TEST REPORT

IEC 61727

Photovoltaic (PV) systems
Characteristics of the utility interface

Report reference number ..... :	**PV200511N080-2-R1**
Date of issue ..... ::	2020-11-20
Total number of pages ..... ::	49
Testing laboratory name ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China
Accreditation ..... :	ilac-MRA ACCREDITED Certificate # 2951.01
Applicant's name..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Test specification	
Standard..... :	IEC 61727:2004-12
Test Report Form No. ..... :	IEC/EN 61727 VER.2
TRF Originator ..... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF ..... :	Dated 2020-03-20
Test item description ..... :	**Solar Grid-tied Inverter**
Trademark..... :	SOFAR SOLAR
Model / Type ..... :	SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3, SOFAR 22KTLX-G3, SOFAR 24KTLX-G3,

Ratings .....:	SOFAR 15KTLX-G3	SOFAR 17KTLX-G3	SOFAR 20KTLX-G3	SOFAR 22KTLX-G3	SOFAR 24KTLX-G3
Input DC voltage [V] .....:	Max. 1100Vd.c.				
MPP DC voltage range [V] .....:	140-1000Vd.c.				
Input DC current [A] .....:	26,0A / 26,0A				
Output AC voltage [V] .....:	380/400Va.c., 3W+N+PE; 50/60Hz				
Max. Output AC current [A] .....:	23,9	27,1	31,9	35,1	38,3
Nominal Output power [kW] .....:	15,0	17,0	20,0	22,0	24,0
Maximum Output power [kVA] .....:	16,5	18,7	22,0	24,2	26,4

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China
Tested by (name and signature) ..... :	Lukes Lin 
Approved by (name and signature) ..... :	James Huang 
Manufacturer's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Manufacturer address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Factory's 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

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2020-10-21	Lukes Lin	Initial report was written	0
2020-11-20	Lukes Lin	Updated the name of Applicant and Manufacturer.	R1
Supplementary information:			

Test items particulars

Equipment mobility ..... :	Permanent connection
Operating condition ..... :	Continuous
Class of equipment ..... :	Class I
Protection against ingress of water .. :	IP65 according to EN 60529
Mass of equipment [kg] ..... :	Approx. 20,0 kg for SOFAR 15KTLX-G3; Approx. 22,0 kg for SOFAR 17KTLX-G3, SOFAR 20KTLX-G3; Approx. 23,0 kg for SOFAR 22KTLX-G3, SOFAR 24KTLX-G3;

Test case verdicts

Test case does not apply to the test object ..... :	N/A
Test item does meet the requirement ..... :	P(ass)
Test item does not meet the requirement ..... :	F(ail)

Testing

Date of receipt of test item ..... :	2020-05-11
Date(s) of performance of test ..... :	2020-05-11 to 2020-10-18

General remarks:

The test result presented in this report relate only to the object(s) tested.
This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

”(see Annex #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

This report is to replace the earlier Test Report Ref. No. **PV200511N080-2** issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-10-21.

The IEC61727does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN 50438:

- Voltage: +/- 1% of the nominal voltage;
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

This Test Report consists of the following documents:

1. Test Results
2. Annex No. 1 – Pictures of the unit
3. Annex No. 2 – Test equipment list

Copy of marking plates:

SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 15KTLX-G3
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	140~1000V
Max. Input Current	26A/26A
Max. PV Isc	36A/36A
Nominal Grid Voltage	3/N/PE,380/400V
Max.Output Current	3x23.9A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	15000W
Max.Output Power	16500VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-30℃~+60℃
Protective Class	Class I

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
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727
IEC62116,UTE C15-712-1,AS4777

SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 17KTLX-G3
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	140~1000V
Max. Input Current	26A/26A
Max. PV Isc	36A/36A
Nominal Grid Voltage	3/N/PE,380/400V
Max.Output Current	3x27.1A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	17000W
Max.Output Power	18700VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-30℃~+60℃
Protective Class	Class I

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
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727
IEC62116,UTE C15-712-1,AS4777

SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 20KTLX-G3
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	140~1000V
Max. Input Current	26A/26A
Max. PV Isc	36A/36A
Nominal Grid Voltage	3/N/PE,380/400V
Max.Output Current	3x31.9A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	20000W
Max.Output Power	22000VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-30℃~+60℃
Protective Class	Class I

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
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727
IEC62116,UTE C15-712-1,AS4777

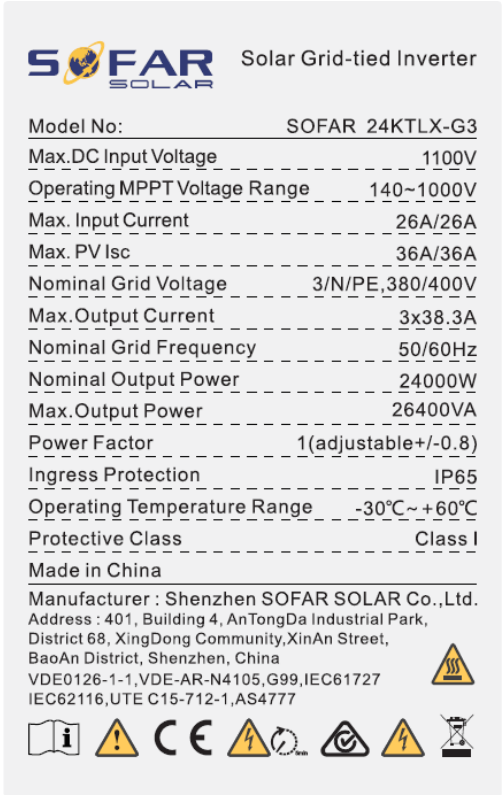
SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 22KTLX-G3
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	140~1000V
Max. Input Current	26A/26A
Max. PV Isc	36A/36A
Nominal Grid Voltage	3/N/PE,380/400V
Max.Output Current	3x35.1A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	22000W
Max.Output Power	24200VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-30℃~+60℃
Protective Class	Class I

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
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727
IEC62116,UTE C15-712-1,AS4777

Copy of marking plates:



General product information:

The Solar Grid-tied Inverter converts DC voltage into AC voltage.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.

Description of the electrical circuit:

The internal control is redundant built. It consists of Microcontroller A (U30) and Microcontroller B (U23).

The Microcontroller A (U30) control the relays by switching signals; measures the PV voltage, PV current, Bus voltage, grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Microcontroller B (U23) is measures the grid voltage, grid frequency, DCI and residual current, also can switch off the relays independently, and communicate with the Microcontroller A (U30) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Microcontroller A (U30). The Microcontroller A (U30) tests and calibrates before each start up all current sensors.

The unit provides two relays in series in all output conductors. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up.

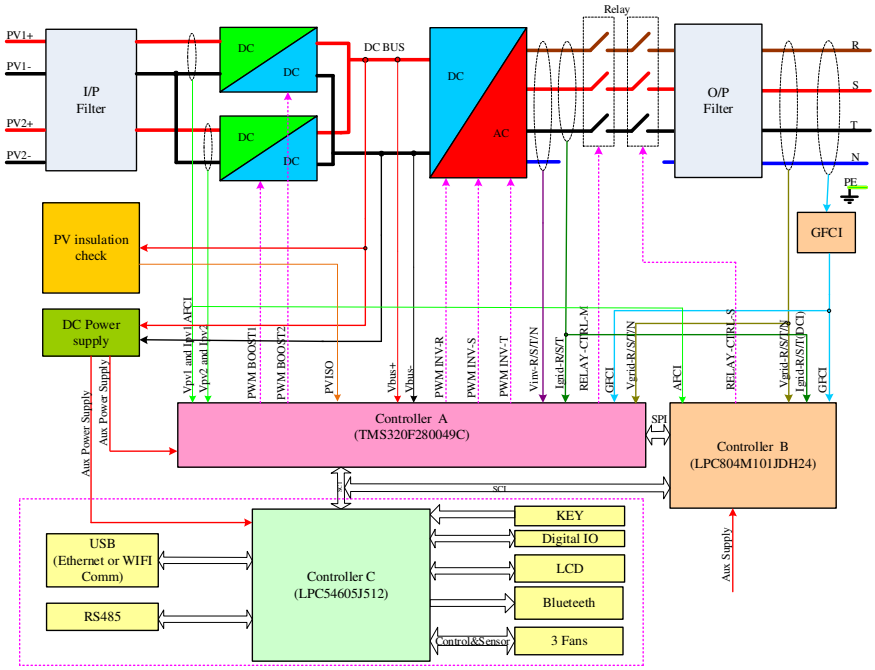


Figure 1- Block diagram

Model difference:

The models SOFAR 15KTL-G3, SOFAR 17KTL-G3, SOFAR 20KTL-G3, SOFAR 22KTL-G3 and SOFAR 24KTL-G3 are use the identical hardware platform, control unit, control system and software except the output power derated by software and in following table descripts for different.

	SOFAR 15KTLX-G3	SOFAR 17KTLX-G3	SOFAR 20KTLX-G3	SOFAR 22KTLX-G3	SOFAR 24KTLX-G3
Thin-film capacitor of BUS	4pcs (110uF, 550V)	6pcs (110uF, 550V)			
INV IGBT (Q60, Q67, Q71 Q72, Q75, Q76)	6pcs 40A, 1200V	6pcs 75A, 1200V			
External Fan	1	2			

The product was tested on:

Hardware Version: V101
Software Version: V010000

All tests were performed on SOFAR 15KTL-G3 and SOFAR 24KTL-G3 are valid for the SOFAR 17KTL-G3, SOFAR 20KTL-G3 and SOFAR 22KTL-G3 since it's use the identical hardware and software construction except output power derated by software.

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4	**General** The quality of power provided by the PV system for the on-site AC loads and for power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor. Deviation from these standards represents out-of-bounds conditions and may require the PV system to sense the deviation and properly disconnect from the utility system. All power quality parameters (voltage, flicker, frequency, harmonics, and power factor) must be measured at the utility interface/ point of common coupling unless otherwise specified.	Noticed	**P**
4.1	**Voltage, current and frequency** The PV system AC voltage, current and frequency shall be compatible with the utility system.	Derived from tests	**P**
4.2	**Normal voltage operating range** Utility-interconnected PV systems do not normally regulate voltage; they inject current into the utility. Therefore, the voltage operating range for PV inverters is selected as a protection function that responds to abnormal utility conditions, not as a voltage regulation function.	Derived from tests	**P**
4.3	**Flicker** The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with current of 16 A and above.	See table 4.3	**P**
4.4	**DC injection** The PV system shall not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	See table 4.4	**P**
4.5	**Normal frequency operating range** The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.	See table 4.5 and 5.2.2	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4.6	**Harmonics and waveform distortion** Low levels of current and voltage harmonics are desirable; the higher harmonic levels increase the potential for adverse effects on connected equipment. Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads/apparatus, and established utility practice. The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in Table 1. Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed. (see Clause 4.6 Table 1 – Current distortion limits)	See tables 4.6	**P**
4.7	**Power factor** The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.	See table 4.7	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5	**General** This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.	Noticed	**P**
5.1	**Loss of utility voltage** To prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits. A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to fault conditions or the distribution line switched out during maintenance. If inverters (single or multiple) have DC SELV input and have accumulated power below 1 kW then no mechanical disconnect (relay) is required.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project No. PV200511N080-1	**P**
5.2	**Over/under voltage and frequency** Abnormal conditions can arise on the utility system that requires a response from the connected photovoltaic system. This response is to ensure the safety of utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system. The abnormal utility conditions of concern are voltage and frequency excursions above or below the values stated in this Clause, and the complete disconnection of the utility, presenting the potential for a distributed resource island.	See table 5.2.1 and 5.2.2	**P**
5.2.1	**Over/under voltage** When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system shall cease to energize the utility distribution system. This applies to any phase of a multiphase system. All discussions regarding system voltage refer to the local nominal voltage. The system shall sense abnormal voltage and respond. The following conditions should be met, with voltages in RMS and measured at the point of utility connection. (see clause 5.2.1 Table 2 – Response to abnormal voltages) The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping. The unit does not have to cease to energize if the voltage returns to the normal utility continuous operation condition within the specified trip time.	See table 5.2.1	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5.2.2	**Over/under frequency** When the utility frequency deviates outside the specified conditions the photovoltaic system shall cease to energize the utility line. The unit does not have to cease to energize if the frequency returns to the normal utility continuous operation condition within the specified trip time. When the utility frequency is outside the range of ±1 Hz, the system shall cease to energize the utility line within 0,2 s. The purpose of the allowed range and time delay is to allow continued operation for short-term disturbances and to avoid excessive nuisance tripping in weak-utility system conditions.	See table 5.2.2	**P**
5.3	**Islanding protection** The PV system must cease to energize the utility line within 2 s of loss of utility.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project No. PV200511N080-1	**P**
5.4	**Response to utility recovery** Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system shall not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges**.**	See table 5.2.1 and 5.2.2	**P**
5.5	**Earthing** The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.6	**Short circuit protection** The photovoltaic system shall have short-circuit protection in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.7	**Isolation and switching** A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.	Stated in the manual.	**P**

Test overview:

IEC 61727:2004-12		
Clause	**Test**	**Result**
4	Type test:	
4.3	Voltage Fluctuations and Flicker	**P**
4.4	Monitoring of DC-Injection	**P**
4.5	Normal frequency operating range (see 5.2.2 below)	**P**
4.6	Harmonics and waveform distortion	**P**
4.7	Power factor	**P**
5.2.1	Voltage monitoring	**P**
5.2.2	Frequency monitoring	**P**

Test Results

4.3 Voltage fluctuation and flicker			P
inverter >16A			
Limit	dc% = 3.3	P_{st}=1.0	P_{lt}=0.65
Test value	See below		

SOFAR 15KTLX-G3

L1 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.087	Pass	0.188	Pass	0.0	Pass	0.041	Pass		
2	0.085	Pass	0.159	Pass	0.0	Pass	0.039	Pass		
3	0.110	Pass	0.159	Pass	0.0	Pass	0.048	Pass		
4	0.113	Pass	0.161	Pass	0.0	Pass	0.054	Pass		
5	0.113	Pass	0.153	Pass	0.0	Pass	0.053	Pass		
6	0.115	Pass	0.136	Pass	0.0	Pass	0.058	Pass		
7	0.106	Pass	0.162	Pass	0.0	Pass	0.061	Pass		
8	0.103	Pass	0.137	Pass	0.0	Pass	0.057	Pass		
9	0.104	Pass	0.156	Pass	0.0	Pass	0.056	Pass		
10	0.097	Pass	0.134	Pass	0.0	Pass	0.054	Pass		
11	0.103	Pass	0.162	Pass	0.0	Pass	0.054	Pass		
12	0.099	Pass	0.154	Pass	0.0	Pass	0.057	Pass		
Result		Pass		Pass		Pass		Pass	0.053	Pass

L2 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.004	Pass	0.111	Pass	0.0	Pass	0.142	Pass		
2	0.003	Pass	0.119	Pass	0.0	Pass	0.141	Pass		
3	0.011	Pass	0.101	Pass	0.0	Pass	0.140	Pass		
4	0.012	Pass	0.111	Pass	0.0	Pass	0.140	Pass		
5	0.000	Pass	0.000	Pass	0.0	Pass	0.140	Pass		
6	0.000	Pass	0.000	Pass	0.0	Pass	0.140	Pass		
7	0.000	Pass	0.000	Pass	0.0	Pass	0.139	Pass		
8	0.018	Pass	0.158	Pass	0.0	Pass	0.140	Pass		
9	0.014	Pass	0.123	Pass	0.0	Pass	0.139	Pass		
10	0.009	Pass	0.107	Pass	0.0	Pass	0.140	Pass		
11	0.006	Pass	0.102	Pass	0.0	Pass	0.139	Pass		
12	0.009	Pass	0.117	Pass	0.0	Pass	0.140	Pass		
Result		Pass		Pass		Pass		Pass	0.140	Pass

L3 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.000	Pass	0.000	Pass	0.0	Pass	0.053	Pass		
2	0.000	Pass	0.000	Pass	0.0	Pass	0.051	Pass		
3	0.000	Pass	0.000	Pass	0.0	Pass	0.049	Pass		
4	0.000	Pass	0.000	Pass	0.0	Pass	0.050	Pass		
5	0.017	Pass	0.108	Pass	0.0	Pass	0.050	Pass		
6	0.020	Pass	0.106	Pass	0.0	Pass	0.049	Pass		
7	0.014	Pass	0.104	Pass	0.0	Pass	0.050	Pass		
8	0.057	Pass	0.109	Pass	0.0	Pass	0.050	Pass		
9	0.049	Pass	0.108	Pass	0.0	Pass	0.049	Pass		
10	0.002	Pass	0.106	Pass	0.0	Pass	0.048	Pass		
11	0.000	Pass	0.000	Pass	0.0	Pass	0.049	Pass		
12	0.000	Pass	0.000	Pass	0.0	Pass	0.049	Pass		
Result		Pass		Pass		Pass		Pass	0.050	Pass

SOFAR 24KTLX-G3

L1 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.114	Pass	0.159	Pass	0.0	Pass	0.044	Pass		
2	0.068	Pass	0.109	Pass	0.0	Pass	0.037	Pass		
3	0.092	Pass	0.132	Pass	0.0	Pass	0.027	Pass		
4	0.017	Pass	0.165	Pass	0.0	Pass	0.033	Pass		
5	0.098	Pass	0.213	Pass	0.0	Pass	0.025	Pass		
6	0.071	Pass	0.133	Pass	0.0	Pass	0.025	Pass		
7	0.078	Pass	0.171	Pass	0.0	Pass	0.026	Pass		
8	0.104	Pass	0.199	Pass	0.0	Pass	0.032	Pass		
9	0.036	Pass	0.151	Pass	0.0	Pass	0.027	Pass		
10	0.095	Pass	0.152	Pass	0.0	Pass	0.028	Pass		
11	0.081	Pass	0.146	Pass	0.0	Pass	0.030	Pass		
12	0.090	Pass	0.144	Pass	0.0	Pass	0.033	Pass		
Result		Pass		Pass		Pass		Pass	0.032	Pass

L2 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.010	Pass	0.119	Pass	0.0	Pass	0.139	Pass		
2	0.007	Pass	0.111	Pass	0.0	Pass	0.138	Pass		
3	0.006	Pass	0.114	Pass	0.0	Pass	0.137	Pass		
4	0.000	Pass	0.000	Pass	0.0	Pass	0.136	Pass		
5	0.007	Pass	0.104	Pass	0.0	Pass	0.136	Pass		
6	0.009	Pass	0.103	Pass	0.0	Pass	0.137	Pass		
7	0.000	Pass	0.000	Pass	0.0	Pass	0.136	Pass		
8	0.006	Pass	0.105	Pass	0.0	Pass	0.137	Pass		
9	0.000	Pass	0.000	Pass	0.0	Pass	0.137	Pass		
10	0.011	Pass	0.104	Pass	0.0	Pass	0.136	Pass		
11	0.010	Pass	0.119	Pass	0.0	Pass	0.137	Pass		
12	0.000	Pass	0.000	Pass	0.0	Pass	0.137	Pass		
Result		Pass		Pass		Pass		Pass	0.137	Pass

L3 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.000	Pass	0.000	Pass	0.0	Pass	0.048	Pass		
2	0.000	Pass	0.000	Pass	0.0	Pass	0.047	Pass		
3	0.013	Pass	0.101	Pass	0.0	Pass	0.046	Pass		
4	0.009	Pass	0.101	Pass	0.0	Pass	0.045	Pass		
5	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
6	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
7	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
8	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
9	0.000	Pass	0.000	Pass	0.0	Pass	0.046	Pass		
10	0.020	Pass	0.108	Pass	0.0	Pass	0.046	Pass		
11	0.000	Pass	0.000	Pass	0.0	Pass	0.047	Pass		
12	0.000	Pass	0.000	Pass	0.0	Pass	0.047	Pass		
Result		Pass		Pass		Pass		Pass	0.046	Pass

Note:

*The stationary deviance of dc% is more relevant than the dynamic deviance of d_{max} at starting and stopping.

Mains Impedance according EN61000-3-11: **R_{max} = 0.24Ω; jX_{max}= 0.15Ω @50Hz (|Z_{max}| = 0.283/0.4717Ω)**

for single phase inverter use also **R_n = 0.16Ω; jX_n= 0.1Ω**

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$

The tests should be based on the limits of the EN 61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.

The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 is valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

4.4 Monitoring of DC-Injection				P
SOFAR 15KTLX-G3				
Test conditions:	U_N = 230Va.c. Uinput = 640Vd.c. Rated Power:15,0kW			
DC Injection [A]	**Limits**	**Trip Time [ms]**	**Trip Time [ms]**	**Trip Time [ms]**
L1 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	154,5	155,0	155,5
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	156,0	155,5	155,0
L2 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	134,5	135,5	135,0
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	135,5	135,0	134,55
L3 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	154,5	155,0	154,5
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	156,0	155,0	154,5

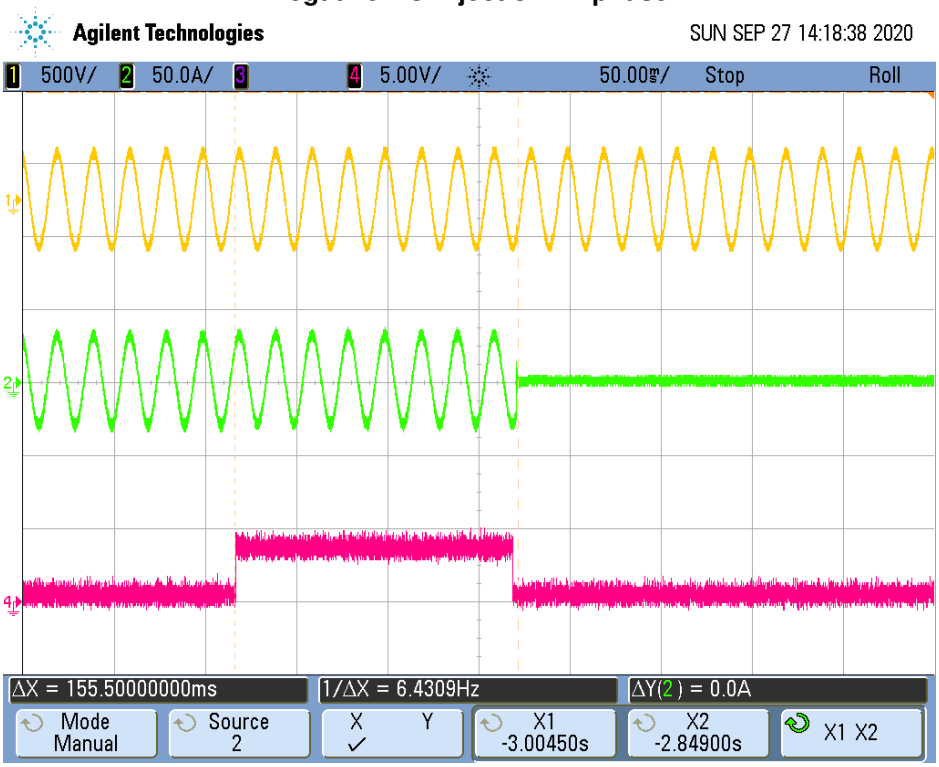
SOFAR 24KTLX-G3				
Test conditions:	U_N = 230Va.c. Uinput = 640Vd.c. Rated Power:24,0kW			
DC Injection [A]	**Limits**	**Trip Time [ms]**	**Trip Time [ms]**	**Trip Time [ms]**
L1 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	155,5	156,0	155,5
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	156,0	156,5	156,5
L2 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	154,0	153,5	154,0
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	153,5	154,5	154,0
L3 phase				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	156,0	155,5	155,0
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	155,0	156,0	155,5

Note:
A dc-current of 1A is injected, disconnection time of max. 0,2s

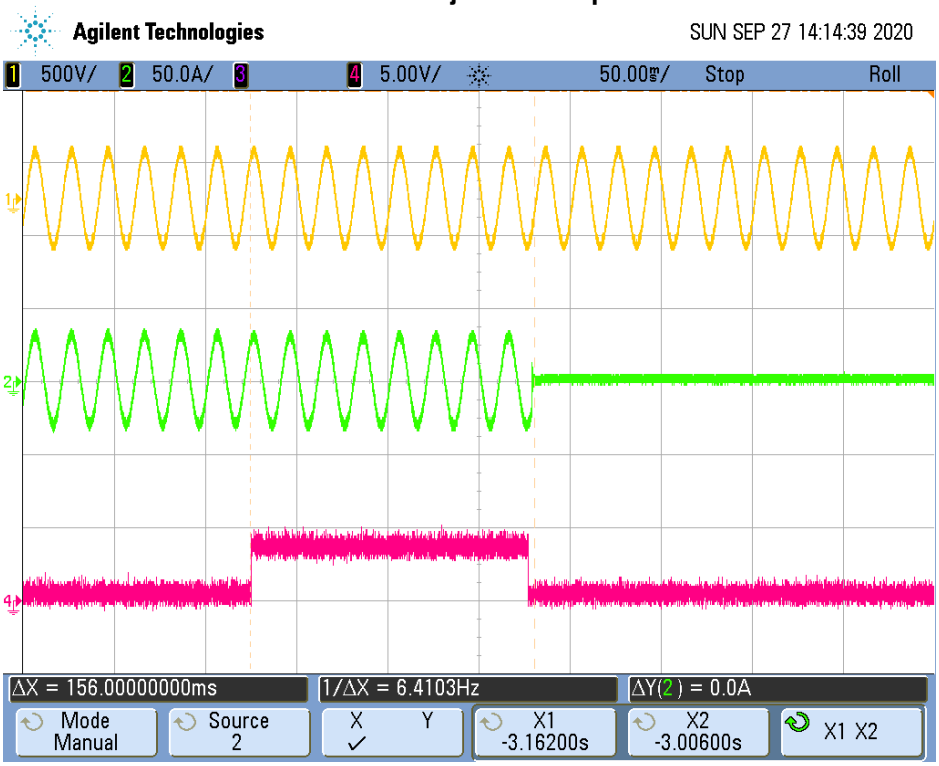
The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 is valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

SOFAR 15KTLX-G3

Negative DC-Injection:L1 phase

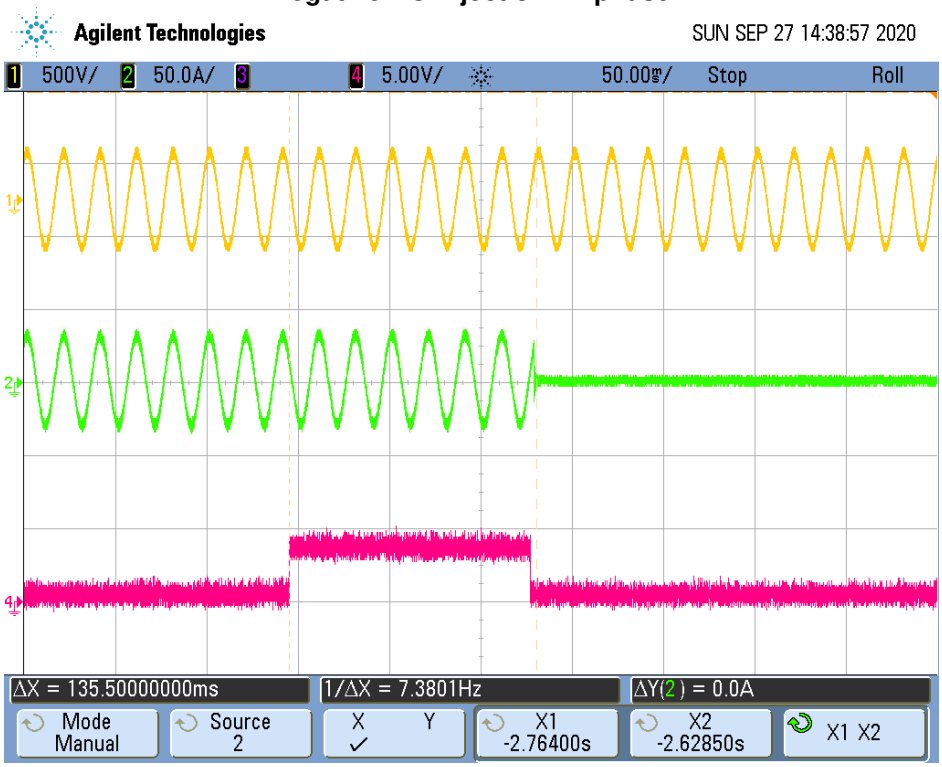


Positive DC-Injection: L1 phase



SOFAR 15KTLX-G3

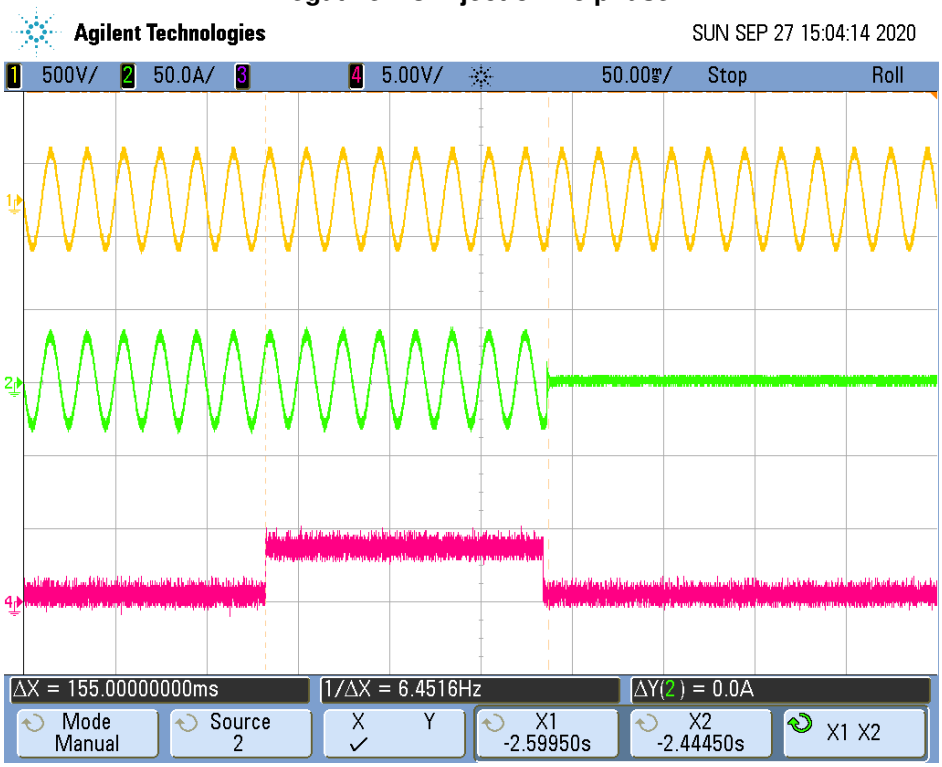
Negative DC-Injection:L2 phase



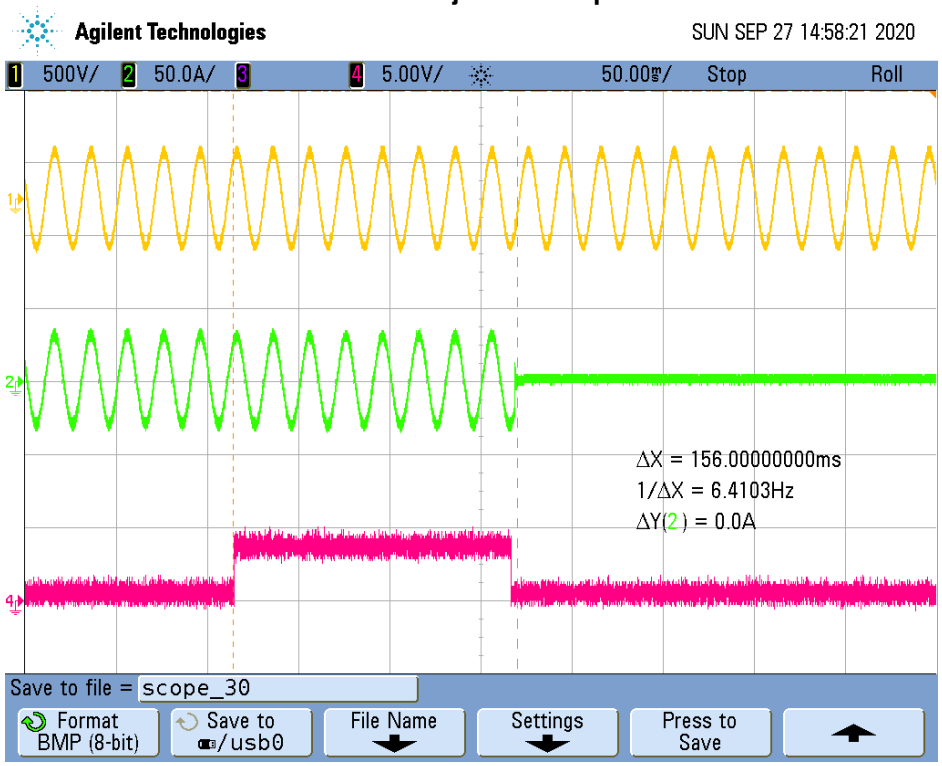
Positive DC-Injection: L2 phase

SOFAR 15KTLX-G3

Negative DC-Injection:L3 phase

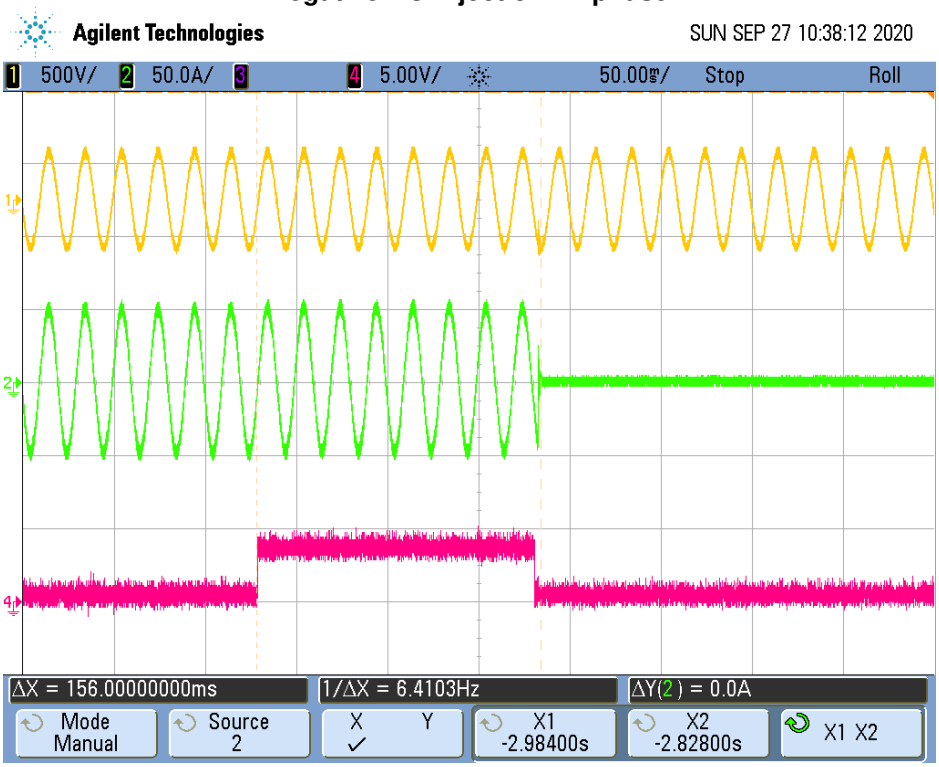


Positive DC-Injection: L3 phase

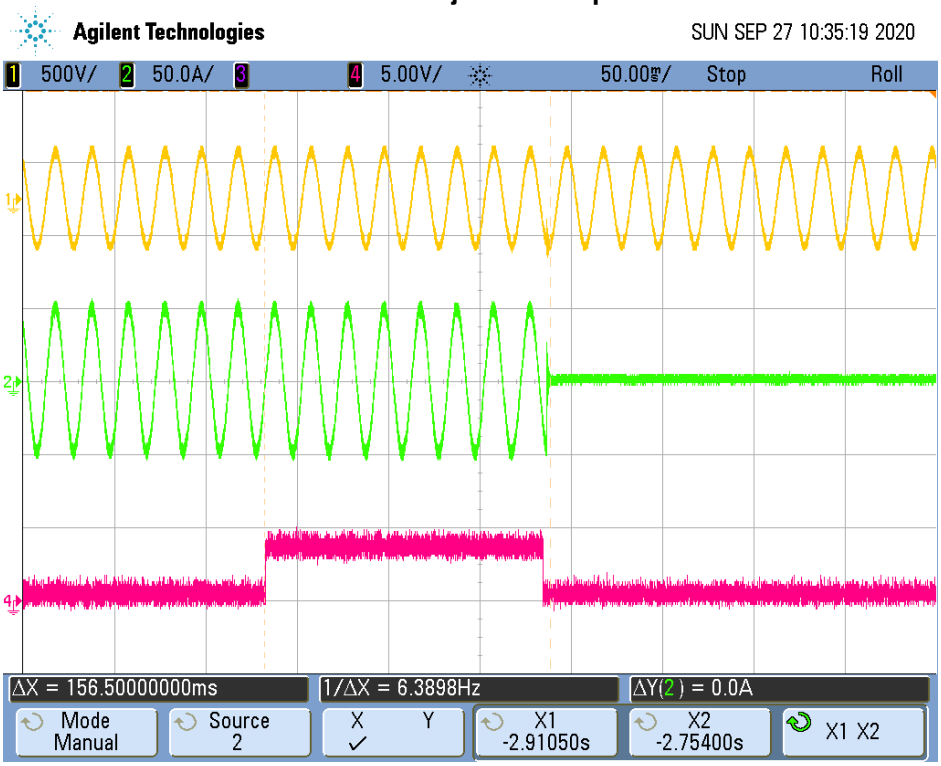


SOFAR 24KTLX-G3

Negative DC-Injection:L1 phase

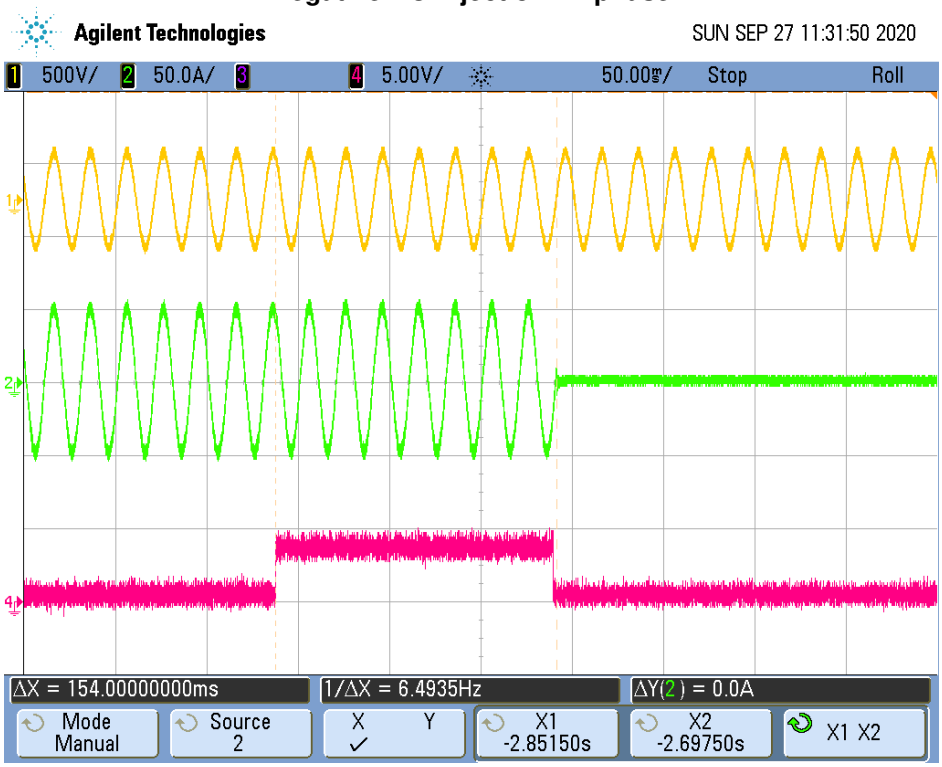


Positive DC-Injection: L1 phase

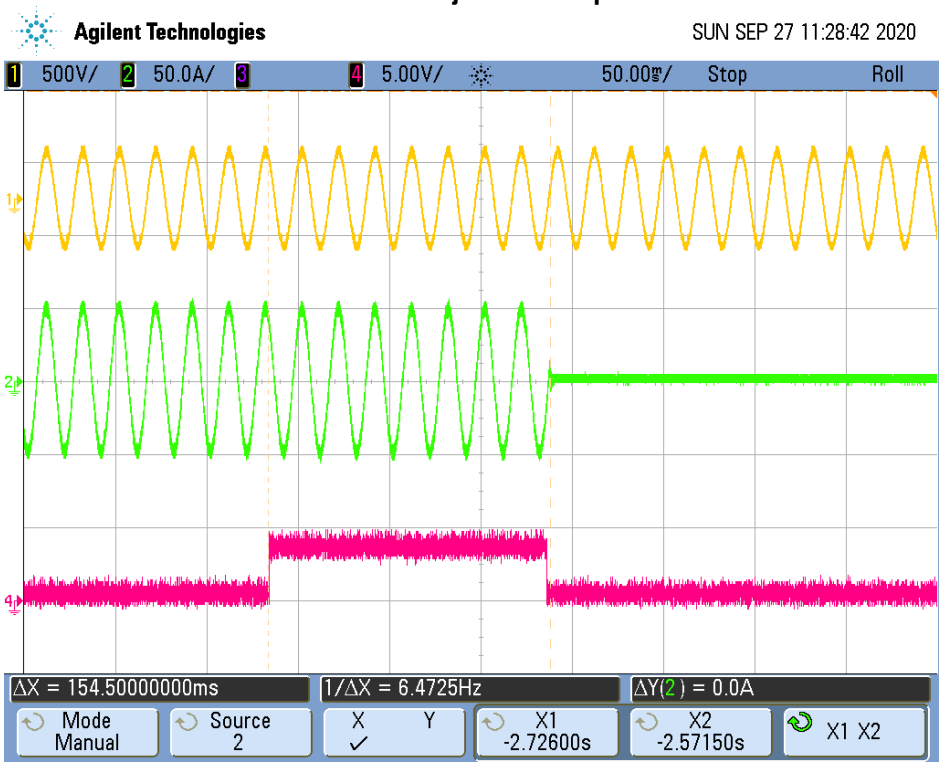


SOFAR 24KTLX-G3

Negative DC-Injection:L2 phase

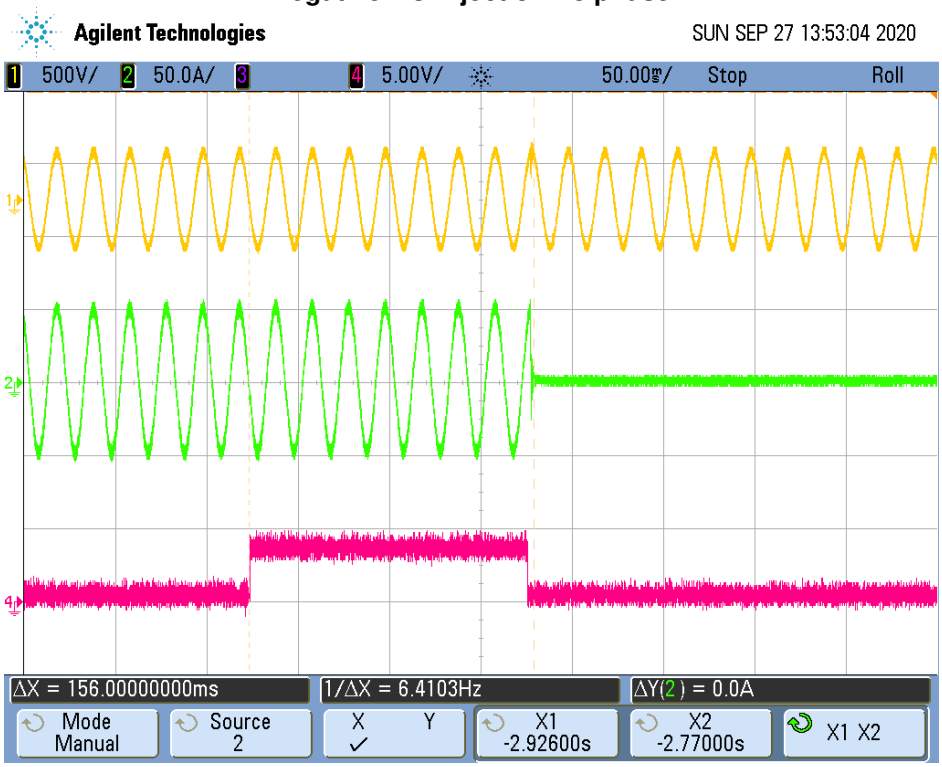


Positive DC-Injection: L2 phase

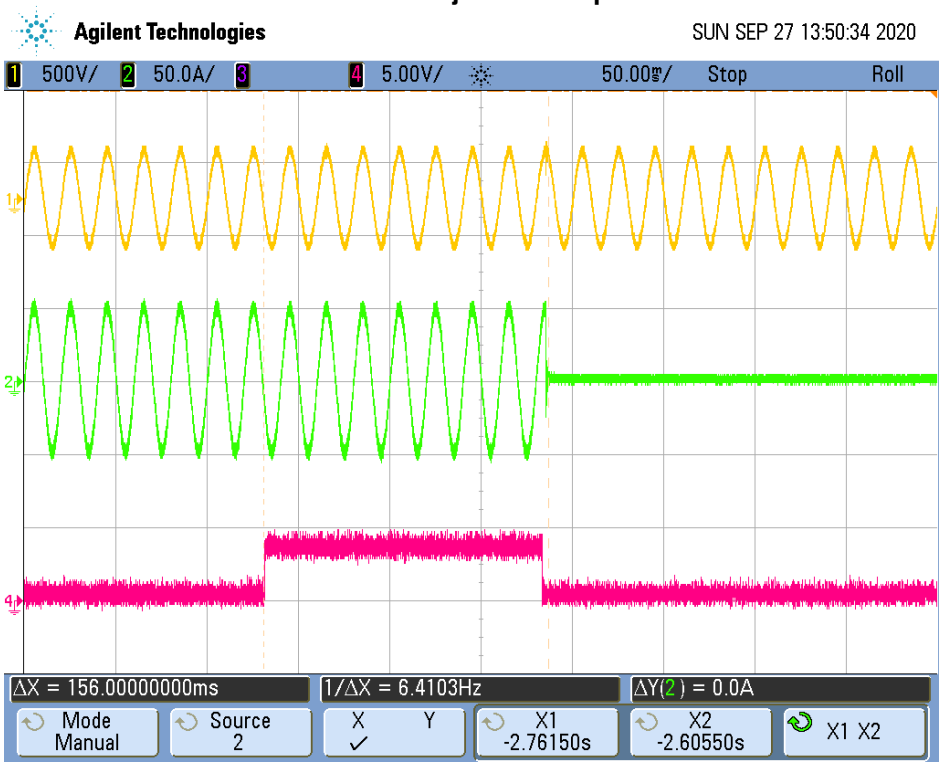


SOFAR 24KTLX-G3

Negative DC-Injection:L3 phase

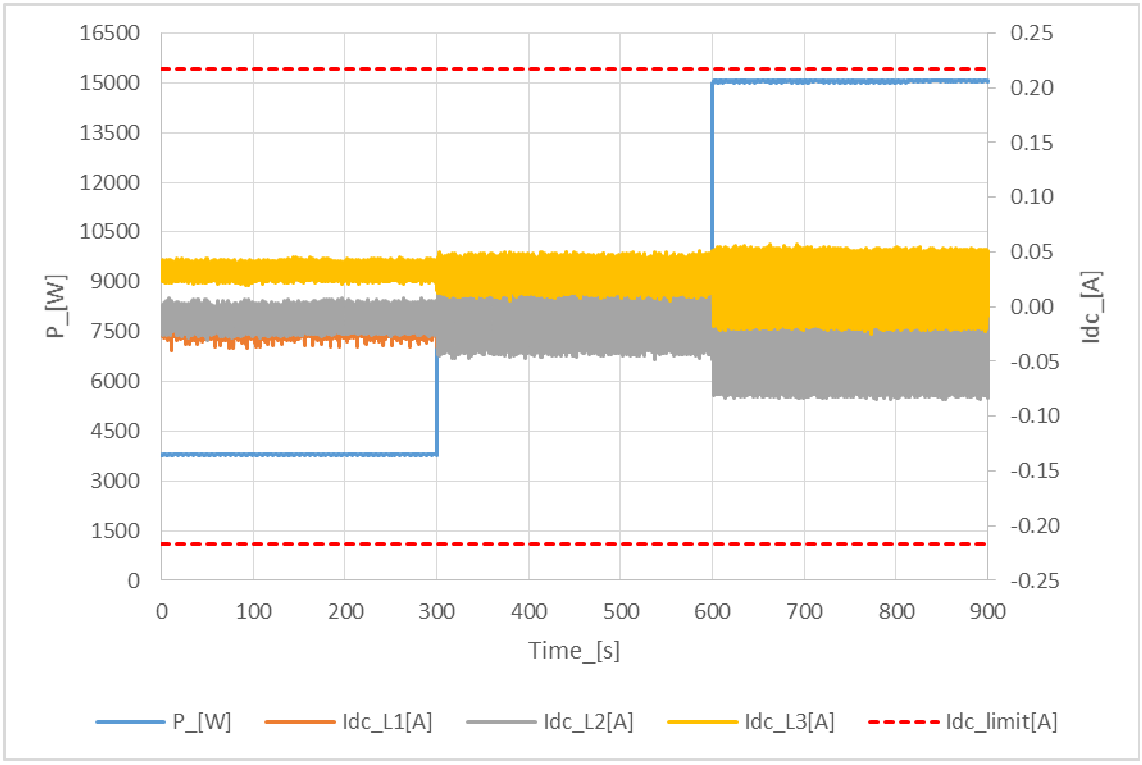


Positive DC-Injection: L3 phase

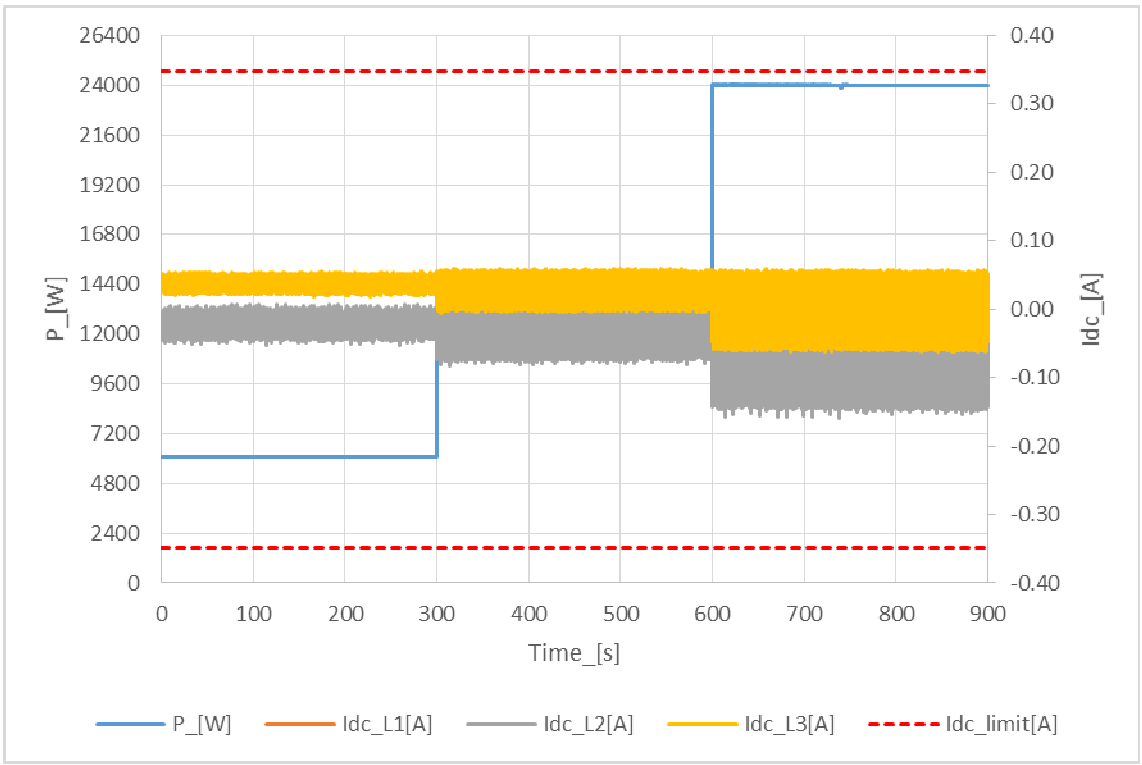


4.4 Monitoring of Permanent DC-Injection			P
SOFAR 15KTLX-G3			
IEC61727 Limit:	**1% of Inom (0,217 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value:L1	0,040	0,038	0,056
Abs. Ave. Test Value:L1	0,023	0,024	0,032
Abs. Max. Test Value:L2	0,031	0,048	0,084
Abs. Ave. Test Value:L2	0,012	0,019	0,037
Abs. Max. Test Value:L3	0,046	0,051	0,057
Abs. Ave. Test Value:L3	0,033	0,029	0,026
SOFAR 24KTLX-G3			
IEC61727 Limit:	**1% of Inom (0,348 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value:L1	0,040	0,054	0,096
Abs. Ave. Test Value:L1	0,024	0,031	0,050
Abs. Max. Test Value:L2	0,053	0,082	0,159
Abs. Ave. Test Value:L2	0,022	0,034	0,066
Abs. Max. Test Value:L3	0,056	0,060	0,063
Abs. Ave. Test Value:L3	0,037	0,028	0,038
Note: The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 is valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.			

SOFAR 15KTLX-G3



SOFAR 24KTLX-G3



4.6 Harmonic Current Limit Test — P

SOFAR 15KTLX-G3

Watts_[kW]	**5,011**	**5,020**	**5,024**
VA_[kVA]	**0,050**	**0,050**	**0,050**
Vrms_[Vac]	**230,9**	**230,9**	**231,0**
Arms_[A]	**21,727**	**21,764**	**21,768**
PF	**0,9989**	**0,9988**	**0,9989**
Frequency_[Hz]		**50,00**	
THD50_[%]	**1,640**	**1,496**	**1,553**

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	21,713	21,749	21,753	--	--	--	Three Phase	--
2nd	0,026	0,016	0,017	0,118	0,073	0,076	Three Phase	1
3rd	0,105	0,032	0,085	0,482	0,148	0,392	Three Phase	4
4th	0,013	0,009	0,006	0,062	0,040	0,029	Three Phase	1
5th	0,232	0,215	0,225	1,066	0,989	1,032	Three Phase	4
6th	0,008	0,006	0,005	0,036	0,026	0,023	Three Phase	1
7th	0,184	0,167	0,171	0,849	0,769	0,787	Three Phase	4
8th	0,006	0,004	0,004	0,027	0,018	0,019	Three Phase	1
9th	0,016	0,011	0,023	0,073	0,048	0,106	Three Phase	4
10th	0,005	0,004	0,004	0,021	0,017	0,017	Three Phase	0,5
11th	0,089	0,080	0,049	0,411	0,368	0,225	Three Phase	2
12th	0,004	0,003	0,003	0,017	0,016	0,016	Three Phase	0,5
13th	0,019	0,026	0,031	0,087	0,120	0,141	Three Phase	2
14th	0,004	0,004	0,004	0,020	0,018	0,017	Three Phase	0,5
15th	0,024	0,015	0,010	0,112	0,070	0,045	Three Phase	2
16th	0,003	0,003	0,003	0,014	0,014	0,015	Three Phase	0,5
17th	0,047	0,060	0,068	0,217	0,274	0,311	Three Phase	1,5
18th	0,004	0,003	0,003	0,016	0,014	0,016	Three Phase	0,5
19th	0,065	0,072	0,079	0,298	0,332	0,361	Three Phase	1,5
20th	0,004	0,003	0,003	0,017	0,016	0,015	Three Phase	0,5
21th	0,009	0,011	0,006	0,041	0,050	0,027	Three Phase	1,5
22th	0,004	0,003	0,003	0,017	0,013	0,016	Three Phase	0,5
23th	0,019	0,024	0,021	0,086	0,109	0,095	Three Phase	0,6
24th	0,005	0,004	0,004	0,022	0,019	0,020	Three Phase	0,5
25th	0,041	0,051	0,048	0,188	0,233	0,221	Three Phase	0,6
26th	0,004	0,004	0,005	0,020	0,020	0,022	Three Phase	0,5
27th	0,009	0,011	0,006	0,042	0,052	0,026	Three Phase	0,6
28th	0,004	0,003	0,003	0,017	0,014	0,016	Three Phase	0,5
29th	0,036	0,038	0,031	0,165	0,177	0,144	Three Phase	0,6
30th	0,004	0,004	0,004	0,019	0,016	0,017	Three Phase	0,5
31th	0,046	0,059	0,054	0,213	0,271	0,247	Three Phase	0,6
32th	0,004	0,003	0,003	0,017	0,013	0,015	Three Phase	0,5
33th	0,007	0,005	0,005	0,031	0,023	0,024	Three Phase	0,6
34th	0,003	0,003	0,003	0,015	0,013	0,014	Three Phase	--
35th	0,043	0,039	0,038	0,199	0,181	0,174	Three Phase	--
36th	0,004	0,003	0,003	0,017	0,015	0,014	Three Phase	--
37th	0,030	0,032	0,031	0,137	0,149	0,143	Three Phase	--
38th	0,003	0,003	0,003	0,015	0,013	0,014	Three Phase	--

4.6 Harmonic Current Limit Test								P
39th	0,005	0,006	0,007	0,022	0,026	0,030	Three Phase	--
40th	0,004	0,003	0,003	0,016	0,013	0,013	Three Phase	--
41th	0,034	0,033	0,030	0,155	0,151	0,136	Three Phase	--
42th	0,003	0,003	0,003	0,016	0,016	0,015	Three Phase	--
43th	0,021	0,022	0,024	0,095	0,100	0,111	Three Phase	--
44th	0,008	0,004	0,006	0,036	0,017	0,027	Three Phase	--
45th	0,004	0,005	0,004	0,018	0,023	0,020	Three Phase	--
46th	0,005	0,005	0,005	0,023	0,022	0,021	Three Phase	--
47th	0,034	0,032	0,032	0,158	0,149	0,145	Three Phase	--
48th	0,005	0,005	0,005	0,023	0,021	0,023	Three Phase	--
49th	0,013	0,011	0,012	0,061	0,052	0,057	Three Phase	--
50th	0,003	0,003	0,003	0,013	0,012	0,012	Three Phase	--

4.6 Harmonic Current Limit Test — P

SOFAR 24KTLX-G3

Watts_[kW]	**8,015**	**8,029**	**8,036**
VA_[kVA]	**0,050**	**0,050**	**0,050**
Vrms_[Vac]	**230,9**	**230,9**	**231,1**
Arms_[A]	**34,750**	**34,810**	**34,815**
PF	**0,9989**	**0,9988**	**0,9989**
Frequency_[Hz]	**50,00**		
THD50_[%]	**1,634**	**1,490**	**1,547**

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	34,726	34,786	34,793	--	--	--	Three Phase	--
2nd	0,042	0,025	0,030	0,121	0,072	0,086	Three Phase	1
3rd	0,168	0,052	0,136	0,484	0,149	0,391	Three Phase	4
4th	0,022	0,014	0,010	0,062	0,039	0,029	Three Phase	1
5th	0,368	0,342	0,357	1,060	0,984	1,027	Three Phase	4
6th	0,013	0,009	0,008	0,036	0,026	0,023	Three Phase	1
7th	0,294	0,266	0,273	0,847	0,766	0,784	Three Phase	4
8th	0,009	0,006	0,006	0,026	0,018	0,018	Three Phase	1
9th	0,026	0,017	0,037	0,073	0,049	0,107	Three Phase	4
10th	0,007	0,006	0,006	0,019	0,016	0,017	Three Phase	0,5
11th	0,143	0,127	0,078	0,410	0,366	0,225	Three Phase	2
12th	0,006	0,005	0,005	0,018	0,016	0,015	Three Phase	0,5
13th	0,031	0,043	0,049	0,090	0,123	0,141	Three Phase	2
14th	0,007	0,006	0,006	0,019	0,018	0,017	Three Phase	0,5
15th	0,040	0,025	0,016	0,114	0,071	0,047	Three Phase	2
16th	0,005	0,005	0,005	0,014	0,013	0,015	Three Phase	0,5
17th	0,075	0,095	0,108	0,216	0,274	0,311	Three Phase	1,5
18th	0,005	0,005	0,005	0,014	0,013	0,015	Three Phase	0,5
19th	0,102	0,114	0,124	0,293	0,329	0,356	Three Phase	1,5
20th	0,006	0,005	0,006	0,017	0,015	0,016	Three Phase	0,5
21th	0,014	0,017	0,009	0,041	0,049	0,026	Three Phase	1,5
22th	0,005	0,004	0,005	0,015	0,013	0,014	Three Phase	0,5
23th	0,030	0,038	0,033	0,087	0,109	0,094	Three Phase	0,6
24th	0,008	0,007	0,007	0,022	0,020	0,020	Three Phase	0,5
25th	0,065	0,081	0,076	0,186	0,232	0,219	Three Phase	0,6
26th	0,008	0,007	0,008	0,022	0,020	0,022	Three Phase	0,5
27th	0,015	0,018	0,009	0,042	0,052	0,026	Three Phase	0,6
28th	0,006	0,005	0,006	0,017	0,016	0,017	Three Phase	0,5
29th	0,057	0,061	0,050	0,164	0,176	0,143	Three Phase	0,6
30th	0,007	0,006	0,006	0,019	0,017	0,018	Three Phase	0,5
31th	0,074	0,094	0,086	0,214	0,271	0,246	Three Phase	0,6
32th	0,006	0,005	0,005	0,016	0,013	0,015	Three Phase	0,5
33th	0,011	0,008	0,008	0,031	0,024	0,024	Three Phase	0,6
34th	0,005	0,005	0,005	0,015	0,013	0,014	Three Phase	--
35th	0,069	0,063	0,060	0,198	0,181	0,173	Three Phase	--
36th	0,005	0,005	0,005	0,016	0,015	0,014	Three Phase	--
37th	0,048	0,052	0,050	0,139	0,150	0,145	Three Phase	--
38th	0,005	0,004	0,005	0,015	0,013	0,014	Three Phase	--
39th	0,008	0,009	0,010	0,022	0,027	0,030	Three Phase	--

4.6 Harmonic Current Limit Test								P
40th	0,006	0,005	0,005	0,016	0,014	0,013	Three Phase	--
41th	0,054	0,053	0,048	0,156	0,152	0,137	Three Phase	--
42th	0,005	0,005	0,005	0,014	0,014	0,013	Three Phase	--
43th	0,033	0,035	0,039	0,096	0,102	0,111	Three Phase	--
44th	0,005	0,004	0,004	0,015	0,012	0,013	Three Phase	--
45th	0,007	0,008	0,007	0,019	0,024	0,021	Three Phase	--
46th	0,007	0,007	0,007	0,021	0,021	0,020	Three Phase	--
47th	0,055	0,052	0,051	0,159	0,150	0,146	Three Phase	--
48th	0,008	0,007	0,006	0,022	0,021	0,018	Three Phase	--
49th	0,024	0,019	0,024	0,068	0,053	0,068	Three Phase	--
50th	0,004	0,004	0,004	0,012	0,011	0,012	Three Phase	--

Note:
The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 is valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

4.7 Power factor					P
Test conditions:	**SOFAR 15KTLX-G3**				
Output power / **Test AC voltage**	**~10%** **1,513kW**	**~25%** **3,792 kW**	**~50%** **7,565kW**	**~75%** **11,310kW**	**~100%** **15,028kW**
230Va.c.	**0,9894i**	**0,9978i**	**0,9987i**	**0,9988i**	**0,9988i**
Test conditions:	**SOFAR 24KTLX-G3**				
Output power / **Test AC voltage**	**~10%** **2,410kW**	**~25%** **6,066 kW**	**~50%** **12,110kW**	**~75%** **18,103kW**	**~100%** **24,050kW**
230Va.c.	**0,9896i**	**0,9977i**	**0,9988i**	**0,9988i**	**0,9988i**

Note:
*The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50% of the rated inverter output power.

The letter “i” is short for “inductive” and indicates inductive power factor. In case of capacitive power factor the letter “c” is used instead.

The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 is valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

5.2.1 Voltage monitoring	P

IEC 61727: First Level

SOFAR 24KTLX-G3

Test conditions:	Output power: 24,0kW Frequency: 50Hz

L1 phase

	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**		
Trip value	194,0				254,8			
Disconnection time [ms]	200V to 190V	1,735	1,730	1,760	248V to 258V	1,755	1,735	1,740

L2 phase

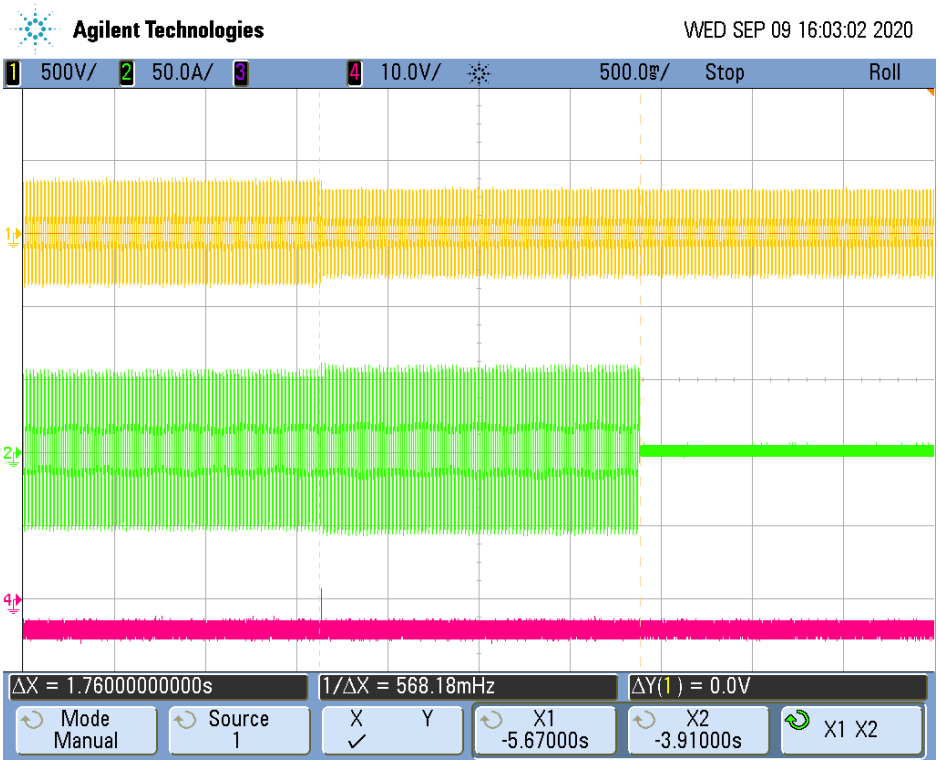
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**		
Trip value	194,1				254,2			
Disconnection time [ms]	200V to 190V	1,750	1,760	1,750	248V to 258V	1,750	1,740	1,745

L3 phase

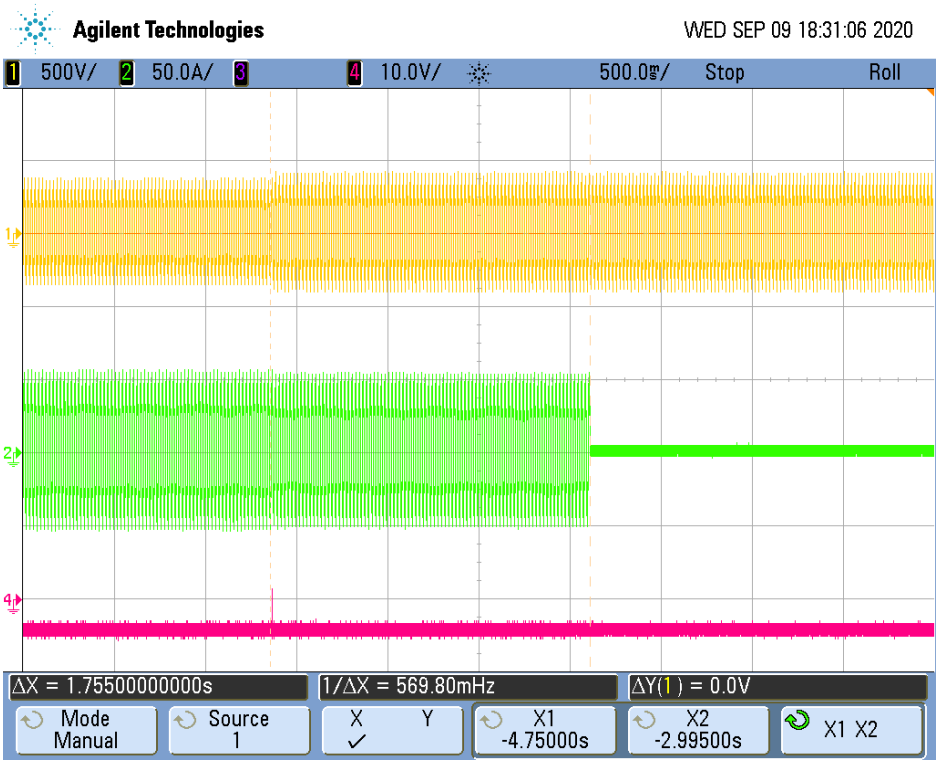
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**		
Trip value	194,1				254,2			
Disconnection time [ms]	200V to 190V	1,755	1,735	1,750	248V to 258V	1,735	1,735	1,730
Reconnection time [s]	20s<t<300s	63s			20s<t<300s	62s		

IEC 61727: Second Level								
Test conditions:	Output power: 24,0kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	114,2				281,1			
Disconnection time [ms]	230V to 110V	82,4	76,8	74,8	230V to 290V	31,4	36,8	35,0
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	114,3				281,4			
Disconnection time [ms]	230V to 110V	73,6	73,4	71,6	230V to 290V	33,8	32,6	40,2
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	114,3				281,5			
Disconnection time [ms]	230V to 110V	76,0	70,8	70,4	230V to 290V	24,6	23,8	22,2
Reconnection time [s]	20s<t<300s	63s			20s<t<300s	63s		
Note: The tests had been performed on the SOFAR 24KTLX-G3 is valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.								

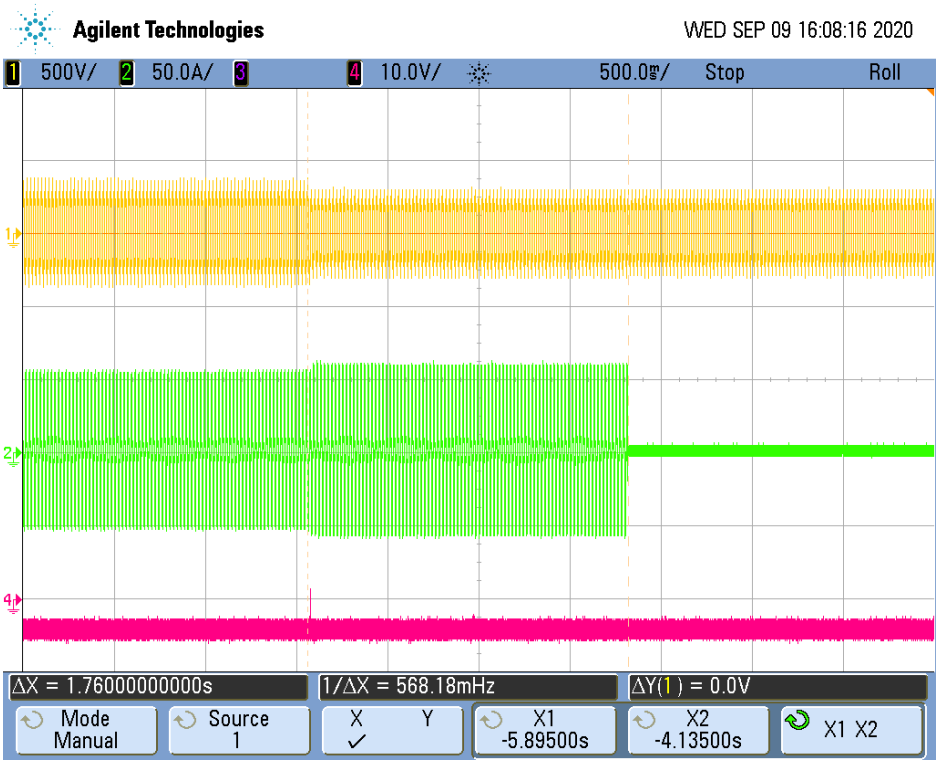
Under Voltage First Level, L1 phase



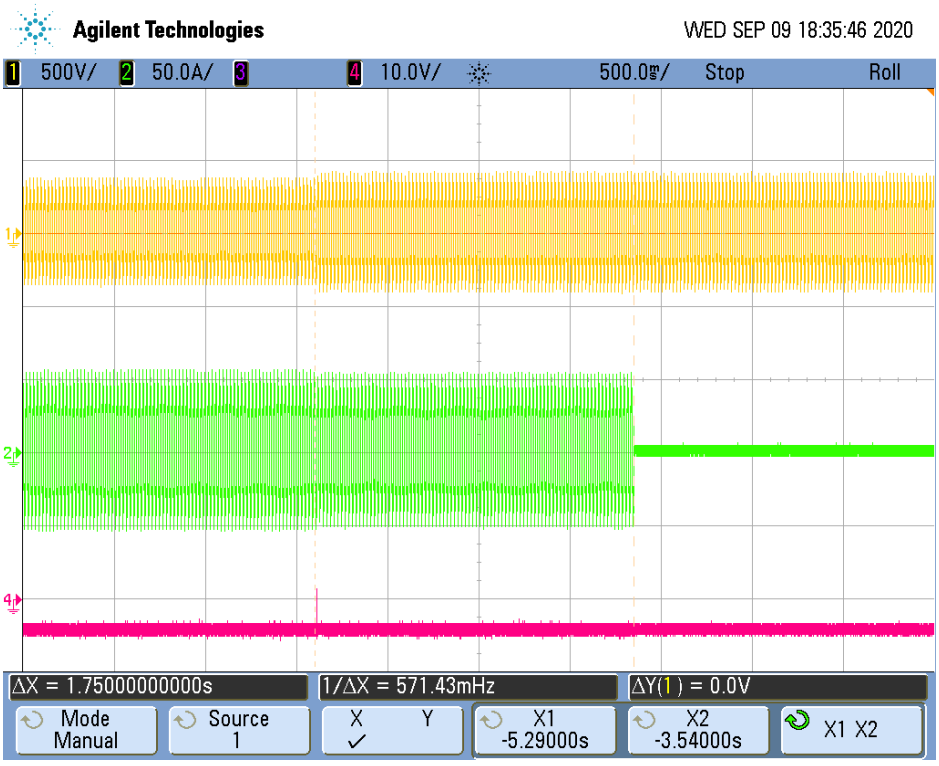
Over voltage First Level, L1 phase



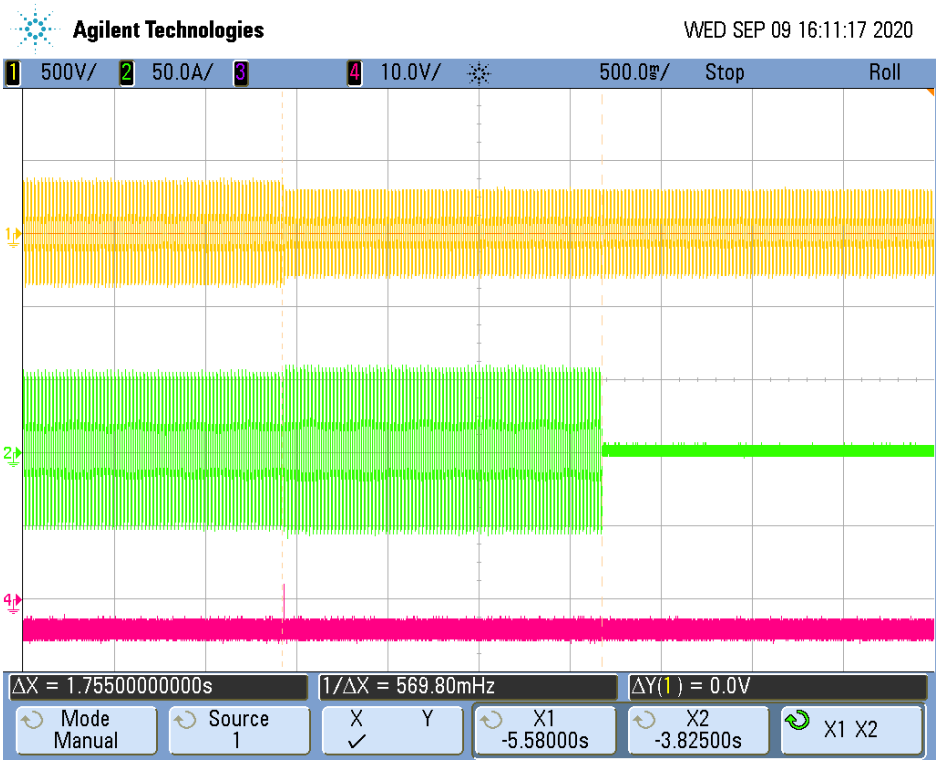
Under Voltage First Level, L2 phase



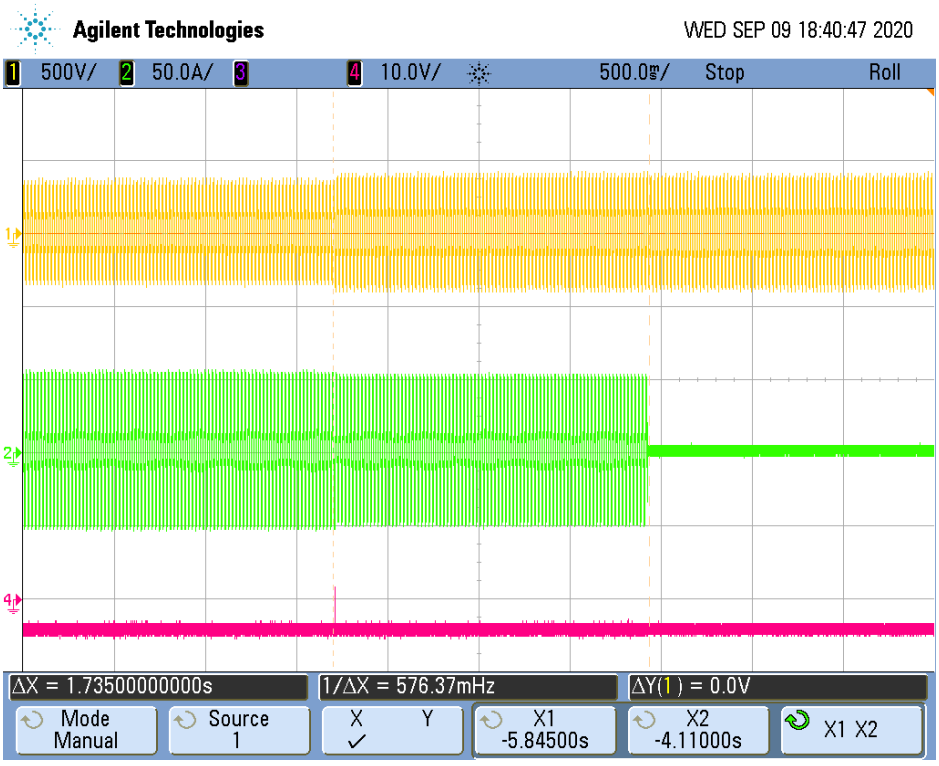
Over voltage First Level, L2 phase



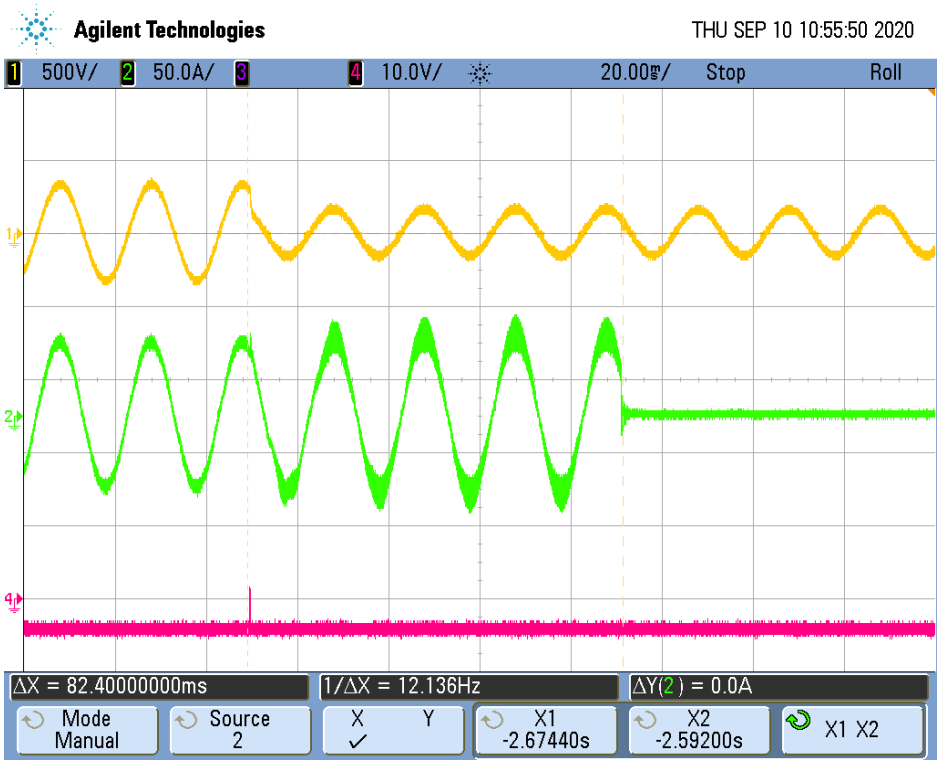
Under Voltage First Level, L3 phase



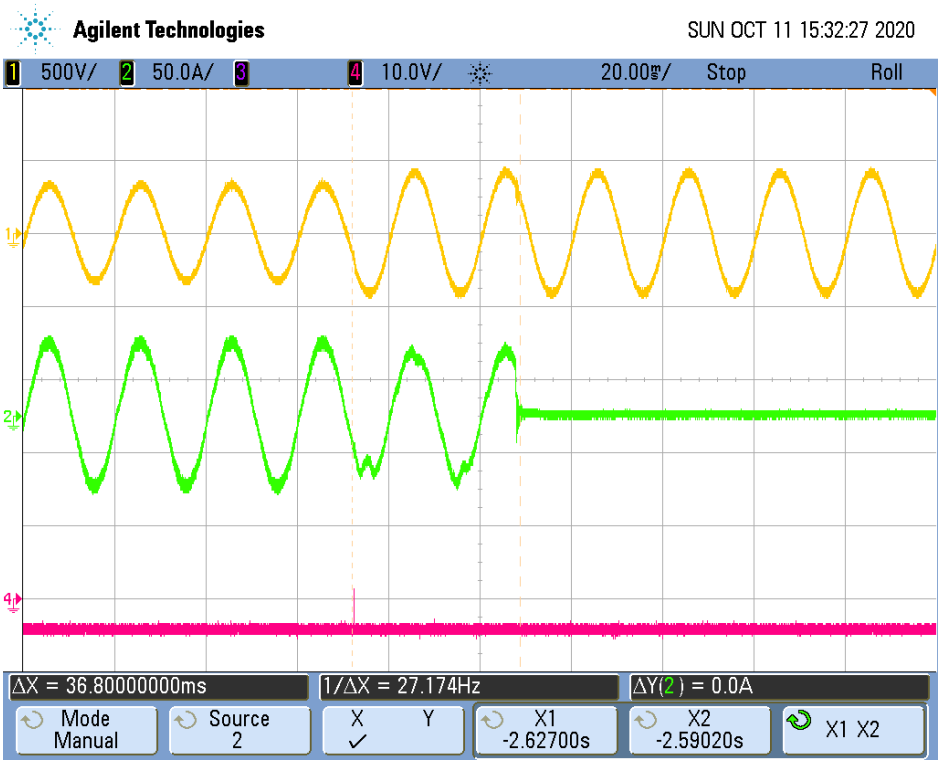
Over voltage First Level, L3 phase



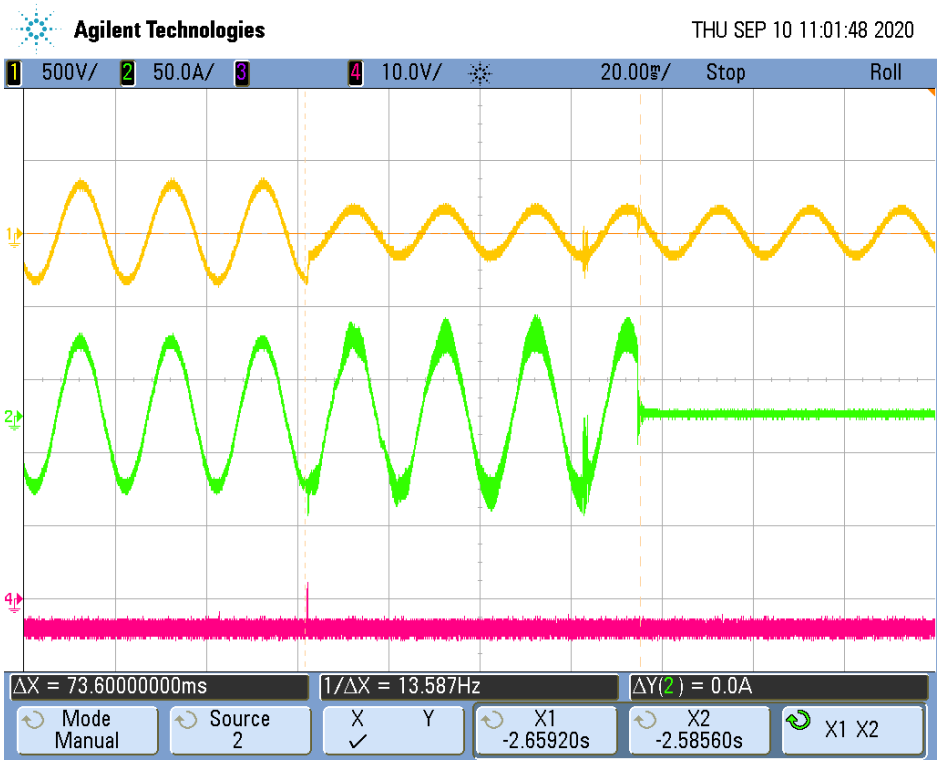
Under Voltage Second Level, L1 phase



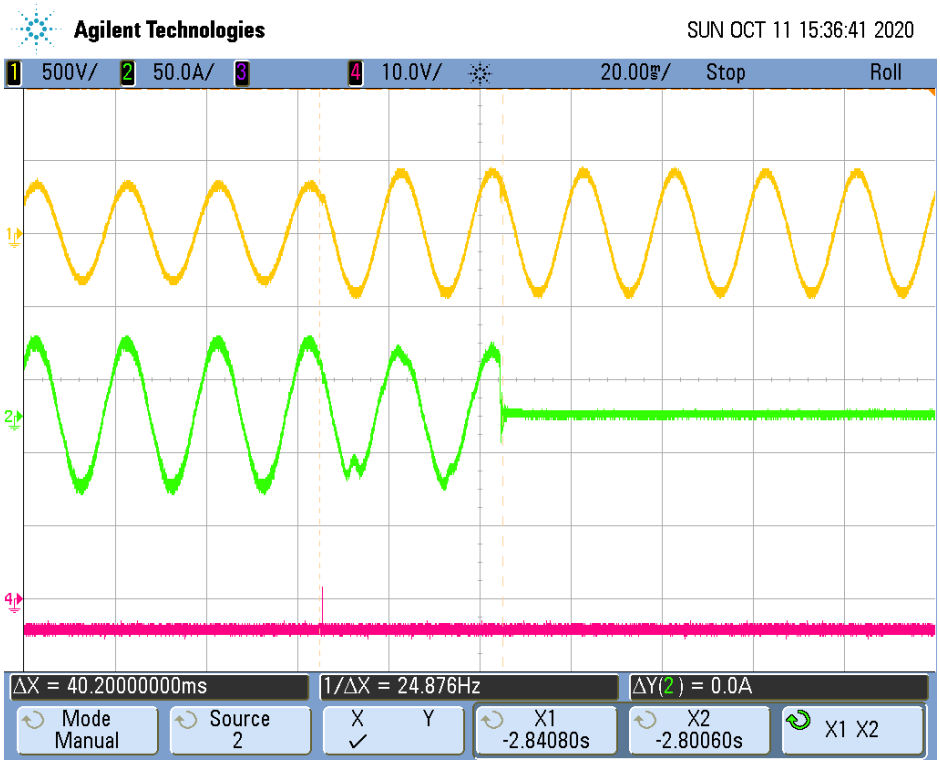
Over voltage Second Level, L1 phase



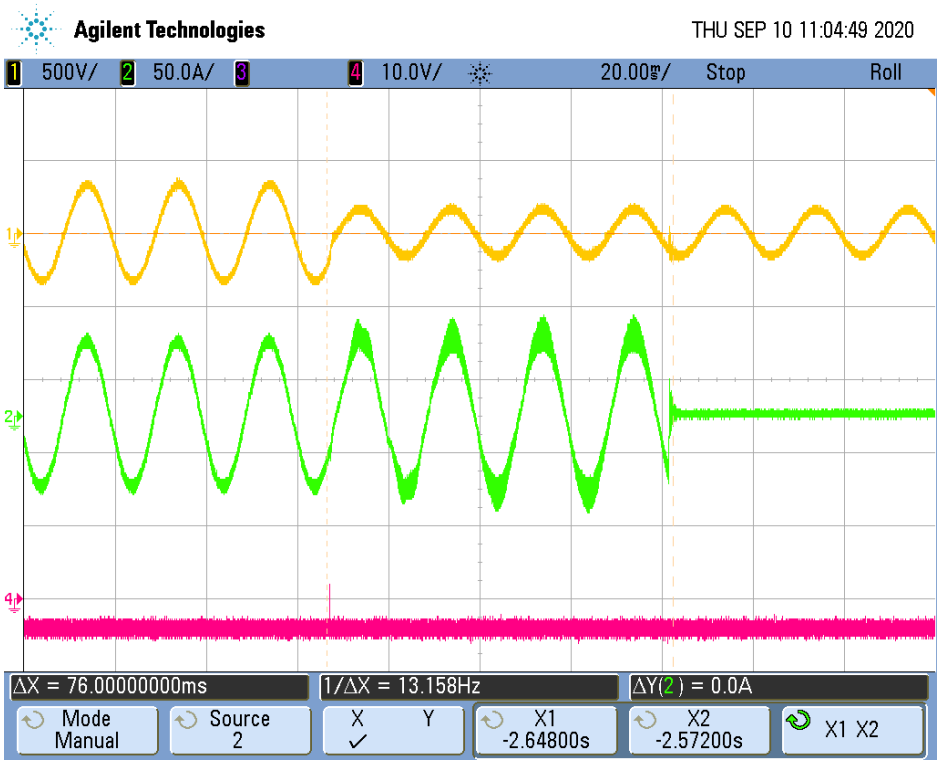
Under Voltage Second Level, L2 phase



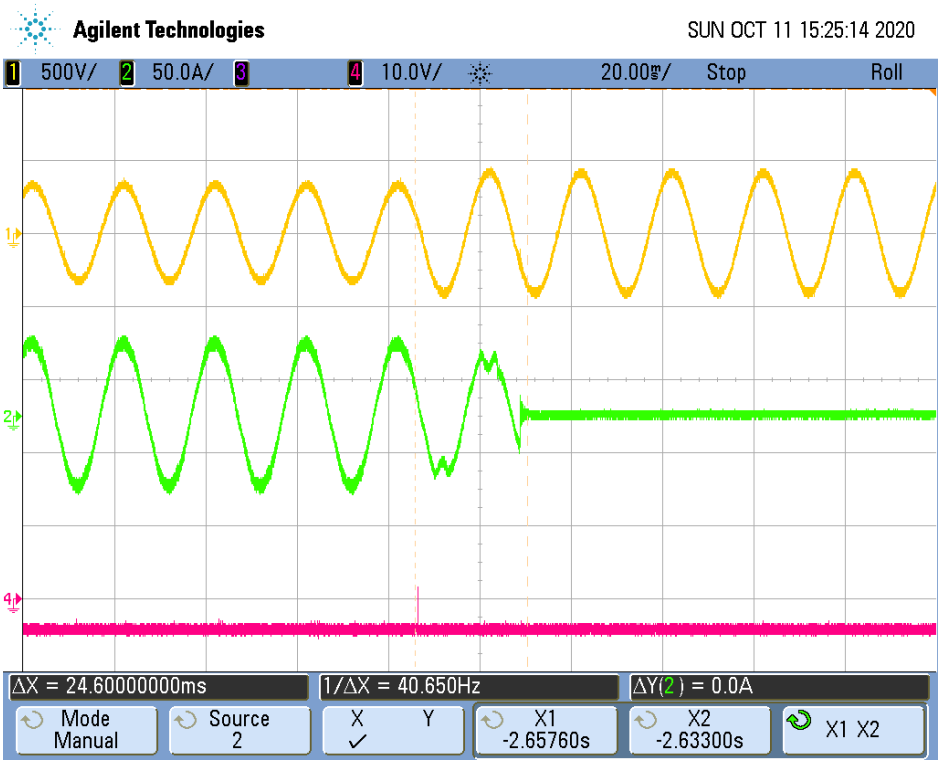
Over voltage Second Level, L2 phase



Under Voltage Second Level, L3 phase



Over voltage Second Level, L3 phase



5.2.2 Frequency monitoring	P

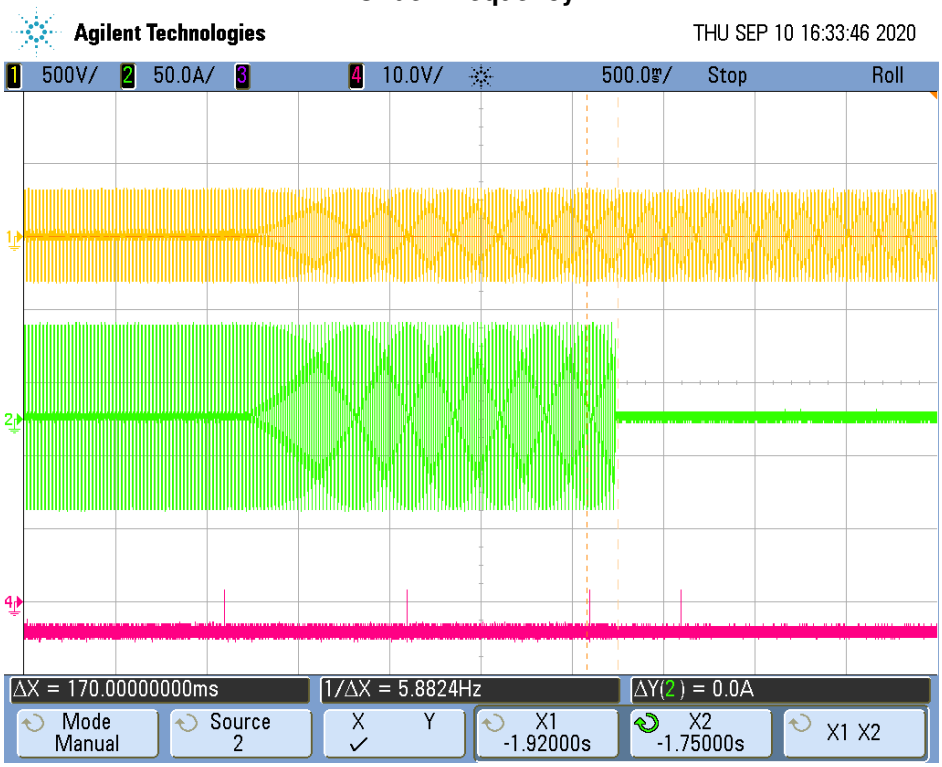
IEC 61727

SOFAR 24KTLX-G3

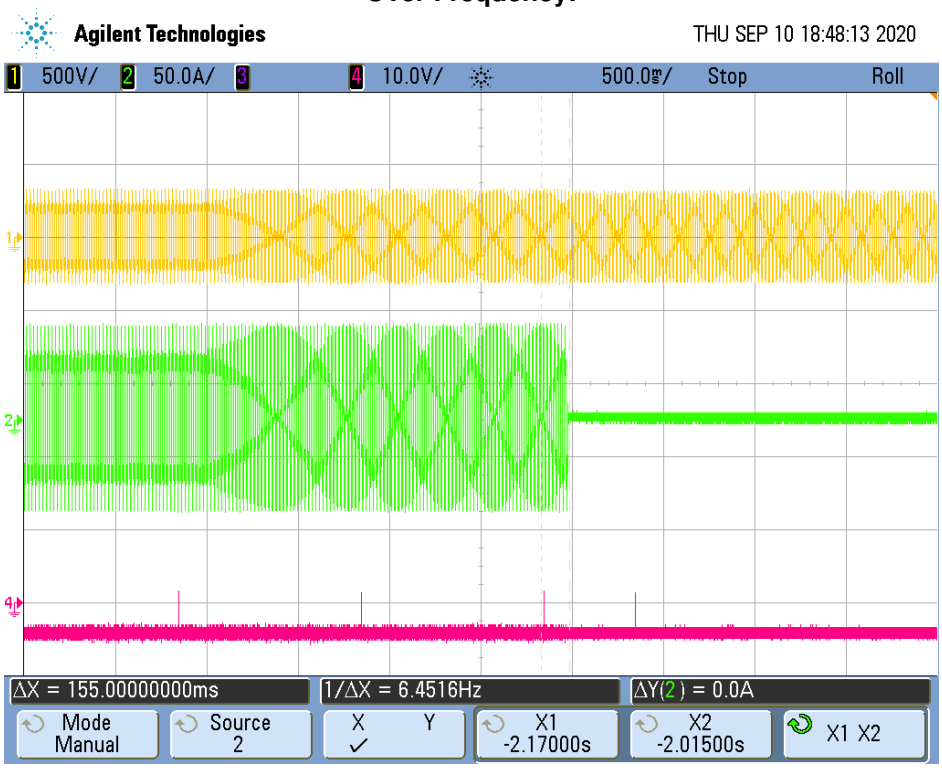
Test conditions:	Any output power level							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N
Limit	49,00Hz	200ms	200ms	200ms	51,00Hz	200ms	200ms	200ms
Trip value		49,00 Hz	49,00 Hz	49,00 Hz		50,90Hz	50,90Hz	50,9Hz
Disconnection time	49,5Hz to 48,5Hz	170	150	160	50,5Hz to 51,5Hz	155	145	135
Reconnection time	20s<t<300s	62s			20s<t<300s	62s		

Note:
The tests had been performed on the SOFAR 24KTLX-G3 is valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

Under Frequency:



Over Frequency:



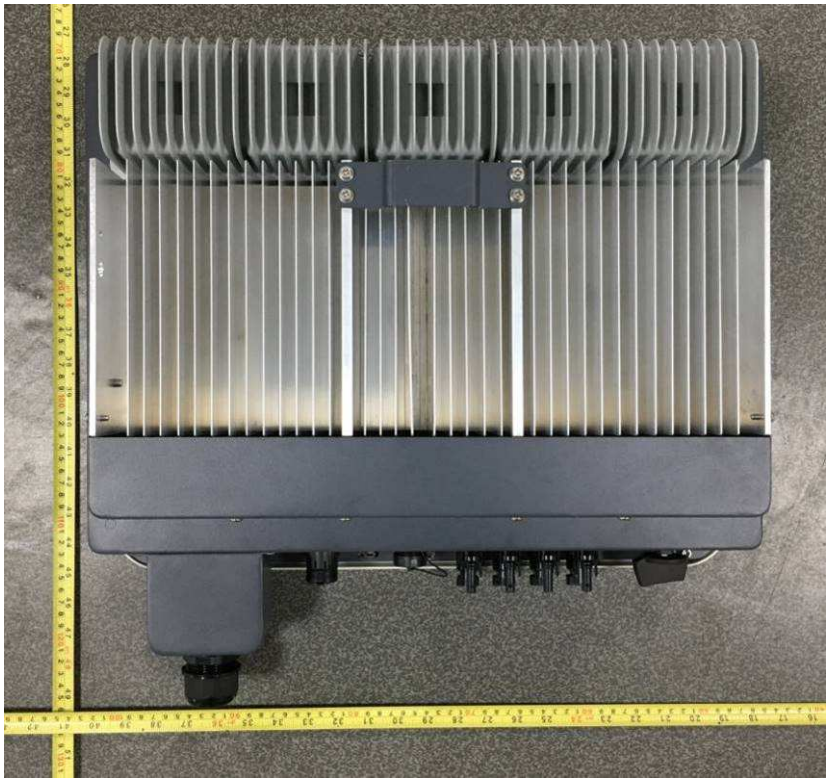
Annex 1

Pictures of the unit

EUT Photo

General view – 1 of Front

General view – 1 of Rear



EUT Photo

General view – 1 of Bottom
SOFAR 15KTLX-G3, SOFAR 17KTLX-G3

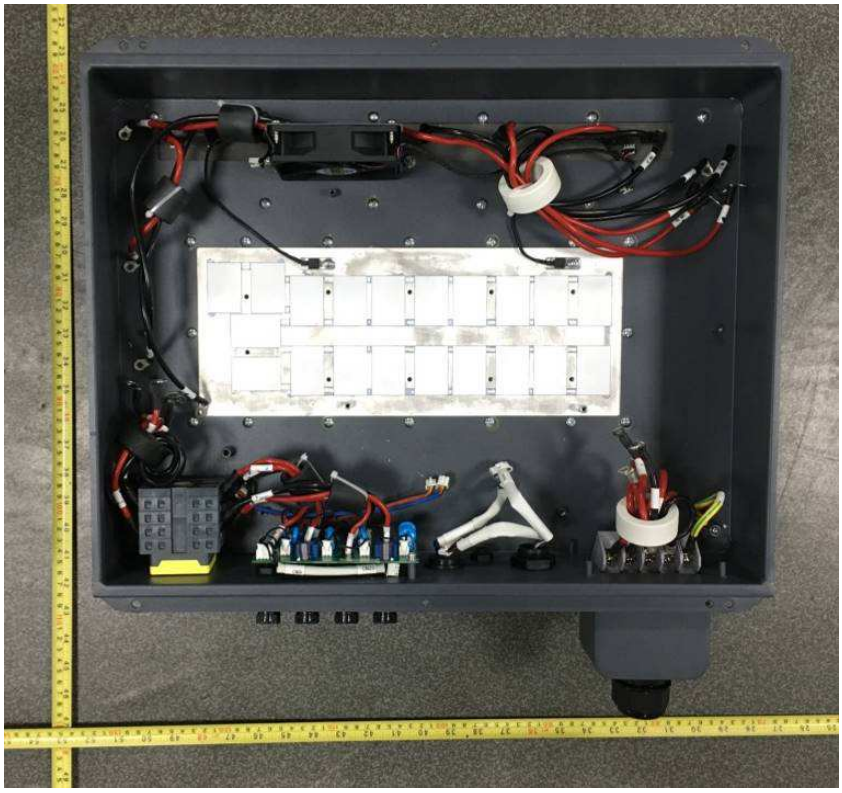
General view – 1 of Bottom
SOFAR 20KTLX-G3, SOFAR 22KTLX-G3, SOFAR 24KTLX-G3

EUT Photo

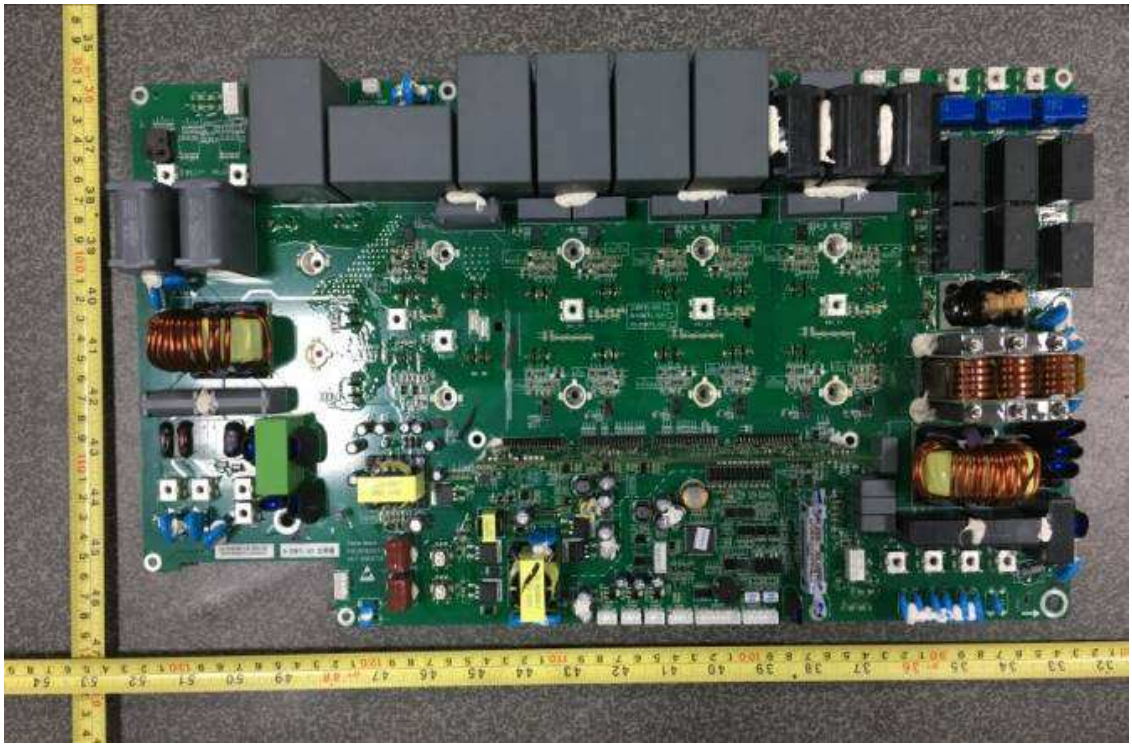
General view – 1 of Side

Internal view – 1

EUT Photo
Internal view – 2

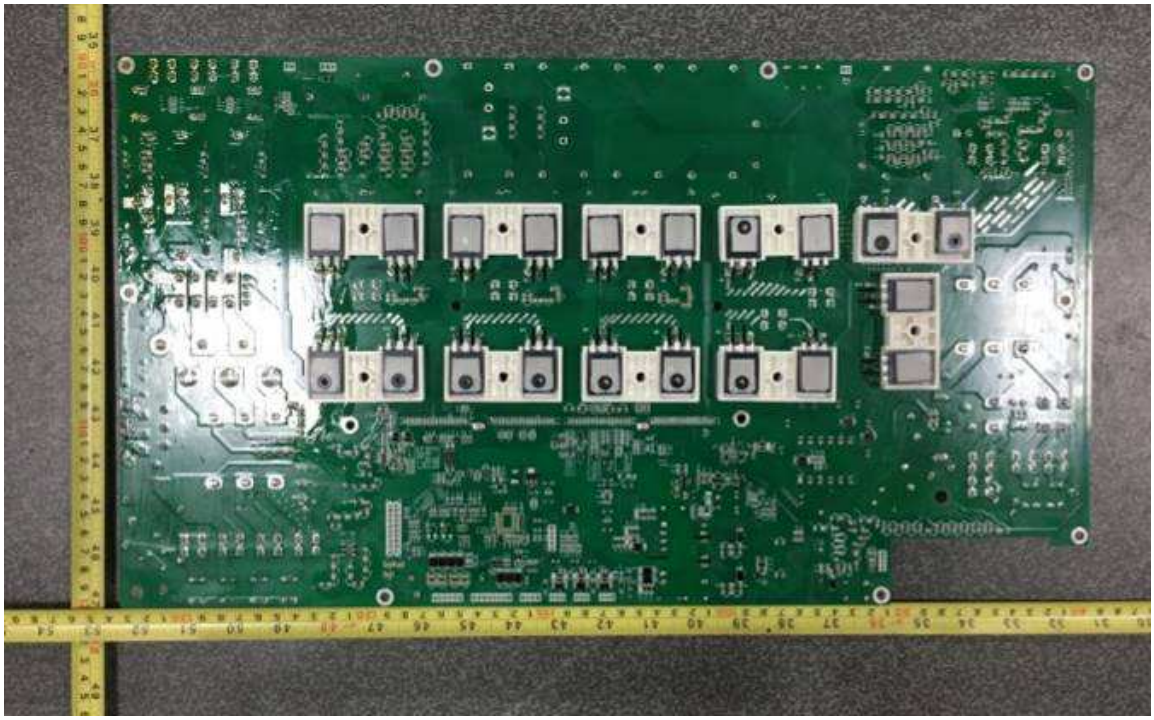


General view – 1 of Power board

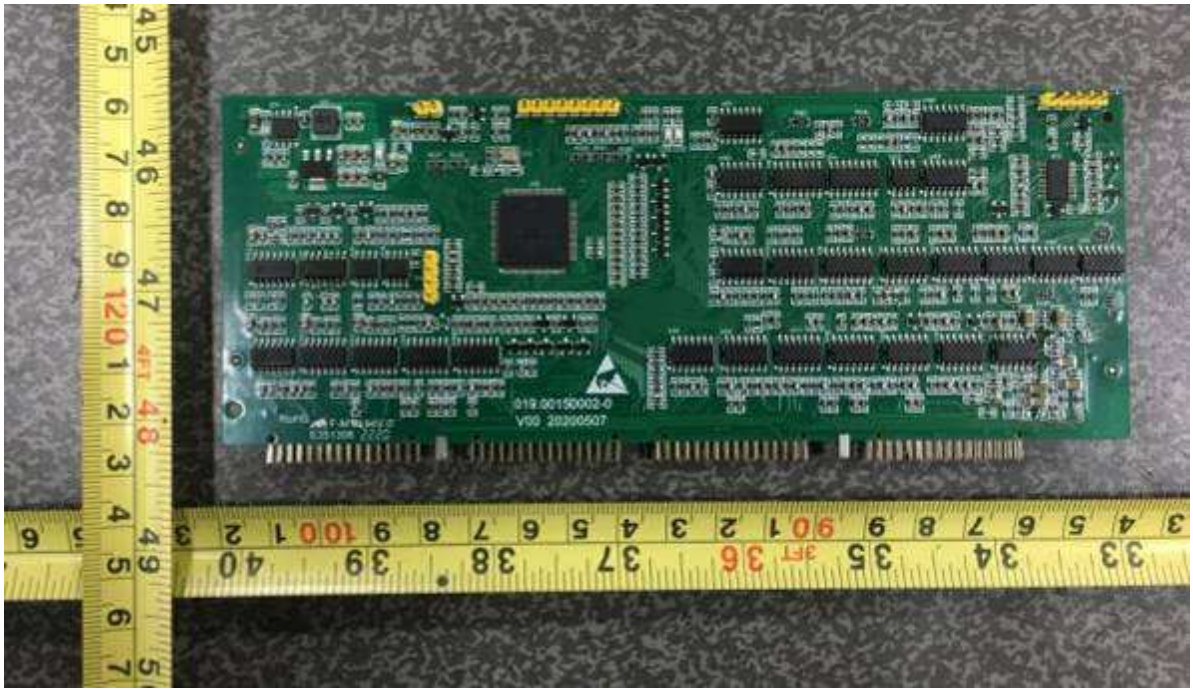


EUT Photo

General view – 2 of Power board

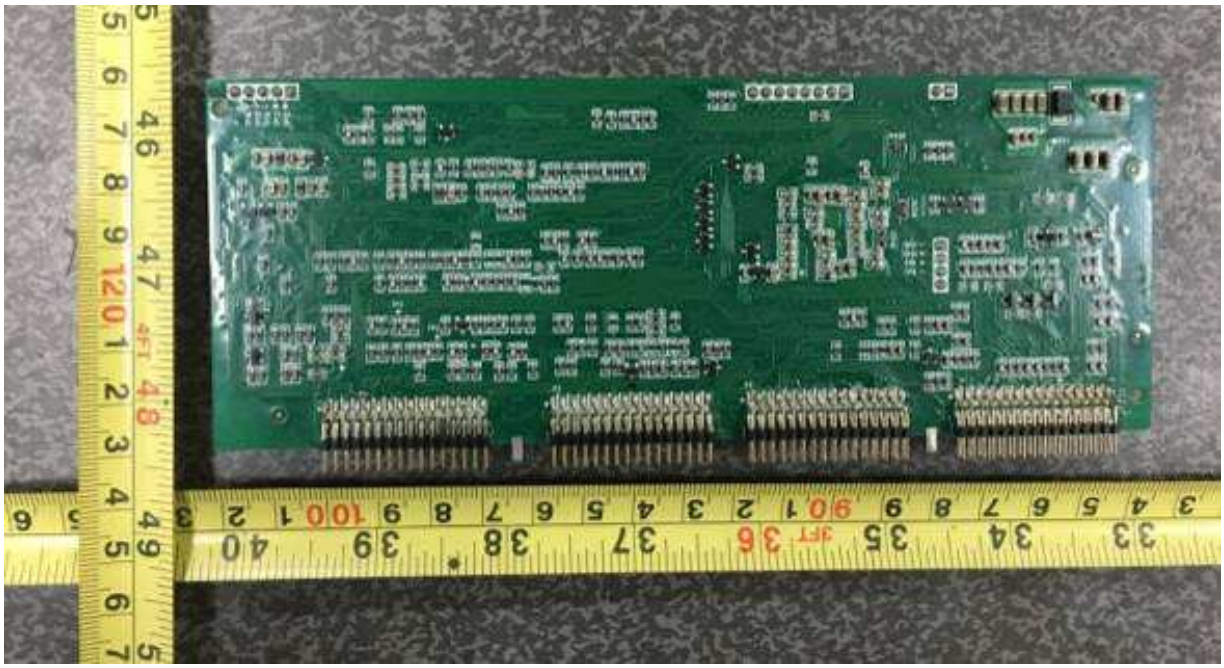


General view – 1 of Control board

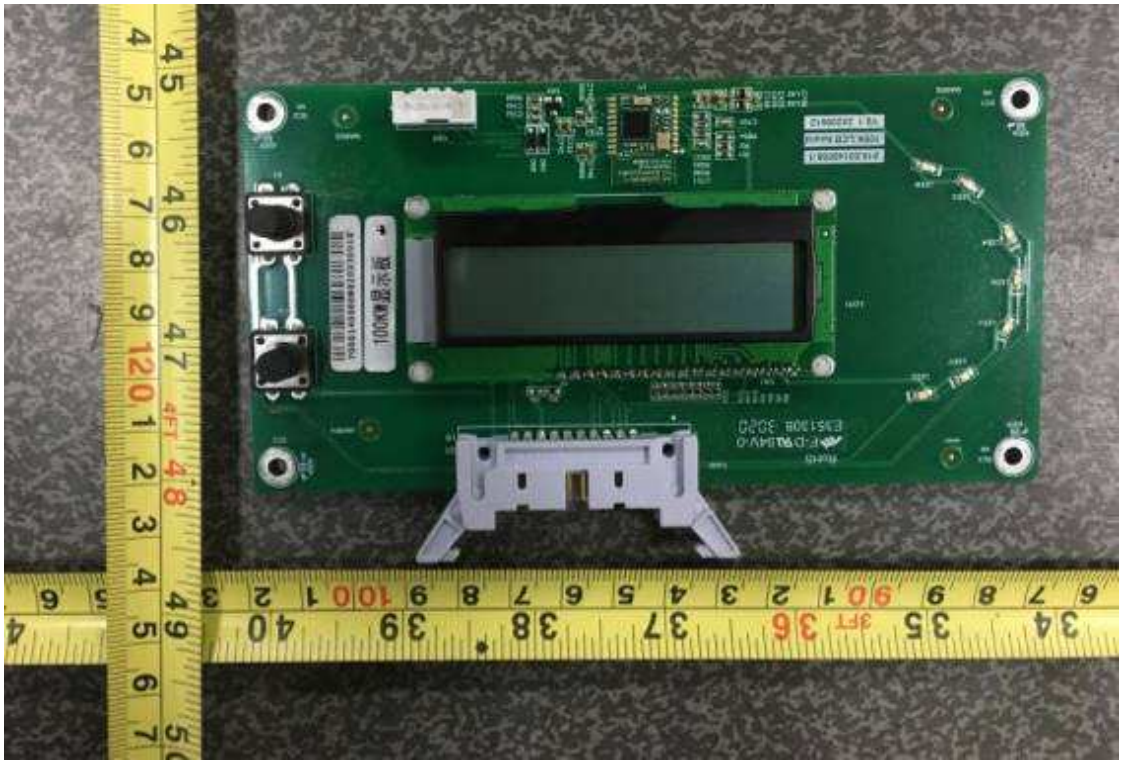


EUT Photo

General view – 2 of Control board

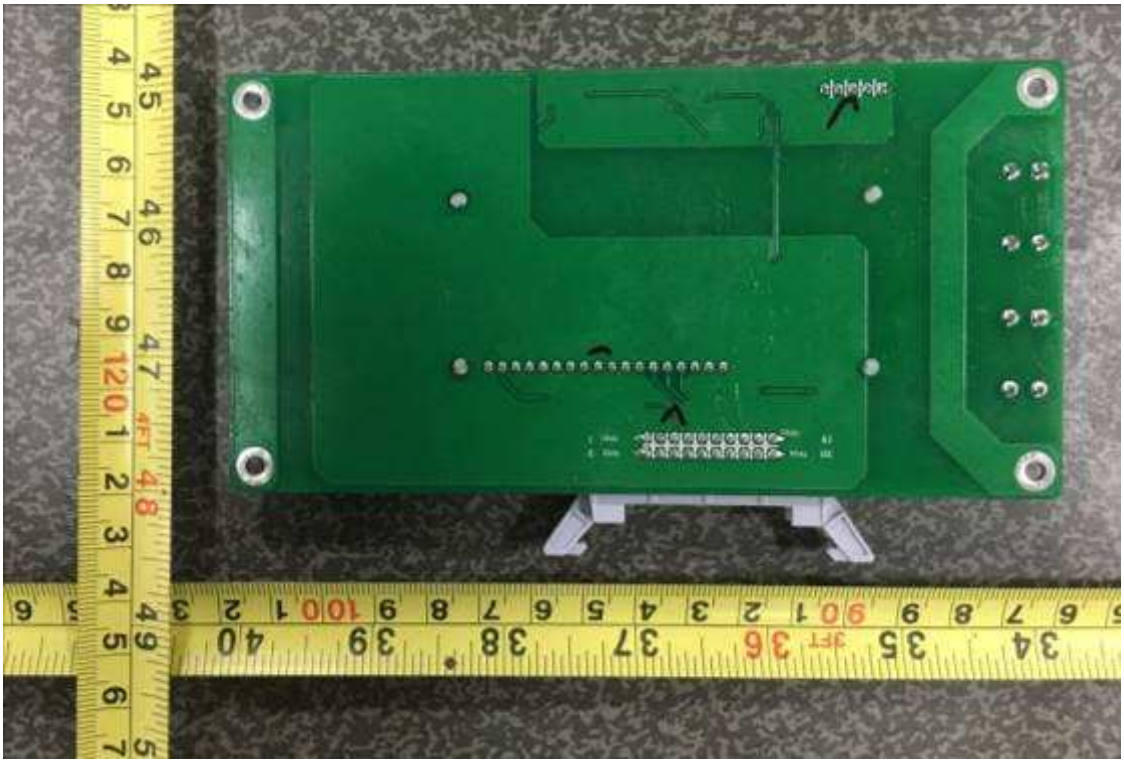


General view – 1 of LCD panel



EUT Photo

General view – 2 of LCD panel



General view of Grouding point

Annex 2
Test equipment list

Date(s) of performance test: 2020-05-11 to 2020-10-18

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration date
Power Analyser	A4080002DG	YOKOGAWA	WT3000	91M210852	Jun. 16, 2021
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyser
	A7040020DG	Chroma	61512	61512000438	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	
Oscilloscope	//	Agilent	DS05014A	MY50070288	Jan. 13, 2021
Oscilloscope current probe	//	CYBERTEK	CP1000A	C181000922	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000925	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000929	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000931	Jan. 13, 2021
Oscilloscope probe	//	SANHUA	SI-9110	152627	Jan. 13, 2021
	//	SIALENT	DS5034X	SDS5XEAC3R0011	Jan. 13, 2021
	//	AGILENT	N2863B	YF0139	Jan. 13, 2021