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TEST REPORT
IEC 62109-2
Safety of power converters for use in photovoltaic power systems – Part2: Particular requirements for inverters

Report Reference No.	15093538 001 attachment 1.	
Tested by (name + signature)	See cover page	.....
Witnessed by (name + signature) ..	N/A	.....
Supervised by (name + signature) .	N/A	.....
Approved by (name + signature)	See cover page	.....
Date of issue.....	See cover page	

Testing Laboratory.....	TÜV Rheinland (Shanghai) Co., Ltd.
Address	B1-13/F, No.177, Lane 777, West Guangzhong Road, Zhabei District, Shanghai 200072, P. R. China
Testing location/ procedure	CBTL☐ TMP☐ WMT☐ SMT☐ RMT☐ CCATL☒
Testing location/ address	See cover page

Applicant's name	See cover page
Address	See cover page

Test specification:	
Standard.....	IEC/EN 62109-2: 2011
Test procedure	TÜV Bauart
Non-standard test method……..:	N/A

Test Report Form No.....	IEC 62109-2: 2011
Test Report Form(s) Originator	TÜV Rheinland Group
Master TRF	2011-08

Test item description	See report 15093538 001.
Trade Mark	See report 15093538 001.
Manufacturer	See report 15093538 001.
Model/Type reference.....	See report 15093538 001.
Ratings	See report 15093538 001.

Testing procedure and testing location:	
☒ **CB Testing Laboratory:**	
Testing location/ address.....:	
☐ **Associated CB Test Laboratory:**	
Testing location/ address.....:	
Tested by (name + signature)..... :	See cover page
Approved by (+ signature)..... :	See cover page
☐ Testing procedure: TMP	
Tested by (name + signature)..... :	
Approved by (+ signature)..... :	
Testing location/ address.....:	
☐ Testing procedure: WMT	
Tested by (name + signature)..... :	
Witnessed by (+ signature) ..... :	
Approved by (+ signature)..... :	
Testing location/ address.....:	
☐ Testing procedure: SMT	
Tested by (name + signature)..... :	
Approved by (+ signature)..... :	
Supervised by (+ signature) ..... :	
Testing location/ address.....:	
☐ Testing procedure: RMT	
Tested by (name + signature)..... :	
Approved by (+ signature)..... :	
Supervised by (+ signature) ..... :	
Testing location/ address.....:	

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

See report 15093538 001.

Summary of testing

Tests performed (name of test and test clause):	**Testing location:**
The critical tests were performed for this equipment included clauses 4.4.4.15.1, 4.4.4.15.2, 4.8.2.1, 4.8.3.5.2, 4.8.3.5.3 in scope of this standard.	The laboratory described on cover page.

Summary of compliance with National Differences

List of countries addressed: None.

☒ The product fulfils the requirements of IEC/EN 62109-2: 2011.

Copy of marking plate:

See report 15093538 001.

Equipment mobility	☐ movable	☐ hand-held
	☐ stationary	☒ fixed (Wall mounted)
Connection to the mains	☐ pluggable equipment	☐ direct plug-in
	☒ permanent connection	☐ for building-in
Enviromental category	☒ outdoor	☒ indoor conditional ☒ indoor unconditional
Operating condition	☒ continuous	☐ short-time ☐ intermittent
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 (%)	According to specified supply range	
Tested for IT power systems	☐ Yes	☒ No
IT testing, phase-phase voltage (V)	N/A	
Class of equipment	☒ Class I	☐ Class II
	☐ Class III	☐ Not classified
Mass of equipment (kg)	See model list	
Pollution degree	☐ PD 1	☒ PD 2 (inside) ☒ PD 3 (outside)
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	Pass (P)
- test object does not meet the requirement	Fail (F)

Testing:	
Date of receipt of test items	See report 15093538 001
Date(s) of performance of tests	See report 15093538 001

General remarks:

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

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

The tests 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 testing laboratory.

List of test equipment must be kept on file and available for review.

Additional test data and/or information provided in the attachments to this report.

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

Determination of the test results includes consideration of measurement uncertainty from the test equipment and methods.

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

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.

Name and address of factory (ies) :	See report 15093538 001

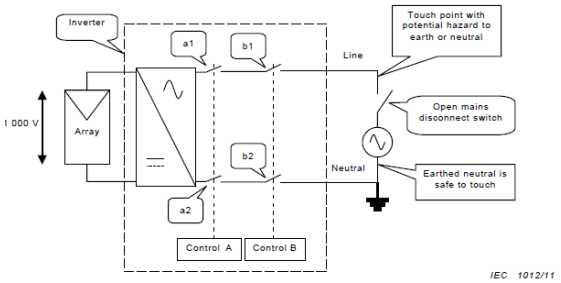
General product information:

See report 15093538 001.

Throughout the test report following abbreviations may be used:

- input	i/p	- Test repeated, similar result(3 times)	TRSR
- output	o/p	- No indication of dielectric breakdown	NB
- short-circuited	s-c	- Cheesecloth remained intact	NC
- overloaded	o-l	- Tissue paper remained intact	NT
- open-circuited	o-c	- No hazards	NH
- normal conditions	N.C.	- The PCE can recover to operate automaticly after removing the abnormal condition	RO
- single fault conditions	SFC	- functional insulation	FI
- between parts of opposite polarity	BOP	- basic insulation	BI
- internal protection operated	IPO	- supplementary insulation	SI
- Component damage (list damaged component)	CD	- double insulation	DI
- No component damaged	NCD	- reinforced insulation	RI

Indicate used abbreviations (if any)

IEC 62109-2: 2011			
Clause	Requirement – Test	Result - Remark	Verdict
4	General testing requirements *This clause of Part 1 is applicable with the following exceptions:*		P
4.4	Testing in SINGLE FAULT CONDITIONS		P
4.4.4	SINGLE FAULT CONDITIONS to be applied: *Additional subclauses:*	The PCE could detect and indicate the fault condition and disconnect from or not connect to the grid in case of single fault condition. Refer to the appended table 4.4 of IEC/EN 62109-1 test report 15093538 001.	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		P
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		P
4.4.4.15.2.1	General		P
4.4.4.15.2.2	Design of insulation or separation  **Figure 20 – Example system discussed in Note 2 above**		P
4.4.4.15.2.3	Automatic checking of the disconnect means		P
4.4.4.16	Stand-alone inverters-load transfer test	Grid-connected PV Inverter.	N/A
4.4.4.17	Cooling system failure – Blanketing test	Enclosure: 72 ºC	P
4.7	Electrical Ratings Tests *Additional subclauses:*	Refer to the appended table 4.7 of IEC/EN 62109-1 test report 15093538 001.	P
4.7.3	Measurement requirements for AC output ports for stand-alone inverters	Grid-connected PV Inverter.	N/A
4.7.4	Stand-alone Inverter AC output voltage and frequency	Grid-connected PV Inverter.	N/A
4.7.4.1	General		N/A

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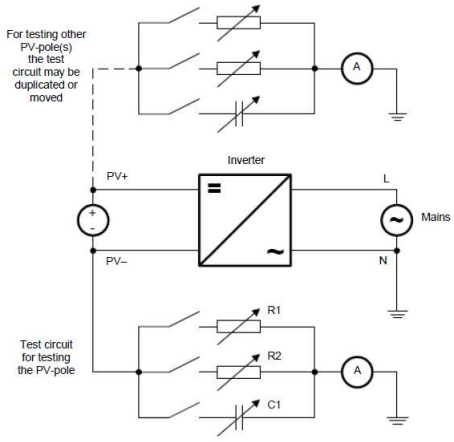
Clause	Requirement – Test	Result - Remark	Verdict
4.7.4.2	Steady state output voltage at nominal DC input		N/A
4.7.4.3	Steady state output voltage across the DC input range		N/A
4.7.4.4	Load step response of the output voltage at nominal DC input		N/A
4.7.4.5	Steady state output frequency		N/A
4.7.5	Stand-alone inverter output voltage waveform		N/A
4.7.5.1	General		N/A
4.7.5.2	Sinusoidal output voltage waveform requirements		N/A
4.7.5.3	Non-sinusoidal output waveform requirements		N/A
4.7.5.3.1	General		N/A
4.7.5.3.2	Total harmonic distortion		N/A
4.7.5.3.3	Waveform slope		N/A
4.7.5.3.4	Peak voltage		N/A
4.7.5.4	Information requirements for non-sinusoidal waveforms		N/A
4.7.5.5	Output voltage waveform requirements for inverters for dedicated loads		N/A
4.8	Additional tests for grid-interactive inverters	See below.	P
4.8.1	General requirements regarding inverter isolation and array grounding	Non-isolated inverters for ungrounded arrays.	P
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays	See below.	P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays	Inverter indicated the insulation fault and didn't connect to the grid when a resistor below 100 kΩ (required above 33 kΩ) linked between PV+/- to earth.	P
4.8.2.2	Array insulation resistance detection for inverters for functionally grounded arrays	See above.	N/A
4.8.3	Array residual current detection		P
4.8.3.1	General		P
4.8.3.2	30mA touch current type test for isolated inverters	See appended table.	P
4.8.3.3	Fire hazard residual current type test for isolated inverters	See appended table.	N/A
4.8.3.4	Protection by application of RCD's	The RCD provided integral to the inverter	P

IEC 62109-2: 2011			
Clause	Requirement – Test	Result - Remark	Verdict
4.8.3.5	Protection by residual current monitoring		P
4.8.3.5.1	General	See below.	P
	Table 31 – Response time limits for sudden changes in residual current Residual current sudden change / Max. time to inverter disconnection from the mains 30 mA / 0,3 s 60 mA / 0,15 s 150 mA / 0,04 s NOTE These values of residual current and time are based on the RCD standard IEC61008-1.	See appended table.	P
	 For the continuous residual current test, R1 establishes a baseline current just below the trip point, and R2 is switched in to cause the current to exceed the trip point. Capacitor C1 is not used. For the sudden change residual current test, C1 establishes a baseline current and R1 or R2 is switched in to cause the desired value of sudden change. The other resistor is not used. IEC 1013/11 **Figure 21 – Example test circuit for residual current detection testing**	See appended table.	P
4.8.3.5.2	Test for detection of excessive continuous residual current	See appended table.	P
4.8.3.5.3	Test for detection of sudden changes in residual current	See appended table.	P
4.8.3.6	Systems located in closed electrical operating areas	Not specified to be located in closed electrical operating area.	N/A
5	Marking and documentation *This clause of Part 1 is applicable with the following exceptions:*	See report 15093538 001.	P

IEC 62109-2: 2011			
Clause	Requirement – Test	Result - Remark	Verdict
5.1	Marking		P
5.1.4	Equipment ratings *Replacement:*		P
5.2	Warning markings		P
5.2.2	Content for warning markings		P
5.2.2.6	Inverters for closed electrical operating areas		P
5.3	Documentation		P
5.3.2	Information related to installation *Additional subclauses:*		P
5.3.2.1	Ratings		P
5.3.2.2	Grid-interactive inverter setpoints	No adjustable setting available. Only the factory default values, however the adjustment shall be performed by distribution network operator.	N/A
5.3.2.3	Transformers and isolation	Transformerless PCE.	N/A
5.3.2.4	Transformers required but not provided	Transformerless PCE	N/A
5.3.2.5	PV modules for non-isolated inverters		P
5.3.2.6	Non-sinusoidal output waveform information	Grid-connection inverter.	N/A
5.3.2.7	Systems located in closed electrical operating areas	Not specified to be located in closed electrical operating area.	N/A
5.3.2.8	Stand- alone inverter output circuit bonding	Grid-connection inverter.	N/A
5.3.2.9	Protection by application of RCD's	Integrated RCM provided in inverter.	N/A
5.3.2.10	Remote indication of faults	The instructions are specified in section of "Connecting Communications Cables " in the user's manual.	P
5.3.2.11	External array insulation resistance measurement and response	Subclause 4.8.2.1 compliance.	N/A
5.3.2.12	Array functional grounding information	No such requirements.	N/A
5.3.2.13	Stand-alone inverters for dedicated loads	Grid-connection inverter.	N/A
5.3.2.14	Identification of firmware version(s)	The firmware version is disclosed by communication interface.	P

IEC 62109-2: 2011			
Clause	Requirement – Test	Result - Remark	Verdict
6	Environmental requirements and conditions *This clause of Part 1 is applicable.*		P
7	Protection against electric shock and energy hazards *This clause of Part 1 is applicable except for the following additions:*	See report 15093538 001.	P
7.3	Protection against electric shock *Additional subclauses:*		P
7.3.10	Additional requirements for stand-alone inverters	Grid-connection inverter	N/A
	Stand-alone inverter output circuit bonding		N/A
	Stand-alone inverter isolation and protection of DVC-A circuits		N/A
7.3.11	Functionally grounded arrays		N/A
8	Protection against mechanical hazards *This clause of Part 1 is applicable.*	See report 15093538 001.	P
9	Protection against fire hazards *This clause of Part 1 is applicable with the following exceptions:*	See report 15093538 001.	P
9.3	Short-circuit and overcurrent protection *Additional subclause:*		P
9.3.4	Inverter backfeed current onto the array		P
10	Protection against sonic pressure hazards *This clause of Part 1 is applicable*	See report 15093538 001.	P
11	Protection against liquid hazards *This clause of Part 1 is applicable*	See report 15093538 001.	P
12	Protection against chemical hazards *This clause of Part 1 is applicable*	See report 15093538 001.	P
13	Physical requirements *This clause of Part 1 is applicable with the following exception:* *Additional subclause:*	See report 15093538 001.	P

IEC 62109-2: 2011			
Clause	Requirement – Test	Result - Remark	Verdict
13.9	Fault indication		P
	a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and	Fault light is available for fault indication.	P
	b) an electrical or electronic indication that can be remotely accessed and used.	The error message also can be remotely accessed and used	P
14	Components *This clause of Part 1 is applicable*	See report 15093538 001.	P

4.8.2.1	TABLE: Insulation resistance measurement				P
Conditions	Measurement [I.F. / N.O.]				Identification
	PV / DC Supply Voltage [Vdc]				
	600	700	850	1000	
PV+ to PE: 90 [kΩ]	I.F.	I.F.	I.F.	I.F.	I.F.: Isolation Fault N.O.: Normal Operation
PV- to PE: 90 [kΩ]	I.F.	I.F.	I.F.	I.F.	
PV+ to PE: 100 [kΩ]	N.O.	N.O.	N.O.	N.O.	
PV- to PE: 100 [kΩ]	N.O.	N.O.	N.O.	N.O.	
PV+ to PE: 110 [kΩ]	N.O.	N.O.	N.O.	N.O.	
PV- to PE: 110 [kΩ]	N.O.	N.O.	N.O.	N.O.	
Note: Array Insulation Resistance Threshold Value R = 100 [kΩ] (Should be larger than R = $V_{MAX\,PV}$ / 30mA.) The accuracy of resistance measurement ΔR = 10 [kΩ] (the value declared by manufacturer)					

4.8.3.2, 4.8.3.3	TABLE: Touch current and fire hazard residual current measurement			N/A
Condition	PV power supply " + " → terminal A [mA]	PV power supply " - " →terminal A [mA]	Limit [mA]	Comments
Condition	PV power supply " + " → earthing [mA]	PV power supply " - " → earthing [mA]	Limit [mA]	Comments
Note: Using measurement circuit of IEC 60990 figure 4 for testing touch current. Using ammeter for testing fire hazard residual current.				

4.8.3.5.1	TABLE: Residual current monitoring test		P
Conditions	Steadily Residual current threshold value		
	Measurement [mA]		Limit [mA]
	U_N		

PV+ to Neutral	263.0	300
	294.0	300
	280.0	300
	271.0	300
	268.0	300
PV- to Neutral	279.0	300
	268.0	300
	283.0	300
	271.0	300
	278.0	300
Note: 100% output power and Vmppmax input voltage		

4.8.3.5.1	TABLE: Residual current monitoring test		P
Conditions	Trigger disconnection maximum time		
	Measurement [ms]		Limit [ms]
	U_N		
Sudden residual current ≥ 30mA			
PV+ to Neutral	208		300
	223		300
	214		300
	218		300
	224		300
PV- to Neutral	212		300
	203		300
	198		300
	210		300
	197		300
Sudden residual current ≥ 60mA			
PV+ to Neutral	103		150
	99		150
	98		150
	101		150

	100	150
PV- to Neutral	138	150
	137	150
	137	150
	138	150
	141	150
Sudden residual current ≥ 150mA		
PV+ to Neutral	25	40
	24	40
	25	40
	28	40
	24	40
PV- to Neutral	23	40
	22	40
	22	40
	25	40
	24	40
Note: 100% output power and Vmppmax input voltage		

- End of test report -