TEST REPORT
IEC 62109-1
Safety of Power Converter for use in Photovoltaic Power Systems
Part 1: General requirements

Report Reference No. .....:	64.290.16.00045.03 part 1 of 2
Date of issue.....:	2017-12-18
Total number of pages .....:	85 pages
Testing Laboratory.....:	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch
Address .....:	5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West, Guangzhou 510656, P. R. China
Applicant's name.....:	Shenzhen Kstar New Energy Company Limited
Address .....:	The 9th Floor, R&D Building, Kstar Industrial Park, Guangming Hi-tech Industrial Zone, 518107 Shenzhen, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard.....:	IEC 62109-1:2010, EN 62109-1:2010
Test procedure .....:	Type test
Non-standard test method……..:	N/A
Test Report Form No.....:	IEC62109_1B
TRF Originator.....:	VDE Testing and Certification Institute
Master TRF.....:	Dated 2016-04

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Test item description ..... :	PV grid-interactive inverter	
Trade Mark ..... :	KSTAR	
Manufacturer ..... :	Same as applicant	
Model/Type reference ..... :	KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV	
Ratings ..... :	See page 7	
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
☒ **Testing Laboratory:**	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch	
Testing location/ address ..... :	5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West, Guangzhou 510656, P. R. China	
Tested by (name, function, signature) ..... :	Max Fang (Fang Wensong) Kennen Wang (Wang Kaixiang)	Max Fang Kennen Wang
Approved by (name, function, signature) .. :	Billy Qiu (Qiu Bili)	

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

This test report contains 4 parts listed in below table:

Item	Description	Pages
Part 1	IEC/EN 62109-1:2010 test report	85
Part 2	IEC/EN 62109-2:2011 test report	29

This test report shall be also used in conjunction with 23 pages of Photo documentation.

Summary of testing:

All tests were carried out according to IEC 62109-1:2010. The text of IEC 62109-1:2010 was approved by CENELEC as a European Standard without any modification.

Tests performed (name of test and test clause):

Clause	Requirement
4.3	Thermal testing
4.4	Testing in single fault condition
4.5	Humidity preconditioning
4.6.1	Backfeed tests under normal conditions
4.6.2	Backfeed tests under single-fault conditions
4.7	Electrical ratings tests
5.1.2	Durability of markings
6.3	Ingress protection
7.3	Protection against electric shock
7.4	Protection against energy hazards
7.5	Electrical tests related to shock hazard
8.5	Wall mounting
10.2	Sonic pressure and sound level
13.1	Handles and manual controls
13.6	Polymeric materials
13.7	Mechanical resistance to deflection, impact, or drop
15	Software and firmware performing safety functions.

Note: If no especial indicated, all the tests are applied for model: KSG-60K.

Testing location:

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Copy of marking plate:

Below electric ratings are silk-screen on label and affixed side of enclosure.

KSTAR

Model: KSG-30K	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	620 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	26 Adc ×3
Maximum total PV array short-circuit current	28 Adc ×3
Nominal a.c. output voltage	3/N/PE 400 Vac / 230 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	48 Aac
Maximum continuous a.c. output current	44 Aac
Maximum continuous a.c. output power	33 KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

5minutes

MADE IN CHINA

KSTAR

Model: KSG-36K-HV	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	720 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	26 Adc ×3
Maximum total PV array short-circuit current	28 Adc ×3
Nominal a.c. output voltage	3~PE, 480 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	48 Aac
Maximum continuous a.c. output current	44 Aac
Maximum continuous a.c. output power	40KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

5minutes

MADE IN CHINA

KSTAR

Model: KSG-50K	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	620 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	36 Adc ×3
Maximum total PV array short-circuit current	38 Adc ×3
Nominal a.c. output voltage	3/N/PE 400 Vac / 230 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	80 Aac
Maximum continuous a.c. output current	72 Aac
Maximum continuous a.c. output power	55 KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

5minutes

MADE IN CHINA

KSTAR

Model: KSG-50K-HV	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	720 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	36 Adc ×3
Maximum total PV array short-circuit current	38 Adc ×3
Nominal a.c. output voltage	3~PE, 480 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	68 Aac
Maximum continuous a.c. output current	61 Aac
Maximum continuous a.c. output power	55 KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

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KSTAR

Model: KSG-60K	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	620 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	40 Adc ×3
Maximum total PV array short-circuit current	42 Adc ×3
Nominal a.c. output voltage	3/N/PE 400 Vac / 230 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	95 Aac
Maximum continuous a.c. output current	87 Aac
Maximum continuous a.c. output power	66 KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

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KSTAR

Model: KSG-60K-HV	
Maximum PV array open-circuit voltage	1000 Vdc
Nominal input voltage	720 Vdc
PV input operating voltage range	250~950 Vdc
Maximum operating PV input current	40 Adc ×3
Maximum total PV array short-circuit current	42 Adc ×3
Nominal a.c. output voltage	3~PE, 480 Vac
Nominal a.c. output frequency	50/60 Hz
Maximum a.c. output overcurrent protection	80 Aac
Maximum continuous a.c. output current	72 Aac
Maximum continuous a.c. output power	66KVA
Power factor range	0.8 under-excited to 0.8 over-excited
Ingress protection	IP65

Protective class: I

Serial No.:

5minutes

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Dimension (Approx.): 70x100 mm.

Note: The above artwork nameplate may be only a draft. For the final production, the additional markings or other words which do not conflict with this standard may be added.

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Test item particulars ..... :		
Equipment mobility ..... :	☐ movable ☐ hand-held ☒ stationary ☒ fixed ☐ transportable ☐ for building-in	
Connection to the mains ..... :	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in	
Enviromental category ..... :	☒ outdoor ☐ indoor unconditional ☐ indoor conditional	
Over voltage category Mains ..... :	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV	
Over voltage category PV ..... :	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV	
Mains supply tolerance (%) ..... :	+/- 10%	
Tested for power systems ..... :	TN or TT system for models: KSG-30K, KSG-50K, KSG-60K; IT system for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	
IT testing, phase-phase voltage (V) ..... :	480 Va.c. for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	
Class of equipment ..... :	☒ Class I ☐ Class II ☐ Class III ☐ Not classified	
Mass of equipment (kg) ..... :	Net weight: 61 kg ~ 67,4 kg (Approx.)	
Pollution degree ..... :	3 (External), 2 (Internal)	
IP protection class ..... :	IP65	

Testing	
Date of receipt of test item(s) ..... :	27 November 2015
Dates tests performed ..... :	10 January 2016 ~ 29 April 2016 and 8 December 2017 to 15 December 2017

Possible test case verdicts:

– test case does not apply to the test object ..... :	N/A
– test object does meet the requirement ..... :	Pass (P)
– test object was not evaluated for the requirement ..... :	N/E
– test object does not meet the requirement ..... :	Fail (F)

General remarks:

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

This TRF was modified by TUV SUD Guangzhou branch by adding Cl.4 and Annex A to J.

Abbreviations used in the report:

Basic insulation (BI); Supplementary insulation (SI); Double insulation (DI); Reinforced insulation (RI); Functional insulation (FI); Single fault condition (SFC); Normal condition (NC); Mains overvoltage category (OVC); Pollution degree (PD), CDF (Construction Data form)

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Revision history

This report is based on original report No.: 64.290.16.00045.02 (Certificate No.: Z2 16 08 75386 045, N8A 16 08 75386 046), with the parameters of 60 Hz added. Original test report and certificates are reserved.

General product information:

(1)	The PGU unit is non-isolated (transformerless) PV grid-interactive DC-AC inverter for connection with public low voltage grid, for outdoor or indoor use.
(2)	The PV grid-interactive inverter shall be used at specified ambient range. Temperature range: -25 °C ~ +60 °C, auto-derating after 45 °C; Altitude: < 2000 m; Overvoltage category: II(DC side), III(AC side); Relative humidity range: 4 % ~ 100 %.
(3)	The PV grid-interactive inverter provides six disconnection relays, two for each line conductor. The internal control is redundant built. It consists of one main DSP (U27) and another slave DSP (U20). Both DSP can open relays independently and communicate with each other.
(4)	For this standard test, the inverter is designed to be operated with a fixed Cos phi=1 settings inside. The power factor can be adjustable via RS 485 communication port and it's adjustable range is not evaluated in this report.
(5)	In order to protect the PCE, user and installer, external DC and AC circuit breaker shall be equipped at the end-use application.
(6)	Low voltage electrical installations shall comply with national and local regulation.
(7)	The setting of rated frequency and protection are described in the user manual.

Model differences:

The six models have same enclosure, same PCB layout, similar electrical control circuits, with mainly differences as below:

(1) Model: KSG-30K, KSG-36K-HV are natural cooling, model: KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV are fans forced cooling.

(2) Have different amounts of bus capacitors. For detail, see CDF.

(3) Have different parameter of boost, invert inductor and AC output EMI inductor. For detail, see CDF.

(4) Have different parameter of power semiconductors. For detail, see CDF.

(5) Have different parameter of X capacitor on AC EMI board. For detail, see CDF.

Name and address of factory (ies)..... :

Shenzhen KSTAR Science & Technology Co., Ltd. Guangming Branch

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Electrical Ratings:

Model	KSG-30K	KSG-36K-HV	KSG-50K
Vmax PV	1000 Vd.c.	1000 Vd.c.	1000 Vd.c.
Isc PV	28 Ad.c. x 3	28 Ad.c. x 3	38 Ad.c. x 3
Max. Continuous input current	26 Ad.c. x 3	26 Ad.c. x 3	36 Ad.c. x 3
MPPT tracker / strings	3 / 2	3 / 2	3 / 4
Nominal AC voltage	3/N/PE, 230/400 Va.c.	3~PE, 480 Va.c.	3/N/PE, 230/400 Va.c.
Nominal Frequency	50/60 Hz	50/60 Hz	50/60 Hz
Max. Continuous output current	44 Aa.c.	44 Aa.c.	72 Aa.c.
Nominal output power	30 kW	36 kW	50 kW
Max. Continuous output power	33 kVA	40 kVA	55 kVA
Power factor (full load)	>0,99	>0,99	>0,99
Protective class	I	I	I
Ingress protection	IP65	IP65	IP65
Temperature	-25 °C ~ +60 °C	-25 °C ~ +60 °C	-25 °C ~ +60 °C

Model	KSG-50K-HV	KSG-60K	KSG-60K-HV
Vmax PV	1000 Vd.c.	1000 Vd.c.	1000 Vd.c.
Isc PV	38 Ad.c. x 3	42 Ad.c. x 3	42 Ad.c. x 3
Max. Continuous input current	36 Ad.c. x 3	40 Ad.c. x 3	40 Ad.c. x 3
MPPT tracker / strings	3 / 4	3 / 4	3 / 4
Nominal AC voltage	3~PE, 480 Va.c.	3/N/PE, 230/400 Va.c.	3~PE, 480 Va.c.
Nominal Frequency	50/60 Hz	50/60 Hz	50/60 Hz
Max. Continuous output current	61 Aa.c.	87 Aa.c.	72 Aa.c.
Nominal output power	50 kW	60 kW	60 kW
Max. Continuous output power	55 kVA	66 kVA	66 kVA
Power factor (full load)	>0,99	>0,99	>0,99
Protective class	I	I	I
Ingress protection	IP65	IP65	IP65
Temperature	-25 °C ~ +60 °C	-25 °C ~ +60 °C	-25 °C ~ +60 °C

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict
4	General testing requirements		P
4.1	General		P
4.2	General conditions for testing		P
4.2.1	Sequence of tests		P
4.2.2	Reference test conditions		P
4.2.2.1	Environmental conditions		P
	Unless otherwise specified, the following ambient environmental conditions shall exist in the test location: a) temperature of 15 °C to 40 °C b) a relative humidity of not more than 75 % and not less than 5% c) an air pressure of 75 kPa to 106 kPa. d) no frost, dew, percolating water, rain, solar radiation, etc.		P
4.2.2.2	State of equipment		P
4.2.2.3	Position of equipment	The equipment were installed in accordance with the manufacturer's instructions, in the configuration that results in the worst-case test conditions	P
4.2.2.4	Accessories	No accessories or operator interchangeable parts	N/A
4.2.2.5	Covers and removable parts		N/A
4.2.2.6	Main supply	TN, TT, IT	P
4.2.2.7	Supply ports other than the mains		P
4.2.2.7.1	Photovoltaic supply sources	PV input, 3 MPPT trackers	P
4.2.2.7.2	Battery inputs	No batteries inputs.	N/A
4.2.2.8	Conditions of loading for output ports	DC-AC inverter. a.c. output port was loaded with linear loads to obtain the maximum rated output power. Continuous operation ratings, until steady conditions are established.	P

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Clause	Requirement – Test	Result – Remark	Verdict
4.2.2.9	Earthing terminals	Protective conductor terminal was connected to earth. No functional earth terminal.	P
4.2.2.10	Controls		N/A
	Controls which the operator can adjust shall be set to any position except that	No controls intended for user to adjust.	N/A
	a) mains selection devices shall be set to the correct value unless otherwise noted in this standard;	No mains selection devices.	N/A
	b) Combinations of settings shall not be made if they are prohibited by the manufacturer's instructions provided with the equipment.	No combinations of settings devices.	N/A
4.2.2.11	Available short circuit current		N/A
4.3	Thermal testing		P
4.3.1	General		P
4.3.2	Maximum temperature	Tests of equipment rated for use in ambient temperatures up to 60 °C	P
4.3.2.1	General		P
	Materials and components shall be selected so that under the most severe rated operating conditions, the temperatures do not exceed the temperature limits.		P
	Conformity is verified by measuring temperatures under the conditions given in 4.2 for each rated operating condition or mode of the PCE that could affect the resulting temperatures.		P
	The temperature limits specified below are total temperature limits (not temperature rise limits).		P
	Tests of equipment rated for use in ambient temperatures up to 50°C may be conducted at any ambient temperature in the range given in 4.2.2.1, in which case the difference between the maximum rated ambient temperature and the test ambient is to be subtracted from or added to (as appropriate) the measured temperatures for comparison to the limits specified below.		N/A

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict
	PCE rated for use in ambient temperatures more than 50°C shall be tested at the maximum rated ambient temperature +/- 5°C. the difference between the maximum rated ambient temperature and the test ambient is to be subtracted from or added to the measured temperatures for comparison to the limits specified.	Maximum rated ambient temperature of the unit: 60 °C. Tested at an ambient temperature to simulate the worst condition. (see appended table)	P
	PCE with different output ratings or with automatic derating for different ambient temperatures shall be tested under as many conditions as are necessary to record worst-case temperatures, including at least the maximum ambient before derating, and the maximum ambient with derating.	Auto-derating at 45 °C.	P
	During thermal testing within NORMAL CONDITIONS protective devices shall not operate.		P
	Temperatures are to be measured by thermocouples, except that for coils the change of resistance method may be used.	Method of thermocouples is used, including transformers, inductors, and other coils. Multiple embedded thermocouples, where the thermocouples are attached during winding of the part, are more likely to record hot-spot temperatures.	P
	Limits: - for coils and their insulation systems, the temperature limits in Table 1 apply.		P
	- for other components the measured temperatures shall not exceed the lower of:	(see appended table)	P
	- the applicable IEC component standards		P
	- the component or material's rated manufacturer's operating temperature		P
	- if neither of the above exists, temperature limits are given in Table 2.		P
4.3.2.2	Touch temperatures		P
	The maximum temperature for accessible parts of the PCE shall be in compliance with table 3	(see appended table)	P

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict
	It is permitted that accessible parts that are required to get hot as part of their intended function (for example heatsinks) may have temperatures up to 100 °C, if the parts are marked with the hot surface marking of symbol 14 of Annex C. For products only for use in a closed electrical operating area the 100 °C limit does not apply.	For metal enclosure, heatsinks, the limit 100 °C apply.	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.		P
4.4	Testing in single fault condition		P
4.4.1	General		P
	Testing in single fault conditions is done to determine that no hazards result from reasonably expected fault conditions that may arise in normal service or from reasonably expected misuse.		P
	Fault testing shall be done unless it can be conclusively demonstrated that no hazards could arise from a particular fault condition, or unless alternative methods of checking conformity are specified in this standard in place of fault testing.		P
4.4.2	Test conditions and duration for testing under fault conditions		P
4.4.2.1	General		P
	The equipment shall be operated under the combination of conditions in 4.2, which is least favourable for the particular fault test being performed.		P
	Fault conditions are to be applied only one at a time and shall be applied in turn in any convenient order. Multiple simultaneous faults shall not be applied, but a subsequent fault may arise as a consequence from an applied fault. Separate samples of the EUT may be used for each separate fault test applied, or the same sample may be used for many tests if damage from previous fault tests has been repaired or will not affect the results of further tests.		P
4.4.2.2	Duration of tests		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The equipment shall be operated until further change as a result of the applied fault is unlikely, as determined by (for example) opening of a device that removes the influence of the fault, stabilization of temperatures, etc.		P
	If a non-resettable, manual, or automatically resetting protective device or circuit operates in such a way as to interrupt or mitigate the fault condition, the test duration is as follows:		P
	- automatic reset devices or circuits: allow the protection to cycle on and off until no further change as a result of the applied fault is likely, until the ultimate result is obtained, or until temperatures stabilize		N/A
	- manual reset devices or circuits: three cycles, with the device or circuit reset as soon as possible after tripping	No manual reset devices used in the inverter.	N/A
	- non-resettable devices or circuits: one cycle		P
4.4.3	Pass/fail criteria for testing under fault conditions		P
4.4.3.1	Protection against shock hazard		P
	Compliance with requirements for protection against electric shock is checked after the application of single faults as follows:	(see appended table)	P
	a) by making measurements to check that no accessible DVC-A circuits have become shock-hazardous using the steady state limits for DVC-A in Table 6 and the short-term limits of 7.3.2.3, and that such circuits remain separated from live parts at voltages greater than DVC A with at least basic insulation. Compliance is checked by the test of 7.5.2 (without humidity preconditioning) for basic insulation; and		P
	b) by performing a dielectric strength test as per 7.5.2 (without humidity preconditioning) in the following cases:		P
	i) on reinforced or double Insulation, using the test level for Basic insulation, and		P

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Clause	Requirement – Test	Result – Remark	Verdict
	ii) on basic insulation in Protective Class I equipment, using the test level for Basic insulation, unless it can be determined that the fault did not result in any damage to the protective earthing conductor or terminal, or to protective bonding means; and		P
	c) by inspection to ensure a fuse connected between the protective earthing terminal and the protective earthing conductor in the test setup has not opened; the fuse shall be rated 3A non-time-delay (for equipment rated for use on circuits protected by overcurrent protection rated 30A or less) or 30A to 35A non-time-delay(for equipment rated for use on circuits protected by overcurrent protection rated more than 30A); the enclosure is not to be contacting earth in any other location during the testing; and		P
	d) by inspection of the enclosure to ensure that no damage has resulted that allows access to parts that are hazardous live.		P
4.4.3.2	Protection against the spread of fire		P
	Compliance with requirements for protection against the spread of fire is checked by placing the equipment on white tissue-paper covering a softwood surface and covering the equipment with cheesecloth or surgical cotton during the fault testing. As an alternative, the cheesecloth or surgical cotton may be placed only over the openings of large equipment.		P
	There shall be no emission of molten metal, burning insulation, or flaming or glowing particles from the fire enclosure, and there shall be no charring, glowing, or flaming of the tissue paper, cheesecloth, or glowing or flaming of surgical cotton.		P
4.4.3.3	Protection against other hazards		P
	Conformity with requirements for protection against other HAZARDS after application of the fault tests is checked as specified elsewhere in this standard.		P
4.4.3.4	Protection against parts expulsion hazards		P

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict
	Failure of any component within the PCE shall not release parts outside the PCE enclosure with sufficient energy to lead to a hazard, for example, expulsion of material into an area occupied by personnel.		P
4.4.4	Single Fault conditions to be applied		P
4.4.4.1	Component fault tests	(see appended table)	P
	The following faults are simulated:		P
	a) Short circuit or open circuit of relevant components		P
	b) Short circuit or open circuit of any components or insulation where failure could adversely affect supplementary insulation or reinforced insulation.		P
	c) In addition, where required by Method 2 of 9.1.1, components that could result in a fire hazard are to be overloaded unless they comply with the requirements of 9.1.3		N/A
4.4.4.2	Equipment or parts for short-term or intermittent operation	Not for short-term or intermittent operation.	N/A
	Components such as motors, relays, other electromagnetic devices and heaters, which are normally operated only intermittently, shall be operated continuously if continuous operation could occur in a single fault conditions.		N/A
4.4.4.3	Motors	DC fans	P
	Motors shall be stopped while fully energized or prevented from starting, whichever is less favourable.		P
4.4.4.4	Transformer short circuit tests		P
	The output windings of transformers shall be short-circuited one at a time. A transformer damaged during one test may be repaired or replaced before the next test.		P
4.4.4.5	Output short circuit		P
	Testing is required to be performed on all combinations of terminals for the port under consideration, two at a time, including neutral and earth terminals, and one test with all current-carrying terminals of the port shorted together at once.		P

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Clause	Requirement – Test	Result – Remark	Verdict
	the short-circuit currents are to be recorded and if they exceed the maximum rated current of the circuit, the maximum measured current shall be provided in the installation manual for the purpose of coordination of overcurrent protection of the external circuit conductors.		P
4.4.4.6	Backfeed current test		P
	For equipment intended to be connected simultaneously to more than one source of supply, each input of the PCE shall be tested one at a time, to determine if hazardous conditions can result from current from one source of supply flowing into the wiring for another source under fault conditions.	DC and AC consider as source of supply.	P
	With the PCE operating under normal conditions, a short circuit shall be applied at the field wiring terminals of the circuit under consideration, with all intended other sources connected to the PCE through the over current protective devices (if any) intended to be present in the installation.		P
	the short-circuit currents are to be recorded and if they exceed the maximum rated current for the port, the maximum measured current shall be provided in the installation manual for the purpose of coordination of overcurrent protection of the external circuit conductors		P
4.4.4.7	Output overload		P
	Each output of the PCE, and each section of a tapped output, shall be overloaded in turn, one at a time. The other windings are loaded or not loaded whichever load condition of normal use is less favorable. Overloading is carried out by connecting a variable resistor across the winding. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 min to maintain the applicable overload. No further readjustments are then permitted.	For high frequency transformer used for SMPS, each section of a tapped output can't be overload.	P

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Clause	Requirement – Test	Result – Remark	Verdict
	If over-current protection is provided by a current-sensitive device or circuit, the overload test current is the maximum current which the over-current protection device is just capable of passing for 1 h. If this value cannot be derived from the specification, it is to be established by test. Before the test, the device is made inoperative or replaced by a link with negligible impedance.		N/A
	For equipment in which the output voltage is designed to collapse when a specified overload current is reached, the overload is slowly increased to the point of maximum output power before the point which causes the output voltage to collapse.		P
	In all other cases, the loading is the maximum power output obtainable from the output.		P
4.4.4.8	Cooling system failure		N/A
4.4.4.9	Heating devices	No heating devices used.	N/A
	In equipment incorporating heating devices, the following faults shall be applied one at a time: a) timers which limit the heating period shall be overridden to energize the heating circuit continuously; b) temperature control devices or circuits shall have single fault conditions applied such that control over the heater is lost. Over-temperature protection devices meeting the requirements of 14.3 are left operational during the test.		N/A
4.4.4.10	Safety interlock	No safety interlock	N/A
4.4.4.11	Reverse d.c. connections	Reverse tracker 1+ and tracker 1-, the unit cannot start-up, no input power, no damage, can resettable, no hazard.	P
4.4.4.12	Voltage selector mismatch	No voltage selector.	N/A
4.4.4.13	Mis-wiring with incorrect phase sequence or polarity		P
4.4.4.14	PWB short-circuit test	Functional insulation less than required spacing is suffered by short-circuit test. Two location of printed wiring board track are performed.	P
4.5	Humidity preconditioning		P

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Clause	Requirement – Test	Result – Remark	Verdict
4.5.1	General		P
4.5.2	Conditions		P
	Relative humidity (%), temperature (°C)	95% RH., 40 °C, 48 h	P
4.6	Voltage Backfeed protection		P
4.6.1	Backfeed tests under normal conditions	See Clause 4.6.3	P
4.6.2	Backfeed tests under single-fault condtions	Discharge circuit loop components are disabled.	P
4.6.3	Compliance with backfeed tests		P
	The PCE is compliant with the requirements if during the tests in 4.6.1 and 4.6.2 no hazardous voltage or energy is present on the PCE terminals for the source under test. Measurements are taken 15 s or 1 s after the source is de-energized or disconnected, as follows:		P
	- 15 s for sources that are connected by fixed wiring		P
	- 1 s for sources that are cord-connected or use connectors that can be opened without the use of a tool		N/A
4.7	Electrical ratings tests		P
4.7.1	Input ratings		P
4.7.1.1	Measurement requirements for DC input ports		P
4.7.2	Output ratings		P
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	Label are marked on the PCE and graphic symbol is explained in user manual	P
	Graphic symbols may be used and shall be in accordance with Annex C or IEC 60417 as applicable.		P
	Graphic symbols shall be explained in the documentation provided with the PCE.		P
5.1.2	Durability of markings		P

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Clause	Requirement – Test	Result – Remark	Verdict
	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		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	Trade mark	P
	b) model number, name or other means to identify the equipment	Model number	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	See below	P
	Unless otherwise specified in another part of IEC 62109, the following ratings, as applicable shall be marked on the equipment:	Special requirement as per IEC 62109-2.	P
	– input voltage, type of voltage (a.c. or d.c.), frequency, and max. continuous current for each input	Refer to the marking label	P
	– output voltage, type of voltage (a.c. or d.c.), frequency, max. continuous current, and for a.c. outputs, either the power or power factor for each output	Refer to the marking label	P
	– the ingress protection (IP) rating as in 6.3 below	IP65	P
5.1.5	Fuse identification		N/A
	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.		N/A
	Where fuses with special fusing characteristics such as time delay or breaking capacity are necessary, the type shall also be indicated		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	For fuses not located in operator access areas and for soldered-in fuses located in operator access areas, it is permitted to provide an unambiguous cross-reference (for example, F1, F2, etc.) to the servicing instructions which shall contain the relevant information.		N/A
5.1.6	Terminals, Connections, and Controls	DC input, grid connection and communication interface	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. The symbols in Annex C may be used, and where there is insufficient space, symbol 9 of Annex C may be used.	Symbol 9 are marked on the PCE and user manual indicate the installation and safety of connection of connector, control and indicator.	P
	Push-buttons and actuators of emergency stop devices, and indicator lamps used only to indicate a warning of danger or the need for urgent action shall be coloured red.	No emergency stop.	N/A
	A multiple-voltage unit shall be marked to indicate the particular voltage for which it is set when shipped from the factory. The marking is allowed to be in the form of a paper tag or any other nonpermanent material.	There is no voltage setting device.	N/A
	A unit with d.c. terminals shall be plainly marked indicating the polarity of the connections, with:		P
	– the sign “+“ for positive and “-„ for negative; or		P
	– a pictorial representation illustrating the proper polarity where the correct polarity can be unambiguously determined from the representation		N/A
5.1.6.1	Protective Conductor Terminals		P
	The means of connection for the protective earthing conductor shall be marked with:	The PE terminal is connected via AC output cable	N/A
	– symbol 7 of Annex C; or		P
	– the letters “PE“; or		N/A
	– the colour coding green-yellow.		P
5.1.7	Switches and circuit-breakers		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The on and off-positions of switches and circuits breakers shall be clearly marked. If a push-button switch is used as the power switch, symbols 10 and 16 of Annex C may be used to indicate the on-position, or symbols 11 and 17 to indicate the off-position, with the pair of symbols (10 and 16, or 11 and 17) close together.		P
5.1.8	Class II Equipment	Class I	N/A
	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 Table Annex C.		N/A
	Where such equipment has provision for the connection of an earthing conductor for functional reasons (see 7.3.6.4) it shall be marked with symbol 6 of Annex C		N/A
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		N/A
	b) a marking to warn the installer to consult the installation instruction. Symbol 9 of Table D-1 is an acceptable marking		P
5.2	Warning markings		P
5.2.1	Visibility and legibility requirements for warning markings		P
	Warning markings shall be legible, and shall have minimum dimensions as follows:		P
	– Printed symbols shall be at least 2,75 mm high		P
	– Printed text characters shall be at least 1.5 mm high and shall contrast in colour with the background		P

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Clause	Requirement – Test	Result – Remark	Verdict
	– Symbols or text that are moulded, stamped or engraved in a material shall have a character height of at least 2,0 mm, and if not contrasting in colour from the background, shall have a depht or raised height of at least 0,5 mm.		N/A
	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	The manual provide necessary information for the warning marking.	P
	Symbol 9 of Annex C is not required to be used adjacent to symbols that are explained in the manual		P
5.2.2	Content for warning markings		P
5.2.2.1	Ungrounded heatsinks and similar parts	Grounded heatsink and metal enclosure.	N/A
	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.		N/A
5.2.2.2	Hot Surfaces	See below	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 or equivalent.	Symbol 14 marked on PCE.	P
5.2.2.3	Coolant	Coolant is not used.	N/A
	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:		N/A
	a) statement that coolant system servicing is to be done only by SERVICE PERSONNEL, or		N/A
	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/A
5.2.2.4	Stored energy		P

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Clause	Requirement – Test	Result – Remark	Verdict
	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.	Symbol 21 is marked on PCE.	P
5.2.2.5	Motor guarding		N/A
	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).		N/A
5.2.3	Sonic hazard markings and instructions	No sonic hazard	N/A
	If required by 10.2.1 a PCE shall:		N/A
	a) be marked to warn the operator of the sonic pressure hazard; or		N/A
	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.		N/A
5.2.4	Equipment with multiple sources of supply	PV array and AC mains.	P
	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.	Symbol 13 provided on PCE	P
	The symbol shall be located on the outside of the unit or shall be prominently visible behind any cover giving access to hazardous parts.		P
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.	The measured touch current is 6,5 mA. Symbol 15 of Annex C presented on the PCE and information also provided in the installation manual.	P
5.3	Documentation		P
5.3.1	General		P

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Clause	Requirement – Test	Result – Remark	Verdict
	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 makings, including symbols used		P
	b) location and function of terminals and controls		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:		P
	– ENVIRONMENTAL CATEGORY as per 6.1	Outdoor	P
	– WET LOCATIONS classification fort he intended external environment as per 6.1	Suitable for wet location	P
	– POLLUTION DEGREE classification for the intended external environment as per 6.2	3	P
	– INGRESS PROTECTION rating as per 6.3	IP65	P
	– Ambient temperature and relative humidity ratings	Max. 60 ºC and 100%RH	P
	– MAXIMUM altitude rating	Up to 2000 m	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;	OVC II (PV), OVC III (Mains)	P
	d) a warning that when the photovoltaic array is exposed to light, it supplies a d.c. voltage to the PCE		P
5.3.1.1	Language	English provide	P
	Instructions related to safety shall be in a language that is acceptable in the country where the equipment is to be installed.	For other country language, further evaluation is needed.	N/A
5.3.1.2	Format		P

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Clause	Requirement – Test	Result – Remark	Verdict
	In general, the documentation must be provided in printed form and is to be delivered with the equipment.	Printed form provided and is to be delivered with equipment.	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.		P
5.3.2	Information related to installation		P
	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:		P
	a) assembly, location, and mounting requirements:		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;		P
	c) ratings and means of connection of any outputs from the PCE, and any requirements related to wiring and externals controls, colour coding of leads, or overcurrent protection needed;		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)		P
	e) ventilation requirements;		P
	f) requirements for special services, for example cooling liquid;	No cooling liquid or other special service.	N/A
	g) instructions and information relating to sound pressure level if required by 10.2.1;		N/A
	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;	No such battery.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	i) tightening torque to be applied to wiring terminals;		P
	j) values of backfeed short-circuit currents available from the PCE on input and output conductors under fault conditions, if those currents exceeds the max. rated current of the circuit, as per 4.4.4.6;		P
	k) for each input to the PCE, the max value of short-circuit current available from the source, for which the PCE is designed; and		P
	l) compatibility with RCD and RCM;	Internal RCM is used.	N/A
	m) instructions for protective earthing, including the information required by 7.3.6.3.7 if a second protective earthing conductor is to be installed:	Provided in the installation manual.	P
	n) where required by 7.3.8, the installation instructions shall include the following or equivalent wording:		P
	"This product can cause a d.c. current in the external protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in a case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product."		P
	o) for PCE intended to charge batteries, the battery nominal voltage rating, size, and type	Grid interactive, not intended to charge batteries.	N/A
	p) PV array configuration information, such as ratings, whether the array is to be grounded or floating, any external protection devices needed, etc.		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;		P
	– Instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials;		P

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	– 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		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.		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);		P
	– Instructions for accessing operator access areas, if any are present, including a warning not to enter other areas of the equipment;		P
	– Part numbers and instructions for obtaining any required operator replaceable parts;	No replaceable parts.	N/A
	– Instructions for safe cleaning (if recommended)		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.		P
5.3.4.1	Battery maintenance	No energy storage battery inside.	N/A
	Where required by 14.8.5, the documentation shall include the applicable items from the following list of instructions regarding maintenance of batteries:		N/A
	– Servicing of batteries should be performed or supervised by personnel knowledgeable about batteries and the required precautions		N/A
	– When replacing batteries, replace with the same type and number of batteries or battery packs		N/A
	– General instructions regarding removal and installation of batteries		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	– CAUTION: Do not dispose of batteries in a fire. The batteries may explode.		N/A
	– CAUTION: Do not open or damage batteries. Released electrolyte is harmful to the skin and eyes. It may be toxic.		N/A
	– 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:		N/A
	a) Remove watches, rings, or other metal objects.		N/A
	b) Use tools with insulated handles.		N/A
	c) Wear rubber gloves and boots.		N/A
	d) Do not lay tools or metal parts on top of batteries		N/A
	e) Disconnect charging source prior to connecting or disconnecting battery terminals		N/A
	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/A
6	**ENVIRONMENTAL REQUIREMENTS AND CONDITIONS**		P
	The manufacturer shall rate the PCE for the following environmental conditions:		P
	– ENVIRONMENTAL CATEGORY, as in 6.1 below	Outdoor use	P
	– Suitability for WET LOCATIONS or not	Suitability for wet locations	P
	– POLLUTION DEGREE rating in 6.2 below	External: PD3, Internal: PD2	P
	– INGRESS PROTECTION (IP) rating, as in 6.3 below	IP65	P
	– Ultraviolet (UV) exposure rating, as in 6.4 below	Plastic cover of LCD and top case are suitable used outdoor	P

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Clause	Requirement – Test	Result – Remark	Verdict
	– Ambient temperature and relative humidity ratings, as in 6.5 below		P
6.1	Environmental categories and minimum environmental conditions		P
6.1.1	Outdoor	Yes	P
6.1.2	Indoor, unconditioned		N/A
6.1.3	Indoor, conditioned		N/A
6.2	Pollution degree	External: PD3, Internal: PD2	P
6.3	Ingress Protection	IP65	P
6.4	UV exposure	Yes	P
6.5	Temperature and humidity		P
7	**PROTECTION AGAINST ELECTRIC SHOCK AND ENERGY HAZARDS**		P
7.1	General		P
7.2	Fault conditions	Normal and single fault condition are considered.	P
7.3	Protection against electric shock		P
7.3.1	General	In the PCE the earthed metal enclosure is evaluated by means of basic insulation from DVC C circuit. DVC A circuit and unearthed accessible parts are evaluated by means of reinforce insulation from DVC C. DVC C: The PV input and mains output. DVC A: the communication interface.	P
7.3.2	Decisive voltage classification		P
7.3.2.1	Use of decisive voltage class (DVC)	Working voltage and protective measures are considered.	P
7.3.2.2	Limits of DVC (according table 6)	Wet location is considered for PCE outside only	P
7.3.2.3	Short-terms limits of accessible voltages under fault conditions		P

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Clause	Requirement – Test	Result – Remark	Verdict
7.3.2.4	Requirements for protection (according table 7)	Single fault condition is considered. Accessible earthed conductive parts are separated from DVC-C circuits by basic insulation. Accessible unearthed conductive parts separated from DVC C circuit by reinforce insulation	P
7.3.2.5	Connection to PELV and SELV circuits	The external signal communication interface considered as SELV.	P
7.3.2.6	Working voltage and DVC		P
7.3.2.6.1	General	Transients and voltage fluctuations are disregarded. And worst case normal operating condition is considered.	P
7.3.2.6.2	AC working voltage (see Figure 2)	277 Vr.m.s / 480 Vr.m.s	P
7.3.2.6.3	DC working voltage (see Figure 3)	Max. DC open voltage: 1000 V	P
7.3.2.6.4	Pulsating working voltage (see Figure 4)		N/A
7.3.3	protective separation	See description in Cl. 7.3.1	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		P
	▪ protective impedance comprising limitation of current per 7.3.5.3 and of discharged energy per 7.3.5.4, or		P
	▪ limitation of voltage according to 7.3.5.4.		N/A
	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

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Clause	Requirement – Test	Result – Remark	Verdict
	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 measure given in 7.3.4.2 (enclosures and barriers) and 7.3.4.3 (insulation).	Enclosure provided.	P
	Open type sub-assemblies and devices do not require protective measures against direct contact but the instruction provided with the equipment must indicate that such measures must be provided in the end equipment or in the installation.	End use product.	N/A
	Product intended for installation in CLOSED ELECTRICAL OPERATING AREAS, (see 3.9) need not have protective measures against direct contact, except as required by 7.3.4.2.4.	No use under this condition.	N/A
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.	Enclosure provided to prevent access to inside live parts.	P
7.3.4.2.1	General		P
	Parts of enclosures and barriers that provide protection in accordance with these requirements shall not be removable without the use of a tool (see 7.3.4.2.3).	Secured by screws.	P
	Polymeric materials used to meet these requirements shall also meet the requirements of 13.6		P
7.3.4.2.2	Access probe criteria		P
	Protection is considered to be achieved when the separation between the test probes and live parts, when tested as described below, is as follows:		P
	a) decisive voltage classification A, (DVC A) - the probe may touch the live parts	The communication interface is considered as DVC A.	P
	b) decisive voltage classification B, (DVC B) - the probe must not touch bare live parts	The DVC B circuit is not accessible by probe.	P
	c) decisive voltage classification C, (DVC C) – the probe must have adequate clearance to live parts, based on the clearance for Basic insulation using the recurring peak working voltage involved,	The DVC C circuit is not accessible by probe.	P
7.3.4.2.3	Access probe tests		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Compliance with 7.3.4.2.1 is checked by all of the following:		P
	a) Inspection; and		P
	b) Tests with the test finger (Figure D.1) and test pin (Figure D.2) of 0E, the results of which shall comply with the requirements of 7.3.4.2.1 a), b), and c) as applicable. Probe tests are performed on openings in the enclosures after removal of parts that can be detached or opened by an operator without the use of a tool, including fuseholders, and with operator access doors and covers open. It is permitted to leave lamps in place for this test. Connectors that can be separated by an operator without use of a tool, shall also be tested during and after disconnection. Any movable parts are to be put in the most unfavorable position.		P
	The test finger and the test pin are applied as above, without appreciable force, in every possible position, except that floor-standing equipment having a mass exceeding 40 kg is not tilted.		P
	Equipment intended for building-in or rack mounting, or for incorporation in larger equipment, is tested with access to the equipment limited according to the method of mounting detailed in the installation instructions.		N/A
	c) Openings preventing the entry of the jointed test finger (Figure E-1 of 0E) during test b) above, are further tested by means of straight unjointed test finger (Figure E-3 of 0E), applied with a force of 30 N. If the unjointed finger enters, the test with the jointed finger is repeated except that the finger is applied using any necessary force up to 30 N.	No openings.	N/A
	d) In addition to a) – c) above, top surfaces of enclosure shall be tested with the IP3X probe of IEC 60529. The test probe shall not penetrate the top surface of the enclosure when probed from the vertical direction ±5 ° only.	No openings.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
7.3.4.2.4	Service access areas	70 s@35 Vpeak bus after disconnecting DC side. Inside PCE are not intentionally touched with energized parts when installation and maintenance. Symbol 21 of Annex C are marked on PCE and explained in user manual.	P
7.3.4.3	Protection by means of insulation of live parts	The earthed enclosure is with basic insulation from the live parts inside.	P
	Where the requirements of 7.3.4.2 are not met, live parts shall be provided with insulation if:		P
	– their working voltage is greater than the maximum limit of decisive voltage class A, or		P
	– for a DVC A or B circuit, protective separation from adjacent circuit of DVC C is not provided (see note "‡" under Table 7)		P
7.3.5	Protection in case of direct contact	The communication interface are direct contact and evaluated with reinforce insulation from hazard live parts.	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.		P
	The protection against direct contact according to 7.3.4 is not required if the circuit contacted is separated from other circuits according to 7.3.2.3, and:	Considered	P
	– is of decisive voltage class A and complies with 7.3.5.2, or	The communication interface is DVC A and reinforce insulation from the live parts by means of isolation transformer and opto-coupler	P
	– is provided with protective impedance according to 7.3.5.3, or		N/A
	– is limited in voltage according to 7.3.5.4		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	In addition to the measures as given in 7.3.5.2 to 7.3.5.4, it shall be ensured that in the event of error or polarity reversal of connectors no voltages that exceed DVC A can be connected into a circuit with protective separation. This applies for example to plug-in-sub-assemblies or other plug-in devices which can be plugged-in without the use of a tool (key) or which are accessible without the use of a tool.	Considered	P
	Conformity is checked by visual inspection and trial insertion.		P
7.3.5.2	Protection using decisive voltage class A	The communication interface is DVC A and reinforce insulation from the live parts by means of isolation transformer and opto-coupler	P
7.3.5.3	Protection by means of protective impedance	At least three resistors (total resistance >2MΩ) in series for PV voltage and AC mains voltage sampling.	P
	Circuits and conductive parts do not require protection against direct contact if any connection to circuits of DVC-B or DVC-C is through protective impedance, and the accessible circuit or part is otherwise provided with protective separation from circuits of DVC-B or DVC-C according 7.3.3.		P
7.3.5.3.1	Limitation of current through protective impedance		P
	The current available through protective impedance to earth and between simultaneously accessible parts, measured at the accessible live parts, shall not exceed a value of 3,5 mA a.c. or 10 mA d.c. under normal and single-fault conditions.	Touch current is 6,5 mA at normal and single fault conditions.	P
7.3.5.3.2	Limitation of discharging energy through protective impedance		P
	The discharging energy available between simultaneously accessible parts protected by protective impedance shall not exceed the charging voltage and capacitance limits given in Table 9, which applies to both wet and dry locations, under normal and single fault conditions. Refer to figure 8.		P
7.3.5.4	Protection by means of limited voltages	No such design	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	That portion of a circuit that has its voltage reduced to DVC-A by a voltage divider that complies with the following requirements, and that is otherwise provided with protective separation from circuits of DVC-B or DVC-C according to 7.3.3, does not require protection against direct contact.		N/A
	The voltage divider shall be designed so that under normal and single fault conditions, including faults in the voltage division circuit, the voltage across the output of the voltage divider does not exceed the limit for DVC-A.		N/A
	This type of protection shall not be used in case of protective class II or unearthed circuits, because it relies on protective earth being connected.		N/A
7.3.6	Protection against indirect contact		P
7.3.6.1	General		P
	Protection against indirect contact is required to prevent shock- hazardous current 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), class II (double or reinforced insulation) or class III (limitation of voltages)	Class I also with reinforce insulation design inside PCE.	P
	That part of a PCE meets the requirements of 7.3.6.2 and 7.3.6.3 is defined as protective class I	The earthed metal enclosure meet this requirement.	P
	That part of a PCE meets the requirements of 7.3.6.4 is defined as protective class II.	The communication interface is reinforce insulated from live parts inside.	P
	That part of PCE which meets the requirements of decisive voltage class A and in which no hazardous voltages are derived, is defined as protective class III. No shock hazard is present in such circuits.		N/A
	Where protection against indirect contact is dependent on means provided during installation, the installation instructions shall provide details of the required means and shall indicate the associated hazards.	The manual require the PCE must be securely earthed.	P
7.3.6.2	Insulation between live parts and accessible conductive parts	See Cl. 7.3.7.4 and Cl. 7.3.7.5	P

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Clause	Requirement – Test	Result – Remark	Verdict
	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		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:		P
	a) accessible conductive parts that are protected by one of the measures in 7.3.5.2 to 7.3.5.4, or		N/A
	b) accessible conductive parts are separated from live parts of DVC-B or -C using double or reinforced insulation.		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;		N/A
	c) through a dedicated protective bonding conductor;		P
	d) through other metallic components of the PCE		N/A
	Where direct metallic contact is used and one or both of the parts involved is painted or coated, the paint or coating shall be removed in the area of contact, or reliably penetrated, to ensure metal to metal contact.		P
	For moving or removable parts, hinges or sliding contacts designed and maintained to have a low resistance are examples of acceptable means if they comply with the requirements of 7.3.6.3.3.	No such design.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Metal ducts of flexible or rigid construction and metallic sheaths shall not be used as protective bonding conductors, unless the device or material has been investigated as suitable for protective bonding purposes.	No such design.	N/A
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. 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.		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/A
	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.		P
	As alternative to a) and b) the protective bonding may designed according to the requirements for the external protective earthing conductor in 7.3.6.3.5, in which case no testing is required.		P
	The impedance of protective bonding means shall be checked by passing a test current through the bond for a period of time as specified below. The test current is based on the rating of the overcurrent protection for the equipment or part of the equipment under consideration, as follows:		P
	a) For pluggable equipment type A, the overcurrent protective device is that provided external to the equipment (for example, in the building wiring, in the mains plug or in an equipment rack);		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	b) For pluggable equipment type B and fixed equipment, the maximum rating of the overcurrent protective device specified in the equipment installation instructions to be provided external to the equipment;	fixed equipment.	P
	c) For a circuit or part of the equipment for which an overcurrent protective device is provided as part of the equipment, the rating of the provided overcurrent device.		N/A
	Voltages are measured from the protective earthing terminal to all parts whose protective bonding means are being considered. The impedance of the protective earthing conductor is not included in the measurement. However, if the protective earthing conductor is supplied with the equipment, it is permitted to include the conductor in the test circuit but the measurement of the voltage drop is made only from the main protective earthing terminal to the accessible part required to be earthed.	Measured from the farthest part of earthed metal enclosure to the input earth terminal	P
	On equipment where the protective earth conncection to a subassembly or to a separate unit is part of a cable that also supplies power to that subassembly or unit, the resistance of the protective bonding conductor in that cable is not included in the protective bond impedance measurements for the subassembly or separate unit, as shown in Figure 11. However, this option is only permitted if the cab le is protected by a suitably rated protective device that takes into account the size of the conductor. Otherwise the impedance of the protective bonding conductor between the separate units is to be included, by measuring to the protective earthing terminal where the power source enters the first unit in the system, as shown in Figure 12.	Figure 11 used	P
7.3.6.3.3.1	Test current, duration, and acceptance criteria		P
	The test current, duration of the test and acceptance criteria are as follows:		P
	a) For PCE with an overcurrent protective device rating of 16 A or less, the test current is 200% of the overcurrent protective device rating, but not less than 32 A, applied for 120s. The impedance of the protective bonding means during and at the end of the test shall not exceed 0,1 Ω.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	b) For PCE with an overcurrent protective device rating of more than 16 A, the test current is 200% of the overcurrent protective device rating and the duration of the test is as shown in Table 10 below. The voltage drop in the protective bonding means, during and at the end of the test, shall not exceed 2,5 V.		P
	c) During and after the test, there shall be no melting, loosening, or other damage that would impair the effectiveness of the protective bonding means.		P
	The test current is derived from an a.c or d.c supply source, the output of which is not earthed.	DC supply.	P
	As an alternative to Table 10, where the time-current characteristic of the overcurrent protective device that limits the fault current in the protective bonding means is known because the device is either provided in the equipment or fully specified in the installation instructions, the test duration may be based on that specific device's time-current characteristic,. The tests are conducted for a duration corresponding to the 200% current value on the time-current characteristic.		P
7.3.6.3.4	Protective bonding impedance (routine test)		N/A
	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. The test shall be as in 7.3.6.3.3, except for the following:	Declared by Manufacturer and working instruction checked during factory inspection.	N/A
	▪ 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:		N/A
	▪ the test duration may be reduced to no less than 2 s		N/A
	For equipment subject to the type test in 7.3.6.3.3.1a), the impedance during the routine test shall not exceed 0,1Ω.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	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).		N/A
7.3.6.3.5	External protective earthing conductor		N/A
	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.		N/A
	If the external protective earthing conductor is routed through a plug and socket or similar means of disconnection, it shall not be possible to disconnect it unless power is simultaneously removed from the part to be protected.		N/A
	The cross-sectional area of every external protective earthing conductor which does not form part of the supply cable or cable enclosure shall, in any case, be not less than:	External protective earthing conductor is integrated with output cable.	N/A
	▪ 2,5 mm² if mechanical protection is provided;		N/A
	▪ 4 mm² if mechanical protection is not provided.		N/A
	For cord-connected equipment, provisions shall be made so that the external protective earthing conductor in the cord shall, in the case of failure of the strain-relief mechanism, be the last conductor to be interrupted.		N/A
7.3.6.3.6	Means of connection for the external protective earthing conductor		P
7.3.6.3.6.1	General		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The means of connection for the external protective earthing conductor shall be located near the terminals for the respective live conductors. The means of connections shall be corrosion-resistant and shall be suitable for the connection of cables according to 7.3.6.3.5. 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. A separate means of connection shall be provided for each external protective earthing conductor. 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.	Integrated within output cable.	P
	The means of connection for the protective earthing conductor shall be permanently marked with:		P
	• symbol 7 of Annex C; or		N/A
	• the colour coding green-yellow		P
	Marking shall not be done on easily changeable parts such as screws.		N/A
7.3.6.3.7	Touch current in case of failure of the protective earthing conductor		P
	The requirements of this sub-clause shall be satisfied to maintain safety in case of damage to or disconnection of the protective earthing conductor.		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 mA d.c.	The measured touch current is 6,5 mA.	P
	For all other PCE, one or more of the following measure shall be applied, unless the touch current measured in accordance with 7.5.4 using the test network of IEC 60990 test figure 4 shall not exceed 3,5 mA a.c. or 10 mA d.c.		P
	a) Permanently connected wiring, and:		P
	• a cross-section of the protective earthing conductor of at least 10 mm² Cu or 16 mm² Al; or		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	• automatic disconnection of the supply in case of discontinuity of the protective earthing conductor; or	If protective earthing conductor unearthed before energized DC and AC power, the PCE can detect the fault and can't connect to AC mains, also indicate the fault.	N/A
	• 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 instruction requiring a second protective earthing conductor to be installed or		N/A
	b) Connection with an industrial connector according to IEC 60309 and a minimum protective earthing conductor cross-section of 2,5 mm² as part of a multi-conductor power cable. Adequate strain relief shall be provided.		N/A
	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.		N/A
	When it is intended and allowed to connect two or more PCEs in parallel using one common PE conductor, the above touch current requirements apply to the maximum number of the PCEs to be connected in parallel, unless one of the measures in a)		N/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.		N/A
7.3.6.4	Protective Class II – Double or Reinforced Insulation	Communication interface is evaluated with Reinforced insulation from live part inside. Comply with clause 7.3.4.3	P
	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/A

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Clause	Requirement – Test	Result – Remark	Verdict
	• 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/A
	• metal-encased equipment of protective class II may have provision on its enclosure for the connection of an equipotential bonding conductor;		N/A
	• equipment of protective class II may have provision for the connection of an earthing conductor for functional reasons or for damping of overvoltages; it shall, however, be insulated as though it is a live part;		N/A
	• equipment employing protective class II shall be marked according to 5.1.8.		N/A
7.3.7	Insulation Including Clearance and Creepage Distance		P
7.3.7.1	General		P
	This subclause gives minimum requirements for insulation, based on the principles of IEC 60664.		P
	Manufacturing tolerances shall be taken into account during measurement of creepage, clearance, and insulation distance in the PCE.		P
	Insulation shall be selected after consideration of the following influences:		P
	• pollution degree	PD3 outside, PD2 inside	P
	• overvoltage category	PV (OVC II), Mains (OVC III)	P

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Clause	Requirement – Test	Result – Remark	Verdict
	• supply earthing system	TN or TT system for models: KSG-30K, KSG-50K, KSG-60K; IT system for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	P
	• insulation voltage	PV input: max. 1000 Vd.c. and Mains: 277 Va.c. / 480 Va.c.	P
	• location of insulation	See table 7.3.7.4 and 7.3.7.5 for detail	P
	• type of insulation	See table 7.3.7.4 and 7.3.7.5 for detail	P
	Compliance of insulation, creepage distances, and clearance distances, shall be verified by measurement or visual inspection, and the tests of 7.5.		P
7.3.7.1.3	Supply earthing systems		P
	Three basic types of earthing system are described in IEC 60364-1. They are:		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 systems, TN-C, TN-S and TN-C-S, are defined according to the arrangement of the neutral and protective conductor.	TN or TT system for models: KSG-30K, KSG-50K, KSG-60K; IT system for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	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;		P
	• IT sytem: 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.	TN or TT system for models: KSG-30K, KSG-50K, KSG-60K; IT system for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	P
7.3.7.1.4	Insulation voltages	See table 7.3.7.4 and 7.3.7.5 for detail	P
	Table 12 makes use of the circuit system voltage and overvoltage category to define the impulse withstand voltage and the temporary overvoltage.		P
7.3.7.2	Insulation between a circuit and its surroundings		P

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Clause	Requirement – Test	Result – Remark	Verdict
7.3.7.2.1	General Basic, supplementary and reinforced insulation between a circuit and its surroundings shall be designed according to: Impulse voltage; temporary overvoltage; working voltage of the circuit;	277 Va.c. / 480 Va.c., OVC III (4000 V impulse voltage, 1500 Vrms temporary overvoltage) for the AC output terminal; 1000 Vdc, OVC II (4464 V impulse voltage, no temporary overvoltage) for the PV input terminal; No isolation between PV and AC mains output. Maximum 1000 Vdc working voltage is assumed between DVC A circuit and DVC C circuit.	P
7.3.7.2.2	Circuit connected directly to the mains Clearance and solid insulation between circuit 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	System voltage for mains is 300 Vrms according to table 12. 4464 V impulse voltage gives the most severe requirement.	P
7.3.7.2.3	Circuit other than mains circuit Clearance and solid insulation between circuit other than the mains and their surroundings shall be designed according to impulse voltage and recurring peak voltage	System voltage for PV is 1000 Vdc.	P
7.3.7.2.4	Insulation between circuits a) For clearances and insulation, the requirements are determined by the circuit having the higher impulse voltage; b) For creepages, r.m.s. working voltage across the insulation determines the requirements.	Impulse voltage (4464 V), temporary overvoltage (1500 Vr.m.s) is calculated from table 12 for clearance. Working voltage (1000 Vdc) across insulation is used for creepage.	P
7.3.7.3	Functional insulation For parts or circuit in OVC I, functional insulation shall be designed according to the working voltage across the insulation For parts or circuit in OVC II, 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

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Clause	Requirement – Test	Result – Remark	Verdict
7.3.7.4.1	Determination Table 13 defines the minimum clearance distances required to provide functional, basic , or supplementary insulation		P
	Clearance for use in altitudes above 2000 m shall be calculated with correction factor according to Table A.2 of IEC 60664-1	Not attended to use in altitudes above 2000 m.	N/A
	For reinforced insulation, the value corresponding to the next higher impulse voltage, or 1.6 times the temporary overvoltage, or 1.6 times the working voltage shall be used, whichever results in the most severe requirement		P
7.3.7.4.2	Electric field homogeneity For homogeneous electric field and impulse voltage is equal to or greater than 6000V for a circuit connected directly to the mains or 4000V within a circuit, the clearance may be reduced to the requirement by Table F.2 Case B of IEC 60664-1. In this case, impulse voltage test shall be performed on the clearance	Inhomogeneous electric field is considered for PCE.	N/A
7.3.7.4.3	Clearance to conductive enclosures Clearance shall be measured following the deformation test of 13.7 for conductive enclosures		P
7.3.7.5	Creeage distances		P
7.3.7.5.1	General Creepage distances shall be large enough to prevent long-term degradation of the surface of solid insulators. For reinforced insulation, the value is doubled. If less than clearance, it shall be increased to that clearance	PV Maximum 1000 Vdc system voltage is used for the RMS voltage across insulation.	P
7.3.7.5.2	Voltage r.m.s. value of working voltage is used. Interpolation is permitted		P
7.3.7.5.3	Materials	Certified PWB used. Other material are considered IIIb The inside parts are considered pollution degree 2.	P
7.3.7.6	Coating	No coating provided insulation	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
7.3.7.7	PWB spacings for functional insulation	PWB rated V-0 and has a minimum CTI of 175, short-circuit test are considered.	P
7.3.7.8	Solid insulation		P
7.3.7.8.1	General Material for solid insulation shall be able to withstand mechanical, electrical, thermal and climatic stresses in normal use and ageing during the expected lifetime. Compliance is evaluated by test and inspection.	Communication isolated optocouplers (U1, U4, U5, U7, U8, U9, U10, U11, U12, U13) and Insolated transformer.	P
7.3.7.8.2	Requirements for electrical withstand capability of solid insulation		P
7.3.7.8.2.1	Basic and supplementary, reinforced, and double insulation. Solid insulation shall withstand the impulse voltage test 7.5.1 and voltage test 7.5.2.		P
	In addition, if recurring peak working voltage across the insulation is greater than 700 V and voltage stress on insulation is greater than 1kV/mm, double and reinforced insulation shall withstand the partial discharge test according to 7.5.3		N/A
7.3.7.8.2.2	Functional insulation		N/A
7.3.7.8.3	Thin sheet or tape material		P
7.3.7.8.3.1	General Insulation of thin sheet or tape less than 0,7 mm is subject to this requirement		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.		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.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	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.		P
7.3.7.8.3.3	Material thickness less than 0,2 mm		N/A
	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/A
	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/A
	Reinforced insulation consisting of a single layer of material less than 0,2 mm thick is not permitted.		N/A
7.3.7.8.3.4	Compliance Component, sub-assembly, or material is checked by applicable tests 7.5.1 to 7.5.3 according to 7.3.7.8.		P
7.3.7.8.4	Printed wiring boards (PWBs)		P
7.3.7.8.4.1	General 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.		P
	For the inner layers of multi-layer PWBs, the insulation between adjacent tracks on the same layer shall be treated as either:		P
	a creepage distance for pollution degree 1 and a clearance as in air (see Annex A, figure A.13); or		N/A
	as solid insulation, in which case it shall meet the requirements of 7.3.7.8.		P
7.3.7.8.4.2	Use of coating materials		N/A
7.3.7.8.5	Wound components		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Varnish or enamel insulation of wires shall not be used for basic, supplementary, double or reinforced insulation.	Varnish are not considered as insulation and voltage test performed as routine test. See also Cl.7.3.7.8.1 to Cl.7.3.7.8.2	P
	Wound components shall meet the requirements of 7.3.7.8.1 and 7.3.7.8.2.		N/A
	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.		P
7.3.7.8.6	Potting materials		P
	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.	Potting materials used in invert and boost inductor.	N/A
7.3.7.9	Insulation requirements above 30 kHz		P
	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.	Isolated transformer for communication circuit.	P
	Annex G contains flow-charts for the determination of clearance and creepage distances under these circumstances. For convenience, Tables 1 and 2 of IEC 60664-4 are also included in Annex G.		P
7.3.8	Residual Current-operated protective (RCD) or monitoring (RCM) device compatibility.	Internal RCM is used according to IEC 62109-2 type test.	P
	RCD and RCM are used to provide protection against insulation faults in some domestic and industrial installations, additional to that provided by the installed equipment.		N/A
7.3.9	Protection against shock hazard due to stored energy		P
7.3.9.1	Operator access area	Accessible communication interface is DVC A	P

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Clause	Requirement – Test	Result – Remark	Verdict
	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.		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.		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).	70 s@35 Vpeak bus after disconnecting DC side. Inside capacitor discharge to DVC A and no energy hazard level within 5 minutes.	P
	For energy storage devices (such as batteries or ultra capacitors) 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.	Warning symbol 21 of Annex C is marked on PCE	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	Condition b is considered	P
	a) The voltage is 2 V or more, and power available after 60 s exceeds 240 VA.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	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 20J: $E = 0,5\ CU^2$		P
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.	No energized parts accessible by user.	P
7.4.3	Services 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.		P
	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	Warning symbol 21 of Annex C is marked.	P
7.5	Electrical tests related to shock hazard		P
7.5.1	Impulse voltage test (type test)		P
7.5.2	Voltage test (dielectric strength test) (type test)		P
7.5.3	Partial discharge test (type test or sample test)		N/A
7.5.4	Touch current measurement (type test)		P
	The touch current shall be measured if required by 7.3.6.3.7 and shall not be greater than 3.5 mA a.c. or 10 mA d.c. or special measures of protection as given in 7.3.6.3.7 are required.	Measured touch current is 6,5 mA. See clause 7.3.6.3.7	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 touch current test.		P
7.5.5	Equipment with multiple sources of supply		N/A
8	**PROTECTION AGAINST MECHANICAL HAZARDS**		P
8.1	General		P

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Clause	Requirement – Test	Result – Remark	Verdict
	Operation shall not lead to a mechanical HAZARD in NORMAL CONDITION or SINGLE FAULT CONDITION. 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.		P
	Conformity is checked as specified in 8.2 to 8.6.		P
8.2	Moving parts		P
	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.	DC fan's blade can't touched	P
8.2.1	Protection of service persons		P
	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 Table D-1 shall be applied on or near the guard.		P
8.3	Stability		N/A
	Equipment and assemblies of equipment not secured to the building structure before operation shall be physically stable in NORMAL USE.	Wall mounted	N/A
8.4	Provisions for lifting and carrying		P
	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.		N/A
	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.		P
8.5	Wall mounting		P
	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.		P
8.6	Expelled parts		N/A
	Equipment shall contain or limit the energy of parts that could cause a HAZARD if expelled in the event of a fault.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict

9	**PROTECTION AGAINST FIRE HAZARDS**		P
9.1	Resistance to fire		P
	This sub-clause 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.	Components are witnessed at normal condition and abnormal tests are verified.	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.	Method 1 used	P
9.1.2	Conditions for a fire enclosure		P
	A FIRE ENCLOSURE is required for equipment or parts of equipment for which Method 2 is not fully applied and complied with.		P
9.1.2.1	Parts requiring a fire enclosure		P
	Except where Method 2 is used, or as permitted in 9.1.2.2, the following are considered to have a risk of ignition and, therefore, require a FIRE ENCLOSURE:		P
	– components in PRIMARY CIRCUITS		P
	– components in SECONDARY CIRCUITS supplied by power sources which exceed the limits for a LIMITED POWER SOURCE as specified in 9.2;		P
	– components in SECONDARY CIRCUITS supplied by a LIMITED POWER SOURCE as specified in 9.2, but not mounted on a material of FLAMMABILITY CLASS V-1;		N/A
	– components within a power supply unit or assembly having a limited power output complying with the criteria for a LIMITED POWER SOURCE as specified in 9.2, including overcurrent protective devices, limiting impedances, regulating networks and wiring, up to the point where the LIMITED POWER SOURCE output criteria are met;		P
	– components having unenclosed arcing parts, such as open switch and relay contacts and commutators, in a circuit at HAZARDOUS VOLTAGE or at a HAZARDOUS ENERGY LEVEL; and	Certified relay with fire enclosure.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	– insulated wiring, except as permitte in 9.1.2.2.	PVC wire	N/A
9.1.2.2	Parts not requiring a fire enclosure	Fire enclosure used.	N/A
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.		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.		P
9.1.3.3	Materials for components and other parts inside fire enclosures	At least V-1 material used inside fire enclosure, PCB rated V-0 and internal wire rated VW-1.	P
9.1.3.4	Materials for air filter assemblies		N/A
9.1.4	Openings in fire enclosures		N/A
9.1.4.1	General		N/A
	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.	The equipment is intended to be used one orientation.	N/A
	These requirements are in addition to those in the following sections:		N/A
	– 7.3.4, Protection against direct contact;		N/A
	– 7.4, Protection against energy hazards;		N/A
	– 13.5, Openings in enclosures		N/A
9.1.4.2	Side openings treated as bottom openings		N/A
9.1.4.3	Openings in the bottom of a fire enclosure		N/A
	The bottom of a FIRE ENCLOSURE or individual barriers, shall 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/A
9.1.4.4	Equipment for use in a CLOSED ELECTRICAL OPERATING AREA	Not intend use at this area.	N/A

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict
	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:		N/A
	WARNING: FIRE HAZARD SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY		N/A
9.1.4.5	Doors or covers in fire enclosures	No door or cover operated by user.	N/A
9.1.4.6	Additional requirements for openings in transportable equipment		N/A
9.2	LIMITED POWER SOURCES		N/A
9.2.1	General		N/A
9.2.2	Limited power source tests		N/A
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.	External wiring and external protective devices shall be used in field installation.	P
9.3.2	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.		P
9.3.3	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.	External circuit breaker shall be used for AC and DC side in field installation.	P
10	**PROTECTION AGAINST SONIC PRESSURE HAZARDS**		P
10.1	General		P

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Clause	Requirement – Test	Result – Remark	Verdict
	The equipment shall provide protection against the effect of sonic pressure. Conformity tests are carried out if the equipment is likely to cause such HAZARDS.		P
10.2	Sonic pressure and Sound level		P
10.2.1	Hazardous Noise Levels		P
11	**PROTECTION AGAINST LIQUID HAZARDS**		N/A
11.1	Liquid Containment, Pressure and Leakage	No liquid containment system.	N/A
	The liquid containment system components shall be compatible with the liquid to be used.		N/A
	There shall be no leakage of liquid onto live parts as a result of:		N/A
	a) Normal operation, including condensation;		N/A
	b) Servicing of the equipment; or		N/A
	c) Inadvertent loosening or detachment of hoses or other cooling system parts over time.		N/A
11.2	Fluid pressure and leakage		N/A
11.2.1	Maximum pressure		N/A
11.2.2	Leakage from parts		N/A
11.2.3	Overpressure safety device		N/A
11.3	Oil and grease		N/A
12	**CHEMICAL HAZARDS**		N/A
12.1	General		N/A
13	**PHYSICAL REQUIREMENTS**		P
13.1	Handles and manual controls		P
	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. Sealing compounds and the like, other than selfhardening resins, shall not be used to prevent loosening. 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 hazard.	30 N axial pull to be applied for DC Switch disconnector.	P
13.1.1	Adjustable controls		N/A
13.2	Securing of parts		P

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Clause	Requirement – Test	Result – Remark	Verdict
13.3	Provisions for external connections		P
13.3.1	General		P
13.3.2	Connection to an a.c. Mains supply	Terminal block	P
13.3.2.1	General		P
	For safe and reliable connection to a MAINS supply, equipment shall be provided with one of the following:		P
	– terminals or leads or a non-detachable power supply cord for permanent connection to the supply; or		P
	– a non-detachable power supply cord for connection to the supply by means of a plug		N/A
	– an appliance inlet for connection of a detachable power supply cord; or		N/A
	– a mains plug that is part of direct plug-in equipment as in 13.3.8		N/A
13.3.2.2	Permanently connected equipment		P
13.3.2.3	Appliance inlets		N/A
13.3.2.4	Power supply cord		N/A
13.3.2.5	Cord anchorages and strain relief		N/A
	For equipment with a non-detachable power supply cord, a cord anchorage shall be supplied such that:		N/A
	– the connecting points of the cord conductors are relieved from strain; and		N/A
	– the outer covering of the cord is protected from abrasion.		N/A
13.3.2.6	Protection against mechanical damage		P
13.3.3	Wiring terminals for connection of external conductors		P
13.3.3.1	Wiring terminals		P
13.3.3.2	Screw terminals		P
13.3.3.3	Wiring terminal sizes		P
13.3.3.4	Wiring terminal design		P
13.3.3.5	Grouping of wiring terminals		P
13.3.3.6	Stranded wire		N/A
13.3.4	Supply wiring space		N/A
13.3.5	Wire bending space for wires 10 mm² and greater		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
13.3.6	Disconnection from supply sources	Installation manual instruct the circuit breaker shall be provided before connecting AC mains and PV array.	P
13.3.7	Connectors, plugs and sockets	No such connectors, plugs and sockets employed	N/A
13.3.8	Direct plug-in equipment		N/A
13.4	Internal wiring and connections		P
13.4.1	General		P
13.4.2	Routing	Internal wire is routed to avoid sharp edge and overheat.	P
13.4.3	Colour coding	Green-yellow wire used as protective bonding only.	P
13.4.4	Splices and connections		P
13.4.5	Interconnections between parts of the PCE		N/A
13.5	Openings in enclosures		N/A
13.5.1	Top and side openings		N/A
	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.		N/A
13.6	Polymeric Materials		P
13.6.1	General		P
13.6.1.1	Thermal index or capability		P
13.6.2	Polymers serving as enclosures or barriers preventing access to hazards	Polymers serving as barriers preventing access to hazards.	P
13.6.2.1	Stress relief test	Plastic cover for protective LCD.	P
13.6.3	Polymers serving as solid insulation		P
13.6.3.1	Resistance to arcing	Arcing parts are enclosed inside certified relay.	N/A
13.6.4	UV resistance		P
	Polymeric parts of an OUTDOOR ENCLOSURE required for compliance with this standard shall be sufficiently resistance to degradation by ultra-violet (UV) radiation	LCD cover is approved by UL according to UV resistance.	P
13.7	Mechanical resistance to deflection, impact, or drop		P
13.7.1	General		P
13.7.2	250-N deflection test for metal enclosures		P
13.7.3	7-J impact test for polymeric enclosures		P

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Clause	Requirement – Test	Result – Remark	Verdict
13.7.4	Drop test		N/A
13.8	Thickness requirements for metal enclosures		P
13.8.1	General		P
13.8.2	Cast metal		N/A
13.8.3	Sheet metal		N/A
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
	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 test 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;		P
	b) the requirements of this standard and, where necessary for the application, any additional applicable safety requirements of the relevant IEC component standard;		P
	c) if there is no relevant IEC standard, the requirements of this standard;		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.		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 routine test.		P
14.2	Motor Over temperature Protection		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	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 over-temperature or thermal protection device meeting the requirements of 14.3.		N/A
14.3	Overtemperature protection devices		N/A
14.4	Fuse holders		N/A
14.5	MAINS voltage selecting devices		N/A
14.6	Printed circuit boards		P
	Printed circuit boards shall be made of material with a flammability classification of V-1 of IEC 60707 or better.	V-0	P
	This requirement does not apply to thin-film flexible printed circuit boards that contain only circuits powered from limited power sources meeting the requirements of 9.2.		N/A
	Conformity of the flammability RATING is checked by inspection of data on the materials. Alternatively, conformity is checked by performing the V-1 tests specified in IEC 60707 on three samples of the relevant parts.		N/A
14.7	Circuits or components used as transient overvoltage limiting devices		N/A
	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 7-10 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.		N/A
14.8	Batteries		N/A
	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.	No battery used.	N/A
14.8.1	Battery Enclosure Ventilation		N/A
14.8.1.1	Ventilation requirements		N/A
14.8.1.2	Ventilation testing		N/A
14.8.1.3	Ventilation instructions		N/A
14.8.2	Battery Mounting		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	Compliance is verified by the application of the force to the battery's mounting surface. The test force is to be increased gradually so as to reach the required value in 5 to 10 s, and is to be maintained at that value for 1 min. A nonmetallic rack or tray shall be tested at the highest normal condition operating temperature.		N/A
14.8.3	Electrolyte spillage		N/A
	Battery trays and cabinets shall have an electrolyte-resistant coating.		N/A
	The ENCLOSURE or compartment housing a VENTED BATTERY shall be constructed so that spillage or leakage of the electrolyte from one battery will be contained within the ENCLOSURE and be prevented from:		N/A
	a) reaching the PCE outer surfaces that can be contacted by the USER		N/A
	b) contaminating adjacent electrical components or materials; and		N/A
	c) bridging required electrical distances		N/A
14.8.4	Battery Connections		N/A
	Reverse battery connection of the terminals shall be prevented if reverse connection could result in a hazard within the meaning of this Standard		N/A
14.8.5	Battery maintenance instructions		N/A
	The information and instructions listed in 5.3.4.1 shall be included in the operator manual for equipment in which battery maintenance is performed by the operator, or in the service manual if battery maintenance is to be performed by service personnel only.		N/A
14.8.6	Battery accessibility and maintainability		N/A
	Battery terminals and connectors shall be accessible for maintenance with the correct TOOLS. Batteries with liquid electrolyte, requiring maintained shall be so located that the battery cell caps are accessible for electrolyte tests and readjusting of electrolyte levels.		N/A
15	Software and firmware performing safety functions		P
Annex A	Measurement of clearances and creepage distances (see 7.3.7.4 and 7.3.7.5)		P
Annex B	Programmable Equipment		P

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Clause	Requirement – Test	Result – Remark	Verdict
B.1	Software or firmware that perform safety critical functions		P
B.1.1	Firmware or software that performs a critical safety function/s, the failure of which can result in a risk of fire, electric shock or other hazard as specified by this standard, shall be evaluated by one of the following means.		P
	a) All software or firmware limits or controls shall be disabled before the test to evaluate the hardware circuitry during the abnormal test condition related to the safety function.		P
	b) Protective controls employing software or firmware to perform their function(s), shall be so constructed that they comply with IEC 60730-1 Annex H to address the risks identified in B.2.1.		N/A
B.2	Evaluation of controls employing software		P
Annex C	Symbols to be used in equipment markings		P

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Clause	Requirement – Test	Result – Remark	Verdict
Annex D	Test Probes for Determining Access		P
Annex E	RCDs		N/A
Annex F	Altitude correction for clearances		N/A
Annex G	Clearance and creepage distance determination for frequencies greater than 30 kHz		P
Annex H	Measuring Instrument for Touch Current Measure-ments		P
H.1	Measuring instrument		P
H.2	Alternative measuring instrument		N/A
Annex I	Examples of Protection, Insulation, and Overvolt-age Category Requirements for PCE		P
Annex J	Ultraviolet light conditioning test	LCD cover is approved by UL according to UV resistance.	P

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Clause	Requirement – Test	Result – Remark	Verdict

4.7	TABLE: mains supply electrical data in normal condition					P
Model	U (V) DC	I (A) DC	P (kW) DC	U (V) AC	I (A) AC	P (kW) AC
KSG-30K	480 Vd.c.	58,65	28,12	207/360 Va.c.	43,92	27,05
	480 Vd.c.	64,32	30,81	230/400 Va.c.	43,85	30,02
	480 Vd.c.	70,43	33,67	253/440 Va.c.	43,57	32,74
	800 Vd.c.	35,12	27,92	207/360 Va.c.	43,92	27,00
	800 Vd.c.	38,69	30,77	230/400 Va.c.	43,89	29,97
	800 Vd.c.	42,72	33,94	253/440 Va.c.	43,78	32,89
KSG-60K-HV	550 Vd.c.	102,63	55,34	432 Va.c.	72,36	54,36
	550 Vd.c.	113,67	60,83	480 Va.c.	72,24	60,03
	550 Vd.c.	121,82	67,00	528 Va.c.	72,12	66,27
	800 Vd.c.	68,94	54,74	432 Va.c.	72,35	53,94
	800 Vd.c.	76,36	60,76	480 Va.c.	72,17	60,00
	800 Vd.c.	83,78	66,72	528 Va.c.	72,24	65,92

Remark:

(1)	the inverter is designed to be operated with a fixed Cos phi=1 settings inside to conduct this test;
(2)	PV simulators and AC simulator used to apply these tests;
(3)	As the inverter topology and the controlling software is identical to the each other, for this clause tests were performed on the model: KSG-30K and KSG-60K-HV can cover other models.

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Clause	Requirement – Test	Result – Remark	Verdict

4.3	**Thermal testing (by thermocouples)**								P
No.	Ambient (°C)	Humidity (RH)	Test duration	Input			Output		
				Vd.c.	A	kW	Va.c.	A	kVA
Model: KSG-60K-HV									
(1)	29,6	65%	3,5 hours	550 Vd.c.	121,82	67,00	528 Va.c.	72,12	66,27
(2)	24,7	65%	2,5 hours	800 Vd.c.	83,78	66,72	528 Va.c.	72,24	65,92
(3)	60,7	--	2 hours	550 Vd,c,	102,68	51,13	480 Va.c.	60,67	50,28
Model: KSG-30K									
(4)	27,0	63%	3,5 hours	480 Vd.c.	70,43	33,67	253/440 Va.c.	43,57	32,74
(5)	24,1	63%	2,5 hours	800 Vd.c.	42,72	33,94	253/440 Va.c.	43,78	32,89
(6)	61,9	--	2,5 hours	480 Vd.c.	60,67	29,05	230/400 Va.c.	40,83	28,10

No.	Temperature (°C) of part/at:	Measured temperature (°C)		Temperature at calculated to 45 °C ambient		Limits (°C)
		(1)	(2)	(1)	(2)	
01	Test ambient temperature	29,6	24,7	45,0	45,0	--
02	Internal input lead wire	53,2	46,6	68,6	66,9	105
03	DC switch-disconnector	54,5	42,7	69,9	63,0	85
04	Y Capacitor C11, (DC EMI board)	57,5	49,8	72,9	70,1	125
05	Magnet wire of inductor L2, (DC EMI board)	58,4	51,3	73,8	71,6	110
06	Bus capacitor C28, (BOOST board)	64,9	53,7	80,3	74,0	105
07	Magnet wire of transformer TX1, (Boost driving board)	61,2	50,1	76,6	70,4	110
08	Bus capacitor C14, (Invert board)	59,6	51,2	75,0	71,5	105
09	Magnet wire of transformer TX1, (Power supply board)	75,0	64,8	90,4	85,1	110
10	Magnet wire of transformer TX01, (Power supply board)	83,4	72,8	98,8	93,1	110
11	Isolated optocoupler U2, (Power supply board)	68,4	57,9	83,8	78,2	105
12	Diode D05, (Power supply board)	74,7	64,4	90,1	84,7	For ref.

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13	Q02, (Power supply board)	74,7	64,4	90,1	84,7	For ref.
14	Lead wire, S phase (Invert output)	67,3	59,8	82,7	80,1	105
15	HCT5, (AC EMI board)	72,9	66,3	88,3	86,6	For ref.
16	X capacitor C52, (AC EMI board)	60,7	53,0	76,1	73,3	125
17	Coil of Relay for disconnect AC mains RY3, (AC EMI board)	65,6	58,3	81,0	78,6	110
18	Y capacitor C53, (AC EMI board)	64,6	53,7	80,0	74,0	125
19	Magnet wire of inductor L5, (AC EMI board)	63,0	55,5	78,4	75,8	120
20	X capacitor C56, (AC EMI board)	58,9	51,2	74,3	71,5	110
21	MOV12, (AC EMI board)	59,7	52,4	75,1	72,7	85
22	Fuse link J35 body, (AC EMI board)	61,6	54,1	77,0	74,4	90
23	Output lead wire, (internal)	55,9	50,3	71,3	70,6	105
24	Output terminal block	32,6	27,0	48,0	47,3	85
25	Communication isolated optocoupler U7	54,1	47,3	69,5	67,6	115
26	Magnet wire of BOOST inductor, tracker 2	67,2	40,3	82,6	60,6	110
27	Magnet wire of INVERT inductor, S phase	62,8	66,5	78,2	86,8	110
28	D3, (BOOST board)	78,3	56,0	93,7	76,3	For ref.
29	Q19, (BOOST board)	73,3	49,1	88,7	69,4	For ref.
30	Q17, (BOOST board)	73,4	46,9	88,8	67,2	For ref.
31	PCB surface near Q19, (BOOST board)	74,2	51,0	89,6	71,3	130
32	Q10, (Invert board)	96,7	89,5	112,1	109,8	For ref.
33	D18, (Invert board)	78,5	72,0	93,9	92,3	For ref.
34	Q11, (Invert board)	84,8	78,2	100,2	98,5	For ref.
35	Q13, (Invert board)	86,2	79,8	101,6	100,1	For ref.
36	Q16, (Invert board)	92,5	85,8	107,9	106,1	For ref.

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37	PCB, near Q13, (Invert board)	80,5	74,0	95,9	94,3	130
38	Outer surface, top	44,3	39,4	59,7	59,7	For ref.
39	Outer surface, side	59,3	51,9	74,7	72,2	For ref.
40	Outer surface, front	45,0	37,7	60,4	58,0	For ref.
No.	Temperature (°C) of part/at:	Measured temperature (°C)		Temperature at calculated to 45 °C ambient		Limits (°C)
		(4)	(5)	(4)	(5)	
01	Test ambient temperature	27,0	24,1	45,0	45,0	--
02	Internal input lead wire	45,1	34,2	63,1	55,1	105
03	DC switch-disconnector	41,2	31,6	59,2	52,5	85
04	Y Capacitor C11, (DC EMI board)	48,0	34,3	66,0	55,2	125
05	Magnet wire of inductor L2, (DC EMI board)	48,9	45,1	66,9	66,0	110
06	Bus capacitor C28, (BOOST board)	51,6	45,4	69,6	66,3	105
07	Magnet wire of transformer TX1, (Boost driving board)	48,7	38,9	66,7	59,8	110
08	Bus capacitor C14, (Invert board)	49,6	40,7	67,6	61,6	105
09	Magnet wire of transformer TX1, (Power supply board)	63,0	57,7	81,0	78,6	110
10	Magnet wire of transformer TX01, (Power supply board)	71,0	68,2	89,0	89,1	110
11	Isolated optocoupler U2, (Power supply board)	56,2	51,4	74,2	72,3	105
12	Diode D05, (Power supply board)	62,6	58,7	80,6	79,6	For ref.
13	Q02, (Power supply board)	62,6	58,9	80,6	79,8	For ref.
14	Lead wire, S phase (Invert output)	58,2	48,0	76,2	68,9	105
15	HCT5, (AC EMI board)	64,5	59,2	82,5	80,1	For ref.
16	X capacitor C52, (AC EMI board)	51,1	40,9	69,1	61,8	125

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

17	Coil of Relay for disconnect AC mains RY3, (AC EMI board)	56,6	53,1	74,6	74,0	110
18	Y capacitor C53, (AC EMI board)	52,1	40,0	70,1	60,9	125
19	Magnet wire of inductor L5, (AC EMI board)	53,6	46,5	71,6	67,4	120
20	X capacitor C56, (AC EMI board)	49,7	43,2	67,7	64,1	110
21	MOV12, (AC EMI board)	50,8	43,0	68,8	63,9	85
22	Fuse link J35 body, (AC EMI board)	52,5	46,2	70,5	67,1	90
23	Output lead wire, (internal)	49,0	42,1	67,0	63,0	105
24	Output terminal block	25,7	25,8	43,7	46,7	85
25	Communication isolated optocoupler U7	45,7	40,4	63,7	61,3	115
26	Magnet wire of BOOST inductor, tracker 2	37,6	58,9	55,6	79,8	110
27	Magnet wire of INVERT inductor, S phase	59,8	58,1	77,8	79,0	110
28	D3, (BOOST board)	54,9	66,1	72,9	87,0	For ref.
29	Q19, (BOOST board)	48,0	60,7	66,0	81,6	For ref.
30	Q17, (BOOST board)	45,9	61,9	63,9	82,8	For ref.
31	PCB surface near Q19, (BOOST board)	49,8	61,1	67,8	82,0	130
32	Q10, (Invert board)	88,2	80,8	106,2	101,7	For ref.
33	D18, (Invert board)	70,9	66,3	88,9	87,2	For ref.
34	Q11, (Invert board)	77,1	72,7	95,1	93,6	For ref.
35	Q13, (Invert board)	78,6	73,7	96,6	94,6	For ref.
36	Q16, (Invert board)	84,6	79,8	102,6	100,7	For ref.
37	PCB, near Q13, (Invert board)	72,6	65,1	90,6	86,0	130
38	Outer surface, top	39,0	36,5	57,0	57,4	For ref.
39	Outer surface, side	51,6	45,1	69,6	66,0	For ref.

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Clause	Requirement – Test	Result – Remark	Verdict

40	Outer surface, front	36,6	35,9	54,6	56,8	For ref.

No.	Temperature (°C) of part/at:	Measured temperature (°C)		Limits (°C)
		(3)	(6)	
01	Test ambient temperature	60,7	61,9	--
02	Internal input lead wire	68,5	68,3	105
03	DC switch-disconnector	80,9	72,5	85
04	Y Capacitor C11, (DC EMI board)	71,0	70,5	125
05	Magnet wire of inductor L2, (DC EMI board)	78,8	79,4	110
06	Bus capacitor C28, (BOOST board)	75,7	76,3	105
07	Magnet wire of transformer TX1, (Boost driving board)	75,9	74,4	110
08	Bus capacitor C14, (Invert board)	77,7	77,0	105
09	Magnet wire of transformer TX1, (Power supply board)	88,2	87,6	110
10	Magnet wire of transformer TX01, (Power supply board)	96,5	96,4	110
11	Isolated optocoupler U2, (Power supply board)	83,2	82,1	105
12	Diode D05, (Power supply board)	88,6	88,0	For ref.
13	Q02, (Power supply board)	88,8	88,4	For ref.
14	Lead wire, S phase (Invert output)	83,0	82,9	105
15	HCT5, (AC EMI board)	79,3	79,4	For ref.
16	X capacitor C52, (AC EMI board)	76,7	76,2	125
17	Coil of Relay for disconnect AC mains RY3, (AC EMI board)	82,5	82,1	110
18	Y capacitor C53, (AC EMI board)	77,1	75,7	125
19	Magnet wire of inductor L5, (AC EMI board)	89,7	89,5	120
20	X capacitor C56, (AC EMI board)	76,3	75,3	110
21	MOV12, (AC EMI board)	76,2	75,7	85

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Clause	Requirement – Test	Result – Remark	Verdict

22	Fuse link J35 body, (AC EMI board)	87,8	87,4	90
23	Output lead wire, (internal)	80,9	80,5	105
24	Output terminal block	78,0	73,9	85
25	Communication isolated optocoupler U7	80,0	78,9	115
26	Magnet wire of BOOST inductor, tracker 2	72,5	98,1	110
27	Magnet wire of INVERT inductor, S phase	88,8	87,6	110
28	D3, (BOOST board)	87,5	85,7	For ref.
29	Q19, (BOOST board)	90,5	87,6	For ref.
30	Q17, (BOOST board)	88,8	85,0	For ref.
31	PCB surface near Q19, (BOOST board)	97,7	98,3	130
32	Q10, (Invert board)	110,5	98,2	For ref.
33	D18, (Invert board)	93,6	93,3	For ref.
34	Q11, (Invert board)	98,8	98,2	For ref.
35	Q13, (Invert board)	98,8	98,1	For ref.
36	Q16, (Invert board)	105,0	103,3	For ref.
37	PCB, near Q13, (Invert board)	90,6	90,8	130
38	Outer surface, top	80,5	88,3	For ref.
39	Outer surface, side	76,0	77,1	For ref.
40	Outer surface, front	72,3	70,3	For ref.
Remark: N/A				

4.4	**TABLE: fault condition tests**		P
	Ambient temperature (°C) …… :	25 °C ~ 29 °C	—
	Relative humidity……:	62%RH	—

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Clause	Requirement – Test	Result – Remark	Verdict

No.	component	Fault	Input (V)	Output (Vac, kW)	Test duration	Observation
01	HCT1, feedback pin 7 and positive power supply pin 8, (DC EMI board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
02	HCT1, feedback pin 7 and negative power supply pin 9, (DC EMI board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
03	Bus capacitor C2, (Boost board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
04	Q5 (g-c), (Boost board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
05	Q5 (g-e), (Boost board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately. IGBT Q6, Q7, Q8 are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
06	Q5 (c-e), (Boost board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
07	Q5 (pin e), (Boost board)	Open	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately. IGBT Q6, Q7, Q8 are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
08	Q10 (g-c), (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
09	Q10 (c-e), (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.

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Clause	Requirement – Test	Result – Remark	Verdict

10	Q10 (pin e), (Invert board)	Open	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
11	Q13 (g-c), (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
12	Q13 (c-e), (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
13	Q13 (pin e), (Invert board)	Open	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
14	D17, (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
15	D22, (Invert board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit's output AC relays disconnected immediately and IGBT are damaged, indicate fault. Non-resettable. No emission of molten metal, or burning insulation, or flaming or glowing particles. Can withstand electric strength test.
16	HCT4, feedback pin 7 and positive power supply pin 8, (AC EMI board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
17	HCT4, feedback pin 7 and negative power supply pin 9, (AC EMI board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
18	HCT4, feedback pin 7, (AC EMI board)	Open	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.

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19	Q1 (d-s), (IGBT drive board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	Operating as normal, no damage, no hazard.
20	Q1 (g-s), (IGBT drive board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
21	Q1 (g-d), (IGBT drive board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	Operating as normal, no damage, no hazard.
22	U1, pin 5 and pin 8, (IGBT drive board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
23	D3, (IGBT drive board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected. Can resettable. No damage. No hazard.
24	U02, pin 1, (SMPS board)	Open	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	Operating as normal, no damage, no hazard.
25	U02, pin3 and pin 4, (SMPS board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	Operating as normal, no damage, no hazard.
26	U01, pin 6 and pin 8, (SMPS board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected. Can resettable. No damage. No hazard.
27	U01, pin 6 and pin 3, (SMPS board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected. Can resettable. No damage. No hazard.
28	U01, pin 6 and pin 4, (SMPS board)	Short	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	10 minutes	The unit protected immediately and output AC relays disconnected. Can resettable. No damage. No hazard.
29	Tracker 1, Negative and positive	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.

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30	Tracker 1, Negative and Tracker 2 positive	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.
31	Output Line and Neutral conductor	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.
32	Output Line 1 and Line 2 conductor	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.
33	Output Line 1 and Line 3 conductor	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.
34	Output Line 2 and Line 3 conductor	Reversed	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	The unit can't start and indicate fault. Can resettable. No damage. No hazard.
35	Output PE conductor	Disconnected before energized DC and AC	Vmax.= 1000 Vd.c., Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	Can't connect to grid after energized DC and AC power. Output AC relays opened. Indicate fault. Can resettable. No damage. No hazard.
36	Cooling fan for inductor	One locked	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	60 minutes	The unit protected after 30 minutes and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.
37	Cooling fan for IGBT	One locked	800 Vdc	3/N/PE, 230/400 Va.c., 60 kW	50 minutes	The unit protected after 25 minutes and output AC relays disconnected, indicate fault. Can resettable. No damage. No hazard.

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Supplementary information:

(1) PV simulator used for apply these fault condition tests.

(2) If no special indicate, all single fault condition tests are conduct after normal operating.

7.3.7	**TABLE: Creepage distances and clearances for appliances**					P
Clearances and Creepage distance at:	System voltage (V)	OVC	Required Cl (mm)	Cl (mm)	Required Cr (mm)	Cr (mm)
Hazard live parts and earthed terminal on DC EMI board, PCB top layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	6,2	5,0	6,2
Hazard live parts and earthed terminal on DC EMI board, PCB bottom layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	7,0	5,0	7,0
Hazard live parts and earthed terminal on Boost board, PCB top layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	6,0	5,0	6,0
Hazard live parts and earthed terminal on Boost board, PCB bottom layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	6,5	5,0	6,5
Hazard live parts and earthed terminal on invert board, PCB top layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	6,5	5,0	6,5
Hazard live parts and earthed terminal on invert board, PCB bottom layer, (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	7,0	5,0	7,0
Hazard live parts and ELV circuit on auxiliary power supply board, PCB top layer, (BI), through optocouplers U02 and isolated transformer TX01	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	7,5	5,0	7,5
Hazard live parts and ELV circuit on auxiliary power supply board, PCB bottom layer, (BI), through optocouplers U02 and isolated transformer TX01	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	8,5	5,0	8,5
Isolated transformer TX01 pri. winding (N1, N5, N6) and sec. winding (N2, N3, N4, N7), (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	5,5	5,0	5,5
ELV circuit and SELV circuit (communication port) on auxiliary power supply board, PCB top layer, (SI), through optocouplers U2 and isolated transformer TX1	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	7,5	5,0	7,5

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ELV circuit and SELV circuit (communication port) on auxiliary power supply board, PCB bottom layer, (SI), through optocouplers U2 and isolated transformer TX1	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	8,5	5,0	8,5
Isolated transformer TX1 pri. winding (N2, N3) and sec. winding (N1, N4), (BI)	1000 Vd.c. 277 Va.c.	PV: II Mains: III	3,6	6,5	5,0	6,5
Across the contacts of relays, (BI)	1000 Vd.c.	PV: II	2x1,8	2x2,1	--	--
PCB track for disconnect AC mains relays contact on AC EMI board, PCB bottom layer, (BI)	1000 Vd.c.	PV: II	2x1,8	2x2,7	2x1,8	2x2,1

Note:

(1) For PV circuit, system voltage is 1000 V and overvoltage category is OVC II, impulse voltage correspond to PV circuit is 4464 V. For AC mains circuit, nominal voltage is 277 V(phase to neutral) and overvoltage category is OVC III, impulse voltage correspond to mains circuit is 4464 V.

(2) For insulations between hazard live parts, which PV circuit and mains circuit is not isolated, PV system voltage 1000 V is considered for the maximum working voltage;

(3) The PCE enclosure is rated IP65 and the pollution degree inside enclosure is reduced from PD3 to PD2;

(4) Refer to IEC 62109-2, Cl.4.4.4.15.2.2, the Cl. Requirements between contacts of relay in open position are divided by relays in different Lines. Therefore the Cl. requirement for contacts of each relay in open position is 1,8 mm.

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Clause	Requirement – Test	Result – Remark	Verdict

7.3.7.8.3.2 to 7.3.7.8.3.3	**TABLE: distance through insulation measurement**			P
distance through insulation di at/of:	U r.m.s. (V)	test voltage (V)	required dti (mm)	dti (mm)
Communication isolated optocouplers (BI)	1000 Vd.c. 277 Va.c.	1680 $V_{r.m.s}$	>0,4	Certified
Multi-layer insulated winding wire as sec. winding in isolated transformer (RI)	1000 Vd.c. 277 Va.c.	1680 $V_{r.m.s}$	--	Certified
Note: detail see Critical components list (CDF)				

7.5	**TABLE: electric strength measurements, impulse voltage test and partial discharge test**			P
test voltage applied between:	test voltage (V)	impulse withstand voltage (V)	partial discharge extinction voltage (V)	result
PV input terminal and PE, (BI)	1680 $V_{r.m.s}$	4464 V_{peak}	N/A	No breakdown
AC output terminal and PE, (relay contact short-circuit), (BI)	1680 $V_{r.m.s}$	4464 V_{peak}	N/A	No breakdown
PV input terminal and 485 Communication port, (RI)	3360 $V_{r.m.s}$	6464 V_{peak}	N/A	No breakdown
AC output terminal and Communication port, (relay contact short-circuit), (RI)	3360 $V_{r.m.s}$	6464 V_{peak}	N/A	No breakdown

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Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
Metal enclosure	Shenzhen Kstar New Energy Company Limited	--	LxWxD: 1010mmx636mmx260 mm, AL5052 H32 with outdoor powder coatings	IEC 62109-1 IEC 62109-2	Tested with appliance
Heat sink (KSG-30K, KSG-36K-HV)	Shenzhen Kstar New Energy Company Limited	--	LxWxD: 590mmx450mmx80,5mm, 6063 aluminum alloy	IEC 62109-1 IEC 62109-2	Tested with appliance
Heat sink (KSG-50K, KSG-60K, KSG-50K-HV, KSG-60K-HV)	Shenzhen Kstar New Energy Company Limited	--	LxWxD: 525mmx410mmx80,5mm, 6063 aluminum alloy	IEC 62109-1 IEC 62109-2	Tested with appliance
Plastic cover for protective LCD	LG Chemical (Guangzhou) Engineering Plastics Co., Ltd.	LUPOY GP-1006F(f1), LUPOY GP-1006F(m)(f1)	V-0, 120 °C, 56mmx28mm for LCD window	--	UL E248280
--Alternative	Various	UL Recognized	UV resistance, V-1, 120 °C or above	--	UL Recognized
PV connector	Phoenix	PV-FT-CF-C-4-250-BV-SP; PV-FT-CM-C-4-250-RD-SP	1000 Vdc, 40 A, -40 °C ~ +85 °C, IP65	EN 50521	TÜV R 60029159
--(alternative PV connector)	Amphenol	Helios H4 4 mm²	1000 Vdc, 40 A@Ta=90 °C, 4 mm², -40 °C ~ +85 °C, IP68	EN 50521	TÜV R 50157783
DC Switch disconnector (KSG-30K, KSG-36K-HV)	Santon International B.V.	XA100.16P6E-D	1000V/16A, 850V/20A, 800V/25A, 650V/32A	EN 60947-3	KEMA 2152871.02
DC Switch disconnector (KSG-50K, KSG-60K, KSG-50K-HV, KSG-60K-HV)	Santon International B.V.	X75.32P6E-D	750V/32A, 1000V/10A, 800V/25A, 650V/40A	EN 60947-3	KEMA 2124402.01
Cable gland for AC output (KSG-30K, KSG-36K-HV, KSG-50K)	BEISIT ELECTRIC (HANGZHOU) CO.,LTD.	MG4030B	Cable diameter range: 24 ~ 30 mm, -40 °C ~ +100 °C, IP68, UV resistance	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
Cable gland for AC output (KSG-50K-HV, KSG-60K, KSG-60K-HV)	BEISIT ELECTRIC (HANGZHOU) CO.,LTD.	MG5040B	Cable diameter range: 30 ~ 40 mm, -40 °C ~ +100 °C, IP68, UV resistance	IEC 62109-1 IEC 62109-2	Tested with appliance
Cable gland for external communication cable	BEISIT ELECTRIC (HANGZHOU) CO.,LTD.	M25-H2-8	No. of holes x d(mm): 2x8, -40 °C ~ +100 °C, IP68, UV resistance	IEC 62109-1 IEC 62109-2	Tested with appliance
Output terminal block (KSG-36K-HV, KSG-50K-HV, KSG-60K-HV)	Shenzhen Connection Electronic Co., Ltd.	DRTB38-04-NR	100 A, 600 V, 2~10AWG, 125 °C	--	UL E304128
Output terminal block (KSG-30K, KSG-50K, KSG-60K)	Shenzhen Connection Electronic Co., Ltd.	DRTB38-05-NR	100 A, 600 V, 2~10AWG, 125 °C	--	UL E304128
Internal lead wire(between DC switch disconnector and PCB)	3Q Wire & Cable Co., Ltd.	UL 10269	1000 Vac, 1250 Vdc, 105 °C, 10AWG, VW-1	--	UL E341104
--(alternative)	Various	UL 10269	1000 Vac, 1250 Vdc, 105 °C, 10AWG, VW-1	--	UL Recognized
Internal lead wire, PE	Various	UL 1015	600 Vac, 105 °C, 12AWG, VW-1	--	UL Recognized
Y capacitor, PV side (C1, C84, C10, C94, C11, C86, C20, C92, C25, C88, C29, C90, C85, C2, C9, C95, C87, C12, C19, C93, C89, C26, C30, C91)	Shantou High-New Technology Dev. Zone Songtian Enterprise Co., Ltd.	CD-Series	400 Vac, 4700 PF, Y1, 25/125/21	EN 60384-14	VDE 40025754
--(alternative)	Various	Various	400 Vac, 4700 PF, Y1, 25/125/21	IEC/EN 60384-14	TUV, VDE or other EU certification marks
Inductor, PV side (L1, L2, L3)	Boluo Da Xin Electronic Co., Ltd.	3811-0569	N1(1,2-7,8): 2.5Φ*2P*6Ts; N2(3,4-5,6): 2.5Φ*2P*6Ts	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufactur-er/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
-- Magnet wire	Various	UL Recognized	155 °C or above	--	UL Recog-nized
--Epoxy board	Various	UL Recognized	V-0, 130 °C or above	--	UL Recog-nized
--Insulation tape	Jingjiang Ya-hua Pressure Sensitive Glue Co., Ltd.	CT	130 ºC	--	UL E165111
D1, D2, D3, D4, D5, D6 on DC EMI board (KSG-30K, KSG-36K-HV)	Cree	C4D20120D	32 A, 1200 V	IEC 62109-1 IEC 62109-2	Tested with appliance
D1, D2, D3, D4, D5, D6 on DC EMI board (KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV)	Cree	C4D10120D	18 A, 1200 V	IEC 62109-1 IEC 62109-2	Tested with appliance
Q5, Q6, Q7, Q8, Q17, Q18, Q19, Q20, Q29, Q30, Q31, Q32 on DC EMI board	Fairchild	FGH25T120SMD	25 A, 1200 V	IEC 62109-1 IEC 62109-2	Tested with appliance
Boost inductor (KSG-30K, KSG-36K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technol-ogy Co., Ltd.	30K BOOST1 30K BOOST2 30K BOOST3	BOOST1=BOOST2=BOOST3=Φ2,2x2Px48Ts	IEC 62109-1 IEC 62109-2	Tested with appliance
Boost inductor (KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technol-ogy Co., Ltd.	50K BOOST1 50K BOOST2 50K BOOST3	BOOST1=BOOST2=BOOST3=Φ2,0x4Px74Ts	IEC 62109-1 IEC 62109-2	Tested with appliance
Invert inductor (KSG-30K, KSG-36K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technol-ogy Co., Ltd.	30K-INV1 30K-INV2 30K-INV3	INV1=INV2=INV3=Φ2,1x4Px64Ts	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
Invert inductor (KSG-50K, KSG-50K-HV, KSG-60K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technology Co., Ltd.	50K-INV1 50K-INV2 50K-INV3	INV1=INV2=INV3=Φ1,5 x14Px31Ts	IEC 62109-1 IEC 62109-2	Tested with appliance
Invert inductor (KSG-60K)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technology Co., Ltd.	60K-INV1 60K-INV2 60K-INV3	INV1=INV2=INV3=Φ1,4 x20Px27Ts	IEC 62109-1 IEC 62109-2	Tested with appliance
AC output EMI inductor (KSG-30K, KSG-36K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technology Co., Ltd.	EMI-30K	L1=L2=L3=Φ1,5x6Px19 Ts, three inductor located in one box	IEC 62109-1 IEC 62109-2	Tested with appliance
AC output EMI inductor (KSG-50K, KSG-50K-HV, KSG-60K-HV)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technology Co., Ltd.	EMI-50K	L1=L2=L3=Φ1,6x6Px17 Ts, three inductor located in one box	IEC 62109-1 IEC 62109-2	Tested with appliance
AC output EMI inductor (KSG-60K)	Boluo Da Xin Electronic Co., Ltd. Shenzhen Click Technology Co., Ltd.	EMI-60K	L1=L2=L3=Φ1,6x8Px15 Ts, three inductor located in one box	IEC 62109-1 IEC 62109-2	Tested with appliance
--Below list are the critical components in the above boost inductor, invert inductor and AC output EMI inductor (KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV)					
--Magnet wire	Various	UL Recognized	180 °C or above	--	UL Recognized
--Lead wire	Various	UL 10269	1000 Vac, 1250 Vdc, 105 °C, 8AWG, VW-1	--	UL Recognized
--Heat shrinkable tubing	Changyuan Electronics Group Co., Ltd.	CB-HFT	600 V, 125 °C, VW-1	--	UL E180908

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
--fiberglass sleeving	Shenzhen Wahchangwei Industrial Co., Ltd.	SRS-70*	600 V, 200 °C, Grade A Silicone coated fiberglass sleeving	--	UL E233803
--Nomex insulation sheet	Zhuzhou Times Electric Insulation Co., Ltd.	TJ6640 NMN	180 °C	--	UL E355960
--Insulating tape	Jingjiang Yahua Pressure Sensitive Glue Co., Ltd.	PF* (d)(g)	180 °C, Polyimide film insulating tapes	--	UL E165111
--Margin tape	Jingjiang Yahua Pressure Sensitive Glue Co., Ltd.	WF	130 ºC	--	UL E165111
--Silicone Molding resin	Shenzhen Anpin Silicone Material Co., Ltd.	AP-905*	V-0, 105 °C	--	UL E257078
--Above list are the critical components in the above boost inductor, invert inductor and AC output EMI inductor (KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV)					
Cooling fans, 2 pcs used for boost and invert inductor, 4 pcs used for IGBT heat sink	Sanyo Denki Co., Ltd.	9WP0812G403	12 Vdc, 0,38 A, 4500RPM	EN 60950-1	TÜV R 50122368
Q1, Q2… ~ Q24 on invert board, (KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K-HV)	Fairchild	FGA60N65SMD	60 A, 650 V	IEC 62109-1 IEC 62109-2	Tested with appliance
Q1, Q2… ~ Q24 on invert board, (KSG-60K)	Fairchild	FGH75T65SHD	75 A, 650 V	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
D5, D6, D9, D10, D17, D18, D21, D22, D29, D30, D33, D34 on invert board (KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K-HV)	Fairchild	FFH60UP60STU	60 A, 600 V	IEC 62109-1 IEC 62109-2	Tested with appliance
D5, D6, D9, D10, D17, D18, D21, D22, D29, D30, D33, D34 on invert board (KSG-60K)	Fairchild	FFH75H60S	75 A, 600 V	IEC 62109-1 IEC 62109-2	Tested with appliance
X capacitor C49, C52, C58 on AC EMI board, (KSG-30K, KSG-50K, KSG-60K)	Shenzhen Jinghao Capacitor Co., Ltd.	CBB62B	2,2 µF, 305 Vac, X2, 40/110/56	IEC/EN 60384-14	VDE 40018690
--(alternative)	Various	Various	2,2 µF, 305 Vac, X2, 40/110/56	IEC/EN 60384-14	TUV, VDE or other EU certification marks
Capacitor C49, C52, C58 on AC EMI board, (KSG-36K-HV, KSG-50K-HV, KSG-60K-HV)	EPCOS	Metallized Polypropylene Film Capacitors (MKP)	2,2 µF, 350 Vac, MKP	IEC 62109-1 IEC 62109-2	Tested with appliance
Capacitor C35, C40, C45 on AC EMI board, (KSG-30K, KSG-50K, KSG-60K)	EPCOS	B32796E3206K000	20 µF, 300 Vac, MKP film capacitors	IEC 62109-1 IEC 62109-2	Tested with appliance
Capacitor C35, C40, C45 on AC EMI board, (KSG-36K-HV, KSG-50K-HV, KSG-60K-HV)	EPCOS	B32796E8206J000	20 µF, 350 Vac, MKP film capacitors	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
Relays for disconnect AC output on AC EMI board RY1, RY2, RY3, RY4, RY5, RY6, (KSG-30K, KSG-36K-HV)	Song Chuan Precision Co., Ltd.	510-P-2A-C	Contact ratings: 35 A, 250 Vac, double pole, 2,1 mm contact gap, T85, Coil ratings: 12 Vdc, 2,4 W, class F	IEC/EN 61810-1	TÜV R 50199385
Relays for disconnect AC output on AC EMI board RY1, RY2, RY3, RY4, RY5, RY6, (KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV)	Song Chuan Precision Co., Ltd.	510H-P-2A-F-C	Contact ratings: 54 A, 250 Vac, double pole, 2 mm contact gap, T85, Coil ratings: 12 Vdc, 4,8 W, class F	IEC/EN 61810-1	TÜV R 50199385
Y capacitor C53, C54, C57, C50, C59, C65 on AC EMI board	Shantou High-New Technology Dev. Zone Songtian Enterprise Co., Ltd.	CD-Series	400 Vac, 4700 PF, Y1, 25/125/21	EN 60384-14	VDE 40025754
--alternative	Various	Various	400 Vac, 4700 PF, Y1, 25/125/21	IEC/EN 60384-14	TUV, VDE or other EU certification marks
Filter on AC EMI board (L5)	Boluo Da Xin Electronic Co., Ltd.	30KW-EMI	L1=L2=L3=Φ2,2x5Px5 Ts, class B	IEC 62109-1 IEC 62109-2	Tested with appliance
MOV10, MOV11, MOV12 on AC EMI board	Shantou High-New Technology Dev. Zone Songtian Enterprise Co., Ltd.	STE-20D621K	385 Vac, 6500 A_{peak}, 40/085/21	IEC 61051-2-2	VDE 40023049
Gas tubes ZV1 on AC EMI board, (KSG-30K, KSG-50K, KSG-60K)	EPCOS	A81-A600X	600 V, 20 kA	--	UL E163070
Gas tubes ZV1 on AC EMI board, (KSG-36K-HV, KSG-50K-HV, KSG-60K-HV)	EPCOS	A71-H08X	800 V, 10 kA	--	UL E163070

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
Fuse link on AC EMI board, (KSG-30K, KSG-36K-HV)	Bussmann	80LET	80 A, 240 Vac	--	UL E91958
Fuse link on AC EMI board, (KSG-50K, KSG-60K, KSG-50K-HV, KSG-60K-HV)	Bussmann	125LET	125 A, 240 Vac	--	UL E91958
X capacitor C51, C56, C60 on AC EMI board, (KSG-30K, KSG-50K, KSG-60K)	Shenzhen Jinghao Capacitor Co., Ltd.	CBB62B	2,2 µF, 305 Vac, X2, 40/110/56	IEC/EN 60384-14	VDE 40018690
X capacitor C51, C56, C60 on AC EMI board, (KSG-36K-HV, KSG-50K-HV, KSG-60K-HV)	EPCOS	B32794D8225J000	2,2 µF, 305 Vac, Metallized polypropylene film capacitors	IEC/EN 60384-14	VDE 40018690
Communication isolated optocouplers (U5, U7, U8, U9, U10, U4, U1, U11, U12, U13)	Cosmo Electronics Corp.	K1010-4C	V_{IORM}=890 V, DTI≥0,5, Cr=Cl≥6,5, mm, 55/115/21	EN 60747-5-5	VDE 101347
Isolated transformer on auxiliary power supply board (TX1)	Shenzhen Click Technology Co., Ltd.	3801-2296	Pri.:N2(pin8-10)Φ0,4*2P(2uew-B) 20Ts, N3(pin6-7)Φ0,2*1P(2uew-B) 14Ts; Sec.: N1(pin5-4)Φ0,3*2P(TEX-E)8Ts N4(pin2-3)Φ0,3*2P(TEX-E)2Ts	IEC 62109-1 IEC 62109-2	Tested with appliance
Isolated transformer on auxiliary power supply board (TX01)	Shenzhen Click Technology Co., Ltd.	3801-2316	Pri.: N1(pin6-7)Φ0,2*1P(2uew-B) 40Ts, N6(pin7-8)Φ0,2*1P(2uew-B) 40Ts, N5(pin9-10)Φ0,2*1P(2uew-B)	IEC 62109-1 IEC 62109-2	Tested with appliance

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IEC 62109-1			
Clause	Requirement – Test	Result – Remark	Verdict

Critical components list (CDF)					
Object/part No.	**manufacturer/ trademark**	**type/model**	**technical data**	**Standard**	**mark(s) of conformity[1])**
	Suzhou Cormex Electronics Co., Ltd.		14Ts; Sec.: N7(pin1-2)Φ0,2*1P(2UEW-B) 13Ts, N2(pin2-4)Φ0,35*5P(2UEW-B) 8Ts, N3(pin4-3)Φ0,35*5P(2UEW-B) 3Ts, N4(pin3-5)Φ0,35*5P(2UEW-B) 2Ts		
Isolated opto-couplers on auxiliary power supply board (U02)	Cosmo Electronics Corp.	K1010-4C	V_{IORM}=890 V, DTI≥0,5, Cr=Cl≥6,5, mm, 55/115/21	EN 60747-5-5	VDE 101347
PCB	Various	Various	V-0, CTI>175, 130 °C	--	UL recognized
Note: (1) If no special indicate, list of critical components are applied for all models. (2) Throughout this file (CDF) a comma is used as the decimal separator.					

……..End of test report……..

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TEST REPORT

IEC 62109-2:2011

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

Report Number. .....:	64.290.16.00045.03 part 2 of 2
Date of issue .....:	2017-12-18
Total number of pages	29 pages
Applicant's name .....:	Shenzhen Kstar New Energy Company Limited
Address .....:	The 9th Floor, R&D Building, Kstar Industrial Park, Guangming Hi-tech Industrial Zone, 518107 Shenzhen, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard .....:	IEC 62109-2:2011, EN 62109-2:2011
Test procedure.....:	Type test
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 2016-08

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This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

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Test item description..... :	PV grid-interactive inverter
Trade Mark..... :	KSTAR
Manufacturer..... :	Same as applicant
Model/Type reference..... :	KSG-30K, KSG-36K-HV, KSG-50K, KSG-50K-HV, KSG-60K, KSG-60K-HV
Ratings..... :	See report No.: 64.290.16.00045.03 Part 1 of 2

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):

☒	**Testing Laboratory:**	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch	
Testing location/ address ..... :		5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West, Guangzhou 510656, P. R. China	
Tested by (name, function, signature) ..... :		Max Fang (Fang Wensong) Kennen Wang (Wang Kaixiang)	Max Fang Kennen Wang
Approved by (name, function, signature) .. :		Billy Qiu (Qiu Bili)	

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

This test report contains 4 parts listed in below table:

Item	Description	Pages
Part 1	IEC/EN 62109-1:2010 test report	85
Part 2	IEC/EN 62109-2:2011 test report	29

This test report shall be also used in conjunction with 23 pages of Photo documentation.

Summary of testing:

All tests were carried out according to IEC 62109-2:2011. The text of IEC 62109-2:2011 was approved by CENELEC as a European Standard without any modification.

Tests performed (name of test and test clause):

Clause	Requirement
4.4.4.15	Fault-tolerance of protection for grid-interactive inverters
4.4.4.17	Cooling system failure – Blanketing test
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays
4.8.3.5	Protection by residual current monitoring
9.3.4	Inverter backfeed current onto the array

Note: If no especial indicated, all the tests are applied for model: KSG-60K.

Testing location:

TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch

5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West, Guangzhou 510656, P. R. China

Copy of marking plate:

See report No.: 64.290.16.00045.03 Part 1 of 2

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Test item particulars .....:	
Equipment mobility .....:	☐ movable ☐ hand-held ☒ stationary ☒ fixed ☐ transportable ☐ for building-in
Connection to the mains.....:	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in
Enviromental category.....:	☒ outdoor ☐ indoor unconditional ☐ indoor conditional
Over voltage category Mains.....:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV.....:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Mains supply tolerance (%).....:	+/- 10%
Tested for power systems .....:	TN or TT system for models: KSG-30K, KSG-50K, KSG-60K; IT system for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV
IT testing, phase-phase voltage (V).....:	480 Va.c. for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV
Class of equipment.....:	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg).....:	Net weight: 61 kg ~ 67,4 kg (Approx.)
Pollution degree.....:	3 (External), 2 (Internal)
IP protection class .....:	IP65
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 .....:	27 November 2015
Date (s) of performance of tests .....:	10 January 2016 ~ 29 April 2016 and 8 December 2017 to 15 December 2017

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
Throughout this report a ☒ comma / ☐ point is used as the decimal separator.

Revision history

This report is based on original report No.: 64.290.16.00045.02 (Certificate No.: Z2 16 08 75386 045, N8A 16 08 75386 046), with the parameters of 60 Hz added. Original test report and certificates are reserved.

Manufacturer's Declaration per sub-clause 6.2.5 of IECEE 02:

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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 .....:	☐ Yes ☒ Not applicable
When differences exist; they shall be identified in the General product information section.	

General product information: See report No.: 64.290.16.00045.03 Part 1 of 2
Model differences: See report No.: 64.290.16.00045.03 Part 1 of 2
Name and address of factory (ies)…….. Shenzhen KSTAR Science & Technology Co., Ltd. Guangming Branch Kstar High Tech Park, Guangming High, Technology Town, Gongming Street, Baoan District, 518107 Shenzhen City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
Electrical Ratings: See report No.: 64.290.16.00045.03 Part 1 of 2

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IEC 62109-2:2011			
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	(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		N/A
	- not re-connect after any sequence of removing and reconnecting PV power		N/A
	- not re-connect after any sequence of removing and reconnecting AC power		N/A
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		N/A
	- Indicates a fault in accordance with §13.9		N/A
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		P
4.4.4.15.2 .1	The means provided for automatic disconnection of a grid-interactive inverter from the mains shall:		P
	- disconnect all grounded current-carrying conductors from the mains		P

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Clause	Requirement + Test	Result - Remark	Verdict
	- disconnect all ungrounded current-carrying conductors from the mains		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 table) 4.4.4.15.2 Fault-tolerance of automatic disconnecting.	P
	If the check fail: 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:	Grid interactive inverter.	N/A
	- shall continue to operate normally		N/A
	- shall not present a risk of fire as the result of an out-of-phase transfer		N/A
	- shall not present a risk of shock as the result of an out-of-phase transfer		N/A
	- And having control preventing switching: components for malfunctioning ……..…:		N/A
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 table) Cooling system failure – Blanketing test.	P
	Test stop condition: time duration value or stabilized temperature ……..:		P

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Clause	Requirement + Test	Result - Remark	Verdict
4.7	Electrical ratings tests		N/A
4.7.4	Stand-alone Inverter AC output voltage and frequency		N/A
4.7.4.1	General		N/A
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.		N/A
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.		N/A
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.		N/A
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 %.		N/A
4.7.5	Stand-alone inverter output voltage waveform		N/A
4.7.5.1	General		N/A
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 %.		
4.7.5.3	Non-sinusoidal output waveform requirements		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

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Clause	Requirement + Test	Result - Remark	Verdict
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/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/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
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		N/A
	- Type of Array grounding supported ……:		N/A
	- Inverter isolation ……..:		N/A
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays	(see appended table)	P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays		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.		N/A
	Measured DC insulation resistance: ……:		P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value R= Vmax/30mA under normal conditions		P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value R= Vmax/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		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 = (VMAX 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, exceeds the residual current values and times in Table 31		N/A
	b-2) Inverter shall either disconnect the resistor or limit the current by other means ……:		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	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		N/A
4.8.3.3	Fire hazard residual current type test for 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..		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 limits:		P

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Clause	Requirement + Test	Result - Remark	Verdict
	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 ouput power rating ≤30kV;		N/A
	- maximum 10 mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA.		P
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		N/A
	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
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		N/A
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 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 and150mA) of Table 31.	(see appended table)	P
4.8.3.6	Systems 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:		P

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IEC 62109-2:2011			
Clause	Requirement + Test	Result - Remark	Verdict
	- Vmax PV (absolute maximum) (d.c. V)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	a.c. output ratings:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	a.c input ratings:		N/A
	- Voltage (nominal or range) (a.c. V)		N/A
	- Current (maximum continuous) (a.c. A)		N/A
	- Frequency (nominal or range) (Hz)		N/A
	d.c. 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)		P
	Ingress protection (IP) rating per part 1		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.		N/A
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

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Clause	Requirement + Test	Result - Remark	Verdict

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 :		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)		P
	a.c. output quantities:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Current (inrush) (a.c. A, peak and duration)		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)		P
	- Maximum output overcurrent protection (a.c. A)		P
	a.c. input quantities:		N/A
	- Voltage (nominal or range) (a.c. V)		N/A
	- Current (maximum continuous) (a.c. A)		N/A
	- Current (inrush) (a.c. A, peak and duration)		N/A
	- Frequency (nominal or range) (Hz)		N/A
	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

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Clause	Requirement + Test	Result - Remark	Verdict
	- Current (maximum continuous) (d.c. A)		N/A
	Protective class (I or II or III)		P
	Ingress protection (IP) rating per part 1		P
5.3.2.2	Grid-interactive inverter setpoints	Non-adjustable to operator, pre-set by manufacturer before shipment.	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 rom the PCE		N/A
5.3.2.3	Transformers and isolation		P
	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.	The PV array shall not be earthed. External isolate transformer shall used for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV	P
	An inverter shall be provided with information to the installer regarding:		P
	- providing of internal isolation transformer		N/A
	- the level of insulation (functional, basic, reinforced, or double)	External isolate transformer shall used for models: KSG-36K-HV, KSG-50K-HV, KSG-60K-HV.	P
	The instructions shall also indicate what the resulting installation requirements are regarding:		P
	- earthing or not earthing the array	Not earthing	P
	- providing external residual current detection devices		N/A
	- requiring an external isolation transformer,	Isolated frequency transformer.	P
5.3.2.4	Transformers required but not provided		P

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IEC 62109-2:2011			
Clause	Requirement + Test	Result - Remark	Verdict

	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:		P
	- the configuration type		P
	- electrical ratings		P
	- environmental ratings		P
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		P
	If the maximum AC mains operating voltage is higher than the PV array maximum system voltage then the instructions shall require PV modules that have a maximum system voltage rating based upon the AC mains voltage.		N/A
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

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IEC 62109-2:2011			
Clause	Requirement + Test	Result - Remark	Verdict
	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 must be installed in closed electrical operating areas		N/A
	- 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		N/A
	Where required by 7.3.10, the documentation for an inverter shall include the following:		N/A
	- if output circuit bonding is required but is not provided integral to the inverter, the required means shall be described in the installation instructions, including which conductor is to be bonded and the required current carrying capability or cross-section of the bonding means;		N/A
	- if the output circuit is intended to be floating, the documentation for the inverter shall indicate that the output is floating.		N/A
5.3.2.9	Protection by application of RCD's		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,.		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.		P
5.3.2.11	External array insulation resistance measurement and response		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	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
	- 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		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 = VMAX PV/30 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

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Clause	Requirement + Test	Result - Remark	Verdict
	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.		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……..	Provided by display panel when the PCE started.	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		N/A
	One circuit conductor bonded to earth to create a grounded conductor and an earthed system.		N/A
	The means used to bond the grounded conductor to protective earth provided within the inverter or		N/A
	as part of the installation		N/A
	If not provided integral to the inverter, the required means shall be described in the installation instructions as per 5.3.2.8.		N/A
	The means used to bond the grounded conductor to protective earth shall comply with the requirements for protective bonding in Part 1,		N/A
	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.		N/A
	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..		N/A
	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.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	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……..		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.		P
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		P
	b) an electrical or electronic indication that can be remotely 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

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Clause	Requirement + Test	Result - Remark	Verdict

4.4.4	**TABLE: Single fault condition to be applied**		P
	Ambient temperature (°C)	24 °C ~ 27 °C	—
	Relative humidity……:	60%RH	—
4.4.4.15.1	Fault-tolerance of residual current monitoring		

No.	component	Fault	Input (Vdc)	Output (Vac)	Test duration	Fuse current (A)	Observation
Short-circuit before energized							
1	Q3 (d-s), (AC EMI board)	Short	PV Simulator used with settings Vmax = 1000 Vdc, Isc=42 Ad.c. x 3	3/N/PE, 230/400 Va.c.	10 minutes	--	Do not connect to AC mains unless remove fault condition. The red LED was light and LCD indicate fault. No damage. No hazard.
2	Q3 (g-d), (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
3	Q3 (g-s), (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
4	Q3 pin d, (AC EMI board)	Open		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
5	HCT7, pin 3 and pin 4, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
6	HCT7, pin 3 and pin 2, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
7	HCT7, pin 3 and pin 1, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
8	HCT7, pin 4 and pin 2, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;

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Clause	Requirement + Test	Result - Remark	Verdict

9	HCT7, pin 4 and pin 1, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
10	HCT7, pin 3, (AC EMI board)	Open		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
11	HCT7, pin 4	Open		3/N/PE, 230/400 Va.c.	10 minutes	--	Same as above;
12	U1, pin 3 and pin 5, (AC EMI board)	Short		3/N/PE, 230/400 Va.c.	10 minutes	--	Operating as normal, passes testing in accordance with 4.8.3.5 showing that the residual current monitoring system functions properly under the single fault condition, and indicates a fault in accordance with 13.9,

Supplementary information:

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Clause	Requirement + Test	Result - Remark	Verdict

4.4.4	**TABLE: Single fault condition to be applied**		P
	Ambient temperature (°C) ..... :	21 °C ~ 23°C	—
	Power source for EUT: Manufacturer, model/type, output rating ..... :	--	—
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		

Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
Relay K1, contact	Each Relay contact short-circuit one at a time before energized PV and AC	PV Simulator used with settings Vmax = 1000 Vdc, Isc=42 Ad.c. x 3	10 minutes	--	--	LCD indicates fault “Relay fault”, Does not connect to AC mains, can reset by remove fault condition. See below picture.
Relay K2, contact			10 minutes	--	--	Same as above
Relay K3, contact			10 minutes	--	--	Same as above
Relay K4, contact			10 minutes	--	--	Same as above
Relay K5, contact			10 minutes	--	--	Same as above
Relay K6, contact			10 minutes	--	--	Same as above
Check that the relays fulfil the basic insulation or simple separation based on the PV circuit working voltage.						The remaining relay gaps in series provided basic clearance: 2,0 mm
Each active phase can be switched. (L and N)						Three Line conductors disconnected simultaneously.
Supplementary information: Analysis of the design indicates that all the models can be expected to have the same result.						

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Clause	Requirement + Test	Result - Remark	Verdict

4.4.4.17	**Cooling system failure – Blanketing test**		P
	Test voltage (Vdc)	Vmax = 1000 Vdc	—
	Test current (Idc)	Isc=42 Ad.c. x 3	—
	Test voltage (Vac)	3/N/PE, 230/400 Va.c.	—
	Test current (Iac)	Output full load	—
	t_{amb1} (°C)	24,0 °C	—
	t_{amb2} (°C)	27,5 °C	—
	Test duration……..	7 hours	
maximum temperature T of part/at::		T (°C)	T_{max} (°C)
Outer surface, top		87,3	For ref.
Outer surface, side		79,8	For ref.
Outer surface, front		77,9	For ref.
Supplementary information: N/A			

4.8.2	**TABLE: Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays**				P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays				P
DC Voltage below minimum operating voltage (V)	DC Voltage for inverter begin operation (V)	Resistance between ground and PV input terminal (Ω)	Required Insulation resistance R = ($V_{MAX\ PV}$ / 30mA) (Ω)	Result	
DC+ (PV Simulator used with settings Vmax = 1000 Vdc, Isc=42 Ad.c. x 3)					
200 Vdc	250 Vdc	>1 MΩ	1000 Vdc / 30 mA=33,33 kΩ	LCD indicates fault. The unit does not connect to AC mains, can reset by remove fault condition. See below picture.	
DC- (PV Simulator used with settings Vmax = 1000 Vdc, Isc=42 Ad.c. x 3)					
200 Vdc	250 Vdc	>1 MΩ	1000 Vdc / 30 mA=33,33 kΩ	As above	
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.					

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Supplementary information:

	Tracker 1 DC+	Tracker 1 DC-	Tracker 2 DC+	Tracker 2 DC-	Tracker 3 DC+	Tracker 3 DC-
Trip settings (kΩ)	40000 kΩ	40000 kΩ	40000 kΩ	40000 kΩ	40000 kΩ	40000 kΩ
Measured trigger point (kΩ)	40023 kΩ	40035 kΩ	40026 kΩ	40028 kΩ	40024 kΩ	40031 kΩ
Measured recover point (kΩ)	40028 kΩ	40039 kΩ	40030 kΩ	40031 kΩ	40035 kΩ	40038 kΩ

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Clause	Requirement + Test	Result - Remark	Verdict

4.8.3.5	**TABLE: Protection by residual current monitoring**								P
Test conditions:	See below								
4.8.3.5.2	Test for detection of excessive continuous residual current								P
Tracker No.	PV (+ or -)	Input (Vdc)	Output (Vac, kW)	Baseline trip current (mA)	Measured trigger time (ms) shall < 300 ms (repeat 5 times)				
1	+	800 V	3/N/PE, 230/400 Va.c., 60 kW	230 mA	256 ms	272 ms	280 ms	218 ms	232 ms
1	-	800 V	3/N/PE, 230/400 Va.c., 60 kW	211 mA	216 ms	204 ms	220 ms	270 ms	221 ms

Note:
– 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.
This test shall be repeated 5 times, and for all 5 tests the time to disconnect shall not exceed 0,3s.
The test is repeated for each PV input terminal. It is not required to test all PV input terminals if analysis of the design indicates that one or more terminals can be expected to have the same result, for example where multiple PV string inputs are in parallel.

Supplementary information:

(1) The unit have three independent MPP trackers, analysis of the design indicates that any one PV + or PV – terminal can be expected to have the same result.

(2) All above tests indicate a fault in accordance with clause 13.9 as below LCD display;

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Clause	Requirement + Test	Result - Remark	Verdict

4.8.3.5	**TABLE: Protection by residual current monitoring**								P
Test conditions:	See below								
4.8.3.5.3	TABLE: Test for detection of sudden changes in residual current								P
Tracker No.	PV (+ or -)	Input (Vdc)	Output (Vac, kW)	Baseline trip current (mA)	Measured trigger time (ms) shall < 300 ms for 30 mA; (repeat 5 times)				
30 mA sudden changes in residual current									
1	+	800 V	3/N/PE, 230/400 Va.c., 60 kW	230 mA	202 ms	218 ms	216 ms	234 ms	218 ms
1	-	800 V	3/N/PE, 230/400 Va.c., 60 kW	211 mA	240 ms	256 ms	200 ms	214 ms	217 ms

Note:

The capacitive current is risen until disconnection.

Test condition: I_c + 30/60/150mA <= I_{cmax}. R_1 is set that 30/60/150mA Flow and switch S is closed.

Supplementary information:

(1) The unit have three independent MPP trackers, analysis of the design indicates that any one PV + or PV – terminal can be expected to have the same result.

(2) All above tests indicate a fault in accordance with clause 13.9 as below LCD display;

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4.8.3.5	**TABLE: Protection by residual current monitoring**								P
Test conditions:	See below								
4.8.3.5.3	TABLE: Test for detection of sudden changes in residual current								P
Tracker No.	PV (+ or -)	Input (Vdc)	Output (Vac, kW)	Baseline trip current (mA))	Measured trigger time (ms) shall <150 ms for 60 mA; (repeat 5 times)				
60 mA sudden changes in residual current									
1	+	800 V	3/N/PE, 230/400 Va.c., 60 kW	230 mA	108 ms	137 ms	142 ms	138 ms	135 ms
1	-	800 V	3/N/PE, 230/400 Va.c., 60 kW	211 mA	130 ms	100 ms	138 ms	130 ms	134 ms

Note:

The capacitive current is risen until disconnection.

Test condition: I_c + 30/60/150mA <= I_{cmax}. R_1 is set that 30/60/150mA Flow and switch S is closed.

Supplementary information:

(1) The unit have three independent MPP trackers, analysis of the design indicates that any one PV + or PV – terminal can be expected to have the same result.

(2) All above tests indicate a fault in accordance with clause 13.9 as below LCD display;

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Clause	Requirement + Test	Result - Remark	Verdict

4.8.3.5	**TABLE: Protection by residual current monitoring**								P
Test conditions:	See below								
4.8.3.5.3	TABLE: Test for detection of sudden changes in residual current								P
Tracker No.	PV (+ or -)	Input (Vdc)	Output (Vac, kW)	Baseline trip current (mA)	Measured trigger time (ms) shall <40 ms for 150 mA; (repeat 5 times)				
150 mA sudden changes in residual current									
1	+	800 V	3/N/PE, 230/400 Va.c., 60 kW	230 mA	28 ms	29 ms	32 ms	32 ms	38 ms
1	-	800 V	3/N/PE, 230/400 Va.c., 60 kW	211 mA	18 ms	18 ms	21 ms	23 ms	29 ms

Note:

The capacitive current is risen until disconnection.

Test condition: I_c + 30/60/150mA <= I_{cmax}. R_1 is set that 30/60/150mA Flow and switch S is closed.

Supplementary information:

(1) The unit have three independent MPP trackers, analysis of the design indicates that any one PV + or PV – terminal can be expected to have the same result.

(2) All above tests indicate a fault in accordance with clause 13.9 as below LCD display;

…….End of test report……..

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