TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH :

TECHNICAL REGULATION 3.2.2 FOR PV POWER PLANTS ABOVE 11 KW ENERGINET. (REVISION 4. DATED ON 14TH JULY 2016)

Protocol. PE.T-LE-62

Test Report Number ..... :	2220-0076-C
Trademark..... :	SOFAR SOLAR
Tested Model ..... :	SOFAR 15000TL-G2
Variants Models ..... :	SOFAR 12000TL-G2, SOFAR 10000TL-G2

APPLICANT

Name ..... :	Shenzhen SOFAR SOLAR Co., Ltd.
Address..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen City, Guangdong Province, P.R. China

TESTING LABORATORY

Name ..... :	SGS Tecnos, S.A. (Electrical Testing Laboratory)
Address..... :	C/ Trespaderne, 29 - Edificio Barajas 1 28042 Madrid (Spain)
Conducted (tested) by ..... :	Hugo Zhang (Project Engineer)
	Roger Hu (Project Engineer)
Reviewed & Approved by ..... :	Jacobo Tevar (Technical Reviewer)
Date of issue..... :	21/05/2020
Number of pages ..... :	106

SGS Tecnos, S.A.
Laboratorio de Ensayos E&E

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Test Report Historical Revision:

Test Report Version	Date	Resume
2220-0076-C	21/05/2020	First issuance

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1 SCOPE

SGS Tecnos, S.A. (Electrical Testing Laboratory) has been contracted by Shenzhen SOFAR SOLAR Co., Ltd., in order to perform the testing according the following standard: "**Technical regulation 3.2.2 for PV power plants above 11 kW**", by ENERGINET (rev. 4. Dated on 14th July 2016).

Note: The tests offered at this test report evaluate the EUT compliance with the requirements of **category** A2 and B defined as below. Plant categories in relation to the total rated power in the Point of Connection:

A2. Plants above 11 kW up to and including 50 kW
B. Plants above 50 kW up to and including 1.5 MW
C. Plants above 1.5 MW up to and including 25 MW
D. Plants above 25 MW or connected to over 100 kV.

2 GENERAL INFORMATION

2.1 Testing Period and Climatic conditions

The necessary testing has been performed along 13 working days between 13th December of 2019 and 3th April of 2020.

All the tests and checks have been performed in accordance with the reference Standard (the tests are done at ≈ 25 ºC).

SITE TEST

Name..... : Shenzhen SOFAR SOLAR Co., Ltd.

Address ..... : 5/F Building 4, AnTongDa Industrial Park, No. 1Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China

2.2 Equipment under Testing

Apparatus type/ Installation ..... : Solar Grid-tied Inverter

Manufacturer/ Supplier/ Installer..... : Shenzhen SOFAR SOLAR Co., Ltd.

Trade mark ..... :

Model/ Type..... : SOFAR 15000TL-G2

Serial Number..... : ZN1CS015K1R081

Software Version ..... : V3.00

Rated Characteristics..... : DC input: 160V-960V Max.21A /11 A

AC output: 3/N/PE 230/400Va.c, 50Hz,3 x 21.7A (Max.3 x 24A), 15000W.

Date of manufacturing: 2019

Test item particulars

Input ..... : DC

Output..... 3~N/PE

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

Degree of protection against moisture ..... : IP 65

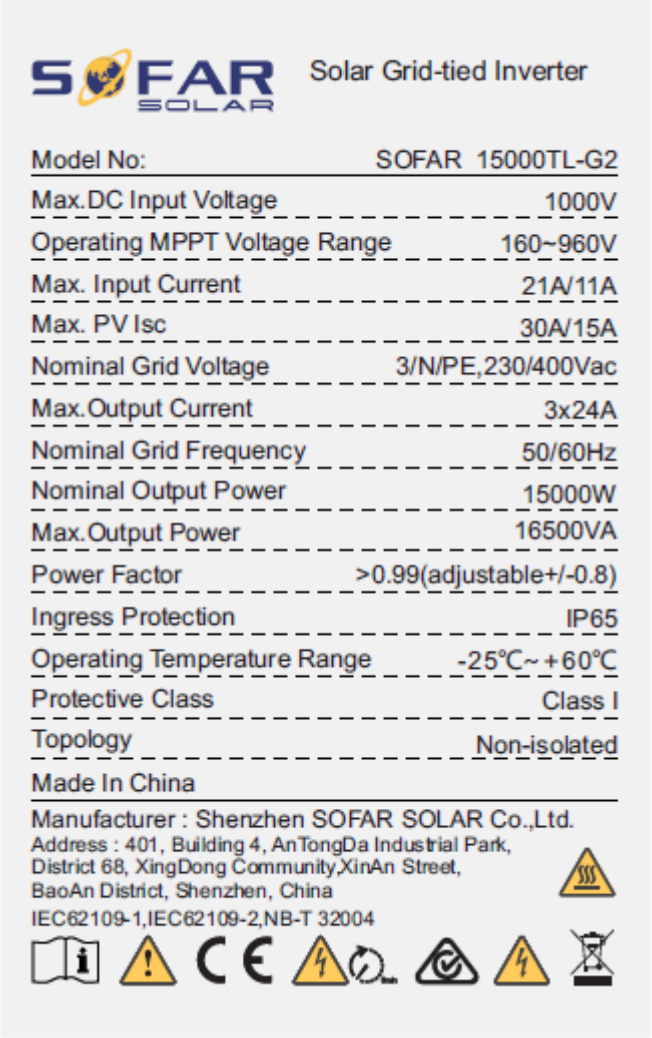
Type of connection to the main supply ..... : Three phase – Fixed installation

Cooling group ..... Fans

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 SOFAR 15000TL-G2's except the parameters of rating.

Equipment under testing:

– SOFAR 15000TL-G2

The variants models are:

– SOFAR 12000TL-G2
– SOFAR 10000TL-G2

The parameter of each model as following:

Model Number	SOFAR 15000TL-G2	SOFAR 12000TL-G2	SOFAR 10000TL-G2
Max. input voltage	1000Vd.c.		
Max. input current	21A/11A		
Operating MPPT voltage range	160V-960V		
Rated voltage	600V		
Full load DC Voltage Range	500V-850V	500V-850V	350V-850V
Rated grid voltage	3/N/PE 230/400Va.c		
Rated grid frequency	50Hz		
Rated output power	15000W	12000W	10000W
Max. output current	3 x 24A	3 x 20A	3 x 16.5A
Rating output current	3 x 21.7A	3 x 17.4A	3 x 14.5A
Power factor	0.8 leading to 0.8 lagging		
Ambient temperature	-25 ºC ~60 ºC		
Ingress protection	IP65		
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 2.5 and 2/3 of the rated power output of the EUT.
- 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

Equipment use from 2019/12/13 to 2020/01/14

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofar solar	1	Voltage probe	SanHua / SI-9110	111541	2019/2/13	2020/2/12
	2	Voltage probe	SanHua / SI-9110	152627	2019/2/13	2020/2/12
	3	Voltage probe	SanHua / SI-9110	111134	2019/2/13	2020/2/12
	4	Power analyzer	Yokogawa / WT3000	91N610888	2019/2/13	2020/2/12
	5	Current probe	Fluke / i1000s	29503223	2019/2/13	2020/2/12
	6	Current probe	Fluke / i1000s	30413448	2019/2/13	2020/2/12
	7	Current probe	CYBERTEK / CP1000A	C181000927	2019/2/13	2020/2/12
	8	Temperature & Humidity meter	Anymeters / TH101B	201030245220	2019/2/13	2020/2/12
	9	Power analyzer	ZLG/ PA3000	PA3005-P0005-1246	2019/2/14	2020/2/12
	10	Temperature & Humidity Chamber	Henggong / HGTP-225R	HG13030801	2019-02-13	2020-02-12
SGS	11	True RMS Multimeter	Fluke / 289C	GZE012-53	2019/2/26	2020/2/25

Equipment use from 2020/03/04 to 2020/04/03

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofar Solar	12	Digital oscilloscope	Agilent / DS05014A	MY50070288	2020/1/14	2021/1/13
	13	Voltage probe	SanHua / SI-9110	111152	2020/1/14	2021/1/13
	14	Voltage probe	SanHua / SI-9110	152627	2020/1/14	2021/1/13
	15	Voltage probe	SanHua / SI-9110	111134	2020/1/14	2021/1/13
	16	Power analyzer	Yokogawa / WT3000	91N610888	2020/1/14	2021/1/13
	17	Power analyzer	ZLG/PA3000	PA3005-P0005-1246	2020/1/14	2021/1/13
	18	Current probe	CYBERTEK/ CP1000A	C181000922	2020/1/14	2021/1/13
	19	Current probe	CYBERTEK/ CP1000A	C181000925	2020/1/14	2021/1/13
	20	Current probe	CYBERTEK/ CP1000A	C181000929	2020/1/14	2021/1/13
	21	Temperature & Humidity meter	Anymeters / TH101B	ZB-WSDJ-001	2020/1/14	2021/1/13
SGS	22	True RMS Multimeter	Fluke / 187	GZE012-8	2019/12/5	2020/12/4

2.4 Measurement Uncertainly

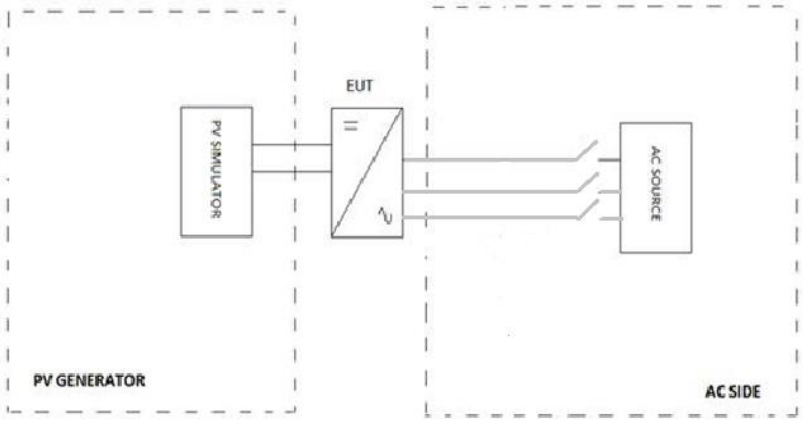
Magnitude	Uncertainty
Voltage measurement uncertainty	±1.5 %
Current measurement uncertainty	±2.0 %
Frequency measurement uncertainty	±0.2 %
Time measurement uncertainty	±0.2 %
Power measurement uncertainty	±2.5 %
Phase Angle	±1º
cosφ	±0.01
Note1: Measurements uncertainties showed in this table are maximum 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.	

2.5 Definitions

ESE	Auxiliary inverter	Pn	Nominal Power
EUT	Equipment under testing	Q_f	Quality factor
In	Nominal Current	UF	Under frequency
OF	Over frequency	Un	Nominal Voltage
OV	Over voltage	UV	Under voltage
PF	Power Factor		

2.6 Test set up

Below is the simplified construction of the test set up.



Current and voltage clamps have been connected to the inverter output for all the tests.

All the tests and checks have been performed in accordance with the reference Standard as specified previously.

The test bench used includes:

EQUIPMENT	MARK / MODEL	RATED CHARACTERISTICS	OWNER / ID.CODE
AC source	Kwell / AFG-S-33800	Voltage: 0-600 V 600Kw	Sofar solar / EP-026
PV source	Kwell / TVS-630Kw	Voltage: 0 – 1000 V 630Kw	Sofar solar / EP-027
RLC load	Qunlin / ACLT3803H	33.33 kW, 33.33 kVAr	Sofar solar / YF0225

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

Standard Section	STANDARD REQUIREMENTS	
	Technical regulation 3.2.2 for PV power plants above 11 kW	
	Technical requirements	Result
3.2	Normal operating conditions	
3.2.1	Normal production requirements	P
3.3	Abnormal operating conditions	
3.3.1	Voltage dip tolerance	NA
3.3.2	Recurring faults in the public electricity supply grid	NA
4	Power quality	
4.2	DC content	P
4.3	Asymmetry	P
4.4	Flicker	P
4.5	Harmonic distortions	P
4.6	Interharmonic distortions	P
4.7	Distortions in the 2-9 kHz frequency range	P
5	Control and regulation	
5.2	Active power control functions	
5.2.1	Frequency response	P
5.2.2	Frequency control	NA
5.2.3	Constraint functions	P
5.2.3.1	Absolute power constraint	P
5.2.3.2	Delta power constraint (spinning reserve)	NA
5.2.3.3	Ramp rate constraint	P
5.3	Reactive power and voltage control functions	
5.3.1	Q control	P
5.3.2	Power factor control	P
5.3.3	Voltage control	NA
5.3.4	Automatic power factor control	P
5.4	System protection	NA
6.1	Reconnection	P
6.3.2	Voltage and frequency trips	P

Note: The declaration of conformity has been evaluated taking into account the IEC Guide 115.

4 TEST RESULTS

The tests offered at this test report evaluate the EUT compliance with the requirements for Standard "Technical Regulation 3.2.2 for PV power plants above 11 kW" as category A2 and B.

4.1 NORMAL OPERATING CONDITIONS

4.1.1 Normal Operating Requirements

Within the normal production range, the normal operating voltage is Uc±10%, and the frequency range is 47.00 to 52.00 Hz. Tests have been tested according to chapter 3.2 of the standard, and the requirements should be referred to the chapter 3.2.1 of the standard.

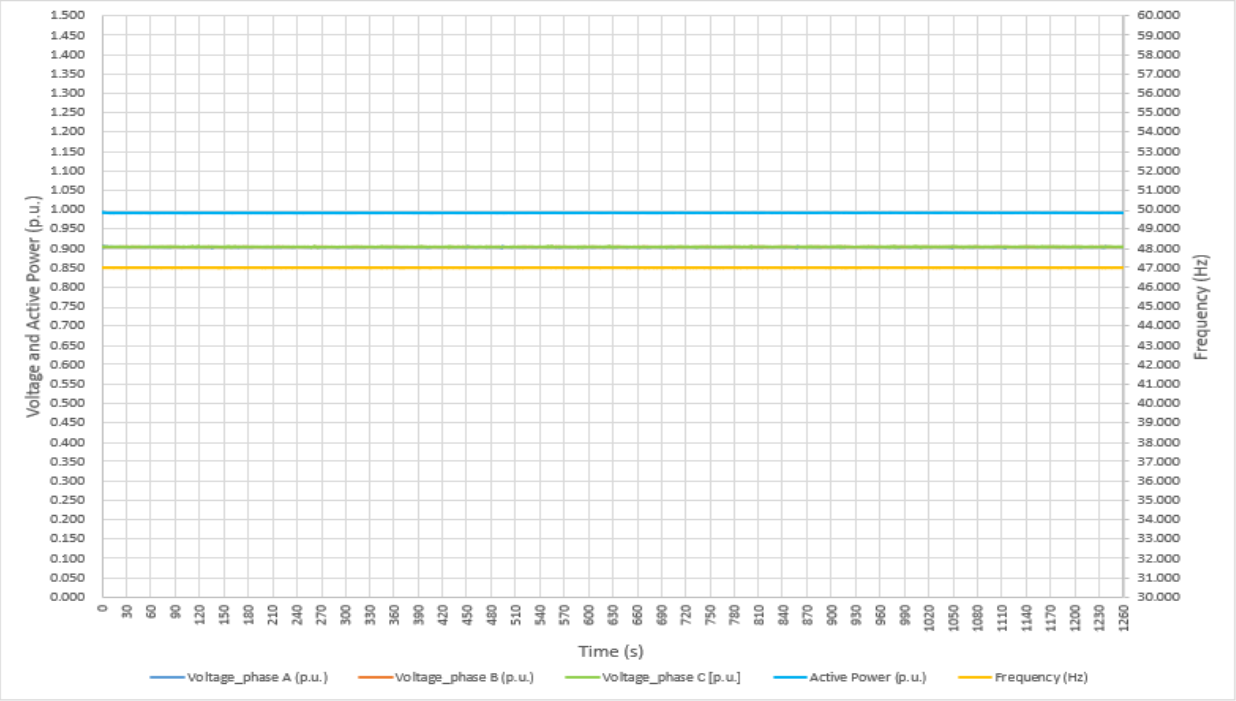
Test results are offered at the tables below.

Test 1		Under Voltage + Under Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
90.0%Un	47.0 Hz	99.2%Pn	Continuous operation	> 20 minutes
Disconnection		☒ NO ☐ YES		

Test 2		Over Voltage + Over Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
110.0%Un	52.0 Hz	100.1%Pn	Continuous operation	> 20 minutes
Disconnection		☒ NO ☐ YES		

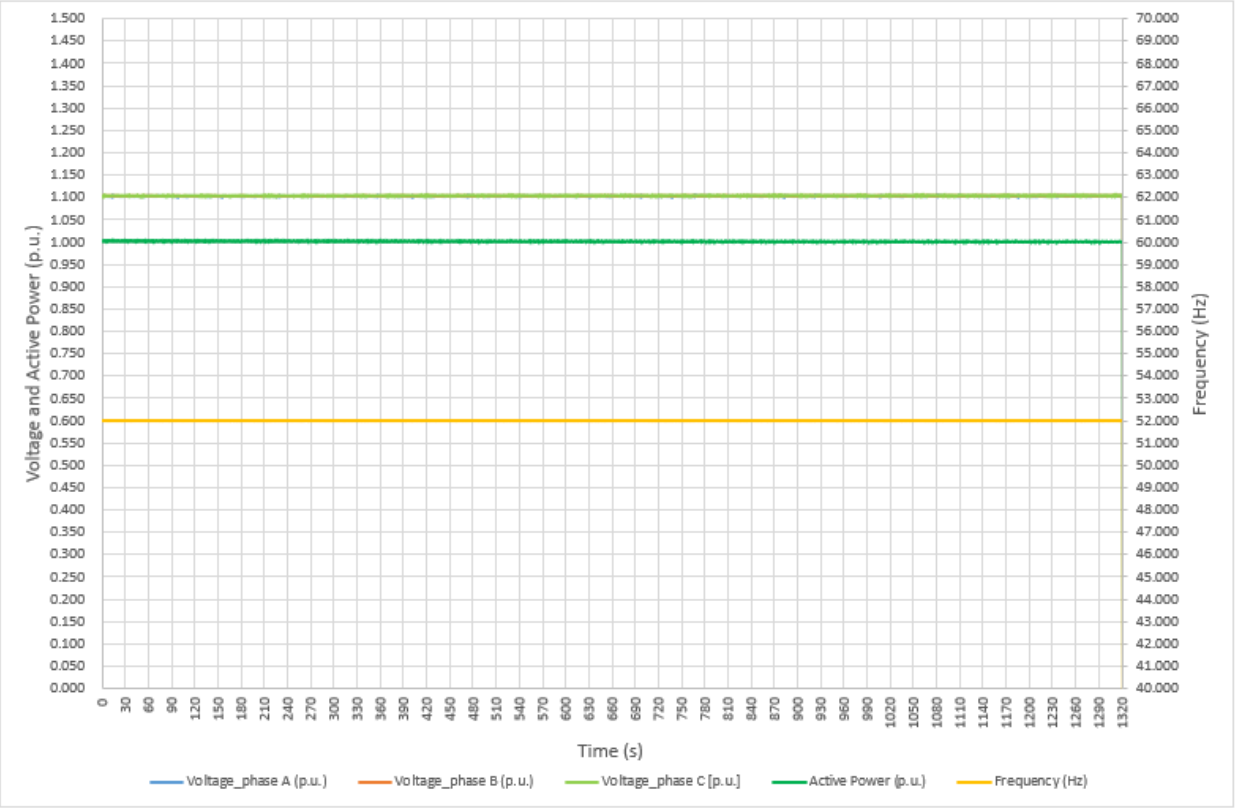
Test results are represented in graphics on the following pages.

Test 1 (V = 90.0%Un and F = 47.0 Hz)



	Time measured: 21 min
Voltage average measured: 90.4 %Un	Frequency measured: 47.00 Hz

Test 2 (V = 110.0%Un and F = 52.0 Hz)



	Time measured: 22 min
Voltage average measured: 100.3 %Un	Frequency measured: 52.00 Hz

4.2 ABNORMAL OPERATING CONDITIONS

According to chapter 3.3 of the standard, the PV power plant must be designed to withstand transitory (80-100 ms) phase jumps of up to 20° in the Point of Connection (POC) without disrupting or reducing its output.

It is not applicable due to the inverter is apply to Categories A2 and B defined in this standard, according to manufacturer Statements. Requirements only apply to category C and D.

4.2.1 Voltage Dip Tolerance

According to chapter 3.3.1 of the standard, in the Point of Connection, a PV power plant must be designed to withstand voltage dips down to 10% of the voltage in the Point of Connection over a period of minimum 250 ms (line-to-line voltages for the 50 Hz component), as shown in Figure below, without disconnecting.

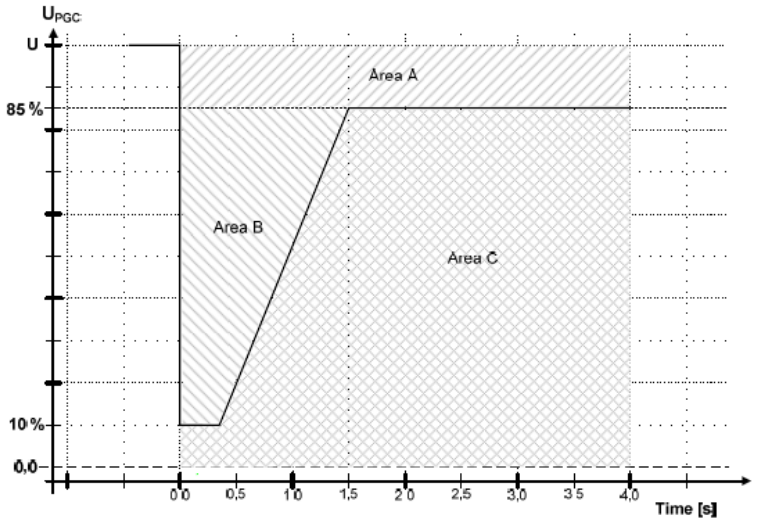


Figure 5 Voltage dip tolerance requirements for category C and D PV power plants.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. Requirements only apply to category C and D.

4.2.2 Recurring Faults in The Public Electricity Supply Grid

According to chapter 3.3.2 of the standard, the PV power plant and any compensation equipment must stay connected during and after faults have occurred in the public electricity supply grid as specified in Table below. These requirements apply to the Point of Connection, but the fault sequence is at a random point in the public electricity supply grid.

Type	**Duration of fault**
Three-phase short circuit	Short circuit for 150 ms
Phase-to-phase-to-earth short circuit/phase-to-phase short circuit	Short circuit for 150 ms followed by a new short circuit 0.5 to 3 seconds later, also with a duration of 150 ms
Phase-to-earth short circuit	Phase-to-earth fault for 150 ms followed by a new phase-to-earth fault 0.5 to 3 seconds later, also with a duration of 150 ms

Table 2 Types and duration of faults in the public electricity supply grid.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. Requirements only apply to category C and D.

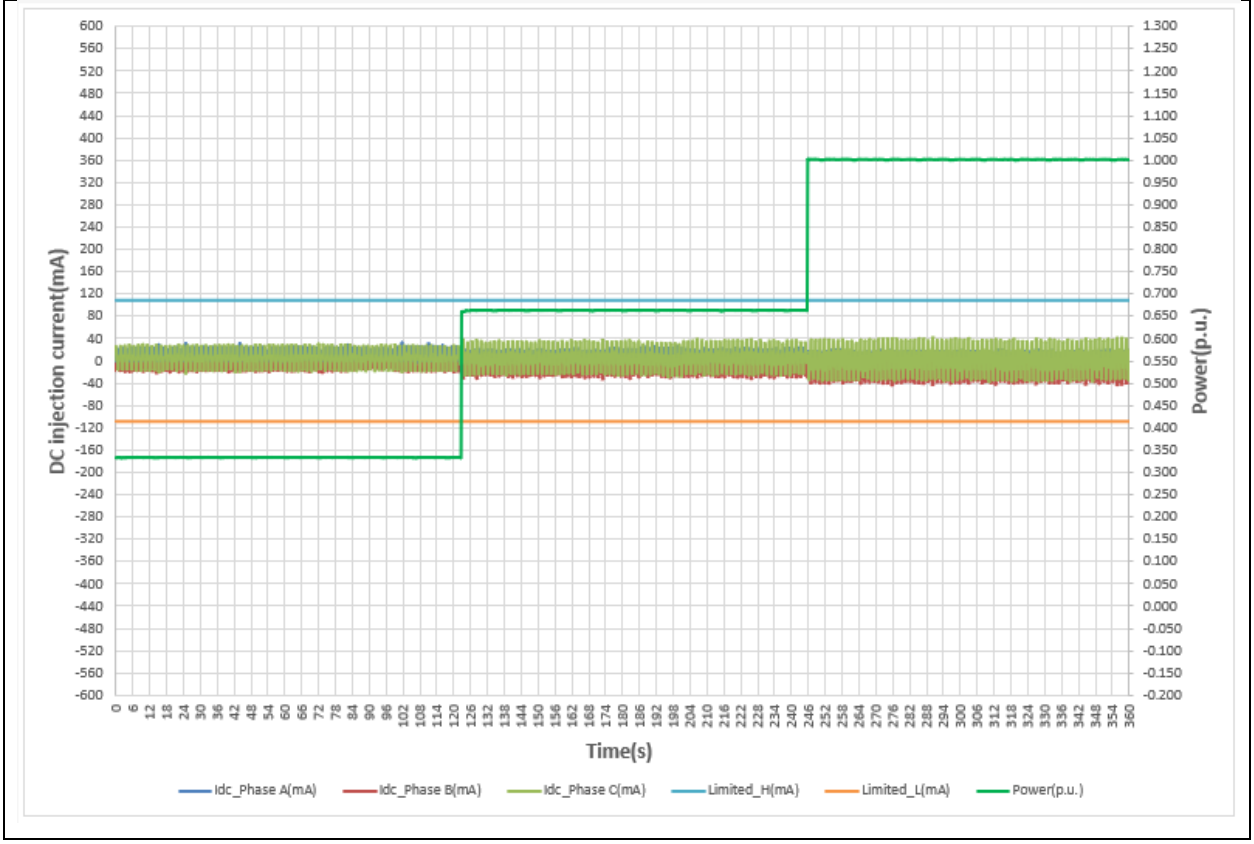
4.3 POWER QUALITY

4.3.1 DC Content

According to chapter 4.2 of the standard, the DC content of the supplied AC current in the plant's Point of Connection (POC) may not exceed 0.5% of the nominal current.

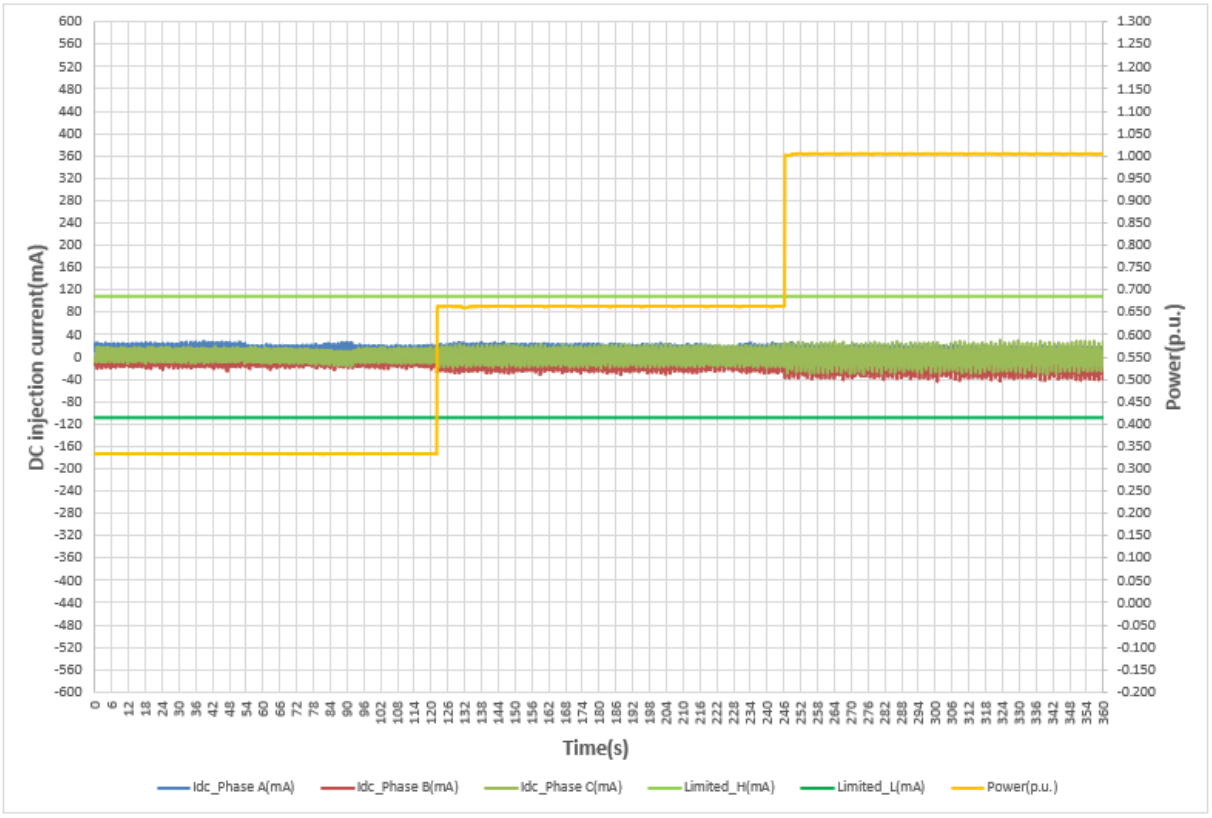
DC component emission test (-10ºC)			
Power Lever	**Min ~ 33%**	**Medium ~ 66%**	**Max ~ 100%**
Watt(W)	5001	9948	15021
Vrms(V)	230.3	230.6	230.8
Arms(A)	7.3	14.4	21.7
PF	0.998	0.999	1.000
Phase A			
d.c.(mA)	10	7	4
d.c(% In)	0.05	0.03	0.02
Phase B			
d.c.(mA)	-10	-14	-18
d.c(% In)	-0.04	-0.06	-0.08
Phase C			
d.c.(mA)	5	5	2
d.c(% In)	0.02	0.02	0.01

DC component emission test (-10ºC)



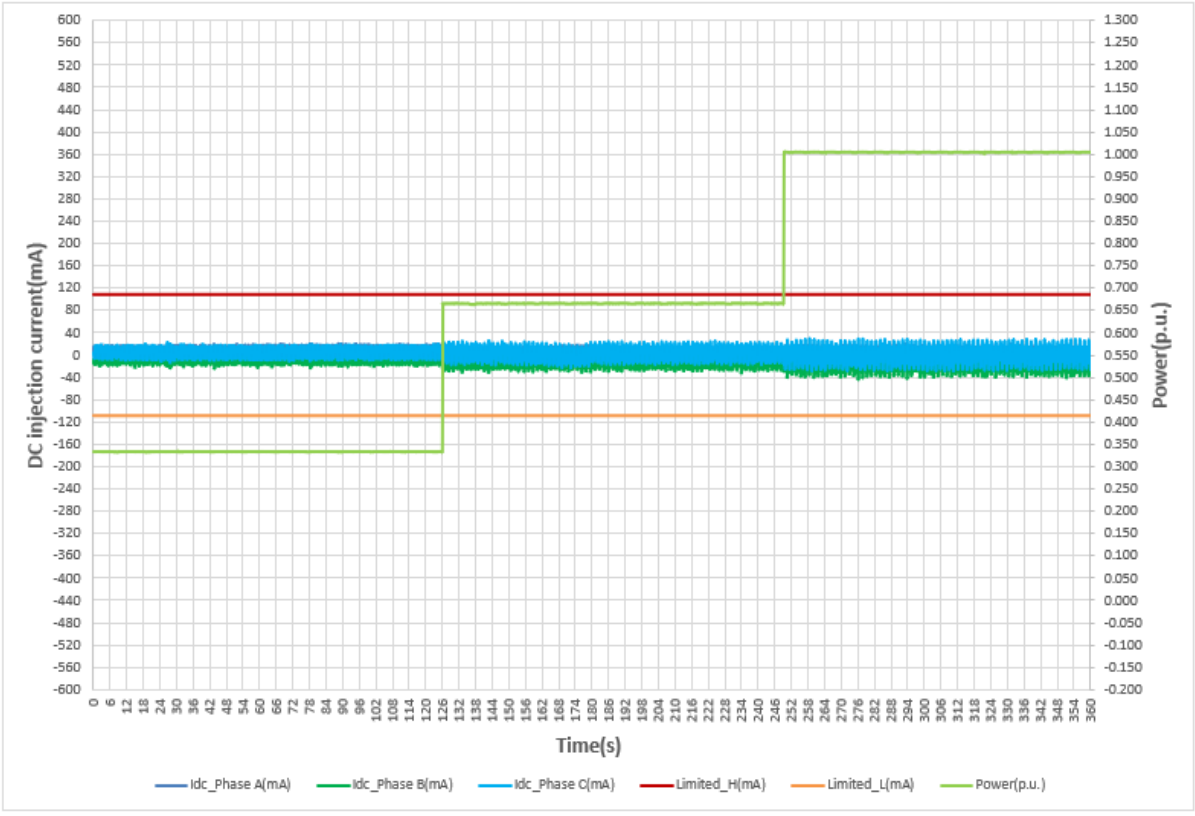
DC component emission test (22ºC)			
Power Lever	**Min ~ 33%**	**Medium ~ 66%**	**Max ~ 100%**
Watt(W)	5002	9949	15069
Vrms(V)	230.3	230.6	230.8
Arms(A)	14.4	14.4	21.8
PF	0.998	0.999	1.000
Phase A			
d.c.(mA)	13	13	10
d.c(% In)	0.06	0.06	0.06
Phase B			
d.c.(mA)	-11	-14	-20
d.c(% In)	-0.05	-0.06	-0.09
Phase C			
d.c.(mA)	3	1	-1
d.c(% In)	0.01	0.01	0.00

DC component emission test (22ºC)



DC component emission test (55ºC)			
Power Lever	**Min ~ 33%**	**Medium ~ 66%**	**Max ~ 100%**
Watt(W)	5001	9978	15067
Vrms(V)	230.3	230.6	230.8
Arms(A)	7.3	14.4	21.8
PF	0.998	0.999	1.000
Phase A			
d.c.(mA)	8	5	7
d.c(% In)	0.10	0.02	0.09
Phase B			
d.c.(mA)	-11	-14	-19
d.c(% In)	-0.05	-0.07	-0.09
Phase C			
d.c.(mA)	4	2	0
d.c(% In)	0.02	0.01	0.00

DC component emission test (55ºC)



4.3.2 Asymmetry

According to chapter 4.3 of the standard, the asymmetry between the phases at normal operation or in the event of faults in the electricity generating unit may not exceed 16A.

Below is the maximum asymmetry tested at normal and fault conditions.

Normal operation 100%Pn				
	Maximum Asymmetry between Phase A and B	**Maximum Asymmetry between Phase A and C**	**Maximum Asymmetry between Phase B and C**	**Asymmetry Required**
Current	-0.060 A	0.000 A	0.061 A	< 16A

Fault operation 100%Pn				
	Maximum Asymmetry between Phase A and B	**Maximum Asymmetry between Phase A and B**	**Maximum Asymmetry between Phase A and B**	**Asymmetry Required**
Current	-0.053 A	0.001 A	0.055 A	< 16A

4.3.3 Flicker

Test is to verify that the flicker emission from continuous operation of the PV power plant is below the limit value in the Point of Connection according to chapter 4.4 of the standard.

The measurements of voltage fluctuations have been measured according to the standard, at 33%, 66% and 100 % of the nominal power value of the inverter.

Starting operation and Stopping operation 33%Pn				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1.0	0.23	0.14	0.19
PLT	≤ 0.65	0.19	0.12	0.16
dc	≤ 3.30%	0.10%	0.15%	0.19%
dmax	4%	0.41%	0.31%	0.39%

Starting operation and Stopping operation 66%Pn				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1.0	0.25	0.16	0.20
PLT	≤ 0.65	0.21	0.13	0.16
dc	≤ 3.30%	0.16%	0.30%	0.30%
dmax	4%	0.47%	0.47%	0.41%

Starting operation and Stopping operation 100%Pn				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1.0	0.26	0.17	0.20
PLT	≤ 0.65	0.21	0.14	0.17
dc	≤ 3.30%	0.29%	0.30%	0.36%
dmax	4%	0.97%	0.49%	0.73%

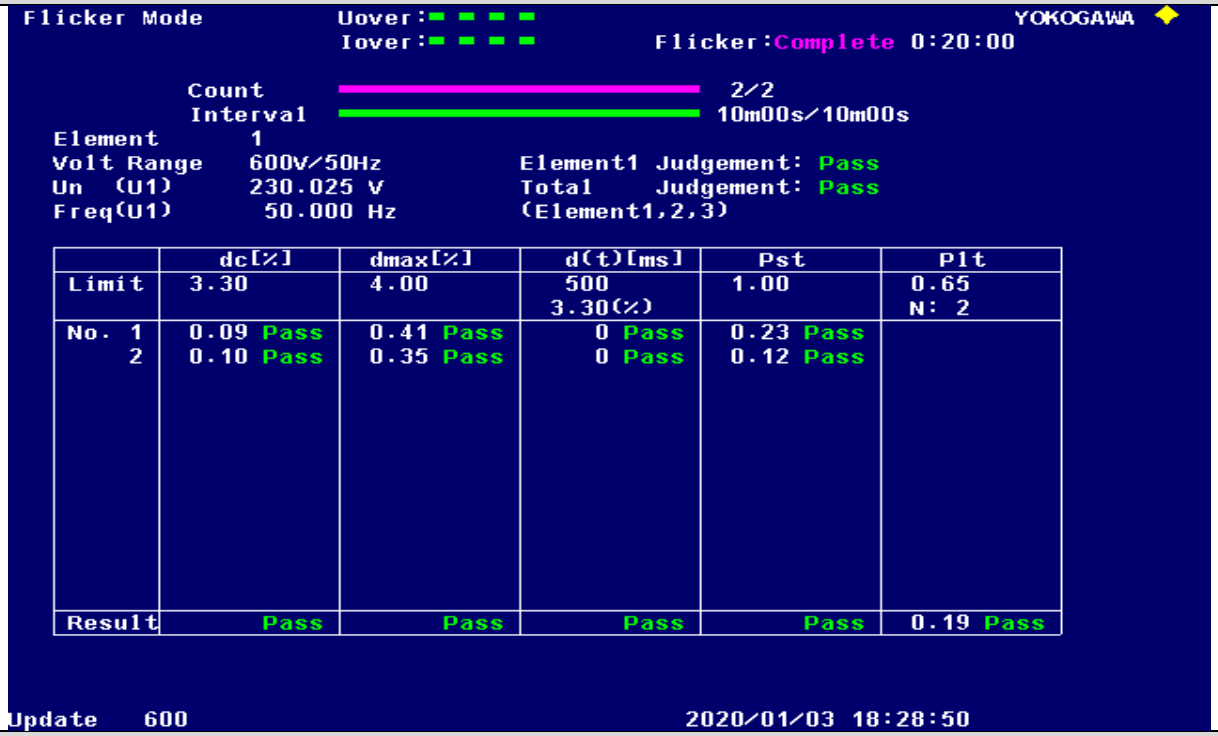
As it can be seen in the next screenshots, this test has two steps and 10min for each step:

1. Starting operation
2. Stopping operation

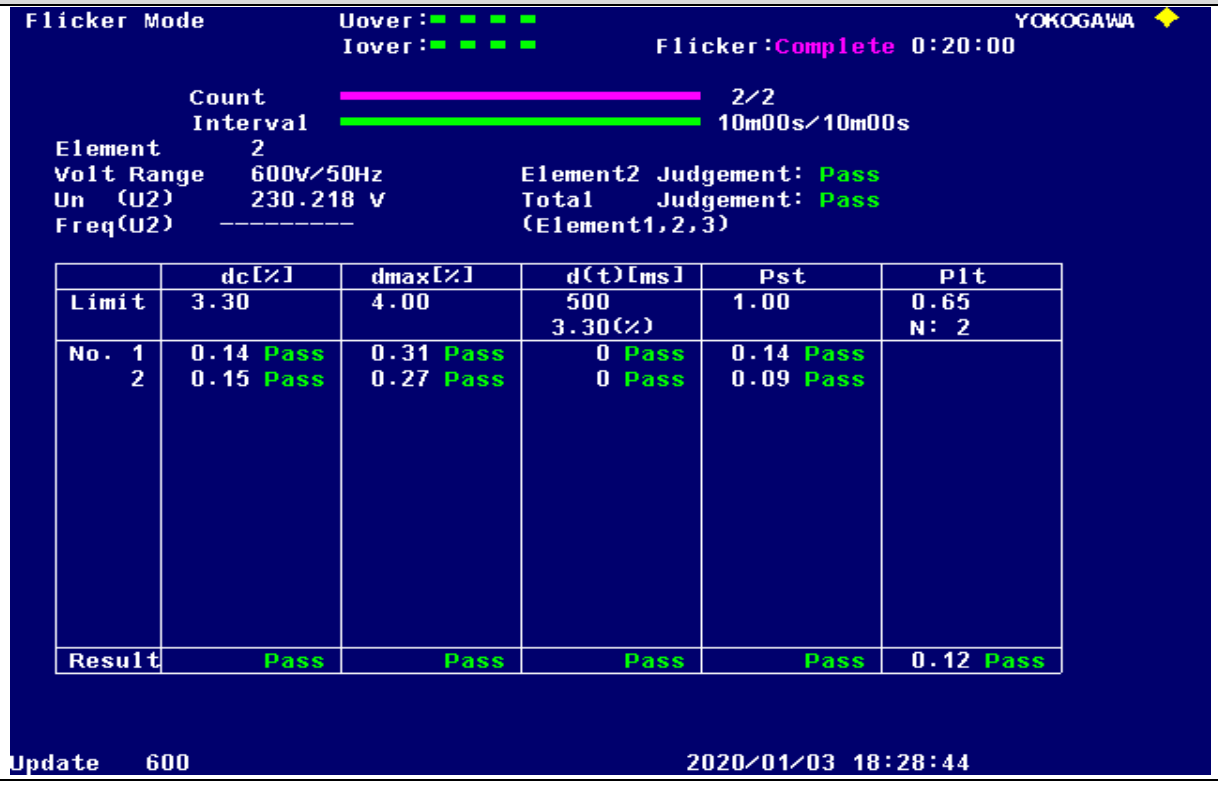
All values are the most unfavorable of the two steps.

Starting operation and Stopping operation 33% Pn

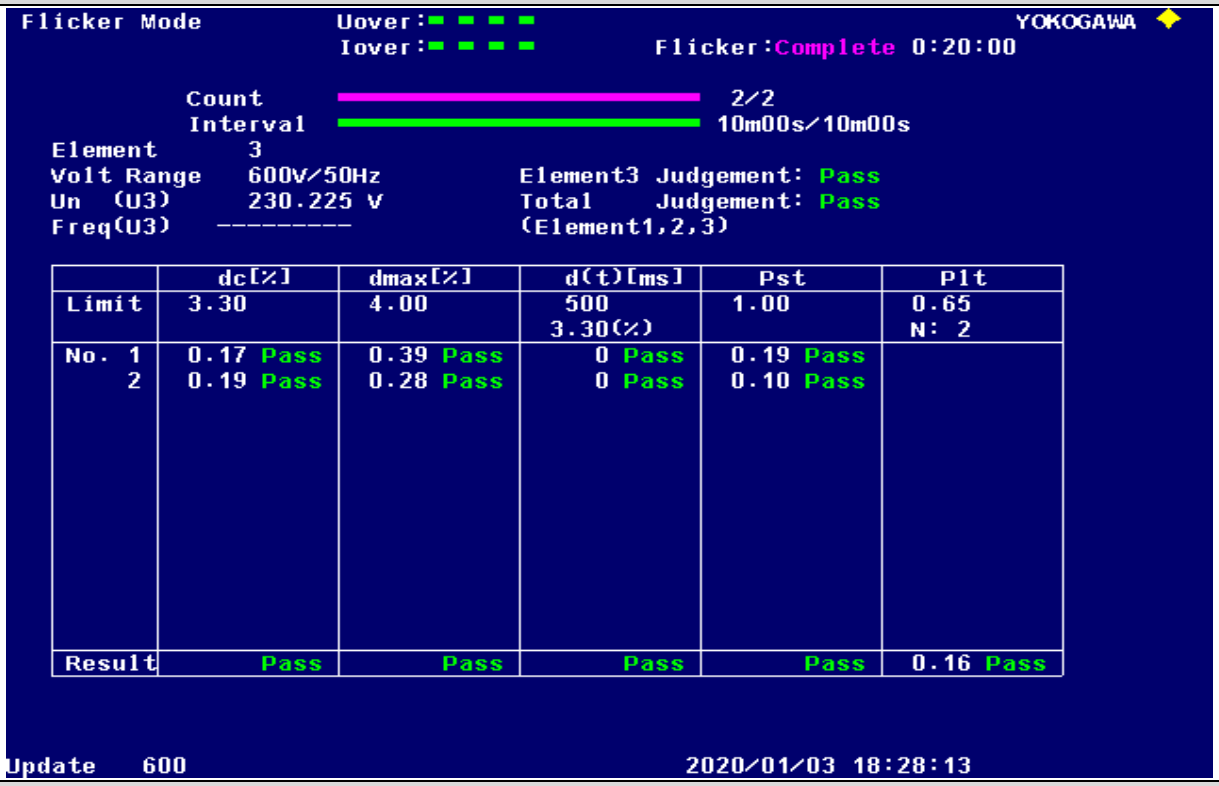
Phase A



Phase B

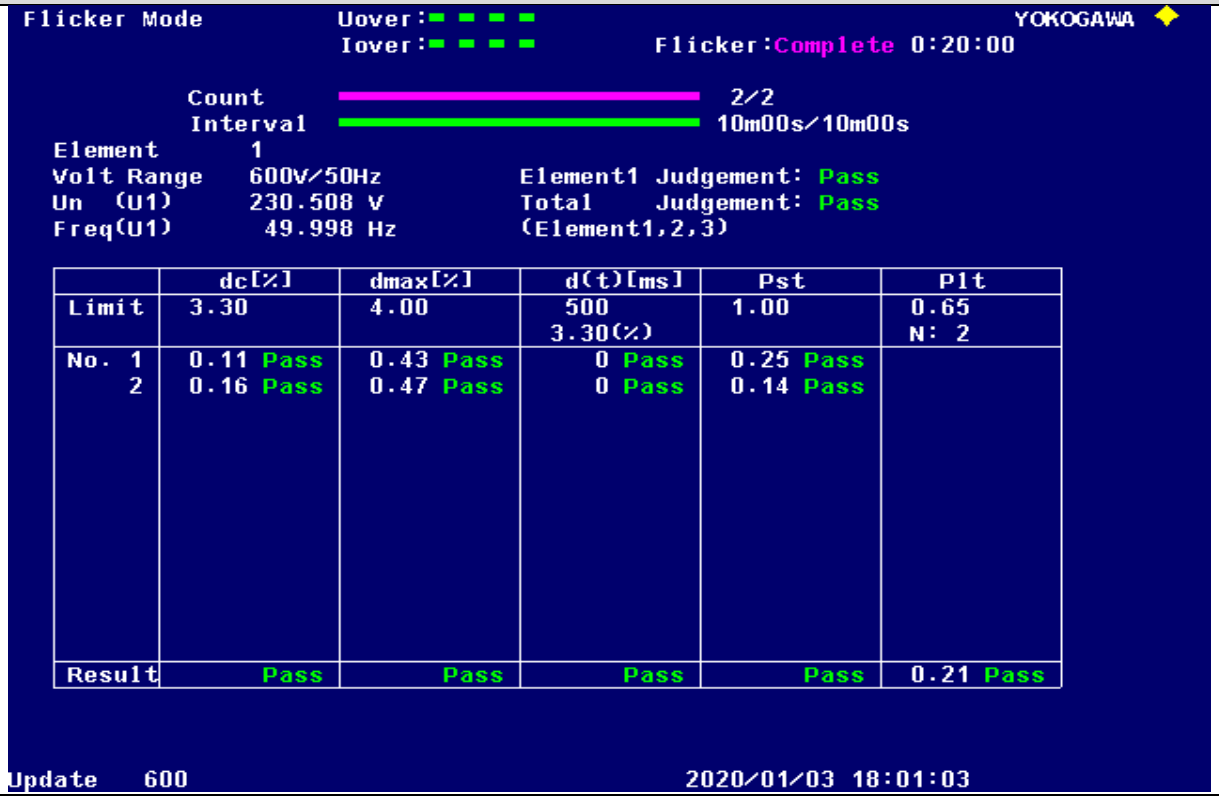


Phase C

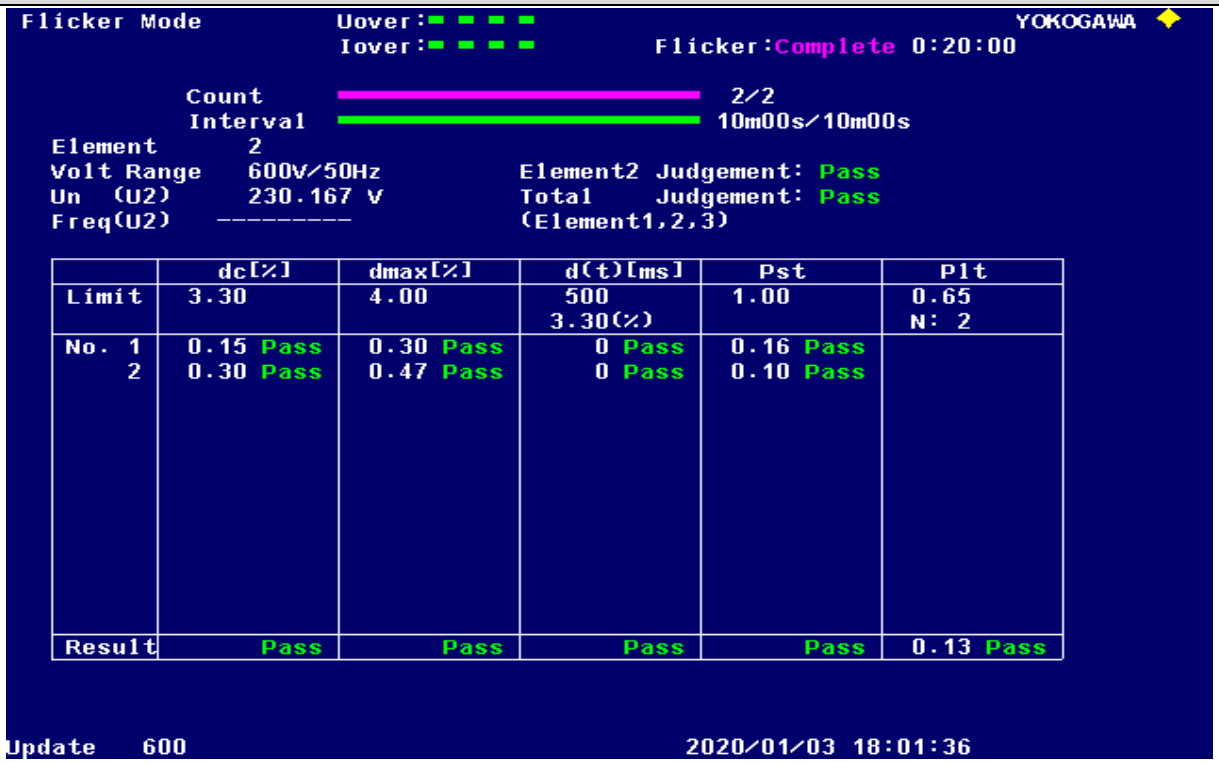


Starting operation and Stopping operation 66% Pn

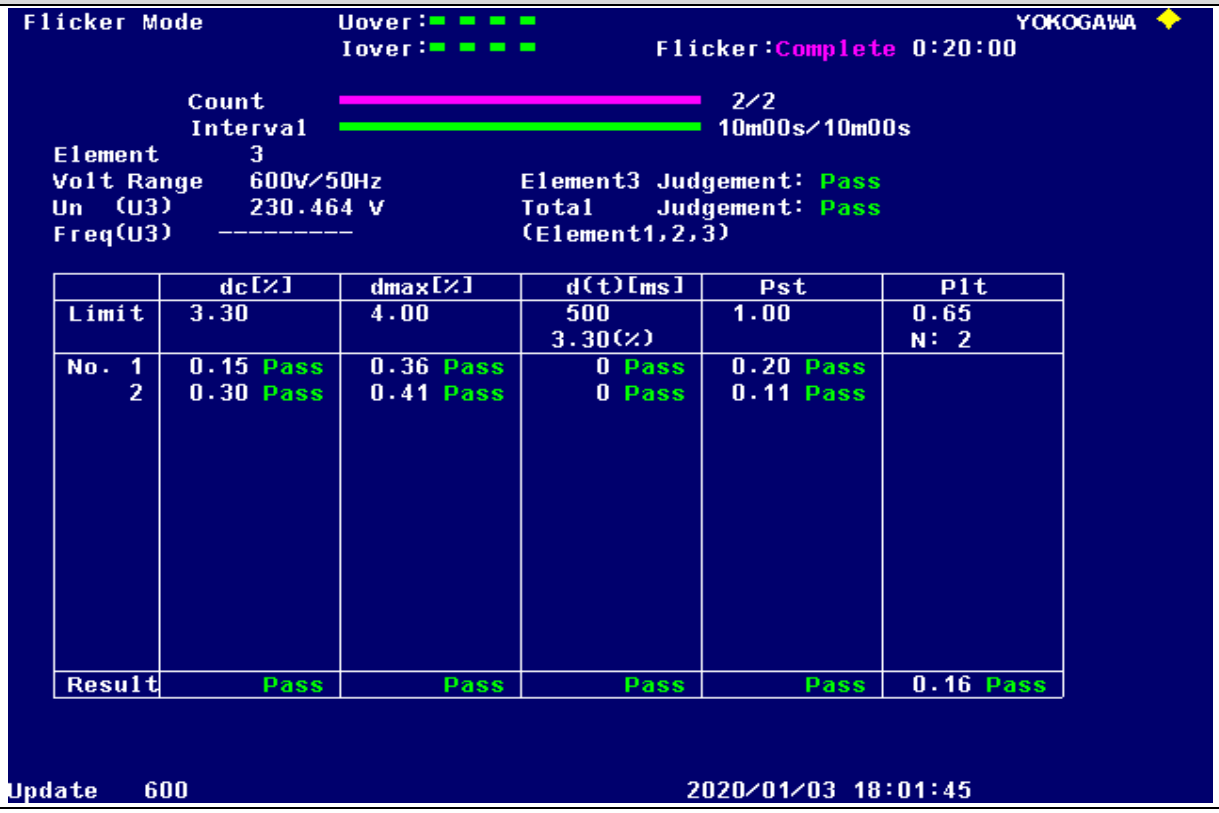
Phase A



Phase B

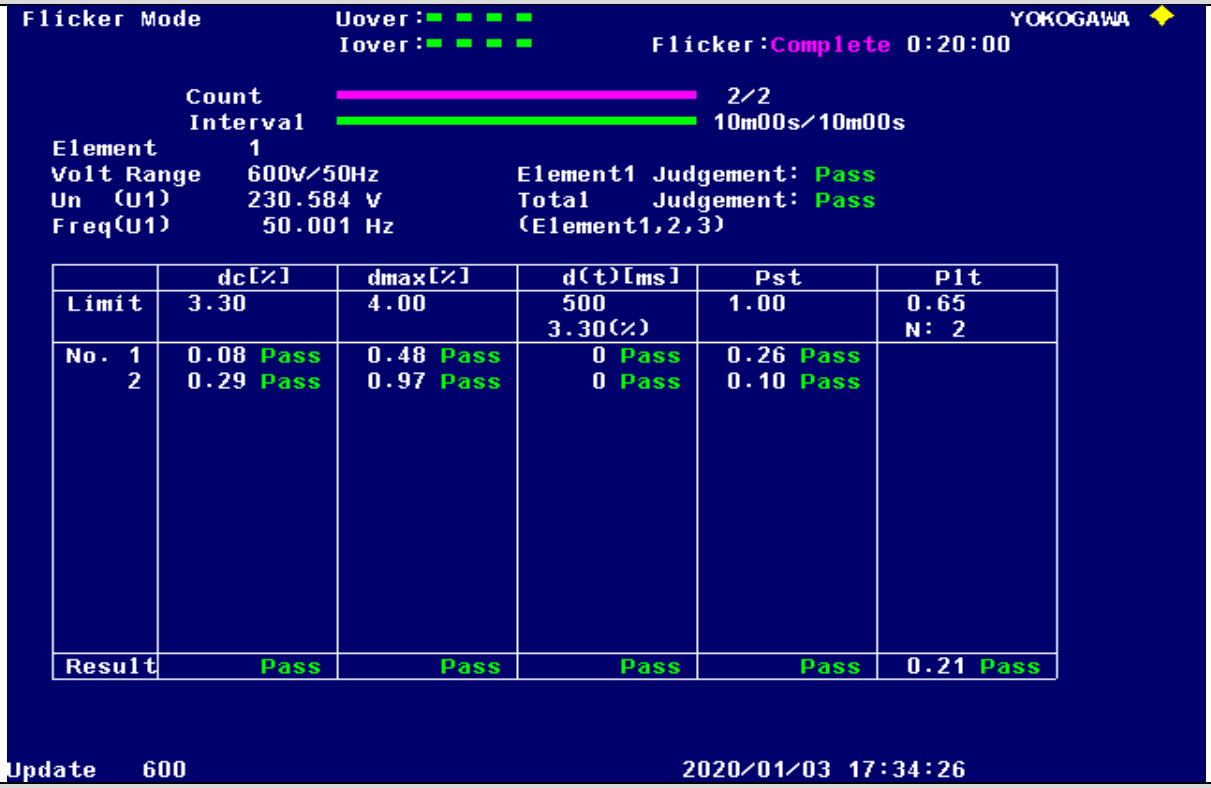


Phase C

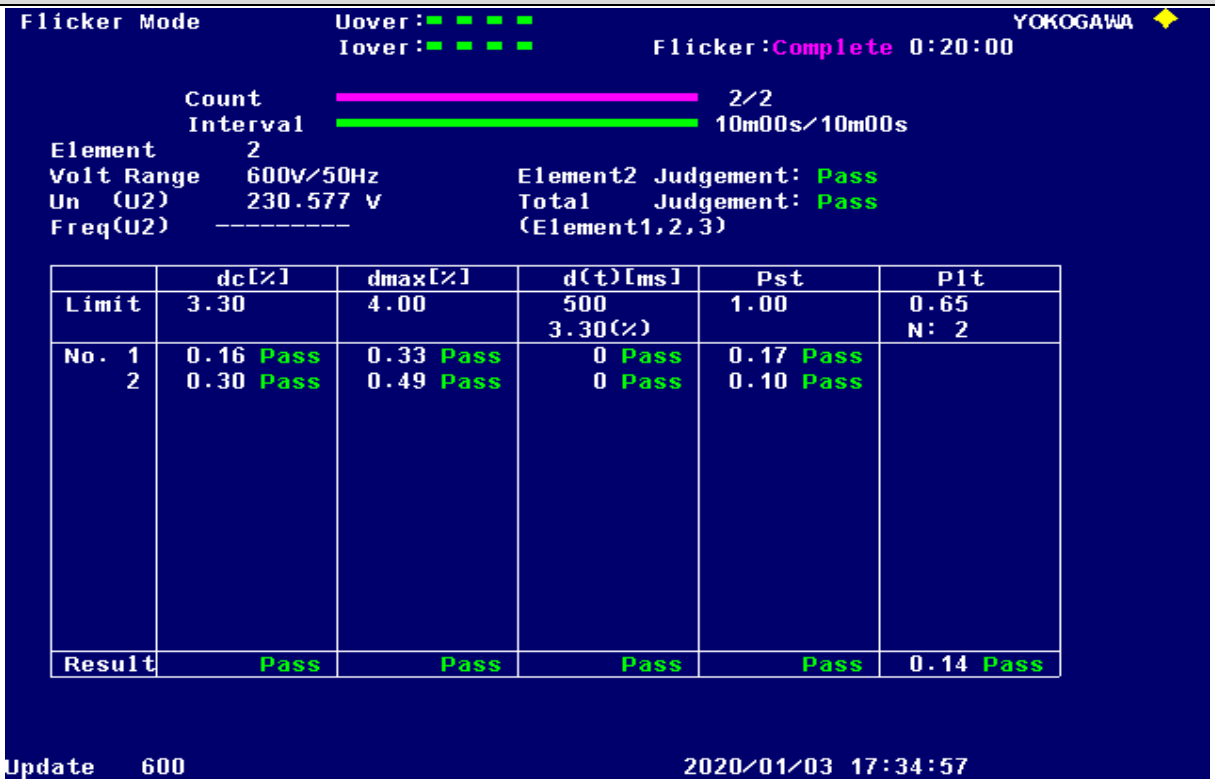


Starting operation and Stopping operation 100% Pn

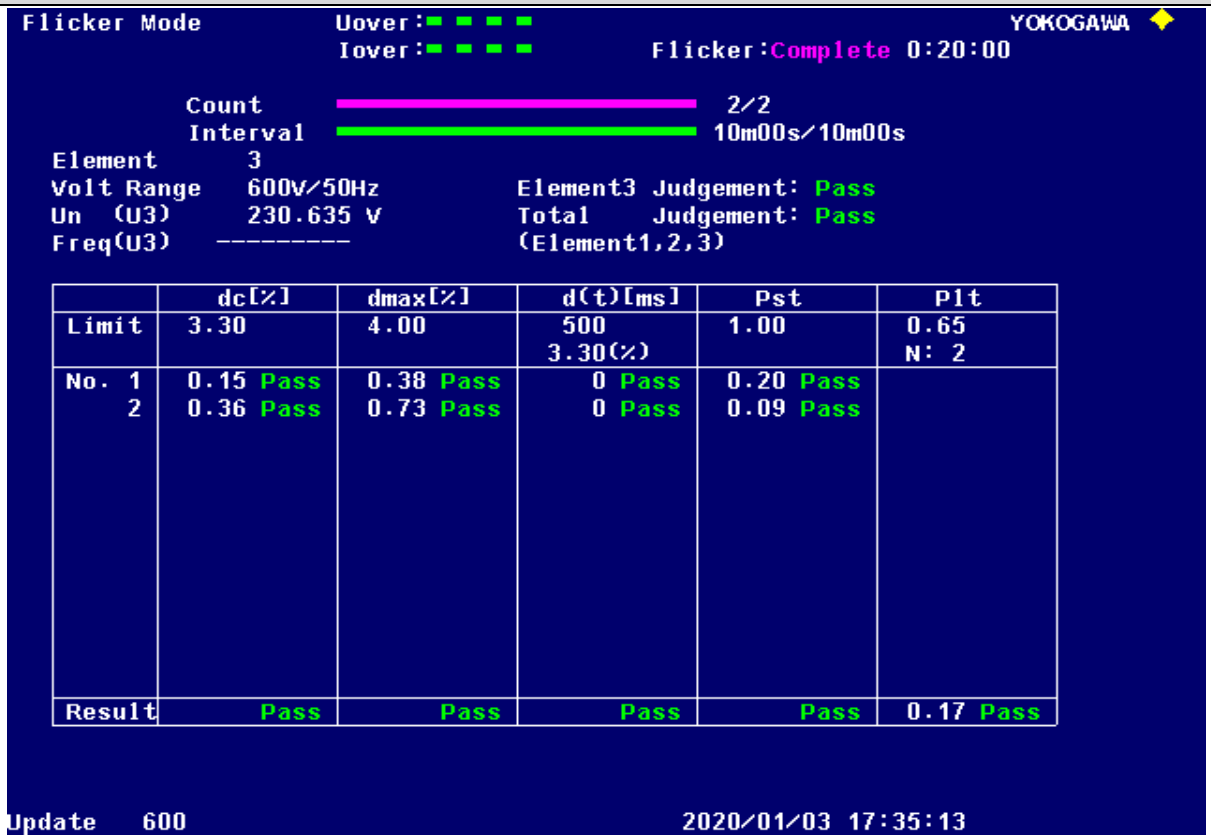
Phase A



Phase B



Phase C


Flicker Mode
Uover:
Iover:
YOKOGAWA
Flicker:Complete 0:20:00
Count
2/2
Interval
10m00s/10m00s
Element 3
Volt Range 600V/50Hz
Un (U3) 230.635 V
Freq(U3) ---------
Element3 Judgement: Pass
Total Judgement: Pass
(Element1,2,3)
dc[%] dmax[%] d(t)[ms] Pst Plt
Limit 3.30 4.00 500 1.00 0.65
3.30(%) N: 2
No. 1 0.15 Pass 0.38 Pass 0 Pass 0.20 Pass
2 0.36 Pass 0.73 Pass 0 Pass 0.09 Pass
Result Pass Pass Pass Pass 0.17 Pass
Update 600
2020/01/03 17:35:13

Running operation 33%				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1.0	0.34	0.31	0.30
PLT	≤ 0.65	0.28	0.29	0.27
dc	≤ 3.30%	0.27%	0.28%	0.35%
dmax	4%	1.24%	1.29%	1.09%

Running operation 66%				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1.0	0.29	0.31	0.30
PLT	≤ 0.65	0.29	0.26	0.29
dc	≤ 3.30%	0.27%	0.23%	0.36%
dmax	4%	1.36%	1.23%	1.36%

Running operation 100%				
Pbin (%)	**Limit**	**Phase A**	**Phase B**	**Phase C**
PST	≤ 1	0.35	0.33	0.27
PLT	≤ 0.65	0.29	0.29	0.26
dc	≤ 3.30%	0.26%	0.35%	0.40%
dmax	4%	1.49%	1.49%	1.51%

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 of 10 minutes each one.

Running operation

33% Pn Phase A

Flicker Mode Uover:▬ ▬ ▬ ▬ U1-3 : 600V YOKOGAWA
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 1
Volt Range 600V/50Hz Element1 Judgement: Pass
Un (U1) 231.004 V Total Judgement: Pass
Freq(U1) 50.007 Hz (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.17 Pass	1.18 Pass	0 Pass	0.32 Pass	
2	0.21 Pass	1.21 Pass	0 Pass	0.34 Pass	
3	0.16 Pass	1.21 Pass	0 Pass	0.32 Pass	
4	0.18 Pass	1.24 Pass	0 Pass	0.28 Pass	
5	0.17 Pass	1.23 Pass	0 Pass	0.28 Pass	
6	0.27 Pass	1.20 Pass	0 Pass	0.28 Pass	
7	0.13 Pass	1.24 Pass	0 Pass	0.29 Pass	
8	0.21 Pass	1.20 Pass	0 Pass	0.27 Pass	
9	0.16 Pass	1.21 Pass	0 Pass	0.27 Pass	
10	0.18 Pass	1.24 Pass	0 Pass	0.27 Pass	
11	0.17 Pass	1.23 Pass	0 Pass	0.27 Pass	
12	0.24 Pass	1.20 Pass	0 Pass	0.28 Pass	
Result	Pass	Pass	Pass	Pass	0.28 Pass

Update 3600 2020/03/07 11:28:58

33% Pn Phase B

Flicker Mode Uover:▬ ▬ ▬ ▬ U1-3 : 600V YOKOGAWA
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 2
Volt Range 600V/50Hz Element2 Judgement: Pass
Un (U2) 231.150 V Total Judgement: Pass
Freq(U2) --------- (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.19 Pass	1.24 Pass	0 Pass	0.31 Pass	
2	0.21 Pass	1.21 Pass	0 Pass	0.28 Pass	
3	0.16 Pass	1.24 Pass	0 Pass	0.28 Pass	
4	0.18 Pass	1.23 Pass	0 Pass	0.29 Pass	
5	0.17 Pass	1.23 Pass	0 Pass	0.31 Pass	
6	0.22 Pass	1.26 Pass	0 Pass	0.30 Pass	
7	0.24 Pass	1.28 Pass	0 Pass	0.28 Pass	
8	0.24 Pass	1.26 Pass	0 Pass	0.28 Pass	
9	0.19 Pass	1.25 Pass	0 Pass	0.28 Pass	
10	0.27 Pass	1.29 Pass	0 Pass	0.28 Pass	
11	0.28 Pass	1.23 Pass	0 Pass	0.28 Pass	
12	0.26 Pass	1.26 Pass	0 Pass	0.28 Pass	
Result	Pass	Pass	Pass	Pass	0.29 Pass

Update 3600 2020/03/07 11:29:29

33% Pn Phase C

Flicker Mode Uover:▬ ▬ ▬ ▬ U1-3 : 600V YOKOGAWA ◆
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 3
Volt Range 600V/50Hz Element3 Judgement: Pass
Un (U3) 230.600 V Total Judgement: Pass
Freq(U3) --------- (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	0.30 Pass	1.01 Pass	0 Pass	0.24 Pass	
2	0.19 Pass	1.06 Pass	0 Pass	0.25 Pass	
3	0.19 Pass	1.00 Pass	0 Pass	0.25 Pass	
4	0.27 Pass	1.09 Pass	0 Pass	0.24 Pass	
5	0.28 Pass	1.05 Pass	0 Pass	0.25 Pass	
6	0.35 Pass	1.07 Pass	0 Pass	0.25 Pass	
7	0.21 Pass	1.06 Pass	0 Pass	0.28 Pass	
8	0.16 Pass	1.09 Pass	0 Pass	0.28 Pass	
9	0.18 Pass	1.00 Pass	0 Pass	0.30 Pass	
10	0.17 Pass	1.09 Pass	0 Pass	0.28 Pass	
11	0.30 Pass	1.05 Pass	0 Pass	0.28 Pass	
12	0.30 Pass	1.00 Pass	0 Pass	0.25 Pass	
Result	Pass	Pass	Pass	Pass	0.27 Pass

Update 3600 2020/03/07 11:29:35

Running operation

66% Pn Phase A

Flicker Mode Uover:▬ ▬ ▬ ▬ YOKOGAWA ◆
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 1
Volt Range 600V/50Hz Element1 Judgement: Pass
Un (U1) 230.300 V Total Judgement: Pass
Freq(U1) 49.999 Hz (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	0.27 Pass	1.21 Pass	0 Pass	0.28 Pass	
2	0.20 Pass	1.22 Pass	0 Pass	0.29 Pass	
3	0.16 Pass	1.20 Pass	0 Pass	0.28 Pass	
4	0.22 Pass	1.27 Pass	0 Pass	0.23 Pass	
5	0.21 Pass	1.36 Pass	0 Pass	0.28 Pass	
6	0.18 Pass	1.13 Pass	0 Pass	0.22 Pass	
7	0.20 Pass	1.22 Pass	0 Pass	0.28 Pass	
8	0.16 Pass	1.20 Pass	0 Pass	0.29 Pass	
9	0.22 Pass	1.27 Pass	0 Pass	0.29 Pass	
10	0.21 Pass	1.36 Pass	0 Pass	0.22 Pass	
11	0.18 Pass	1.24 Pass	0 Pass	0.28 Pass	
12	0.27 Pass	1.20 Pass	0 Pass	0.29 Pass	
Result	Pass	Pass	Pass	Pass	0.29 Pass

Update 3600 2020/03/07 11:28:58

66% Pn Phase B

Flicker Mode Uover:▬ ▬ ▬ ▬ YOKOGAWA
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 2
Volt Range 600V/50Hz Element2 Judgement: Pass
Un (U2) 230.228 V Total Judgement: Pass
Freq(U2) --------- (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	0.19 Pass	1.10 Pass	0 Pass	0.26 Pass	
2	0.15 Pass	1.23 Pass	0 Pass	0.22 Pass	
3	0.22 Pass	1.23 Pass	0 Pass	0.25 Pass	
4	0.21 Pass	1.10 Pass	0 Pass	0.22 Pass	
5	0.18 Pass	1.07 Pass	0 Pass	0.26 Pass	
6	0.13 Pass	1.05 Pass	0 Pass	0.22 Pass	
7	0.13 Pass	1.04 Pass	0 Pass	0.25 Pass	
8	0.19 Pass	1.05 Pass	0 Pass	0.25 Pass	
9	0.15 Pass	1.10 Pass	0 Pass	0.25 Pass	
10	0.23 Pass	1.10 Pass	0 Pass	0.31 Pass	
11	0.23 Pass	1.23 Pass	0 Pass	0.26 Pass	
12	0.20 Pass	1.20 Pass	0 Pass	0.29 Pass	
Result	Pass	Pass	Pass	Pass	0.26 Pass

Update 3600 2020/03/07 13:34:13

66% Pn Phase C

0.28:ker Mode Uover:▬ ▬ ▬ ▬ YOKOGAWA
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 3
Volt Range 600V/50Hz Element3 Judgement: Pass
Un (U3) 230.030 V Total Judgement: Pass
Freq(U3) --------- (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	0.23 Pass	1.21 Pass	0 Pass	0.29 Pass	
2	0.24 Pass	1.36 Pass	0 Pass	0.24 Pass	
3	0.25 Pass	1.28 Pass	0 Pass	0.29 Pass	
4	0.26 Pass	1.29 Pass	0 Pass	0.28 Pass	
5	0.22 Pass	1.32 Pass	0 Pass	0.29 Pass	
6	0.21 Pass	1.33 Pass	0 Pass	0.28 Pass	
7	0.18 Pass	1.29 Pass	0 Pass	0.30 Pass	
8	0.19 Pass	1.26 Pass	0 Pass	0.29 Pass	
9	0.24 Pass	1.36 Pass	0 Pass	0.29 Pass	
10	0.25 Pass	1.28 Pass	0 Pass	0.28 Pass	
11	0.26 Pass	1.29 Pass	0 Pass	0.28 Pass	
12	0.36 Pass	1.26 Pass	0 Pass	0.30 Pass	
Result	Pass	Pass	Pass	Pass	0.29 Pass

Update 3600 2020/03/07 13:34:30

Running operation

100% Pn Phase A

Flicker Mode   Uover:■ ■ ■ ■   U1-3 : 600V   YOKOGAWA ◆
Iover:■ ■ ■ ■   Flicker:Complete 2:00:00

Count   12/12
Interval   10m00s/10m00s

Element 1
Volt Range 600V/50Hz   Element1 Judgement: Pass
Un (U1) 231.200 V   Total Judgement: Pass
Freq(U1) 50.001 Hz   (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	0.25 Pass	1.28 Pass	0 Pass	0.25 Pass	
2	0.13 Pass	1.23 Pass	0 Pass	0.24 Pass	
3	0.24 Pass	1.30 Pass	0 Pass	0.23 Pass	
4	0.13 Pass	1.49 Pass	0 Pass	0.28 Pass	
5	0.20 Pass	1.31 Pass	0 Pass	0.25 Pass	
6	0.13 Pass	1.28 Pass	0 Pass	0.24 Pass	
7	0.25 Pass	1.24 Pass	0 Pass	0.28 Pass	
8	0.24 Pass	1.25 Pass	0 Pass	0.27 Pass	
9	0.13 Pass	1.42 Pass	0 Pass	0.32 Pass	
10	0.20 Pass	1.29 Pass	0 Pass	0.29 Pass	
11	0.18 Pass	1.23 Pass	0 Pass	0.35 Pass	
12	0.26 Pass	1.23 Pass	0 Pass	0.32 Pass	
Result	Pass	Pass	Pass	Pass	0.29 Pass

Update 3600   2020/03/07 15:40:50

100% Pn Phase B

Flicker Mode   Uover:■ ■ ■ ■   U1-3 : 600V   YOKOGAWA ◆
Iover:■ ■ ■ ■   Flicker:Complete 2:00:00

Count   12/12
Interval   10m00s/10m00s

Element 2
Volt Range 600V/50Hz   Element2 Judgement: Pass
Un (U2) 231.008 V   Total Judgement: Pass
Freq(U2) ---------   (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	0.28 Pass	1.23 Pass	0 Pass	0.33 Pass	
2	0.13 Pass	1.49 Pass	0 Pass	0.31 Pass	
3	0.20 Pass	1.31 Pass	0 Pass	0.24 Pass	
4	0.18 Pass	1.26 Pass	0 Pass	0.27 Pass	
5	0.24 Pass	1.27 Pass	0 Pass	0.30 Pass	
6	0.24 Pass	1.34 Pass	0 Pass	0.30 Pass	
7	0.24 Pass	1.30 Pass	0 Pass	0.27 Pass	
8	0.13 Pass	1.49 Pass	0 Pass	0.30 Pass	
9	0.20 Pass	1.31 Pass	0 Pass	0.33 Pass	
10	0.35 Pass	1.31 Pass	0 Pass	0.33 Pass	
11	0.20 Pass	1.26 Pass	0 Pass	0.31 Pass	
12	0.31 Pass	1.27 Pass	0 Pass	0.27 Pass	
Result	Pass	Pass	Pass	Pass	0.29 Pass

Update 3600   2020/03/07 15:41:24

100% Pn Phase C

Flicker Mode Uover:▬ ▬ ▬ ▬ U1-3 : 600V YOKOGAWA ◆
Iover:▬ ▬ ▬ ▬ Flicker:Complete 2:00:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 12/12
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s

Element 3
Volt Range 600V/50Hz Element3 Judgement: Pass
Un (U3) 231.226 V Total Judgement: Pass
Freq(U3) --------- (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.39 Pass	1.01 Pass	0 Pass	0.26 Pass	
2	0.28 Pass	1.49 Pass	0 Pass	0.26 Pass	
3	0.24 Pass	1.31 Pass	0 Pass	0.23 Pass	
4	0.13 Pass	1.26 Pass	0 Pass	0.25 Pass	
5	0.20 Pass	1.51 Pass	0 Pass	0.25 Pass	
6	0.21 Pass	1.28 Pass	0 Pass	0.26 Pass	
7	0.19 Pass	1.01 Pass	0 Pass	0.25 Pass	
8	0.28 Pass	1.10 Pass	0 Pass	0.25 Pass	
9	0.17 Pass	1.07 Pass	0 Pass	0.27 Pass	
10	0.17 Pass	1.28 Pass	0 Pass	0.23 Pass	
11	0.40 Pass	1.28 Pass	0 Pass	0.25 Pass	
12	0.21 Pass	1.07 Pass	0 Pass	0.25 Pass	
Result	Pass	Pass	Pass	Pass	0.26 Pass

Update 3600 2020/03/07 15:42:10

4.3.4 Harmonic Distortions

Test is according to chapter 4.5 of the standard TR3.2.2.

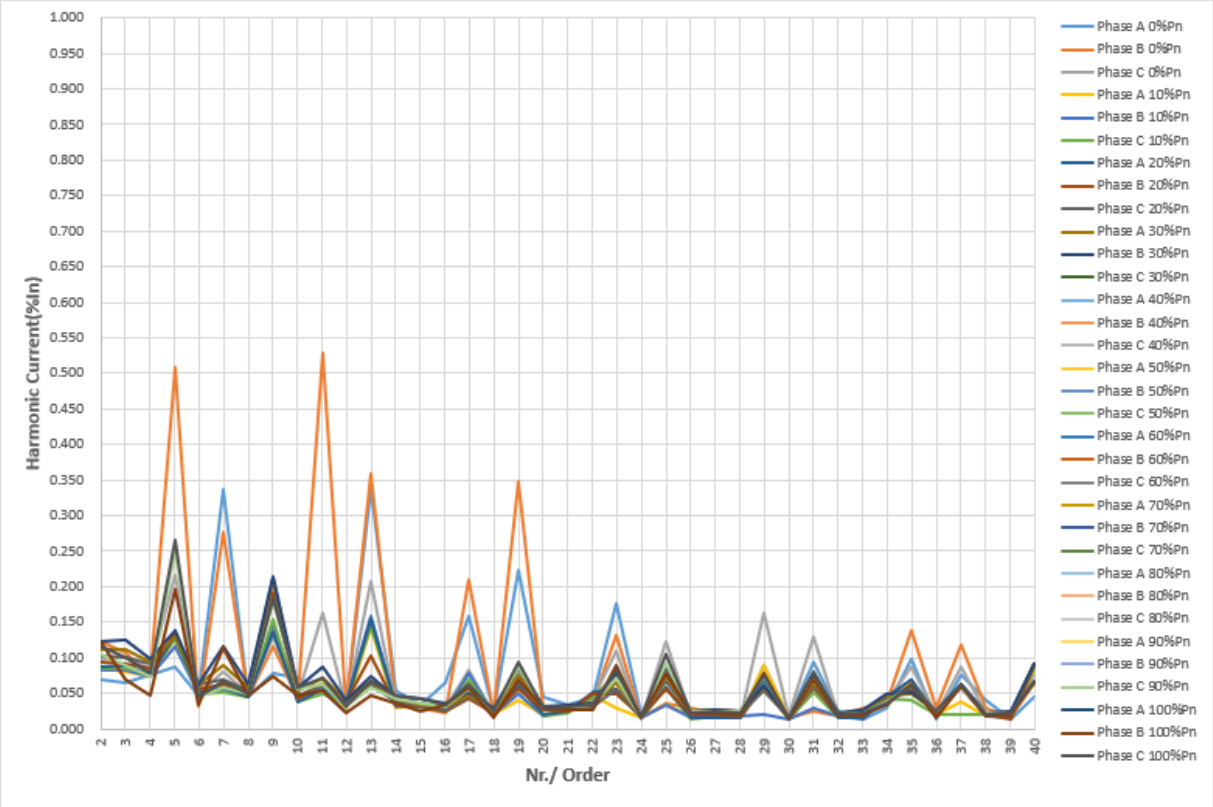
The results of harmonics measurements are represented in the tables and graphics below

Phase A													
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category A2 Limit**	**Category B Limit**
Nr./ Order	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2	0.070	0.123	0.098	0.085	0.083	0.084	0.087	0.095	0.104	0.112	0.122	-	-
3	0.065	0.106	0.101	0.081	0.082	0.085	0.089	0.092	0.101	0.111	0.125	-	-
4	0.076	0.073	0.084	0.073	0.073	0.077	0.076	0.085	0.092	0.093	0.098	-	-
5	0.088	0.510	0.216	0.128	0.115	0.128	0.132	0.135	0.129	0.128	0.139	10.7	3.6
6	0.047	0.031	0.050	0.048	0.048	0.050	0.052	0.056	0.062	0.062	0.063	-	-
7	0.337	0.277	0.080	0.061	0.055	0.051	0.059	0.062	0.069	0.088	0.117	7.2	2.5
8	0.044	0.044	0.049	0.051	0.048	0.044	0.045	0.048	0.053	0.059	0.063	-	-
9	0.078	0.117	0.129	0.142	0.147	0.153	0.137	0.193	0.209	0.212	0.215	-	-
10	0.072	0.043	0.047	0.045	0.043	0.038	0.039	0.042	0.047	0.054	0.058	-	-
11	0.052	0.529	0.163	0.065	0.064	0.049	0.056	0.062	0.061	0.072	0.088	3.1	1.0
12	0.027	0.032	0.032	0.030	0.036	0.036	0.036	0.037	0.038	0.040	0.040	-	-
13	0.338	0.358	0.209	0.144	0.158	0.144	0.154	0.102	0.062	0.068	0.074	2	0.7
14	0.054	0.036	0.034	0.029	0.032	0.033	0.034	0.034	0.038	0.042	0.045	-	-
15	0.035	0.029	0.028	0.033	0.035	0.032	0.032	0.031	0.032	0.034	0.043	-	-
16	0.064	0.022	0.028	0.026	0.026	0.024	0.025	0.024	0.027	0.032	0.036	-	-
17	0.158	0.210	0.082	0.054	0.079	0.069	0.048	0.044	0.044	0.047	0.052	-	-
18	0.024	0.021	0.020	0.019	0.020	0.022	0.021	0.023	0.027	0.027	0.028	-	-
19	0.223	0.348	0.090	0.040	0.050	0.063	0.060	0.057	0.066	0.077	0.085	-	-
20	0.045	0.026	0.031	0.020	0.017	0.017	0.021	0.026	0.028	0.031	0.032	-	-
21	0.033	0.027	0.028	0.025	0.027	0.021	0.025	0.025	0.028	0.030	0.033	-	-
22	0.044	0.038	0.043	0.047	0.045	0.045	0.051	0.050	0.032	0.035	0.035	-	-
23	0.177	0.132	0.110	0.029	0.055	0.075	0.057	0.050	0.055	0.064	0.077	-	-
24	0.019	0.017	0.014	0.016	0.015	0.015	0.016	0.018	0.018	0.018	0.018	-	-
25	0.088	0.036	0.123	0.034	0.033	0.058	0.057	0.055	0.067	0.075	0.086	-	-
26	0.021	0.030	0.019	0.017	0.016	0.013	0.015	0.019	0.023	0.025	0.026	-	-
27	0.020	0.022	0.023	0.024	0.020	0.017	0.016	0.020	0.025	0.027	0.026	-	-
28	0.017	0.016	0.016	0.017	0.017	0.015	0.015	0.019	0.022	0.024	0.025	-	-
29	0.089	0.079	0.162	0.090	0.021	0.063	0.069	0.057	0.053	0.057	0.060	-	-
30	0.015	0.016	0.017	0.015	0.015	0.014	0.014	0.016	0.016	0.016	0.017	-	-
31	0.094	0.025	0.129	0.078	0.030	0.050	0.063	0.058	0.060	0.065	0.073	-	-
32	0.025	0.019	0.019	0.018	0.018	0.016	0.016	0.020	0.022	0.022	0.023	-	-
33	0.012	0.028	0.018	0.024	0.014	0.019	0.016	0.017	0.023	0.024	0.026	-	-
34	0.028	0.035	0.038	0.041	0.044	0.043	0.045	0.045	0.046	0.047	0.049	-	-
35	0.098	0.138	0.086	0.067	0.060	0.040	0.069	0.057	0.050	0.048	0.050	-	-
36	0.014	0.029	0.021	0.020	0.018	0.019	0.019	0.022	0.024	0.025	0.025	-	-
37	0.076	0.118	0.087	0.038	0.062	0.020	0.061	0.058	0.058	0.061	0.062	-	-
38	0.039	0.029	0.022	0.019	0.018	0.020	0.018	0.019	0.022	0.022	0.022	-	-
39	0.014	0.016	0.017	0.018	0.018	0.015	0.016	0.013	0.020	0.022	0.024	-	-
40	0.045	0.065	0.077	0.083	0.087	0.088	0.089	0.090	0.091	0.091	0.092	-	-
THD (%)	0.661	1.018	0.540	0.371	0.366	0.371	0.380	0.389	0.400	0.423	0.458	13	4.5
PWHD (%)	0.501	0.576	0.425	0.275	0.263	0.264	0.286	0.260	0.259	0.275	0.294	22	7.9

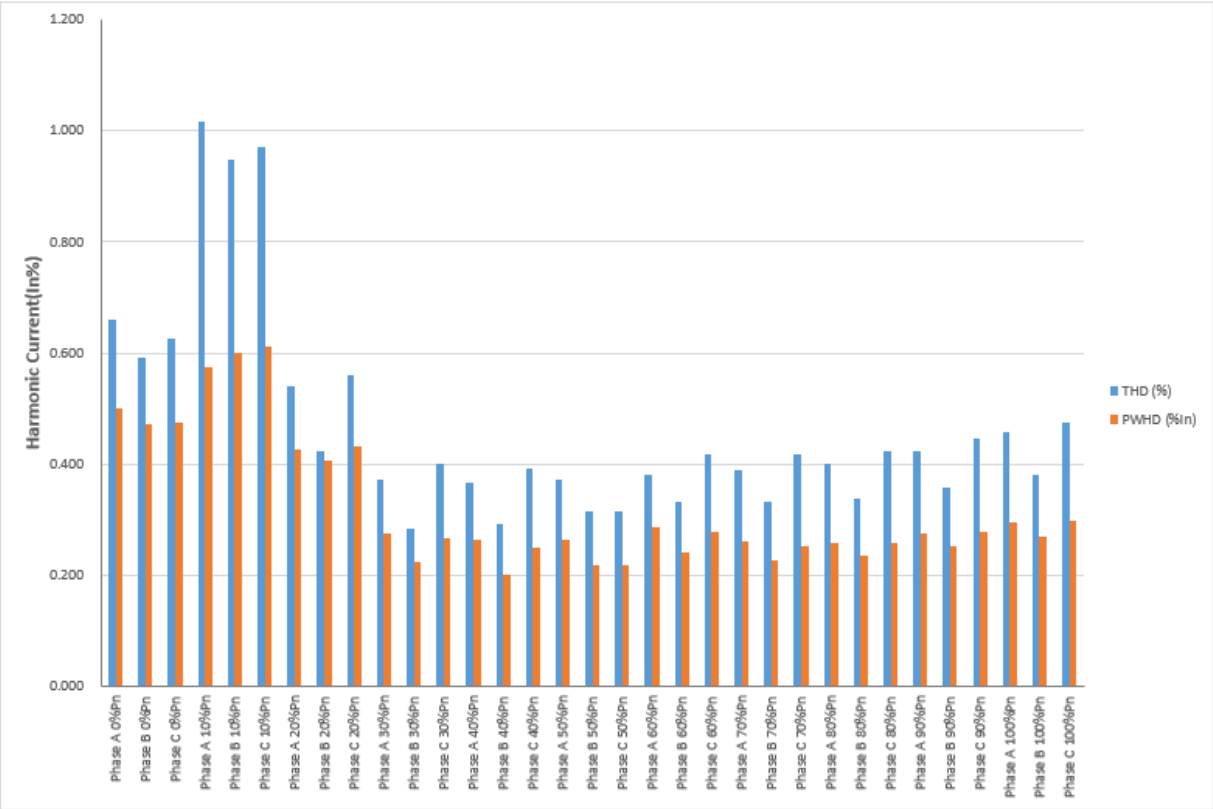
Phase B													
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category A2 Limit**	**Category B Limit**
Nr./ Order	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2	0.068	0.120	0.080	0.065	0.057	0.058	0.066	0.080	0.095	0.110	0.123	-	-
3	0.066	0.041	0.046	0.049	0.056	0.058	0.059	0.060	0.062	0.064	0.069	-	-
4	0.064	0.078	0.038	0.028	0.031	0.034	0.034	0.035	0.040	0.044	0.048	-	-
5	0.131	0.367	0.136	0.141	0.158	0.179	0.186	0.192	0.191	0.192	0.197	10.7	3.6
6	0.035	0.034	0.029	0.027	0.024	0.024	0.025	0.028	0.031	0.032	0.033	-	-
7	0.251	0.284	0.097	0.063	0.073	0.091	0.109	0.107	0.098	0.100	0.113	7.2	2.5
8	0.039	0.043	0.025	0.024	0.025	0.024	0.025	0.029	0.036	0.043	0.047	-	-
9	0.048	0.064	0.046	0.044	0.051	0.053	0.050	0.063	0.071	0.070	0.073	-	-
10	0.074	0.042	0.026	0.027	0.024	0.021	0.022	0.029	0.037	0.043	0.048	-	-
11	0.067	0.500	0.085	0.075	0.084	0.065	0.052	0.048	0.036	0.039	0.054	3.1	1.0
12	0.024	0.022	0.021	0.022	0.023	0.020	0.019	0.020	0.021	0.022	0.022	-	-
13	0.284	0.338	0.102	0.078	0.092	0.070	0.069	0.063	0.051	0.043	0.046	2	0.7
14	0.060	0.030	0.025	0.018	0.017	0.017	0.018	0.021	0.027	0.033	0.036	-	-
15	0.041	0.031	0.030	0.028	0.021	0.018	0.019	0.020	0.024	0.023	0.025	-	-
16	0.069	0.023	0.021	0.015	0.015	0.014	0.017	0.022	0.027	0.033	0.035	-	-
17	0.147	0.248	0.094	0.032	0.079	0.091	0.073	0.060	0.058	0.057	0.059	-	-
18	0.025	0.018	0.015	0.015	0.015	0.016	0.015	0.016	0.016	0.017	0.016	-	-
19	0.220	0.376	0.068	0.024	0.070	0.076	0.060	0.051	0.056	0.065	0.068	-	-
20	0.055	0.030	0.025	0.018	0.013	0.013	0.015	0.019	0.023	0.027	0.029	-	-
21	0.017	0.036	0.018	0.023	0.020	0.015	0.015	0.017	0.020	0.022	0.027	-	-
22	0.040	0.022	0.027	0.017	0.016	0.015	0.018	0.020	0.023	0.026	0.027	-	-
23	0.170	0.168	0.110	0.030	0.039	0.072	0.066	0.060	0.067	0.078	0.090	-	-
24	0.019	0.014	0.012	0.013	0.012	0.012	0.013	0.014	0.014	0.015	0.015	-	-
25	0.091	0.061	0.130	0.036	0.029	0.065	0.065	0.060	0.065	0.074	0.079	-	-
26	0.034	0.020	0.014	0.015	0.013	0.012	0.013	0.018	0.021	0.023	0.023	-	-
27	0.017	0.022	0.018	0.014	0.014	0.012	0.011	0.014	0.016	0.020	0.023	-	-
28	0.023	0.016	0.016	0.015	0.013	0.012	0.014	0.018	0.021	0.022	0.021	-	-
29	0.099	0.064	0.170	0.081	0.014	0.054	0.068	0.062	0.066	0.074	0.079	-	-
30	0.017	0.012	0.015	0.013	0.012	0.011	0.012	0.013	0.013	0.014	0.014	-	-
31	0.092	0.030	0.144	0.076	0.024	0.048	0.064	0.060	0.060	0.064	0.068	-	-
32	0.022	0.014	0.017	0.015	0.015	0.013	0.014	0.018	0.020	0.020	0.018	-	-
33	0.014	0.016	0.016	0.014	0.012	0.011	0.011	0.012	0.015	0.017	0.020	-	-
34	0.030	0.028	0.027	0.029	0.030	0.031	0.032	0.033	0.033	0.035	0.034	-	-
35	0.089	0.142	0.091	0.069	0.050	0.032	0.062	0.052	0.053	0.057	0.062	-	-
36	0.015	0.024	0.018	0.015	0.013	0.013	0.013	0.014	0.015	0.016	0.016	-	-
37	0.067	0.122	0.098	0.051	0.057	0.017	0.059	0.057	0.056	0.059	0.060	-	-
38	0.033	0.025	0.018	0.016	0.015	0.015	0.015	0.017	0.018	0.019	0.018	-	-
39	0.015	0.013	0.013	0.013	0.011	0.010	0.010	0.012	0.015	0.018	0.020	-	-
40	0.043	0.045	0.053	0.057	0.060	0.061	0.061	0.063	0.064	0.063	0.064	-	-
THD (%)	0.592	0.947	0.425	0.282	0.293	0.316	0.331	0.331	0.339	0.356	0.381	13	4.5
PWHD (%)	0.472	0.601	0.406	0.224	0.201	0.217	0.241	0.227	0.235	0.253	0.268	22	7.9

Phase C													
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category A2 Limit**	**Category B Limit**
Nr./ Order	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2	0.076	0.125	0.113	0.084	0.072	0.058	0.078	0.087	0.097	0.105	0.117	-	-
3	0.078	0.087	0.075	0.057	0.062	0.058	0.064	0.070	0.079	0.089	0.101	-	-
4	0.070	0.078	0.076	0.062	0.060	0.034	0.061	0.068	0.074	0.074	0.078	-	-
5	0.092	0.446	0.262	0.209	0.205	0.179	0.234	0.240	0.241	0.250	0.267	10.7	3.6
6	0.032	0.030	0.044	0.041	0.038	0.024	0.041	0.043	0.046	0.045	0.045	-	-
7	0.313	0.266	0.105	0.089	0.080	0.091	0.098	0.088	0.067	0.058	0.066	7.2	2.5
8	0.039	0.048	0.046	0.044	0.037	0.024	0.035	0.039	0.043	0.048	0.050	-	-
9	0.058	0.108	0.121	0.123	0.124	0.053	0.110	0.162	0.178	0.182	0.183	-	-
10	0.080	0.042	0.037	0.036	0.036	0.021	0.034	0.040	0.048	0.055	0.059	-	-
11	0.051	0.455	0.169	0.111	0.086	0.065	0.078	0.077	0.062	0.062	0.072	3.1	1.0
12	0.027	0.023	0.030	0.025	0.026	0.020	0.029	0.030	0.030	0.031	0.031	-	-
13	0.328	0.370	0.183	0.138	0.164	0.070	0.152	0.103	0.057	0.058	0.068	2	0.7
14	0.065	0.030	0.025	0.023	0.026	0.017	0.028	0.033	0.038	0.043	0.046	-	-
15	0.038	0.041	0.039	0.034	0.026	0.018	0.024	0.024	0.030	0.035	0.043	-	-
16	0.064	0.022	0.030	0.022	0.021	0.014	0.020	0.023	0.028	0.031	0.034	-	-
17	0.122	0.247	0.095	0.059	0.109	0.091	0.072	0.055	0.052	0.055	0.062	-	-
18	0.030	0.019	0.019	0.019	0.018	0.016	0.017	0.020	0.025	0.024	0.024	-	-
19	0.221	0.371	0.079	0.033	0.054	0.076	0.072	0.067	0.077	0.088	0.093	-	-
20	0.052	0.030	0.024	0.019	0.015	0.013	0.018	0.025	0.027	0.029	0.029	-	-
21	0.029	0.027	0.029	0.021	0.020	0.015	0.021	0.021	0.027	0.029	0.032	-	-
22	0.037	0.035	0.042	0.043	0.040	0.015	0.046	0.046	0.031	0.034	0.034	-	-
23	0.146	0.157	0.087	0.034	0.055	0.072	0.072	0.061	0.065	0.072	0.082	-	-
24	0.017	0.018	0.015	0.015	0.014	0.012	0.014	0.015	0.015	0.016	0.016	-	-
25	0.092	0.054	0.147	0.036	0.023	0.065	0.059	0.062	0.078	0.091	0.106	-	-
26	0.031	0.023	0.017	0.017	0.015	0.012	0.015	0.020	0.023	0.024	0.023	-	-
27	0.020	0.028	0.025	0.022	0.019	0.012	0.016	0.020	0.024	0.024	0.025	-	-
28	0.018	0.018	0.018	0.018	0.015	0.012	0.016	0.020	0.023	0.024	0.023	-	-
29	0.090	0.059	0.172	0.086	0.020	0.054	0.081	0.072	0.069	0.073	0.076	-	-
30	0.016	0.014	0.015	0.015	0.014	0.011	0.014	0.014	0.014	0.015	0.015	-	-
31	0.090	0.026	0.144	0.089	0.025	0.048	0.055	0.054	0.062	0.070	0.081	-	-
32	0.029	0.016	0.019	0.016	0.016	0.013	0.016	0.020	0.021	0.021	0.021	-	-
33	0.013	0.020	0.018	0.023	0.015	0.011	0.014	0.017	0.022	0.022	0.023	-	-
34	0.019	0.027	0.029	0.030	0.032	0.031	0.033	0.034	0.036	0.037	0.036	-	-
35	0.094	0.163	0.099	0.071	0.060	0.032	0.073	0.066	0.062	0.060	0.060	-	-
36	0.016	0.024	0.020	0.018	0.017	0.013	0.018	0.020	0.024	0.025	0.024	-	-
37	0.076	0.107	0.094	0.053	0.055	0.017	0.054	0.048	0.052	0.058	0.063	-	-
38	0.035	0.025	0.020	0.017	0.016	0.015	0.017	0.019	0.019	0.022	0.021	-	-
39	0.014	0.021	0.017	0.018	0.015	0.010	0.015	0.015	0.021	0.021	0.023	-	-
40	0.038	0.047	0.056	0.060	0.064	0.061	0.065	0.067	0.067	0.067	0.067	-	-
THD (%)	0.627	0.970	0.561	0.401	0.392	0.316	0.417	0.419	0.424	0.445	0.476	13	4.5
PWHD (%)	0.476	0.612	0.433	0.266	0.249	0.217	0.279	0.254	0.258	0.278	0.298	22	7.9

Harmonics Test



THD and PWHD



4.3.5 Interharmonic Distortions

Test is according to chapter 4.6 of the standard TR3.2.2.

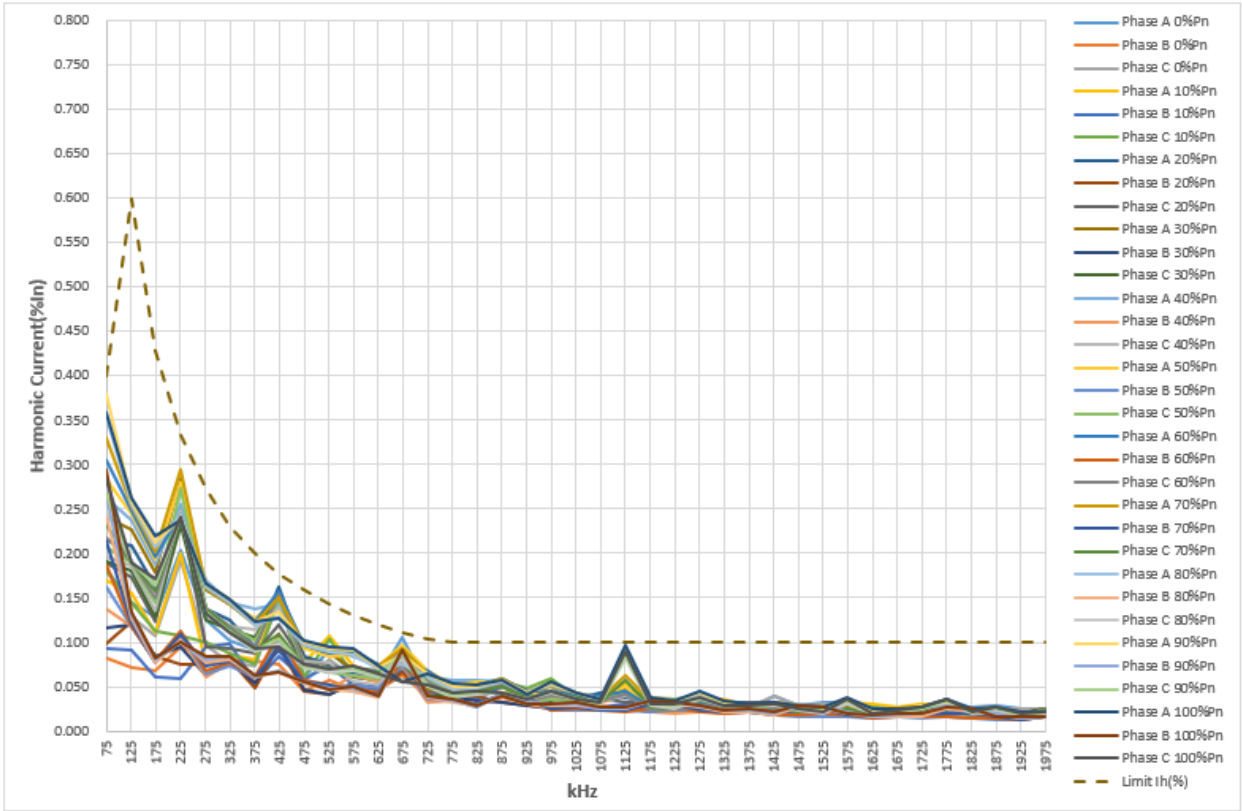
The results of inter-harmonics measurements are represented in the tables and graphics below

Phase A												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f [Hz]	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
75	0.183	0.170	0.214	0.240	0.263	0.284	0.305	0.329	0.354	0.380	0.359	0.400
125	0.145	0.155	0.209	0.226	0.237	0.244	0.248	0.253	0.255	0.260	0.262	0.600
175	0.129	0.110	0.162	0.179	0.187	0.194	0.197	0.201	0.208	0.213	0.220	0.429
225	0.203	0.200	0.240	0.284	0.255	0.280	0.245	0.294	0.245	0.239	0.238	0.333
275	0.124	0.075	0.137	0.160	0.169	0.164	0.160	0.161	0.163	0.166	0.166	0.273
325	0.102	0.087	0.124	0.143	0.145	0.142	0.142	0.143	0.145	0.147	0.148	0.231
375	0.091	0.081	0.094	0.120	0.137	0.128	0.123	0.121	0.119	0.123	0.123	0.200
425	0.156	0.154	0.163	0.152	0.142	0.150	0.157	0.150	0.129	0.135	0.126	0.176
475	0.060	0.077	0.084	0.095	0.098	0.093	0.097	0.096	0.096	0.100	0.102	0.158
525	0.092	0.107	0.075	0.087	0.090	0.084	0.087	0.090	0.089	0.094	0.094	0.143
575	0.065	0.074	0.065	0.070	0.084	0.086	0.089	0.087	0.086	0.091	0.093	0.130
625	0.061	0.062	0.064	0.067	0.073	0.074	0.076	0.072	0.069	0.071	0.073	0.120
675	0.105	0.089	0.094	0.092	0.078	0.096	0.077	0.092	0.076	0.085	0.055	0.111
725	0.050	0.059	0.050	0.046	0.061	0.068	0.067	0.064	0.061	0.064	0.065	0.103
775	0.043	0.047	0.042	0.045	0.057	0.052	0.049	0.045	0.046	0.050	0.053	0.100
825	0.056	0.040	0.053	0.050	0.057	0.056	0.052	0.050	0.048	0.050	0.052	0.100
875	0.055	0.052	0.054	0.056	0.056	0.056	0.059	0.060	0.056	0.058	0.058	0.100
925	0.044	0.039	0.042	0.040	0.041	0.043	0.044	0.043	0.043	0.042	0.041	0.100
975	0.050	0.057	0.033	0.038	0.040	0.038	0.045	0.049	0.052	0.054	0.055	0.100
1025	0.031	0.037	0.035	0.034	0.029	0.035	0.041	0.043	0.042	0.043	0.044	0.100
1075	0.038	0.036	0.042	0.035	0.036	0.038	0.039	0.036	0.035	0.035	0.036	0.100
1125	0.048	0.053	0.037	0.046	0.044	0.050	0.045	0.062	0.089	0.091	0.097	0.100
1175	0.035	0.036	0.033	0.026	0.028	0.026	0.028	0.033	0.036	0.037	0.038	0.100
1225	0.034	0.037	0.027	0.028	0.026	0.028	0.031	0.033	0.033	0.034	0.034	0.100
1275	0.040	0.035	0.041	0.029	0.035	0.029	0.031	0.037	0.039	0.042	0.044	0.100
1325	0.027	0.036	0.031	0.026	0.030	0.024	0.028	0.033	0.031	0.032	0.034	0.100
1375	0.024	0.029	0.032	0.025	0.026	0.024	0.026	0.029	0.028	0.029	0.030	0.100
1425	0.039	0.032	0.031	0.023	0.029	0.023	0.027	0.031	0.030	0.031	0.032	0.100
1475	0.029	0.028	0.027	0.023	0.019	0.021	0.020	0.023	0.025	0.027	0.029	0.100
1525	0.031	0.026	0.026	0.023	0.024	0.022	0.026	0.027	0.026	0.027	0.027	0.100
1575	0.033	0.031	0.027	0.029	0.021	0.024	0.021	0.026	0.032	0.036	0.038	0.100
1625	0.027	0.030	0.022	0.020	0.021	0.019	0.017	0.021	0.021	0.023	0.024	0.100
1675	0.022	0.026	0.023	0.020	0.020	0.019	0.020	0.023	0.022	0.024	0.025	0.100
1725	0.030	0.031	0.026	0.019	0.023	0.019	0.021	0.025	0.027	0.028	0.028	0.100
1775	0.028	0.029	0.025	0.026	0.025	0.025	0.026	0.030	0.031	0.032	0.035	0.100
1825	0.026	0.024	0.023	0.018	0.018	0.017	0.017	0.021	0.022	0.025	0.026	0.100
1875	0.028	0.024	0.022	0.023	0.020	0.018	0.019	0.020	0.023	0.027	0.027	0.100
1925	0.024	0.019	0.020	0.020	0.017	0.018	0.016	0.016	0.017	0.019	0.021	0.100
1975	0.024	0.023	0.023	0.022	0.021	0.021	0.023	0.022	0.020	0.021	0.022	0.100

Phase B												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f [Hz]	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
75	0.083	0.093	0.098	0.116	0.138	0.163	0.188	0.215	0.242	0.268	0.295	0.400
125	0.071	0.092	0.123	0.119	0.118	0.118	0.118	0.122	0.127	0.131	0.134	0.600
175	0.069	0.060	0.083	0.084	0.081	0.079	0.078	0.077	0.077	0.080	0.081	0.429
225	0.095	0.060	0.074	0.095	0.105	0.109	0.112	0.109	0.102	0.100	0.100	0.333
275	0.081	0.094	0.075	0.063	0.061	0.064	0.068	0.073	0.076	0.080	0.083	0.273
325	0.080	0.099	0.081	0.078	0.076	0.073	0.076	0.079	0.080	0.084	0.085	0.231
375	0.079	0.055	0.049	0.053	0.060	0.060	0.061	0.062	0.061	0.061	0.062	0.200
425	0.075	0.084	0.097	0.102	0.107	0.102	0.108	0.091	0.067	0.068	0.066	0.176
475	0.044	0.058	0.044	0.047	0.055	0.056	0.058	0.056	0.053	0.055	0.055	0.158
525	0.058	0.073	0.042	0.042	0.046	0.048	0.052	0.052	0.047	0.047	0.047	0.143
575	0.047	0.052	0.053	0.054	0.063	0.052	0.047	0.044	0.044	0.049	0.051	0.130
625	0.046	0.047	0.049	0.048	0.055	0.047	0.043	0.041	0.037	0.039	0.039	0.120
675	0.063	0.068	0.066	0.073	0.073	0.076	0.078	0.087	0.089	0.090	0.092	0.111
725	0.039	0.044	0.041	0.033	0.033	0.035	0.037	0.038	0.038	0.039	0.039	0.103
775	0.040	0.039	0.037	0.038	0.035	0.033	0.035	0.034	0.032	0.033	0.036	0.100
825	0.051	0.036	0.040	0.034	0.030	0.027	0.029	0.031	0.028	0.028	0.029	0.100
875	0.043	0.050	0.032	0.033	0.037	0.041	0.041	0.040	0.039	0.041	0.040	0.100
925	0.043	0.045	0.028	0.028	0.031	0.037	0.038	0.036	0.033	0.032	0.031	0.100
975	0.043	0.034	0.028	0.025	0.024	0.022	0.023	0.026	0.028	0.030	0.030	0.100
1025	0.031	0.026	0.028	0.028	0.024	0.023	0.025	0.026	0.028	0.030	0.032	0.100
1075	0.032	0.027	0.025	0.025	0.028	0.023	0.024	0.024	0.025	0.026	0.028	0.100
1125	0.040	0.030	0.026	0.026	0.024	0.023	0.022	0.023	0.025	0.025	0.027	0.100
1175	0.035	0.034	0.027	0.021	0.022	0.022	0.026	0.030	0.033	0.035	0.034	0.100
1225	0.035	0.029	0.026	0.022	0.020	0.023	0.028	0.031	0.031	0.032	0.031	0.100
1275	0.034	0.028	0.028	0.025	0.022	0.022	0.022	0.024	0.026	0.028	0.028	0.100
1325	0.026	0.023	0.020	0.021	0.022	0.019	0.020	0.021	0.021	0.023	0.024	0.100
1375	0.023	0.024	0.025	0.022	0.023	0.022	0.021	0.022	0.022	0.023	0.026	0.100
1425	0.032	0.027	0.021	0.020	0.018	0.018	0.018	0.019	0.019	0.020	0.021	0.100
1475	0.029	0.023	0.028	0.021	0.018	0.017	0.018	0.024	0.027	0.030	0.029	0.100
1525	0.027	0.024	0.026	0.019	0.019	0.016	0.020	0.024	0.026	0.027	0.027	0.100
1575	0.027	0.020	0.019	0.019	0.017	0.017	0.017	0.018	0.020	0.022	0.021	0.100
1625	0.025	0.019	0.018	0.015	0.017	0.014	0.015	0.015	0.015	0.017	0.017	0.100
1675	0.021	0.018	0.016	0.018	0.015	0.016	0.016	0.016	0.016	0.017	0.019	0.100
1725	0.025	0.020	0.018	0.017	0.016	0.015	0.015	0.017	0.017	0.019	0.019	0.100
1775	0.025	0.024	0.021	0.021	0.016	0.016	0.016	0.021	0.025	0.028	0.027	0.100
1825	0.022	0.022	0.020	0.019	0.015	0.014	0.015	0.019	0.022	0.025	0.024	0.100
1875	0.024	0.018	0.015	0.016	0.014	0.013	0.015	0.016	0.018	0.019	0.017	0.100
1925	0.024	0.016	0.014	0.016	0.014	0.013	0.013	0.013	0.014	0.015	0.016	0.100
1975	0.021	0.019	0.018	0.017	0.017	0.016	0.017	0.016	0.016	0.017	0.017	0.100

Phase C												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f [Hz]	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
75	0.183	0.180	0.189	0.192	0.197	0.207	0.218	0.232	0.248	0.267	0.284	0.400
125	0.128	0.145	0.173	0.180	0.186	0.190	0.190	0.192	0.190	0.190	0.190	0.600
175	0.106	0.113	0.123	0.128	0.135	0.145	0.150	0.157	0.164	0.167	0.171	0.429
225	0.193	0.108	0.248	0.232	0.249	0.274	0.242	0.244	0.243	0.240	0.240	0.333
275	0.096	0.100	0.095	0.124	0.137	0.137	0.138	0.138	0.133	0.132	0.132	0.273
325	0.077	0.087	0.092	0.115	0.119	0.117	0.118	0.115	0.111	0.112	0.111	0.231
375	0.073	0.076	0.088	0.106	0.114	0.102	0.094	0.090	0.089	0.092	0.093	0.200
425	0.148	0.148	0.120	0.153	0.139	0.150	0.153	0.109	0.098	0.103	0.094	0.176
475	0.055	0.060	0.076	0.080	0.079	0.072	0.075	0.073	0.071	0.074	0.074	0.158
525	0.081	0.103	0.069	0.075	0.076	0.066	0.066	0.067	0.066	0.070	0.070	0.143
575	0.061	0.062	0.068	0.061	0.055	0.062	0.072	0.071	0.068	0.070	0.073	0.130
625	0.057	0.056	0.064	0.057	0.051	0.058	0.067	0.066	0.061	0.062	0.064	0.120
675	0.084	0.082	0.078	0.076	0.092	0.093	0.089	0.075	0.080	0.088	0.055	0.111
725	0.045	0.050	0.046	0.039	0.049	0.056	0.056	0.053	0.051	0.051	0.052	0.103
775	0.042	0.042	0.039	0.041	0.047	0.044	0.041	0.038	0.037	0.039	0.042	0.100
825	0.051	0.042	0.043	0.043	0.047	0.048	0.046	0.044	0.041	0.044	0.044	0.100
875	0.048	0.056	0.051	0.058	0.055	0.050	0.051	0.050	0.044	0.043	0.043	0.100
925	0.044	0.047	0.040	0.044	0.038	0.032	0.035	0.037	0.036	0.036	0.035	0.100
975	0.053	0.059	0.031	0.035	0.036	0.035	0.040	0.042	0.044	0.045	0.045	0.100
1025	0.032	0.037	0.032	0.034	0.027	0.032	0.036	0.037	0.035	0.035	0.036	0.100
1075	0.038	0.035	0.038	0.035	0.034	0.033	0.035	0.033	0.031	0.031	0.031	0.100
1125	0.043	0.046	0.033	0.041	0.039	0.044	0.041	0.058	0.081	0.083	0.089	0.100
1175	0.032	0.037	0.035	0.025	0.028	0.026	0.024	0.027	0.028	0.030	0.031	0.100
1225	0.034	0.037	0.031	0.026	0.027	0.025	0.024	0.025	0.026	0.028	0.030	0.100
1275	0.042	0.039	0.038	0.026	0.032	0.026	0.029	0.033	0.036	0.038	0.038	0.100
1325	0.030	0.032	0.030	0.026	0.030	0.023	0.027	0.030	0.028	0.028	0.029	0.100
1375	0.026	0.028	0.031	0.025	0.027	0.024	0.026	0.028	0.027	0.028	0.028	0.100
1425	0.039	0.031	0.033	0.021	0.026	0.020	0.024	0.029	0.028	0.030	0.030	0.100
1475	0.028	0.025	0.023	0.025	0.019	0.021	0.021	0.022	0.023	0.024	0.024	0.100
1525	0.030	0.028	0.027	0.027	0.022	0.023	0.024	0.023	0.020	0.022	0.022	0.100
1575	0.030	0.029	0.024	0.026	0.022	0.022	0.021	0.025	0.031	0.034	0.035	0.100
1625	0.027	0.026	0.021	0.020	0.021	0.018	0.018	0.020	0.020	0.020	0.020	0.100
1675	0.023	0.023	0.021	0.021	0.019	0.019	0.018	0.021	0.021	0.021	0.023	0.100
1725	0.029	0.027	0.026	0.023	0.021	0.018	0.018	0.023	0.024	0.026	0.027	0.100
1775	0.028	0.027	0.023	0.026	0.027	0.026	0.027	0.032	0.033	0.034	0.036	0.100
1825	0.024	0.021	0.019	0.020	0.019	0.016	0.019	0.020	0.020	0.022	0.021	0.100
1875	0.025	0.022	0.023	0.020	0.019	0.017	0.017	0.019	0.023	0.026	0.027	0.100
1925	0.024	0.019	0.020	0.019	0.017	0.018	0.016	0.016	0.017	0.018	0.019	0.100
1975	0.025	0.024	0.025	0.025	0.023	0.023	0.025	0.023	0.020	0.021	0.022	0.100

Inter-Harmonics Current



4.3.6 Distortions In The 2-9 kHz Frequency Range

Test is according to chapter 4.7 of the standard TR3.2.2.

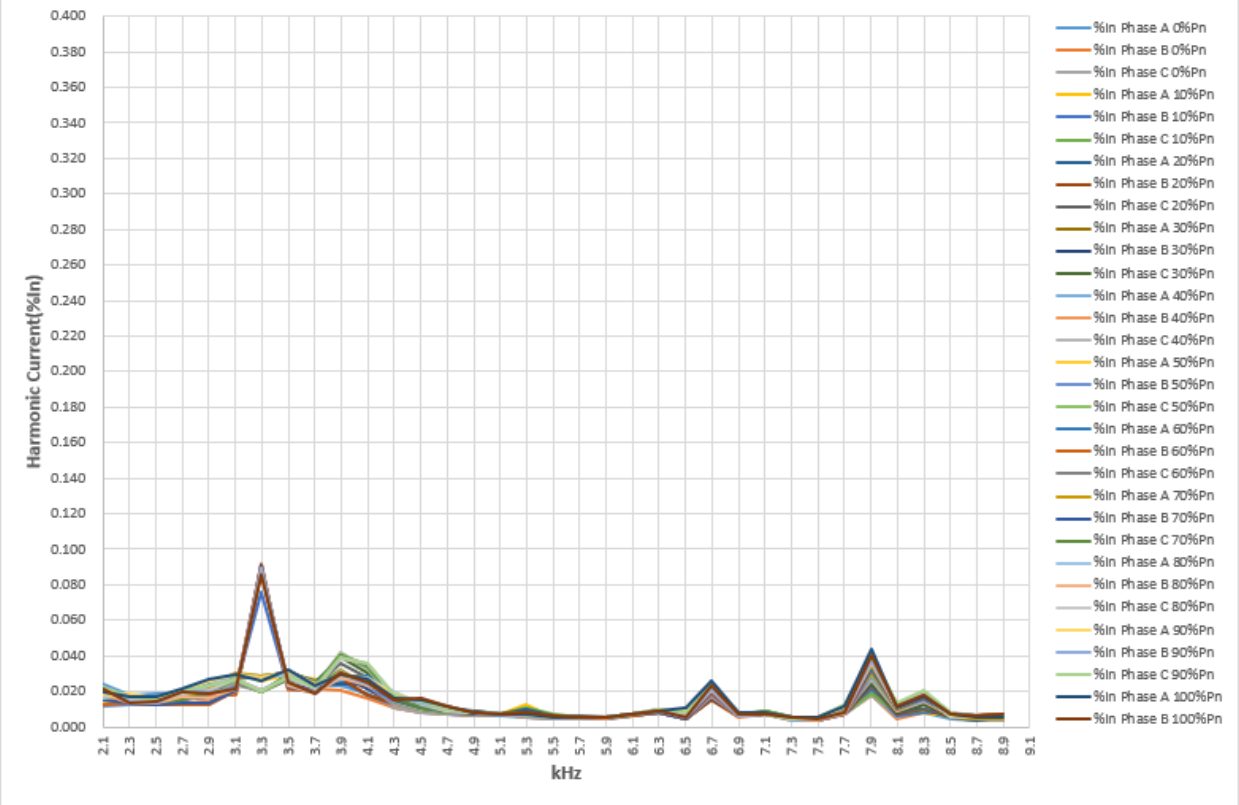
The results of higher frequency components measurements are represented in the tables and graphics below.

Phase A												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f (kHz)	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2.1	0.024	0.020	0.017	0.018	0.017	0.015	0.016	0.016	0.016	0.018	0.020	0.2
2.3	0.017	0.016	0.016	0.017	0.018	0.015	0.016	0.016	0.018	0.018	0.017	0.2
2.5	0.019	0.017	0.016	0.016	0.016	0.015	0.016	0.015	0.016	0.016	0.017	0.2
2.7	0.019	0.019	0.018	0.019	0.016	0.016	0.016	0.016	0.018	0.020	0.021	0.2
2.9	0.024	0.024	0.023	0.022	0.022	0.020	0.021	0.021	0.023	0.026	0.027	0.2
3.1	0.026	0.030	0.028	0.028	0.028	0.029	0.029	0.030	0.029	0.029	0.030	0.2
3.3	0.029	0.026	0.028	0.027	0.028	0.028	0.028	0.028	0.028	0.027	0.026	0.2
3.5	0.029	0.029	0.032	0.031	0.030	0.030	0.031	0.031	0.030	0.031	0.032	0.2
3.7	0.023	0.027	0.024	0.025	0.024	0.025	0.026	0.025	0.024	0.024	0.024	0.2
3.9	0.023	0.024	0.024	0.027	0.029	0.028	0.029	0.028	0.027	0.028	0.029	0.2
4.1	0.018	0.025	0.024	0.025	0.026	0.026	0.028	0.028	0.027	0.027	0.027	0.2
4.3	0.011	0.013	0.013	0.014	0.013	0.014	0.015	0.017	0.020	0.019	0.016	0.2
4.5	0.008	0.010	0.011	0.011	0.011	0.011	0.010	0.011	0.012	0.013	0.015	0.2
4.7	0.007	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.010	0.011	0.2
4.9	0.006	0.008	0.009	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.2
5.1	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
5.3	0.005	0.013	0.009	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
5.5	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.2
5.7	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.2
5.9	0.004	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2
6.1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
6.3	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.2
6.5	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.009	0.010	0.010	0.2
6.7	0.016	0.018	0.018	0.018	0.019	0.020	0.021	0.022	0.024	0.025	0.026	0.2
6.9	0.006	0.007	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
7.1	0.007	0.009	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
7.3	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.2
7.5	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.2
7.7	0.007	0.007	0.009	0.009	0.009	0.010	0.010	0.011	0.011	0.012	0.012	0.2
7.9	0.024	0.024	0.027	0.029	0.030	0.032	0.034	0.036	0.039	0.041	0.044	0.2
8.1	0.007	0.010	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.2
8.3	0.008	0.008	0.010	0.013	0.015	0.016	0.017	0.018	0.018	0.018	0.017	0.2
8.5	0.004	0.006	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.2
8.7	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2
8.9	0.004	0.005	0.005	0.006	0.006	0.005	0.005	0.005	0.005	0.005	0.006	0.2

Phase B												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f (kHz)	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2.1	0.022	0.020	0.020	0.015	0.016	0.012	0.013	0.015	0.019	0.022	0.022	0.2
2.3	0.015	0.014	0.013	0.013	0.014	0.012	0.013	0.013	0.014	0.015	0.013	0.2
2.5	0.016	0.014	0.014	0.014	0.014	0.012	0.013	0.013	0.014	0.014	0.014	0.2
2.7	0.016	0.016	0.016	0.017	0.013	0.013	0.013	0.013	0.017	0.021	0.020	0.2
2.9	0.018	0.018	0.016	0.015	0.014	0.013	0.013	0.013	0.016	0.019	0.018	0.2
3.1	0.018	0.023	0.019	0.020	0.020	0.020	0.021	0.021	0.021	0.021	0.022	0.2
3.3	0.092	0.076	0.087	0.088	0.089	0.090	0.091	0.091	0.089	0.088	0.086	0.2
3.5	0.021	0.022	0.024	0.024	0.023	0.021	0.022	0.023	0.023	0.025	0.025	0.2
3.7	0.021	0.022	0.020	0.021	0.020	0.019	0.020	0.020	0.019	0.019	0.019	0.2
3.9	0.020	0.026	0.027	0.029	0.031	0.030	0.030	0.029	0.028	0.030	0.031	0.2
4.1	0.016	0.018	0.018	0.021	0.023	0.023	0.025	0.024	0.024	0.024	0.025	0.2
4.3	0.010	0.013	0.013	0.013	0.013	0.014	0.015	0.015	0.018	0.017	0.015	0.2
4.5	0.008	0.010	0.010	0.010	0.010	0.010	0.010	0.011	0.013	0.013	0.016	0.2
4.7	0.007	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.010	0.011	0.2
4.9	0.006	0.008	0.008	0.007	0.007	0.008	0.008	0.008	0.008	0.008	0.008	0.2
5.1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
5.3	0.005	0.009	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
5.5	0.005	0.006	0.006	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.2
5.7	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.2
5.9	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2
6.1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
6.3	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.2
6.5	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2
6.7	0.015	0.016	0.015	0.016	0.017	0.018	0.018	0.020	0.021	0.022	0.023	0.2
6.9	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.2
7.1	0.007	0.009	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
7.3	0.004	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.2
7.5	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.2
7.7	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.2
7.9	0.018	0.021	0.023	0.025	0.027	0.029	0.031	0.033	0.036	0.038	0.040	0.2
8.1	0.005	0.007	0.007	0.008	0.009	0.010	0.010	0.011	0.011	0.011	0.012	0.2
8.3	0.008	0.008	0.010	0.013	0.014	0.015	0.016	0.017	0.017	0.018	0.018	0.2
8.5	0.006	0.009	0.007	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
8.7	0.003	0.004	0.004	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.2
8.9	0.004	0.005	0.005	0.007	0.007	0.007	0.007	0.006	0.006	0.007	0.007	0.2

Phase C												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category B Limit**
f (kHz)	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2.1	0.022	0.021	0.020	0.015	0.017	0.015	0.016	0.018	0.020	0.022	0.021	0.2
2.3	0.017	0.016	0.016	0.016	0.017	0.015	0.015	0.015	0.016	0.017	0.017	0.2
2.5	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.014	0.015	0.016	0.017	0.2
2.7	0.019	0.020	0.017	0.019	0.016	0.015	0.015	0.016	0.019	0.020	0.020	0.2
2.9	0.022	0.023	0.022	0.021	0.020	0.019	0.019	0.019	0.020	0.023	0.024	0.2
3.1	0.024	0.026	0.025	0.026	0.025	0.026	0.027	0.027	0.026	0.027	0.027	0.2
3.3	0.021	0.019	0.020	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.019	0.2
3.5	0.027	0.028	0.029	0.029	0.027	0.027	0.028	0.027	0.027	0.029	0.029	0.2
3.7	0.023	0.024	0.024	0.025	0.023	0.022	0.023	0.023	0.022	0.022	0.021	0.2
3.9	0.028	0.033	0.036	0.040	0.042	0.041	0.040	0.040	0.038	0.039	0.039	0.2
4.1	0.022	0.023	0.027	0.030	0.033	0.033	0.034	0.035	0.036	0.036	0.037	0.2
4.3	0.011	0.015	0.015	0.015	0.014	0.015	0.016	0.016	0.018	0.018	0.016	0.2
4.5	0.008	0.010	0.012	0.011	0.010	0.010	0.010	0.011	0.013	0.015	0.017	0.2
4.7	0.007	0.008	0.010	0.009	0.009	0.009	0.009	0.009	0.009	0.010	0.012	0.2
4.9	0.006	0.008	0.009	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.2
5.1	0.007	0.007	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
5.3	0.005	0.010	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
5.5	0.005	0.007	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.2
5.7	0.004	0.006	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.2
5.9	0.004	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2
6.1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.2
6.3	0.009	0.008	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.010	0.2
6.5	0.006	0.006	0.007	0.006	0.006	0.006	0.007	0.007	0.008	0.008	0.009	0.2
6.7	0.016	0.017	0.017	0.018	0.019	0.020	0.021	0.022	0.023	0.025	0.026	0.2
6.9	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.008	0.2
7.1	0.007	0.009	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.2
7.3	0.004	0.005	0.005	0.005	0.004	0.004	0.005	0.004	0.005	0.005	0.005	0.2
7.5	0.004	0.005	0.005	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.2
7.7	0.007	0.008	0.009	0.010	0.010	0.011	0.012	0.012	0.012	0.012	0.012	0.2
7.9	0.018	0.018	0.023	0.025	0.027	0.030	0.032	0.034	0.037	0.040	0.043	0.2
8.1	0.006	0.008	0.008	0.008	0.009	0.010	0.011	0.012	0.013	0.014	0.015	0.2
8.3	0.009	0.009	0.009	0.012	0.014	0.016	0.018	0.019	0.020	0.020	0.021	0.2
8.5	0.006	0.007	0.007	0.007	0.008	0.008	0.007	0.007	0.007	0.008	0.008	0.2
8.7	0.003	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.006	0.006	0.2
8.9	0.003	0.006	0.006	0.007	0.007	0.007	0.007	0.006	0.006	0.007	0.007	0.2

Current high frequency harmonics



4.4 CONTROL AND REGULATION

4.4.1 Active Power Control Functions

A PV power plant must be equipped with active power control functions capable of controlling the active power supplied by a PV power plant in the Point of Connection using activation orders with set points. It must be possible to indicate set points for active power with a 1 kW resolution or better.

4.4.1.1 Frequency Response

The test is to verify the automatic response for active power reduction due to over frequency variations according to chapter 5.2.1 of the standard.

In the event of frequency deviations in the public electricity supply grid, the PV power plant must contribute to grid stability by automatically reducing active power at grid frequencies above f_R. This is referred to as frequency response.

It must be possible to set the frequency response function for the frequency points shown in Figure 8.

It must be possible to set the frequency f_R to any value in the 50.00-52.001 Hz range with an accuracy of 10 mHz or higher. The standard f_R value is 50.20 Hz. The f_R setting value is determined by the transmission system operator.

It must be possible to set the droop for the downward regulation to any value in the range 2-12% of Pn and this must be effected with an accuracy of ±10% of Pn. The standard value for droop is 4% of Pn. In this context, droop is the change in active power as a function of the grid frequency. Droop is stated as a percentage of the plant's nominal output.

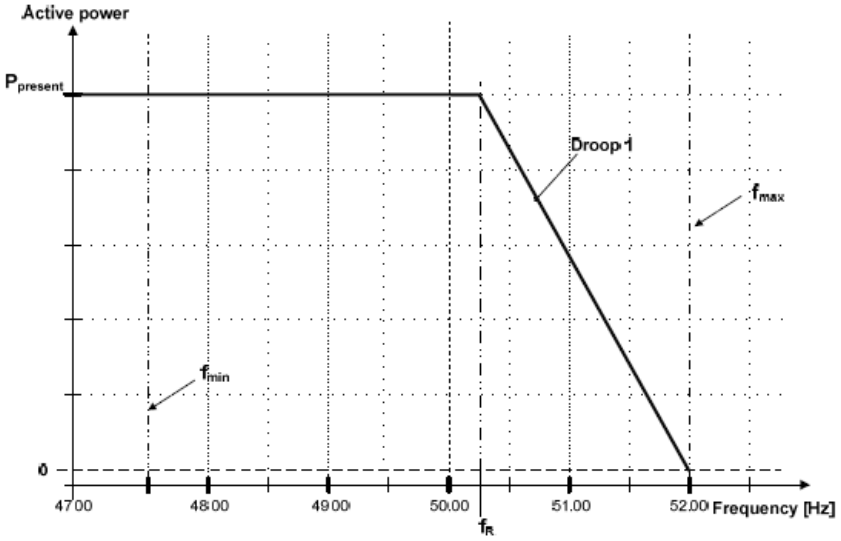
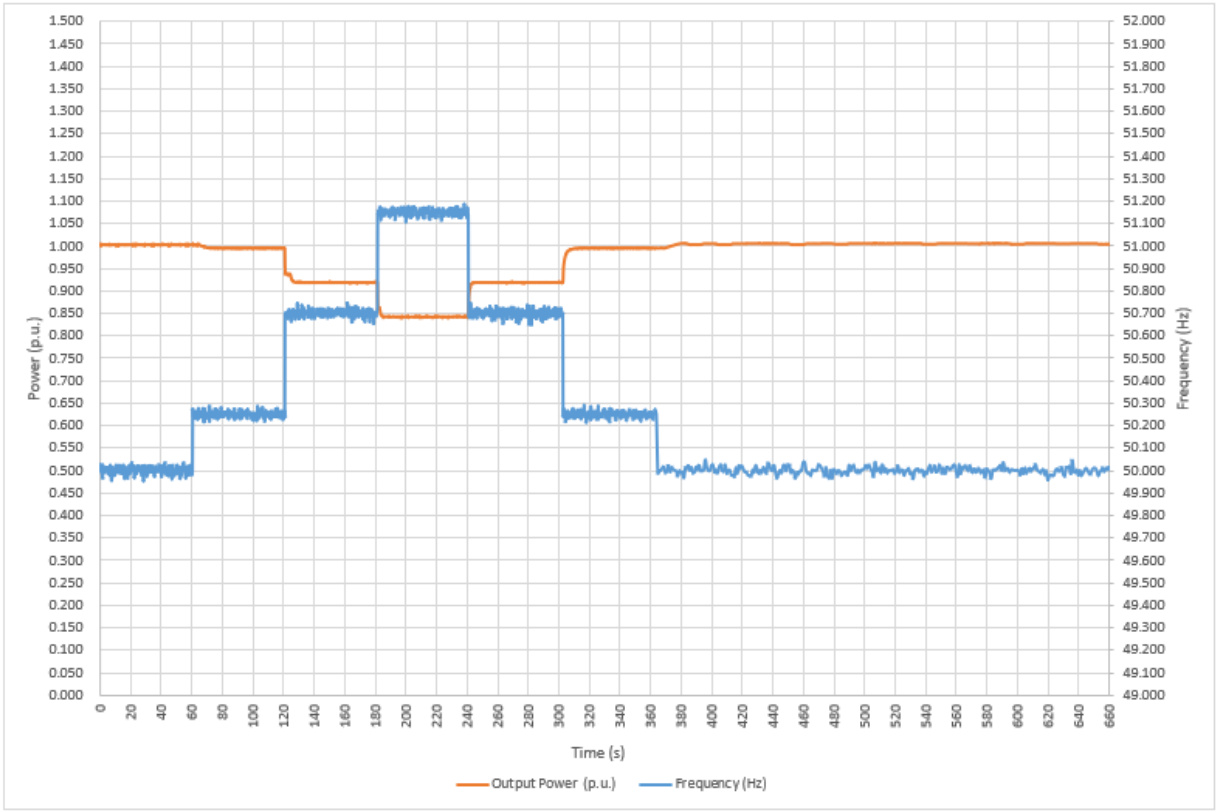


Figure 8 Frequency response for a PV power plant.

The following measuring points a) to g) have be tested:

Threshold frequency 50.20 Hz in combination with a droop of 12 % at 100% Pn							
Step	**Frequency measured**	**Power measured (%Pn)**	**Power desired (%Pn)**	**Deviation (%Pn)**	**Variation expected**	**Variation measured (%Pn)**	**Delay time measured (<2s)**
a)	50.00	100.2	100.0	0.2	No power variation	-	--
b)	50.25	99.6	99.2	0.4	-0.8% Pn	-0.7%	0.6s
c)	50.70	92.0	91.7	0.3	-8.3% Pn	-8.2%	0.6s
d)	51.15	84.3	84.2	0.1	-15.8% Pn	-16.0%	0.6s
e)	50.70	91.8	91.7	0.1	-8.3% Pn	-8.4%	0.8s
f)	50.25	99.3	99.2	0.1	-0.8% Pn	-0.9%	1.0s
g)	50.00	100.5	100.0	0.5	No power variation	--	1.0s

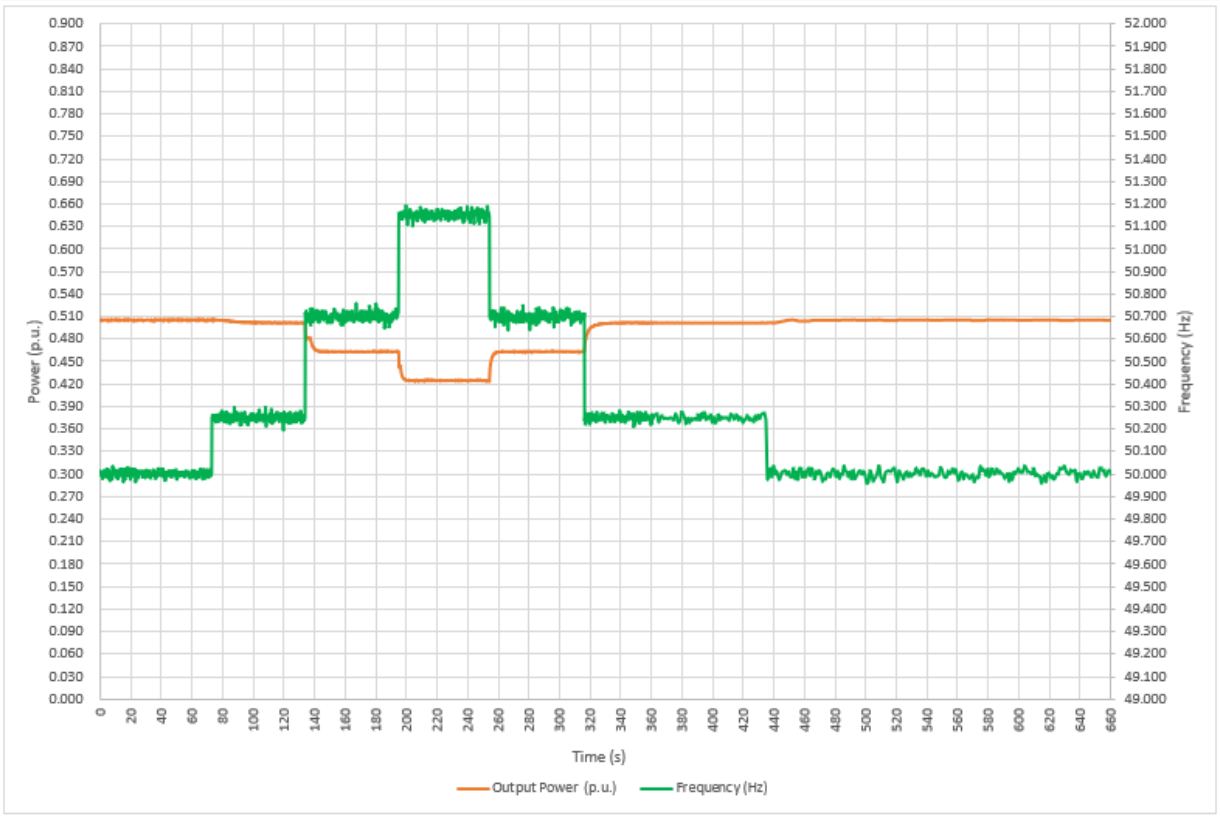
Over-frequency curve (droop of 12 % at 100% Pn)



Remark:
Test for frequency threshold 50.2Hz with droop 12%, intentional delay is setting to 0s.

Threshold frequency 50.20 Hz in combination with a droop of 12 % at 50% Pn							
Step	**Frequency measured**	**Power measured (%Pn)**	**Power desired (%Pn)**	**Deviation (%Pn)**	**Variation expected**	**Variation measured (%Pn)**	**Delay time measured (<2s)**
a)	50.00	50.5	50.0	1.0	No power variation	--	--
b)	50.25	50.2	49.6	1.3	-0.4% Pn	-0.3%	0.6s
c)	50.70	46.5	45.9	1.4	-4.1% Pn	-4.1%	0.8s
d)	51.15	42.5	42.1	1.0	-7.9% Pn	-8.0%	1.0s
e)	50.70	46.2	45.9	1.0	-4.1% Pn	-4.3%	0.6s
f)	50.25	50.0	49.6	0.8	-0.4% Pn	-0.5%	0.8s
g)	50.00	50.5	50.0	1.0	No power variation	--	0.8s

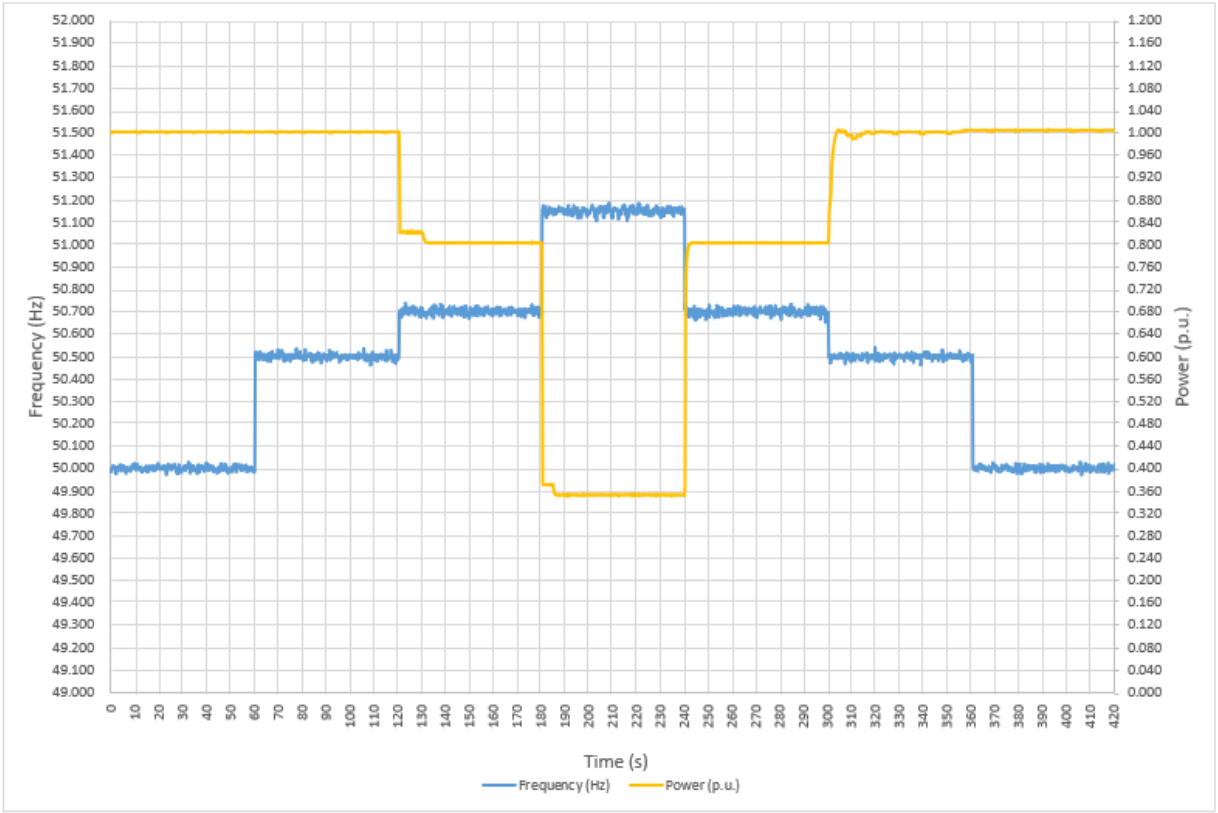
Over-frequency curve (droop of 12 % at 50% Pn)



Remark:
Test for frequency threshold 50.2Hz with droop 12%, intentional delay is setting to 0s.

Threshold frequency 50.50 Hz in combination with a droop of 2 % at 100% Pn							
Step	**Frequency measured**	**Power measured (%Pn)**	**Power desired (%Pn)**	**Deviation (%Pn)**	**Variation expected**	**Variation measured (%Pn)**	**Delay time measured (<2s)**
a)	50.00	100.1	100.0	0.1	No power variation	--	--
b)	50.50	100.1	100.0	0.1	No power variation	--	0.4s
c)	50.70	80.7	80.0	0.9	-20.0% Pn	-19.5%	0.8s
d)	51.15	35.5	35.0	1.4	-65.0% Pn	-64.6%	1.0s
e)	50.70	80.1	80.0	0.1	-20.0% Pn	-20.1%	0.6s
f)	50.50	99.7	100.0	-0.3	No power variation	--	0.8s
g)	50.00	100.4	100.0	0.4	No power variation	--	1.0s

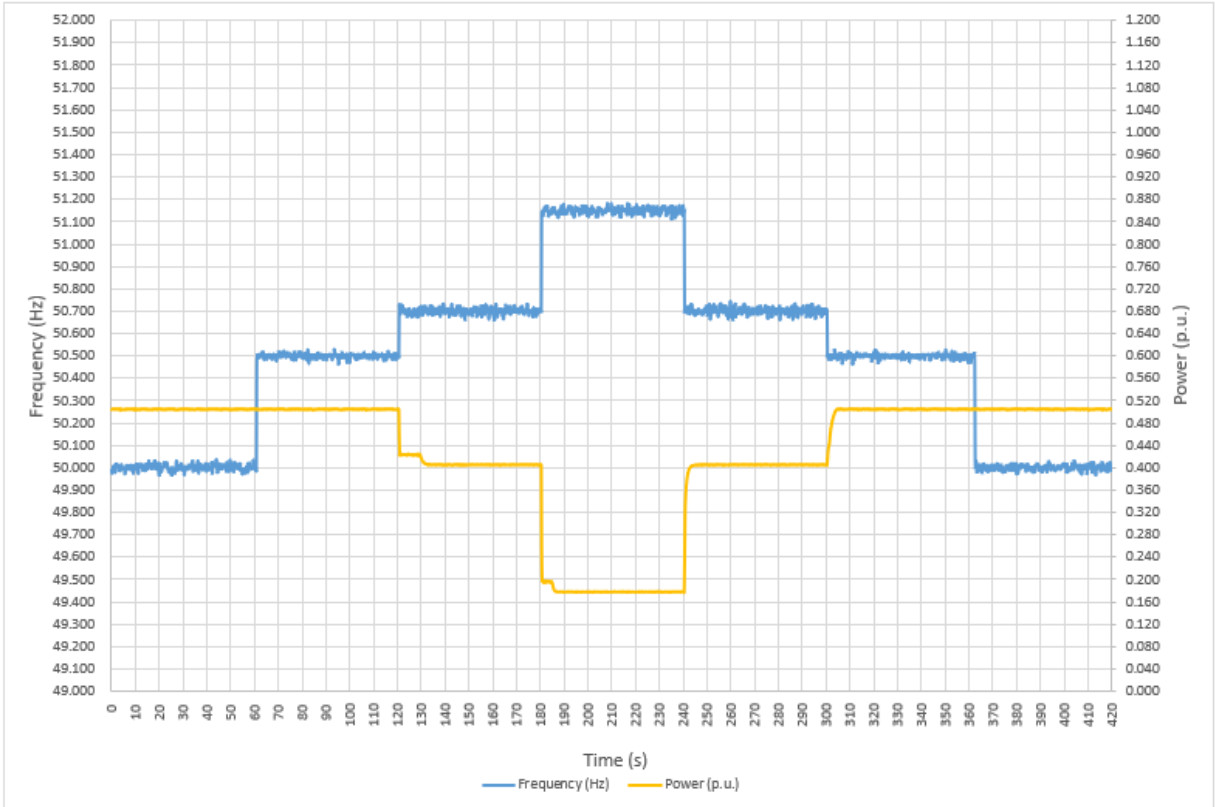
Over-frequency curve (droop of 2 % at 100% Pn)



Remark:
Test for frequency threshold 50.5Hz with droop 2%, intentional delay is setting to 0s.

Threshold frequency 50.5 Hz in combination with a droop of 2 % at 50% Pn							
Step	**Frequency measured**	**Power measured (%p.u)**	**Power desired (%p.u)**	**Deviation (%)**	**Variation expected**	**Variation measured (%Pn)**	**Delay time measured (<2s)**
a)	50.00	50.4	50.0	0.9	No power variation	--	--
b)	50.50	50.4	50.0	0.9	No power variation	--	0.8s
c)	50.70	40.8	40.0	2.0	-10.0% Pn	-9.6%	0.8s
d)	51.15	18.0	17.5	2.6	-32.5% Pn	-32.4%	1.0s
e)	50.70	40.3	40.0	0.8	-10.0% Pn	-10.1%	0.6s
f)	50.50	50.2	50.0	0.5	No power variation	--	0.4s
g)	50.00	50.4	50.0	0.9	No power variation	--	0.6s

Over-frequency curve (droop of 2 % at 50% Pn)



Remark:
Test for frequency threshold 50.5Hz with droop 2%, intentional delay is setting to 0s.

4.4.1.2 Frequency Control

The test is to verify the frequency control function according to chapter 5.2.2 of the standard.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. The test is only applicable to plant categories C and D.

4.4.1.3 Constraint Functions

A PV power plant must be equipped with constraint functions, i.e. supplementary active power control functions.

The constraint functions are used to avoid instability or overloading of the public electricity supply grid in connection with switching in the public electricity supply grid, in fault situations or the like.

4.4.1.3.1 Absolute Power Constraint

An absolute power constraint is used to limit active power from a PV power plant to a set point-defined maximum power limit in the Point of Connection.

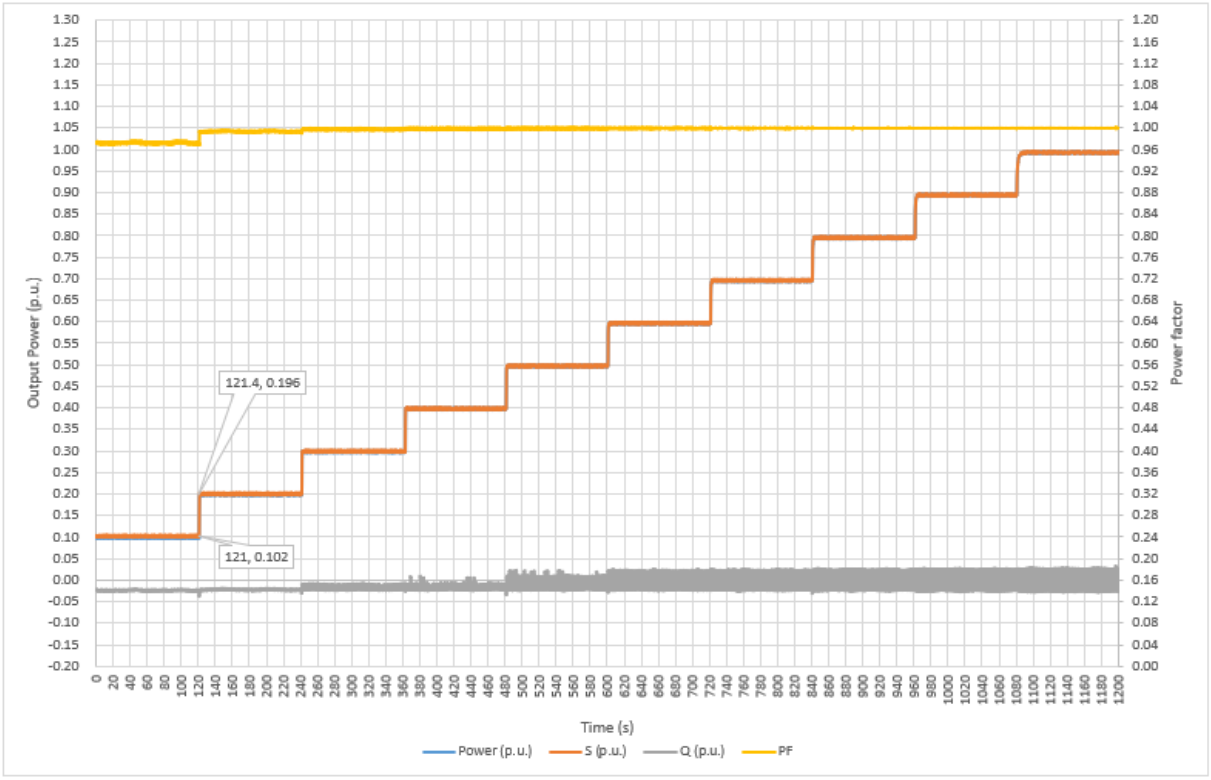
The test has been performed according to chapter 5.2.3.1 of the standard.

Test results are offered at the table below.

Active Power Setpoint (%Pn)	Power measured (%Pn)	Active Power Deviation from setpoint (%)	Time Response (<2s)
10	9.9	-0.1	-
20	19.9	-0.1	< 0.5
30	29.8	-0.2	< 0.5
40	39.8	-0.3	< 0.5
50	49.7	-0.3	< 0.5
60	59.6	-0.4	< 0.5
70	69.5	-0.5	< 0.5
80	79.5	-0.5	< 0.5
90	89.4	-0.6	< 0.5
100	99.2	-0.8	< 0.5

Test results are graphically represented below.

Absolute Power Constraint



4.4.1.3.2 Delta Power Constraint (Spinning Reserve)

A delta power constraint is used to limit the active power from a PV power plant to a desired constant value in proportion to the possible active power.

The test should be performed according to chapter 5.2.3.2 of the standard.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. The test is only applicable to plant categories C and D.

4.4.1.3.3 Ramp Rate Constraint

Ramp rate constraint is used to limit the maximum speed by which the active power can be changed in the event of changes in power or in the set points for a PV power plant.

The test has been performed according to chapter 5.2.3.3 of the standard. The maximum standard value for the ramp rate constraint cannot be greater than 100kW/s.

Gradient (ΔP) range can be setting from 10W/s to 250W/s. the following test is performed by setting gradient at 10W/s and 250W/s

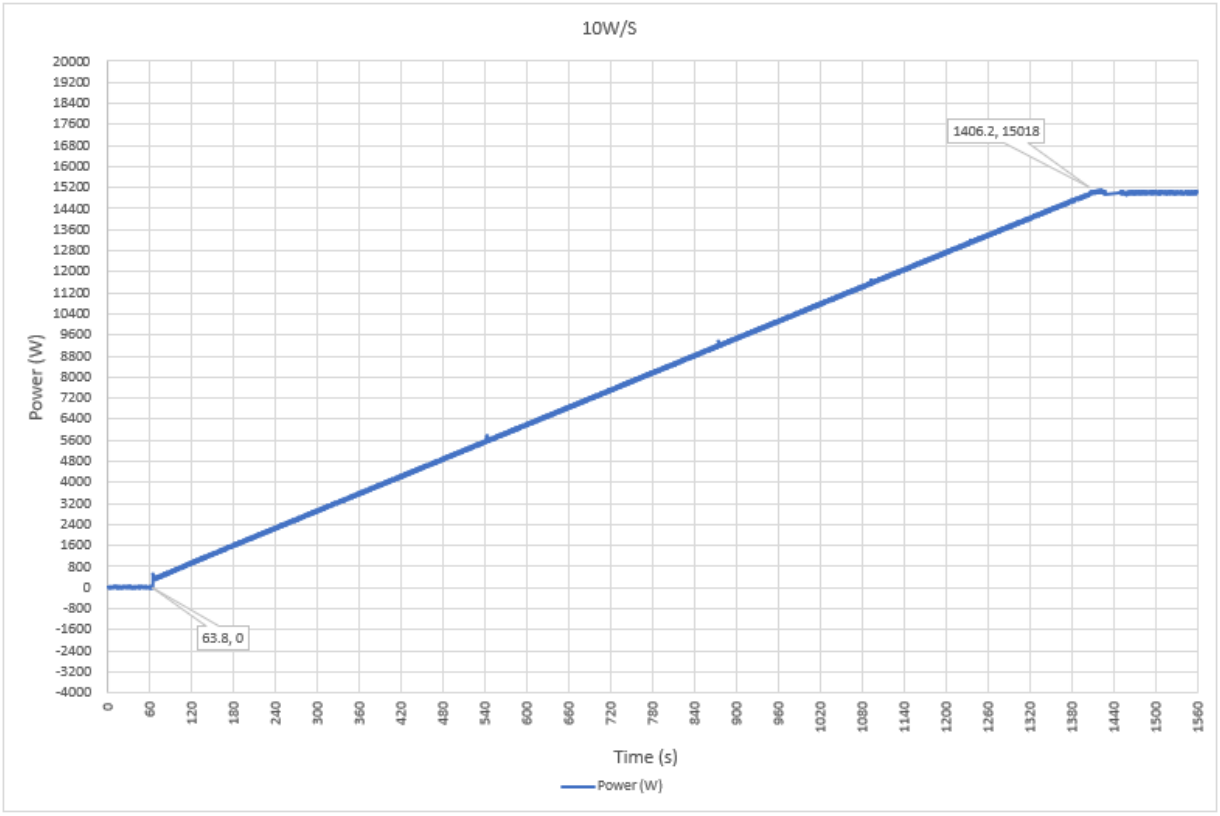
Test results are offered in the table and pictures below:

Increase of Active Power			
Gradient (ΔP) desired (W/s)	**Nominal Ramp Time (s)**	**Gradient measured (W/s)**	**Measured Ramp time (s)**
10.0	1500.0	11.2	1342.4
250.0	60.0	242.1	62.0

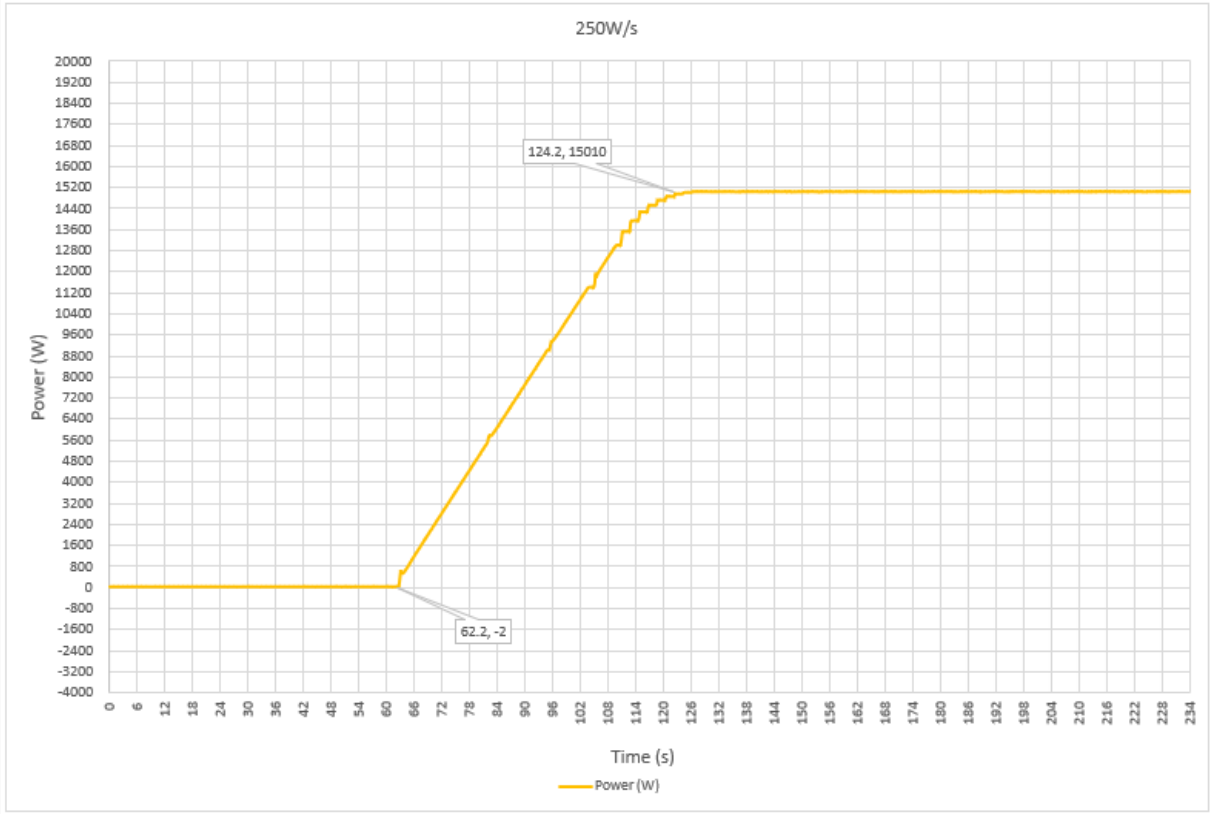
Decrease of Active Power			
Gradient (ΔP) desired (W/s)	**Nominal Ramp Time (s)**	**Gradient measured (W/s)**	**Measured Ramp time (s)**
10.0	1500.0	10.0	1480.2
250.0	60.0	251.1	58.6

Note:
1. The Gradient is adjustable from 10W/s to 250W/s.

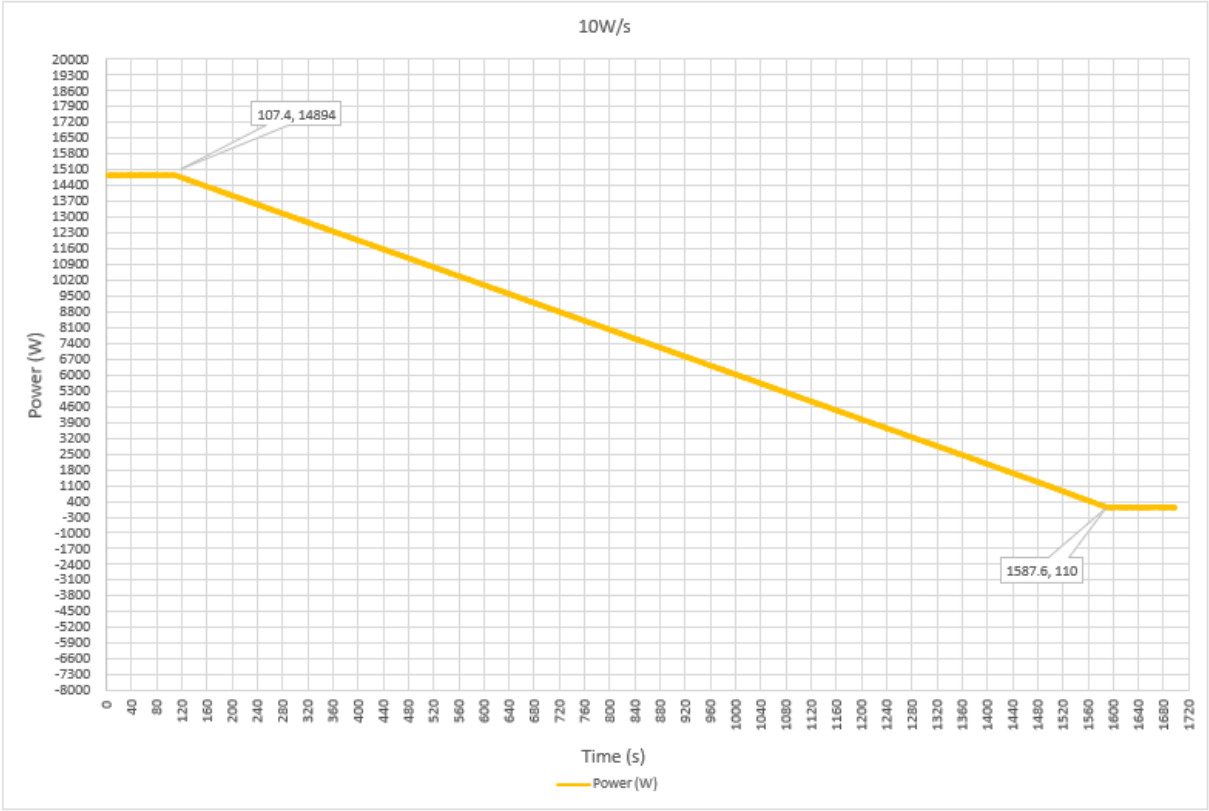
Increase of Active Power with 10W/s



Increase of Active Power with 250W/s



Decrease of Active Power with 10W/s



Decrease of Active Power with 250W/s

4.4.2 Reactive power and voltage control functions

A PV power plant must be equipped with reactive power and voltage control functions capable of controlling the reactive power supplied by a PV power plant in the Point of Connection, and with a control function capable of controlling the voltage in the voltage reference point via activation orders containing set points for the specified parameters.

4.4.2.1 Q Control

This test verifies the capability of the inverter to provide a fixed value of reactive power according to chapter 5.3.1 of standard TR3.2.1 and TR3.2.2. The accuracy of the control performed and of the set point may not deviate by more than ±2% of the set point value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

At high active power levels the reactive power provided by the inverter is automatically limited by the inverter in order to protect against over current.

The following table shows the test results:

Rectangular Curve (Q=48.43%Sn / Capacitive)						
P Desired (%Sn)	**Power DC (W)**	**P measured (%Sn)**	**Q desired (%Sn)**	**Q measured (%Sn)**	**Q Measured Accuracy (*) (Limited ±0.97%Pn)**	**Power Factor (cos φ)**
0	148.6	0.0	-48.4	-49.2	-0.8	0.000
5	755.8	4.0	-48.4	-49.1	-0.7	0.082
10	1538.2	9.3	-48.4	-49.1	-0.6	0.185
15	2311.2	14.4	-48.4	-49.1	-0.6	0.281
20	3083.2	19.5	-48.4	-49.0	-0.6	0.369
25	3855.2	24.6	-48.4	-49.0	-0.6	0.448
30	4624.7	29.7	-48.4	-49.0	-0.6	0.518
35	5398.8	34.8	-48.4	-49.0	-0.5	0.579
40	6170.2	39.8	-48.4	-49.0	-0.5	0.631
45	6939.6	44.9	-48.4	-49.0	-0.5	0.676
50	7713.8	50.0	-48.4	-49.0	-0.5	0.714
55	8485.6	55.0	-48.4	-48.9	-0.5	0.747
60	9251.8	60.0	-48.4	-48.9	-0.4	0.775
65	10029.6	65.1	-48.4	-48.8	-0.4	0.800
70	10800.9	70.1	-48.4	-48.8	-0.3	0.821
75	11571.7	75.1	-48.4	-48.7	-0.3	0.839
80	12338.8	80.1	-48.4	-48.6	-0.2	0.855
85	13113.4	85.1	-48.4	-49.1	-0.7	0.866
90	13884.1	90.1	-48.4	-49.1	-0.6	0.878
95	14654.2	95.0	-48.4	-49.0	-0.6	0.889
100	15425.1	99.9	-48.4	-49.0	-0.5	0.898

(*) The accuracy of the control performed and of the set point may not deviate by more than ±2% of the set point value.

Setting Point value is -48.43% x 15000W = -7264.5W

The accuracy should be ±2% x (-7264.5) W = ± 145.3W which is ±0.97%Pn

Rectangular Curve (Q=48.43%Sn / Inductive)						
P Desired (%Sn)	**Power DC (W)**	**P measured (%Sn)**	**Q desired (%Sn)**	**Q measured (%Sn)**	**Q Measured Accuracy (*) (Limited ±0.97%Pn)**	**Power Factor (cos φ)**
0	148.9	0.0	48.4	47.6	-0.8	0.001
5	756.1	4.1	48.4	47.5	-0.9	0.083
10	1538.0	9.3	48.4	47.6	-0.8	0.186
15	2311.2	14.4	48.4	47.7	-0.8	0.282
20	3083.3	19.5	48.4	47.8	-0.7	0.369
25	3856.8	24.6	48.4	47.8	-0.6	0.447
30	4624.1	29.7	48.4	47.9	-0.6	0.516
35	5400.7	34.8	48.4	47.9	-0.5	0.577
40	6171.0	39.9	48.4	47.9	-0.5	0.629
45	6938.7	44.9	48.4	48.0	-0.4	0.673
50	7714.3	50.0	48.4	48.1	-0.4	0.711
55	8483.8	55.0	48.4	48.2	-0.2	0.743
60	9253.5	60.1	48.4	48.3	-0.2	0.771
65	10027.1	65.1	48.4	48.3	-0.1	0.795
70	10800.5	70.2	48.4	48.0	-0.4	0.818
75	11571.2	75.2	48.4	48.1	-0.3	0.835
80	12338.7	80.1	48.4	48.2	-0.2	0.850
85	13112.7	85.2	48.4	48.3	-0.1	0.863
90	13885.3	90.2	48.4	48.4	0.0	0.875
95	14653.5	95.1	48.4	48.5	0.1	0.885
100	15426.2	100.1	48.4	48.6	0.2	0.895

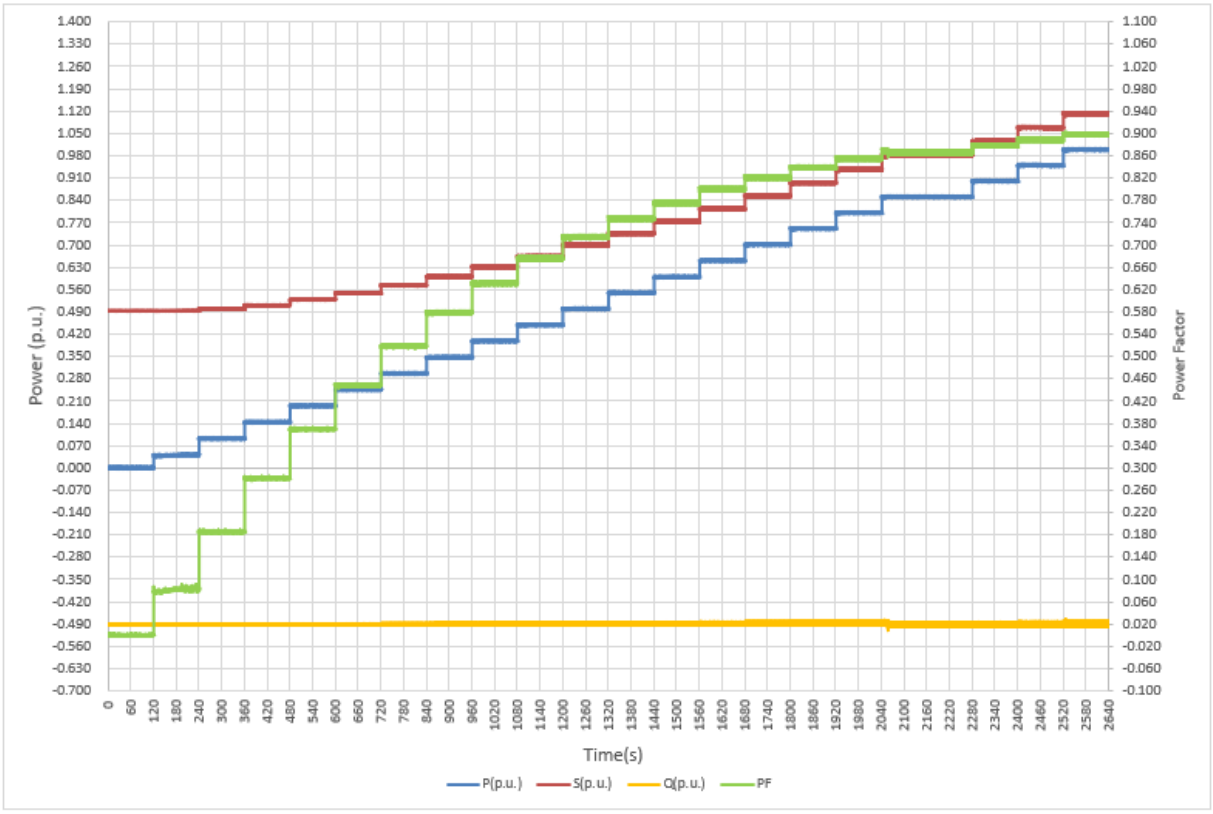
(*) The accuracy of the control performed and of the set point may not deviate by more than ±2% of the set point value.

Setting Point value is 48.43% x 15000W = 7264.5W

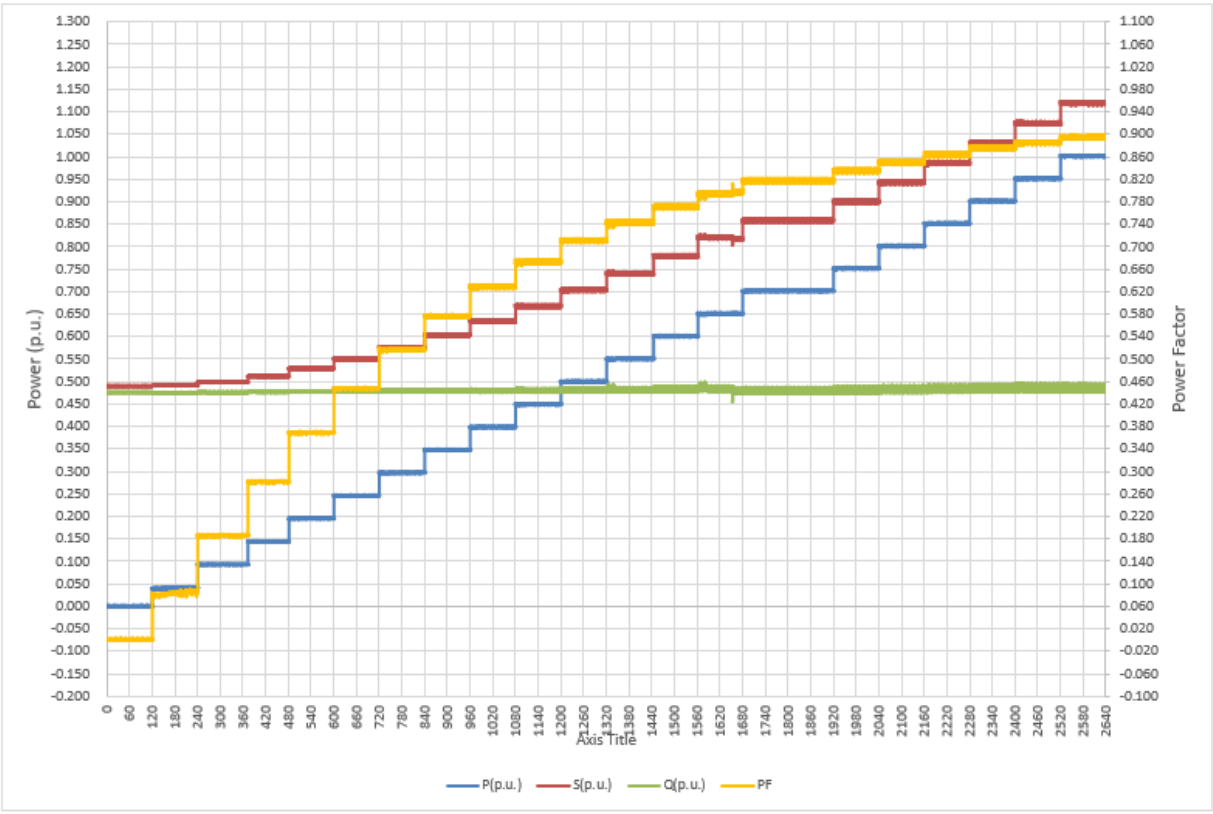
The accuracy should be ±2% x 7264.5W = ± 145.3W which is ±0.97%Pn

Test results are represented at diagrams below.

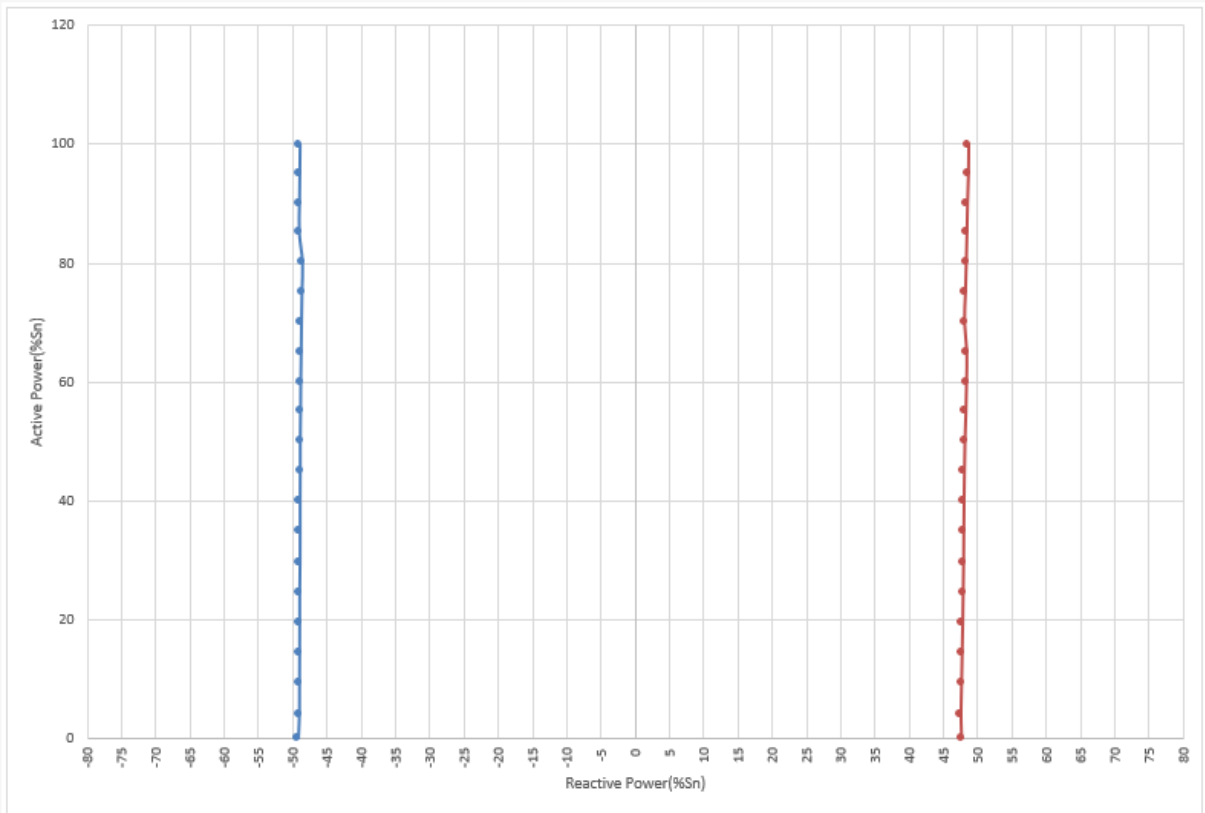
Rectangular Curve (Q=48.43%Sn / Capacitive)



Rectangular Curve (Q=48.43%S_n / Inductive)



Rectangular Curve (Capacitive vs Inductive)



4.4.2.2 Power Factor Control

Fixed power factor tests have been done according to chapter 5.3.2 of the standard.

The accuracy of the control performed and of the setpoint shall not deviate by more than ±2% of the set point value or by ±0.5% of the rated power, depending on which yields the highest tolerance

The following table shows the test results:

PF = 1.00					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.020) (*)**
0	0.009	-0.015	0.514	--	-0.486
10	0.099	-0.015	0.977	--	-0.023
20	0.202	-0.015	0.995	1.000	-0.005
30	0.304	-0.015	0.998	1.000	-0.002
40	0.405	-0.015	0.999	1.000	-0.001
50	0.506	-0.015	0.999	1.000	-0.001
60	0.604	-0.015	0.999	1.000	-0.001
70	0.705	-0.015	1.000	1.000	0.000
80	0.806	-0.015	1.000	1.000	0.000
90	0.906	-0.015	1.000	1.000	0.000
100	1.005	-0.015	1.000	1.000	0.000
(*) ± 2% of the set value used to define the limit value above 10%Pn.					

PF = 0.90 Inductive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.020) (*)**
0	0.009	-0.008	0.630	--	-0.270
10	0.103	0.049	0.901	--	0.001
20	0.203	0.098	0.900	0.900	0.000
30	0.305	0.150	0.897	0.900	-0.003
40	0.406	0.202	0.895	0.900	-0.005
50	0.505	0.254	0.893	0.900	-0.007
60	0.604	0.289	0.902	0.900	0.002
70	0.706	0.341	0.901	0.900	0.001
80	0.805	0.393	0.899	0.900	-0.001
90	0.904	0.444	0.898	0.900	-0.002
100	0.989	0.483	0.899	0.900	-0.001
(*) ± 2% of the set value used to define the limit value above 10%Pn.					

PF = 0.90 Capacitive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.020) (*)**
0	0.009	-0.017	0.449	--	-0.451
10	0.100	-0.049	0.895	--	-0.005
20	0.202	-0.102	0.892	0.900	-0.008
30	0.303	-0.147	0.900	0.900	0.000
40	0.404	-0.202	0.895	0.900	-0.005
50	0.504	-0.248	0.897	0.900	-0.003
60	0.604	-0.295	0.899	0.900	-0.001
70	0.704	-0.342	0.900	0.900	0.000
80	0.803	-0.389	0.900	0.900	0.000
90	0.902	-0.436	0.901	0.900	0.001
100	0.996	-0.460	0.908	0.900	0.008
(*) ± 2% of the set value used to define the limit value above 10%Pn.					

PF = 0.80 Inductive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.020) (*)**
0	0.008	0.022	0.340	--	-0.460
10	0.099	0.074	0.802	--	0.002
20	0.200	0.150	0.799	0.800	-0.001
30	0.300	0.227	0.797	0.800	-0.003
40	0.400	0.300	0.800	0.800	0.000
50	0.500	0.372	0.802	0.800	0.002
60	0.599	0.454	0.797	0.800	-0.003
70	0.698	0.527	0.798	0.800	-0.002
80	0.796	0.600	0.799	0.800	-0.001
90	0.897	0.673	0.800	0.800	0.000
100 (**)	0.908	0.682	0.799	0.800	-0.001
(*) ± 2% of the set value used to define the limit value above 10%Pn.					

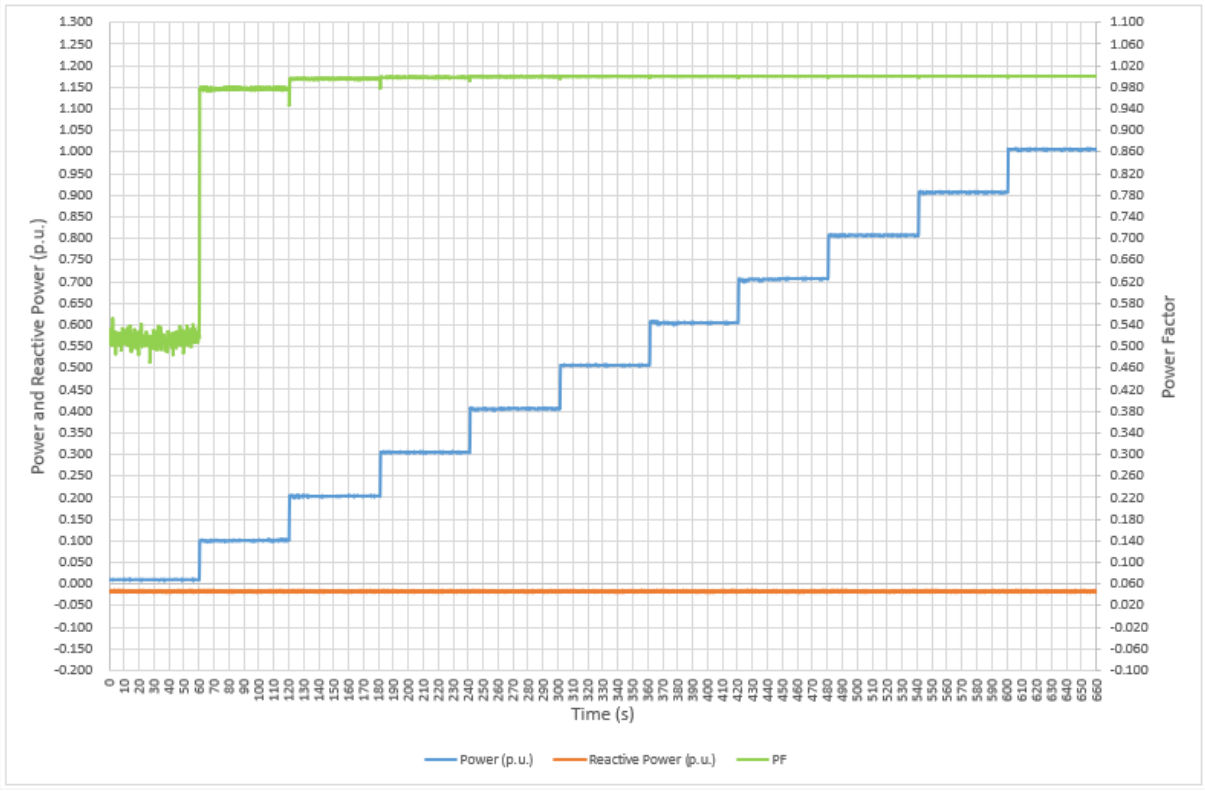
(**) Because of limited by apparent power, the active does not reach to 100% when cos φ = 0.8.

PF = 0.80 Capacitive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.020) (*)**
0	0.008	-0.022	0.333	--	-0.467
10	0.099	-0.073	0.801	--	0.001
20	0.200	-0.149	0.801	0.800	0.001
30	0.300	-0.227	0.797	0.800	-0.003
40	0.400	-0.300	0.800	0.800	0.000
50	0.500	-0.373	0.802	0.800	0.002
60	0.599	-0.454	0.797	0.800	-0.003
70	0.698	-0.527	0.798	0.800	-0.002
80	0.797	-0.599	0.799	0.800	-0.001
90	0.895	-0.673	0.799	0.800	-0.001
100 (**)	0.908	-0.682	0.800	0.800	0.000
(*) ± 2% of the set value used to define the limit value above 10%Pn.					

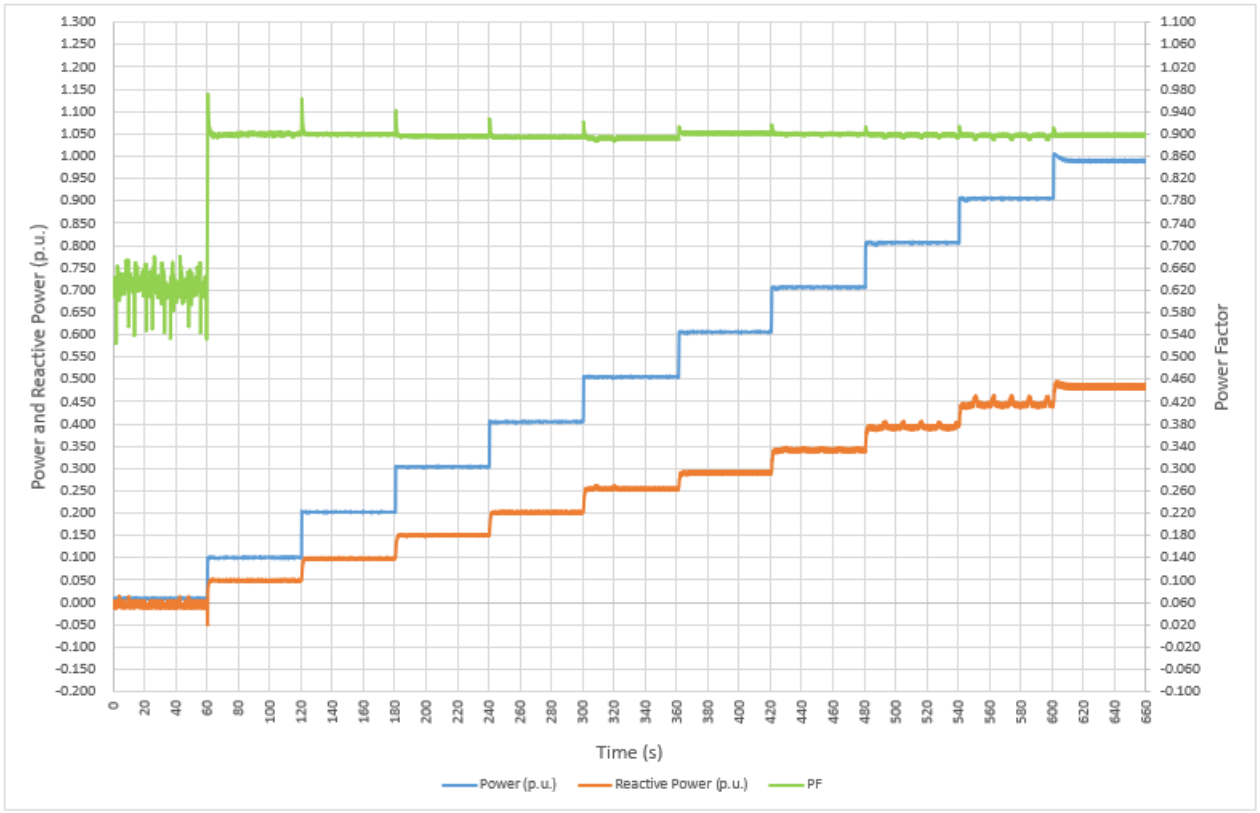
(**) Because of limited by apparent power, the active does not reach to 100% when cos φ = 0.8.

Test results are represented at diagrams below.

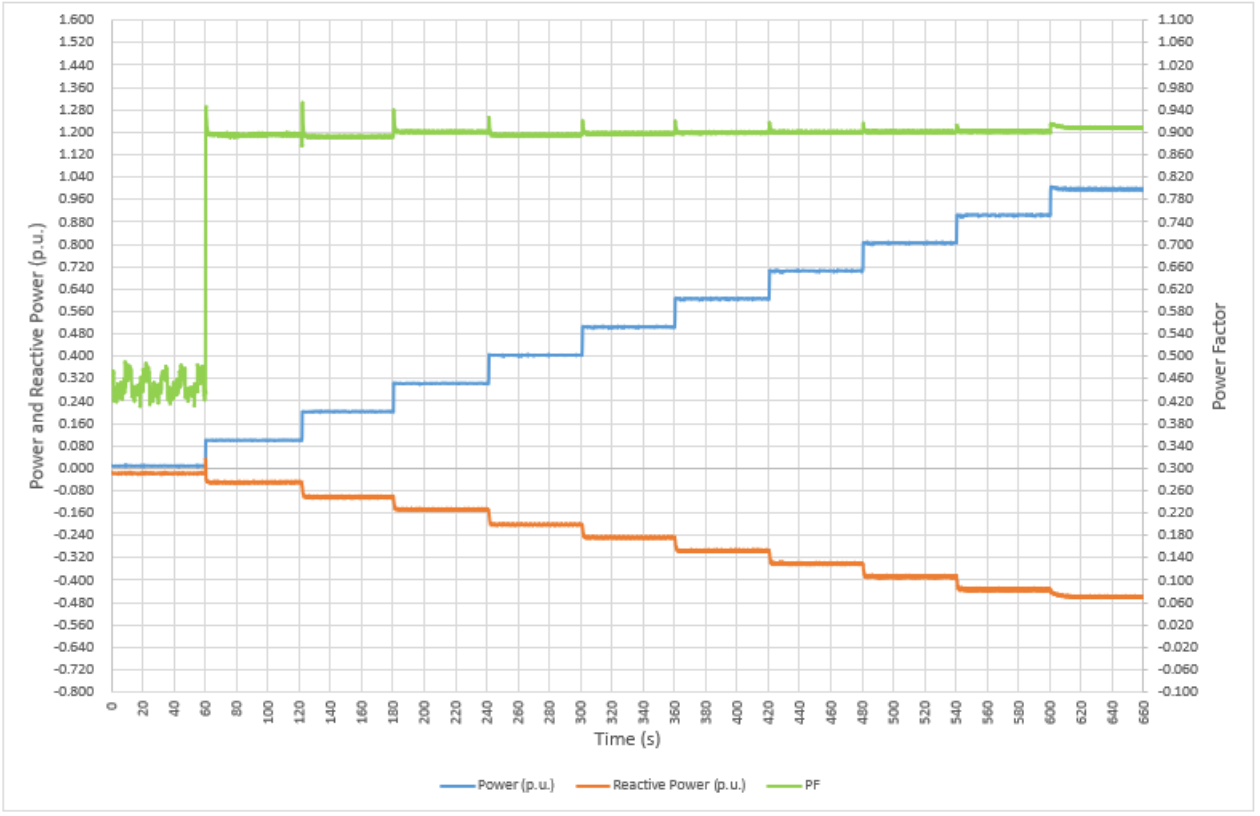
PF =1.00



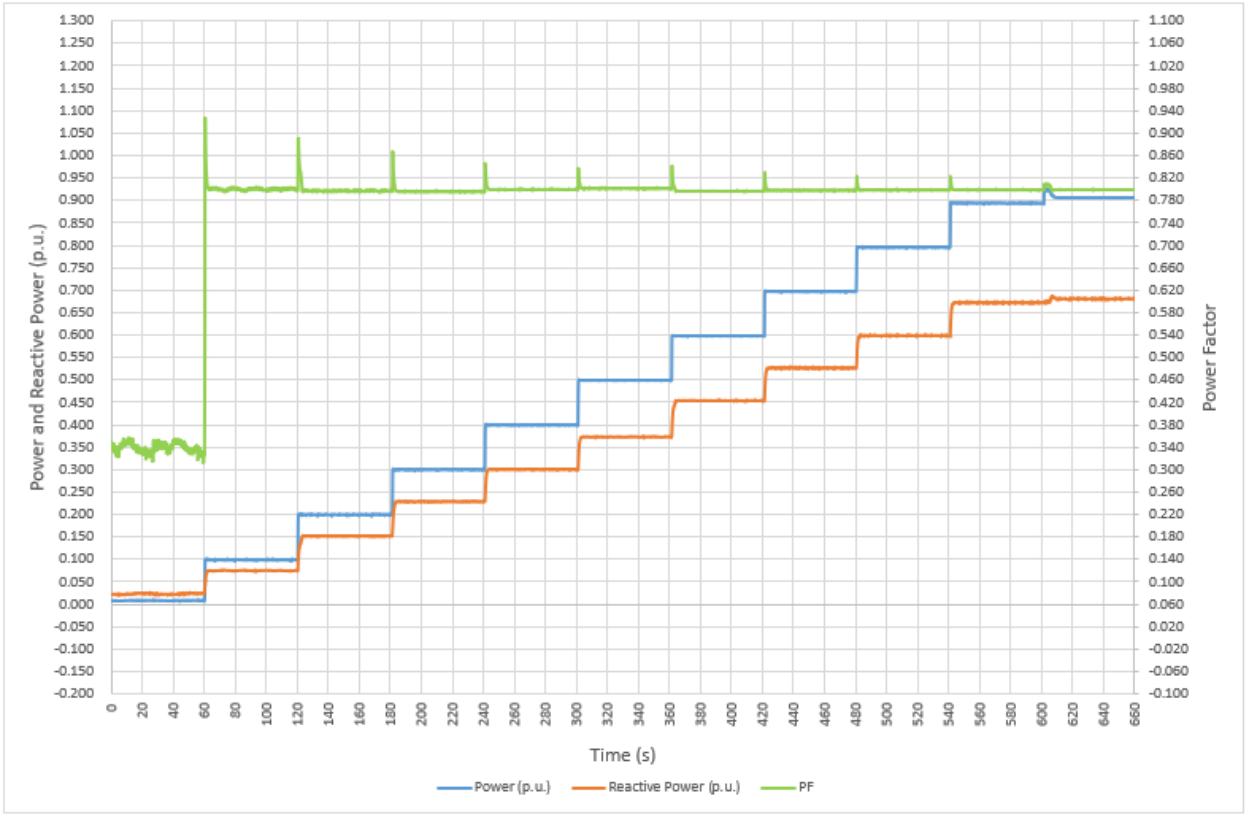
PF =0.90 Inductive



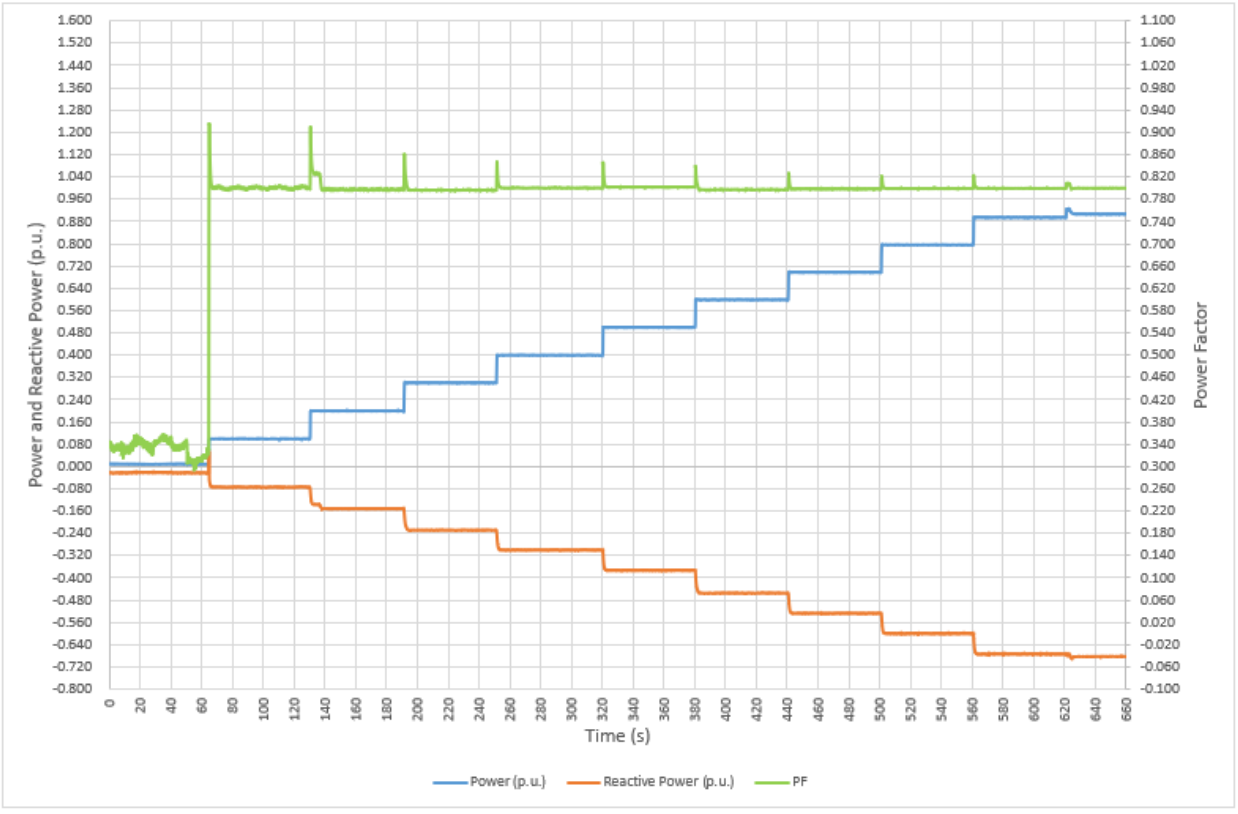
PF =0.90 Capacitive



PF =0.80 Inductive



PF =0.80 Capacitive



4.4.2.3 Voltage Control

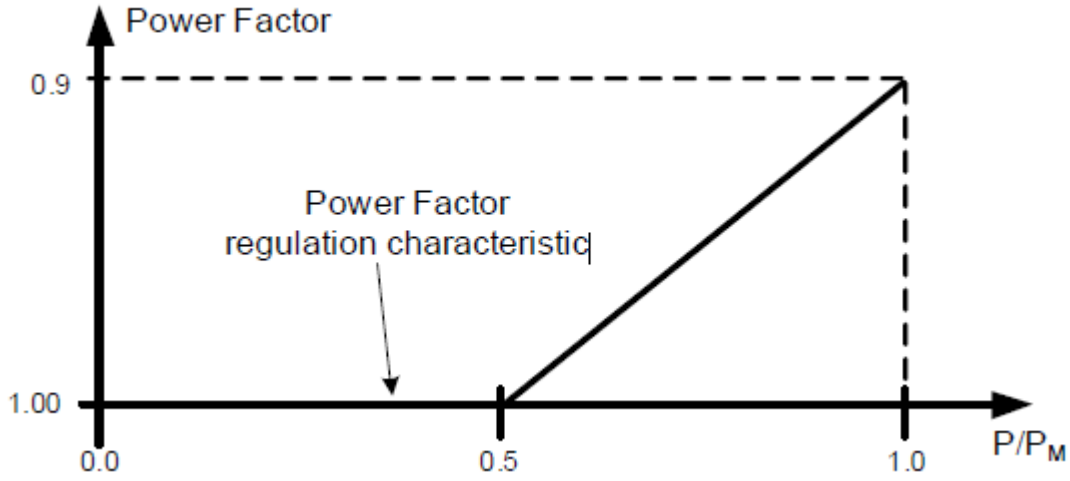
According to chapter 5.3.3 of the standard, the voltage control function stabilises the voltage in the voltage reference point. Voltage control must have a setting range within minimum to maximum voltage, with an accuracy of 0.5% or better of the nominal voltage.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. The test is only applicable to plant categories C and D.

4.4.2.4 Automatic Power Factor Control

According to chapter 5.3.4 of the standard, the automatic Power Factor control function automatically activates/deactivates the Power Factor control at defined voltage levels in the voltage reference point.

The principle of the automatic Power Factor control is illustrated in Figure below:



The default setting for the automatic control (PF) is given by the following three support points with linear interpolation between them:

1: P/P_M = 0.0, PF = 1.00
2: P/P_M = 0.5, PF = 1.00
3: P/P_M = 1.0, PF = 0.90

Note: P_M indicates the active power which can be generated under the given circumstances.

The activation level for the function is normally 105% of the nominal voltage, and the deactivation level is normally 100% of the nominal voltage. The activation/deactivation level must be adjustable via set points.

The test has been done with the following threshold values settled at the inverter.

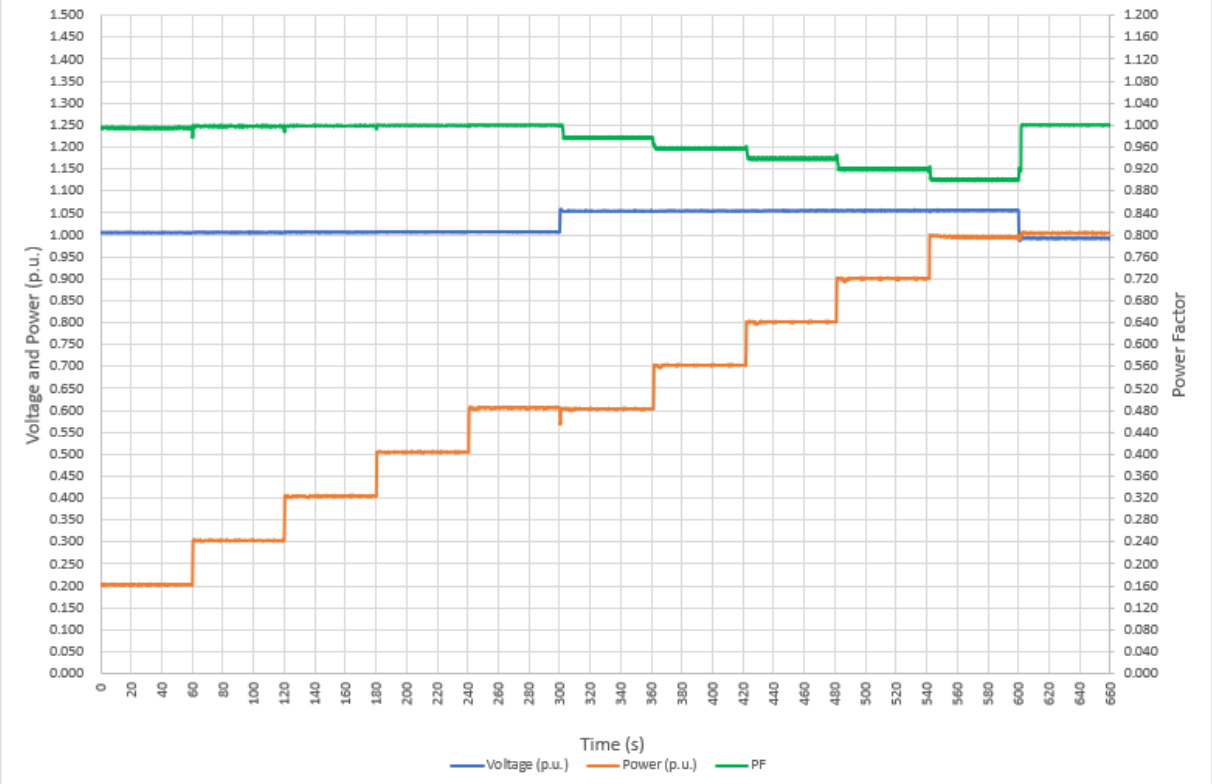
Curve Parameters		
Point	**Active Power**	**cos φ**
A	20%*P_n	1.000
B	50%* P_n	1.000
C	100%* P_n	0.900
V lock-in		**V lock-out**
105%Un		100%Un

Test results are offered at the table below.

Test results							
P Desired (%Sn)	P measured (p.u.)	Q measured (p.u.)	Voltage Desired (p.u.)	Voltage Measured (p.u.)	Power Factor desired (cos φ)	Power Factor measured (cos φ)	Power Factor Deviation (cos φ)
0.200	0.200	-0.020	<1.050	1.000	1.000	0.995	-0.005
0.300	0.300	-0.020	<1.050	1.010	1.000	0.998	-0.002
0.400	0.400	-0.020	<1.050	1.010	1.000	0.999	-0.001
0.500	0.500	-0.020	<1.050	1.010	1.000	0.999	-0.001
0.600	0.610	-0.020	<1.050	1.010	1.000	0.999	-0.001
0.600	0.600	-0.130	>1.050	1.050	0.980	0.978	-0.002
0.700	0.700	-0.210	>1.050	1.050	0.960	0.958	-0.002
0.800	0.800	-0.290	>1.050	1.050	0.940	0.939	-0.001
0.900	0.900	-0.380	>1.050	1.050	0.920	0.920	0.000
1.000	1.000	-0.480	>1.050	1.060	0.900	0.901	0.001
1.000	1.000	-0.020	<=1.000	0.990	1.000	0.998	-0.002
Supplementary information: This test has the maximum settling time observed. This is from step *60%P & <105%Un* to *60%P & >105%Un*.							

Test results are graphically represented at the diagrams below:

Power Factor vs Power



4.4.3 System Protection

According to chapter 5.4 of the standard, a PV power plant must be equipped with system protection – a control function which must be capable of very quickly regulating the active power supplied by a PV power plant to one or more predefined set points based on a downward regulation order. The set points are determined by the electricity supply undertaking upon commissioning.

The PV power plant must have at least five different configurable regulation step options.
The following regulation steps are recommended as default values:

1. Up to 70% of rated power
2. Up to 50% of rated power
3. Up to 40% of rated power
4. Up to 10% of rated power
5. Up to 0% of rated power, ie the plant is shut down, but not disconnected from the grid.

It is not applicable due to the inverter is tested as Categories A2 and B defined in this standard, according to manufacturer Statements. The test is only applicable to plant categories C and D.

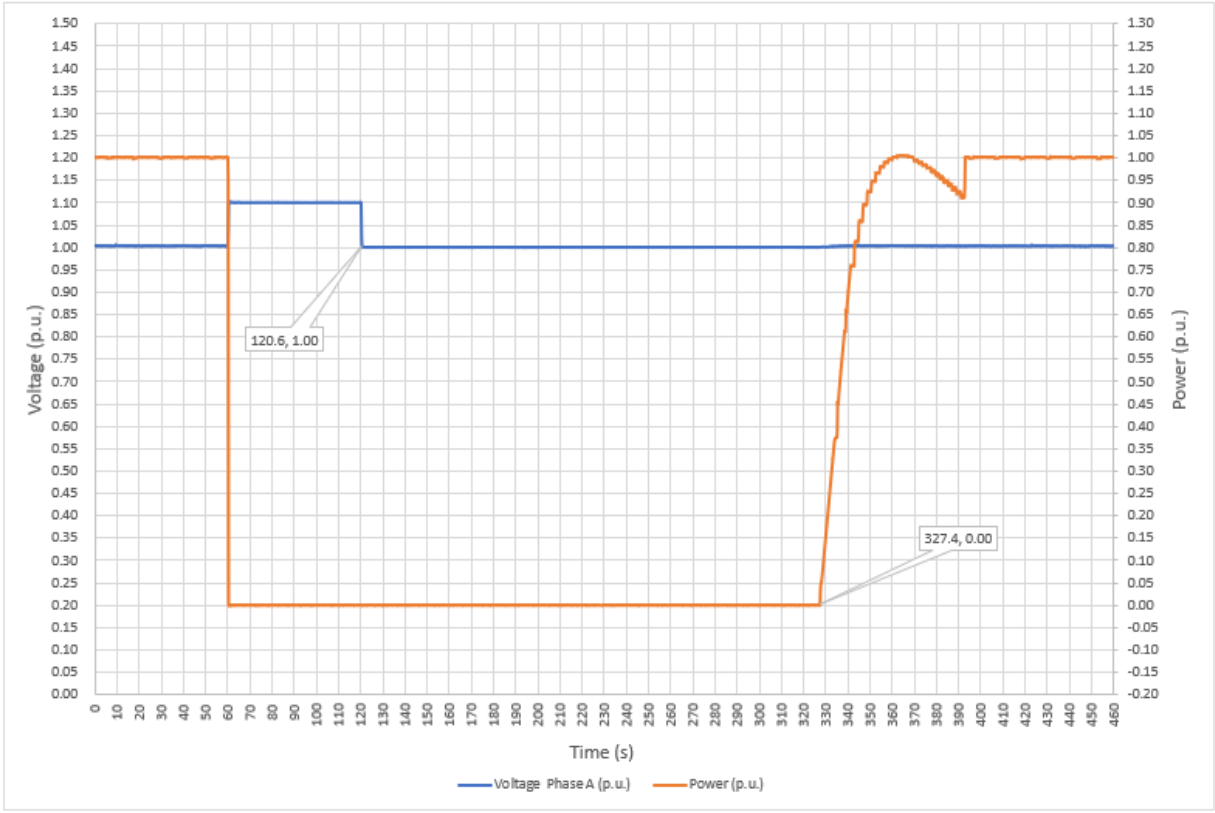
4.5 RECONNECTION

The inverter must be capable to reconnect when voltage and frequency are within the normal ranges according to standard. And the automatic connection of a PV power plant can take place no earlier than three minutes after the voltage and frequency have come within the normal production range.

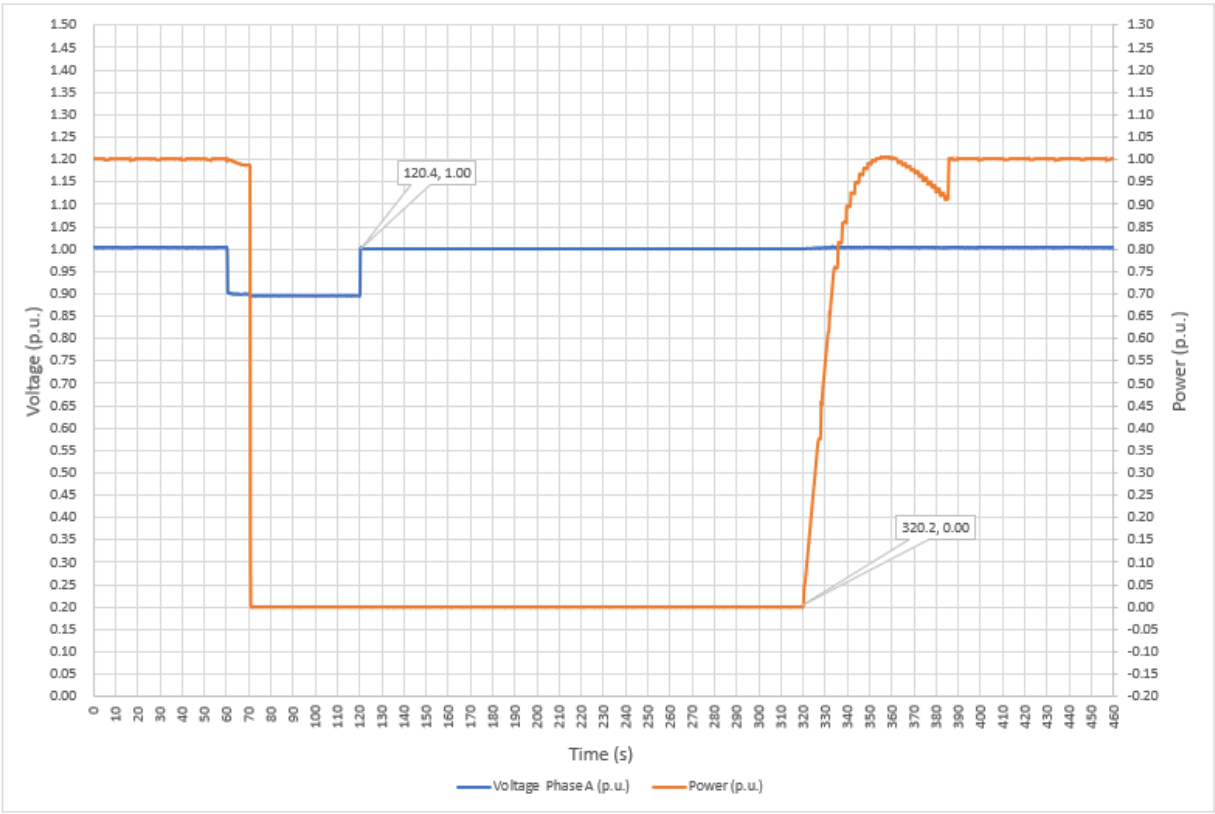
For plant category A2 or B:

Type	Required Delay time	Time measured (s)
OV: 110%Un	>3 min	206.8
UV: 90%Un	>3 min	199.8
OF: 52.00 Hz	>3 min	206.6
UF: 47.00 Hz	>3 min	207.0

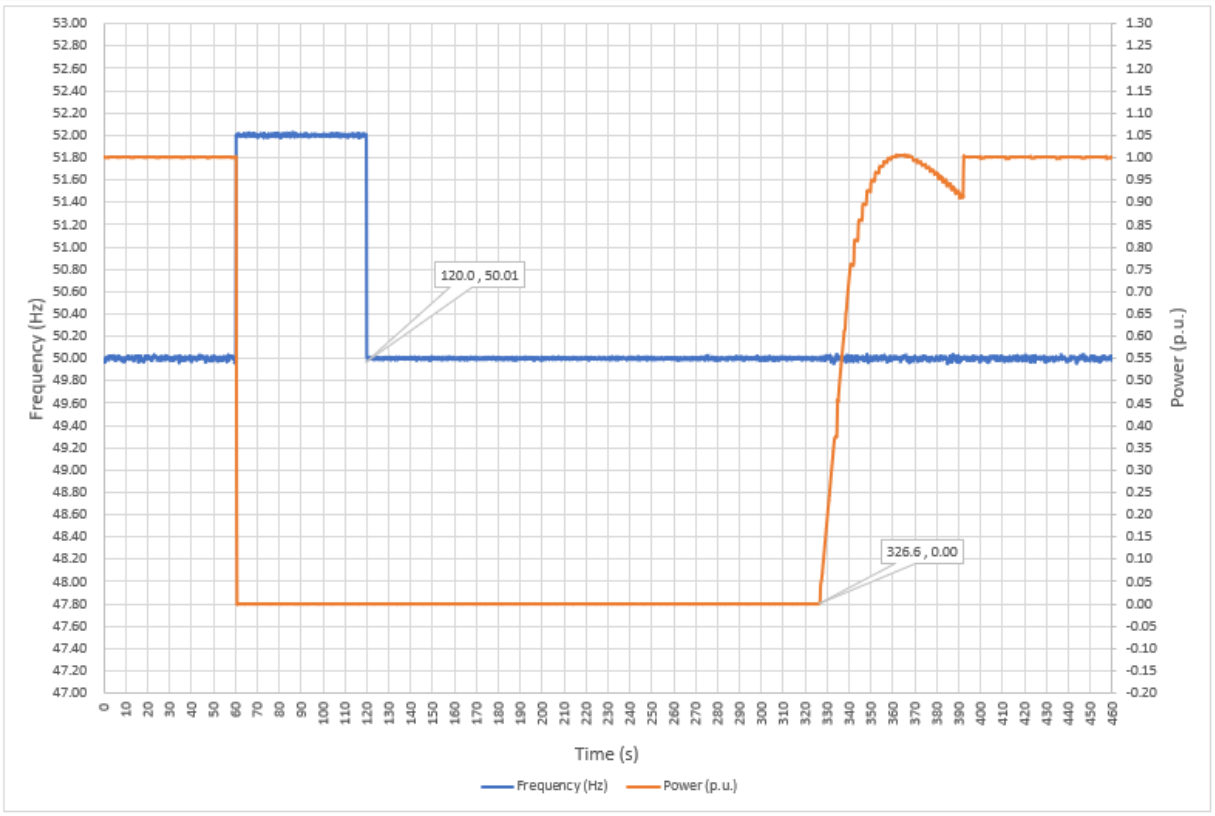
OV: 110%Un



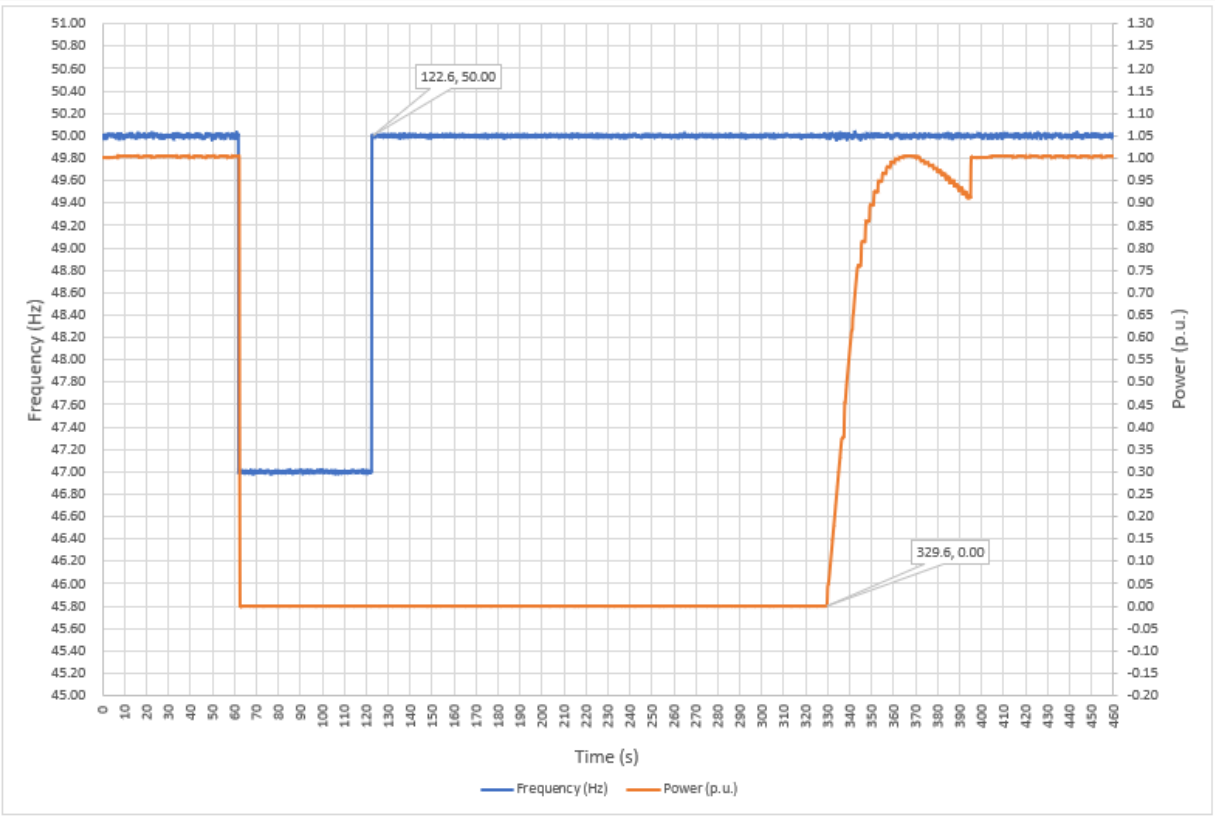
UV: 90%Un



OF: 52.0 Hz



UF: 47.0 Hz



4.6 VOLTAGE AND FREQUENCY TRIPS

Voltage and frequency trips requirements are different when unit is connected as plant category A2 and B. The settings of reconnect voltage and frequency are adjustable.

For connected as plant category A2, according to chapter 6.3.2 of standard TR3.2.2, protective functions with associated operating settings and trip time must match the values in the table below.

Protective function	Symbol	Setting		Trip time		Standard value
Overvoltage (step 2)	$U_{>>}$	1.15 · U_n	V	200	ms	200 ms
Overvoltage (step 1)	$U_{>}$	1.10 · U_n	V	60	s	60 s
Undervoltage (step 1)	$U_{<}$	0.85 · U_n	V	10...60	s	50 s
Undervoltage (step 2) ***)	U<<	0.80 · U_n	V	100...200	ms	100 ms
Overfrequency	$f_{>}$	52.0	Hz	200	ms	200 ms
Underfrequency	$f_{<}$	47.0	Hz	200	ms	200 ms
Change of frequency ***)	*df/dt*	±2.5	Hz/s	50...100	ms	80 ms

***) One of the specified functions must be implemented.

For connected as plant category B, according to chapter 6.3.2 of standard TR3.2.2, protective functions with associated operating settings and trip time must match the values in the table below.

Protective function	Symbol	Setting		Trip time		Standard value
Overvoltage (step 2)	$U_{>>}$	1.15 · U_n	V	200	ms	200 ms
Overvoltage (step 1)	$U_{>}$	1.10 · U_n	V	60	s	60 s
Undervoltage (step 1)	$U_{<}$	0.90 · U_n	V	10...60	s	10 s
Overfrequency	$f_{>}$	52	Hz	200	ms	200 ms
Underfrequency	$f_{<}$	47	Hz	200	ms	200 ms
Change of frequency	*df/dt*	±2.5	Hz/s	50...100	ms	80 ms

The settings of voltage and frequency trips is adjustable.

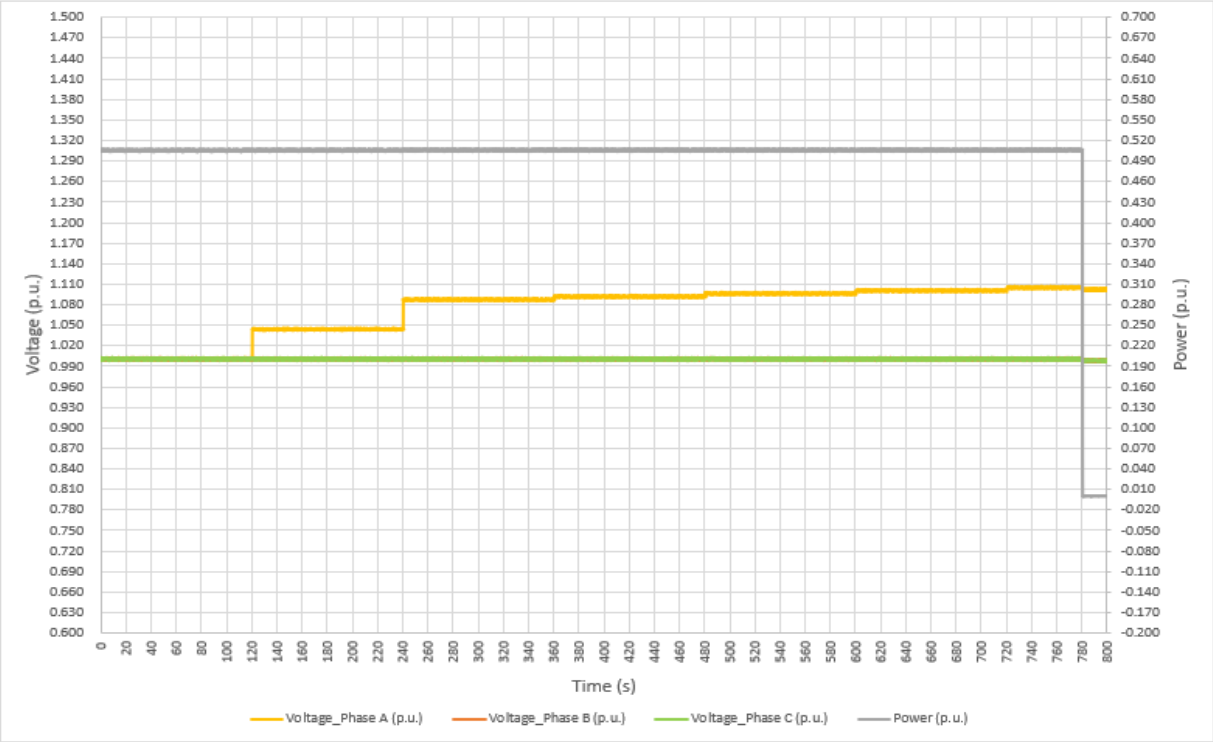
Test results are offered at the tables below.

4.6.1 Voltage Trip

Voltage	Disconnection time limits (s)	Disconnection time measured (s)	
Un+10%Un	60	Phase A	59.600
		Phase B	59.300
		Phase C	59.360
		Phase ABC	59.500
Un+15%Un	0.2	Phase A	0.112
		Phase B	0.128
		Phase C	0.120
		Phase ABC	0.123
Un-10%Un	10 to 60	Phase A	59.340
		Phase B	59.342
		Phase C	59.250
		Phase ABC	59.392
Un-15%Un	10 to 60	Phase A	50.240
		Phase B	50.342
		Phase C	50.250
		Phase ABC	50.220
Un-20%Un	0.1 to 0.2	Phase A	0.114
		Phase B	0.122
		Phase C	0.129
		Phase ABC	0.112

Un+10%Un Phase A

Trip Voltage

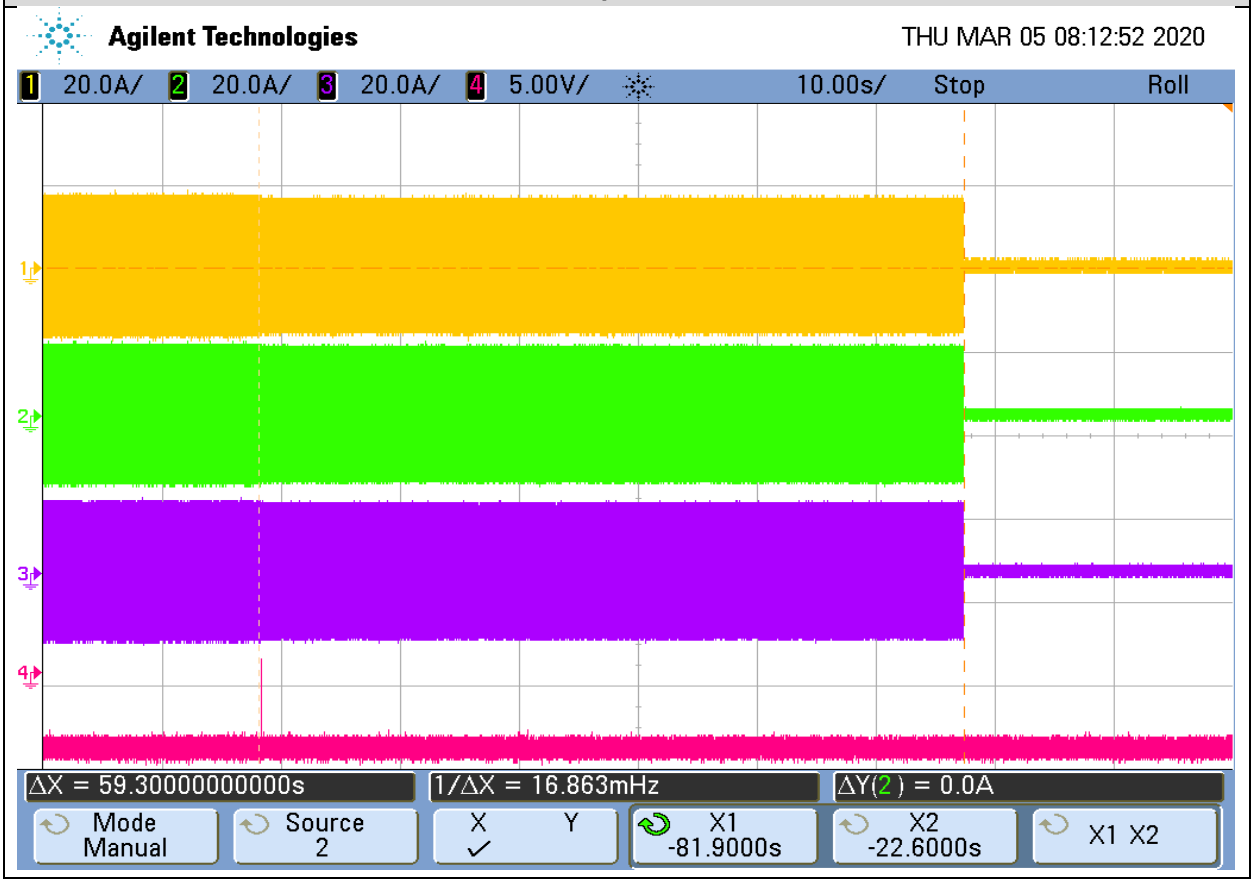


Trip Time

Un+10%Un Phase B

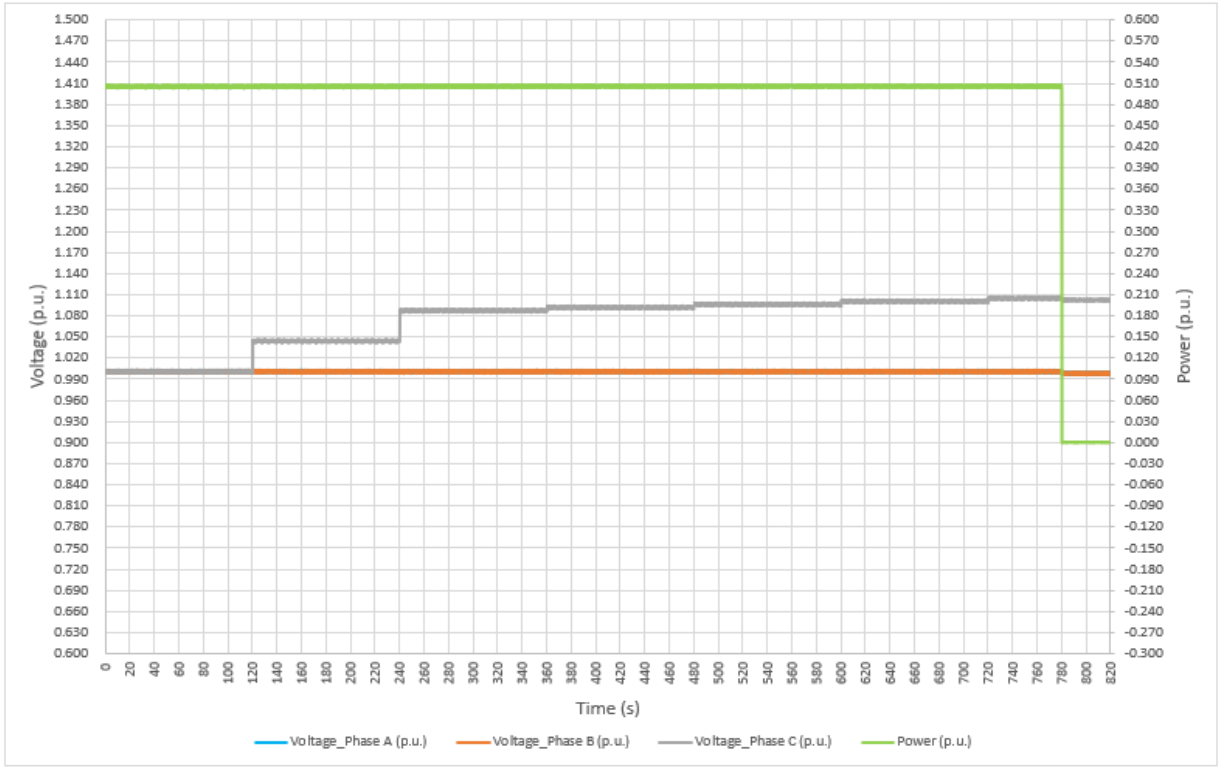
Trip Voltage

Trip Time

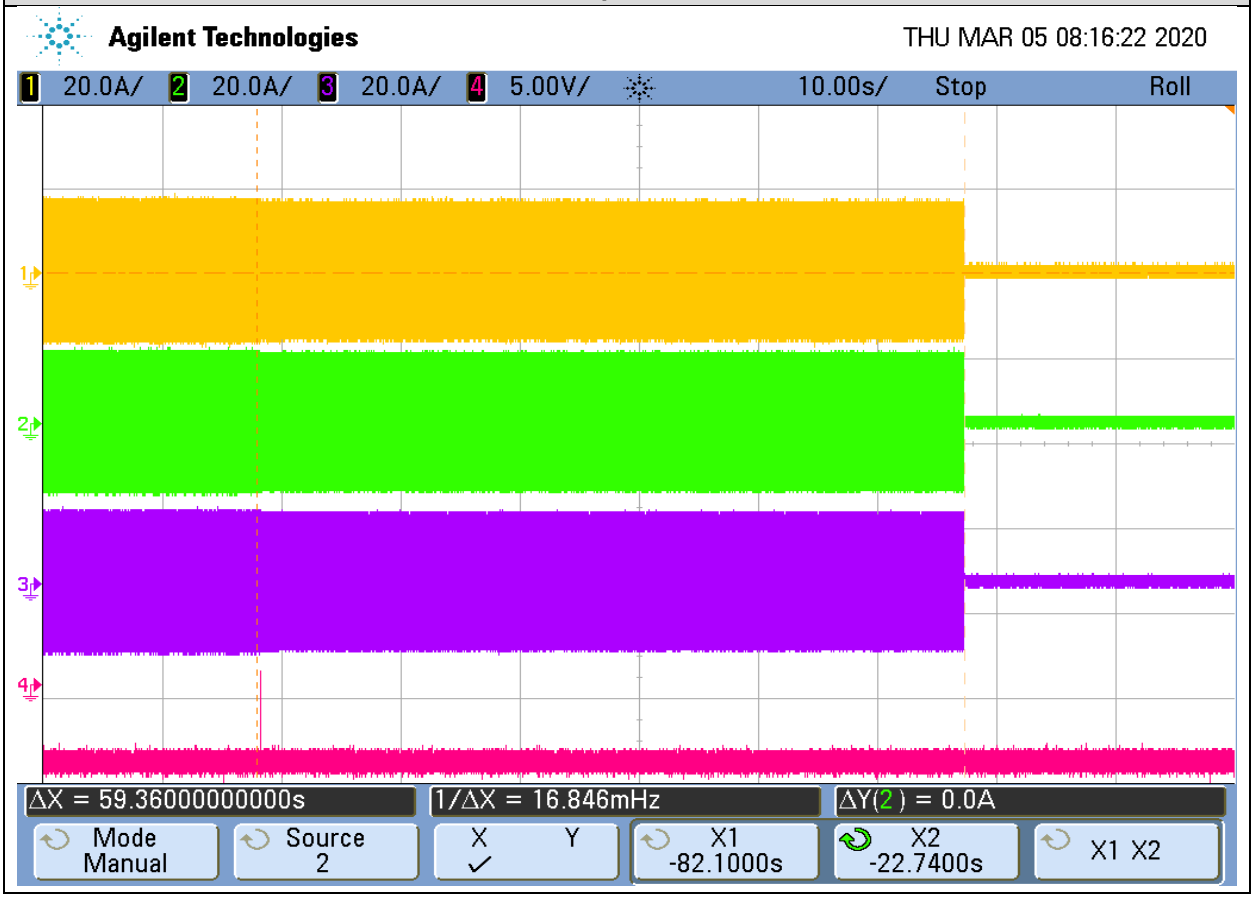


Un+10%Un Phase C

Trip Voltage

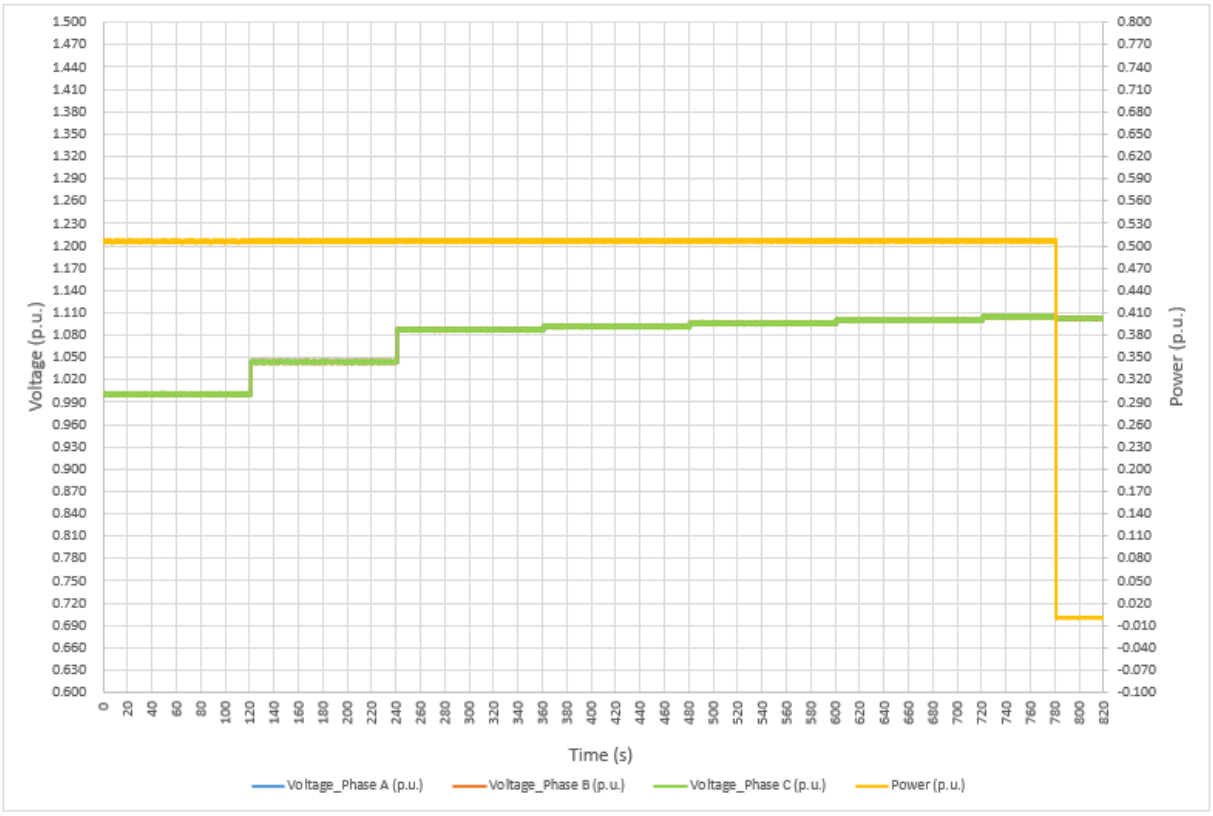


Trip Time



Un+10%Un Phase ABC

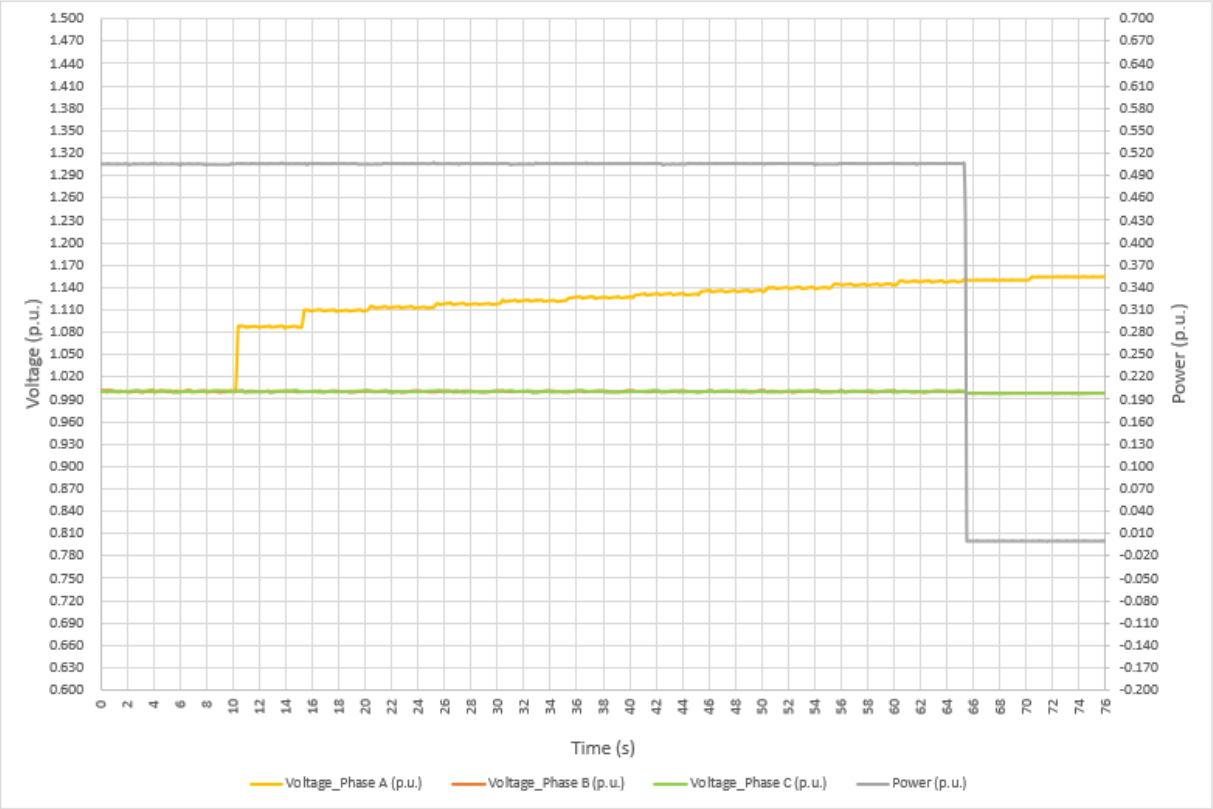
Trip Voltage



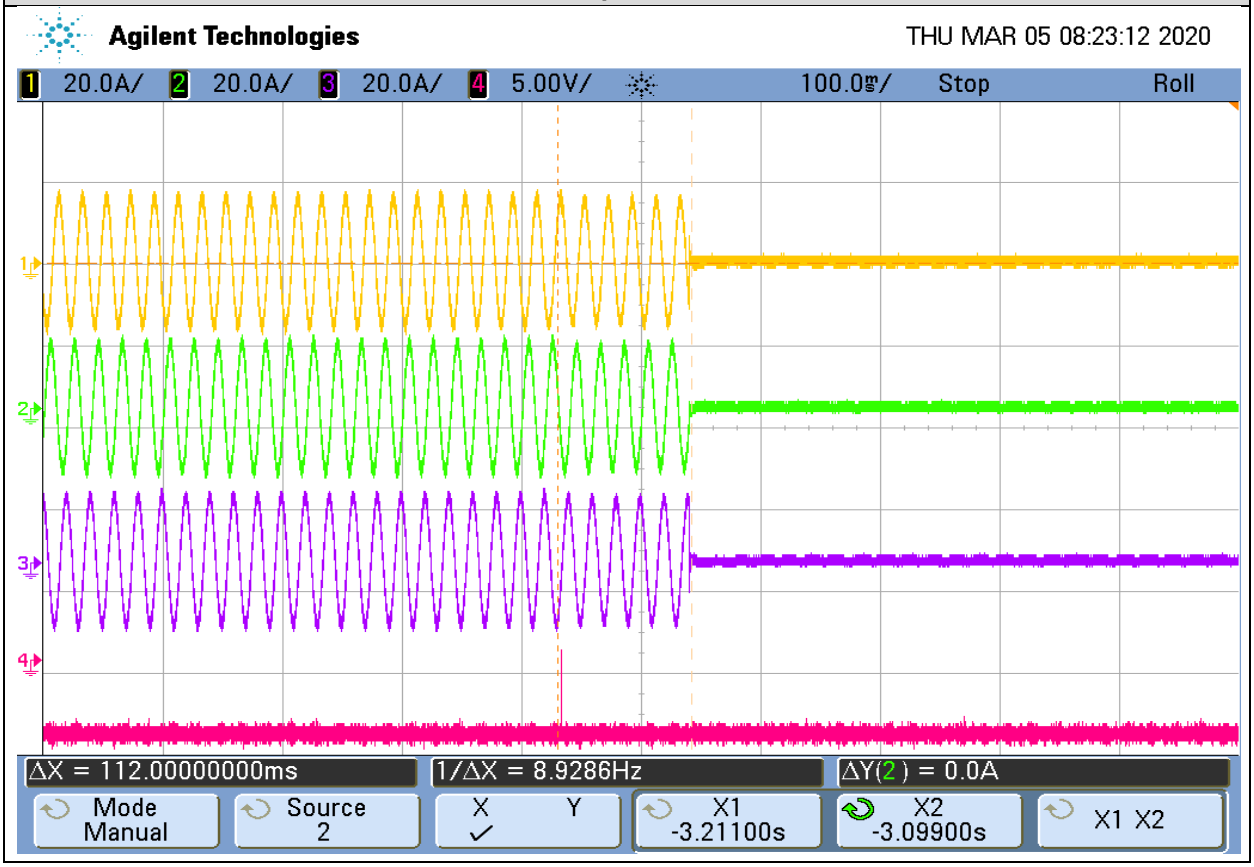
Trip Time

Un+15%Un Phase A

Trip Voltage

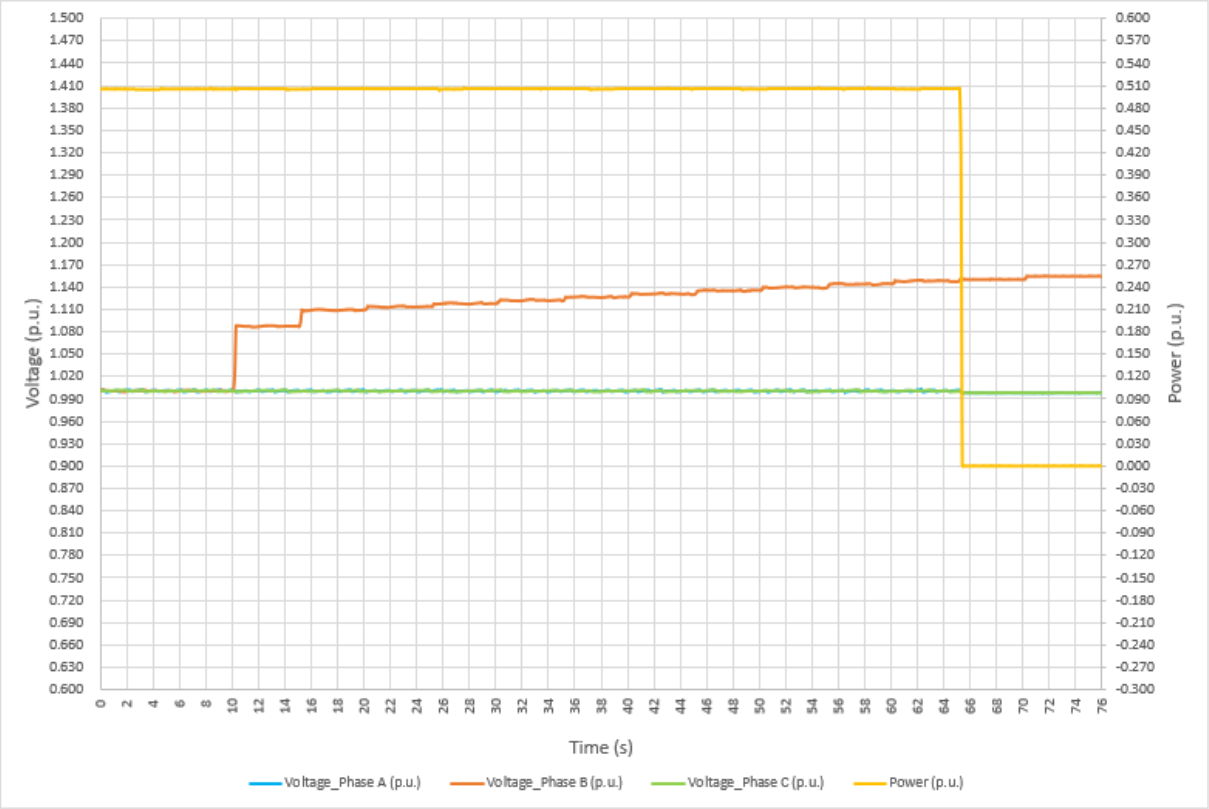


Trip Time

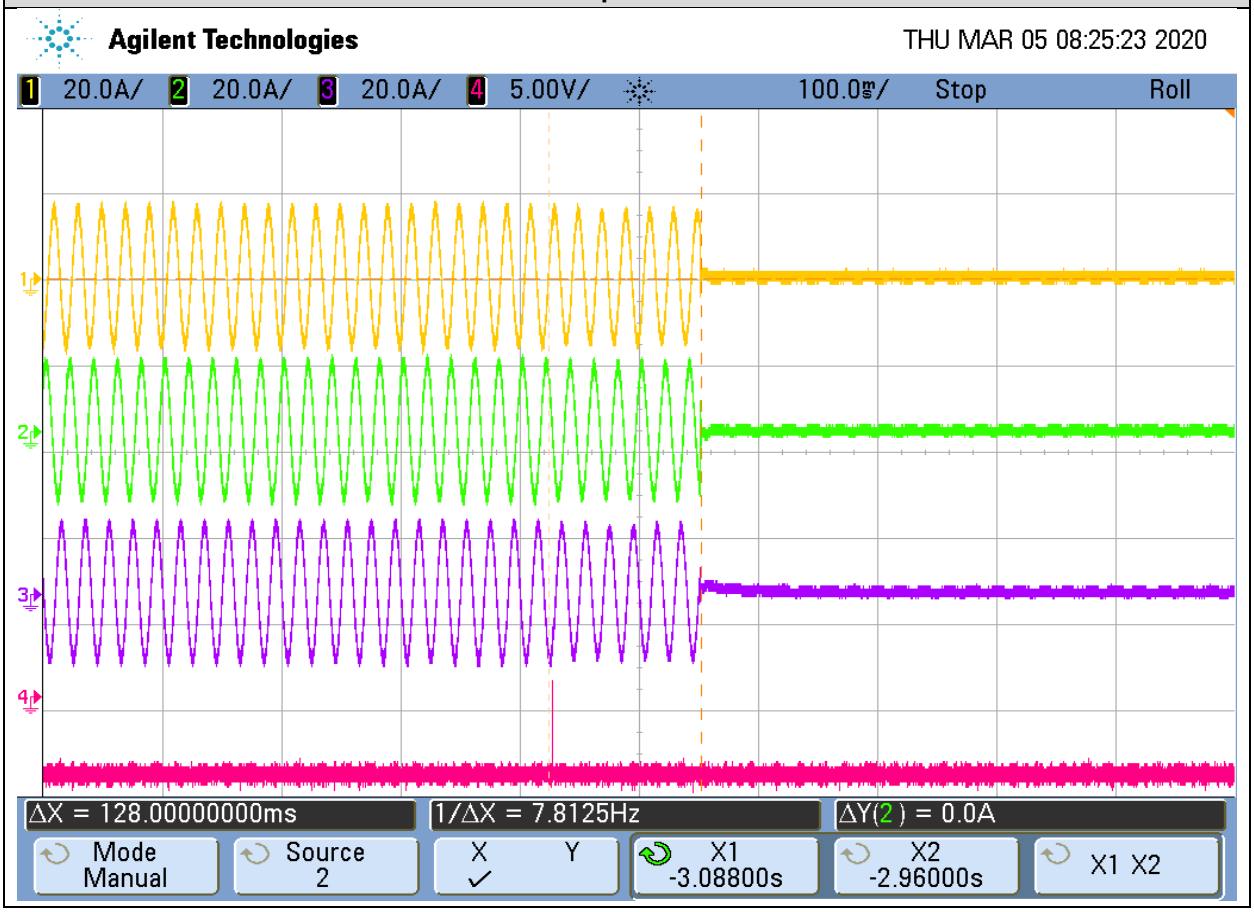


Un+15%Un Phase B

Trip Voltage

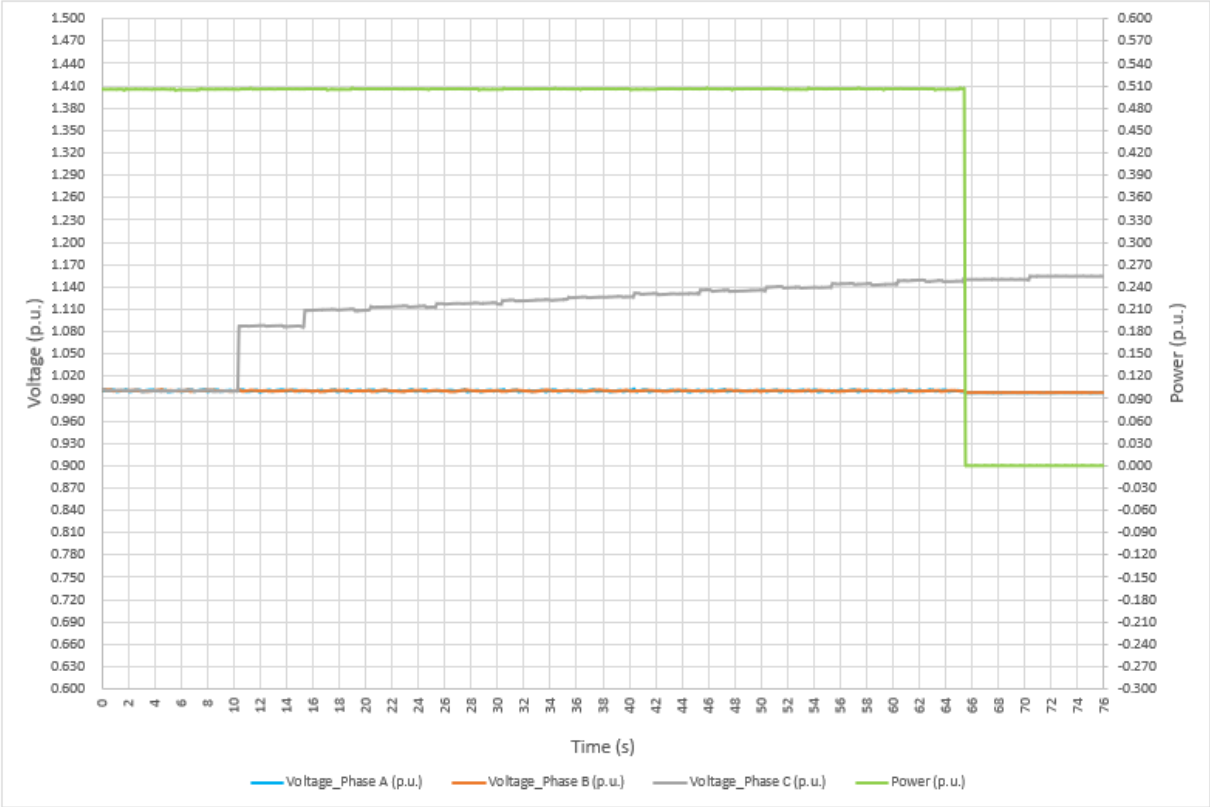


Trip Time

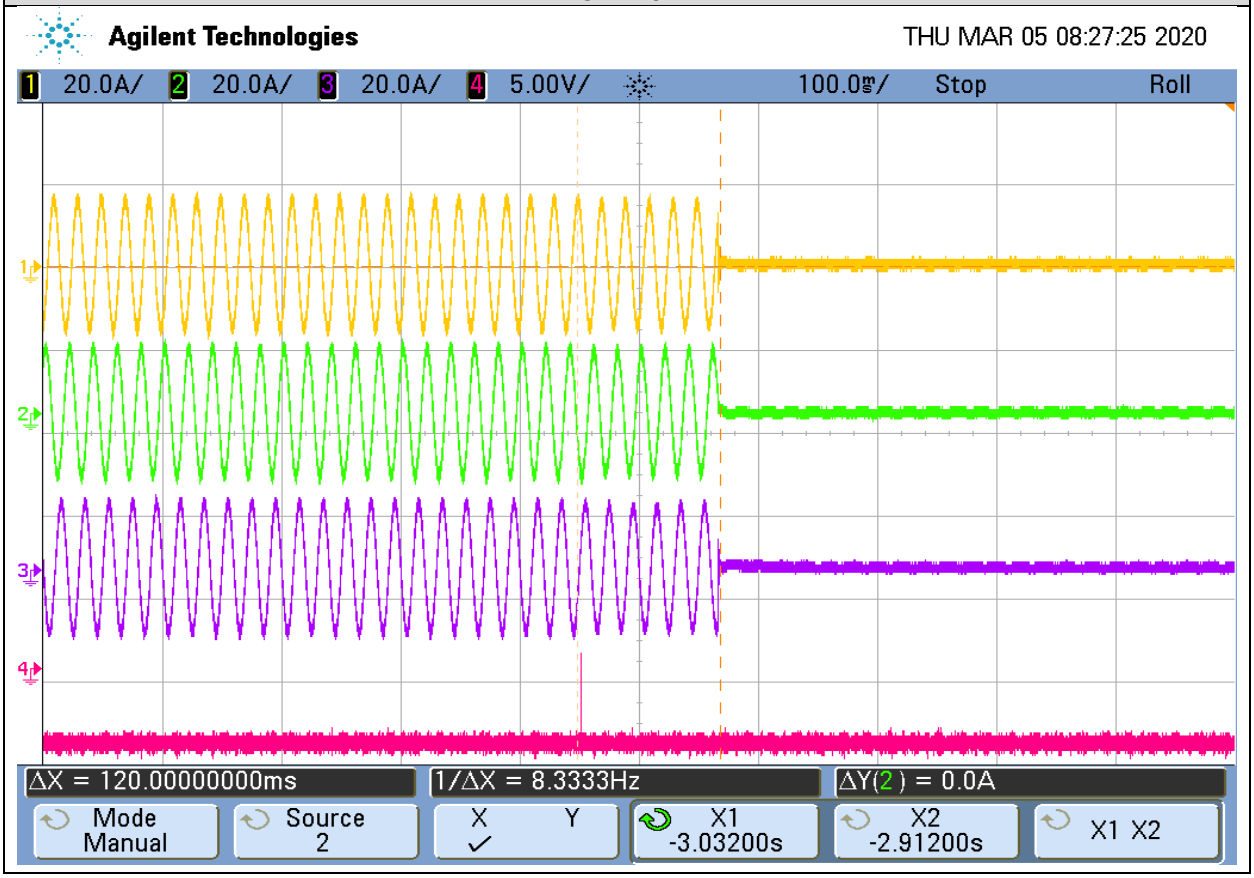


Un+15%Un Phase C

Trip Voltage

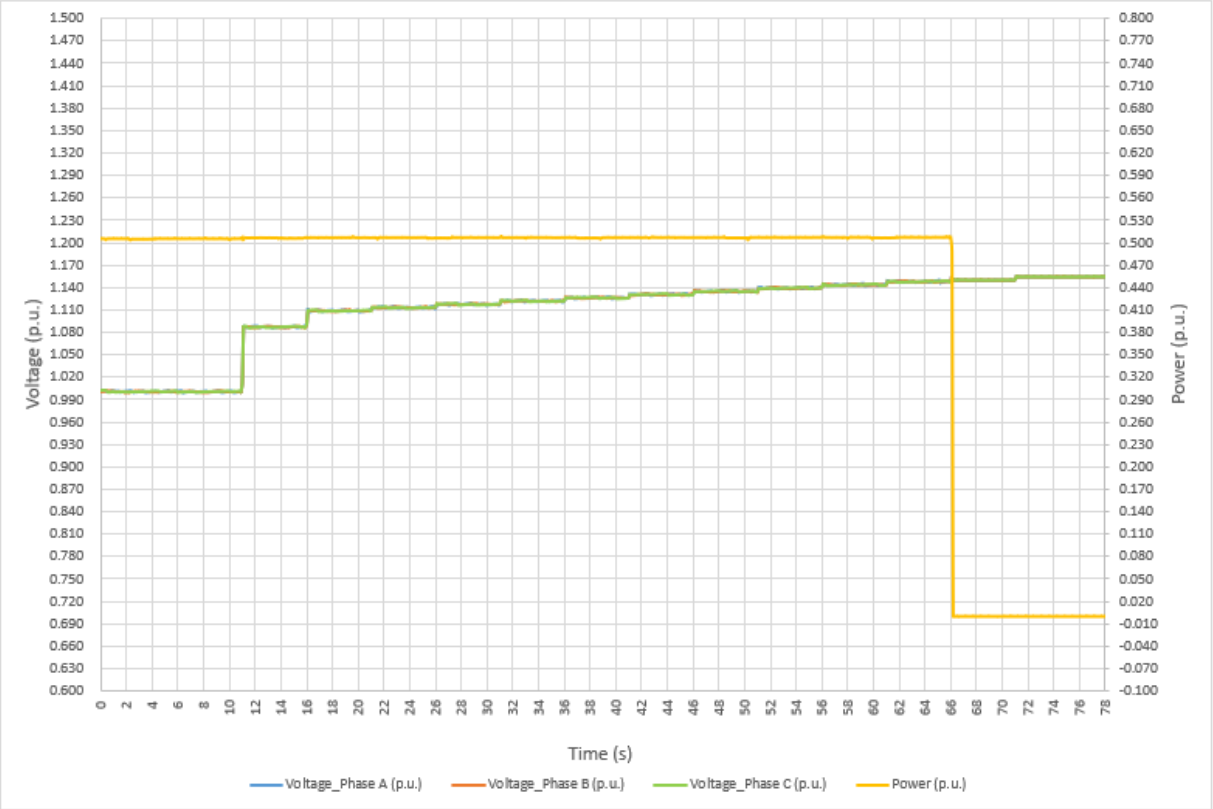


Voltage Trip Time

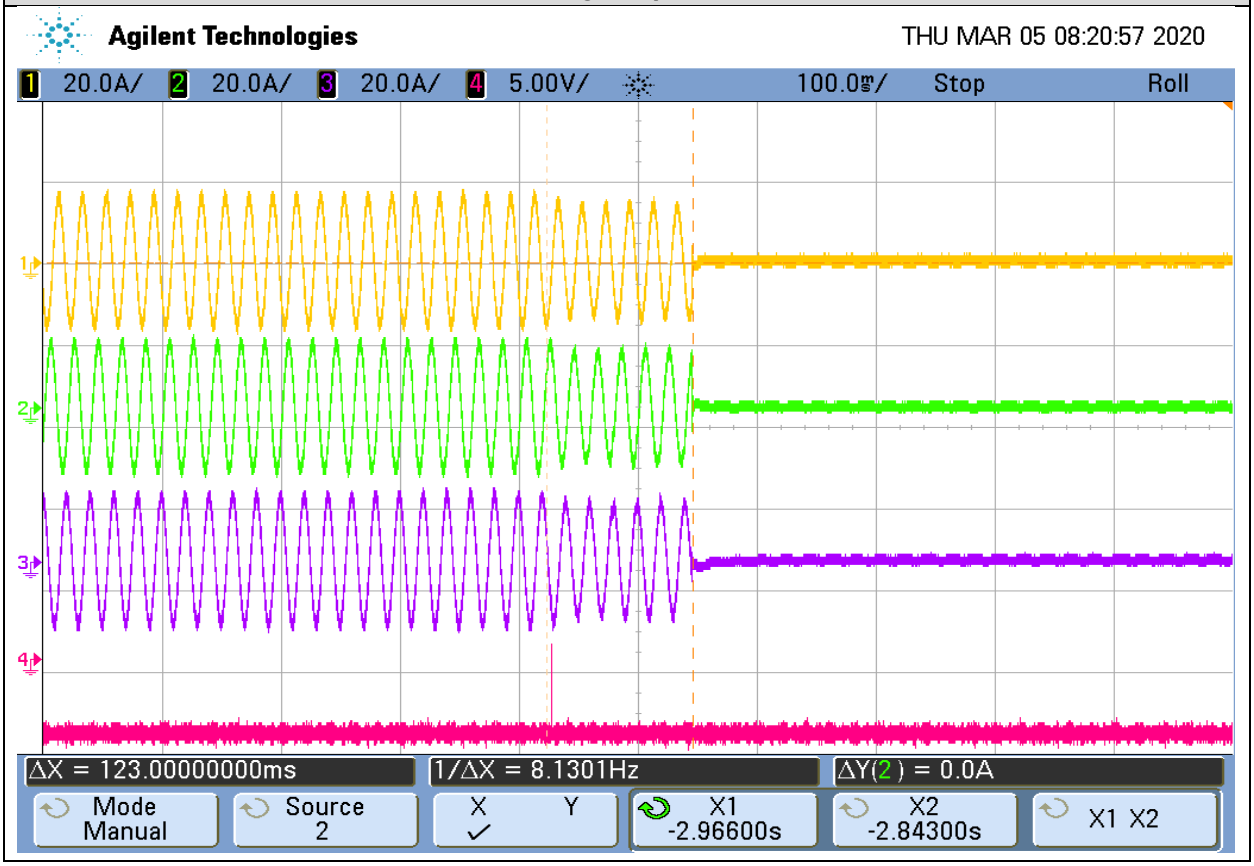


Un+15%Un Phase ABC

Trip Voltage

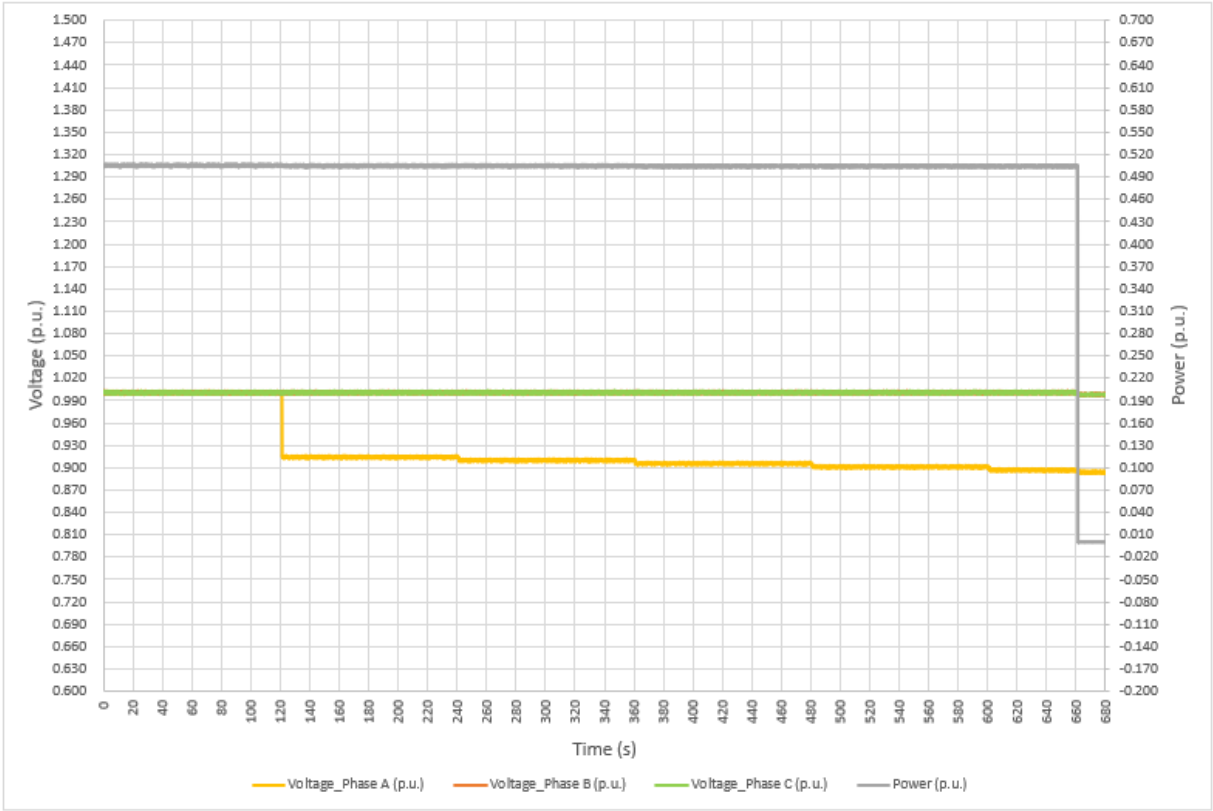


Voltage Trip Time

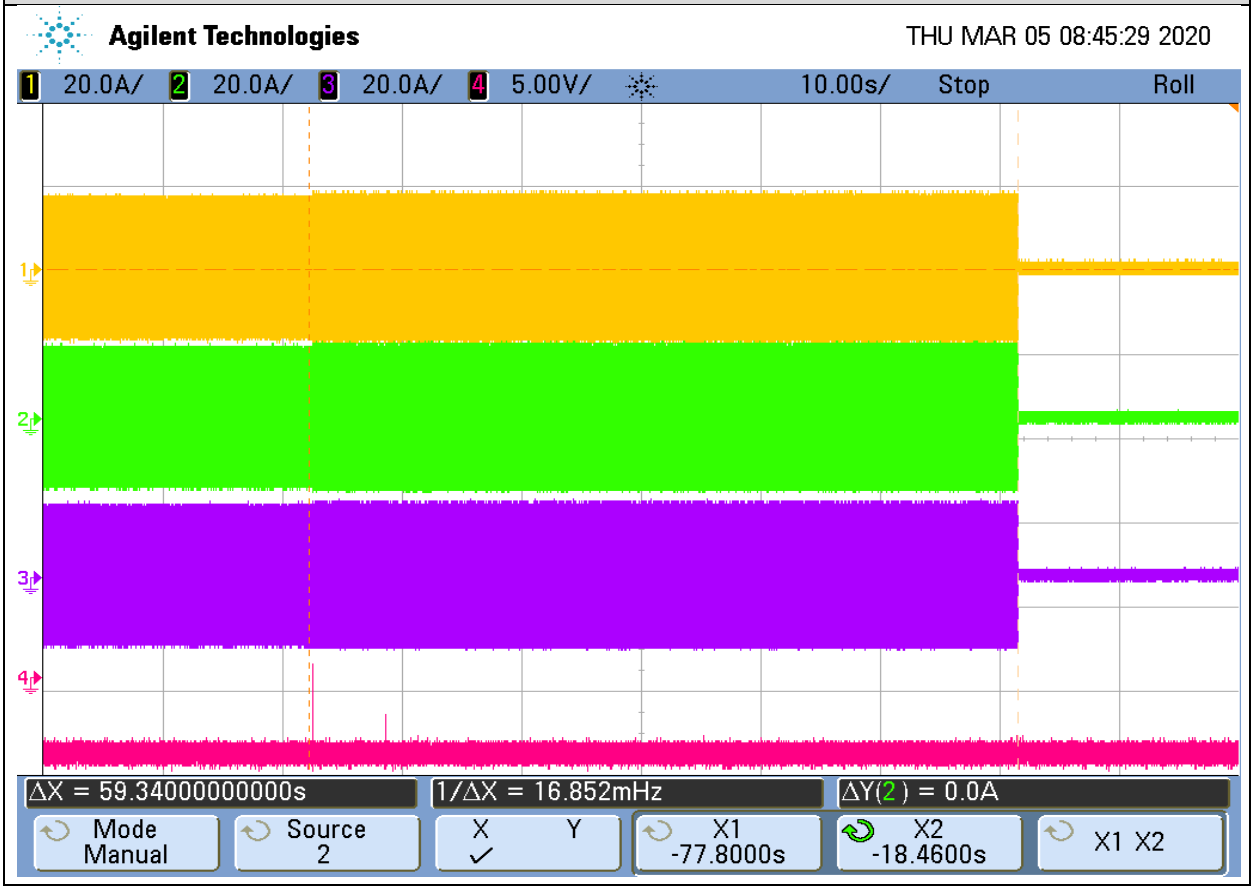


Un-10%Un Phase A

Trip Voltage

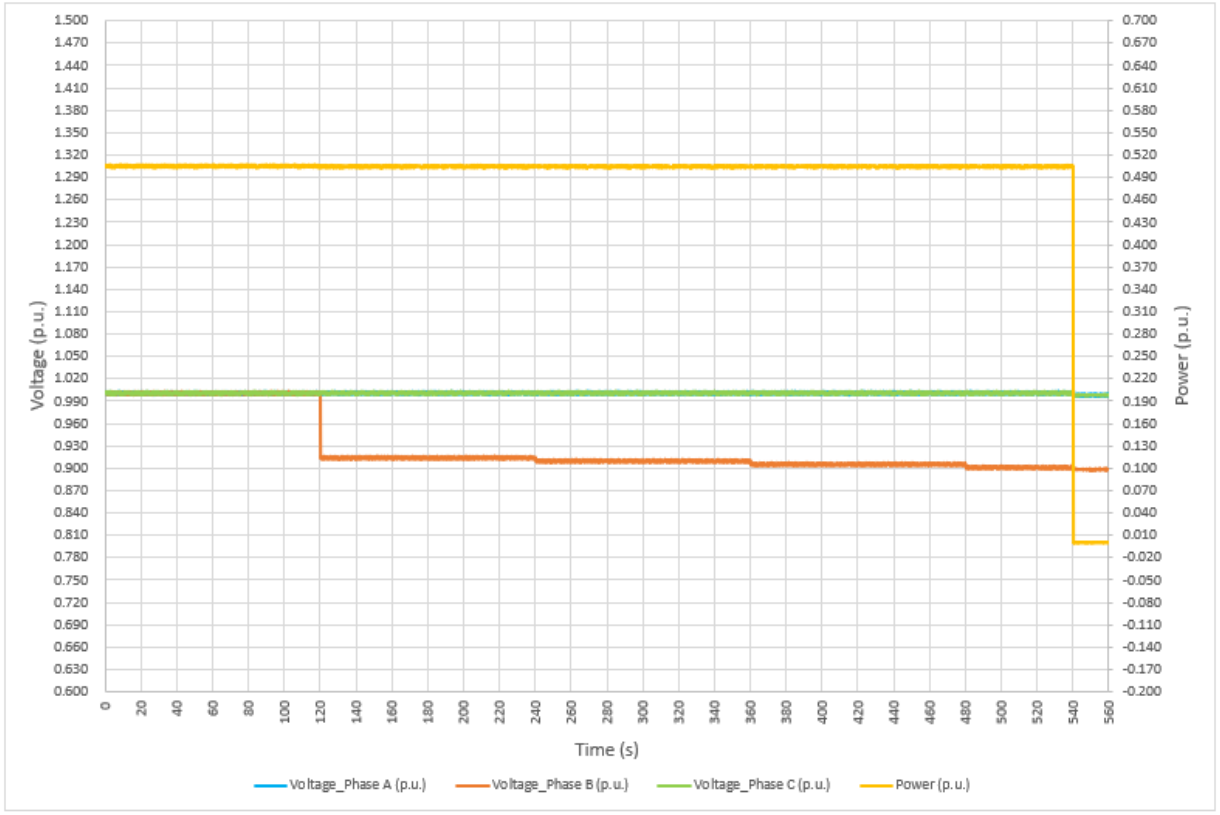


Trip Time

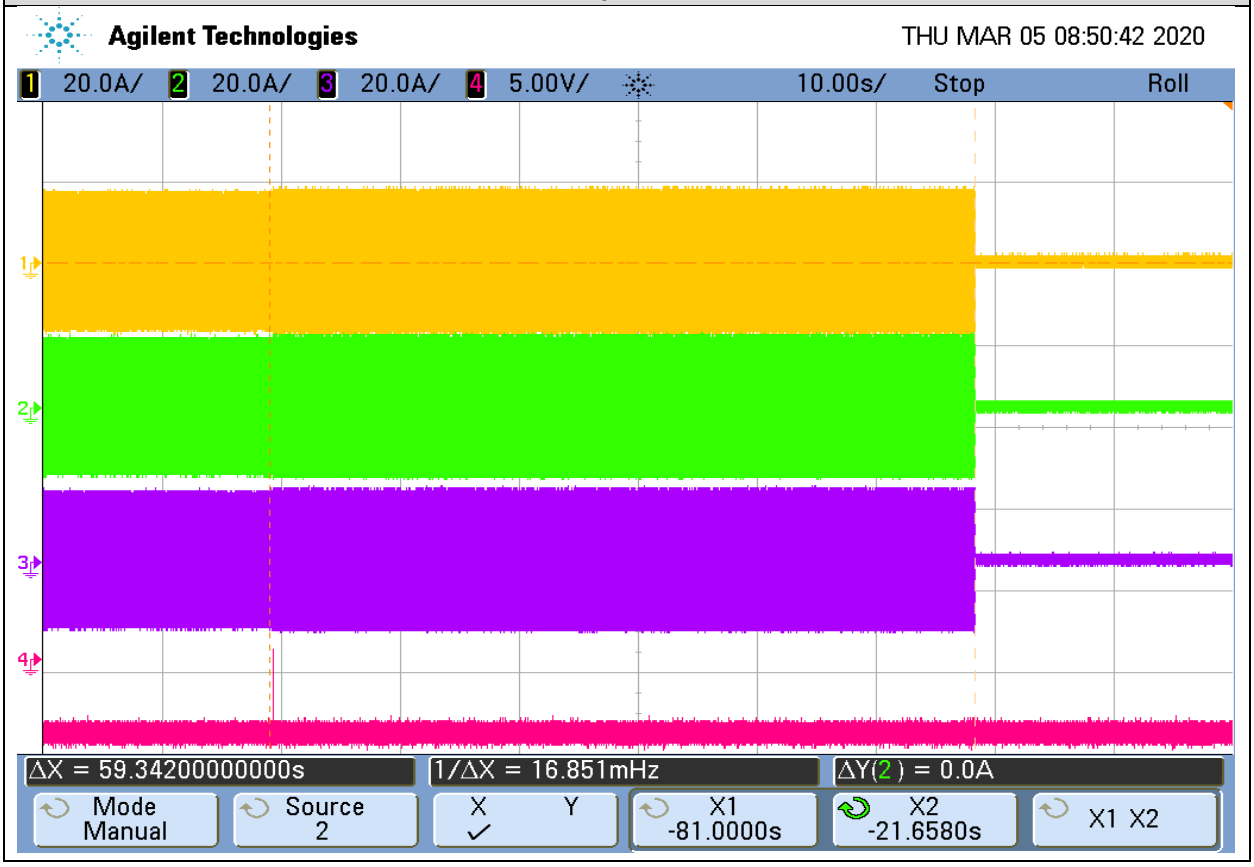


Un-10%Un Phase B

Trip Voltage

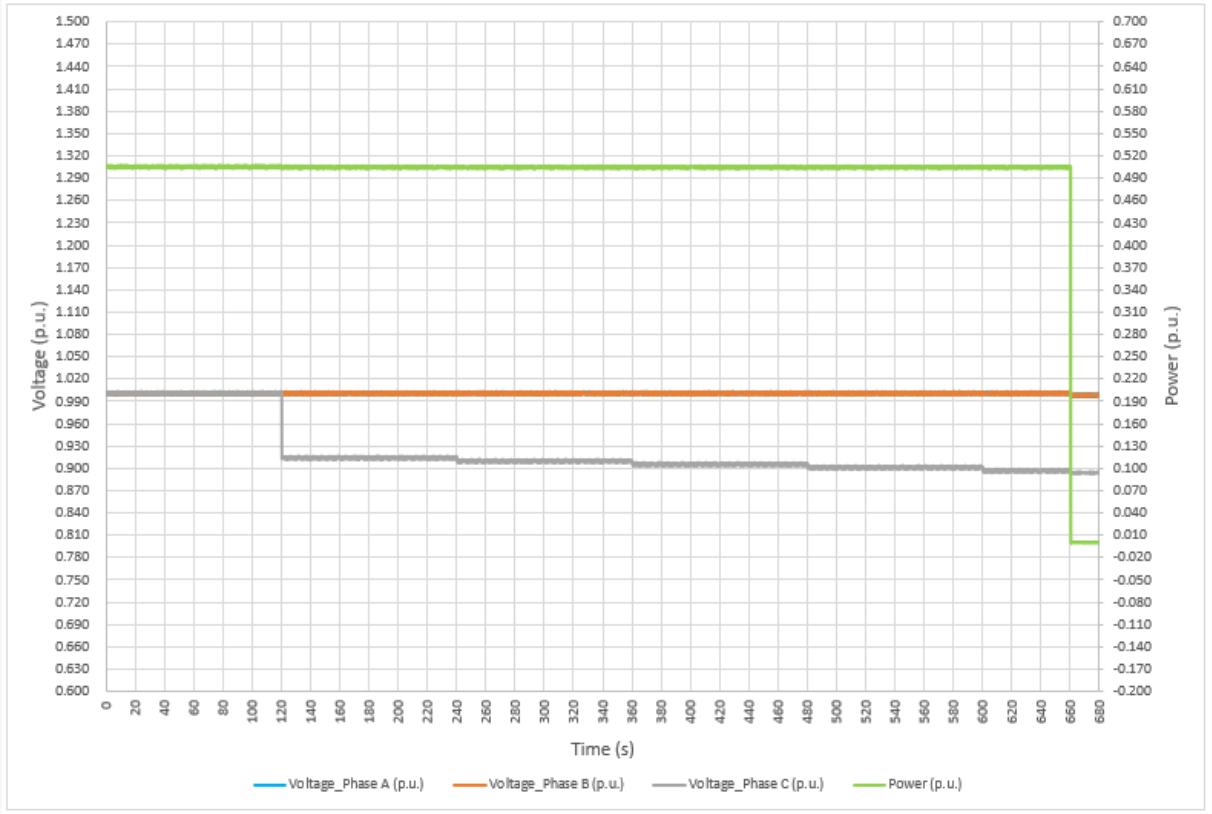


Trip Time

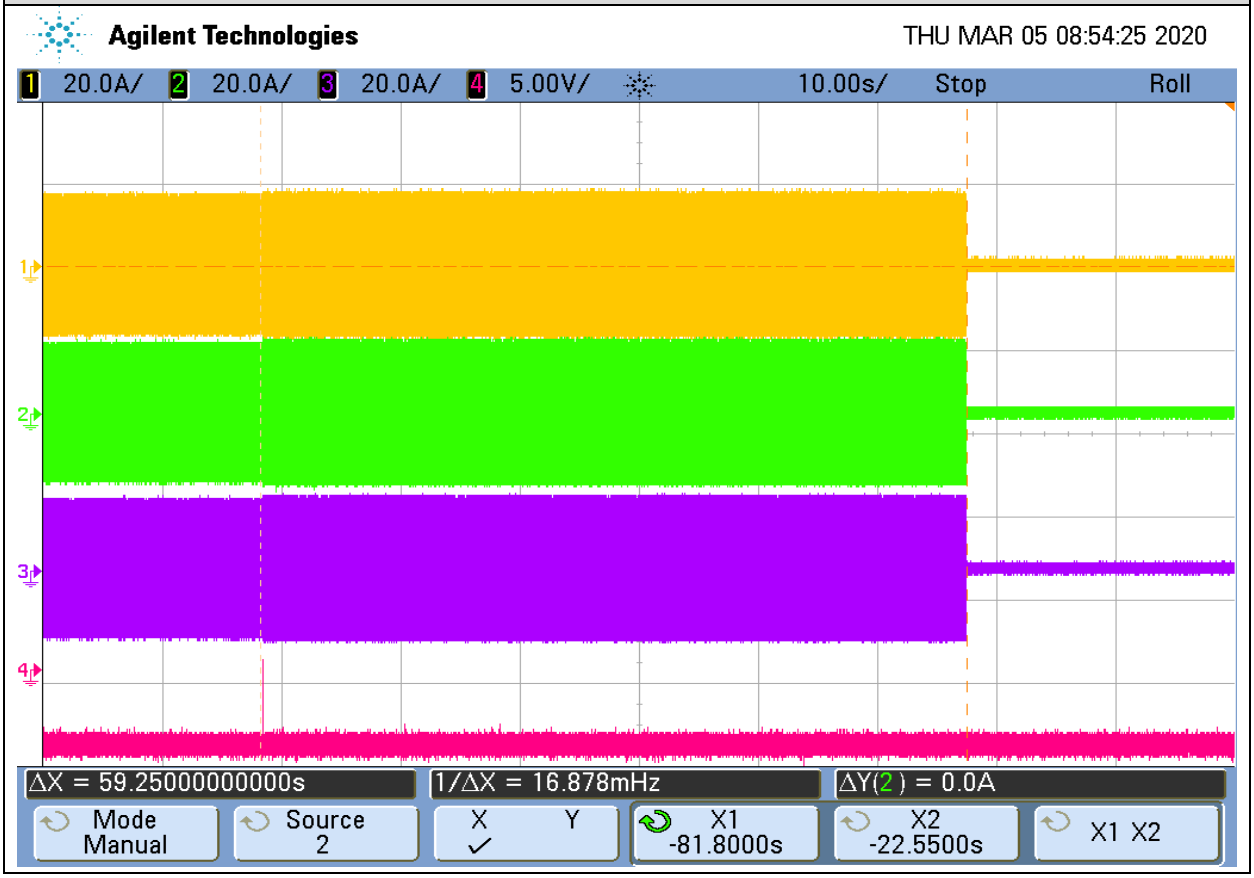


Un-10%Un Phase C

Trip Voltage

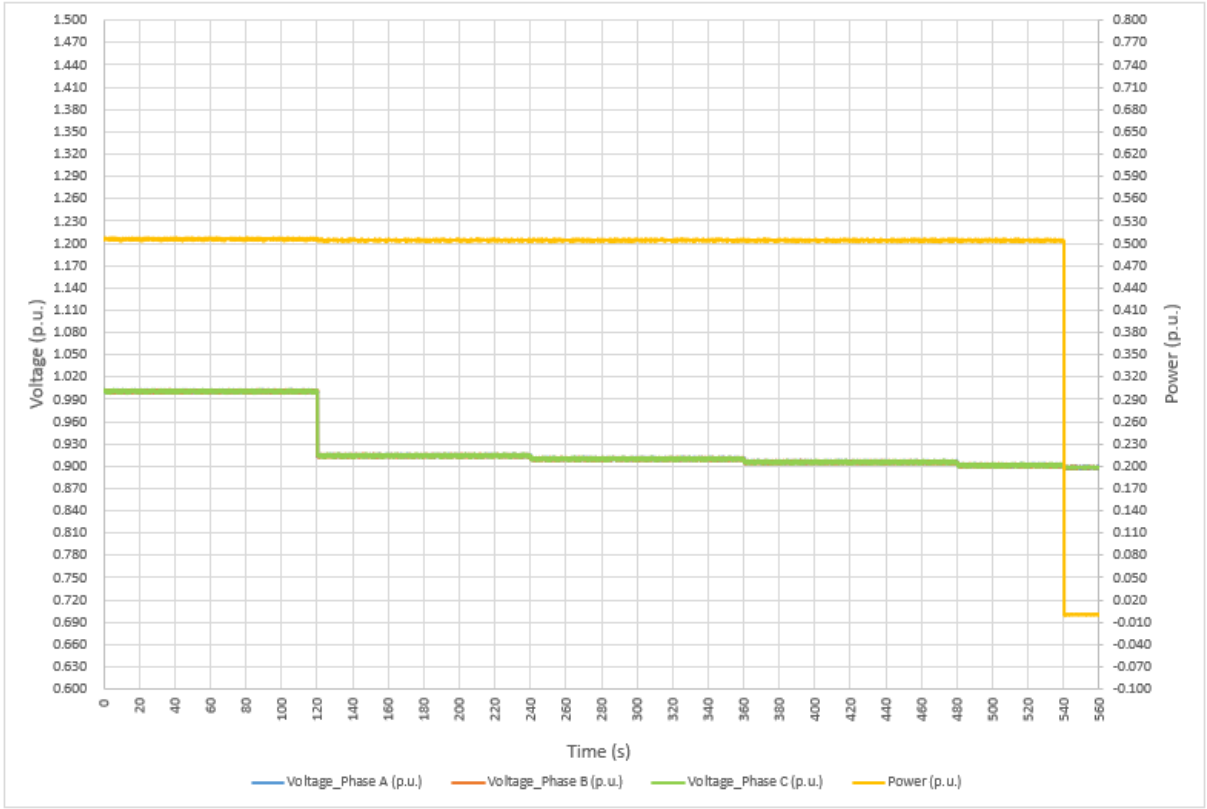


Voltage Trip Time

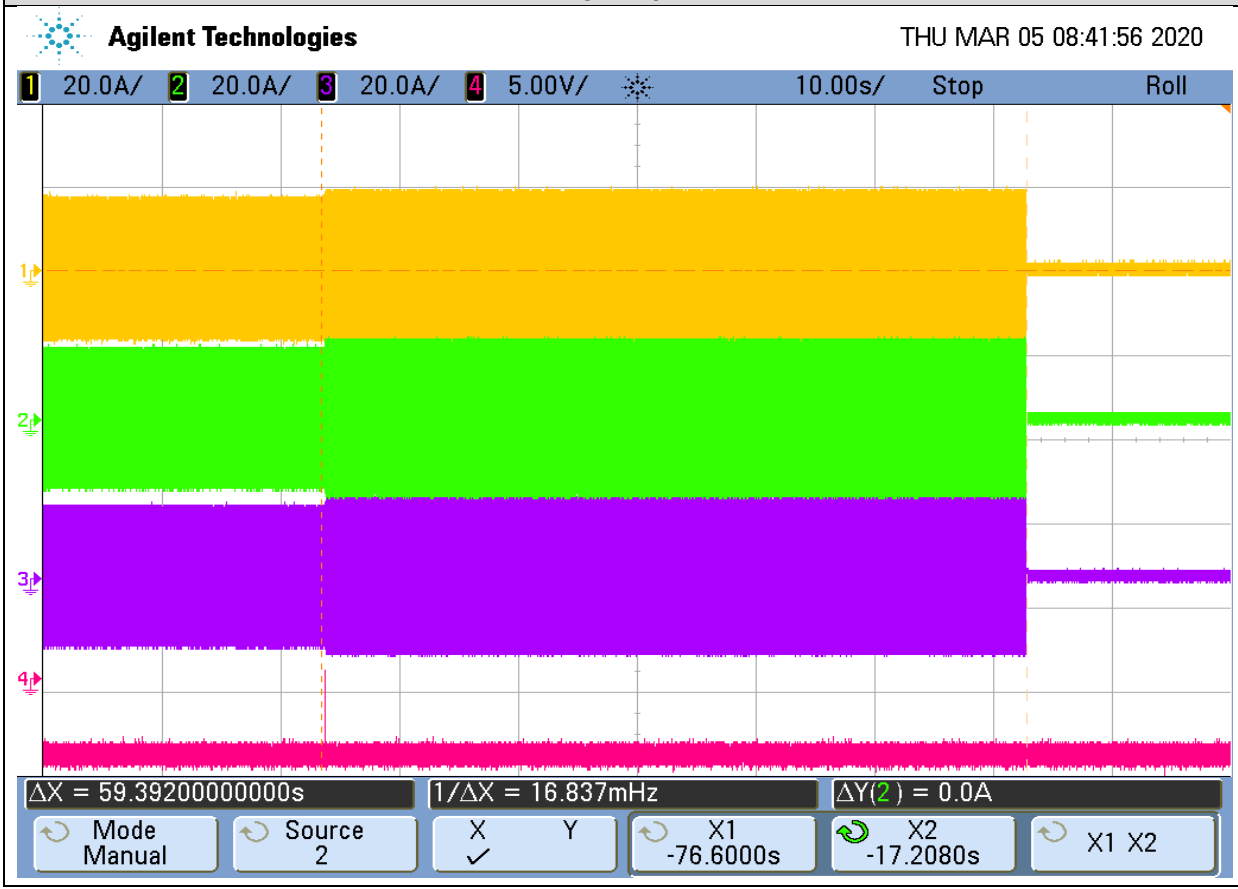


Un-10%Un Phase ABC

Trip Voltage

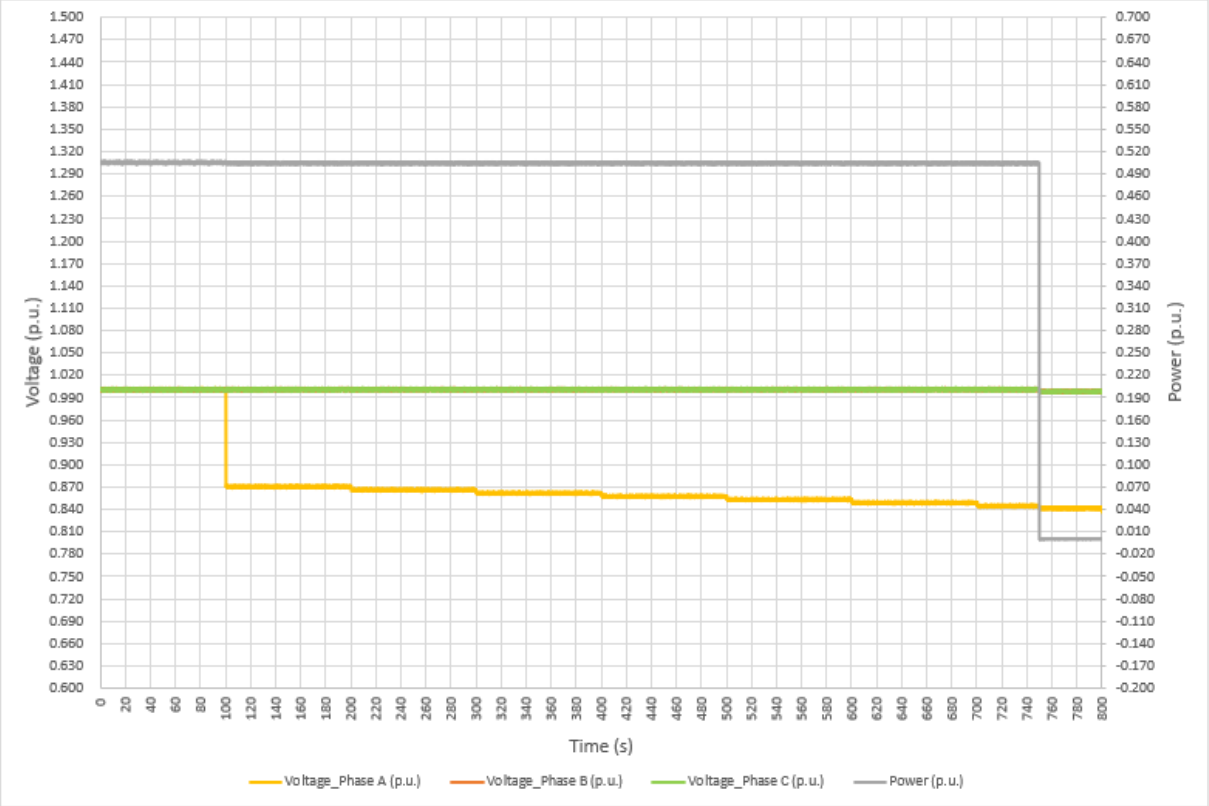


Voltage Trip Time

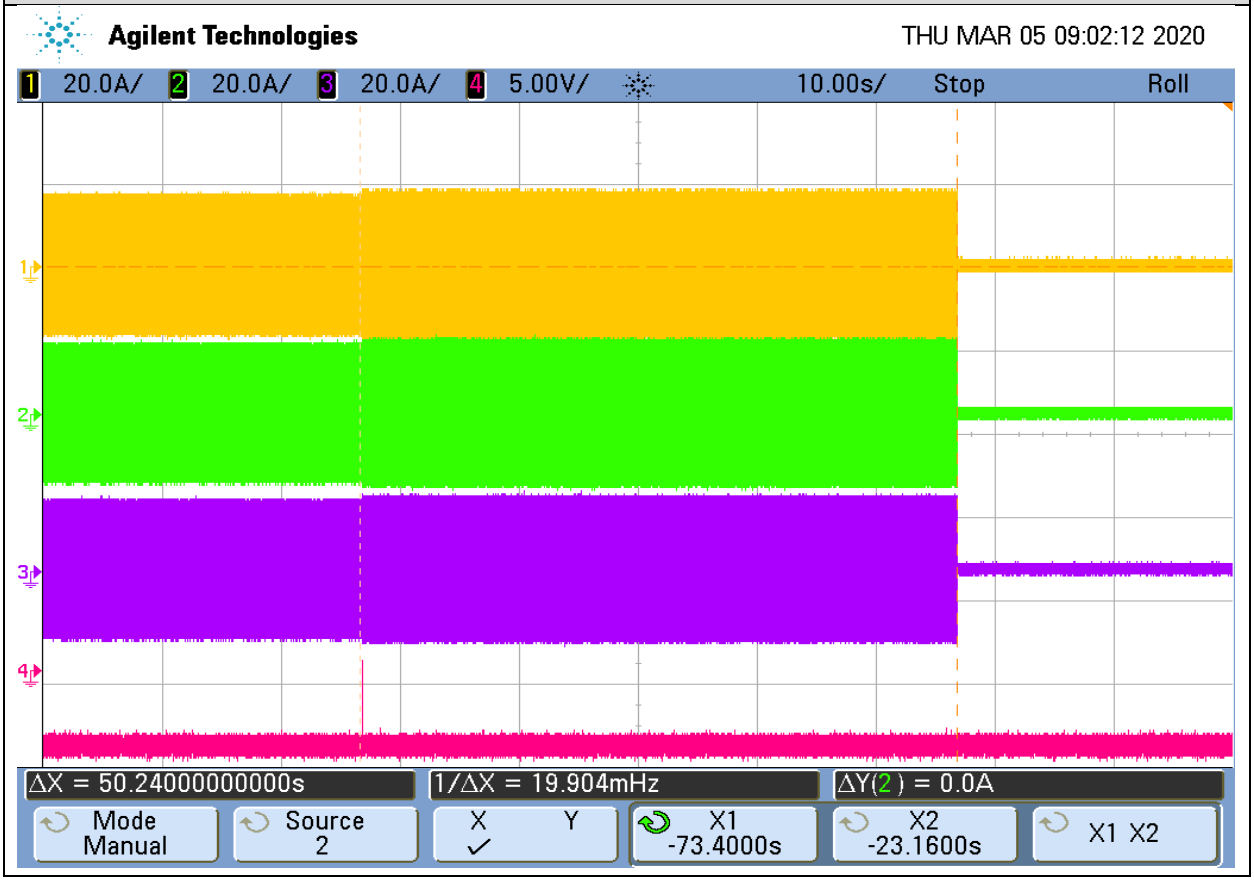


Un-15%Un Phase A

Trip Voltage

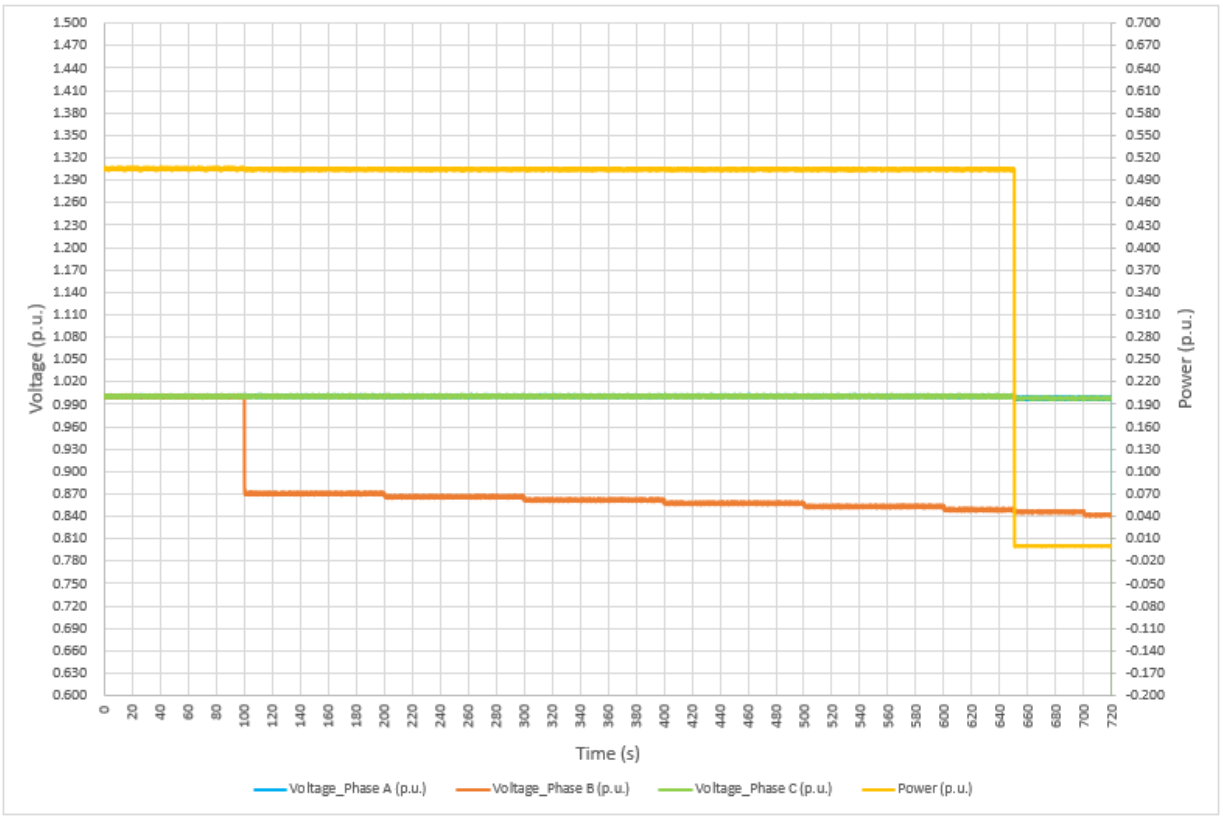


Trip Time

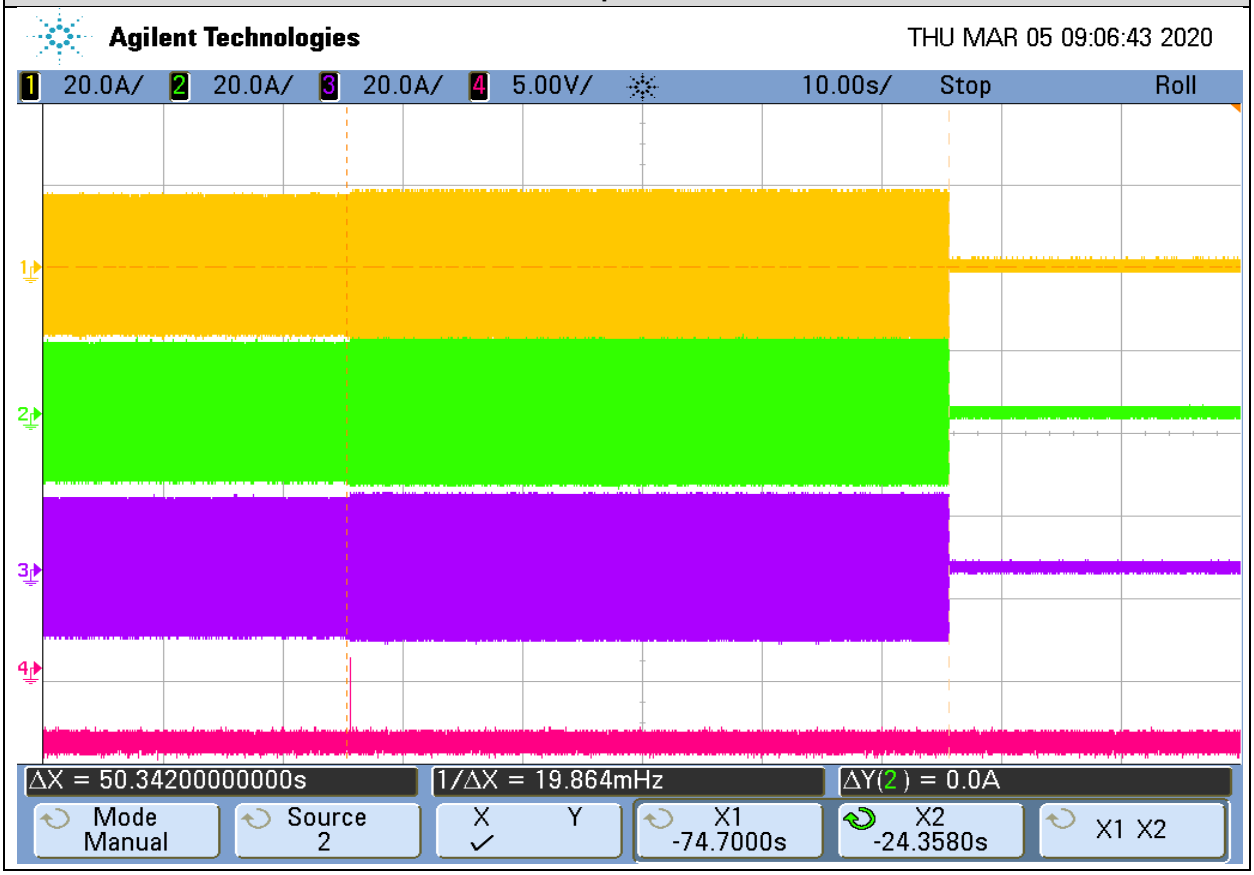


Un-15%Un Phase B

Trip Voltage

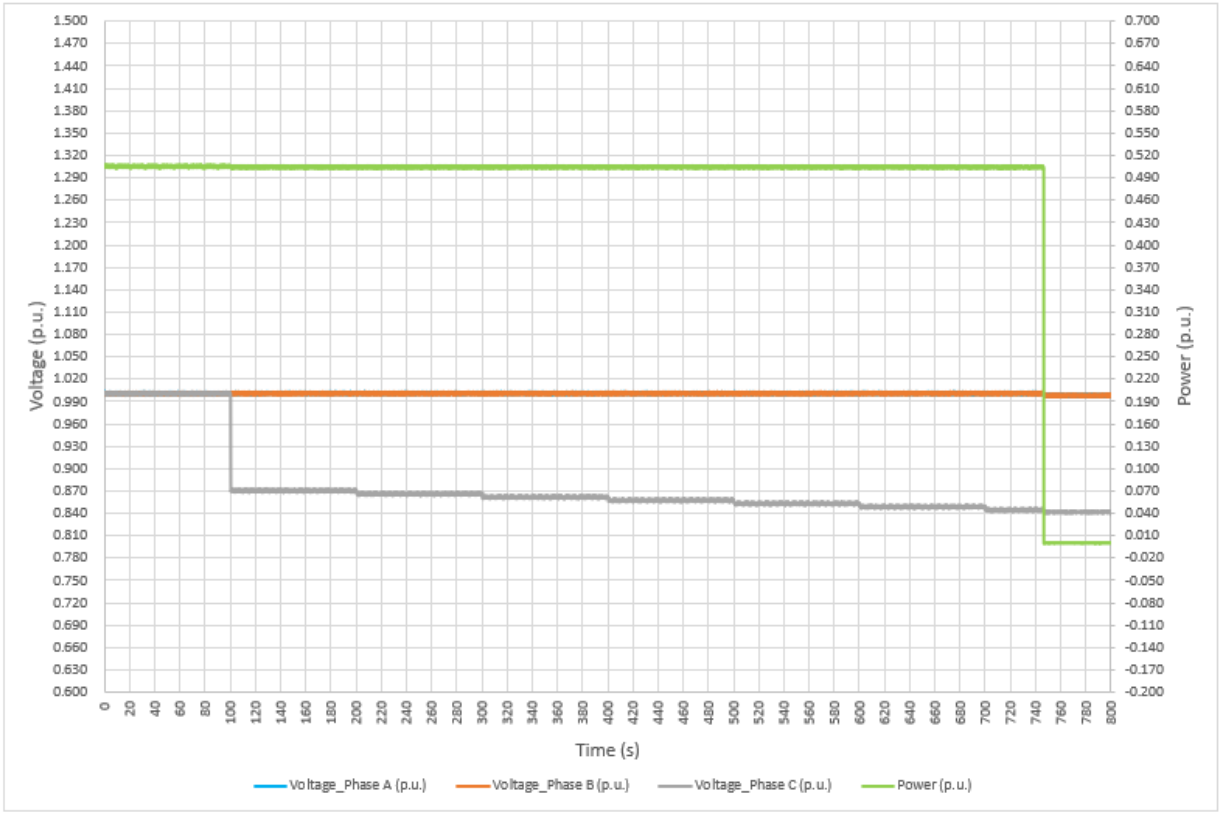


Trip Time

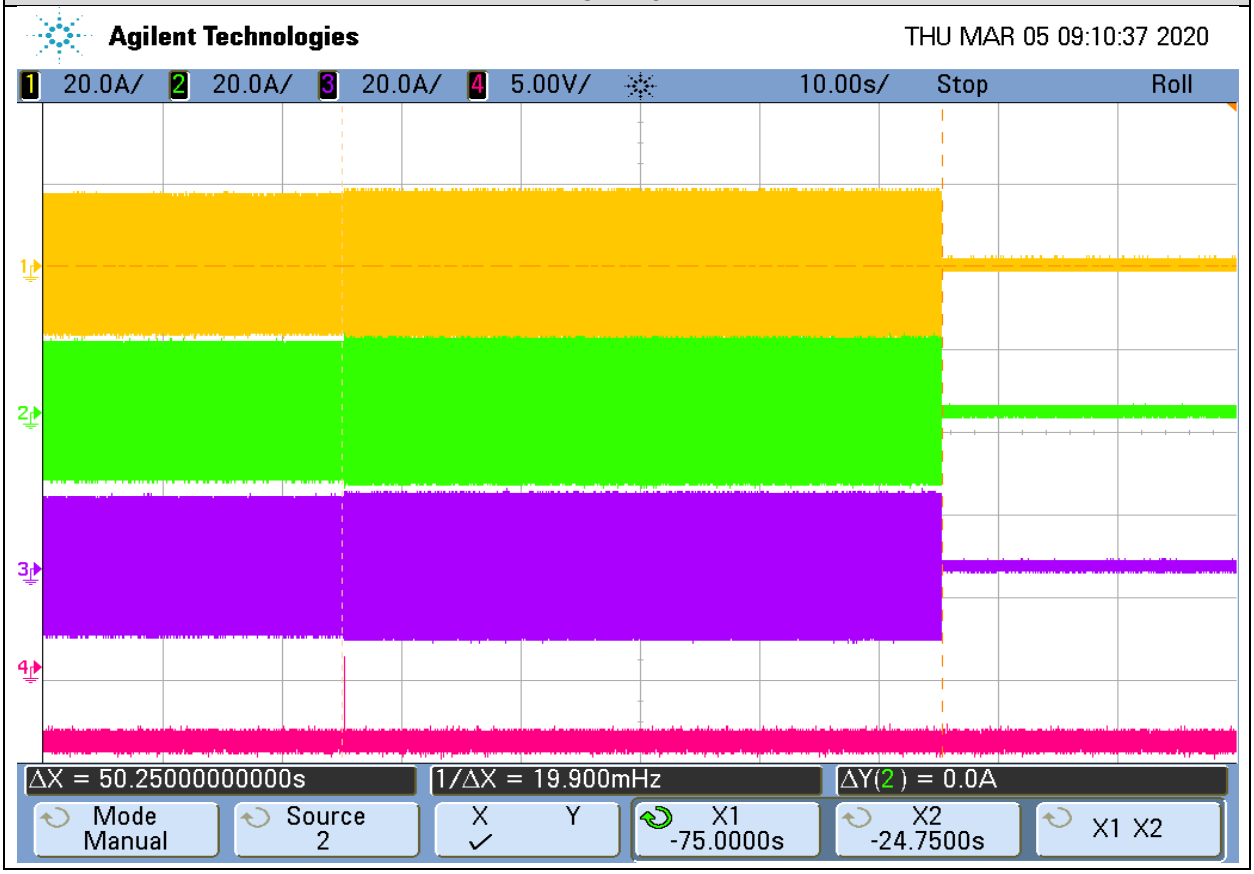


Un-15%Un Phase C

Trip Voltage

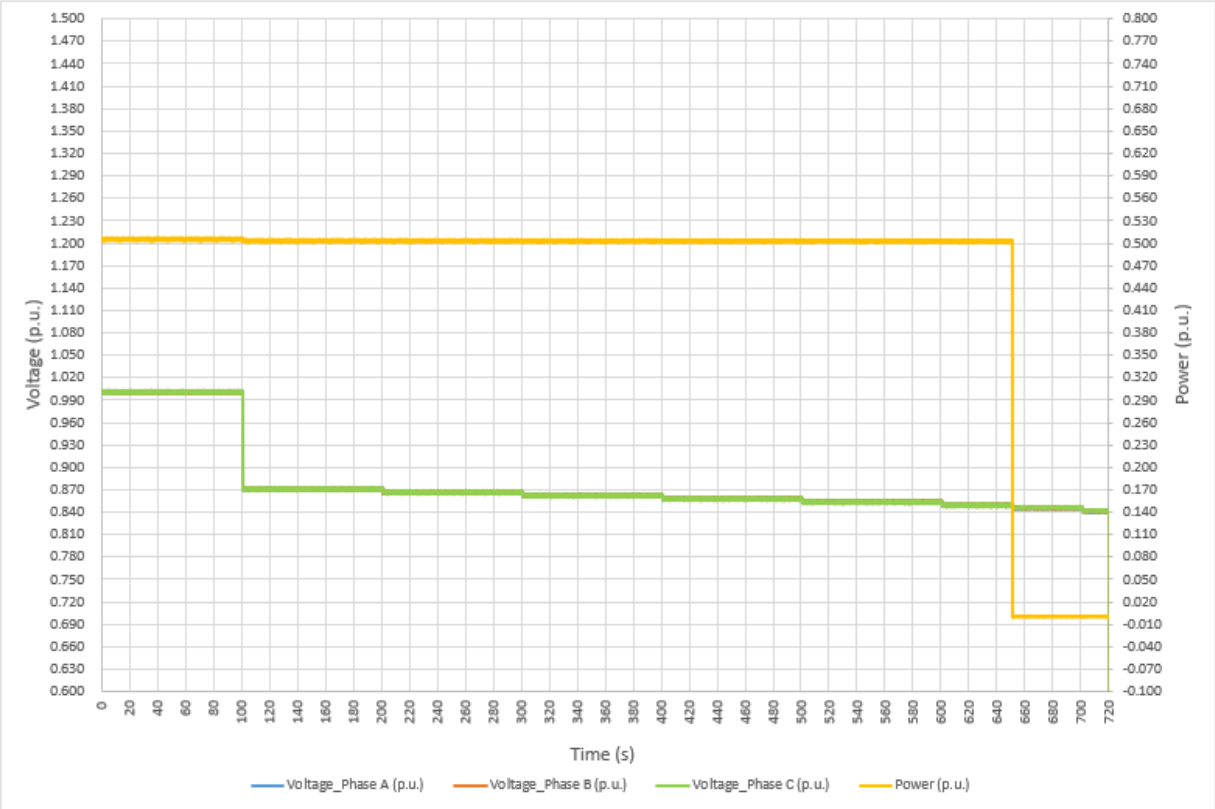


Voltage Trip Time

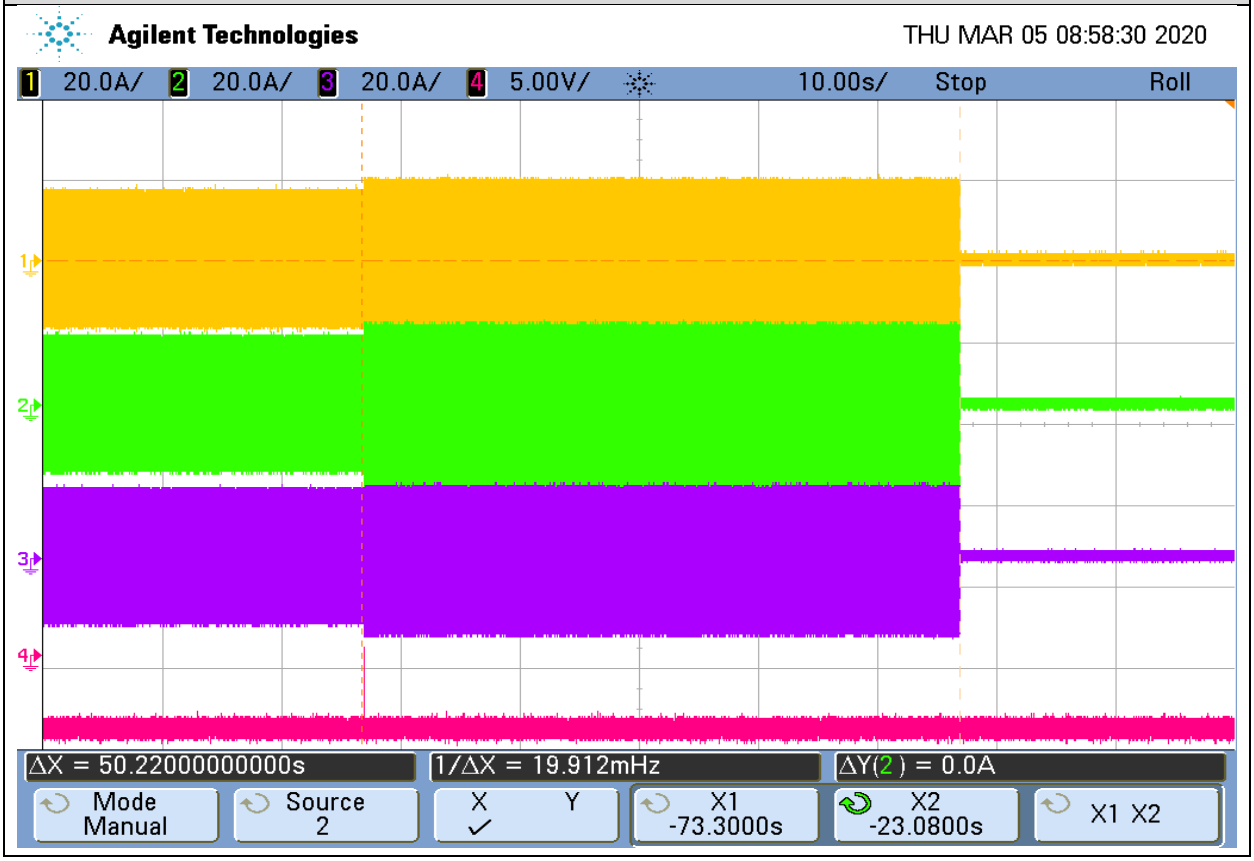


Un-15%Un Phase ABC

Trip Voltage

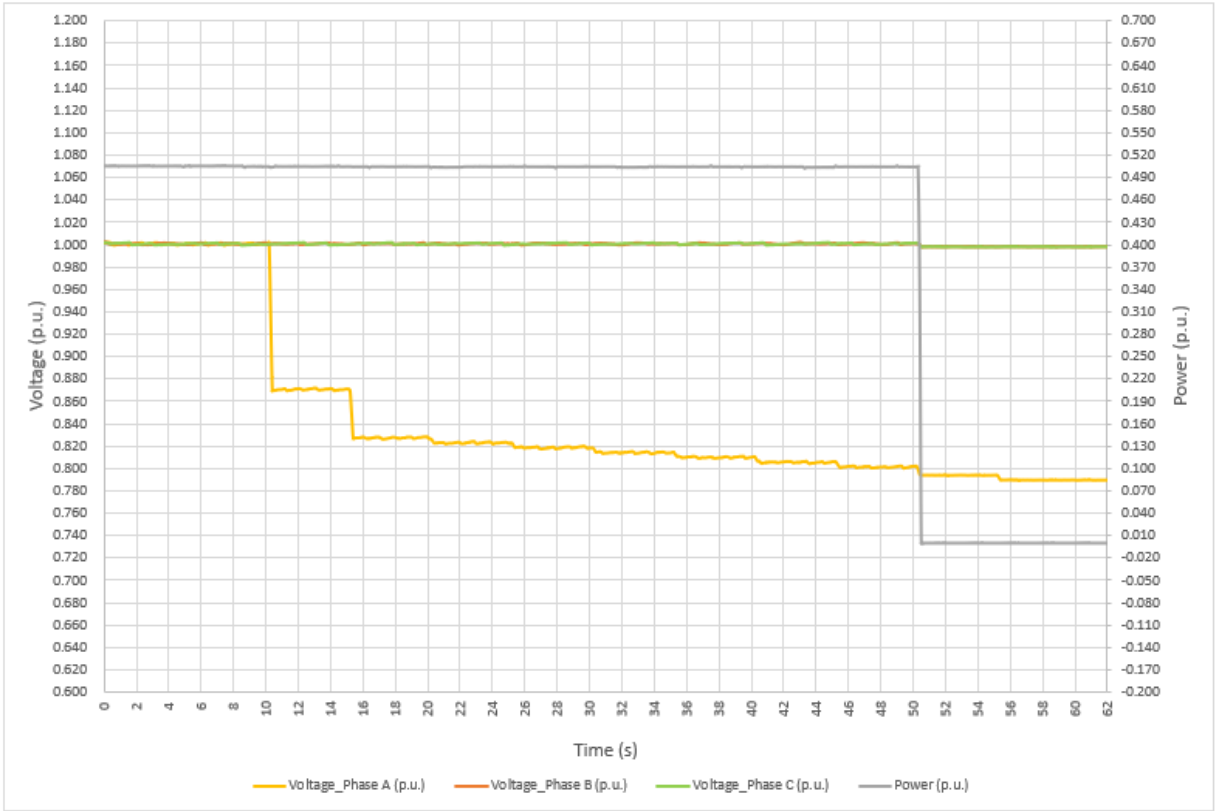


Voltage Trip Time

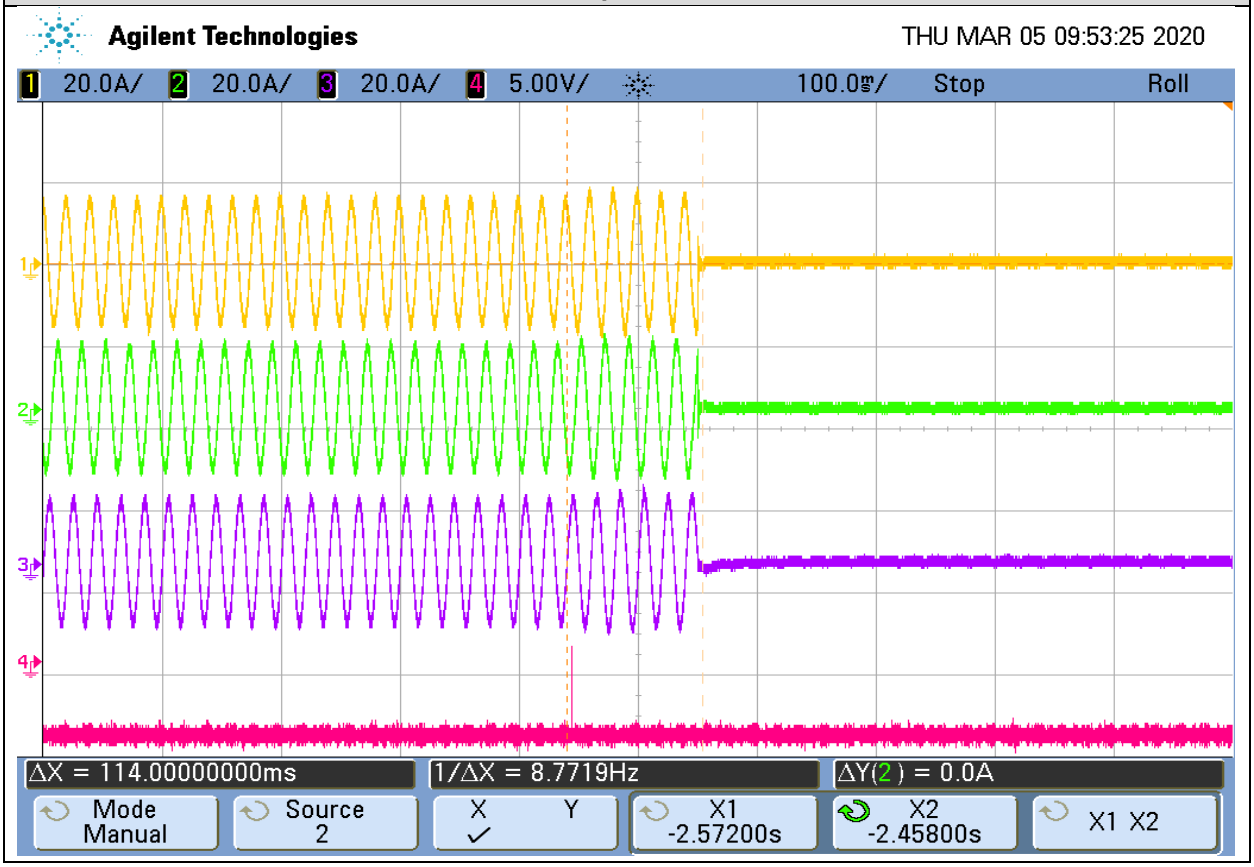


Un-20%Un Phase A

Trip Voltage

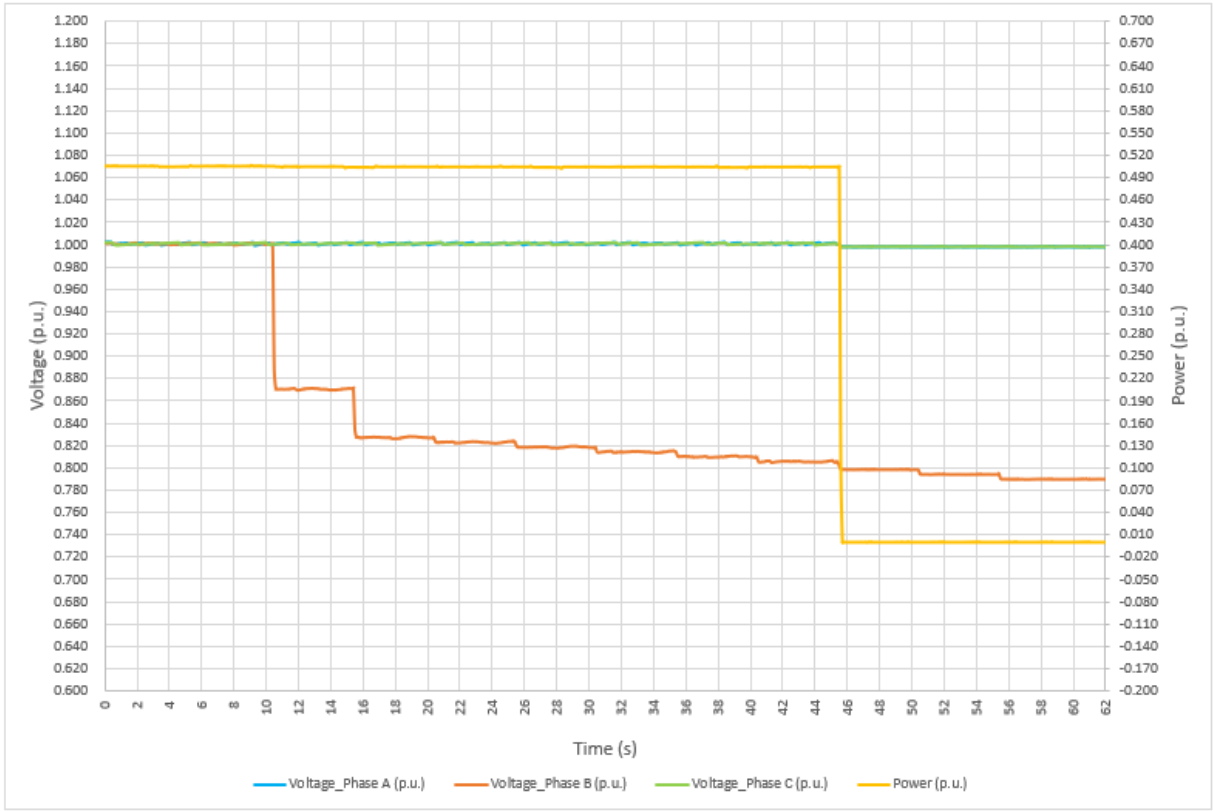


Trip Time

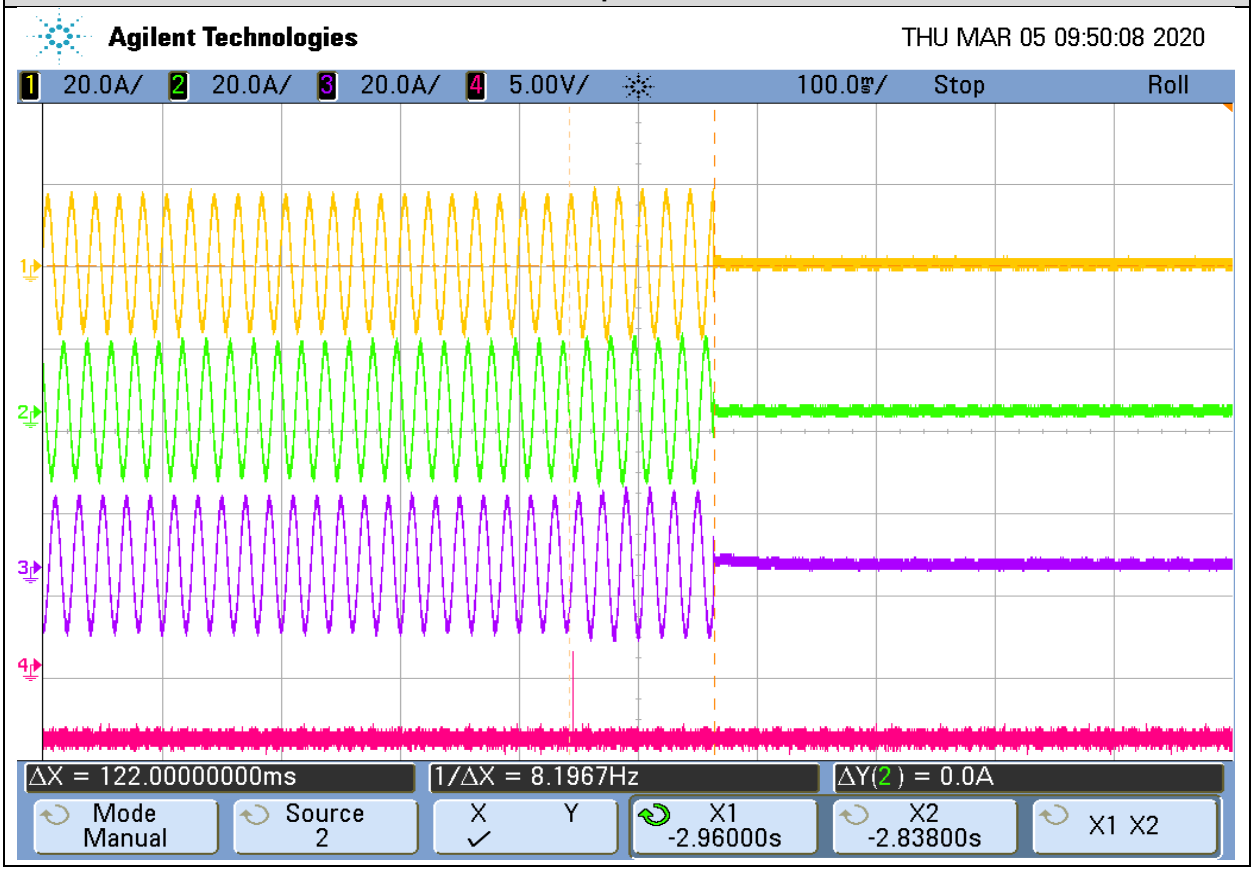


Un-20%Un Phase B

Trip Voltage



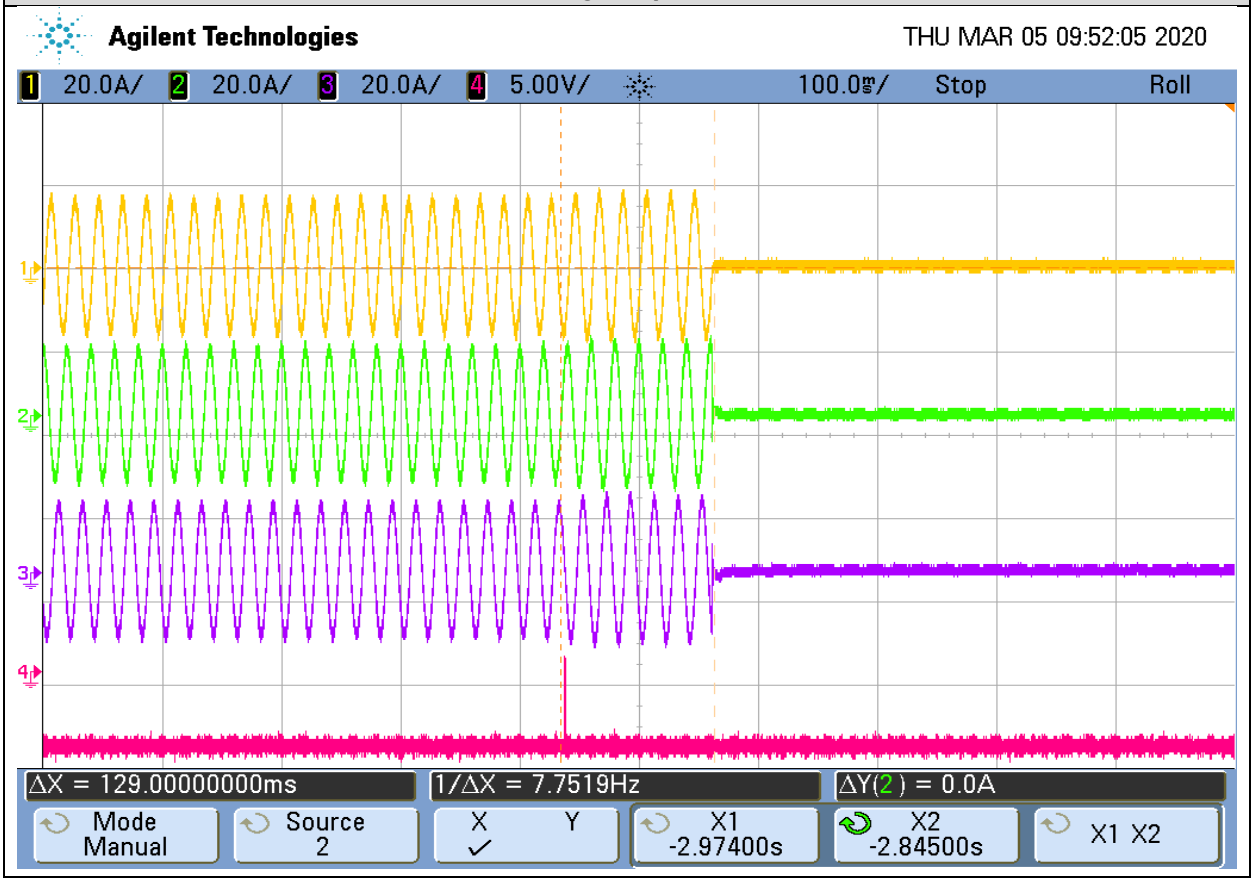
Trip Time



Un-20%Un Phase C

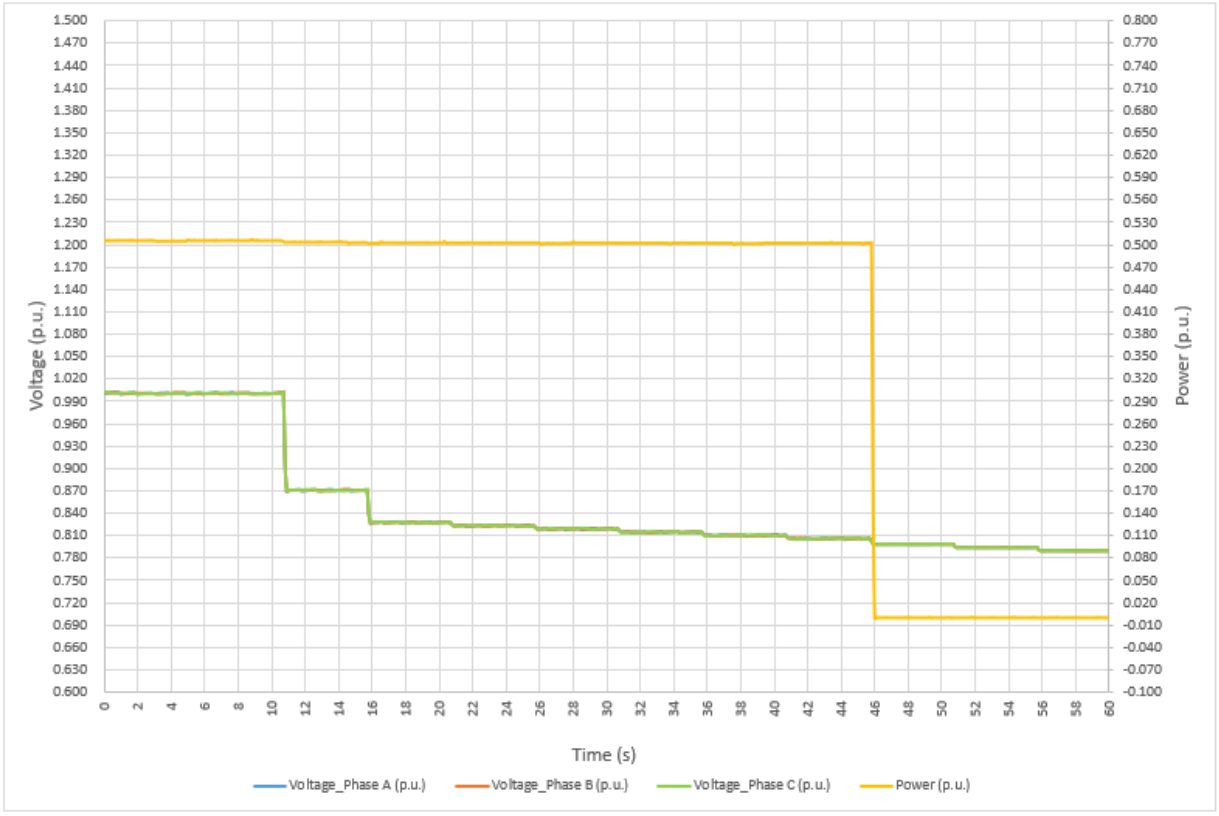
Trip Voltage

Voltage Trip Time

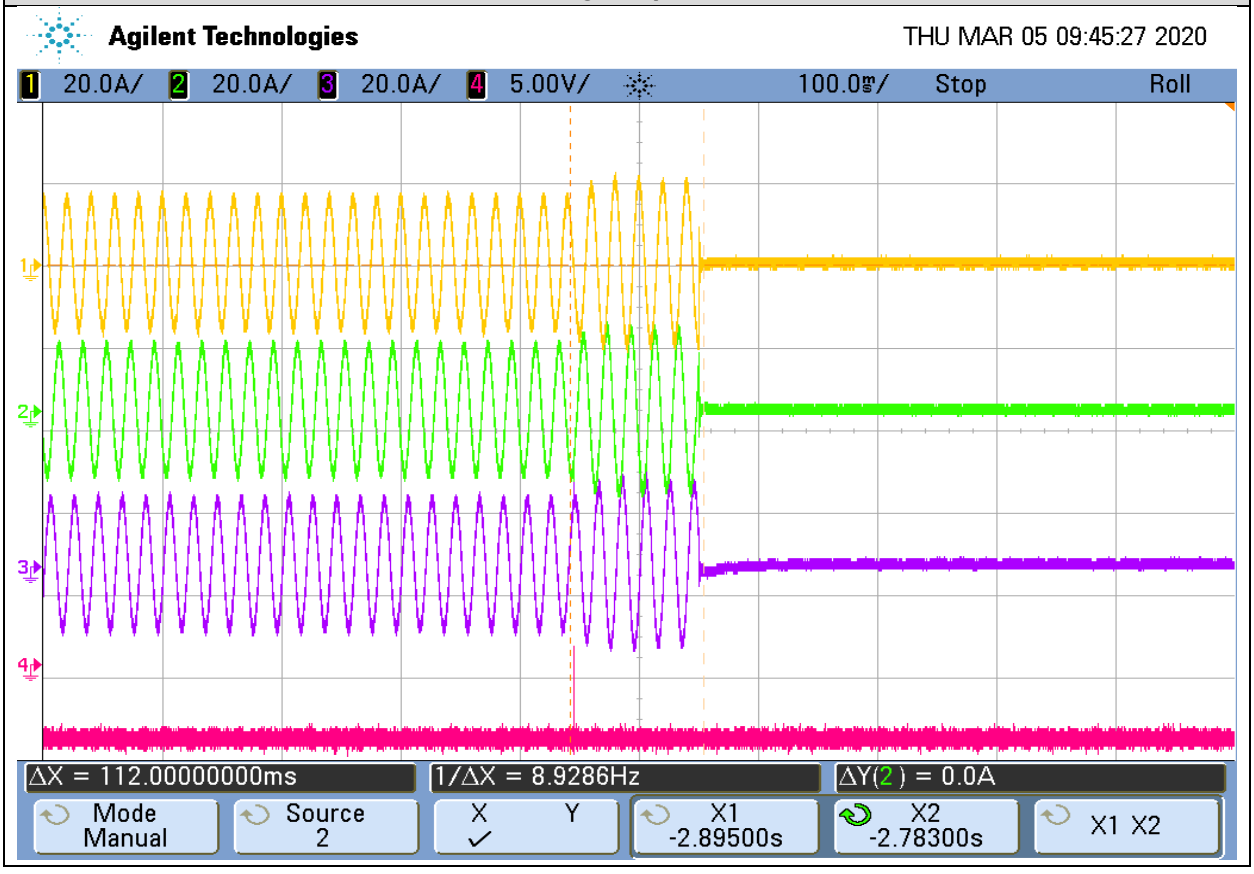


Un-20%Un Phase ABC

Trip Voltage



Voltage Trip Time

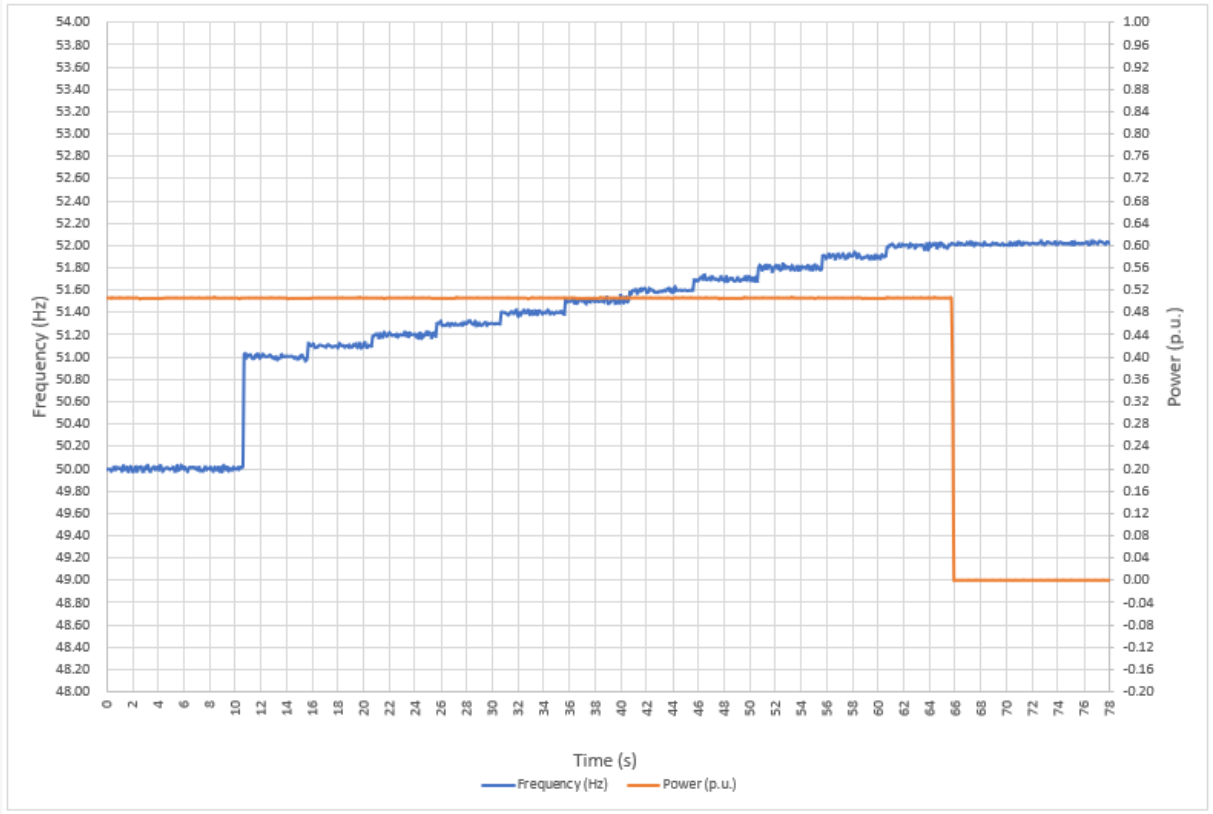


4.6.2 Frequency disconnection

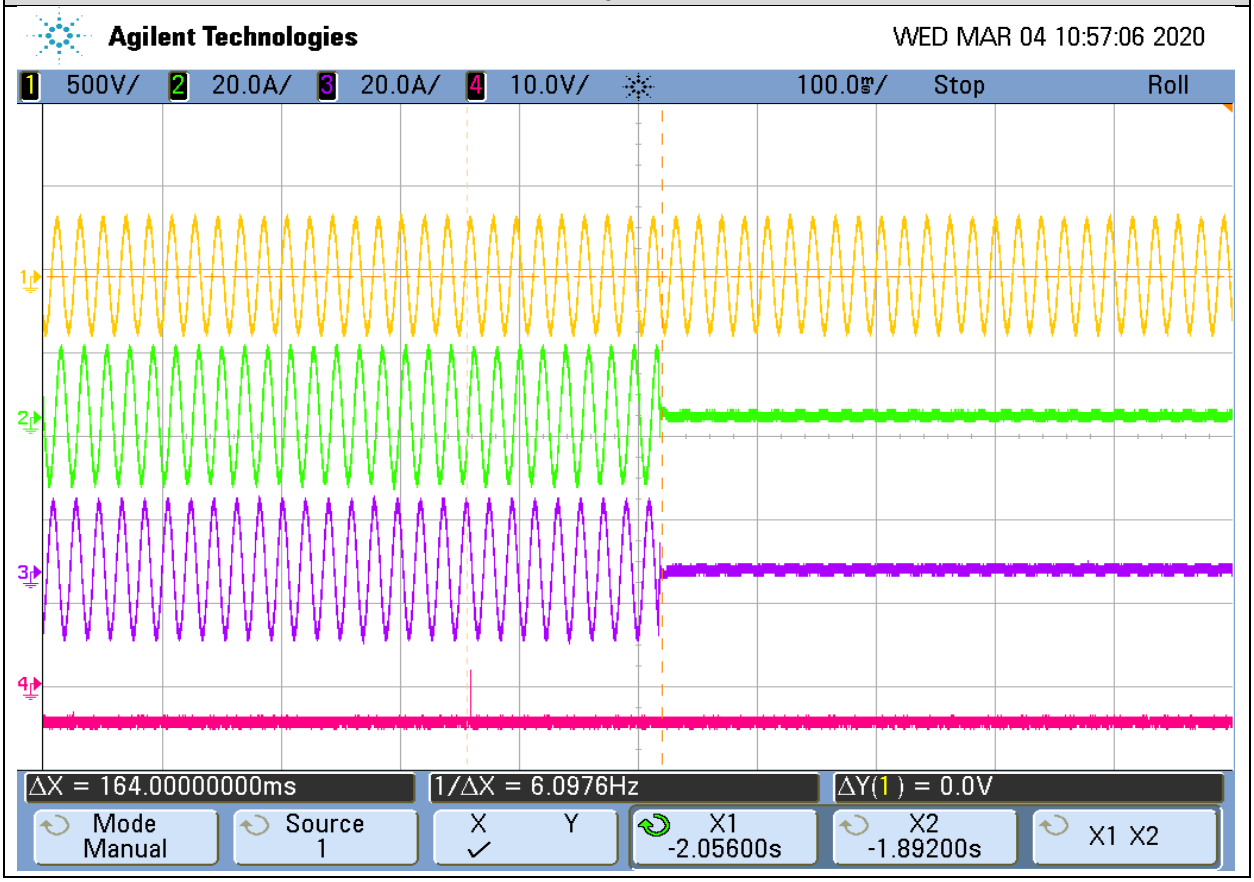
Frequency (Hz)	Disconnection time limits (ms)	Disconnection time measured (ms)
52	200	164
47	200	181

Frequency measured: 52 Hz

Trip value

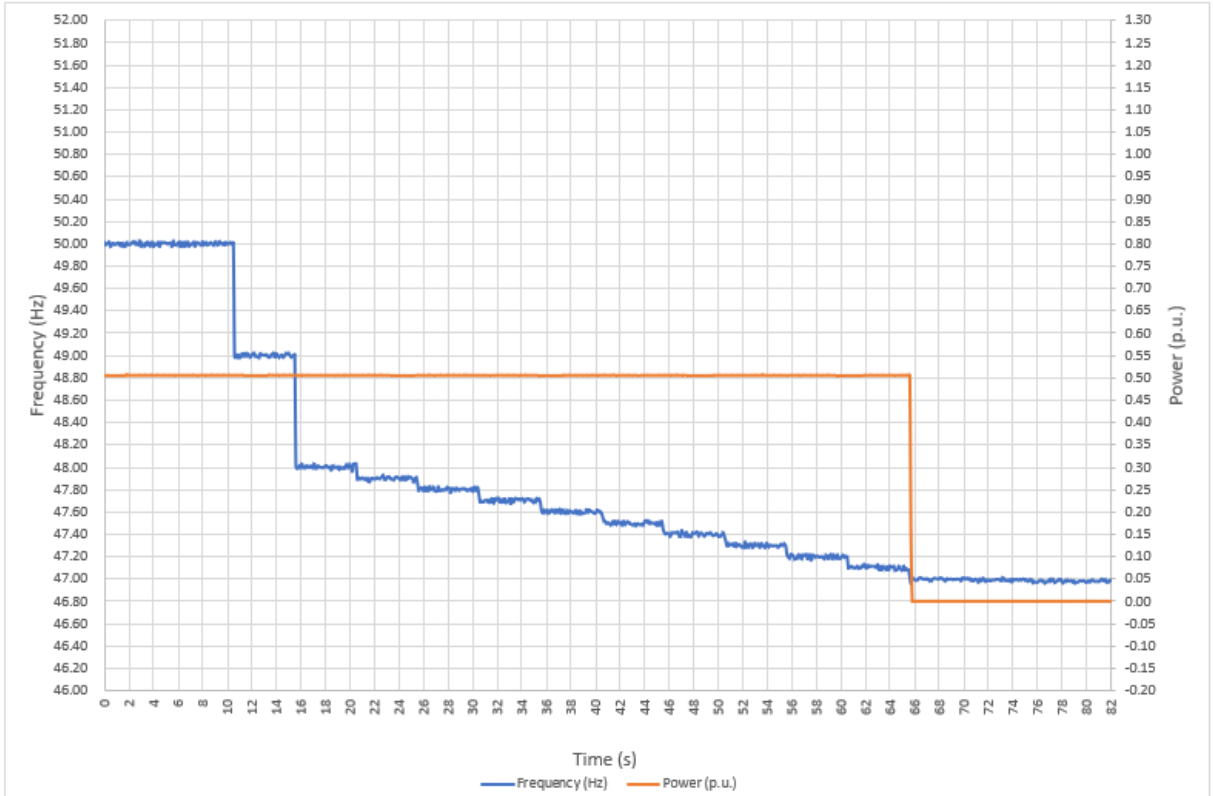


Trip time

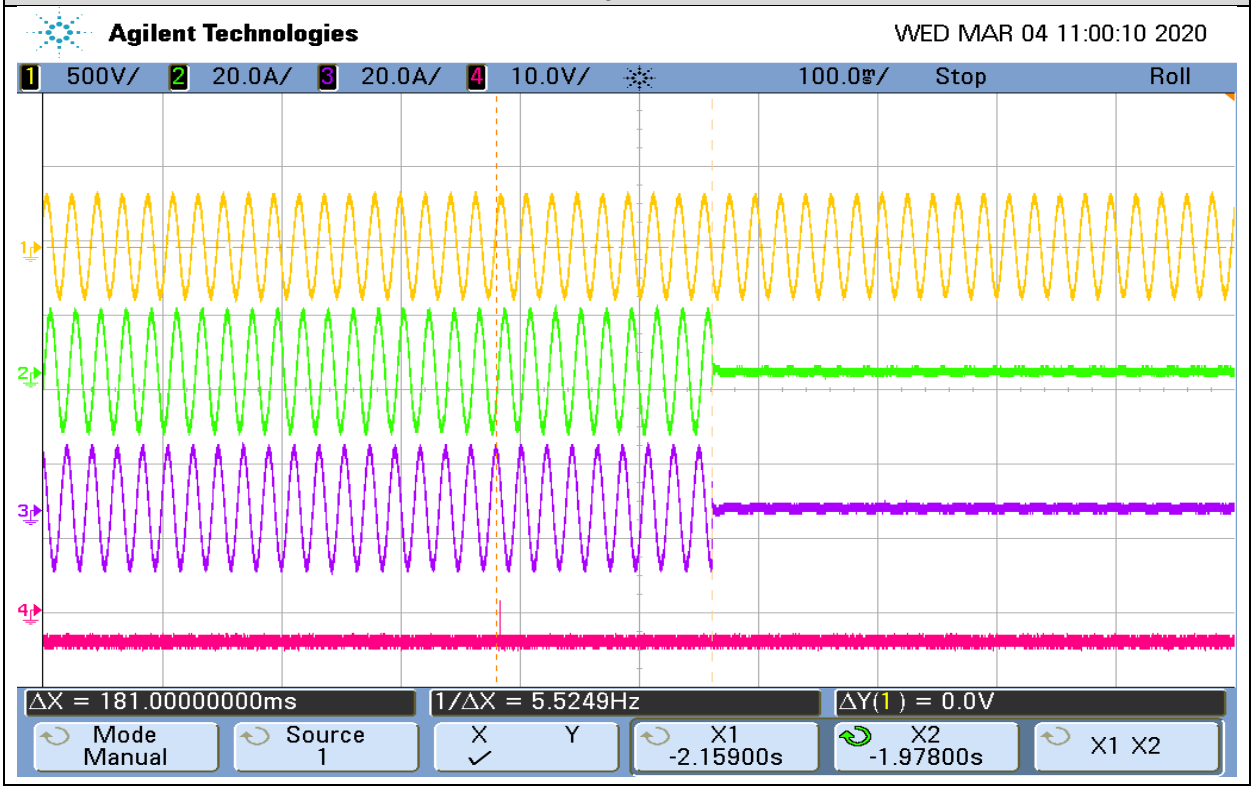


Frequency measured: 47 Hz

Trip value



Trip time



4.6.3 Change Of Frequency

Test results are offered at the table below.

Type of drift	Start Frequency (Hz)	Final Value (Hz)	Ramp measured (Hz/s)	**Disconnection time limits (ms)**	**Disconnection time measured (ms)**
Positive frequency drift	50.0	51.3	2.6	50 to 100	55
Negative frequency drift	50.0	48.7	2.6	50 to 100	65

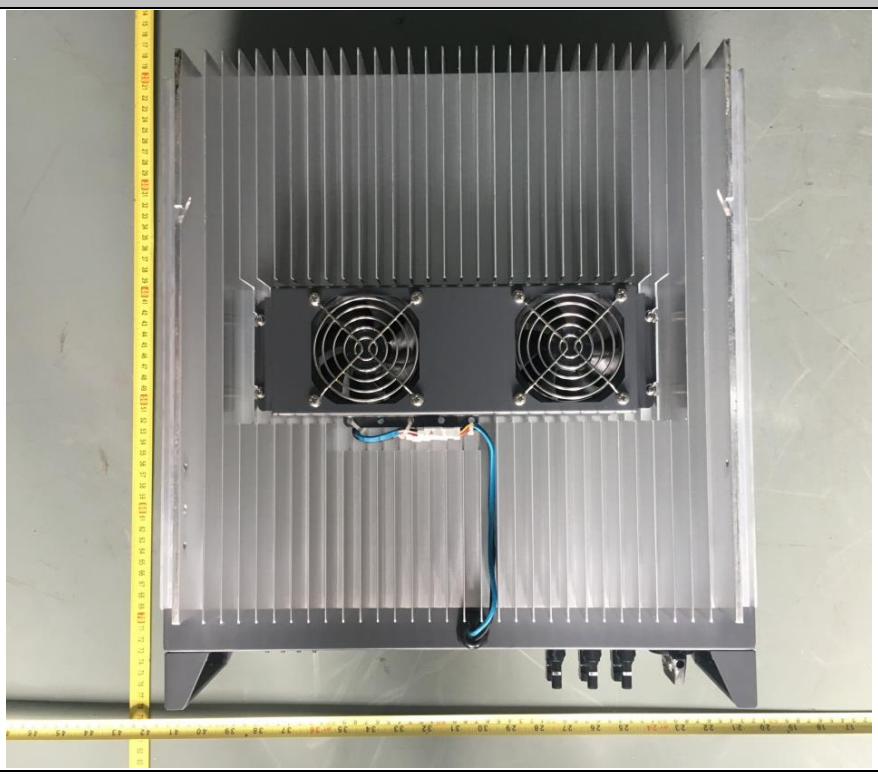
Test results are represented at the images below.

Disconnection time of Positive frequency drift

Disconnection time of Positive frequency drift

5 PICTURES

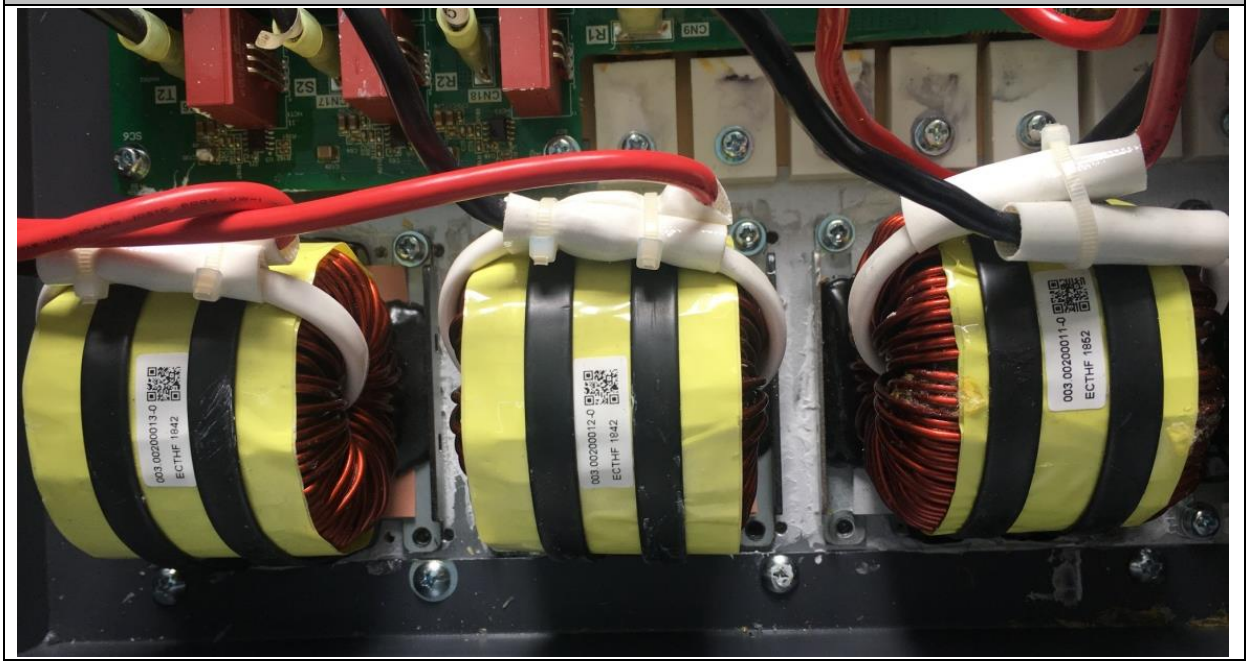
Front view

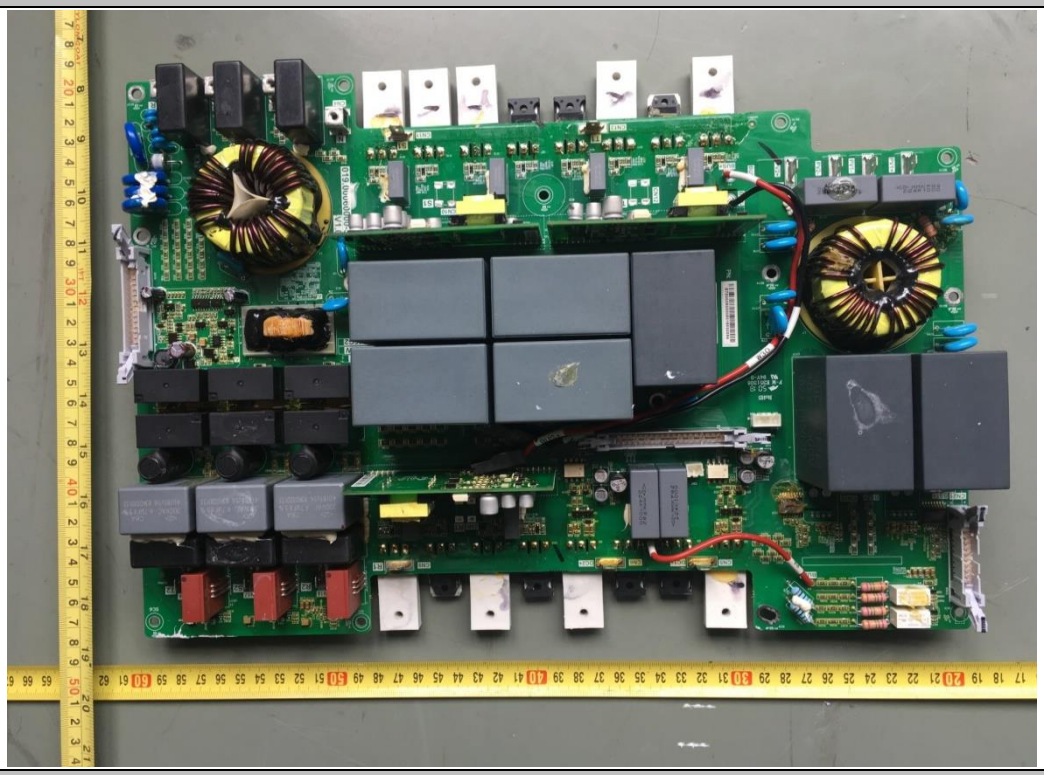
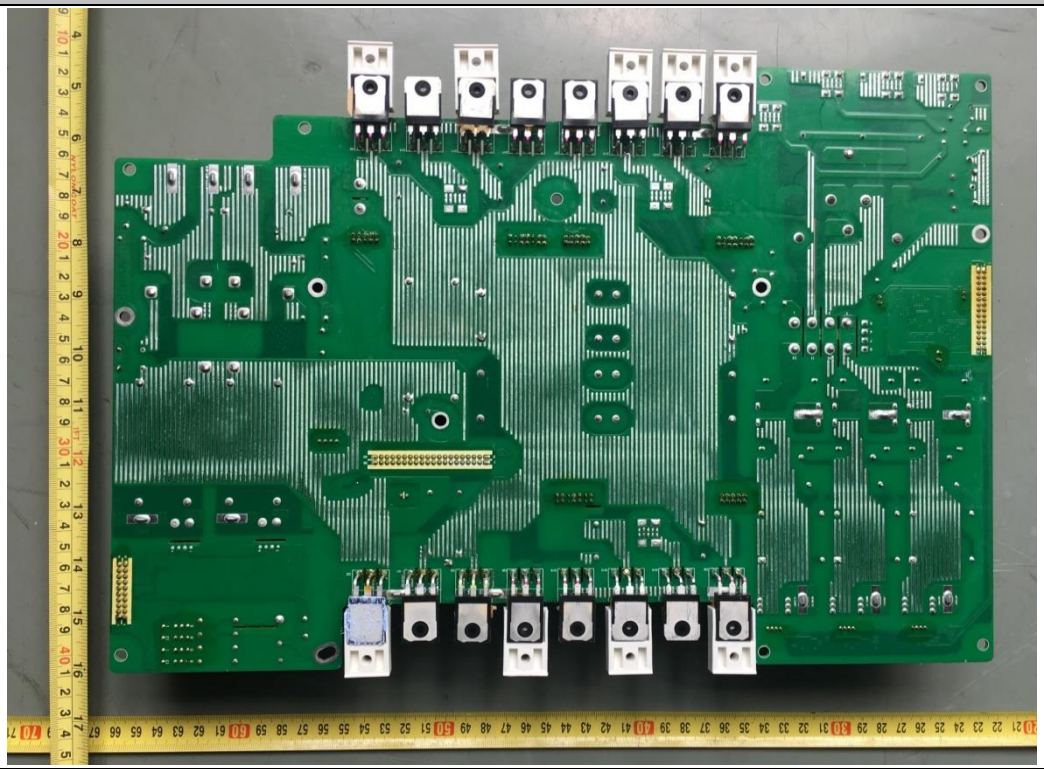
Back view


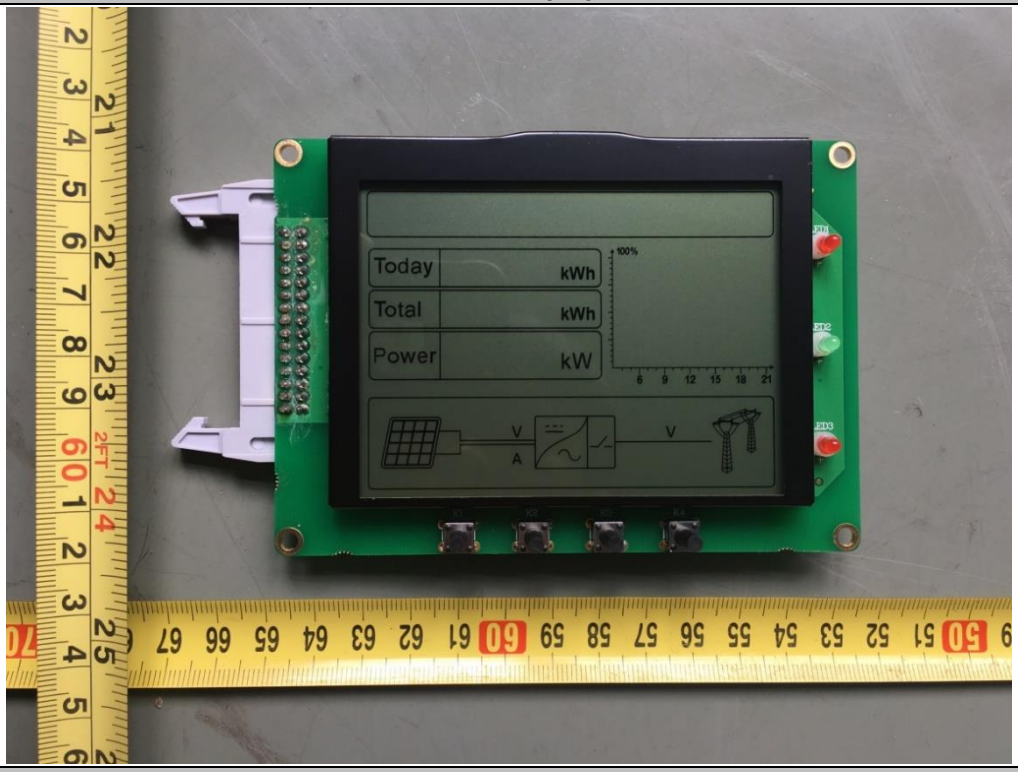
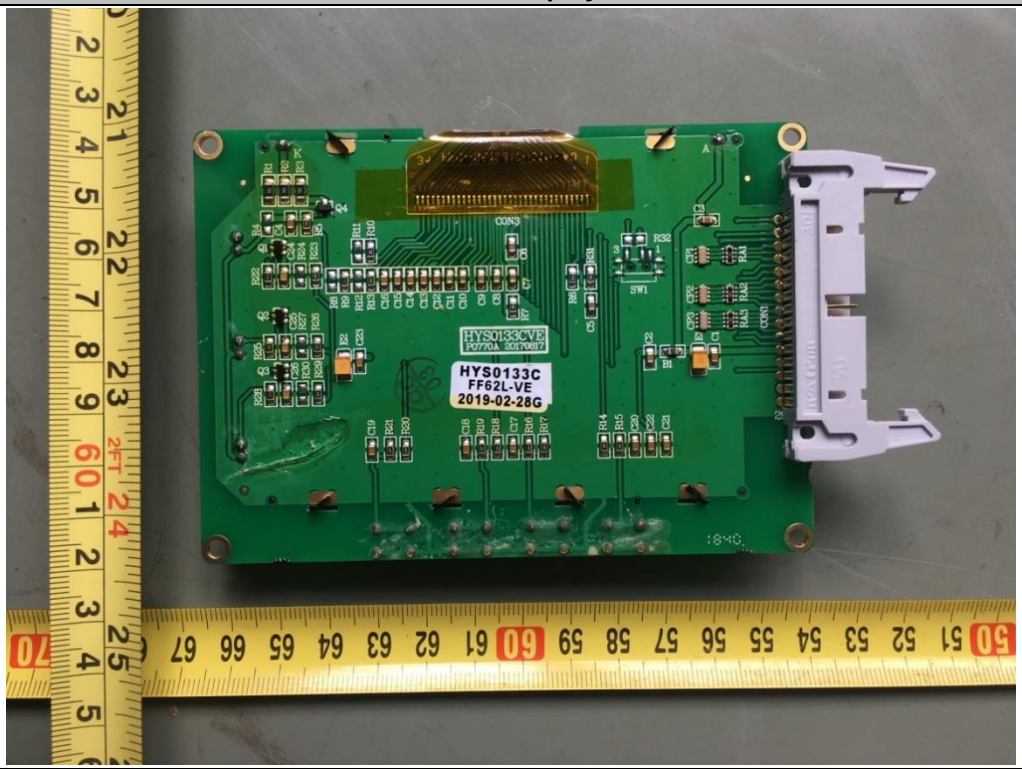
Internal view of model SOFAR 15000TL-G2

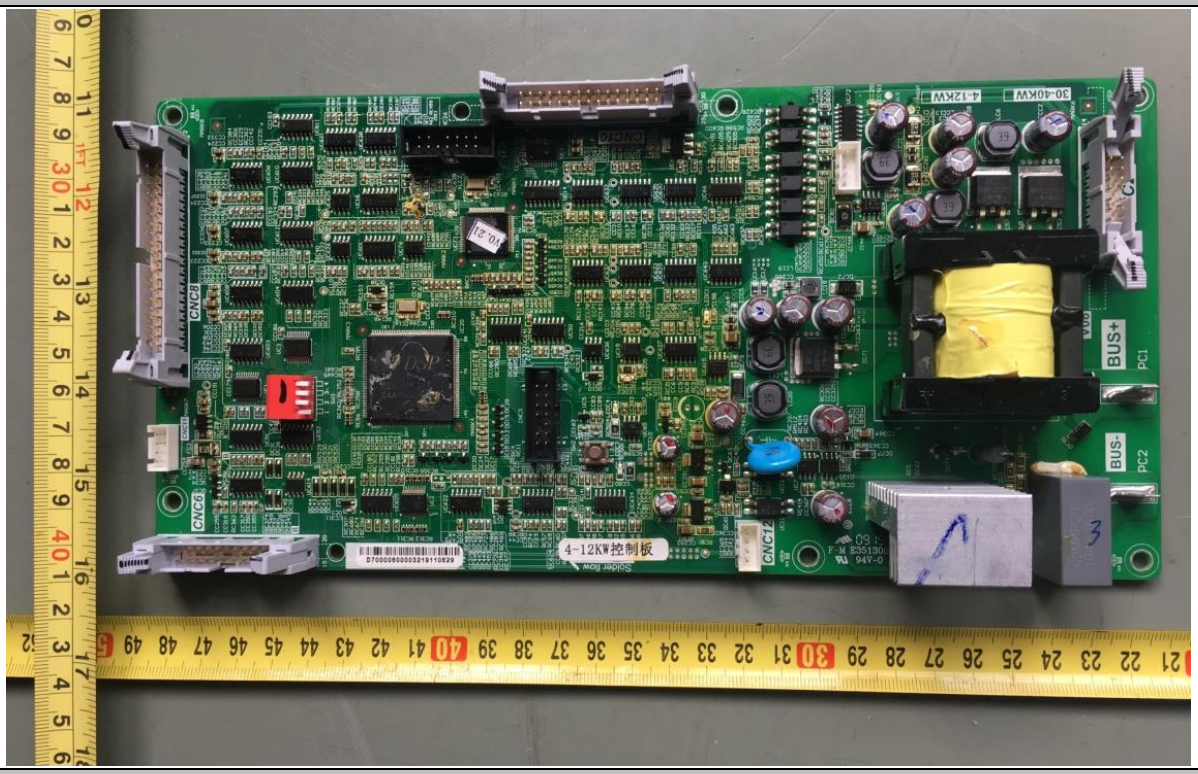
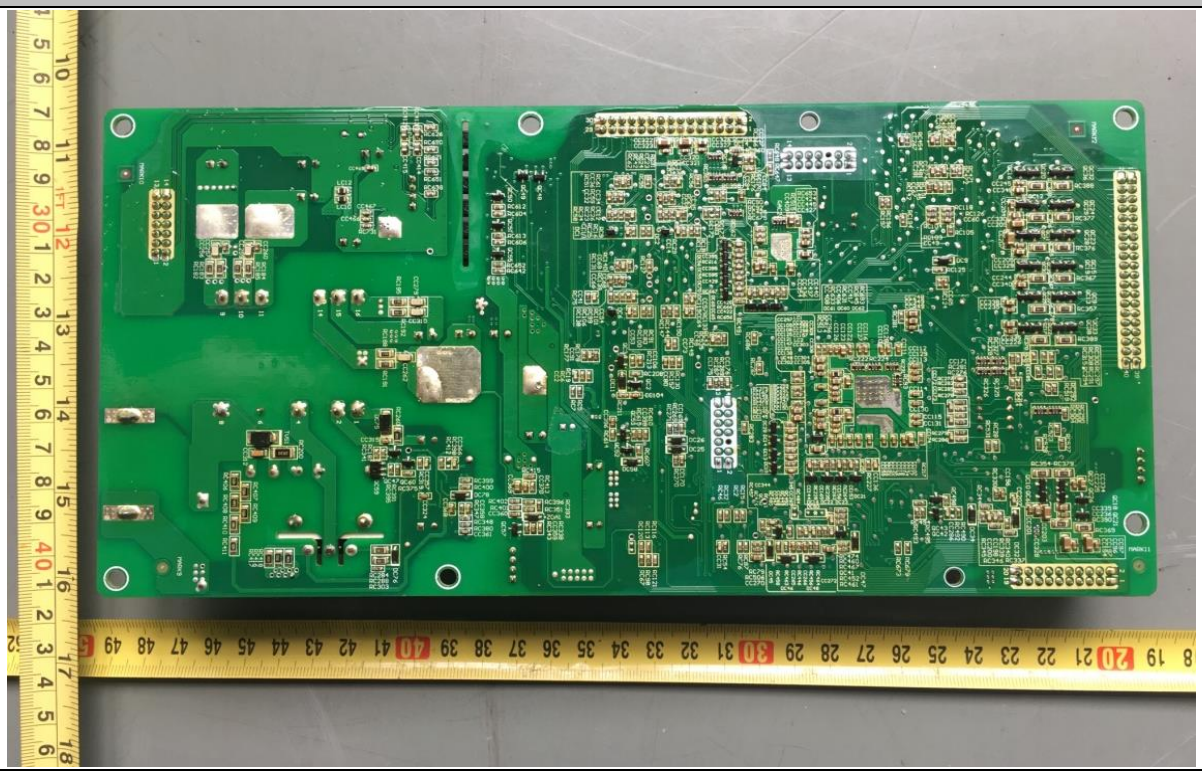
Internal view of models SOFAR 10000TL-G2 and SOFAR 12000TL-G2

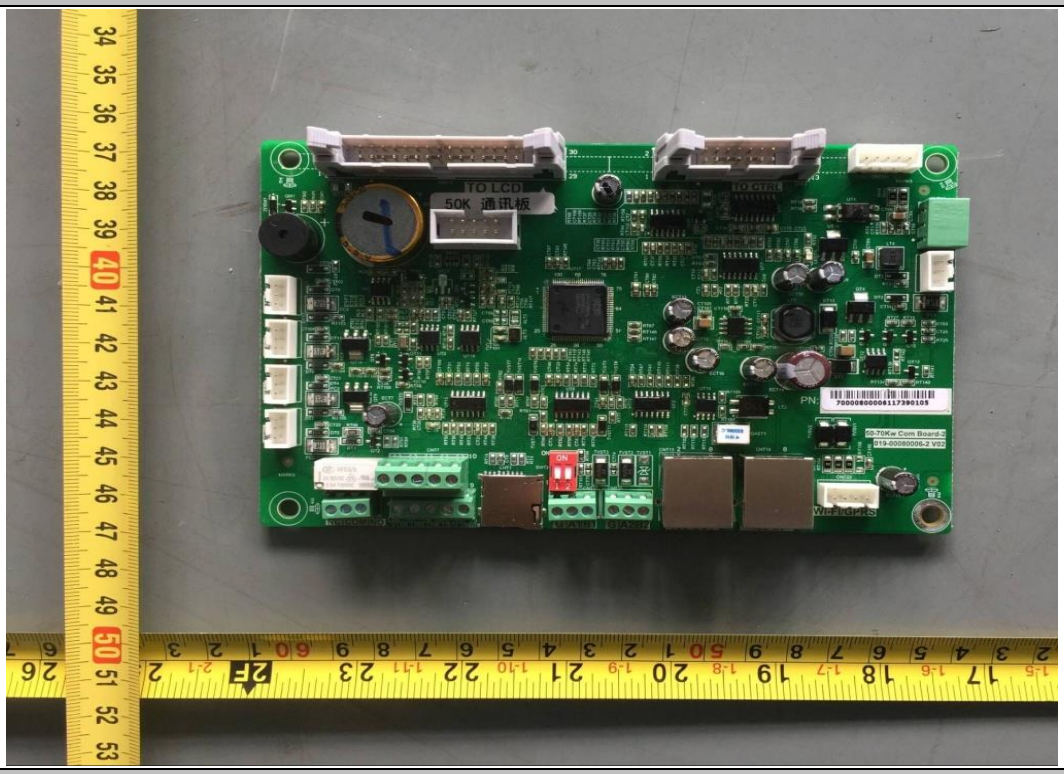
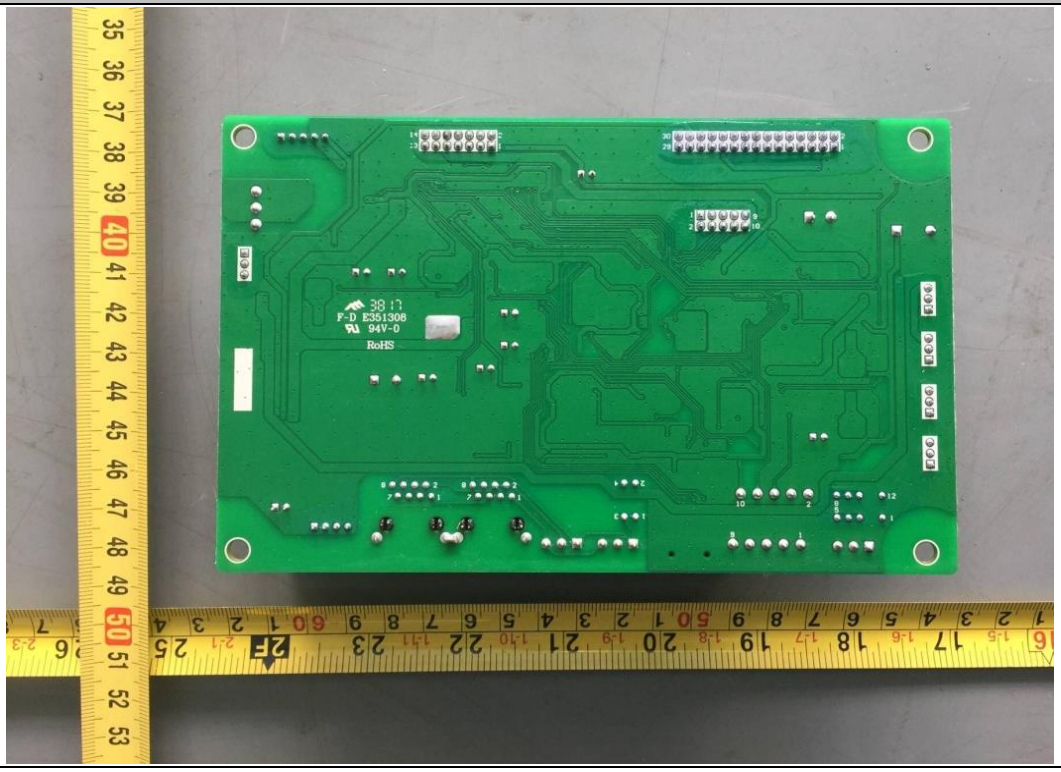
15000TL-G2 INV Inductance

10000TL-G2 and 12000TL-G2INV Inductance


Front side of main board

Back side of main board


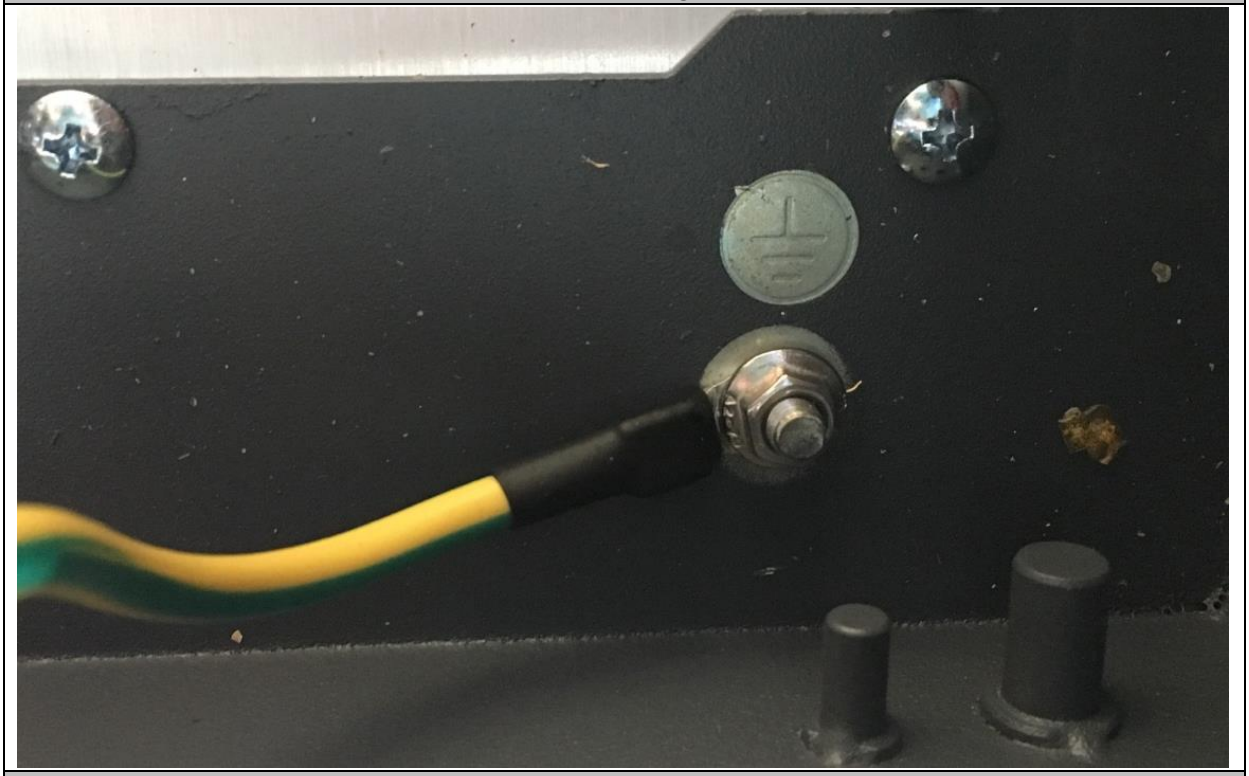
Front side of Display board

Back side of Display board


Front side of Control board

Back side of Control board


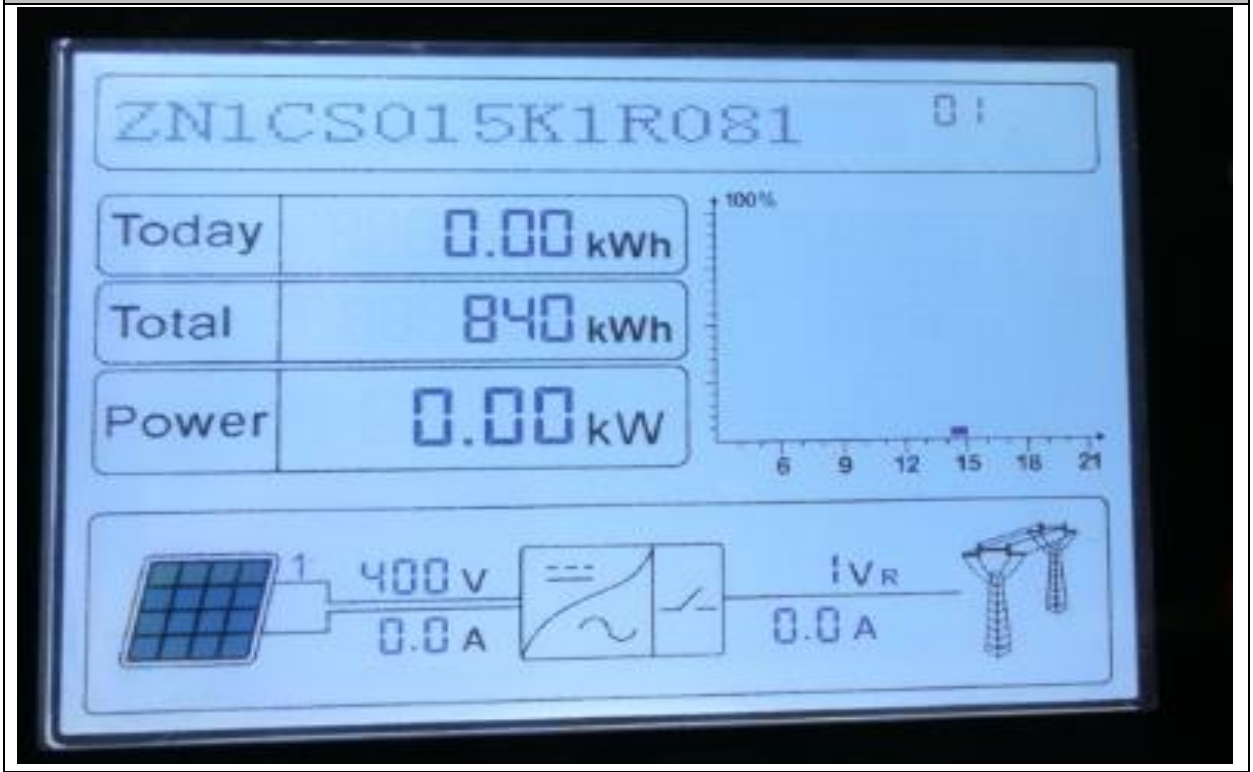
Front side of Communication board

Back side of Communication board


Front view of RS232 board

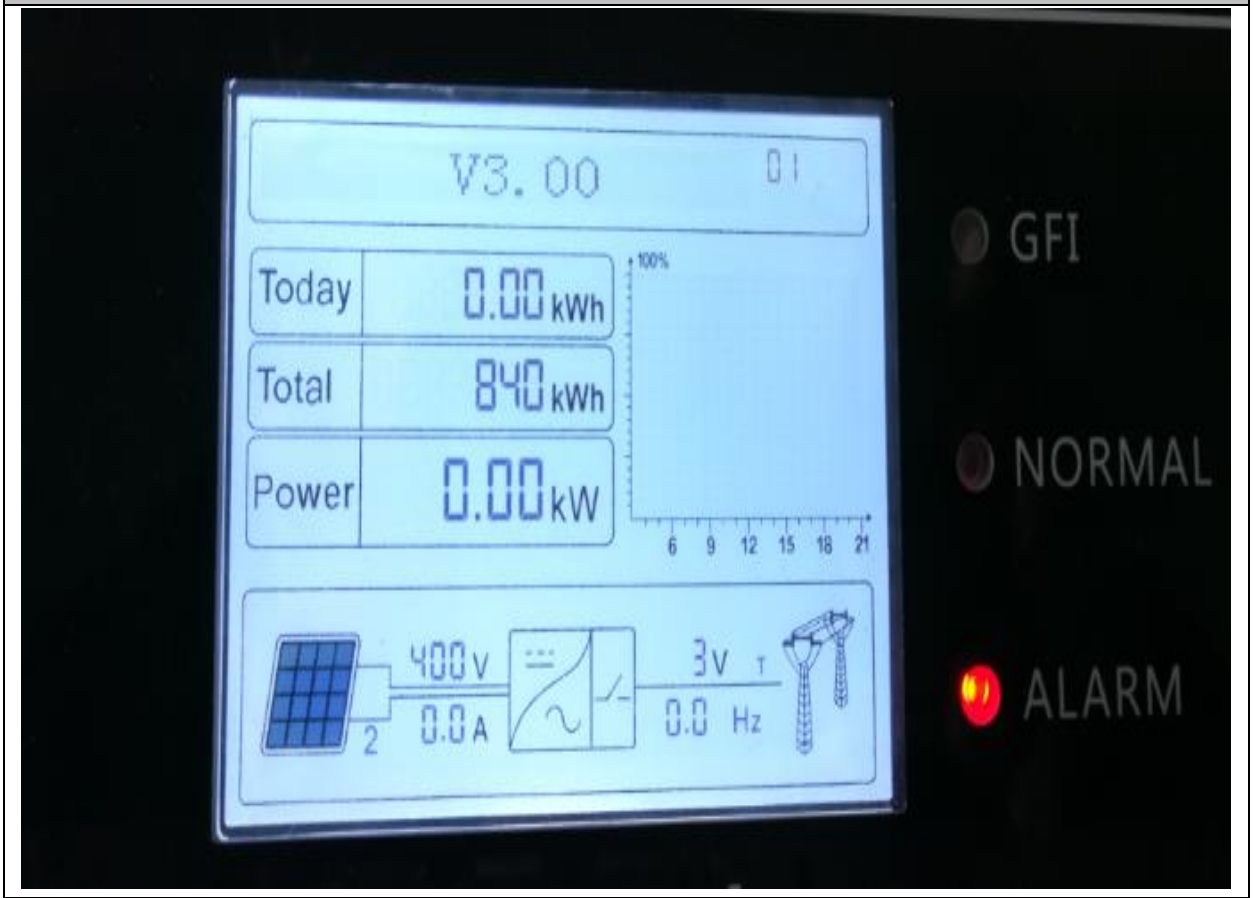
Back view of RS232 board

Grounding

Connection interface


Serial Number

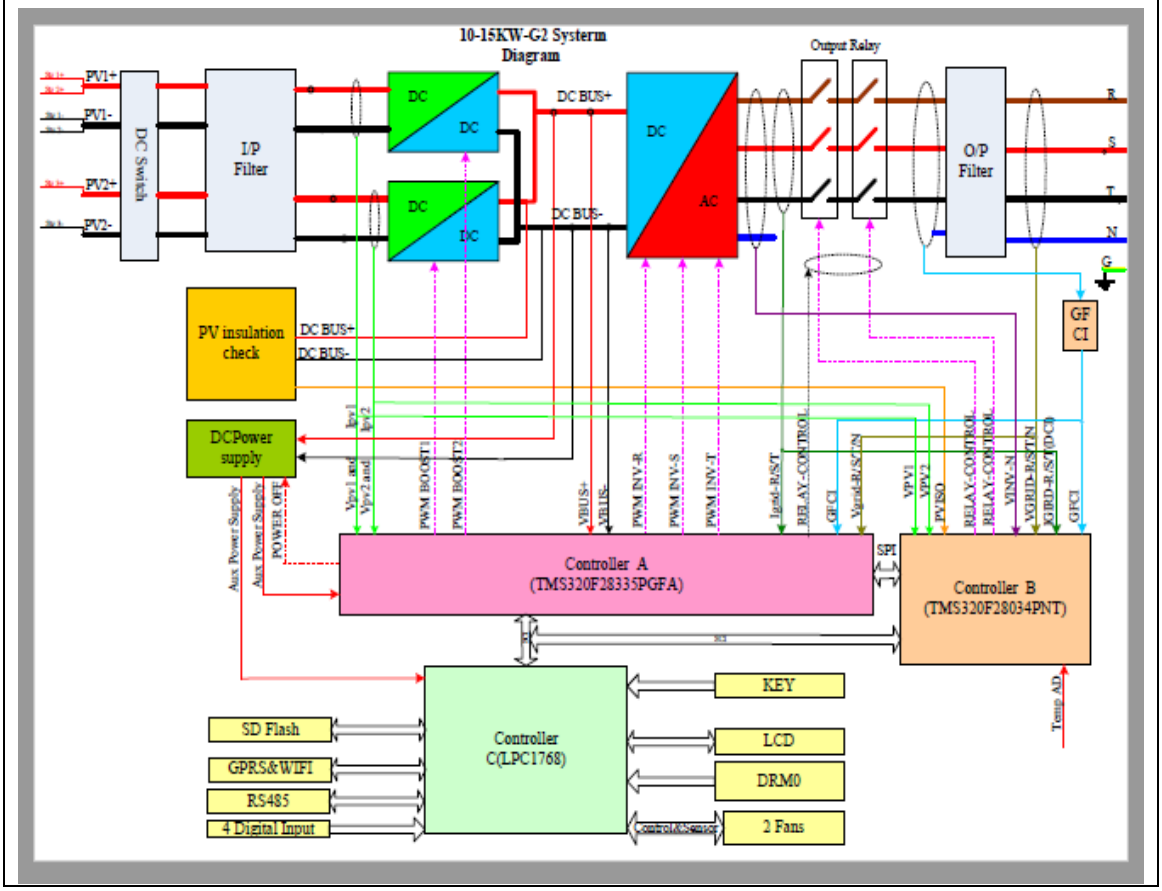


Software Version



6 ELECTRICAL SCHEME

Equipment under testing



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