

TEST REPORT
IEC 62116 2nd ed.
Test procedure of islanding prevention measures for
Utility-interconnected photovoltaic inverters

Report Reference No. : 160408064GZU-004
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CB Testing Laboratory : Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address..... : Block E, No.7-2 Guang Dong Software Science Park, Caipin Road,
 Guangzhou Science City, GETDD, Guangzhou, China
Testing location / procedure..... : CBTL SMT TMP TL
Testing location / address : Same as above


Applicant's name : Shenzhen SOFARSOLAR Co., Ltd.
Address..... : 3A-1, Huake Building, East Technology Park, Qiaoxiang Road,
 Nanshan District, Shenzhen, China

Test specification:
Standard : IEC 62116 2nd ed. 2014-02
Test procedure..... : Type test
Non-standard test method..... : N/A



Test Report Form No. : IEC62116_2ed_b
TTRF Originator..... : Intertek
Master TRRF : Dated 2014-03

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Test item description	Solar Inverter
Trade Mark	
Manufacturer.....	Same as applicant
Model/Type reference.....	Sofar 10000TL-Sx Series, Sofar 15000TL-Sx Series, Sofar 17000TL-Sx Series, Sofar 20000TL-Sx Series (x=2, 4, 5)
Ratings DC input	<p>Maximum d.c. input voltage: 1000 V</p> <p>Input voltage rang: 250-960 V</p> <p>MPPT voltage range with full power output: 430-850 V(for Sofar 20000TL-Sx); 420-850 V(for Sofar 17000TL-Sx); 370-850 V(for Sofar 15000TL-Sx); 350-850 V(for Sofar 10000TL-Sx)</p> <p>Max. input current: 2×24 A (for Sofar 20000TL-Sx); 2×21 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx); 2×15 A (for Sofar 10000TL-Sx)</p> <p>Max. PV Isc: 2×30 A (for Sofar 20000TL-Sx); 2×27 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx); 2×20 A (for Sofar 10000TL-Sx)</p>
Ratings AC Output.....	<p>Nominal output voltage: 3/N/PE230V/400V</p> <p>Max. output current: 3×29 A (for Sofar 20000TL-Sx); 3×25 A (for Sofar 17000TL-Sx); 3×22 A (for Sofar 15000TL-Sx); 3×15 A (for Sofar 10000TL-Sx)</p> <p>Nominal frequency: 50 Hz</p> <p>Max. output power: 20000 W (for Sofar 20000TL-Sx); 17000 W (for Sofar 17000TL-Sx); 15000 W (for Sofar 15000TL-Sx); 10000 W (for Sofar 10000TL-Sx)</p> <p>Ingress protection: IP65</p> <p>Operating temperature range: -25~60°C</p>
Software version.....	V1.00

Copy of marking plate:

	
Solar Inverter	Sofar 20000TL-S2
Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max. Input Current	2*24A
Max. PV Isc	2*30A
Nominal Grid Voltage	3/N/PE,230/400V
Max. Output Current	3*29A
Nominal Grid Frequency	50Hz
Max. Output Power	20000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25~+60°C
Protective Class	Class I
Manufacturer: shenzhen SOFARSOLAR Co.,Ltd	
Made in China	
	
<small>VDE-AR-N4105, RD1699, VDE0126-1-1, G59/3, UTE C15-712-1, C10/11, IEC62116, IEC61727</small>	



Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation.
3. Labels of the other models are same as above except of the model name and parameters of rating.

Summary of testing:

The sample(s) tested complied with the type test requirement of IEC 62116 2nd ed. 2014-02

Test item particulars :	
Classification of installation and use..... :	Fixed and outdoor use
Supply Connection..... :	Permanent connection
..... :	
..... :	
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..... :	08 Apr., 2016
Date (s) of performance of tests..... :	08 Apr., 2016 – 29 Apr., 2016
General remarks:	
This report is not valid as a CB Test Report	
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.	
When determining for test conclusion, measurement uncertainty of tests has been considered. This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.	
"(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:

1. Product covered by this report is non-isolated grid-connected PV inverter for connection with low voltage grid.
2. The inverters intended to operate at ambient temperature -25°C - +60°C and 250-960 Vdc input, which will be specified in the user manual; The inverters will output full power when operated at 45°C. If operated at higher than 45°C temperature, the output power derating.

For all models, if the DC input voltage is higher than 850 Vdc the output power will be derating.
 For model Sofar 20000TL-Sx, if the DC input voltage is lower than 430 Vdc, the output power will be derating.
 For model Sofar 17000TL-Sx, if the DC input voltage is lower than 420 Vdc, the output power will be derating.
 For model Sofar 15000TL-Sx, if the DC input voltage is lower than 370 Vdc, the output power will be derating.
 For model Sofar 10000TL-Sx, if the DC input voltage is lower than 350 Vdc, the output power will be derating.
 For all models, if the AC output voltage is lower than 230 Vac the output current will be limited to not higher than rated output current.

Model difference:

All the models have identical mechanical and electrical construction except some components and some parameter of the software architecture in order to control the max output power. And refer to the following table for detail.

Model	DC surge arrester	AC surge arrester
Sofar 20000TL-S2 Sofar 17000TL-S2 Sofar 15000TL-S2 Sofar 10000TL-S2		
Sofar 20000TL-S4 Sofar 17000TL-S4 Sofar 15000TL-S4 Sofar 10000TL-S4	√	
Sofar 20000TL-S5 Sofar 17000TL-S5 Sofar 15000TL-S5 Sofar 10000TL-S5	√	√

√ denote incorporating this component

Unless other special note, the model Sofar 20000TL-S5 was selected as representative sample for testing in this report.

Factory information:

Factory: Dongguan dingqiang Machinery & Electric Co., Ltd.
 Address: No. 8, Fulong road, Qingxi town, Dongguan city, Guangdong, China

IEC62116			
Cl.	Requirement - Test	Result	Verdict
5	Testing equipment		P
5.1	Measuring instruments		P
	Waveform observation shall be measured by a device with memory function	Agilent oscillograph equipped with memory function	P
	The waveform measurement/capture device shall be able to record the waveform from the beginning of the islanding test until the EUT ceases to energize the island.	Waveform caught from the switch open and the EUT cease to energize	P
	For multi-phase EUT, all phases shall be monitored.		P
	The minimum measurement accuracy shall be 1 % or less of rated EUT nominal output voltage		P
	1 % or less of rated EUT output current, real power and reactive power measurements through switch S1 used to determined the circuit balance condition	Less than 1% of the rated EUT output current	P
5.2	DC power source		P
5.2.1	DC power source shall provide voltage and current necessary to meet the testing requirement described in Clause 6	Topcon PV simulator used	P
5.2.2	PV array simulator		P
	The test shall be conducted at the input voltage defined in Table 2		P
	And the current shall be limited to 1.5 times the rated photovoltaic input current		P
	Except when specified otherwise by the test requirements		P
5.2.3	Current and voltage limited DC power supply with series resistance		N/A
	DC power source used as the EUT input source shall be capable of EUT maximum input power at minimum and maximum EUT input operating voltage		N/A
	Power source should provide 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.		N/A
5.2.4	PV array		N/A
	EUT input source shall be capable of EUT maximum input power at minimum and maximum EUT operating voltage		N/A

IEC62116			
Cl.	Requirement - Test	Result	Verdict
	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		N/A
5.3	AC power source		P
	The utility grid or other AC power source may be used as long as it meets the condition specified in table 4.		P
5.4	AC loads		P
	Non-inductive resistors, low loss inductors, and capacitors with low effective series resistance and effective series inductance shall be utilized in the test circuit		P
	Iron core inductors if used, shall not exceed a current THD of 2% when operated at nominal voltage.		P
	Resistor power ratings should be chosen so as to minimize thermally-induced drift in resistance values during the course of the test		P
6	Test for single or multi-phase inverter		P
6.1	Test procedure		P
	This test shall be performed with the EUT conditions as in Table 5		P
6.1a	Determine EUT test output power P_{EUT} , to be used from table 5. Test conditions A, B, and C may be performed in any order convenient to testing		P
6.1b	By adjusting the DC input source, operate the EUT at the selected P_{EUT} and measure EUT reactive power, Q_{EUT}		P
	The utility disconnect switch S1 should be closed.		P
	With no local load connected (that is S2 open so that the RLC load is not connected at this time), and the EUT connected to the utility (S1 is closed),		P
	Turn the EUT on and operate it at the output determined in step a.		P
	Measure the fundamental frequency (50 or 60Hz) real and reactive power flow, P_{AC} and Q_{AC} .		P
	The real power should equal P_{AC} . The reactive power Q_{AC} measured in this step is designated Q_{EUT}		P
6.1c	Turn off the EUT and open S1		P

IEC62116			
Cl.	Requirement - Test	Result	Verdict
6.1d	Adjust the RLC circuit to have $Q_f = 1,0 \pm 0,05$		P
6.1e	Connect the RLC load configured in step d to the EUT by closing S2		P
	Close S1 and turn the EUT on, making certain that the power output is as determined in step a		P
	Adjust R, L and C as necessary to ensure that the fundamental (50 Hz or 60 Hz) component of current I_{AC} through S1 is 0,0A with tolerance of $\pm 1\%$ of the rated current of the EUT on a steady state basis in each phase		P
6.1f	Open the utility-disconnect switch S1 to initiate the test. Run-on time, t_R shall be recorded as the time between the opening of switch s1 and the point at which the EUT output current drops and remains below 1% of its rated output levels.		P
6.1g	For test condition A in Table 5 (100%), adjust the real load and only one of the reactive load components (either capacitance C, or inductance L) to each of the load imbalance conditions shown in the shaded portion of table 6.		P
	After each adjustment, an island test is run and run-on time is recorded		P
	If any of the recorded run-on times are longer than the one recorded for the rated balance condition (i.e. test f)		P
	Then, the non-shaded parameter combinations also require testing.		P
	If no run-on time exceeds the one of balance condition, then this part of test sequence is deemed be completed.		P
6.1h	For test conditions B and C, adjust the only one reactive load components (either capacitance C or inductance L may be chosen) by approximately 1% per test, with a total range of 95% to 105% of the operating point as shown in table 7.		P
	After each adjustment, an island test is run and run-on time is recorded.		P
	If run-on times are still increasing at the 95% or 105% points, additional 1% increments shall be taken until run-on times begin decreasing.		P

IEC62116			
Cl.	Requirement - Test	Result	Verdict
6.2	Pass/fail criteria		P
	An EUT is considered to comply with the requirements for islanding protection when each case of record run-on time is less than 2s or	See appendix table below	P
	Meets the requirements of local codes		P

Appendix 1: The test table

Specification of the EUT provided by manufacturer

1) Rating			
a) Maximum output power	20000W		
b) DC. voltage range	250-960V		
c) DC. current limits	2x24A		
d) AC voltage range	207V-253V		
e) Frequency range	50Hz		
f) AC current limits	3x29A		
g) Efficiency	98%		
h) Voltage and frequency trip settings (magnitude and timing)(the most severe condition)	Parameter	Magnitude	Timing
	Over voltage	253V	2s
	Under voltage	184V	2s
	Over frequency	51Hz	2s
	Under frequency	48Hz	2s
i) Other software settings	Island trip settings: <2s;		
j) Firmware version	V1.00		
2) Others			
a) Displays	LCD/LED		
b) Temperature range	-25°C to +60°C		
c) Humidity	0~95%		
d) Size	707.5*492*240mm		
e) Weight	48kg		

Table 9 – List of tested condition and run on time

No.	PEUT ¹⁾ (% of EUT rating)	Reactive load (% of QL in 6.1.d)1)	PAC ²⁾ (% of nominal)	QAC ³⁾ (% of nominal)	Run on time (ms)	PEUT (W)	Actual Qf	VDC	Remarks ⁴⁾
1	100	100	0	0	1160	20000	1.00	800	Test A at BL
2	66	66	0	0	1130	13200	1.00	600	Test B at BL
3	33	33	0	0	1170	6600	1.00	350	Test C at BL
4	100	100	-5	-5	1120	20000	1.00	800	Test A at IB
5	100	100	-5	0	1100	20000	1.05	800	Test A at IB
6	100	100	-5	5	1080	20000	1.10	800	Test A at IB
7	100	100	0	-5	1130	20000	0.95	800	Test A at IB
8	100	100	0	5	1050	20000	1.05	800	Test A at IB
9	100	100	5	-5	988	20000	0.90	800	Test A at IB
10	100	100	5	0	1010	20000	0.95	800	Test A at IB
11	100	100	5	5	1050	20000	1.00	800	Test A at IB
12	66	66	0	-5	1030	13200	0.95	600	Test B at IB
13	66	66	0	-4	1120	13200	0.96	600	Test B at IB
14	66	66	0	-3	1110	13200	0.97	600	Test B at IB

Appendix 1: The test table

15	66	66	0	-2	1110	13200	0.98	600	Test B at IB
16	66	66	0	-1	1100	13200	0.99	600	Test B at IB
17	66	66	0	1	970	13200	1.01	600	Test B at IB
18	66	66	0	2	990	13200	1.02	600	Test B at IB
19	66	66	0	3	1125	13200	1.03	600	Test B at IB
20	66	66	0	4	870	13200	1.04	600	Test B at IB
21	66	66	0	5	850	13200	1.05	600	Test B at IB
22	33	33	0	-5	892	6600	0.95	350	Test C at IB
23	33	33	0	-4	916	6600	0.96	350	Test C at IB
24	33	33	0	-3	900	6600	0.97	350	Test C at IB
25	33	33	0	-2	888	6600	0.98	350	Test C at IB
26	33	33	0	-1	880	6600	0.99	350	Test C at IB
27	33	33	0	1	908	6600	1.01	350	Test C at IB
28	33	33	0	2	904	6600	1.02	350	Test C at IB
29	33	33	0	3	906	6600	1.03	350	Test C at IB
30	33	33	0	4	898	6600	1.04	350	Test C at IB
31	33	33	0	5	890	6600	1.05	350	Test C at IB

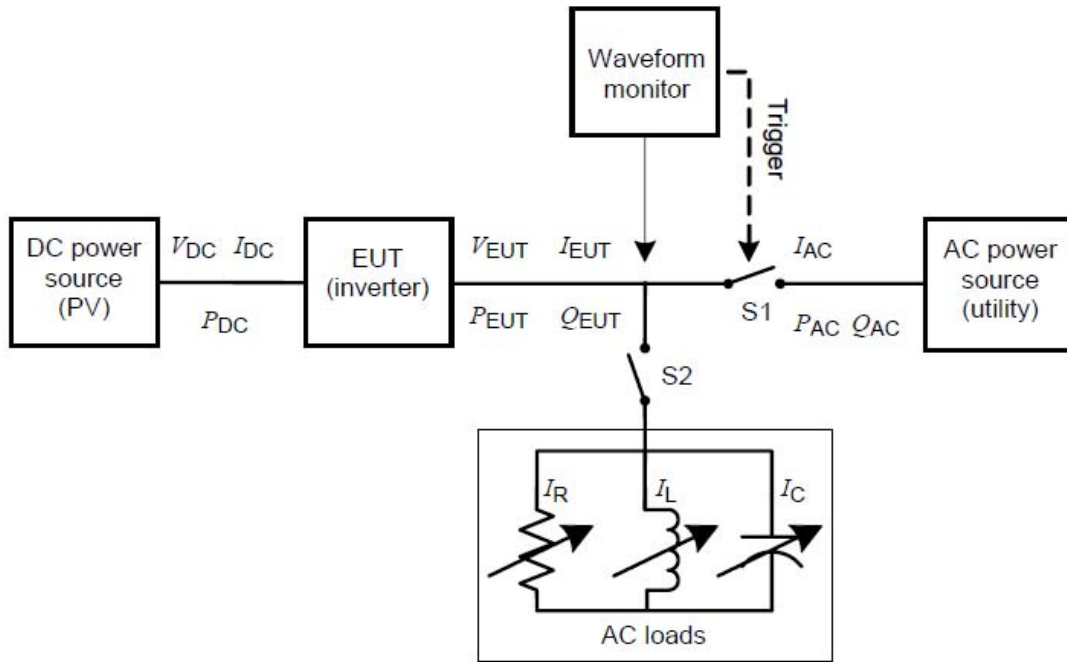
Remark:

- 1) PEUT: EUT output power
- 2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.
- 3) QAC: Reactive power flow at S1 in Figure 1. Positive means power form EUT to utility. Nominal is the 0% test condition value.
- 4) BL: Balance condition, IB: Imbalance condition.

Note: test condition A (100%): If any of the recorded run-on times are longer than the one recorded for the rated balance condition, i.e. test procedure 6.1 f), then the non-shaded parameter combinations (no.32~47) also require testing.

Appendix 2: Specification of testing equipment

Items	Specifications
1) DC power source (or PV array simulator)	
a) Voltage range	0 – 1000Vdc (0.01V step)
b) Current range	0 – 40A (0.01A step)
2) AC power source	
a) Output wiring	Single phase
b) Output capacity	48KVA
c) Output voltage	10-300Vrms
d) Output frequency	45-65Hz
e) Voltage stability	± 100ppm/°C
f) Output voltage distortion	0.05% max.
3) Digital meter	
a) Voltage range	0 – 1000Vdc, 0 – 600Vrms
b) Current range	0 – 30A
c) Frequency range (accuracy)	0.2%
d) Measurement items	Voltage (V) Current (A) Active power (W) Reactive power (Var) Volt-ampere (VA) Power factor (PF) Frequency (Hz) Electric energy (Wh)
4) Waveform recorder	
a) Sampling speed	1000K/s
b) Recording device	Memory record and USB reading
c) Time accuracy	± 500ppm
5) AC load	
a) Resistive load	Maximum voltage: 300Vrms Current range: 0 – 100A (0.001Ω step) Capacity: 100KVA
b) Inductive load	Maximum voltage: 300Vrms Current range: 0 – 100A (0.001Ω step) Capacity: 100KVA
c) Capacitive load	Maximum voltage: 300Vrms Current range: 0 – 100A



IEC 1567/08

Figure: Test circuit for islanding detection function of inverter

(End of the report)