TEST REPORT

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

Report Number. .....:	ES200211001P
Date of issue.....:	March 01. 2020
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……..:	HPS30
Firmware version……:	TI1.0
Date of receipt of test item.....:	February 13. 2020
Date(s) of performance of test.....:	February 13. 2020 to March 01. 2020
Date of report issue .....:	March 01. 2020

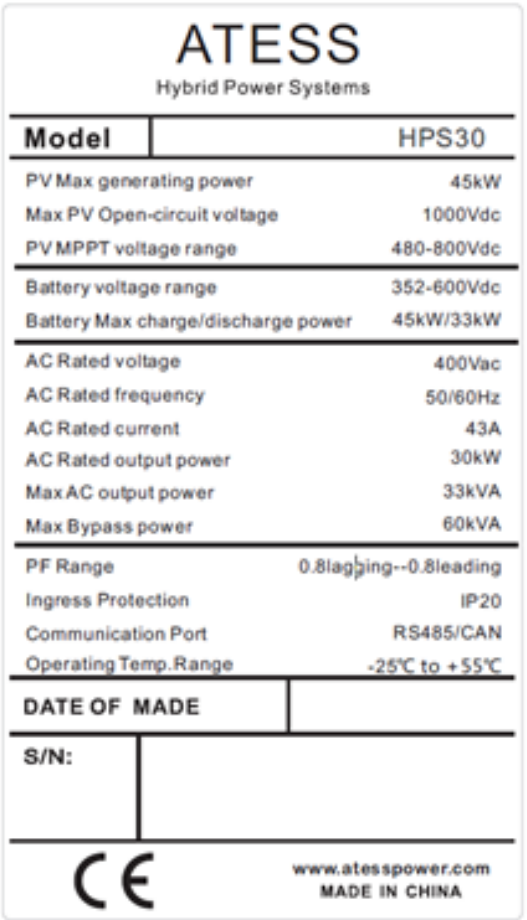
Tested by	Review by	Approved by
Tom Tao	Double Lee	Paladin Hu
(Mr. Tom Tao)	(Mr. Double Lee)	(Mr. Paladin Hu)
Testing Engineer	Project Engineer	Department Manager
(2020-03-01)	(2020-03-01)	(2020-03-01)

Summary of testing

Test result of Hybrid power systems model HPS30, 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] ..... : 480-800Vd.c

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

Input DC current max [A]..... : 94A

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

Output AC current rated [A] .....: 43A

Output power [W]..... : 30kW

Equipment mobility ..... : [x] movable [] hand-held
[] 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: 735kg

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%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	15.076	99.514	29.948	99.437	44.824	99.649	L1	-	P
2	0.387	0.334	0.690	0.892	1.150	0.991	L1	<1%	P
3	0.536	0.462	0.326	0.421	0.757	0.653	L1	<4%	P
4	0.065	0.056	0.132	0.171	0.252	0.217	L1	<1%	P
5	0.495	0.427	1.338	1.730	3.234	2.788	L1	<4%	P
6	0.184	0.159	0.071	0.092	0.125	0.108	L1	<1%	P
7	0.966	1.143	0.923	1.193	1.830	1.578	L1	<4%	P
8	0.017	0.045	0.042	0.054	0.071	0.061	L1	<1%	P
9	0.043	0.114	0.097	0.126	0.187	0.161	L1	<4%	P
10	0.035	0.091	0.053	0.069	0.179	0.154	L1	<1%	P
11	0.293	0.767	0.399	0.516	1.348	1.162	L1	<2%	P
12	0.014	0.038	0.024	0.031	0.060	0.052	L1	<0.5%	P
13	0.233	0.610	0.380	0.491	0.796	0.686	L1	<2%	P
14	0.035	0.093	0.061	0.079	0.152	0.131	L1	<0.5%	P
15	0.098	0.256	0.217	0.280	0.168	0.145	L1	<2%	P
16	0.075	0.197	0.105	0.136	0.387	0.334	L1	<0.5%	P
17	0.278	0.729	0.552	0.713	0.536	0.462	L1	<1.5%	P
18	0.019	0.050	0.036	0.047	0.065	0.056	L1	<0.375%	P
19	0.137	0.358	0.331	0.428	0.495	0.427	L1	<1.5%	P
20	0.030	0.079	0.050	0.065	0.184	0.159	L1	<0.375%	P
21	0.032	0.085	0.071	0.092	0.166	0.143	L1	<1.5%	P
22	0.025	0.065	0.030	0.039	0.052	0.045	L1	<0.375%	P
23	0.077	0.201	0.108	0.140	0.510	0.440	L1	<0.6%	P
24	0.005	0.012	0.015	0.020	0.051	0.044	L1	<0.15%	P
25	0.044	0.115	0.040	0.052	0.316	0.272	L1	<0.6%	P
26	0.010	0.027	0.008	0.010	0.063	0.054	L1	<0.15%	P
27	0.006	0.017	0.013	0.017	0.029	0.025	L1	<0.6%	P
28	0.004	0.010	0.004	0.005	0.030	0.026	L1	<0.15%	P
29	0.018	0.046	0.019	0.024	0.148	0.128	L1	<0.6%	P
30	0.004	0.010	0.003	0.004	0.023	0.020	L1	<0.15%	P
31	0.027	0.071	0.023	0.030	0.153	0.132	L1	<0.6%	P
32	0.007	0.019	0.010	0.013	0.041	0.035	L1	<0.15%	P
33	0.003	0.007	0.002	0.003	0.023	0.020	L1	<0.6%	P
34	0.003	0.008	0.004	0.005	0.026	0.022	L1	<0.15%	P
35	0.007	0.018	0.003	0.004	0.068	0.059	L1	<0.3%	P
36	0.003	0.009	0.005	0.006	0.015	0.013	L1	<0.075%	P
37	0.020	0.052	0.008	0.010	0.116	0.100	L1	<0.3%	P
38	0.006	0.016	0.002	0.003	0.043	0.037	L1	<0.075%	P
39	0.006	0.015	0.009	0.011	0.017	0.015	L1	<0.3%	P
40	0.008	0.022	0.003	0.004	0.061	0.053	L1	<0.075%	P
THDi	--	2.047	---	2.657	---	3.913	L1	≤ 5%	P
Supplementary information:									

1	TABLE: Current Harmonics								P
	Condition of test						Power (kW)		
	supplying power to balance linear loads 33% ±5%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	15.028	98.644	29.868	99.371	44.800	99.438	L2		P
2	0.133	0.185	0.261	0.181	0.234	0.202	L2	<1%	P
3	0.351	0.488	0.739	0.513	0.561	0.484	L2	<4%	P
4	0.132	0.184	0.285	0.198	0.232	0.200	L2	<1%	P
5	0.908	1.261	2.707	1.880	2.383	2.054	L2	<4%	P
6	0.052	0.072	0.122	0.085	0.104	0.090	L2	<1%	P
7	0.314	0.436	1.581	1.098	1.576	1.359	L2	<4%	P
8	0.078	0.109	0.167	0.116	0.137	0.118	L2	<1%	P
9	0.094	0.131	0.204	0.142	0.157	0.135	L2	<4%	P
10	0.074	0.103	0.181	0.126	0.143	0.123	L2	<1%	P
11	0.242	0.336	0.802	0.557	0.992	0.855	L2	<2%	P
12	0.085	0.118	0.180	0.125	0.151	0.130	L2	<0.5%	P
13	0.250	0.347	0.504	0.350	0.688	0.593	L2	<2%	P
14	0.101	0.140	0.213	0.148	0.193	0.166	L2	<0.5%	P
15	0.119	0.165	0.251	0.174	0.210	0.181	L2	<2%	P
16	0.112	0.155	0.245	0.170	0.195	0.168	L2	<0.5%	P
17	0.284	0.394	0.336	0.233	0.556	0.479	L2	<1.5%	P
18	0.122	0.170	0.252	0.175	0.209	0.180	L2	<0.375%	P
19	0.194	0.269	0.348	0.242	0.430	0.371	L2	<1.5%	P
20	0.141	0.196	0.281	0.195	0.244	0.210	L2	<0.375%	P
21	0.142	0.197	0.292	0.203	0.251	0.216	L2	<1.5%	P
22	0.147	0.204	0.302	0.210	0.248	0.214	L2	<0.375%	P
23	0.223	0.310	0.413	0.287	0.389	0.335	L2	<0.6%	P
24	0.087	0.121	0.183	0.127	0.264	0.128	L2	<0.15%	P
25	0.199	0.276	0.393	0.273	0.327	0.282	L2	<0.6%	P
26	0.030	0.042	0.068	0.047	0.293	0.053	L2	<0.15%	P
27	0.180	0.250	0.370	0.257	0.296	0.255	L2	<0.6%	P
28	0.041	0.057	0.089	0.062	0.309	0.066	L2	<0.15%	P
29	0.007	0.010	0.055	0.038	0.355	0.066	L2	<0.6%	P
30	0.052	0.072	0.112	0.078	0.324	0.079	L2	<0.15%	P
31	0.247	0.343	0.435	0.302	0.342	0.295	L2	<0.6%	P
32	0.069	0.096	0.135	0.094	0.349	0.091	L2	<0.15%	P
33	0.215	0.299	0.444	0.308	0.355	0.306	L2	<0.6%	P
34	0.014	0.019	0.081	0.056	0.013	0.011	L2	<0.15%	P
35	0.040	0.056	0.037	0.026	0.009	0.008	L2	<0.3%	P
36	0.007	0.010	0.027	0.019	0.002	0.002	L2	<0.075%	P
37	0.070	0.097	0.163	0.113	0.010	0.009	L2	<0.3%	P
38	0.024	0.034	0.020	0.014	0.009	0.008	L2	<0.075%	P
39	0.009	0.012	0.029	0.020	0.003	0.003	L2	<0.3%	P
40	0.036	0.050	0.014	0.010	0.007	0.006	L2	<0.075%	P
THDi	---	2.065	---	2.465	---	3.847	L2	≤ 5%	P
Supplementary information:									

1	TABLE: Current Harmonics								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		P
	Output Current Harmonics Measurement							Limit (% of output current)	Result
Order	33% of rated output current		66% of rated output current		100% of rated output current		Phase		
	(A)	(%)	(A)	(%)	(A)	(%)			
1	15.076	99.926	29.976	99.952	44.824	99.975	L3		P
2	0.387	0.334	0.690	0.892	1.150	0.991	L3	<1%	P
3	0.536	0.462	0.326	0.421	0.757	0.653	L3	<4%	P
4	0.065	0.056	0.132	0.171	0.252	0.217	L3	<1%	P
5	0.495	0.427	1.338	1.730	3.234	2.788	L3	<4%	P
6	0.184	0.159	0.071	0.092	0.125	0.108	L3	<1%	P
7	0.966	1.143	0.923	1.193	1.830	1.578	L3	<4%	P
8	0.017	0.045	0.042	0.054	0.071	0.061	L3	<1%	P
9	0.043	0.114	0.097	0.126	0.187	0.161	L3	<4%	P
10	0.035	0.091	0.053	0.069	0.179	0.154	L3	<1%	P
11	0.293	0.767	0.399	0.516	1.348	1.162	L3	<2%	P
12	0.014	0.038	0.024	0.031	0.060	0.052	L3	<0.5%	P
13	0.233	0.610	0.380	0.491	0.796	0.686	L3	<2%	P
14	0.035	0.093	0.061	0.079	0.152	0.131	L3	<0.5%	P
15	0.098	0.256	0.217	0.280	0.168	0.145	L3	<2%	P
16	0.075	0.197	0.105	0.136	0.387	0.334	L3	<0.5%	P
17	0.278	0.729	0.552	0.713	0.536	0.462	L3	<1.5%	P
18	0.019	0.050	0.036	0.047	0.065	0.056	L3	<0.375%	P
19	0.137	0.358	0.331	0.428	0.495	0.427	L3	<1.5%	P
20	0.030	0.079	0.050	0.065	0.184	0.159	L3	<0.375%	P
21	0.032	0.085	0.071	0.092	0.166	0.143	L3	<1.5%	P
22	0.025	0.065	0.030	0.039	0.052	0.045	L3	<0.375%	P
23	0.077	0.201	0.108	0.140	0.510	0.440	L3	<0.6%	P
24	0.005	0.012	0.015	0.020	0.051	0.044	L3	<0.15%	P
25	0.044	0.115	0.040	0.052	0.316	0.272	L3	<0.6%	P
26	0.010	0.027	0.008	0.010	0.063	0.054	L3	<0.15%	P
27	0.006	0.017	0.013	0.017	0.029	0.025	L3	<0.6%	P
28	0.004	0.010	0.004	0.005	0.030	0.026	L3	<0.15%	P
29	0.018	0.046	0.019	0.024	0.148	0.128	L3	<0.6%	P
30	0.004	0.010	0.003	0.004	0.023	0.020	L3	<0.15%	P
31	0.027	0.071	0.023	0.030	0.153	0.132	L3	<0.6%	P
32	0.007	0.019	0.010	0.013	0.041	0.035	L3	<0.15%	P
33	0.003	0.007	0.002	0.003	0.023	0.020	L3	<0.6%	P
34	0.003	0.008	0.004	0.005	0.026	0.022	L3	<0.15%	P
35	0.007	0.018	0.003	0.004	0.068	0.059	L3	<0.3%	P
36	0.003	0.009	0.005	0.006	0.015	0.013	L3	<0.075%	P
37	0.020	0.052	0.008	0.010	0.116	0.100	L3	<0.3%	P
38	0.006	0.016	0.002	0.003	0.043	0.037	L3	<0.075%	P
39	0.006	0.015	0.009	0.011	0.017	0.015	L3	<0.3%	P
40	0.008	0.022	0.003	0.004	0.061	0.053	L3	<0.075%	P
THDi		2.356		2.782		3.509	L3	≤ 5%	P
Supplementary information:									

1	TABLE: Voltage Harmonics								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		P
	Output 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	230.09	99	230.26	99	230.18	99	L1	-	P
2	0.182	0.082	0.172	0.078	0.169	0.077	L1	<2%	P
3	1.735	0.784	1.714	0.779	1.773	0.806	L1	<4%	P
4	0.018	0.008	0.035	0.016	0.565	0.257	L1	<2%	P
5	0.207	0.094	0.268	0.122	0.264	0.120	L1	<4%	P
6	0.002	0.001	0.015	0.007	0.018	0.008	L1	<2%	P
7	0.139	0.063	0.216	0.098	0.207	0.094	L1	<4%	P
8	0.020	0.009	0.002	0.001	0.002	0.001	L1	<2%	P
9	0.099	0.045	0.154	0.070	0.139	0.063	L1	<4%	P
10	0.026	0.012	0.015	0.007	0.020	0.009	L1	<2%	P
11	0.403	0.183	0.095	0.043	0.099	0.045	L1	<4%	P
12	0.026	0.012	0.022	0.010	0.026	0.012	L1	<2%	P
13	0.048	0.020	0.044	0.015	0.403	0.183	L1	<4%	P
14	0.009	0.010	0.022	0.009	0.145	0.066	L1	<2%	P
15	0.044	0.038	0.084	0.040	0.097	0.044	L1	<4%	P
16	0.013	0.009	0.020	0.010	0.048	0.022	L1	<2%	P
17	0.095	0.043	0.095	0.045	0.451	0.205	L1	<4%	P
18	0.013	0.006	0.013	0.007	0.048	0.022	L1	<2%	P
19	0.062	0.028	0.062	0.027	0.354	0.161	L1	<4%	P
20	0.009	0.004	0.011	0.005	0.011	0.005	L1	<2%	P
21	0.092	0.042	0.099	0.045	0.099	0.045	L1	<4%	P
22	0.004	0.002	0.009	0.004	0.009	0.004	L1	<2%	P
23	0.048	0.022	0.048	0.022	0.048	0.022	L1	<4%	P
24	0.009	0.004	0.009	0.004	0.009	0.004	L1	<2%	P
25	0.031	0.014	0.044	0.020	0.044	0.020	L1	<4%	P
26	0.011	0.005	0.013	0.006	0.013	0.006	L1	<2%	P
27	0.042	0.019	0.042	0.019	0.048	0.022	L1	<4%	P
28	0.015	0.007	0.013	0.006	0.081	0.037	L1	<2%	P
29	0.029	0.013	0.035	0.016	0.097	0.044	L1	<4%	P
30	0.013	0.006	0.015	0.007	0.015	0.007	L1	<2%	P
31	0.022	0.010	0.022	0.010	0.112	0.051	L1	<4%	P
32	0.009	0.004	0.007	0.003	0.048	0.022	L1	<2%	P
33	0.004	0.002	0.009	0.004	0.033	0.015	L1	<4%	P
34	0.007	0.003	0.004	0.002	0.125	0.057	L1	<2%	P
35	0.004	0.002	0.007	0.003	0.062	0.028	L1	<4%	P
36	0.007	0.003	0.009	0.004	0.035	0.016	L1	<2%	P
37	0.040	0.018	0.037	0.017	0.092	0.042	L1	<4%	P
38	0.009	0.004	0.011	0.005	0.013	0.006	L1	<2%	P
39	0.033	0.015	0.035	0.016	0.013	0.006	L1	<4%	P
40	0.007	0.003	0.004	0.002	0.013	0.006	L1	<2%	P
THDv	--	0.813	--	0.875	--	0.899	L1	≤ 5%	P
Supplementary information:									

1	TABLE: Voltage Harmonics								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						9.987		P
	supplying power to balance linear loads 66 %±5%						19.981		P
	supplying power to balance linear loads 100 %±5%						30.014		P

	Output 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	230.11	99	230.31	99	230.01	99	L2	-	P
2	0.169	0.082	0.178	0.081	0.172	0.077	L2	<2%	P
3	1.773	0.784	1.701	0.773	1.714	0.806	L2	<4%	P
4	0.565	0.008	0.033	0.015	0.035	0.257	L2	<2%	P
5	0.264	0.094	0.299	0.136	0.268	0.120	L2	<4%	P
6	0.018	0.001	0.009	0.004	0.015	0.008	L2	<2%	P
7	0.207	0.063	0.174	0.079	0.216	0.094	L2	<4%	P
8	0.002	0.009	0.004	0.002	0.002	0.001	L2	<2%	P
9	0.139	0.045	0.136	0.062	0.154	0.063	L2	<4%	P
10	0.020	0.012	0.015	0.007	0.015	0.009	L2	<2%	P
11	0.099	0.183	0.059	0.027	0.095	0.045	L2	<4%	P
12	0.026	0.012	0.020	0.009	0.022	0.012	L2	<2%	P
13	0.403	0.020	0.026	0.012	0.044	0.183	L2	<4%	P
14	0.009	0.010	0.018	0.008	0.022	0.066	L2	<2%	P
15	0.044	0.038	0.084	0.038	0.097	0.044	L2	<4%	P
16	0.013	0.009	0.015	0.007	0.048	0.022	L2	<2%	P
17	0.095	0.043	0.088	0.040	0.451	0.205	L2	<4%	P
18	0.013	0.006	0.011	0.005	0.048	0.022	L2	<2%	P
19	0.062	0.028	0.070	0.032	0.354	0.161	L2	<4%	P
20	0.009	0.004	0.011	0.005	0.011	0.005	L2	<2%	P
21	0.092	0.042	0.088	0.040	0.099	0.045	L2	<4%	P
22	0.004	0.002	0.007	0.003	0.009	0.004	L2	<2%	P
23	0.048	0.022	0.064	0.029	0.048	0.022	L2	<4%	P
24	0.009	0.004	0.011	0.005	0.009	0.004	L2	<2%	P
25	0.031	0.014	0.033	0.015	0.044	0.020	L2	<4%	P
26	0.011	0.005	0.015	0.007	0.013	0.006	L2	<2%	P
27	0.042	0.019	0.048	0.022	0.048	0.022	L2	<4%	P
28	0.015	0.007	0.020	0.009	0.081	0.037	L2	<2%	P
29	0.029	0.013	0.029	0.013	0.097	0.044	L2	<4%	P
30	0.013	0.006	0.015	0.007	0.015	0.007	L2	<2%	P
31	0.022	0.010	0.013	0.006	0.112	0.051	L2	<4%	P
32	0.009	0.004	0.009	0.004	0.048	0.022	L2	<2%	P
33	0.004	0.002	0.007	0.003	0.033	0.015	L2	<4%	P
34	0.007	0.003	0.009	0.004	0.125	0.057	L2	<2%	P
35	0.004	0.002	0.004	0.002	0.062	0.028	L2	<4%	P
36	0.007	0.003	0.009	0.004	0.035	0.016	L2	<2%	P
37	0.040	0.018	0.040	0.018	0.092	0.042	L2	<4%	P
38	0.009	0.004	0.009	0.004	0.013	0.006	L2	<2%	P
39	0.033	0.015	0.035	0.016	0.013	0.006	L2	<4%	P
40	0.007	0.003	0.007	0.003	0.013	0.006	L2	<2%	P
THDv	--	0.842	--	0.878	--	0.906	L2	≤ 5%	P

Supplementary information:

1	TABLE: Voltage Harmonics								P
	Condition of test					Power(kW)			
	supplying power to balance linear loads 33% ±5%					9.987			P
	supplying power to balance linear loads 66 %±5%					19.981			P
	supplying power to balance linear loads 100 %±5%					30.014			P

	Output 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	230.10	100	230.13	100	230.01	100	L3	-	P
2	0.182	0.082	0.172	0.078	0.169	0.077	L3	<2%	P
3	1.735	0.784	1.714	0.779	1.773	0.806	L3	<4%	P
4	0.018	0.008	0.035	0.016	0.565	0.257	L3	<2%	P
5	0.207	0.094	0.268	0.122	0.264	0.120	L3	<4%	P
6	0.002	0.001	0.015	0.007	0.018	0.008	L3	<2%	P
7	0.139	0.063	0.216	0.098	0.207	0.094	L3	<4%	P
8	0.020	0.009	0.002	0.001	0.002	0.001	L3	<2%	P
9	0.099	0.045	0.154	0.070	0.139	0.063	L3	<4%	P
10	0.026	0.012	0.015	0.007	0.020	0.009	L3	<2%	P
11	0.403	0.183	0.095	0.043	0.099	0.045	L3	<4%	P
12	0.026	0.012	0.022	0.010	0.026	0.012	L3	<2%	P
13	0.048	0.020	0.044	0.015	0.403	0.183	L3	<4%	P
14	0.009	0.010	0.022	0.009	0.145	0.066	L3	<2%	P
15	0.044	0.038	0.084	0.040	0.097	0.044	L3	<4%	P
16	0.013	0.009	0.020	0.010	0.048	0.022	L3	<2%	P
17	0.095	0.043	0.095	0.045	0.451	0.205	L3	<4%	P
18	0.013	0.006	0.013	0.007	0.048	0.022	L3	<2%	P
19	0.062	0.028	0.062	0.027	0.354	0.161	L3	<4%	P
20	0.009	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	0.004	0.002	0.009	0.004	0.009	0.004	L3	<2%	P
23	0.048	0.022	0.048	0.022	0.048	0.022	L3	<4%	P
24	0.009	0.004	0.009	0.004	0.009	0.004	L3	<2%	P
25	0.031	0.014	0.044	0.020	0.044	0.020	L3	<4%	P
26	0.011	0.005	0.013	0.006	0.013	0.006	L3	<2%	P
27	0.042	0.019	0.042	0.019	0.048	0.022	L3	<4%	P
28	0.015	0.007	0.013	0.006	0.081	0.037	L3	<2%	P
29	0.029	0.013	0.035	0.016	0.097	0.044	L3	<4%	P
30	0.013	0.006	0.015	0.007	0.015	0.007	L3	<2%	P
31	0.022	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	0.004	0.002	0.009	0.004	0.033	0.015	L3	<4%	P
34	0.007	0.003	0.004	0.002	0.125	0.057	L3	<2%	P
35	0.004	0.002	0.007	0.003	0.062	0.028	L3	<4%	P
36	0.007	0.003	0.009	0.004	0.035	0.016	L3	<2%	P
37	0.040	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	0.033	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	--	0.824	--	0.869	--	0.897	L3	≤ 5%	P

Supplementary information:

2	TABLE: Voltage Fluctuation				P
Flicker measurement 1	EUT values			Limit	Result
	L1	L2	L3		
Pst	0.26	0.24	0.26	1.00	P
Plt	0.25	0.27	0.21	0.65	P
dc [%]	0.06	0.06	0.06	3.30	P
dmax [%]	0.80	0.79	0.78	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%						9.987	P
	supplying power to balance linear loads 66% ±5%						19.981	P
	supplying power to balance linear loads 100% ±5%						30.014	P
	Normal rated output current						43A	
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	0.044	0.307	0.042	0.195	0.046	0.107	≤0.5	P
L2	0.046	0.321	0.053	0.246	0.049	0.114	≤0.5	P
L3	0.049	0.342	0.055	0.256	0.052	0.121	≤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	1.035	0.0345	-30.282	-1.0106	1.128	0.0371	0.032154
10	2.772	0.0925	-30.174	-1.0070	2.994	0.0986	0.091486
20	6.375	0.2128	-29.622	-0.9886	6.864	0.2260	0.210395
30	9.099	0.3037	-28.902	-0.9645	9.660	0.3182	0.300296
40	11.775	0.3930	-27.918	-0.9317	12.366	0.4074	0.388613
50	15.072	0.5030	-26.286	-0.8772	15.504	0.5108	0.497426
60	18.234	0.6085	-24.198	-0.8076	18.684	0.6154	0.601782
70	21.108	0.7044	-21.738	-0.7255	21.582	0.7109	0.706634
80	24.075	0.8035	-18.396	-0.6140	24.492	0.8067	0.804546
90	27.069	0.9034	-13.614	-0.4544	27.480	0.9052	0.902362
100	29.964	1.0000	-4.500	-0.2136	30.360	1.0000	0.992912

+Q max							
Power Set	Active Power [W]		Reactive power [Var]		DC power		Power factor
	kW	p.u.	kVAR	p.u.	(kW)	p.u.	
1	1.095	0.0365	30.282	1.0106	1.200	0.0395	0.036142
10	2.841	0.0948	30.168	1.0068	3.018	0.0992	0.093742
20	6.534	0.2180	29.586	0.9874	6.864	0.2257	0.215623
30	9.495	0.3167	28.776	0.9603	9.810	0.3226	0.313334
40	11.808	0.3939	27.906	0.9313	12.072	0.3971	0.389734
50	15.132	0.5048	26.205	0.8761	15.396	0.5063	0.499455
60	18.096	0.6036	24.300	0.8111	18.372	0.6042	0.607234
70	21.063	0.7026	21.780	0.7269	21.492	0.7069	0.695156
80	24.225	0.8081	18.198	0.6074	24.672	0.8114	0.809678
90	27.153	0.9057	13.446	0.4488	27.564	0.9067	0.896342
100	29.979	1.0000	4.398	0.1468	30.402	1.0000	0.911443

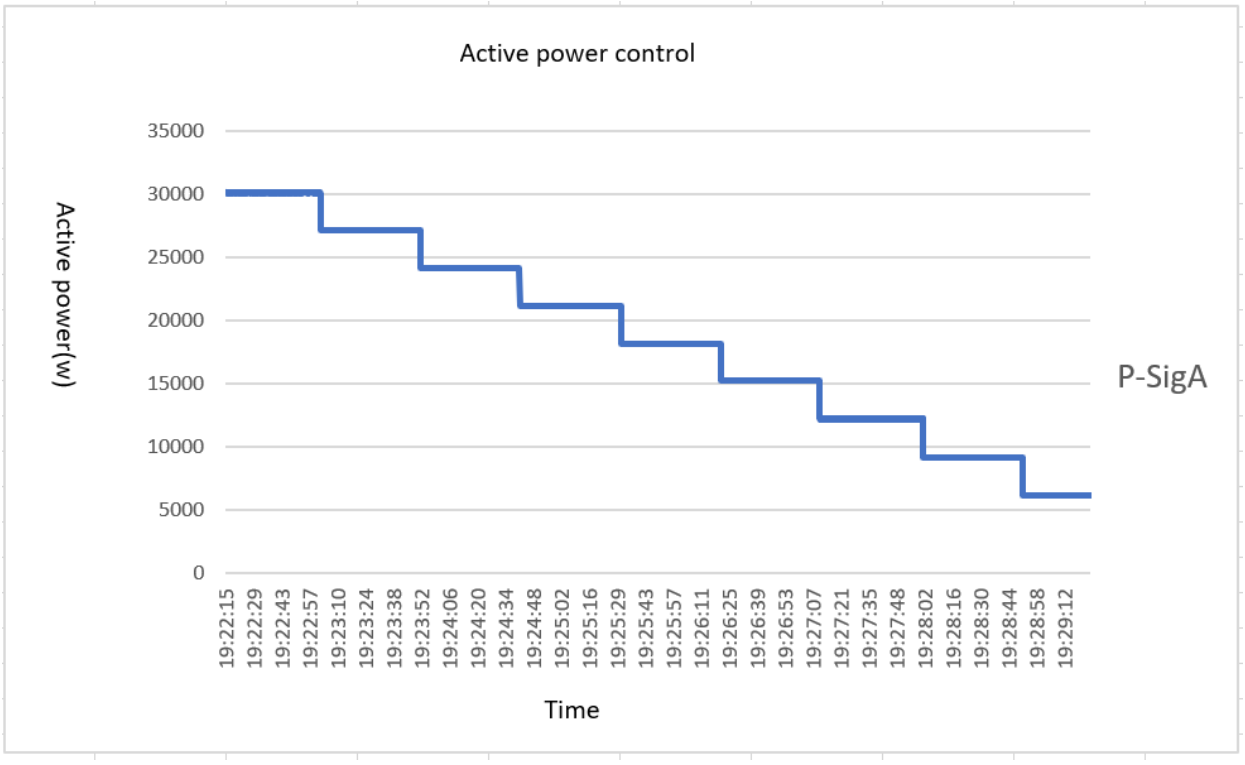
4.1	TABLE : Reactive power control			P
4.1 fixed displacement factor cos Ø				
P (setting)	PF (setting)	P (measuring)	Q (max measuring)	PF (measuring)
P.F. setting 0.95 lagging				
0% (1%)	0.95 lagging	1.422	-0.474	0.9498
10%	0.95 lagging	2.841	-0.960	0.9497
20%	0.95 lagging	5.706	-1.851	0.9502
30%	0.95 lagging	8.571	-2.757	0.9501
40%	0.95 lagging	11.367	-3.873	0.9499
50%	0.95 lagging	14.298	-4.533	0.9502
60%	0.95 lagging	17.097	-5.643	0.9494
70%	0.95 lagging	19.884	-6.729	0.9496
80%	0.95 lagging	22.869	-7.275	0.9501
90%	0.95 lagging	25.668	-8.358	0.9503
100%	0.95 lagging	28.524	-9.243	0.9504
P.F. setting 0.95 leading				
0% (1%)	0.95 leading	1.425	0.465	0.9501
10%	0.95 leading	2.844	0.951	0.9499
20%	0.95 leading	5.712	1.845	0.9501
30%	0.95 leading	8.571	2.739	0.9502
40%	0.95 leading	11.397	3.762	0.9495
50%	0.95 leading	14.229	4.767	0.9497
60%	0.95 leading	17.154	5.493	0.9503
70%	0.95 leading	19.971	6.462	0.9507
80%	0.95 leading	22.746	7.647	0.9493
90%	0.95 leading	25.668	8.412	0.9503
100%	0.95 leading	28.551	9.228	0.9503
P.F. setting 0.9 lagging				
0% (1%)	0.90 lagging	1.347	-0.449	0.8999
10%	0.90 lagging	2.691	-0.909	0.8998

20%	0.90 lagging	5.406	-1.754	0.9003
30%	0.90 lagging	8.120	-2.612	0.9004
40%	0.90 lagging	10.769	-3.669	0.8996
50%	0.90 lagging	13.545	-4.294	0.9003
60%	0.90 lagging	16.197	-5.346	0.8997
70%	0.90 lagging	18.837	-6.375	0.8998
80%	0.90 lagging	21.665	-6.892	0.9010
90%	0.90 lagging	24.317	-7.918	0.9009
100%	0.90 lagging	27.023	-8.757	0.9003
P.F. setting 0.9 leading				
0% (1%)	0.90 leading	1.350	0.441	0.9010
10%	0.90 leading	2.694	0.901	0.8995
20%	0.90 leading	5.411	1.748	0.9007
30%	0.90 leading	8.120	2.595	0.9006
40%	0.90 leading	10.797	3.564	0.8996
50%	0.90 leading	13.480	4.516	0.8999
60%	0.90 leading	16.251	5.204	0.9004
70%	0.90 leading	18.920	6.122	0.9005
80%	0.90 leading	21.549	7.245	0.8999
90%	0.90 leading	24.317	7.969	0.9003
100%	0.90 leading	27.048	8.742	0.9006
P.F. setting PF 1.0				
0% (1%)	1.0	1.479	-0.237	0.9895
10%	1.0	2.973	-0.381	0.9923
20%	1.0	5.961	-0.678	0.9935
30%	1.0	8.952	-0.900	0.9943
40%	1.0	11.964	-0.912	0.9972
50%	1.0	14.958	-1.014	0.9976
60%	1.0	17.979	-0.873	0.9989
70%	1.0	20.979	-0.867	0.9992
80%	1.0	23.994	-0.717	0.9996
90%	1.0	26.997	-0.519	0.9998
100%	1.0	30.009	-0.396	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%	30	30.003	-0.003	-0.01
90%	27	26.994	0.006	0.02
80%	24	23.994	0.006	0.03
70%	21	20.988	0.012	0.06
60%	18	17.973	0.027	0.15
50%	15	14.967	0.033	0.22
40%	12	11.943	0.057	0.48
30%	9	8.943	0.057	0.63
20%	6	5.952	0.048	0.80
10%	3	2.973	0.027	0.09

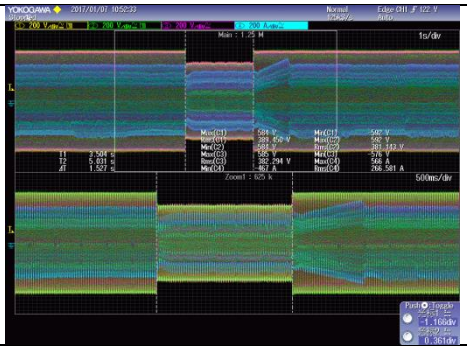
Supplementary information:



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)	1.5097
	0.3-0.5 (V2/Vnom)	0.1603
	0-0.049 (V3/Vnom)	0.1604
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5092
	0.3-0.5 (V2/Vnom)	0.1605
	0-0.049 (V3/Vnom)	0.1603
file:3-B-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.4975
	0.3-0.5 (V2/Vnom)	0.1603
	0-0.049 (V3/Vnom)	0.1602
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5194
	0.3-0.5 (V2/Vnom)	0.1601
	0-0.049 (V3/Vnom)	0.1601
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.5207
	0.3-0.5 (V5/Vnom)	0.1660
	0-0.049 (V6/Vnom)	0.1660
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5203
	0.3-0.5 (V8/Vnom)	0.1614
	0-0.049 (V9/Vnom)	0.1623
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5325
	0.3-0.5 (V8/Vnom)	0.1607
	0-0.049 (V9/Vnom)	0.1607
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)	1.5226
	0.3-0.5 (V2/Vnom)	0.1602
	0-0.049 (V3/Vnom)	0.1602
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5202
	0.3-0.5 (V2/Vnom)	0.1601
	0-0.049 (V3/Vnom)	0.1602
file:3-B-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5270
	0.3-0.5 (V2/Vnom)	0.1601
	0-0.049 (V3/Vnom)	0.1620
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5270
	0.3-0.5 (V2/Vnom)	0.1620
	0-0.049 (V3/Vnom)	0.1610
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.5320
	0.3-0.5 (V5/Vnom)	0.1660
	0-0.049 (V6/Vnom)	0.1607
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5320
	0.3-0.5 (V8/Vnom)	0.1602
	0-0.049 (V9/Vnom)	0.1601
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5220
	0.3-0.5 (V8/Vnom)	0.1602
	0-0.049 (V9/Vnom)	0.1602
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)	1.5020
	0.3-0.5 (V2/Vnom)	0.1620
	0-0.049 (V3/Vnom)	0.1620
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5070
	0.3-0.5 (V2/Vnom)	0.1610
	0-0.049 (V3/Vnom)	0.1610
file:3-B-phase – C- phase symmetrical	0.7-0.8 (V1/Vnom)	1.5070
	0.3-0.5 (V2/Vnom)	0.1620

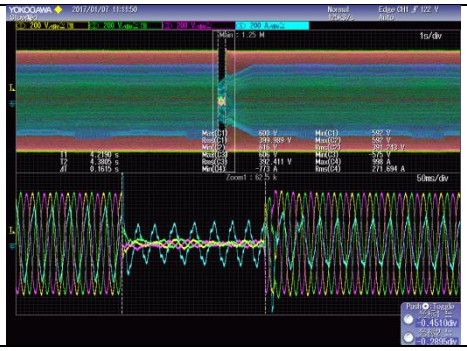
faults	0-0.049 (V3/Vnom)	0.1602
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.5012
	0.3-0.5 (V2/Vnom)	0.1612
	0-0.049 (V3/Vnom)	0.1613
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.5274
	0.3-0.5 (V5/Vnom)	0.1672
	0-0.049 (V6/Vnom)	0.1663
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5375
	0.3-0.5 (V8/Vnom)	0.1622
	0-0.049 (V9/Vnom)	0.1623
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.5322
	0.3-0.5 (V8/Vnom)	0.1623
	0-0.049 (V9/Vnom)	0.1622

Supplementary information(90% Power):



Three-phase faults 0.7-0.8 Vn

Three-phase faults 0.3-0.5 Vn



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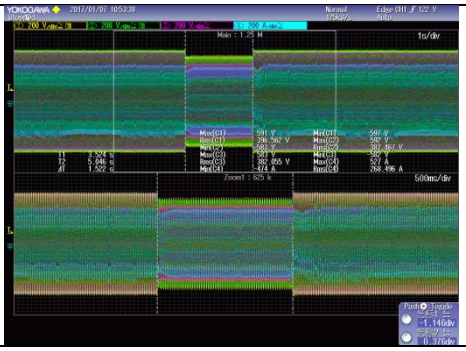
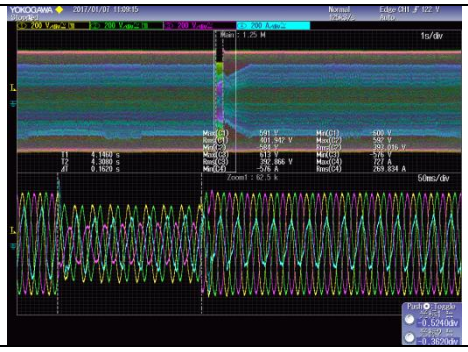
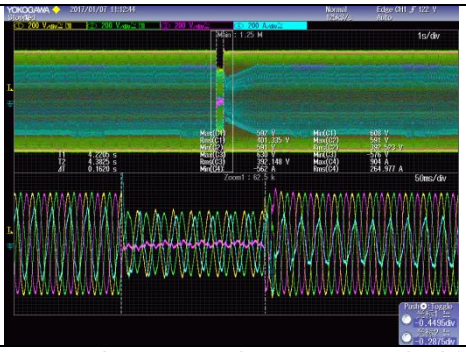


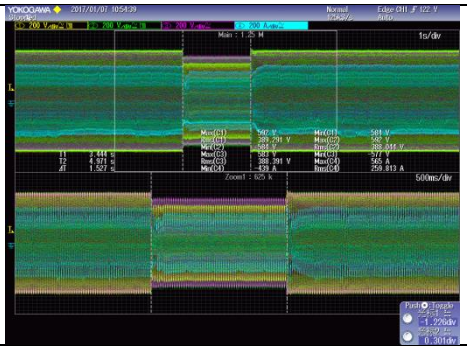
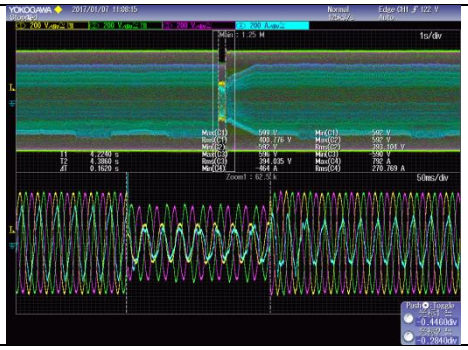
A-phase – B- phase symmetrical faults 0.7-0.8 Vn



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



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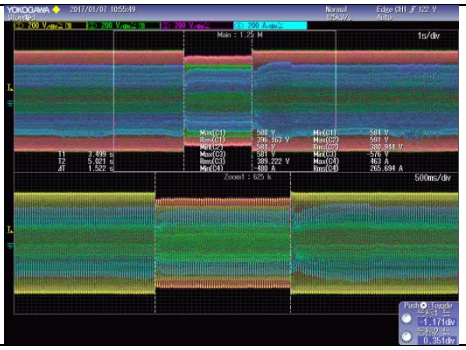
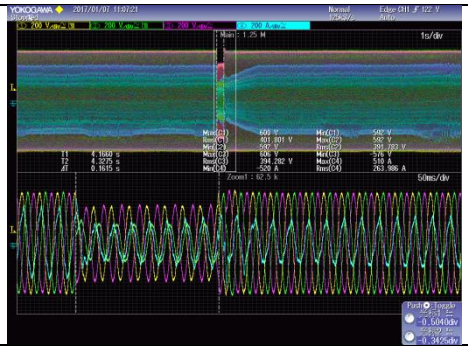
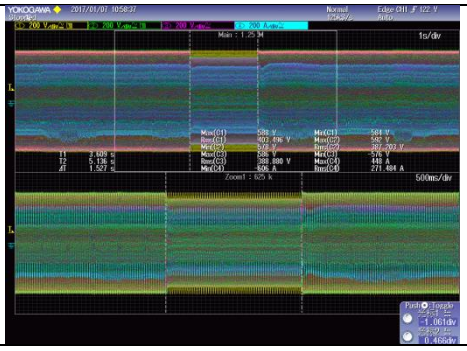
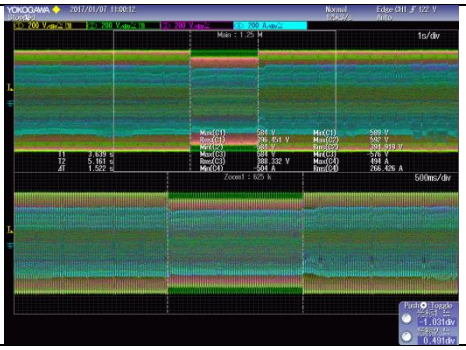
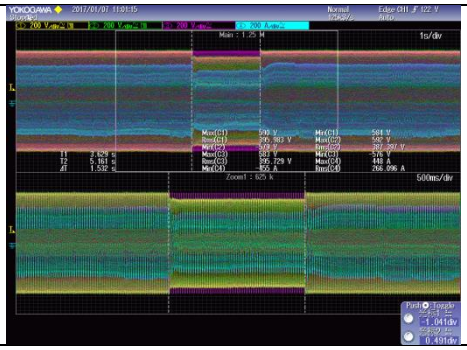
	
B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – C- phase symmetrical faults 0.3-0.5 Vn	A-phase – C- phase symmetrical faults 0-0.049 Vn
	
A-phase symmetrical faults 0.7-0.8 Vn	A-phase symmetrical faults 0.3-0.5 Vn

			
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	
			
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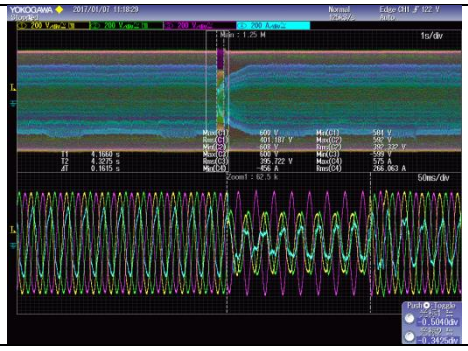
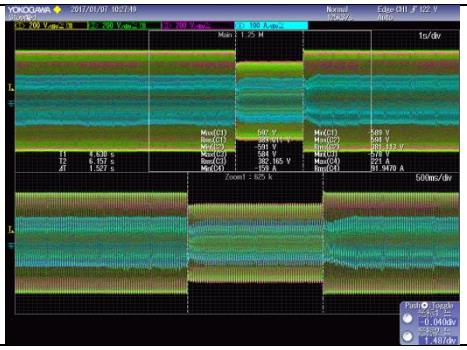
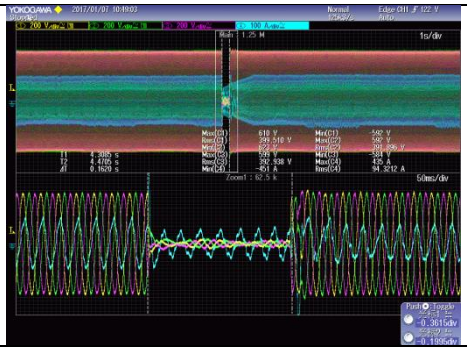
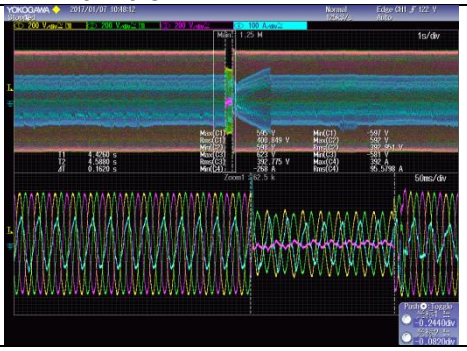
		--	
C- phase symmetrical faults 0-0.049 Vn		--	
Supplementary information(30% Power):			

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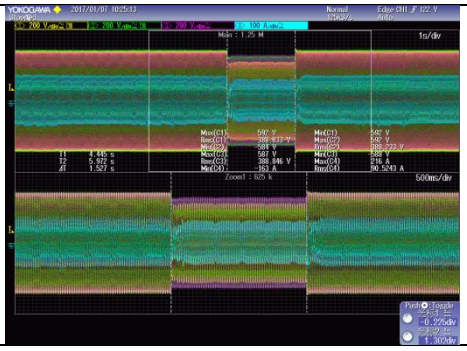
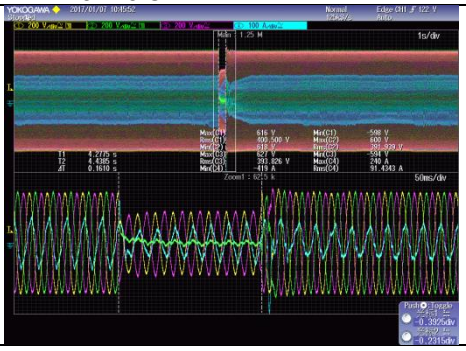
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn

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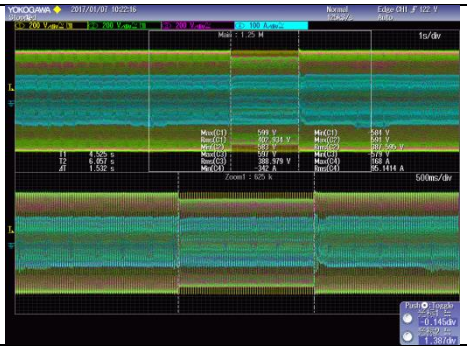	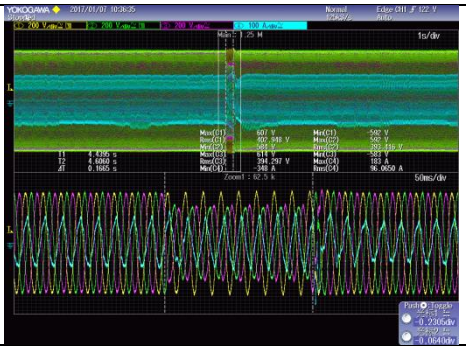
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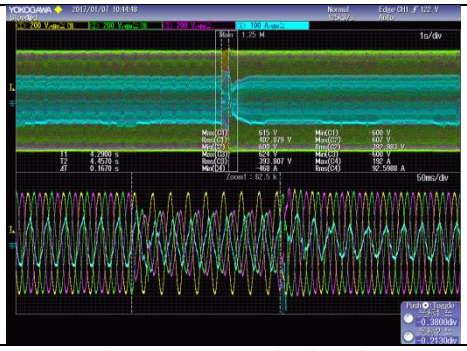
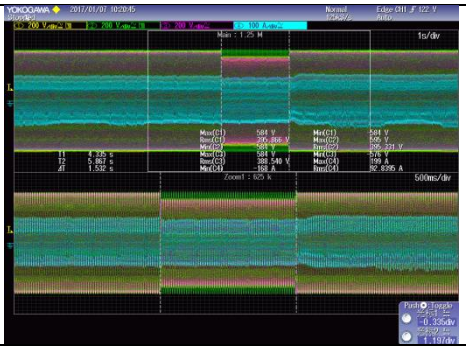
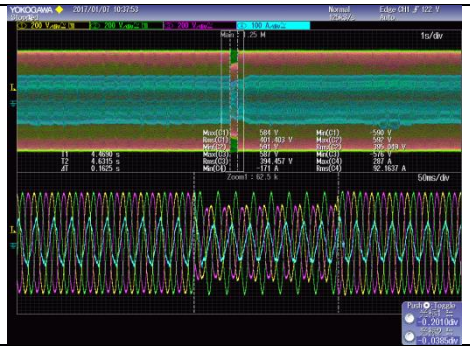
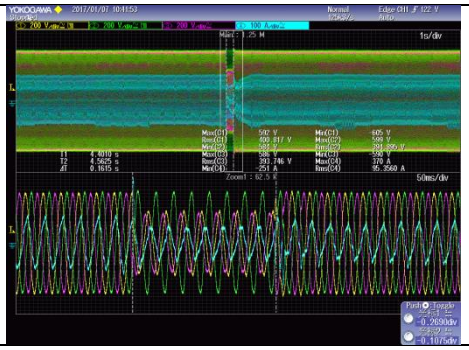
	
A-phase symmetrical faults 0-0.049 Vn	B-phase symmetrical faults 0.7-0.8 Vn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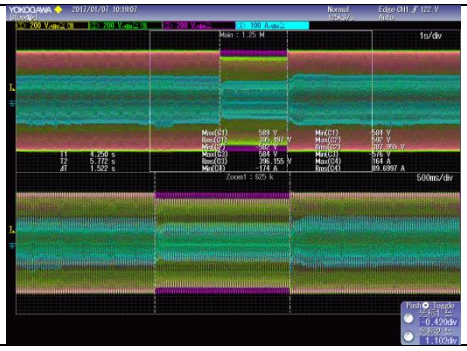			
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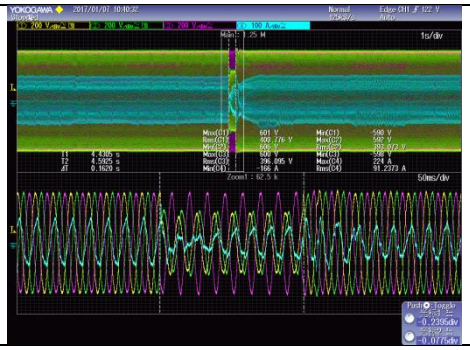
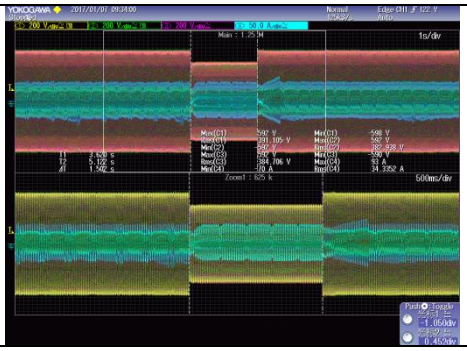
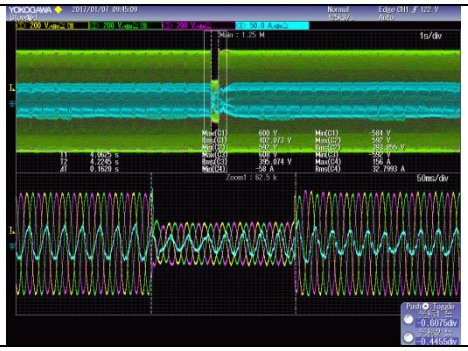
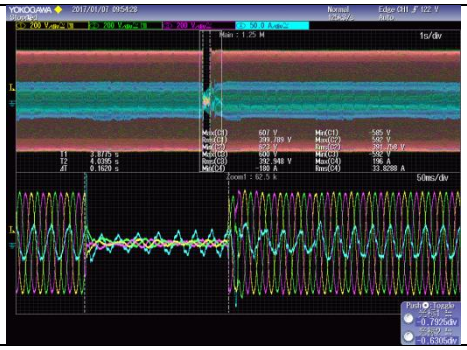
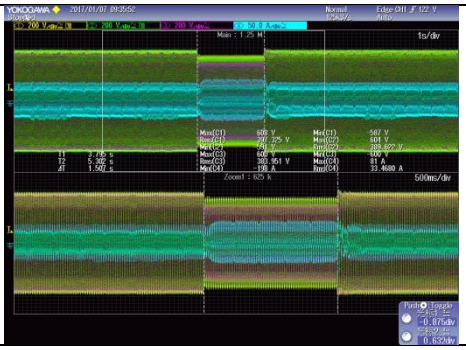
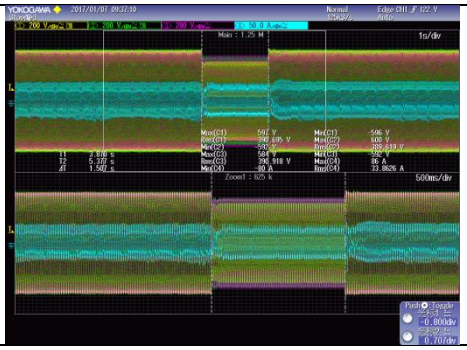
		--	
C- phase symmetrical faults 0-0.049 Vn		--	
Supplementary information(10% Power):			
			
Three-phase faults 0.7-0.8 Vn		Three-phase faults 0.3-0.5 Vn	

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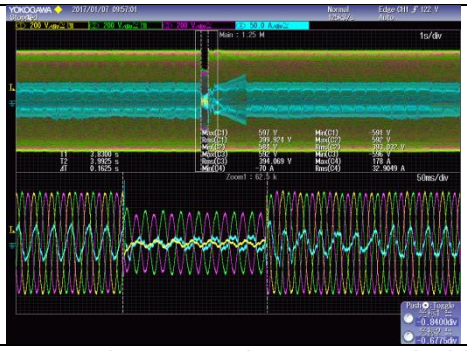
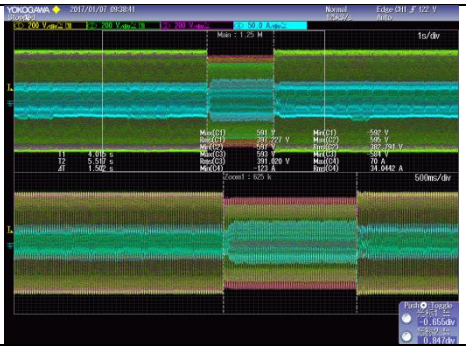
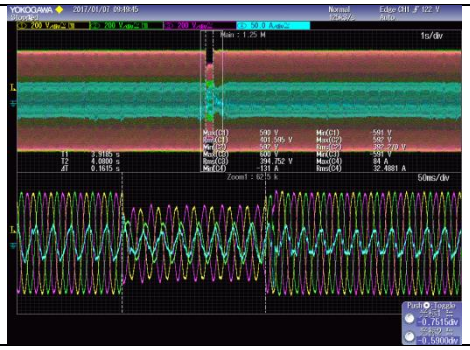
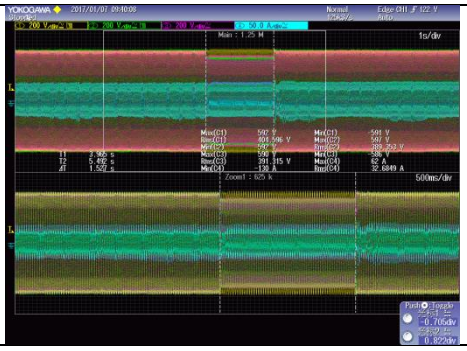
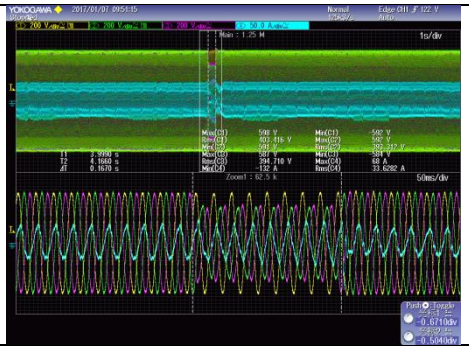
	
B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn

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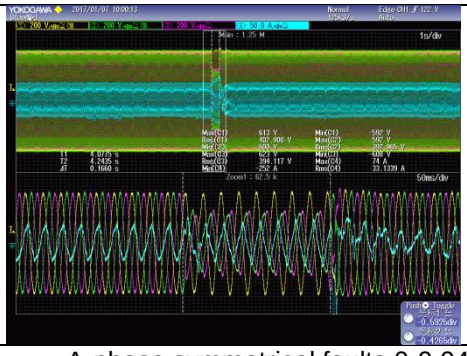
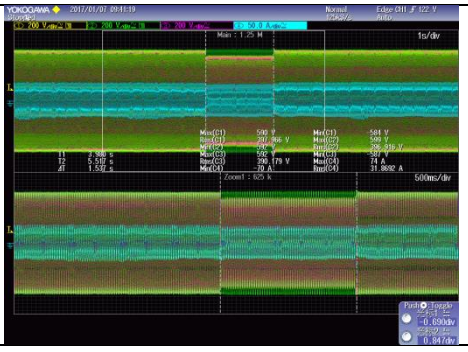
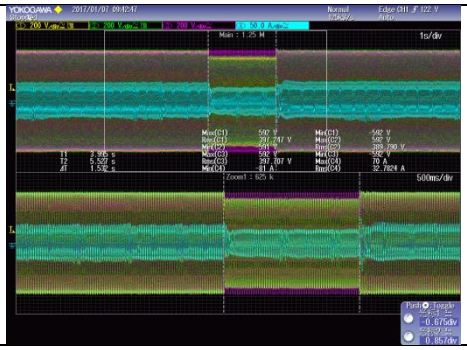
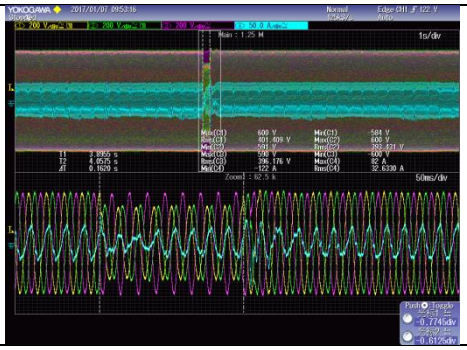
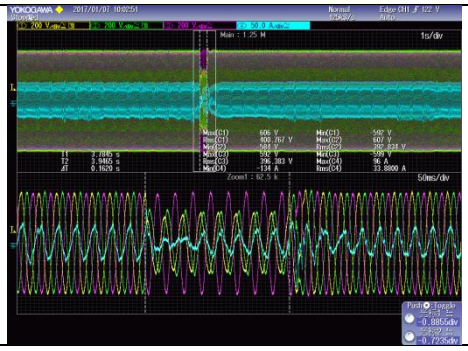
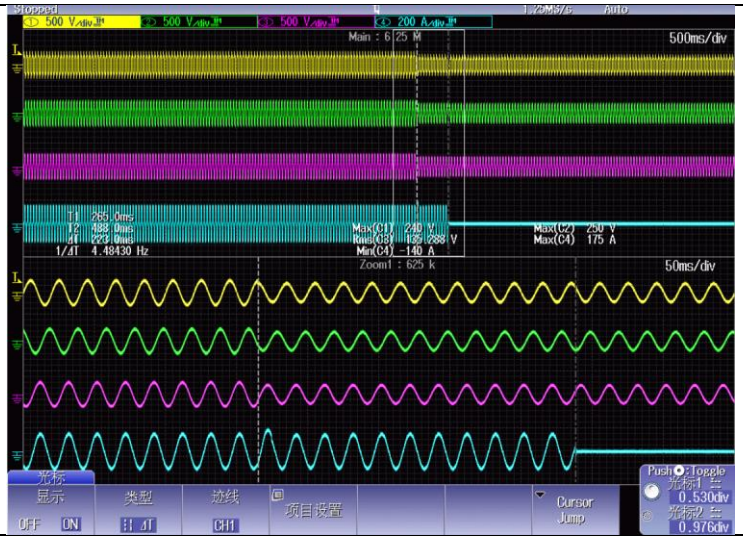
	
A-phase symmetrical faults 0-0.049 Vn	B-phase symmetrical faults 0.7-0.8 Vn
	
B-phase symmetrical faults 0.3-0.5 Vn	B-phase symmetrical faults 0-0.049 Vn

		
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		--

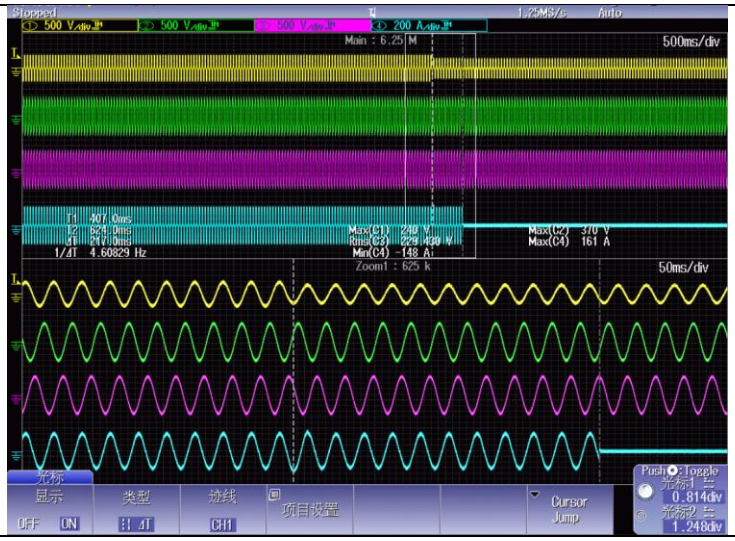
7	TABLE: Operating Voltage Range						P
No.	Voltage Range (V)	Setting voltage (V)	Setting time (s)	Test voltage (V)	Disconnecting time (s)	Max. Disconnecting time (s)	Result
1	V<50%	L1 = L2 = L3 =110V	0.1	L1 = L2 = L3 =109V	0.221	0.3	P
		L1 = 110 V, L2 = L3 = 220 V		L1 = 109V, L2 = L3 = 220 V	0.216	0.3	P
		L2 = 110V, L1 = L3 = 220 V		L2 = 109V, L1 = L3 = 220 V	0.212	0.3	P
		L3 = 110 V, L1 = L2 = 220 V		L3 = 109 V, L1 = L2 = 220 V	0.212	0.3	P
2	50%≤V<90%	L1 = L2 = L3 =111 V	0.1	L1 = L2 = L3 =112 V	1.810	2	P
		L1 = 111 V, L2 = L3 = 220 V	0.1	L1 = 112 V, L2 = L3 = 220 V	1.796	2	P
		L2 = 111 V, L1 = L3 = 220 V	0.1	L2 = 112 V, L1 = L3 = 220 V	1.803	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 = L3 = 220 V	0.1	L2 = 196 V, L1 = L3 = 220 V	1.814	2	P

		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	0797	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	0.108	0.16	P

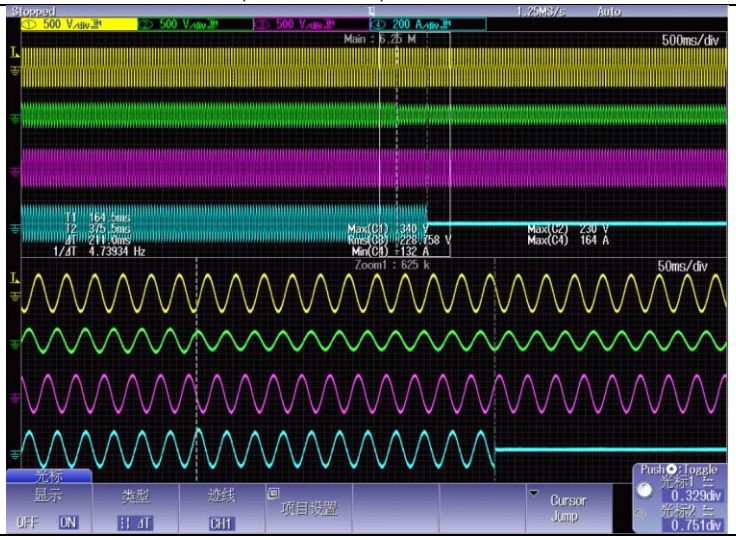
Supplementary information:



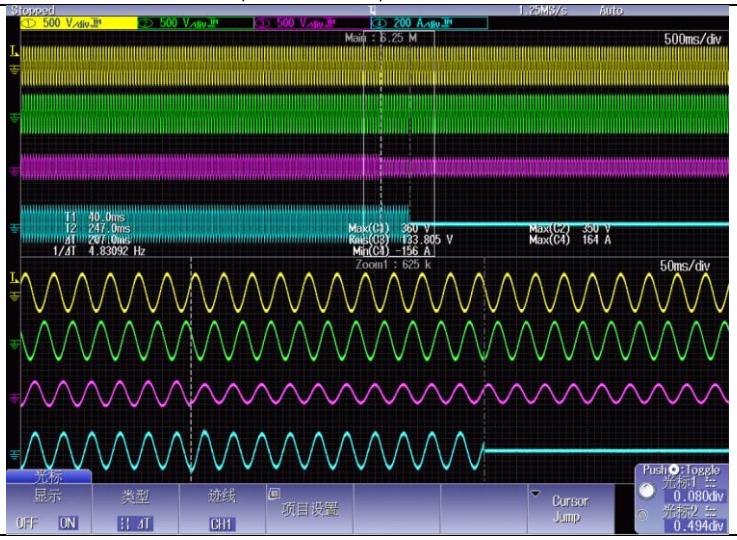
V<50%, L1 = L2 = L3 =109V



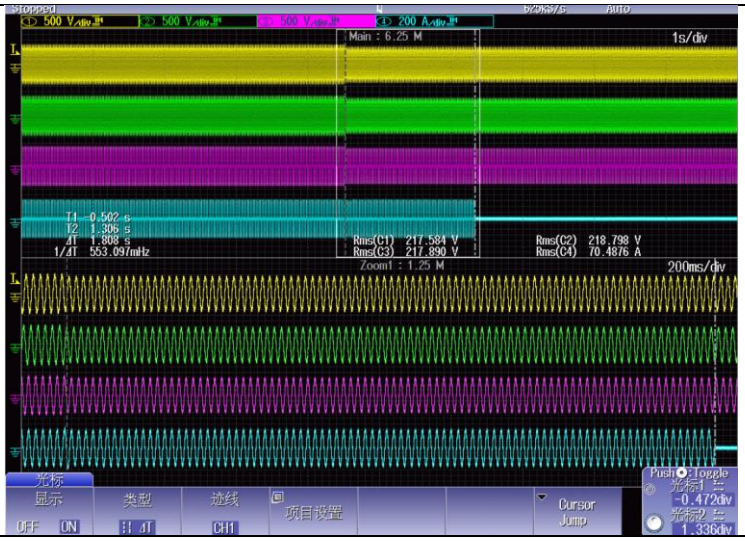
V<50%, L1 = 109V, L2 = L3 = 220 V



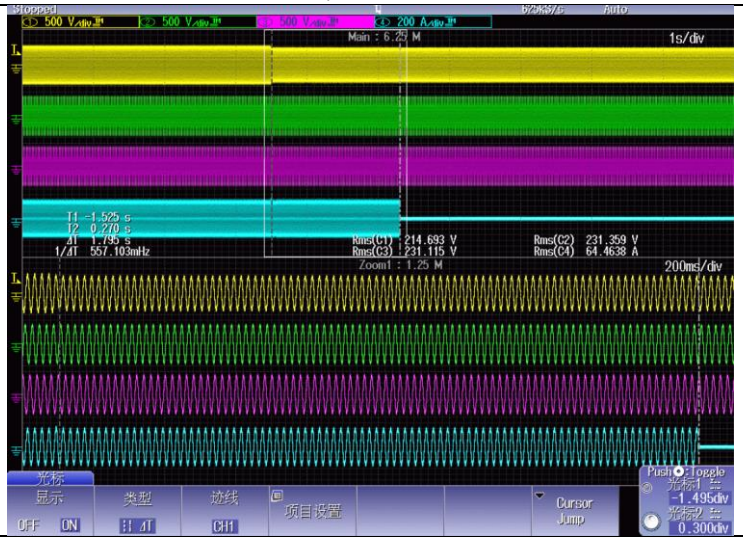
V<50%, L2 = 109V, L1 = L3 = 220 V



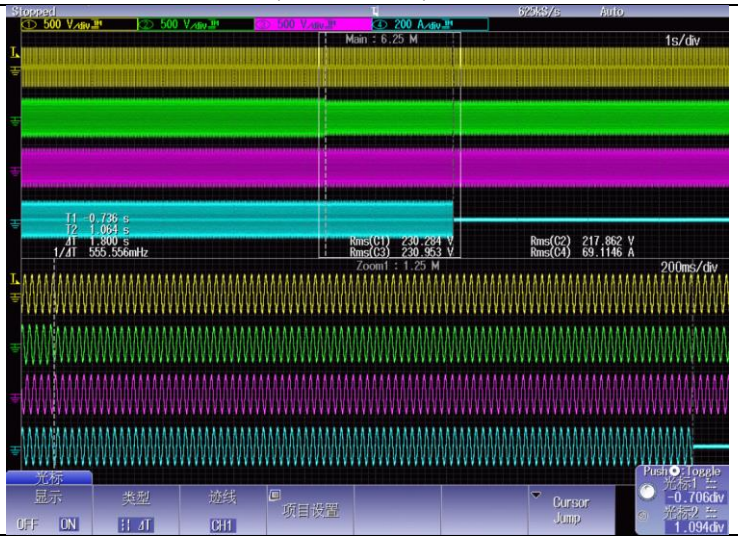
V<50%, L3 = 109V, L1 = L2 = 220 V



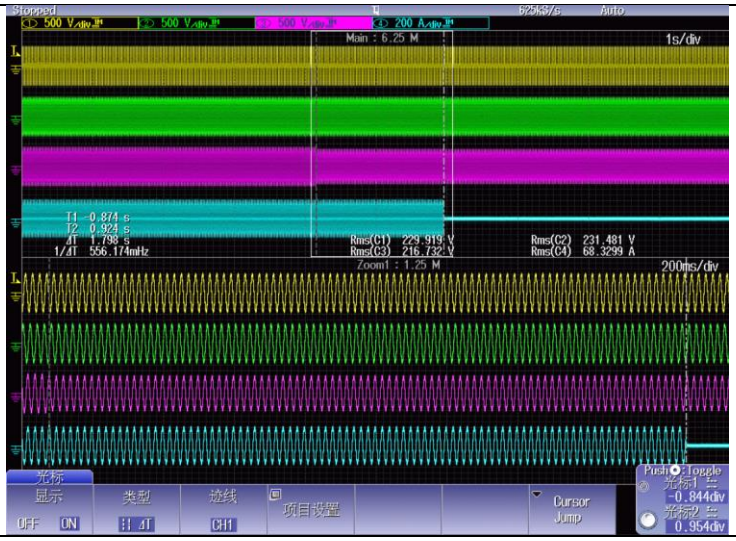
50%≤V<90%, L1 = L2 = L3 =112 V



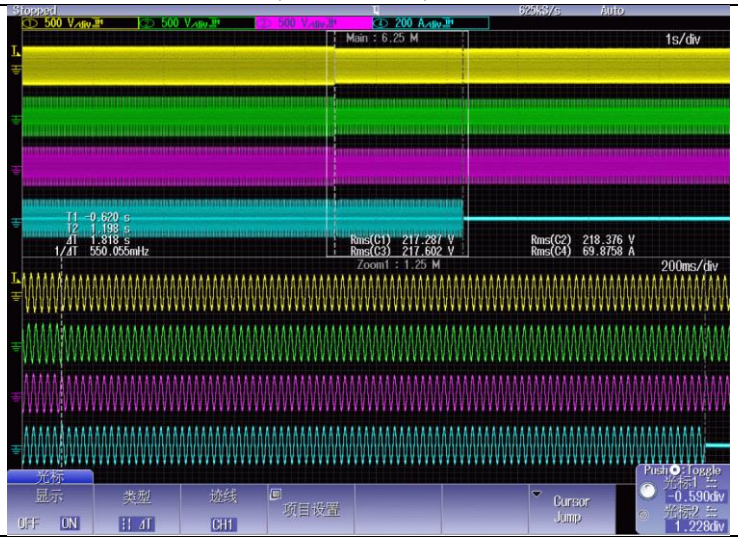
50%≤V<90%, L1 = 112 V, L2 = L3 = 220 V



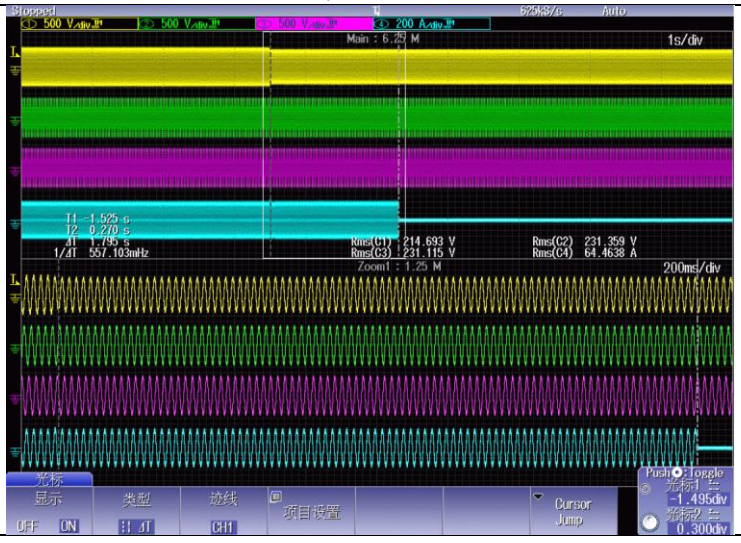
50%≤V<90%, L2 = 112 V, L1 = L3 = 220 V



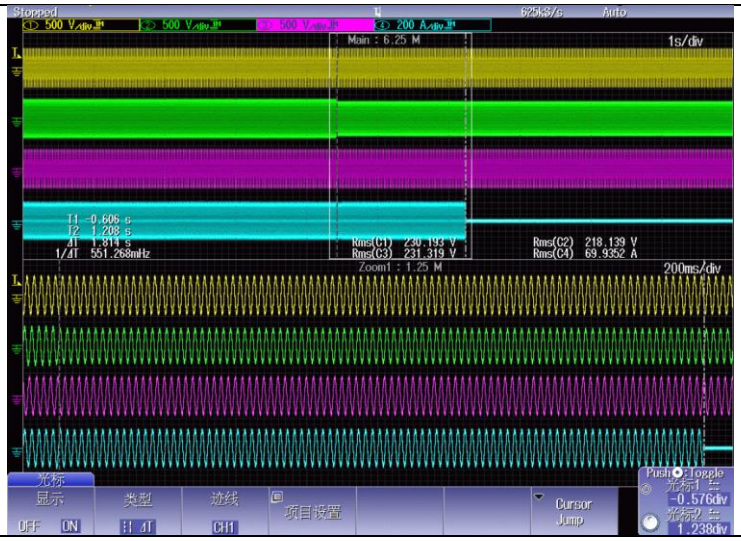
50%≤V<90%, L3 = 112 V, L1 = L2 = 220 V



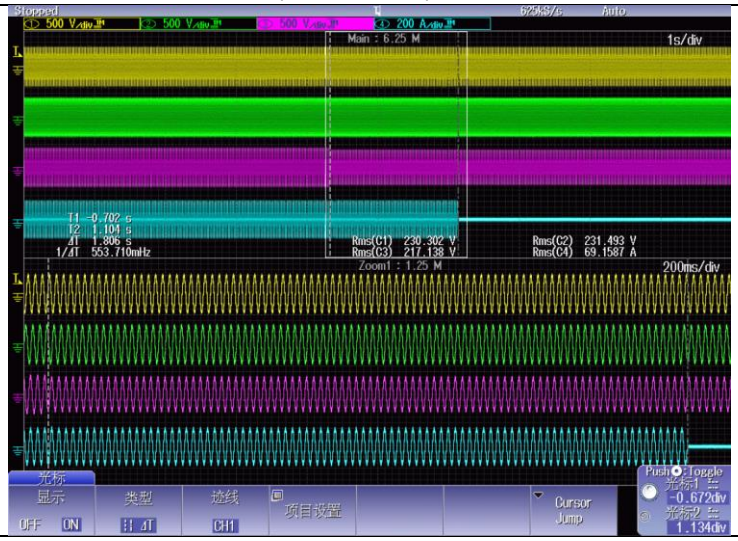
50%≤V<90%, L1 = L2 = L3 =196 V



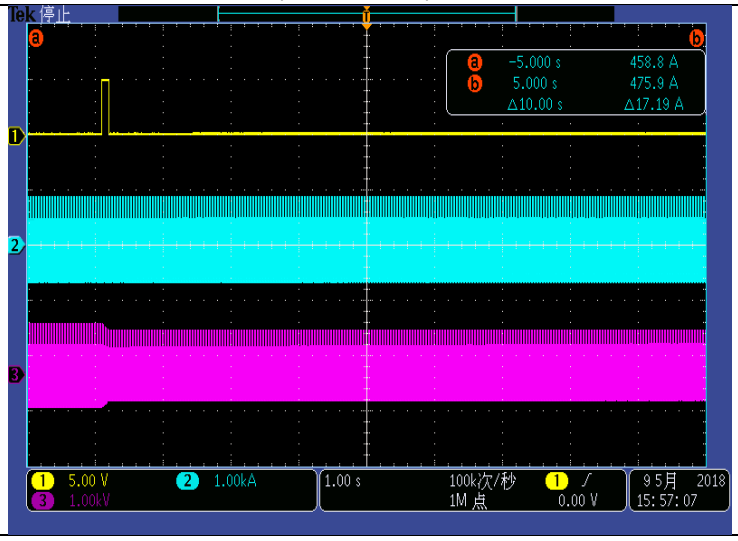
50%≤V<90%, L1 = 196 V, L2 = L3 = 220 V



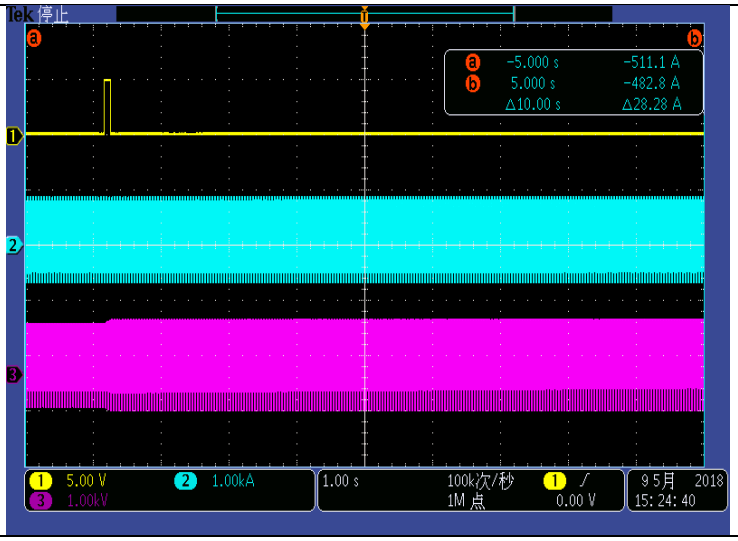
50%≤V<90%, L2 = 196 V, L1 = L3 = 220 V



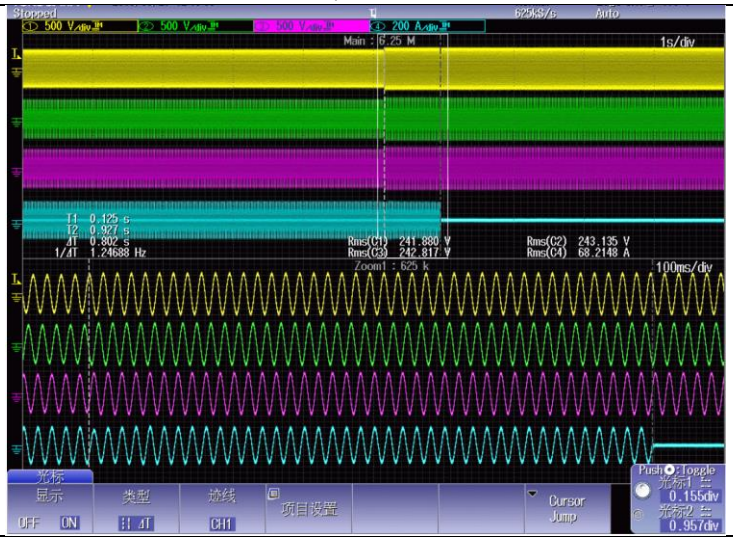
50%≤V<90%, L3 = 196 V, L1 = L2 = 220 V



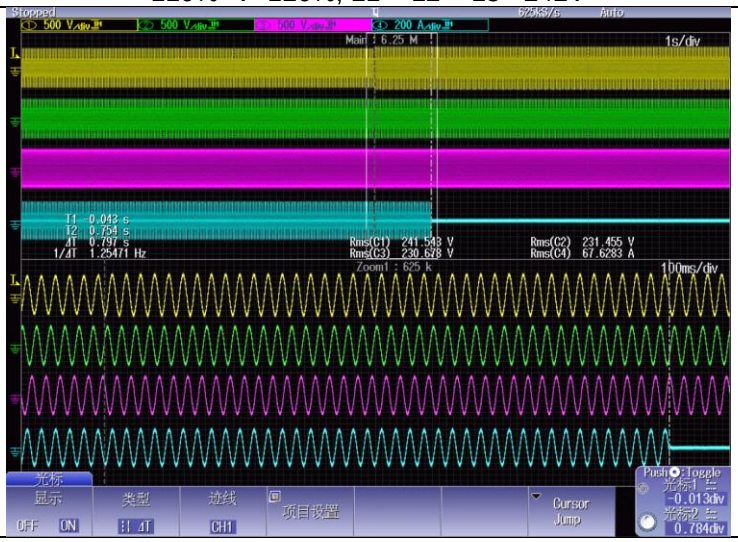
90%≤V≤110%, L1 = L2 = L3 =198 V



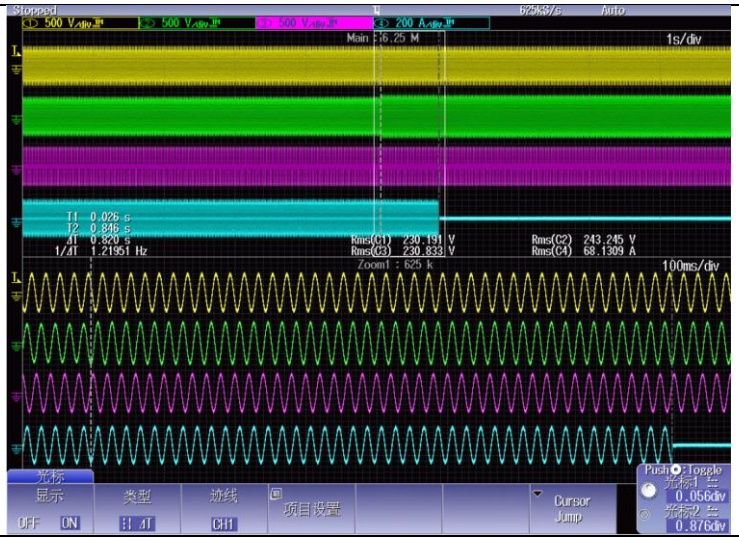
90%≤V≤110%, L1 = L2 = L3 =240 V



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

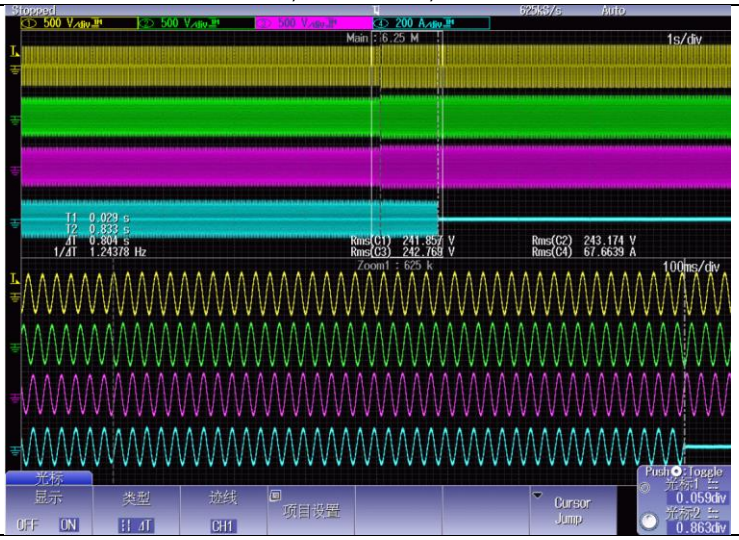


110%<V<120%, L1 = 242V, L2 = L3 = 220 V

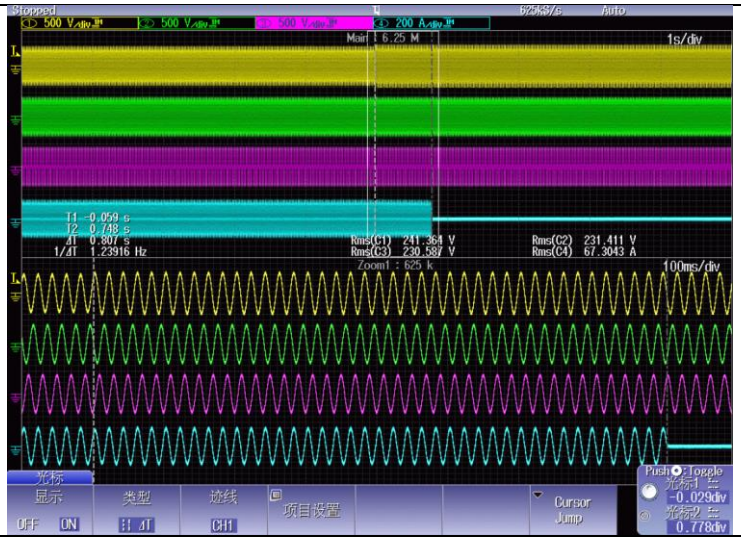


110%<V<120%, L2 = 242V, L1 = L3 = 220 V

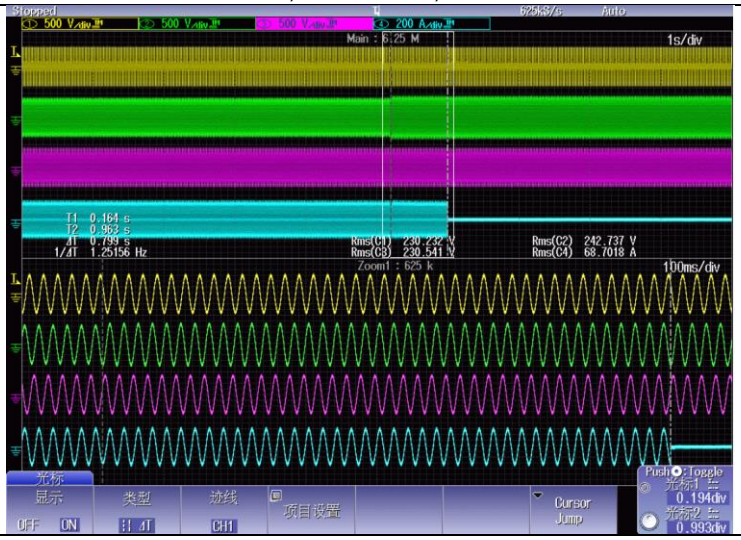
110%<V<120%, L3 = 242V, L1 = L2 = 220 V



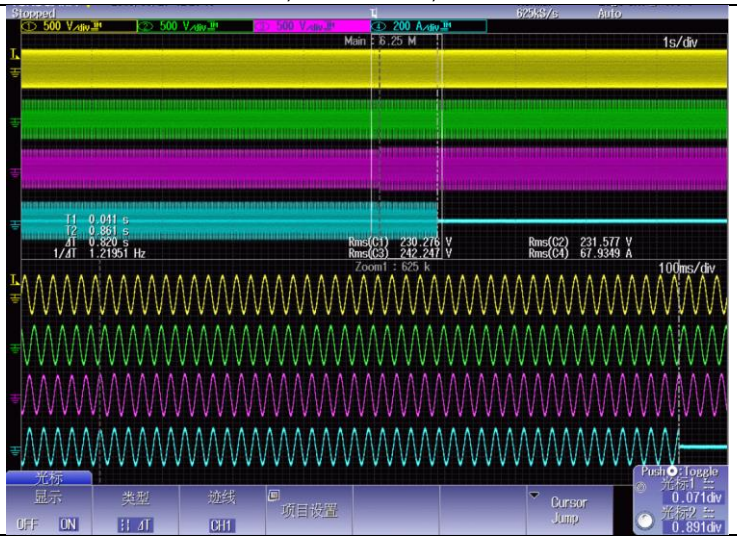
110%<V<120%, L1 = L2 = L3 = 261 V



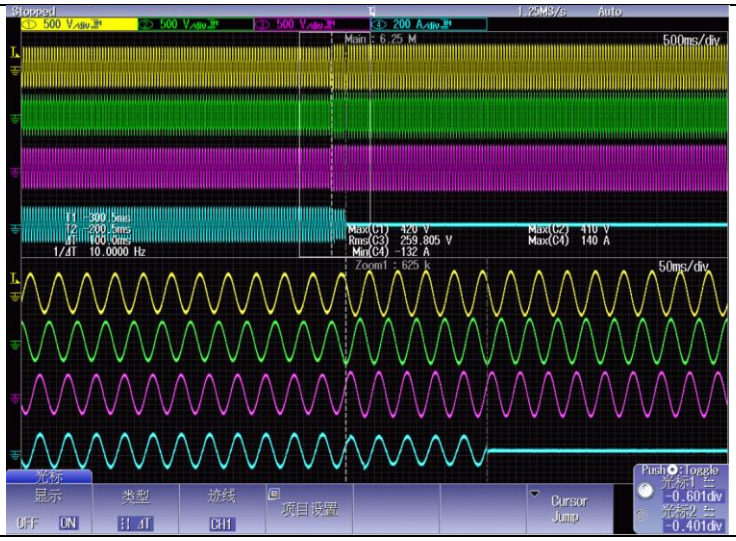
110%<V<120%, L1 = 261 V, L2 = L3 = 220 V



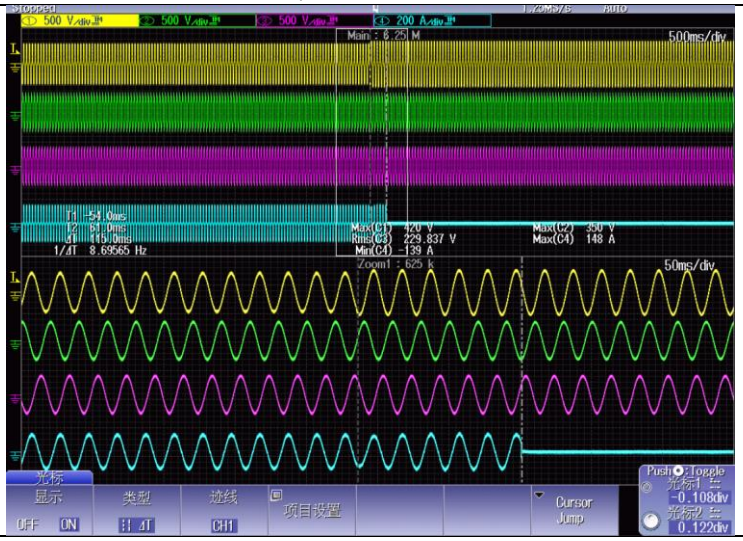
110%<V<120%, L2 = 261 V, L1 = L3 = 220 V



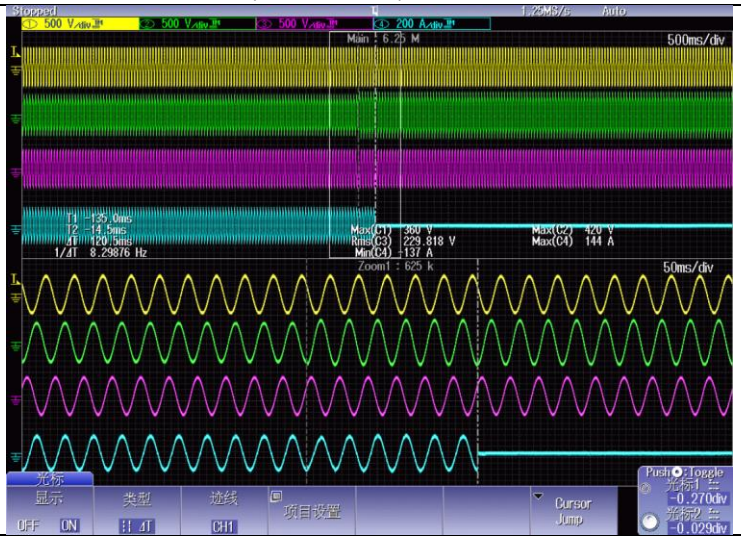
110%<V<120%, L3 = 261 V, L1 = L2 = 220 V



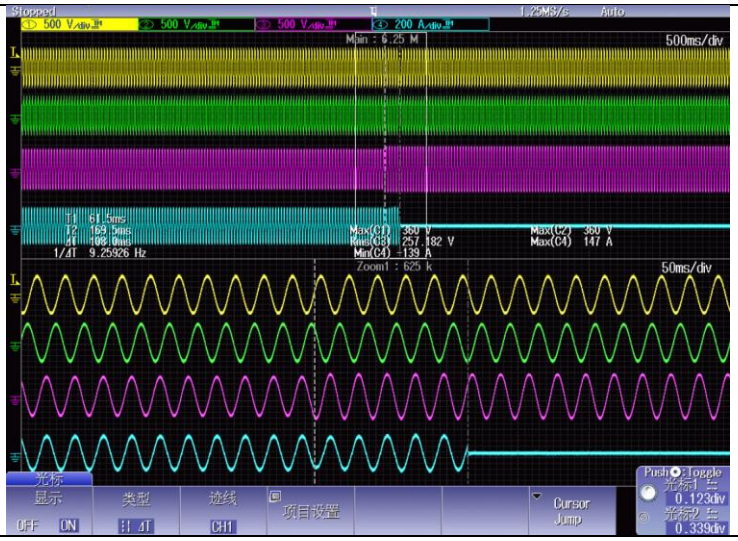
V≥120%, L1 = L2 = L3 =264 V



V≥120%, L1 = 264 V, L2 = L3 = 220 V



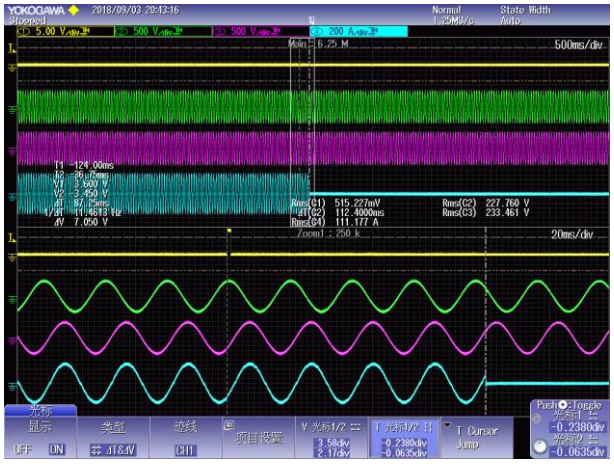
V≥120%, L2 = 264 V, L1 = L3 = 220 V



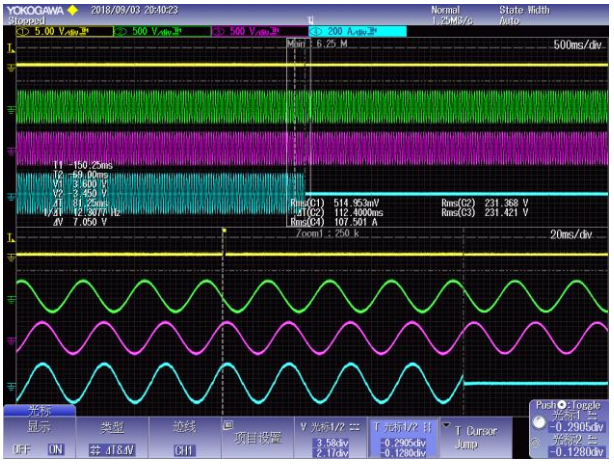
V≥120%, L3 = 264 V, L1 = L2 = 220 V

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	0.0873	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	0.0813	0.1	P

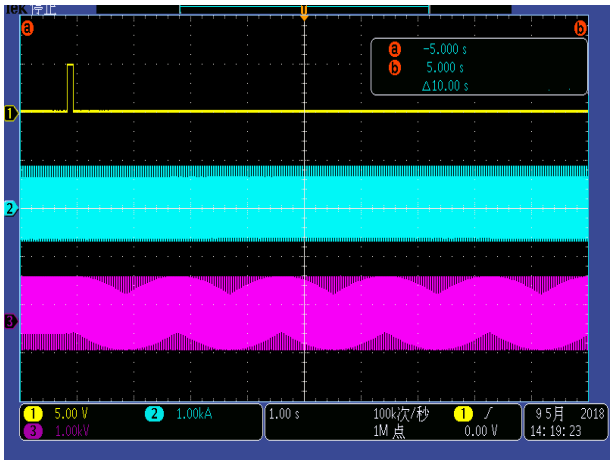
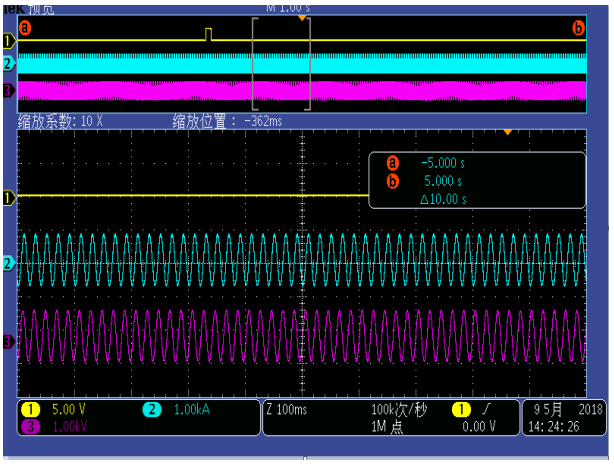
Supplementary information:
OFT: Over frequency Trip Setting
UFT: Under frequency Trip Setting
Cont.: Continuous operated



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

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

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

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

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

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

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

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

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=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	66	66	0	-5	386	6.022	0.977	540	Test B at IB
2	66	66	0	-4	282	6.022	0.982	540	Test B at IB
3	66	66	0	-3	303	6.022	0.987	540	Test B at IB
4	66	66	0	-2	182	6.022	0.992	540	Test B at IB
5	66	66	0	-1	176	6.022	0.997	540	Test B at IB
6	66	66	0	0	259	6.022	1.002	540	Test B at BL
7	66	66	0	1	265	6.022	1.007	540	Test B at IB
8	66	66	0	2	235	6.022	1.012	540	Test B at IB

9	66	66	0	3	297	6.022	1.017	540	Test B at IB
10	66	66	0	4	252	6.022	1.022	540	Test B at IB
11	66	66	0	5	273	6.022	1.027	540	Test B at IB

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

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) 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	483	3.137	0.971	332	Test C at IB
2	33	33	0	-4	402	3.137	0.986	332	Test C at IB
3	33	33	0	-3	401	3.137	0.986	332	Test C at IB
4	33	33	0	-2	386	3.137	0.991	332	Test C at IB
5	33	33	0	-1	384	3.137	0.996	332	Test C at IB
6	33	33	0	0	397	3.137	1.001	332	Test C at BL
7	33	33	0	1	295	3.137	1.006	332	Test C at IB
8	33	33	0	2	297	3.137	1.011	332	Test C at IB
9	33	33	0	3	312	3.137	1.016	332	Test C at IB
10	33	33	0	4	297	3.137	1.021	332	Test C at IB
11	33	33	0	5	301	3.137	1.026	332	Test C at IB

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

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

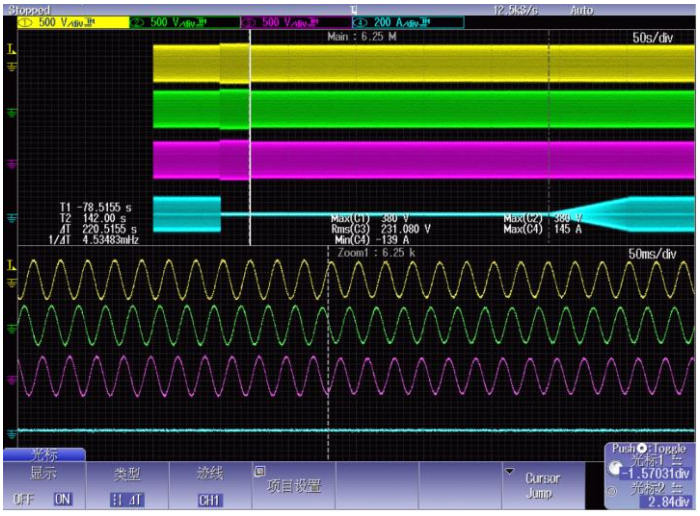
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = 33% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For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

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

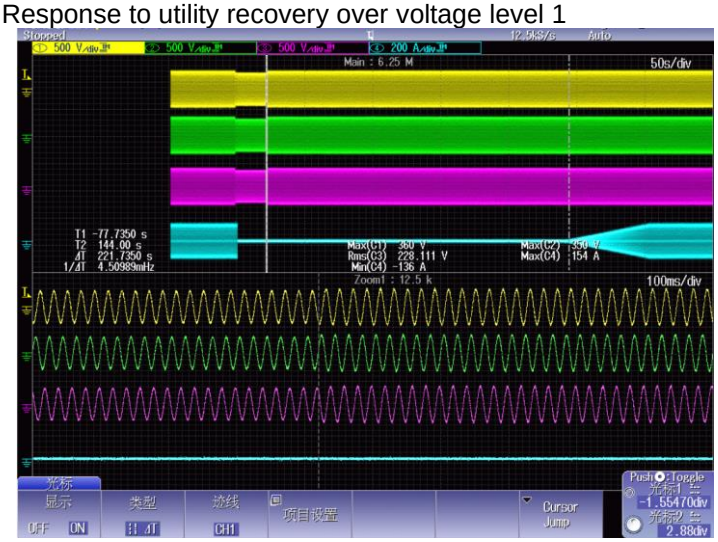
Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

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

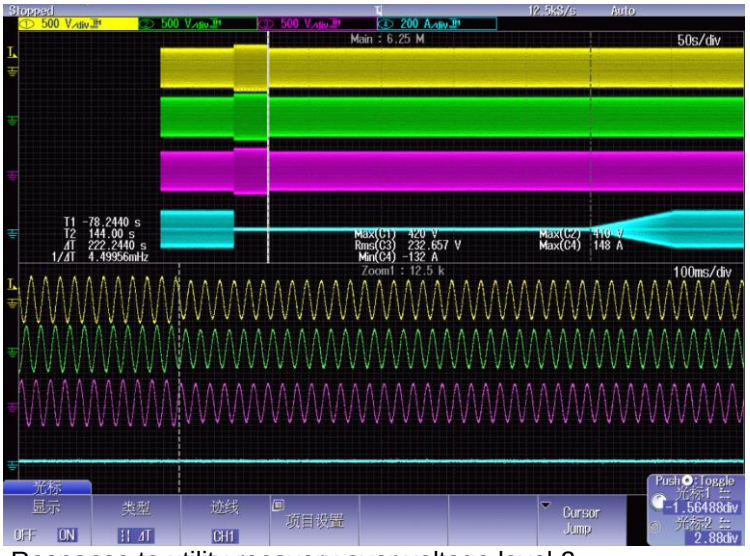
	Table: Response to Utility recovery test			P
Test condition	Limit (sec)	Actual Setting (sec)	Test Result (sec)	Result
Under frequency (46.9Hz)	20 - 300	27	225	P
Over frequency (52.1 Hz)		27	228	P
Under voltage level 1 (355 V)		27	221	P
Over voltage level 1 (443 V)		27	220	P
Under voltage level 2 (200 V)		27	223	P
Over voltage level 2 (478 V)		27	222	P
Supplementary				



Response to utility recovery over voltage level 1

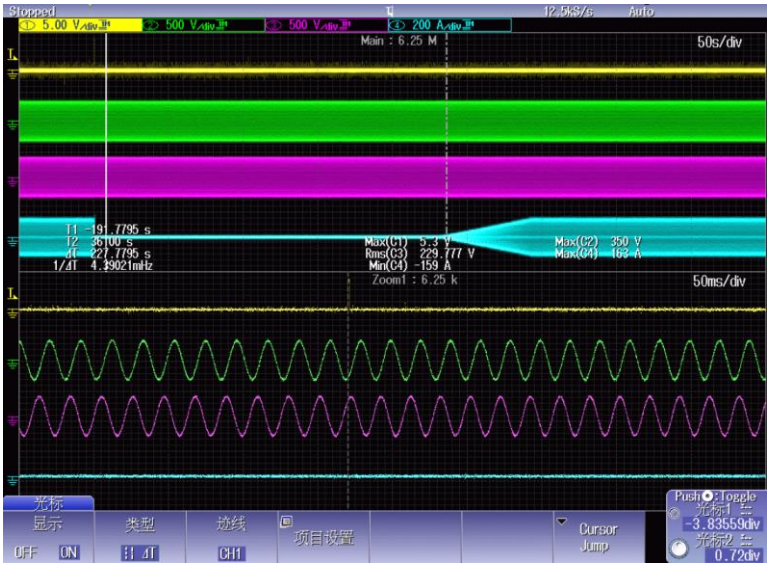


Response to utility recovery under voltage level 1



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