




TEST REPORT IEC 62109-2 Safety of Power Converter for use in Photovoltaic Power Systems Part 2: Particular requirements for inverters	
Report Number.....	70.409.19.175.01-00 part 2 of 2
Date of issue	2019-05-07
Total number of pages	26
TÜV SÜD Branch.....	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
Applicant's name	Huawei Technologies Co., Ltd.
Address	Administration Building Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, 518129 Shenzhen, PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard.....	IEC 62109-2:2011 (First Edition)
Test procedure.....	TÜV Mark
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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Test item description:	SOLAR INVERTER
Trade Mark	 HUAWEI
Manufacturer	Huawei Technologies Co., Ltd.
Model/Type reference	SUN2000-175KTL-H0, SUN2000-185KTL-INH0, SUN2000-168KTL-H1, SUN2000-185KTL-H1
Ratings	See rating labels on report 70.409.19.175.01-00 part 1 of 2 pages 4 to 5

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):	
<input checked="" type="checkbox"/> TÜV SÜD Branch:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
Location/ address	3-13, No.151 Heng Tong Road, 200070, Shanghai, P.R. China
<input checked="" type="checkbox"/> Associated Testing Laboratory:	Nanjing CQC - Trusted Testing Technology Co., Ltd.
Testing location/ address:	No.99, Wenlan Road, Xianlin University Zone, Xiatu Street, Qixia District, NanJing, China
Tested by (name, function, signature):	<i>Shan Huang</i> 
Approved by (name, function, signature) ..:	<i>Bin Wu</i> 
<input type="checkbox"/> Testing procedure: CTF Stage 1:	
Testing location/ address:	
Tested by (name, function, signature):	
Approved by (name, function, signature) ..:	
<input type="checkbox"/> Testing procedure: CTF Stage 2:	
Testing location/ address:	
Tested by (name + signature)	
Witnessed by (name, function, signature) ..:	
Approved by (name, function, signature) ..:	
<input type="checkbox"/> Testing procedure: CTF Stage 3:	
<input type="checkbox"/> Testing procedure: CTF Stage 4:	
Testing location/ address:	
Tested by (name, function, signature):	
Witnessed by (name, function, signature) ..:	
Approved by (name, function, signature) ..:	



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

Tests against:

IEC 62109-1(ed.1)/EN 62109-1:2010, IEC 62109-2(ed.1)/EN 62109-2:2011

Total test reports contains 2 parts and 1 attachments listed in below table:

Item	Description	Pages
Part 1	IEC 62109-1(ed.1)/EN 62109-1:2010 test report	74
Part 2	IEC 62109-2(ed.1)/EN 62109-2:2011 test report	26
Attachment	Data form for electrical and electronic component(CDF)	24

Summary of testing:

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

Tests performed (name of test and test clause):

Family products design, full tests were conducted on representative model **SUN2000-175KTL-H0**.

- Fault-tolerance of residual current monitoring – 4.4.4.15.1;
- Fault-tolerance of automatic disconnecting means - 4.4.4.15.2;
- Cooling system failure – Blanketing test – 4.4.4.17;
- Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays - 4.8.2;
- Array residual current detection - 4.8.3;
- Inverter backfeed current onto the array -9.3.4 as combined with 4,4 in IEC/EN 62109-1;

Testing location:

Nanjing CQC - Trusted Testing Technology Co., Ltd.

No.99, Wenlan Road, Xianlin University Zone, Xianlin Street, Qixia District, NanJing, China

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

All tests were carried out according to IEC 62109-2(ed.1)/EN 62109-2:2011.

The text of IEC 62109-2(ed.1) was approved by CENELEC as a European Standard without any modification. Also compliance with EN 62109-2:2011, Annex ZA of EN 62109-1:2011 is recorded at the end of this report.

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

Copy of marking plate:

Please refer to report 70.409.19.175.01-00 part 1 of 2.

Test item particulars :	
Equipment mobility	<input type="checkbox"/> movable <input type="checkbox"/> hand-held <input type="checkbox"/> stationary <input checked="" type="checkbox"/> fixed <input type="checkbox"/> transportable <input type="checkbox"/> for building-in
Connection to the mains	<input type="checkbox"/> pluggable equipment <input type="checkbox"/> direct plug-in <input checked="" type="checkbox"/> permanent connection <input type="checkbox"/> for building-in
Environmental category	<input checked="" type="checkbox"/> outdoor <input type="checkbox"/> indoor unconditional <input type="checkbox"/> indoor conditional
Over voltage category Mains	<input type="checkbox"/> OVC I <input type="checkbox"/> OVC II <input checked="" type="checkbox"/> OVC III <input type="checkbox"/> OVC IV
Over voltage category PV	<input type="checkbox"/> OVC I <input checked="" type="checkbox"/> OVC II <input type="checkbox"/> OVC III <input type="checkbox"/> OVC IV
Mains supply tolerance (%)	-90 / +110 %
Tested for power systems	IT
IT testing, phase-phase voltage (V)	800V
Class of equipment	<input checked="" type="checkbox"/> Class I <input type="checkbox"/> Class II <input type="checkbox"/> Class III <input type="checkbox"/> Not classified
Mass of equipment (kg)	See page 11 of report 70.409.19.175.01-00 part 1 of 2
Pollution degree	3(external environment), 2(internal environment)
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	: 2019-04-15
Date (s) of performance of tests	: 2019-04-15 to 2019-04-30
General remarks:	
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report.	
Throughout this report a <input checked="" type="checkbox"/> comma / <input type="checkbox"/> point is used as the decimal separator.	
Manufacturer's Declaration per sub-clause 4.2.5 of IEC60335-1:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable
When differences exist; they shall be identified in the General product information section.	



Name and address of factory (ies).....:	1) Huawei Machine Co., Ltd. No. 2 City Avenue, Songshan Lake Sci. & Tech. Industry Park, 523808 Dongguan, Guangdong, PEOPLE'S REPUBLIC OF CHINA
General product information: Please refer to page 8 to 12 of report 70.409.19.175.01-00 part 1 of 2.	



IEC 62109-2			
Clause	Requirement + Test	Result - Remark	Verdict
4	GENERAL TESTING REQUIREMENTS		P
4.4.4	Single fault conditions to be applied		P
4.4.4.15	Fault-tolerance of protection for grid-interactive inverters		P
4.4.4.15.1	Fault-tolerance of residual current monitoring according to 4.8.3.5: the residual current monitoring system operates properly	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		P
	- the residual current monitoring system operates properly under single fault condition		P
	- Indicates a fault in accordance with §13.9		P
	c)..- The inverter continues to operate regardless of loss of residual current monitoring functionality		P
	- not re-connect after any sequence of removing and reconnecting PV power		P
	- not re-connect after any sequence of removing and reconnecting AC power		P
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		P
	- Indicates a fault in accordance with §13.9		P
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		P
4.4.4.15.2 .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	Not allowed to be used in grounded current-carrying system.	N/A
	- 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	See appended table 4.4.4.15.2	P

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Clause	Requirement + Test	Result - Remark	Verdict
	maintained between the PV array and the mains when the disconnecting means is intended to be in the open state.		
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.	The detail see report of Part 1	P
4.4.4.15.2.3	For non-isolated inverter, automatic checking of the isolation provided by a disconnect means after single fault.		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:	Not stand-alone 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 test table 4.4.4.17	P
	Test stop condition: time duration value or stabilized temperature	Stabilized temperature without external surface of the inverter exceed 90°C	P
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	Not stand-alone inverter	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		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The steady-state AC output voltage shall not be less than 85 % or more than 110 % of the rated nominal voltage with the inverter supplied with any value within the rated range of DC input voltage.		
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	Not stand-alone inverter	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 %.		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	The total harmonic distortion (THD) of the voltage waveform shall not exceed 40 %.		N/A
4.7.5.3.3	The slope of the rising and falling edges of the positive and negative half-cycles of the voltage waveform shall not exceed 10 V/ μ s measured between the points at which the waveform has a voltage of 10 % and 90 % of the peak voltage for that half-cycle.		N/A
4.7.5.3.4	The absolute value of the peak voltage of the positive and negative half-cycles of the waveform shall not exceed 1,414 times 110 % of the RMS value of the rated nominal AC output voltage.		N/A
4.7.5.4	Information requirements for non-sinusoidal waveforms The instructions provided with a stand-alone inverter not complying with 4.7.5.2 shall include the information in 5.3.2.6.		N/A
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		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	with the applicable product safety standards.		
	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		P
	- Type of Array grounding supported	The PCE is intended to be used with ungrounded array	P
	- Inverter isolation	transformer-less solar inverter, but required an isolating transformer between the MAINS and inverter	P
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays	(See attached table)	P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays	Minimum Insulation Resistance before connection to the MAINS: 1500V/30mA=50,0 kΩ	P
	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:	50kΩ x 0,9=45 kΩ	P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value $R = V_{max}/30mA$ under normal conditions		P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value $R = V_{max}/30mA$ with ground fault in the PV array		P
	Isolated inverters shall indicate a fault if the insulation resistance is less than the limit value		P
	Isolated inverter fault indication maintained until insulation resistance has recovered to a value higher than the limit value		P
	Non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30:		N/A
	- shall indicate a fault in accordance with 13.9		N/A
	- shall not connect to the mains		N/A
4.8.2.2	Array insulation resistance detection for inverters for functionally grounded arrays	Not for functionally grounded arrays	N/A
	a-1)The value of the total resistance, including the intentional resistance for array		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	functional grounding, the expected insulation resistance of the array to ground, and the resistance of any other networks connected to ground (for example measurement networks) must not be lower than $R = (V_{MAX} PV/30 \text{ mA})$ ohms.		
	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
	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	RCM is provided integrated in inverter	P

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Clause	Requirement + Test	Result - Remark	Verdict
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
	a) Continuous residual current: The inverter shall disconnect within 0,3 s and indicate a fault in accordance with 13.9 if the continuous residual current exceeds:		P
	- maximum 300 mA for inverters with continuous output power rating ≤ 30 kV;		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.		P
	b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31		P
	The inverter indicates a fault in accordance with 13.9, if a sudden increase in the RMS residual current is detected exceeding the value in the table.		P
	- 30mA@0,3s		P
	- 60mA@0,15s		P
	- 150mA@0,04s		P
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		P
4.8.3.5.2	Test for detection of excessive continuous residual current: test repeated 5 times and time to disconnect shall not exceed 0,3 s.	See appended test table 4.8.3.5.2 Test for detection of excessive continuous residual current	P
4.8.3.5.3	Test for detection of sudden changes in residual current repeated 5 times and each of the 5 results shall not exceed the time limit indicated in for each row (30mA, 60mA and 150mA) of Table 31.	See appended test table 4.8.3.5.3 Test for detection of sudden changes in residual current	P
4.8.3.6	Systems located in closed electrical	Not limited to be located in closed	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	operating areas	electrical operating areas.	
	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:	All applicable parameters refer to copy of marking plate in part 1 of test report 70.409.19.175.01-00	P
	- Vmax PV (absolute maximum) (d.c. V)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	a.c. output ratings:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	a.c input ratings:		N/A
	- Voltage (nominal or range) (a.c. V)		N/A
	- Current (maximum continuous) (a.c. A)		N/A
	- Frequency (nominal or range) (Hz)		N/A
	d.c. output ratings:		N/A
	- Voltage (nominal or range) (d.c. V)		N/A
	- Current (maximum continuous) (d.c. A)		N/A
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP65	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		P
5.2.2	Content for warning markings		P
5.2.2.6	Inverters for closed electrical operating areas	Not specified to be located in closed electrical operating area.	N/A
	Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be marked with a warning that the inverter is only for use in a closed electrical operating area, and referring to the installation instructions.		N/A
5.3	Documentation		P

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Clause	Requirement + Test	Result - Remark	Verdict
5.3.2	Information related to installation		P
5.3.2.1	Ratings. Subclause 5.3.2 of Part 1 requires the documentation to include ratings information for each input and output. For inverters this information shall be as in Table 33 below. Only those ratings that are applicable based on the type of inverter are required.		P
	PV input quantities:	All applicable parameters refer to user manual	P
	- Vmax PV (absolute maximum) (d.c. V)		P
	- PV input operating voltage range (d.c. V)		P
	- Maximum operating PV input current (d.c. A)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	- Max. inverter backfeed current to the array (a.c. or d.c. A)		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
	- Current (maximum continuous) (d.c. A)		N/A
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP65	P
5.3.2.2	Grid-interactive inverter setpoints		P

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Clause	Requirement + Test	Result - Remark	Verdict
	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:	Relevant information provided in user manual.	P
	The setting of field adjustable setpoints shall be accessible from the PCE	Special software via communication with password protected	P
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.	No internal isolation transformer	N/A
	An inverter shall be provided with information to the installer regarding:		N/A
	- providing of internal isolation transformer		N/A
	- the level of insulation (functional, basic, reinforced, or double)		N/A
	The instructions shall also indicate what the resulting installation requirements are regarding:		P
	- earthing or not earthing the array	Unearthed array	P
	- providing external residual current detection devices	Pls. follow national regulations	P
	- requiring an external isolation transformer,		P
5.3.2.4	Transformers required but not provided	Required, pls. refer to HUAWEI technical information about transformer	P
	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	IEC 61730 Class A rating required	P

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Clause	Requirement + Test	Result - Remark	Verdict
	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
	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

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Clause	Requirement + Test	Result - Remark	Verdict
	- 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,.	If required strictly, should be type B	N/A
	and shall specify its rating, type, and required circuit location		N/A
5.3.2.10	Remote indication of faults		P
	The installation instructions shall include an explanation of how to properly make connections to (where applicable), and use, the electrical or electronic fault indication required by 13.9.	Refer to user manual	P
5.3.2.11	External array insulation resistance measurement and response	IRM function integrated in inverter	N/A
	The installation instructions for an inverter for use with ungrounded arrays that does not incorporate all the aspects of the insulation resistance measurement and response requirements in 4.8.2.1, must include:		N/A
	- for isolated inverters: an explanation of what aspects of array insulation resistance measurement and response are not provided, and		N/A
	- an instruction to consult local regulations to determine if any additional functions are required or not;		N/A
	- for non-isolated inverters: an explanation of what external equipment must be provided in the system, and		N/A
	- what the setpoints and response implemented by that equipment must be, and:		N/A
	- how that equipment is to be interfaced with the rest of the system.		N/A
5.3.2.12	Array functional grounding information	Not functional ground array used	N/A
	Where approach a) of 4.8.2.2 is used, the installation instructions for the inverter shall include all of the following:		N/A
	a) the value of the total resistance between the PV circuit and ground integral to the inverter		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	b) the minimum array insulation resistance to ground that system designer or installer must meet when selecting the PV panel and system design, based on the minimum value that the design of the PV functional grounding in the inverter was based on		N/A
	c) the minimum value of the total resistance $R = V_{MAX PV}/30 \text{ mA}$ that the system must meet, with an explanation of how to calculate the total		N/A
	d) a warning that there is a risk of shock hazard if the total minimum resistance requirement is not met.		N/A
5.3.2.13	Stand-alone inverters for dedicated loads		N/A
	Where the approach of 4.7.5.5 is used, the installation instructions for the inverter shall include a warning that the inverter is only to be used with the dedicated load for which it was evaluated, and		N/A
	shall specify the dedicated load.		N/A
5.3.2.14	Identification of firmware version(s)		P
	An inverter utilizing firmware for any protective functions shall provide means to identify the firmware version.	V300R001	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.....	Refer to user manual	P
7	PROTECTION AGAINST ELECTRIC SHOCK AND ENERGY HAZARDS		N/A
7.3	Protection against electric shock		N/A
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

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Clause	Requirement + Test	Result - Remark	Verdict
	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
	Outputs that are intentionally floating with no circuit conductor bonded to ground, must not have any voltages with respect to ground that are a shock hazard in accordance with Clause 7 of Parts 1 and 2.		N/A
	The documentation for the inverter shall indicate that the output is floating as per 5.3.2.8.		N/A
7.3.11	Functionally grounded arrays		N/A
	All PV conductors in a functionally grounded array shall be treated as being live parts with respect to protection against electric shock.		N/A
9	PROTECTION AGAINST FIRE HAZARDS		P
9.3	Short-circuit and overcurrent protection		P
9.3.4	Inverter backfeed current onto the array		P
	The backfeed current testing and documentation requirements in Part 1 apply, including but not limited to the following.		P
	Inverter backfeed current onto the PV array maximum value.....	Maximum inverter backfeed current from grid to the array is 0A based on test/circuit topology analysis.	P
	This inverter backfeed current value shall be provided in the installation instructions regardless of the value of the current, in accordance with Table 33.	Refer to user manual	P
13	PHYSICAL REQUIREMENTS		P
13.9	Fault indication		P
	Where this Part 2 requires the inverter to indicate a fault, both of the following shall be provided:		P
	a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and	Visible indication	P

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Clause	Requirement + Test	Result - Remark	Verdict
	b) an electrical or electronic indication that can be remotely accessed and used.	communication method for remote accessed and used.	P
	The installation instructions shall include information regarding how to properly make connections (where applicable) and use the electrical or electronic means in b) above, in accordance with 5.3.2.10.	Refer to user manual	P
	EN 62109-2:2010		P
Annex ZA	Normative references to international publications with their corresponding European publications	Considered	P

4.4.4		TABLE: Single fault condition to be applied					P
	Ambient temperature (°C)	N/A(at the prevailing ambient temperature)					—
	Power source for EUT: Manufacturer, model/type, output rating	DC source: Keysight, N8957APV, 1500V, 30A AC source: AMETEK, RS180, 800Vac, 15-500Hz					—
4.4.4.15.1		Fault-tolerance of residual current monitoring					
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation	
C407	SC	1080Vdc/800Vac	10 min	-	-	PV inverter work normally. No components damage, no hazard.	
R1554	OC	1080Vdc/800Vac	10 min	-	-	PV inverter work normally. No components damage, no hazard.	
U34 Pin 2-3	SC before start-up	1080Vdc/800Vac	10 min	-	-	PV inverter work normally. No components damage, no hazard.	
U511 Pin 9-10	SC before start-up	1080Vdc/800Vac	10 min	-	-	PV inverter cannot start up, indicate RCD sensor fault. No components damage, no hazard.	
R1342	OC before start-up	1080Vdc/800Vac	10 min	-	-	PV inverter cannot start up, indicate RCD sensor fault. No components damage, no hazard.	
Q33 D-S	SC before start-up	1080Vdc/800Vac	10 min	-	-	PV inverter cannot start up, indicate RCD sensor fault. No components damage, no hazard.	
R1318	OC before start-up	1080Vdc/800Vac	10 min	-	-	PV inverter cannot start up, indicate RCD sensor fault. No components damage, no hazard.	
Check that the residual current monitoring operates properly						Yes	
Supplementary information:							

4.4.4		TABLE: Single fault condition to be applied					P
	Ambient temperature (°C)	N/A(at the prevailing ambient temperature)					—
	Power source for EUT: Manufacturer, model/type, output rating	DC source: Keysight, N8957APV, 1500V, 30A AC source: AMETEK, RS180, 800Vac, 15-500Hz					—
4.4.4.15.2		Fault-tolerance of automatic disconnecting means					
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation	
C339	SC	1080Vdc/800Vac	10 min	-	-	PV inverter cannot start up, indicate grid relay fault. No components damage, no hazard.	

Q30	SC	1080Vdc/ 800Vac	10 min	-	-	PV inverter work normally. No components damage, no hazard.
Q35 G-S	SC	1080Vdc/ 800Vac	10 min	-	-	PV inverter cannot start up. No components damage, no hazard.
Q35 D-S	SC	1080Vdc/ 800Vac	10 min	-	-	PV inverter cannot start up. No components damage, no hazard.
R1090	OC	1080Vdc/ 800Vac	10 min	-	-	PV inverter cannot start up. No components damage, no hazard.
K12 Contacts	SC	1080Vdc/ 800Vac	10 min	-	-	PV inverter cannot start up, indicate grid relay fault. No components damage, no hazard.
K12 Contacts	OC	1080Vdc/ 800Vac	10 min	-	-	PV inverter cannot start up, indicate grid relay fault. No components damage, no hazard.
Check that the relays fulfil the basic insulation or simple separation based on the PV circuit working voltage.						Yes
Each active phase can be switched.						Yes
Supplementary information:						

4.4.4.17	TABLE: heating temperature rise measurements- Blanketing test		P
	Test voltage (V)	880VDC/720VAC	—
Max. temperature T of part/at:	T (°C)	Permitted T (°C)	
Ambient	40,0	--	
Core of INV inductor	89,4	--	
Coil of INV inductor	97,3	--	
Core of Boost inductor	77,6	--	
Coil of Boost inductor	79,2	--	
INV IGBT module (Phase A)	90,4	--	
INV IGBT module (Phase B)	90,2	--	
INV IGBT module (Phase C)	94,9	--	
Boost IGBT(DEF)	83,7	--	
Boost IGBT(GHI)	83,8	--	
Boost inductor wire	75,6	--	
INV inductor wire	78,3	--	
X capacitor (C173)	74,9	--	
Fly Cap.(C286)	76,2	--	
Drive Optocoupler(Phase B)	78,2	--	
Boost Current Hall(U47)	75,9	--	
PV SPD(F304)	71,6	--	
PV SPD(F604)	73,5	--	
PV input Y capacitor(C608)	73,7	--	
Relay(K9)	79,0	--	
Relay(K1)	74,1	--	
ISO relay(K8)	75,6	--	
ISO relay(K4)	75,0	--	
INV BUS Capacitor(C1427)	77,1	--	
PCB	81,8	--	
Hall(U10)	73,1	--	
Hall(U28)	75,2	--	
DC AUX IC(U23)	77,5	--	

Coil of DC Aux Transformer T2	81,1	--
Core of DC Aux Transformer T2	80,1	--
AC AUX IC(U24)	79,3	--
Bobbin of DC Aux Transformer T2	76,0	--
Optocoupler(U40)	77,3	--
Optocoupler(U1101)	75,8	--
Optocoupler(U14)	81,4	--
MOS of AC Aux(Q42)	90,0	--
Bobbin of AC Aux Transformer T1	79,3	--
MOS of DC Aux(Q38)	80,7	--
Coil of AC Aux Transformer T1	83,8	--
Core of AC Aux Transformer T1	82,4	--
DC AUX Current Sampling Transformer(T8)	75,5	--
5v BUCK IC(U36)	79,8	--
3.3V BUCK IC(U35)	78,3	--
Optocoupler(U41)	78,4	--
7V BUCK IC(U54)	75,4	--
PWM IC(U61)	74,1	--
MOS for Grid relay(Q5)	74,3	--
Optocoupler of external fan(U20)	73,2	--
Optocoupler of CAN(U17)	76,3	--
DC Aux TVS(D174)	76,7	--
Optocoupler of 48V Dummy load(U45)	73,4	--
DC Aux drive transformer(T3)	72,2	--
AC Aux drive transformer(T5)	82,4	--
Optocoupler of external fan(U62)	73,1	--
AC Aux TVS(D104)	95,0	--
DSP1(U1500)	73,8	--
DSP2(U5)	73,8	--
AC X capacitor(C376)	73,5	--
AC Y capacitor(C502)	74,1	--
Grid relay(K10)	76,1	--
AC Aux sampling transformer(T10)	75,6	--
Inductor (L10)	84,1	--
X(C104)	68,7	--
Grid relay(K11)	75,9	--
INV Current Hall(U25)	75,5	--
BUS capacitor	70,9	--
Ambient of Internal Fan	71,1	--
EMI Chock(T11)	77,1	--
AC SPD(F2)	74,5	--
Ambient of Internal Fan	72,4	--
EMI chock(T11)	80,5	--
X capacitor(C478,C1708)	76,9	--
RCD Hall(U34)	74,2	--
Internal Fan	74,3	--
Mounting Surface	42,6	90
PV connector	65,4	90
Air outlet	69,3	--
AC terminal block	78,8	90
AC output power cord	82,3	90
Front cover	54,6	90
Ambient of DC switch	44,2	--

Output current Hall(U43)	79,8	--
PV internal wire	69,9	--
PV voltage Hall(U18)	80,3	--
DC switch	69,9	90
Supplementary information:		

4.7.4	TABLE: Steady state Inverter AC output voltage and frequency		N/A
	Nominal DC input (V): Nominal output AC voltage (V):		
AC output U (V)	Frequency (Hz)	Condition/status	Comments
		Without load	
		Resistive load application	
		Resistive load removal	
Supplementary information:			

4.8.2	TABLE: Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays			P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays			P
DC Voltage below minimum operating voltage (V)	DC Voltage for inverter begin operation (V)	Resistance between ground and PV input terminal (kΩ)	Required Insulation resistance $R = (V_{MAX PV} / 30mA)$ (kΩ)	Result
ISO setting=50kΩ				
DC1+ to earth				
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
DC1- to earth				
500	550	45	50	Insulation fault

500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	45	50	Insulation fault
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation
500	550	55	50	Normal Operation

Note:

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

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

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

Supplementary information:

Additional test with first one pole ground fault, following an insulation resistance below limit simulated, then allow the inverter to start, the inverter shall not connect to the mains.

4.8.3.2	TABLE: 30mA touch current type test for isolated inverters		N/A
	Condition	Current (mA)	Limit
Supplementary information: Not isolated inverter.			

4.8.3.3	TABLE: Fire hazard residual current type test for isolated inverters		N/A
	Condition	Current (mA)	Limit (300mA or 10mA per kVA)
Supplementary information: Not isolated inverter.			

4.8.3.5	TABLE: Protection by residual current monitoring		P
Test conditions:	Output power (kVA): 175 Input voltage (VDC): 1080 Frequency (Hz): 50 Output AC Voltage (VAC): 800		

4.8.3.5.2	Test for detection of excessive continuous residual current			P
Fault Current (mA)		Disconnection time (ms)		
Measured Fault Current	Limit 300mA for output power ≤ 30 kVA 10mA per kVA for output power > 30 kVA	Measured Disconnection time	Limit	
Default: 1750mA@300ms PV1+ to earth:				
1265	1750	139,5	300	
1265	1750	142,5	300	
1265	1750	130,0	300	
1265	1750	164,0	300	
1328	1750	179,0	300	
PV1- to earth:				
1106	1750	172,0	300	
1212	1750	171,0	300	
1312	1750	169,0	300	
1125	1750	161,0	300	
1521	1750	163,0	300	
<p>Note:</p> <ul style="list-style-type: none"> – 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. <p>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.</p>				

4.8.3.5.3	TABLE: Test for detection of sudden changes in residual current			P
PV1+ to earth:				
Limit (mA)	UN			Limit (ms)
	Disconnection time (ms)			
Default: 30mA@300ms				
30	199,9			300
30	197,2			300
30	190,2			300
30	188,2			300
30	195,6			300
Default: 60mA@150ms				
60	117,5			150
60	115,0			150
60	115,5			150
60	120,0			150
60	120,0			150
Default: 150mA@40ms				
150	39,0			40
150	37,5			40
150	36,0			40

150	39,0	40
150	37,0	40
PV1- to earth		
Limit (mA)	UN	
	Disconnection time (ms)	
Limit (ms)		
Default: 30mA@300ms		
30	204,6	300
30	199,6	300
30	202,3	300
30	200,2	300
30	205,3	300
Default: 60mA@150ms		
60	116,0	150
60	114,5	150
60	120,5	150
60	127,5	150
60	124,0	150
Default: 150mA@40ms		
150	32,5	40
150	36,0	40
150	36,0	40
150	34,0	40
150	35,5	40
<p>Note: The capacitive current is risen until disconnection. Test condition: $I_c + 30/60/150\text{mA} \leq I_{c\text{max}}$. R1 is set that 30/60/150mA Flow and switch S is closed.</p>		
<p>Supplementary information: Same design on other MPP trackers, it is not required to test on other MPP trackers because analysis of the design indicates that other MPP trackers expected to have the same result.</p>		

.....End of test report.....