TESTREPORT

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

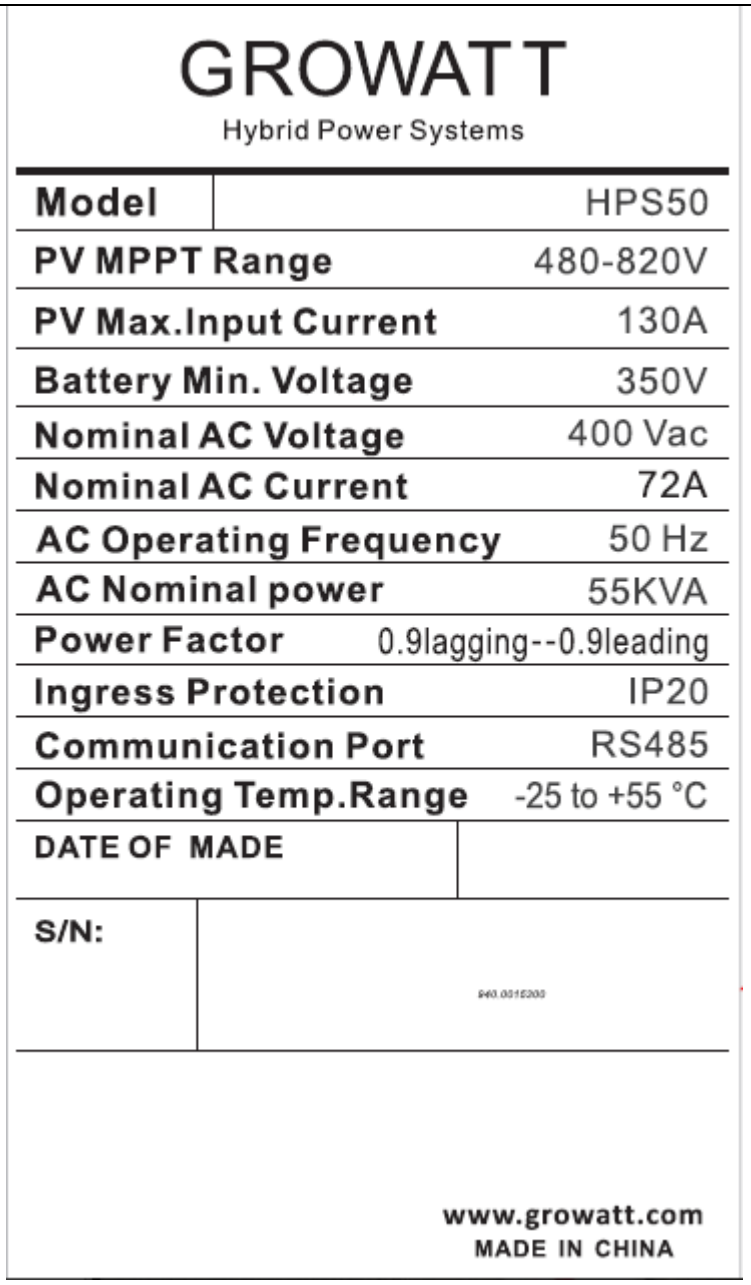
Report Number. .....:	ES171227982P
Date of issue.....:	March 23. 2018
Total number of pages.....:	49 pages
Testing Laboratory Name .....:	EMTEK (SHENZHEN) CO., LTD.
Address.....:	Bldg 69. Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China
Applicant's name.....:	SHENZHEN GROWATT NEW ENERGY TECHNOLOGY CO.,LTD
Address.....:	1st East & 3rd Floor of Building A, Building B, Jiayu Industrial Park, #28, GuangHui Road, LongTeng Community, Shiyan Street, Baoan District, Shenzhen, P.R.China
Test specification:	
Standard .....:	IEC 61727-2004. IEC 62116-2014
Non-standard test method.....:	N/A
Test item description.....:	Hybrid inverter
Trade mark.....:	Growatt
Reference.....:	N/A
Number.....:	HPS50
Firmware version.....:	V1.0
Date of receipt of test item.....:	December 03. 2017
Date(s) of performance of test.....:	December 04. 2017 to March 22. 2018
Date of report issue .....:	March 23. 2018

Tested by	Review by	Approved by
(Mr. Tom Tao)	(Mr. Double Lee)	(Mr. Paladin Hu)
Testing Engineer	Project Engineer	Department Manager
(2018-03-23)	(2018-03-23)	(2018-03-23)

Summary of testing
Test result of Photovoltaic Grid-Tied Inverter model iMars BG10KTR, 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 61000-3-11	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:



GROWATT

Hybrid Power Systems

Model	HPS50
PV MPPT Range	480-820V
PV Max.Input Current	130A
Battery Min. Voltage	350V
Nominal AC Voltage	400 Vac
Nominal AC Current	72A
AC Operating Frequency	50 Hz
AC Nominal power	55KVA
Power Factor	0.9lagging--0.9leading
Ingress Protection	IP20
Communication Port	RS485
Operating Temp.Range	-25 to +55 °C
DATE OF MADE	
S/N:	

940.0315200

www.growatt.com
MADE IN CHINA

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]..... : 130A Output AC voltage [V]..... : 230/400. 3/N/PE, 50Hz Output AC current rated [A] .....: 72A Output power [W]..... : 50kW 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: >7kg 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		N
	IEC 61000-3-11 (2000) for inverters with rated currents ≤75 A.	See table 2	P
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

<table>
<tr><th colspan="4">GRID-CONNECTED INVERTER REGULATION OF PROVINCIAL ELECTRICITY AUTHORITY (PEA)</th></tr>
<tr><th>Clause</th><th>Requirement – Test</th><th>Result – Remark</th><th>Verdict</th></tr>
<tr><td>4.3</td><td>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</td><td></td><td>P</td></tr>
<tr><td></td><td>Reactive Power Control Methods: can control which a fixed displacement factor cos θ</td><td></td><td>P</td></tr>
<tr><td></td><td>Reactive Power Control Methods: can control which a variable reactive power depending on the voltage Q(U)</td><td></td><td>P</td></tr>
<tr><td>5</td><td>Active Power Control</td><td></td><td>P</td></tr>
<tr><td></td><td>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.</td><td>See table 5</td><td>P</td></tr>
<tr><td>6</td><td>Low Voltage Fault Ride Through</td><td></td><td>P</td></tr>
<tr><td></td><td>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
<table>
<tr><th>Voltage at PCC</th><th>Duration Time (Second)</th></tr>
<tr><td>1) Low voltage
2) Moderate voltage or high
voltage (electrical installation
not exceeding 500kilowatt)</td><td>Not required</td></tr>
<tr><td>3) Moderate voltage or high
voltage (electrical installation
exceeding 500kilowatt).</td><td>As shown in Picture 1.</td></tr>
</table></td><td>See table 6</td><td>P</td></tr>
<tr><td>7</td><td>Under and Over Voltage Protection</td><td></td><td>P</td></tr>
</table>

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%						16.56		P
	supplying power to balance linear loads 66 %±5%						33.15		P
	supplying power to balance linear loads 100 %±5%						49.98		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	23.784	99.514	47.581	99.437	72.090	99.649	L1	-	P
2	0.195	0.821	0.427	0.897	0.597	0.830	L1	<1%	P
3	0.440	1.850	0.307	0.645	0.222	0.310	L1	<4%	P
4	0.129	0.541	0.196	0.411	0.487	0.680	L1	<1%	P
5	0.402	1.687	0.975	2.048	1.153	1.600	L1	<4%	P
6	0.048	0.200	0.070	0.148	0.119	0.160	L1	<1%	P
7	0.331	1.391	0.703	1.476	1.071	1.490	L1	<4%	P
8	0.085	0.358	0.150	0.314	0.126	0.170	L1	<1%	P
9	0.042	0.178	0.051	0.108	0.037	0.050	L1	<4%	P
10	0.067	0.283	0.128	0.268	0.108	0.150	L1	<1%	P
11	0.072	0.304	0.205	0.431	0.281	0.390	L1	<2%	P
12	0.008	0.033	0.019	0.040	0.022	0.030	L1	<0.5%	P
13	0.035	0.148	0.092	0.193	0.122	0.170	L1	<2%	P
14	0.034	0.143	0.082	0.173	0.028	0.040	L1	<0.5%	P
15	0.010	0.044	0.020	0.043	0.020	0.030	L1	<2%	P
16	0.026	0.108	0.053	0.112	0.020	0.030	L1	<0.5%	P
17	0.040	0.170	0.032	0.068	0.064	0.090	L1	<1.5%	P
18	0.010	0.042	0.010	0.022	0.012	0.020	L1	<0.375%	P
19	0.026	0.108	0.036	0.075	0.066	0.090	L1	<1.5%	P
20	0.015	0.064	0.032	0.067	0.015	0.020	L1	<0.375%	P
21	0.015	0.064	0.017	0.036	0.018	0.020	L1	<1.5%	P
22	0.017	0.072	0.044	0.092	0.016	0.020	L1	<0.375%	P
23	0.033	0.140	0.048	0.101	0.048	0.070	L1	<0.6%	P
24	0.011	0.046	0.009	0.019	0.011	0.020	L1	<0.15%	P
25	0.035	0.149	0.034	0.071	0.035	0.050	L1	<0.6%	P
26	0.020	0.084	0.029	0.060	0.015	0.020	L1	<0.15%	P
27	0.015	0.061	0.022	0.046	0.018	0.030	L1	<0.6%	P
28	0.028	0.119	0.059	0.123	0.025	0.030	L1	<0.15%	P
29	0.022	0.094	0.020	0.043	0.036	0.050	L1	<0.6%	P
30	0.021	0.087	0.016	0.034	0.015	0.020	L1	<0.15%	P
31	0.018	0.077	0.013	0.028	0.064	0.090	L1	<0.6%	P
32	0.032	0.136	0.058	0.121	0.025	0.040	L1	<0.15%	P
33	0.019	0.079	0.014	0.030	0.016	0.020	L1	<0.6%	P
34	0.017	0.070	0.038	0.079	0.016	0.020	L1	<0.15%	P
35	0.010	0.044	0.013	0.027	0.088	0.120	L1	<0.3%	P
36	0.006	0.026	0.006	0.013	0.015	0.020	L1	<0.075%	P
37	0.026	0.110	0.059	0.123	0.060	0.080	L1	<0.3%	P
38	0.006	0.027	0.007	0.014	0.027	0.040	L1	<0.075%	P
39	0.007	0.031	0.007	0.014	0.031	0.040	L1	<0.3%	P
40	0.007	0.029	0.005	0.011	0.033	0.050	L1	<0.075%	P
THDi	---	3.129	---	2.888	---	2.516	L1	≤ 5%	P
Supplementary information:									

1	TABLE: Current Harmonics								P
	Condition of test						Power (kW)		
	supplying power to balance linear loads 33% ±5%						16.71		P
	supplying power to balance linear loads 66 %±5%						33.18		P
	supplying power to balance linear loads 100 %±5%						49.77		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	23.793	98.644	47.589	99.371	72.104	99.438	L2		P
2	0.213	0.895	0.379	0.796	0.545	0.760	L2	<1%	P
3	0.466	1.958	0.477	1.002	0.089	0.120	L2	<4%	P
4	0.131	0.551	0.293	0.615	0.380	0.530	L2	<1%	P
5	0.300	1.260	0.835	1.753	1.315	1.820	L2	<4%	P
6	0.069	0.291	0.178	0.374	0.131	0.180	L2	<1%	P
7	0.317	1.330	0.813	1.708	1.048	1.450	L2	<4%	P
8	0.037	0.154	0.131	0.276	0.142	0.200	L2	<1%	P
9	0.024	0.099	0.035	0.073	0.038	0.050	L2	<4%	P
10	0.060	0.253	0.153	0.322	0.090	0.130	L2	<1%	P
11	0.069	0.290	0.216	0.454	0.329	0.460	L2	<2%	P
12	0.008	0.033	0.011	0.024	0.024	0.030	L2	<0.5%	P
13	0.024	0.101	0.081	0.170	0.092	0.130	L2	<2%	P
14	0.043	0.181	0.084	0.177	0.046	0.060	L2	<0.5%	P
15	0.007	0.028	0.027	0.057	0.010	0.010	L2	<2%	P
16	0.023	0.097	0.059	0.123	0.023	0.030	L2	<0.5%	P
17	0.042	0.176	0.022	0.047	0.052	0.070	L2	<1.5%	P
18	0.005	0.020	0.013	0.028	0.014	0.020	L2	<0.375%	P
19	0.032	0.136	0.035	0.073	0.071	0.100	L2	<1.5%	P
20	0.023	0.095	0.054	0.114	0.010	0.010	L2	<0.375%	P
21	0.006	0.027	0.009	0.018	0.011	0.020	L2	<1.5%	P
22	0.017	0.071	0.034	0.071	0.017	0.020	L2	<0.375%	P
23	0.044	0.183	0.051	0.107	0.028	0.040	L2	<0.6%	P
24	0.005	0.021	0.017	0.036	0.008	0.010	L2	<0.15%	P
25	0.025	0.105	0.019	0.040	0.029	0.040	L2	<0.6%	P
26	0.028	0.118	0.052	0.110	0.012	0.020	L2	<0.15%	P
27	0.006	0.025	0.011	0.024	0.013	0.020	L2	<0.6%	P
28	0.029	0.121	0.059	0.124	0.026	0.040	L2	<0.15%	P
29	0.023	0.097	0.028	0.059	0.027	0.040	L2	<0.6%	P
30	0.015	0.065	0.027	0.057	0.011	0.020	L2	<0.15%	P
31	0.018	0.075	0.035	0.074	0.066	0.090	L2	<0.6%	P
32	0.030	0.127	0.065	0.137	0.037	0.050	L2	<0.15%	P
33	0.011	0.045	0.010	0.021	0.017	0.020	L2	<0.6%	P
34	0.022	0.094	0.042	0.088	0.027	0.040	L2	<0.15%	P
35	0.013	0.056	0.011	0.024	0.069	0.100	L2	<0.3%	P
36	0.005	0.021	0.006	0.013	0.013	0.020	L2	<0.075%	P
37	0.030	0.127	0.045	0.095	0.052	0.070	L2	<0.3%	P
38	0.003	0.014	0.007	0.014	0.018	0.030	L2	<0.075%	P
39	0.005	0.023	0.009	0.018	0.016	0.020	L2	<0.3%	P
40	0.006	0.025	0.006	0.012	0.030	0.040	L2	<0.075%	P
THDi	---	2.970	---	2.956	---	2.583	L2	≤ 5%	P
Supplementary information:									

1	TABLE: Current Harmonics								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						16.41		P
	supplying power to balance linear loads 66 %±5%						33.03		P
	supplying power to balance linear loads 100 %±5%						50.07		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	23.793	99.926	47.586	99.952	72.100	99.975	L3		P
2	0.204	0.855	0.433	0.910	0.542	0.750	L3	<1%	P
3	0.294	1.233	0.419	0.880	0.165	0.230	L3	<4%	P
4	0.092	0.388	0.178	0.374	0.336	0.470	L3	<1%	P
5	0.476	2.001	1.032	2.168	1.382	1.920	L3	<4%	P
6	0.105	0.442	0.114	0.240	0.069	0.100	L3	<1%	P
7	0.351	1.475	0.747	1.569	1.110	1.540	L3	<4%	P
8	0.084	0.352	0.115	0.242	0.083	0.120	L3	<1%	P
9	0.036	0.151	0.035	0.074	0.014	0.020	L3	<4%	P
10	0.051	0.214	0.112	0.236	0.073	0.100	L3	<1%	P
11	0.071	0.299	0.199	0.417	0.317	0.440	L3	<2%	P
12	0.010	0.040	0.026	0.054	0.022	0.030	L3	<0.5%	P
13	0.049	0.205	0.042	0.089	0.129	0.180	L3	<2%	P
14	0.040	0.169	0.085	0.179	0.038	0.050	L3	<0.5%	P
15	0.012	0.051	0.023	0.049	0.015	0.020	L3	<2%	P
16	0.030	0.127	0.050	0.105	0.016	0.020	L3	<0.5%	P
17	0.026	0.110	0.031	0.065	0.045	0.060	L3	<1.5%	P
18	0.008	0.034	0.014	0.029	0.014	0.020	L3	<0.375%	P
19	0.034	0.142	0.038	0.080	0.054	0.070	L3	<1.5%	P
20	0.018	0.074	0.046	0.097	0.013	0.020	L3	<0.375%	P
21	0.015	0.064	0.022	0.046	0.021	0.030	L3	<1.5%	P
22	0.023	0.096	0.035	0.073	0.013	0.020	L3	<0.375%	P
23	0.028	0.118	0.026	0.055	0.044	0.060	L3	<0.6%	P
24	0.009	0.038	0.021	0.044	0.010	0.010	L3	<0.15%	P
25	0.027	0.114	0.034	0.071	0.035	0.050	L3	<0.6%	P
26	0.021	0.087	0.044	0.093	0.018	0.020	L3	<0.15%	P
27	0.012	0.050	0.021	0.044	0.014	0.020	L3	<0.6%	P
28	0.034	0.144	0.058	0.121	0.029	0.040	L3	<0.15%	P
29	0.013	0.054	0.024	0.051	0.049	0.070	L3	<0.6%	P
30	0.015	0.061	0.033	0.069	0.014	0.020	L3	<0.15%	P
31	0.020	0.082	0.040	0.085	0.049	0.070	L3	<0.6%	P
32	0.027	0.114	0.060	0.126	0.033	0.050	L3	<0.15%	P
33	0.012	0.049	0.019	0.039	0.013	0.020	L3	<0.6%	P
34	0.019	0.078	0.023	0.049	0.021	0.030	L3	<0.15%	P
35	0.009	0.036	0.019	0.040	0.090	0.120	L3	<0.3%	P
36	0.005	0.020	0.010	0.020	0.013	0.020	L3	<0.075%	P
37	0.033	0.140	0.058	0.122	0.074	0.100	L3	<0.3%	P
38	0.004	0.016	0.009	0.018	0.028	0.040	L3	<0.075%	P
39	0.009	0.037	0.010	0.020	0.024	0.030	L3	<0.3%	P
40	0.004	0.017	0.006	0.012	0.027	0.040	L3	<0.075%	P
THDi	---	3.030	---	3.070	---	2.683	L3	≤ 5%	P
Supplementary information:									

1	TABLE: Voltage Harmonics								P
	Condition of test						Power(kW)		
	supplying power to balance linear loads 33% ±5%						16.56		P
	supplying power to balance linear loads 66 %±5%						33.15		P
	supplying power to balance linear loads 100 %±5%						49.98		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	220.11	99.514	220.17	99.437	220.08	99.649	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%						16.71		P
	supplying power to balance linear loads 66 %±5%						33.18		P
	supplying power to balance linear loads 100 %±5%						49.77		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	220.12	98.684	220.16	99.371	220.10	99.438	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%						16.41		P
	supplying power to balance linear loads 66 %±5%						33.03		P
	supplying power to balance linear loads 100 %±5%						50.07		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	220.13	99.926	220.18	99.952	220.05	99.975	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	0.25	0.26	0.27	1.00	P
Plt	0.23	0.20	0.20	0.80	P
dc [%]	0.06	0.05	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%						16.56	P
	supplying power to balance linear loads 66% ±5%						33.14	P
	supplying power to balance linear loads 100% ±5%						49.98	P
	Normal rated output current						72.3	
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	0.045	0.190	0.095	0.199	0.142	0.198	≤0.5	P
L2	0.051	0.213	0.136	0.285	0.183	0.253	≤0.5	P
L3	0.037	0.153	0.115	0.241	0.176	0.243	≤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	1.725	0.0345	-50.47	-1.0106	1.88	0.0371	0.034158
10	4.620	0.0925	-50.29	-1.0070	4.99	0.0986	0.091485
20	10.625	0.2128	-49.37	-0.9886	11.44	0.2260	0.210396
30	15.165	0.3037	-48.17	-0.9645	16.10	0.3182	0.300297
40	19.625	0.3930	-46.53	-0.9317	20.61	0.4074	0.388614
50	25.120	0.5030	-43.81	-0.8772	25.84	0.5108	0.497426
60	30.390	0.6085	-40.33	-0.8076	31.14	0.6154	0.601782
70	35.180	0.7044	-36.23	-0.7255	35.97	0.7109	0.696634
80	40.125	0.8035	-30.66	-0.6140	40.82	0.8067	0.794554
90	45.115	0.9034	-22.69	-0.4544	45.80	0.9052	0.893366
100	49.940	1.0000	-7.50	-0.2136	50.60	1.0000	0.988911

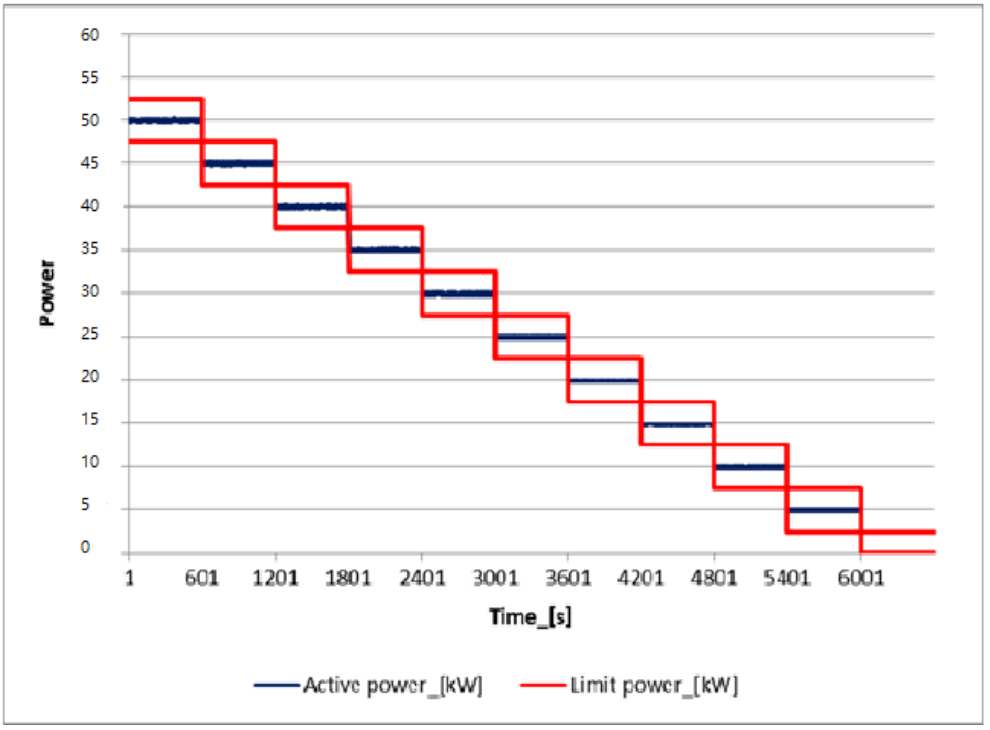
+Q max							
Power Set	Active Power [W]		Reactive power [Var]		DC power		Power factor
	kW	p.u.	kVAR	p.u.	(kW)	p.u.	
1	1.825	0.0365	50.47	1.0106	2.00	0.0395	0.036139
10	4.735	0.0948	50.28	1.0068	5.03	0.0992	0.093762
20	10.89	0.2180	49.31	0.9874	11.44	0.2257	0.215644
30	15.825	0.3167	47.96	0.9603	16.35	0.3226	0.313366
40	19.68	0.3939	46.51	0.9313	20.12	0.3971	0.389703
50	25.22	0.5048	43.75	0.8761	25.66	0.5063	0.499406
60	30.16	0.6036	40.50	0.8111	30.62	0.6042	0.597228
70	35.105	0.7026	36.30	0.7269	35.82	0.7069	0.695149
80	40.375	0.8081	30.33	0.6074	41.12	0.8114	0.799505
90	45.255	0.9057	22.41	0.4488	45.94	0.9067	0.896139
100	49.965	1.0000	7.33	0.1468	50.67	1.0000	0.989406

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	2.37	-0.79	0.9498
10%	0.95 lagging	4.74	-1.60	0.9497
20%	0.95 lagging	9.51	-3.09	0.9502
30%	0.95 lagging	14.29	-4.60	0.9503
40%	0.95 lagging	18.95	-6.46	0.9495
50%	0.95 lagging	23.83	-7.56	0.9502
60%	0.95 lagging	28.50	-9.41	0.9496
70%	0.95 lagging	33.14	-11.22	0.9497
80%	0.95 lagging	38.12	-12.13	0.9509
90%	0.95 lagging	42.78	-13.93	0.9508
100%	0.95 lagging	47.54	-15.41	0.9502
P.F. setting 0.95 leading				
0% (1%)	0.95 leading	2.38	0.78	0.9509
10%	0.95 leading	4.74	1.59	0.9494
20%	0.95 leading	9.52	3.08	0.9506
30%	0.95 leading	14.29	4.57	0.9505
40%	0.95 leading	19.00	6.27	0.9495
50%	0.95 leading	23.72	7.95	0.9498
60%	0.95 leading	28.59	9.16	0.9503
70%	0.95 leading	33.29	10.77	0.9504
80%	0.95 leading	37.91	12.75	0.9498
90%	0.95 leading	42.78	14.02	0.9502
100%	0.95 leading	47.59	15.38	0.9505
P.F. setting PF 1.0				
0% (1%)	1.0	2.47	-0.40	0.9872
10%	1.0	4.96	-0.64	0.9916
20%	1.0	9.94	-1.13	0.9931

30%	1.0	14.92	-1.50	0.9944
40%	1.0	19.94	-1.52	0.9968
50%	1.0	24.93	-1.69	0.9975
60%	1.0	29.97	-1.46	0.9987
70%	1.0	34.97	-1.45	0.9990
80%	1.0	39.99	-1.20	0.9995
90%	1.0	45.00	-0.87	0.9998
100%	1.0	50.02	-0.66	0.9999

4.3	TABLE : A variable reactive power depending on the voltage Q(U) test							P
Power set point	Voltage set point	Active power	Voltage UW	Voltage VW	Voltage UV	Reactive power	Expected Q	Q shifting
[%]	[V]	[W]	[V]	[V]	[V]	[VAr]	[VAr]	(Δ Q<2.5%Pn)
Lower Limits								
<20	0.93Vn	4088.8	370.3	370.8	371.1	-0.98	0.00	-0.98
<20	0.91Vn	4111.4	363.5	363.1	363.4	-4.11	0.00	-4.11
20-30	0.91Vn	10995.3	362.9	362.5	363.3	4337.69	4358.73	-21.04
40	0.91Vn	17790.7	363.1	362.3	363.4	4322.51	4358.73	-36.22
50	0.91Vn	22259.8	362.9	361.7	363.3	4316.15	4358.73	-42.57
60	0.91Vn	26760.3	362.9	362.0	362.8	4309.47	4358.73	-49.26
70	0.91Vn	31186.8	362.9	362.7	363.1	4289.83	4358.73	-68.90
80	0.91Vn	35658.2	362.8	362.1	363.2	4274.27	4358.73	-84.46
90	0.91Vn	40116.1	362.7	363.4	363.2	4266.87	4358.73	-91.86
100	0.91Vn	44424.8	363.1	363.3	362.8	4260.71	4358.73	-98.02
100	0.9Vn	44518.0	359.1	359.3	358.7	4253.08	4358.73	-105.65
100-10	0.9Vn	4260.5	358.9	358.7	359.3	4418.58	4358.73	59.85
10-<5	0.9Vn	2039.9	359.3	358.7	359.1	-2.97	0.00	-2.97
Upper Limits								
<20	1.07 Vn	6503.2	429.7	430.1	428.6	580.7	0.0	580.7
<20	1.09 Vn	6578.1	437.7	437.1	436.6	634.1	0.0	634.1
20-30	1.09 Vn	10474.8	438.7	437.6	436.9	-21219.5	-21793.7	574.2
40	1.09 Vn	17235.4	438.5	437.8	436.4	-21257.9	-21793.7	535.8
50	1.09 Vn	21769.2	439.1	436.8	436.8	-21715.5	-21793.7	78.2
60	1.09 Vn	26226.2	438.0	436.3	436.9	-21804.7	-21793.7	-11.0
70	1.09 Vn	30786.4	437.8	436.7	436.4	-21905.3	-21793.7	-111.6
80	1.09 Vn	35391.8	439.1	438.4	436.8	-22065.5	-21793.7	-271.8
90	1.09 Vn	39852.1	438.1	439.9	436.6	-22031.7	-21793.7	-238.0
100	1.09 Vn	44318.9	438.0	437.7	436.7	-22081.3	-21793.7	-287.6
100	1.10 Vn	44217.0	440.1	440.4	440.2	-22068.5	-21793.7	-274.8
100-10	1.10 Vn	3768.7	440.4	440.3	440.2	-21509.5	-21793.7	284.2
10-<5	1.10 Vn	1527.6	440.1	440.1	440.4	276.0	0.0	276.0

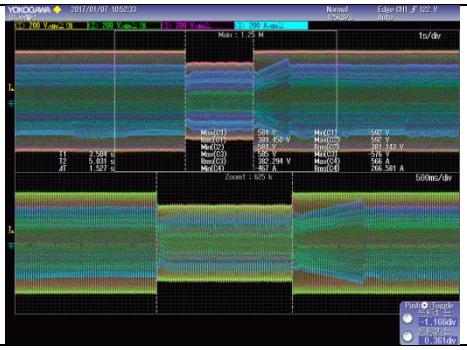
5	TABLE : Active power control			P
Power Setting		Power Measuring [kW]	Power Deviation of set point	
Power [%]	Power [kW]		Power [kW]	Power [%]
100%	50	50.01	-0.01	-0.02
90%	45	44.99	0.01	0.02
80%	40	39.99	0.01	0.03
70%	35	34.98	0.02	0.06
60%	30	29.96	0.05	0.17
50%	25	24.95	0.06	0.24
40%	20	19.91	0.10	0.50
30%	15	14.91	0.10	0.67
20%	10	9.92	0.08	0.81
10%	5	4.96	0.05	1.01
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)	1.527
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.161
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)	1.522
	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)	1.532
	0.3-0.5 (V8/Vnom)	0.161
	0-0.049 (V9/Vnom)	0.161
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)	1.527
	0.3-0.5 (V2/Vnom)	0.162
	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)	0.161
	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)	0.167
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.532
	0.3-0.5 (V8/Vnom)	0.162
	0-0.049 (V9/Vnom)	0.161
file:7- C-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.522
	0.3-0.5 (V8/Vnom)	0.162
	0-0.049 (V9/Vnom)	0.162
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)	1.502
	0.3-0.5 (V2/Vnom)	0.162
	0-0.049 (V3/Vnom)	0.162
file:2-A-phase – B- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.507
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.161
file:3-B-phase – C- phase symmetrical	0.7-0.8 (V1/Vnom)	1.507
	0.3-0.5 (V2/Vnom)	0.162

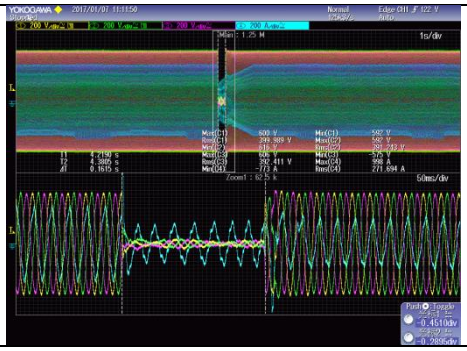
faults	0-0.049 (V3/Vnom)	0.162
file:4-A-phase – C- phase symmetrical faults	0.7-0.8 (V1/Vnom)	1.502
	0.3-0.5 (V2/Vnom)	0.161
	0-0.049 (V3/Vnom)	0.161
file:5- A-phase symmetrical faults	0.7-0.8 (V4/Vnom)	1.527
	0.3-0.5 (V5/Vnom)	0.167
	0-0.049 (V6/Vnom)	0.166
file:6- B-phase symmetrical faults	0.7-0.8 (V7/Vnom)	1.537
	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)	0.162
	0-0.049 (V9/Vnom)	0.162

Supplementary information(90% Power):

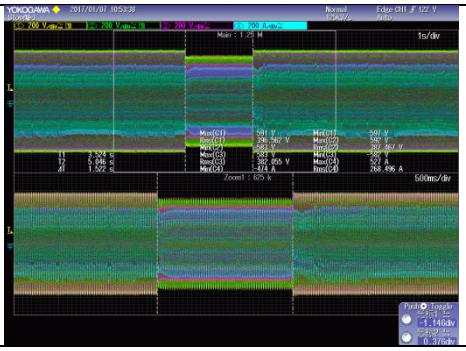


Three-phase faults 0.7-0.8 Vn

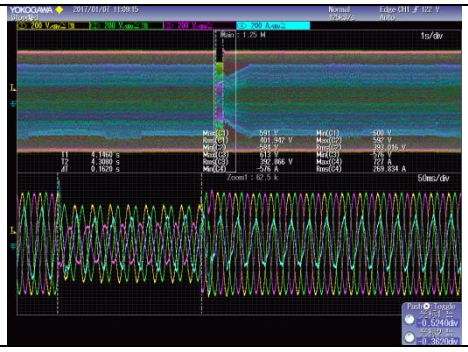
Three-phase faults 0.3-0.5 Vn



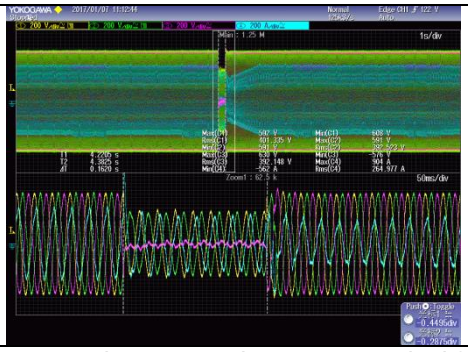
Three-phase faults 0-0.049 Vn



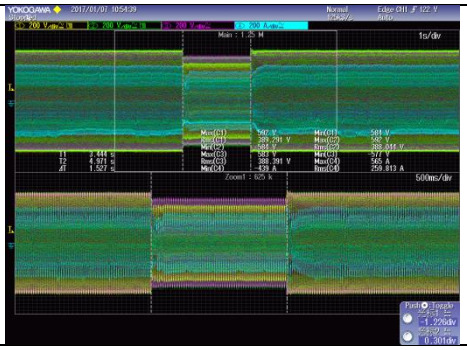
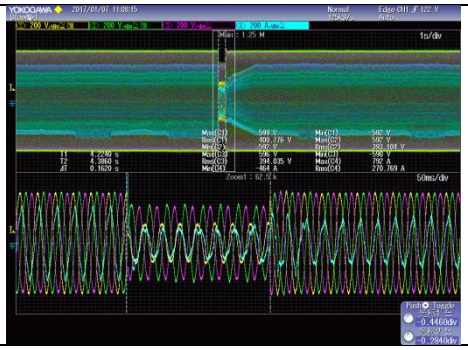
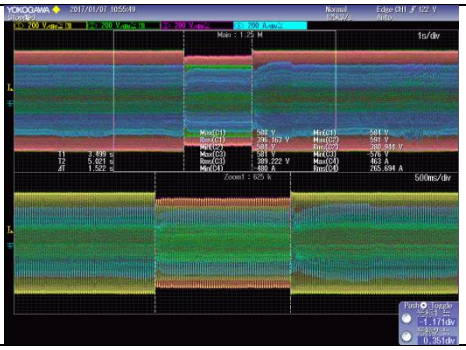
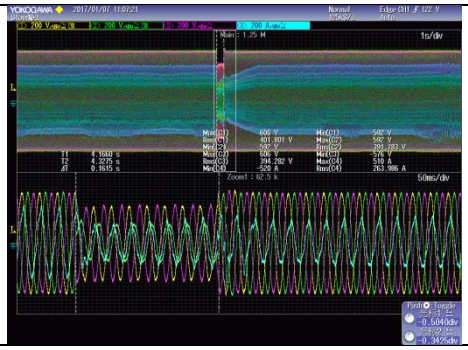
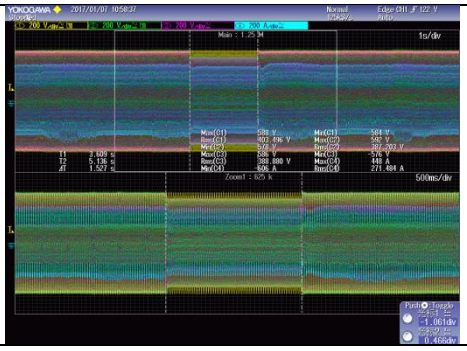
A-phase – B- phase symmetrical faults 0.7-0.8 Vn

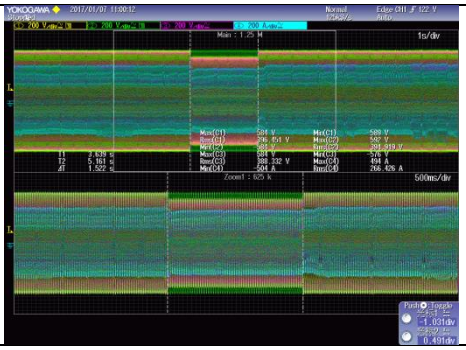
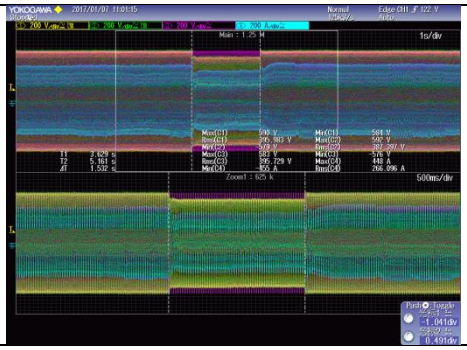
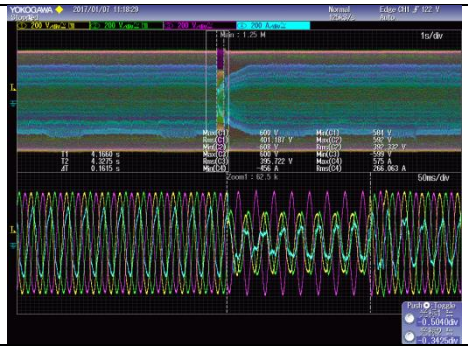


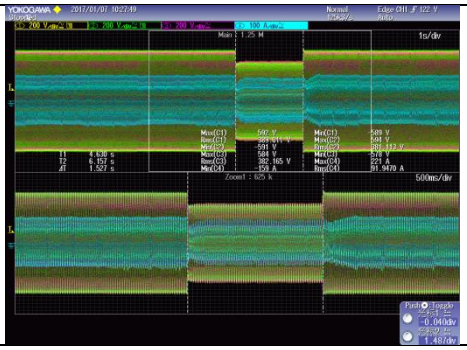
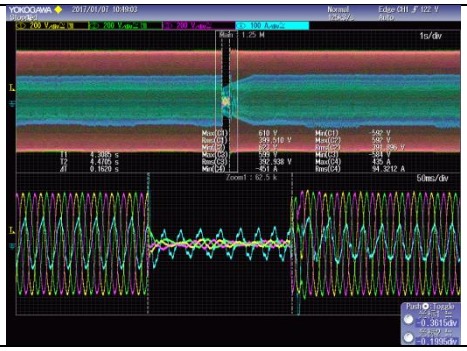
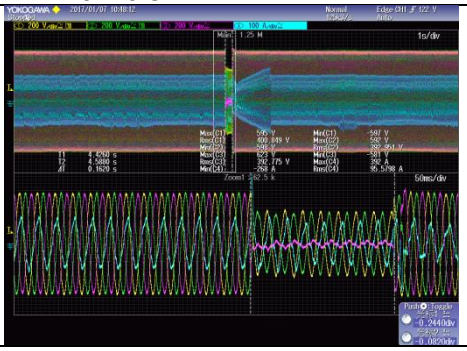
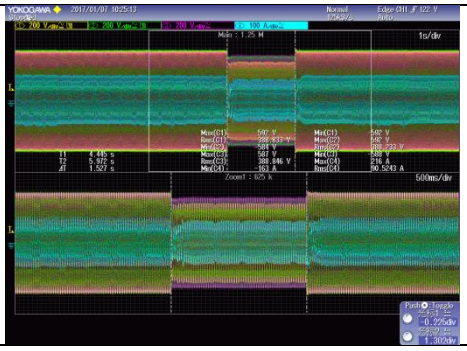
A-phase – B- phase symmetrical faults 0.3-0.5 Vn

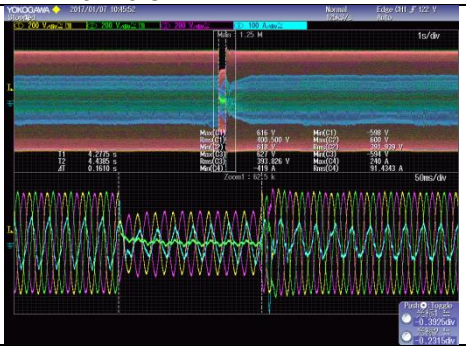
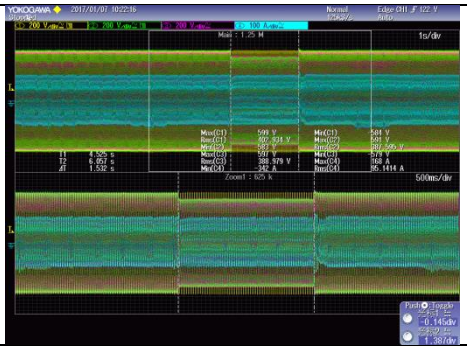
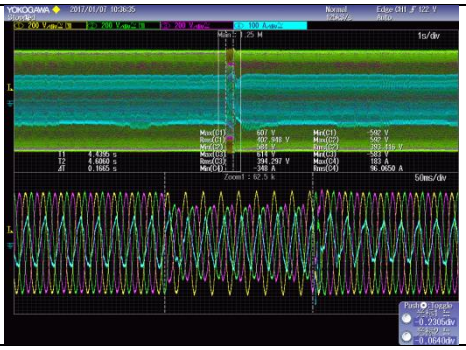
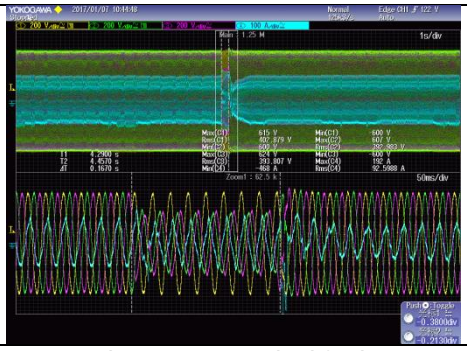
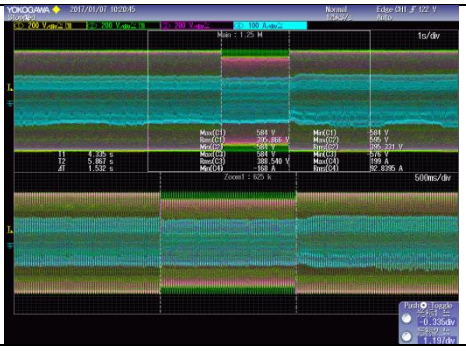


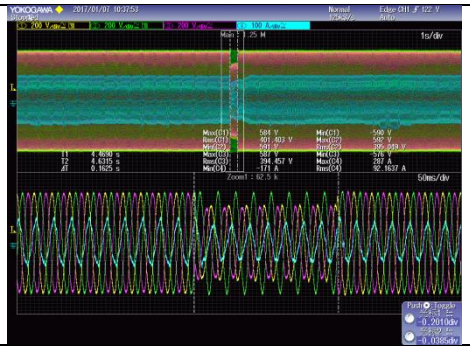
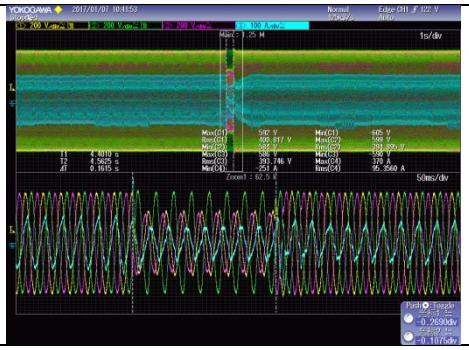
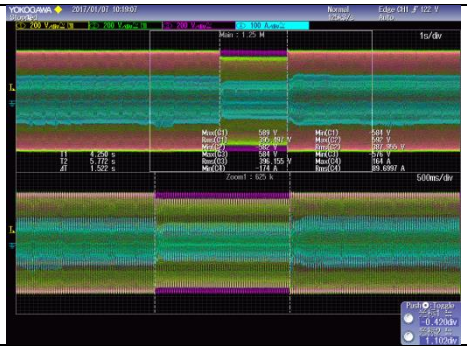
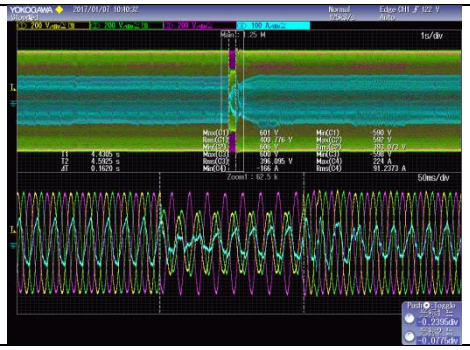
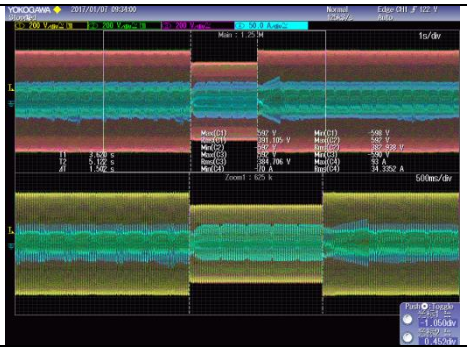
A-phase – B- phase symmetrical faults 0-0.049 Vn

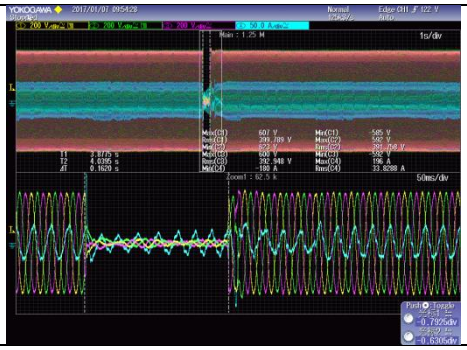
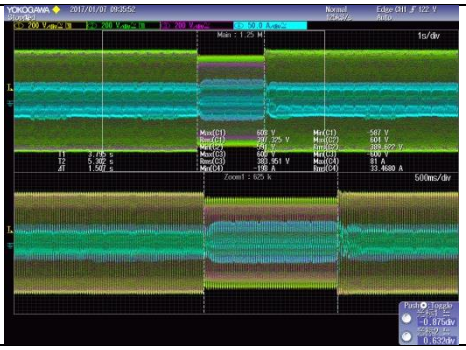
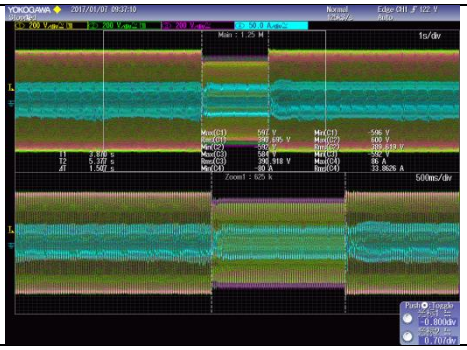
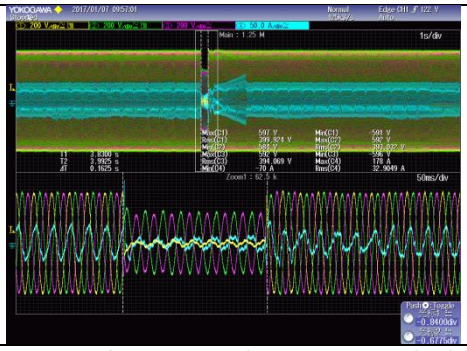
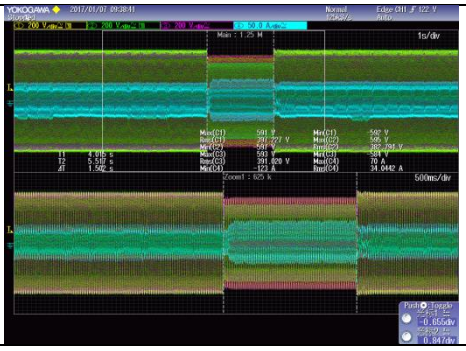
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn
	
B-phase – C- phase symmetrical faults 0-0.049 Vn	A-phase – C- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – C- phase symmetrical faults 0.3-0.5 Vn	A-phase – C- phase symmetrical faults 0-0.049 Vn
	
A-phase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

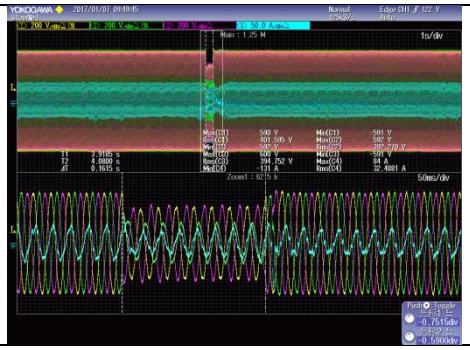
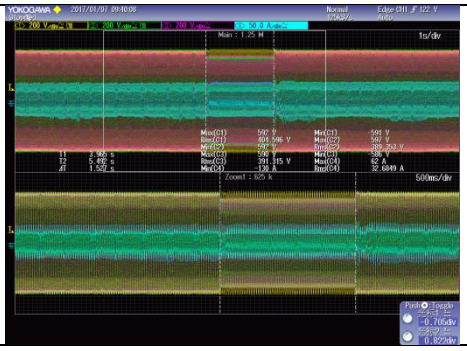
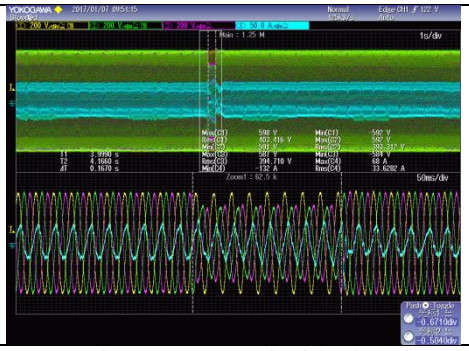
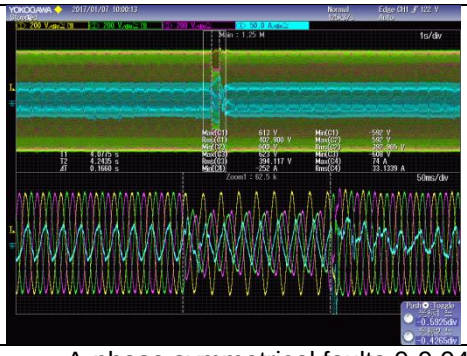
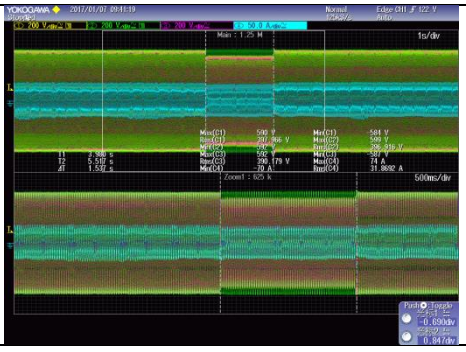
			
A-phase symmetrical faults 0-0.049 Vn		B-phase symmetrical faults 0.7-0.8 Vn	
			
B-phase symmetrical faults 0.3-0.5 Vn		B-phase symmetrical faults 0-0.049 Vn	
			
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn	
		--	
C- phase symmetrical faults 0-0.049 Vn		--	
Supplementary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

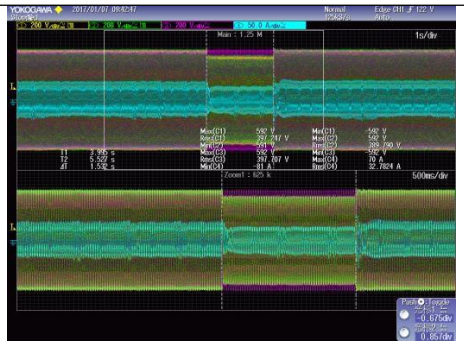
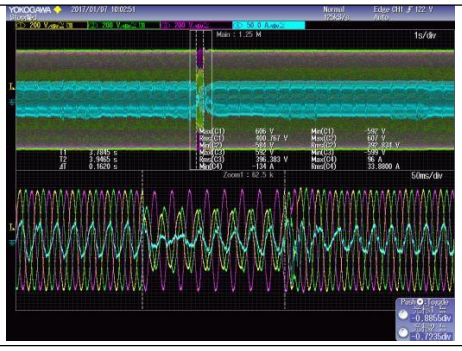
	
Three-phase faults 0.7-0.8 Vn	Three-phase faults 0.3-0.5 Vn
	
Three-phase faults 0-0.049 Vn	A-phase – B- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – B- phase symmetrical faults 0.3-0.5 Vn	A-phase – B- phase symmetrical faults 0-0.049 Vn
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase –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

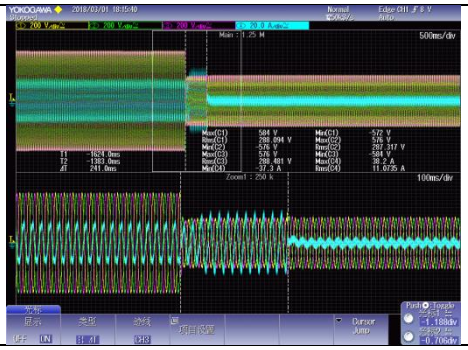
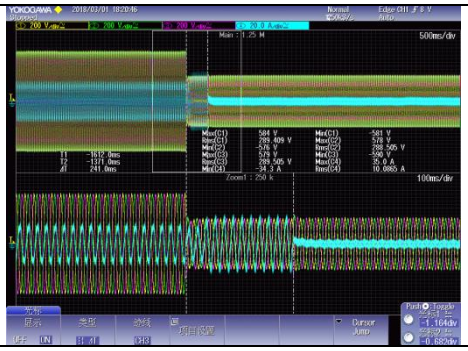
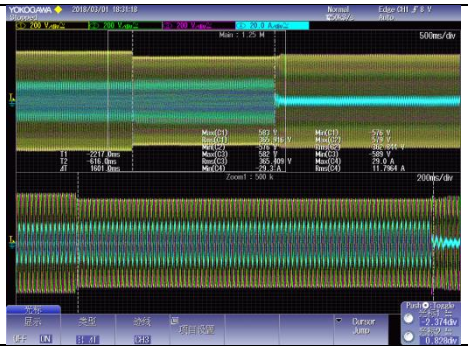
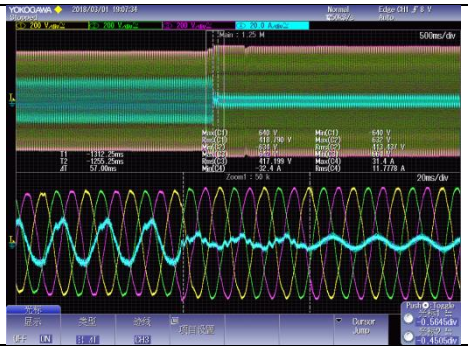
		
B-phase symmetrical faults 0.3-0.5 Vn		B-phase symmetrical faults 0-0.049 Vn
		
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn
		--
C- phase symmetrical faults 0-0.049 Vn		--
Supplementary information(10% Power):		
		
Three-phase faults 0.7-0.8 Vn		Three-phase faults 0.3-0.5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

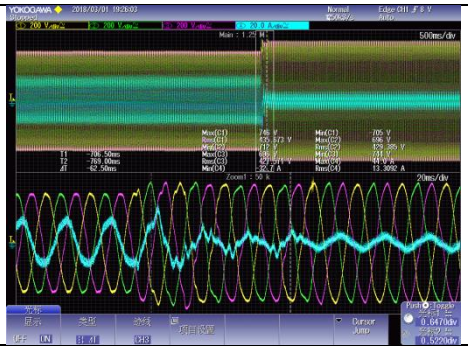
	
Three-phase faults 0-0.049 Vn	A-phase – B- phase symmetrical faults 0.7-0.8 Vn
	
A-phase – B- phase symmetrical faults 0.3-0.5 Vn	A-phase – B- phase symmetrical faults 0-0.049 Vn
	
B-phase – C- phase symmetrical faults 0.7-0.8 Vn	B-phase – C- phase symmetrical faults 0.3-0.5 Vn
	
B-phase – C- phase symmetrical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

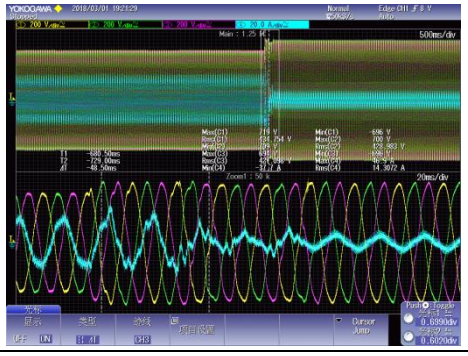
		
C-phase symmetrical faults 0.7-0.8 Vn		C-phase symmetrical faults 0.3-0.5 Vn
		--
C- phase symmetrical faults 0-0.049 Vn		--

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%	199	0.1	199	0.241	0.3	P
2	V<50%	199	0.1	199	0.241	0.3	P
5	50%≤V<90%	201	1.6	201	1.610	2.0	P
6	50%≤V<90%	359	1.6	359	1.610	2.0	P
7	90%≤V≤110%	359	--	359	CONTINUE	CONTINUE	P
8	90%≤V≤110%	359	--	359	CONTINUE	CONTINUE	P
9	90%≤V≤110%	440	--	440	CONTINUE	CONTINUE	P
10	90%≤V≤110%	440	--	440	CONTINUE	CONTINUE	P
11	110%<V<120%	440	0.1	440	0.057	1.0	P
12	110%<V<120%	440	0.1	441	0.062	1.0	P
15	V≥120%	480	0.1	480	0.048	0.16	P
16	V≥120%	481	0.1	481	0.048	0.16	P

Supplementary information:

V < 50%, 199V

50%≤V<90%，201V

50% < V < 90%, 359V

110%<V<120%, 441V



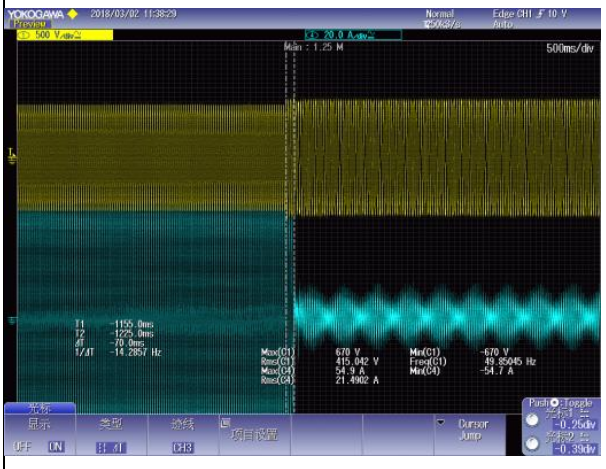
110%<V<120%, 479V



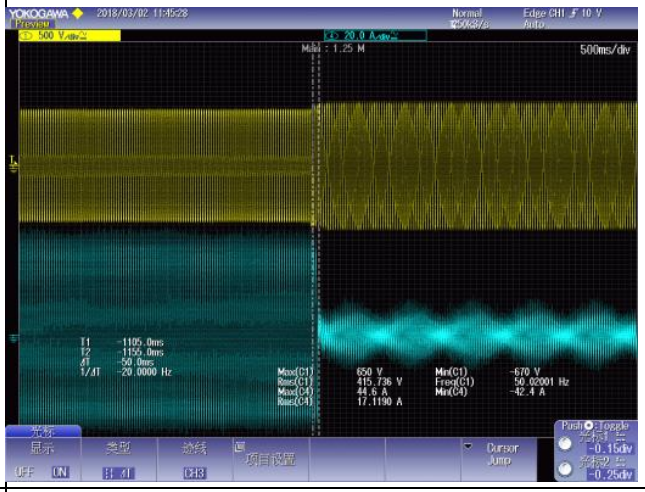
V≥120%, 481V

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	0.05	46.9	0.092	0.1	P
2	110%UFT	51.7	--	51.7	Cont.	Cont.	P
3	90%OFT	47.5	--	47.5	Cont.	Cont.	P
4	101%OFT	52.1	0.05	52.1	0.081	0.1	P

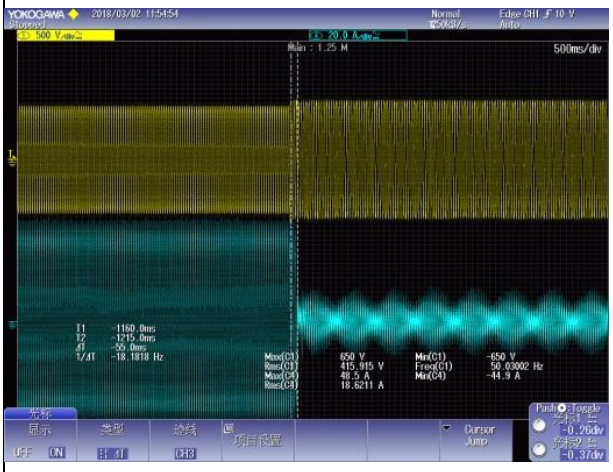
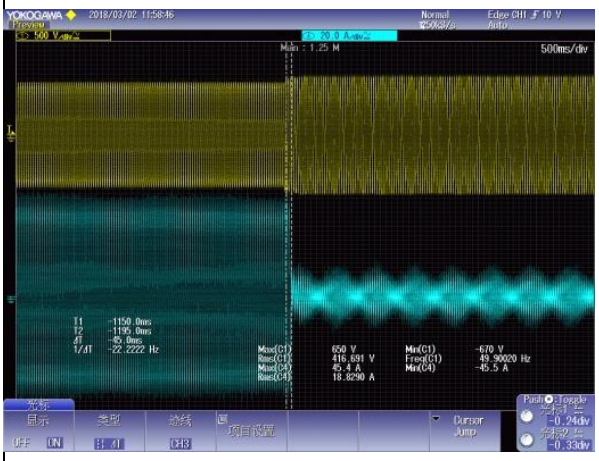
Supplementary information:
OFT: Over frequency Trip Setting
UFT: Under frequency Trip Setting
Cont.: Continuous operated



Under frequency < 46.9 Hz



Over frequency > 51.7 Hz

	
Under frequency < 47.5 Hz	Over frequency > 52.1Hz

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	106	17.193	0.997	820	Test A at BL
2	100	100	-5	-5	60	17.193	1.023	820	Test A at IB
3	100	100	-5	0	89	17.193	1.049	820	Test A at IB
4	100	100	-5	+5	68	17.193	1.075	820	Test A at IB
5	100	100	0	-5	64	17.193	0.971	820	Test A at IB
6	100	100	0	+5	58	17.193	1.021	820	Test A at IB
7	100	100	+5	-5	59	17.193	0.925	820	Test A at IB
8	100	100	+5	0	57	17.193	0.949	820	Test A at IB
9	100	100	+5	+5	87	17.193	0.973	820	Test A at IB
Parameter at 0% per phase			L= 52.52 mH		R= 16.57 Ω		C= 190.08 µF		
IAC fundamental current at balance condition			L1: 75 mA		L2: 97 mA		L3: 78 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	86	11.091	0.977	704	Test B at IB
2	66	66	0	-4	87	11.091	0.982	704	Test B at IB
3	66	66	0	-3	80	11.091	0.987	704	Test B at IB
4	66	66	0	-2	82	11.091	0.992	704	Test B at IB
5	66	66	0	-1	56	11.091	0.997	704	Test B at IB
6	66	66	0	0	90	11.091	1.002	704	Test B at BL
7	66	66	0	1	71	11.091	1.007	704	Test B at IB
8	66	66	0	2	63	11.091	1.012	704	Test B at IB
9	66	66	0	3	69	11.091	1.017	704	Test B at IB
10	66	66	0	4	68	11.091	1.022	704	Test B at IB
11	66	66	0	5	54	11.091	1.027	704	Test B at IB

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

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

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

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

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	62	5.491	0.971	592	Test C at IB
2	33	33	0	-4	75	5.491	0.986	592	Test C at IB
3	33	33	0	-3	61	5.491	0.986	592	Test C at IB
4	33	33	0	-2	76	5.491	0.991	592	Test C at IB
5	33	33	0	-1	74	5.491	0.996	592	Test C at IB
6	33	33	0	0	73	5.491	1.001	592	Test C at BL
7	33	33	0	1	65	5.491	1.006	592	Test C at IB
8	33	33	0	2	112	5.491	1.011	592	Test C at IB
9	33	33	0	3	88	5.491	1.016	592	Test C at IB

10	33	33	0	4	57	5.491	1.021	592	Test C at IB
11	33	33	0	5	46	5.491	1.026	592	Test C at IB

Parameter at 0% per phase	L= 151.97 mH	R= 48.13 Ω	C= 65.77 µF
IAC fundamental current at balance condition	L1: 46 mA	L2: 57 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.

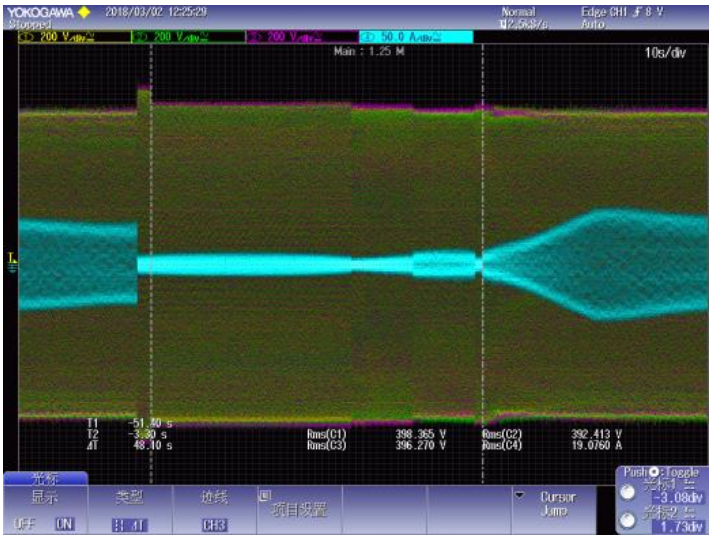
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = 33% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For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

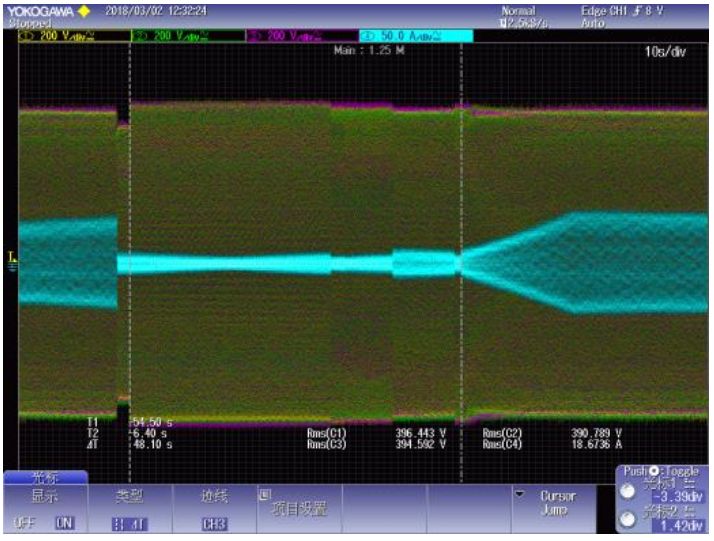
Attention:
For Thailand only picture with all three current phases L1. L2 and L3 are accepted
All relays are direct coupled and open directly by receiving the islanding signal from the controller.

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

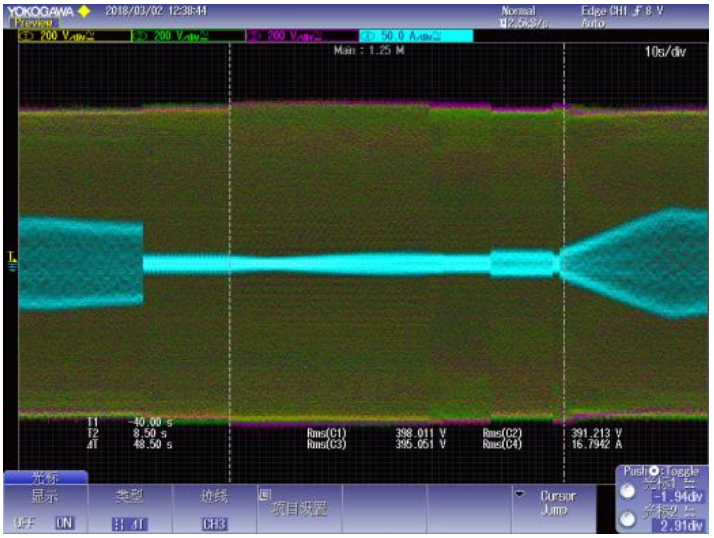
	Table: Response to Utility recovery test			P
Test condition	Limit (sec)	Actual Setting (sec)	Test Result (sec)	Result
Under frequency (46.9Hz)	20 - 300	27	48.4	P
Over frequency (52.1 Hz)		27	48.1	P
Under voltage level 1 (355 V)		27	48.5	P
Over voltage level 1 (443 V)		27	48.4	P
Supplementary				



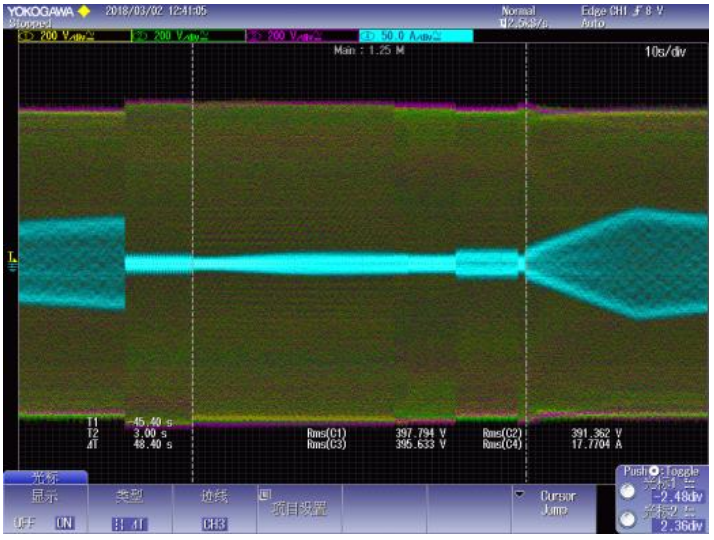
Response to utility recovery over voltage level 1



Response to utility recovery under voltage level 1



Response to utility recovery under Frequency



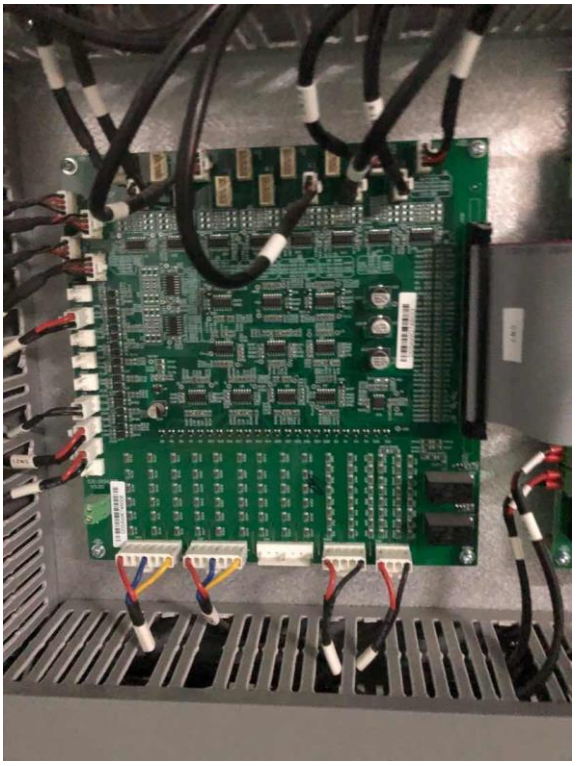
Response to utility recovery over Frequency

Annex I
Equipment of test

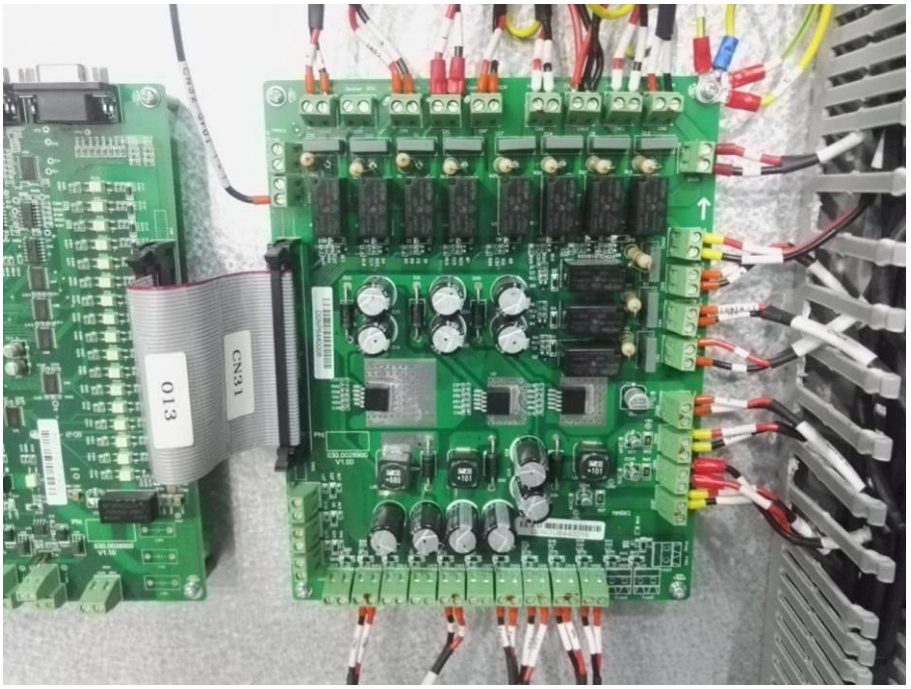
Equipment name	Trade name	Model	S/N	Cal. Due. Date
Power Analyzer	YOKOGAVA	WT3000	EP-011	2018/09/25
Programmable DC Power supply	GROWATT	DC1000	RD.02.100	--
Programmable AC Source	GROWATT	AC1000	RD.02.101	--
Programmable DC Power supply	Kewell	TVS-630kW	EP-027	--
Programmable AC Source	APC	AFG-S-33800	EP-026	--
Programmable RLC Load	Qunling	ACLT-38160H	EP-028	--
Digital oscilloscope	YOKOGAVA	DL850	EP-001	2018/09/06
Differential probe	CYBERTEK	VP5200	EP-003	2018/09/06
Current probe	YOKOGAVA	CT-1000	EP-012	2018/09/24
Current probe	YOKOGAVA	CT-1000	EP-013	2018/09/24
Current probe	YOKOGAVA	CT-1000	EP-014	2018/09/24
Three phase impedance	Teseq	CCN 1000-3	EE206-1	2018/08/24
Signal conditioning Unit	Teseq/Germany	INA2197/37A	EE206-2	N/A
Three phase impedance	Teseq/Germany	INA 2196/75A	EE206-3	N/A

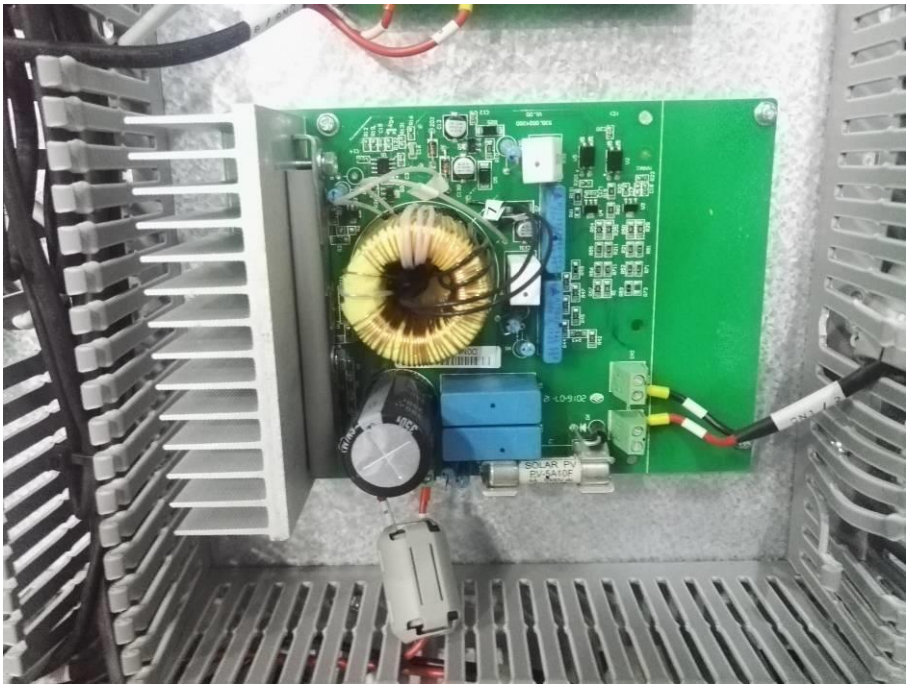
Annex II
Specification of Inverter

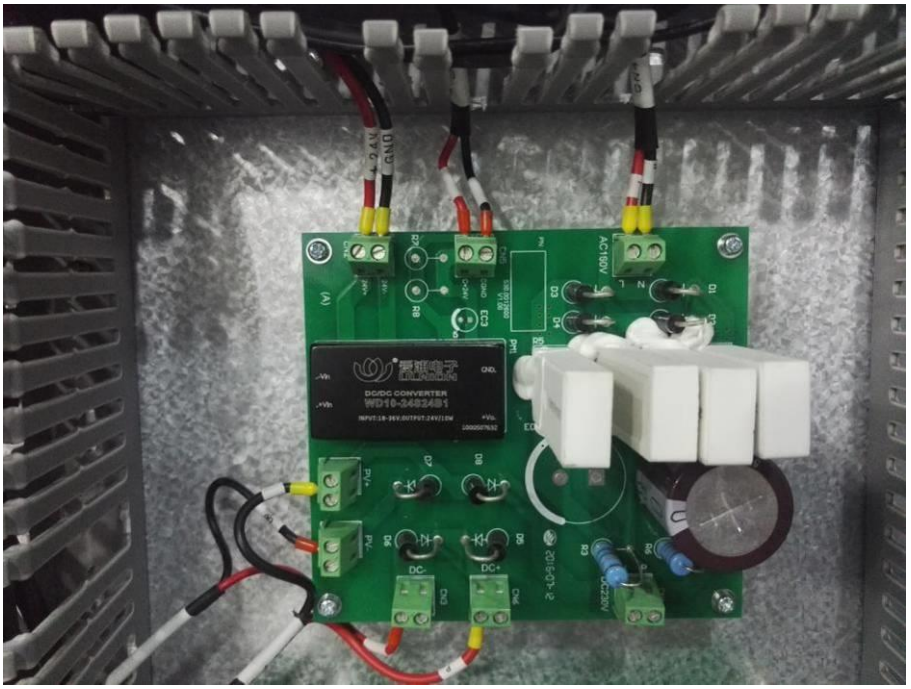

TK6070iQ

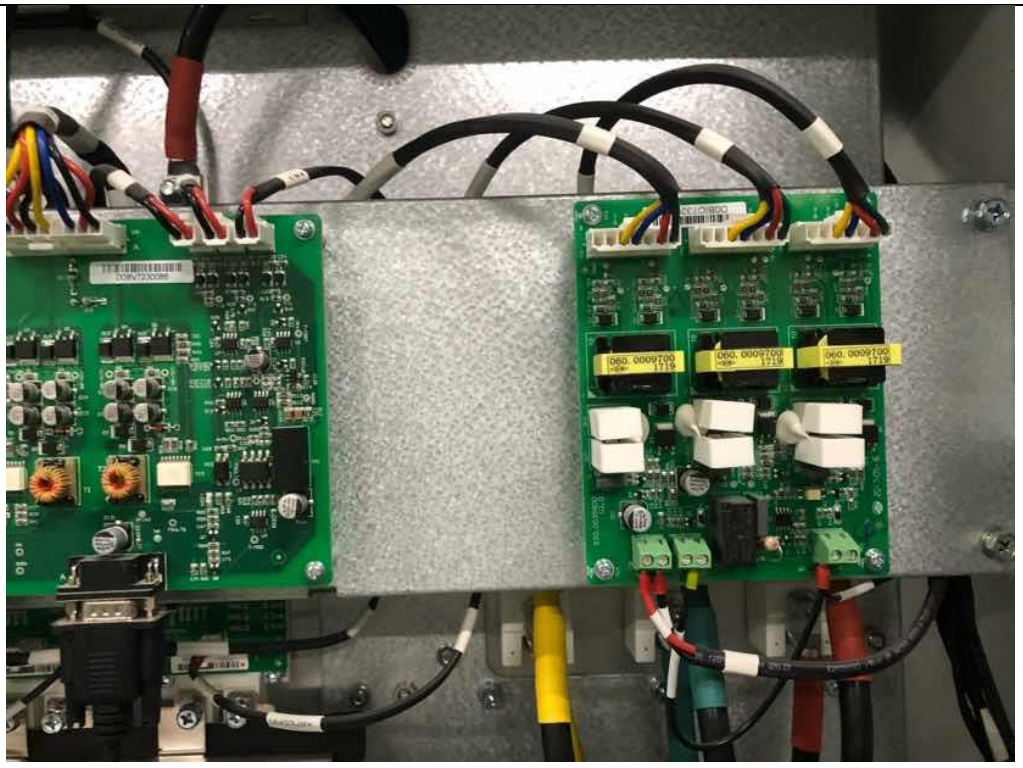


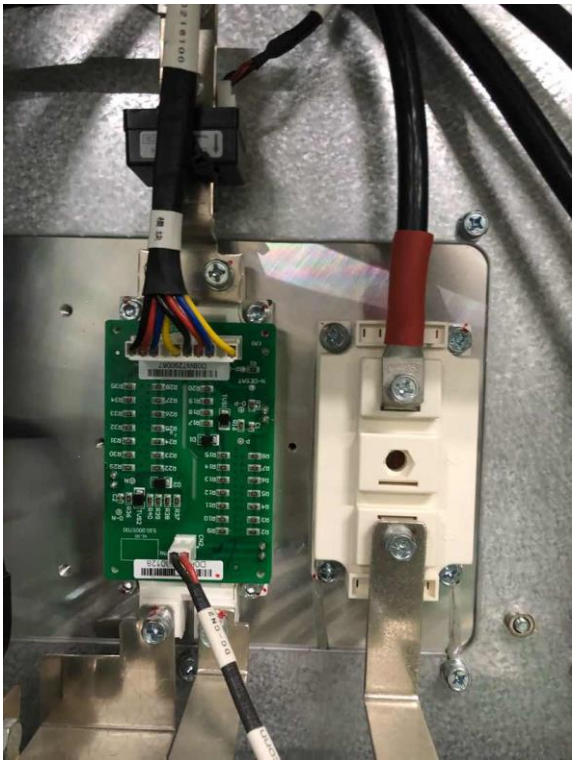

014
CN3
013

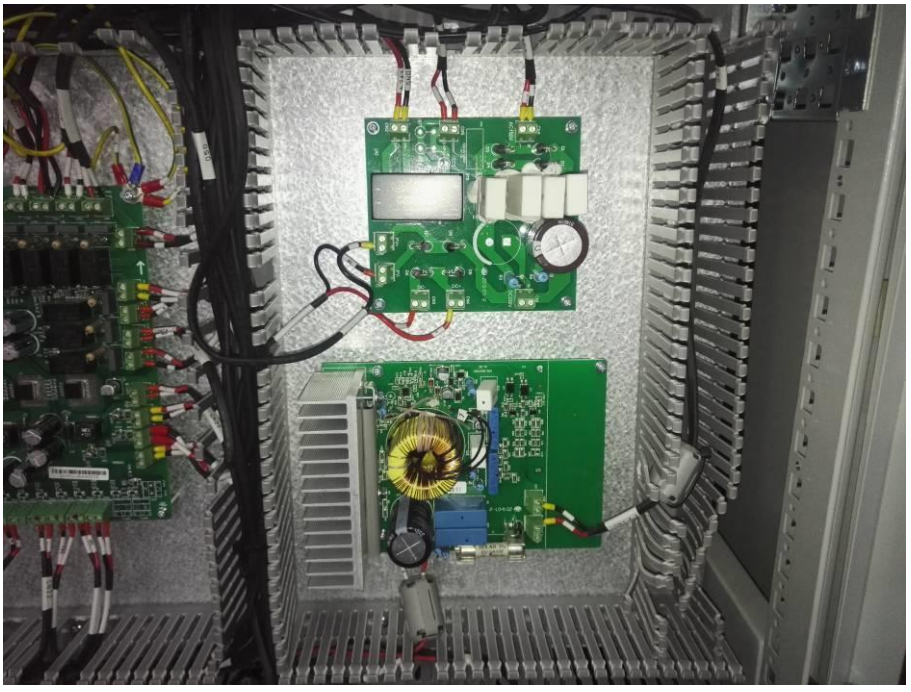

CN31
013

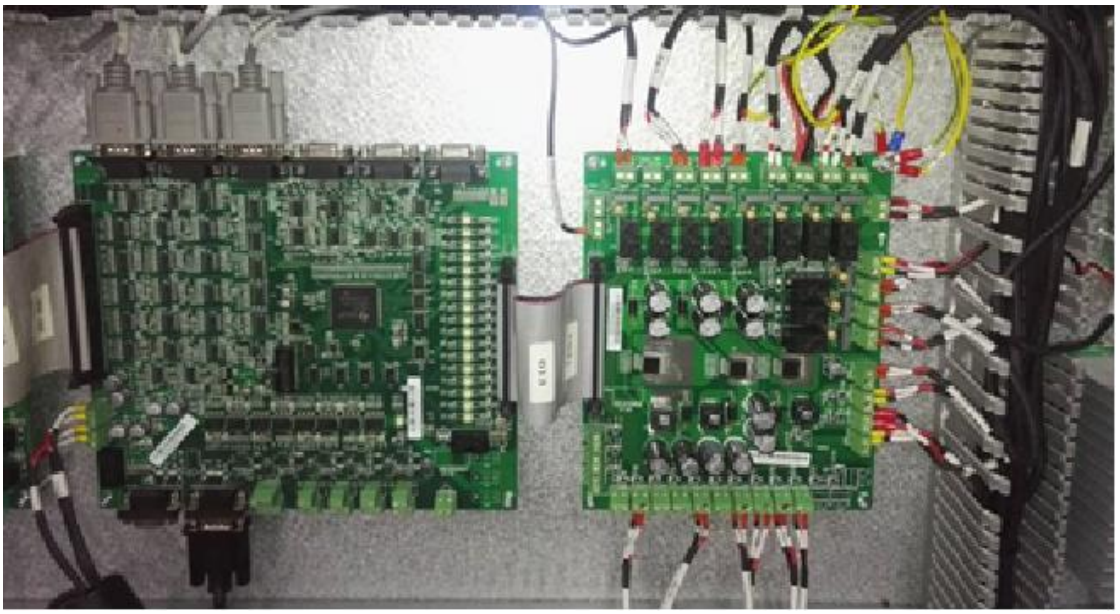


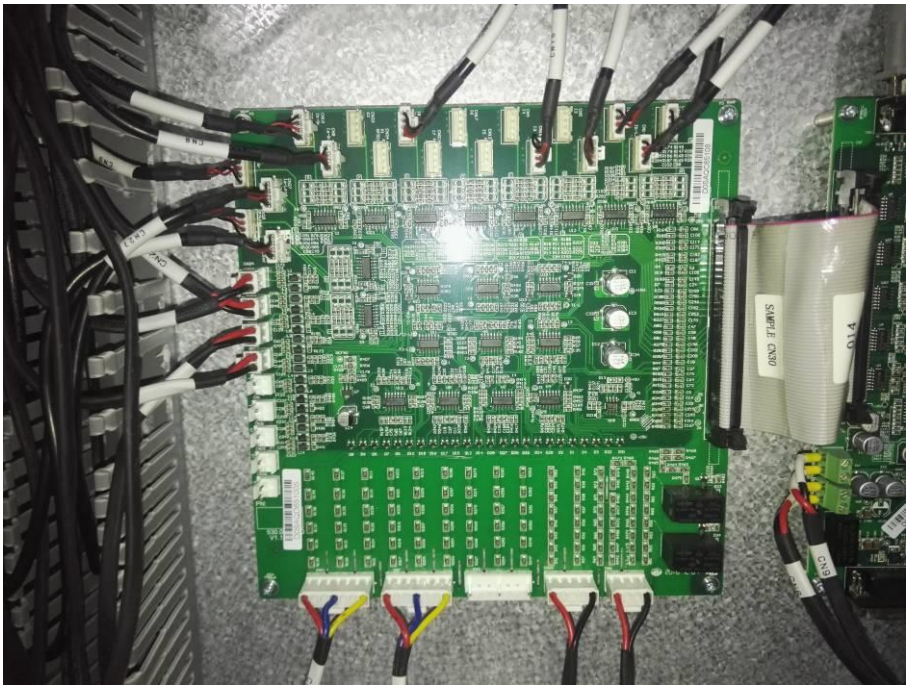

GND
+24V
AC100V
DC-
DC+
DC/DC CONVERTER

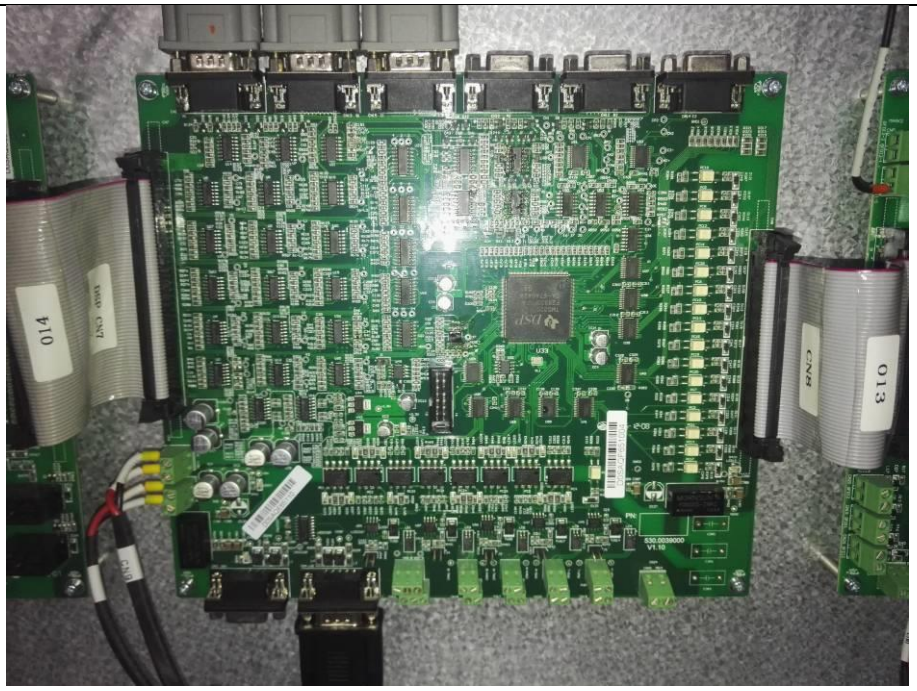


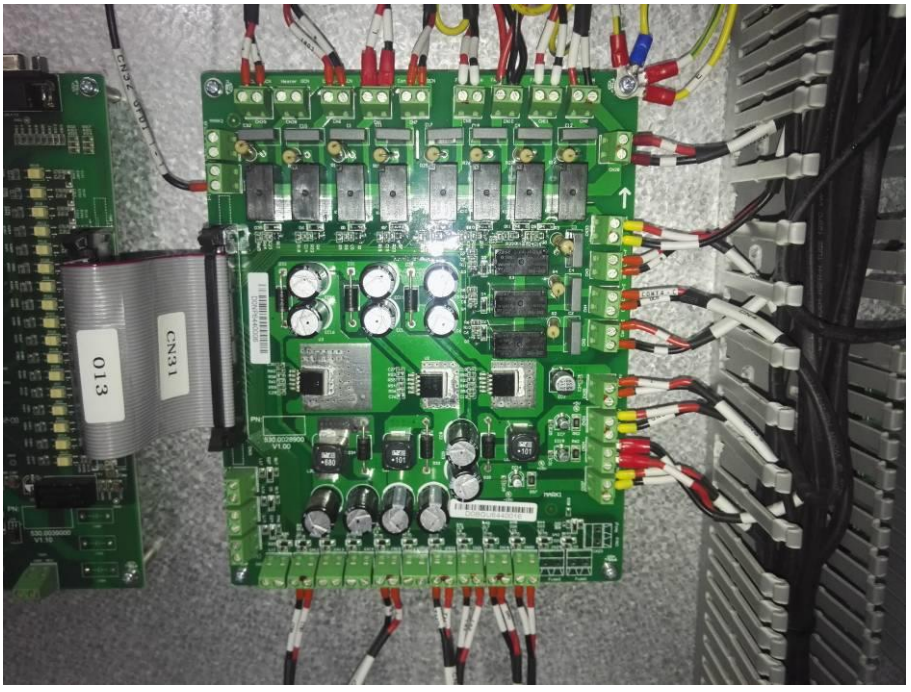


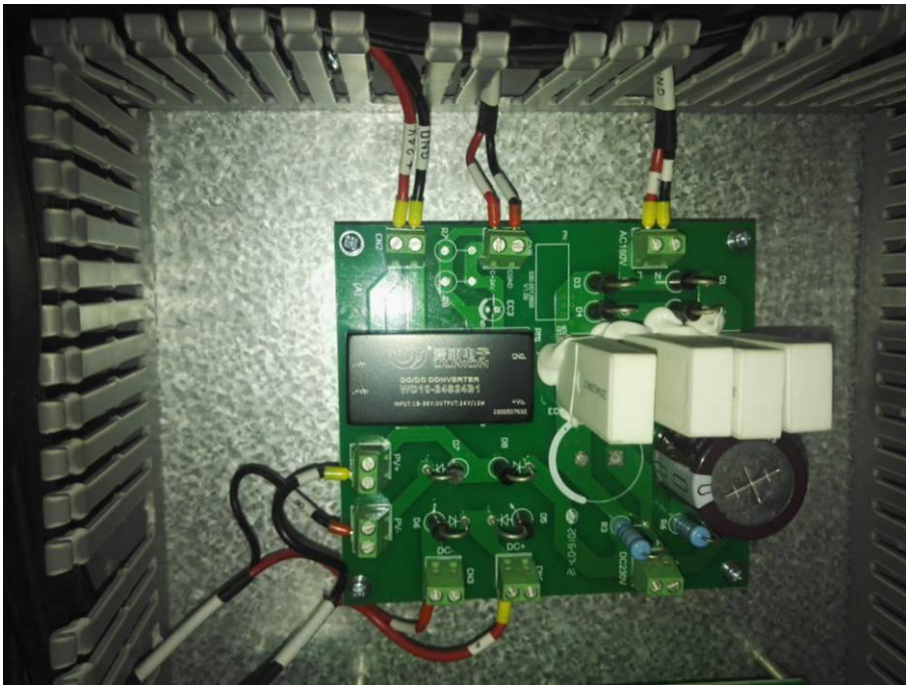


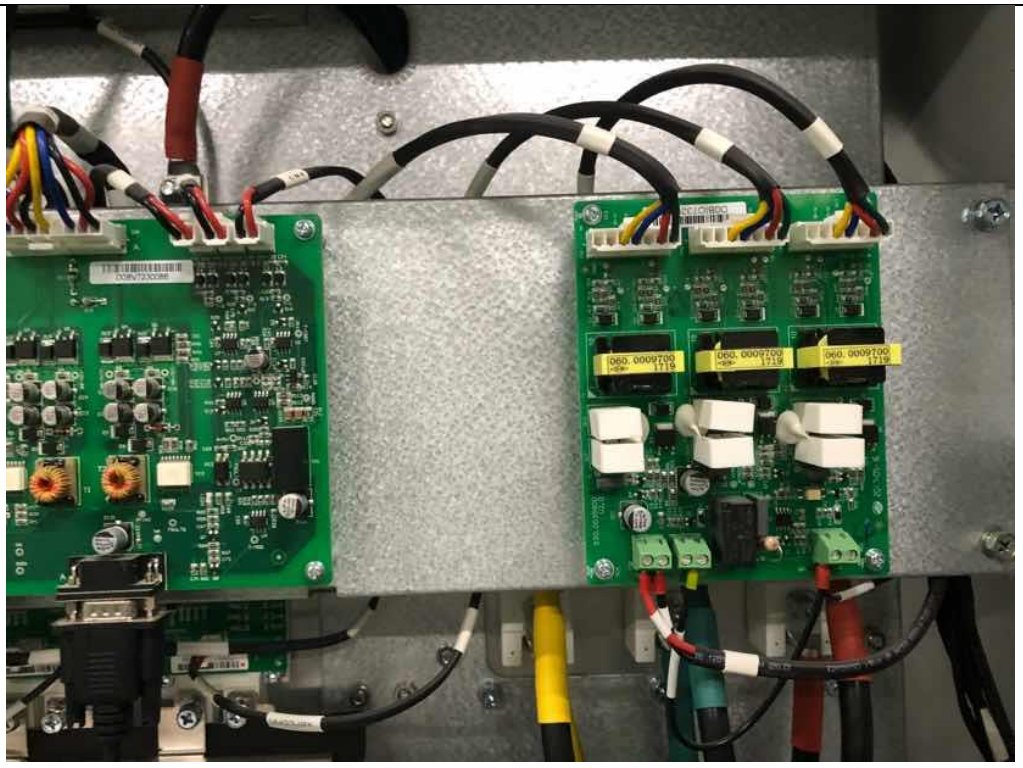



SAMPLE CN30
CN19

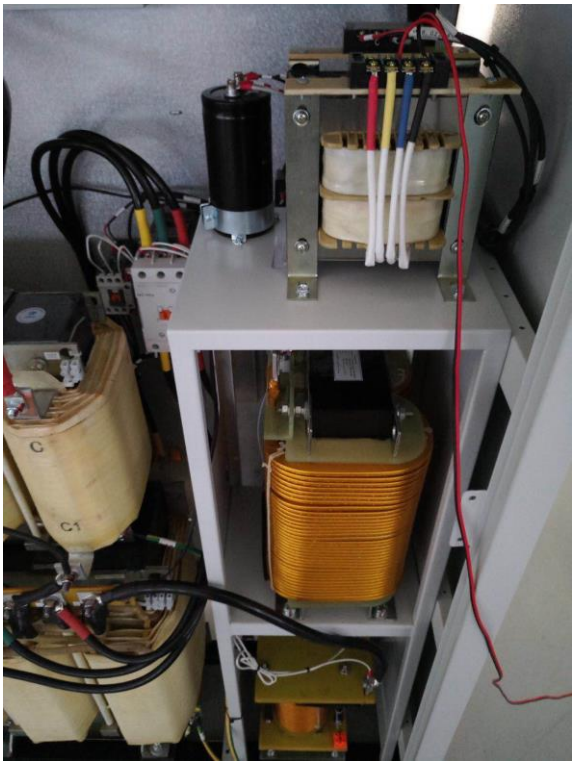

014
CN7
CN8
013


013
CN31






Growatt




A
B
C
A1
C1

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