The setting of field adjustable setpoints shall be accessible from the PCE		N/A
5.3.2.3	Transformers and isolation	No internal isolation transformer between PV and mains	N/A
	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, etc.		N/A
	An inverter shall be provided with information to the installer regarding:		N/A
	- providing of internal isolation		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	transformer		
	- the level of insulation (functional, basic, reinforced, or double)		N/A
	The instructions shall also indicate what the resulting installation requirements are regarding:		P
	- earthing or not earthing the array	Unearthed array	P
	- providing external residual current detection devices	Pls. follow national regulations	P
	- requiring an external isolation transformer,		N/A
5.3.2.4	Transformers required but not provided	Not required	N/A
	An inverter that requires an external isolation transformer not provided with the unit, shall be provided with instructions that specify, and for the external isolation transformer with which it is intended to be used:		N/A
	- the configuration type		N/A
	- electrical ratings		N/A
	- environmental ratings		N/A
5.3.2.5	PV modules for non-isolated inverters		P
	Non-isolated inverters shall be provided with installation instructions that require PV modules that have an IEC 61730 Class A rating	IEC 61730 Class A rating required	P
	If the maximum AC mains operating voltage is higher than the PV array maximum system voltage then the instructions shall require PV modules that have a maximum system voltage rating based upon the AC mains voltage.		P
5.3.2.6	Non-sinusoidal output waveform information		N/A
	The instruction manual for a stand-alone inverter not complying with 4.7.5.2 shall include a warning that:		N/A
	- the waveform is not sinusoidal,		N/A
	- some loads may experience increased heating,		N/A
	- the user should consult the manufacturers of the intended load equipment before operating that load with the inverter		N/A
	The inverter manufacturer shall provide information regarding:		N/A
	- what types of loads may experience increased heating		N/A
	- recommendations for maximum operating times with such loads		N/A
	The inverter manufacturer shall specify for the waveforms as determined by the testing in 4.7.5.3.2 through 4.7.5.3.4.:		N/A
	- THD		N/A
	- slope		N/A
	- peak voltage		N/A
5.3.2.7	Systems located in closed electrical operating areas		N/A
	Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be provided with installation instructions:		N/A
	- requiring that the inverter and the array		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	must be installed in closed electrical operating areas		
	- 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)		N/A
5.3.2.8	Stand-alone inverter output circuit bonding	Refer to user manual	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;	Refer to user manual	P
	- if the output circuit is intended to be floating, the documentation for the inverter shall indicate that the output is floating.		N/A
5.3.2.9	Protection by application of RCD's		N/A
	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.	RCMU integrated in inverter used for monitoring the residual current	N/A
	and shall specify its rating, type, and required circuit location		N/A
5.3.2.10	Remote indication of faults		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.	Refer to user manual	P
5.3.2.11	External array insulation resistance measurement and response	IRM function integrated in inverter	N/A
	The installation instructions for an inverter for use with ungrounded arrays that does not incorporate all the aspects of the insulation resistance measurement and response requirements in 4.8.2.1, must include:		N/A
	- for isolated inverters: an explanation of what aspects of array insulation resistance measurement and response are not provided, and		N/A
	- an instruction to consult local regulations to determine if any additional functions are required or not;		N/A
	- for non-isolated inverters: an explanation of what external equipment must be provided in the system, and		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	- what the setpoints and response implemented by that equipment must be, and:		N/A
	- how that equipment is to be interfaced with the rest of the system.		N/A
5.3.2.12	Array functional grounding information	Not functional ground array used	N/A
	Where approach a) of 4.8.2.2 is used, the installation instructions for the inverter shall include all of the following:		N/A
	a) the value of the total resistance between the PV circuit and ground integral to the inverter		N/A
	b) the minimum array insulation resistance to ground that system designer or installer must meet when selecting the PV panel and system design, based on the minimum value that the design of the PV functional grounding in the inverter was based on		N/A
	c) the minimum value of the total resistance $R = V_{MAX} PV/30 \text{ mA}$ that the system must meet, with an explanation of how to calculate the total		N/A
	d) a warning that there is a risk of shock hazard if the total minimum resistance requirement is not met.		N/A
5.3.2.13	Stand-alone inverters for dedicated loads		N/A
	Where the approach of 4.7.5.5 is used, the installation instructions for the inverter shall include a warning that the inverter is only to be used with the dedicated load for which it was evaluated, and		N/A
	shall specify the dedicated load.		N/A
5.3.2.14	Identification of firmware version(s)		P
	An inverter utilizing firmware for any protective functions shall provide means to identify the firmware version.	Firmware/software: BMS: V1.0; Inverter V1.0	P
	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.....	The firmware version can be identified communication APP.	P

7	PROTECTION AGAINST ELECTRIC SHOCK AND ENERGY HAZARDS		P
7.3	Protection against electric shock		P
7.3.10	Additional requirements for stand-alone inverters		P
	One circuit conductor bonded to earth to create a grounded conductor and an earthed system.		P
	The means used to bond the grounded conductor to protective earth provided within the inverter or	Neutral continuity id maintained external to the inverter.	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	as part of the installation	See installation manual	P
	If not provided integral to the inverter, the required means shall be described in the installation instructions as per 5.3.2.8.		P
	The means used to bond the grounded conductor to protective earth shall comply with the requirements for protective bonding in Part 1,		P
	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.		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.		P
	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		N/A
	Inverters intended to have a circuit conductor bonded to earth shall not impose any normal current on the bond except for leakage current.		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.		N/A
	The documentation for the inverter shall indicate that the output is floating as per 5.3.2.8.		N/A
7.3.11	Functionally grounded arrays		N/A
	All PV conductors in a functionally grounded array shall be treated as being live parts with respect to protection against electric shock.		N/A

9	PROTECTION AGAINST FIRE HAZARDS		P
9.3	Short-circuit and overcurrent protection		P
9.3.4	Inverter backfeed current onto the array		P
	The backfeed current testing and documentation requirements in Part 1 apply, including but not limited to the following.		P
	Inverter backfeed current onto the PV array maximum value.....	Maximum inverter backfeed current from grid to the array is 0A based on test/circuit topology analysis.	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.	Refer to user manual	P



IEC 62109-2			
Clause	Requirement + Test	Result - Remark	Verdict
13	PHYSICAL REQUIREMENTS		P
13.9	Fault indication		P
	Where this Part 2 requires the inverter to indicate a fault, both of the following shall be provided:		P
	a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and	Visible indication	P
	b) an electrical or electronic indication that can be remotely accessed and used.	RS485 port as communication method for remote accessed and used.	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.		P



4.4.4		TABLE: Single fault condition to be applied				P
		Ambient temperature (°C): N/A (at the prevailing ambient temperature)				—
4.4.4.15.1 Fault-tolerance of residual current monitoring						
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
RCMU monitoring circuit R1329	Open-circuit Before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 3, Residual current device fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
RCMU monitoring circuit R1334	Open-circuit Before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 3, Residual current device fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
RCMU monitoring circuit Q1301 B to C	Short-circuit before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 3, Residual current device fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
RCMU monitoring circuit R1337	Open-circuit Before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 3, Residual current device fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Master DSP U201	+3,3V power decrease continuously	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. DSP protection worked for low voltage. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Master DSP U201	+3,3V power rise continuously	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. DSP protection worked for high voltage and broken at last. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input type="checkbox"/> Yes / <input checked="" type="checkbox"/> No, NCD: <input type="checkbox"/> Yes / <input checked="" type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No



Master DSP U201	Oscillator disabled	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Slave DSP U401	+3,3V power decrease continuously	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. DSP protection worked for low voltage. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input type="checkbox"/> Yes / <input checked="" type="checkbox"/> No, NCD: <input type="checkbox"/> Yes / <input checked="" type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Slave DSP U401	+3,3V power rise continuously	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. DSP protection worked for high voltage and broken at last. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Communication between CPUs	Open-circuit	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter shut down immediately. Error code: 14, Internal communication fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Check that the residual current monitoring operates properly						Inverter ceases to operate, indicates a fault in accordance with 13.9, disconnects from the mains, and does not reconnect after any sequence of removing and reconnecting PV power, AC power, or both.
FID	Fault Indication			DST	Dielectric strength test	
SD	PCE Shut Down			RO	Recovered to Operate after removing the single fault setting	
NCD	No comp. or parts damaged			NH	No hazards occurred	
MT	Max. Temperature			OC	Open-circuit	
SC	Short-circuit			-	-	
Supplementary information: Also see IEC 62109-1 test report.						

4.4.4	TABLE: Single fault condition to be applied	P
	Ambient temperature (°C) : N/A (at the prevailing ambient temperature)	—
4.4.4.15.2	Fault-tolerance of automatic disconnecting means	



Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
Grid output relay RY1302 contactors	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay RY1304 contactors	Open-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay RY1305 contactors	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay RY1306 contactors	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay RY1301 contactors	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay RY1303 contactors	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, Q1307 pin C	Short-circuit, before inverter	MAINS: 230 PV: 550 Battery:	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault.



to E	start-up	409.6				SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, R1367	Open-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, R202	Open-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, Q201 pin C to E	Short-circuit before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, Q1304 pin C to E	Short-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Grid output relay driver, R1349	Open-circuit, before inverter start-up	MAINS: 230 PV: 550 Battery: 409.6	10min	-	-	FID: The inverter cannot start. Error code: 4 Rly-Check Fault Grid Relay Fault. SD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, RO: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NCD: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, NH: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No, DST: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No
Check that the relays fulfil the basic insulation or simple separation based on the PV circuit working voltage.						The remaining relays gaps in series provided basic clearance: 2 x 1.8 mm (each two relays of RY1305, RY1302, RY1301 on L conductor; and each two relays of RY1303, RY1304, RY1306 on neutral conductor)
Each active phase can be switched. (all live conductors and						Yes



neutral conductor)			
FID	Fault Indication	DST	Dielectric strength test
SD	PCE Shut Down	RO	Recovered to Operate after removing the single fault setting
NCD	No comp. or parts damaged	NH	No hazards occurred
MT	Max. Temperature	OC	Open-circuit
SC	Short-circuit	-	-
Supplementary information: Also see IEC 62109-1 test report.			

4.4.4.17	TABLE: heating temperature rise measurements for cooling system failure (blanketing)			P
Model:	FH3X-8K-HY-1P-20			
	test voltage (V)	See Note 1	-	—
	t1 (°C)	55.0	-	—
	t2 (°C)	60.4	-	—
Max. temperature T of part/at:		T (°C)		permitted T (°C)
Heatsink		77.8	-	90
LED cover		67.6	-	90
PV connector		71.5	-	90
GRID connector		71.4	-	90
Backup connector		70.7	-	90
PV switch		74.4	-	90
BAT circuit breaker		74.0	-	90
Grid power wire		75.3	-	90
Backup power wire		75.8	-	90
BAT power wire		75.3	-	90
Metal enclosure		73.7	-	90
Battery pack electrode welding bracket		66.4	-	90
Bracket cover		64.2	-	90
Ambient		60.4	-	Ref.
Supplementary information: 1) Blanketing condition: Grid to charge Battery and backup: AC 230V/12kW from AC Grid input, DC 409.6/6kW for Battery in charge and AC 230V/6kW for Backup output. / 55.1°C (power derating to thermal steady). The duration of the test is less than 7 h for the temperatures stabilize and no external surface of the inverter is at a temperature exceeding 90 °C, no hazard observed. No over temperature observed in components, no hazard observed.				

4.7.3	TABLE: mains supply electrical data in normal condition	P
Ref to clause 4.2.2.6 and table 4.7 of report IEC 62109-1 test report.		

4.7.4	TABLE: Steady state Inverter AC output voltage and frequency				P
Type of DC input voltage	U (V) DC	AC output U (V)	Frequency (Hz)	Condition/status	
Steady state output voltage at nominal DC input					
Rated input	360.19	233.57	50.00	Without load	
Rated input	359.85	220.56	49.99	Resistive load application	



Rated input	359.99	233.56	49.99	Resistive load removal
Steady state output voltage across the DC input range				
Min. input	189.76	233.56	49.99	Without load
Min. input	190.26	220.56	49.99	Resistive load application
Min. input	190.00	233.56	50.00	Resistive load removal
Max. input	518.84	234.00	50.00	Without load
Max. input	518.46	220.00	50.00	Resistive load application
Max. input	516.36	234.00	49.99	Resistive load removal
Battery	426.12	233.54	50.00	Without load
Battery	421.91	220.57	50.00	Resistive load application
Battery	425.34	233.54	50.00	Resistive load removal
3) Load step response of the output voltage at nominal DC input				
Rated input	360.21	226.50	50.00	0—full load
Rated input	360.26	227.37	49.99	Full load--0
Supplementary information: Note 1: 4.7.4.2 & 4.7.4.4, with nominal DC input voltage, the measure AC output voltage should be $90\%AC_{normal} \leq AC_{Measure} \leq 110\% AC_{normal}$. And the measure time is at the time $t=1.5s$ after the load step change. Note 2: 4.7.4.3, with minimum & maximum value within the rated range of DC input voltage, the measure AC output voltage should be $85\%AC_{normal} \leq AC_{Measure} \leq 110\% AC_{normal}$ at each load step change. Note 3: 4.7.4.5, with minimum & maximum value within the rated range of DC input voltage, the measure AC output voltage should be $-6\%HZ_{normal} \leq HZ_{Measure} \leq +4\%HZ_{normal}$ at each load step change. Note 4: The manufacturer declares that the inverter does not support PV to EPS mode.				

4.7.5.2		TABLE: Voltage harmonics (u)			P
Harmon. Nr.(U)	P/Prated			Limit	
	5%	50%	100%		
	U (%)	U (%)	U (%)		
2	0.008	0.008	0.023	6%	
3	2.017	2.001	2.005	6%	
4	0.008	0.009	0.008	6%	
5	1.460	1.456	1.499	6%	
6	0.005	0.005	0.006	6%	



7	2.018	2.067	2.063	6%
8	0.004	0.004	0.004	6%
9	0.024	0.021	0.037	6%
10	0.003	0.004	0.004	6%
11	0.037	0.031	0.032	6%
12	0.003	0.003	0.004	6%
13	0.023	0.024	0.024	6%
14	0.002	0.002	0.002	6%
15	0.029	0.013	0.020	6%
16	0.002	0.002	0.002	6%
17	0.012	0.012	0.016	6%
18	0.001	0.001	0.001	6%
19	0.013	0.011	0.015	6%
20	0.001	0.001	0.001	6%
21	0.004	0.003	0.012	6%
22	0.001	0.001	0.001	6%
23	0.369	0.331	0.334	6%
24	0.001	0.001	0.001	6%
25	0.005	0.005	0.010	6%
26	0.001	0.001	0.001	6%
27	0.011	0.005	0.010	6%
28	0.001	0.001	0.001	6%
29	0.005	0.005	0.006	6%
30	0.001	0.001	0.001	6%
31	0.150	0.134	0.129	6%
32	0.001	0.001	0.001	6%
33	0.004	0.004	0.005	6%
34	0.001	0.001	0.001	6%
35	0.004	0.002	0.003	6%
36	0.001	0.001	0.001	6%
37	0.001	0.001	0.002	6%
38	0.001	0.000	0.001	6%
39	0.002	0.001	0.001	6%
40	0.001	0.000	0.001	6%
THD (2-40)	3.230	3.244	3.264	10%



Supplementary information:-

4.8.2	TABLE: Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays				P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays				P
DC Voltage below minimum operating voltage (V)	DC Voltage for inverter begin operation (V)	Resistance between ground and PV input terminal (kΩ)	Required Insulation resistance $R = (V_{MAX} PV / 30mA)$ (kΩ)	Result	
Model: FH3X-8K-HY-1P-20					
ISO setting=200kΩ					
PV1+(MPP tracker 1)					
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
PV2+ (MPP tracker 2)					
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
80	125	220	20	Normal Operation	
PV1/2-					
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	
80	125	180	20	Insulation fault	



80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
PV3+ (MPP tracker 3)				
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
PV3-				
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	180	20	Insulation fault
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation
80	125	220	20	Normal Operation

Note:

For isolated inverters, shall indicate a fault in accordance with 13.9 (operation is allowed); the fault indication shall be maintained until the array insulation resistance has recovered to a value higher than the limit above.

For non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, shall indicate a fault in accordance with 13.9, and shall not connect to the mains; the inverter may continue to make the measurement, may stop indicating a fault and may connect to the mains if the array insulation resistance has recovered to a value higher than the limit above.

It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel.

Supplementary information:

Additional test with first one pole ground fault, following an insulation resistance below limit simulated, then allow the inverter to start, the inverter shall not connect to the mains. Also tested with blind spot of PV+ and PV- with low insulation resistance together.



4.8.3.5	TABLE: Protection by residual current monitoring			P
Test conditions:	Model: FH3X-8K-HY-1P-20 Output power (kVA): 8.0 Input voltage (VDC): 520 Frequency (Hz): 50 Output AC Voltage (VAC): 230V			
4.8.3.5.2	Test for detection of excessive continuous residual current			P
Fault Current (mA)		Disconnection time (ms)		
Measured Fault Current	Limit 300mA for output power ≤ 30 kVA 10mA per kVA for output power > 30 kVA	Measured Disconnection time	Limit	
Default: 80mA@160ms				
PV1+ to N:				
82.7	300	180.0	300	
83.5	300	175.5	300	
83.3	300	172.5	300	
84.5	300	180.5	300	
83.3	300	170.0	300	
PV2+ to N:				
82.6	300	162.5	300	
82.0	300	170.5	300	
83.2	300	165.0	300	
82.6	300	153.0	300	
82.3	300	161.5	300	
PV1/2- to N:				
82.1	300	165.5	300	
82.2	300	169.5	300	
82.3	300	156.5	300	
82.1	300	164.0	300	
82.2	300	167.5	300	
PV3+ to N:				
82.9	300	212.5	300	
82.7	300	159.0	300	
82.2	300	168.0	300	
82.9	300	172.5	300	
82.7	300	163.5	300	
PV3- to N:				
82.6	300	160.5	300	
82.4	300	165.0	300	
82.3	300	166.5	300	
82.0	300	169.5	300	
82.5	300	175.0	300	
Note:				
1. – maximum 300mA for inverters with continuous output power rating ≤30 kVA;				



– maximum 10mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA.

2. This test shall be repeated 5 times, and for all 5 tests the time to disconnect shall not exceed 0,3s.

3. The test is repeated for each PV input terminal. It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel.

4.8.3.5.3	TABLE: Test for detection of sudden changes in residual current	P
PV1+ to N:		
Limit (mA)	UN	Limit (ms)
	Disconnection time (ms)	
Setting: 25mA@100ms		
30	119.5	300
30	131.0	300
30	128.0	300
30	126.5	300
30	119.5	300
Setting: 55mA@80ms		
60	120.5	150
60	117.0	150
60	126.0	150
60	110.0	150
60	118.5	150
Setting: 110mA@20ms		
150	29.5	40
150	33.5	40
150	38.0	40
150	25.5	40
150	24.5	40
PV2+ to N:		
Limit (mA)	UN	Limit (ms)
	Disconnection time (ms)	
Setting: 25mA@100ms		
30	111.5	300
30	119.5	300
30	121.5	300
30	121.5	300
30	114.5	300
Setting: 55mA@80ms		
60	105.5	150
60	103.0	150
60	105.5	150
60	103.0	150
60	102.5	150
Setting: 110mA@20ms		
150	20.0	40
150	20.5	40
150	23.5	40
150	20.0	40



150	21.5	40
PV1/2- to N:		
Limit (mA)	UN	
	Disconnection time (ms)	
Setting: 25mA@100ms		
30	127.0	300
30	120.0	300
30	121.0	300
30	118.0	300
30	116.5	300
Setting: 55mA@80ms		
60	100.0	150
60	98.5	150
60	100.5	150
60	95.5	150
60	104.5	150
Setting: 110mA@20ms		
150	26.5	40
150	27.0	40
150	24.5	40
150	25.5	40
150	24.5	40
PV3+ to N:		
Limit (mA)	UN	
	Disconnection time (ms)	
Setting: 25mA@100ms		
30	114.5	300
30	111.5	300
30	112.5	300
30	117.0	300
30	123.5	300
Setting: 55mA@80ms		
60	118.5	150
60	112.5	150
60	111.0	150
60	91.0	150
60	108.0	150
Setting: 110mA@20ms		
150	32.0	40
150	29.5	40
150	24.5	40
150	28.5	40
150	23.0	40
PV3- to N:		
Limit (mA)	UN	
	Disconnection time (ms)	
Setting: 25mA@100ms		
30	123.0	300



30	110.0	300
30	109.0	300
30	127.5	300
30	116.5	300
Setting: 55mA@80ms		
60	100.5	150
60	109.0	150
60	108.5	150
60	105.5	150
60	106.5	150
Setting: 110mA@20ms		
150	24.5	40
150	28.0	40
150	22.0	40
150	20.5	40
150	16.0	40

Note:

- 1.The capacitive current is risen until disconnection.
- 2.Test condition: $I_c + 30/60/150\text{mA} \leq I_{c\text{max}}$. R1 is set that 30/60/150mA Flow and switch S is closed.
3. The test is repeated for each PV input terminal. It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel.

--- End of test report---