

**TESTING FOR THE VERIFICATION OF
COMPLIANCE OF PV INVERTER WITH :
UNE 206007-1 IN: 2013, REQUISITOS DE CONEXIÓN
A LA RED ELÉCTRICA.
PARTE 1: INVERSORES PARA CONEXIÓN A LA
RED DE DISTRIBUCIÓN
(MAYO 2013)**

Protocol. PE.T-LE-62

Test Report Number.....: 2220 / 0076 - D
 Type.....: Three Phase Inverter
 Tested Model: SOFAR 15000TL-G2
 Variants Models: SOFAR 12000TL-G2, SOFAR 10000TL-G2

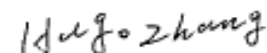
APPLICANT

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 Address.....: C/ Trespaderne, 29 - Edificio Barajas 1
 28042 MADRID (Spain)
 Hired by: 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

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 28042 Madrid (Spain)

Conducted (tested) by.....: Hugo Zhang
 (Project Engineer)



Roger Hu
 (Project Engineer)



Reviewed & Approved by: Jacobo Tevar
 (Technical Reviewer)

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Test Report Historical Revision:

Test Report Version	Date	Resume
2220 / 0076 - D	13/04/2020	First issuance

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1 SCOPE

SGS Tecnos, S.A. (Electrical Testing Laboratory) has been contracted by SGS Tecnos, S.A. (Certification body), in order to perform the testing according the following standard: "UNE 206007-1 IN, Requisitos de conexión a la red eléctrica. Parte 1: Inversores para conexión a la red de distribución" (mayo 2013).

2 GENERAL INFORMATION

2.1 Testing Period and Climatic conditions


The necessary testing has been performed along 11 working days from 2019/12/26 to 2020/01/09 and from 2020/02/25 to 2020/03/18.

All the tests and checks have been performed in accordance with the reference Standard (the tests were done at $\approx 25\text{ }^{\circ}\text{C}$).

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: Three phase inverter / Fix installed
 Manufacturer/ Supplier/ Installer.....: Shenzhen SOFAR SOLAR Co., Ltd.
 Trade mark: 
 Model/ Type.....: SOFAR 15000TL-G2
 Serial Number.....: ZN1CS015K1R081
 Serial Number ESE.....: ZN1CS015K1R172
 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):

 Solar Grid-tied Inverter	
Model No:	SOFAR 15000TL-G2
Max.DC Input Voltage	1000V
Operating MPPT Voltage Range	160-960V
Max. Input Current	21A/11A
Max. PV Isc	30A/15A
Nominal Grid Voltage	3/N/PE,230/400Vac
Max.Output Current	3x24A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	15000W
Max.Output Power	16500VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~ +60°C
Protective Class	Class I
Topology	Non-isolated
Made In China	
Manufacturer : Shenzhen SOFAR SOLAR Co.,Ltd. Address : 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community,XinAn Street, BaoAn District, Shenzhen, China IEC62109-1,IEC62109-2,NB-T 32004	
	

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.

Tested model:

- 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 °C ~60 °C		
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 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 used from 2019/12/26 to 2020/01/09

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofar solar	1	Digital oscilloscope	KEYSIGHT/ DS0X3024T	MY57251898	2019-02-13	2020-02-12
	2	Voltage probe	SanHua / SI-9110	111541	2019-02-13	2020-02-12
	3	Voltage probe	SanHua / SI-9110	152627	2019-02-13	2020-02-12
	4	Voltage probe	SanHua / SI-9110	111134	2019-02-13	2020-02-12
	5	Power analyzer	Yokogawa / WT3000	91N610888	2019-02-13	2020-02-12
	6	Current probe	Fluke / i1000s	29503223	2019-02-13	2020-02-12
	7	Current probe	Fluke / i1000s	30413448	2019-02-13	2020-02-12
	8	Current probe	CYBERTEK / CP1000A	C181000927	2019-02-13	2020-02-12
	9	Temperature & Humidity meter	Anymeters / TH101B	20103024522 0	2019-02-13	2020-02-12
	10	Temperature & Humidity Chamber	Henggong / HGTP-225R	HG13030801	2019-02-13	2020-02-12
SGS	11	True RMS Multimeter	Fluke / 289C	GZE012-53	2019-02-26	2020-02-25

Equipment used from 2020/02/25 to 2020/03/18

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofar Solar	12	Digital oscilloscope	Agicent / DS05014A	MY50070266	2020-01-14	2021-01-13
	13	Voltage probe	SanHua / SI-9110	111152	2020-01-14	2021-01-13
	14	Voltage probe	SanHua / SI-9110	152627	2020-01-14	2021-01-13
	15	Voltage probe	SanHua / SI-9110	111134	2020-01-14	2021-01-13
	16	Power analyzer	ZLG/ PA3000	PA3004- P0004-1422	2020-01-14	2021-01-13
	17	Current probe	CYBERTEK/ CP1000A	C181000922	2020-01-14	2021-01-13
	18	Current probe	CYBERTEK/ CP1000A	C181000925	2020-01-14	2021-01-13
	19	Current probe	CYBERTEK/ CP1000A	C181000929	2020-01-14	2021-01-13
	20	Temperature & Humidity meter	Anymeters / TH101B	20103024522 0	2020-01-14	2021-01-13
	21	Temperature & Humidity meter	KSQN/ KTHG-415TBS	14864K	2020-01-14	2021-01-13
	SGS	22	True RMS Multimeter	Fluke / 187	GZE012-8	2019-12-05

2.4 Factory information

Factory Name : **Dongguan SOFAR SOLAR Co., Ltd.**
 Factory Address : 1F – 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China.

2.5 Measurement Uncertainty

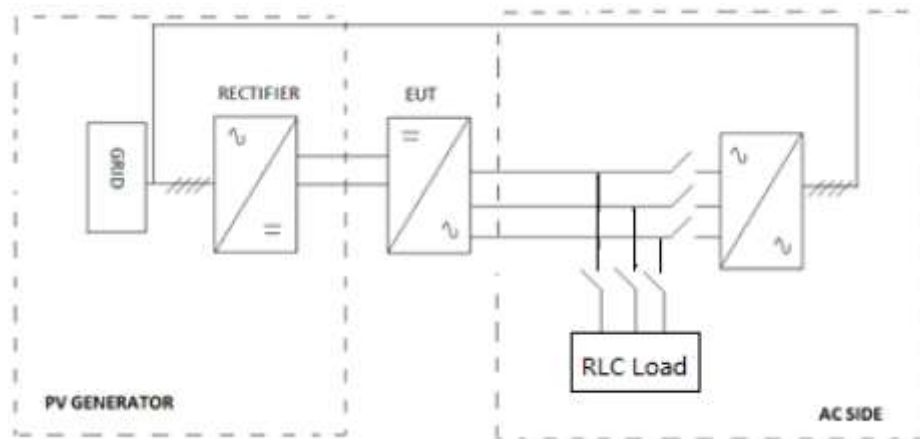
Magnitude	Uncertainty
Voltage measurement uncertainty	±1.5 %
Current measurement uncertainty	±2.0 %
Frequency measurement uncertainty	±0.2 %
Time measurement uncertainty	±0.2 %
Power measurement uncertainty	±2.5 %
Phase Angle	±1 °
cosφ	±0.01
Note1: Measurements uncertainties showed in this table are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

2.6 Definitions

ESE	Auxiliary inverter	P _n	Nominal Power
EUT	Equipment under testing	Q _r	Quality factor
I _n	Nominal Current	UF	Under frequency
OF	Over frequency	U _n	Nominal Voltage
OV	Over voltage	UV	Under voltage

2.7 Test set up.

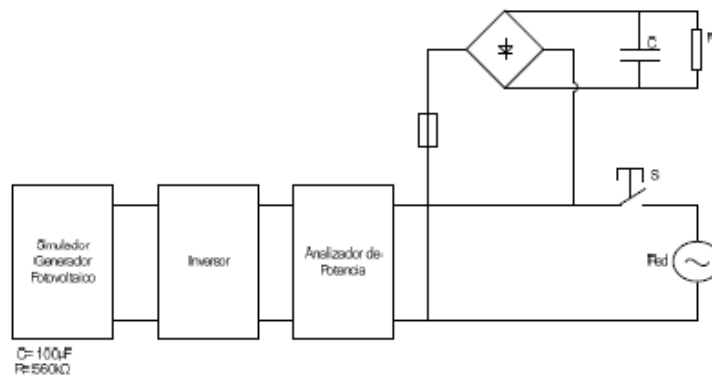
Below is the simplified construction of the test set up.



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 used quality factor of resonant load was $Q_f=2$.

For overvoltage generation test, the following test set up has been done.



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	
	UNE 206007-1 IN: 2013	
5	Technical requirements	
5.1	Limitation of the DC injection into the grid side	P
5.2	Requirements base on inverter isolation and array grounding	N/R
5.3	Fault tolerance of residual current monitoring	N/R
5.4	Frequency and Voltage trip limits and trip times	P
5.5	Self-reconnection	P
5.6	Unintentional islanding	P
5.7	Overvoltage generation	P
5.8	Grid quality	P
5.9	Reconnection out of synchronism	P

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

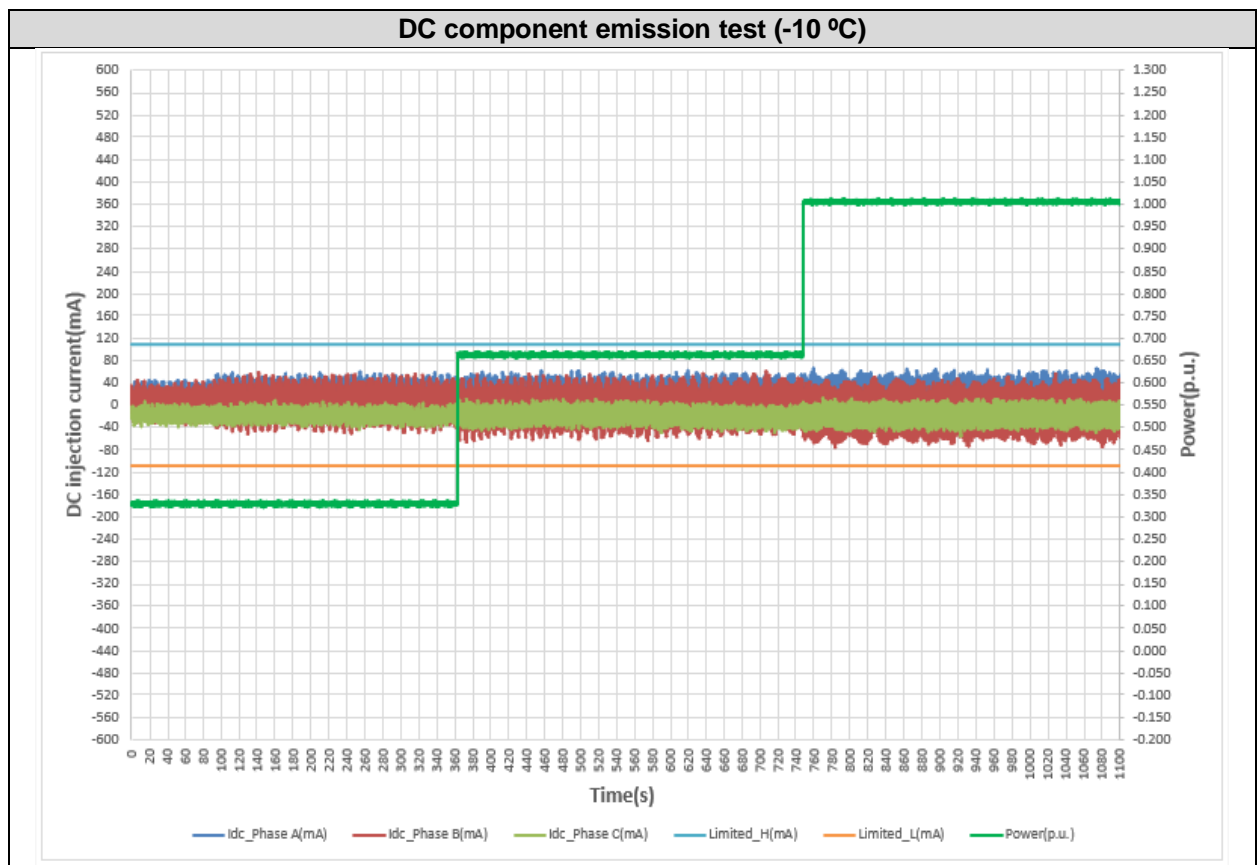
4 TEST RESULTS

4.1 LIMITATION OF DC INJECTION

The verification of DC component emission test has been measured according to the chapter 5.1 of the standard. DC current injection shall be $\leq 0.5 \%I_n$ which is 109mA.

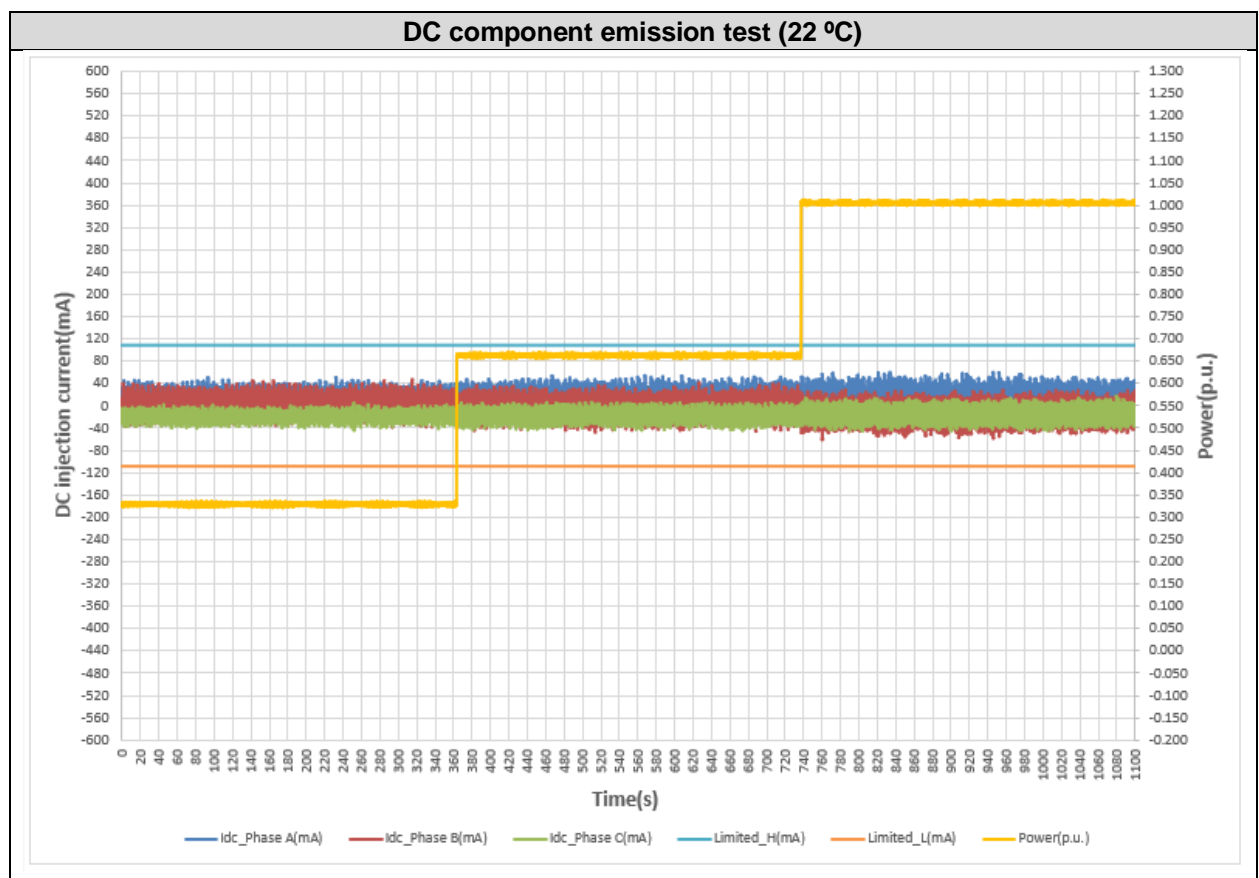
DC component emission test (-10 °C)			
Power Lever	Min ~ 33 %Pn	Medium ~ 66 % Pn	Max ~ 100 % Pn
Watt (W)	4931	9942	15079
Vrms (V)	229.6	229.9	230.3
Arms (A)	7.2	14.4	21.8
PF	0.997	0.999	0.999
Phase A			
d.c. (mA)	60	63	66
d.c. (%In) (*)	0.28	0.29	0.31
Phase B			
d.c. (mA)	59	61	56
d.c. (%In) (*)	0.27	0.28	0.26
Phase C			
d.c. (mA)	9	11	13
d.c. (%In) (*)	0.04	0.05	0.06

(*) The values obtained are in percentage with respect to the value of 21.7 A



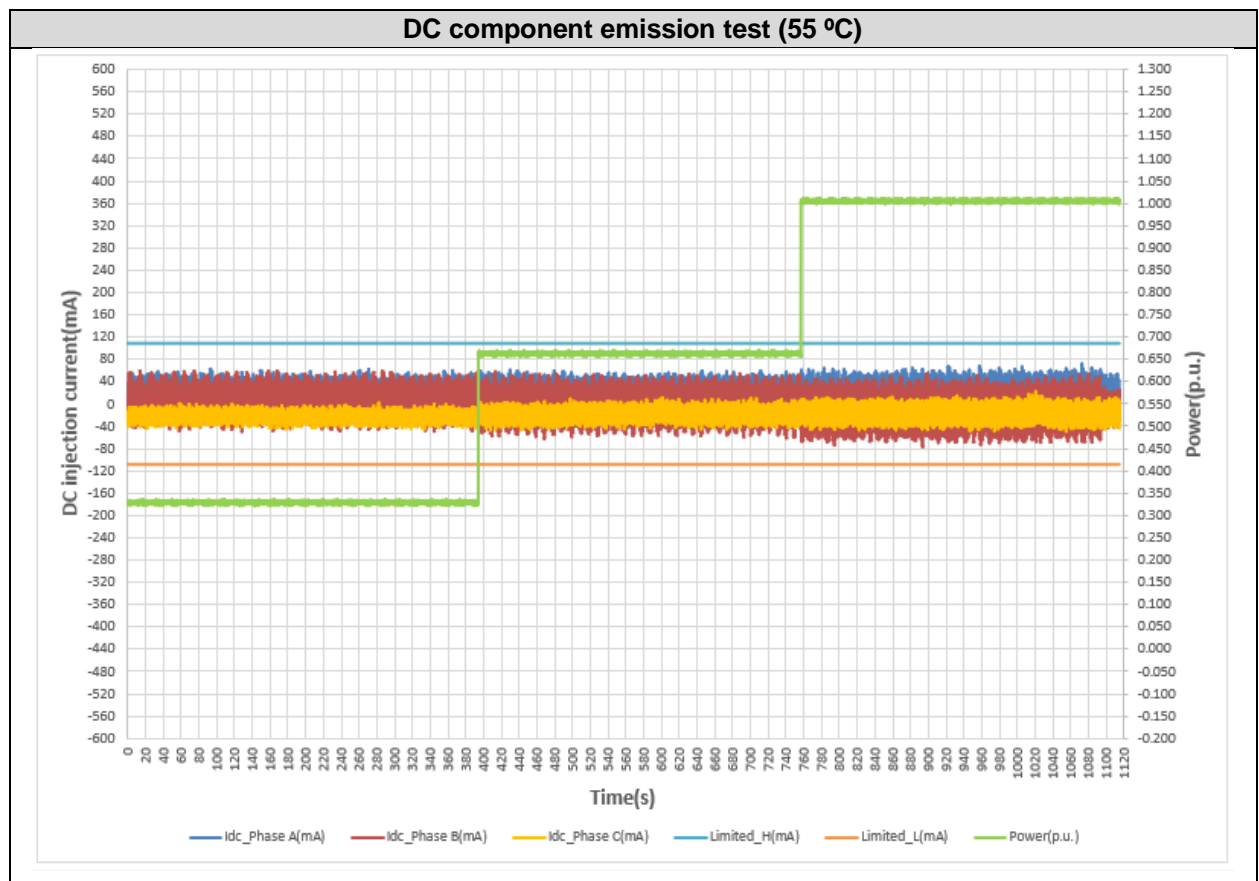
DC component emission test (22 °C)			
Power Lever	Min ~ 33 %	Medium ~ 66 %	Max ~ 100 %
Watt (W)	4932	9944	15081
Vrms (V)	229.6	229.9	230
Arms (A)	7.2	14.4	21.8
PF	0.997	0.999	0.999
Phase A			
d.c. (mA)	52	55	61
d.c. (%In) (*)	0.24	0.25	0.28
Phase B			
d.c. (mA)	47	41	28
d.c. (%In) (*)	0.22	0.19	0.13
Phase C			
d.c. (mA)	6	7	18
d.c. (%In) (*)	0.03	0.03	0.08

(*) The values obtained are in percentage with respect to the value of 21.7 A



DC component emission test (55 °C)			
Power Lever	Min ~ 33 %	Medium ~ 66 %	Max ~ 100 %
Watt (W)	4931	9942	15078
Vrms (V)	229.6	230.0	230
Arms (A)	7.2	14.4	21.8
PF	0.997	0.999	0.999
Phase A			
d.c. (Ma)	63	61	73
d.c. (%In) (*)	0.29	0.28	0.33
Phase B			
d.c. (Ma)	59	58	53
d.c. (%In) (*)	0.27	0.27	0.24
Phase C			
d.c. (Ma)	2	11	23
d.c. (%In) (*)	0.01	0.05	0.11

(*) The values obtained are in percentage with respect to the value of 21.7 A



4.2 REQUIREMENTS BASE ON THE INVERTER ISOLATION AND ARRAY GROUNDING

According to chapter 5.2 the inverter should not start unless the resistance between ground and PV input terminal is higher than the required insulation resistance.

The compliances with these requirements are stated in section 4.8.2 of the following test report:

- IEC 62109-2:2011: Test Report n° 190411091GZU-006 on 18 Jun.,2019 which issued by Intertek Testing Services Shenzhen Ltd. Guangzhou Branch.

4.3 DETECTION OF RESIDUAL CURRENT MONITORING IN THE PV

This test is required according to the chapter 5.3 of the standard.

The compliances with these requirements are stated in section 4.8.3 of following test report:

- IEC 62109-2:2011: Test Report n° 190411091GZU-006 on 18 Jun.,2019 which issued by Intertek Testing Services Shenzhen Ltd. Guangzhou Branch.

4.4 FREQUENCY AND VOLTAGE TRIP LIMITS AND TRIP TIMES

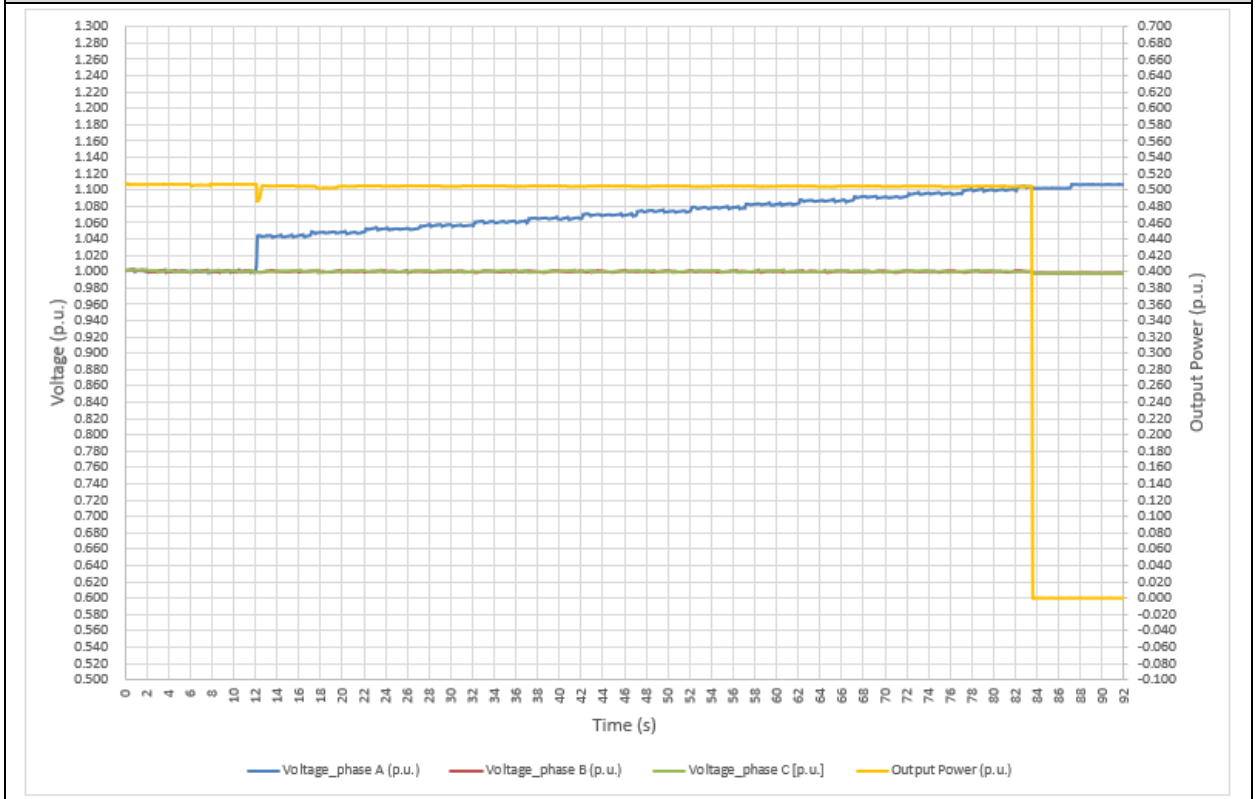
Abnormal conditions tests have been performed according to ranges and requirements stated in chapter 5.4 of the standard.

Thresholds stated in the Real Decreto 1699/2011 have been considered.

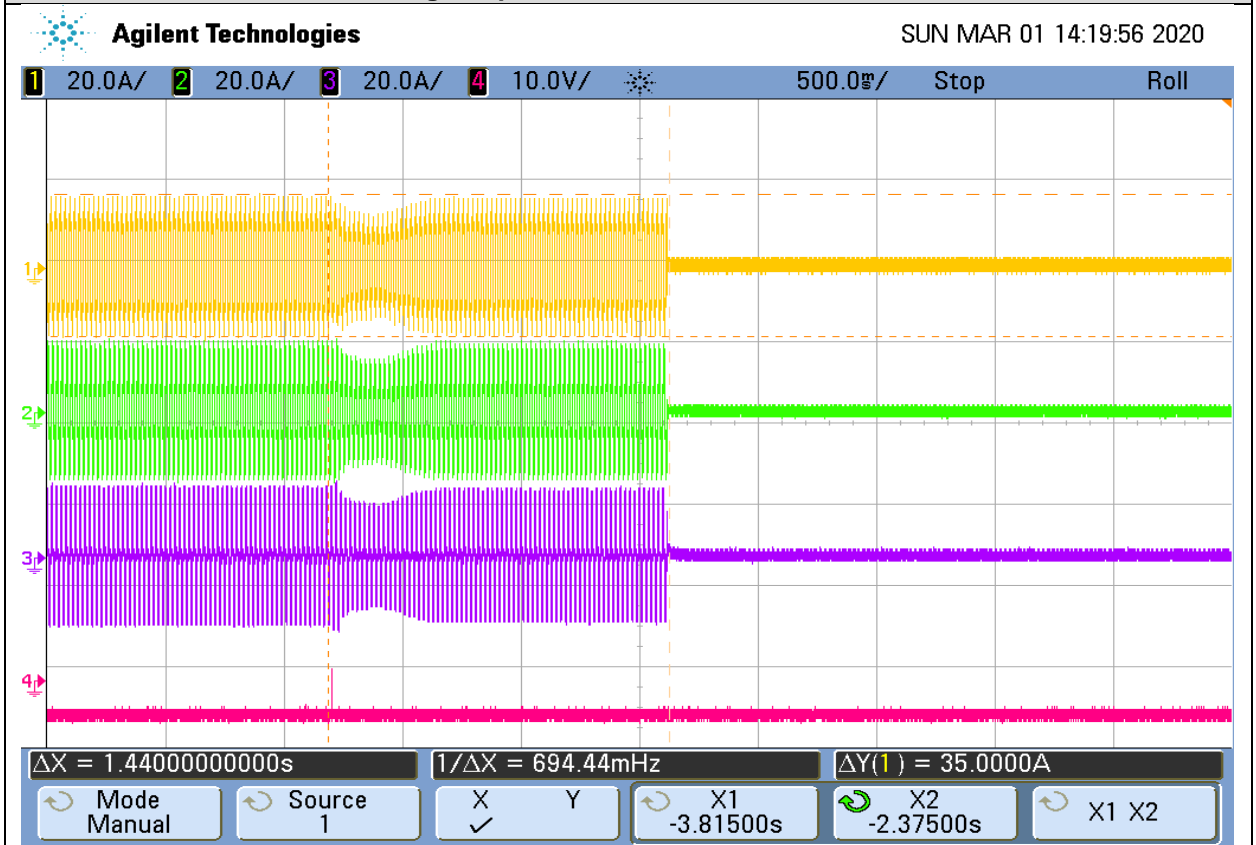
4.4.1 Voltage

Setting Voltage	Measured Voltage (p.u.)	Disconnection time limits (s)	Disconnection time measured (s)	
			Phase	Time (s)
Un + 10 %Un	1.102	1.5	Phase A-N	1.440
	1.102		Phase B-N	1.455
	1.102		Phase C-N	1.445
	1.102		Phase ABC-N	1.450
Un + 15 %Un	1.150	0.2	Phase A-N	0.193
	1.150		Phase B-N	0.194
	1.150		Phase C-N	0.190
	1.150		Phase ABC-N	0.194
Un – 15 %Un	0.842	1.5	Phase A-N	1.440
	0.846		Phase B-N	1.450
	0.846		Phase C-N	1.460
	0.846		Phase ABC-N	1.455

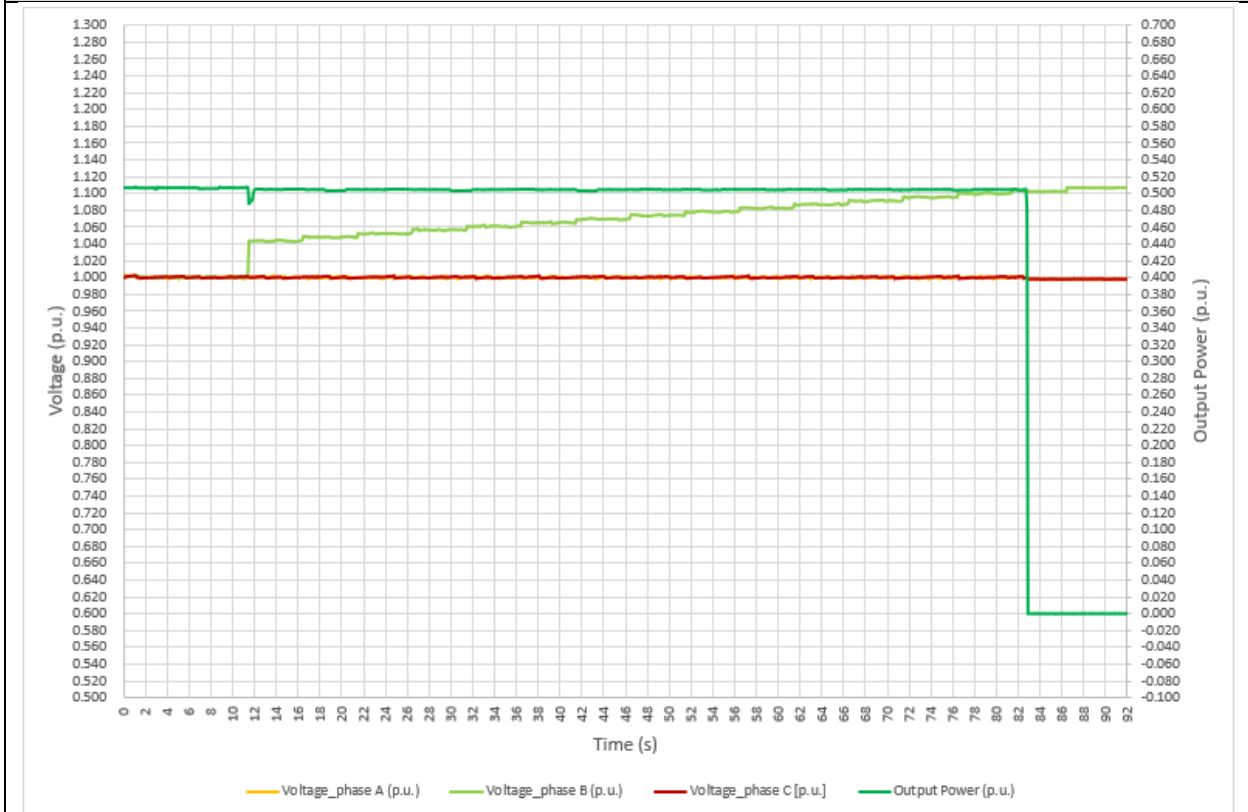
Voltage measured: Un +10 %Un Phase A-N



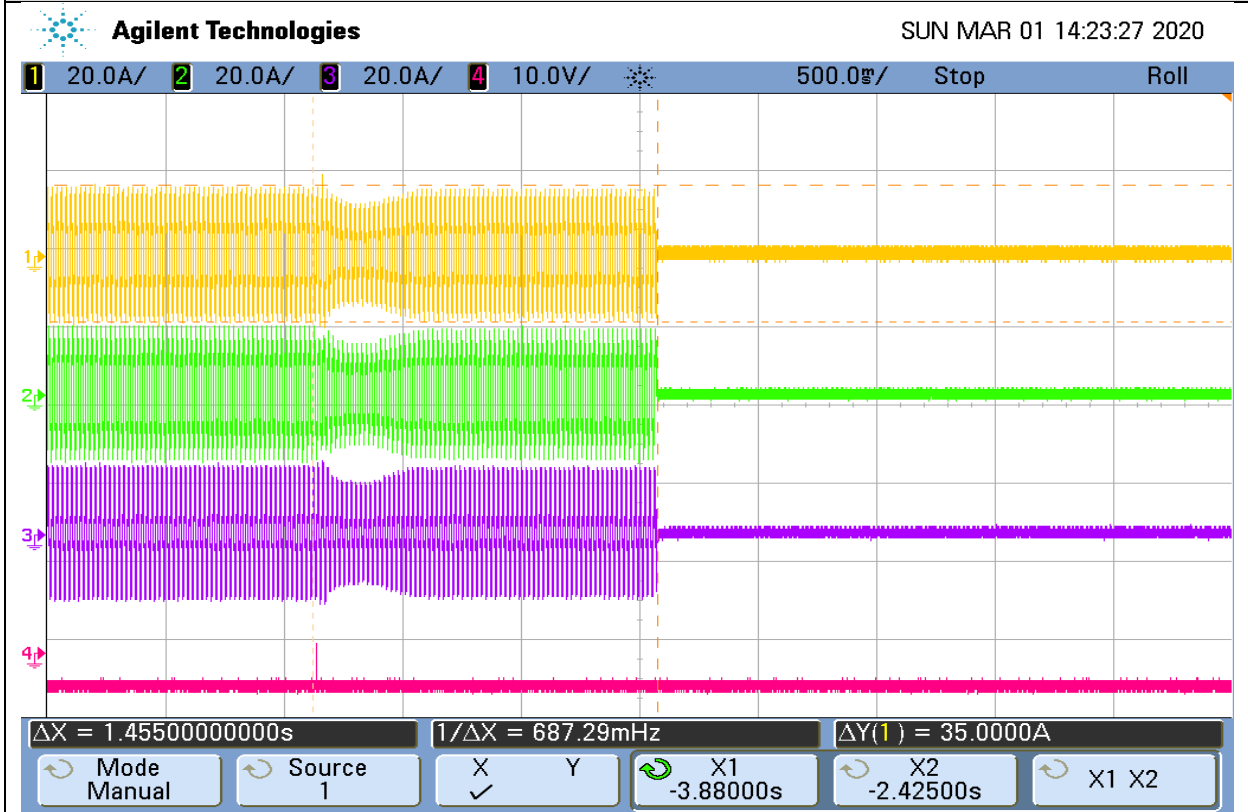
Voltage Trip Time: Un +10 %Un Phase A-N



Voltage measured: Un + 10 %Un Phase B-N



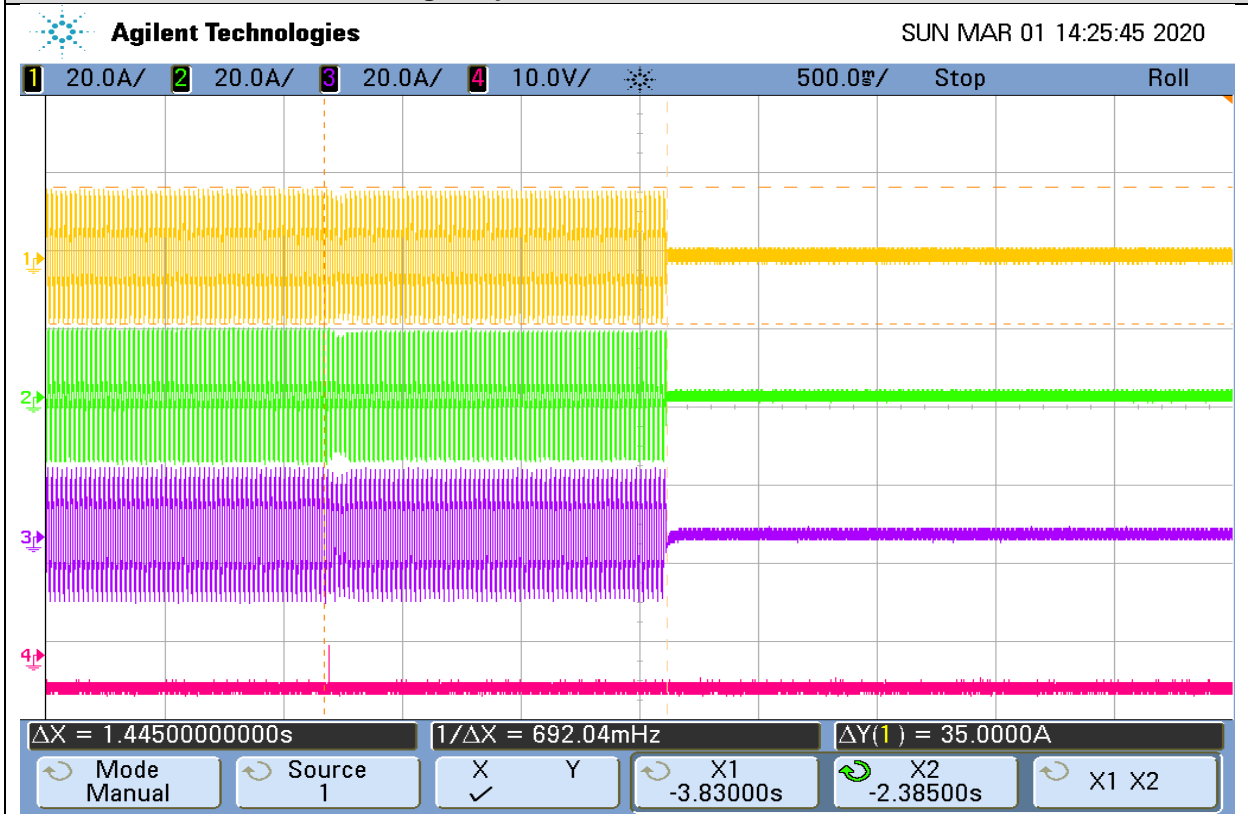
Voltage Trip Time: Un + 10 %Un Phase B-N



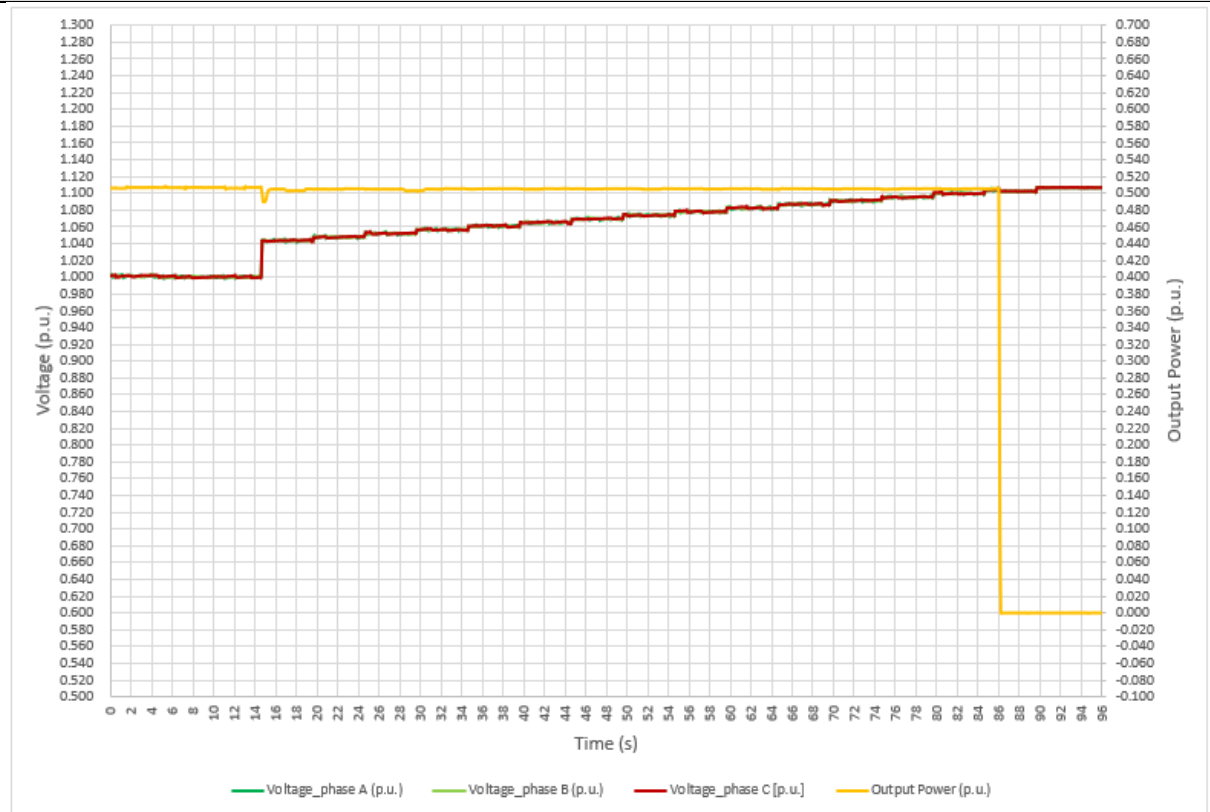
Voltage measured: Un + 10 %Un Phase C-N



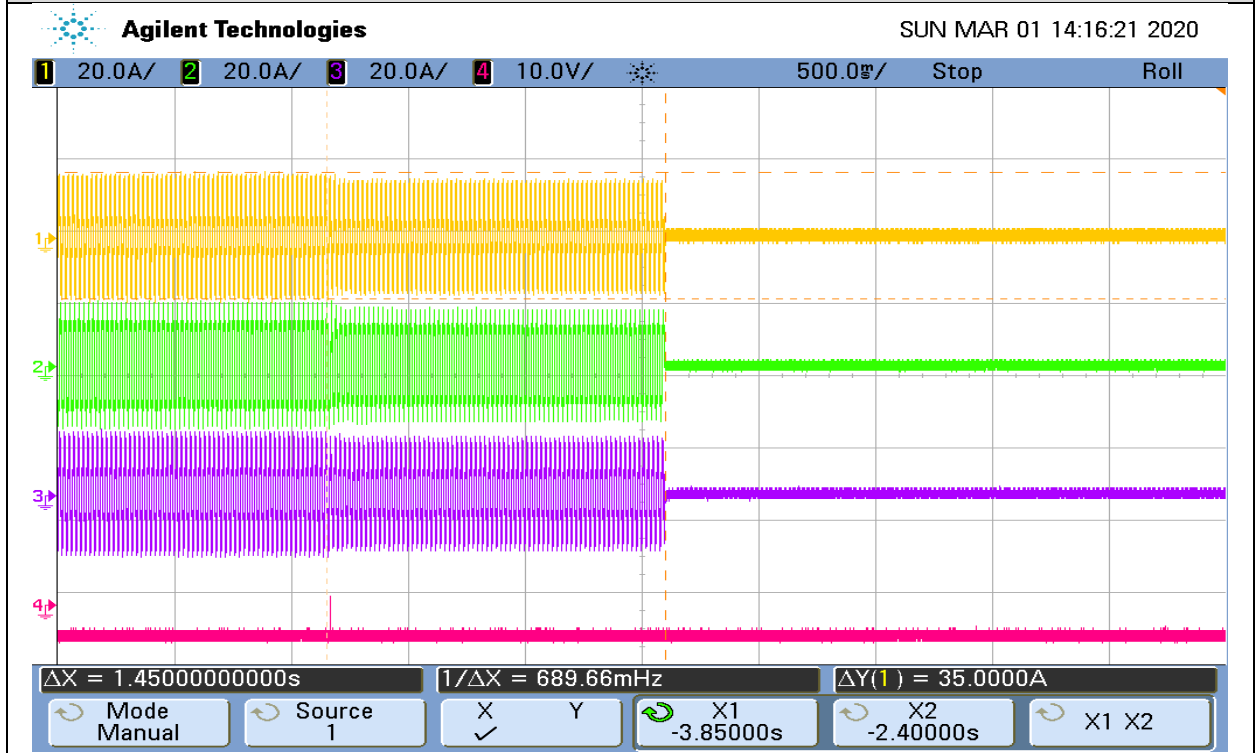
Voltage Trip Time: Un + 10 %Un Phase C-N



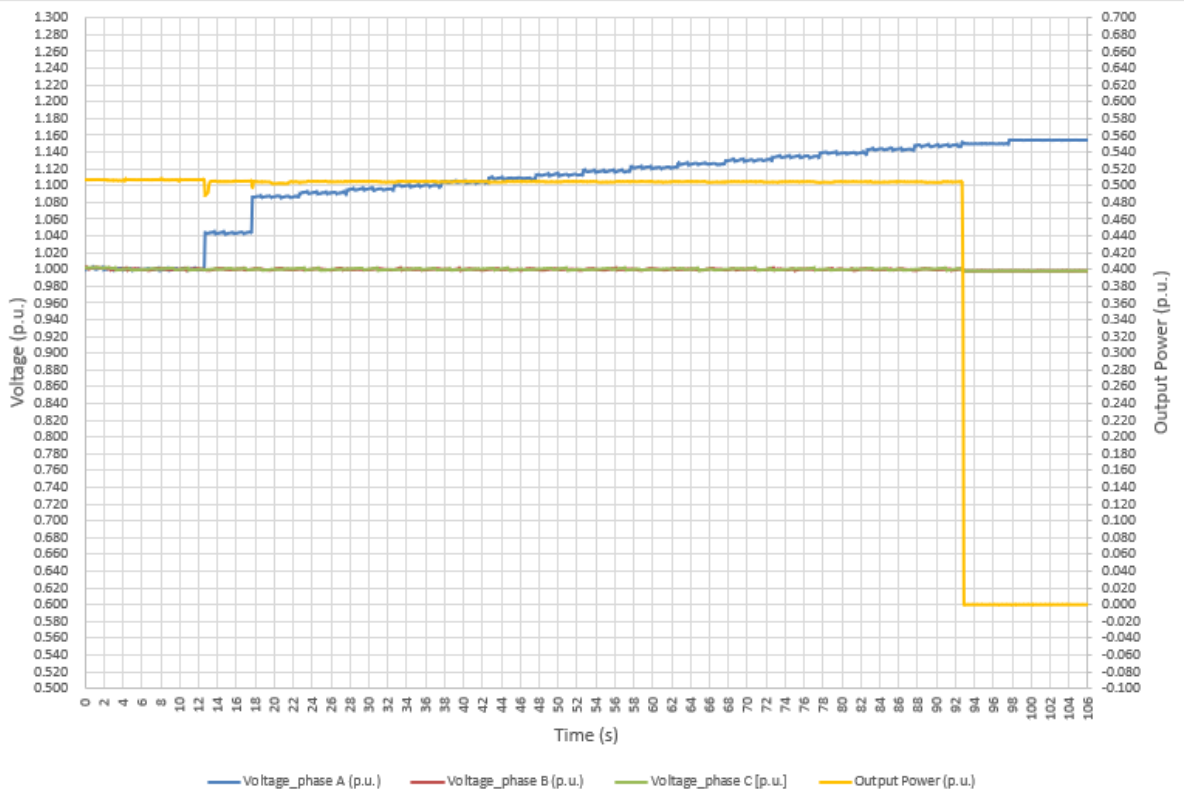
Voltage measured: Un+10%Un Phase ABC-N



Voltage Trip Time: Un+10%Un Phase ABC-N



Voltage measured: Un + 15 %Un Phase A-N



Voltage Trip Time: Un+15%Un Phase A-N

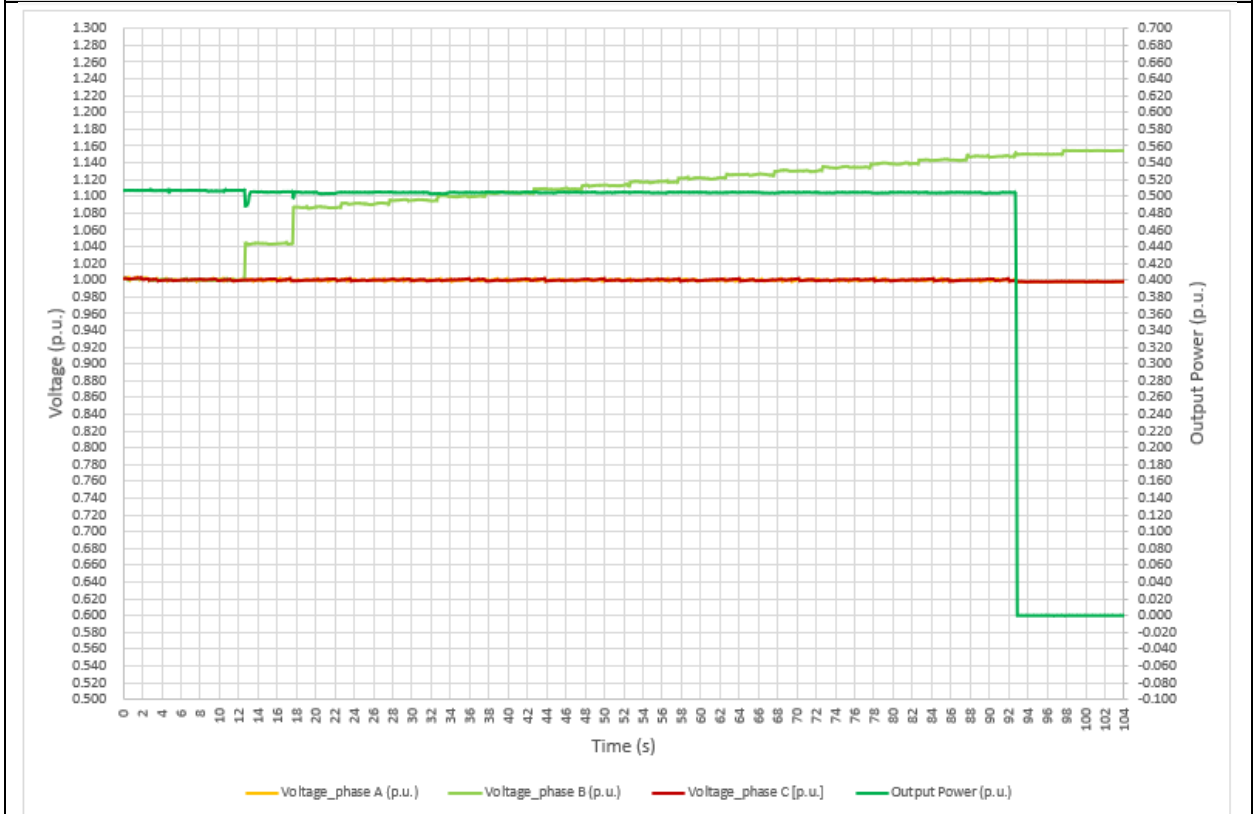
Agilent Technologies SUN MAR 01 14:33:01 2020

1 20.0A/ 2 20.0A/ 3 20.0A/ 4 10.0V/ 100.0% Stop Roll

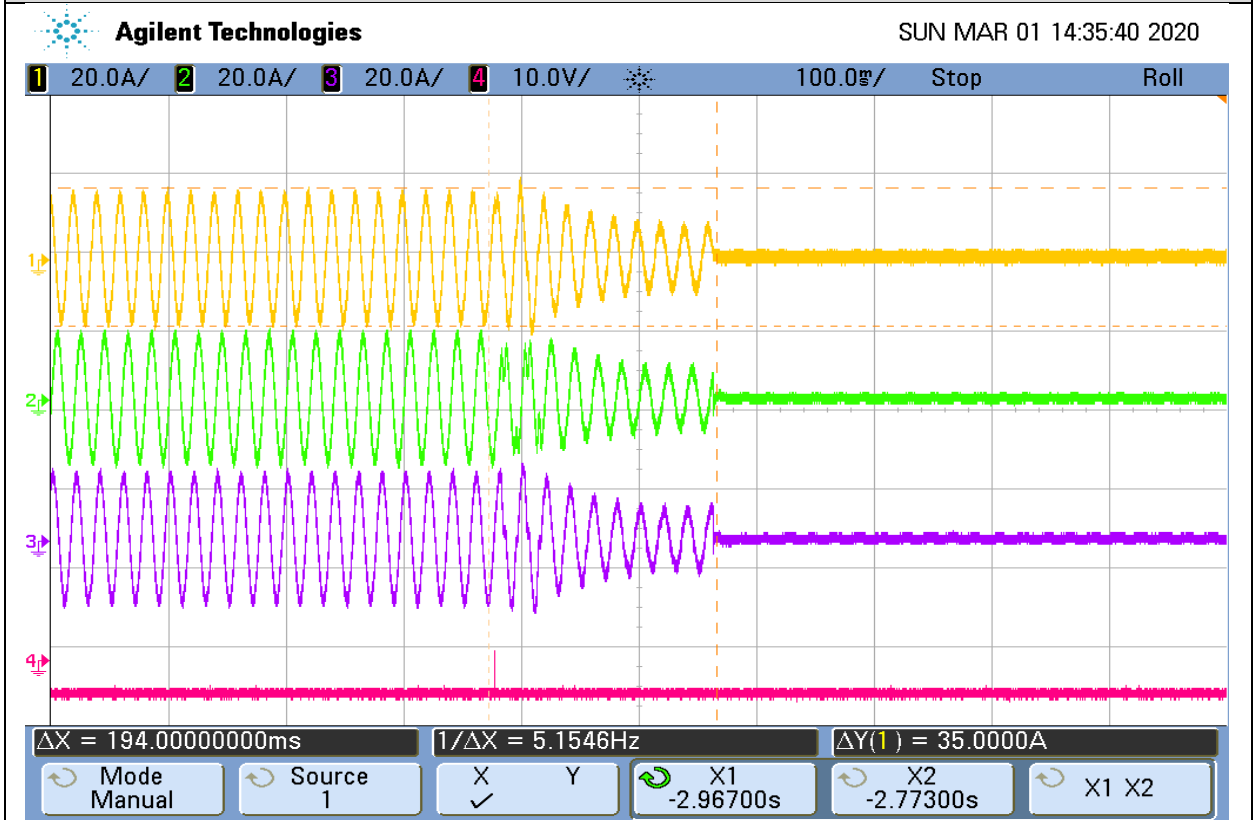
$\Delta X = 193.00000000\text{ms}$ $1/\Delta X = 5.1813\text{Hz}$ $\Delta Y(1) = 35.0000\text{A}$

Mode Manual Source 1 X Y X1 -2.92500s X2 -2.73200s X1 X2

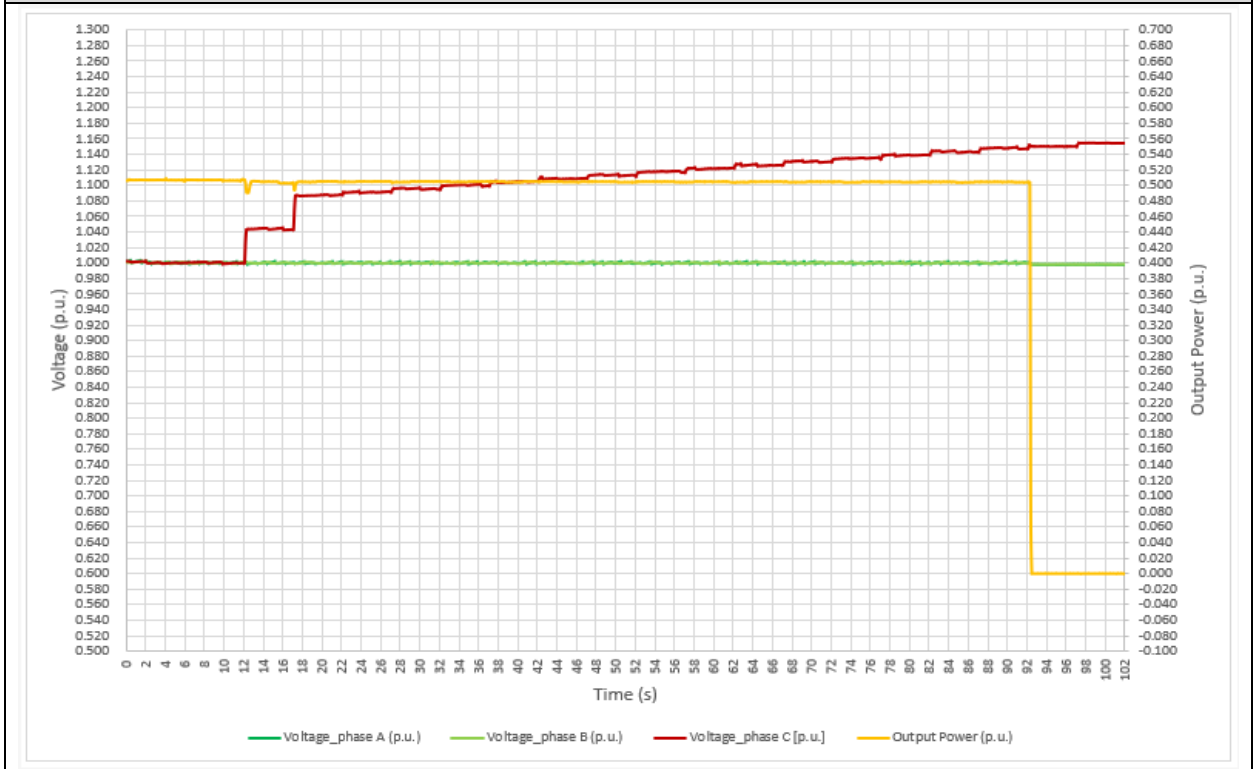
Voltage measured: Un + 15 %Un Phase B-N



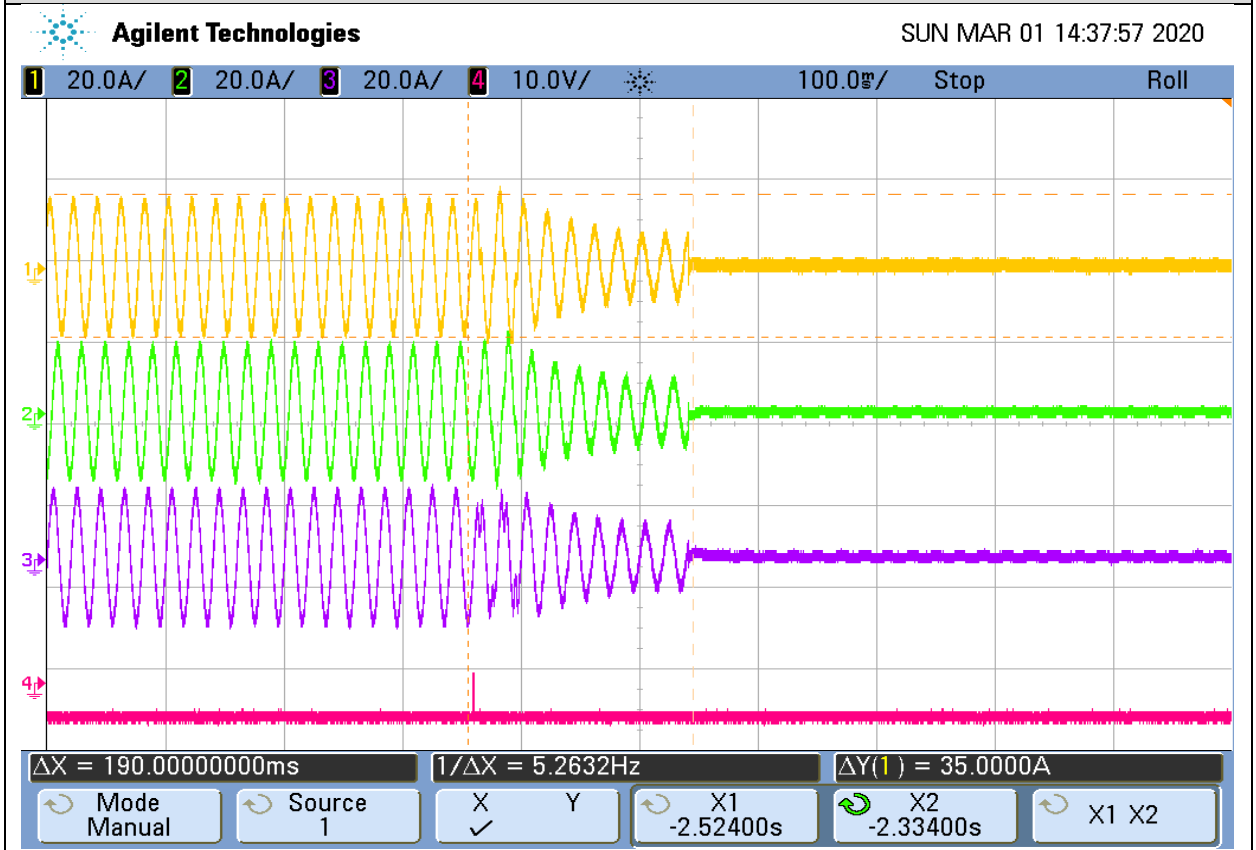
Voltage Trip Time: Un + 15 %Un Phase B-N



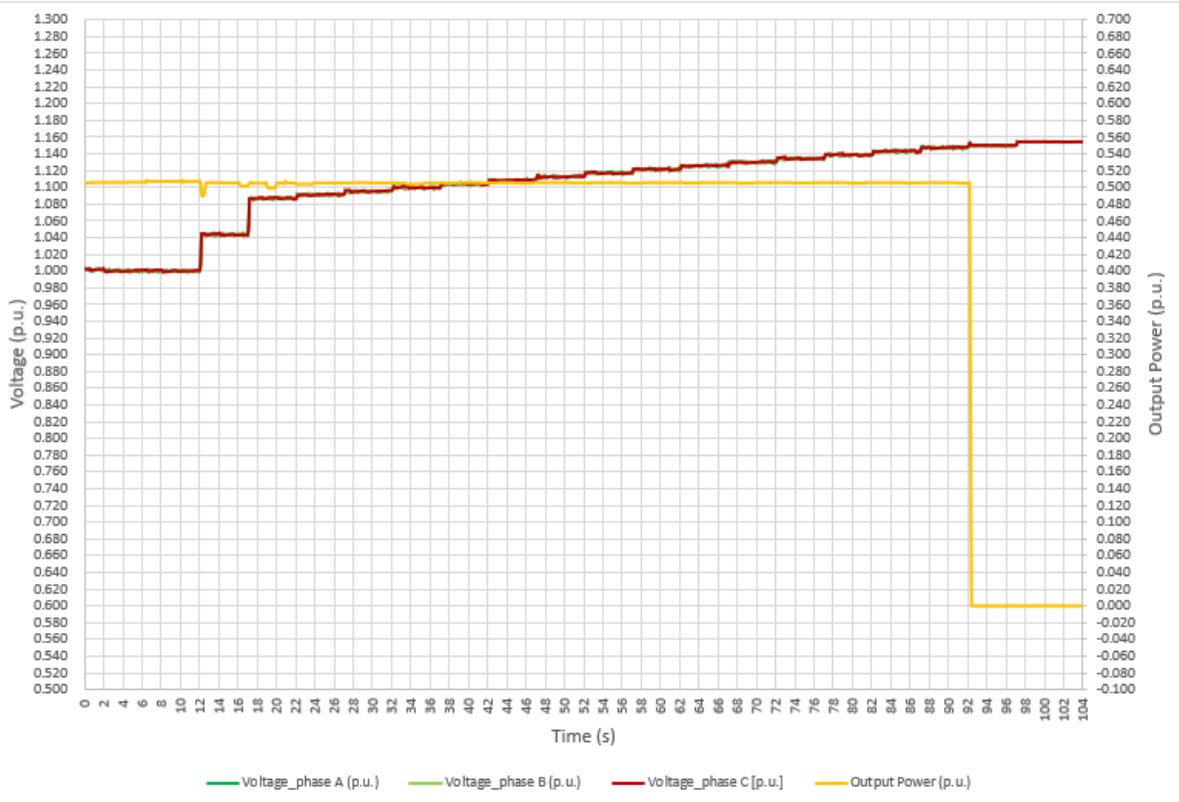
Voltage measured: Un + 15 %Un Phase C-N



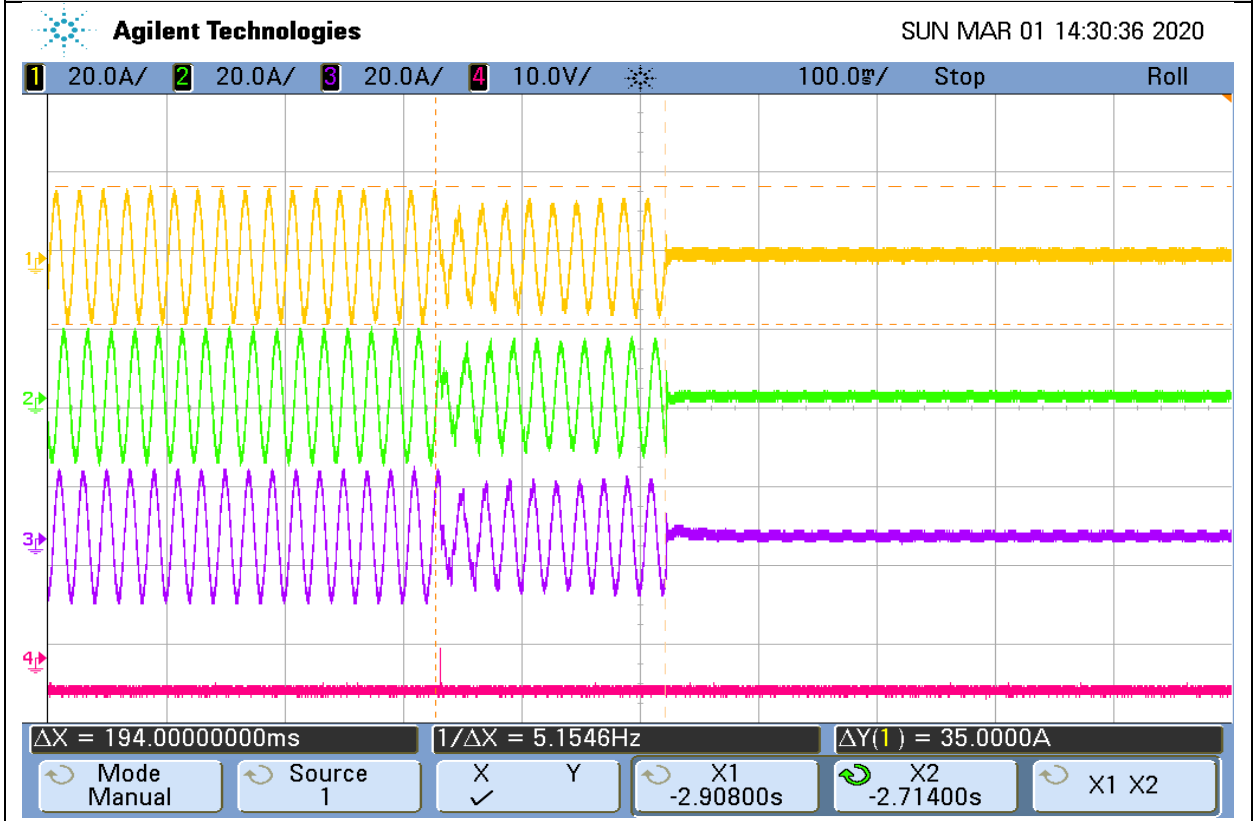
Voltage Trip Time: Un + 15 %Un Phase C-N



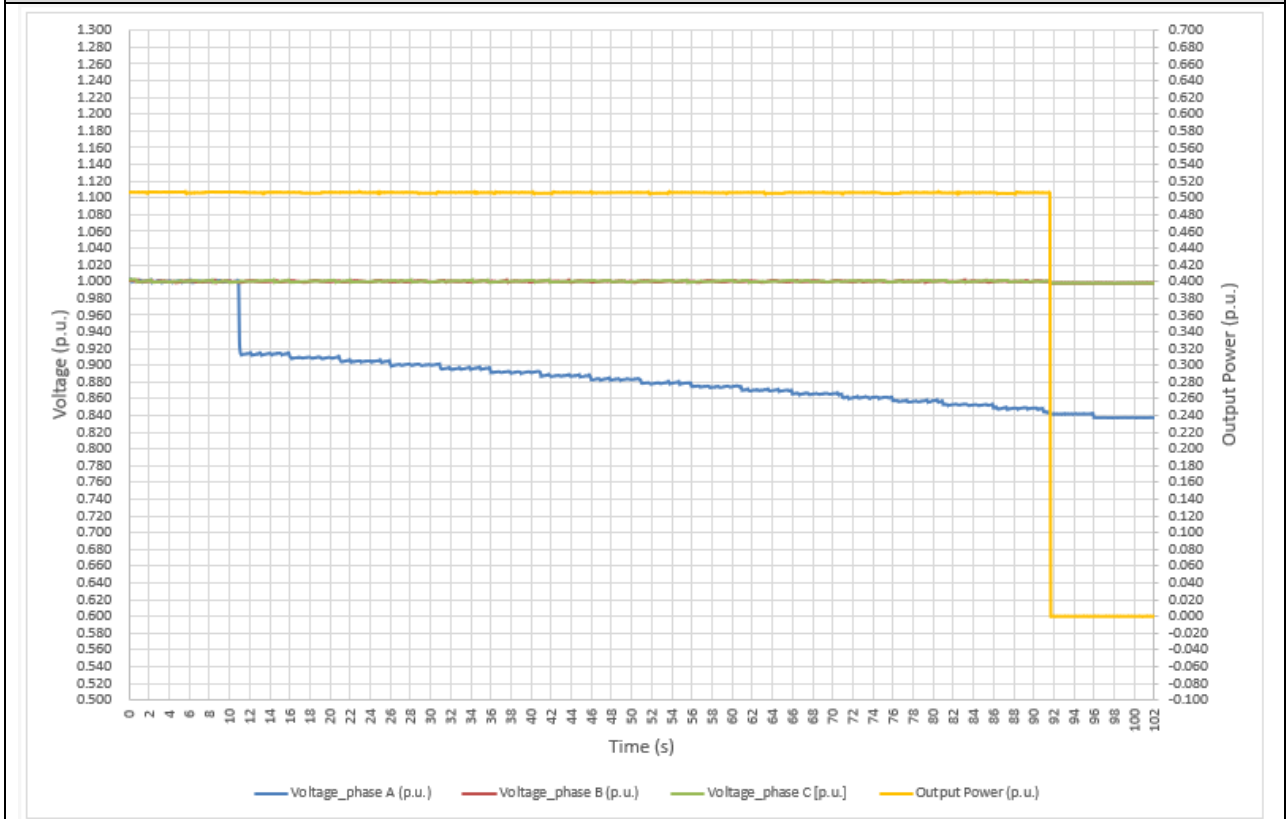
Voltage measured: Un + 15 %Un Phase ABC-N



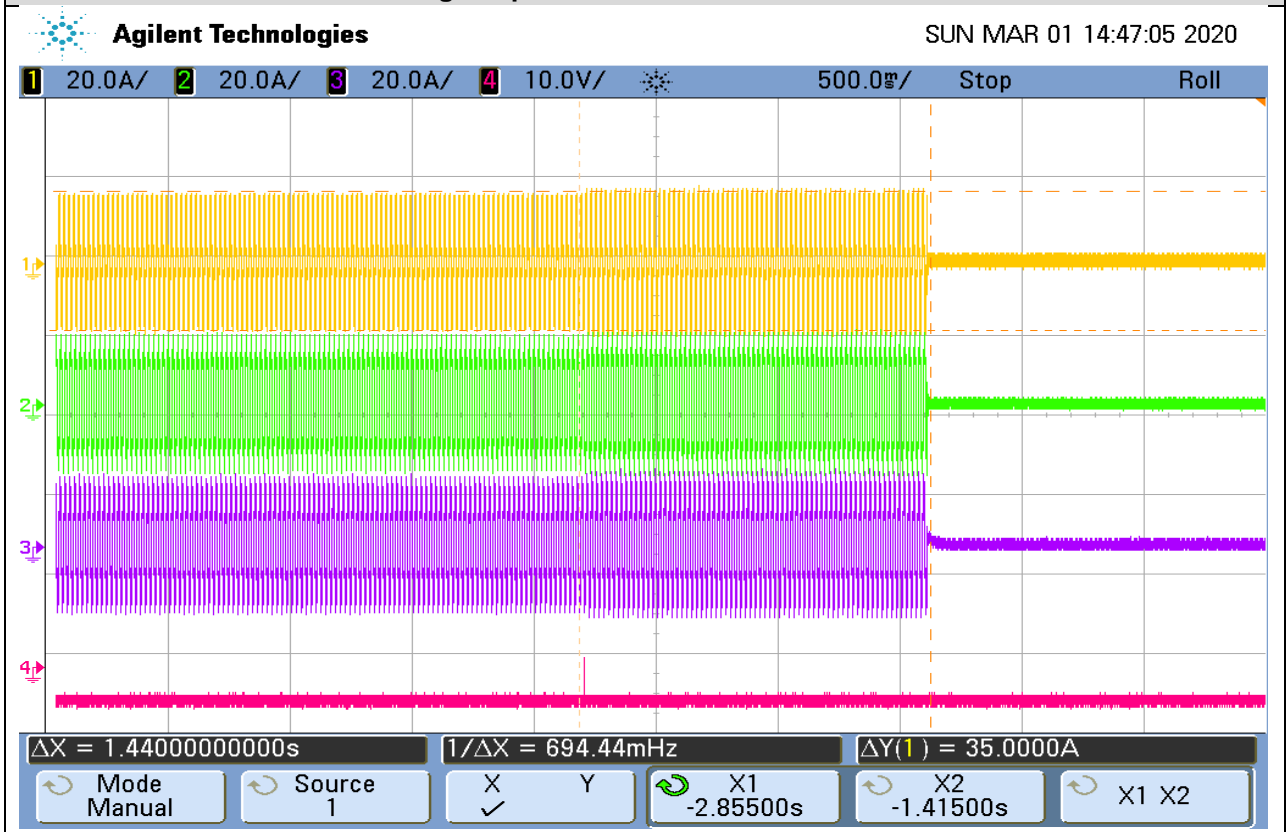
Voltage Trip Time: Un + 15 %Un Phase ABC-N



Voltage measured: Un – 15 %Un Phase A-N



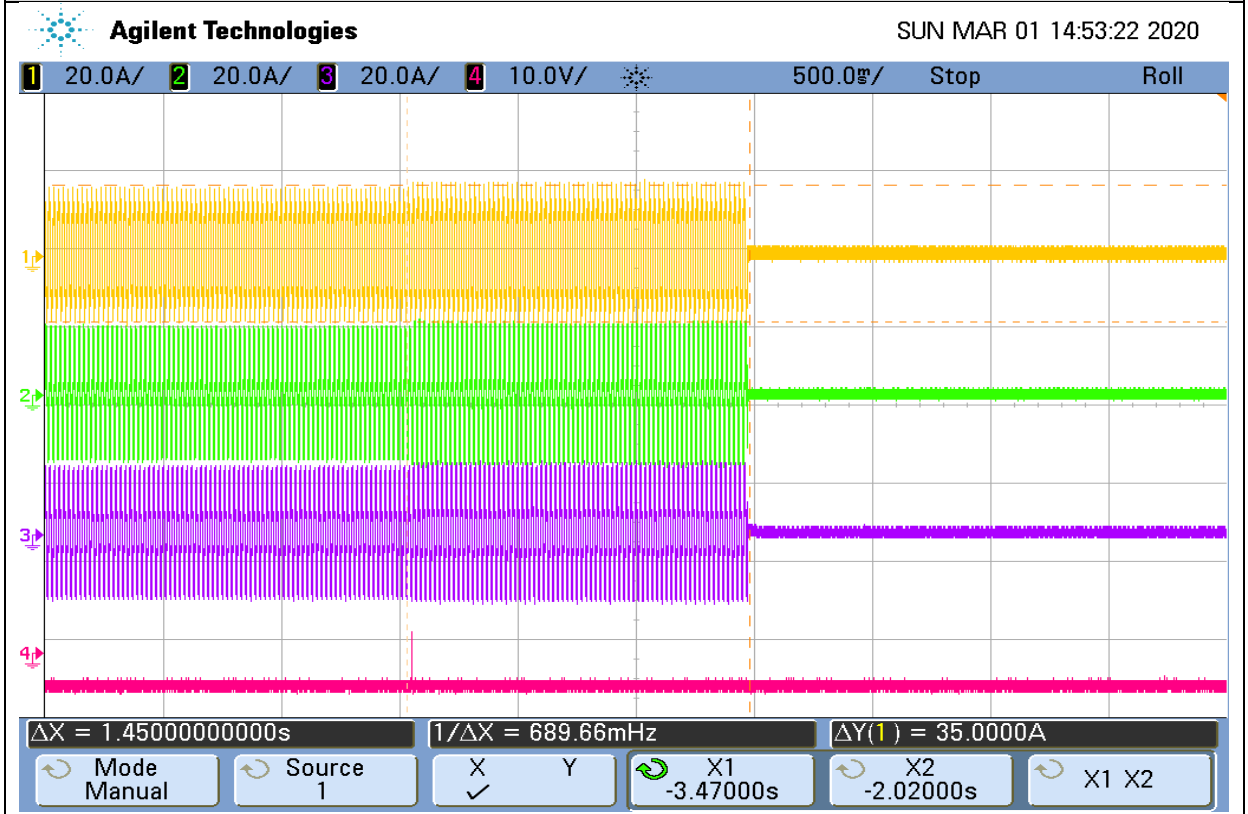
Voltage Trip Time: Un – 15 %Un Phase A-N



Voltage measured: Un – 15 %Un Phase B-N



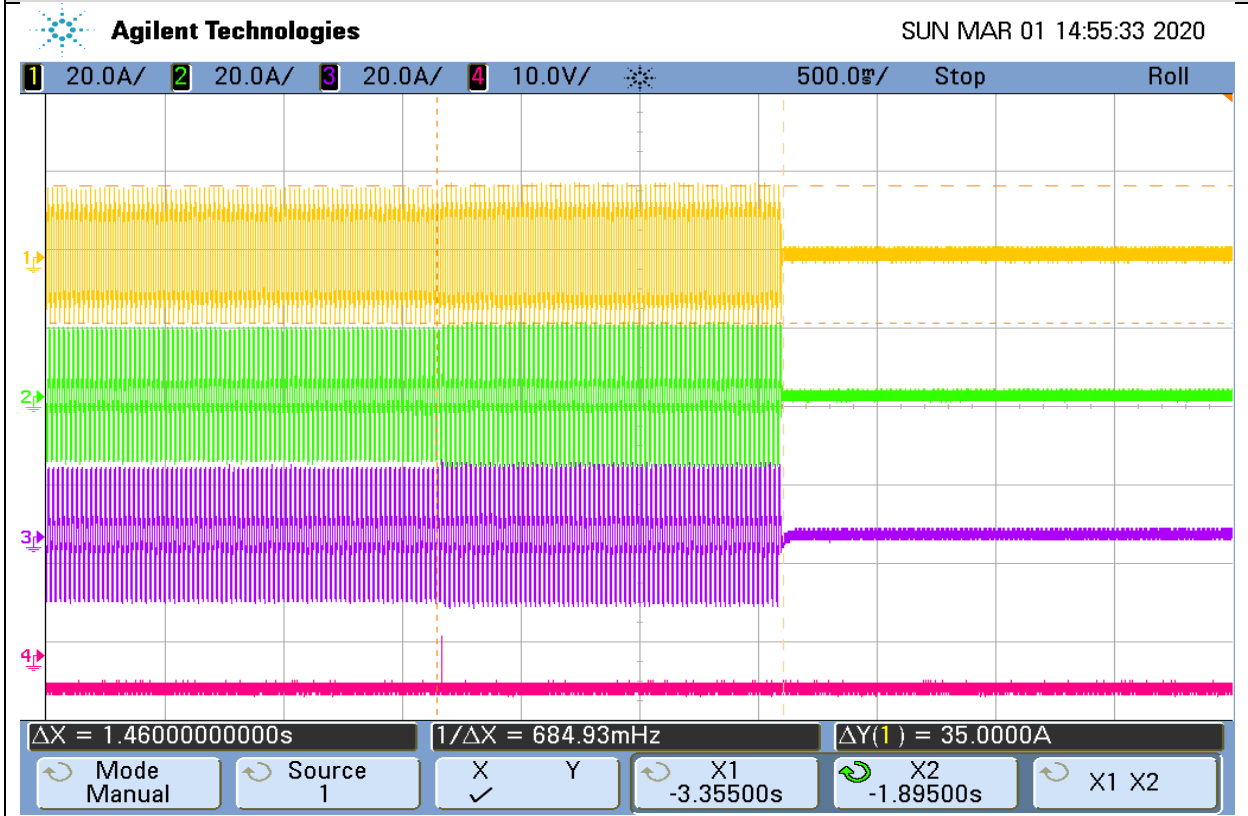
Voltage Trip Time: Un – 15 %Un Phase B-N



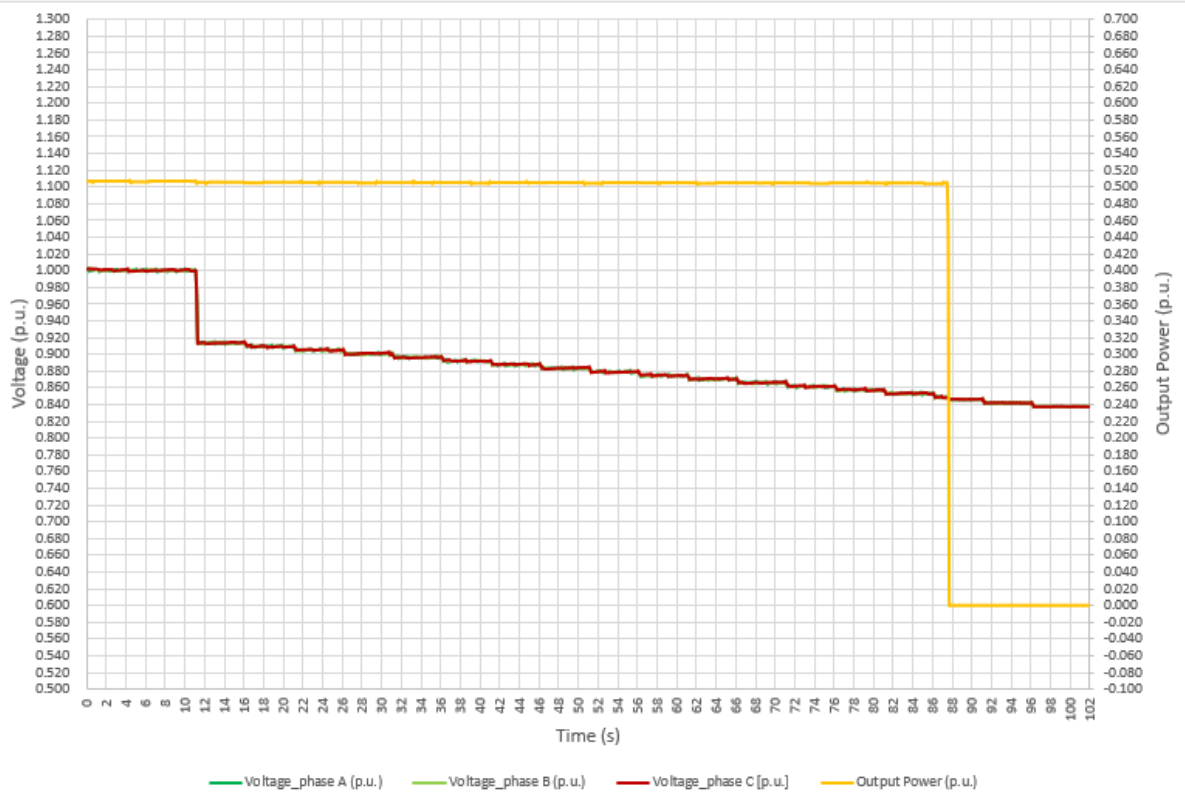
Voltage measured: $U_n - 15\%U_n$ Phase C-N



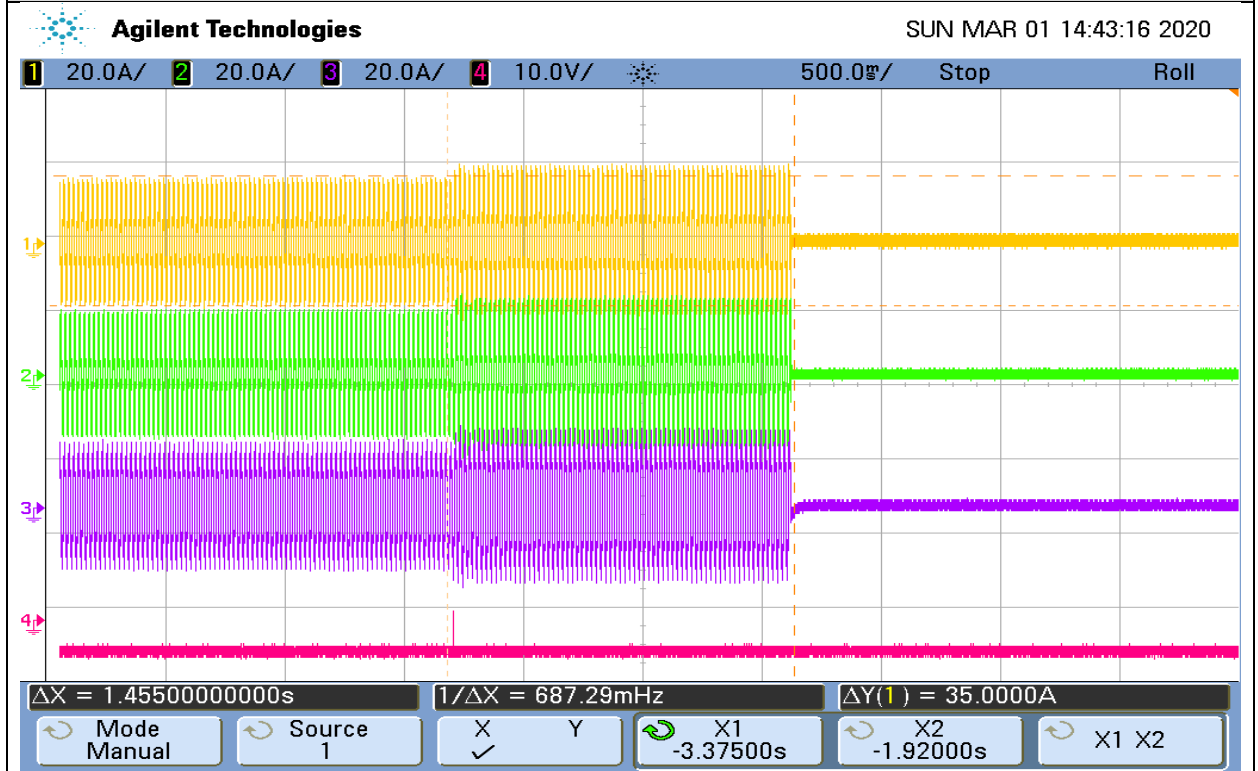
Voltage Trip Time: $U_n - 15\%U_n$ Phase C-N



Voltage measured: Un – 15 %Un Phase ABC-N



Voltage Trip Time: Un – 15 %Un Phase ABC-N



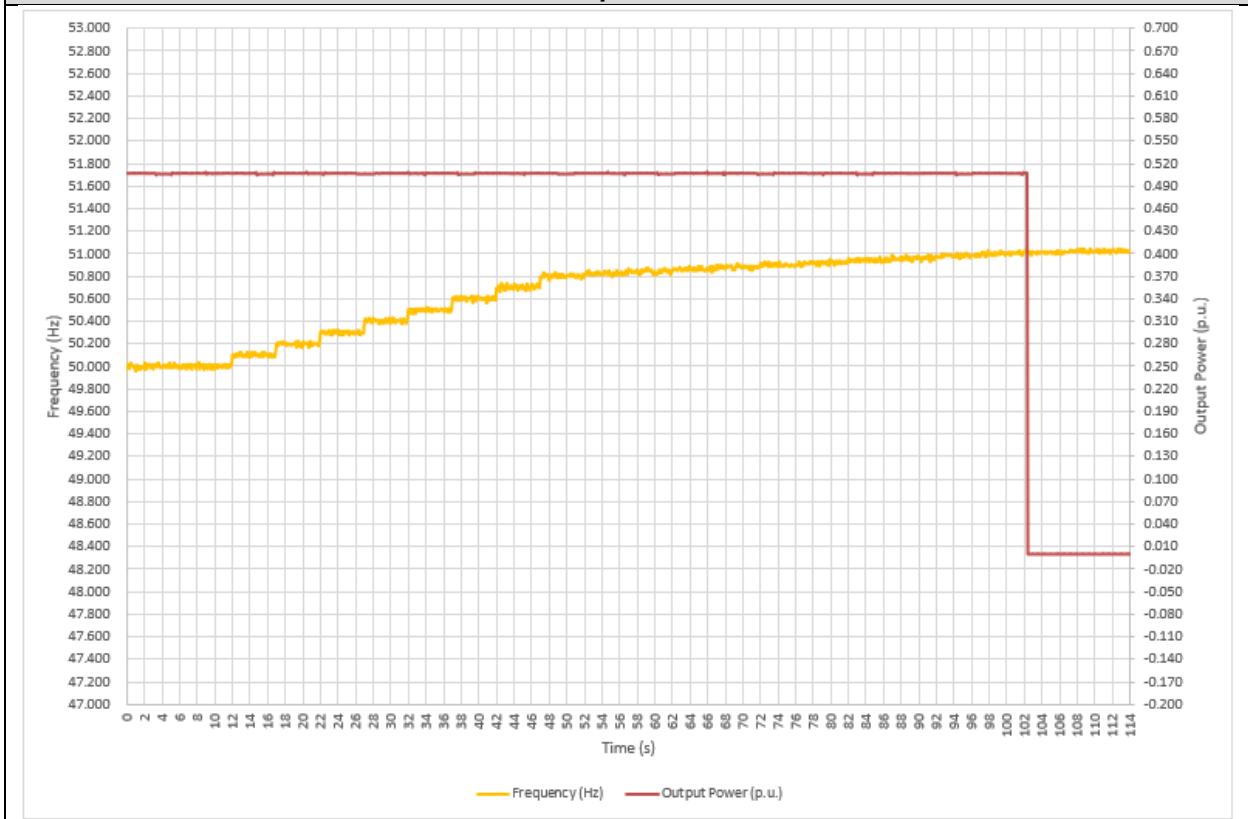
4.4.2 Frequency disconnection

Setting Frequency (Hz)	Measured Frequency (Hz)	Disconnection time limits (s)	Disconnection time measured (s)
51	51.02	0.5	0.418
48	48.00	>3.0(*)	3.080

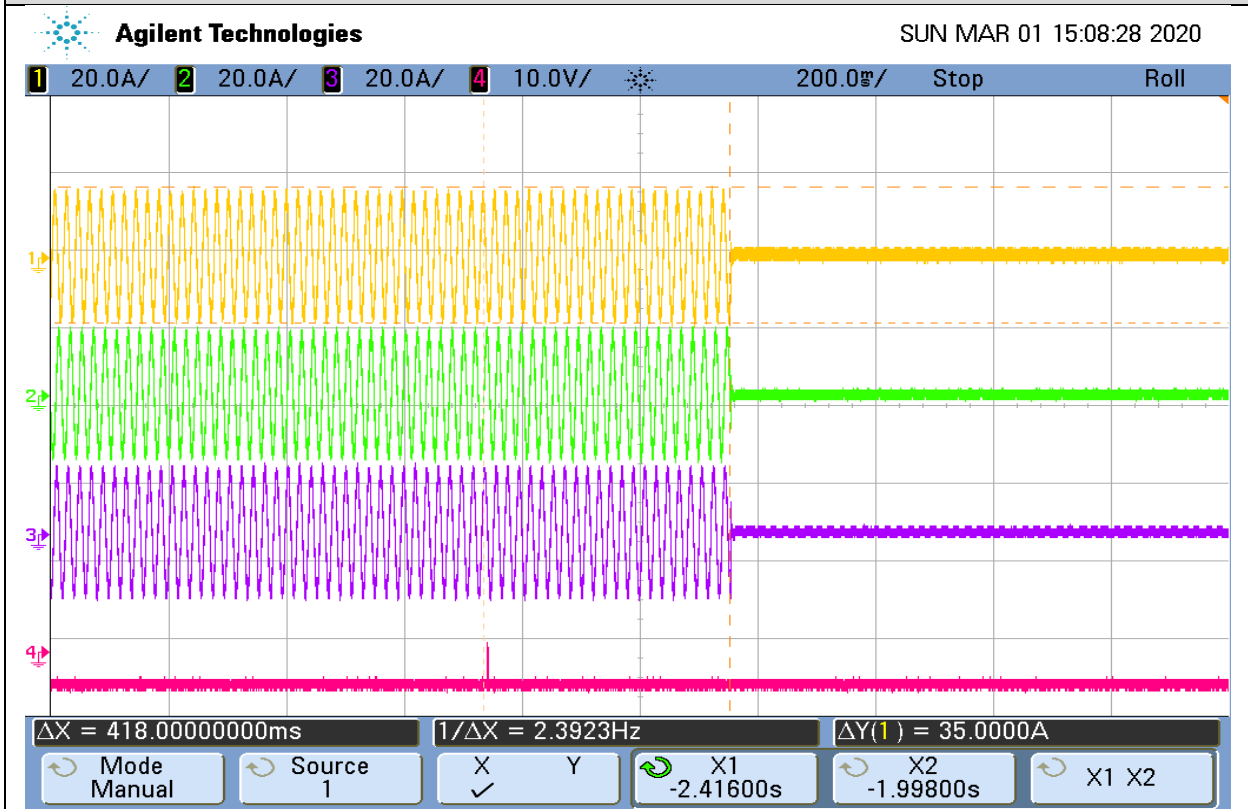
(*) The requirement according to RD1699/2011, the minimum disconnection time is 3s

Frequency measured: 51 Hz

Trip value

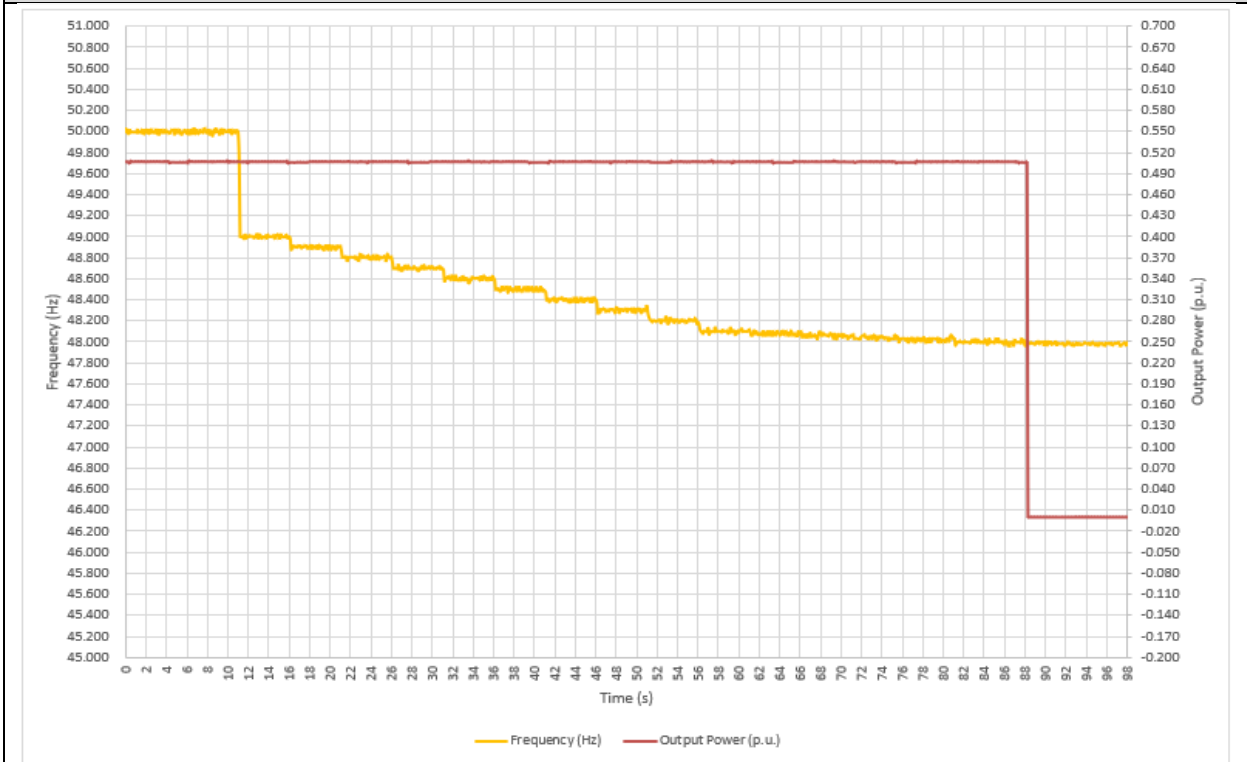


Disconnection time

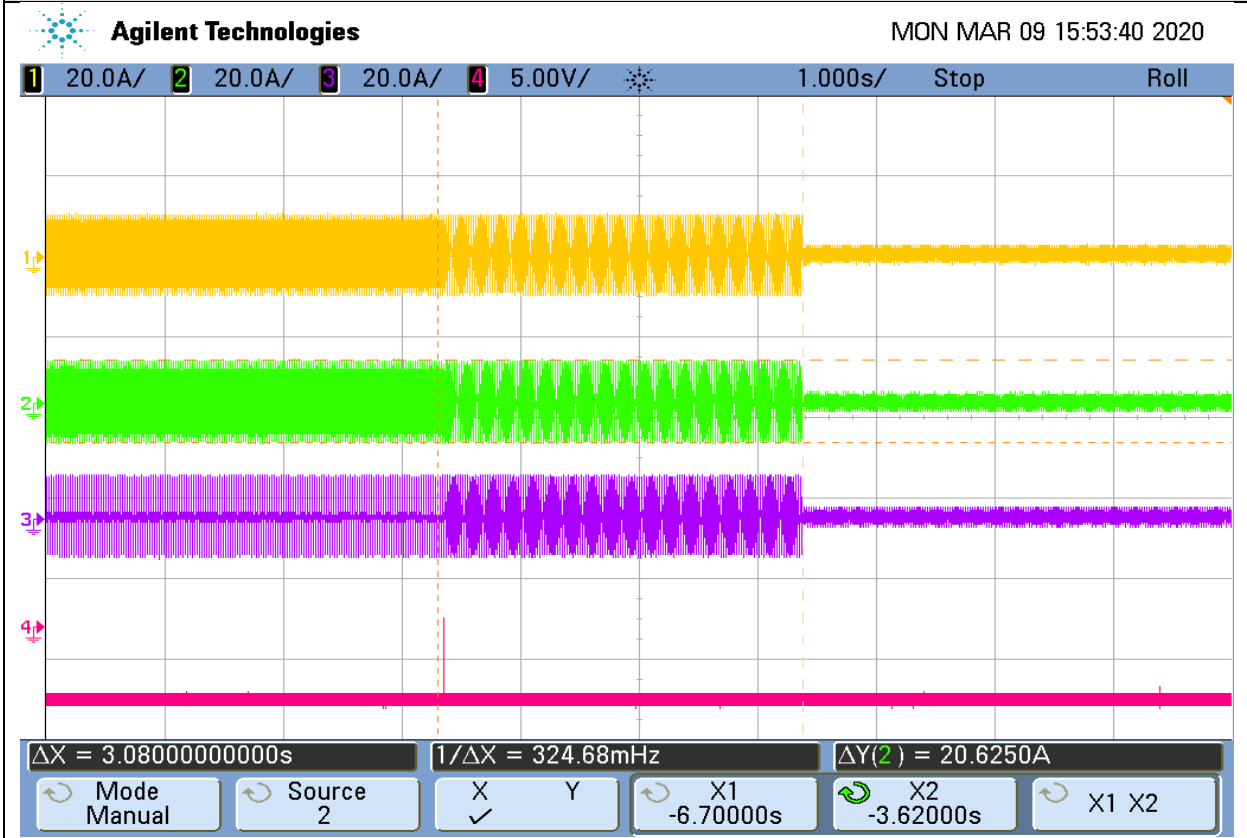


Frequency measured: 48 Hz

Trip value



Disconnection time

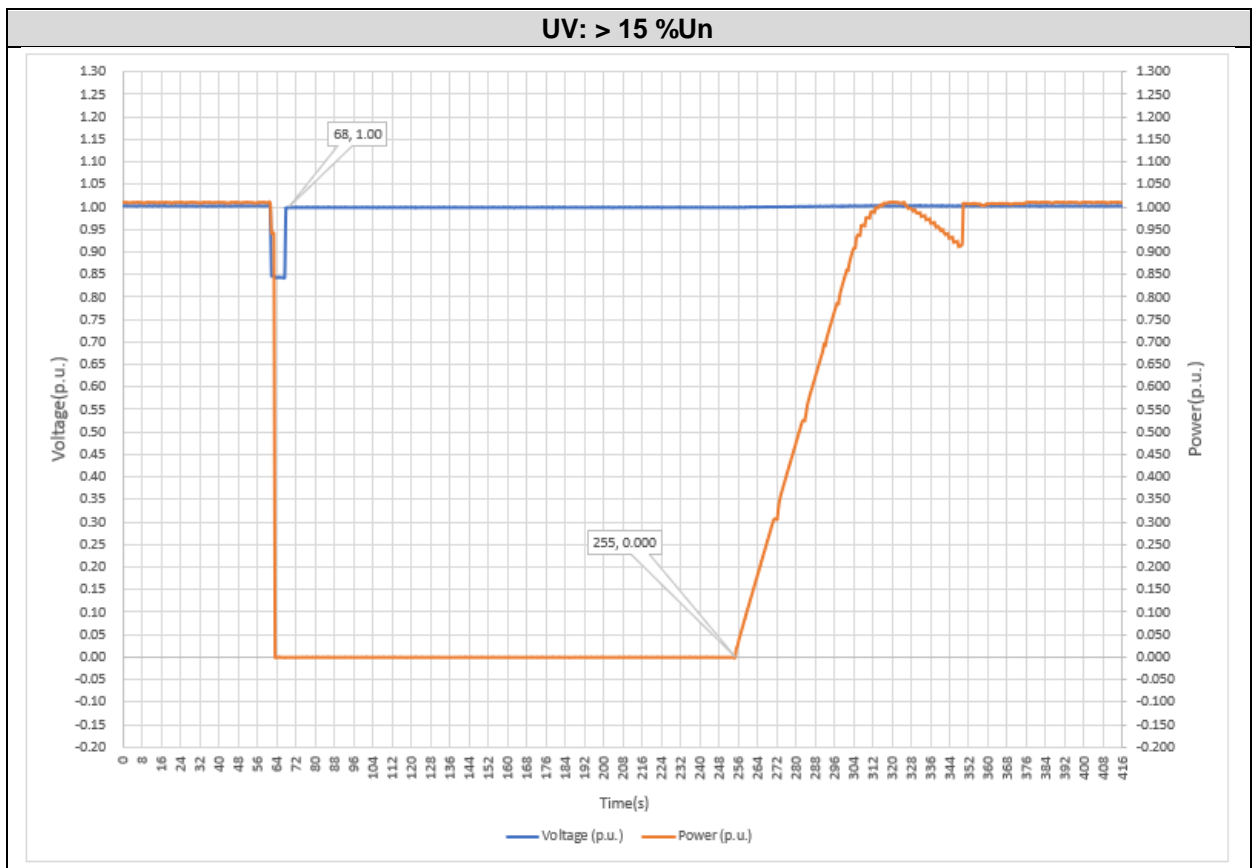
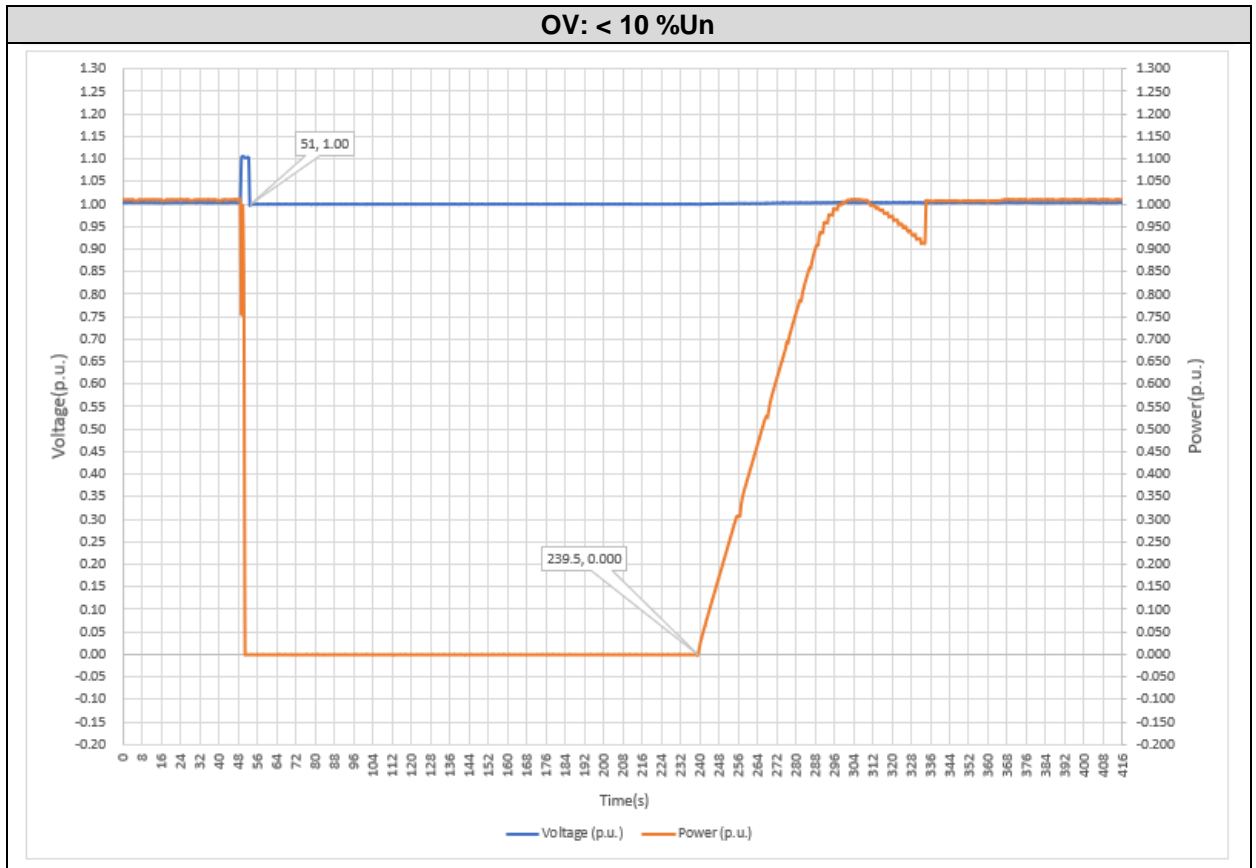


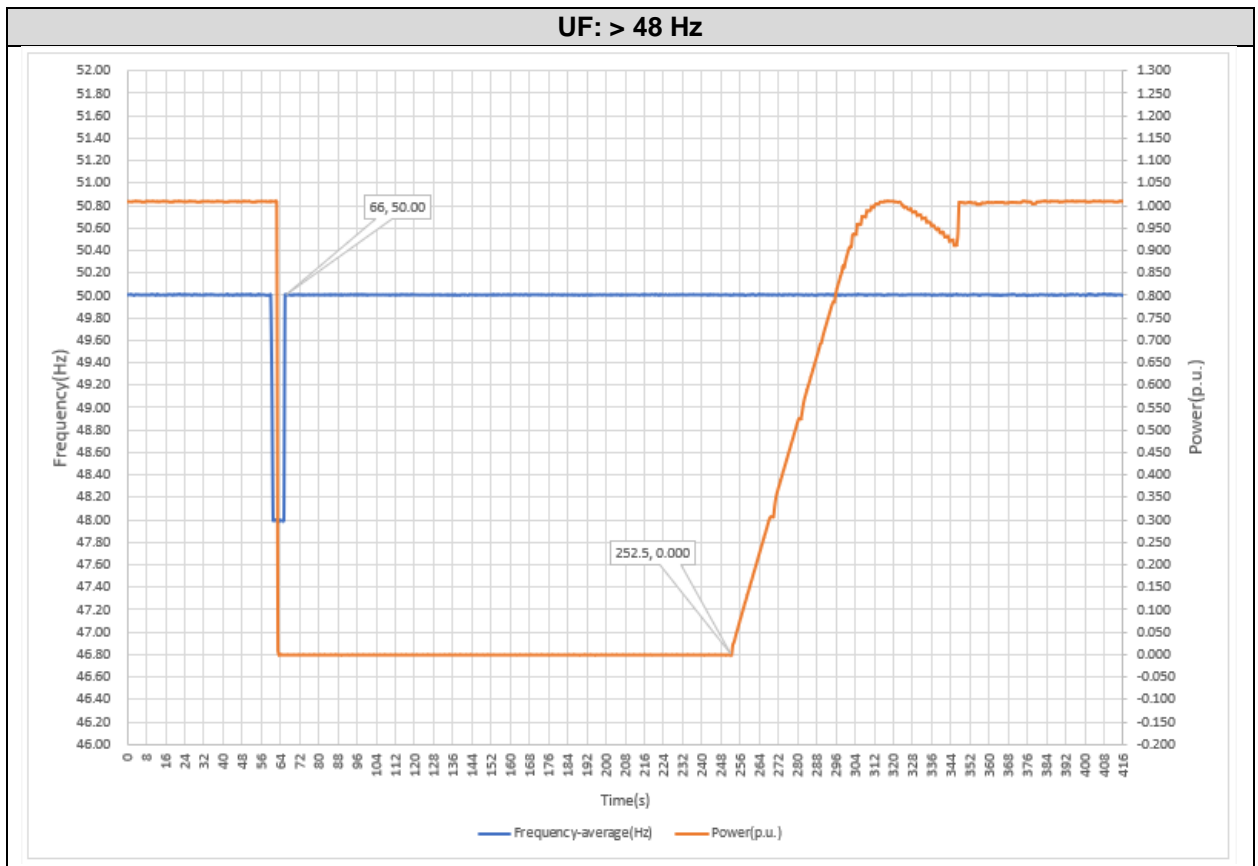
4.5 SELF-RECONNECTION

Self-reconnection tests have been performed according to the chapter 5.5 of the standard.

The inverter must be capable to reconnect when voltage and frequency are within the normal ranges according to standard.

Type	Delay time	Time measured (s)
OV: < 10 %Un	>3 min	188.5
UV: > 15 %Un	>3 min	187.0
OF: < 50.5 Hz	--	186.0
UF: > 48.0 Hz	--	186.5





4.6 UNINTENTIONAL ISLANDING

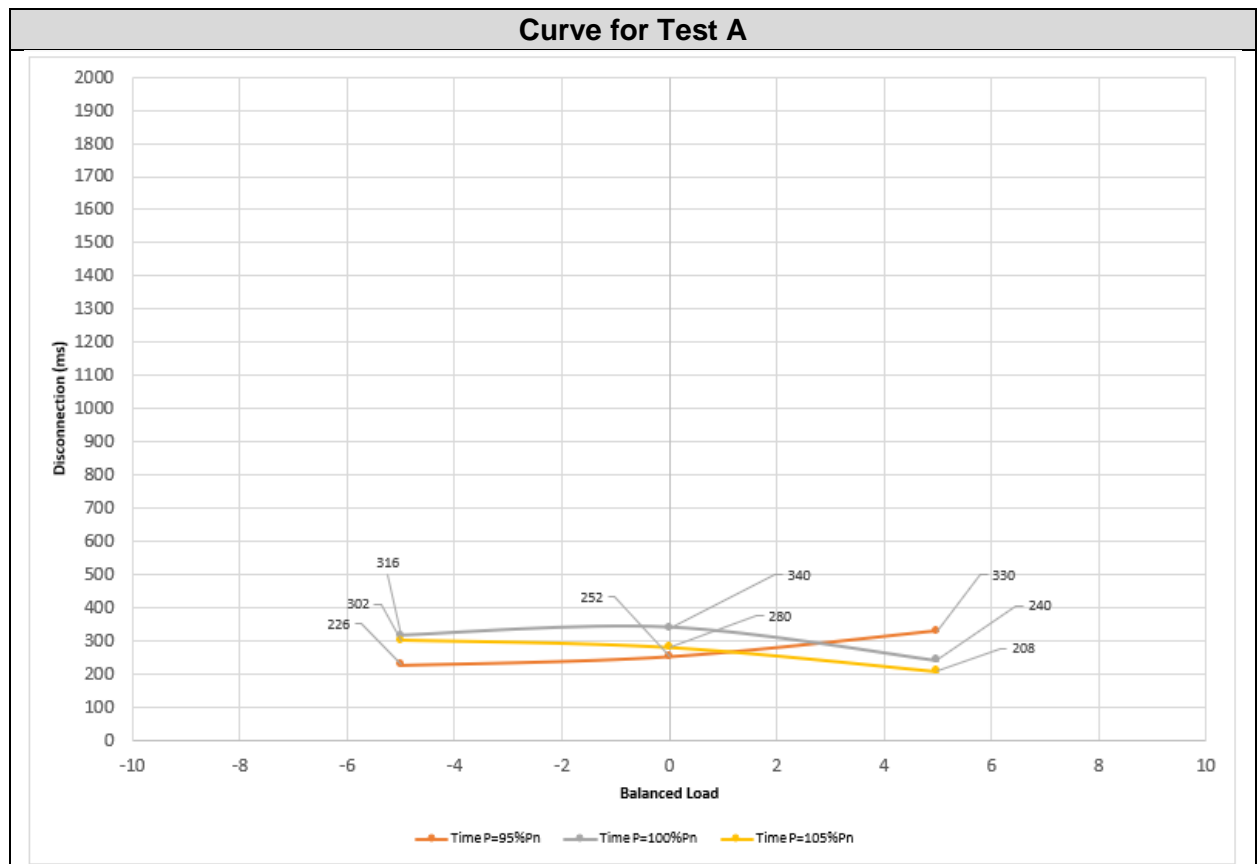
Anti-Islanding requirements are detailed in the chapter 5.6 of the standard. Test A is at full power, Test B is at 66 %Pn, Test C is at 33 %Pn.

As the inverter can be connected to the LV network, compliance with these requirements have been verified according to the standard UNE 206006. The following conditions with an ESE inverter has been tested:

- Condition 1: EUT and ESE with islanding prevention activated.
- Condition 2: EUT with islanding prevention activated and ESE deactivated.
- Condition 3: EUT and ESE with islanding prevention deactivated.

4.6.1 Active Power > 90 %Pn. Test A

Balanced Load		Disconnection (ms) (limit at t=2s)
M (%)	N (%)	
-5	+5	302
-5	0	316
-5	-5	226
0	+5	280
0	0	340
0	-5	252
+5	+5	208
+5	0	240
+5	-5	330

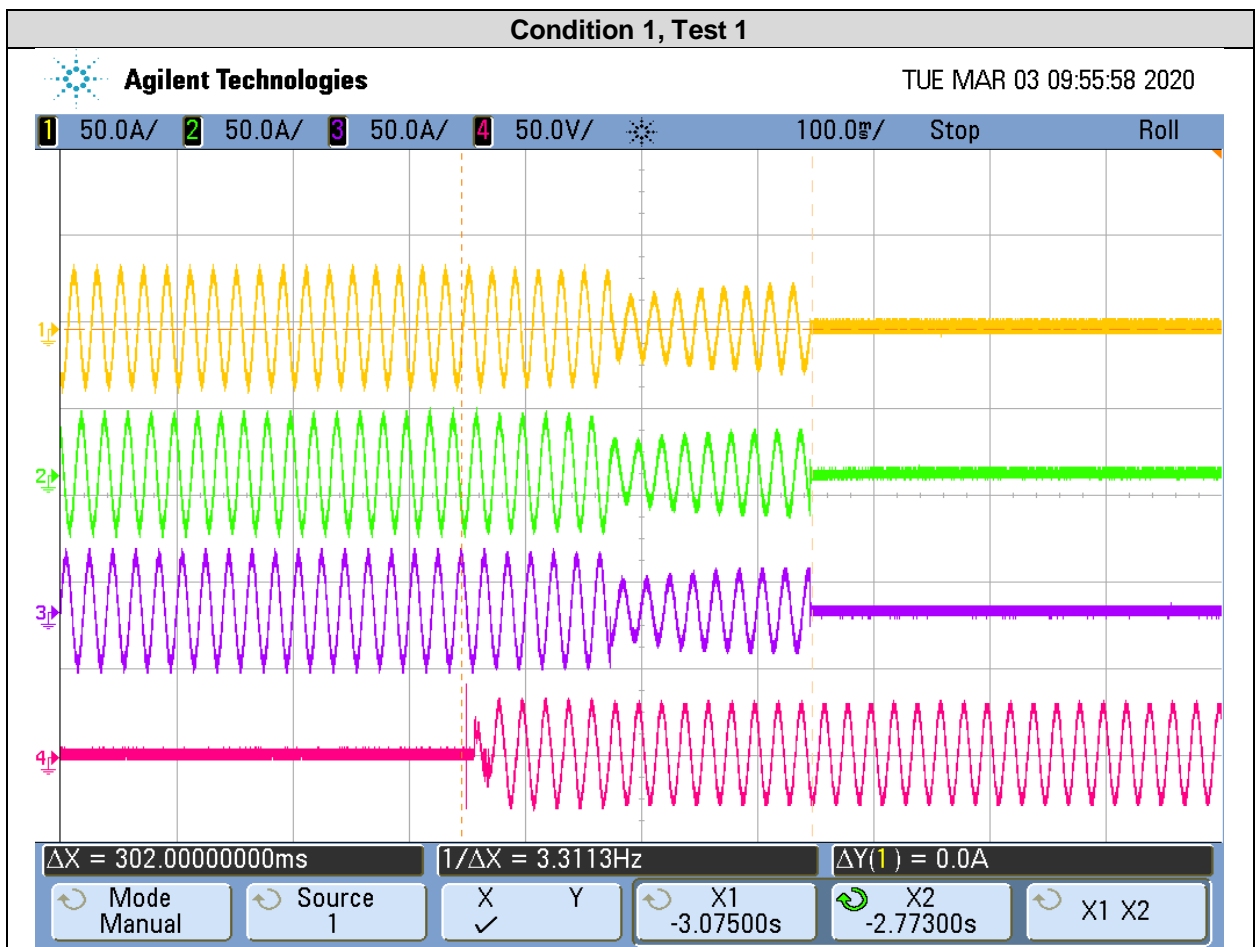


Conditions	P (kW)	Qc (kVAr)	Ql (kVAr)	Time limit (s)	Time measured (ms)
1	14.126	-15.093	15.008	< 2	302
1	14.126	-15.093	15.008	< 2	350
2	14.126	-15.093	15.008	< 2	1086
2	14.126	-15.093	15.008	< 2	764
3	14.126	-15.093	15.008	--	--

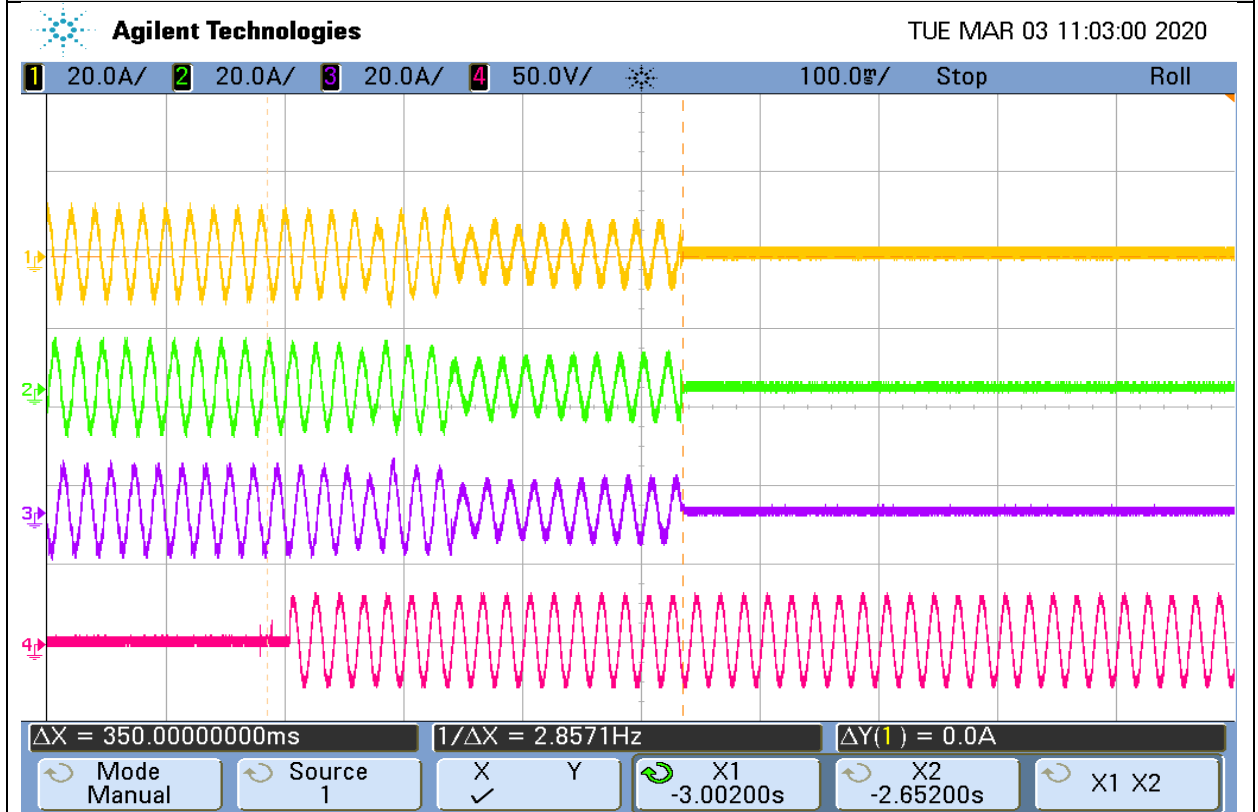
Condition 1: EUT and ESE with islanding prevention activated.

Condition 2: EUT with islanding prevention activated and ESE deactivated.

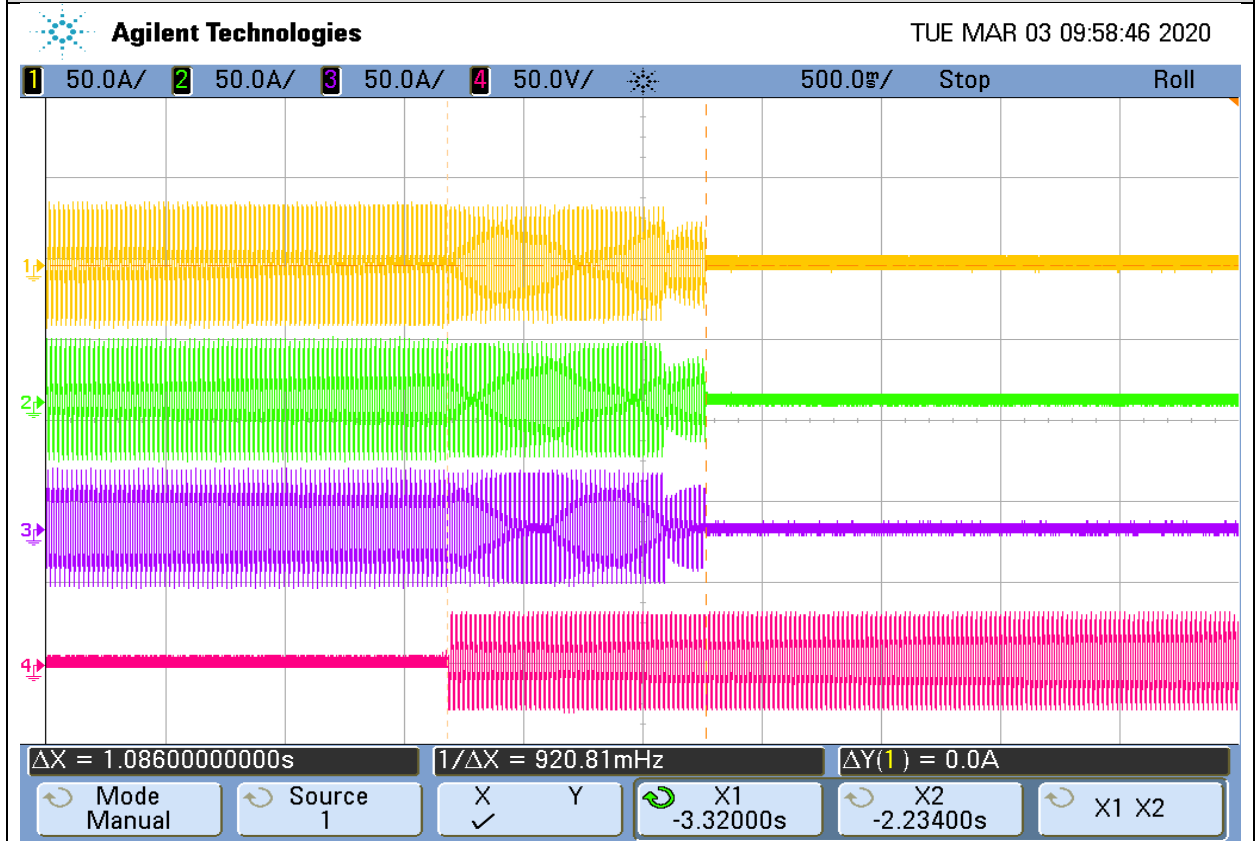
Condition 3: EUT and ESE with islanding prevention deactivated.



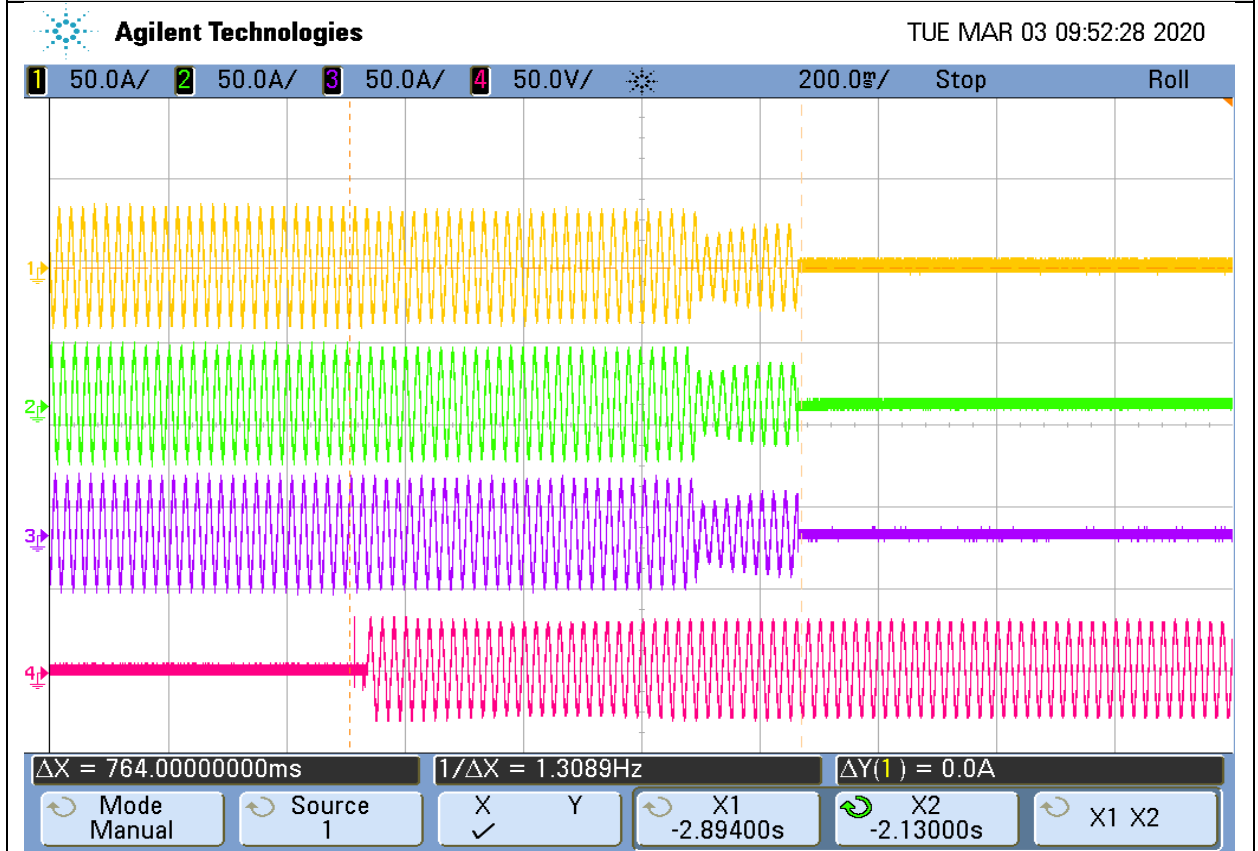
Condition 1, Test 2



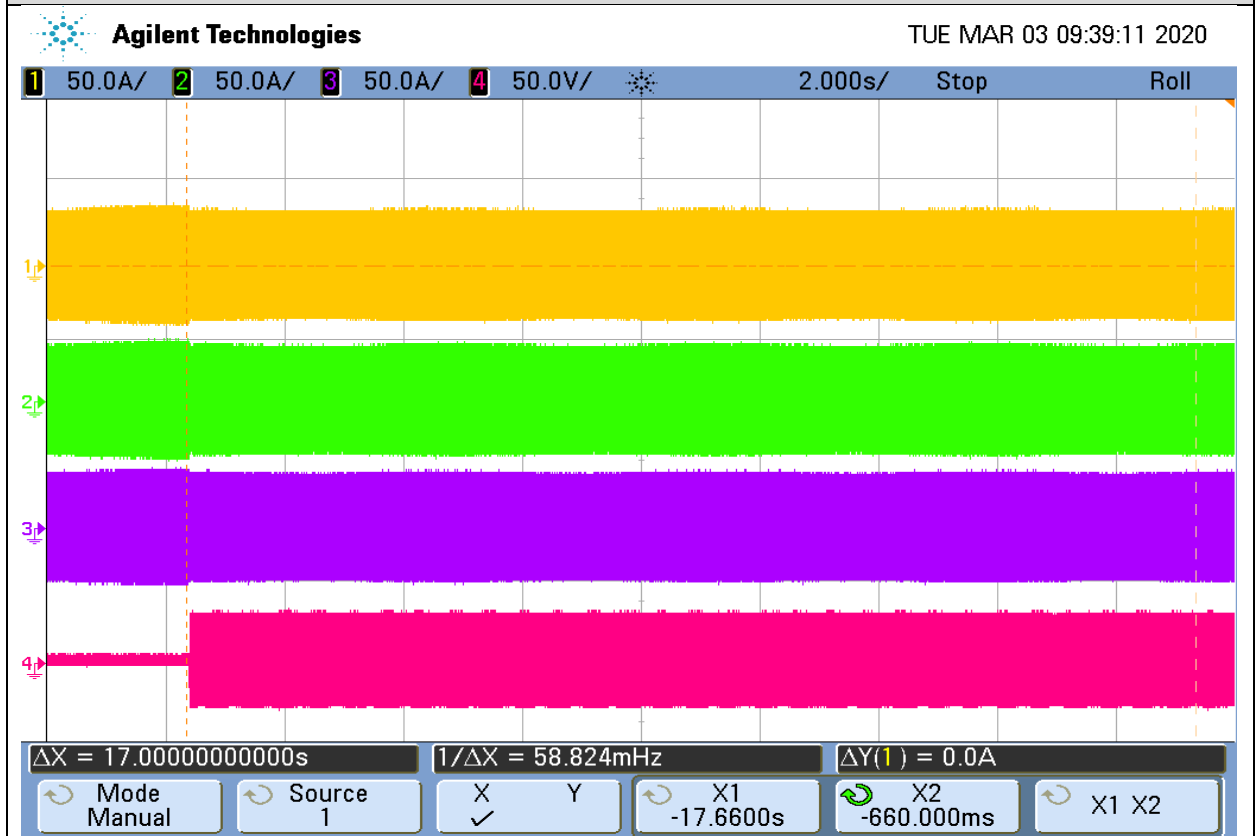
Condition 2, Test 1



Condition 2, Test 2

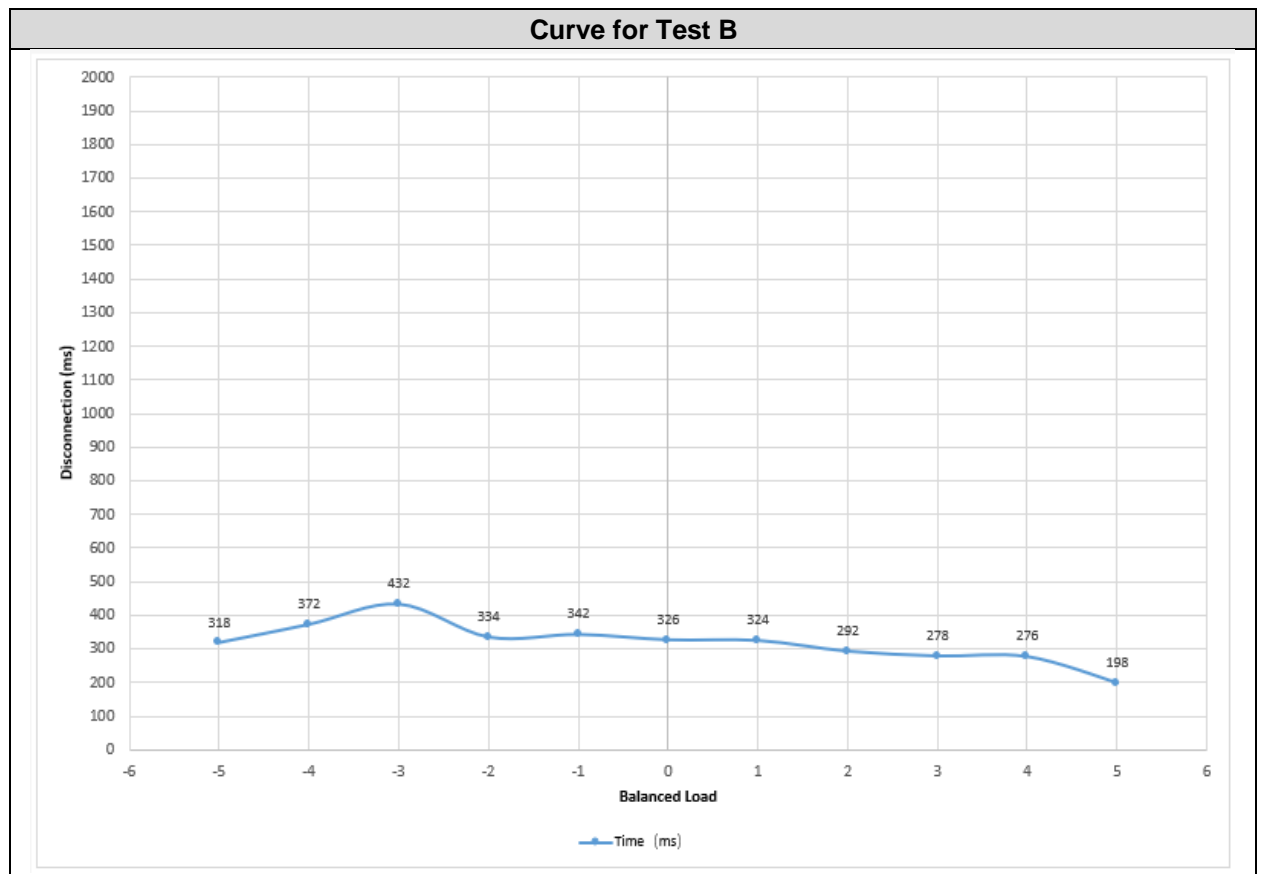


Condition 3



4.6.2 Active Power 50-66 %P_n. Test B

Balanced Load		
M (%)	N (%)	Disconnection (ms) (limit at t=2s)
0	-5	318
0	-4	372
0	-3	432
0	-2	334
0	-1	342
0	0	326
0	+1	324
0	+2	292
0	+3	278
0	+4	276
0	+5	198

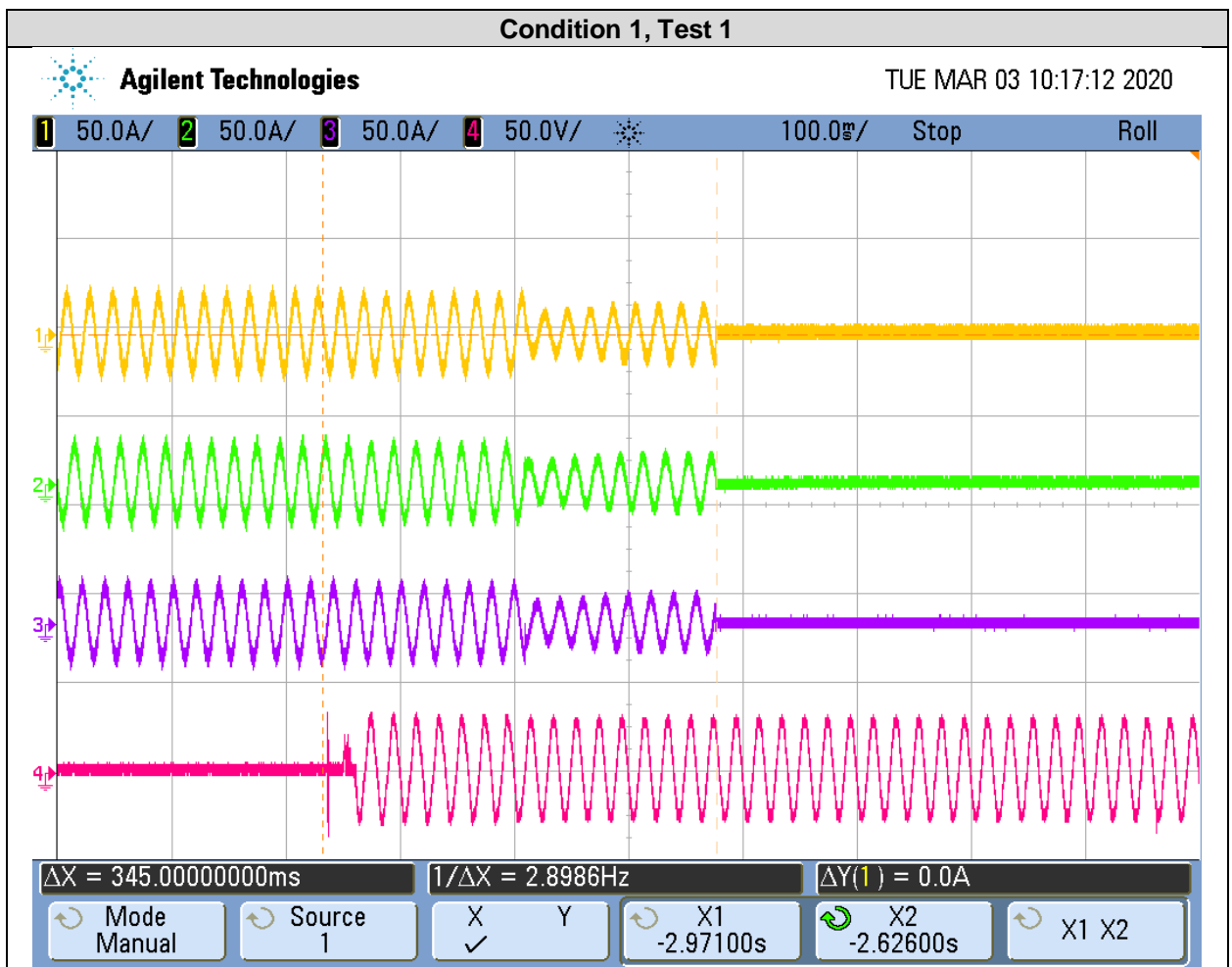


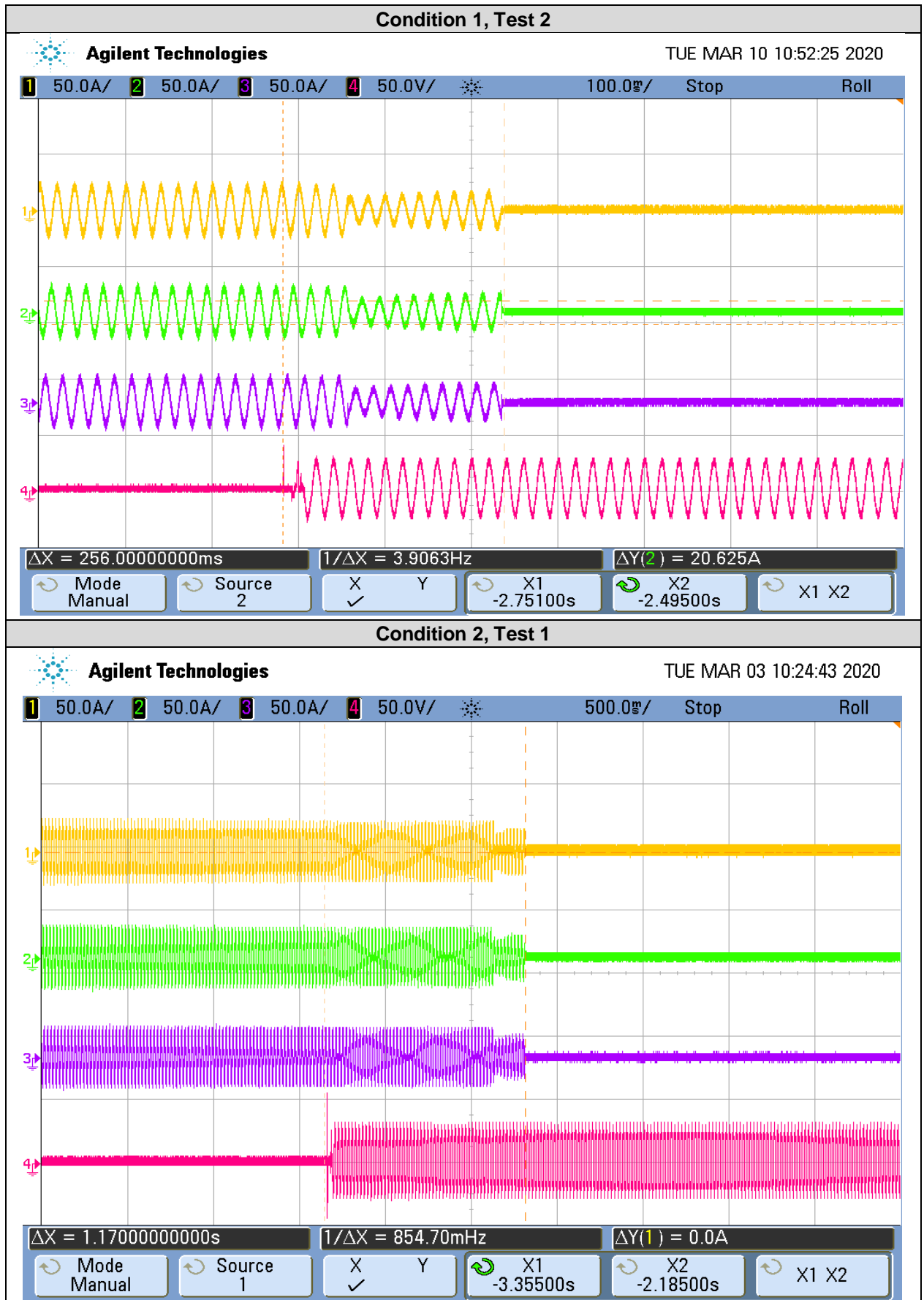
Conditions	P (kW)	Qc (kVAr)	QI (kVAr)	Time limit (s)	Time measured (ms)
1	9.278	-9.986	9.993	< 2	345
1	9.278	-9.986	9.993	< 2	256
2	9.278	-9.986	9.993	< 2	1170
2	9.278	-9.986	9.993	< 2	1115
3	9.278	-9.986	9.993	--	--

Condition 1: EUT and ESE with islanding prevention activated.

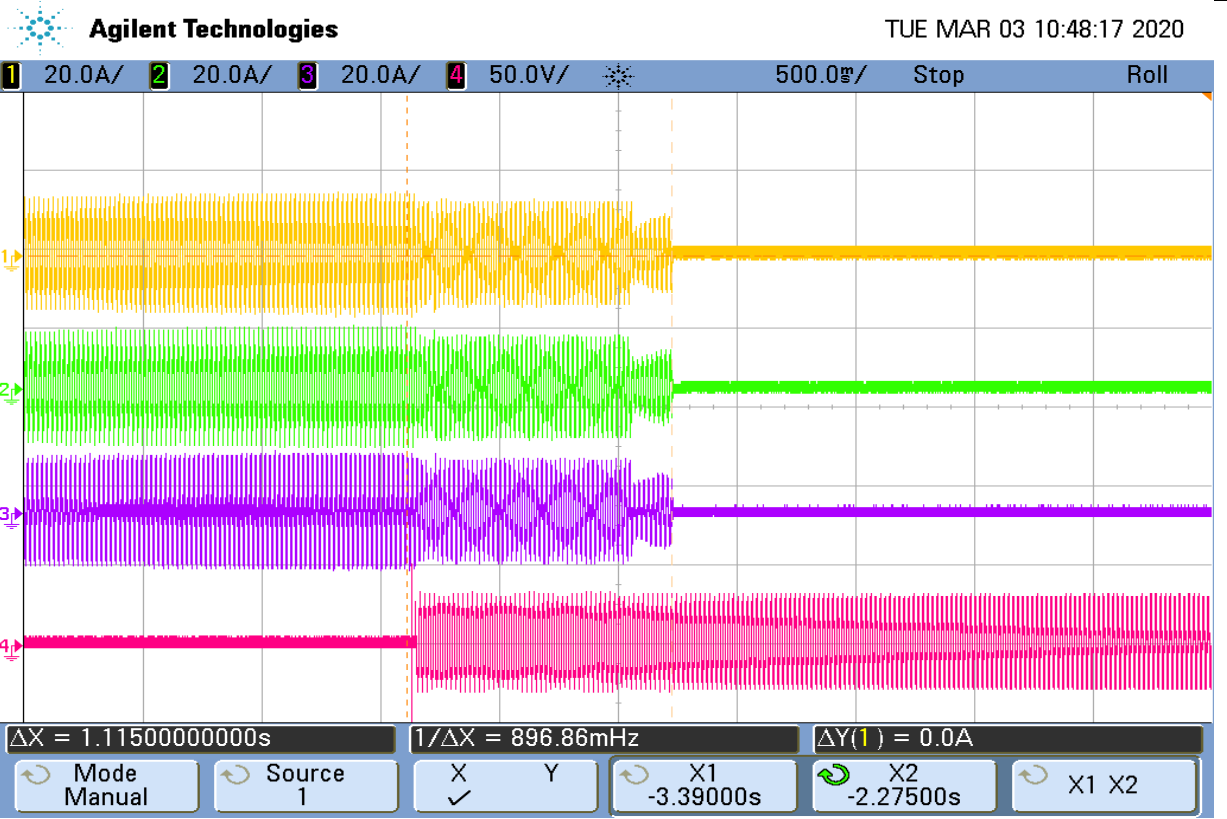
Condition 2: EUT with islanding prevention activated and ESE deactivated.

Condition 3: EUT and ESE with islanding prevention deactivated.

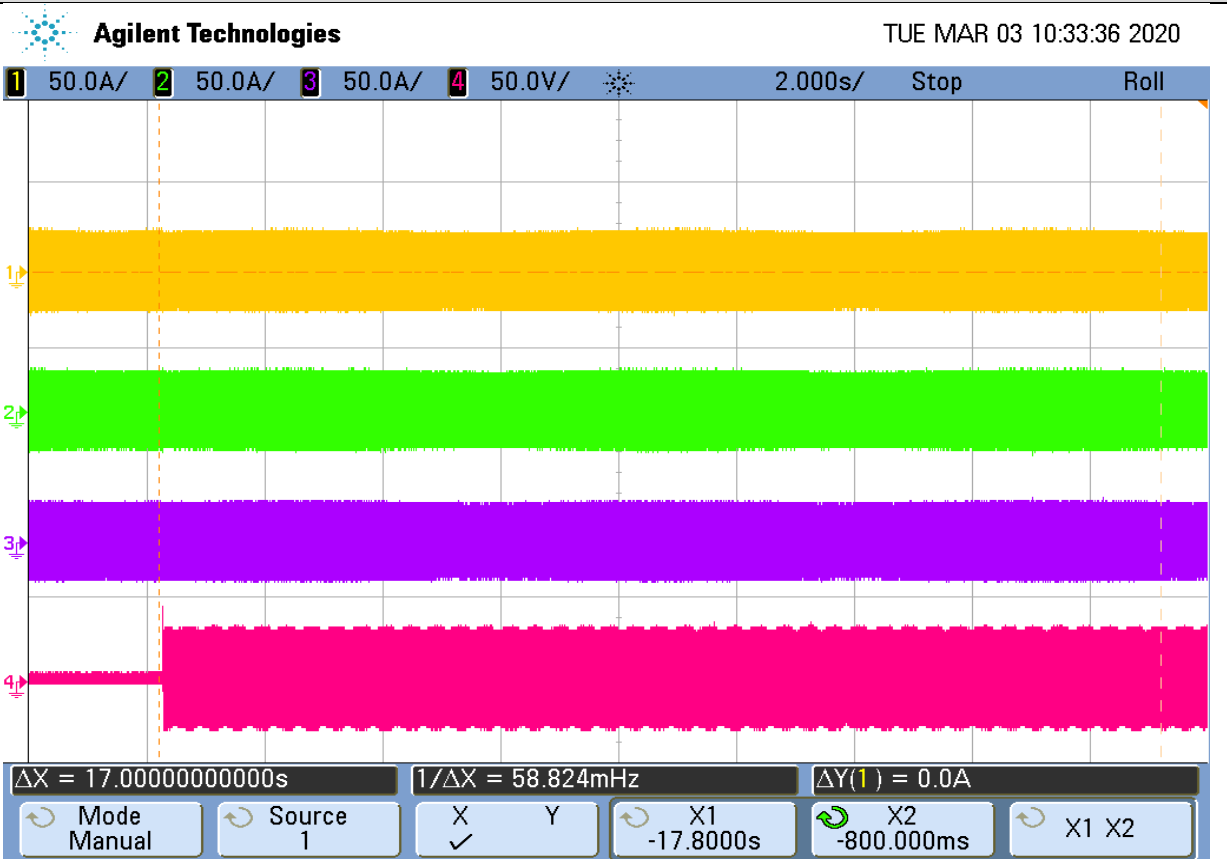




Condition 2, Test 2



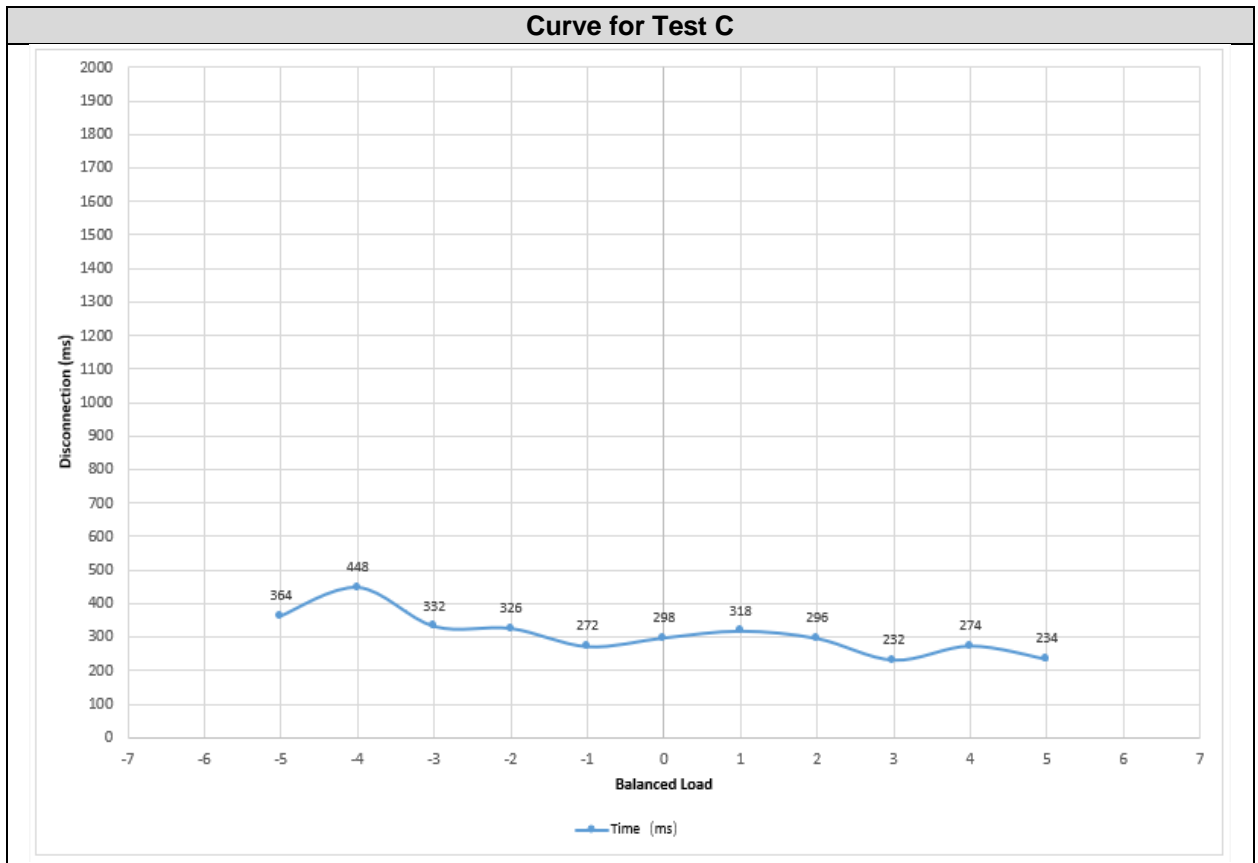
Condition 3



4.6.3 Active Power 25-33 %Pn. Test C

Balanced Load		
M (%)	N (%)	Disconnection (ms) (limit at t=2s)
0	-5	364
0	-4	448
0	-3	332
0	-2	326
0	-1	272
0	0	298
0	+1	318
0	+2	296
0	+3	232
0	+4	274
0	+5	234

Curve for Test C

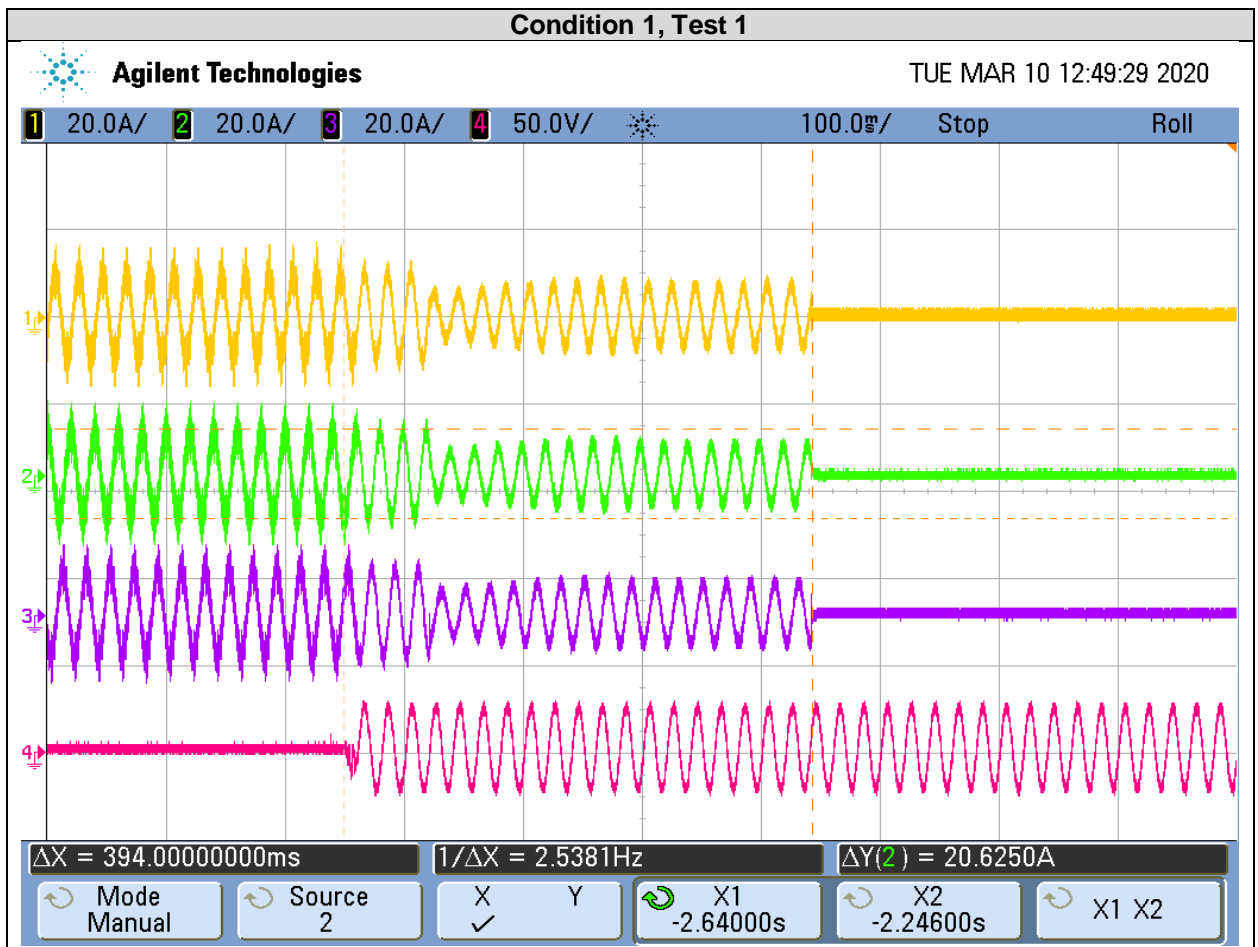


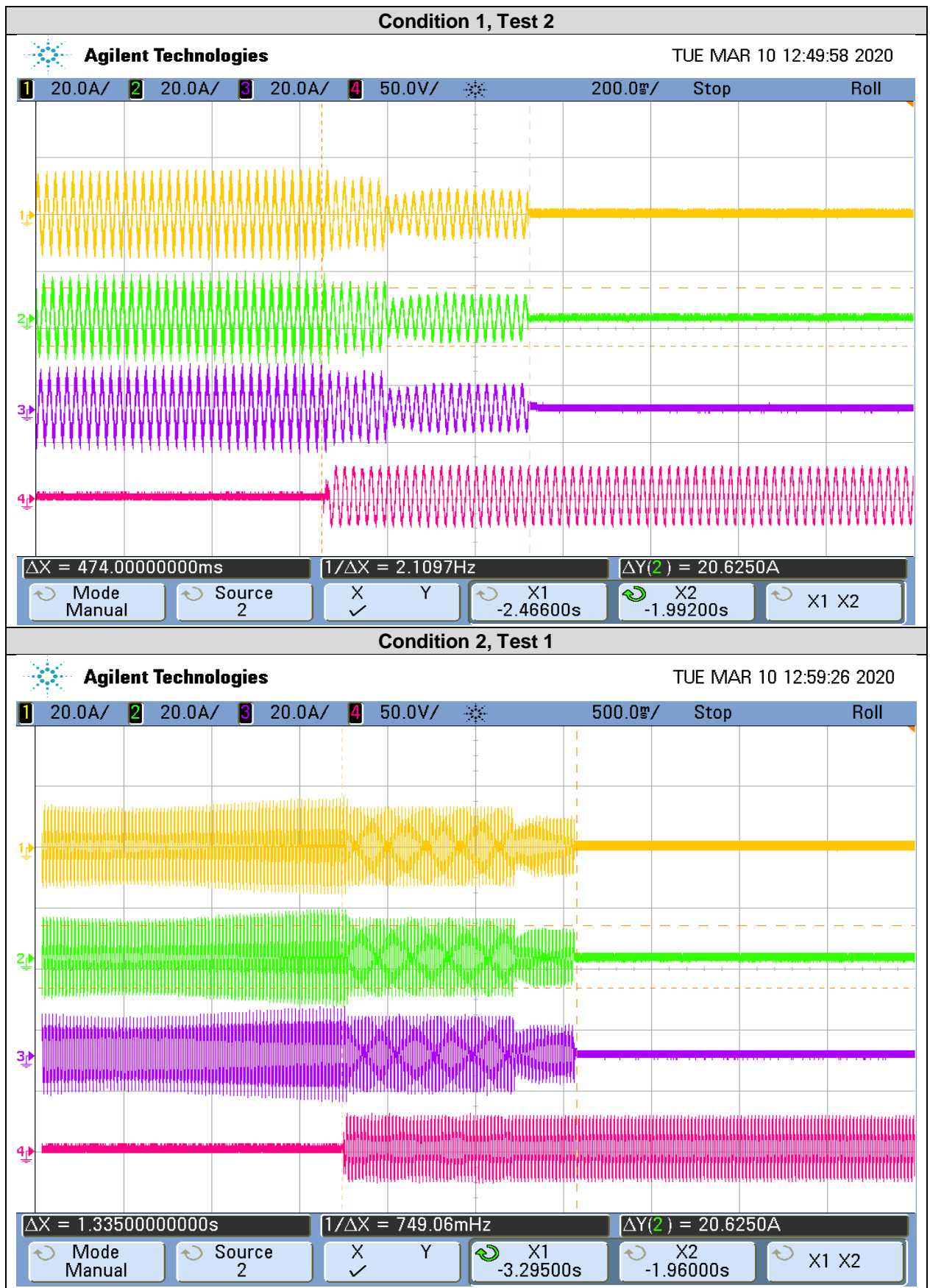
Conditions	P (kW)	Qc (kVAr)	QI (kVAr)	Time limit (s)	Time measured (ms)
1	4.561	-4.968	4.969	< 2	394
1	4.561	-4.968	4.969	< 2	474
2	4.561	-4.968	4.969	< 2	1335
2	4.561	-4.968	4.969	< 2	1255
3	4.561	-4.968	4.969	--	--

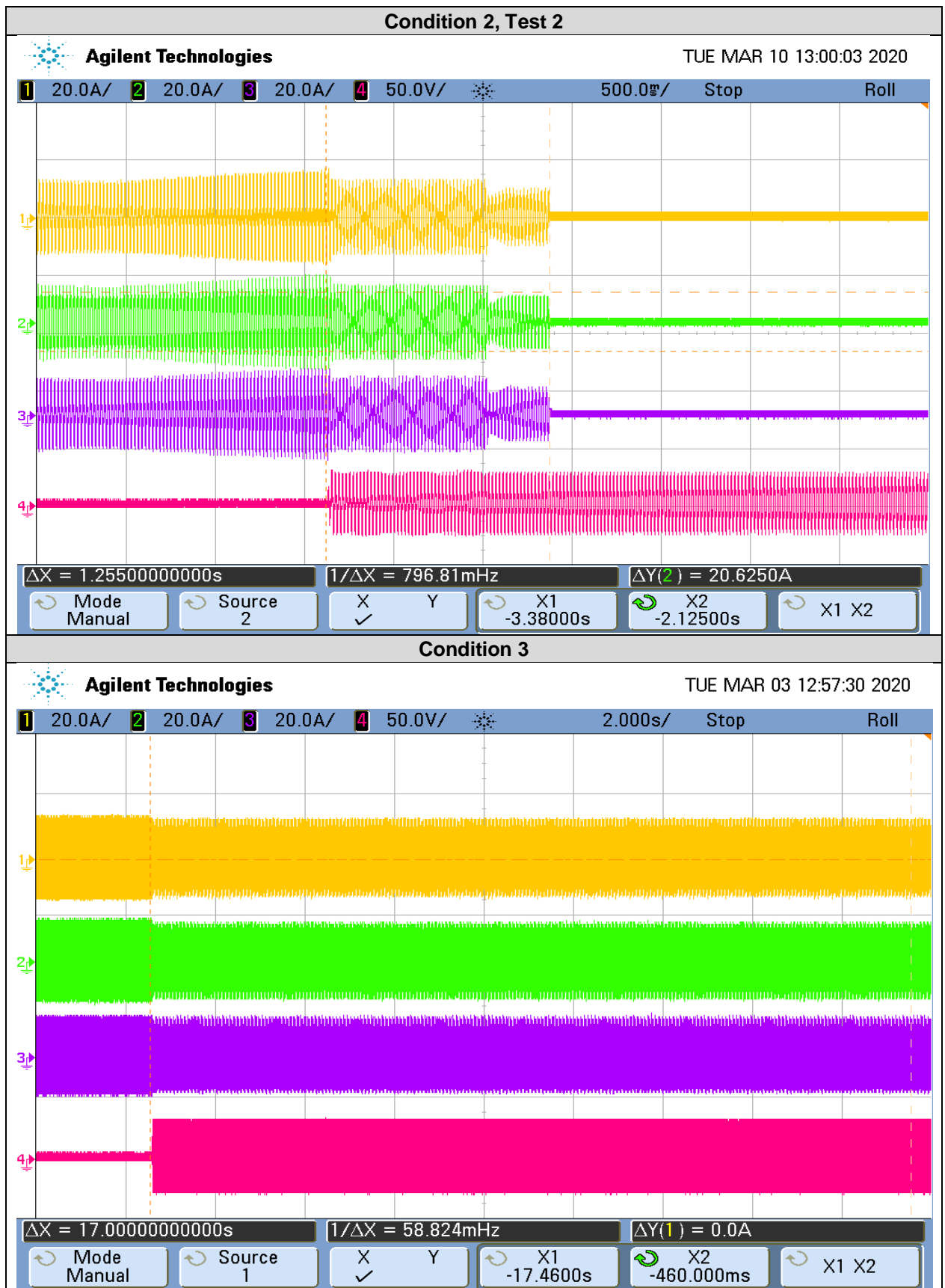
Condition 1: EUT and ESE with islanding prevention activated.

Condition 2: EUT with islanding prevention activated and ESE deactivated.

Condition 3: EUT and ESE with islanding prevention deactivated.



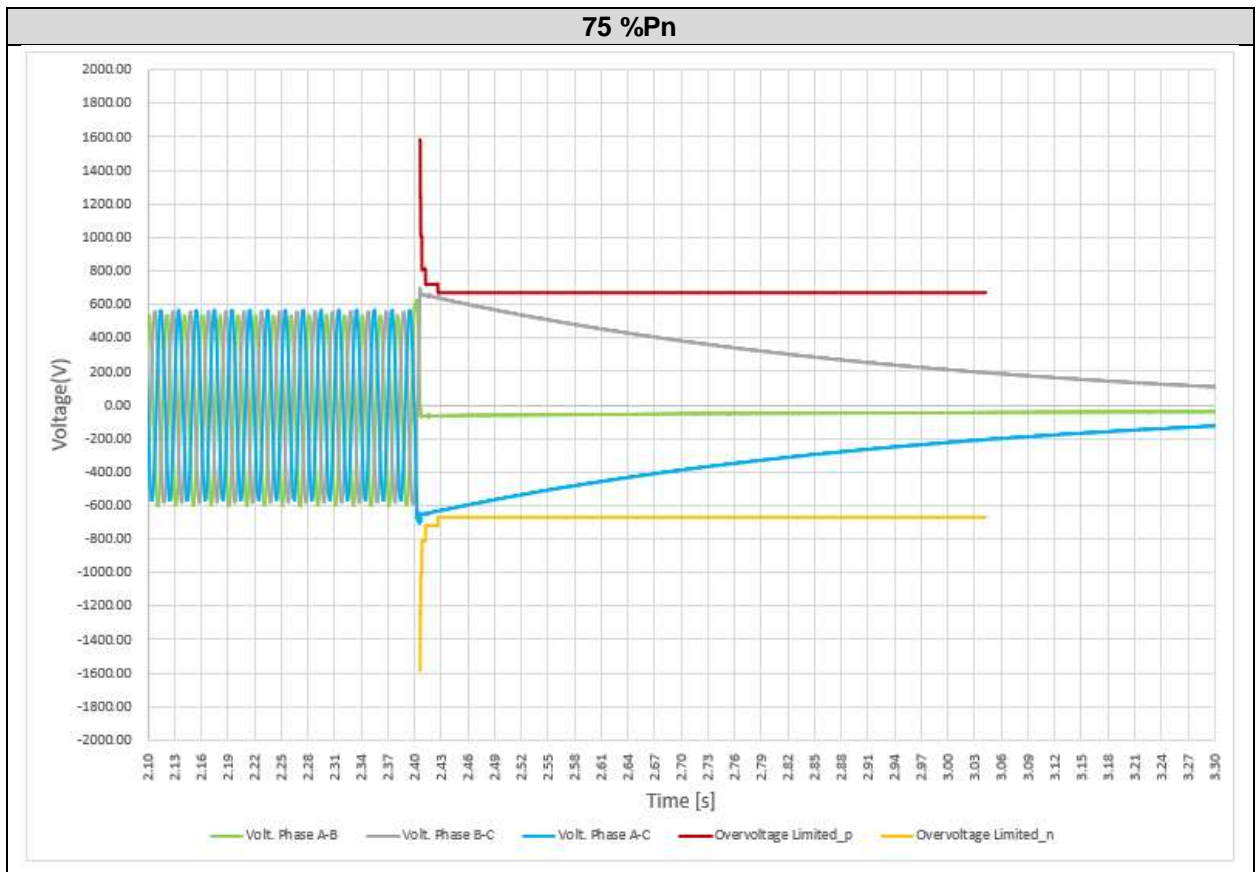
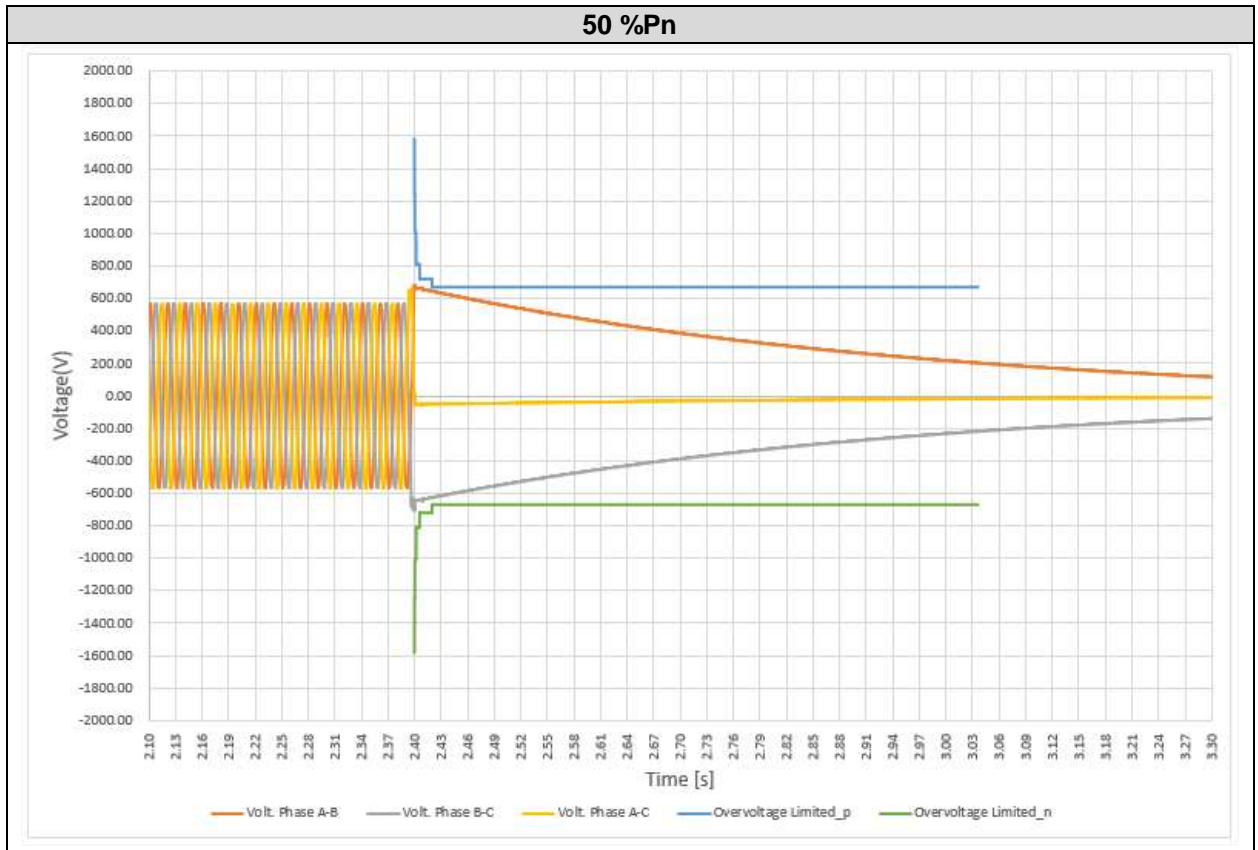




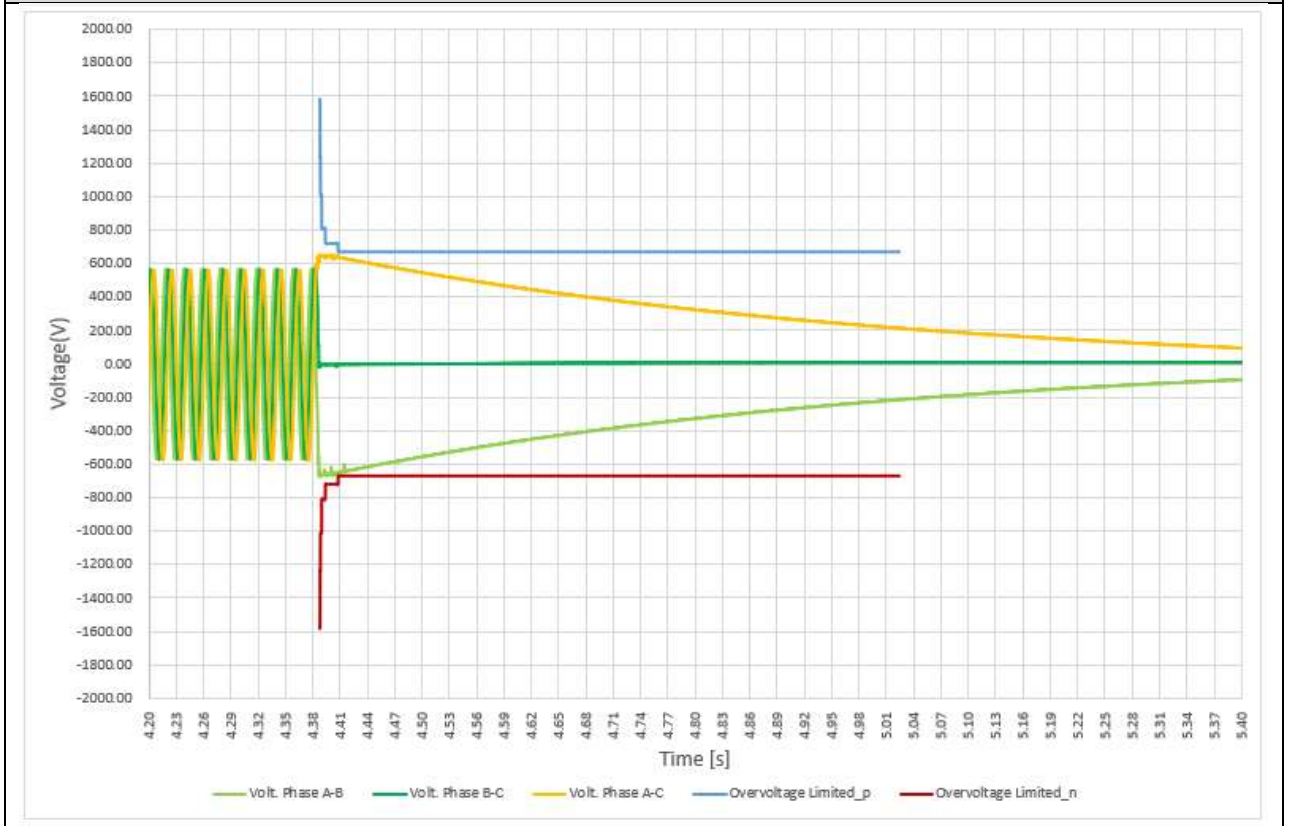
4.7 OVERVOLTAGE GENERATION

The purpose of this test is to verify that the inverter complies with the transient voltage limits specified below when the grid is disconnected from the inverter. The transient voltage limits have been measured according to the chapter 5.7 of the standard.

Overvoltage duration (s)	Overvoltage limit value (%Un)	Overvoltage value measured (%Un) at 50 %Pn	Overvoltage value measured (%Un) at 75 %Pn	Overvoltage value measured (%Un) at 100 %Pn
Phase A – Phase B				
0.0002	±280	117	109	-117
0.0006	±218	119	109	-118
0.002	±178	117	72	-117
0.006	±145	117	-12	-117
0.02	±129	114	-12	-115
0.06	±120	106	-11	-108
0.2	±120	82	-10	-85
0.6	±120	38	-8	-41
Phase B – Phase C				
0.0002	±280	-123	119	101
0.0006	±218	-115	116	99
0.002	±178	-114	116	83
0.006	±145	-114	116	-1
0.02	±129	-111	113	-1
0.06	±120	-104	105	-1
0.2	±120	-82	81	0
0.6	±120	-41	37	1
Phase C – Phase A				
0.0002	±280	115	-124	114
0.0006	±218	110	-120	114
0.002	±178	55	-115	114
0.006	±145	-10	-115	114
0.02	±129	-9	-112	113
0.06	±120	-9	-105	105
0.2	±120	-7	-81	83
0.6	±120	-3	-39	40

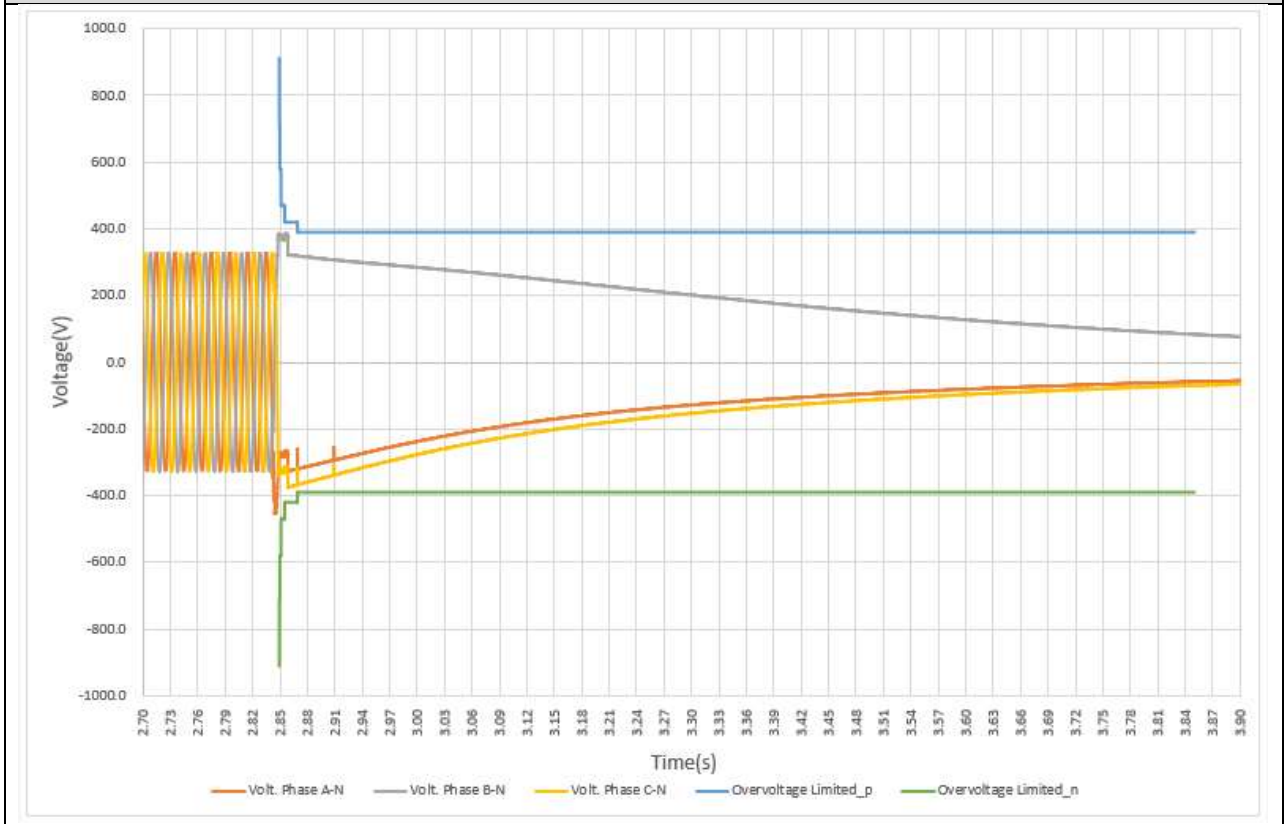


100 %Pn

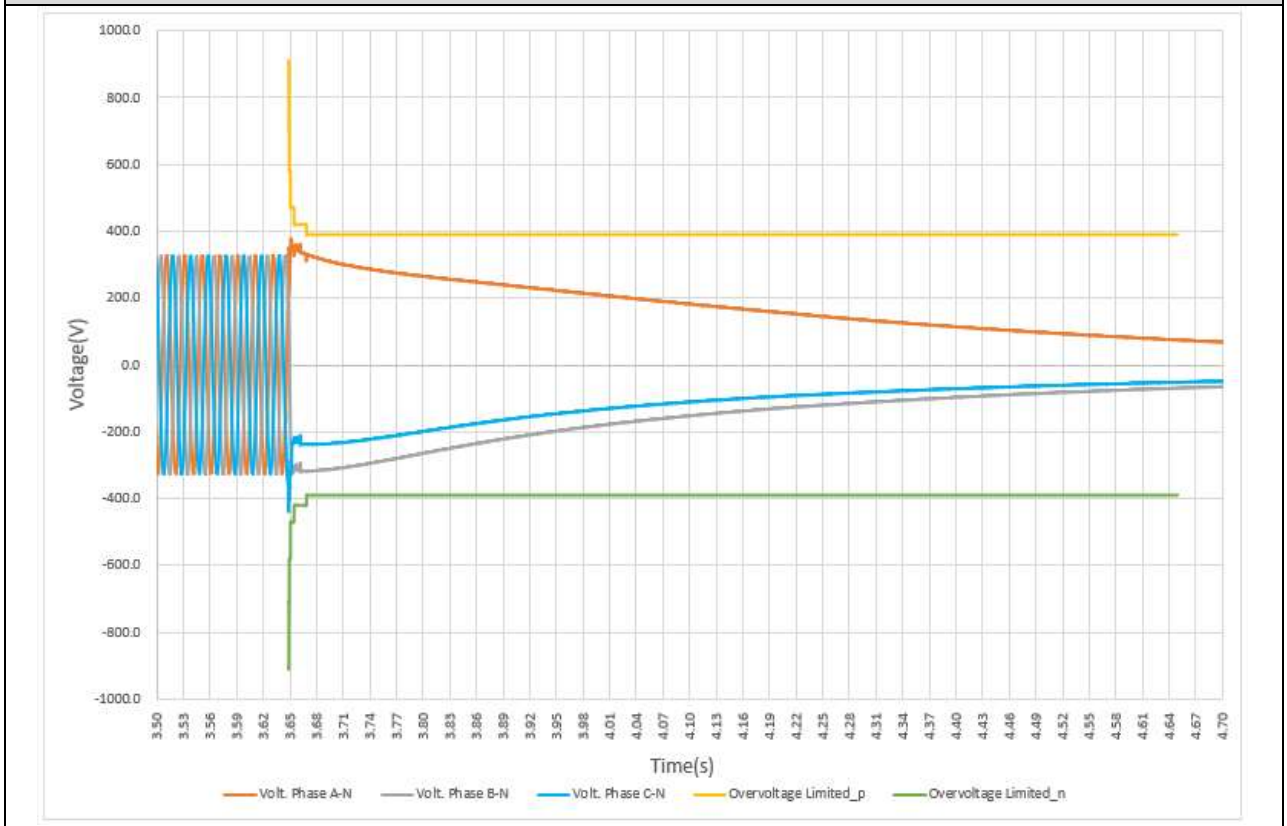


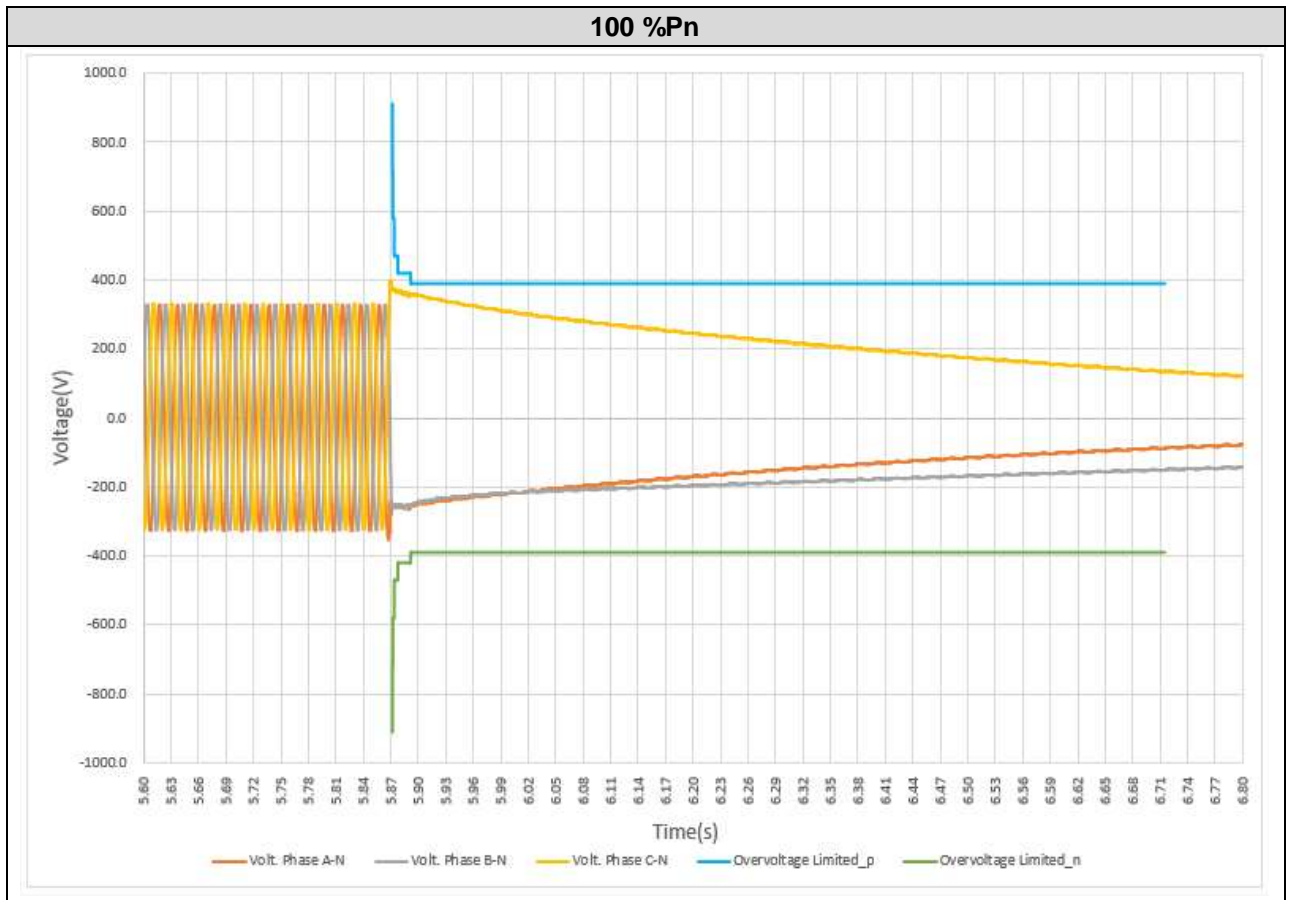
Overvoltage duration (s)	Overvoltage limit value (%Un)	Overvoltage value measured (%Un) at 50 %Pn	Overvoltage value measured (%Un) at 75 %Pn	Overvoltage value measured (%Un) at 100 %Pn
Phase A – N				
0.0002	±280	-86	108	-79
0.0006	±218	-85	107	-78
0.002	±178	-85	103	-78
0.006	±145	-84	100	-78
0.02	±129	-80	95	-78
0.06	±120	-78	93	-74
0.2	±120	-65	77	-62
0.6	±120	-31	45	-37
Phase B – N				
0.0002	±280	116	38	-80
0.0006	±218	116	25	-80
0.002	±178	115	-57	-78
0.006	±145	115	-96	-78
0.02	±129	98	-98	-77
0.06	±120	94	-95	-72
0.2	±120	84	-74	-65
0.6	±120	50	-37	-53
Phase C – N				
0.0002	±280	-101	-125	116
0.0006	±218	-100	-124	115
0.002	±178	-99	-100	114
0.006	±145	-100	-70	112
0.02	±129	-98	-73	110
0.06	±120	-95	-72	104
0.2	±120	-77	-55	86
0.6	±120	-37	-27	55

50 %Pn



75 %Pn





4.8 GRID QUALITY

4.8.1 Harmonics

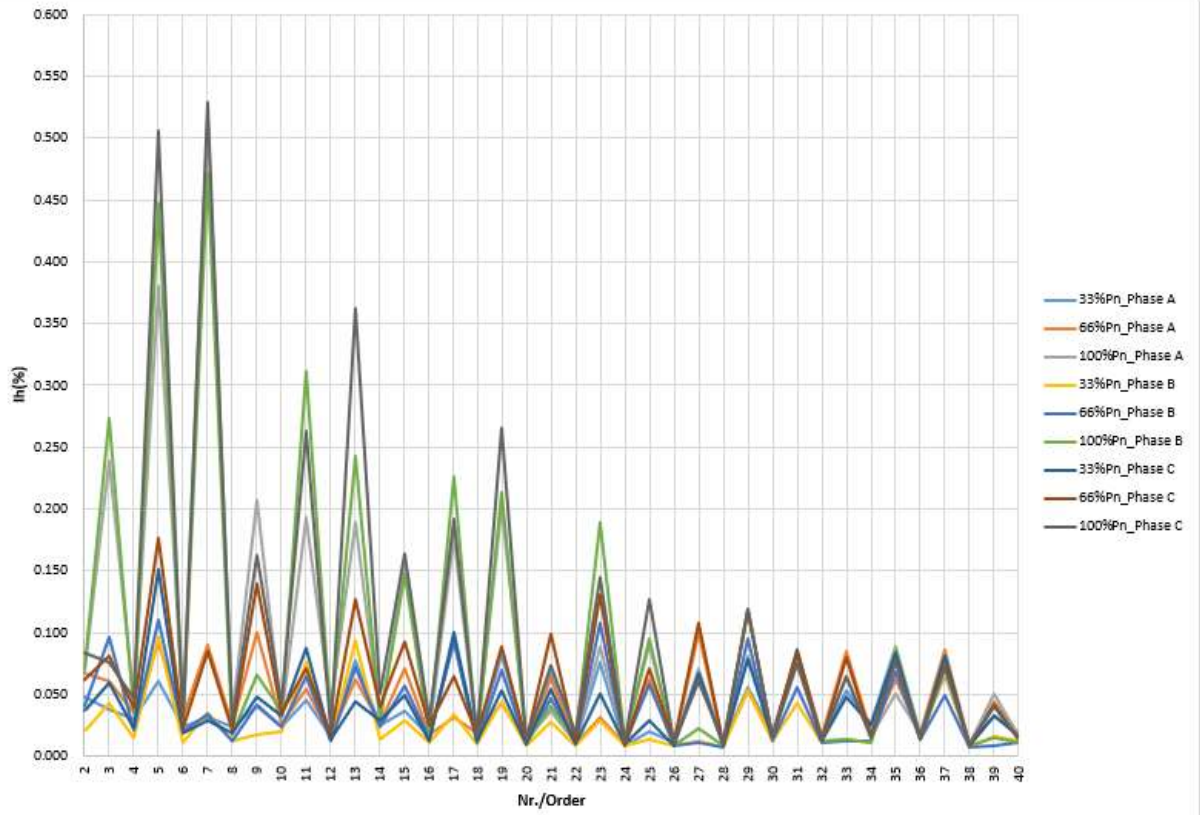
The test has been done according to the standard EN 61000-3-12.

Phase A				
P _{bin} (%)	33	66	100	LIMIT (%)
Nr./Order	I _h (%)	I _h (%)	I _h (%)	
2	0.048	0.067	0.068	8
3	0.038	0.060	0.239	5.3
4	0.030	0.036	0.046	4
5	0.061	0.092	0.380	10.7
6	0.024	0.031	0.039	2.7
7	0.031	0.090	0.513	7.2
8	0.024	0.025	0.033	2
9	0.041	0.100	0.207	1.8
10	0.023	0.027	0.031	1.6
11	0.045	0.054	0.193	3.1
12	0.016	0.016	0.040	1.3
13	0.078	0.062	0.189	2
14	0.025	0.027	0.030	--
15	0.036	0.071	0.153	--
16	0.016	0.017	0.019	--
17	0.093	0.031	0.178	--
18	0.012	0.019	0.015	--
19	0.083	0.043	0.203	--
20	0.011	0.011	0.014	--
21	0.068	0.064	0.037	--
22	0.011	0.009	0.011	--
23	0.076	0.031	0.089	--
24	0.009	0.010	0.014	--
25	0.020	0.062	0.090	--
26	0.011	0.010	0.011	--
27	0.068	0.100	0.071	--
28	0.010	0.009	0.010	--
29	0.055	0.054	0.082	--
30	0.018	0.017	0.020	--
31	0.080	0.085	0.081	--
32	0.013	0.016	0.016	--
33	0.054	0.085	0.065	--
34	0.027	0.019	0.016	--
35	0.089	0.062	0.050	--
36	0.017	0.018	0.019	--
37	0.065	0.087	0.075	--
38	0.010	0.010	0.010	--
39	0.032	0.044	0.051	--
40	0.019	0.017	0.016	--
THD (%)	0.287	0.326	0.863	13
PWHD (%)	1.271	1.315	1.802	22

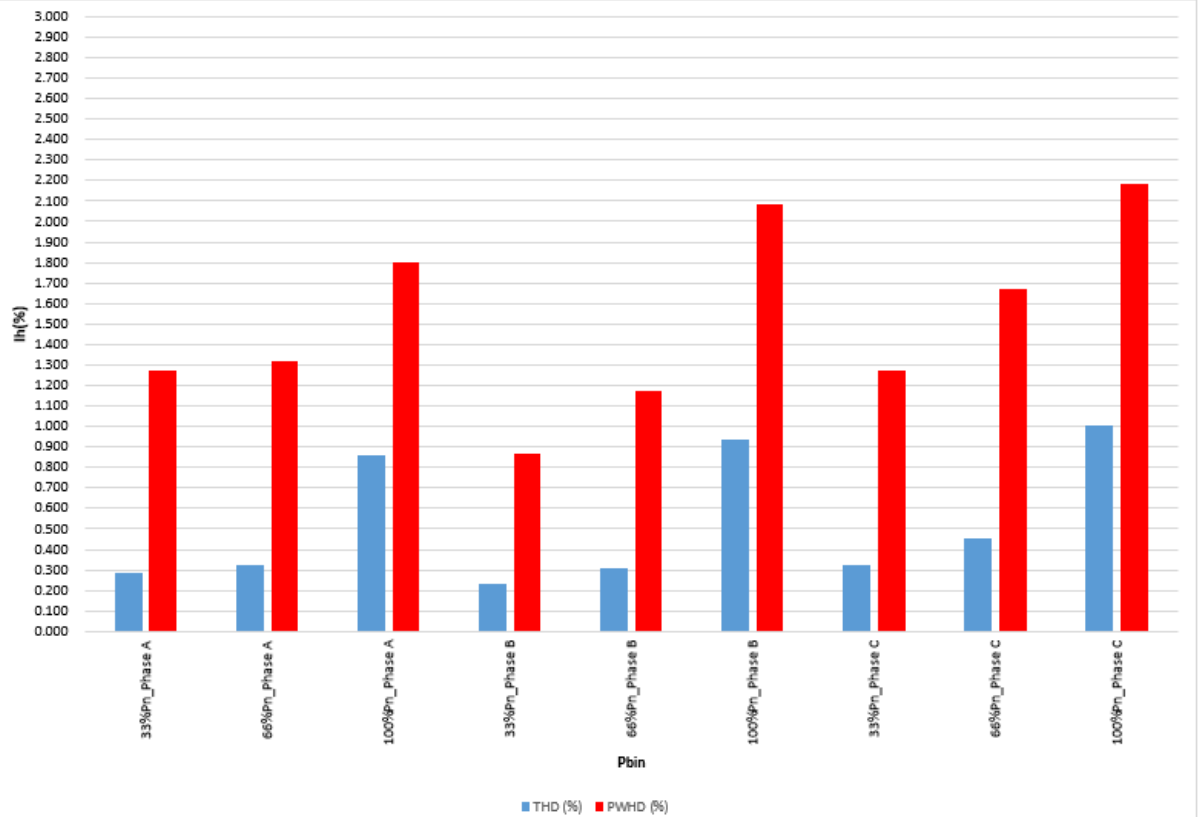
Phase B				
P_{bin} (%)	33	66	100	LIMIT (%)
Nr./Order	I_h (%)	I_h (%)	I_h (%)	
2	0.020	0.041	0.071	8
3	0.043	0.096	0.273	5.3
4	0.016	0.021	0.036	4
5	0.096	0.110	0.447	10.7
6	0.011	0.020	0.026	2.7
7	0.036	0.034	0.471	7.2
8	0.012	0.012	0.018	2
9	0.017	0.042	0.066	1.8
10	0.021	0.024	0.037	1.6
11	0.076	0.064	0.311	3.1
12	0.013	0.012	0.028	1.3
13	0.093	0.072	0.243	2
14	0.014	0.024	0.029	--
15	0.029	0.057	0.147	--
16	0.011	0.015	0.019	--
17	0.034	0.093	0.226	--
18	0.009	0.011	0.012	--
19	0.045	0.070	0.213	--
20	0.009	0.010	0.011	--
21	0.027	0.047	0.040	--
22	0.008	0.011	0.014	--
23	0.029	0.108	0.189	--
24	0.008	0.010	0.012	--
25	0.014	0.058	0.096	--
26	0.009	0.008	0.009	--
27	0.012	0.011	0.023	--
28	0.007	0.008	0.008	--
29	0.053	0.095	0.118	--
30	0.013	0.013	0.014	--
31	0.043	0.055	0.084	--
32	0.011	0.011	0.013	--
33	0.014	0.012	0.013	--
34	0.011	0.013	0.012	--
35	0.088	0.069	0.086	--
36	0.013	0.014	0.016	--
37	0.068	0.049	0.075	--
38	0.007	0.008	0.009	--
39	0.016	0.009	0.014	--
40	0.012	0.012	0.012	--
THD (%)	0.231	0.305	0.932	13
PWHD (%)	0.866	1.170	2.081	22

Phase C				
P_{bin} (%)	33	66	100	LIMIT (%)
Nr./Order	I_h (%)	I_h (%)	I_h (%)	
2	0.037	0.062	0.084	8
3	0.060	0.082	0.076	5.3
4	0.022	0.039	0.046	4
5	0.151	0.176	0.507	10.7
6	0.019	0.023	0.028	2.7
7	0.029	0.086	0.529	7.2
8	0.019	0.021	0.027	2
9	0.048	0.139	0.163	1.8
10	0.033	0.035	0.043	1.6
11	0.088	0.071	0.263	3.1
12	0.014	0.018	0.021	1.3
13	0.044	0.127	0.363	2
14	0.029	0.041	0.050	--
15	0.049	0.092	0.163	--
16	0.013	0.026	0.029	--
17	0.101	0.064	0.192	--
18	0.012	0.018	0.017	--
19	0.054	0.089	0.266	--
20	0.010	0.013	0.013	--
21	0.055	0.099	0.074	--
22	0.010	0.013	0.018	--
23	0.051	0.131	0.145	--
24	0.009	0.009	0.011	--
25	0.030	0.071	0.127	--
26	0.009	0.011	0.011	--
27	0.067	0.108	0.061	--
28	0.008	0.009	0.011	--
29	0.079	0.117	0.119	--
30	0.015	0.014	0.015	--
31	0.086	0.083	0.075	--
32	0.013	0.014	0.013	--
33	0.048	0.080	0.064	--
34	0.025	0.016	0.015	--
35	0.084	0.078	0.077	--
36	0.015	0.015	0.014	--
37	0.081	0.074	0.072	--
38	0.008	0.009	0.009	--
39	0.033	0.042	0.041	--
40	0.016	0.013	0.014	--
THD (%)	0.321	0.450	1.002	13
PWHD (%)	1.276	1.673	2.182	22

Current Harmonics



THD and PWHD



4.8.2 Flickers

The measurements of voltage fluctuations have been measured at 33%, 66% and 100% of the nominal power value of the inverter according to the standard IEC 61000-3-11:2000.

This test has two steps and 10min for each step:

1. Starting operation
2. Stopping operation

The values took of Pst and Plt are the most unfavorable of the two steps.

P _{bin} (%)	Limit	33%	66%	100%
Phase A				
P _{st}	≤ 1	0.23	0.25	0.26
P _{lt}	≤ 0.65	0.19	0.21	0.12
Phase B				
P _{st}	≤ 1	0.14	0.16	0.17
P _{lt}	≤ 0.65	0.12	0.13	0.08
Phase C				
P _{st}	≤ 1	0.19	0.20	0.20
P _{lt}	≤ 0.65	0.16	0.16	0.09

33%

Phase A

Flicker Mode Uover: ■ ■ ■ ■ YOKOGAWA ◆
 Iover: ■ ■ ■ ■ Flicker: Complete 0:20:00

Count ████████████████████ 2/2
 Interval ████████████████████ 10m00s/10m00s

Element 1
 Volt Range 600V/50Hz Element1 Judgement: Pass
 Un (U1) 230.025 V Total Judgement: Pass
 Freq(U1) 50.000 Hz (Element1,2,3)


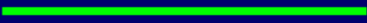
	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N: 2
No. 1	0.09 Pass	0.41 Pass	0 Pass	0.23 Pass	
2	0.10 Pass	0.35 Pass	0 Pass	0.12 Pass	
Result	Pass	Pass	Pass	Pass	0.19 Pass

Update 600 2020/01/04 10:25:43

33%

Phase B

Flicker Mode Uover: ■ ■ ■ ■ Iover: ■ ■ ■ ■ Flicker: **Complete** 0:20:00 YOKOGAWA ◆

Count  2/2
 Interval  10m00s/10m00s

Element 2
 Volt Range 600V/50Hz Element2 Judgement: **Pass**
 Un (U2) 230.218 V Total Judgement: **Pass**
 Freq(U2) ----- (Element1,2,3)


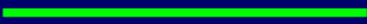
	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N: 2
No. 1	0.14 Pass	0.31 Pass	0 Pass	0.14 Pass	
2	0.15 Pass	0.27 Pass	0 Pass	0.09 Pass	
Result	Pass	Pass	Pass	Pass	0.12 Pass

Update 600 2020/01/04 10:25:35

33%

Phase C

Flicker Mode Uover: ■ ■ ■ ■ Iover: ■ ■ ■ ■ Flicker: **Complete** 0:20:00 YOKOGAWA ◆

Count  2/2
 Interval  10m00s/10m00s

Element 3
 Volt Range 600V/50Hz Element3 Judgement: **Pass**
 Un (U3) 230.225 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: 2
No. 1	0.17 Pass	0.39 Pass	0 Pass	0.19 Pass	
2	0.19 Pass	0.28 Pass	0 Pass	0.10 Pass	
Result	Pass	Pass	Pass	Pass	0.16 Pass

Update 600 2020/01/04 10:25:22

66%

Phase A

Flicker Mode Uover: ■ ■ ■ ■ YOKOGAWA ◆
 Iover: ■ ■ ■ ■ Flicker: Complete 0:20:00

Count  2/2
 Interval  10m00s/10m00s

Element 1
 Volt Range 600V/50Hz Element1 Judgement: Pass
 Un (U1) 230.508 V Total Judgement: Pass
 Freq(U1) 49.998 Hz (Element1,2,3)



	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N: 2
No. 1	0.11 Pass	0.43 Pass	0 Pass	0.25 Pass	
2	0.16 Pass	0.47 Pass	0 Pass	0.14 Pass	
Result	Pass	Pass	Pass	Pass	0.21 Pass

Update 600 2020/01/04 09:56:33

66%

Phase B

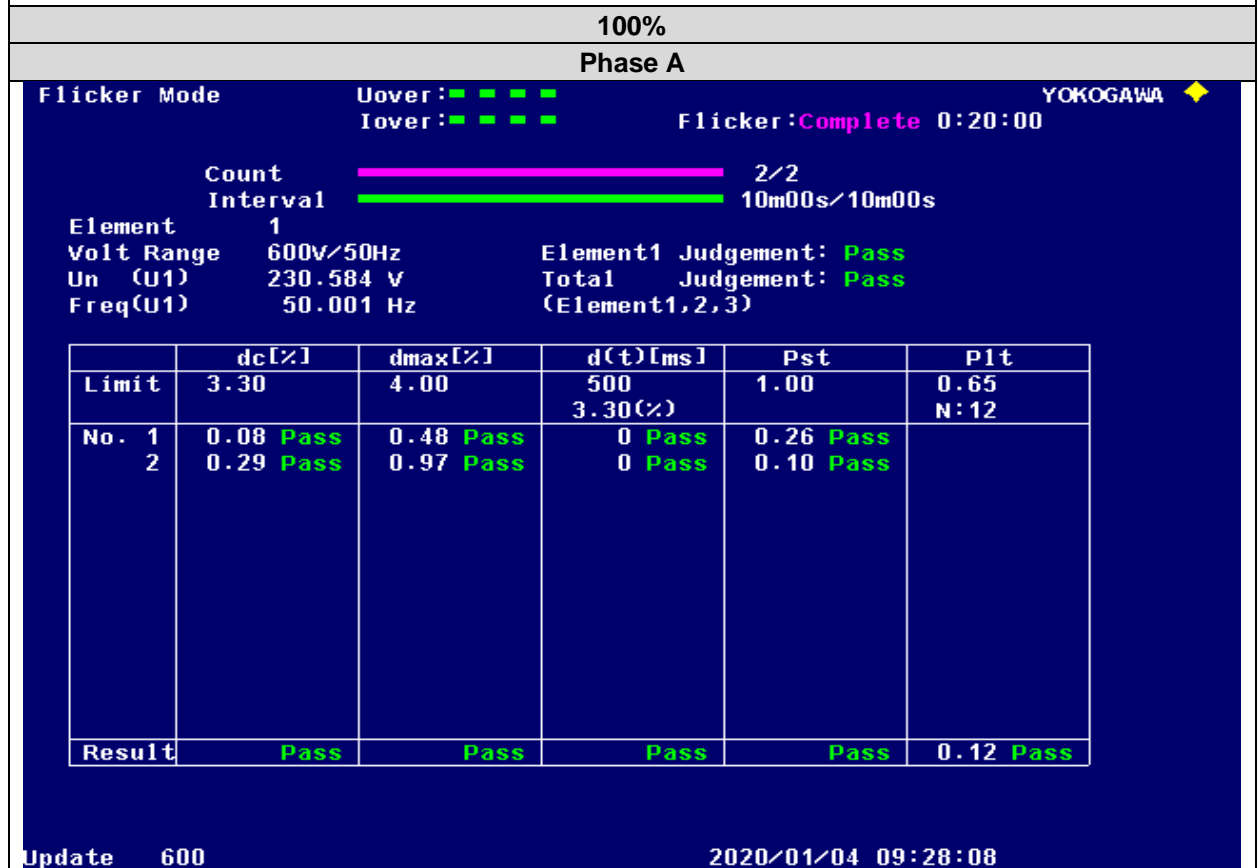
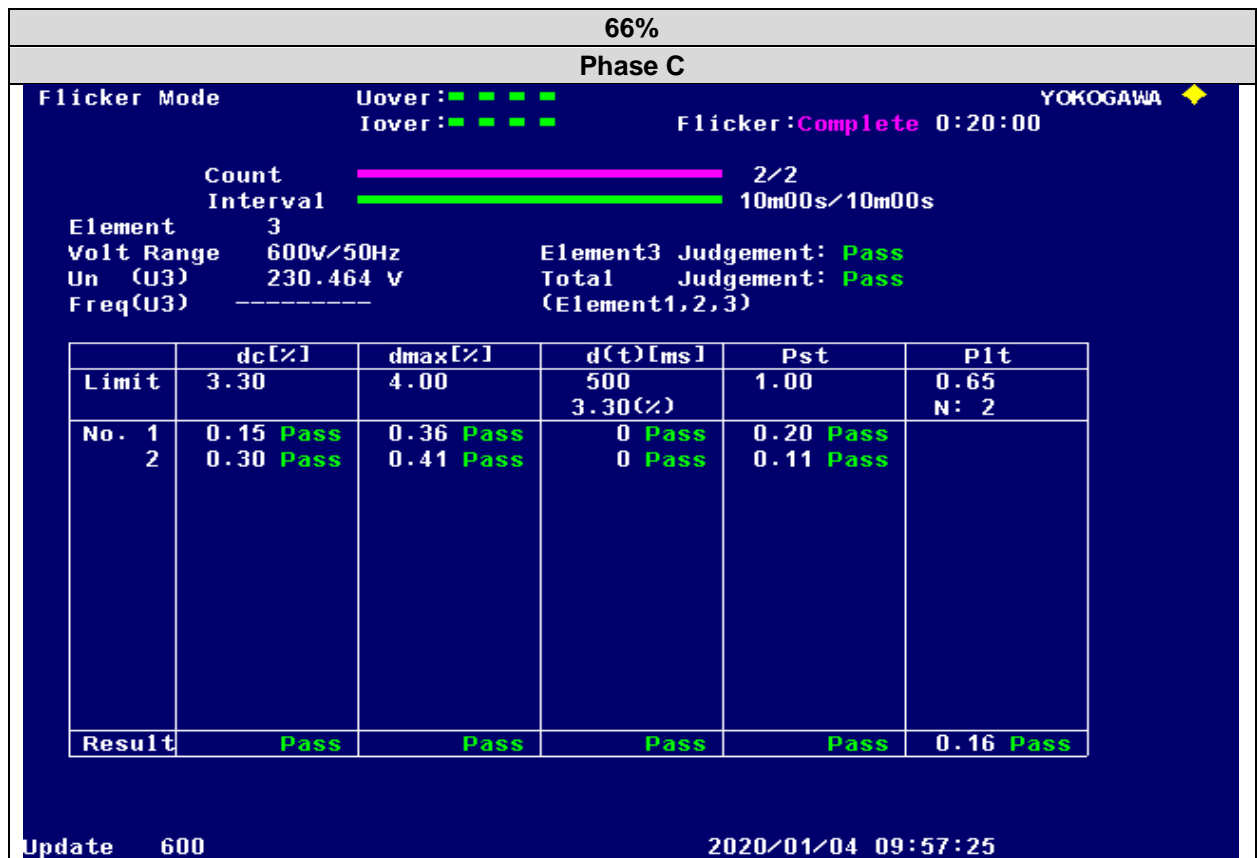
Flicker Mode Uover: ■ ■ ■ ■ YOKOGAWA ◆
 Iover: ■ ■ ■ ■ Flicker: Complete 0:20:00

Count  2/2
 Interval  10m00s/10m00s

Element 2
 Volt Range 600V/50Hz Element2 Judgement: Pass
 Un (U2) 230.167 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: 2
No. 1	0.15 Pass	0.30 Pass	0 Pass	0.16 Pass	
2	0.30 Pass	0.47 Pass	0 Pass	0.10 Pass	
Result	Pass	Pass	Pass	Pass	0.13 Pass

Update 600 2020/01/04 09:57:15

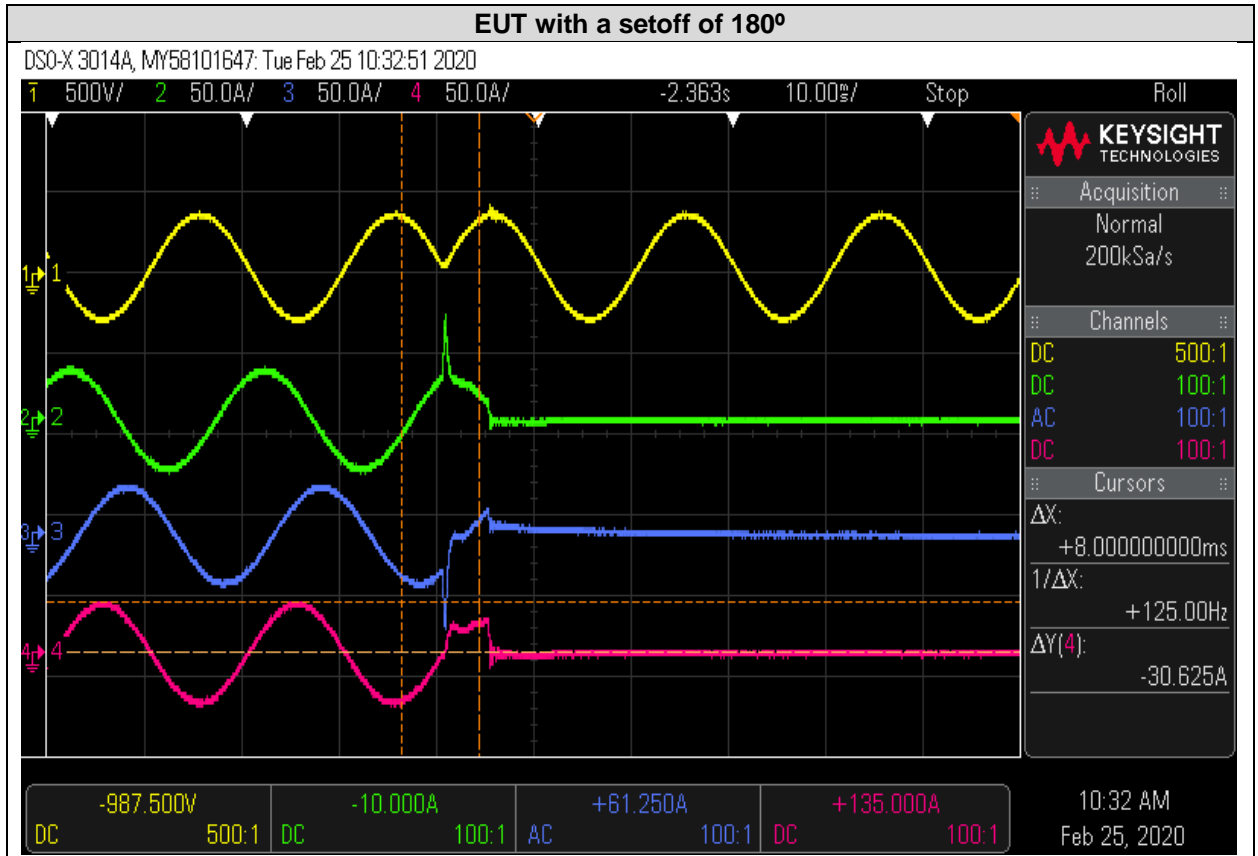
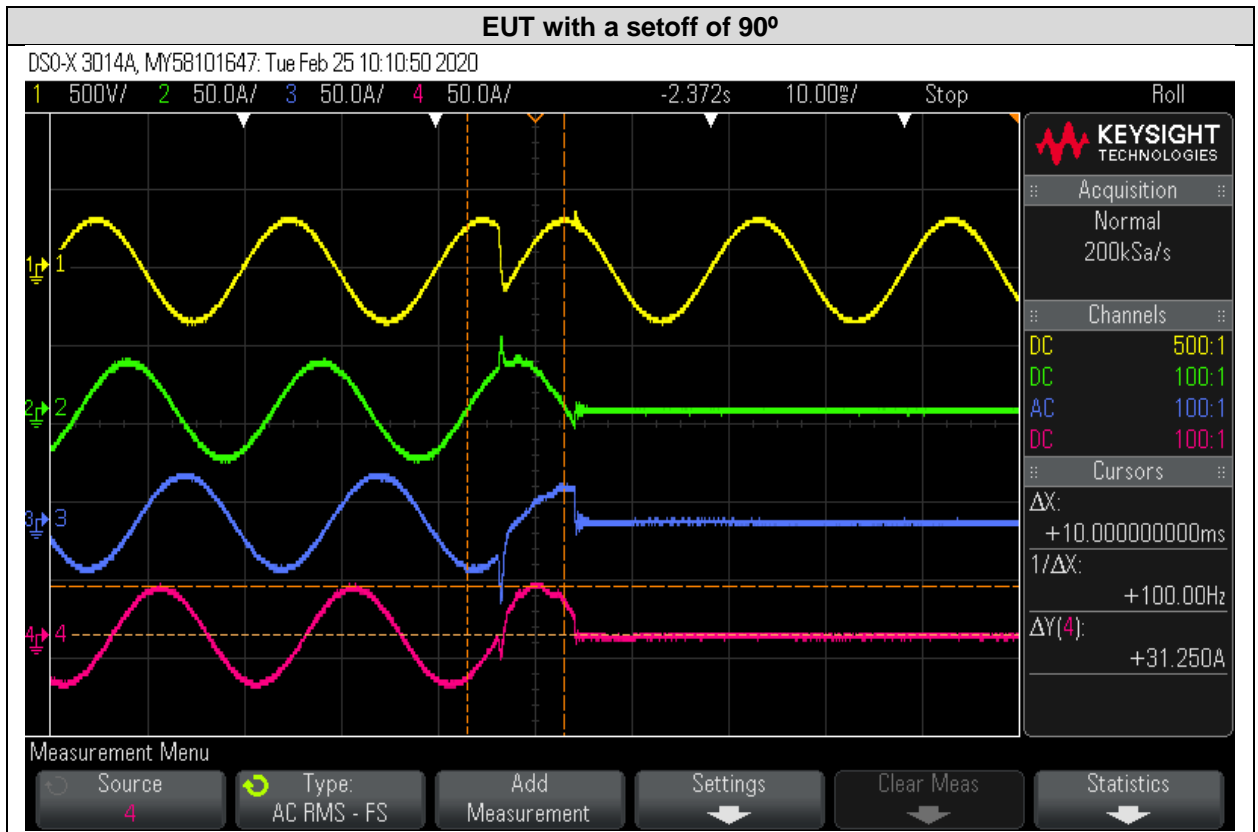


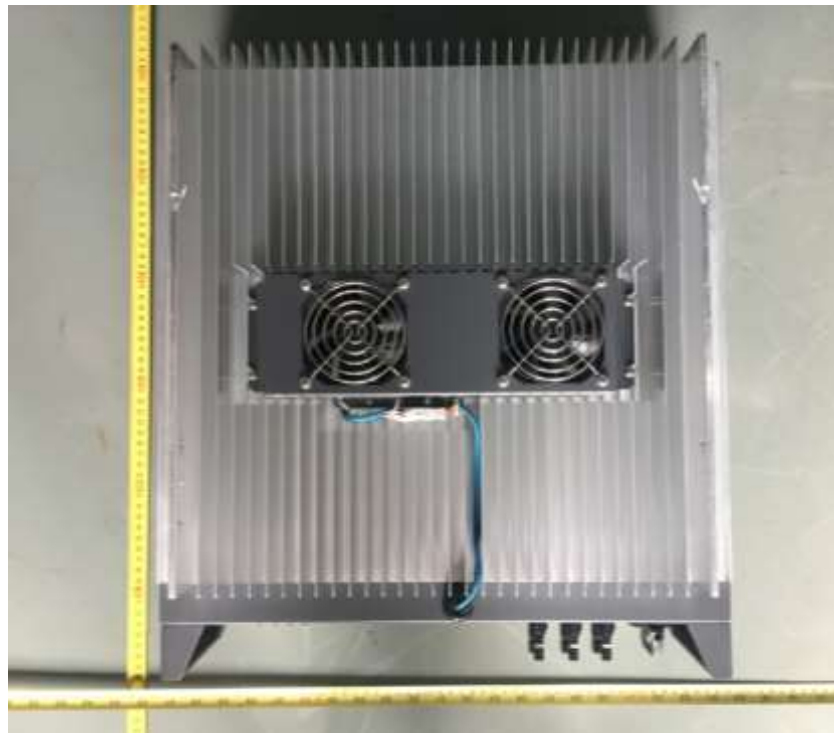
100%					
Phase B					
Flicker Mode		Uover: ■ ■ ■ ■		YOKOGAWA ◆	
		Iover: ■ ■ ■ ■		Flicker: Complete 0:20:00	
Count		Interval		2/2	
				10m00s/10m00s	
Element 2		Element2 Judgement: Pass			
Volt Range 600V/50Hz		Total Judgement: Pass			
Un (U2) 230.577 V		(Element1,2,3)			
Freq(U2) -----					
	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.16 Pass	0.33 Pass	0 Pass	0.17 Pass	
2	0.30 Pass	0.49 Pass	0 Pass	0.10 Pass	
Result	Pass	Pass	Pass	Pass	0.08 Pass
Update 600		2020/01/04 09:29:14			
100%					
Phase C					
Flicker Mode		Uover: ■ ■ ■ ■		YOKOGAWA ◆	
		Iover: ■ ■ ■ ■		Flicker: Complete 0:20:00	
Count		Interval		2/2	
				10m00s/10m00s	
Element 3		Element3 Judgement: Pass			
Volt Range 600V/50Hz		Total Judgement: Pass			
Un (U3) 230.635 V		(Element1,2,3)			
Freq(U3) -----					
	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
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	0.09 Pass
Update 600		2020/01/04 09:29:24			

4.9 RECONNECTION OUT OF SYNCHRONISM

The compliance with these requirements is stated in following test report:

Setoff	Angle before the setoff	Angle after the setoff	Current 20 ms before the setoff	Current 200 ms after the setoff
90°	0°	90°	Phase A: 21.9 A Phase B: 21.4 A Phase C: 22.0 A	Phase A: 5.0 A Phase B: 4.8 A Phase C: 5.0 A
180°	0°	180°	Phase A: 21.8 A Phase B: 21.2 A Phase C: 21.7 A	Phase A: 2.9 A Phase B: 1.6 A Phase C: 2.5 A



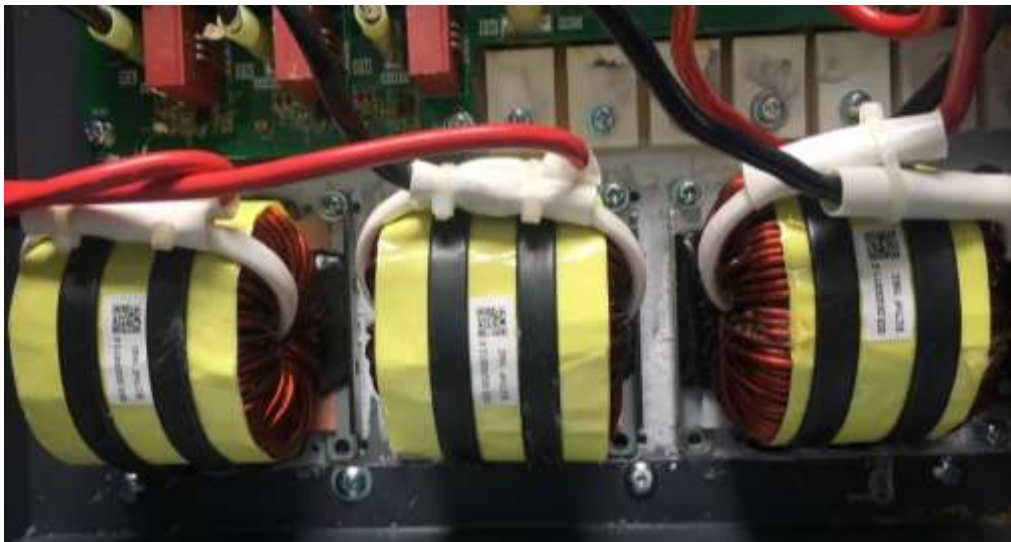
5 PICTURES**Front view****Back view**

Internal View of SOFAR 15000TL-G2

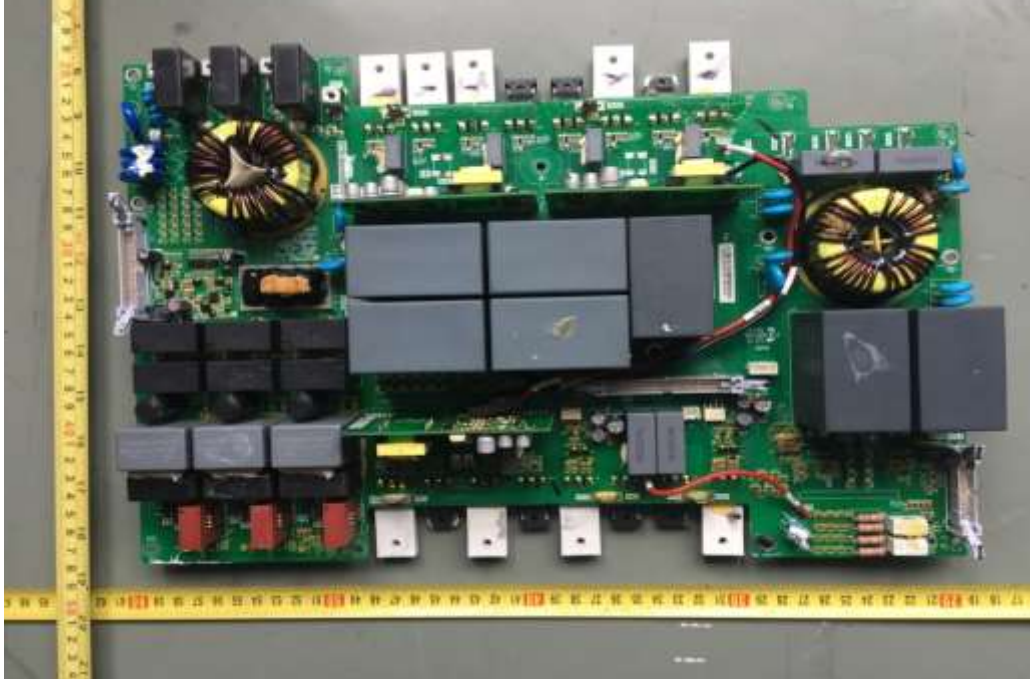


Internal View of Model SOFAR 10000TL-G2, SOFAR 12000TL-G2

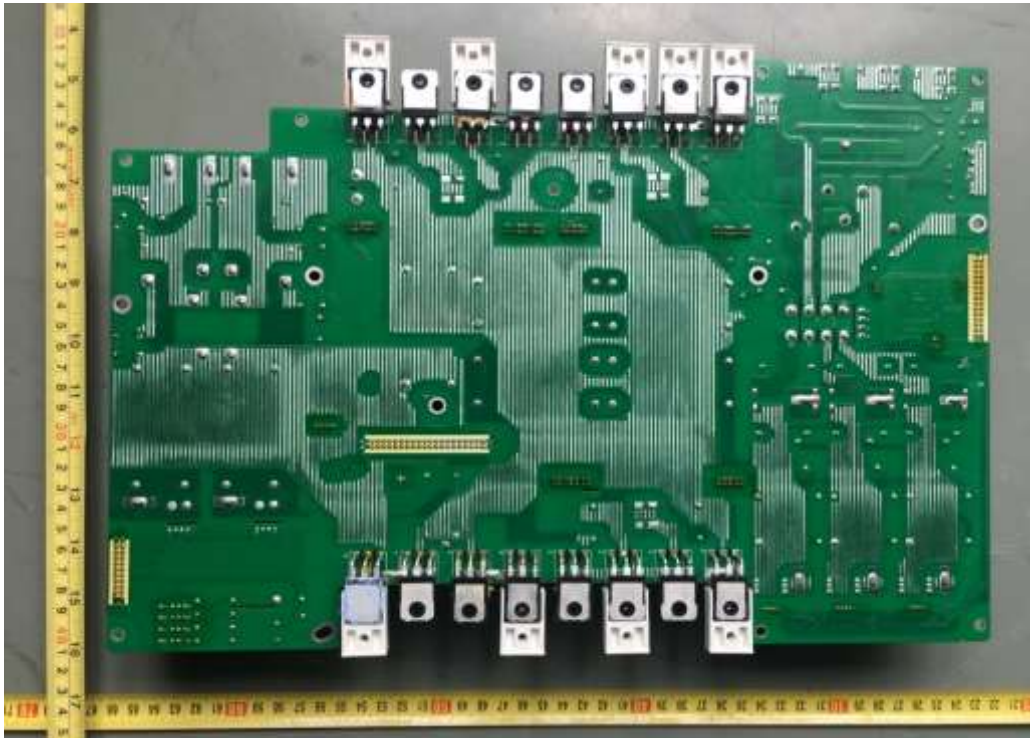


15000TL-G2 INV Inductance**10000TL-G2, 12000TL-G2 INV Inductance**

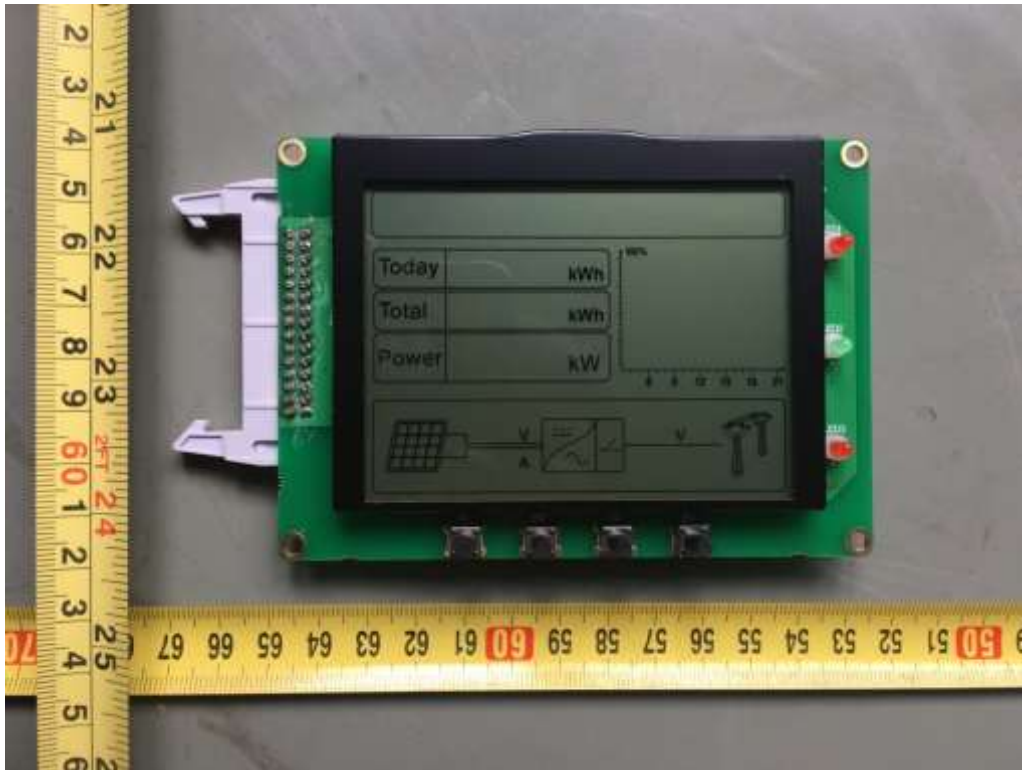
Front side of main board



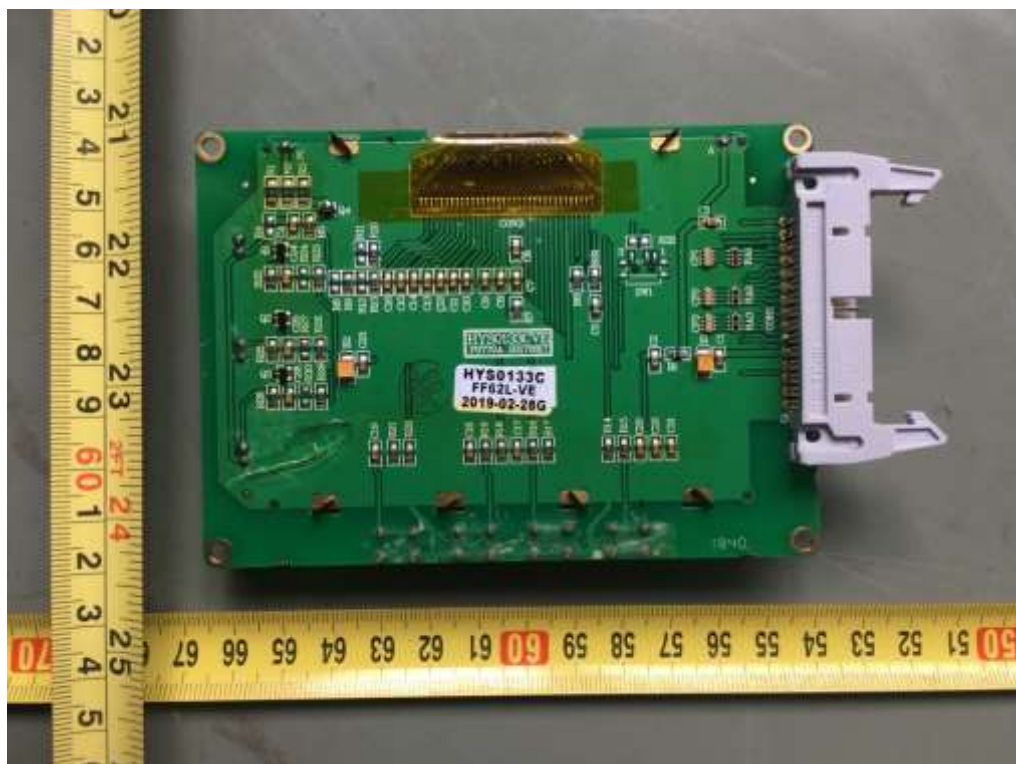
Back side of main board



Front side of Display board



Back side of Display board



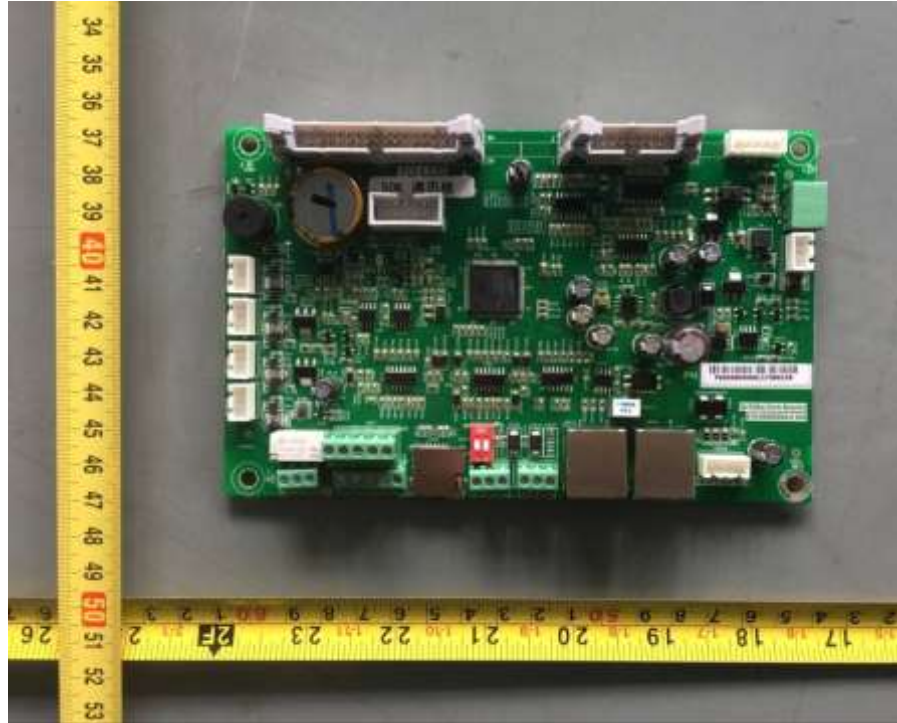
Front side of Control board



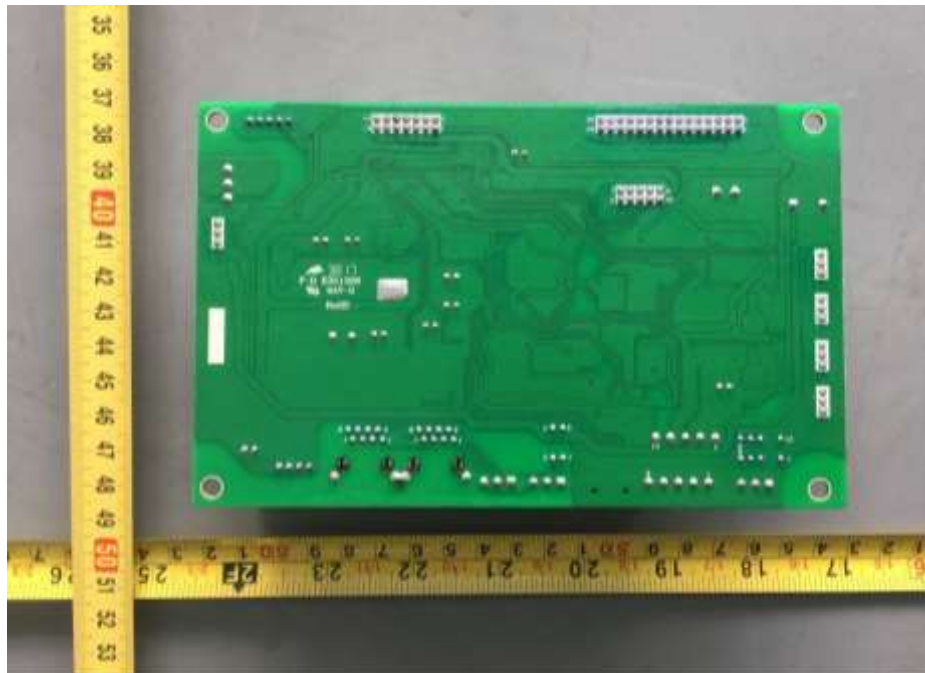
Front side of Control board



Front side of Communication board



Front side of Communication board



Front view of RS 232 board



Back view of RS 232 board



Grounding



Connection interface



Serial Number of EUT



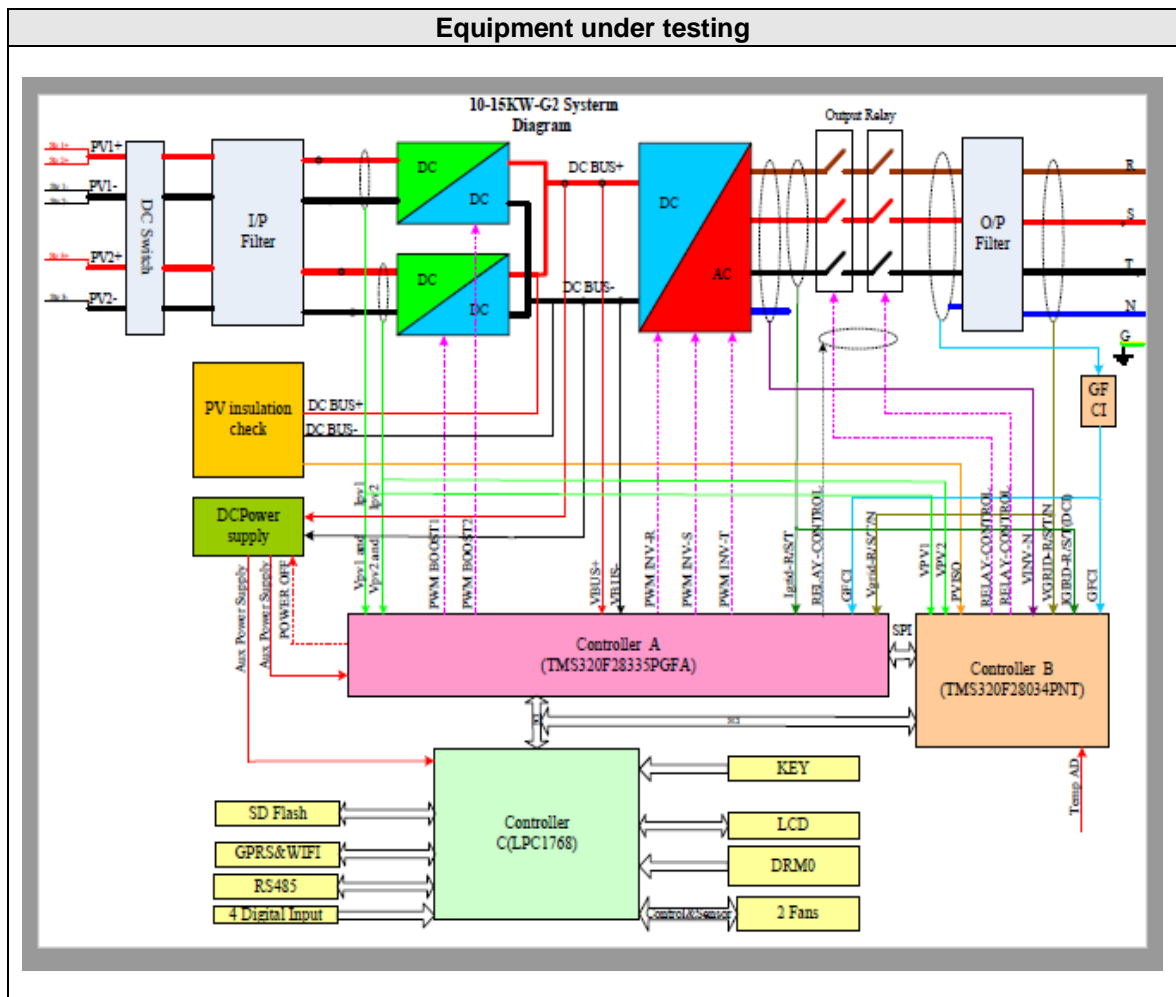
Serial Number of ESE



Software Version



6 ELECTRICAL SCHEME




7 CERTIFICATE OF CONFORMITY

Test Verification of Conformity

Verification Number: 190411091GZU-001

On the basis of the referenced test reports, samples tested of the below product have been found to comply with the standards harmonized with the directives listed on this verification at the time the tests were carried out. Other standards and Directives may be relevant to the product. This verification is part of the full test reports and should be read in conjunction with them.

Once compliance with all product relevant  mark directives are verified, including any relevant e.g. risk assessment and production control, the manufacturer may indicate compliance by signing a Declaration of Conformity themselves and applying the mark to products identical to the tested samples.

Applicant Name & Address:	Shenzhen SOFAR SOLAR Co., Ltd. 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Commur XinAn Street, BaoAn District, Shenzhen, China
Product Description:	Solar Grid-tied Inverter
Ratings & Principle Characteristics:	See Appendix: Test Verification of Conformity
Models/Type References:	SOFAR 10000TL-G2, SOFAR 12000TL-G2, SOFAR 15000TL-G2
Brand Name:	SOFAR SOLAR
Standard(s)/Directives:	See Appendix: Test Verification of Conformity
Verification Issuing Office Name & Address:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Test Report Numbers:	190411091GZU-005, 190411091GZU-006

Additional information in Appendix




Signature

Name: Tommy Zhong
Position: Technical Manager
Date: 30 Jul 2019

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APPENDIX: Test Verification of Conformity

This is an Appendix to Test Verification of Conformity Number: 190411091GZU-001

Ratings & Principle Characteristics:

Model	SOFAR 10000TL-G2	SOFAR 12000TL-G2	SOFAR 15000TL-G2
Max.PV voltage	1000 d.c.V		
PV MPPT voltage range	160-960 d.c.V		
Max.input current	21 /11 d.c.A		
PV Isc	30/15 d.c.A		
Max.output power	10000W	12000W	15000W
Max.apparent power	11000VA	13200VA	16500VA
Nominal output voltage	3/N/PE, 230 /400 a.c.V		
Max.output current	3×16.5 a.c.A	3×20.0 a.c.A	3×24.0 a.c.A
Nominal output Frequency	50/60 Hz		
Power factor range	0.8Leading – 0.8 lagging		
Inverter technology	Non-isolated		
Safety level	Class I		
Ingress Protection	IP 65		
Operation Ambient Temperature	-25°C - +60°C		
Software Version	V0.21		

Standard(s)/Directive(s):

IEC/EN 62109-1: 2010 Safety of power converters for use in photovoltaic power systems – Part 1: General requirements
 IEC/EN 62109-2: 2011 Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters
 Low Voltage Directive 2014/35/EU

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