Test Report issued under the responsibility of:

TEST REPORT

IS 16169: 2014/IEC 62116:2008

Test Procedure of Islanding Prevention Measures for Utility-Interconnected - Photovoltaic Inverters

Report Reference No. ..... :

Date of issue ..... :

Total number of pages .....

Testing Laboratory..... :

Address ..... :

Applicant's name.....:	
Address.....:	
Test specification ..... **:**	
Standard .....:	IS 16169: 2014/ IEC 62116:2008
Test procedure .....:	
Non-standard test method .....:	N/A
Test Report Form No. .....:	IS 16169/ IEC 62116:2008_V1.0
Test Report Form Originator.....:	BIS
Master TRF.....:	Dated: 05.04.2018
Test item description..... **:**	Photovoltaic (PV) Inverter(s)
Trade Mark .....:	

Manufacturer .....:	
Factory.....:	
Model/Type reference.....:	
Ratings.....:	

Testing procedure and testing location:
☐ **Testing Laboratory**: Testing location/ address.....: Tested by (name + signature)..... : Approved by (+ signature) ..... :

Summary of testing:	
Tests performed (name of test and test clause):	**Testing location:**
Unintensional Islanding	
Copy of marking plate:	

The marking plate above represents all models covered by this report except for difference in electrical ratings and model designation. See “General product information” for electrical ratings for all models.

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Clause	Requirement + Test	Result - Remark	Verdict

GENERAL INFORMATION	
Test item particulars:	
Accessories and detachable parts included in the evaluation .....:	
Options included .....:	
Possible test case verdicts:	
Abbreviations used in the report:	
EUT – Equipment Under Test	MPPT – Maximum Power Point Tracking
Q_f – Quality factor	W - Utility Real Power
Var – Utility Reactive Power	V_{DC} – DC Voltage
V_{EUT} – AC Voltage of EUT	t_R – Run on time
I_R – Resistive load current	I_L – Inductive load current
I_C – Capacitive load current	P_{AC} – Utility Real Power
Q_{AC} – Utility Reactive Power	I_{AC} – Utility Current
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)

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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.
"(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 point is used as the decimal separator.

General Product Information:

Product Electrical Ratings

Parameter	Value		Remarks
1) Rating			
a) Maximum output power			
b) DC voltage range			
c) DC current limits			
d) AC voltage range			
e) Frequency range			
f) AC current limits			
g) Efficiency			
h) Voltage trip settings (magnitude and timing)	V		
i) Frequency trip settings (magnitude and timing)	V		
i) Other software settings			
j) Firmware version			
2) Others			
a) Displays			
b) Temperature range			
c) Humidity			
d) Size			
e) Weight			

IS 16169:2014 /IEC 62116:2008

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4	Testing circuit		
	The testing circuit shown in Figure 1 is employed.		
	Similar circuits are used for three-phase output.		
	Parameters to be measured are shown in Table 1 and Figure 1. Parameters to be recorded in the test report are discussed in Clause 7.		
5	Testing equipment		
5.1	Measuring instruments		
	The waveform measurement/capture device is able to record the waveform from the beginning of the islanding test until the EUT ceases to energize the island.		
	For multi-phase EUT, all phases are monitored.		
	A waveform monitor designed to detect and calculate the run-on time may be used.		
	For multi-phase EUT, the test and measurement equipment is recorded each phase current and each phase-to-neutral or phase-to-phase voltage, as appropriate, to determine fundamental frequency active and reactive power flow over the duration of the test.		
	A sampling rate of 10 kHz or higher is recommended. The minimum measurement accuracy is 1 % or less of rated EUT nominal output voltage and 1 % or less of rated EUT output current		
	Current, active power, and reactive power measurements through switch S1 used to determine the circuit balance conditions report the fundamental (50 Hz or 60 Hz) component.		
5.2	DC power source		
5.2.1	General		
	A PV array or PV array simulator (preferred) may be used. If the EUT can operate in utility-interconnected mode from a storage battery, a DC power source may be used in lieu of a battery as long as the DC power source is not the limiting device as far as the maximum EUT input current is concerned.		
	The DC power source provides voltage and current necessary to meet the testing requirements described in Clause 6.		
5.2.2	PV array simulator		
	The tests are conducted at the input voltage defined in Table 2 below, and the current is limited to 1,5 times the rated photovoltaic input current, except when specified otherwise by the test requirements.		
	A PV array simulator is recommended, however, any type of power source may be used if it does not influence the test results.		

IS 16169:2014 /IEC 62116:2008

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5.2.3	Current and voltage limited DC power supply with series resistance		
	A DC power source used as the EUT input source is capable of EUT maximum input power (so as to achieve EUT maximum output power) at minimum and maximum EUT input operating voltage.		
	The power source provides adjustable current and voltage limit, set to provide the desired short circuit current and open circuit voltage when combined with the series and shunt resistance described below.		
	A series resistance (and, optionally, a shunt resistance) is selected to provide a fill factor within the range: Output power: Sufficient to provide maximum EUT output power and other levels specified by test conditions of table 5. Response speed: The response time of a simulator to a step in output voltage, due to a 5% load change, results in a settling of the output current to within 10% of its final value in less than 1ms. Stability: Excluding the variations caused by the EUT MPPT, simulator output power remains stable within 2 % of specified power level over the duration of the test: from the point where load balance is achieved until the island condition is cleared or the allowable run-on time is exceeded. Power factor: 0.25 to 0.8		
5.2.4	PV array		
	A PV array used as the EUT input source is capable of EUT maximum input power at minimum and maximum EUT input operating voltage.		
	Testing is limited to times when the irradiance varies by no more than 2 % over the duration of the test as measured by a silicon-type pyranometer or reference device. It may be necessary to adjust the array configuration to achieve the input voltage and power levels prescribed in 6.1.		
5.3	AC power source		
	The utility grid or other AC power source may be used as long as it meets the conditions specified in Table 4. **Table 4 – AC power source requirements** Items: Voltage — Conditions: Nominal ±2,0 % Items: Voltage THD — Conditions: < 2,5 % Items: Frequency — Conditions: Nominal ±0,1 Hz Items: Phase angle distance [1] — Conditions: 120 ° ± 1,5 ° [1] Three-phase case only		
5.4	AC loads		

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	On the AC side of the EUT, variable resistance, capacitance, and inductance are connected in parallel as loads between the EUT and the AC power source. Other sources of load, such as electronic loads, may be used if it can be shown that the source does not cause results that are different than would be obtained with passive resistors, inductors, and capacitors.		
	All AC loads are rated for and adjustable to all test conditions. The equations for Qf are based upon an ideal parallel RLC circuit. For this reason, non-inductive resistors, low loss (high Qf) inductors, and capacitors with low effective series resistance and effective series inductance are utilized in the test circuit. Iron core inductors, if used, are not exceed a current THD of 2 % when operated at nominal voltage. Load components are conservatively rated for the voltage and power levels expected. Resistor power ratings are chosen so as to minimize thermally-induced drift in esistance values during the course of the test.		
	Active and reactive power is calculated (using the measurements provided in Table 1) in each of the R, L and C legs of the load so that these parasitic parameters (and parasitics introduced by variacs or autotransformers) are properly accounted for when calculating Qf.		
6	Test for single or multi-phase inverter		
6.1	Test procedure	(see appended table)	
	The test uses an RLC load, resonant at the EUT nominal frequency (50 Hz or 60 Hz) and matched to the EUT output power.		
	For multi-phase EUT, the load is balanced across all phases and the switch S1 as in Figure 1 opens all phases		
	This test is performed with the EUT conditions as in Table 5, where power and voltage values are given as a percent of EUT full output rating.		
	a). Determine EUT test output power		
	b) Adjusting the DC input source		
	c) Turn off the EUT and open S1		
	d) Adjust the RLC circuit to have Qf = 1.0 ±0.05		
	e). Connect the RLC load configured in step d) to the EUT by closing S2		
	f).. Open the utility-disconnect switch S1 to initiate the test, Run-on time is recorded.		
	g). For test condition A, adjust the real load and only one of the reactive load components to each of the load imbalance conditions shown in the shaded portion of table 6. If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.		

IS 16169:2014 /IEC 62116:2008			
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	h) For test condition B and C, adjust the only one reactive load components by approximately 1,0% per test, within a total range of 95% to 105% of the operating point. If run-on times are still increasing at the 95% or 105% points, additional 1% increments have to be taken until run-on times begin decreasing.		
6.2	Pass/fail criteria		
	An EUT is considered to comply with the requirements for islanding protection when each case of recorded run-on time is less than 2 s or meets the requirements of local codes.		
7	Documentation		
	At a minimum, the following information is recorded and maintained in the test report.		
	a) Specifications of EUT. Table 8 provides an example of the type of information that is provided.		
	b) Measurement results. Table 9 provides an example of the type of information that is provided. Actual measured values is to be recorded.		
	c) Block diagram of test circuit.		
	d) Specifications of the test and measurement equipment. Table 10 provides an example of the type of information that is provided.		
	e) Any test configuration or procedure details such as methods of achieving specified load and EUT output conditions.		
	f) Any additional information required by the testing laboratory's accreditation.		
	g) Specify the evaluation criterion from clause 6.2 that was utilized to determine if the product passed or failed the test.		
Annex A	Islanding as it applies to PV systems(Informative)		--
A.1	General		--
A.2	Impact of distortion on islanding		--
Annex B	Test for independent islanding detection device (relay)(Informative)		--
B.1	Introduction		--
B.2	Testing circuit		--
B.3	Testing equipment		--
B.4	Testing procedure		--
B.5	Documentation		--

IS 16169:2014 /IEC 62116:2008			
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6.1	Table: Tested condition and run-on time											
S no.	PEUT a (% of EUT rating)	Reactive load (% of QL)	PACb (% of nominal)	QACc (% of nominal)	Run on time (ms)	PEUT (KW)	Pr (resistive) KW	Pl (Inductive) Kvar	Pc (Capacitve) Kvar	Actual Qf	VDC	Remarks d
1	100	100	0	0								
2	66	66	0	0								
3	33	33	0	0								
4	100	100	-5	-5								
5	100	100	-5	0								
6	100	105	-5	5								
7	100	100	0	-5								
8	100	100	0	5								
9	100	100	5	-5								
10	100	100	5	0								
11	100	100	5	5								
12	100	100	-10	10								
13	100	100	-5	10								
14	100	100	0	10								
15	100	100	10	10								
16	100	100	10	5								
17	100	100	10	0								
18	100	100	10	-5								
19	100	100	10	-10								
20	100	100	5	-10								
21	100	100	0	-10								
22	100	100	-5	-10								
23	100	100	-10	-10								
24	100	100	-10	-5								
25	100	100	-10	0								
26	100	100	-10	5								
27	66	66	0	-5								
28	66	66	0	-4								
29	66	66	0	-3								
30	66	66	0	-2								
31	66	66	0	-1								
32	66	66	0	1								
33	66	66	0	2								
34	66	66	0	3								
35	66	66	0	4								
36	66	66	0	5								

IS 16169:2014 /IEC 62116:2008												
Clause	Requirement + Test							Result - Remark				Verdict
37	33	33	0	-5								
38	33	33	0	-4								
39	33	33	0	-3								
40	33	33	0	-2								
41	33	33	0	-1								
42	33	33	0	1								
43	33	33	0	2								
44	33	33	0	3								
45	33	33	0	4								
46	33	33	0	5								

a PEUT: EUT output power.
b PAC: Active power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
c QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
d BL: balance condition, IB: imbalance condition.

Appendix A Photographs (If any)
___kW Inverter

Waveforms:
100% Balanced Condition

66% Balanced Condition

33% Balanced Condition

100% Un-Balanced Condition

66% Un-Balanced Condition

33% Un-Balanced Condition

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