TEST REPORT IEC 61727:2004 TÜV SÜD Test report for Photovoltaic (PV) systems – Characteristics of the utility interface	
Report reference No.	70.409.18.025.20-00 part 1 of 3
Date of issue	2018-10-10
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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)	39
Number of pages (Attachments)	Detail see page 2
Compiled by (+ signature)	*Bin Wu*
Approved by (+ signature)	*Pengdong Yang*

Test sample……..:	Engineering prototype
Type of test object ..... :	PV Grid-connected Inverter
Trademark ..... :	SUNGROW
Model and/or type reference ..... :	SG1500UD, SG1250UD
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……. ..... :	2018-06-05
Date of receipt of test item..... :	2018-08-31
Date(s) of performance of test ..... :	2018-09-03 – 2018-09-30

Test item particulars:

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

Attachments:

Total test reports contain 3 parts listed in below table:

Item #	Description	Pages
Part 1	IEC 61727:2004 test report	39
Part 2	IEC 62116:2014 test report	10
Part 3	IEC 61683:1999 test report	13

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:

IO_UMCG-V2_V1_A ,DSP_SG1250UD-V11_V1_A

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

☒ 4.3 Flicker (SG1500UD and SG1250UD)

☒ 4.4 Direct current injection (SG1500UD and SG1250UD)

☒ 4.6 Harmonic and waveform distortion (SG1500UD and SG1250UD)

☒ 4.7 Power factor (SG1500UD and SG1250UD)

☒ 5.2.1 & 5.4 Voltage protection and reconnection (SG1500UD and SG1250UD)

☒ 5.2.2 & 5.4 Frequency protection and reconnection(SG1500UD)

☒ 5.3 Islanding protection (SG1500UD)

Copy of marking plate:

Picture of the product

Front

left

Rear

Right

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

Model	SG1500UD	SG31250UD
Vmax PV	d.c. 1100 V	d.c. 1100V
Min. MPP voltage	d.c. 580V	d.c. 520V
Max. MPP voltage	d.c. 1000V	d.c. 1000V
Max. input current	d.c. 2×1448 A	d.c. 2×1356 A
Isc PV	d.c. 2×1810 A	d.c. 2×1695 A
Nominal AC power	1500 kW	1260kW
Maximum output apparent power	1650 kVA	1386 kVA
Max. AC output current	a.c. 2381 A	a.c. 2222 A
Nominal grid voltage	a.c. 400 V,3~	a.c. 360 V,3~
Nominal grid frequency	50 Hz	50 Hz
THD	<3% at nominal power	<3% at nominal power
DC current injection	<0.5% at nominal output current	<0.5% at nominal output current
Power factor 0.8	0.8 (leading)~0.8 (lagging)	0.8 (leading)~0.8 (lagging)
Dimensions(W×H×D)	2150 mm x 2120 mm x 850 mm	2150 mm x 2120 mm x 850 mm
Weight	1900 kg	1900 kg
Protection degree	IP65	IP65
Night self-consumption	<40 W	<40 W
Operating ambient temperature range	-35℃~+60℃ (> 50℃ derating)	-35℃~+60℃ (> 50℃ derating)
Cooling method Temperature	Temperature controlled forced air cooling	Temperature controlled forced air cooling
Relative humidity	0～95% (non-condensing)	0～95% (non-condensing)
Max. working altitude	4000 m (> 3000m derating)	4000 m (> 3000m derating)
Communication port/protocol	RS485,Ethernet	RS485,Ethernet

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

This type of device is a non-transformer integrated grid-connected PV inverter which converts direct current optimized by photovoltaic DC conditioner to alternating current, but inverters only be used in power stations to connect the mains through a LV/MV step-up transformer to generate electric power supply to public utility.

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: < (50%Un)*
	2,0s	50 % ≤ V < 85 %	2,0s	Line-line: (50%Un) ≤ V <(85%Un)*
	Continuous operation	85 % ≤ V ≤ 110 %	Continuous operation	85 % Un ≤ V ≤ 110 % Un*
	2,0s	110 % < V <135 %	2,0s	Line-line: 110%Un < V < 135%Un*
	0,05s	135 % ≤ V	0,05s	Line-line: 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	-

*SG1500 Un is 400V(Line-line), SG1250 Un is 360V(Line-line),

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

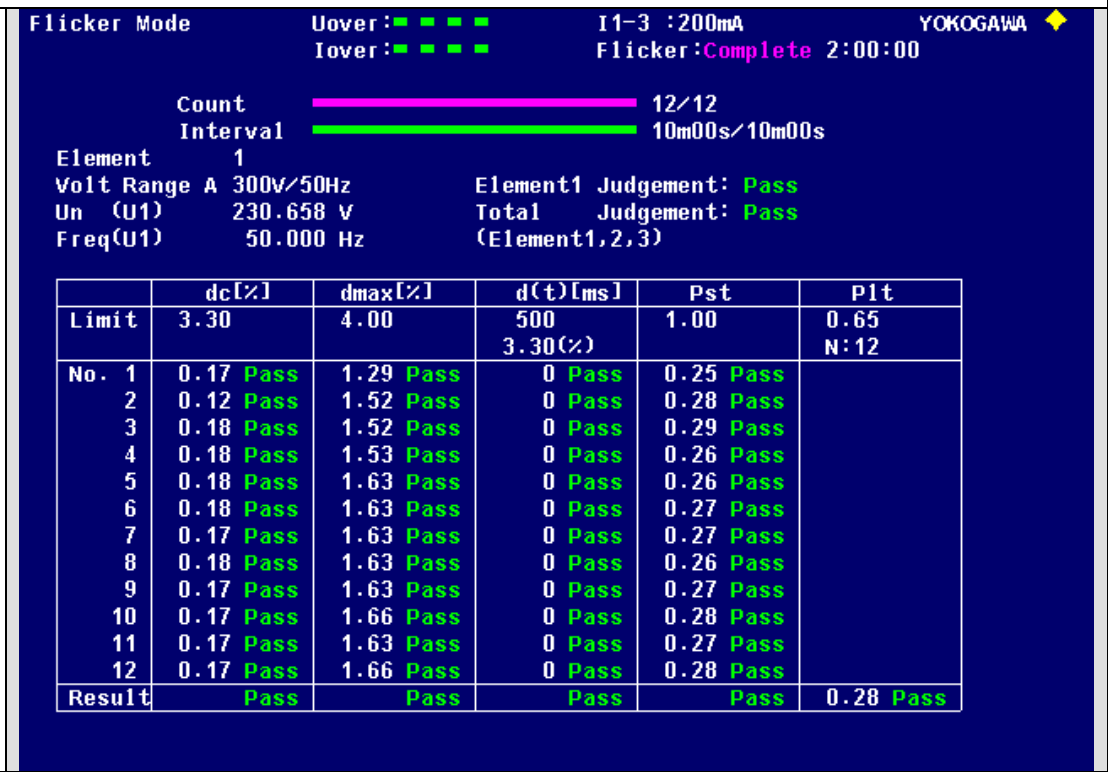
Clause	Requirement + Test	Result - Remark	Verdict
	Table 1 – Current distortion limits **Odd harmonics** / **Distortion limit** 3rd through 9th / Less than 4,0 % 11th through 15th / Less than 2,0 % 17th through 21st / Less than 1,5 % 23rd through 33rd / Less than 0,6 % **Even harmonics** / **Distortion limit** 2nd through 8th / Less than 1,0 % 10th through 32nd / Less than 0,5 %		P
4.7	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.	(see appended table 4.7)	P
5	Personnel safety and equipment protection		P
	This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.		P
5.1	Loss of utility voltage		P
	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.	.	P
	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.		P
5.2	Over/under voltage and frequency		P
	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.		P
5.2.1	Over/under voltage		P
	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.	(see appended table 5.2.1 & 5.4)	P
	Table 2 – Response to abnormal voltages **Voltage (at point of utility connection)** / **Maximum trip time*** V < 0,5 × Vnominal / 0,1 s 50 % ≤ V < 88 % / 2,0 s 85 % ≤ V ≤ 110 % / Continuous operation 110 % < V < 135 % / 2,0 s 135 % ≤ V / 0,05 s * 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.		P
5.2.2	Over/under frequency		P

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 (SG1500UD)				P
Limit	dmax=4,0%	dc=3,3%	d(t)=3,3%	Pst < 1,0	Plt < 0,65
measured	1,66%/ 1,75%/1,86%	0,18%/0,12%/0,18%	0%/0%/0%	0,28/0,30/0,30	0,28/0,27/0,28

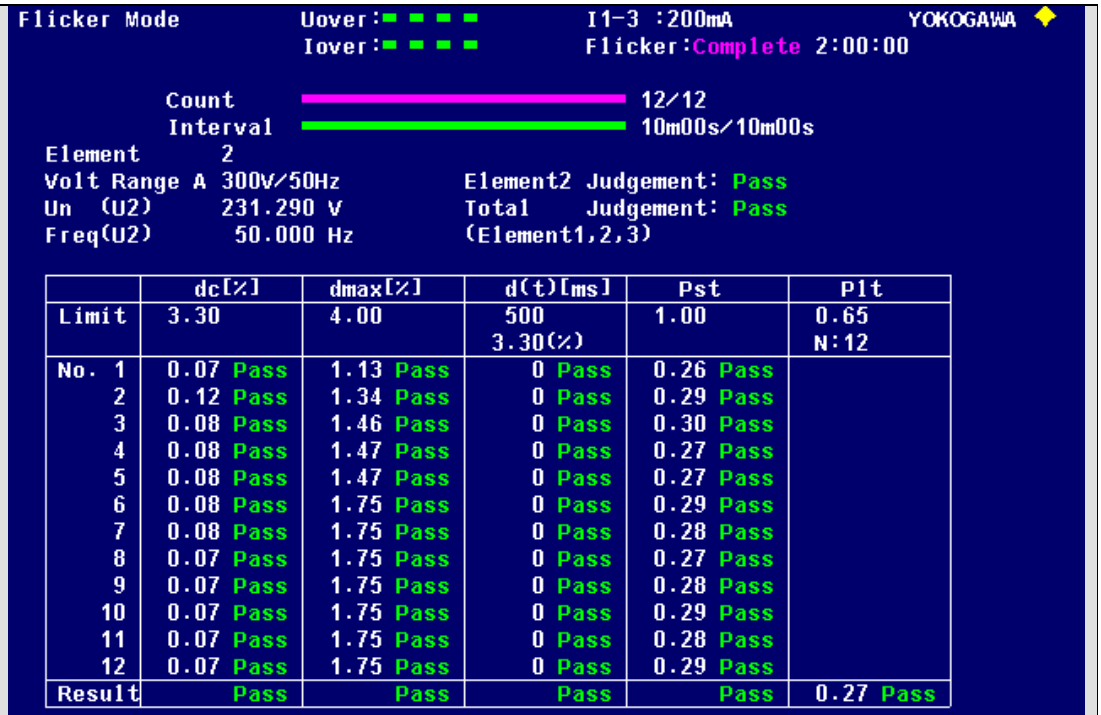
Detail information for test:

Phase A



	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.17 Pass	1.29 Pass	0 Pass	0.25 Pass	
2	0.12 Pass	1.52 Pass	0 Pass	0.28 Pass	
3	0.18 Pass	1.52 Pass	0 Pass	0.29 Pass	
4	0.18 Pass	1.53 Pass	0 Pass	0.26 Pass	
5	0.18 Pass	1.63 Pass	0 Pass	0.26 Pass	
6	0.18 Pass	1.63 Pass	0 Pass	0.27 Pass	
7	0.17 Pass	1.63 Pass	0 Pass	0.27 Pass	
8	0.18 Pass	1.63 Pass	0 Pass	0.26 Pass	
9	0.17 Pass	1.63 Pass	0 Pass	0.27 Pass	
10	0.17 Pass	1.66 Pass	0 Pass	0.28 Pass	
11	0.17 Pass	1.63 Pass	0 Pass	0.27 Pass	
12	0.17 Pass	1.66 Pass	0 Pass	0.28 Pass	
Result	Pass	Pass	Pass	Pass	0.28 Pass

Phase B



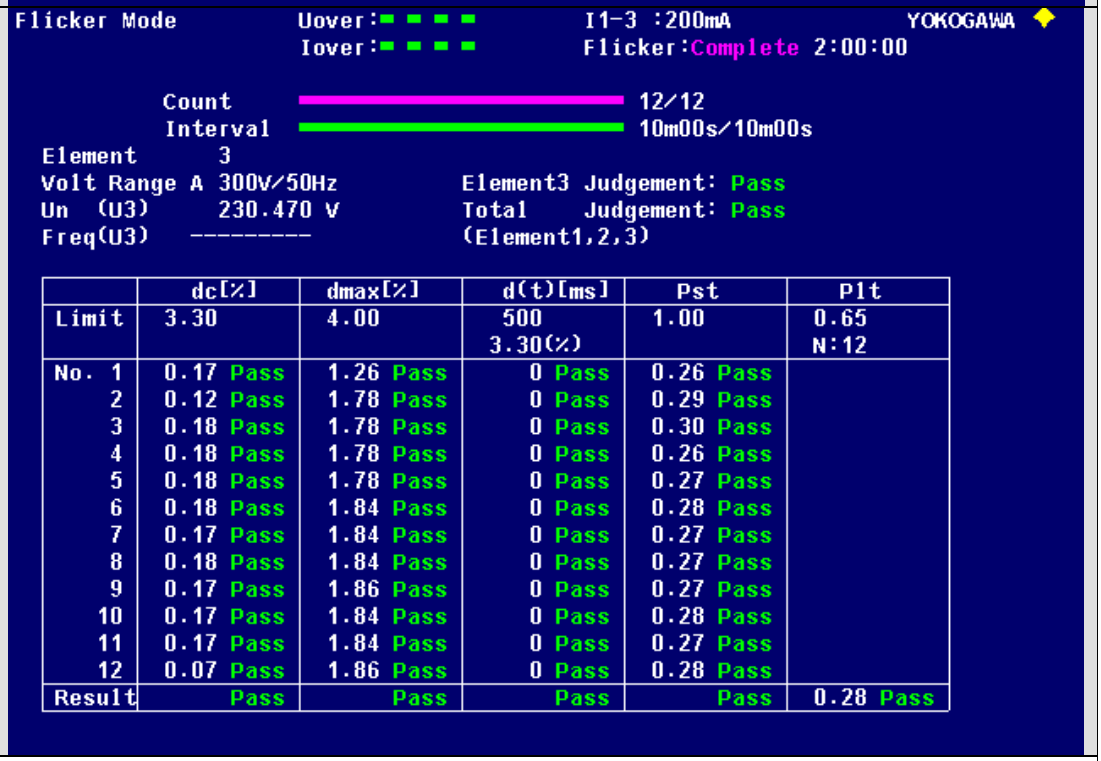
Flicker Mode Uover:- - - - I1-3 :200mA YOKOGAWA
Iover:- - - - Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s

Element 2
Volt Range A 300V/50Hz Element2 Judgement: Pass
Un (U2) 231.290 V Total Judgement: Pass
Freq(U2) 50.000 Hz (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.07 Pass	1.13 Pass	0 Pass	0.26 Pass	
2	0.12 Pass	1.34 Pass	0 Pass	0.29 Pass	
3	0.08 Pass	1.46 Pass	0 Pass	0.30 Pass	
4	0.08 Pass	1.47 Pass	0 Pass	0.27 Pass	
5	0.08 Pass	1.47 Pass	0 Pass	0.27 Pass	
6	0.08 Pass	1.75 Pass	0 Pass	0.29 Pass	
7	0.08 Pass	1.75 Pass	0 Pass	0.28 Pass	
8	0.07 Pass	1.75 Pass	0 Pass	0.27 Pass	
9	0.07 Pass	1.75 Pass	0 Pass	0.28 Pass	
10	0.07 Pass	1.75 Pass	0 Pass	0.29 Pass	
11	0.07 Pass	1.75 Pass	0 Pass	0.28 Pass	
12	0.07 Pass	1.75 Pass	0 Pass	0.29 Pass	
Result	Pass	Pass	Pass	Pass	0.27 Pass

Phase C



Flicker Mode Uover:- - - - I1-3 :200mA YOKOGAWA
Iover:- - - - Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s

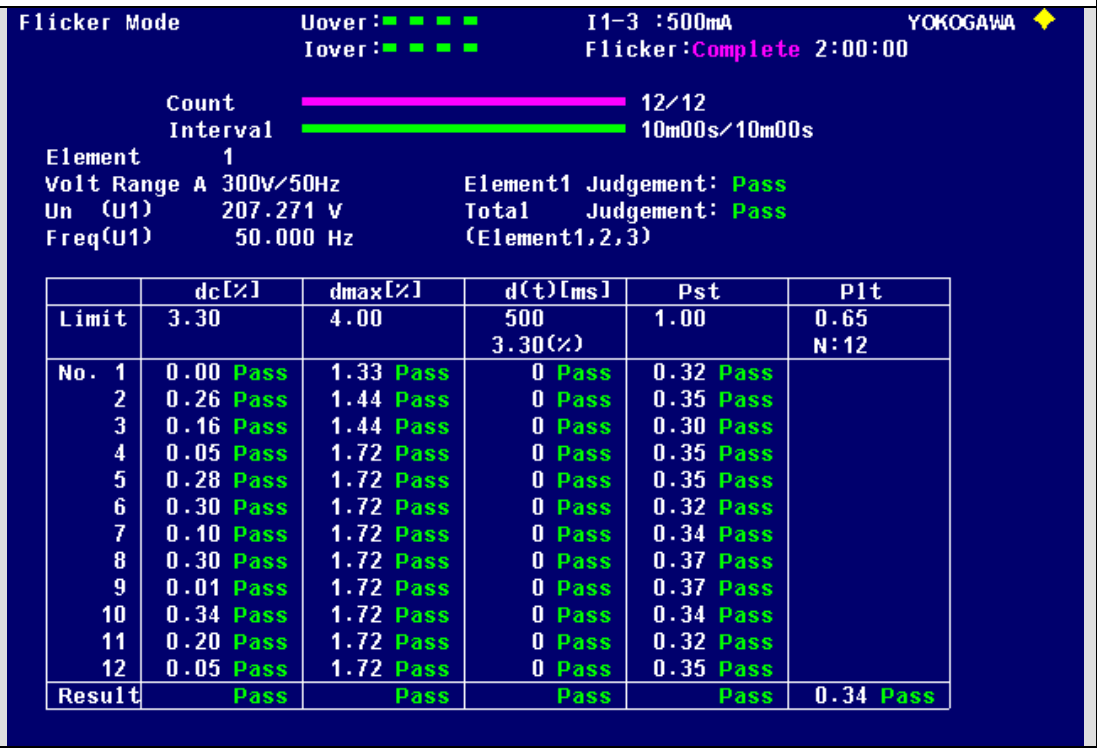
Element 3
Volt Range A 300V/50Hz Element3 Judgement: Pass
Un (U3) 230.470 V Total Judgement: Pass
Freq(U3) --------- (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.17 Pass	1.26 Pass	0 Pass	0.26 Pass	
2	0.12 Pass	1.78 Pass	0 Pass	0.29 Pass	
3	0.18 Pass	1.78 Pass	0 Pass	0.30 Pass	
4	0.18 Pass	1.78 Pass	0 Pass	0.26 Pass	
5	0.18 Pass	1.78 Pass	0 Pass	0.27 Pass	
6	0.18 Pass	1.84 Pass	0 Pass	0.28 Pass	
7	0.17 Pass	1.84 Pass	0 Pass	0.27 Pass	
8	0.18 Pass	1.84 Pass	0 Pass	0.27 Pass	
9	0.17 Pass	1.86 Pass	0 Pass	0.27 Pass	
10	0.17 Pass	1.84 Pass	0 Pass	0.28 Pass	
11	0.17 Pass	1.84 Pass	0 Pass	0.27 Pass	
12	0.07 Pass	1.86 Pass	0 Pass	0.28 Pass	
Result	Pass	Pass	Pass	Pass	0.28 Pass

Supplementary information:
The test is conducted in the worst case of maximum rated output power.

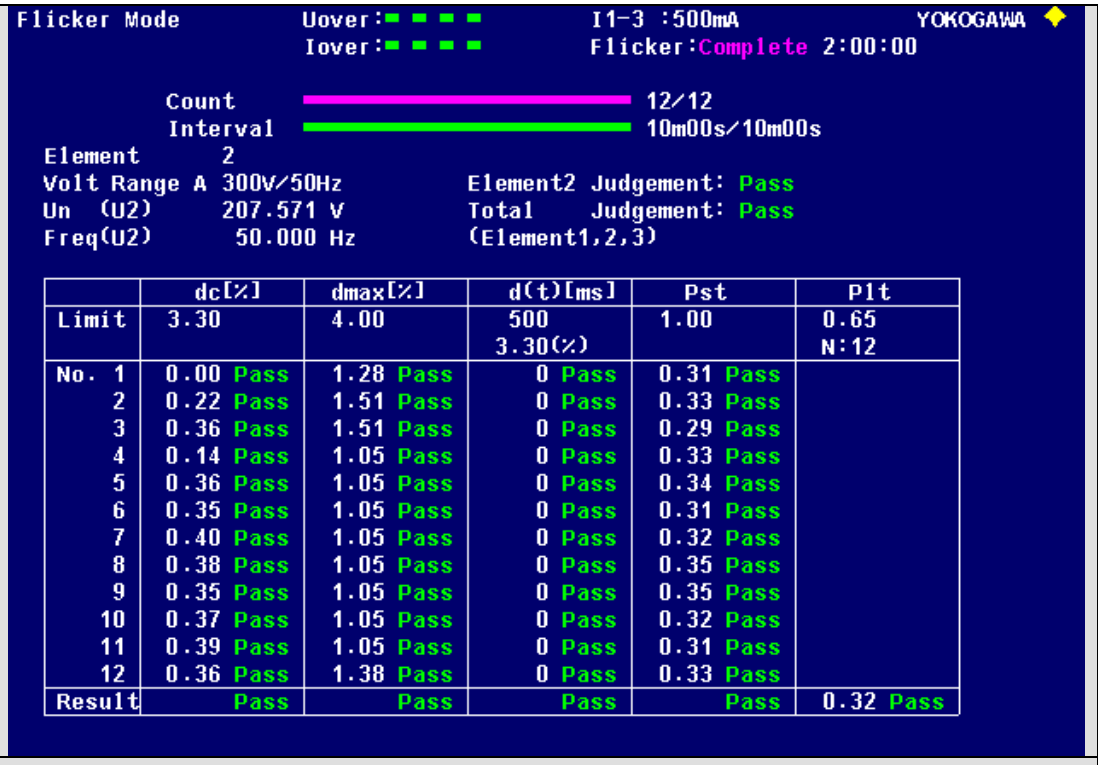
4.3	Flicker (SG1250UD)				P
Limit	dmax=4,0%	dc=3,3%	d(t)=3,3%	Pst < 1,0	Plt < 0,65
measured	1,72%/ 1,51%/1,43%	0,34%/0,40%/0,32%	0%/0%/0%	0,37/0,35/0,36	0,34/0,32/0,33
Detail information for test:					

Phase A



	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	1.33 Pass	0 Pass	0.32 Pass	
2	0.26 Pass	1.44 Pass	0 Pass	0.35 Pass	
3	0.16 Pass	1.44 Pass	0 Pass	0.30 Pass	
4	0.05 Pass	1.72 Pass	0 Pass	0.35 Pass	
5	0.28 Pass	1.72 Pass	0 Pass	0.35 Pass	
6	0.30 Pass	1.72 Pass	0 Pass	0.32 Pass	
7	0.10 Pass	1.72 Pass	0 Pass	0.34 Pass	
8	0.30 Pass	1.72 Pass	0 Pass	0.37 Pass	
9	0.01 Pass	1.72 Pass	0 Pass	0.37 Pass	
10	0.34 Pass	1.72 Pass	0 Pass	0.34 Pass	
11	0.20 Pass	1.72 Pass	0 Pass	0.32 Pass	
12	0.05 Pass	1.72 Pass	0 Pass	0.35 Pass	
Result	Pass	Pass	Pass	Pass	0.34 Pass

Phase B



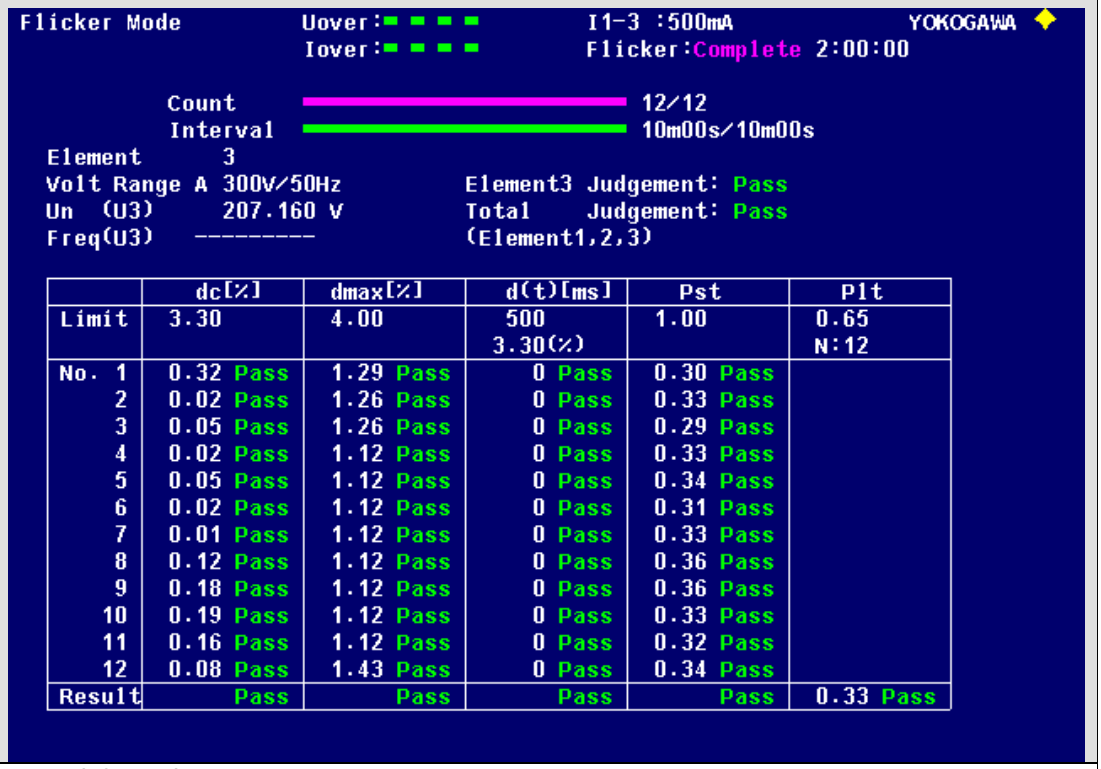
Flicker Mode Uover:■ ■ ■ ■ I1-3 :500mA YOKOGAWA
Iover:■ ■ ■ ■ Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s

Element 2
Volt Range A 300V/50Hz Element2 Judgement: Pass
Un (U2) 207.571 V Total Judgement: Pass
Freq(U2) 50.000 Hz (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	1.28 Pass	0 Pass	0.31 Pass	
2	0.22 Pass	1.51 Pass	0 Pass	0.33 Pass	
3	0.36 Pass	1.51 Pass	0 Pass	0.29 Pass	
4	0.14 Pass	1.05 Pass	0 Pass	0.33 Pass	
5	0.36 Pass	1.05 Pass	0 Pass	0.34 Pass	
6	0.35 Pass	1.05 Pass	0 Pass	0.31 Pass	
7	0.40 Pass	1.05 Pass	0 Pass	0.32 Pass	
8	0.38 Pass	1.05 Pass	0 Pass	0.35 Pass	
9	0.35 Pass	1.05 Pass	0 Pass	0.35 Pass	
10	0.37 Pass	1.05 Pass	0 Pass	0.32 Pass	
11	0.39 Pass	1.05 Pass	0 Pass	0.31 Pass	
12	0.36 Pass	1.38 Pass	0 Pass	0.33 Pass	
Result	Pass	Pass	Pass	Pass	0.32 Pass

Phase C



Flicker Mode Uover:■ ■ ■ ■ I1-3 :500mA YOKOGAWA
Iover:■ ■ ■ ■ Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s

Element 3
Volt Range A 300V/50Hz Element3 Judgement: Pass
Un (U3) 207.160 V Total Judgement: Pass
Freq(U3) --------- (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.32 Pass	1.29 Pass	0 Pass	0.30 Pass	
2	0.02 Pass	1.26 Pass	0 Pass	0.33 Pass	
3	0.05 Pass	1.26 Pass	0 Pass	0.29 Pass	
4	0.02 Pass	1.12 Pass	0 Pass	0.33 Pass	
5	0.05 Pass	1.12 Pass	0 Pass	0.34 Pass	
6	0.02 Pass	1.12 Pass	0 Pass	0.31 Pass	
7	0.01 Pass	1.12 Pass	0 Pass	0.33 Pass	
8	0.12 Pass	1.12 Pass	0 Pass	0.36 Pass	
9	0.18 Pass	1.12 Pass	0 Pass	0.36 Pass	
10	0.19 Pass	1.12 Pass	0 Pass	0.33 Pass	
11	0.16 Pass	1.12 Pass	0 Pass	0.32 Pass	
12	0.08 Pass	1.43 Pass	0 Pass	0.34 Pass	
Result	Pass	Pass	Pass	Pass	0.33 Pass

Supplementary information:
The test is conducted in the worst case of maximum rated output power.

4.4	Direct current injection (SG1500UD)					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)		
2174	25%	3,08	1,35	1,76	No	21,74
2174	50%	3,74	1,52	2,86	No	21,74
2174	100%	4,40	3,12	1,62	No	21,74
Remark: Ir=1500000/3/230=2174A						

4.4	Direct current injection (SG1250UD)					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)		
2004	25%	3,98	0,84	3,12	No	20,04
2004	50%	5,52	1,38	4,22	No	20,04
2004	100%	10,53	3,34	7,33	No	20,04
Remark: Ir=1250000/1.732/360=2004A						

4.6	Harmonics and waveform distortion			P
Table of Harmonic current measurement (SG1500UD)				
Order	Harmonic %			Harmonic limit %
	L1	L2	L3	
2	0,5440	0,3510	0,5951	1,0%
3	0,1828	0,2986	0,1832	4,0%
4	0,1617	0,1933	0,3410	1,0%
5	0,9106	0,9072	0,9741	4,0%
6	0,1695	0,0547	0,2155	1,0%
7	1,6460	1,6821	1,7337	4,0%
8	0,0566	0,0360	0,0878	1,0%
9	0,0104	0,0378	0,0377	4,0%
10	0,0535	0,0919	0,0737	0,5%
11	0,1303	0,1051	0,0952	2,0%
12	0,0370	0,0214	0,0427	0,5%

13	0,3099	0,3290	0,3065	2,0%
14	0,0574	0,0719	0,0440	0,5%
15	0,0086	0,0101	0,0085	2,0%
16	0,0512	0,0657	0,0509	0,5%
17	0,1629	0,1814	0,1671	1,5%
18	0,0176	0,0120	0,0142	0,5%
19	0,1454	0,1462	0,1463	1,5%
20	0,0261	0,0211	0,0181	0,5%
21	0,0038	0,0032	0,0036	1,5%
22	0,0157	0,0194	0,0207	0,5%
23	0,0404	0,0437	0,0417	0,6%
24	0,0049	0,0026	0,0038	0,5%
25	0,0341	0,0337	0,0341	0,6%
26	0,0073	0,0053	0,0066	0,5%
27	0,0020	0,0021	0,0021	0,6%
28	0,0061	0,0050	0,0064	0,5%
29	0,0146	0,0153	0,0146	0,6%
30	0,0030	0,0020	0,0025	0,5%
31	0,0118	0,0109	0,0118	0,6%
32	0,0032	0,0033	0,0039	0,5%
33	0,0016	0,0018	0,0017	0,6%
Total harmonic distortion	2,0252%	2,0259%	2,1639%	5,0%

Table of Harmonic current measurement (SG1250UD)				
Order	Harmonic %			Harmonic limit %
	L1	L2	L3	
2	0,3375	0,2451	0,5595	1,0%
3	0,2101	0,3199	0,4942	4,0%
4	0,1933	0,2619	0,4518	1,0%
5	0,5066	0,2359	0,3984	4,0%

6	0,1220	0,1474	0,2411	1,0%
7	0,9367	0,9441	0,8738	4,0%
8	0,0410	0,0345	0,0737	1,0%
9	0,0250	0,0223	0,0501	4,0%
10	0,0143	0,0268	0,0141	0,5%
11	0,0758	0,0645	0,0683	2,0%
12	0,0234	0,0113	0,0185	0,5%
13	0,1077	0,1111	0,1034	2,0%
14	0,0131	0,0192	0,0193	0,5%
15	0,0131	0,0070	0,0121	2,0%
16	0,0159	0,0118	0,0133	0,5%
17	0,0636	0,0729	0,0643	1,5%
18	0,0061	0,0055	0,0061	0,5%
19	0,0434	0,0437	0,0424	1,5%
20	0,0045	0,0075	0,0056	0,5%
21	0,0046	0,0026	0,0037	1,5%
22	0,0049	0,0066	0,0035	0,5%
23	0,0193	0,0200	0,0193	0,6%
24	0,0026	0,0023	0,0024	0,5%
25	0,0149	0,0162	0,0148	0,6%
26	0,0021	0,0027	0,0022	0,5%
27	0,0022	0,0015	0,0020	0,6%
28	0,0017	0,0023	0,0020	0,5%
29	0,0075	0,0080	0,0074	0,6%
30	0,0025	0,0019	0,0019	0,5%
31	0,0078	0,0083	0,0075	0,6%
32	0,0017	0,0018	0,0015	0,5%
33	0,0016	0,0013	0,0017	0,6%
Total harmonic distortion	1,1714%	1,079%	1,3316%	5,0%

Supplementary information: test at 100% rated power

4.7	Power factor	P

Output

Model: SG1500UD

No	Voltage (V)	Current (A)	Active Power (W)	Apparent Power (VA)	Power factor	Rated output (% of V.A)
1	230,6/231,1/230,4	1086,1/1084,4/1081,7	750046	750093	0,9999	(50±5)%
2	230,5/231,1/230,4	1305,0/1303,0/1300,2	900900	900935	0,9999	(60±5)%
3	230,3/231,0/230,0	1522,2/1519,7/1516,9	1050073	1050098	0,9999	(70±5)%
4	230,0/230,9/229,8	1744,9/1741,9/1738,8	1202630	1202644	0,9999	(80±5)%
5	230,4/ 231,1/229,9	1958,2/1954,7/1952,2	1351131	1351141	0,9999	(90±5)%
6	230,1 /230,8/229,4	2179,1/2174,4/2173,2	1501112	1501115	0,9999	(100±5)%

Model: SG1250UD

No	Voltage (V)	Current (A)	Active Power (W)	Apparent Power (VA)	Power factor	Rated output (% of V.A)
1	231,1/230,9/231,2	906,5/907,3/906,1	628468	628472	0,9999	(50±5)%
2	230,5/230,9/230,2	1083,6/1085,9/1085,0	749295	749296	0,9999	(60±5)%
3	231,4/230,8/230,0	1262,3/1265,6/1270,0	876341	876341	0,9999	(70±5)%
4	230,1/231,6/231,1	1451,7/1442,3/1445,4	1002158	1002159	0,9999	(80±5)%
5	231,7/230,4/231,3	1619,8/1628,9/1622,6	1125904	1125906	0,9999	(90±5)%
6	231,0/230,1/230,6	2018,0/ 2016,0/2014,1	1252161	1252167	0,9999	(100±5)%

Supplementary information: test at fixed cos φ = 1

5.3	Loss of utility voltage (SG1500UD)	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	341,0	601,3	1,01	850	Test A, BL
2	66	66	0	0	325,0	397,5	1.02	730	Test B, BL

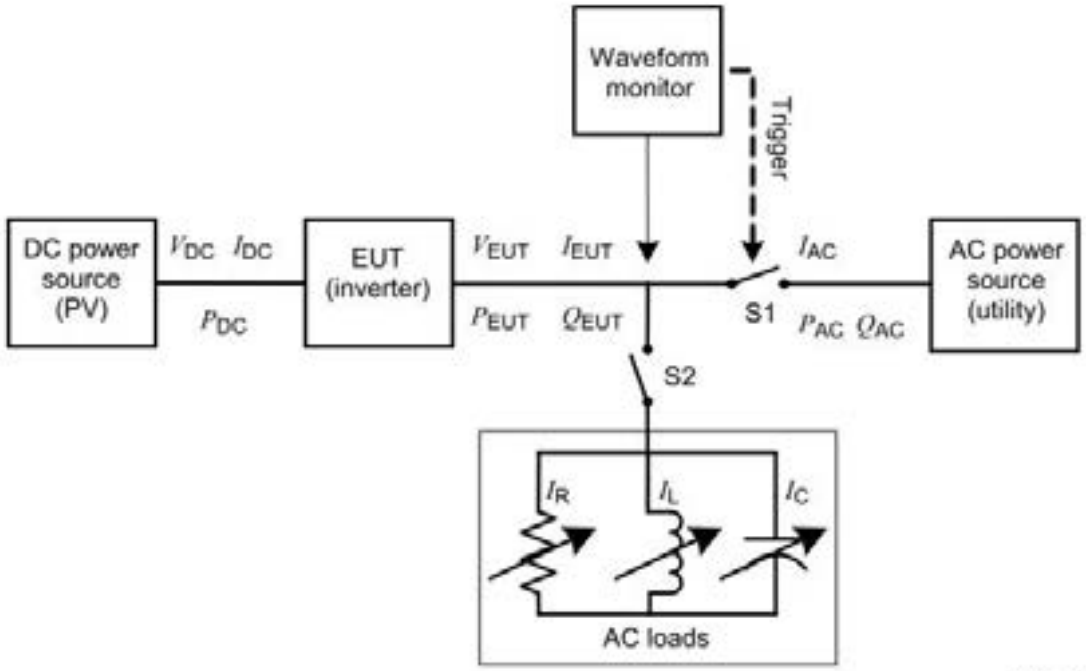
3	33	33	0	0	793,2	199,0	1,01	600	Test C, BL
4	100	100	-5	-5	171,0	601,3	1,05	850	Test A, IB[1]
5	100	100	-5	0	250,0	601,3	1,08	850	Test A, IB[1]
6	100	100	-5	+5	313,0	601,3	1,10	850	Test A, IB[1]
7	100	100	0	-5	269,0	601,3	1,04	850	Test A, IB[1]
8	100	100	0	+5	257,0	601,3	1,05	850	Test A, IB[1]
9	100	100	+5	-5	289,0	601,3	0,95	850	Test A, IB[1]
10	100	100	+5	0	317,0	601,3	0,97	850	Test A, IB[1]
11	100	100	+5	+5	207,0	601,3	1,01	850	Test A, IB[1]
12	66	66	0	-5	184,4	397,5	0,95	730	Test B, IB
13	66	66	0	-4	253,6	397,5	0,96	730	Test B, IB
14	66	66	0	-3	310,0	397,5	0,97	730	Test B, IB
15	66	66	0	-2	312,0	397,5	0,98	730	Test B, IB
16	66	66	0	-1	318,2	397,5	0,99	730	Test B, IB
17	66	66	0	1	315,2	397,5	1.01	730	Test B, IB
18	66	66	0	2	279,4	397,5	1.02	730	Test B, IB
19	66	66	0	3	269,2	397,5	1,03	730	Test B, IB
20	66	66	0	4	266,4	397,5	1,04	730	Test B, IB
21	66	66	0	5	253,2	397,5	1,05	730	Test B, IB
22	33	33	0	-5	193,6	199,0	0,95	600	Test C, IB
23	33	33	0	-4	280,6	199,0	0,96	600	Test C, IB
24	33	33	0	-3	254,8	199,0	0,97	600	Test C, IB
25	33	33	0	-2	567,2	199,0	1,00	600	Test C, IB
26	33	33	0	-1	557,2	199,0	1,00	600	Test C, IB
27	33	33	0	1	596,6	199,0	1,01	600	Test C, IB
28	33	33	0	2	306,2	199,0	1,02	600	Test C, IB

29	33	33	0	3	288,2	199,0	1,03	600	Test C, IB
30	33	33	0	4	271,2	199,0	1,04	600	Test C, IB
31	33	33	0	5	181,6	199,0	1,05	600	Test C, IB

1. Because of the limitation of island test system capacity, the inverter limits the output power to 600 kW.

test record Qf at balance condition of 100%, 66% and 33% of power with 600kW.

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 (SG1500UD)	P

Under-voltage monitoring: trip limit and tolerance

Iteration	Measured voltage (V)	Deviation from nominal voltage (%)	Limit (%)
SG1500UD Under voltage Setting(step 1): 0,85UN @ 400V			
1- Phase L1-L2(step 1)	341,5	0,38	± 1

2- Phase L1-L2(step 1)	341,0	0,25	± 1
3- Phase L1-L2(step 1)	341,0	0,25	± 1
1- Phase L2-L3(step 1)	340,0	0,00	± 1
2- Phase L2-L3(step 1)	339,0	-0,25	± 1
3- Phase L2-L3(step 1)	339,0	-0,25	± 1
1- Phase L1-L3(step 1)	339,5	-0,13	± 1
2- Phase L1-L3(step 1)	339,5	-0,13	± 1
3- Phase L1-L3(step 1)	339,5	-0,13	± 1
SG1250UD Under voltage Setting(step 1): 0,85UN @ 360V			
1- Phase L1-L2(step 1)	307,5	0,42	± 1
2- Phase L1-L2(step 1)	307,5	0,42	± 1
3- Phase L1-L2(step 1)	307,0	0,28	± 1
1- Phase L2-L3(step 1)	307,0	0,28	± 1
2- Phase L2-L3(step 1)	307,5	0,42	± 1
3- Phase L2-L3(step 1)	307,0	0,28	± 1
1- Phase L1-L3(step 1)	305,0	-0,28	± 1
2- Phase L1-L3(step 1)	305,0	-0,28	± 1
3- Phase L1-L3(step 1)	305,0	-0,28	± 1
SG1500UD Under voltage Setting(step 2): 0,5UN @ 400V			
1- Phase L1-L2(step 2)	198,5	-0,38	± 1
2- Phase L1-L2(step 2)	199,0	-0,25	± 1
3- Phase L1-L2(step 2)	198,5	-0,38	± 1
1- Phase L2-L3(step 2)	199,0	-0,25	± 1
2- Phase L2-L3(step 2)	199,5	-0,13	± 1
3- Phase L2-L3(step 2)	199,5	-0,13	± 1

1- Phase L1-L3(step 2)	198,0	-0,50	± 1
2- Phase L1-L3(step 2)	198,5	-0,38	± 1
3- Phase L1-L3(step 2)	198,5	-0,38	± 1
SG1250UD Under voltage Setting(step 2): 0,5UN @ 360V			
1- Phase L1-L2(step 2)	181,0	0,28	± 1
2- Phase L1-L2(step 2)	181,5	0,42	± 1
3- Phase L1-L2(step 2)	181,5	0,42	± 1
1- Phase L2-L3(step 2)	180,5	0,14	± 1
2- Phase L2-L3(step 2)	180,5	0,14	± 1
3- Phase L2-L3(step 2)	180,5	0,14	± 1
1- Phase L1-L3(step 2)	179,0	-0,28	± 1
2- Phase L1-L3(step 2)	178,5	-0,42	± 1
3- Phase L1-L3(step 2)	179,0	-0,28	± 1

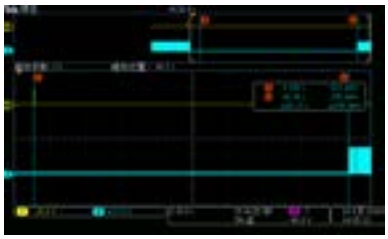
Under-voltage monitoring: trip time and reconnection time

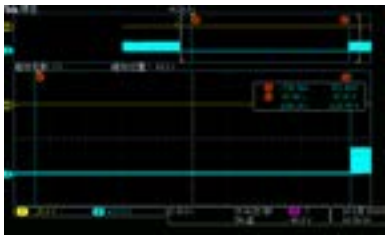
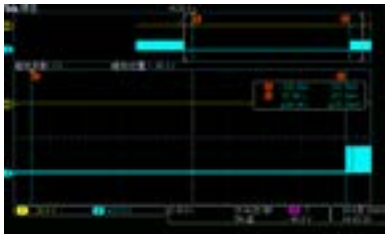
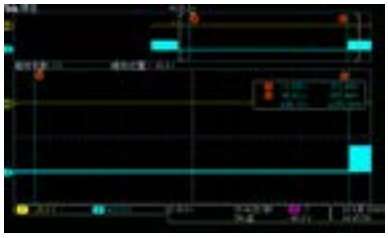
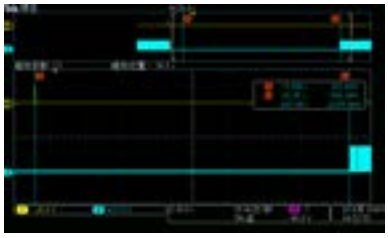
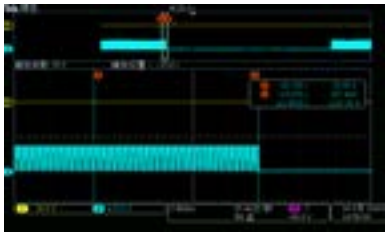
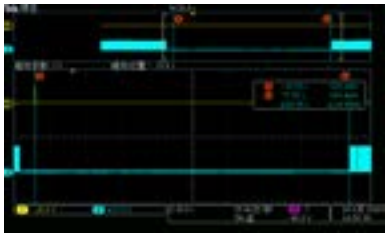
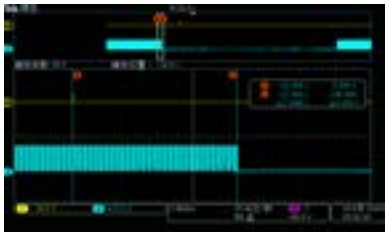
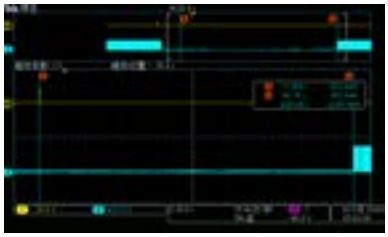
Curve illustration:

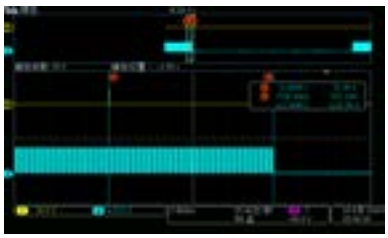
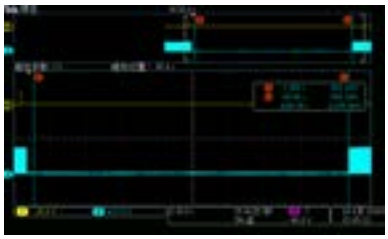
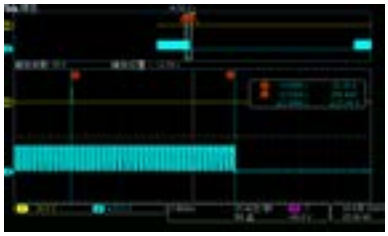
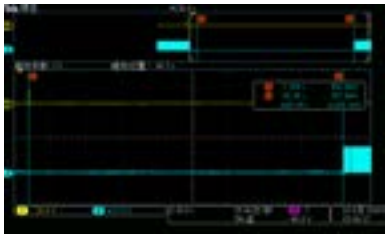
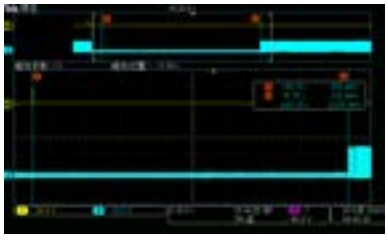
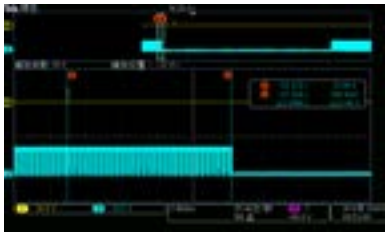
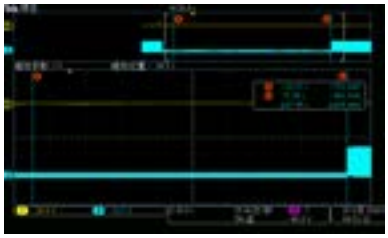
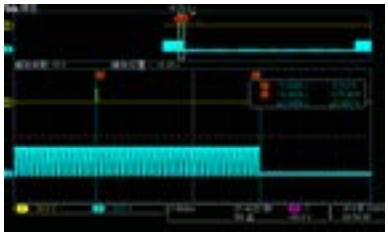
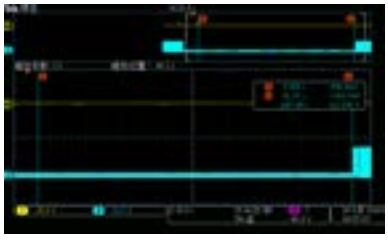
Channel 1: Trigger signal of turning into under-voltage state or return to normal voltage range, provided by the programmable AC grid simulator

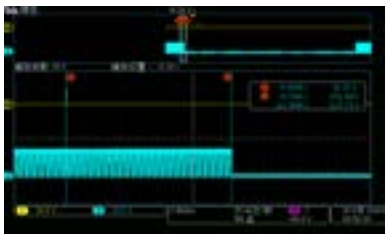
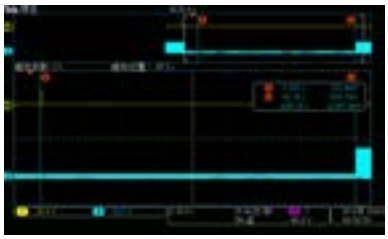
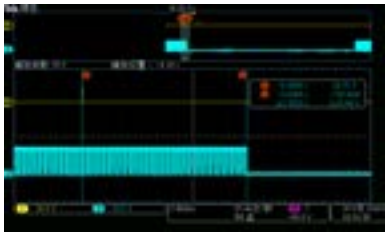
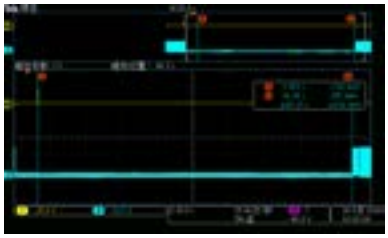
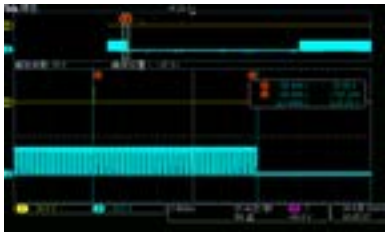
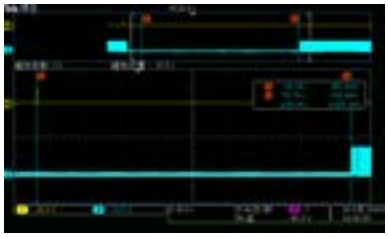
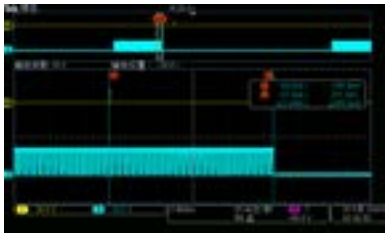
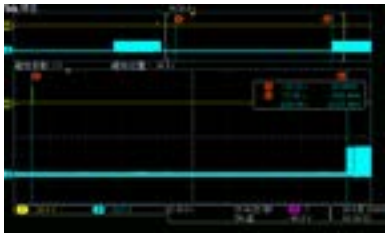
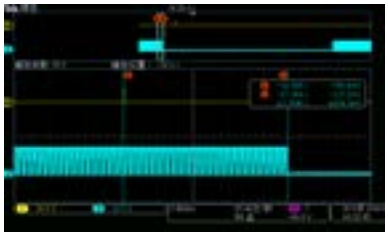
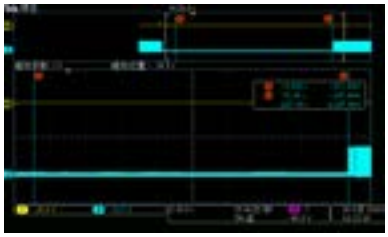
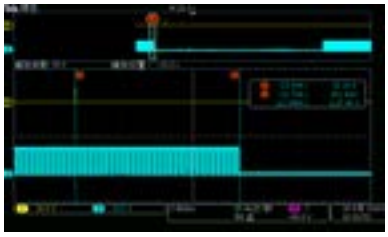
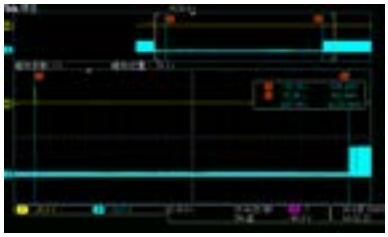
Channel 2: Waveform of PV inverter output current PWM signal at grid connection terminals

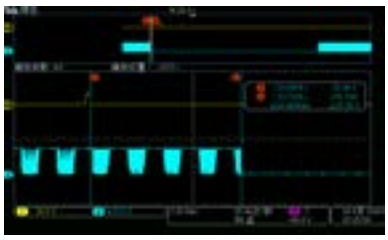
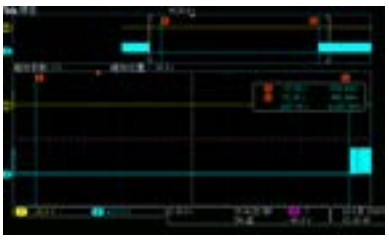
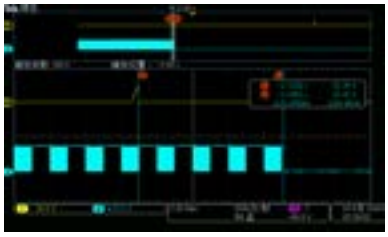
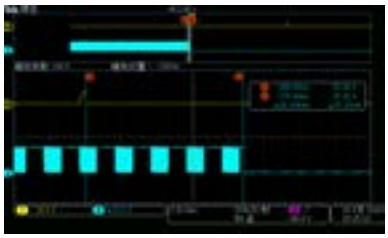
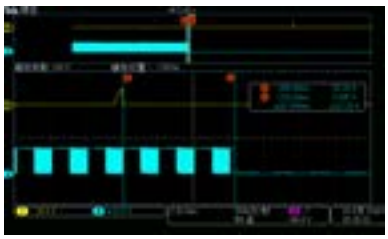
SG1500UD Under voltage Setting(step 1): 0,85UN @ 400V

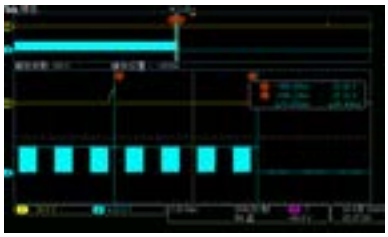
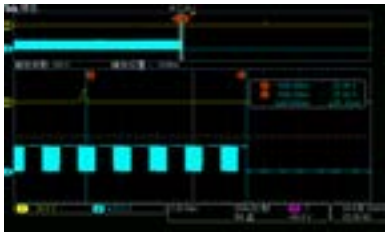
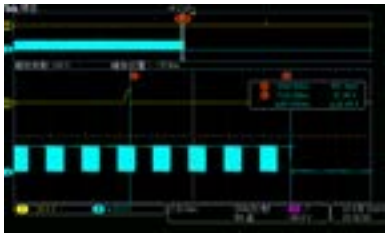
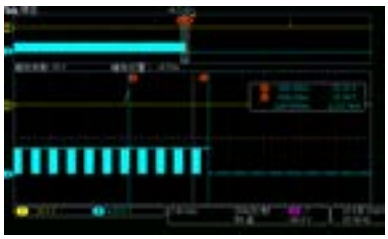
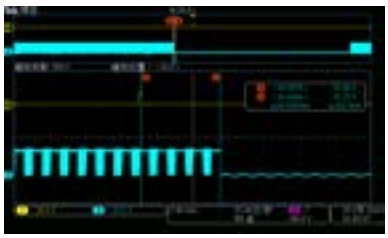
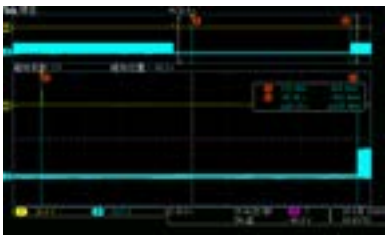
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)
1- Phase L1-L2(step 1)	1848		88,15	

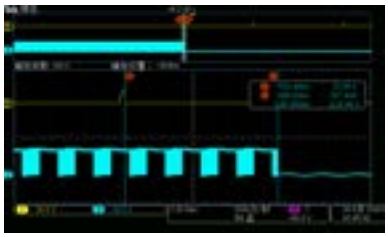
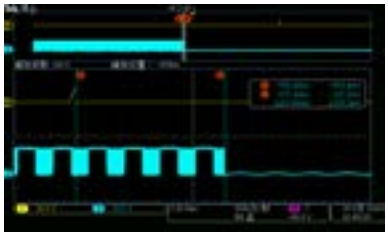
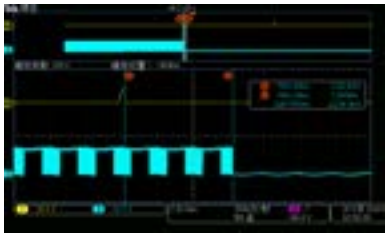
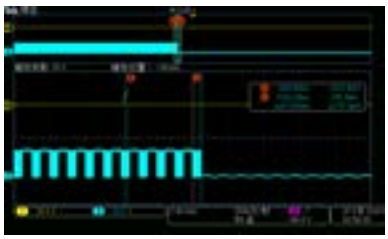
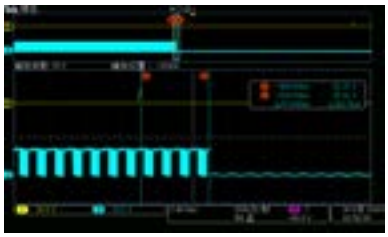
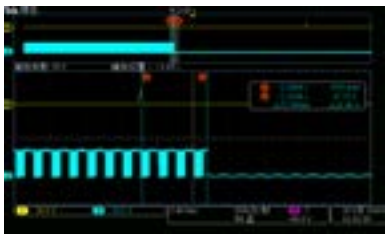
2- Phase L1-L2(step 1)	1840		88,14	
3- Phase L1-L2(step 1)	1836		88,04	
1- Phase L2-L3(step 1)	1828		88,13	
2- Phase L2-L3(step 1)	1844		87,94	
3- Phase L2-L3(step 1)	1852		88,05	
1- Phase L1-L3(step 1)	1844		88,04	

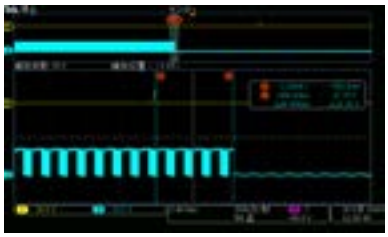
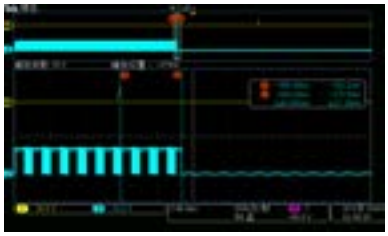
2- Phase L1-L3(step 1)	1844		88,04	
3- Phase L1-L3(step 1)	1840		88,04	
SG1250UD Under voltage Setting(step 1): 0,85UN @ 360V				
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)
1- Phase L1-L2(step 1)	1848		88,25	
2- Phase L1-L2(step 1)	1848		87,95	
3- Phase L1-L2(step 1)	1840		87,94	

1- Phase L2-L3(step 1)	1864		88,16	
2- Phase L2-L3(step 1)	1852		88,15	
3- Phase L2-L3(step 1)	1836		88,04	
1- Phase L1-L3(step 1)	1840		88,04	
2- Phase L1-L3(step 1)	1844		87,84	
3- Phase L1-L3(step 1)	1840		87,94	

SG1500UD Under voltage Setting(step 2): 0,5UN @ 400V				
1- Phase L1-L2(step 2)	84,4		87,88	
2- Phase L1-L2(step 2)	82,7		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L1-L2(step 2)	81,0		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L2-L3(step 2)	88,2		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L2-L3(step 2)	62,8		-	Same software used for reconnection after trip, test once for verification in above

3- Phase L2-L3(step 2)	79,8		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L3-L1(step 2)	89,6		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L3-L1(step 2)	90,0		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L3-L1(step 2)	89,6		-	Same software used for reconnection after trip, test once for verification in above
SG1250UD Under voltage Setting(step 2): 0,5UN @ 400V				
1- Phase L1-L2(step 2)	88,8		88,19	

2- Phase L1-L2(step 2)	85,8		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L1-L2(step 2)	83,4		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L2-L3(step 2)	60,6		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L2-L3(step 2)	83,6		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L2-L3(step 2)	75,6		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L3-L1(step 2)	72,8		-	Same software used for reconnection after trip, test once for verification in above

2- Phase L3-L1(step 2)	86,4		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L3-L1(step 2)	68,8		-	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 (%)
SG1500UD over voltage Setting(step 1): 1,1UN @ 400V			
1- Phase L1-L2(step 1)	441,5	0,38	± 1
2- Phase L1-L2(step 1)	441,0	0,25	± 1
3- Phase L1-L2(step 1)	441,0	0,25	± 1
1- Phase L2-L3(step 1)	439,5	-0,13	± 1
2- Phase L2-L3(step 1)	439,5	-0,13	± 1
3- Phase L2-L3(step 1)	439,5	-0,13	± 1
1- Phase L1-L3(step 1)	438,5	-0,38	± 1
2- Phase L1-L3(step 1)	438,5	-0,38	± 1
3- Phase L1-L3(step 1)	439,0	-0,25	± 1
SG1250UD over voltage Setting(step 1): 1,1UN @ 360V			
1- Phase L1-L2(step 1)	395,0	-0,28	± 1
2- Phase L1-L2(step 1)	395,0	-0,28	± 1
3- Phase L1-L2(step 1)	395,0	-0,28	± 1

1- Phase L2-L3(step 1)	395,5	-0,14	± 1
2- Phase L2-L3(step 1)	395,5	-0,14	± 1
3- Phase L2-L3(step 1)	395,5	-0,14	± 1
1- Phase L1-L3(step 1)	396,0	0,00	± 1
2- Phase L1-L3(step 1)	396,5	0,14	± 1
3- Phase L1-L3(step 1)	396,5	0,14	± 1
SG1500UD over voltage Setting(step 2): 1,35UN @ 400V			
1- Phase L1-L2(step 2)	541,5	0,38	± 1
2- Phase L1-L2(step 2)	542,0	0,50	± 1
3- Phase L1-L2(step 2)	541,5	0,38	± 1
1- Phase L2-L3(step 2)	539,0	-0,25	± 1
2- Phase L2-L3(step 2)	538,5	-0,38	± 1
3- Phase L2-L3(step 2)	538,5	-0,38	± 1
1- Phase L1-L3(step 2)	538,0	-0,50	± 1
2- Phase L1-L3(step 2)	538,0	-0,50	± 1
3- Phase L1-L3(step 2)	538,0	-0,50	± 1
SG1250UD over voltage Setting(step 2): 1,35UN @ 360V			
1- Phase L1-L2(step 2)	484,0	-0,56	± 1
2- Phase L1-L2(step 2)	484,0	-0,56	± 1
3- Phase L1-L2(step 2)	484,0	-0,56	± 1
1- Phase L2-L3(step 2)	484,5	-0,42	± 1
2- Phase L2-L3(step 2)	484,5	-0,42	± 1
3- Phase L2-L3(step 2)	484,5	-0,42	± 1
1- Phase L1-L3(step 2)	485,0	-0,28	± 1
2- Phase L1-L3(step 2)	485,0	-0,28	± 1

3- Phase L1-L3(step 2)	485,5	-0,14	± 1

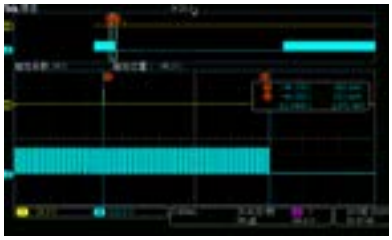
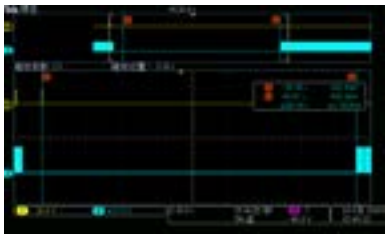
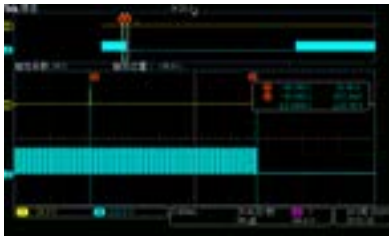
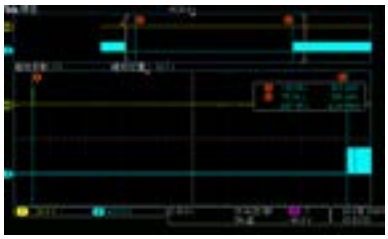
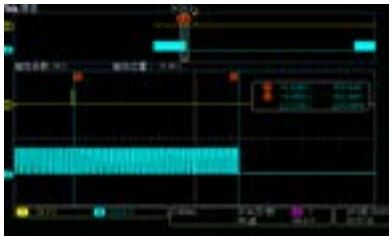
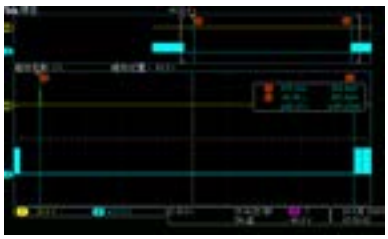
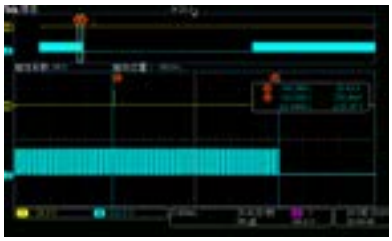
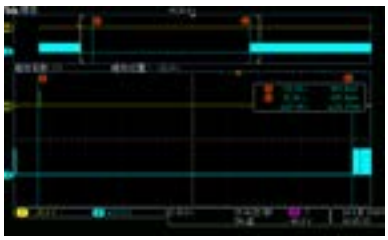
Over-voltage monitoring: trip time and reconnection time

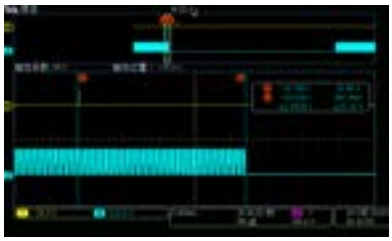
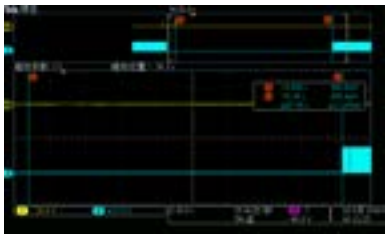
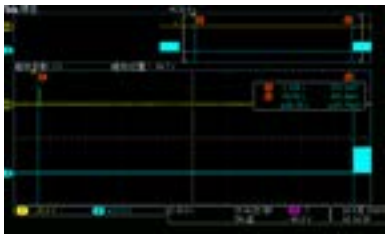
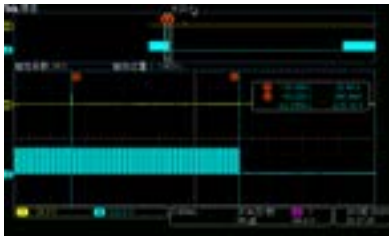
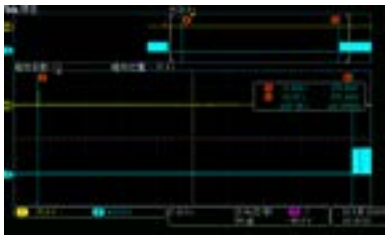
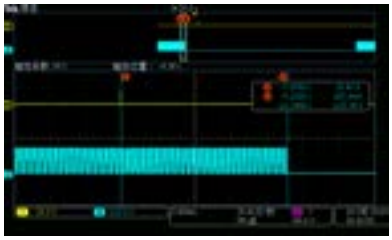
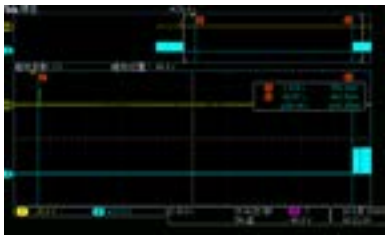
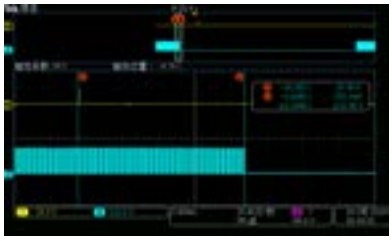
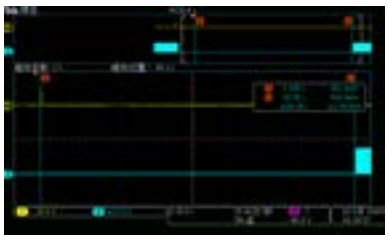
Curve illustration:

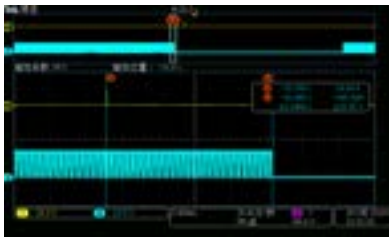
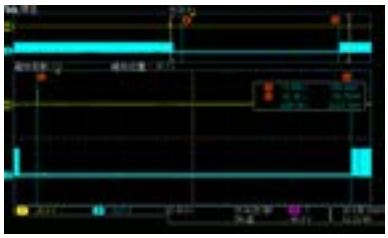
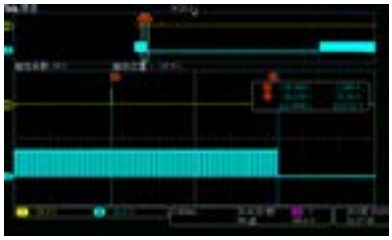
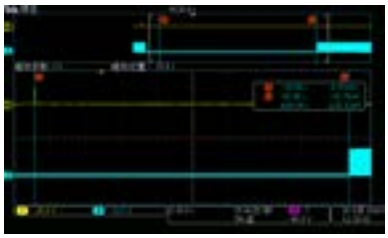
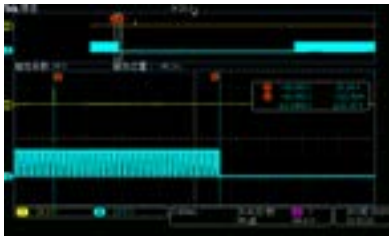
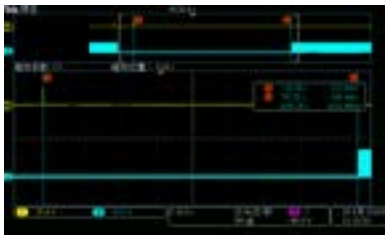
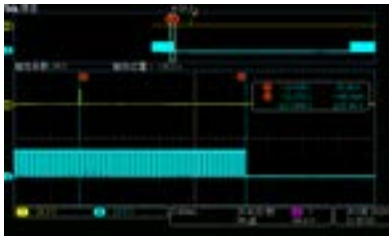
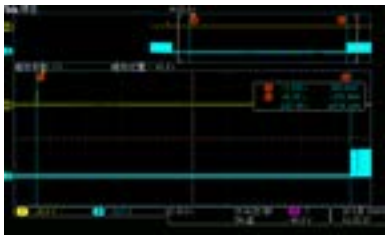
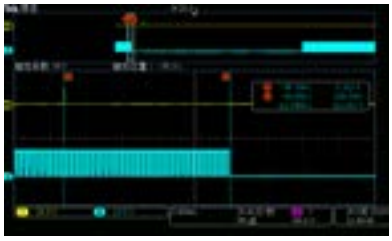
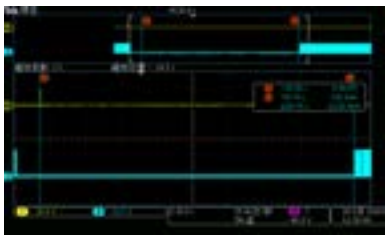
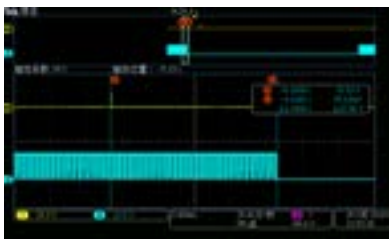
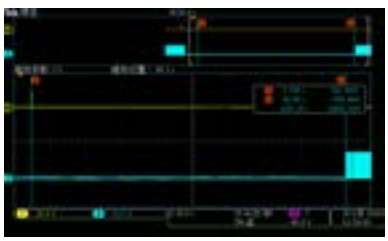
Channel 1: Trigger signal of turning into over-voltage state or return to normal voltage range, provided by the programmable AC grid simulator

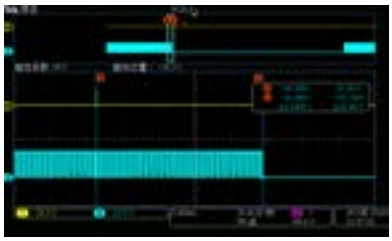
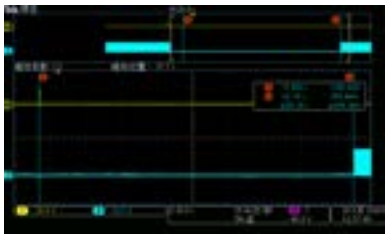
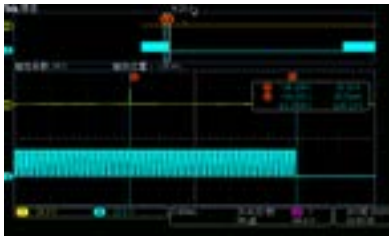
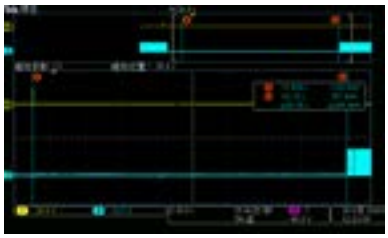
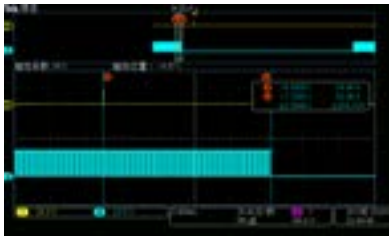
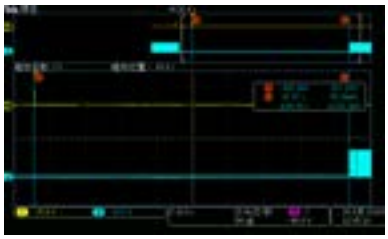
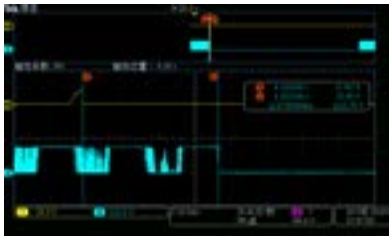
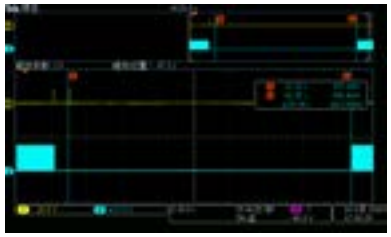
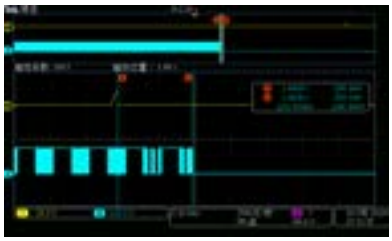
Channel 2: Waveform of PV inverter output current PWM signal at grid connection terminals

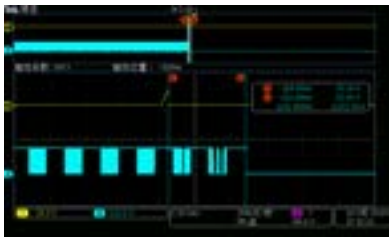
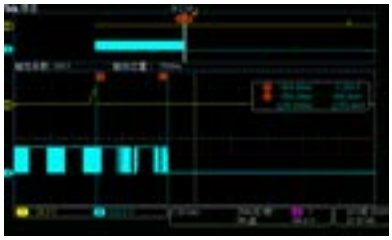
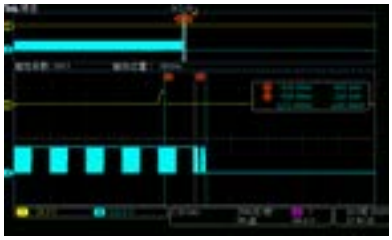
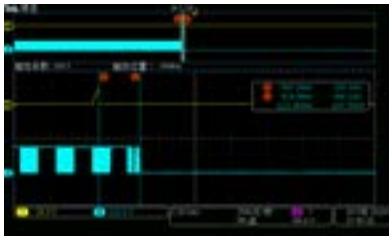
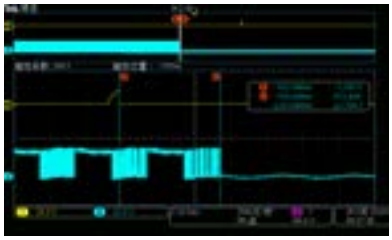
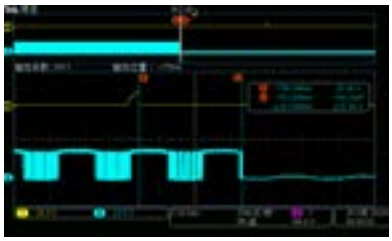
SG1500UD over voltage Setting(step 1): 1,1UN @ 400V

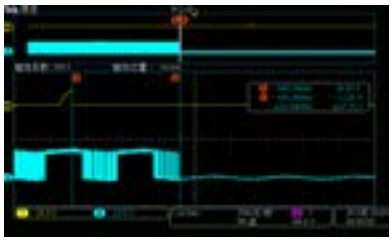
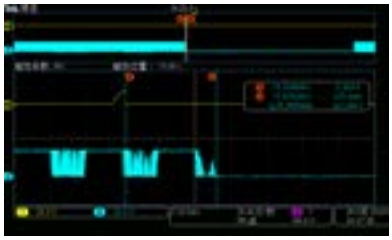
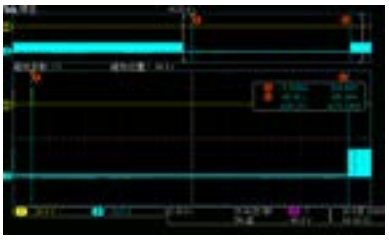
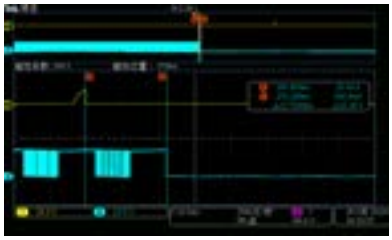
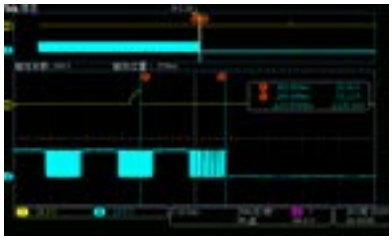
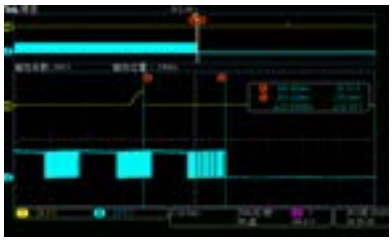
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)
1- Phase L1-L2(step 1)	1844		88,04	
2- Phase L1-L2(step 1)	1848		87,95	
3- Phase L1-L2(step 1)	1828		88,03	
1- Phase L2-L3(step 1)	1844		87,94	

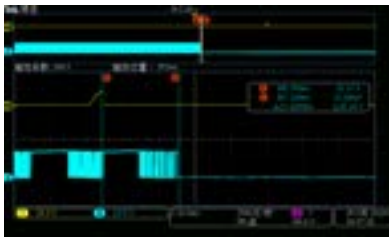
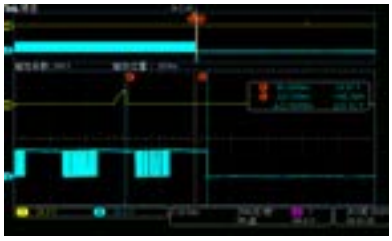
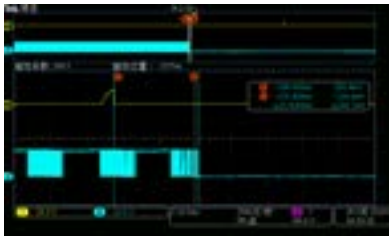
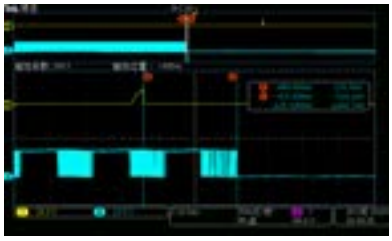
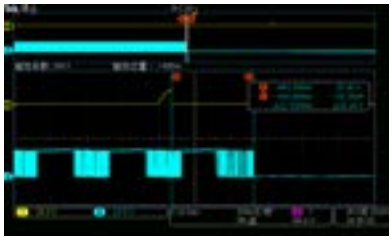
2- Phase L2-L3(step 1)	1852		87,85	
3- Phase L2-L3(step 1)	1850		88,05	
1- Phase L1-L3(step 1)	1856		87,96	
2- Phase L1-L3(step 1)	1844		88,04	
3- Phase L1-L3(step 1)	1844		88,04	
SG1250UD over voltage Setting(step 1): 1,1UN @ 360V				
Iteration	Disconnect time (ms)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms (showing time and power)

1- Phase L1-L2(step 1)	1840		88,04	
2- Phase L1-L2(step 1)	1844		88,04	
3- Phase L1-L2(step 1)	1840		88,24	
1- Phase L2-L3(step 1)	1844		87,94	
2- Phase L2-L3(step 1)	1848		88,05	
3- Phase L2-L3(step 1)	1844		88,14	

1- Phase L1-L3(step 1)	1844		88,14	
2- Phase L1-L3(step 1)	1852		88,05	
3- Phase L1-L3(step 1)	1864		88,16	
SG1500UD over voltage Setting(step 2): 1,35UN @ 400V				
1- Phase L1-L2(step 2)	37,6		78,94	
2- Phase L1-L2(step 2)	41,6		-	Same software used for reconnection after trip, test once for verification in above

3- Phase L1-L2(step 2)	42,4		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L2-L3(step 2)	39,8		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L2-L3(step 2)	23,0		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L2-L3(step 2)	22,4		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L3-L1(step 2)	28,0		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L3-L1(step 2)	28,5		-	Same software used for reconnection after trip, test once for verification in above

3- Phase L3-L1(step 2)	29,9		-	Same software used for reconnection after trip, test once for verification in above
SG1250UD over voltage Setting(step 2): 1,35UN @ 360V				
1- Phase L1-L2(step 2)	25,3		88,23	
2- Phase L1-L2(step 2)	22,8		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L1-L2(step 2)	23,7		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L2-L3(step 2)	22,8		-	Same software used for reconnection after trip, test once for verification in above

2- Phase L2-L3(step 2)	21,4		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L2-L3(step 2)	22,6		-	Same software used for reconnection after trip, test once for verification in above
1- Phase L3-L1(step 2)	23,6		-	Same software used for reconnection after trip, test once for verification in above
2- Phase L3-L1(step 2)	26,1		-	Same software used for reconnection after trip, test once for verification in above
3- Phase L3-L1(step 2)	22,7		-	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 (SG1500UD)**	**P**

Under-frequency monitoring: trip limit and tolerance

Iteration	Measured trip frequency (Hz)	Deviation from nominal frequency (Hz)	Limit (Hz)

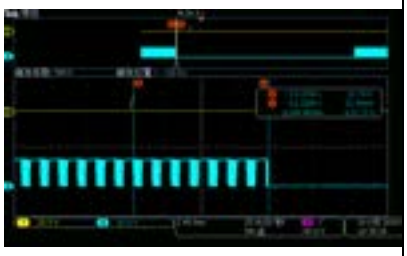
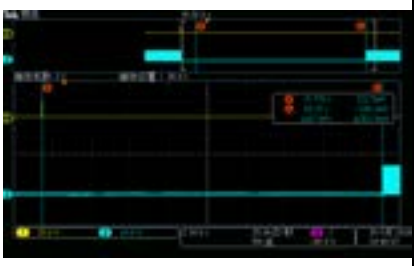
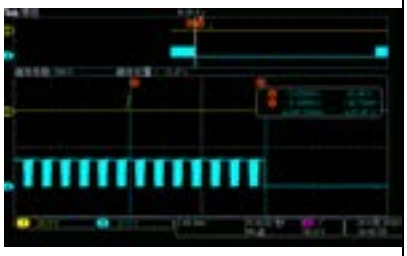
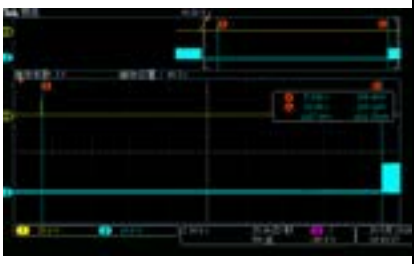
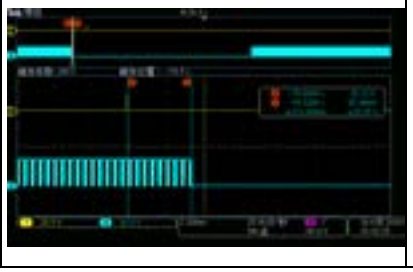
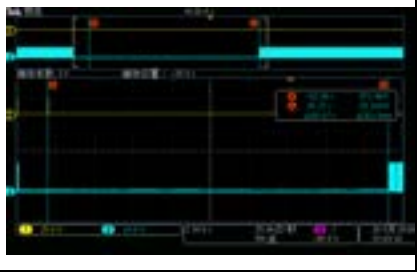
Setting: 49,00Hz@nominal frequency 50Hz			
1 – at Un	49,00	0,00	± 1
2 – at Un	49,00	0,00	± 1
3 – at Un	49,00	0,00	± 1
4 – at Un	49,01	0,01	± 1
5 – at Un	49,00	0,00	± 1

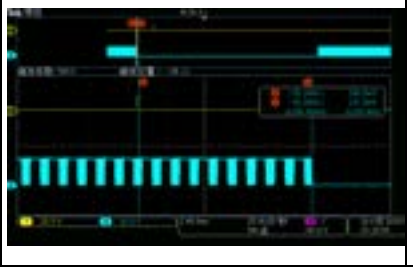
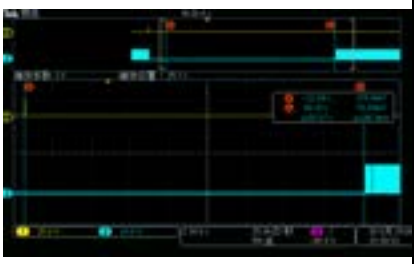
Under-frequency trip time and reconnection time@ nominal frequency 50Hz

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 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	144,4		87,94	
49,6Hz to 48,4Hz, to 50Hz	145,2		87,94	
49,6Hz to 48,4Hz, to 50Hz	171,0		88,07	

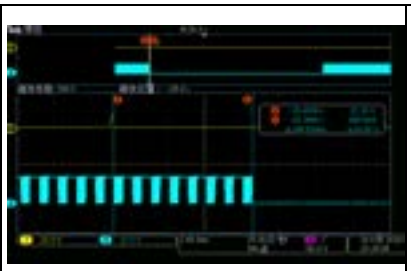
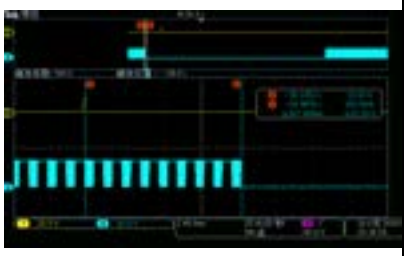
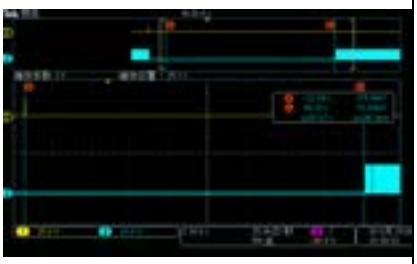
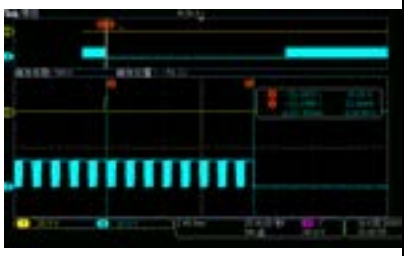
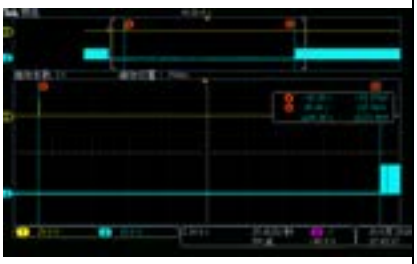
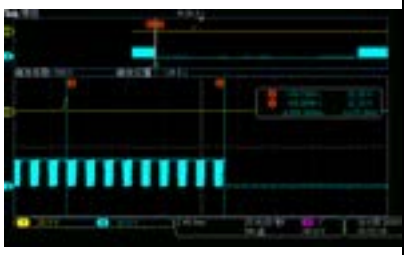
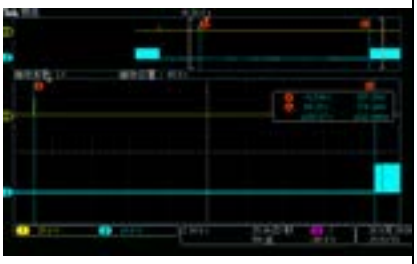
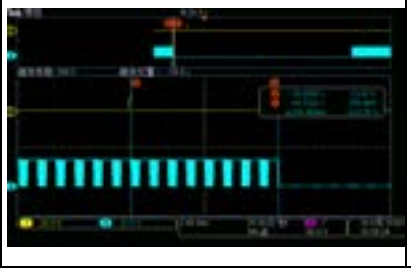
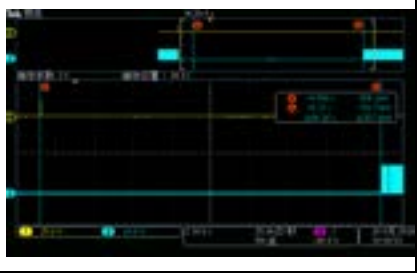
49,6Hz to 48,4Hz, to 50Hz	136,2		88,24	
49,6Hz to 48,4Hz, to 50Hz	186,4		88,39	

Over-frequency monitoring: trip limit and tolerance
Curve illustration: Channel 1: Trigger signal of turning into over-frequency state or return to normal voltage range, provided by the programmable AC grid simulator Channel 2: 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	51,00	0,00	± 1
2 – at Un	51,00	0,00	± 1
3 – at Un	51,00	0,00	± 1
4 – at Un	50,99	-0,01	± 1
5 – at Un	51,00	0,00	± 1

Over-frequency trip time and reconnection time@ nominal frequency 50Hz

Iteration	Disconnect time (s)	Oscilloscope recorded waveforms	Restore time(s)	Oscilloscope recorded waveforms

50,4Hz to 51,6Hz, to 50Hz	149,6		88,25	
50,4Hz to 51,6Hz, to 50Hz	167,6		88,07	
50,4Hz to 51,6Hz, to 50Hz	157,6		88,36	
50,4Hz to 51,6Hz, to 50Hz	169,2		88,07	
50,4Hz to 51,6Hz, to 50Hz	158,4		88,26	

--- End of test report---

TEST REPORT

IEC 62116

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

Report Number.....:	70.409.18.025.20-00 part 2 of 3
Date of issue.....:	2018-10-10
Total number of pages.....	10
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 (Second Edition)
Test procedure .....:	N/A
Non-standard test method.....:	N/A
Test Report Form No.....:	IEC62116A
Test Report Form(s) Originator ....:	TÜV SÜD Product Service GmbH
Master TRF .....:	Dated 2014-10

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General disclaimer:

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 CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

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 ..... :	SG1500UD, SG1250UD
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 contain 3 parts listed in below table:

Item #	Description	Pages
Part 1	IEC 61727:2004 test report	39
Part 2	IEC 62116:2014 test report	10
Part 3	IEC 61683:1999 test report	13

Summary of testing:

Tests performed (name of test and test clause):

All clauses tested on model SG1500UD 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 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 ..... :	2018-08-31
Date (s) of performance of tests ..... :	2018-09-03 – 2018-09-30

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☒ 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

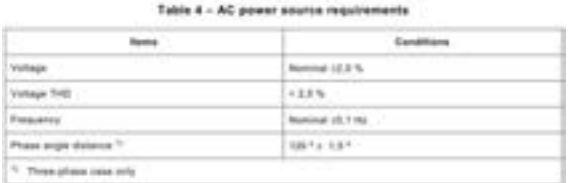
General product information:

This type of device is a non-transformer integrated grid-connected PV inverter which converts direct current optimized by photovoltaic DC conditioner to alternating current, but inverters only be used in power stations to connect the mains through a LV/MV step-up transformer to generate electric power supply to public utility.

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

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**		

IEC 62116			
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

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict
	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		--

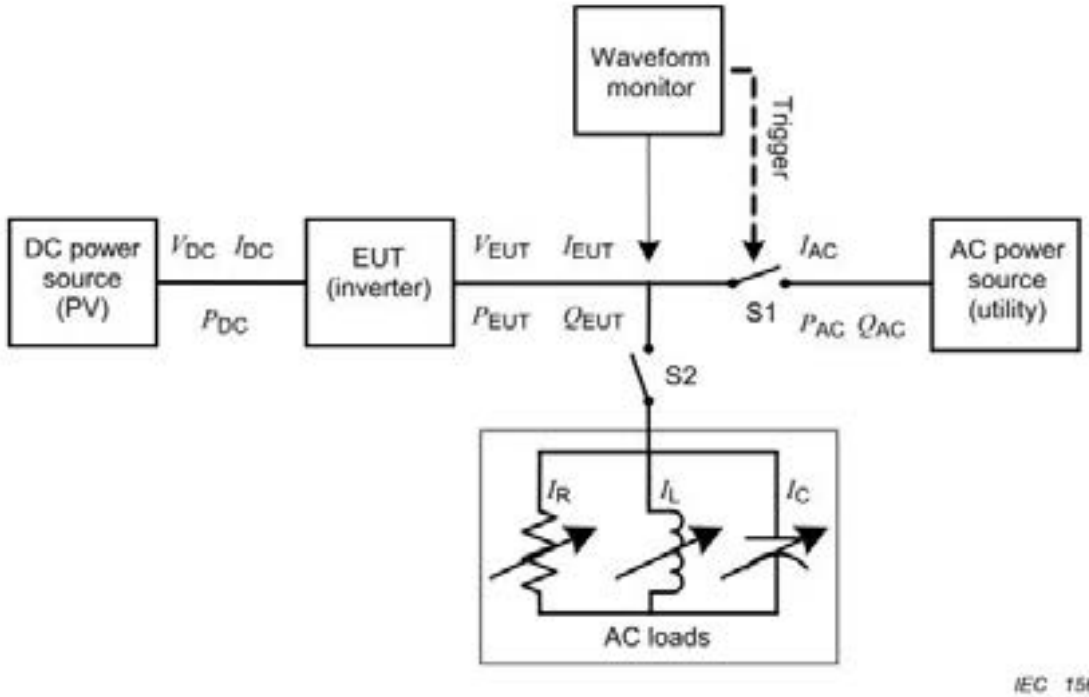
6.1	Table: tested condition and run-on time								P
Disconnection limit:			2 s						
No.	P_{EUT} (% of EUT rating)	Reactive Load (% of Q_L)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on time (ms)	P_{EUT} (kW)	Actual Q_f	V_{DC}(V)	Remarks
1	100	100	0	0	341,0	601,3	1,01	850	Test A, BL
2	66	66	0	0	325,0	397,5	1.02	730	Test B, BL
3	33	33	0	0	793,2	199,0	1,01	600	Test C, BL
4	100	100	-5	-5	171,0	601,3	1,05	850	Test A, IB[1]
5	100	100	-5	0	250,0	601,3	1,08	850	Test A, IB[1]
6	100	100	-5	+5	313,0	601,3	1,10	850	Test A, IB[1]
7	100	100	0	-5	269,0	601,3	1,04	850	Test A, IB[1]
8	100	100	0	+5	257,0	601,3	1,05	850	Test A, IB[1]
9	100	100	+5	-5	289,0	601,3	0,95	850	Test A, IB[1]
10	100	100	+5	0	317,0	601,3	0,97	850	Test A, IB[1]
11	100	100	+5	+5	207,0	601,3	1,01	850	Test A, IB[1]
12	66	66	0	-5	184,4	397,5	0,95	730	Test B, IB
13	66	66	0	-4	253,6	397,5	0,96	730	Test B, IB
14	66	66	0	-3	310,0	397,5	0,97	730	Test B, IB
15	66	66	0	-2	312,0	397,5	0,98	730	Test B, IB
16	66	66	0	-1	318,2	397,5	0,99	730	Test B, IB
17	66	66	0	1	315,2	397,5	1.01	730	Test B, IB
18	66	66	0	2	279,4	397,5	1.02	730	Test B, IB
19	66	66	0	3	269,2	397,5	1,03	730	Test B, IB
20	66	66	0	4	266,4	397,5	1,04	730	Test B, IB
21	66	66	0	5	253,2	397,5	1,05	730	Test B, IB
22	33	33	0	-5	193,6	199,0	0,95	600	Test C, IB
23	33	33	0	-4	280,6	199,0	0,96	600	Test C, IB

24	33	33	0	-3	254,8	199,0	0,97	600	Test C, IB
25	33	33	0	-2	567,2	199,0	1,00	600	Test C, IB
26	33	33	0	-1	557,2	199,0	1,00	600	Test C, IB
27	33	33	0	1	596,6	199,0	1,01	600	Test C, IB
28	33	33	0	2	306,2	199,0	1,02	600	Test C, IB
29	33	33	0	3	288,2	199,0	1,03	600	Test C, IB
30	33	33	0	4	271,2	199,0	1,04	600	Test C, IB
31	33	33	0	5	181,6	199,0	1,05	600	Test C, IB

1. Because of the limitation of island test system capacity, the inverter limits the output power to 600 kW.

test record Qf at balance condition of 100%, 66% and 33% of power with 600kW.

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



--- End of test report---

TEST REPORT
IEC 61683
Photovoltaic systems – Power conditioners – Procedure for measuring efficiency

Report Number. ..... :	70.409.18.025.20-00 part 3 of 3
Date of issue ..... :	2018-10-10
Total number of pages	13
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
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 61683:1999 (First Edition)
Test procedure ..... :	N/A
Non-standard test method ..... :	N/A
Test Report Form No. ..... :	IEC61683A
Test Report Form(s) Originator ..... :	TÜV SÜD Product Service GmbH
Master TRF ..... :	Dated 2014-10

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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 ..... :	SG1500UD, SG1250UD
Ratings ..... :	See rating label

Responsible Testing Laboratory (as applicable), testing procedure and testing location:			
☐	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 contain 3 parts listed in below table:

Item #	Description	Pages
Part 1	IEC 61727:2004 test report	39
Part 2	IEC 62116:2014 test report	10
Part 3	IEC 61683:1999 test report	13

Summary of testing:

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

Tests performed (name of test and test clause):

No test of IEC 60068-2-1:2007, IEC 60068-2-2:2007, IEC 60068-2-14:2009 and IEC 60068-2-30:2005, all visual inspection, hi-pot test verification, over-voltage/under-voltage, over-frequency/under-frequency function are conducted, efficiency according to IEC 61683:1999 are conducted.

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:

☒ The product fulfils the requirements of IEC 61683:1999

Copy of marking plate:

Refer to IEC 61727:2004 test report.

Test item particulars..... :	
Classification of installation and use ..... :	Fixed equipment
Supply Connection..... :	Non-detachable power supply cord
..... :	
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 .....:	2018-08-31
Date (s) of performance of tests.....:	2018-09-03 – 2018-09-30

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☒ 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

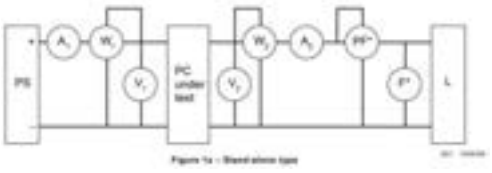
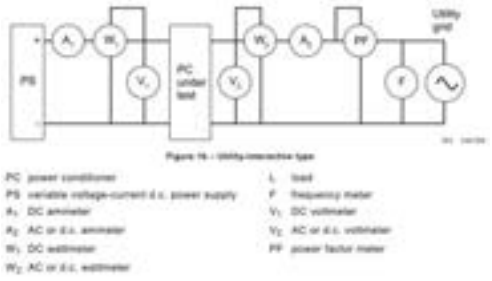
General product information:

This type of device is a non-transformer integrated grid-connected PV inverter which converts direct current optimized by photovoltaic DC conditioner to alternating current, but inverters only be used in power stations to connect the mains through a LV/MV step-up transformer to generate electric power supply to public utility.

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

IEC 61683			
Clause	Requirement – Test	Measuring result – Remark	Verdict
4	Efficiency measurement conditions		P
	Efficiency is measured under the conditions in the following clauses.		P
	Specific conditions may be excluded by mutual agreement when those conditions are outside the manufacturer's allowable operating range.		P
4.1	DC power source for testing		P
	For power conditioners operating with fixed input voltage, the d.c. power source is a storage battery or constant voltage power source to maintain the input voltage.		P
	For power conditioners that employ maximum power point tracking (MPPT) and shunt-type power conditioners, either a photovoltaic array or a photovoltaic array simulator is utilized.		N/A
4.2	Temperature		P
	All measurements are to be made at an ambient temperature of 25 °C ± 2 °C.		P
	Other ambient temperatures may be allowed by mutual agreement. However, the temperature used must be clearly stated in all documentation.		N/A
4.3	Output voltage and frequency		P
	The output voltage and frequency are maintained at the manufacturer's stated nominal values.		P
4.4	Input voltage		P
	Measurements performed in each of the following tests are repeated at three power conditioner input voltages: a) manufacturer's minimum rated input voltage; b) the inverter's nominal voltage or the average of its rated input range; c) 90 % of the inverter's maximum input voltage.		P
	In the case where a power conditioner is to be connected with a battery at its input terminals, only the nominal or rated input voltage may be applied.		N/A
4.5	Ripple and distortion		P
	Record input voltage and current ripple for each measurement. Also record output voltage and current distortion (if a.c.) or ripple (if d.c.). Ensure that these measurements remain within the manufacturer's specified values.		P

IEC 61683			
Clause	Requirement – Test	Measuring result – Remark	Verdict
4.6	Resistive loads/utility grid		P
	At unity power factor, or at the intrinsic power factor of grid-connected inverters without power factor adjustment, measure the efficiency for power levels of 10 %, 25 %, 50 %, 75 %, 100 % and 120 % of the inverter's rating.		P
	Stand-alone inverters are also measured at a power level of 5 % of rated. The power conditioner test is conducted with a specified resistive and reactive grid impedance.		N/A
4.7	Reactive loads		N/A
	For stand-alone inverters, measure the efficiency with a load which provides a power factor equal to the manufacturer's specified minimum level (or 0,25, whichever is greater) and at power levels of 25 %, 50 % and 100 % of rated VA.		N/A
	Repeat for power factors of 0,5 and 0,75 (do not go below the manufacturer's specified minimum PF) and power levels of 25 %, 50 %, and 100 % of rated VA.		N/A
4.8	Resistive plus non-linear loads		N/A
	For stand-alone inverters, measure the efficiency with a fixed non-linear load (total harmonic distortion (THD) = (80 ± 5) %) equal to (25 ± 5) % of the inverter's rated VA plus sufficient resistive load in parallel to achieve a total load of 25 %, 50 % and 100 % of rated VA.		N/A
	Repeat the measurements with a fixed non-linear load equivalent to (50 ± 5) % of the inverter's rated VA plus sufficient resistive load in parallel to achieve a total load of 50% and 100% of rated VA.		N/A
	The type of non-linear load must be clearly stated in all documentation.		N/A
4.9	Complex loads		N/A
	When a non-linear plus a sufficient reactive load condition is specified for stand-alone inverters, measure the efficiency with a fixed non-linear load (THD = (80 ± 5) %) equal to (50 ± 5) % of the inverter's rated VA plus a sufficient reactive load (PF = 0,5) in parallel to achieve a total load of 50 % and 100 % of rated VA.		N/A
	The type of complex load is clearly stated in all documentation.		N/A

IEC 61683			
Clause	Requirement – Test	Measuring result – Remark	Verdict
5	Efficiency calculations		P
5.1	Rated output efficiency		P
5.2	Partial output efficiency		P
5.3	Energy efficiency		P
5.4	Efficiency tolerances		P
6	Conditions of loading for output ports		P
6.1	Test circuit		P
	Figure 1a is applied to standard-alone power conditioners		N/A
			N/A
	Figure 1b is applied to utility-interactive power conditioners		P
			P
6.2	Measurement procedure		P
7	Loss measurement		P
7.1	No-load loss		N/A
7.2	Standby loss		P
Annex A	Power conditioner description		P
Annex B	Power efficiency and conversion factor		P
Annex C	Weighted-average energy efficiency		P
Annex D	Derivation of efficiency tolerance in table 2		P

Efficiency measurement before environment conditioning:								
TABLE	Efficiency recording and efficient calculation sheet							
power conditioner type	Grid connected PV Inverter							
Model:	SG1500HV							
Parameters of power conditioner	Minimum rated input voltage(full load): 580VDC Nominal voltage(full load): 730VDC Maximum input voltage(full load): 880VDC Rated output voltage: 3/PE~, 400VAC Rated output frequency: 50Hz Rated output power: 1500kVA Remark: Vmax=1100V, and Max, input voltage should not more than 0,8 times of Vmax							
PV input voltage	a) Manufacturer's minimum rated input voltage							
Temperature(°C)	25,1							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%
Input voltage (V)	582,06	580,24	580,51	580,54	580,37	580,95	581,12	580,82
Input current (A)	134,65	261,58	526,46	655,64	785,18	1306,75	1965,49	2623,91
Input power (Pi) (W)	78371	151778	305616	380618	455691	759160	1142161	1523949
Output voltage (V)	230,31	229,41	229,39	229,42	229,46	229,71	229,15	229,56
	230,25	229,49	229,65	229,75	229,77	230,20	229,78	230,28
	230,06	229,26	229,27	229,32	229,32	229,51	228,91	229,31
Output current (A)	112,23	218,50	440,19	548,06	656,62	1090,40	1639,10	2179,96
	111,79	218,76	440,10	547,89	656,50	1089,93	1638,22	2178,18
	110,39	216,40	437,69	545,48	654,29	1087,99	1637,08	2176,87
Output power (Po) (W)	75807,1	149416,2	301990	376328	451251	750850	1126070	1500118
Output efficiency	96,73%	98,44%	98,81%	98,87%	99,03%	98,91%	98,59%	98,44%
Input energy (Wi) (Wh)	13061,88	25296,25	50936	63436,33	75948,5	126526,7	190360,2	253991,5
Output energy (Wo) (Wh)	12634,52	24902,7	50331,67	62721,33	75208,5	125141,7	187678,3	250019,7
Energy efficiency	96,73%	98,44%	98,81%	98,87%	99,03%	98,91%	98,59%	98,44%

PV input voltage	b) Manufacturer's nominal input voltage							
Temperature(°C)	25,2							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%
Input voltage (V)	719,90	729,97	726,19	733,59	724,41	725,60	727,63	722,53
Input current (A)	108,49	209,81	419,23	518,62	623,78	1047,97	1573,67	2111,59
Input power (Pi) (W)	78099	153154	304436	380452	451855	760403	1145042	1525667
Output voltage (V)	229,12	229,30	229,32	229,33	229,34	229,56	229,72	229,93
	229,04	229,23	229,41	229,49	229,51	229,95	230,38	230,77
	228,82	228,95	229,02	229,05	229,06	229,32	229,53	229,78
Output current (A)	112,49	220,38	438,06	547,59	650,41	1092,00	1638,25	2175,54
	112,18	219,85	437,42	546,85	649,79	1091,23	1637,69	2174,99
	111,06	218,70	436,08	545,61	648,57	1089,84	1635,93	2172,42
Output power (Po) (W)	75762	150484	300346	375727	446581	751365	1128691	1500580
Output efficiency	97,01%	98,26%	98,66%	98,76%	98,83%	98,81%	98,57%	98,36%
Input energy (Wi) (Wh)	13016,6	25525,7	50739,3	63408,7	75309,2	126733,8	190840,3	254277,8
Output energy (Wo) (Wh)	12626,9	25080,7	50057,7	62621,2	74430,2	125227,5	188115,2	250096,7
Energy efficiency	97,01%	98,26%	98,66%	98,76%	98,83%	98,81%	98,57%	98,36%
PV input voltage	c) Manufacturer's maximum rated input voltage							
Temperature(°C)	25,1							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%

Input voltage (V)	879,89	880,18	879,18	877,27	879,14	875,16	877,49	880,28
Input current (A)	138,18	176,44	346,92	436,19	521,78	871,80	1302,30	1737,16
Input power (Pi) (W)	121590	155297	305007	382655	458718	762966	1142748	1529174
Output voltage (V)	229,51	229,56	230,34	230,05	230,01	230,10	230,02	230,09
	229,53	229,64	230,50	230,23	230,20	230,49	230,72	230,85
	229,30	229,41	230,14	229,77	229,71	229,81	229,75	229,82
Output current (A)	175,45	222,46	436,74	548,08	657,40	1093,01	1632,55	2175,20
	175,23	222,13	434,15	545,99	655,00	1088,61	1628,71	2171,61
	173,59	220,40	433,84	544,94	653,98	1088,74	1627,59	2171,25
Output power (Po) (W)	119445	152067	300128	376575	451866	752432	1124760	1500110
Output efficiency	98,24%	97,92%	98,40%	98,41%	98,51%	98,62%	98,43%	98,10%
Input energy (Wi) (Wh)	20265,1	25882,8	50834,5	63775,8	76453,0	127161,0	190458	254862,3
Output energy (Wo) (Wh)	19907,4	25344,4	50021,3	62762,5	75311,0	125405,3	187460	250018,3
Energy efficiency	98,24%	97,92%	98,40%	98,41%	98,51%	98,62%	98,43%	98,10%
Supplementary information: If limited by design, inverter is not capable to operate with the 120% of rated output load, test under max, available output power.								

Efficiency measurement before environment conditioning:	
TABLE	Efficiency recording and efficient calculation sheet
power conditioner type	Grid connected PV Inverter
Model:	SG1250HV
Parameters of power conditioner	Minimum rated input voltage(full load): 520VDC Nominal voltage(full load): 685VDC Maximum input voltage(full load): 850VDC Rated output voltage: 3/PE~, 400VAC Rated output frequency: 50Hz Rated output power: 1250kVA Remark: Vmax=1100V, and Max, input voltage should not more than 0,8 times of Vmax
PV input voltage	a) Manufacturer's minimum rated input voltage

Temperature(°C)	25,1							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%
Input voltage (V)	522,53	520,40	520,22	520,44	520,38	520,59	525,70	526,76
Input current (A)	123,46	241,38	492,94	604,39	731,58	1219,57	1815,40	2409,53
Input power (Pi) (W)	64512	125610	256436	314552	380697	634894	954346	1269176
Output voltage (V)	207,41	207,44	207,60	207,57	207,62	207,73	208,15	208,37
	207,34	207,45	207,69	207,71	207,77	208,12	208,79	209,06
	207,16	207,22	207,32	207,30	207,35	207,53	207,94	208,15
Output current (A)	102,10	199,01	407,49	500,31	605,76	1007,88	1508,53	2000,04
	102,96	199,93	408,19	500,98	606,54	1008,50	1508,62	2000,47
	101,13	197,94	406,17	498,93	604,66	1006,67	1507,18	1999,47
Output power (Po) (W)	62800	123393	253360	311127	377001	627967	941655	1249902
Output efficiency	97,35%	98,23%	98,80%	98,91%	99,03%	98,91%	98,67%	98,48%
Input energy (Wi) (Wh)	10752,0	20935,1	42739,3	52425,3	63449,5	105815,7	159057,7	211529,3
Output energy (Wo) (Wh)	10466,6	20565,4	42226,7	51854,5	62833,5	104661,2	156942,5	208317,0
Energy efficiency	97,35%	98,23%	98,80%	98,91%	99,03%	98,91%	98,67%	98,48%
PV input voltage	b) Manufacturer's nominal input voltage							
Temperature(°C)	25,2							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%
Input voltage (V)	684,92	687,87	679,38	675,45	688,90	684,35	682,81	685,24
Input current (A)	93,99	185,50	374,17	473,28	554,83	933,18	1400,29	1859,47
Input power (Pi) (W)	64372	127600	254191	319635	382220	638623	956130	1274153

Output voltage (V)	206,72	206,74	206,80	206,93	206,82	207,03	207,45	207,81
	206,66	206,81	207,00	207,18	207,08	207,57	208,00	208,66
	206,48	206,59	206,65	206,78	206,66	206,88	207,07	207,54
Output current (A)	101,50	202,48	404,47	508,33	608,49	1014,62	1513,27	2007,37
	101,71	202,63	404,18	508,12	608,23	1014,06	1511,82	2005,20
	100,96	201,75	403,44	507,40	607,51	1013,10	1512,37	2005,63
Output power (Po) (W)	62223	125130	250496	315199	377178	629972	941104	1250940
Output efficiency	96,66%	98,06%	98,55%	98,61%	98,68%	98,65%	98,43%	98,18%
Input energy (Wi) (Wh)	10728,7	21266,8	42365,2	53272,5	63703,3	106437,2	159355	212358,8
Output energy (Wo) (Wh)	10370,5	20854,9	41749,3	52533,2	62863,0	104995,3	156850,7	208490,0
Energy efficiency	96,66%	98,06%	98,55%	98,61%	98,68%	98,65%	98,43%	98,18%
PV input voltage	c) Manufacturer's maximum rated input voltage							
Temperature(°C)	25,1							
Operating period for energy measurement (min)	10 min							
Percentage of rated output VA	5%	10%	20%	25%	30%	50%	75%	100%
Input voltage (V)	846,70	844,15	845,95	849,21	843,61	846,74	842,35	846,42
Input current (A)	76,32	150,79	303,94	376,09	452,86	751,64	1133,15	1509,76
Input power (Pi) (W)	64622	127287	257114	319376	382038	636447	954502	1277879
Output voltage (V)	206,50	206,41	206,55	206,61	206,61	206,87	207,09	207,57
	206,38	206,47	206,72	206,88	206,89	207,36	207,85	208,46
	206,22	206,21	206,39	206,43	206,42	206,58	206,87	207,19
Output current (A)	102,50	202,12	409,39	508,41	608,24	1010,94	1510,68	2013,00
	101,42	200,97	408,01	506,99	606,82	1008,92	1509,44	2010,09
	101,64	201,09	408,07	507,06	607,02	1009,13	1508,07	2010,05
Output power (Po) (W)	62186	124287	252877	314349	376282	626618	938132	1252576
Output efficiency	96,23%	97,64%	98,35%	98,43%	98,49%	98,46%	98,28%	98,02%

Input energy (Wi) (Wh)	10770,3	21214,5	42852,3	53229,3	63673,0	106074,5	159083,7	212979,8
Output energy (Wo) (Wh)	10364,3	20714,5	42146,2	52391,5	62713,7	104436,3	156355,3	208762,7
Energy efficiency	96,23%	97,64%	98,35%	98,43%	98,49%	98,46%	98,28%	98,02%
Supplementary information: If limited by design, inverter is not capable to operate with the 120% of rated output load, test under max, available output power.								

--- End of test report---