TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH :

TECHNICAL REGULATION 3.2.1 FOR POWER PLANTS UP TO AND INCLUDING 11 KW AND TECHNICAL REGULATION 3.2.2 FOR PV POWER PLANTS ABOVE 11 KW.

Protocol. PE.T-LE-62

Test Report Number ..... :	**2219/0185-E**
Trademark ..... :	
Tested Model ..... :	SOFAR 2700TL-G3
Variants Models ..... :	SOFAR 3300TL-G3, SOFAR 3000TL-G3, SOFAR 2200TL-G3, SOFAR 1600TL-G3, SOFAR 1100TL-G3

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 ..... :	**19/11/2019**
Number of pages ..... :	**84**

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

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Test Report Historical Revision:

Test Report Version	Date	Resume
2219/0185-E	19/11/2019	First issuance

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1 SCOPE

SGS Tecnos, S.A. (Electrical Testing Laboratory) has been contracted by Shenzhen **SOFAR SOLAR Co., Ltd.**to perform the testing according the following standard: "**Technical regulation 3.2.1 for power plants up to and including 11 kW",** by ENERGINET (rev. 2. Dated on 29th June 2016).and "**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 **categories A1, A2 and B** defined as below:

Plant categories in relation to the total rated power at the Point of Connection:

A1. Plants up to and including 11 kW
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 14 working days between the18th September of 2019 and the 31th October of 2019.

All the tests and checks have been performed in accordance with the reference Standard (the tests are done at 25 ± 5ºC, 96 kPa ± 10 kPa and 65% RH ± 10% RH).

SITE TEST

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

2.2 Equipment under Testing

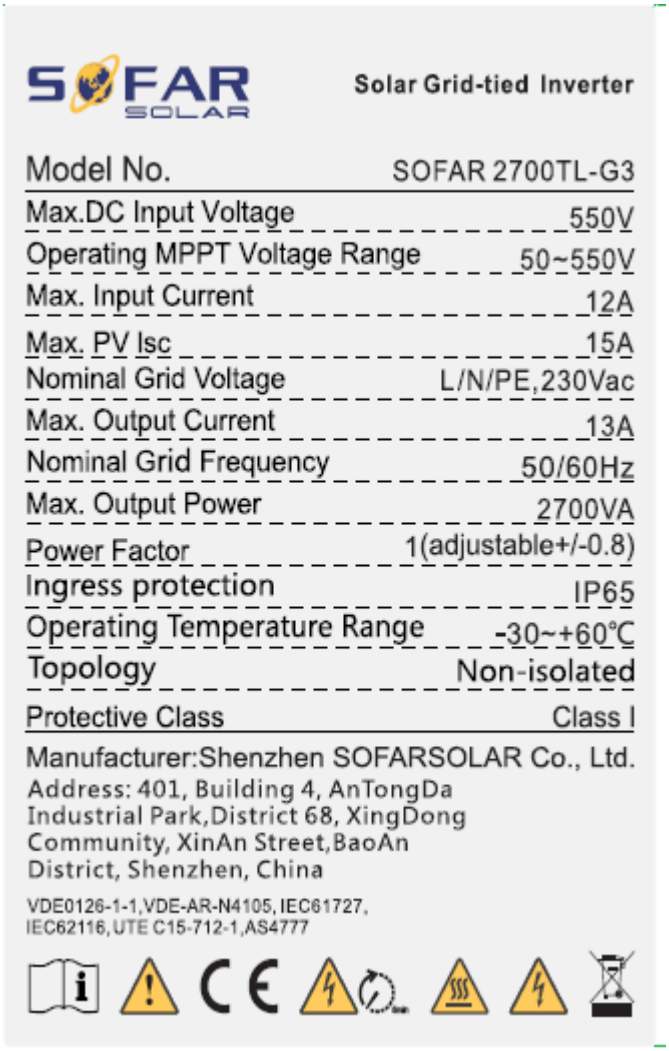
Apparatus type/ Installation ..... :	Solar Grid-tied Inverter (Single Phase Inverter)
Manufacturer/ Supplier/ Installer ..... :	Shenzhen SOFAR SOLAR Co., Ltd.
Trade mark ..... :	SOFAR SOLAR
Model/ Type ..... :	**SOFAR 2700TL-G3**
Serial Number..... :	**SA3CS127K8M010**
Software Version ..... :	V 1.00
Rated Characteristics ..... :	DC input: Operating MPPT range 50-550V; Max.12A AC output: 230Vac, 50Hz, Max.13A, 2700VA

Date of manufacturing: 2018

Test item particulars

Input..... :	PV
Output	AC
Class of protection against electric shock ..... :	Class I
Degree of protection against moisture ..... :	IP 65
Type of connection to the main supply..... :	Single phase – Fixed installation
Cooling group	Natural Convection
Modular.....	No
Internal Transformer	No

Copy of marking plate (representative):



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 wit SOFAR 2700TL-G3's except the parameters of rating.

Equipment under testing:

- SOFAR 2700TL-G3

Variant models:

- SOFAR 3300TL-G3
- SOFAR 3000TL-G3
- SOFAR 2200TL-G3
- SOFAR 1600TL-G3
- SOFAR 1100TL-G3

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

AC Coupled Inverter technical datasheets for all models are offered below:

Model Number	SOFAR 3300TL-G3	SOFAR 3000TL-G	SOFAR 2700TL-G3	SOFAR 2200TL-G3	SOFAR 1600TL-G3	SOFAR 1100TL-G3
Max. input voltage	550Vd.c.			500Vd.c		
Max. input current	12Ad.c.	12Ad.c.	12Ad.c.	12Ad.c.	12Ad.c.	12Ad.c.
Operating MPPT voltage range	50-550Vd.c.			50-500Vd.c.		
Full load DC Voltage Range	300-500 Vd.c.	275-500 Vd.c.	250-500 Vd.c.	200-450 Vd.c.	150-450 Vd.c.	110-450 Vd.c.
Rated voltage	360V					
Rated grid voltage	230Va.c.					
Rated grid frequency	50Hz					
Rated output power	3.3kW	3.0kW	2.7kW	2.2kW	1.6kW	1.1kW
Rated output current	13Aa.c.	13 Aa.c.	11.8Aa.c.	9.6Aa.c.	7Aa.c.	4.8Aa.c.
Max. Output Current	16Aa.c.	14.5 Aa.c.	13Aa.c.	10.6Aa.c.	7.7Aa.c.	5.3Aa.c.
Power factor	0.8 leading to 0.8 lagging					
Ambient temperature	-30 ºC ~60ºC					
Ingress protection	IP65					
Protective class	Class I					

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

2.3 Test Equipment List

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofarsolar	1	Digital oscilloscope	DS0X3024T	MY57251898	2019-02-13	2020-02-12
	2	Voltage probe	SI-9110	111541	2019-02-13	2020-02-12
	3	Voltage probe	SI-9110	152627	2019-02-13	2020-02-12
	4	Voltage probe	SI-9110	111134	2019-02-13	2020-02-12
	5	Power analyzer	WT3000	91N610888	2019-02-13	2020-02-12
	6	Current probe	i1000s	29503223	2019-02-13	2020-02-12
	7	Current probe	i1000s	30413448	2019-02-13	2020-02-12
	8	Current probe	CP5150	C150150008	2019-02-13	2020-02-12
	9	Temperature & Humidity meter	TH101B	201030245220	2019-02-13	2020-02-12
	10	Power analyzer	PA3000	PA3005-P0005-1246	2019-02-13	2020-02-12
SGS	11	True RMS Multimeter	Fluke / 289C	GZE012-53	2019-02-26	2020-02-25

2.4 Measurement Uncertainly

	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.

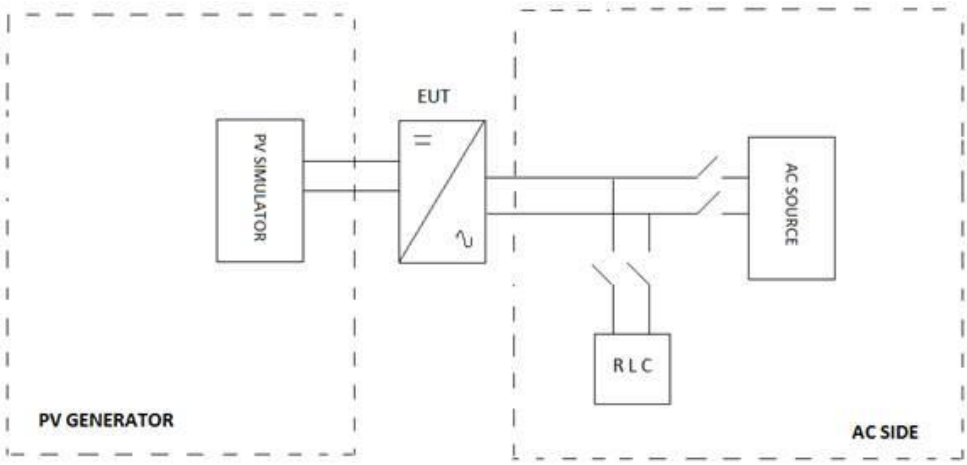
Note2: Where the standard requires lower uncertainties that those in this table. Most restrictive uncertainty has been considered.

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	Chroma / 61860	100KVA 10-300Vrms 45-65Hz	--
DC source	Chroma / 62150H-1000S	0 – 1000Vdc (0.01V step) 0 – 40A (0.01A step)	--

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 3.2.1 for PV power plants up to and including 11 kW	
	Technical requirements	
3.2	Normal operating conditions	P
3.3	Abnormal operating conditions	P
4	Power quality	
4.1	Voltage changes	P
4.2	DC content	P
4.3	Asymmetry	NA
4.4	Flicker	P
4.5	Harmonic distortions	P
4.6	Interharmonic distortions	NA
4.7	Distortions in the 2-9 kHz frequency range	NA
5	Control and regulation	
5.2	Active power control functions	
5.2.1	Frequency response	P
5.2.2	Constraint functions	
5.2.2.1	Absolute power constraint	P
5.2.2.2	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	Automatic power factor control	P
6.1	Reconnection	P
6.2	Voltage and frequency trips	P

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

Standard Section	STANDARD REQUIREMENTS Technical regulation 3.2.2 for PV power plants above 11 kW	
	Technical requirements	
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	NA
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	
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 3.2.1 for PV power plants up to and including 11 kW" as category A1 and "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

Normal operating requirements are different when unit is connected as plant category A1 or plant category A2, B.

For connected as plant category A1, the normal operating voltage is Uc+10% and Uc-15%, and the frequency range is 49.00 to 51.00 Hz. Tests have been tested according to chapter 3.2 of TR3.2.1, and the requirements should be referred to the chapter 3.2.1 of the standard.

For connected as plant category A2 or B, 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 TR3.2.2, and the requirements should be referred to the chapter 3.2.1 of the standard.

The settings of normal voltage and frequency is adjustable.

Test results are offered at the tables below.

For category A1:

Test 1		Under Voltage + Under Frequency		
Voltage	Frequency	Active Power measured (*)	Minimum Operation Time	Time measured
85.0%Un	49.0 Hz	94.25%Pn	Continuous operation	> 30 minutes
Disconnection		☒ NO ☐ YES		

Test 2		Over Voltage + Over Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
110.0%Un	51.0 Hz	99.95%Pn	Continuous operation	> 30 minutes
Disconnection		☒ NO ☐ YES		

Test 3		Normal Voltage + Under Frequency		
Voltage	Frequency	Active Power measured (*)	Minimum Operation Time	Time measured
100.0%Un	47.5 Hz	100.15%Pn	Continuous operation	> 30 minutes
Disconnection		☒ NO ☐ YES		

Test 4		Normal Voltage + Over Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
100.0%Un	51.5 Hz	99.95%Pn	Continuous operation	> 30 minutes
Disconnection		☒ NO ☐ YES		

Test 5		Normal Voltage + Under Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
100.0%Un	47.1 Hz	100.1%Pn	Continuous operation	> 10 s
Disconnection		☒ NO ☐ YES		

Test 6		Normal Voltage + Over Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
100.0%Un	51.9 Hz	99.93%Pn	Continuous operation	> 10 s
Disconnection		☒ NO ☐ YES		

For category A2 and B:

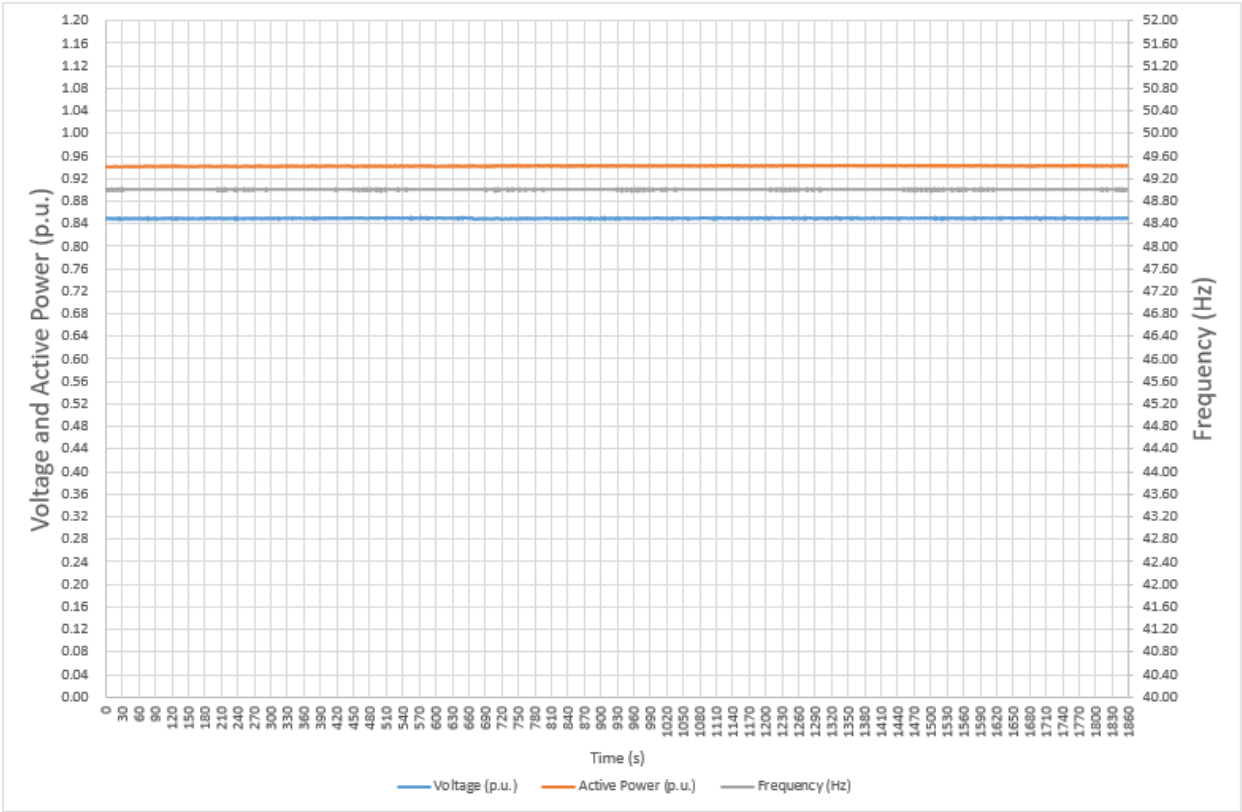
Test 7		Under Voltage + Under Frequency		
Voltage	Frequency	Active Power measured (*)	Minimum Operation Time	Time measured
90.0%Un	47.0 Hz	99.46%Pn	Continuous operation	> 4 minutes
Disconnection		☒ NO ☐ YES		

Test 8		Over Voltage + Over Frequency		
Voltage	Frequency	Active Power measured	Minimum Operation Time	Time measured
110.0%Un	52.0 Hz	99.92%Pn	Continuous operation	> 4 minutes
Disconnection		☒ NO ☐ YES		

(*) The full value of active power has not been reached due to limitations in the maximum current of the inverter.

Test results are represented in graphics on the following pages.

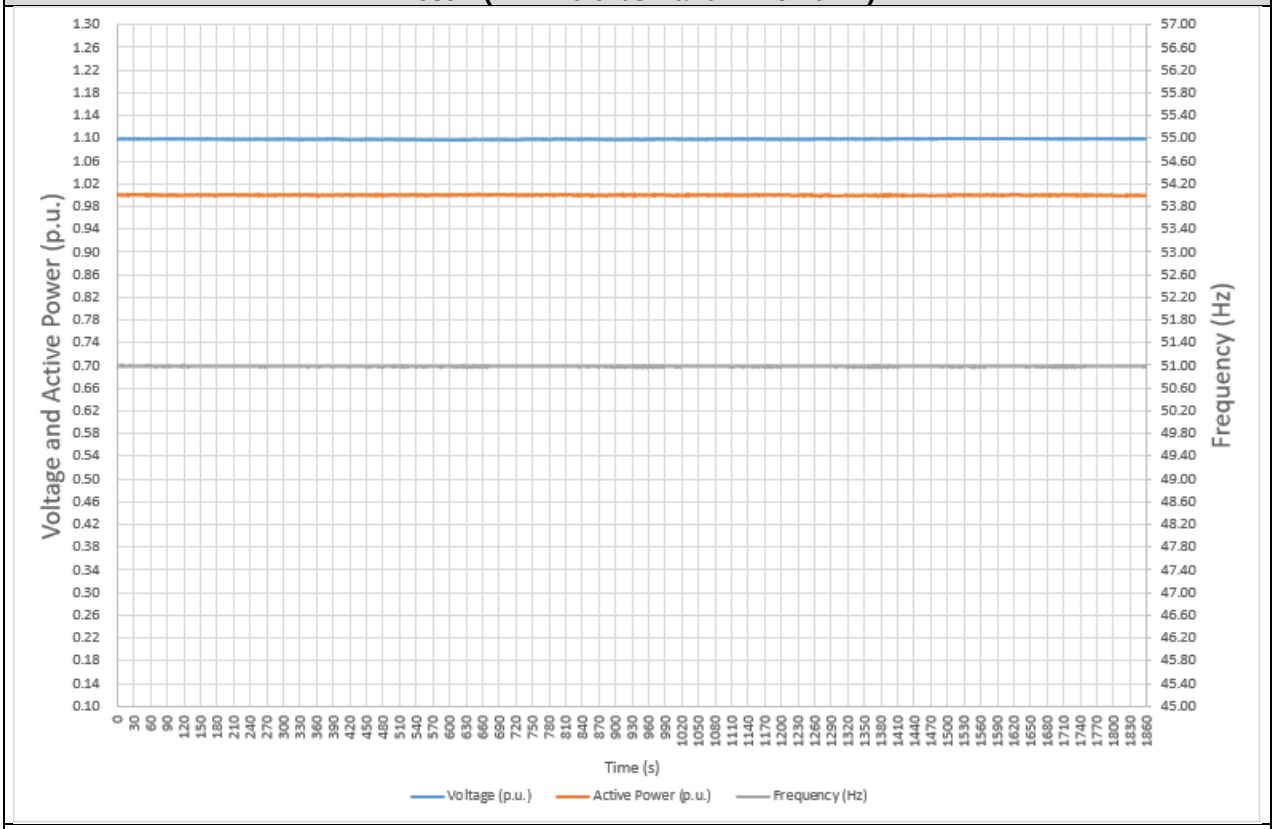
Test 1 (V = 85.0%Un and F = 49.0 Hz)



Time measured:1860 s

Voltage average measured: 85.1 %Un	Frequency measured: 49.0 Hz

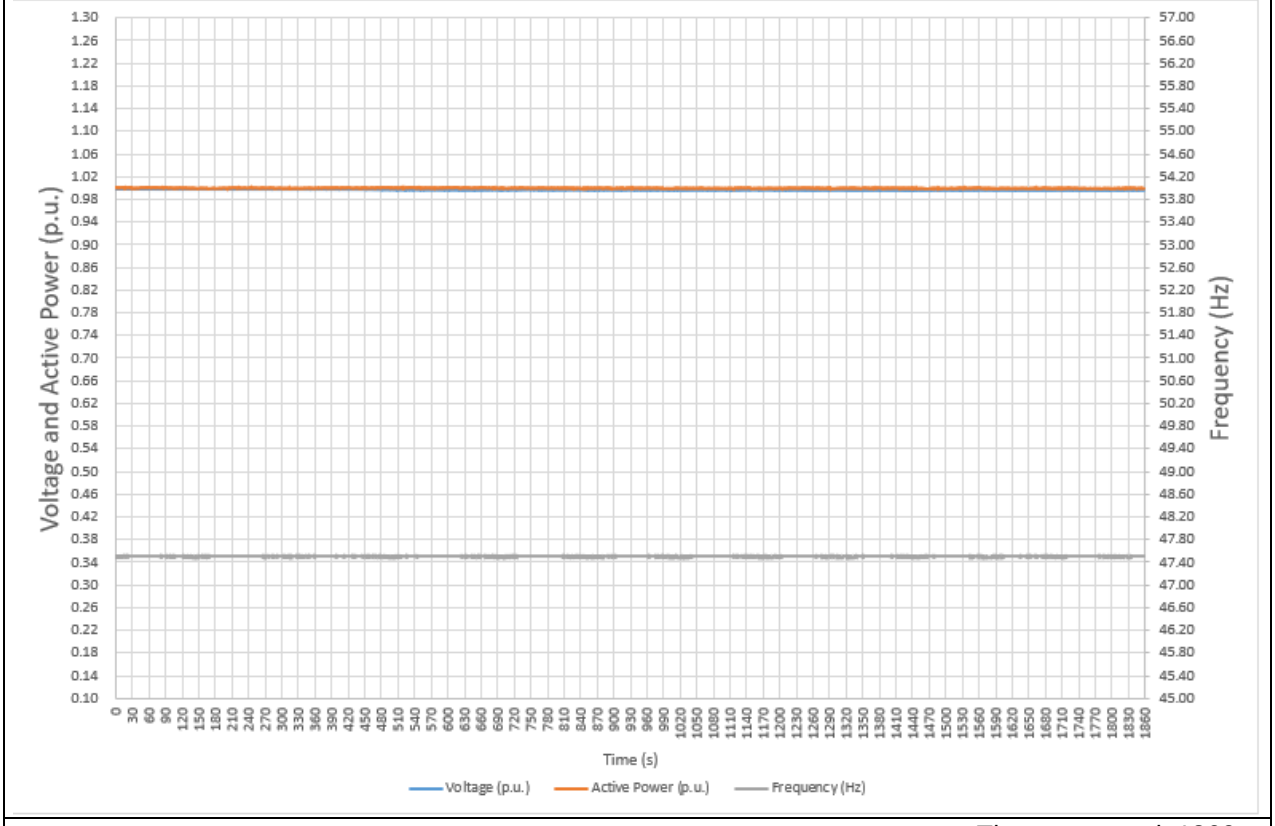
Test 2 (V = 110.0%Un and F = 51.0 Hz)



Time measured: 1860 s

Voltage average measured: 109.9 %Un | Frequency measured: 51.0 Hz

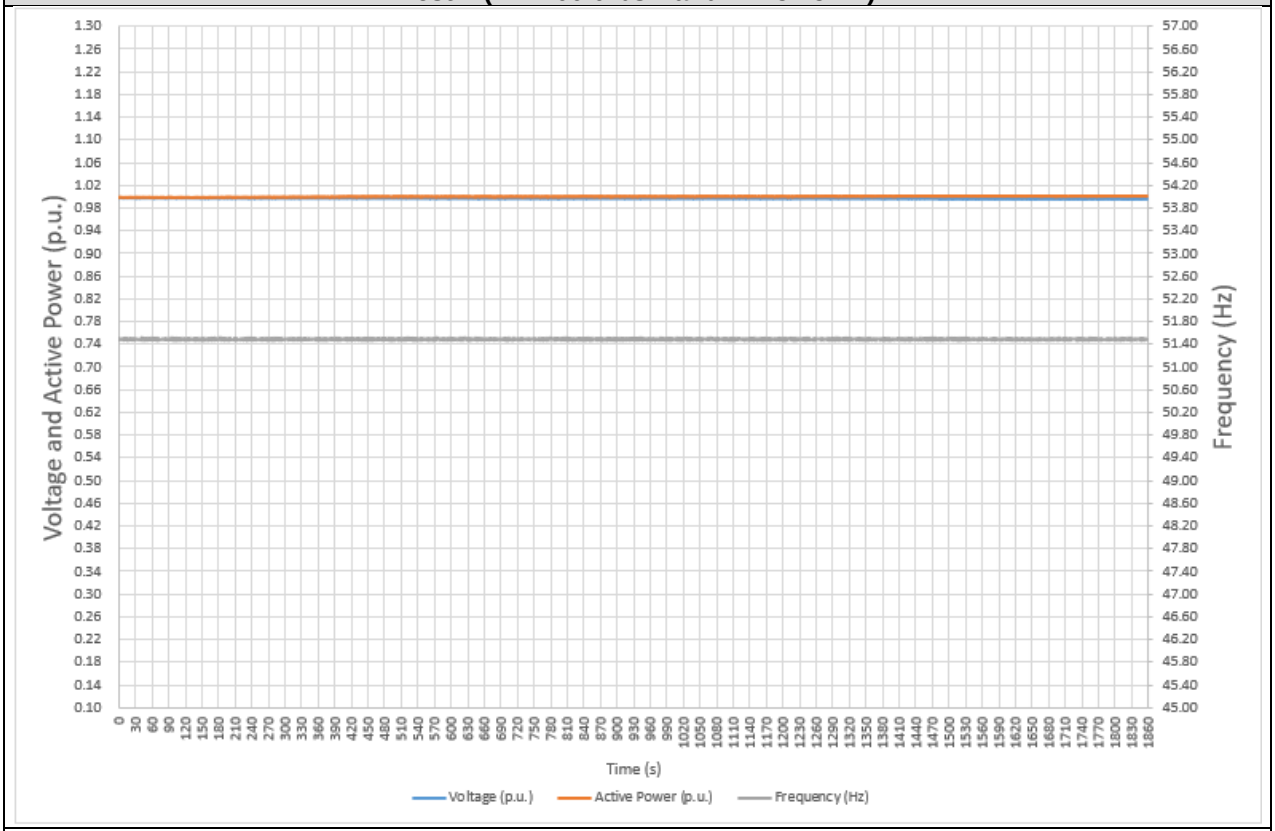
Test 3 (V = 100.0%Un and F = 47.5 Hz)



Time measured: 1860 s

Voltage average measured: 99.9 %Un | Frequency measured: 47.5 Hz

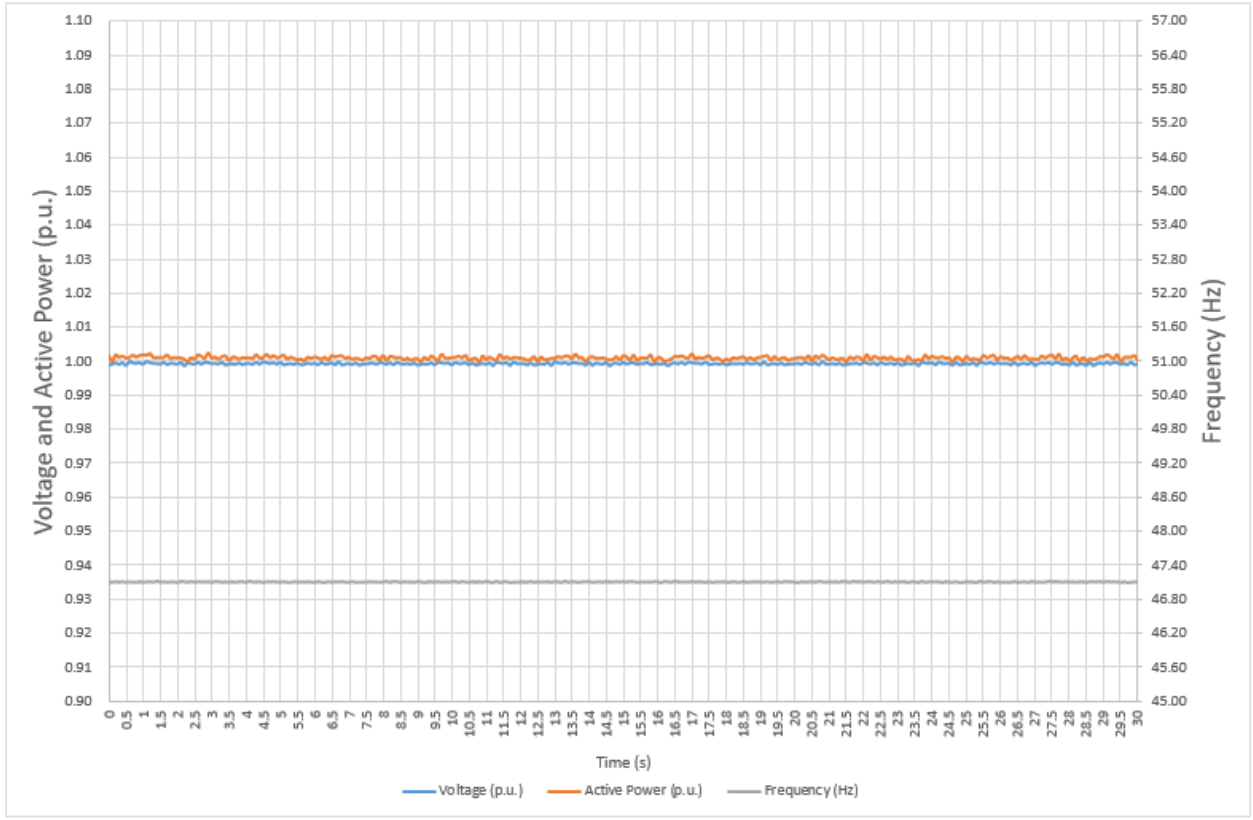
Test 4 (V = 100.0%Un and F = 51.5 Hz)



Time measured:1860 s

Voltage average measured: 100.0 %Un	Frequency measured: 51.5 Hz

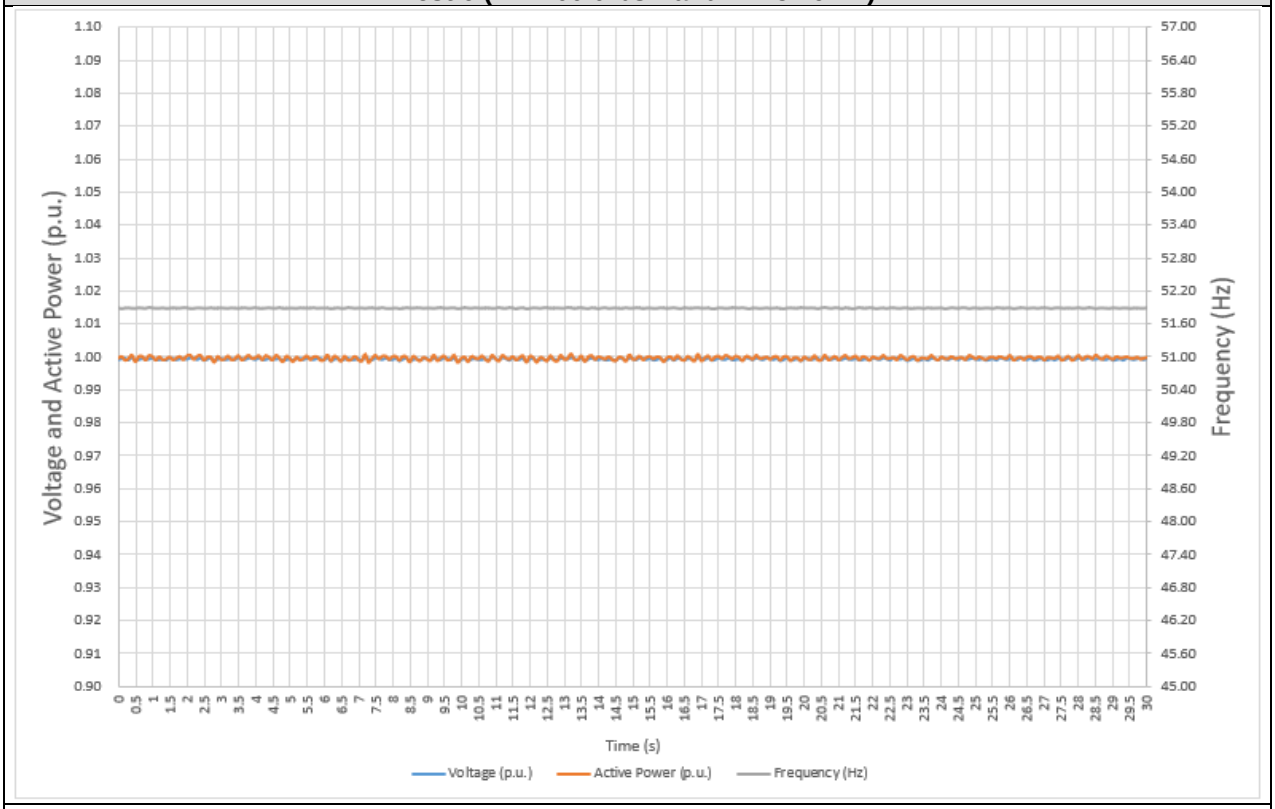
Test 5 (V = 100.0%Un and F = 47.1 Hz)



Time measured: 30 s

Voltage average measured: 99.9 %Un	Frequency measured: 47.1 Hz

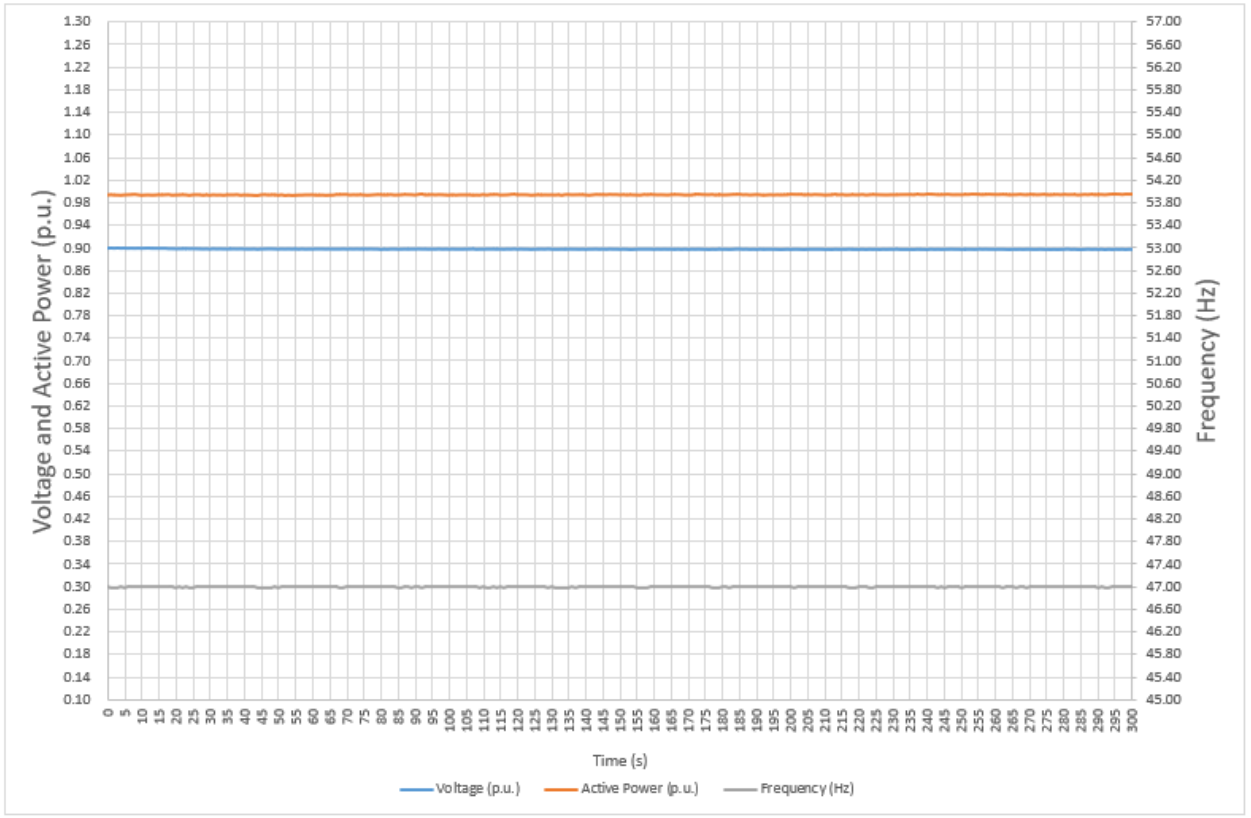
Test 6 (V = 100.0%Un and F = 51.9 Hz)



Time measured: 50 s

Voltage average measured: 100.0 %Un	Frequency measured: 51.9 Hz

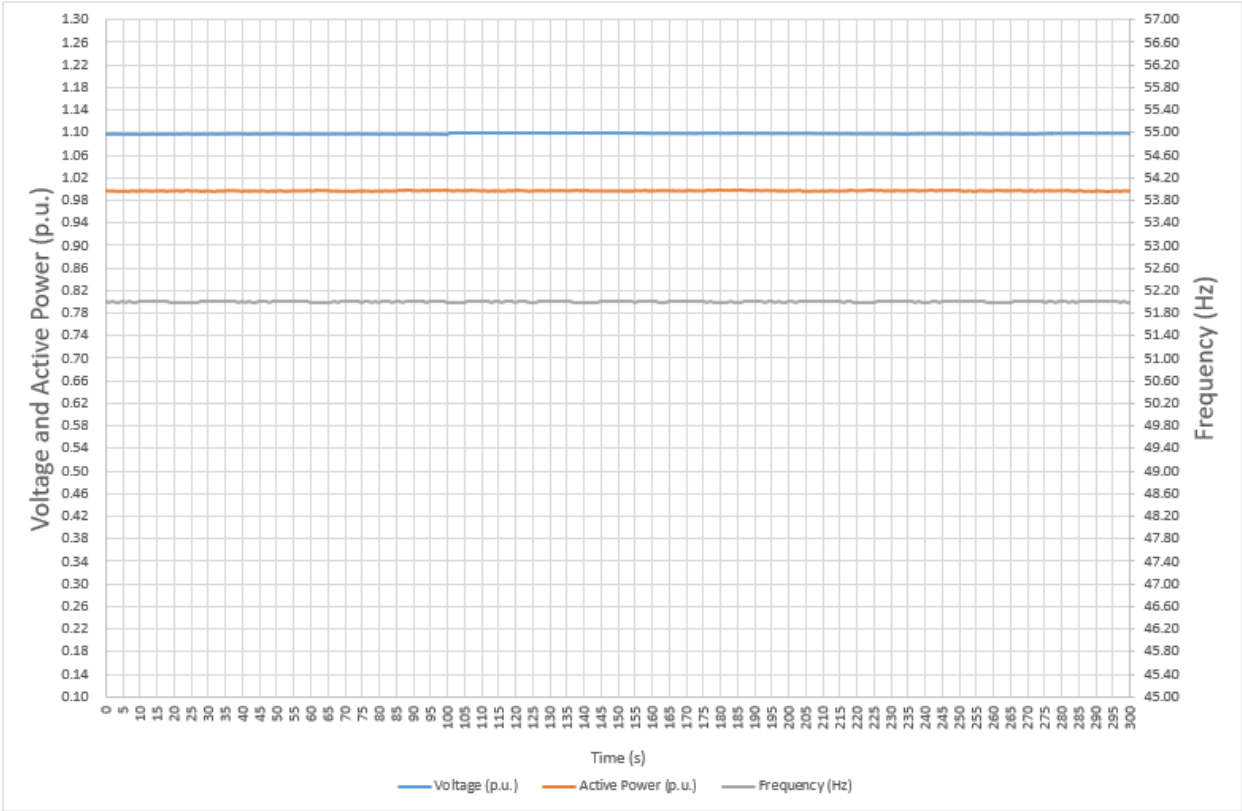
Test 7 (V = 90.0%Un and F = 47.0 Hz)



Time measured: 300 s

Voltage average measured: 90.0 %Un	Frequency measured: 47.0 Hz

Test 8 (V = 110.0%Un and F = 52.0 Hz)



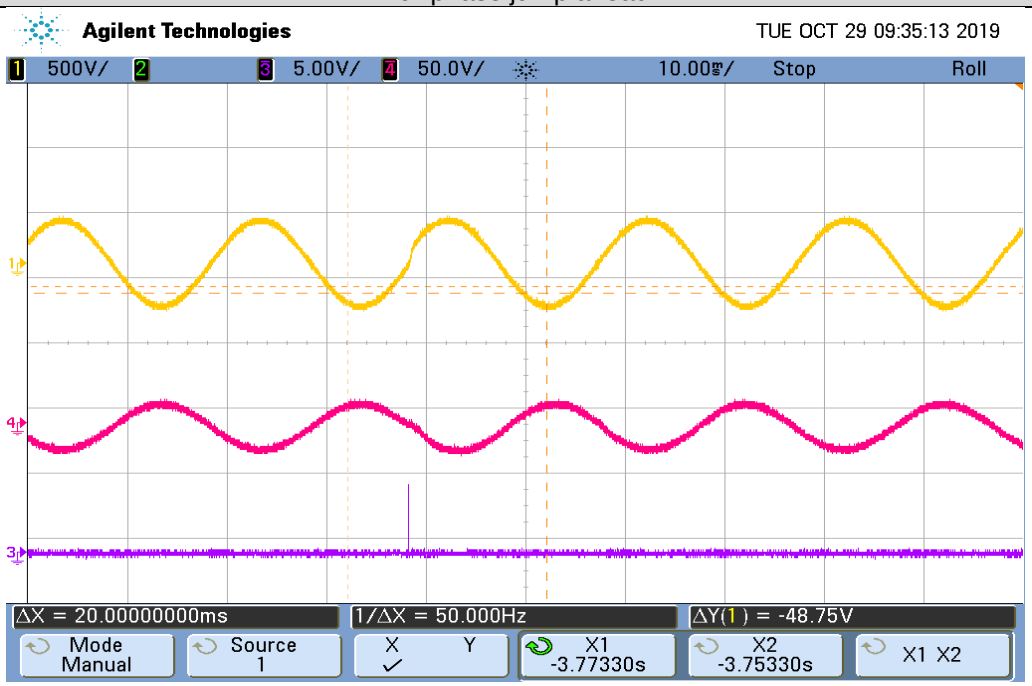
	Time measured: 300 s
Voltage average measured: 109.9%Un	Frequency measured: 52.0 Hz

4.2 ABNORMAL OPERATING CONDITIONS

According to chapter 3.3 of standard TR3.2.1, a plant in plant category A1 must be designed to withstand transitory (80-100 ms) phase jumps of up to 20° in the Point of Connection (POC) without disrupting

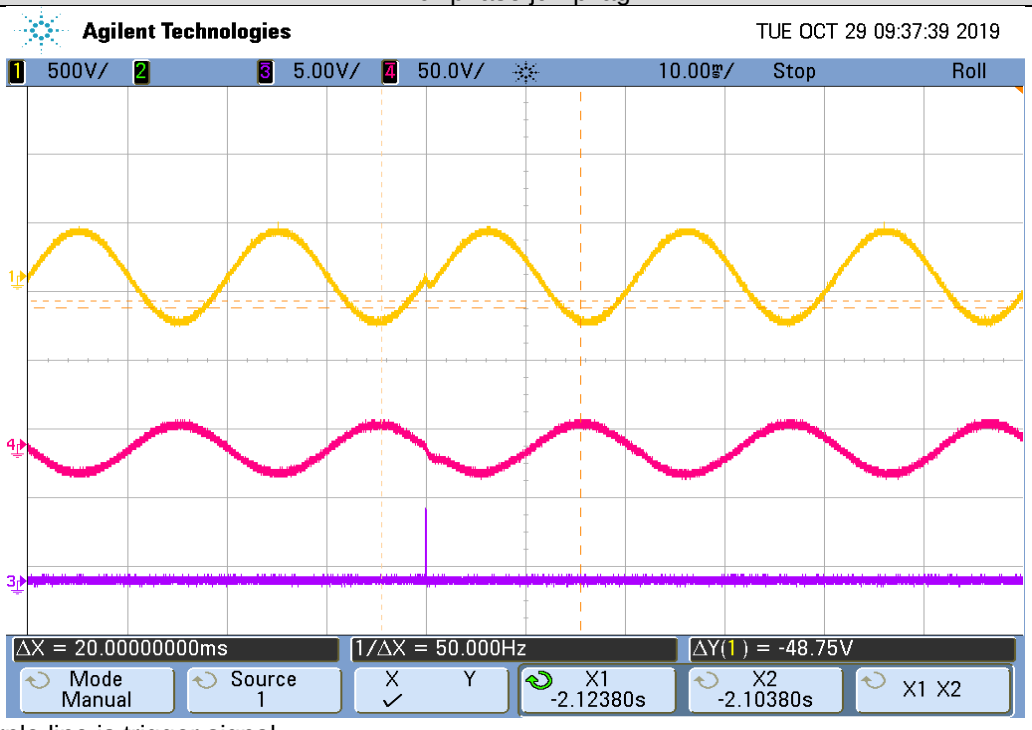
Test results are represented in graphics below.

20° phase jump ahead



Note: Purple line is trigger signal.

20° phase jump lag



Note: Purple line is trigger signal.

Note: It is not applicable when the inverter is installed as plant category A2 and B according to standard TR3.2.2.

4.2.1 Voltage Dip Tolerance

According to chapter 3.3.1 of standard TR3.2.2, 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.

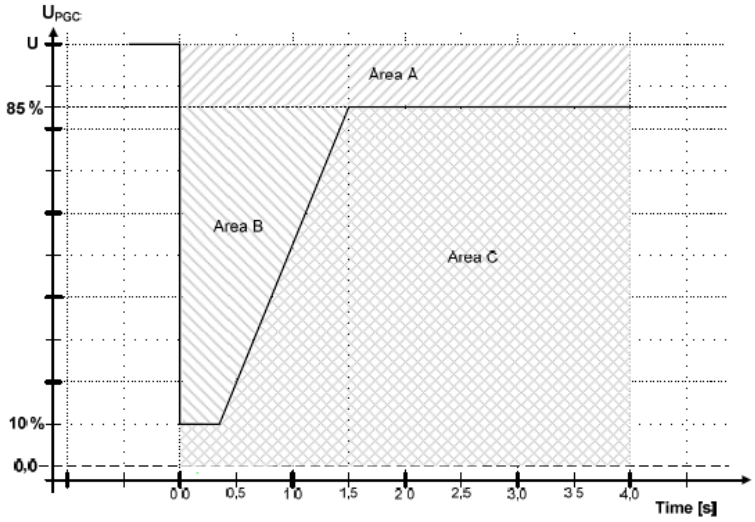


Figure 5 Voltage dip tolerance requirements for category C and D PV power plants.

It is not applicable due to the inverter is applying to plant category A1, 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 standard TR3.2.2, 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 applying to plant category A1, A2 and B defined in this standard, according to manufacturer Statements. The test is only applicable to plant categories C and D.

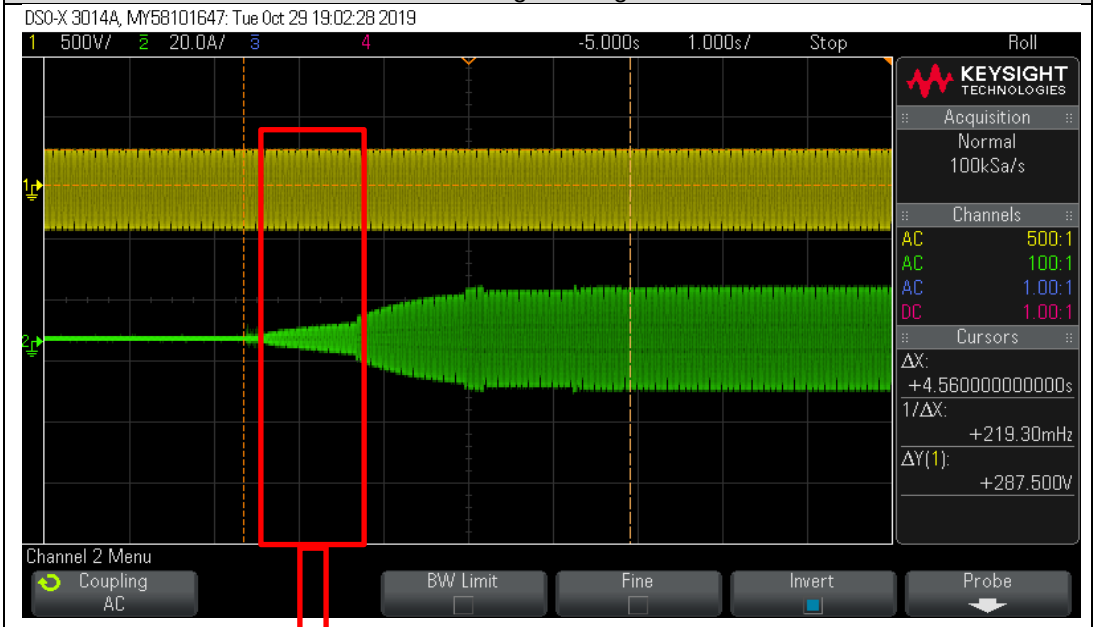
4.3 POWER QUALITY

4.3.1 Voltage Changes

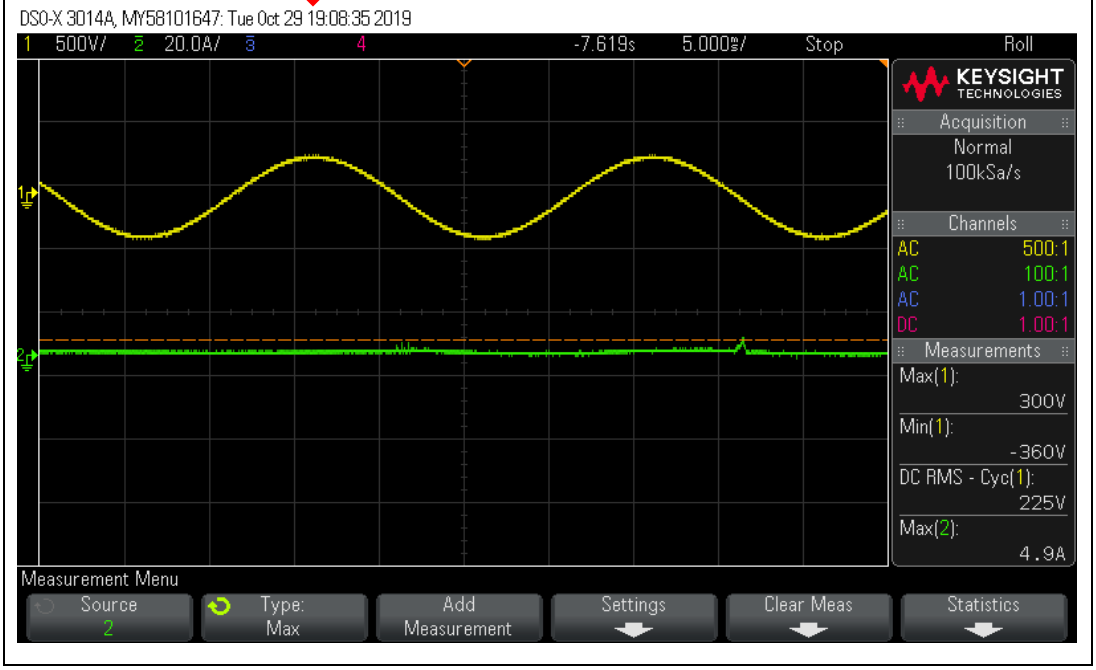
According to chapter 4.1 of standard TR3.2.1, The inrush current must not lead to a voltage change of more than 4% in the Point of Connection.

Test results is represented in graphics below.

Voltage Change



Zoom In



It is measured the test voltage change is 225V which is -2.17% in the Point of Connection

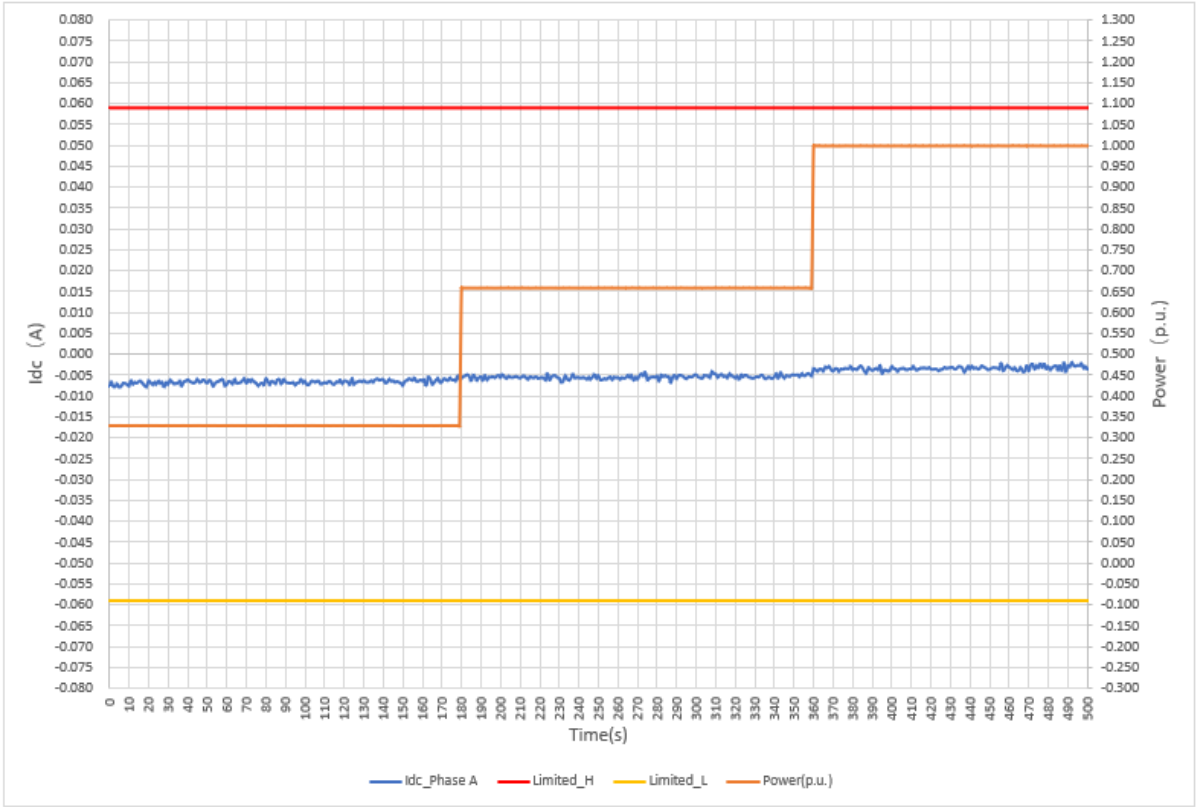
4.3.2 DC Content

According to chapter 4.2 of standard TR3.2.1 and TR3.2.2, 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.

Ratio of rated output power (VA)	33%Pn	66%Pn	100%Pn
Test value (phase A)	-0.007A	-0.005A	-0.003A
Limit (A)	0.059	0.059	0.059

Test results is represented in graphics below

DC component emission test



4.3.3 Asymmetry

According to chapter 4.3 of standard TR3.2.1 and TR3.2.2, the asymmetry between the phases at normal operation or in the event of faults in the electricity-generating unit may not exceed 16A.

It is not applicable due to the unit is single phase.

4.3.4 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 standard TR3.2.1 and TR3.2.2.

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.

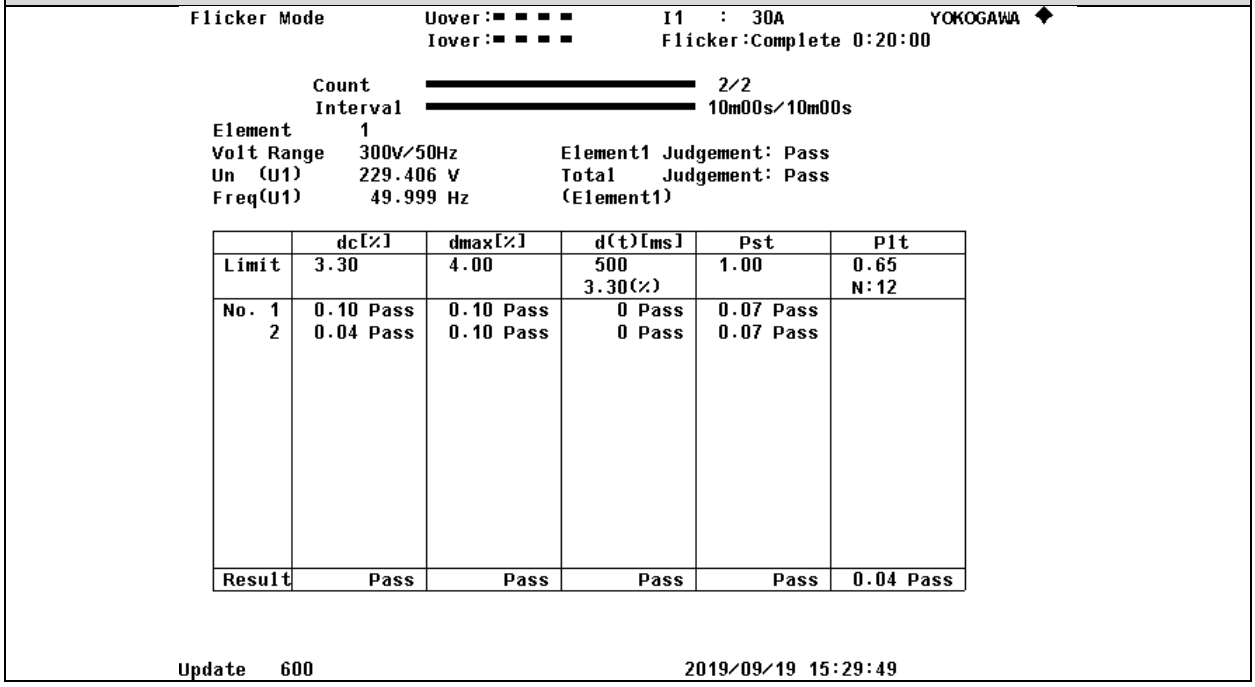
Starting operation and Stopping operation				
P_{bin}(%)	Limit	33 %	66 %	100 %
PST	≤ 1	0.07	0.07	0.08
PLT	≤ 0.65	0.04	0.04	0.04
dc	≤ 3.30%	0.10%	0.19%	0.29%
dmax	4%	0.10%	0.20%	0.32%

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

1.Starting operation
2.Stopping operation

All values are the most unfavorable of the two steps.

Starting operation and Stopping operation 33% Pn



	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.10 Pass	0.10 Pass	0 Pass	0.07 Pass	
2	0.04 Pass	0.10 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Starting operation and Stopping operation 66% Pn

Flicker Mode Uover:▬ ▬ ▬ ▬ I1 : 20A YOKOGAWA ◆
Iover:▬ ▬ ▬ ▬ Flicker:Complete 0:20:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 2/2
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s
Element 1
Volt Range 300V/50Hz Element1 Judgement: Pass
Un (U1) 229.465 V Total Judgement: Pass
Freq(U1) 49.999 Hz (Element1)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.10 Pass	0.10 Pass	0 Pass	0.07 Pass	
2	0.19 Pass	0.20 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Update 600 2019/09/19 14:40:06

Starting operation and Stopping operation 100% Pn

Flicker Mode Uover:▬ ▬ ▬ ▬ I1 : 30A YOKOGAWA ◆
Iover:▬ ▬ ▬ ▬ Flicker:Complete 0:20:00

Count ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 2/2
Interval ▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬▬ 10m00s/10m00s
Element 1
Volt Range 300V/50Hz Element1 Judgement: Pass
Un (U1) 229.414 V Total Judgement: Pass
Freq(U1) 49.999 Hz (Element1)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.10 Pass	0.10 Pass	0 Pass	0.07 Pass	
2	0.29 Pass	0.32 Pass	0 Pass	0.08 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Update 600 2019/09/19 15:07:31

Running operation				
P_{bin}(%)	Limit	33 %	66 %	100 %
PST	≤ 1	0.07	0.07	0.07
PLT	≤ 0.65	0.07	0.07	0.09
dc	≤ 3.30%	0.07%	0.08%	0.44%
dmax	4%	0.16%	0.20%	0.47%

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

Flicker Mode Uover:▬ ▬ ▬ I1 : 30A YOKOGAWA
Iover:▬ ▬ ▬ Flicker:Complete 2:00:00

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

Element 1
Volt Range 300V/50Hz Element1 Judgement: Pass
Un (U1) 229.674 V Total Judgement: Pass
Freq(U1) 49.999 Hz (Element1)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.07 Pass	0.15 Pass	0 Pass	0.07 Pass	
8	0.05 Pass	0.16 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07 Pass

Update 3600 2019/09/19 18:35:05

Running operation 66% Pn

Flicker Mode Uover:- - - - Iover:- - - - YOKOGAWA

Flicker:Complete 2:00:

Flicker Form

Measurement

Flicker dmax

Count 12/12

Interval 10m00s/10m00s

Element 1

Volt Range 300V/50Hz Element1 Judgement: Pass

Un (U1) 230.091 V Total Judgement: Pass

Freq(U1) 49.999 Hz (Element1)

Initialize Exec

Start

Reset

Flicker Settings

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.08 Pass	0.20 Pass	0 Pass	0.07 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07

Update 3600 2019/09/21 15:30:20

Running operation 100% Pn

Flicker Mode Uover:- - - - Iover:- - - - YOKOGAWA

Flicker:Complete 2:00:00

Count 12/12

Interval 10m00s/10m00s

Element 1

Volt Range 300V/50Hz Element1 Judgement: Pass

Un (U1) 230.358 V Total Judgement: Pass

Freq(U1) 49.999 Hz (Element1)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.44 Pass	0.47 Pass	0 Pass	0.09 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.05 Pass	0.18 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07 Pass

Update 3600 2019/09/21 13:16:51

4.3.5 Harmonic Distortions

Test is according to chapter 4.5 of standard TR3.2.1 and TR3.2.2.

The values measured for current harmonics is respectively offered in the following points.

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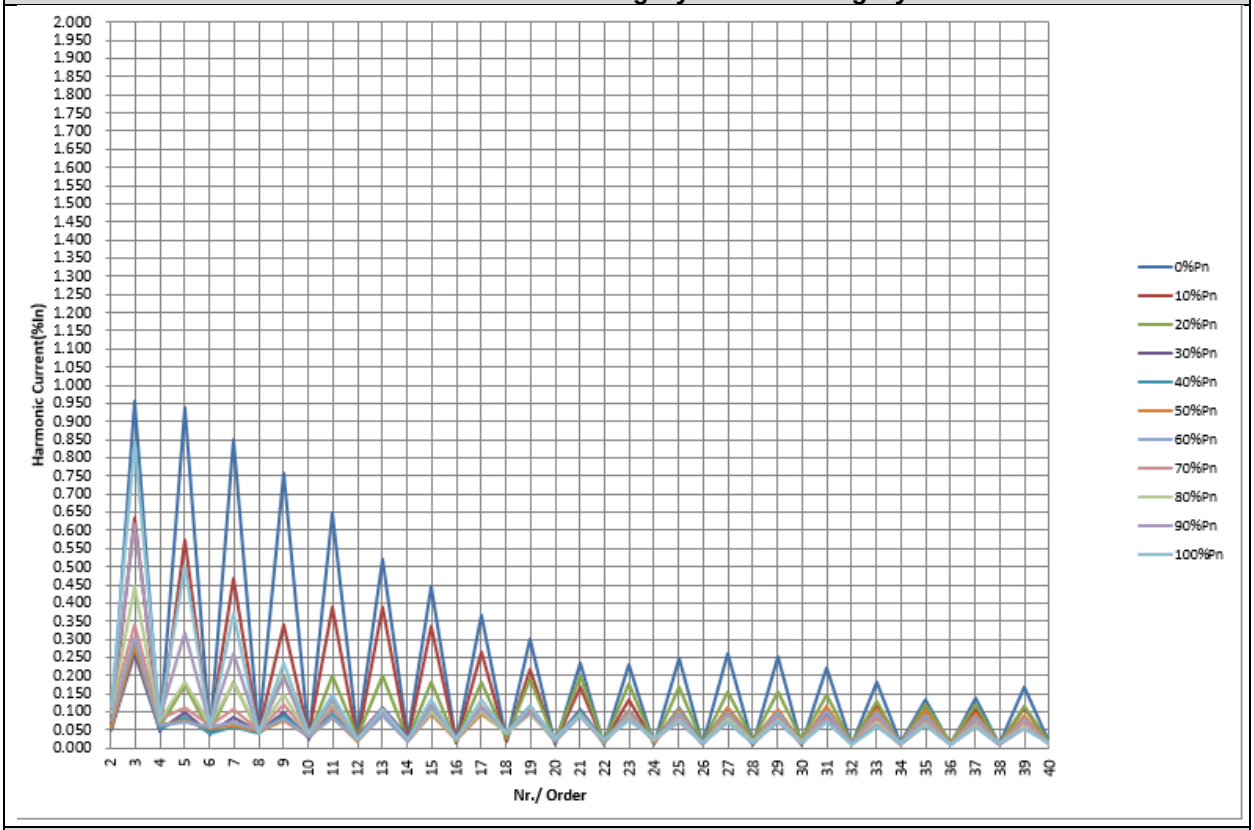
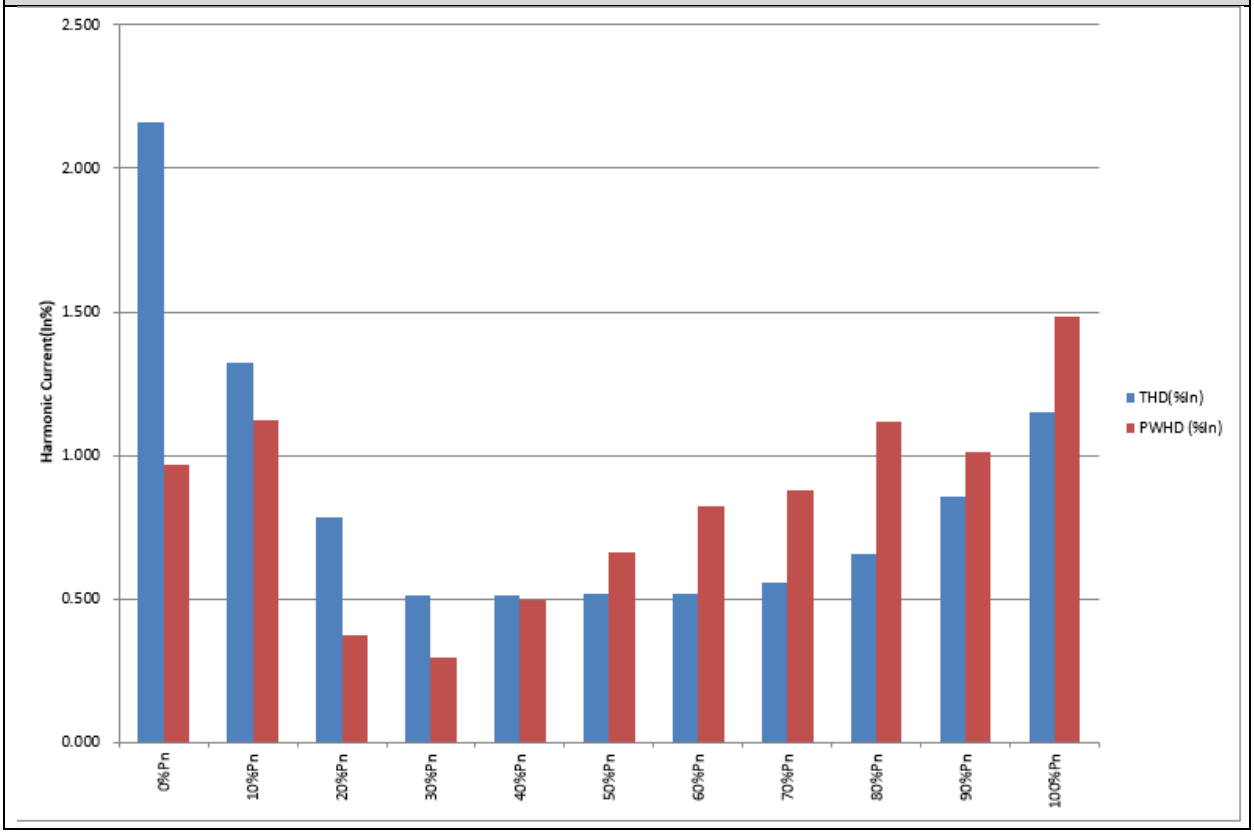
Harmonic Test for Category A2 and Category B													
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category A2 Limit**	**Category B Limit**
Nr./ Order	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**	**I_h(%)**
2	0.053	0.063	0.052	0.049	0.053	0.060	0.076	0.101	0.097	0.108	0.117	-	-
3	0.954	0.634	0.295	0.261	0.280	0.284	0.305	0.340	0.448	0.615	0.842	-	-
4	0.044	0.049	0.058	0.051	0.055	0.064	0.064	0.079	0.078	0.084	0.083	-	-
5	0.937	0.571	0.175	0.096	0.084	0.078	0.071	0.109	0.182	0.319	0.504	10.7	3.6
6	0.035	0.051	0.046	0.043	0.043	0.052	0.059	0.063	0.069	0.061	0.061	-	-
7	0.850	0.466	0.183	0.085	0.059	0.062	0.070	0.105	0.179	0.260	0.371	7.2	2.5
8	0.042	0.045	0.041	0.044	0.043	0.045	0.051	0.051	0.049	0.045	0.040	-	-
9	0.760	0.340	0.200	0.098	0.089	0.076	0.082	0.120	0.147	0.196	0.236	-	-
10	0.022	0.035	0.032	0.029	0.032	0.031	0.030	0.037	0.035	0.038	0.041	-	-
11	0.649	0.388	0.201	0.112	0.092	0.085	0.084	0.111	0.124	0.133	0.149	3.1	1.0
12	0.033	0.021	0.030	0.031	0.027	0.021	0.022	0.026	0.024	0.024	0.024	-	-
13	0.520	0.390	0.197	0.113	0.093	0.092	0.089	0.106	0.101	0.096	0.108	2	0.7
14	0.028	0.018	0.021	0.031	0.022	0.018	0.019	0.023	0.025	0.021	0.021	-	-
15	0.448	0.335	0.180	0.114	0.104	0.096	0.100	0.100	0.101	0.116	0.132	-	-
16	0.013	0.014	0.019	0.028	0.021	0.023	0.026	0.029	0.027	0.026	0.023	-	-
17	0.365	0.266	0.182	0.111	0.098	0.093	0.103	0.114	0.103	0.111	0.134	-	-
18	0.019	0.019	0.028	0.044	0.047	0.045	0.040	0.040	0.041	0.044	0.042	-	-
19	0.302	0.216	0.189	0.114	0.111	0.106	0.099	0.098	0.092	0.100	0.116	-	-
20	0.012	0.014	0.017	0.022	0.021	0.019	0.021	0.026	0.027	0.030	0.029	-	-
21	0.233	0.167	0.200	0.107	0.101	0.092	0.087	0.091	0.092	0.088	0.090	-	-
22	0.011	0.014	0.014	0.017	0.016	0.015	0.021	0.021	0.020	0.020	0.024	-	-
23	0.231	0.132	0.179	0.104	0.101	0.103	0.098	0.088	0.084	0.080	0.077	-	-
24	0.011	0.013	0.014	0.018	0.019	0.019	0.017	0.019	0.025	0.027	0.027	-	-
25	0.250	0.104	0.168	0.098	0.112	0.108	0.097	0.085	0.075	0.072	0.077	-	-
26	0.011	0.012	0.015	0.014	0.014	0.012	0.012	0.013	0.014	0.013	0.014	-	-
27	0.260	0.100	0.154	0.096	0.112	0.110	0.099	0.086	0.078	0.074	0.073	-	-
28	0.010	0.012	0.025	0.023	0.024	0.018	0.015	0.014	0.017	0.016	0.012	-	-
29	0.252	0.096	0.154	0.094	0.103	0.106	0.099	0.085	0.075	0.073	0.075	-	-
30	0.010	0.011	0.022	0.018	0.016	0.013	0.013	0.019	0.018	0.016	0.015	-	-
31	0.223	0.110	0.148	0.090	0.107	0.114	0.102	0.086	0.075	0.074	0.072	-	-
32	0.012	0.012	0.014	0.012	0.011	0.010	0.010	0.011	0.011	0.012	0.012	-	-
33	0.183	0.117	0.130	0.084	0.100	0.106	0.097	0.083	0.070	0.062	0.059	-	-
34	0.014	0.015	0.012	0.012	0.010	0.010	0.013	0.011	0.012	0.012	0.014	-	-
35	0.135	0.109	0.122	0.086	0.093	0.103	0.091	0.075	0.069	0.063	0.063	-	-
36	0.010	0.013	0.014	0.011	0.009	0.009	0.009	0.009	0.011	0.011	0.010	-	-
37	0.137	0.108	0.120	0.087	0.086	0.095	0.085	0.073	0.064	0.057	0.058	-	-
38	0.011	0.012	0.012	0.012	0.010	0.009	0.010	0.010	0.012	0.012	0.013	-	-
39	0.168	0.112	0.118	0.078	0.079	0.090	0.083	0.070	0.060	0.052	0.056	-	-
40	0.013	0.013	0.013	0.010	0.009	0.008	0.009	0.009	0.011	0.013	0.013	-	-
THD (%)	2.160	1.321	0.785	0.511	0.513	0.516	0.516	0.555	0.655	0.855	1.150	13	4.5
PWHD (%)	0.969	1.123	0.375	0.298	0.493	0.661	0.822	0.880	1.118	1.012	1.483	22	7.9

-

Harmonics Test for Category A2 and Category B

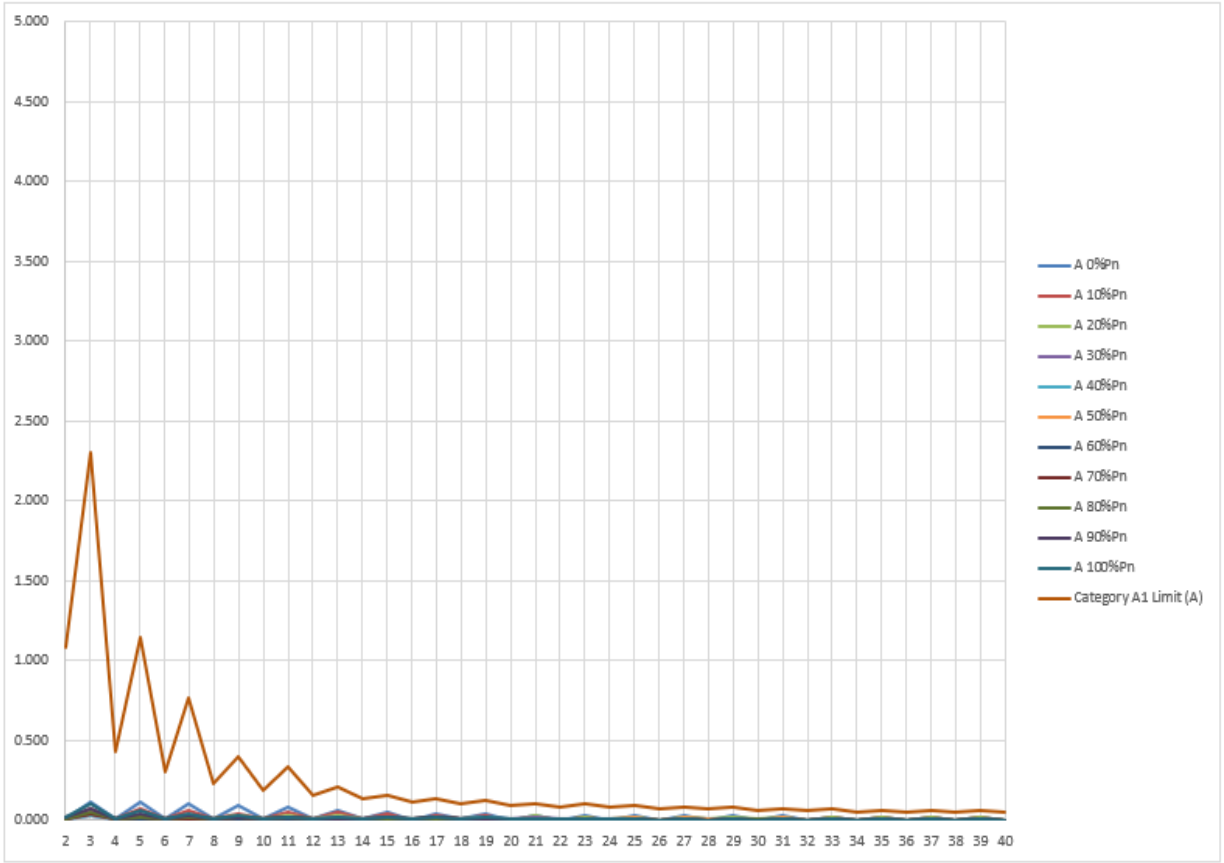


THD and PWHD



Harmonic Test for Category A1												
P (%P_n)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Category A1 Limit**
Nr./ Order	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**
2	0.006	0.007	0.006	0.006	0.006	0.007	0.009	0.012	0.011	0.013	0.014	1.080
3	0.113	0.075	0.035	0.031	0.033	0.034	0.036	0.040	0.053	0.073	0.099	2.300
4	0.005	0.006	0.007	0.006	0.006	0.008	0.008	0.009	0.009	0.010	0.010	0.430
5	0.111	0.067	0.021	0.011	0.010	0.009	0.008	0.013	0.021	0.038	0.060	1.140
6	0.004	0.006	0.005	0.005	0.005	0.006	0.007	0.007	0.008	0.007	0.007	0.300
7	0.100	0.055	0.022	0.010	0.007	0.007	0.008	0.012	0.021	0.031	0.044	0.770
8	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.005	0.005	0.230
9	0.090	0.040	0.024	0.012	0.010	0.009	0.010	0.014	0.017	0.023	0.028	0.400
10	0.003	0.004	0.004	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.184
11	0.077	0.046	0.024	0.013	0.011	0.010	0.010	0.013	0.015	0.016	0.018	0.330
12	0.004	0.002	0.004	0.004	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.153
13	0.061	0.046	0.023	0.013	0.011	0.011	0.010	0.012	0.012	0.011	0.013	0.210
14	0.003	0.002	0.002	0.004	0.003	0.002	0.002	0.003	0.003	0.002	0.003	0.131
15	0.053	0.040	0.021	0.013	0.012	0.011	0.012	0.012	0.012	0.014	0.016	0.150
16	0.002	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.115
17	0.043	0.031	0.021	0.013	0.012	0.011	0.012	0.013	0.012	0.013	0.016	0.132
18	0.002	0.002	0.003	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.102
19	0.036	0.025	0.022	0.013	0.013	0.013	0.012	0.012	0.011	0.012	0.014	0.118
20	0.001	0.002	0.002	0.003	0.003	0.002	0.002	0.003	0.003	0.004	0.003	0.092
21	0.028	0.020	0.024	0.013	0.012	0.011	0.010	0.011	0.011	0.010	0.011	0.107
22	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.084
23	0.027	0.016	0.021	0.012	0.012	0.012	0.012	0.010	0.010	0.009	0.009	0.098
24	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.077
25	0.029	0.012	0.020	0.012	0.013	0.013	0.011	0.010	0.009	0.009	0.009	0.090
26	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.002	0.071
27	0.031	0.012	0.018	0.011	0.013	0.013	0.012	0.010	0.009	0.009	0.009	0.083
28	0.001	0.001	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.066
29	0.030	0.011	0.018	0.011	0.012	0.013	0.012	0.010	0.009	0.009	0.009	0.078
30	0.001	0.001	0.003	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.061
31	0.026	0.013	0.018	0.011	0.013	0.013	0.012	0.010	0.009	0.009	0.009	0.073
32	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.058
33	0.022	0.014	0.015	0.010	0.012	0.013	0.011	0.010	0.008	0.007	0.007	0.068
34	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.054
35	0.016	0.013	0.014	0.010	0.011	0.012	0.011	0.009	0.008	0.007	0.007	0.064
36	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.051
37	0.016	0.013	0.014	0.010	0.010	0.011	0.010	0.009	0.008	0.007	0.007	0.061
38	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.048
39	0.020	0.013	0.014	0.009	0.009	0.011	0.010	0.008	0.007	0.006	0.007	0.058
40	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.046

Harmonics Test for Category A1



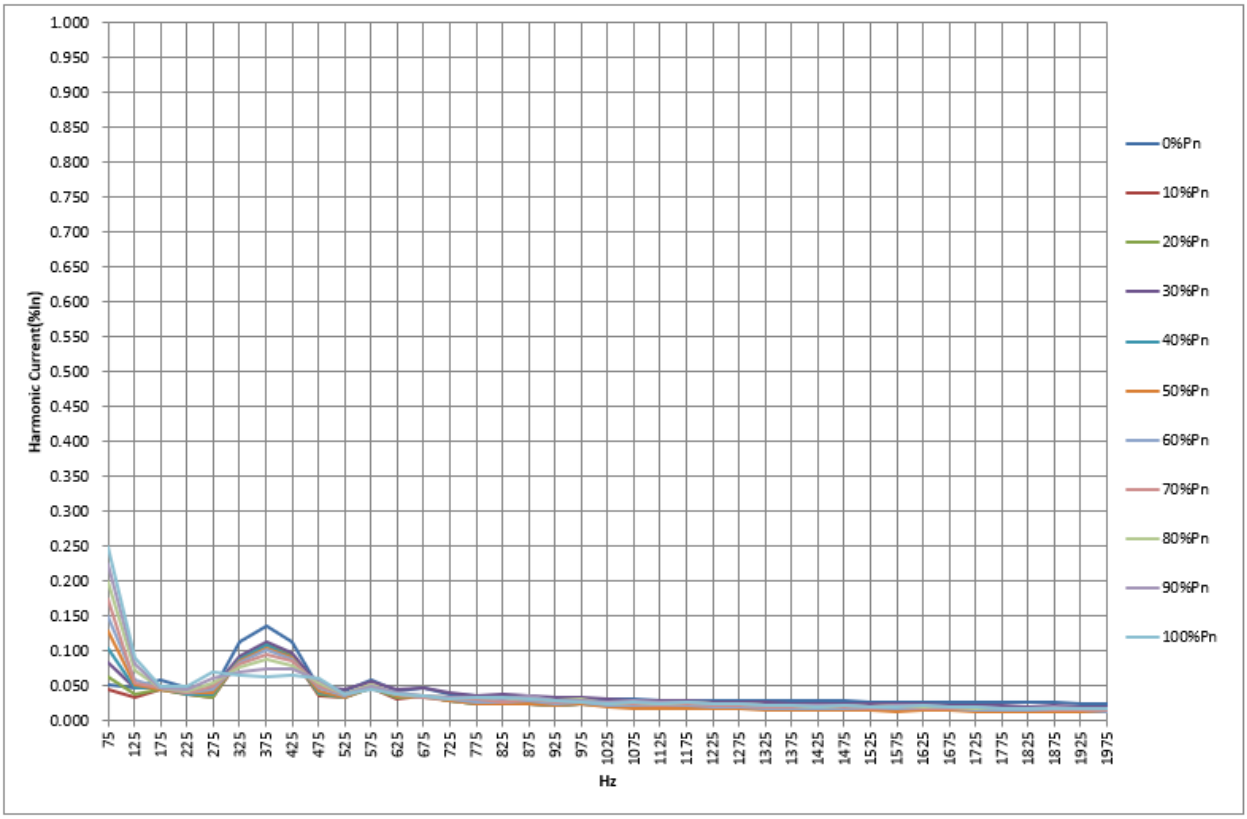
4.3.6 Interharmonic Distortions

Test is according to chapter 4.6 of standard TR3.2.1 and TR3.2.2.

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

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	0.052	0.045	0.062	0.084	0.104	0.129	0.151	0.175	0.201	0.224	0.250	0.400
125	0.048	0.035	0.038	0.047	0.047	0.052	0.060	0.055	0.073	0.082	0.090	0.600
175	0.060	0.046	0.046	0.050	0.047	0.046	0.047	0.048	0.047	0.048	0.050	0.429
225	0.047	0.038	0.037	0.044	0.038	0.039	0.040	0.041	0.043	0.046	0.050	0.333
275	0.042	0.034	0.034	0.045	0.039	0.041	0.045	0.049	0.054	0.061	0.069	0.273
325	0.113	0.088	0.089	0.093	0.088	0.087	0.084	0.081	0.077	0.070	0.065	0.231
375	0.136	0.110	0.110	0.114	0.108	0.105	0.102	0.095	0.087	0.075	0.063	0.200
425	0.114	0.093	0.094	0.097	0.092	0.090	0.088	0.085	0.080	0.074	0.066	0.176
475	0.047	0.037	0.038	0.050	0.041	0.043	0.046	0.050	0.054	0.058	0.062	0.158
525	0.043	0.035	0.034	0.046	0.035	0.033	0.036	0.037	0.038	0.038	0.039	0.143
575	0.058	0.048	0.048	0.056	0.049	0.049	0.051	0.052	0.051	0.050	0.046	0.130
625	0.042	0.032	0.033	0.044	0.036	0.036	0.038	0.039	0.039	0.039	0.038	0.120
675	0.047	0.036	0.035	0.046	0.035	0.033	0.035	0.034	0.036	0.036	0.036	0.111
725	0.038	0.030	0.029	0.040	0.030	0.029	0.031	0.032	0.034	0.033	0.032	0.103
775	0.035	0.026	0.025	0.037	0.025	0.023	0.027	0.031	0.033	0.034	0.033	0.100
825	0.036	0.027	0.026	0.037	0.026	0.024	0.027	0.028	0.031	0.032	0.033	0.100
875	0.034	0.025	0.025	0.036	0.026	0.025	0.030	0.032	0.035	0.035	0.032	0.100
925	0.032	0.023	0.023	0.033	0.023	0.022	0.025	0.027	0.030	0.030	0.030	0.100
975	0.032	0.024	0.025	0.033	0.024	0.024	0.027	0.029	0.031	0.030	0.028	0.100
1025	0.031	0.022	0.022	0.030	0.021	0.021	0.023	0.026	0.026	0.026	0.025	0.100
1075	0.031	0.022	0.021	0.030	0.020	0.018	0.022	0.024	0.027	0.028	0.027	0.100
1125	0.030	0.021	0.020	0.029	0.020	0.018	0.021	0.022	0.025	0.026	0.025	0.100
1175	0.030	0.021	0.021	0.028	0.020	0.018	0.021	0.024	0.026	0.027	0.026	0.100
1225	0.030	0.021	0.020	0.028	0.020	0.017	0.020	0.022	0.024	0.025	0.024	0.100
1275	0.029	0.021	0.020	0.027	0.020	0.018	0.020	0.022	0.023	0.024	0.024	0.100
1325	0.029	0.020	0.020	0.026	0.019	0.016	0.019	0.021	0.022	0.023	0.023	0.100
1375	0.029	0.020	0.020	0.026	0.018	0.015	0.018	0.020	0.022	0.022	0.022	0.100
1425	0.029	0.019	0.019	0.025	0.018	0.016	0.018	0.019	0.021	0.021	0.021	0.100
1475	0.028	0.019	0.019	0.025	0.018	0.015	0.018	0.019	0.022	0.023	0.022	0.100
1525	0.028	0.019	0.019	0.025	0.018	0.015	0.018	0.019	0.021	0.021	0.021	0.100
1575	0.028	0.018	0.019	0.024	0.018	0.014	0.017	0.019	0.021	0.021	0.021	0.100
1625	0.027	0.018	0.019	0.024	0.018	0.014	0.017	0.018	0.020	0.022	0.021	0.100
1675	0.027	0.018	0.019	0.023	0.018	0.014	0.017	0.018	0.019	0.020	0.019	0.100
1725	0.026	0.018	0.018	0.022	0.017	0.013	0.016	0.017	0.018	0.019	0.019	0.100
1775	0.027	0.017	0.018	0.022	0.016	0.013	0.015	0.017	0.019	0.019	0.018	0.100
1825	0.026	0.017	0.018	0.021	0.016	0.013	0.015	0.017	0.018	0.018	0.017	0.100
1875	0.026	0.017	0.018	0.021	0.017	0.013	0.015	0.017	0.018	0.019	0.018	0.100
1925	0.026	0.016	0.018	0.020	0.017	0.013	0.015	0.016	0.018	0.018	0.018	0.100
1975	0.025	0.016	0.018	0.020	0.016	0.012	0.014	0.016	0.018	0.018	0.018	0.100

Inter-Harmonics Current



Note: There are no interharmonic distortion emission requirements for plant category A1.

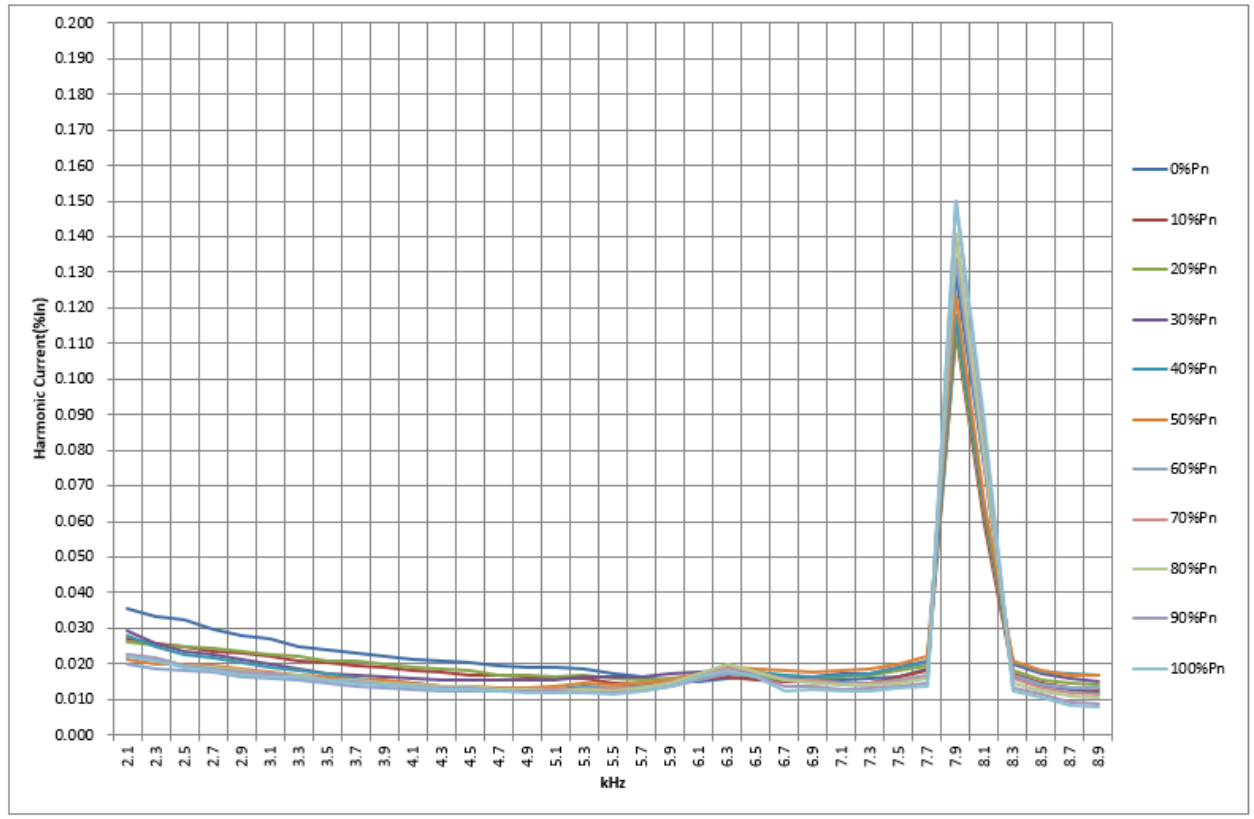
4.3.7 Distortions In The 2-9 kHz Frequency Range

Test is according to chapter 4.7 of standard TR3.2.1 and TR3.2.2.

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

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	0.036	0.027	0.026	0.029	0.028	0.021	0.020	0.023	0.022	0.023	0.022	0.2
2.3	0.033	0.026	0.025	0.026	0.025	0.020	0.019	0.021	0.021	0.022	0.021	0.2
2.5	0.032	0.025	0.025	0.024	0.023	0.020	0.018	0.020	0.019	0.020	0.019	0.2
2.7	0.030	0.023	0.024	0.023	0.022	0.019	0.017	0.019	0.019	0.019	0.018	0.2
2.9	0.028	0.023	0.023	0.021	0.020	0.018	0.016	0.018	0.018	0.017	0.017	0.2
3.1	0.027	0.022	0.023	0.020	0.019	0.018	0.016	0.017	0.017	0.017	0.016	0.2
3.3	0.025	0.021	0.022	0.019	0.018	0.017	0.015	0.016	0.017	0.016	0.016	0.2
3.5	0.024	0.020	0.021	0.017	0.017	0.016	0.014	0.015	0.016	0.016	0.015	0.2
3.7	0.023	0.019	0.021	0.017	0.016	0.015	0.014	0.015	0.015	0.015	0.015	0.2
3.9	0.022	0.019	0.020	0.016	0.015	0.015	0.013	0.015	0.014	0.014	0.014	0.2
4.1	0.021	0.018	0.019	0.016	0.014	0.014	0.013	0.014	0.014	0.014	0.014	0.2
4.3	0.021	0.018	0.019	0.016	0.013	0.014	0.012	0.014	0.014	0.013	0.013	0.2
4.5	0.020	0.017	0.018	0.015	0.013	0.013	0.012	0.013	0.014	0.013	0.013	0.2
4.7	0.020	0.017	0.017	0.015	0.013	0.013	0.012	0.013	0.013	0.012	0.012	0.2
4.9	0.019	0.016	0.017	0.016	0.012	0.013	0.012	0.013	0.013	0.012	0.012	0.2
5.1	0.019	0.016	0.016	0.016	0.013	0.013	0.012	0.013	0.012	0.012	0.012	0.2
5.3	0.018	0.016	0.017	0.016	0.014	0.015	0.013	0.013	0.013	0.012	0.012	0.2
5.5	0.017	0.015	0.016	0.016	0.013	0.014	0.012	0.013	0.012	0.012	0.012	0.2
5.7	0.016	0.014	0.016	0.016	0.014	0.014	0.014	0.013	0.013	0.012	0.012	0.2
5.9	0.015	0.014	0.016	0.017	0.015	0.015	0.014	0.015	0.015	0.014	0.014	0.2
6.1	0.015	0.015	0.017	0.018	0.016	0.017	0.016	0.016	0.017	0.016	0.016	0.2
6.3	0.016	0.016	0.018	0.018	0.018	0.019	0.017	0.019	0.020	0.018	0.018	0.2
6.5	0.016	0.016	0.016	0.018	0.017	0.019	0.017	0.018	0.018	0.016	0.016	0.2
6.7	0.016	0.015	0.015	0.017	0.017	0.018	0.016	0.015	0.016	0.014	0.012	0.2
6.9	0.016	0.015	0.016	0.016	0.016	0.018	0.015	0.015	0.015	0.013	0.013	0.2
7.1	0.016	0.015	0.016	0.017	0.017	0.018	0.015	0.014	0.014	0.013	0.012	0.2
7.3	0.016	0.015	0.017	0.017	0.017	0.019	0.015	0.015	0.014	0.013	0.012	0.2
7.5	0.016	0.017	0.018	0.019	0.019	0.020	0.015	0.015	0.015	0.014	0.013	0.2
7.7	0.019	0.018	0.019	0.021	0.020	0.022	0.017	0.017	0.016	0.015	0.014	0.2
7.9	0.129	0.113	0.114	0.118	0.118	0.123	0.134	0.141	0.141	0.150	0.150	0.2
8.1	0.075	0.059	0.062	0.063	0.063	0.065	0.076	0.078	0.078	0.084	0.088	0.2
8.3	0.016	0.017	0.018	0.020	0.020	0.021	0.017	0.016	0.015	0.013	0.012	0.2
8.5	0.014	0.015	0.016	0.017	0.018	0.018	0.014	0.013	0.012	0.011	0.011	0.2
8.7	0.013	0.013	0.015	0.016	0.017	0.017	0.013	0.012	0.011	0.009	0.008	0.2
8.9	0.012	0.013	0.014	0.015	0.017	0.017	0.013	0.012	0.011	0.009	0.008	0.2

Current high frequency harmonics



Note: There are no high-frequency distortion emission requirements for plant category A1.

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 standard TR3.2.1 and TR3.2.2.

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 50.00-52.00 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 tested 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.

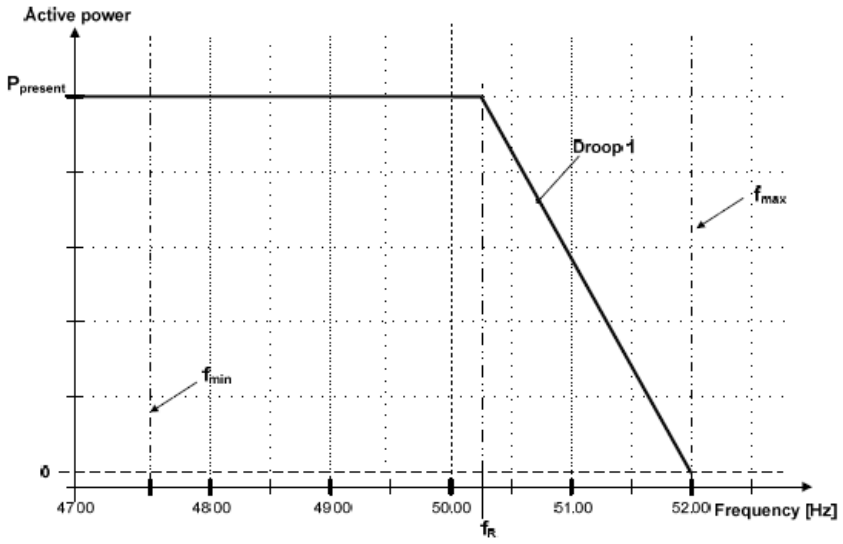
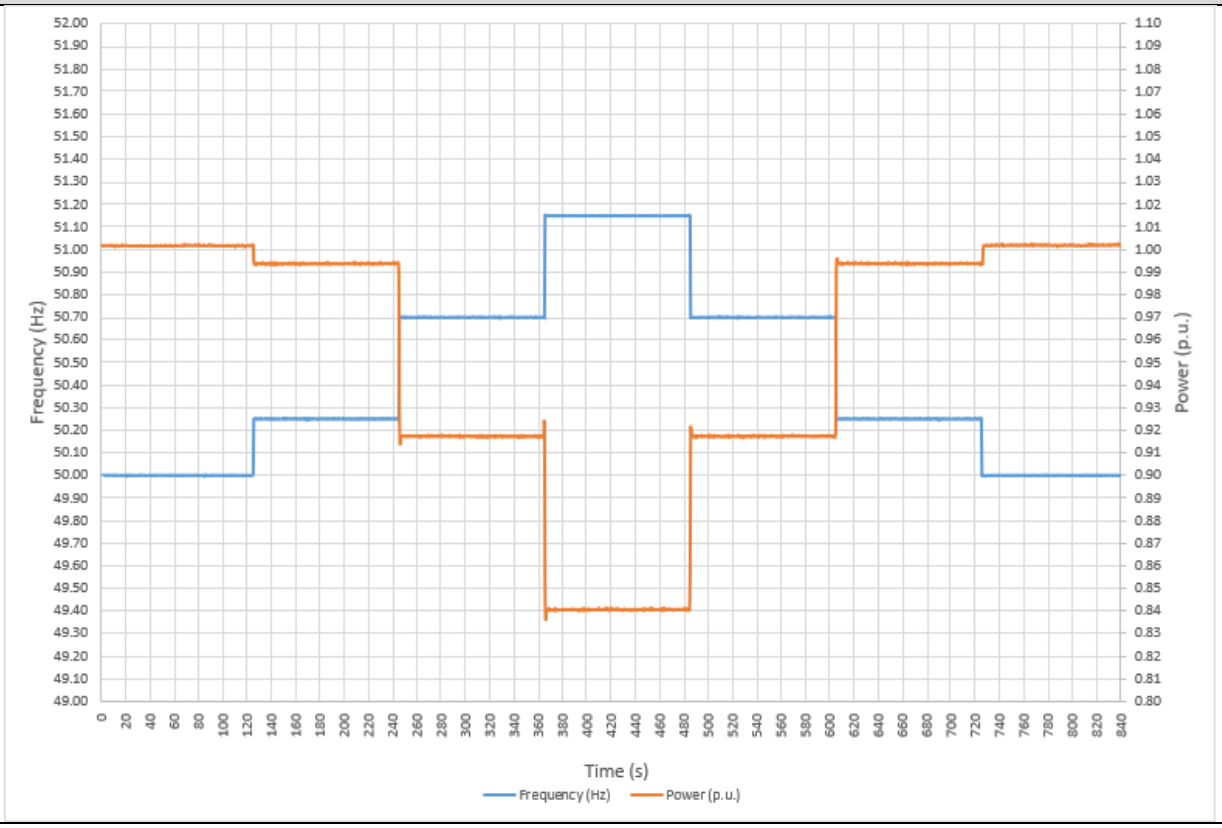


Figure 8 Frequency response for a PV power plant.

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 (p.u)**	**Power desired (p.u)**	**Deviation (%)**	**Variation expected**	**Variation measured**	**Delay time measured (<2s)**
a)	50.00	1.002	1.000	0.2	No power variation	0.2% Pn	--
b)	50.25	0.994	0.992	0.2	-0.8% Pn	-0.6% Pn	0.5s
c)	50.70	0.917	0.917	0.0	-8.3% Pn	-8.3% Pn	0.5s
d)	51.15	0.841	0.842	-0.1	-15.8% Pn	-15.9% Pn	0.5s
e)	50.70	0.917	0.917	0.0	-8.3% Pn	-8.3% Pn	0.5s
f)	50.25	0.994	0.992	0.2	-0.8% Pn	-0.6% Pn	0.5s
g)	50.00	1.002	1.000	0.2	No power variation	0.2% Pn	0.5s

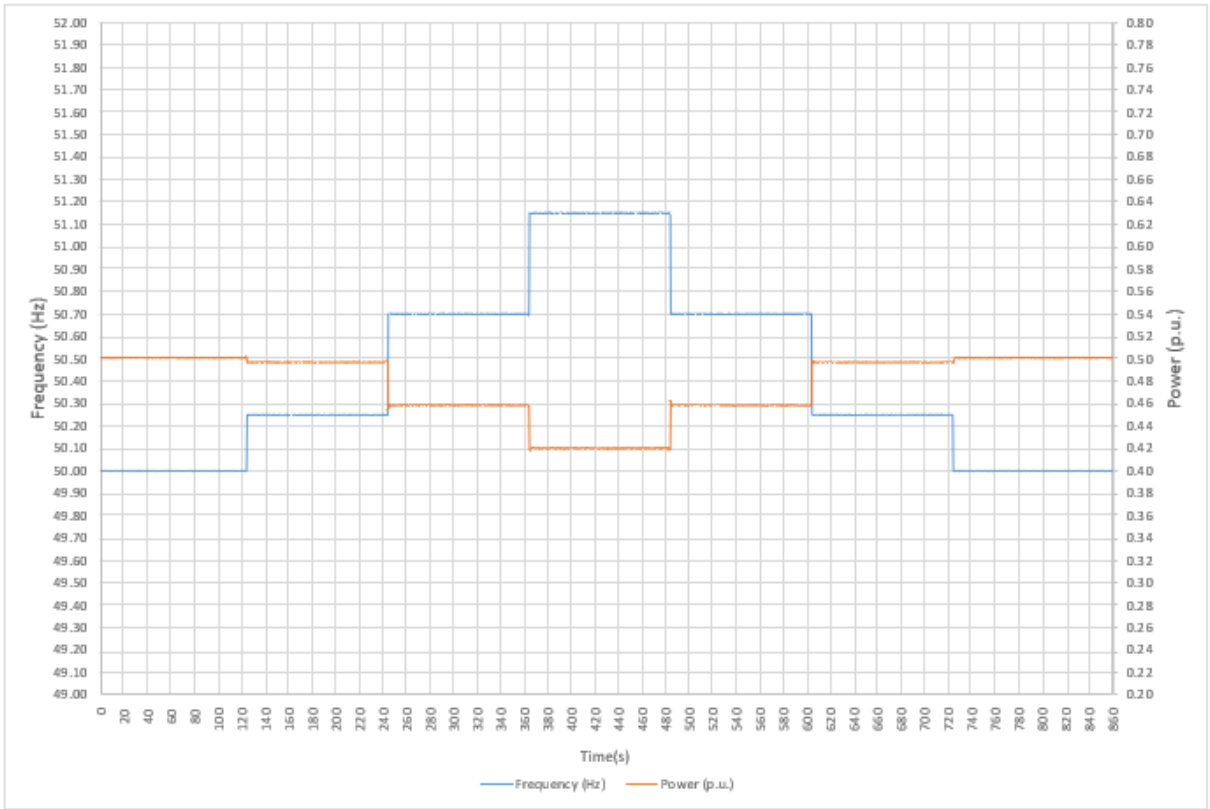
Over-frequency curve (droop of 12 % at 100% Pn)



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 (p.u)**	**Power desired (p.u)**	**Deviation (%)**	**Variation expected**	**Variation measured**	**Delay time measured (<2s)**
a)	50.00	0.501	0.500	0.1	No power variation	0.2% Pn	--
b)	50.25	0.497	0.496	0.1	-0.8% Pn	-0.6% Pn	0.5s
c)	50.70	0.458	0.458	0.0	-8.3% Pn	-8.4% Pn	0.5s
d)	51.15	0.420	0.421	-0.1	-15.8% Pn	-16.0% Pn	0.5s
e)	50.70	0.458	0.458	0.0	-8.3% Pn	-8.4% Pn	0.5s
f)	50.25	0.497	0.496	0.1	-0.8% Pn	0.6% Pn	0.5s
g)	50.00	0.501	0.500	0.1	No power variation	0.2% Pn	0.5s

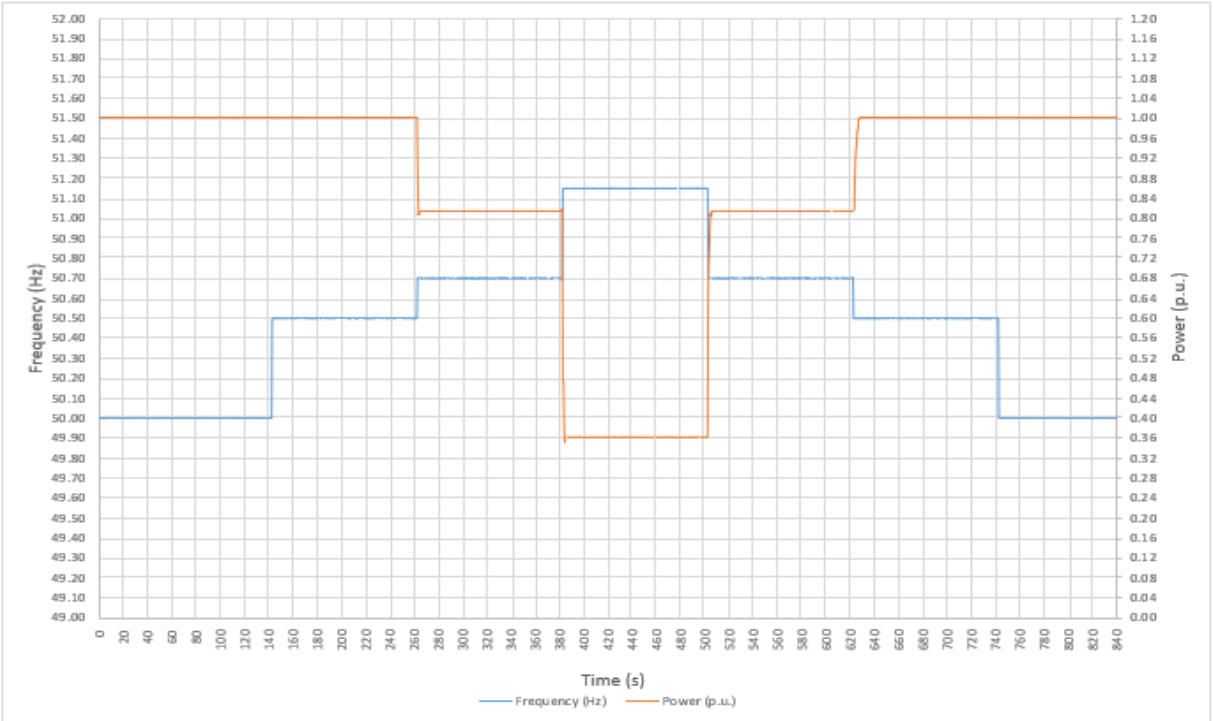
Over-frequency curve (droop of 12 % at 50% Pn)



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 (p.u)**	**Power desired (p.u)**	**Deviation (%)**	**Variation expected**	**Variation measured**	**Delay time measured (<2s)**
a)	50.00	1.002	1.000	0.2	No power variation	0.2% Pn	--
b)	50.50	1.002	1.000	0.2	No power variation	0.2% Pn	0.1s
c)	50.70	0.815	0.800	1.5	-20.0% Pn	-18.5% Pn	0.5s
d)	51.15	0.363	0.350	1.3	-65.0% Pn	-63.7% Pn	0.1s
e)	50.70	0.814	0.800	1.4	-20.0% Pn	-18.6% Pn	0.1s
f)	50.50	1.002	1.000	0.2	No power variation	0.2% Pn	0.4s
g)	50.00	1.002	1.000	0.2	No power variation	0.2% Pn	0.1s

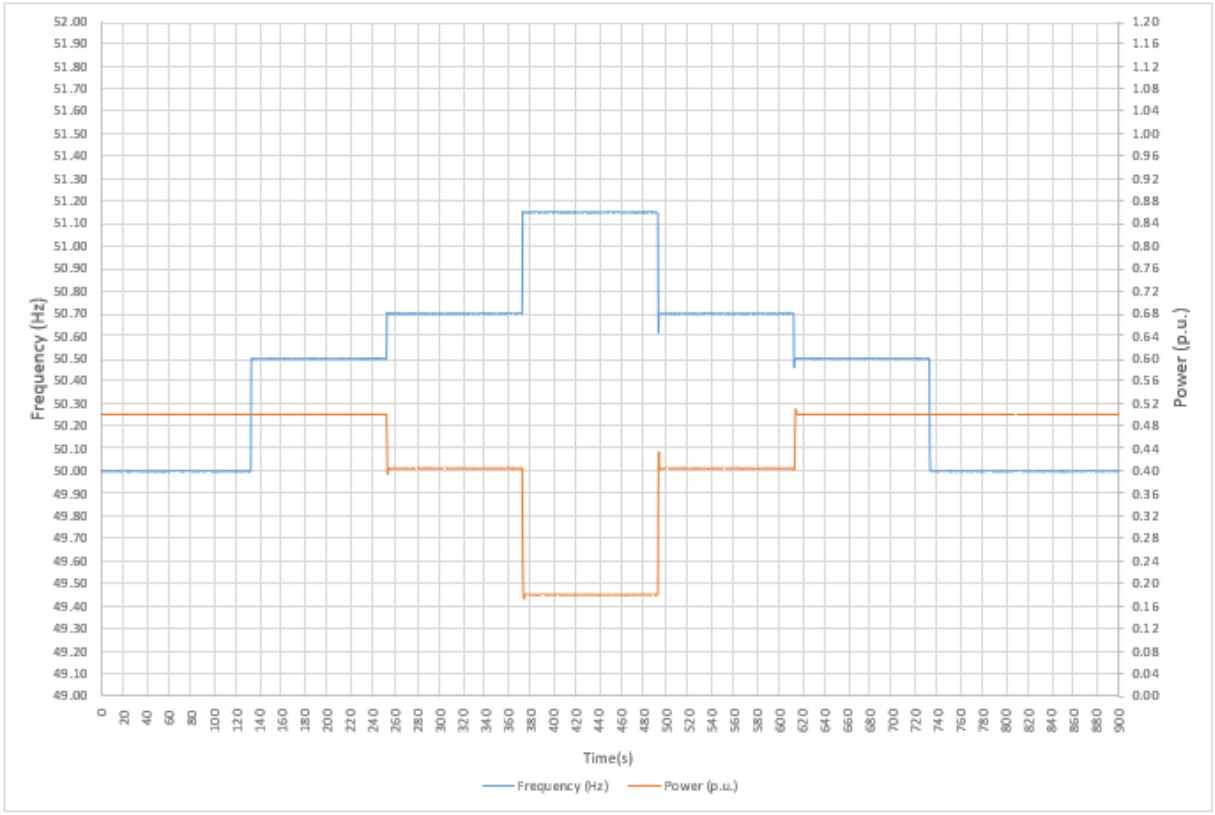
Over-frequency curve (droop of 2 % at 100% Pn)



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**	**Delay time measured (<2s)**
a)	50.00	0.501	0.500	0.1	No power variation	0.2% Pn	--
b)	50.50	0.501	0.500	0.1	No power variation	0.2% Pn	0.1s
c)	50.70	0.405	0.400	0.5	-20.0% Pn	-19.0% Pn	0.4s
d)	51.15	0.180	0.175	0.5	-65.0% Pn	-64.0% Pn	0.5s
e)	50.70	0.405	0.400	0.5	-20.0% Pn	-19.0% Pn	0.4s
f)	50.50	0.501	0.500	0.1	No power variation	0.2% Pn	0.5s
g)	50.00	0.501	0.500	0.1	No power variation	0.2% Pn	0.1s

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 standard TR3.2.2.

It is not applicable due to the inverter is applying to plant category A1, 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.

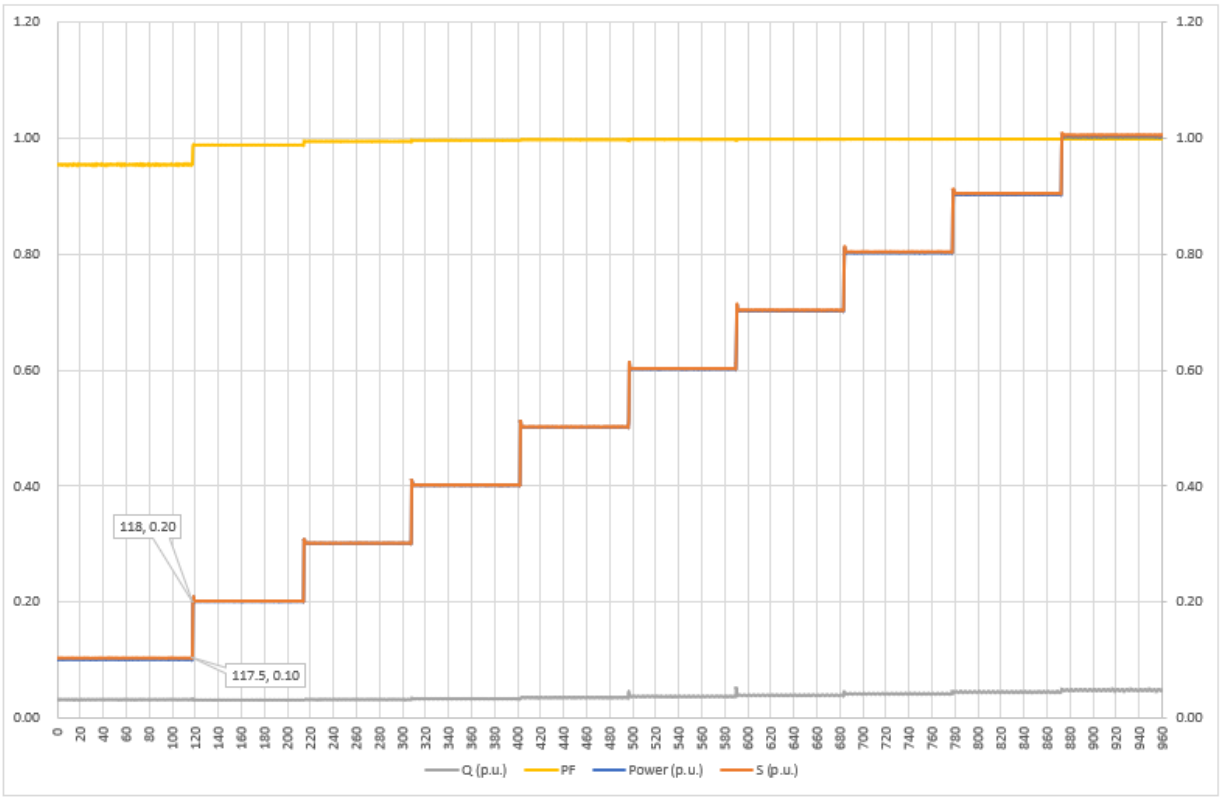
The test has been performed according to chapter 5.2.2.1 of standard TR3.2.1 and chapter 5.2.3.1 of standard TR3.2.2.

Test results are offered at the table below.

Active Power Setpoint (%Pn)	Power measured (%Pn)	Active Power Deviation from setpoint (%)	Time Response (s)
10%	10%	0.0%	< 0.5
20%	20.1%	0.0%	< 0.5
30%	30.1%	0.1%	< 0.5
40%	40.1%	0.1%	< 0.5
50%	50.1%	0.1%	< 0.5
60%	60.2%	0.2%	< 0.5
70%	70.2%	0.2%	< 0.5
80%	80.2%	0.2%	< 0.5
90%	90.4%	0.4%	< 0.5
100%	100.3%	0.3%	< 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 standard TR3.2.2.

It is not applicable due to the inverter is apply to plant category A1, 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 5.2.2.2 of standard TR3.2.1 and chapter 5.2.3.3 of standard TR3.2.2. The maximum standard value for the ramp rate constraint cannot be greater than 100kW/s

Gradient (ΔP) range can be setting from 1.8W/s to 45W/s. the following test is performed by setting gradient at 1.8W/s and 45W/s

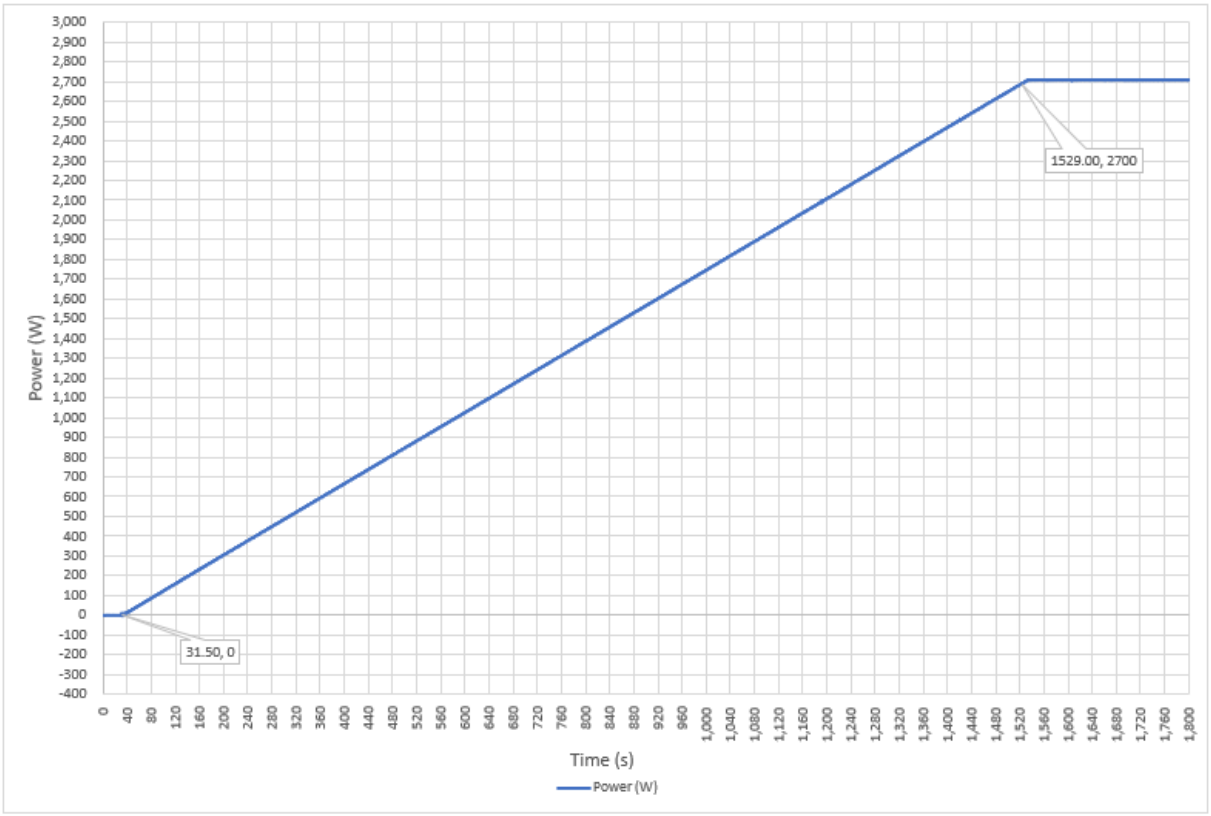
Test results are offered in the table and pictures below:

Increase of Active Power			
Gradient (ΔP) desired (W/s)	**Nominal Ramp Time (s)**	**Gradient measured (W/s)**	**Measured Ramp time (s)**
1.8	1500.0	1.8	1482.0
45.0	60.0	45.2	60.0

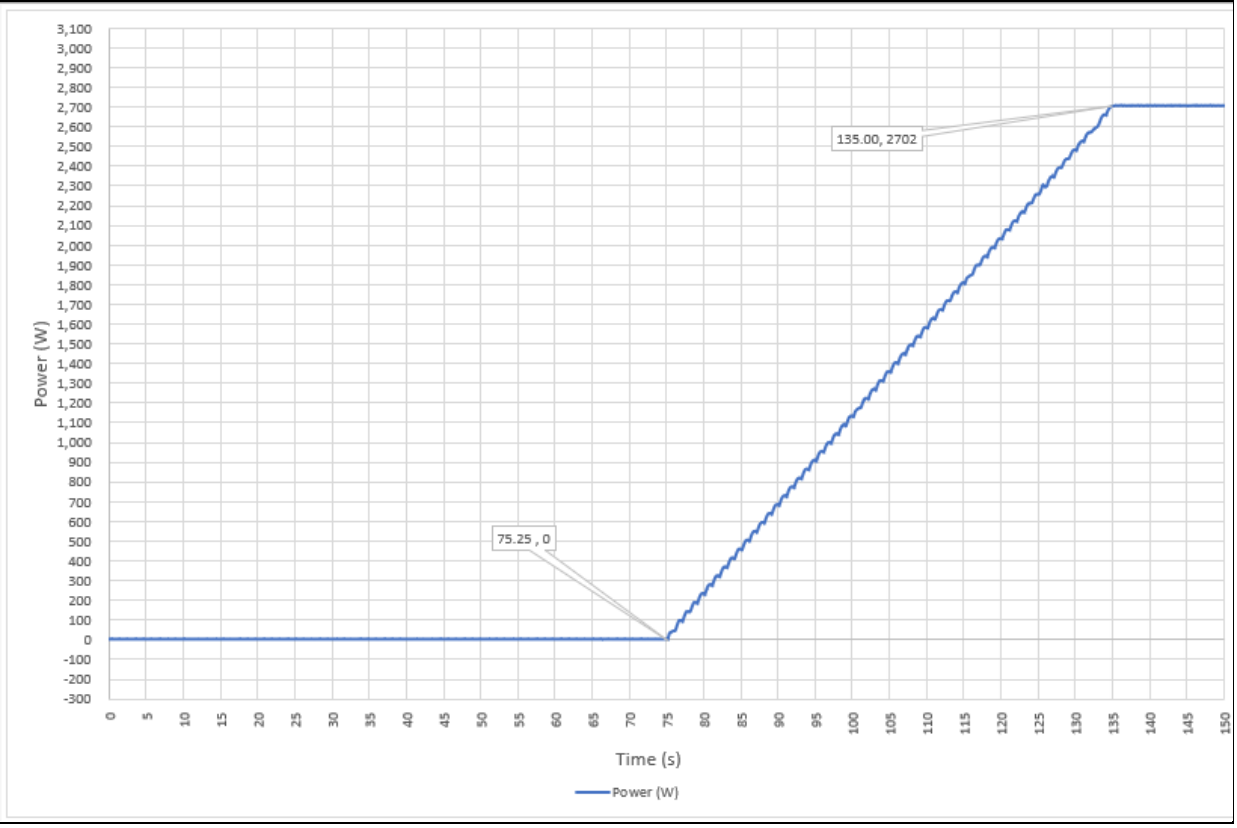
Decrease of Active Power			
Gradient (ΔP) desired (W/s)	**Nominal Ramp Time (s)**	**Gradient measured (W/s)**	**Measured Ramp time (s)**
1.8	1500.0	1.8	1486
45.0	60.0	45.1	60.0

Note:
1. The Gradient is adjustable from 1.8W/s to 45W/s.
2. It has been verified that the inverter complies with a maximum nonlinearity less than ±10%.

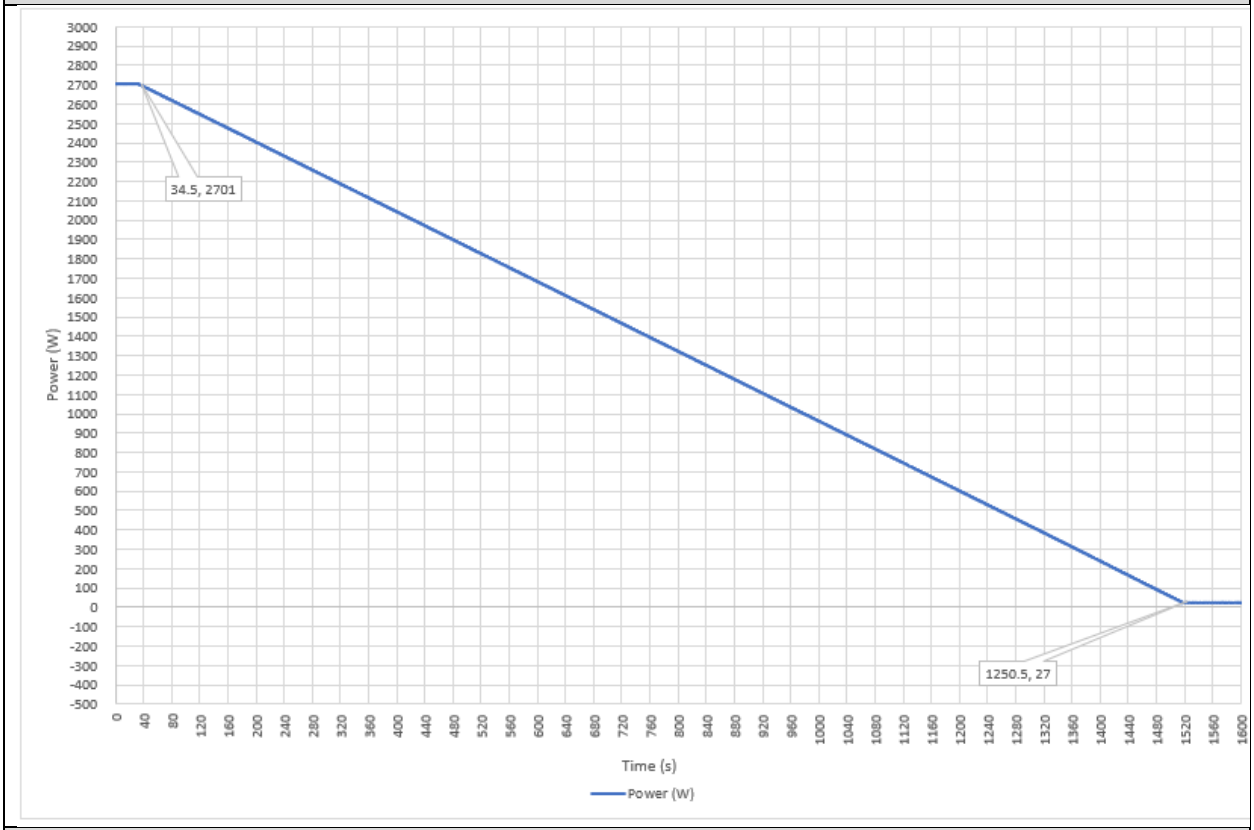
Increase of Active Power with 18w/s



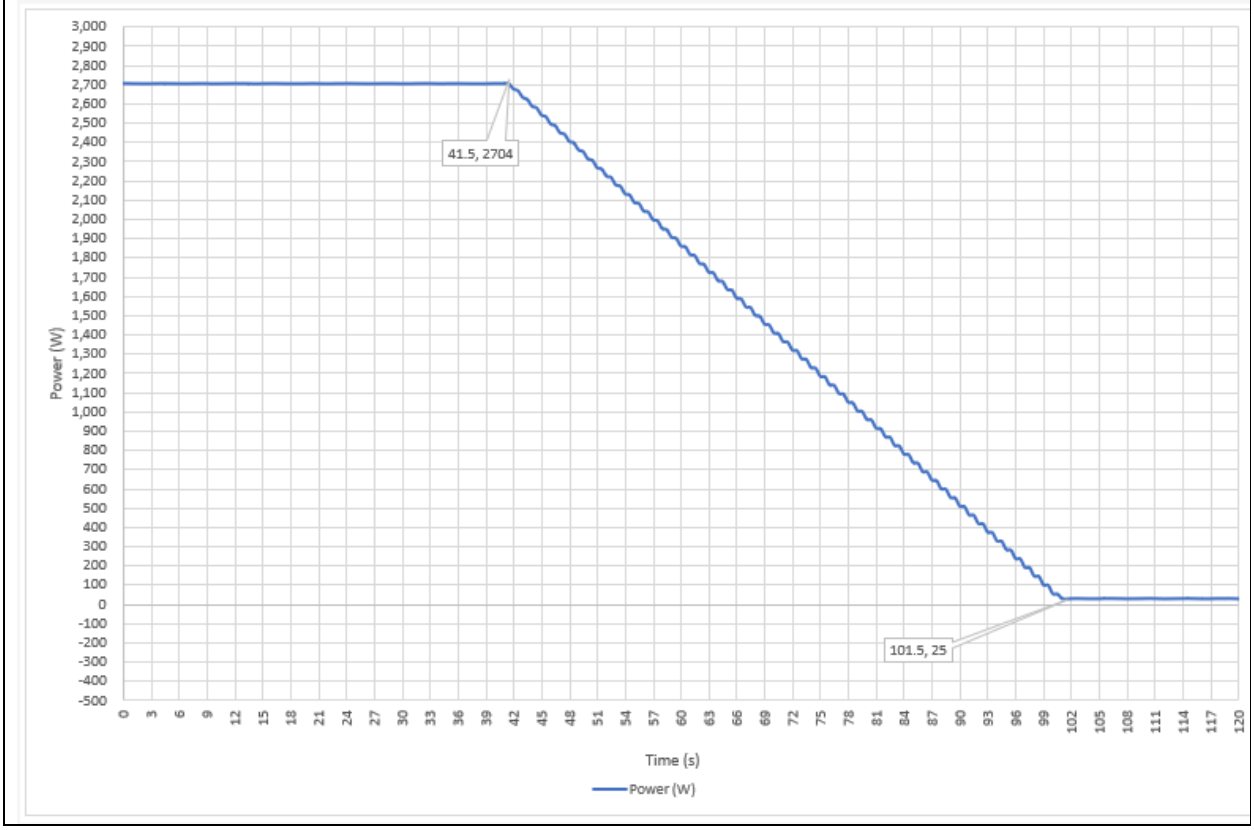
Increase of Active Power with 45w/s



Decrease of Active Power with 18w/s



Decrease of Active Power with 45w/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:

P Desired (%Sn)	Power DC (W)	P measured (%Sn)	Q desired (%Sn)	Q measured (%Sn)	Power Factor (cos φ)	Q Measured Accuracy(*) (Limited ±0.97%Pn)
10%	290	9.4	-48.43	-48.06	0.192	0.37
20%	560	19.5	-48.43	-47.94	0.377	0.49
30%	828	29.4	-48.43	-48.40	0.519	0.03
40%	1104	39.4	-48.43	-47.95	0.635	0.48
50%	1367	49.1	-48.43	-47.67	0.717	0.76
60%	1656	59.4	-48.43	-48.43	0.775	0.00
70%	1887	67.3	-48.43	-49.20	0.807	-0.77
80%	2177	78.0	-48.43	-48.32	0.850	0.11
90%	2411	86.4	-48.43	-47.92	0.875	0.51
100%	2415	86.4	-48.43	-47.91	0.875	0.52

(*) 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 2700W = -1308W

The accuracy should be ±2% x (-1308) W = ± 26.16W 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)**	**Power Factor (cos φ)**	**Q Measured Accuracy(*) (Limited ±0.97%Pn)**
10%	290	9.4	48.43	47.98	0.192	-0.45
20%	559	19.3	48.43	47.82	0.374	-0.61
30%	828	29.1	48.43	48.57	0.514	0.14
40%	1103	39.2	48.43	48.23	0.630	-0.20
50%	1365	48.7	48.43	47.99	0.712	-0.44
60%	1656	59.2	48.43	48.64	0.773	0.21
70%	1888	67.6	48.43	48.28	0.814	-0.15
80%	2178	78.0	48.43	48.29	0.850	-0.14
90%	2404	86.1	48.43	48.22	0.872	-0.21
100%	2408	86.2	48.43	48.21	0.873	-0.22

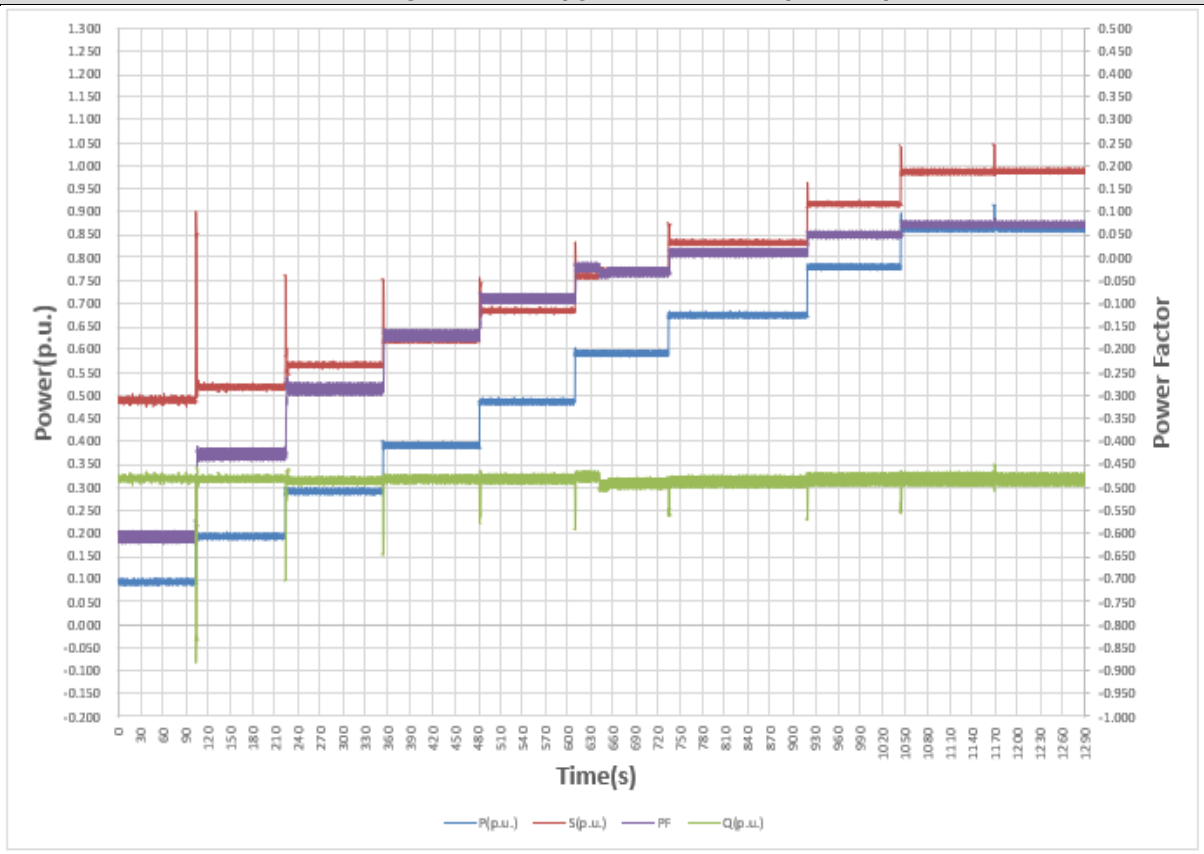
(*) The accuracy of the control performed and of the set point may not deviate by more than ±2% of the set point value.

Setting Point value is 48.43% x 2700W = 1308W

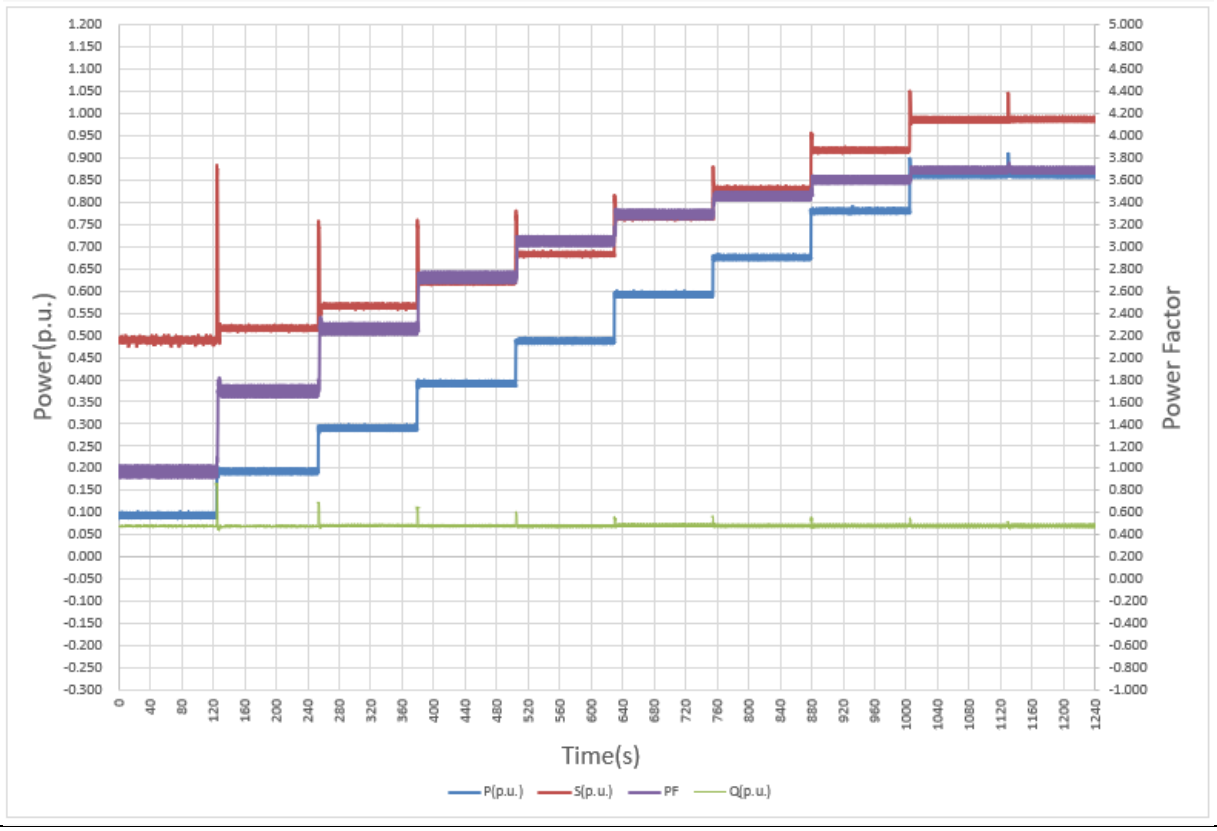
The accuracy should be ±2% x 1308W = ± 26.16W which is ±0.97%Pn

Test results are represented at diagrams below.

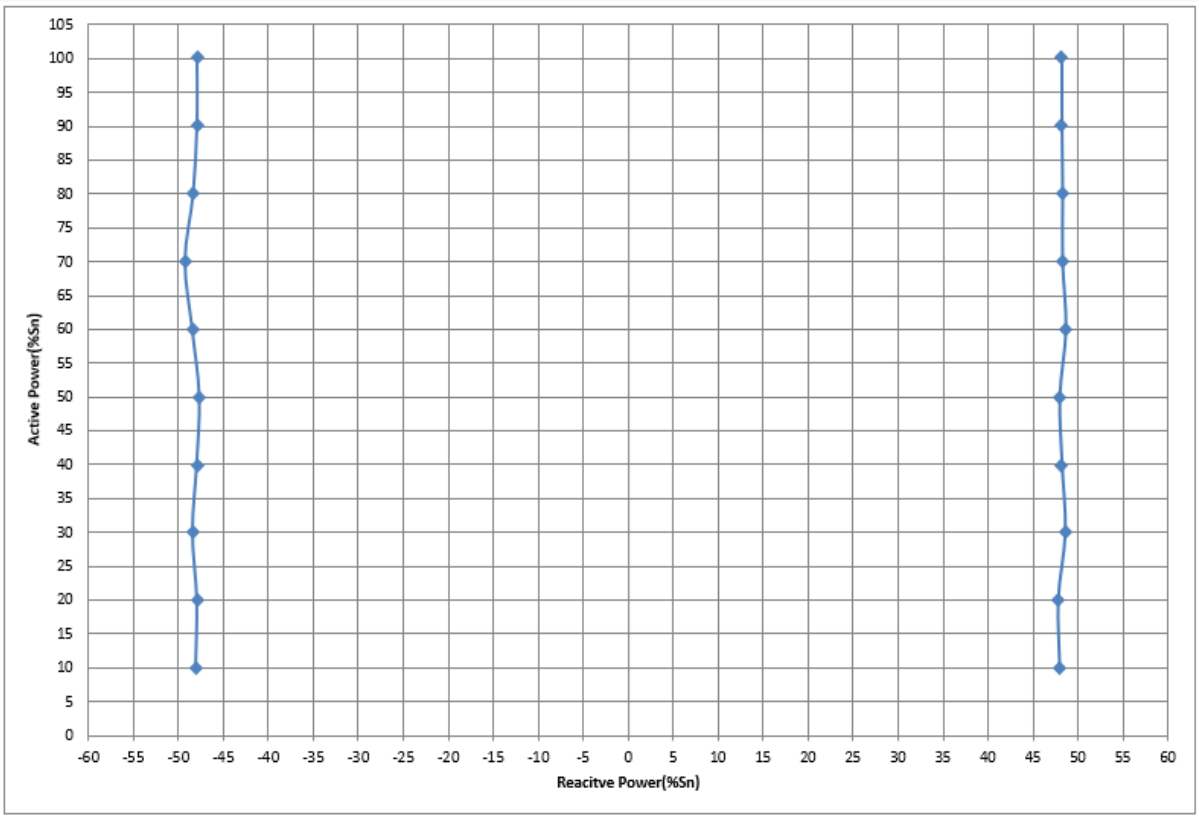
Rectangular Curve (Q=48.43%Sn / Capacitive)



Rectangular Curve (Q=48.43%S_n / Inductive)



Rectangular Curve (Capacitive vs Inductive)



4.4.2.2 Power Factor Control

The power factor control function controls reactive power proportionately to the active power in the Point of Connection. Tests have been done according to chapter 5.3.2 of standard TR3.2.1 and TR3.2.2.

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 test have been performed to check the possibility of establishing a power factor limit on current Injection, first at 1.0, second at 0.9 and 0.8. 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)**
20%	0.199	0.015	0.997	1.000	-0.003
30%	0.296	0.017	0.998	1.000	-0.002
40%	0.407	0.019	0.999	1.000	-0.001
50%	0.502	0.021	0.999	1.000	-0.001
60%	0.606	0.023	0.999	1.000	-0.001
70%	0.701	0.026	0.999	1.000	-0.001
80%	0.805	0.028	0.999	1.000	-0.001
90%	0.898	0.032	0.999	1.000	-0.001
100%	0.998	0.036	0.999	1.000	-0.001
Note: ±2% of the set point value used for defining the limited					

PF = 0.90 Inductive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.018)**
20%	0.199	0.096	0.901	0.900	0.001
30%	0.306	0.143	0.906	0.900	0.006
40%	0.405	0.199	0.898	0.900	-0.002
50%	0.499	0.242	0.900	0.900	0.000
60%	0.603	0.285	0.904	0.900	0.004
70%	0.697	0.337	0.900	0.900	0.000
80%	0.801	0.379	0.904	0.900	0.004
90%	0.904	0.435	0.901	0.900	0.001
100% (*)	0.956	0.463	0.900	0.900	0.000
Note: ±2% of the set point value used for defining the limited					

PF = 0.90 capactive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.018)**
20%	0.205	-0.097	0.904	0.900	0.004
30%	0.306	-0.141	0.908	0.900	0.008
40%	0.406	-0.199	0.898	0.900	-0.002
50%	0.500	-0.233	0.907	0.900	0.007
60%	0.604	-0.289	0.902	0.900	0.002
70%	0.698	-0.325	0.906	0.900	0.006
80%	0.801	-0.388	0.900	0.900	0.000
90%	0.904	-0.429	0.903	0.900	0.003
100% (*)	0.939	-0.444	0.904	0.900	0.004
Note: ±2% of the set point value used for defining the limited					

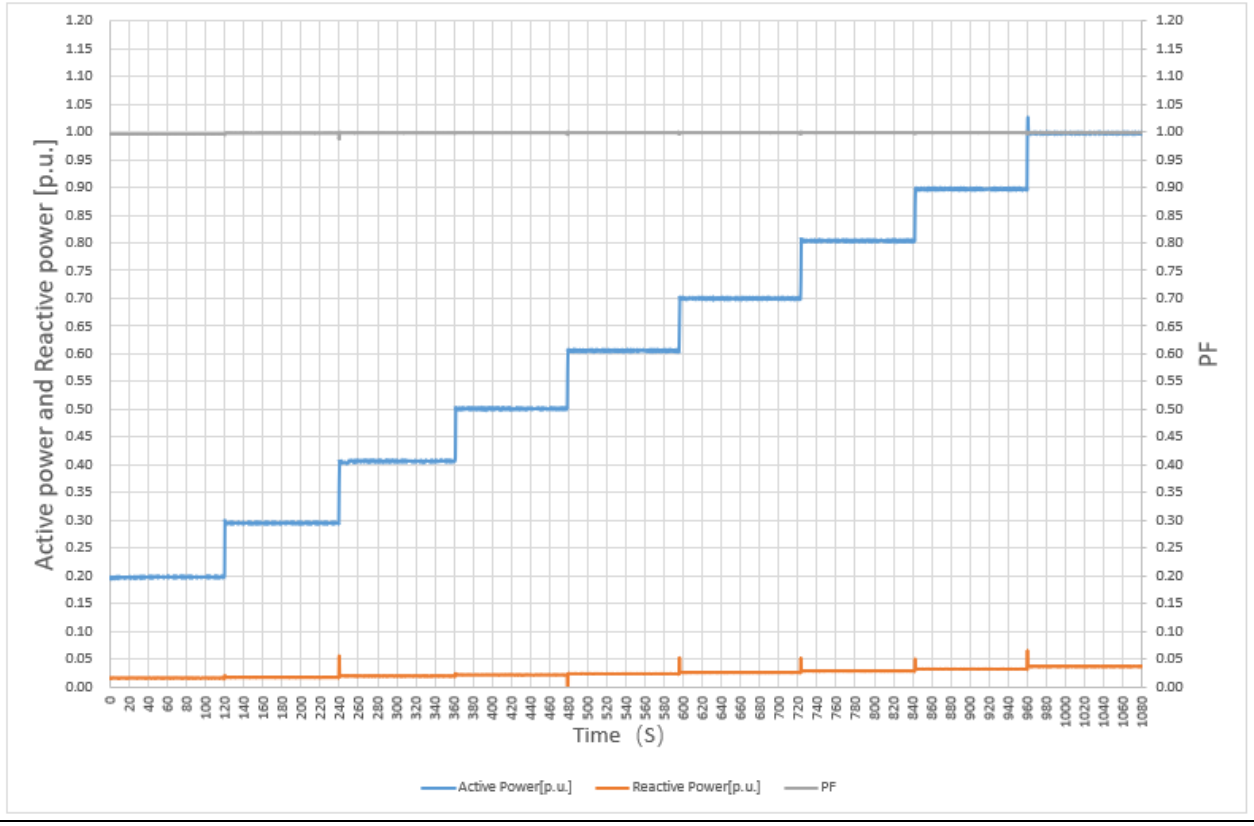
(*) Because of limited by apparent power, the active does not reach to 100% when cos φ = 0.9.

PF = 0.80 Inductive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.016)**
20%	0.198	0.146	0.805	0.800	0.005
30%	0.295	0.219	0.802	0.800	0.002
40%	0.404	0.302	0.801	0.800	0.001
50%	0.498	0.370	0.802	0.800	0.002
60%	0.602	0.447	0.803	0.800	0.003
70%	0.694	0.525	0.798	0.800	-0.002
80%	0.808	0.595	0.805	0.800	0.005
90% (*)	0.857	0.634	0.804	0.800	0.004
100% (*)	0.857	0.634	0.804	0.800	0.004
Note: ±2% of the set point value used for defining the limited					

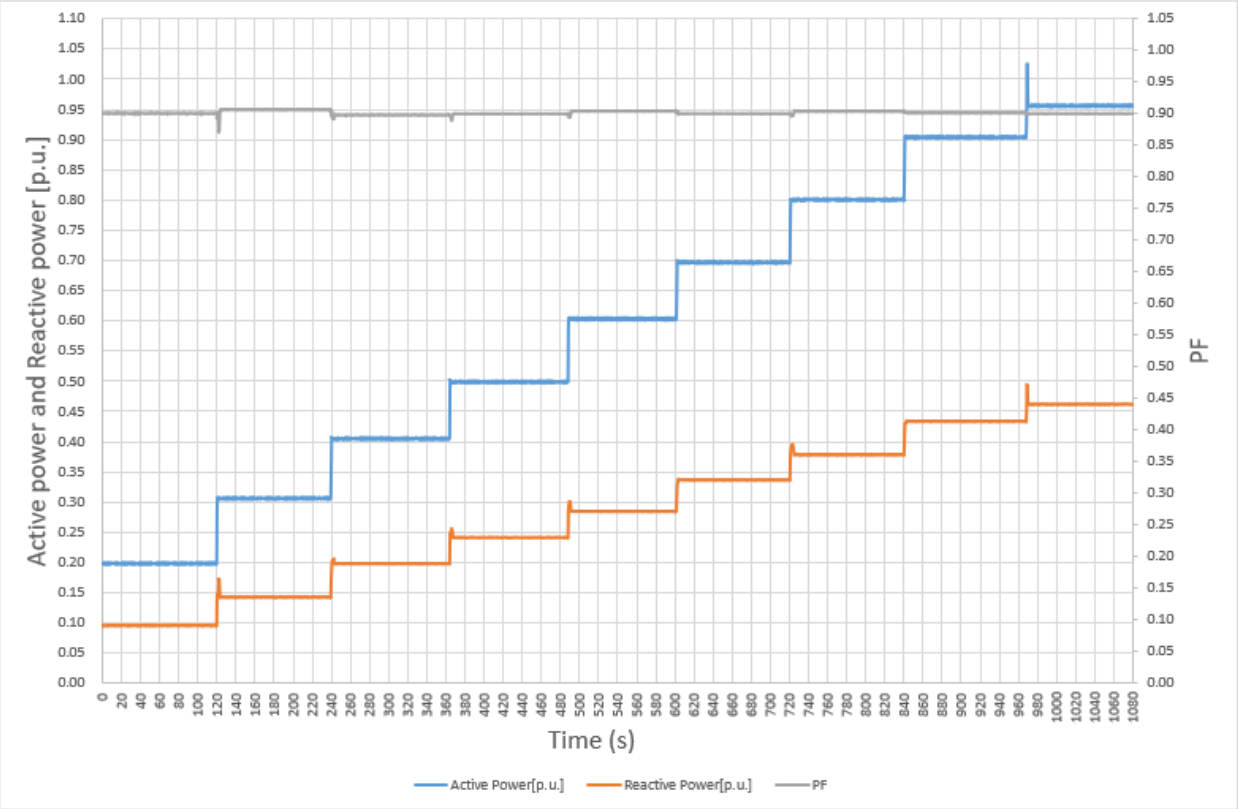
PF = 0.80 capactive					
P/Pn (%)	**Power (p.u.)**	**Q (p.u.)**	**Measured cos φ**	**Desired cos φ**	**Δ cos φ (±0.016)**
20%	0.199	-0.151	0.796	0.800	-0.004
30%	0.306	-0.226	0.805	0.800	0.005
40%	0.405	-0.301	0.803	0.800	0.003
50%	0.498	-0.372	0.801	0.800	0.001
60%	0.602	-0.449	0.801	0.800	0.001
70%	0.705	-0.515	0.808	0.800	0.008
80%	0.807	-0.603	0.801	0.800	0.001
90% (*)	0.829	-0.618	0.802	0.800	0.002
100% (*)	0.829	-0.617	0.802	0.800	0.002
Note: ±2% of the set point value used for defining the limited					

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

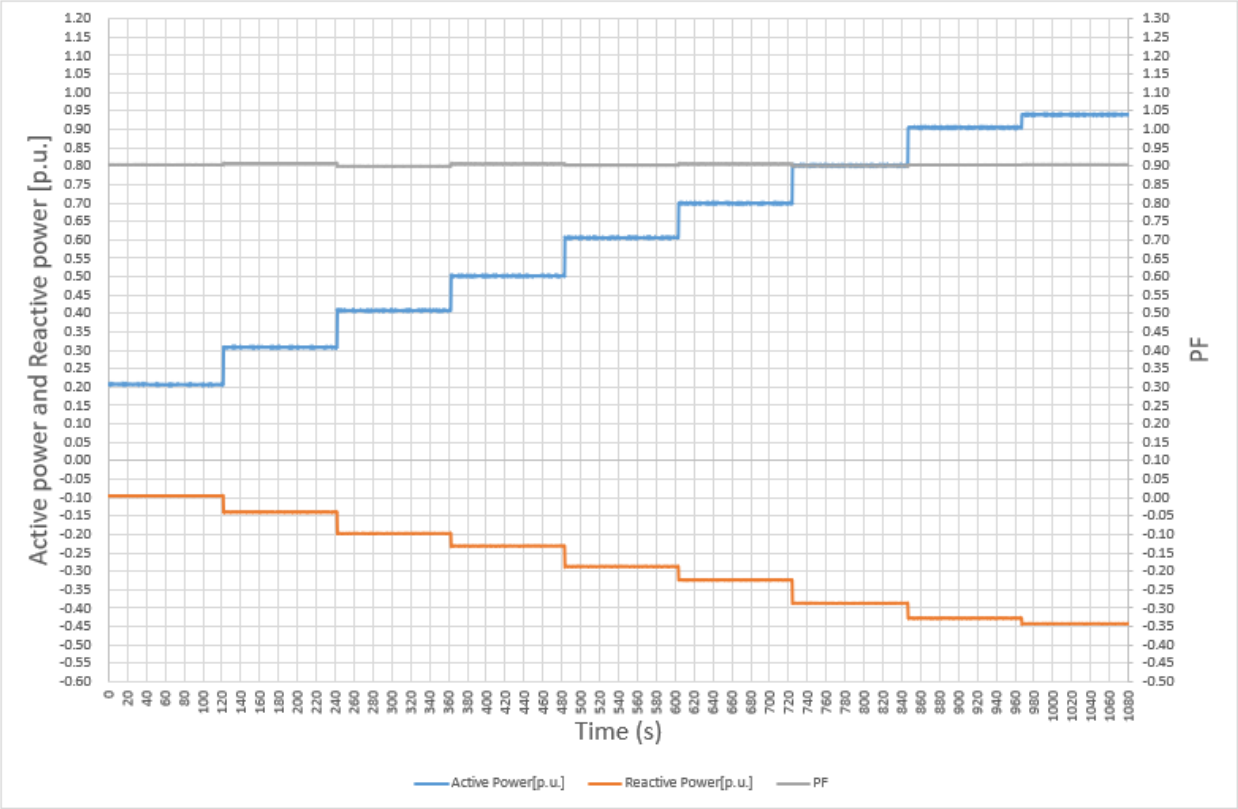
PF =1.00



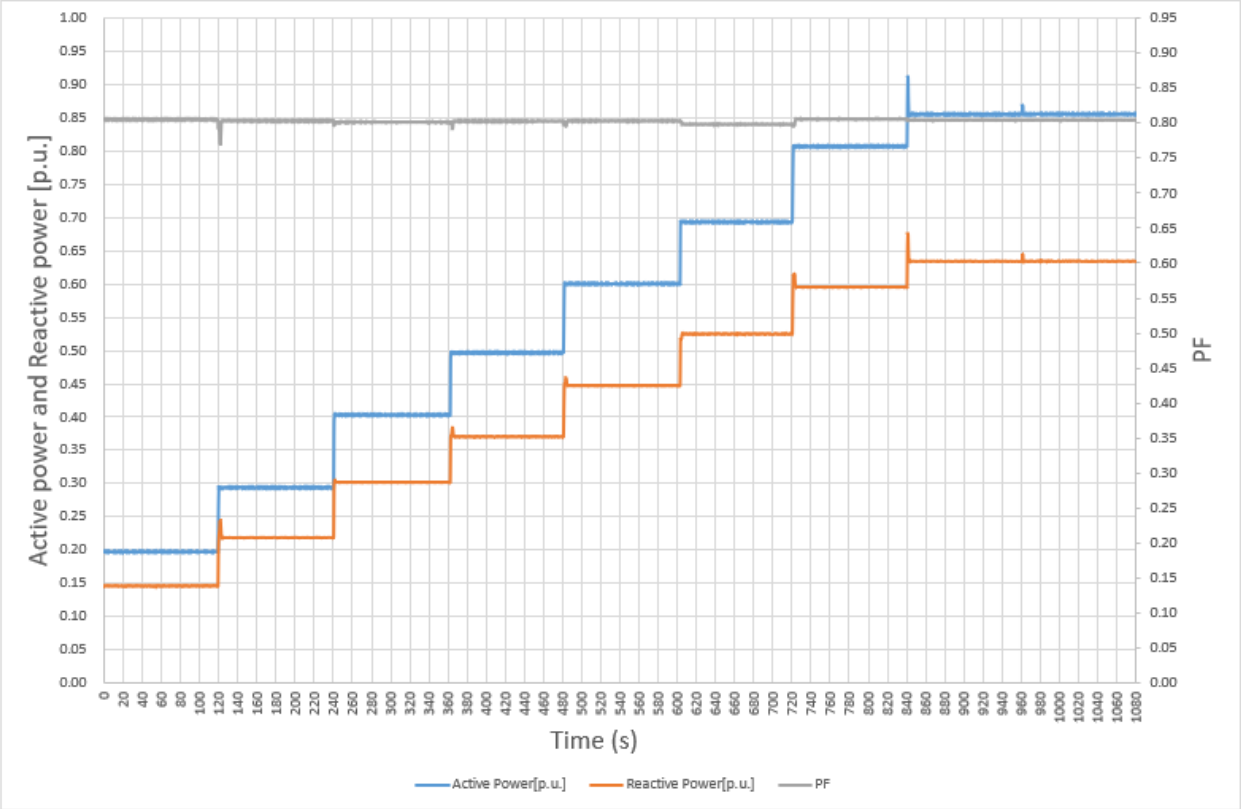
PF = 0.90 Inductive



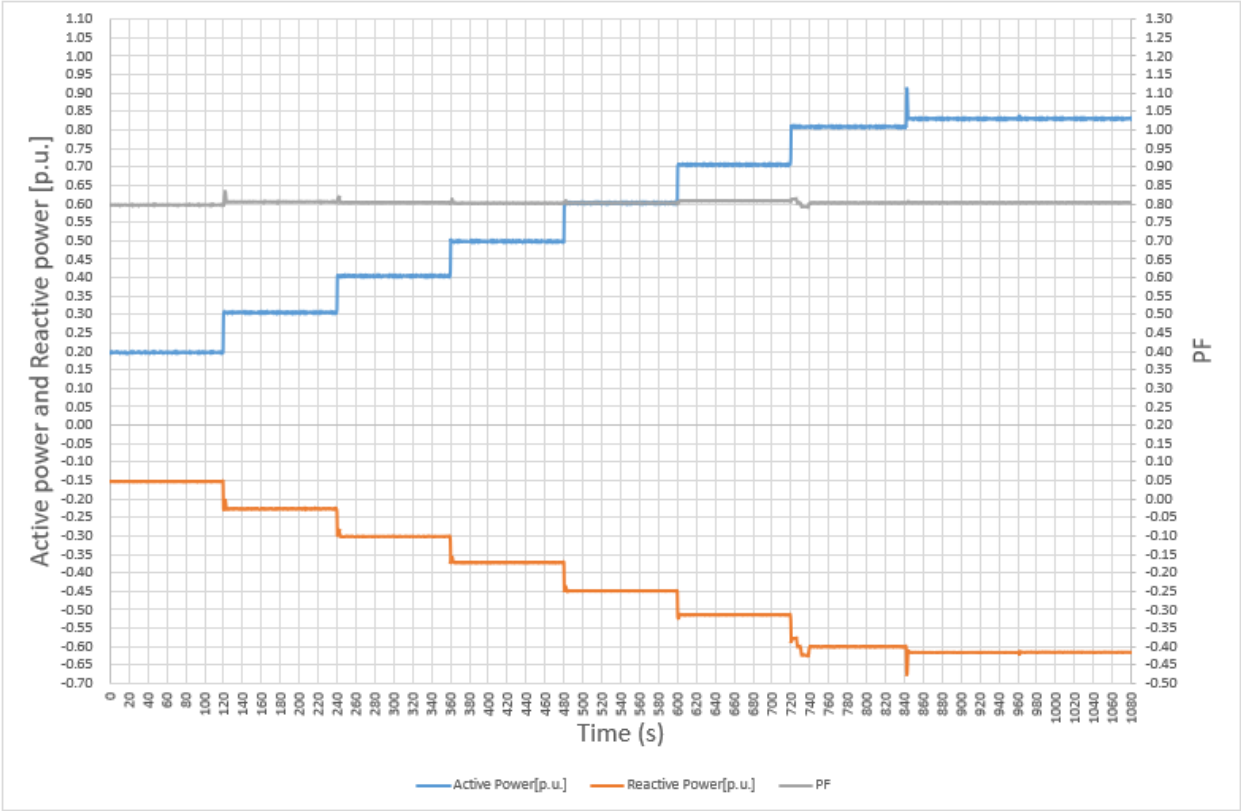
PF = 0.90 capactive



PF = 0.80 Inductive



PF = 0.80 capactive



4.4.2.3 Voltage Control

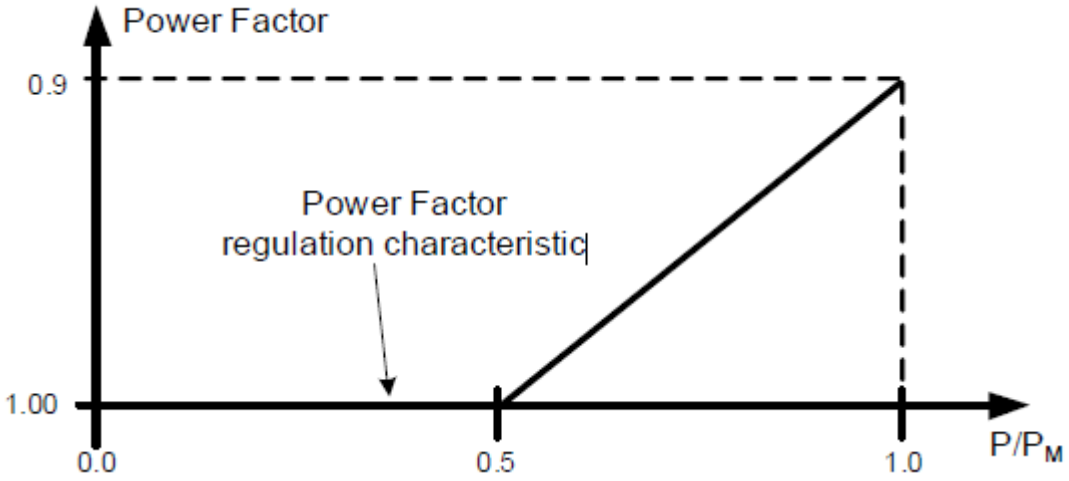
According to chapter 5.3.3 of standard TR3.2.2, the voltage control function stabilises the voltage in the voltage reference point. Voltage control must have a setting range within minimum to maximum voltage, with an accuracy of 0.5% or better of the nominal voltage.

It is not applicable due to the inverter is apply to plant category A1, 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 5.3.3 of standard TR3.2.1 and chapter 5.3.4 of standard TR3.2.2, 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

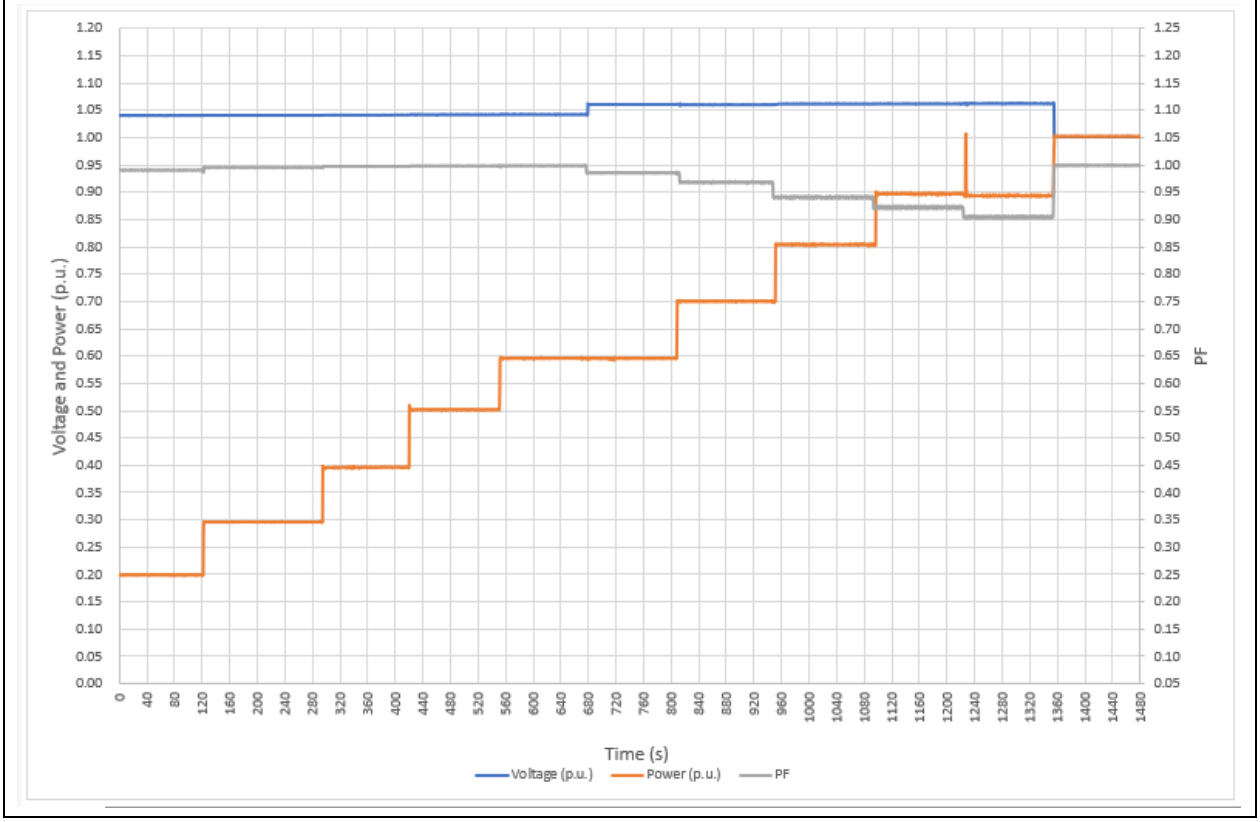
Test results are offered in the table below.

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)
0.20	0.199	0.028	<1.05	1.040	1.000	0.990	-0.010
0.30	0.296	0.029	<1.05	1.041	1.000	0.995	-0.005
0.40	0.396	0.030	<1.05	1.041	1.000	0.997	-0.003
0.50	0.501	0.033	<1.05	1.042	1.000	0.998	-0.002
0.60	0.596	0.032	<1.05	1.042	1.000	0.998	-0.002
0.60	0.596	-0.103	>1.05	1.061	0.980	0.985	0.005
0.70	0.700	-0.182	>1.05	1.060	0.960	0.968	0.008
0.80	0.804	-0.292	>1.05	1.061	0.940	0.940	0.000
0.90	0.897	-0.378	>1.05	1.062	0.920	0.922	0.002
1.00	0.894	-0.422	>1.05	1.062	0.900	0.904	0.004
1.00	1.002	0.050	<=1.00	1.001	1.000	0.999	-0.001

Supplementary information:
This test has the maximum settling time observed. This is from step *60%P & <105%Un* to *60%P & >105%Un*. Time observed 3 s

Test results are graphically represented at the diagrams below:

Power Factor vs Power



4.4.3 System Protection

According to chapter 5.4 of standard TR3.2.2, 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 apply to plant category A1, 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

Reconnection requirements are different when unit is connected as plant category A1 or plant category A2, B. The settings of reconnect voltage and frequency is adjustable.

For connected as plant category A1, the normal operating voltage is Uc+10% and Uc-15%, and the frequency range is 49.00 to 51.00 Hz. Automatic connection of a plant can at the earliest take place three minutes after the voltage has come within the normal operating voltage range, and the frequency is within the 47.00 to 50.20 Hz range. The maximum permitted upward regulation of the active power is at a droop of 10% Pn/min.

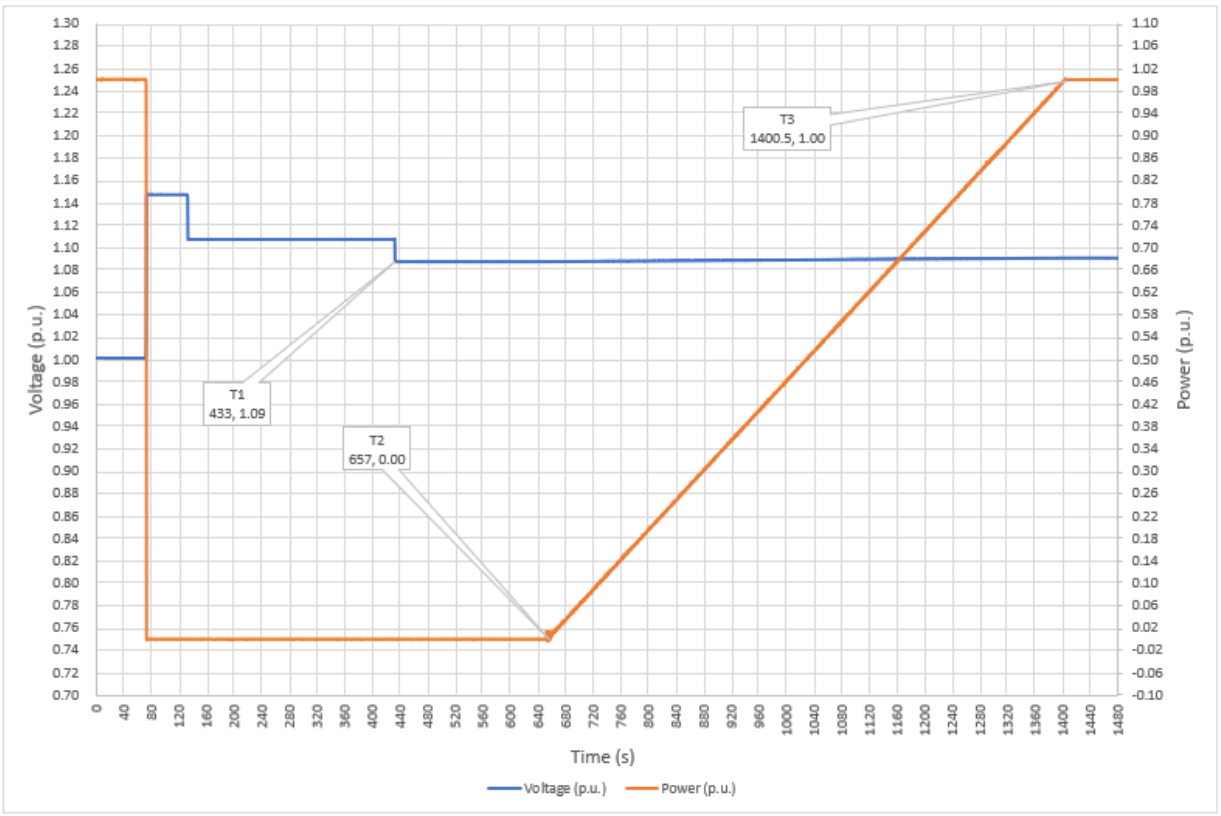
For connected as plant category A2 or B, the normal operating voltage is Uc±10%, and the frequency range is 47.00 to 52.00 Hz. Automatic connection of a PV power plant can take place no earlier than three minutes after the voltage and frequency have come within the normal production range.

Test results are graphically represented at the diagrams below:

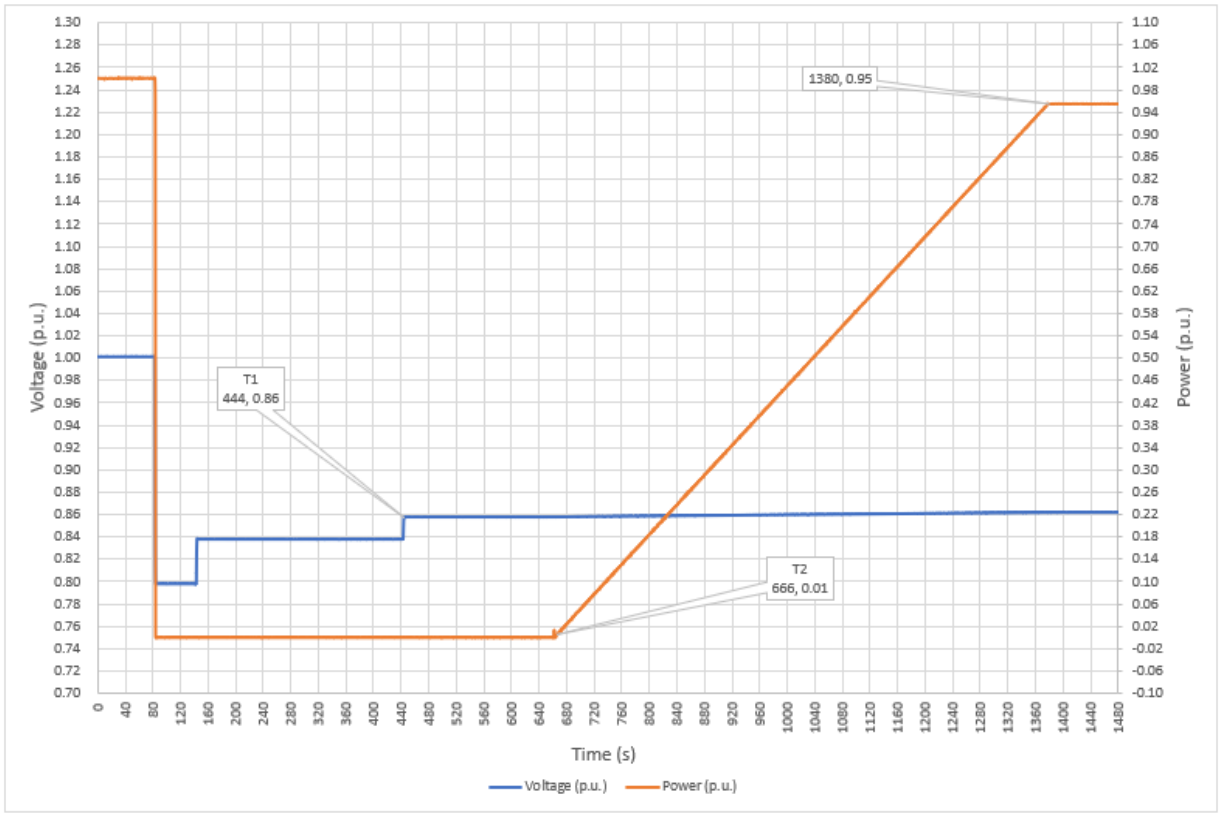
For plant category A1:

Type	Required Delay time	Time measured (s)	Upward regulation of the active power
OV: 110%Un	>3 min	224.0	8.1% Pn/min
UV: 85%Un	>3 min	222.0	7.9% Pn/min
OF: 50.2 Hz	>3 min	222.5	8.0% Pn/min
UF: 47.0 Hz	>3 min	221.0	8.1% Pn/min

OV: 110%Un

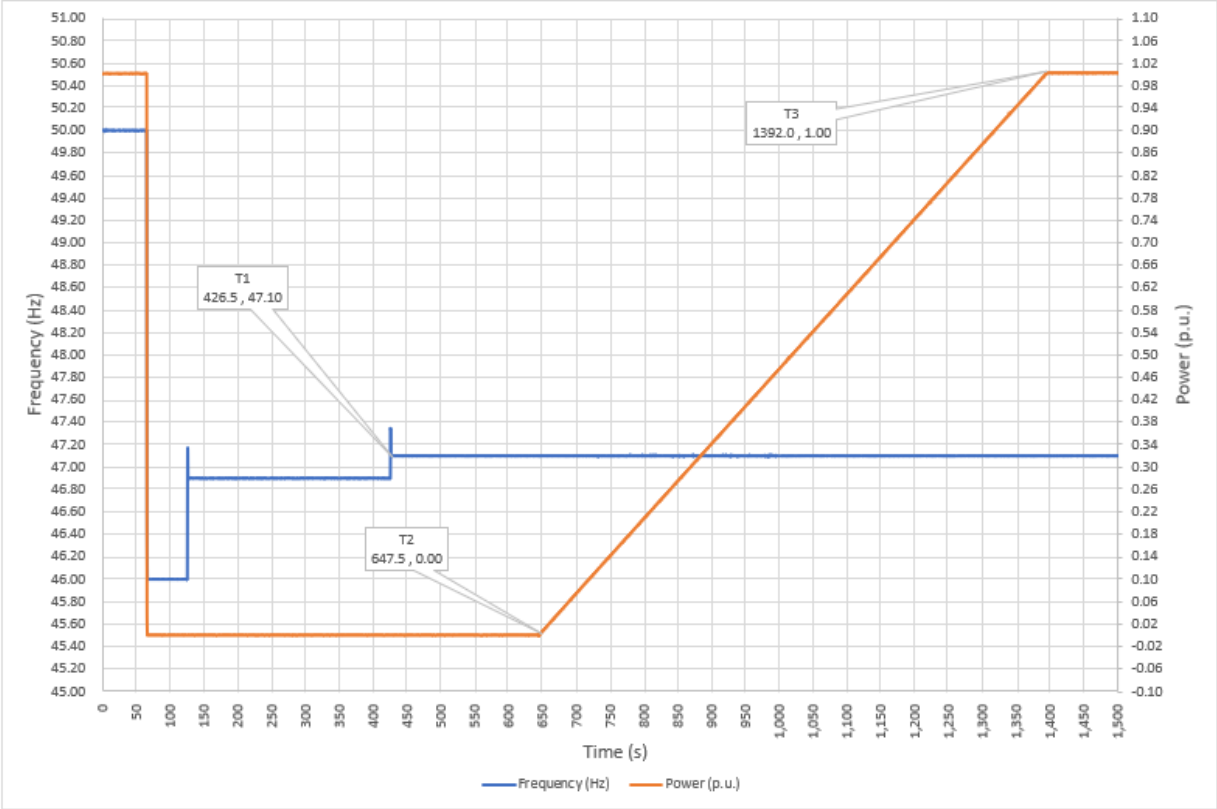


UV: 85%Un



OF: 52.0 Hz

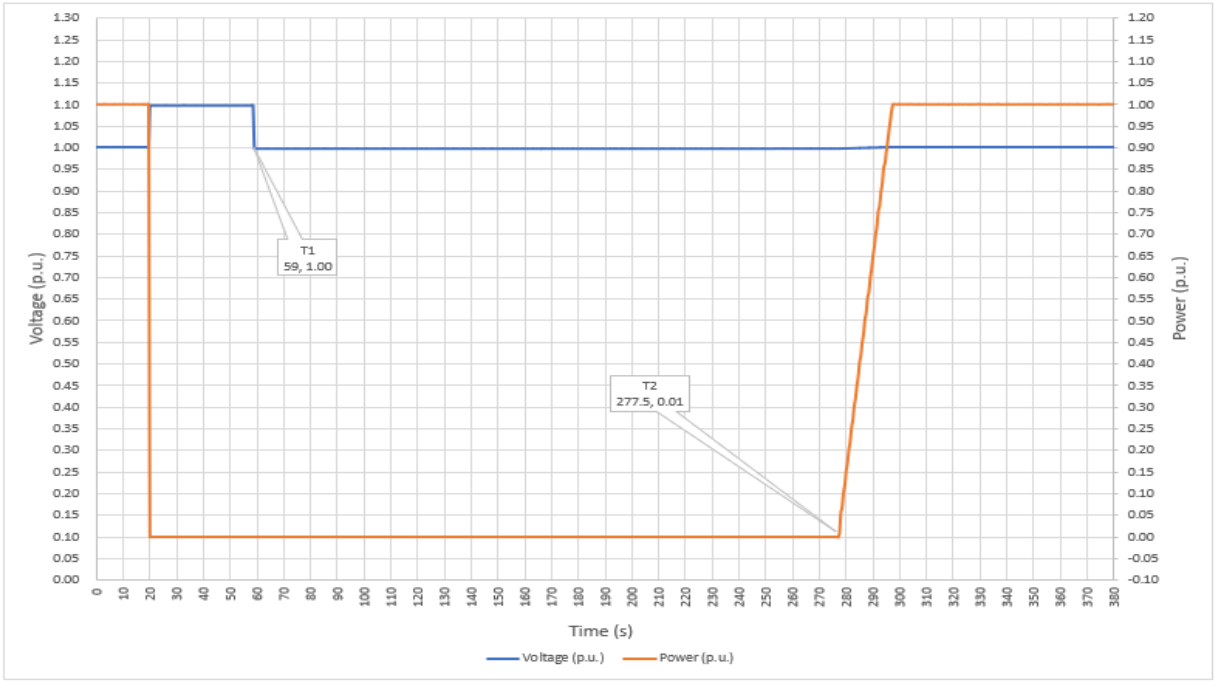
UF: 47.0 Hz



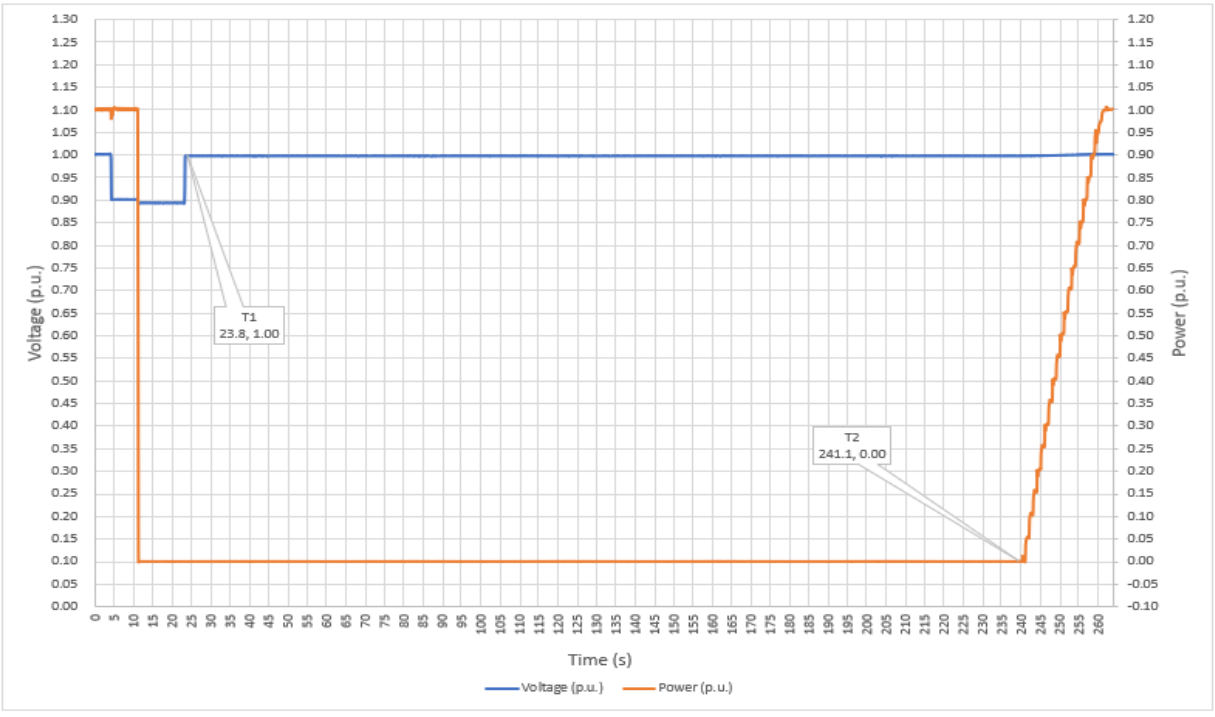
For plant category A2 or B:

Type	Required Delay time	Time measured (s)
OV: 110%Un	>3 min	218.5
UV: 90%Un	>3 min	217.3
OF: 52.0 Hz	>3 min	218.6
UF: 47.0 Hz	>3 min	219.0

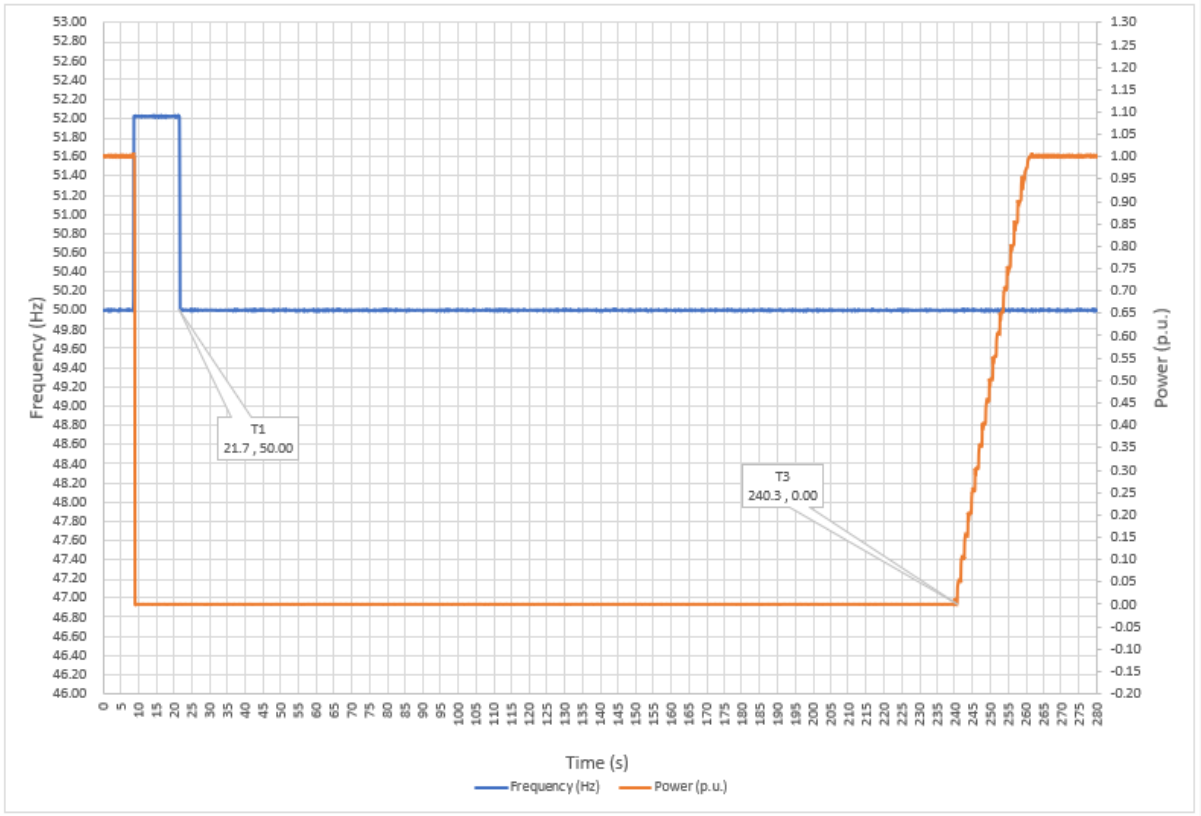
OV: 110%Un



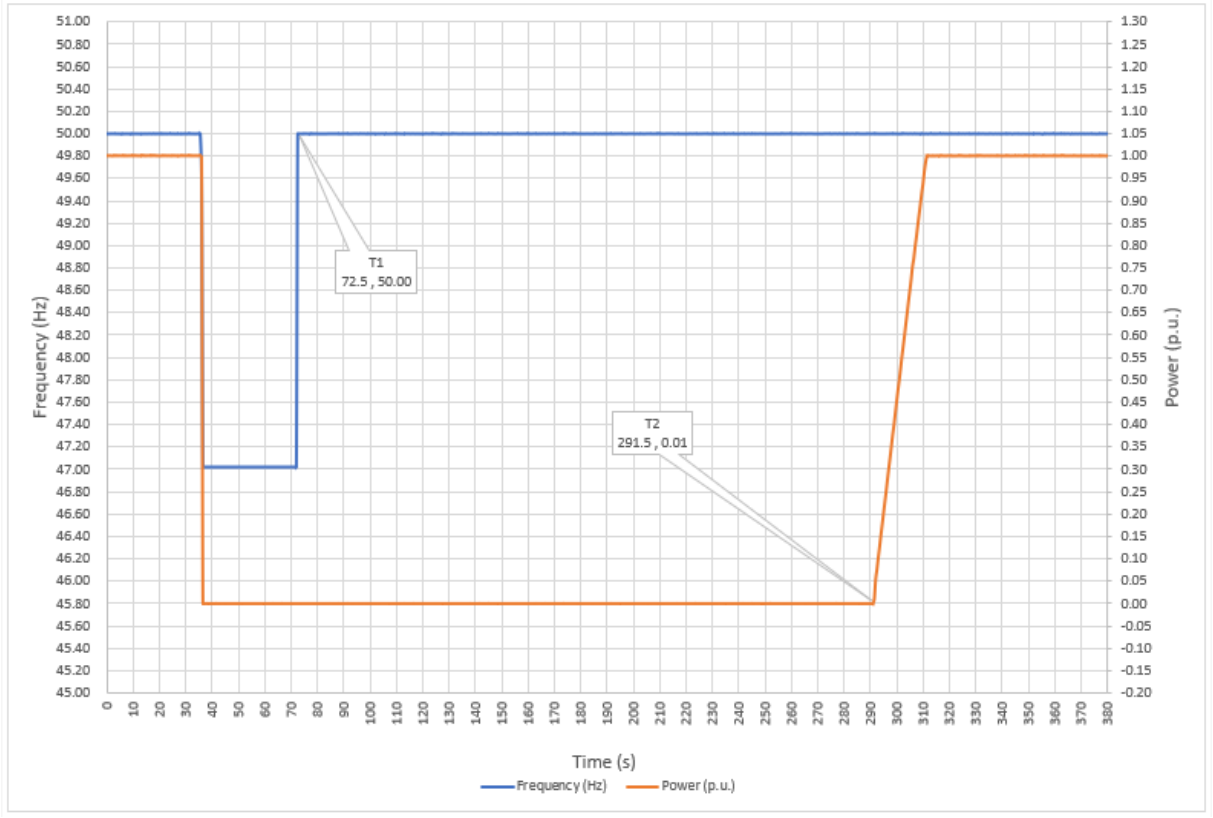
UV: 90%Un



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 A1 or plant category A2, B. The settings of reconnect voltage and frequency is adjustable.

For connected as plant category A1, according to chapter 6.2 of standard TR3.2.1, protective functions with associated operating settings and trip time must match the values in the table below.

Protective function	Symbol	Setting		Functional area		Standard setting**
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	ms	100 ms
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

***) One of the specified functions must be implemented.
**) This value is used unless agreed otherwise with the *electricity supply undertaking*.

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

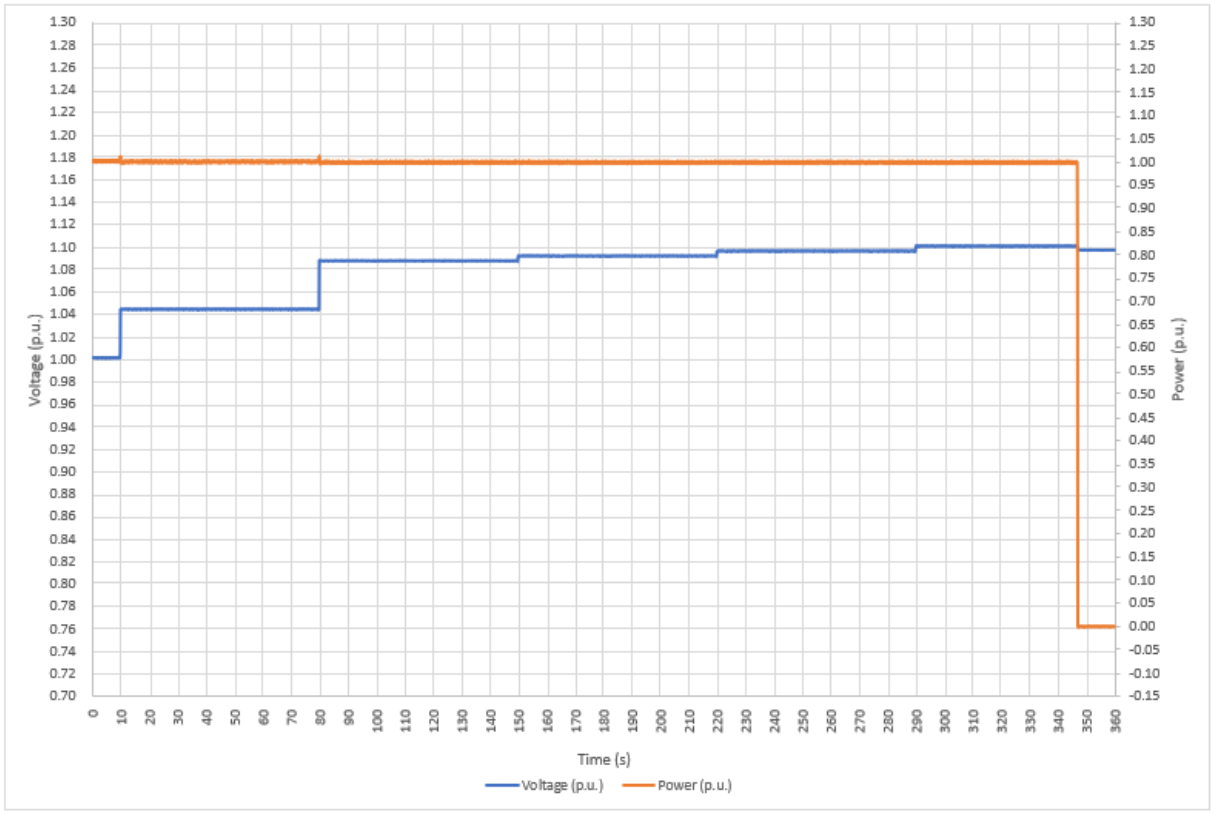
The settings of voltage and frequency trips is adjustable.

Test results are offered at the tables below.

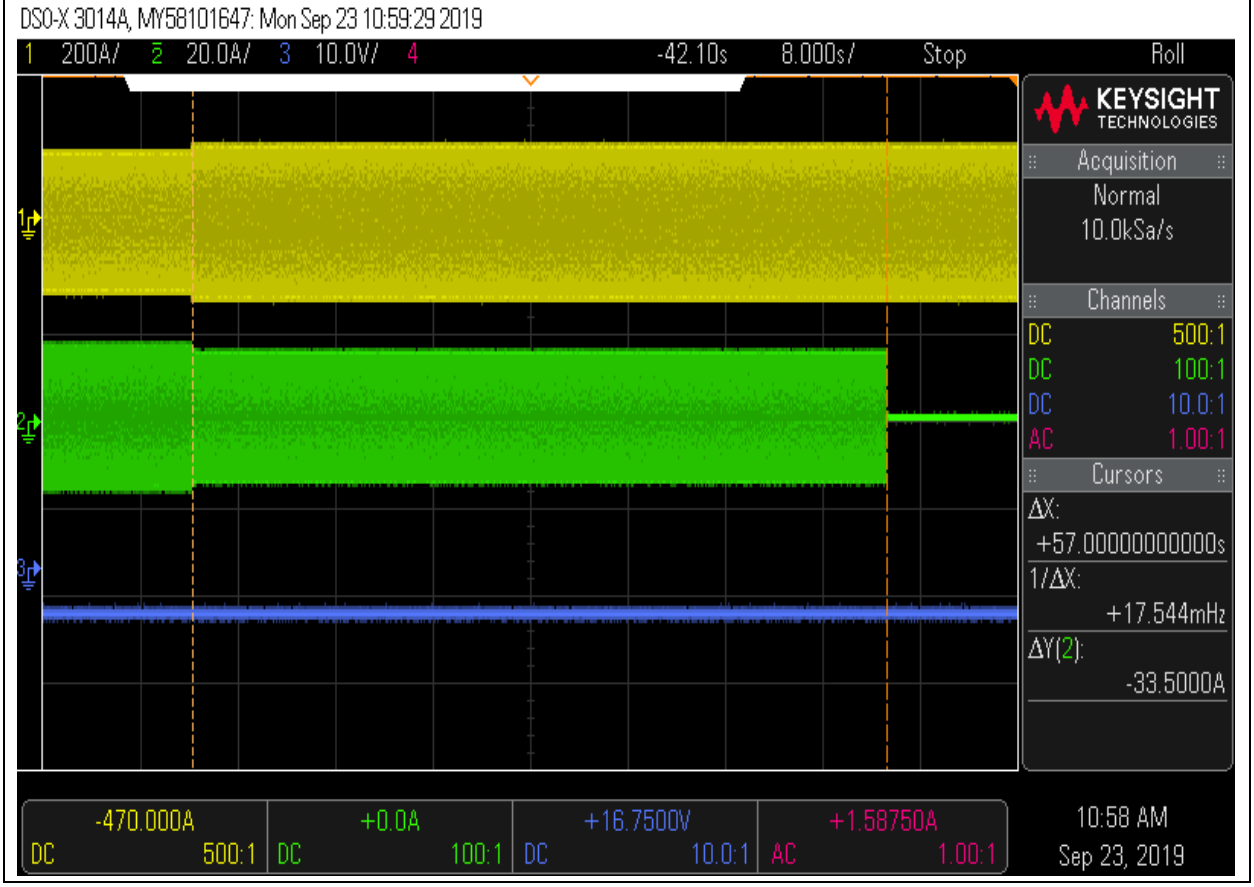
4.6.1 Voltage Trip

Voltage	Disconnection time limits (s)	Disconnection time measured (s)
Un+10%Un	60	57.000
Un+15%Un	0.2	0.146
Un-10%Un	10 to 60	57.000
Un-15%Un	10 to 60	50.100
Un-20%Un	0.1 to 0.2	0.113

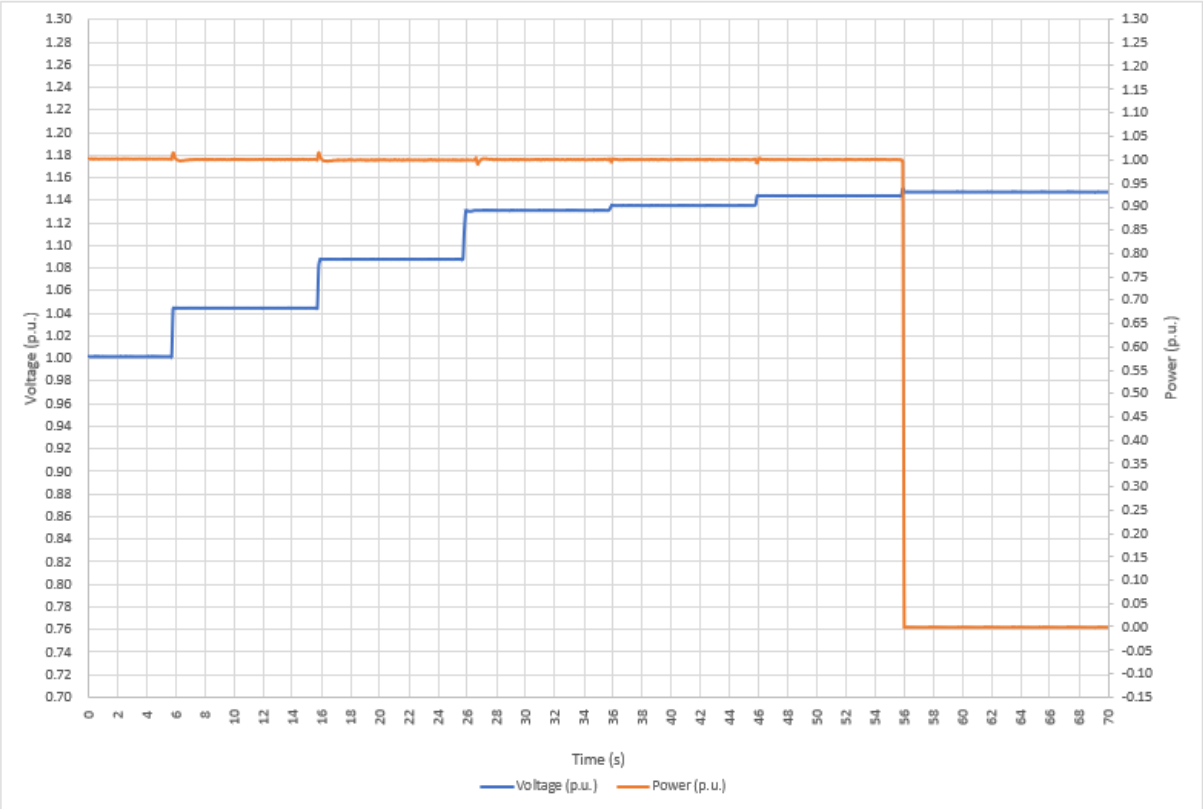
Voltage measured: Un+10%Un



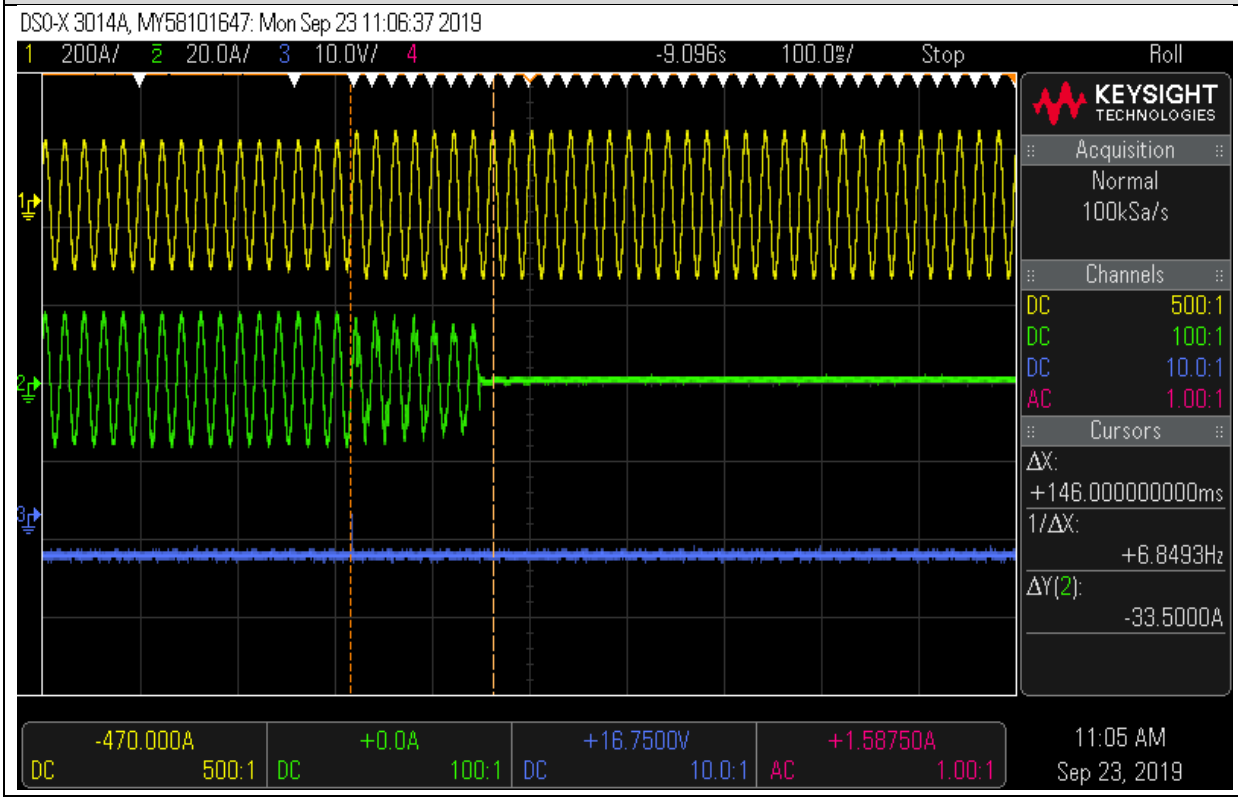
Voltage Trip Time: Un+10%Un



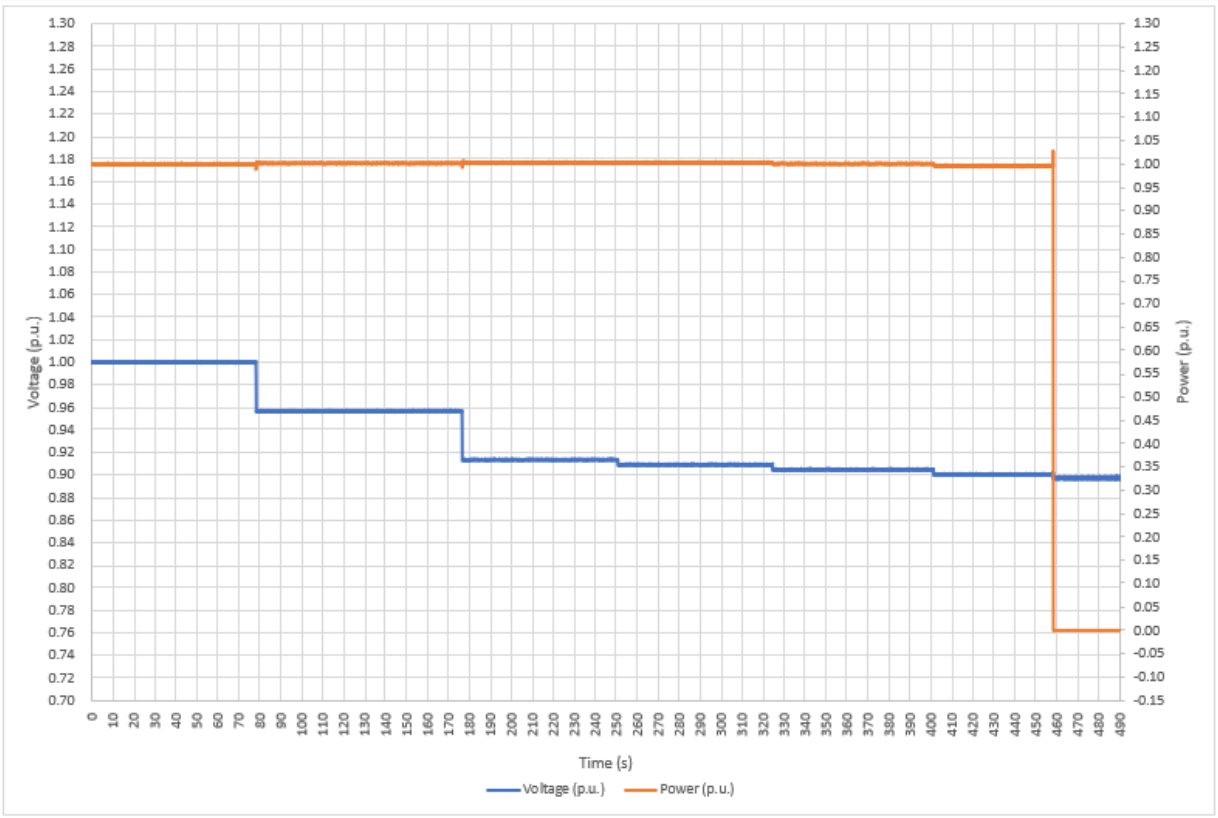
Voltage measured: Un+15%Un



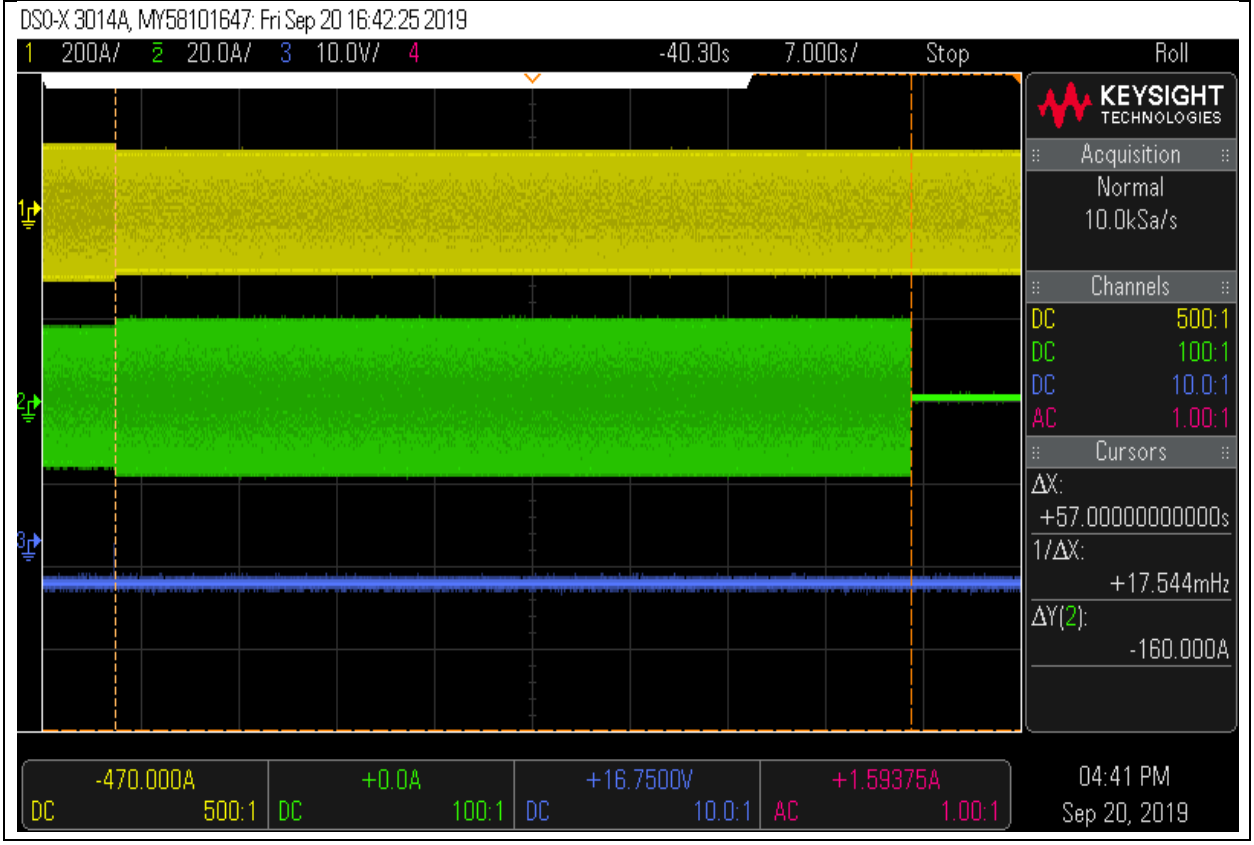
Voltage Trip Time: Un+15%Un



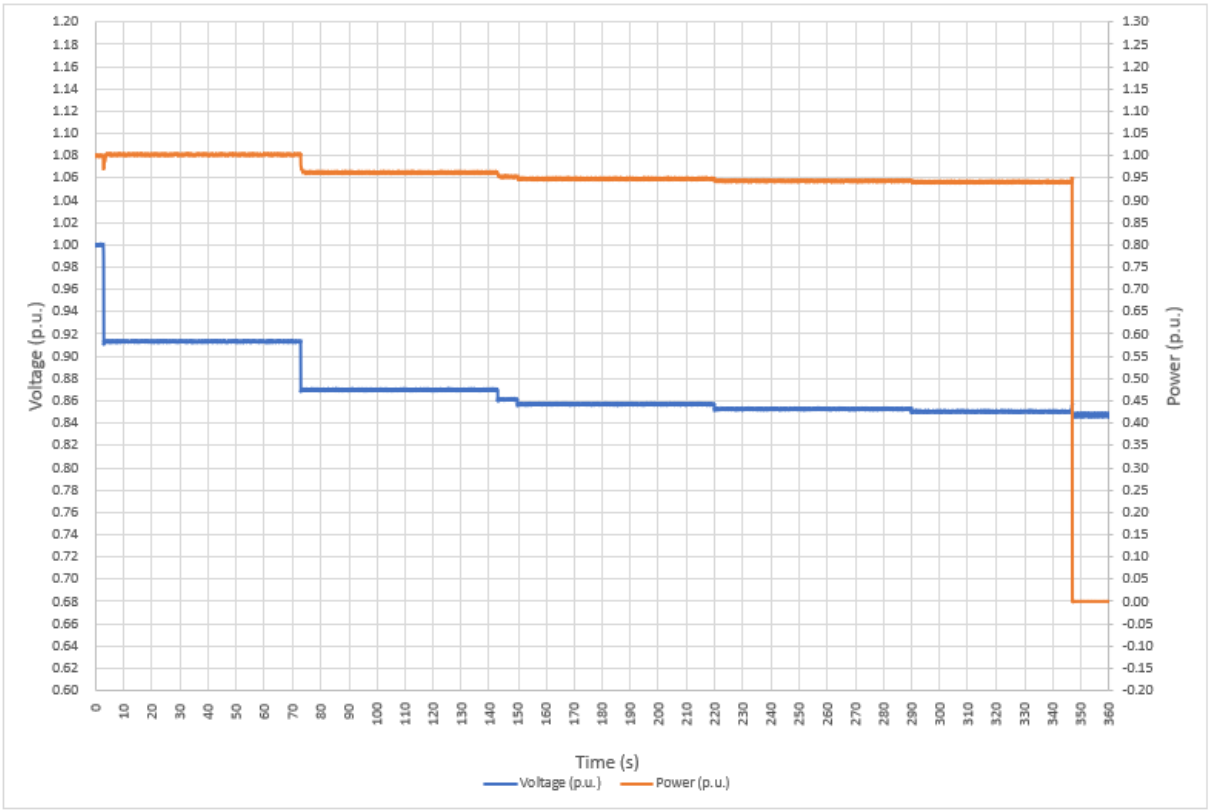
Voltage measured: Un-10%Un



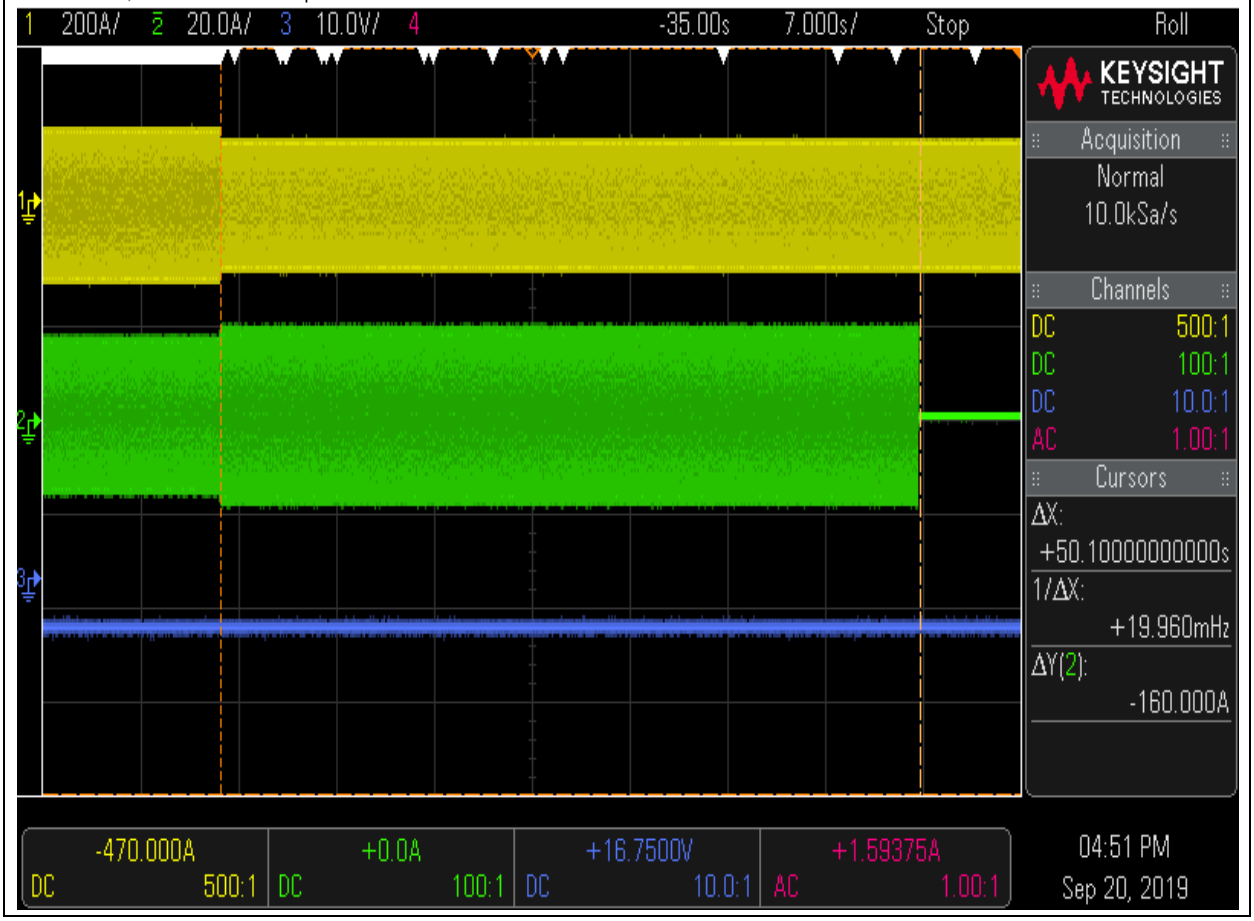
Voltage Trip Time: Un-10%Un



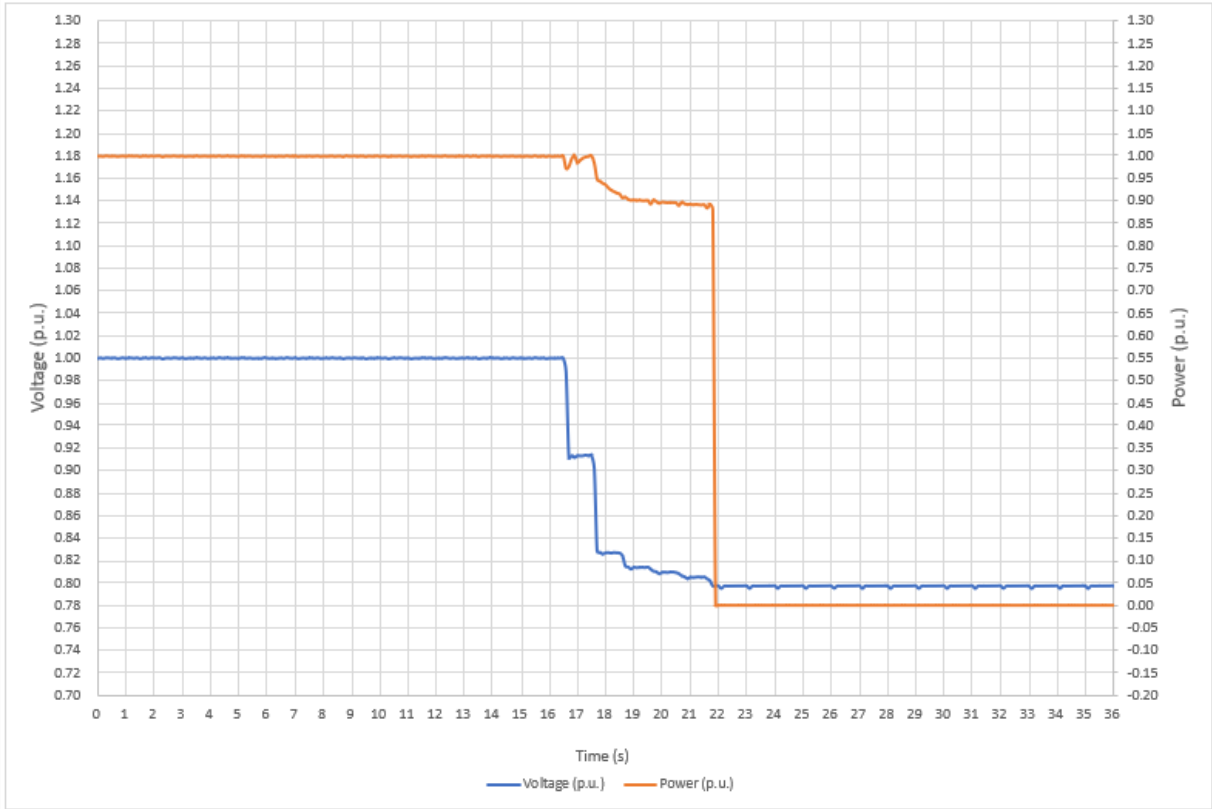
Voltage measured: Un-15%Un



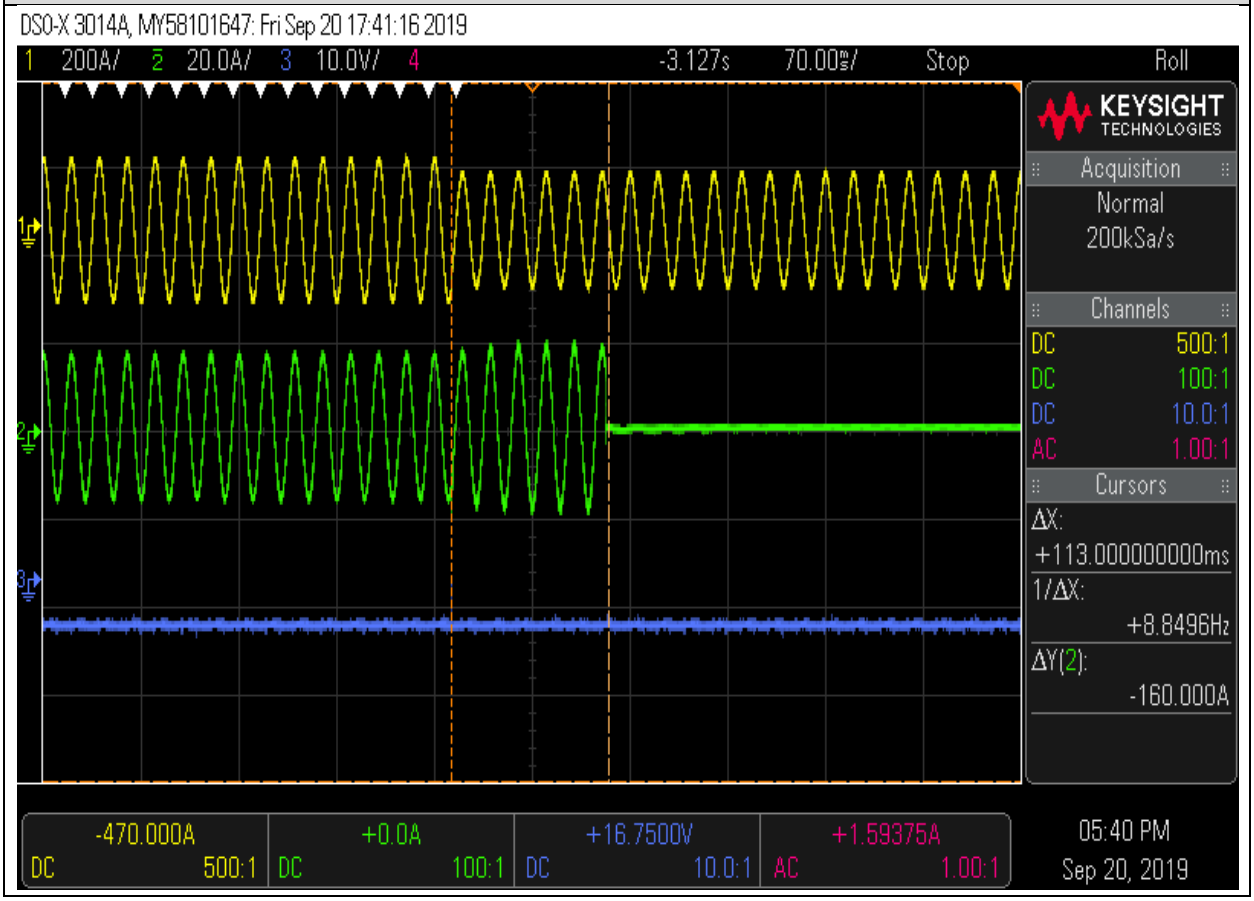
Voltage Trip Time: Un-15%Un



Voltage measured: Un-20%Un



Voltage Trip Time: Un-20%Un



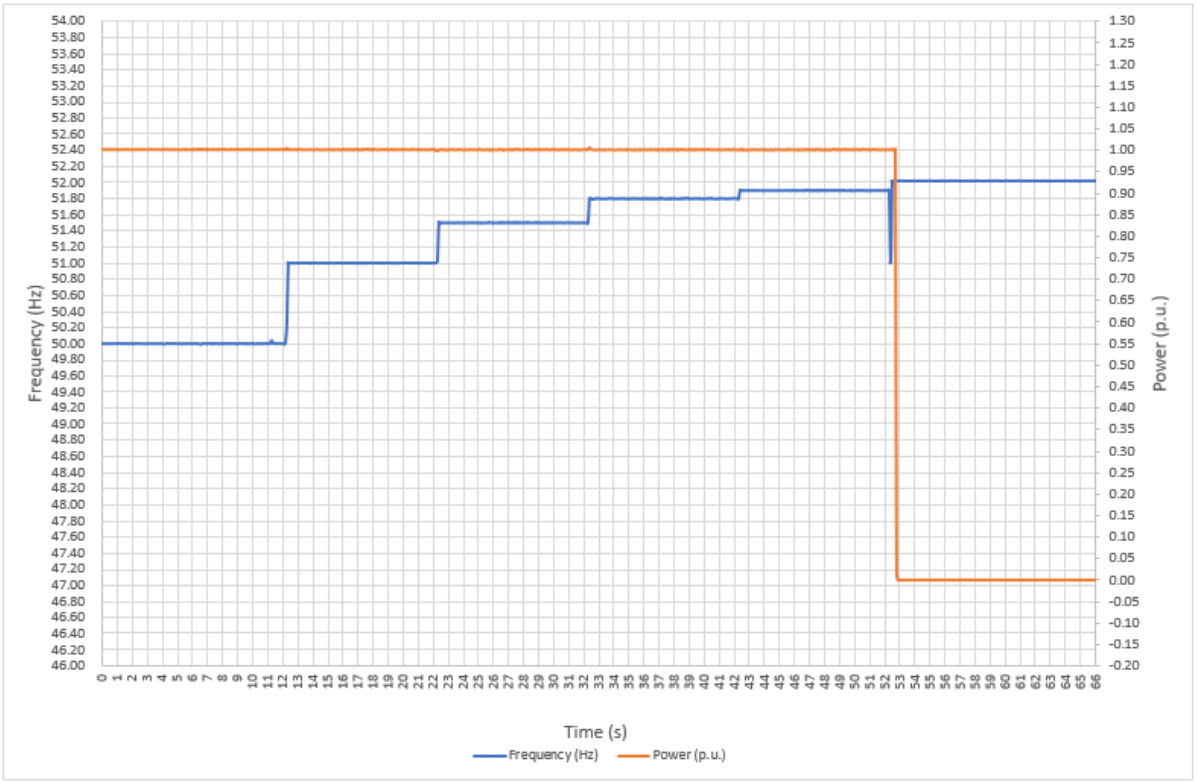
4.6.2 Frequency disconnection

Frequency (Hz)	Disconnection time limits (ms)	Disconnection time measured (ms)
52	200	138
47	200	150

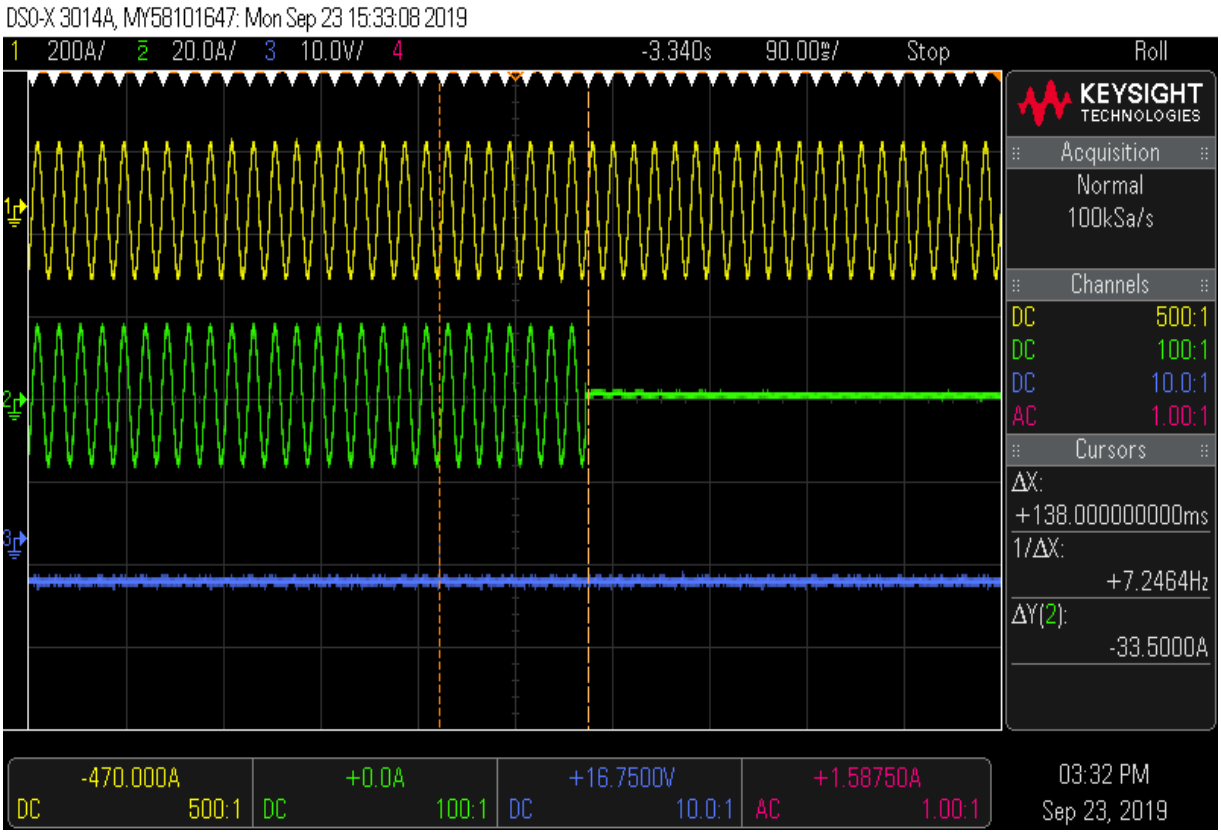
Test results are represented at the images below.

Frequency measured: 52 Hz

Trip value

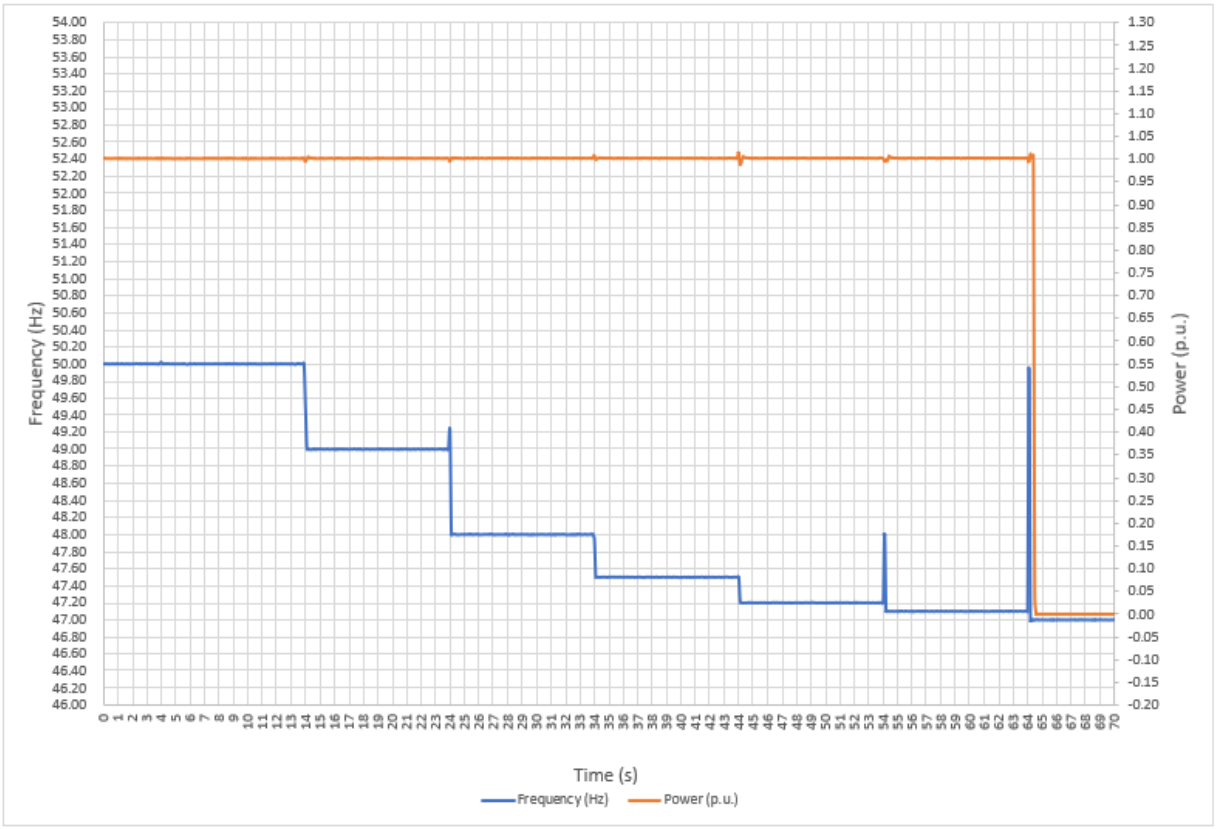


Disconnection time

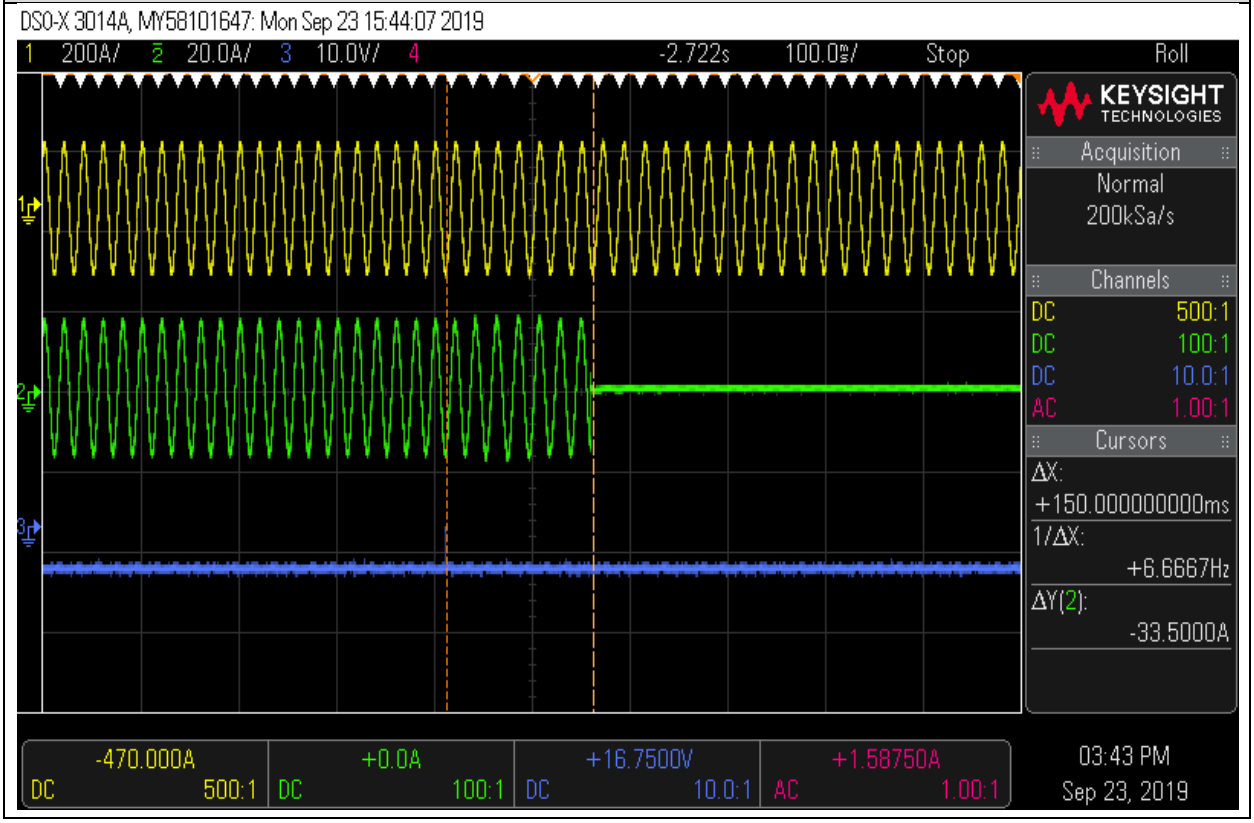


Frequency measured: 47 Hz

Trip value



Disconnection time



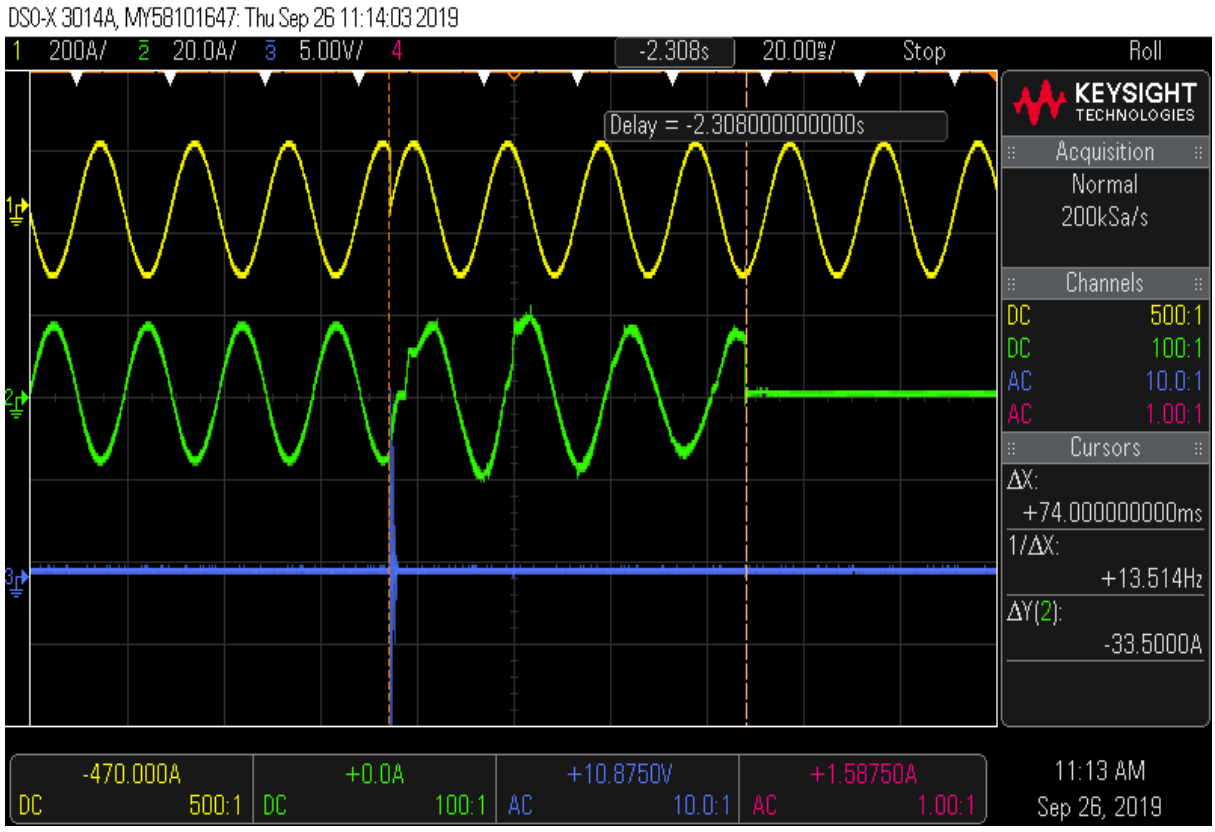
4.6.3 Change Of Frequency

Test results are offered at the table below.

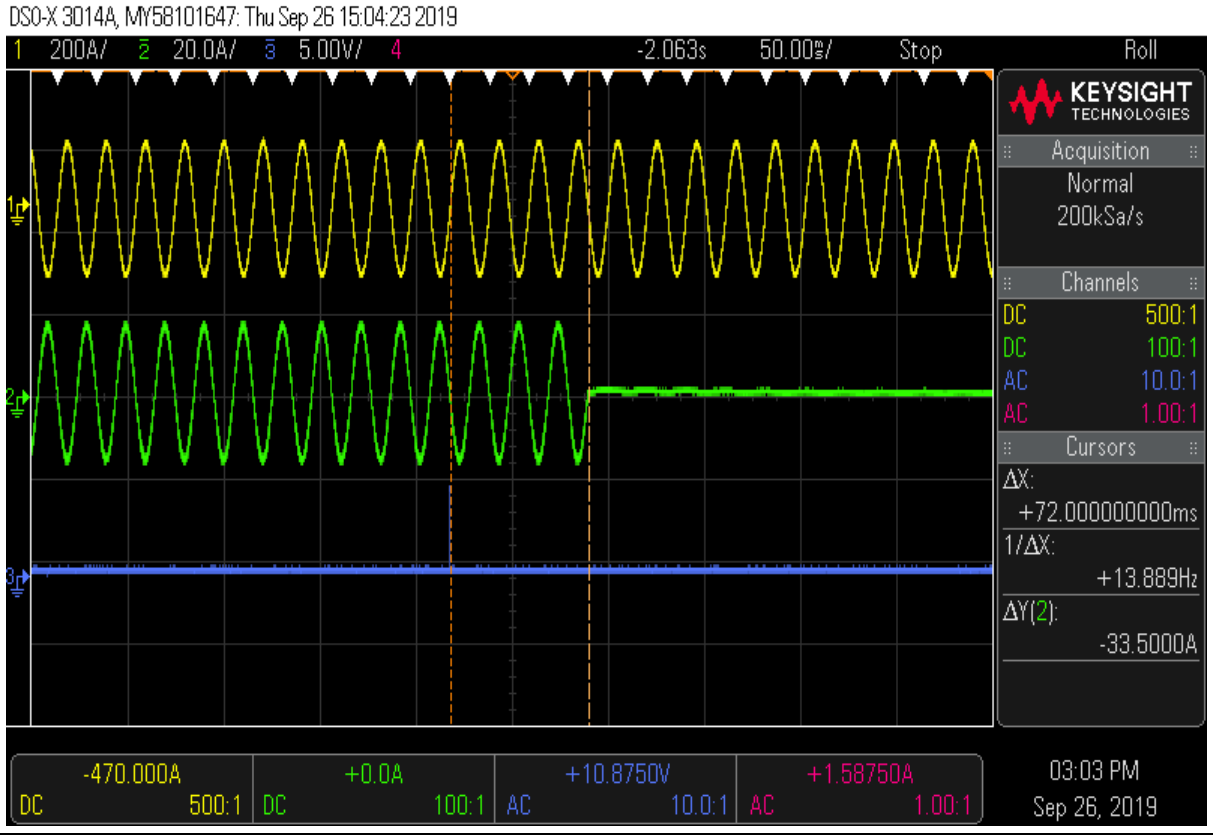
Type of drift	Start Frequency (Hz)	Final Value (Hz)	Ramp measured (Hz/s)	**Disconnection time limits (ms)**	**Disconnection time measured (ms)**
Positive frequency drift	50.0	51.3	2.6	50 to 100	74
Negative frequency drift	50.0	48.7	2.6	50 to 100	72

Test results are represented at the images below.

Disconnection time of Positive frequency drift



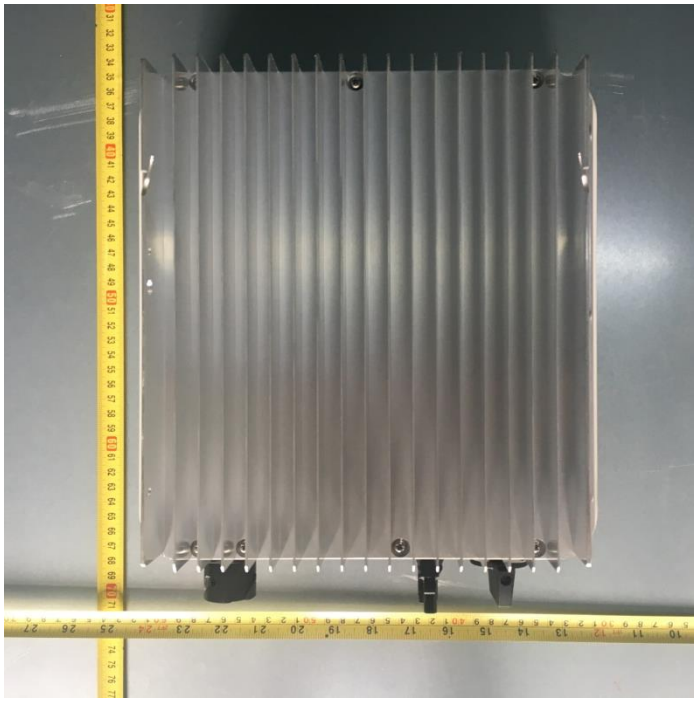
Disconnection time of Negative frequency drift



5 PICTURES

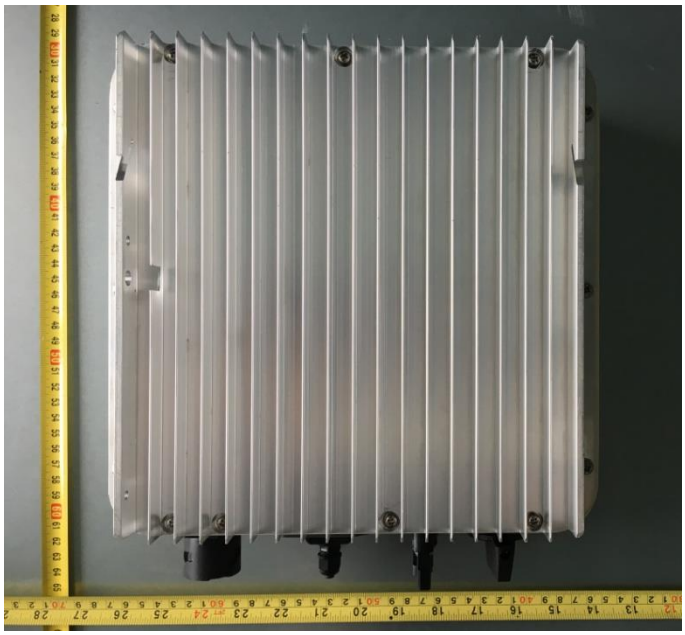
Front view 1 (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)

Back view 1 (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)

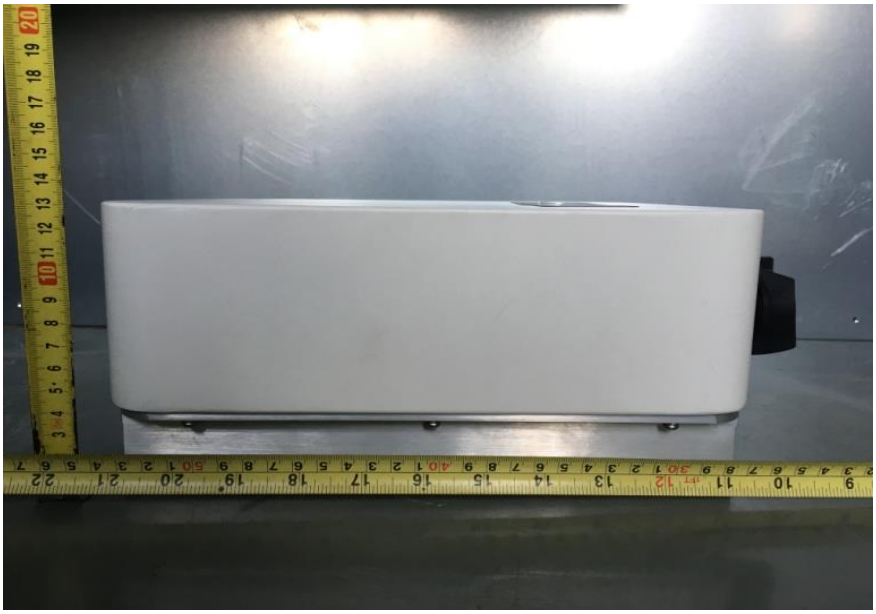


Front view 2 (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)

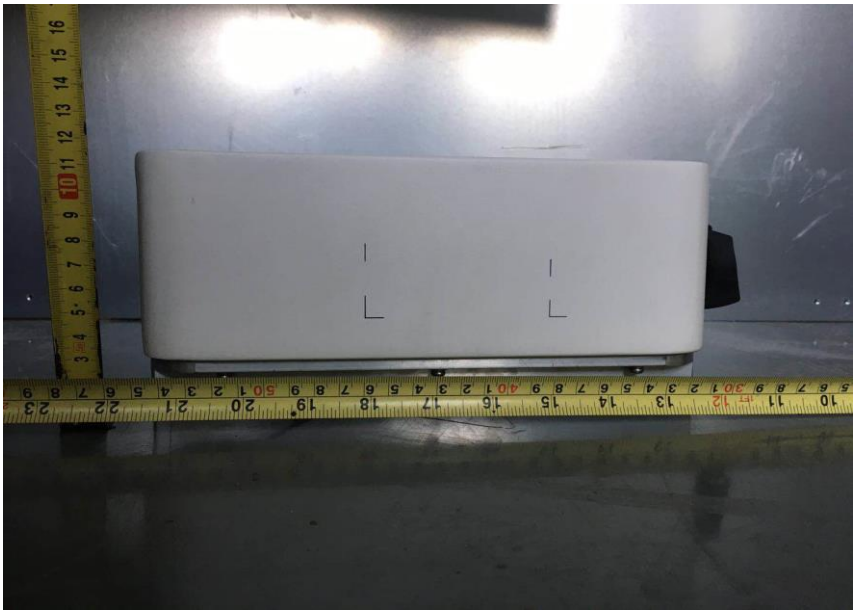
Back view 2 (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)



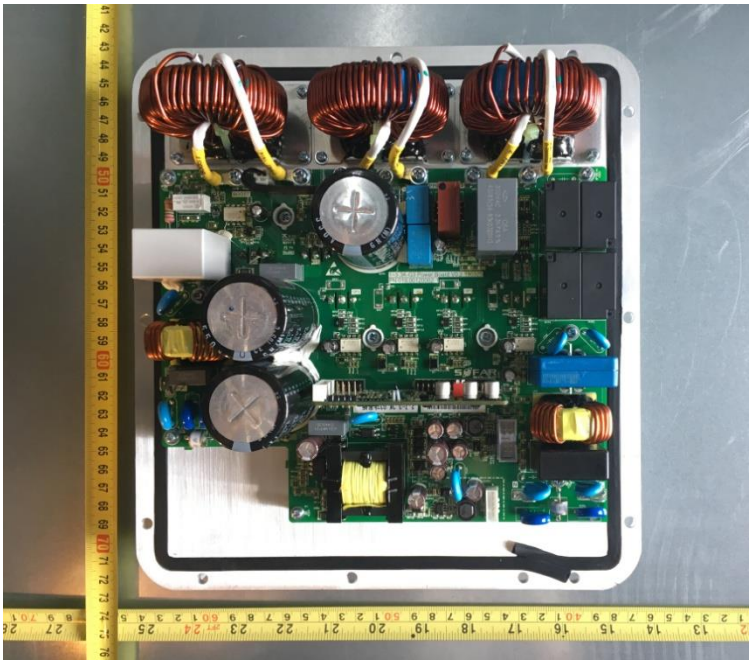
Side View (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)



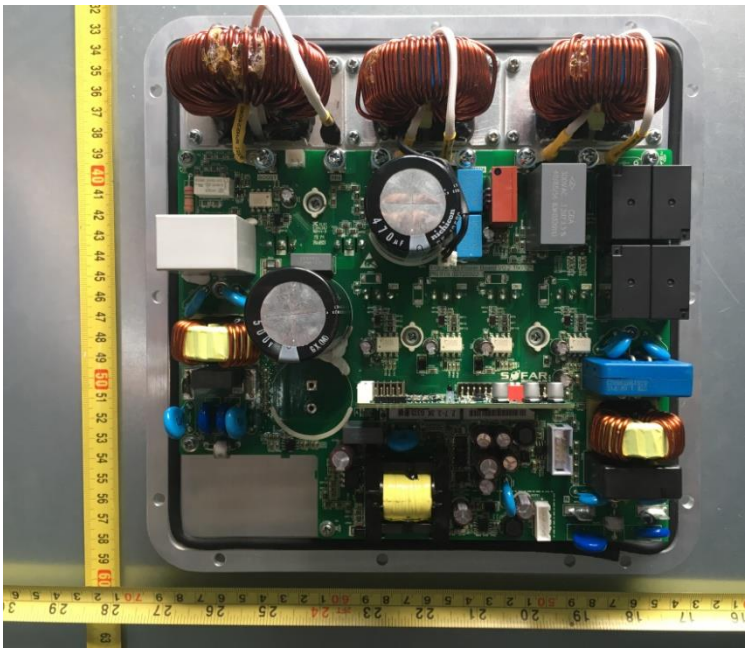
Side View (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)



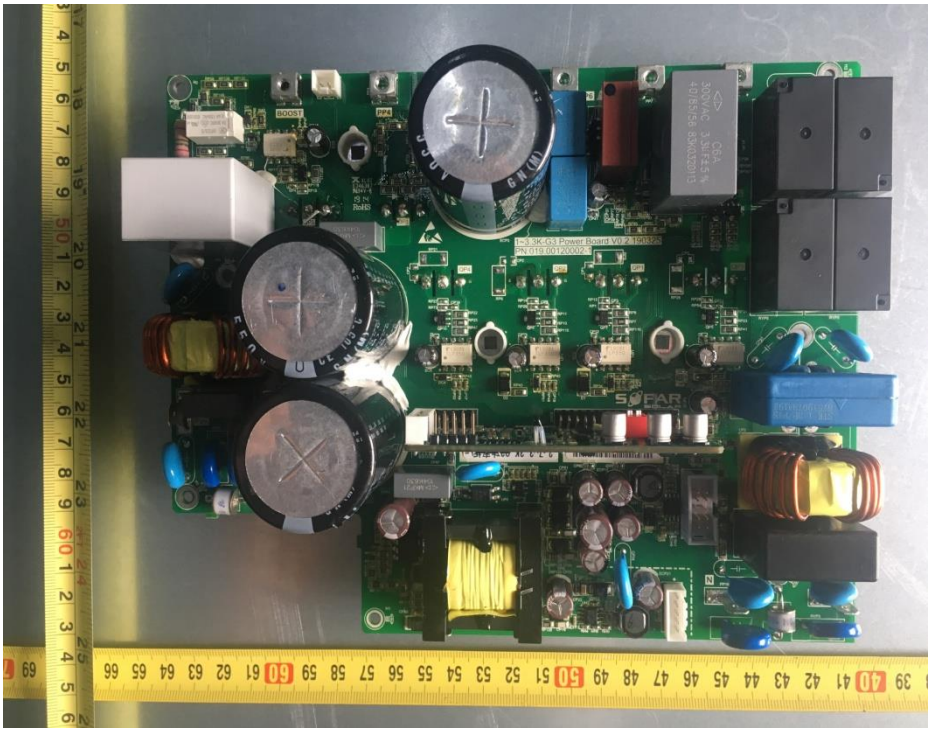
Internal view of enclosure (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)



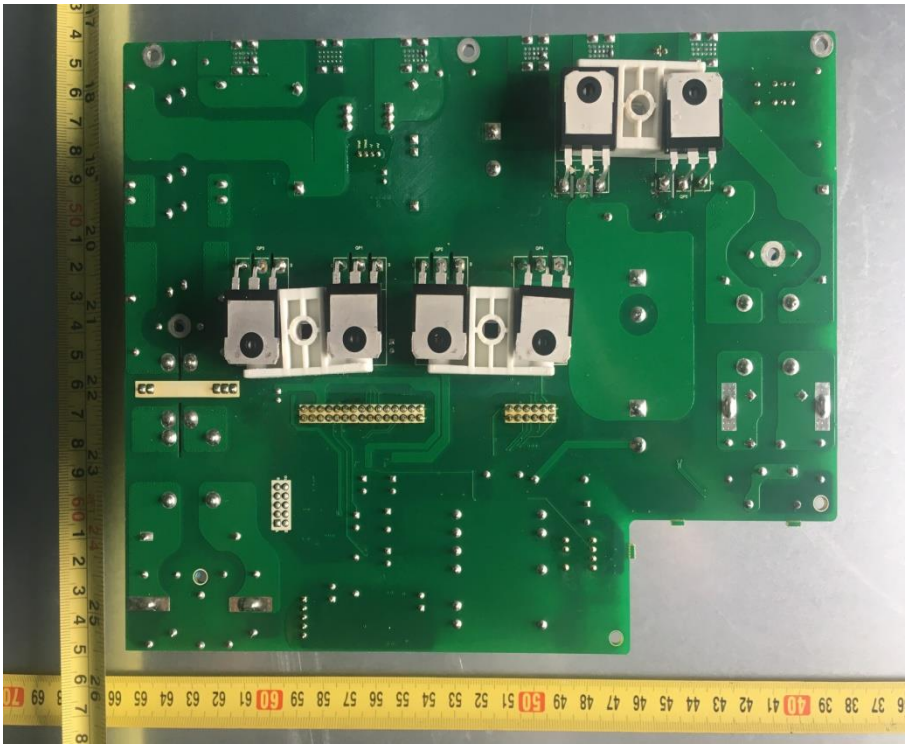
Internal view of enclosure (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)



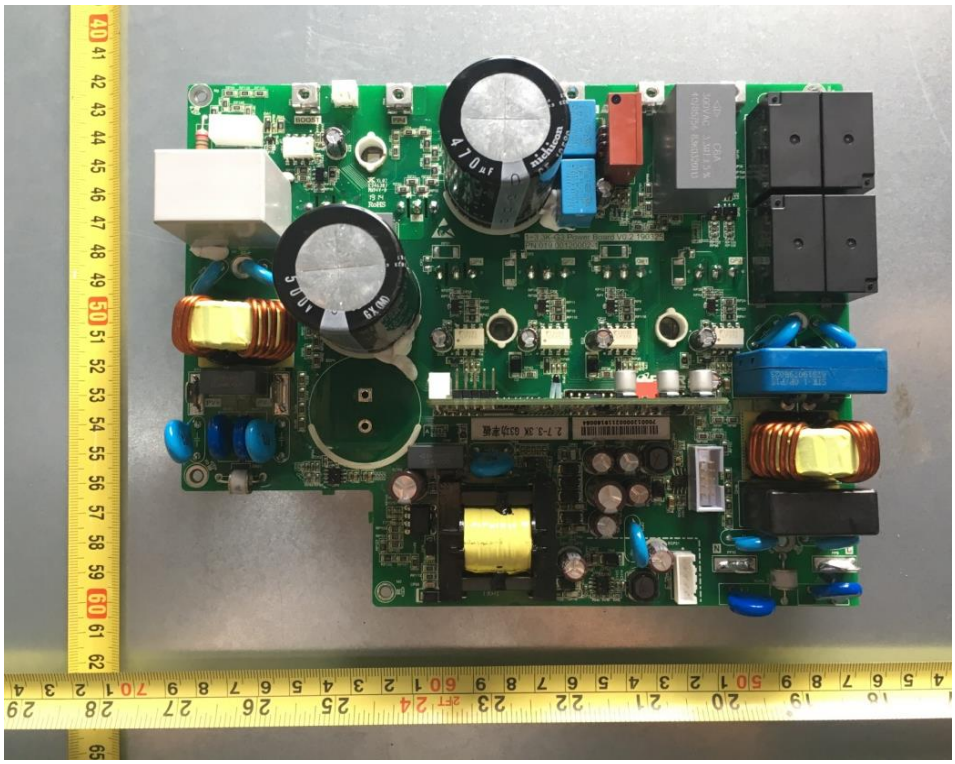
Front side of main board 1 (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)



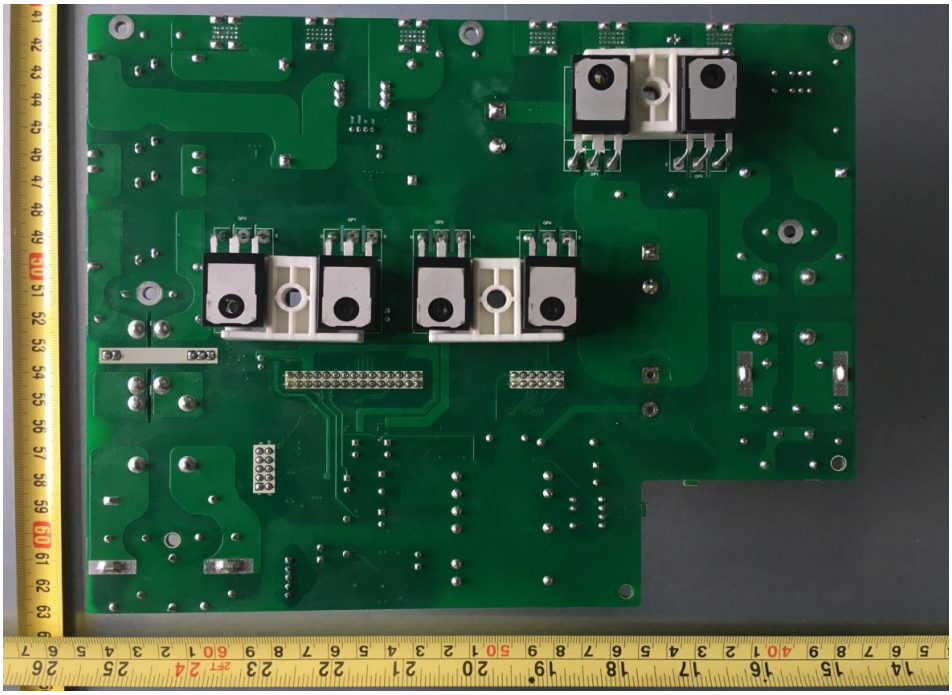
Back side of main board 1 (SOFAR 2700TL-G3, SOFAR 3000TL-G3, SOFAR 3300TL-G3)



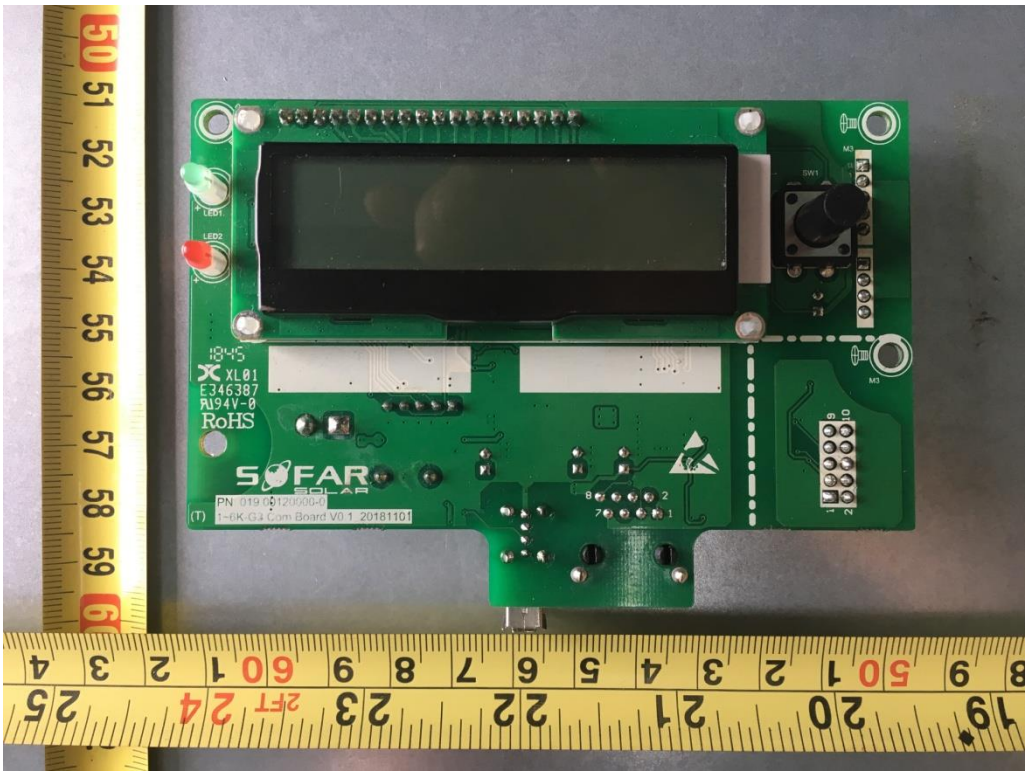
Front side of main board 2 (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)



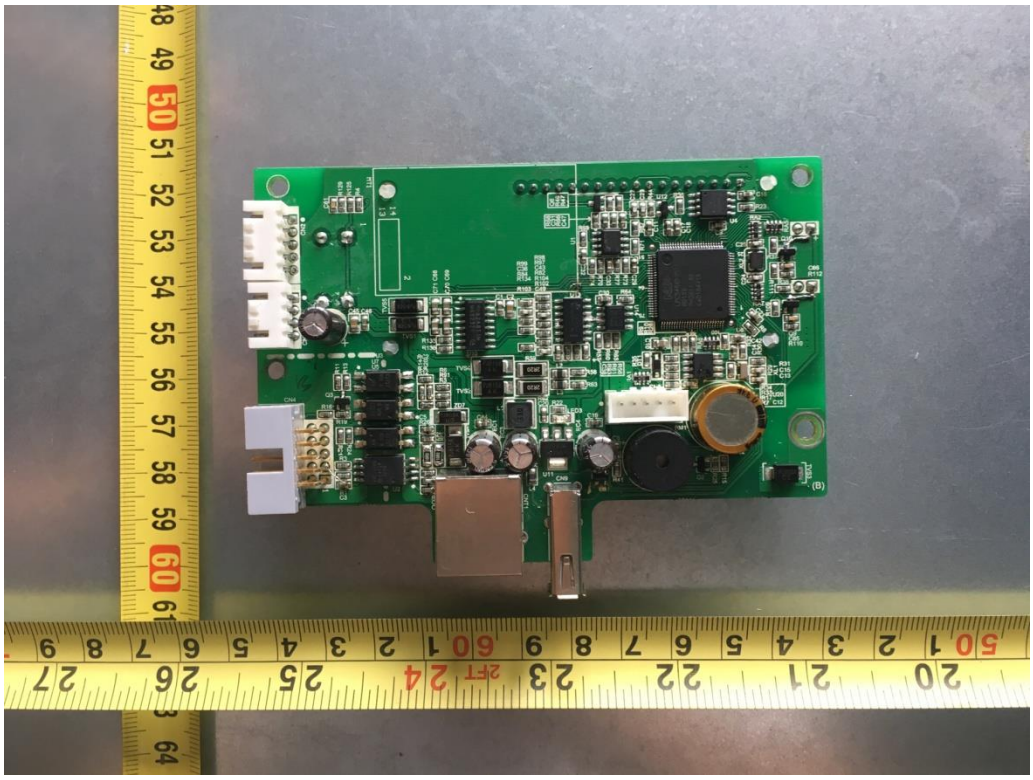
Back side of main board 2 (SOFAR 1100TL-G3, SOFAR 1600TL-G3, SOFAR 2200TL-G3)



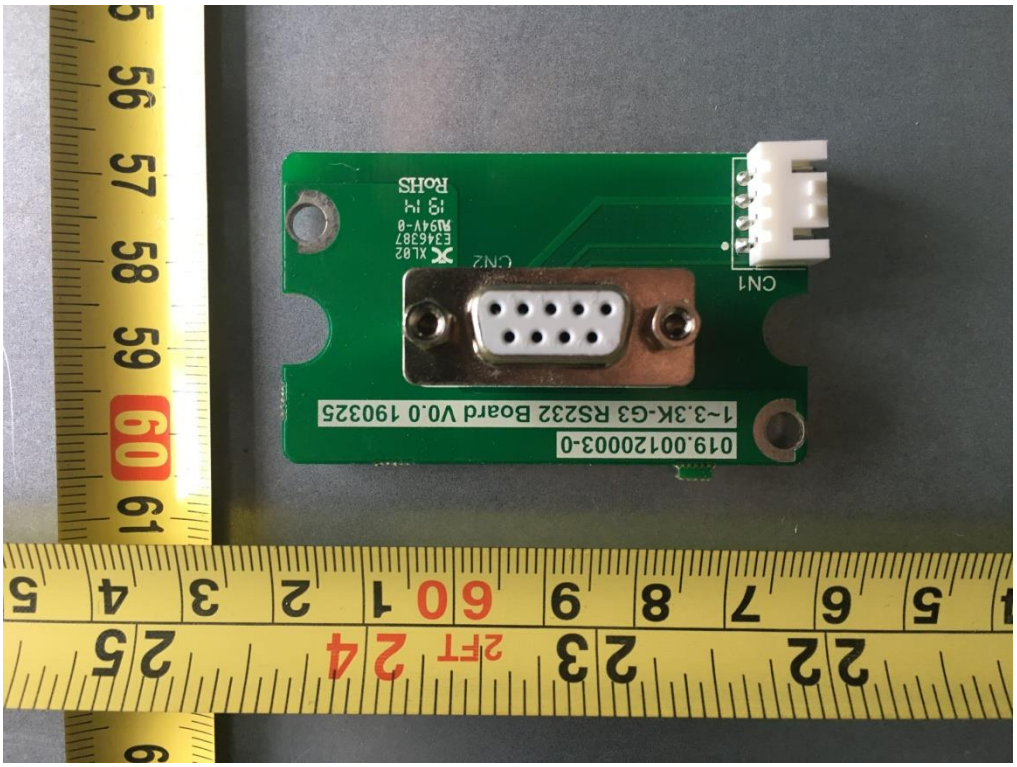
Front side of Control board



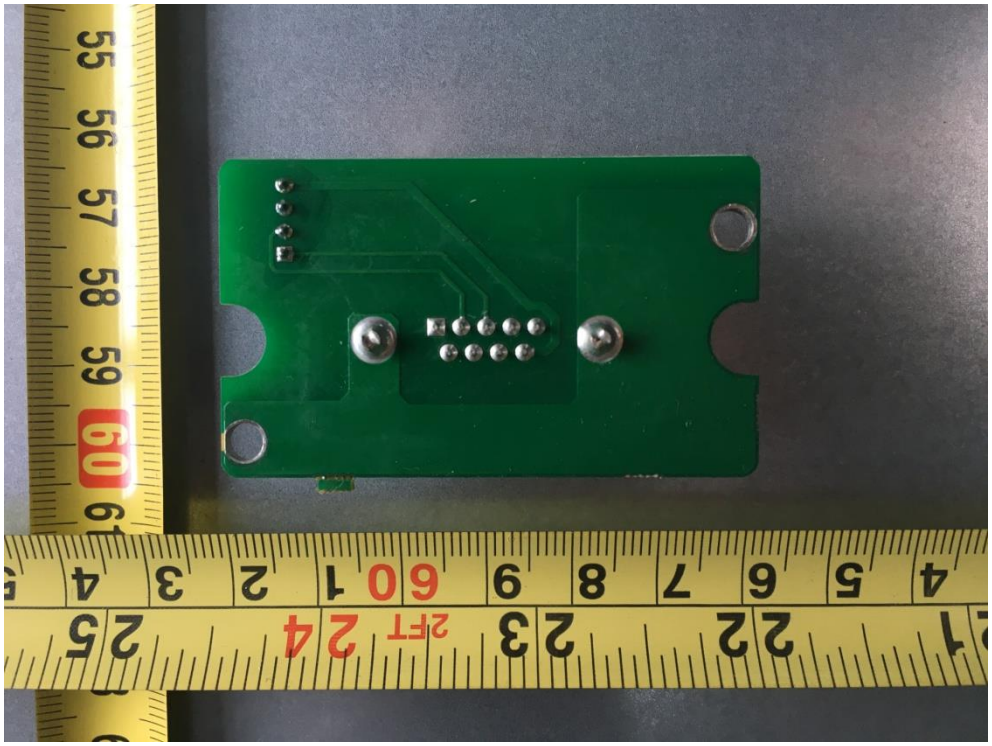
Front side of Control board



Front view of RS 232 board



Back view of RS 232 board

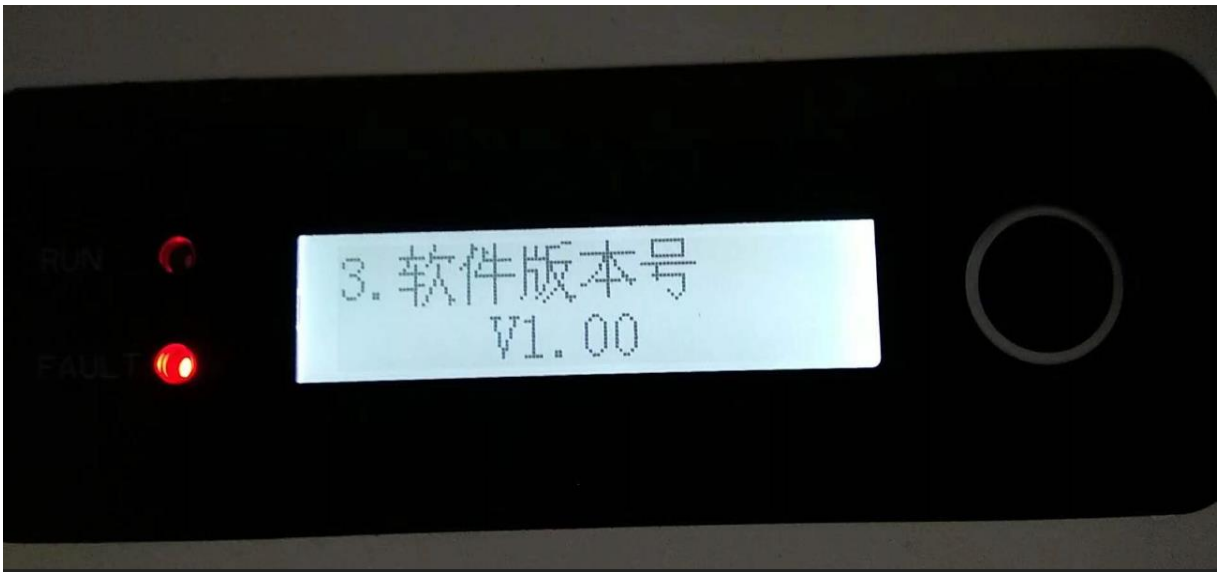


Connection interface

Grounding

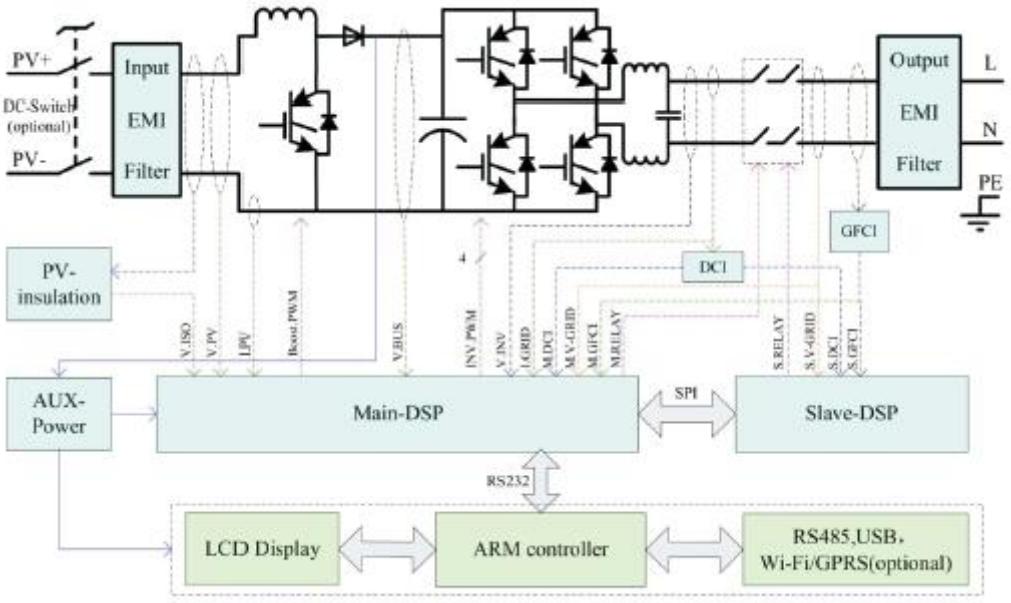

Software Number

Software version



6 ELECTRICAL SCHEME

Equipment under testing



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