TEST REPORT

IEC 61727:2004

TÜV SÜD Test report for Photovoltaic (PV) systems – Characteristics of the utility interface

Report reference No. ..... :	70.409.18.025.48-00 part 1 of 2
Date of issue..... :	2018-03-18
Project handler..... :	Bin Wu
TÜV SÜD Branch..... :	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
Address ..... :	3-13, No.151 Heng Tong Road, 200070, Shanghai, P.R. China
Testing Laboratory..... :	Sungrow Power Supply Co., Ltd.
Testing location ..... :	No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China
Client..... :	Sungrow Power Supply Co., Ltd.
Client number..... :	73342
Address ..... :	No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China
Contact person.....	Mr. Cao Shandong
Standard..... :	This TÜV SÜD test report form is based on the following requirements: IEC 61727:2004
TRF originated by. ..... :	TÜV SÜD Certification and Testing (China) Co., Ltd. Mr. Frank Zhu
Copyright blank test report..... :	This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TUV SUD Product Service GmbH. TUV SUD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
Test procedure ..... :	☐ GS, ☐ TÜV Mark, ☐ EU-Directive, ☐ without certification ☒ Type verification of conformity
Non-standard test method..... :	N/A
National deviations ..... :	N/A
Number of pages (Report) ..... :	37
Number of pages (Attachments) ..... :	Detail see page 2
Compiled by ... : *Bin Wu* (+ signature)	Approved by ... : *Pengdong Yang* (+ signature)

Test sample..... :	Engineering prototype
Type of test object ..... :	PV Grid-connected Inverter
Trademark..... :	阳 光 电 源 SUNGROW
Model and/or type reference ..... :	SG110CX
Rating(s)..... :	See rating labels
Manufacturer ..... :	Sungrow Power Supply Co., Ltd.
Manufacturer number..... :	73342
Address ..... :	No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China
Sub-contractors/ tests (clause)..... :	Sungrow Power Supply Co., Ltd.
Name..... :	All clauses(detail see summary of testing)

Order description..... :

☒	Complete test according to TRF
☐	Partial test according to manufacturer's specifications
☐	Preliminary test
☐	Spot check

Date of order..... :	2018-12-14
Date of receipt of test item..... :	2019-03-01
Date(s) of performance of test ..... :	2019-03-04 – 2019-03-15

Test item particulars:

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

Attachments:

Total test reports contains 2 parts listed in below table:

Item #	Description	Pages
Part 1	IEC 61727:2004 test report	37
Part 2	IEC 62116:2014 test report	11

General remarks:

"(see remark #)" refers to a remark appended to the report.
"(see appended table)" refers to a table appended to the report.
Throughout this report a comma is used as the decimal separator.
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 testing laboratory.

Summary of testing:

☐ deviation(s) found

☒ no deviations found

Individual inverter assessed based on component basis.

Firmware version:

LCD_AMBER-S_V11_V01_A， MDSP_AMBER-S_V11_V01_A

Test items below according to IEC 61727:2004, tested model refer to below information.

☒ 4.3 Flicker

☒ 4.4 Direct current injection

☒ 4.6 Harmonic and waveform distortion

☒ 4.7 Power factor

☒ 5.2.1 & 5.4 Voltage protection and reconnection

☒ 5.2.2 & 5.4 Frequency protection and reconnection

☒ 5.3 Islanding protection

Copy of marking plate:


WARNING: Electric Shock Hazards! DC conductors of the photovoltaic system are ungrounded and may carry lethal voltage.
WARNING: Electric Shock Hazards! DC conductors of the photovoltaic system are generally ungrounded but will be interm ittently grounded without indication when the inverter measures the PV array insul- ation resistance.
CAUTION: Risk of Electric Shock! Do not remove the cover. No user ser- viceable components inside. Maintained by qualified personnel only.
CAUTION: Risk of Electric Shock! (a) Both AC and DC wiring terminals are inside the device. Disconnect each cir- cuit before maintenance. (b) Once exposed to sunlight, the PV array will generate voltage.
5min
CAUTION: Risk of electric shock from energy stored in the capacitor. Do not remove the cover until 5 minutes later after disconnecting all sources of supply.
CAUTION: Beware of Burning! – Hot surface. Do not touch the running device.
CAUTION: Read the manual before operation and maintenance.
警告：触电危险警告，光伏系统的直流 导线未接地，其可能带电。
警告：触电危险警告，光伏系统直流导 线通常不接地，当逆变器测量光伏阵列绝 缘电阻时，其会出现间歇性接地而没有指 示。
注意：触电危险警告，请勿拆卸机盖。 内部无用户可检修部件。有资质的专业 人员方可检修。
触电危险警告
a）本设备交流和直流均为内部接线，检 修前每路电路必须单独断开；
b）光伏方阵暴露在阳光下，会产生直流 电压到本设备；
5min
注意：注意储存在电容器中的 危险能量，注意触电危险，切断所 有电源后，5分钟内请勿拆卸机盖。
注意：表面灼热，请勿触摸，小心烫伤。
注意：检修前，请阅读产品说明书。
SUNGROW
Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Road, Hefei, 230088, P.R.China
EU/EEA Importer
Sungrow Deutschland GmbH
Balanstrasse 59, 81541 München, Germany
CE
33mm
58mm

Picture of the product

Front

left

Rear

Right

Top

Bottom

Characteristic data(following data are exact from user manual directly for reference)

Model	SG110CX
Vmax PV	d.c. 1100V
Min. MPP voltage	d.c. 200V
Max. MPP voltage	d.c. 1000V
Max. input current	d.c. 9×26A
Isc PV	d.c. 2×40 A
Nominal AC power	100 kW
Maximum output apparent power	110 KVA
Max. AC output current	158.8 A
Nominal grid voltage	3/N/PE ~, 400/230V
Nominal grid frequency	50 Hz
THD	<3% at nominal power
DC current injection	<0.5% at nominal output current
Power factor 0.8	0.8 (leading)~0.8 (lagging)
Dimensions(W×H×D)	1051×660×363mm
Weight	85 kg
Protection degree	IP66
Night self-consumption	<2 W
Operating ambient temperature range	-30℃~＋60℃ (> 45℃ derating)
Cooling method Temperature	controlled forced air cooling
Relative humidity	0～95% (non-condensing)
Max. working altitude	4000 m
Communication port/protocol	RS485/Modbus, Ethernet(communication distance of RS485 ≤1000m; communication distance of Ethernet ≤100m)

Characteristic data Factory:

Sungrow Power Supply Co., Ltd.

No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China Note: Type verification of conformity, no FI required.

Purpose of the product

These devices are transformer-less grid-connected PV inverters which converts direct current optimized by photovoltaic DC conditioner to alternating current, and it is intended to be connected in parallel with the low-voltage mains to supply common load.

They are intended for professional incorporation into PV system, and they are assessed on a component test basis.

The following safety parameters are factory set and fixed per IEC 61727:2004 and IEC 62116:2014:

Default interface protection settings

Parameters	Normative requirements		Internal threshold setting	
	Maximum clearance time	Trip limit	Maximum clearance time (factory setting)	Factory setting
Response to abnormal voltages	0,1s	V < 50%	0,1s	Line-line: <200 V (50%Un)
	2,0s	50 % ≤ V < 85 %	2,0s	Line-line: 200 V(50%Un) ≤ V < 340 V(85%Un)
	Continuous operation	85 % ≤ V ≤ 110 %	Continuous operation	85 % ≤ V ≤ 110 %
	2,0s	110 % < V < 135 %	2,0s	Line-line: 440 V(110%Un) < V < 540 V(135%Un)
	0,05s	135 % ≤ V	0,05s	Line-line: 540 V(135%Un) ≤ V
Over frequency	0,2s	f > 51Hz	0,2s	f > 51,00Hz
Under frequency	0,2s	f < 49Hz	0,2s	f < 49,00Hz
Islanding protection	2s	Islanding	2s	Islanding
Response to utility recovery	20s – 5min	-	Default 60s, adjustable range: 20s – 5min	-

Alteration of the above settings or full setting range of the interface protection may cause a breach of the type-certificate marking.Unauthorised access to factory safety parameters setting and software should be prohibited. A reset to the factory safety parameters requires retesting and verification in conjunction with the end-use system.

Possible test case verdicts:

- test case does not apply to the test object.....: N/A / not included in the order
- test object does meet the requirement .....: P / (pass)
- test object does not meet the requirement .....: F. / (fail)

Possible suffixes to the verdicts:

- suffix for detailed information for the client.....: - C / (comment)
- suffix for important information for factory inspection...: - M / (manufacturing)

Clause	Requirement + Test	Result - Remark	Verdict
4	Utility compatibility		P
	The quality of power provided by the PV system for the on-site AC loads and for power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor.		P
	Deviation from these standards represents out-of-bounds conditions and may require the PV system to sense the deviation and properly disconnect from the utility system.		P
4.1	Voltage, current and frequency		P
	The PV system AC voltage, current and frequency shall be compatible with the utitliy system.		P
4.2	Normal voltage operating range		P
	Utility-interconnected PV systems do not normally regulate voltage, they inject current into the utility. Therefore, the voltage operating range for PV inverters is selected as a protection function that responds to abnormal utility conditions, not as a voltage regulation function.		P
4.3	Flicker		P
	The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with current of 16 A and above.	(see appended table 4.3)	P
4.4	DC injection		P
	The PV system shall not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	(see appended table 4.4)	P
4.5	Normal frequency operating range		P
	The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.	(see appended table 4.5 & 5.2.2)	P
4.6	Harmonics and waveform distortion		P
	Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in Table 1.	(see appended table 4.6)	P
	Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed.		P

<table>
<tr><th>Clause</th><th>Requirement + Test</th><th>Result - Remark</th><th>Verdict</th></tr>
<tr><td></td><td>Table 1 – Current distortion limits
<table>
<tr><th>Odd harmonics</th><th>Distortion limit</th></tr>
<tr><td>3rd through 9th</td><td>Less than 4,0 %</td></tr>
<tr><td>11th through 15th</td><td>Less than 2,0 %</td></tr>
<tr><td>17th through 21st</td><td>Less than 1,5 %</td></tr>
<tr><td>23rd through 33rd</td><td>Less than 0,6 %</td></tr>
</table>
<table>
<tr><th>Even harmonics</th><th>Distortion limit</th></tr>
<tr><td>2nd through 8th</td><td>Less than 1,0 %</td></tr>
<tr><td>10th through 32nd</td><td>Less than 0,5 %</td></tr>
</table></td><td></td><td>P</td></tr>
<tr><td>4.7</td><td>The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.</td><td>(see appended table 4.7)</td><td>P</td></tr>
<tr><td>5</td><td colspan="2">Personnel safety and equipment protection</td><td>P</td></tr>
<tr><td></td><td>This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.</td><td></td><td>P</td></tr>
<tr><td>5.1</td><td>Loss of utility voltage</td><td></td><td>P</td></tr>
<tr><td></td><td>To prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits.</td><td>.</td><td>P</td></tr>
<tr><td></td><td>A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to fault conditions or the distribution line switched out during maintenance.</td><td></td><td>P</td></tr>
<tr><td>5.2</td><td>Over/under voltage and frequency</td><td></td><td>P</td></tr>
<tr><td></td><td>The abnormal utility conditions of concern are voltage and frequency excursions above or below the values stated in this Clause, and the complete disconnection of the utility, presenting the potential for a distributed resource island.</td><td></td><td>P</td></tr>
<tr><td>5.2.1</td><td>Over/under voltage</td><td></td><td>P</td></tr>
<tr><td></td><td>When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system shall cease to energize the utility distribution system. This applies to any phase of a multiphase system.</td><td>(see appended table 5.2.1 & 5.4)</td><td>P</td></tr>
<tr><td></td><td>Table 2 – Response to abnormal voltages
<table>
<tr><th>Voltage (at point of utility connection)</th><th>Maximum trip time*</th></tr>
<tr><td>V < 0,5 × Vnominal</td><td>0,1 s</td></tr>
<tr><td>50 % ≤ V < 85 %</td><td>2,0 s</td></tr>
<tr><td>85 % ≤ V ≤ 110 %</td><td>Continuous operation</td></tr>
<tr><td>110 % < V < 135 %</td><td>2,0 s</td></tr>
<tr><td>135 % ≤ V</td><td>0,05 s</td></tr>
<tr><td colspan="2">* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The PV system control circuits shall actually remain connected to the utility to allow sensing of utility electrical conditions for use by the "reconnect" feature.</td></tr>
</table></td><td></td><td>P</td></tr>
<tr><td>5.2.2</td><td>Over/under frequency</td><td></td><td>P</td></tr>
</table>

Clause	Requirement + Test	Result - Remark	Verdict
	When the utility frequency deviates outside the specified conditions the photovoltaic system shall cease to energize the utility line. The unit does not have to cease to energize if the frequency returns to the normal utility continuous operation condition within the specified trip time.	(see appended table 5.2.2 & 5.4)	P
	When the utility frequency is outside the range of ±1 Hz, the system shall cease to energize the utility line within 0,2 s. The purpose of the allowed range and time delay is to allow continued operation for short-term disturbances and to avoid excessive nuisance tripping in weak-utility system conditions.		P
5.3	Islanding protection	Refer to IEC 62116:2014 test report	P
	The PV system must cease to energize the utitliy line within 2 s of loss of utility.		P
5.4	Response to utility recovery		P
	Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system shall not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges.	(see appended table 5.2.1 & 5.4 and 5.2.2 & 5.4)	P
5.5	Earthing		P
	The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712.		P
5.6	Short circuit protection	Take into consideration in end system in accordance with IEC 60364-7-712.	N/A
	The photovoltaic system shall have short-circuit protection in accordance with IEC 60364-7-712.		N/A
5.7	Isolation and switching		N/A
	A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.		N/A

4.3	Flicker				P
Limit	dmax=4,0%	dc=3,3%	d(t)=3,3%	Pst < 1,0	Plt < 0,65
measured	1,45%/ 1,17%/1,17%	0,12%/0,46%/0,46%	0%/0%/0%	0,33/0,32/0,32	0,29/0,28/0,28
Supplementary information: The test is conducted in the worst case of maximum rated output power.					

4.4	Direct current injection					P
Rated output current (A)	Ratio of rated output power (VA)	Measured DC output current between terminals			Isolated transformer ? (Yes/No)	Limit (A)
		L1(A)	L2(A)	L3(A)		
144,93	25%	0,63	0,65	0,66	No	1,449
144,93	50%	0,72	0,78	0,78	No	1,449
144,93	100%	0,93	0,92	0,92	No	1,449
Remark: Ir=100000/3/230=144,93A						

4.6	Harmonics and waveform distortion								**P**
Order	Harmonic			Harmonic limit %	Order	Harmonic			Harmonic limit %
	L1	L2	L3			L1	L2	L3	
2	0,18	0,17	0,17	1%	3	0,30	0,16	0,14	4%
4	0,02	0,03	0,02	1%	5	1,43	1,33	1,28	4%
6	0,02	0,02	0,02	1%	7	0,45	0,38	0,44	4%
8	0,02	0,02	0,02	1%	9	0,05	0,02	0,03	4%
10	0,03	0,02	0,03	0,5%	11	0,70	0,70	0,69	2%
12	0,02	0,02	0,02	0,5%	13	0,64	0,66	0,67	2%
14	0,02	0,02	0,03	0,5%	15	0,03	0,02	0,02	2%
16	0,02	0,02	0,02	0,5%	17	0,56	0,55	0,58	1,5%
18	0,02	0,02	0,02	0,5%	19	0,46	0,49	0,46	1,5%
20	0,01	0,02	0,01	0,5%	21	0,02	0,01	0,01	1,5%
22	0,01	0,01	0,01	0,5%	23	0,34	0,31	0,35	0,6%
24	0,01	0,01	0,01	0,5%	25	0,25	0,27	0,25	0,6%
26	0,02	0,02	0,02	0,5%	27	0,02	0,02	0,01	0,6%

28	0,01	0,01	0,01	0,5%	29	0,17	0,16	0,18	0,6%
30	0,02	0,02	0,02	0,5%	31	0,12	0,14	0,11	0,6%
32	0,02	0,02	0,02	0,5%	33	0,02	0,01	0,01	0,6%
Total harmonic distortion	2,12	2,02	2,01	5%					
Supplementary information: test at 100% rated power									

4.7	Power factor					P
Output						
No	Watts (W)	VA (VA)	Vrms (V)	Irms (A)	PF	Power level (% of VA)
1	55084	55117	231,7/231,2/231,2	79,28/79,47/79,48	0,9994	55084
2	66213	66240	231,3/231,3/231,4	95,46/95,47/95,42	0,9996	66213
3	77073	77103	231,4/231,6/231,2	111,06/110,97/111,16	0,9996	77073
4	88136	88172	231,3/231,4/231,5	127,07/127,01/126,96	0,9996	88136
5	98988	99018	231,2/231,5/231,7	142,76/142,57/142,45	0,9997	98988
6	110950	110972	231,5/231,6/231,7	159,78/159,72/159,65	0,9998	110950
Supplementary information: test at fixed cos φ = 1						

5.1	Loss of utility voltage	P
Disconnection limit:	2 s	

No.	P_{EUT} (% of EUT rating)	Reactive Load (% of Q_L)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on time (ms)	P_{EUT} (kW)	Actual Q_f	V_{DC}(V)	Remarks
1	100	100	0	0	302	110	1,01	820	Test A, BL
2	66	66	0	0	252	72,6	1,02	685	Test B, BL
3	33	33	0	0	214	36,3	1,03	540	Test C, BL
4	100	100	-5	-5	252	110	1,02	820	Test A, IB[1]
5	100	100	-5	0	254	110	1,04	820	Test A, IB[1]
6	100	100	-5	+5	180	110	1,06	820	Test A, IB[1]
7	100	100	0	-5	224	110	0,99	820	Test A, IB[1]
8	100	100	0	+5	176	110	1,01	820	Test A, IB[1]

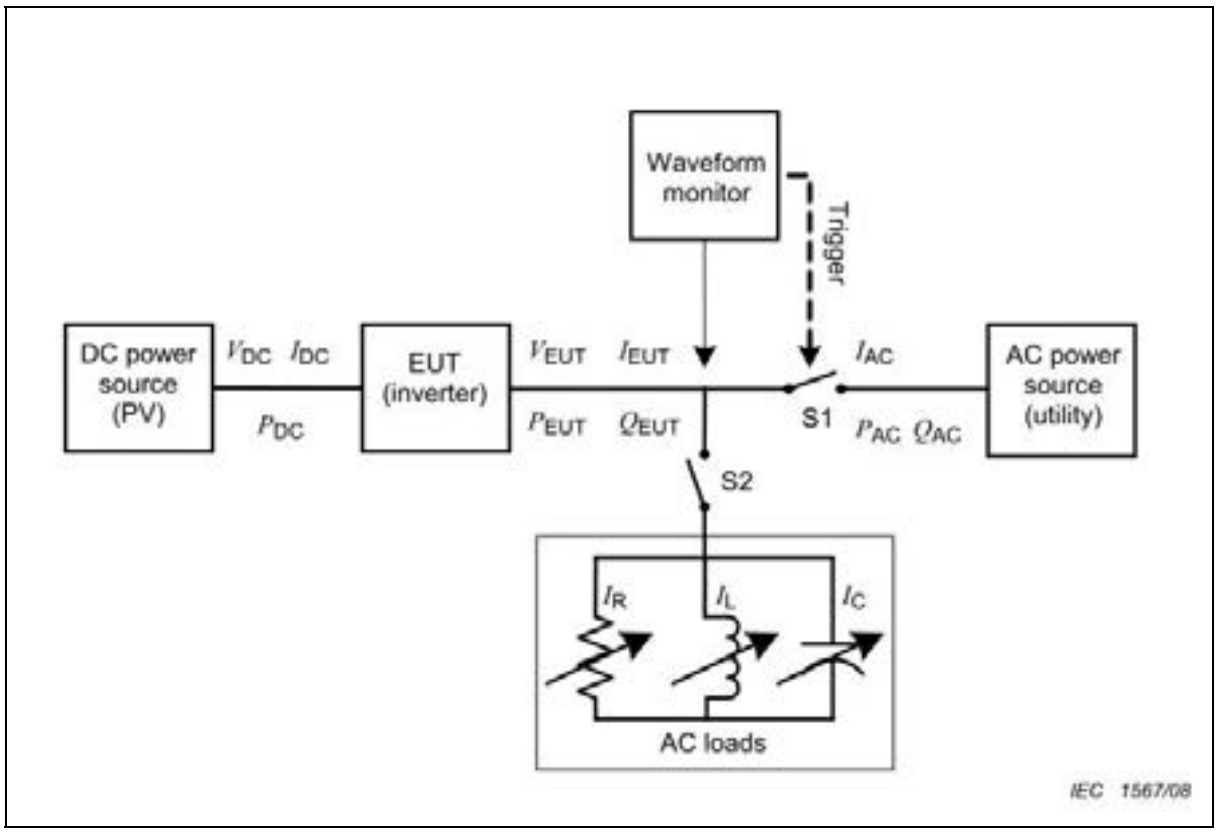
9	100	100	+5	-5	266	110	0,96	820	Test A, IB[1]
10	100	100	+5	0	262	110	0,95	820	Test A, IB[1]
11	100	100	+5	+5	194	110	0,97	820	Test A, IB[1]
12	100	100	-10	+10	196	110	1,04	820	Test A, IB[1]
13	100	100	-5	+10	187	110	1,08	820	Test A, IB[1]
14	100	100	0	+10	190	110	1,04	820	Test A, IB[1]
15	100	100	+5	+10	186	110	1,0	820	Test A, IB[1]
16	100	100	+10	+10	168	110	0,95	820	Test A, IB[1]
17	100	100	-10	+5	173	110	1,12	820	Test A, IB[1]
18	100	100	+10	+5	186	110	0,93	820	Test A, IB[1]
19	100	100	-10	0	180	110	1,10	820	Test A, IB[1]
20	100	100	+10	0	196	110	0,93	820	Test A, IB[1]
21	100	100	-10	-5	192	110	1,07	820	Test A, IB[1]
22	100	100	+10	-5	188	110	0,93	820	Test A, IB[1]
23	100	100	-10	-10	192	110	1,05	820	Test A, IB[1]
24	100	100	-5	-10	196	110	1,00	820	Test A, IB[1]
25	100	100	0	-10	178	110	0,95	820	Test A, IB[1]
26	100	100	+5	-10	192	110	0,90	820	Test A, IB[1]
27	100	100	+10	-10	191	110	0,89	820	Test A, IB[1]
28	66	66	0	-5	204	72,6	0,97	685	Test B, IB
29	66	66	0	-4	213	72,6	0,98	685	Test B, IB
30	66	66	0	-3	220	72,6	0,98	685	Test B, IB
31	66	66	0	-2	224	72,6	0,99	685	Test B, IB
32	66	66	0	-1	227	72,6	0,99	685	Test B, IB
33	66	66	0	1	236	72,6	1,00	685	Test B, IB
34	66	66	0	2	227	72,6	1,01	685	Test B, IB

35	66	66	0	3	212	72,6	1,01	685	Test B, IB
36	66	66	0	4	206	72,6	1,02	685	Test B, IB
37	66	66	0	5	192	72,6	1,02	685	Test B, IB
38	33	33	0	-5	192	36,3	0,97	540	Test C, IB
39	33	33	0	-4	220	36,3	0,98	540	Test C, IB
40	33	33	0	-3	222	36,3	0,98	540	Test C, IB
41	33	33	0	-2	224	36,3	0,99	540	Test C, IB
42	33	33	0	-1	222	36,3	1,00	540	Test C, IB
43	33	33	0	1	216	36,3	1,01	540	Test C, IB
44	33	33	0	2	194	36,3	1,01	540	Test C, IB
45	33	33	0	3	190	36,3	1,02	540	Test C, IB
46	33	33	0	4	182	36,3	1,03	540	Test C, IB
47	33	33	0	5	174	36,3	1,03	540	Test C, IB

1. Because of the limitation of island test system capacity, the inverter limits the output power to 635KW.

test record Qf at balance condition of 100%, 66% and 33% of power with 635kW.

Test method is referring to IEC 62116:2014, with the following setup.



5.2.1 & 5.4	Under and over-voltage trip test and reconnection test	P

Under-voltage monitoring: trip limit and tolerance

Iteration	Measured voltage (V)	Deviation from nominal voltage (%)	Limit (%)
Setting(step 1): 195,5V(L-N), 340V(L-L)@ rated voltage 230/400V			
1- Phase L1-N(step 1)	194,4	-0,48	± 1
2- Phase L1-N(step 1)	194,1	-0,61	± 1
3- Phase L1-N(step 1)	193,4	-0,91	± 1
1- Phase L2-N(step 1)	194,1	-0,61	± 1
2- Phase L2-N(step 1)	194,0	-0,65	± 1
3- Phase L2-N(step 1)	193,9	-0,70	± 1
1- Phase L3-N(step 1)	194,4	-0,48	± 1

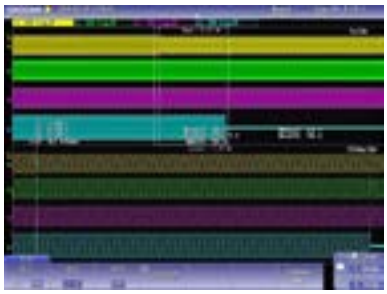
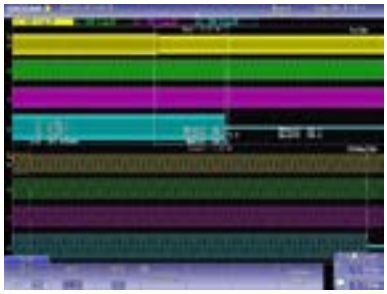
2- Phase L3-N(step 1)	194,0	-0,65	± 1
3- Phase L3-N(step 1)	194,4	-0,48	± 1
1- Phase L1-L2(step 1)	338,7	-0,32	± 1
2- Phase L1-L2(step 1)	337,5	-0,62	± 1
3- Phase L1-L2(step 1)	339,2	-0,20	± 1
1- Phase L2-L3(step 1)	339,3	-0,18	± 1
2- Phase L2-L3(step 1)	338,0	-0,50	± 1
3- Phase L2-L3(step 1)	339,5	-0,12	± 1
1- Phase L1-L3(step 1)	339,2	-0,20	± 1
2- Phase L1-L3(step 1)	337,7	-0,58	± 1
3- Phase L1-L3(step 1)	337,2	-0,70	± 1
Setting(step 2): 115V(L-N), 200V(L-L)@ rated voltage 230/400V			
1- Phase L1-N(step 2)	115,8	0,34	± 1
2- Phase L1-N (step 2)	115,7	0,30	± 1
3- Phase L1-N (step 2)	116,1	0,48	± 1
1- Phase L2-N(step 2)	113,9	-0,48	± 1
2- Phase L2-N(step 2)	115,5	0,22	± 1
3- Phase L2-N(step 2)	115,4	0,17	± 1
1- Phase L3-N(step 2)	115,4	0,17	± 1
2- Phase L3-N(step 2)	115,4	0,17	± 1
3- Phase L3-N(step 2)	115,8	0,35	± 1
1- Phase L1-L2(step 2)	199,9	-0,03	± 1
2- Phase L1-L2(step 2)	199,6	-0,10	± 1
3- Phase L1-L2(step 2)	200,2	0,05	± 1
1- Phase L2-L3(step 2)	200,2	0,05	± 1

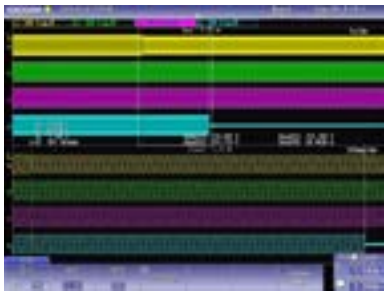
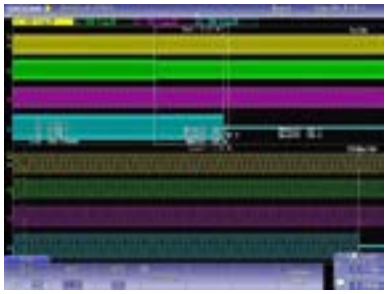
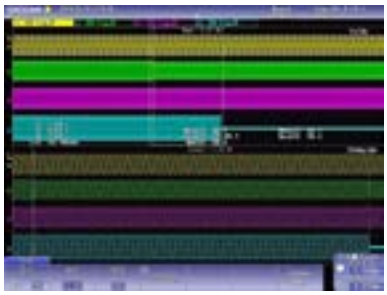
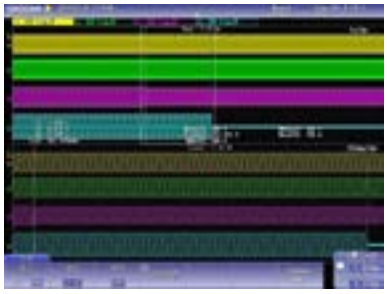
2- Phase L2-L3(step 2)	199,9	-0,03	± 1
3- Phase L2-L3(step 2)	199,6	-0,10	± 1
1- Phase L1-L3(step 2)	200,4	0,10	± 1
2- Phase L1-L3(step 2)	200,4	0,10	± 1
3- Phase L1-L3(step 2)	200,2	0,05	± 1

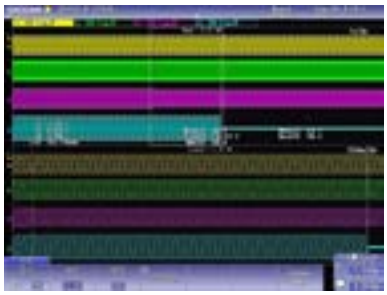
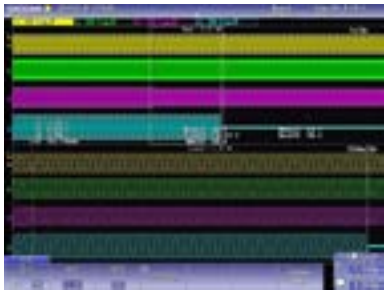
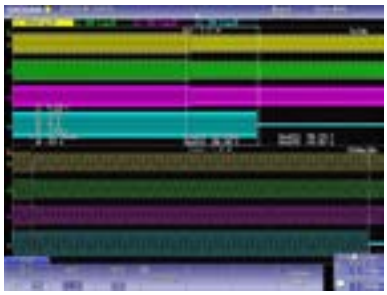
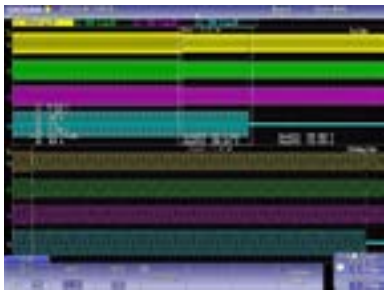
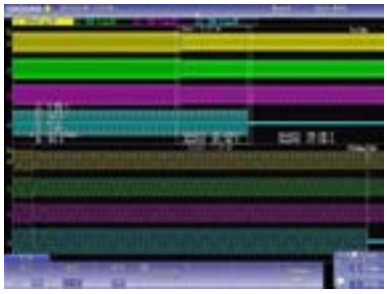
Under-voltage monitoring: trip time and reconnection time

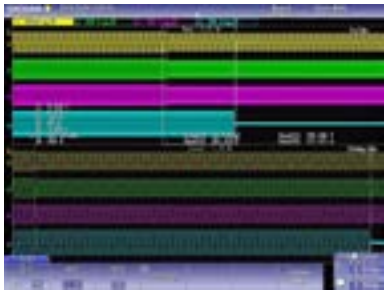
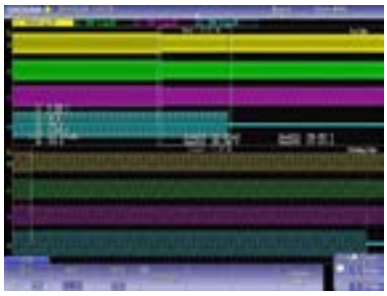
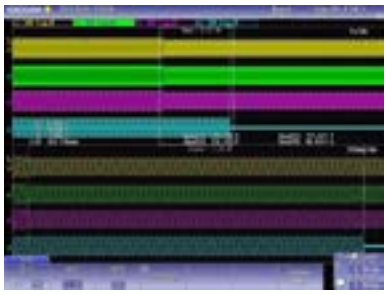
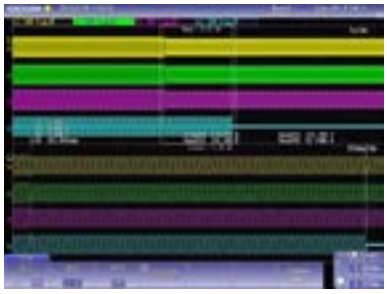
Curve illustration:
Channel 1: Waveform of PV inverter output voltage at grid connection terminals L1,
Channel 2: Waveform of PV inverter output voltage at grid connection terminals L2,
Channel 3: Waveform of PV inverter output voltage at grid connection terminals L3,
Channel 4: Waveform of PV inverter output current at grid connection terminals.

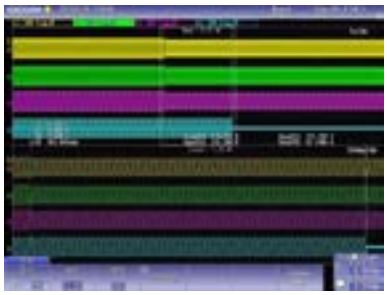
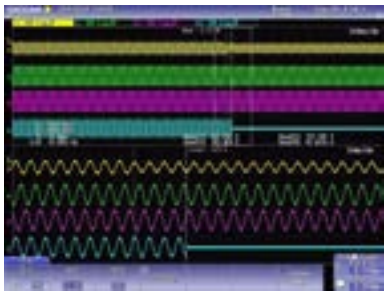
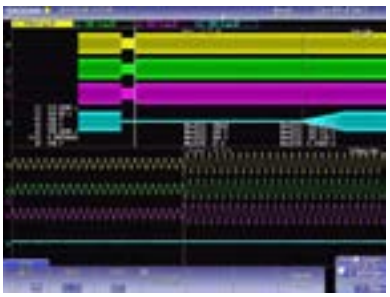
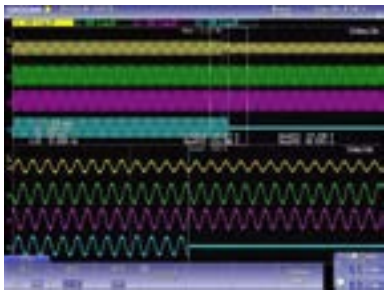
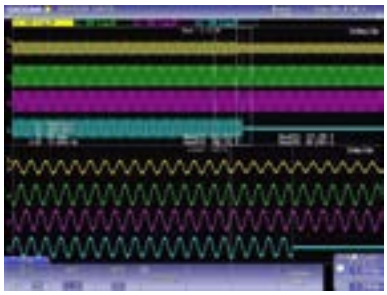
Under-voltage: Setting(step 1): 195,5V(L-N), 340V(L-L)@ rated voltage 230/400V

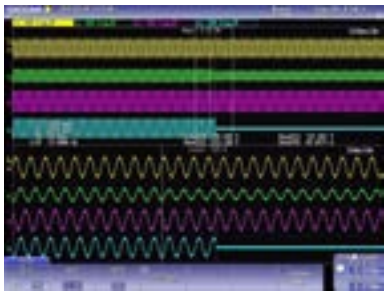
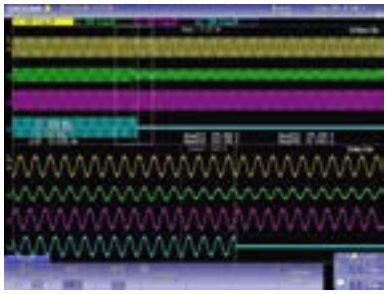
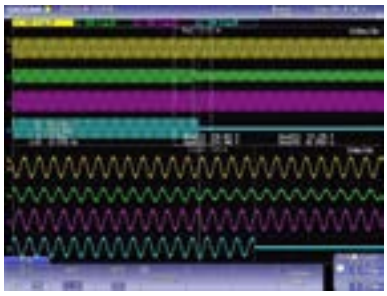
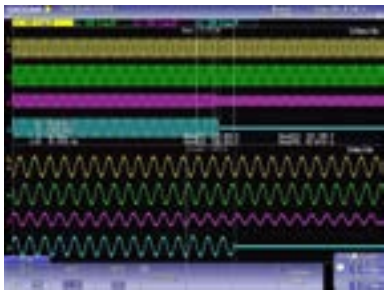
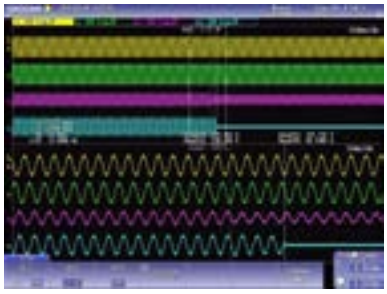
Iteration	Disconnect time (s)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)
1- Phase L1-N(step 1)	1,794		108,98	
2- Phase L1-N(step 1)	1,812		-	Same software used for reconnection after trip, test once for verification in above.

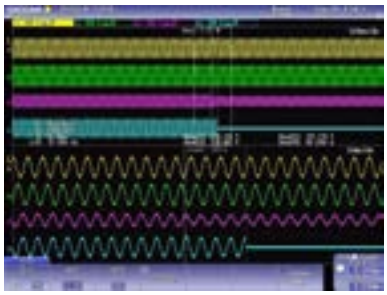
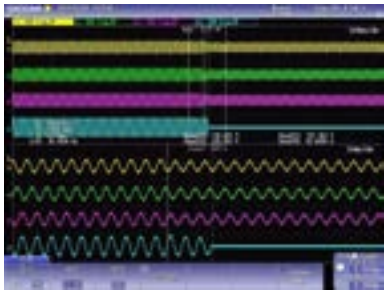
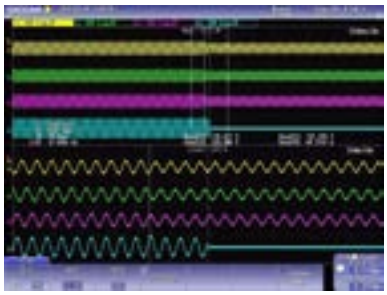
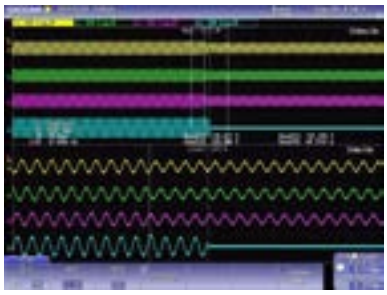
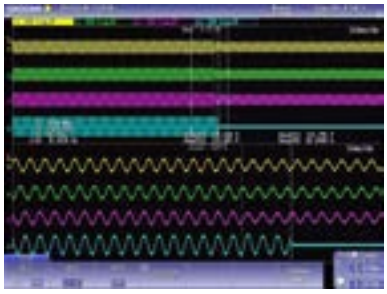
3- Phase L1-N(step 1)	1,795		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-N(step 1)	1,798		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-N(step 1)	1,810		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-N(step 1)	1,814		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L3-N(step 1)	1,794		-	Same software used for reconnection after trip, test once for verification in above.

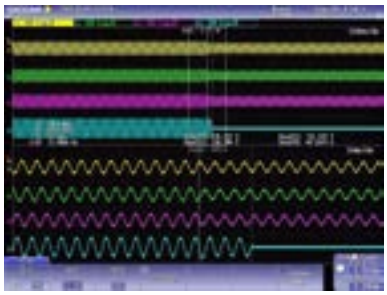
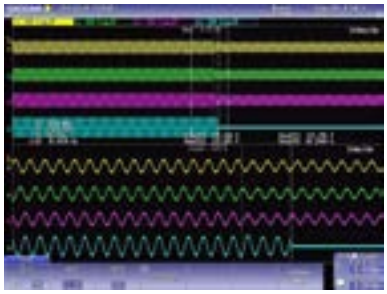
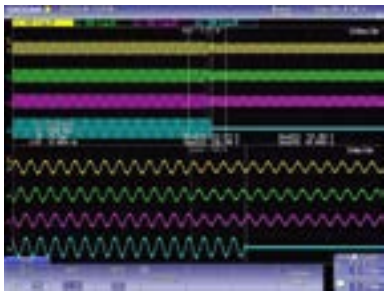
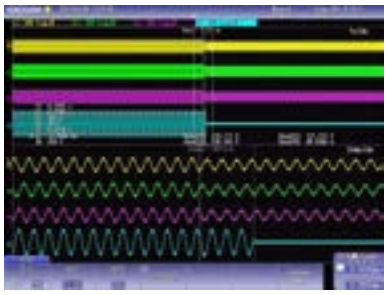
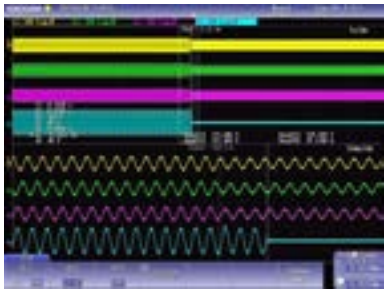
2- Phase L3-N(step 1)	1,806		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L3-N(step 1)	1,806		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L1-L2(step 1)	1,810		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L1-L2(step 1)	1,789		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-L2(step 1)	1,802		-	Same software used for reconnection after trip, test once for verification in above.

1- Phase L2-L3(step 1)	1,804		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-L3(step 1)	1,804		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-L3(step 1)	1,804		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L1-L3(step 1)	1,806		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L1-L3(step 1)	1,808		-	Same software used for reconnection after trip, test once for verification in above.

3- Phase L1-L3(step 1)	1,808		-	Same software used for reconnection after trip, test once for verification in above.
Under-voltage: Setting(step 2): 115V(L-N), 200V(L-L)@ rated voltage 230/400V				
1- Phase L1-N(step 2)	0,070		108,99	
2- Phase L1-N(step 2)	0,078		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-N(step 2)	0,084		-	Same software used for reconnection after trip, test once for verification in above.

1- Phase L2-N(step 2)	0,073		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-N(step 2)	0,074		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-N(step 2)	0,074		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L3-N(step 2)	0,066		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L3-N(step 2)	0,073		-	Same software used for reconnection after trip, test once for verification in above.

3- Phase L3-N(step 2)	0,082		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L1-L2(step 2)	0,061		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L1-L2(step 2)	0,079		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-L2(step 2)	0,079		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-L3(step 2)	0,066		-	Same software used for reconnection after trip, test once for verification in above.

2- Phase L2-L3(step 2)	0,071		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-L3(step 2)	0,067		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L3-L1(step 2)	0,074		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L3-L1(step 2)	0,073		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L3-L1(step 2)	0,065		-	Same software used for reconnection after trip, test once for verification in above.

Over-voltage monitoring: trip limit and tolerance			
Iteration	Measured voltage (V)	Deviation from setting point (%)	Limit (%)
Setting(step 1): 253V(L-N), 440(L-L)@ rated voltage 230/400V			
1- Phase L1-N(step 1)	253,2	0,08	± 1
2- Phase L1-N(step 1)	252,9	-0,04	± 1
3- Phase L1-N(step 1)	252,9	-0,04	± 1
1- Phase L2-N(step 1)	253,1	0,04	± 1
2- Phase L2-N(step 1)	253,1	0,04	± 1
3- Phase L2-N(step 1)	253,2	0,08	± 1
1- Phase L3-N(step 1)	253,2	0,08	± 1
2- Phase L3-N(step 1)	253,1	0,04	± 1
3- Phase L3-N(step 1)	253,2	0,08	± 1
1- Phase L1-L2(step 1)	437,4	-0,65	± 1
2- Phase L1-L2(step 1)	437,3	-0,67	± 1
3- Phase L1-L2(step 1)	437,8	-0,55	± 1
1- Phase L2-L3(step 1)	438,2	-0,45	± 1
2- Phase L2-L3(step 1)	438,1	-0,48	± 1
3- Phase L2-L3(step 1)	438,4	-0,40	± 1
1- Phase L1-L3(step 1)	438,2	-0,45	± 1
2- Phase L1-L3(step 1)	438,1	-0,48	± 1
3- Phase L1-L3(step 1)	438,1	-0,48	± 1
Setting(step 2): 310,5V(L-N), 540V(L-L)@ rated voltage 230/400V			
1- Phase L1-N(step 2)	311,5	0,43	± 1

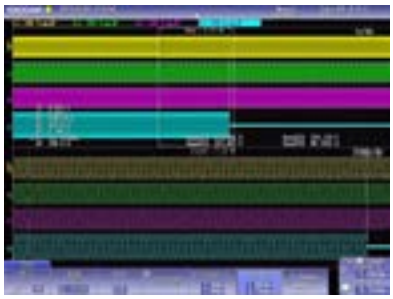
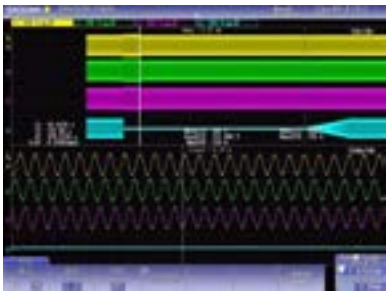
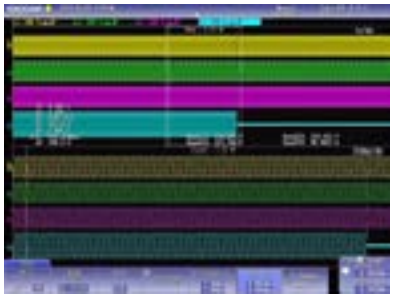
2- Phase L1-N(step 2)	311,0	0,22	± 1
3- Phase L1-N(step 2)	311,5	0,43	± 1
1- Phase L2-N(step 2)	311,2	0,30	± 1
2- Phase L2-N(step 2)	311,5	0,43	± 1
3- Phase L2-N(step 2)	311,5	0,43	± 1
1- Phase L3-N(step 2)	311,8	0,56	± 1
2- Phase L3-N(step 2)	311,2	0,30	± 1
3- Phase L3-N(step 2)	311,5	0,43	± 1
1- Phase L1-L2(step 2)	541,2	0,30	± 1
2- Phase L1-L2(step 2)	541,5	0,37	± 1
3- Phase L1-L2(step 2)	541,6	0,40	± 1
1- Phase L2-L3(step 2)	539,5	-0,13	± 1
2- Phase L2-L3(step 2)	540,5	-0,13	± 1
3- Phase L2-L3(step 2)	541,0	0,25	± 1
1- Phase L1-L3(step 2)	541,5	0,38	± 1
2- Phase L1-L3(step 2)	541,6	0,40	± 1
3- Phase L1-L3(step 2)	541,8	0,45	± 1

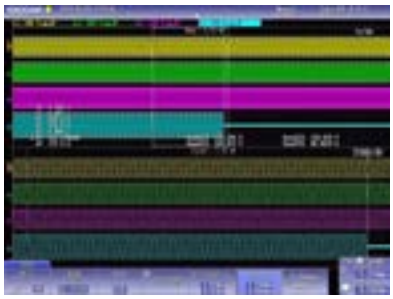
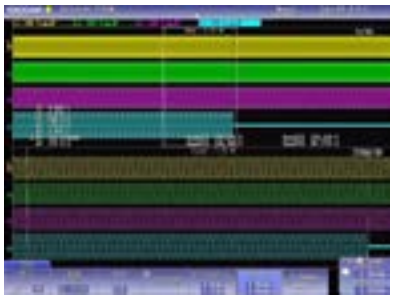
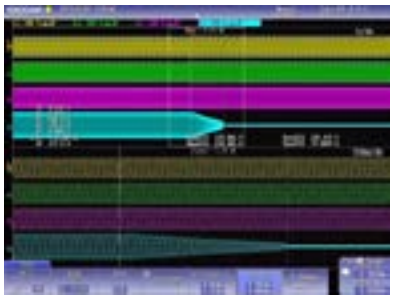
Over-voltage monitoring: trip time and reconnection time

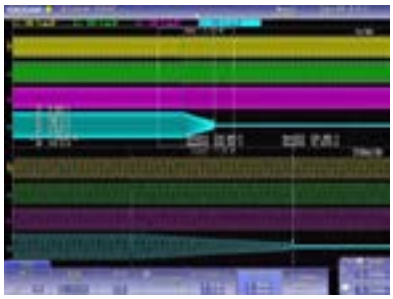
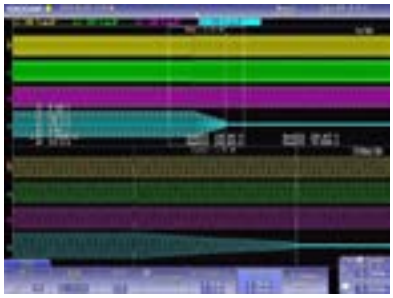
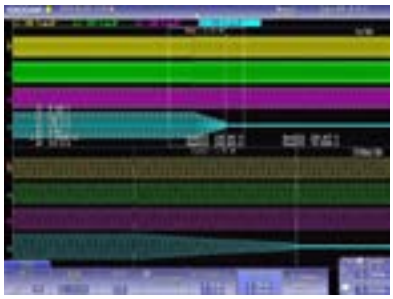
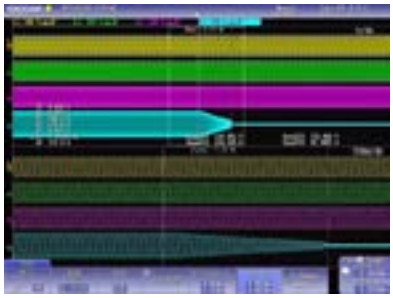
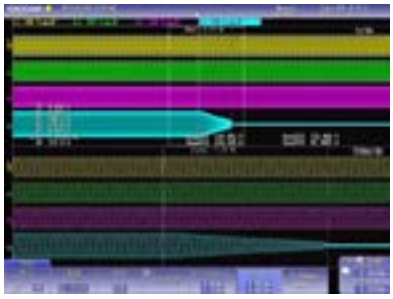
Over-voltage Setting(step 1): 253V(L-N), 440(L-L)@ rated voltage 230/400V

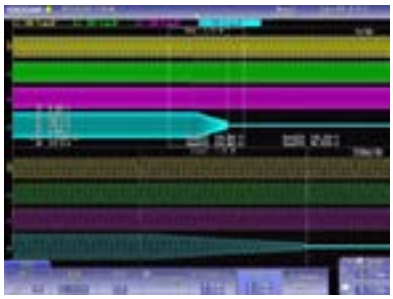
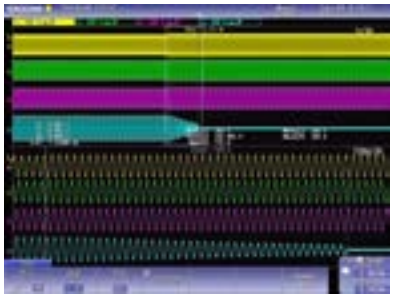
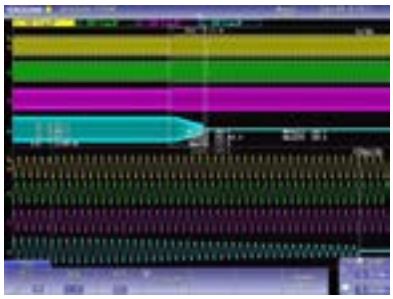
Curve illustration:
Channel 1: Waveform of PV inverter output voltage at grid connection terminals L1,
Channel 2: Waveform of PV inverter output voltage at grid connection terminals L2,
Channel 3: Waveform of PV inverter output voltage at grid connection terminals L3,
Channel 4: Waveform of PV inverter output current at grid connection terminals.

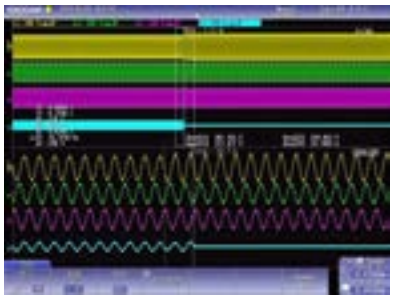
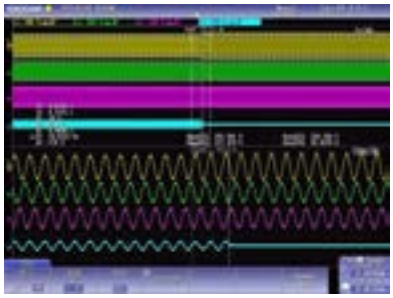
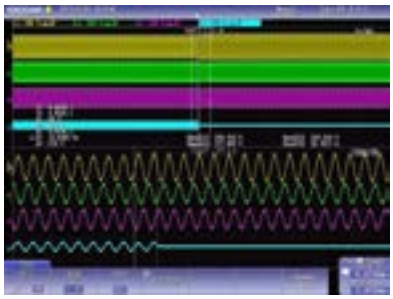
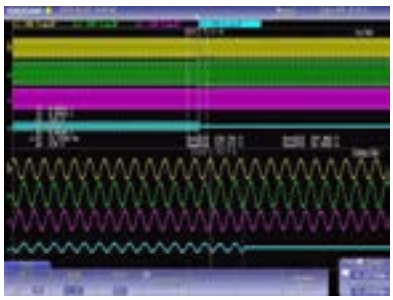
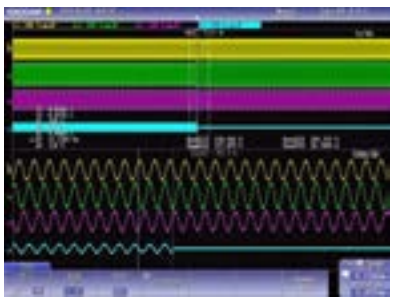
Iteration	Disconnect time (s)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)

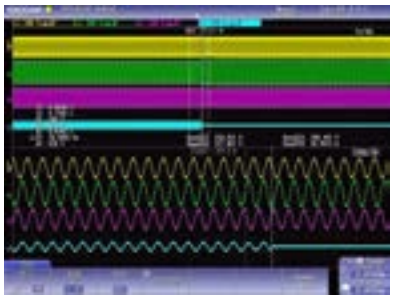
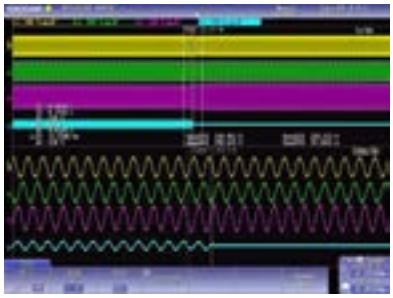
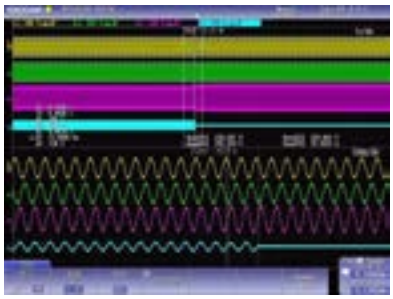
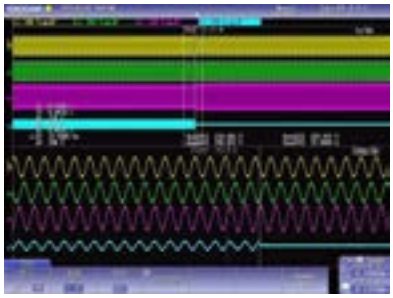
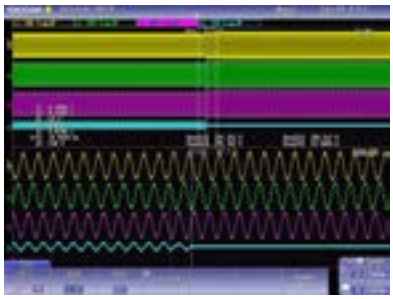
1- Phase L1-N(step 1)	1,795		109.51	
2- Phase L1-N(step 1)	1,804		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-N(step 1)	1,809		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-N(step 1)	1,800		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-N(step 1)	1,805		-	Same software used for reconnection after trip, test once for verification in above.

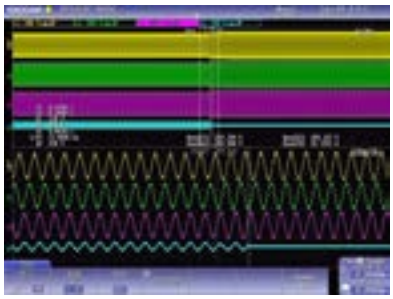
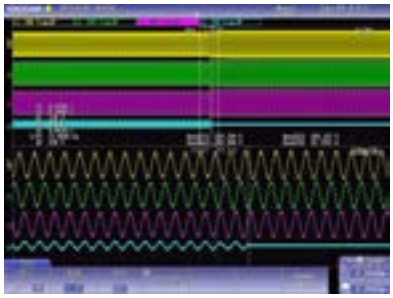
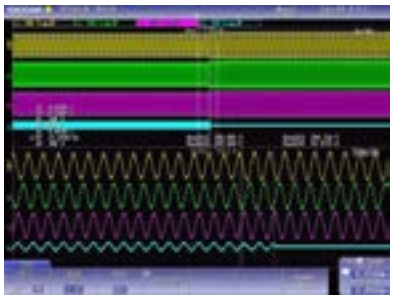
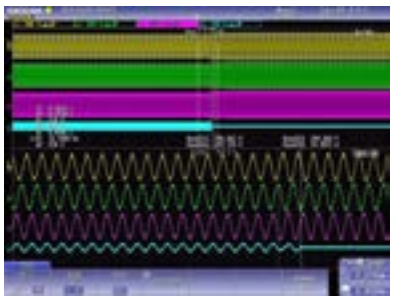
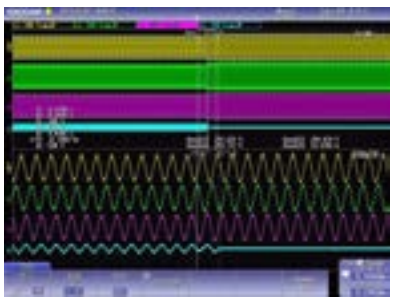
3- Phase L2-N(step 1)	1,806		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L3-N(step 1)	1,806		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L3-N(step 1)	1,812		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L3-N(step 1)	1,810		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L1-L2(step 1)	0,890		-	Same software used for reconnection after trip, test once for verification in above.

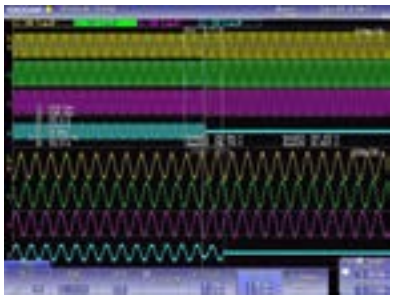
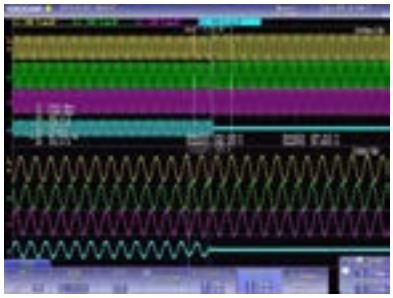
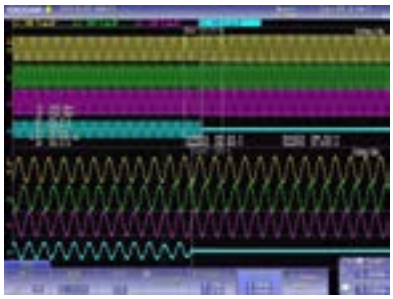
2- Phase L1-L2(step 1)	0,858		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-L2(step 1)	0,858		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-L3(step 1)	0,862		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-L3(step 1)	0,874		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-L3(step 1)	0,874		-	Same software used for reconnection after trip, test once for verification in above.

1- Phase L1-L3(step 1)	0,886		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L1-L3(step 1)	0,800		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-L3(step 1)	0,817		-	Same software used for reconnection after trip, test once for verification in above.
Setting(step 2): 310,5V(L-N), 540V(L-L)@ rated voltage 230/400V				
Curve illustration: Channel 1: Waveform of PV inverter output voltage at grid connection terminals L1, Channel 2: Waveform of PV inverter output voltage at grid connection terminals L2, Channel 3: Waveform of PV inverter output voltage at grid connection terminals L3, Channel 4: Waveform of PV inverter output current at grid connection terminals.				
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)

1- Phase L1-N(step 2)	38,00		109,62	
2- Phase L1-N(step 2)	48,00		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-N(step 2)	29,50		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-N(step 2)	43,00		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-N(step 2)	46,00		-	Same software used for reconnection after trip, test once for verification in above.

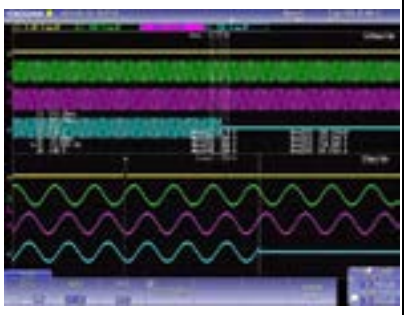
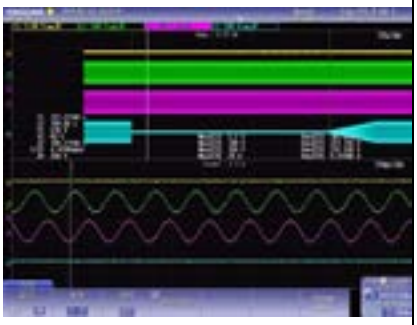
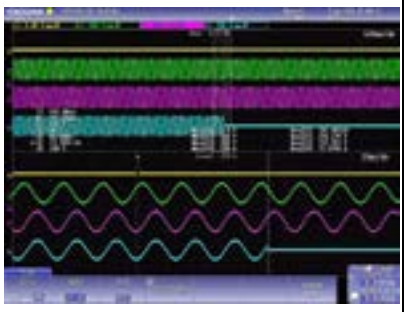
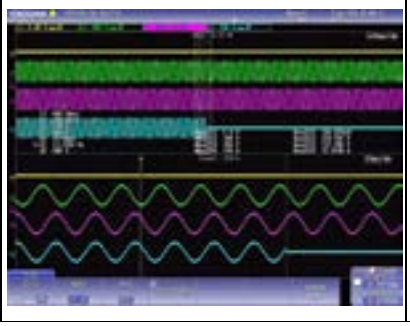
3- Phase L2-N(step 2)	34,50		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L3-N(step 2)	32,00		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L3-N(step 2)	42,00		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L3-N(step 2)	43,50		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L1-L2(step 2)	29,00		-	Same software used for reconnection after trip, test once for verification in above.

2- Phase L1-L2(step 2)	42,00		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L1-L2(step 2)	42,00		-	Same software used for reconnection after trip, test once for verification in above.
1- Phase L2-L3(step 2)	43,00		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L2-L3(step 2)	30,50		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L2-L3(step 2)	30,50		-	Same software used for reconnection after trip, test once for verification in above.

1- Phase L3-L1(step 2)	30,00		-	Same software used for reconnection after trip, test once for verification in above.
2- Phase L3-L1(step 2)	28,00		-	Same software used for reconnection after trip, test once for verification in above.
3- Phase L3-L1(step 2)	38,00		-	Same software used for reconnection after trip, test once for verification in above.

5.2.2 & 5.4	Over/under frequency trip test and reconnection test		P
Under-frequency monitoring: trip limit and tolerance			
Iteration	Measured trip frequency (Hz)	Deviation from nominal frequency (Hz)	Limit (Hz)
Setting: 49,00Hz@nominal frequency 50Hz			
1 – at Un	49,00	0	± 1
2 – at Un	49,00	0	± 1
3 – at Un	49,00	0	± 1
Under-frequency trip time and reconnection time@ nominal frequency 50Hz			

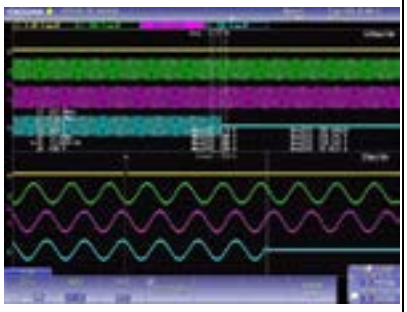
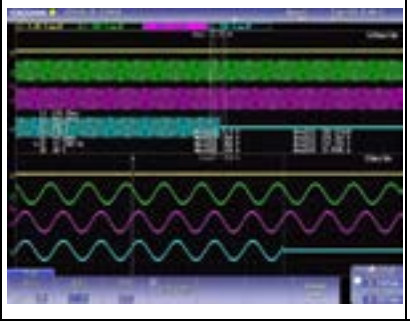
Curve illustration:
Channel 1: Trigger signal of turning into under-frequency state or return to normal voltage range, provided by the programmable AC grid simulator
Channel 2: Waveform of PV inverter output voltage signal at grid connection terminals
Channel 3: Waveform of PV inverter output voltage signal at grid connection terminals
Channel 4: Waveform of PV inverter output current signal at grid connection terminals.

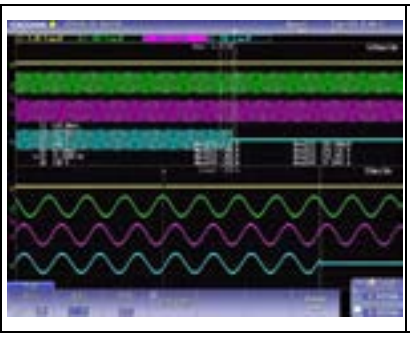
Transient program	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)
49,6Hz to 48,4Hz, to 50Hz	70,11		108,27	
49,6Hz to 48,4Hz, to 50Hz	68,00		-	Same software used for reconnection after trip, test once for verification in above.
49,6Hz to 48,4Hz, to 50Hz	75.50		-	Same software used for reconnection after trip, test once for verification in above.

Over-frequency monitoring: trip limit and tolerance

Curve illustration:
Channel 1: Trigger signal of turning into under-frequency state or return to normal voltage range, provided by the programmable AC grid simulator
Channel 2: Waveform of PV inverter output voltage signal at grid connection terminals
Channel 3: Waveform of PV inverter output voltage signal at grid connection terminals

Channel 4: Waveform of PV inverter output current signal at grid connection terminals.			
Iteration	Measured trip frequency (Hz)	Deviation from nominal frequency (Hz)	Limit (Hz)
Setting: 51,00Hz@nominal frequency 50Hz			
1 – at Un	51,01	0,02	±1
2 – at Un	51,01	0,02	±1
3 – at Un	51,01	0,02	±1

Over-frequency trip time and reconnection time@ nominal frequency 50Hz				
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms
50,4Hz to 51,6Hz, to 50Hz	73,50		108,28	
50,4Hz to 51,6Hz, to 50Hz	78,50			Same software used for reconnection after trip, test once for verification in above.

50,4Hz to 51,6Hz, to 50Hz	81,50			Same software used for reconnection after trip, test once for verification in above.

--- End of test report---

TEST REPORT

IEC 62116

Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters

Report Number.....:	70.409.18.025.48-00 part 2 of 2
Date of issue.....:	2019-03-18
Total number of pages.....	11
TÜV SÜD Branch .....:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch 3-13, No.151 Heng Tong Road, 200070, Shanghai, P.R. China
Applicant's name .....:	Sungrow Power Supply Co., Ltd.
Address .....:	No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China
Test specification:	
Standard .....:	IEC 62116:2014
Test procedure .....:	N/A
Non-standard test method.....:	N/A
Test Report Form No. .....:	IEC62116B
Test Report Form(s) Originator....:	TÜV SÜD Product Service GmbH
Master TRF .....:	Dated 2017-11-03

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Test item description ..... :	PV Grid-connected Inverter
Trade Mark ..... :	阳光电源 SUNGROW
Manufacturer ..... :	Sungrow Power Supply Co., Ltd. No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China
Model/Type reference ..... :	SG110CX
Ratings ..... :	See rating label

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
☐ **TÜV SÜD Branch:**		
Testing location/ address ..... :		
☐ **Associated Testing Laboratory:**		
Testing location/ address ..... :		
Tested by (name, function, signature) ..... :		
Approved by (name, function, signature) .. :		
☒ **Testing procedure: TMP/CTF Stage 1:**	Sungrow Power Supply Co., Ltd.	
Testing location/ address ..... :	No. 1699 Xiyou Road, New & High, Technology Industrial Development Zone, 230088 Hefei, Anhui, People's Republic of China	
Tested by (name, function, signature) ..... :	Bin Wu	
Approved by (name, function, signature ... :	Pengdong Yang	
☐ **Testing procedure: WMT/CTF Stage 2:**		
Testing location/ address ..... :		
Tested by (name, function, signature) ..... :		
Witnessed by (name, function, signature) . :		
Approved by (name, function, signature) .. :		
☐ **Testing procedure: SMT/CTF Stage 3 or 4:**		
Testing location/ address ..... :		
Tested by (name, function, signature) ..... :		
Witnessed by (name, function, signature) . :		
Approved by (name, function, signature) .. :		
Supervised by (name, function, signature) ..... :		

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

Total test reports contains 2 parts listed in below table:

Item #	Description	Pages
Part 1	IEC 61727:2004 test report	37
Part 2	IEC 62116:2014 test report	11

Summary of testing:

Tests performed (name of test and test clause):

All clauses tested on model SG110CX according to IEC 62116:2014

☒ Clause 6 Test for single or multi-phase inverter

Testing location:

Testing Center of Sungrow Power Supply Co., Ltd. (CNAS L8066)

No.1699, Xiyou Road, Hi-Tech Industrial Development Zone, Hefei, Anhui, China

Summary of compliance with National Differences:

List of countries addressed

N/A

☒ **The product fulfils the requirements of IEC 62116:2014**

Copy of marking plate:

Refer to part1 of IEC 61727:2004 test report.

Test item particulars ..... :	All the tests results confirmed to the requirements of this standard.
Classification of installation and use ..... :	☐ movable ☐ hand-held ☐ stationary ☒ fixed ☐ transportable ☐ for building-in
Supply Connection ..... :	☒ pluggable equipment ☐ direct plug-in ☐ permanent connection ☐ for building-in
..... :	
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 ..... :	2019-03-01
Date (s) of performance of tests ..... :	2019-03-04 – 2019-03-15

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 ☒ comma / ☐ point is used as the decimal separator.

Manufacturer's Declaration per sub-clause 4.2.5 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) ..... : N/A, Type verification of conformity

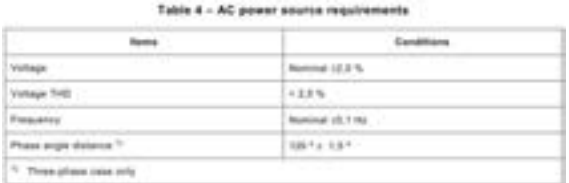
General product information:

These devices are transformer-less grid-connected PV inverters which converts direct current optimized by photovoltaic DC conditioner to alternating current, and it is intended to be connected in parallel with the low-voltage mains to supply common load.
They are intended for professional incorporation into PV system, and they are assessed on a component test basis.

Firmware Version: LCD_AMBER-S_V11_V01_A， MDSP_AMBER-S_V11_V01_A

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict

4	**Testing circuit**		
	The testing circuit shown in Figure 1 is employed.		P
	Similar circuits are used for three-phase output.	Three phase inverter	P
	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.		P
5	**Testing equipment**		
5.1	**Measuring instruments**		P
	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.		P
	For multi-phase EUT, all phases are monitored.		P
	A waveform monitor designed to detect and calculate the run-on time may be used.		P
	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.		P
	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		P
	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.		P
5.2	**DC power source**		
5.2.1	**General**		P
	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.	PV array simulator used	P
	The DC power source provides voltage and current necessary to meet the testing requirements described in Clause 6.		P
5.2.2	**PV array simulator**		P
	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.		P
	A PV array simulator is recommended, however, any type of power source may be used if it does not influence the test results.		P

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict
5.2.3	**Current and voltage limited DC power supply with series resistance**		N/A
	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.		N/A
	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.		N/A
	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		N/A
5.2.4	**PV array**		N/A
	A PV array used as the EUT input source is capable of EUT maximum input power at minimum and maximum EUT input operating voltage.		N/A
	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.		N/A
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 		P
5.4	**AC loads**		

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Clause	Requirement + Test	Result - Remark	Verdict
	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.		P
	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.		P
	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.		P
6	**Test for single or multi-phase inverter**		
6.1	**Test procedure**	**(see appended table)**	P
	The test uses an RLC load, resonant at the EUT nominal frequency (50 Hz or 60 Hz) and matched to the EUT output power.		P
	For multi-phase EUT, the load is balanced across all phases and the switch S1 as in Figure 1 opens all phases		P
	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.		P
	a). Determine EUT test output power		P
	b) Adjusting the DC input source		P
	c). Turn off the EUT and open S1		P
	d) Adjust the RLC circuit to have Qf = 1.0 ±0.05		P
	e). Connect the RLC load configured in step d) to the EUT by closing S2		P
	f) . Open the utility-disconnect switch S1 to initiate the test, Run-on time is recorded.		P

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	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.		P
	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.		P
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.		P
7	**Documentation**		
	At a minimum, the following information is recorded and maintained in the test report.		P
	a) Specifications of EUT. Table 8 provides an example of the type of information that is provided.		P
	b) Measurement results. Table 9 provides an example of the type of information that is provided. Actual measured values is to be recorded.		P
	c) Block diagram of test circuit.		P
	d) Specifications of the test and measurement equipment. Table 10 provides an example of the type of information that is provided.		P
	e) Any test configuration or procedure details such as methods of achieving specified load and EUT output conditions.		P
	f) Any additional information required by the testing laboratory's accreditation.		P
	g) Specify the evaluation criterion from clause 6.2 that was utilized to determine if the product passed or failed the test.		P
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		--

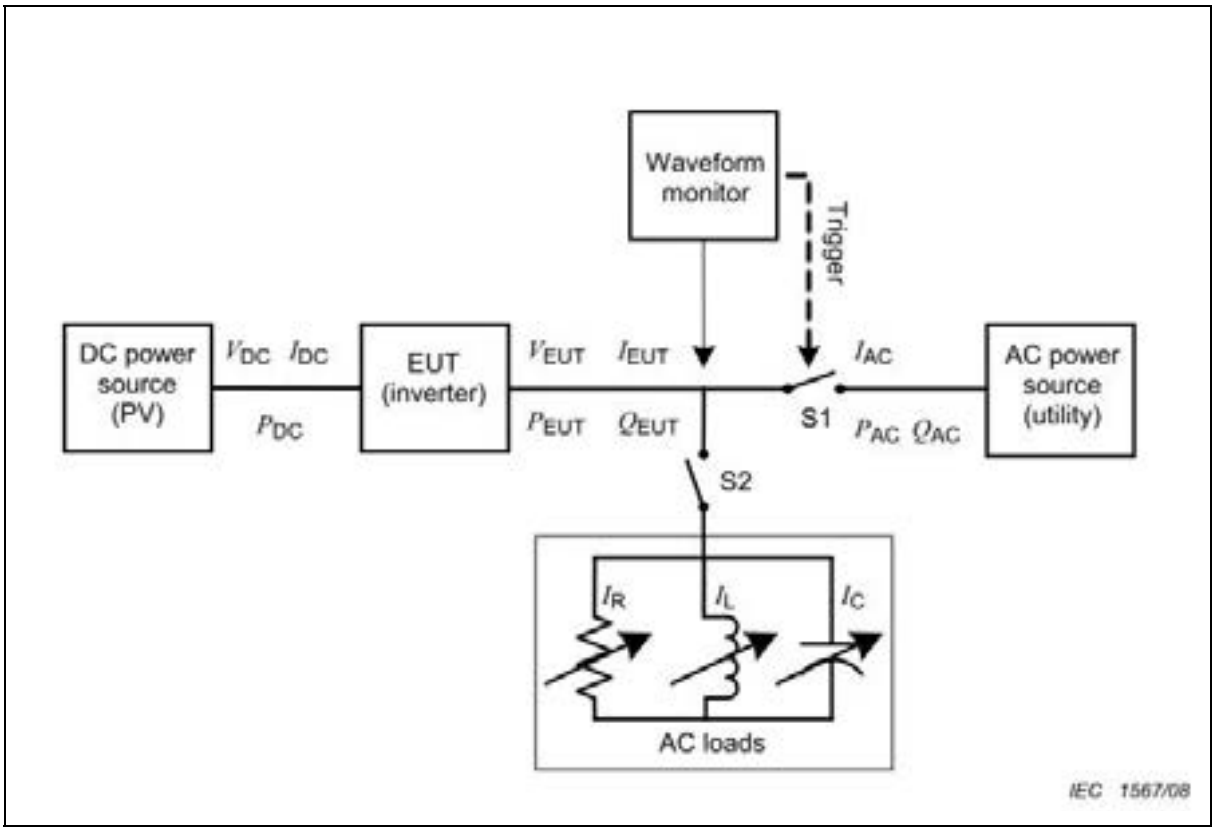
6.1	Table: tested condition and run-on time								P
Disconnection limit:			2 s						
No.	P_{EUT} (% of EUT rating)	Reactive Load (% of Q_L)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on time (ms)	P_{EUT} (kW)	Actual Q_f	V_{DC}(V)	Remarks
1	100	100	0	0	302	110	1,01	820	Test A, BL
2	66	66	0	0	252	72,6	1,02	685	Test B, BL
3	33	33	0	0	214	36,3	1,03	540	Test C, BL
4	100	100	-5	-5	252	110	1,02	820	Test A, IB[1]
5	100	100	-5	0	254	110	1,04	820	Test A, IB[1]
6	100	100	-5	+5	180	110	1,06	820	Test A, IB[1]
7	100	100	0	-5	224	110	0,99	820	Test A, IB[1]
8	100	100	0	+5	176	110	1,01	820	Test A, IB[1]
9	100	100	+5	-5	266	110	0,96	820	Test A, IB[1]
10	100	100	+5	0	262	110	0,95	820	Test A, IB[1]
11	100	100	+5	+5	194	110	0,97	820	Test A, IB[1]
12	100	100	-10	+10	196	110	1,04	820	Test A, IB[1]
13	100	100	-5	+10	187	110	1,08	820	Test A, IB[1]
14	100	100	0	+10	190	110	1,04	820	Test A, IB[1]
15	100	100	+5	+10	186	110	1,0	820	Test A, IB[1]
16	100	100	+10	+10	168	110	0,95	820	Test A, IB[1]
17	100	100	-10	+5	173	110	1,12	820	Test A, IB[1]
18	100	100	+10	+5	186	110	0,93	820	Test A, IB[1]
19	100	100	-10	0	180	110	1,10	820	Test A, IB[1]
20	100	100	+10	0	196	110	0,93	820	Test A, IB[1]
21	100	100	-10	-5	192	110	1,07	820	Test A, IB[1]
22	100	100	+10	-5	188	110	0,93	820	Test A, IB[1]
23	100	100	-10	-10	192	110	1,05	820	Test A, IB[1]

24	100	100	-5	-10	196	110	1,00	820	Test A, IB[1]
25	100	100	0	-10	178	110	0,95	820	Test A, IB[1]
26	100	100	+5	-10	192	110	0,90	820	Test A, IB[1]
27	100	100	+10	-10	191	110	0,89	820	Test A, IB[1]
28	66	66	0	-5	204	72,6	0,97	685	Test B, IB
29	66	66	0	-4	213	72,6	0,98	685	Test B, IB
30	66	66	0	-3	220	72,6	0,98	685	Test B, IB
31	66	66	0	-2	224	72,6	0,99	685	Test B, IB
32	66	66	0	-1	227	72,6	0,99	685	Test B, IB
33	66	66	0	1	236	72,6	1,00	685	Test B, IB
34	66	66	0	2	227	72,6	1,01	685	Test B, IB
35	66	66	0	3	212	72,6	1,01	685	Test B, IB
36	66	66	0	4	206	72,6	1,02	685	Test B, IB
37	66	66	0	5	192	72,6	1,02	685	Test B, IB
38	33	33	0	-5	192	36,3	0,97	540	Test C, IB
39	33	33	0	-4	220	36,3	0,98	540	Test C, IB
40	33	33	0	-3	222	36,3	0,98	540	Test C, IB
41	33	33	0	-2	224	36,3	0,99	540	Test C, IB
42	33	33	0	-1	222	36,3	1,00	540	Test C, IB
43	33	33	0	1	216	36,3	1,01	540	Test C, IB
44	33	33	0	2	194	36,3	1,01	540	Test C, IB
45	33	33	0	3	190	36,3	1,02	540	Test C, IB
46	33	33	0	4	182	36,3	1,03	540	Test C, IB
47	33	33	0	5	174	36,3	1,03	540	Test C, IB

1. Because of the limitation of island test system capacity, the inverter limits the output power to 635KW.

test record Qf at balance condition of 100%, 66% and 33% of power with 635kW.

Test method is referring to IEC 62116:2014, with the following setup.



--- End of test report---