TEST REPORT
IEC 61727: 2004
Photovoltaic (PV) systems - Characteristics of the utility interface
IEC 62116: 2014
Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters

Report Reference No.	ES190510002P
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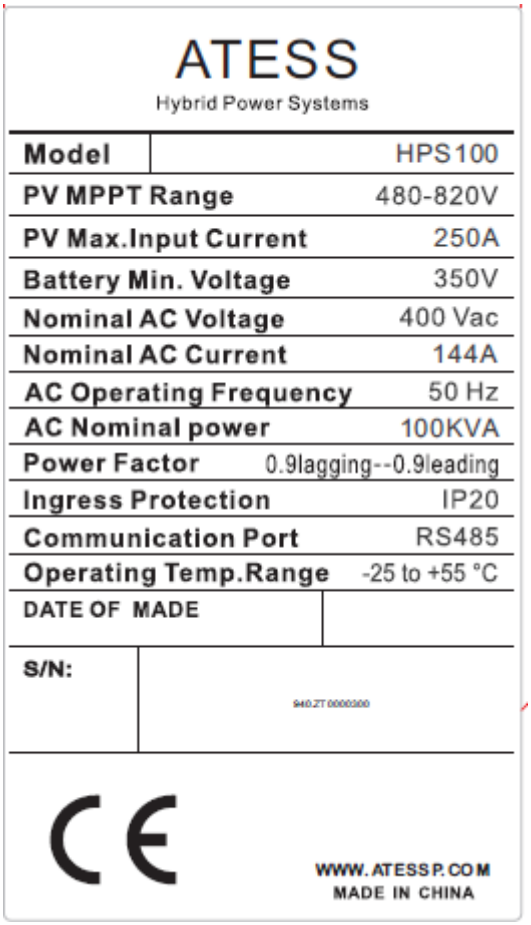
Testing Laboratory name	EMTEK(SHENZHEN) CO., LTD.
Address	Bldg 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China
Testing location/ address	Same as above
Applicant's name	: Shenzhen ATESS Power Technology Co.,Ltd
Address	1st Floor of Building 3 at Sector B and 3rd Floor of Building 9, Henglong Industrial Park, No.4 Industrial Zone, Shuitian Community, Shiyan Street, Baoan District, Shenzhen
Test specification:	
Standard	IEC 61727: 2004 IEC 62116: 2014
Test procedure	IEC report
Non-standard test method	N/A
Test Report Form No.	IEC61727A IEC62116A
Test Report Form(s) Originator	EMTEK
Master TRF	Dated 2013-06
Test item description	Hybrid Power systems
Trade Mark	ATESS
Manufacturer	: Shenzhen ATESS Power Technology Co.,Ltd
Address	1st Floor of Building 3 at Sector B and 3rd Floor of Building 9, Henglong Industrial Park, No.4 Industrial Zone, Shuitian Community, Shiyan Street, Baoan District, Shenzhen
Model/Type reference	HPS100
Firmware Version	TI1.0
Ratings	See the rating label.

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 ..... : May 05. 2019
Date (s) of performance of tests ..... : May 05. 2019 to December 10. 2019
General remarks:
"(see Attachment #)" refers to additional information appended to the report. "(see appended table)" refers to a table appended to the report. The tests 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. List of test equipment must be kept on file and available for review. Additional test data and/or information provided in the attachments to this report. Throughout this report a ☐ comma / ☒ point is used as the decimal separator. The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in the grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA 2013).
General product information: 1) It's intended for professional incorporation into Hybrid power systems, and it is assessed on a component test basis; 2) The enclosure assembly was secured by screws; 3) The PCE shall be used at specified ambient temperature range: -25 ℃ ~ +55 ℃.
Copy of marking plate:



Interface protection settings with deviations according the grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA)

(Thailand MEA)

Parameter	Max. clearance time*	Trip setting
Over voltage (level 2)	0.05s	230V +12% (311V)**
Over voltage (level 1)	2.0s	230V +4.3% (240V)
Under voltage (level 1)	2.0s	230V -13% (200V)
Under voltage (level 2)	0.1s	230V -50% (115V)**
Over frequency	0.1s	50Hz + 2% (52.0Hz)
Under frequency	0.1s	50Hz -2% (47.0Hz)
Reconnection time	At least 120s	
Permanent DC-injection	0.5% of rated inverter output current	
Loss of main IEC 62116:2014	Inverter shall detect and disconnect within 2s	

* 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.

** The inverter can be adjusted for overvoltage trip setting up to 311V.

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Clause	Requirement – Test	Result - Remark	Verdict

SECTION 4: Utility compatibility			
4	General 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. 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. All power quality parameters (voltage, flicker, frequency, harmonics, and power factor) must be measured at the utility interface/ point of common coupling unless otherwise specified.	Noticed	P
4.1	Voltage, current and frequency The PV system AC voltage, current and frequency shall be compatible with the utility system.	Derived from tests	P
4.2	Normal voltage operating range 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.	Derived from tests	P
4.3	Flicker 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 table 4.3	P
4.4	DC injection The PV system shall not inject DC current greater than 0.5 % of the rated inverter output current, into the utility AC interface under any operating condition.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013) See table 4.4	P
4.5	Normal frequency operating range The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in MEA.	The following deviations were used: a) Metropolitan Electricity	P

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Clause	Requirement – Test	Result - Remark	Verdict
		Authority (MEA 2013) See table 4.5 and 5.2.2	
4.6	Harmonics and waveform distortion Low levels of current and voltage harmonics are desirable; the higher harmonic levels increase the potential for adverse effects on connected equipment. Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads/apparatus, and established utility practice. The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in clause 3.1.1 of MEA.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013) See tables 4.6 (1) and 4.6 (2)	P
4.7	Power factor The power factor base on products.		P
SECTION 5: Personnel safety and equipment protection			
5	General This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.	Noticed	P
5.1	Loss of utility voltage 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. 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. If inverters (single or multiple) have DC SELV input and have accumulated power below 1 kW then no mechanical disconnect (relay) is required.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013)	P
5.2	Over/under voltage and frequency Abnormal conditions can arise on the utility	The following deviations were used:	P

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	system that requires a response from the connected photovoltaic system. This response is to ensure the safety of utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system. 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.	a) Metropolitan Electricity Authority (MEA 2013) See table 5.2.1 and 5.2.2	
5.2.1	Over/under voltage 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. All discussions regarding system voltage refer to the local nominal voltage. The system shall sense abnormal voltage and respond. The following conditions should be met, with voltages in RMS and measured at the point of utility connection. (see clause 5.2.1 Table 2 – Response to abnormal voltages) The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping. The unit does not have to cease to energize if the voltage returns to the normal utility continuous operation condition within the specified trip time.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013) See table 5.2.1	P
5.2.2	Over/under frequency 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. When the utility frequency is outside the range of ±1 Hz, the system shall cease to energize the utility line within 0.1 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.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013) See table 5.2.2	P
5.3	Islanding protection The PV system must cease to energize the utility	The following deviations were used:	P

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	line within 0.3 s of loss of utility.	a) Metropolitan Electricity Authority (MEA 2013)	
5.4	Response to utility recovery 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 120 s after the utility service voltage and frequency have recovered to within the specified ranges.	The following deviations were used: a) Metropolitan Electricity Authority (MEA 2013) See table 5.2 (1) and 5.2 (2)	P
5.5	Earthing The utility interface equipment shall be earthed /grounded in accordance with IEC 60364-7-712.	Stated in the manual.	P
5.6	Short circuit protection The photovoltaic system shall have short -circuit protection in accordance with IEC 60364-7-712.	Stated in the manual.	P
5.7	Isolation and switching A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.	Stated in the manual.	P

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Clause	Requirement – Test	Result - Remark	Verdict

Test overview:		
Clause	Test	Result
1	Response to protection operation - fault condition tests (according VDE0126-1-1:2006)	P
4	Type test:	
4.3	Voltage Fluctuations and Flicker	P
4.4	Monitoring of DC-Injection	P
4.5	Normal frequency operating range (see 5.2.2 below)	P
4.6	Harmonics and waveform distortion	P
4.7	Power factor	P
5.2.1	Voltage monitoring	P
5.2.2	Frequency monitoring	P

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Clause	Requirement – Test	Result - Remark	Verdict

1. Response to protection operation - fault condition tests							P
	Ambient temperature (oC) :			24,9 C			—
No.	Component no.	Fault	Test voltage (V)	Test time	Fuse no.	Fuse current (A)	Result
1	PV input	Polarity reverse	820Vdc / 230Vac	10 minutes	/	/	Inverter alarm, No output , no hazard.
2	AC output L-L	S-C	820Vdc / 230Vac	10 minutes	/	/	Breaker is broken, No output, no hazard.
3	AC output L-N	S-C	820Vdc / 230Vac	10 minutes	/	/	Breaker is broken, No output, no hazard.
4	AC output	Phase sequence errors	820Vdc / 230Vac	10 minutes	/	/	Inverter work normally.
5	VCC of main CPU	O-C	820Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
6	VCC of secondary CPU	O-C	820Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
7	Communication of main CPU and secondary CPU	O-C	820Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
8	C1 (I/O board)	S-C	820Vdc / 230Vac	10 minutes	/	/	Inverter disconnected from grid immediately and shut down, No output, no hazard.
9	C16 (I/O board)	S-C	820Vdc / 230Vac	10minutes	/	/	Inverter disconnected from grid immediately and shut down, No output, no hazard.
10	BUS R251 (I/O board)	O-C	820Vdc / 230Vac	10minutes	/	/	Error message: “122”. Inverter disconnected from grid immediately and shut down.
11	D52 (I/O board)	S-C	820Vdc / 230Vac	10minutes	/	/	Inverter work normally.
12	Q6(PIN1-PIN2) (I/O board)	S-C	820Vdc / 230Vac	10minutes	/	/	Inverter work normally.

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13	R325 (I/O board)	O-C	820Vdc / 230Vac	10minutes	/	/	Inverter work normally.
14	RY3A (I/O board)	S-C	820Vdc / 230Vac	10minutes	/	/	Inverter doesn't disconnect with grid.
15	Q1(PIN2-PIN3) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
16	RY9A (I/O board)	O-C	820Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
17	Q28(PIN2-PIN3)(I/O board)	O-C	820Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
18	Q10(PIN2-PIN3) (I/O board)	O-C	820Vdc / 230Vac	2 minutes	/	/	Error message: "101". Inverter disconnected from grid immediately and shut down.
19	Q10(pin1-pin2) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
20	TX5(PIN4- PIN8) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shut down.
21	Q7(PIN2-PIN3) (I/O board)	O-C	820Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
22	C151 (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
23	C152 (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
24	C294 (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
25	C305 (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.

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Clause	Requirement – Test	Result - Remark	Verdict

26	C314 (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
27	C322(I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
28	D60(I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
29	Q40(PIN2-PIN3) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Error message: “101”. Inverter disconnected from grid immediately.
30	Q40(PIN1-PIN2) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately.
31	TX5(PIN4- PIN8) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shut down.
32	TX1(PIN1- PIN3) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
33	Q33(PIN2- PIN3) (I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
34	C335(I/O board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
35	C276 (CTRL board)	S-C	820Vdc / 230Vac	2 minutes	/	/	PVA voltage detection is 0. Inverter disconnected from grid immediately.
36	C168 (CTRL board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Error message: “122”.
37	C261(CTRL board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Leakage current is fault. Inverter disconnected from grid immediately and shut down.

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Clause	Requirement – Test	Result - Remark	Verdict

38	C262(CTRL board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Leakage current is fault. Inverter disconnected from grid immediately and shut down.
39	C151(CTRL board)	S-C	820Vdc / 230Vac	2 minutes	/	/	Error message: “101”. Inverter disconnected from grid immediately and shut down.
40	GFCI power(CTRL board)	O-C	820Vdc / 230Vac	10 minutes	/	/	Error message: “119”. Inverter disconnected from grid immediately.
41	C292 (power board)	S-C	820Vdc / 230Vac	10 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
42	C299 (power board)	S-C	820Vdc / 230Vac	10 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
Supplementary information: S-C=short-circuited, O-C=open-circuited, O-L=overload.							

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Clause	Requirement – Test	Result - Remark	Verdict

4.3 Voltage fluctuation and flicker the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)				P
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-5			
	Starting	Stopping	Running	
Limit	3.3%	3.3%	Pst = 1.0	Plt = 0.65
Test value	*	*	*	*
Inverter > 16A				
Limit	dc% =3.3		Pst = 1.0	Plt = 0.65
Test value	0.06		0.26	0.24

Note:
The stationary deviance of dc% is more relevant than the dynamic deviance of dmax at starting and stopping. Mains Impedance according EN61000-3-11:Rmax = 0.24Ω; jXmax= 0.15Ω @50Hz (|Zmax| = 0.283/0.4717Ω)

Calculation of the maximum permissible grid impedance at the point of common coupling based on dc: Zmax = Zref * 3.3% / dc(Pn)

The tests should be based on the limits of the EN 61000-3-11 for more than 16A.

4.4 Monitoring of Permanent DC-Injection the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)			P
MEA Limit:	0.5% of Inom		
Output power:	33%	66%	100%
As % of rated AC current, L1:	0.055%	0.057%	0.054%
As % of rated AC current, L2:	0.143%	0.134%	0.136%
As % of rated AC current, L3:	0.102%	0.105%	0.108%

Note:
Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

4.6	TABLE: Harmonic Current Limit Test The grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)	P

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Clause	Requirement – Test	Result - Remark	Verdict

	Condition of test				Power(kW)				
	supplying power to balance linear loads 33% ±5%				33.290				P
	supplying power to balance linear loads 66 %±5%				66.656				P
	supplying power to balance linear loads 100 %±5%				99.946				P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	47.683	99.938	96.704	99.945	144.954	99.963	L1	-	P
2	0.072	0.188	0.140	0.181	0.234	0.202	L1	<1%	P
3	0.187	0.491	0.397	0.513	0.561	0.484	L1	<4%	P
4	0.071	0.187	0.153	0.198	0.232	0.200	L1	<1%	P
5	0.482	1.264	1.454	1.880	2.383	2.054	L1	<4%	P
6	0.029	0.075	0.066	0.085	0.104	0.090	L1	<1%	P
7	0.167	0.439	0.849	1.098	1.576	1.359	L1	<4%	P
8	0.043	0.112	0.090	0.116	0.137	0.118	L1	<1%	P
9	0.051	0.134	0.110	0.142	0.157	0.135	L1	<4%	P
10	0.040	0.106	0.097	0.126	0.143	0.123	L1	<1%	P
11	0.129	0.339	0.431	0.557	0.992	0.855	L1	<2%	P
12	0.046	0.121	0.097	0.125	0.151	0.130	L1	<0.5%	P
13	0.134	0.350	0.271	0.350	0.688	0.593	L1	<2%	P
14	0.055	0.143	0.114	0.148	0.193	0.166	L1	<0.5%	P
15	0.064	0.168	0.135	0.174	0.210	0.181	L1	<2%	P
16	0.060	0.158	0.132	0.170	0.195	0.168	L1	<0.5%	P
17	0.151	0.397	0.180	0.233	0.556	0.479	L1	<1.5%	P
18	0.066	0.173	0.135	0.175	0.209	0.180	L1	<0.375%	P
19	0.104	0.272	0.187	0.242	0.430	0.371	L1	<1.5%	P
20	0.076	0.199	0.151	0.195	0.244	0.210	L1	<0.375%	P
21	0.076	0.200	0.157	0.203	0.251	0.216	L1	<1.5%	P
22	0.079	0.207	0.162	0.210	0.248	0.214	L1	<0.375%	P
23	0.119	0.313	0.222	0.287	0.389	0.335	L1	<0.6%	P
24	0.085	0.124	0.176	0.127	0.264	0.128	L1	<0.15%	P
25	0.106	0.279	0.211	0.273	0.327	0.282	L1	<0.6%	P
26	0.093	0.045	0.191	0.047	0.293	0.053	L1	<0.15%	P
27	0.097	0.253	0.199	0.257	0.296	0.255	L1	<0.6%	P
28	0.099	0.060	0.203	0.062	0.309	0.066	L1	<0.15%	P
29	0.119	0.013	0.246	0.038	0.355	0.066	L1	<0.6%	P
30	0.105	0.075	0.215	0.078	0.324	0.079	L1	<0.15%	P
31	0.132	0.346	0.234	0.302	0.342	0.295	L1	<0.6%	P
32	0.114	0.099	0.235	0.094	0.349	0.091	L1	<0.15%	P
33	0.115	0.302	0.238	0.308	0.355	0.306	L1	<0.6%	P
34	0.008	0.022	0.043	0.056	0.013	0.011	L1	<0.15%	P
35	0.023	0.059	0.020	0.026	0.009	0.008	L1	<0.3%	P
36	0.005	0.013	0.015	0.019	0.002	0.002	L1	<0.075%	P
37	0.038	0.100	0.087	0.113	0.010	0.009	L1	<0.3%	P
38	0.014	0.037	0.011	0.014	0.009	0.008	L1	<0.075%	P
39	0.006	0.015	0.015	0.020	0.003	0.003	L1	<0.3%	P
40	0.020	0.053	0.008	0.010	0.007	0.006	L1	<0.075%	P
THDi	---	2.770	---	2.680	---	3.140	L1	≤ 5%	P
Supplementary information:									

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Clause	Requirement – Test	Result - Remark	Verdict

4.6	TABLE: Harmonic Current Limit Test The grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)								P
	Condition of test						Power (kW)		
	supplying power to balance linear loads 33% ±5%						33.290		P
	supplying power to balance linear loads 66 %±5%						66.656		P
	supplying power to balance linear loads 100 %±5%						99.946		P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	48.113	99.923	96.000	99.945	145.013	99.969	L2		P
2	0.376	0.985	0.690	0.892	1.150	0.991	L2	<1%	P
3	0.165	0.433	0.326	0.421	0.757	0.653	L2	<4%	P
4	0.049	0.128	0.132	0.171	0.252	0.217	L2	<1%	P
5	0.799	2.095	1.338	1.730	3.234	2.788	L2	<4%	P
6	0.018	0.046	0.071	0.092	0.125	0.108	L2	<1%	P
7	0.478	1.254	0.923	1.193	1.830	1.578	L2	<4%	P
8	0.017	0.045	0.042	0.054	0.071	0.061	L2	<1%	P
9	0.043	0.114	0.097	0.126	0.187	0.161	L2	<4%	P
10	0.035	0.091	0.053	0.069	0.179	0.154	L2	<1%	P
11	0.293	0.767	0.399	0.516	1.348	1.162	L2	<2%	P
12	0.014	0.038	0.024	0.031	0.060	0.052	L2	<0.5%	P
13	0.233	0.610	0.380	0.491	0.796	0.686	L2	<2%	P
14	0.035	0.093	0.061	0.079	0.152	0.131	L2	<0.5%	P
15	0.098	0.256	0.217	0.280	0.168	0.145	L2	<2%	P
16	0.075	0.197	0.105	0.136	0.387	0.334	L2	<0.5%	P
17	0.278	0.729	0.552	0.713	0.536	0.462	L2	<1.5%	P
18	0.019	0.050	0.036	0.047	0.065	0.056	L2	<0.375%	P
19	0.137	0.358	0.331	0.428	0.495	0.427	L2	<1.5%	P
20	0.030	0.079	0.050	0.065	0.184	0.159	L2	<0.375%	P
21	0.032	0.085	0.071	0.092	0.166	0.143	L2	<1.5%	P
22	0.025	0.065	0.030	0.039	0.052	0.045	L2	<0.375%	P
23	0.077	0.201	0.108	0.140	0.510	0.440	L2	<0.6%	P
24	0.005	0.012	0.015	0.020	0.051	0.044	L2	<0.15%	P
25	0.044	0.115	0.040	0.052	0.316	0.272	L2	<0.6%	P
26	0.010	0.027	0.008	0.010	0.063	0.054	L2	<0.15%	P
27	0.006	0.017	0.013	0.017	0.029	0.025	L2	<0.6%	P
28	0.004	0.010	0.004	0.005	0.030	0.026	L2	<0.15%	P
29	0.018	0.046	0.019	0.024	0.148	0.128	L2	<0.6%	P
30	0.004	0.010	0.003	0.004	0.023	0.020	L2	<0.15%	P
31	0.027	0.071	0.023	0.030	0.153	0.132	L2	<0.6%	P
32	0.007	0.019	0.010	0.013	0.041	0.035	L2	<0.15%	P
33	0.003	0.007	0.002	0.003	0.023	0.020	L2	<0.6%	P
34	0.003	0.008	0.004	0.005	0.026	0.022	L2	<0.15%	P
35	0.007	0.018	0.003	0.004	0.068	0.059	L2	<0.3%	P
36	0.003	0.009	0.005	0.006	0.015	0.013	L2	<0.075%	P
37	0.020	0.052	0.008	0.010	0.116	0.100	L2	<0.3%	P
38	0.006	0.016	0.002	0.003	0.043	0.037	L2	<0.075%	P
39	0.006	0.015	0.009	0.011	0.017	0.015	L2	<0.3%	P
40	0.008	0.022	0.003	0.004	0.061	0.053	L2	<0.075%	P

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

THDi	---	2.204	---	1.982	---	2.643	L2	≤ 5%	P
Supplementary information:									

4.6	TABLE: Harmonic Current Limit Test The grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)								P
	Condition of test					Power(kW)			
	supplying power to balance linear loads 33% ±5%					33.290			P
	supplying power to balance linear loads 66 %±5%					66.656			P
	supplying power to balance linear loads 100 %±5%					99.946			P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	48.075	99.946	97.144	99.965	145.000	99.973	L3		P
2	0.087	0.227	0.184	0.238	0.295	0.254	L3	<1%	P
3	0.140	0.367	0.323	0.417	0.469	0.404	L3	<4%	P
4	0.074	0.195	0.151	0.195	0.227	0.196	L3	<1%	P
5	0.468	1.228	1.386	1.792	2.275	1.961	L3	<4%	P
6	0.028	0.074	0.060	0.078	0.101	0.087	L3	<1%	P
7	0.202	0.529	0.948	1.226	1.724	1.486	L3	<4%	P
8	0.041	0.108	0.087	0.113	0.133	0.115	L3	<1%	P
9	0.055	0.144	0.142	0.184	0.187	0.161	L3	<4%	P
10	0.041	0.107	0.104	0.134	0.146	0.126	L3	<1%	P
11	0.120	0.315	0.406	0.525	0.920	0.793	L3	<2%	P
12	0.046	0.121	0.098	0.127	0.150	0.129	L3	<0.5%	P
13	0.150	0.393	0.306	0.396	0.781	0.673	L3	<2%	P
14	0.054	0.141	0.112	0.145	0.187	0.161	L3	<0.5%	P
15	0.071	0.187	0.134	0.173	0.217	0.187	L3	<2%	P
16	0.061	0.161	0.134	0.173	0.200	0.172	L3	<0.5%	P
17	0.132	0.346	0.191	0.247	0.516	0.445	L3	<1.5%	P
18	0.066	0.174	0.136	0.176	0.205	0.177	L3	<0.375%	P
19	0.122	0.321	0.183	0.236	0.495	0.427	L3	<1.5%	P
20	0.076	0.199	0.151	0.195	0.239	0.206	L3	<0.375%	P
21	0.093	0.244	0.157	0.203	0.261	0.225	L3	<1.5%	P
22	0.080	0.209	0.163	0.211	0.247	0.213	L3	<0.375%	P
23	0.109	0.287	0.207	0.267	0.378	0.326	L3	<0.6%	P
24	0.085	0.124	0.175	0.126	0.266	0.129	L3	<0.15%	P
25	0.109	0.286	0.227	0.294	0.358	0.309	L3	<0.6%	P
26	0.093	0.144	0.190	0.145	0.287	0.147	L3	<0.15%	P
27	0.097	0.254	0.207	0.267	0.302	0.26	L3	<0.6%	P
28	0.099	0.066	0.203	0.062	0.310	0.067	L3	<0.15%	P
29	0.115	0.302	0.227	0.294	0.345	0.297	L3	<0.6%	P
30	0.105	0.076	0.217	0.078	0.322	0.078	L3	<0.15%	P
31	0.132	0.347	0.248	0.321	0.353	0.304	L3	<0.6%	P
32	0.113	0.097	0.233	0.101	0.345	0.097	L3	<0.15%	P
33	0.126	0.329	0.251	0.324	0.357	0.308	L3	<0.6%	P
34	0.006	0.016	0.026	0.034	0.014	0.012	L3	<0.15%	P
35	0.026	0.067	0.029	0.038	0.006	0.005	L3	<0.3%	P
36	0.004	0.01	0.018	0.023	0.008	0.007	L3	<0.075%	P

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

37	0.036	0.095	0.012	0.015	0.008	0.007	L3	<0.3%	P
38	0.013	0.034	0.070	0.091	0.005	0.004	L3	<0.075%	P
39	0.008	0.021	0.009	0.012	0.003	0.003	L3	<0.3%	P
40	0.021	0.055	0.010	0.013	0.003	0.003	L3	<0.075%	P
THDi	---	2.15	---	2.76	---	3.14	L3	≤ 5%	P
Supplementary information:									

4.7 Power Factor the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)			P
Load (%)	Location	Measured	Limit
10	L1(230Vac)	0.9916	N/A
	L2(230Vac)	0.9931	
	L3(230Vac)	0.9944	
50	L1(230Vac)	0.9968	>0.90
	L2(230Vac)	0.9975	>0.90
	L3(230Vac)	0.9987	>0.90
100	L1(230Vac)	0.9990	>0.90
	L2(230Vac)	0.9995	>0.90
	L3(230Vac)	0.9998	>0.90
Note: The PV system shall have a lagging power factor greater than 0.95 when the output is greater than 50% of the rated inverter output power.			

5.2.1 Voltage monitoring 1.8.4.7 Under and Over Voltage Protection(MEA: 2013) 1.11.4.10 Response to utility recovery the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2013)										P
First Level										
Test conditions:	Output power: 37.25kW Frequency: 50 Hz									
	Under Voltage					Over Voltage				
Parameter	/	Voltage (V)				/	Voltage (V)			
Set Value	/	199V				/	241V			
Measured trip value(V)	Phase	ALL	L1	L2	L3	Phase	ALL	L1	L2	L3
	/	198.7	198.4	198.8	198.7	/	240.6	241.2	240.2	240.7
		198.6	198.5	198.7	198.4		241.0	240.8	241.0	240.6

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

		198.5	198.7	198.6	198.5		241.2	240.8	241.0	240.7
		198.4	198.6	198.5	198.7		240.8	240.6	241.0	240.4
	/	198.6	198.5	198.7	198.6	/	240.6	241.2	240.2	240.7
Parameter	/	Time(s)				/	Time(s)			
Limit	/	⩽2.0s				/	⩽2.0s			
Disconnection time (Sec)	204V to 198V	All	L1	L2	L3	236V to 242V	All	L1	L2	L3
		1.804	1.810	1.802	1.808		1.798	1.790	1.810	1.798
		1.798	1.810	1.796	1.806		1.800	1.810	1.812	1.800
		1.806	1.796	1.812	1.798		1.804	1.812	1.810	1.804
		1.804	1.815	1.808	1.810		1.802	1.810	1.814	1.802
		1.798	1.804	1.812	1.804		1.800	1.810	1.812	1.802
Reconnection time (Sec)	At least 120s	225s				At least 120s	224s			
Second Level										
Test conditions:	Output power: 39.38kW Frequency: 50 Hz									
	Under Voltage					Over Voltage				
Parameter	/	Voltage (V)				/	Voltage (V)			
Set Value	/	114V				/	311V			
Measured trip value(V)	Phase	All	L1	L2	L3	Phase	All	L1	L2	L3
	/	114.3	114.6	114.2	114.4	/	309.9	309.8	309.8	309.9
		114.5	114.4	114.2	114.6		309.6	309.8	309.4	309.5
		114.7	114.3	114.4	114.2		309.5	309.7	309.3	309.7
		114.3	114.5	114.6	114.2		309.4	309.5	309.5	309.7
	/	114.7	114.7	114.6	114.2	/	309.7	309.9	309.8	309.7
Parameter	/	Time(ms)				/	Time(ms)			
Limit	/	⩽100ms				/	⩽50ms			
Disconnection time (mSec)	204V to 113V	All	L1	L2	L3	236V to 311V	All	L1	L2	L3
		65	73	63	72		29	38	40	32
		72	68	75	65		33	35	41	41
		73.5	82	56	76		36	42	42	32
		65	68	73	74		34	43	29	32
		70	66	71	66		42	44.5	42	43
Reconnection	At least	224s				At least	221s			

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

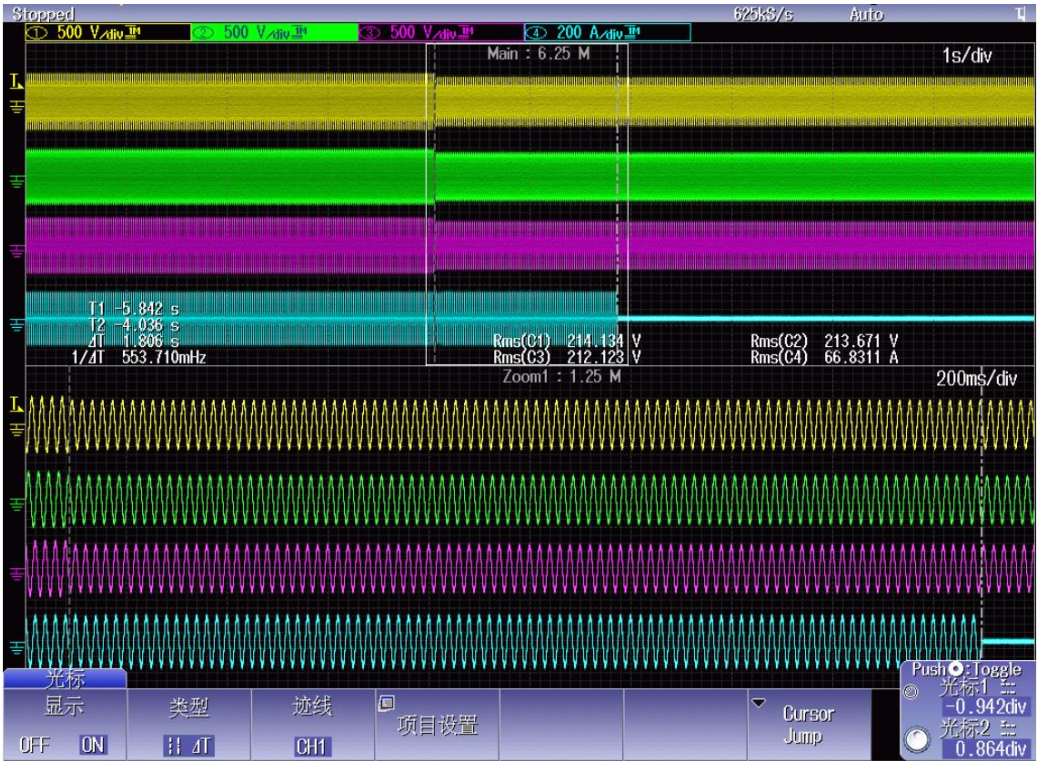
time (Sec)	120s		120s	

Note:

The tests are according MEA: 2013. The voltage setting of EUT are set for the tests as stated to 199V, 114V for undervoltage and 241V, 311V for overvoltage.

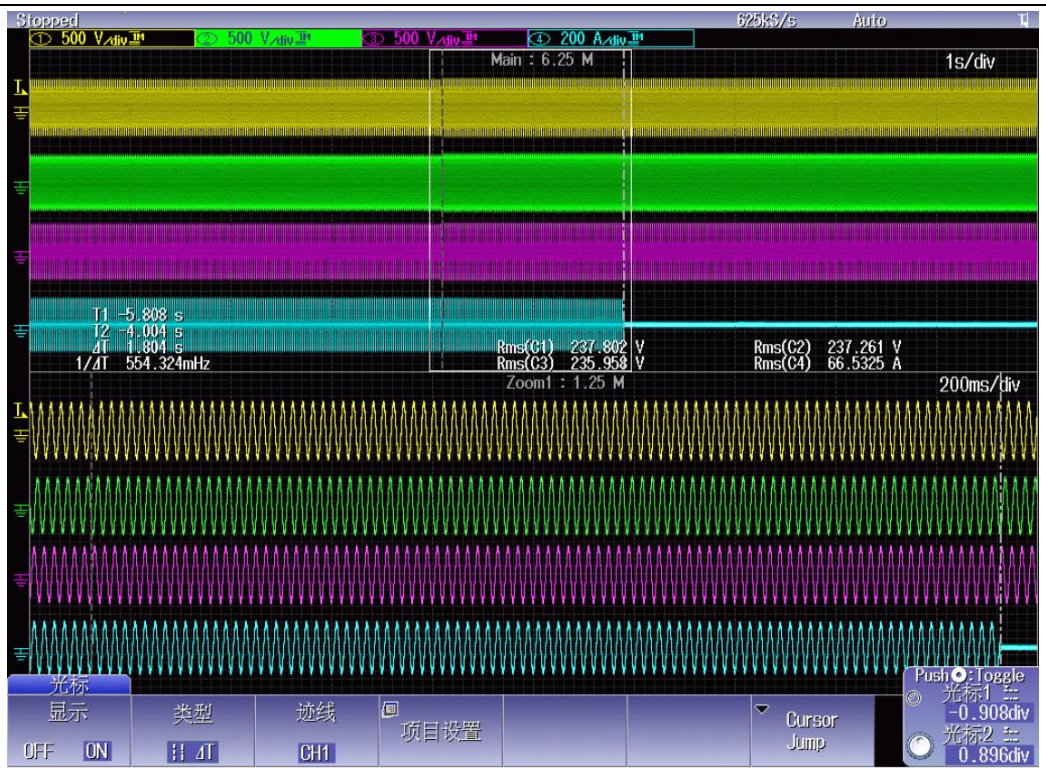
Response to utility recovery is according to the appropriate IEEE or IEC standard test methods.

Under Voltage First Level (All Phase)

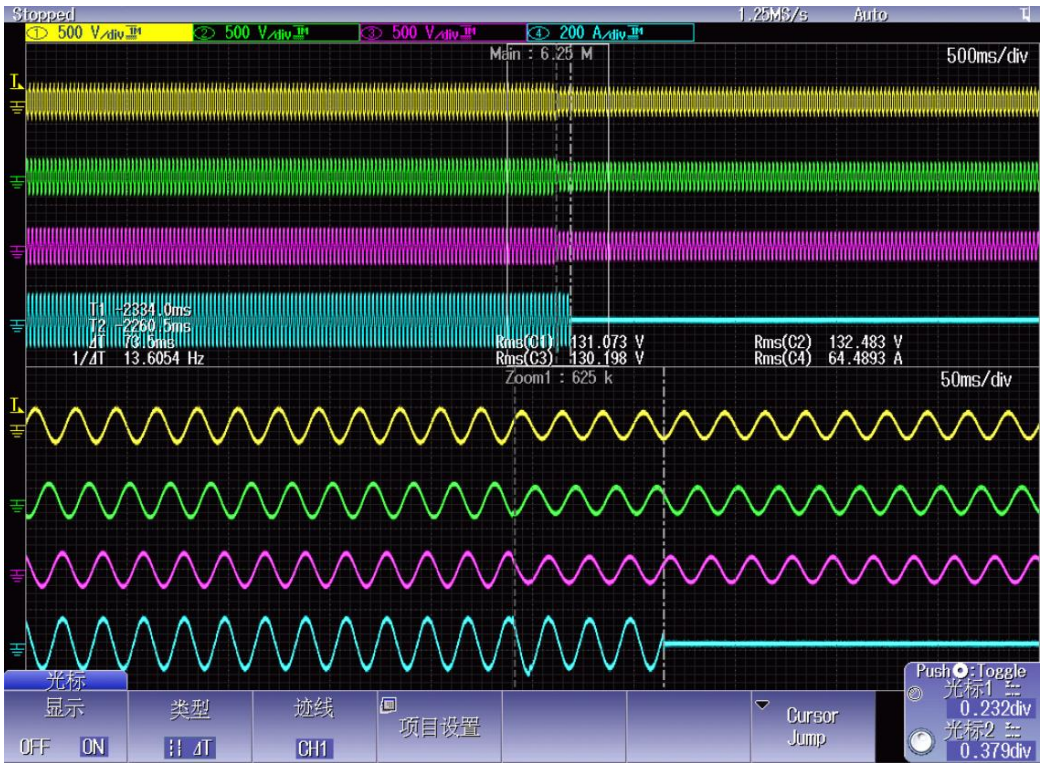


Over Voltage First Level (All Phase)

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

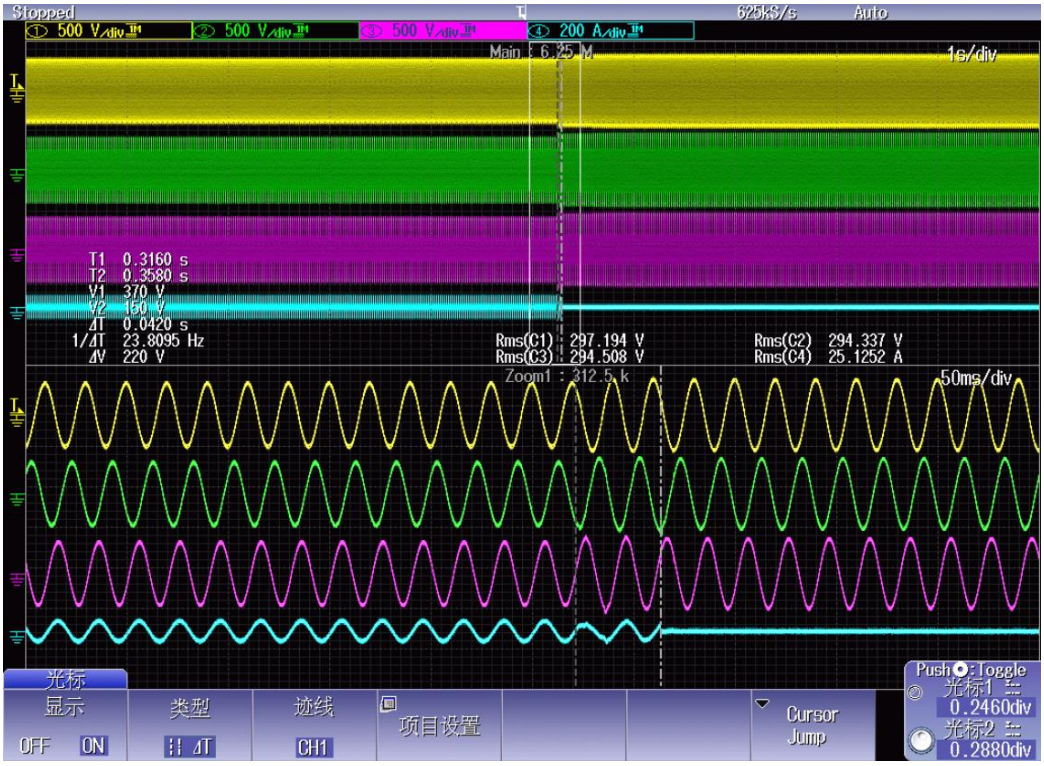


Under Voltage Second Level (All Phase)

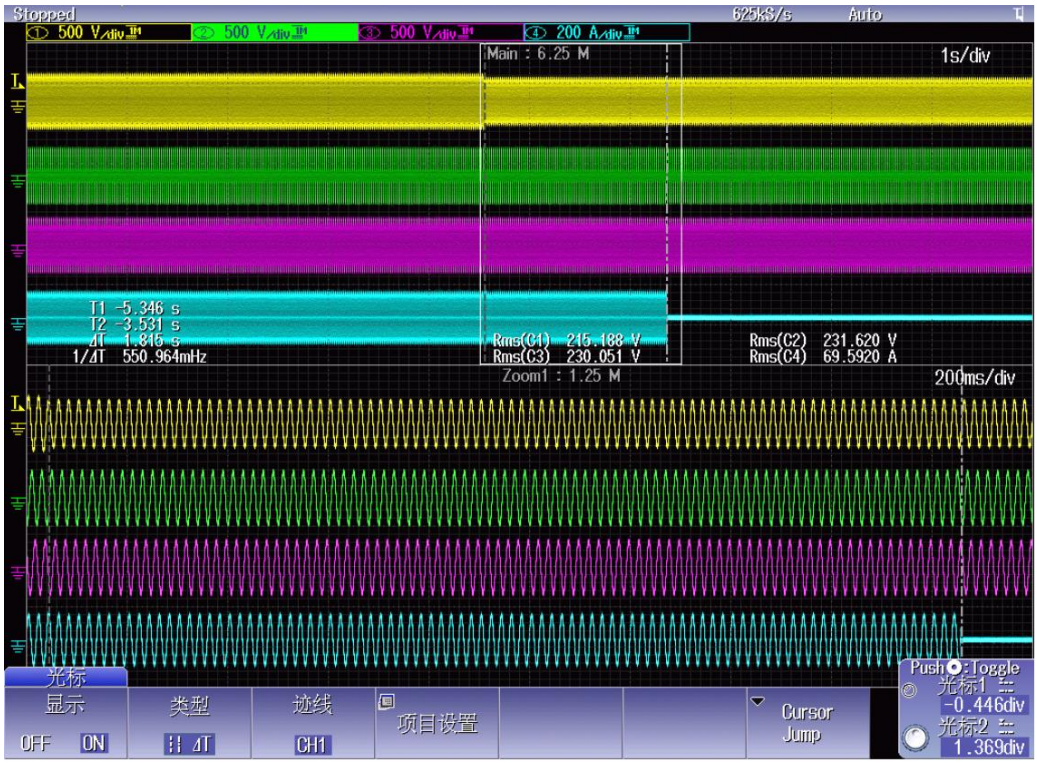


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage Second Level (All Phase)

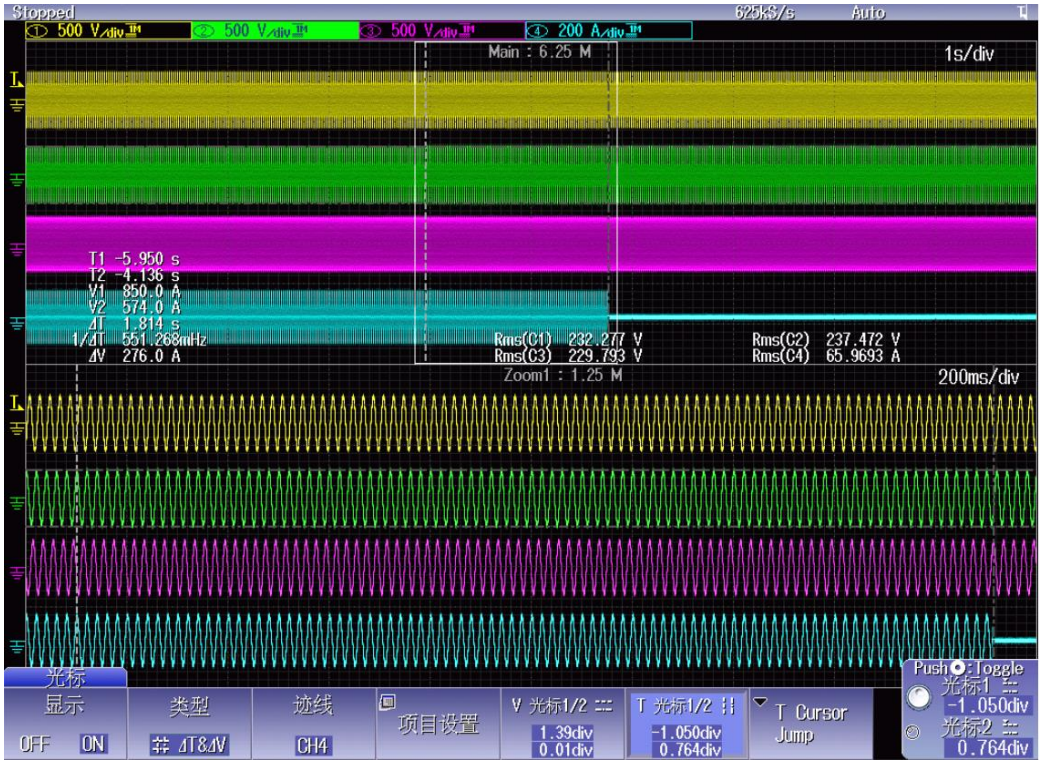


Under Voltage First Level (Each Phase)

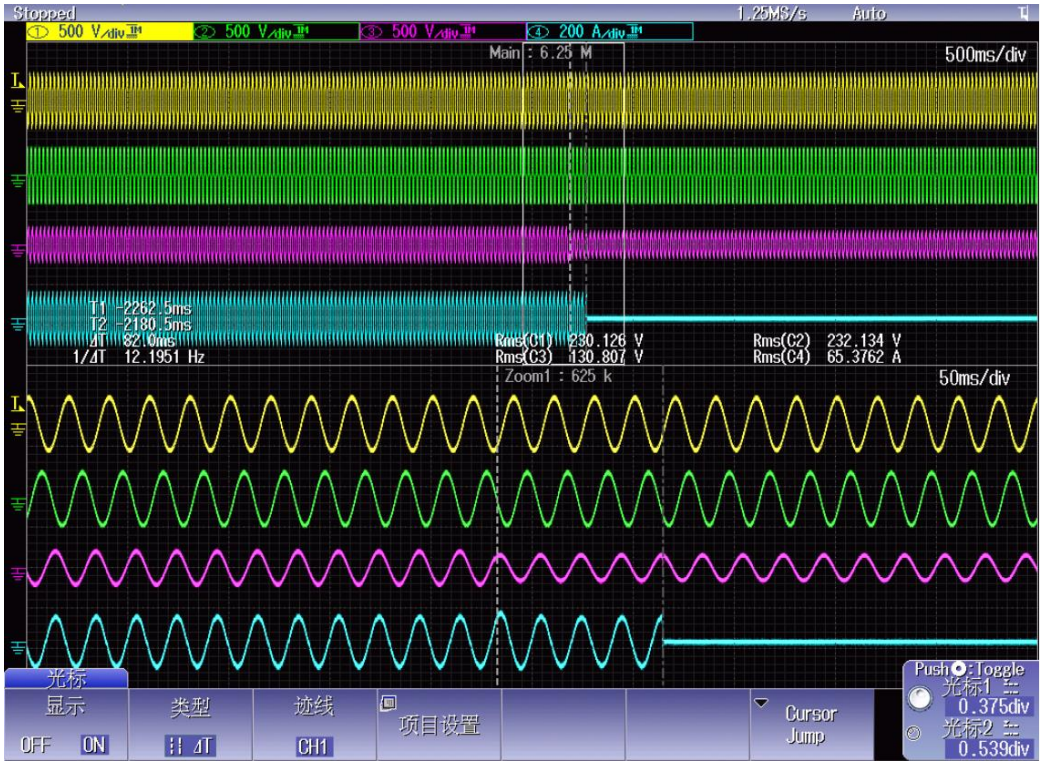


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage First Level (Each Phase)

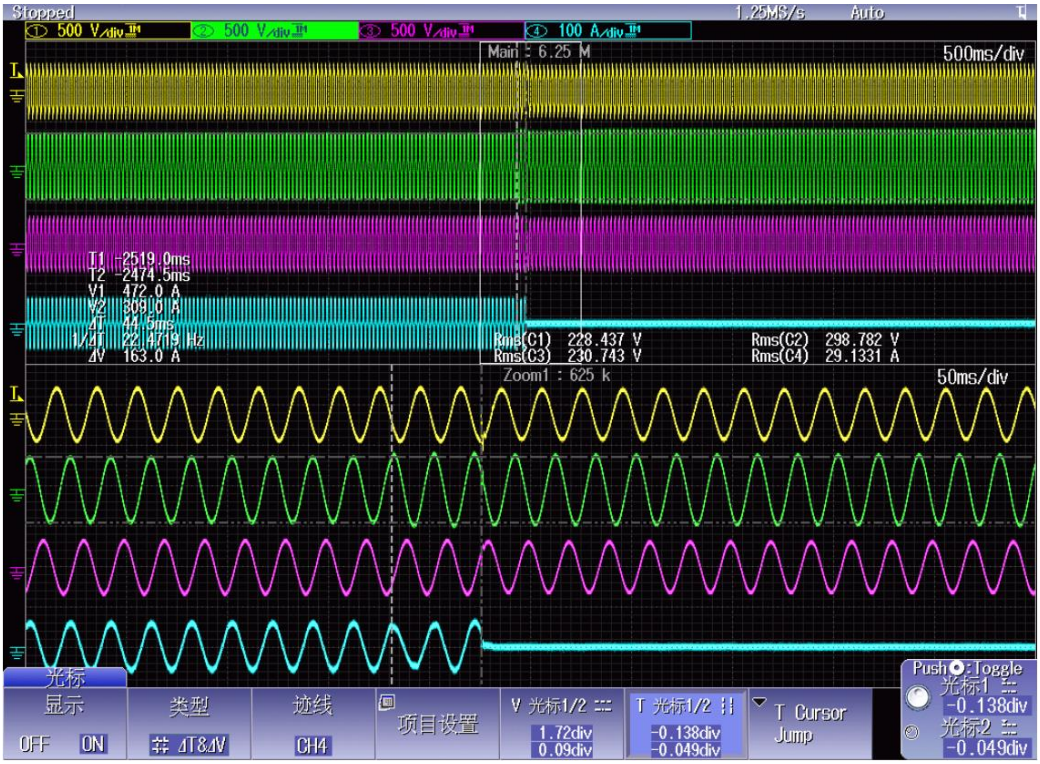


Under Voltage Second Level (Each Phase)

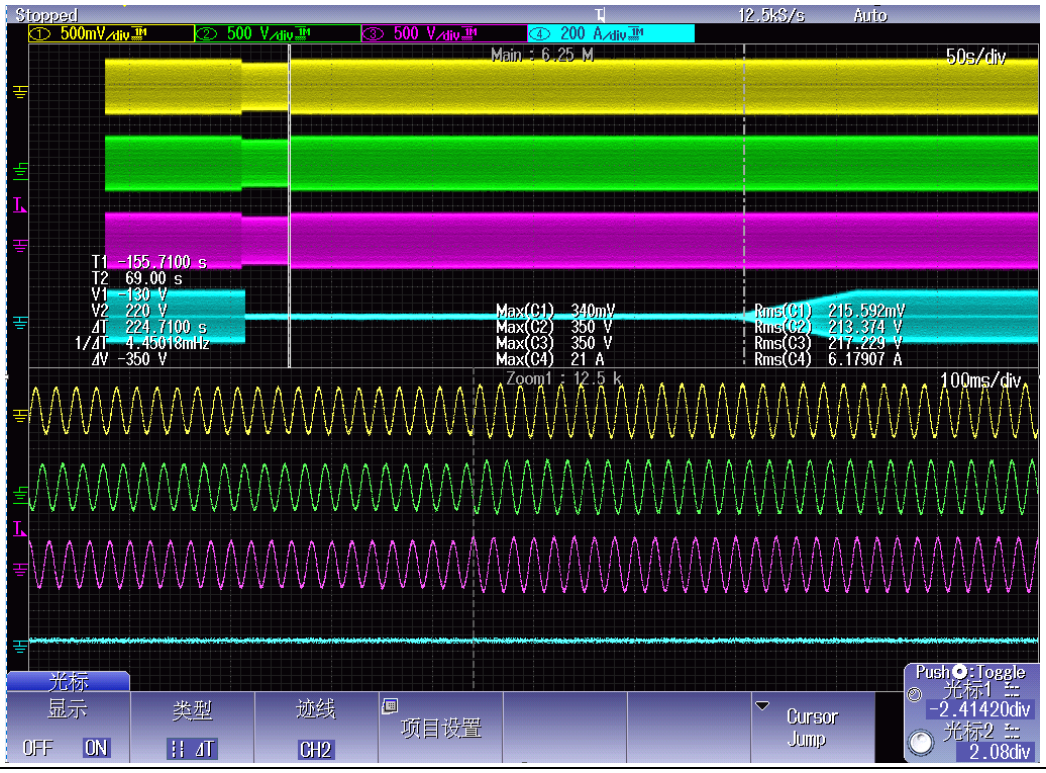


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage Second Level (Each Phase)

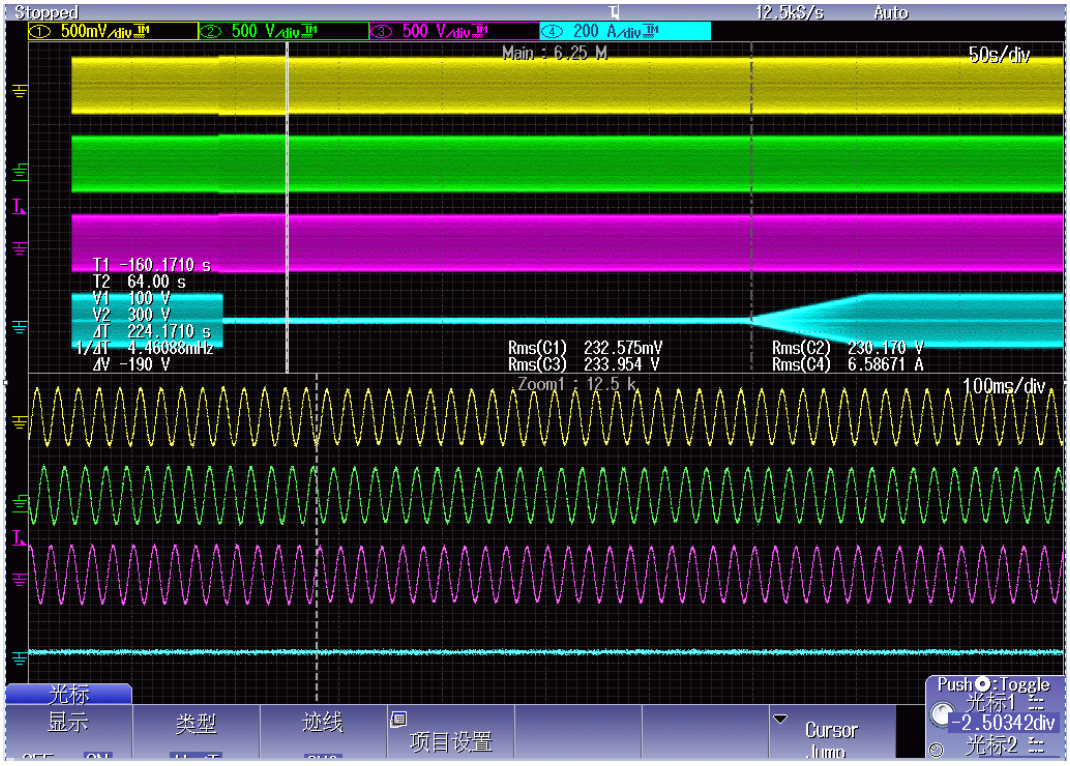


Reconnection after Under Voltage First Level

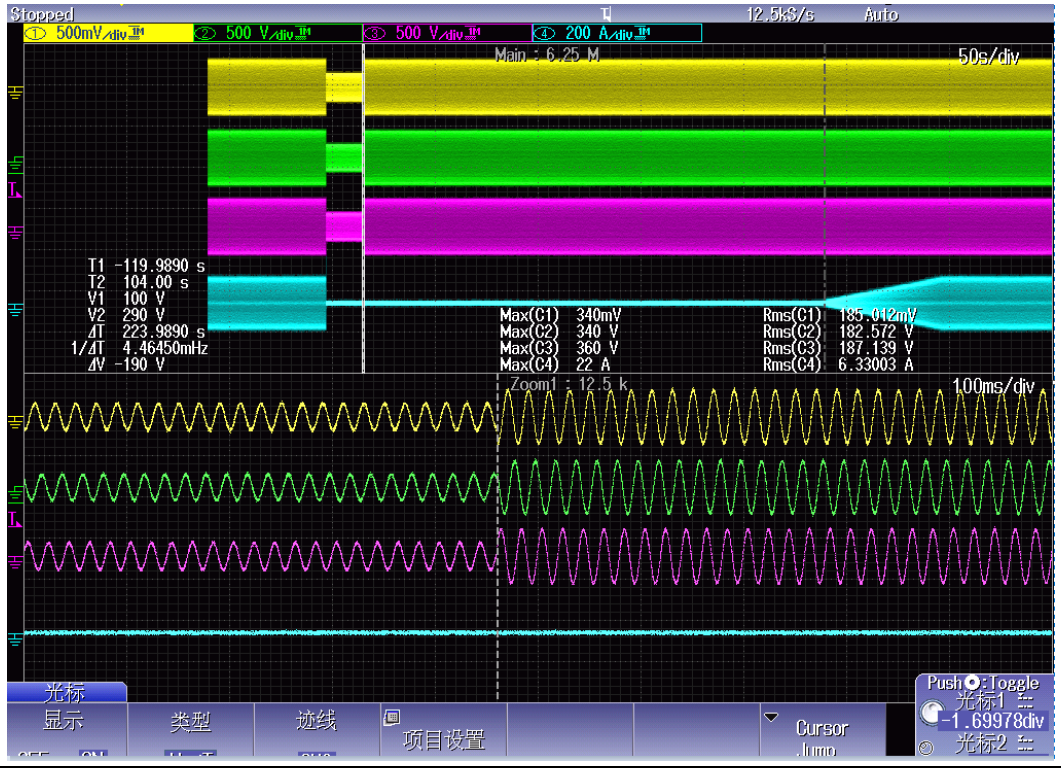


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Reconnection after Over Voltage First Level

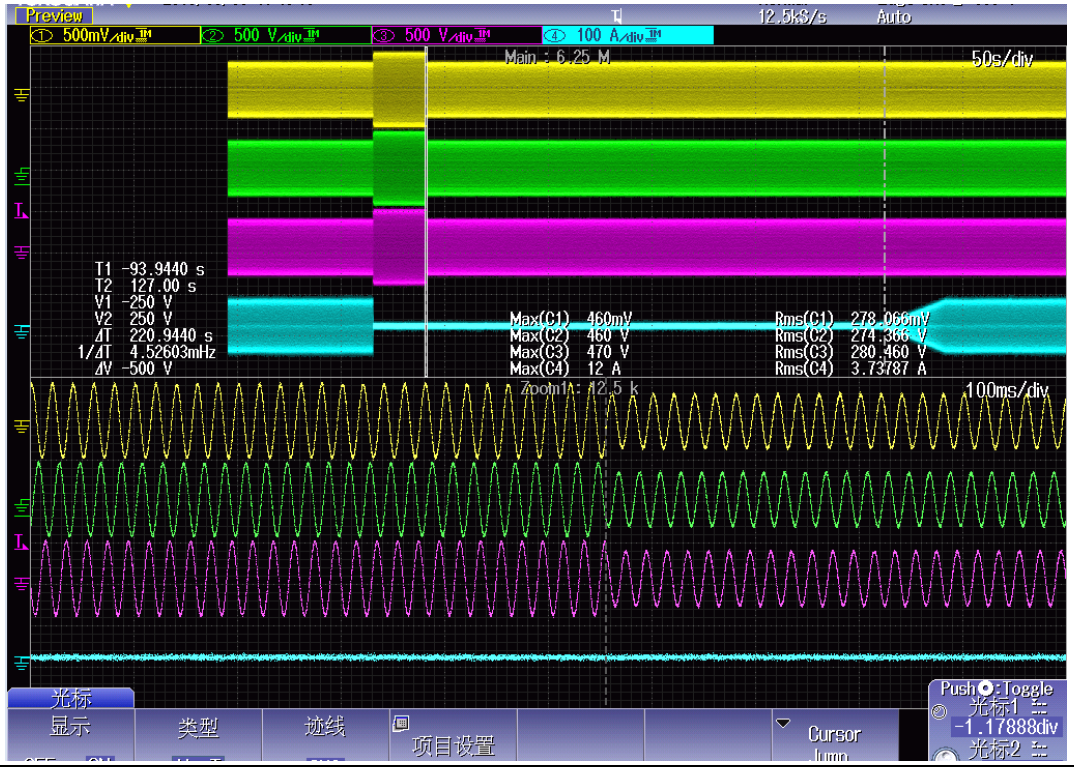


Reconnection after Under Voltage Second Level



IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Reconnection after Over Voltage Second Level



Note:

CH1, CH2, CH3: Grid voltage; CH4, CH5, CH6: EUT of current

5.2.2 Frequency monitoring					P
Test conditions:	Any output power level				
	Under Frequency		Over Frequency		
Parameter		Frequency(Hz)		Frequency(Hz)	
Output Voltage		Un		Un	
Set value		46.92		52.07	
Measured trip value		46.92		52.08	
		46.92		52.08	
		46.92		52.08	
		46.92		52.08	
		46.92		52.08	
		46.92		52.08	

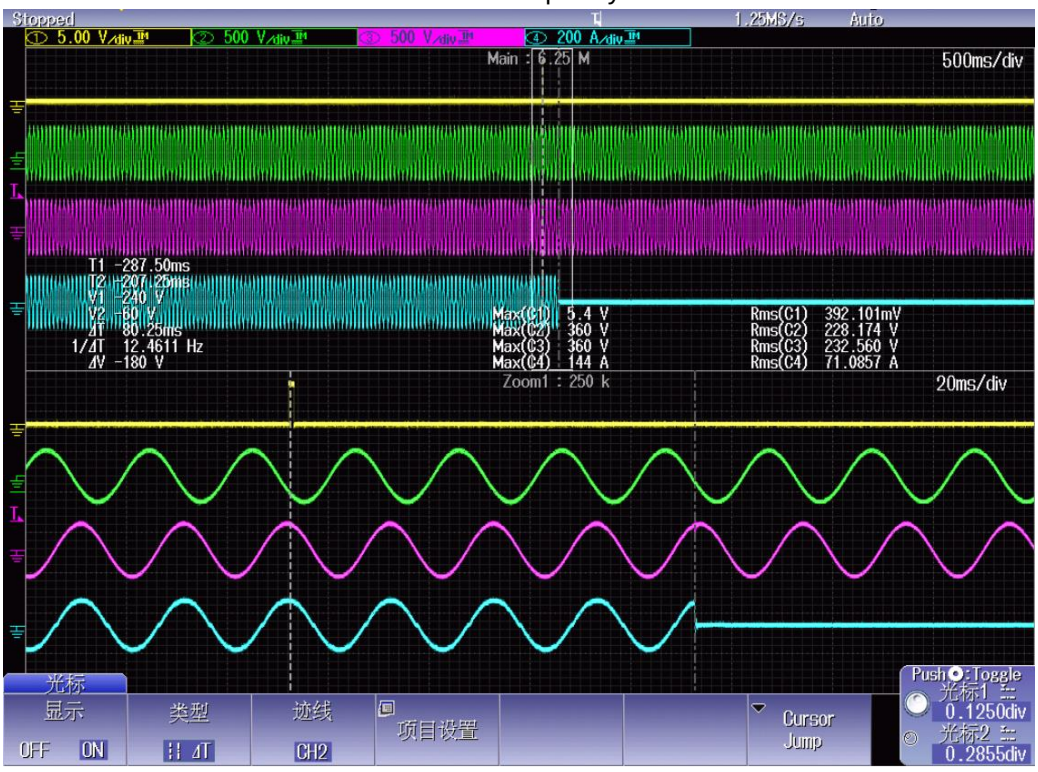
IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Parameter		Time [ms]		Time [ms]
Limit		<= 100ms		<= 100ms
Disconnection time	49.40Hz to 48.80Hz	76.0	50.60 Hz to 51.20 Hz	76.3
		76.0		74.2
		76.2		80.5
		68.4		89.5
		70.2		76.2
		80.3		78.3
Reconnection time(Sec)	at least 120s	226.3s	at least 120s	225.3s

Note:
Set all other parameter to the normal operating conditions for inverter.
Suddenly increase testing voltage to over frequency trip setting -/+0.1 Hz and maintain this value until the inverter stop energize. All the time it takes to cut off the power must be within 0.1s.

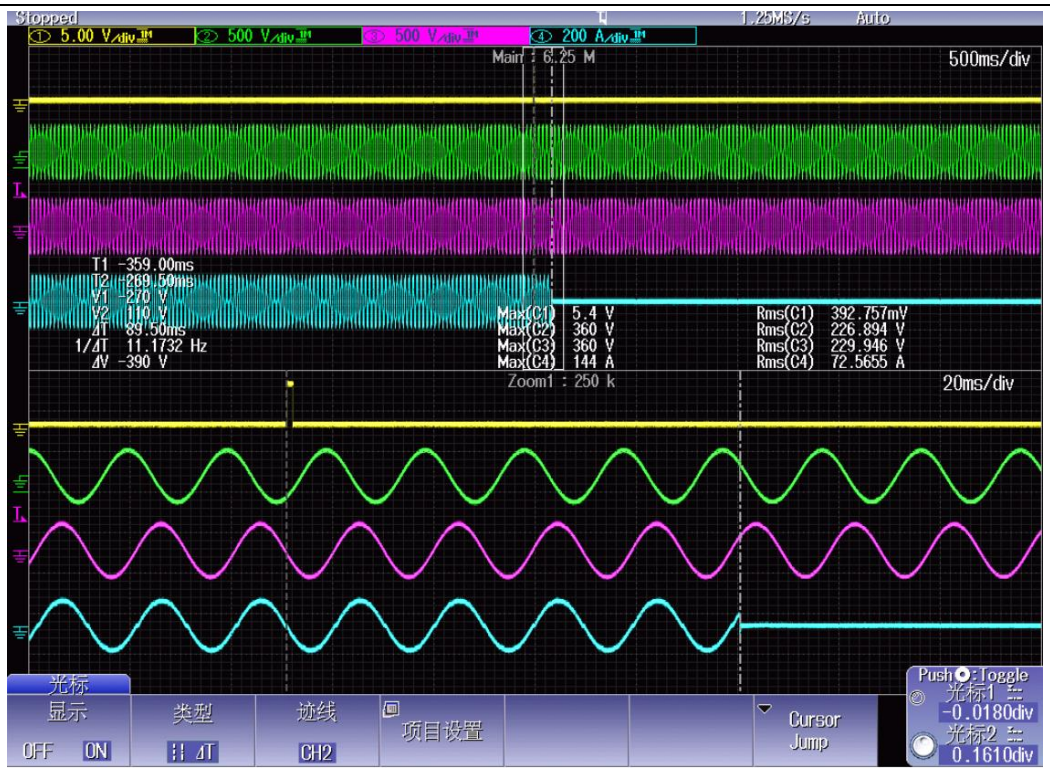
Response to Utility Recovery Test:
The test methods shall be in accordance with IEEE 1547.1-2005 clause 5.10 and evaluation criteria refer to clause 3.2.4 in this regulation.

Under Frequency

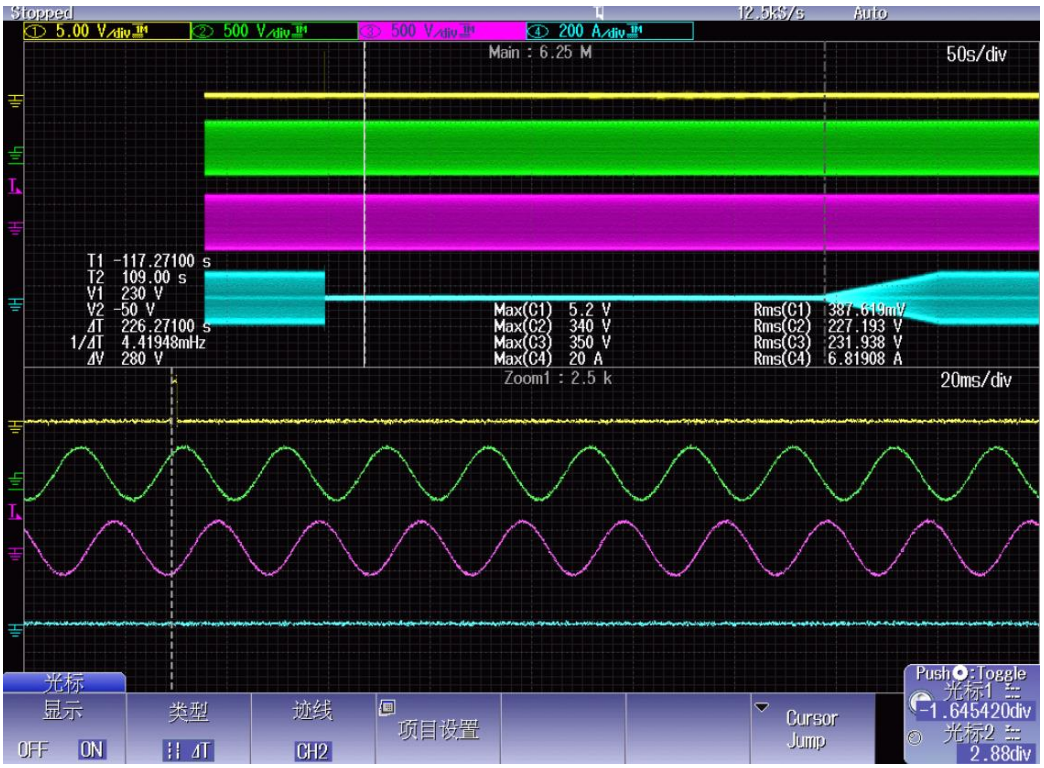


Over Frequency

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

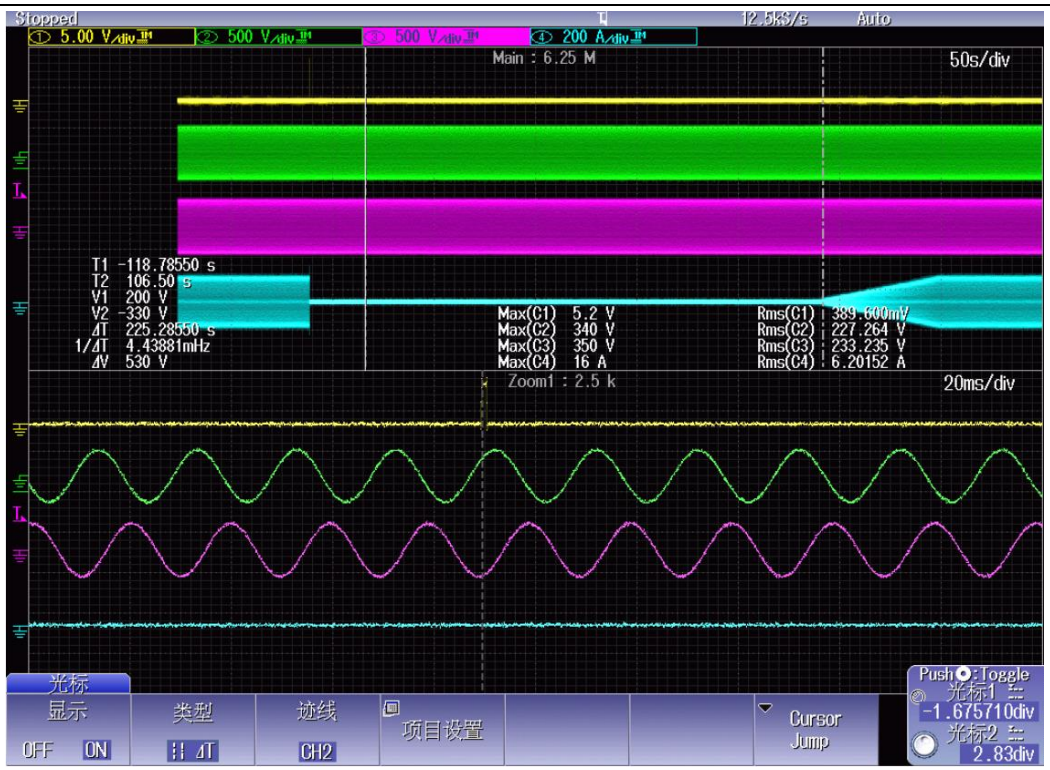


Reconnection after Under Frequency:



Reconnection after Over Frequency

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict



Note:

Yellow, Purple, Red for L1. L2, L3 Voltage; Green, Turquoise, Brown for L1. L2, L3 Current; Blue for Trigger signal.

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

Clause	Test	Result
	Type test:	
6.1	Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)	P
6.1	Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)	P
6.1	Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	P

6.1	TABLE: Islanding protection (EUT output = 100%)								P
Test conditions			Frequency: 50+/-0.1Hz UN=220+/-3Vac Distortion factor of chokes < 2% Quality =1						
Disconnection limit			2s for MEA						
No	1) PEUT (% of EUT rating)	Reactive load (% of QL in 6.1.d) 1)	2) PAC (% of nominal)	3) QAC (% of nominal)	Run on Time (ms)	PEUT (kW per phase)	Actual Qf	V (V)	Remarks4)
1	100	100	0	0	311	33.193	0.997	748	Test A at BL
2	100	100	-5	-5	252	33.193	1.023	748	Test A at IB
3	100	100	-5	0	254	33.193	1.049	748	Test A at IB
4	100	100	-5	+5	180	33.193	1.075	748	Test A at IB
5	100	100	0	-5	224	33.193	0.971	748	Test A at IB
6	100	100	0	+5	176	33.193	1.021	748	Test A at IB
7	100	100	+5	-5	266	33.193	0.925	748	Test A at IB
8	100	100	+5	0	262	33.193	0.949	748	Test A at IB
9	100	100	+5	+5	194	33.193	0.973	748	Test A at IB
Parameter at 0% per phase			L= 18.07 mH		R= 6.39Ω		C= 603.00 µF		
IAC fundamental current at balance condition			L1:103 mA		L2: 146 mA		L3: 368 mA		

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) PEUT: EUT output power

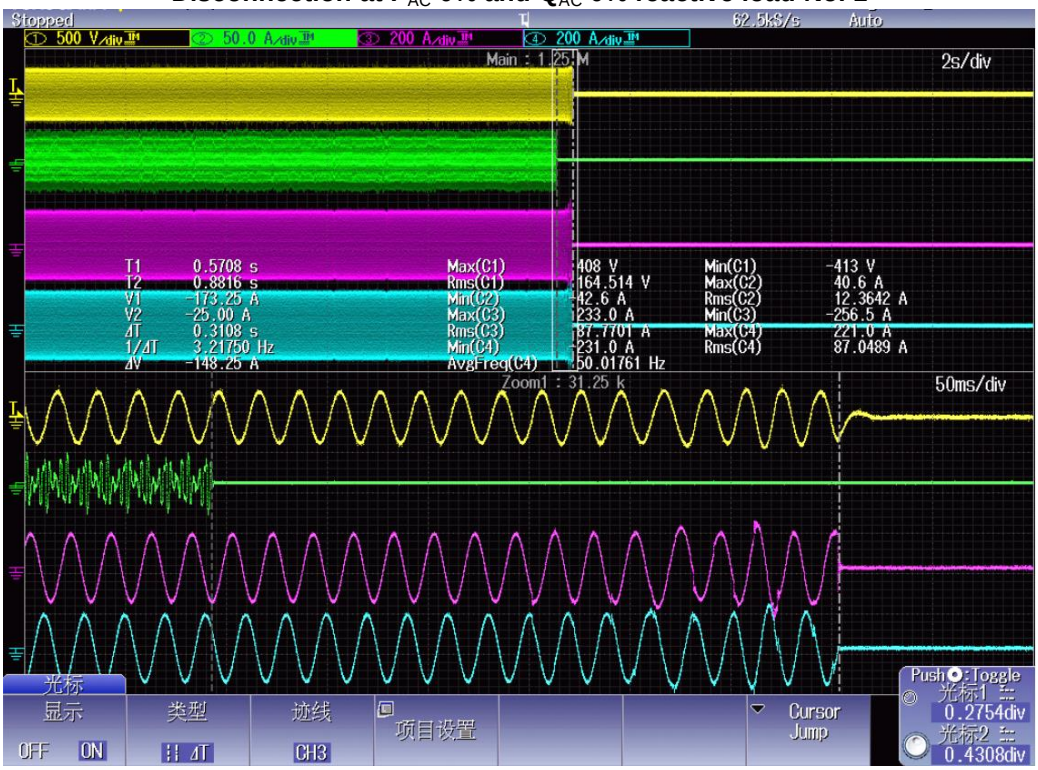
2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

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

Condition A:
EUT output power PEUT = Maximum5)
EUT input voltage 6) = 100% of rated input voltage range

5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0.9 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load No. 1



Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

Note:
CH1. CH2. CH3: L1. L2. L3 current of EUT(8A/div); CH4. CH5. CH6: L1. L2. L3 I_{AC}(2A/div).

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

6.1	TABLE: **Islanding protection (EUT output = 66%)**	**P**

Test conditions	Frequency: 50+/-0.1Hz UN=220+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	2s for MEA

No	1) PEUT (% of EUT rating)	Reactive load (% of QL in 6.1.d) 1)	2) PAC (% of nominal)	3) QAC (% of nominal)	Run on Time (ms)	PEUT (kW per phase)	Actual Qf	V (V)	Remarks4)
1	66	66	0	-5	217	22.091	0.977	640	Test B at IB
2	66	66	0	-4	210	22.091	0.982	640	Test B at IB
3	66	66	0	-3	205	22.091	0.987	640	Test B at IB
4	66	66	0	-2	204	22.091	0.992	640	Test B at IB
5	66	66	0	-1	204	22.091	0.997	640	Test B at IB
6	66	66	0	0	213	22.091	1.002	640	Test B at BL
7	66	66	0	1	212	22.091	1.007	640	Test B at IB
8	66	66	0	2	192	22.091	1.012	640	Test B at IB
9	66	66	0	3	209	22.091	1.017	640	Test B at IB
10	66	66	0	4	196	22.091	1.022	640	Test B at IB
11	66	66	0	5	203	22.091	1.027	640	Test B at IB

Parameter at 0% per phase	L= 80.30 mH	R= 25.30 Ω	C= 126.00 µF
IAC fundamental current at balance condition	L1: 18 mA	L2: 41 mA	L3: 47 mA

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) PEUT: EUT output power

2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) BL: Balance condition, IB: Imbalance condition.
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = 66% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0.9 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

Disconnection at P_{AC} 0% and Q_{AC} -5% reactive load No. 1

Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

Note:
CH1. CH2. CH3: L1. L2. L3 current of EUT(8A/div); CH4. CH5. CH6: L1. L2. L3 I_{AC}(0.8A/div).

6.1	TABLE: **Islanding protection (EUT output = 33%)**	**P**
Test conditions	Frequency: 50+/-0.1Hz UN=220+/-3Vac Distortion factor of chokes < 2% Quality =1	
Disconnection limit	2s for MEA	

No	1) PEUT (% of EUT rating)	Reactive load (% of QL in 6.1.d) 1)	2) PAC (% of nominal)	3) QAC (% of nominal)	Run on Time (ms)	PEUT (kW per phase)	Actual Qf	V (V)	Remarks4)
1	33	33	0	-5	236	10.994	0.971	485	Test C at IB
2	33	33	0	-4	222	10.994	0.986	485	Test C at IB
3	33	33	0	-3	224	10.994	0.986	485	Test C at IB
4	33	33	0	-2	220	10.994	0.991	485	Test C at IB
5	33	33	0	-1	222	10.994	0.996	485	Test C at IB
6	33	33	0	0	237	10.994	1.001	485	Test C at BL

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

7	33	33	0	1	216	10.994	1.006	485	Test C at IB
8	33	33	0	2	194	10.994	1.011	485	Test C at IB
9	33	33	0	3	174	10.994	1.016	485	Test C at IB
10	33	33	0	4	182	10.994	1.021	485	Test C at IB
11	33	33	0	5	190	10.994	1.026	485	Test C at IB

Parameter at 0% per phase	L= 52.17 mH	R= 16.76 Ω	C= 201.54 μF
IAC fundamental current at balance condition	L1: 82mA	L2: 96mA	L3: 147mA

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) PEUT: EUT output power
2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) BL: Balance condition, IB: Imbalance condition.

Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = 33% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0.9 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load No. 6

Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

Note:
CH1. CH2. CH3: L1. L2. L3 current of EUT(2A/div); CH4. CH5. CH6: L1. L2. L3 I_{AC}(0.8A/div).

Pictures

Equipment of test

Equipment name	Trade name	Model	S/N	Cal. Due. Date
Power Analyzer	YOKOGAVA	WT3000	EP-011	2020/09/23
Programmable DC	GROWATT	DC1000	RD.02.100	--
Programmable AC	GROWATT	AC1000	RD.02.101	--
Programmable DC	Kewell	TVS-630kW	EP-027	--
Programmable AC	APC	AFG-S-33800	EP-026	--
Programmable RLC	Qunling	ACLT-38160H	EP-028	--
Digital oscilloscope	YOKOGAVA	DL850	EP-001	2020/09/04
Differential probe	CYBERTEK	VP5200	EP-003	2020/09/00
Current probe	YOKOGAVA	CT-1000	EP-012	2020/09/23
Current probe	YOKOGAVA	CT-1000	EP-013	2020/09/23
Current probe	YOKOGAVA	CT-1000	EP-014	2020/09/23
Three phase impedance	Teseq	CCN 1000-3	EE206-1	2020/09/23
Signal conditioning Unit	Teseq/Germany	INA2197/37A	EE206-2	N/A
Three phase impedance	Teseq/Germany	INA 2196/75A	EE206-3	N/A

Laboratory Accreditation Certificate

ilac-MRA CNAS

China National Accreditation Service for Conformity Assessment

LABORATORY ACCREDITATION CERTIFICATE

(Registration No. CNAS L2291)

EMTEK (Shenzhen) Co., Ltd.

Building 69, Majialong Industry Zone,

Nanshan District, Shenzhen, Guangdong, China

is accredited in accordance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories(CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence to undertake the service described in the schedule attached to this certificate.

The scope of accreditation is detailed in the attached schedule bearing the same registration number as above. The schedule form an integral part of this certificate.

Date of Issue: 2016-10-24

Date of Expiry: 2022-10-28

Date of Initial Accreditation: 2005-11-02

Signed on behalf of China National Accreditation Service for Conformity Assessment

China National Accreditation Service for Conformity Assessment(CNAS) is authorized by Certification and Accreditation Administration of the People's Republic of China (CNCA) to operate the national accreditation schemes for conformity assessment. CNAS is a signatory of the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA) and the Asia Pacific Laboratory Accreditation Cooperation Mutual Recognition Arrangement (APLAC MRA).

The validity of the certificate can be checked on CNAS website at http://www.cnas.org.cn/english/findanaccreditedbody/index.shtml