TESTREPORT

Grid-connected Inverter Regulation of Provincial Electricity Authority(PEA)

Report Number. .....:	ES190702001P
Date of issue.....:	July 30. 2019
Total number of pages.....	48 pages
Testing Laboratory Name .....:	EMTEK (SHENZHEN) CO., LTD.
Address.....:	Bldg 69. Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China
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
Non-standard test method…….....:	N/A
Test item description……..:	Hybrid Power systems
Trade mark……..:	ATESS
Reference……..:	N/A
Number……..:	HPS120
Firmware version……..:	TI1.0
Date of receipt of test item.....:	July 03. 2019
Date(s) of performance of test.....:	July 03. 2019 to July 29. 2019
Date of report issue .....:	July 30. 2019

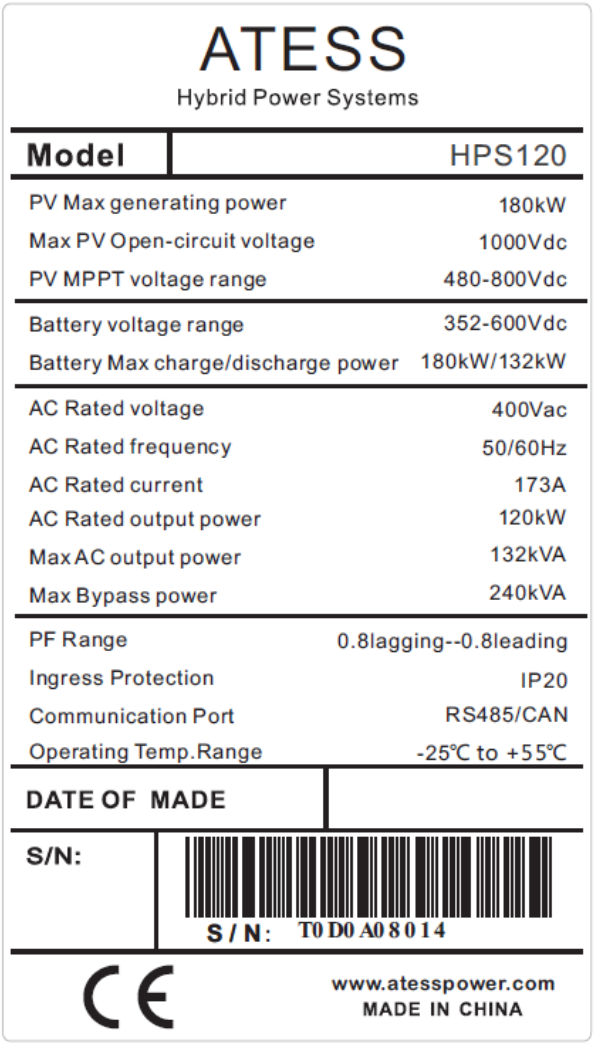
Tested by	Review by	Approved by
Tom Tao	Double Lee	Paladin Hu
(Mr. Tom Tao)	(Mr. Double Lee)	(Mr. Paladin Hu)
Testing Engineer	Project Engineer	Department Manager
(2019-07-30)	(2019-07-30)	(2019-07-30)

Summary of testing

Test result of PV Grid-tied inverter model HPS120, It was tested by SHENZHEN EMTEK CO., LTD and complied according to requirements on grid connection of Provincial Electricity Authority (PEA) as following

Clause	Item	Standard method	Result
1	Harmonics	IEC 61000-3-2	PASS
2	Voltage Fluctuation	IEC 61000-3-5	PASS
3	Direct Current Injection	IEC 61727	PASS
4	Reactive Power Control	PEA	PASS
5	Active Power Control	PEA	PASS
6	Low Voltage Fault Ride Through	PEA	PASS
7	Under and Over Voltage Protection	IEC 61727	PASS
8	Under and Over Frequency Protection	IEC 61727	PASS
9	Anti-Islanding	IEC 62116	PASS
10	Response to Utility Recovery	IEC 61727	PASS

Copy of marking plate:



Test item particulars .....

Type of the Test……..: [x] Design Test []Routine Test

Rating

MPP DC voltage range [V] ..... : 480-820Vd.c

Input DC voltage max [V] ..... : 1000Vd.c

Input DC current max [A]..... : 300A

Output AC voltage [V]..... : 400Va.c

Output AC current rated [A] .....: 173A

Output power [W]..... : 120kW

Equipment mobility ..... : [] movable [] hand-held
[x] stationary []fixed
[] transportable [] for building-in

Connection to the mains..... : []pluggable equipment [] direct plug-in
[x] permanent connection [] for building-in

Mass of equipment (kg) .....: For Inverter: 100kg

IP protection class .....: IP20

Possible test case verdicts:

– test case does not apply to the test object ... N/A

– test object does meet the requirement ..... Pass (P)

– test object does not meet the requirement .... Fail (F)

General remarks:

"(see Attachment #)" refers to additional information appended to the report.

"(see 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.

GRID-CONNECTED INVERTER REGULATION OF PROVINCIAL ELECTRICITY AUTHORITY (PEA)			
Clause	Requirement – Test	Result – Remark	Verdict
1	Harmonics		P
	The power generating system of VSPP must not inject harmonic current to the grid system exceeding the limit based on the PEA's rules concerning the Regulations of Grid Connection B.E.2559. In terms of verification at other levels of voltage beyond the aforementioned requirements, the appropriate standard of IEC must be applied.	See table 1	P
2	Voltage Fluctuation		P
	The power generating system of VSPP must not create voltage fluctuation exceeding the limit based on the PEA's rules concerning the Regulations on Grid Connection B.E.2559.		P
	Inverters shall not cause voltage fluctuation beyond the limits defined by the IEC 61000-3-3 (2008) for inverters with rated current ≤ 16 A		N
	IEC 61000-3-5 (2009) for inverters with rated currents greater than 75 A or	See table 2	P
	IEC 61000-3-11 (2000) for inverters with rated currents ≤75 A.		N
3	Direct Current Injection		P
	The power generating system of VSPP must not supply direct current to the grid system exceeding the limit based on the PEA's regulations concerning the Regulations on Grid Connection B.E.2559.	See table 3	P
4	Reactive Power Control		P
	The power generating system of VSPP must be able to control power factor (PF) or reactive power to maintain voltage level at PCC aligned with PEA's standards. The power generating system of service applicants must have capacity as stated in Table 1.	See table 4	P
4.1	Voltage Level at PCC is Low voltage Capacity in Adjusting Power Factor at 0.95 lagging to 0.95 leading as a minimum Reactive Power Control Methods: At least one method can control which is a fixed displacement factor cos θ	See table 4.1	P
4.2	Voltage Level at PCC is moderate voltage or high voltage (electrical installation not exceeding 500 kilowatt). Capacity in Adjusting Power Factor at 0.95 lagging to 0.95 leading as a minimum Reactive Power Control Methods: At least one method can control which is a fixed displacement factor cos θ		N

GRID-CONNECTED INVERTER REGULATION OF PROVINCIAL ELECTRICITY AUTHORITY (PEA)			
Clause	Requirement – Test	Result – Remark	Verdict
4.3	Voltage Level at PCC is Moderate voltage or high voltage (electrical installation exceeding 500 kilowatt). Capacity in Adjusting Power Factor at 0.90 lagging to 0.90 leading as a minimum		N
	Reactive Power Control Methods: can control which a fixed displacement factor cos θ		N
	Reactive Power Control Methods: can control which a variable reactive power depending on the voltage Q(U)		N
5	Active Power Control		P
	The power generating system of VSPP must be capable of reducing electric power from 100% to zero by decreasing 10% electric power per one minute. In this regard, if there is any abnormality occurred in the grid system or any incident considered by PEA as an impact affecting safety and stability of the grid system, PEA would inform and/or give an order to the VSPP to reduce electric power as appropriate.	See table 5	P
6	Low Voltage Fault Ride Through		P
	The power system of VSPP must not disconnect itself from the grid system within the required period during temporary low voltage of the grid system. The voltage at PCC is determined as shown in Table 2. Table 2. Duration of Low Voltage Fault Ride Through	See table 6	P
7	Under and Over Voltage Protection		P

Voltage at PCC	Duration Time (Second)
1) Low voltage 2) Moderate voltage or high voltage (electrical installation not exceeding 500kilowatt)	Not required
3) Moderate voltage or high voltage (electrical installation exceeding 500kilowatt).	As shown in Picture 1.

GRID-CONNECTED INVERTER REGULATION OF PROVINCIAL ELECTRICITY AUTHORITY (PEA)			
Clause	Requirement – Test	Result – Remark	Verdict
	The power system of VSPP must disconnect itself from the grid system if voltage level of line to neutral in the utility system is out of ranges as stated in Table 3 Table 3. The Disconnect Duration of Falling Voltage Out of Rated Voltage Ranges	see table 7	P
8	Under and Over Frequency Protection		P
	The power generating system of VSPP must disconnect itself from the grid system within 0.1 seconds if the frequency at PCC is not in the range of 47Hz-52Hz.	See table 8	P
9	Anti-Islanding		P
	In order to prevent anti-islanding while there is no electricity in grid system to be supplied to the power system of VSPP, the power generating system of VSPP must disconnect itself from the utility system within 1 seconds	See table 9	P
10	Response to Utility Recovery		P
	After the power generating system of VSPP disconnect itself from the grid system because of power outage or voltage/frequency is out of the ranges, when the grid system is back to normal, the power system of VSPP must delay the time to reconnect itself to the grid system at a minimum of 20 seconds to 5 minutes.	See table 10	P

1	TABLE: Current Harmonics								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	57.450	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:									

1	TABLE: Current Harmonics								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
THDi	---	2.472	---	2.449	---	2.125	L2	≤ 5%	P
Supplementary information:									

1	TABLE: Current Harmonics								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
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:									

1	TABLE: Voltage Harmonics								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 Voltage Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(V)	(%)	(V)	(%)	(V)	(%)			
1	230.01	100	230.03	100	230.18	100	L1	-	P
2	0.177	0.077	0.186	0.081	0.177	0.077	L1	<2%	P
3	1.854	0.806	1.778	0.773	1.854	0.806	L1	<4%	P
4	0.591	0.257	0.035	0.015	0.591	0.257	L1	<2%	P
5	0.276	0.120	0.313	0.136	0.276	0.120	L1	<4%	P
6	0.018	0.008	0.009	0.004	0.018	0.008	L1	<2%	P
7	0.216	0.094	0.182	0.079	0.216	0.094	L1	<4%	P
8	0.002	0.001	0.005	0.002	0.002	0.001	L1	<2%	P
9	0.145	0.063	0.143	0.062	0.145	0.063	L1	<4%	P
10	0.021	0.009	0.016	0.007	0.021	0.009	L1	<2%	P
11	0.104	0.045	0.062	0.027	0.104	0.045	L1	<4%	P
12	0.028	0.012	0.021	0.009	0.028	0.012	L1	<2%	P
13	0.421	0.183	0.028	0.012	0.421	0.183	L1	<4%	P
14	0.152	0.066	0.018	0.008	0.152	0.066	L1	<2%	P
15	0.101	0.044	0.087	0.038	0.101	0.044	L1	<4%	P
16	0.051	0.022	0.016	0.007	0.051	0.022	L1	<2%	P
17	0.472	0.205	0.092	0.040	0.472	0.205	L1	<4%	P
18	0.051	0.022	0.012	0.005	0.051	0.022	L1	<2%	P
19	0.370	0.161	0.074	0.032	0.370	0.161	L1	<4%	P
20	0.012	0.005	0.012	0.005	0.012	0.005	L1	<2%	P
21	0.104	0.045	0.104	0.045	0.104	0.045	L1	<4%	P
22	0.009	0.004	0.009	0.004	0.009	0.004	L1	<2%	P
23	0.051	0.022	0.051	0.022	0.051	0.022	L1	<4%	P
24	0.009	0.004	0.009	0.004	0.009	0.004	L1	<2%	P
25	0.046	0.020	0.046	0.020	0.046	0.020	L1	<4%	P
26	0.014	0.006	0.014	0.006	0.014	0.006	L1	<2%	P
27	0.051	0.022	0.044	0.019	0.051	0.022	L1	<4%	P
28	0.085	0.037	0.014	0.006	0.085	0.037	L1	<2%	P
29	0.101	0.044	0.037	0.016	0.101	0.044	L1	<4%	P
30	0.016	0.007	0.016	0.007	0.016	0.007	L1	<2%	P
31	0.117	0.051	0.023	0.010	0.117	0.051	L1	<4%	P
32	0.051	0.022	0.007	0.003	0.051	0.022	L1	<2%	P
33	0.035	0.015	0.009	0.004	0.035	0.015	L1	<4%	P
34	0.131	0.057	0.005	0.002	0.131	0.057	L1	<2%	P
35	0.064	0.028	0.007	0.003	0.064	0.028	L1	<4%	P
36	0.037	0.016	0.009	0.004	0.037	0.016	L1	<2%	P
37	0.097	0.042	0.039	0.017	0.097	0.042	L1	<4%	P
38	0.014	0.006	0.012	0.005	0.014	0.006	L1	<2%	P
39	0.014	0.006	0.037	0.016	0.014	0.006	L1	<4%	P
40	0.014	0.006	0.005	0.002	0.014	0.006	L1	<2%	P
THDv	--	0.843	--	0.816	--	0.892	L1	≤ 5%	P
Supplementary information:									

1	TABLE: Voltage Harmonics								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 Voltage Harmonics Measurement								
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase	Limit (% of output current)	Result
	(V)	(%)	(V)	(%)	(V)	(%)			
1	230.03	100	230.31	100	230.01	100	L2	-	P
2	0.169	0.077	0.189	0.082	0.177	0.077	L2	<2%	P
3	1.773	0.806	1.803	0.784	1.854	0.806	L2	<4%	P
4	0.565	0.257	0.018	0.008	0.591	0.257	L2	<2%	P
5	0.264	0.120	0.216	0.094	0.276	0.120	L2	<4%	P
6	0.018	0.008	0.002	0.001	0.018	0.008	L2	<2%	P
7	0.207	0.094	0.145	0.063	0.216	0.094	L2	<4%	P
8	0.002	0.001	0.021	0.009	0.002	0.001	L2	<2%	P
9	0.139	0.063	0.104	0.045	0.145	0.063	L2	<4%	P
10	0.020	0.009	0.028	0.012	0.021	0.009	L2	<2%	P
11	0.099	0.045	0.421	0.183	0.104	0.045	L2	<4%	P
12	0.026	0.012	0.028	0.012	0.028	0.012	L2	<2%	P
13	0.403	0.183	0.046	0.020	0.421	0.183	L2	<4%	P
14	0.145	0.066	0.023	0.010	0.152	0.066	L2	<2%	P
15	0.087	0.038	0.087	0.038	0.101	0.044	L2	<4%	P
16	0.016	0.007	0.021	0.009	0.051	0.022	L2	<2%	P
17	0.092	0.040	0.099	0.043	0.472	0.205	L2	<4%	P
18	0.012	0.005	0.014	0.006	0.051	0.022	L2	<2%	P
19	0.074	0.032	0.064	0.028	0.370	0.161	L2	<4%	P
20	0.012	0.005	0.009	0.004	0.012	0.005	L2	<2%	P
21	0.092	0.040	0.097	0.042	0.104	0.045	L2	<4%	P
22	0.007	0.003	0.005	0.002	0.009	0.004	L2	<2%	P
23	0.067	0.029	0.051	0.022	0.051	0.022	L2	<4%	P
24	0.012	0.005	0.009	0.004	0.009	0.004	L2	<2%	P
25	0.035	0.015	0.032	0.014	0.046	0.020	L2	<4%	P
26	0.016	0.007	0.012	0.005	0.014	0.006	L2	<2%	P
27	0.051	0.022	0.044	0.019	0.051	0.022	L2	<4%	P
28	0.021	0.009	0.016	0.007	0.085	0.037	L2	<2%	P
29	0.030	0.013	0.030	0.013	0.101	0.044	L2	<4%	P
30	0.016	0.007	0.014	0.006	0.016	0.007	L2	<2%	P
31	0.014	0.006	0.023	0.010	0.117	0.051	L2	<4%	P
32	0.009	0.004	0.009	0.004	0.051	0.022	L2	<2%	P
33	0.007	0.003	0.005	0.002	0.035	0.015	L2	<4%	P
34	0.009	0.004	0.007	0.003	0.131	0.057	L2	<2%	P
35	0.005	0.002	0.005	0.002	0.064	0.028	L2	<4%	P
36	0.009	0.004	0.007	0.003	0.037	0.016	L2	<2%	P
37	0.041	0.018	0.041	0.018	0.097	0.042	L2	<4%	P
38	0.009	0.004	0.009	0.004	0.014	0.006	L2	<2%	P
39	0.037	0.016	0.035	0.015	0.014	0.006	L2	<4%	P
40	0.007	0.003	0.007	0.003	0.014	0.006	L2	<2%	P
THDv	--	0.838	--	0.826	--	0.901	L2	≤ 5%	P

Supplementary information:

1	TABLE: Voltage Harmonics								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 Voltage Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(V)	(%)	(V)	(%)	(V	(%)			
1	230.08	100	230.13	100	230.01	100	L3	-	P
2	0.179	0.078	0.172	0.077	0.169	0.077	L3	<2%	P
3	1.792	0.779	1.714	0.806	1.773	0.806	L3	<4%	P
4	0.037	0.016	0.035	0.257	0.565	0.257	L3	<2%	P
5	0.281	0.122	0.268	0.120	0.264	0.120	L3	<4%	P
6	0.016	0.007	0.015	0.008	0.018	0.008	L3	<2%	P
7	0.225	0.098	0.216	0.094	0.207	0.094	L3	<4%	P
8	0.002	0.001	0.002	0.001	0.002	0.001	L3	<2%	P
9	0.161	0.070	0.154	0.063	0.139	0.063	L3	<4%	P
10	0.016	0.007	0.015	0.009	0.020	0.009	L3	<2%	P
11	0.062	0.027	0.095	0.045	0.099	0.045	L3	<4%	P
12	0.021	0.009	0.022	0.012	0.026	0.012	L3	<2%	P
13	0.028	0.012	0.044	0.183	0.403	0.183	L3	<4%	P
14	0.018	0.008	0.022	0.066	0.145	0.066	L3	<2%	P
15	0.087	0.038	0.097	0.044	0.097	0.044	L3	<4%	P
16	0.016	0.009	0.020	0.010	0.048	0.022	L3	<2%	P
17	0.092	0.043	0.095	0.045	0.451	0.205	L3	<4%	P
18	0.012	0.006	0.013	0.007	0.048	0.022	L3	<2%	P
19	0.074	0.028	0.062	0.027	0.354	0.161	L3	<4%	P
20	0.012	0.004	0.011	0.005	0.011	0.005	L3	<2%	P
21	0.092	0.042	0.099	0.045	0.099	0.045	L3	<4%	P
22	0.007	0.002	0.009	0.004	0.009	0.004	L3	<2%	P
23	0.067	0.022	0.048	0.022	0.048	0.022	L3	<4%	P
24	0.012	0.004	0.009	0.004	0.009	0.004	L3	<2%	P
25	0.035	0.014	0.044	0.020	0.044	0.020	L3	<4%	P
26	0.016	0.005	0.013	0.006	0.013	0.006	L3	<2%	P
27	0.051	0.019	0.042	0.019	0.048	0.022	L3	<4%	P
28	0.021	0.007	0.013	0.006	0.081	0.037	L3	<2%	P
29	0.030	0.013	0.035	0.016	0.097	0.044	L3	<4%	P
30	0.016	0.006	0.015	0.007	0.015	0.007	L3	<2%	P
31	0.014	0.010	0.022	0.010	0.112	0.051	L3	<4%	P
32	0.009	0.004	0.007	0.003	0.048	0.022	L3	<2%	P
33	0.007	0.002	0.009	0.004	0.033	0.015	L3	<4%	P
34	0.009	0.003	0.004	0.002	0.125	0.057	L3	<2%	P
35	0.005	0.002	0.007	0.003	0.062	0.028	L3	<4%	P
36	0.009	0.003	0.009	0.004	0.035	0.016	L3	<2%	P
37	0.041	0.018	0.037	0.017	0.092	0.042	L3	<4%	P
38	0.009	0.004	0.011	0.005	0.013	0.006	L3	<2%	P
39	0.037	0.015	0.035	0.016	0.013	0.006	L3	<4%	P
40	0.007	0.003	0.004	0.002	0.013	0.006	L3	<2%	P
THDv	--	0.829	--	0.834	--	0.907	L3	≤ 5%	P
Supplementary information:									

2	TABLE: Voltage Fluctuation				P
Flicker measurement 1	EUT values			Limit	Result
	L1	L2	L3		
Pst	0.22	0.23	0.24	1.00	P
Plt	0.26	0.21	0.22	0.80	P
dc [%]	0.07	0.06	0.07	3.30	P
dmax [%]	0.78	0.82	0.80	4.00	P
dt [s]	0	0	0	--	-
Supplementary information:					

3	TABLE: Direct Current Injection							P
	Condition of test					Output 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
	Normal rated output current					173A		
Phase	Output DC current Measurement						Limit [%]	Verdict [P/F]
	33% of rated output current		66% of rated output current		100% of rated output current			
	(A)	(%)	(A)	(%)	(A)	(%)		
L1	0.147	0.258	0.182	0.157	0.163	0.094	≤0.5	P
L2	0.152	0.258	0.146	0.126	0.179	0.103	≤0.5	P
L3	0.143	0.257	0.127	0.110	0.155	0.090	≤0.5	P
Supplementary information:								

4	TABLE : Reactive power control						P
-Q max							
Power Set [%]	Active Power		Reactive power		DC power		Power factor
	kW	p.u.	kVAR	p.u.	(kW)	p.u.	
1	4.140	0.037	-121.128	-1.000	4.512	0.0347	0.034272
10	11.088	0.095	-120.696	-0.996	11.976	0.0992	0.091424
20	25.500	0.216	-118.488	-0.978	27.456	0.3327	0.211442
30	36.396	0.306	-115.608	-0.954	38.640	0.3943	0.301035
40	47.100	0.396	-111.672	-0.921	49.464	0.4187	0.389421
50	60.288	0.506	-105.144	-0.867	62.016	0.5192	0.507417
60	72.936	0.611	-96.792	-0.797	74.736	0.6201	0.601782
70	84.432	0.707	-86.952	-0.715	86.328	0.7114	0.694325
80	96.300	0.806	-73.584	-0.603	97.968	0.8162	0.809923
90	108.276	0.906	-54.456	-0.444	109.920	0.9097	0.893396
100	119.856	1.000	-18.000	-0.203	121.440	1.0000	0.990924

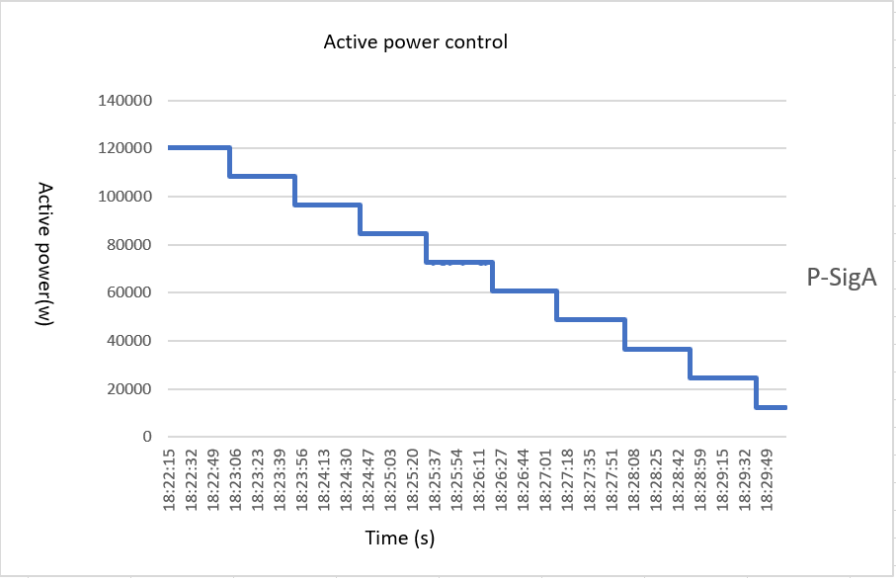
+Q max							
Power Set	Active Power [W]		Reactive power [Var]		DC power		Power factor
	kW	p.u.	kVAR	p.u.	(kW)	p.u.	
1	4.380	0.039	121.128	1.017	4.800	0.0407	0.036153
10	11.364	0.098	120.672	0.998	12.072	0.1004	0.093776
20	26.136	0.221	118.344	0.971	27.456	0.2269	0.215658
30	37.980	0.319	115.104	0.942	39.240	0.3238	0.313380
40	47.232	0.397	111.624	0.887	48.288	0.3983	0.389717
50	60.528	0.508	105.000	0.822	61.584	0.5075	0.499420
60	72.384	0.606	97.200	0.738	73.488	0.6054	0.597242
70	84.252	0.705	87.120	0.618	85.968	0.7081	0.695163
80	96.900	0.811	72.792	0.459	98.688	0.8126	0.799519
90	108.612	0.908	53.784	0.248	110.256	0.9079	0.896153
100	119.916	1.000	17.592	0.157	121.608	1.0000	0.990462

4.1	TABLE : Reactive power control			P
4.1 fixed displacement factor cos Ø				
P (setting)	PF (setting)	P (measuring)	Q (max measuring)	PF (measuring)
P.F. setting 0.95 lagging				
0% (1%)	0.95 lagging	5.69	-1.90	0.9501
10%	0.95 lagging	11.38	-3.84	0.9500
20%	0.95 lagging	22.82	-7.42	0.9505
30%	0.95 lagging	34.30	-11.04	0.9504
40%	0.95 lagging	45.48	-15.50	0.9502
50%	0.95 lagging	57.19	-18.14	0.9505
60%	0.95 lagging	68.40	-22.58	0.9497
70%	0.95 lagging	79.54	-26.93	0.9499
80%	0.95 lagging	91.49	-29.11	0.9504
90%	0.95 lagging	102.67	-33.43	0.9506
100%	0.95 lagging	114.10	-36.98	0.9507
P.F. setting 0.95 leading				
0% (1%)	0.95 leading	5.71	1.87	0.9504
10%	0.95 leading	11.38	3.82	0.9502
20%	0.95 leading	22.85	7.39	0.9504
30%	0.95 leading	34.30	10.97	0.9505
40%	0.95 leading	45.60	15.05	0.9498
50%	0.95 leading	56.93	19.08	0.9500
60%	0.95 leading	68.62	21.98	0.9506
70%	0.95 leading	79.90	25.85	0.9510
80%	0.95 leading	90.98	30.60	0.9496
90%	0.95 leading	102.67	33.65	0.9506
100%	0.95 leading	114.22	36.91	0.9506
P.F. setting 0.9 lagging				
0% (1%)	0.90 lagging	5.39	-2.61	0.9002
10%	0.90 lagging	10.78	-5.22	0.9001

20%	0.90 lagging	21.62	-10.47	0.9006
30%	0.90 lagging	32.49	-15.74	0.9005
40%	0.90 lagging	43.09	-20.87	0.9003
50%	0.90 lagging	54.18	-26.25	0.9006
60%	0.90 lagging	64.80	-31.39	0.8998
70%	0.90 lagging	75.35	-36.50	0.9000
80%	0.90 lagging	86.67	-41.99	0.9005
90%	0.90 lagging	97.27	-47.12	0.9007
100%	0.90 lagging	108.09	-52.37	0.9008
P.F. setting 0.9 leading				
0% (1%)	0.90 leading	5.41	2.62	0.9005
10%	0.90 leading	10.78	5.22	0.9003
20%	0.90 leading	21.65	10.49	0.9005
30%	0.90 leading	32.49	15.74	0.9006
40%	0.90 leading	43.20	20.93	0.8999
50%	0.90 leading	53.93	26.13	0.9001
60%	0.90 leading	65.01	31.49	0.9007
70%	0.90 leading	75.69	36.67	0.9011
80%	0.90 leading	86.19	41.76	0.8997
90%	0.90 leading	97.27	47.12	0.9007
100%	0.90 leading	108.21	52.42	0.9007
P.F. setting PF 1.0				
0% (1%)	1.0	5.93	-0.96	0.9887
10%	1.0	11.90	-1.54	0.9934
20%	1.0	23.86	-2.71	0.9936
30%	1.0	35.81	-3.60	0.9943
40%	1.0	47.86	-3.65	0.9975
50%	1.0	59.83	-4.06	0.9978
60%	1.0	71.93	-3.50	0.9990
70%	1.0	83.93	-3.48	0.9992
80%	1.0	95.98	-2.88	0.9997
90%	1.0	108.00	-2.09	0.9998
100%	1.0	120.05	-1.58	0.9999

5	TABLE : Active power control			P
Power Setting		Power Measuring [kW]	Power Deviation of set point	
Power [%]	Power [kW]		Power [kW]	Power [%]
100%	120.00	120.02	-0.01	-0.01
90%	108.00	107.98	0.02	0.02
80%	96.00	95.98	0.03	0.03
70%	84.00	83.95	0.04	0.05
60%	72.00	71.90	0.05	0.07
50%	60.00	59.88	0.06	0.10
40%	48.00	47.78	0.10	0.21
30%	36.00	35.78	0.10	0.28
20%	24.00	23.81	0.08	0.34
10%	12.00	11.90	0.05	0.42

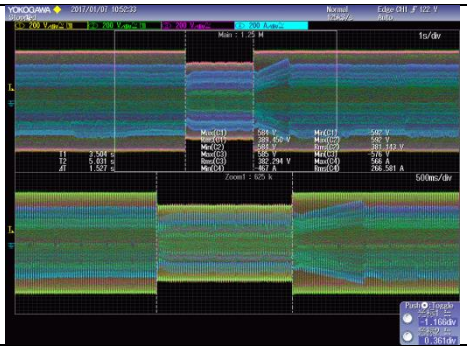
Supplementary information:



6	Low Voltage Fault Ride Through（90% Power）	P
List of tests	Residual amplitude of phase-to-phase voltage V/Vnom	Duration Time (sec)
file:1-three-phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.520
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.162
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.522
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.162
file:3-B-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.527
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.162
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.522
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.161
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.527
	0.3-0.5 (V5/Vnom)	0.166
	0-0.049 (V6/Vnom)	0.166
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.527
	0.3-0.5 (V8/Vnom)	0.162
	0-0.049 (V9/Vnom)	0.162
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.532
	0.3-0.5 (V8/Vnom)	0.160
	0-0.049 (V9/Vnom)	0.160
Low Voltage Fault Ride Through（30% Power）		
List of tests	Residual amplitude of phase-to-phase voltage V/Vnom	Duration Time (sec)
file:1-three-phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.532
	0.3-0.5 (V2/Vnom)	0.160
	0-0.049 (V3/Vnom)	0.160
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.522
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.162
file:3-B-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.527
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.162
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.527
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.161
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.532
	0.3-0.5 (V5/Vnom)	0.166
	0-0.049 (V6/Vnom)	0.160
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.527
	0.3-0.5 (V8/Vnom)	0.161
	0-0.049 (V9/Vnom)	0.162
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.527
	0.3-0.5 (V8/Vnom)	0.162
	0-0.049 (V9/Vnom)	0.160
Low Voltage Fault Ride Through（10% Power）		
List of tests	Residual amplitude of phase-to-phase voltage V/Vnom	Duration Time (sec)
file:1-three-phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.507
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.160
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.506
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.162
file:3-B-phase – C- phase symmetrical	0.7-0.8 (V1/Vnom)	1.507
	0.3-0.5 (V2/Vnom)	0.162

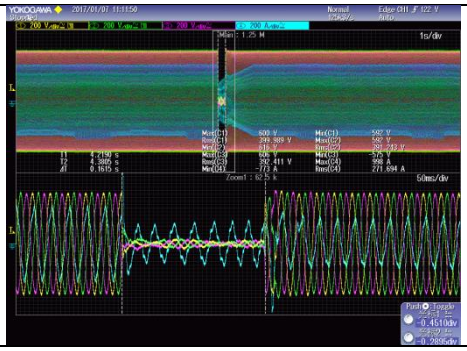
faults	0-0.049 (V3/Vnom)	0.160
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.501
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.161
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.527
	0.3-0.5 (V5/Vnom)	0.167
	0-0.049 (V6/Vnom)	0.166
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.501
	0.3-0.5 (V8/Vnom)	0.161
	0-0.049 (V9/Vnom)	0.161
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.527
	0.3-0.5 (V8/Vnom)	0.160
	0-0.049 (V9/Vnom)	0.160

Supplementary information(90% Power):

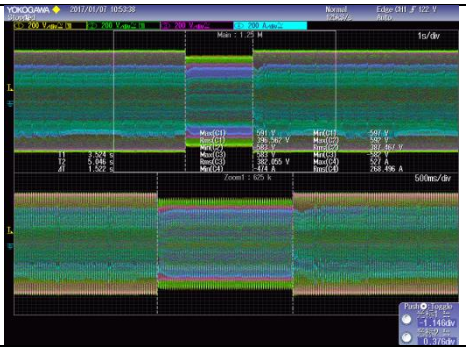


Three-phase faults 0.7-0.8 Vn

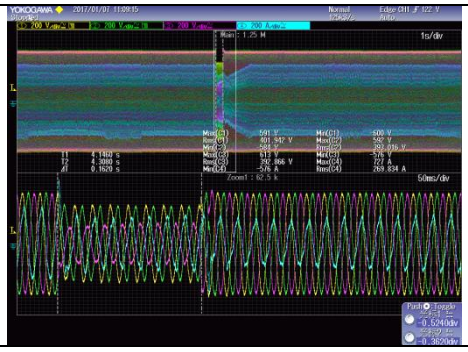
Three-phase faults 0.3-0.5 Vn



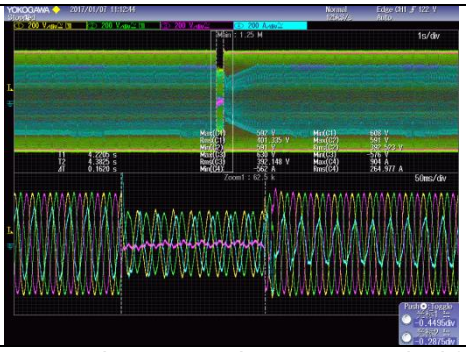
Three-phase faults 0-0.049 Vn



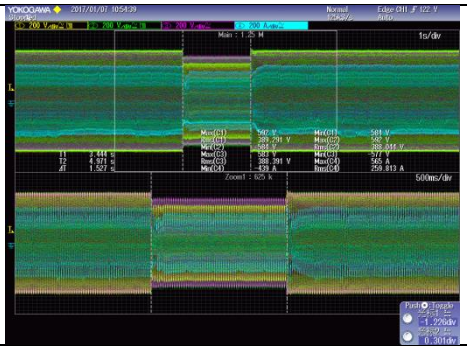
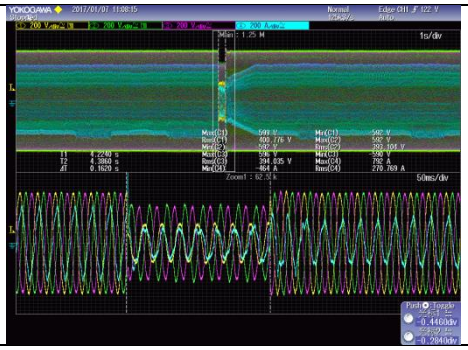
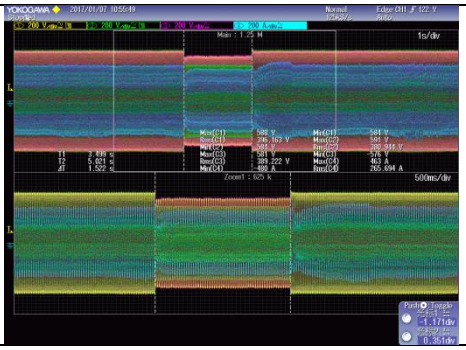
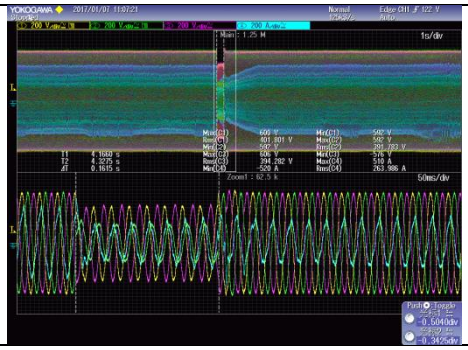
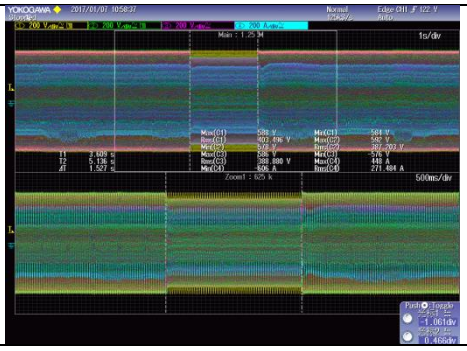
A-phase – B- phase symmetrical faults 0.7-0.8 Vn

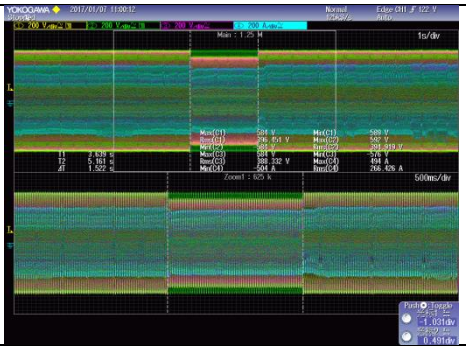
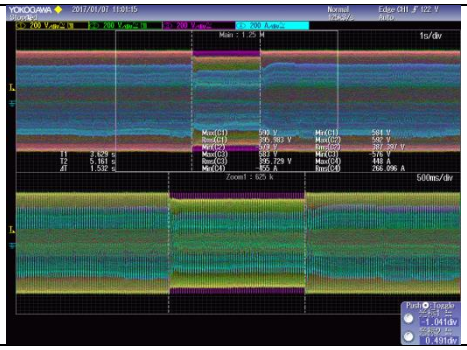
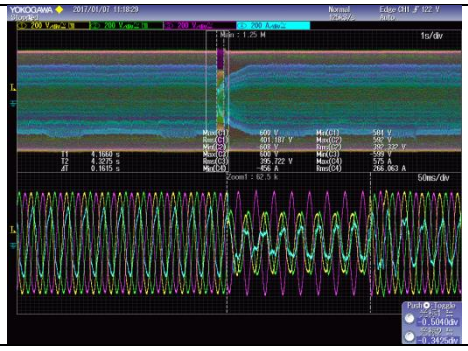


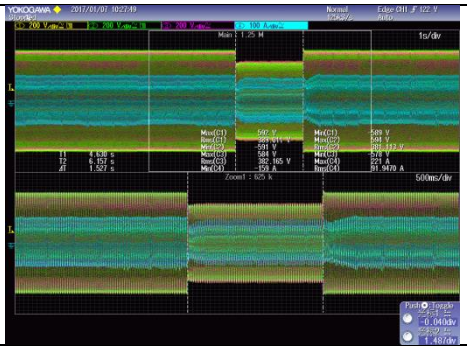
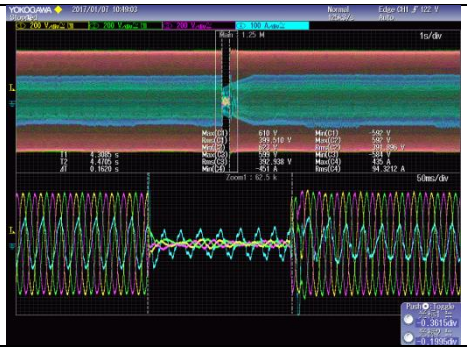
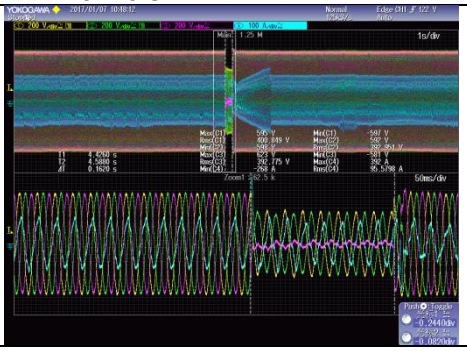
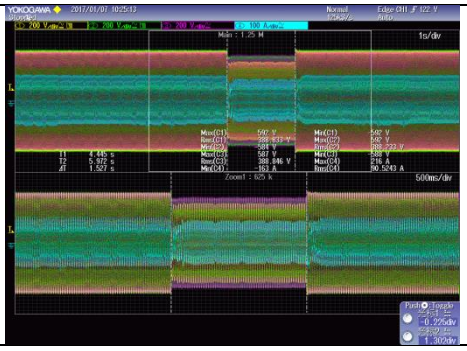
A-phase – B- phase symmetrical faults 0.3-0.5 Vn

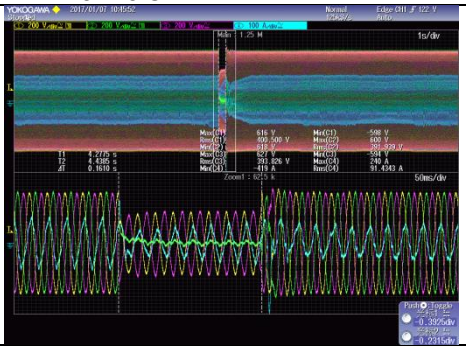
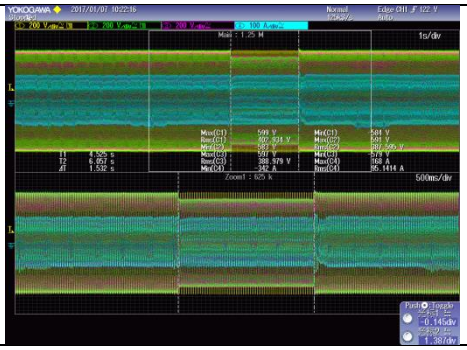
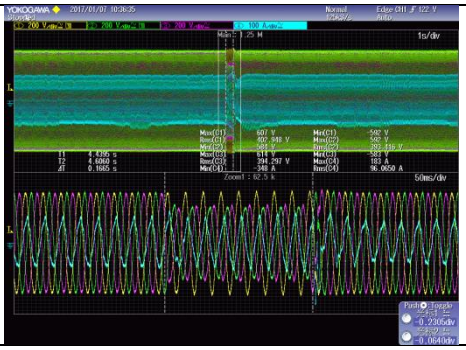
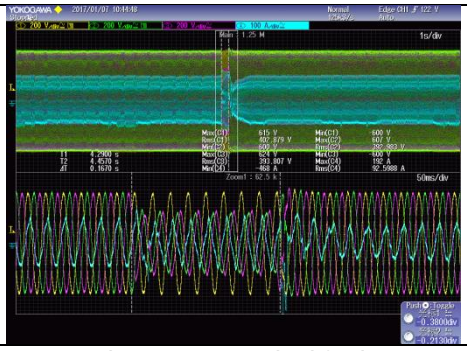
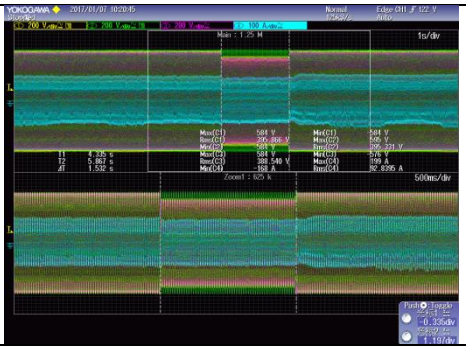


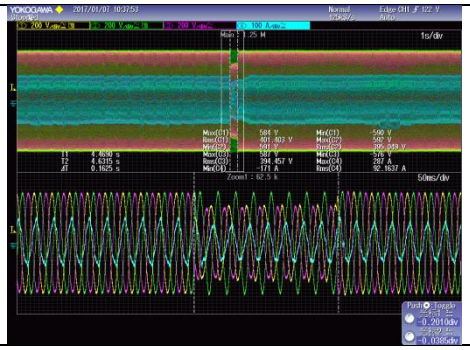
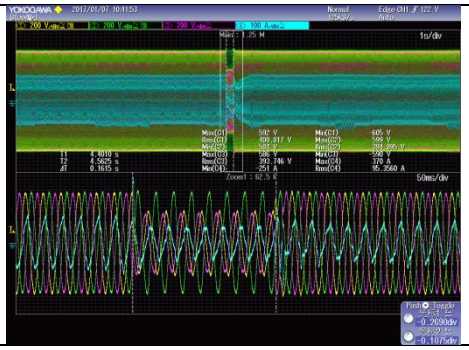
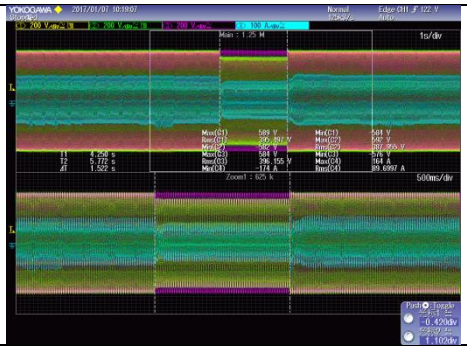
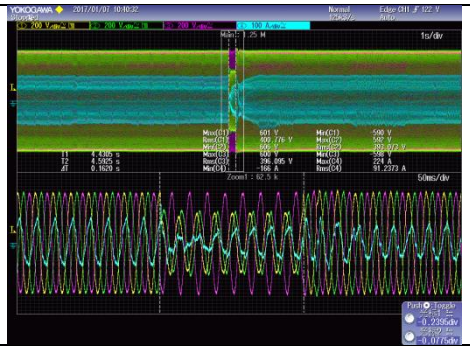
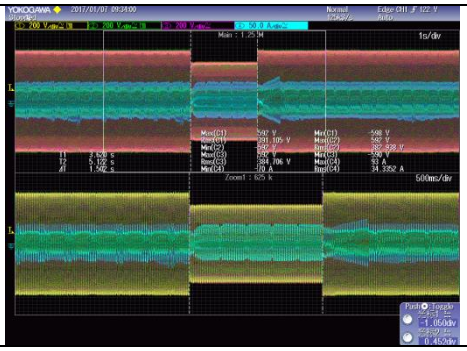
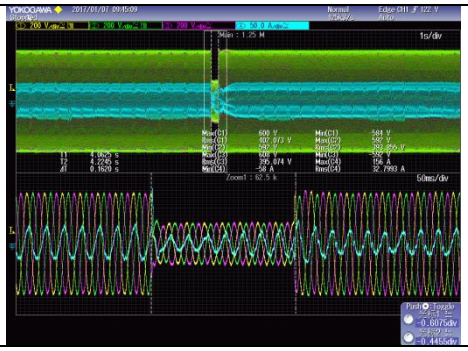
A-phase – B- phase symmetrical faults 0-0.049 Vn

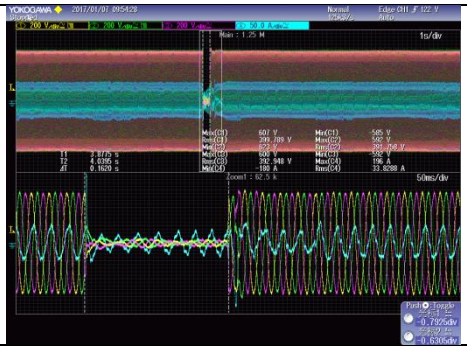
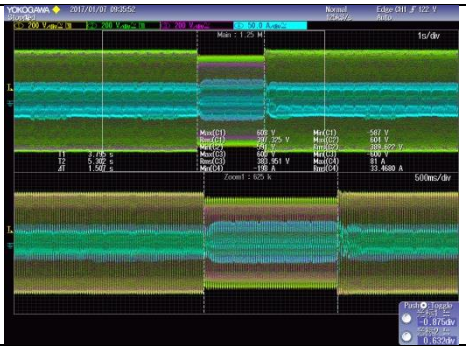
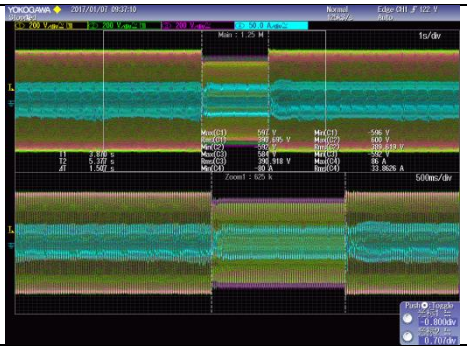
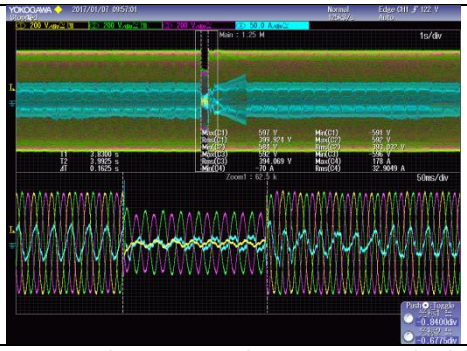
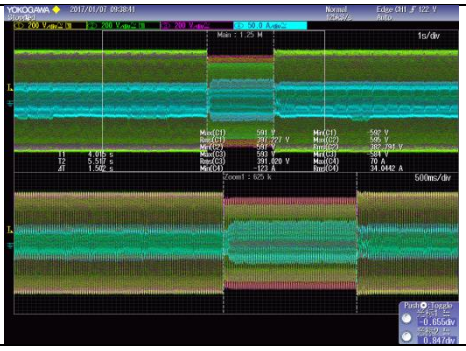
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn
	
B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – C- phase symmetrical faults 0.3-0.5 Vn	A-phase – C- phase symmetrical faults 0-0.049 Vn
	
A-phase symmetrical faults 0.7-0.8 Vn	A-phase symmetrical faults 0.3-0.5 Vn

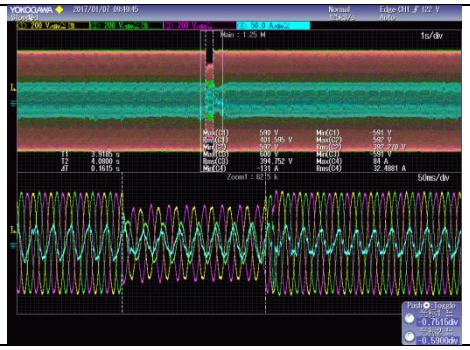
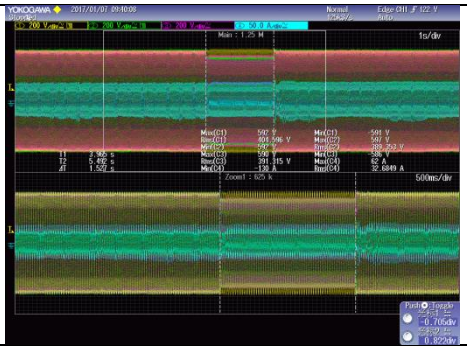
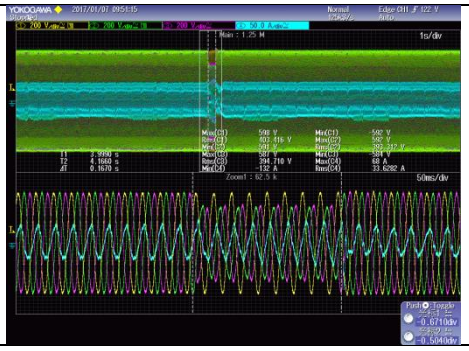
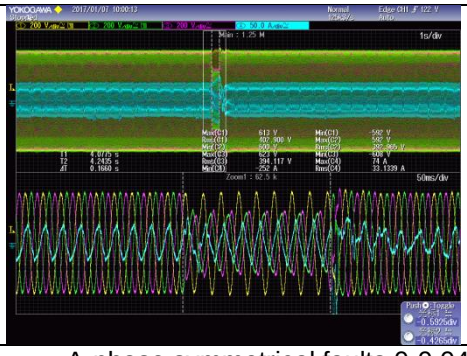
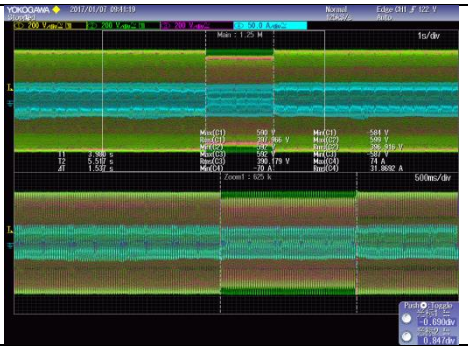
			
A-phase symmetrical faults 0-0.049 Vn		B-phase symmetrical faults 0.7-0.8 Vn	
B-phase symmetrical faults 0.3-0.5 Vn		B-phase symmetrical faults 0-0.049 Vn	
			
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn	
		--	
C- phase symmetrical faults 0-0.049 Vn		--	
Supplementary information(30% Power):			

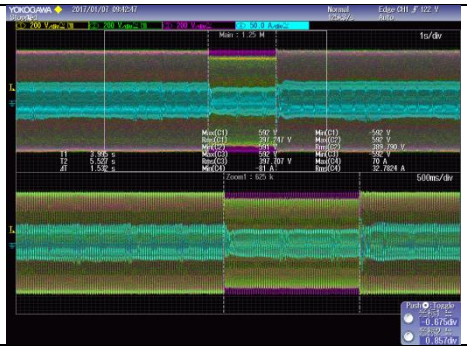
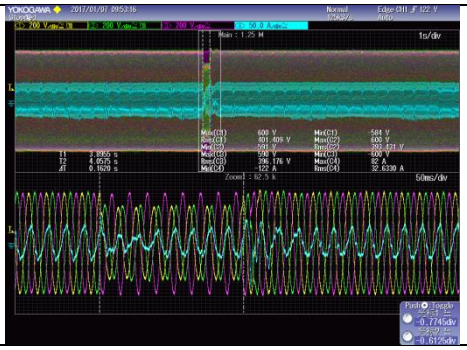
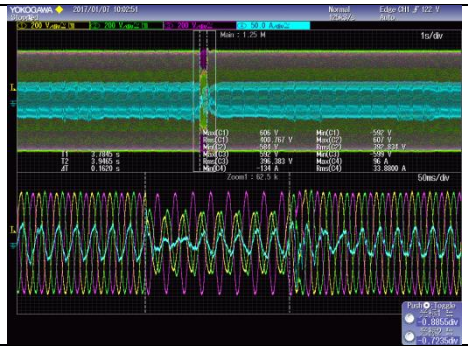
	
Three-phase faults 0.7-0.8 Vn	Three-phase faults 0.3-0.5 Vn
	
Three-phase faults 0-0.049 Vn	A-phase – B- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – B- phase symmetrical faults 0.3-0.5 Vn	A-phase – B- phase symmetrical faults 0-0.049 Vn
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn

B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – C- phase symmetrical faults 0.3-0.5 Vn	A-phase – C- phase symmetrical faults 0-0.049 Vn
	
A-phase symmetrical faults 0.7-0.8 Vn	A-phase symmetrical faults 0.3-0.5 Vn
	
A-phase symmetrical faults 0-0.049 Vn	B-phase symmetrical faults 0.7-0.8 Vn

			
B-phase symmetrical faults 0.3-0.5 Vn		B-phase symmetrical faults 0-0.049 Vn	
			
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn	
		--	
C- phase symmetrical faults 0-0.049 Vn		--	
Supplementary information(10% Power):			
			
Three-phase faults 0.7-0.8 Vn		Three-phase faults 0.3-0.5 Vn	

	
Three-phase faults 0-0.049 Vn	A-phase – B- phase symmetrical faults 0.7-0.8 Vn
A-phase – B- phase symmetrical faults 0.3-0.5 Vn	A-phase – B- phase symmetrical faults 0-0.049 Vn
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn
	
B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn

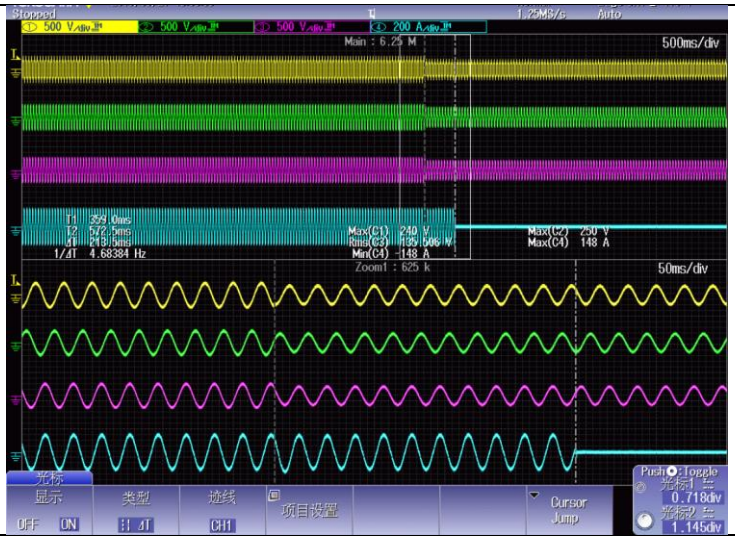
	
A-phase – C- phase symmetrical faults 0.3-0.5 Vn	A-phase – C- phase symmetrical faults 0-0.049 Vn
	
A-phase symmetrical faults 0.7-0.8 Vn	A-phase symmetrical faults 0.3-0.5 Vn
	
A-phase symmetrical faults 0-0.049 Vn	B-phase symmetrical faults 0.7-0.8 Vn
B-phase symmetrical faults 0.3-0.5 Vn	B-phase symmetrical faults 0-0.049 Vn

		
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn
		--
C- phase symmetrical faults 0-0.049 Vn		--

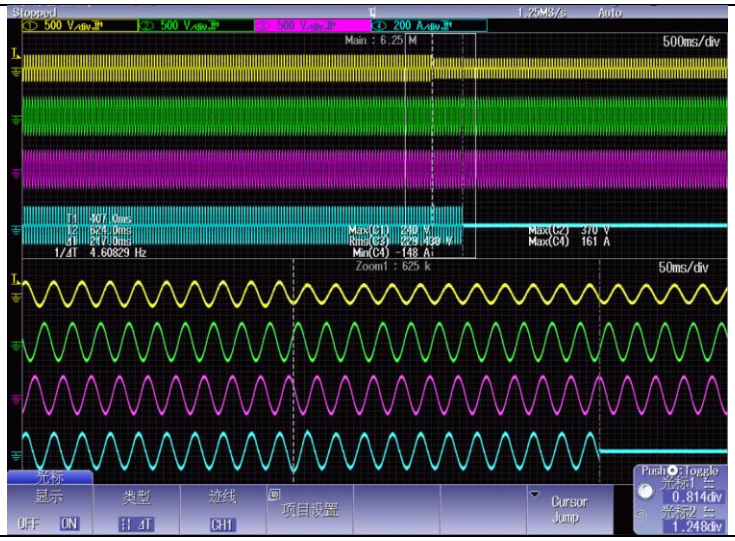
7	TABLE: Operating Voltage Range						P
No.	Voltage Range (V)	Setting voltage (V)	Setting time (s)	Test voltage (V)	Disconnecting time (s)	Max. Disconnecting time (s)	Result
1	V<50%	L1 = L2 = L3 =110V	0.1	L1 = L2 = L3 =109V	0.213	0.3	P
		L1 = 110 V, L2 = L3 = 220 V		L1 = 109V, L2 = L3 = 220 V	0.217	0.3	P
		L2 = 110V, L1 = L3 = 220 V		L2 = 109V, L1 = L3 = 220 V	0.223	0.3	P
		L3 = 110 V, L1 = L2 = 220 V		L3 = 109 V, L1 = L2 = 220 V	0.207	0.3	P
2	50%≤V<90%	L1 = L2 = L3 =111 V	0.1	L1 = L2 = L3 =112 V	1.808	2	P
		L1 = 111 V, L2 = L3 = 220 V	0.1	L1 = 112 V, L2 = L3 = 220 V	1.795	2	P
		L2 = 111 V, L1 = L3 = 220 V	0.1	L2 = 112 V, L1 = L3 = 220 V	1.800	2	P
		L3 = 111 V, L1 = L2 = 220 V	0.1	L3 = 112 V, L1 = L2 = 220 V	1.798	2	P
		L1 = L2 = L3 =197 V	0.1	L1 = L2 = L3 =196 V	1.818	2	P
		L1 = 197 V, L2 = L3 = 220 V	0.1	L1 = 196 V, L2 = L3 = 220 V	1.795	2	P
		L2 = 197 V, L1 =	0.1	L2 = 196 V, L1	1.814	2	P

		L3 = 220 V		= L3 = 220 V			
		L3 = 197 V, L1 = L2 = 220 V	0.1	L3 = 196 V, L1 = L2 = 220 V	1.806	2	P
3	90%≤V≤110%	L1 = L2 = L3 =197 V	--	L1 = L2 = L3 =198 V	CONTINUE	CONTINUE	P
4		L1 = L2 = L3 =241V	--	L1 = L2 = L3 =240V	CONTINUE	CONTINUE	P
5	110%<V<120%	L1 = L2 = L3 =241V	0.1	L1 = L2 = L3 =242V	0.802	1	P
		L1 = 241 V, L2 = L3 = 220 V	0.1	L1 = 242V, L2 = L3 = 220 V	0.797	1	P
		L2 = 241 V, L1 = L3 = 220 V	0.1	L2 = 242 V, L1 = L3 = 220 V	0.820	1	P
		L3 = 241 V, L1 = L2 = 220 V	0.1	L3 = 242 V, L1 = L2 = 220 V	0.820	1	P
		L1 = L2 = L3 =262V	0.1	L1 = L2 = L3 =261 V	0.804	1	P
		L1 = 262 V, L2 = L3 = 220 V	0.1	L1 = 261V, L2 = L3 = 220 V	0.807	1	P
		L2 = 262 V, L1 = L3 = 220 V	0.1	L2 = 261V, L1 = L3 = 220 V	0.799	1	P
		L3 = 262 V, L1 = L2 = 220 V	0.1	L3 = 261 V, L1 = L2 = 220 V	0.820	1	P
6	V≥120%	L1 = L2 = L3 =263V	0.1	L1 = L2 = L3 =264 V	0.100	0.16	P
		L1 = 263 V, L2 = L3 = 220 V	0.1	L1 = 264 V, L2 = L3 = 220 V	0.115	0.16	P
		L2 = 263 V, L1 = L3 = 220 V	0.1	L2 = 264 V, L1 = L3 = 220 V	0.120	0.16	P
		L3 = 263 V, L1 = L2 = 220 V	0.1	L3 = 264 V, L1 = L2 = 220 V	0.128	0.16	P

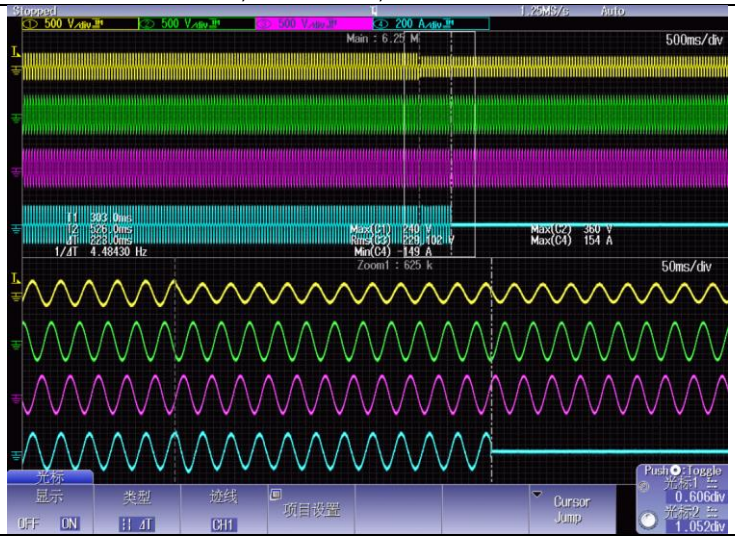
Supplementary information:



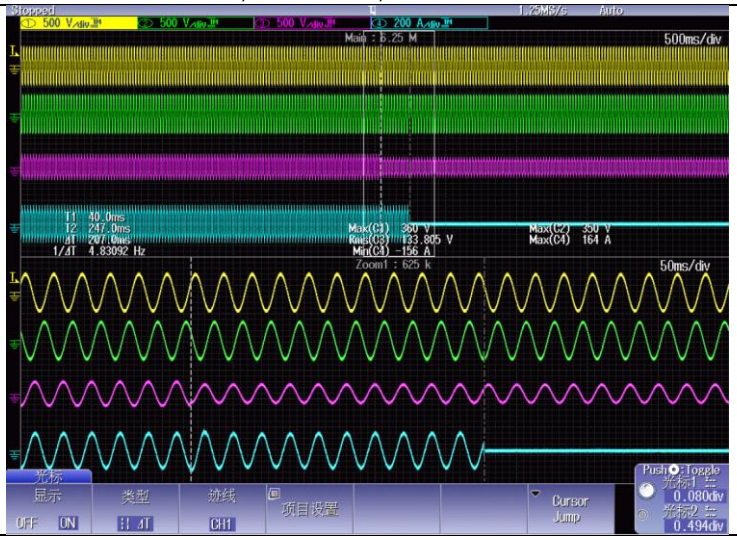
V<50%, L1 = L2 = L3 =109V



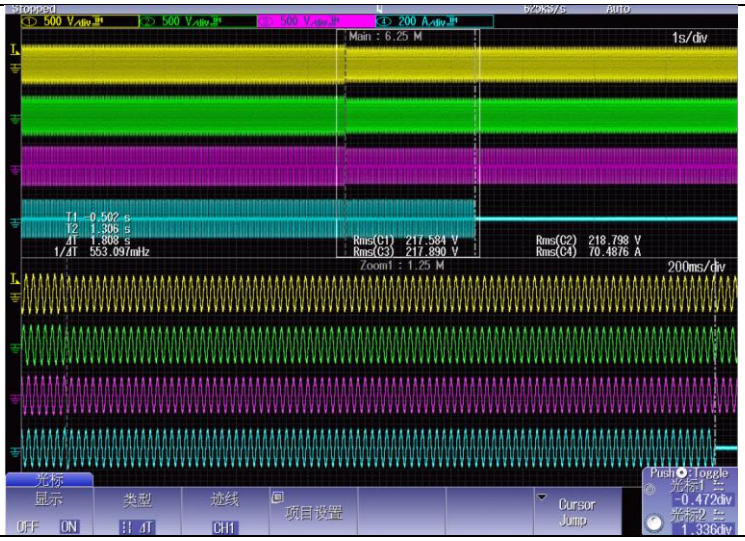
V<50%, L1 = 109V, L2 = L3 = 220 V



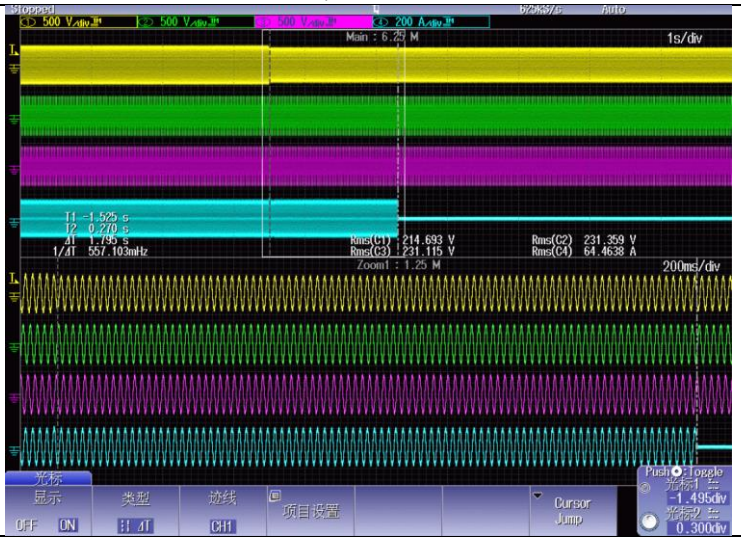
V<50%, L2 = 109V, L1 = L3 = 220 V



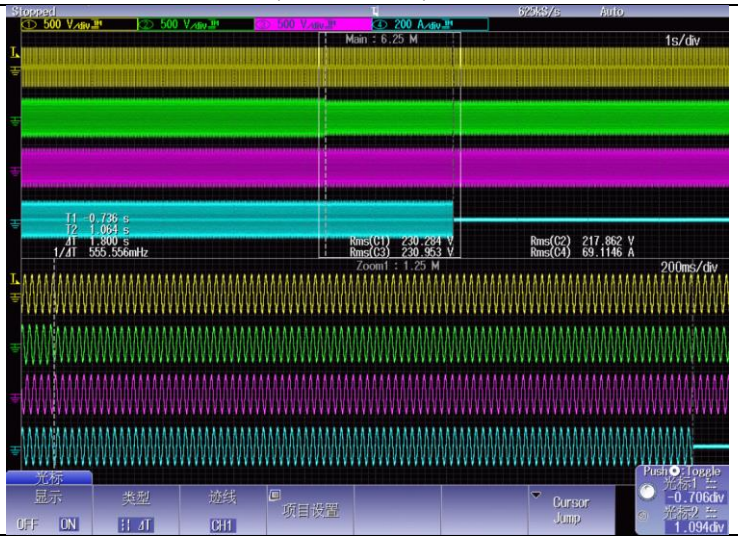
V<50%, L3 = 109V, L1 = L2 = 220 V



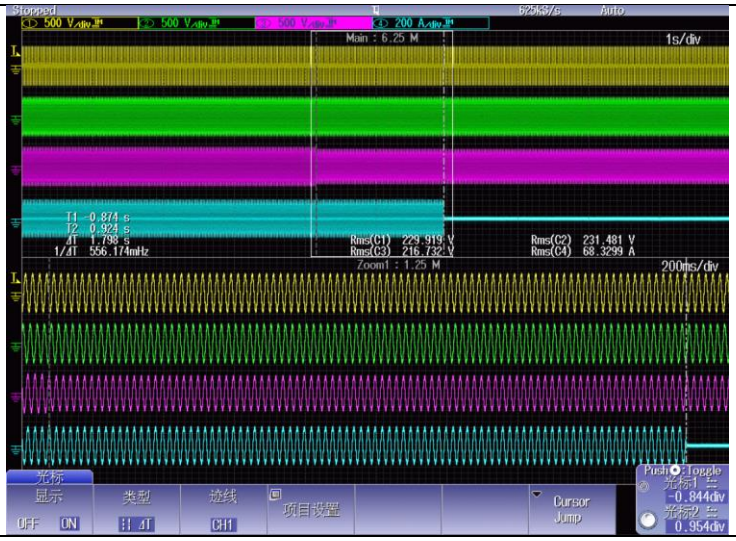
50%≤V<90%, L1 = L2 = L3 =112 V



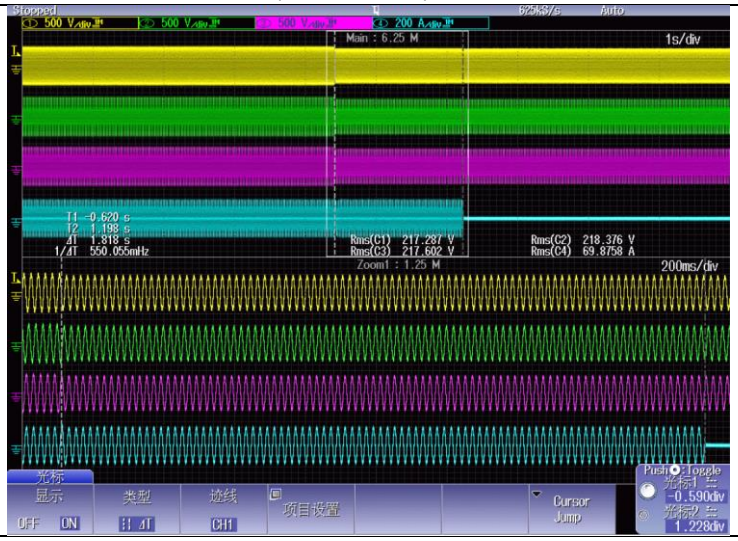
50%≤V<90%, L1 = 112 V, L2 = L3 = 220 V



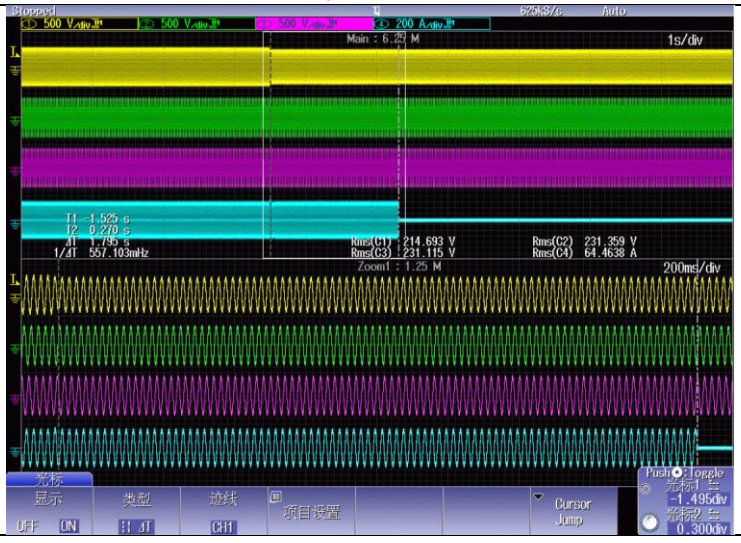
50%≤V<90%, L2 = 112 V, L1 = L3 = 220 V



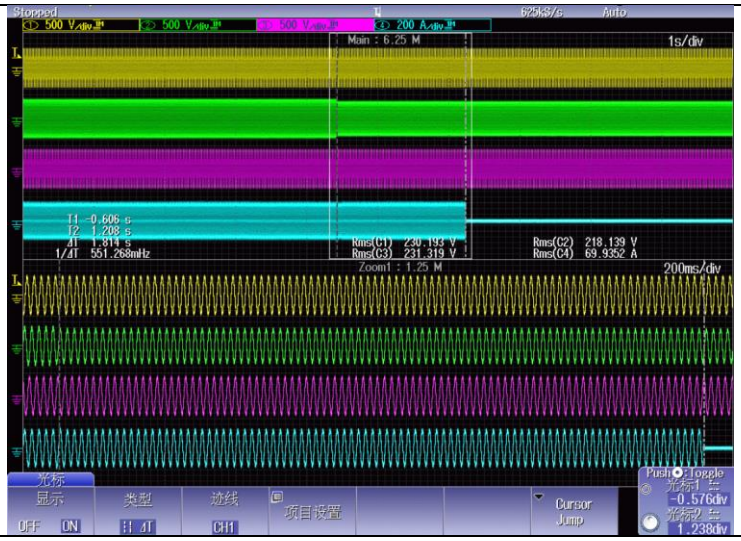
50%≤V<90%, L3 = 112 V, L1 = L2 = 220 V



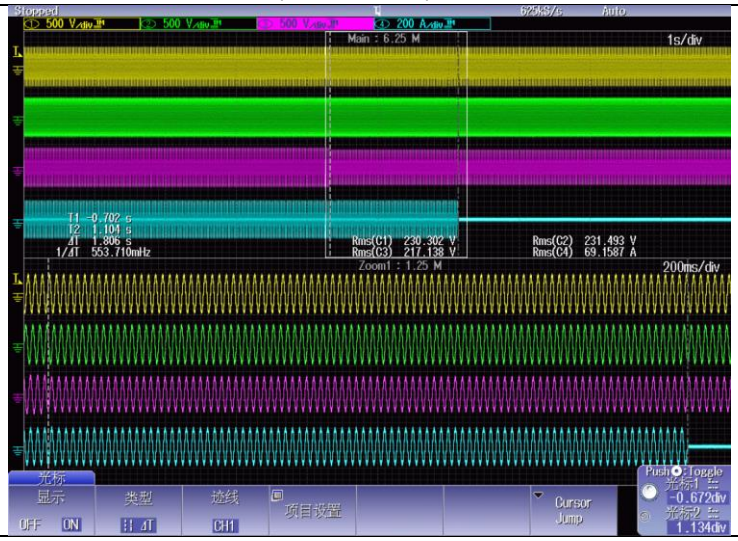
50%≤V<90%, L1 = L2 = L3 =196 V



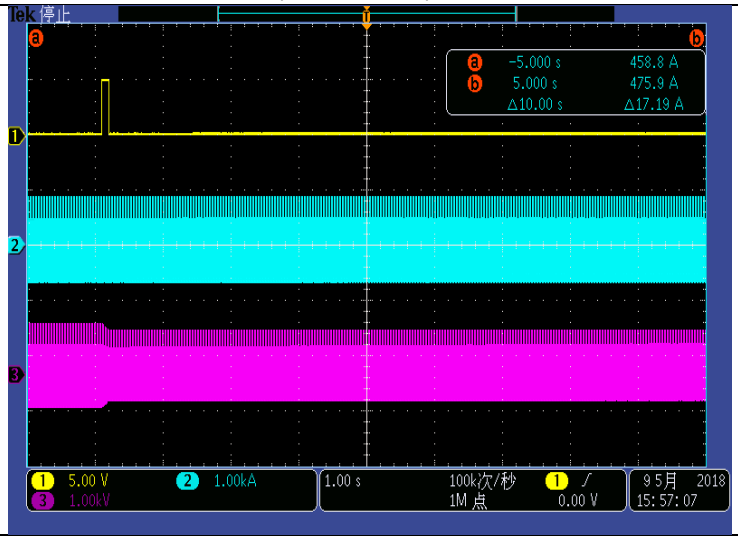
50%≤V<90%, L1 = 196 V, L2 = L3 = 220 V



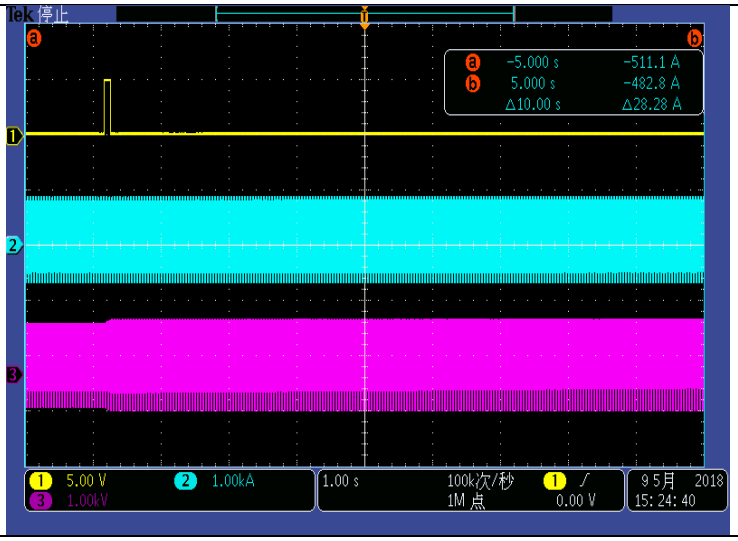
50%≤V<90%, L2 = 196 V, L1 = L3 = 220 V



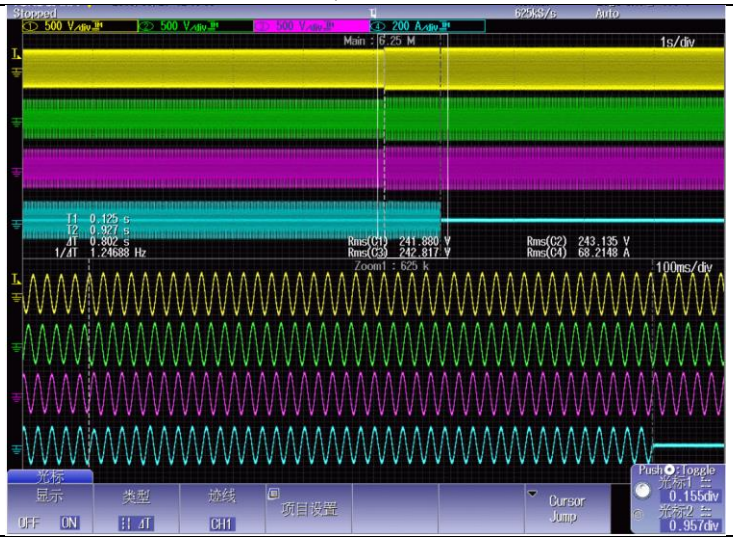
50%≤V<90%, L3 = 196 V, L1 = L2 = 220 V



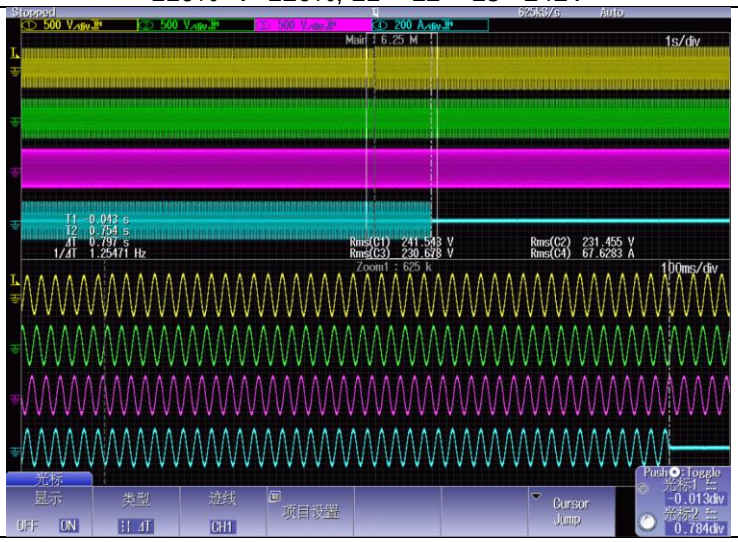
90%≤V≤110%, L1 = L2 = L3 =198 V



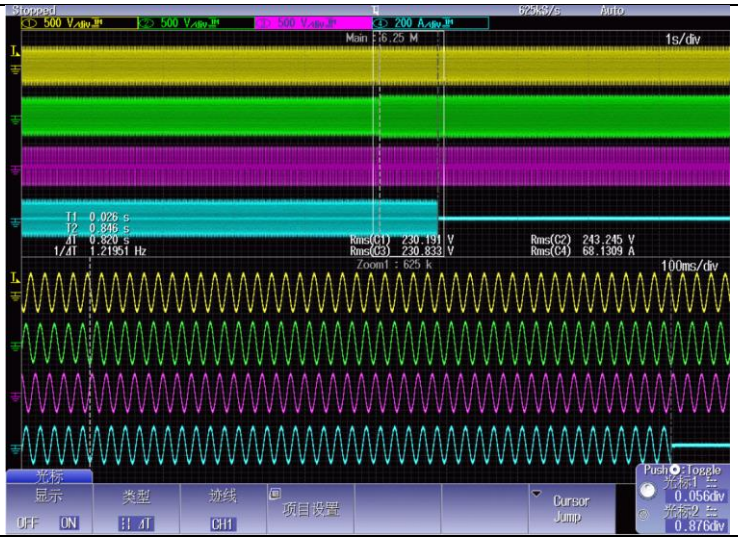
90%≤V≤110%, L1 = L2 = L3 =240 V



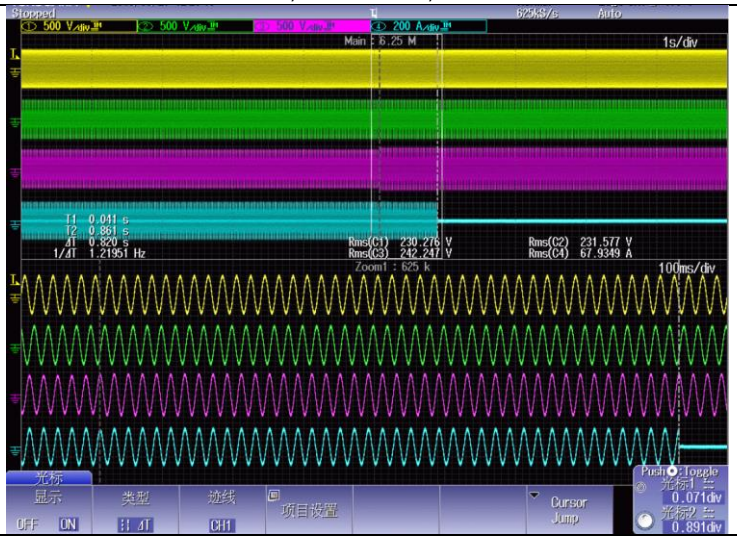
110%<V<120%, L1 = L2 = L3 =242V



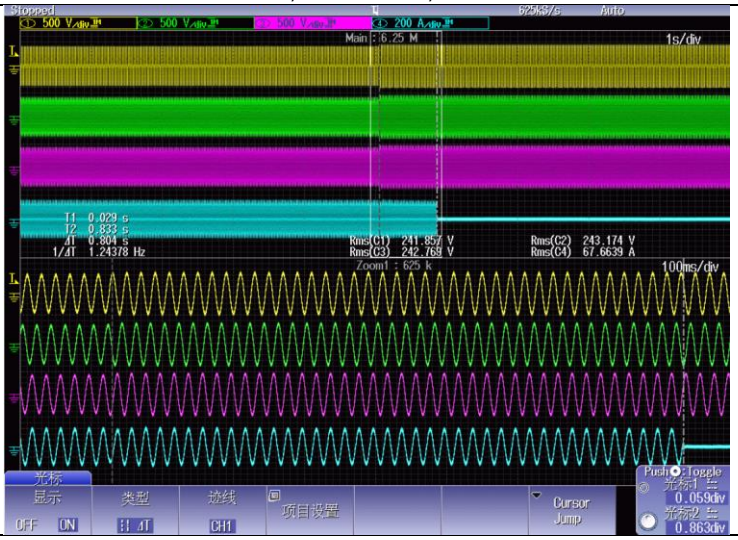
110%<V<120%, L1 = 242V, L2 = L3 = 220 V



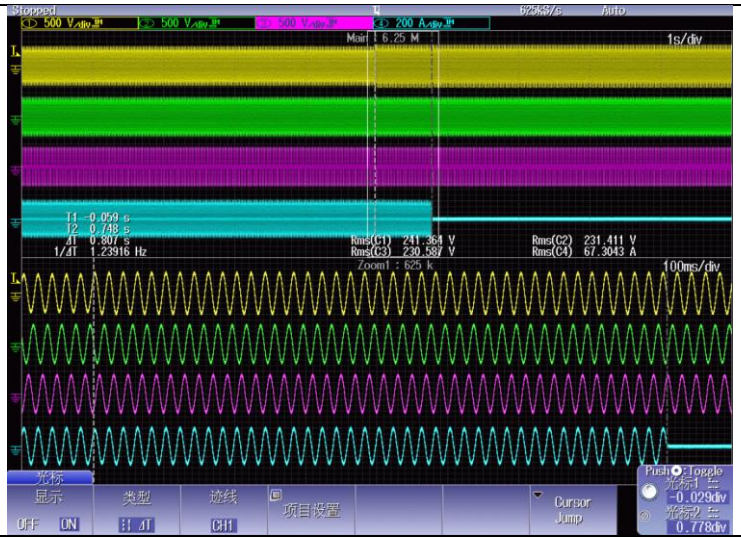
110%<V<120%, L2 = 242V, L1 = L3 = 220 V



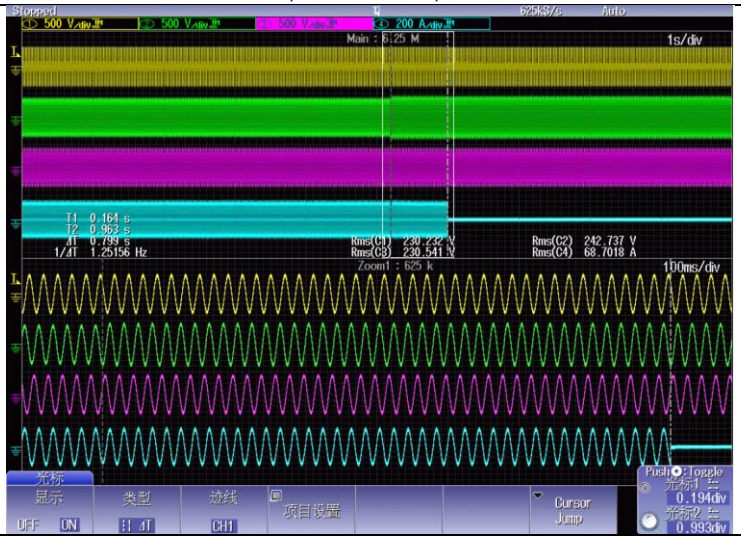
110%<V<120%, L3 = 242V, L1 = L2 = 220 V



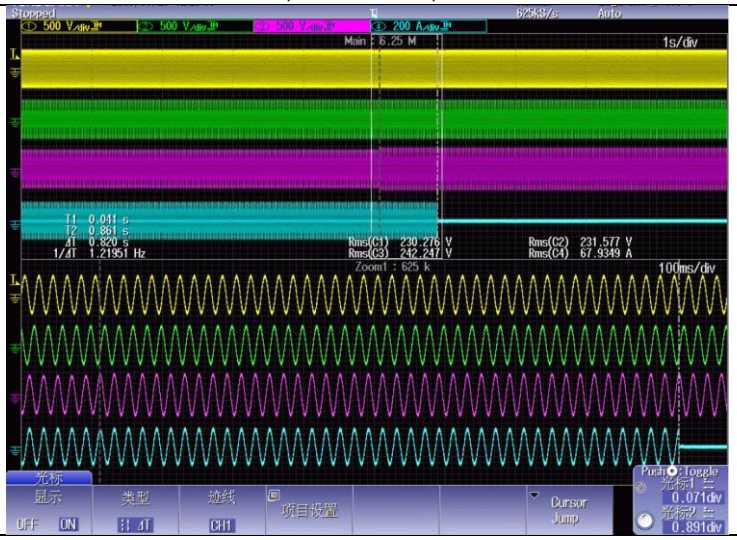
110%<V<120%, L1 = L2 = L3 = 261 V



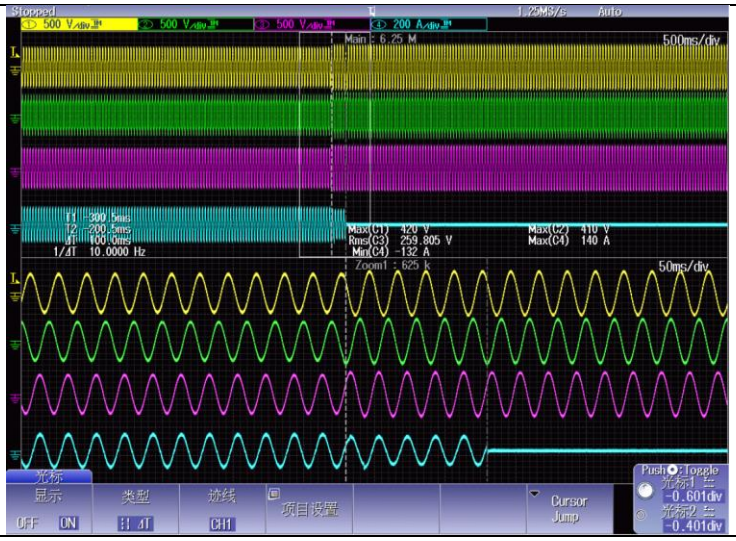
110%<V<120%, L1 = 261 V, L2 = L3 = 220 V



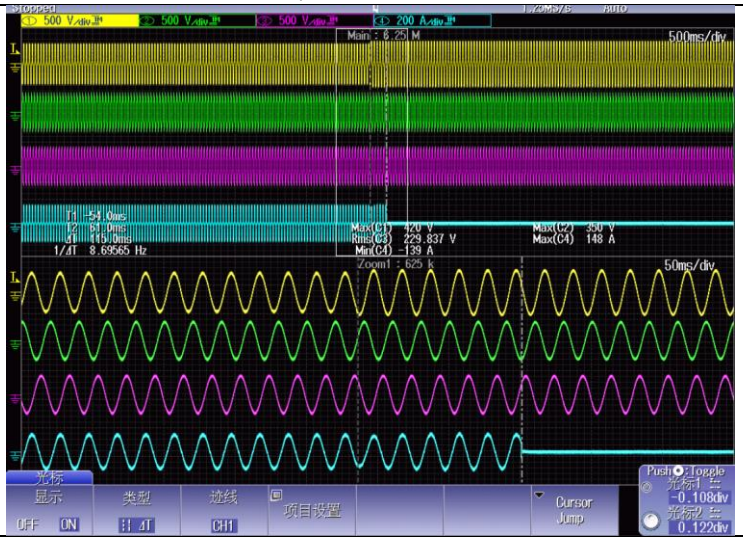
110%<V<120%, L2 = 261 V, L1 = L3 = 220 V



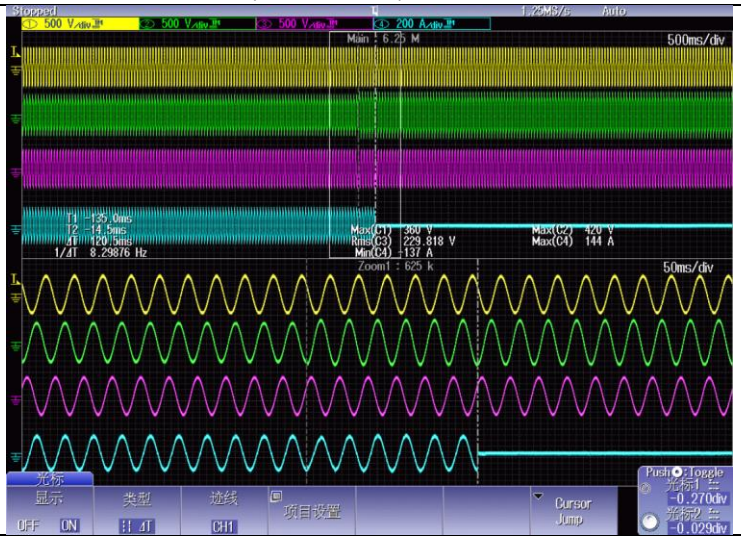
110%<V<120%, L3 = 261 V, L1 = L2 = 220 V



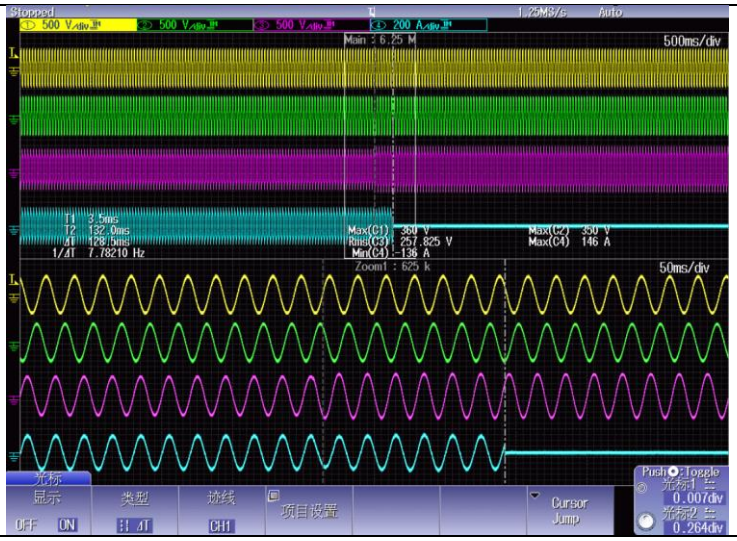
V≥120%, L1 = L2 = L3 =264 V



V≥120%, L1 = 264 V, L2 = L3 = 220 V



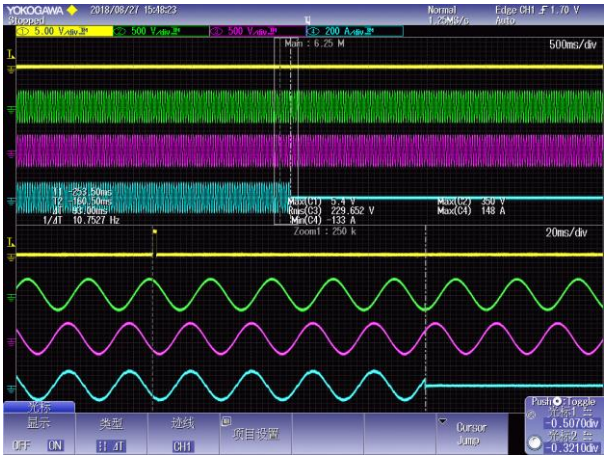
V≥120%, L2 = 264 V, L1 = L3 = 220 V



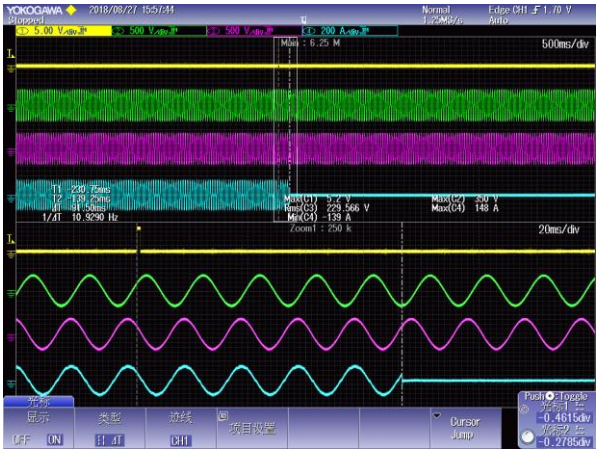
V≥120%, L3 = 264 V, L1 = L2 = 220 V

8	TABLE: Operating Frequency Range						P
No.	Frequency Range (Hz)	Setting Frequency (Hz)	Setting time (s)	Test Frequency (Hz)	Disconnecting Time (S)	Max. Disconnecting Time (S)	Result
1	99%UFT	46.9	0.06	46.9	0.0930	0.1	P
2	110%UFT	47.1	--	47.1	Cont.	Cont.	P
3	90%OFT	51.9	--	51.9	Cont.	Cont.	P
4	101%OFT	52.1	0.06	52.1	0.0915	0.1	P

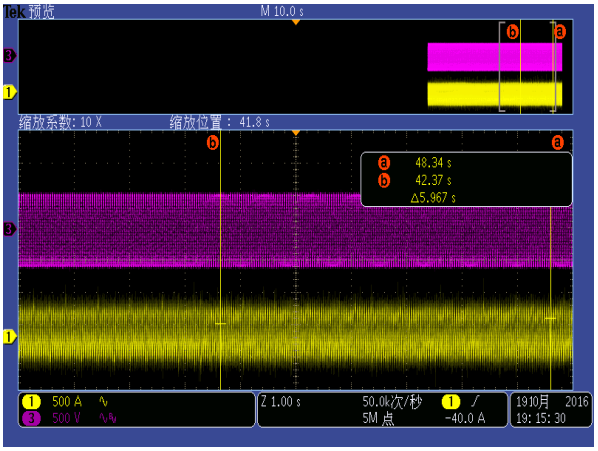
Supplementary information:
OFT: Over frequency Trip Setting
UFT: Under frequency Trip Setting
Cont.: Continuous operated



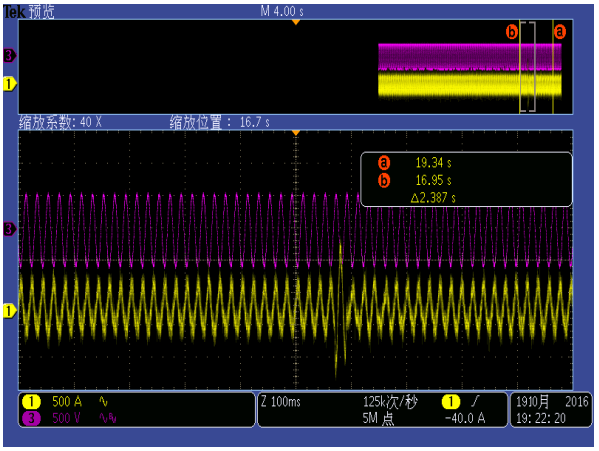
Under frequency < 46.9 Hz



Over frequency > 52.1 Hz



Frequency = 47.1 Hz



Frequency = 51.9Hz

9	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 PEA

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	196	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
10	100	100	-10	+10	168	39.891	0.998	818	Test A at BL
11	100	100	-5	+10	134	39.891	1.021	818	Test A at IB
12	100	100	0	+10	168	39.891	1.039	818	Test A at IB
13	100	100	+5	+10	159	39.891	1.081	818	Test A at IB
14	100	100	+10	+10	157	39.891	0.972	818	Test A at IB
15	100	100	-10	+5	157	39.891	1.020	818	Test A at IB
16	100	100	+10	+5	168	39.891	0.928	818	Test A at IB
17	100	100	-10	0	157	39.891	0.957	818	Test A at IB
18	100	100	+10	0	157	39.891	0.964	818	Test A at IB
19	100	100	-10	-5	168	39.891	1.081	818	Test A at IB
20	100	100	+10	-5	134	39.891	0.972	818	Test A at IB
21	100	100	-10	-10	168	39.891	1.020	818	Test A at IB
22	100	100	-5	-10	159	39.891	0.928	818	Test A at IB
23	100	100	0	-10	168	39.891	0.957	818	Test A at IB
24	100	100	+5	-10	147	39.891	0.964	818	Test A at IB
25	100	100	-10	-10	153	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

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

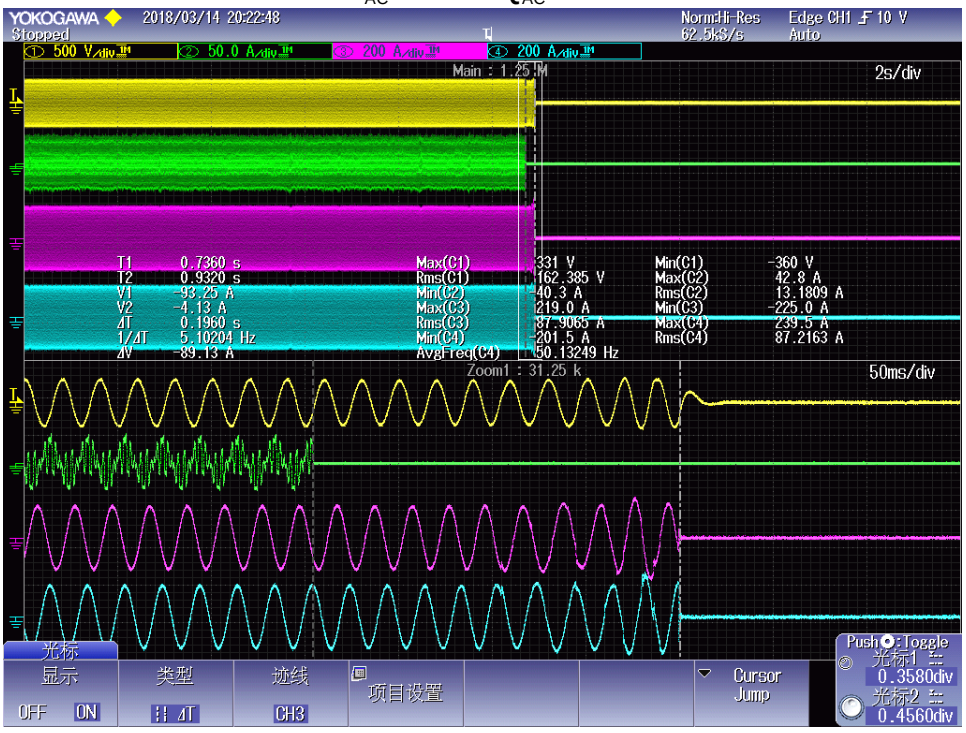
2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

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).

9	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 PEA						
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

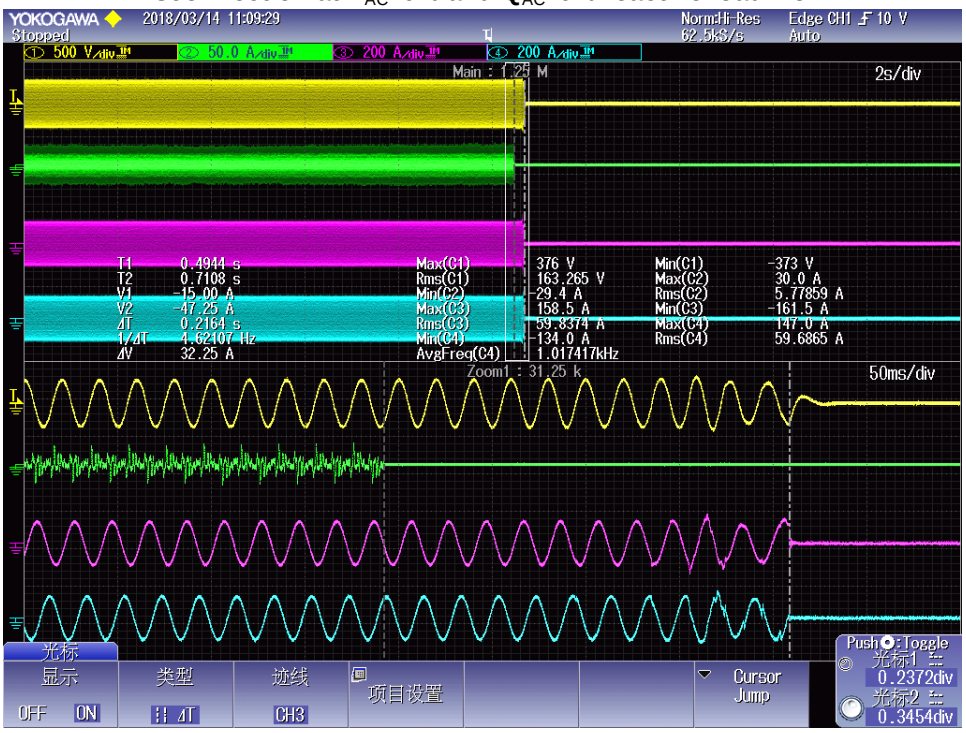
Parameter at 0% per phase	L= 78.43 mH	R= 24.39 Ω	C= 117.08 µF
IAC fundamental current at balance condition	L1: 16 mA	L2: 39 mA	L3: 41 mA

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.

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}(0.8A/div).

9	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 PEA						
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	221	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
6	33	33	0	0	173	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.

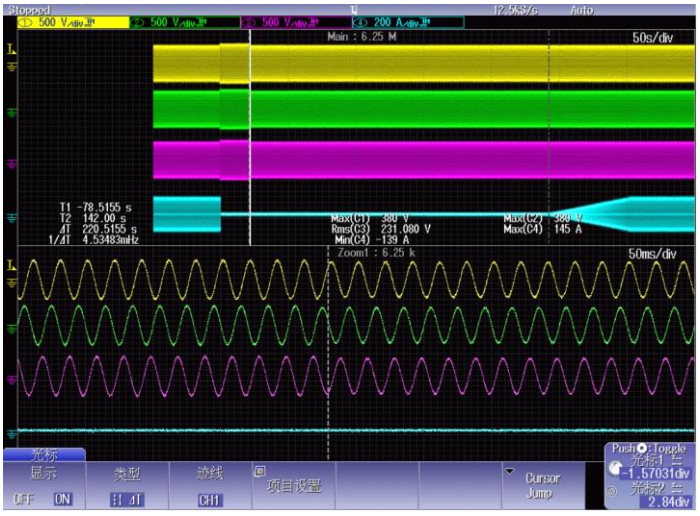
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = 33% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For 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.

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

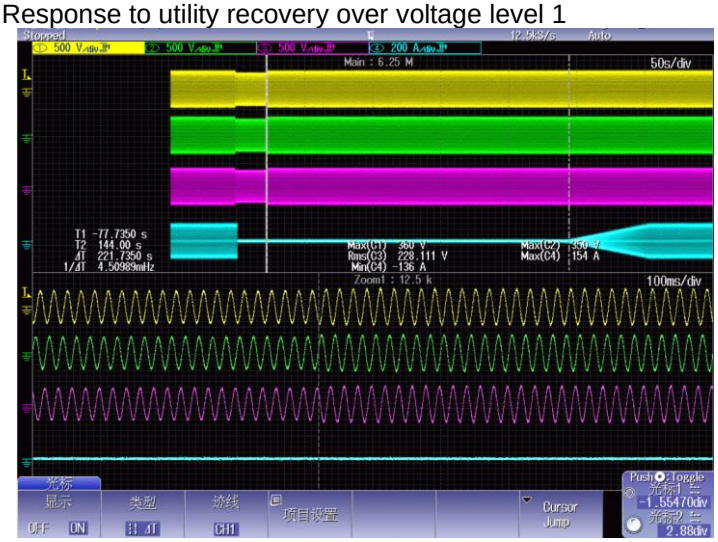
Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

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

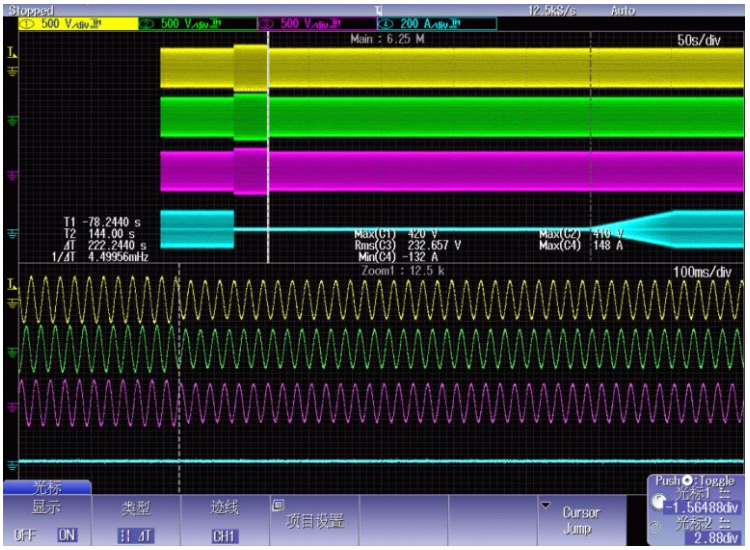
	Table: Response to Utility recovery test			P
Test condition	Limit (sec)	Actual Setting (sec)	Test Result (sec)	Result
Under frequency (46.9Hz)	20 - 300	27	228	P
Over frequency (52.1 Hz)		27	225	P
Under voltage level 1 (355 V)		27	222	P
Over voltage level 1 (443 V)		27	220	P
Under voltage level 2 (200 V)		27	223	P
Over voltage level 2 (478 V)		27	222	P
Supplementary				



Response to utility recovery over voltage level 1

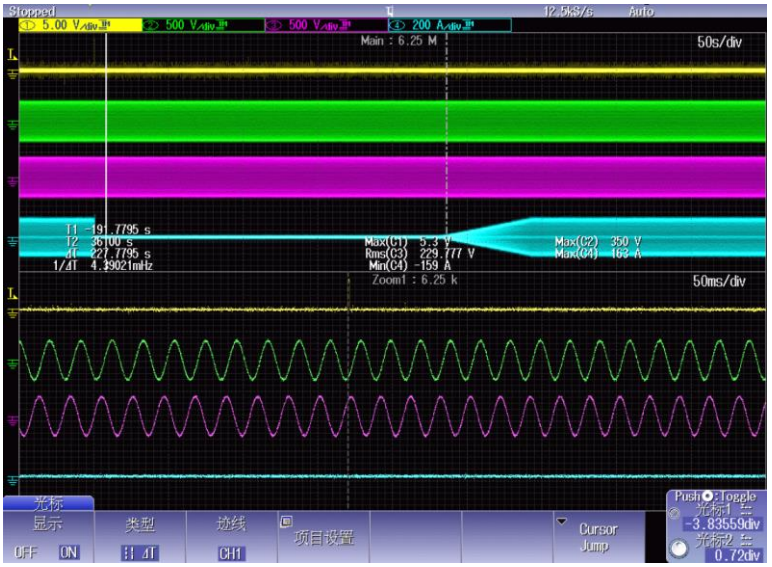


Response to utility recovery under voltage level 1



Response to utility recovery over voltage level 2

Response to utility recovery under voltage level 2



Response to utility recovery under Frequency

Response to utility recovery over Frequency

Annex I
Equipment of test

Equipment name	Trade name	Model	S/N	Cal. Due. Date
Power Analyzer	YOKOGAVA	WT3000	EP-011	2020/09/24
Programmable DC Power supply	ATESS	DC1000	RD.02.100	--
Programmable AC Source	ATESS	AC1000	RD.02.101	--
Programmable DC Power supply	Kewell	TVS-630kW	EP-027	--
Programmable AC Source	APC	AFG-S-33800	EP-026	--
Programmable RLC Load	Qunling	ACLT-38160H	EP-028	--
Digital oscilloscope	YOKOGAVA	DL850	EP-001	2020/09/05
Differential probe	CYBERTEK	VP5200	EP-003	2020/09/05
Current probe	YOKOGAVA	CT-1000	EP-012	2020/09/24
Current probe	YOKOGAVA	CT-1000	EP-013	2020/09/24
Current probe	YOKOGAVA	CT-1000	EP-014	2020/09/24
Three phase impedance	Teseq	CCN 1000-3	EE206-1	2020/08/23
Signal conditioning Unit	Teseq/Germany	INA2197/37A	EE206-2	N/A
Three phase impedance	Teseq/Germany	INA 2196/75A	EE206-3	N/A

Annex II Specification of Inverter

Annex IV
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

Finger 3 Laboratory Accreditation Certificate