TEST REPORT

Testing for the verification of compliance of GRID connected POWER CONVERSION SYSTEM with:

Short Duration Undervoltage response test：28 July 2020

Report Reference No…… ...:	200902099GZU-003
Date of issue ……:	14 Sep 2020
Total number of pages……:	19 pages

Testing Laboratory	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address.....	Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, China
Testing location/ address.....	Same as above
Tested by (name + signature)……:	Sunny Lin Engineer
Approved by (+ signature).....	Jason Fu Technical Team Leader

Applicant's name	Shenzhen SOFAR SOLAR Co., Ltd.
Address.....	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China

Test specification:

Standard	Short Duration Undervoltage response test：28 July 2020
Test procedure.....	Type approval
Non-standard test method……..:	N/A

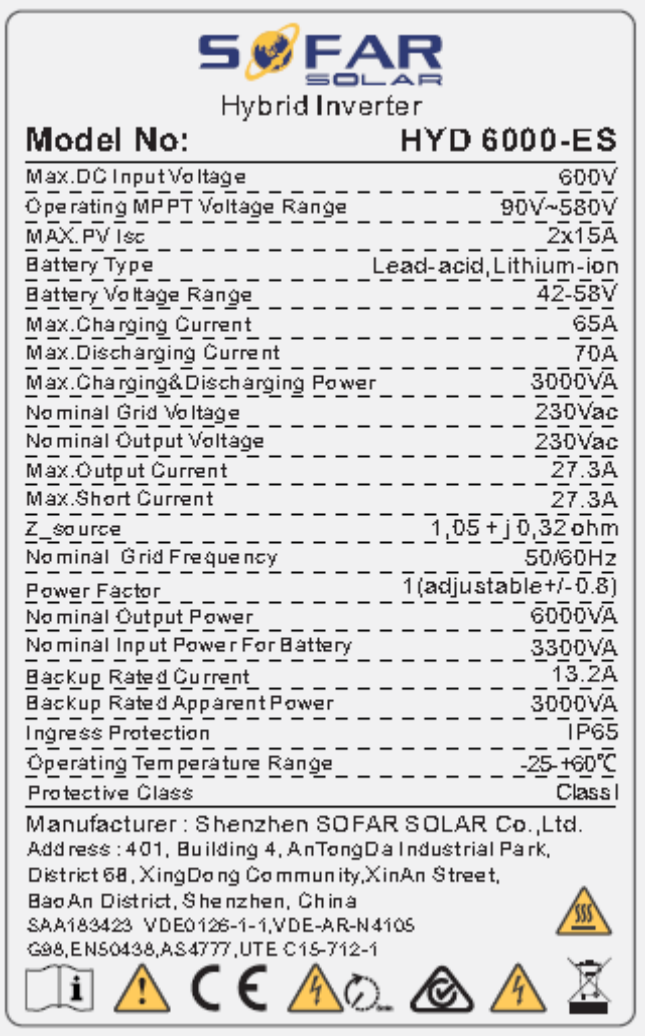
Test Report Form No.	VDRT_a
Test Report Form(s) Originator	Intertek Guangzhou
Master TRF	Dated 2020-09

Test item description	Hybrid inverter
Trade Mark.....	SOFAR SOLAR
Manufacturer.....	Same as Applicant
Model/Type reference.....	HYD 6000-ES, HYD 5000-ES, HYD 4000-ES, HYD 3600-ES, HYD 3000-ES
Ratings.....	See ratings in page 5 for details

Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
All applicable tests The model HYD 6000-ES is type tested For certification testing for compliance with AS/NZS 4777.2:2015 refer to report No. 180903076GZU-004, dated 14 Nov 2018, issued by Intertek Testing Services Shenzhen Ltd. Guangzhou Branch	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, China

Copy of marking plate



Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. The other labels are identical with model label above, except the model No and rating.

Test item particulars.....:	
Temperature range .....:	-25℃ - 60℃
AC Overvoltage category.....:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
DC Overvoltage category .....:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
IP protection class .....:	IP 65
Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A (Not applicable)
- test object does meet the requirement ..... :	P (Pass)
- test object does not meet the requirement ..... :	F (Fail)
Testing..... :	
Date of receipt of test item..... :	04 Sep 2020
Date (s) of performance of tests..... :	04 Sep 2020 – 11 Sep 2020

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

When determining for test conclusion, measurement uncertainty of tests has been considered.
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The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.

Throughout this report a point is used as the decimal separator.

General product information:

The unit is a single-phase hybrid inverter, it can convert the high PV voltage and Grid voltage to low DC for charge battery, also converts PV voltage and battery voltage to AC output.

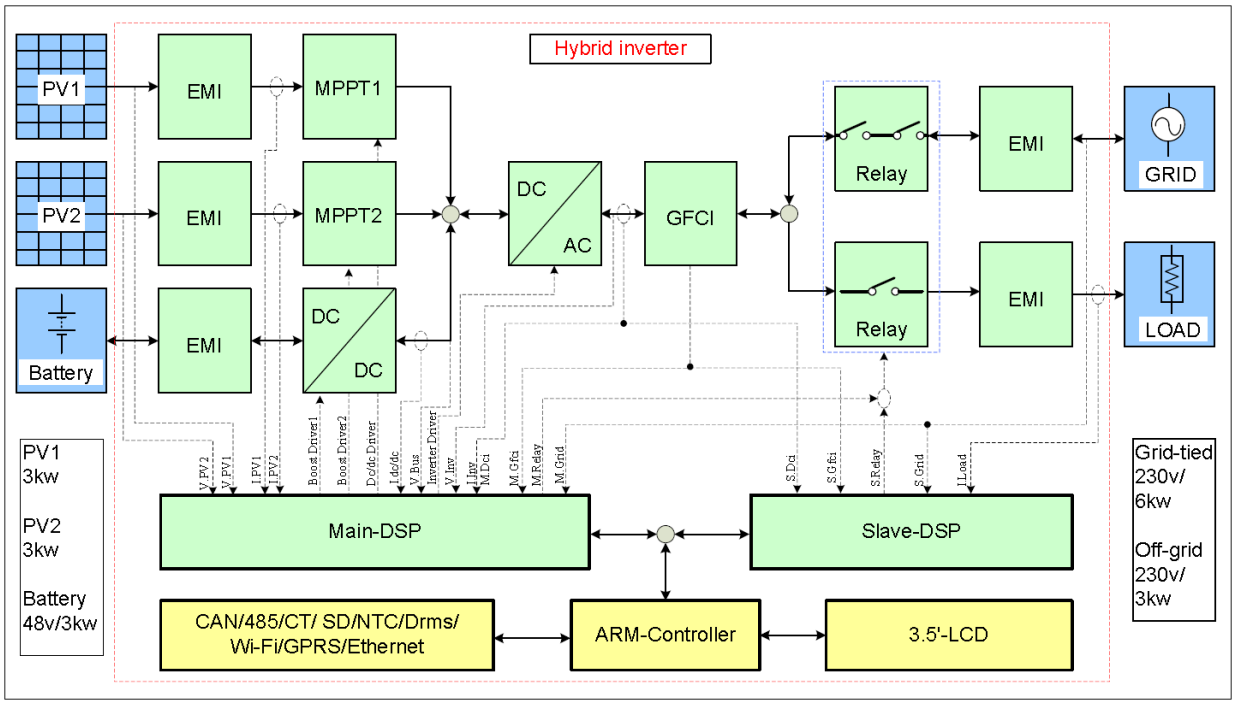
The unit is providing EMC filtering at the PV and battery side. It does provide galvanic separation from PV side to Grid. The battery circuit does provide high frequency isolation to PV side and AC mains.

The unit has two controllers. the master DSP controller monitor the charge or discharge statue; measure the PV voltage and current, battery voltage, bus voltage, buck voltage and current, AC voltage, current, GFCI and frequency.

The slave DSP controller monitor AC voltage, current, frequency, GFCI and communicate with the master controller

The master DSP and slave DSP are used together to control relay open or close, if the single fault on one DSP, the other one DSP can be capable to open the relay, so that still providing safety means

The topology diagram as following:



Model differences:

The models HYD 3000-ES, HYD 3600-ES, HYD 4000-ES , HYD 5000-ES and HYD 6000-ES are completely identical and output power derated by software, except for the following table.

Model	HYD 6000-ES	HYD 5000-ES	HYD 4000-ES	HYD 3600-ES	HYD 3000-ES
R332, R334,R336	0Ω, NC, 0Ω		NC, 0Ω, NC		
Bus capacitance	8pcs		6pcs		
INV inductor	0.75mH		1.035mH		
R123,R132	1.5KΩ, 1.5KΩ		499Ω, 499Ω		

Version of software: V1.00

Version of hardware: V1.00

Rating:

Model	HYD 3000-ES	HYD 3600-ES	HYD 4000-ES	HYD 5000-ES	HYD 6000-ES
Max. DC Input Voltage	600 d.c.V				
Max. PV Isc	2 X 15 d.c.A				
Battery Type	Lead-acid, Lithium-ion				
Battery Voltage Range	42-58 d.c.V				
Max. Charging Current	65 d.c.A				
Max. Discharging Current	70 d.c.A				
Max. Charging & Discharging Power	3000VA				
Nominal Grid voltage	230 a.c.V				
Nominal Output Voltage (backup)	230 a.c.V				
Max. output current	13.7 a.c.A	16 a.c.A	18.2 a.c.A	22.8 a.c.A	27.3 a.c.A
Nominal Grid Frequency	50Hz				
Power Factor	1 (adjustable +/-0.8)				
Nominal output power	3000VA	3680VA	4000VA	5000VA	6000VA
Backup Rated current	13.2 a.c.A				
Backup Rated Apparent Power	3000VA				
Ingress Protection	IP 65				
Protective Class	Class I				
Operating temperature range	-25 ~ +60℃				

Short Duration Undervoltage response test			
Clause	Requirement – Test	Result – Remark	Verdict
1	General test and reporting requirements		P
1.1	General		P
1.2	Test condition		P
1.3	Inverter setup		P
1.4	Grid source		P
2	Test procedure		P
2.1	General		P
2.2	Undervoltage(V<) disconnection test in response to event duration exceeding trip delay time		P
2.3	Undervoltage(V<) withstand test in response to event duration of less than trip delay time		P
2.4	Criterial for acceptance		P

1.1 Customer Equipment

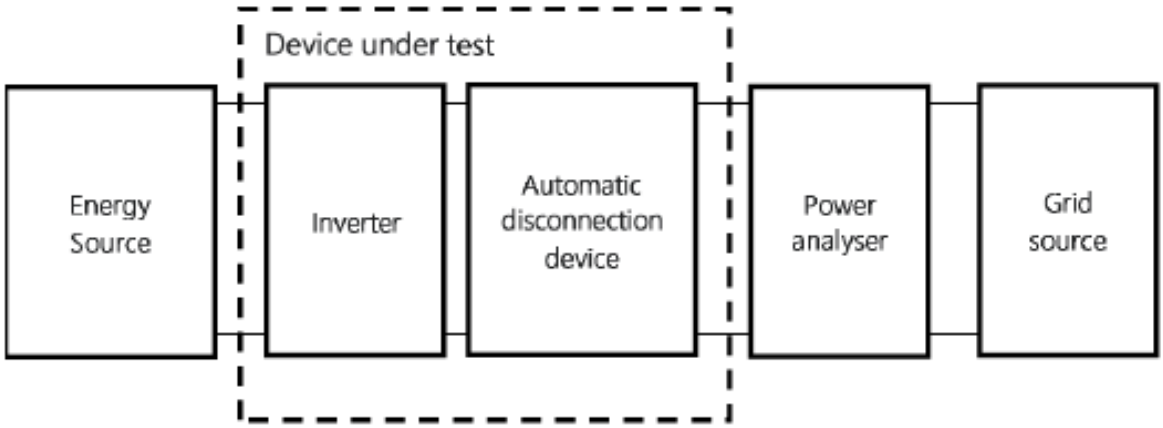
Equipment	Manufacturer	Type	Serial No.
Hybrid inverter	Shenzhen SOFAR SOLAR Co., Ltd.	HYD 6000-ES	ZM1ES050E31001

1.2 Intertek Equipment

Asset	Description	Manufacturer	Model	Cal Date	Cal Due
SA200-16	Precision Power Analyzer	YOKOGAWA	WT3000	11 Aug 2020	10 Aug 2021
SA200-52	AC power source	Chroma	61860	/	/
SA050-33	Scope recorder	YOKOGAWA	DL 850E	31 Oct 2019	30 Oct 2020
SA050-33-01	AC Current Probe	Chauvin Arnoux	C173	14 Jan 2020	13 Jan 2021
SA050-33-02	AC Current Probe	Chauvin Arnoux	C173	14 Jan 2020	13 Jan 2021
SA050-33-03	AC Current Probe	Chauvin Arnoux	C173	14 Jan 2020	13 Jan 2021
SA200-18	TopCon series DC power supply	REGATRON	TC.P.32.1000.400.PV.HMI	07 Aug 2020	06 Aug 2021

2. Test set up & Test Conditions

Below is the simplified construction of the test set up used in all tests of this report.



Test Conditions		
Condition	**Value**	**Comments**
the average r.m.s. current on each phase is within ±5 % of the intended test point;	50% ±5 %In	--
the average r.m.s. voltage on each phase is within ±1 % of the grid test voltage	See test result	--
For three-phase supply, the angle between the fundamental voltages of each pair of phases shall be maintained at 120 ± 1.5°.	N/A	Single phase
For three-phase supply, the average r.m.s. voltages between each pair of phases shall be maintained within ±1 %.	N/A	Single phase
The grid test voltage shall be 230 V a.c. phase to neutral, 50 ± 0.1 Hz	230V,50Hz	--
AC source used for test	See equipment list	simulated test grid
The impedance of the test point should not cause a voltage rise greater than 0.5 % of the grid test voltage at the rated current output of the device under test.	Voltage at no load condition: 230.11V Voltage at full load condition: 230.75V	--
Note 1: These test conditions have been used in all the test performed in Sections 3.1 to 3.2 of this report.		

2.1. Voltage harmonic for Test bench

The real grid or a simulated test grid should be free from harmonic distortion which could interfere with testing. The voltage harmonic distortions of the real or simulated test grid shall be less than the limits specified in the table below.

Harmonic order number	Limit based on percentage of fundamental
3	0.9 %
5	0.4 %
7	0.3 %
9	0.2 %
Even harmonics 2–10	0.2 %
11–50	0.1 %
Total harmonic distortion (to the 50th harmonic)	5 %

Nr./ Order	Phase A U_h(%)	Phase B U_h(%)	Phase C U_h(%)	Limited (%)
2	0.0080	0.0220	0.0110	0.2
3	0.0150	0.0170	0.0150	0.9
4	0.0030	0.0010	0.0010	0.2
5	0.0190	0.0200	0.0190	0.4
6	0.0020	0.0030	0.0020	0.2
7	0.0090	0.0120	0.0080	0.3
8	0.0020	0.0010	0.0020	0.2
9	0.0060	0.0050	0.0040	0.2
10	0.0030	0.0010	0.0050	0.2
11	0.0010	0.0010	0.0030	0.1
12	0.0020	0.0020	0.0020	0.1
13	0.0010	0.0030	0.0010	0.1
14	0.0020	0.0050	0.0010	0.1
15	0.0030	0.0030	0.0040	0.1
16	0.0030	0.0010	0.0040	0.1
17	0.0000	0.0010	0.0020	0.1
18	0.0030	0.0010	0.0030	0.1
19	0.0010	0.0020	0.0010	0.1
20	0.0010	0.0010	0.0020	0.1
21	0.0020	0.0030	0.0030	0.1
22	0.0020	0.0020	0.0030	0.1
23	0.0030	0.0030	0.0030	0.1
24	0.0020	0.0010	0.0010	0.1
25	0.0020	0.0020	0.0010	0.1
26	0.0010	0.0010	0.0020	0.1
27	0.0030	0.0030	0.0040	0.1
28	0.0020	0.0020	0.0020	0.1
29	0.0030	0.0010	0.0040	0.1
30	0.0020	0.0020	0.0020	0.1
31	0.0020	0.0020	0.0020	0.1
32	0.0040	0.0020	0.0030	0.1

33	0.0030	0.0020	0.0010	0.1
34	0.0020	0.0010	0.0010	0.1
35	0.0030	0.0020	0.0030	0.1
36	0.0010	0.0010	0.0010	0.1
37	0.0030	0.0020	0.0030	0.1
38	0.0030	0.0020	0.0020	0.1
39	0.0030	0.0010	0.0000	0.1
40	0.0050	0.0010	0.0020	0.1
41	0.0030	0.0030	0.0010	0.1
42	0.0010	0.0030	0.0020	0.1
43	0.0020	0.0010	0.0040	0.1
44	0.0020	0.0020	0.0020	0.1
45	0.0000	0.0010	0.0020	0.1
46	0.0130	0.0050	0.0040	0.1
47	0.0010	0.0010	0.0020	0.1
48	0.0100	0.0070	0.0050	0.1
49	0.0020	0.0000	0.0020	0.1
50	0.0020	0.0010	0.0020	0.1
THD (%)	0.052	0.059	0.054	5

3. Test result

3.1 Undervoltage(V<) disconnection test in response to event duration exceeding trip delay time

Grid source voltage		230.0V			Test at 50 ±5% rated output current (A):			13.61		
Test step	Grid source voltage Setting (V)	Grid source voltage measured (V)			Disconnection time (s) (*) 1s<t<2s			Reconnection time (s) t >60s		
		Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
a)	177.5	177.47	177.51	177.54	1.22	1.21	1.31	--	--	--
b)	230	230.34	230.24	230.22	--	--	--	70.04	70.24	69.83

Note:
(*) The disconnection time recorded shall be greater than the trip delay time of AS4777.2:2015 of 1 s and less than the disconnection time of AS4777.2:2015 of 2 s

	Voltage drop time measured	Voltage drop time Limited
230V→177.5	1.0ms	2ms

Undervoltage (V<) disconnection test in response to event duration exceeding trip delay time

Test 1: Disconnection time

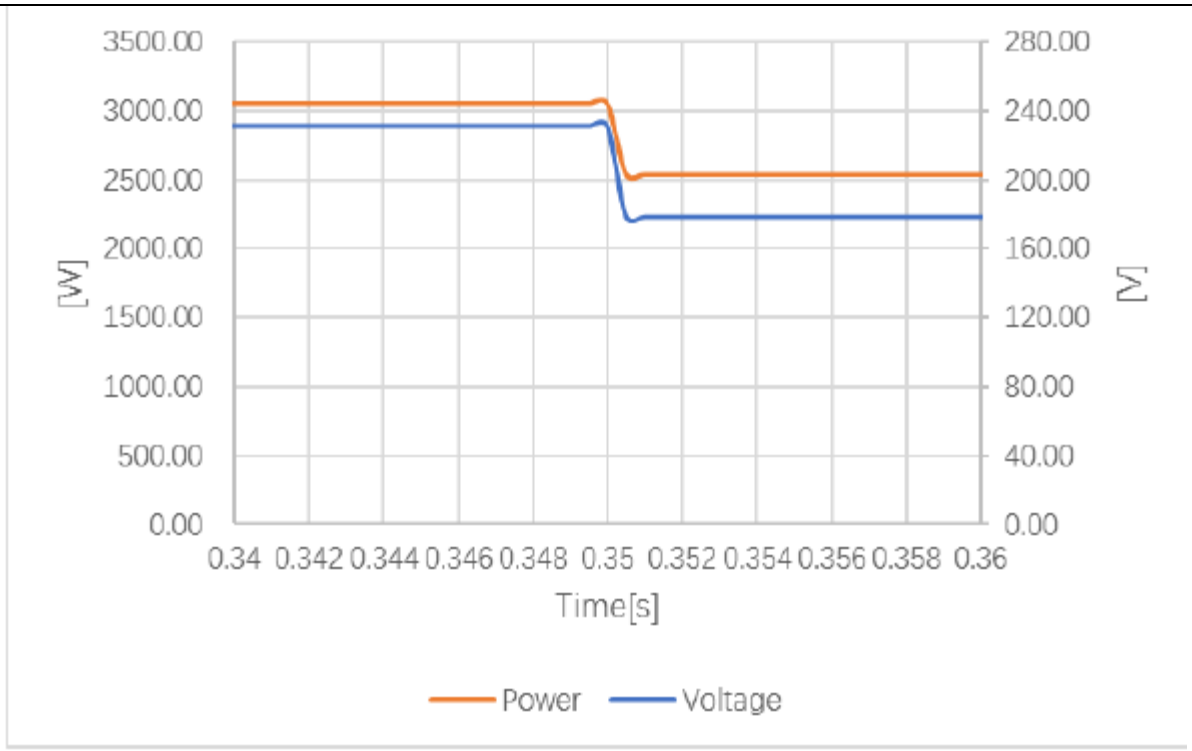
CH1: trip signal; CH9: Grid Voltage; CH10: Current of EUT


CH10 : 10.000A/div
Position : 0.01 div
Display Group
Zoom1:40.0k
Main:200.0k
AcqMode : Normal
2kS/s 10s/div
<Main>
<Zoom1>
↔2s/div
X1 -15.2395s
X2 -14.0295s
ΔX 1.2100s
RMS :CH1 4.43190V
RMS :CH9 177.512V
RMS :CH10 249.292mA
RMS :#1_Urms1 177.50V
Stopped
2020/09/11 15:29:22.11439684
Auto
:File
2020/09/11 15:30:16

Test 2


CH10 : 10.000A/div
Position : 0.01 div
Display Group
Zoom1:40.0k
Main:200.0k
AcqMode : Normal
2kS/s 10s/div
<Main>
<Zoom1>
↔2s/div
X1 -13.0395s
X2 -11.7295s
ΔX 1.3100s
RMS :CH1 4.54663V
RMS :CH9 177.544V
RMS :CH10 254.645mA
RMS :#1_Urms1 177.57V
Stopped
2020/09/11 15:33:53.51296670
Auto
:File
2020/09/11 15:34:51

Test 3



Voltage drop time

Test 1: Reconnection time

CH1: trip signal; CH9: Grid Voltage; CH10: Current of EUT


CH10 : 10.000A/div
Position : 0.01 div
Display Group
1 2 3 4 P H
Zoom1:40.0k
Main:200.0k
AcqMode : Normal
1kS/s 20s/div
<Main>
<Zoom1>
4s/div
X1 -106.099s
X2 -36.859s
ΔX 70.240s
RMS :CH1 4.53429V
RMS :CH9 230.235V
RMS :CH10 13.8649A
RMS :#1_Urms1 230.32V
Stopped
1
2020/09/11 15:32:40.91167212
Auto
:File
2020/09/11 15:33:11

Test 2


CH10 : 10.000A/div
Position : 0.01 div
Display Group
1 2 3 4 P H
Zoom1:40.0k
Main:200.0k
AcqMode : Normal
1kS/s 20s/div
<Main>
<Zoom1>
4s/div
X1 -103.899s
X2 -34.059s
ΔX 69.840s
RMS :CH1 4.58137V
RMS :CH9 230.494V
RMS :CH10 13.9228A
RMS :#1_Urms1 230.22V
Stopped
1
2020/09/11 15:37:12.97569658
Auto
:File
2020/09/11 15:37:44

Test 3

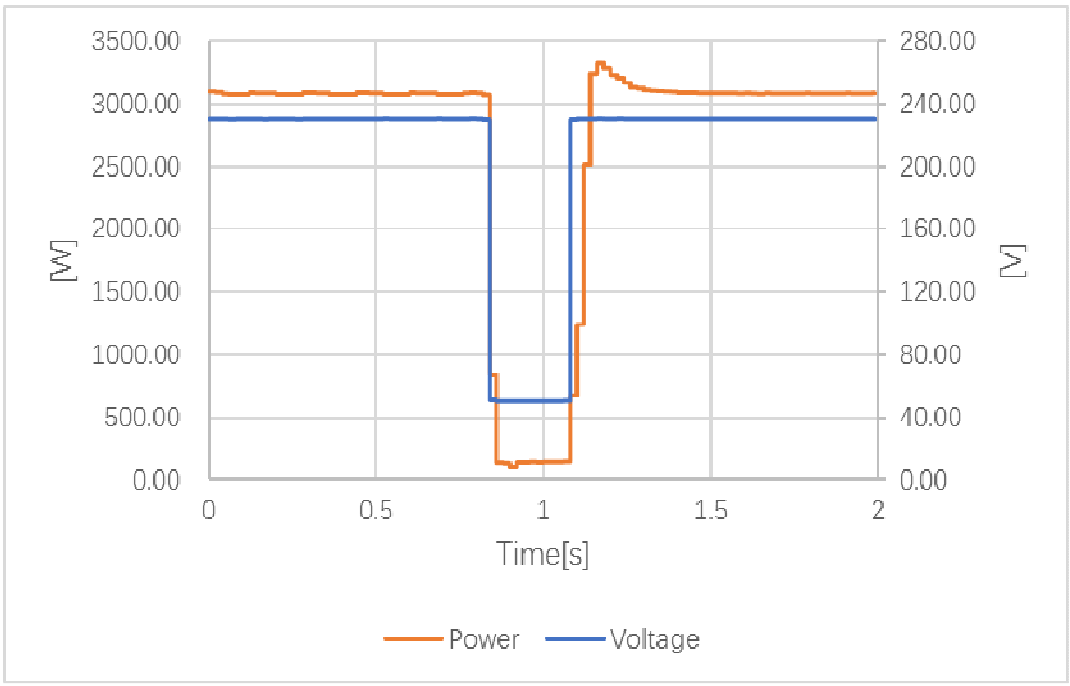
3.2 Undervoltage (V<) withstand test in response to event duration of less than trip delay time

Grid source voltage		230V			Test at 50 ±5% rated output current (A):			6.85		
Test step	Grid source voltage Setting (V)	Grid source voltage measured (V)			Remain time duration (220ms) Time measured (ms)			Power recovery time measured (ms)		
		Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
a)	230	230.21	230.29	230.29	--	--	--	--	--	--
b)	50	50.17	50.13	50.17	240	240	240	--	--	--
c)	230	230.33	230.04	230.21	--	--	--	320.0	340.0	320.0

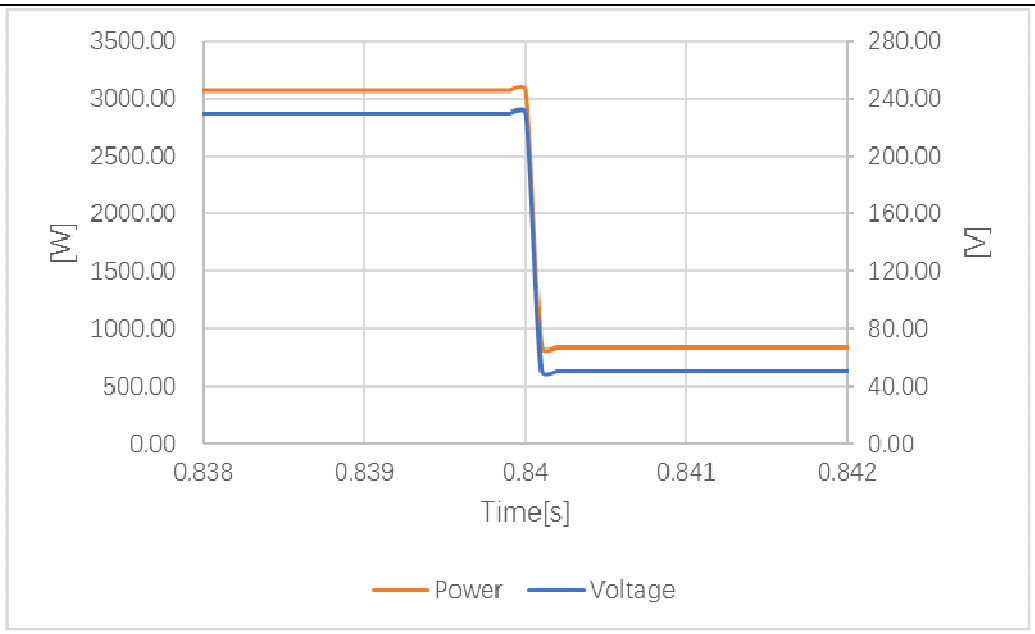
Test step	Voltage drop time measured	Voltage drop time Limited
a)→b)	0.5ms	2ms
b)→c)	0.5ms	2ms

Test Number	Power measured	
	Before voltage drop	Power recovery
Test 1	3097.90W	3083.30W
Test 2	3085.40W	3081.30W
Test 3	3085.40W	3081.30W

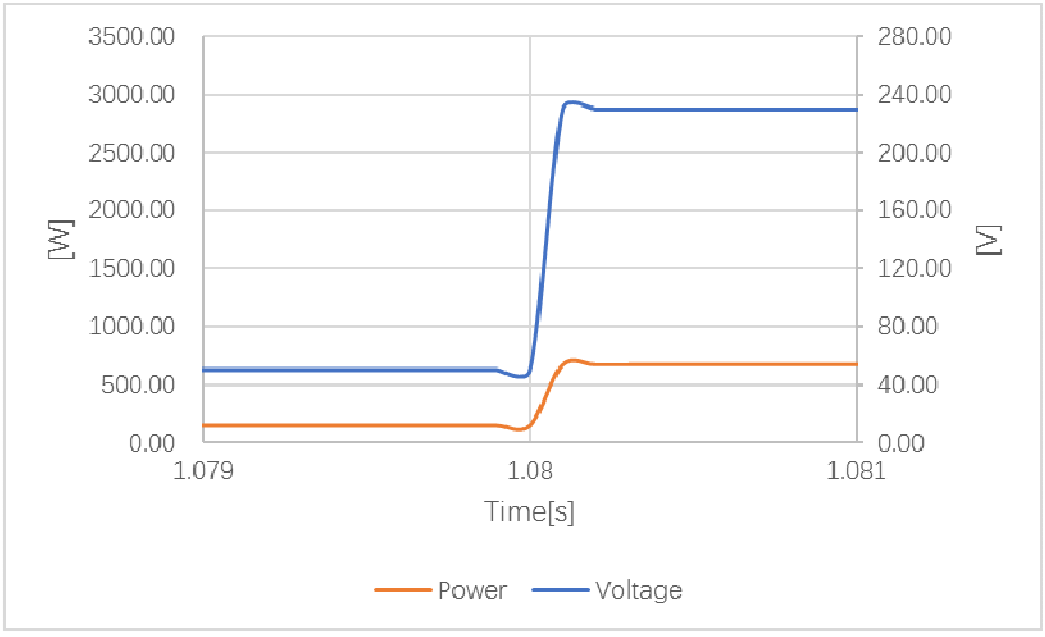
Undervoltage (V<) withstand test in response to event duration of less than trip delay time



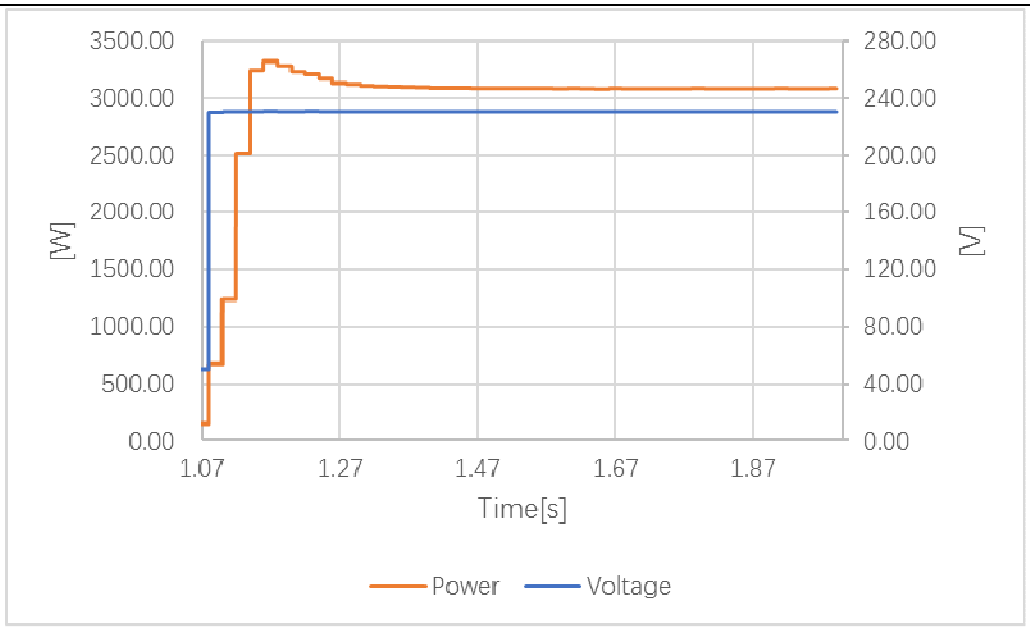
Undervoltage process



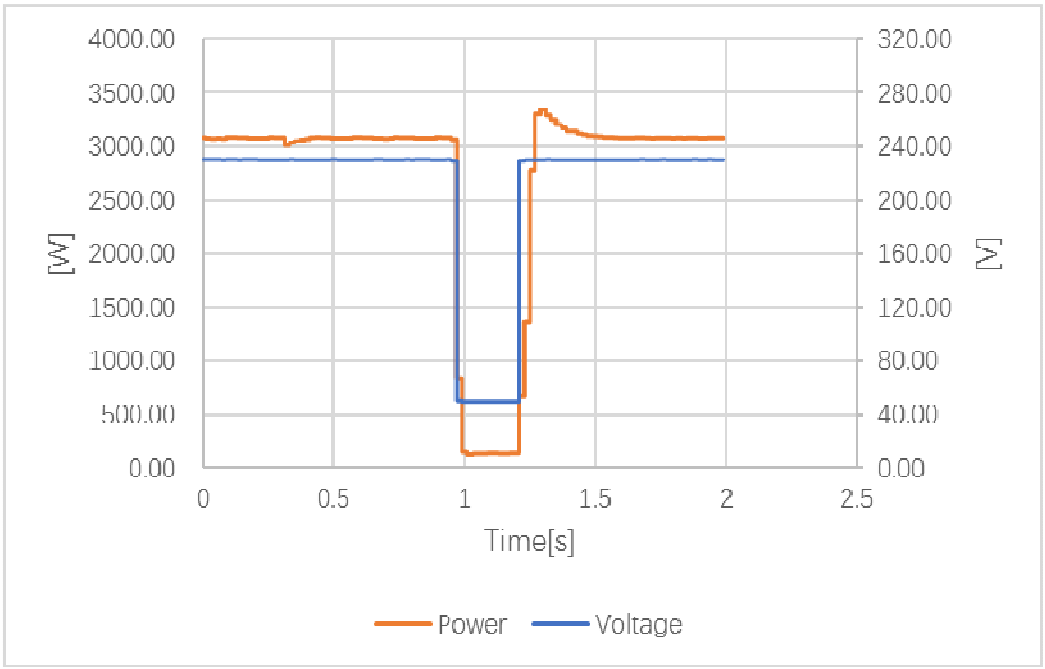
Voltage drop



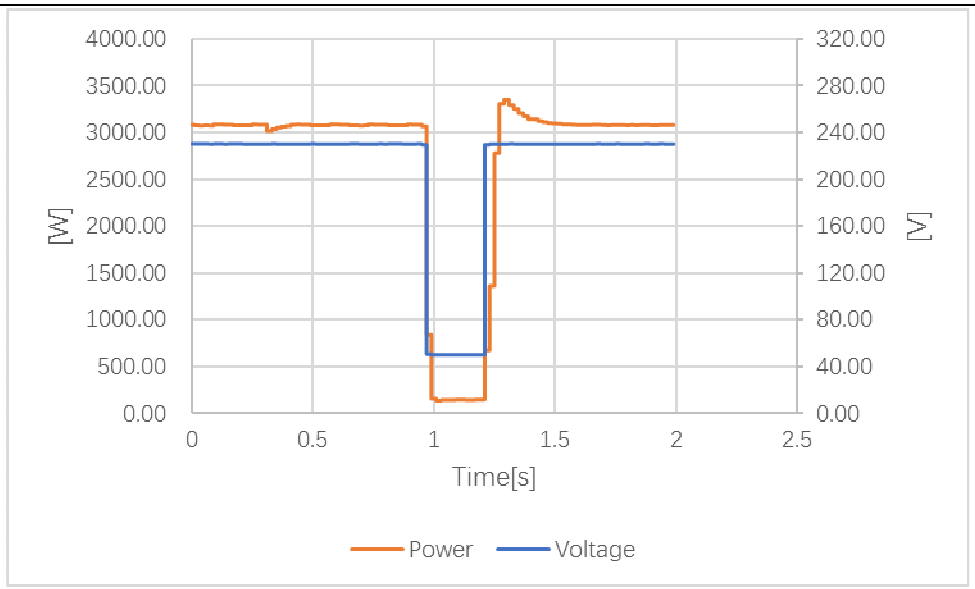
Voltage recovery



Power recovery



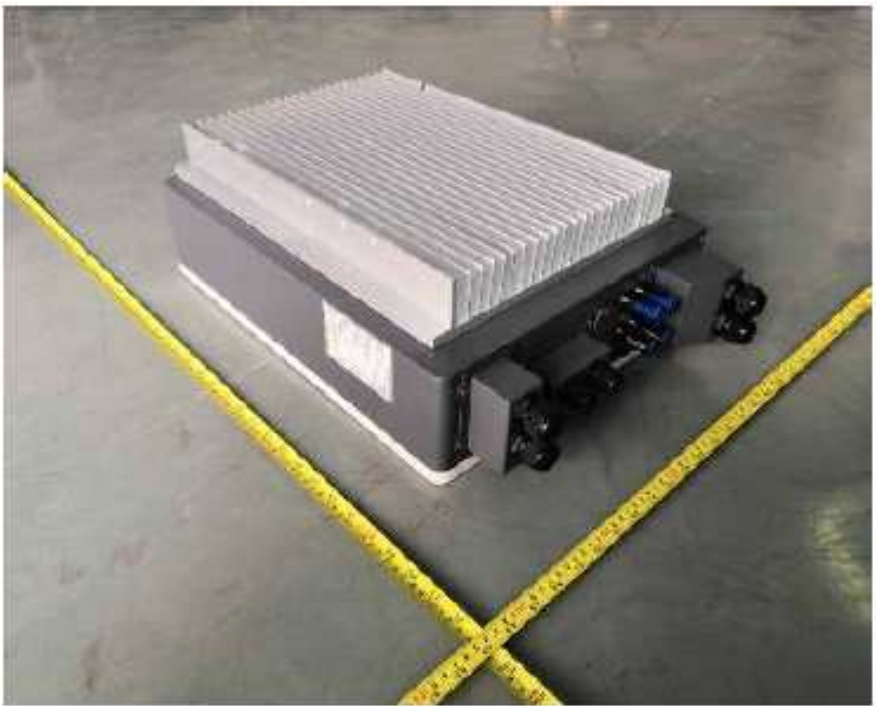
Test 2


4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
[W]
320.00
280.00
240.00
200.00
160.00
120.00
80.00
40.00
0.00
[V]
0
0.5
1
1.5
2
2.5
Time[s]
Power
Voltage

Test 3

Photos

Front view of inverter



Rear view

(End of Report)