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.....	ES200211002P
Compiled by (name + signature)	Double Lee
Approved by (name + signature)	Paladin Hu
Date of issue.....	March 01. 2020
Total number of pages.....	33 pages

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 2015-06
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.....	HPS30
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 ..... : February 13. 2020

Date (s) of performance of tests ..... : February 13. 2020 to March 01. 2020

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.

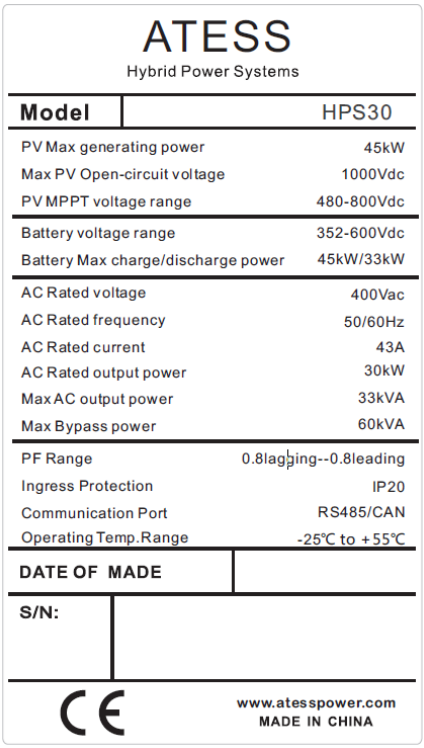
The IEC61727 does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in the grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA 2015).

General product information:

The Solar Inverter converts DC voltage into AC voltage. The input and output are protected by varistors to earth.

1) It's intended for professional incorporation into PV systems, and it is assessed on a component test basis;
2) The enclosure assembly was secured by screws;
3) The inverter is intended to be mounted on the concrete wall with screws and expansion tube;
4) 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 2015) 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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		Authority (MEA 2015) 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 2015) 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 2015)	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 2015) 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 2015) 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 2015) 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 2015)	
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 2015) 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
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

4.3 Voltage fluctuation and flicker the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2015)					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	L1	0.06		0.26	0.22
	L2	0.06		0.25	0.22
	L3	0.06		0.25	0.23

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 2015)			P
MEA Limit:	0.5% of Inom		
Output power:	33%	66%	100%
As % of rated AC current, L1:	0.043%	0.069%	0.087%
As % of rated AC current, L2:	0.039%	0.062%	0.094%
As % of rated AC current, L3:	0.042%	0.070%	0.083%

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.

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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 2015)								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		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	15.076	99.514	29.948	99.437	44.824	99.649	L1	-	P
2	0.387	0.334	0.690	0.892	1.150	0.991	L1	<1%	P
3	0.536	0.462	0.326	0.421	0.757	0.653	L1	<4%	P
4	0.065	0.056	0.132	0.171	0.252	0.217	L1	<1%	P
5	0.495	0.427	1.338	1.730	3.234	2.788	L1	<4%	P
6	0.184	0.159	0.071	0.092	0.125	0.108	L1	<1%	P
7	0.966	1.143	0.923	1.193	1.830	1.578	L1	<4%	P
8	0.017	0.045	0.042	0.054	0.071	0.061	L1	<1%	P
9	0.043	0.114	0.097	0.126	0.187	0.161	L1	<4%	P
10	0.035	0.091	0.053	0.069	0.179	0.154	L1	<1%	P
11	0.293	0.767	0.399	0.516	1.348	1.162	L1	<2%	P
12	0.014	0.038	0.024	0.031	0.060	0.052	L1	<0.5%	P
13	0.233	0.610	0.380	0.491	0.796	0.686	L1	<2%	P
14	0.035	0.093	0.061	0.079	0.152	0.131	L1	<0.5%	P
15	0.098	0.256	0.217	0.280	0.168	0.145	L1	<2%	P
16	0.075	0.197	0.105	0.136	0.387	0.334	L1	<0.5%	P
17	0.278	0.729	0.552	0.713	0.536	0.462	L1	<1.5%	P
18	0.019	0.050	0.036	0.047	0.065	0.056	L1	<0.375%	P
19	0.137	0.358	0.331	0.428	0.495	0.427	L1	<1.5%	P
20	0.030	0.079	0.050	0.065	0.184	0.159	L1	<0.375%	P
21	0.032	0.085	0.071	0.092	0.166	0.143	L1	<1.5%	P
22	0.025	0.065	0.030	0.039	0.052	0.045	L1	<0.375%	P
23	0.077	0.201	0.108	0.140	0.510	0.440	L1	<0.6%	P
24	0.005	0.012	0.015	0.020	0.051	0.044	L1	<0.15%	P
25	0.044	0.115	0.040	0.052	0.316	0.272	L1	<0.6%	P
26	0.010	0.027	0.008	0.010	0.063	0.054	L1	<0.15%	P
27	0.006	0.017	0.013	0.017	0.029	0.025	L1	<0.6%	P
28	0.004	0.010	0.004	0.005	0.030	0.026	L1	<0.15%	P
29	0.018	0.046	0.019	0.024	0.148	0.128	L1	<0.6%	P
30	0.004	0.010	0.003	0.004	0.023	0.020	L1	<0.15%	P
31	0.027	0.071	0.023	0.030	0.153	0.132	L1	<0.6%	P
32	0.007	0.019	0.010	0.013	0.041	0.035	L1	<0.15%	P
33	0.003	0.007	0.002	0.003	0.023	0.020	L1	<0.6%	P
34	0.003	0.008	0.004	0.005	0.026	0.022	L1	<0.15%	P
35	0.007	0.018	0.003	0.004	0.068	0.059	L1	<0.3%	P
36	0.003	0.009	0.005	0.006	0.015	0.013	L1	<0.075%	P
37	0.020	0.052	0.008	0.010	0.116	0.100	L1	<0.3%	P
38	0.006	0.016	0.002	0.003	0.043	0.037	L1	<0.075%	P
39	0.006	0.015	0.009	0.011	0.017	0.015	L1	<0.3%	P
40	0.008	0.022	0.003	0.004	0.061	0.053	L1	<0.075%	P

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Clause	Requirement – Test	Result - Remark	Verdict

THDi	--	2.047	---	2.657	---	3.913	L1	≤ 5%	P
Supplementary information:									

4.6	TABLE: Harmonic Current Limit Test The grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2015)								P
	Condition of test					Power (kW)			
	supplying power to balance linear loads 33% ±5%					9.987			P
	supplying power to balance linear loads 66 %±5%					19.981			P
	supplying power to balance linear loads 100 %±5%					30.014			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	15.028	98.644	29.868	99.371	44.800	99.438	L2		P
2	0.133	0.185	0.261	0.181	0.234	0.202	L2	<1%	P
3	0.351	0.488	0.739	0.513	0.561	0.484	L2	<4%	P
4	0.132	0.184	0.285	0.198	0.232	0.200	L2	<1%	P
5	0.908	1.261	2.707	1.880	2.383	2.054	L2	<4%	P
6	0.052	0.072	0.122	0.085	0.104	0.090	L2	<1%	P
7	0.314	0.436	1.581	1.098	1.576	1.359	L2	<4%	P
8	0.078	0.109	0.167	0.116	0.137	0.118	L2	<1%	P
9	0.094	0.131	0.204	0.142	0.157	0.135	L2	<4%	P
10	0.074	0.103	0.181	0.126	0.143	0.123	L2	<1%	P
11	0.242	0.336	0.802	0.557	0.992	0.855	L2	<2%	P
12	0.085	0.118	0.180	0.125	0.151	0.130	L2	<0.5%	P
13	0.250	0.347	0.504	0.350	0.688	0.593	L2	<2%	P
14	0.101	0.140	0.213	0.148	0.193	0.166	L2	<0.5%	P
15	0.119	0.165	0.251	0.174	0.210	0.181	L2	<2%	P
16	0.112	0.155	0.245	0.170	0.195	0.168	L2	<0.5%	P
17	0.284	0.394	0.336	0.233	0.556	0.479	L2	<1.5%	P
18	0.122	0.170	0.252	0.175	0.209	0.180	L2	<0.375%	P
19	0.194	0.269	0.348	0.242	0.430	0.371	L2	<1.5%	P
20	0.141	0.196	0.281	0.195	0.244	0.210	L2	<0.375%	P
21	0.142	0.197	0.292	0.203	0.251	0.216	L2	<1.5%	P
22	0.147	0.204	0.302	0.210	0.248	0.214	L2	<0.375%	P
23	0.223	0.310	0.413	0.287	0.389	0.335	L2	<0.6%	P
24	0.087	0.121	0.183	0.127	0.264	0.128	L2	<0.15%	P
25	0.199	0.276	0.393	0.273	0.327	0.282	L2	<0.6%	P
26	0.030	0.042	0.068	0.047	0.293	0.053	L2	<0.15%	P
27	0.180	0.250	0.370	0.257	0.296	0.255	L2	<0.6%	P
28	0.041	0.057	0.089	0.062	0.309	0.066	L2	<0.15%	P
29	0.007	0.010	0.055	0.038	0.355	0.066	L2	<0.6%	P
30	0.052	0.072	0.112	0.078	0.324	0.079	L2	<0.15%	P
31	0.247	0.343	0.435	0.302	0.342	0.295	L2	<0.6%	P
32	0.069	0.096	0.135	0.094	0.349	0.091	L2	<0.15%	P
33	0.215	0.299	0.444	0.308	0.355	0.306	L2	<0.6%	P
34	0.014	0.019	0.081	0.056	0.013	0.011	L2	<0.15%	P
35	0.040	0.056	0.037	0.026	0.009	0.008	L2	<0.3%	P
36	0.007	0.010	0.027	0.019	0.002	0.002	L2	<0.075%	P

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37	0.070	0.097	0.163	0.113	0.010	0.009	L2	<0.3%	P
38	0.024	0.034	0.020	0.014	0.009	0.008	L2	<0.075%	P
39	0.009	0.012	0.029	0.020	0.003	0.003	L2	<0.3%	P
40	0.036	0.050	0.014	0.010	0.007	0.006	L2	<0.075%	P
THDi	---	2.065	---	2.465	---	3.847	L2	≤ 5%	P
Supplementary information:									

4.6	TABLE: Harmonic Current Limit Test The grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2015)								P
	Condition of test					Power(kW)			
	supplying power to balance linear loads 33% ±5%					9.987			P
	supplying power to balance linear loads 66 %±5%					19.981			P
	supplying power to balance linear loads 100 %±5%					30.014			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	15.076	99.926	29.976	99.952	44.824	99.975	L3		P
2	0.387	0.334	0.690	0.892	1.150	0.991	L3	<1%	P
3	0.536	0.462	0.326	0.421	0.757	0.653	L3	<4%	P
4	0.065	0.056	0.132	0.171	0.252	0.217	L3	<1%	P
5	0.495	0.427	1.338	1.730	3.234	2.788	L3	<4%	P
6	0.184	0.159	0.071	0.092	0.125	0.108	L3	<1%	P
7	0.966	1.143	0.923	1.193	1.830	1.578	L3	<4%	P
8	0.017	0.045	0.042	0.054	0.071	0.061	L3	<1%	P
9	0.043	0.114	0.097	0.126	0.187	0.161	L3	<4%	P
10	0.035	0.091	0.053	0.069	0.179	0.154	L3	<1%	P
11	0.293	0.767	0.399	0.516	1.348	1.162	L3	<2%	P
12	0.014	0.038	0.024	0.031	0.060	0.052	L3	<0.5%	P
13	0.233	0.610	0.380	0.491	0.796	0.686	L3	<2%	P
14	0.035	0.093	0.061	0.079	0.152	0.131	L3	<0.5%	P
15	0.098	0.256	0.217	0.280	0.168	0.145	L3	<2%	P
16	0.075	0.197	0.105	0.136	0.387	0.334	L3	<0.5%	P
17	0.278	0.729	0.552	0.713	0.536	0.462	L3	<1.5%	P
18	0.019	0.050	0.036	0.047	0.065	0.056	L3	<0.375%	P
19	0.137	0.358	0.331	0.428	0.495	0.427	L3	<1.5%	P
20	0.030	0.079	0.050	0.065	0.184	0.159	L3	<0.375%	P
21	0.032	0.085	0.071	0.092	0.166	0.143	L3	<1.5%	P
22	0.025	0.065	0.030	0.039	0.052	0.045	L3	<0.375%	P
23	0.077	0.201	0.108	0.140	0.510	0.440	L3	<0.6%	P
24	0.005	0.012	0.015	0.020	0.051	0.044	L3	<0.15%	P
25	0.044	0.115	0.040	0.052	0.316	0.272	L3	<0.6%	P
26	0.010	0.027	0.008	0.010	0.063	0.054	L3	<0.15%	P
27	0.006	0.017	0.013	0.017	0.029	0.025	L3	<0.6%	P
28	0.004	0.010	0.004	0.005	0.030	0.026	L3	<0.15%	P
29	0.018	0.046	0.019	0.024	0.148	0.128	L3	<0.6%	P
30	0.004	0.010	0.003	0.004	0.023	0.020	L3	<0.15%	P
31	0.027	0.071	0.023	0.030	0.153	0.132	L3	<0.6%	P
32	0.007	0.019	0.010	0.013	0.041	0.035	L3	<0.15%	P

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

33	0.003	0.007	0.002	0.003	0.023	0.020	L3	<0.6%	P
34	0.003	0.008	0.004	0.005	0.026	0.022	L3	<0.15%	P
35	0.007	0.018	0.003	0.004	0.068	0.059	L3	<0.3%	P
36	0.003	0.009	0.005	0.006	0.015	0.013	L3	<0.075%	P
37	0.020	0.052	0.008	0.010	0.116	0.100	L3	<0.3%	P
38	0.006	0.016	0.002	0.003	0.043	0.037	L3	<0.075%	P
39	0.006	0.015	0.009	0.011	0.017	0.015	L3	<0.3%	P
40	0.008	0.022	0.003	0.004	0.061	0.053	L3	<0.075%	P
THDi		2.356		2.782		3.509	L3	≤ 5%	P
Supplementary information:									

4.7 Power Factor the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2015)			P
Load (%)	Location	Measured	Limit
10	L1(230Vac)	0.9937	N/A
	L2(230Vac)	0.9945	
	L3(230Vac)	0.9952	
50	L1(230Vac)	0.9981	>0.90
	L2(230Vac)	0.9982	>0.90
	L3(230Vac)	0.9989	>0.90
100	L1(230Vac)	0.9996	>0.90
	L2(230Vac)	0.9998	>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: 2015) 1.11.4.10 Response to utility recovery the grid-connected inverter regulations of the Metropolitan Electricity Authority(MEA 2015)					P
First Level					
Test conditions:	Output power: 25.7kW Frequency: 50 Hz				
	Under Voltage		Over Voltage		
Parameter	/	Voltage (V)	/	Voltage (V)	

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Set Value	/	199V				/	241V			
Measured trip value(V)	Phase	All	L1	L2	L3	All	L1	L2	L3	L3
	/	198.6	198.1	198.2	198.3	/	240.4	240. 5	240.6	241.2
	/	198.6	198.5	198.1	198.2	/	241.0	241. 0	240.8	241.2
	/	198.5	198.7	198.4	198.3	/	240.8	240.5	241.0	241.0
	/	198.3	198.5	198.7	198.5	/	240.3	240.2	240.5	240.8
	/	198.7	198.2	198.7	198.4	/	240.5	240.3	240.6	241.2
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
		1.800	1.812	1.812	1.810		1.798	1.798	1.812	1.796
		1.810	1.808	1.800	1.812		1.804	1.810	1.806	1.804
		1.804	1.812	1.808	1.810		1.802	1.812	1.808	1.810
		1.798	1.812	1.796	1.804		1.800	1.806	1.806	1.810
		1.796	1.804	1.812	1.804		1.802	1.812	1.808	1.800
Reconnection time (Sec)	At least 120s	220s				At least 120s	220s			
Second Level										
Test conditions:	Output power: 27.0kW 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
	/	114.6	114.5	114.3	114.6	/	309.8	309.9	309.8	309.8
	/	114.4	114.6	114.3	114.2	/	309.8	309.9	309.7	309.5
	/	114.3	114.3	114.5	114.3	/	309.6	309.7	309.7	309.5
	/	114.3	114.5	114.6	114.3	/	309.9	309.9	309.7	309.9
	/	114.8	114.6	114.7	114.6	/	309.7	309.8	309.9	309.6
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	63	64	62		32	37	33	32
		70	64	66	66		29	36	30	32

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

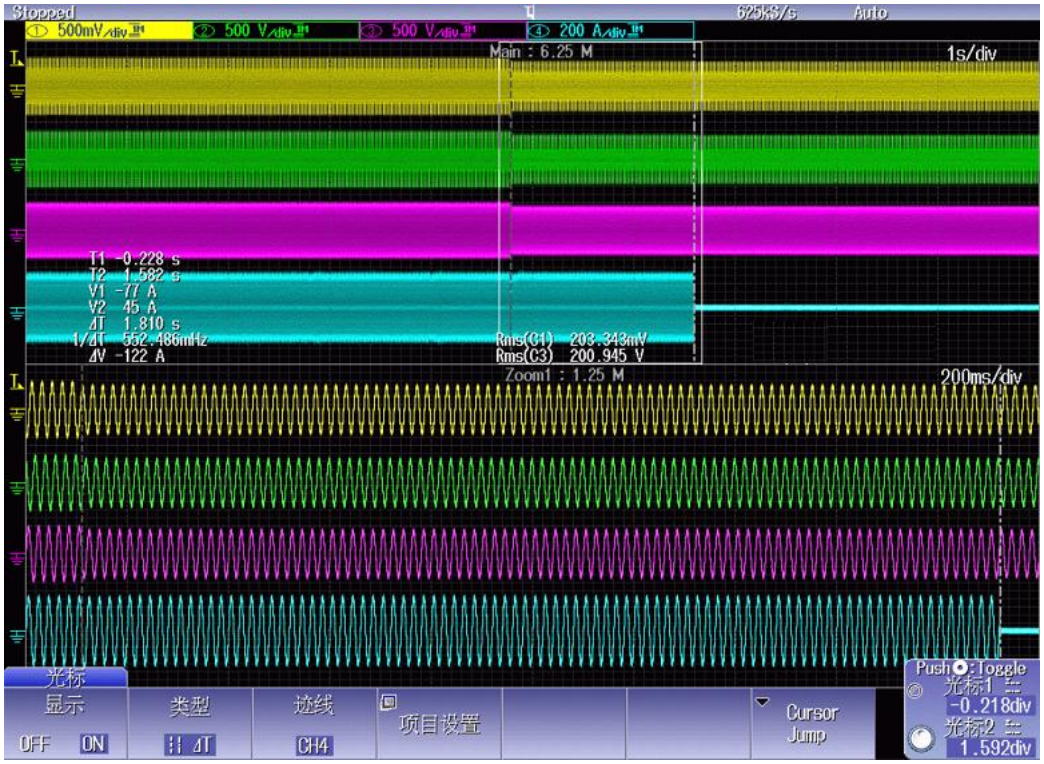
		71	65	66	75		33	32	31	37
		73	62	69	64		41	38	38	36
		72	68	78	64		43	38	36	33
Reconnection time (Sec)	At least 120s	224s				At least 120s	221s			

Note:

The tests are according MEA: 2015. The voltage setting of EUT are set for the tests as stated to 199V, 114V for undervoltage and 241V, 311V for overvoltage.

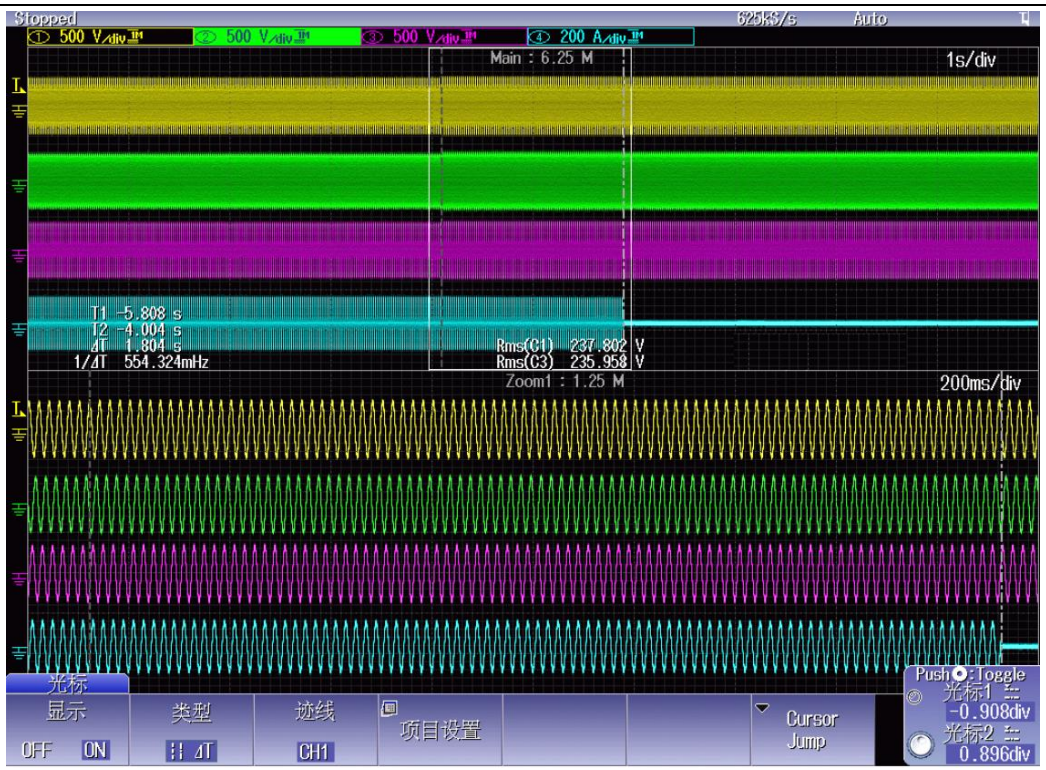
Response to utility recovery is according to the appropriate IEEE or IEC standard test methods.

Under Voltage First Level (All Phase)

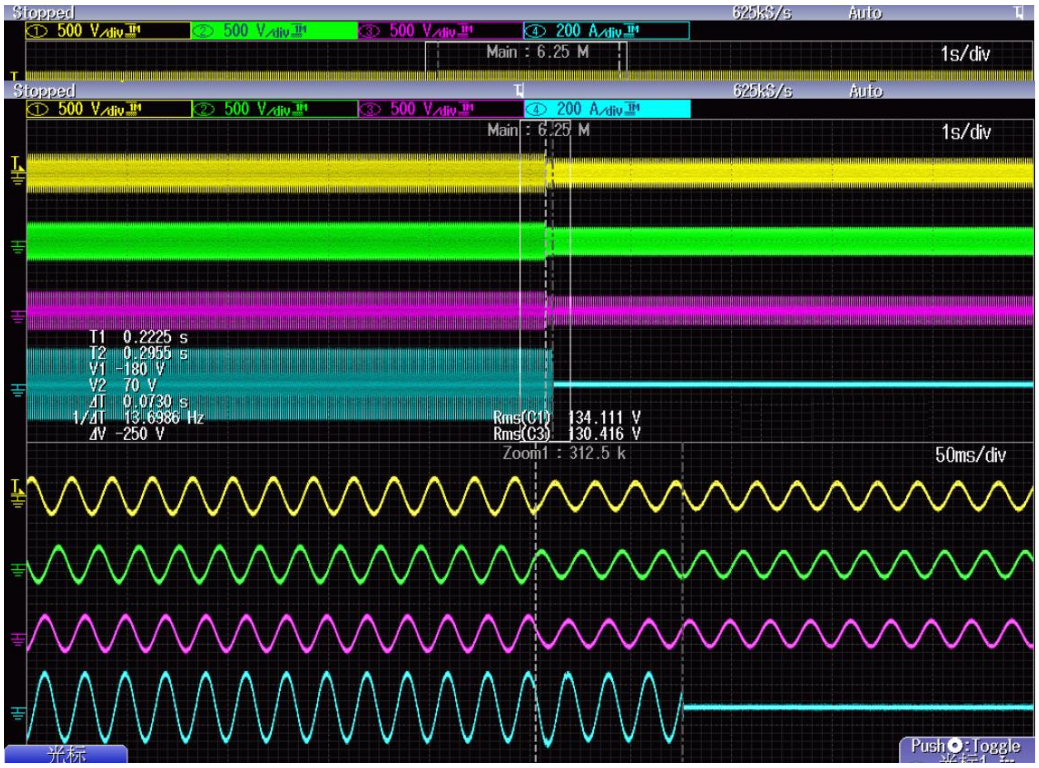


Over Voltage First Level (All Phase)

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

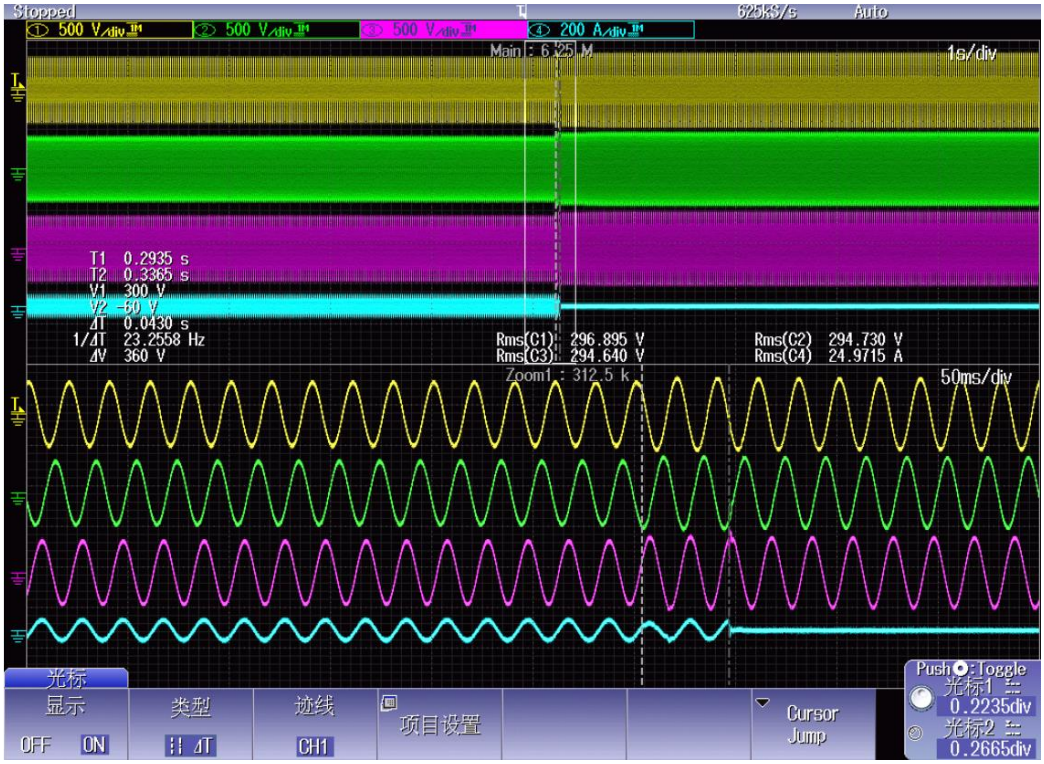


Under Voltage Second Level (All Phase)

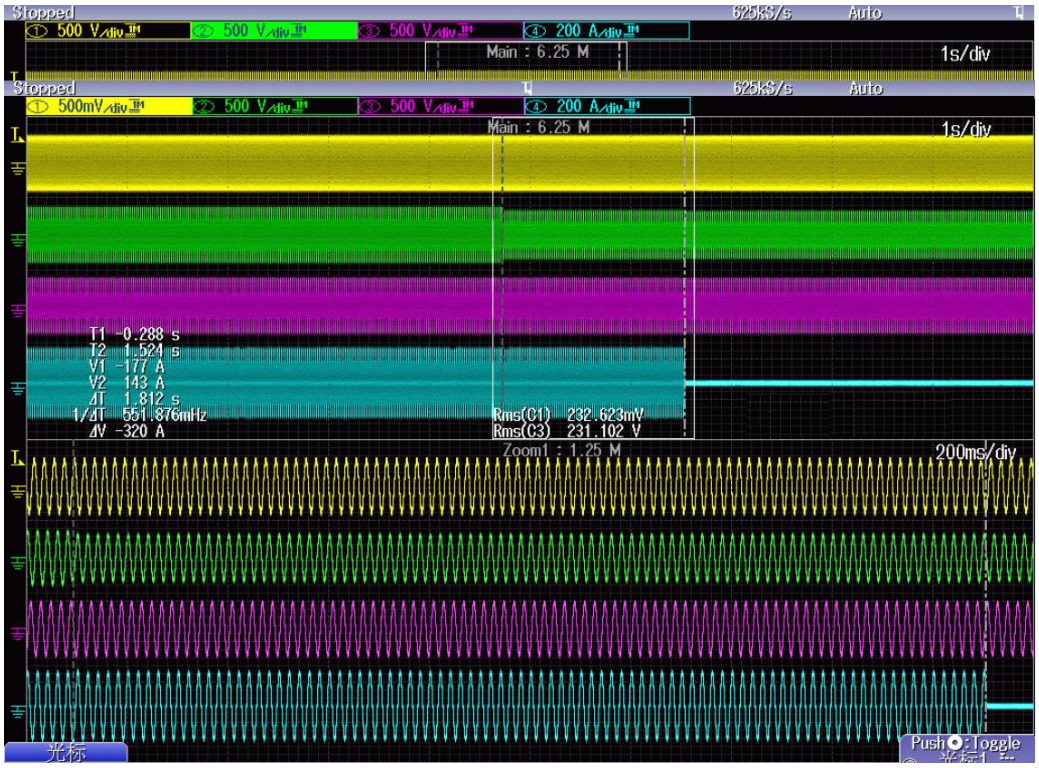


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage Second Level (All Phase)

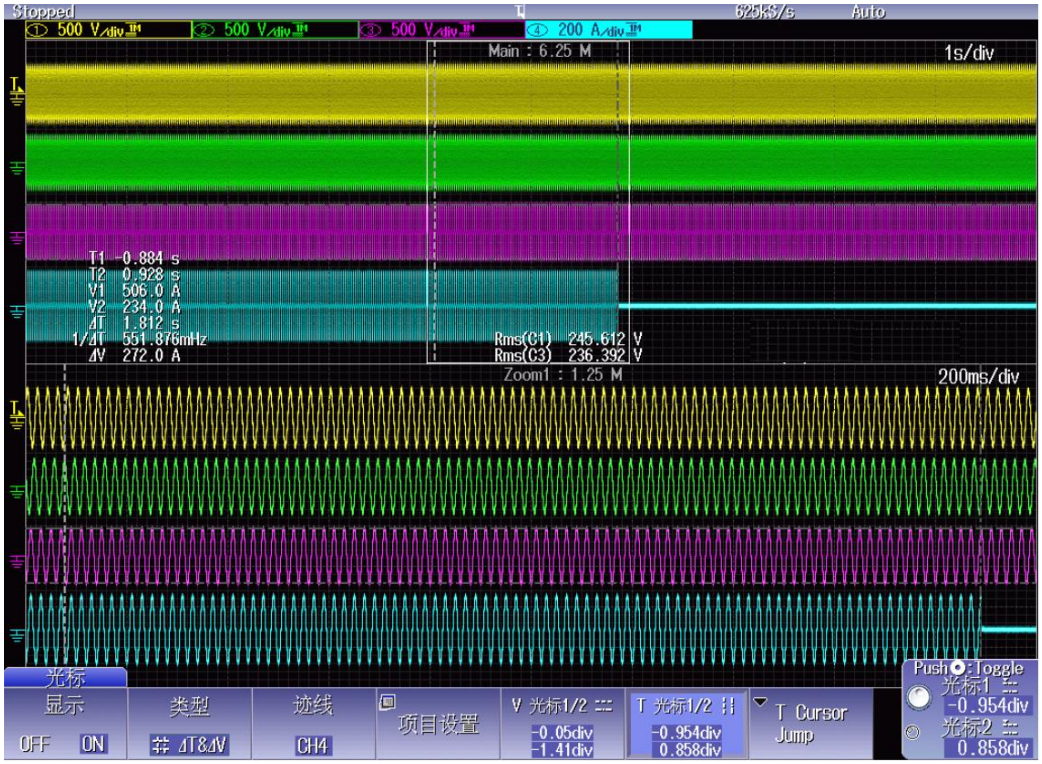


Under Voltage First Level (Each Phase)

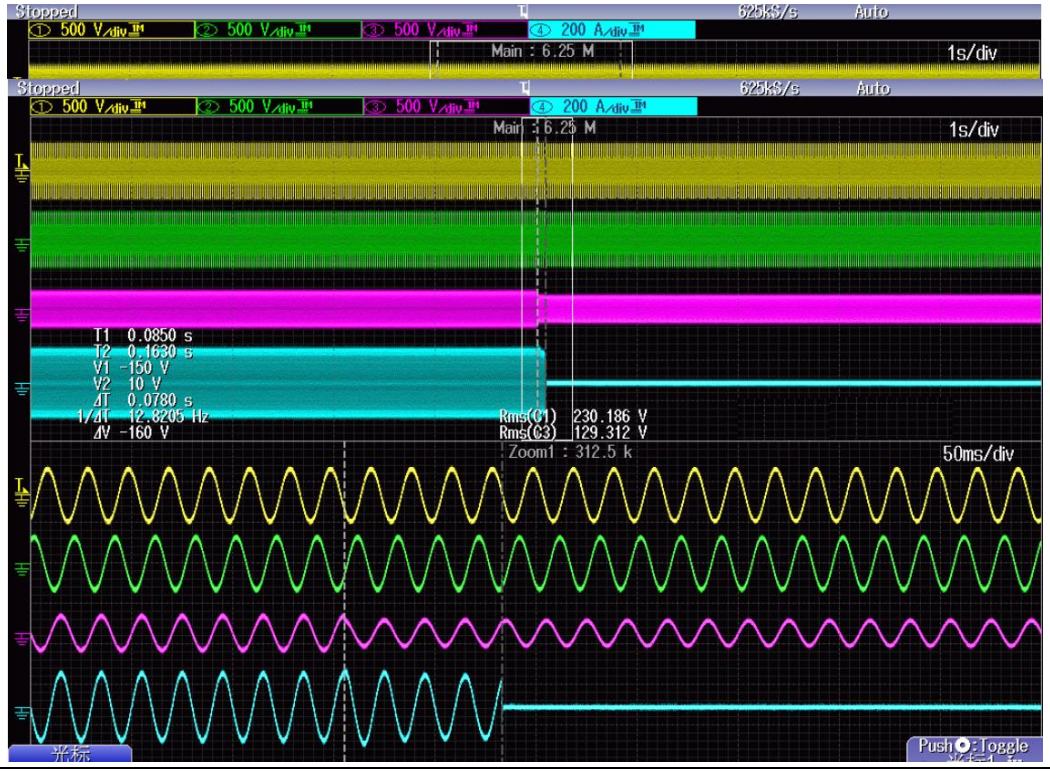


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage First Level (Each Phase)

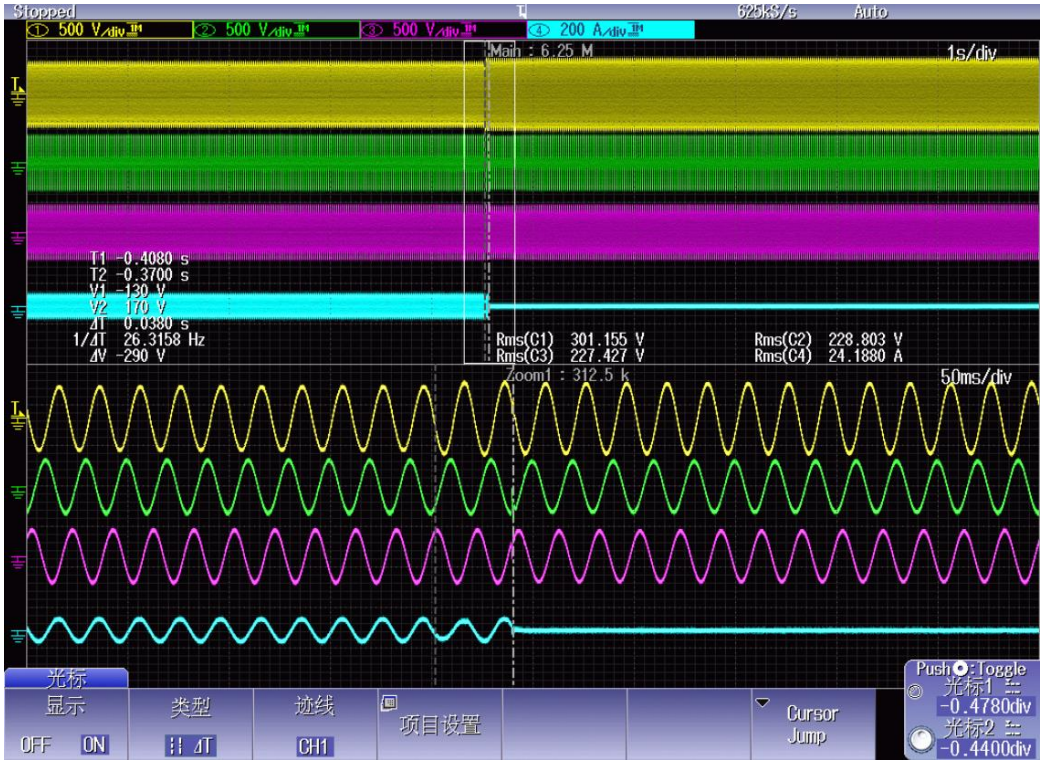


Under Voltage Second Level (Each Phase)

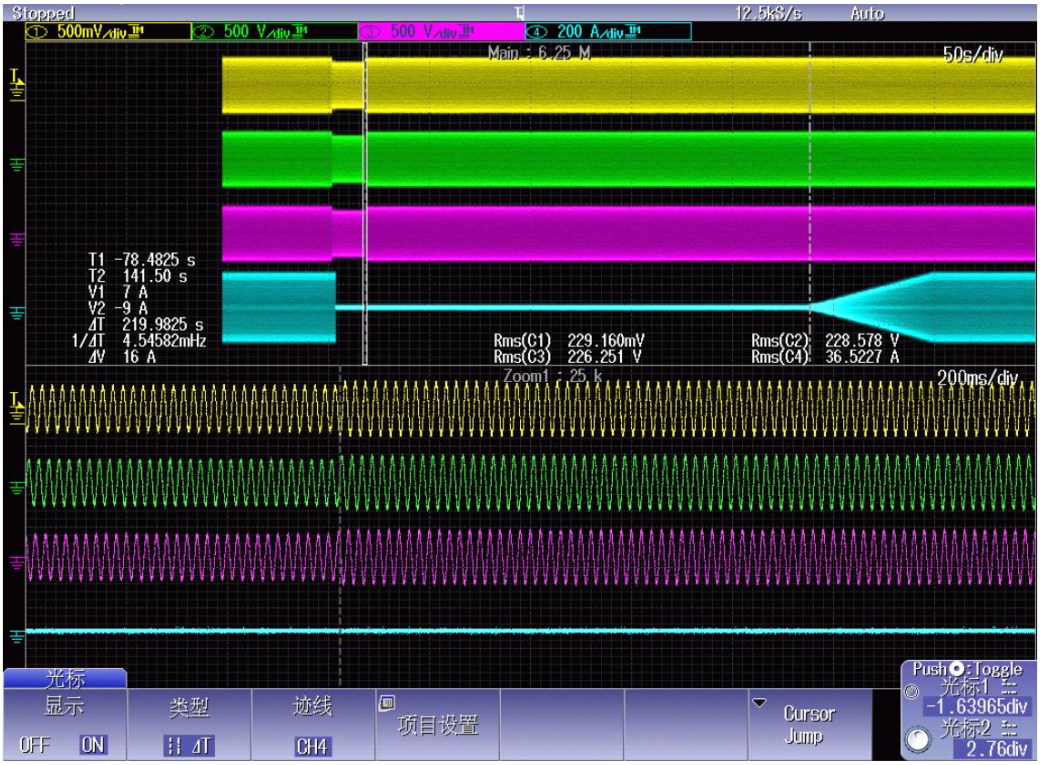


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage Second Level (Each Phase)

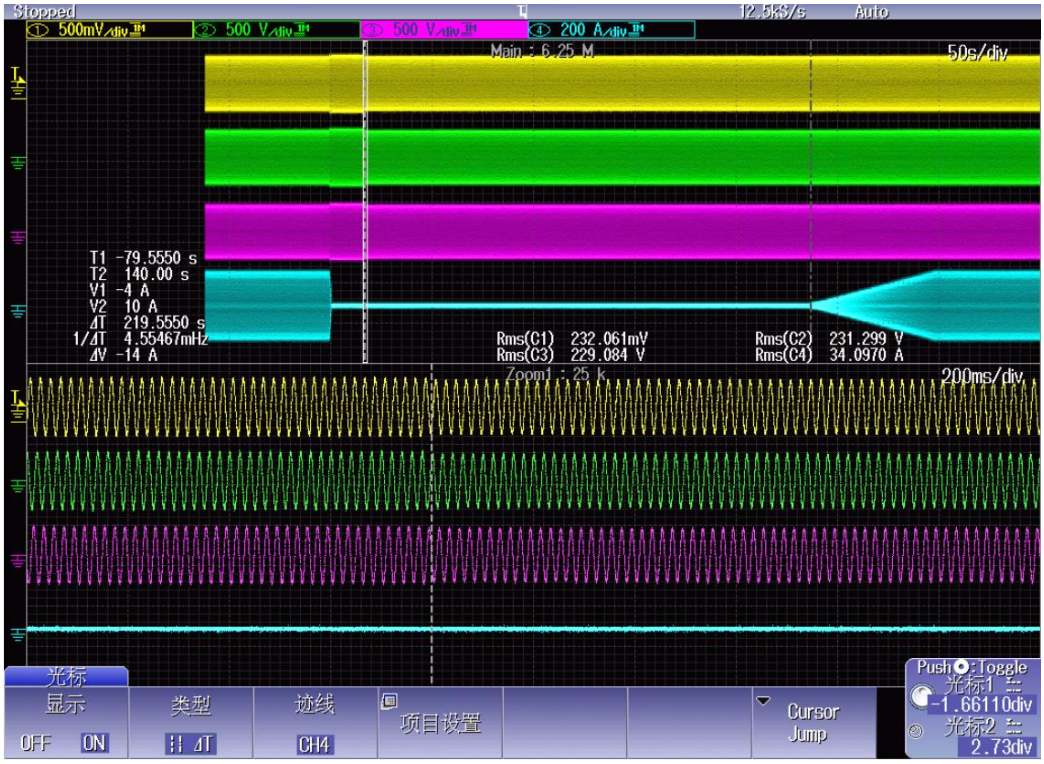


Reconnection after Under Voltage First Level

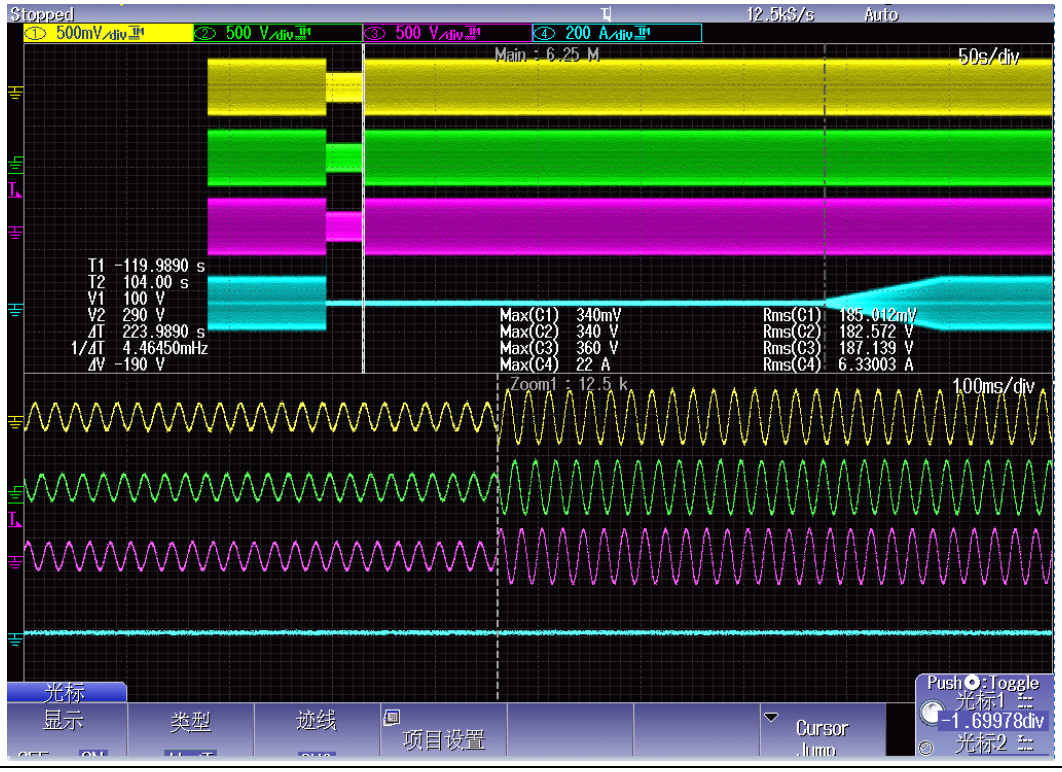


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Reconnection after Over Voltage First Level

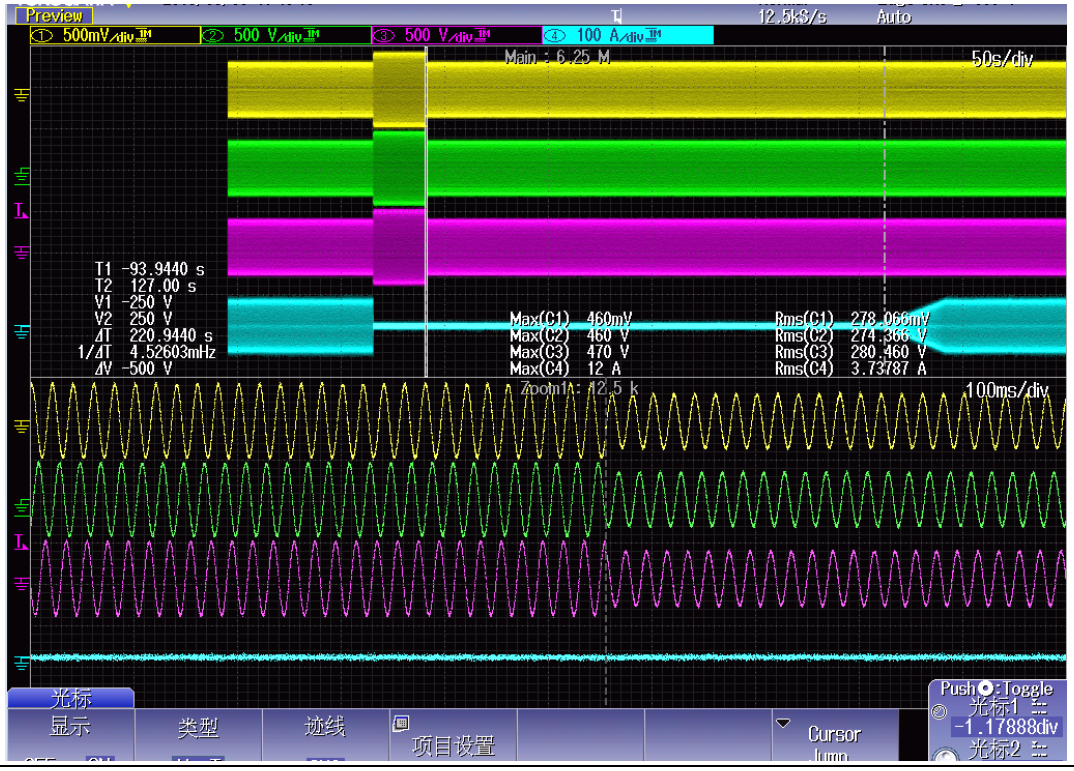


Reconnection after Under Voltage Second Level



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		46.90		52.10	
Measured trip value		46.91		52.09	
		46.91		52.09	
		46.91		52.09	
		46.91		52.09	
		46.91		52.09	

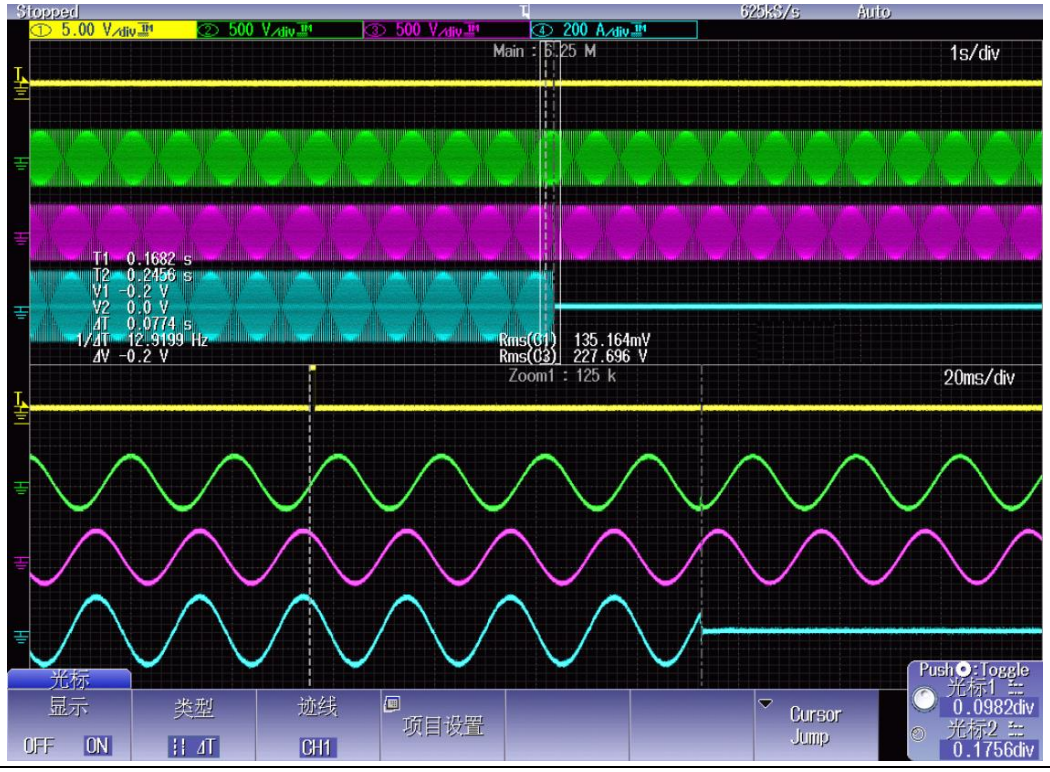
IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

		46.91		52.09
Parameter		Time [ms]		Time [ms]
Limit		<= 100ms		<= 100ms
Disconnection time	49.40Hz to 48.80Hz	74	50.60 Hz to 51.20 Hz	61
		76		65
		72		68
		73		65
		73		63
		77		63
Reconnection time(Sec)	at least 120s	226s	at least 120s	225s

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.

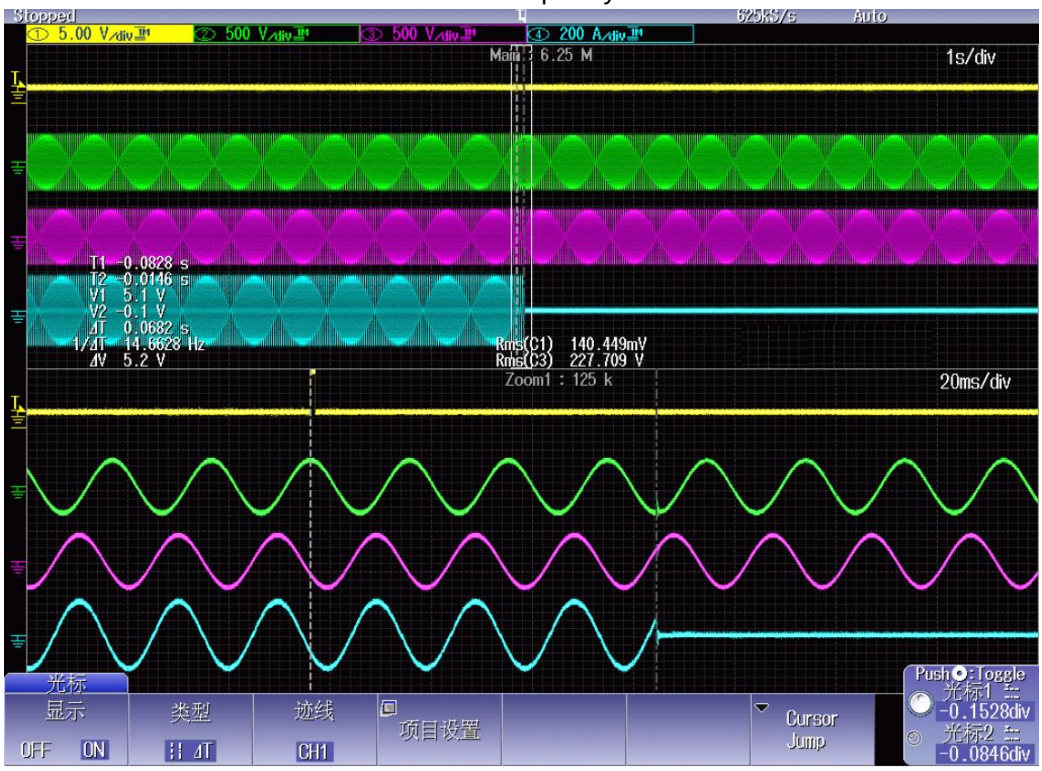
Response to Utility Recovery Test:
The test methods shall be in accordance with IEEE 1547.1-2005 clause 5.10 and evaluation criteria refer to clause 3.2.4 in this regulation.

Under Frequency

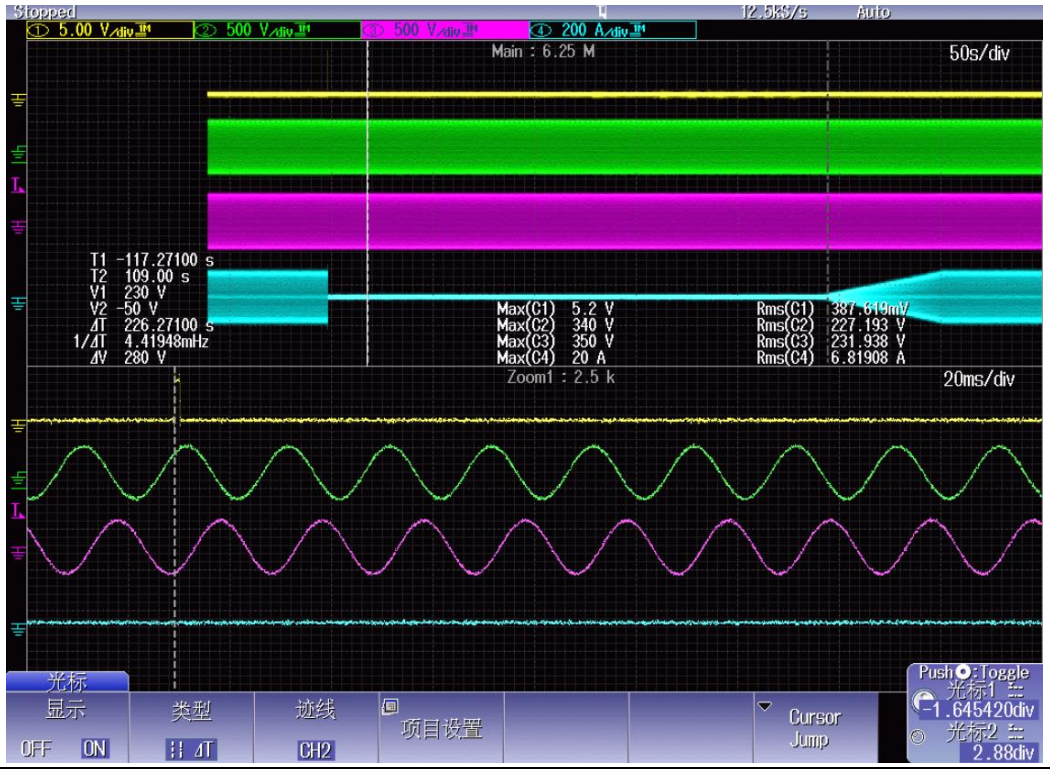


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Frequency

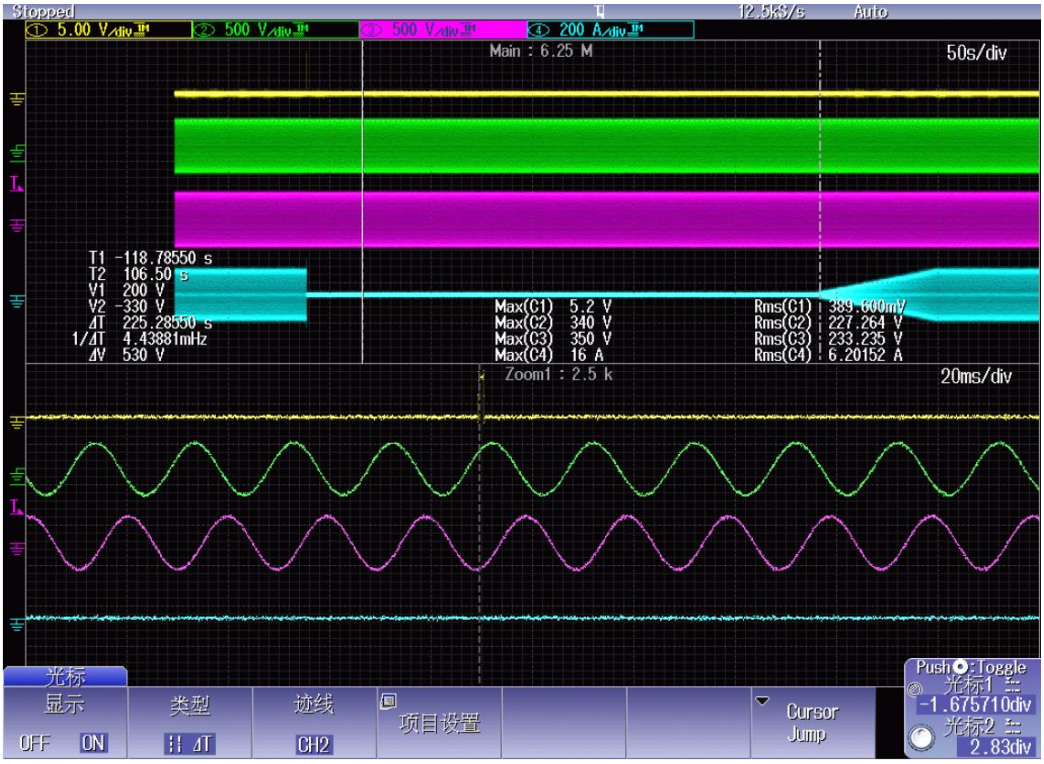


Reconnection after Under Frequency:



IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Reconnection after Over Frequency



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=230+/-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	474	9.931	0.997	748	Test A at BL
2	100	100	-5	-5	303	9.931	1.023	748	Test A at IB
3	100	100	-5	0	382	9.931	1.049	748	Test A at IB
4	100	100	-5	+5	385	9.931	1.075	748	Test A at IB
5	100	100	0	-5	290	9.931	0.971	748	Test A at IB
6	100	100	0	+5	293	9.931	1.021	748	Test A at IB
7	100	100	+5	-5	297	9.931	0.925	748	Test A at IB
8	100	100	+5	0	282	9.931	0.949	748	Test A at IB
9	100	100	+5	+5	288	9.931	0.973	748	Test A at IB
10	100	100	-10	+10	326	9.931	0.997	748	Test A at BL
11	100	100	-5	+10	335	9.931	1.023	748	Test A at IB
12	100	100	0	+10	267	9.931	1.049	748	Test A at IB
13	100	100	+5	+10	279	9.931	1.075	748	Test A at IB
14	100	100	+10	+10	294	9.931	0.971	748	Test A at IB
15	100	100	-10	+5	303	9.931	1.021	748	Test A at IB
16	100	100	+10	+5	341	9.931	0.925	748	Test A at IB

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

17	100	100	-10	0	221	9.931	0.949	748	Test A at IB
18	100	100	+10	0	267	9.931	0.973	748	Test A at IB
19	100	100	-10	-5	287	9.931	1.021	748	Test A at IB
20	100	100	+10	-5	265	9.931	0.925	748	Test A at IB
21	100	100	-10	-10	243	9.931	0.949	748	Test A at IB
22	100	100	-5	-10	254	9.931	0.973	748	Test A at IB
23	100	100	0	-10	287	9.931	1.075	748	Test A at IB
24	100	100	+5	-10	291	9.931	0.971	748	Test A at IB
25	100	100	-10	-10	226	9.931	1.021	748	Test A at IB

Parameter at 0% per phase	L= 17.52 mH	R= 5.57 Ω	C= 590.08 µF
IAC fundamental current at balance condition	L1: 105 mA	L2: 141 mA	L3: 289 mA

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

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

3) Q_{AC}: 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.

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

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).

6.1	TABLE: **Islanding protection (EUT output = 66%)**	**P**
Test conditions	Frequency: 50+/-0.1Hz UN=230+/-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	386	6.022	0.977	540	Test B at IB
2	66	66	0	-4	282	6.022	0.982	540	Test B at IB
3	66	66	0	-3	303	6.022	0.987	540	Test B at IB
4	66	66	0	-2	182	6.022	0.992	540	Test B at IB

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

5	66	66	0	-1	176	6.022	0.997	540	Test B at IB
6	66	66	0	0	259	6.022	1.002	540	Test B at BL
7	66	66	0	1	265	6.022	1.007	540	Test B at IB
8	66	66	0	2	235	6.022	1.012	540	Test B at IB
9	66	66	0	3	297	6.022	1.017	540	Test B at IB
10	66	66	0	4	252	6.022	1.022	540	Test B at IB
11	66	66	0	5	273	6.022	1.027	540	Test B at IB

Parameter at 0% per phase	L= 17.30 mH	R= 8.30 Ω	C= 361.00 µF
IAC fundamental current at balance condition	L1: 183 mA	L2: 182 mA	L3: 147 mA

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

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

3) Q_{AC}: 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	483	3.137	0.971	332	Test C at IB
2	33	33	0	-4	402	3.137	0.986	332	Test C at IB
3	33	33	0	-3	401	3.137	0.986	332	Test C at IB
4	33	33	0	-2	386	3.137	0.991	332	Test C at IB
5	33	33	0	-1	384	3.137	0.996	332	Test C at IB
6	33	33	0	0	397	3.137	1.001	332	Test C at BL

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

7	33	33	0	1	295	3.137	1.006	332	Test C at IB
8	33	33	0	2	297	3.137	1.011	332	Test C at IB
9	33	33	0	3	312	3.137	1.016	332	Test C at IB
10	33	33	0	4	297	3.137	1.021	332	Test C at IB
11	33	33	0	5	301	3.137	1.026	332	Test C at IB

Parameter at 0% per phase	L= 37.97 mH	R=12.13 Ω	C= 265.77 µF
IAC fundamental current at balance condition	L1: 46 mA	L2: 107 mA	L3: 49 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) = 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} -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(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.

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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).

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