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.	ES190702001P
Compiled by (name + signature)	Double Lee
Approved by (name + signature)	Paladin Hu
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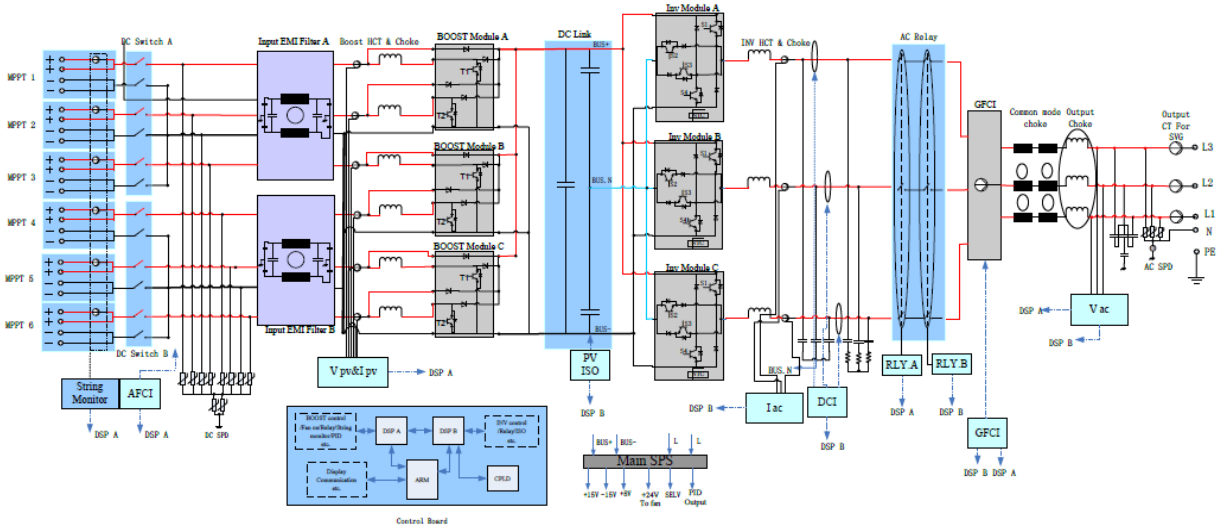
Testing Laboratory name	EMTEK(SHENZHEN) CO., LTD.
Address	Bldg 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China
Testing location/ address	Same as above
Applicant's name	: Shenzhen ATESS Power Technology Co.,Ltd
Address	1st Floor of Building 3 at Sector B and 3rd Floor of Building 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	HPS120
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 ..... : July 08. 2019
Date (s) of performance of tests ..... : July 08. 2019 to July 30. 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:

The Solar Inverter converts DC voltage into AC voltage. The input and output are protected by varistors to earth. The unit is providing EMC filtering at the input and output towards mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a relay in series. This assures that the opening of the output circuit will also operate in case of one error.



Block diagram

The internal control is redundant built. It consists of Microcontroller Controller A (U11) and Controller B (U5). The Controller A (U11) control the relays (RY4-RY6)by switching signals; measures the PV voltage, PV current and BUS voltage, measures grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Controller B (U5) is using for measuring the grid voltage, AC current, grid frequency and residual current, also can switch off the relays (RY1-RY3) independently, and communicate with Controller A (U11) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master DSP. The Master DSP tests and calibrated before each start up all current sensors.

The unit provided two relays in series in all three line conductors. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up. Both controllers can open the relays.

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 ℃ ~ +60 ℃.

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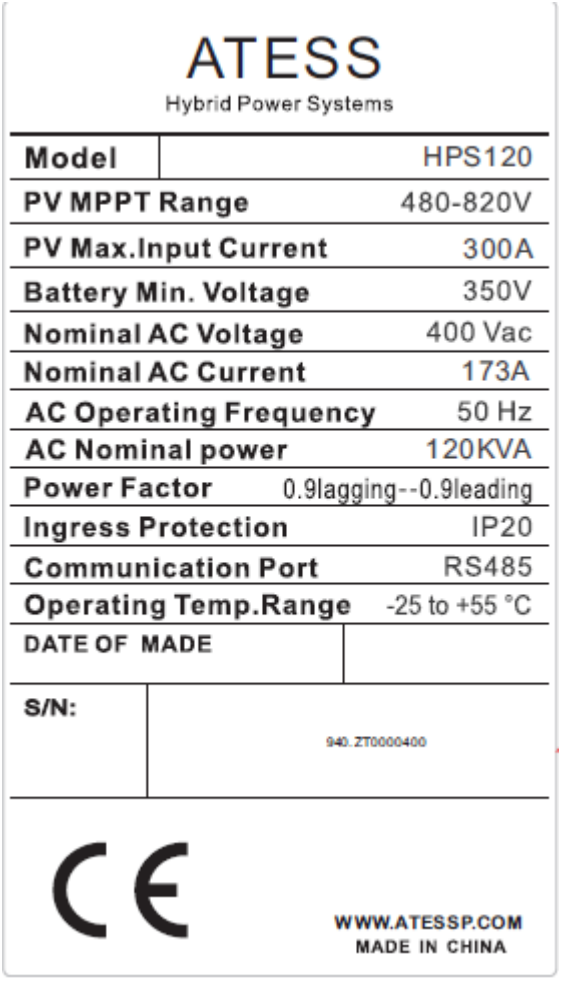

Interface protection settings with deviations according the grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA)

(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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Clause	Requirement – Test	Result - Remark	Verdict
	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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Clause	Requirement – Test	Result - Remark	Verdict
	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	1000Vdc / 230Vac	10 minutes	/	/	Inverter alarm, No output , no hazard.
2	AC output L-L	S-C	1000Vdc / 230Vac	10 minutes	/	/	Breaker is broken, No output, no hazard.
3	AC output L-N	S-C	1000Vdc / 230Vac	10 minutes	/	/	Breaker is broken, No output, no hazard.
4	AC output	Phase sequence errors	1000Vdc / 230Vac	10 minutes	/	/	Inverter work normally.
5	VCC of main CPU	O-C	1000Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
6	VCC of secondary CPU	O-C	1000Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
7	Communication of main CPU and secondary CPU	O-C	1000Vdc / 230Vac	10 minutes	/	/	Error message: “101”. No communication.
8	C1 (I/O board)	S-C	1000Vdc / 230Vac	10 minutes	/	/	Inverter disconnected from grid immediately and shut down, No output, no hazard.
9	C16 (I/O board)	S-C	1000Vdc / 230Vac	10minutes	/	/	Inverter disconnected from grid immediately and shut down, No output, no hazard.
10	BUS R251 (I/O board)	O-C	1000Vdc / 230Vac	10minutes	/	/	Error message: “122”. Inverter disconnected from grid immediately and shut down.
11	D52 (I/O board)	S-C	1000Vdc / 230Vac	10minutes	/	/	Inverter work normally.
12	Q6(PIN1-PIN2) (I/O board)	S-C	1000Vdc / 230Vac	10minutes	/	/	Inverter work normally.

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Clause	Requirement – Test	Result - Remark	Verdict

13	R325 (I/O board)	O-C	1000Vdc / 230Vac	10minutes	/	/	Inverter work normally.
14	RY3A (I/O board)	S-C	1000Vdc / 230Vac	10minutes	/	/	Inverter doesn't disconnect with grid.
15	Q1(PIN2-PIN3) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
16	RY9A (I/O board)	O-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
17	Q28(PIN2-PIN3)(I/O board)	O-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
18	Q10(PIN2-PIN3) (I/O board)	O-C	1000Vdc / 230Vac	2 minutes	/	/	Error message: "101". Inverter disconnected from grid immediately and shut down.
19	Q10(pin1-pin2) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter doesn't disconnect with grid.
20	TX5(PIN4- PIN8) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shut down.
21	Q7(PIN2-PIN3) (I/O board)	O-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
22	C151 (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
23	C152 (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
24	C294 (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
25	C305 (I/O board)	S-C	1000Vdc / 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	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
27	C322(I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
28	D60(I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
29	Q40(PIN2-PIN3) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Error message: “101”. Inverter disconnected from grid immediately.
30	Q40(PIN1-PIN2) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately.
31	TX5(PIN4- PIN8) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shut down.
32	TX1(PIN1- PIN3) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
33	Q33(PIN2- PIN3) (I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter work normally.
34	C335(I/O board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
35	C257.6 (CTRL board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	PVA voltage detection is 0. Inverter disconnected from grid immediately.
36	C168 (CTRL board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Error message: “122”.
37	C261(CTRL board)	S-C	1000Vdc / 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	1000Vdc / 230Vac	2 minutes	/	/	Leakage current is fault. Inverter disconnected from grid immediately and shut down.
39	C151(CTRL board)	S-C	1000Vdc / 230Vac	2 minutes	/	/	Error message: “101”. Inverter disconnected from grid immediately and shut down.
40	GFCI power(CTRL board)	O-C	1000Vdc / 230Vac	10 minutes	/	/	Error message: “119”. Inverter disconnected from grid immediately.
41	C292 (power board)	S-C	1000Vdc / 230Vac	10 minutes	/	/	Inverter disconnected from grid immediately and shutdown, No output, no hazard.
42	C299 (power board)	S-C	1000Vdc / 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.							

IEC 61727			
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		0.33	0.21

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:	0.085%	0.087%	0.053%
As % of rated AC current, L2:	0.071%	0.081%	0.092%
As % of rated AC current, L3:	0.163%	0.157%	0.162%

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

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

	Condition of test				Power(kW)				
	supplying power to balance linear loads 33% ±5%				39.75				P
	supplying power to balance linear loads 66 %±5%				79.60				P
	supplying power to balance linear loads 100 %±5%				119.95				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	57.450	99.623	114.807	99.544	172.270	99.578	L1	-	P
2	0.462	0.804	0.781	0.677	1.685	0.974	L1	<1%	P
3	0.165	0.288	0.417	0.362	0.791	0.457	L1	<4%	P
4	0.113	0.197	0.232	0.201	0.571	0.330	L1	<1%	P
5	0.883	1.537	2.127	1.844	4.214	2.436	L1	<4%	P
6	0.032	0.055	0.085	0.074	0.251	0.145	L1	<1%	P
7	0.755	1.314	1.586	1.375	2.906	1.680	L1	<4%	P
8	0.029	0.051	0.048	0.042	0.100	0.058	L1	<1%	P
9	0.076	0.133	0.134	0.116	0.159	0.092	L1	<4%	P
10	0.035	0.061	0.077	0.067	0.266	0.154	L1	<1%	P
11	0.407	0.708	1.036	0.898	2.126	1.229	L1	<2%	P
12	0.014	0.025	0.044	0.038	0.109	0.063	L1	<0.5%	P
13	0.307	0.534	0.702	0.609	1.048	0.606	L1	<2%	P
14	0.011	0.019	0.039	0.034	0.133	0.077	L1	<0.5%	P
15	0.094	0.163	0.211	0.183	0.199	0.115	L1	<2%	P
16	0.070	0.122	0.209	0.181	0.429	0.248	L1	<0.5%	P
17	0.250	0.435	0.691	0.599	0.590	0.341	L1	<1.5%	P
18	0.018	0.031	0.054	0.047	0.067	0.039	L1	<0.375%	P
19	0.325	0.565	0.373	0.323	0.410	0.237	L1	<1.5%	P
20	0.035	0.061	0.082	0.071	0.213	0.123	L1	<0.375%	P
21	0.037	0.064	0.123	0.107	0.221	0.128	L1	<1.5%	P
22	0.017	0.029	0.024	0.021	0.066	0.038	L1	<0.375%	P
23	0.030	0.052	0.188	0.163	0.896	0.518	L1	<0.6%	P
24	0.003	0.005	0.044	0.038	0.087	0.050	L1	<0.15%	P
25	0.049	0.086	0.149	0.129	0.521	0.301	L1	<0.6%	P
26	0.013	0.023	0.068	0.059	0.154	0.089	L1	<0.15%	P
27	0.005	0.008	0.013	0.011	0.028	0.016	L1	<0.6%	P
28	0.002	0.003	0.016	0.014	0.043	0.025	L1	<0.15%	P
29	0.007	0.012	0.043	0.037	0.206	0.119	L1	<0.6%	P
30	0.002	0.003	0.010	0.009	0.026	0.015	L1	<0.15%	P
31	0.016	0.027	0.067	0.058	0.211	0.122	L1	<0.6%	P
32	0.006	0.010	0.020	0.017	0.045	0.026	L1	<0.15%	P
33	0.001	0.002	0.007	0.006	0.052	0.030	L1	<0.6%	P
34	0.001	0.002	0.008	0.007	0.028	0.016	L1	<0.15%	P
35	0.003	0.006	0.030	0.026	0.145	0.084	L1	<0.3%	P
36	0.000	0.000	0.006	0.005	0.014	0.008	L1	<0.075%	P
37	0.006	0.011	0.062	0.054	0.142	0.082	L1	<0.3%	P
38	0.002	0.003	0.015	0.013	0.055	0.032	L1	<0.075%	P
39	0.001	0.002	0.013	0.011	0.042	0.024	L1	<0.3%	P
40	0.003	0.006	0.016	0.014	0.062	0.036	L1	<0.075%	P
THDi	--	2.713	---	2.325	---	2.211	L1	≤ 5%	P
Supplementary information:									

IEC 61727			
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%						39.75		P
	supplying power to balance linear loads 66 %±5%						79.60		P
	supplying power to balance linear loads 100 %±5%						119.95		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	57.393	99.427	114.782	99.471	172.102	99.426	L2		P
2	0.564	0.982	1.025	0.889	1.709	0.988	L2	<1%	P
3	0.247	0.430	0.482	0.418	1.125	0.650	L2	<4%	P
4	0.072	0.125	0.194	0.168	0.370	0.214	L2	<1%	P
5	1.202	2.092	1.992	1.727	4.818	2.785	L2	<4%	P
6	0.025	0.043	0.103	0.089	0.182	0.105	L2	<1%	P
7	0.719	1.251	1.372	1.190	2.725	1.575	L2	<4%	P
8	0.024	0.042	0.059	0.051	0.100	0.058	L2	<1%	P
9	0.064	0.111	0.142	0.123	0.273	0.158	L2	<4%	P
10	0.051	0.088	0.076	0.066	0.261	0.151	L2	<1%	P
11	0.439	0.764	0.592	0.513	2.005	1.159	L2	<2%	P
12	0.020	0.035	0.032	0.028	0.085	0.049	L2	<0.5%	P
13	0.349	0.607	0.563	0.488	1.182	0.683	L2	<2%	P
14	0.052	0.090	0.088	0.076	0.221	0.128	L2	<0.5%	P
15	0.145	0.253	0.319	0.277	0.246	0.142	L2	<2%	P
16	0.111	0.194	0.153	0.133	0.573	0.331	L2	<0.5%	P
17	0.417	0.726	0.819	0.710	0.794	0.459	L2	<1.5%	P
18	0.027	0.047	0.051	0.044	0.092	0.053	L2	<0.375%	P
19	0.204	0.355	0.490	0.425	0.734	0.424	L2	<1.5%	P
20	0.044	0.076	0.072	0.062	0.270	0.156	L2	<0.375%	P
21	0.047	0.082	0.103	0.089	0.242	0.140	L2	<1.5%	P
22	0.036	0.062	0.042	0.036	0.073	0.042	L2	<0.375%	P
23	0.114	0.198	0.158	0.137	0.756	0.437	L2	<0.6%	P
24	0.005	0.009	0.020	0.017	0.071	0.041	L2	<0.15%	P
25	0.064	0.112	0.057	0.049	0.465	0.269	L2	<0.6%	P
26	0.014	0.024	0.008	0.007	0.088	0.051	L2	<0.15%	P
27	0.008	0.014	0.016	0.014	0.038	0.022	L2	<0.6%	P
28	0.004	0.007	0.002	0.002	0.040	0.023	L2	<0.15%	P
29	0.025	0.043	0.024	0.021	0.216	0.125	L2	<0.6%	P
30	0.004	0.007	0.001	0.001	0.029	0.017	L2	<0.15%	P
31	0.039	0.068	0.031	0.027	0.223	0.129	L2	<0.6%	P
32	0.009	0.016	0.012	0.010	0.055	0.032	L2	<0.15%	P
33	0.002	0.004	0.000	0.000	0.029	0.017	L2	<0.6%	P
34	0.003	0.005	0.002	0.002	0.033	0.019	L2	<0.15%	P
35	0.009	0.015	0.001	0.001	0.097	0.056	L2	<0.3%	P
36	0.003	0.006	0.003	0.003	0.017	0.010	L2	<0.075%	P
37	0.028	0.049	0.008	0.007	0.168	0.097	L2	<0.3%	P
38	0.007	0.013	0.000	0.001	0.059	0.034	L2	<0.075%	P
39	0.007	0.012	0.009	0.008	0.021	0.012	L2	<0.3%	P
40	0.011	0.019	0.001	0.001	0.087	0.050	L2	<0.075%	P

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

THDi	---	2.472	---	2.449	---	2.125	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%					39.75			P
	supplying power to balance linear loads 66 %±5%					79.60			P
	supplying power to balance linear loads 100 %±5%					119.95			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	57.653	99.926	115.286	99.952	172.902	99.975	L3		P
2	0.200	0.677	1.123	0.974	1.391	0.804	L3	<1%	P
3	0.108	0.362	0.527	0.457	0.498	0.288	L3	<4%	P
4	0.060	0.201	0.381	0.330	0.341	0.197	L3	<1%	P
5	0.544	1.844	2.809	2.436	2.659	1.537	L3	<4%	P
6	0.023	0.074	0.167	0.145	0.095	0.055	L3	<1%	P
7	0.406	1.375	1.938	1.680	2.273	1.314	L3	<4%	P
8	0.013	0.042	0.067	0.058	0.088	0.051	L3	<1%	P
9	0.035	0.116	0.106	0.092	0.230	0.133	L3	<4%	P
10	0.021	0.067	0.178	0.154	0.106	0.061	L3	<1%	P
11	0.265	0.898	1.417	1.229	1.225	0.708	L3	<2%	P
12	0.012	0.038	0.073	0.063	0.043	0.025	L3	<0.5%	P
13	0.180	0.609	0.699	0.606	0.924	0.534	L3	<2%	P
14	0.011	0.034	0.089	0.077	0.033	0.019	L3	<0.5%	P
15	0.055	0.183	0.133	0.115	0.282	0.163	L3	<2%	P
16	0.054	0.181	0.286	0.248	0.211	0.122	L3	<0.5%	P
17	0.177	0.599	0.393	0.341	0.753	0.435	L3	<1.5%	P
18	0.015	0.047	0.045	0.039	0.054	0.031	L3	<0.375%	P
19	0.096	0.323	0.273	0.237	0.977	0.565	L3	<1.5%	P
20	0.022	0.071	0.142	0.123	0.106	0.061	L3	<0.375%	P
21	0.032	0.107	0.148	0.128	0.111	0.064	L3	<1.5%	P
22	0.007	0.021	0.044	0.038	0.050	0.029	L3	<0.375%	P
23	0.049	0.163	0.597	0.518	0.090	0.052	L3	<0.6%	P
24	0.012	0.038	0.058	0.050	0.009	0.005	L3	<0.15%	P
25	0.039	0.129	0.347	0.301	0.149	0.086	L3	<0.6%	P
26	0.018	0.059	0.103	0.089	0.040	0.023	L3	<0.15%	P
27	0.004	0.011	0.018	0.016	0.014	0.008	L3	<0.6%	P
28	0.005	0.014	0.029	0.025	0.005	0.003	L3	<0.15%	P
29	0.012	0.037	0.137	0.119	0.021	0.012	L3	<0.6%	P
30	0.004	0.009	0.017	0.015	0.005	0.003	L3	<0.15%	P
31	0.018	0.058	0.141	0.122	0.047	0.027	L3	<0.6%	P
32	0.006	0.017	0.030	0.026	0.017	0.010	L3	<0.15%	P
33	0.003	0.006	0.035	0.030	0.003	0.002	L3	<0.6%	P
34	0.003	0.007	0.018	0.016	0.003	0.002	L3	<0.15%	P
35	0.009	0.026	0.097	0.084	0.010	0.006	L3	<0.3%	P
36	0.002	0.005	0.009	0.008	0.000	0.000	L3	<0.075%	P

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

37	0.017	0.054	0.095	0.082	0.019	0.011	L3	<0.3%	P
38	0.005	0.013	0.037	0.032	0.005	0.003	L3	<0.075%	P
39	0.004	0.011	0.028	0.024	0.003	0.002	L3	<0.3%	P
40	0.005	0.014	0.042	0.036	0.010	0.006	L3	<0.075%	P
THDi		2.417		1.976		2.289	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)	0.9927	N/A
	L2(230Vac)	0.9931	
	L3(230Vac)	0.9957	
50	L1(230Vac)	0.9978	>0.90
	L2(230Vac)	0.9978	>0.90
	L3(230Vac)	0.9991	>0.90
100	L1(230Vac)	0.9992	>0.90
	L2(230Vac)	0.9999	>0.90
	L3(230Vac)	0.9999	>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: 60.2kW 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	All	L1	L2	L3	L3
	/	198.5	198.4	198.3	198.2	/	240.4	240.5	240.4	241.0
		198.4	198.3	198.0	198.1		240.5	240.5	240.4	240.8

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

		198.3	198.4	198.4	198.3		240.2	240.4	240.7	240.9
		198.5	198.7	198.4	198.6		240.3	240.5	240.6	240.3
	/	198.8	198.3	198.4	198.3	/	240.5	240.1	240.5	240.9
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	1.801	1.808	1.804		1.796	1.801	1.801	1.800
		1.804	1.800	1.800	1.799		1.800	1.802	1.808	1.802
		1.799	1.801	1.801	1.800		1.796	1.798	1.802	1.796
		1.796	1.798	1.797	1.792		1.800	1.802	1.796	1.798
		1.802	1.808	1.799	1.806		1.798	1.792	1.809	1.802
Reconnection time (Sec)	At least 120s	220s				At least 120s	220s			
Second Level										
Test conditions:	Output power: 61.8kW 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
	/	114.5	114.5	114.6	114.4	/	309.7	309.7	309.7	309.7
		114.5	114.4	114.3	114.6		309.7	309.6	309.4	309.8
		114.4	114.3	114.2	114.6		309.6	309.8	309.5	309.4
		114.5	114.3	114.6	114.3		309.3	309.6	309.7	309.6
	/	114.5	114.7	114.7	114.8	/	309.4	309.7	309.8	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
		71	74	76	75		28	30	29	28
		68	72	73	71		32	43	36	36
		73	64	63	70		36	38	46	40
		73	53	71	68		42	33	35	31
		77.5	78	78.5	71		29	39	36	38
Reconnection	At least	220s				At least	220s			

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

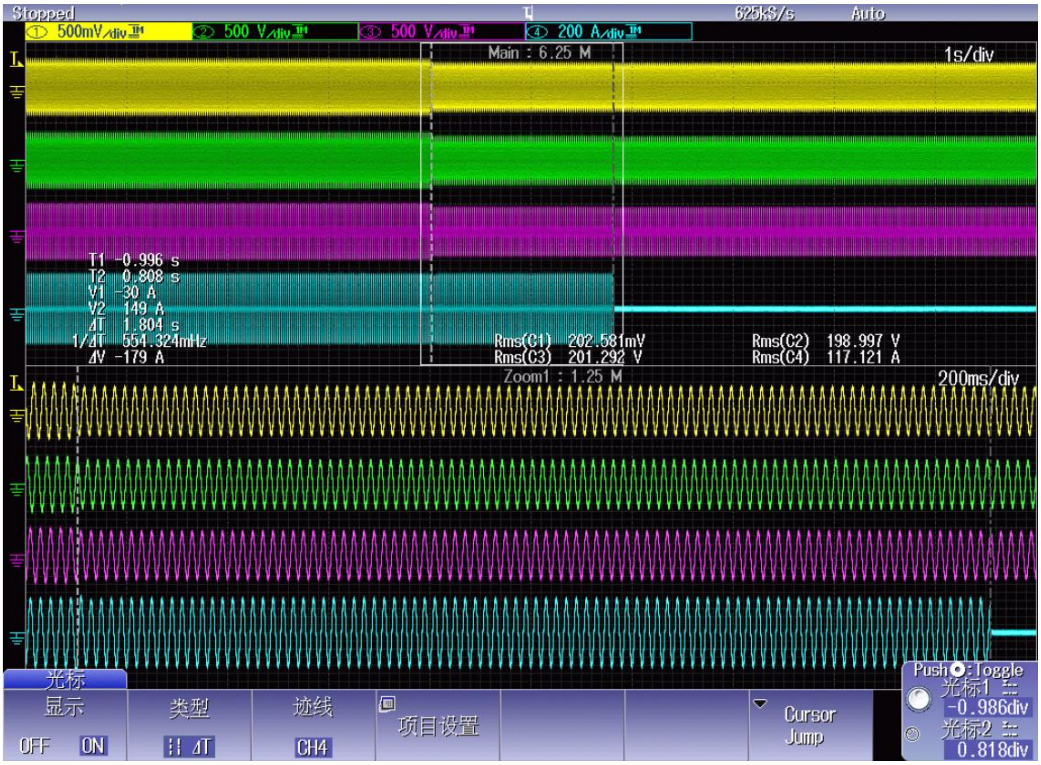
time (Sec)	120s		120s	

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.

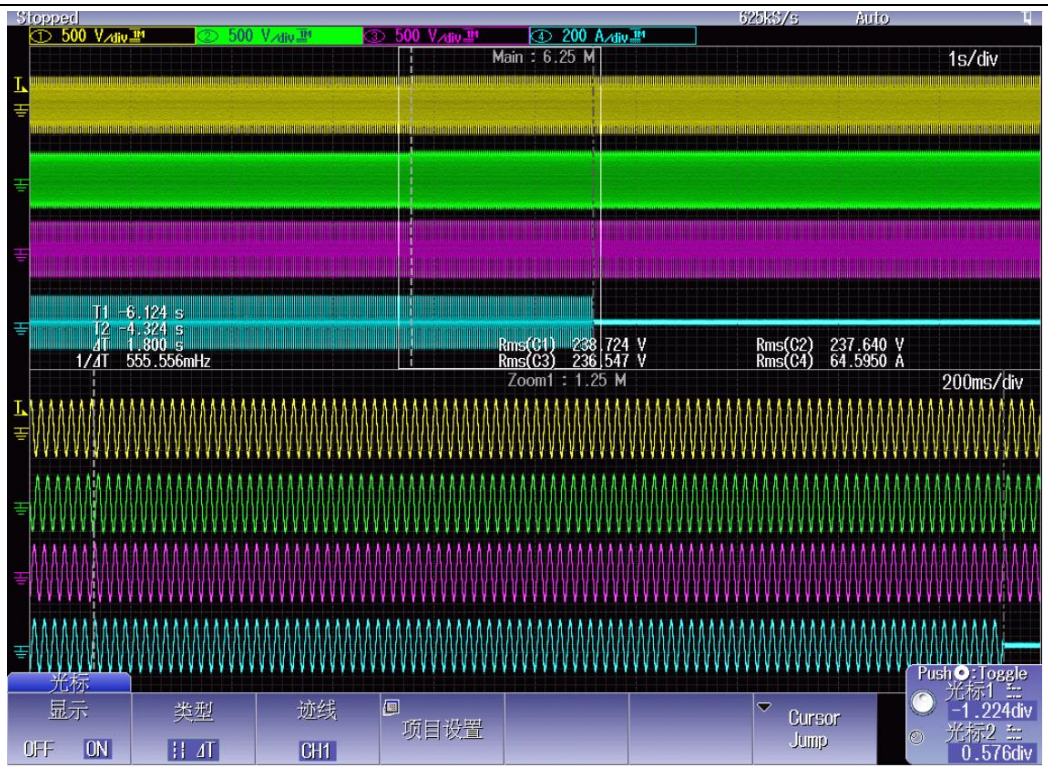
Response to utility recovery is according to the appropriate IEEE or IEC standard test methods.

Under Voltage First Level (All Phase)

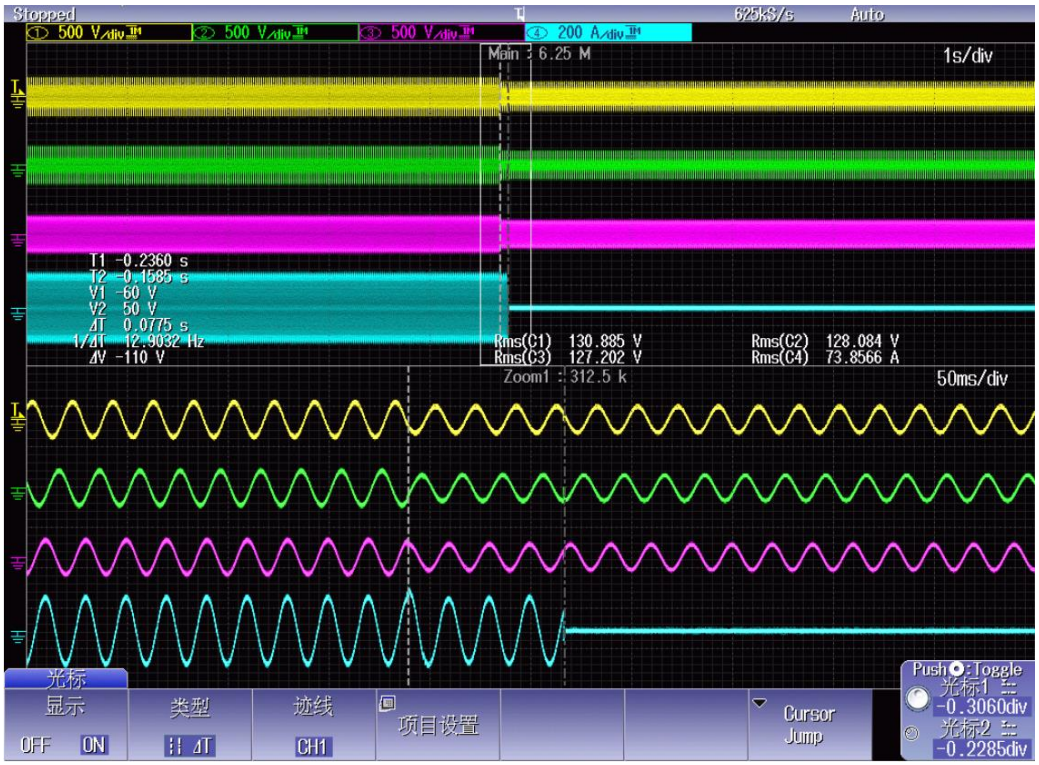


Over Voltage First Level (All Phase)

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

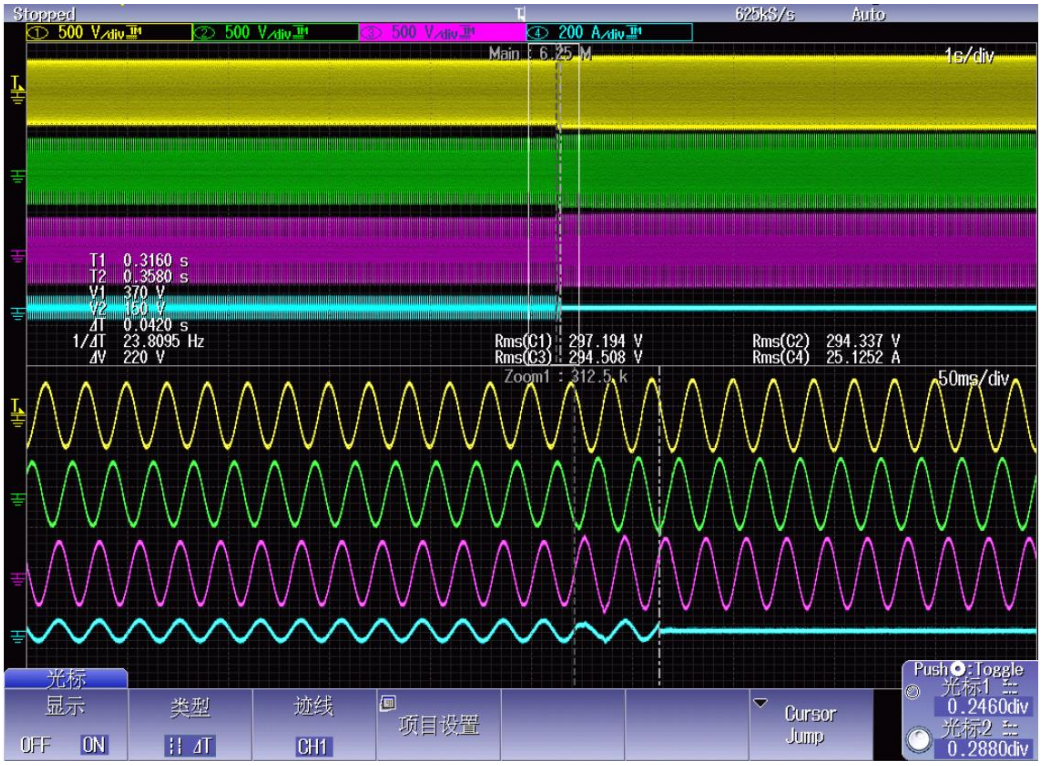


Under Voltage Second Level (All Phase)

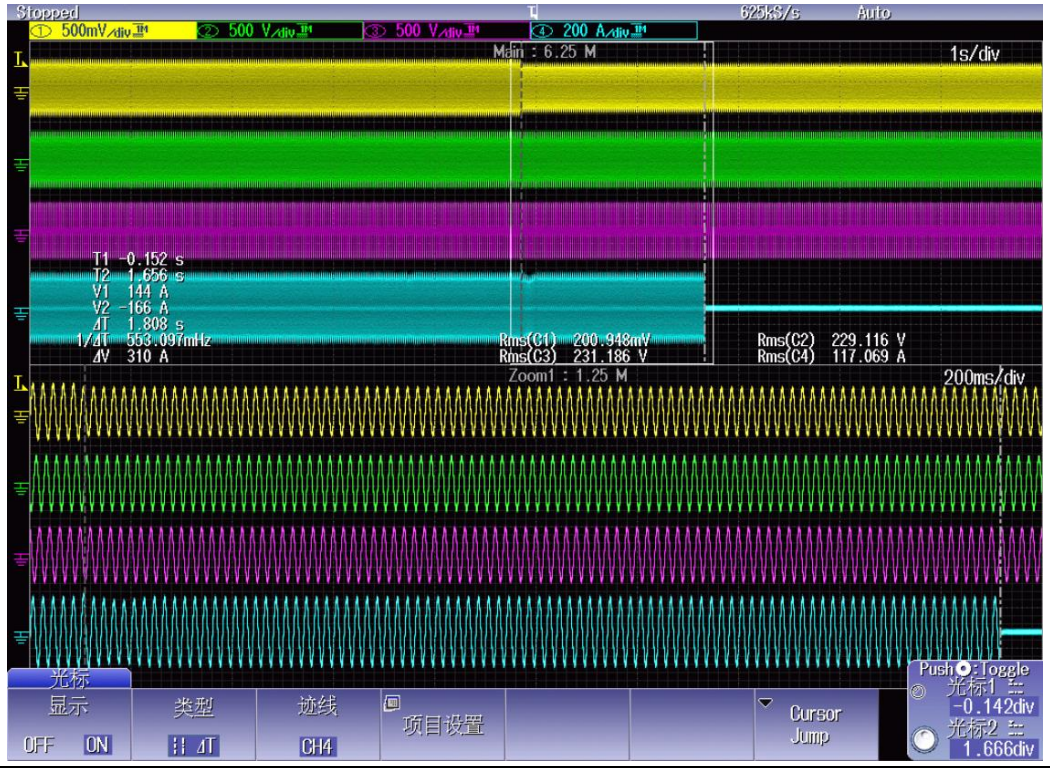


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage Second Level (All Phase)

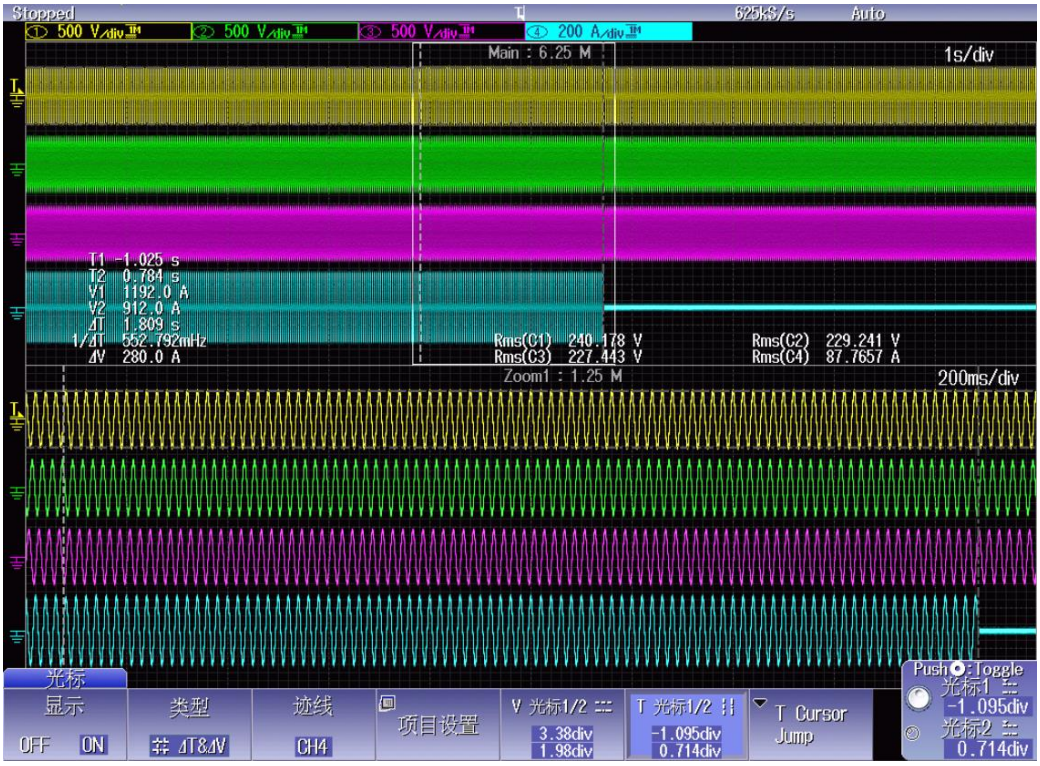


Under Voltage First Level (Each Phase)

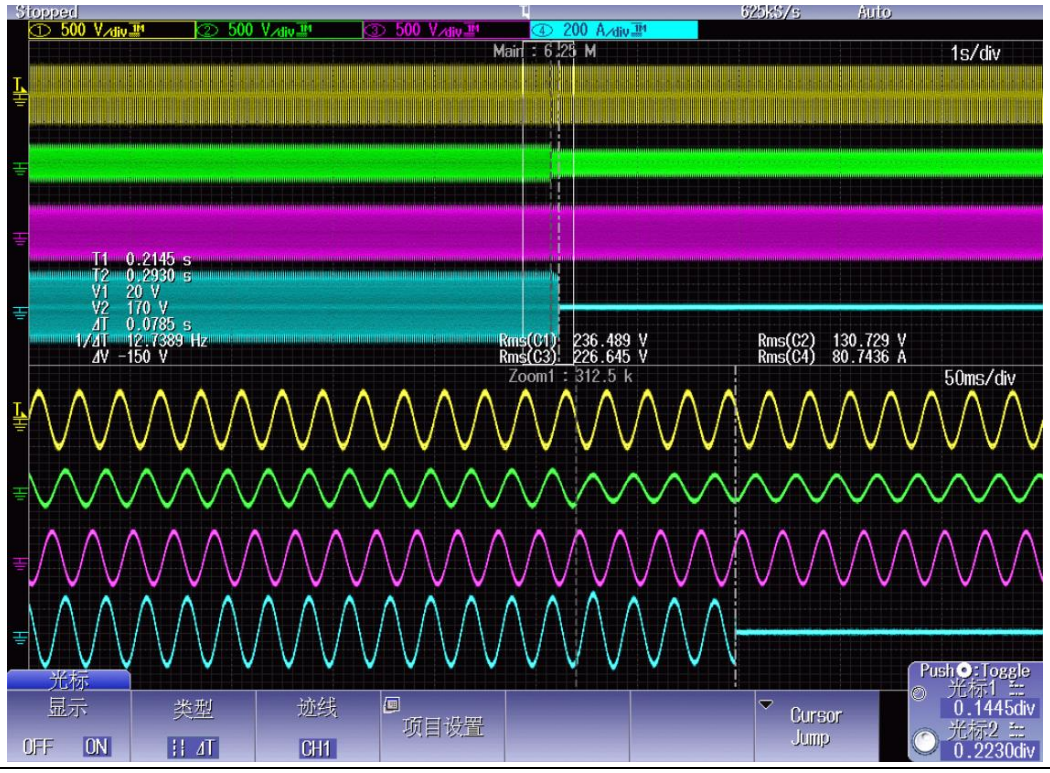


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Voltage First Level (Each Phase)

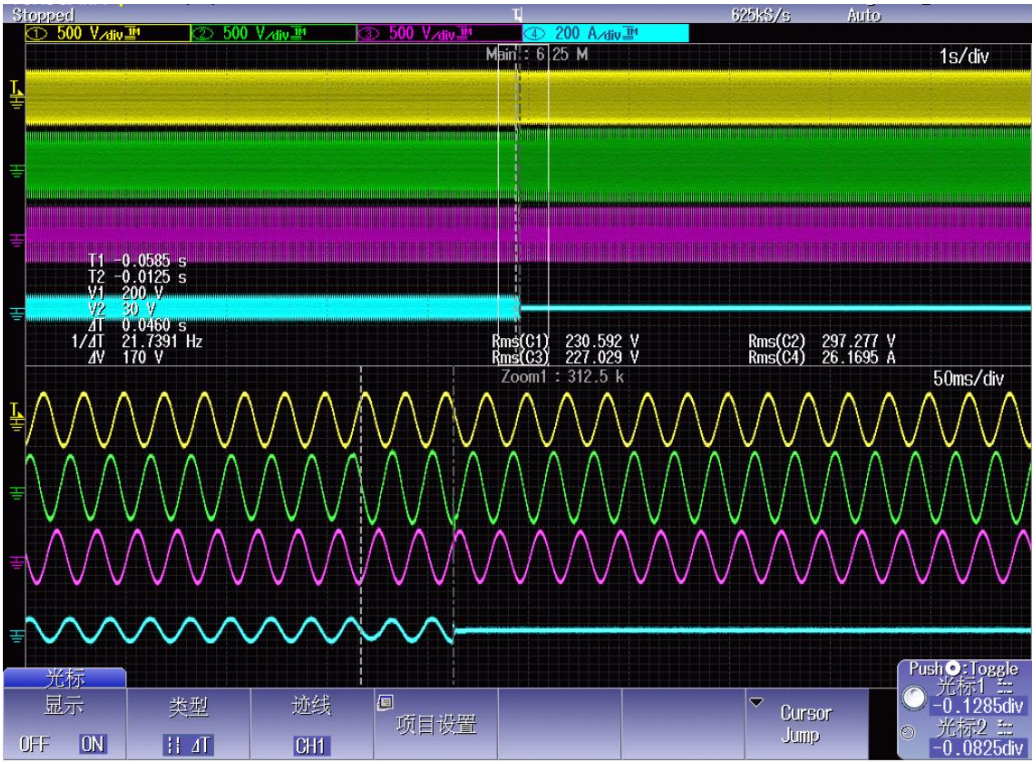


Under Voltage Second Level (Each Phase)



IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

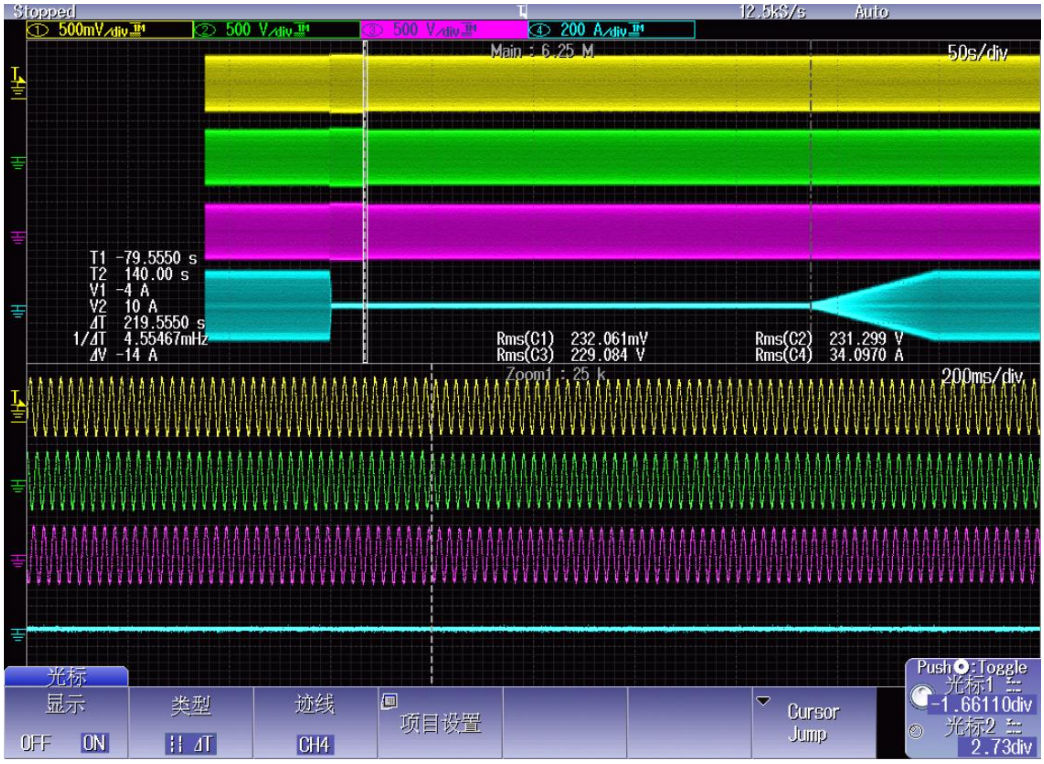
Over Voltage Second Level (Each Phase)



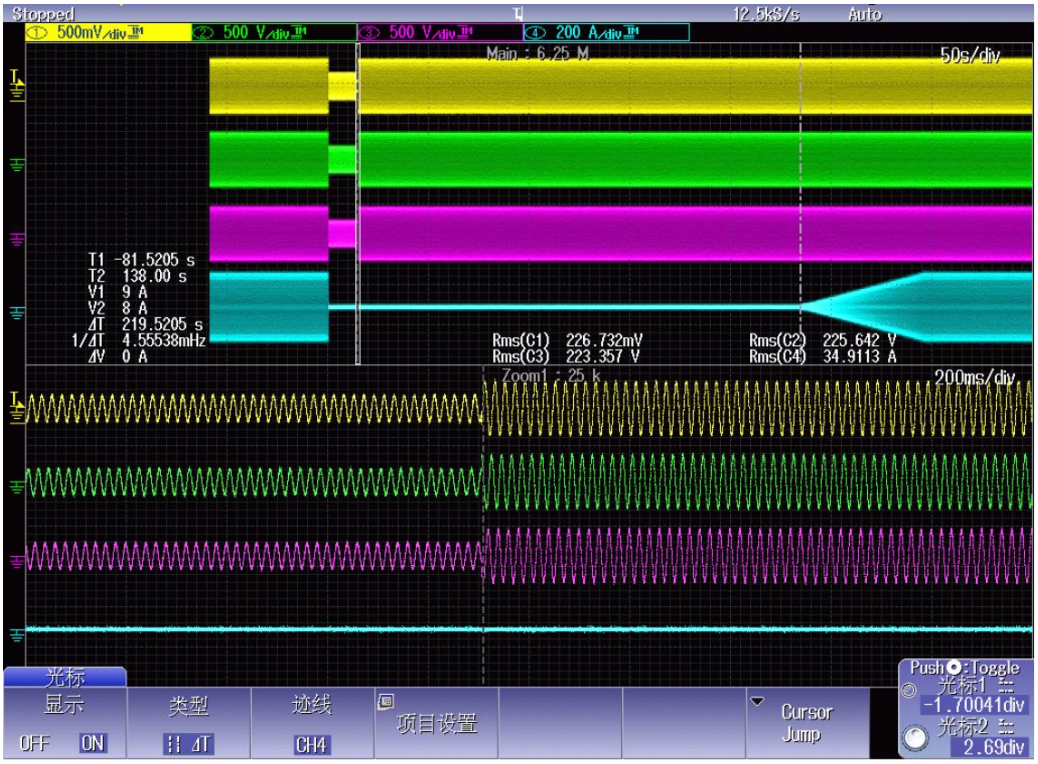
Reconnection after Under Voltage First Level

IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Reconnection after Over Voltage First Level

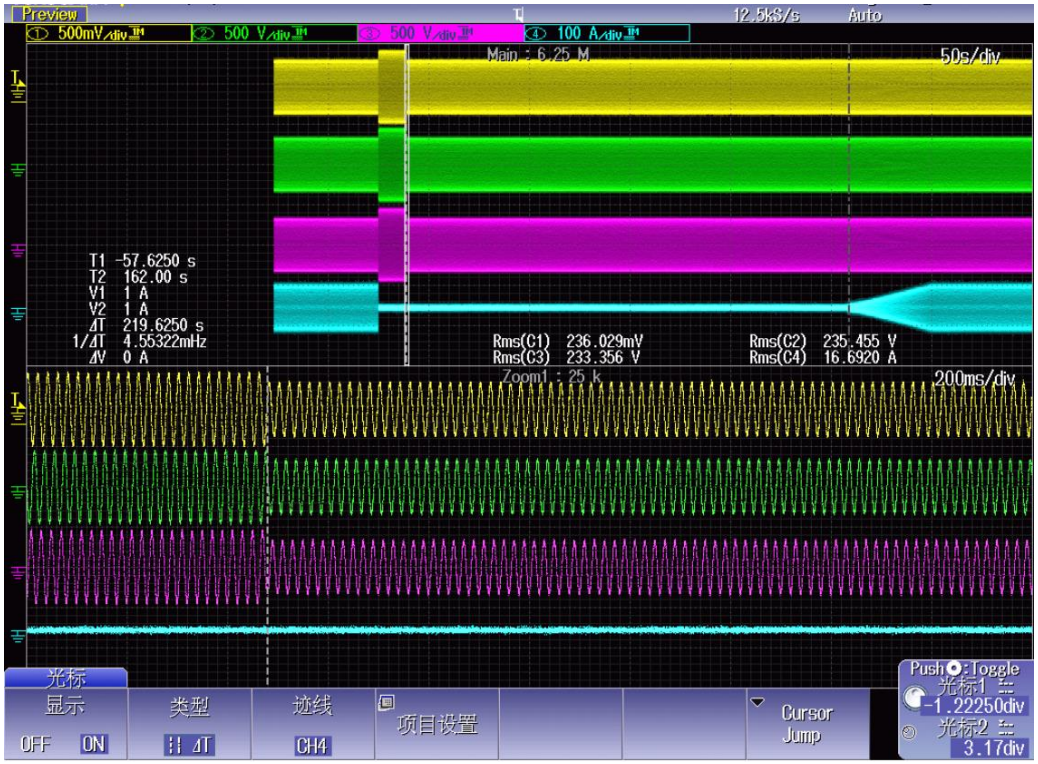


Reconnection after Under Voltage Second Level



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		46.91		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	

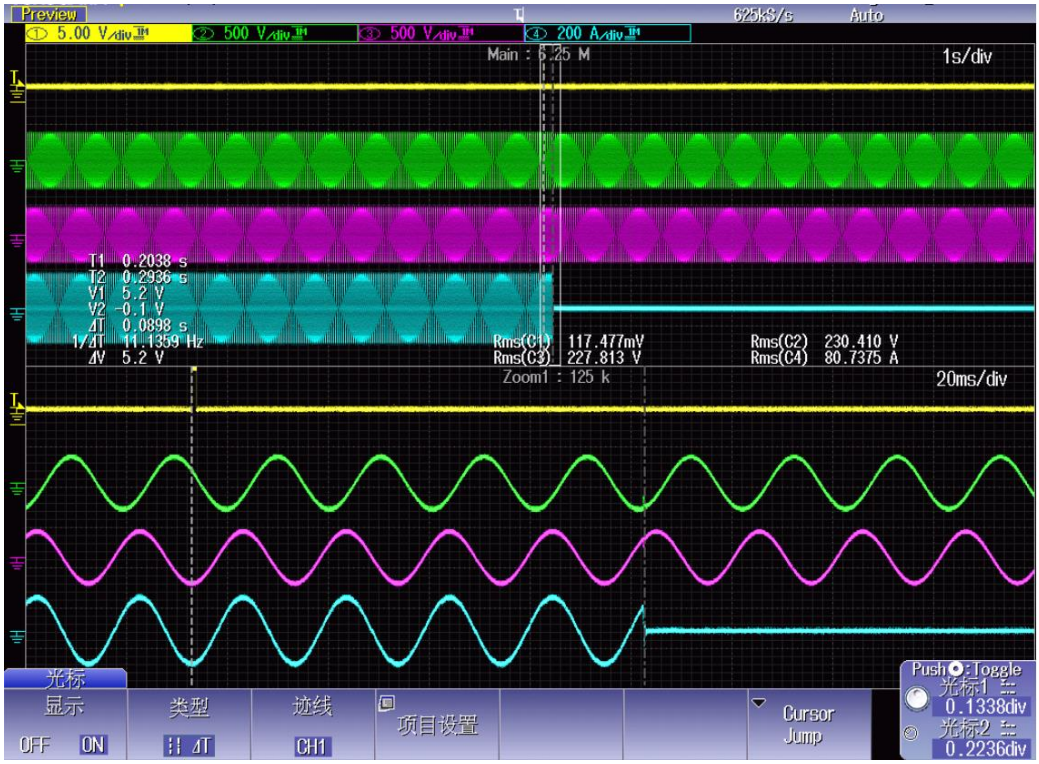
IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

		46.91		52.09
Parameter		Time [ms]		Time [ms]
Limit		<= 100ms		<= 100ms
Disconnection time	49.40Hz to 48.80Hz	68	50.60 Hz to 51.20 Hz	72
		72		76
		74		80
		74		89
		72		78
		90		76
Reconnection time(Sec)	at least 120s	223s	at least 120s	221s

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.

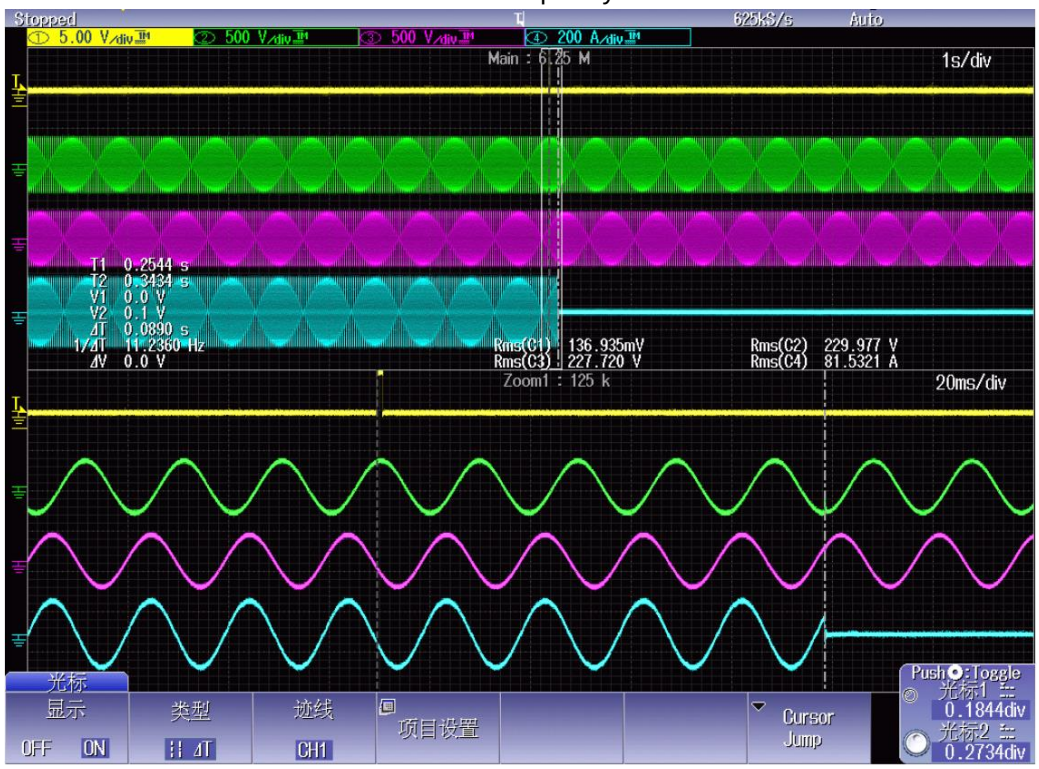
Response to Utility Recovery Test:
The test methods shall be in accordance with IEEE 1547.1-2005 clause 5.10 and evaluation criteria refer to clause 3.2.4 in this regulation.

Under Frequency

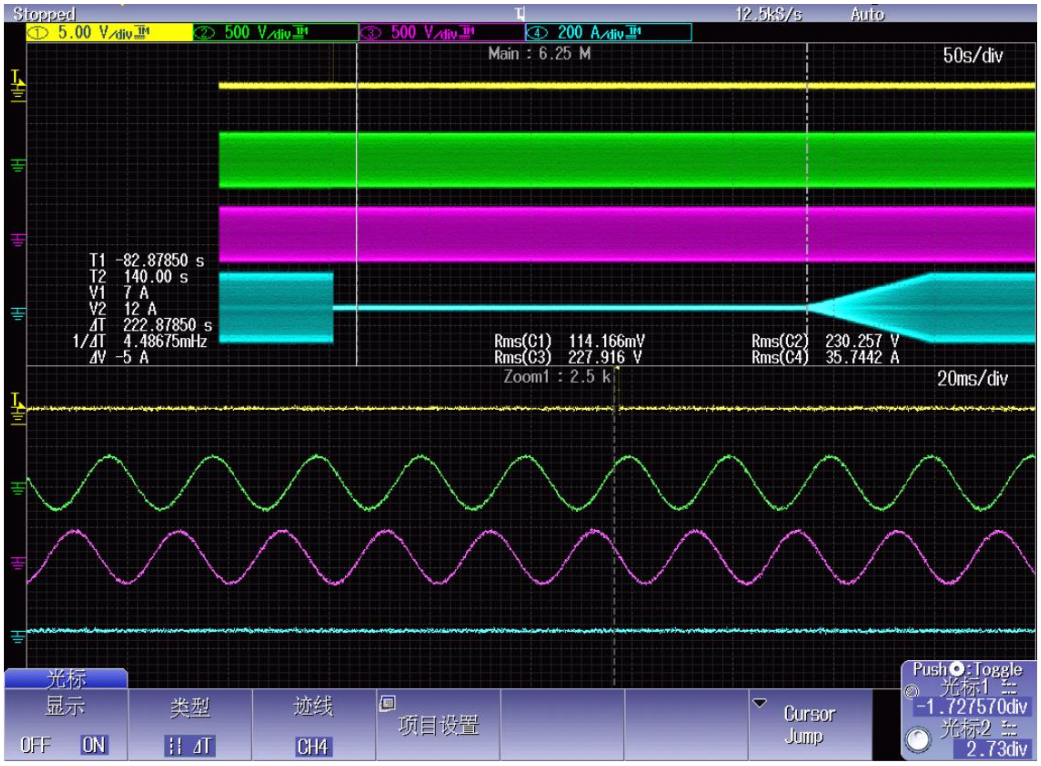


IEC 61727			
Clause	Requirement – Test	Result - Remark	Verdict

Over Frequency

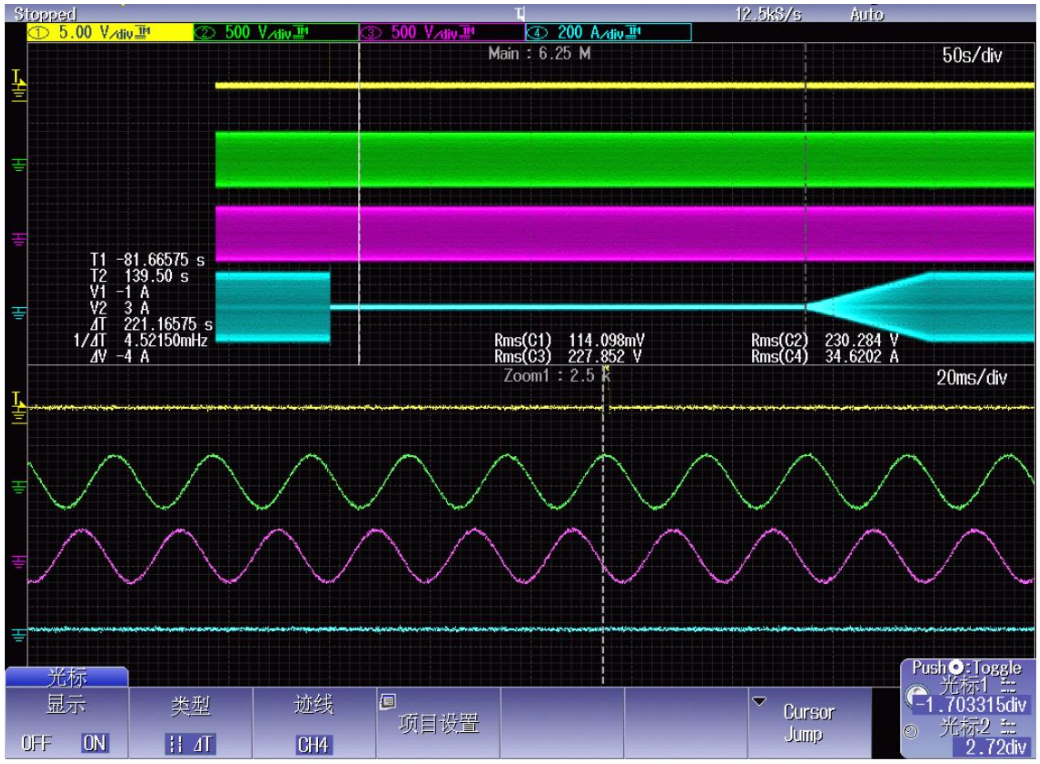


Reconnection after Under Frequency:



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	176	39.891	0.998	818	Test A at BL
2	100	100	-5	-5	160	39.891	1.021	818	Test A at IB
3	100	100	-5	0	159	39.891	1.039	818	Test A at IB
4	100	100	-5	+5	138	39.891	1.081	818	Test A at IB
5	100	100	0	-5	134	39.891	0.972	818	Test A at IB
6	100	100	0	+5	168	39.891	1.020	818	Test A at IB
7	100	100	+5	-5	159	39.891	0.928	818	Test A at IB
8	100	100	+5	0	157	39.891	0.957	818	Test A at IB
9	100	100	+5	+5	157	39.891	0.964	818	Test A at IB
Parameter at 0% per phase			L= 51.49 mH		R= 17.32 Ω		C= 189.73 µF		
IAC fundamental current at balance condition			L1: 71 mA		L2: 89 mA		L3: 71 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

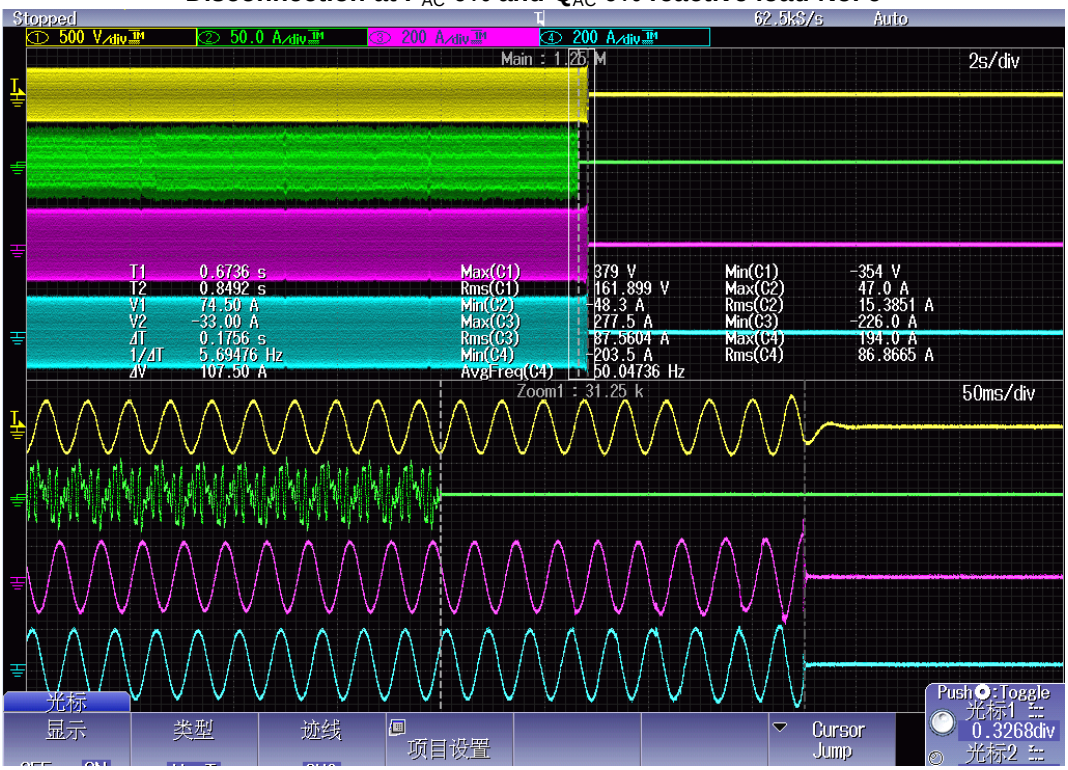
2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

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. 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(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=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	216	26.628	0.985	700	Test B at IB
2	66	66	0	-4	180	26.628	0.987	700	Test B at IB
3	66	66	0	-3	183	26.628	0.981	700	Test B at IB
4	66	66	0	-2	183	26.628	0.995	700	Test B at IB
5	66	66	0	-1	155	26.628	0.998	700	Test B at IB
6	66	66	0	0	196	26.628	1.001	700	Test B at BL
7	66	66	0	1	173	26.628	1.009	700	Test B at IB
8	66	66	0	2	167	26.628	1.012	700	Test B at IB
9	66	66	0	3	165	26.628	1.017	700	Test B at IB
10	66	66	0	4	162	26.628	1.022	700	Test B at IB
11	66	66	0	5	159	26.628	1.027	700	Test B at IB

Parameter at 0% per phase	L= 78.43 mH	R= 24.39 Ω	C= 117.08 µF
IAC fundamental current at balance condition	L1: 16 mA	L2: 39 mA	L3: 41 mA

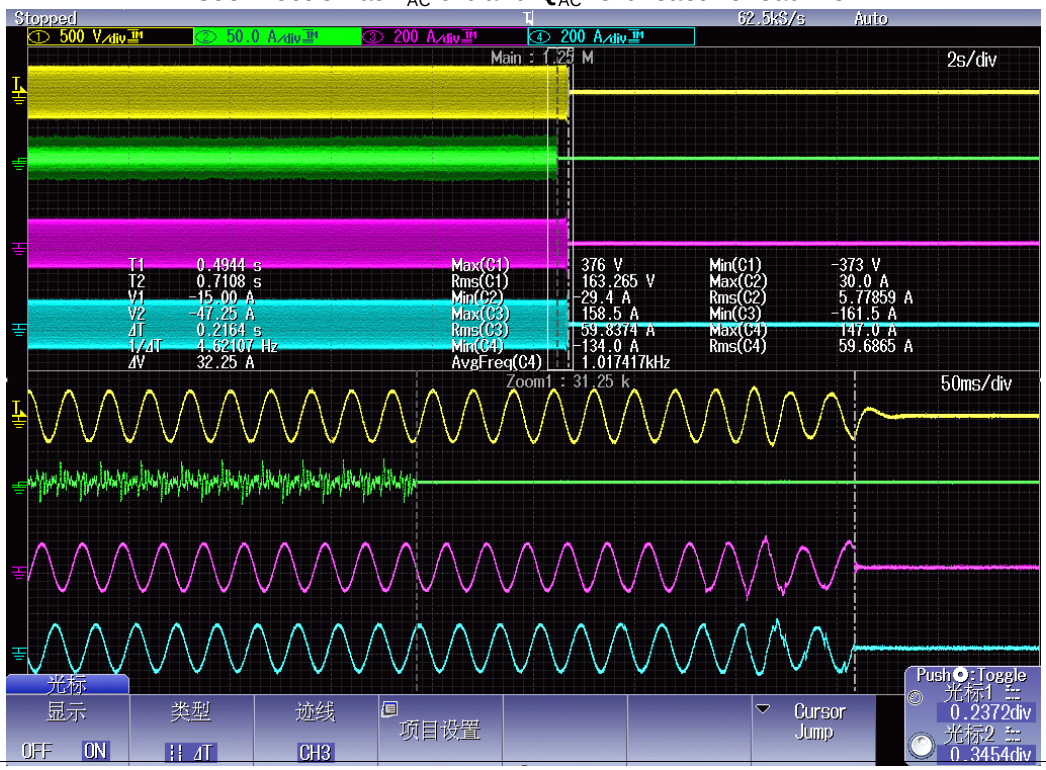
Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) PEUT: EUT output power

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	227	13.227	0.977	590	Test C at IB
2	33	33	0	-4	175	13.227	0.983	590	Test C at IB
3	33	33	0	-3	161	13.227	0.987	590	Test C at IB
4	33	33	0	-2	176	13.227	0.992	590	Test C at IB
5	33	33	0	-1	174	13.227	0.998	590	Test C at IB

IEC 62116			
Clause	Requirement – Test	Result - Remark	Verdict

6	33	33	0	0	127	13.227	1.003	590	Test C at BL
7	33	33	0	1	165	13.227	1.006	590	Test C at IB
8	33	33	0	2	112	13.227	1.011	590	Test C at IB
9	33	33	0	3	188	13.227	1.016	590	Test C at IB
10	33	33	0	4	157	13.227	1.021	590	Test C at IB
11	33	33	0	5	146	13.227	1.026	590	Test C at IB

Parameter at 0% per phase	L= 150.33 mH	R= 48.27 Ω	C= 65.49 µF
IAC fundamental current at balance condition	L1: 42 mA	L2: 54 mA	L3: 44 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. 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

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