TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH : VDE 0126-1-1+VFR:2013 and VFR:2014: AUTOMATIC DISCONNECTION DEVICE BETWEEN A GENERATOR AND THE PUBLIC LOW-VOLTAGE GRID. 2013

Protocol PE.T-LE-62

Test Report Number	:	GZES200702291301
Trademark	:	SOFAR SOLAR
Tested Model	:	HYD 15KTL-3PH
Variant Models	:	HYD 5KTL-3PH, HYD 6KTL-3PH; HYD 8KTL-3PH, HYD 10KTL-3PH, HYD 20KTL-3PH;

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-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch
Address	:	198 Kezhu Road, Science City, Economic & Technology Development Area, Guangzhou, Guangdong, China
Conducted (tested) by	:	Hugo Zhang (Project Engineer)
Reviewed & Approved by	:	Roger Hu (Technical Reviewer)

Date of issue	:	10 / 08 / 2020
Number of pages	:	72

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Test Report Historical Revision:

Test Report Version	Date	Resume
GZES200702291301	10 / 08 / 2020	First issuance

INDEX

1 SCOPE

SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch has been contract by Shenzhen SOFAR SOLAR Co., Ltd. to perform the testing according the VDE 0126-1-1:2013+VFR:2013 and VFR:2014: Automatic disconnection device between a generator and the public low-voltage grid.

2 GENERAL INFORMATION

2.1 Testing Period and Climatic conditions

The necessary testing has been performed along 5 days between the 28st of July and the 03h of August of 2020.

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 ..... : Hybrid Inverter (Three phase)

Installation ..... : Fixed(permanent connection)

Manufacturer ..... : 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

Trade mark ..... :

Model / Type reference ..... : HYD 15KTL-3PH

Serial Number ..... : SP1ES020H71002

Software Version ..... : V2.00

Rated Characteristics ..... : DC input: 180-960 V, Max. 2× 25 A
AC output: 3~/N/PE 230, 50 Hz, 3× 21.7A
(max. 3× 24A), 15000 W

Date of manufacturing: 2020

Input ..... : DC

Output..... AC

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

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

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

Cooling group ..... : Heat sink or Fan

Modular ..... : No

Internal Transformer..... : No

Copy of marking plate(representative):

Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. Labels of other models are as the same with **HYD15KTL-3PH**'s except the parameters of rating.

Equipment under testing:

- HYD 15KTL-3PH;

The variants models are:

- HYD 5KTL-3PH;
- HYD 6KTL-3PH;
- HYD 8KTL-3PH;
- HYD 10KTL-3PH;
- HYD 20KTL-3PH;

Model	HYD 5KTL-3PH	HYD 6KTL-3PH	HYD 8KTL-3PH	HYD 10KTL-3PH	HYD 15KTL-3PH	HYD 20KTL-3PH
PV String Input Data						
Max. DC voltage	1000V					
MPPT voltage range	180V~960V					
Full power MPPT voltage range	250V~850V	320V~850V	360V~850V	220V~850V	350V~850V	450V~850V
Max. input current	12.5A/12.5A	12.5A/12.5A	12.5A/12.5A	25A/25A	25A/25A	25A/25A
Max. short current	15A/15A	15A/15A	15A/15A	30A/30A	30A/30A	30A/30A
Battery Input Data						
Battery voltage range	180V~800V					
Battery voltage range for full load	200V~800V	240V~800V	320V~800V	200V~800V	300V~800V	400V~800V
No. of battery input	1			2		
Nominal charging/discharging power	5000W	6000W	8000W	10000W	15000W	20000W
Max. charging/discharging current	25A	25A	25A	50A (25A/25A)	50A (25A/25A)	50A (25A/25A)
AC Output Data (On-grid)						
Nominal AC power	5000W	6000W	8000W	10000W	15000W	20000W
Max. AC power output to utility grid	5500VA	6600VA	8800VA	11000VA	16500VA	22000VA
Max. AC power from utility grid	10000VA	12000VA	16000VA	20000VA	30000VA	40000VA
Max. AC current output to utility grid	8A	10A	13A	16A	24A	32A
Rated AC current output to utility grid	7.2A	8.7A	11.6A	14.5A	21.7A	29A
Max. AC Current from utility grid	15A	17A	24A	29A	44A	58A

Nominal output voltage	3/N/PE, 230Vac					
Nominal output freqency	50Hz					
Output power factor	~1(0.8 leading to 0.8 lagging)					
AC Output Data (Back-up)						
Nominal output power	5000W	6000W	8000W	10000W	15000W	20000W
Max. output power	5500VA	6600VA	8800VA	11000VA	16500VA	22000VA
Rated. output current	7.2A	8.7A	11.6A	14.5A	21.7A	29A
Max. output current	8A	10A	13A	16A	24A	32A
Nominal output voltage	3/N/PE, 230Vac					
Nominal output freqency	50Hz					
Output power factor	~1(0.8 leading to 0.8 lagging)					
Operating temperature range	-30ºC ~60ºC					
Ingress protection	IP65					
Protective class	Class I					
Cooling method	Heat sink	Heat sink	Heat sink	Fan	Fan	Fan

The variants models have been included in this test report without tests because the following features don´t change regarding to the tested model:

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

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

2.3 Manufacturer and Factory information

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

2.4 Test Equipment List

From	No.	Equipment Name	Model No.	Equipment No.	Calibration Date	Equipment calibration due date
Sofar Solar	1	Digital oscilloscope	DSOX3014A	MY58491772	2020/01/14	2021/01/13
	2	Voltage probe	SI-9110	111152	2020/1/14	2021/1/13
	3	Voltage probe	SI-9110	152627	2020/01/14	2021/01/13
	4	Voltage probe	SI-9110	111134	2020/01/14	2021/01/13
	5	Power analyzer	PA5000H	C8202909082002 110001	2020/03/02	2021/03/01
	6	Current probe	CP1000A	C181000922	2020/01/14	2021/01/13
	7	Current probe	CP1000A	C181000925	2020/01/14	2021/01/13
	8	Current probe	CP1000A	C181000929	2020/01/14	2021/01/13
	9	Temperature & Humidity meter	TH101B	ZB-WSDJ-001	2020/01/14	2021/01/13
	10	Power analyzer	WT3000	91N610888	2020/01/14	2021/01/13
	11	Digital oscilloscope	DSOX3014A	MY58101647	2020/01/14	2021/01/13
	12	Power analyzer	PA5000	C8202909082002 110002	2020/03/02	2021/03/01
SGS	13	True RMS Multimeter	Fluke / 187	GZE012-8	2019/12/05	2020/12/04

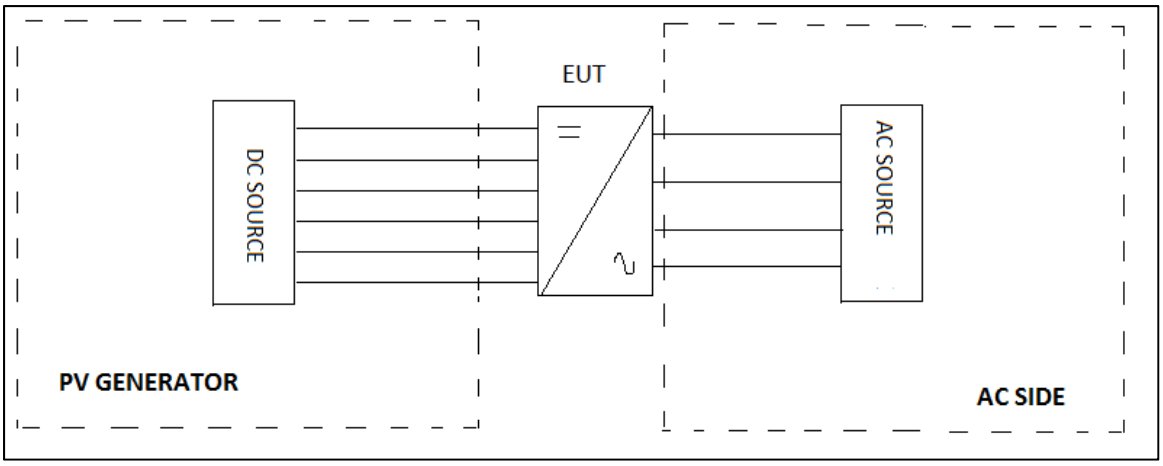
2.5 Measurement Uncertainty

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

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

2.6 Test set up of the different standard

Below is the simplified construction of the test set up.



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

The test bench used includes:

EQUIPMENT	MARK / MODEL	RATED CHARACTERISTICS	OWNER / ID. CODE
AC source	Kwell / AFG-S-33800	Voltage: 0-600 V 750 kVA	Sofarsolar / EP-026
PV source	Kwell / TVS-630kW	Voltage: 0 - 1000 V 630 kW	Sofarsolar / EP-027
RLC load	Qunlin / ACLT3820H	68 kW, 68 kVAr	Sofarsolar / EP-029

2.7 Definitions

In	Nominal Current	P	Power
p.u	Per unit	I	Current
Pn	Nominal Power	M	Change for real power
Sn	Apparent Power	N	Change for reactive power
PGU	Power Generation Unit	F	Frequency
Pst	Short-term flicker strength	Q_f	Quality factor
Plt	Long-term flicker strength	NS	Network and System
$C_{\psi K}$	Flicker coefficient for continuous operation	Un	Nominal Voltage
S_r	Apparent Power Rated	PWHD	Partial weight harmonic distortion
S_k	Short-circuit Apparent Power	THD	Total harmonic distortion
K_{imax}	Maximum switching current factor	Z_{test}	Test circuit impedance at which the emission test
Z_{ref}	The reference impedance	EUT	Equipment under test

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

CHAPTER OF THE STANDARD, DESCRIPTION AND VERIFICATION			
4	**Requirements**		
4.1	Functional safety		P
4.2	Reconnection		P
4.3.1	Voltage monitoring -20%		P
4.3.2	Voltage monitoring +10%		P
4.3.3	Voltage monitoring +15%		P
4.4.1	Frequency monitoring: 51.5Hz		P
4.4.2	Frequency monitoring: 47.5Hz		P
4.5	DC current monitoring		P
4.6	Anti-Islanding Protection		P
4.7	Marking		P
4.8	Residual Current		P
4.9	Table: Active poewr output feed-in at overfrequency		P

4 TEST RESULTS

4.1 FUNCTIONAL SAFETY

The security as defined in 4.3 to 4.8 of the standard must turn in an error state and display this error condition.

Testing of the single-fault tolerance and fault detection with subsequent disconnection is carried out by fault simulation, if necessary with additional fault tests.

It must be checked that a single fault does not lead to loss of the safety function.

The results are offered in the table below:

Based on an analysis of the products circuits, capacitors, diodes, solid –state devices and similar component were subjected to shorting or opening while the product was energized at rated voltage and under load (if grid connected it shall be tied to a simulated grid). Evidence of malfunction as specified above shall be noted and recorder.

In addition the utility – interactive inverter was monitored for backfeed current that flows from the simulated utility source into the photovoltaic array as a result of a faulted components. This was done by monitoring the dc current to the dc supply input with the dc source off and the simulated circuit operating.

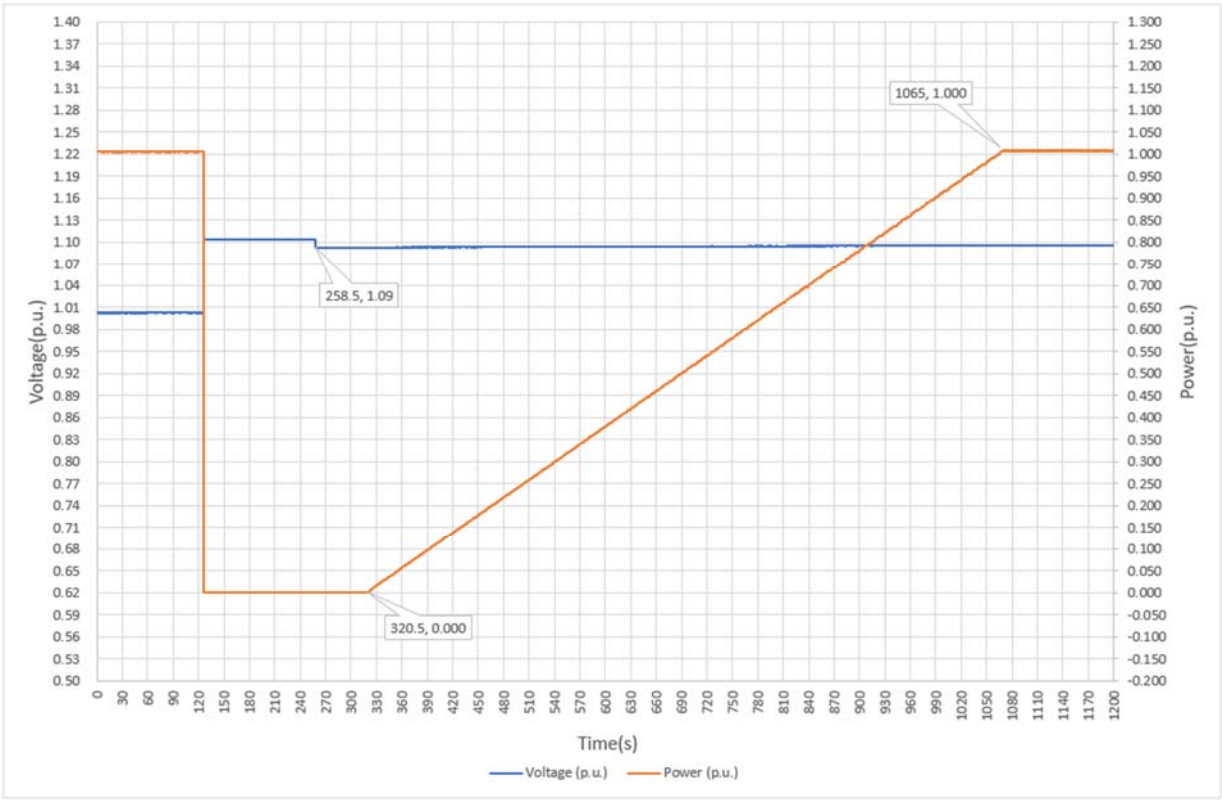
The compliances with these requirements are stated in section 4.4 on pages 58 to 62 of the following test report:

-IEC 62109-1:2010: Test Report nº BL-DG2060127-B01 on 02 July.,2020 which issued by Shenzhen BALUN Technology Co., Ltd.

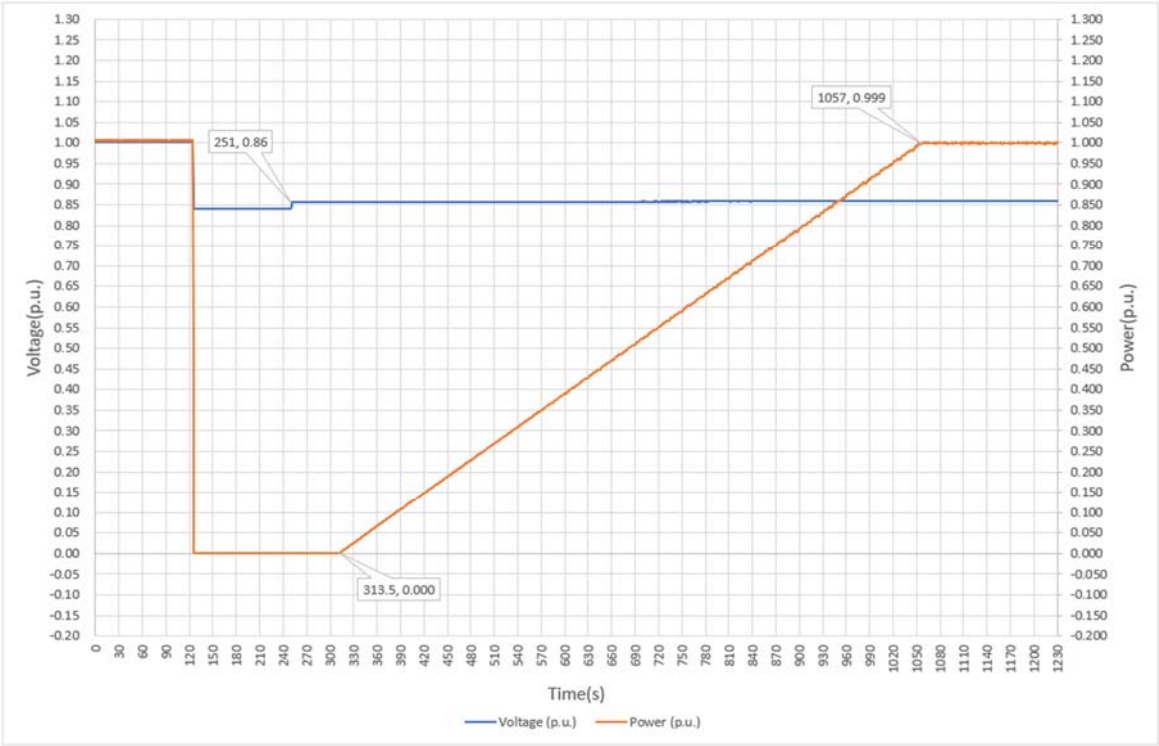
4.2 CONNECTION AND RECONNECTION CONDITIONS

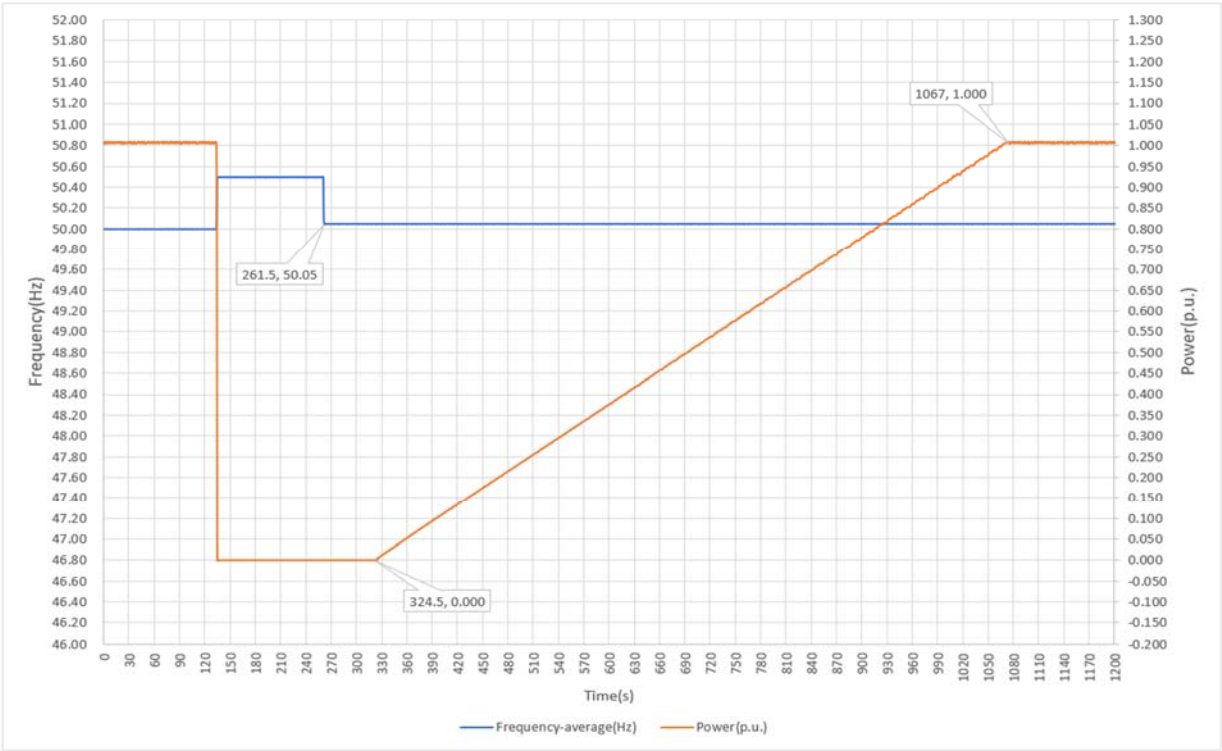
The power generation system shall be connected to the network only if both voltage and frequency are within the tolerance range according to article 4.2. It is shown that the active power don't exceed the gradient of 10 % of the active power per minute (green line).

Overvoltage Un+10%Un

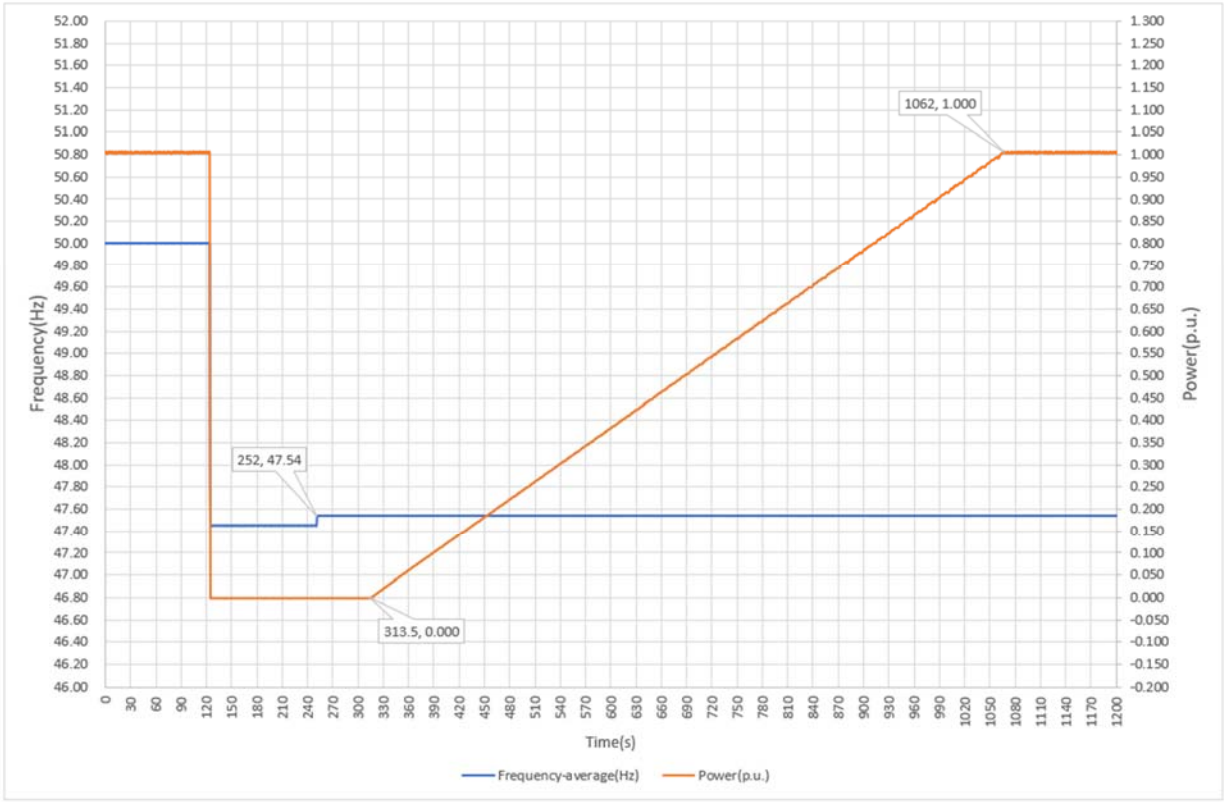


Reconnection delay time limit: 60 s	Reconnection time measured: 62.0 s
Gradient (ΔP) desired (%Pn/min) limit:10%	Gradient measured (%P_n/min):8.1%

Undervoltage Un-15%Un	
	
Reconnection delay time limit: 60 s	Reconnection time measured:62.5 s
Gradient (ΔP) desired (%Pn/min) limit:10%	Gradient measured (%P_n/min):8.1%

Overfrequency 50.05 Hz	
	
Reconnection delay time limit: 60 s	Reconnection time measured: 63.0 s
Gradient (ΔP) desired (%Pn/min) limit:10%	Gradient measured (%P_n/min):8.1%

Underfrequency 47.5 Hz



Reconnection delay time limit: 60 s	Reconnection time measured: 61.5 s
Gradient (ΔP) desired (%Pn/min) limit:10%	Gradient measured (%P_n/min):8.0%

4.3 VOLTAGE MONITORING

According to article 4.3 the NS protection should disconnect the power generation system from the net in the event of inadmissible voltage values. This point of the standard redirect to the point 6.5 of the VDE AR-N 4105:2011.

a) For measurement of the phase to phase voltages the phase angle must be turned so that one phase to phase voltage reaches the limit value, whereby the phase to neutral voltages for testing the overvoltage are set to 110 % *U*n and for undervoltage to 90 % *U*n.

b) For the measurement of the phase to neutral voltage, one phase to neutral voltage should be changed, whereby both other phase to neutral voltages are maintained at the nominal voltage. This test must be carried out separately for each phase.

To measure the response time, a voltage changes of:

– Nominal voltage to 118 % *U*n for overvoltage and
– Nominal voltage to 77 % *U*n for undervoltage

is carried out.

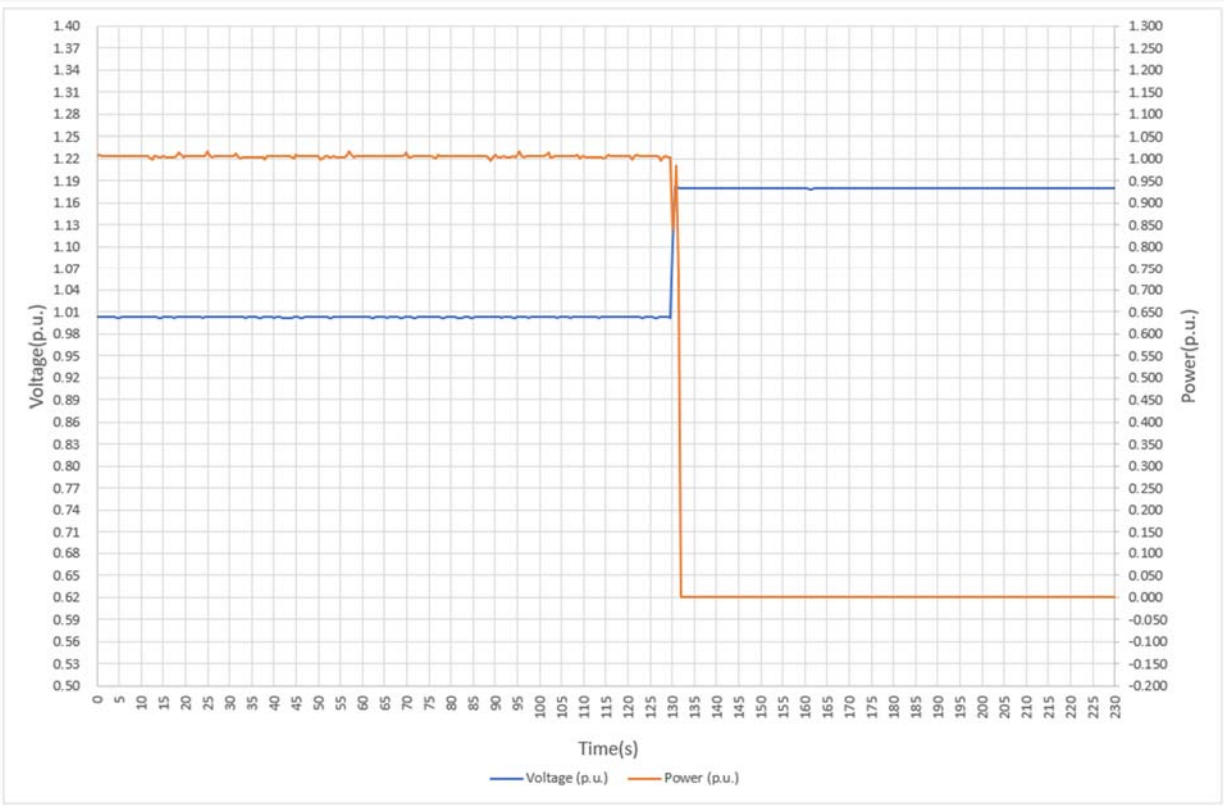
All tests for verification of the disconnection values and times must be carried out three times.

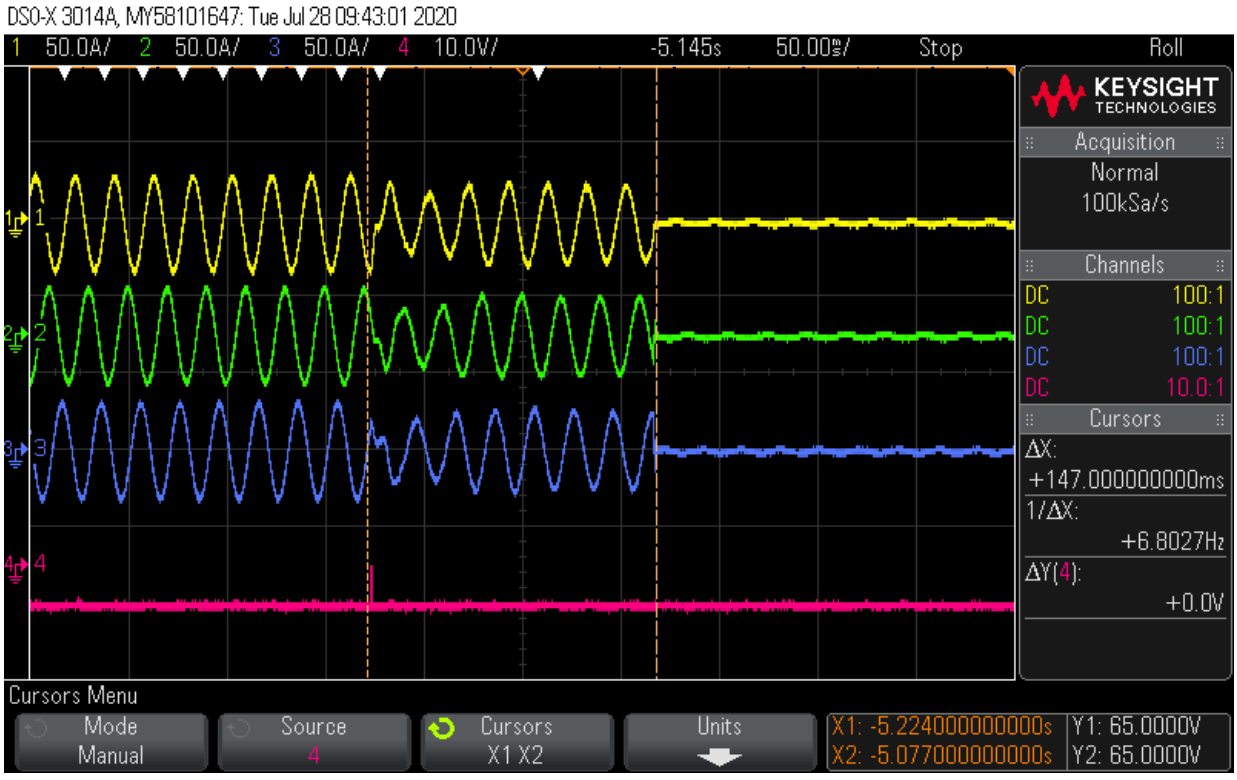
The results are offered in the table below:

Disconnection time measured					
Protective function	**Voltage changes**	**Disconnection time limits**	**Test 1**	**Test 2**	**Test 3**
Rise-in-voltage protection (U>>)	100% Un to 118% Un	< 200 ms	147 ms	153 ms	149 ms
Voltage drop protection (U<)	100% Un to 77% Un	< 200 ms	161 ms	145 ms	151 ms

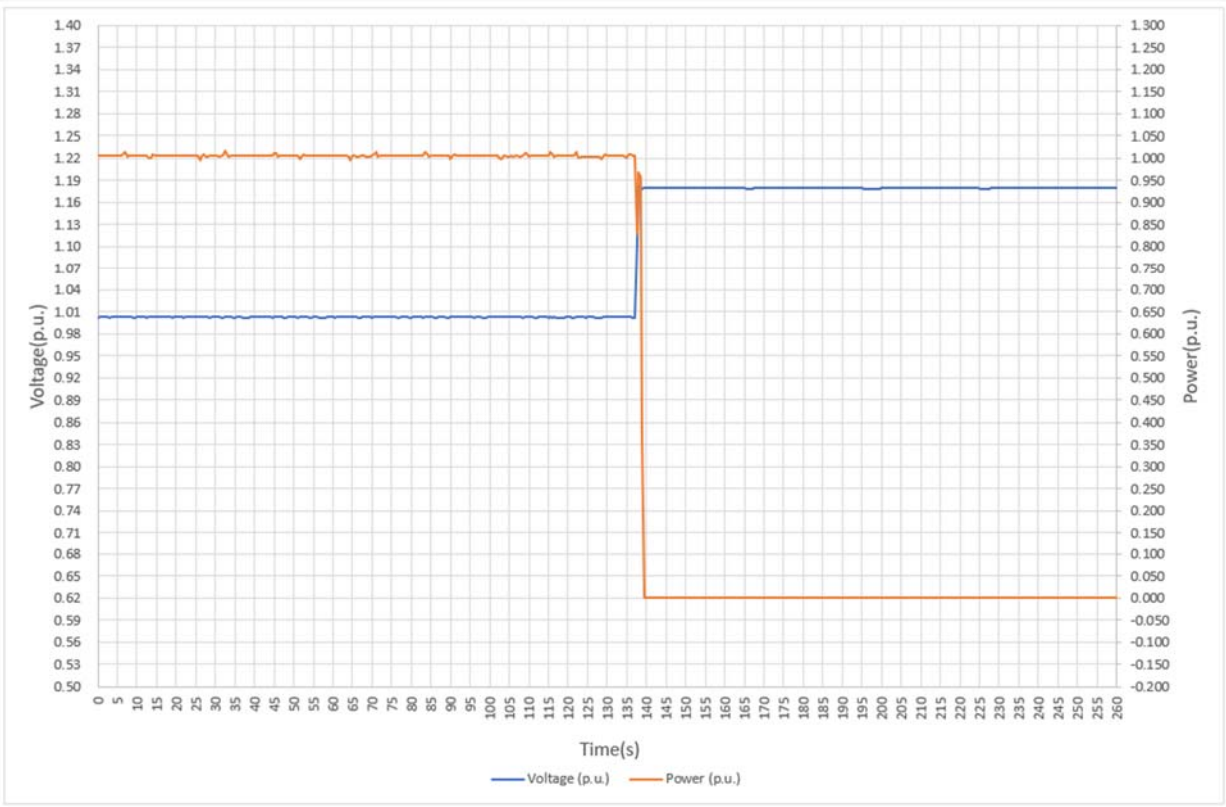
In the picture below are offered waveforms and graphically the results of the test.

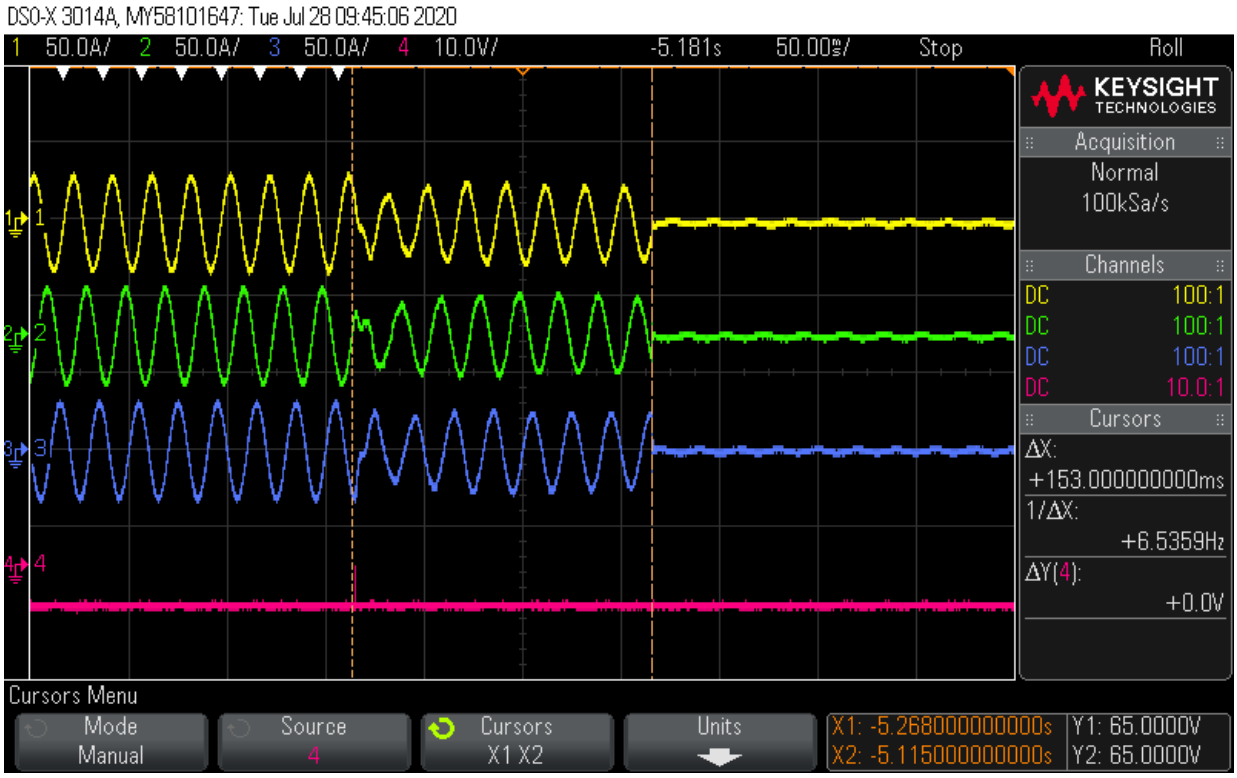
Nominal voltage to 118 % Un for overvoltage - Test 1



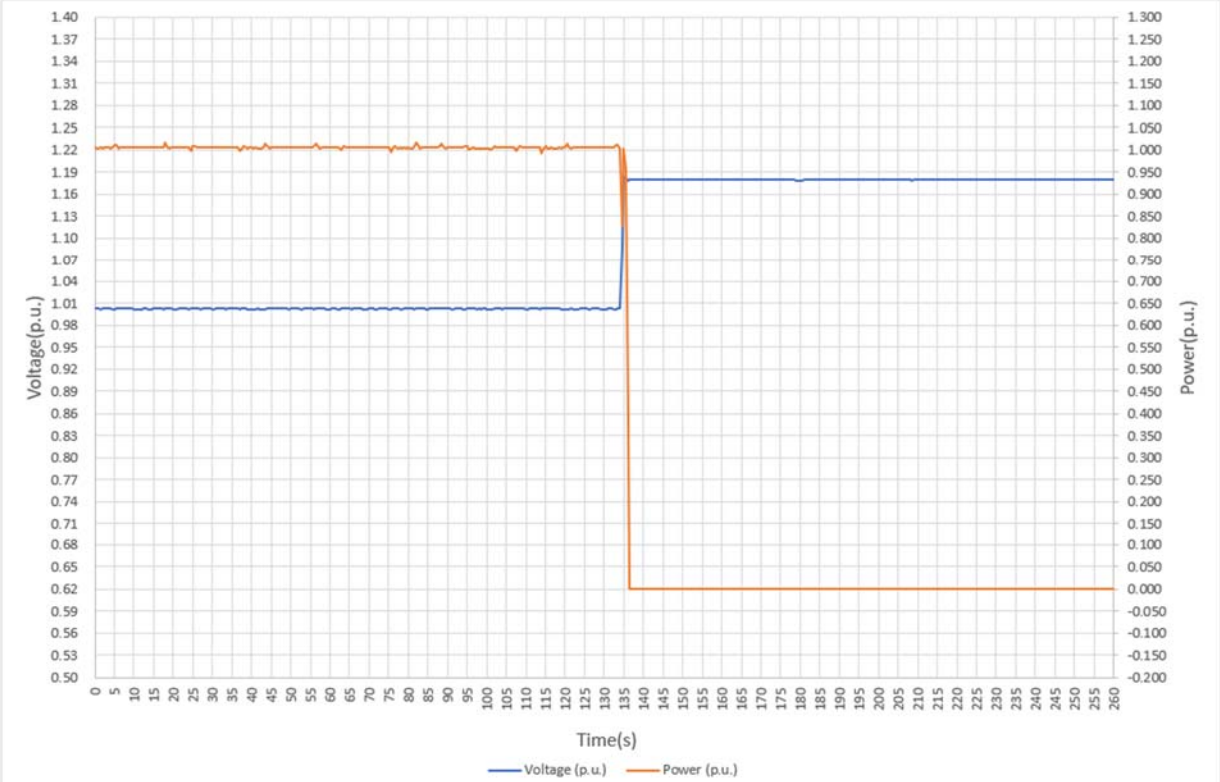


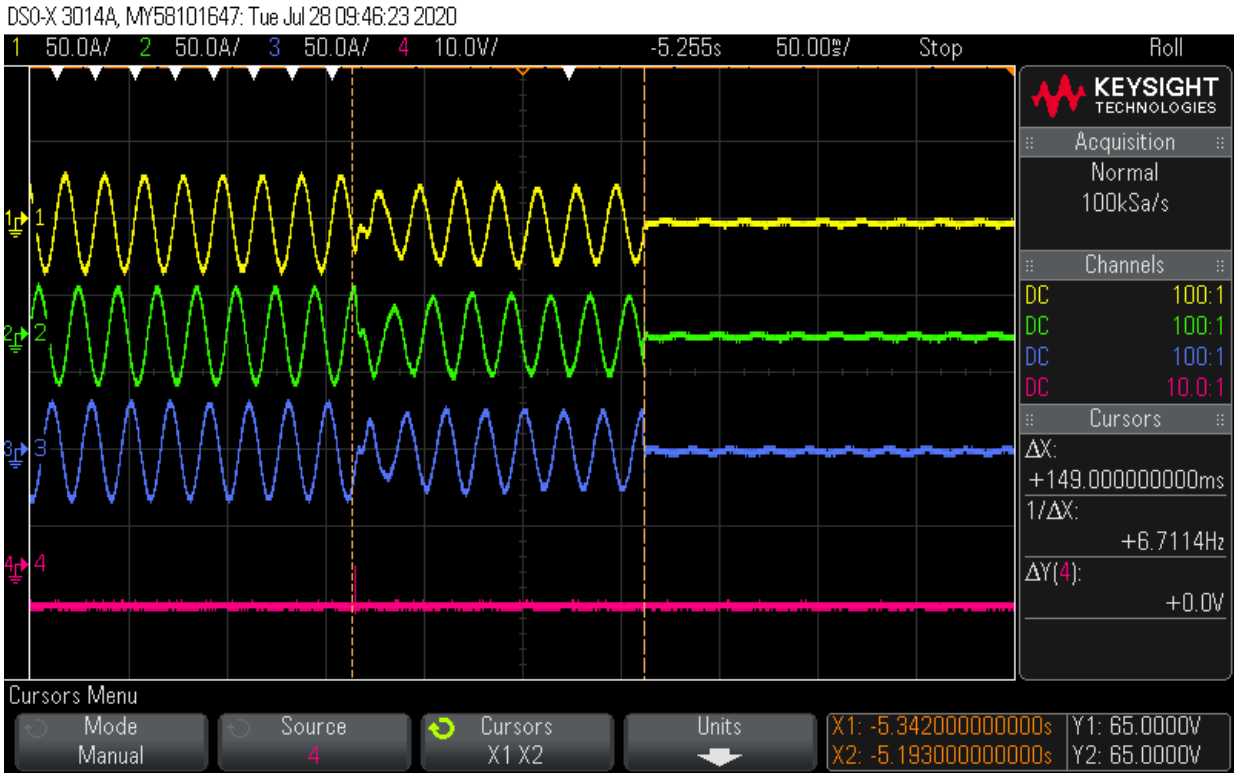
Nominal voltage to 118 % Un for overvoltage - Test 2



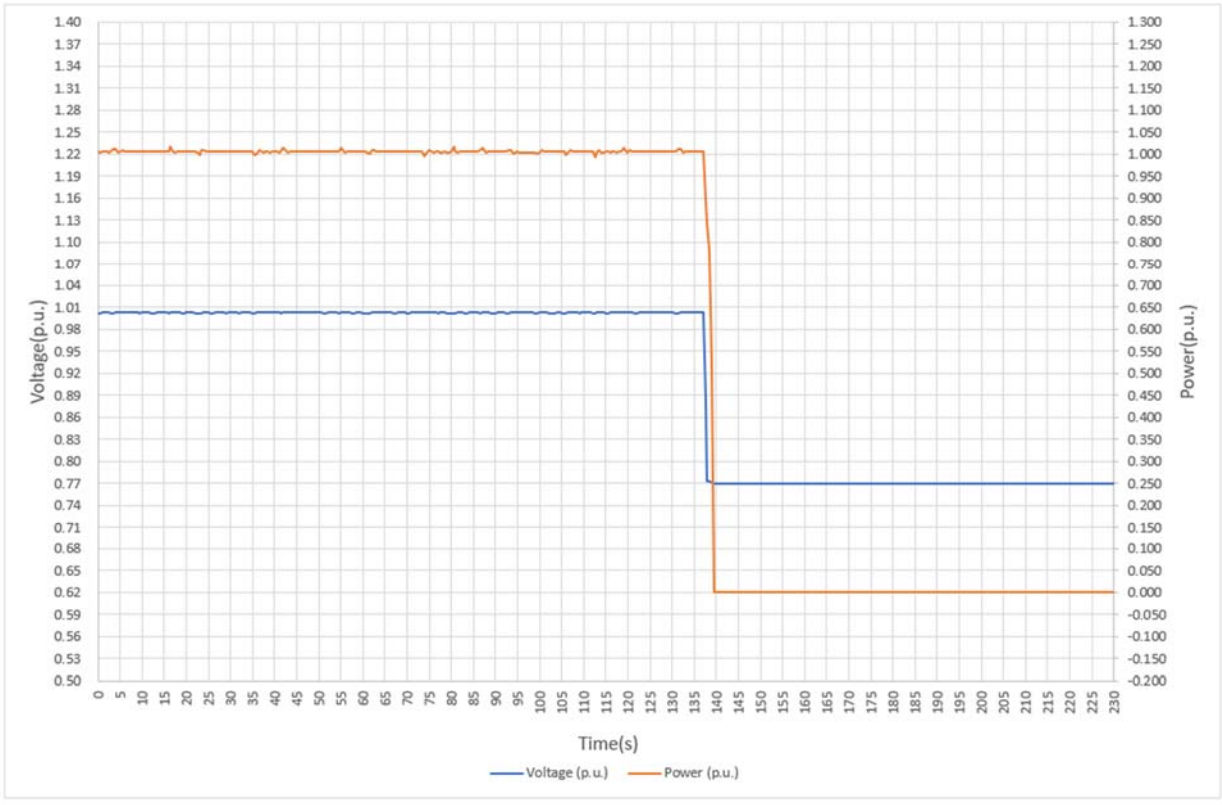


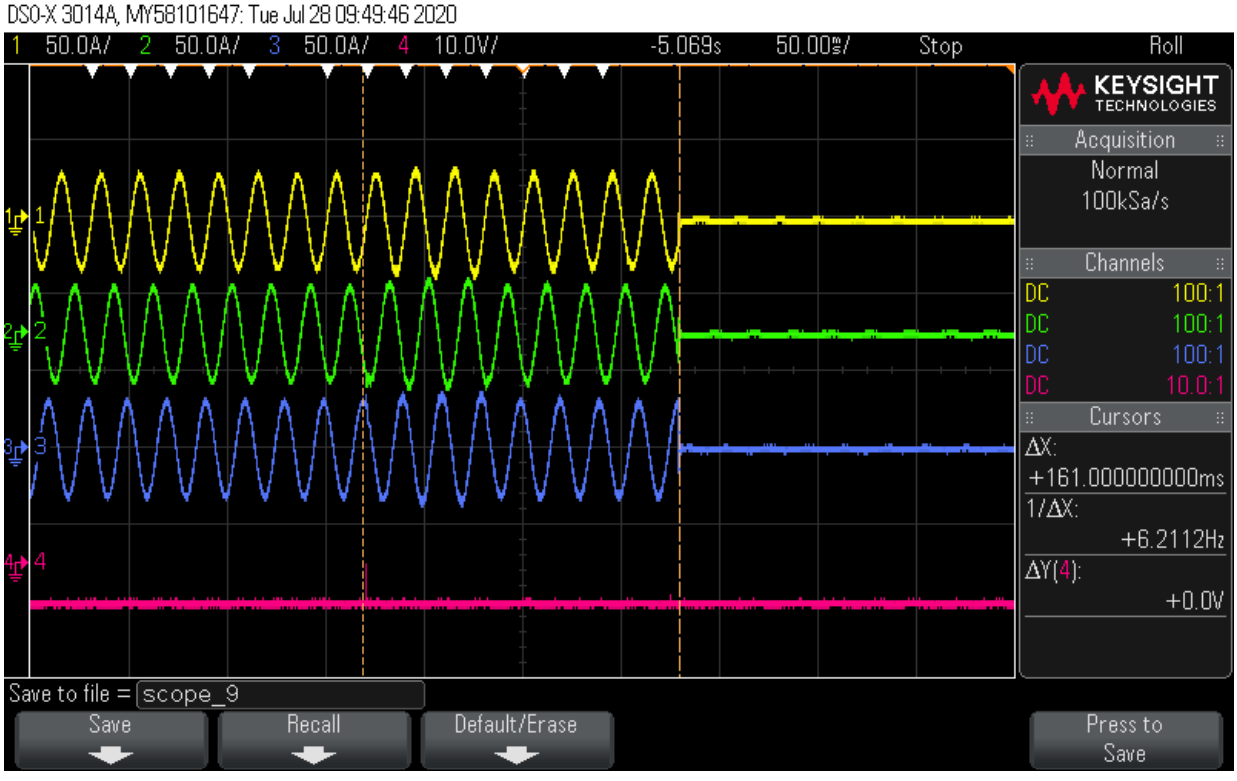
Nominal voltage to 118 % Un for overvoltage - Test 3



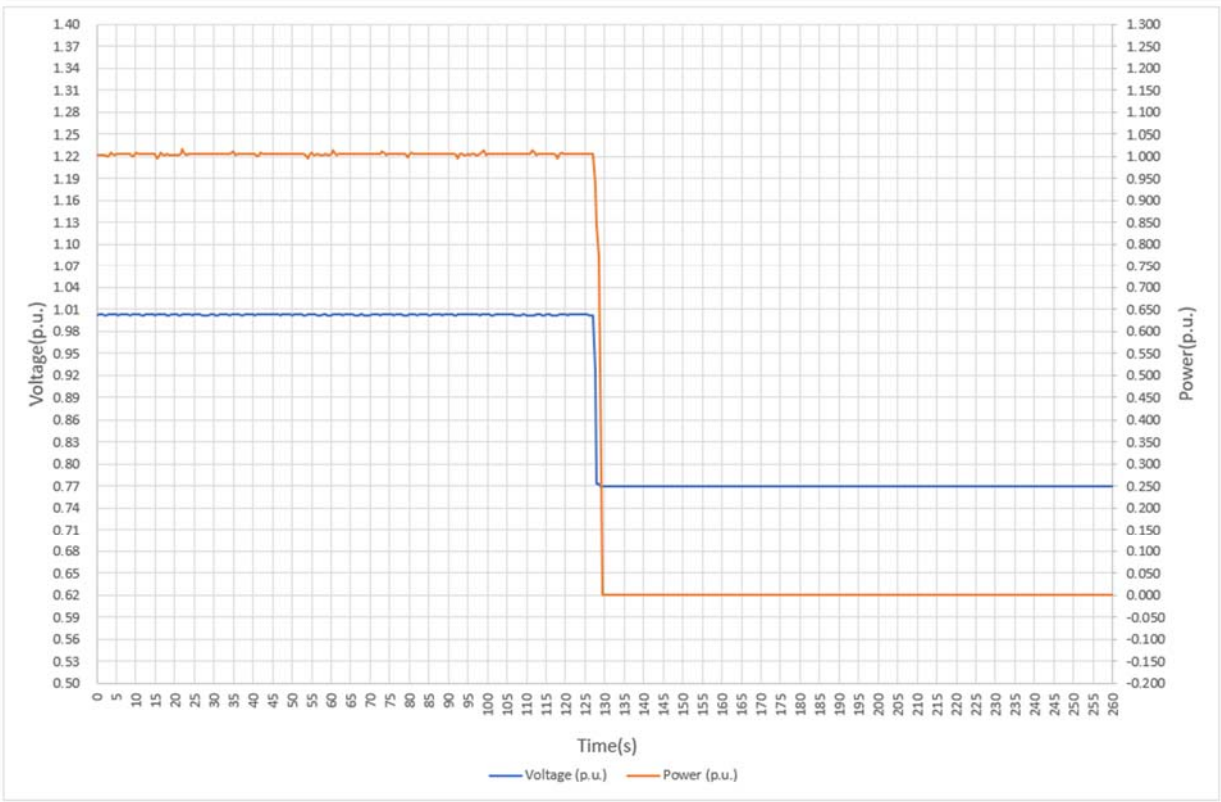


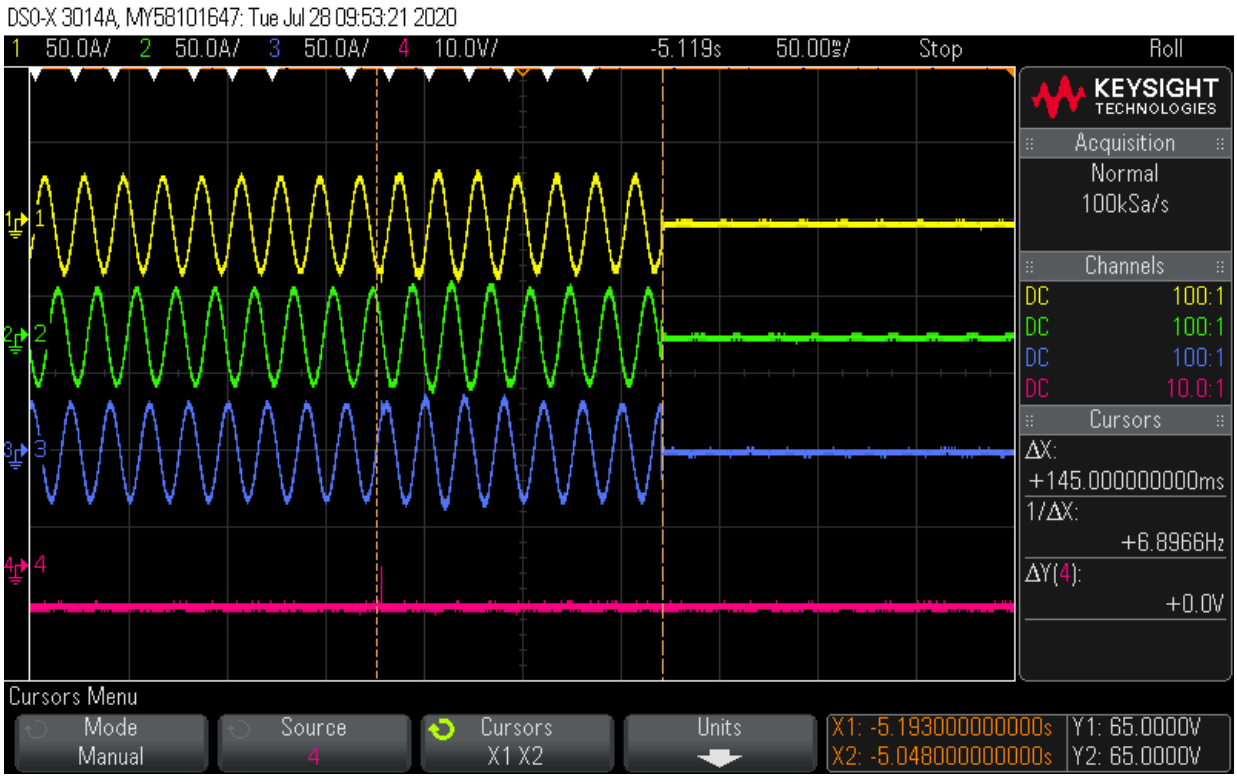
Nominal voltage to 77 % Un for undervoltage - Test 1



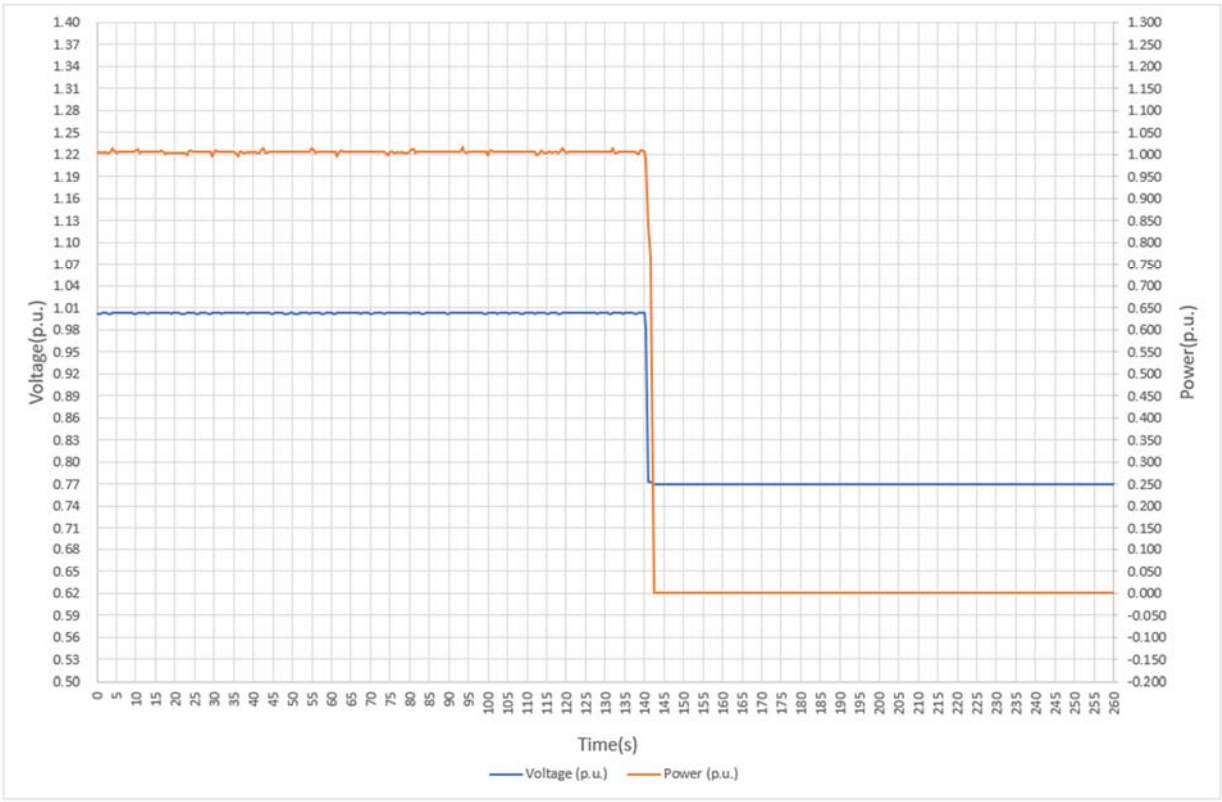


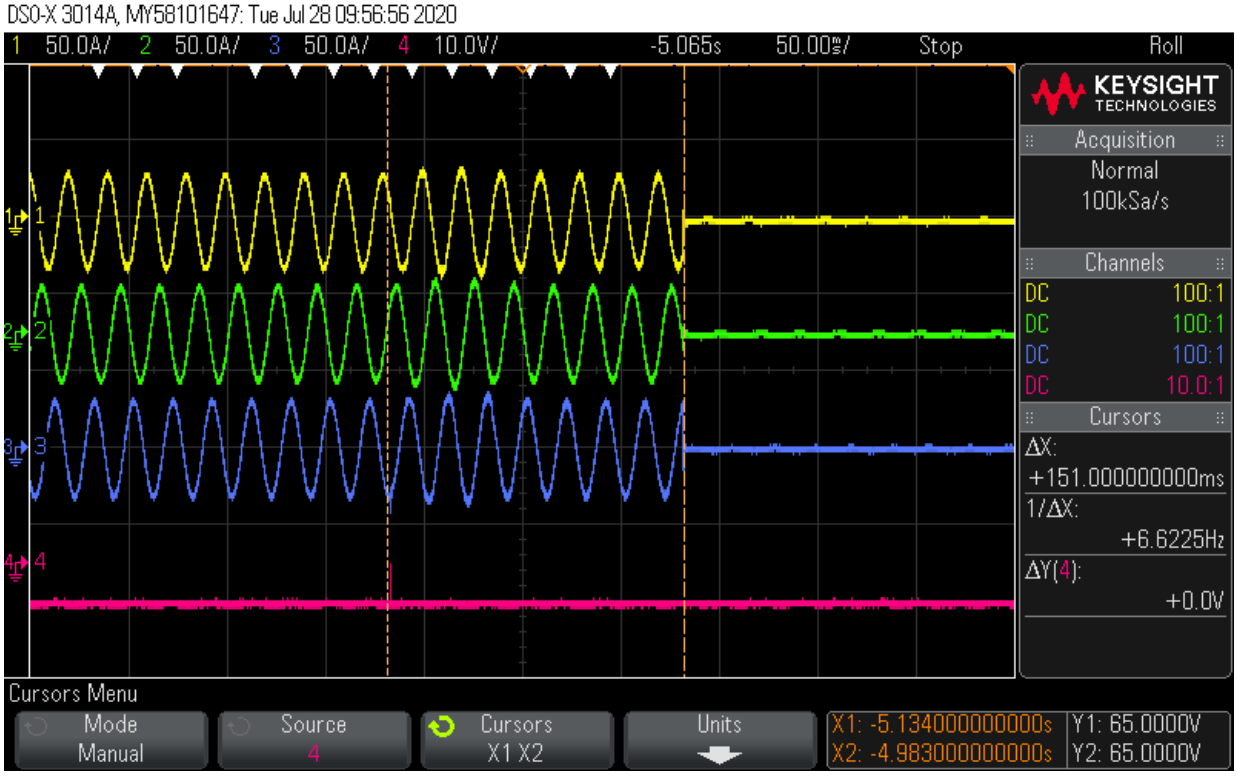
Nominal voltage to 77 % Un for undervoltage - Test 2





Nominal voltage to 77 % Un for undervoltage - Test 3





The rise-in voltage protection *U*> test is carried out as follows:

a) The voltage is set to 100 % U_n and maintained for 600 s. The voltage is then set to 112 % U_n. Disconnection must be effected within 600 seconds.

NOTE This test serves to verify the measuring accuracy and the maximum set time.

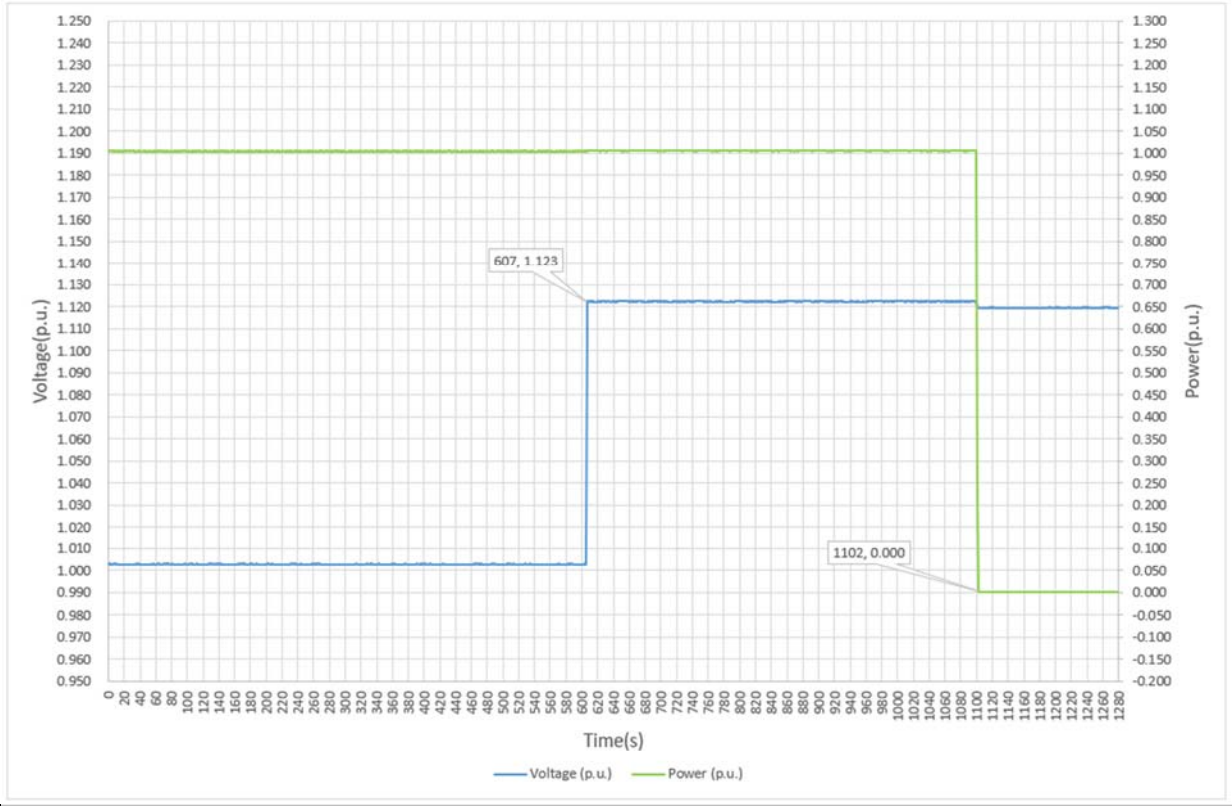
b) The voltage is set for 600 s to U_n, then for 600 s to 108 % U_n. Disconnection should not occur.

NOTE This test serves to verify the measuring accuracy.

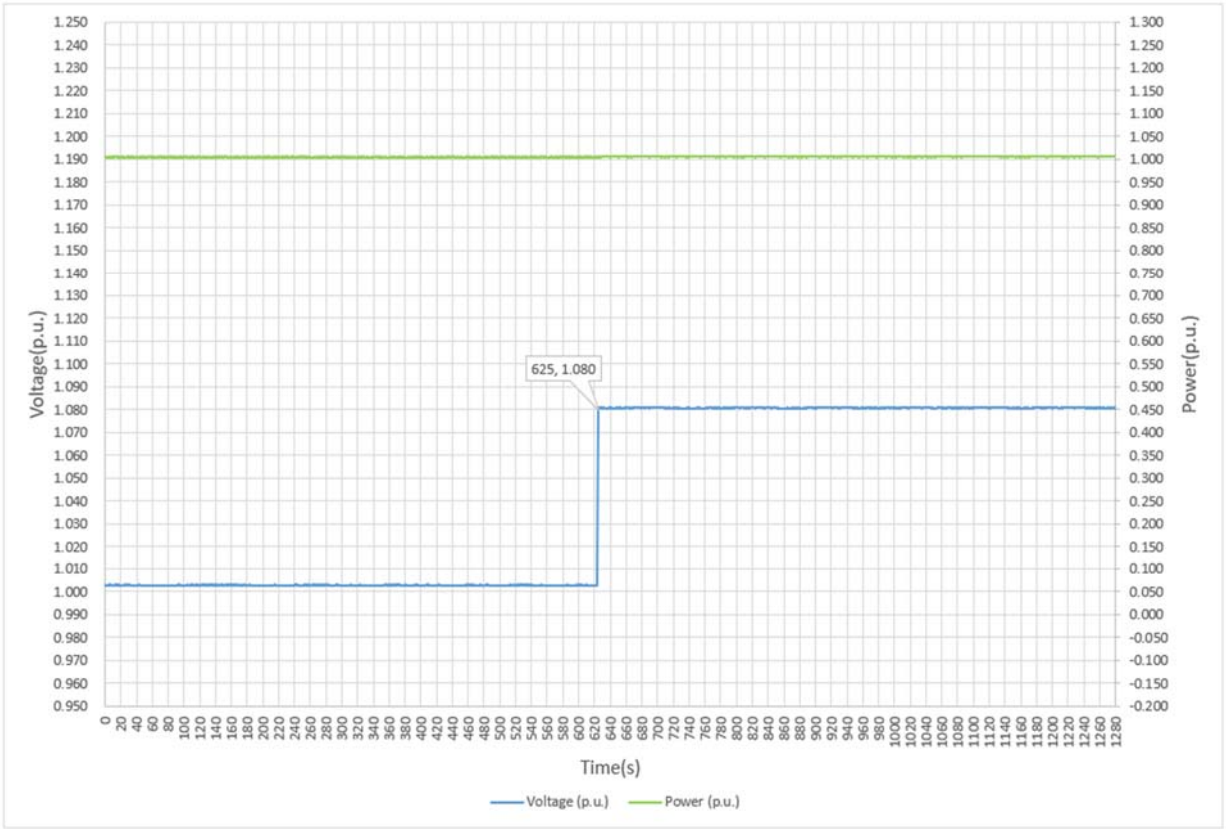
c) The voltage is set to 106 % U_n and maintained for 600 s. The voltage is then set to 114 % U_n. Disconnection must be effected within 300 seconds.

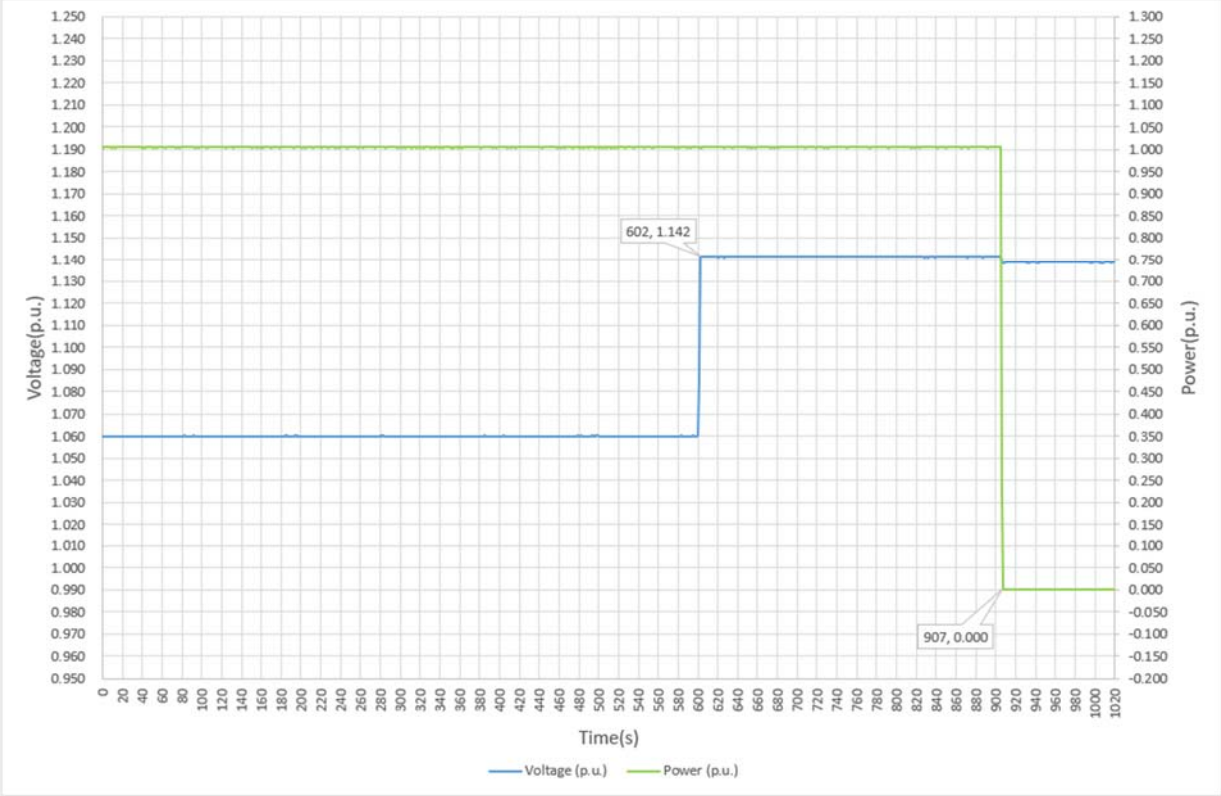
In the pictures below are offered graphically the results of the test.

Measured a)



Measured b)



Measured c)


Voltage(p.u.)
Power(p.u.)
Time(s)
602, 1.142
907, 0.000
Voltage (p.u.)
Power (p.u.)

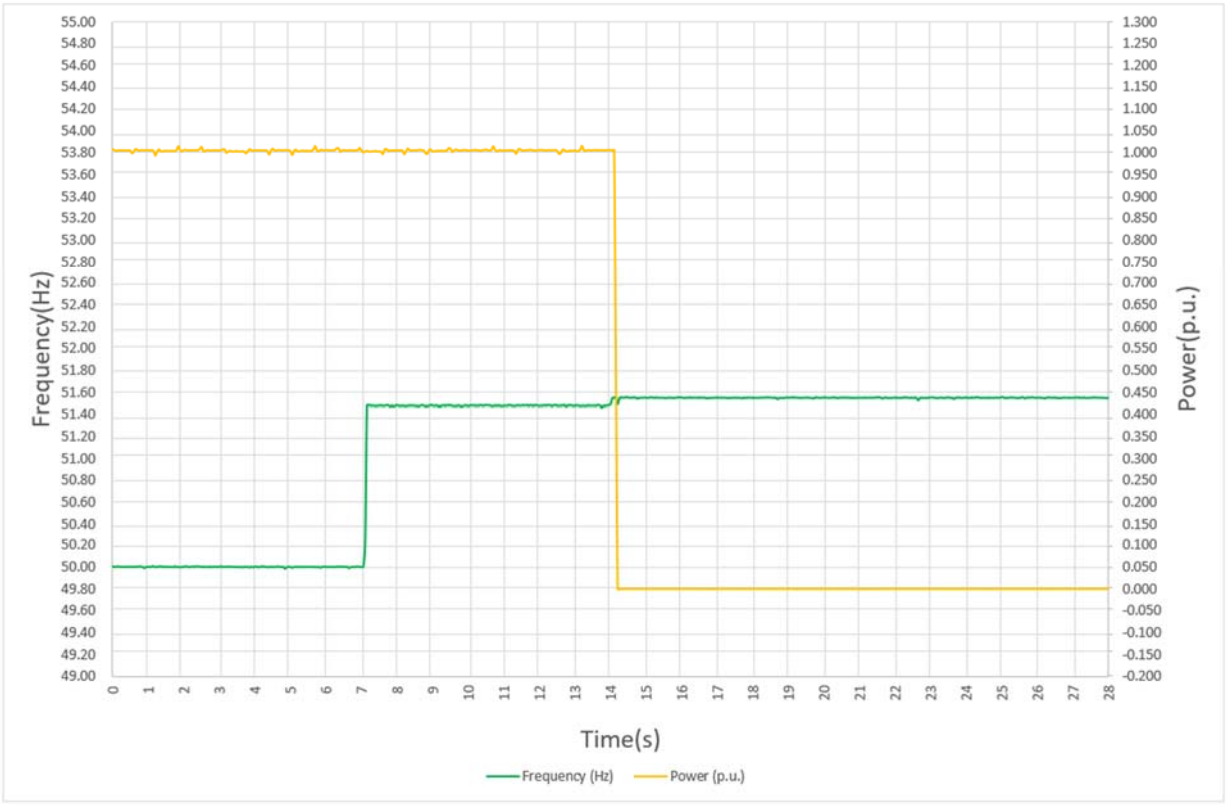
4.4 FREQUENCY MONITORING

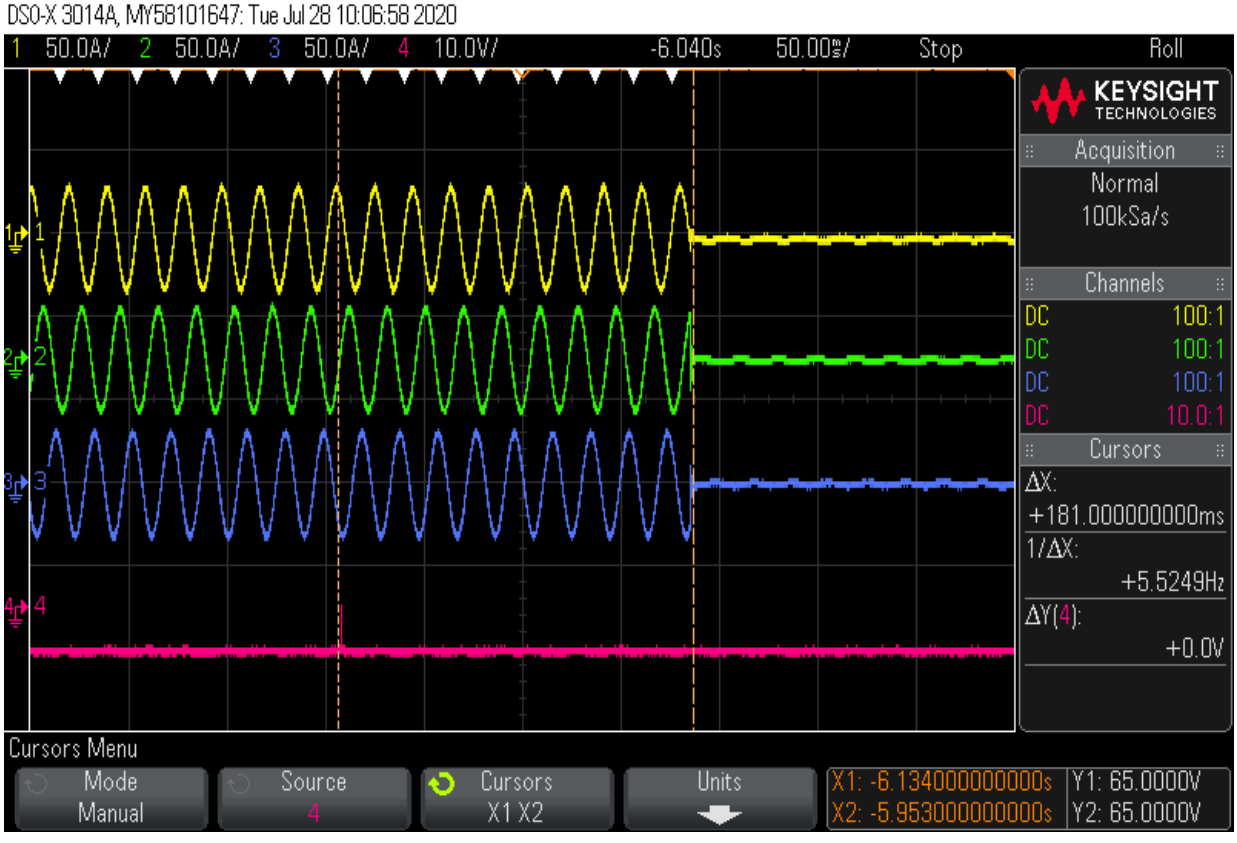
According to article 4.4 the NS protection should disconnect the power generation system from the net in the event of inadmissible frequency values.

Disconnection time measured					
Protective function	**Frequency changes**	**Disconnection time limits**	**Test 1**	**Test 2**	**Test 3**
Frequency increase protection (f>)	50.00 Hz to 51.48 Hz to 51.55 Hz	< 200 ms	181 ms	168ms	176 ms
Frequency decrease protection (f<)	50.00Hz to 47.53Hz to 47.45 Hz	< 200 ms	164 ms	164 ms	179ms

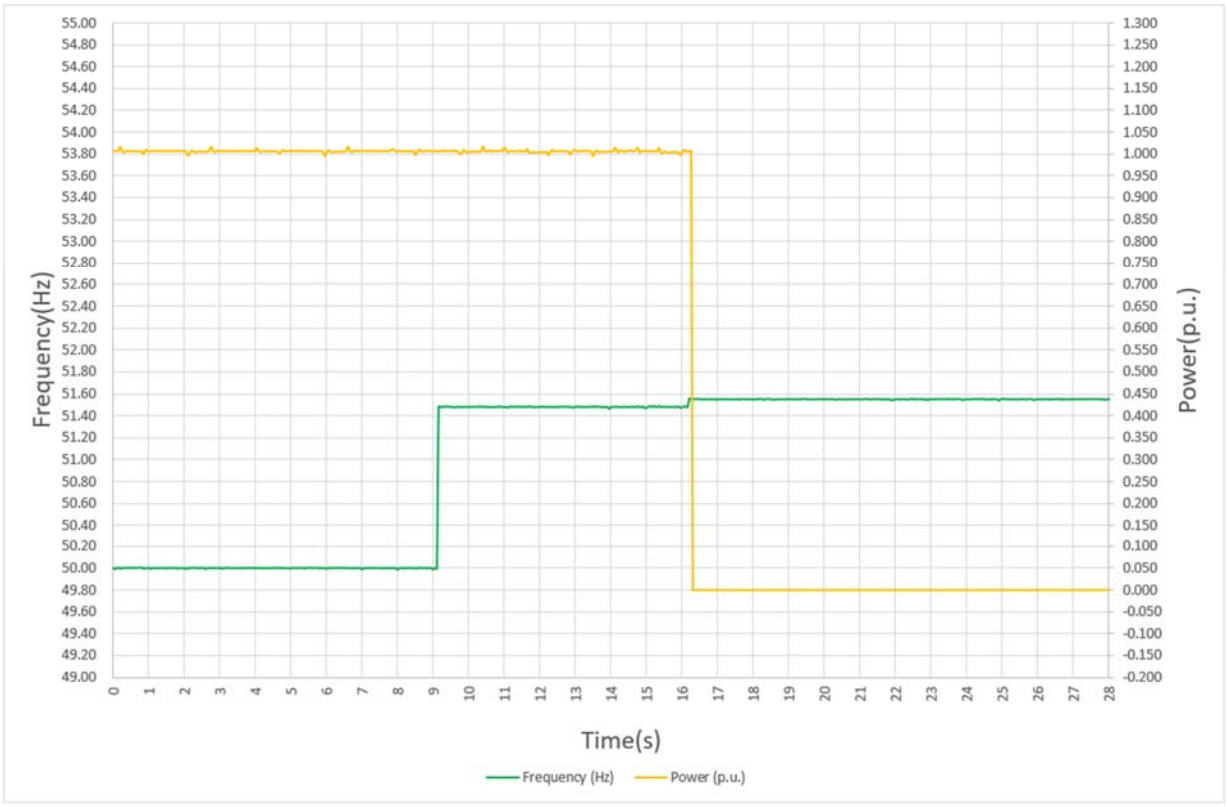
In the picture below are offered waveforms and graphically the results of the test.

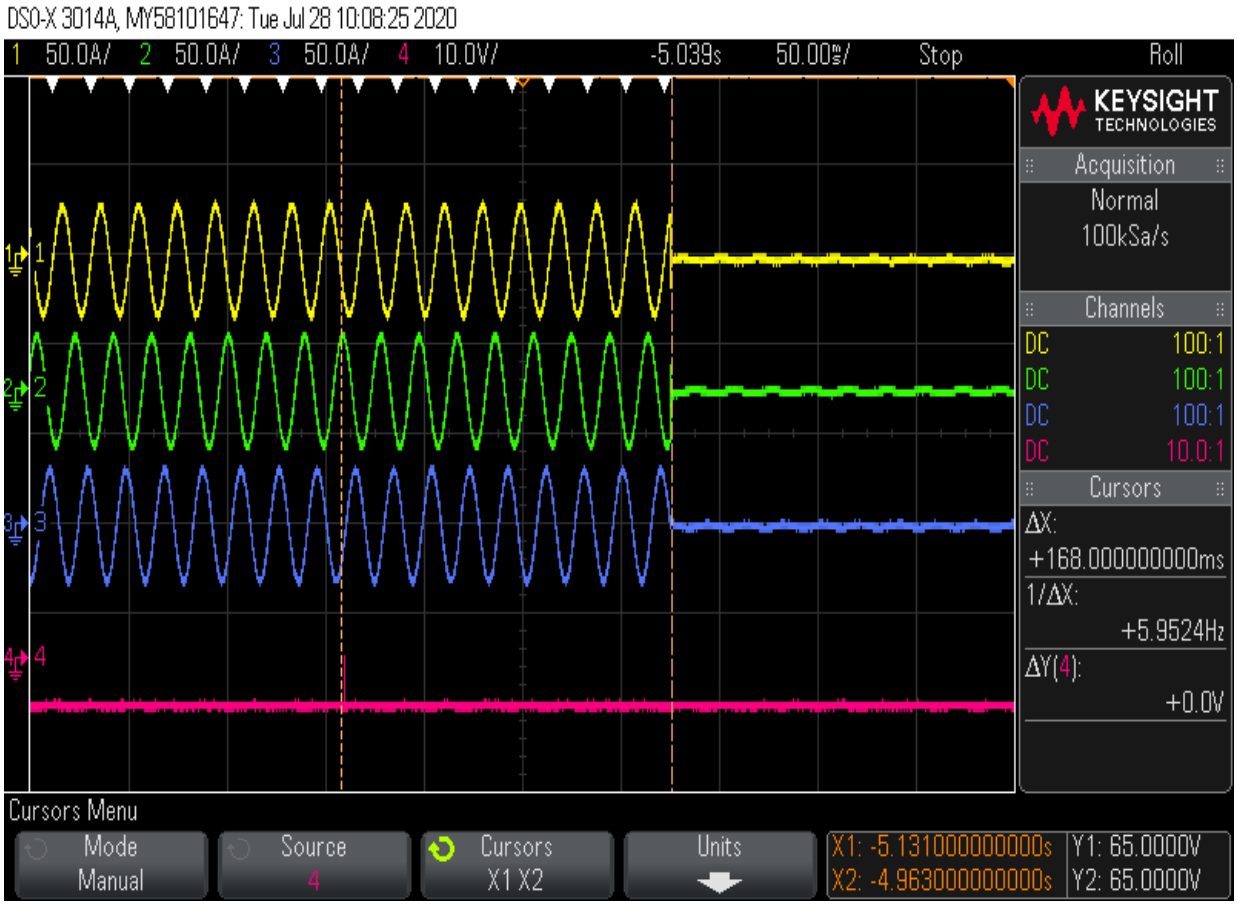
Overfrequency 51.5 Hz- Test 1



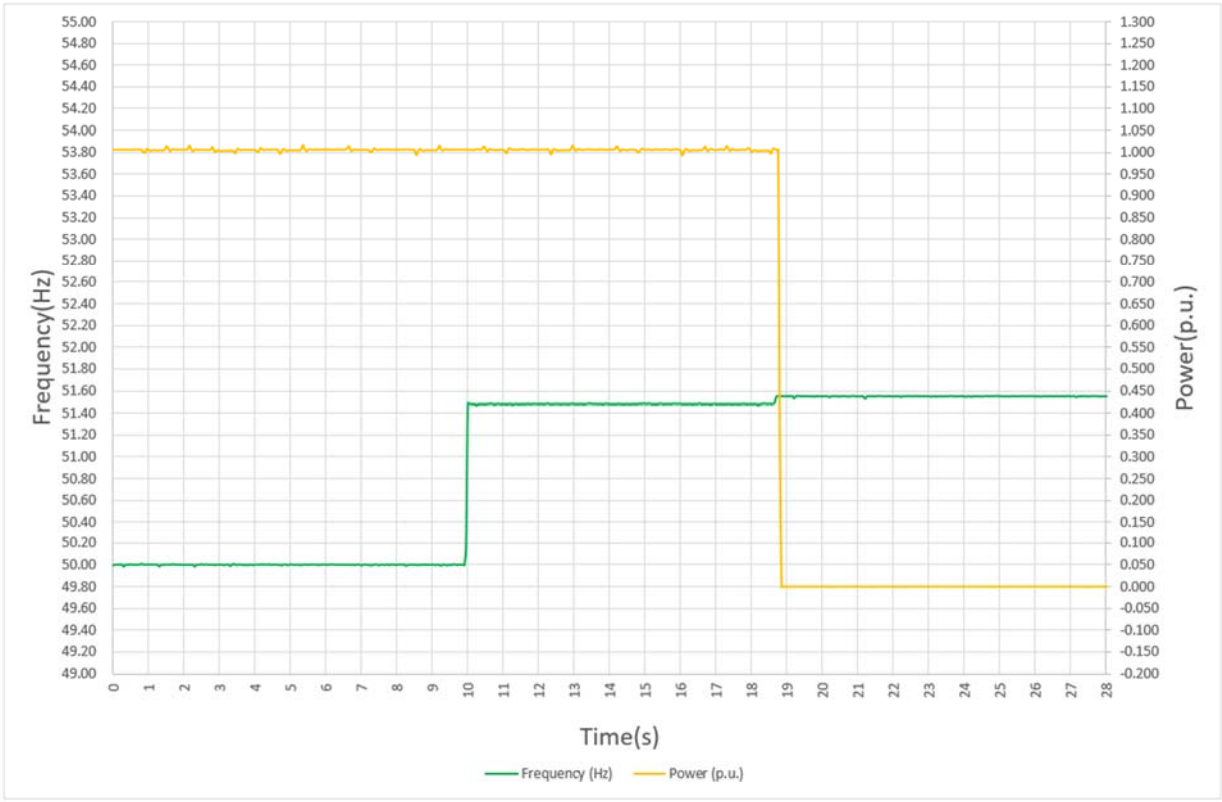


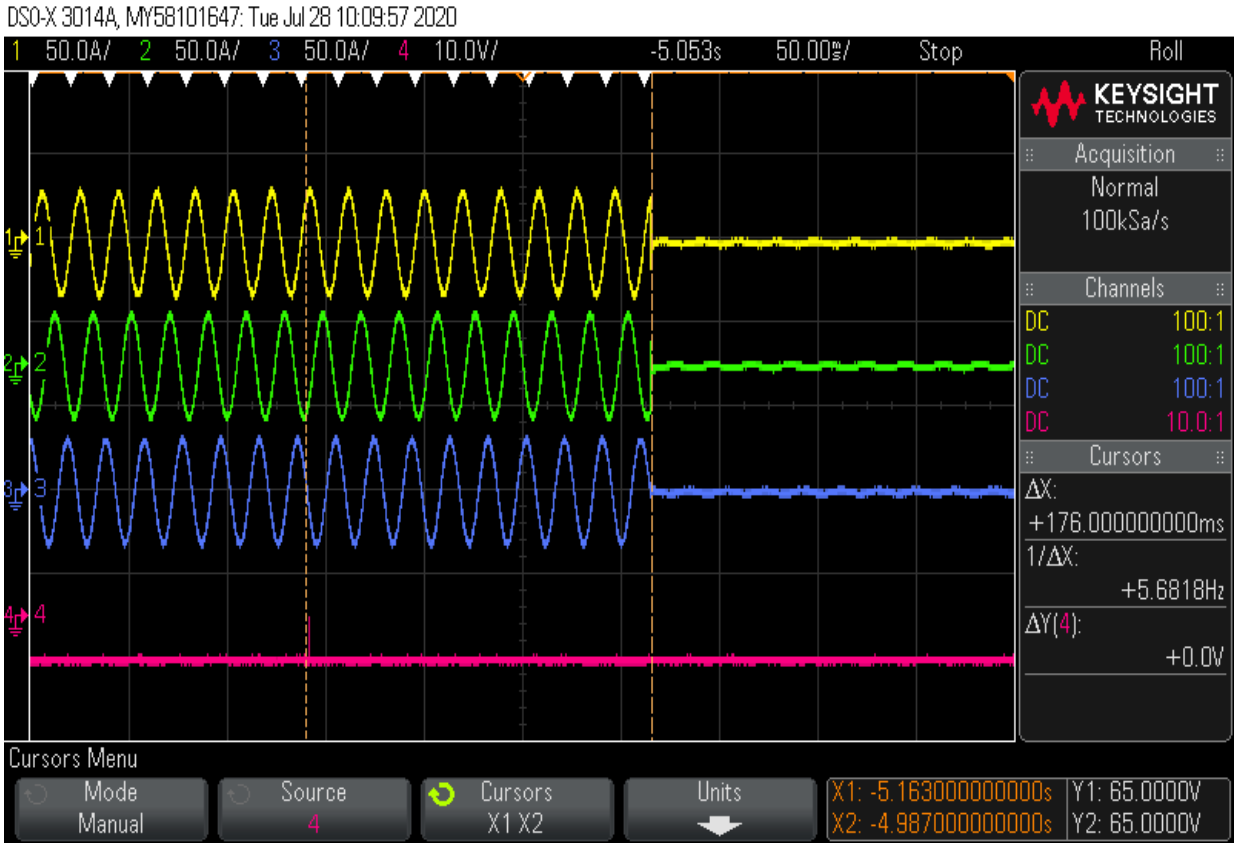
Overfrequency 51.5 Hz- Test 2



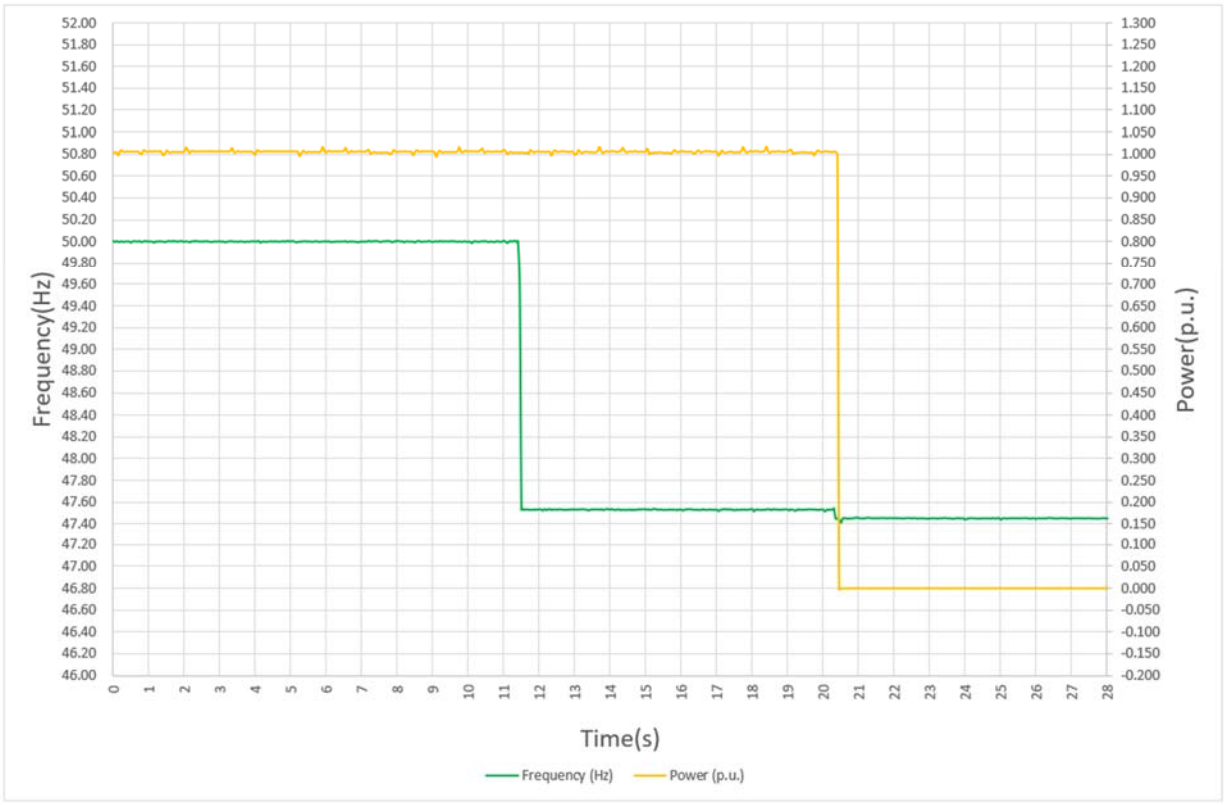


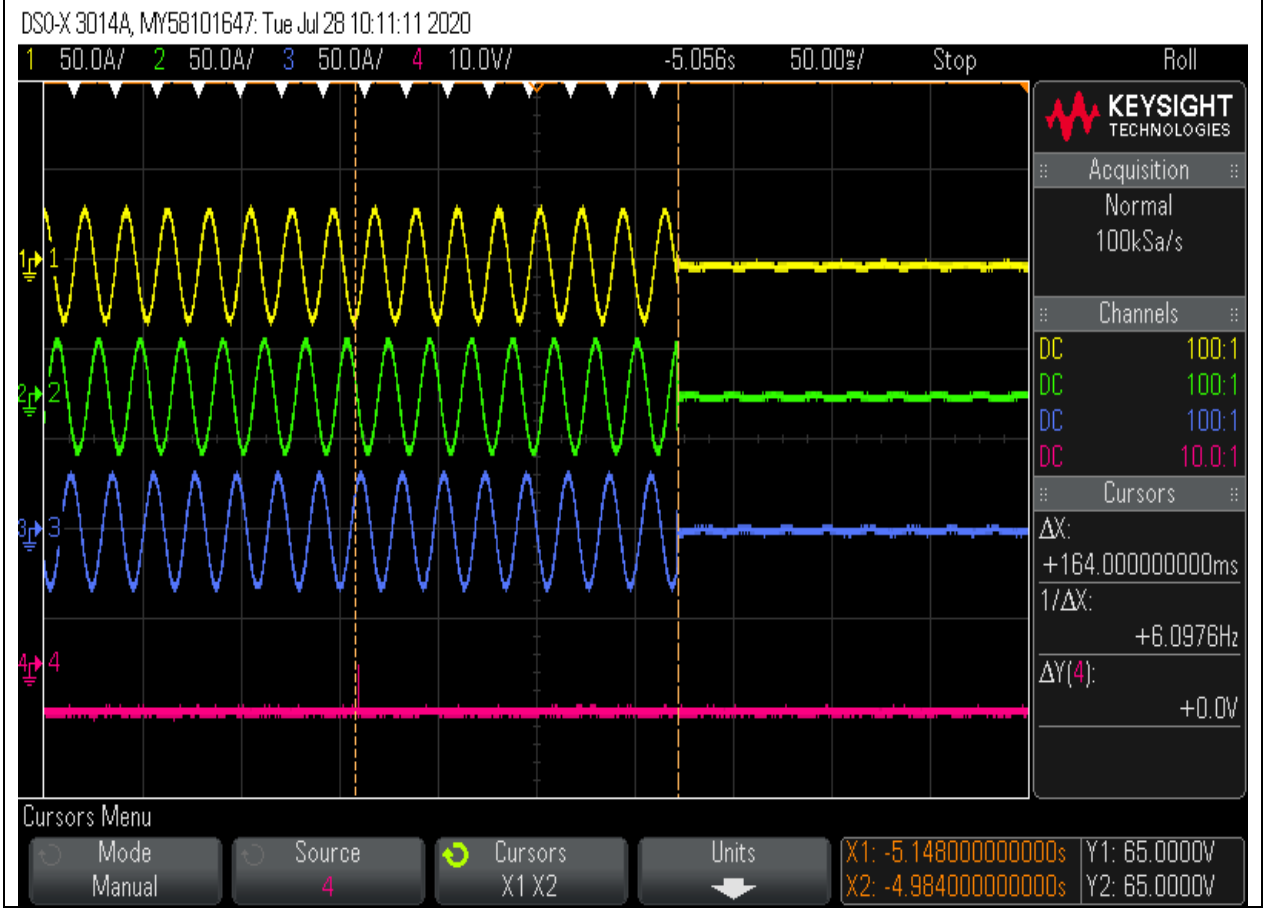
Overfrequency 51.5 Hz- Test 3



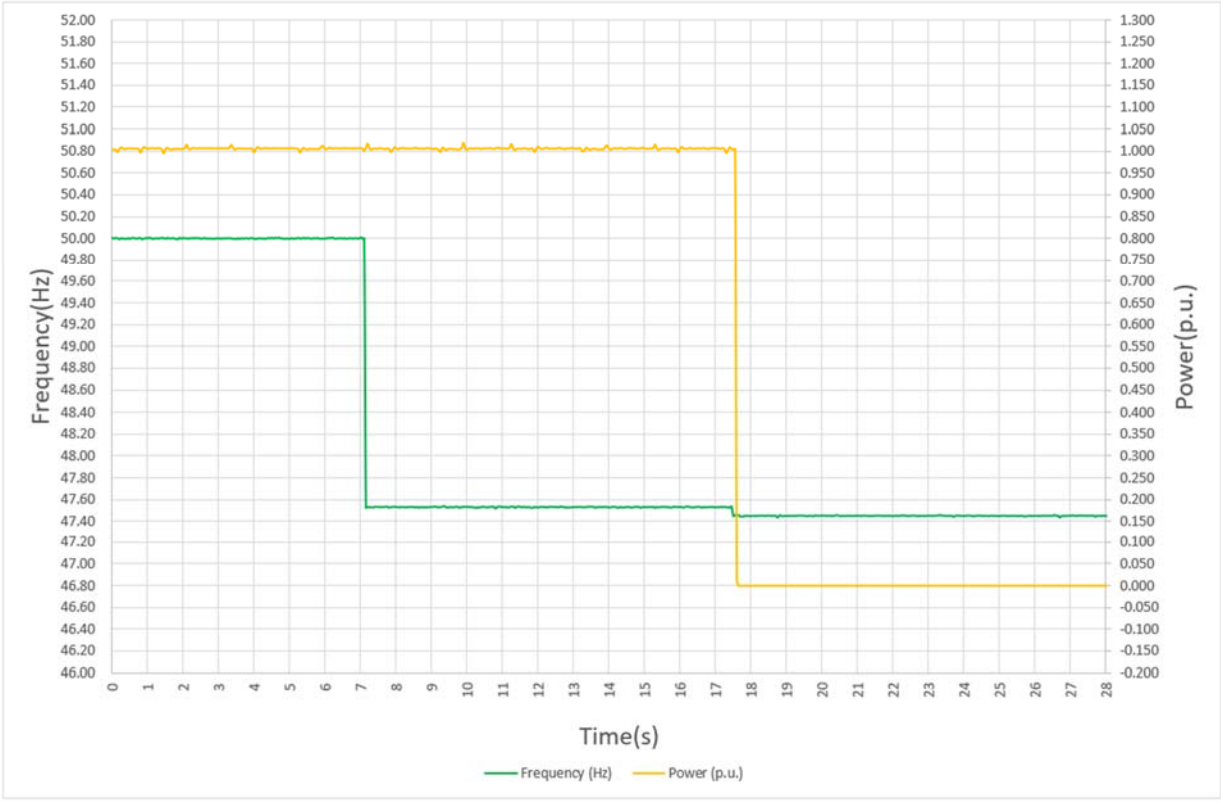


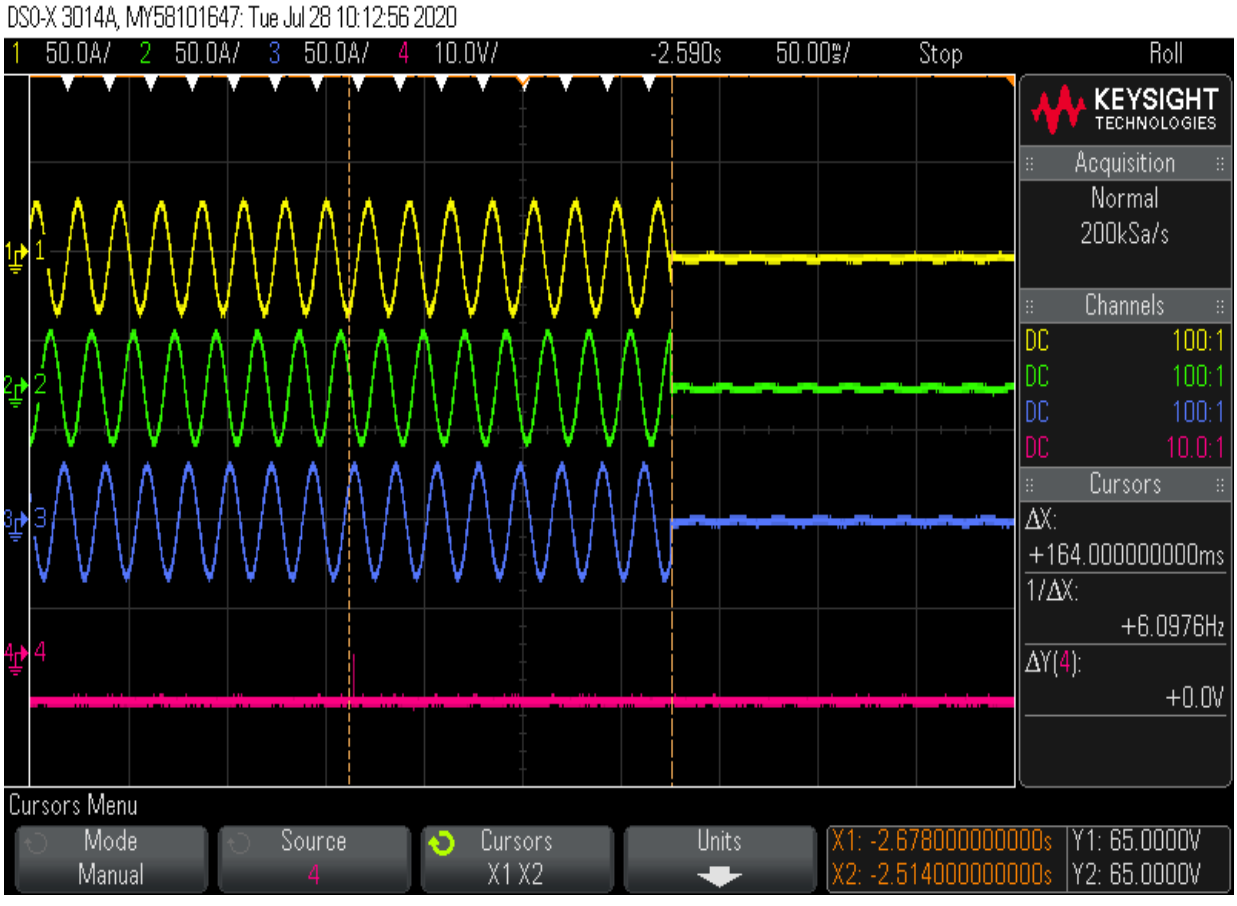
Underfrequency 47.5 Hz- Test 1



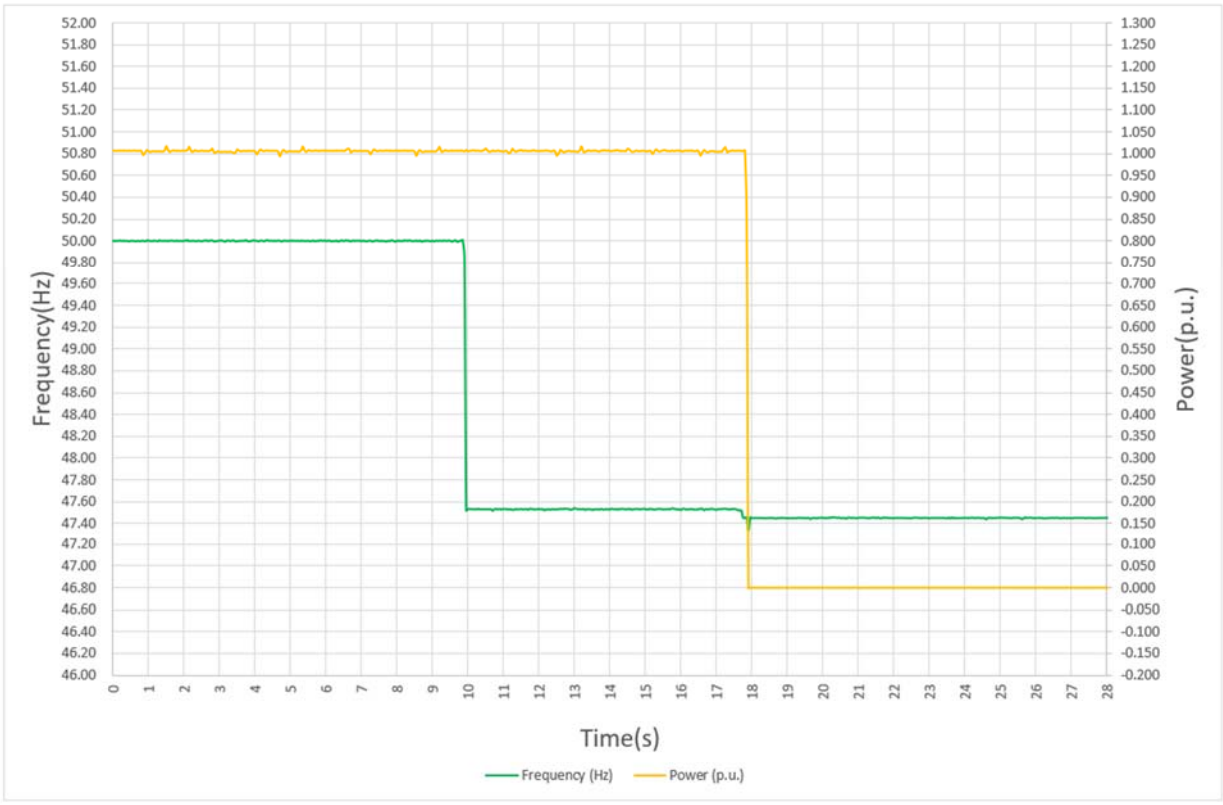


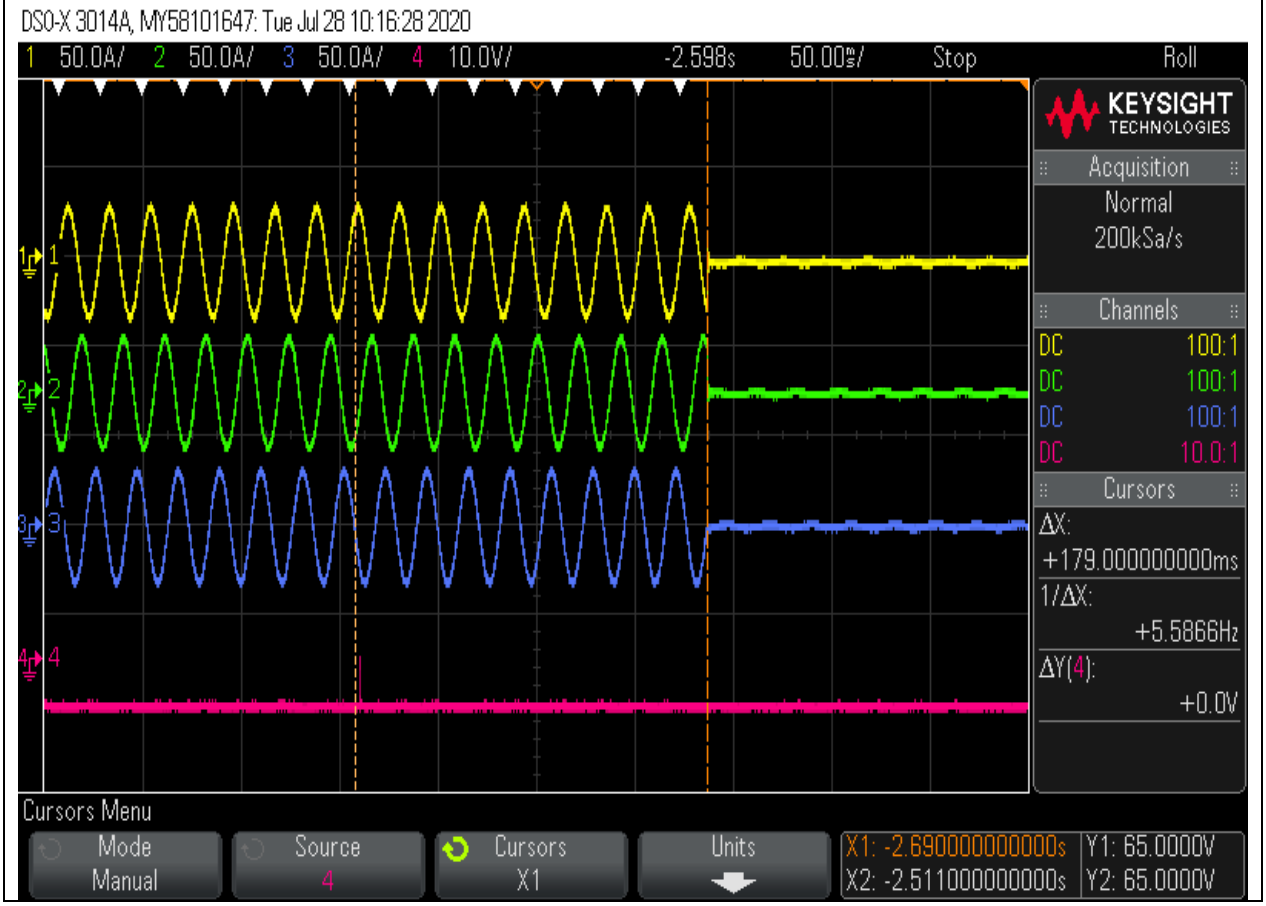
Underfrequency 47.5 Hz- Test 2





Underfrequency 47.5 Hz- Test 3



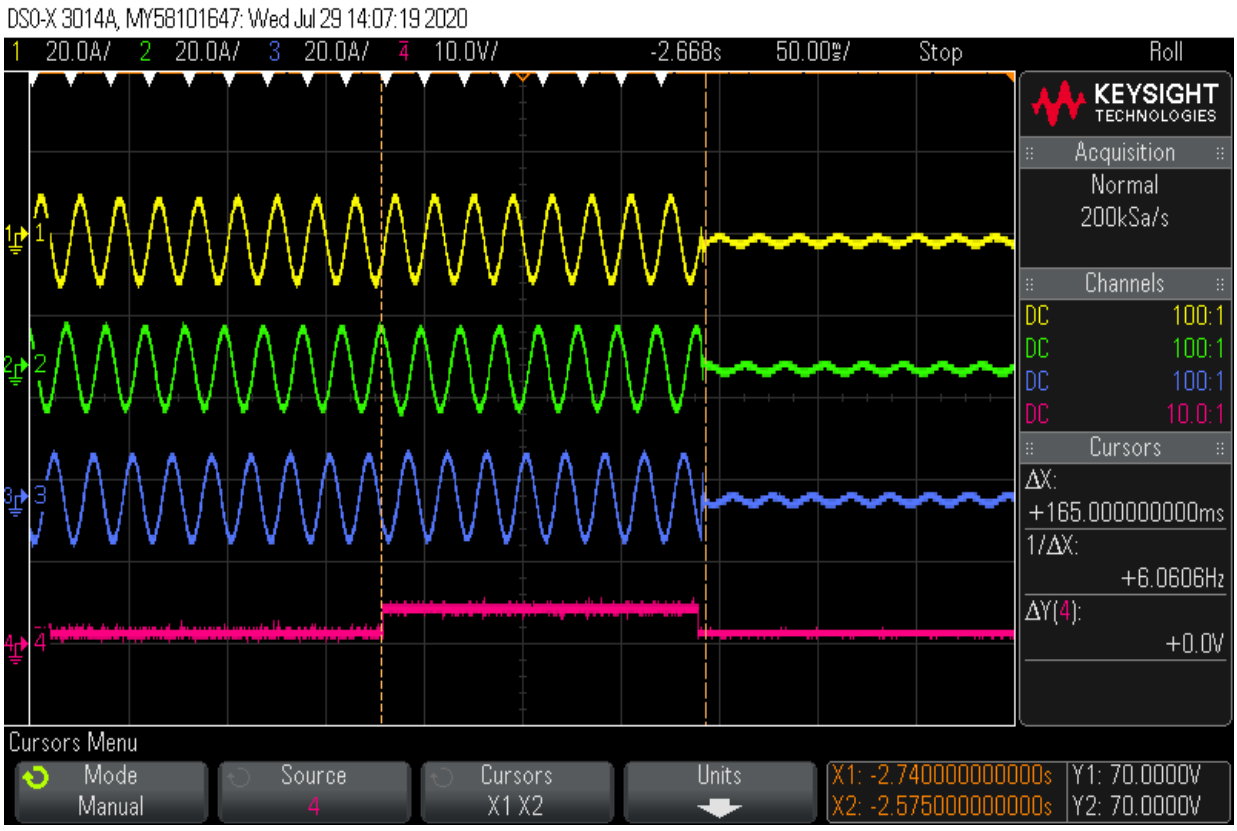


4.5 DC CURRENT MONITORING

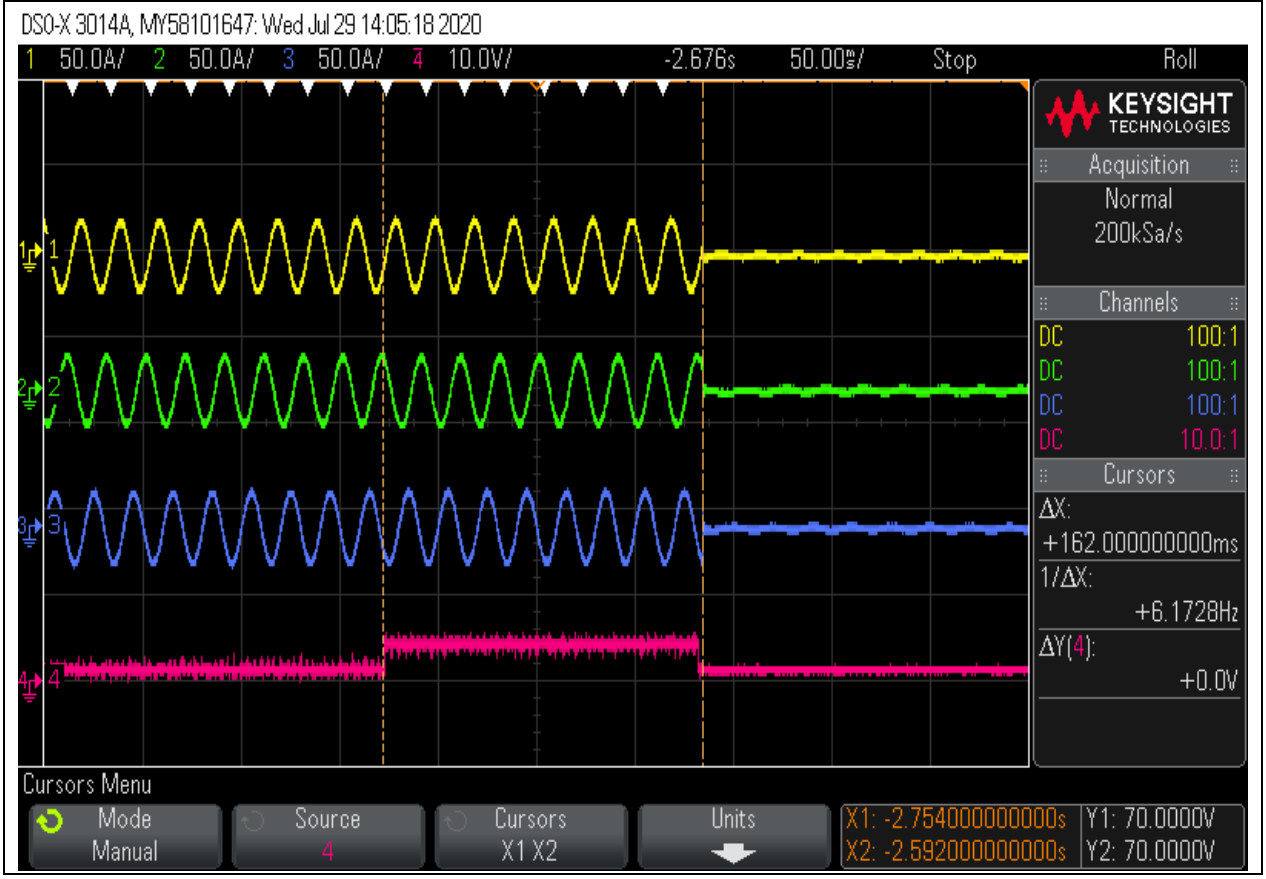
The verification of the protection against DC component emission test has been measured according to the standard, at the required active power levels.

(I > 1 A)			
Output Power %	**(33 ± 5) %**	**(66 ± 5) %**	**(100 ± 5) %**
Time (ms) **Time Limit (200 ms)**	165	162	163

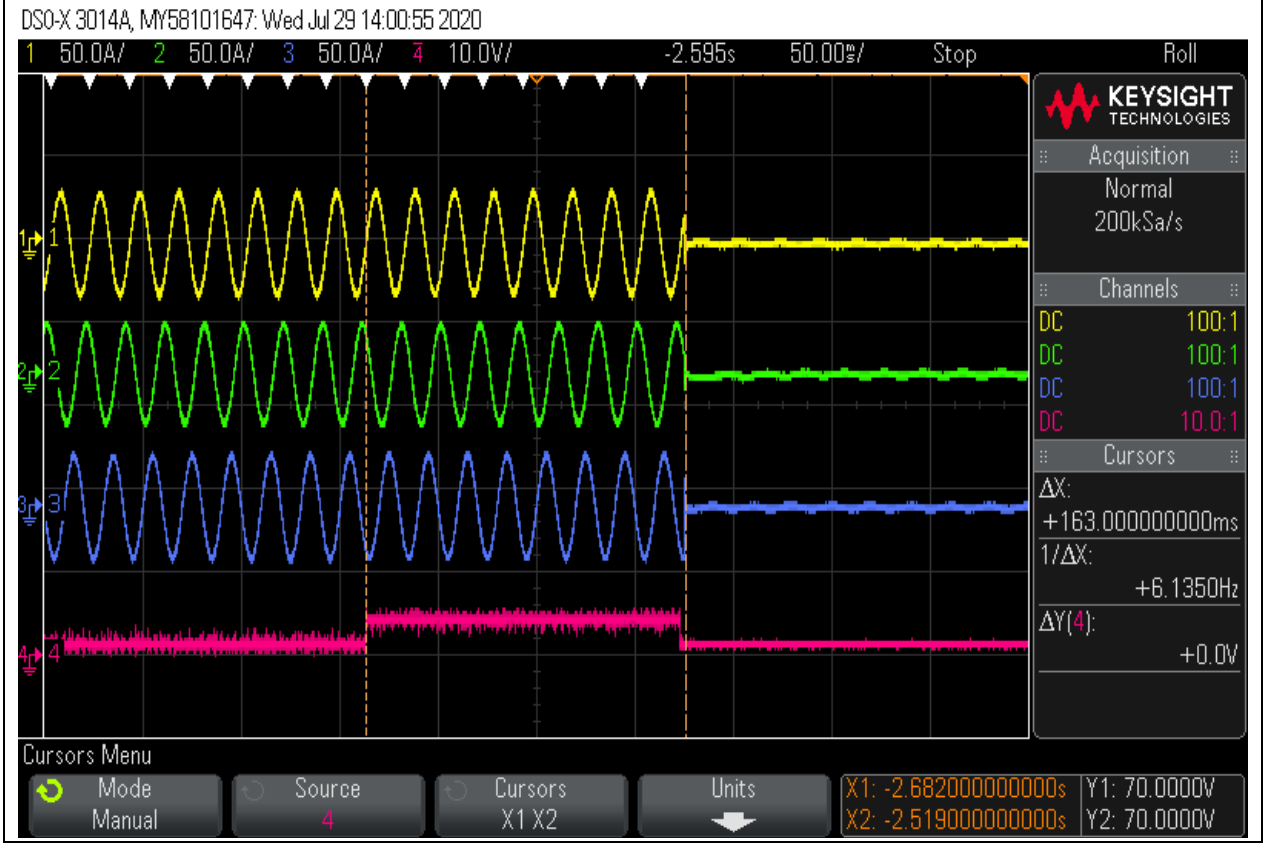
Power at 33%Pn



Power at 66%Pn

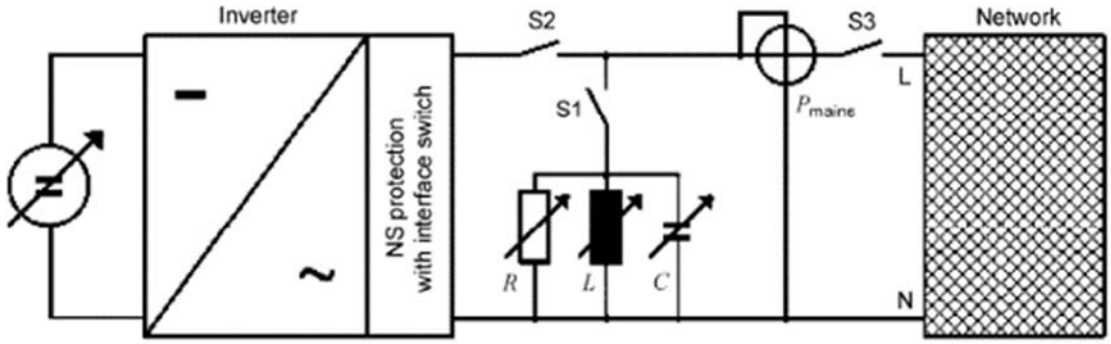


Power at 100%Pn



4.6 ANTI ISLANDING PROTECTION

This test has been performed according to the point 6.5.3 of VDE-AR-N 4105:2011-08 and the paragraph 5.4.6 of VDE V 0124-100:2012-07.

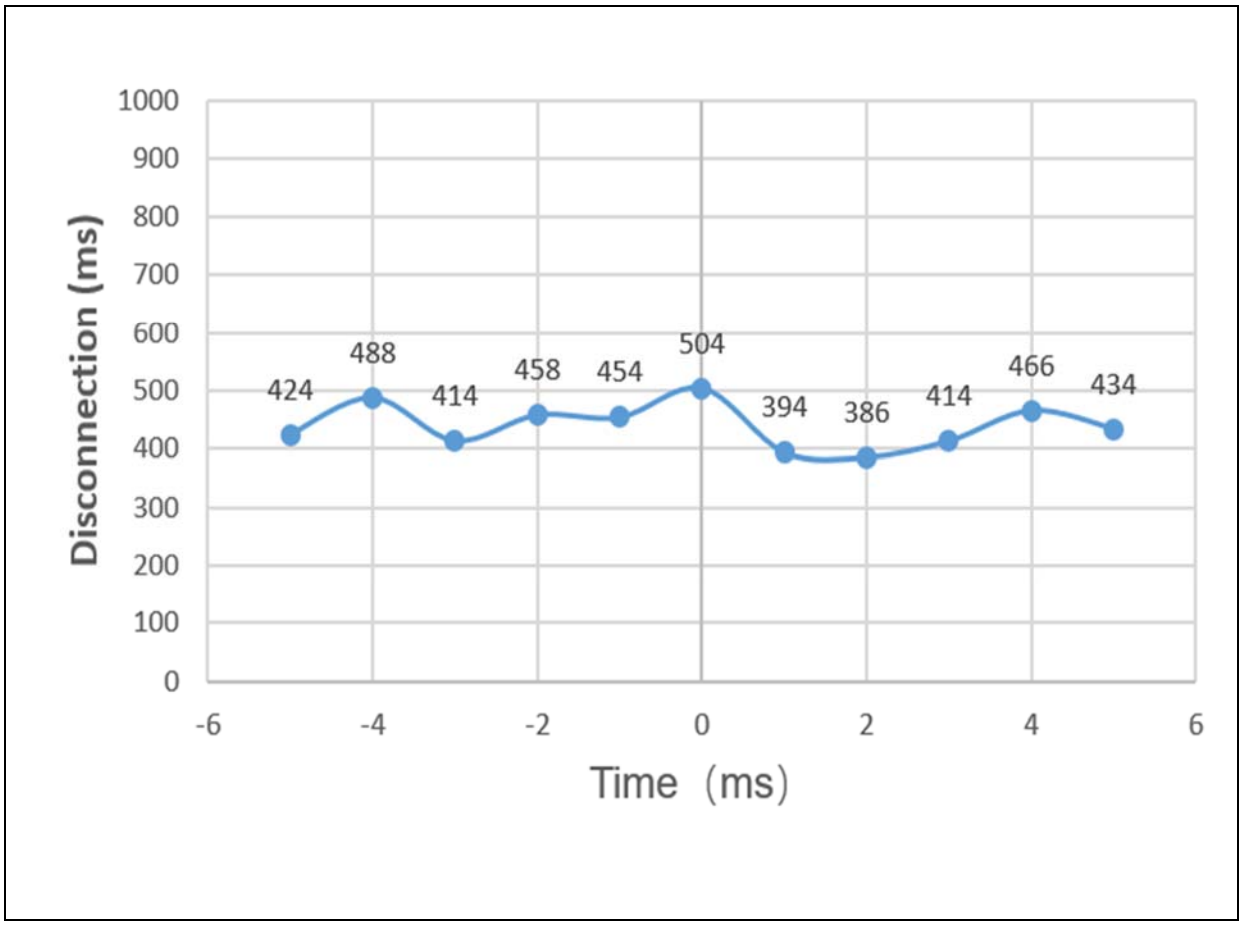


All the tests and checks have been performed in accordance with the reference Standard as specified previously. The used quality factor of resonant load was Qf=2.
There are required three different tests:

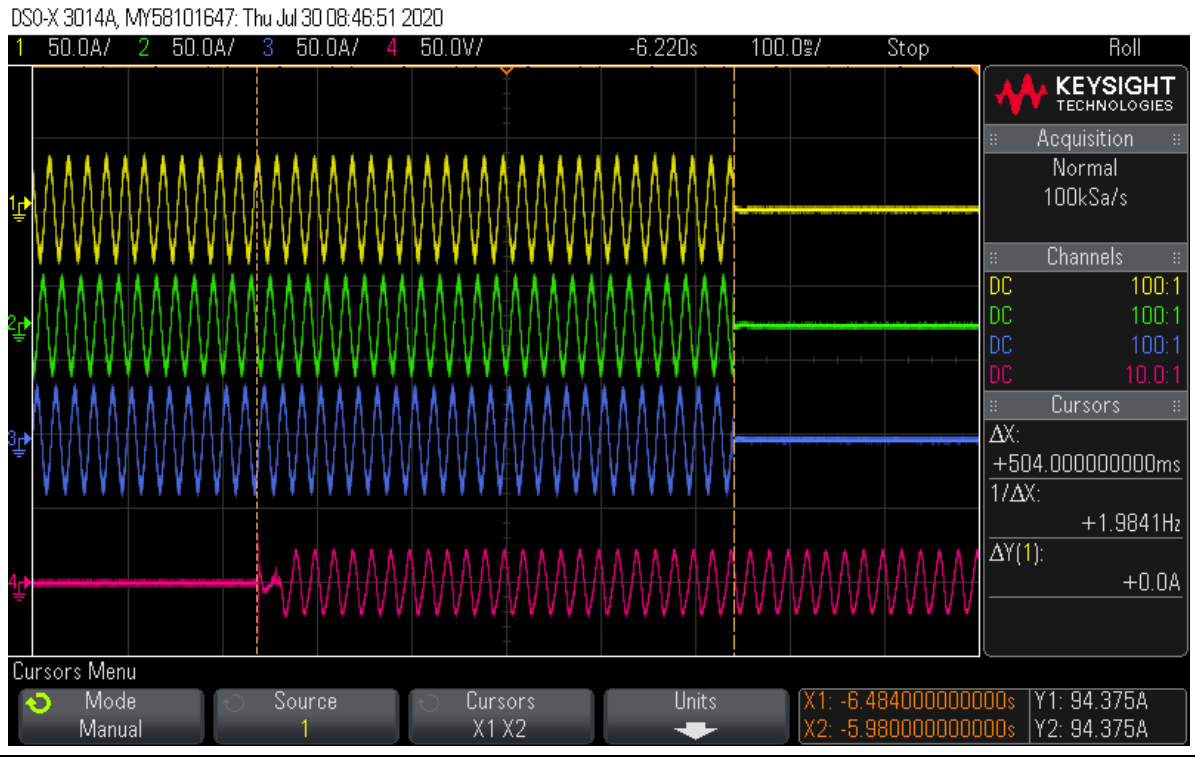
Test A is at full power
Test B is at 50%Pn
Test C is at 20%Pn

4.6.1 Test A

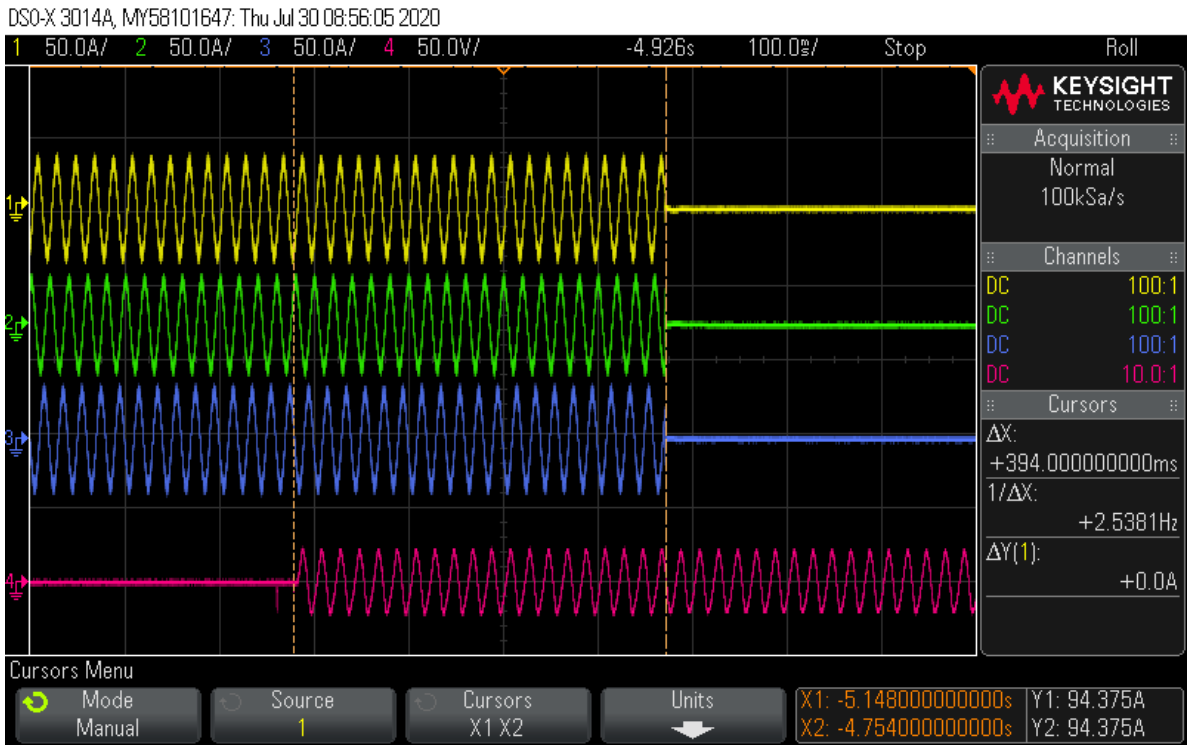
Balanced Load		
M (%)	**N (%)**	**Disconnection (ms) (limit at t=5s)**
0	-5	424
0	-4	488
0	-3	414
0	-2	458
0	-1	454
0	0	504
0	1	394
0	2	386
0	3	414
0	4	466
0	5	434



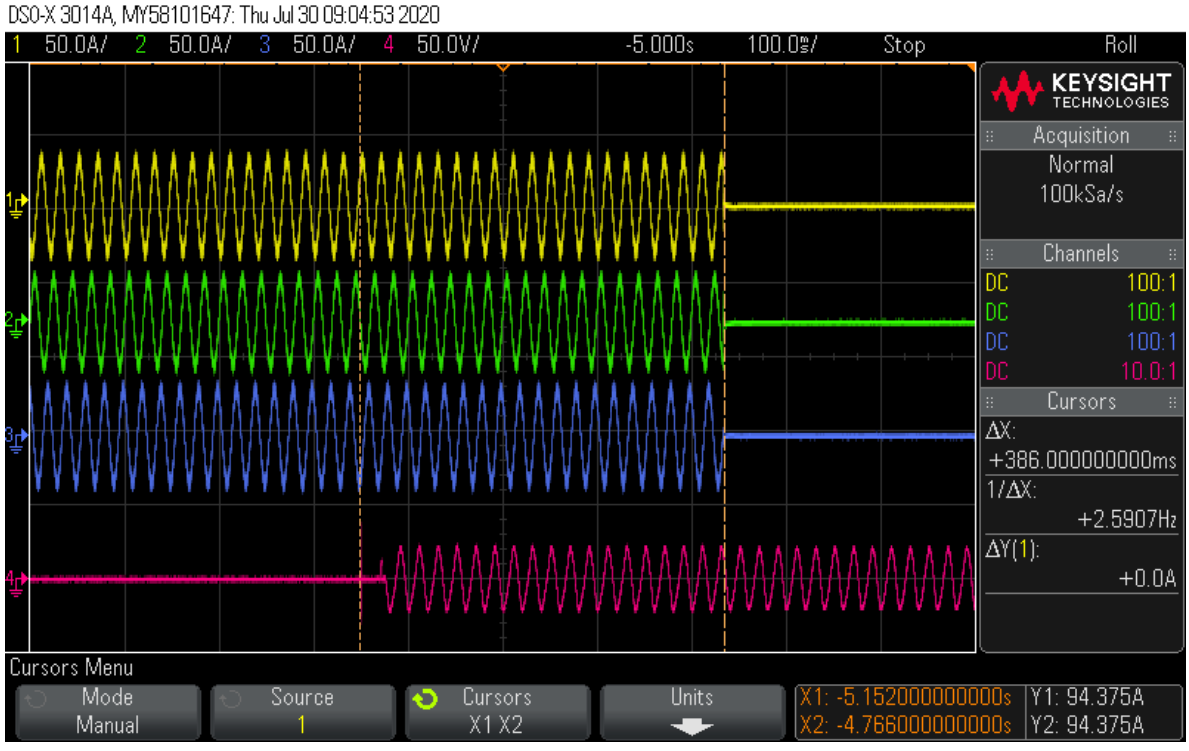
Test A(50Hz)	M(%)=0 & N(%)=0



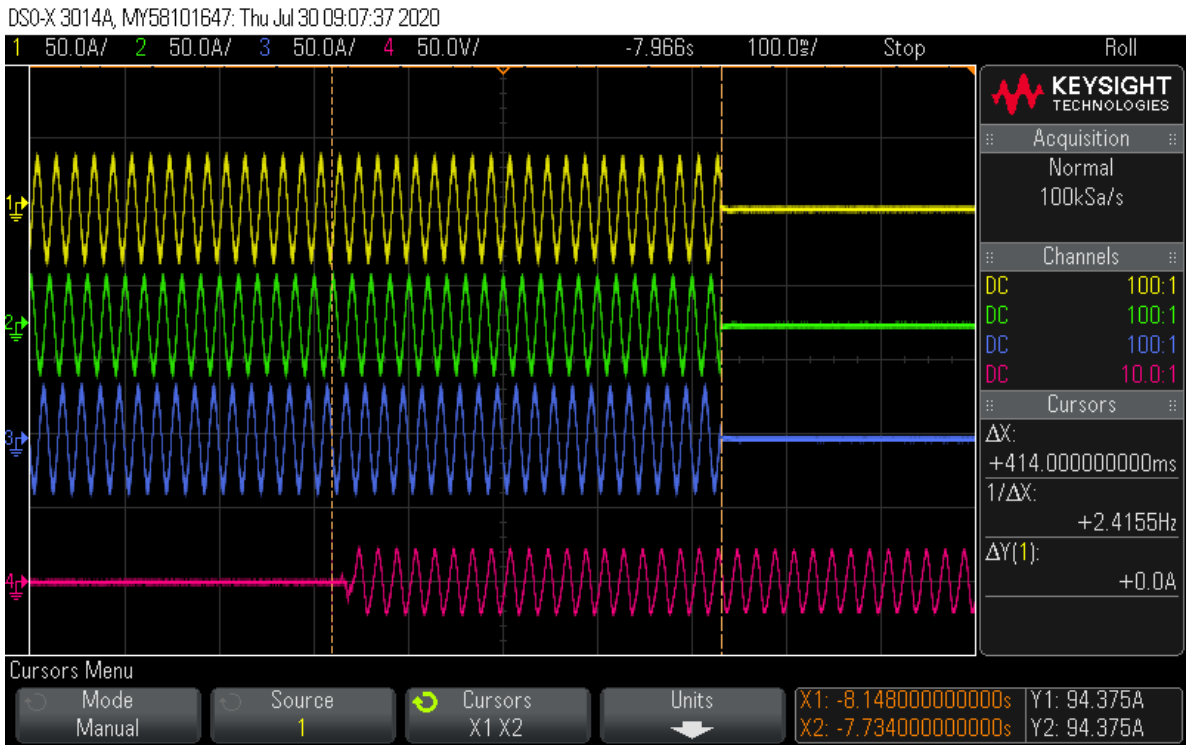
Test A(50Hz)	M(%)=0 & N(%)=+1



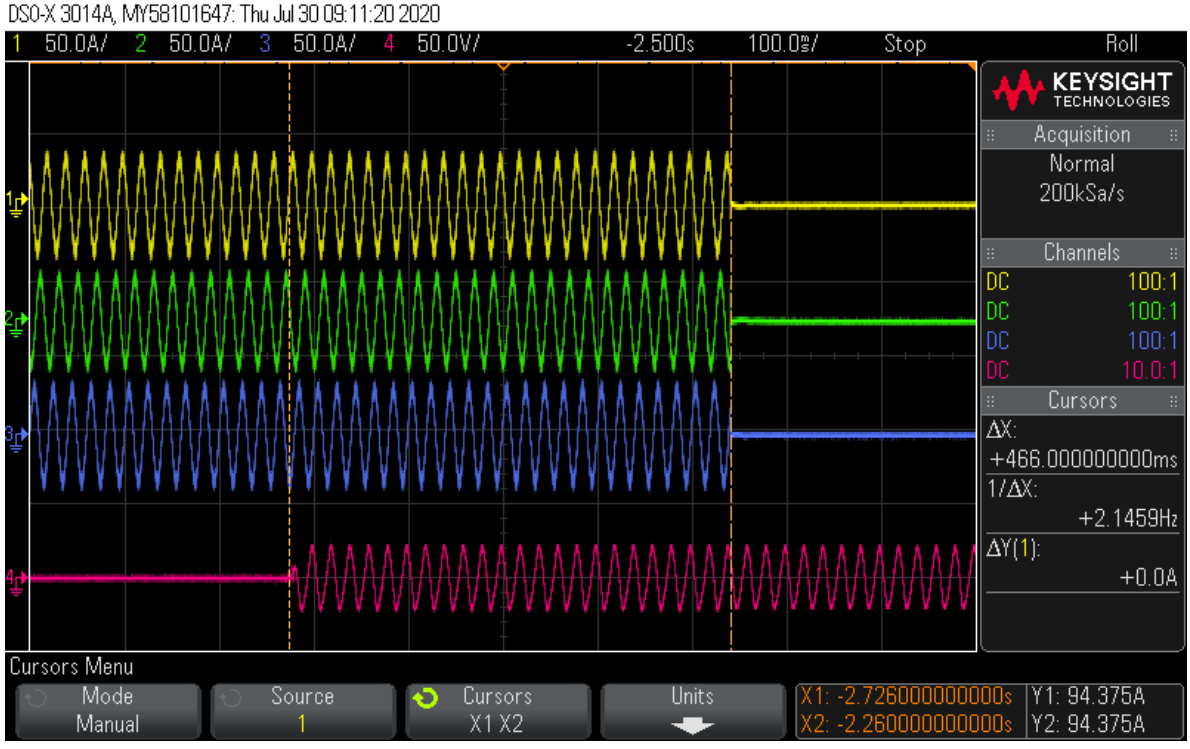
Test A(50Hz)	M(%)=0 & N(%)=+2



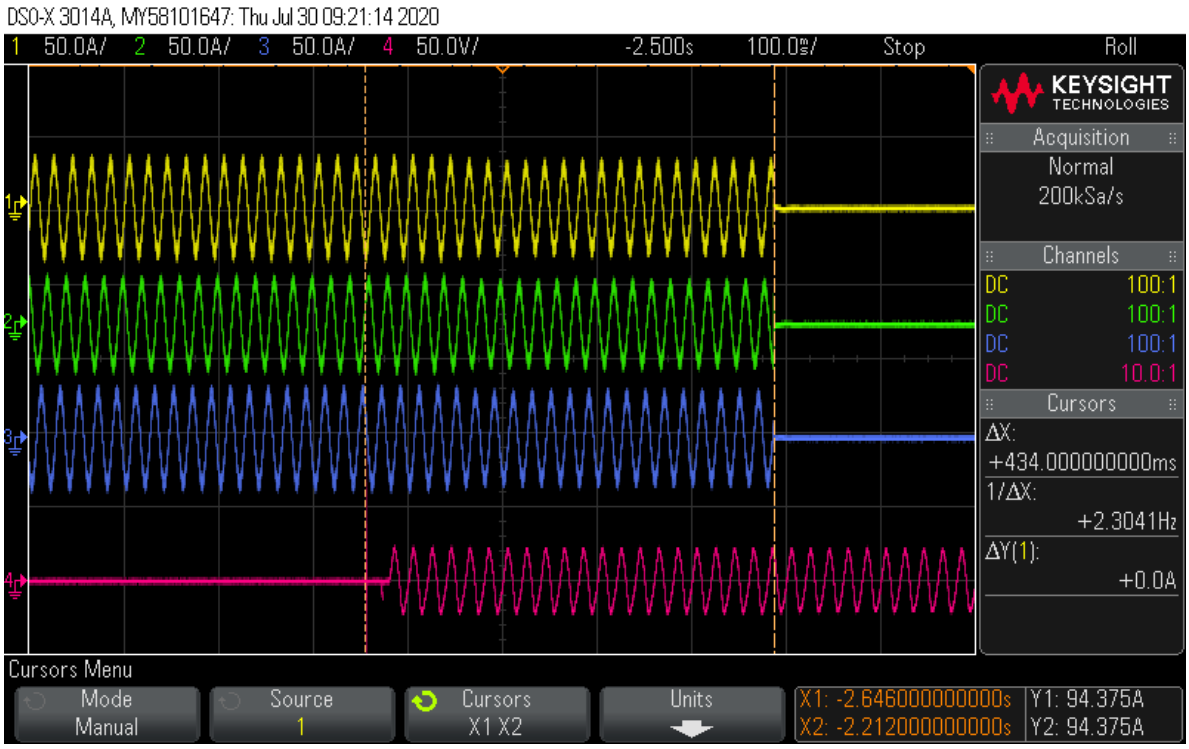
Test A(50Hz)	M(%)=0 & N(%)=+3



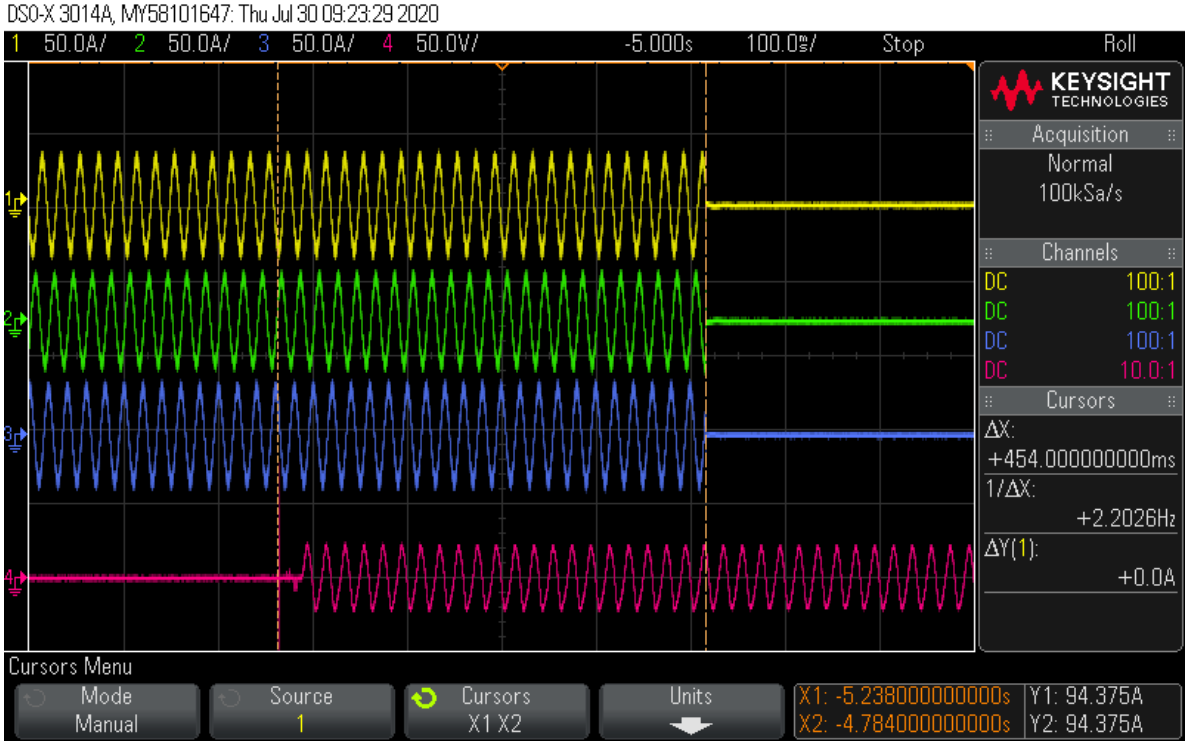
Test A(50Hz)	M(%)=0 & N(%)=+4



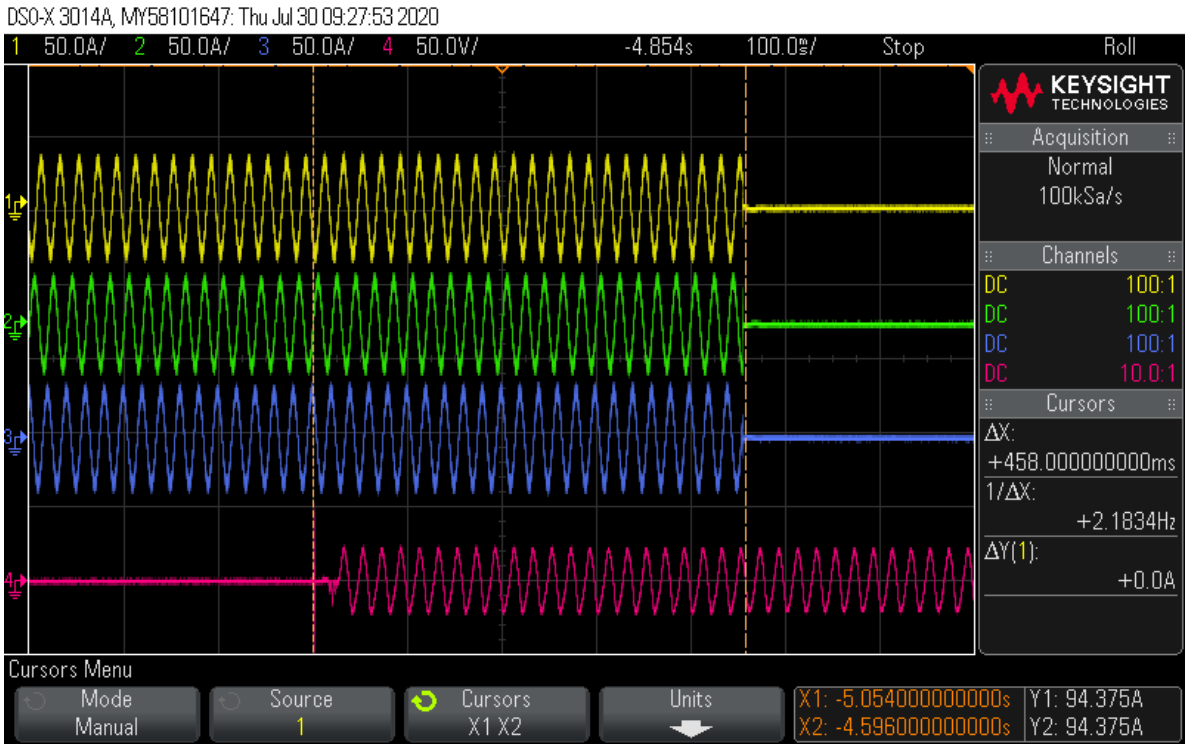
Test A(50Hz)	M(%)=0 & N(%)=+5



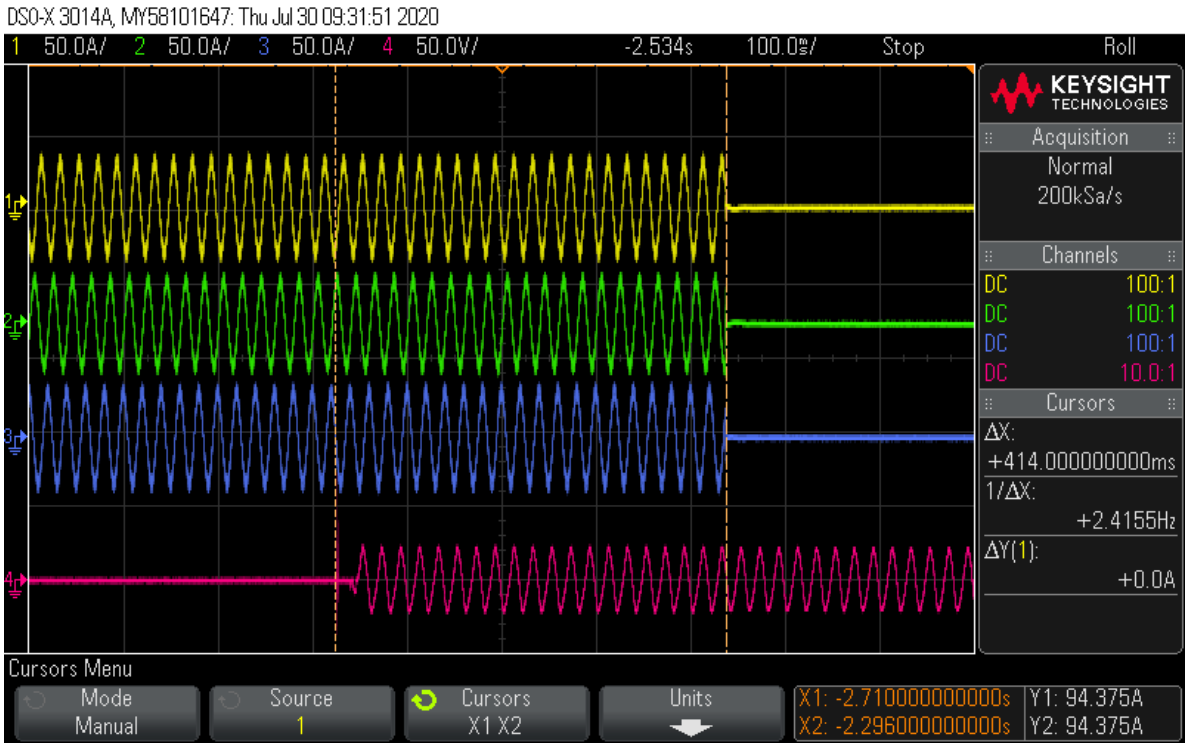
Test A(50Hz)	M(%)=0 & N(%)=-1



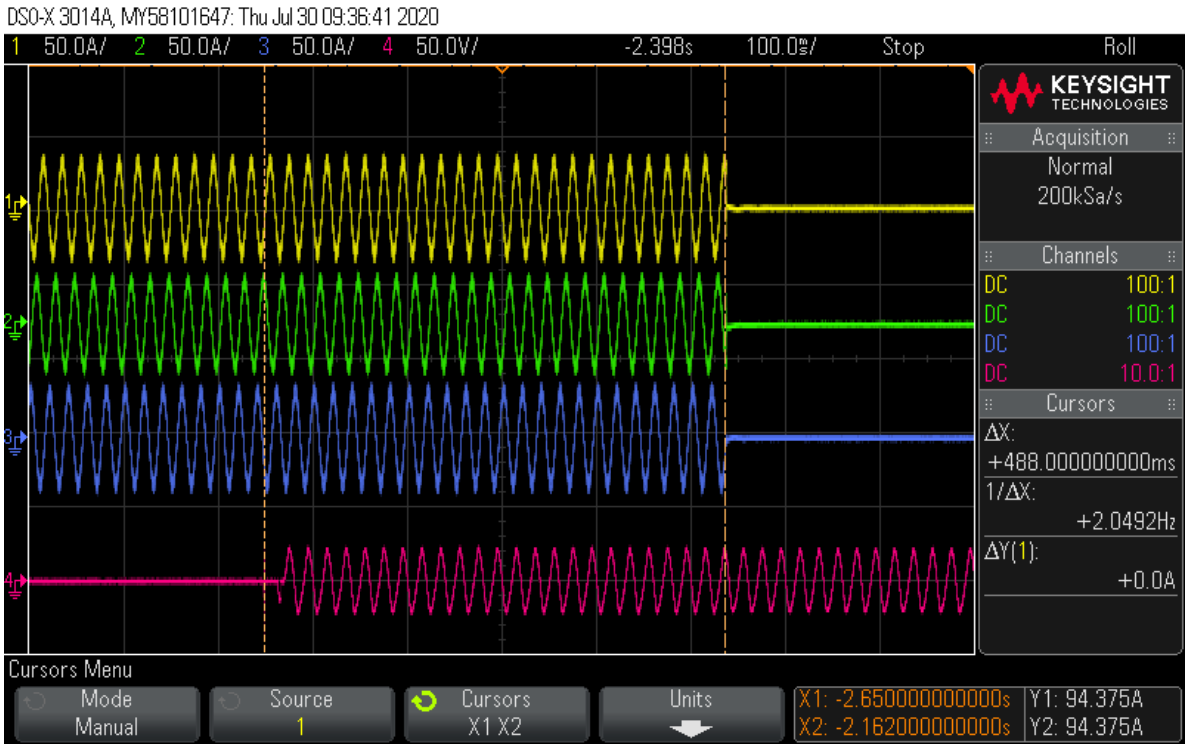
Test A(50Hz)	M(%)=0 & N(%)=-2



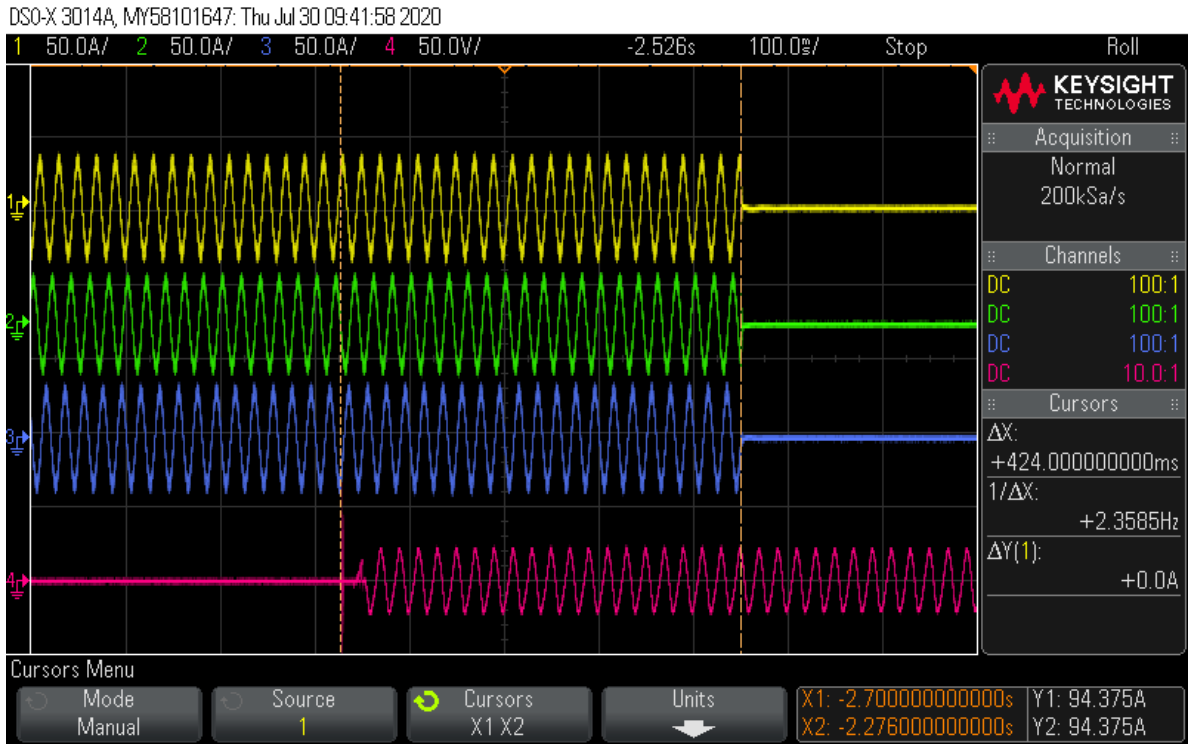
Test A(50Hz)	M(%)=0 & N(%)=-3



Test A(50Hz)	M(%)=0 & N(%)=-4

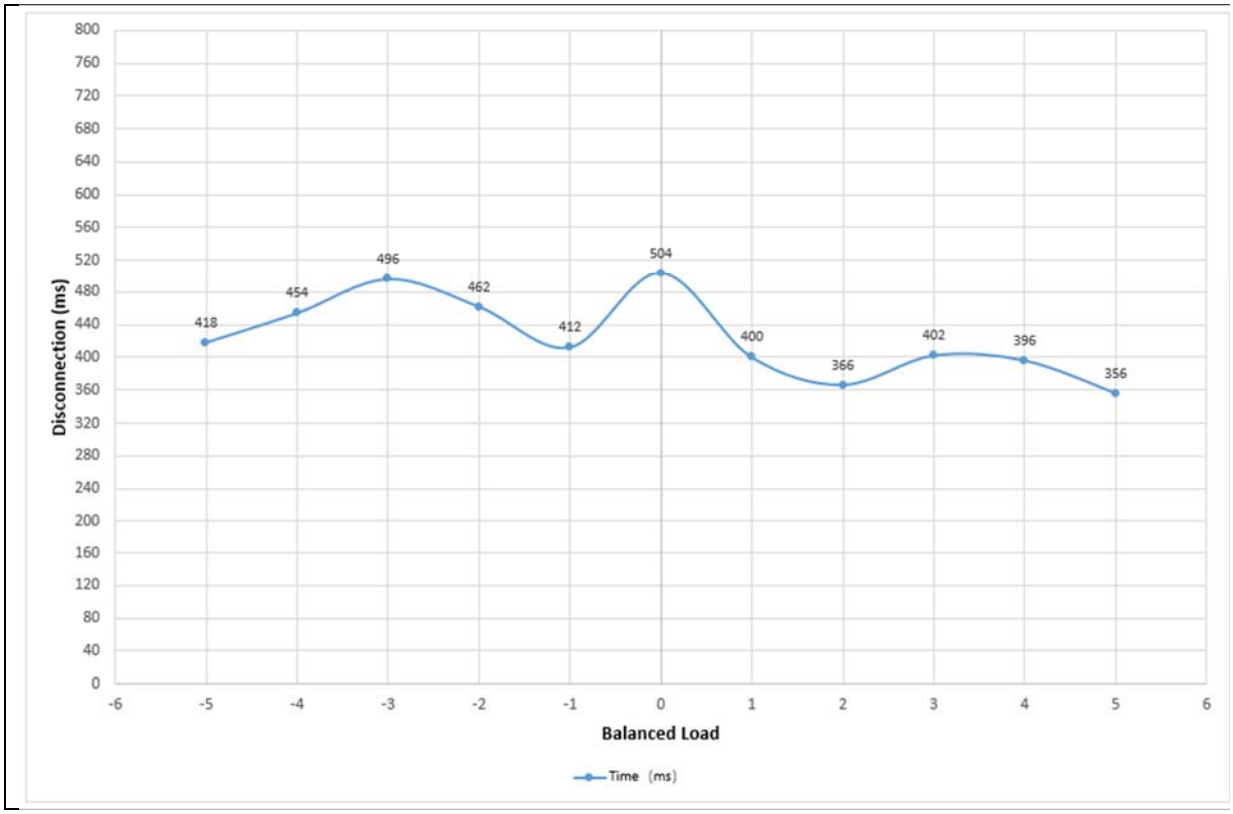


Test A(50Hz)	M(%)=0 & N(%)=-5

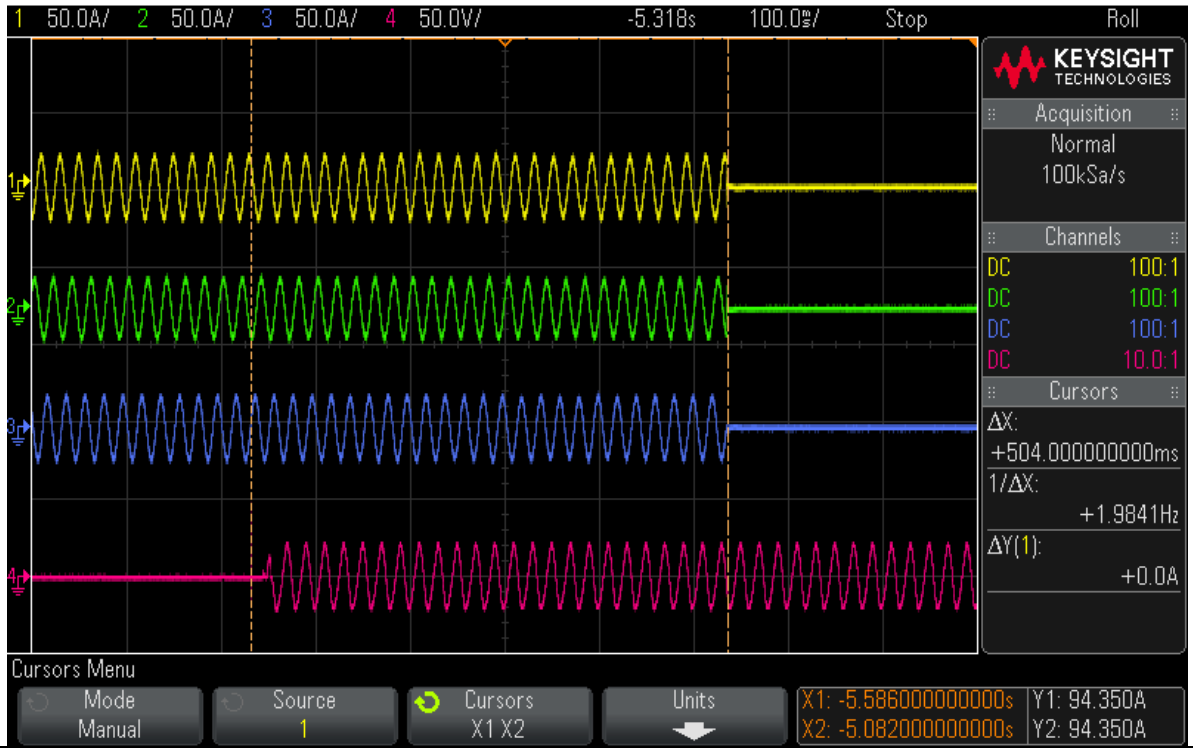


4.6.2 Test B

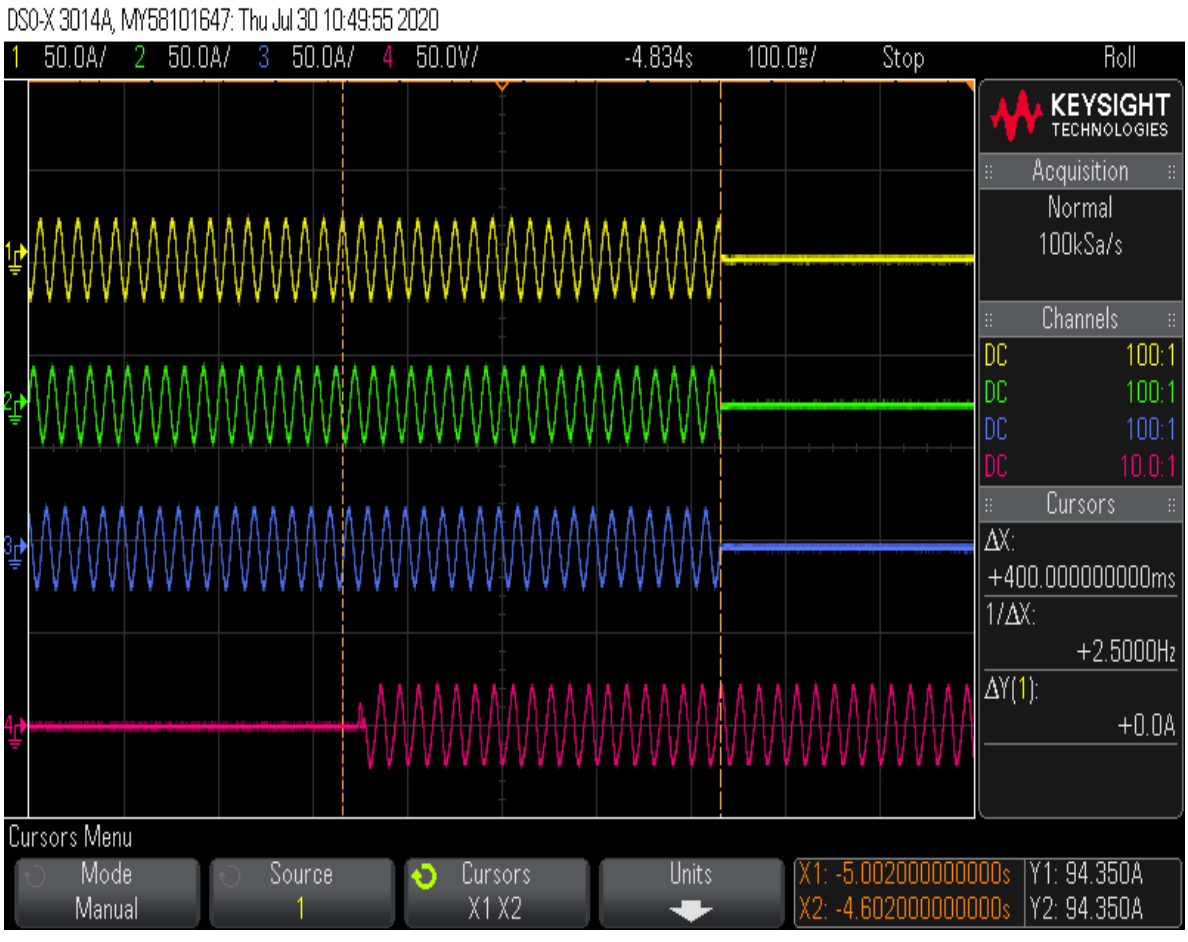
Balanced Load		
M (%)	**N (%)**	**Disconnection (ms) (limit at t=5s)**
0	-5	418
0	-4	454
0	-3	496
0	-2	462
0	-1	412
0	0	504
0	1	400
0	2	366
0	3	402
0	4	396
0	5	356



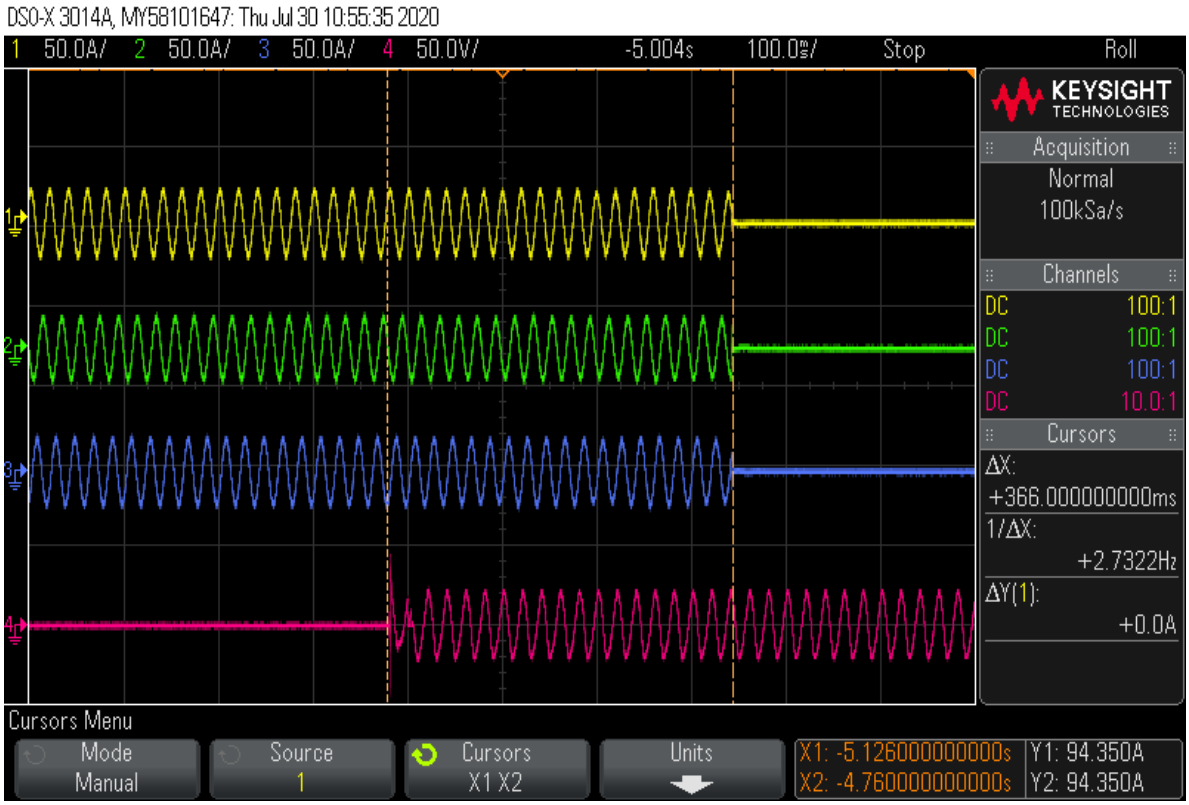
Test B(50Hz) **M(%)=0 & N(%)=0**



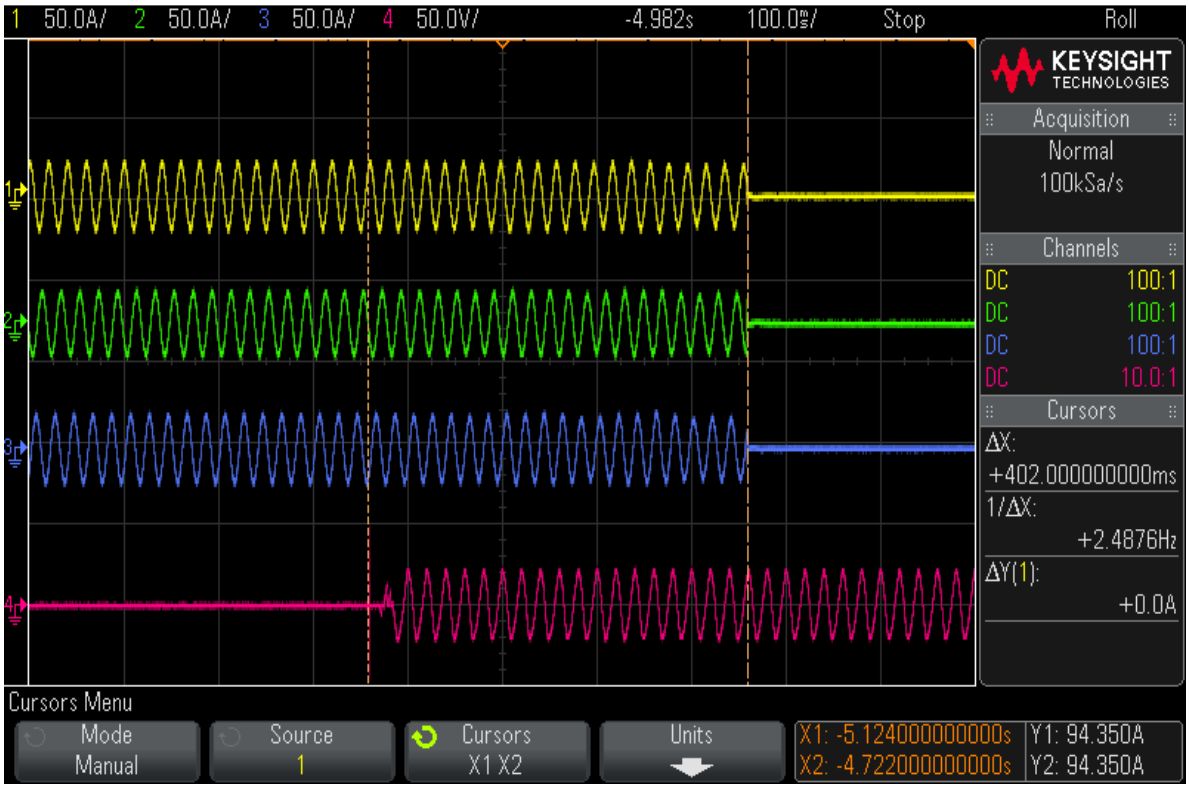
Test B(50Hz) **M(%)=0 & N(%)=+1**



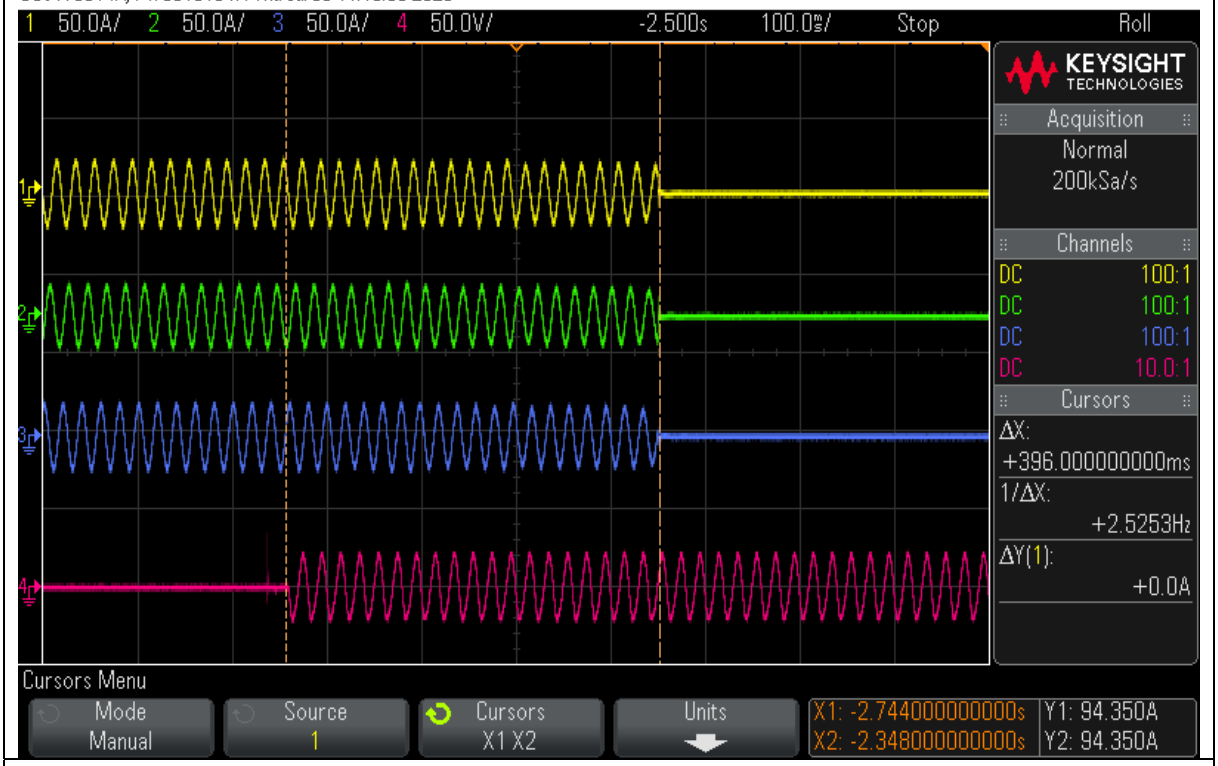
Test B(50Hz)	M(%)=0 & N(%)=+2



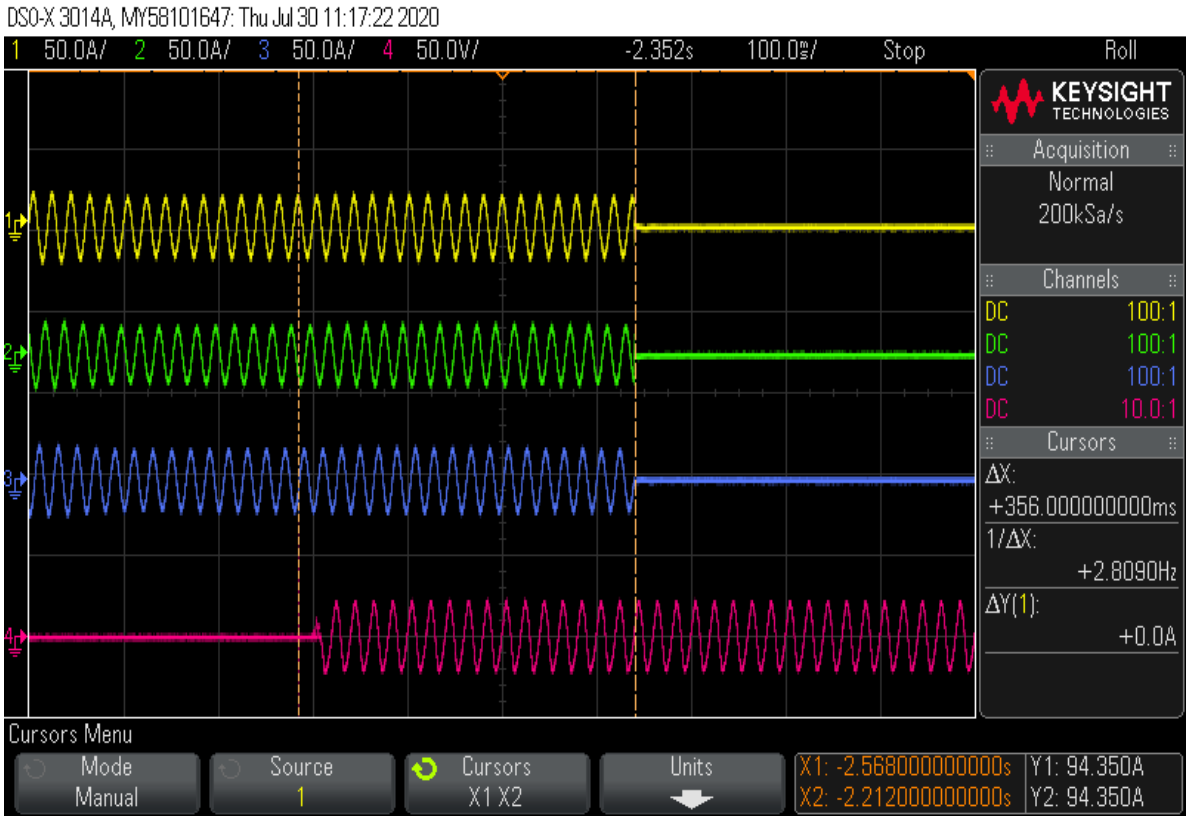
Test B(50Hz)	M(%)=0 & N(%)=+3



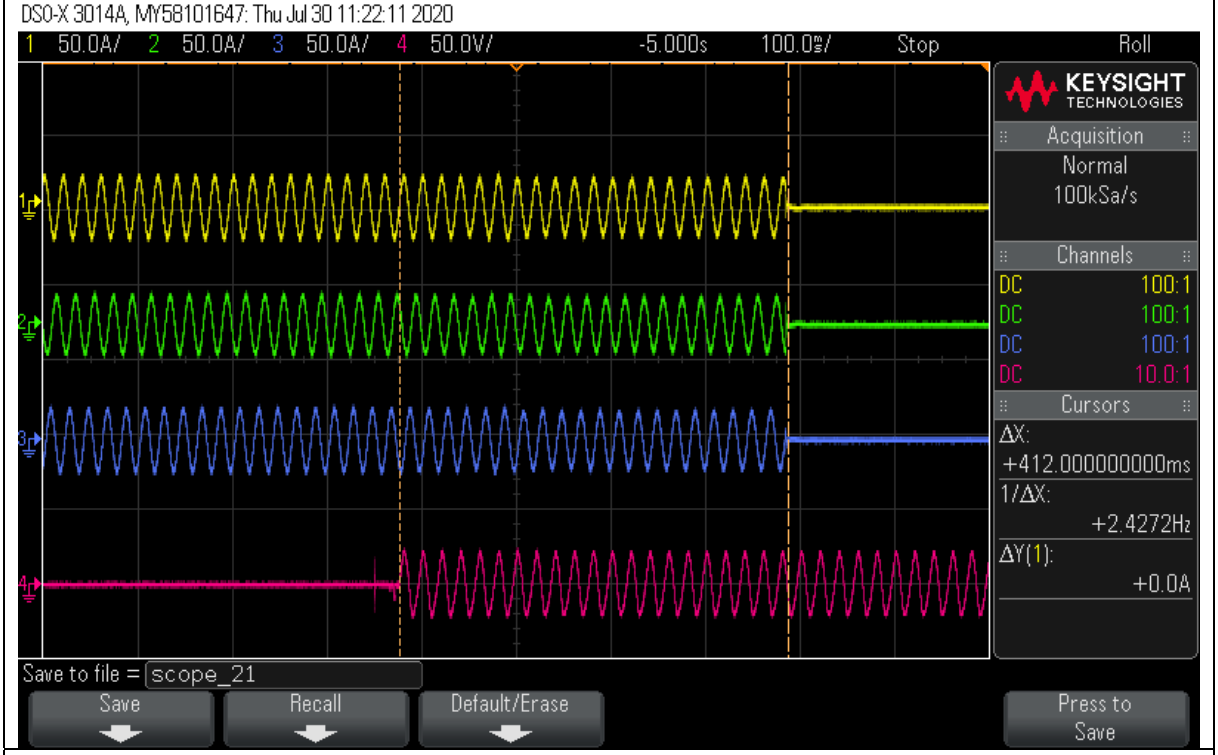
Test B(50Hz) **M(%)=0 & N(%)=+4**



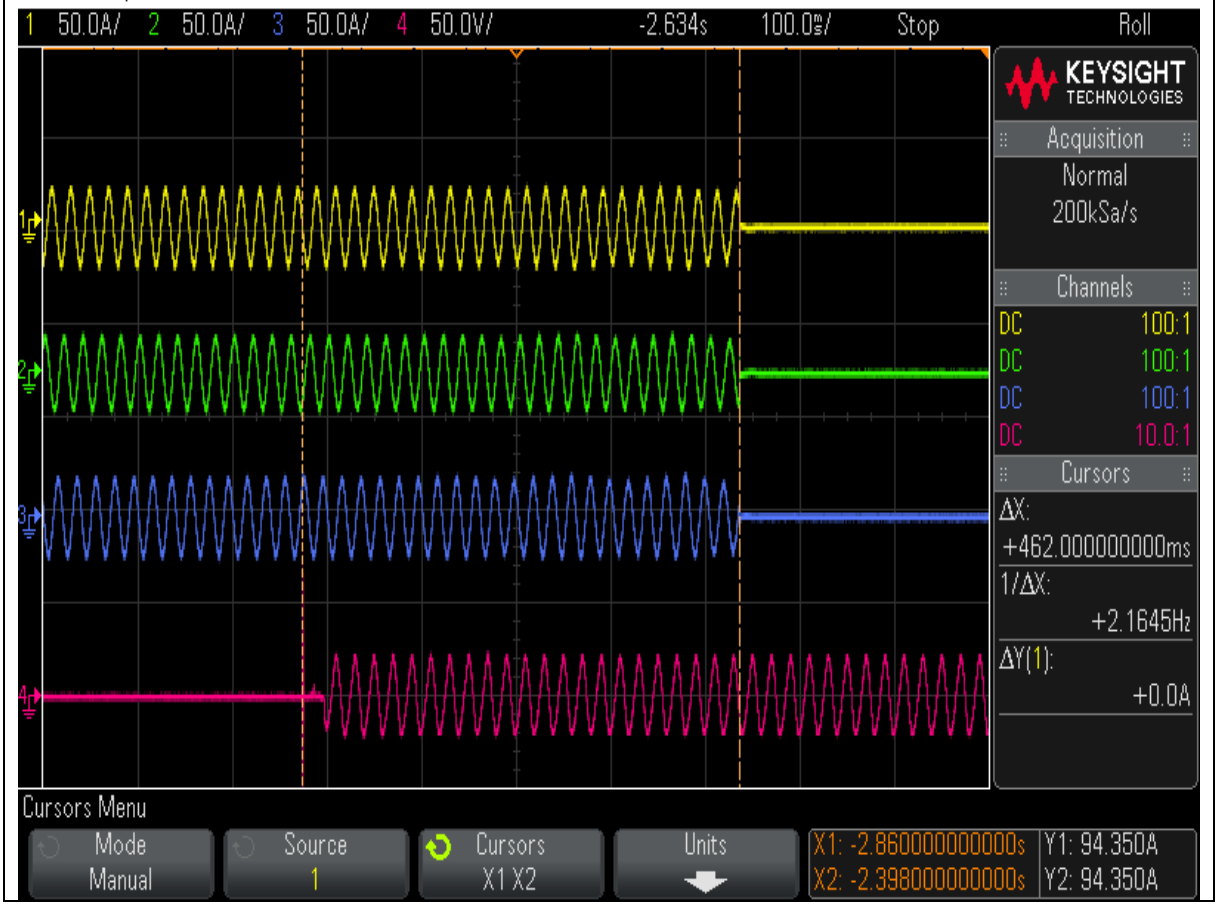
Test B(50Hz) **M(%)=0 & N(%)=+5**



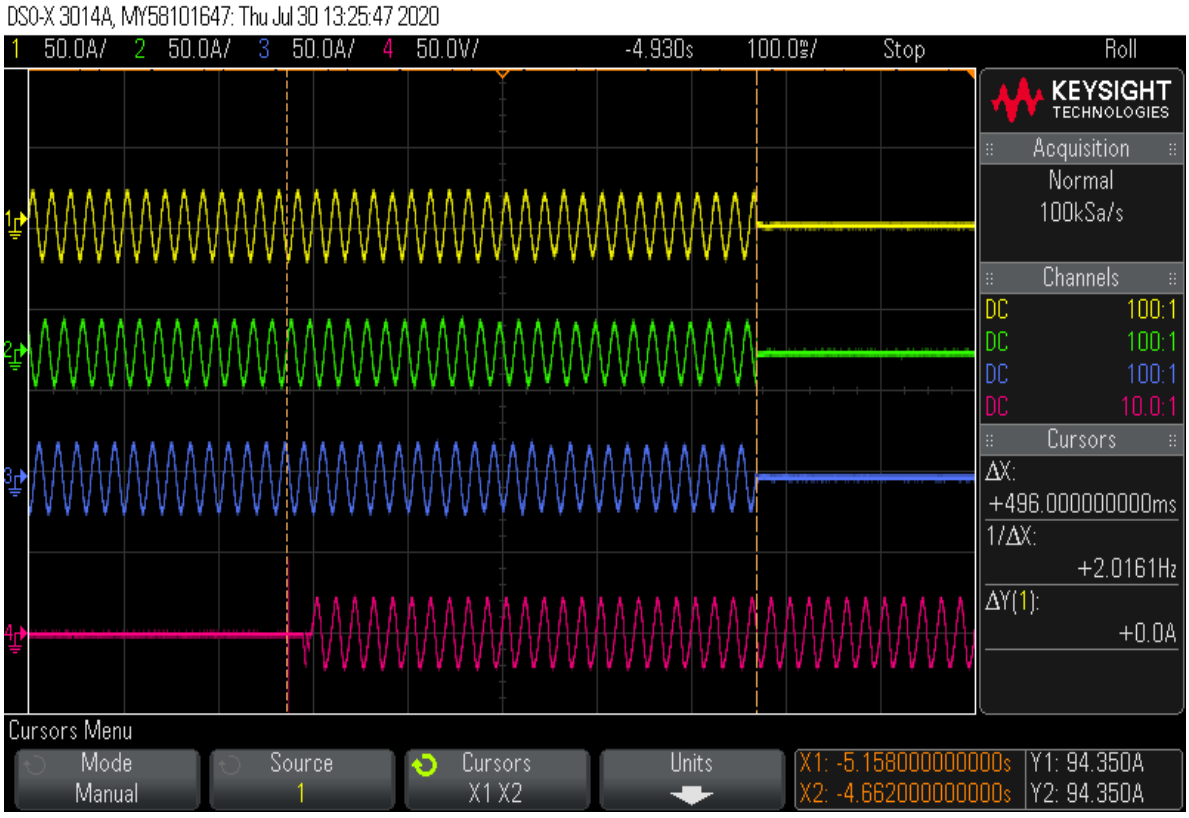
Test B(50Hz) **M(%)=0 & N(%)=-1**



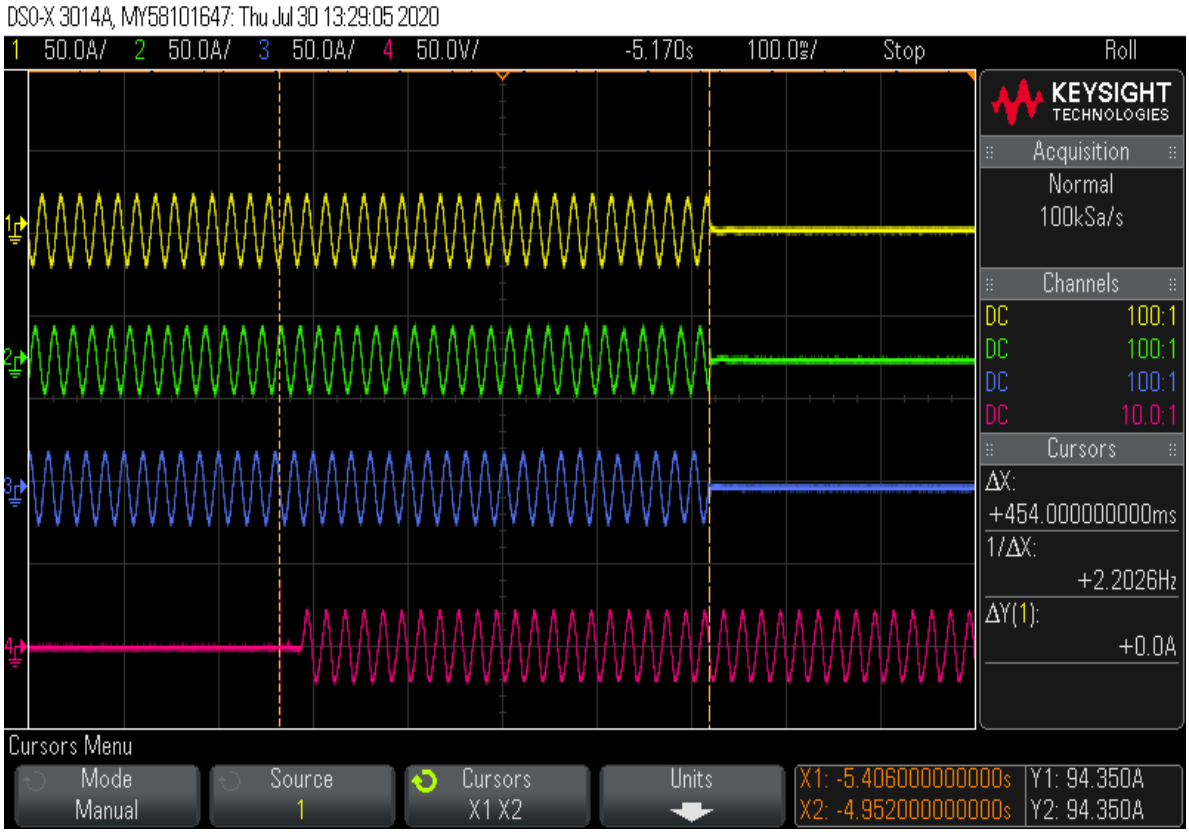
Test B(50Hz) **M(%)=0 & N(%)=-2**



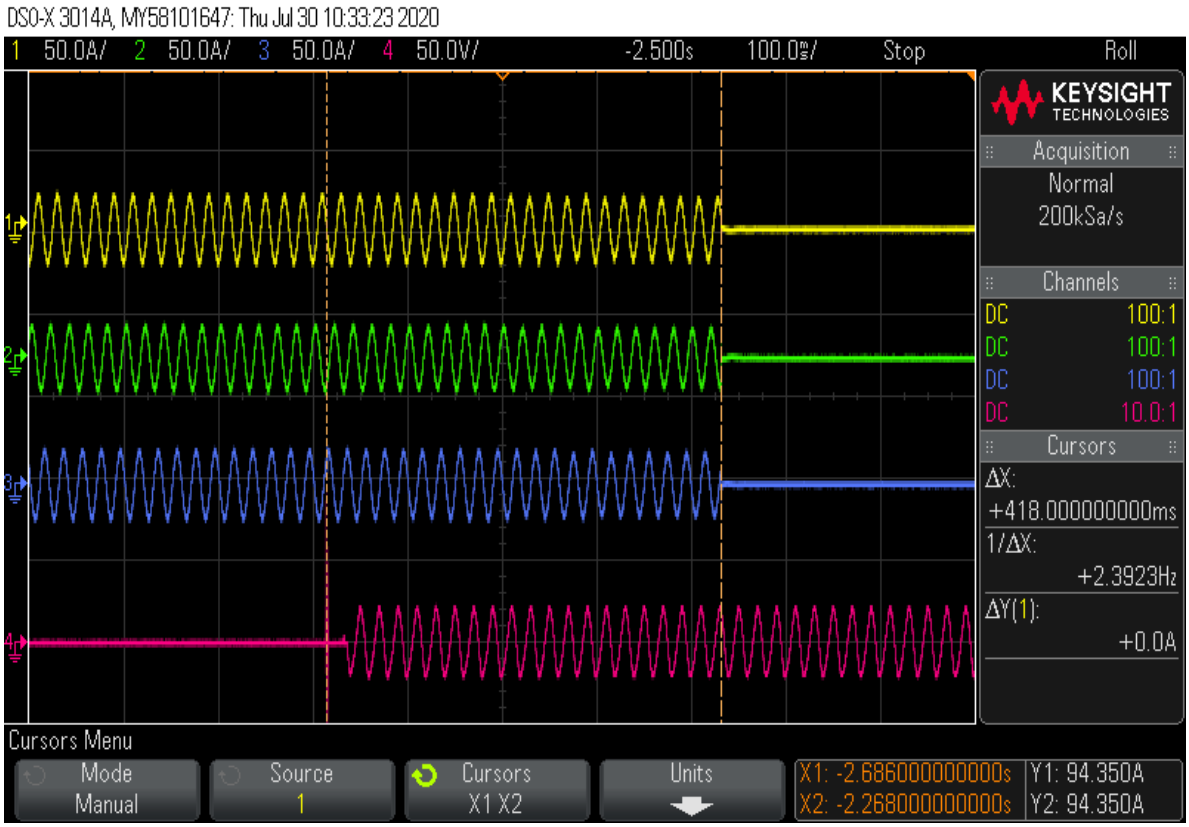
Test B(50Hz) **M(%)=0 & N(%)=-3**



Test B(50Hz) **M(%)=0 & N(%)=-4**

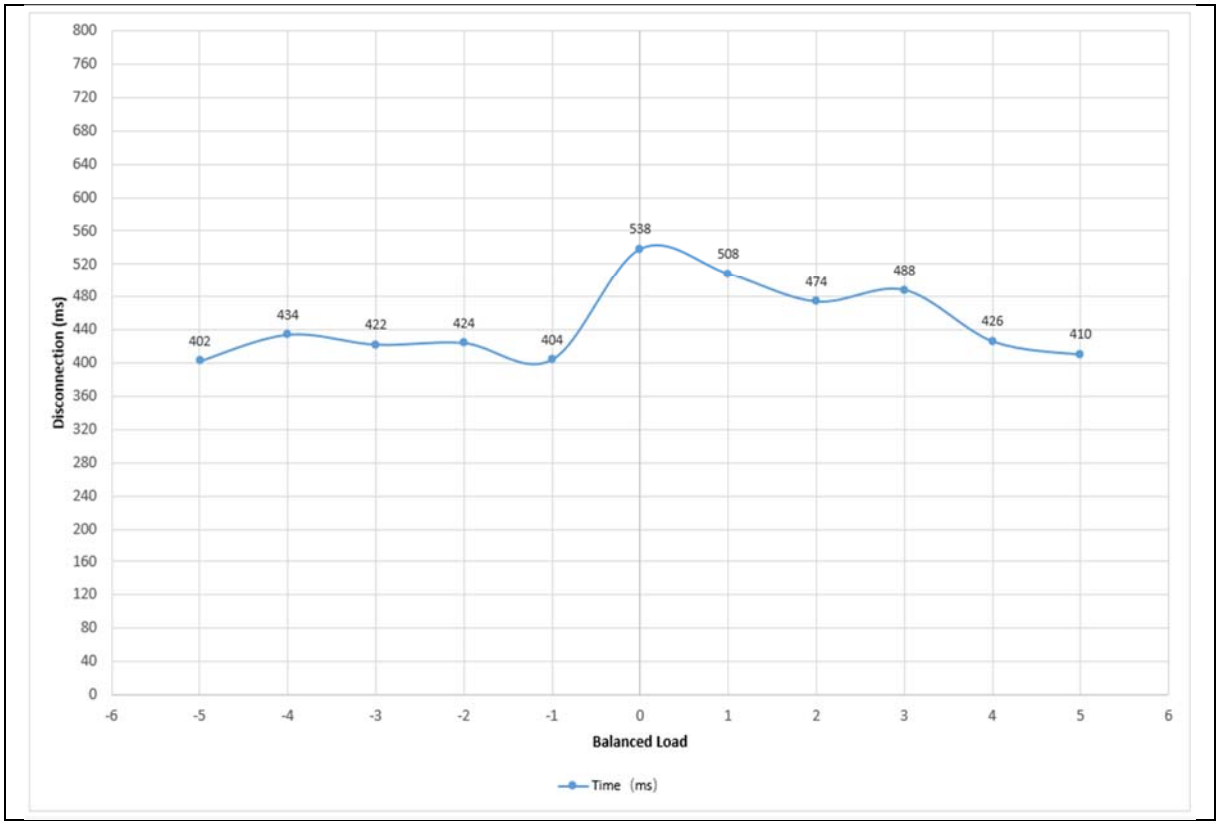


Test B(50Hz)	M(%)=0 & N(%)=-5

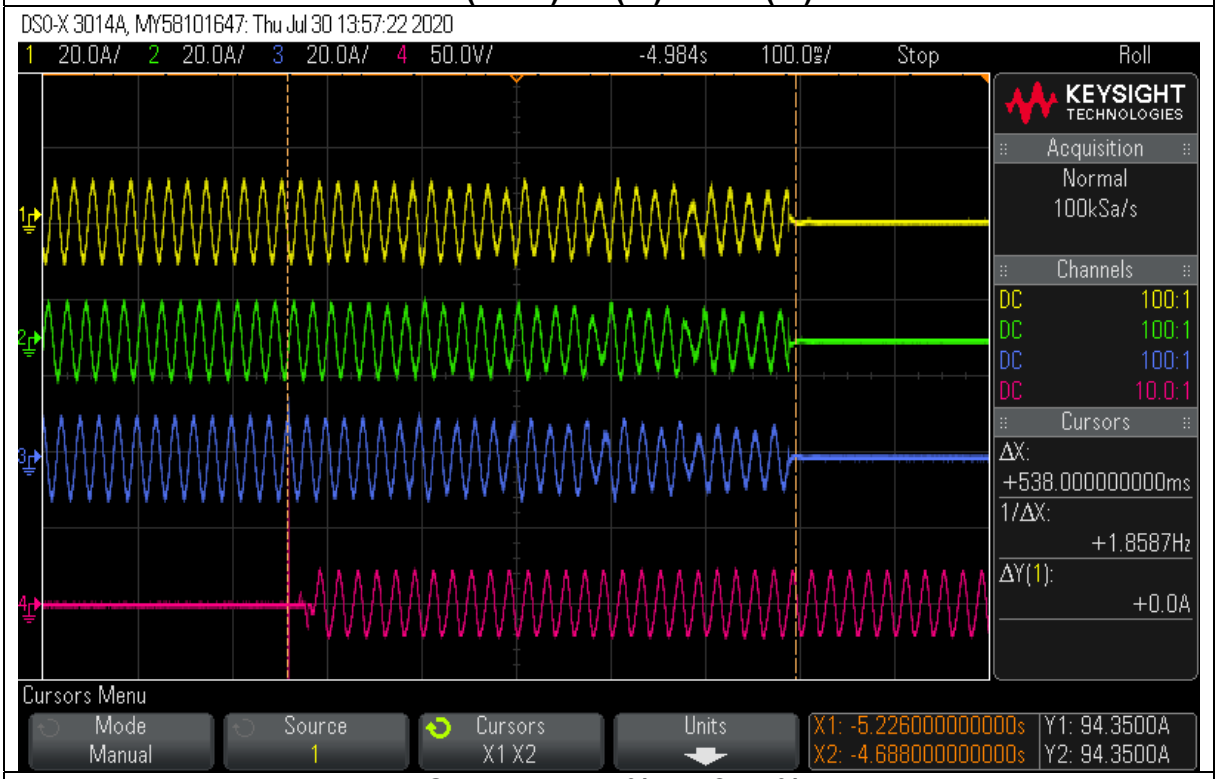


4.6.3 Test C

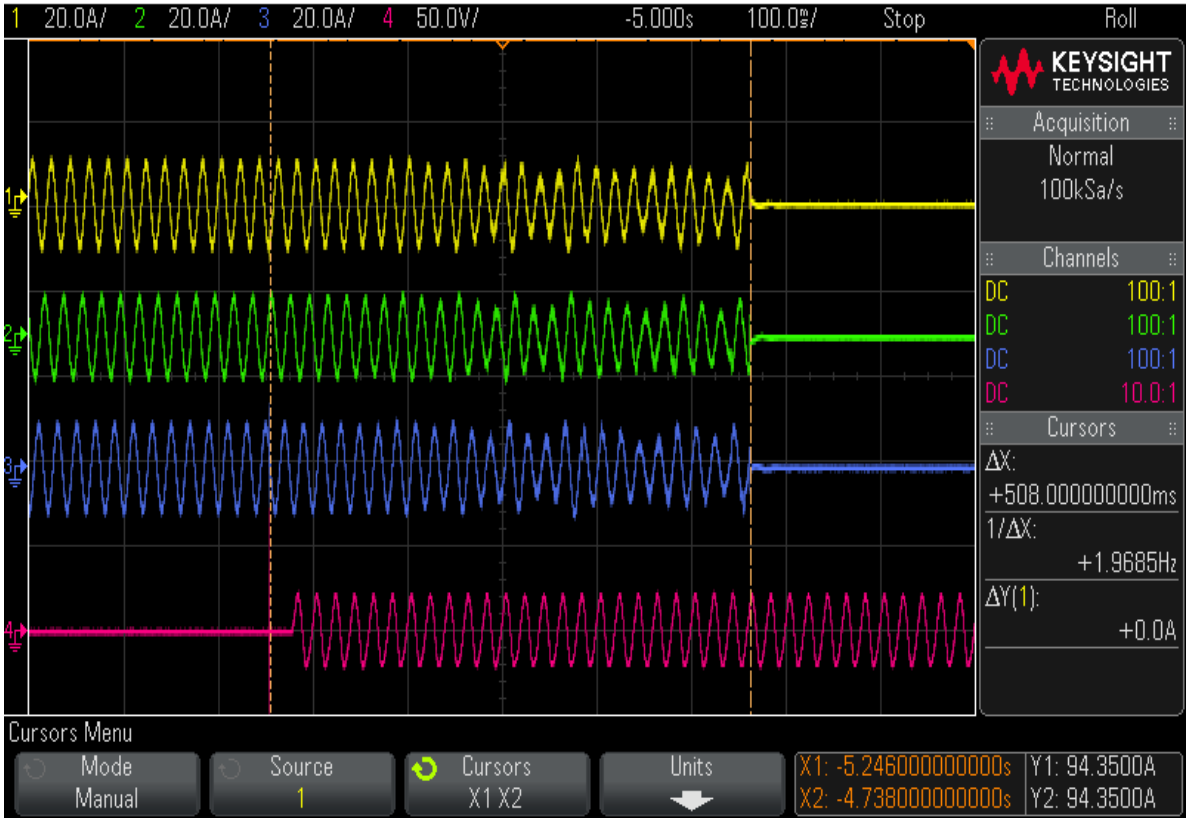
Balanced Load		
M (%)	**N (%)**	**Disconnection (ms) (limit at t=5s)**
0	-5	644
0	-4	762
0	-3	972
0	-2	934
0	-1	1878
0	0	1404
0	1	1102
0	2	1074
0	3	1082
0	4	852
0	5	682



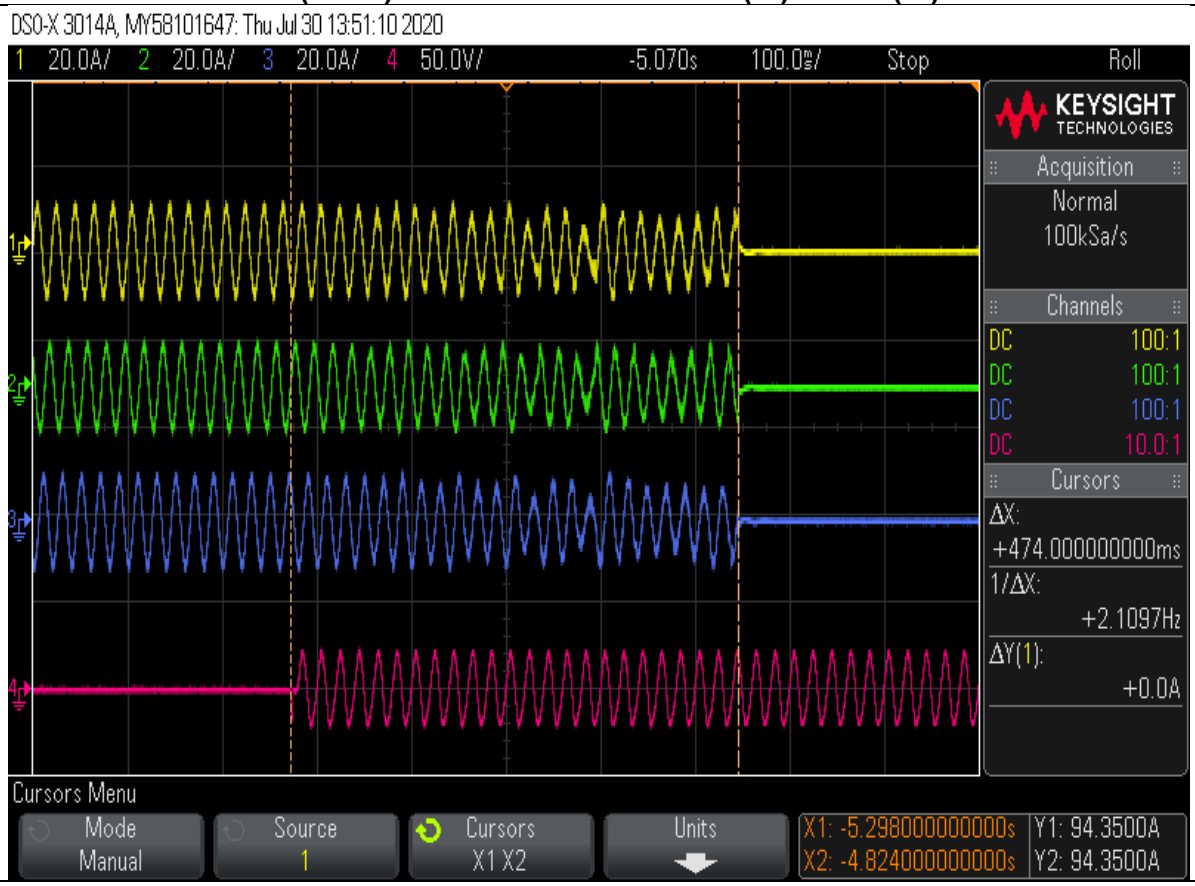
Test C(50Hz) M(%)=0 & N(%)=0



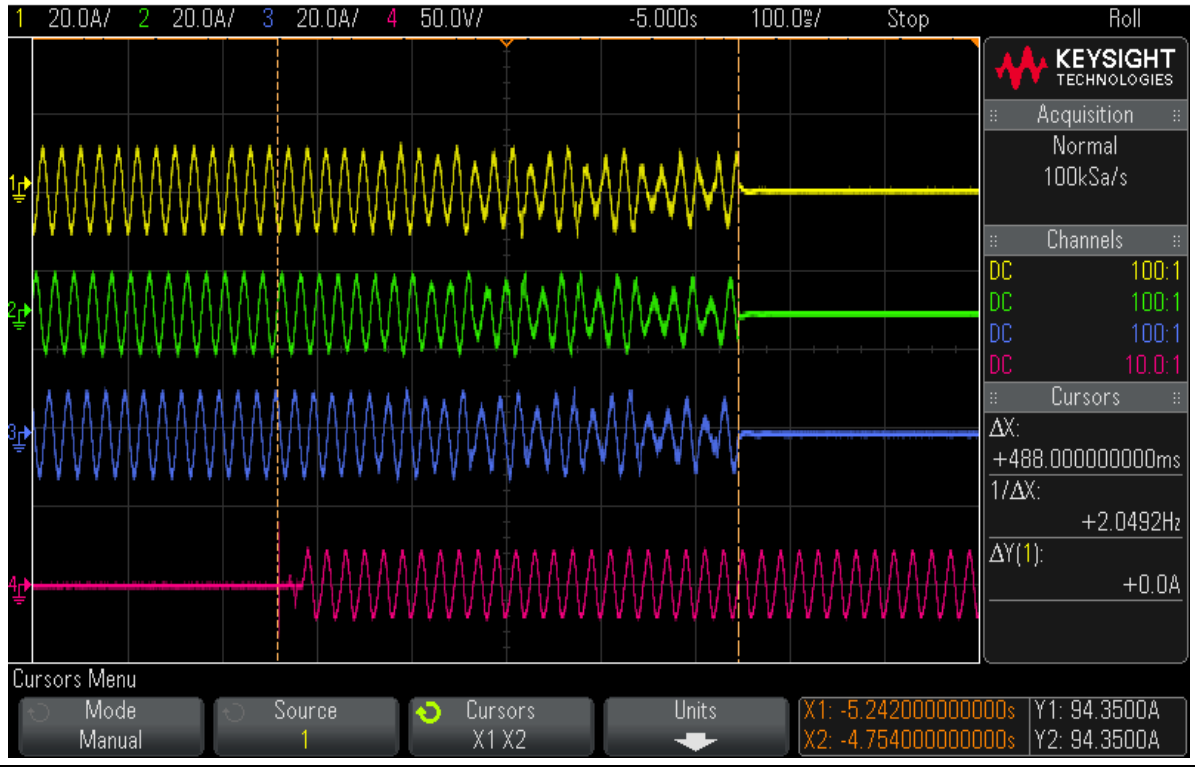
Test C(50Hz) M(%)=0 & N(%)=+1



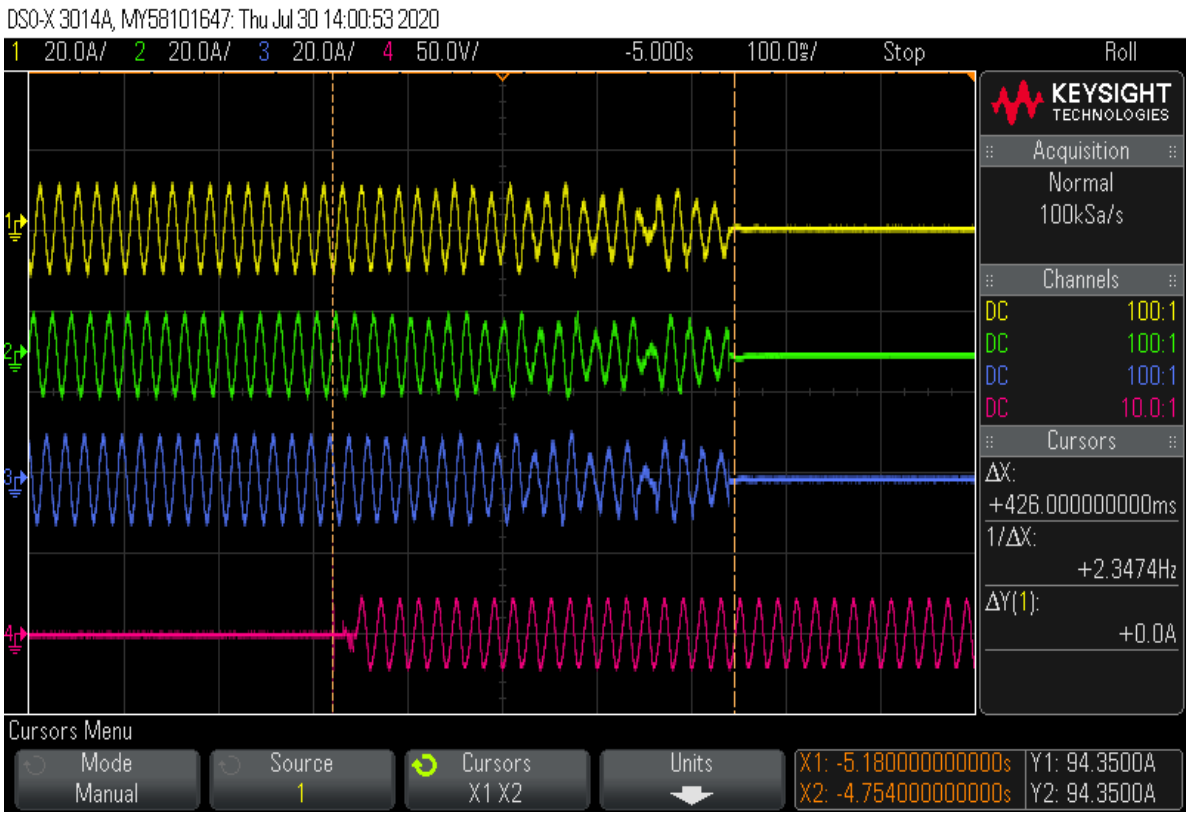
Test C(50Hz) **M(%)=0 & N(%)=+2**



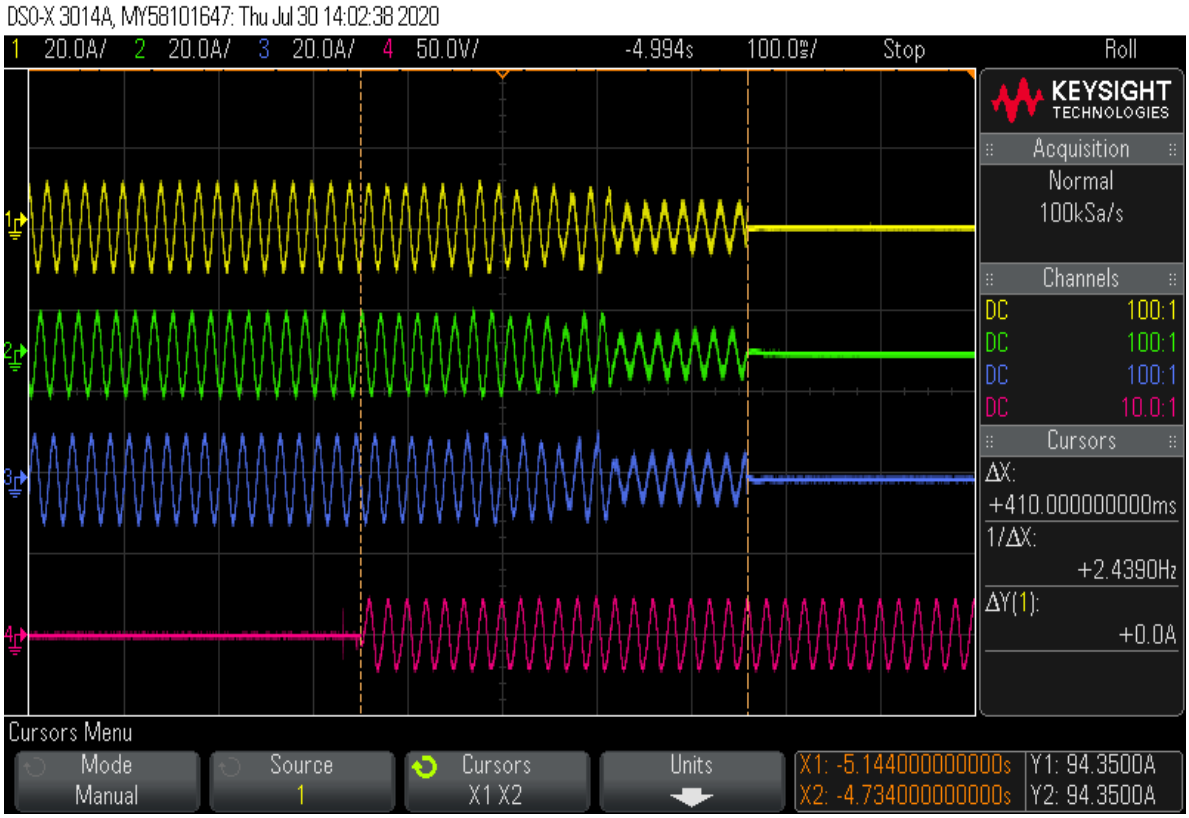
Test C(50Hz) **M(%)=0 & N(%)=+3**



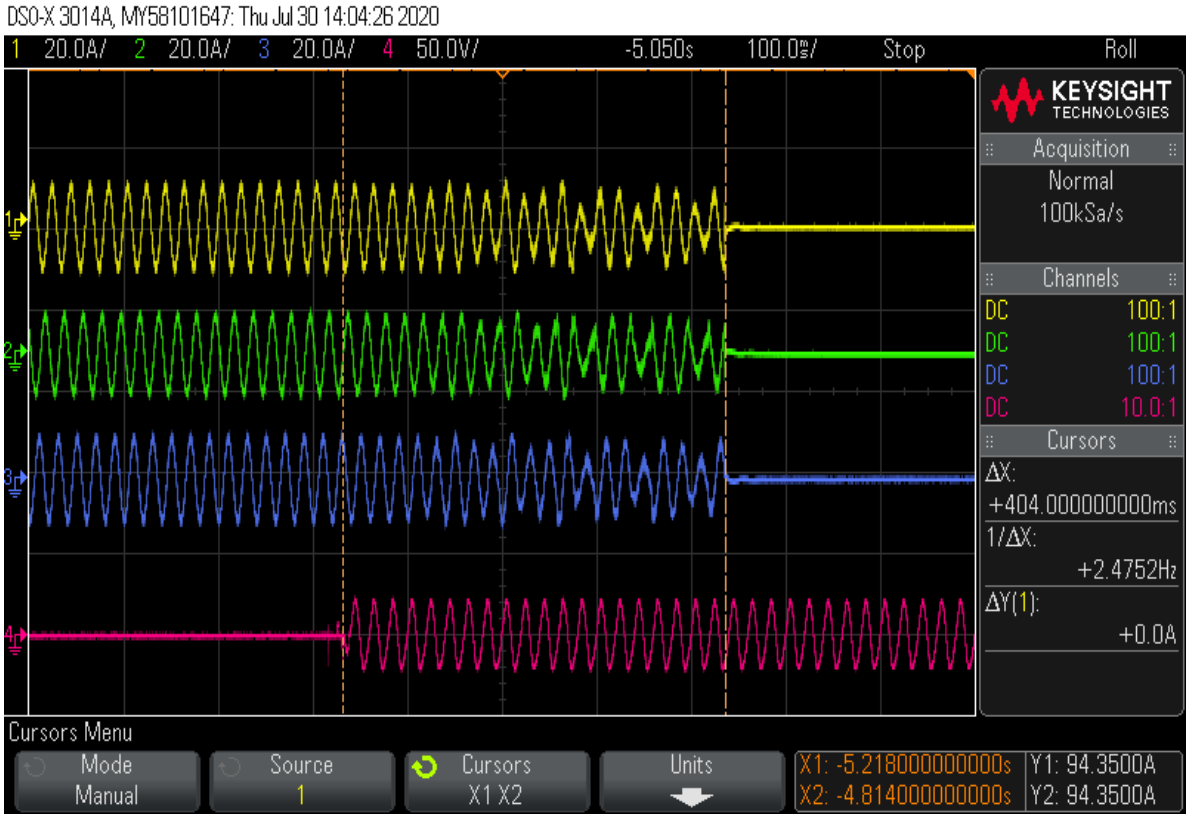
Test C(50Hz)	M(%)=0 & N(%)=+4



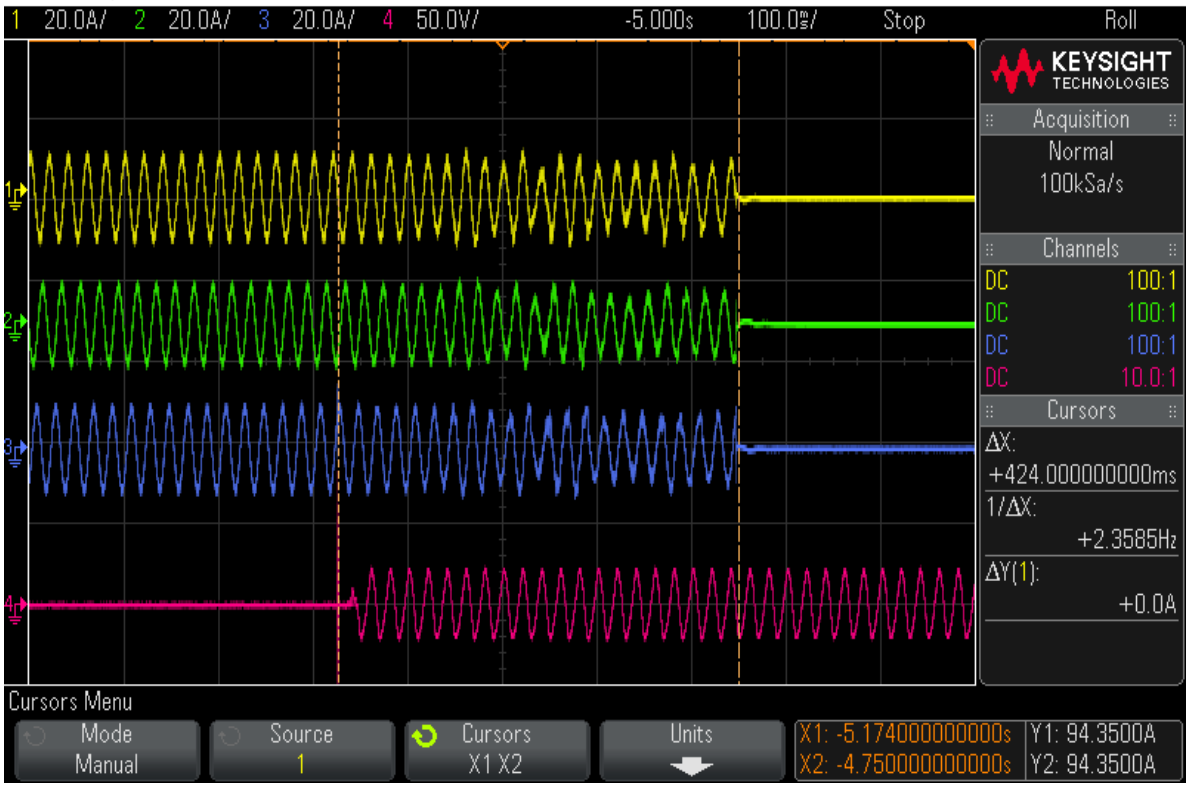
Test C(50Hz)	M(%)=0 & N(%)=+5



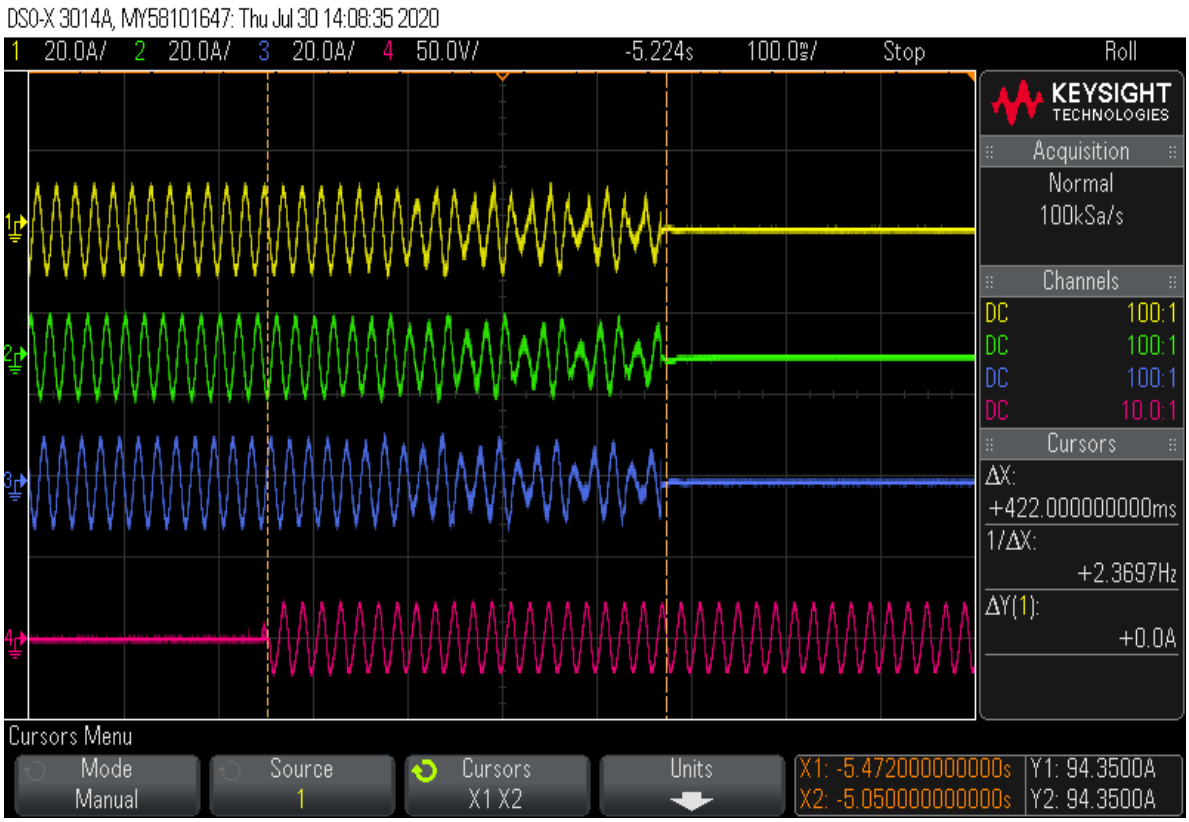
Test C(50Hz) M(%)=0 & N(%)=-1



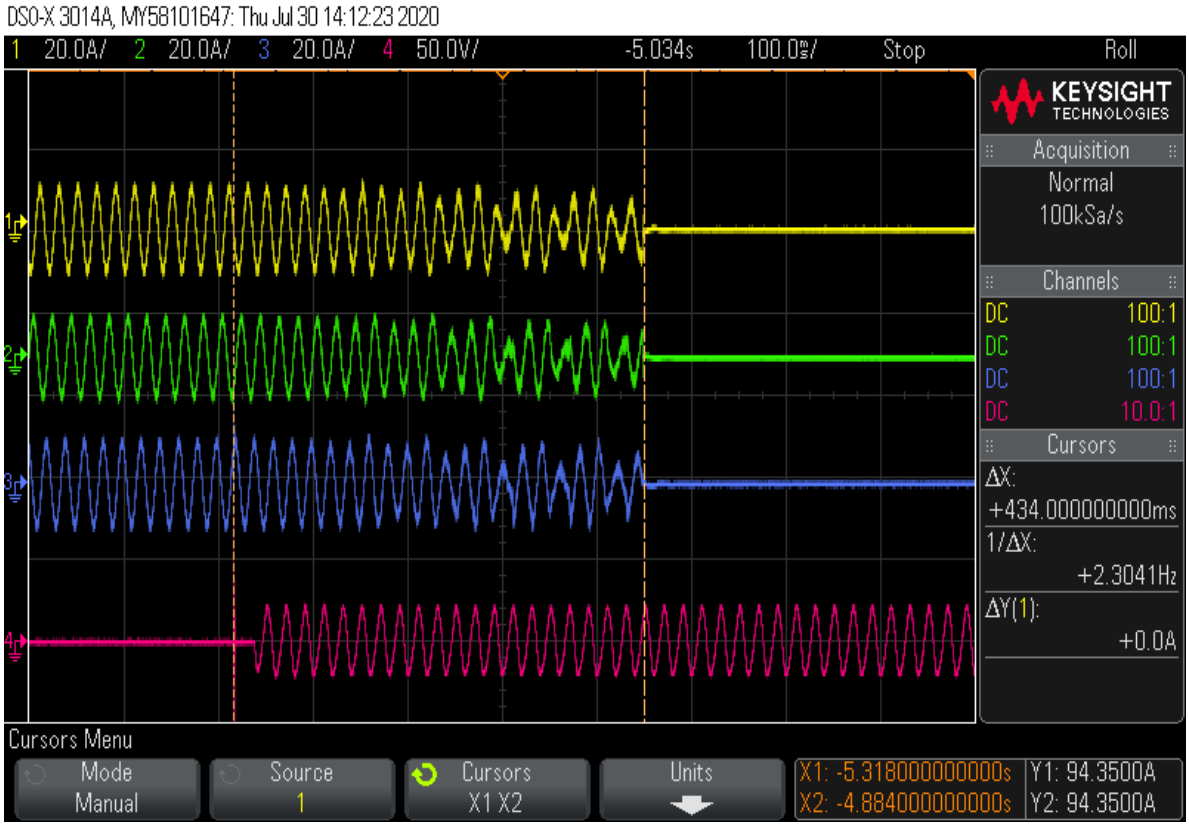
Test C(50Hz) M(%)=0 & N(%)=-2



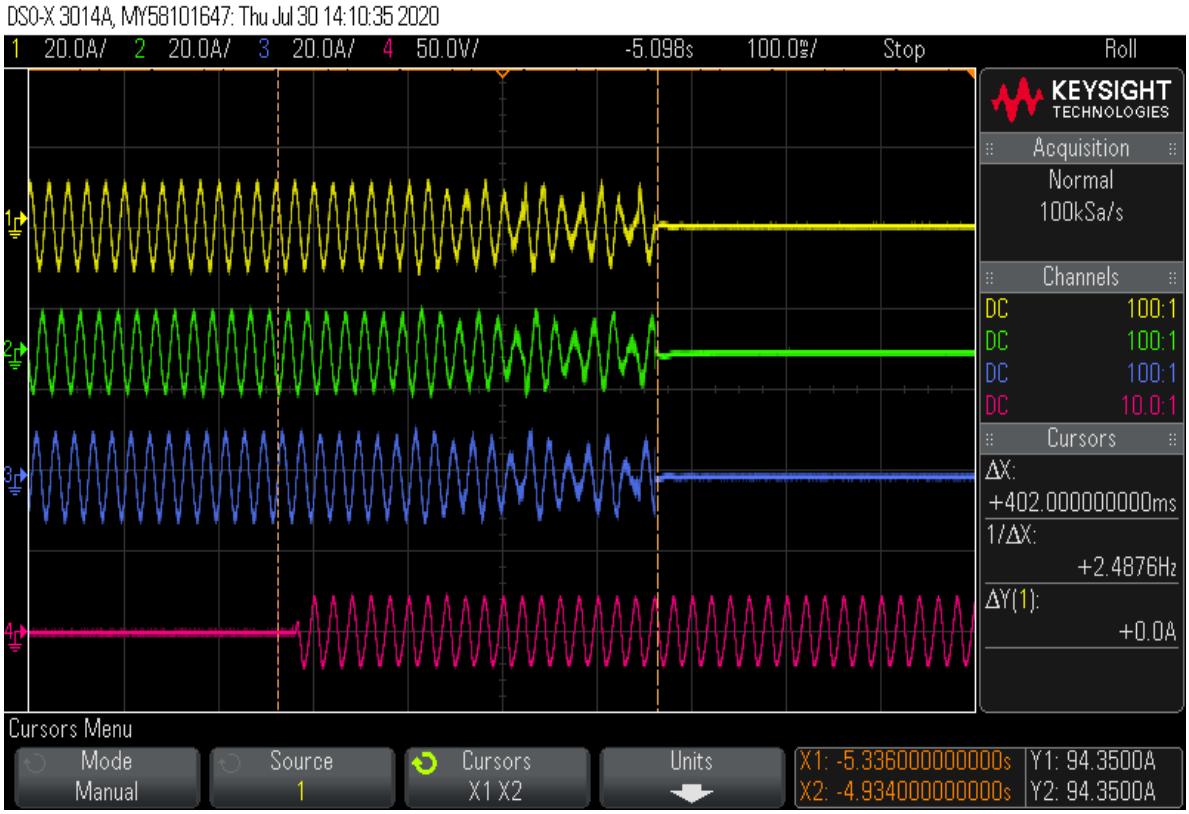
Test C(50Hz)	M(%)=0 & N(%)=-3



Test C(50Hz)	M(%)=0 & N(%)=-4



Test C(50Hz)	M(%)=0 & N(%)=-5



4.7 MARKING

As it can be seen in the pictures below (chapter 5 in this report) and the picture of the rating plate on 2.2 of this report the inverter accomplish all the requirements in this point of the VDE V 0126-1-1.

4.8 RESIDUAL CURRENT

This test has been done according to the standard EN 62109-2:2011, 4.8.3

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

-IEC 62109-2:2011: Test Report nº BL-DG2060127-B01 attachment 1 on 02 July.,2020 which issued by Shenzhen BALUN Technology Co., Ltd.

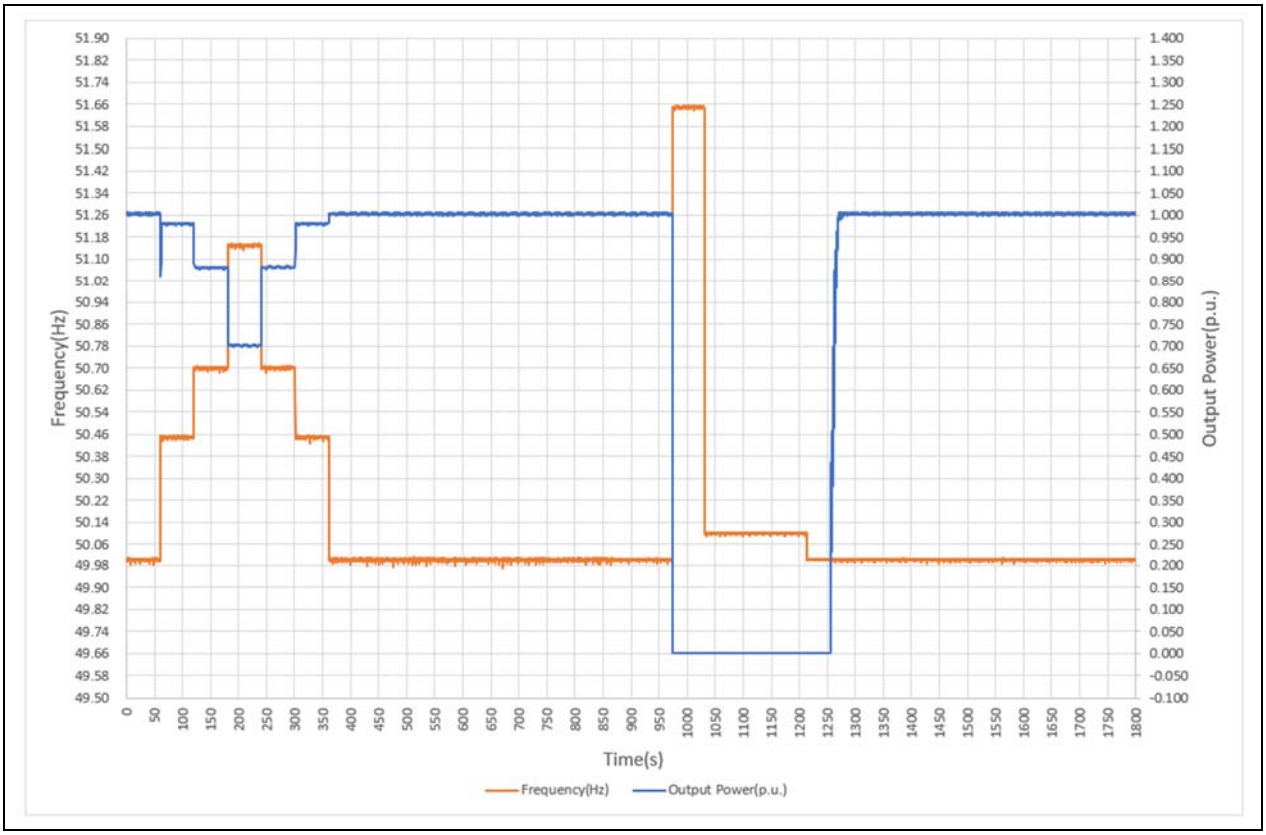
4.9 TABLE: ACTIVE POEWR OUTPUT FEED-IN AT OVERFREQUENCY

VFR 2013：Above 50,4Hz the inverter must start de-rating with 40% per Hz based on the output power at the point, when the inverter reached 50.4Hz (~51.5Hz).

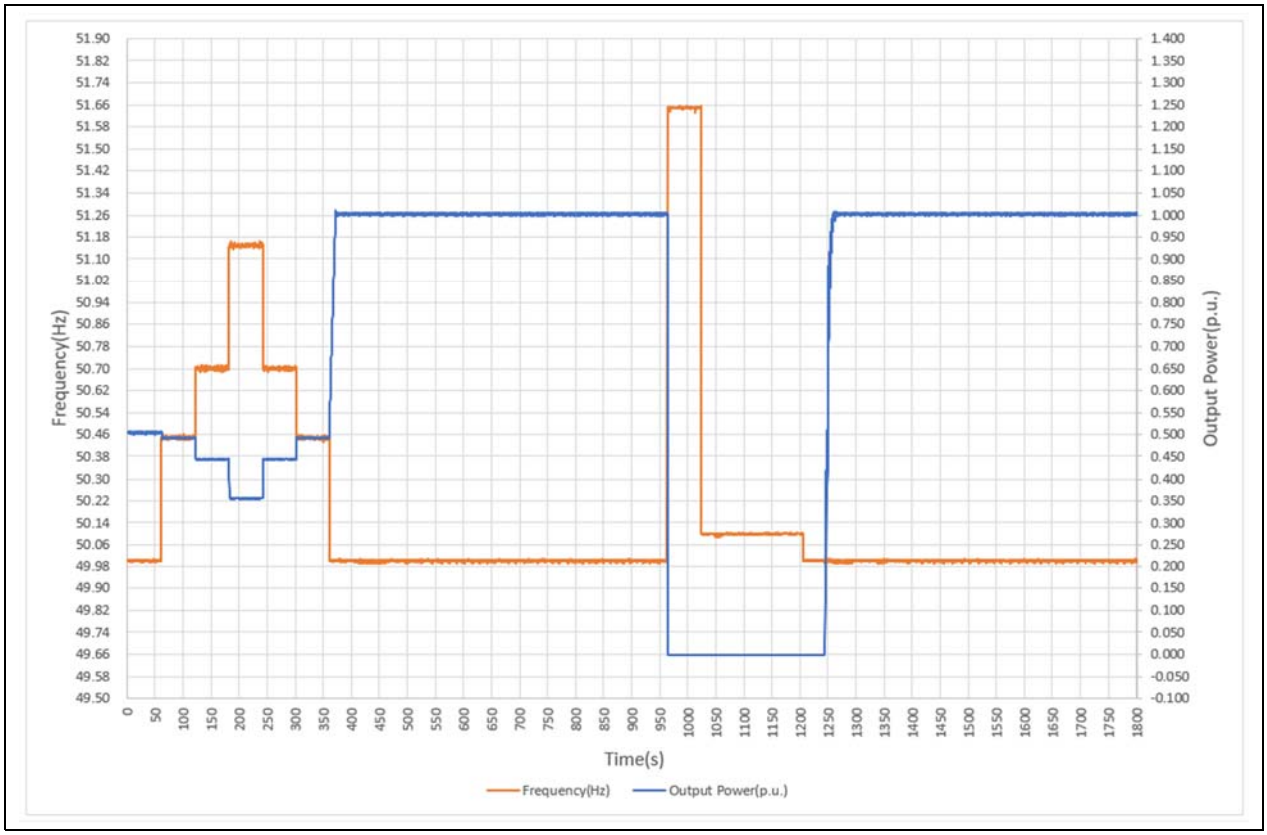
VFR 2014: Above 50,6Hz the inverter must start de-rating with 40% per Hz based on the output power at the point, when the inverter reached 50.4Hz (~51.5Hz).

If the grid frequency decreases, the inverter is allowed to increase the output power in the same rate as the decreasing happened before.

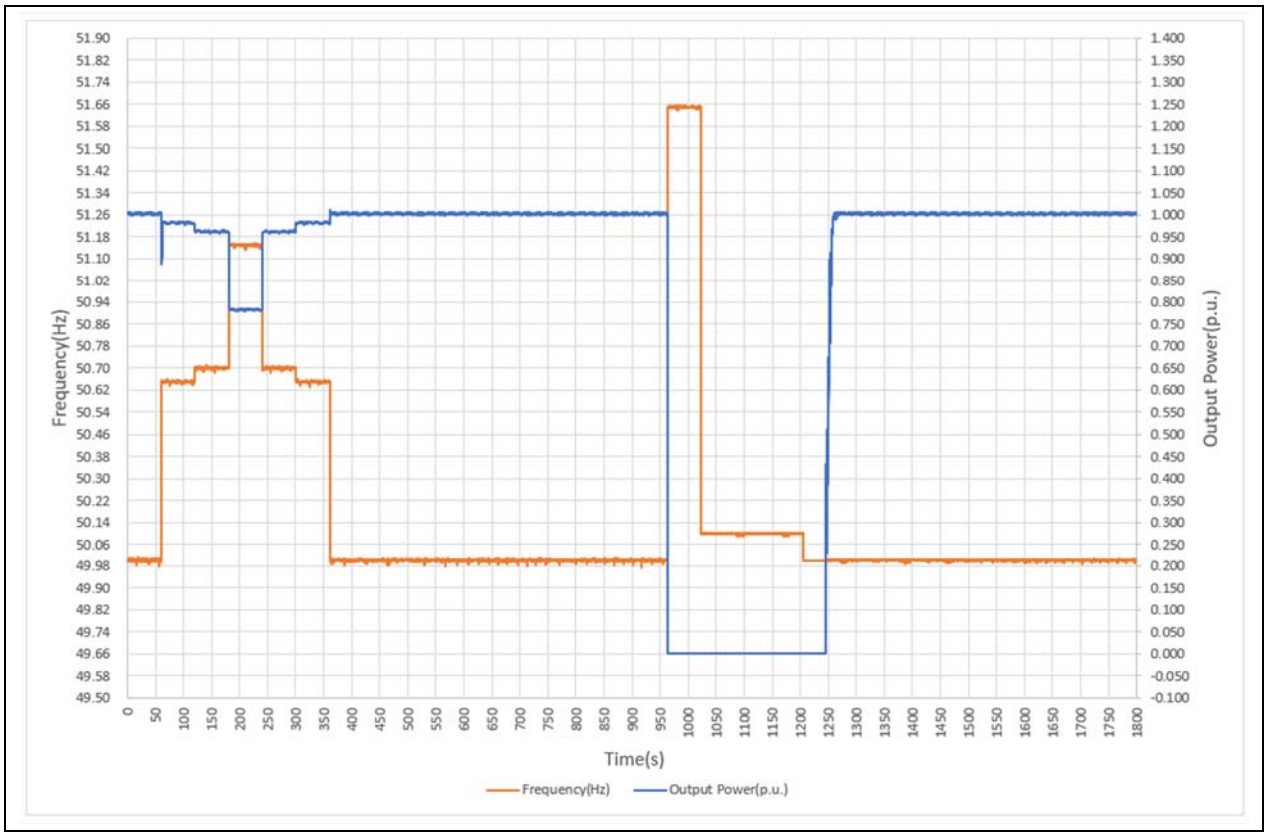
String	1	U_{DC} = Un	600Vdc	Uac = Un	230 Vac	P =P_n= (W)	15000 W
Udc (Vdc)		F (Hz)		F (Hz)		P (W)	time
600		a) 50Hz (± 0.01Hz)		50.00		15047.7	1 min
600		b) 50.45Hz (± 0.05Hz)		50.45		14697.2	1 min
600		c) 50.7Hz (± 0.1Hz)		50.70		13211.1	1 min
600		d) 51.15Hz (± 0.05Hz)		51.15		10521.5	1 min
600		e) 50.75Hz (± 0.10Hz)		50.70		13223.3	1 min
600		f) 50.45Hz (± 0.05Hz)		50.45		14705.6	1 min
600		g) 50Hz (± 0.01Hz)		50.00		15045.4	10 mins
600		h) 51.65Hz (± 0.05Hz)		51.65		-1.6	1 min
600		i) 50Hz (+0.06 ~ +0.1Hz)		50.10		-1.6	3 mins
600		j) 50Hz (± 0.01Hz)		50.00		15045.9	10 mins
Supplementary information: See test curve as following							



String	2	U_{DC} = Un	600Vdc	Uac = Un	230 Vac	P =0.5 P_n= (W)	7500 W
Udc (Vdc)		F (Hz)		F (Hz)		P (W)	time
600		a) 50Hz (± 0.01Hz)		50.00		7555.8	1 min
600		b) 50.45Hz (± 0.05Hz)		50.45		7401.9	1 min
600		c) 50.7Hz (± 0.1Hz)		50.70		6662.2	1 min
600		d) 51.15Hz (± 0.05Hz)		51.15		5321.5	1 min
600		e) 50.75Hz (± 0.10Hz)		50.70		6659.3	1 min
600		f) 50.45Hz (± 0.05Hz)		50.45		7397.4	1 min
600		g) 50Hz (± 0.01Hz)		50.00		15047.1	10 mins
600		h) 51.65Hz (± 0.05Hz)		51.65		-1.6	1 min
600		i) 50Hz (+0.06 ~ +0.1Hz)		50.10		-1.5	3 mins
600		j) 50Hz (± 0.01Hz)		50.00		15046.2	10 mins
Supplementary information: See test curve as following							


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

String	1	U_{DC} = Un	600Vdc	Uac = Un	230 Vac	P =P_n= (W)	15000 W
Udc (Vdc)		F (Hz)		F (Hz)		P (W)	time
600		a) 50Hz (± 0.01Hz)		50.00		15043.8	1 min
600		b) 50.65Hz (± 0.05Hz)		50.65		14724.7	1 min
600		c) 50.7Hz (± 0.1Hz)		50.70		14434.9	1 min
600		d) 51.15Hz (± 0.05Hz)		51.15		11756.9	1 min
600		e) 50.75Hz (± 0.10Hz)		50.70		14433.8	1 min
600		f) 50.65Hz (± 0.05Hz)		50.65		14732.1	1 min
600		g) 50Hz (± 0.01Hz)		50.00		15044.9	10 mins
600		h) 51.65Hz (± 0.05Hz)		51.65		-1.6	1 min
600		i) 50Hz (+0.06 ~ +0.1Hz)		50.10		-1.6	3 mins
600		j) 50Hz (± 0.01Hz)		50.00		14879.2	10 mins
Supplementary information: See test curve as following							

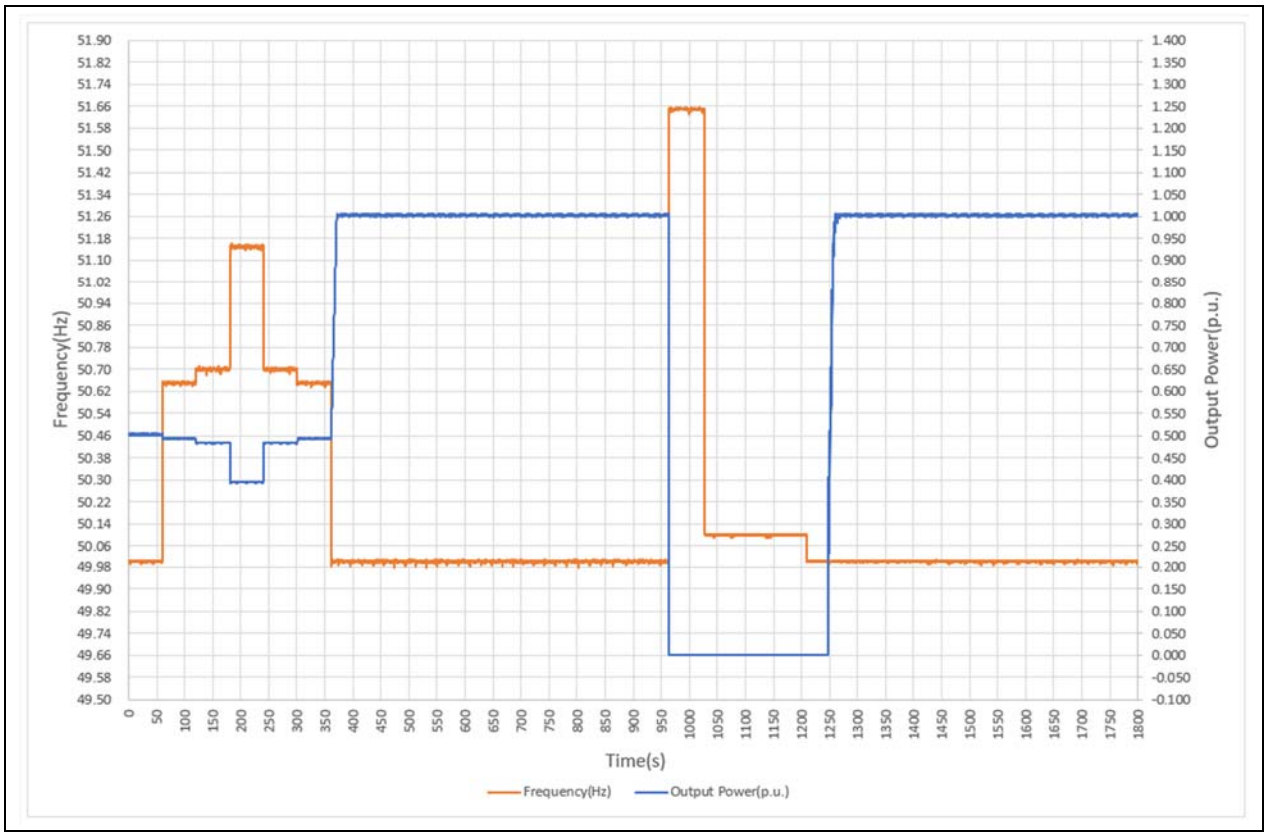


String	2	U_{DC} = Un	600Vdc	Uac = Un	230 Vac	P =0.5 P_n= (W)	7500 W

Udc (Vdc)	F (Hz)	F (Hz)	P (W)	time
600	a) 50Hz (± 0.01Hz)	50.00	7551.9	1 min
600	b) 50.65Hz (± 0.05Hz)	50.65	7415.1	1 min
600	c) 50.7Hz (± 0.1Hz)	50.70	7264.7	1 min
600	d) 51.15Hz (± 0.05Hz)	51.15	5927.5	1 min
600	e) 50.75Hz (± 0.10Hz)	50.70	7264.2	1 min
600	f) 50.65Hz (± 0.05Hz)	50.65	7413.2	1 min
600	g) 50Hz (± 0.01Hz)	50.00	15046.2	10 mins
600	h) 51.65Hz (± 0.05Hz)	51.65	-1.6	1 min
600	i) 50Hz (+0.06 ~ +0.1Hz)	50.10	-1.5	3 mins
600	j) 50Hz (± 0.01Hz)	50.00	15042.5	10 mins

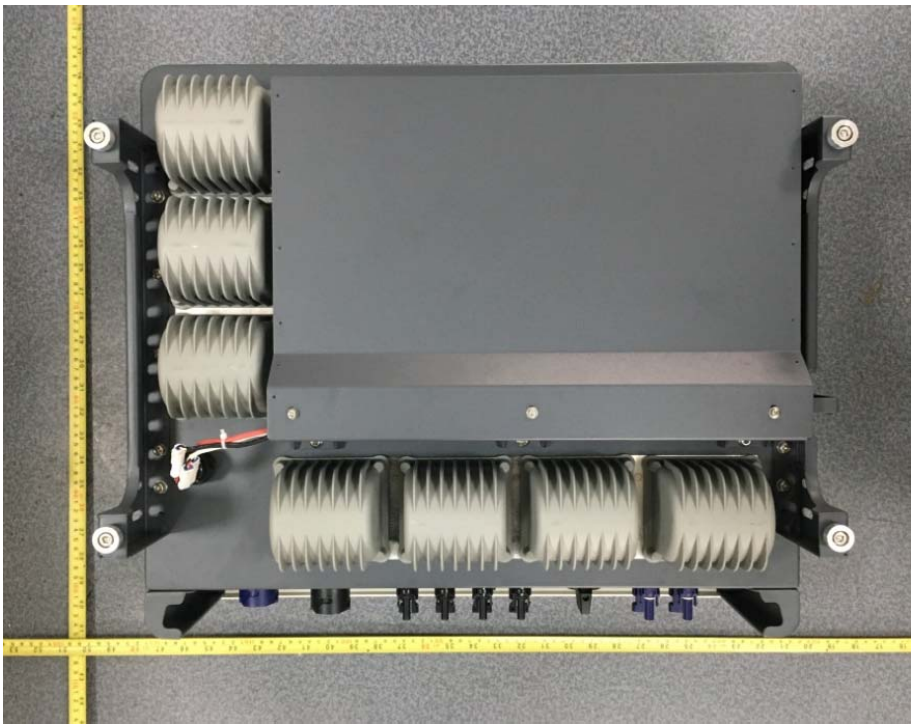
Supplementary information:

See test curve as following

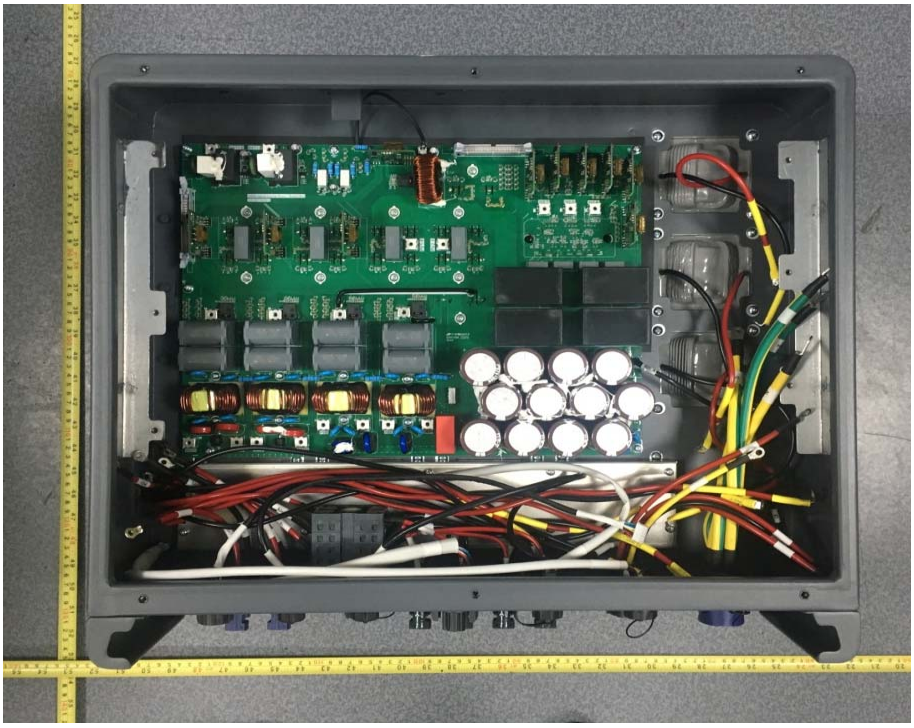


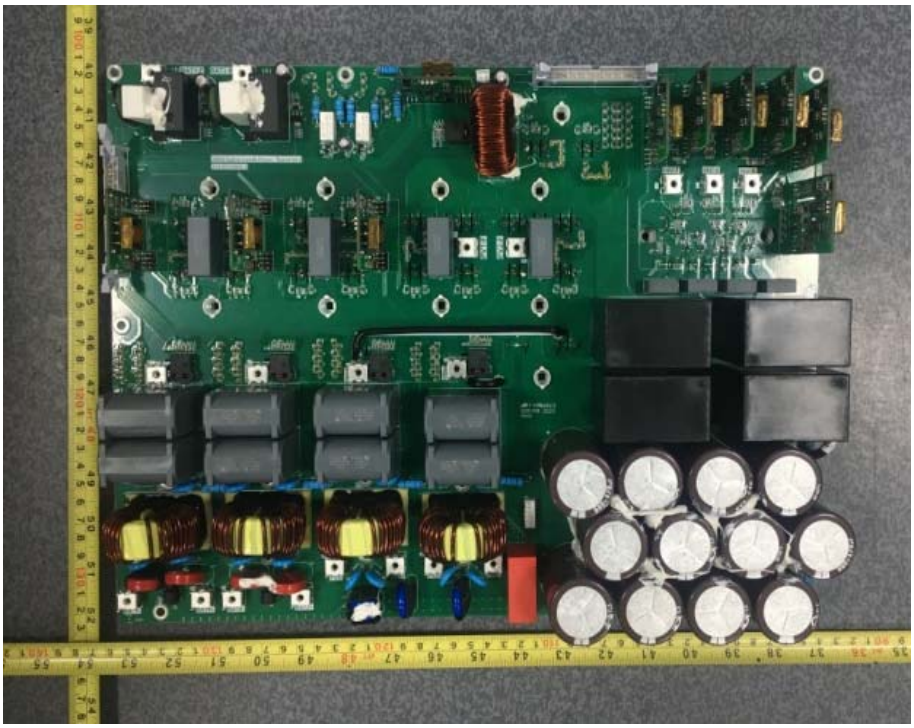
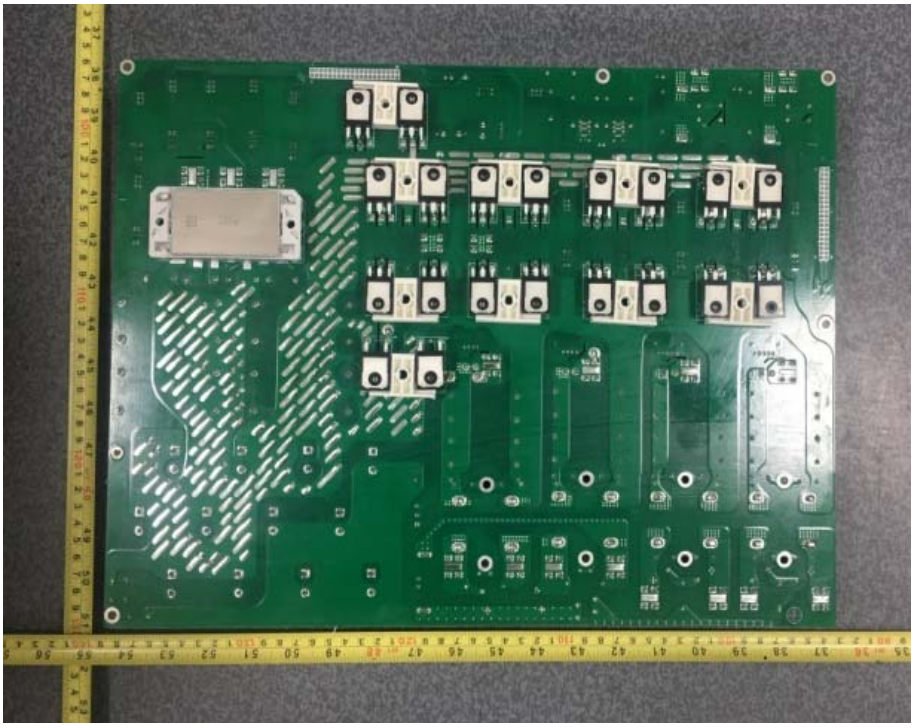
5 PICTURES

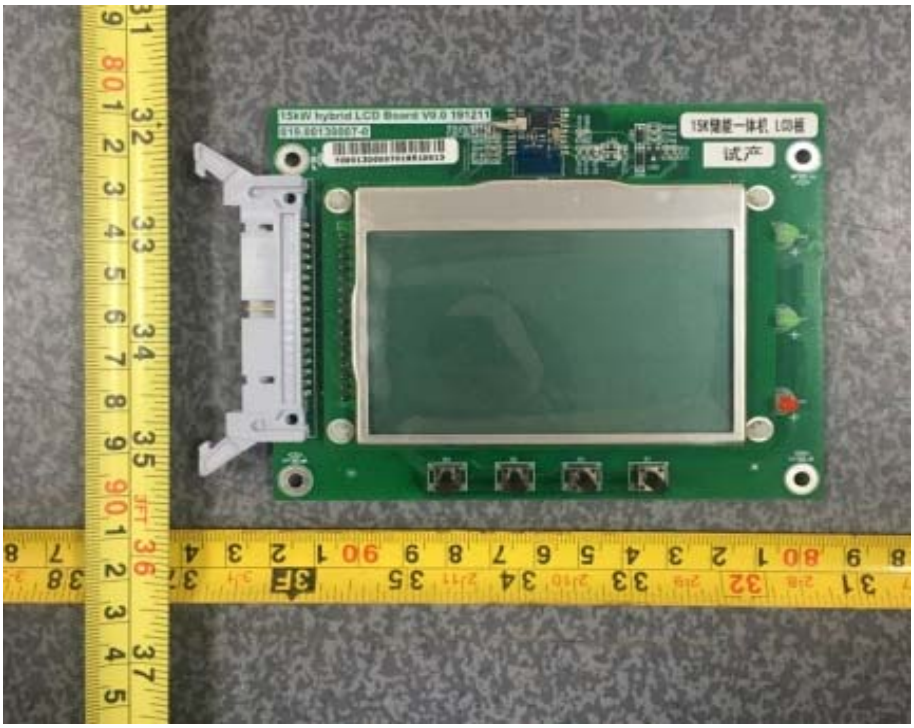
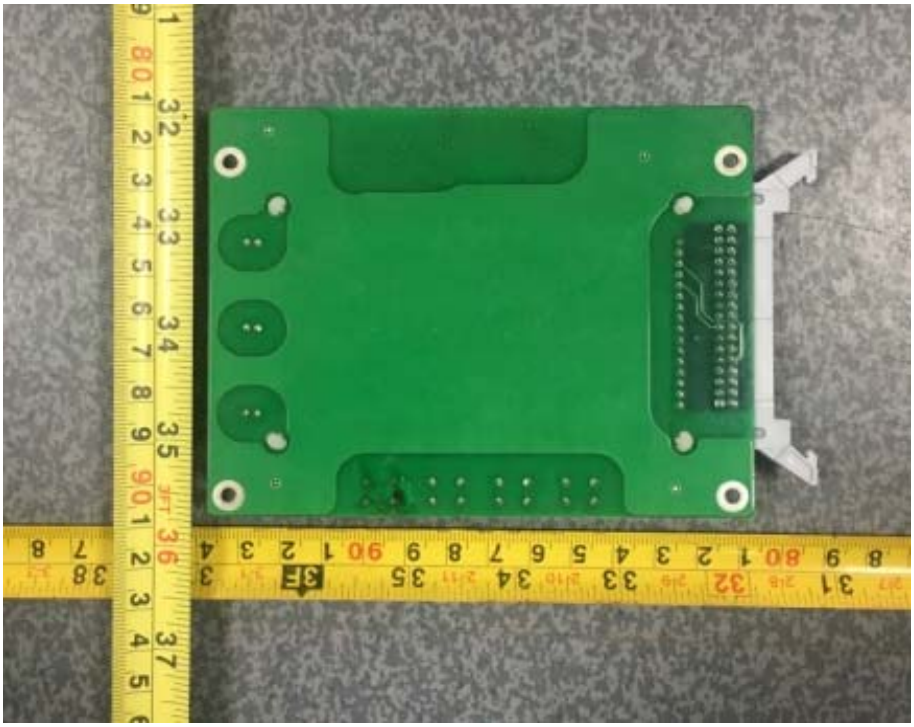
Front view

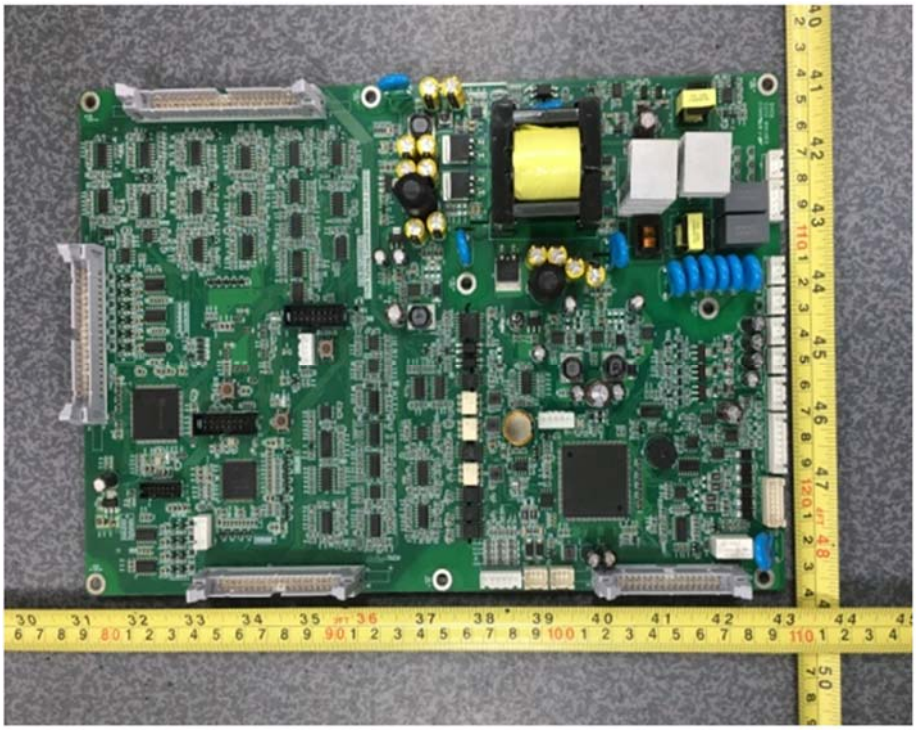
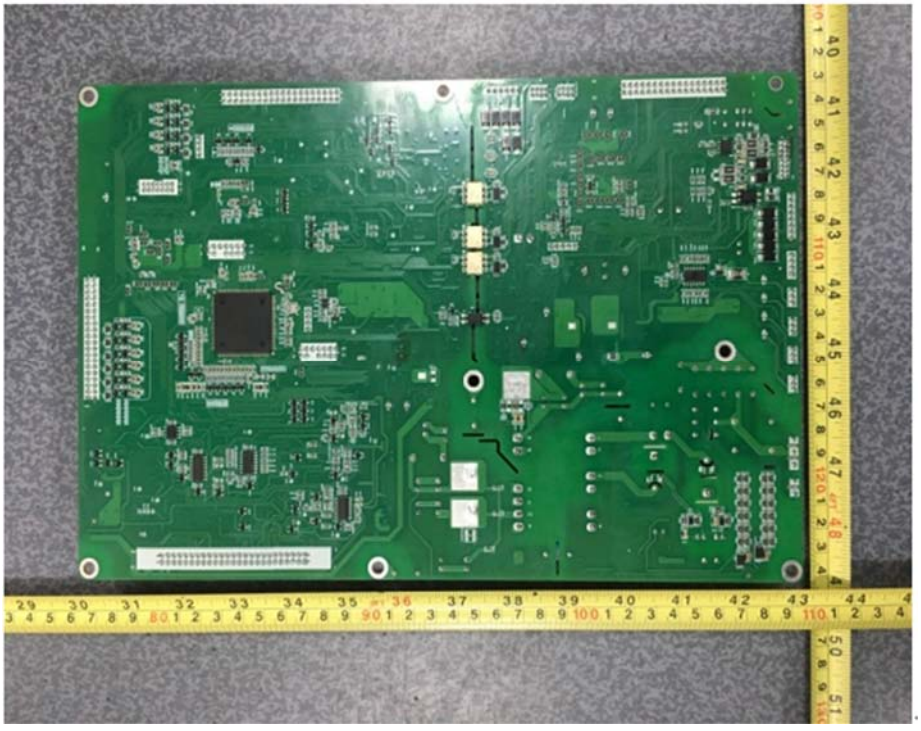
Back view


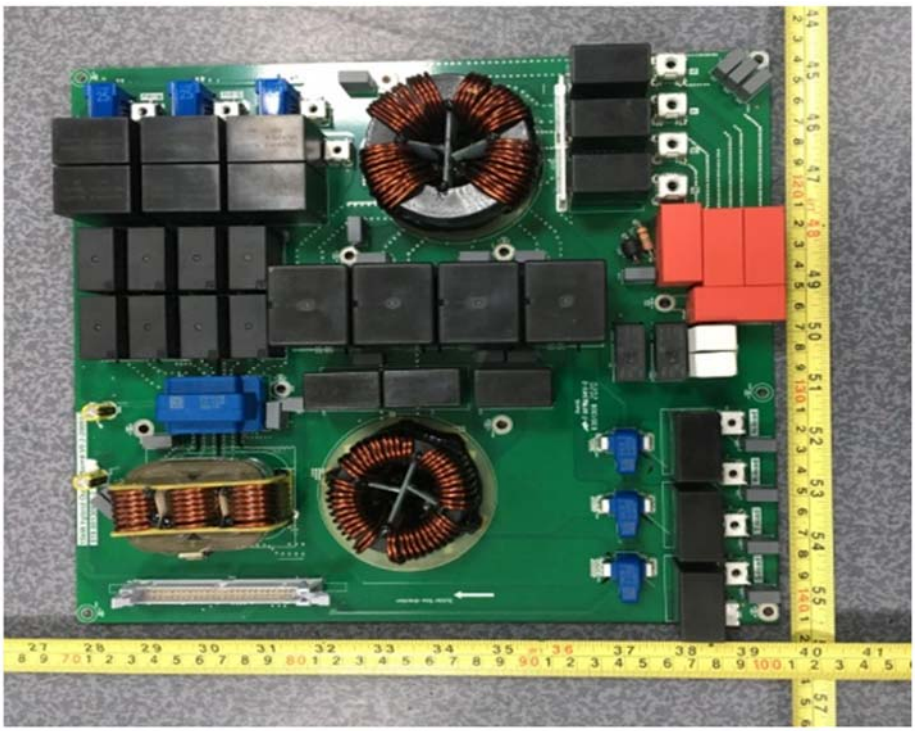
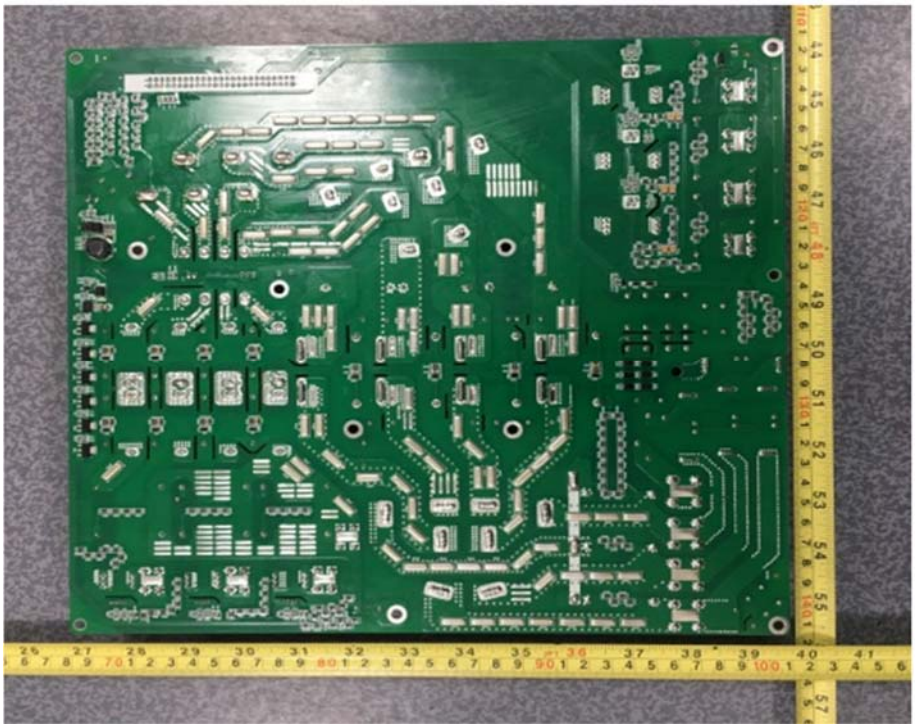
Internal View 1


Internal View 2


Front side of Power board

Back side of Power board


Front side of Display board

Back side of Display board


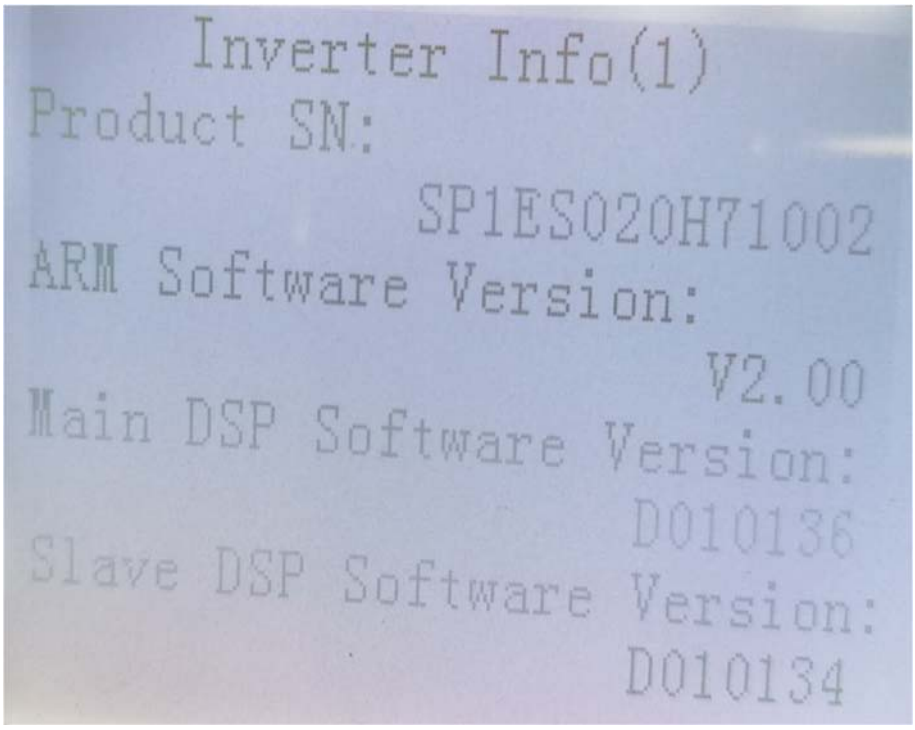
Front side of Control board

Back side of Control board


Front side of Output board front

Back side of Output board front


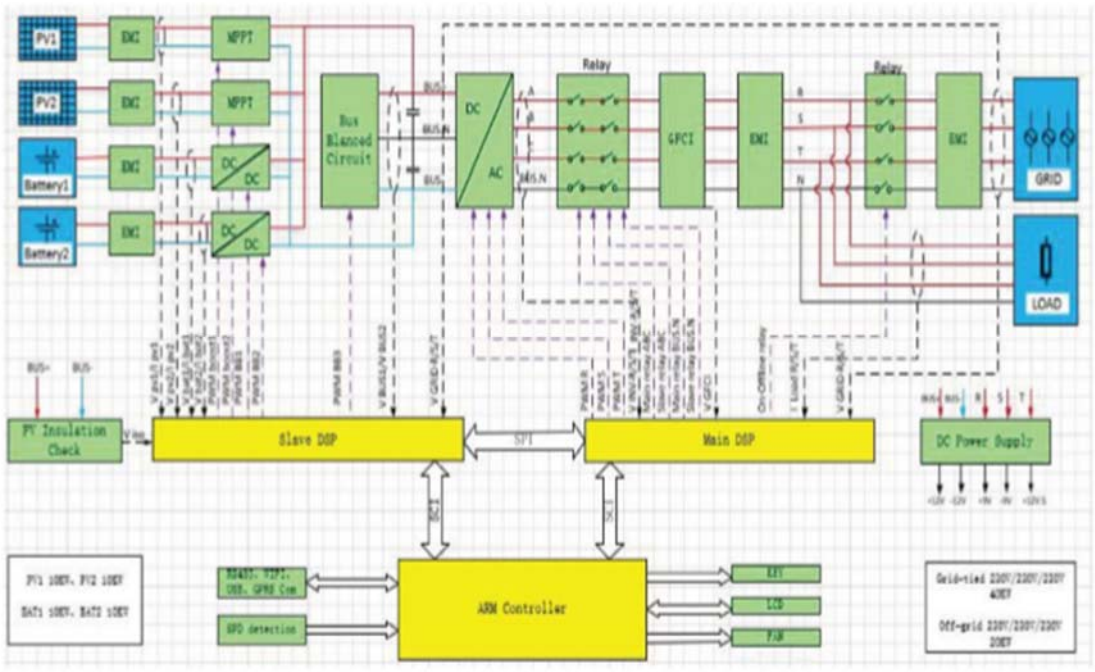
Grounding

Connection interface


Serial Number and Software Version



6 ELECTRICAL SCHEMES



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