TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH :

ENGINEERING RECOMMENDATION G98 ISSUE 1-AMENDMENT 7 3 OCTOBER 2022,

REQUIREMENTS FOR THE CONNECTION OF FULLY TYPE TESTED MICRO-GENERATORS (UP TO AND INCLUDING 16 A PER PHASE) IN PARALLEL WITH PUBLIC LOW VOLTAGE DISTRIBUTION NETWORKS ON OR AFTER 27 APRIL 2019

Test Report Number	:	GZES230300372803
Type	:	
Tested Model	:	EFWN511
Variant Models	:	EFWN511B

APPLICANT

Hired by	:	**EcoFlow Inc.**
Address	:	Plant A202, Founder Technology Industrial Park, Shiyan Subdistrict, Bao'an District Shenzhen, 518000 Guangdong China

TESTING LABORATORY

Name	:	SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch
Address	:	198 Kezhu Road, Science City, Economic & Technology Development Area, Guangzhou, Guangdong, China
Conducted (tested) by	:	Colin Chen (Project Engineer)
Approved by	:	Roger Hu (Technical Reviewer)
Date of issue	:	15 / 07 / 2023
Number of pages	:	110

Important Note:

- This document is issued by the Company under its General Conditions of service accessible at http://www.sgs.com/terms_and_conditions.htm. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

- Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

- Unless otherwise stated the results shown in this test report refer only to the sample(s) tested as received. **Information of derived or extension models of the range as provided by the applicant, (if any), is included in this report only for informative purposes.** The Company SGS shall not be liable for any incorrect results arising from unclear, erroneous, incomplete, misleading or false information provided by Client. This document cannot be reproduced except in full, without prior approval of the Company.

Test Report Historical Revision:

Test Report Version	Date	Resume
GZES230300372802	29 / 06 / 2023	First issuance
GZES230300372803	15 / 07 / 2023	Updated clause 4.1 Updated clause 4.3.4 Updated clause 4.5

INDEX

1 SCOPE

SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch has been contract by **EcoFlow Inc.**, in order to perform the testing according the “Engineering Recommendation G98 Issue 1 - Amendment 7 3 October 2022, Requirements For The Connection Of Fully Type Tested Micro-Generators (Up To And Including 16 A Per Phase) In Parallel With Public Low Voltage Distribution Networks On Or After 27 April 2019”.

2 GENERAL INFORMATION

2.1 TESTING PERIOD AND CLIMATIC CONDITIONS

The necessary testing has been performed along between the 13th of Feb. and 25th of April of 2023.
All the tests and checks have been performed at 25 ± 5ºC, 96 kPa ± 10 kPa and 50% RH ± 10% RH).

SITE TEST

Name .....: **Dongguan BALUN Testing 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 .....: EcoFlow PowerStream Microinverter

Installation .....: Fixed installation

Manufacturer .....: **EcoFlow Inc.**

Address .....: Plant A202, Founder Technology Industrial Park, Shiyan Subdistrict, Bao'an District Shenzhen, 518000 Guangdong China

Trade mark .....:

Model / Type reference.....: **EFWN511**

Serial Number.....: HW51ZEH1RF330001

Software Version .....: V1.0

Rated Characteristics .....: PV input: 11-55 V, Max. 2× 13 A
Battery charging: 30V-58V, Max.: 13A
Battery discharging: 11V-15V/ 40-59V, Max.: 13A
AC output: L/N/PE 230 V, 50 Hz, 3.7 A, 800 W

Date of manufacturing: 2023

Test item particulars

Input.....: DC

Output..... AC

Class of protection against electric shock ...: Class I

Degree of protection against moisture.....: IP 67

Type of connection to the main supply .....: TN

Cooling group .....: Natural Cooling

Modular.....: No

Internal Transformer .....: No

Copy of marking plate（representative）:

Note:

1. 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.
2. Label is attached on the side surface of enclosure and visible after installation
3. Labels of other models are as the same with **EFWN511**'s except the parameters of rating.

Equipment Under Testing:

- EFWN511

The variants models are:

- EFWN511B

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

Following table shows the full ratings of the all models referenced in this report, marked in **bold letters** the ones subjected to testing:

Model	**EFWN511**	EFWN511B
PV Input		
Max. input voltage	55 Vdc	
MPPT operating voltage range	11-55 Vdc	
Max. input current	13 A/13 A	
Battery Input		
Battery charge voltage range	30V-58 Vdc	
Battery charge current	13 A	
Battery discharge voltage range	11V-15, 40-59 Vdc	
Battery discharge current	13 A	
AC Output		
Nominal grid voltage	L/N/PE, 230Vac	
Nominal grid frequency	50 Hz	
Rated AC power	800 W	600 W
Max. AC apparent power	800 VA	600 VA
Rated AC current	3.5 A	2.6A
Max. AC current	3.7 A	2.8A
Output power factor	1 default (adjustable+/-0.8)	
General Data		
Operating temperature range	-40 ºC ~ +50 ºC	
Protection degree	IP67	
Protective class	Class I	
Cooling method	Natural Cooling	
Topology	Isolated	

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 MANUFACTURER AND FACTORY INFORMATION

Manufacturer Name .....: EcoFlow Inc.

Manufacturer Address.....: Plant A202, Founder Technology Industrial Park, Shiyan Subdistrict, Bao'an District Shenzhen, 518000 Guangdong China.

Factory Name .....: Dongguan Streamax Electronics Co., Ltd.

Factory Address.....: Room 101, No.20 Building, Leaguer Zijing Intelligent Manufacture Center, NO.105, Qingbin East Road, Qingxi Town, Dongguan City, Guangdong Province, P. R. China

2.4 TEST EQUIPMENT LIST

From	No.	Equipment Name	Trademark / Model No.	Equipment No.	Calibration Period
Balun	1	Power analyzer	ZLG/ PA6000H	BZ-DGD-L059	2022/10/13 to 2023/10/12
	2	Current probe	HIOKI/ CT6863-05	BZ-DGD-L026-1	2022/02/23 to 2023/02/22 2023/02/20 to 2024/02/19
	3	Current probe	HIOKI/ CT6863-05	BZ-DGD-L026-2	2022/02/23 to 2023/02/22 2023/02/20 to 2024/02/19
	4	Current probe	HIOKI/ CT6863-05	BZ-DGD-L026-4	2022/02/23 to 2023/02/22 2023/02/20 to 2024/02/19
	5	Voltage probe	CYBERTEK/ VP5200A	BZ-DGD-L241	2022/02/23 to 2023/02/22 2023/03/09 to 2024/03/08
	6	Temperature & Humidity meter	CEM/ DT-322	BZ-DGD-L270	2022/10/25 to 2023/10/24
	7	Digital oscilloscope	TEKTRONIX/ MS04054B	BZ-DGD-L064	2022/03/01 to 2023/02/28 2023/03/07 to 2024/03/06
	8	Power Analyzer	DEWETRON / TRIONet	BZ-DGD-L305	2022/08/18 to 2023/08/17
SGS	9	True RMS Multimeter	Fluke/187	GZE012-16	2022/05/21 to 2023/05/20

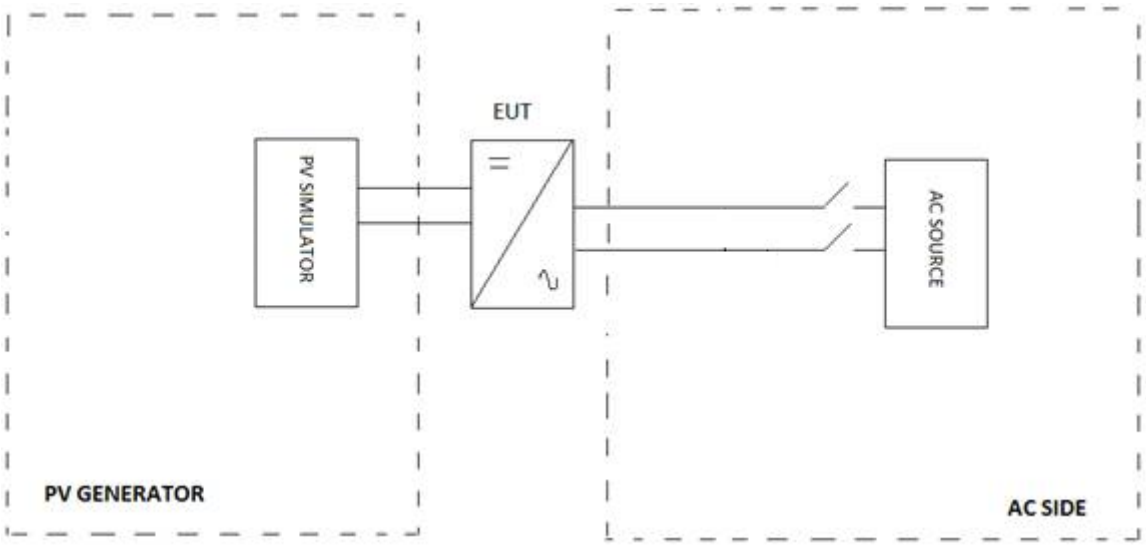
2.5 MEASUREMENT UNCERTAINTY

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

Magnitude	Uncertainty
Voltage measurement	±0.05 %
Current measurement	±0.05 %
Frequency measurement	±0.001 Hz
Time measurement	±0.001s
Power measurement	±0.5 %
Phase Angle	±0.1º
Temperature	±3º 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 solicitant. Note2: Where the standard requires lower uncertainties that those in this table. Most restrictive uncertainty has been considered.	

2.6 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 2.4. 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	KEWELL / KACM-75-33	60 kVA max. 45-65 Hz	BZ-DGD-L193
PV source	CHROMA / Chroma 6215011-1000s	15 kVA max.	BZ-DGD-L009
RLC load	QunLing / ACTL-3820	68 kW,68 kvar	BZ-DGD-L063

2.7 Definitions

EUT	Equipment Under Testing	Hz	Hertz
A	Ampere	V	Volt
VAr	Volt-Ampere reactive	W	Watt
EMC	Electromagnetic Compatibility	p.u	Per unit
Un	Nominal Voltage	Pn	Nominal Active Power
In	Nominal Current	Qn	Nominal Reactive Power
Ia	Active Current	Sn	Nominal Apparent Power
Ir	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
		d(t)	Variation of Voltage
PST	Severity of Flicker Short-Term	OV	Over Voltage
d max	Maximum Absolute Value of Voltage Variation	OF	Over Frequency
UV	Under Voltage	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
	Issue 1 Amendment 7 3 October 2022		
	TEST	REMARKS	
EN 50438 D.3.1.	Operating Range		P
EREC G98 Annex A1 A1.3.1	Harmonics		P
EREC G98 Annex A1 A1.3.3	Voltage fluctuations and Flicker		P
EN 50438 Annex D.3.10	DC injection		P
EN 50538 Annex D.3.4.1	Power factor		P
EREC G98 Annex A1 A.1.2.3	Frequency tests		P
EREC G98 Annex A1 A.1.2.2	Voltage tests		P
BS EN 62116	Loss of Mains test		P
EREC G98 Annex A1 A.1.2.6	Frequency change, Vector Shift Stability test		P
EREC G98 Annex A1 A.1.2.6	Frequency change, RoCoF Stability test		P
EN 50438 Annex D.3.3	Overfrequency test		P
EN 50438 Annex D.3.2	Power output with falling frequency test		P
EN 50438 Annex A12	Re-connection timer.		P
EREC G98 Annex A1 A.1.3.5	Fault level contribution		P
EREC G98 Annex A1 A.1.3.6	Self-Monitoring solid state switching	No solid state switching devices	N/A
EREC G98 Annex A1 A.1.3.7	Electromagnetic Compatibility (EMC)		N/R ([1])
EREC G98 9.4.4	Logic Interface		P
EREC G98 9.7	Cyber security		P

The compliances with these requirements are stated in the following test reports:
([1])EMC Test Report: Test Report no. 18220WC30056802E, issued by Shenzhen Anbotek Compliance Laboratory Limited on 14 Apr. 2023. CNAS L3503.

4 TEST RESULTS

4.1 Operating Range

This test should be carried out as specified in EN 50438 D.3.1.

Active Power shall be recorded every second. The tests will verify that the Micro-generator can operate within the required ranges for the specified period of time.

The Interface Protection shall be disabled during the tests.

In case of a PV Micro-generator the PV primary source may be replaced by a DC source.

In case of a full converter Micro-generator (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source.

In case of a DFIG Micro-generator the mechanical drive system may be replaced by a test bench motor.

Test 1
Voltage = 85% of nominal (195.5 V)
Frequency = 47.0 Hz
Power factor = 1
Period of test 20 seconds

Test 2:

Voltage = 85% of nominal (195.5 V)

Frequency = 47.5 Hz

Power factor = 1

Period of test 90 minutes

Test 3:

Voltage = 110% of nominal (253 V).

Frequency = 51.5 Hz

Power factor = 1

Period of test 90 minutes

Test 4:

Voltage = 110% of nominal (253 V).

Frequency = 52.0 Hz

Power factor = 1

Period of test 15 minutes

Test 5
Voltage = 100% of nominal (230 V).
Frequency = 50.0 Hz
Power factor = 1
Period of test 90 minutes

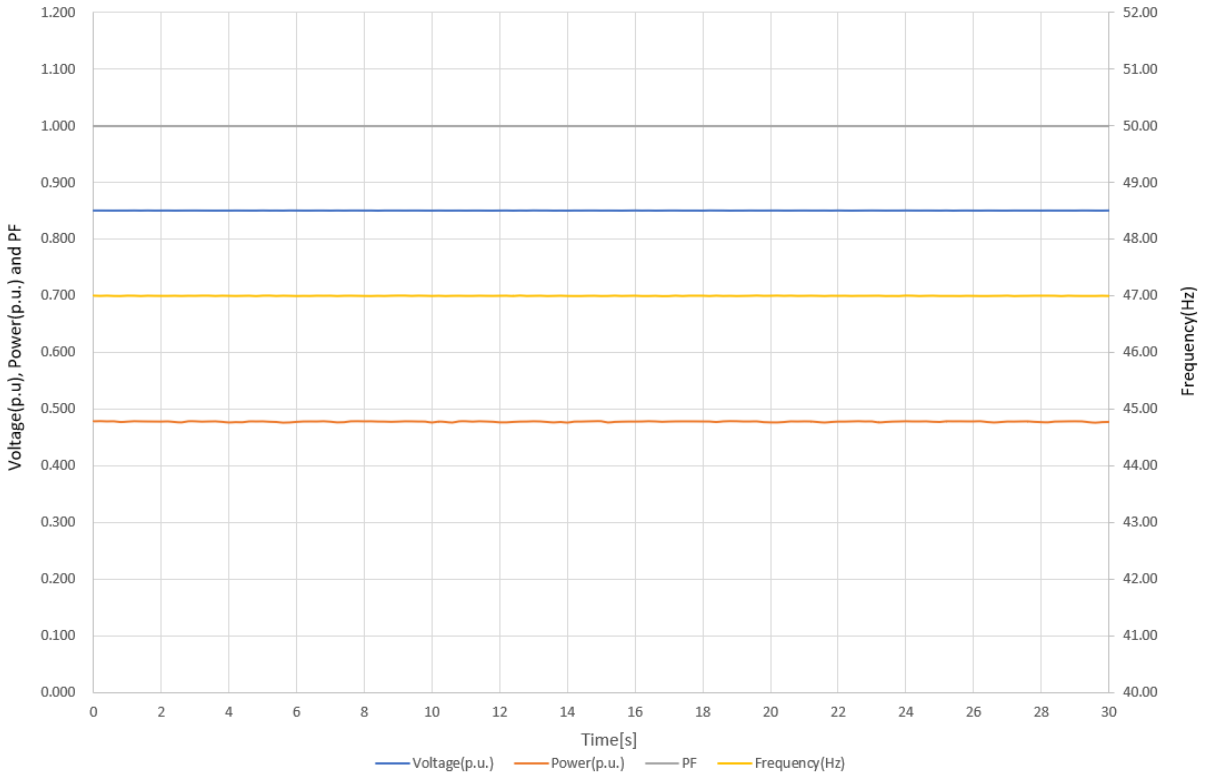
Test 6 RoCoF withstand

Confirm that the **Micro-Generating Plant** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms.

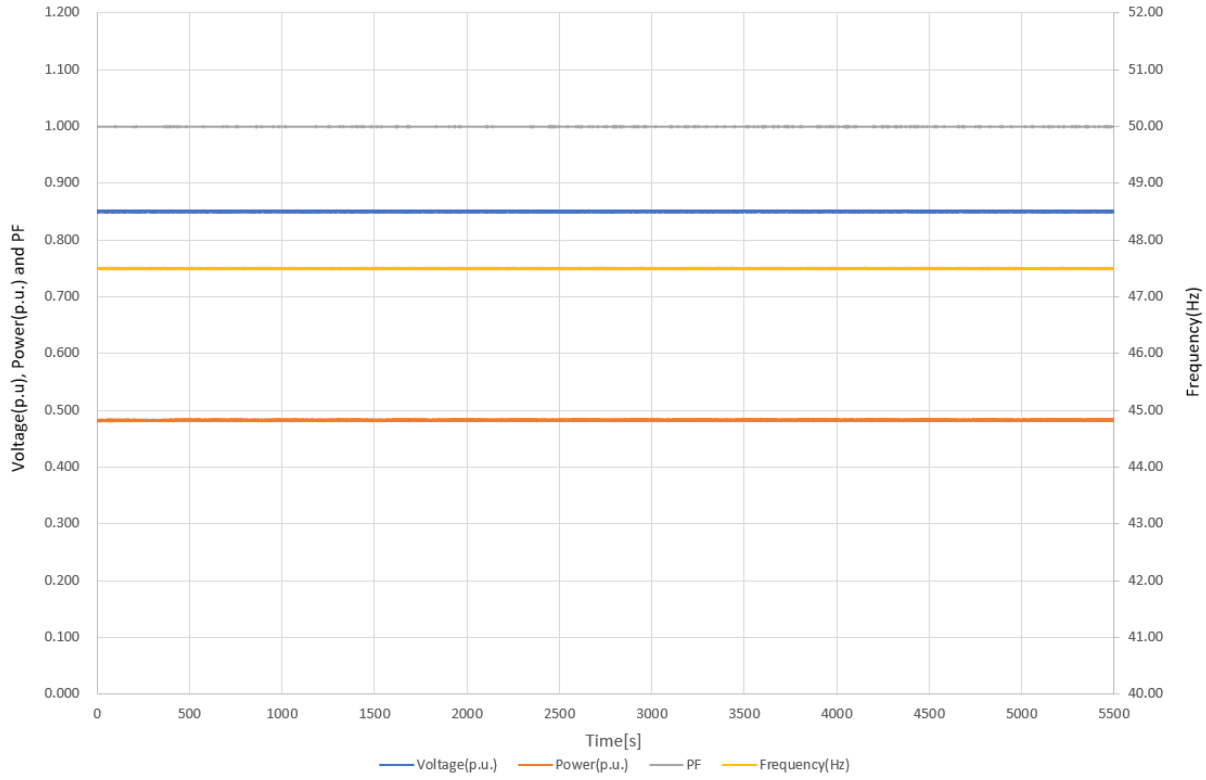
This is not expected to be demonstrated on site.

Test results are graphically shown in following pages.

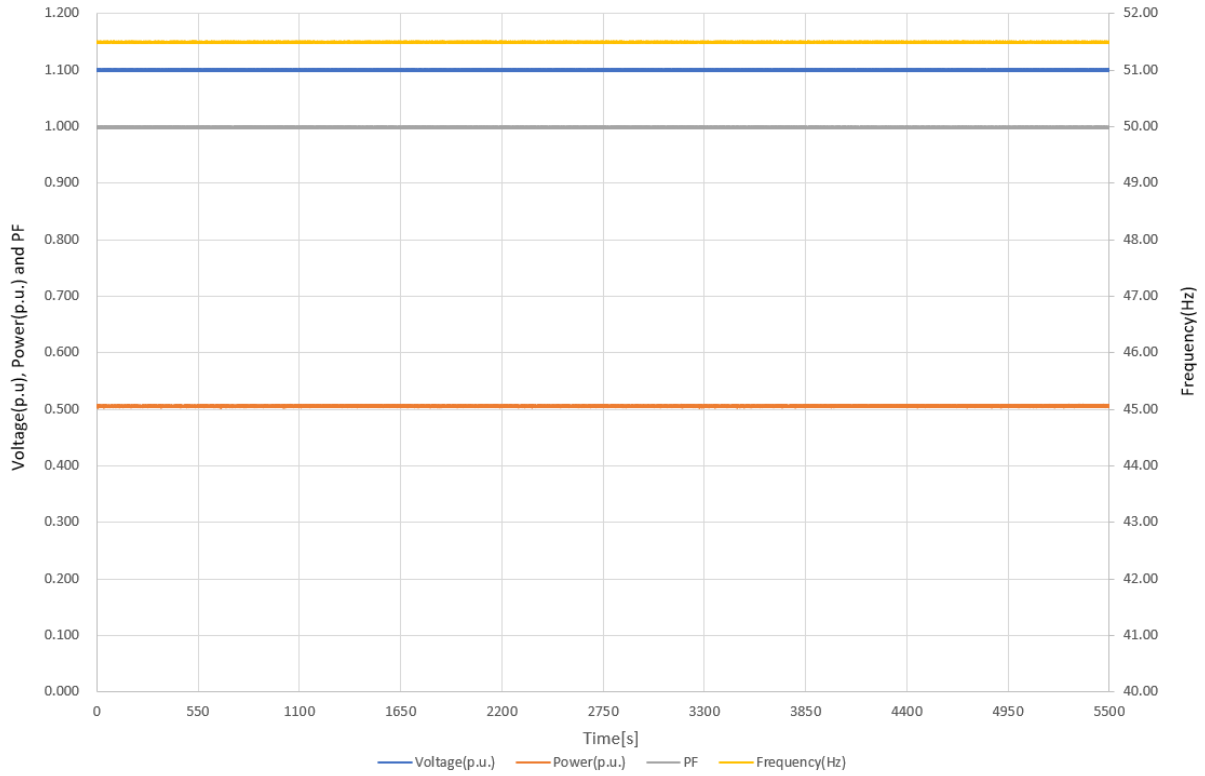
Test 1



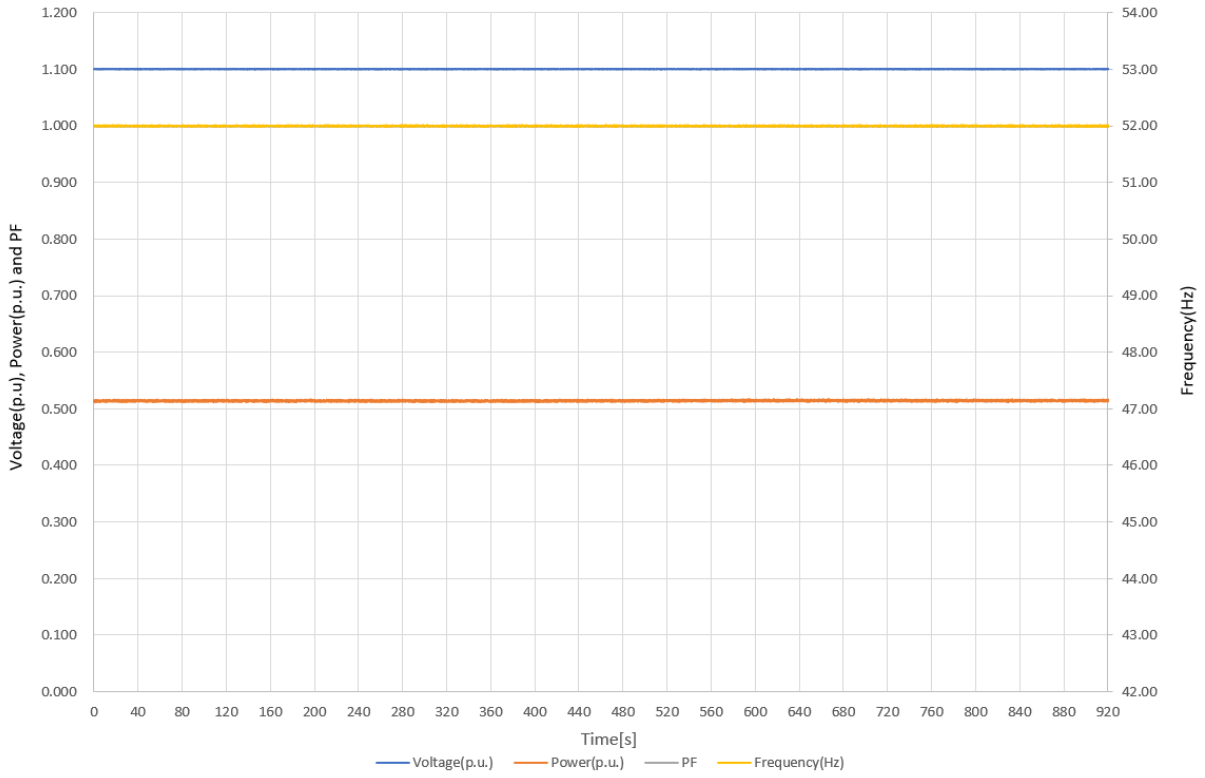
Test 2



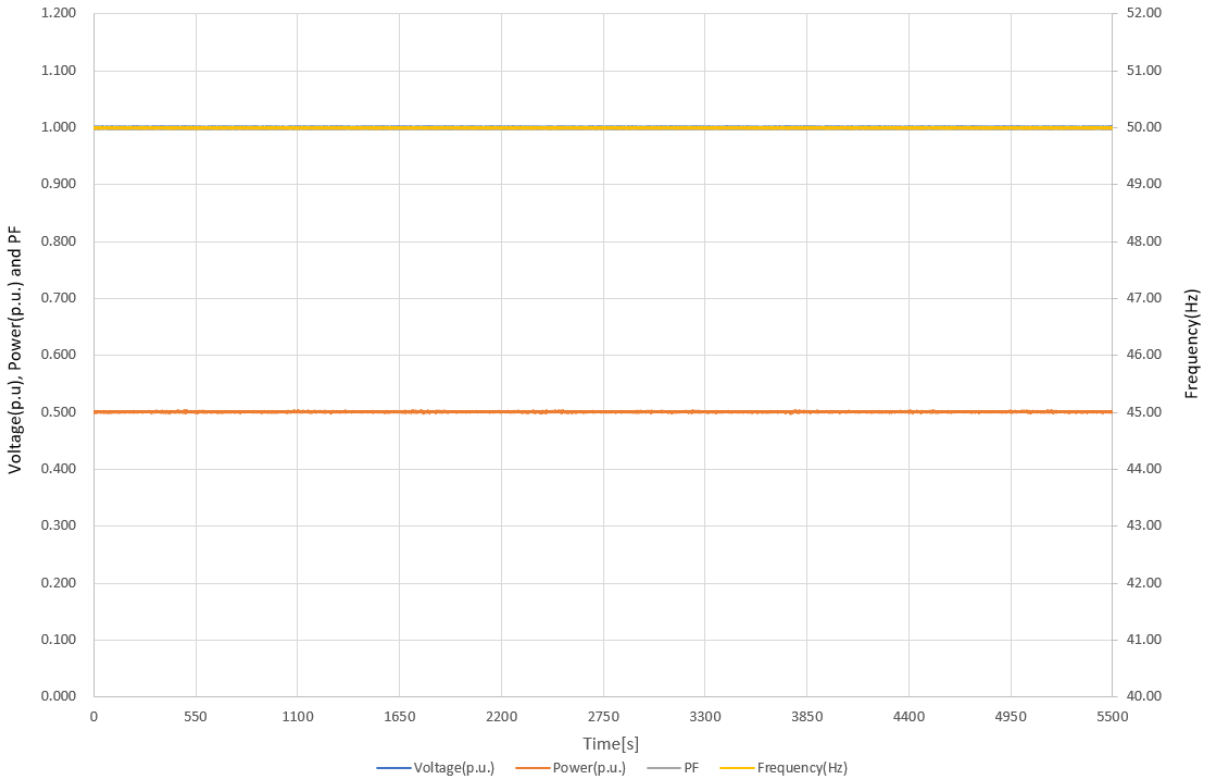
Test 3


Voltage(p.u), Power(p.u.) and PF
Frequency(Hz)
Time[s]
Voltage(p.u.)
Power(p.u.)
PF
Frequency(Hz)

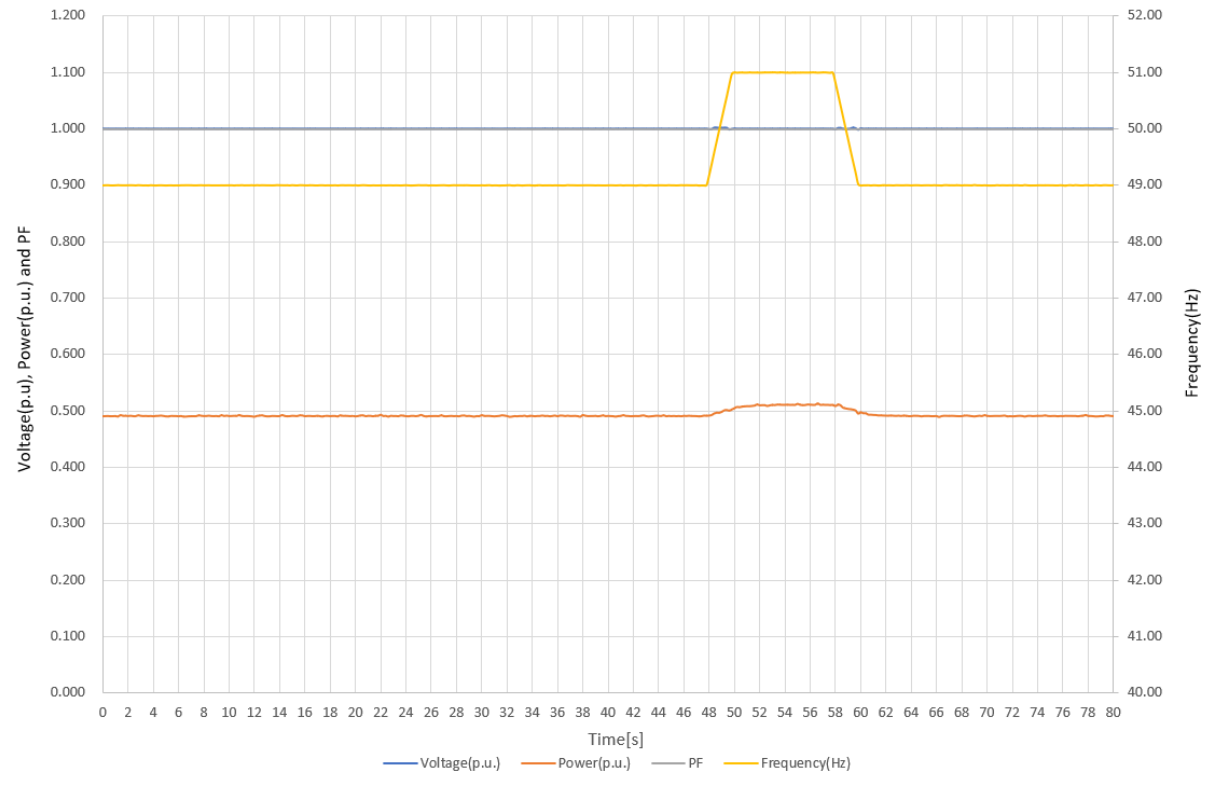
Test 4


Voltage(p.u), Power(p.u.) and PF
Frequency(Hz)
Time[s]
Voltage(p.u.)
Power(p.u.)
PF
Frequency(Hz)

Test 5


Voltage(p.u), Power(p.u.) and PF
Frequency(Hz)
Time[s]
Voltage(p.u.)
Power(p.u.)
PF
Frequency(Hz)

Test 6


Voltage(p.u), Power(p.u.) and PF
Frequency(Hz)
Time[s]
Voltage(p.u.)
Power(p.u.)
PF
Frequency(Hz)

4.2 POWER QUALITY

4.2.1 Current Harmonics

The tests should be carried out as specified in BS EN 61000-3-2 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of Registered Capacity. The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).

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

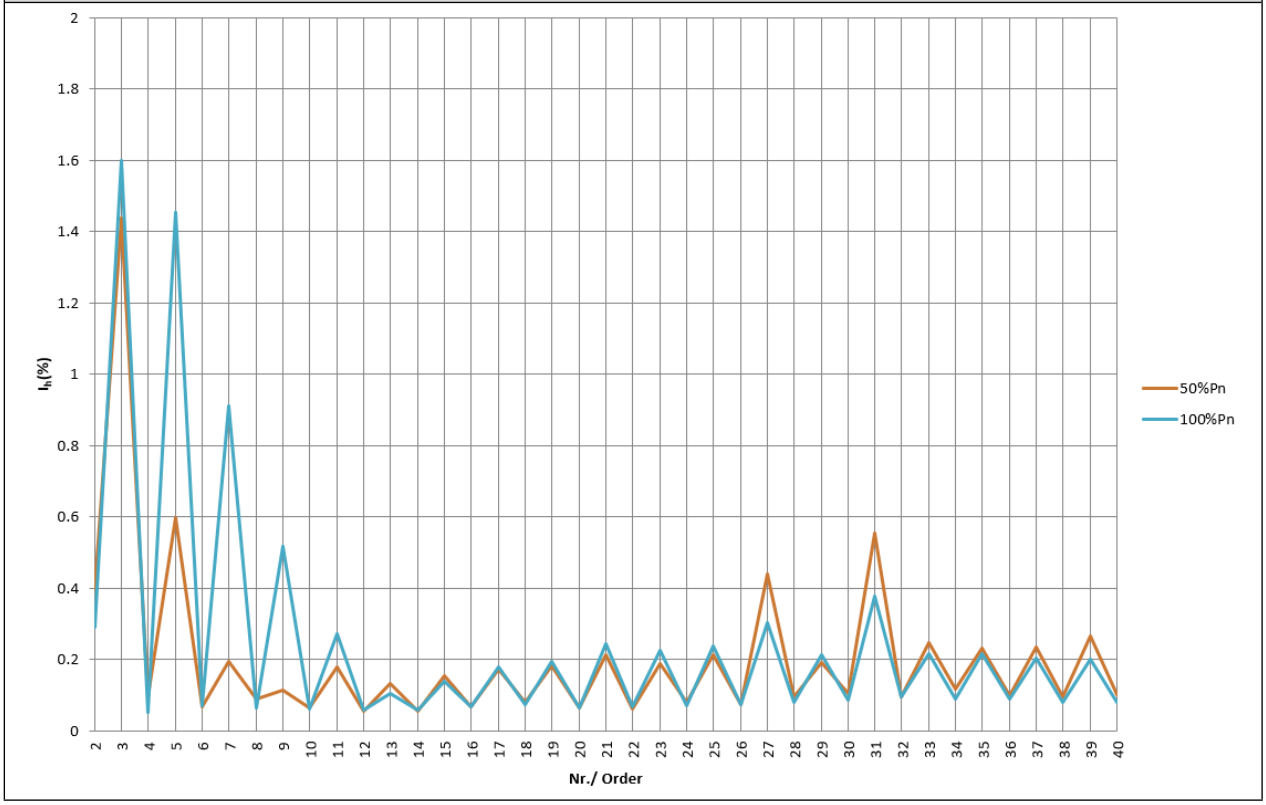
Following tables show the test results:

Micro-generator rating per phase (rpp)			0.8	kW		
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**			
	Measured Value MV in Amps	Ih(%)	Measured Value MV in Amps	Ih(%)	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.014	0.400	0.010	0.291	1.080	
3	0.050	1.437	0.056	1.599	2.300	
4	0.003	0.095	0.002	0.050	0.430	
5	0.021	0.597	0.051	1.454	1.140	
6	0.002	0.066	0.002	0.069	0.300	
7	0.007	0.193	0.032	0.910	0.770	
8	0.003	0.090	0.002	0.064	0.230	
9	0.004	0.112	0.018	0.516	0.400	
10	0.002	0.064	0.002	0.062	0.184	
11	0.006	0.177	0.009	0.270	0.330	
12	0.002	0.056	0.002	0.057	0.153	
13	0.005	0.133	0.004	0.104	0.210	
14	0.002	0.056	0.002	0.057	0.131	
15	0.005	0.153	0.005	0.138	0.150	
16	0.002	0.067	0.002	0.068	0.115	
17	0.006	0.173	0.006	0.178	0.132	
18	0.003	0.079	0.003	0.072	0.102	
19	0.006	0.182	0.007	0.194	0.118	
20	0.002	0.065	0.002	0.064	0.092	
21	0.007	0.213	0.008	0.244	0.107	0.160
22	0.002	0.061	0.002	0.067	0.084	
23	0.007	0.187	0.008	0.225	0.098	0.147
24	0.003	0.079	0.002	0.071	0.077	
25	0.007	0.213	0.008	0.236	0.090	0.135
26	0.003	0.072	0.003	0.072	0.071	
27	0.015	0.438	0.010	0.301	0.083	0.124
28	0.003	0.095	0.003	0.078	0.066	
29	0.007	0.190	0.007	0.212	0.078	0.117
30	0.004	0.104	0.003	0.084	0.061	
31	0.019	0.553	0.013	0.378	0.073	0.109
32	0.003	0.096	0.003	0.095	0.058	
33	0.009	0.247	0.007	0.215	0.068	0.102
34	0.004	0.115	0.003	0.089	0.054	
35	0.008	0.232	0.008	0.216	0.064	0.096
36	0.003	0.097	0.003	0.088	0.051	
37	0.008	0.234	0.007	0.202	0.061	0.091

38	0.003	0.095	0.003	0.078	0.048	
39	0.009	0.266	0.007	0.200	0.058	0.087
40	0.003	0.100	0.003	0.078	0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

Current Harmonics



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	0.24* 0.4^	Ω	X	0.15* 0.25^	Ω
Standard Impedance	R	0.24* 0.4^	Ω	X	0.15* 0.25^	Ω
Maximum Impedance	R	0.24* 0.4^	Ω	X	0.15* 0.25^	Ω
*Applies to three phase and split single phase Micro-generators. ^Applies to single phase Micro-generators and Micro-generators using two phases on a three phase system.						

Starting operation and Stopping operation			
Pbin (%)	**100%**		
	Limit	**Starting measured values**	**Stopping measured values**
PST	≤ 1	0.131	0.034
PLT	≤ 0.65	0.105	0.105
dc	≤ 3.30%	0.250%	0.000%
d(t)	≤ 3.30%	0.000%	0.000%
dmax	4%	0.345%	0.000%

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

Running operation 2 hours		
Pbin (%)	100%	
	Limit	Measured values
PST	≤ 1	0.046
PLT	≤ 0.65	0.046
dc	≤ 3.30%	0.000%
d(t)	≤ 3.30%	0.000%
dmax	4%	0.000%

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

	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	0.046	Pass		
2	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
3	0.000	Pass	0.000	Pass	0.0	Pass	0.045	Pass		
4	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
5	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
6	0.000	Pass	0.000	Pass	0.0	Pass	0.045	Pass		
7	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
8	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
9	0.000	Pass	0.000	Pass	0.0	Pass	0.045	Pass		
10	0.000	Pass	0.000	Pass	0.0	Pass	0.045	Pass		
11	0.000	Pass	0.000	Pass	0.0	Pass	0.045	Pass		
12	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
Result		Pass		Pass		Pass		Pass	0.046	Pass

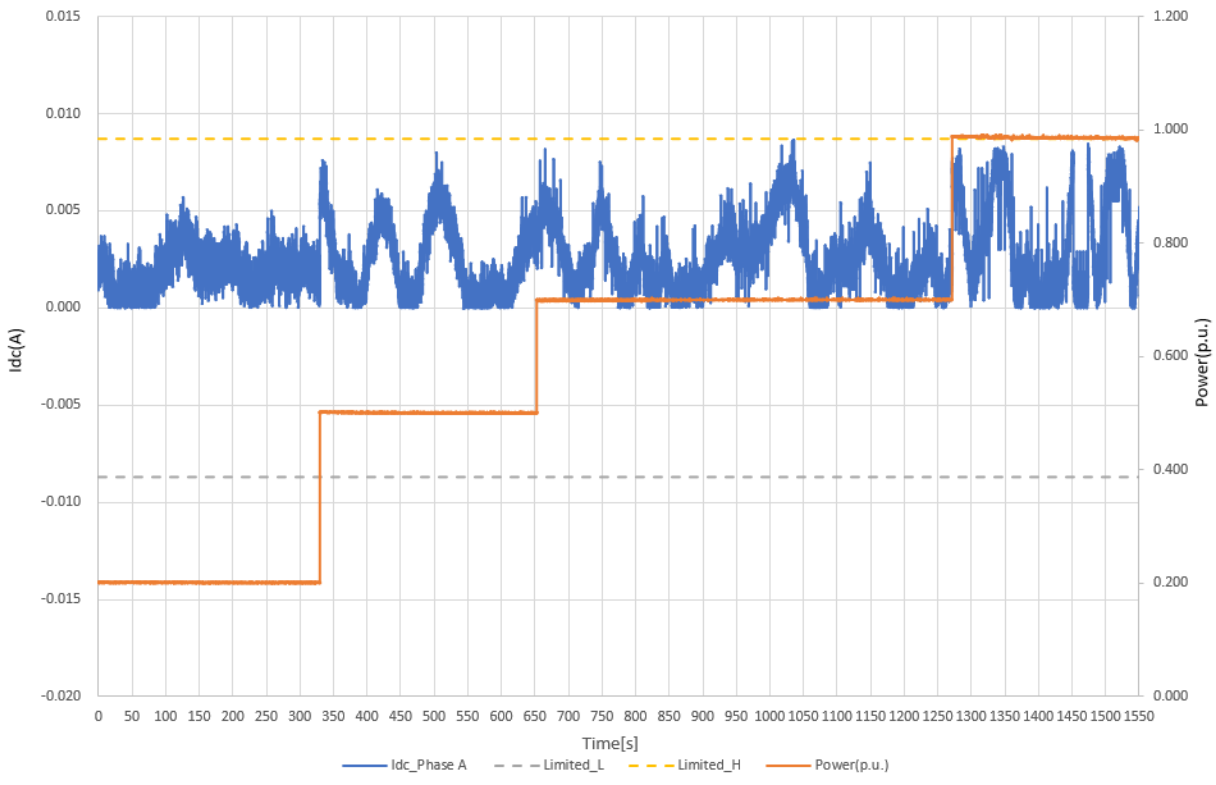
4.2.3 DC Injection

The DC component shall be measured under steady-state conditions for the following power levels: 20 %, 50 %, 75 %, and 100 % of nominal power with a tolerance of ± 5 % of nominal power and as far as adjustable for the tested micro-generator. These tests should be undertaken in accordance with Annex A1.3.4.

Following tables show the test results:

Power quality – DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10				
Test power level	20%	50%	75%	100%
Recorded value in Amps	0.002	0.002	0.003	0.0035
as % of rated AC current	0.058	0.058	0.086	0.101
Limit	0.25%	0.25%	0.25%	0.25%

DC injection test result



4.2.4 Power Factor

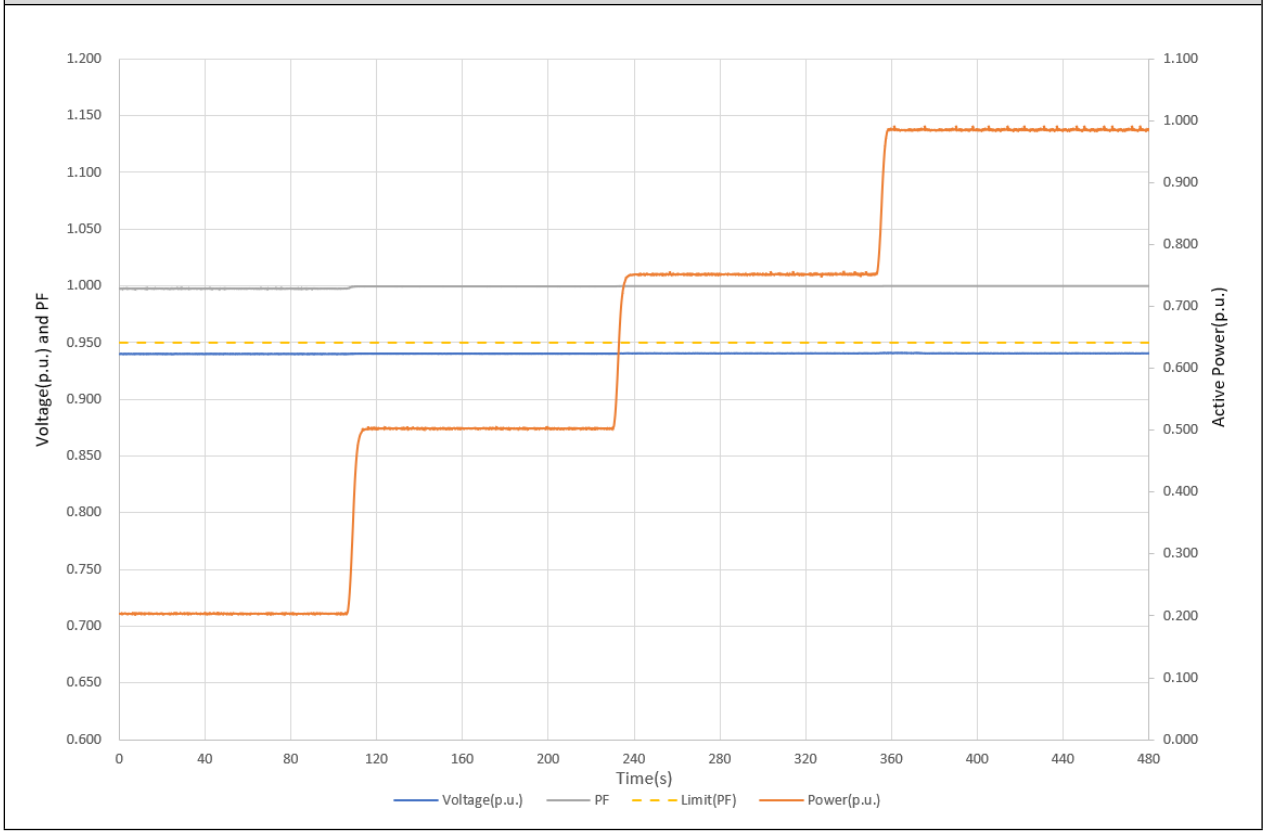
This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within ±1.5% of the stated level during the test.

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

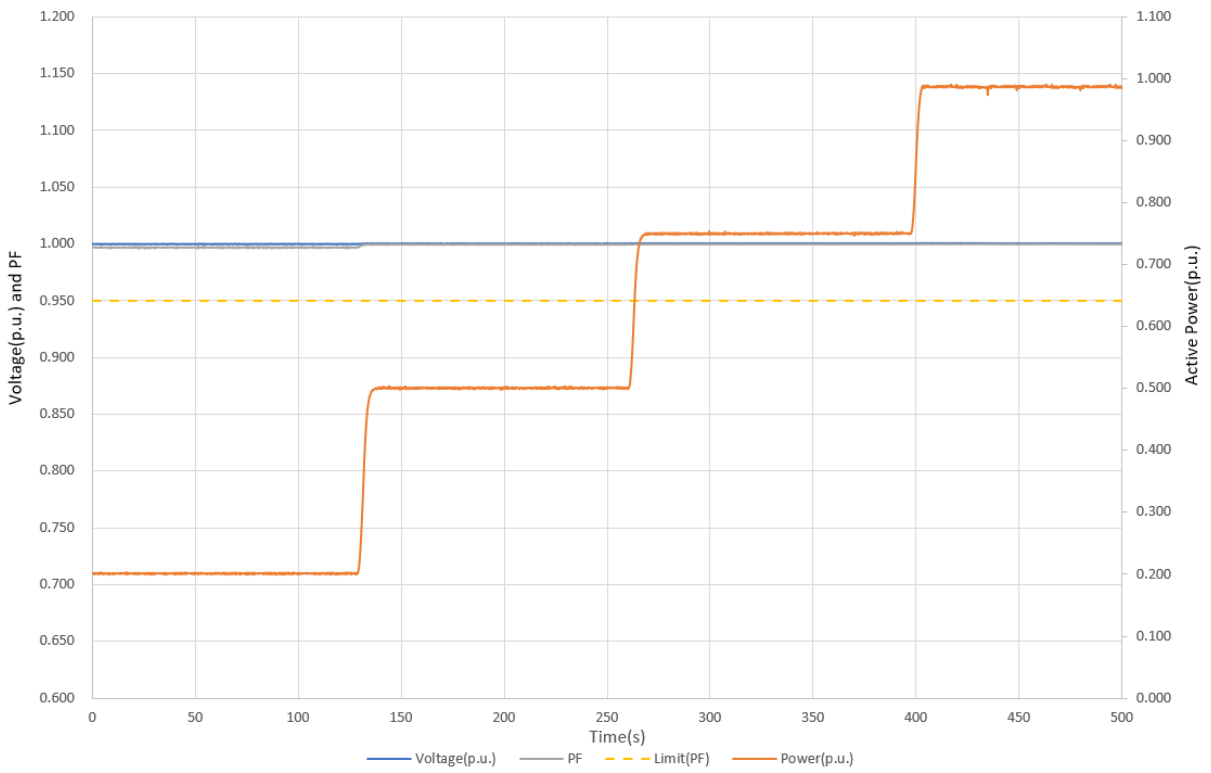
	216.2 V	230 V	253 V
20% of **Registered Capacity**	0.998	0.997	0.998
50% of **Registered Capacity**	1.000	0.999	1.000
75% of **Registered Capacity**	1.000	1.000	1.000
100% of **Registered Capacity**	1.000	1.000	1.000
Limit	>0.95	>0.95	>0.95

Test results are graphically shown below.

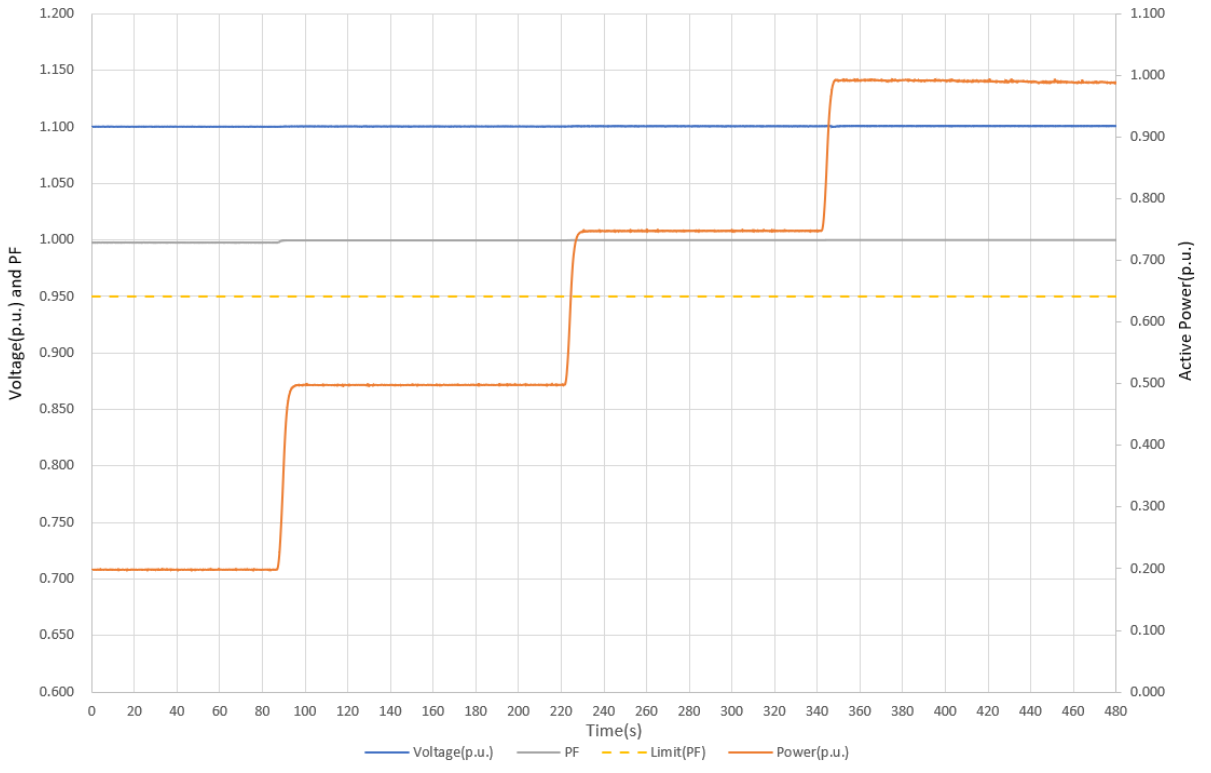
Power Factor 216.2V



Power Factor 230V



Power Factor 253V



4.3 PROTECTION

4.3.1 Frequency tests

These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A.1.2.3 (Inverter connected) or Annex A2 A.2.2.3 (Synchronous).

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.

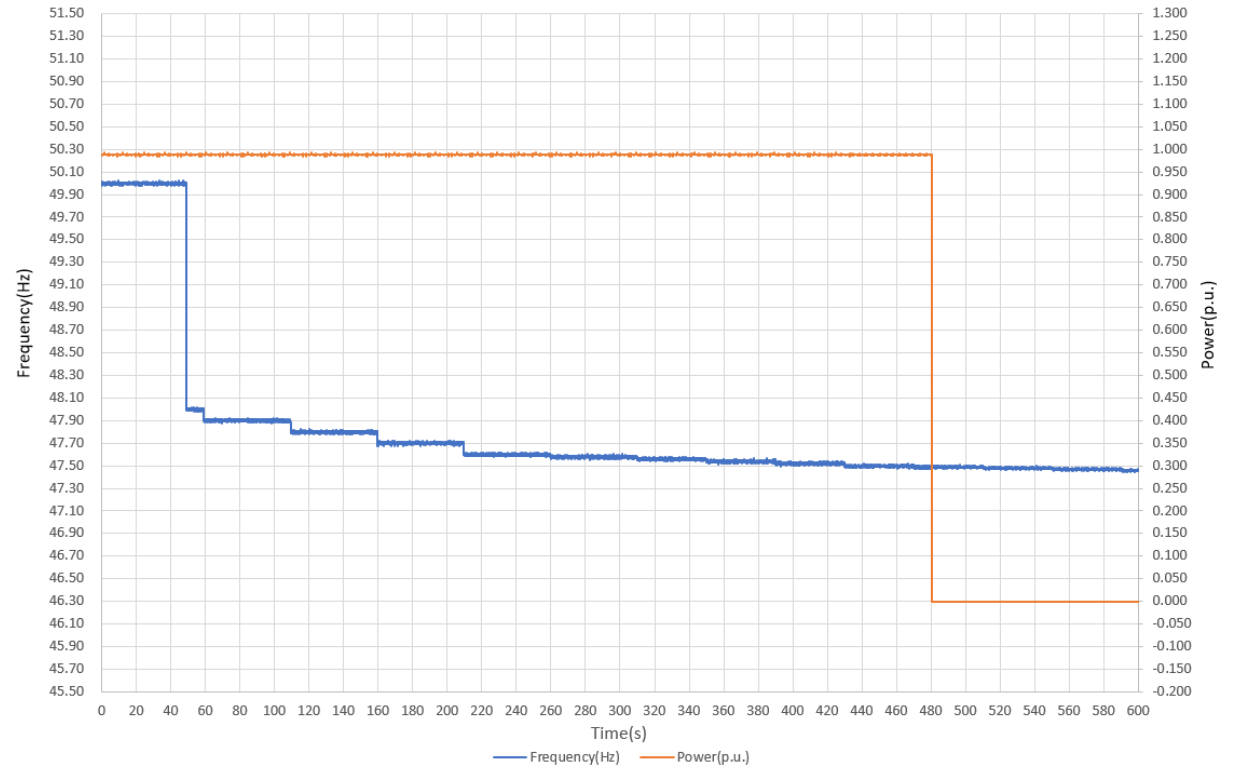
To establish the trip time, the test frequency should be applied starting from 0.3 Hz below or above the recorded trip frequency and should be changed to 0.3 Hz above or below the recorded trip frequency in a single step. For each trip setting five tests shall be carried out.

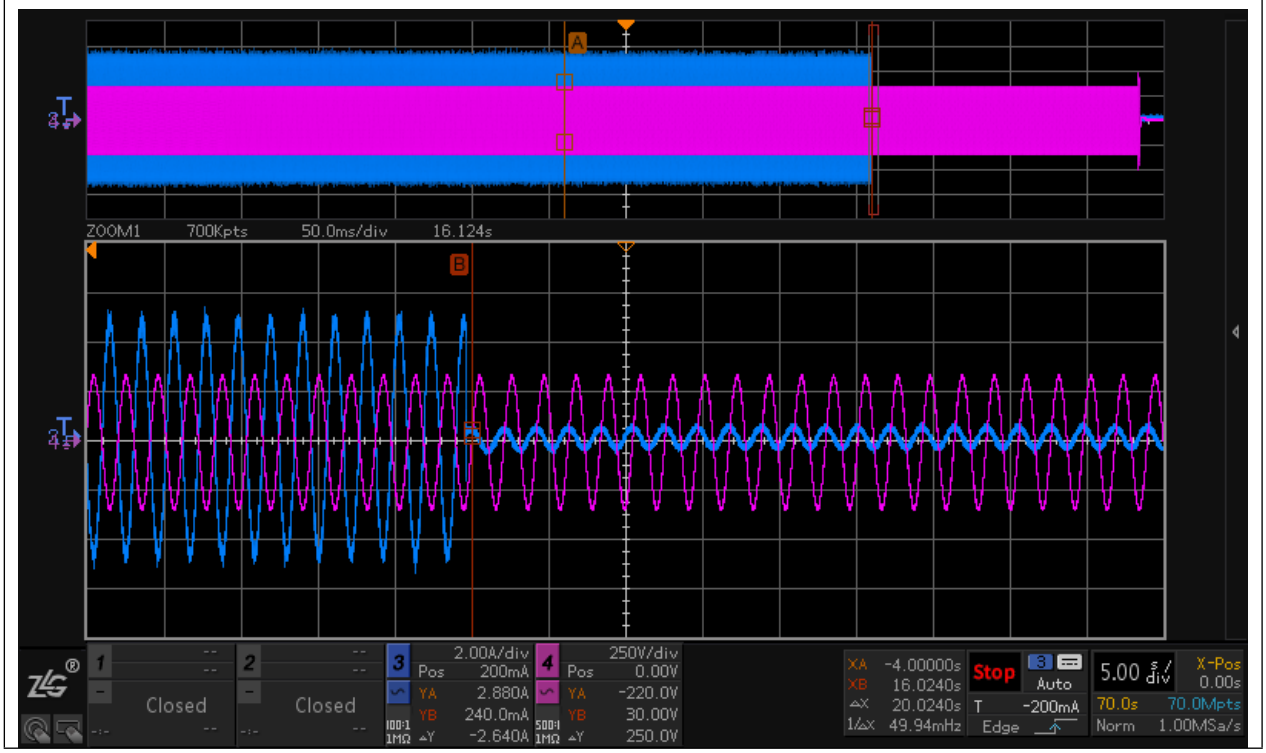
Following tables show the test results:

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	47.49	20.024	47.7 Hz / 30 s	Pass
			47.50	20.060		
			47.50	20.068		
			47.50	20.038		
			47.50	20.078		
U/F stage 2	47 Hz	0.5 s	46.99	0.570	47.2 Hz / 19.5 s	Pass
			46.99	0.580		
			46.99	0.550		
			46.99	0.560		
			46.99	0.540		
					46.8 Hz / 0.45 s	Pass
O/F stage 1	52 Hz	0.5 s	51.98	0.554	51.8 Hz / 120 s	Pass
			51.99	0.560		
			52.00	0.570		
			52.00	0.550		
			52.00	0.560		
					52.2 Hz / 0.45 s	Pass

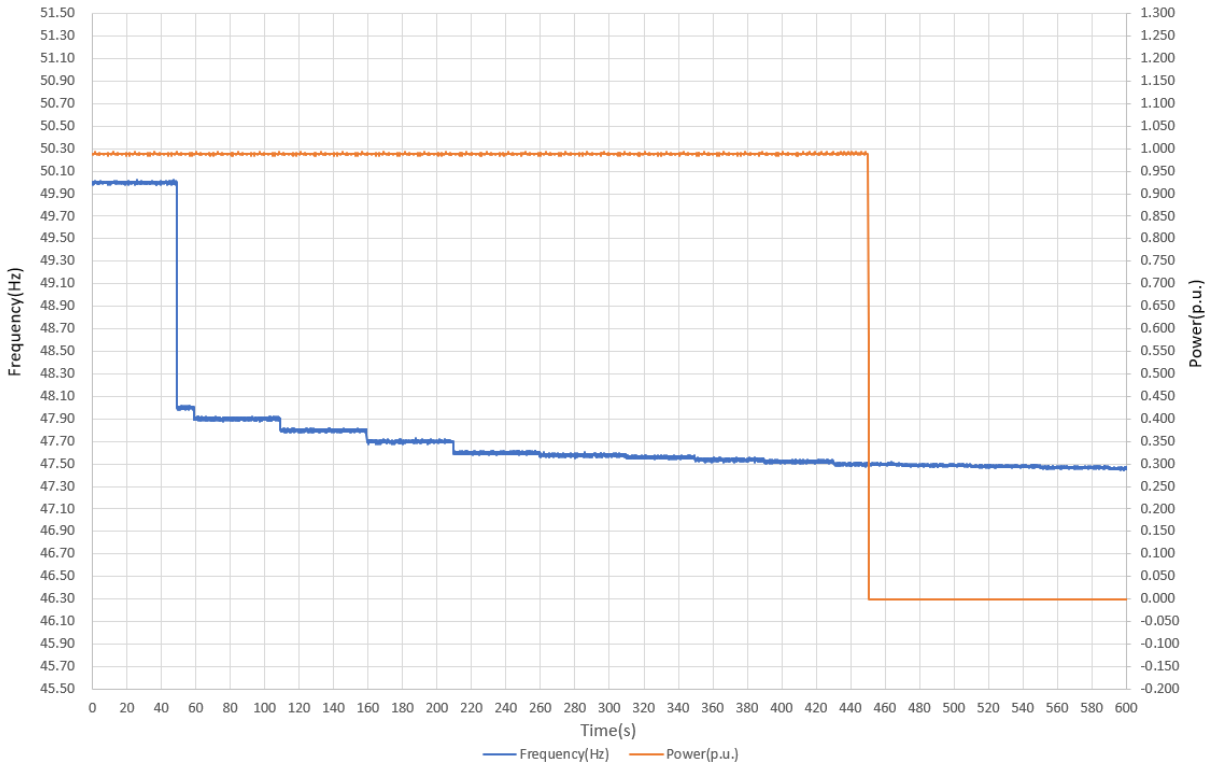
Test results are graphically shown below.

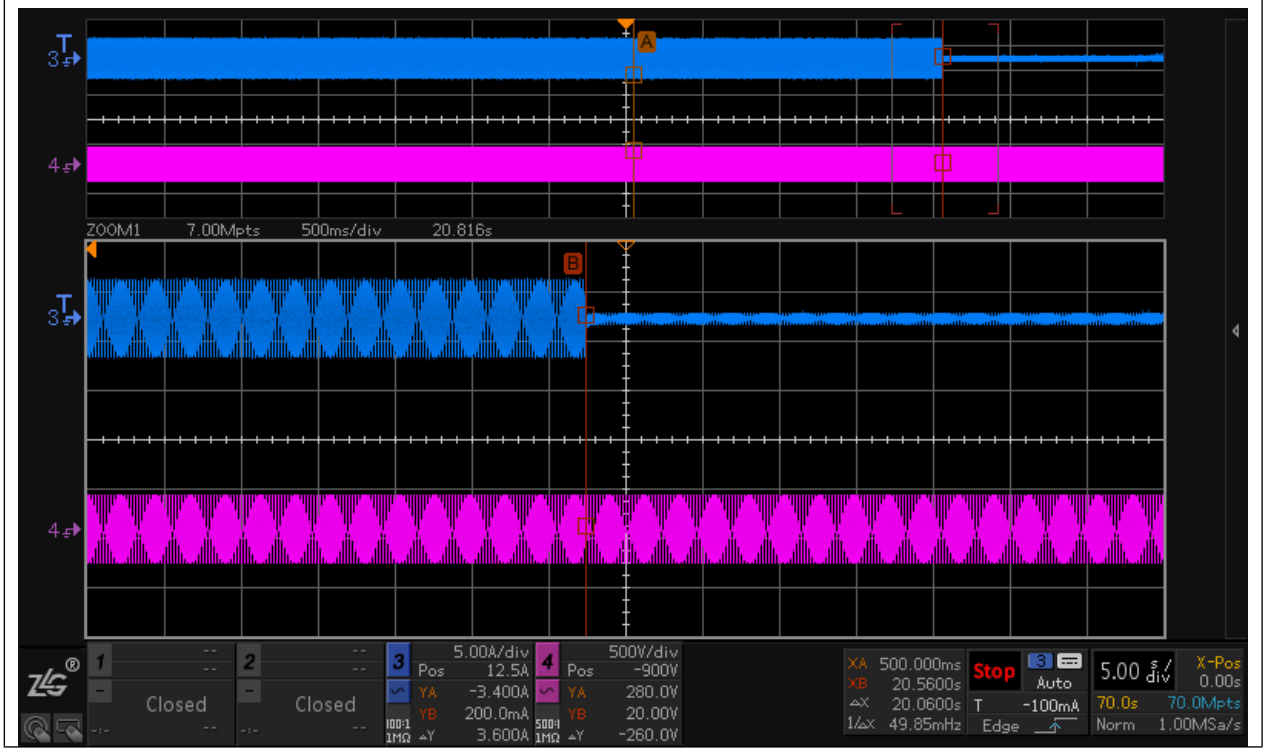
U/F stage 1-1



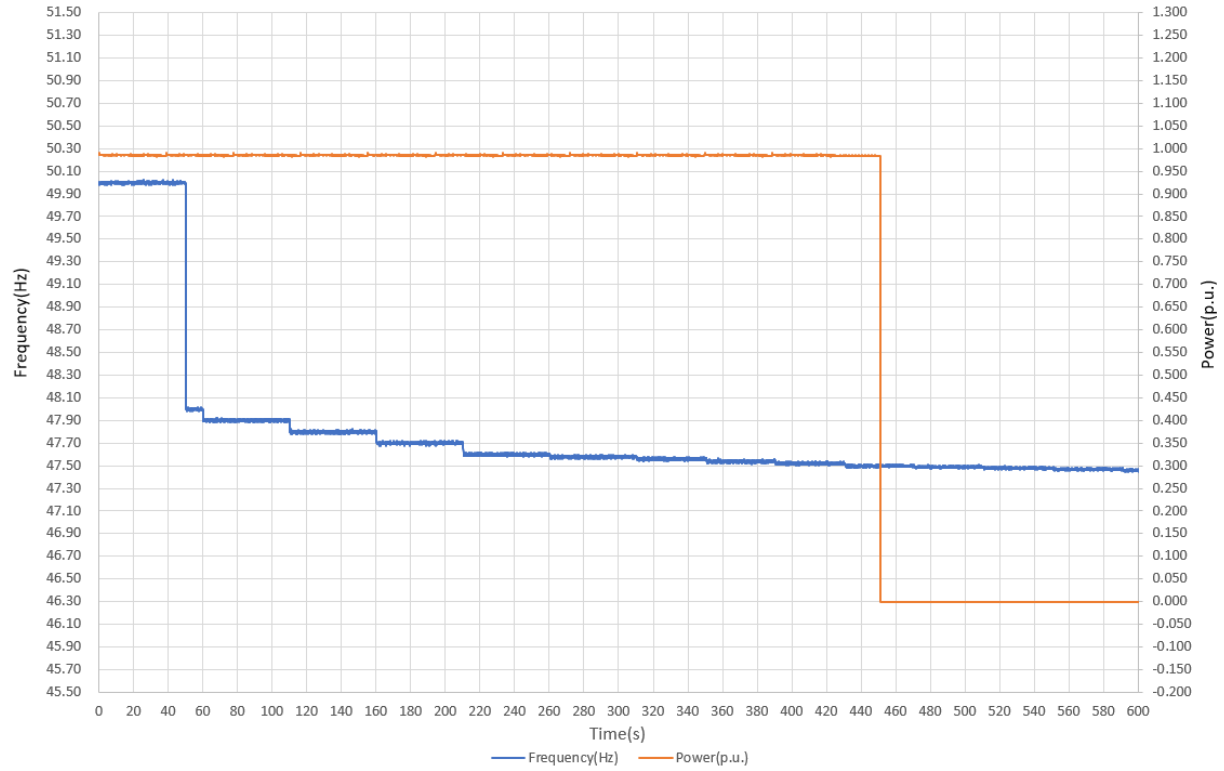


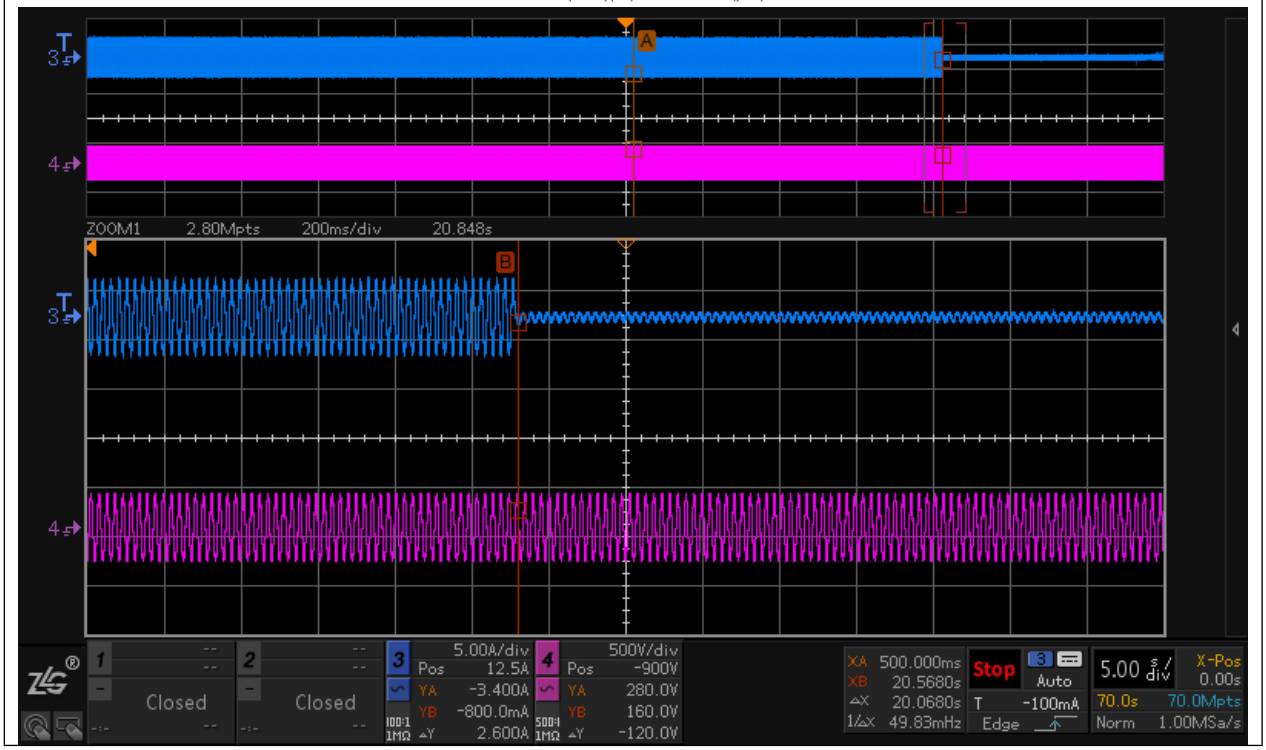
U/F stage 1-2


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

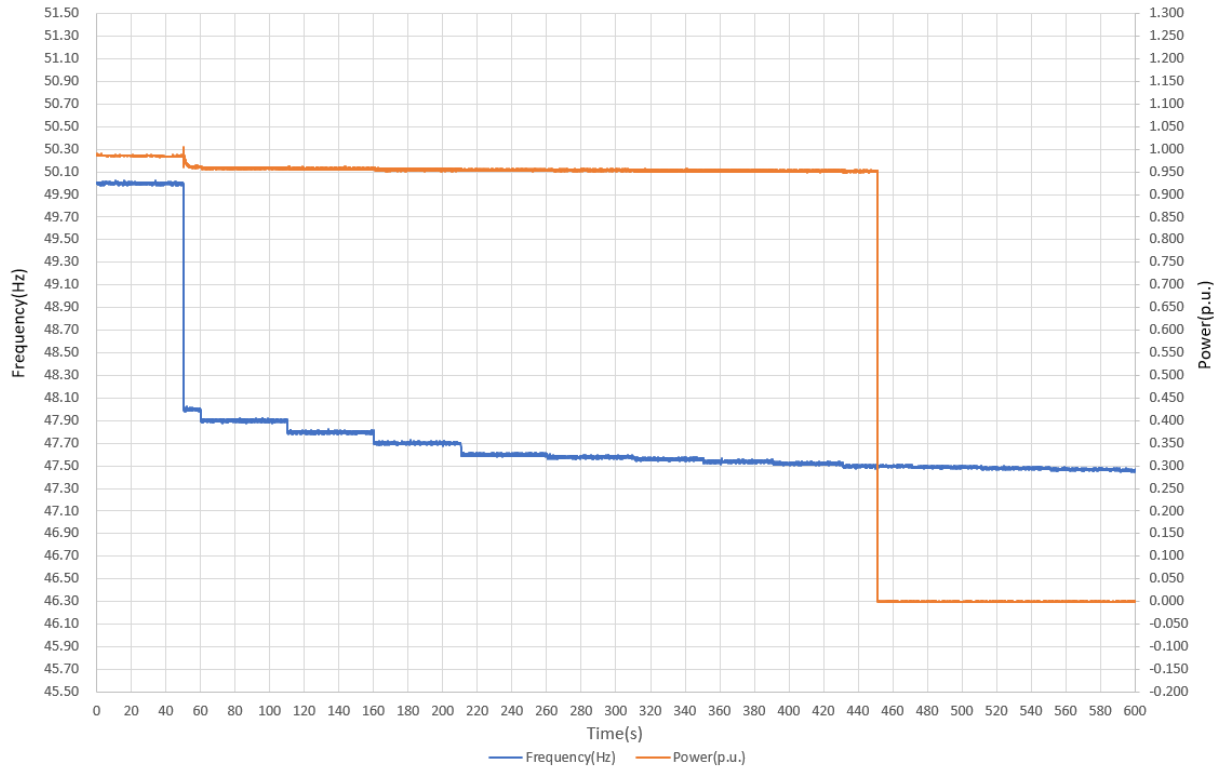

ZOOM1
7.00Mpts
500ms/div
20.816s
Closed
Closed
5.00A/div
Pos 12.5A
YA -3.400A
YB 200.0mA
3.600A
500V/div
Pos -900V
YA 280.0V
YB 20.00V
-260.0V
XA 500.000ms
XB 20.5600s
ΔX 20.0600s
1/ΔX 49.85mHz
Stop
Auto
T -100mA
Edge
5.00 div
X-Pos 0.00s
70.0s
70.0Mpts
Norm 1.00MSa/s

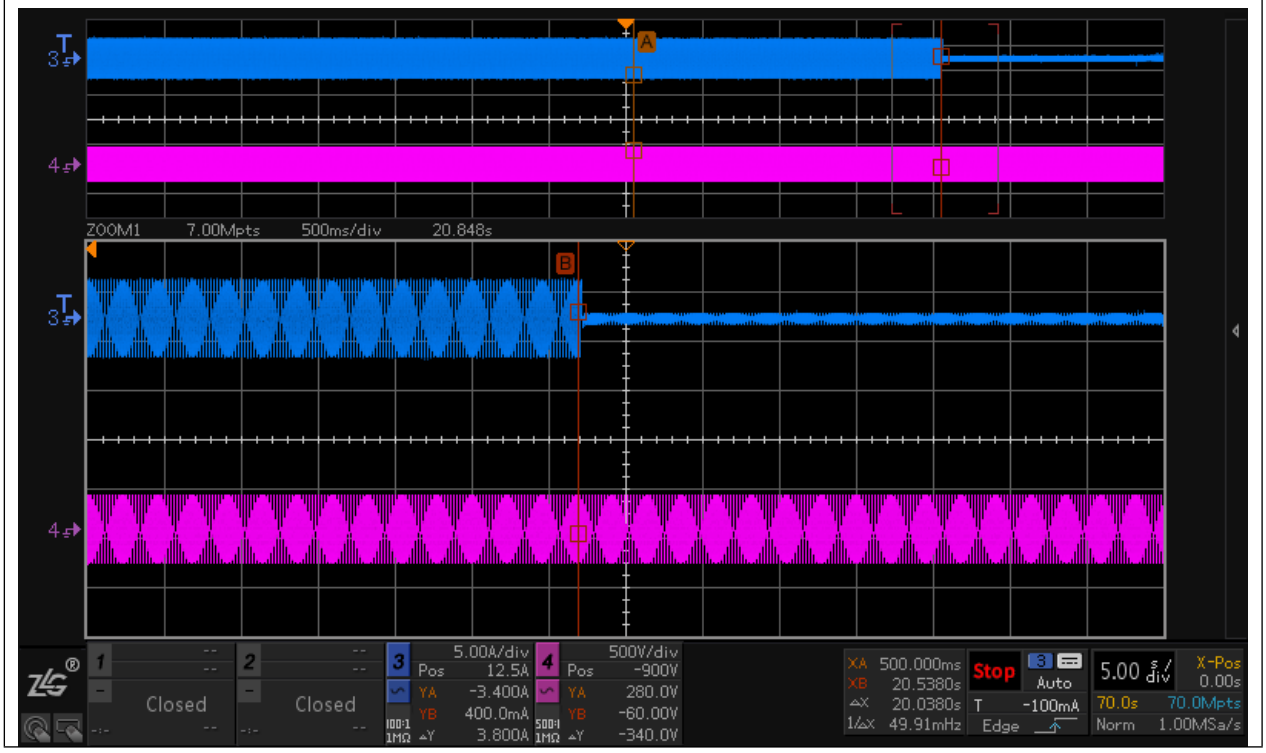
U/F stage 1-3


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

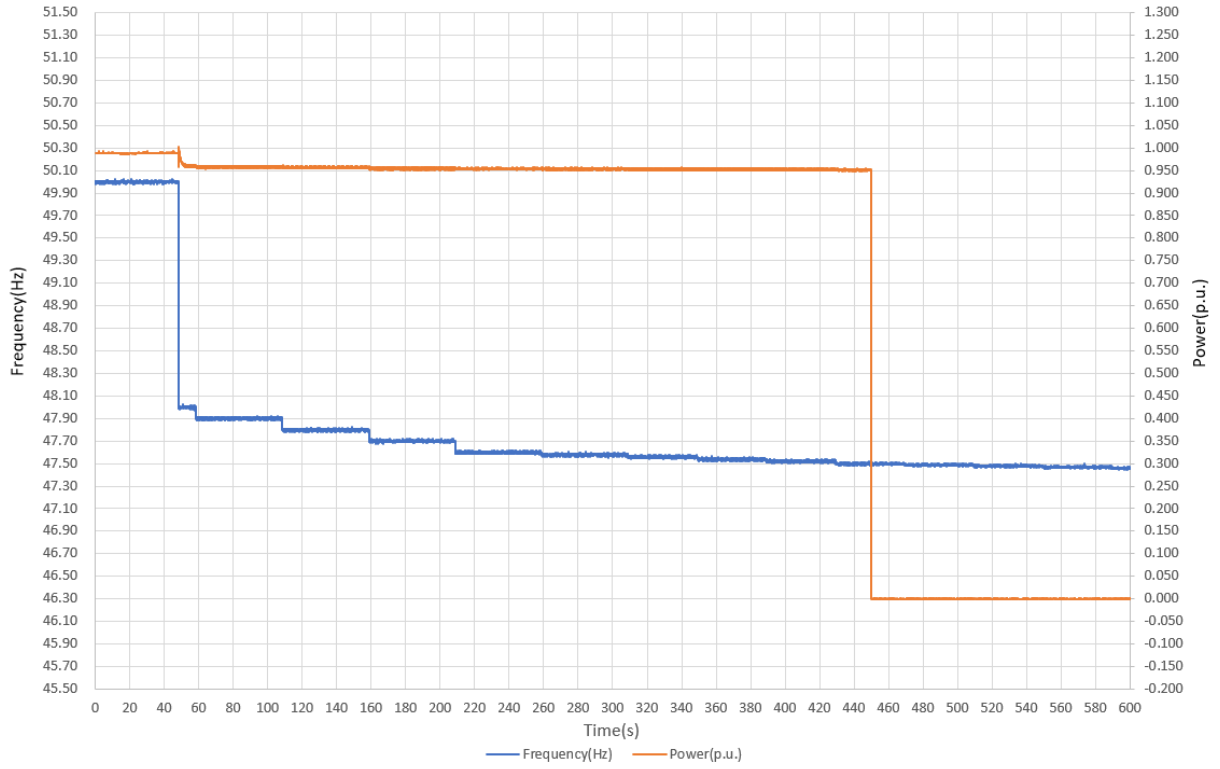

ZOOM1 2.80Mpts 200ms/div 20.848s
Closed
Closed
5.00A/div
Pos 12.5A
YA -3.400A
YB -800.0mA
2.600A
500V/div
Pos -900V
YA 280.0V
YB 160.0V
-120.0V
XA 500.000ms
XB 20.5680s
ΔX 20.0680s
1/ΔX 49.83mHz
Stop
Auto
T -100mA
Edge
5.00 div
X-Pos
0.00s
70.0s
70.0Mpts
Norm 1.00MSa/s

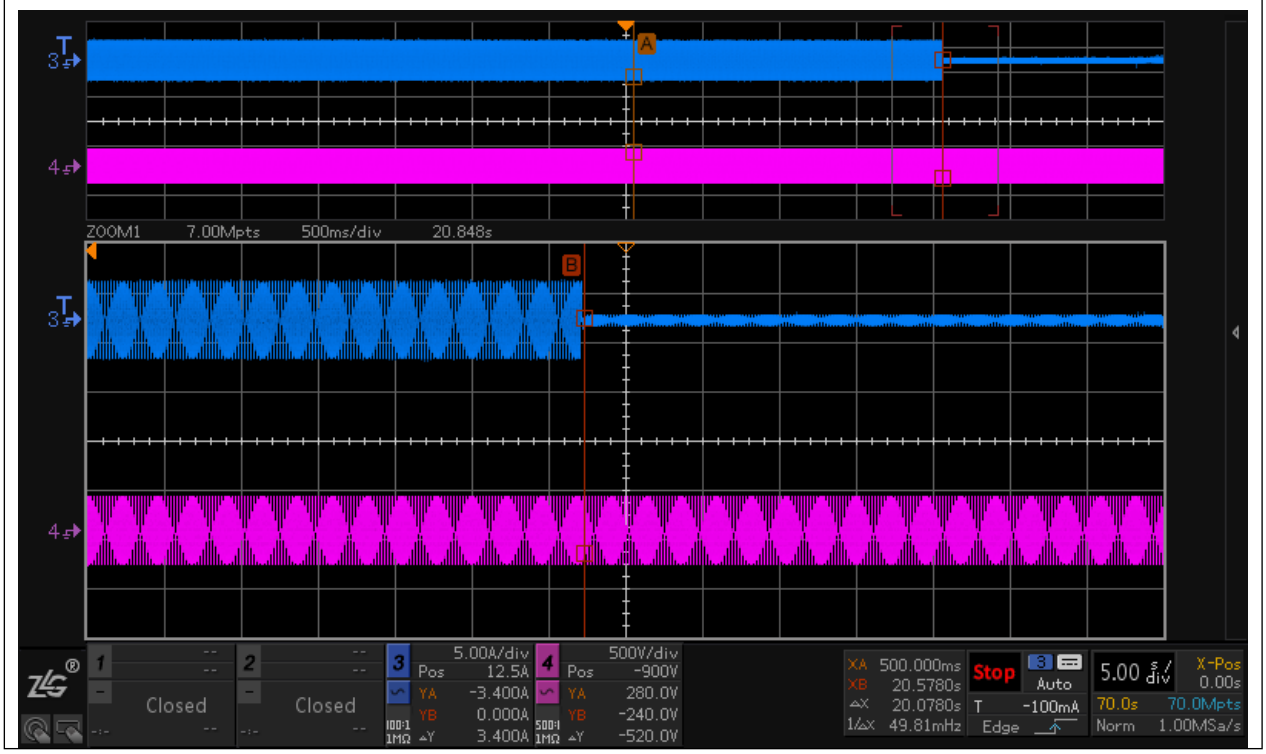
U/F stage 1-4


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

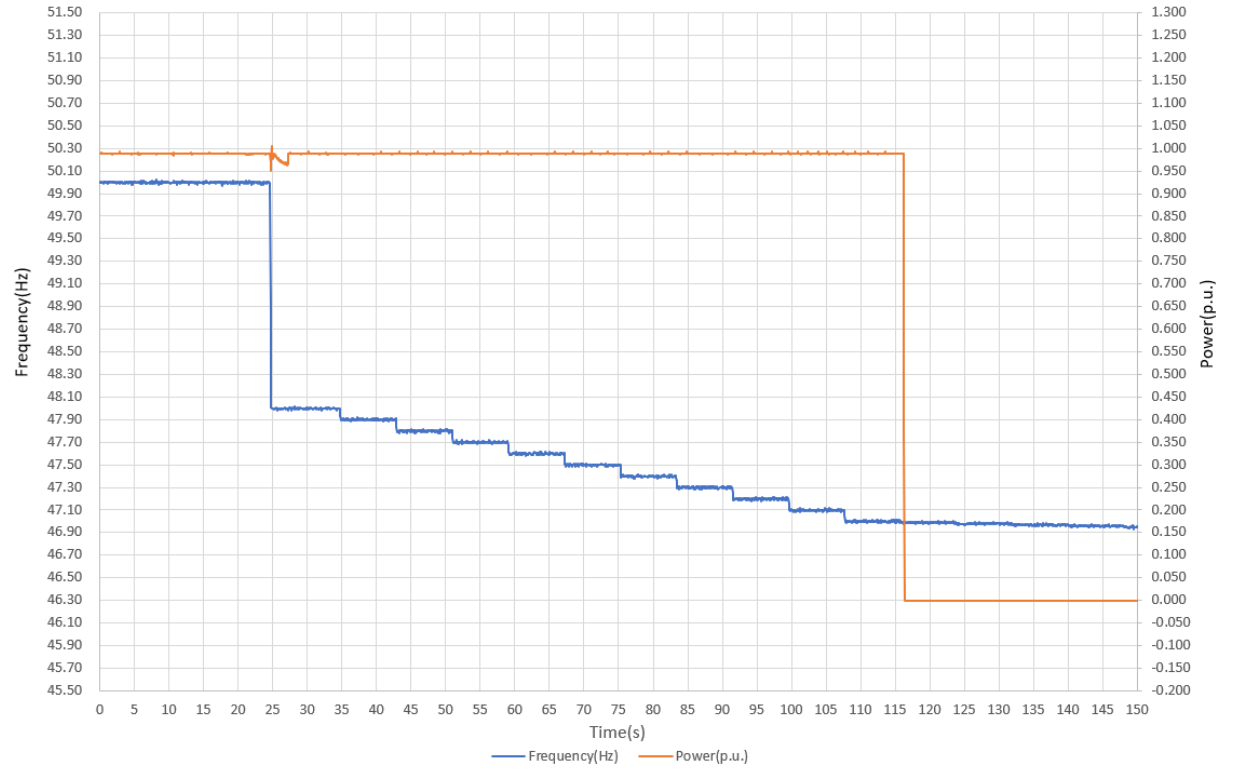

ZOOM1
7.00Mpts
500ms/div
20.848s
Closed
Closed
5.00A/div
Pos 12.5A
YA -3.400A
YB 400.0mA
3.800A
500V/div
Pos -900V
YA 280.0V
YB -60.00V
-340.0V
XA 500.000ms
XB 20.5380s
20.0380s
1/ΔX 49.91mHz
Stop
Auto
T -100mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

U/F stage 1-5


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

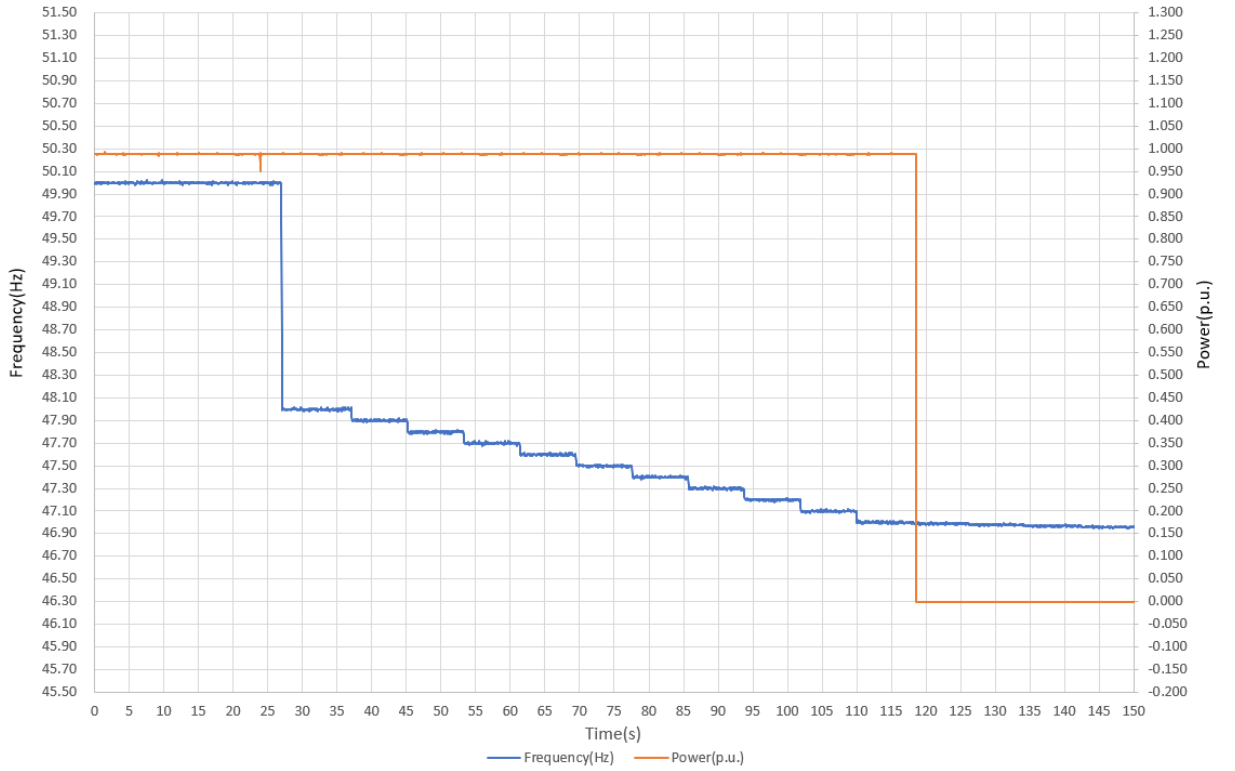

ZOOM1
7.00Mpts
500ms/div
20.848s
Closed
Closed
5.00A/div
Pos 12.5A
YA -3.400A
YB 0.000A
3.400A
500V/div
Pos -900V
YA 280.0V
YB -240.0V
-520.0V
XA 500.000ms
XB 20.5780s
20.0780s
1/ΔX 49.81mHz
Stop
Auto
T -100mA
Edge
5.00 div
X-Pos 0.00s
70.0s
70.0Mpts
Norm 1.00MSa/s

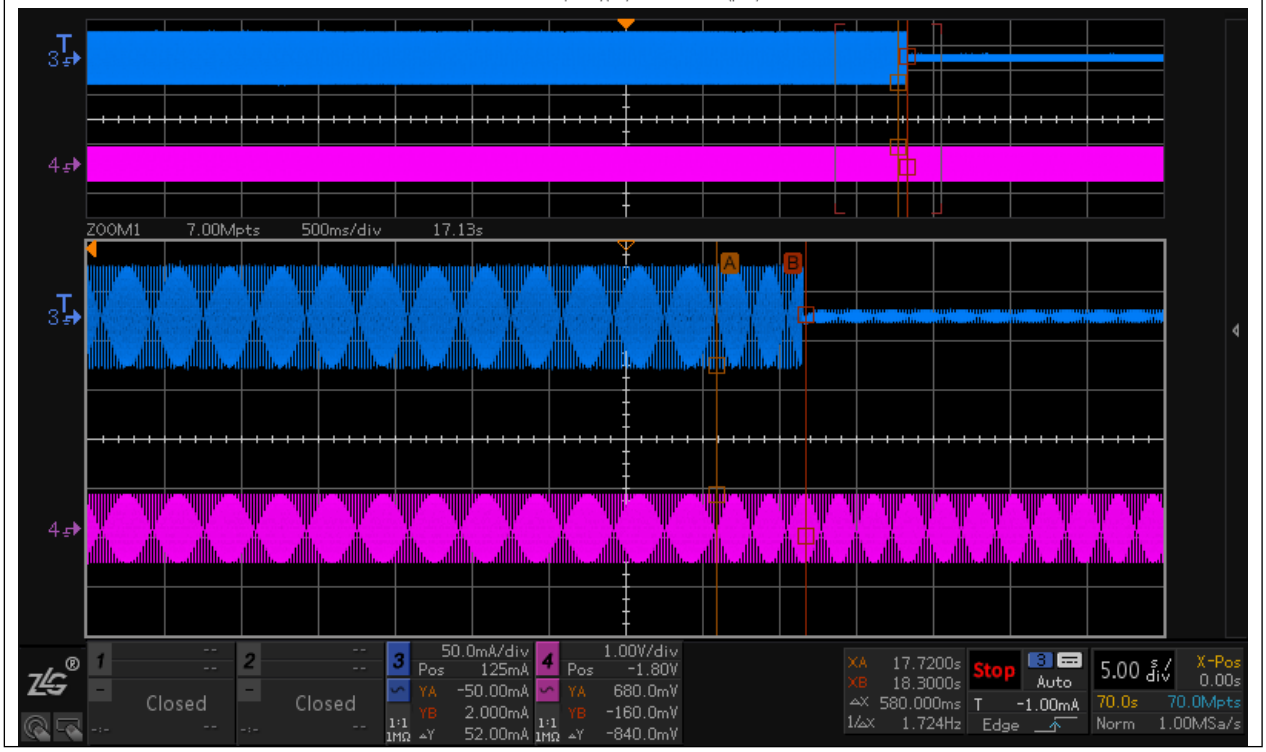
U/F stage 2-1


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

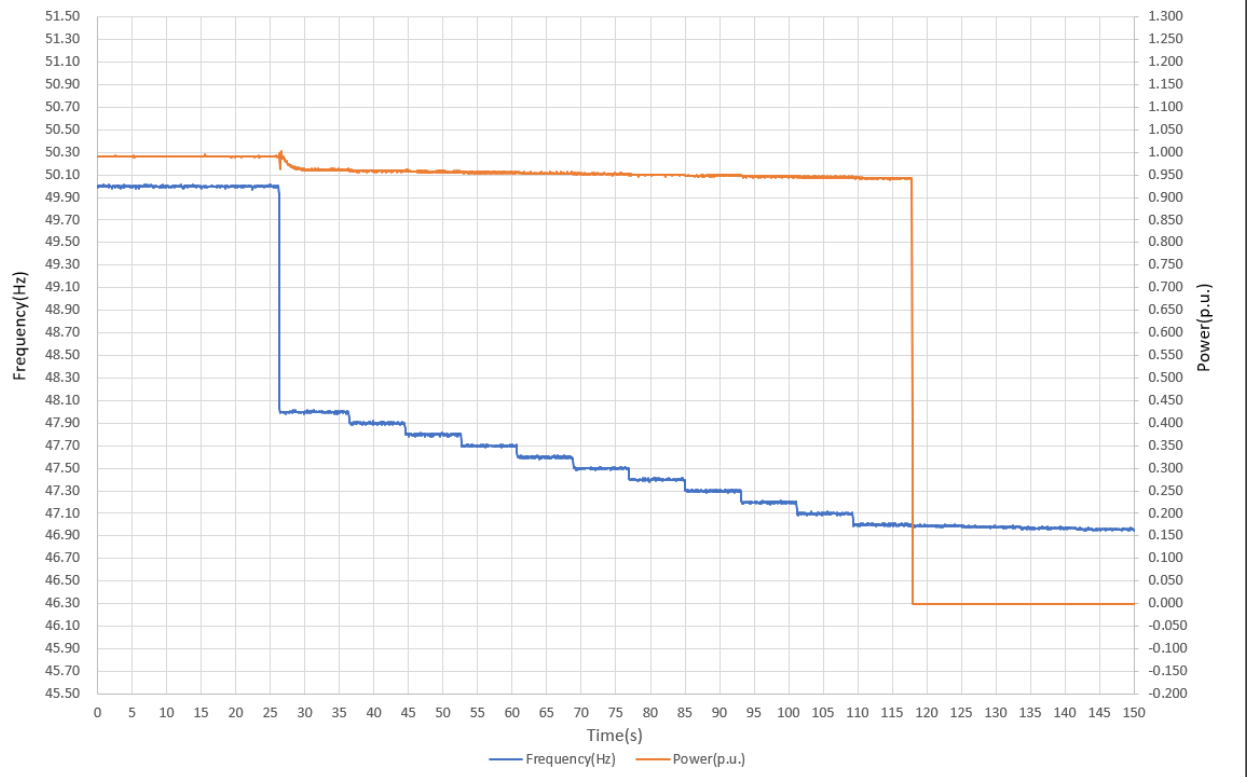

ZOOM1
7.00Mpts
500ms/div
18.00s
Closed
Closed
50.0mA/div
Pos 125mA
YA 48.00mA
YB 2.000mA
-46.00mA
1.00V/div
Pos -1.80V
YA -720.0mV
YB -160.0mV
560.0mV
XA 17.7300s
XB 18.3000s
570.000ms
1.754Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

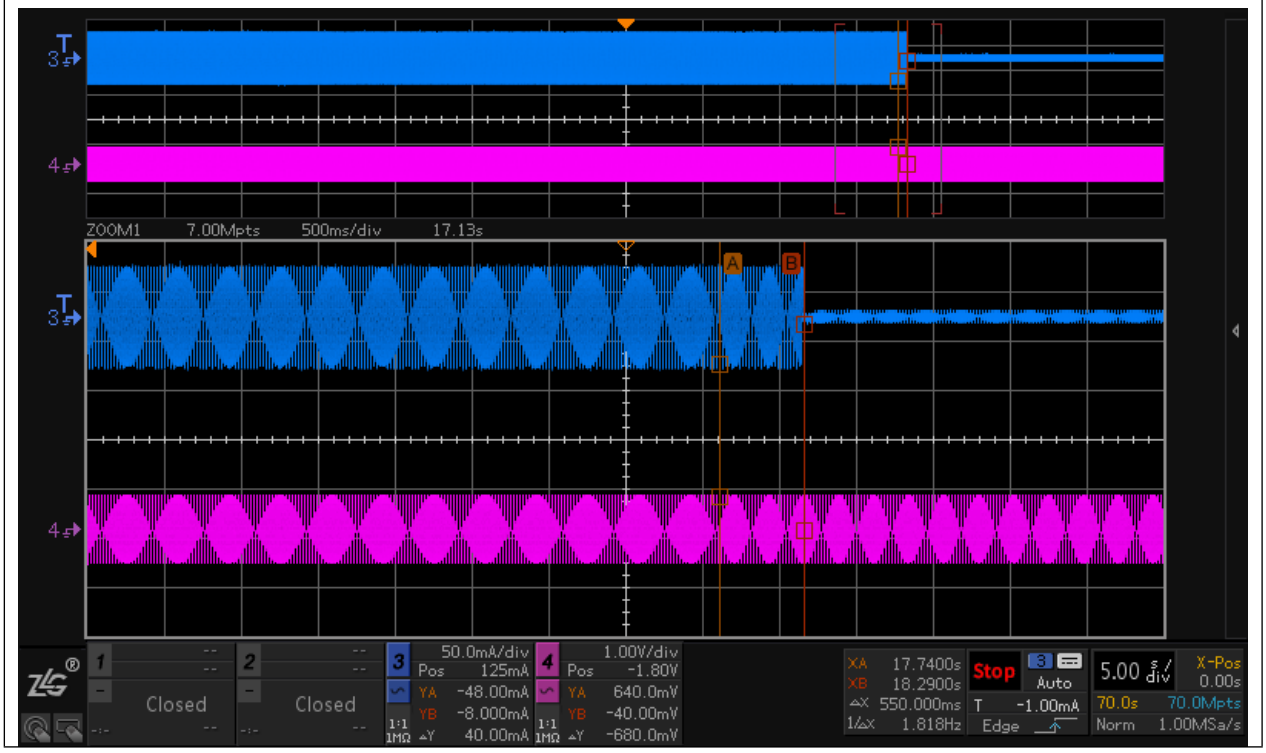
U/F stage 2-2


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

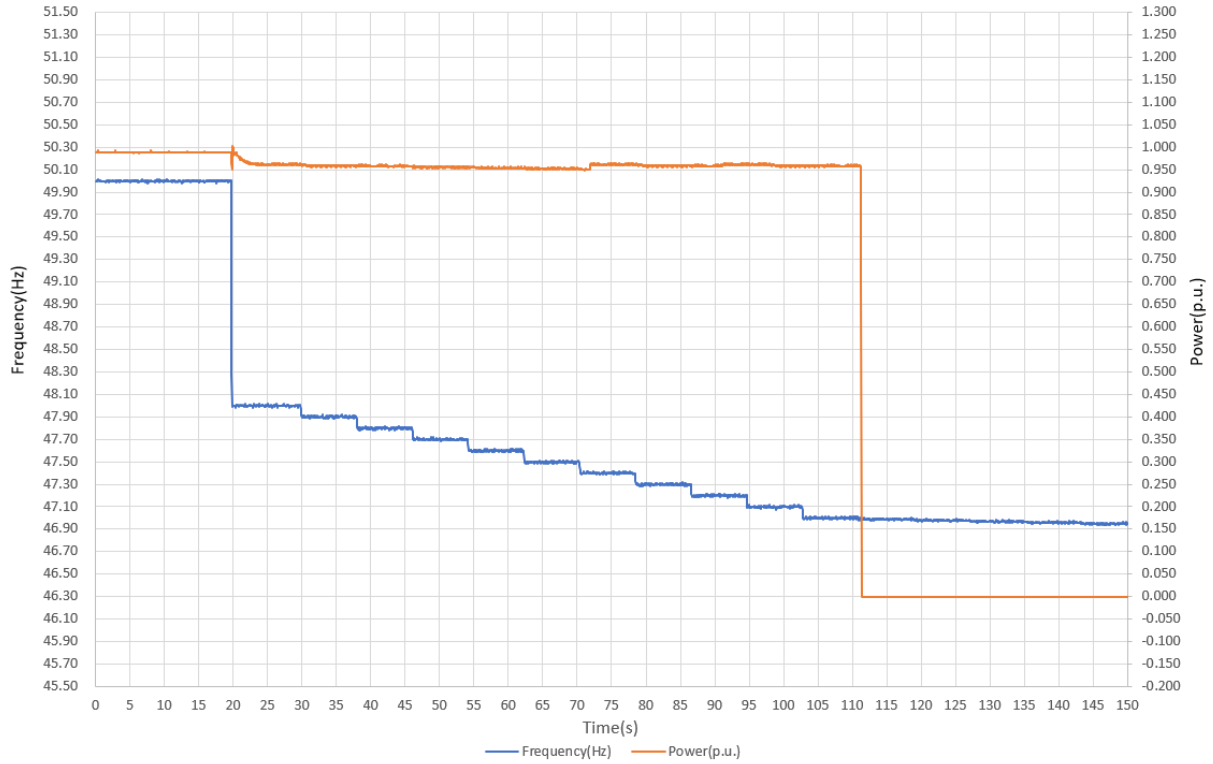

ZOOM1
7.00Mpts
500ms/div
17.13s
Closed
Closed
50.0mA/div
Pos 125mA
YA -50.00mA
YB 2.000mA
52.00mA
1.00V/div
Pos -1.80V
YA 680.0mV
YB -160.0mV
-840.0mV
XA 17.7200s
XB 18.3000s
580.000ms
1.724Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

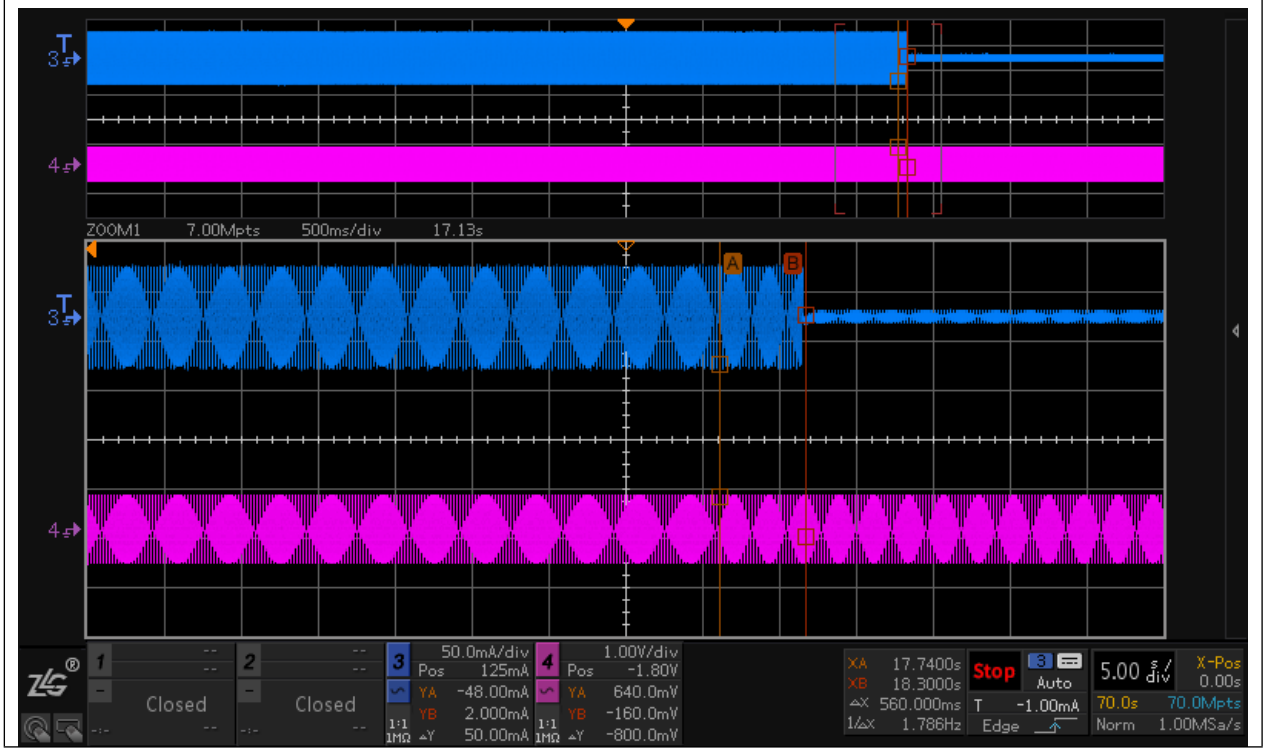
U/F stage 2-3


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

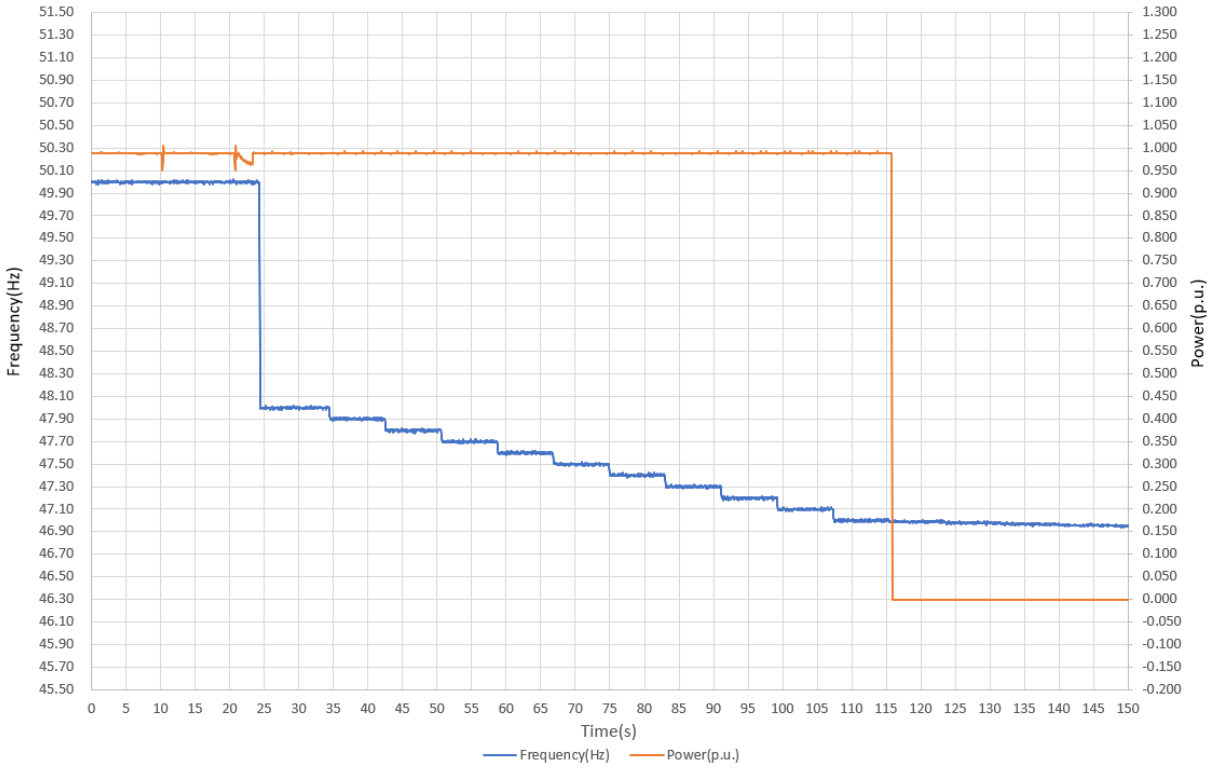

ZOOM1 7.00Mpts 500ms/div 17.13s
Closed
Closed
50.0mA/div
Pos 125mA
YA -48.00mA
YB -8.000mA
40.00mA
1.00V/div
Pos -1.80V
YA 640.0mV
YB -40.00mV
-680.0mV
XA 17.7400s
XB 18.2900s
550.000ms
1.818Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

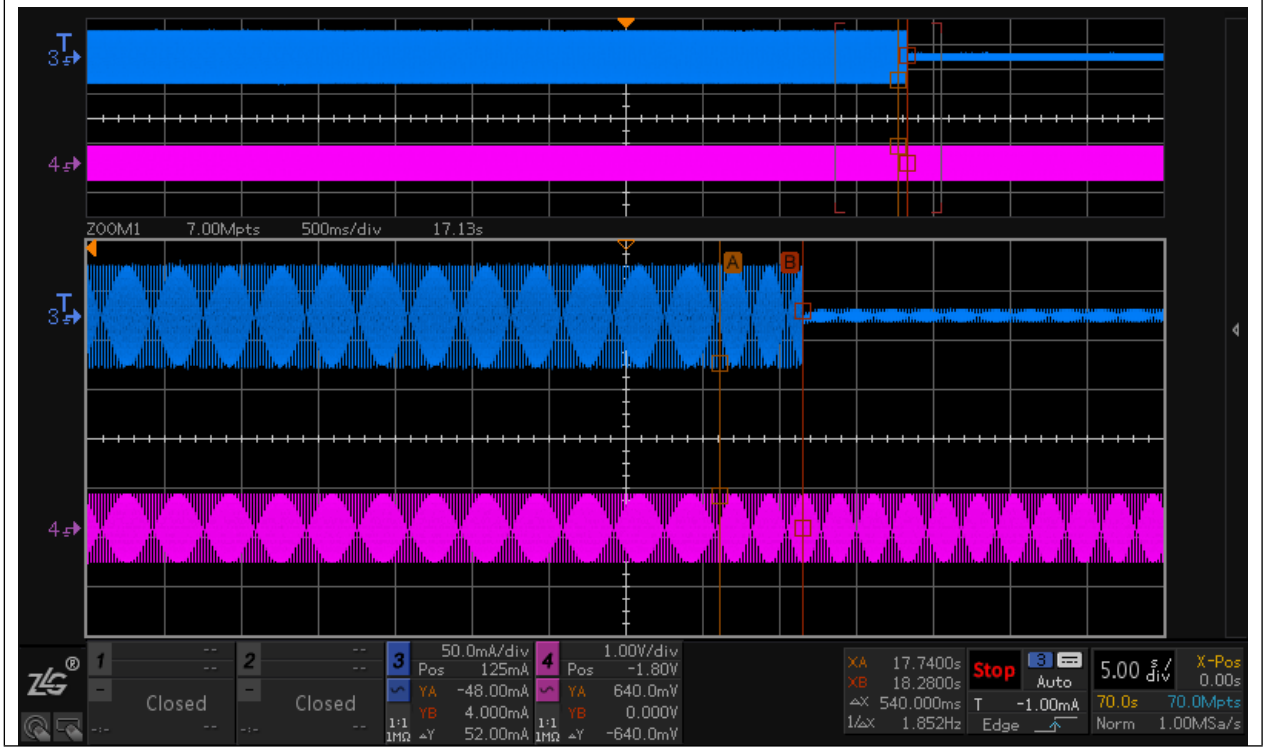
U/F stage 2-4


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

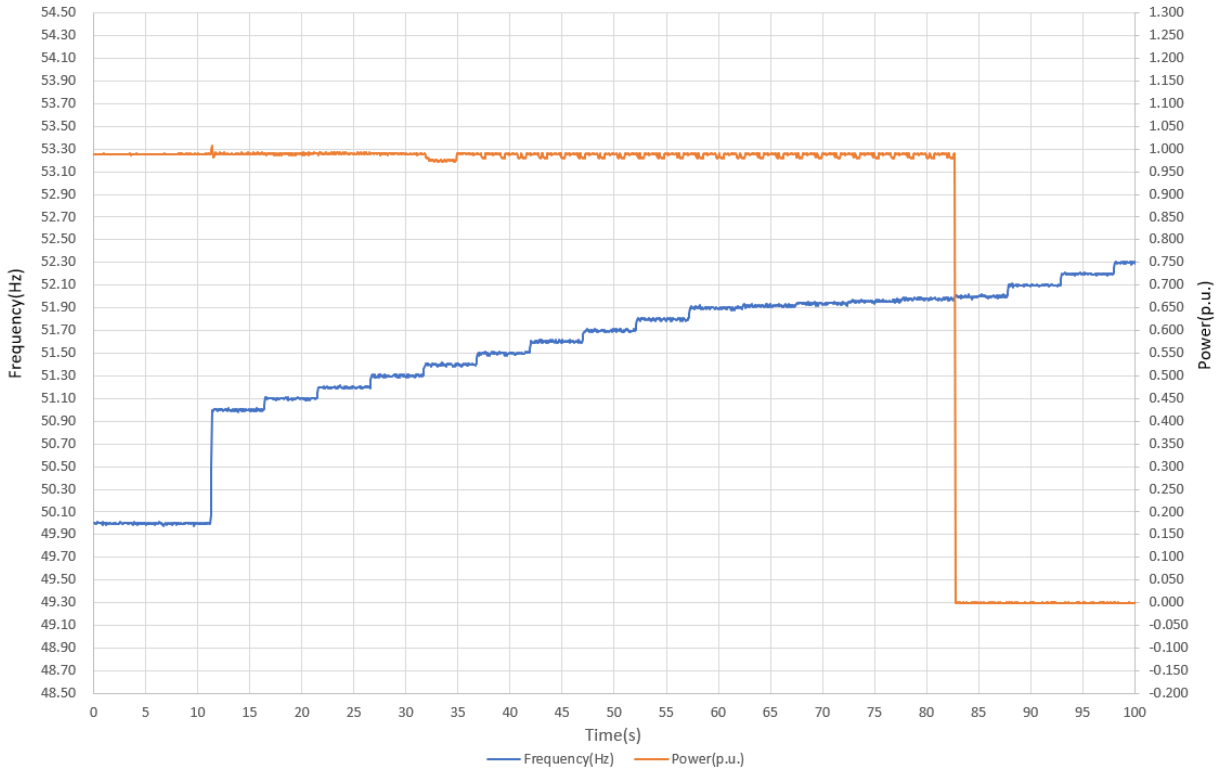

ZOOM1
7.00Mpts
500ms/div
17.13s
Closed
Closed
50.0mA/div
Pos 125mA
YA -48.00mA
YB 2.000mA
50.00mA
1.00V/div
Pos -1.80V
YA 640.0mV
YB -160.0mV
-800.0mV
XA 17.7400s
XB 18.3000s
560.000ms
1.786Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

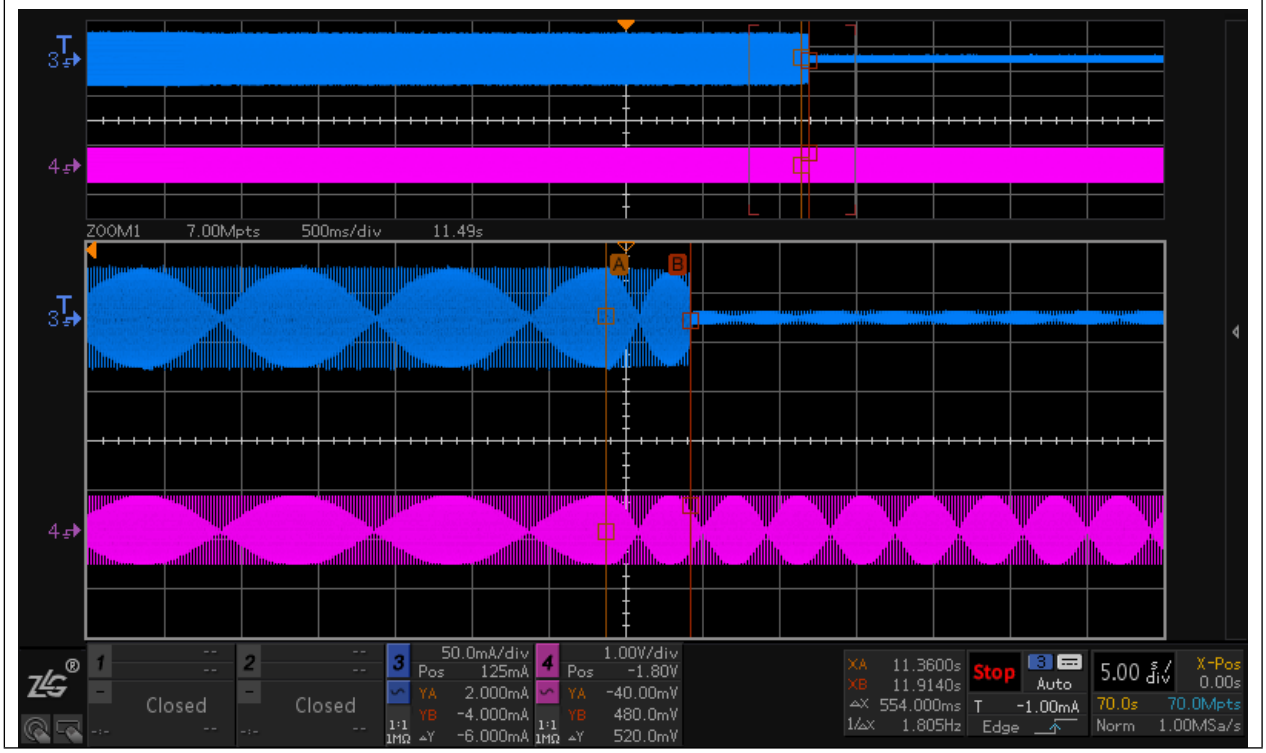
U/F stage 2-5


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

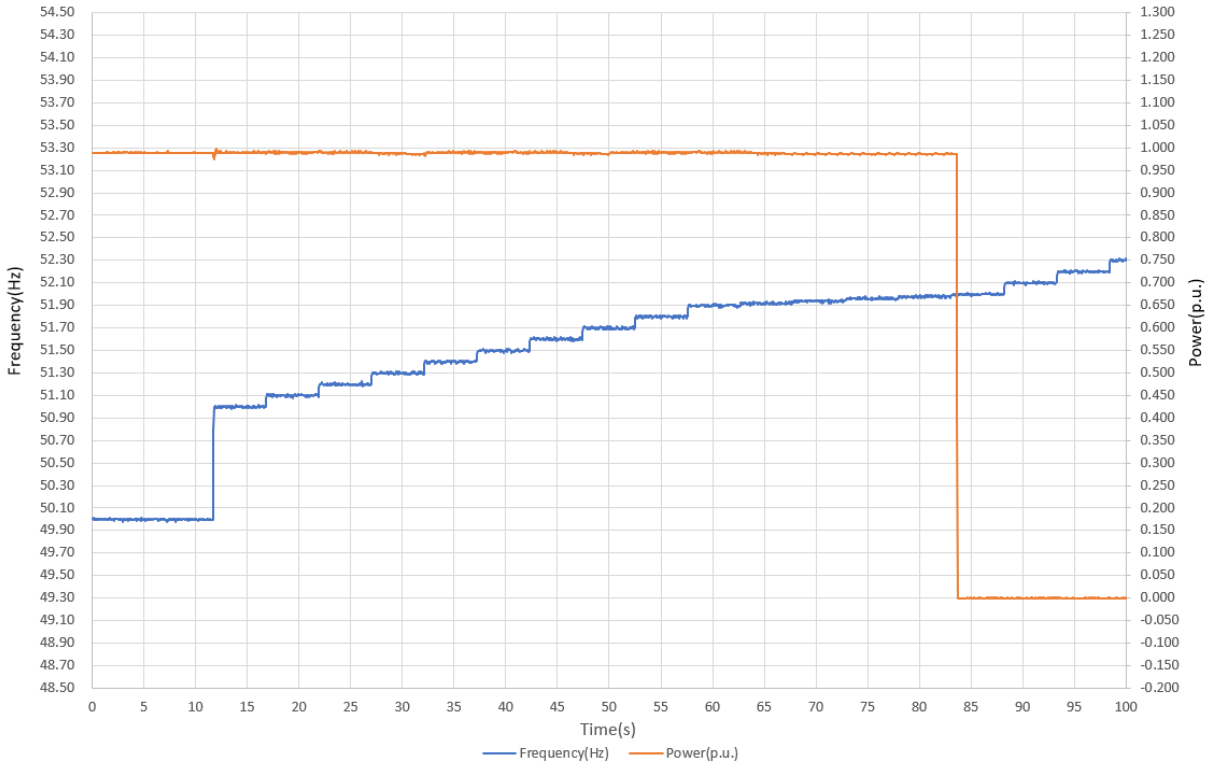

ZOOM1
7.00Mpts
500ms/div
17.13s
Closed
Closed
50.0mA/div
Pos 125mA
YA -48.00mA
YB 4.000mA
52.00mA
1.00V/div
Pos -1.80V
YA 640.0mV
YB 0.000V
-640.0mV
XA 17.7400s
XB 18.2800s
540.000ms
1.852Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

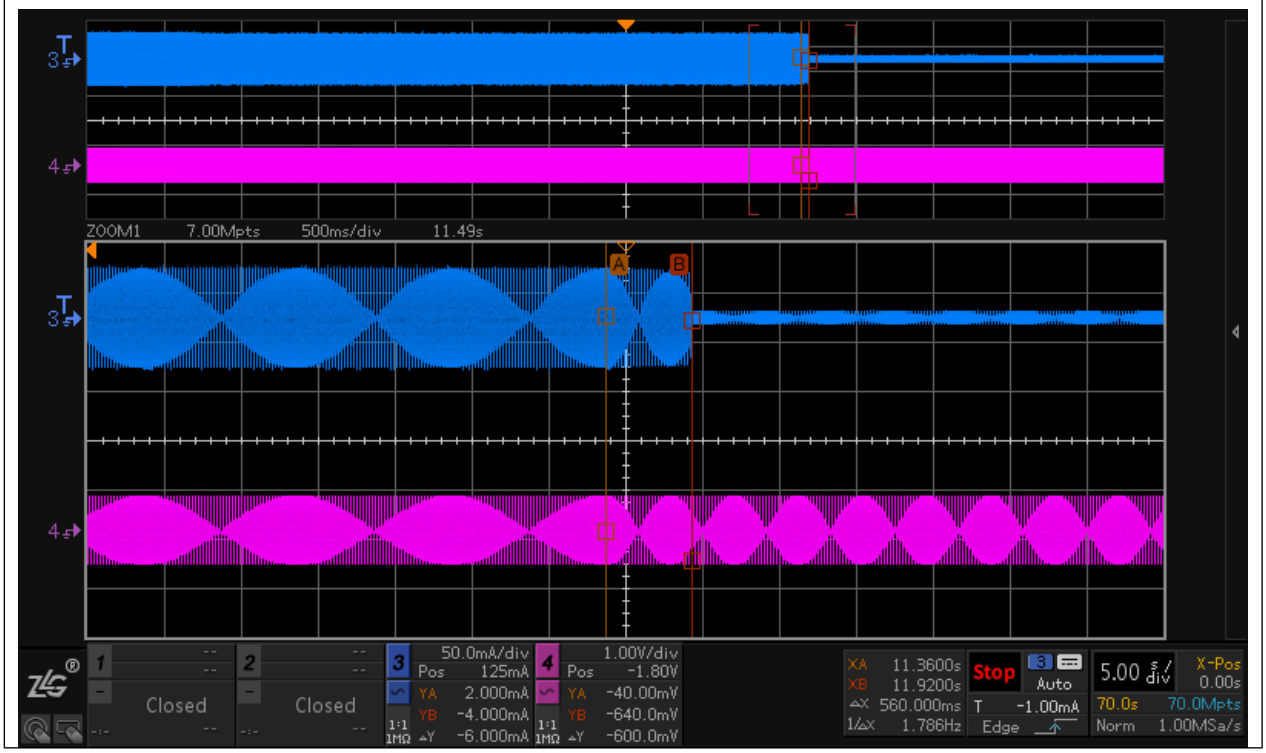
O/F stage 1-1


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

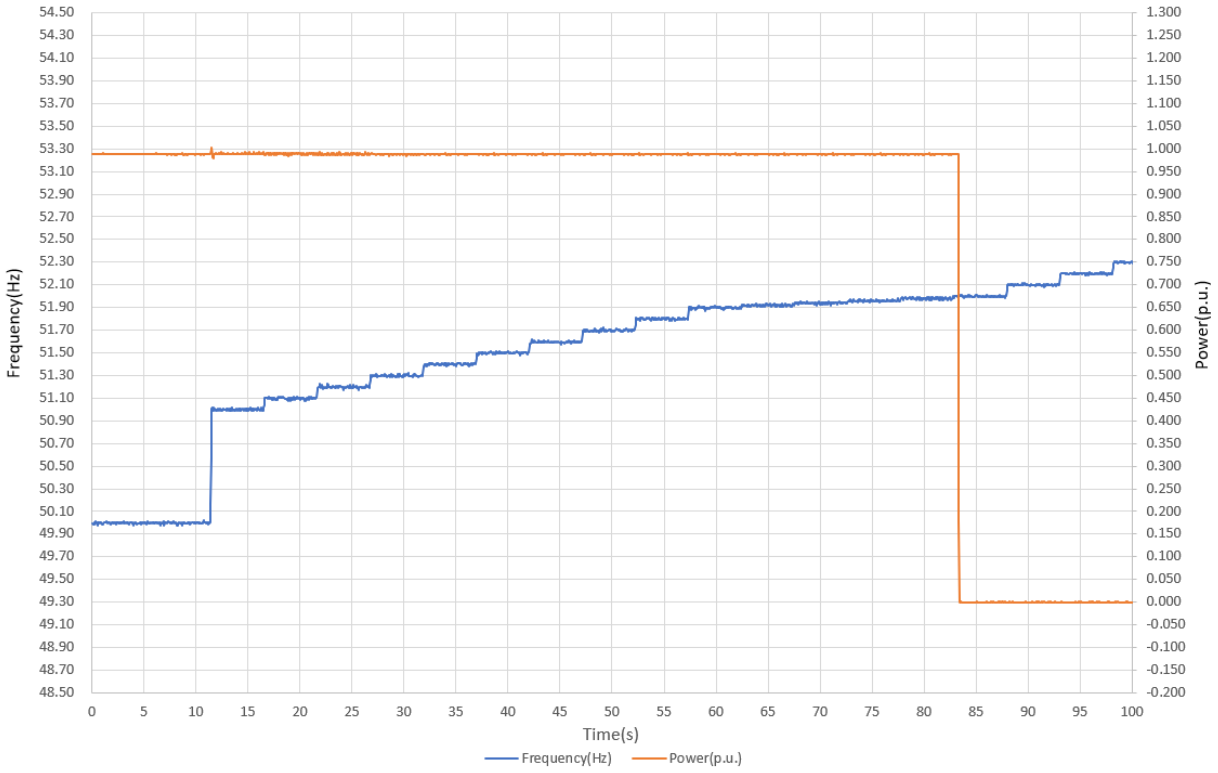

ZOOM1
7.00Mpts
500ms/div
11.49s
Closed
Closed
50.0mA/div
Pos 125mA
YA 2.000mA
YB -4.000mA
-6.000mA
1.00V/div
Pos -1.80V
YA -40.00mV
YB 480.0mV
520.0mV
XA 11.3600s
XB 11.9140s
554.000ms
1.805Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

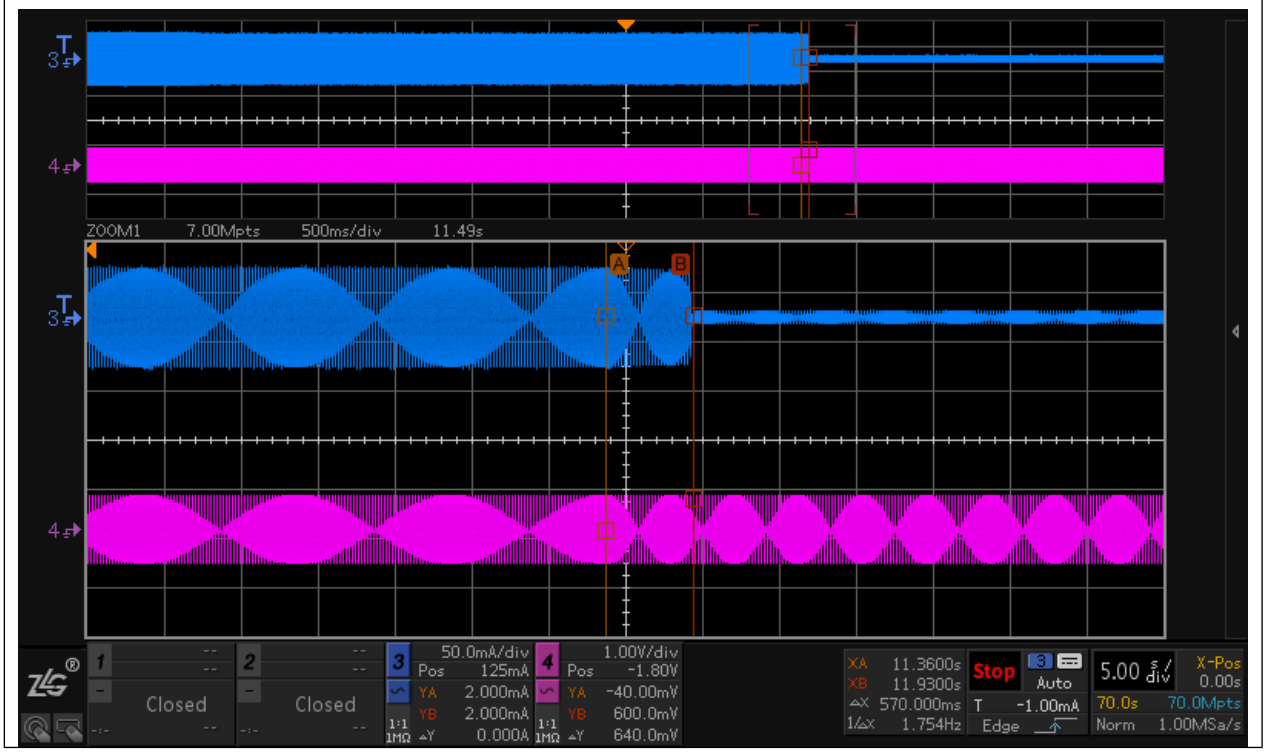
O/F stage 1-2


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

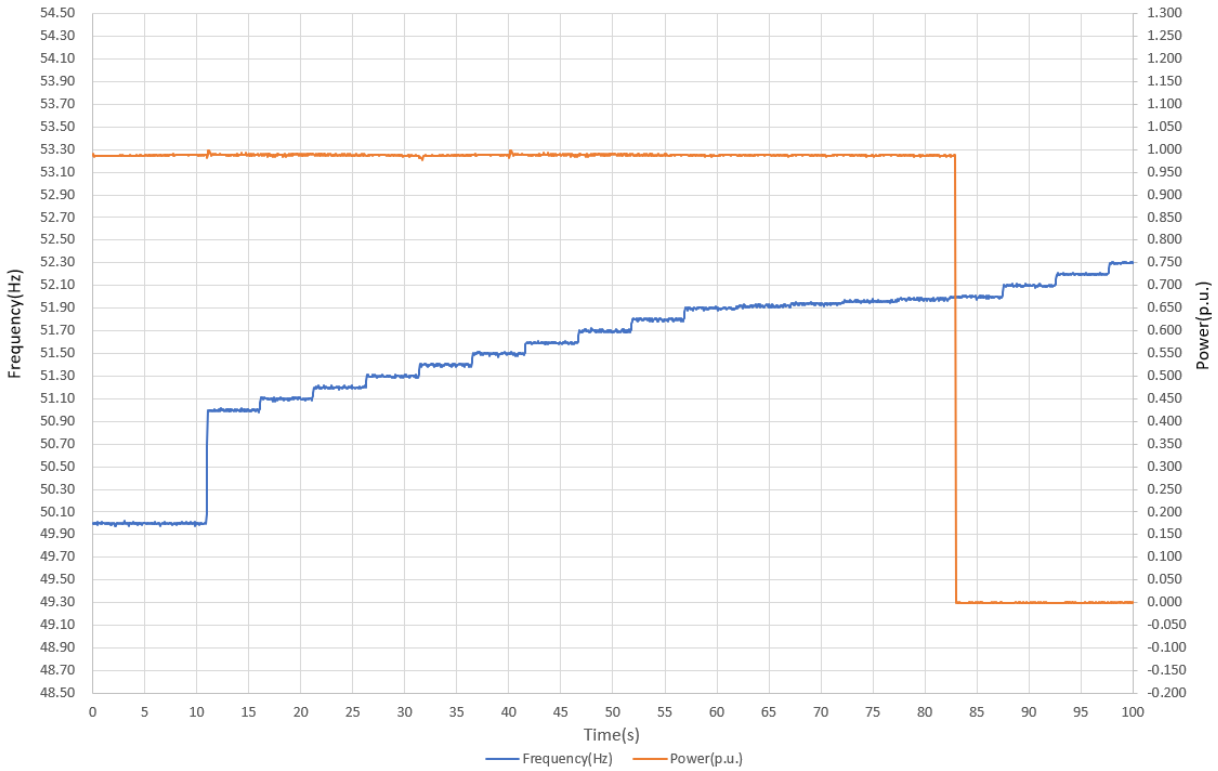

ZOOM1
7.00Mpts
500ms/div
11.49s
Closed
Closed
50.0mA/div
Pos 125mA
YA 2.000mA
YB -4.000mA
-6.000mA
1.00V/div
Pos -1.80V
YA -40.00mV
YB -640.0mV
-600.0mV
XA 11.3600s
XB 11.9200s
560.000ms
1.786Hz
Stop
Auto
T -1.00mA
Edge
5.00 div
X-Pos 0.00s
70.0s
70.0Mpts
Norm 1.00MSa/s

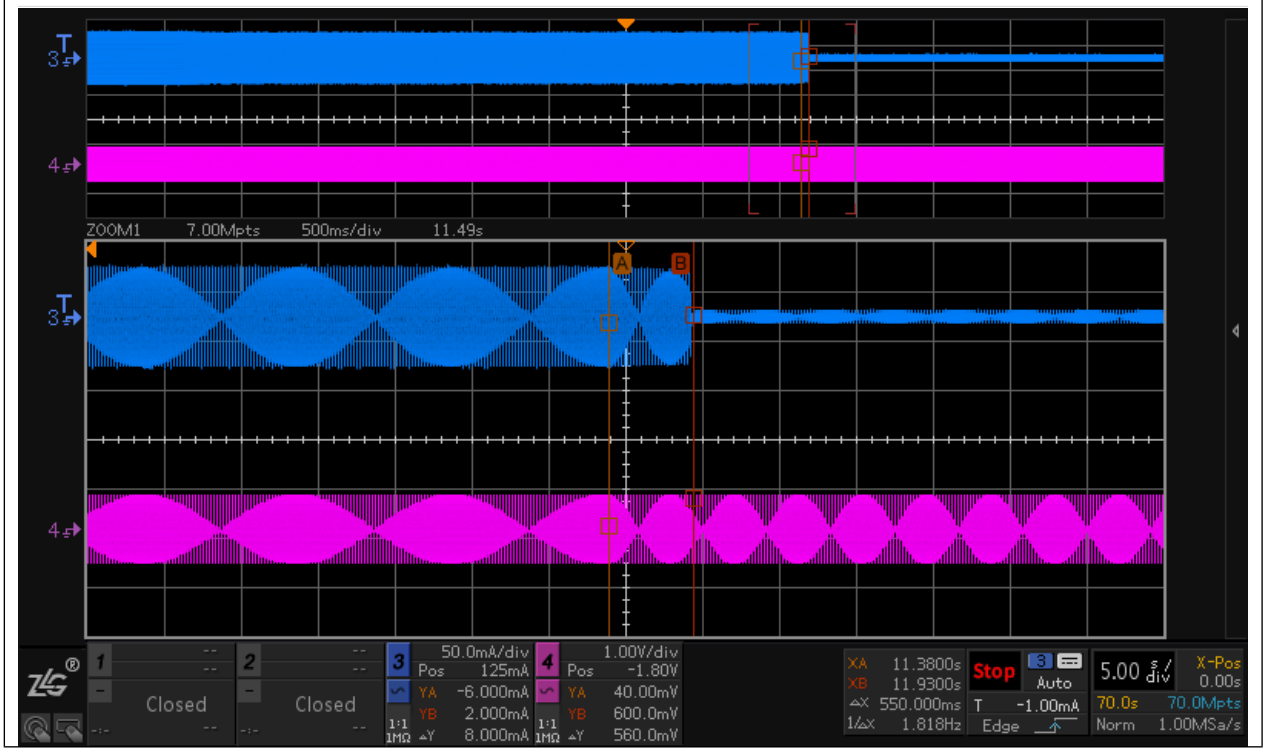
O/F stage 1-3


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

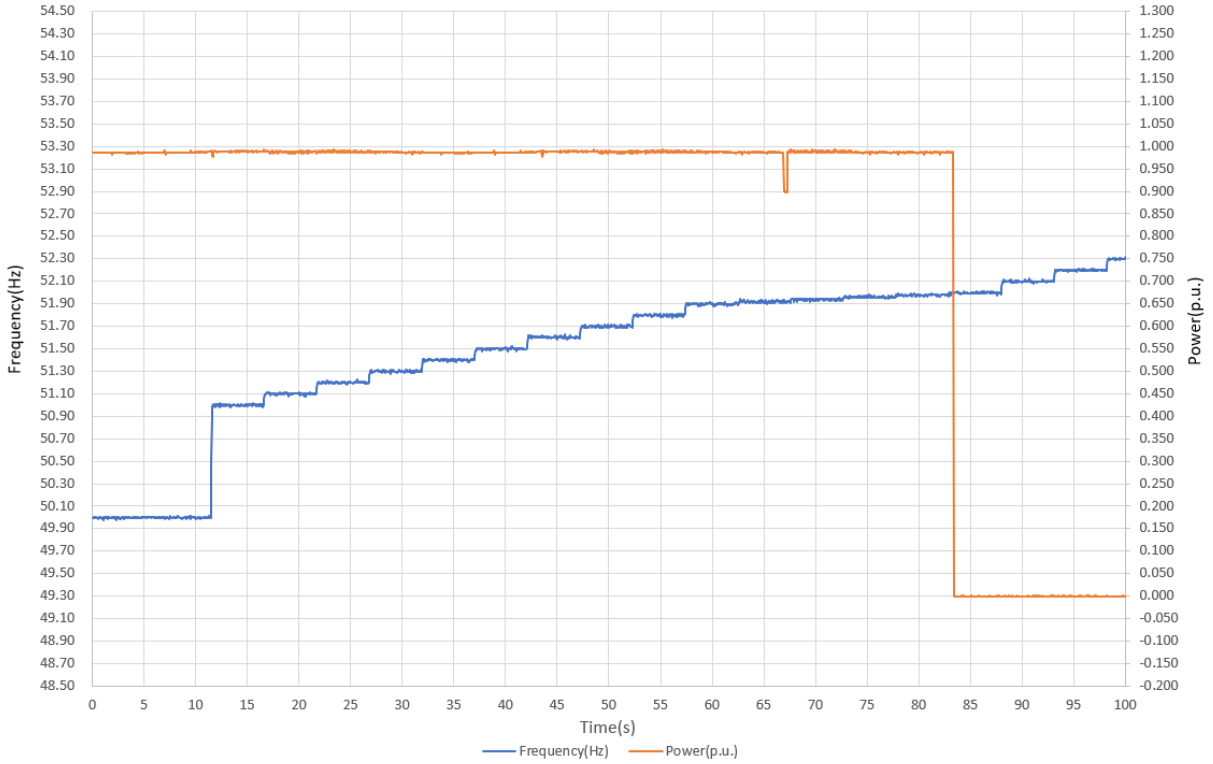

ZOOM1
7.00Mpts
500ms/div
11.49s
Closed
Closed
50.0mA/div
Pos 125mA
YA 2.000mA
YB 2.000mA
0.000A
1.00V/div
Pos -1.80V
YA -40.00mV
YB 600.0mV
640.0mV
XA 11.3600s
XB 11.9300s
570.000ms
1.754Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

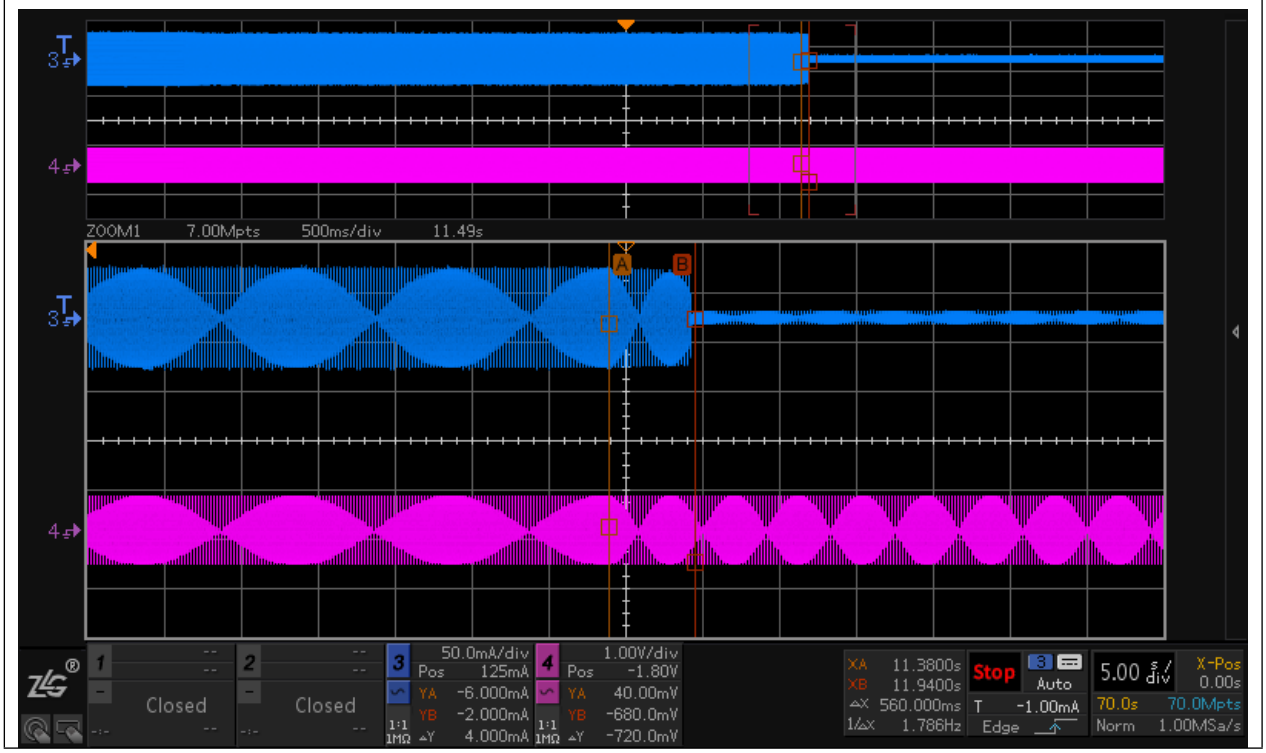
O/F stage 1-4


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

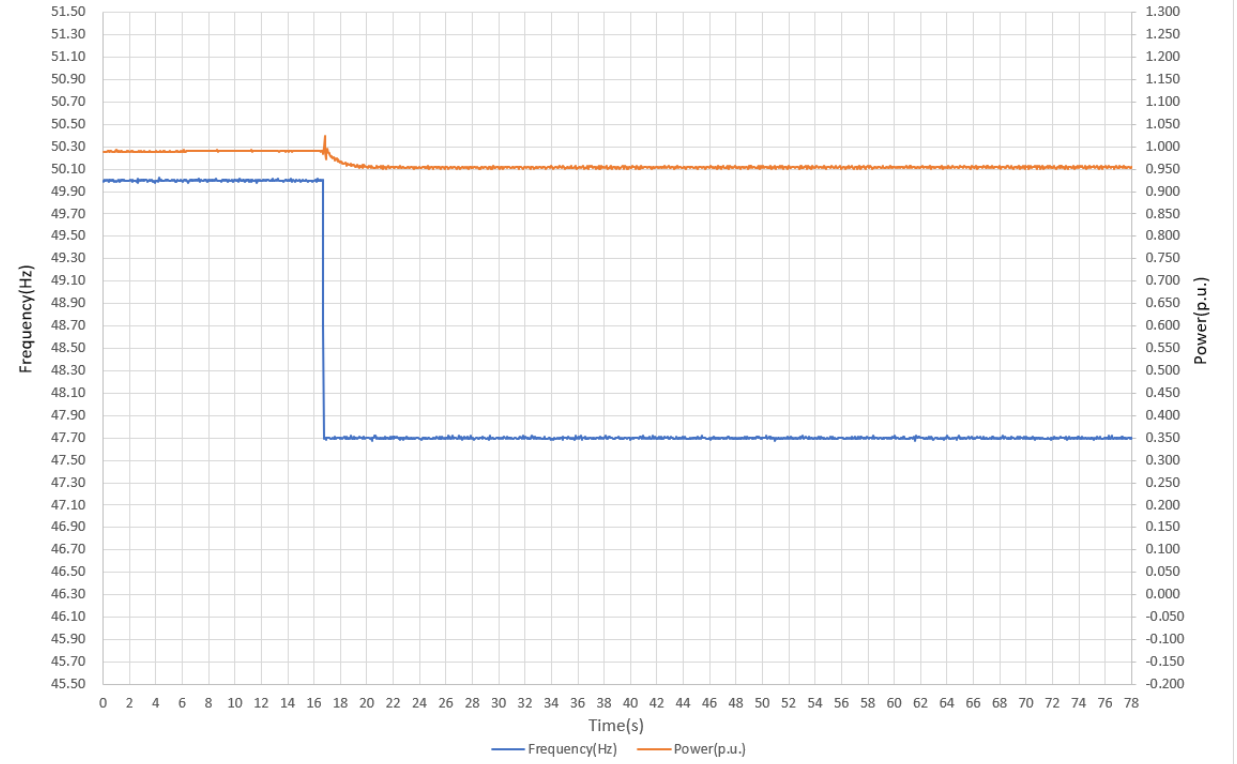

ZOOM1
7.00Mpts
500ms/div
11.49s
Closed
Closed
Stop
Auto
Edge
Norm
1.00MSa/s

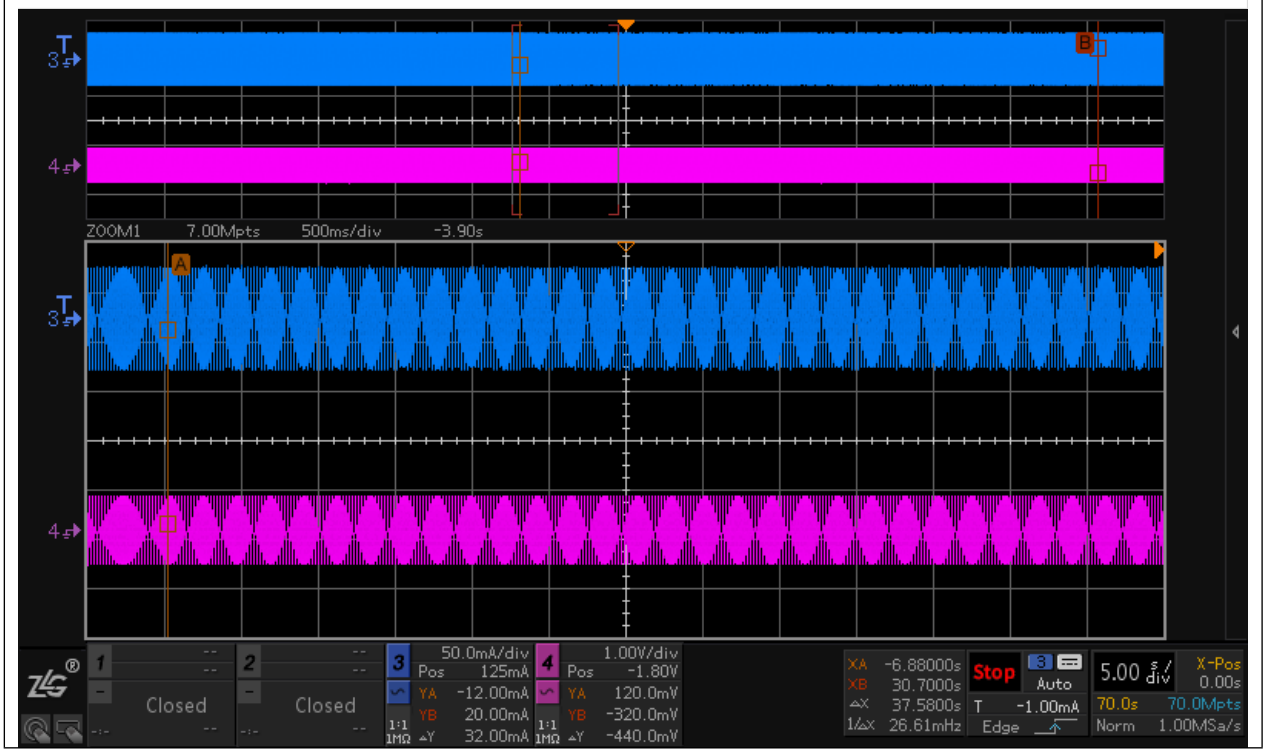
O/F stage 1-5


Frequency(Hz)
Power(p.u.)
Time(s)
Frequency(Hz)
Power(p.u.)

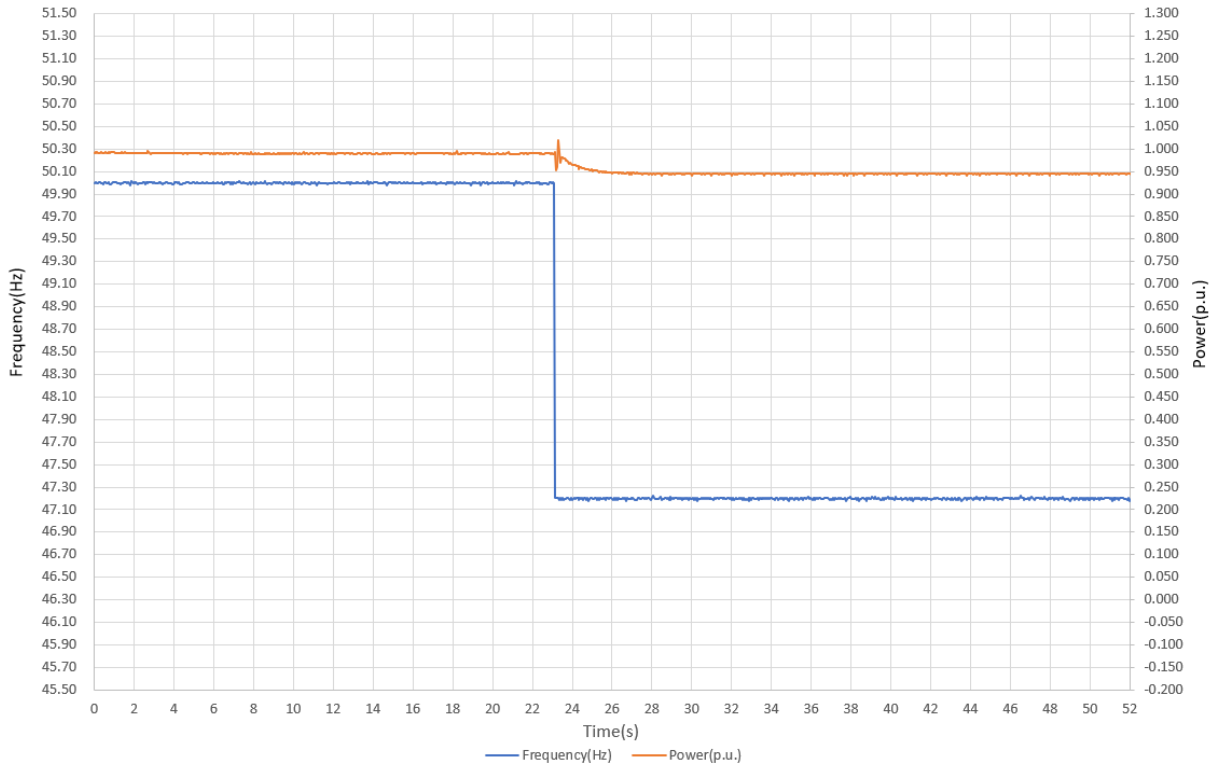

ZOOM1
7.00Mpts
500ms/div
11.49s
Closed
Closed
50.0mA/div
Pos 125mA
YA -6.000mA
YB -2.000mA
4.000mA
1.00V/div
Pos -1.80V
YA 40.00mV
YB -680.0mV
-720.0mV
XA 11.3800s
XB 11.9400s
560.000ms
1.786Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

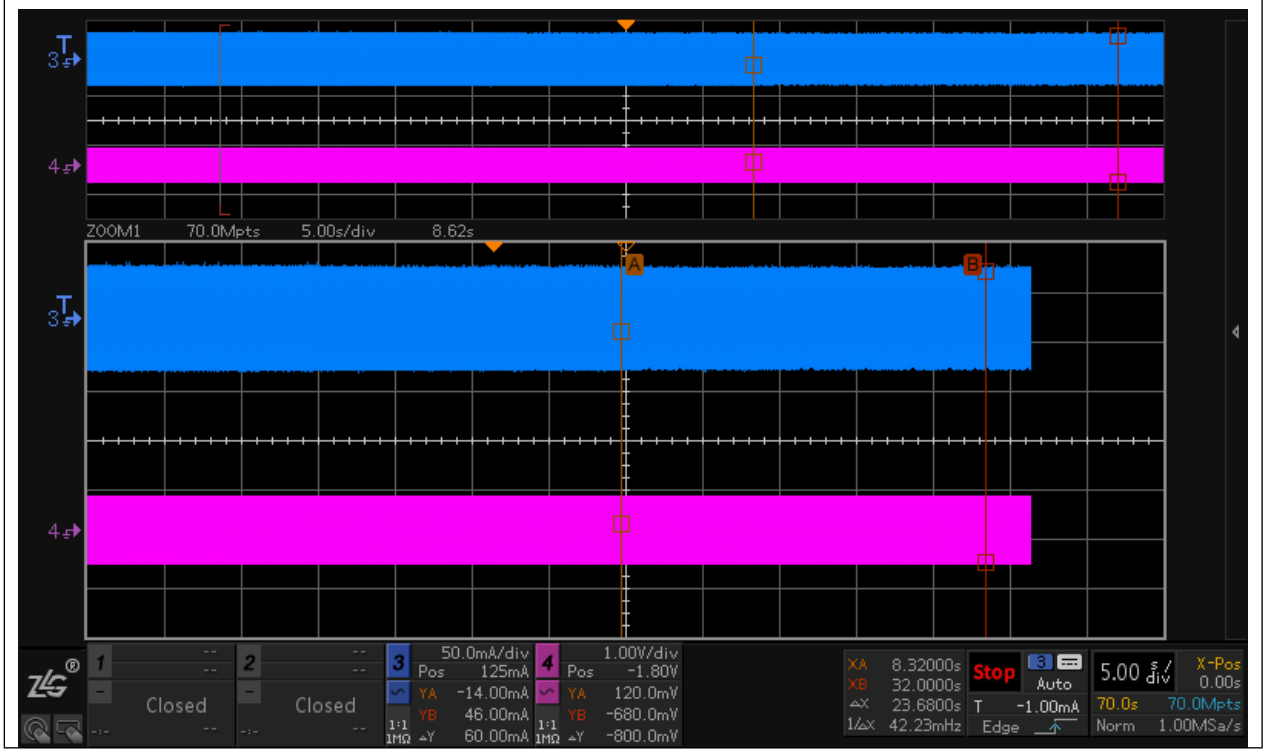
No trip tests - 47.7Hz



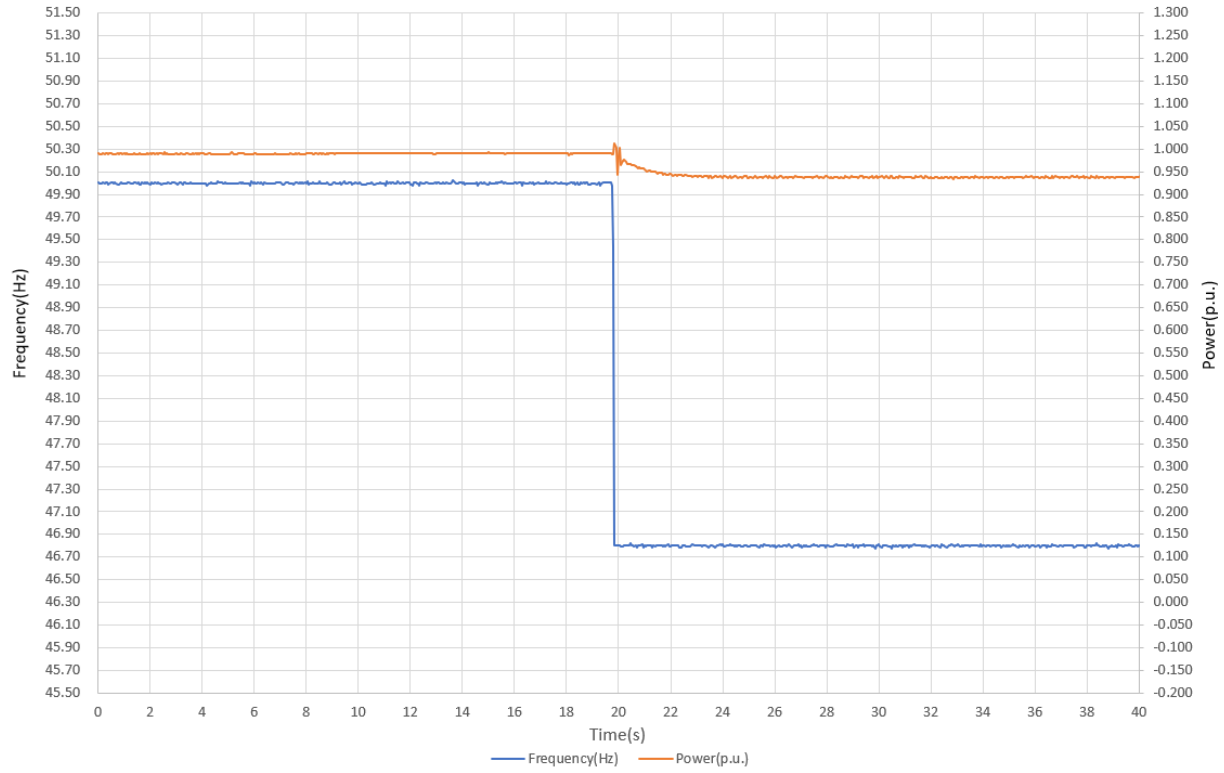


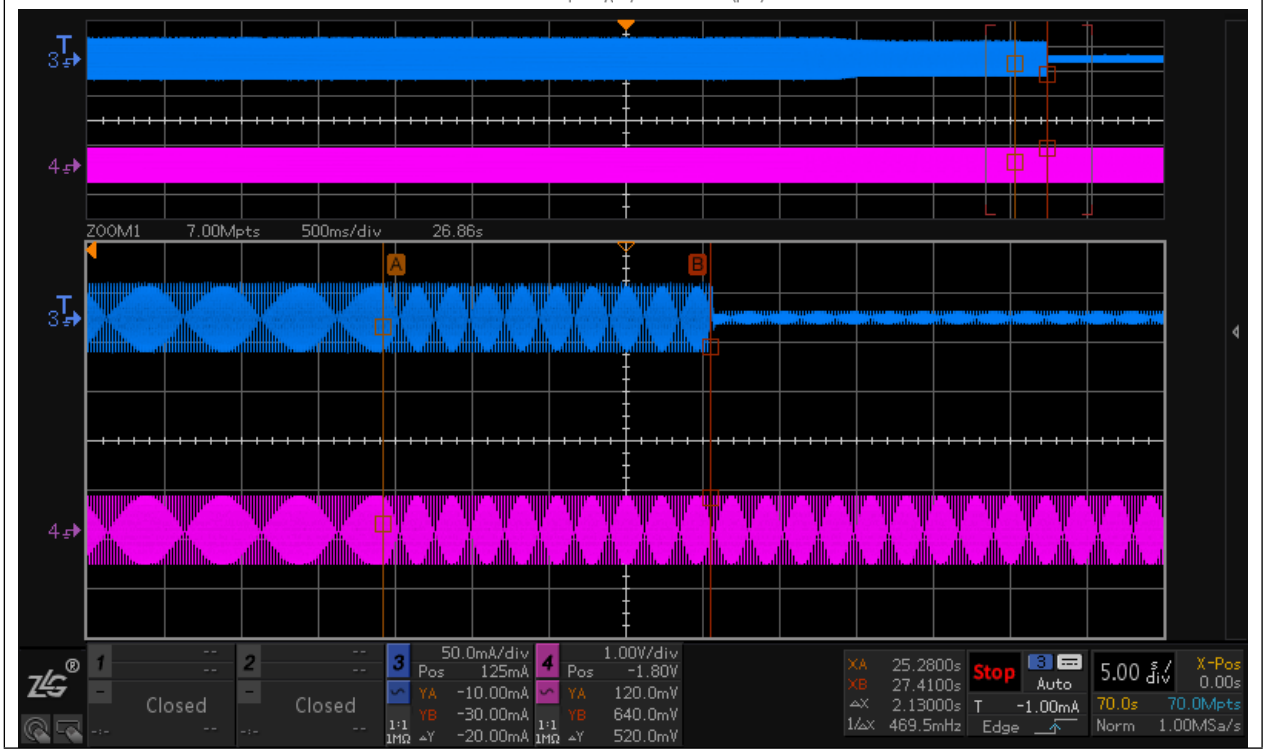
No trip tests – 47.2Hz



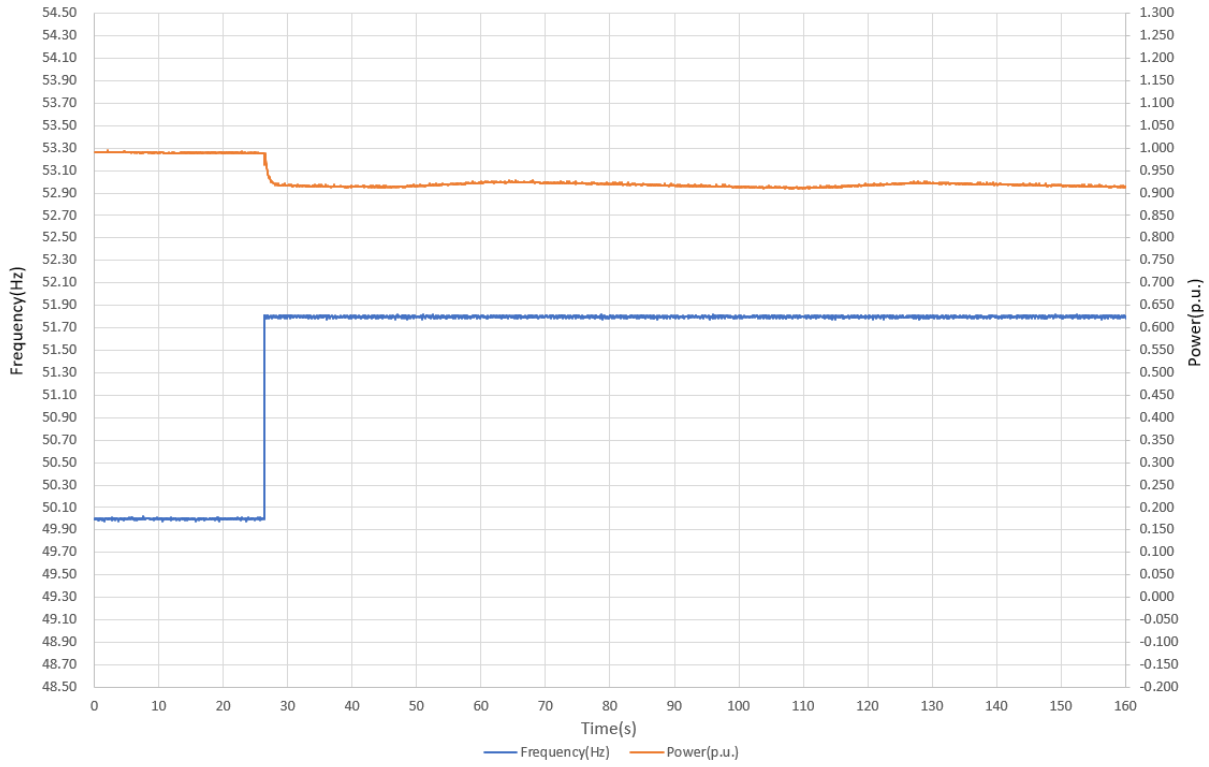


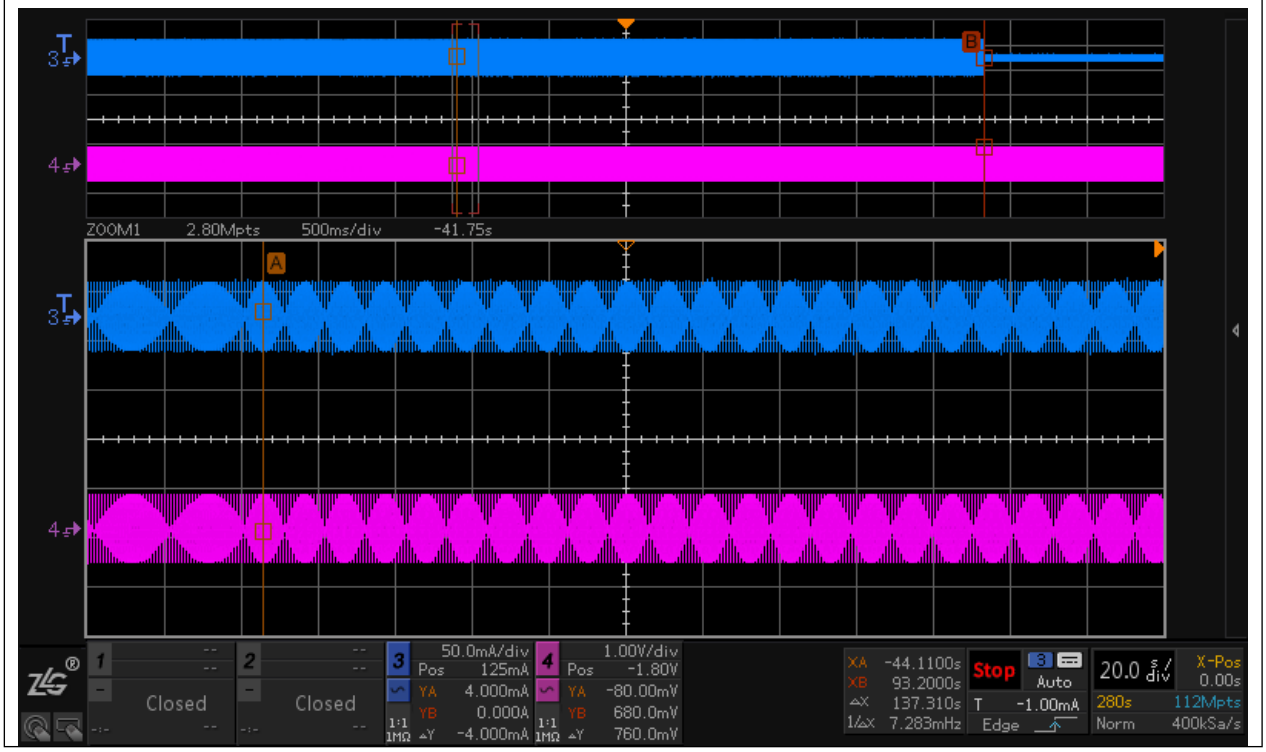
No trip tests – 46.8Hz



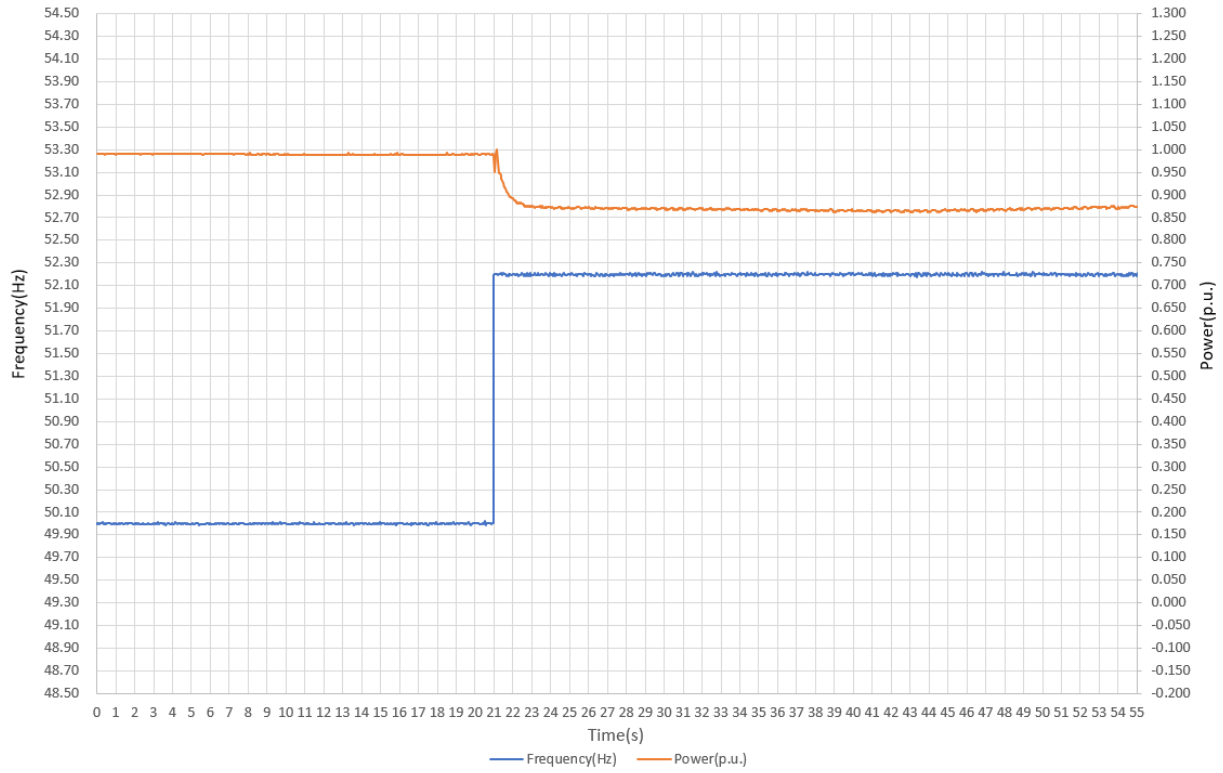


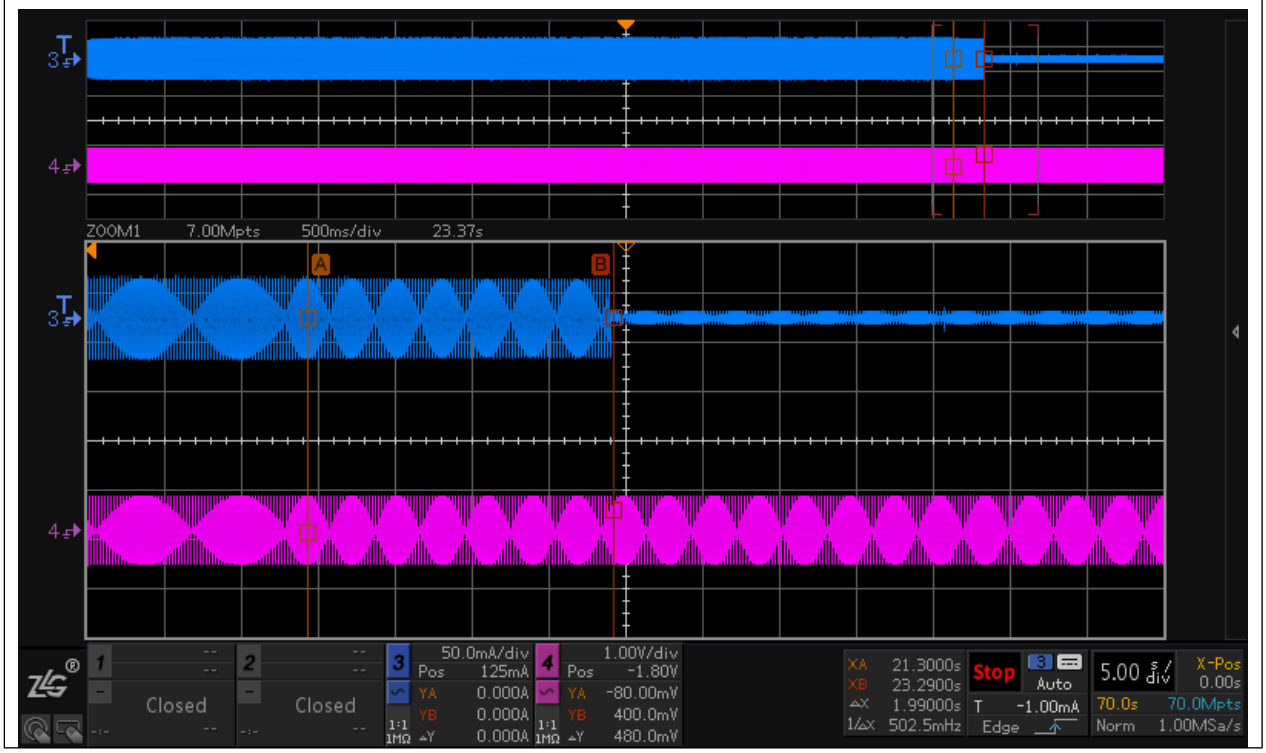
No trip tests - 51.8Hz





No trip tests – 52.2Hz





4.3.2 Voltage tests

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

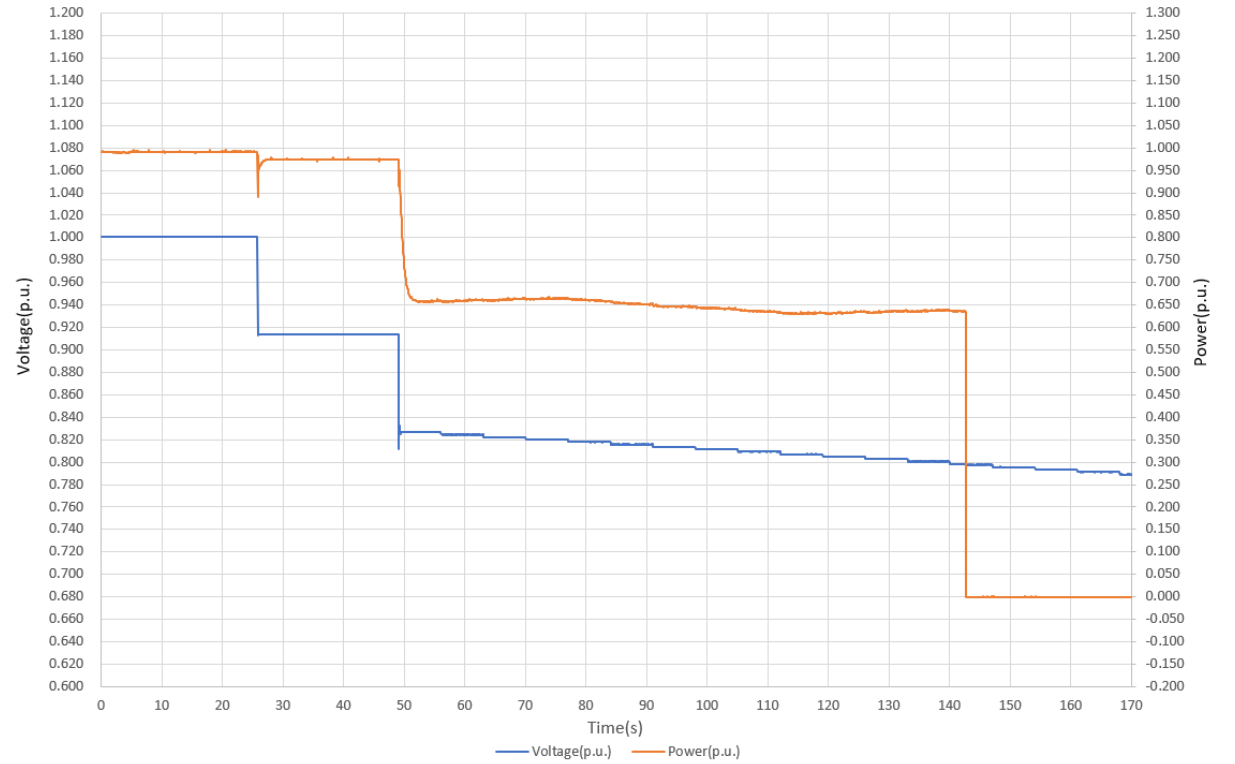
To establish the certified trip time, the test voltage should be applied starting from ± 1.8% below the certified trip voltage in a step of at least ± 0.5% of setting for a duration that is longer than the trip time delay. For each trip setting five tests shall be carried out.

Following tables show the test results:

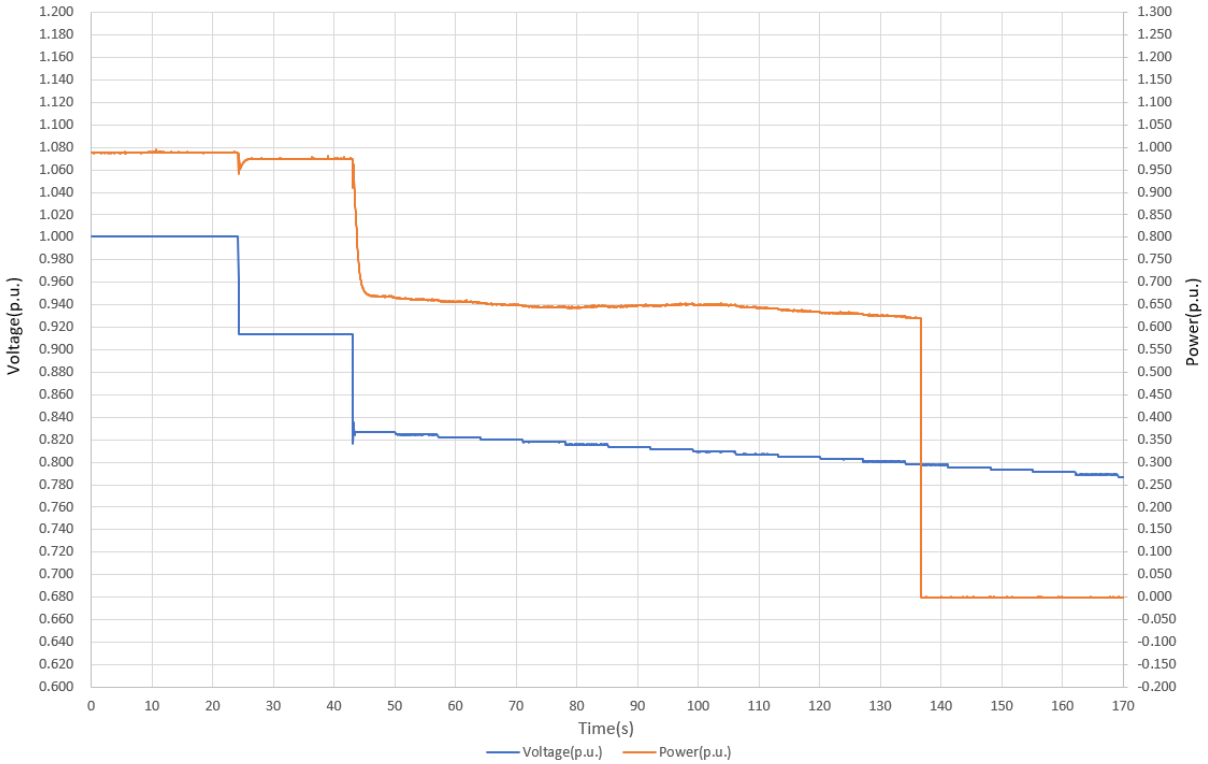
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage (V)	Time delay (s)	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	183.62	2.580	188 V / 5.00 s	Pass
			183.63	2.560		
			183.56	2.570		
			183.62	2.580		
			183.60	2.580		
					180 V / 2.45 s	Pass
O/V stage 1	262.2 V	1.0 s	262.51	1.074	258.2 V / 5.00 s	Pass
			262.30	1.084		
			262.28	1.096		
			262.27	1.038		
			262.32	1.040		
O/V stage 2	273.7 V	0.5 s	273.76	0.512	269.7 V / 0.95 s	Pass
			273.69	0.504		
			273.74	0.520		
			273.72	0.504		
			273.72	0.512		
					277.7 V / 0.45 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.						

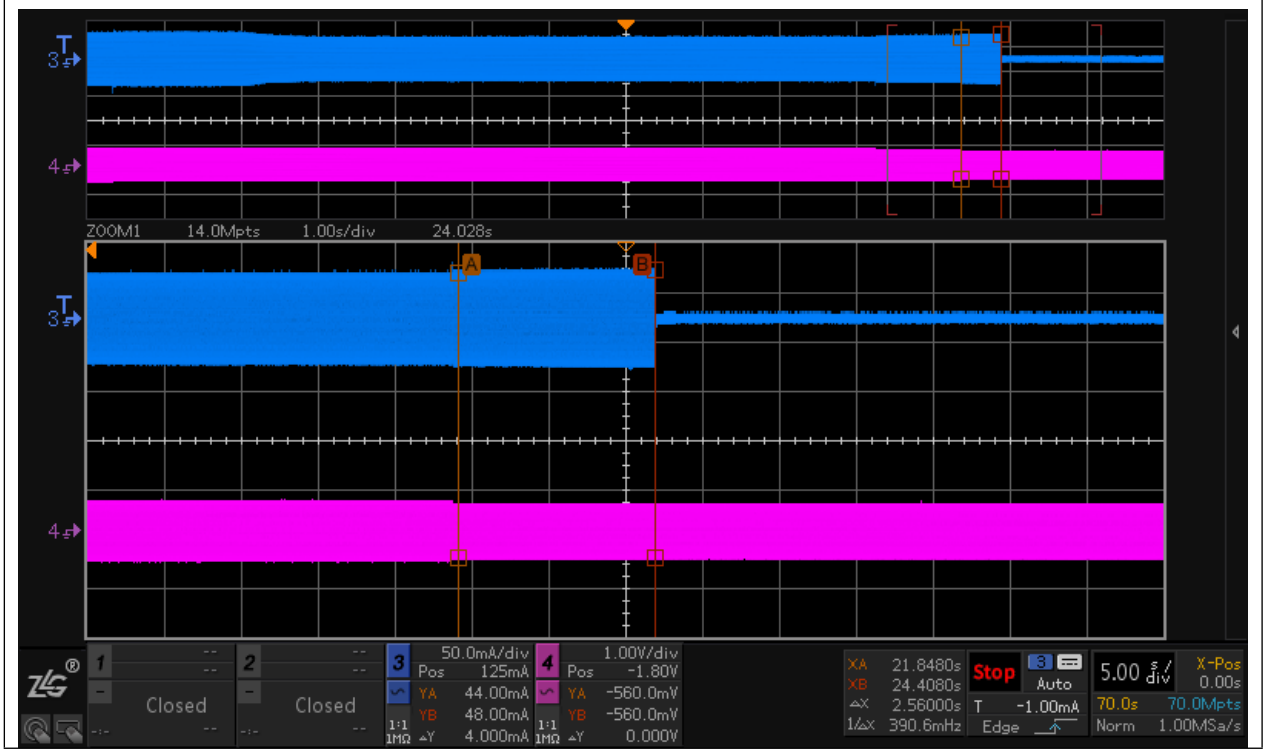
Test results are graphically shown in following pages.

U/V -1

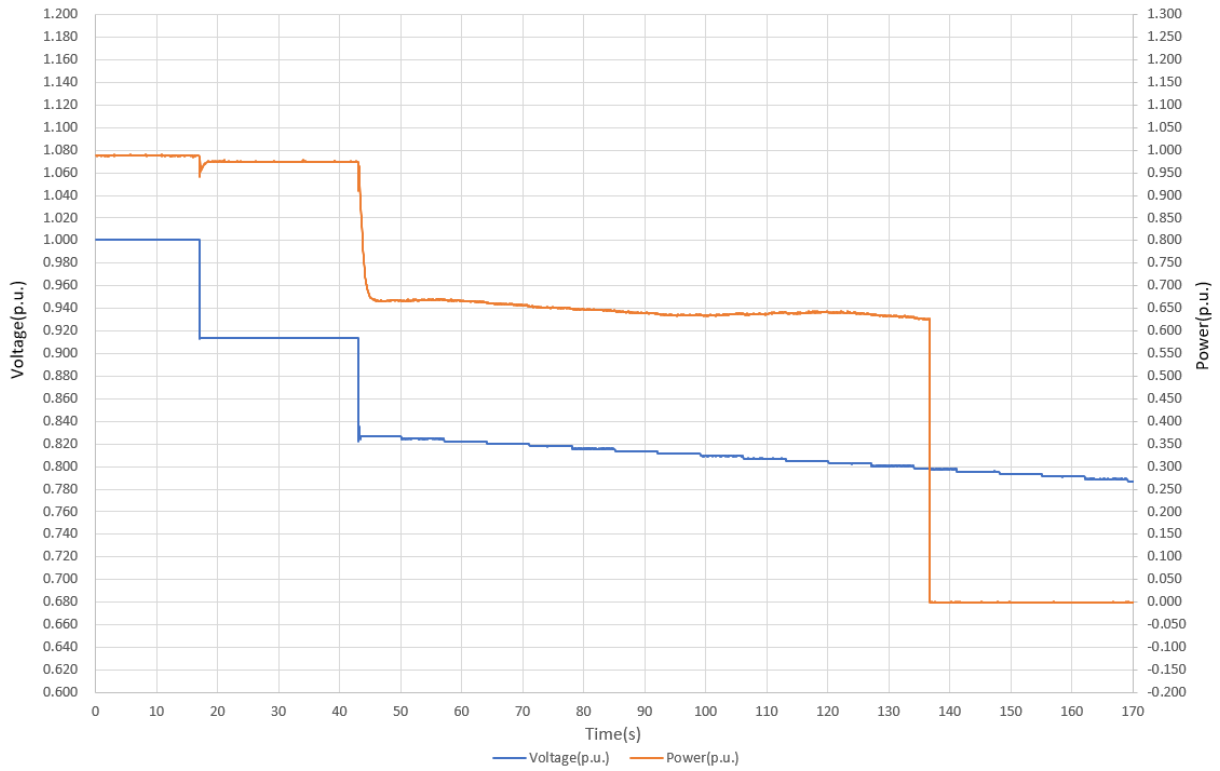


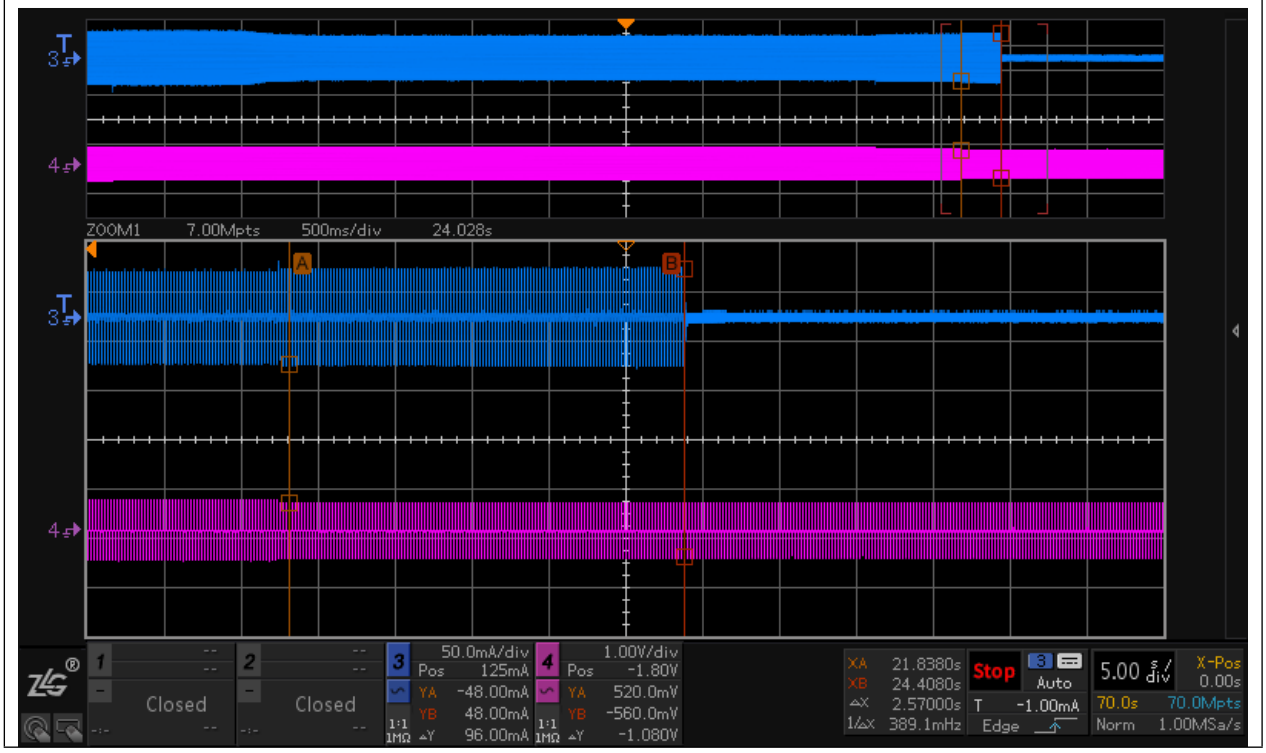
U/V -2


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

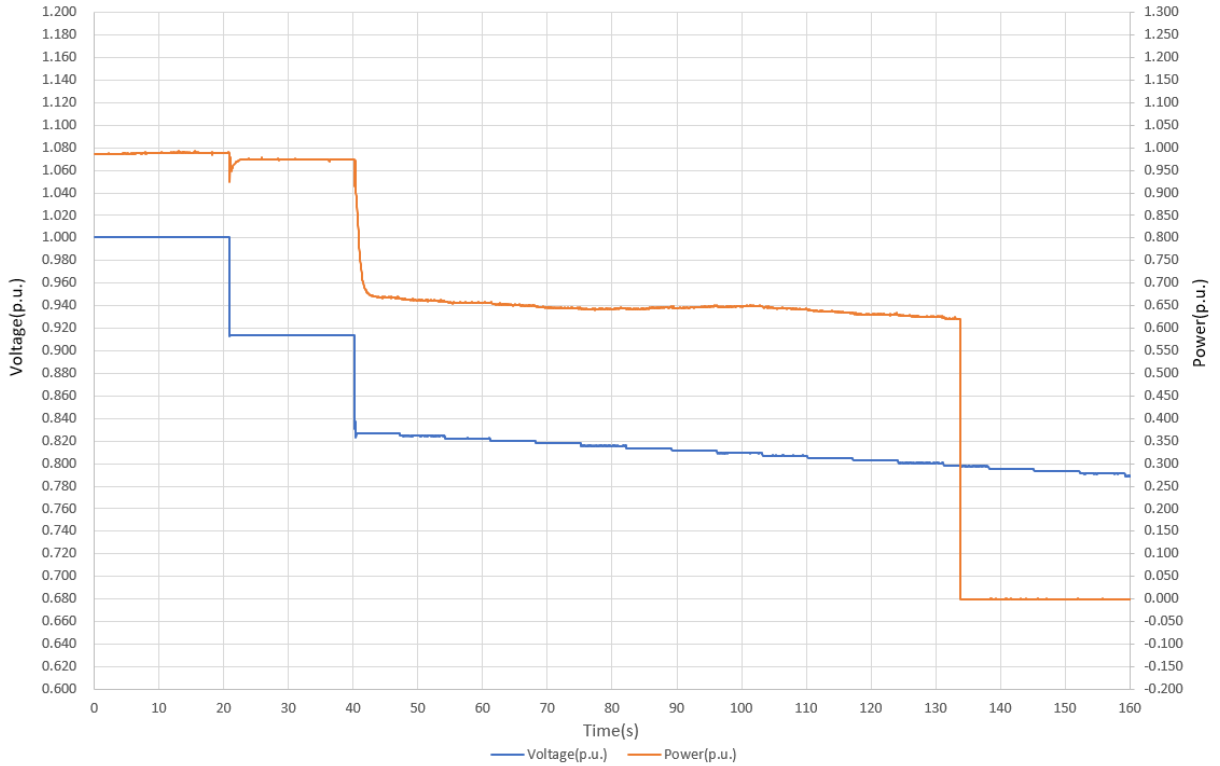

ZOOM1
14.0Mpts
1.00s/div
24.028s
Closed
Closed
50.0mA/div
Pos 125mA
YA 44.00mA
YB 48.00mA
4.000mA
1.00V/div
Pos -1.80V
YA -560.0mV
YB -560.0mV
0.000V
XA 21.8480s
XB 24.4080s
2.56000s
390.6mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

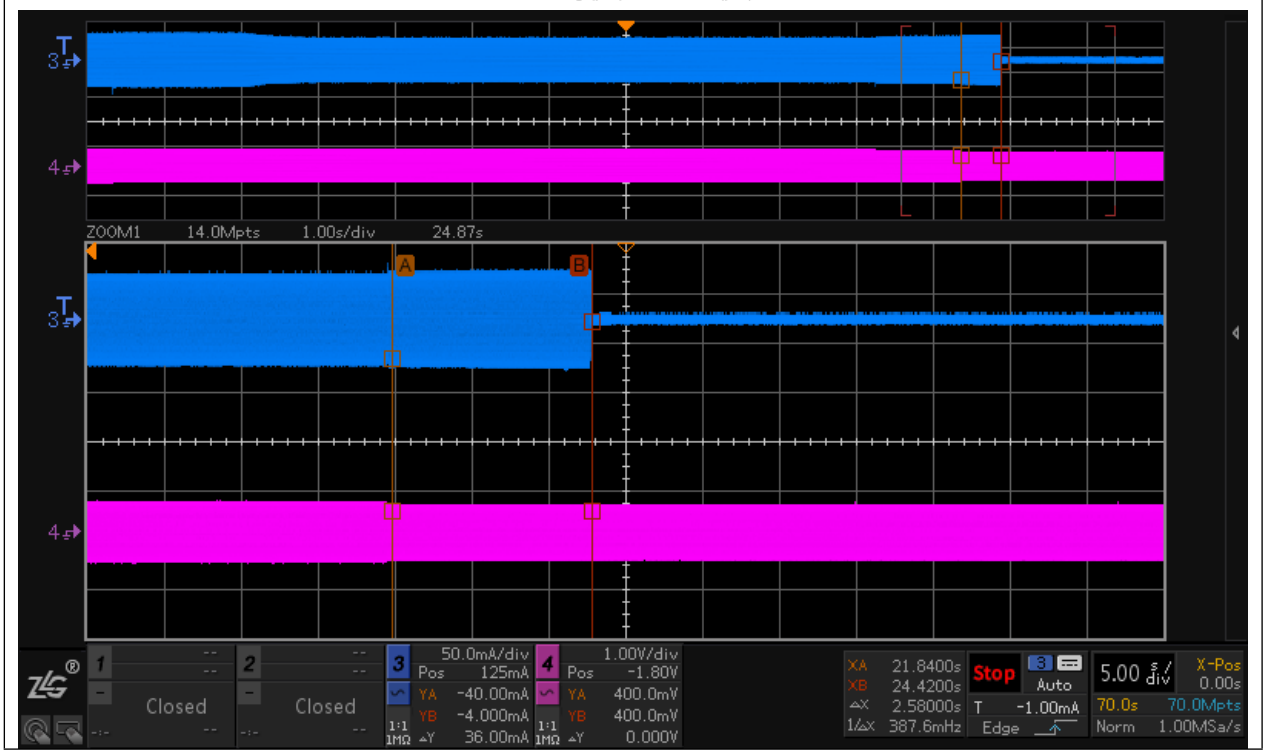
U/V -3


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

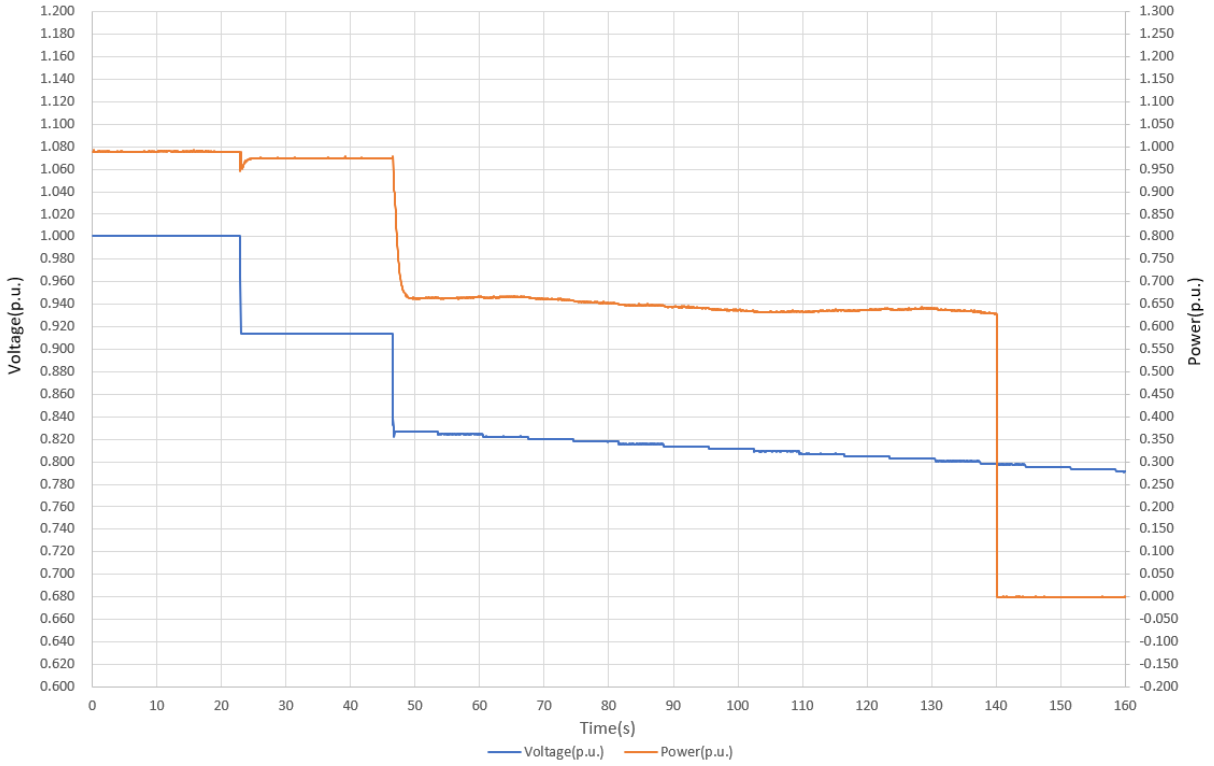

ZOOM1
7.00Mpts
500ms/div
24.028s
Closed
Closed
50.0mA/div
Pos 125mA
YA -48.00mA
YB 48.00mA
96.00mA
1.00V/div
Pos -1.80V
YA 520.0mV
YB -560.0mV
-1.080V
XA 21.8380s
XB 24.4080s
2.57000s
389.1mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

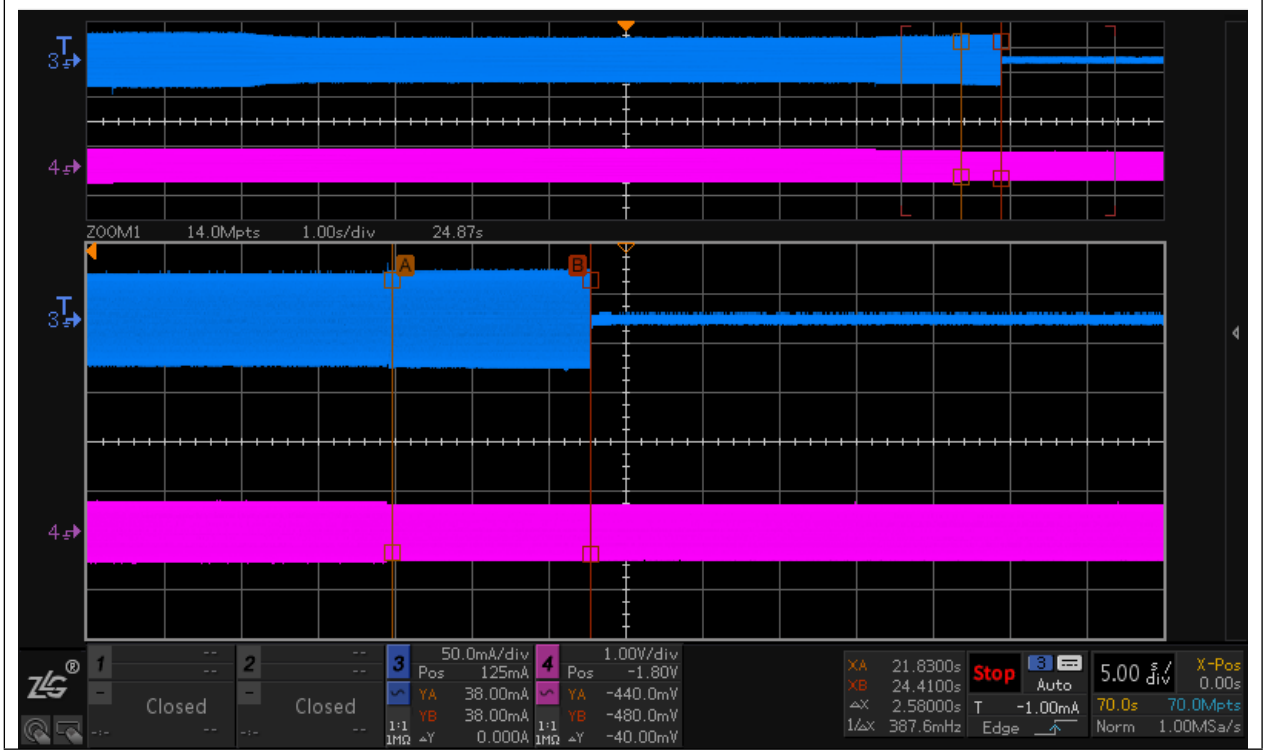
U/V -4


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

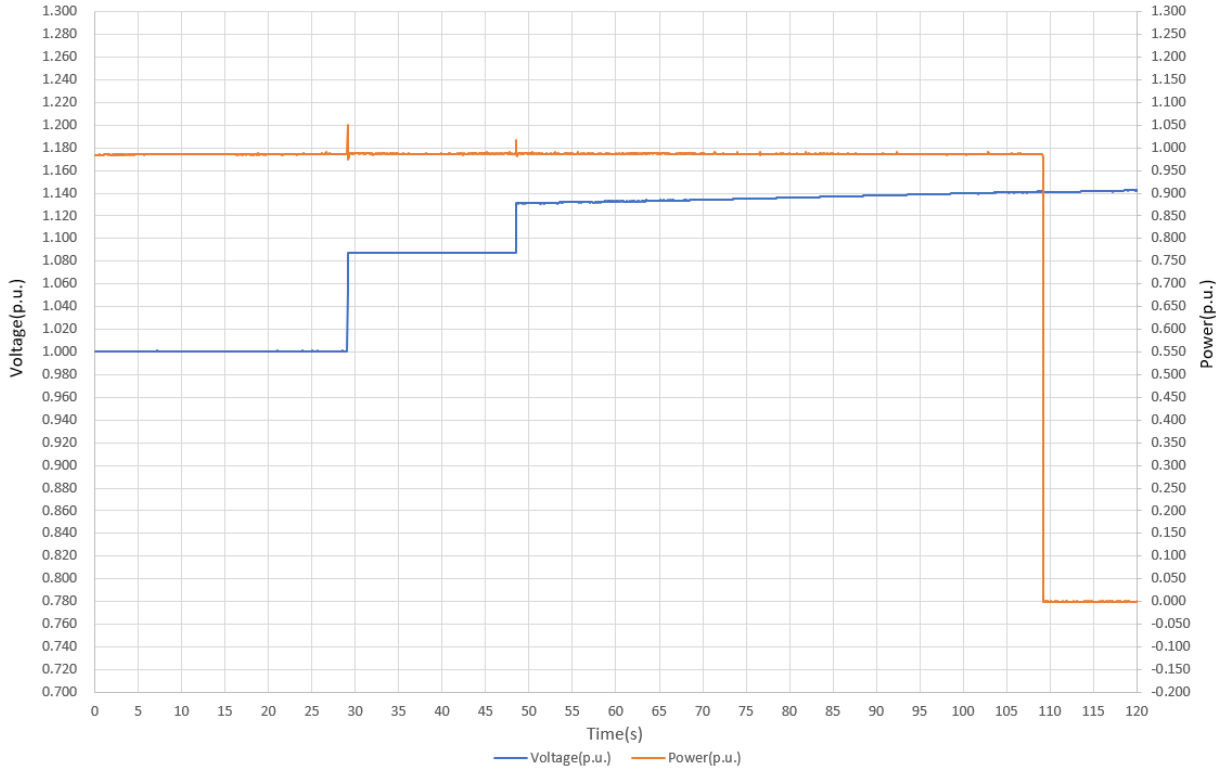

ZOOM1
14.0Mpts
1.00s/div
24.87s
Closed
Closed
50.0mA/div
Pos 125mA
YA -40.00mA
YB -4.000mA
36.00mA
1.00V/div
Pos -1.80V
YA 400.0mV
YB 400.0mV
0.000V
XA 21.8400s
XB 24.4200s
2.58000s
387.6mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

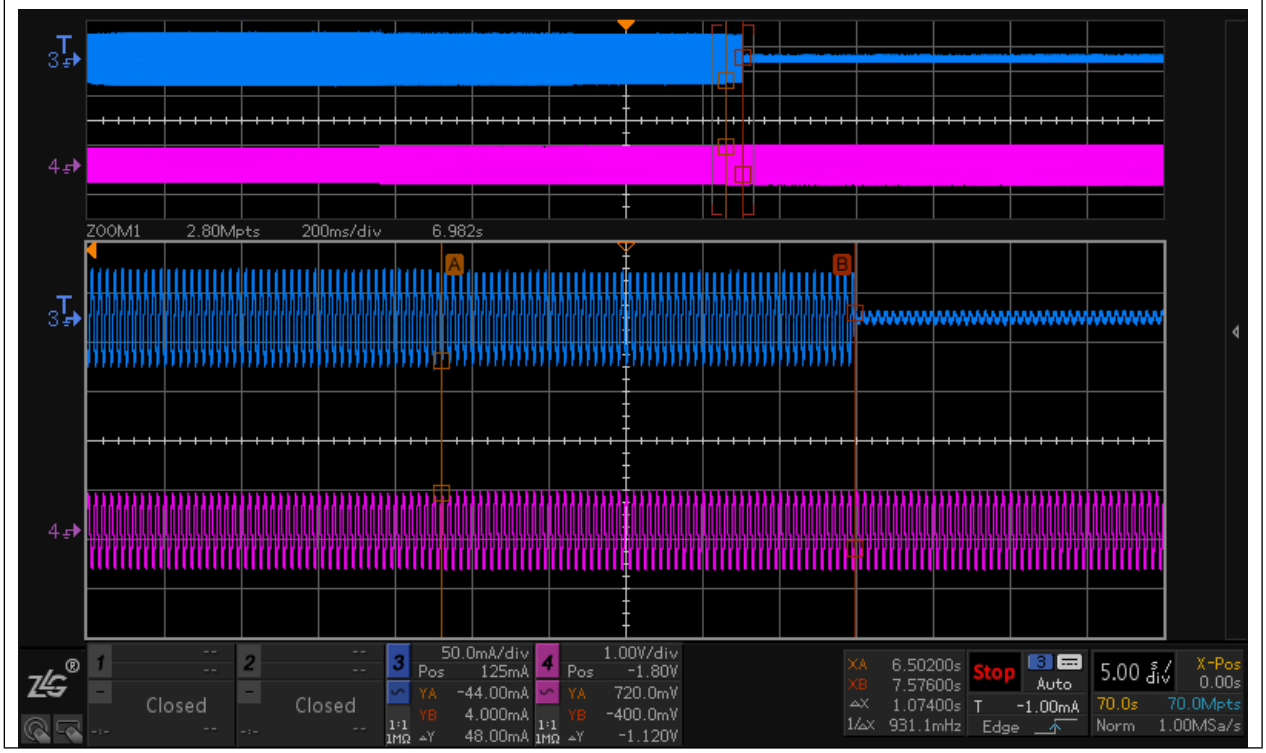
U/V -5


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

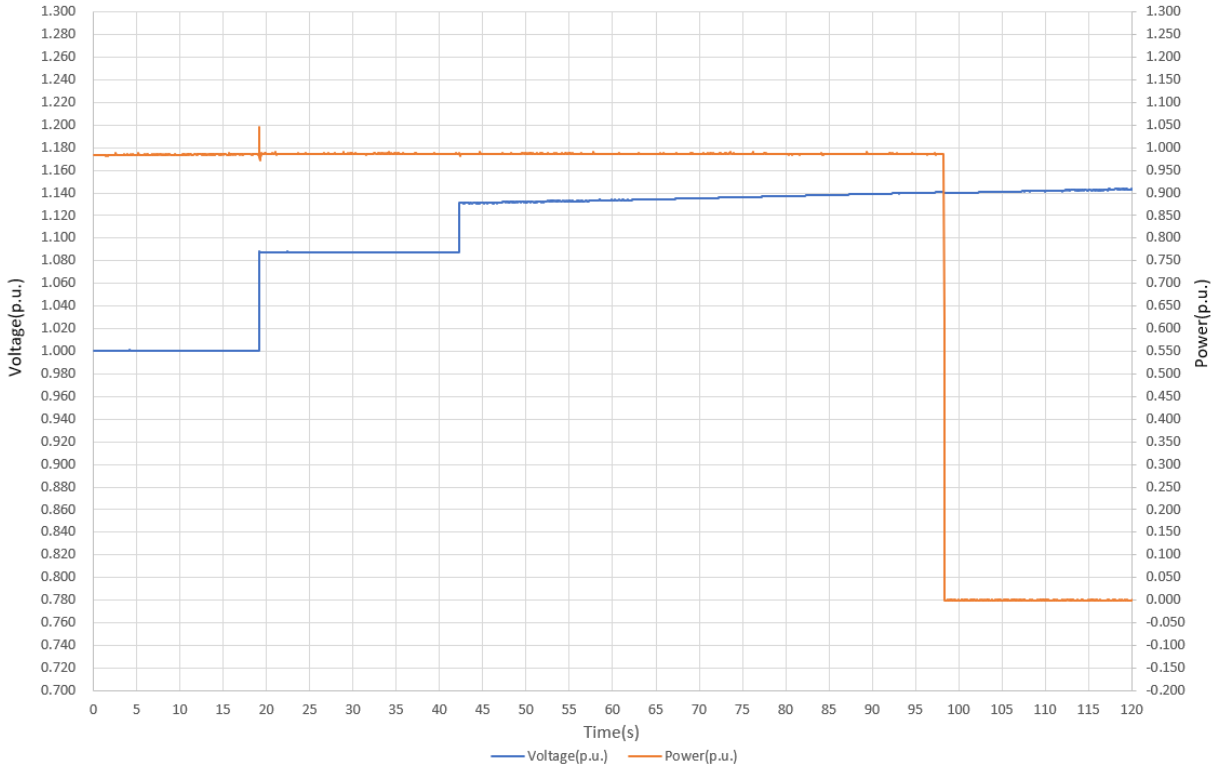

ZOOM1
14.0Mpts
1.00s/div
24.87s
Closed
Closed
50.0mA/div
Pos 125mA
YA 38.00mA
YB 38.00mA
0.000A
1.00V/div
Pos -1.80V
YA -440.0mV
YB -480.0mV
-40.00mV
XA 21.8300s
XB 24.4100s
2.58000s
387.6mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

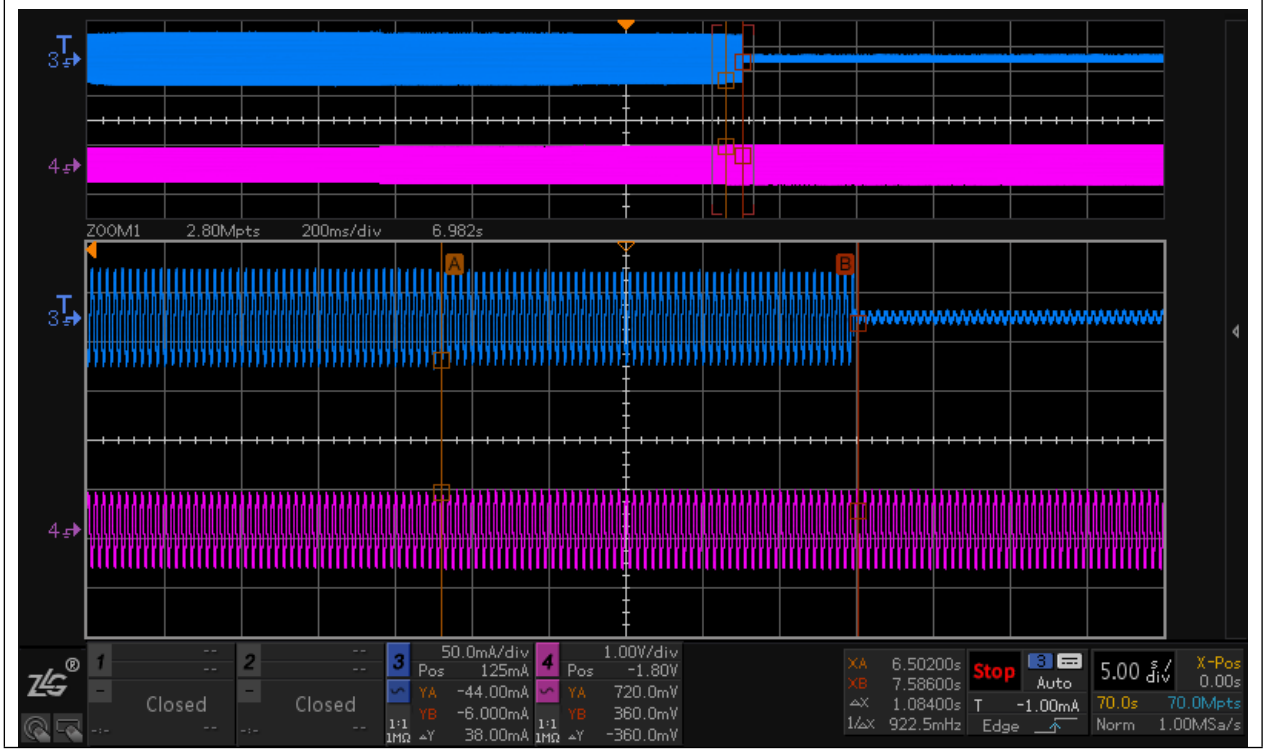
O/V stage 1-1


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

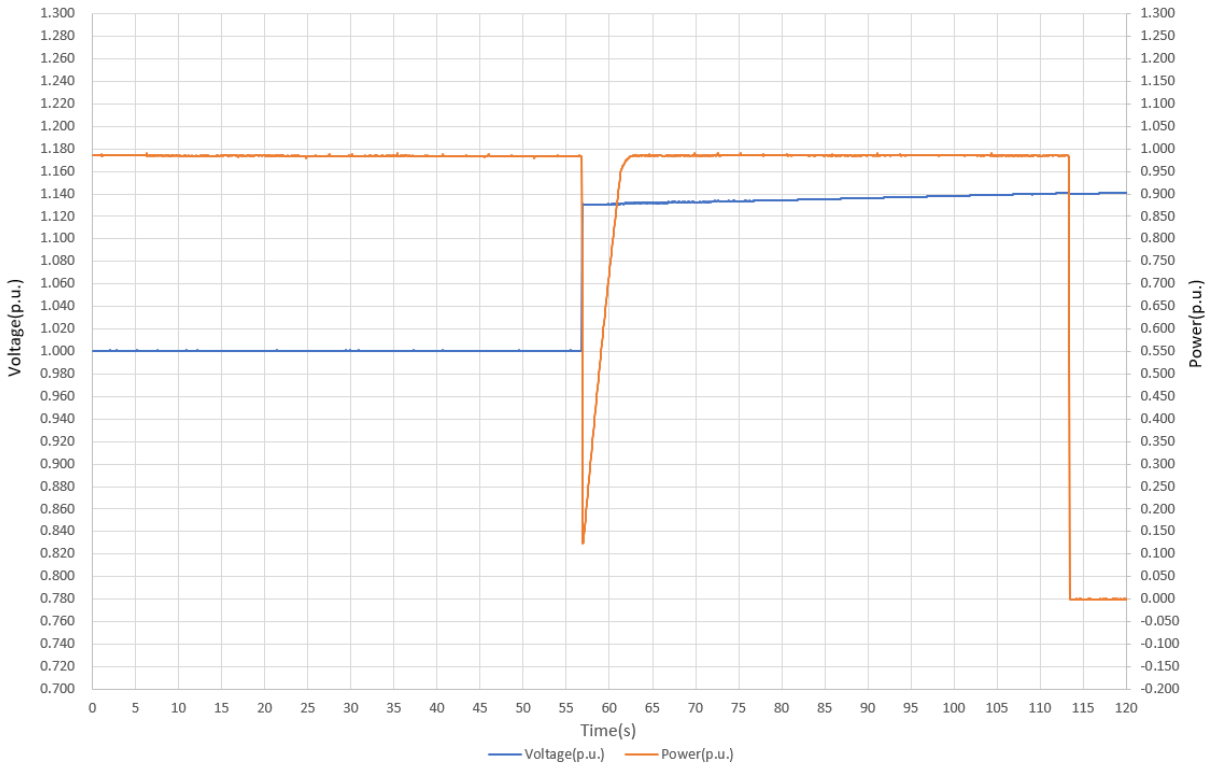

ZOOM1
2.80Mpts
200ms/div
6.982s
Closed
Closed
50.0mA/div
Pos 125mA
YA -44.00mA
YB 4.000mA
48.00mA
1.00V/div
Pos -1.80V
YA 720.0mV
YB -400.0mV
-1.120V
XA 6.50200s
XB 7.57600s
1.07400s
931.1mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

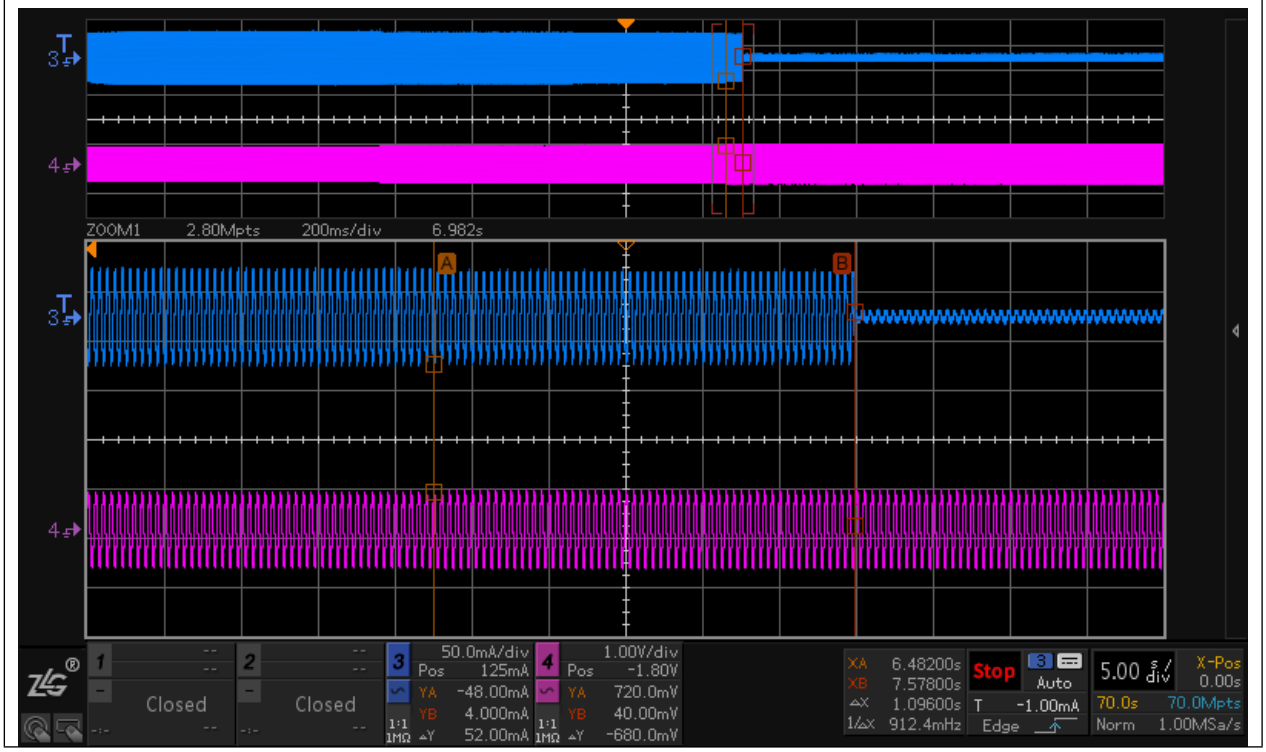
O/V stage 1-2


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

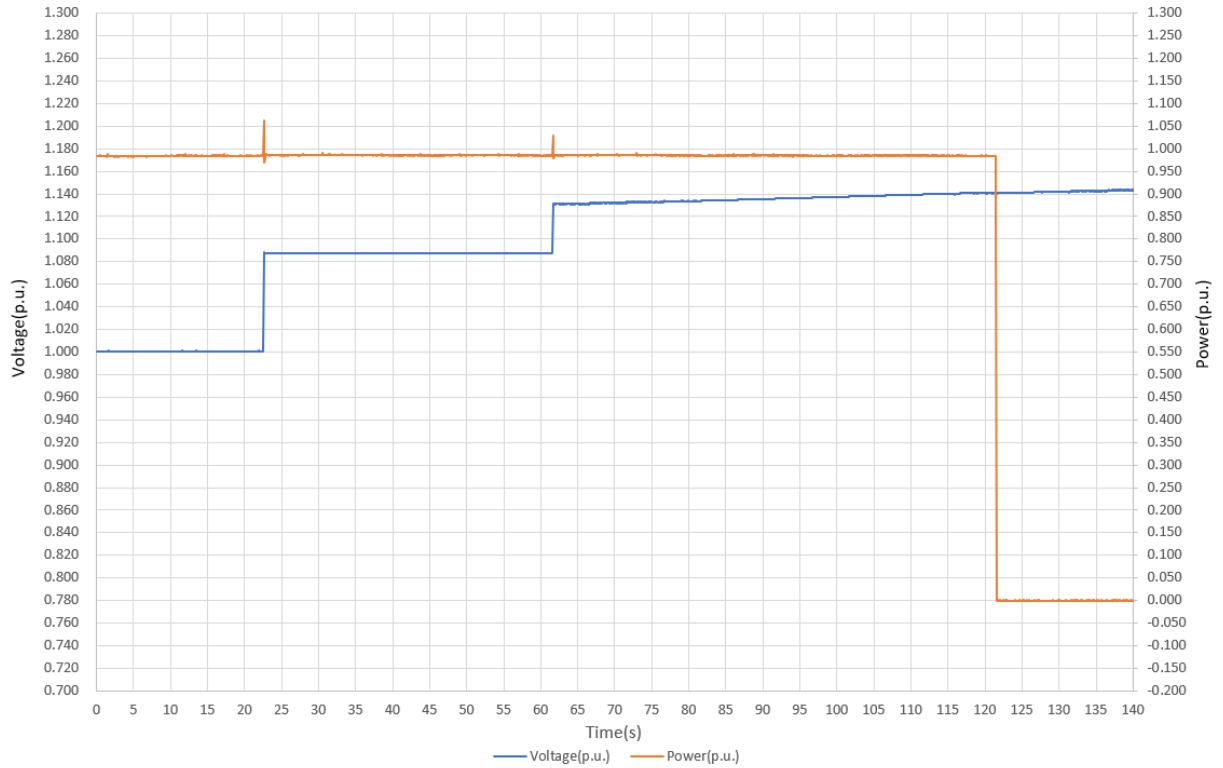

ZOOM1
2.80Mpts
200ms/div
6.982s
Closed
Closed
50.0mA/div
Pos 125mA
YA -44.00mA
YB -6.000mA
38.00mA
1.00V/div
Pos -1.80V
YA 720.0mV
YB 360.0mV
-360.0mV
XA 6.50200s
XB 7.58600s
1.08400s
922.5mHz
Stop
Auto
T -1.00mA
Edge
5.00 div
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

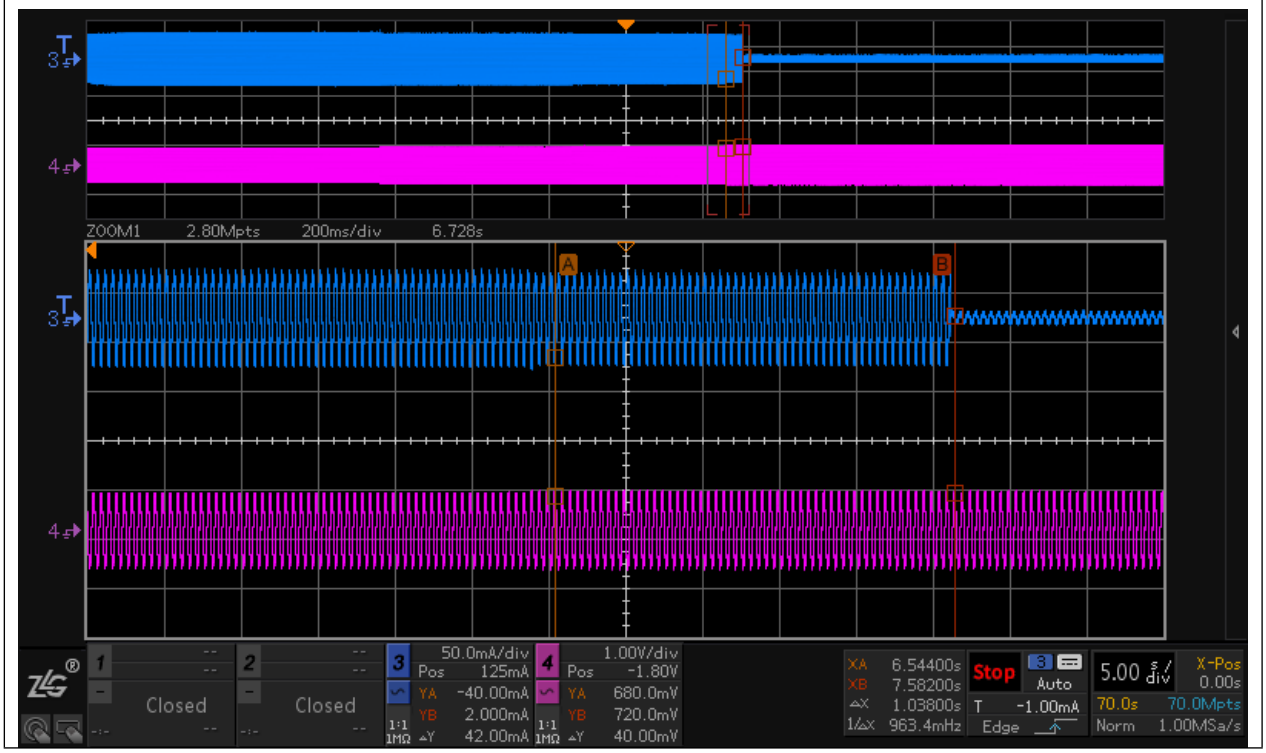
O/V stage 1-3


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

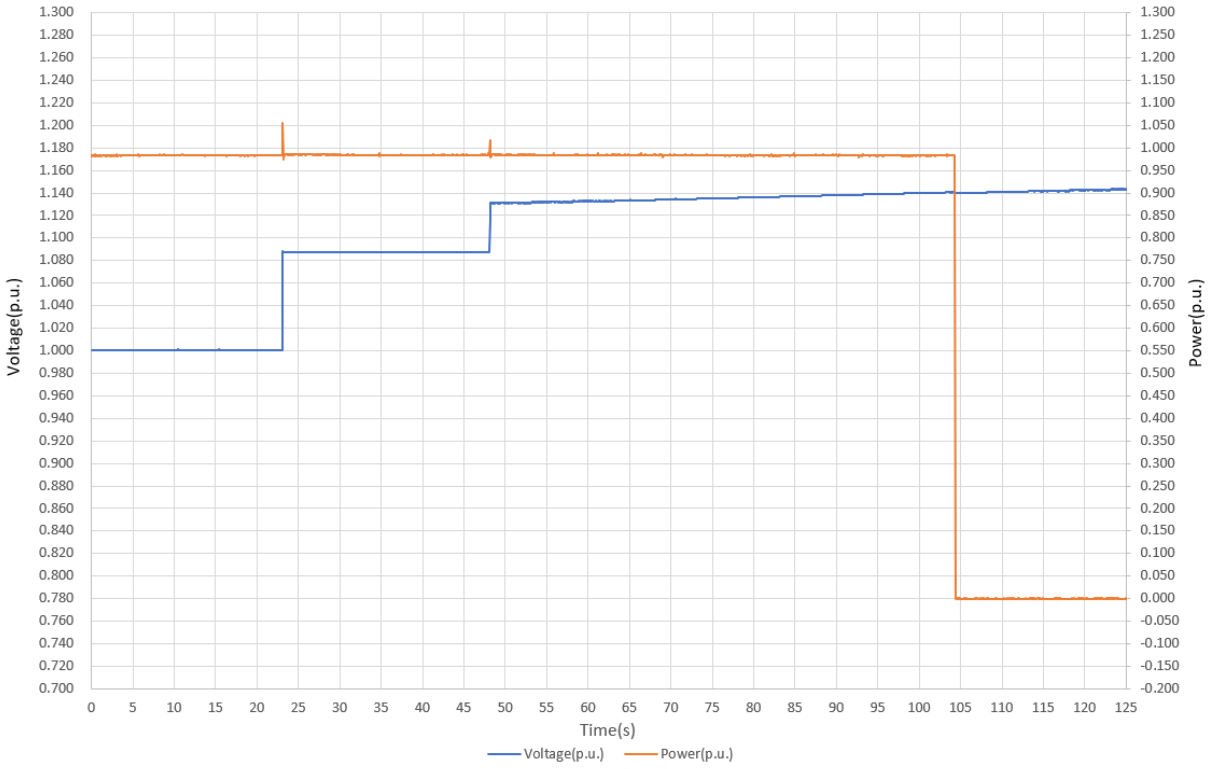

ZOOM1
2.80Mpts
200ms/div
6.982s
Closed
Closed
50.0mA/div
Pos 125mA
YA -48.00mA
YB 4.000mA
52.00mA
1.00V/div
Pos -1.80V
YA 720.0mV
YB 40.00mV
-680.0mV
XA 6.48200s
XB 7.57800s
1.09600s
912.4mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

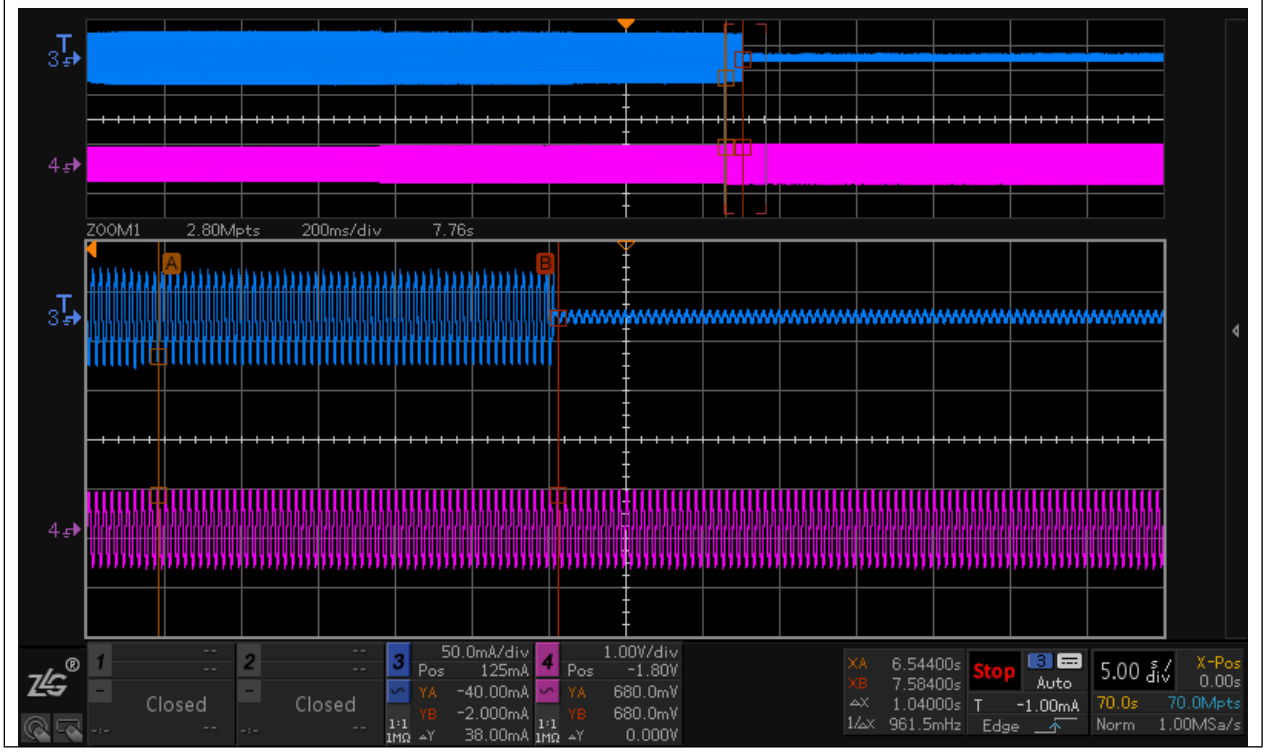
O/V stage 1-4


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

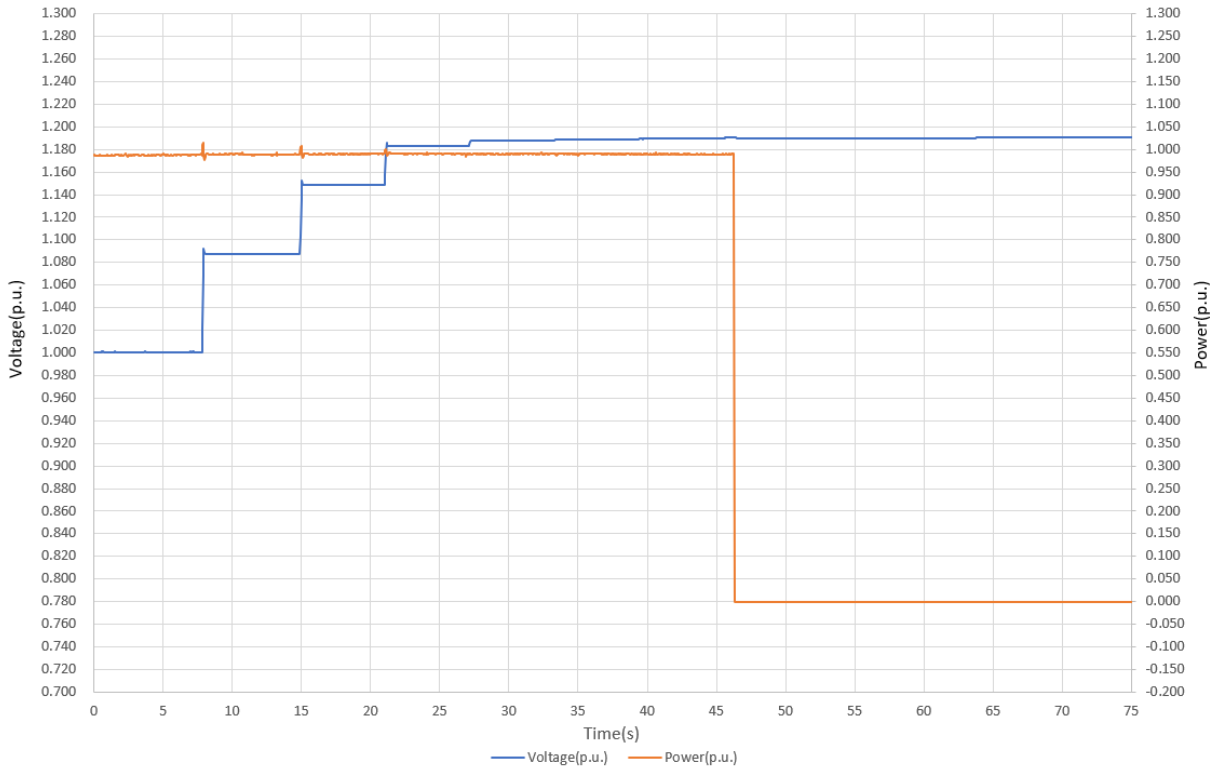

ZOOM1
2.80Mpts
200ms/div
6.728s
Closed
Closed
50.0mA/div
Pos 125mA
YA -40.00mA
YB 2.000mA
42.00mA
1.00V/div
Pos -1.80V
YA 680.0mV
YB 720.0mV
40.00mV
XA 6.54400s
XB 7.58200s
1.03800s
963.4mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

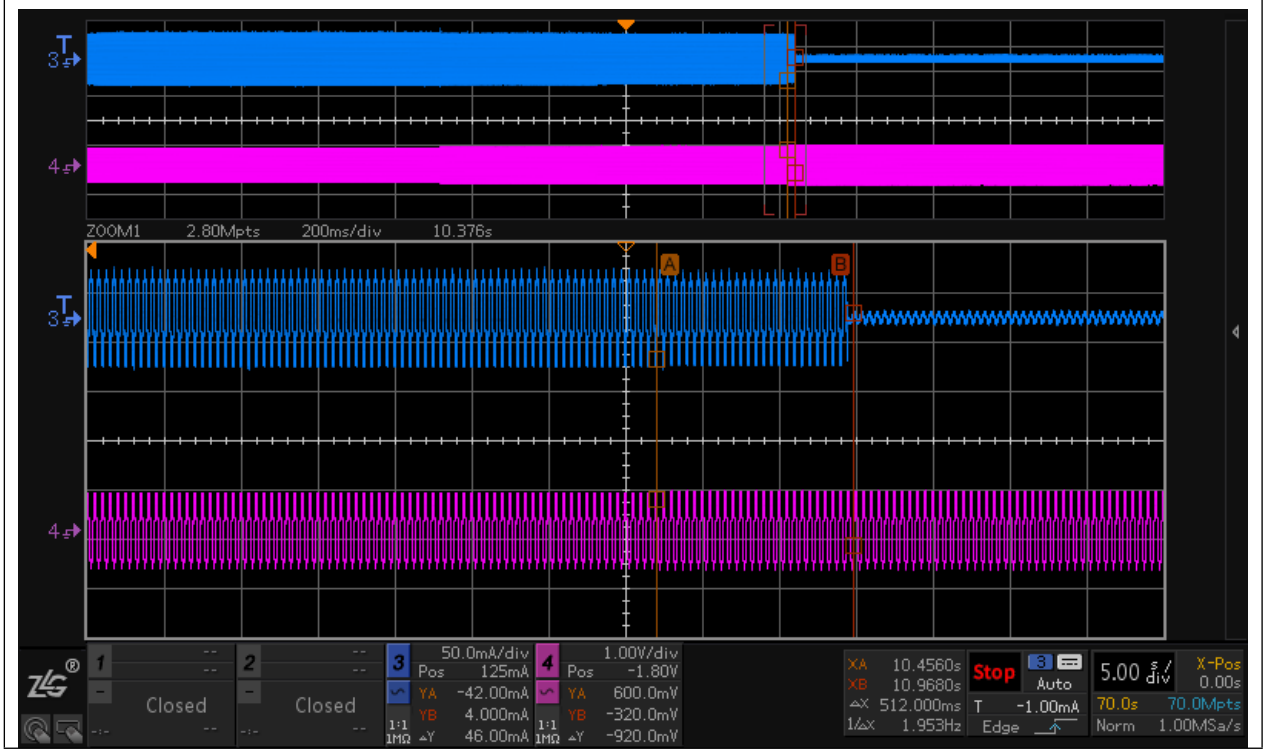
O/V stage 1-5


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

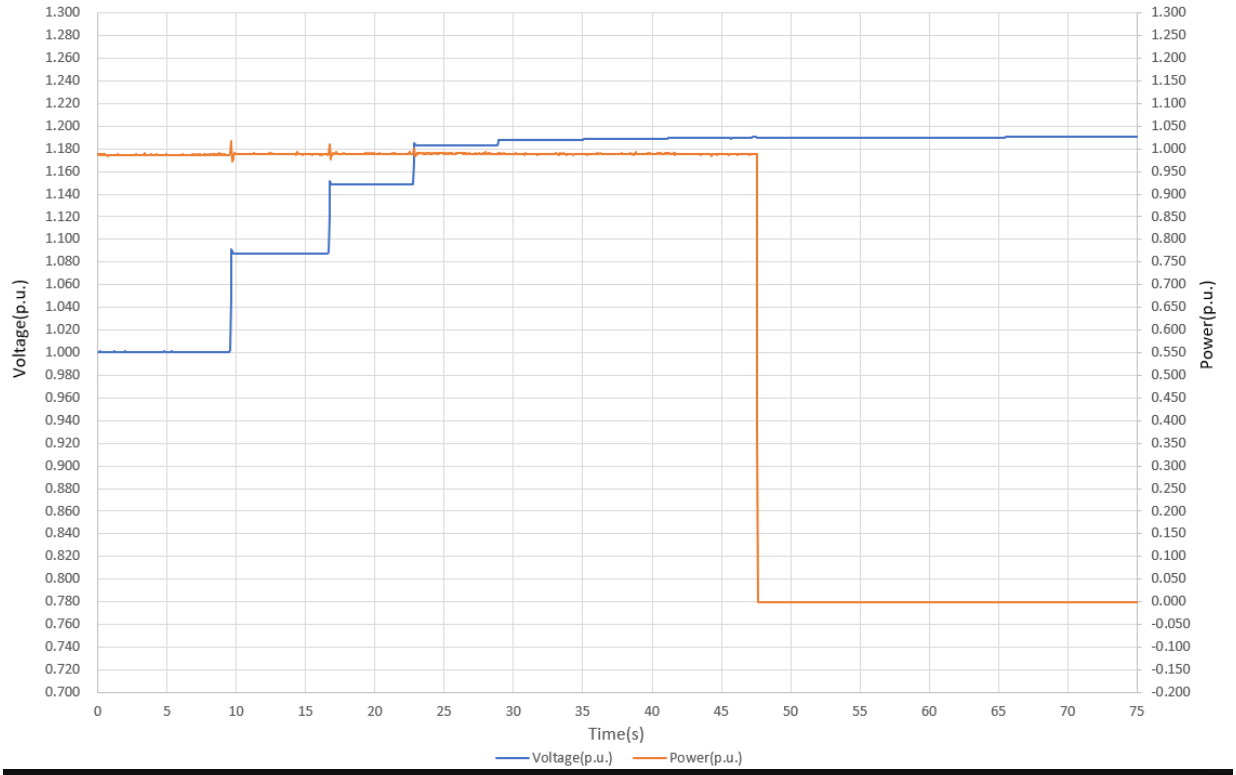

ZOOM1
2.80Mpts
200ms/div
7.76s
Closed
Closed
50.0mA/div
Pos 125mA
YA -40.00mA
YB -2.000mA
38.00mA
1.00V/div
Pos -1.80V
YA 680.0mV
YB 680.0mV
0.000V
XA 6.54400s
XB 7.58400s
1.04000s
961.5mHz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

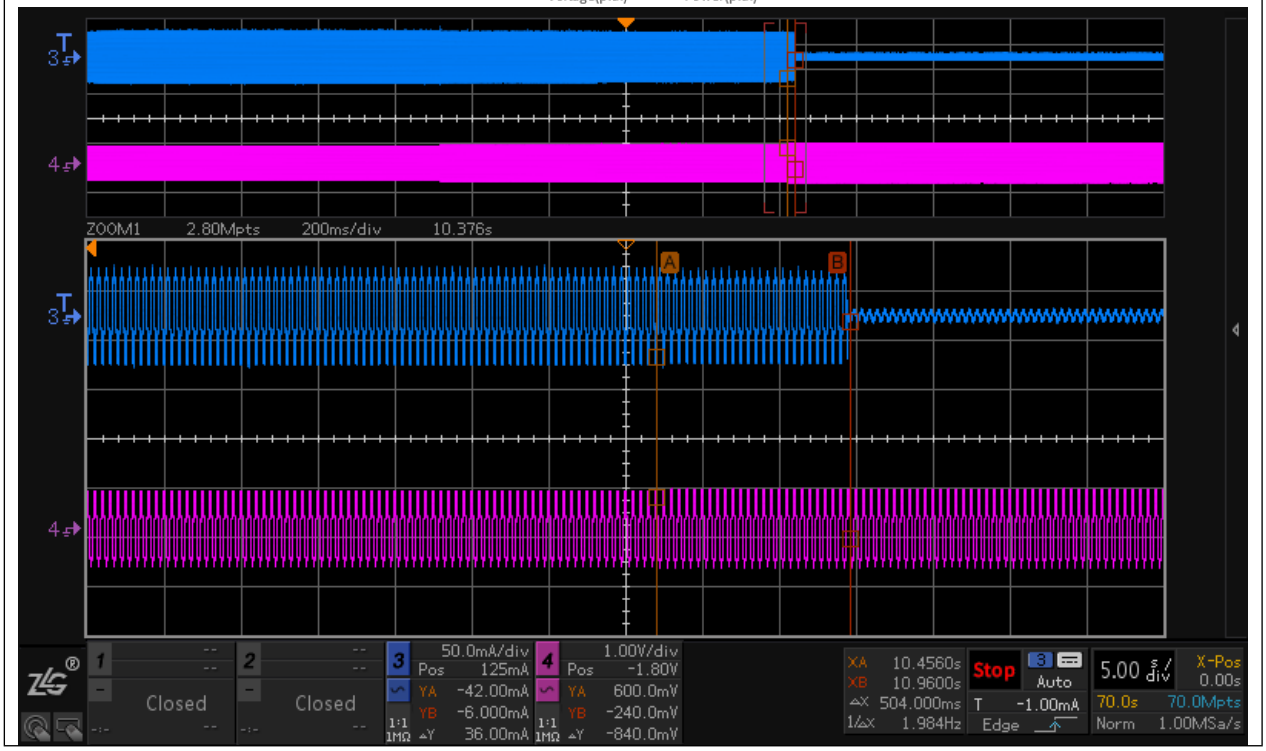
O/V stage 2-1


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

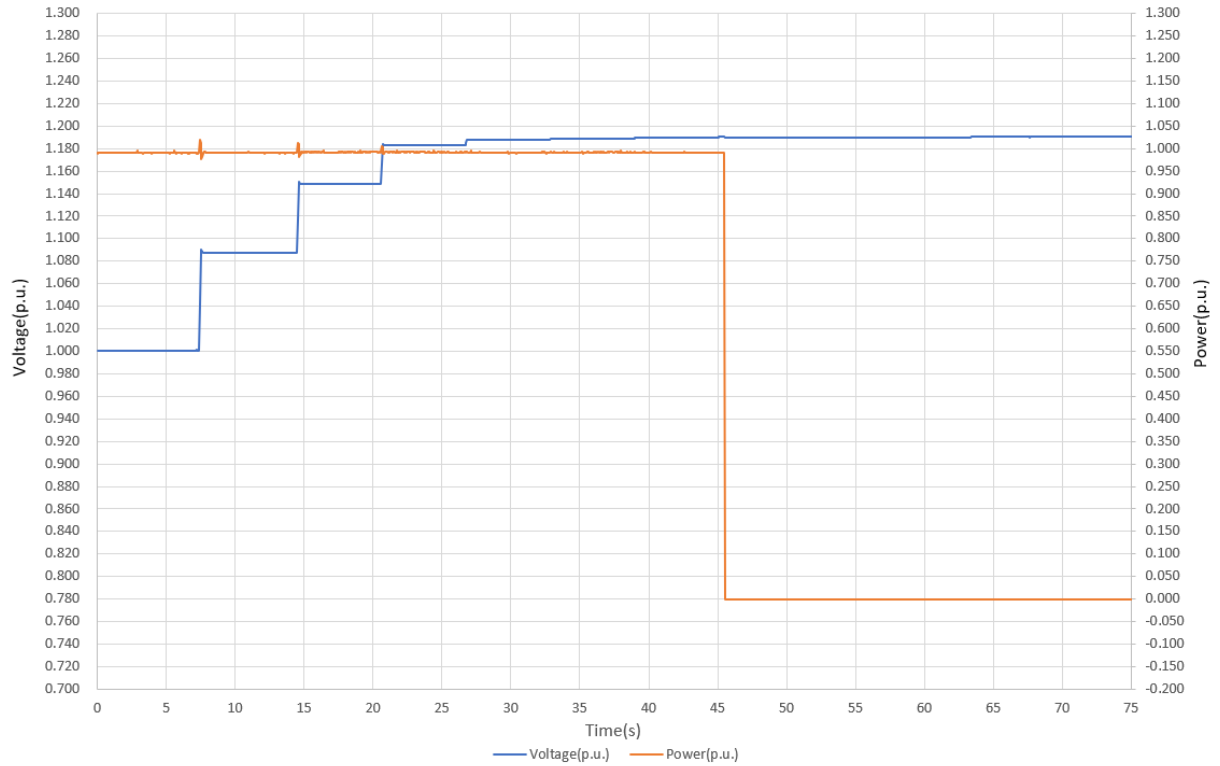

ZOOM1
2.80Mpts
200ms/div
10.376s
Closed
Closed
Stop
Auto
Edge
Norm

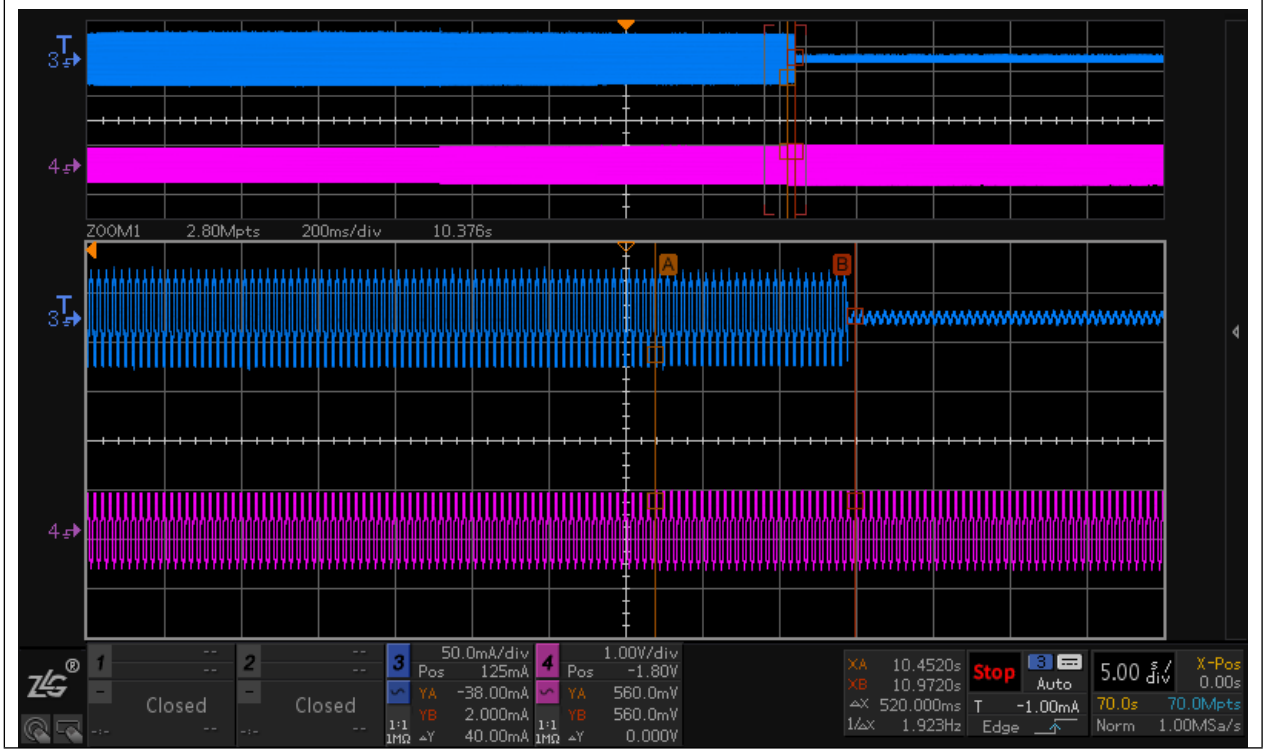
O/V stage 2-2


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

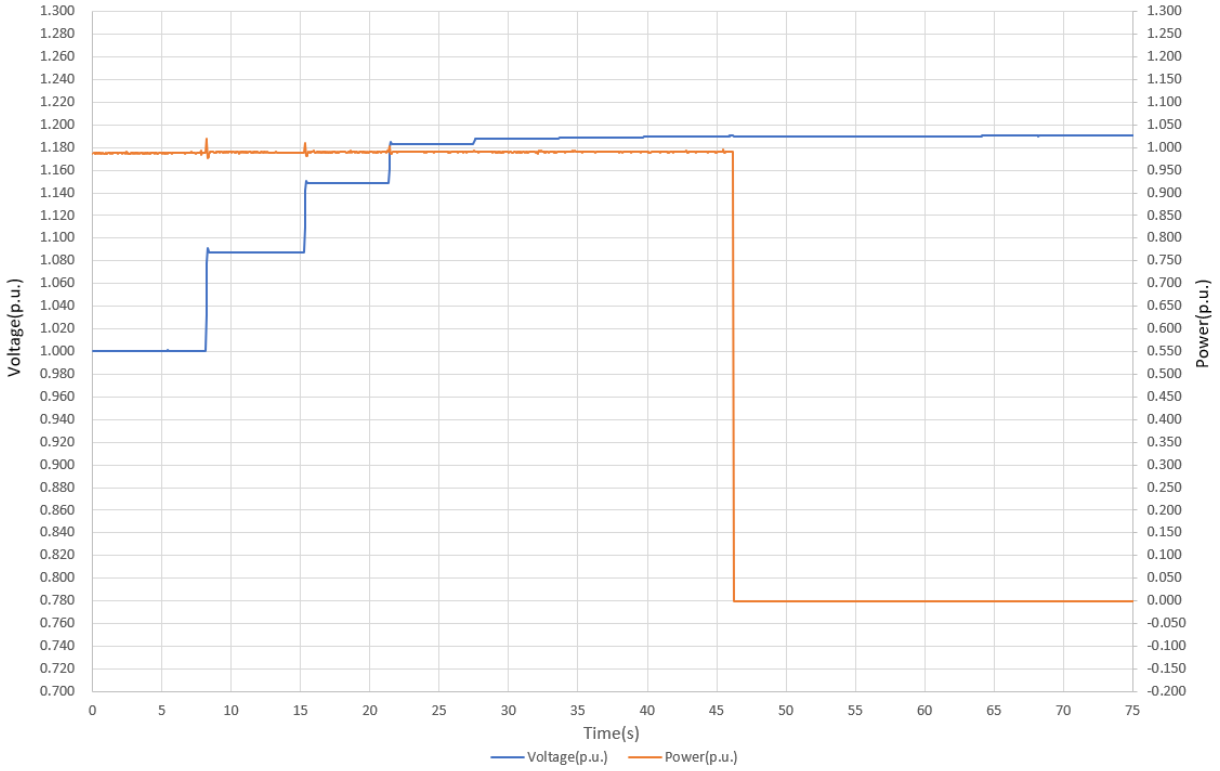

ZOOM1
2.80Mpts
200ms/div
10.376s
Closed
Closed
50.0mA/div
Pos 125mA
YA -42.00mA
YB -6.000mA
36.00mA
1.00V/div
Pos -1.80V
YA 600.0mV
YB -240.0mV
-840.0mV
XA 10.4560s
XB 10.9600s
504.000ms
1.984Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

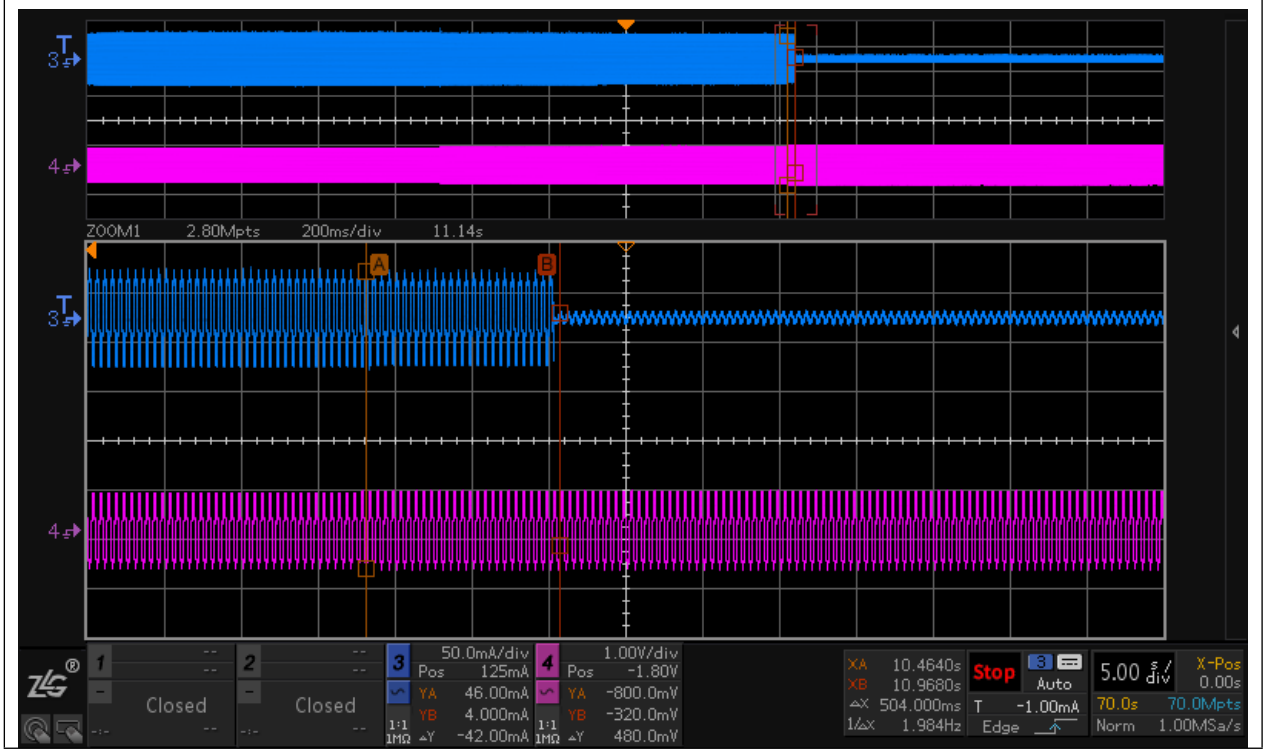
O/V stage 2-3


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

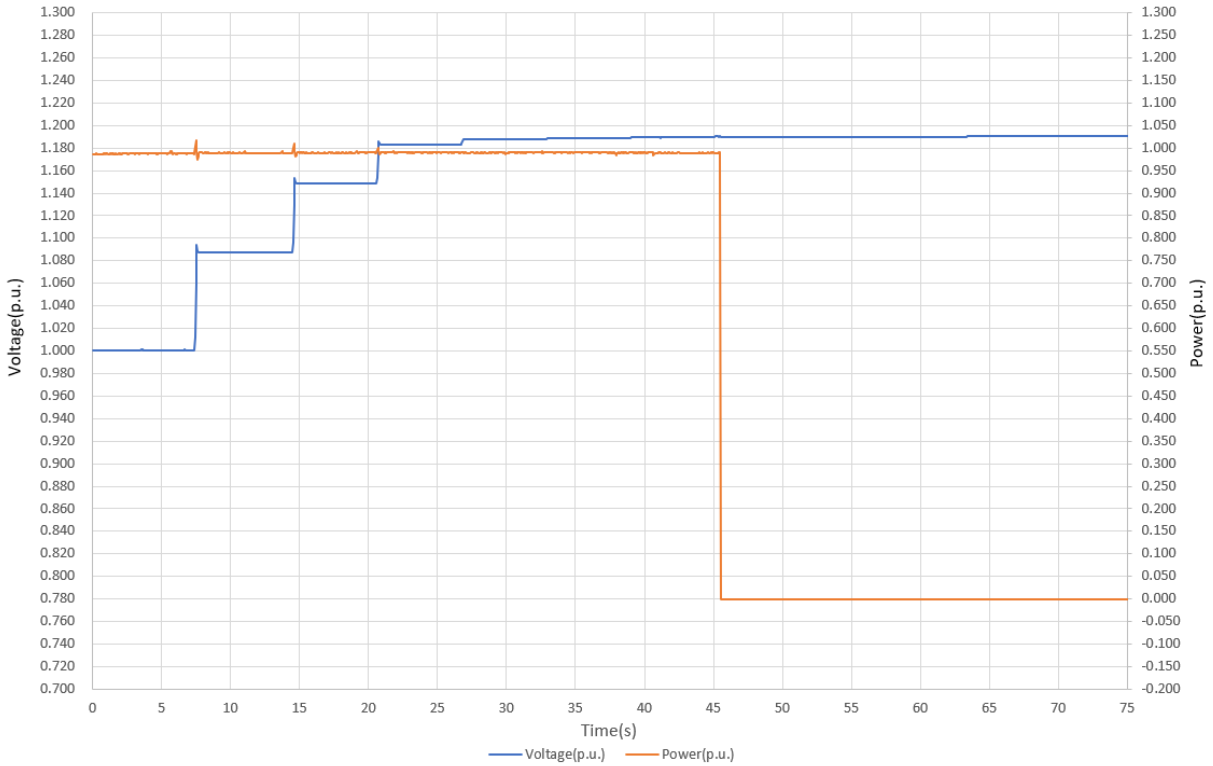

ZOOM1
2.80Mpts
200ms/div
10.376s
A
B
Closed
Closed
50.0mA/div
Pos 125mA
YA -38.00mA
YB 2.000mA
40.00mA
1.00V/div
Pos -1.80V
YA 560.0mV
YB 560.0mV
0.000V
XA 10.4520s
XB 10.9720s
520.000ms
1.923Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

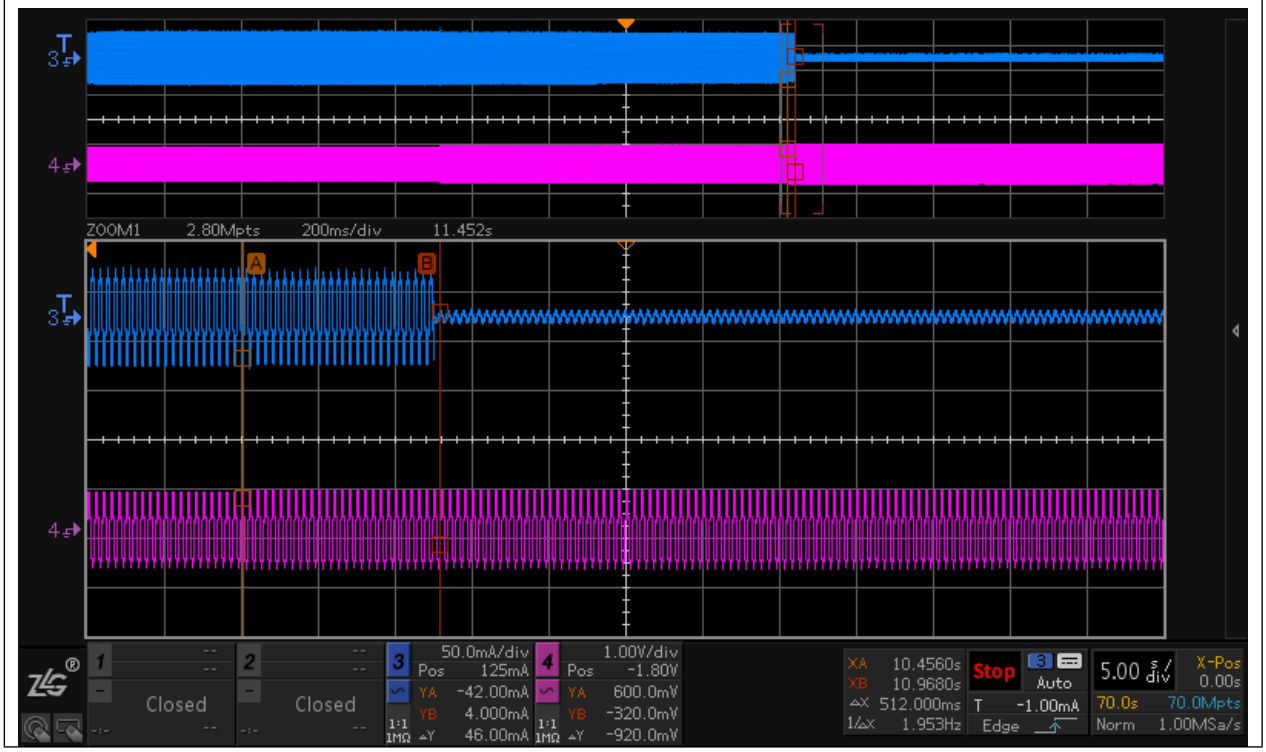
O/V stage 2-4


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

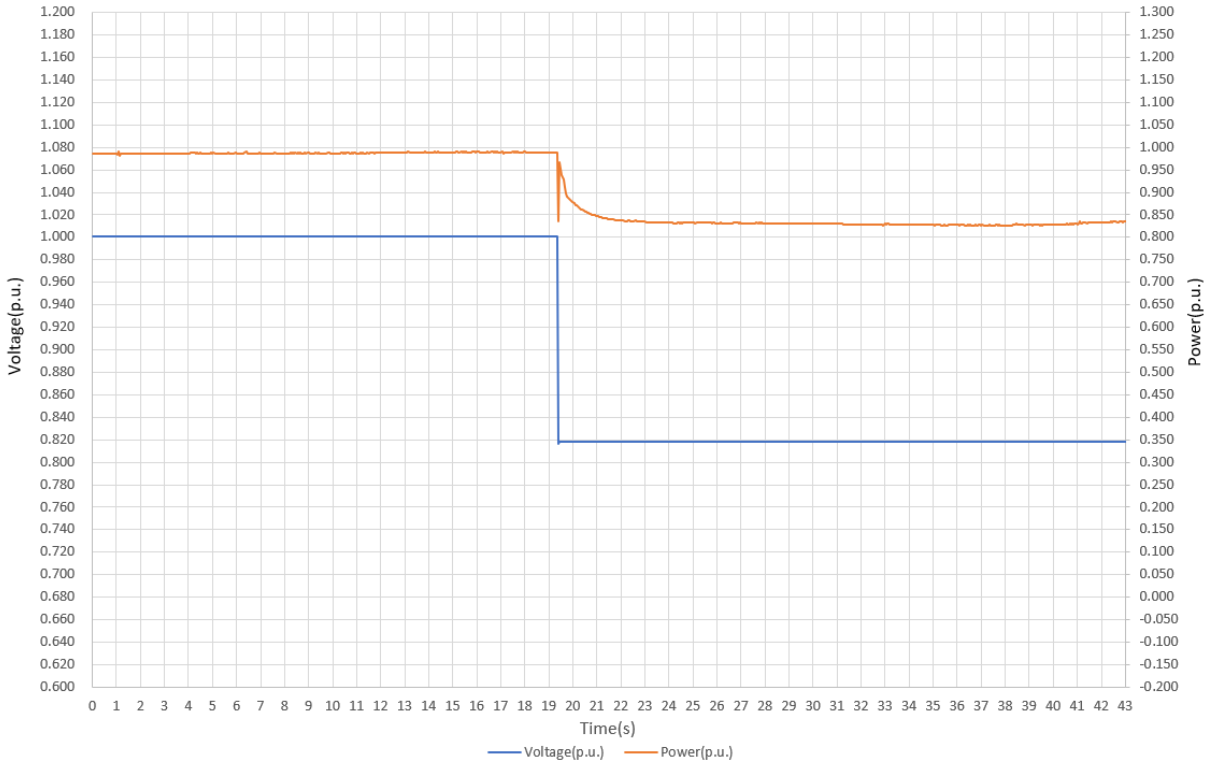

ZOOM1
2.80Mpts
200ms/div
11.14s
Closed
Closed
50.0mA/div
Pos 125mA
YA 46.00mA
YB 4.000mA
-42.00mA
1.00V/div
Pos -1.80V
YA -800.0mV
YB -320.0mV
480.0mV
XA 10.4640s
XB 10.9680s
504.000ms
1.984Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

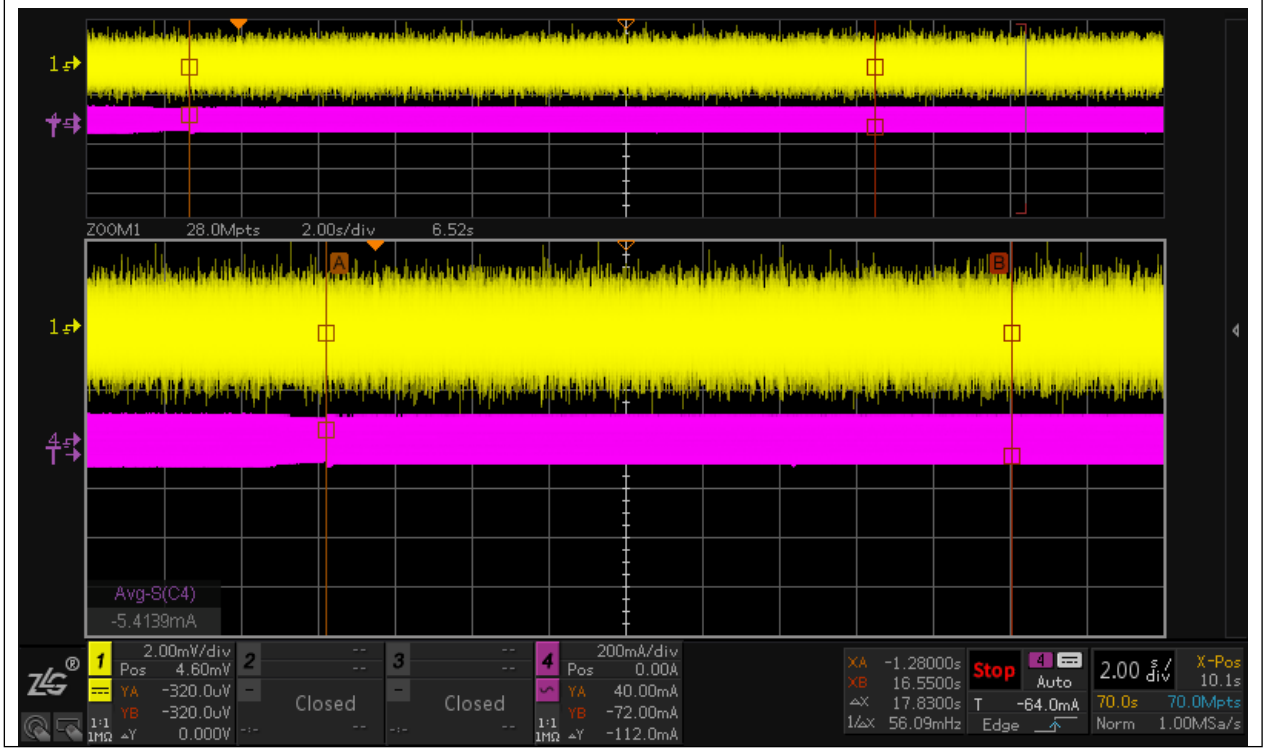
O/V stage 2-5


Voltage(p.u.)
Power(p.u.)
Time(s)
Voltage(p.u.)
Power(p.u.)

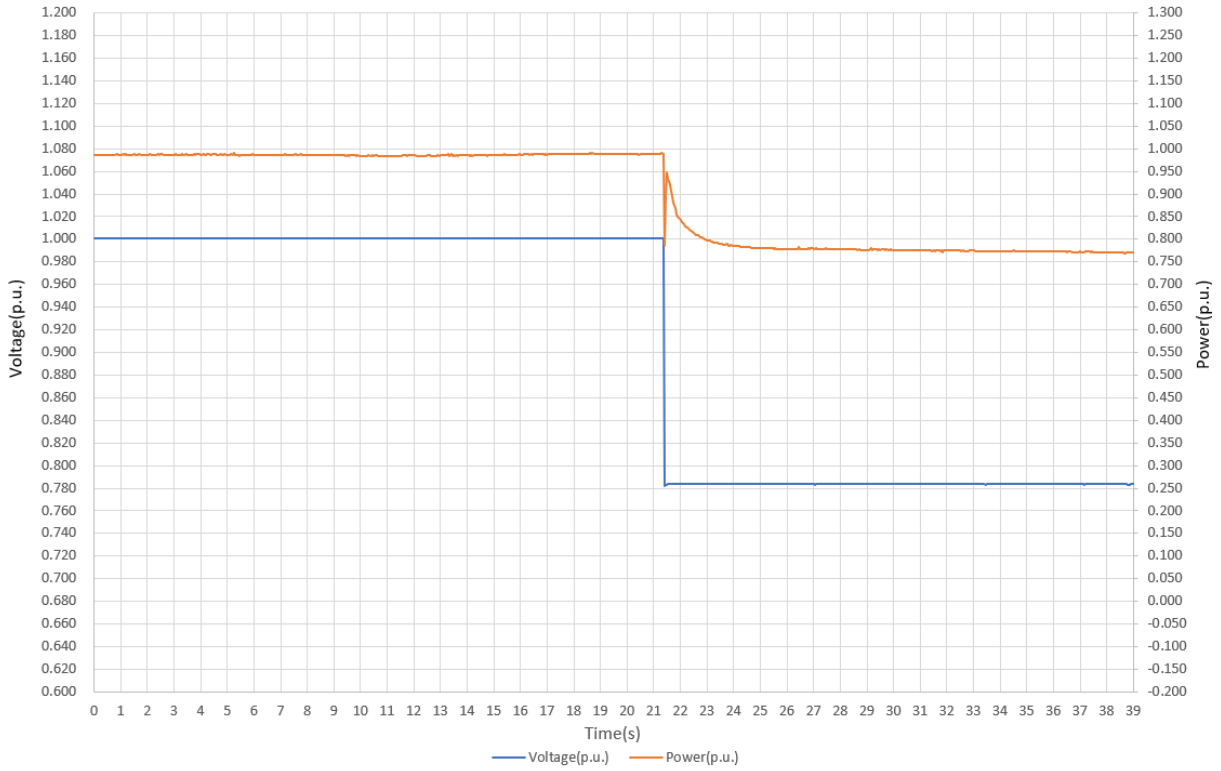

ZOOM1
2.80Mpts
200ms/div
11.452s
Closed
Closed
50.0mA/div
Pos 125mA
YA -42.00mA
YB 4.000mA
46.00mA
1.00V/div
Pos -1.80V
YA 600.0mV
YB -320.0mV
-920.0mV
XA 10.4560s
XB 10.9680s
512.000ms
1.953Hz
Stop
Auto
T -1.00mA
Edge
5.00
X-Pos
0.00s
70.0s
70.0Mpts
Norm
1.00MSa/s

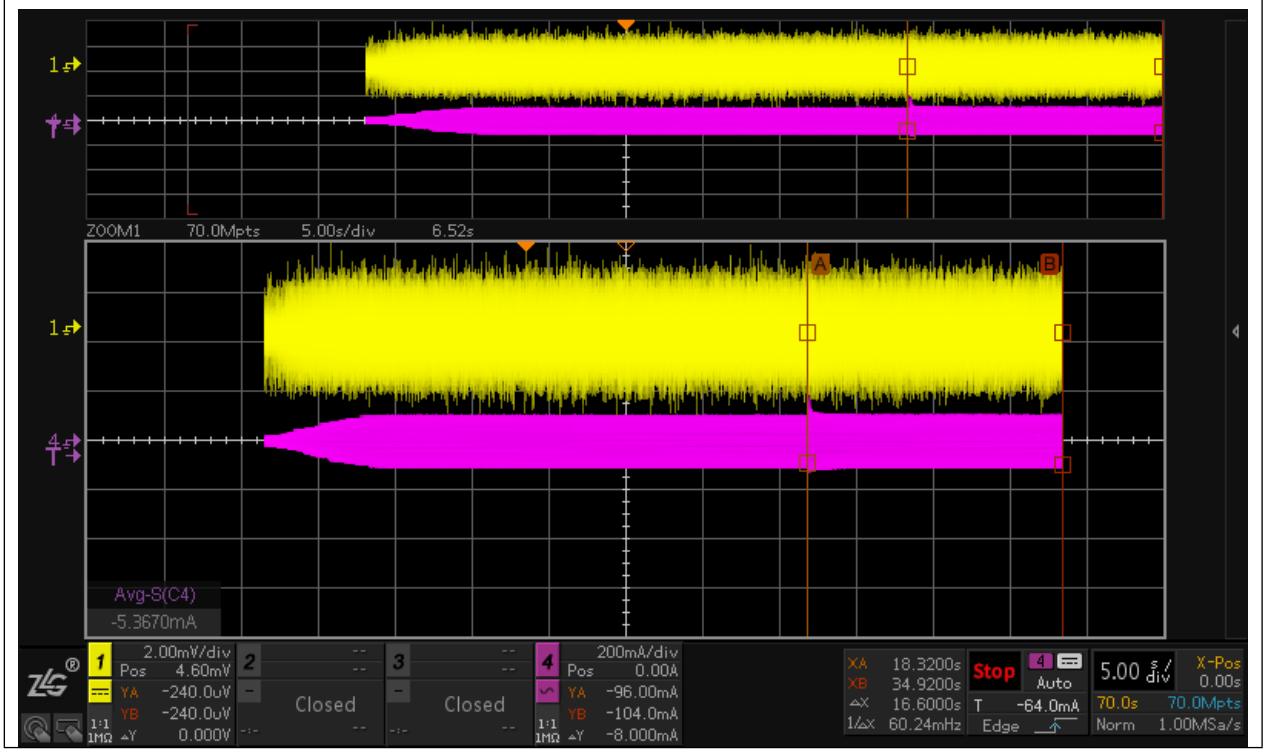
No trip tests – 188V



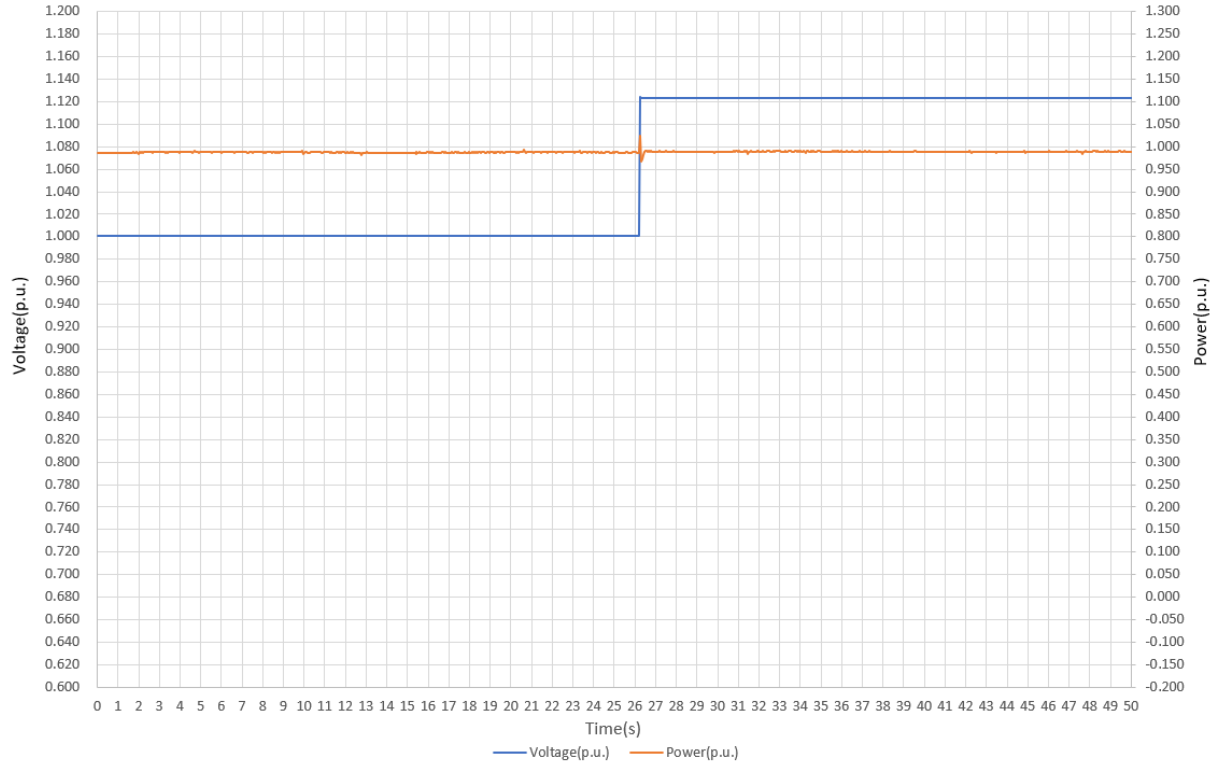


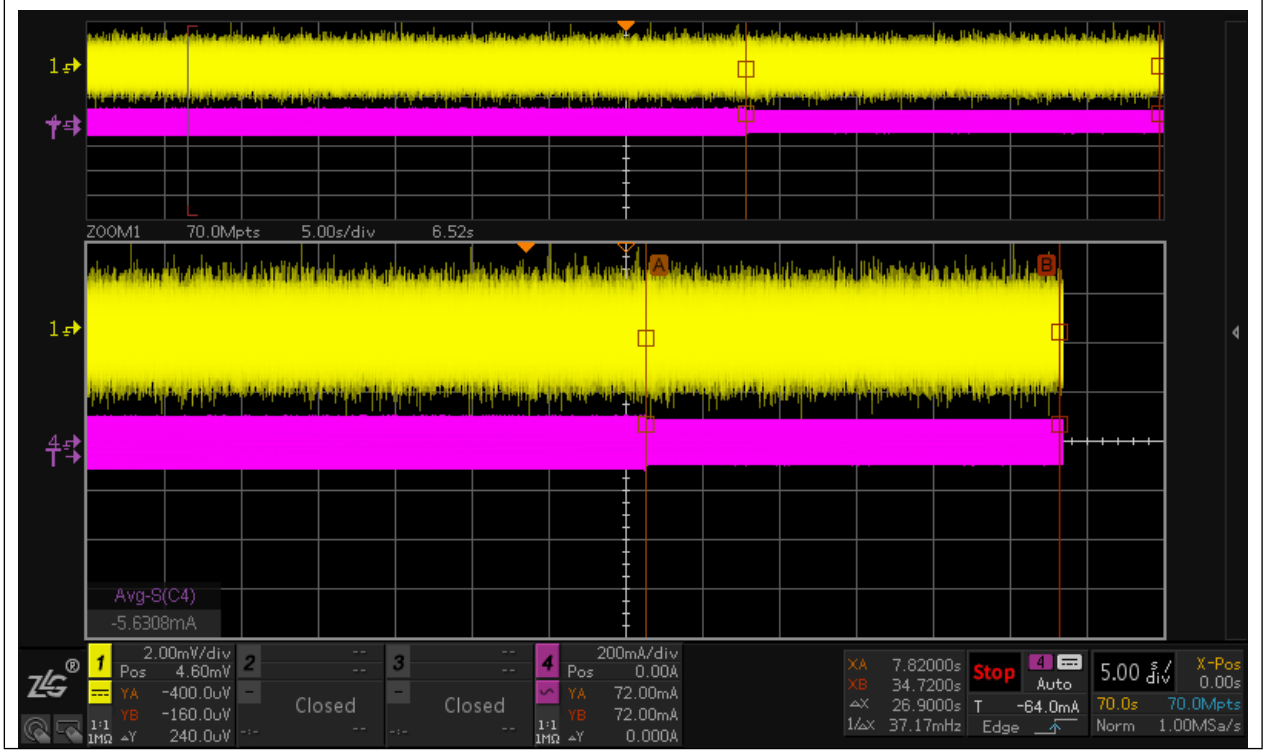
No trip tests – 180V



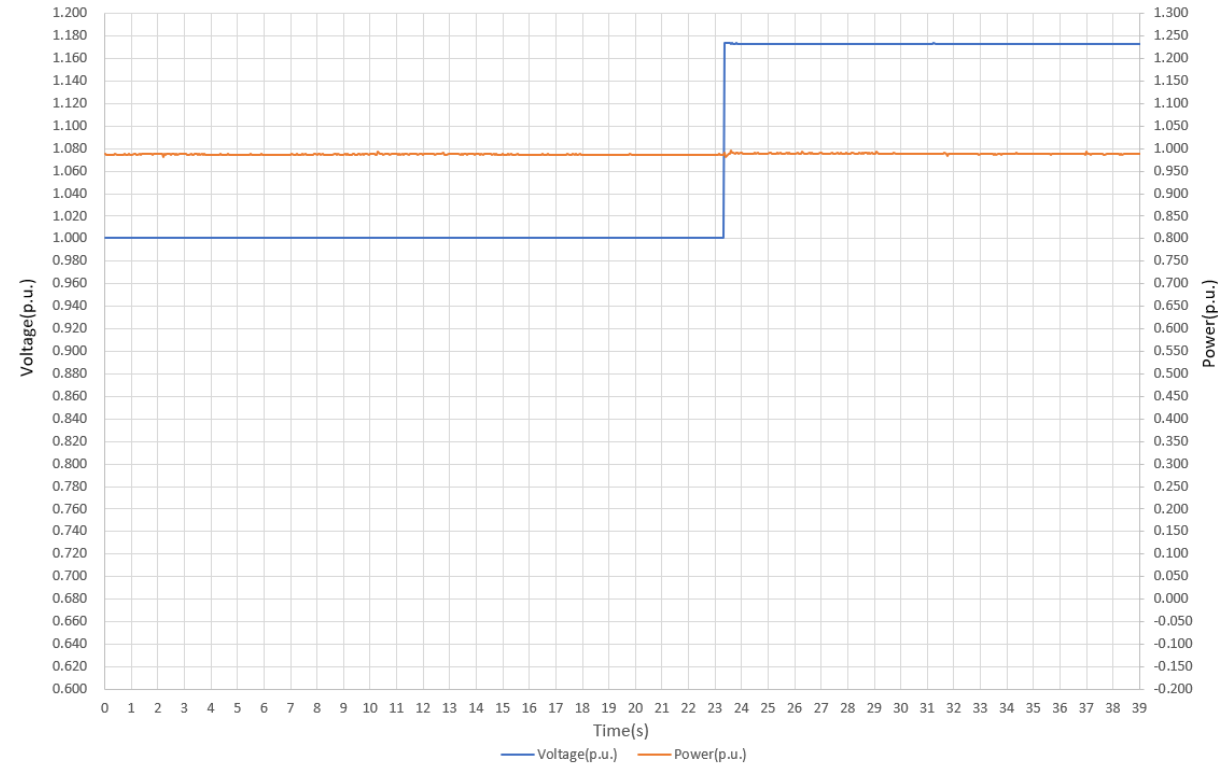


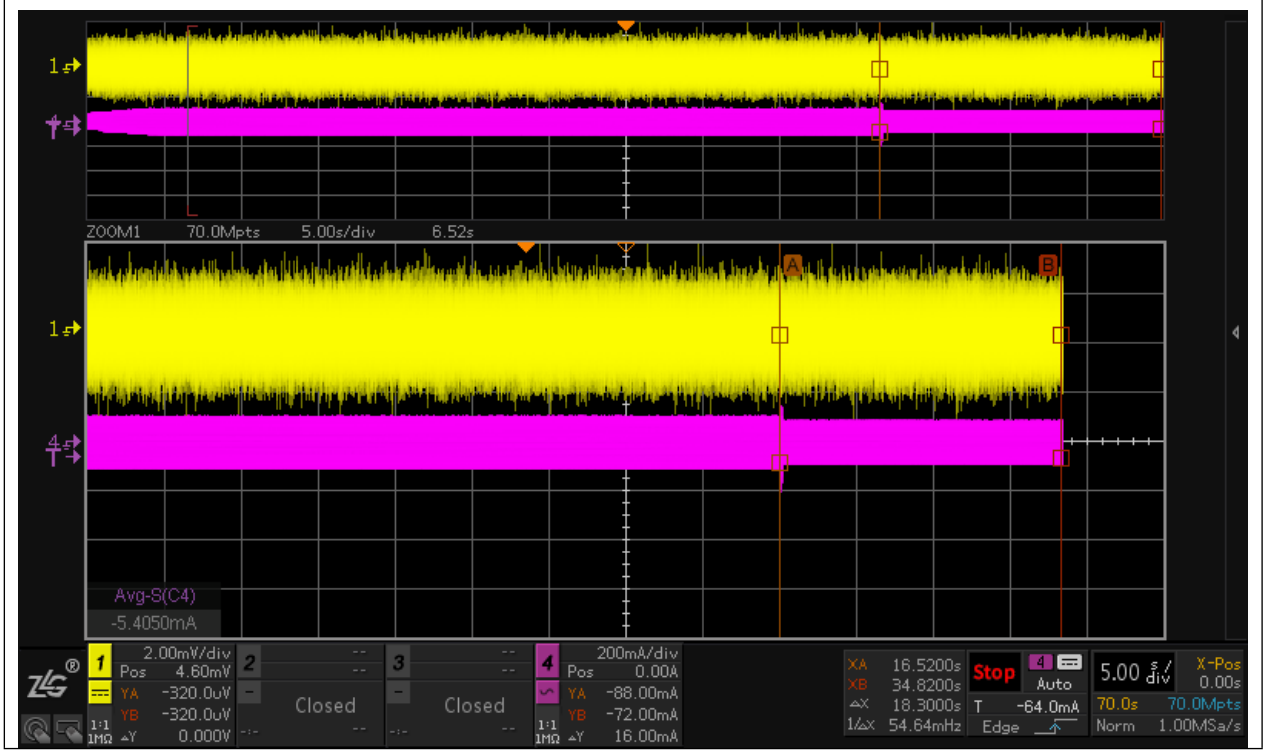
No trip tests – 258.2V



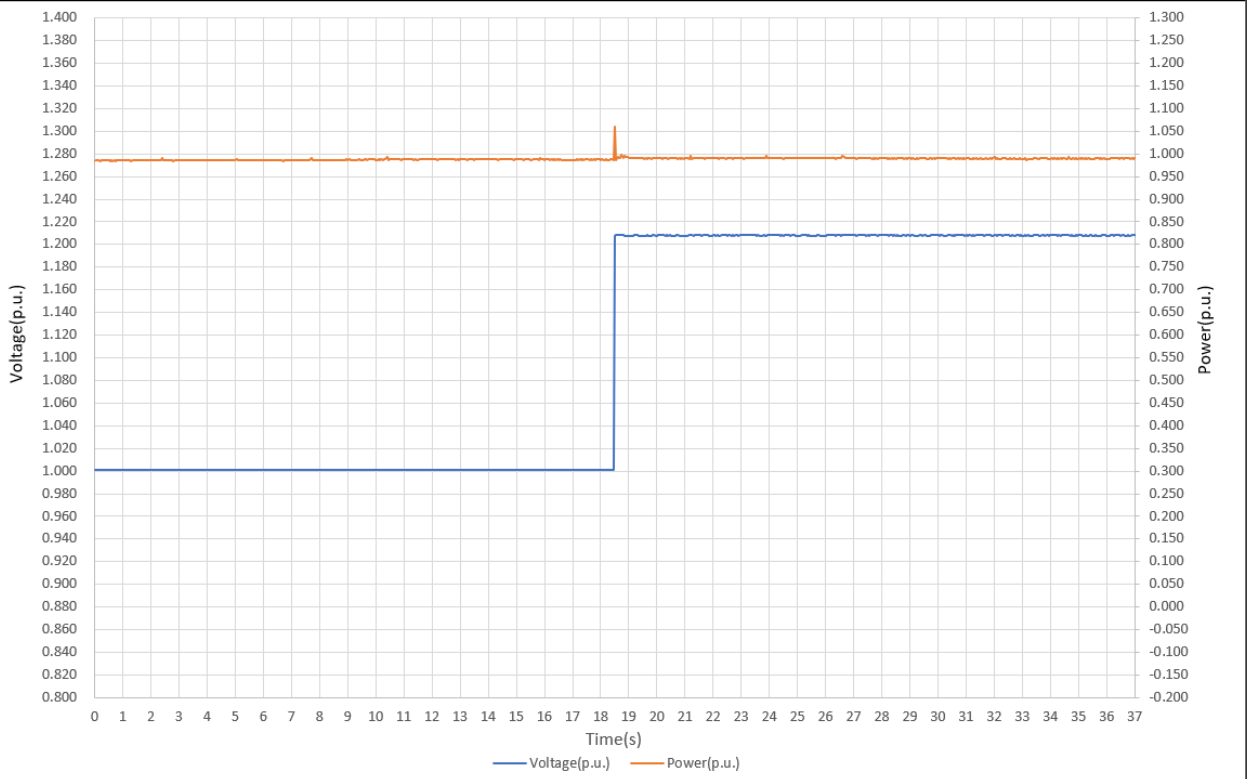


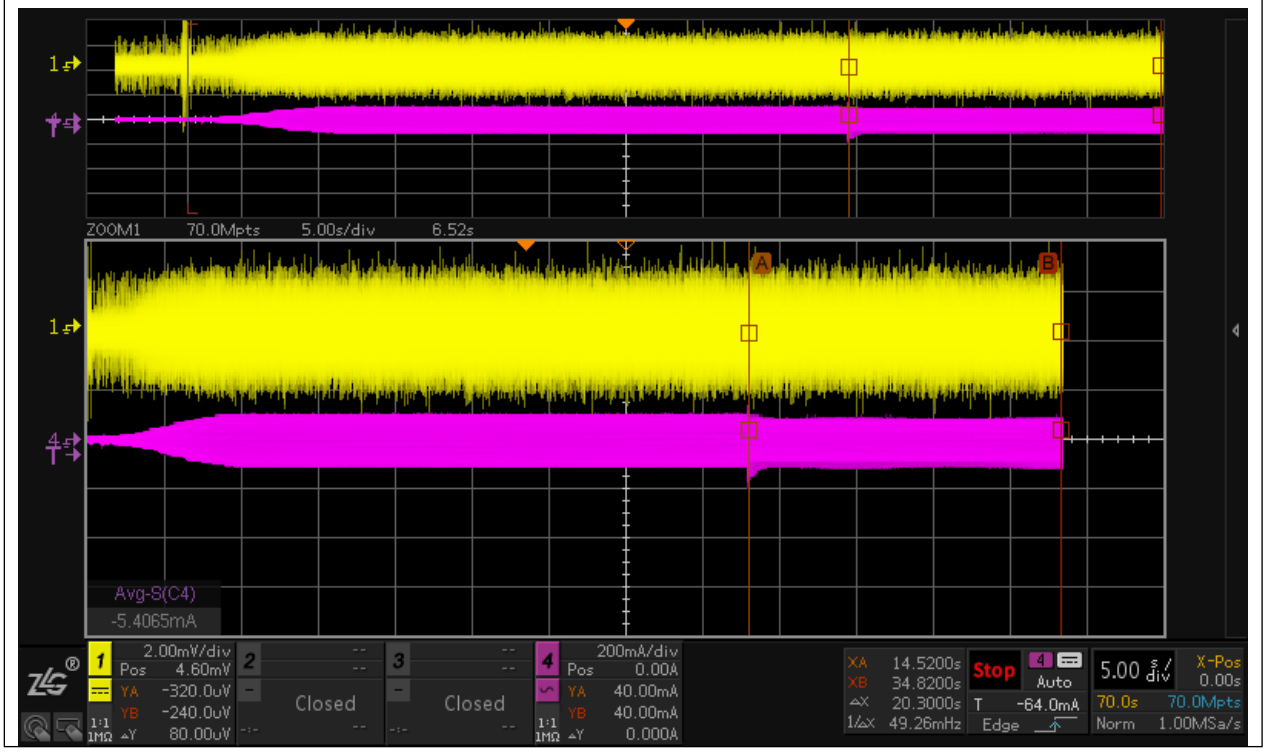
No trip tests – 269.7V





No trip tests – 277.7V





4.3.3 Loss of Mains test

For PV Inverters shall be tested in accordance with BS EN 62116.

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.

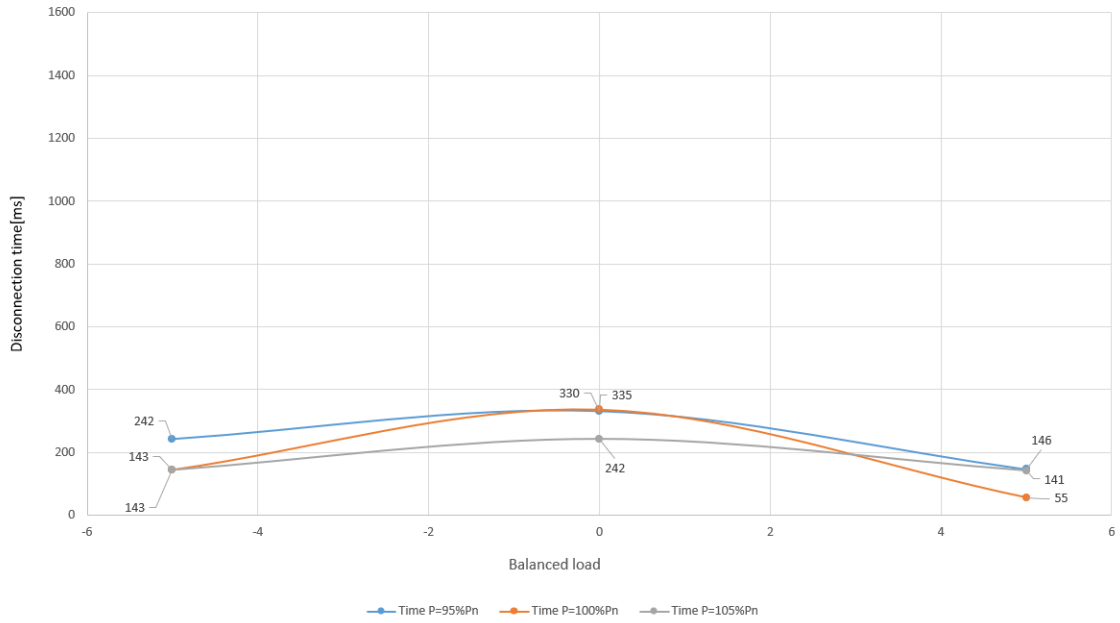
Following tables show the test results:

D

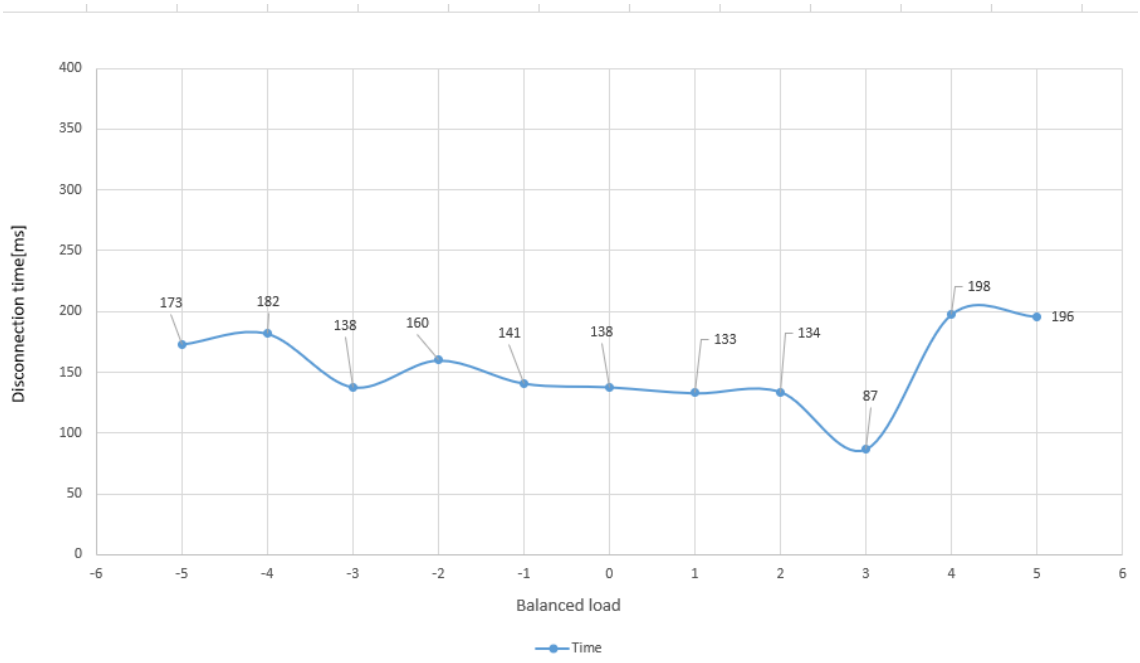
	Table: tested condition and trip time					P
No.	P_{EUT} (% of EUT rating)	Reactive load (% of normial)	P_{AC}	Q_{AC}	Trip time(ms)	Which load is selected to be adjusted (R or L)
Test condition A						
1	100	100	0	0	335	--
2	100	100	-5	-5	242	R/L
3	100	100	-5	0	330	R
4	100	100	-5	+5	146	R/L
5	100	100	0	-5	143	L
6	100	100	0	+5	55	L
7	100	100	+5	-5	143	R/L
8	100	100	+5	0	242	R
9	100	100	+5	+5	141	R/L
10	100	100	-10	+10	--	R/L
11	100	100	-5	+10	--	R/L
12	100	100	0	+10	--	L
13	100	100	+10	+10	--	R/L
14	100	100	+10	+5	--	R/L
15	100	100	+10	0	--	R
16	100	100	+10	-5	--	R/L
17	100	100	+10	-10	--	R/L
18	100	100	+5	-10	--	R/L
19	100	100	+5	+10	--	R/L
20	100	100	0	-10	--	L
21	100	100	-5	-10	--	R/L
22	100	100	-10	-10	--	R/L
23	100	100	-10	-5	--	R/L
24	100	100	-10	0	--	R
25	100	100	-10	+5	--	R/L
Test condition B						
1	66	66	0	0	138	--
2	66	66	0	-5	173	L
3	66	66	0	-4	182	L
4	66	66	0	-3	138	L
5	66	66	0	-2	160	L
6	66	66	0	-1	141	L
7	66	66	0	1	133	L
8	66	66	0	2	134	L
9	66	66	0	3	87	L
10	66	66	0	4	198	L
11	66	66	0	5	196	L
Test condition C						
1	33	33	0	0	187	--
2	33	33	0	-5	108	L
3	33	33	0	-4	202	L
4	33	33	0	-3	155	L
5	33	33	0	-2	146	L
6	33	33	0	-1	207	L
7	33	33	0	1	191	L
8	33	33	0	2	194	L
9	33	33	0	3	141	L
10	33	33	0	4	177	L
11	33	33	0	5	144	L

Test results are graphically shown in following pages.

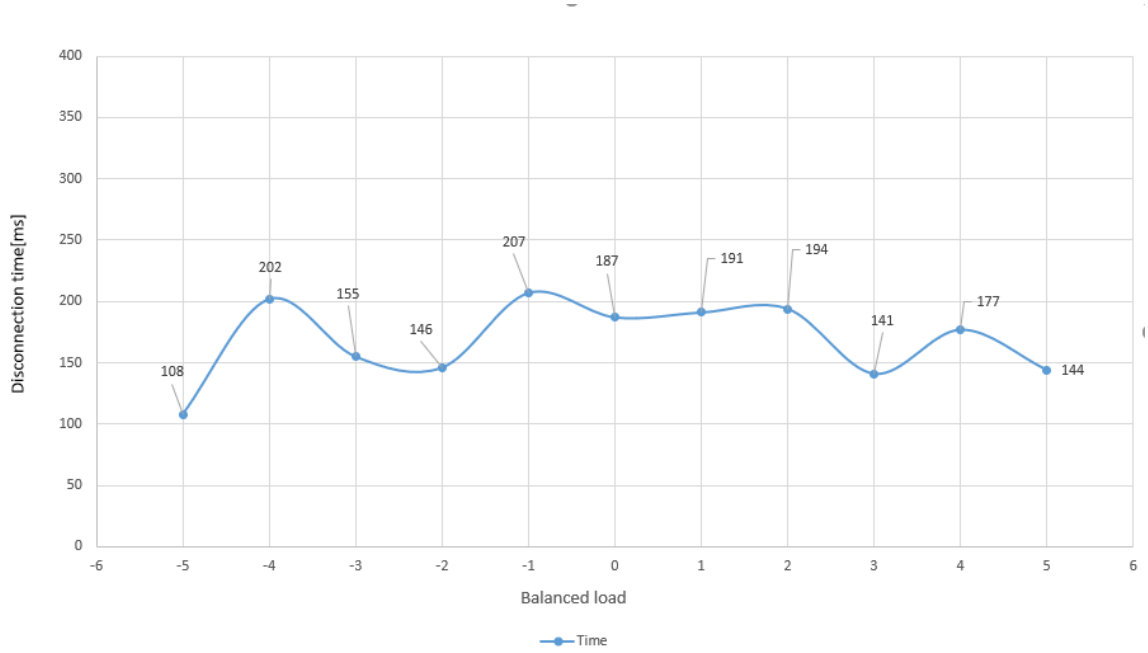
Test Condition A



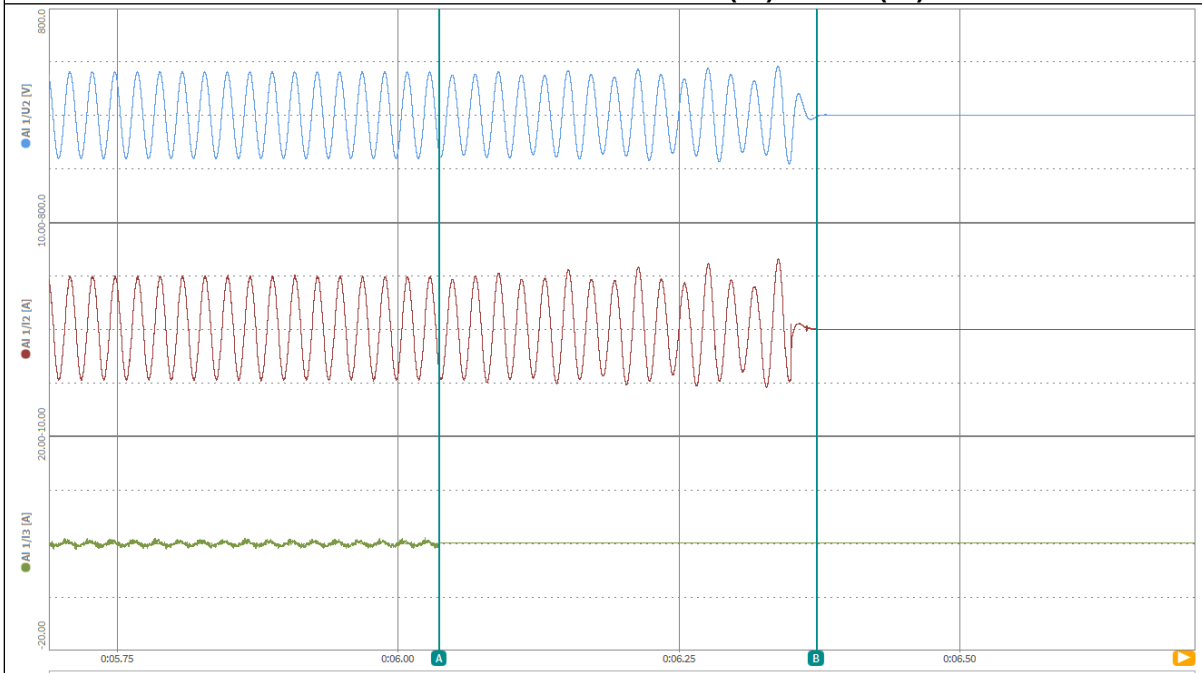
Test Condition B



Test Condition C

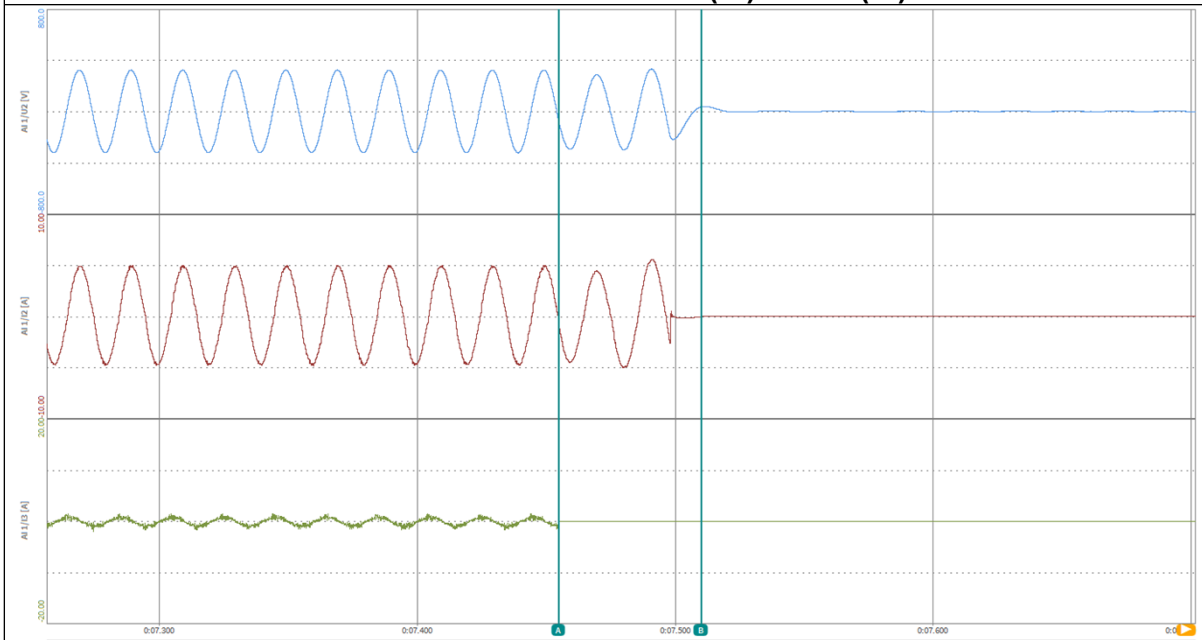


Test A **M(%)=0 & N(%)=0**



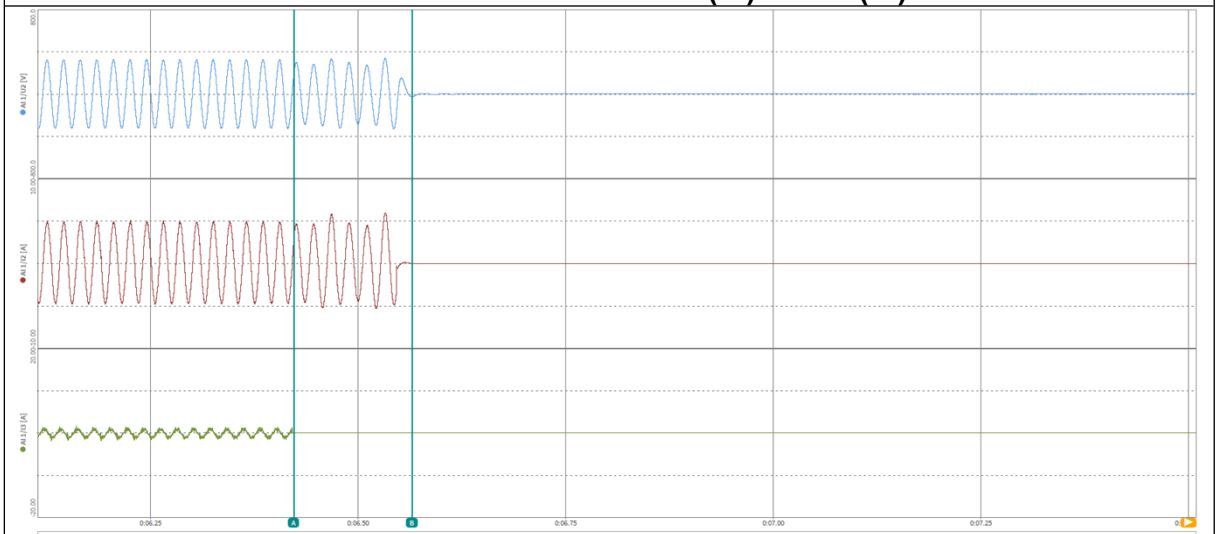
时间 [s]	A 6.0370391	B 6.3724562	间隔 0.3354170
AI 1/U2 [V]	-302.8624	-12.44879	290.4136
AI 1/I2 [A]	-4.264474	0.024319	4.288793
AI 1/I3 [A]	-0.170112	3.219e-3	0.173330

Test A **M(%)=0 & N(%)=+5**



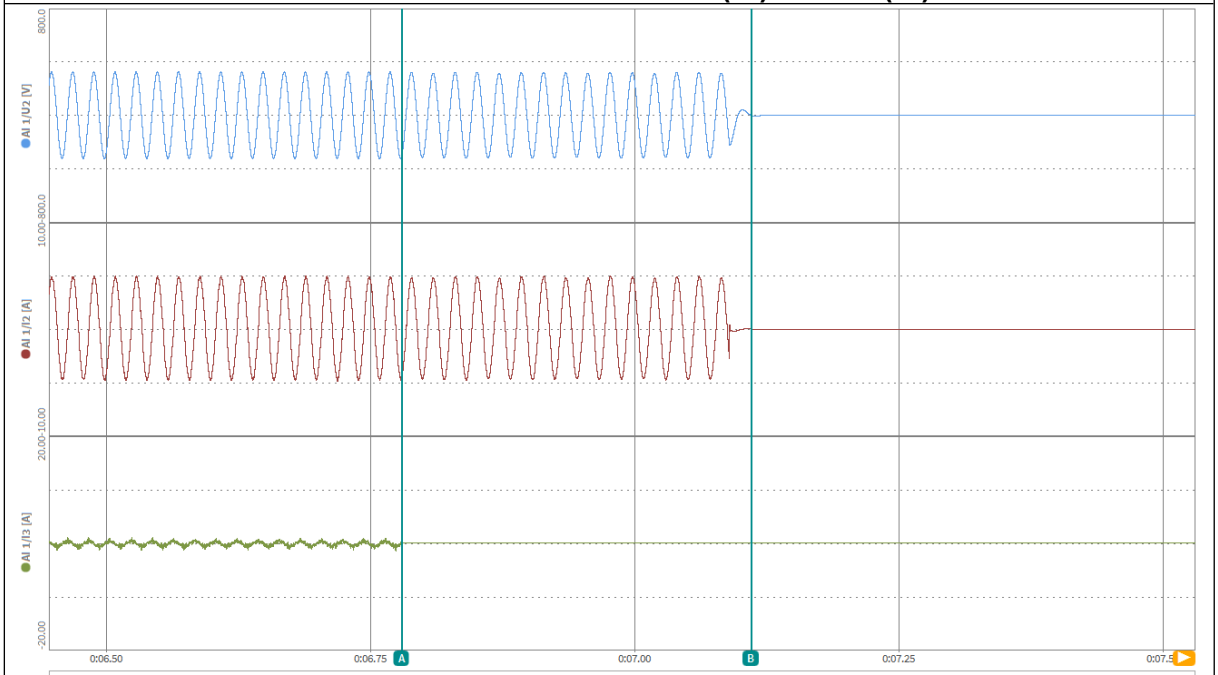
Time [s]	A 7.4549399	B 7.5101209	Delta 0.0551809
AI 1/U2 [V]	-94.08093	37.01568	131.0966
AI 1/I2 [A]	-1.065731	-0.026226	1.039505
AI 1/I3 [A]	0.079513	3.219e-3	-0.076294

Test A **M(%)=0 & N(%)=-5**



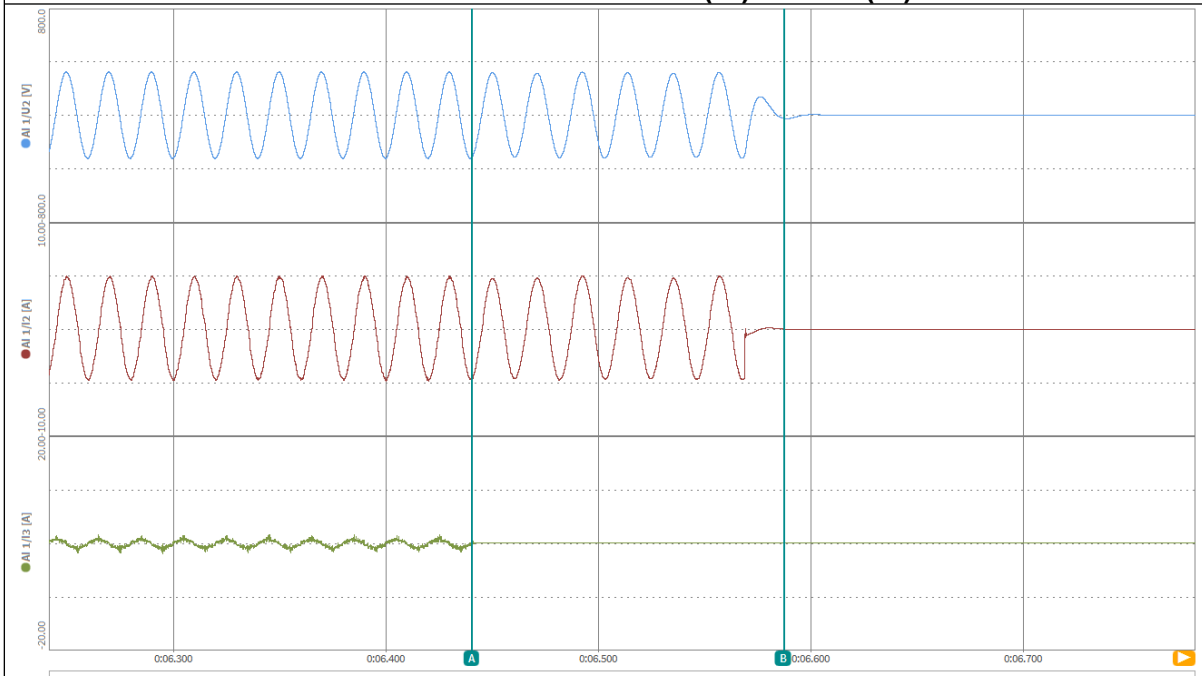
	A	B	Delta
Time [s]	6.422882	6.565417	0.142535
AI 1/U2 [V]	161.1850	-23.88764	-185.0727
AI 1/I2 [A]	2.396345	-9.179e-3	-2.405524
AI 1/I3 [A]	-6.437e-3	-1.788e-3	4.649e-3

Test A **M(%)=-5 & N(%)=0**



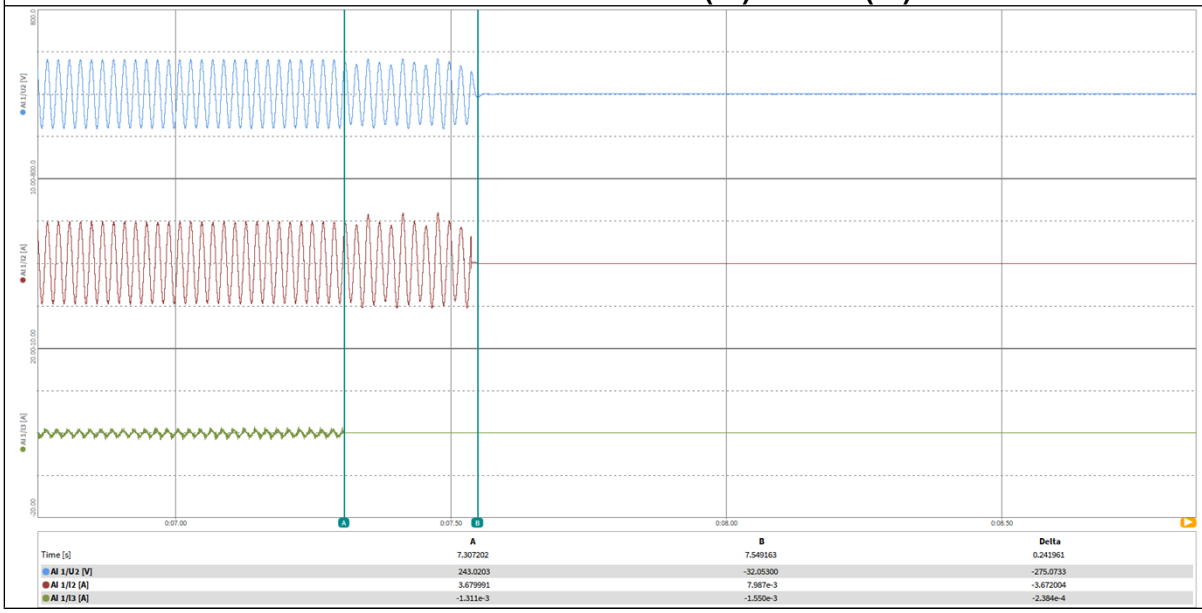
	A	B	间隔
时间 [s]	6.780032	7.110400	0.330369
AI 1/U2 [V]	-316.6685	-0.377655	316.2909
AI 1/I2 [A]	-4.684449	0.011086	4.695535
AI 1/I3 [A]	0.050187	-1.192e-3	-0.051379

Test A **M(%)=-5 & N(%)=+5**



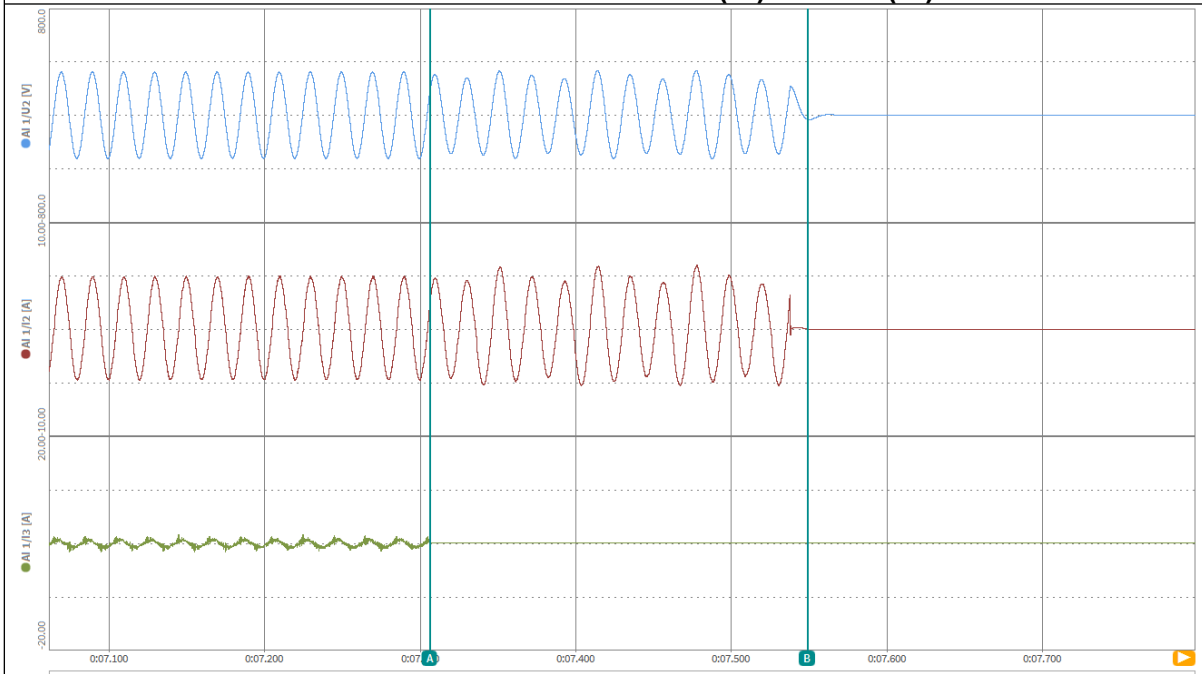
	A	B	间隔
时间 [s]	6.4405393	6.5870281	0.1464887
AI 1/U2 [V]	-319.7415	-23.64016	296.1013
AI 1/I2 [A]	-4.648328	0.010610	4.658938
AI 1/I3 [A]	0.025988	4.768e-4	-0.025511

Test A **M(%)=-5 & N(%)=-5**



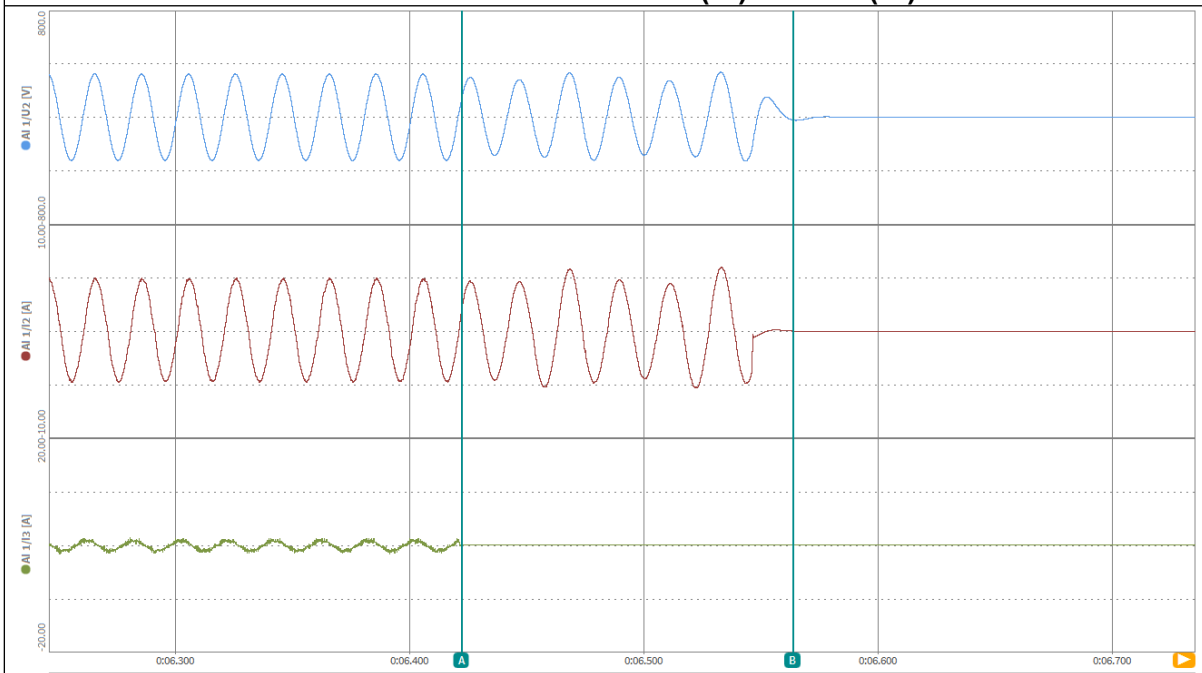
	A	B	Delta
Time [s]	7.307202	7.549163	0.241961
AI 1/U2 [V]	243.0203	-32.05300	-275.0733
AI 1/I2 [A]	3.679991	7.987e-3	-3.672004
AI 1/I3 [A]	-1.311e-3	-1.550e-3	-2.384e-4

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



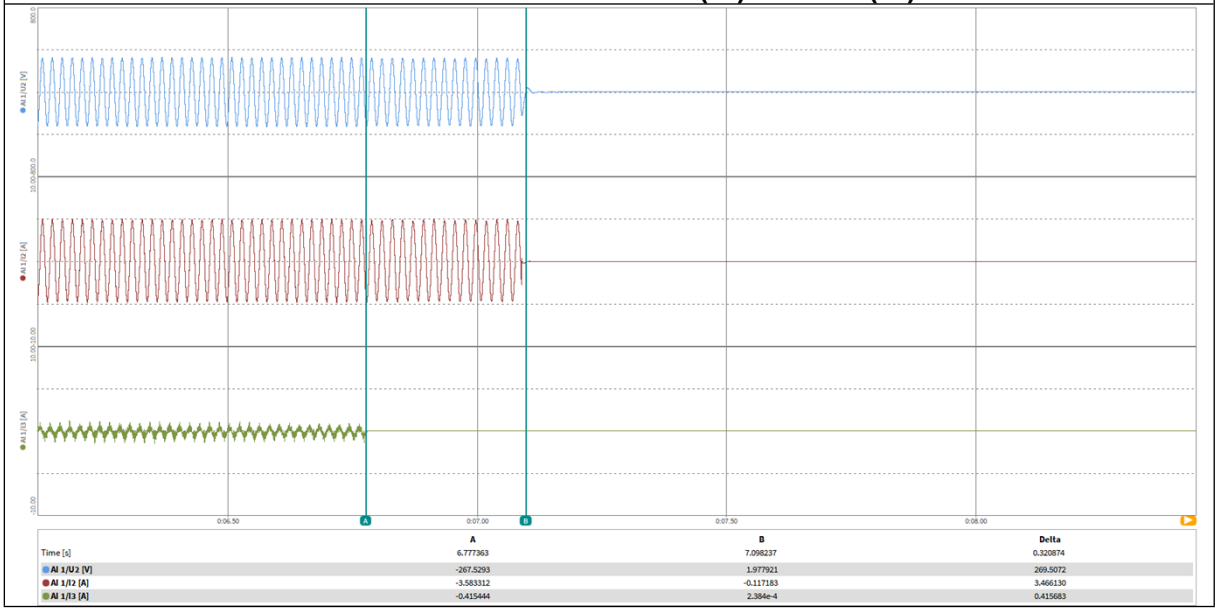
时间 [s]	A 7.3064012	B 7.5489915	间隔 0.2425903
AI 1/U2 [V]	188.9594	-31.40307	-220.3624
AI 1/I2 [A]	2.745748	0.014544	-2.731204
AI 1/I3 [A]	-7.987e-3	1.192e-4	8.106e-3

Test A M(%)=+5 & N(%)=+5



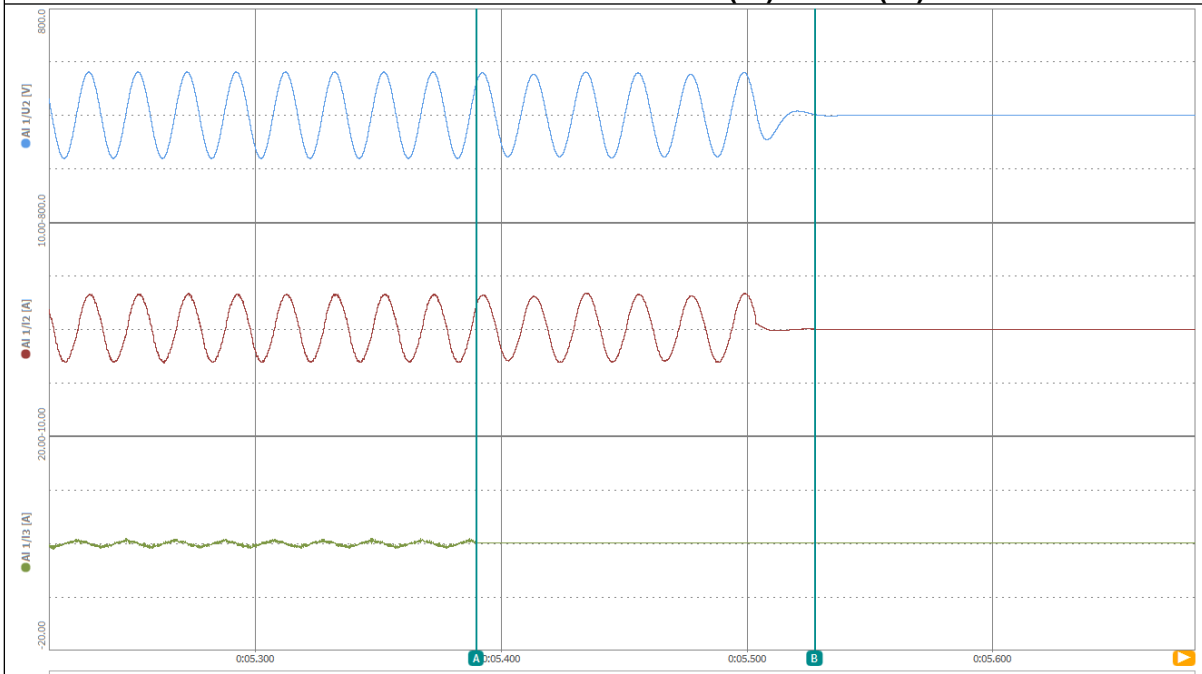
时间 [s]	A 6.4223632	B 6.5636703	间隔 0.1413071
AI 1/U2 [V]	120.4689	-21.32034	-141.7892
AI 1/I2 [A]	1.663804	0.012994	-1.650810
AI 1/I3 [A]	-0.015974	-5.007e-3	0.010967

Test A **M(%)=+5 & N(%)=-5**



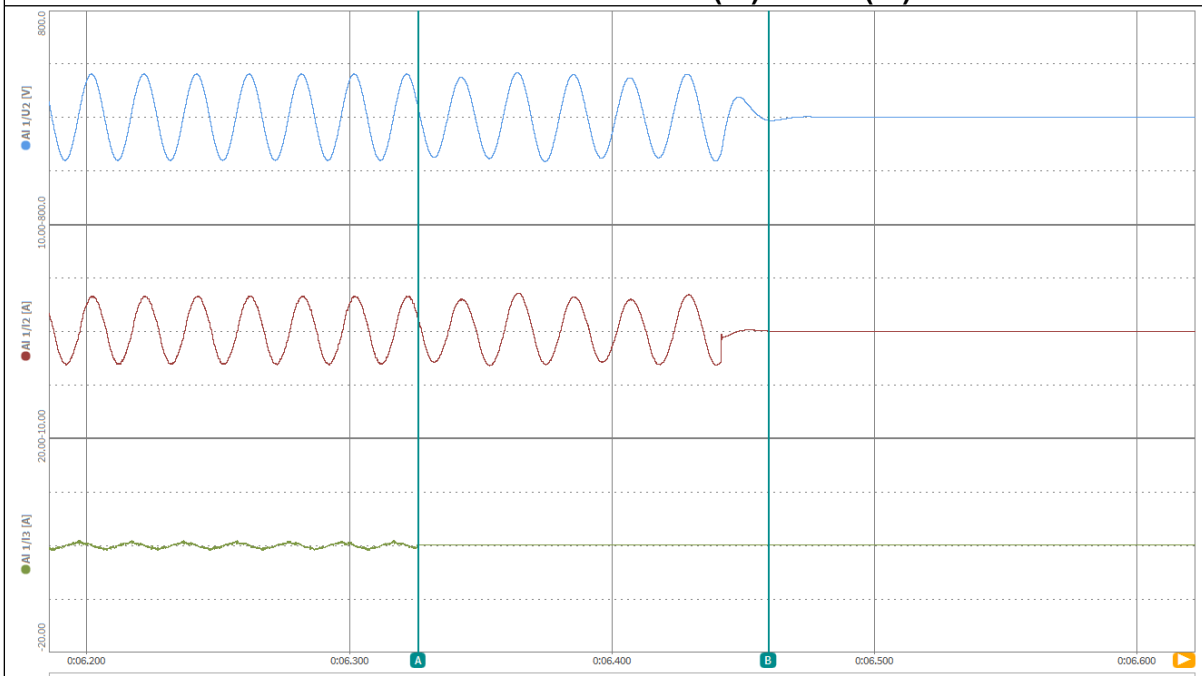
	A	B	Delta
Time [s]	6.777363	7.098237	0.320874
AI 1/U2 [V]	-267.5293	1.977921	269.5072
AI 1/I2 [A]	-3.583312	-0.117183	3.466130
AI 1/I3 [A]	-0.415444	2.384e-4	0.415683

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



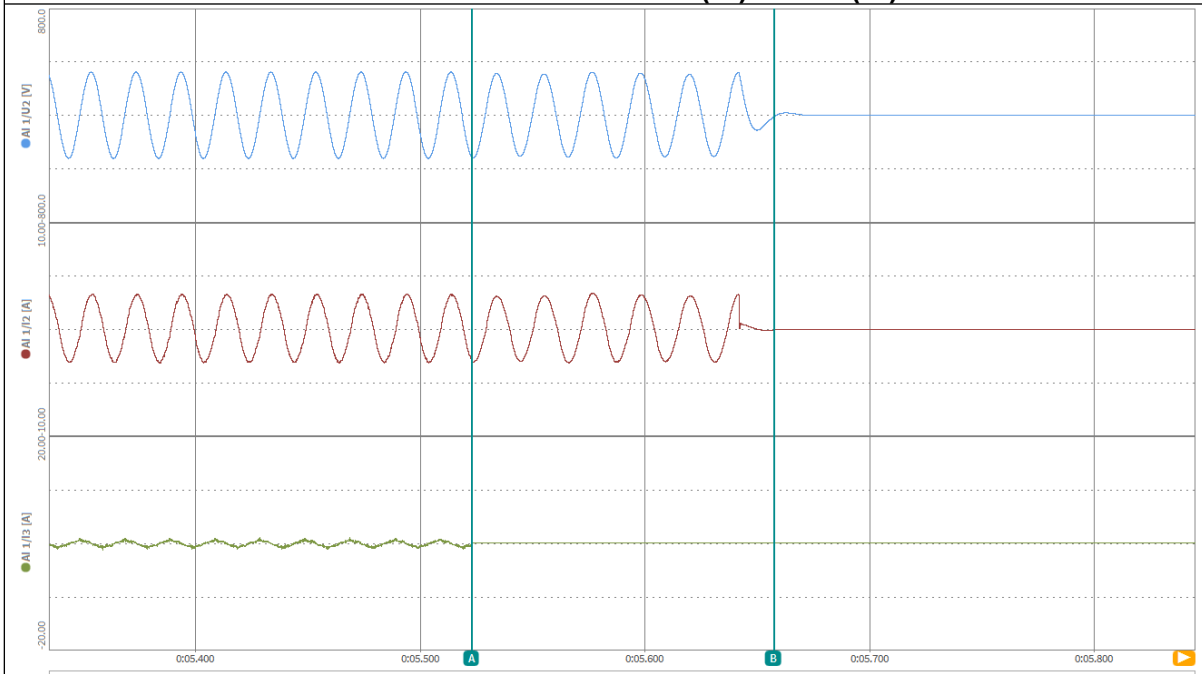
	A	B	间隔
时间 [s]	5.3900343	5.5277499	0.1377157
AI 1/U2 [V]	253.6779	4.917860	-248.7600
AI 1/I2 [A]	2.468348	0.011802	-2.456546
AI 1/I3 [A]	0.060320	-1.550e-3	-0.061870

Test B M(%)=0 & N(%)=+1



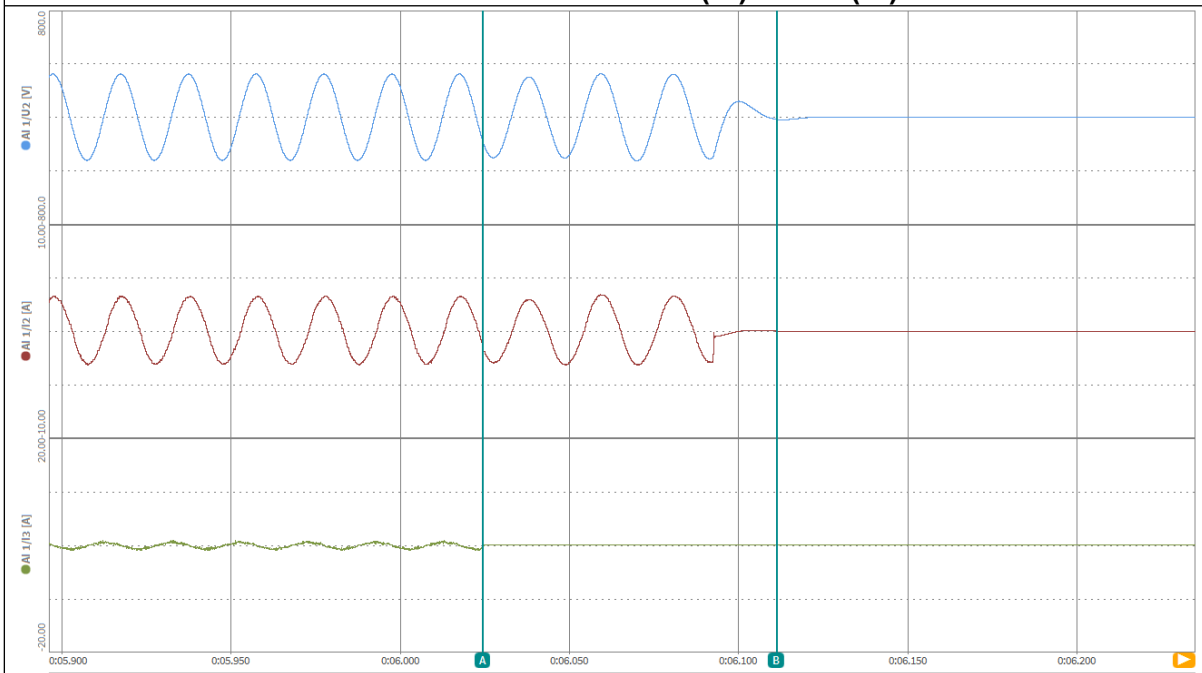
	A	B	间隔
时间 [s]	6.3264458	6.4597756	0.1333298
AI 1/U2 [V]	81.61188	-22.65763	-104.2695
AI 1/I2 [A]	1.186609	0.011325	-1.175284
AI 1/I3 [A]	-0.020146	1.073e-3	0.021219

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



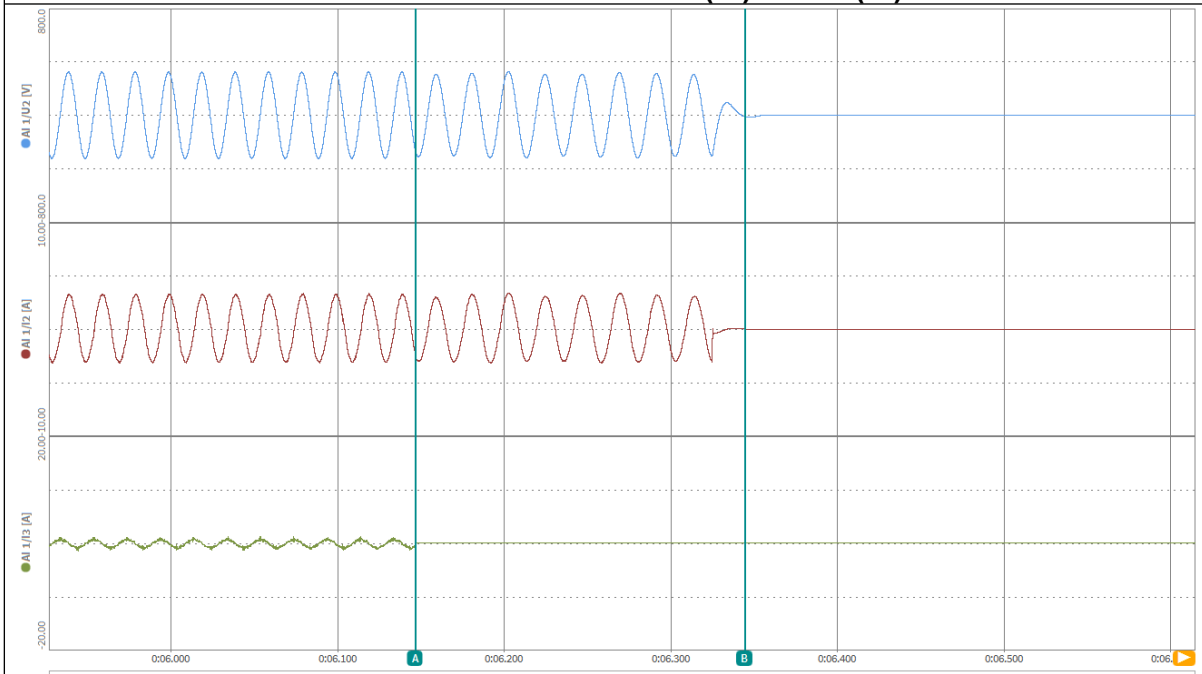
	A	B	间隔
时间 [s]	5.5229949	5.6572872	0.1342924
AI 1/U2 [V]	-316.3715	-12.06946	304.3020
AI 1/I2 [A]	-3.004670	-0.065804	2.938867
AI 1/I3 [A]	-0.018954	2.623e-3	0.021577

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



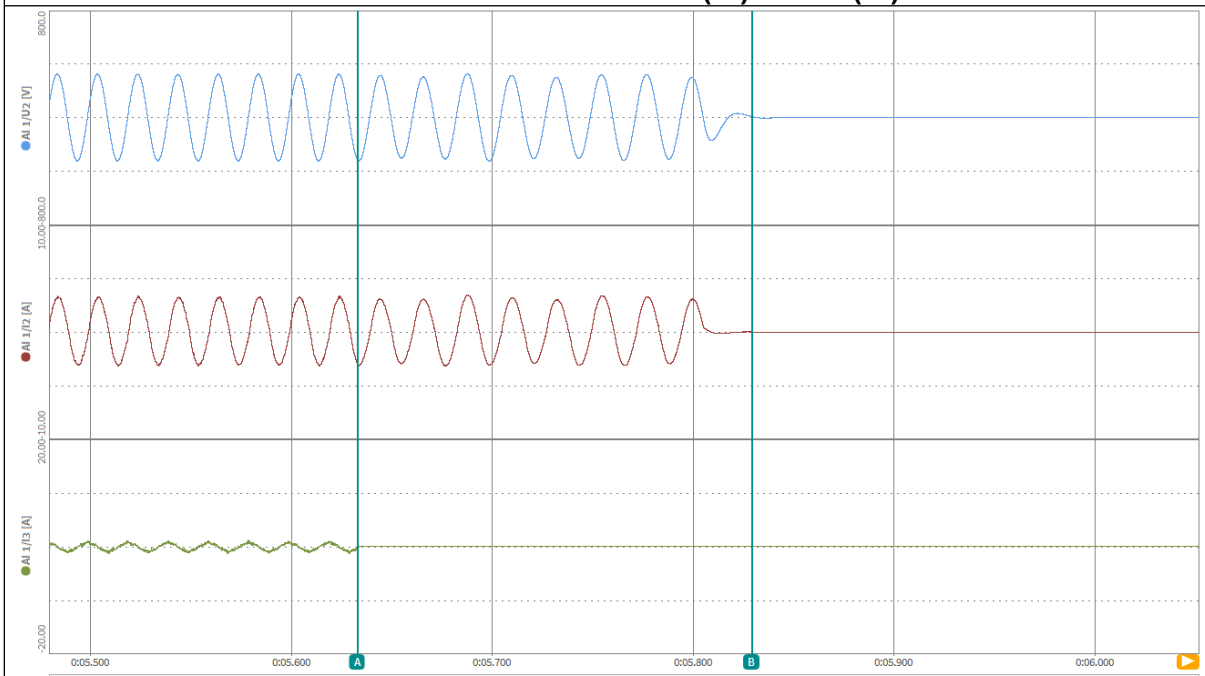
	A	B	间隔
时间 [s]	6.0245389	6.1112185	0.0866796
AI 1/U2 [V]	-191.4873	-16.39819	175.0891
AI 1/I2 [A]	-1.560092	0.010014	1.570106
AI 1/I3 [A]	0.029564	-2.384e-4	-0.029802

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



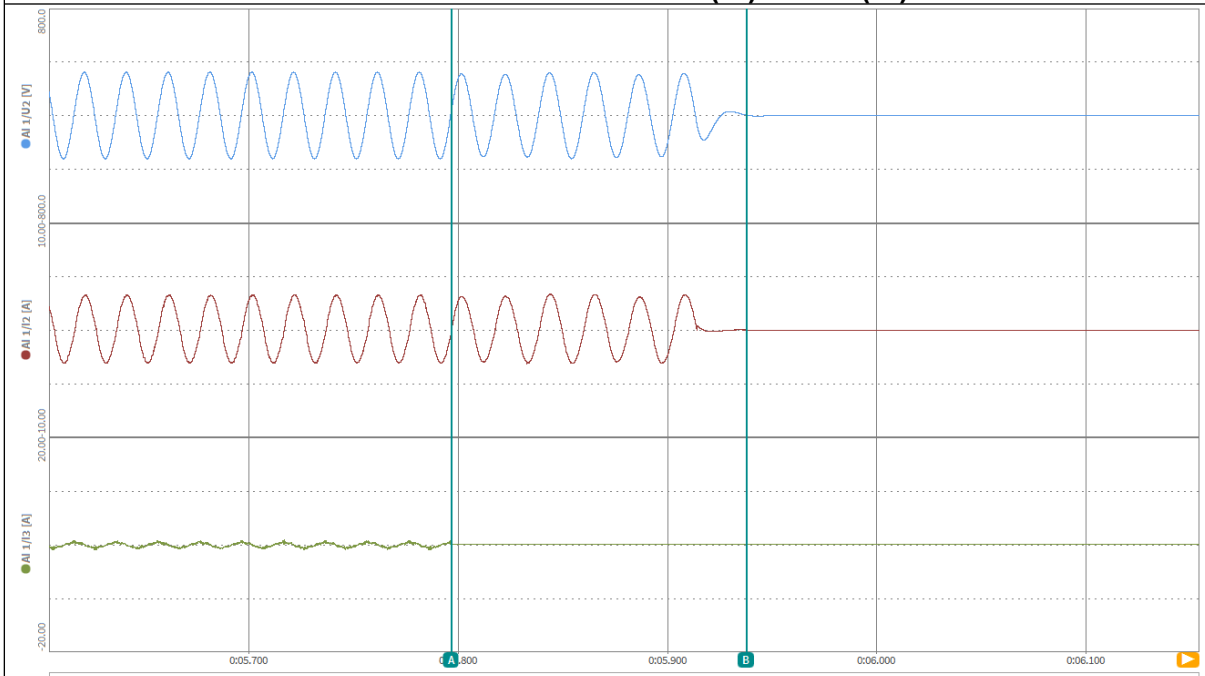
	A	B	间隔
时间 [s]	6.1467976	6.3444709	0.1976733
AI 1/U2 [V]	-263.1428	-11.15513	251.9877
AI 1/I2 [A]	-2.235174	0.012040	2.247214
AI 1/I3 [A]	-0.414729	-2.384e-3	0.412345

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



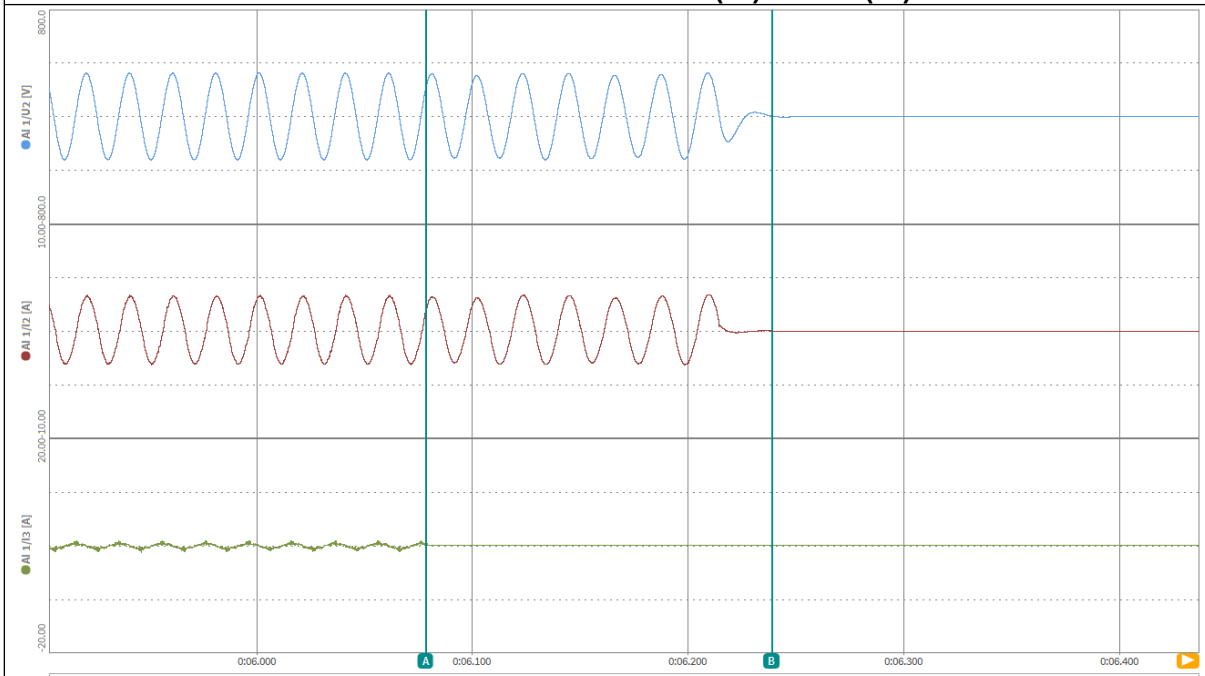
	A	B	间隔
时间 [s]	5.6331810	5.8292955	0.1961145
AI 1/U2 [V]	-314.8449	6.251574	321.0964
AI 1/I2 [A]	-2.807856	0.016332	2.824187
AI 1/I3 [A]	-0.503182	-5.960e-4	0.502586

Test B **M(%)=0 & N(%)=-1**



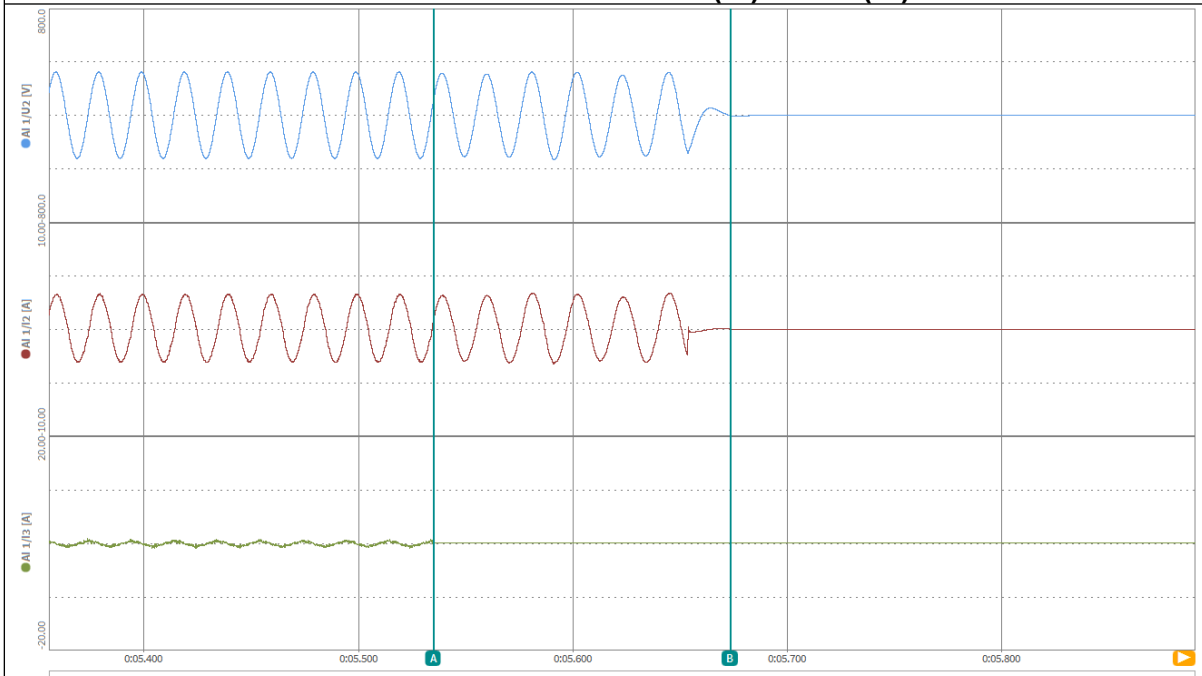
	A	B	间隔
时间 [s]	5.7967470	5.9377208	0.1409738
AI 1/U2 [V]	40.62343	2.462864	-38.16056
AI 1/I2 [A]	-0.079274	0.010133	0.089407
AI 1/I3 [A]	-0.032306	0.000000	0.032306

Test B **M(%)=0 & N(%)=-2**



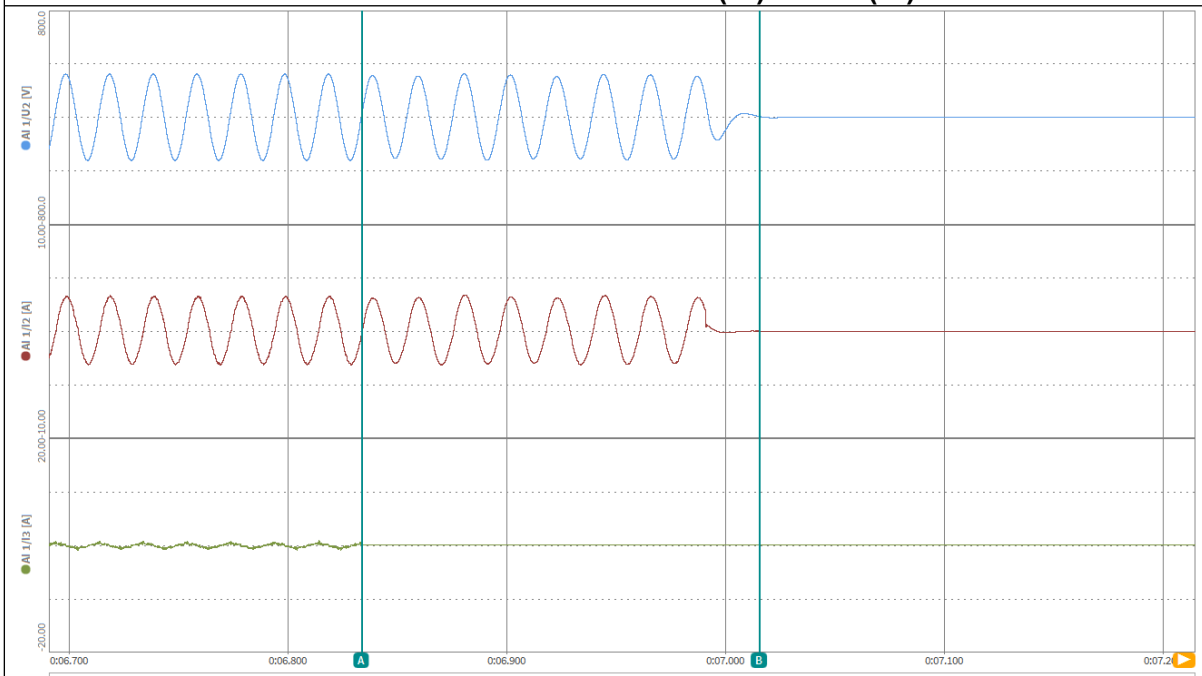
	A	B	间隔
时间 [s]	6.0786093	6.2388888	0.1602795
AI 1/U2 [V]	228.6782	2.429724	-226.2485
AI 1/I2 [A]	2.094031	8.345e-3	-2.085686
AI 1/I3 [A]	0.152469	-2.980e-3	-0.155449

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



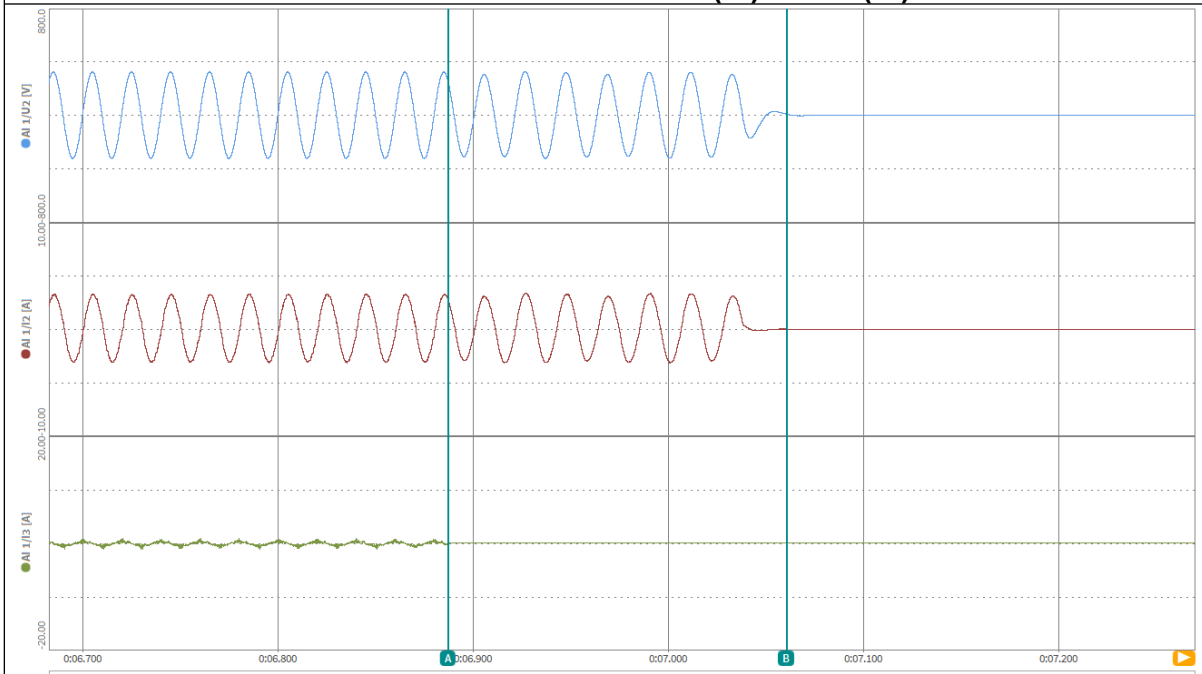
	A	B	间隔
时间 [s]	5.5352222	5.6736449	0.1384227
AI 1/U2 [V]	102.2201	-1.165390	-103.3855
AI 1/I2 [A]	0.697255	0.017762	-0.679493
AI 1/I3 [A]	-0.026703	1.669e-3	0.028372

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



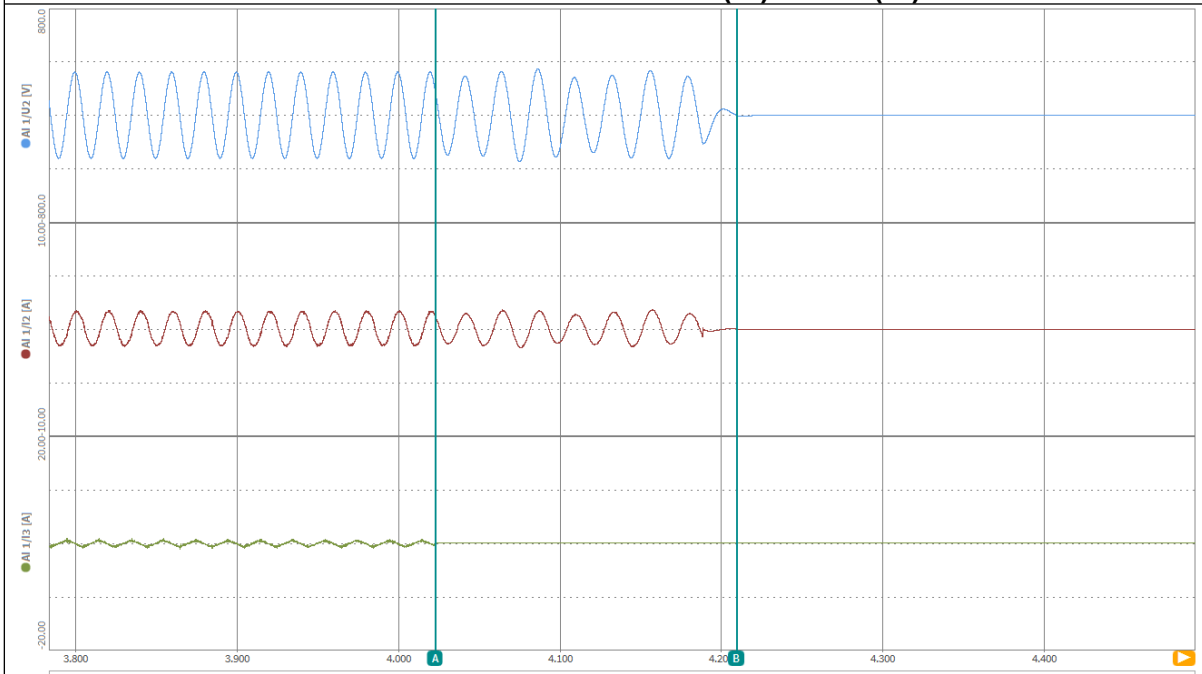
	A	B	间隔
时间 [s]	6.8338007	7.0154438	0.1816431
AI 1/U2 [V]	24.07503	5.298615	-18.77642
AI 1/I2 [A]	-0.128388	0.011444	0.139833
AI 1/I3 [A]	0.033617	3.576e-3	-0.030041

Test B **M(%)=0 & N(%)=-5**



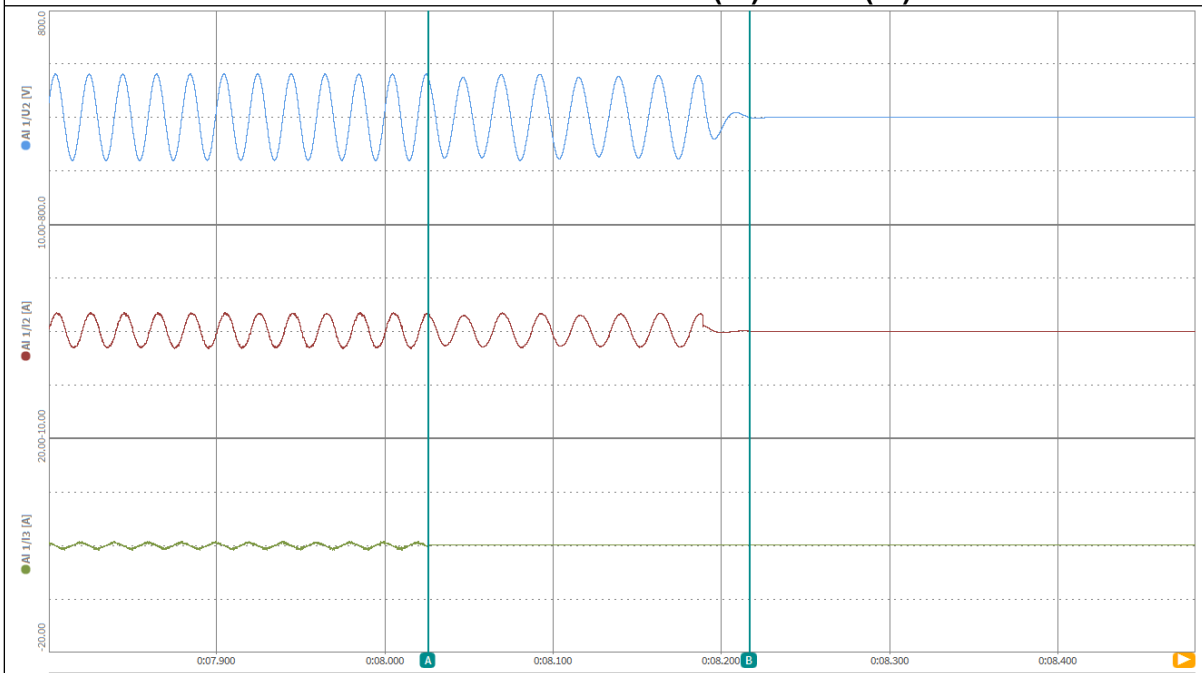
	A	B	间隔
时间 [s]	6.8874513	7.0607427	0.1732914
AI 1/U2 [V]	236.9819	7.139683	-229.8422
AI 1/I2 [A]	2.603293	0.013947	-2.589345
AI 1/I3 [A]	5.960e-4	2.027e-3	1.431e-3

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



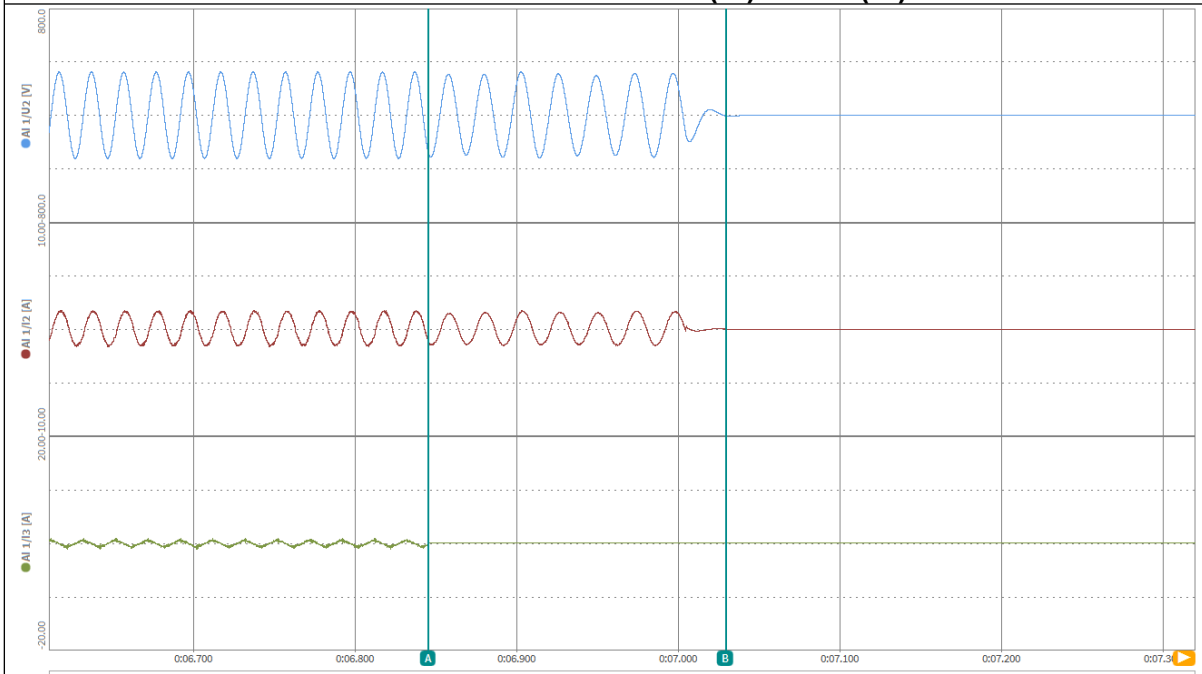
	A	B	间隔
时间 [s]	4.0230097	4.2096801	0.1866704
AI 1/U2 [V]	171.7870	-0.650168	-172.4372
AI 1/I2 [A]	1.089811	0.021338	-1.068473
AI 1/I3 [A]	0.025630	2.027e-3	-0.023603

Test C M(%)=0 & N(%)=+1



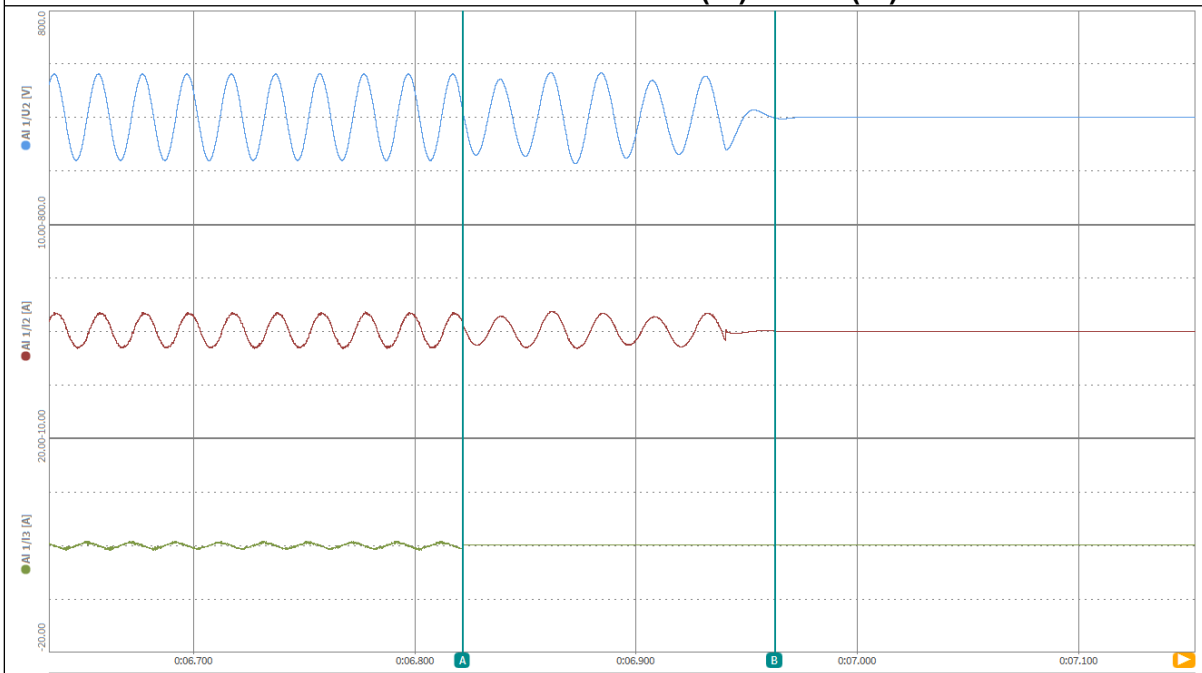
	A	B	间隔
时间 [s]	8.0259535	8.2166765	0.1907230
AI 1/U2 [V]	309.3753	0.366211	-309.0091
AI 1/I2 [A]	1.697183	0.010133	-1.687050
AI 1/I3 [A]	-0.228286	-4.292e-3	0.223994

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



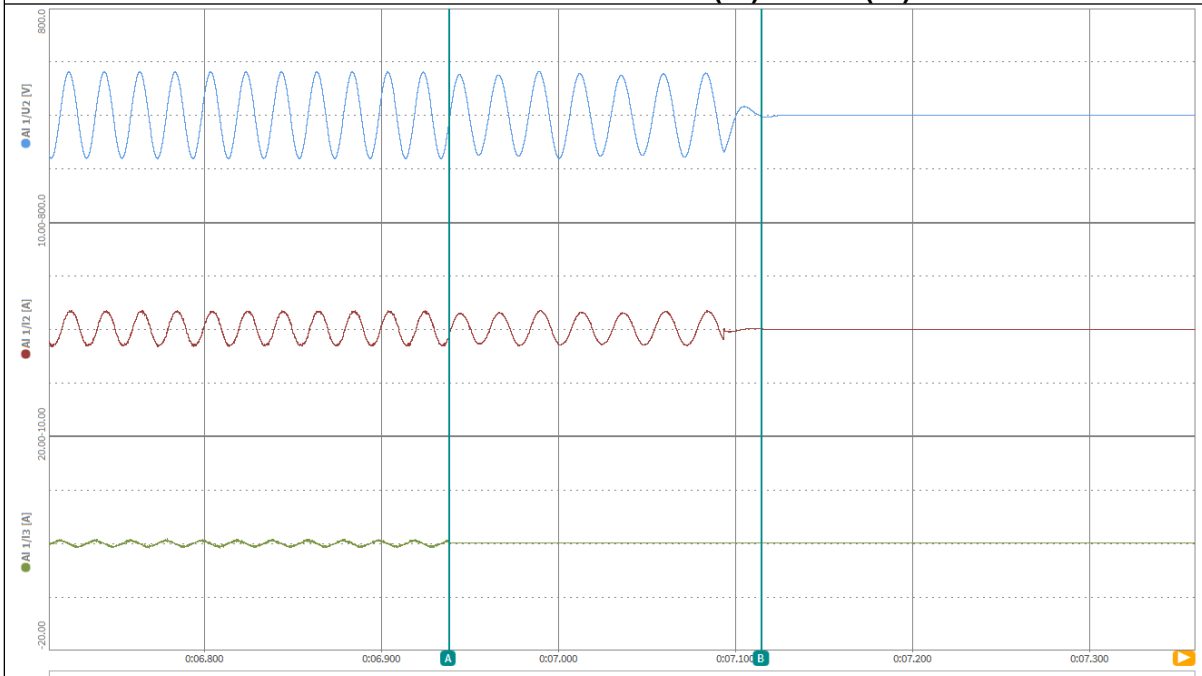
	A	B	间隔
时间 [s]	6.8454974	7.0293291	0.1838317
AI 1/U2 [V]	-269.5334	-4.729986	264.8034
AI 1/I2 [A]	-0.938416	0.010252	0.948668
AI 1/I3 [A]	-0.391841	-4.888e-3	0.386953

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



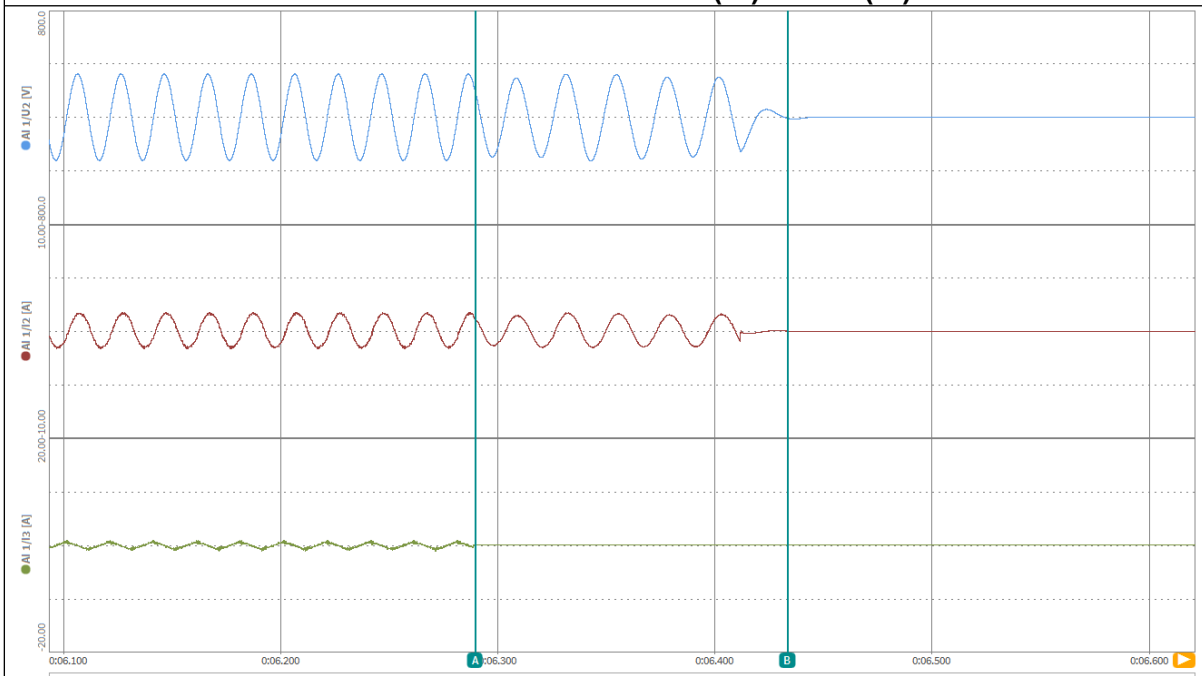
	A	B	间隔
时间 [s]	6.8217948	6.9628239	0.1410291
AI 1/U2 [V]	69.49449	-5.477429	-74.97192
AI 1/I2 [A]	0.985384	0.018477	-0.966907
AI 1/I3 [A]	-0.743628	3.099e-3	0.746727

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



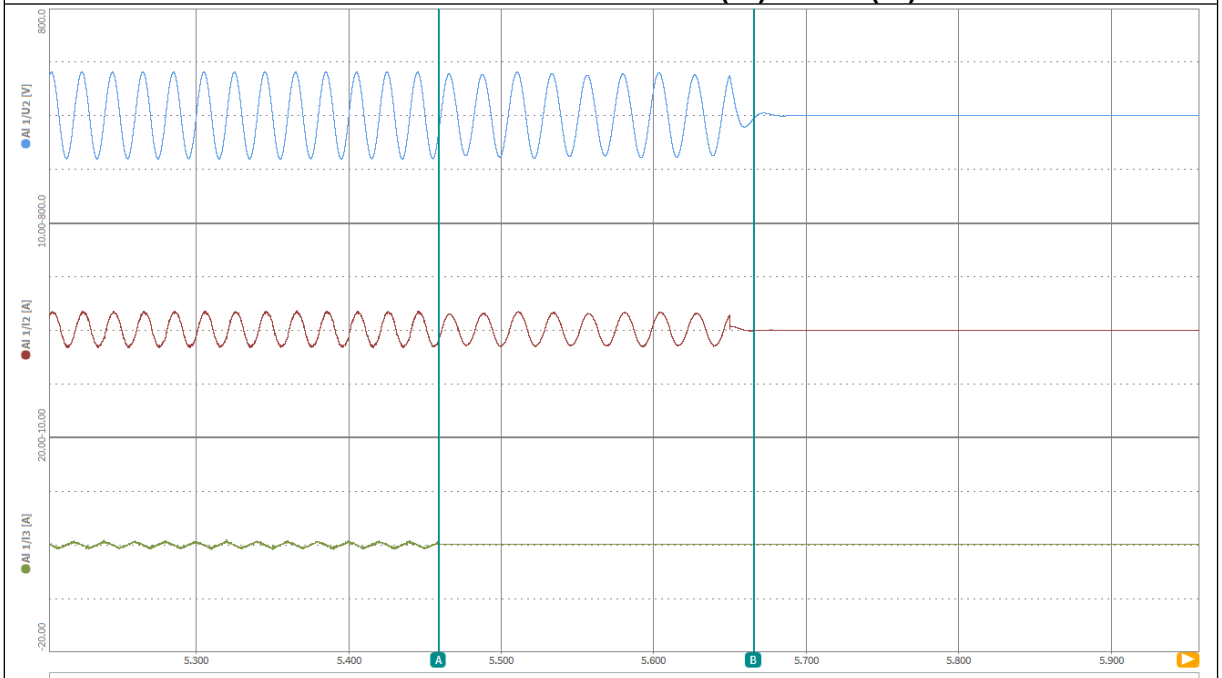
	A	B	间隔
时间 [s]	6.9382643	7.1149422	0.1766779
AI 1/U2 [V]	-105.6156	-7.361412	98.25421
AI 1/I2 [A]	-0.927806	0.022531	0.950337
AI 1/I3 [A]	0.430703	2.980e-3	-0.427723

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



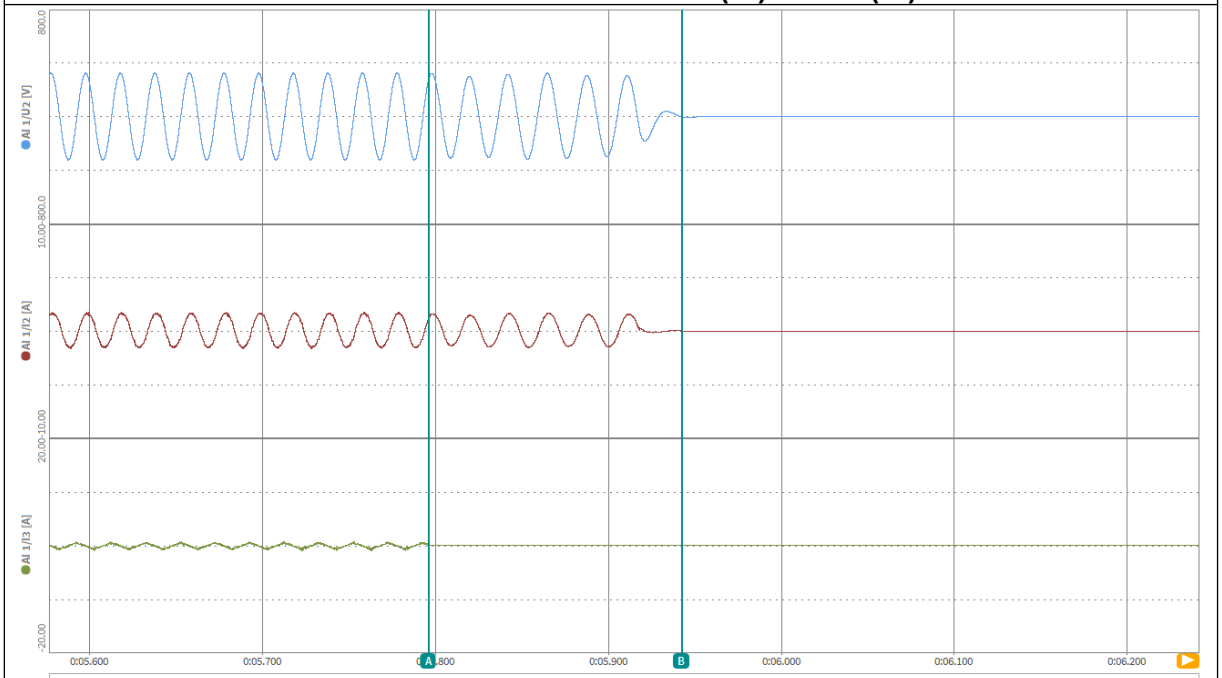
	A	B	间隔
时间 [s]	6.2896890	6.4336114	0.1439224
AI 1/U2 [V]	191.3600	-8.303643	-199.6637
AI 1/I2 [A]	1.202345	0.012040	-1.190305
AI 1/I3 [A]	2.742e-3	-4.768e-4	-3.219e-3

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



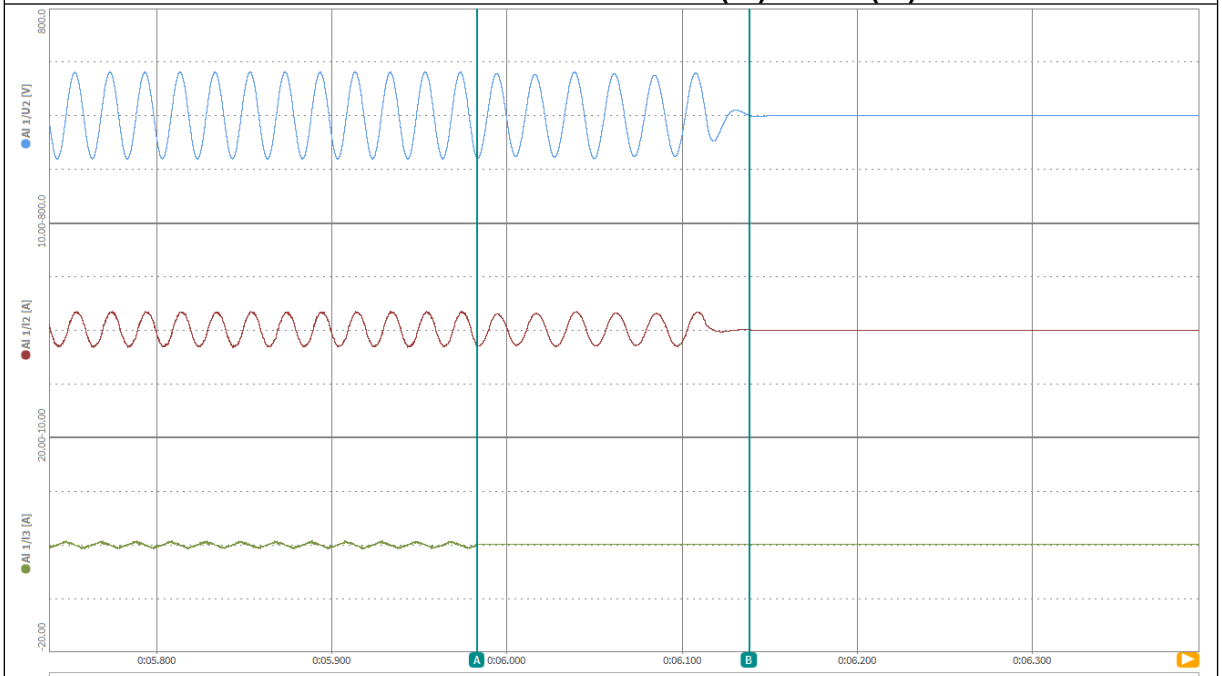
	A	B	间隔
时间 [s]	5.4591995	5.6657202	0.2065206
AI 1/U2 [V]	-154.5739	-26.04485	128.5291
AI 1/I2 [A]	-0.956535	-0.071764	0.884771
AI 1/I3 [A]	-0.125051	-2.980e-3	0.122070

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



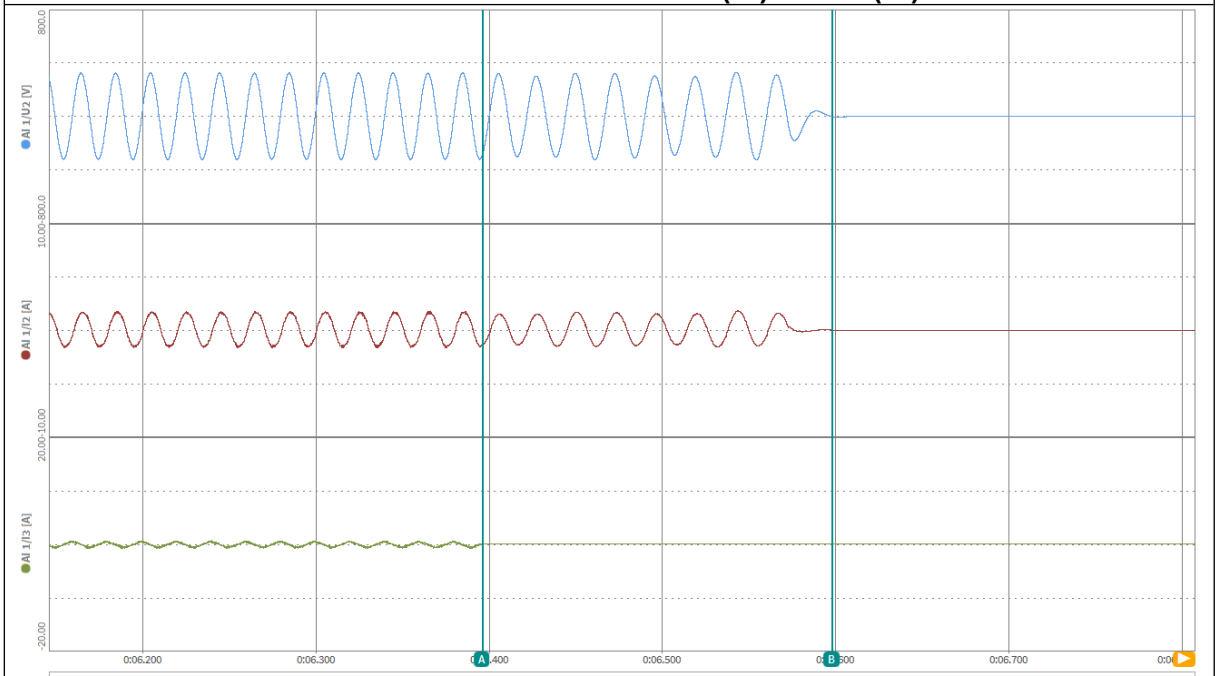
	A	B	间隔
时间 [s]	5.7961015	5.9424647	0.1463632
AI 1/U2 [V]	259.5251	-1.532316	-261.0574
AI 1/I2 [A]	1.065493	0.015259	-1.050234
AI 1/I3 [A]	0.227213	-2.742e-3	-0.229955

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



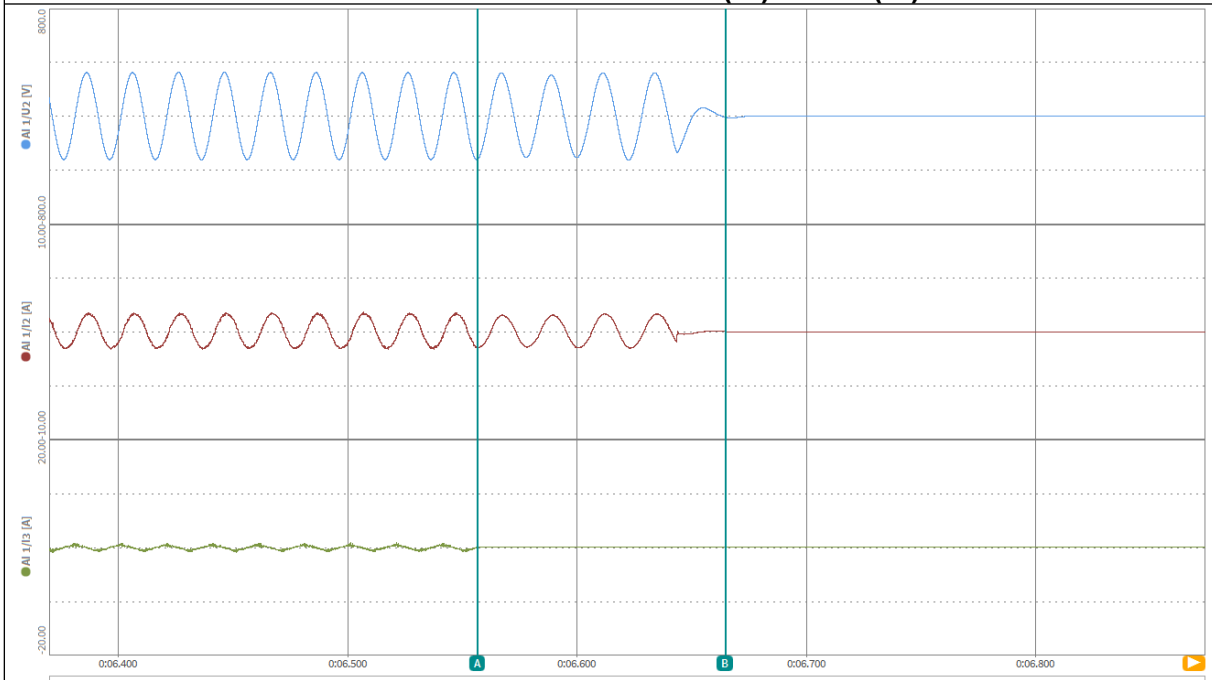
	A	B	间隔
时间 [s]	5.9832548	6.1386069	0.1553521
AI 1/U2 [V]	-319.1395	-0.214577	318.9249
AI 1/I2 [A]	-1.408339	0.015974	1.424313
AI 1/I3 [A]	4.292e-3	1.311e-3	-2.980e-3

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



	A	B	间隔
时间 [s]	6.3961609	6.5979078	0.2017469
AI 1/U2 [V]	-307.1878	-3.099680	304.0881
AI 1/I2 [A]	-1.506209	0.011086	1.517296
AI 1/I3 [A]	-7.153e-4	1.311e-3	2.027e-3

Test C **M(%)=0 & N(%)=-5**



	A	B	间隔
时间 [s]	6.5567959	6.6647329	0.1079370
AI 1/U2 [V]	-323.7572	-8.414746	315.3424
AI 1/I2 [A]	-1.475930	0.015020	1.490951
AI 1/I3 [A]	-0.032187	-2.623e-3	0.029564

4.3.4 Frequency change, Vector Shift Stability test and RoCoF Stability test

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 Micro-generator 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 Micro-generator should not trip during this test.

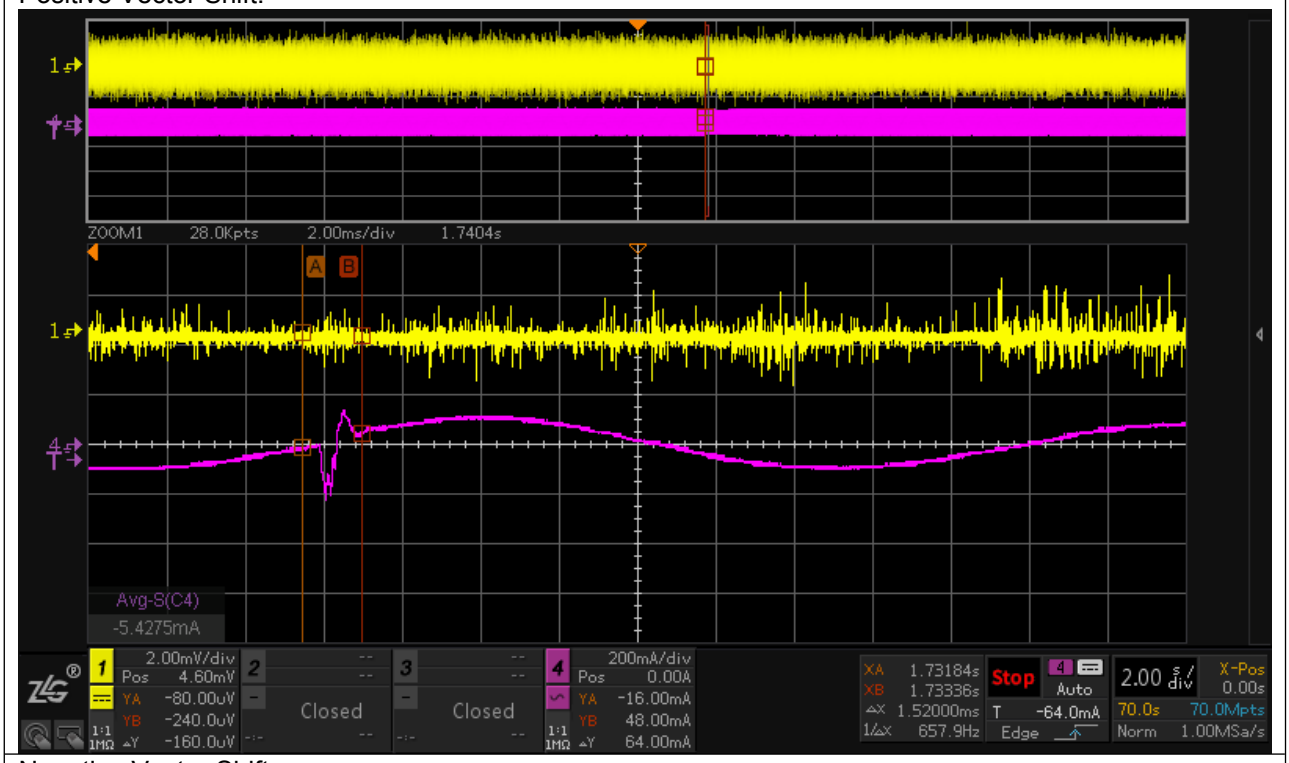
For frequency drift tests the Micro-generator should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0.95 Hzs-1 to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10 s. The Micro-generator should not trip during this test.

Test results are graphically shown in following pages.

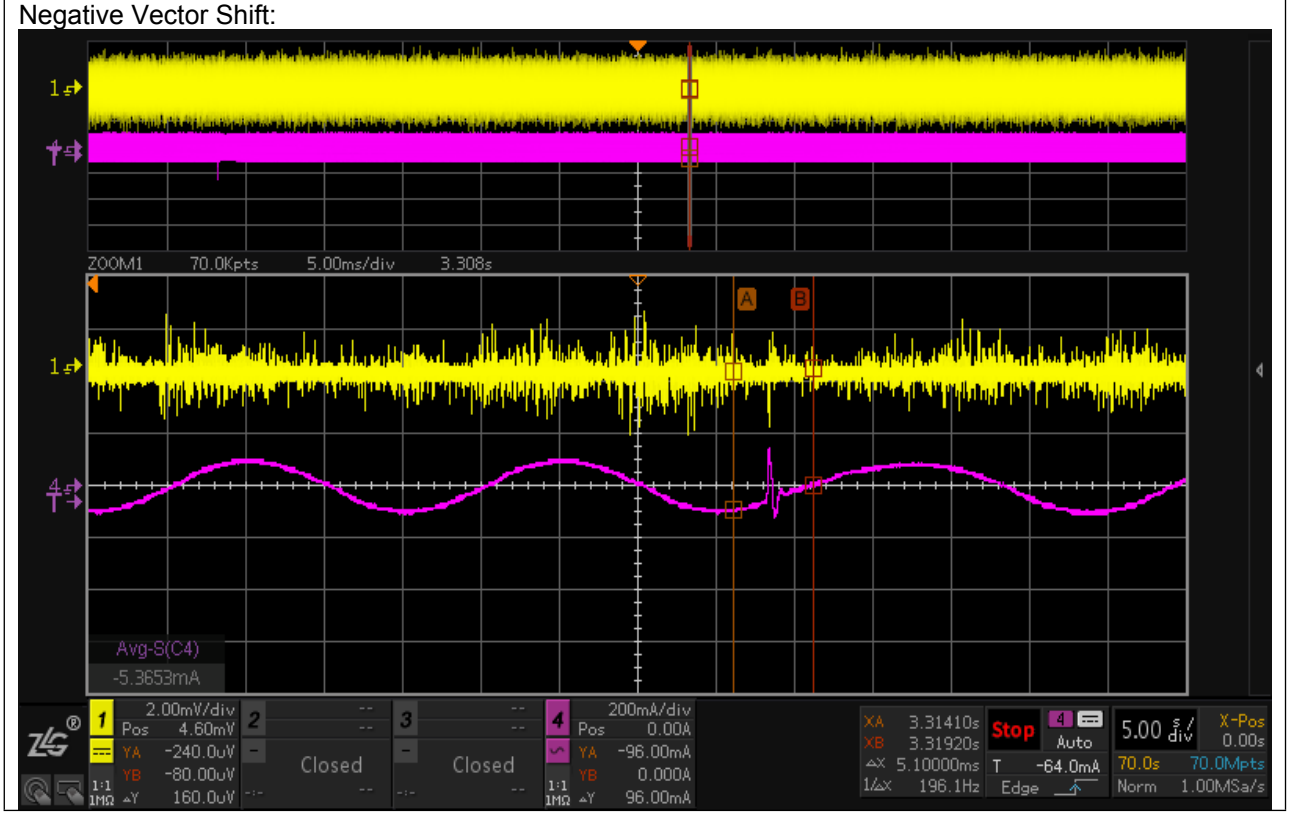
Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous).

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.0 Hz	+50 degrees	Pass
Negative Vector Shift	50.0 Hz	- 50 degrees	Pass

Positive Vector Shift:



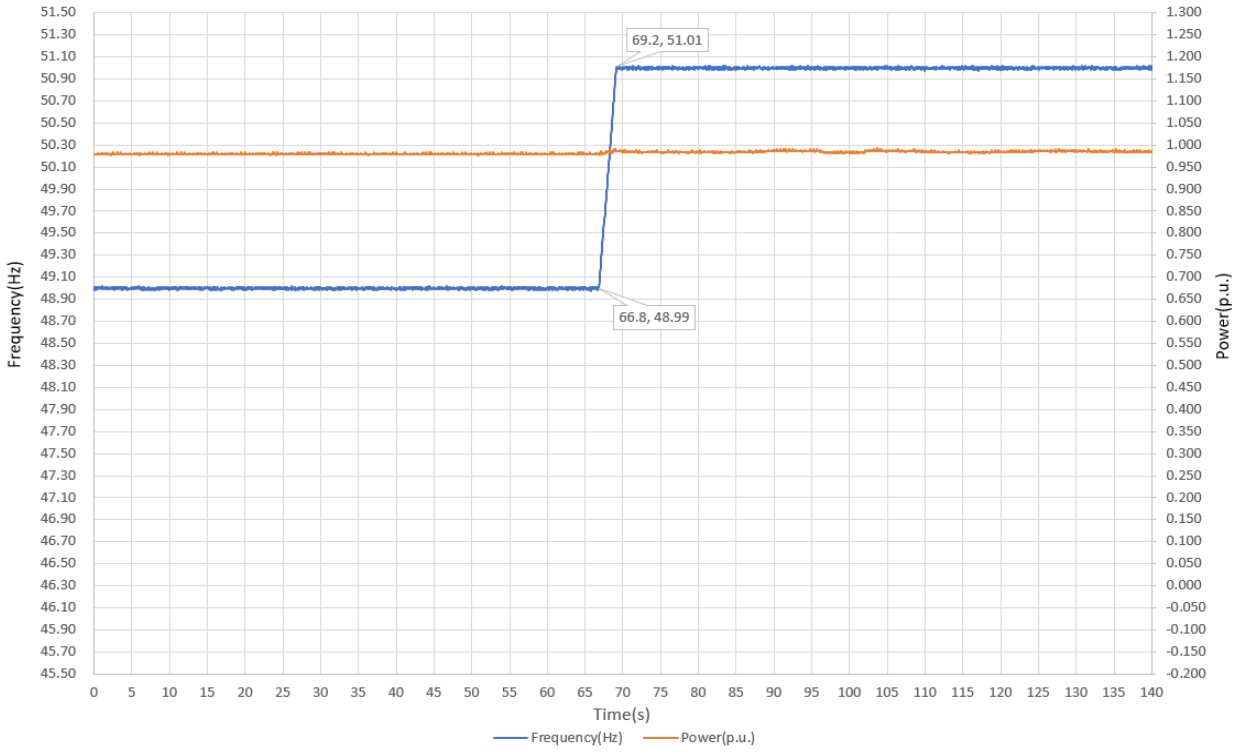
Negative Vector Shift:



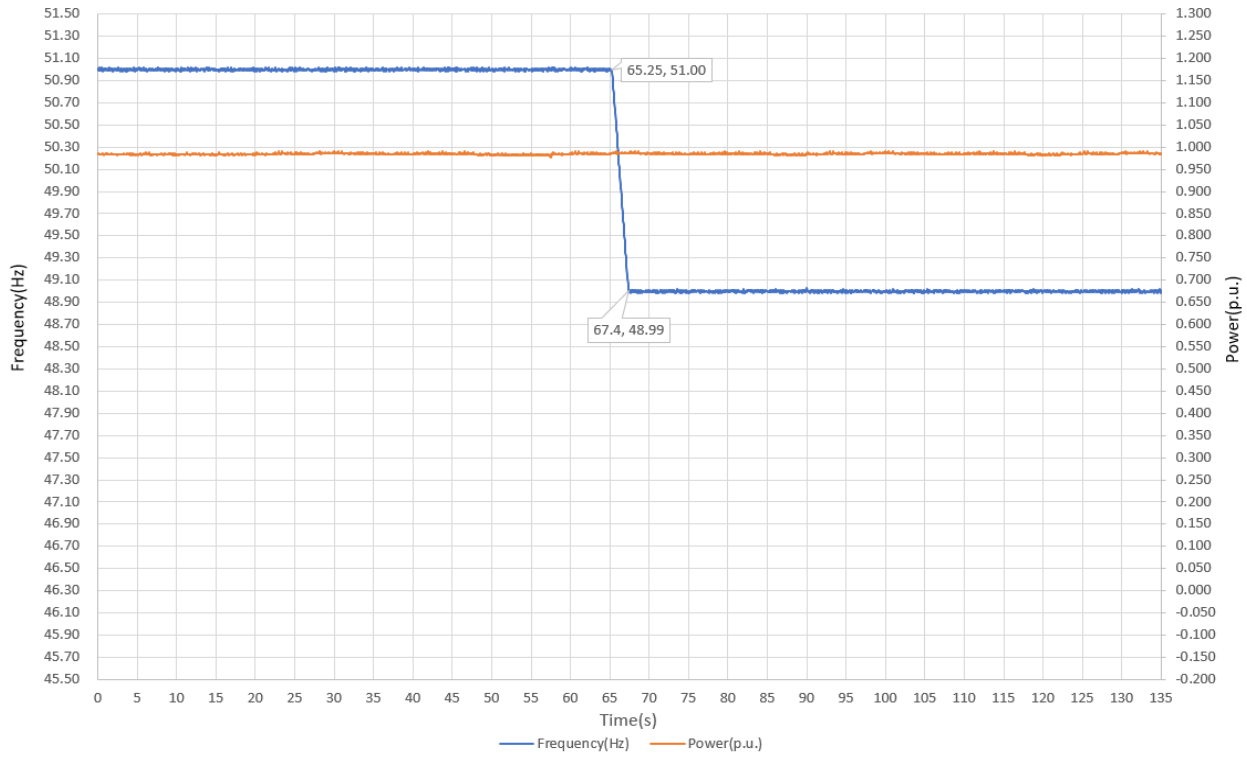
Protection – Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous).

Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.40 s	Pass
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.15 s	Pass

+0.95 Hz/s:



-0.95 Hz/s:



4.4 Limited Frequency Sensitive Mode - Overfrequency test

The test serves to verify the active power reduction of the micro-generator at over-frequency. We perform the test according to EN 50438 Annex D.3.3 Power response to over-frequency.

The tests for providing evidence of the frequency dependent active power feed-in of the micro-generator shall be carried out on a network simulator.

The test should be carried out using the specific threshold frequency of 50.4 Hz and Droop of 10%.

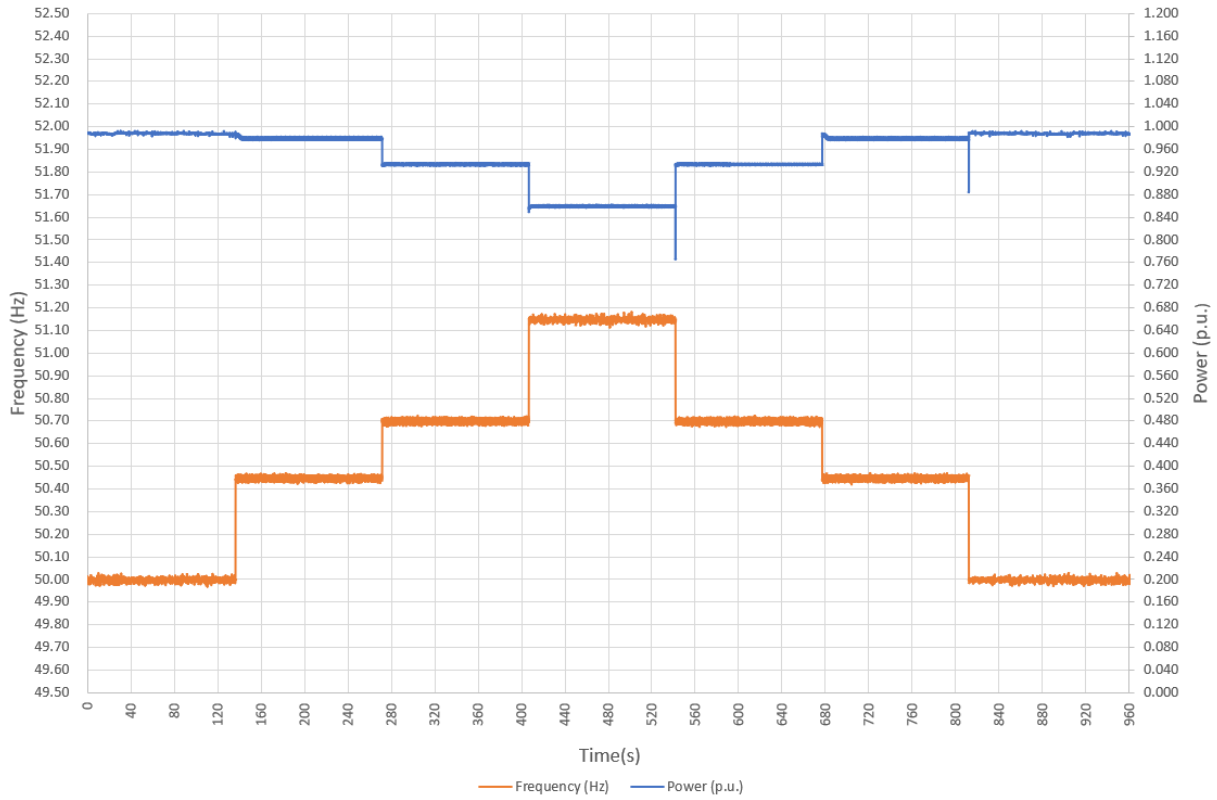
Following tables show the test results:

Test sequence at Registered Capacity >80%	Measured Active Power Output (W)	Frequency (Hz)	Primary Power Source	Active Power Gradient(%)
Step a) 50.00 Hz ±0.01 Hz	790.32	50.00	DC Source	N/A
Step b) 50.45 Hz ±0.05 Hz	782.83	50.45		10.7
Step c) 50.70 Hz ±0.10 Hz	746.38	50.70		10.9
Step d) 51.15 Hz ±0.05 Hz	687.74	51.15		11.7
Step e) 50.70 Hz ±0.10 Hz	746.50	50.70		11.0
Step f) 50.45 Hz ±0.05 Hz	782.60	50.45		10.4
Step g) 50.00 Hz ±0.01 Hz	790.34	50.00		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 ±0.01 Hz	400.24	50.00	DC Source	N/A
Step b) 50.45 Hz ±0.05 Hz	392.73	50.45		10.7
Step c) 50.70 Hz ±0.10 Hz	349.43	50.70		9.4
Step d) 51.15 Hz ±0.05 Hz	270.44	51.15		9.2
Step e) 50.70 Hz ±0.10 Hz	349.47	50.70		9.5
Step f) 50.45 Hz ±0.05 Hz	392.71	50.45		10.6
Step g) 50.00 Hz ±0.01 Hz	400.17	50.00		N/A

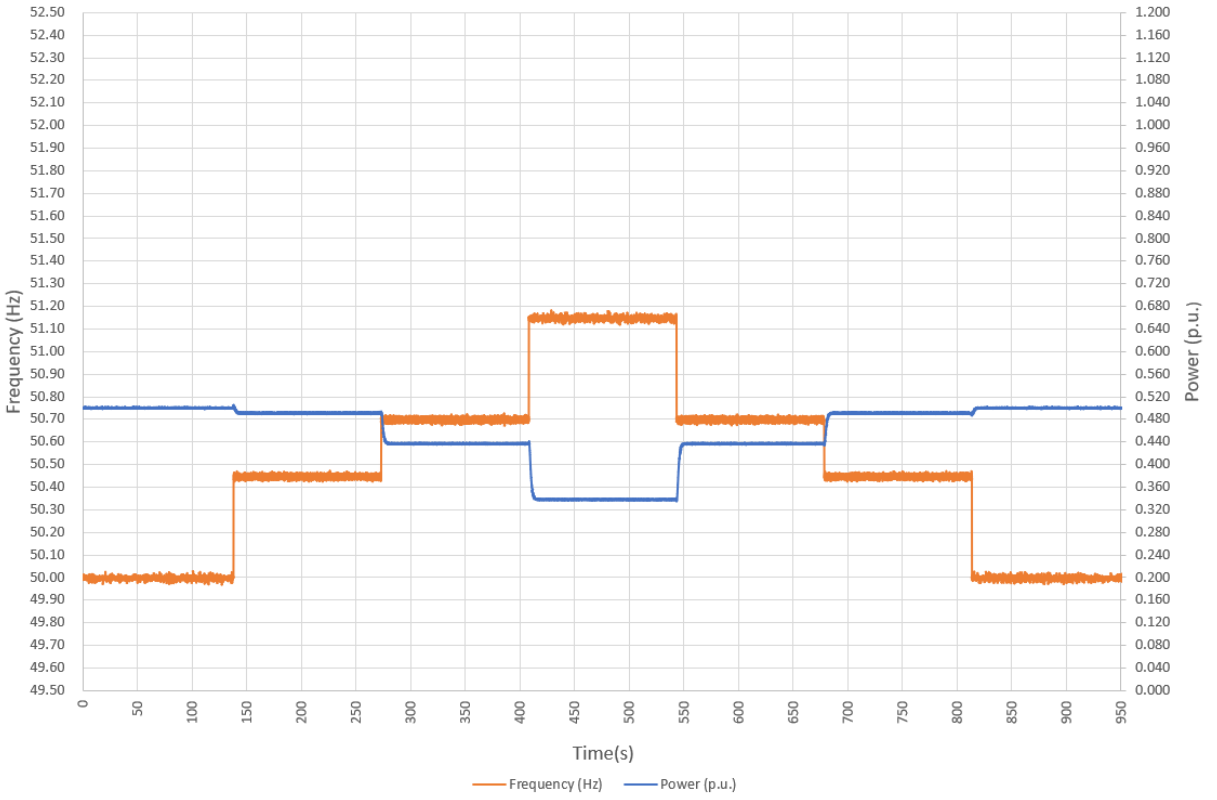
Test results are graphically shown in following pages.

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.

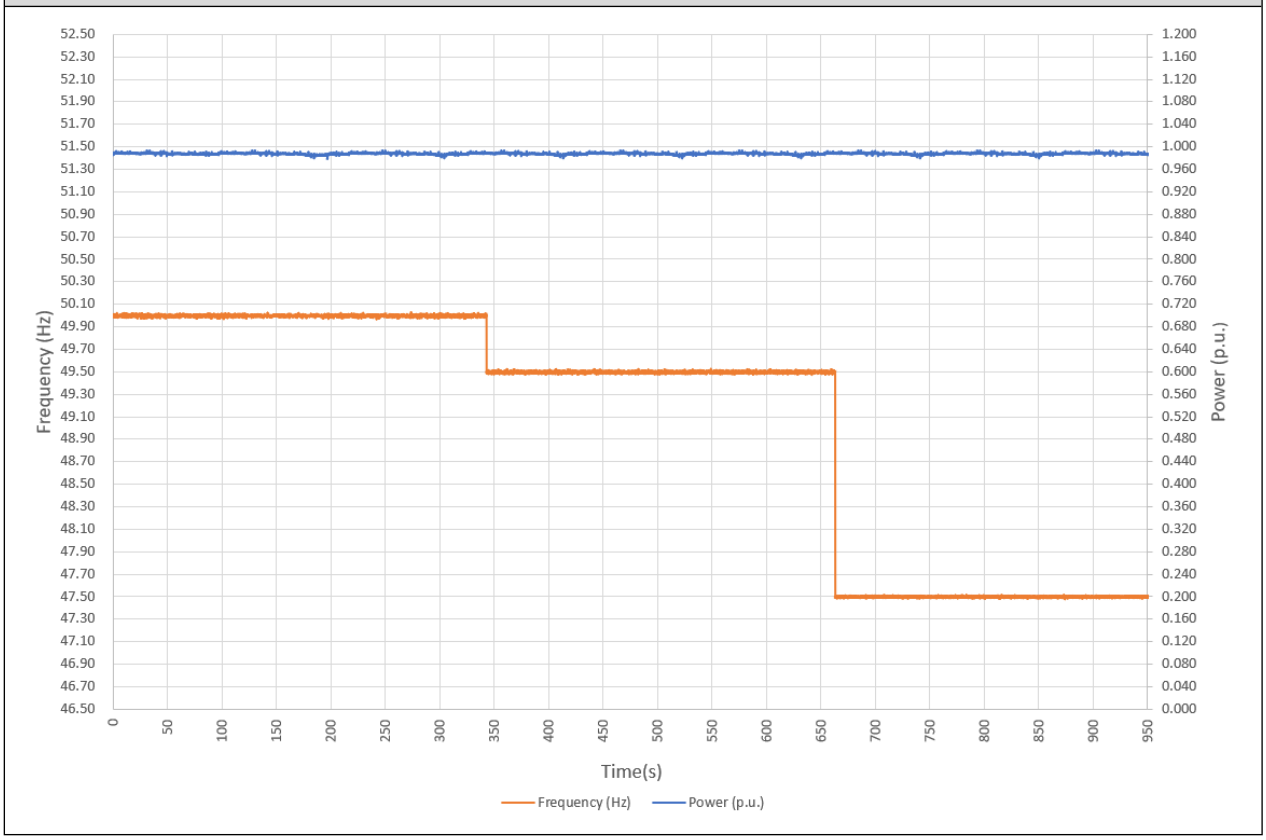
4.5 Power output with falling frequency test

This test should be carried out in accordance with EN 50438 Annex D.3.2 active power feed-in at under-frequency.

Test sequence	Measured Active Power Output (W)	Frequency (Hz)	Primary power source
Test a) 50 Hz ± 0.01 Hz	790.22	50.00	-
Test b) Point between 49.5 Hz and 49.6 Hz	790.69	49.50	-
Test c) Point between 47.5 Hz and 47.6 Hz	789.99	47.50	-
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

Test results are graphically shown in following pages.

POWER OUTPUT WITH FALLING FREQUENCY TEST



4.6 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 2. These tests should be undertaken in accordance with Annex A.2.2.5.

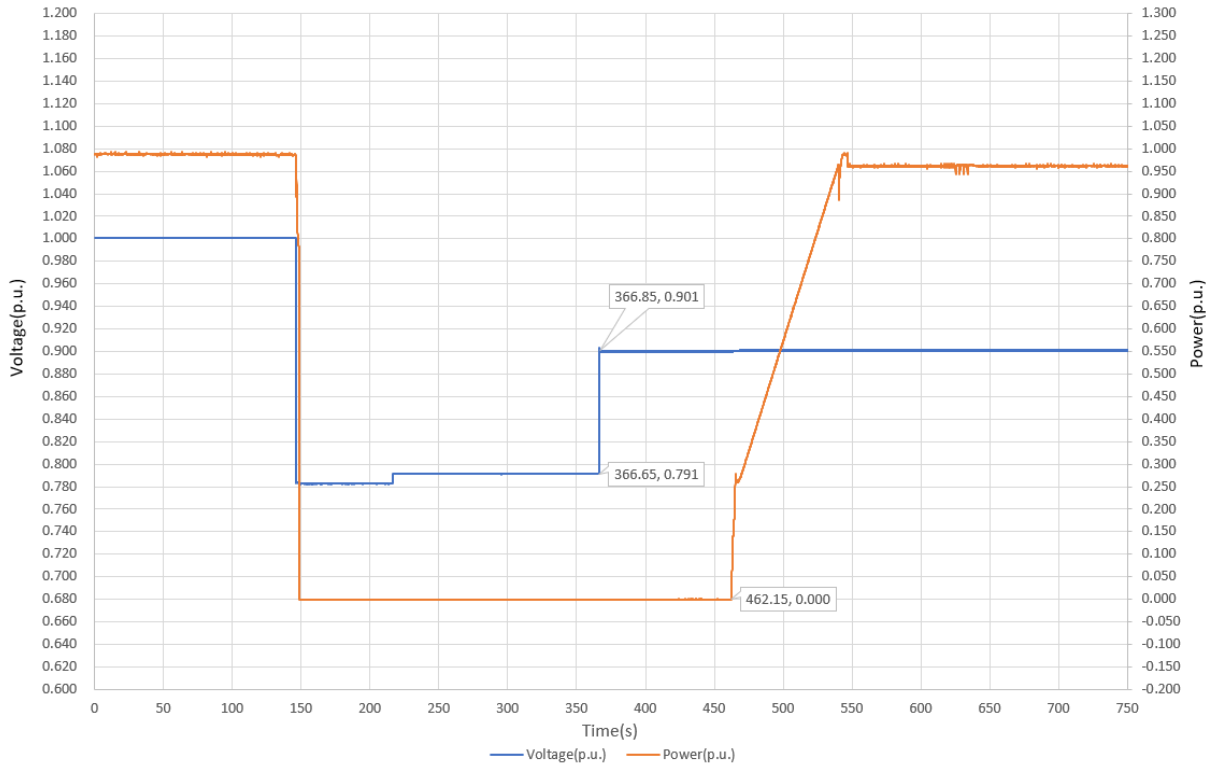
4.6.1 Voltage Reconnection Conditions

The following table detail tests performed.

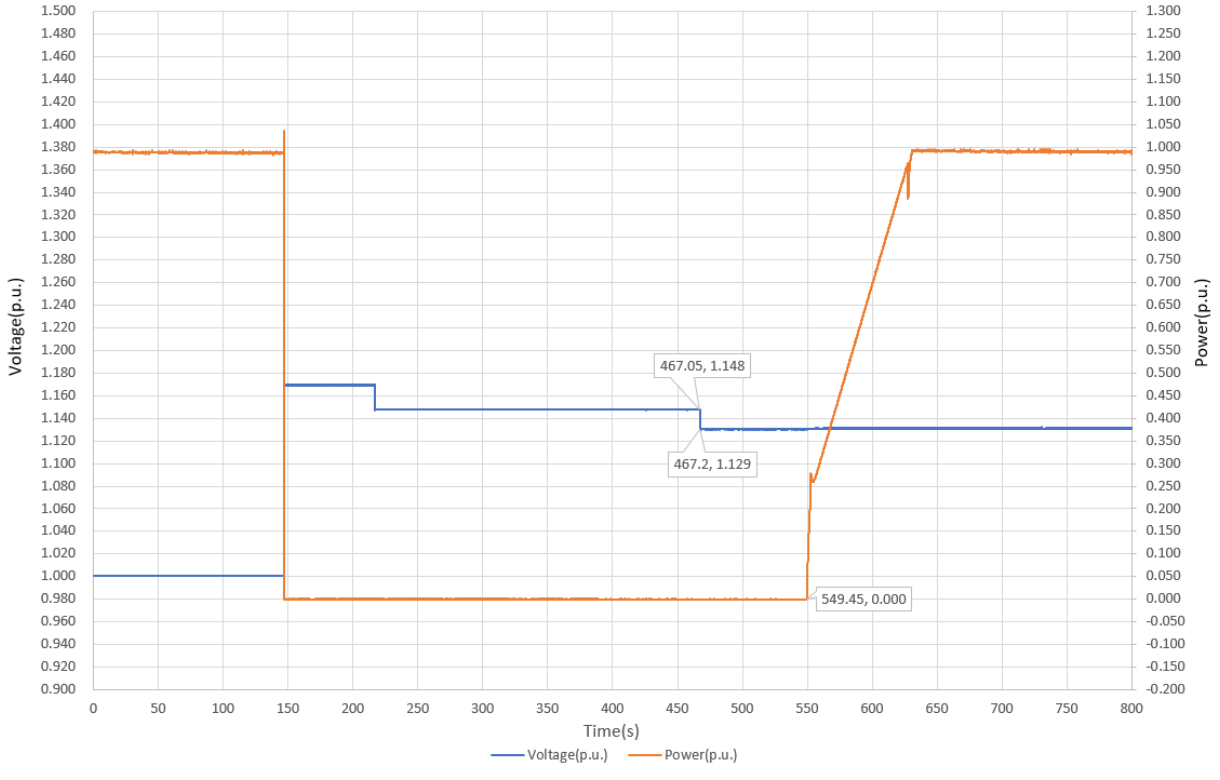
Test at	Time delay setting(s)	Measured delay(s)	Checks on no reconnection when voltage is brought to just outside stage 1 limits of table 1.	
UV	60.0	95.30	At 266.2V	At 180.0 V
OV	60.0	82.25		
Confirmation that the Micro-generator does not re-connect.			Not reconnection	Not reconnection

Test results are graphically shown below.

Under voltage reconnection



Over voltage reconnection



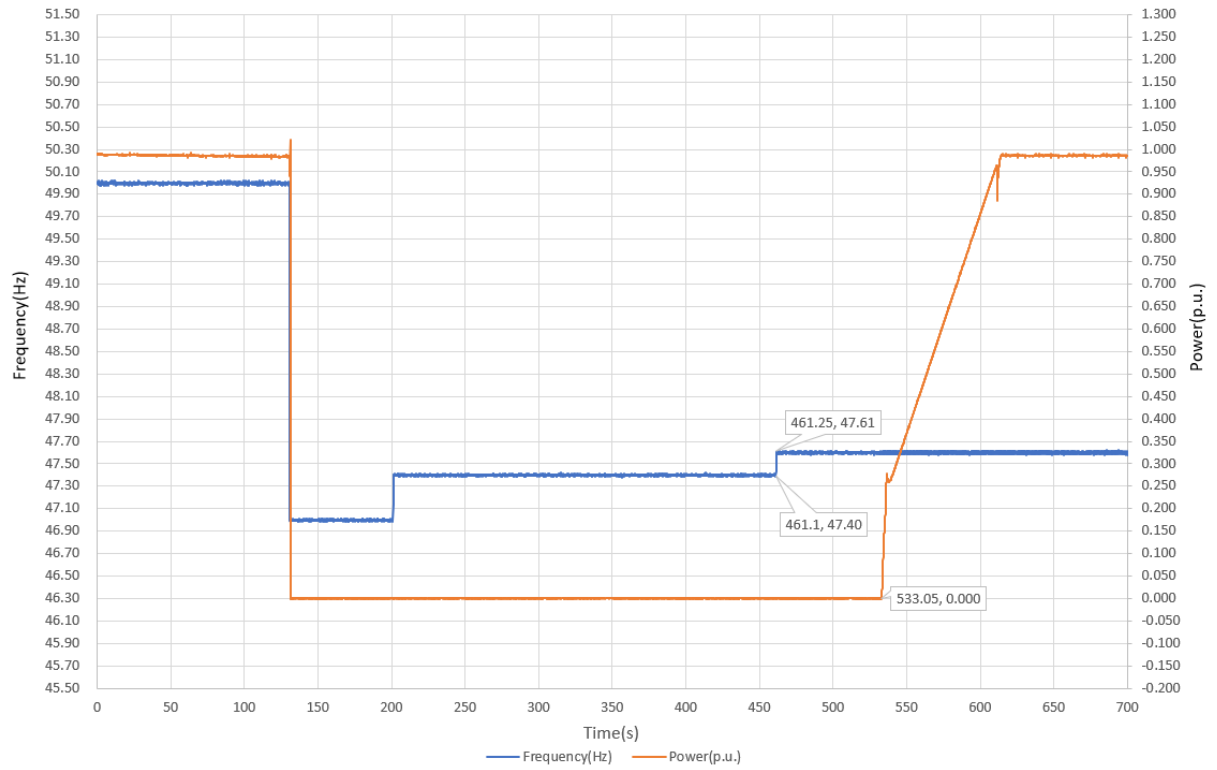
4.6.2 Frequency Reconnection Conditions

The following table detail tests performed.

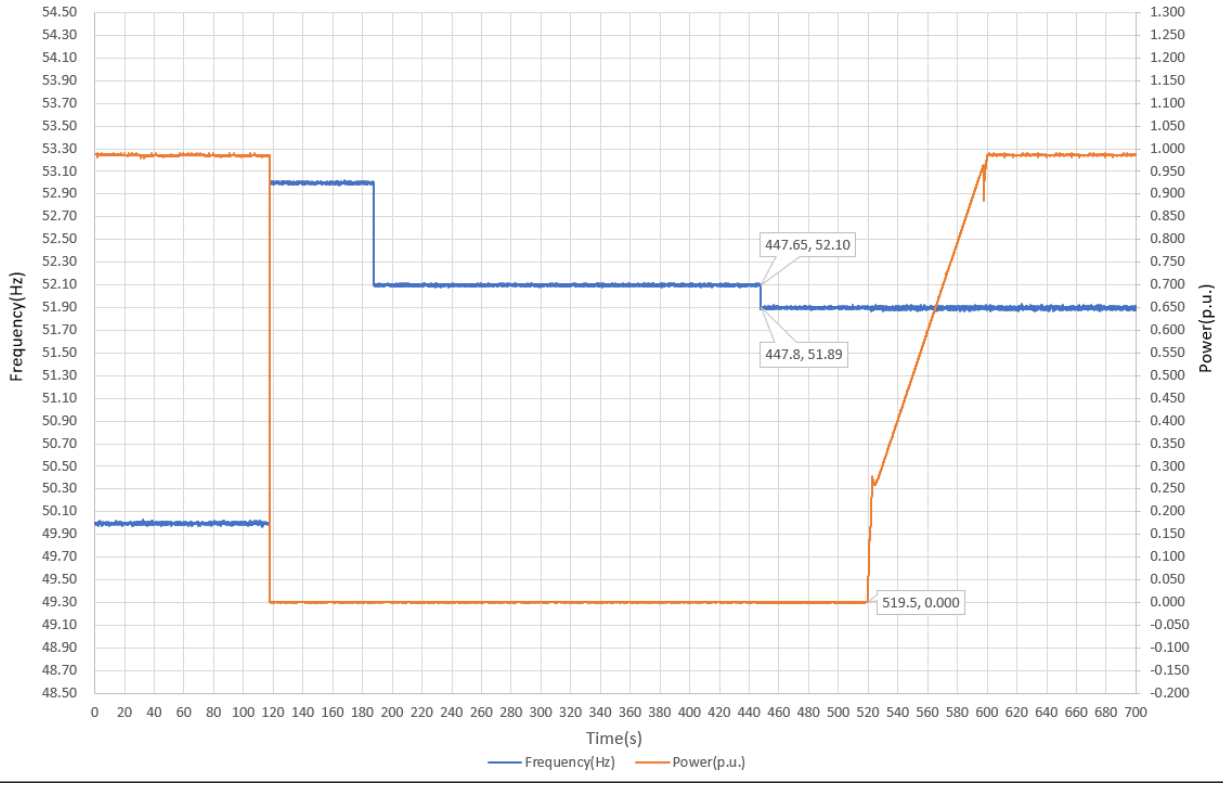
Test at	Time delay setting(s)	Measured delay(s)	Checks on no reconnection when frequency is brought to just outside stage 1 limits of table 1.	
UF	60	71.80	At 47.4Hz	At 52.1Hz
OF	60	71.70		
Confirmation that the Micro-generator does not re-connect.			Not reconnection	Not reconnection

Test results are graphically shown below.

Under frequency reconnection



Over frequency reconnection



4.7 Fault level contribution

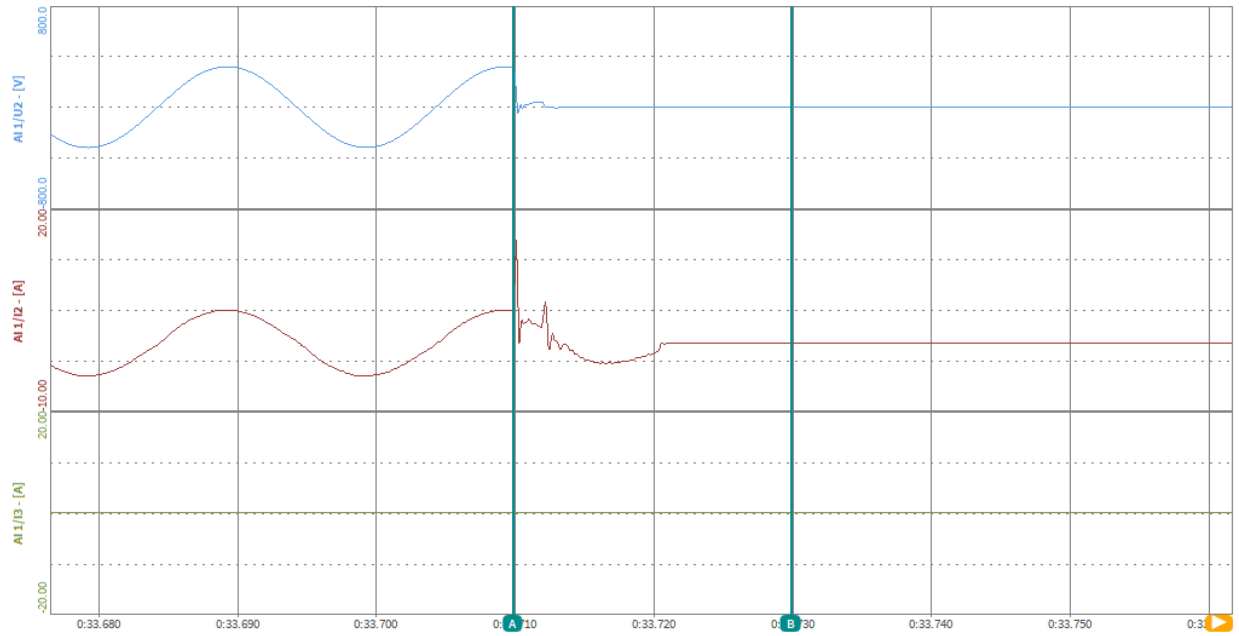
These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (Inverter connected) and Annex A2 A.2.3.4 (Synchronous).

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

Short circuit current		
Time after fault	**Volts(V)**	**Amps(A)**
20ms	0.016	-0.006
100ms	0.017	-0.006
250ms	0.019	-0.006
500ms	0.017	-0.007
Time to trip	0.017	In seconds

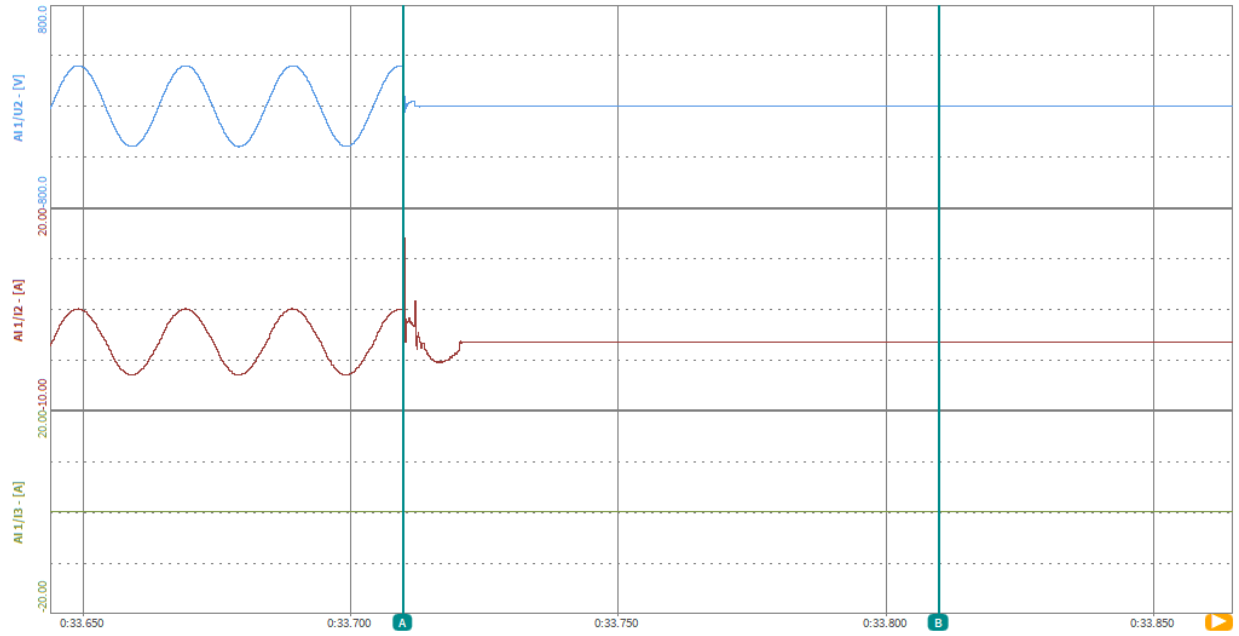
L1-N

Time after 20ms fault



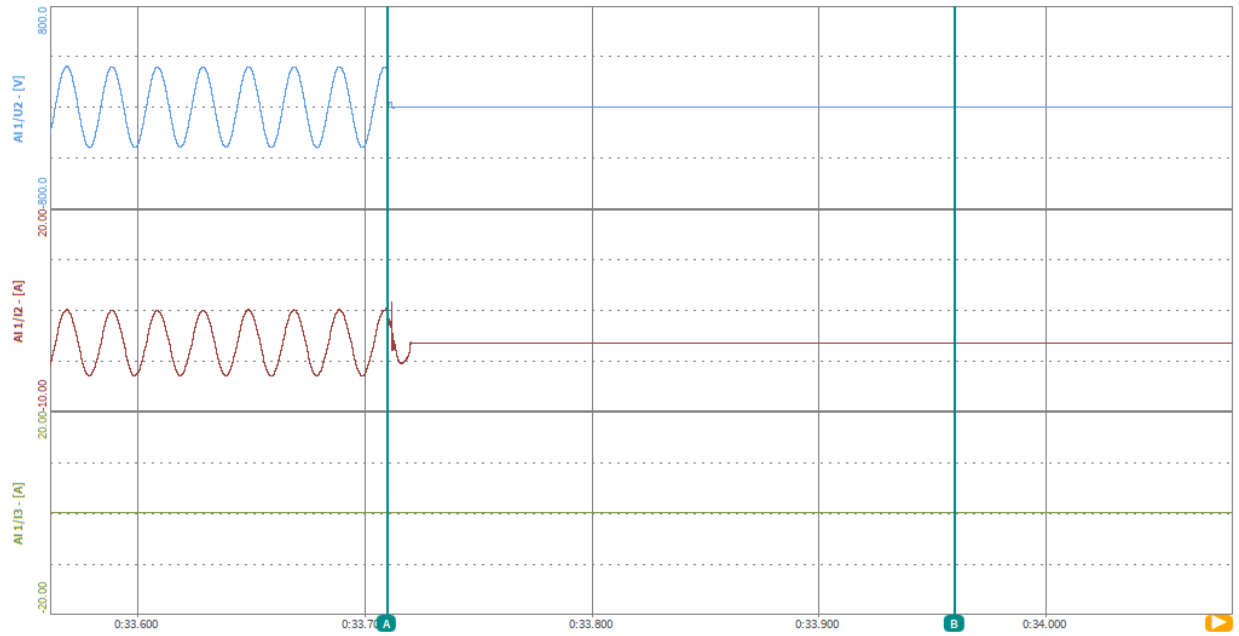
	A	B	间隔
时间 [s]	0:33.709895521	0:33.729899053	0.020003533
AI 1/U2 [V]	316.4854	0.016451	-316.4690
AI 1/I2 [A]	4.882455	-6.318e-3	-4.888773
AI 1/I3 [A]	-1.669e-3	4.292e-3	5.960e-3

Time after 100ms fault



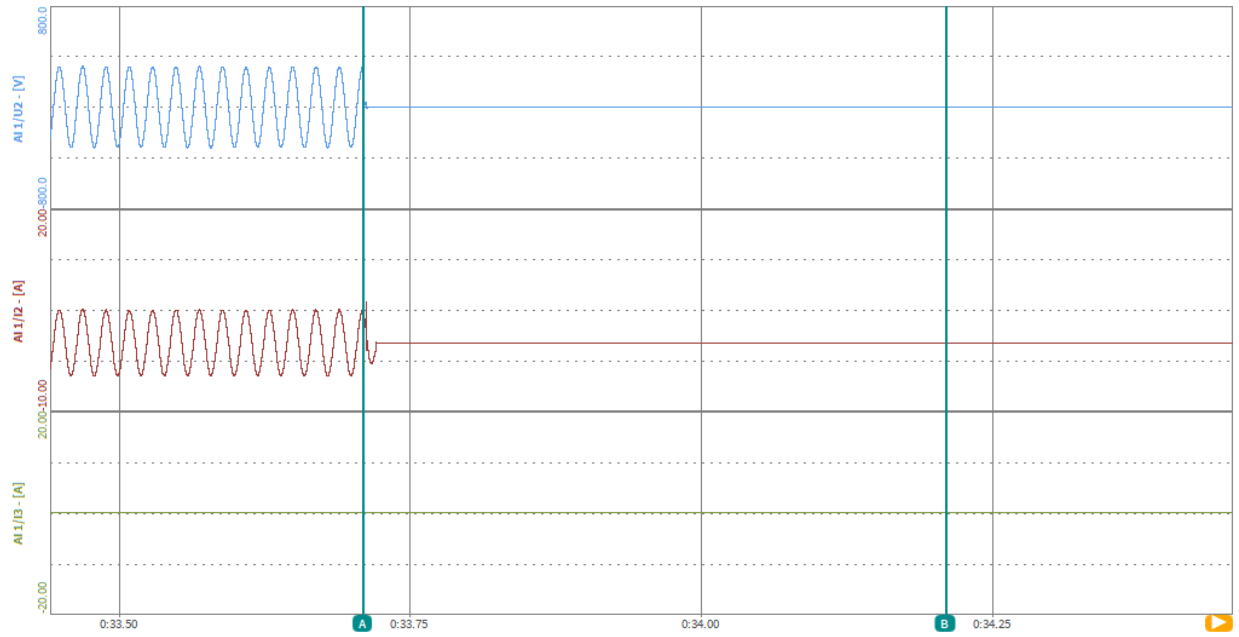
	A	B	间隔
时间 [s]	0:33.709895521	0:33.809895643	0.100000122
AI 1/U2 [V]	316.4854	0.016928	-316.4685
AI 1/I2 [A]	4.882455	-5.126e-3	-4.887581
AI 1/I3 [A]	-1.669e-3	-5.960e-4	1.073e-3

Time after 250ms fault



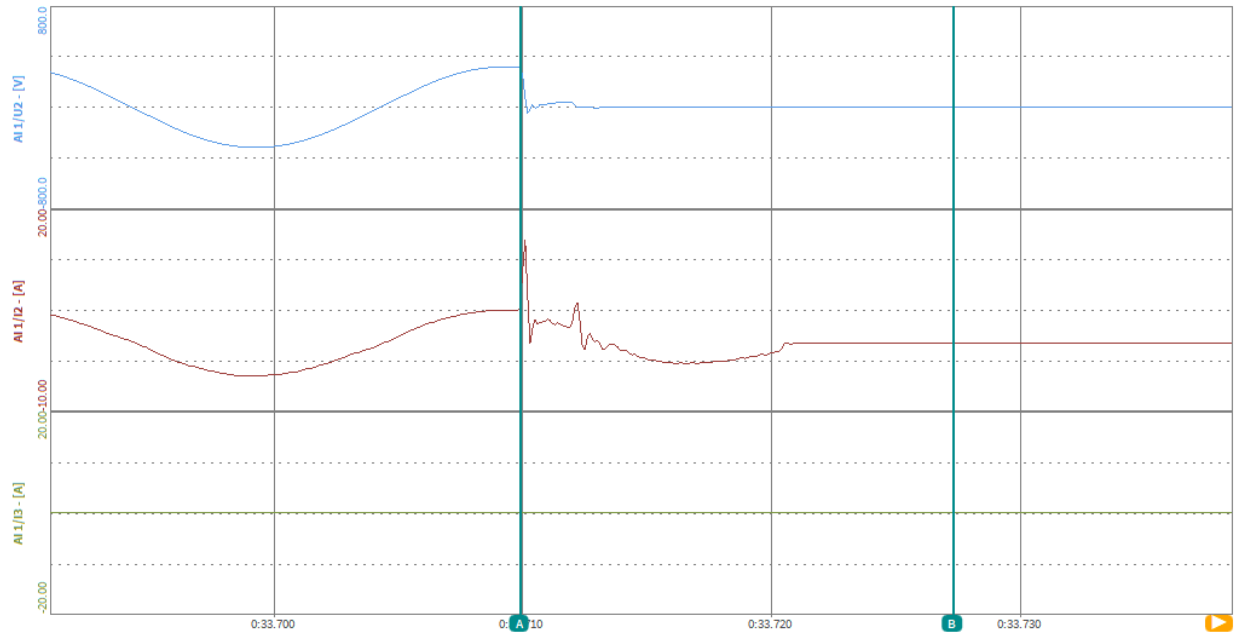
	A	B	间隔
时间 [s]	0:33.709895521	0:33.959904260	0.250008739
AI 1/U2 [V]	316.4854	0.019073	-316.4664
AI 1/I2 [A]	4.882455	-6.080e-3	-4.888535
AI 1/I3 [A]	-1.669e-3	-2.384e-4	1.431e-3

Time after 500ms fault



	A	B	间隔
时间 [s]	0:33.709895521	0:34.209903792	0.500008272
AI 1/U2 [V]	316.4854	0.016928	-316.4685
AI 1/I2 [A]	4.882455	-6.557e-3	-4.889012
AI 1/I3 [A]	-1.669e-3	4.053e-3	5.722e-3

Time to trip



	A	B	间隔
时间 [s]	0:33.709895521	0:33.727299074	0.017403553
AI 1/U2 [V]	316.4854	0.013113	-316.4723
AI 1/I2 [A]	4.882455	-2.861e-3	-4.885316
AI 1/I3 [A]	-1.669e-3	1.192e-4	1.788e-3

4.8 SELF-MONITORING SOLID STATE SWITCHING

The evaluation of this point has been made according to EREC G98 Annex A1 A.1.3.6.

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

4.9 ELECTROMAGNETIC COMPATIBILITY (EMC)

All equipment shall conform to the generic EMC standards: BS EN61000-6-3: Electromagnetic Compatibility, Generic Emission Standard; and BS EN61000-6-1: Electromagnetic Compatibility, Generic Immunity Standard.

The compliances with these requirements are stated in the following test report:

- EMC Test Report: Test Report no. 18220WC30056802E, issued by Shenzhen Anbotek Compliance Laboratory Limited on 14 Apr. 2023. CNAS L3503.

4.10 LOGIC INTERFACE.

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 9.4.3 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.

Ch1: Signal of logic interface.

Ch2: Output Current

4.11 CYBER SECURITY

Confirm that the Manufacturer or Installer of the Micro-generator has provided a statement describing how the Micro-generator has been designed to comply with cyber security requirements, as detailed in 9.7.

The Manufacturer of the Micro-generator has provided a statement describing how the Micro-generator has been designed to comply with cyber security requirements in 9.7.

Additional comments.

The DNO logic interface will take the form of a simple binary output that can be operated by the switch. When the switch is turned off the Power Generating Module can operate normally. When the switch is turned on the Power Generating Module will reduce its Active Power to zero within 5 s. The signal from the Power Generating Module that is being switched is DC (maximum value 3.3Vdc)

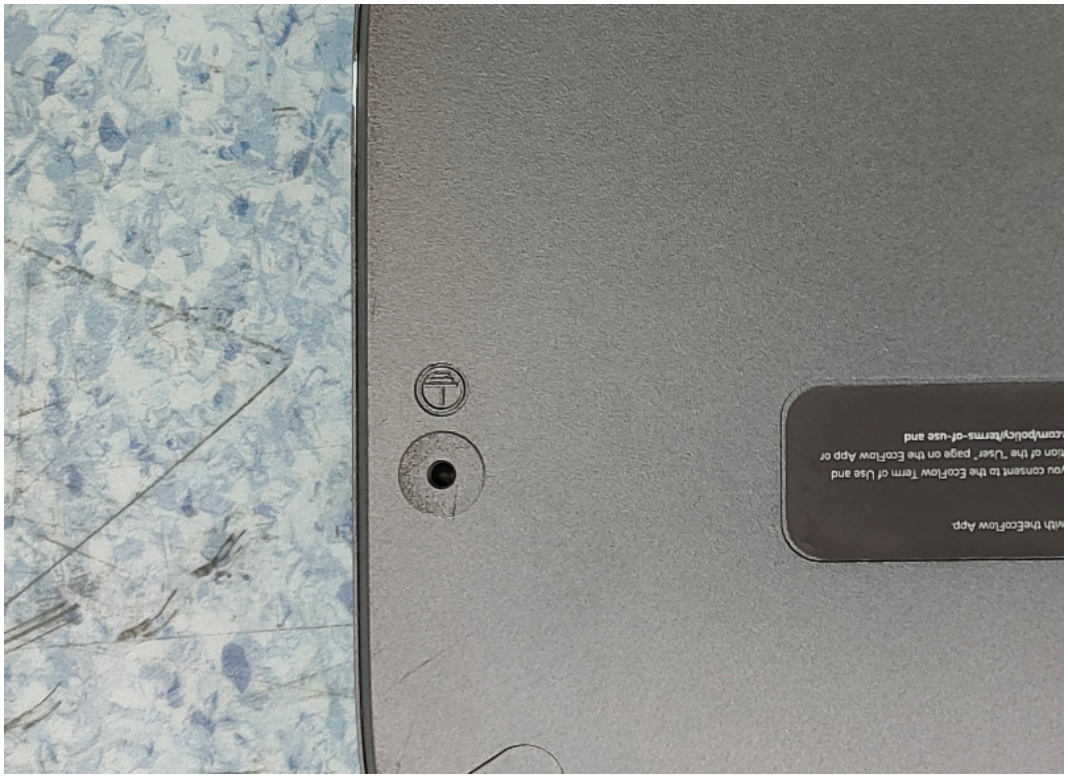
5 PICTURES

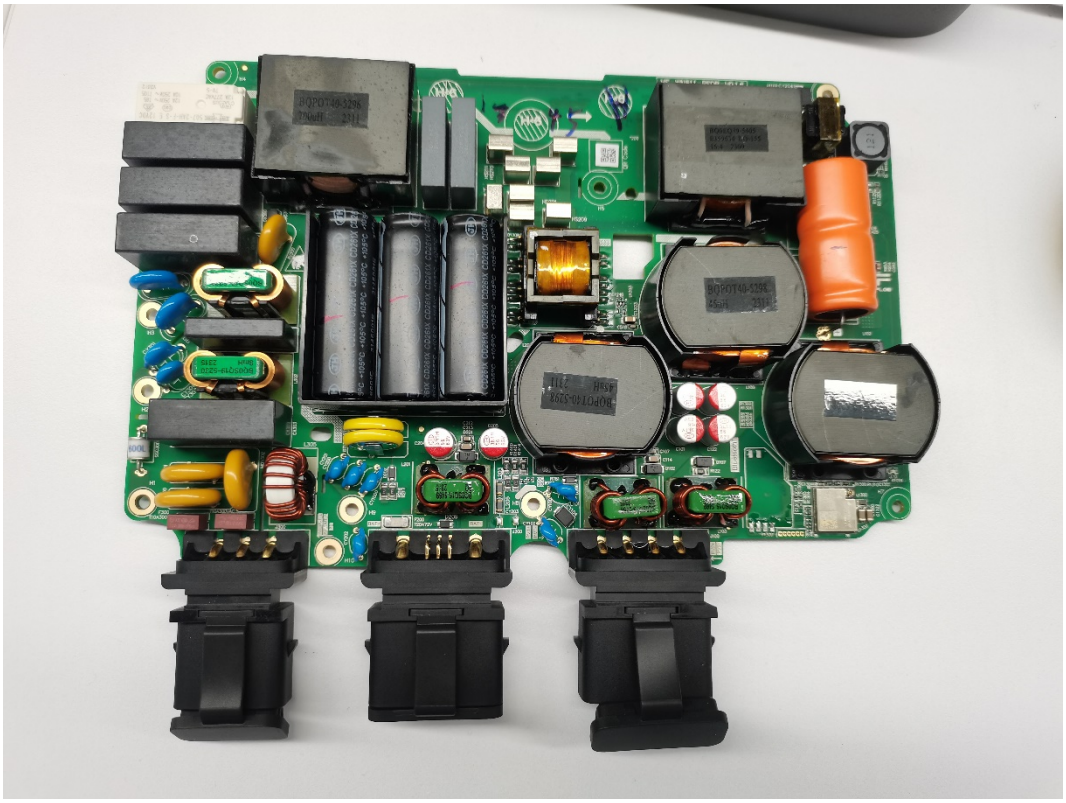
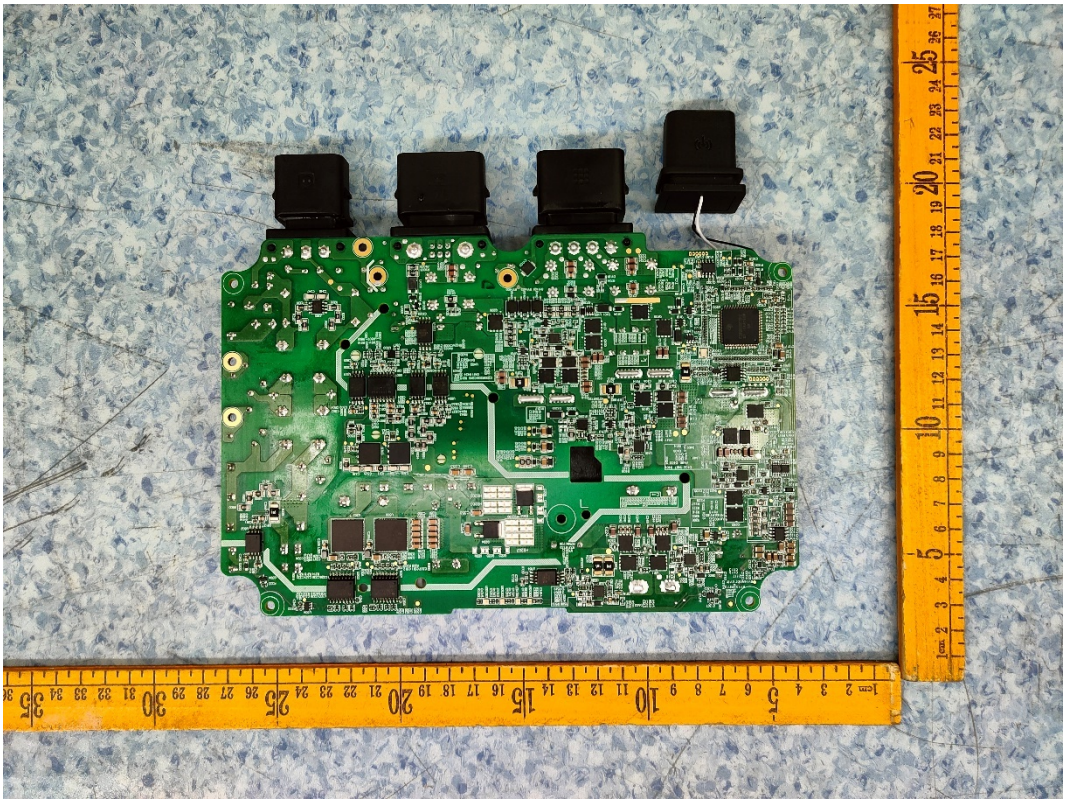
Front view

Back Side


Connection interface

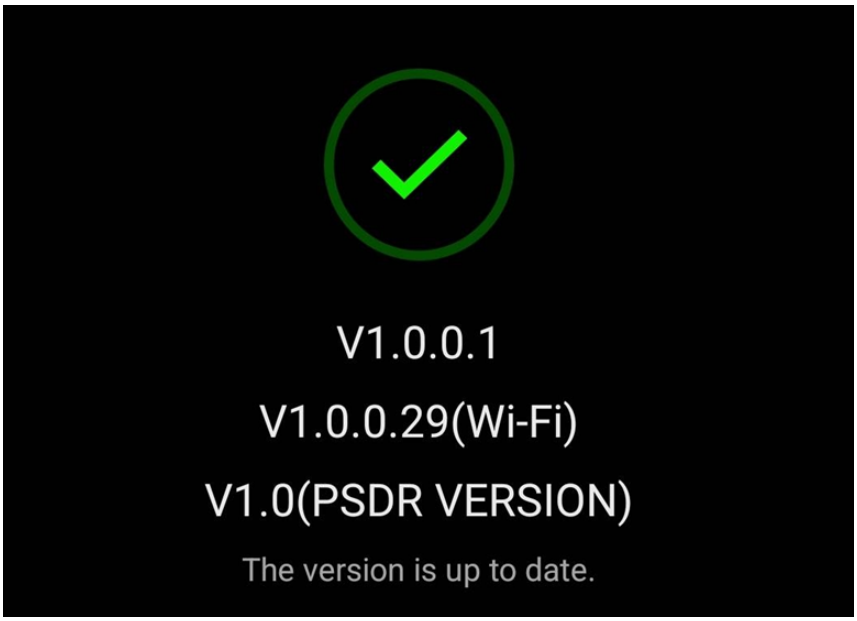
Top Side


External grounding

General Internal view of inverter

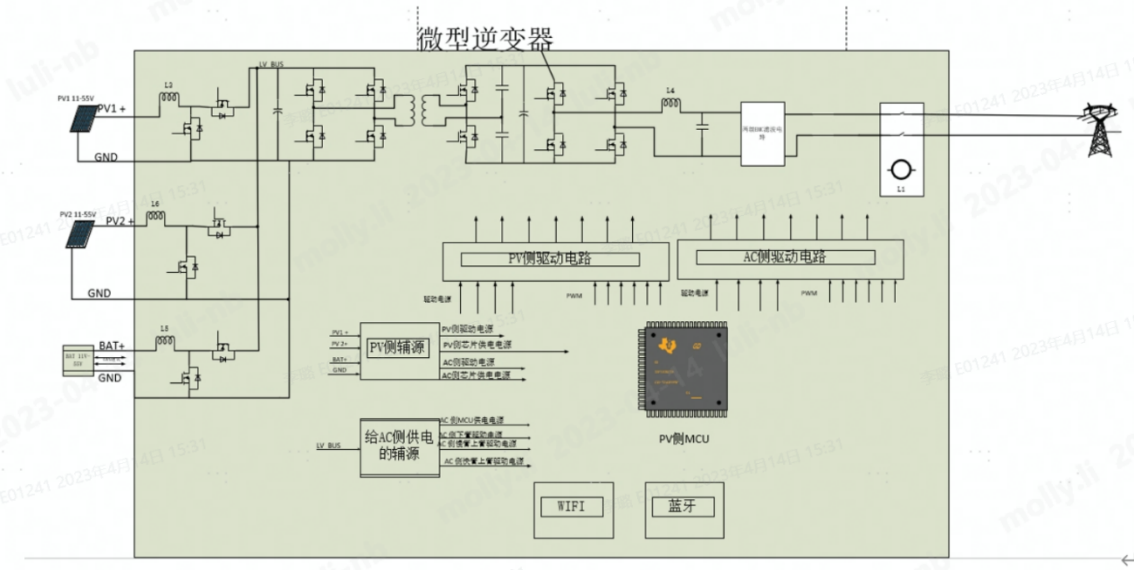

Front of main power board

Back of main power board


Serial Number and Software Version

HW51ZEH1RF330001



6 ELECTRICAL SCHEME

Electrical Scheme of EUT


----------END OF REPORT----------