

**TESTING FOR THE VERIFICATION OF COMPLIANCE OF
PV INVERTER WITH :
ENGINEERING RECOMMENDATION G99 ISSUE 1-
AMENDMENT 3, 16 MAY 2018,
REQUIREMENTS FOR THE CONNECTION OF
GENERATION EQUIPMENT IN PARALLEL WITH PUBLIC
DISTRIBUTION NETWORKS ON OR AFTER 27 APRIL 2019**

Test Report Number : GZES201103126701

Type : Hybrid Inverter

Tested Model..... : HPS50

Variant Models : HPS30

APPLICANT

Name : Shenzhen Ates Power Technology Co., Ltd

Address : 1st Floor of Building 3 at Sector B and 3rd Floor of Building 9,
Henglong Industrial Park, Shuitian, Baoan District, Shenzhen,
Guangdong, China

TESTING LABORATORY

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Guangzhou Branch

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Roger Hu

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Test Report Historical Revision:

Test Report Version	Date	Resume
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1 SCOPE

SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch has been contract by Shenzhen Ates Power Technology Co., Ltd, in order to perform the testing according the “ENGINEERING RECOMMENDATION G99 ISSUE 1-AMENDMENT 3, 16 MAY 2018, REQUIREMENTS FOR THE CONNECTION OF GENERATION EQUIPMENT IN PARALLEL WITH PUBLIC DISTRIBUTION NETWORKS ON OR AFTER 27 APRIL 2019”.

Note: This standard details connection process, technical and compliance requirements for Type A, Type B, Type C and Type D Power Generating Modules. The tests offered at this test report evaluate the EUT compliance with the requirements of **Type A** defined as below:

Type A

A Power Generating Module with a Connection Point below 110 kV and a Registered Capacity of 0.8 kW or greater but less than 1 MW.

Type B

A Power Generating Module with a Connection Point below 110 kV and Registered Capacity of 1 MW or greater but less than 10 MW.

Type C

A Power Generating Module with a Connection Point below 110 kV and a Registered Capacity of 10 MW or greater but less than 50 MW.

Type D

A Power Generating Module with a Connection Point at or greater than 110 kV, and/or with a Registered Capacity of 50 MW or greater.

2 GENERAL INFORMATION

2.1 TESTING PERIOD AND CLIMATIC CONDITIONS

The necessary testing has been performed along between the 07th to 26th of January of 2021.

All the tests and checks have been performed at $25 \pm 5^{\circ}\text{C}$, $96 \text{ kPa} \pm 10 \text{ kPa}$ and $50\% \text{ RH} \pm 10\% \text{ RH}$.

SITE TEST

Name.....: Shenzhen BALUN Technology Co., Ltd.
 Address: Room 104, 204, 205, Building 1, No. 6, Industrial South Road, Songshan Lake District, Dongguan, Guangdong, China

2.2 EQUIPMENT UNDER TESTING

Apparatus type: Hybrid Power Systems (Three phase)
 Installation: Fixed (permanent connection)
 Manufacturer: Shenzhen ATESS Power Technology Co., Ltd
 Address: 1st Floor of Building 3 at Sector B and 3rd Floor of Building 9, Henglong Industrial Park, Shuitian, Baoan District, Shenzhen, Guangdong, China
 Trade mark.....:  **ATESS**
 Model / Type reference: HPS50
 Serial Number: TMD094602A
 Software Version.....: DSP: HV3_SV4.1.14; LCD: HV1.0_SV1.0.8
 Rated Characteristics.....: PV input: 480-800 V_{mpp} (Max. 1000 V input), 136A max;
 Battery input: 352-600 V_{dc}, Charge current 150 A_{dc},
 Discharge current 156 A_{dc};
 AC output: 3P/PE, 400 Vac, 50 Hz, 3*72 A, 50 kW
 Date of manufacturing: 2020
 Test item particulars
 Input: DC
 Output.....: AC
 Class of protection against electric shock...: Class I
 Degree of protection against moisture: IP20
 Type of connection to the main supply: Three phase – Fixed installation
 Cooling group.....: Fans
 Modular: No
 Internal Transformer.....: Yes

Copy of marking plate (representative):

ATESS Hybrid Power Systems	
Model	HPS50
PV Max generating power	75kW
Max PV Open-circuit voltage	1000Vdc
PV MPPT voltage range	480-800Vdc
PV Max input current	136A
ISC PV	170.5A
Battery voltage range	352-600Vdc
Battery Max charge/discharge current	150/156A
Battery Max charge/discharge power	75kW/55kW
AC Rated voltage	400Vac
AC Rated frequency	50/60Hz
AC Rated current	72A
AC Rated output power	50kW
Max AC output power	55kVA
Max AC input power	100kVA
PF Range	0.8lagging--0.8leading
Protective Class	Class I
Ingress Protection	IP20
Communication Port	RS485/CAN
Inverter Topology	Isolated
Operating Temp.Range	-25°C to +55°C
DATE OF MADE	
S/N:	
www.ateesspower.com MADE IN CHINA	

ATESS Hybrid Power Systems	
Model	HPS30
PV Max generating power	45kW
Max PV Open-circuit voltage	1000Vdc
PV MPPT voltage range	480-800Vdc
PV Max input current	90A
ISC PV	100A
Battery voltage range	352-600Vdc
Battery Max charge/discharge current	100/93A
Battery Max charge/discharge power	45kW/33kW
AC Rated voltage	400Vac
AC Rated frequency	50/60Hz
AC Rated current	43A
AC Rated output power	30kW
Max AC output power	33kVA
Max AC input power	60kVA
PF Range	0.8lagging--0.8leading
Protective Class	Class I
Ingress Protection	IP20
Communication Port	RS485/CAN
Inverter Topology	Isolated
Operating Temp.Range	-25°C to +55°C
DATE OF MADE	
S/N:	
www.ateesspower.com MADE IN CHINA	

Note:

- The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
- Label is attached on the side surface of enclosure and visible after installation.

Equipment Under Testing:

- HPS50;

The variants models are:

- HPS30;

Model Number	HPS30	HPS50
PV parameters		
PV rated Power	33kW	55 kW
Max. PV Power	45kW	75 kW
Max. PV input voltage	1000 Vd.c.	
PV MPPT voltage range	480-800 Vd.c.	
Battery parameters		
Battery operating voltage range	352-600 Vd.c.	
Max.Battery charge current	100A	150A
Max.Battery discharge current	93A	156A
Max.Battery charge power	45 kW	75 kW
Max.Battery discharge power	33 kW	55 kW
AC output parameter		
Rated voltage	400 Vac	
Rated current	43 A	72 A
Rated output power	30 kW	50 kW
Rated frequency	50 Hz	
Frequency Range	45-55 Hz	
Max.output power	33 kVA	55 kVA
Max. input power	60 kVA	100 kVA
Power factor	1 default (+/- 0.8 adjustable)	
Ambient temperature	-25 °C ~ 55 °C	
Ingress protection	IP20	
Protective class	Class I	

The variants models have been included in this test report without tests because the following features don't change regarding to the tested model:

- Same connection system and hardware topology
- Same control algorithm.
- Output power within 1/√10 and 2 times of the rated output power or the EUT or Modular inverters.
- Same Firmware Version.

The results obtained apply only to the particular sample tested that is the subject of the present test report. The most unfavorable result values of the verifications and tests performed are contained herein. Throughout this report a point (comma) is used as the decimal separator.

2.3 TEST EQUIPMENT LIST

From	No.	Equipment Name	MARK/Model No.	Equipment No.	Equipment calibration due date
BALUN	1	Current clamp	HIOKI / CT6863-05	BZ-DGD-L026-2	2020-03-04 to 2021-03-03
	2	Current clamp	HIOKI / CT6863-05	BZ-DGD-L026-3	2020-03-04 to 2021-03-03
	3	Current clamp	HIOKI / CT6863-05	BZ-DGD-L026-4	2020-03-04 to 2021-03-03
	4	Power analyzer	HIOKI / PW6001-16	BZ-DGD-L025	2020-03-04 to 2021-03-03
	5	Power analyzer	SIRIUSI-HS-4XIIV-4XLV	BZ-DGD-L163	2020-03-04 to 2021-03-03
	6	Temperature and Humidity meter	CEM / DT-322	BZ-DGD-L005	2020-03-07 to 2021-03-06
SGS	7	True RMS Multimeter	Fluke / 187	GZE012-8	2020-12-04 to 2021-12-03

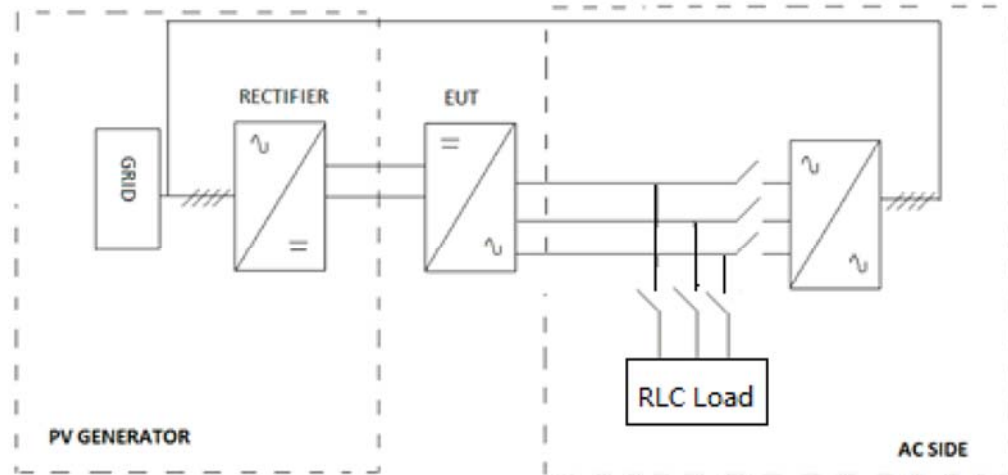
2.4 MEASUREMENT UNCERTAINTY

Associated uncertainties through measurements showed in this this report are the maximum allowable uncertainties.

Magnitude	Uncertainty
Voltage measurement	$\pm 1.5 \%$
Current measurement	$\pm 2.0 \%$
Frequency measurement	$\pm 0.2 \%$
Time measurement	$\pm 0.2 \%$
Power measurement	$\pm 2.5 \%$
Phase Angle	$\pm 1^\circ$
Temperature	$\pm 3^\circ\text{C}$
Note1: Measurements uncertainties showed in this table are maximum allowable uncertainties. The measurement uncertainties associated with other parameters measured during the tests are in the laboratory at disposal of the petitioner. Note2: Where the standard requires lower uncertainties that those in this table. Most restrictive uncertainty has been considered.	

2.5 TEST SET UP OF THE DIFFERENT STANDARD

Below is the simplified construction of the test set up.



Different equipment has been used to take measures as it shows in chapter 2.3. Current and voltage clamps have been connected to the inverter input / output for all the tests. All the tests described in the following pages have used this specified test setup.

The test bench used includes:

EQUIPMENT	MARK / MODEL	RATED CHARACTERISTICS	OWNER / ID. CODE
AC source	Wogo / WLPA-330-75kVA	75 kVA 5-300 Vrms 45-65 Hz	--
DC source	Wogo / WLPA-150kW	0 – 1500 Vdc (0.01 V step) 0 – 200 A (0.01 A step)	--
RLC load	Qunlin / ACLT3820H	68 kW, 68 kVAr	--

2.6 Definitions

EUT	Equipment Under Testing	Hz	Hertz
A	Ampere	V	Volt
VA _r	Volt-Ampere reactive	W	Watt
EMC	Electromagnetic Compatibility	p.u	Per unit
U _n	Nominal Voltage	P _n	Nominal Active Power
I _n	Nominal Current	Q _n	Nominal Reactive Power
I _a	Active Current	S _n	Nominal Apparent Power
I _r	Reactive Current	THD	Total Harmonic Distortion
I _h	Harmonic Current	TDD	Total Demand Distortion
PWHD	Partial Weighted Harmonic Distortion	PLT	Severity of Flicker Long-Term
PST	Severity of Flicker Short-Term	d(t)	Variation of Voltage
d max	Maximum Absolute Value of Voltage Variation	OV	Over Voltage
UV	Under Voltage	OF	Over Frequency
		UF	Under Frequency

3 RESUME OF TEST RESULTS

INTERPRETATION KEYS

Test object does meet the requirement **P** Pass
 Test object does not meet the requirement..... **F** Fails
 Test case does not apply to the test object..... **N/A** Not applicable
 To make a reference to a table or an annex. See additional sheet
 To indicate that the test has not been realized **N/R** Not realized

STANDAARD CLAUSE	STANDARD REQUIREMENTS		RESULT
	G98 Issue 1 Amendment 3 March 2019		
	TEST	REMARKS	
Annex A 2-3 (1)	Operating Range		P
A.7.1.5	Harmonics		P
A.7.1.4.3	Voltage fluctuations and Flicker		P
A.7.1.4.4	DC injection		P
A.7.1.4.2	Power Factor		P
A.7.1.2.3	Frequency tests		P
A.7.1.2.2	Voltage tests:		P
A.7.1.2.4	Loss of Mains test		P
A.7.1.2.6	Loss of Mains Protection, Vector Shift Stability test.		P
	Loss of Mains Protection, RoCoF Stability test		P
A.7.1.3	Limited Frequency Sensitive Mode – Over frequency test		P
Annex A 2-3 (10)	Re-connection timer.		P
A.7.1.5	Fault level contribution		P
A.7.1.7	Self-Monitoring solid state switching	No solid state switching devices	N/A
Para 15.2.1	Wiring functional tests		N/A
Annex A 2-3 (14)	Logic Interface (input port)		P

4 TEST RESULTS

4.1 OPERATING RANGE

Two tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within $\pm 5\%$ of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time.

The Interface Protection shall be disabled during the tests.

The evaluation of this point has been made according to Annex A.7.2.2.

In case of a PV Power Park Module the PV primary source replaced by a DC source.

Test 1:

Voltage = 85% of nominal (338.8V)

Frequency = 47 Hz

Power factor = 1

Period of test 20 s

Test 2:

Voltage = 85% of nominal (338.5 V)

Frequency = 47.5 Hz

Power factor = 1

Period of test 90 minutes

Test 3:

Voltage = 110% of nominal (438.4 V).

Frequency = 51.5 Hz

Power factor = 1

Period of test 90 minutes

Test 4:

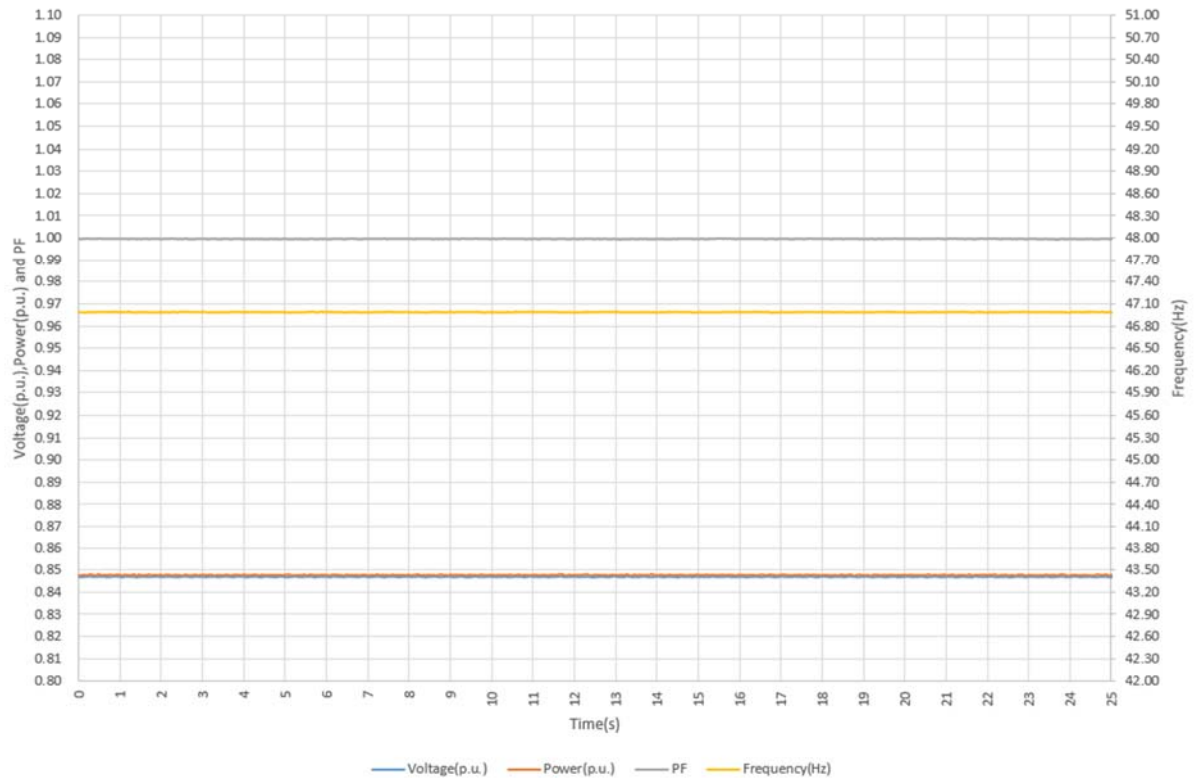
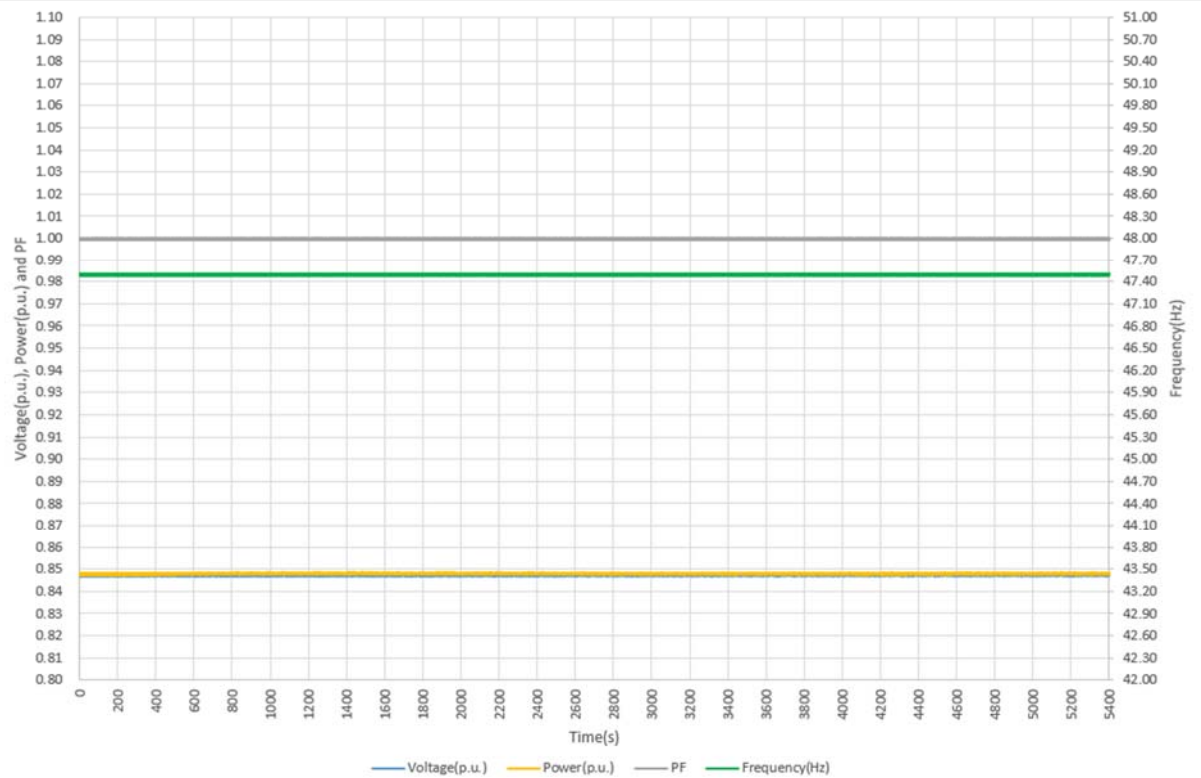
Voltage = 110% of nominal (438.3 V).

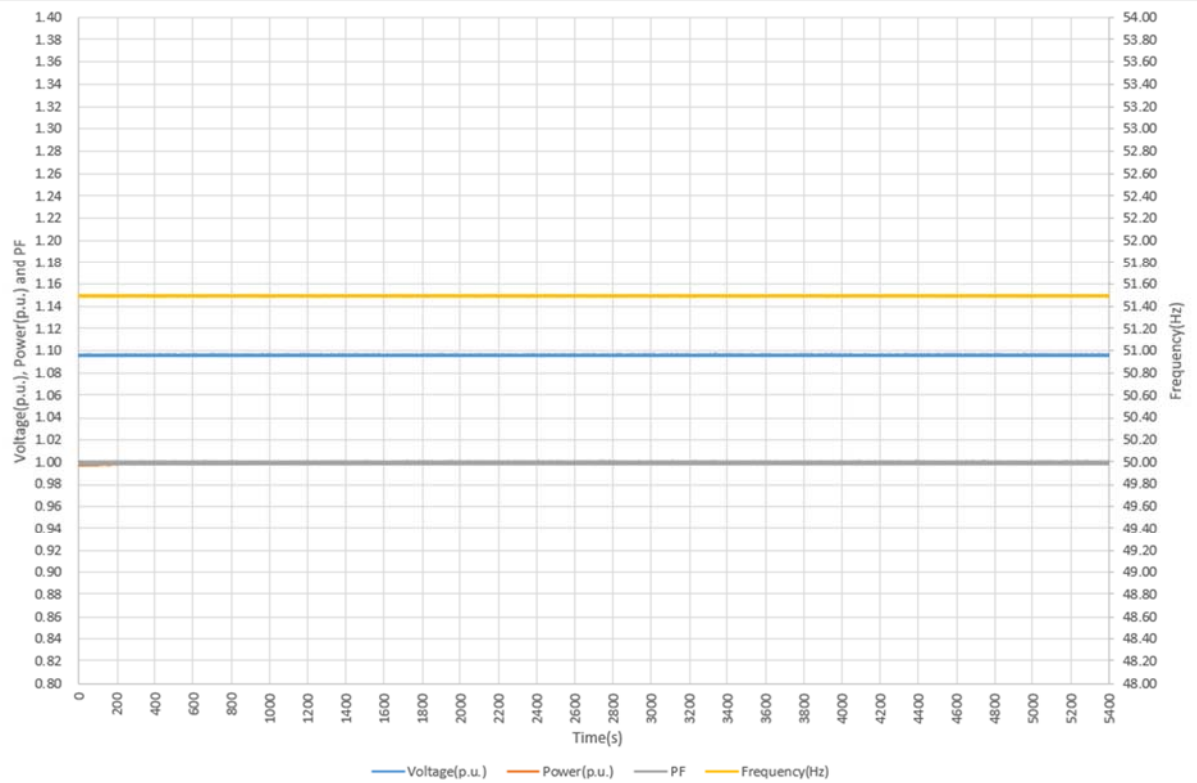
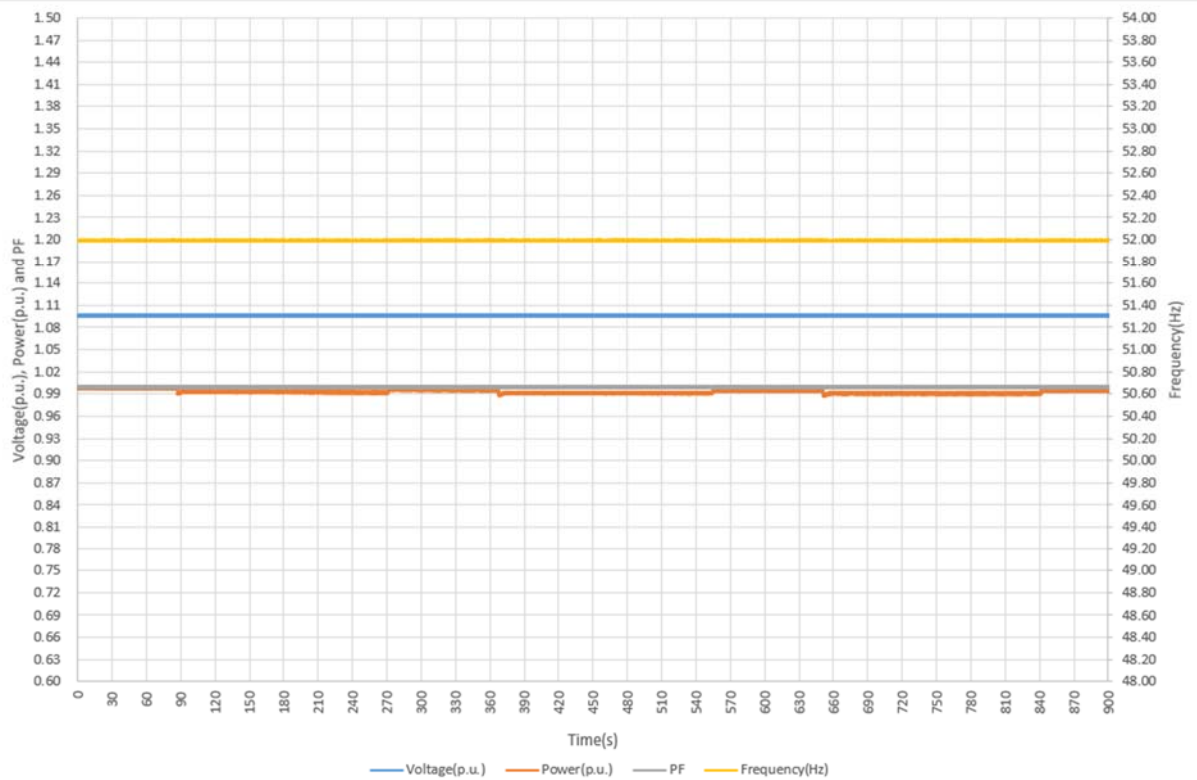
Frequency = 52.0 Hz

Power factor = 1

Period of test 15 minutes

Test results are graphically shown in following pages.

Test 1

Test 2


Test 3

Test 4


4.2 POWER QUALITY

4.2.1 Harmonics

For Power Generating Modules of Registered Capacity of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12 The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 61000-3-12 for three phase equipment.

Power Generating Modules with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the Power Generating Module in order to accept the connection to a Distribution Network.

For Power Generating Modules of Registered Capacity of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.

Measures have been repeated at 50%P_n and 100%P_n.

Following tables show the test results:

Power Generating Module rating per phase (rpp)			50	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Phase A						
Harmonic	At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	(%)	Measured Value MV in Amps	(%)	1 Phase	3 Phase
2	1.103	2.647	1.254	3.009	8%	8%
3	0.871	2.090	1.059	2.542	21.6%	Not stated
4	0.631	1.514	0.864	2.074	4%	4%
5	0.234	0.561	0.236	0.567	10.7%	10.7%
6	0.509	1.222	0.681	1.633	2.67%	2.67%
7	0.102	0.246	0.219	0.526	7.2%	7.2%
8	0.185	0.445	0.220	0.528	2%	2%
9	0.022	0.054	0.020	0.047	3.8%	Not stated
10	0.062	0.149	0.043	0.103	1.6%	1.6%
11	0.177	0.425	0.174	0.419	3.1%	3.1%
12	0.069	0.165	0.070	0.168	1.33%	1.33%
13	0.090	0.217	0.111	0.266	2%	2%
THD	--	4.002	--	4.863	23%	13%
PWHD	--		--		23%	22%

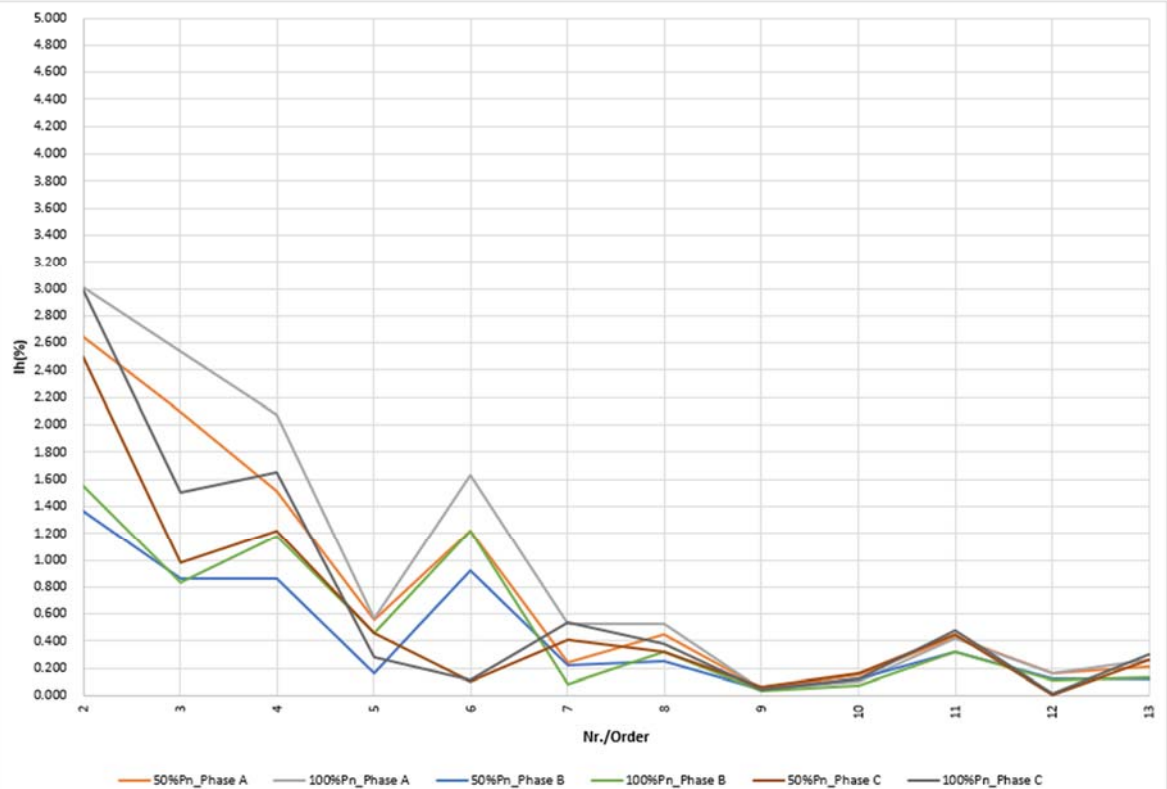
ENA Engineering Recommendation G99 Issue 1 Amendment 3 2018

Phase B						
Harmonic	At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	(%)	Measured Value MV in Amps	(%)	1 Phase	3 Phase
2	0.790	1.362	0.901	1.554	8%	8%
3	0.499	0.861	0.485	0.836	21.6%	Not stated
4	0.498	0.859	0.683	1.178	4%	4%
5	0.093	0.161	0.269	0.463	10.7%	10.7%
6	0.533	0.920	0.705	1.215	2.67%	2.67%
7	0.131	0.226	0.051	0.088	7.2%	7.2%
8	0.148	0.256	0.184	0.318	2%	2%
9	0.028	0.048	0.023	0.039	3.8%	Not stated
10	0.070	0.120	0.043	0.075	1.6%	1.6%
11	0.184	0.317	0.186	0.320	3.1%	3.1%
12	0.070	0.121	0.065	0.112	1.33%	1.33%
13	0.073	0.127	0.077	0.133	2%	2%
THD	--	2.943	--	3.531	23%	13%
PWHD	--		--		23%	22%

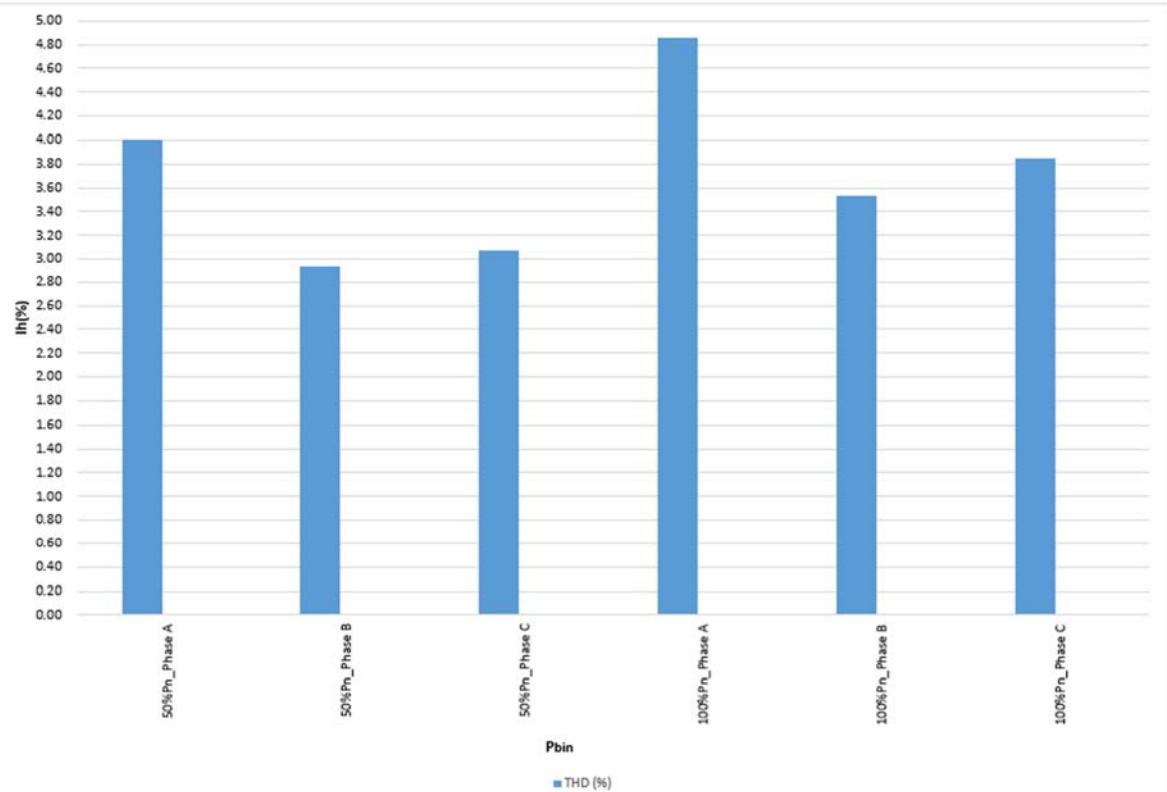
ENA Engineering Recommendation G99 Issue 1 Amendment 3 2018

Phase C						
Harmonic	At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	(%)	Measured Value MV in Amps	(%)	1 Phase	3 Phase
2	1.039	2.495	1.245	2.987	8%	8%
3	0.407	0.976	0.627	1.504	21.6%	Not stated
4	0.506	1.215	0.689	1.654	4%	4%
5	0.193	0.463	0.118	0.283	10.7%	10.7%
6	0.042	0.101	0.047	0.114	2.67%	2.67%
7	0.170	0.408	0.224	0.538	7.2%	7.2%
8	0.135	0.324	0.160	0.383	2%	2%
9	0.027	0.065	0.020	0.047	3.8%	Not stated
10	0.070	0.167	0.051	0.122	1.6%	1.6%
11	0.187	0.450	0.200	0.480	3.1%	3.1%
12	0.004	0.010	0.006	0.014	1.33%	1.33%
13	0.107	0.258	0.125	0.300	2%	2%
THD	--	3.074	--	3.845	23%	13%
PWHD	--		--		23%	22%

Current Harmonics



THD



4.2.2 Voltage fluctuations and Flicker

These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (Inverter connected) or Annex A2 A.2.3.3 (Synchronous).

The measurements of voltage fluctuations have been measured according to the standard, at 100 % of the nominal power value of the inverter.

The test impedance is recorded in the table below:

Test Impedance	R	0.4	Ω	X	0.25	Ω
Standard Impedance	R	0.4	Ω	X	0.25	Ω
Maximum Impedance	R	0.4	Ω	X	0.25	Ω

Starting operation and Stopping operation			
Pbin (%)	100%		
Phase A			
	Limit	Starting measured values	Stopping measured values
PST	≤ 1	0.238	0.245
PLT	≤ 0.65	0.242	0.242
dc	≤ 3.30%	0.161%	0.160%
d(t)	≤ 3.30%	0	0
dmax	4%	0.515%	0.373%
Phase B			
	Limit	Starting measured values	Stopping measured values
PST	≤ 1	0.228	0.217
PLT	≤ 0.65	0.223	0.223
dc	≤ 3.30%	0.130%	0.162%
d(t)	≤ 3.30%	0	0.
dmax	4%	0.413%	0.507%
Phase C			
	Limit	Starting measured values	Stopping measured values
PST	≤ 1	0.278	0.261
PLT	≤ 0.65	0.270	0.270
dc	≤ 3.30%	0.143%	0.121%
d(t)	≤ 3.30%	0	0
dmax	4%	0.439%	0.361%

As it can be seen in the next screenshots, this test has two steps:

1. Starting operation
2. Stopping operation

All values are the most unfavorable of the two steps.

Starting operation and Stopping operation

100% Pn

Phase A



Phase B



ENA Engineering Recommendation G99 Issue 1 Amendment 3 2018

Phase C



Running operation 2 hours				
Pbin (%)	100%			
	Limit	Phase A	Phase B	Phase C
		Measured values	Measured values	Measured values
PST	≤ 1	0.249	0.261	0.231
PLT	≤ 0.65	0.241	0.248	0.219
dc	$\leq 3.30\%$	0.032%	0.045%	0.047%
d(t)	$\leq 3.30\%$	0	0	0
dmax	4%	0.449%	0.347%	0.412%

As it can be seen in the next screenshots is running operation. The values took of Pst and Plt are the most unfavorable of the twelve steps.

Running operation

100% Pn

Phase A

Flicker Mode
Flicker

Range Over
U1 U2 U3 U4 U5 U6 U7
I1 I2 I3 I4 I5 I6 I7

SCL ☒ Line Filter ☒
AVG ☒ Freq Filter ☒

CH: 1 2 3
4 5 6 7

Count 12/12 Complete
Interval 00:00s/10:00s

Element 1
Volt Range 600 V/50Hz
Un (U1) 399.991V
Freq (U1) 49.994Hz
Dmin 0.30%

Element1 Judgement Pass
Total Judgement Pass
(Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30%	1.00	0.65 N:12
No. 1	0.000 Pass	0.000 Pass	0.0 Pass	0.247 Pass	
2	0.000 Pass	0.000 Pass	0.0 Pass	0.236 Pass	
3	0.000 Pass	0.000 Pass	0.0 Pass	0.237 Pass	
4	-0.032 Pass	-0.306 Pass	0.0 Pass	0.235 Pass	
5	0.000 Pass	0.000 Pass	0.0 Pass	0.219 Pass	
6	0.000 Pass	0.000 Pass	0.0 Pass	0.246 Pass	
7	0.000 Pass	0.000 Pass	0.0 Pass	0.244 Pass	
8	0.000 Pass	0.000 Pass	0.0 Pass	0.239 Pass	
9	0.000 Pass	0.000 Pass	0.0 Pass	0.249 Pass	
10	0.040 Pass	-0.449 Pass	0.0 Pass	0.241 Pass	
11	0.000 Pass	0.000 Pass	0.0 Pass	0.249 Pass	
12	0.000 Pass	0.000 Pass	0.0 Pass	0.244 Pass	
Result	Pass	Pass	Pass	Pass	0.241 Pass

ΣA(3V3A)
U1 600 V
I1 500 mV
Sync Src: U1
Integral: Reset
U2 600 V
I2 500 mV
Sync Src: U1
Integral: Reset
U3 600 V
I3 500 mV
Sync Src: U1
Integral: Reset

Element 4
U4 600 V
I4 1 V
Sync Src: U1
Integral: Reset

Element 5
U5 15 V
I5 10 mA
Sync Src: U1
Integral: Reset

Element 6
U6 60 V
I6 50 mA
Sync Src: U1
Integral: Reset

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Phase B



Phase C



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4.2.3 DC Injection

The tests should be carried out on a single Generating Unit. Tests are to be carried out at three defined power levels $\pm 5\%$.

The inverter has an isolation transformer, so this test item is not applicable

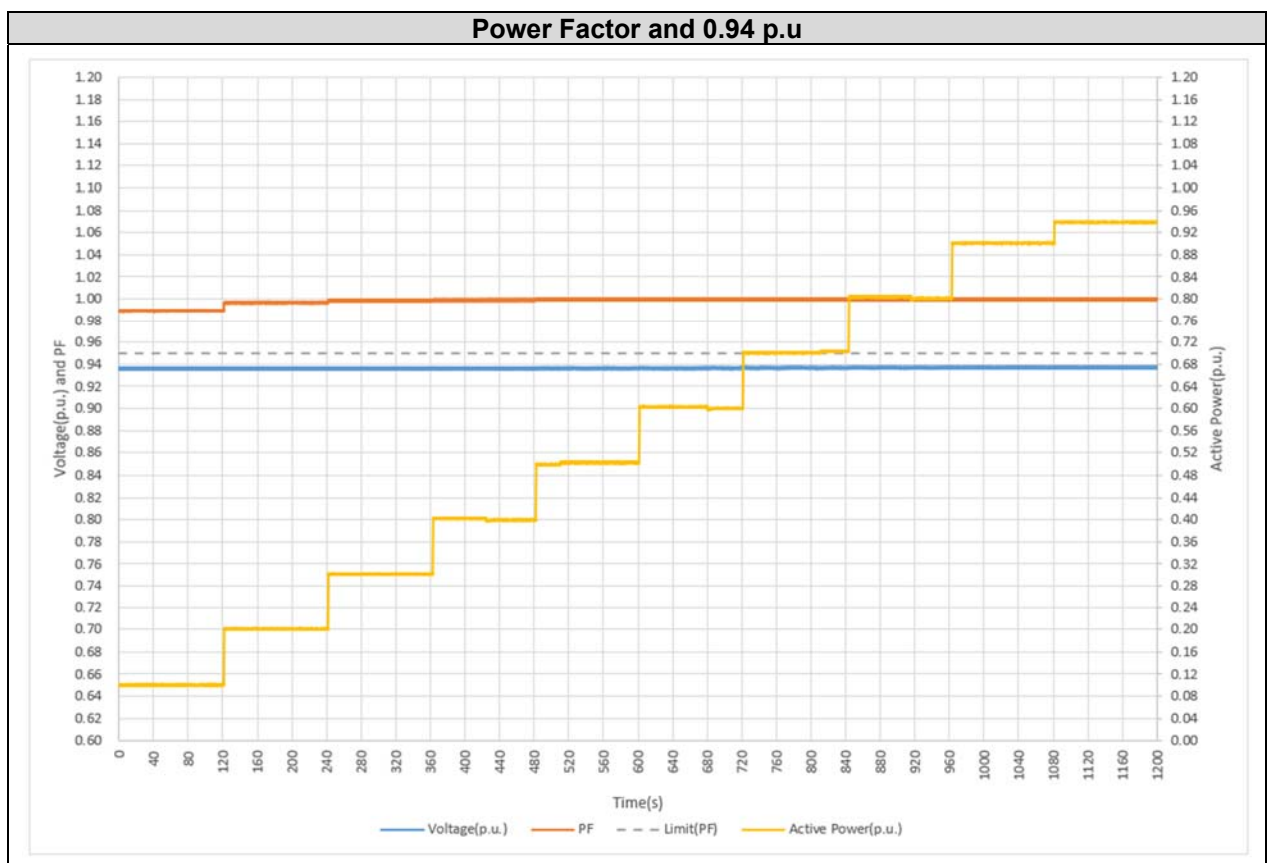
4.2.4 Power Factor

The tests should be carried out on a single Power Generating Module. Tests are to be carried out at three voltage levels and at Registered Capacity. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.

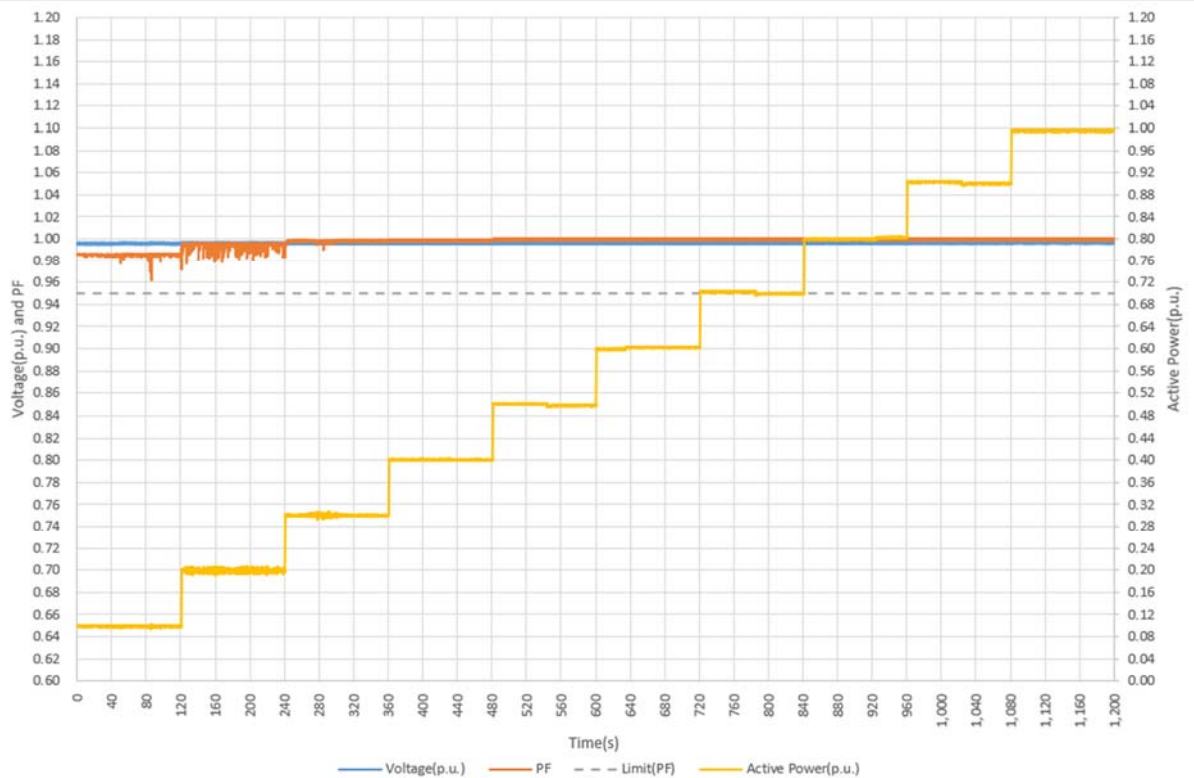
The following table shows the test results at required voltage levels:

Volatge	0.94 p.u (376 V)	1.0 p.u (400 V)	1.1 p.u (440 V)
Measured value	1.00	1.00	1.00
Power Factor Limit	>0.95	>0.95	>0.95

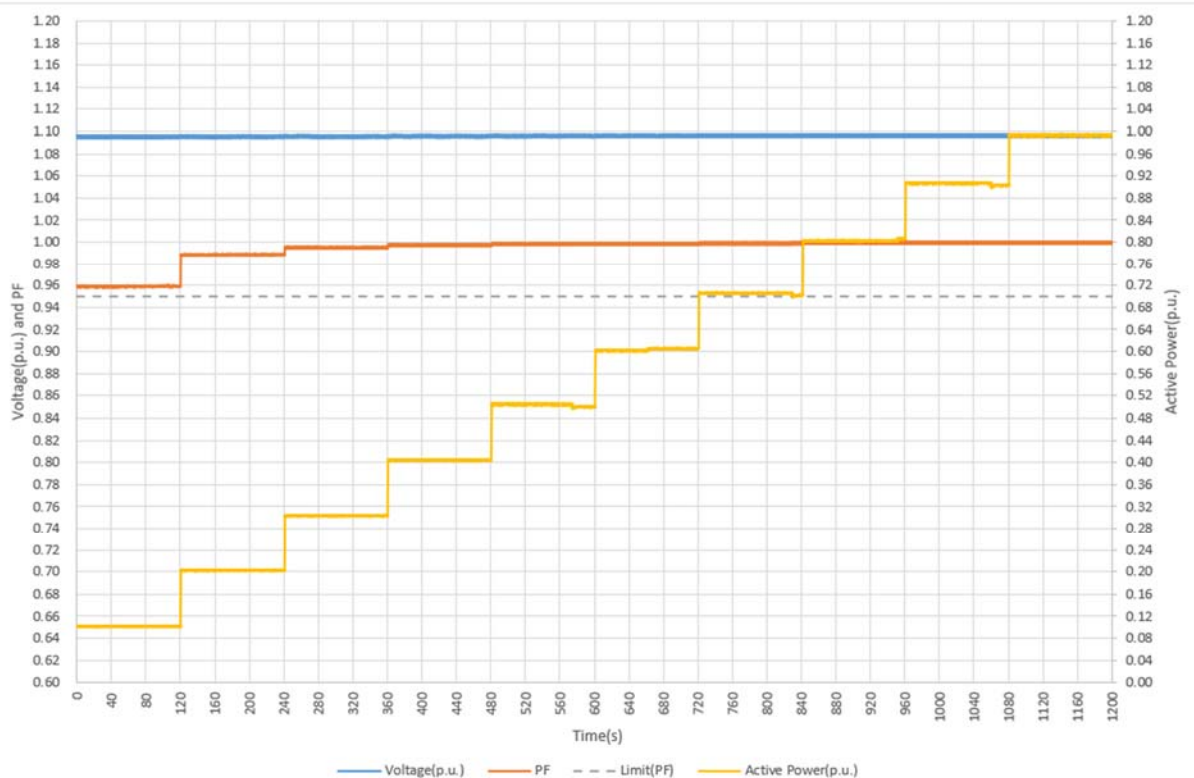
Test results are graphically shown below.



Power Factor and 1.0 p.u



Power Factor and 1.0 p.u



4.3 PROTECTION

4.3.1 Frequency tests

These tests should be carried out in accordance with Annex A.7.1.2.3.

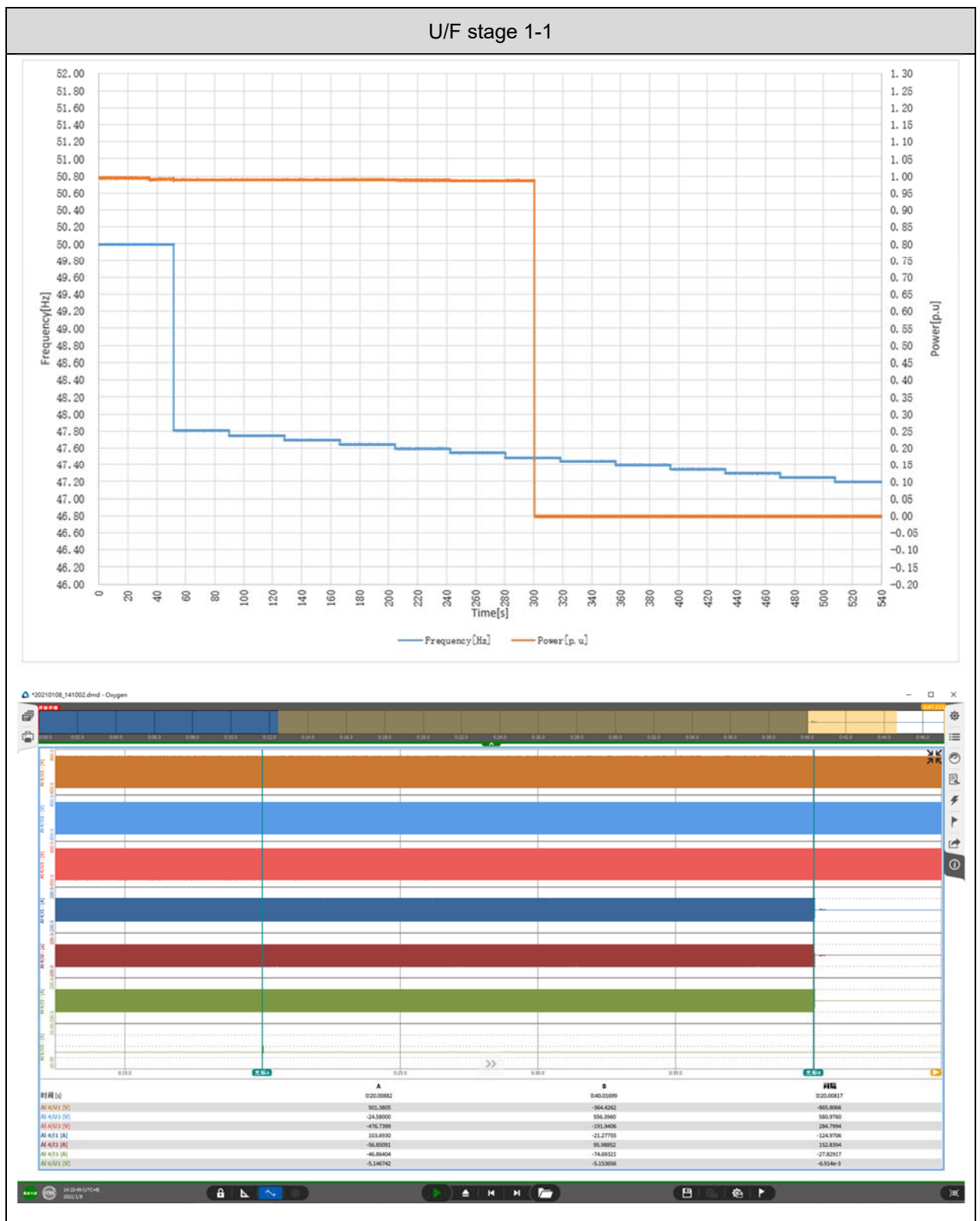
To establish a trip frequency, the test frequency should be applied in a slow ramp rate of less than 0.1 Hz/s, or if this is not possible in steps of 0.05 Hz for a duration that is longer than the trip time delay.

To establish the trip time, the test frequency should be applied starting from 0.3 Hz below or above the recorded trip frequency and should be changed to 0.3 Hz above or below the recorded trip frequency in a single step. For each trip setting five tests shall be carried out.

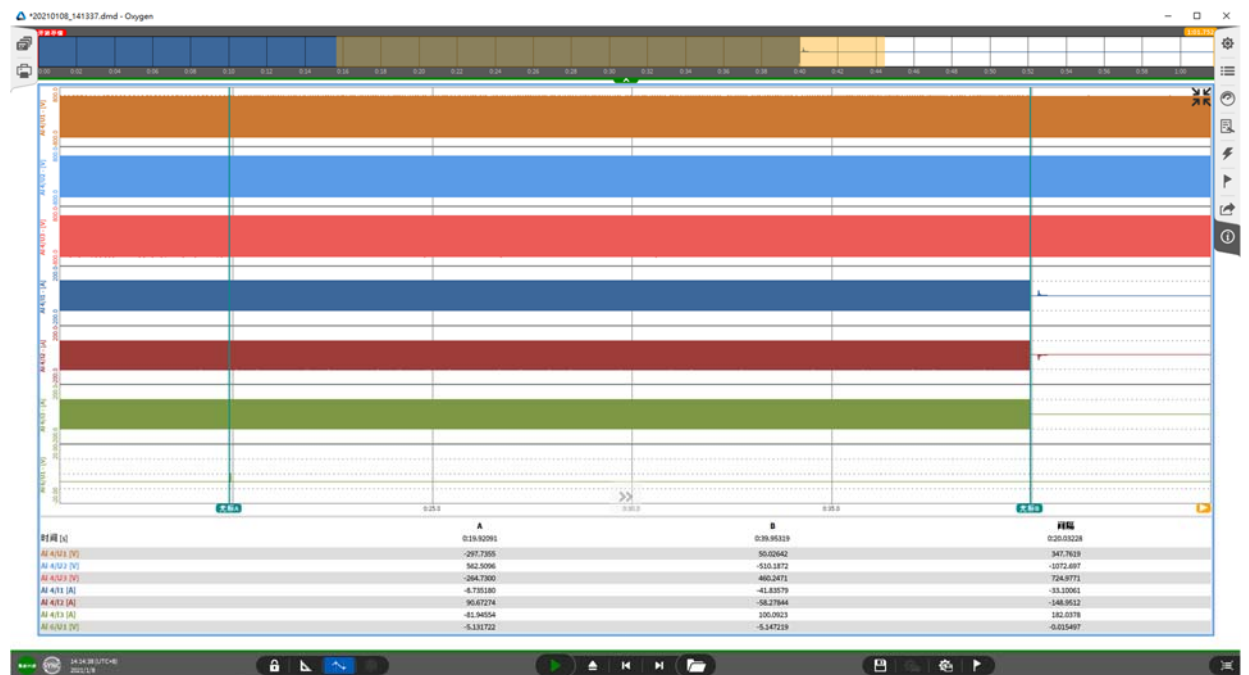
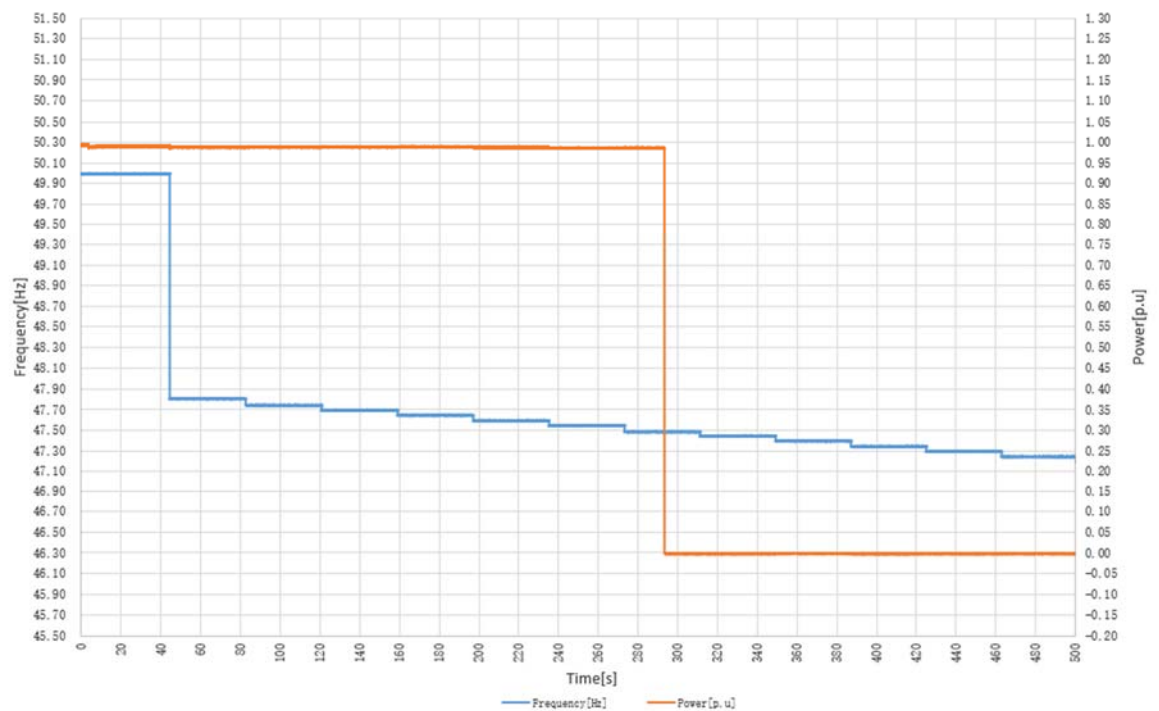
Following tables show the test results:

Function	Setting		Trip test (5 times)		"No trip tests"	
	Frequency	Time delay	Frequency (Hz)	Time delay (s)	Frequency /time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.5	20.008	47.7 Hz / 25 s	Pass
			47.5	20.032		
			47.5	20.014		
			47.5	20.008		
			47.5	20.015		
U/F stage 2	47 Hz	0.5 s	47.0	0.525	47.2 Hz / 19.98 s	Pass
			47.0	0.525		
			47.0	0.526		
			47.0	0.525		
			47.0	0.526		
					46.8 Hz / 0.48 s	Pass
O/F stage 1	52 Hz	0.5 s	52.0	0.501	51.8 Hz / 89.98 s	Pass
			52.0	0.501		
			52.0	0.503		
			52.0	0.501		
			52.0	0.501		
					52.2 Hz / 0.48 s	Pass

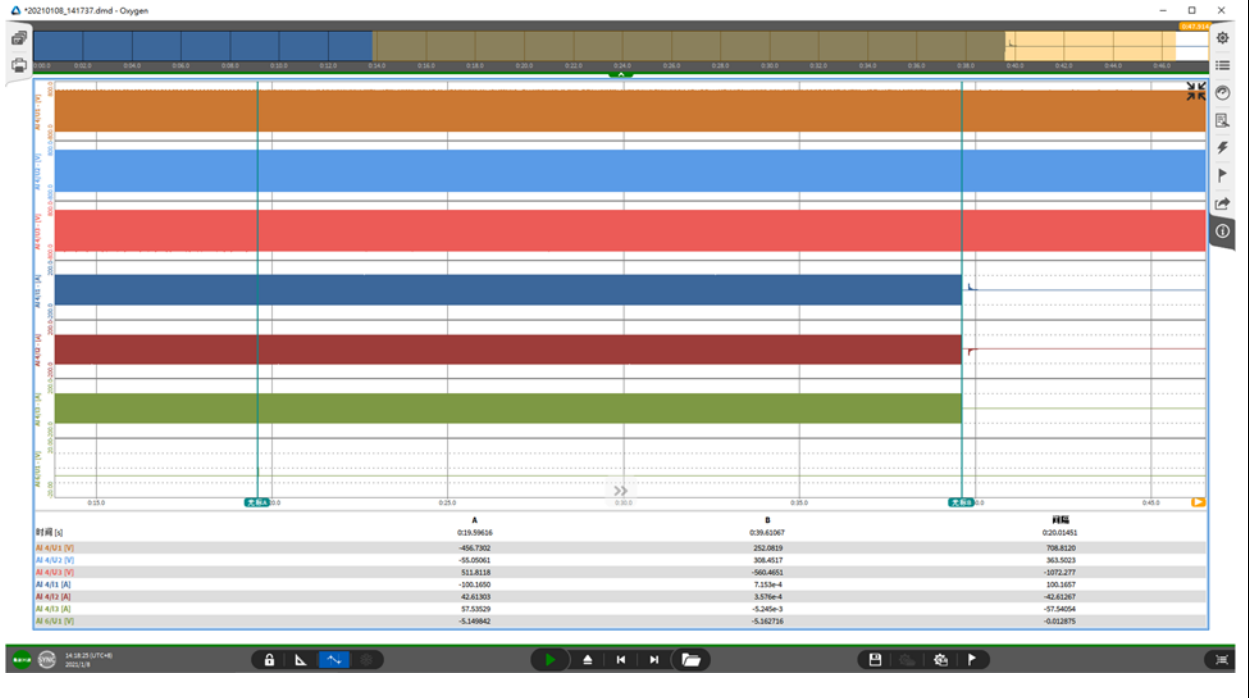
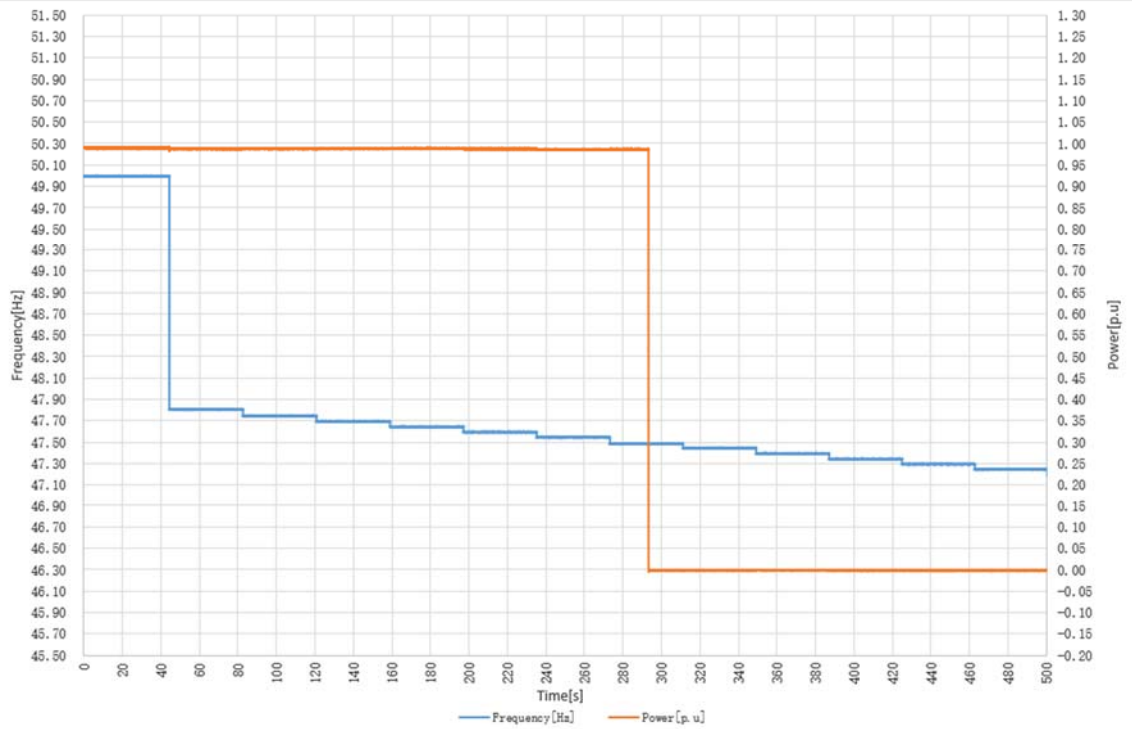
Test results are graphically shown below.



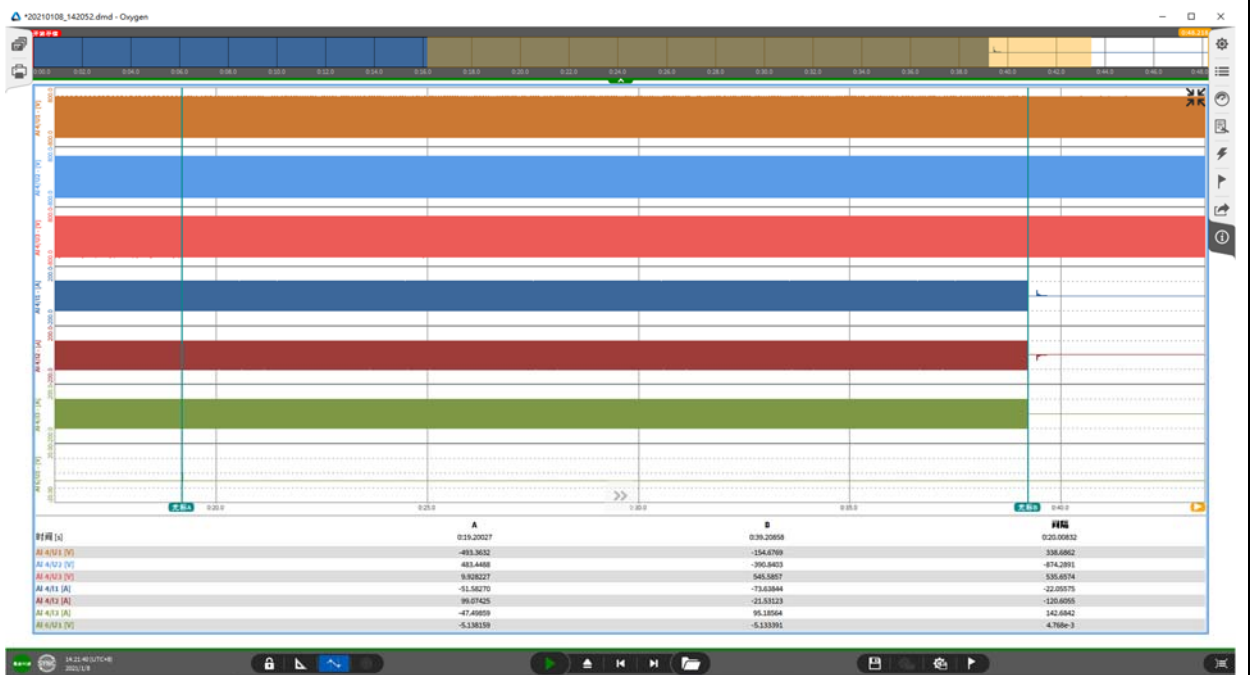
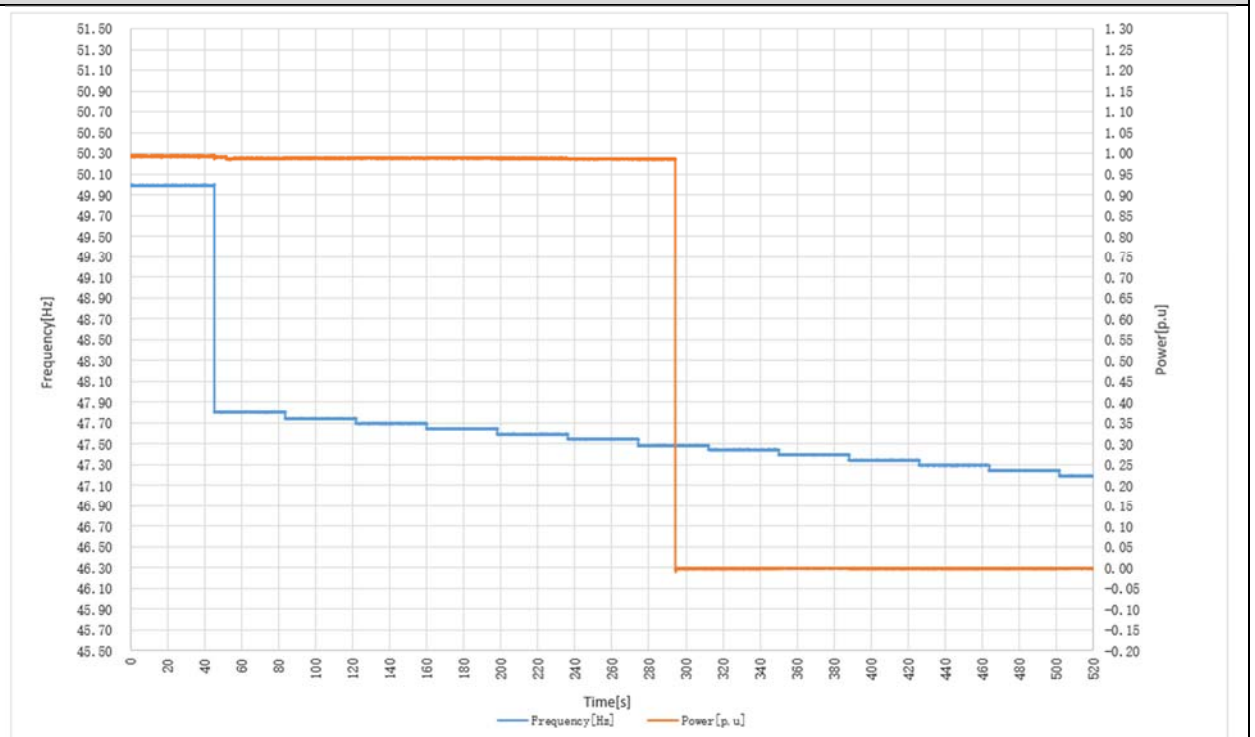
U/F stage 1-2

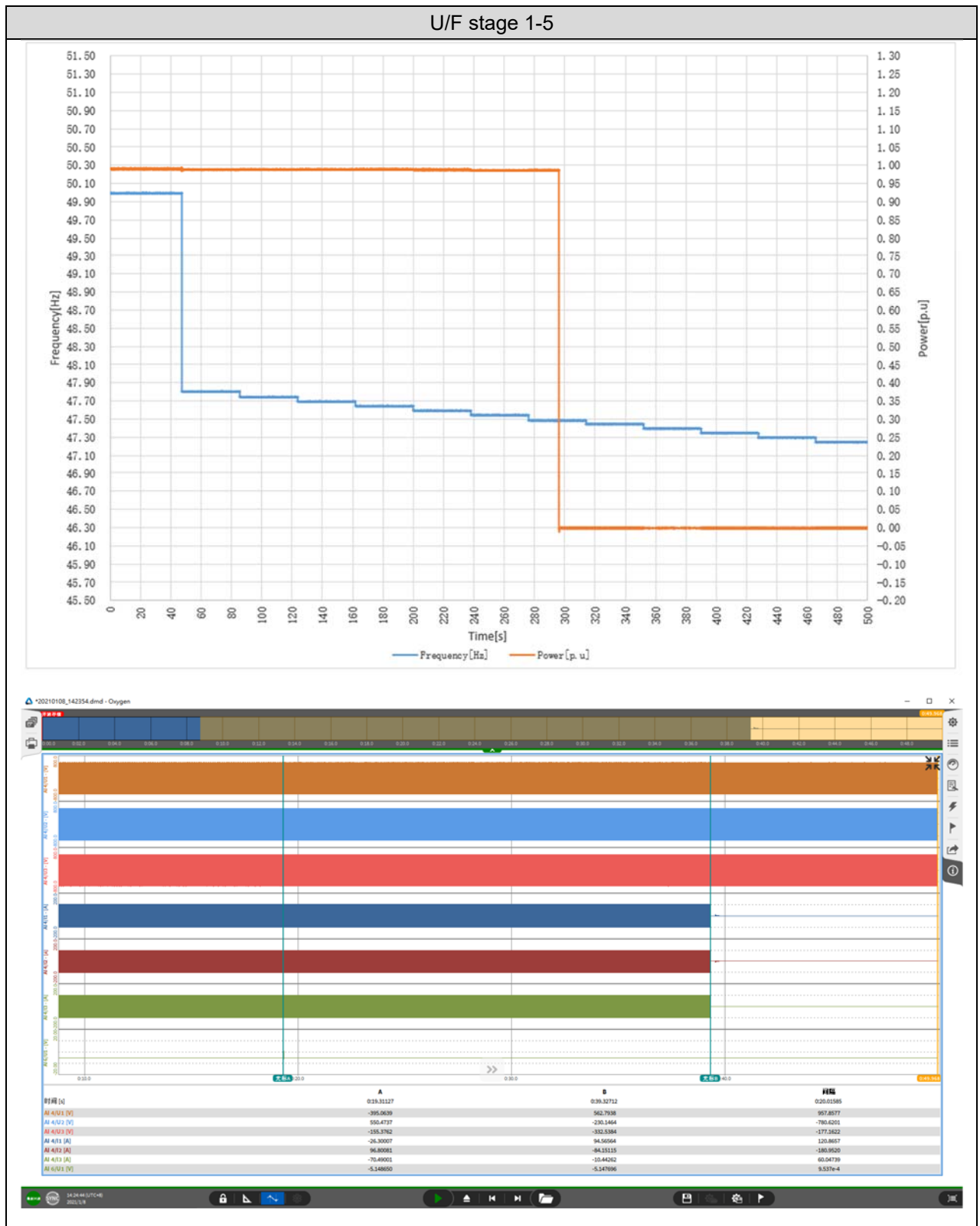


U/F stage 1-3

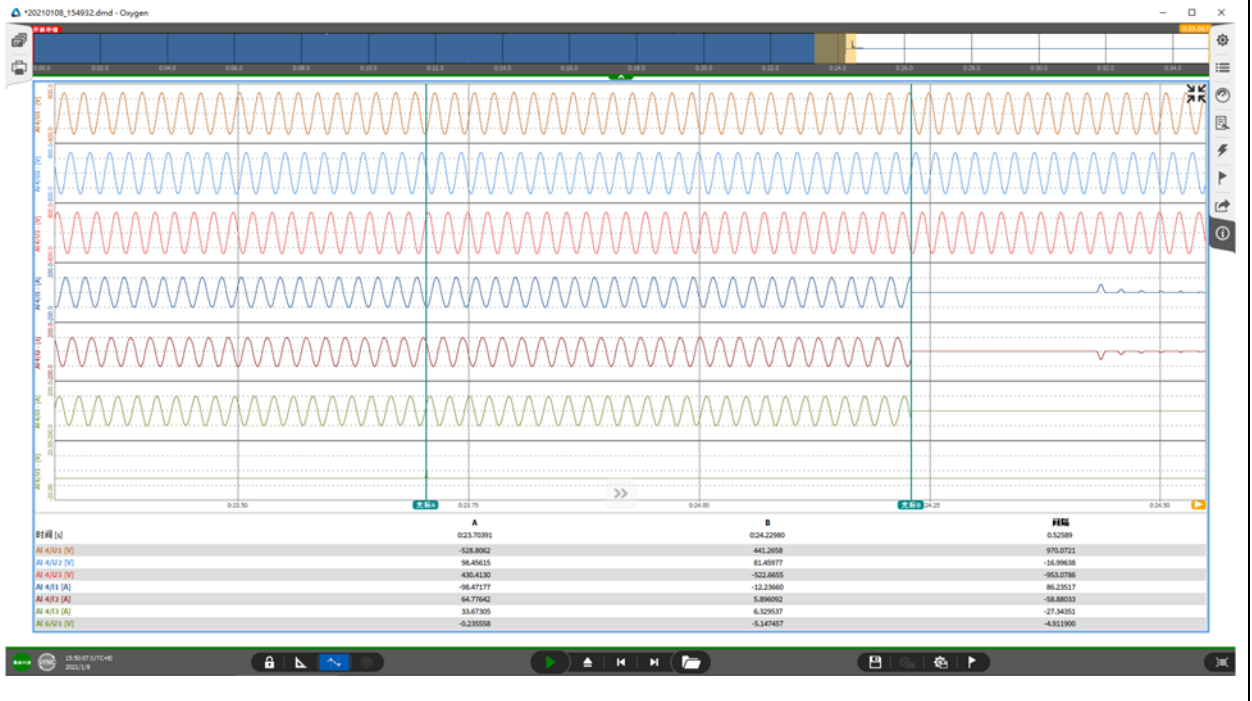
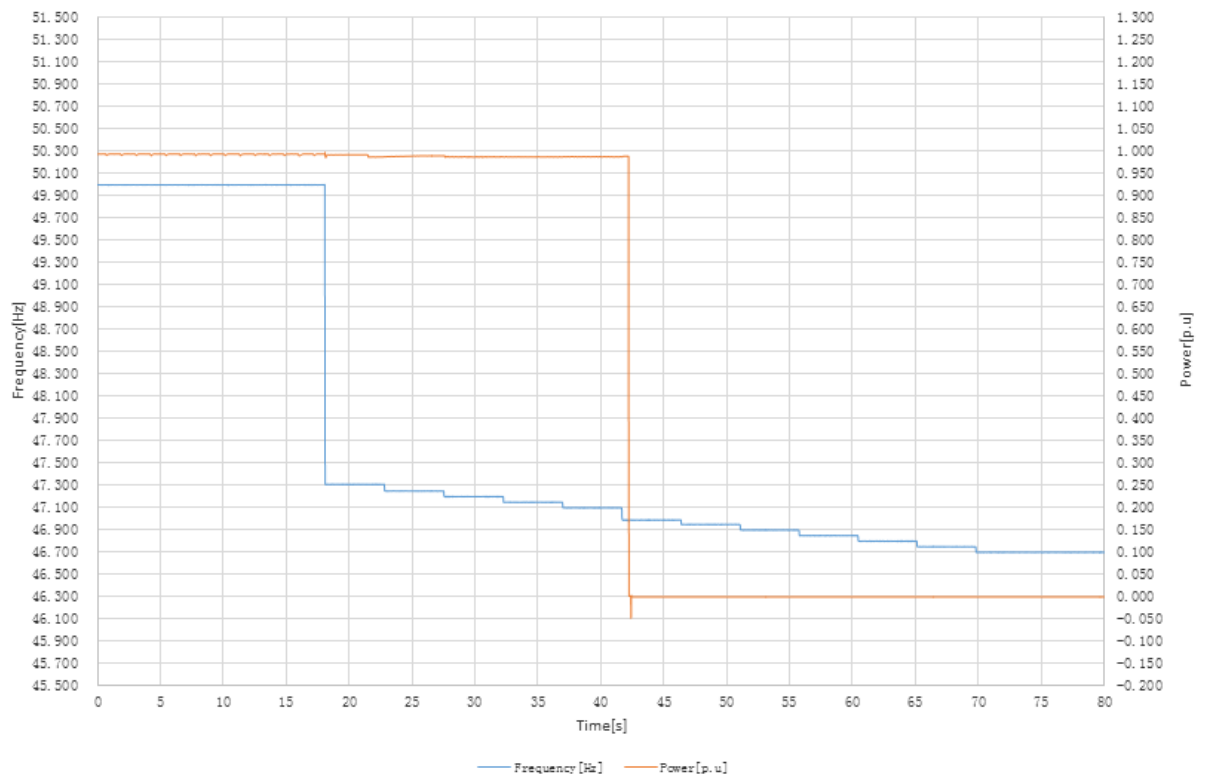


U/F stage 1-4

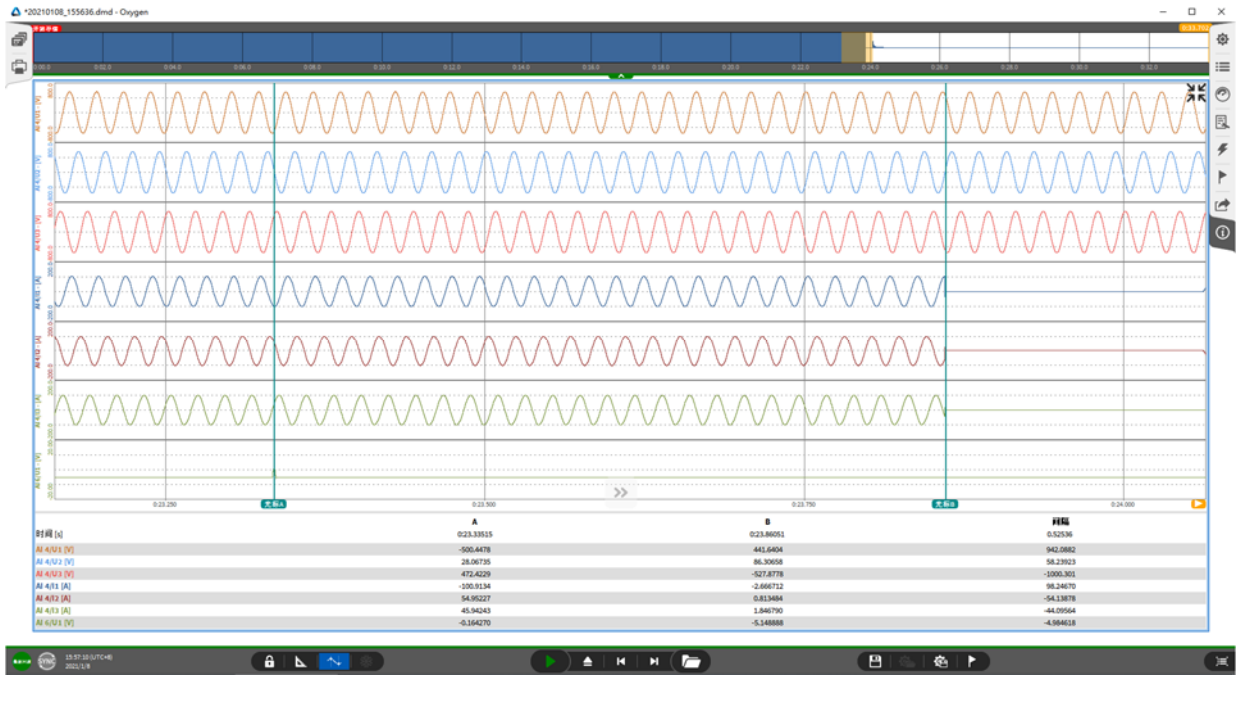
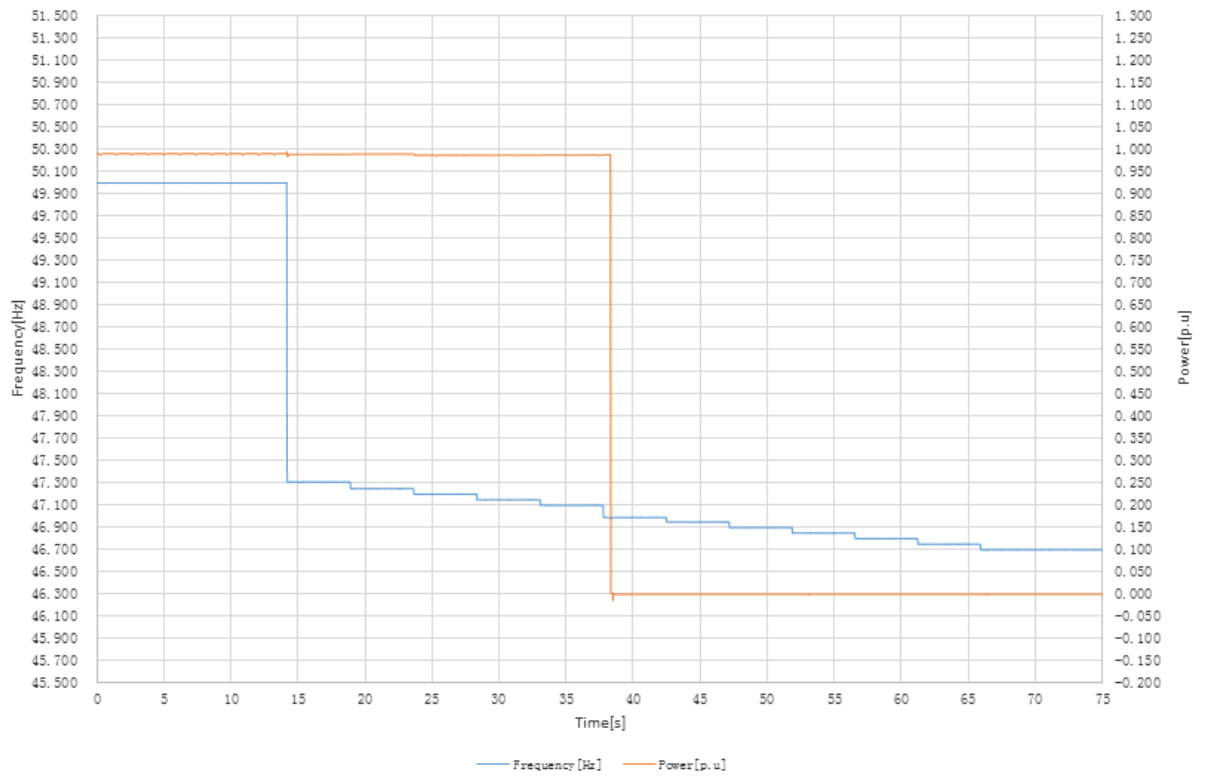




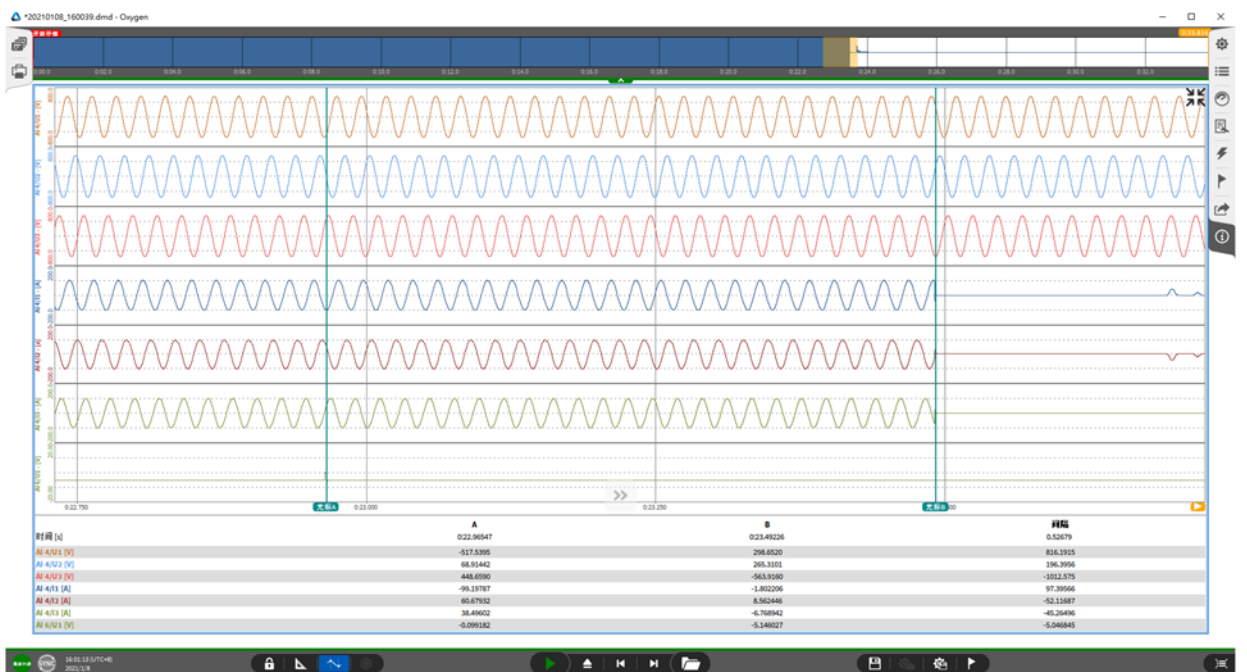
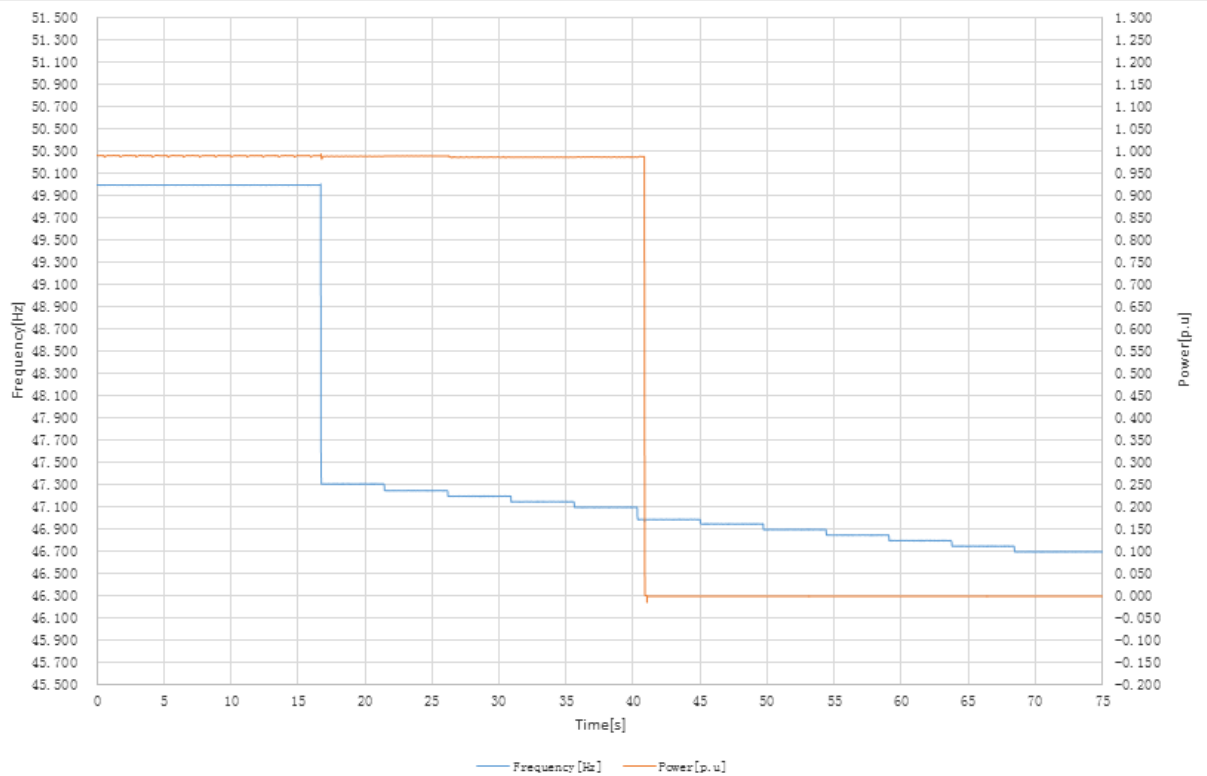
U/F stage 2-1



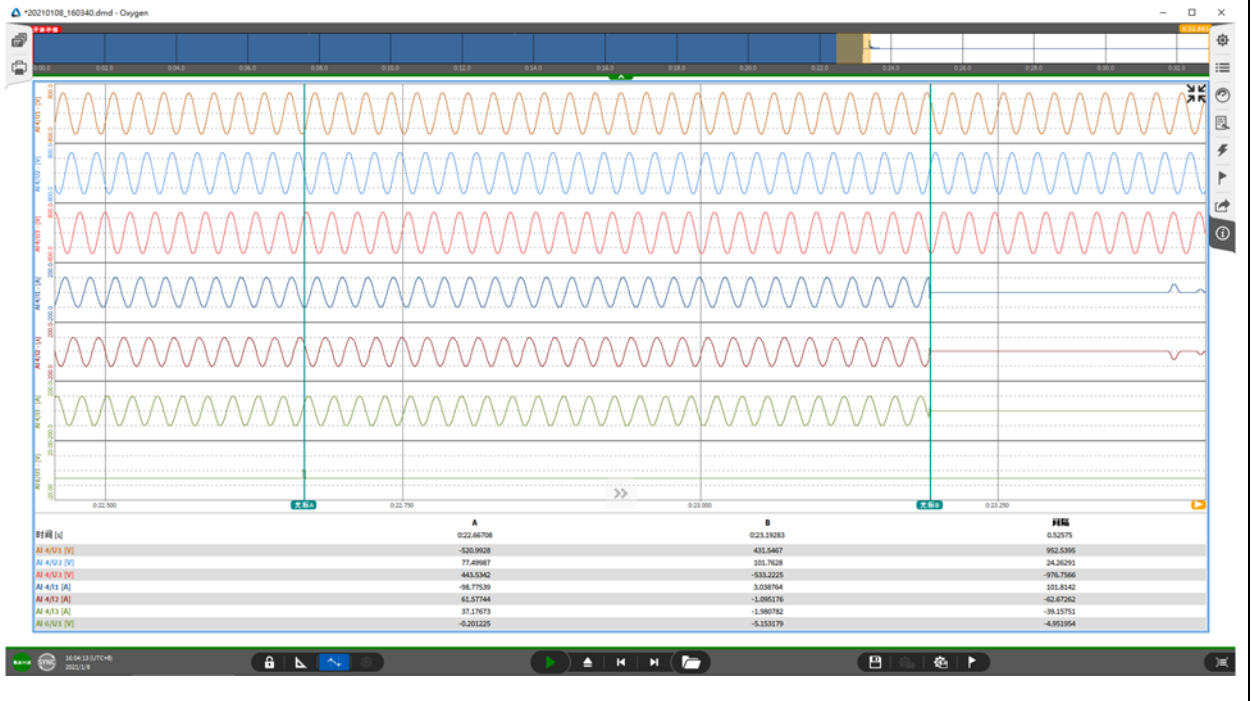
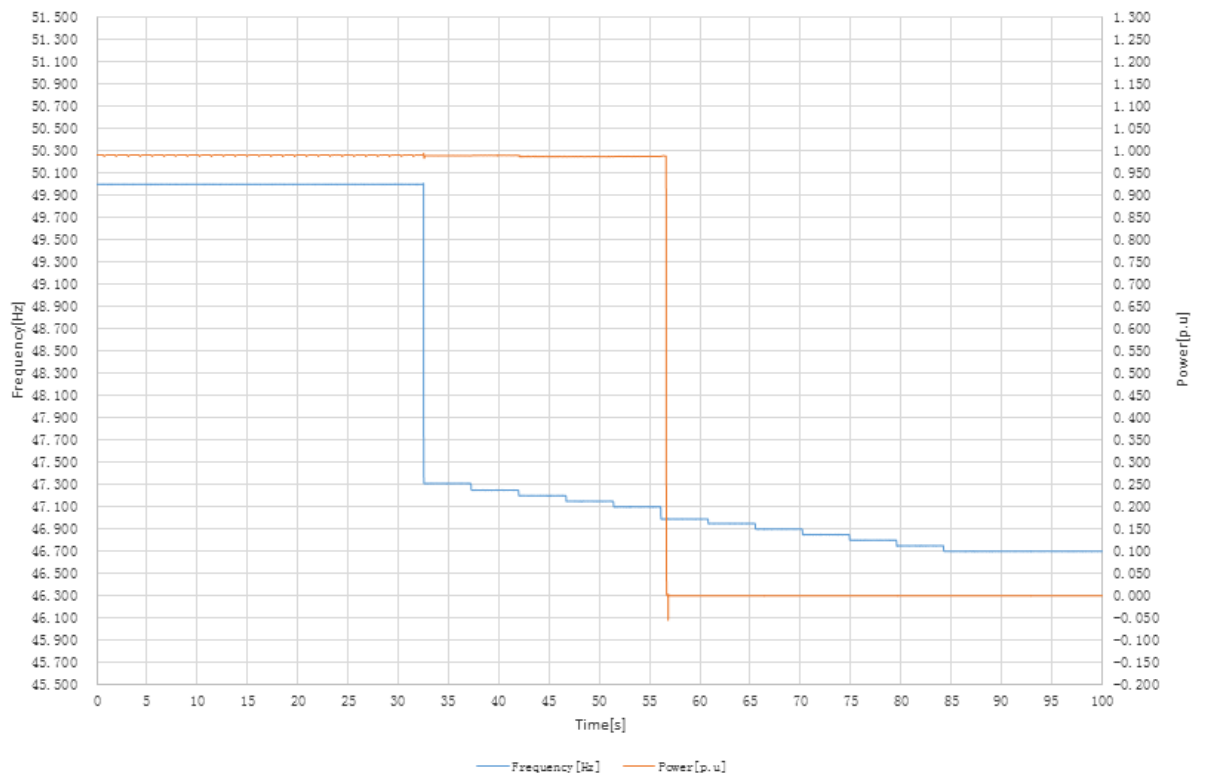
U/F stage 2-2



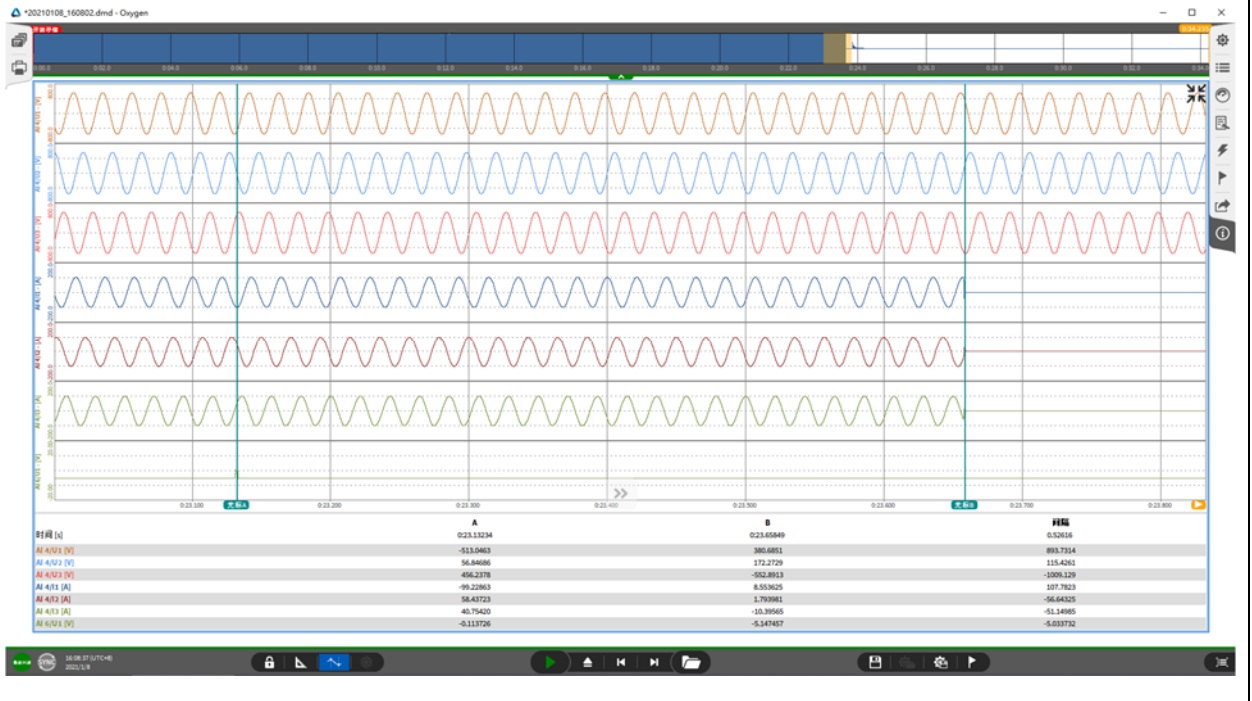
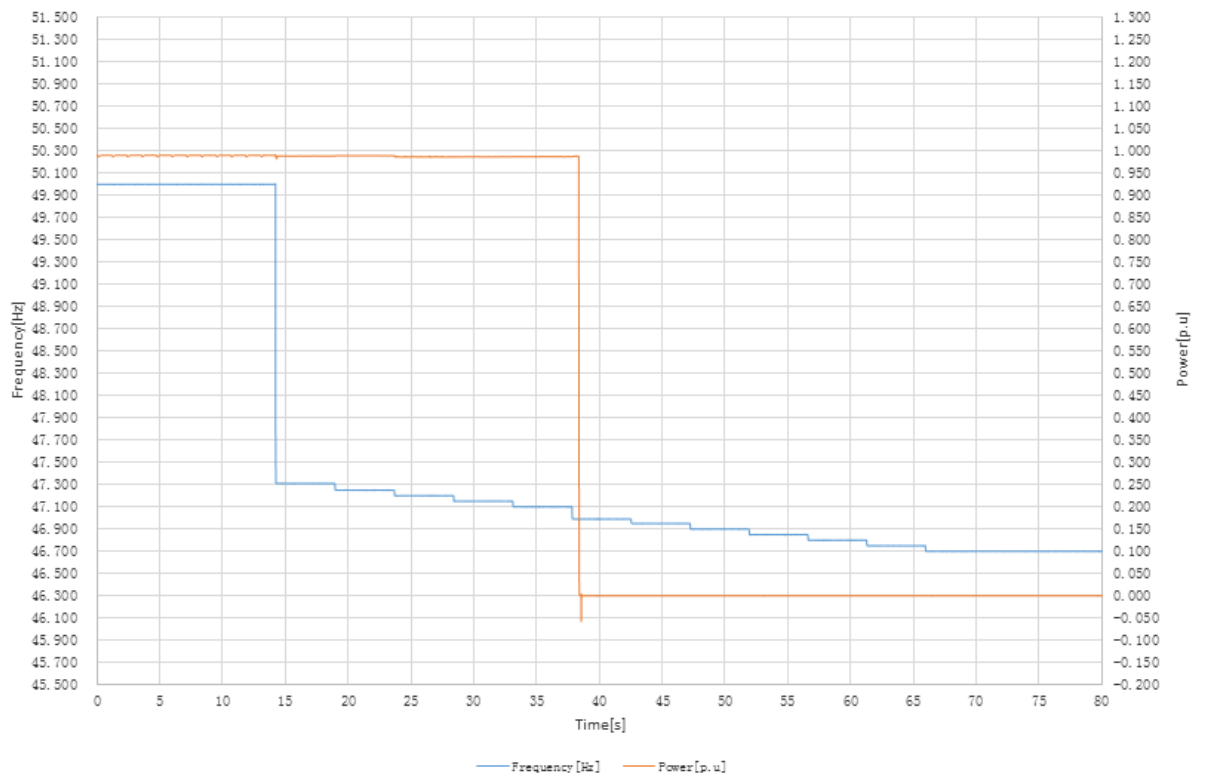
U/F stage 2-3



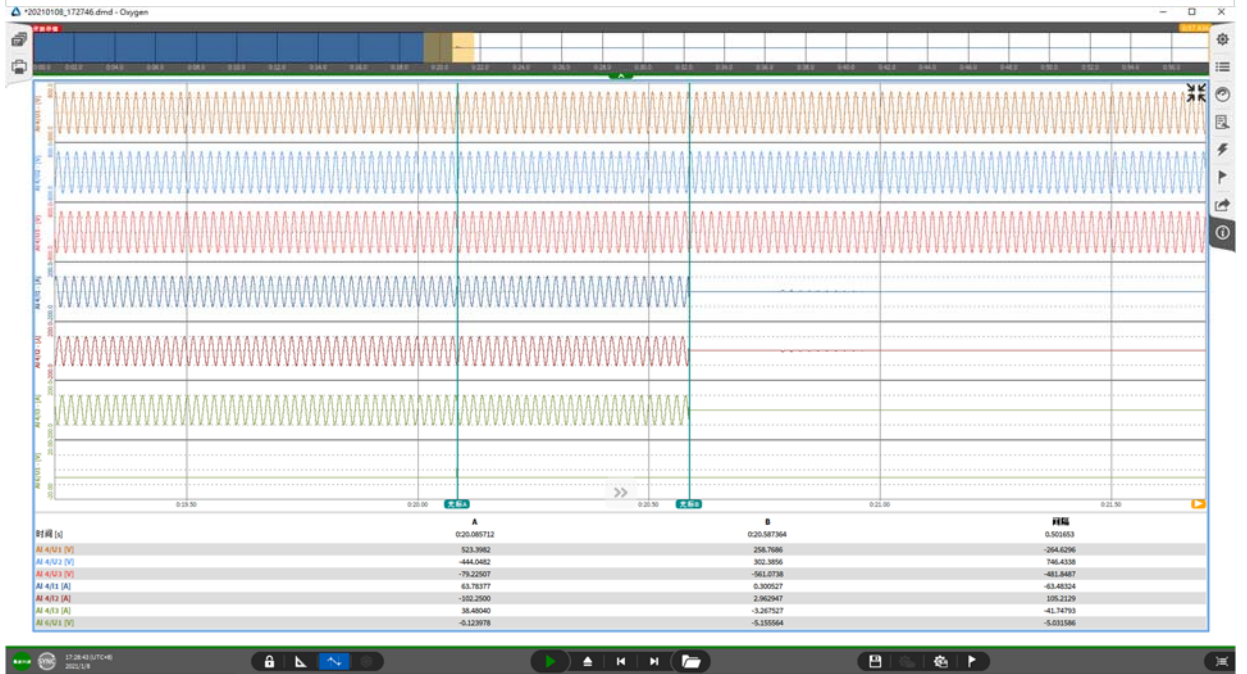
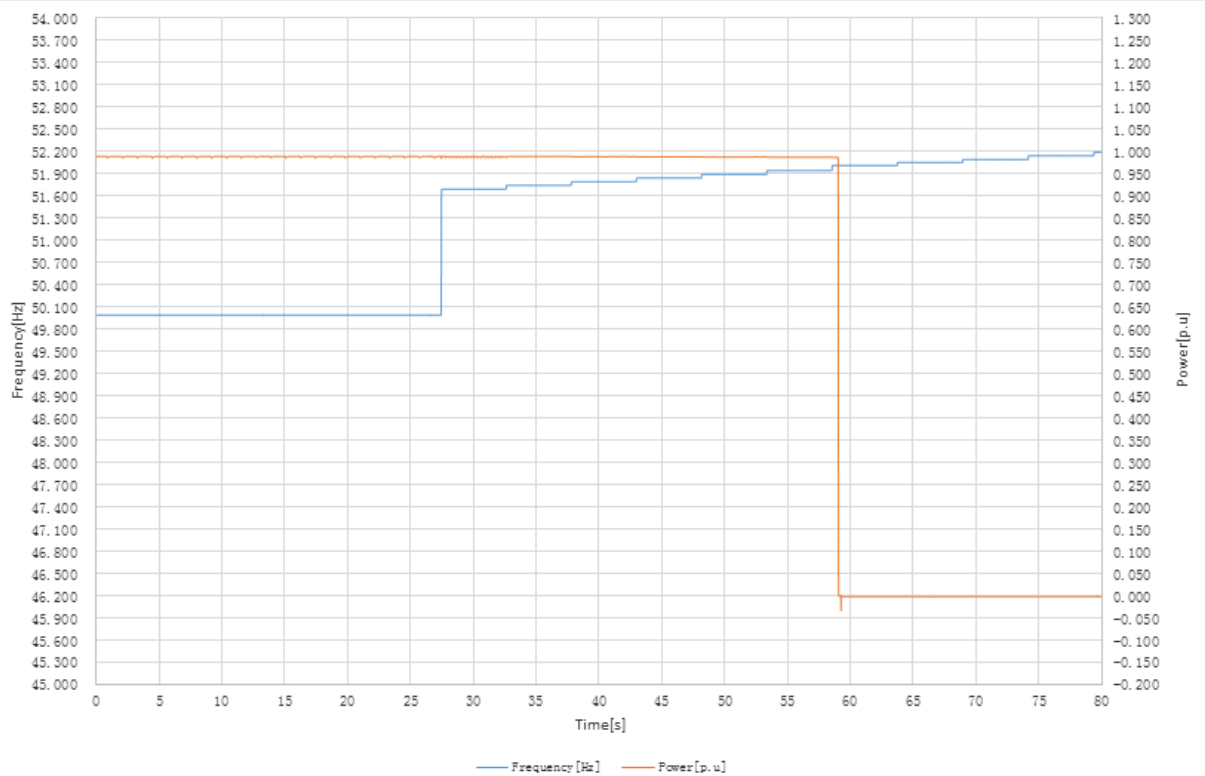
U/F stage 2-4



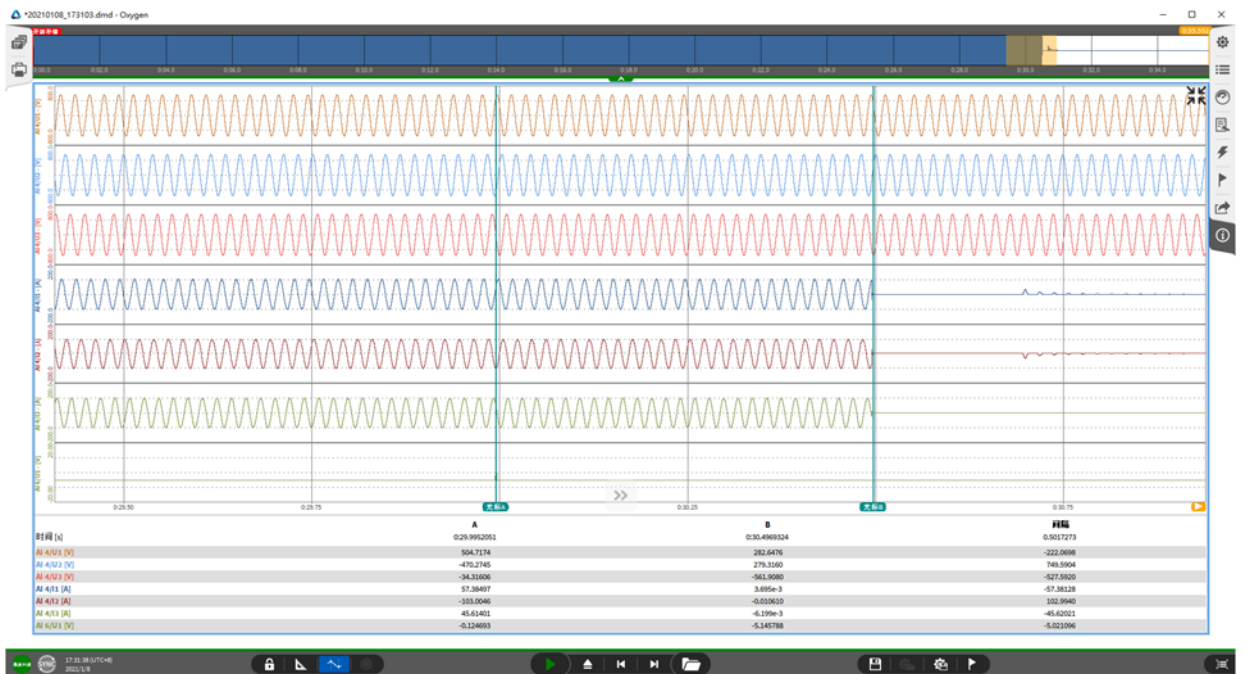
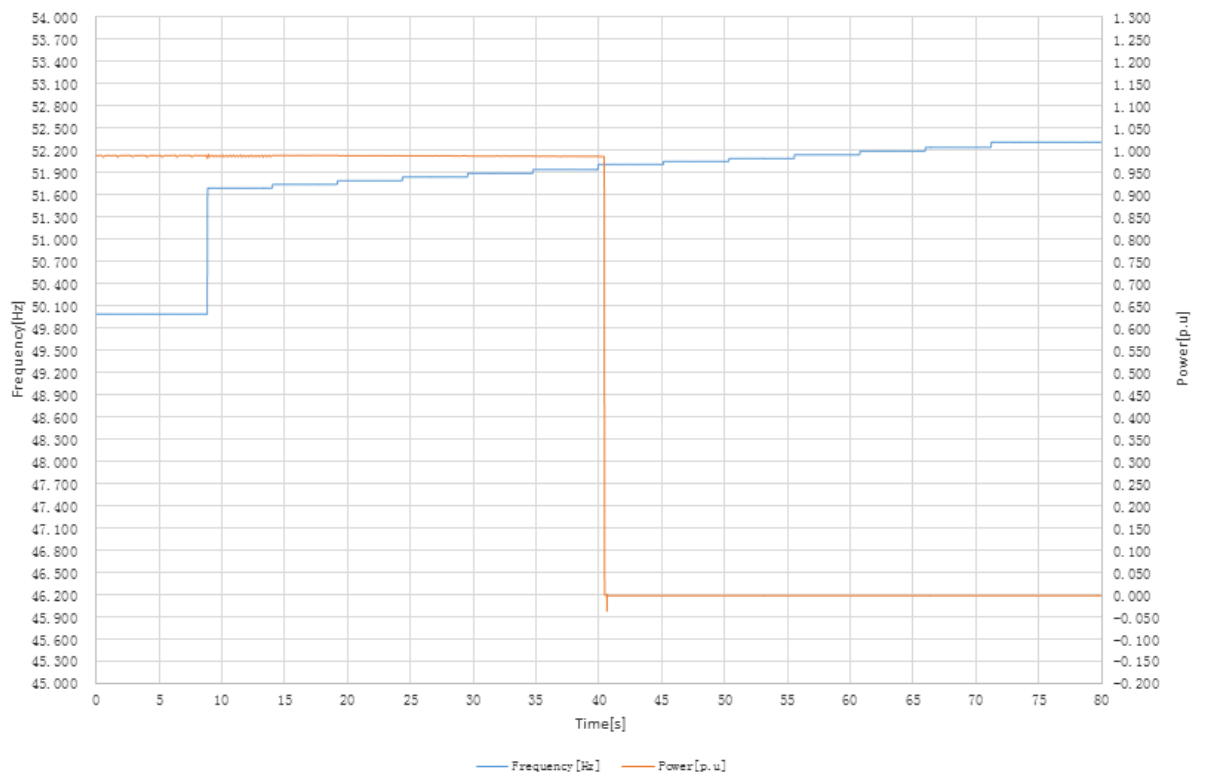
U/F stage 2-5

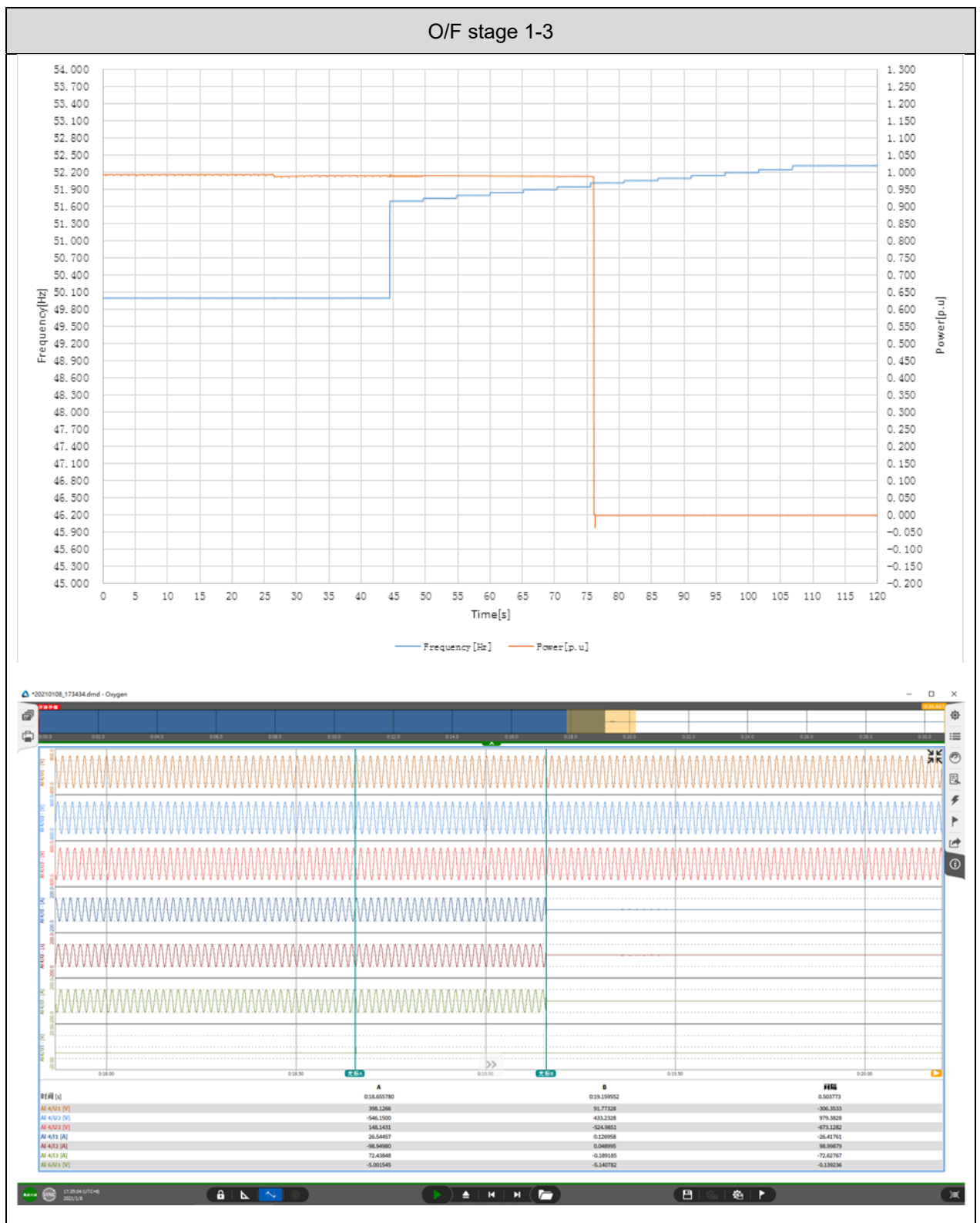


O/F stage 1-1

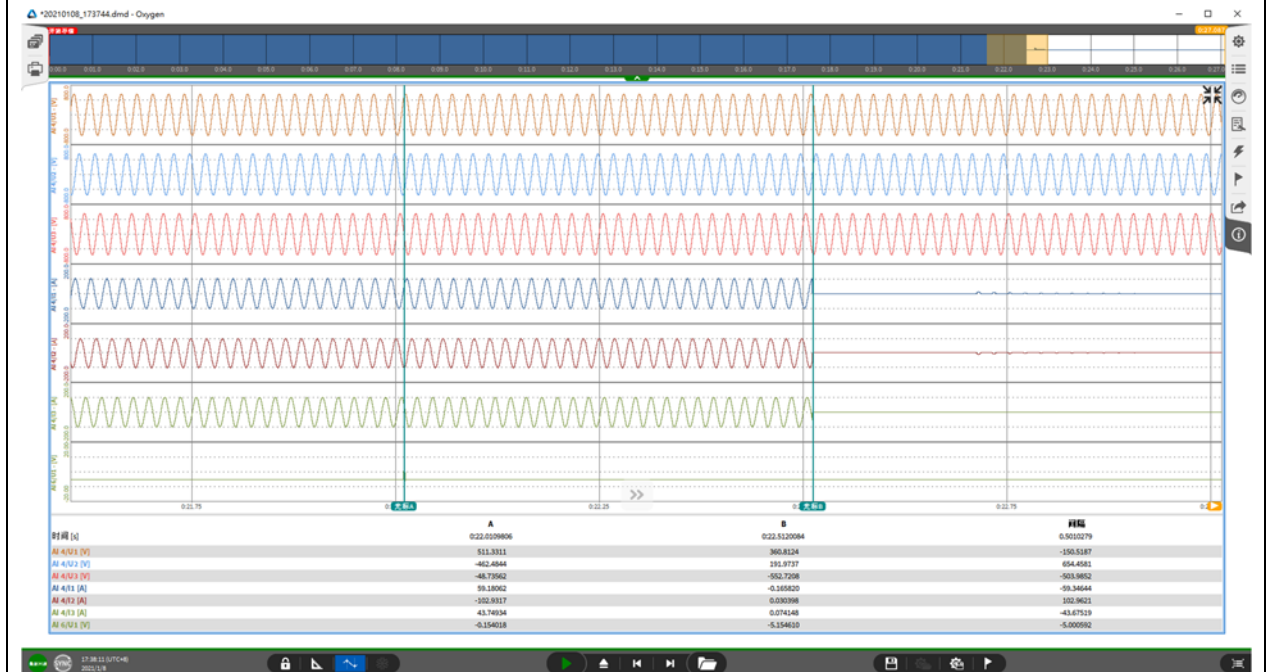
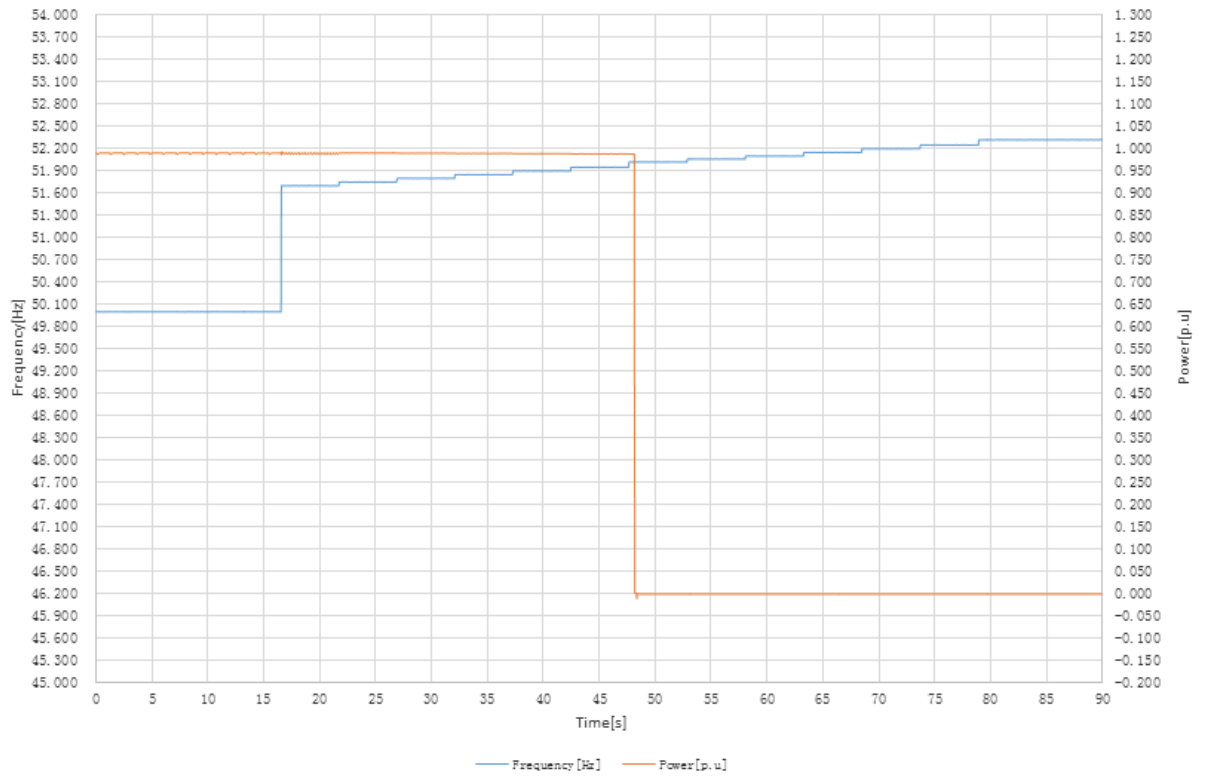


O/F stage 1-2

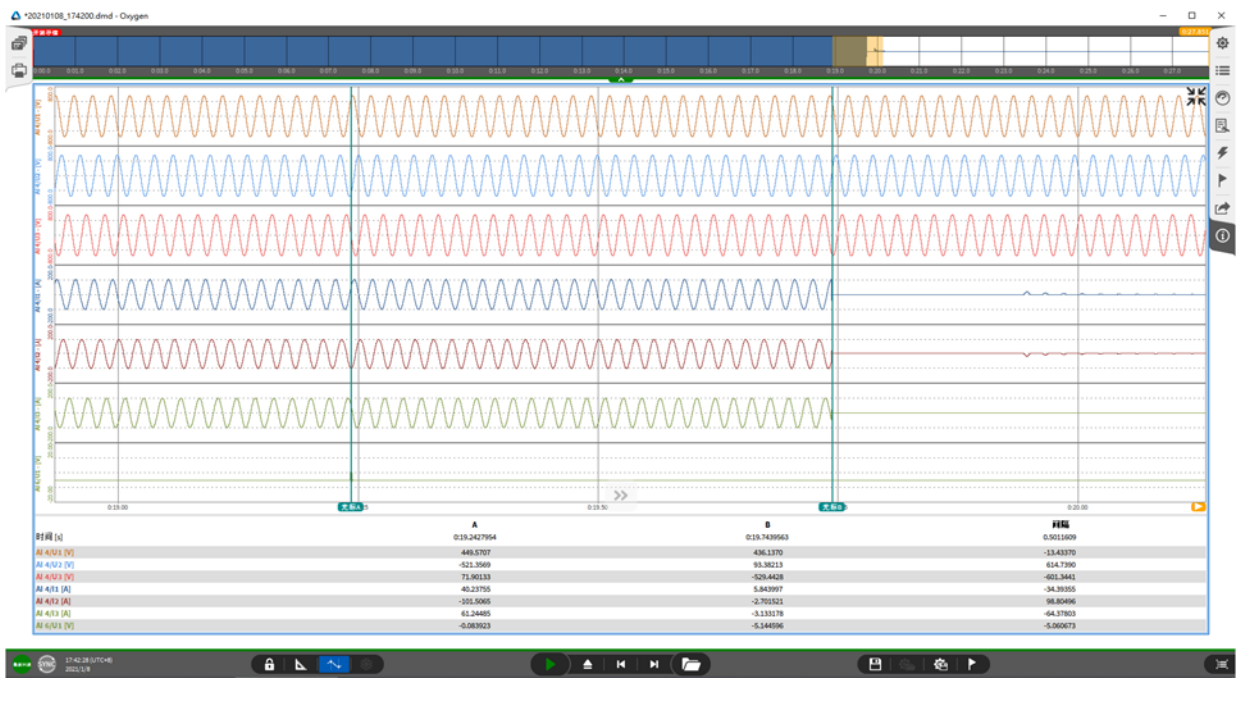
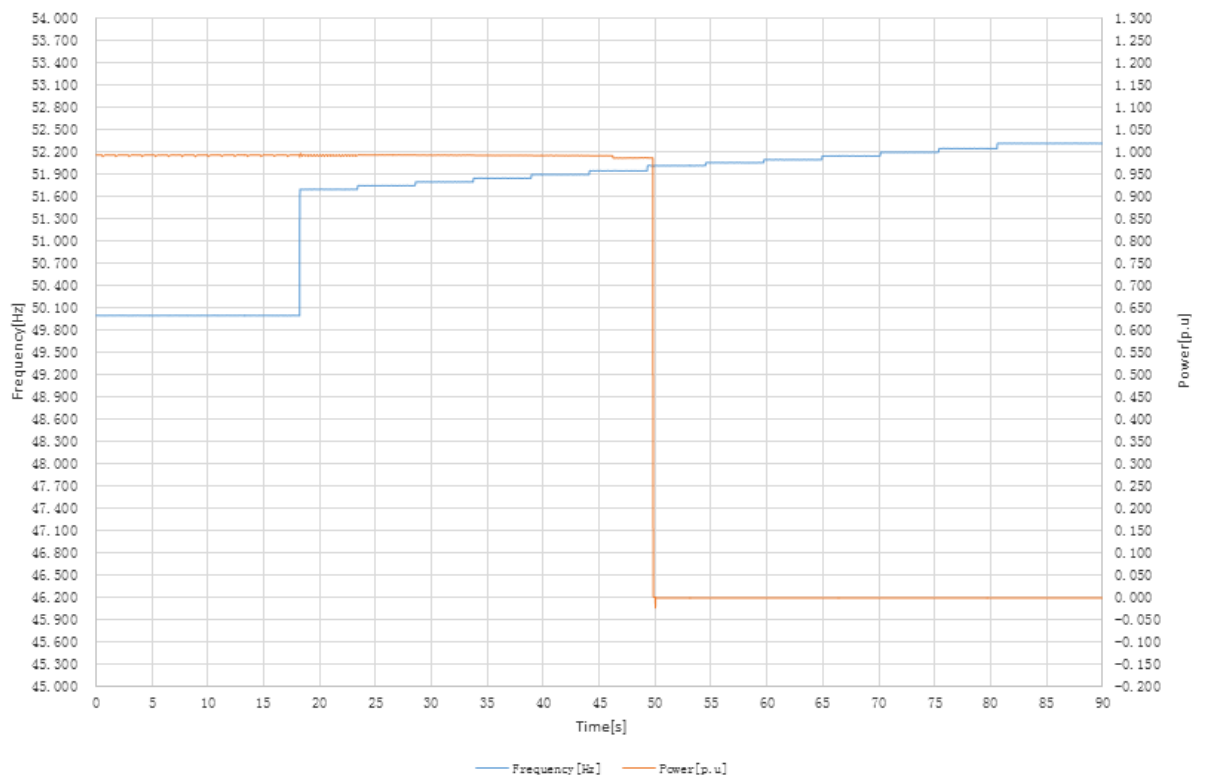




O/F stage 1-4

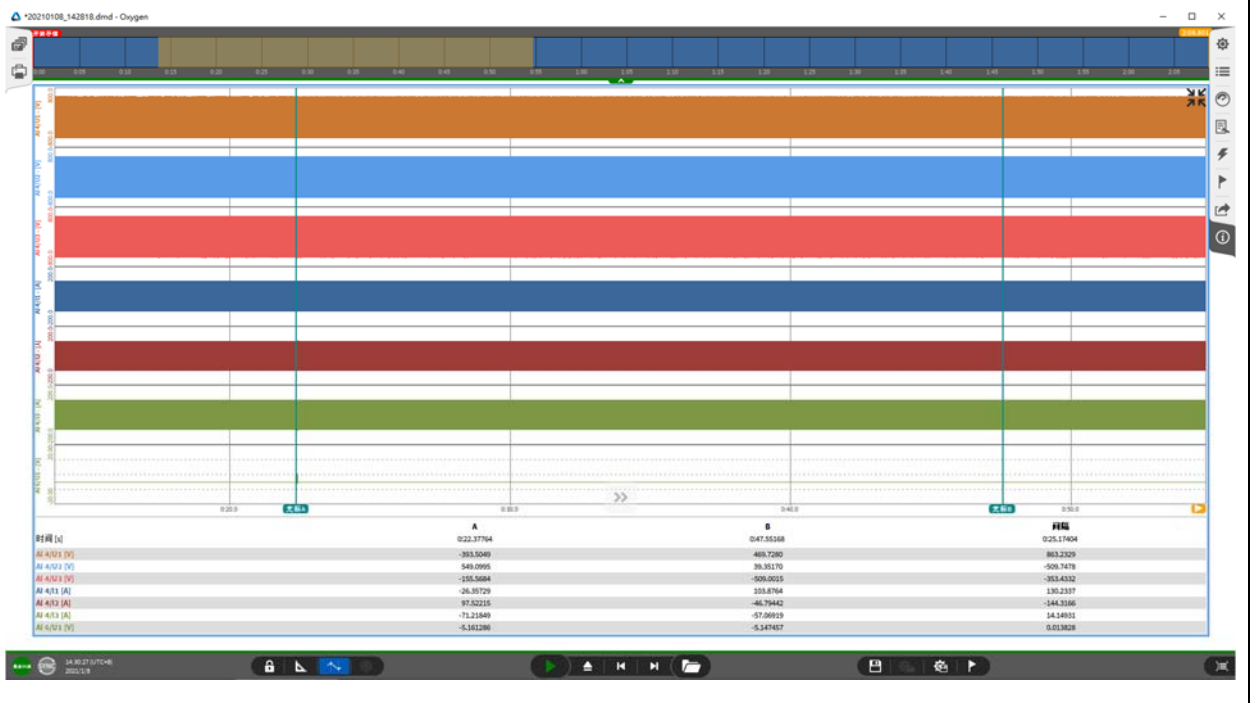
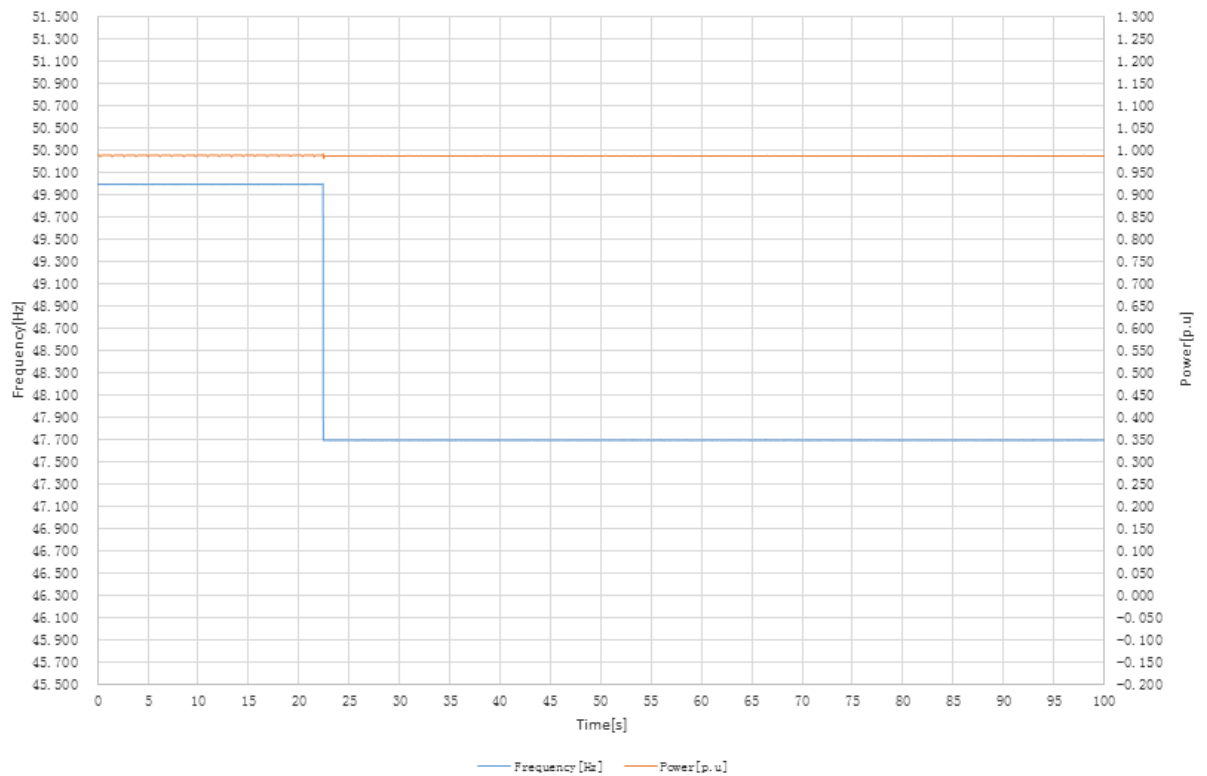


O/F stage 1-5

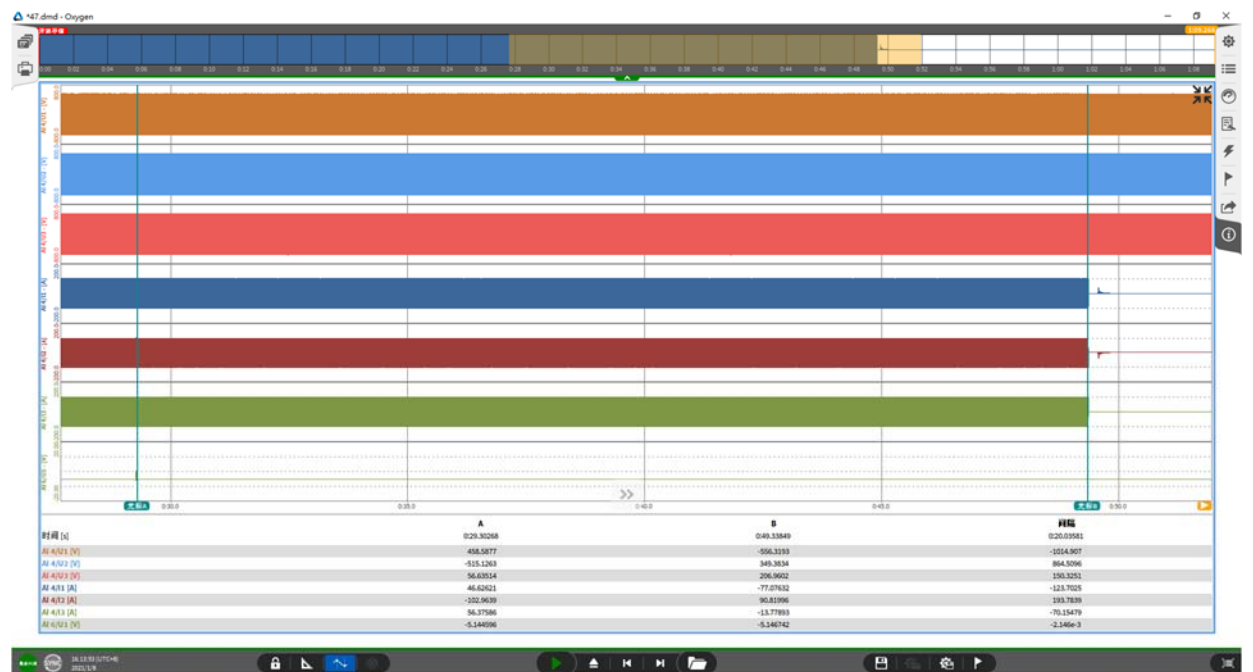
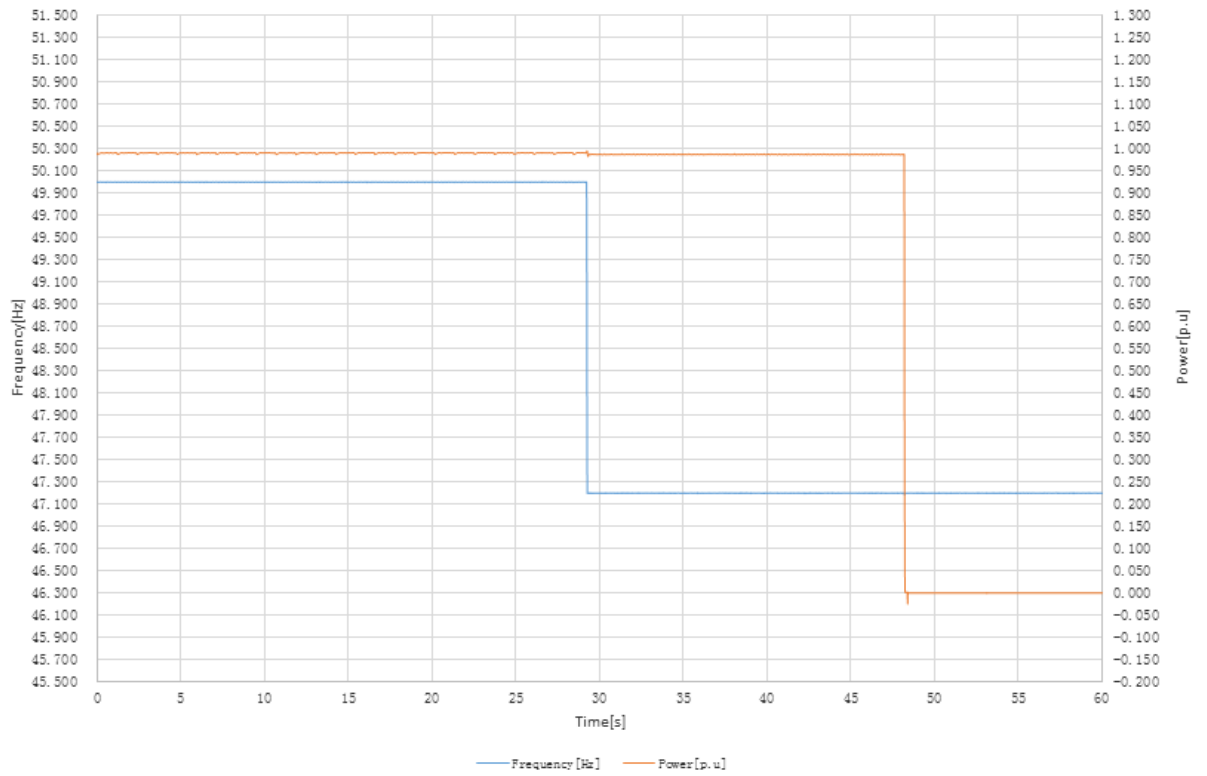


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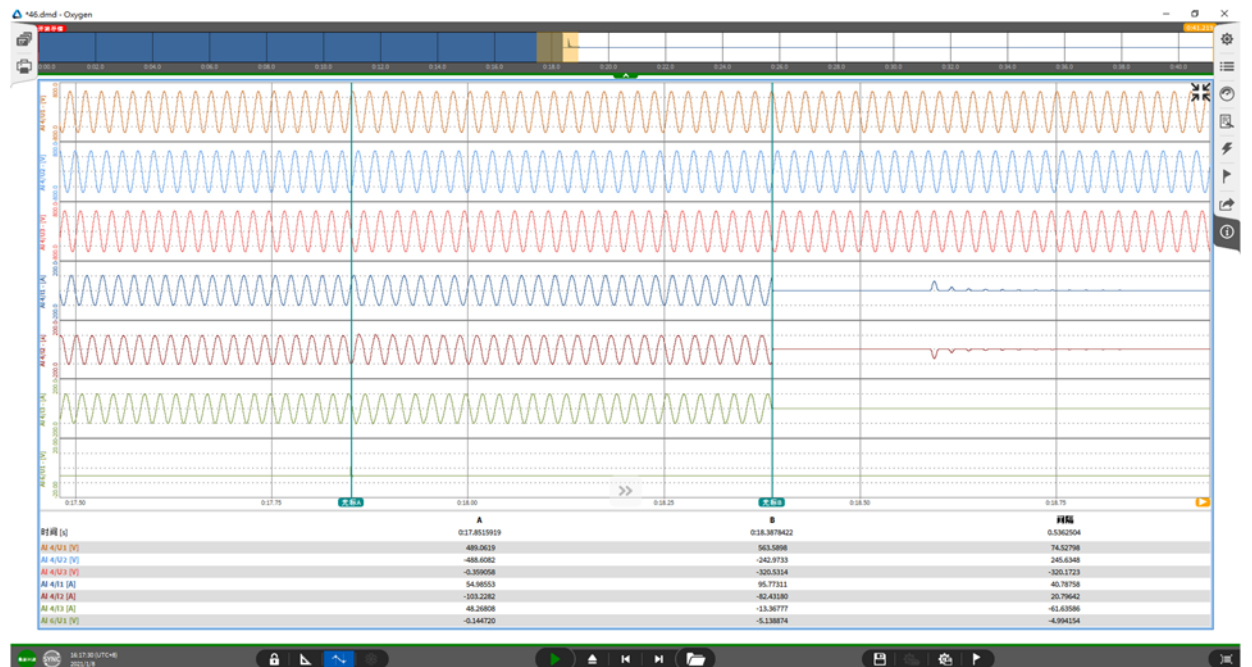
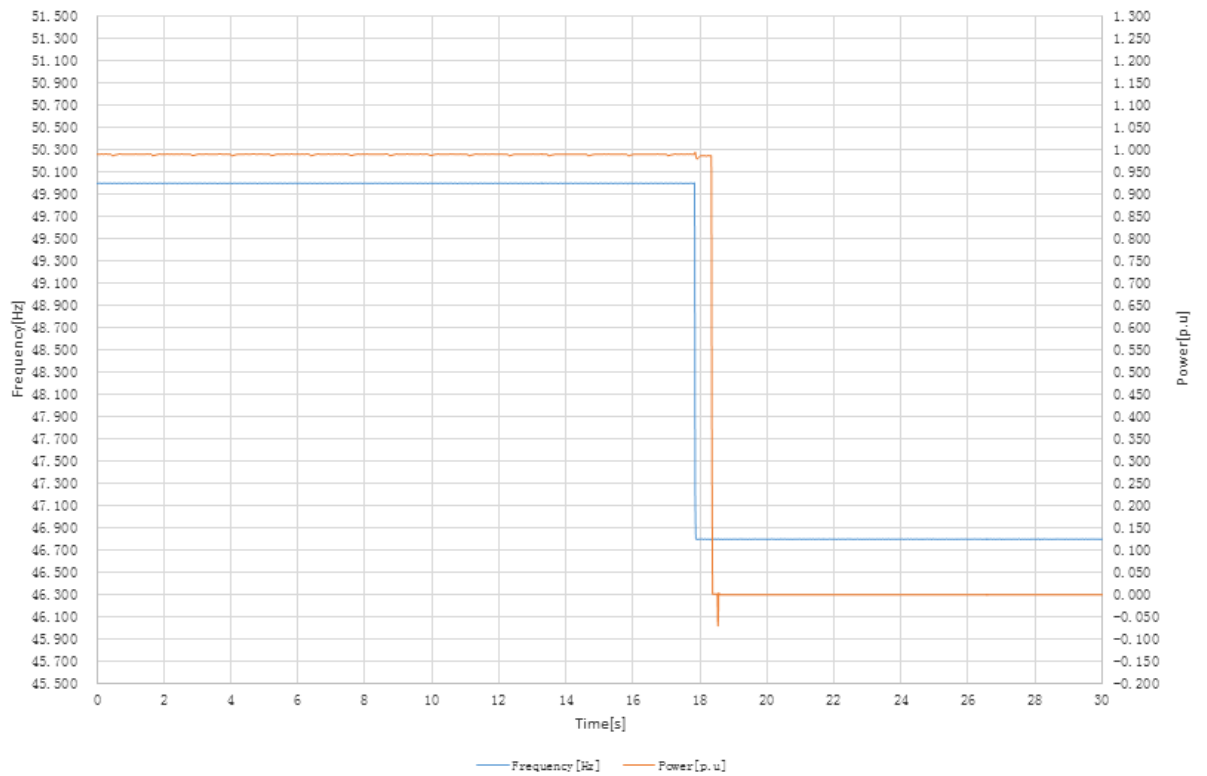
No trip tests - 47.7Hz



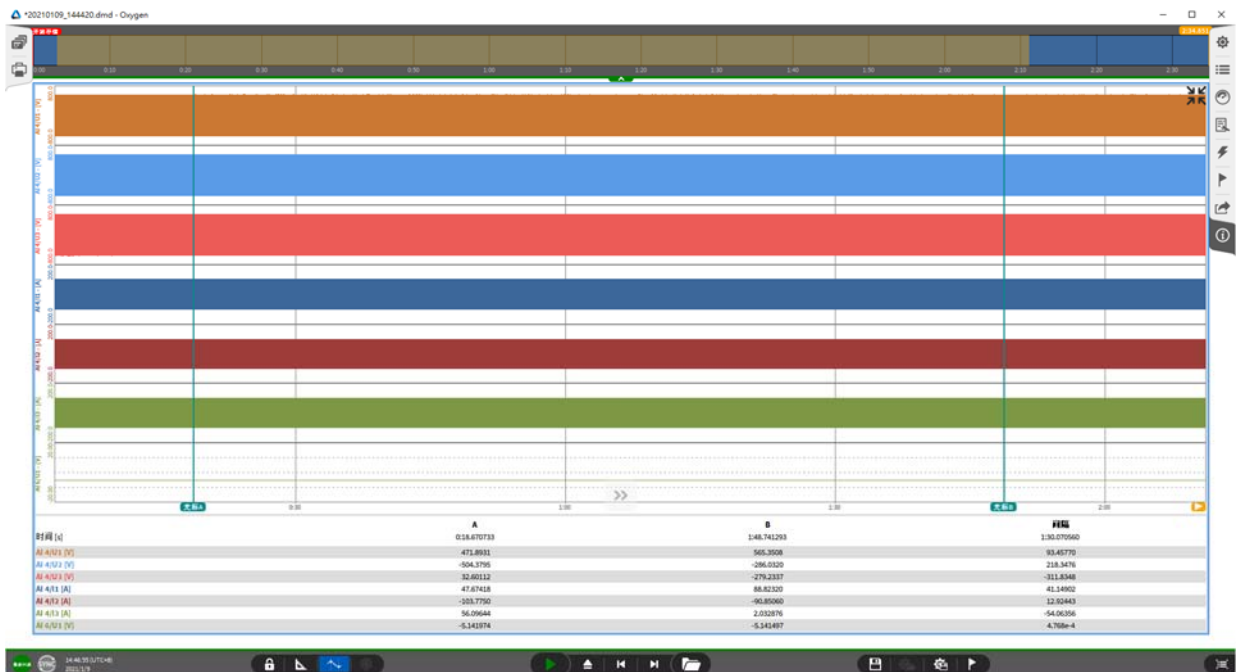
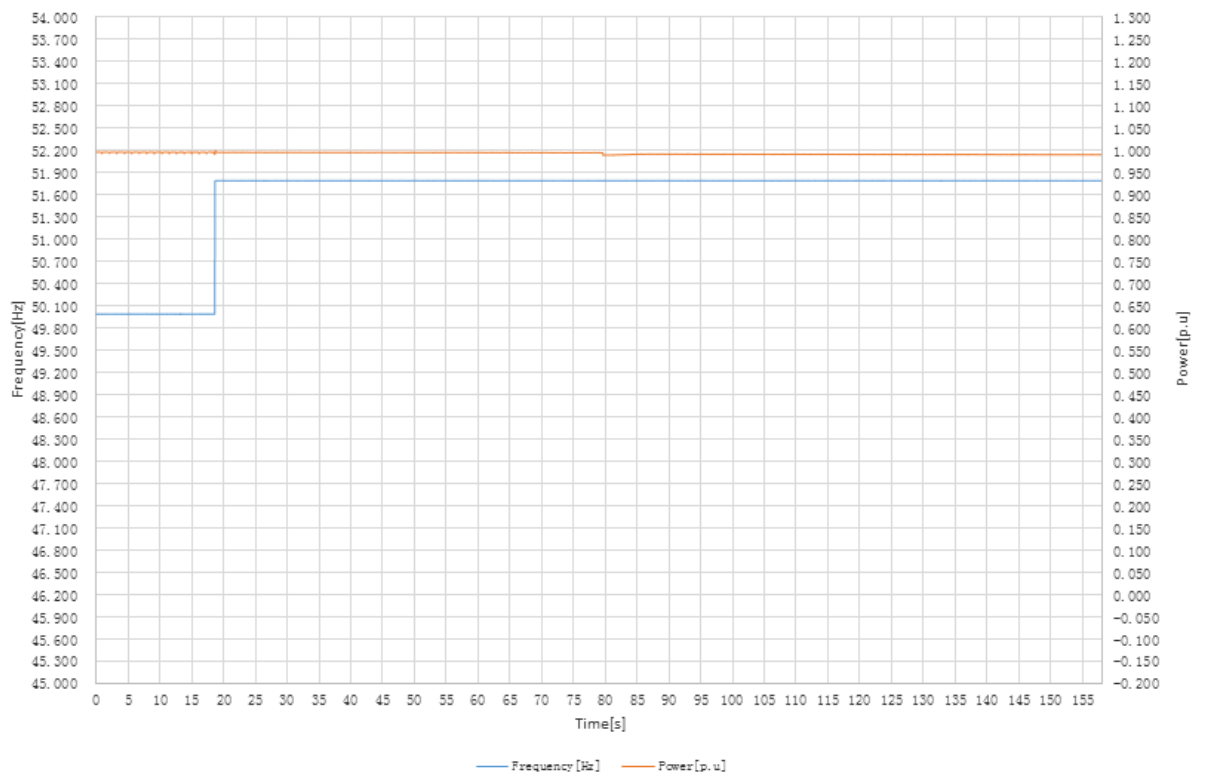
No trip tests – 47.2Hz



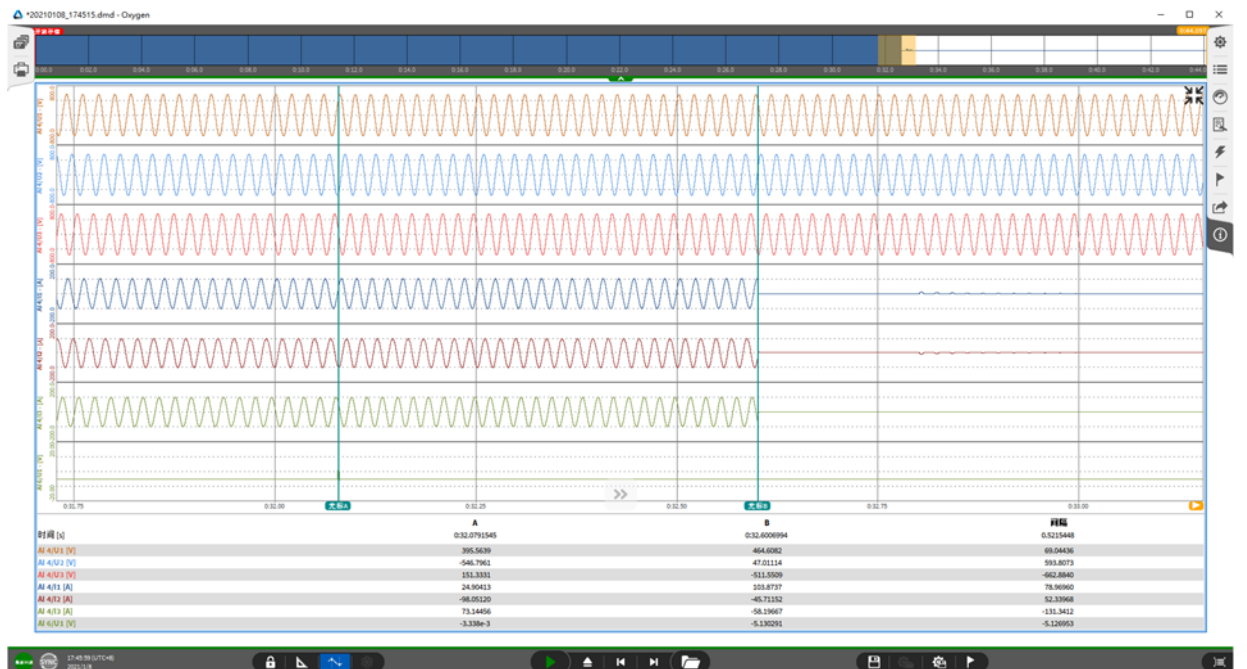
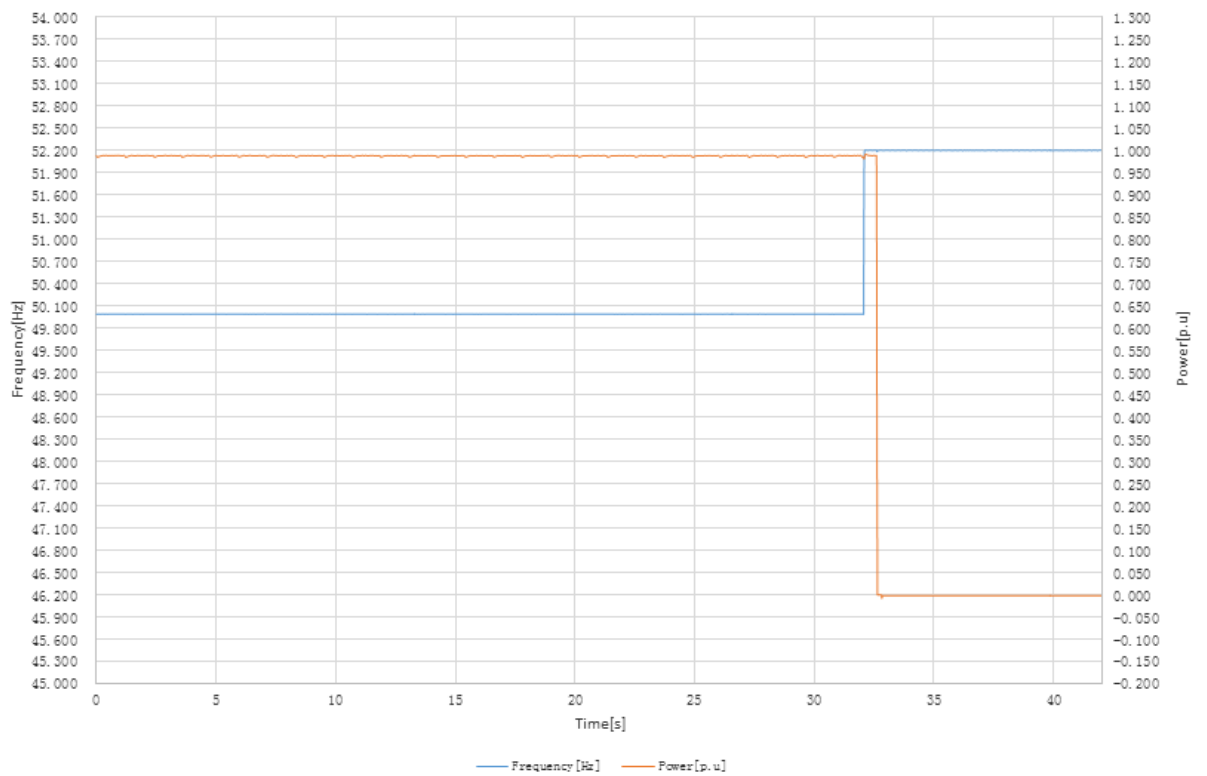
No trip tests – 46.8Hz



No trip tests - 51.8Hz



No trip tests – 52.2Hz



4.3.2 Voltage tests

These tests should be carried out in accordance with Annex A.7.1.2.2.

To establish the certified trip voltage, the test voltage should be applied in steps of $\pm 0.5\%$ of setting for a duration that is longer than the trip time delay.

To establish the certified trip time, the test voltage should be applied starting from $\pm 1.8\%$ below the certified trip voltage in a step of at least $\pm 0.5\%$ of setting for a duration that is longer than the trip time delay. For each trip setting five tests shall be carried out.

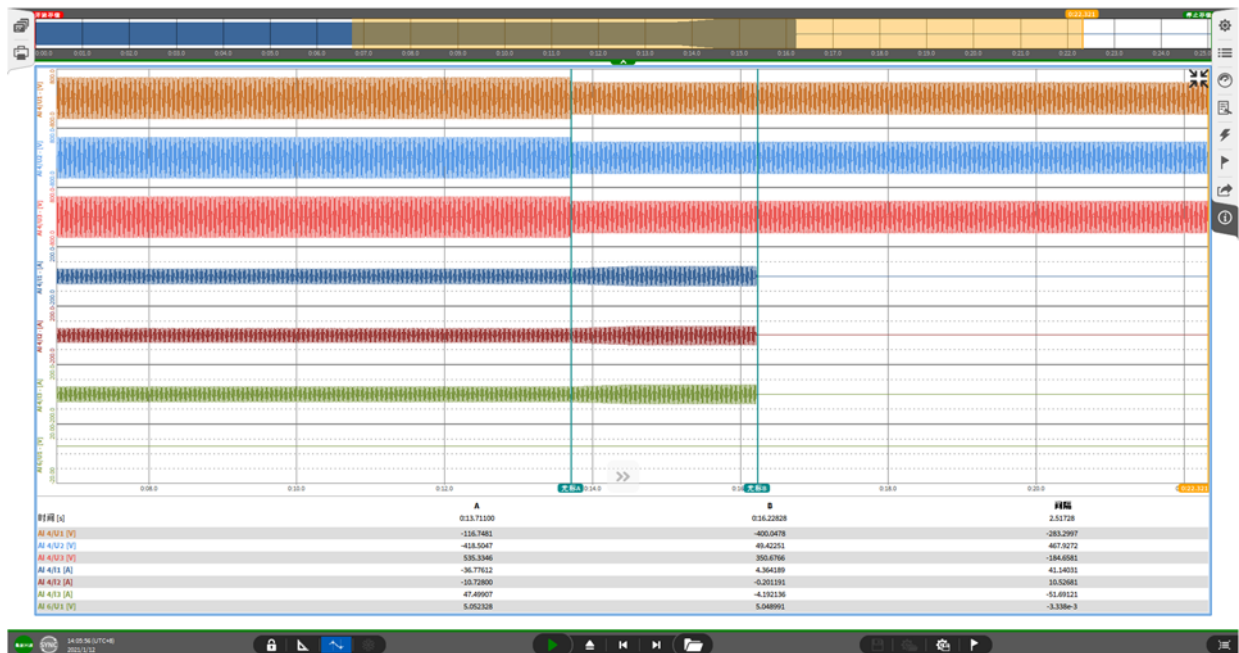
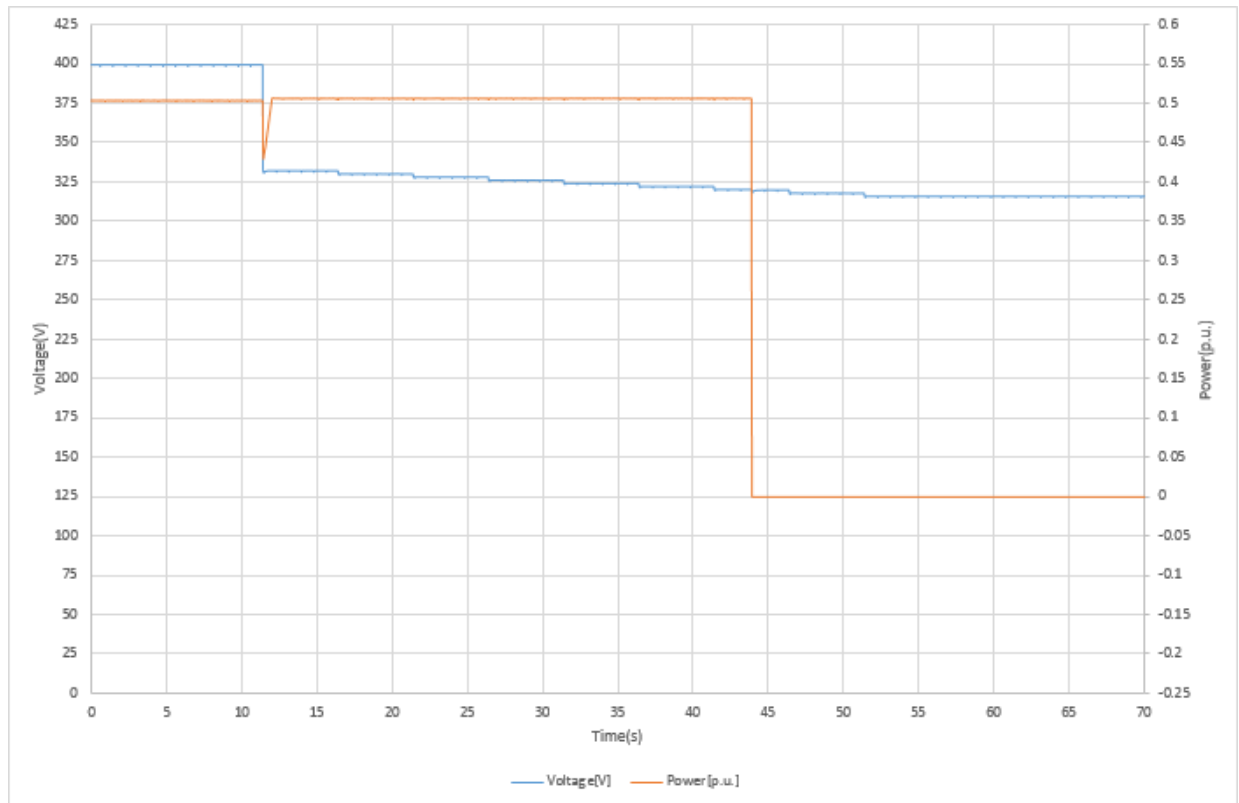
Following tables show the test results:

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage (V)	Time delay (s)	Voltage /time	Confirm no trip
U/V	320 V	2.5 s	320.0	2.517	327 V / 3.51 s	Pass
			320.0	2.520		
			320.0	2.529		
			320.0	2.542		
			320.0	2.533		
					313 V / 2.52 s	Pass
O/V stage 1	456 V	1.0 s	455.3	1.008	448.8 V / 2.48 s	Pass
			455.4	1.015		
			455.3	1.028		
			455.4	1.014		
			455.4	1.018		
O/V stage 2	476 V	0.5 s	475.3	0.515	468.6 V / 1.00 s	Pass
			475.3	0.516		
			475.0	0.522		
			475.3	0.524		
			475.3	0.513		
					482 V / 0.51 s	Pass

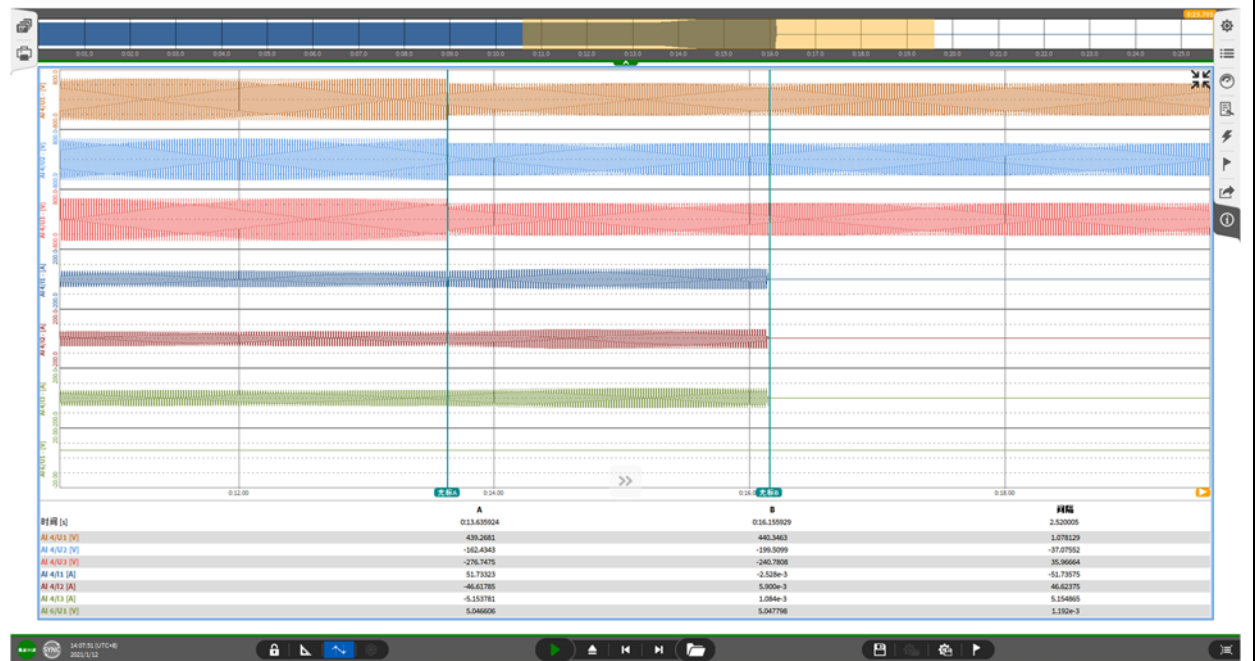
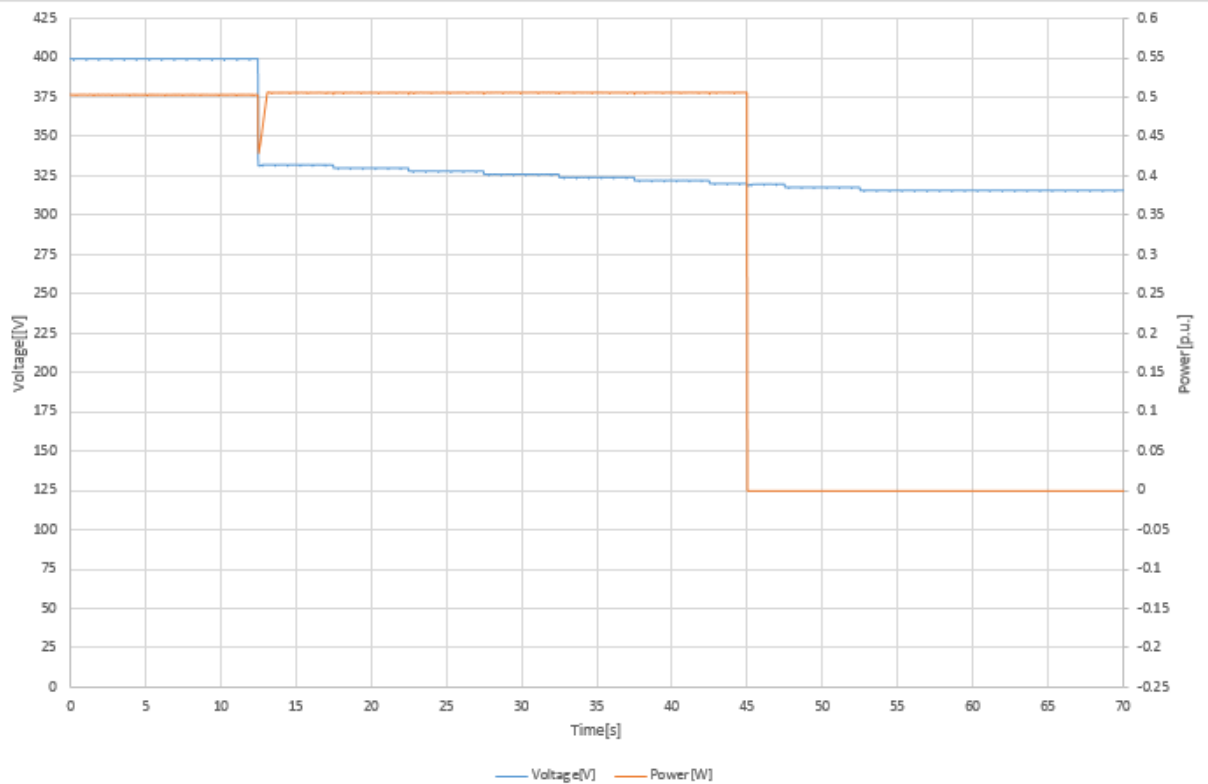
Note for Voltage tests the Voltage required to trip is the setting ± 3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ± 4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Test results are graphically shown in following pages.

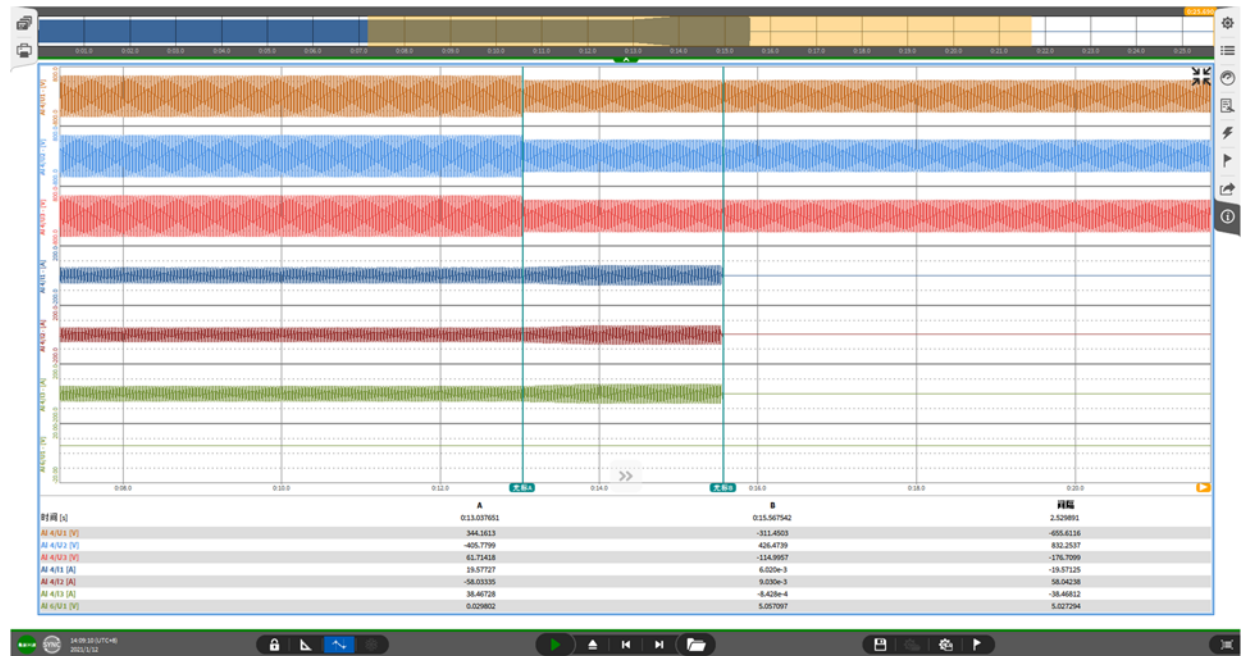
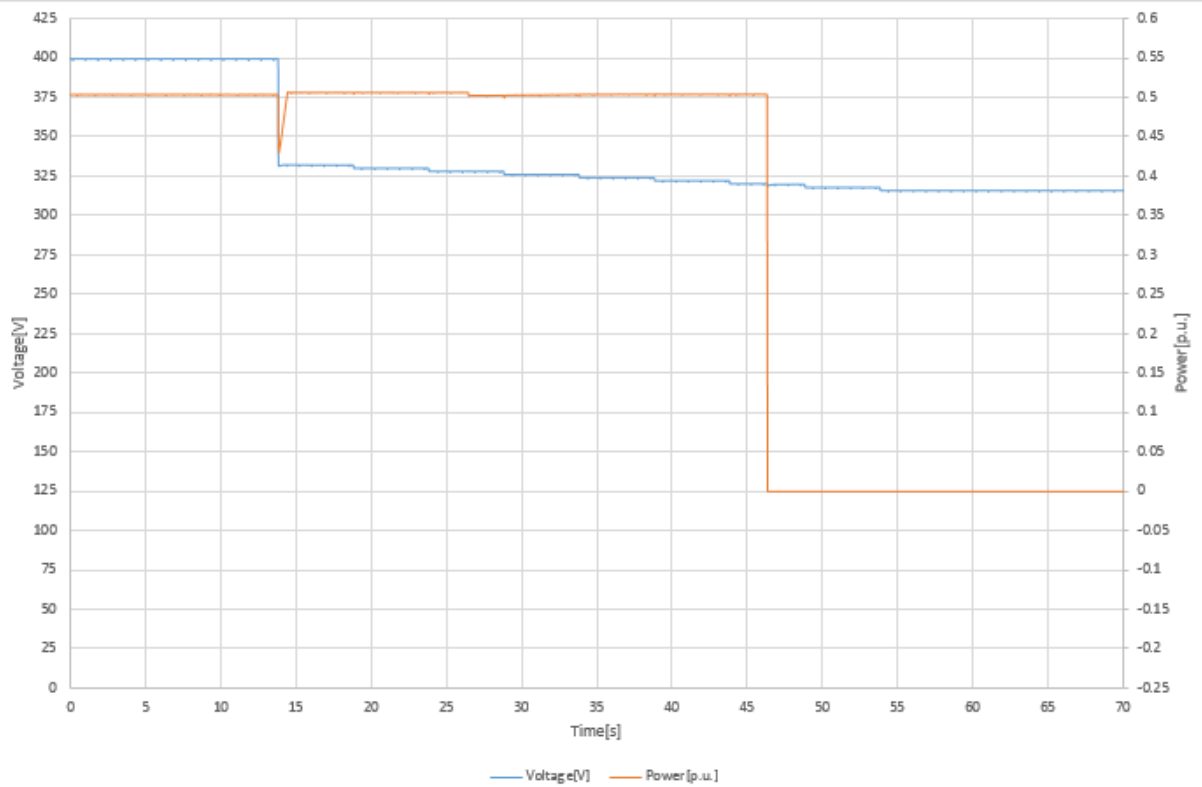
U/V -1

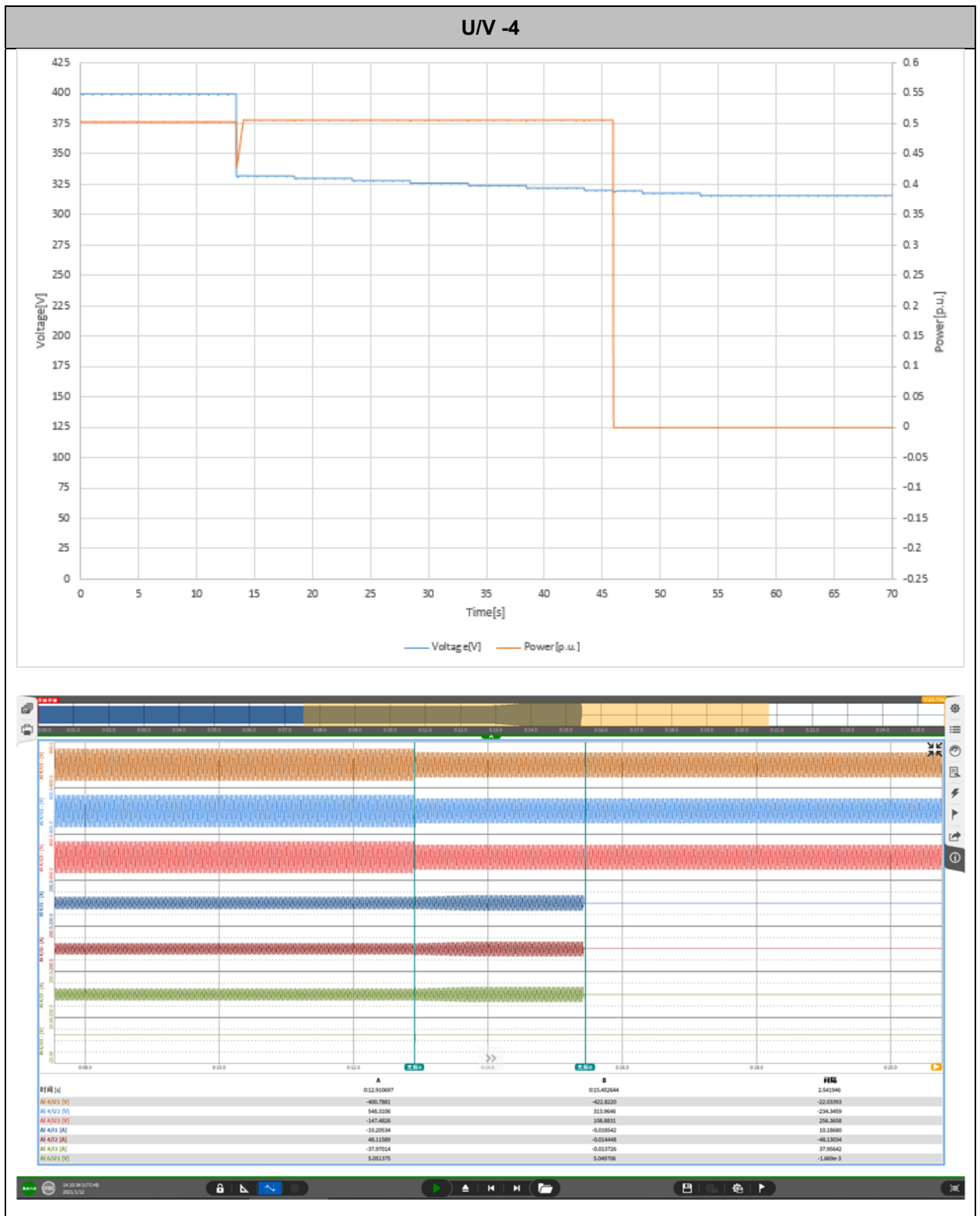


U/V -2

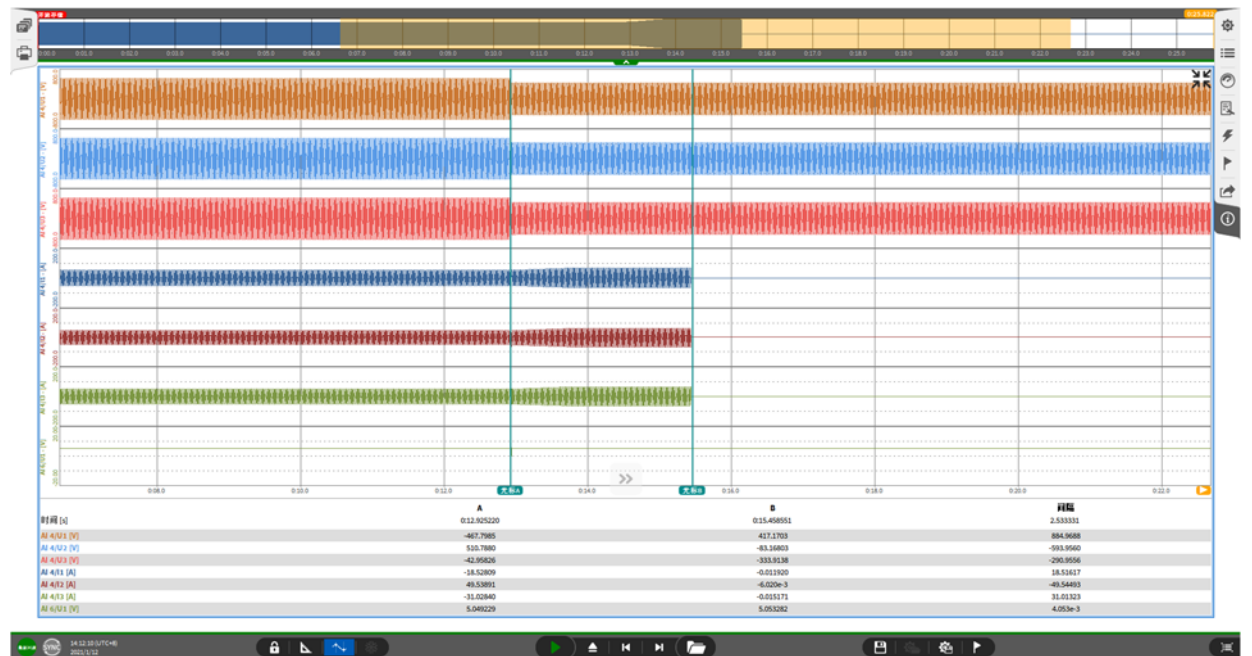
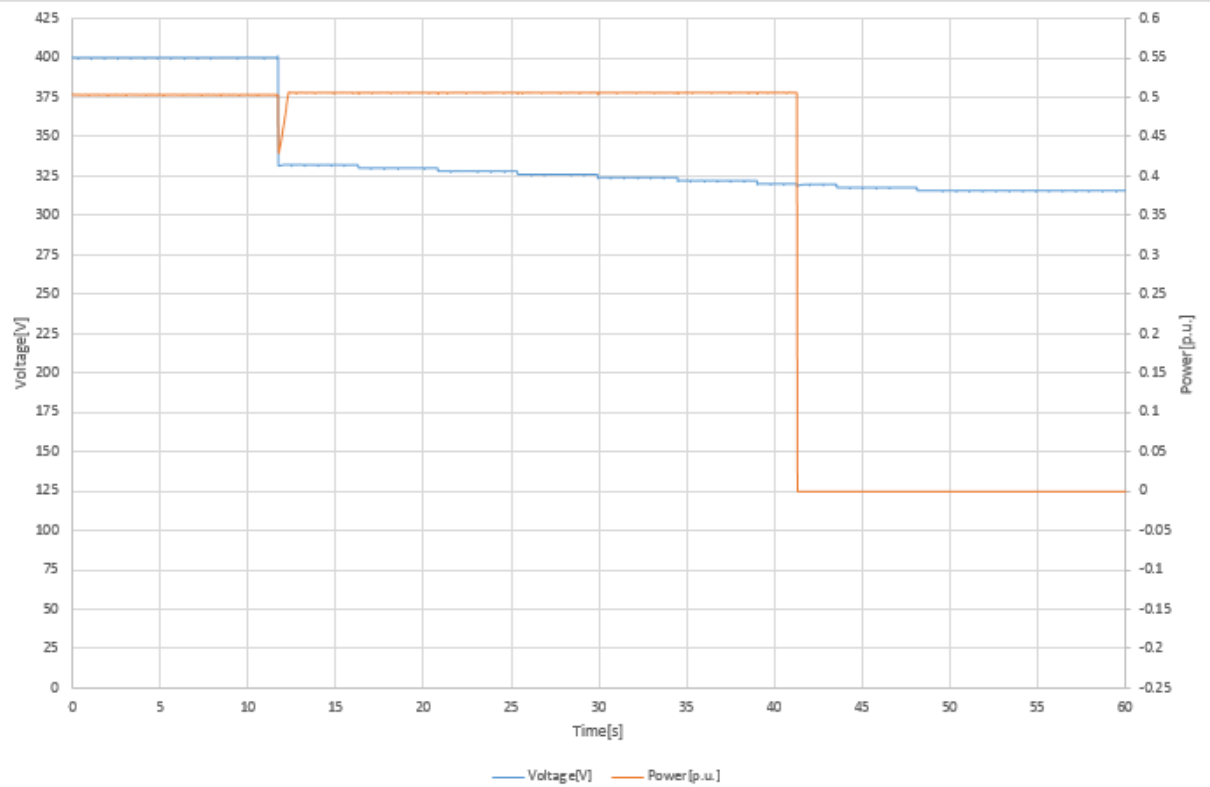


U/V -3

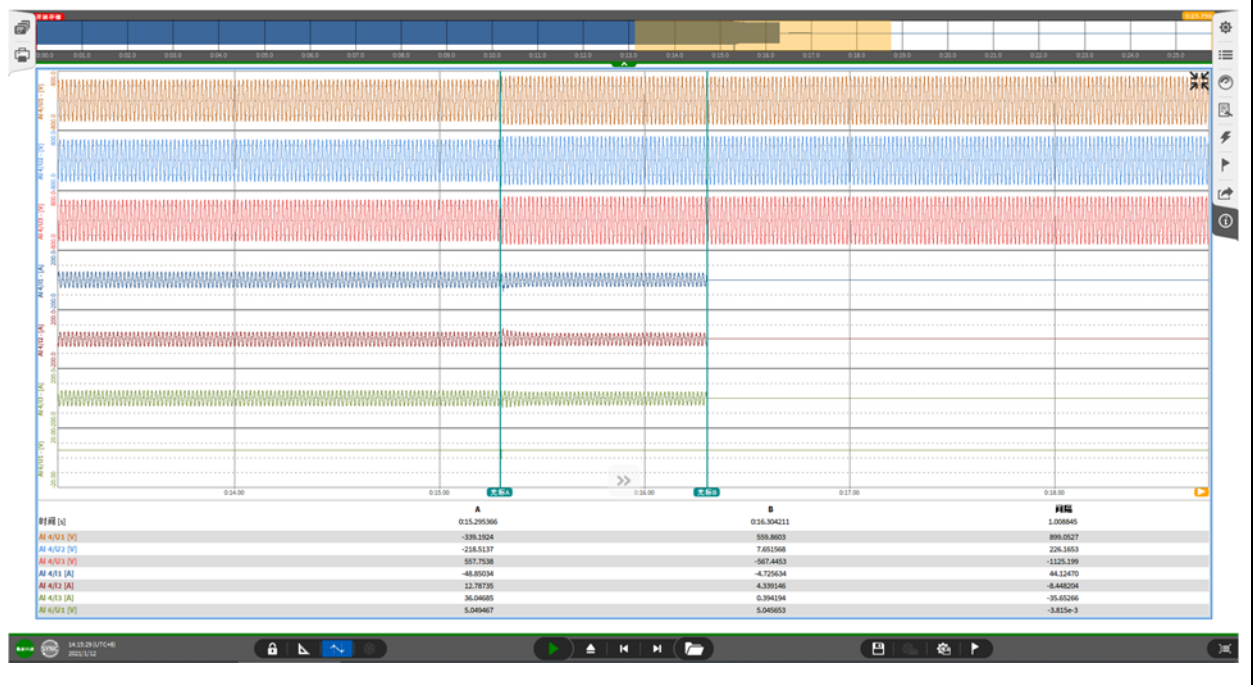
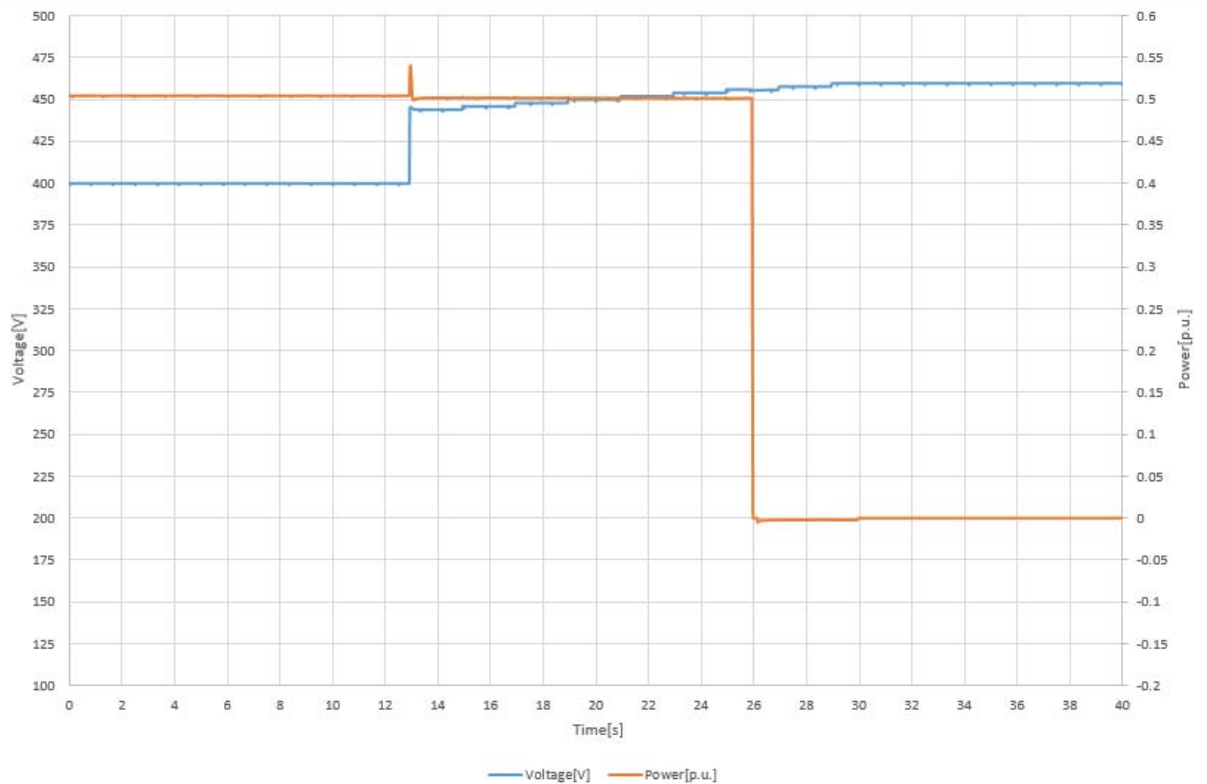




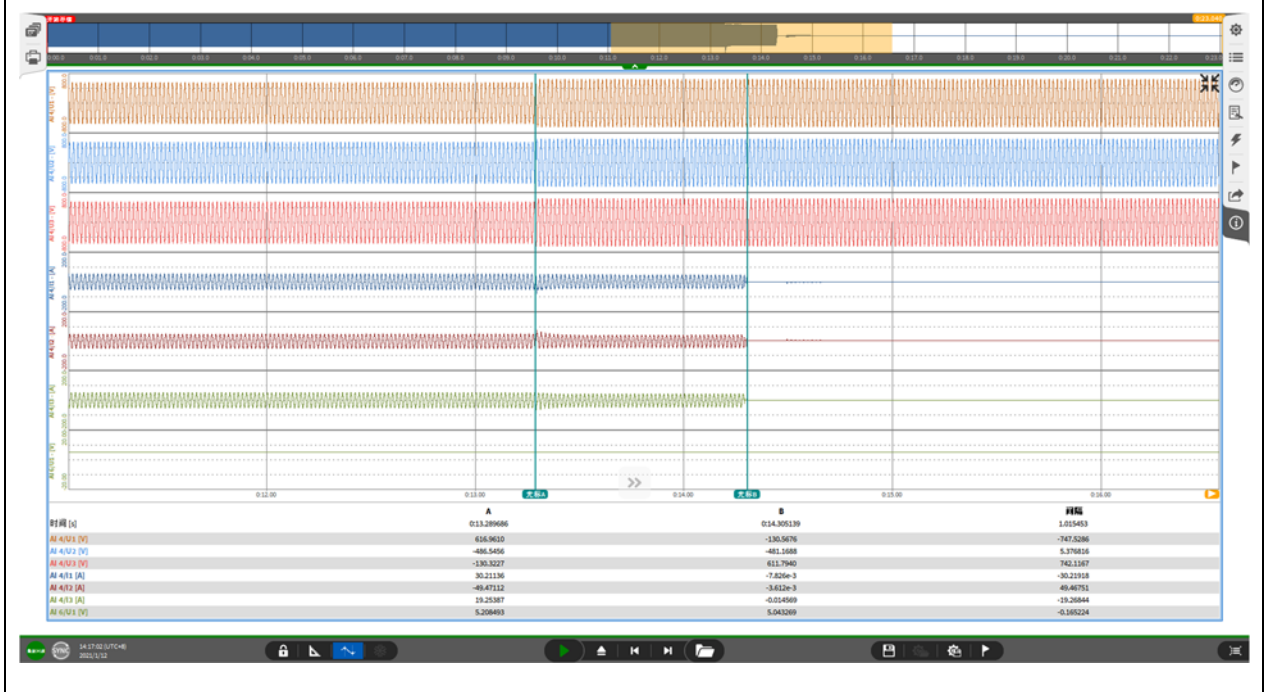
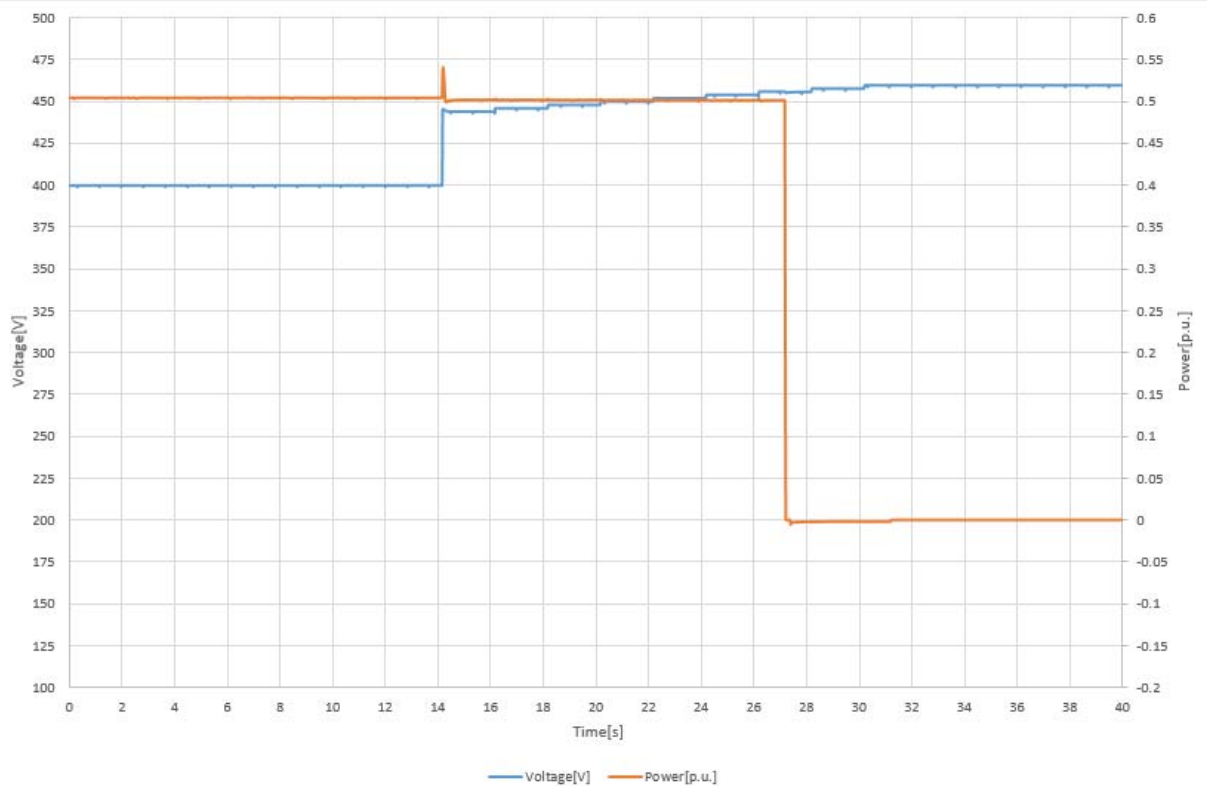
U/V -5



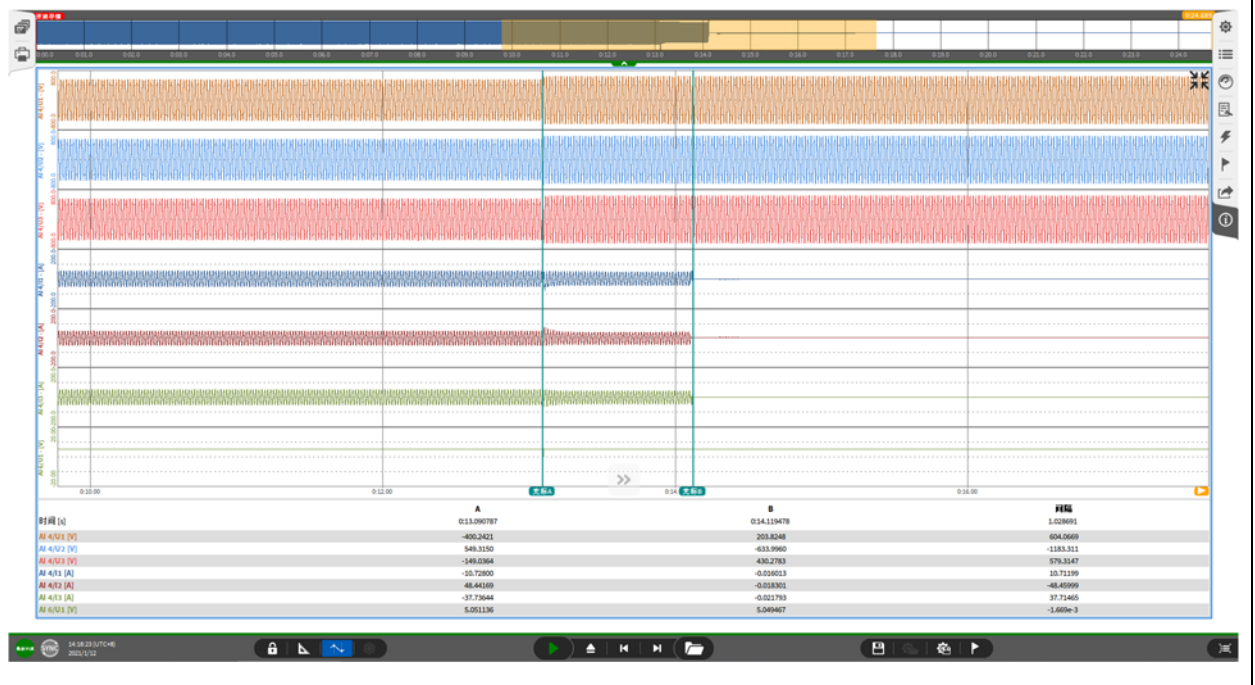
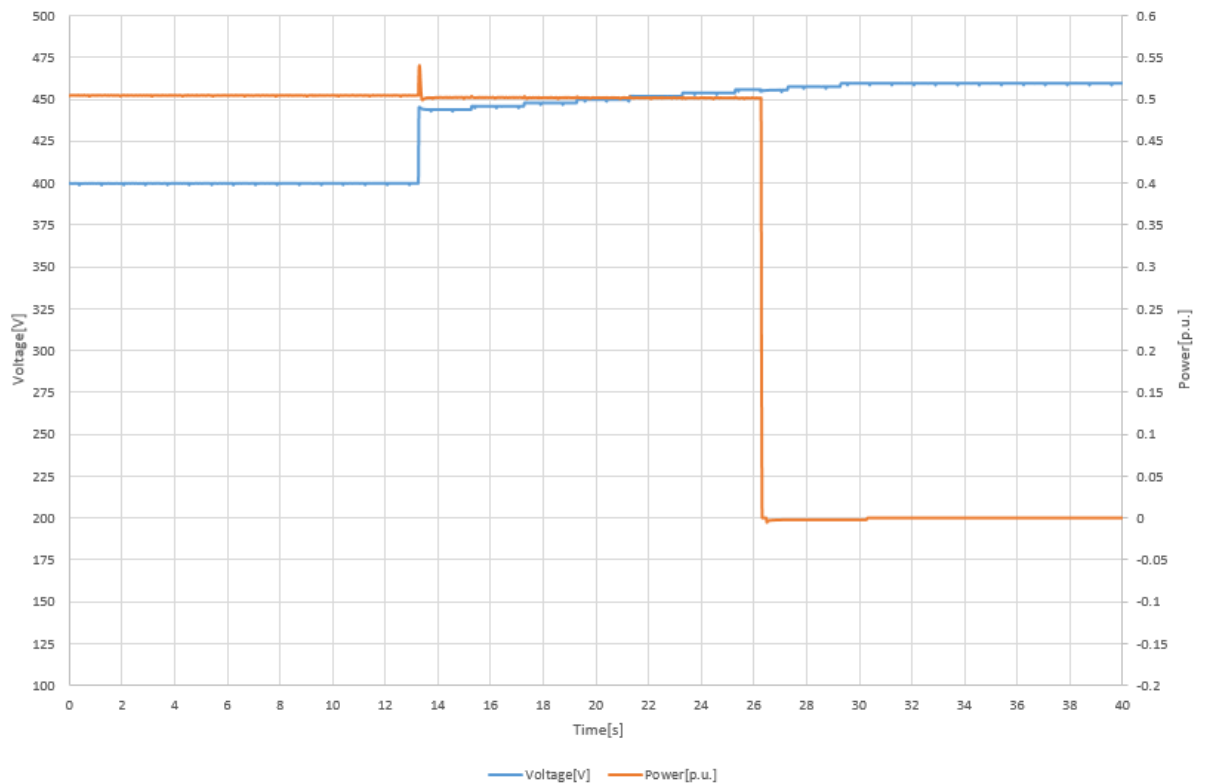
O/V stage 1-1



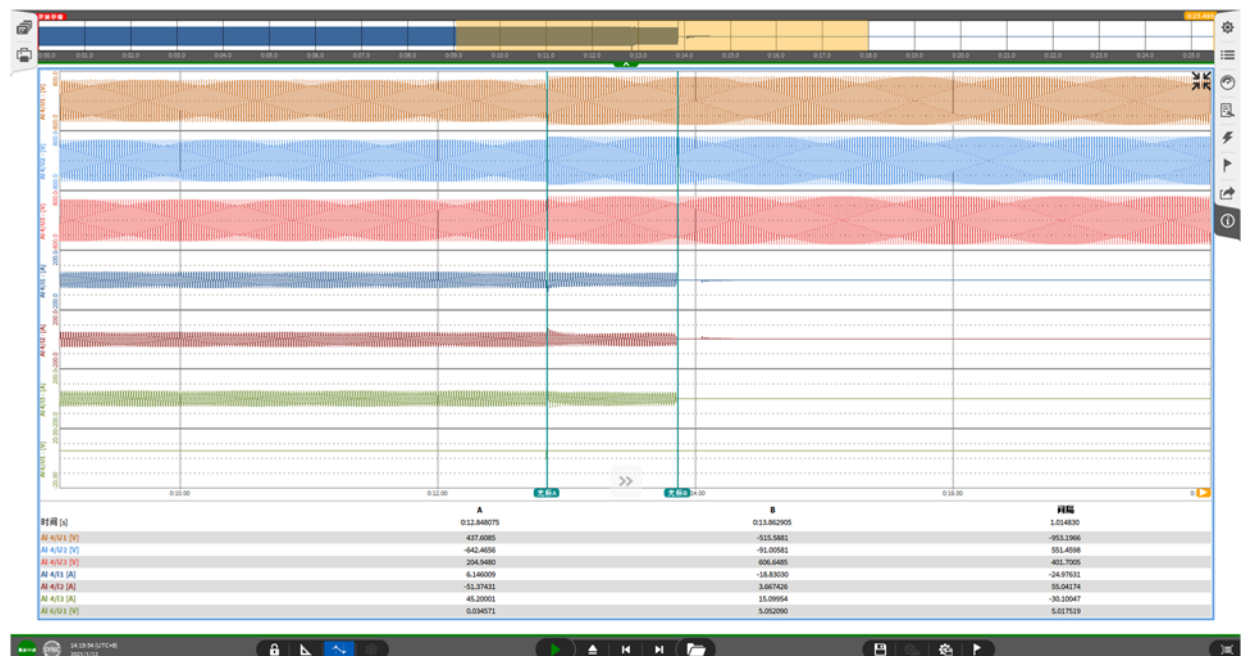
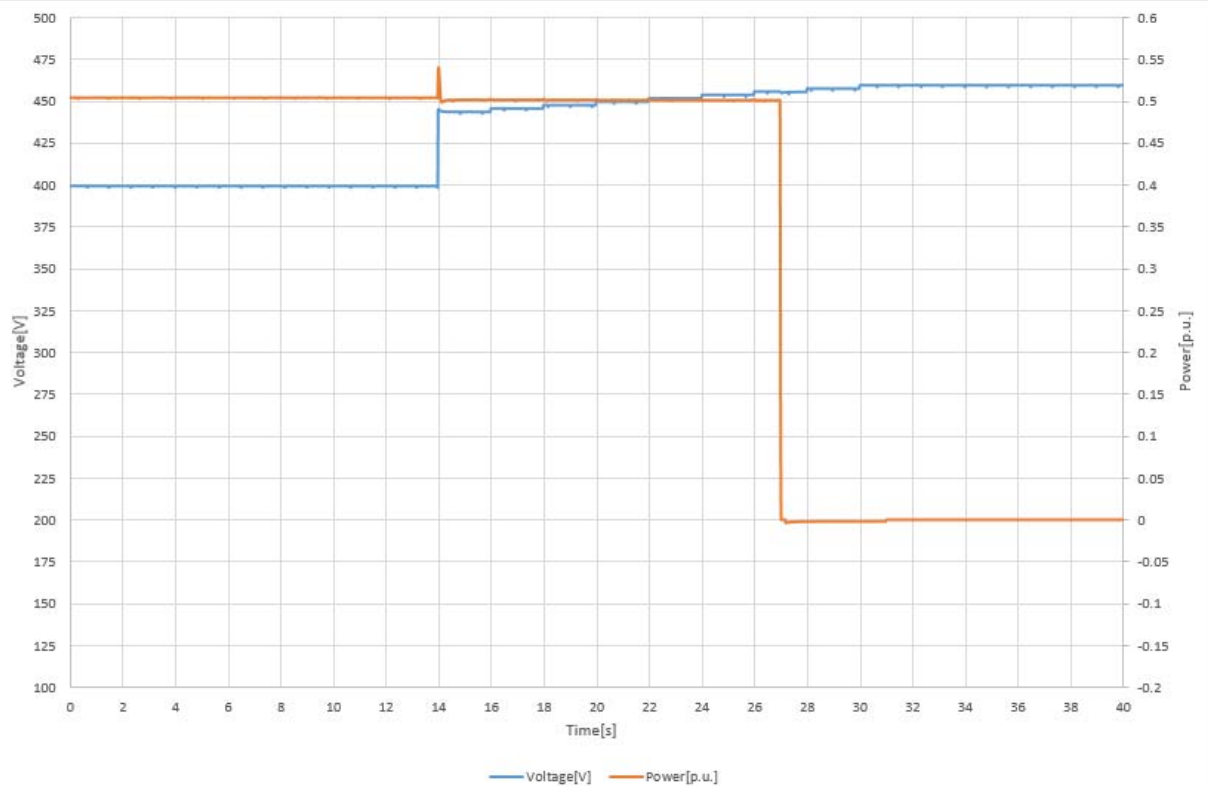
O/V stage 1-2



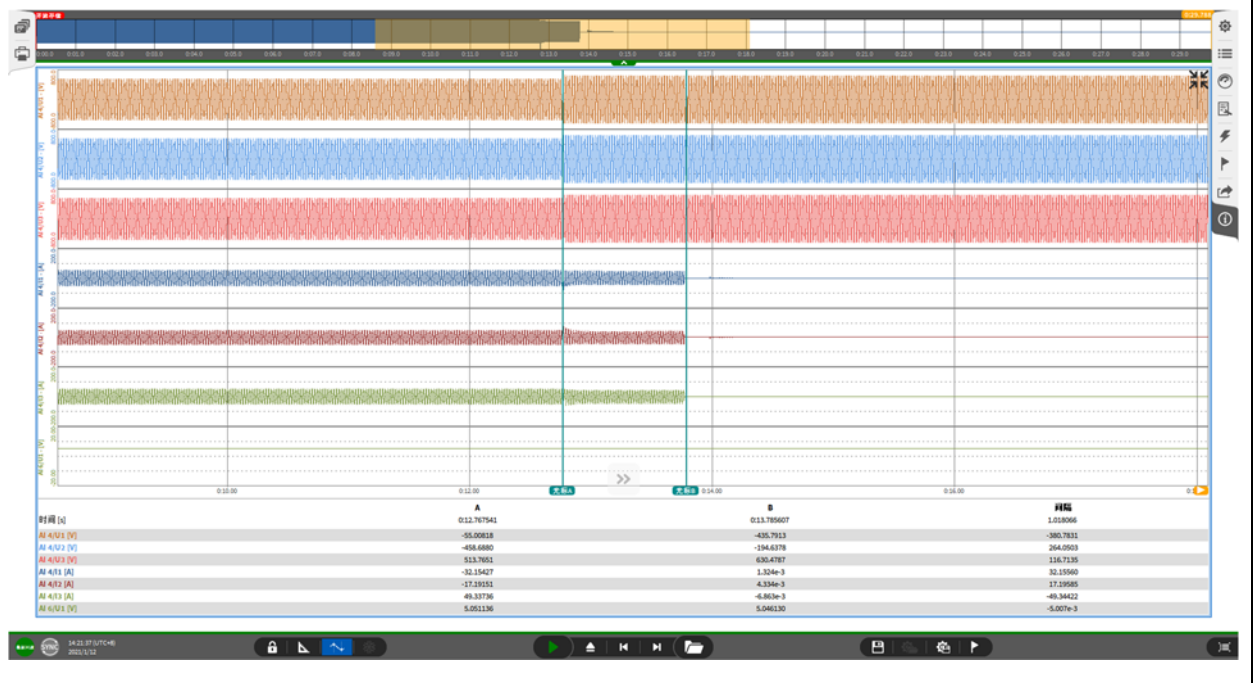
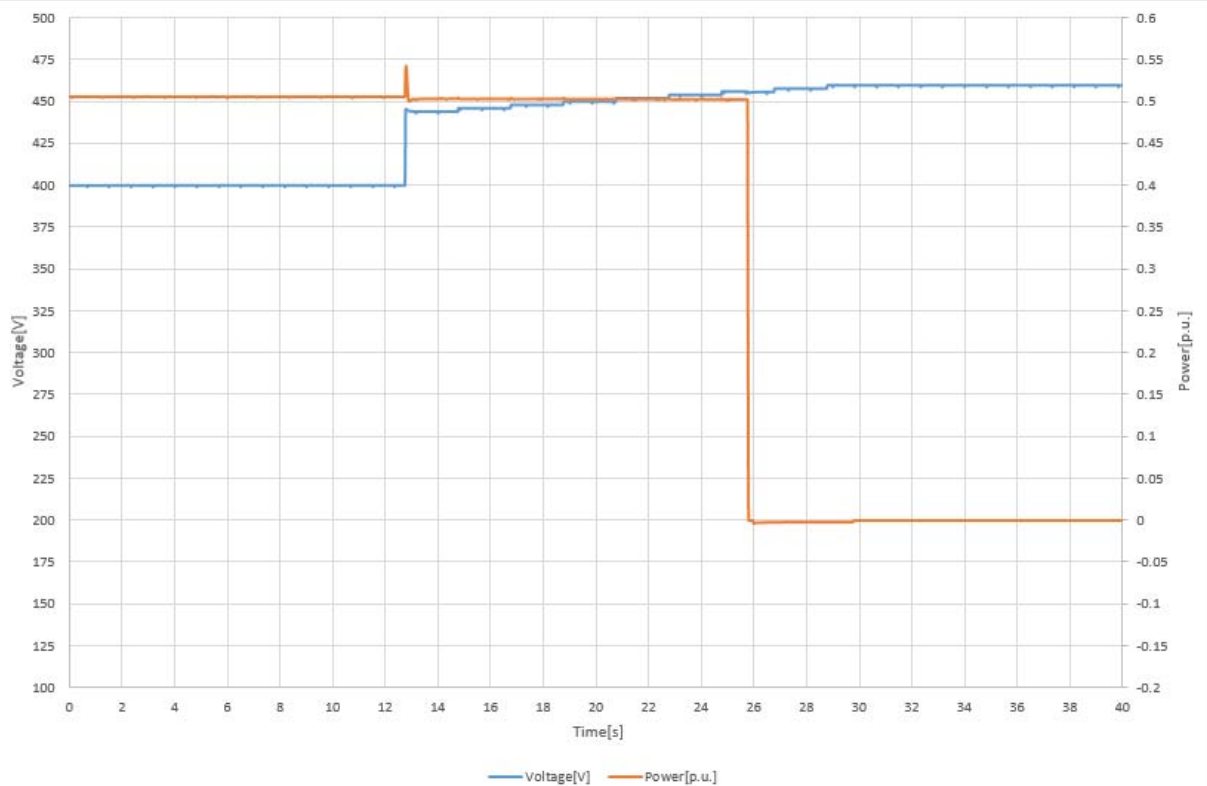
O/V stage 1-3



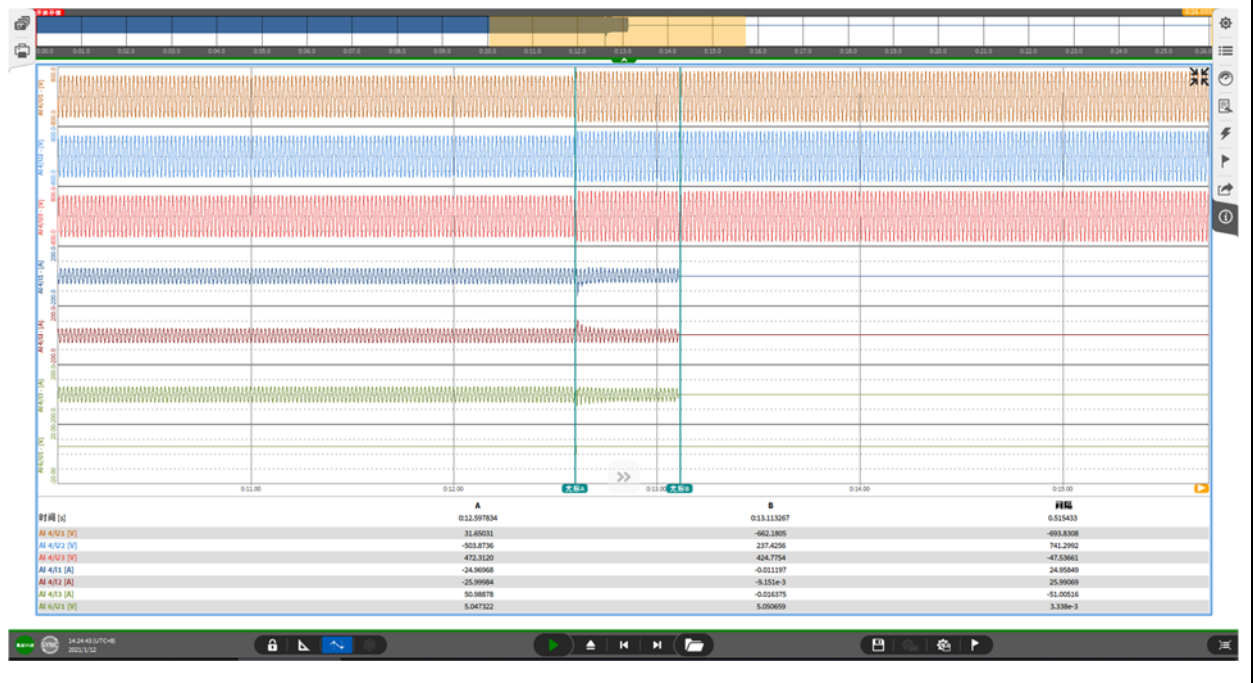
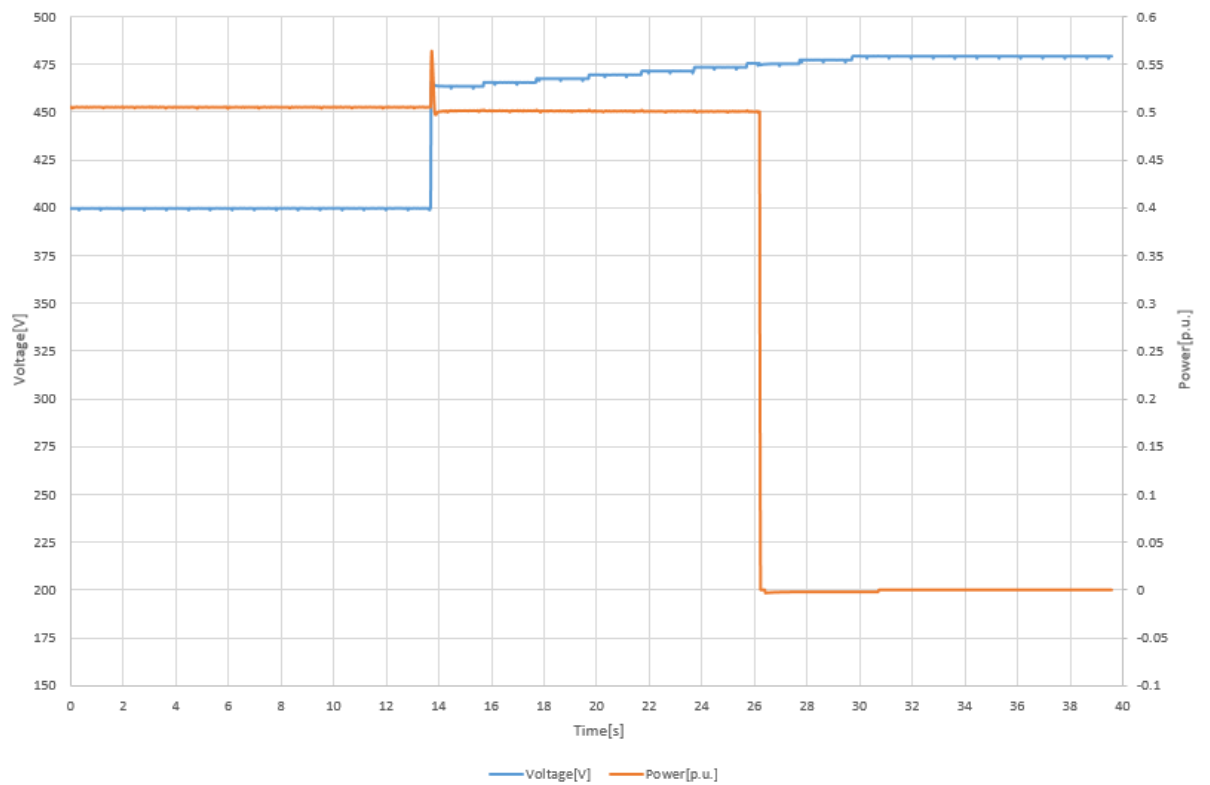
O/V stage 1-4



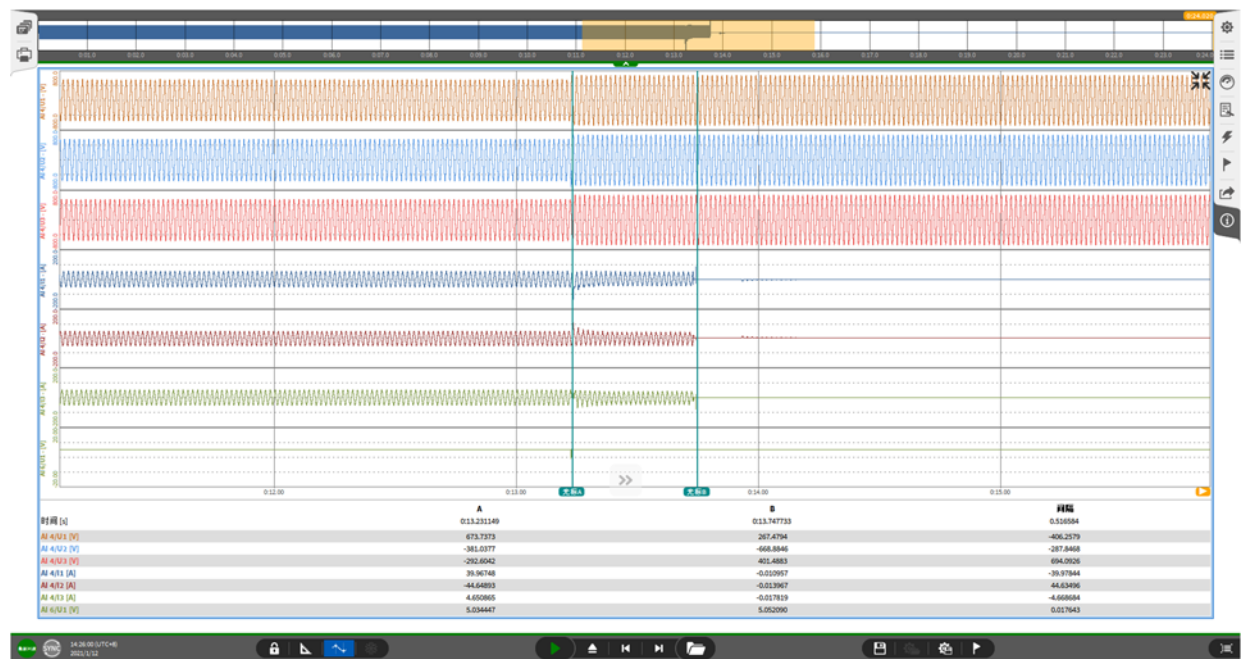
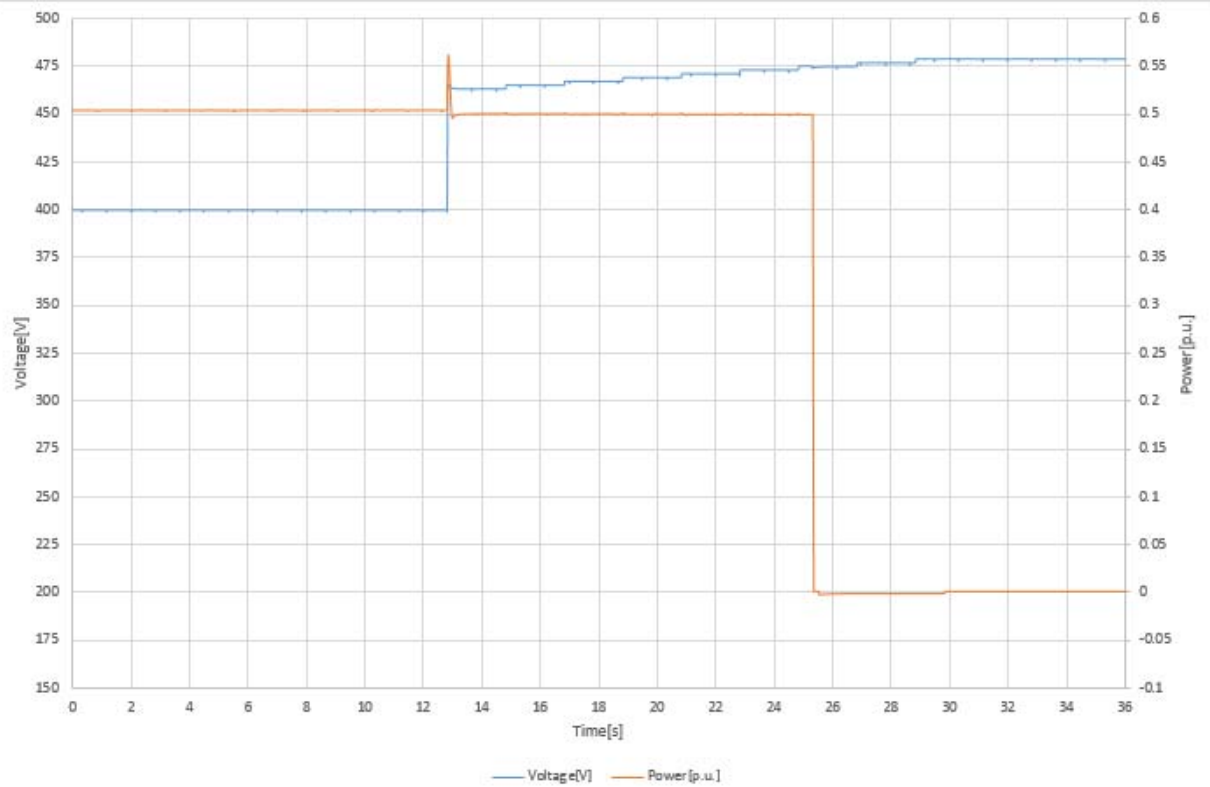
O/V stage 1-5



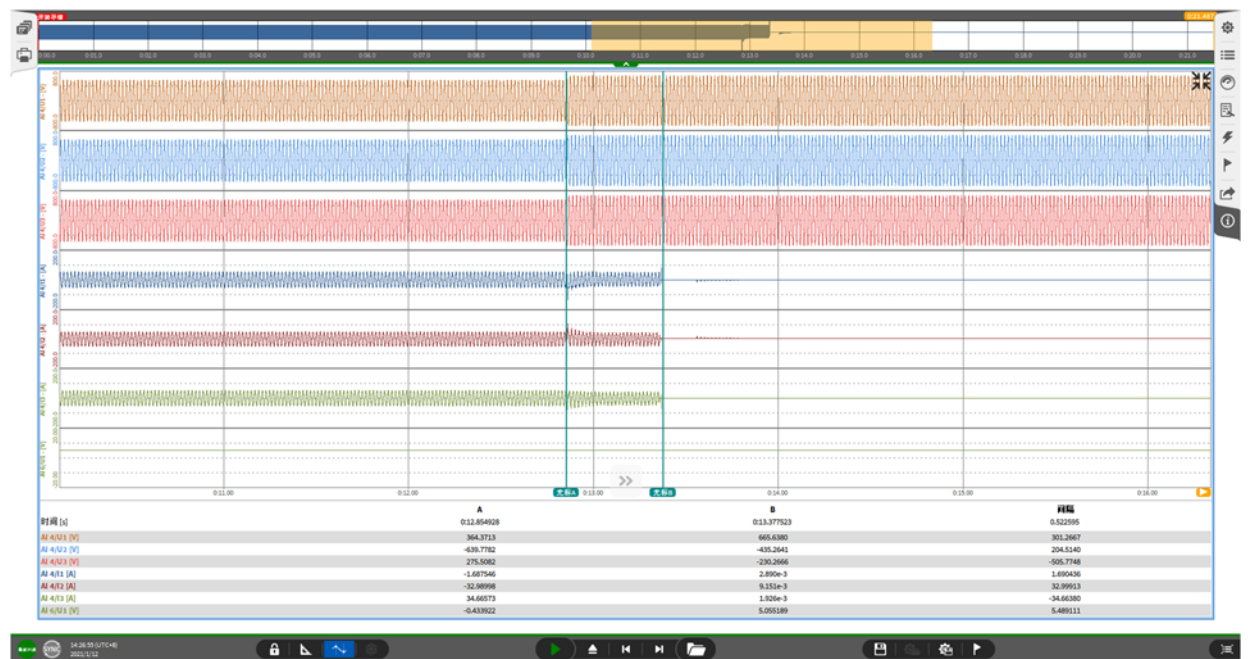
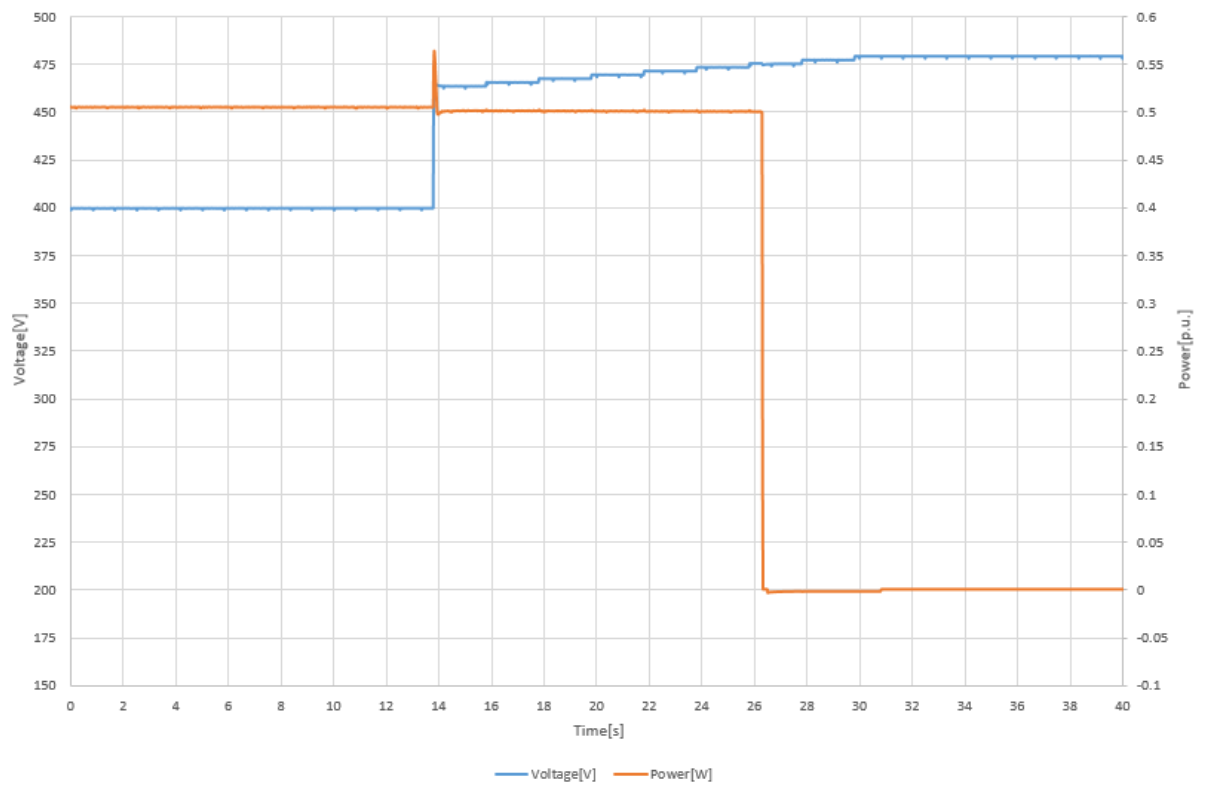
O/V stage 2-1



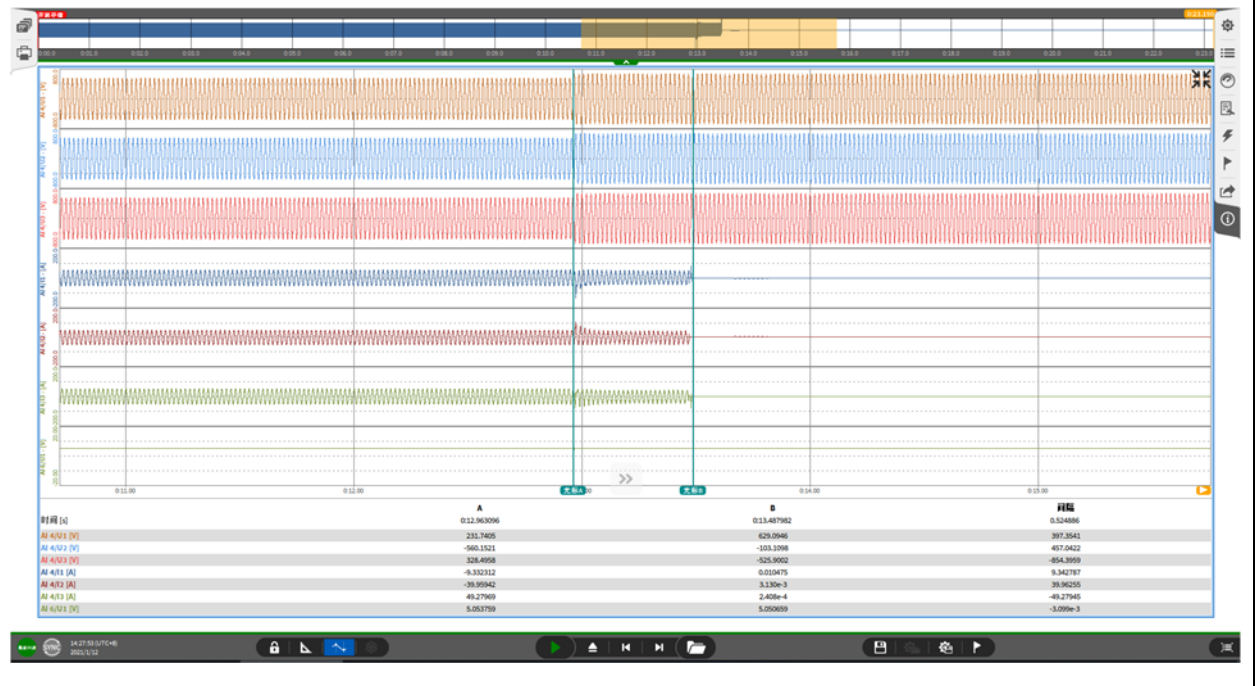
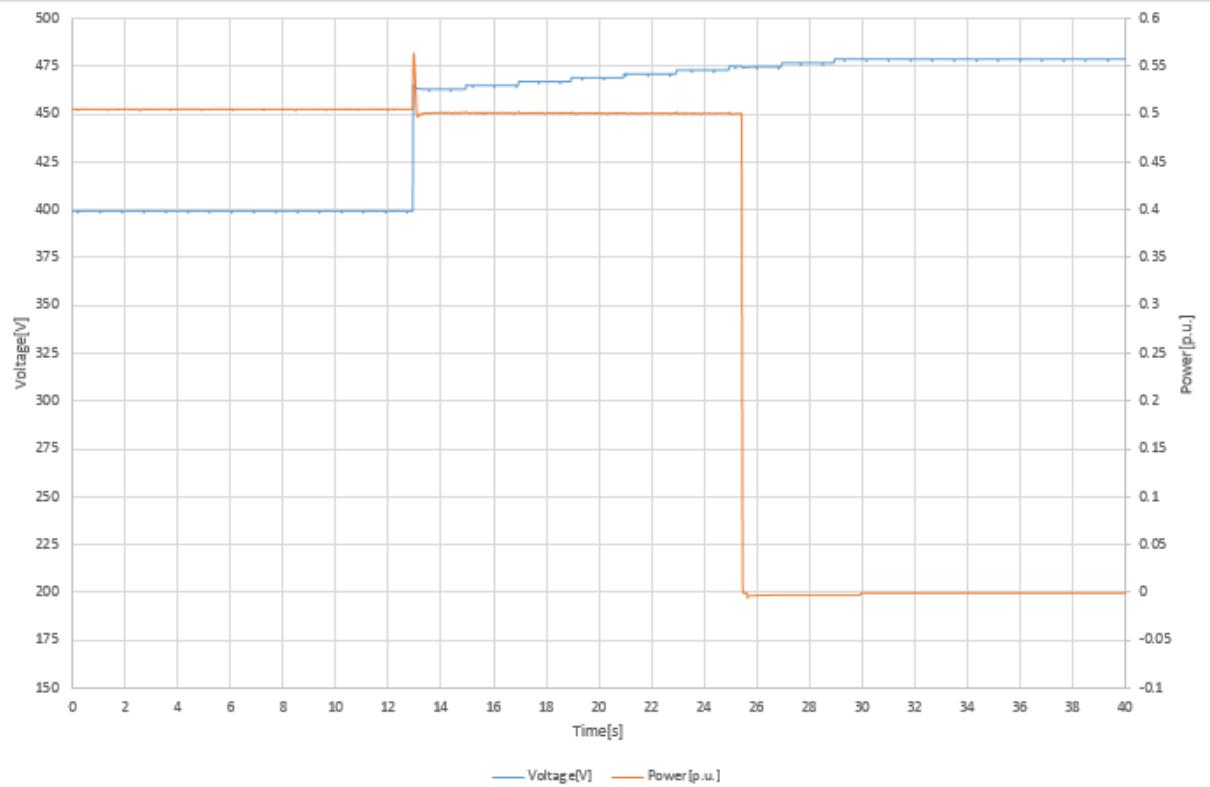
O/V stage 2-2



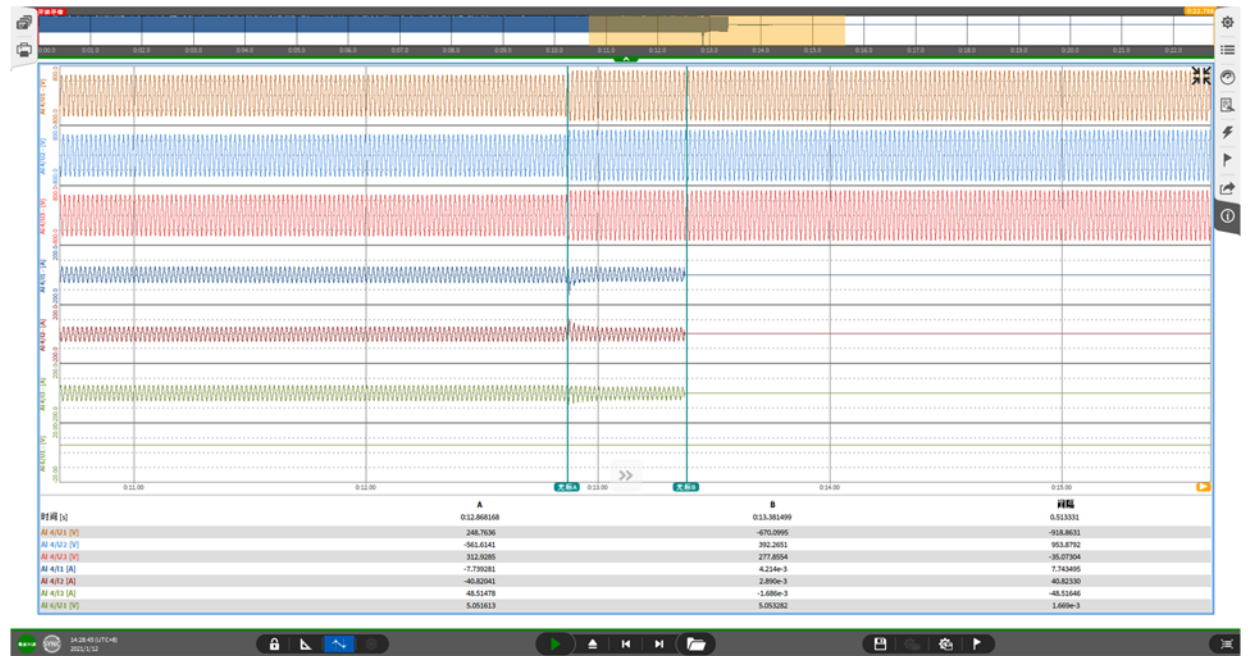
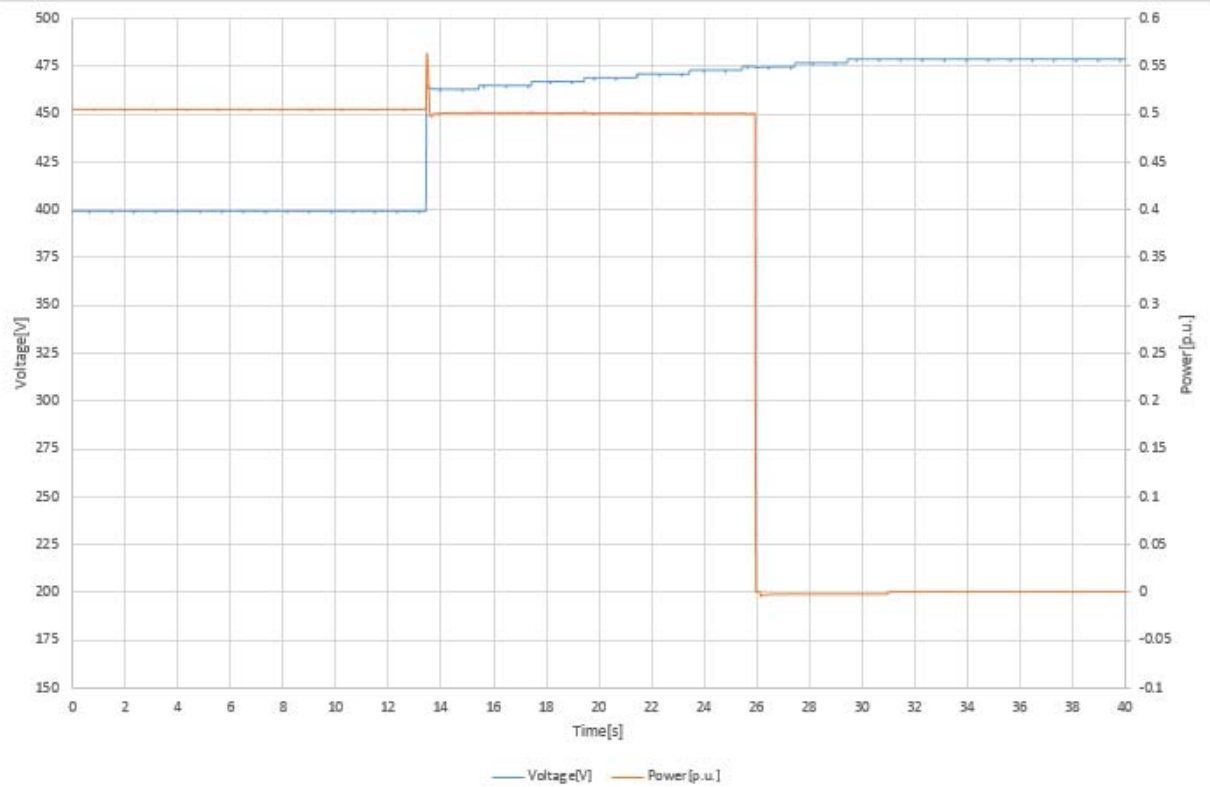
O/V stage 2-3



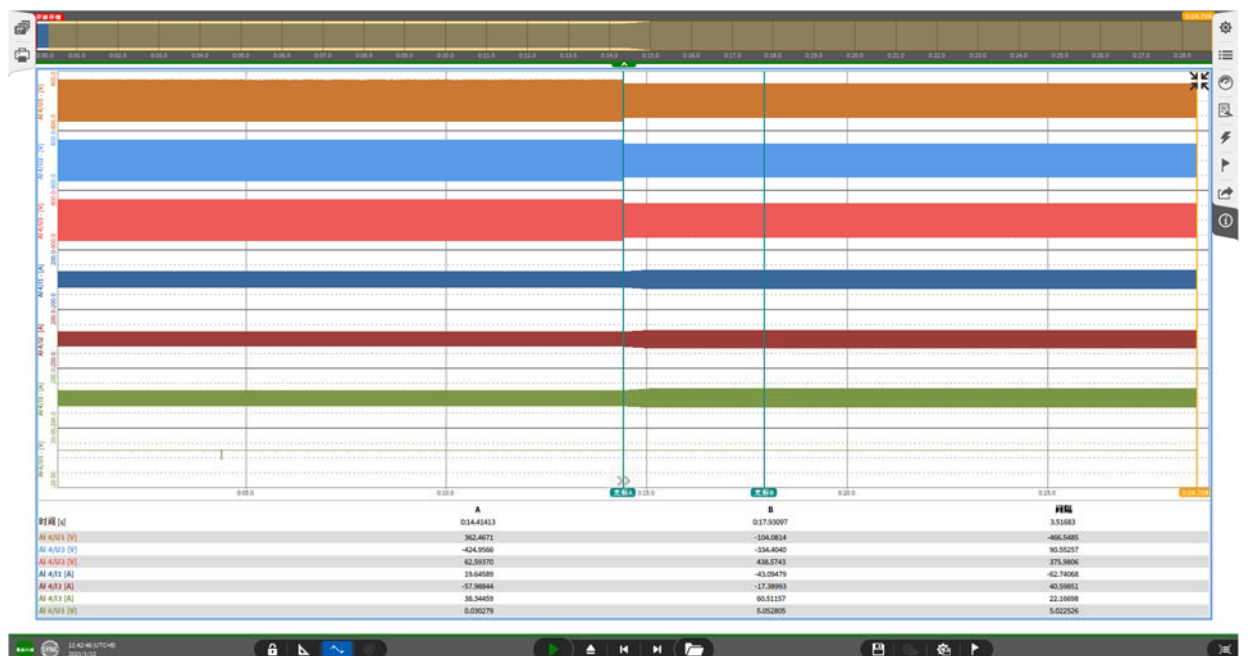
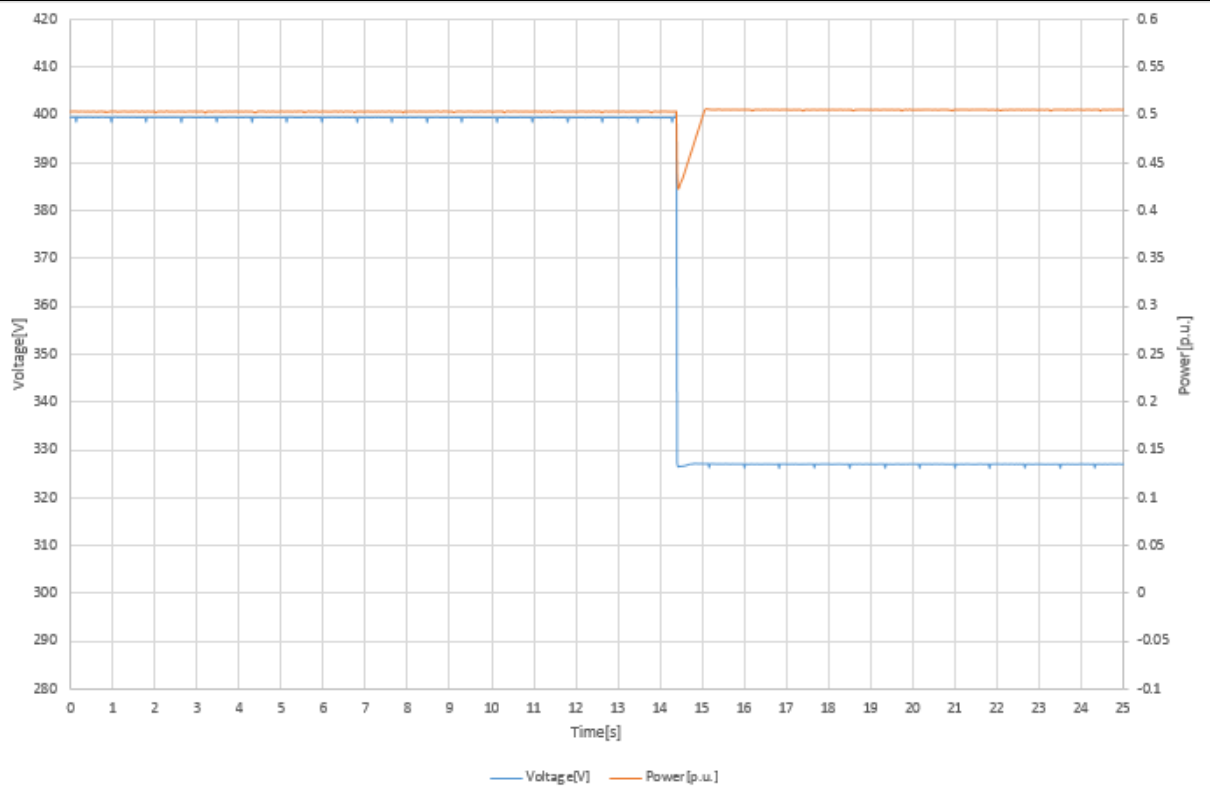
O/V stage 2-4



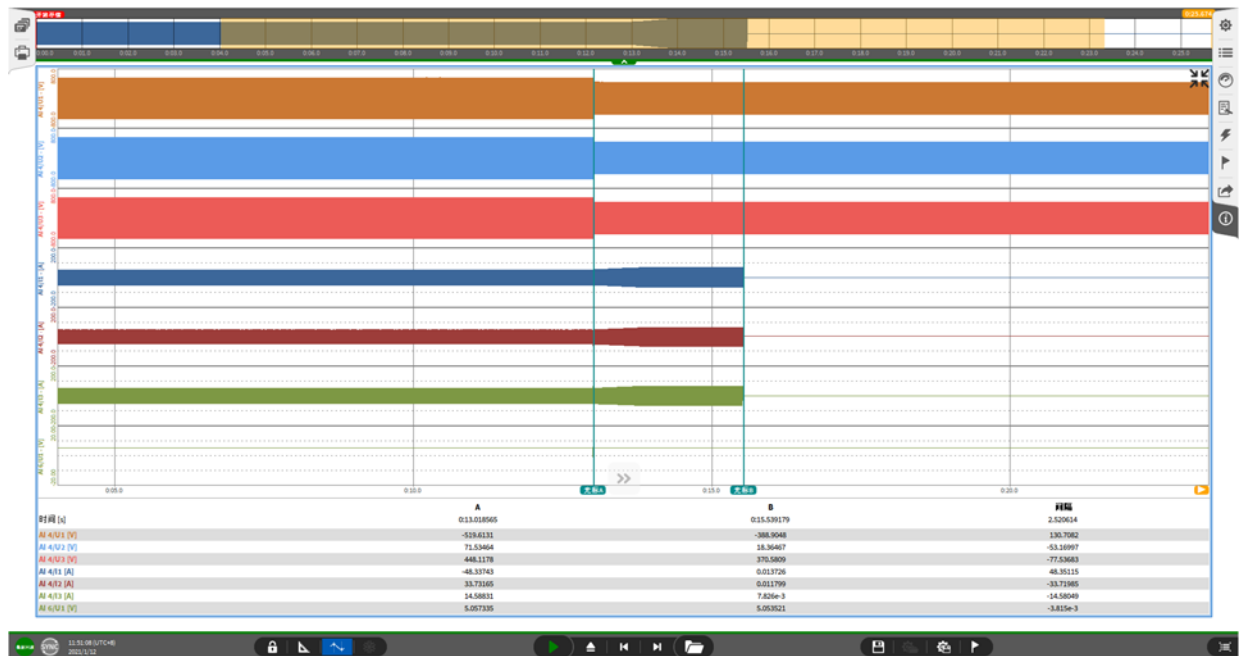
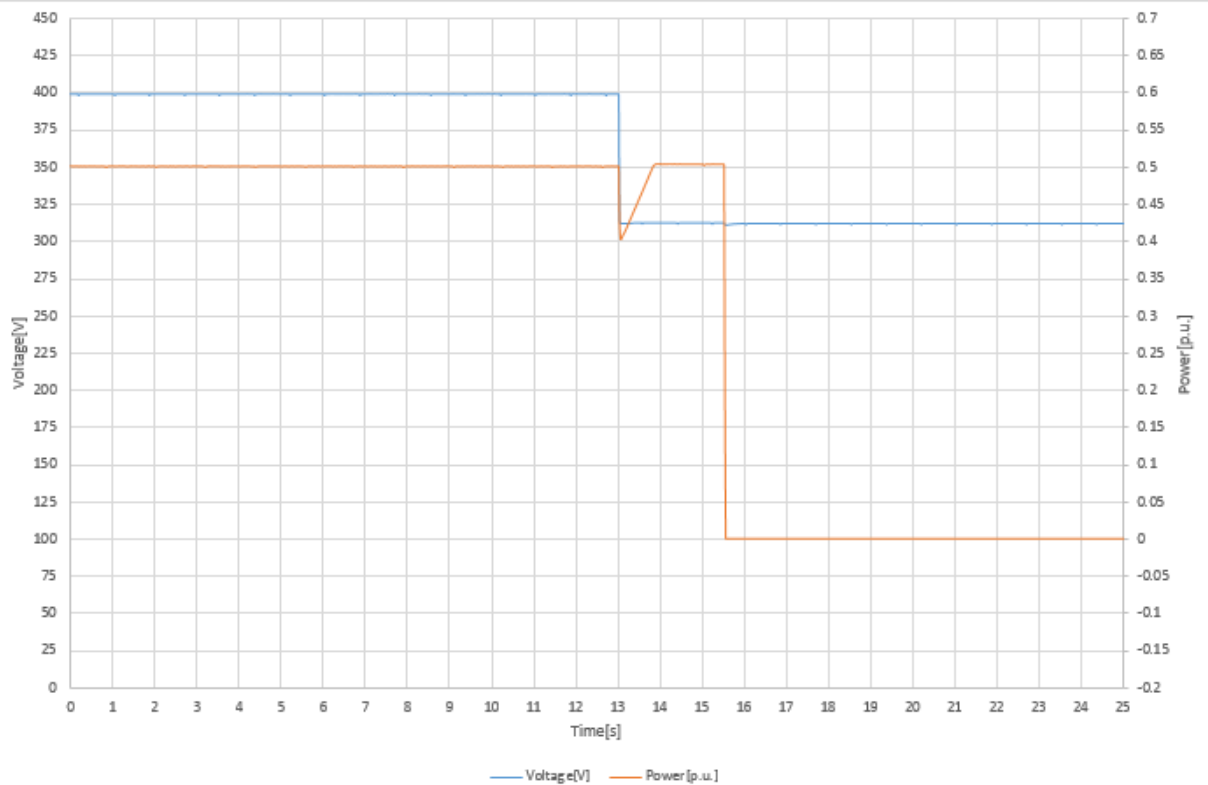
O/V stage 2-5



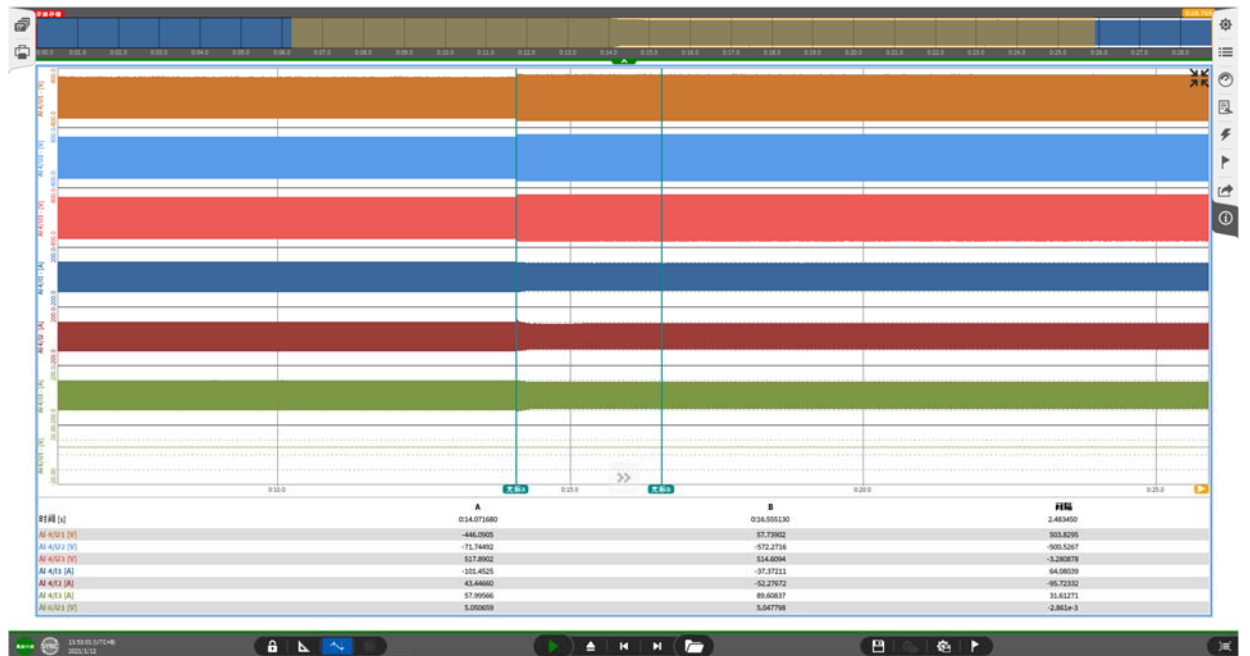
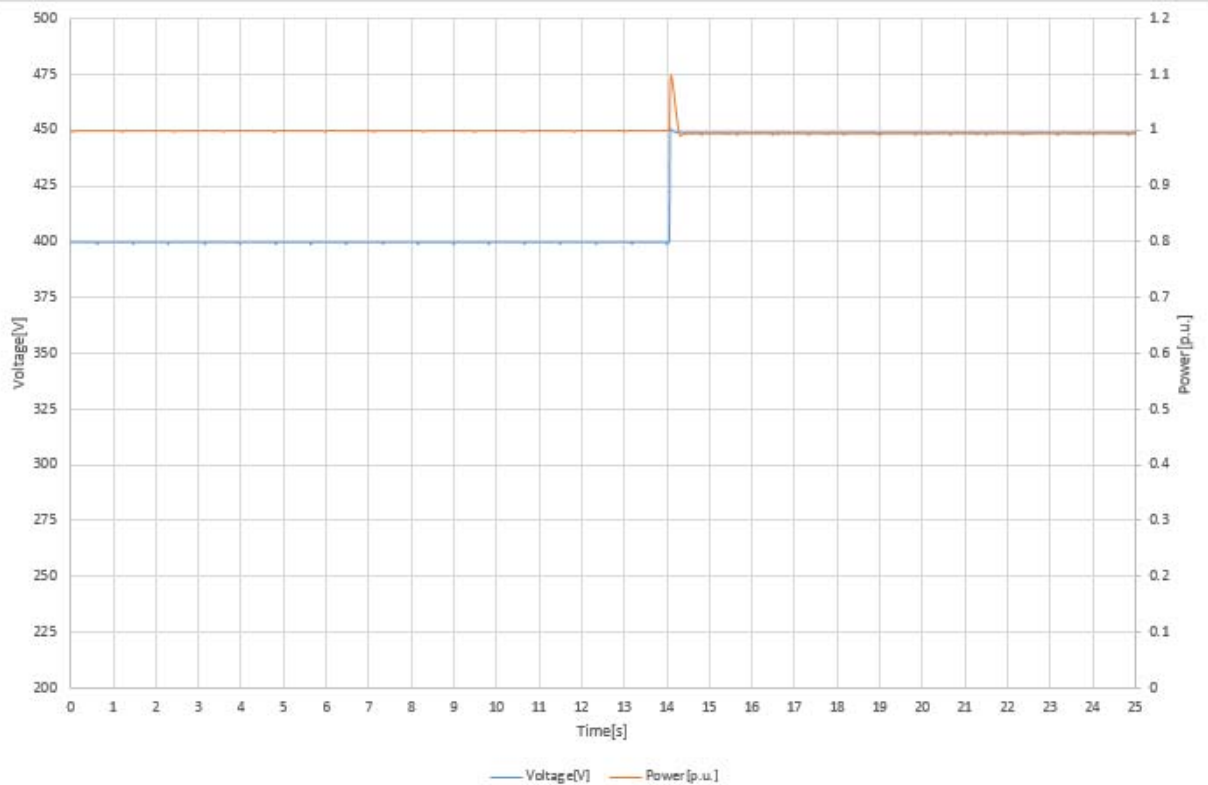
No trip tests – 188V



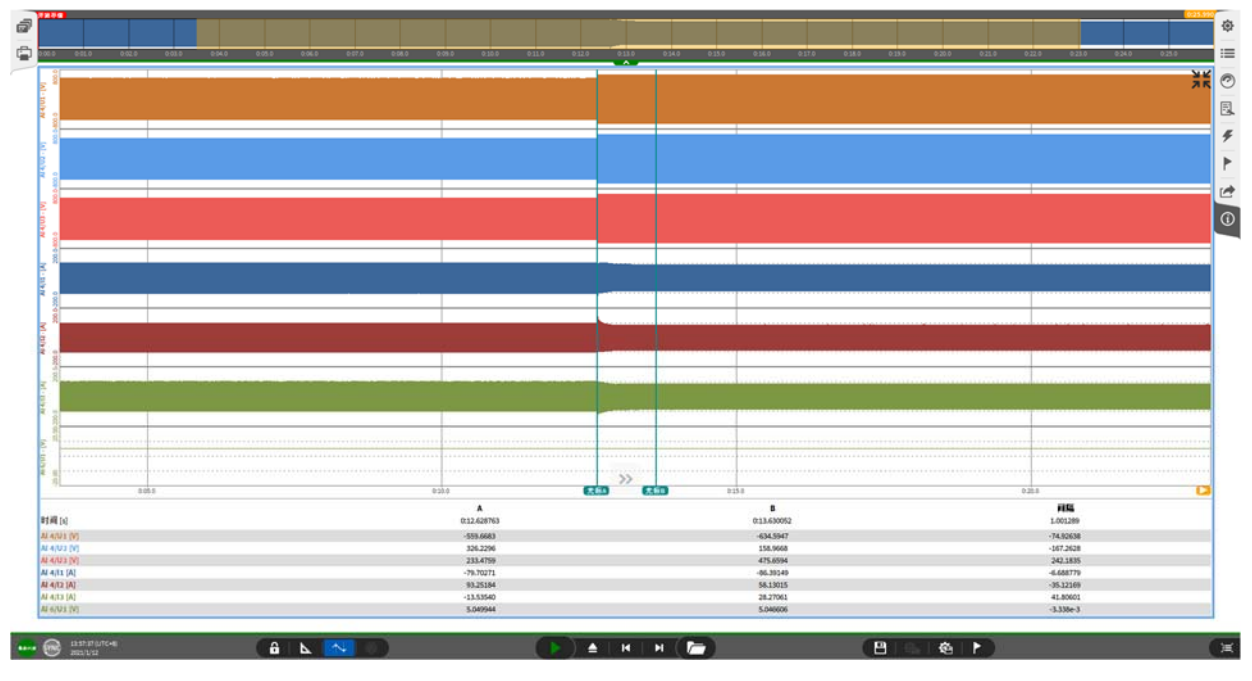
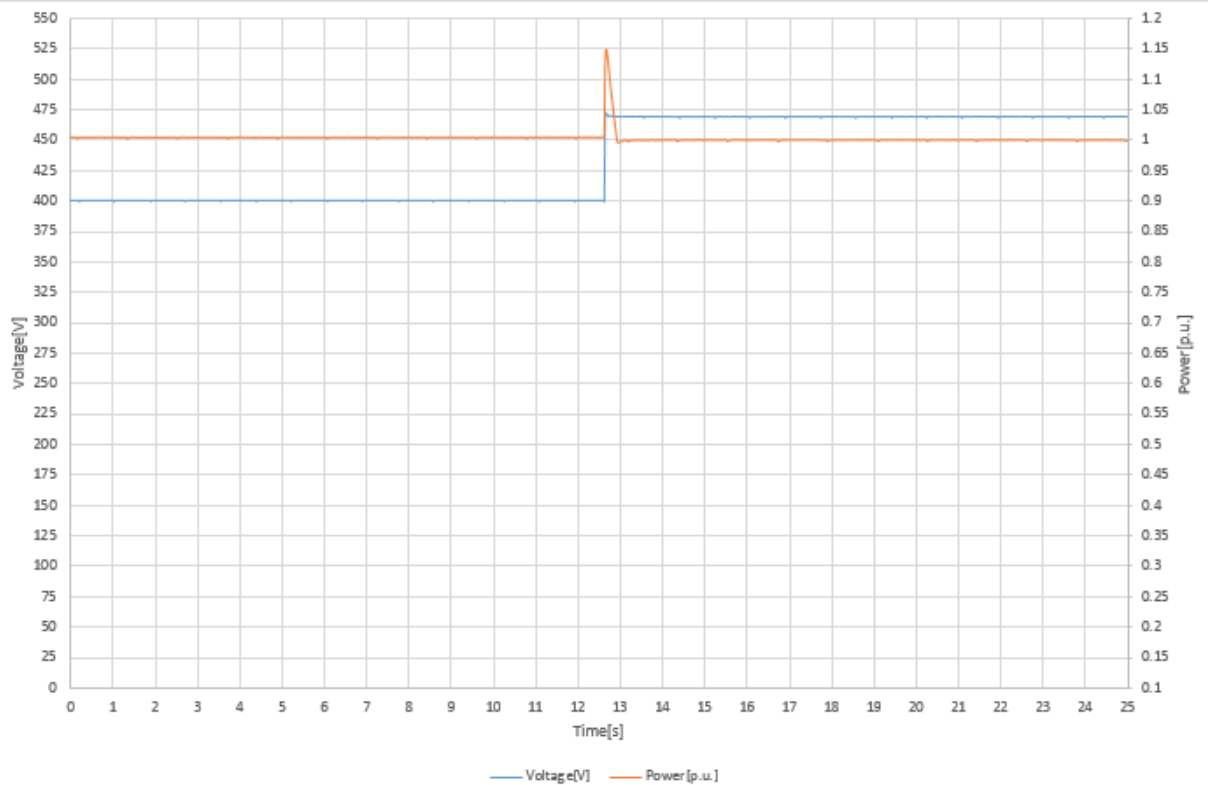
No trip tests – 180V

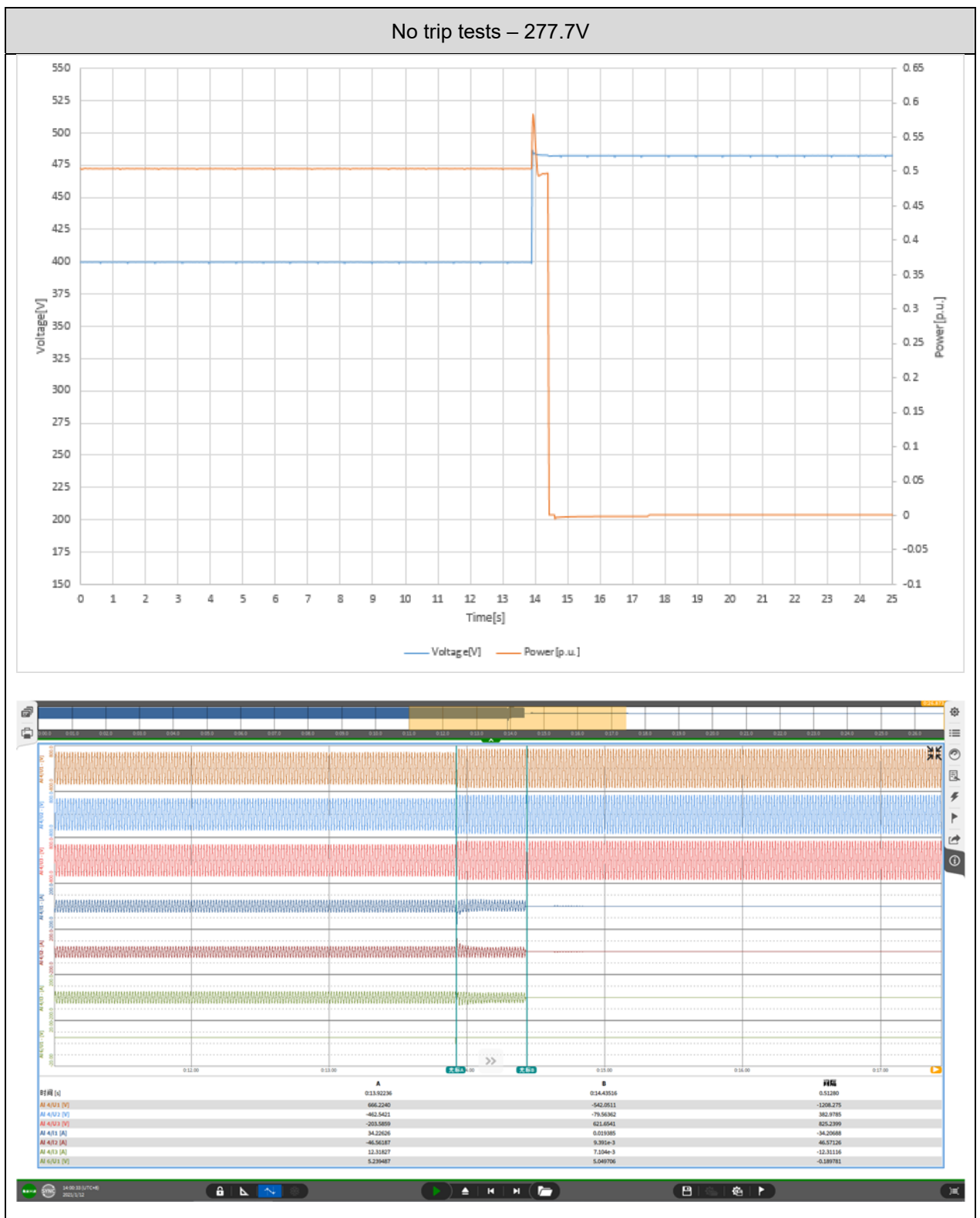


No trip tests – 258.2V



No trip tests – 269.7V





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4.3.3 Loss of Mains test

These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.

The maximum trip time is 0.5 s.

Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.

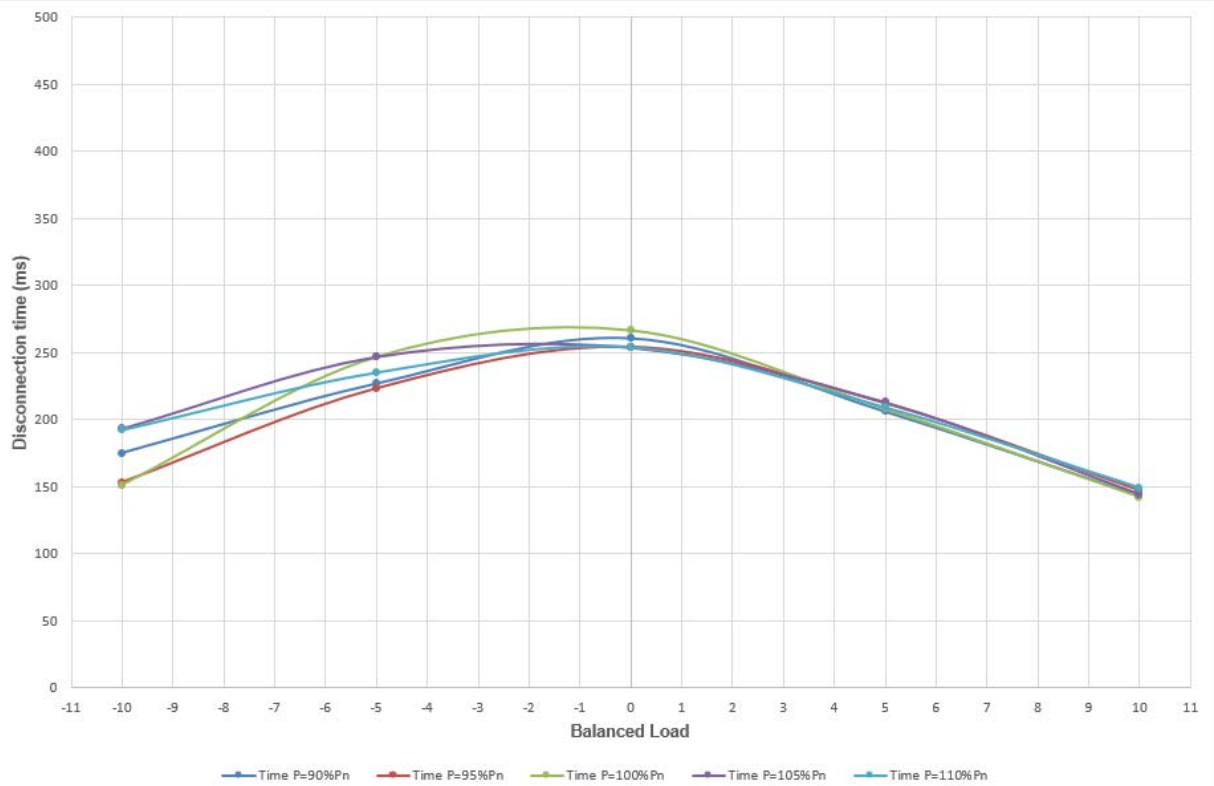
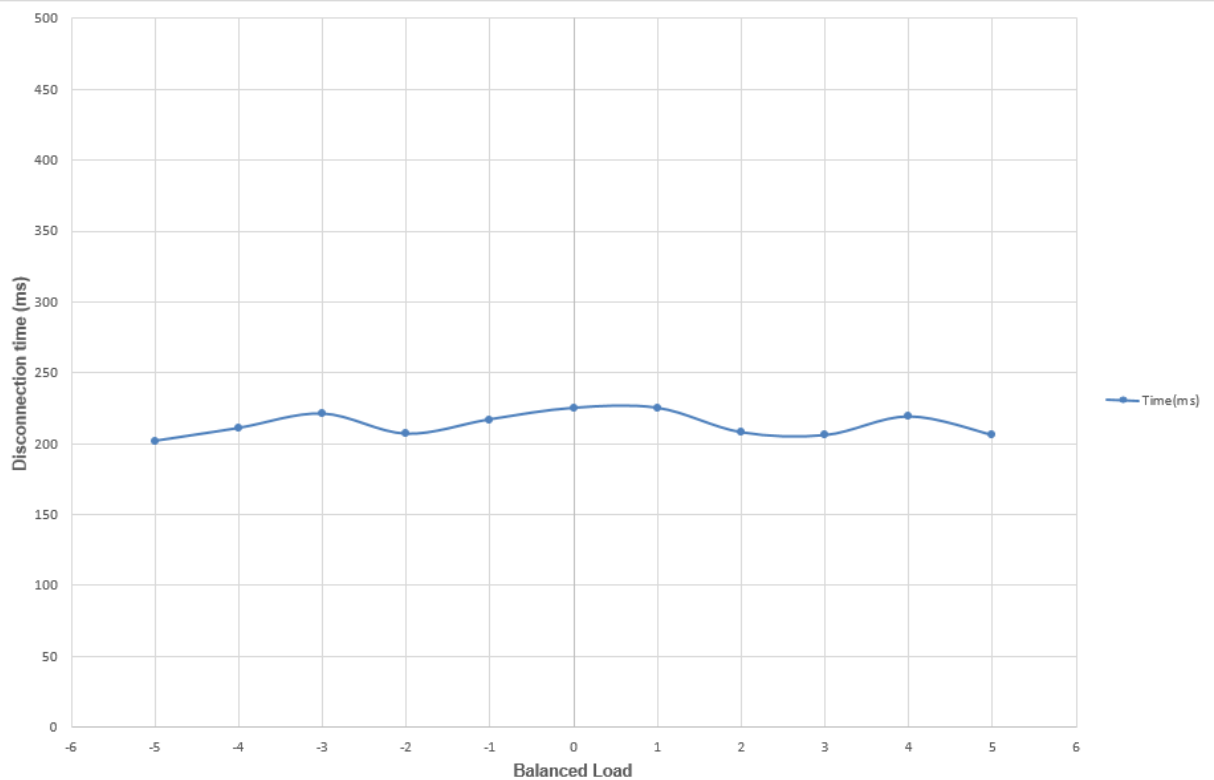
Following tables show the test results:

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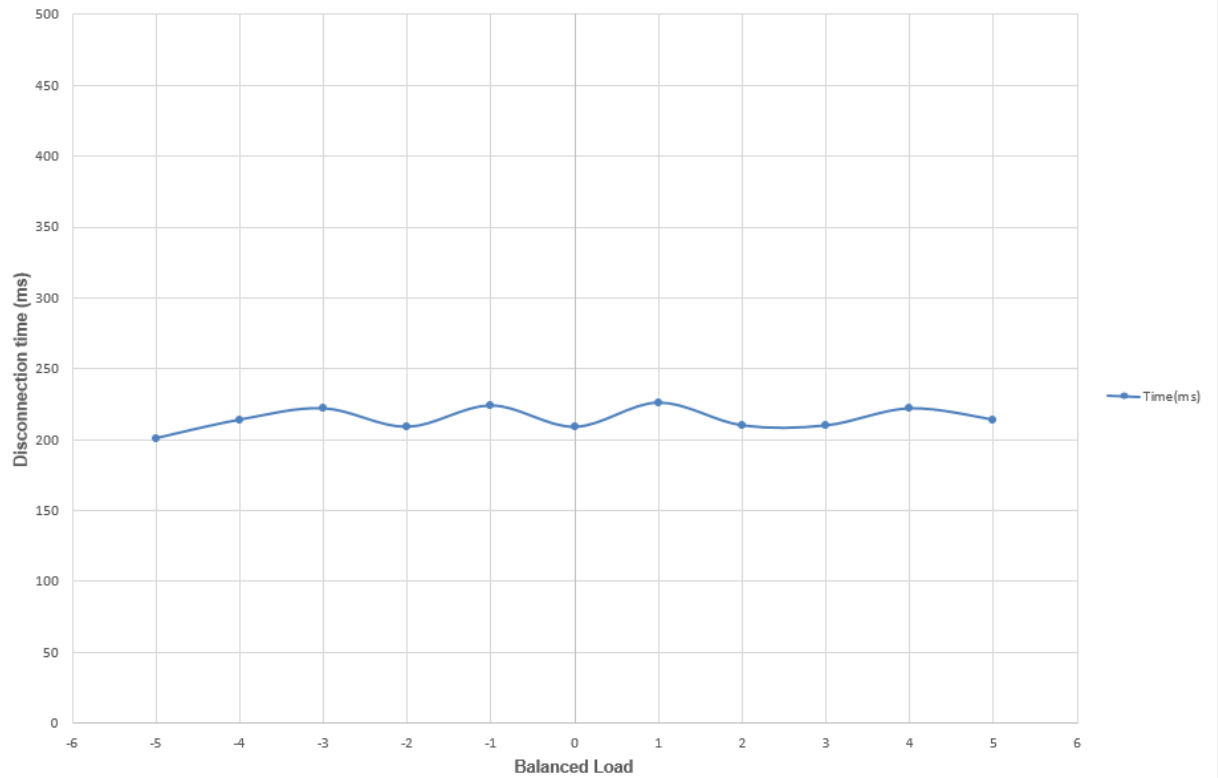
Table: tested condition and trip time						P
No.	P _{EUT} (% of EUT rating)	Reactive load (% of normal)	P _{AC}	Q _{AC}	Trip time(s)	Which load is selected to be adjusted (R or L)
Test condition A						
1	100	100	0	0	267	--
2	100	100	-5	-5	223	R/L
3	100	100	-5	0	247	R
4	100	100	-5	+5	247	R/L
5	100	100	0	-5	254	L
6	100	100	0	+5	254	L
7	100	100	+5	-5	212	R/L
8	100	100	+5	0	208	R
9	100	100	+5	+5	213	R/L
10	100	100	-10	+10	192	R/L
11	100	100	-5	+10	235	R/L
12	100	100	0	+10	254	L
13	100	100	+10	+10	149	R/L
14	100	100	+10	+5	144	R/L
15	100	100	+10	0	142	R
16	100	100	+10	-5	147	R/L
17	100	100	+10	-10	143	R/L
18	100	100	+5	-10	206	R/L
19	100	100	+5	+10	209	R/L
20	100	100	0	-10	261	L
21	100	100	-5	-10	227	R/L
22	100	100	-10	-10	175	R/L
23	100	100	-10	-5	153	R/L
24	100	100	-10	0	151	R
25	100	100	-10	+5	193	R/L
Test condition B						
1	66	66	0	0	225	--
2	66	66	0	-5	202	L
3	66	66	0	-4	211	L
4	66	66	0	-3	221	L
5	66	66	0	-2	207	L
6	66	66	0	-1	217	L
7	66	66	0	1	225	L
8	66	66	0	2	208	L
9	66	66	0	3	206	L
10	66	66	0	4	219	L
11	66	66	0	5	206	L
Test condition C						
1	33	33	0	0	209	--
2	33	33	0	-5	201	L
3	33	33	0	-4	214	L
4	33	33	0	-3	222	L
5	33	33	0	-2	209	L
6	33	33	0	-1	224	L
7	33	33	0	1	226	L
8	33	33	0	2	210	L
9	33	33	0	3	210	L
10	33	33	0	4	222	L
11	33	33	0	5	214	L

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Test results are graphically shown in following pages.

Test Condition A

Test Condition B


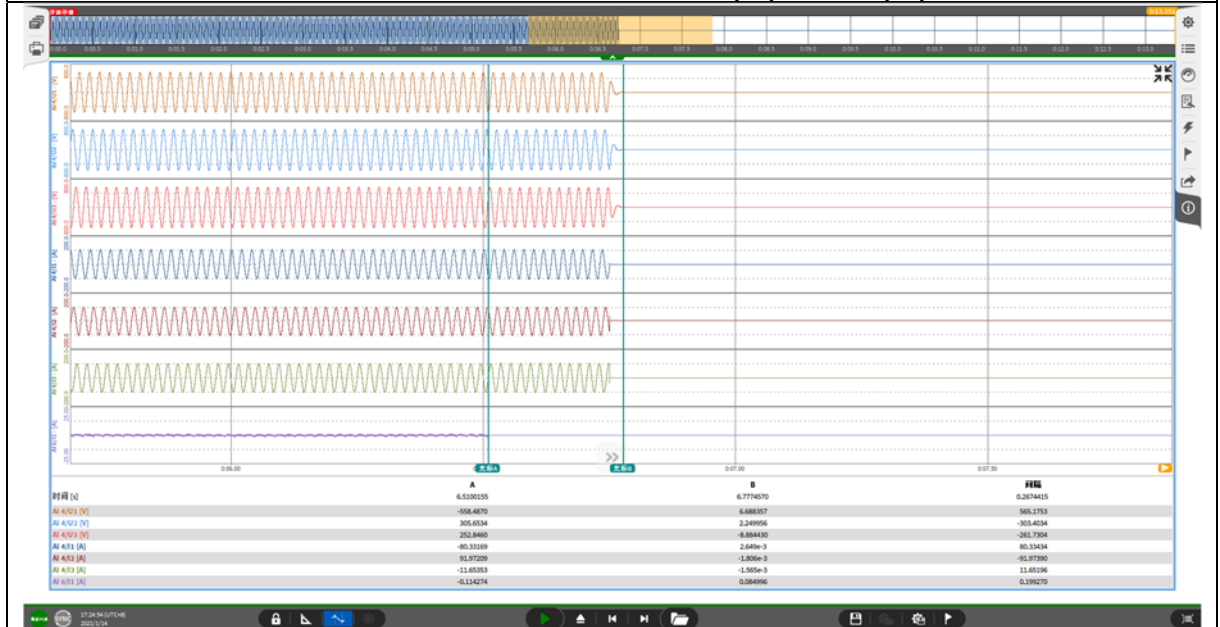
Test Condition C



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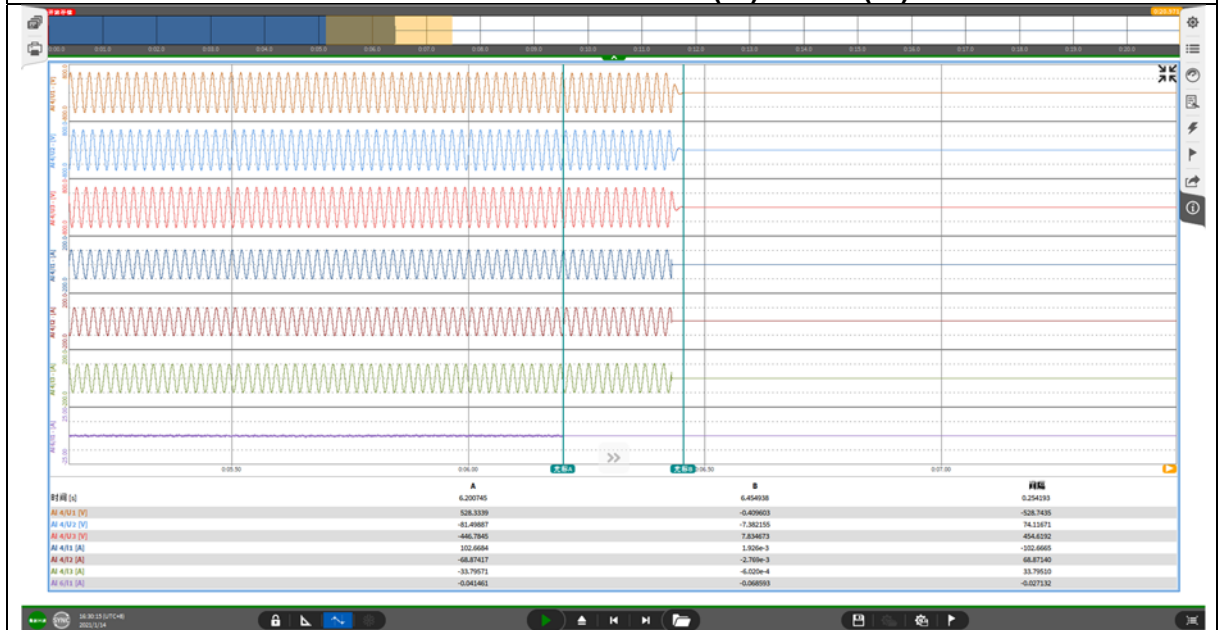
Test A

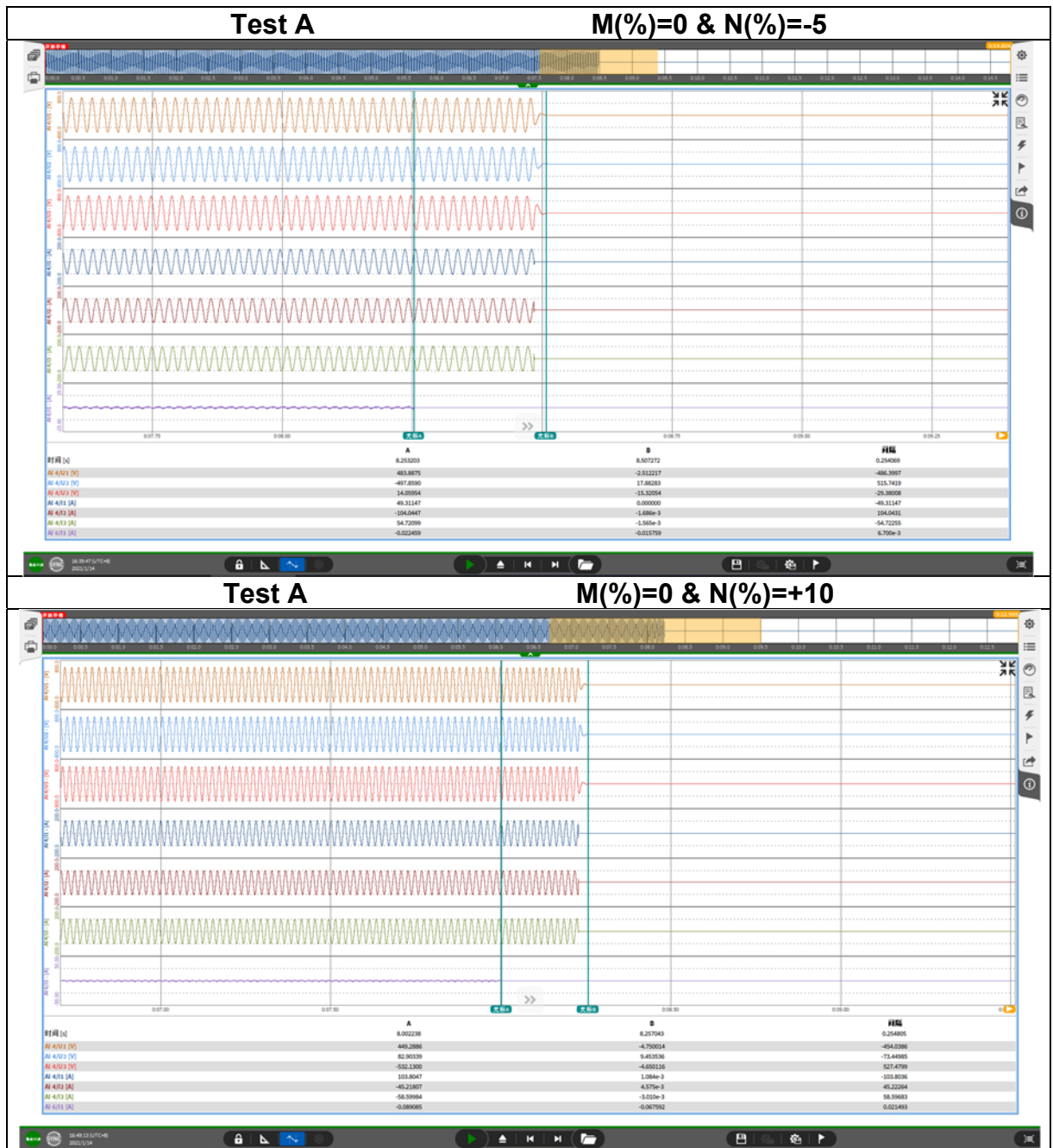
M(%)=0 & N(%)=0



Test A

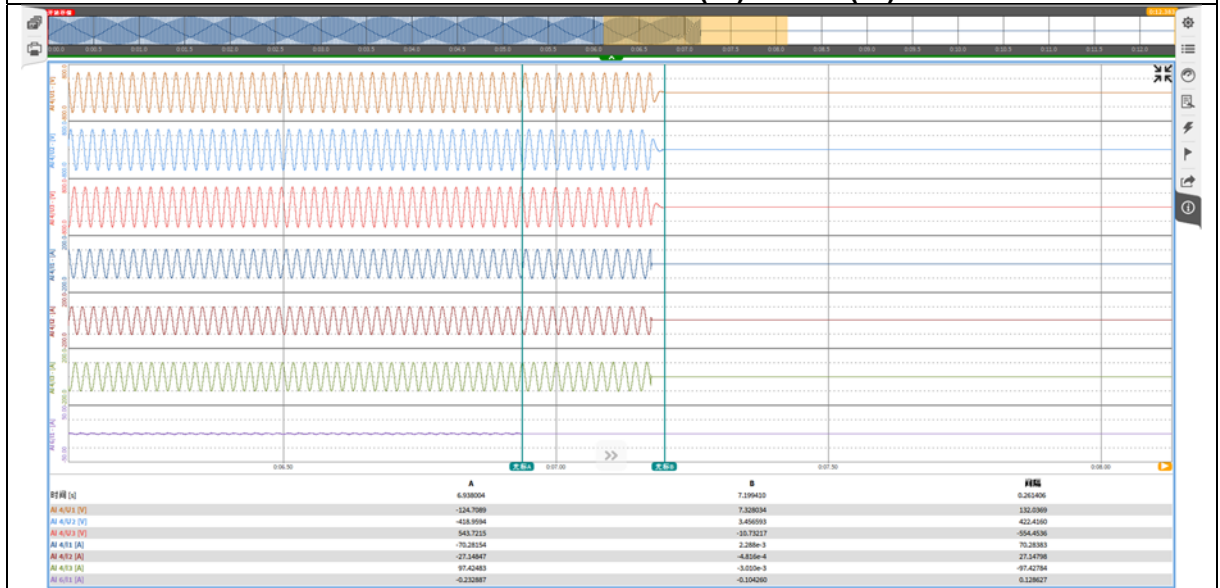
M(%)=0 & N(%)=+5





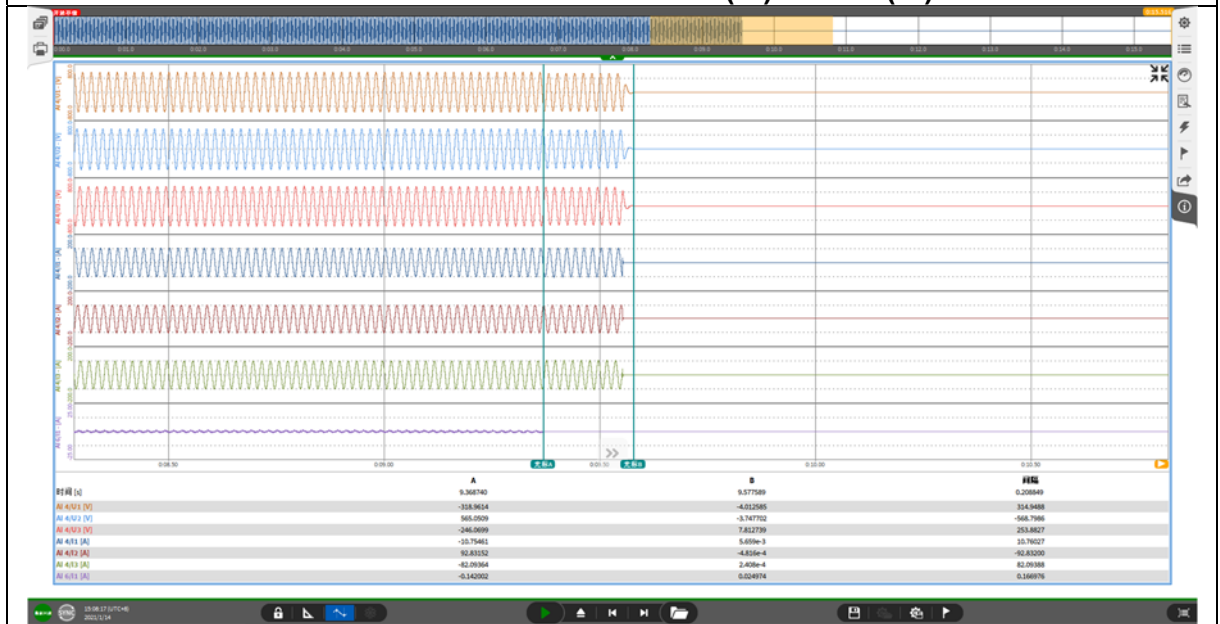
Test A

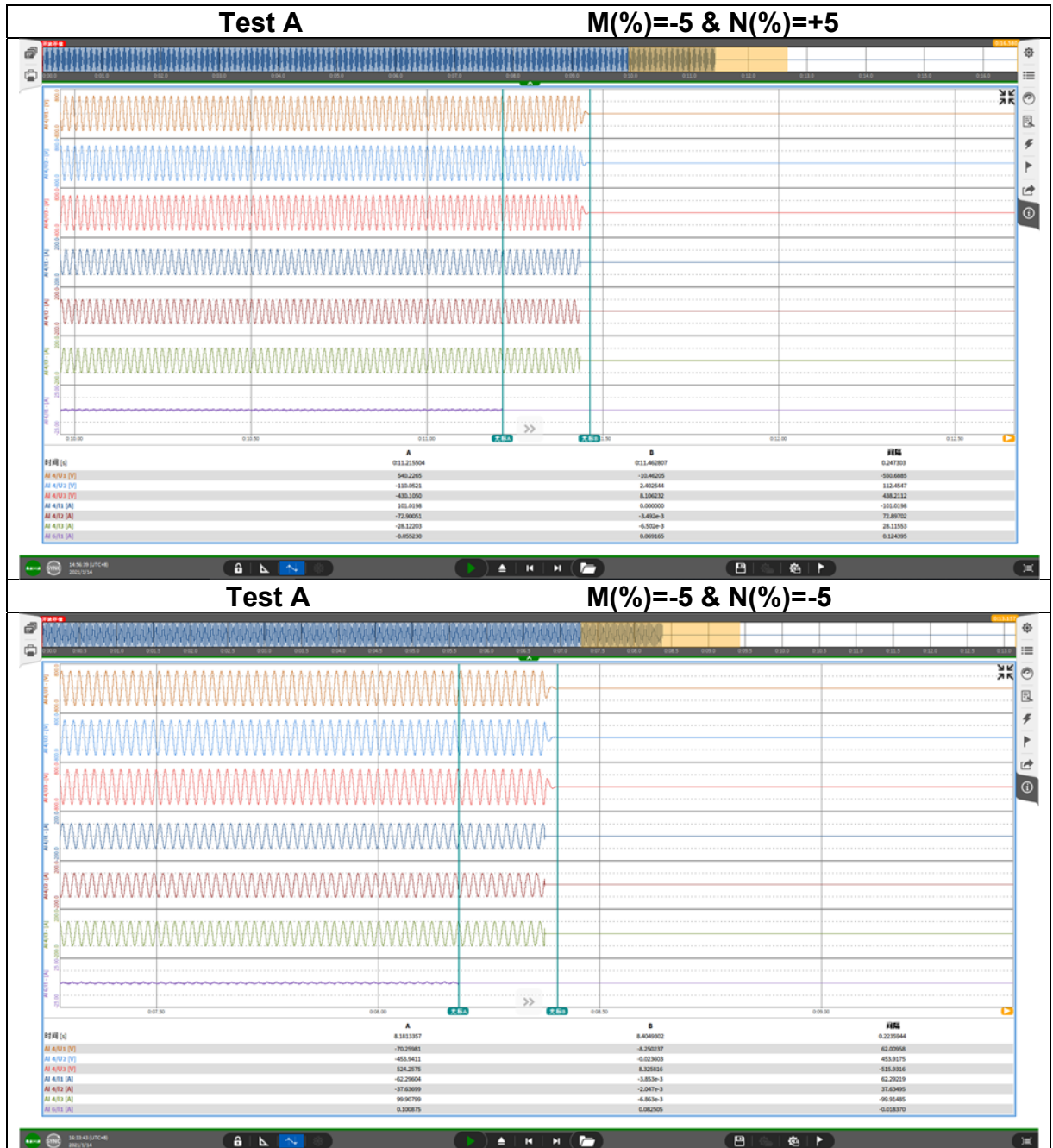
M(%)=0 & N(%)=-10



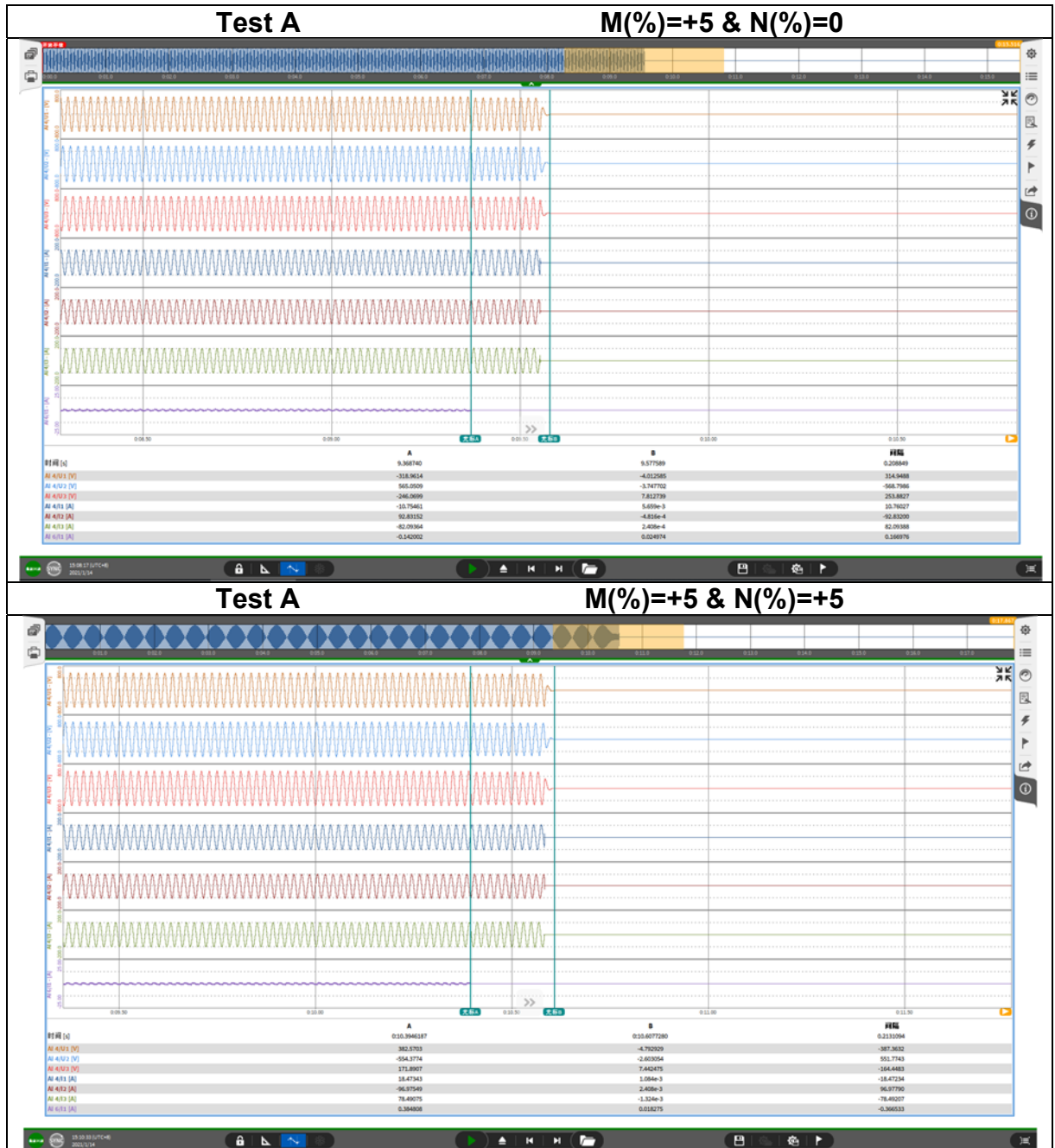
Test A

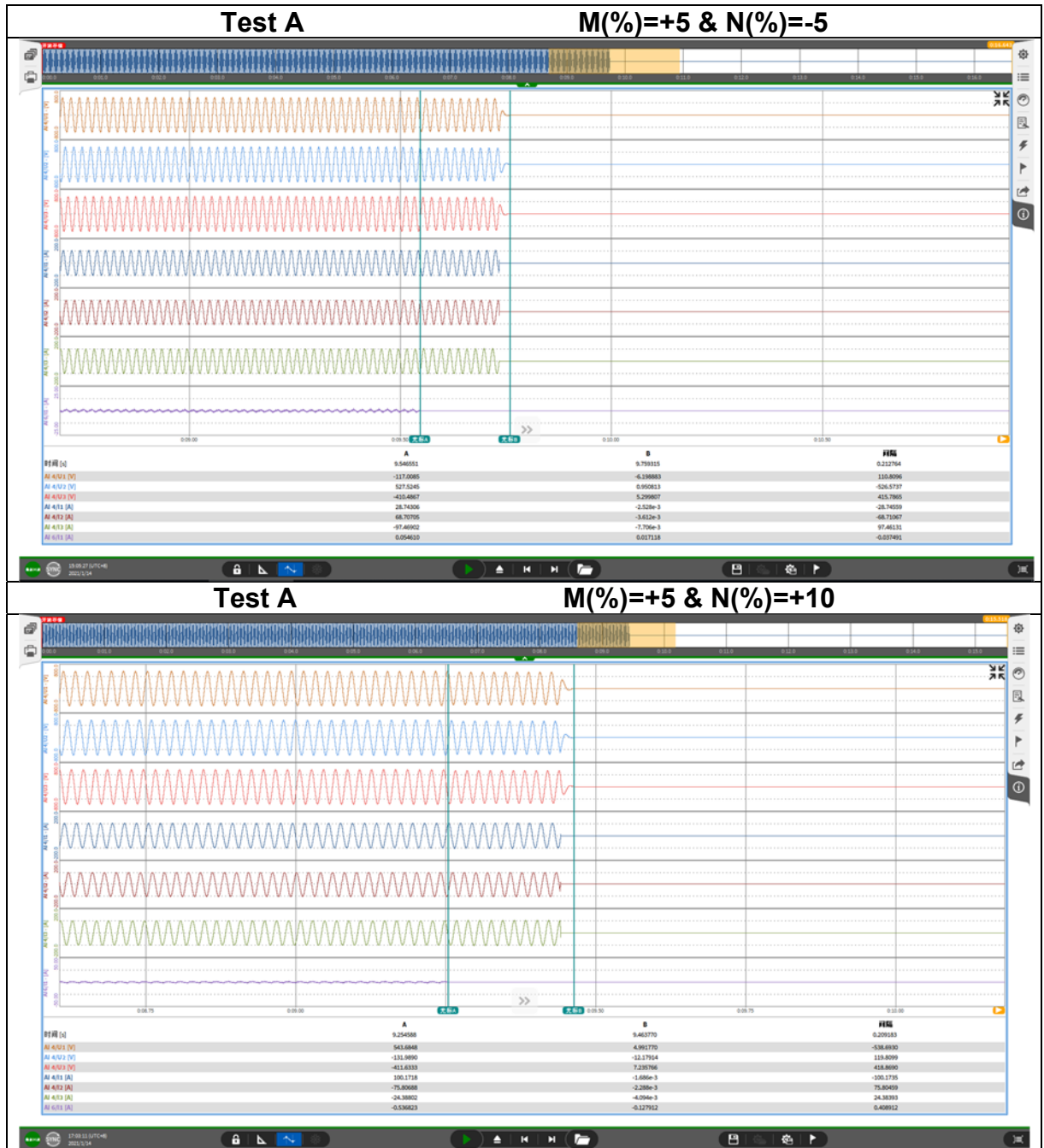
M(%)=-5 & N(%)=0



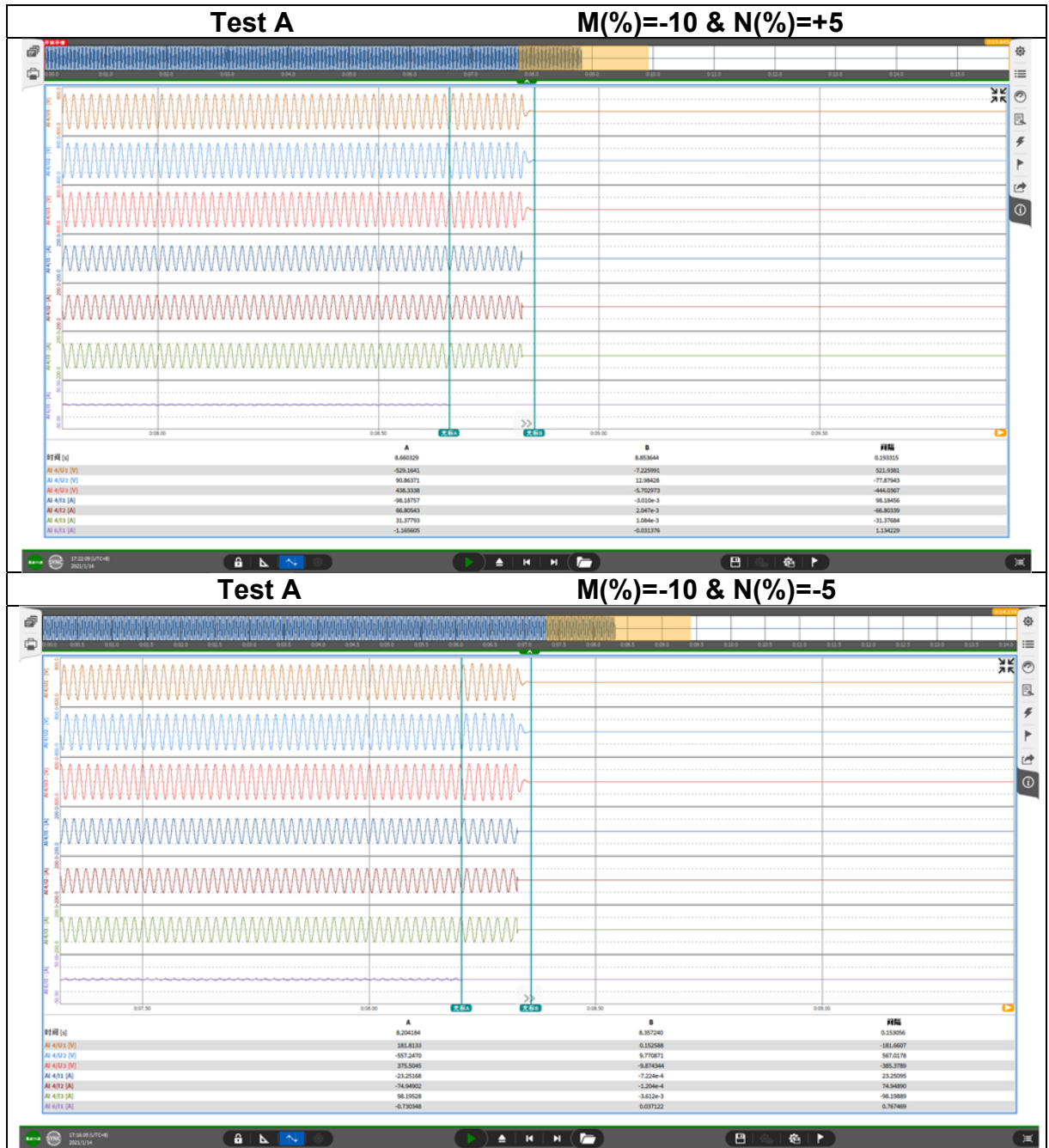


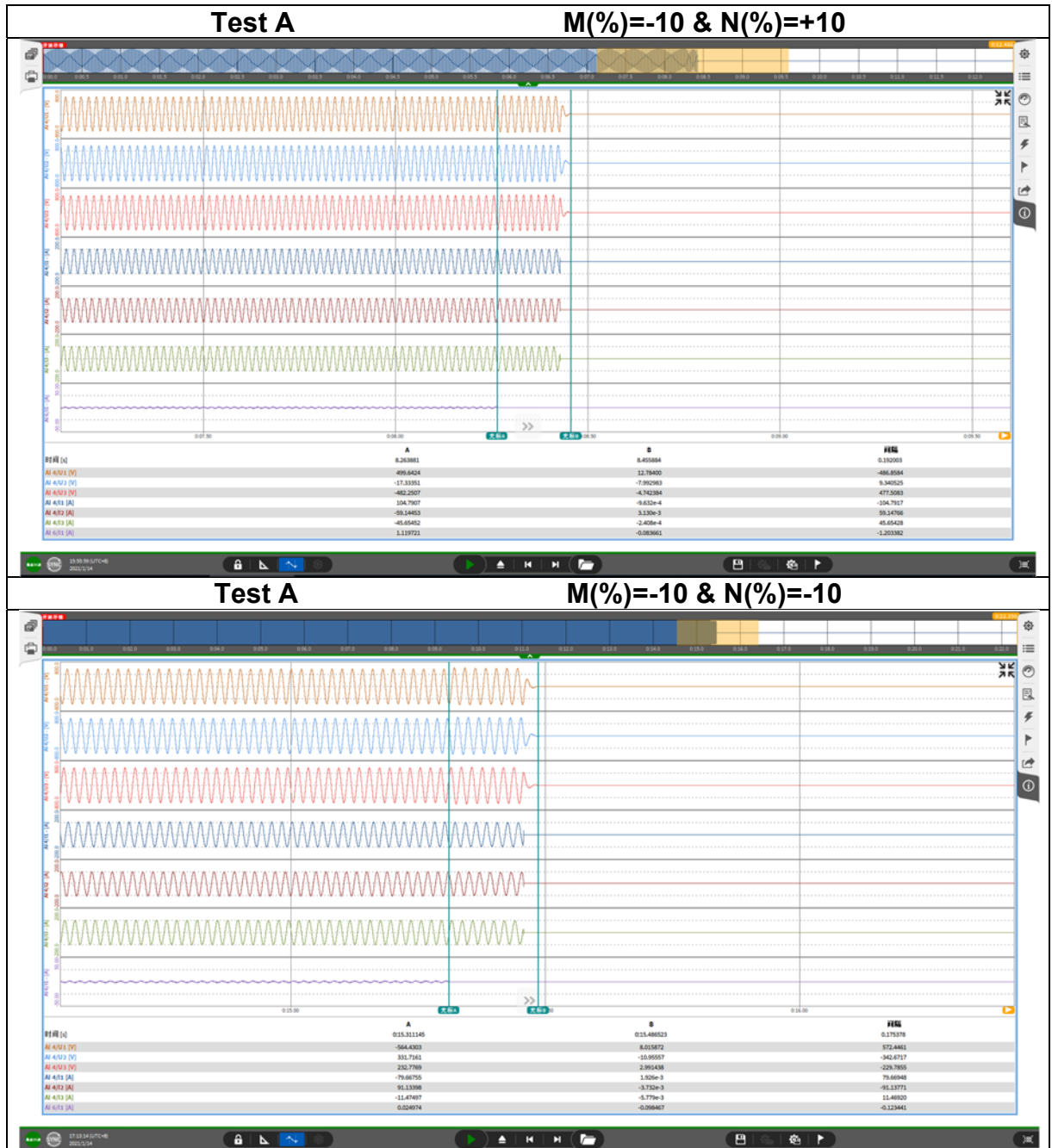


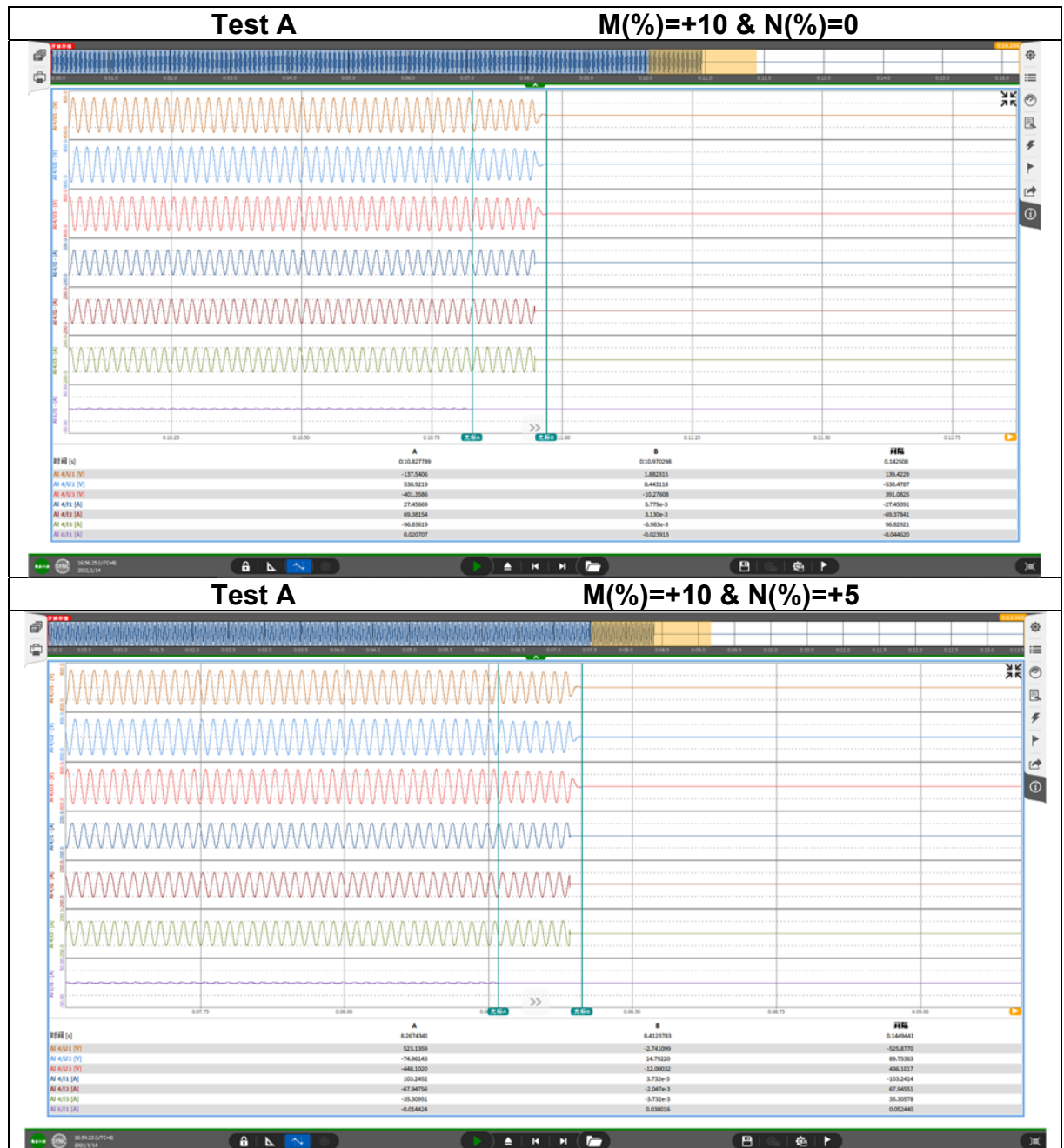


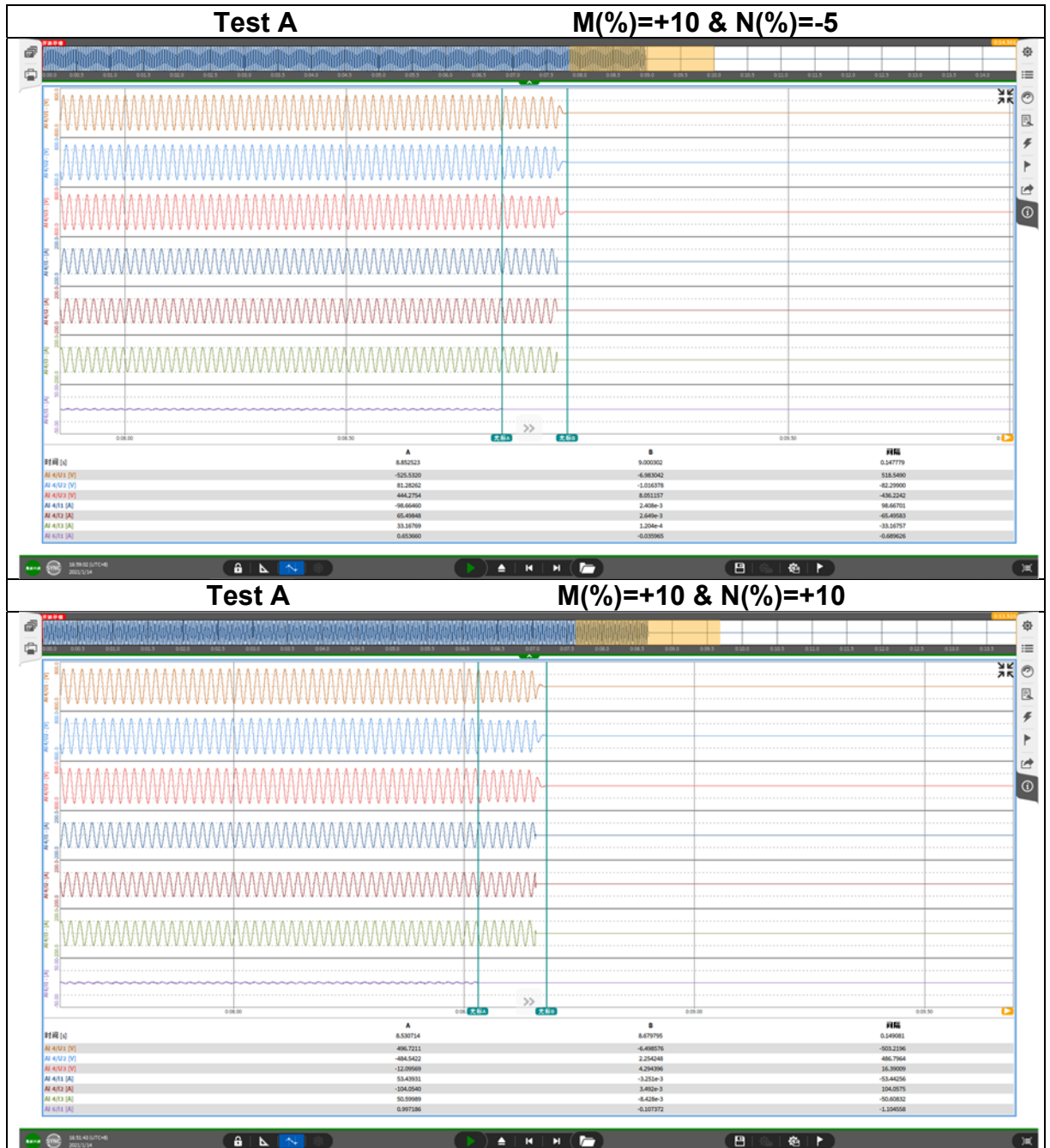


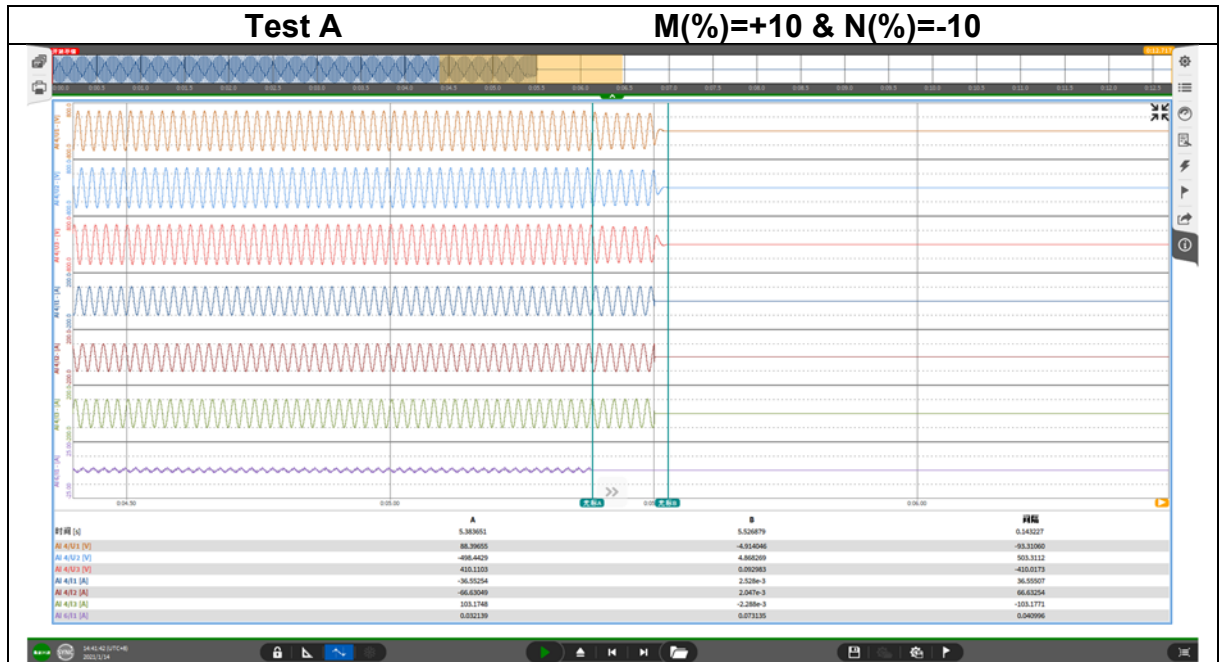








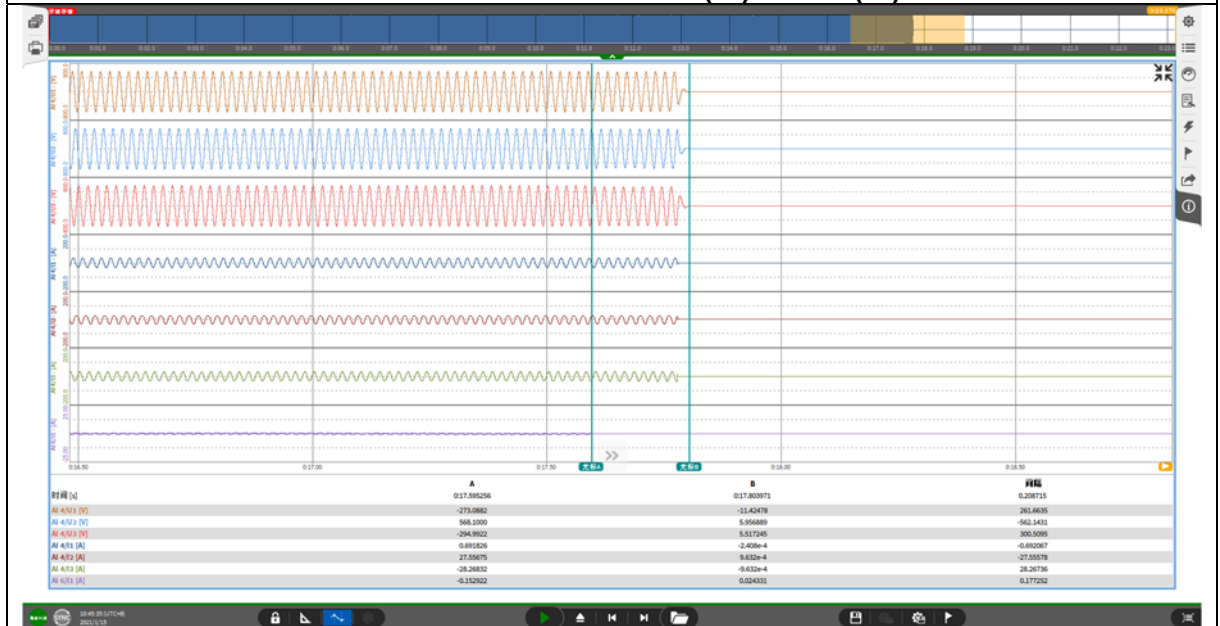






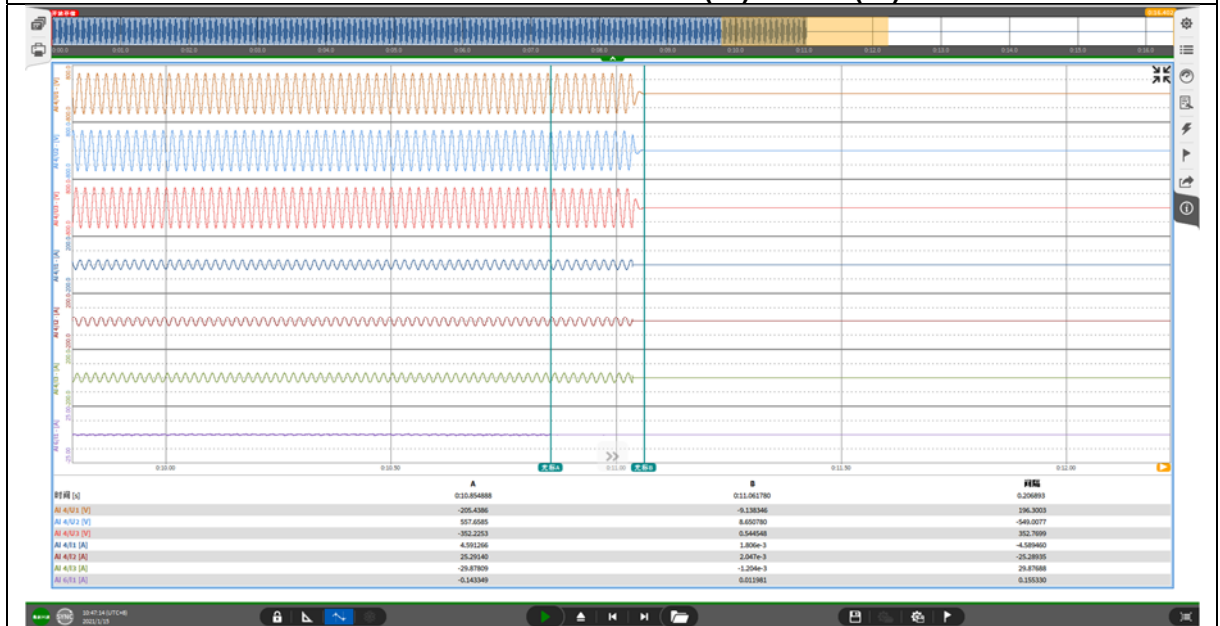
Test B

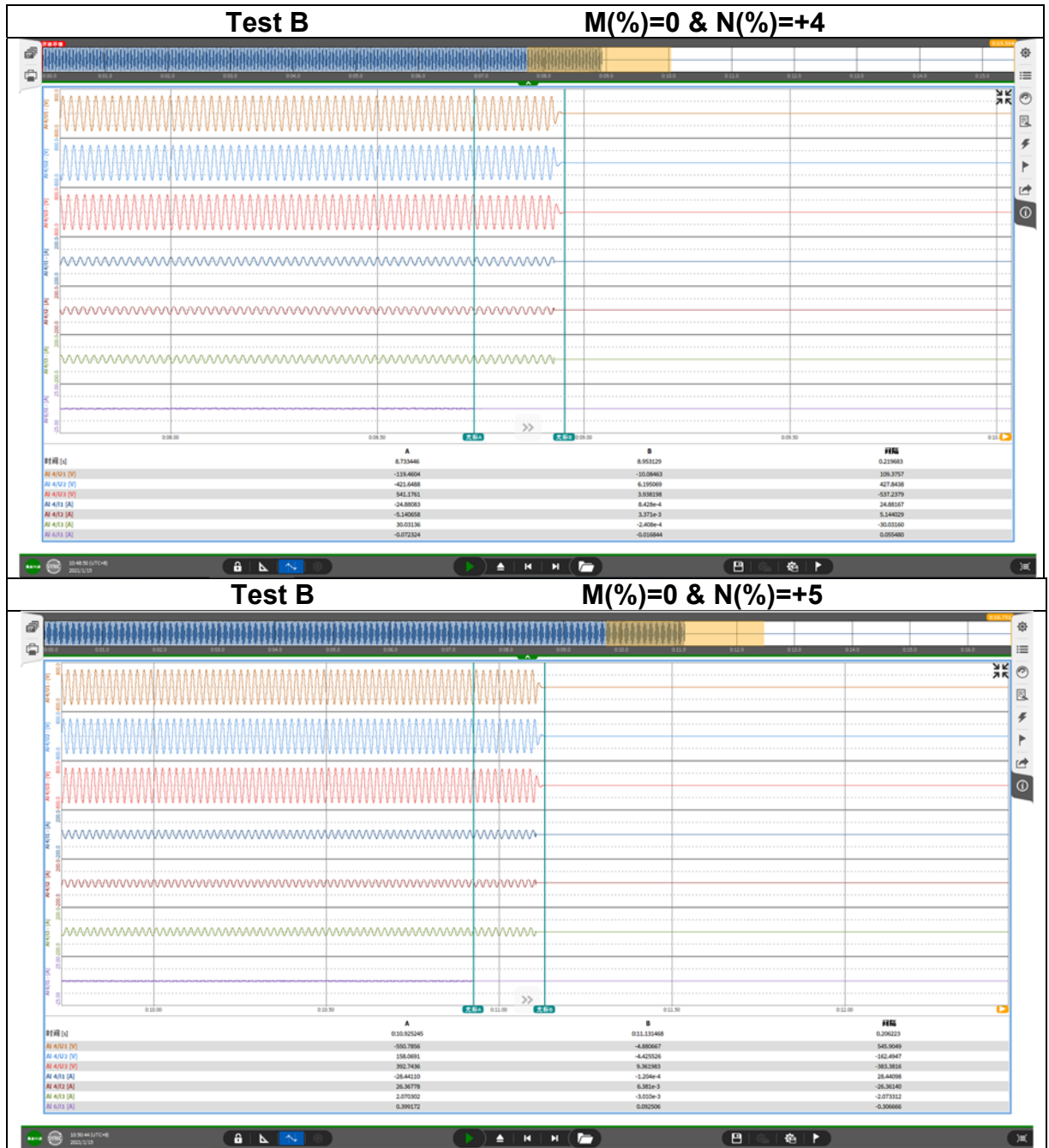
M(%)=0 & N(%)=+2



Test B

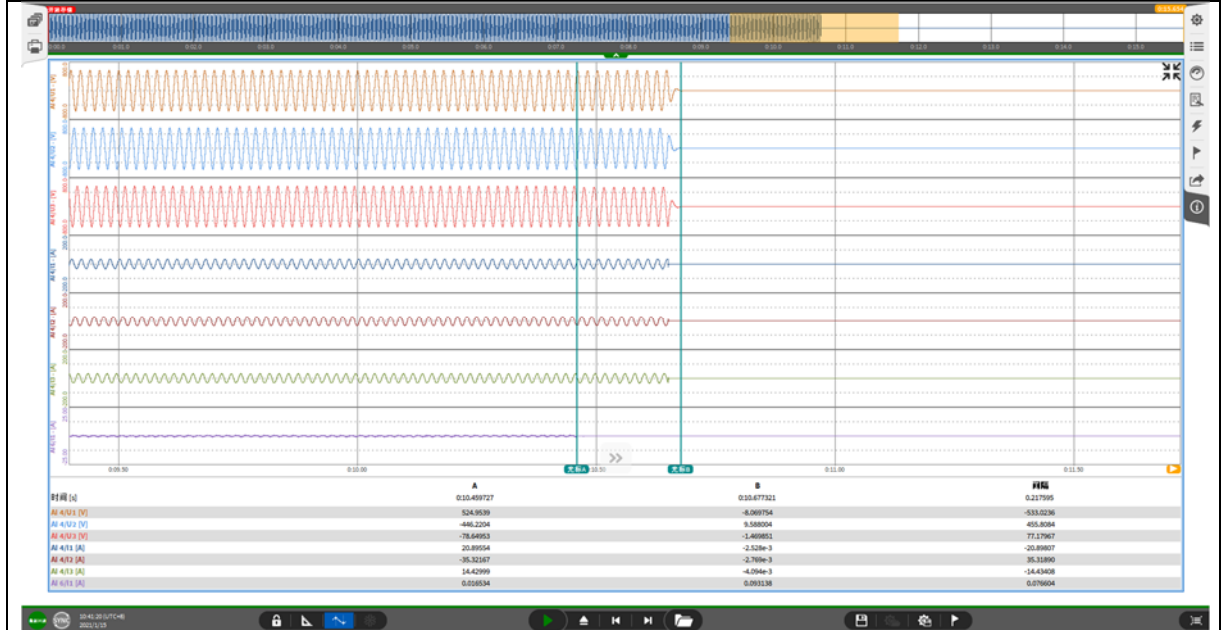
M(%)=0 & N(%)=+3





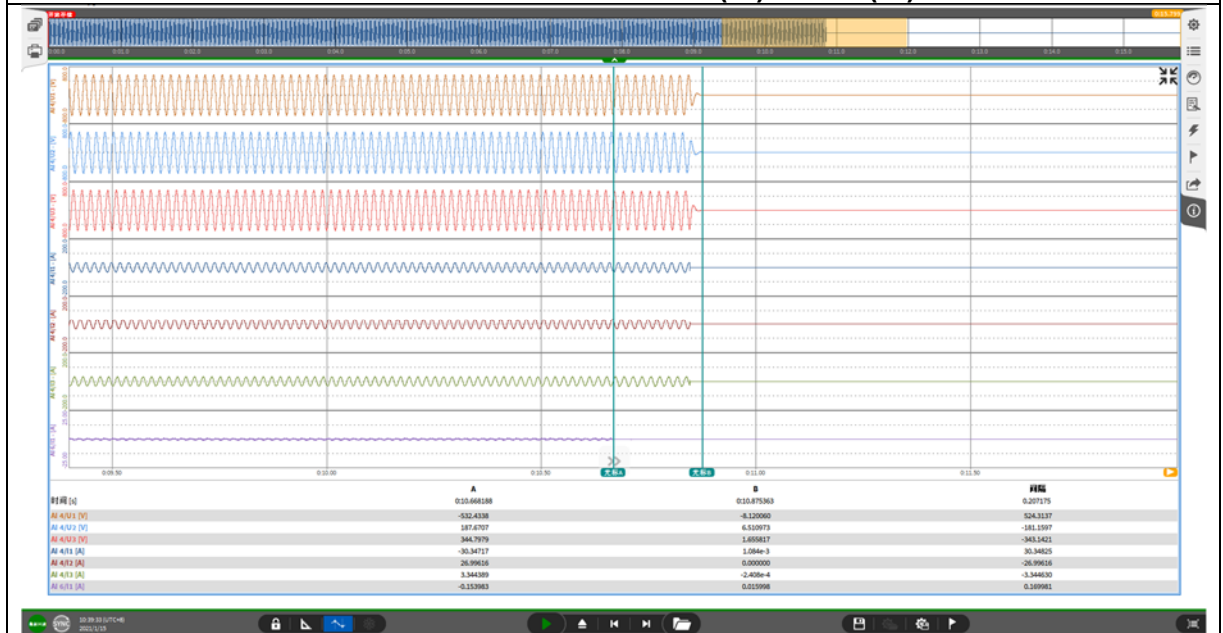
Test B

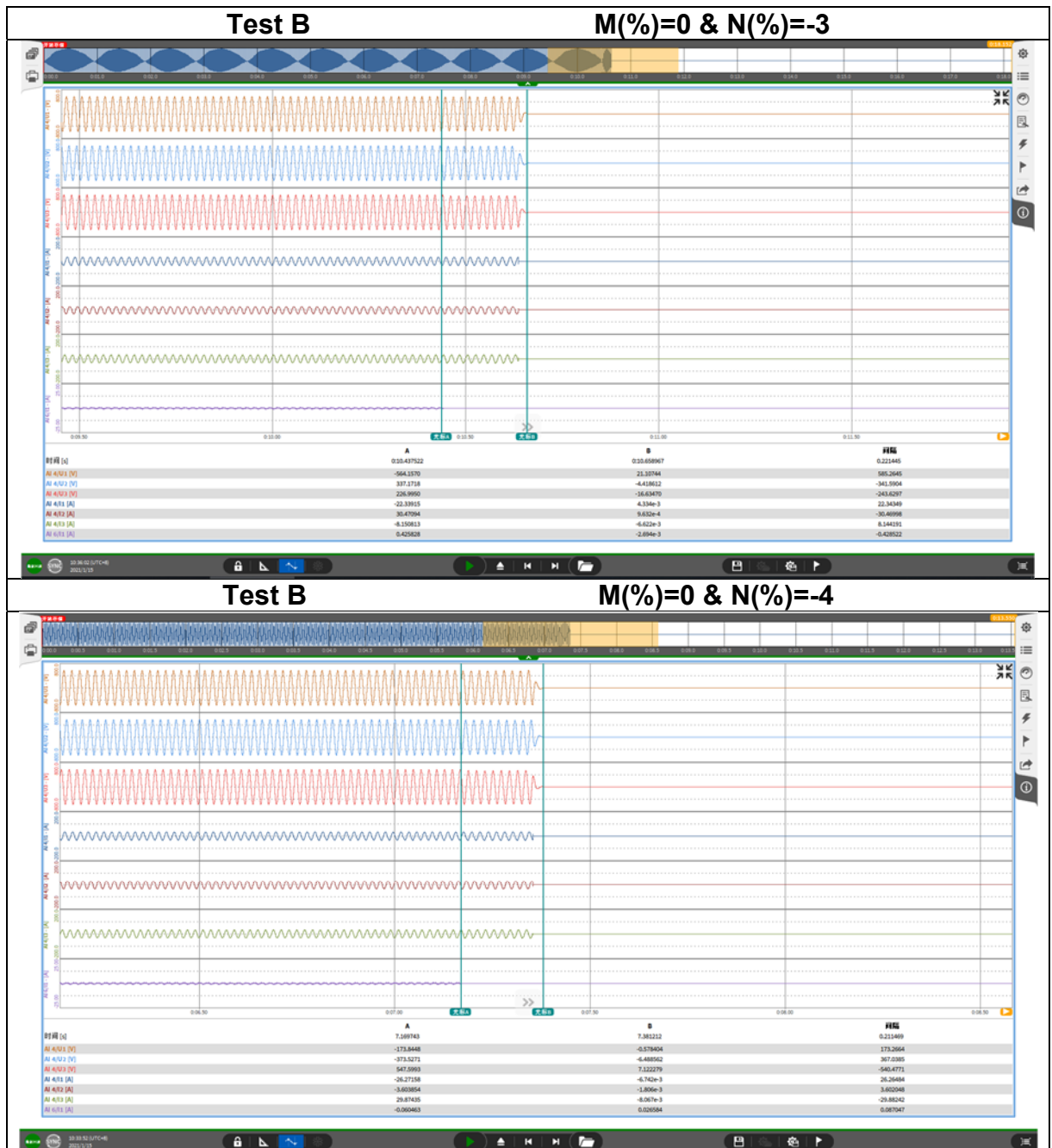
M(%)=0 & N(%)=-1



Test B

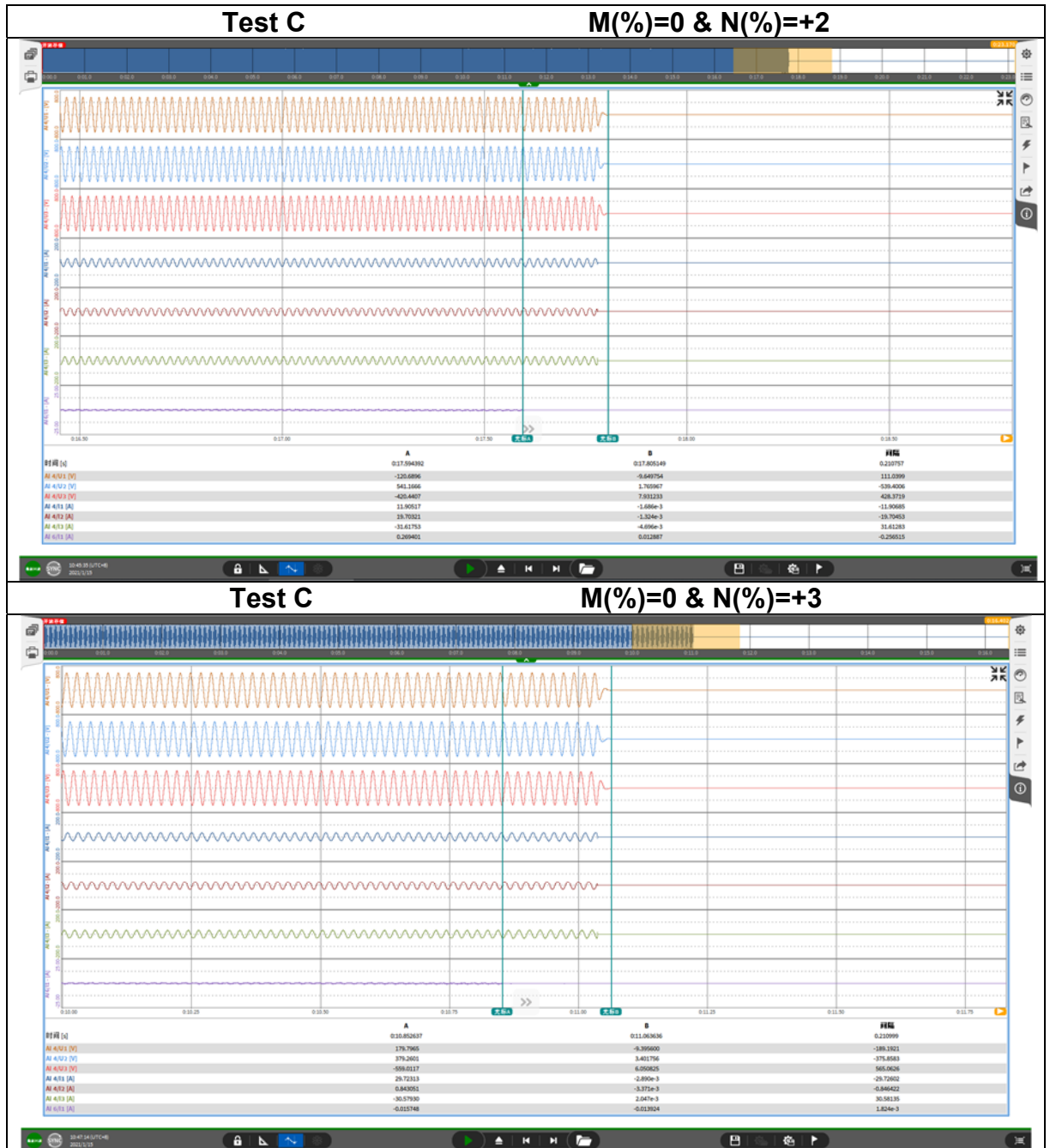
M(%)=0 & N(%)=-2





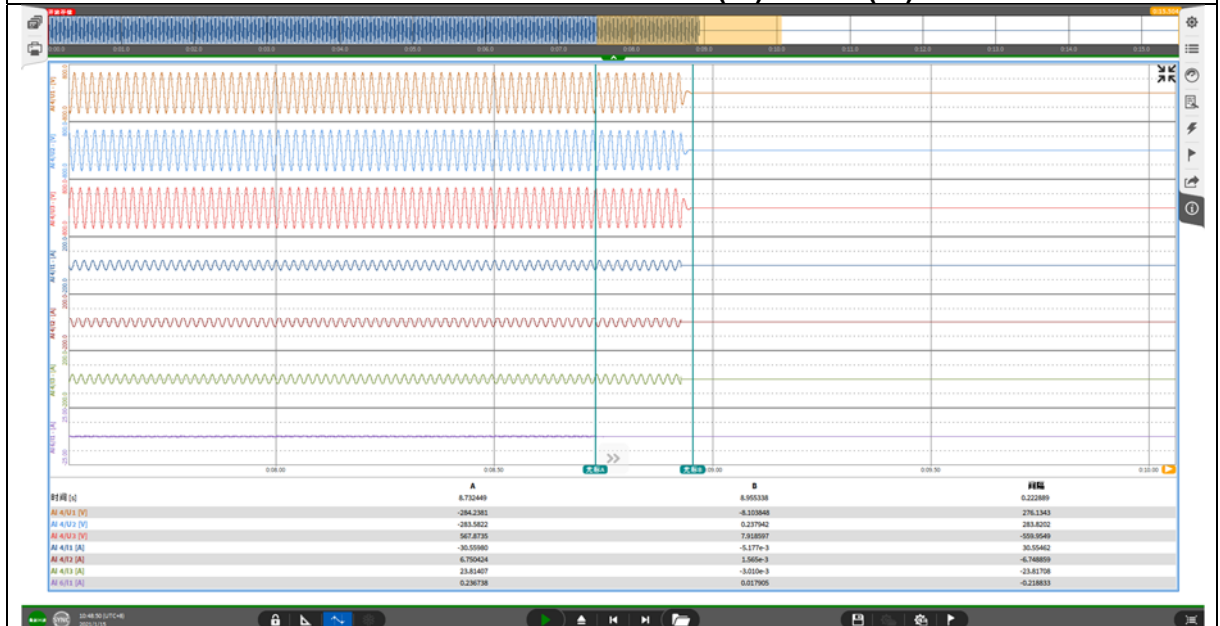






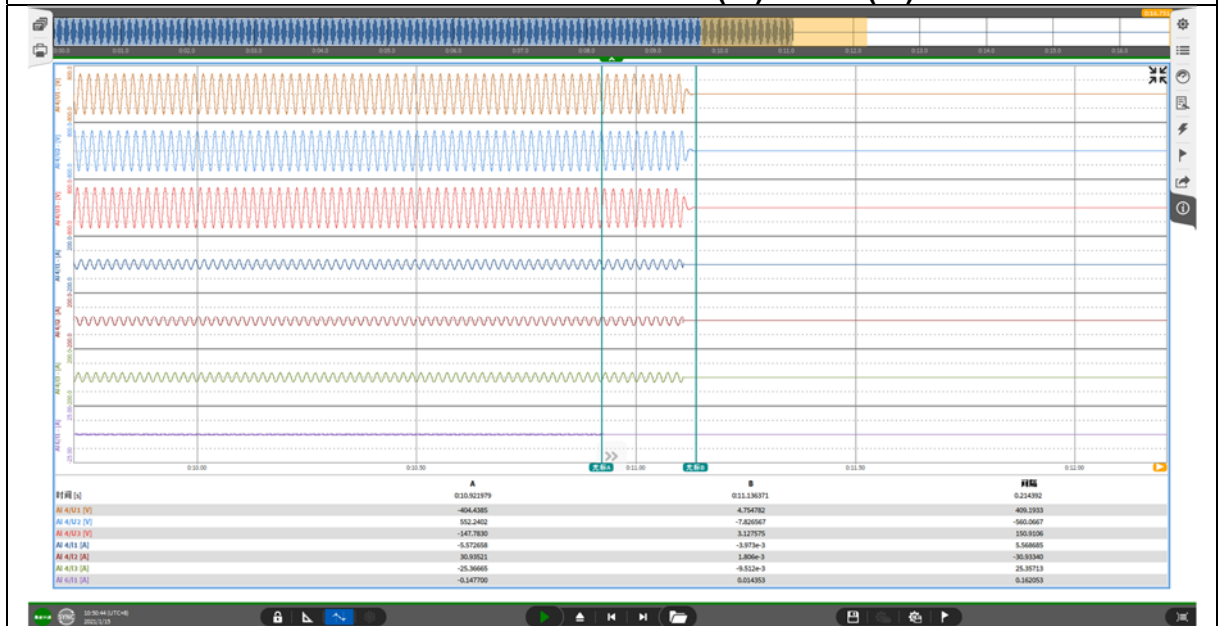
Test C

M(%)=0 & N(%)=+4



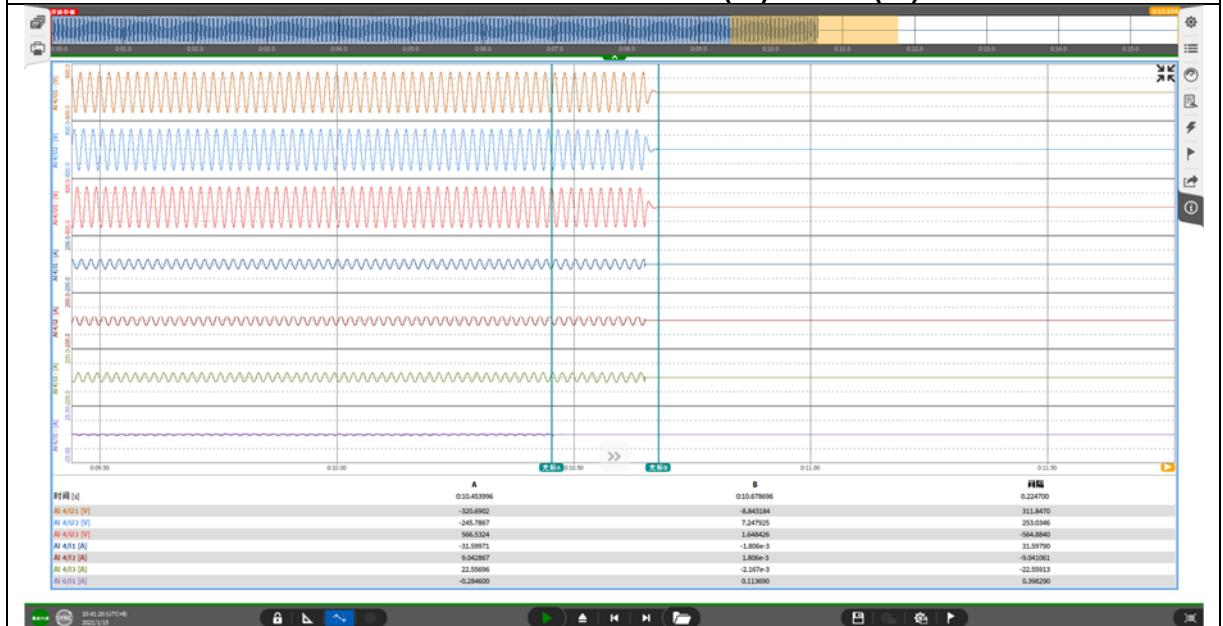
Test C

M(%)=0 & N(%)=+5



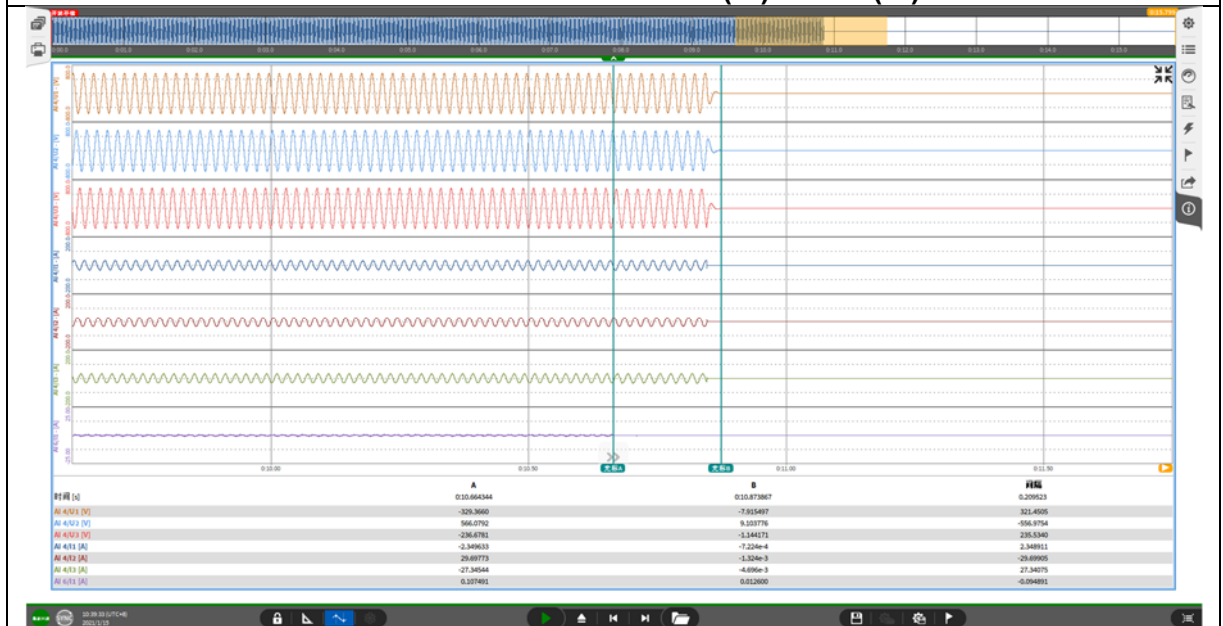
Test C

M(%)=0 & N(%)=-1



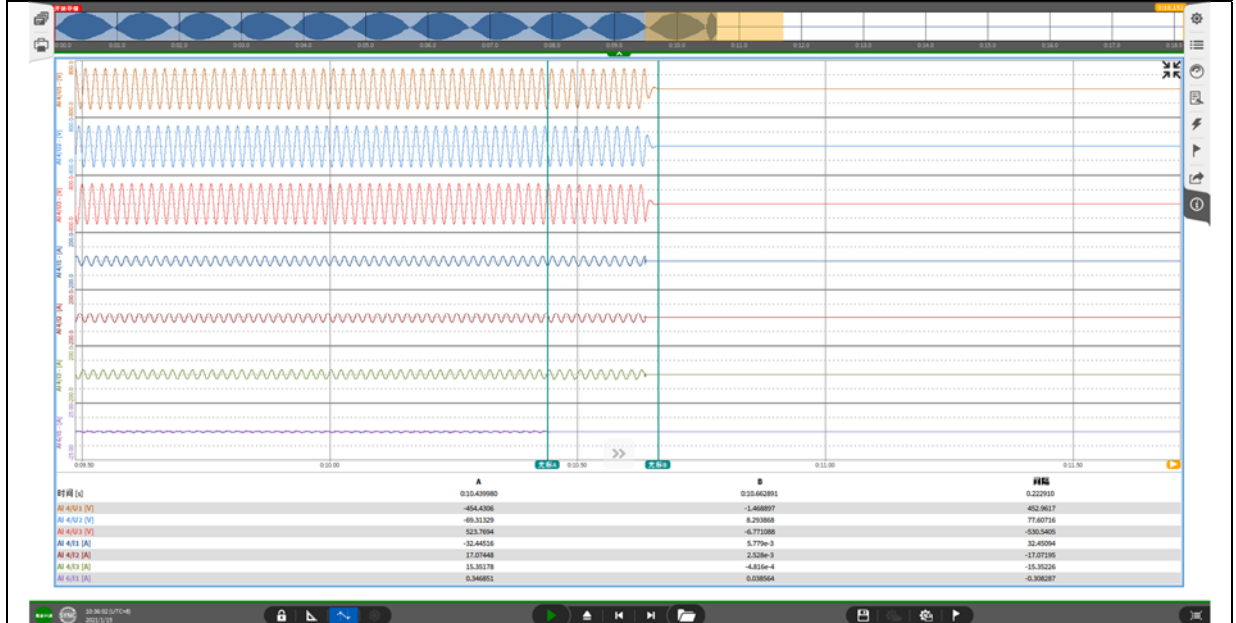
Test C

M(%)=0 & N(%)=-2



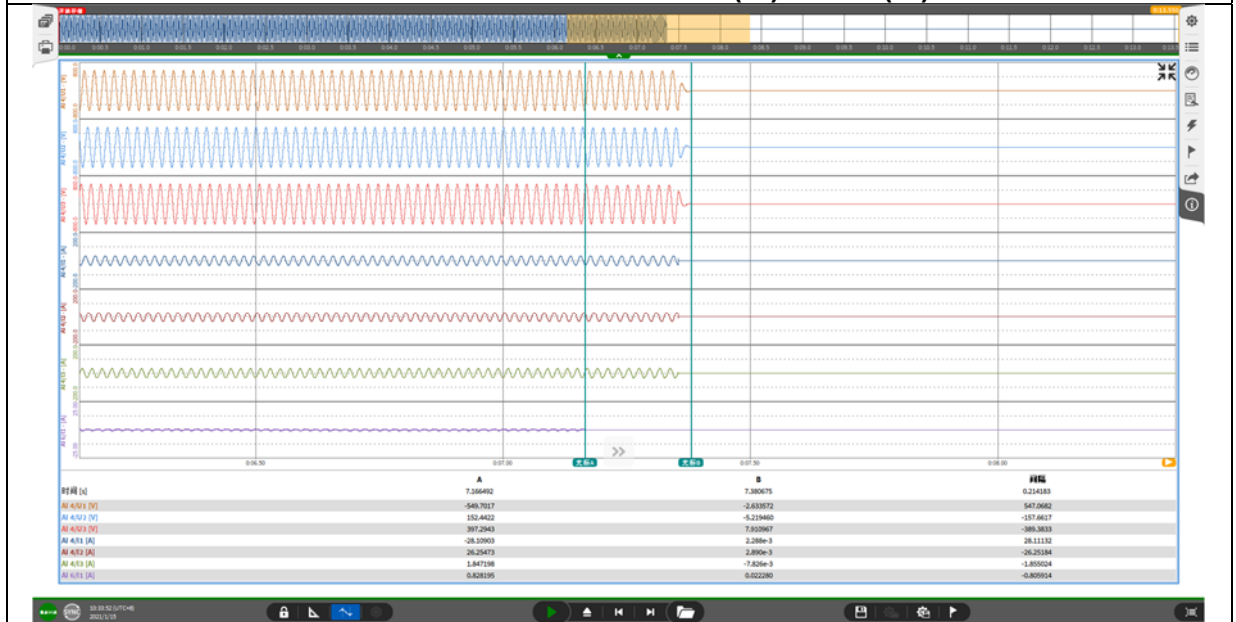
Test C

M(%)=0 & N(%)=-3



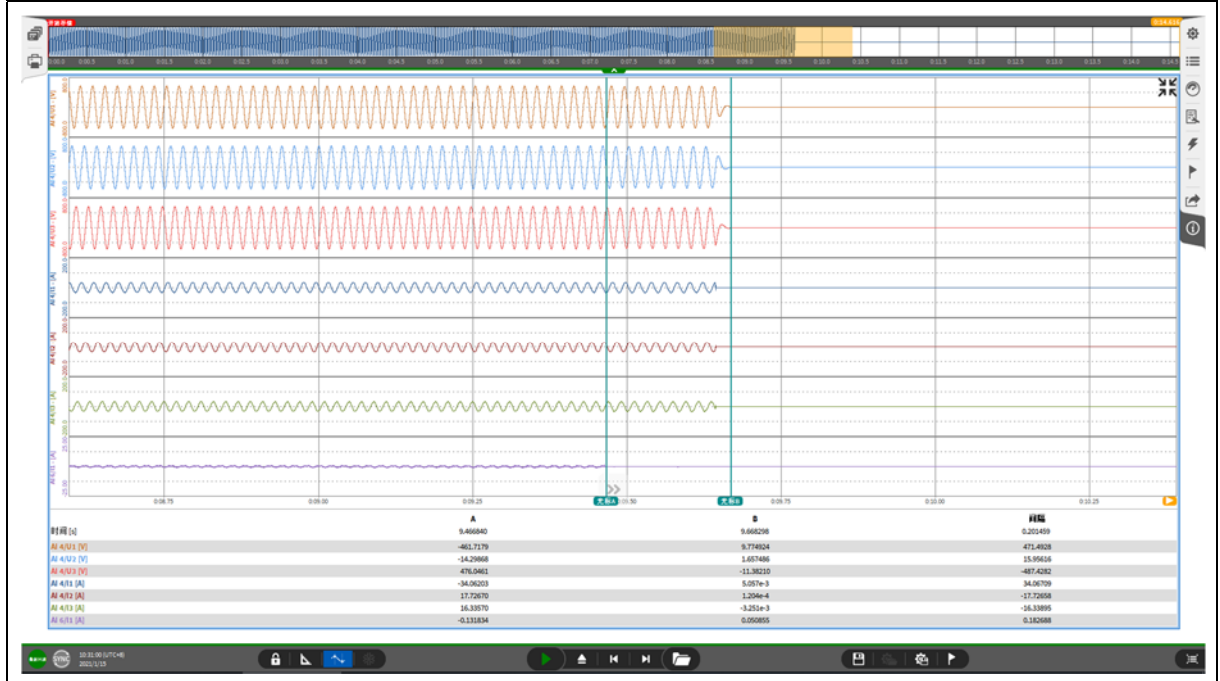
Test C

M(%)=0 & N(%)=-4



Test C

M(%)=0 & N(%)=-5



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4.3.4 Loss of Mains Protection, Vector Shift Stability test and RoCoF Stability test

This test should be carried out in accordance with Annex A.7.1.2.6.

Four tests are required to be carried out with all protection functions enabled including loss of mains. For each stability test the Micro-generator should not trip during the test.

For the step change test the Power Generating Module should be operated with a measurable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 s to complete the test. The Power Generating Module should not trip during this test.

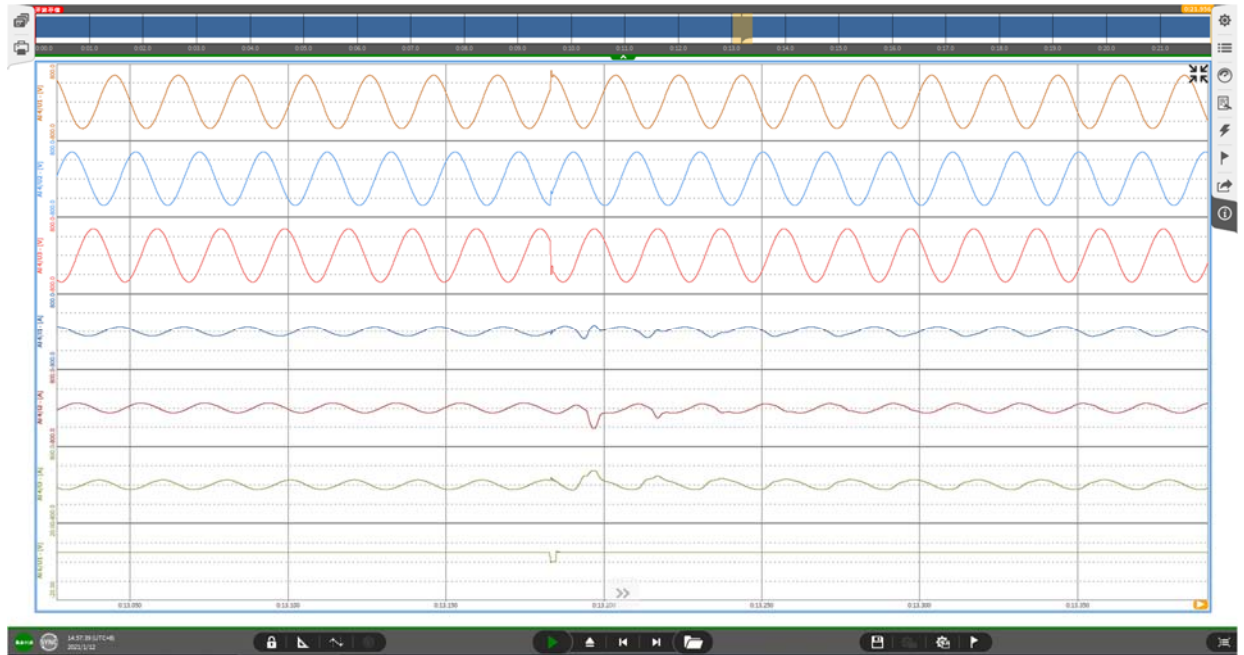
For frequency drift tests the Power Generating Module should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0.95 Hz/s to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10s. The Power Generating Module should not trip during this test.

Test results are graphically shown in following pages.

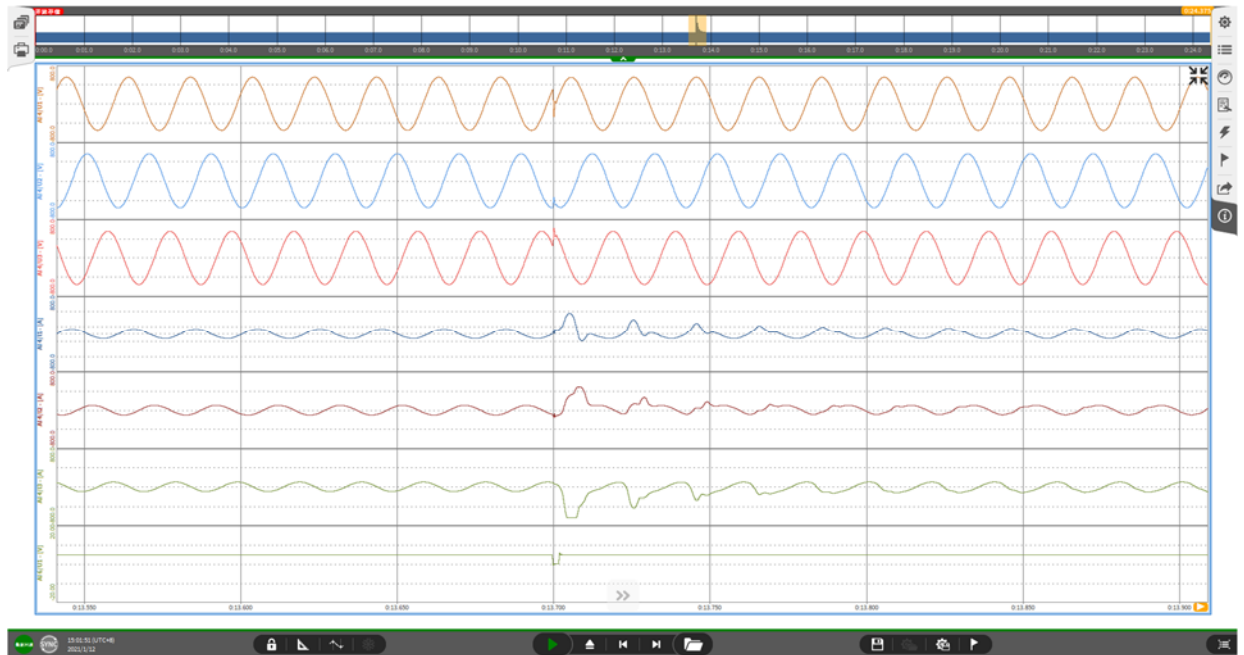
Protection –Loss of Mains Protection, Vector Shift Stability test: This test should be carried out in accordance with Annex A.7.1.2.6.

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	Pass
Negative Vector Shift	50.5 Hz	- 50 degrees	Pass

Positive Vector Shift:

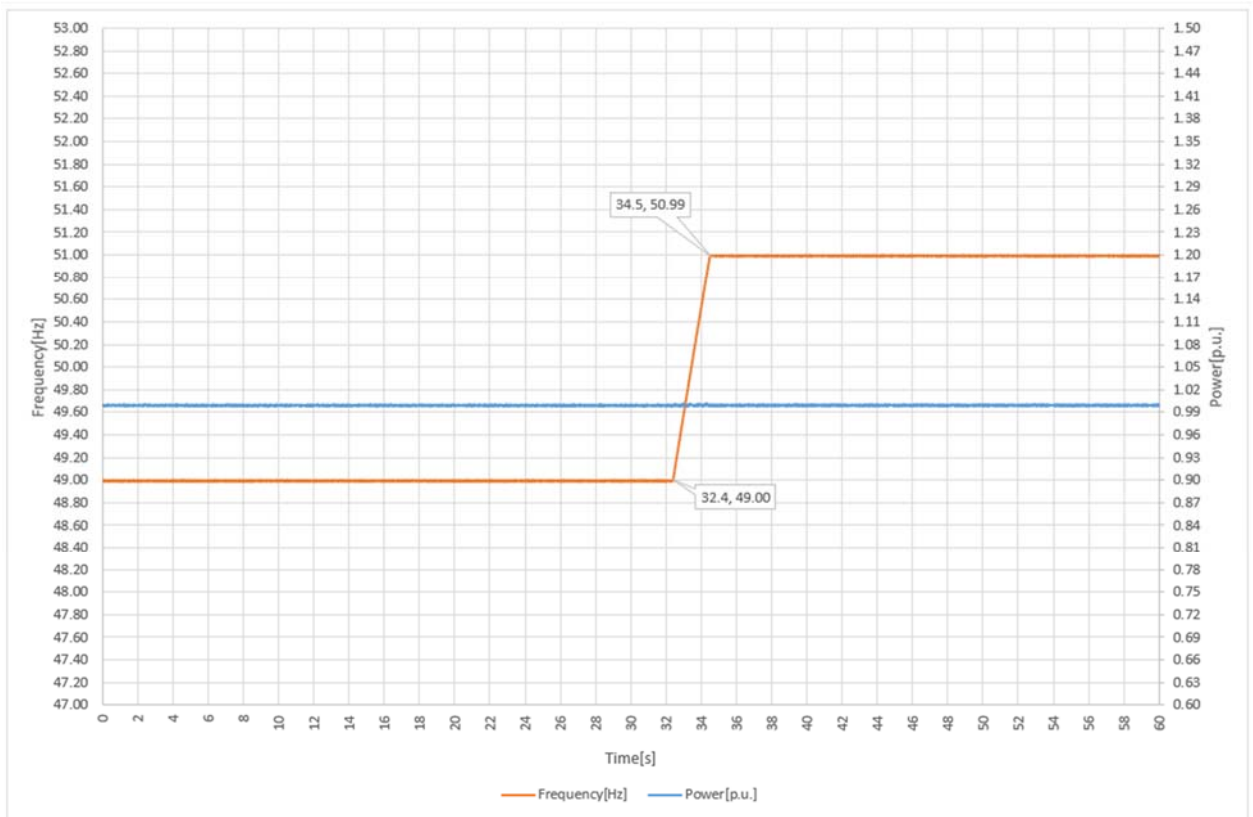


Negative Vector Shift:

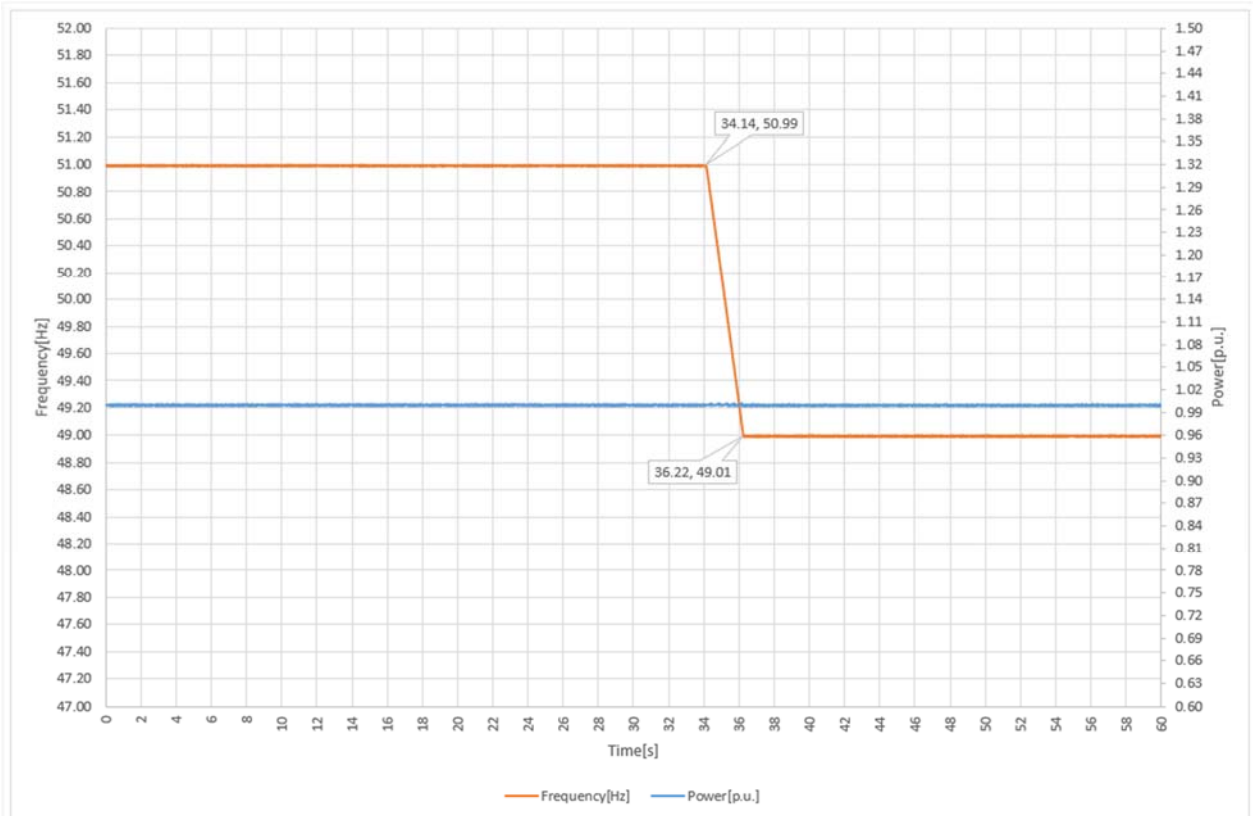


Protection –Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6.			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs ⁻¹	2.2 s	Pass
51.0 Hz to 49.0 Hz	-0.95 Hzs ⁻¹	2.2 s	Pass

+0.95 Hz/s:



-0.95 Hz/s:



4.4 Limited Frequency Sensitive Mode - Overfrequency test

This test should be carried out in accordance with Annex A.7.1.3.

The test should be carried out above 80% Registered Capacity and repeated at 40-60% Registered Capacity using the specific threshold frequency of 50.4 Hz and Droop of 10%.

The Power Park Module should be tested at the following frequencies:

Step a) 50.00 Hz ± 0.01 Hz

Step b) 50.45 Hz ± 0.05 Hz

Step c) 50.70 Hz ± 0.10 Hz

Step d) 51.15 Hz ± 0.05 Hz

Step e) 50.70 Hz ± 0.10 Hz

Step f) 50.45 Hz ± 0.05 Hz

Step g) 50.00 Hz ± 0.01 Hz

The frequency at each step should be maintained for at least one minute and the Active Power reduction in the form of a gradient determined and assessed for compliance with paragraph 11.2.3.

Following tables show the test results:

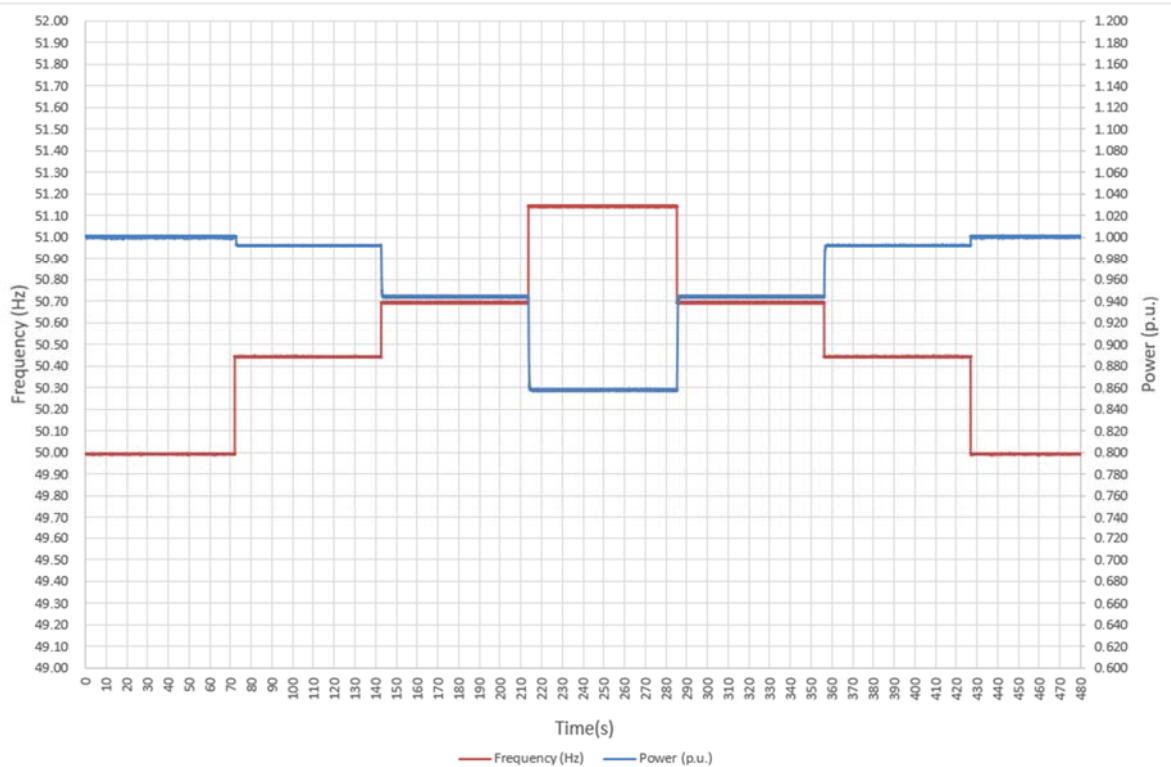
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Test sequence at Registered Capacity >80%	Measured Active Power Output (W)	Frequency (Hz)	Primary Power Source	Active Power Gradient (%)
Step a) 50.00 Hz $\pm$ 0.01 Hz	50036	49.99	DC Souce	N/A
Step b) 50.45 Hz $\pm$ 0.05 Hz	49615	50.44		11.9
Step c) 50.70 Hz $\pm$ 0.10 Hz	47193	50.69		10.6
Step d) 51.15 Hz $\pm$ 0.05 Hz	42896	51.14		10.5
Step e) 50.70 Hz $\pm$ 0.10 Hz	47202	50.69		10.6
Step f) 50.45 Hz $\pm$ 0.05 Hz	49627	50.44		12.3
Step g) 50.00 Hz $\pm$ 0.01 Hz	50049	49.99		N/A

Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output (W)	Frequency (Hz)	Primary Power Source	Active Power Gradient (%)
Step a) 50.00 Hz $\pm$ 0.01 Hz	49.99	25122	DC Souce	N/A
Step b) 50.45 Hz $\pm$ 0.05 Hz	50.44	24905		11.6
Step c) 50.70 Hz $\pm$ 0.10 Hz	50.69	23627		10.1
Step d) 51.15 Hz $\pm$ 0.05 Hz	51.14	21349		10.0
Step e) 50.70 Hz $\pm$ 0.10 Hz	50.69	23632		10.1
Step f) 50.45 Hz $\pm$ 0.05 Hz	50.44	24916		12.2
Step g) 50.00 Hz $\pm$ 0.01 Hz	49.99	25139		N/A

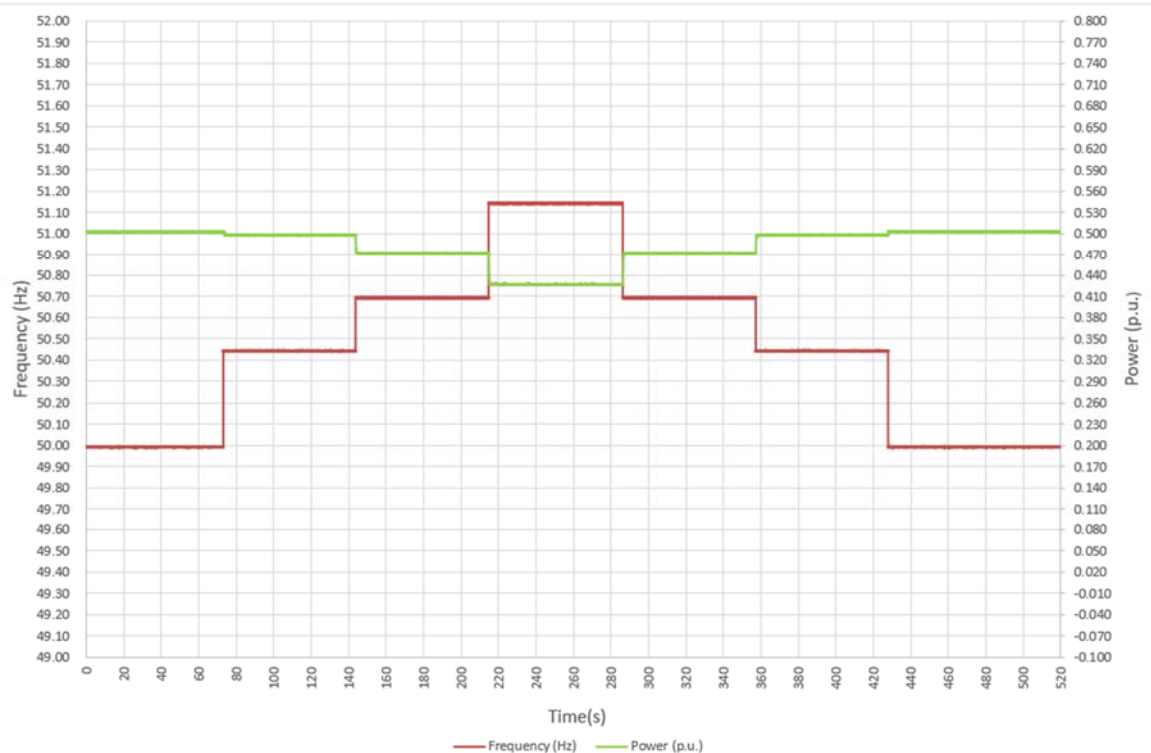
Test results are graphically shown in following pages.

Over-frequency curve (droop of 10 % at 100% Pn)



Remark: Test for frequency threshold 50.4Hz with droop 10%, intentional delay is setting to 0s.

Over-frequency curve (droop of 10 % at 50% Pn)



Remark: Test for frequency threshold 50.4Hz with droop 10%, intentional delay is setting to 0s.

4.5 Re-connection timer

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1.

The evaluation of this point has been made according to Annex A.7.2.2.5.

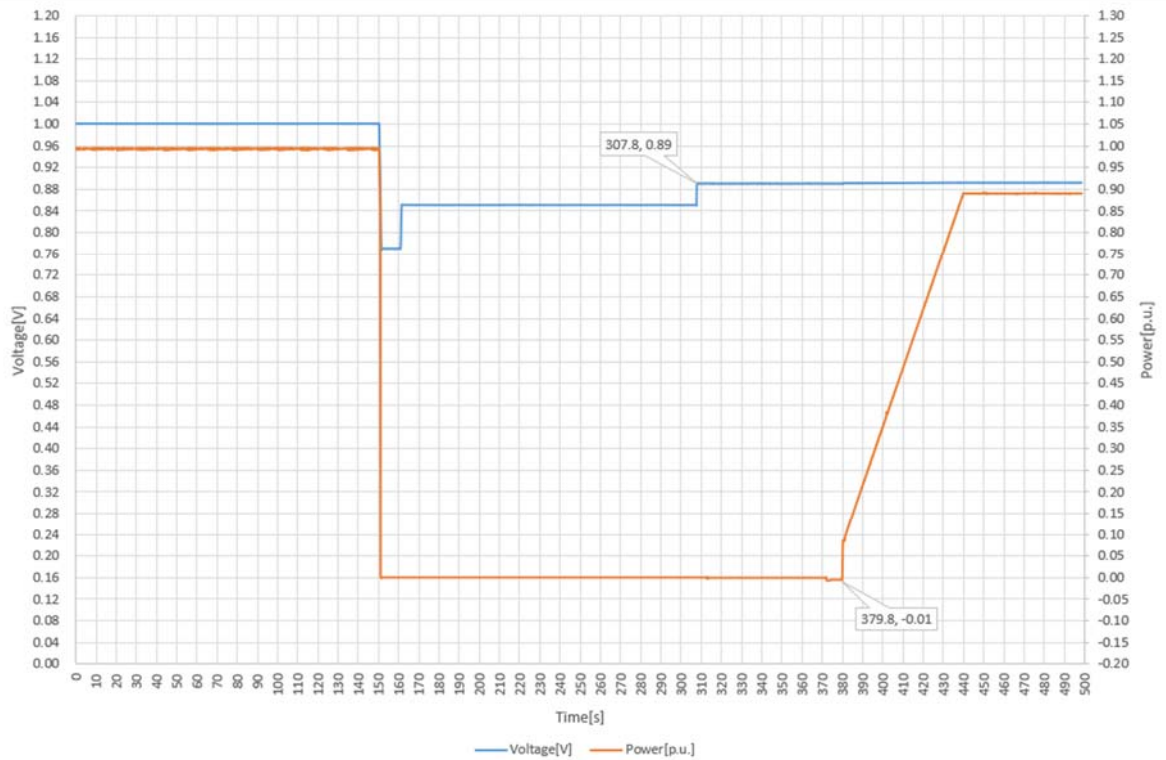
4.5.1 Voltage Reconnection Conditions

The following table detail tests performed.

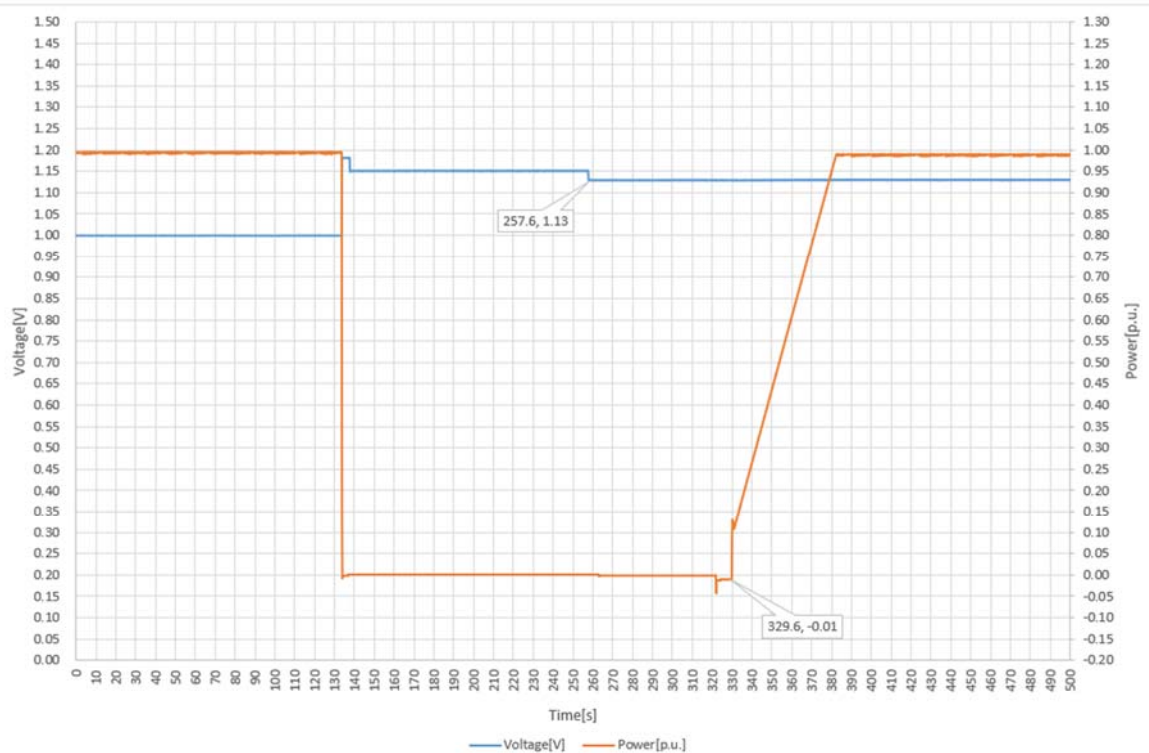
Test at	Time delay setting(s)	Measured delay(s)	Checks on no reconnection when voltage is brought to just outside stage 1 limits of table 1.	
UV	60	72	At 460V	At 340V
OV	60	72		
Confirmation that the Micro-generator does not re-connect.			Not reconnection	Not reconnection

Test results are graphically shown below.

Under voltage reconnection



Over voltage reconnection



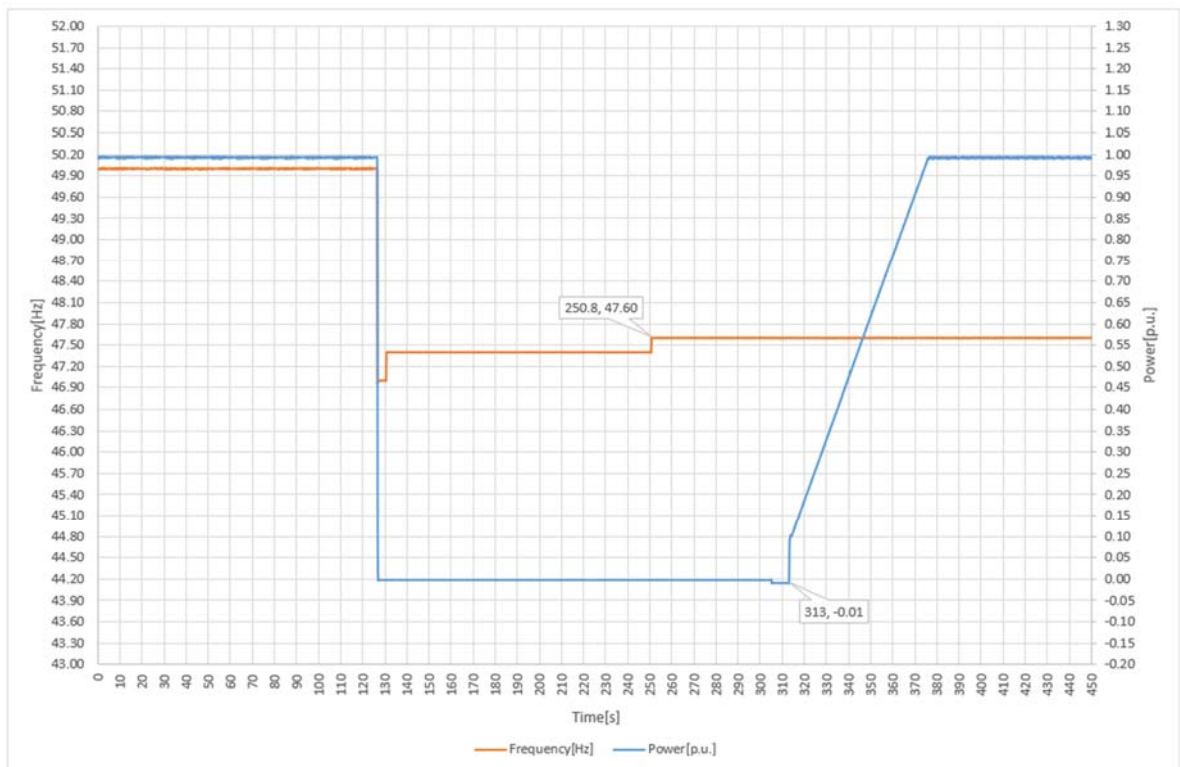
4.5.2 Frequency Reconnection Conditions

The following table detail tests performed.

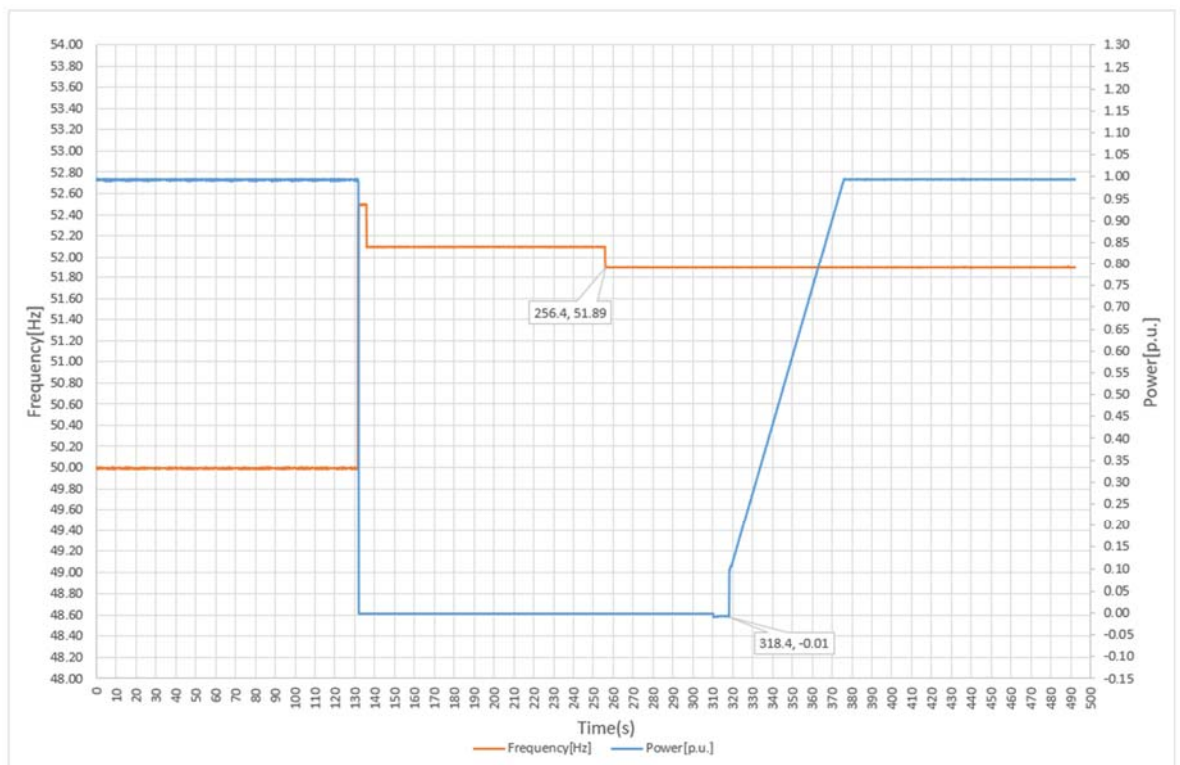
Test at	Time delay setting(s)	Measured delay(s)	Checks on no reconnection when frequency is brought to just outside stage 1 limits of table 1.	
UF	60	62.2	At 47.4Hz	At 52.1Hz
OF	60	62.0		
Confirmation that the Micro-generator does not re-connect.			Not reconnection	Not reconnection

Test results are graphically shown below.

Under frequency reconnection



Over frequency reconnection



4.6 Fault level contribution

These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5.

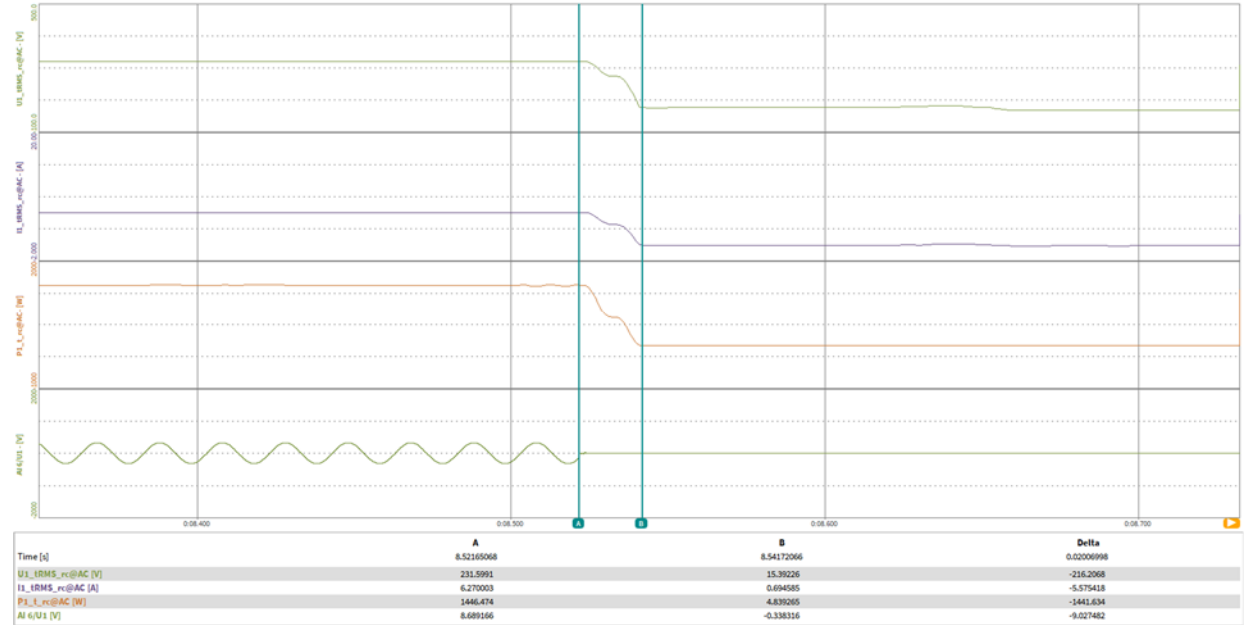
They have been performed different short circuit tests that are detailed in the table and pictures below.

Short circuit current		
L1-N		
Time after fault	Volts(V)	Amps(A)
20ms	15.4	0.7
100ms	15.5	0.6
250ms	1.1	0.5
500ms	1.1	0.5
Time to trip	23ms	In seconds

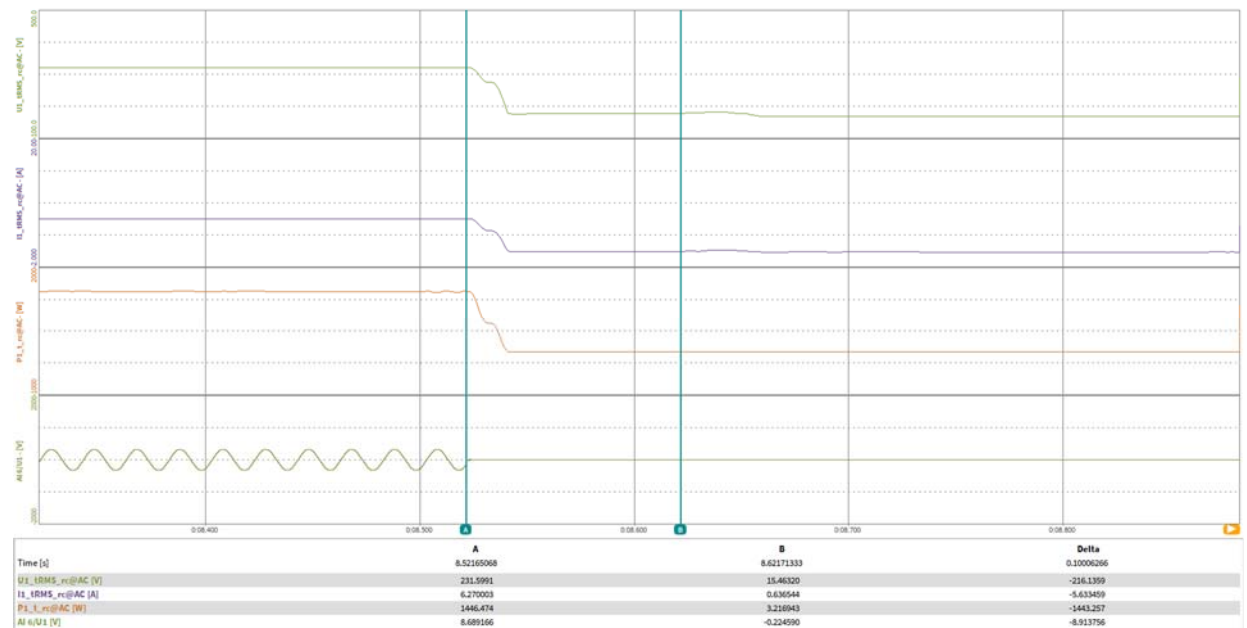
Short circuit current		
L1-L2		
Time after fault	Volts(V)	Amps(A)
20ms	5.4	3.5
100ms	3.1	3.4
250ms	3.1	3.4
500ms	0.0	0.4
Time to trip	432ms	In seconds

L1-N

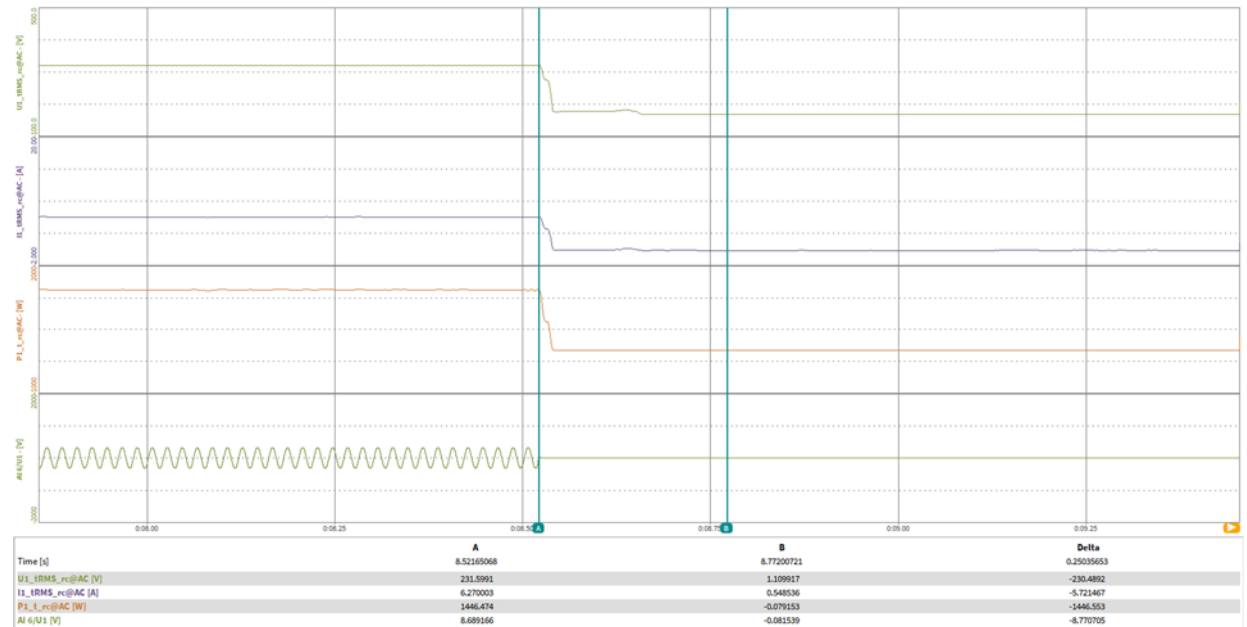
Time after 20ms fault



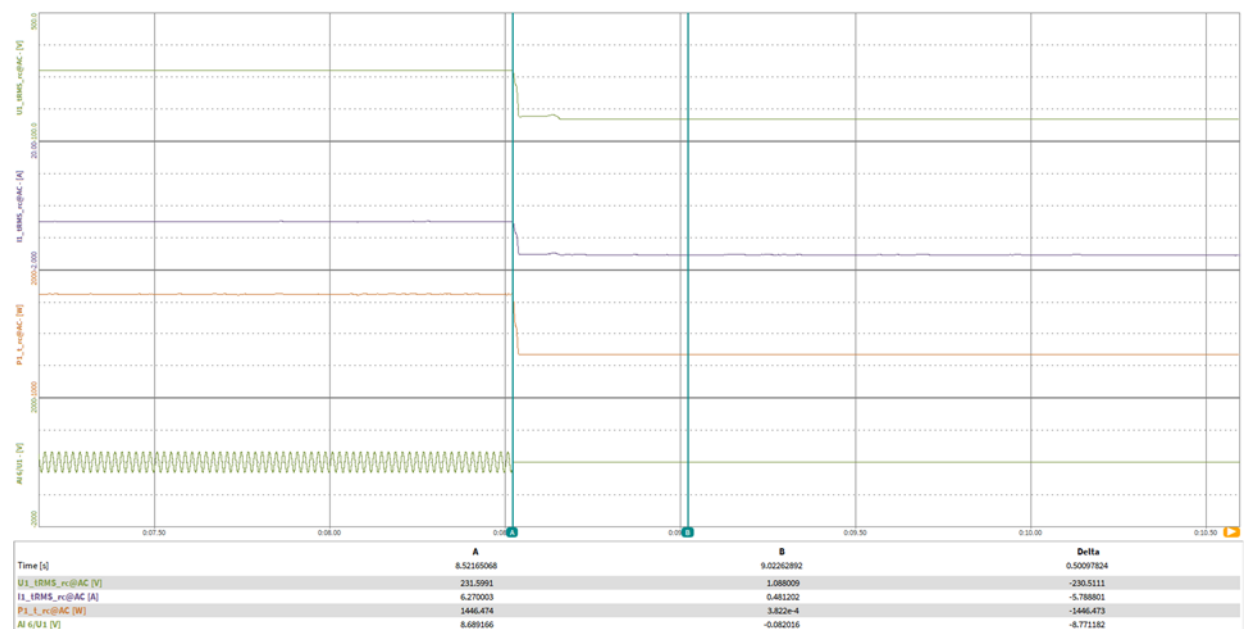
Time after 100ms fault



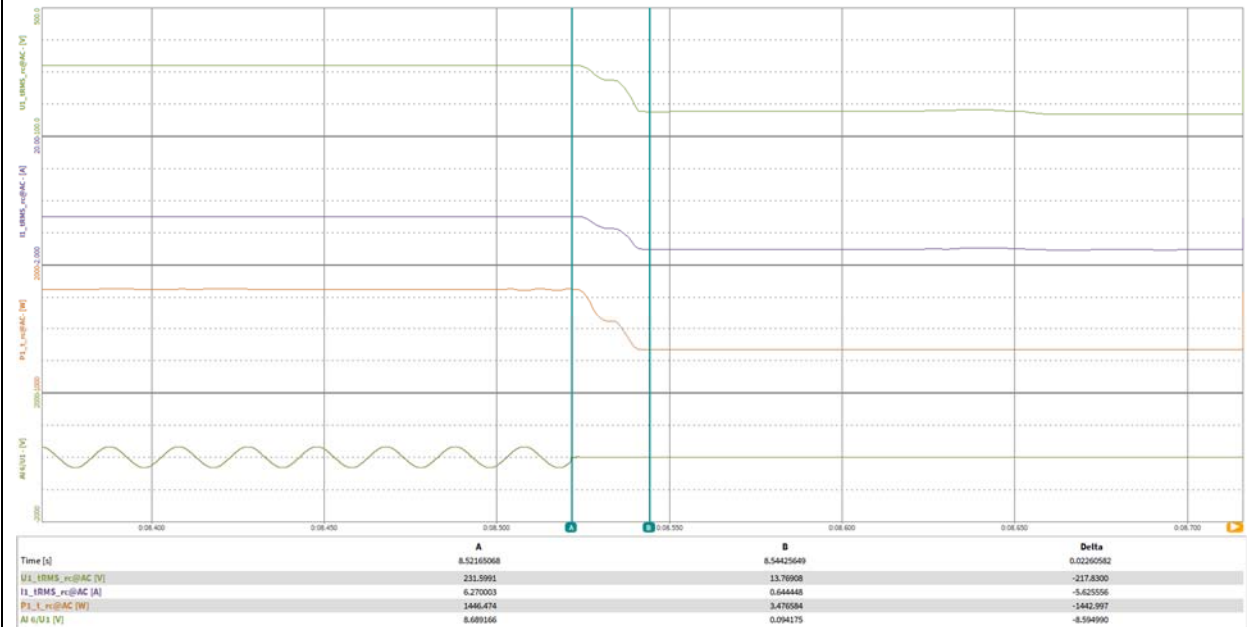
Time after 250ms fault



Time after 500ms fault

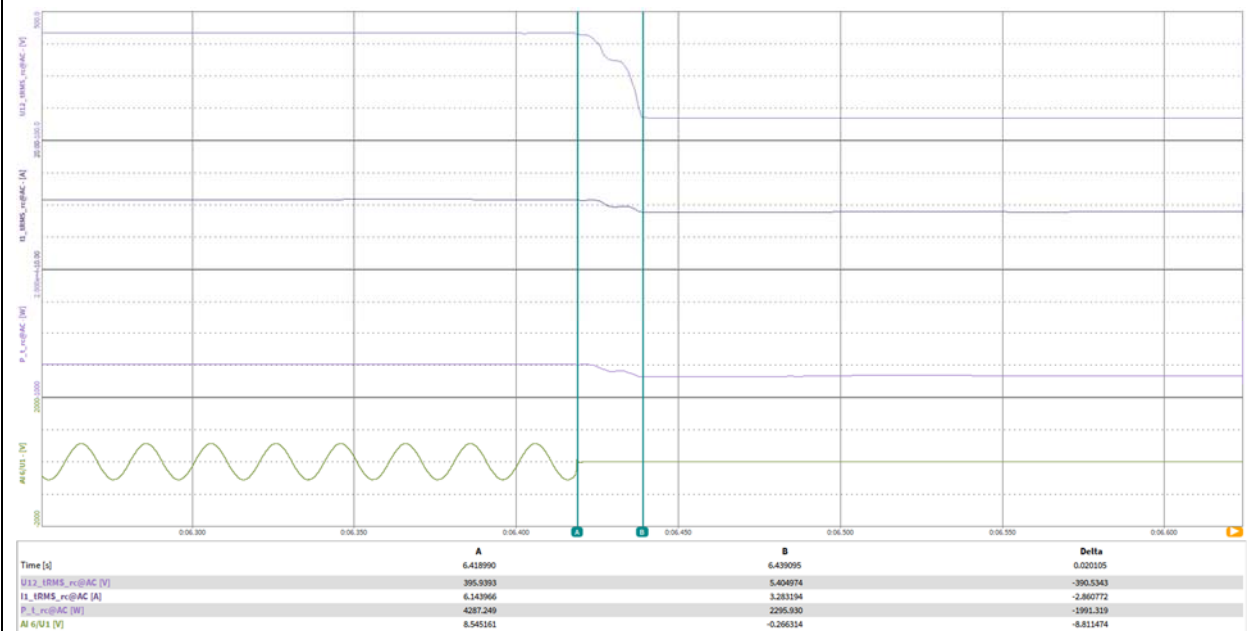


Time to trip

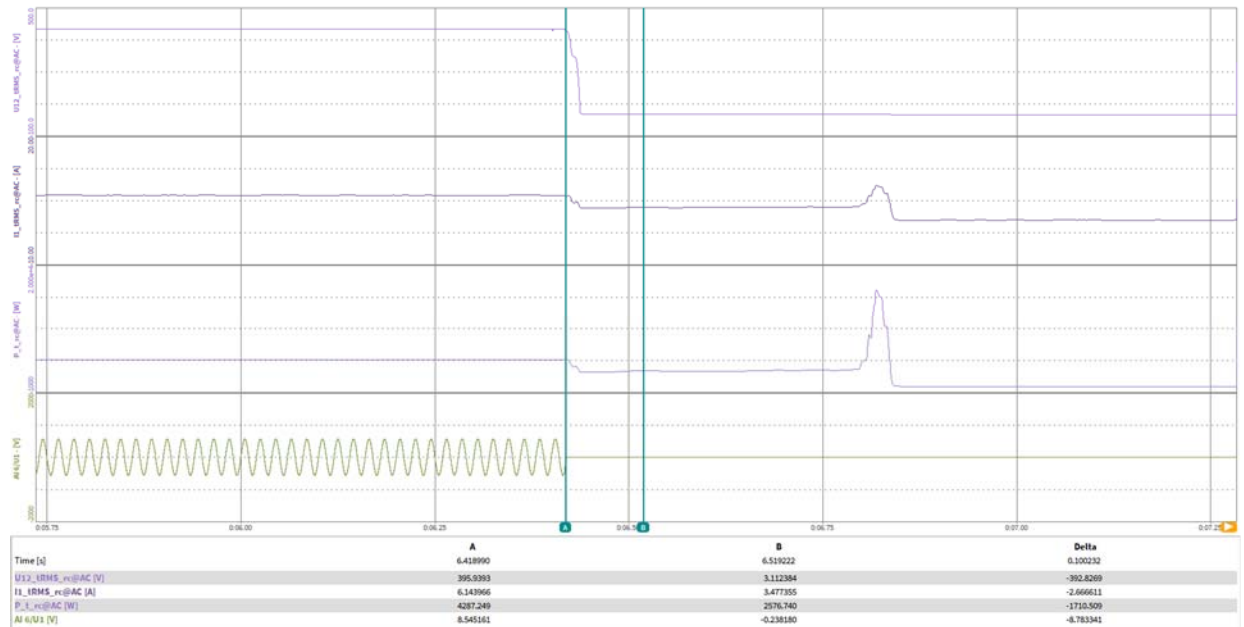


L1-L2

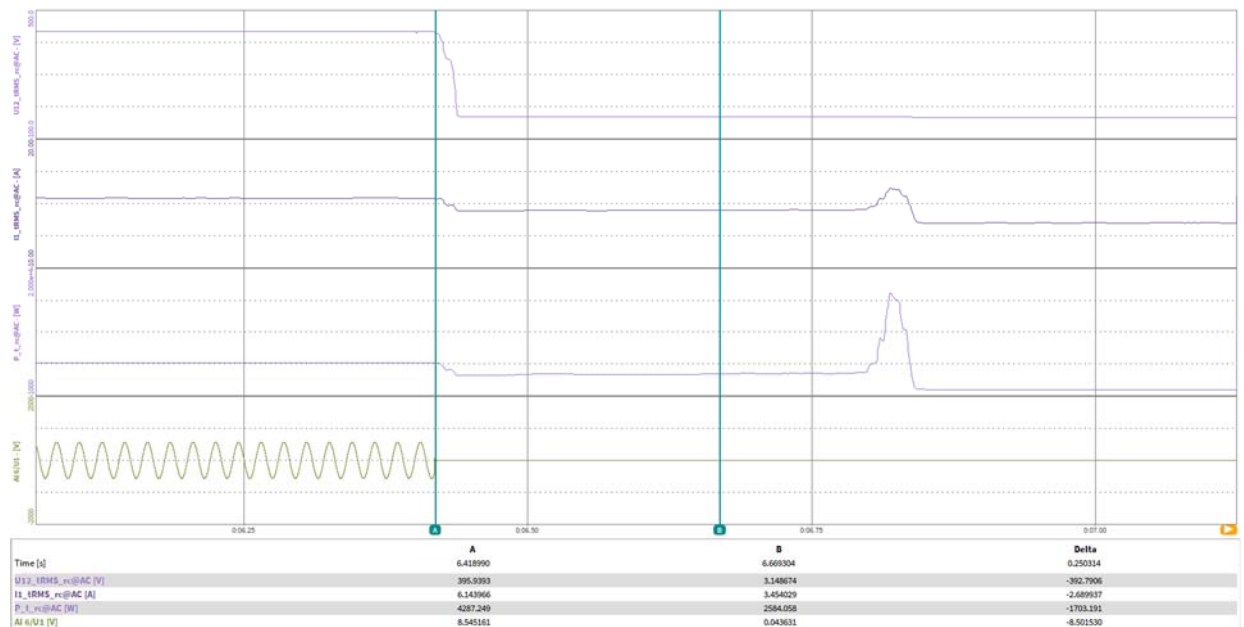
Time after 20ms fault

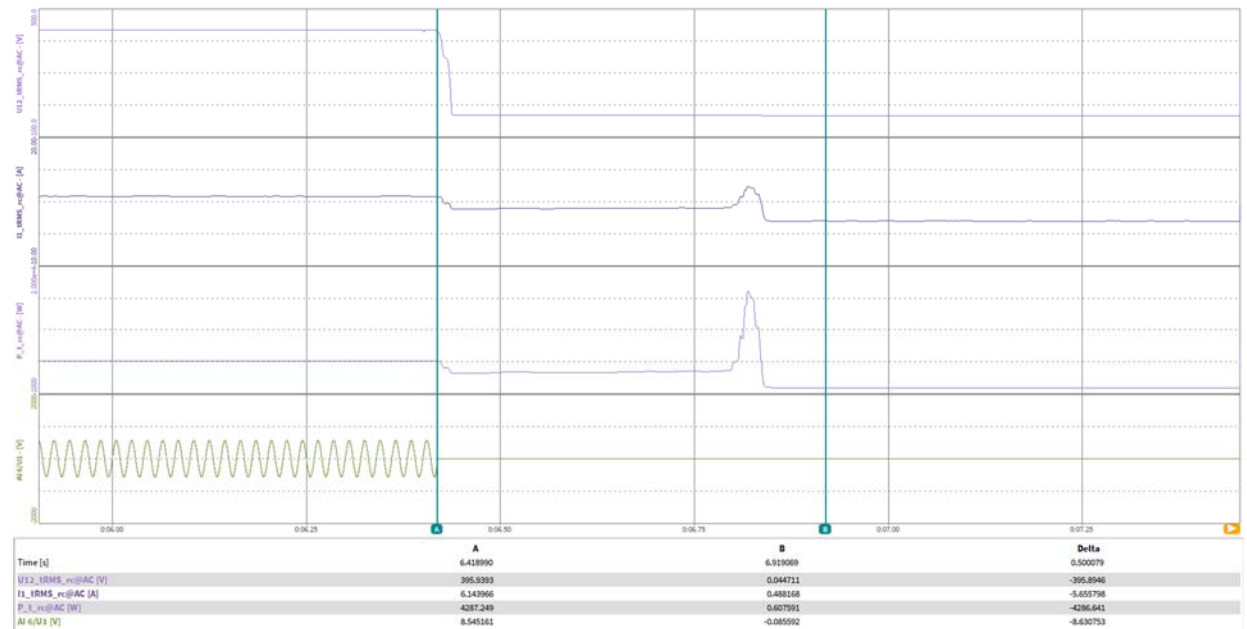
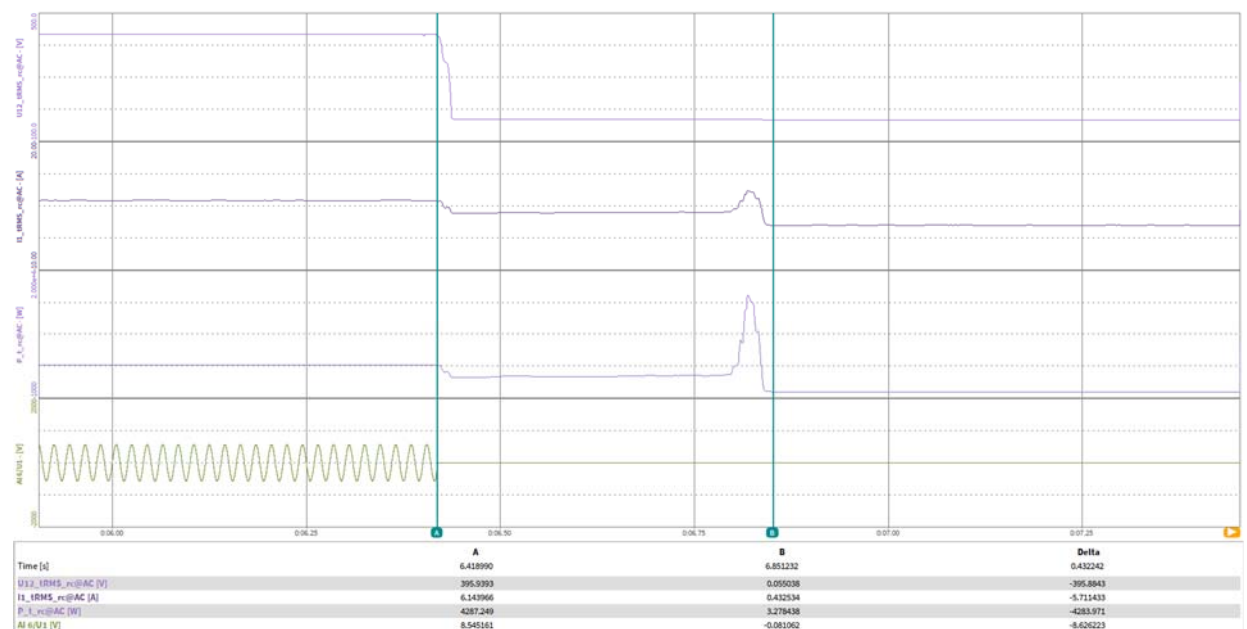


Time after 100ms fault



Time after 250ms fault



Time after 500ms fault

Time to trip


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4.7 SELF-MONITORING SOLID STATE SWITCHING

It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.

The evaluation of this point has been made according to Annex A.7.1.7.

This test does not apply because in the inverter there are not solid-state switching devices.

4.8 WIRING FUNCTIONAL TESTS:

Where Type Tested components are wired together on site, ie not using specifically designed plugs and sockets for the purpose, it will be necessary to prove that all wiring has been correctly terminated by proving the functions which rely on the wiring. The Generator will submit to the DNO for agreement a schedule of the wiring connections to be made, the functions that they enable, and the tests to prove them. Satisfactory completion of the agreed tests will enable the Power Generating Modules to attain or retain Type Tested status.

This test does not apply because connectors were designed error-proof connectors.

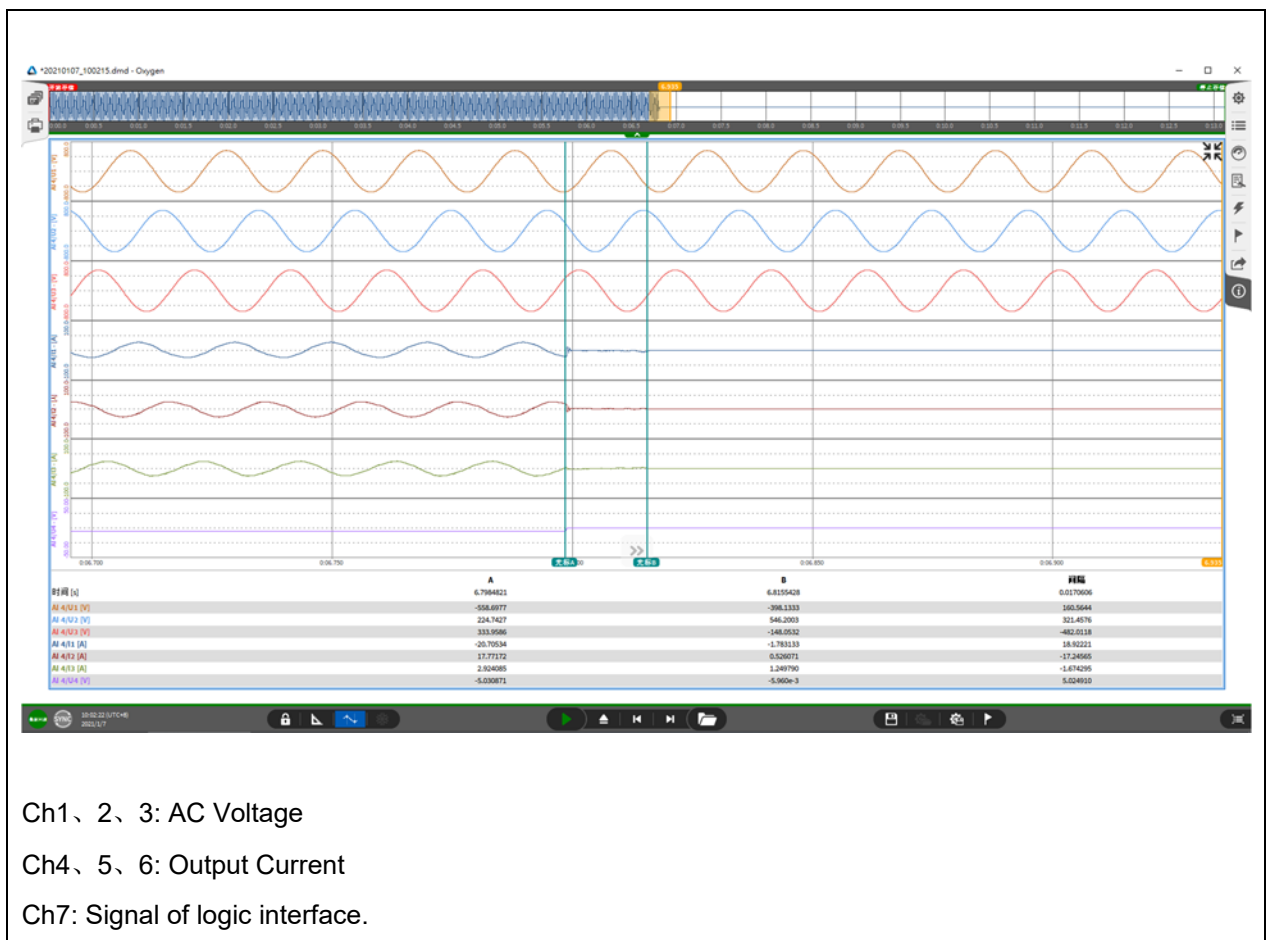
4.9 LOGIC INTERFACE (INPUT PORT).

Confirm that an input port is provided and can be used to shut down the module.

The evaluation of this point has been made according to Clause 11.1.3 of the standard.

Power Generating Modules connected to the DNO's Distribution Network shall be equipped with a logic interface (input port) in order to cease Active Power output within 5 s following an instruction being received at the input port.

Test results are graphically shown as below.



5 PICTURES

Front



Back side



Side view



Internal of Front side



Internal of Back side



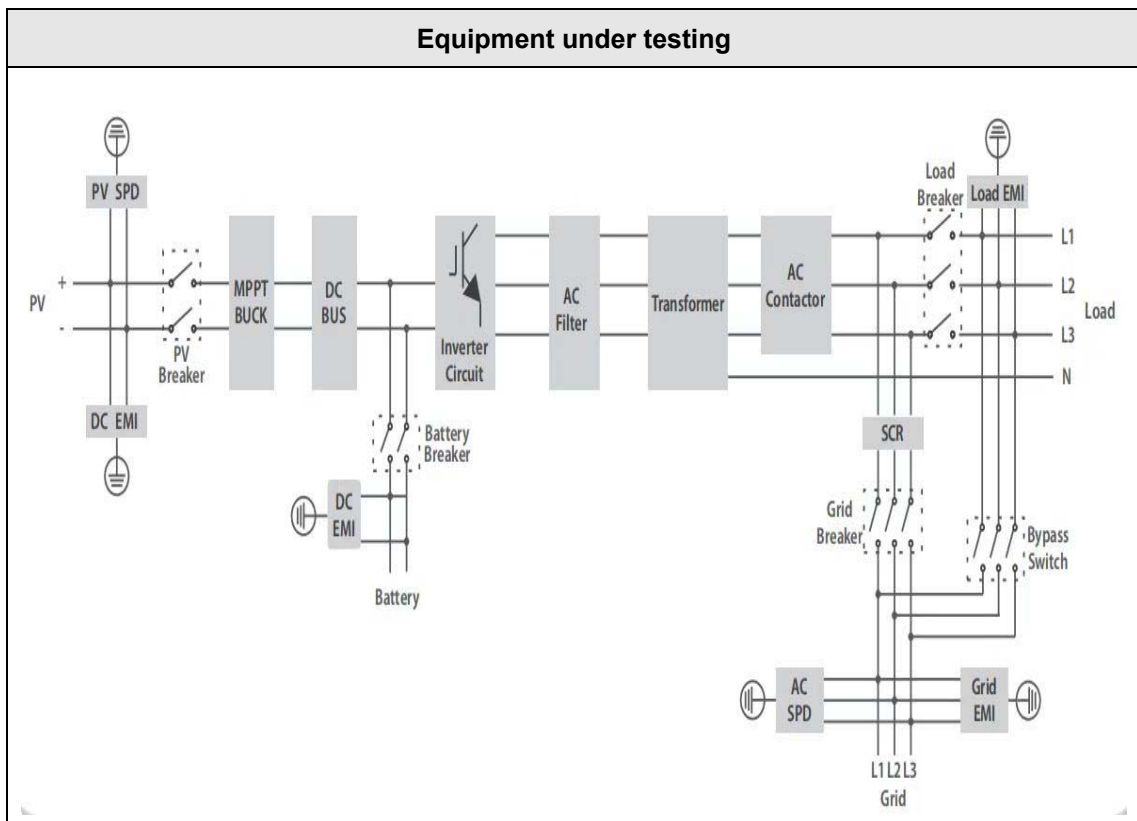
Serial Number



Software Version

Manufacturer	Shenzhen Ateess Power Technology Co.,Ltd
Serial Number	
DSP Software Version	HPS30K_150K_HV3_SV4.1.14_APP50549
LCD Software Version	HPS30_150K_WEINVIEWScreen_HV1.0_SV1.0.8
Hardware Version	SSCP_HW_V1.1.1

6 ELECTRICAL SCHEMES



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