TEST REPORT

Technical regulation 3.2.2

for PV power plants above 11 kW

Report reference number ..... :	**PVDK200511N080-4**
Date of issue ..... :	2021-02-26
Total number of pages ..... :	78
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
Accrediation ..... :	ilac-MRA, CNAS 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 ..... :	Technical regulation 3.2.2 : 2016 for PV power plants above 11 kW
Test Report Form No. ..... :	TR 3.3.2 VER.0
TRF Originator ..... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF ..... :	Dated 2020-08-22
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				
Isc PV [A] ..... :	36,0A / 36,0A				
Output AC voltage [V] ..... :	380/400Va.c., 3W+N+PE; 50/60Hz				
Rated Output AC current [A]..... :	21,7	24,6	29,0	31,9	34,8
Max. Output AC current [A]..... :	23,9	27,1	31,9	35,1	38,3
Rated Output power [kW] ..... :	15,0	17,0	20,0	22,0	24,0
Max 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**
2021-02-26	Lukes Lin	Initial report was written	0
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 2021-02-24

General remarks:

The test result presented in this report relate only to the object(s) tested. The report shall state compliance of the tested objects with the requirements of EN 50549-1. This report shall 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.

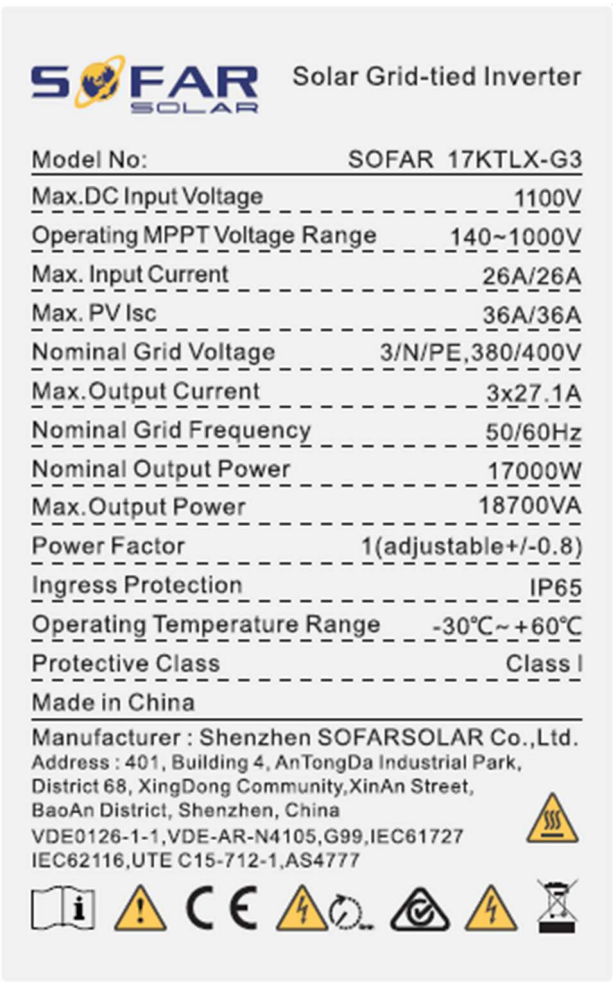
Throughout this report a comma is used as the decimal separator.

The tests were performed at 230Vac/50Hz condition.

This Test Report consists of the following documents:

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

Copy of marking plate



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

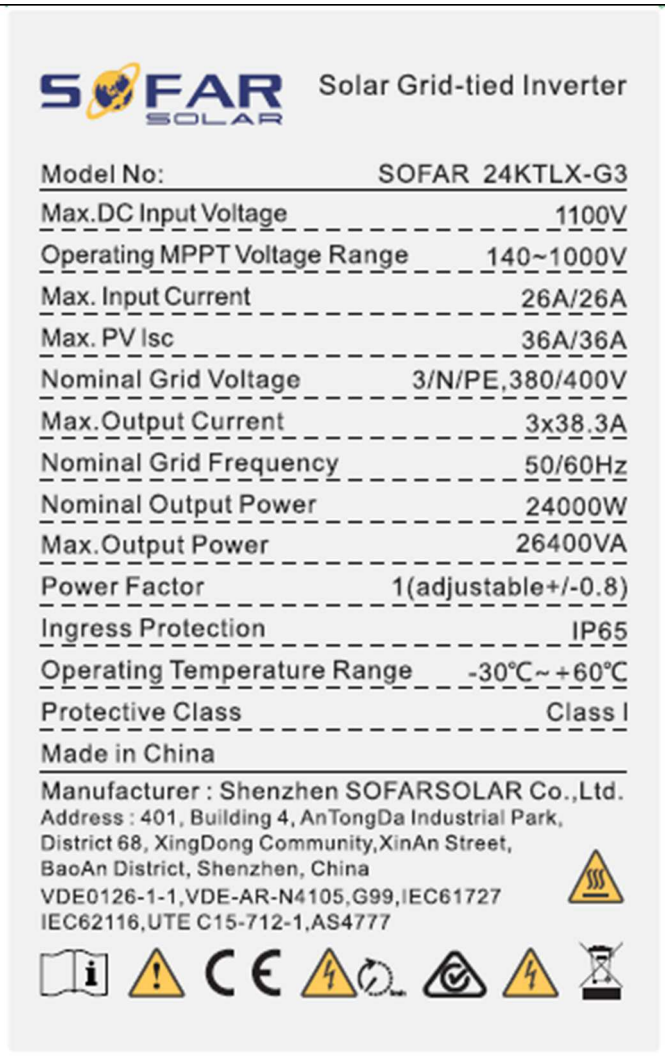
Manufacturer : Shenzhen SOFARSOLAR Co.,Ltd.
Address : 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community,XinAn Street, BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727
IEC62116,UTE C15-712-1,AS4777

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 SOFARSOLAR 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 24KTLX-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 3x38.3A
Nominal Grid Frequency 50/60Hz
Nominal Output Power 24000W
Max.Output Power 26400VA
Power Factor 1(adjustable+/-0.8)
Ingress Protection IP65
Operating Temperature Range -30℃~+60℃
Protective Class Class I
Made in China
Manufacturer : Shenzhen SOFARSOLAR 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

General product information:

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

The DC input of Solar Grid-tied Inverter can be supplied from PV array.

The Solar Grid-tied Inverter is a three-phase type .

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 Main DSP (U30) and slave DSP(U23).

The Main DSP (U30) can control the relays, measures voltage, and frequency, AC current with injected DC, insulation resistance and residual current, In addition it tests the array insulation resistance and the RCMU circuit before each start up.

The slave DSP (U23) is using for detect residual current, also can open the relays independently and communicate with Main DSP (U30).

The unit provides two relays in series on Line and Neutral 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 start up. Both controllers(Main DSP (U30), Slave DSP (U23) can open the relays.

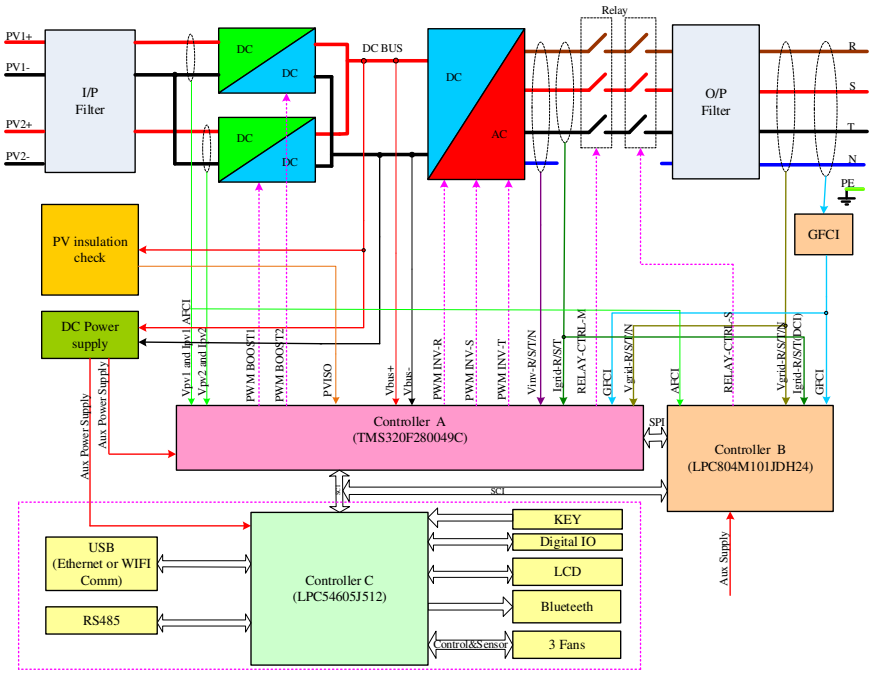


Figure 1 – Block diagram

The product was tested on:

Hardware version: V101

Software version: V010000

Model difference:

The models SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3, SOFAR 22KTLX-G3 and SOFAR 24KTLX-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		

General remarks:

The test results presented in this report relate only to the object(s) tested.
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"(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 comma is used as the decimal separator.

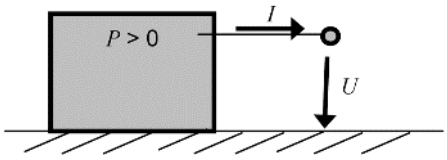
The following suffixes are used for variables in tables and figures:

- "P_n" for the nominal active power:
  $P_n = U_n \times I_n \times \cos \varphi_n$ (single-Phase); $P_n = \sqrt{3} U_n \times I_n \times \cos \varphi_n$ (three-Phase)
- "P_M" for the momentary power
- "(c)" for over-excited
- "(i)" for under-excited

Active and reactive power:

The regarded system of the voltage and current vectors is the load view (Figure 2):

- If the inverter feeds to the grid the active power is measured with negative sign. For the sake of reading the document the measured active infeed power has a positive sign



- If the inverter consumes inductive reactive power the reactive power is marked "inductive" or has a positive sign.
- If the inverter consumes capacitive reactive power the reactive power is marked "capacitive" or has a negative sign.

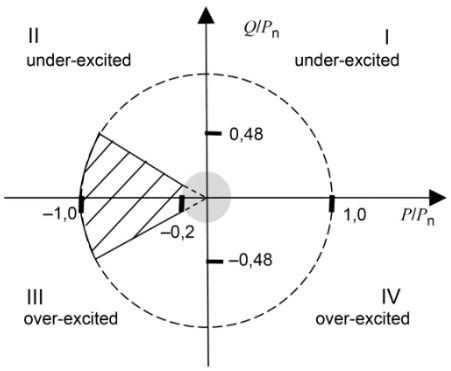


Figure 2

TECHNICAL REGULATION 3.2.2		
Clause	**Test requirement (According to Appendix 1)**	**Result**
3	**Tolerance of frequency and voltage deviations**	**P**
4	**Power quality**	**P**
5	**Control and regulation**	**P**
6	**Protection**	**P**

TECHNICAL REGULATION 3.2.2: Tolerance of frequency and voltage deviations

Clause	Test requirement	Result
3.1	Determination of voltage level	**P**
3.2	Normal operating range	**P**
3.2.1	Normal production requirements	**P**
3.3	Abnormal operating conditions	**N/A**
3.3.1	Voltage dip tolerance	**N/A**
3.3.2	Recurring faults in the public electricity supply grid	**N/A**

3.2 Normal operating conditions		P
Setting value	Min. voltage for connected to grid :	207
	Max. voltage for connected to grid :	253
	Min. frequency for connected to grid :	47,0
	Max. frequency for connected to grid :	52,0
	Observation time (≥180s) :	180

Test:

	Voltage conditons	
a) Start up for voltage range	<90% Un for twice of observation time	>110% Un for twice of observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	≥90% Un within twice setting observation time	≤110% Un within twice setting observation time
Reconnection time [s]	193,0	193,4
Limit:	Connected after setting observation time (≥180s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 100 kW/s., For recorded gradient see diagram below,	
c) In voltage range after voltage failture	≥90% Un for twice of setting observation time	≤110% Un for twice of setting observation time
Reconnection time [s]	193,2	193,0
Limit:	Reconnection after setting observation time (≥180s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 100 kW/s. For recorded gradient see diagram below.	

	Frequency conditions	
d) Start up for frequency range	<47,00 Hz for twice of setting observation time	>52,00 Hz for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	≥47,00 Hz within twice of setting observation time	≤52,00 Hz within twice of setting observation time
Reconnection time [s]	188,2	188,6
Limit:	Connected after setting delay time(≥180s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 100 kW/s., For recorded gradient see diagram below,	
f) In frequency range after frequency failture	≥47,00 Hz for twice of setting observation time	≤52,00 Hz for twice of setting observation time
Reconnection time [s]	187,8	188,4
Limit:	Reconnection after setting observation time (≥180s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 100 kW/s., For recorded gradient see diagram below,	

Test:

Test condition b) and c): voltage within the limits of 90% to 110%U_n.

Test condition e) and f): frequency within the limits of 47,00Hz to 52,00Hz.

In order to avoid continuous starting and disengaging operations of the interface protection relay, the disengaging value of frequency and voltage functions shall be above 2 % deviating from the operate value.

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.

Assessment criterion:

a) the micro generator connects respectively starts generating electrical power only in the permitted range of voltage and frequency and

b) for adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute and

c) for non or partly adjustable generators the connection after trip of the interface protection is delayed by a randomised value between 1 min and 10 min.

3.2.1 Normal production requirements			P
Setting values	Over-voltage [V]:	253	
	Under-voltage [V]:	195,5	
	Over-frequency [Hz]:	52,0	
	Under-frequency [Hz]:	47,0	

- Test 1: U = 207,0 V; f = 47,0 Hz; P = 1,00 S_n; cosφ = 1
- Test 2: U = 195,5 V; f = 48,5 Hz; P = 1,00 S_n; cosφ = 1
- Test 3: U = 253,0 V; f = 51,5 Hz; P = 1,00 S_n; cosφ = 1
- Test 4: U = 230,0 V; f = 50,0 Hz; Voltage Phase jumps Change +20 derees P = 1,00g S_n; cosφ = 1

Test result:

Test sequence	Voltage [V]	Frequency [Hz]	Output power [kW]	Cos φ
Test1	207,36	47,00	24,046	0,9999
Test2	195,74	48,50	22,551	0,9999
Test3	253,05	51,50	24,455	0,9999
Test4	231,61	50,00	24,444	0,9999

Note:

Test method refer clause D.3.1 of EN 50438:2013.

During the tests the interface protection was disabled.

During the sequence of test 3 and 4, automatic adjustment to reduce power in the case of over-frequency was disabled.

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.

TECHNICAL REGULATION 3.3.2: Power quality		
Clause	**Test requirement**	**Result**
4.1	Gneral	**P**
4.2	DC content	**P**
4.3	Asymmetry	**P**
4.4	Flicker	**P**
4.5	Harmonic distortions	**P**
4.6	Interharmonic distortions	**P**
4.7	Distortions in the 2-9 kHz frequency range	**P**

4.2 DC content				P
Test result: SOFAR 15KTLX-G3				
Protection limit	**Tested at four power levels limit 0,5% of $I_{AC;nom}$ (43mA)**			
Output power	~20%	~50%	75%	~100%
Max. test value [mA]	31	56	56	55
Ave. test value [mA]	18	18	18	19
Test result: SOFAR 24KTLX-G3				
Protection limit	**Tested at four power levels limit 0,5% of $I_{AC;nom}$ (109mA)**			
Output power	~20%	~50%	75%	~100%
Max. test value [mA]	46	74	41	49
Ave. test value [mA]	17	19	19	21

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.

Diagram of permanent dc-injection of SOFAR 15KTLX-G3

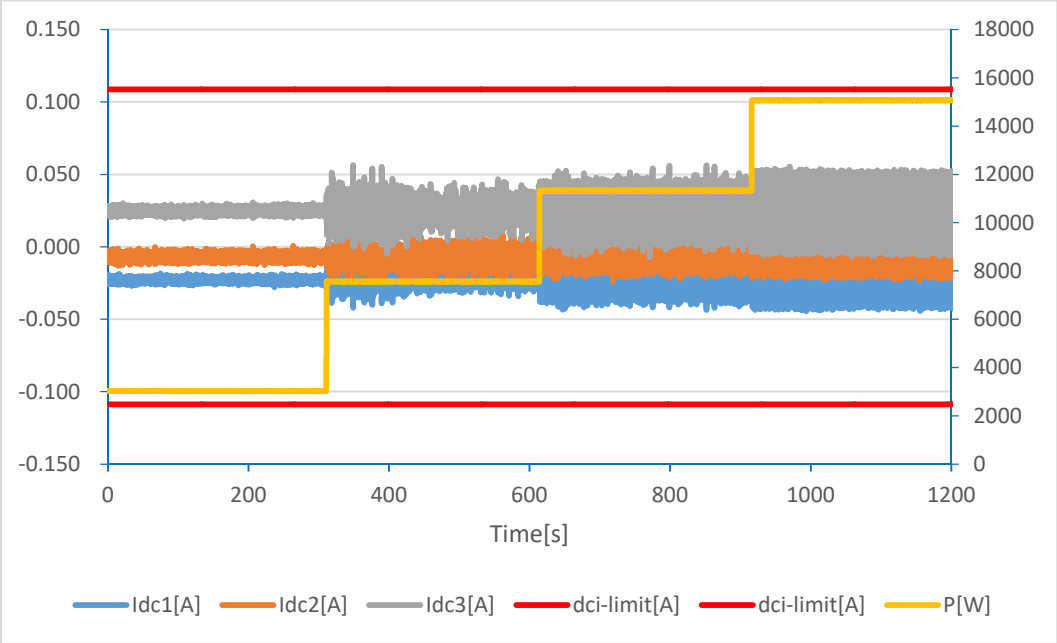
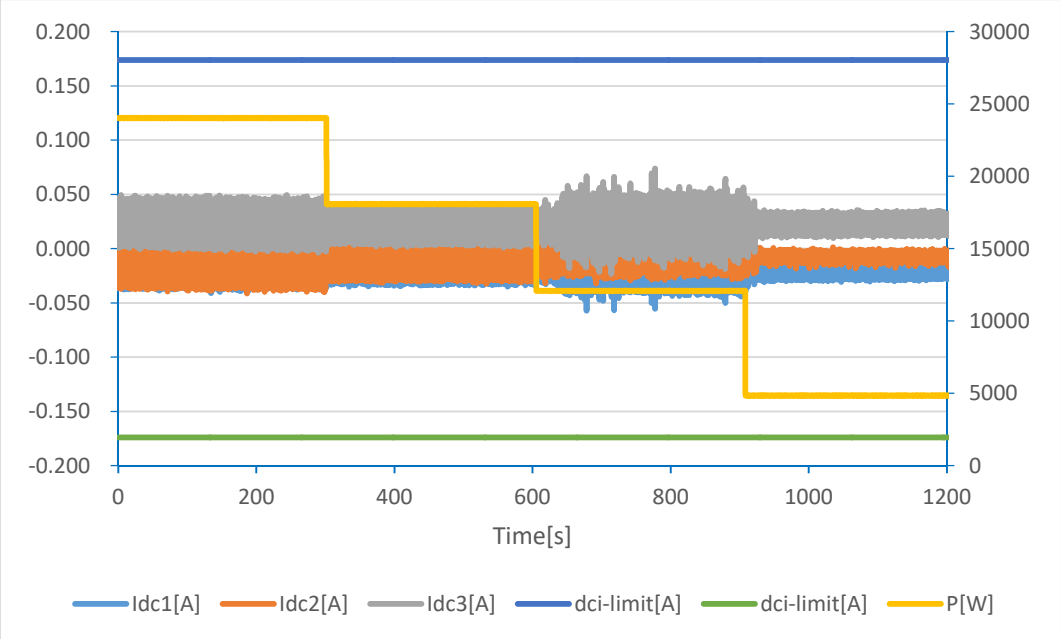


Diagram of permanent dc-injection of SOFAR 24KTLX-G3



4.4 Asymmetry						P
Setting values	PF cos φ = 1					
Test value	L1	L2	L3	L1 – L2	L2 – L3	L3 – L1
100% of rated current [A]	34,667	35,699	33,972	-1,033	1,727	-0,695
	34,668	35,696	33,968	-1,028	1,727	-0,700
	34,668	35,696	33,968	-1,028	1,729	-0,701
	34,666	35,699	33,969	-1,033	1,730	-0,697
	34,666	35,698	33,970	-1,032	1,728	-0,696
Max. Asymmetry current [A]			1,730			

Note:

the asymmetry between the phases at normal operation or in the event of faults in the electricity-generating unit may not exceed 16A.

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.

4.4 Flicker	P

Test result:

Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-3 and/or EN 61000-3-11.

Test:

Value	P_{st}	P_{lt} 2 hours	d(t) 500ms	d_c	d_{max}
Limit	1,0	0,65	3,3%	3,3%	4%
Test value	See below				

SOFAR 15KTLX-G3

	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

	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

	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

	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

	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

	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 dmax at starting and stopping, Mains Impedance according EN61000-3-11:

Rmax = 0,24Ω; jXmax= 0,15Ω @50Hz (|Zmax| = 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 dc:

$Z_{max} = Z_{ref}$ * 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.

The test results refer to the original test report PV200511N080-2 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-10-21.

4.5	Harmonic distortions (EN 61000-3-12)	P

Test result: SOFAR 15KTLX-G3

Watts [KW]	4,981/5,145/4,889
Vrms [V]	230,80,230,74/230,76
Arms [A]	21,590/22,307/21,196
Frequency [Hz]	50,00
THD50* (100% output power)	1,957/1,896/1,851

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
1st	21,580	22,297	21,186	-	-	-	Three Phase	--
2nd	0,006	0,004	0,005	0,029	0,018	0,023	Three Phase	8,000
3rd	0,080	0,014	0,079	0,370	0,061	0,371	Three Phase	21,600
4th	0,006	0,006	0,004	0,028	0,026	0,019	Three Phase	4,000
5th	0,296	0,293	0,264	1,372	1,315	1,247	Three Phase	10,700
6th	0,005	0,005	0,003	0,023	0,021	0,015	Three Phase	2,667
7th	0,172	0,173	0,165	0,797	0,775	0,781	Three Phase	7,200
8th	0,003	0,003	0,003	0,014	0,014	0,015	Three Phase	2,000
9th	0,009	0,007	0,019	0,044	0,030	0,087	Three Phase	3,800
10th	0,004	0,004	0,003	0,018	0,020	0,014	Three Phase	1,600
11th	0,099	0,101	0,071	0,460	0,455	0,335	Three Phase	3,100
12th	0,003	0,004	0,003	0,012	0,016	0,014	Three Phase	1,333
13th	0,044	0,047	0,038	0,204	0,210	0,181	Three Phase	2,000
14th	0,004	0,005	0,004	0,018	0,020	0,018	Three Phase	8,000
15th	0,009	0,005	0,006	0,041	0,024	0,029	Three Phase	N/A
16th	0,004	0,003	0,003	0,018	0,014	0,016	Three Phase	N/A
17th	0,076	0,092	0,081	0,351	0,412	0,380	Three Phase	N/A
18th	0,003	0,004	0,003	0,014	0,019	0,016	Three Phase	N/A
19th	0,123	0,134	0,126	0,568	0,599	0,597	Three Phase	N/A
20th	0,003	0,003	0,003	0,013	0,014	0,016	Three Phase	N/A
21th	0,005	0,009	0,009	0,025	0,042	0,044	Three Phase	N/A
22th	0,004	0,003	0,003	0,018	0,014	0,016	Three Phase	N/A
23th	0,028	0,021	0,025	0,130	0,093	0,116	Three Phase	N/A
24th	0,004	0,003	0,004	0,018	0,015	0,018	Three Phase	N/A
25th	0,089	0,095	0,089	0,410	0,427	0,420	Three Phase	N/A
26th	0,004	0,003	0,004	0,019	0,013	0,018	Three Phase	N/A
27th	0,006	0,010	0,008	0,028	0,045	0,040	Three Phase	N/A
28th	0,003	0,004	0,004	0,014	0,016	0,018	Three Phase	N/A
29th	0,047	0,047	0,045	0,219	0,211	0,215	Three Phase	N/A
30th	0,003	0,003	0,003	0,015	0,015	0,014	Three Phase	N/A
31th	0,071	0,079	0,073	0,329	0,353	0,345	Three Phase	N/A
32th	0,004	0,003	0,003	0,018	0,014	0,016	Three Phase	N/A
33th	0,006	0,007	0,006	0,027	0,032	0,029	Three Phase	N/A
34th	0,003	0,003	0,003	0,015	0,013	0,016	Three Phase	N/A
35th	0,054	0,053	0,048	0,250	0,239	0,227	Three Phase	N/A
36th	0,003	0,003	0,003	0,016	0,013	0,014	Three Phase	N/A
37th	0,030	0,032	0,031	0,141	0,144	0,148	Three Phase	N/A
38th	0,003	0,003	0,003	0,014	0,012	0,013	Three Phase	N/A
39th	0,006	0,006	0,005	0,026	0,027	0,026	Three Phase	N/A
40th	0,003	0,003	0,003	0,013	0,012	0,013	Three Phase	N/A
41th	0,032	0,031	0,028	0,150	0,138	0,132	Three Phase	N/A
42th	0,004	0,003	0,003	0,017	0,015	0,016	Three Phase	N/A

43th	0,008	0,009	0,010	0,037	0,041	0,045	Three Phase	N/A
44th	0,003	0,003	0,003	0,014	0,011	0,012	Three Phase	N/A
45th	0,006	0,005	0,004	0,026	0,022	0,021	Three Phase	N/A
46th	0,005	0,005	0,005	0,025	0,024	0,021	Three Phase	N/A
47th	0,022	0,020	0,019	0,101	0,091	0,092	Three Phase	N/A
48th	0,003	0,003	0,003	0,016	0,015	0,014	Three Phase	N/A
49th	0,008	0,009	0,010	0,039	0,041	0,046	Three Phase	N/A
50th	0,005	0,005	0,004	0,025	0,024	0,021	Three Phase	N/A

Test result: SOFAR 24KTLX-G3	
Watts [KW]	7,975/8,234/7,829
Vrms [V]	230,79/230,80/230,82
Arms [A]	34,569/35,691/33,931
Frequency [Hz]	50,00
THD50* (100% output power)	1,941/1,896/1,849

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
1st	34,553	35,675	33,915	-	-	-	Three Phase	--
2nd	0,009	0,006	0,007	0,026	0,017	0,020	Three Phase	8,000
3rd	0,120	0,022	0,125	0,348	0,061	0,368	Three Phase	21,600
4th	0,008	0,007	0,005	0,022	0,021	0,014	Three Phase	4,000
5th	0,470	0,468	0,422	1,362	1,310	1,246	Three Phase	10,700
6th	0,007	0,007	0,005	0,021	0,020	0,016	Three Phase	2,667
7th	0,276	0,281	0,264	0,798	0,788	0,777	Three Phase	7,200
8th	0,004	0,005	0,005	0,012	0,014	0,014	Three Phase	2,000
9th	0,012	0,012	0,027	0,034	0,033	0,081	Three Phase	3,800
10th	0,007	0,007	0,005	0,020	0,020	0,015	Three Phase	1,600
11th	0,156	0,161	0,116	0,450	0,451	0,343	Three Phase	3,100
12th	0,004	0,006	0,005	0,012	0,017	0,015	Three Phase	1,333
13th	0,069	0,075	0,061	0,198	0,211	0,180	Three Phase	2,000
14th	0,006	0,008	0,007	0,018	0,023	0,021	Three Phase	8,000
15th	0,014	0,008	0,009	0,040	0,024	0,026	Three Phase	N/A
16th	0,006	0,005	0,006	0,017	0,014	0,016	Three Phase	N/A
17th	0,125	0,149	0,128	0,362	0,418	0,377	Three Phase	N/A
18th	0,005	0,007	0,005	0,013	0,019	0,016	Three Phase	N/A
19th	0,196	0,214	0,205	0,567	0,600	0,603	Three Phase	N/A
20th	0,005	0,005	0,006	0,013	0,014	0,017	Three Phase	N/A
21th	0,009	0,014	0,015	0,026	0,040	0,044	Three Phase	N/A
22th	0,006	0,005	0,005	0,017	0,014	0,016	Three Phase	N/A
23th	0,044	0,029	0,040	0,127	0,082	0,117	Three Phase	N/A
24th	0,006	0,006	0,006	0,017	0,017	0,019	Three Phase	N/A
25th	0,140	0,151	0,142	0,406	0,423	0,420	Three Phase	N/A
26th	0,007	0,005	0,007	0,019	0,013	0,019	Three Phase	N/A
27th	0,010	0,015	0,014	0,029	0,043	0,040	Three Phase	N/A
28th	0,005	0,006	0,006	0,015	0,016	0,018	Three Phase	N/A
29th	0,074	0,074	0,073	0,215	0,207	0,215	Three Phase	N/A
30th	0,005	0,006	0,005	0,015	0,016	0,014	Three Phase	N/A
31th	0,113	0,125	0,117	0,327	0,350	0,344	Three Phase	N/A
32th	0,006	0,005	0,006	0,018	0,014	0,017	Three Phase	N/A
33th	0,010	0,012	0,010	0,029	0,034	0,031	Three Phase	N/A
34th	0,005	0,005	0,006	0,016	0,014	0,016	Three Phase	N/A
35th	0,085	0,084	0,075	0,245	0,235	0,222	Three Phase	N/A
36th	0,006	0,005	0,005	0,016	0,014	0,015	Three Phase	N/A
37th	0,049	0,051	0,049	0,141	0,144	0,145	Three Phase	N/A
38th	0,005	0,005	0,005	0,016	0,013	0,014	Three Phase	N/A
39th	0,010	0,011	0,010	0,028	0,031	0,029	Three Phase	N/A
40th	0,005	0,005	0,005	0,014	0,013	0,014	Three Phase	N/A
41th	0,051	0,048	0,044	0,147	0,135	0,129	Three Phase	N/A
42th	0,006	0,006	0,006	0,017	0,016	0,019	Three Phase	N/A
43th	0,013	0,014	0,015	0,039	0,040	0,043	Three Phase	N/A
44th	0,006	0,004	0,005	0,016	0,013	0,015	Three Phase	N/A
45th	0,010	0,008	0,008	0,030	0,024	0,024	Three Phase	N/A
46th	0,009	0,009	0,007	0,025	0,024	0,022	Three Phase	N/A

47th	0,034	0,032	0,030	0,098	0,090	0,088	Three Phase	N/A
48th	0,006	0,006	0,005	0,017	0,016	0,015	Three Phase	N/A
49th	0,013	0,015	0,016	0,038	0,042	0,047	Three Phase	N/A
50th	0,009	0,009	0,007	0,025	0,024	0,022	Three Phase	N/A

Note:
The tests should be based on the limits of the EN 61000-3-12 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.

4.5 **4.6** **4.7**	Harmonic distortions Interharmonic distortions **(EN 61000-4-7)** Distortions in the 2-9 kHz frequency range **(EN 61000-4-7)**	**P**

The currents of the interharmonics to 2 kHz must be measured in accordance with DIN EN 61000-4-7 (VDE 0817-4-7), Annex A, The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with DIN EN 61000-4-7 (VDE 0847-4-7), Annex B.

Test result: SOFAR 24KTLX-G3

Harmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	1,903	10,156	20,303	30,420	40,511	50,567	60,570	71,858	81,999	92,352	102,401	--	--
2	0,359	0,059	0,060	0,058	0,065	0,066	0,071	0,043	0,043	0,050	0,050	--	--
3	0,084	0,193	0,199	0,209	0,218	0,227	0,248	0,116	0,118	0,086	0,094	--	--
4	0,070	0,046	0,041	0,041	0,040	0,039	0,043	0,036	0,040	0,043	0,040	--	--
5	0,568	0,378	0,372	0,346	0,338	0,335	0,340	0,408	0,419	0,227	0,226	10,7	3,6
6	0,030	0,023	0,020	0,023	0,025	0,027	0,025	0,020	0,021	0,024	0,021	--	--
7	0,395	0,224	0,233	0,243	0,250	0,253	0,276	0,284	0,282	0,151	0,161	7,2	2,5
8	0,155	0,021	0,018	0,021	0,024	0,023	0,023	0,016	0,016	0,016	0,015	--	--
9	0,038	0,058	0,062	0,063	0,068	0,073	0,075	0,042	0,041	0,026	0,023	--	--
10	0,097	0,018	0,017	0,018	0,022	0,021	0,021	0,013	0,016	0,015	0,012	--	--
11	0,157	0,110	0,099	0,114	0,136	0,152	0,174	0,174	0,173	0,081	0,080	3,1	1,0
12	0,027	0,016	0,017	0,017	0,020	0,022	0,020	0,011	0,013	0,013	0,011	--	--
13	0,124	0,053	0,064	0,075	0,087	0,098	0,106	0,150	0,146	0,082	0,080	2	0,7
14	0,136	0,018	0,017	0,019	0,022	0,020	0,020	0,011	0,013	0,011	0,009	--	--
15	0,027	0,029	0,030	0,028	0,034	0,033	0,038	0,022	0,022	0,020	0,014	--	--
16	0,123	0,020	0,016	0,017	0,020	0,020	0,022	0,011	0,012	0,014	0,009	--	--
17	0,223	0,100	0,078	0,088	0,084	0,084	0,102	0,112	0,111	0,055	0,065	--	--
18	0,036	0,016	0,015	0,015	0,020	0,019	0,020	0,011	0,013	0,011	0,008	--	--
19	0,143	0,068	0,047	0,064	0,049	0,044	0,041	0,097	0,095	0,055	0,058	--	--
20	0,074	0,023	0,015	0,017	0,020	0,022	0,018	0,011	0,019	0,010	0,008	--	--
21	0,035	0,021	0,023	0,027	0,032	0,029	0,032	0,021	0,023	0,015	0,013	--	--
22	0,086	0,020	0,019	0,021	0,017	0,018	0,017	0,011	0,014	0,009	0,008	--	--
23	0,063	0,066	0,091	0,085	0,089	0,071	0,044	0,092	0,101	0,048	0,067	--	--
24	0,039	0,018	0,015	0,016	0,020	0,021	0,020	0,011	0,012	0,008	0,011	--	--
25	0,066	0,038	0,055	0,040	0,039	0,042	0,058	0,083	0,081	0,051	0,060	--	--
26	0,056	0,015	0,014	0,015	0,019	0,019	0,019	0,014	0,014	0,009	0,009	--	--
27	0,027	0,021	0,021	0,021	0,023	0,026	0,029	0,022	0,020	0,013	0,015	--	--
28	0,071	0,019	0,011	0,012	0,015	0,017	0,018	0,013	0,012	0,008	0,009	--	--
29	0,125	0,055	0,064	0,050	0,070	0,071	0,068	0,079	0,100	0,052	0,076	--	--
30	0,044	0,014	0,011	0,013	0,015	0,019	0,017	0,012	0,011	0,008	0,009	--	--
31	0,057	0,057	0,088	0,057	0,050	0,050	0,083	0,060	0,080	0,044	0,067	--	--
32	0,056	0,016	0,012	0,013	0,017	0,017	0,020	0,011	0,011	0,008	0,008	--	--
33	0,027	0,015	0,015	0,016	0,017	0,019	0,020	0,021	0,021	0,012	0,012	--	--
34	0,054	0,020	0,010	0,011	0,014	0,017	0,017	0,010	0,010	0,006	0,008	--	--
35	0,102	0,077	0,038	0,046	0,030	0,059	0,076	0,070	0,090	0,050	0,076	--	--

36	0,040	0,013	0,010	0,011	0,015	0,018	0,015	0,010	0,010	0,006	0,009	--	--
37	0,036	0,051	0,080	0,068	0,078	0,066	0,081	0,056	0,075	0,049	0,079	--	--
38	0,045	0,014	0,014	0,013	0,016	0,014	0,030	0,010	0,010	0,007	0,017	--	--
39	0,030	0,023	0,017	0,021	0,028	0,027	0,020	0,031	0,031	0,017	0,012	--	--
40	0,041	0,020	0,011	0,013	0,016	0,021	0,019	0,012	0,012	0,007	0,008	--	--
41	0,074	0,072	0,042	0,025	0,026	0,041	0,068	0,060	0,083	0,089	0,092	--	--
42	0,032	0,011	0,010	0,011	0,016	0,018	0,022	0,011	0,012	0,009	0,008	--	--
43	0,052	0,031	0,086	0,081	0,083	0,072	0,069	0,052	0,072	0,430	0,161	--	--
44	0,044	0,012	0,009	0,011	0,014	0,016	0,013	0,008	0,009	0,015	0,011	--	--
45	0,021	0,027	0,024	0,024	0,020	0,021	0,019	0,023	0,021	0,062	0,062	--	--
46	0,036	0,013	0,011	0,030	0,015	0,020	0,016	0,009	0,010	0,011	0,015	--	--
47	0,032	0,058	0,093	0,058	0,034	0,038	0,060	0,049	0,078	0,487	0,186	--	--
48	0,026	0,022	0,009	0,010	0,016	0,019	0,040	0,009	0,011	0,019	0,014	--	--
49	0,036	0,043	0,075	0,078	0,068	0,061	0,049	0,049	0,082	0,044	0,083	--	--
50	0,024	0,014	0,009	0,011	0,014	0,016	0,014	0,011	0,012	0,008	0,016	--	--
Interharmonics													
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0,101	0,062	0,080	0,128	0,161	0,197	0,245	0,021	0,021	0,027	0,027	--	0,40
125	0,103	0,027	0,030	0,046	0,057	0,065	0,077	0,020	0,021	0,023	0,024	--	0,60
175	0,097	0,028	0,038	0,049	0,044	0,050	0,059	0,024	0,021	0,019	0,016	--	0,43
225	0,057	0,034	0,034	0,043	0,049	0,049	0,061	0,021	0,020	0,020	0,016	--	0,33
275	0,053	0,036	0,063	0,042	0,039	0,043	0,043	0,017	0,019	0,021	0,017	--	0,27
325	0,037	0,034	0,054	0,040	0,040	0,045	0,043	0,018	0,018	0,021	0,017	--	0,23
375	0,058	0,033	0,033	0,040	0,040	0,039	0,038	0,018	0,018	0,021	0,017	--	0,20
425	0,056	0,026	0,033	0,036	0,037	0,042	0,043	0,019	0,019	0,021	0,017	--	0,18
475	0,045	0,026	0,033	0,035	0,037	0,041	0,041	0,019	0,020	0,022	0,017	--	0,16
525	0,047	0,026	0,034	0,037	0,040	0,042	0,040	0,019	0,020	0,020	0,019	--	0,14
575	0,043	0,028	0,035	0,042	0,038	0,044	0,042	0,019	0,020	0,019	0,021	--	0,13
625	0,029	0,035	0,036	0,047	0,042	0,046	0,054	0,019	0,020	0,019	0,019	--	0,12
675	0,051	0,031	0,044	0,045	0,044	0,050	0,049	0,019	0,020	0,018	0,016	--	0,11
725	0,051	0,035	0,032	0,043	0,040	0,041	0,049	0,019	0,021	0,017	0,015	--	0,10
775	0,045	0,032	0,045	0,041	0,040	0,045	0,049	0,019	0,021	0,021	0,015	--	0,10
825	0,045	0,046	0,034	0,049	0,043	0,045	0,062	0,019	0,021	0,019	0,014	--	0,09
875	0,039	0,038	0,053	0,048	0,044	0,054	0,068	0,019	0,021	0,016	0,014	--	0,09
925	0,027	0,034	0,031	0,036	0,036	0,038	0,046	0,019	0,021	0,015	0,014	--	0,08
975	0,036	0,035	0,034	0,034	0,038	0,057	0,043	0,019	0,023	0,014	0,014	--	0,08
1025	0,034	0,038	0,027	0,028	0,046	0,032	0,033	0,019	0,028	0,014	0,014	--	0,07
1075	0,028	0,027	0,032	0,044	0,031	0,032	0,034	0,019	0,033	0,014	0,015	--	0,07
1125	0,034	0,029	0,034	0,028	0,033	0,034	0,036	0,020	0,029	0,014	0,014	--	0,07
1175	0,029	0,030	0,025	0,028	0,033	0,036	0,038	0,020	0,027	0,013	0,013	--	0,06
1225	0,023	0,028	0,025	0,029	0,031	0,035	0,039	0,020	0,022	0,013	0,013	--	0,06
1275	0,022	0,024	0,022	0,025	0,030	0,033	0,039	0,020	0,021	0,013	0,013	--	0,06
1325	0,022	0,021	0,021	0,024	0,028	0,030	0,034	0,021	0,023	0,013	0,014	--	0,06
1375	0,023	0,020	0,021	0,023	0,027	0,029	0,034	0,021	0,023	0,013	0,015	--	0,05
1425	0,027	0,024	0,021	0,023	0,028	0,031	0,035	0,021	0,021	0,012	0,015	--	0,05
1475	0,023	0,024	0,019	0,023	0,026	0,031	0,036	0,022	0,021	0,011	0,015	--	0,05
1525	0,018	0,025	0,020	0,023	0,026	0,029	0,035	0,021	0,020	0,011	0,015	--	0,05

1575	0,023	0,024	0,018	0,020	0,025	0,027	0,036	0,020	0,019	0,012	0,014	--	0,05
1625	0,022	0,019	0,017	0,019	0,023	0,025	0,037	0,020	0,020	0,013	0,017	--	0,05
1675	0,019	0,017	0,017	0,019	0,025	0,029	0,031	0,022	0,023	0,014	0,016	--	0,04
1725	0,022	0,020	0,017	0,019	0,022	0,030	0,031	0,025	0,025	0,011	0,013	--	0,04
1775	0,020	0,021	0,017	0,018	0,021	0,028	0,031	0,019	0,018	0,010	0,014	--	0,04
1825	0,016	0,020	0,017	0,019	0,023	0,024	0,030	0,020	0,019	0,010	0,012	--	0,04
1875	0,017	0,017	0,021	0,017	0,023	0,022	0,033	0,019	0,018	0,018	0,011	--	0,04
1925	0,017	0,014	0,024	0,037	0,020	0,026	0,026	0,019	0,019	0,020	0,011	--	0,04
1975	0,018	0,022	0,013	0,018	0,035	0,022	0,028	0,018	0,018	0,010	0,011	--	0,04
Higher Frequencies													
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0,105	0,088	0,099	0,091	0,097	0,099	0,114	0,089	0,116	0,065	0,073	--	0,2
2,3	0,059	0,075	0,105	0,081	0,081	0,082	0,091	0,065	0,088	0,116	0,086	--	0,2
2,5	0,052	0,064	0,084	0,085	0,081	0,077	0,080	0,064	0,089	0,053	0,100	--	0,2
2,7	0,056	0,096	0,109	0,106	0,074	0,071	0,081	0,153	0,167	0,024	0,050	--	0,2
2,9	0,044	0,063	0,053	0,085	0,089	0,104	0,143	0,169	0,188	0,132	0,133	--	0,2
3,1	0,084	0,083	0,095	0,098	0,089	0,063	0,072	0,181	0,191	0,034	0,057	--	0,2
3,3	0,035	0,079	0,061	0,067	0,079	0,085	0,091	0,025	0,053	0,030	0,030	--	0,2
3,5	0,028	0,048	0,034	0,046	0,050	0,058	0,069	0,024	0,024	0,027	0,026	--	0,2
3,7	0,031	0,047	0,035	0,037	0,048	0,060	0,074	0,024	0,024	0,031	0,029	--	0,2
3,9	0,028	0,038	0,033	0,040	0,046	0,060	0,071	0,027	0,027	0,034	0,031	--	0,2
4,1	0,026	0,031	0,027	0,029	0,036	0,038	0,038	0,027	0,026	0,028	0,027	--	0,2
4,3	0,029	0,029	0,032	0,036	0,042	0,049	0,057	0,029	0,028	0,027	0,026	--	0,2
4,5	0,042	0,047	0,046	0,052	0,056	0,061	0,067	0,054	0,054	0,052	0,051	--	0,2
4,7	0,048	0,050	0,044	0,050	0,057	0,059	0,056	0,049	0,046	0,053	0,051	--	0,2
4,9	0,047	0,049	0,049	0,047	0,054	0,053	0,055	0,043	0,040	0,054	0,050	--	0,2
5,1	0,026	0,038	0,040	0,041	0,041	0,048	0,050	0,034	0,029	0,032	0,030	--	0,2
5,3	0,027	0,029	0,028	0,035	0,035	0,036	0,038	0,030	0,029	0,030	0,030	--	0,2
5,5	0,029	0,030	0,029	0,025	0,031	0,036	0,038	0,031	0,029	0,032	0,032	--	0,2
5,7	0,037	0,035	0,033	0,033	0,038	0,041	0,044	0,035	0,033	0,040	0,041	--	0,2
5,9	0,035	0,029	0,023	0,025	0,028	0,048	0,058	0,033	0,034	0,048	0,046	--	0,2
6,1	0,031	0,025	0,029	0,037	0,041	0,027	0,030	0,056	0,065	0,031	0,038	--	0,2
6,3	0,021	0,020	0,018	0,019	0,021	0,023	0,027	0,027	0,028	0,029	0,032	--	0,2
6,5	0,020	0,018	0,019	0,020	0,022	0,023	0,023	0,023	0,024	0,028	0,029	--	0,2
6,7	0,020	0,020	0,021	0,023	0,023	0,025	0,027	0,027	0,030	0,029	0,031	--	0,2
6,9	0,026	0,024	0,025	0,024	0,026	0,026	0,027	0,030	0,032	0,035	0,037	--	0,2
7,1	0,020	0,025	0,025	0,026	0,027	0,027	0,029	0,024	0,024	0,026	0,027	--	0,2
7,3	0,015	0,016	0,017	0,017	0,017	0,017	0,018	0,018	0,019	0,018	0,019	--	0,2
7,5	0,020	0,020	0,020	0,020	0,020	0,021	0,022	0,022	0,023	0,022	0,022	--	0,2
7,7	0,014	0,015	0,015	0,015	0,015	0,016	0,016	0,016	0,016	0,015	0,016	--	0,2
7,9	0,014	0,013	0,013	0,014	0,014	0,014	0,014	0,015	0,016	0,014	0,014	--	0,2
8,1	0,012	0,012	0,012	0,012	0,012	0,013	0,014	0,014	0,014	0,013	0,013	--	0,2
8,3	0,012	0,012	0,012	0,012	0,013	0,013	0,013	0,013	0,013	0,014	0,014	--	0,2
8,5	0,012	0,011	0,011	0,012	0,012	0,013	0,013	0,013	0,013	0,013	0,014	--	0,2
8,7	0,012	0,012	0,012	0,012	0,013	0,013	0,013	0,013	0,013	0,013	0,013	--	0,2
8,9	0,010	0,010	0,010	0,011	0,012	0,012	0,012	0,011	0,011	0,011	0,012	--	0,2

Note:
The normalization current is 34,8 A.
The stated harmonics are maximum values of all 3 phases.
The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 are 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.

Test result: SOFAR 15KTLX-G3

Harmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	2,870	10,145	20,492	30,780	41,094	51,333	61,582	71,802	82,250	92,307	102,366	--	--
2	0,558	0,049	0,058	0,068	0,070	0,072	0,079	0,075	0,045	0,047	0,050	--	--
3	0,133	0,135	0,130	0,142	0,143	0,150	0,149	0,159	0,082	0,086	0,093	--	--
4	0,116	0,088	0,087	0,075	0,072	0,070	0,067	0,062	0,041	0,043	0,041	--	--
5	0,913	0,419	0,567	0,702	0,689	0,676	0,677	0,651	0,228	0,228	0,227	10,7	3,6
6	0,048	0,033	0,038	0,034	0,033	0,035	0,034	0,034	0,023	0,022	0,021	--	--
7	0,617	0,222	0,380	0,477	0,490	0,473	0,465	0,469	0,148	0,152	0,162	7,2	2,5
8	0,251	0,031	0,037	0,026	0,027	0,027	0,026	0,024	0,015	0,013	0,015	--	--
9	0,061	0,043	0,071	0,062	0,063	0,066	0,063	0,063	0,025	0,025	0,023	--	--
10	0,158	0,020	0,028	0,031	0,028	0,025	0,025	0,022	0,014	0,013	0,013	--	--
11	0,246	0,601	0,294	0,210	0,235	0,276	0,298	0,285	0,091	0,080	0,080	3,1	1,0
12	0,044	0,024	0,023	0,018	0,018	0,018	0,018	0,019	0,011	0,010	0,011	--	--
13	0,224	0,489	0,274	0,162	0,167	0,193	0,233	0,247	0,080	0,081	0,080	2	0,7
14	0,226	0,018	0,023	0,015	0,020	0,018	0,018	0,018	0,009	0,010	0,011	--	--
15	0,043	0,071	0,073	0,032	0,031	0,036	0,037	0,033	0,014	0,020	0,015	--	--
16	0,187	0,026	0,022	0,019	0,017	0,021	0,019	0,018	0,008	0,009	0,010	--	--
17	0,342	0,430	0,185	0,091	0,058	0,123	0,166	0,195	0,069	0,055	0,066	--	--
18	0,055	0,018	0,019	0,018	0,017	0,017	0,018	0,017	0,008	0,008	0,009	--	--
19	0,209	0,460	0,088	0,083	0,061	0,076	0,112	0,134	0,061	0,055	0,058	--	--
20	0,129	0,019	0,021	0,015	0,016	0,017	0,017	0,018	0,007	0,008	0,009	--	--
21	0,053	0,040	0,026	0,022	0,026	0,029	0,028	0,028	0,010	0,015	0,013	--	--
22	0,137	0,021	0,021	0,015	0,016	0,017	0,018	0,018	0,006	0,007	0,008	--	--
23	0,116	0,193	0,174	0,123	0,081	0,075	0,152	0,191	0,075	0,048	0,067	--	--
24	0,065	0,019	0,022	0,016	0,017	0,016	0,017	0,018	0,007	0,007	0,008	--	--
25	0,131	0,168	0,177	0,105	0,085	0,044	0,098	0,132	0,062	0,051	0,061	--	--
26	0,089	0,022	0,025	0,020	0,018	0,019	0,022	0,023	0,008	0,008	0,009	--	--
27	0,041	0,048	0,053	0,039	0,032	0,032	0,037	0,037	0,010	0,013	0,015	--	--
28	0,108	0,017	0,025	0,017	0,015	0,017	0,019	0,020	0,007	0,008	0,008	--	--
29	0,193	0,129	0,078	0,185	0,167	0,058	0,127	0,182	0,077	0,052	0,077	--	--
30	0,074	0,017	0,016	0,013	0,013	0,016	0,019	0,019	0,007	0,007	0,007	--	--
31	0,107	0,150	0,077	0,119	0,144	0,084	0,097	0,132	0,070	0,044	0,067	--	--
32	0,100	0,017	0,014	0,016	0,014	0,014	0,017	0,021	0,008	0,007	0,007	--	--
33	0,046	0,034	0,060	0,033	0,037	0,032	0,030	0,039	0,009	0,013	0,011	--	--
34	0,095	0,016	0,014	0,015	0,012	0,016	0,018	0,019	0,006	0,006	0,007	--	--
35	0,132	0,296	0,167	0,074	0,185	0,161	0,080	0,156	0,078	0,051	0,077	--	--
36	0,069	0,014	0,013	0,012	0,011	0,013	0,016	0,020	0,006	0,007	0,008	--	--
37	0,038	0,213	0,084	0,091	0,119	0,139	0,082	0,098	0,092	0,049	0,079	--	--
38	0,066	0,019	0,014	0,014	0,013	0,013	0,016	0,017	0,008	0,009	0,016	--	--
39	0,046	0,053	0,036	0,028	0,034	0,022	0,033	0,039	0,019	0,017	0,012	--	--
40	0,064	0,015	0,013	0,015	0,012	0,013	0,013	0,015	0,009	0,007	0,007	--	--
41	0,120	0,118	0,063	0,130	0,067	0,147	0,093	0,070	0,116	0,088	0,093	--	--
42	0,057	0,013	0,012	0,010	0,013	0,012	0,016	0,015	0,010	0,009	0,008	--	--
43	0,072	0,100	0,072	0,093	0,055	0,104	0,100	0,047	0,053	0,429	0,157	--	--

44	0,069	0,012	0,011	0,011	0,011	0,017	0,021	0,014	0,009	0,014	0,011	--	--
45	0,037	0,019	0,029	0,022	0,025	0,022	0,027	0,028	0,051	0,063	0,060	--	--
46	0,051	0,014	0,009	0,016	0,010	0,014	0,017	0,015	0,010	0,011	0,015	--	--
47	0,055	0,065	0,030	0,062	0,066	0,078	0,091	0,043	0,067	0,487	0,182	--	--
48	0,042	0,013	0,012	0,011	0,011	0,011	0,013	0,013	0,009	0,015	0,014	--	--
49	0,052	0,022	0,036	0,032	0,065	0,044	0,084	0,051	0,018	0,045	0,080	--	--
50	0,046	0,012	0,010	0,011	0,009	0,012	0,013	0,014	0,006	0,008	0,016	--	--
Interharmonics													
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0,150	0,028	0,021	0,024	0,029	0,090	0,090	0,086	0,023	0,026	0,029	--	0,40
125	0,157	0,024	0,019	0,021	0,023	0,032	0,035	0,032	0,015	0,015	0,015	--	0,60
175	0,145	0,023	0,023	0,024	0,027	0,030	0,028	0,026	0,016	0,015	0,016	--	0,43
225	0,090	0,023	0,022	0,026	0,026	0,028	0,027	0,027	0,016	0,016	0,016	--	0,33
275	0,081	0,023	0,023	0,028	0,027	0,031	0,030	0,030	0,016	0,017	0,018	--	0,27
325	0,057	0,023	0,023	0,031	0,028	0,030	0,029	0,029	0,017	0,017	0,018	--	0,23
375	0,098	0,025	0,023	0,032	0,029	0,030	0,030	0,029	0,017	0,017	0,019	--	0,20
425	0,093	0,024	0,023	0,031	0,029	0,030	0,030	0,029	0,016	0,017	0,019	--	0,18
475	0,069	0,025	0,026	0,030	0,030	0,030	0,031	0,030	0,016	0,017	0,019	--	0,16
525	0,076	0,025	0,028	0,028	0,030	0,033	0,032	0,033	0,015	0,016	0,020	--	0,14
575	0,069	0,026	0,028	0,028	0,029	0,031	0,031	0,031	0,015	0,016	0,019	--	0,13
625	0,044	0,033	0,026	0,027	0,029	0,030	0,029	0,029	0,014	0,015	0,018	--	0,12
675	0,084	0,029	0,023	0,028	0,028	0,029	0,029	0,029	0,014	0,015	0,018	--	0,11
725	0,073	0,024	0,024	0,026	0,027	0,028	0,028	0,028	0,014	0,021	0,017	--	0,10
775	0,067	0,025	0,024	0,025	0,027	0,028	0,029	0,029	0,016	0,016	0,017	--	0,10
825	0,069	0,024	0,022	0,024	0,026	0,028	0,028	0,028	0,015	0,014	0,016	--	0,09
875	0,063	0,024	0,022	0,024	0,025	0,026	0,026	0,027	0,013	0,013	0,016	--	0,09
925	0,039	0,024	0,022	0,023	0,024	0,025	0,025	0,026	0,012	0,013	0,015	--	0,08
975	0,054	0,024	0,022	0,022	0,024	0,025	0,025	0,026	0,012	0,012	0,015	--	0,08
1025	0,055	0,023	0,021	0,023	0,023	0,025	0,025	0,026	0,011	0,012	0,014	--	0,07
1075	0,050	0,024	0,022	0,023	0,025	0,026	0,026	0,026	0,012	0,014	0,015	--	0,07
1125	0,049	0,023	0,021	0,022	0,023	0,025	0,025	0,026	0,011	0,012	0,014	--	0,07
1175	0,047	0,022	0,020	0,021	0,022	0,023	0,024	0,025	0,010	0,011	0,013	--	0,06
1225	0,034	0,021	0,020	0,020	0,021	0,023	0,024	0,025	0,010	0,012	0,014	--	0,06
1275	0,037	0,020	0,019	0,020	0,020	0,021	0,022	0,023	0,010	0,011	0,013	--	0,06
1325	0,035	0,020	0,019	0,020	0,020	0,022	0,023	0,024	0,012	0,012	0,014	--	0,06
1375	0,036	0,020	0,019	0,019	0,019	0,021	0,022	0,023	0,011	0,011	0,013	--	0,05
1425	0,036	0,019	0,018	0,018	0,018	0,021	0,022	0,024	0,010	0,011	0,013	--	0,05
1475	0,033	0,018	0,018	0,018	0,018	0,021	0,022	0,024	0,010	0,011	0,013	--	0,05
1525	0,028	0,018	0,017	0,016	0,016	0,018	0,019	0,020	0,010	0,010	0,012	--	0,05
1575	0,033	0,017	0,016	0,016	0,016	0,017	0,019	0,020	0,011	0,010	0,012	--	0,05
1625	0,034	0,016	0,016	0,015	0,015	0,017	0,018	0,020	0,013	0,014	0,016	--	0,05
1675	0,030	0,017	0,016	0,015	0,015	0,017	0,018	0,020	0,011	0,012	0,012	--	0,04
1725	0,033	0,020	0,015	0,015	0,015	0,018	0,019	0,019	0,010	0,010	0,012	--	0,04
1775	0,029	0,017	0,017	0,014	0,015	0,019	0,019	0,019	0,011	0,010	0,012	--	0,04
1825	0,026	0,015	0,016	0,014	0,015	0,018	0,019	0,019	0,010	0,010	0,012	--	0,04
1875	0,026	0,016	0,015	0,015	0,014	0,016	0,017	0,019	0,018	0,018	0,013	--	0,04
1925	0,025	0,014	0,016	0,014	0,013	0,015	0,016	0,019	0,010	0,009	0,010	--	0,04

1975	0,026	0,015	0,013	0,014	0,014	0,025	0,027	0,028	0,011	0,011	0,011	--	0,04
Higher Frequencies													
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	A2 limit	B limit
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0,166	0,148	0,098	0,146	0,085	0,168	0,144	0,095	0,133	0,067	0,177	--	0,2
2,3	0,094	0,068	0,052	0,073	0,075	0,087	0,093	0,069	0,091	0,117	0,172	--	0,2
2,5	0,090	0,046	0,047	0,045	0,073	0,054	0,092	0,065	0,030	0,056	0,096	--	0,2
2,7	0,081	0,064	0,069	0,050	0,070	0,060	0,082	0,073	0,031	0,031	0,050	--	0,2
2,9	0,066	0,062	0,043	0,039	0,041	0,048	0,055	0,057	0,119	0,132	0,147	--	0,2
3,1	0,098	0,099	0,092	0,091	0,092	0,151	0,163	0,178	0,034	0,034	0,040	--	0,2
3,3	0,053	0,051	0,056	0,028	0,041	0,046	0,039	0,045	0,031	0,030	0,030	--	0,2
3,5	0,047	0,036	0,041	0,026	0,032	0,035	0,035	0,036	0,026	0,026	0,027	--	0,2
3,7	0,047	0,042	0,042	0,029	0,034	0,034	0,037	0,034	0,029	0,031	0,029	--	0,2
3,9	0,043	0,054	0,055	0,029	0,036	0,039	0,045	0,038	0,031	0,032	0,031	--	0,2
4,1	0,041	0,041	0,040	0,025	0,027	0,034	0,038	0,034	0,026	0,028	0,027	--	0,2
4,3	0,044	0,043	0,040	0,031	0,032	0,038	0,041	0,038	0,026	0,027	0,027	--	0,2
4,5	0,068	0,072	0,063	0,055	0,055	0,067	0,074	0,076	0,049	0,051	0,051	--	0,2
4,7	0,076	0,071	0,070	0,063	0,060	0,064	0,070	0,075	0,054	0,053	0,051	--	0,2
4,9	0,073	0,071	0,068	0,064	0,058	0,063	0,071	0,074	0,055	0,053	0,050	--	0,2
5,1	0,043	0,039	0,039	0,039	0,035	0,041	0,048	0,050	0,030	0,032	0,030	--	0,2
5,3	0,043	0,041	0,040	0,037	0,036	0,043	0,046	0,049	0,031	0,030	0,029	--	0,2
5,5	0,045	0,044	0,042	0,039	0,037	0,043	0,049	0,052	0,033	0,032	0,032	--	0,2
5,7	0,058	0,058	0,057	0,054	0,050	0,054	0,062	0,066	0,042	0,040	0,041	--	0,2
5,9	0,056	0,055	0,054	0,051	0,048	0,051	0,057	0,061	0,046	0,047	0,051	--	0,2
6,1	0,046	0,046	0,047	0,046	0,046	0,057	0,063	0,068	0,032	0,031	0,034	--	0,2
6,3	0,033	0,032	0,036	0,033	0,031	0,034	0,040	0,044	0,031	0,028	0,032	--	0,2
6,5	0,031	0,033	0,032	0,031	0,031	0,033	0,035	0,037	0,029	0,028	0,030	--	0,2
6,7	0,031	0,032	0,031	0,031	0,032	0,033	0,036	0,041	0,030	0,029	0,031	--	0,2
6,9	0,042	0,042	0,041	0,040	0,041	0,041	0,045	0,048	0,036	0,035	0,037	--	0,2
7,1	0,031	0,031	0,031	0,031	0,034	0,035	0,036	0,037	0,025	0,026	0,027	--	0,2
7,3	0,024	0,023	0,023	0,023	0,026	0,026	0,027	0,029	0,018	0,018	0,019	--	0,2
7,5	0,032	0,031	0,031	0,031	0,033	0,032	0,034	0,036	0,022	0,021	0,023	--	0,2
7,7	0,023	0,023	0,022	0,022	0,023	0,023	0,024	0,025	0,016	0,015	0,016	--	0,2
7,9	0,022	0,022	0,021	0,021	0,022	0,022	0,023	0,023	0,015	0,014	0,014	--	0,2
8,1	0,019	0,019	0,019	0,018	0,020	0,020	0,020	0,021	0,013	0,013	0,013	--	0,2
8,3	0,019	0,019	0,019	0,019	0,020	0,020	0,020	0,021	0,013	0,014	0,014	--	0,2
8,5	0,020	0,019	0,020	0,019	0,020	0,020	0,020	0,021	0,013	0,014	0,013	--	0,2
8,7	0,019	0,019	0,019	0,019	0,019	0,019	0,019	0,020	0,013	0,013	0,013	--	0,2
8,9	0,016	0,016	0,016	0,016	0,016	0,016	0,017	0,017	0,011	0,011	0,011	--	0,2

Note:

The normalization current is 21,7 A.

The stated harmonics are maximum values of all 3 phases.

The tests had been performed on the SOFAR 24KTLX-G3 and SOFAR 15KTLX-G3 are 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.

TECHNICAL REGULATION 3.3.2: Control and regulation		
Clause	**Test requirement**	**Result**
5.1	Gneral requirment	**P**
5.2	Active power control functions	**P**
5.2.1	Frequency response	**P**
5.2.2	Frequency control	**N/A**
5.2.3	Constraint functions	**P**
5.3	Reactive power and voltage control functions	**P**
5.3.1	Q control	**P**
5.3.2	Power factor control	**P**
5.3.3	Voltage control	**N/A**
5.3.4	Automatic power factor control	**P**
5.4	System protection	**N/A**
5.5	Order of priority for control functions and protection	**P**
5.6	Active power control requirements	**P**
5.6.1	Category A2 and B PV power plants	**P**
5.6.2	Category C and D PV power plants	**N/A**
5.7	Reactive power control requirements	**P**
5.7.1	Category A2 PV power plants	**P**
5.7.2	Category B PV power plants	**P**
5.7.3	Category C PV power plants	**N/A**
5.7.4	Category D PV power plants	**N/A**

5.2.1 Frequency response							P
Test result: SOFAR 24KTLX-G3							
1-min mean value [Hz]:	a) 50,00	b) 50,25	c) 50,70	d) 51,90	e) 50,70	f) 50,25	g) 50,00
1. Measurement a) to g): Active power output =100% P_{Emax} s=4% (50% P_n / Hz), threshold frequency for start/return: 50,2Hz							
Frequency [Hz]:	50,00	50,25	50,70	51,90	50,70	50,25	50,00
P_M [kW]:	N/A	23,424	18,024	3,624	18,024	23,424	N/A
P_{E60} [kW]:	24,024	23,370	17,980	3,514	17,979	23,369	24,026
$\Delta P_{E60}/P_M$ [%]:	N/A	0,23	0,18	0,46	0,19	0,23	N/A
2. Measurement a) to g): Active power output 60% after freezing = 100% P_{Emax} s=4% (50% P_n / Hz), threshold frequency for start/return: 50,2Hz							
Frequency [Hz]:	50,00	50,25	50,70	51,90	50,70	50,25	50,00
P_M [kW]:	N/A	13,850	8,450	0,000	8,450	13,850	N/A
P_{E60} [kW]:	14,450	13,952	8,476	0,335	8,476	13,950	24,025
$\Delta P_{E60}/P_M$ [%]:	N/A	0,42	0,11	1,39	0,11	0,42	N/A
Limit $\Delta P/P_{1min}$:	± 10 % of P_{Emax}						

Test:
The test is conducted for two powers. First, the test must start at a power =100% P_{Emax} ("Measurement 1"), and in a second test, for a power 60% P_{Emax} ("Measurement 2"). In the second test, after freezing of the P_M, the available active power output must be increased to a value =100% P_{Emax}, and after the network frequency of 50,2Hz is fallen below, the rise of the active power gradient must be recorded.

Point g) must be held until the micro-generator is again feeding in with the active power output available.

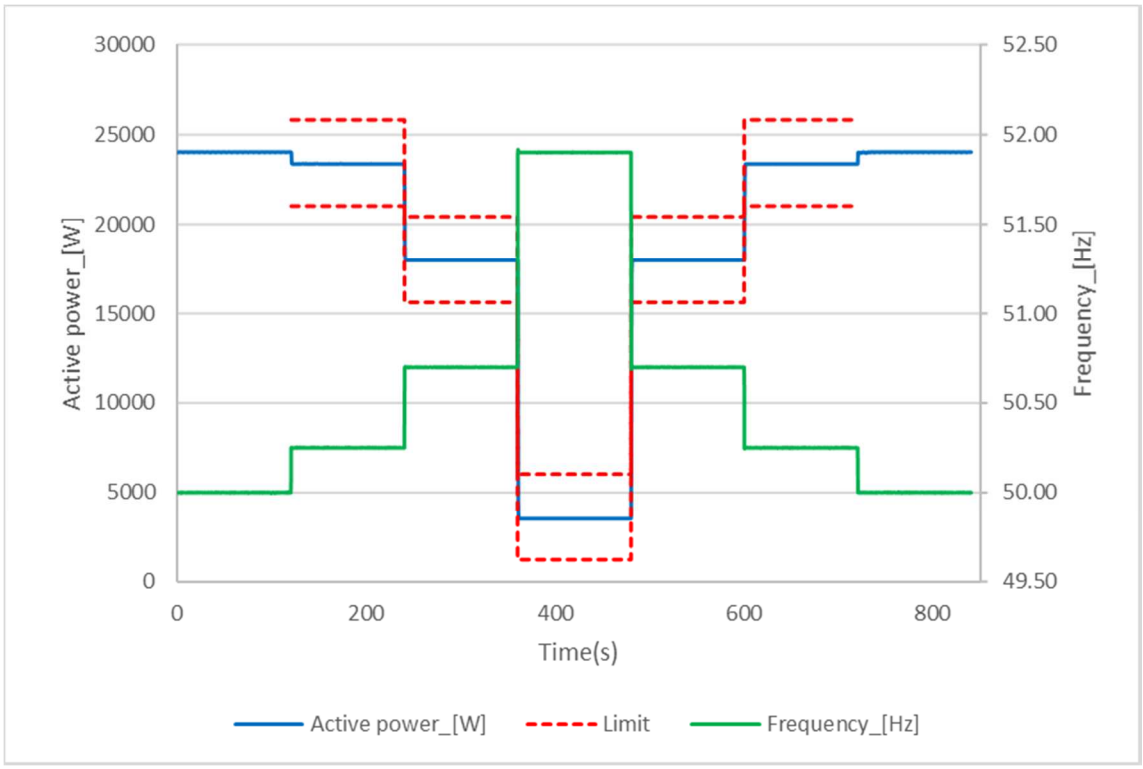
Assessment criterion:
It must be possible to set the frequency f_R to any value in the 50,00-52,00 Hz range with an accuracy of 10 mHz or higher. The standard f_R value is 50,20 Hz.

It must be possible to set the droop for the downward regulation to any value in the range 2-12% of P_n and this must be effected with an accuracy of ±10% of P_n . The standard value for droop is 4% of P_n.

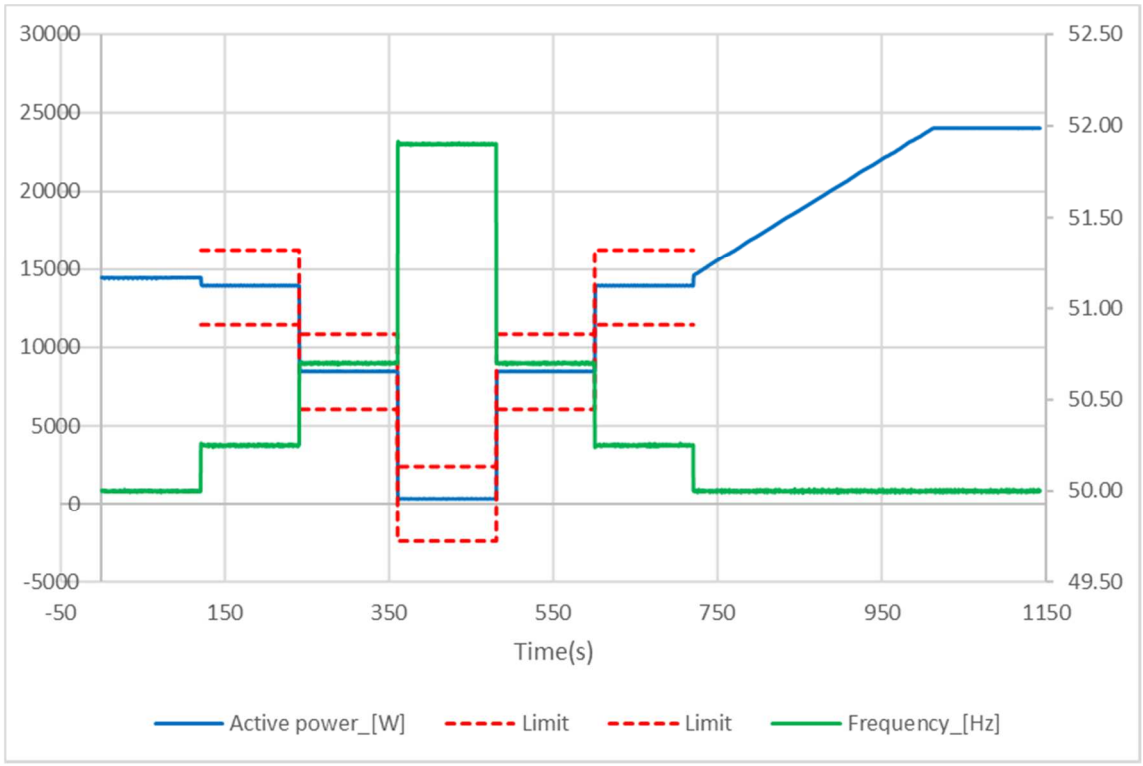
The frequency response control must start no later than two seconds after a frequency change is detected and must be completed within 15 seconds.

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.

Graph of Measurement 1: Active power output > 80% P_{Emax}



Graph of Measurement 2:Active power output 40% and 60% after freezing > 80% P_n



5.2.3 Constraint functions 5.4 System protection	P

Test result:

Setpoint power bin [%P_{Emax}]	P_{set} [kW]	P_{60} [kW]	Deviation [%P_{Emax}]
100%	24,000	24,087	0,364
90%	21,600	21,644	0,185
80%	19,200	19,199	-0,003
70%	16,800	16,747	-0,221
60%	14,400	14,366	-0,140
50%	12,000	12,084	0,351
40%	9,600	9,648	0,201
30%	7,200	7,214	0,059
20%	4,800	4,773	-0,112
10%	2,400	2,462	0,260
3%	0,720	0,591	0,260

	Setpoint power bin [%P_{Emax}]	Deviation [%P_{Emax}]
Max. deviation	100%	0,364
Limit $\Delta P_{E60}/P_{Setpoint}$:	±0.5 % of P_{Emax} or ±2 % of P_{set}, the highest value	

Test:

The setpoint signal must be reduced from 100% to 0% P_{Emax}:

a) for adjustable PGUs in increments of 10% P_{Emax}, 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint, Then the active power of the PGU must be measured as a 1-min mean value.

b) For all other PGUs, in line with their adjustable steps, 5 minutes must elapse after the setpoint setting is changed so that the PGU can settle at the new setpoint, Then the active power of the PGU must be measured as a 1-min mean value.

Assessment criterion:

a) for adjustable PGUs:

- no network disconnection
- the active power value does not exceed the setpoint by more than 5% P_{Emax}
- the setting time determined this way is ≤ 1min

b) For all other PGUs:

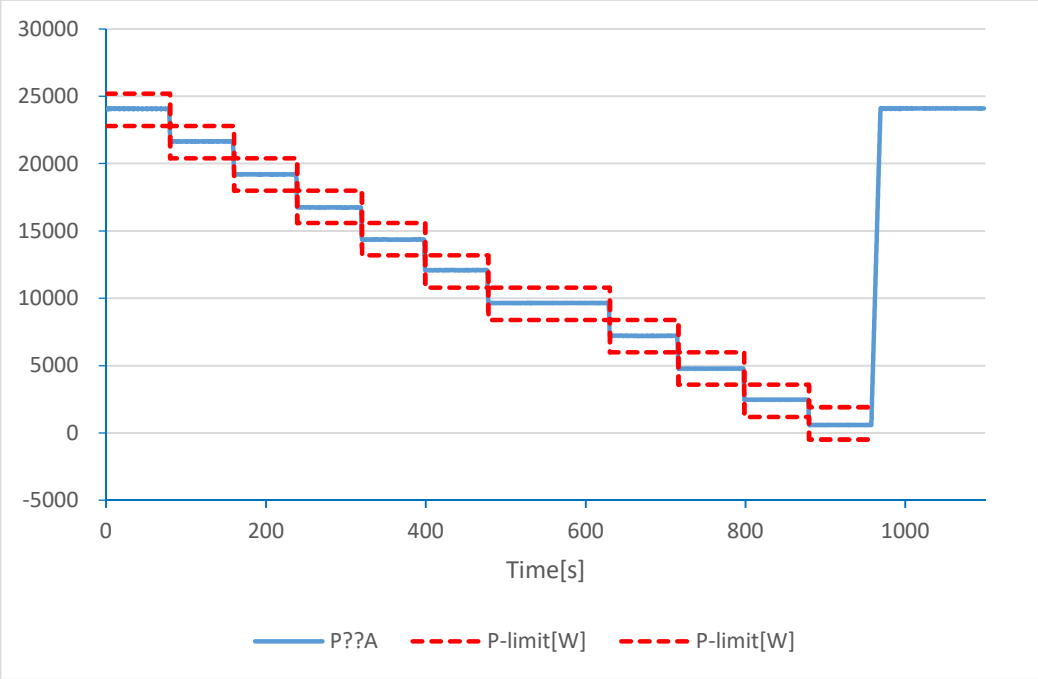
- the active power value does not exceed the setpoint by more than 5% P_{Emax} or
- the setpoint is fallen below within 5 minutes or the PGU has switched off

Note:

The setting time is ≤ 1min. See below “Graph of the setting accuracy”.

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.

Graph of active power on set point



5.3.1 **5.7.1** **5.7.2**	**Q control** **Category A2 PV power plants** **Category B PV power plants**	**P**

Test result:

Inducitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	0,983	-11,624	0,084	229,62
20%	3,430	-11,626	0,283	229,74
30%	5,866	-11,630	0,450	229,84
40%	8,289	-11,626	0,581	229,93
50%	10,720	-11,633	0,678	230,04
60%	13,111	-11,635	0,748	230,14
70%	15,509	-11,627	0,800	230,27
80%	17,896	-11,630	0,838	230,37
90%	20,272	-11,628	0,867	230,47
100%	22,637	-11,632	0,889	230,58
Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	1,011	11,628	0,087	229,69
20%	3,460	11,627	0,285	229,82
30%	5,891	11,628	0,452	229,91
40%	8,318	11,625	0,582	230,00
50%	10,741	11,626	0,679	230,13
60%	13,141	11,626	0,749	230,22
70%	15,540	11,626	0,801	230,34
80%	17,928	11,628	0,839	230,45
90%	20,305	11,626	0,868	230,56
100%	22,669	11,630	0,890	230,67
Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,394	-0,317	0,9999	230,10
20%	4,839	-0,342	0,9999	230,22
30%	7,268	-0,379	0,9999	230,31
40%	9,694	-0,432	0,9999	230,40
50%	12,111	-0,495	0,9999	230,51
60%	14,523	-0,576	0,9999	230,62
70%	16,928	-0,676	0,9999	230,73
80%	19,322	-0,782	0,9999	230,81
90%	21,707	-0,900	0,9999	230,92
100%	24,082	-1,024	0,9999	231,00

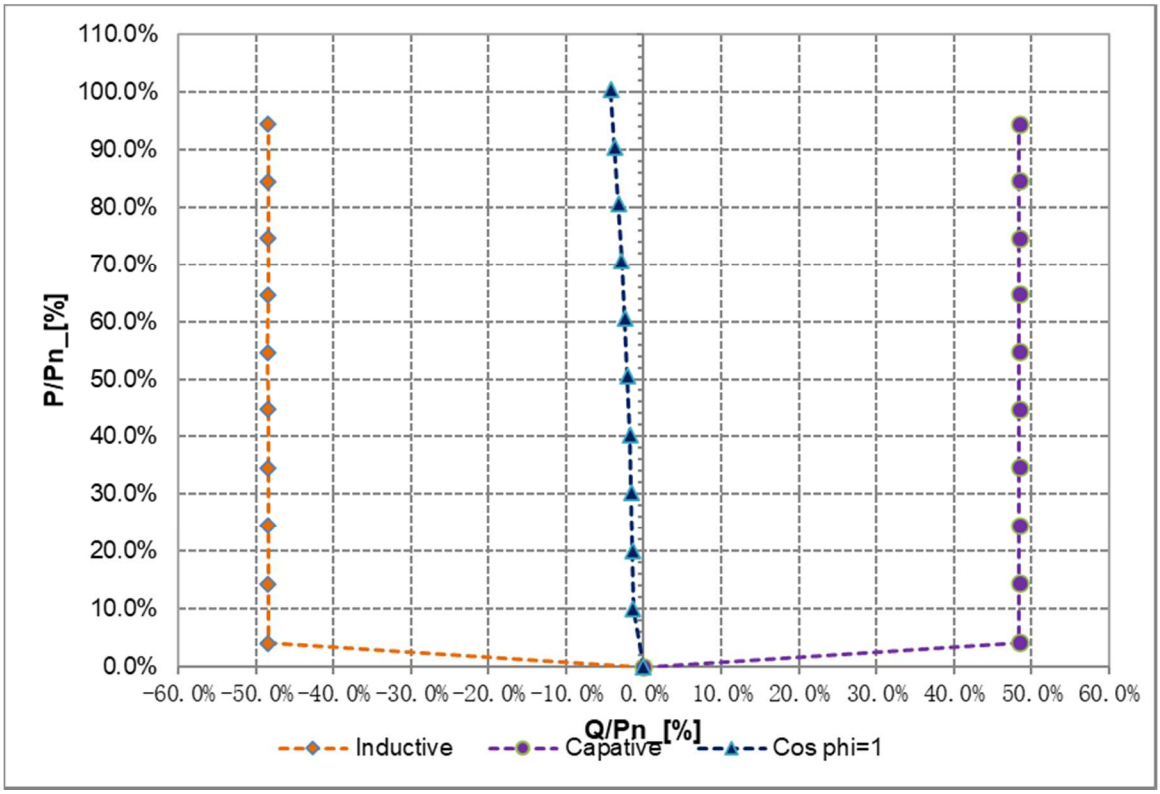
Assessment criterion:

Any change to the Q control set point must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the set point.

The PV power plant must be able to receive a Q set point with an accuracy of 0,1 kVAr.

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.

Diagram



5.3.2 Power factor control 5.7.1 Category A2 PV power plants 5.7.2 Category B PV power plants	P

Test result:

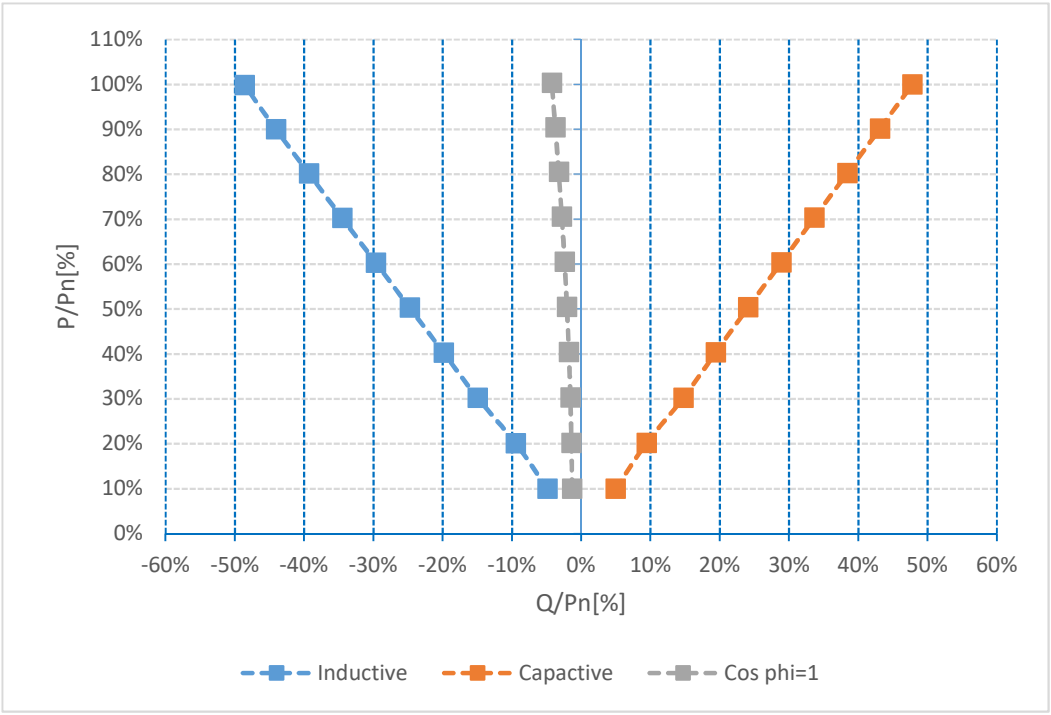
PF = 0,9 / Inducitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,391	-1,174	0,8977	230,10
20%	4,828	-2,270	0,9050	230,15
30%	7,247	-3,590	0,8960	230,27
40%	9,663	-4,770	0,8967	230,34
50%	12,067	-5,942	0,8971	230,46
60%	14,464	-7,117	0,8973	230,51
70%	16,860	-8,284	0,8975	230,61
80%	19,236	-9,436	0,8978	230,72
90%	21,600	-10,581	0,8980	230,81
100%	23,957	-11,665	0,8991	230,93
PF = 0,9 / Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,397	1,188	0,8959	230,18
20%	4,835	2,260	0,9059	230,27
30%	7,258	3,535	0,8991	230,35
40%	9,679	4,657	0,9011	230,44
50%	12,088	5,781	0,9021	230,54
60%	14,490	6,931	0,9021	230,65
70%	1,6880	8,073	0,9021	230,77
80%	19,263	9,213	0,9021	230,86
90%	21,635	10,346	0,9022	230,94
100%	23,993	11,468	0,9022	231,01

Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,394	-0,317	0,9999	230,10
20%	4,839	-0,342	0,9999	230,22
30%	7,268	-0,379	0,9999	230,31
40%	9,694	-0,432	0,9999	230,40
50%	12,111	-0,495	0,9999	230,51
60%	14,523	-0,576	0,9999	230,62
70%	16,928	-0,676	0,9999	230,73
80%	19,322	-0,782	0,9999	230,81
90%	21,707	-0,900	0,9999	230,92
100%	24,082	-1,024	0,9999	231,00

Assessment criterion:

The PV power plant must be able to receive a Power Factor set point with a resolution of 0.01.
Any change to the Power factor set point must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the set point.
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.

Diagram

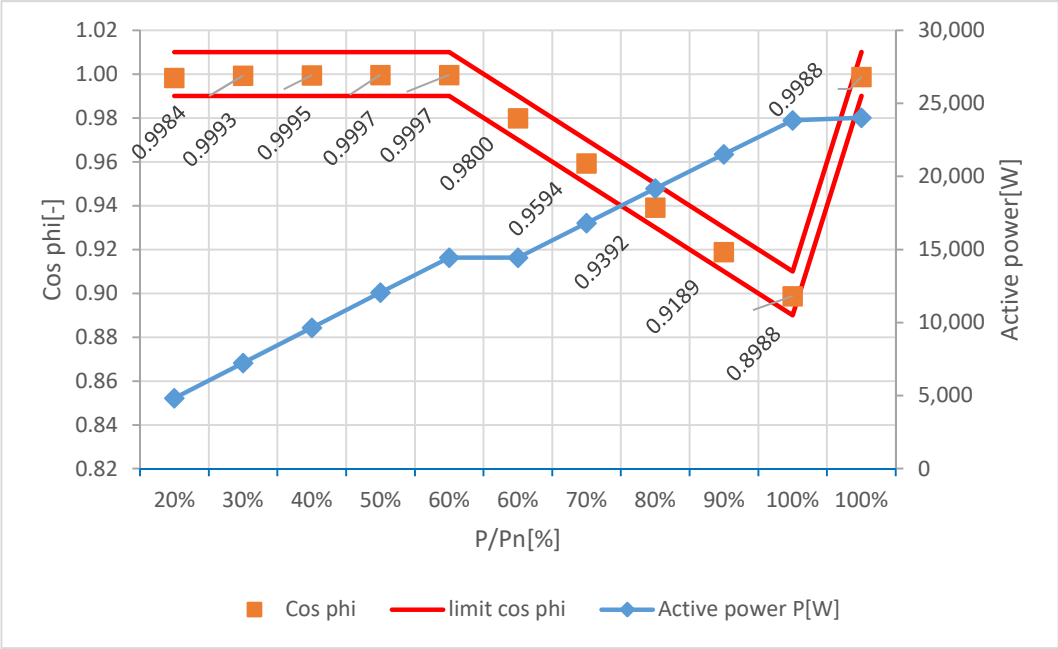


5.3.4	Automatic power factor control	P

Test result: SOFAR 24KTLX-G3

Inductive reactive power absorbation

Power-BIN	Active power P[kW]	Reactive power Q[kVar]	cosφ measured	cosφ expected	Δ cosφ
20%	4,830	-0,256	0,9984	1,00	0,0016
30%	7,249	-0,267	0,9993	1,00	0,0007
40%	9,658	-0,286	0,9995	1,00	0,0005
50%	12,061	-0,315	0,9997	1,00	0,0003
60%	14,448	-2,934	0,9800	0,98	0,0000
70%	16,816	-4,942	0,9594	0,96	0,0006
80%	19,174	-7,008	0,9392	0,94	0,0008
90%	21,520	-9,241	0,9189	0,92	0,0011
100%	23,839	-11,624	0,8988	0,90	0,0012



Note:

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

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.

5.5	Order of priority for control functions and protection	P

Functions	The order of priority
Protective functions, see section 6	1
System protection, see section 5.4	2
Frequency control, see section 5.2.2	3
Constraint functions, see section 5.2.3	4

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.

TECHNICAL REGULATION 3.2.2: Protection		
Clause	**Test requirement**	**Result**
6.1	General	**P**
6.2	Central protection	**N/A**
6.3	Protective setting requirements	**P**
6.3.1	Category A2 PV power plants	**P**
6.3.2	Category B PV power plants	**P**
6.3.3	Category C PV power plants	**N/A**
6.3.4	Category D PV power plants	**N/A**

6.3.1	Category A2 PV power plants	P

Test conditions			Frequency: 50+/-0,2Hz		
Phase	**Limit [V]**	**Trip value [V]**	**Voltage step [V]**	**Disconnection time [s]**	**Limit [s]**
L1	110% of Un = 253,0 (stage 1)	254,2	230,0 to 258,0	60,05	60s ≤ t ≤ 60,1s
		254,2	230,0 to 258,0	60,08	
		254,2	230,0 to 258,0	60,04	
		254,2	230,0 to 258,0	60,09	
		254,2	230,0 to 258,0	60,06	
	115% of Un = 264,5 (stage 2)	265,4	230,0 to 268,0	0,226	0,2s ≤ t ≤ 0,3s
		265,4	230,0 to 268,0	0,228	
		265,4	230,0 to 268,0	0,238	
		265,4	230,0 to 268,0	0,240	
		265,4	230,0 to 268,0	0,244	
	85% of Un = 195,5 (stage 1)	195,9	230,0 to 192,0	50,04	50s ≤ t ≤ 50,1s
		195,9	230,0 to 192,0	50,08	
		195,9	230,0 to 192,0	50,01	
		195,9	230,0 to 192,0	50,06	
		195,9	230,0 to 192,0	50,05	
	80% of U_n = 184 (stage 2)	184,7	230,0 to 180,0	0,143	0,1s ≤ t ≤ 0,2s
		184,7	230,0 to 180,0	0,114	
		184,7	230,0 to 180,0	0,117	
		184,7	230,0 to 180,0	0,144	
		184,7	230,0 to 180,0	0,124	
L2	110% of Un = 253,0 (stage 1)	254,0	230,0 to 258,0	60,08	60s ≤ t ≤ 60,1s
		254,0	230,0 to 258,0	60,09	
		254,0	230,0 to 258,0	60,07	
		254,0	230,0 to 258,0	60,06	
		254,0	230,0 to 258,0	60,08	
	115% of Un = 264,5 (stage 2)	265,5	230,0 to 268,0	0,220	0,2s ≤ t ≤ 0,3s
		265,5	230,0 to 268,0	0,224	
		265,5	230,0 to 268,0	0,230	
		265,5	230,0 to 268,0	0,232	
		265,5	230,0 to 268,0	0,228	
	85% of Un	195,8	230,0 to 192,0	50,02	50s ≤ t ≤ 50,1s
		195,8	230,0 to 192,0	50,05	

	= 195,5 (stage 1)	195,8	230,0 to 192,0	50,03	
		195,8	230,0 to 192,0	50,07	
		195,8	230,0 to 192,0	50,08	
	80% of U_n = 184 (stage 2)	184,4	230,0 to 180,0	0,125	0,1s ≤ t ≤ 0,2s
		184,4	230,0 to 180,0	0,127	
		184,4	230,0 to 180,0	0,141	
		184,4	230,0 to 180,0	0,126	
		184,4	230,0 to 180,0	0,136	
L3	110% of Un = 253,0 (stage 1)	253,9	230,0 to 258,0	60,07	60s ≤ t ≤ 60,1s
		253,9	230,0 to 258,0	60,08	
		253,9	230,0 to 258,0	60,09	
		253,9	230,0 to 258,0	60,08	
		253,9	230,0 to 258,0	60,07	
	115% of Un = 264,5 (stage 2)	264,9	230,0 to 268,0	0,250	0,2s ≤ t ≤ 0,3s
		264,9	230,0 to 268,0	0,230	
		264,9	230,0 to 268,0	0,236	
		264,9	230,0 to 268,0	0,234	
		264,9	230,0 to 268,0	0,240	
	85% of Un = 195,5 (stage 1)	195,8	230,0 to 192,0	50,05	50s ≤ t ≤ 50,1s
		195,8	230,0 to 192,0	50,08	
		195,8	230,0 to 192,0	50,08	
		195,8	230,0 to 192,0	50,07	
		195,8	230,0 to 192,0	50,07	
	80% of U_n = 184 (stage 2)	184,5	230,0 to 180,0	0,123	0,1s ≤ t ≤ 0,2s
		184,5	230,0 to 180,0	0,126	
		184,5	230,0 to 180,0	0,130	
		184,5	230,0 to 180,0	0,129	
		184,5	230,0 to 180,0	0,128	

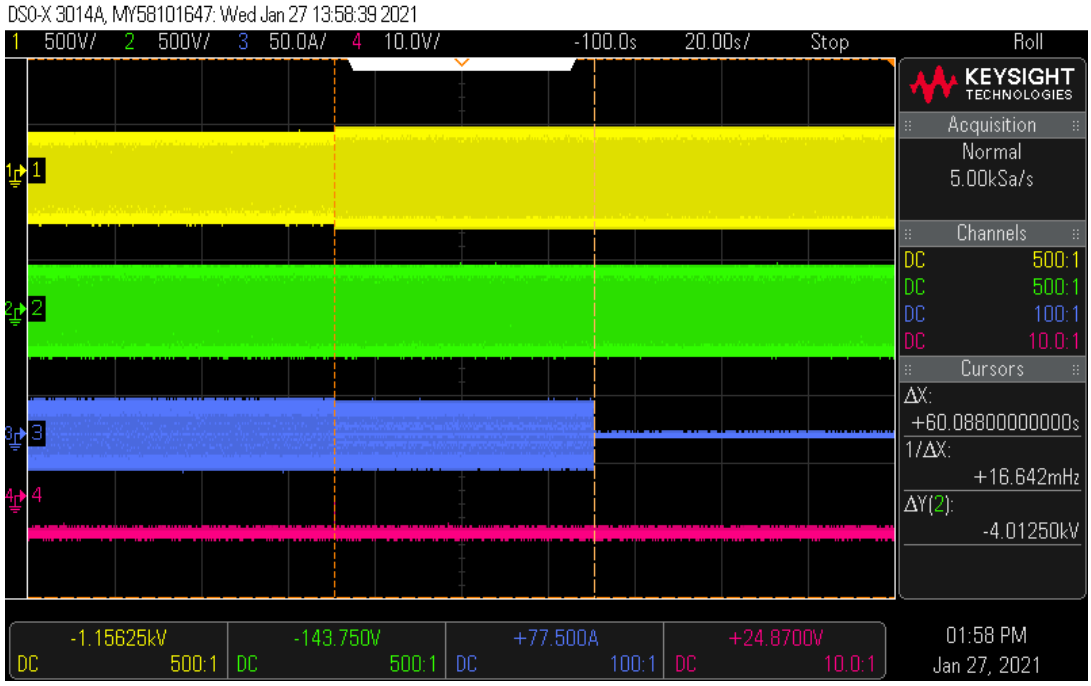
Note:

The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of Un.

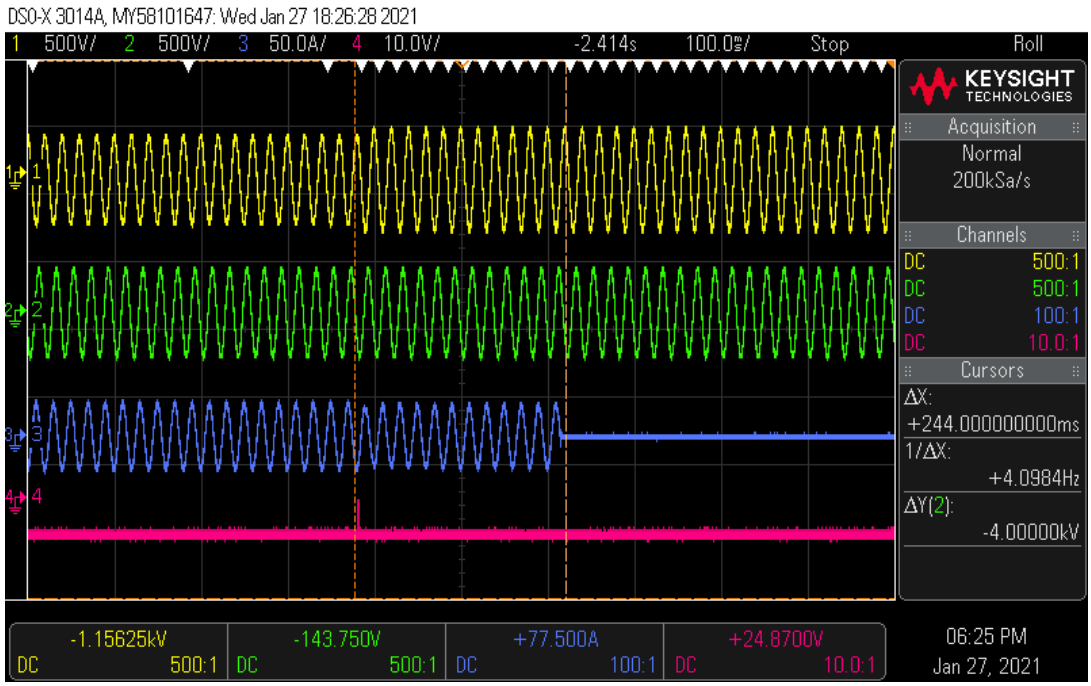
The disconnection time includes disconnect time + operate time of the integrated relay , Therefore limit is give with +100ms according to Table 16 recommended values.

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.

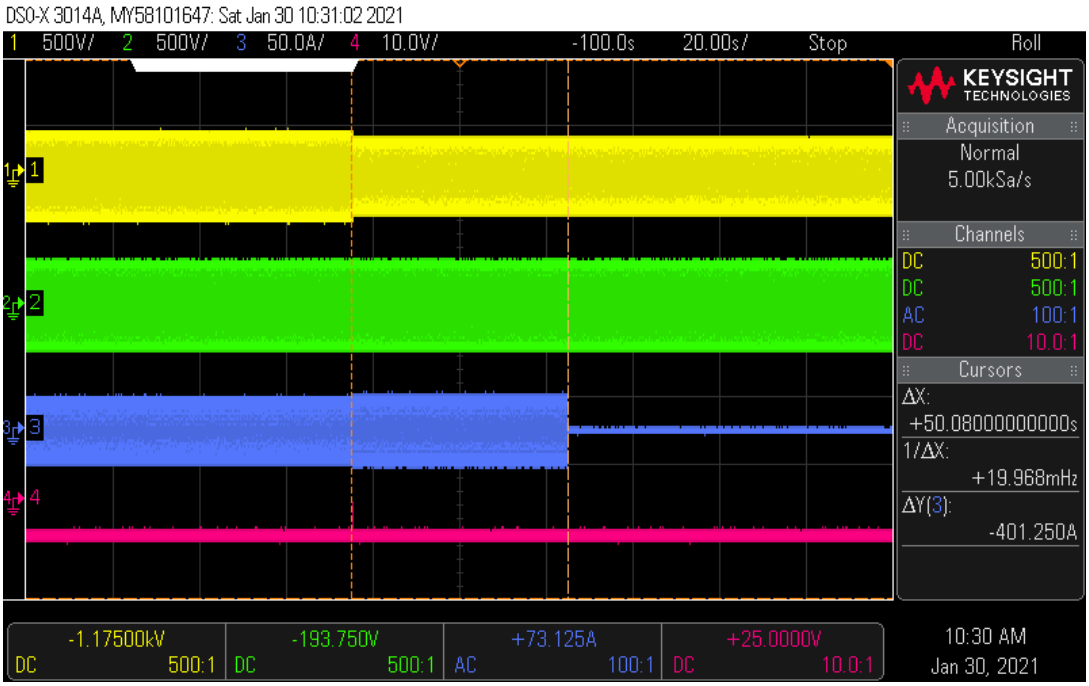
Scope pictures of the disconnection time
Over-voltage - Stage 1 (L1 phase)



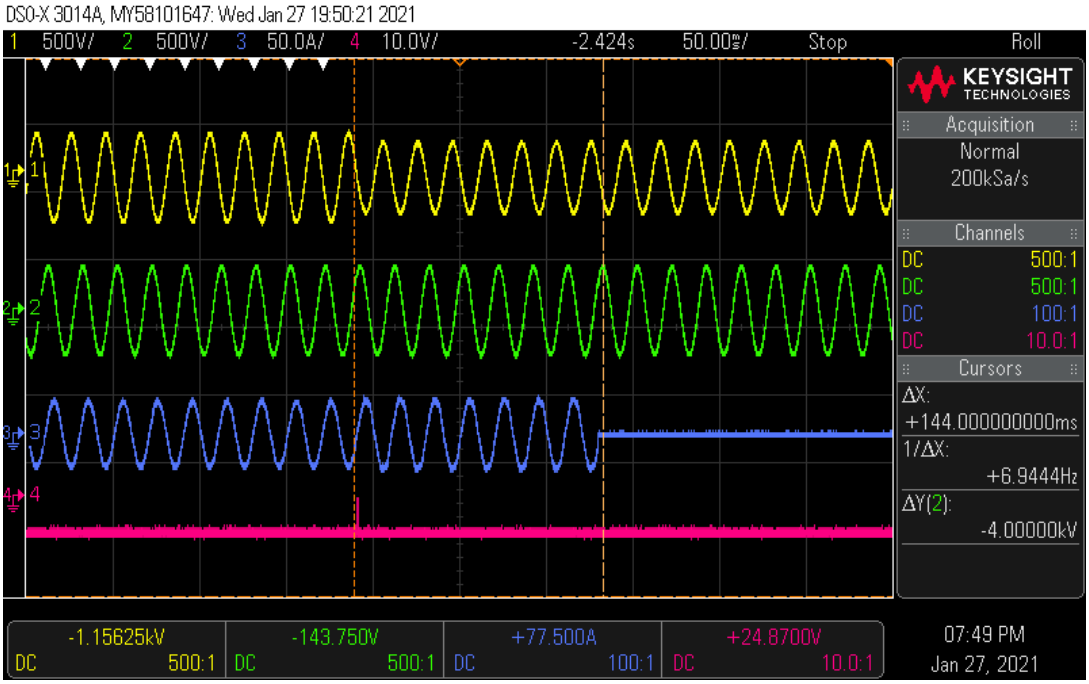
Over-voltage - Stage 2 (L1 phase)



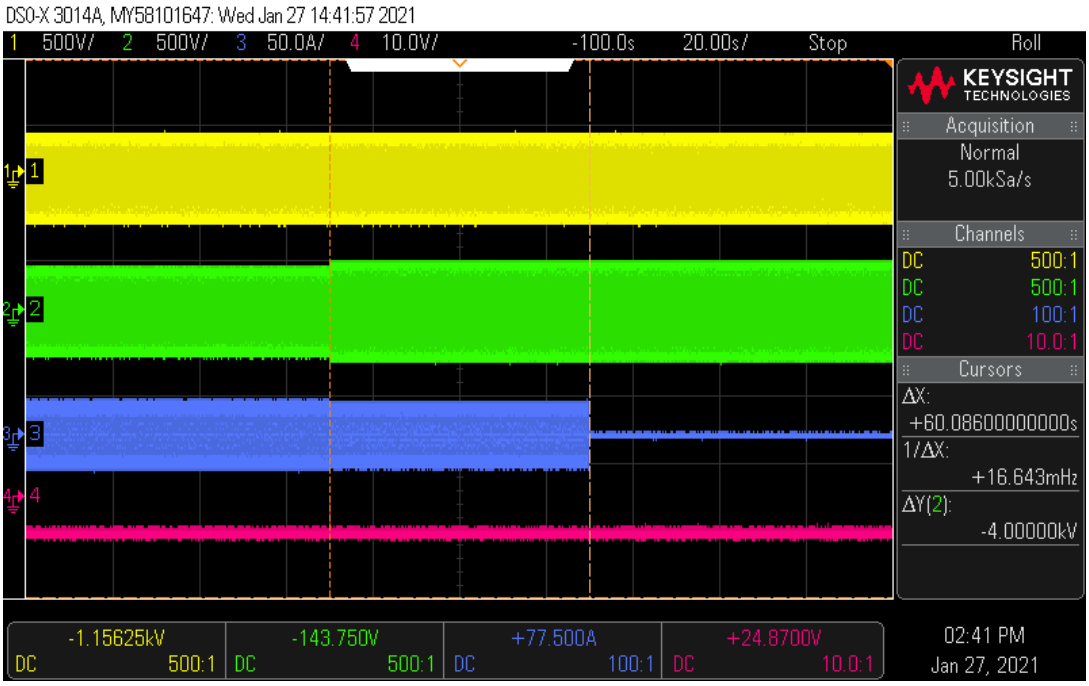
Under-voltage - Stage 1 (L1 phase)



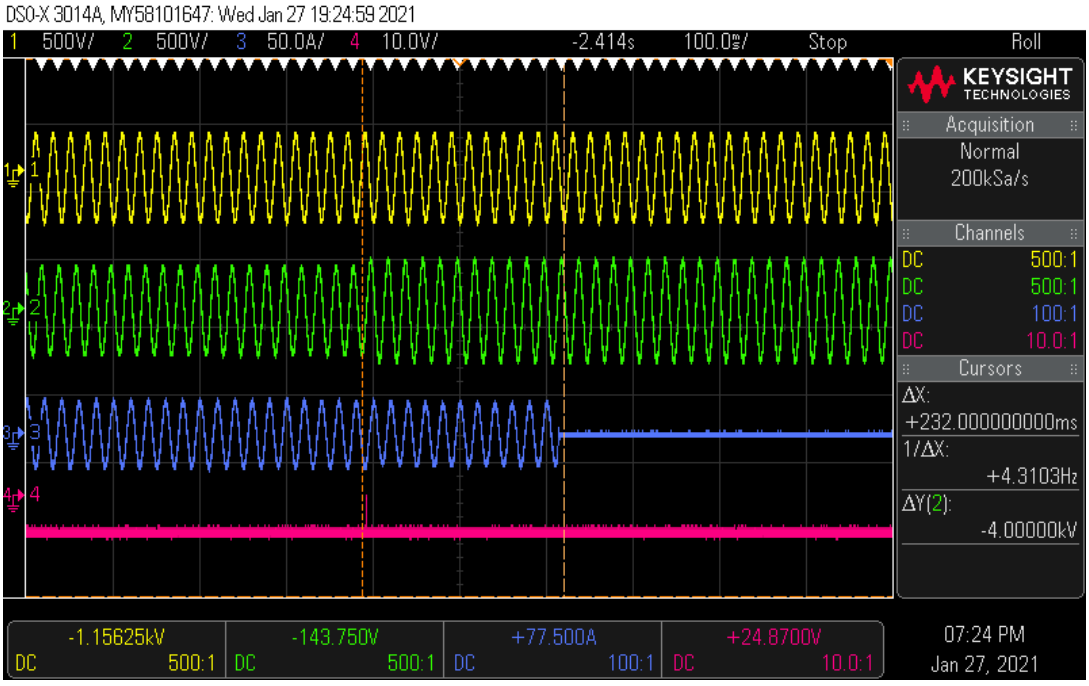
Under-voltage - Stage 2 (L1 phase)



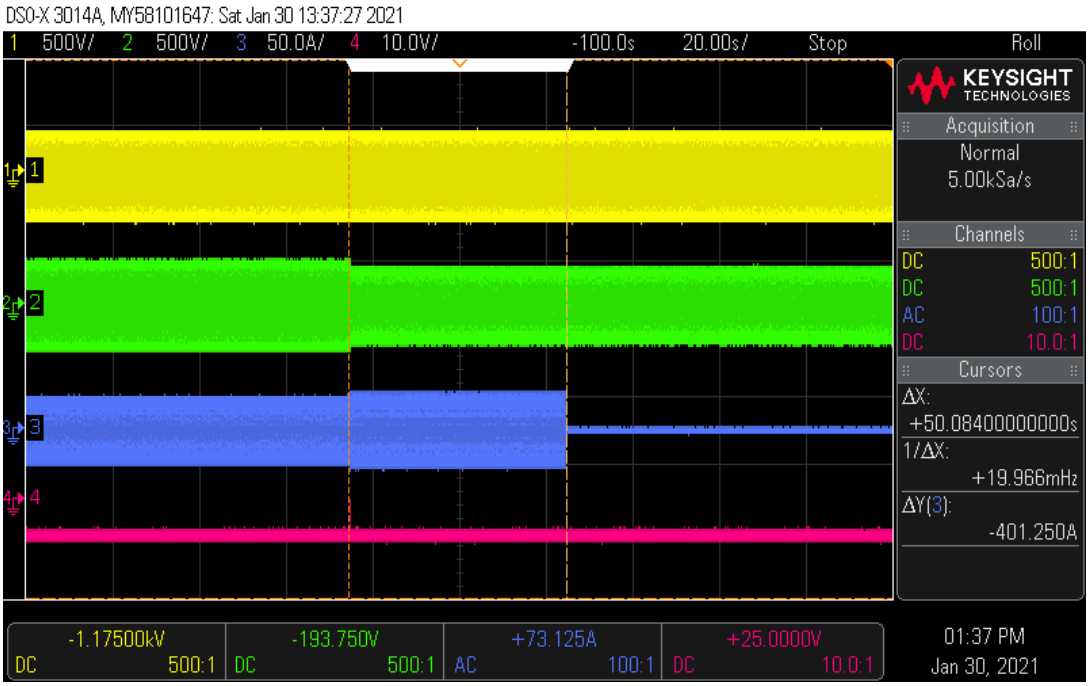
Scope pictures of the disconnection time
Over-voltage - Stage 1 (L2 phase)



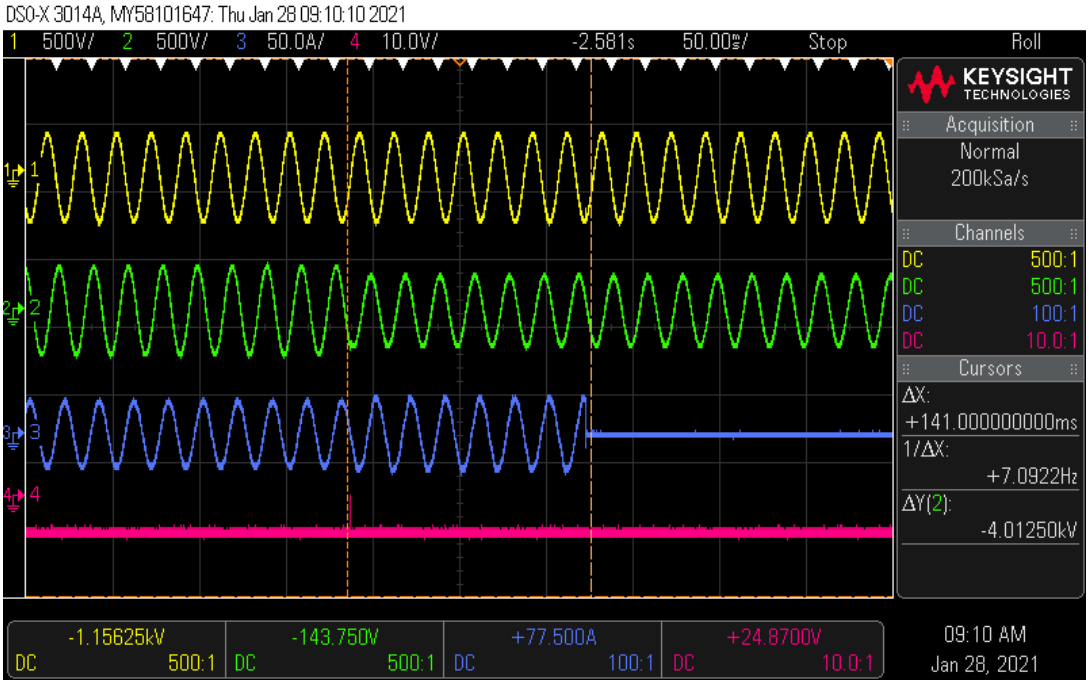
Over-voltage - Stage 2 (L2 phase)



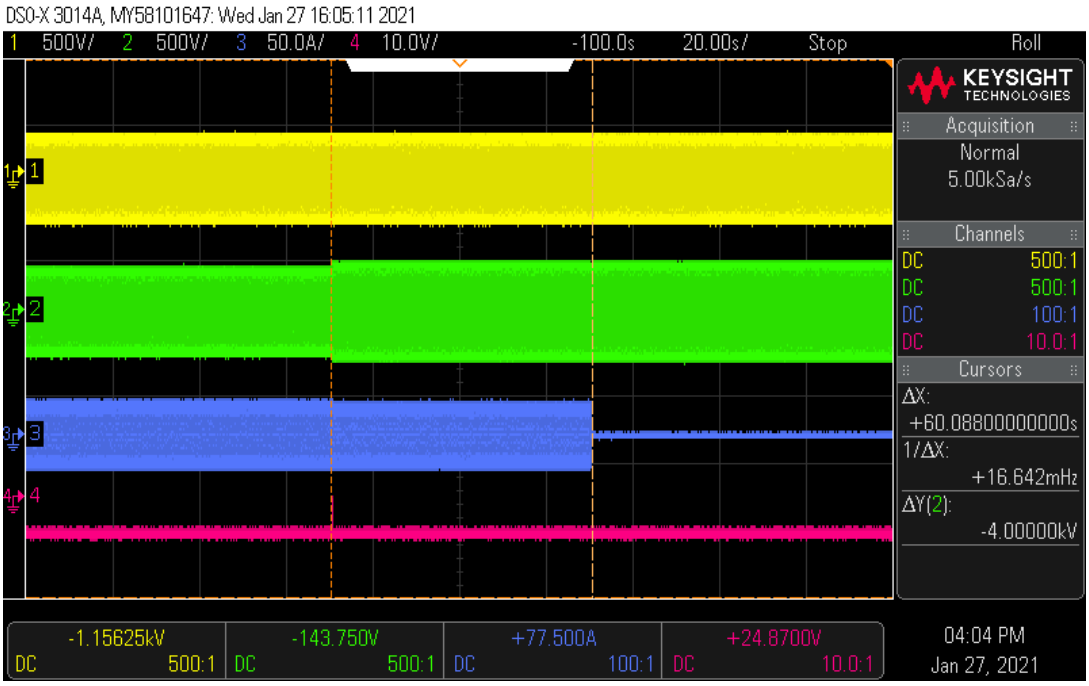
Under-voltage - Stage 1 (L2 phase)



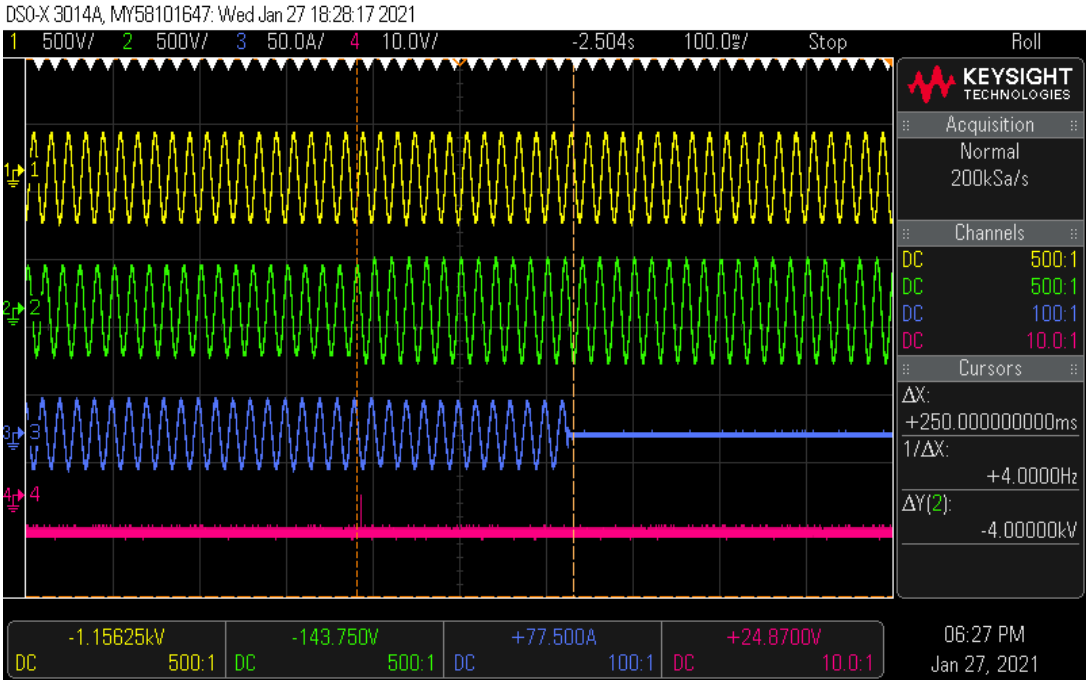
Under-voltage - Stage 2 (L2 phase)



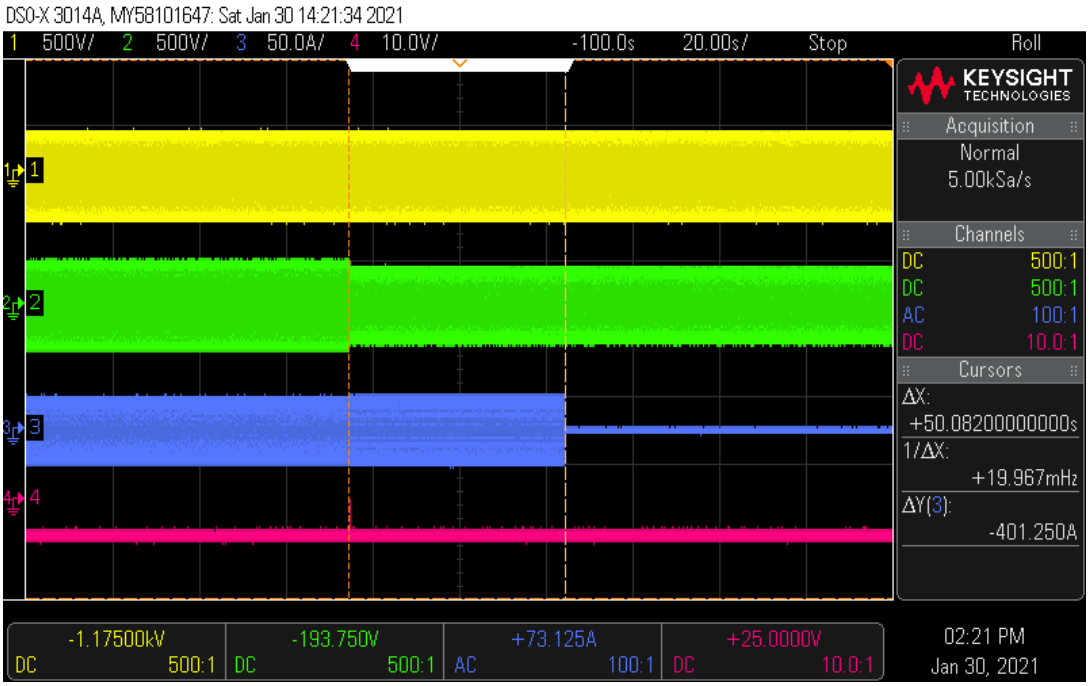
Scope pictures of the disconnection time
Over-voltage - Stage 1 (L3 phase)



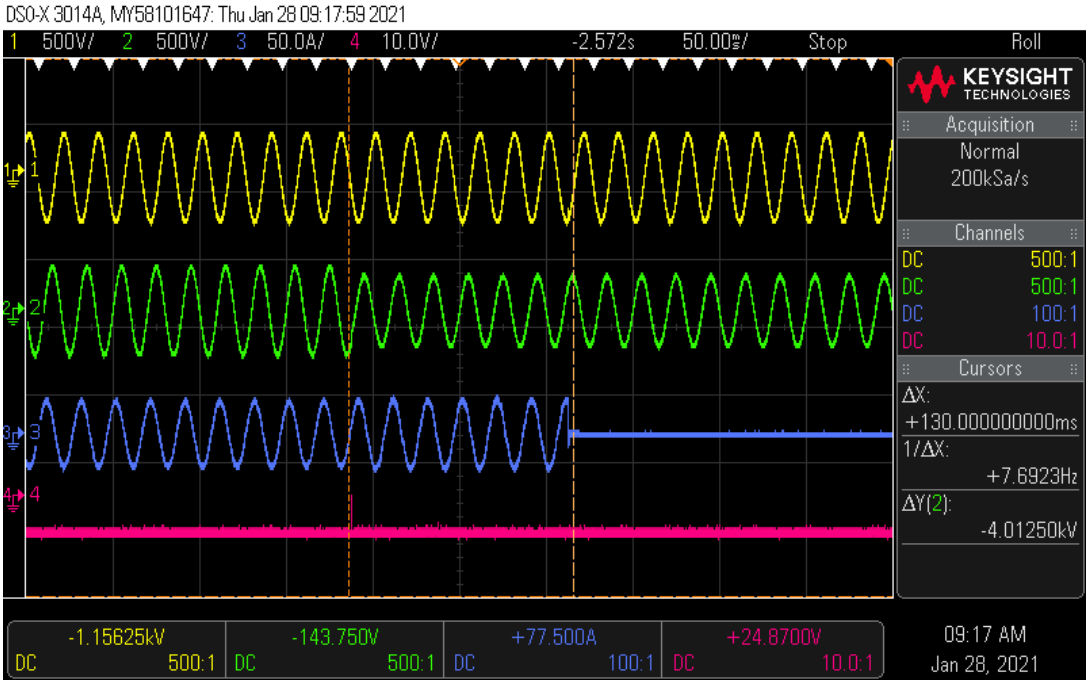
Over-voltage - Stage 2 (L3 phase)



Under-voltage - Stage 1 (L3 phase)



Under-voltage - Stage 2 (L3 phase)



6.3.2	Category B PV power plants (Overvoltage and undervoltage)	P

Test conditions			Frequency: 50+/-0,2Hz		
Phase	**Limit [V]**	**Trip value [V]**	**Voltage step [V]**	**Disconnection time [s]**	**Limit [s]**
L1	110% of Un = 253,0 (stage 1)	254,2	230,0 to 258,0	60,05	60s ≤ t ≤ 60,1s
		254,2	230,0 to 258,0	60,08	
		254,2	230,0 to 258,0	60,04	
		254,2	230,0 to 258,0	60,09	
		254,2	230,0 to 258,0	60,06	
	115% of Un = 264,5 (stage 2)	265,4	230,0 to 268,0	0,226	0,2s ≤ t ≤ 0,3s
		265,4	230,0 to 268,0	0,228	
		265,4	230,0 to 268,0	0,238	
		265,4	230,0 to 268,0	0,240	
		265,4	230,0 to 268,0	0,244	
	90% of Un = 207	207,4	230,0 to 203,0	10,03	10s ≤ t ≤ 10,1s
		207,4	230,0 to 203,0	10,02	
		207,4	230,0 to 203,0	10,03	
		207,4	230,0 to 203,0	10,04	
		207,4	230,0 to 203,0	10,03	
L2	110% of Un = 253,0 (stage 1)	254,0	230,0 to 258,0	60,08	60s ≤ t ≤ 60,1s
		254,0	230,0 to 258,0	60,09	
		254,0	230,0 to 258,0	60,07	
		254,0	230,0 to 258,0	60,06	
		254,0	230,0 to 258,0	60,08	
	115% of Un = 264,5 (stage 2)	265,5	230,0 to 268,0	0,220	0,2s ≤ t ≤ 0,3s
		265,5	230,0 to 268,0	0,224	
		265,5	230,0 to 268,0	0,230	
		265,5	230,0 to 268,0	0,232	
		265,5	230,0 to 268,0	0,228	
	90% of Un = 207	207,4	230,0 to 203,0	10,05	10s ≤ t ≤ 10,1s
		207,4	230,0 to 203,0	10,06	
		207,4	230,0 to 203,0	10,07	
		207,4	230,0 to 203,0	10,08	
		207,4	230,0 to 203,0	10,07	
L3	110% of Un = 253,0	253,9	230,0 to 258,0	60,07	60s ≤ t ≤ 60,1s
		253,9	230,0 to 258,0	60,08	

	(stage 1)	253,9	230,0 to 258,0	60,09	
		253,9	230,0 to 258,0	60,08	
		253,9	230,0 to 258,0	60,07	
	115% of Un = 264,5 (stage 2)	264,9	230,0 to 268,0	0,250	0,2s ≤ t ≤ 0,3s
		264,9	230,0 to 268,0	0,230	
		264,9	230,0 to 268,0	0,236	
		264,9	230,0 to 268,0	0,234	
		264,9	230,0 to 268,0	0,240	
	90% of Un = 207	207,3	230,0 to 203,0	10,02	10s ≤ t ≤ 10,1s
		207,3	230,0 to 203,0	10,04	
		207,3	230,0 to 203,0	10,05	
		207,3	230,0 to 203,0	10,05	
		207,3	230,0 to 203,0	10,06	

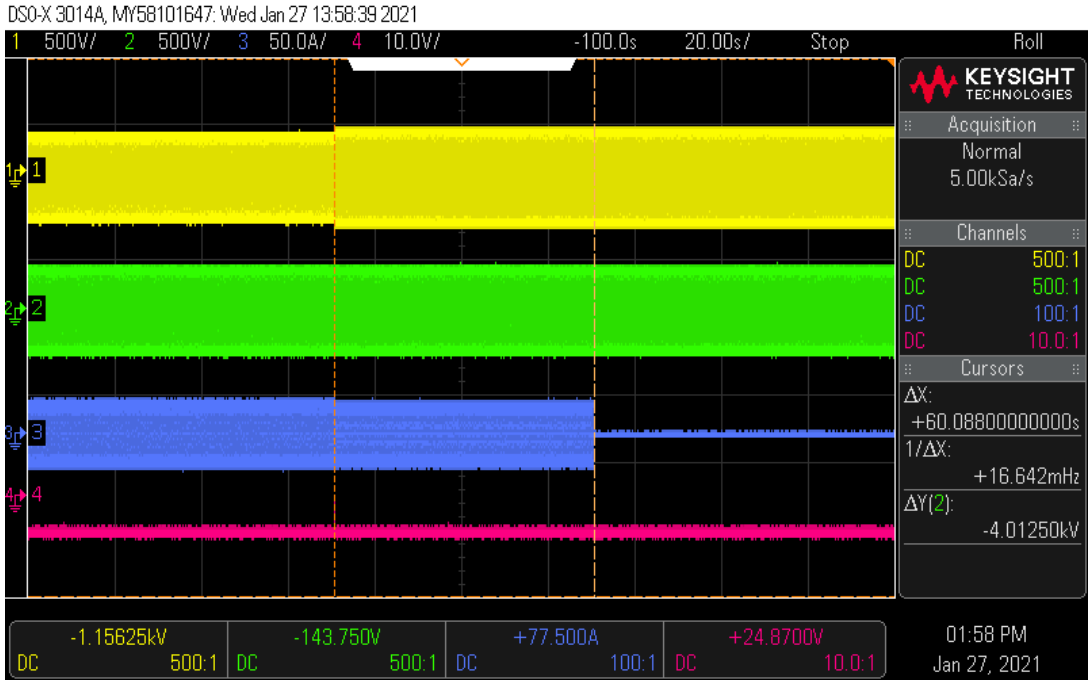
Note:

The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of Un ,

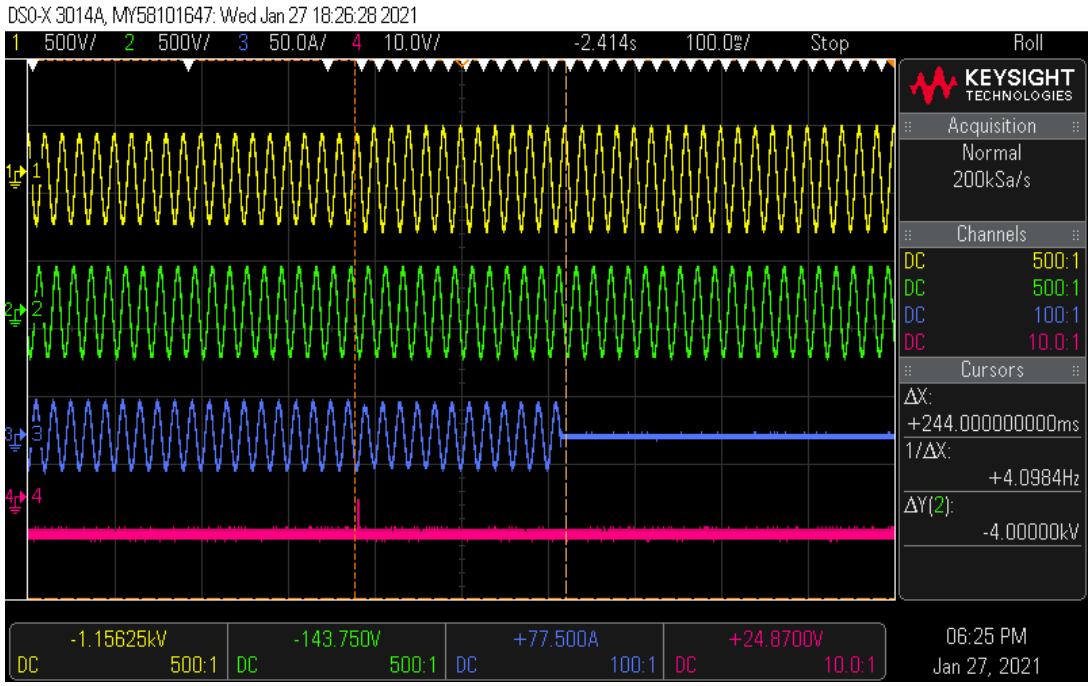
The disconnection time includes disconnect time + operate time of the integrated relay , Therefore limit is give with +100ms according to Table 17recommended values.

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.

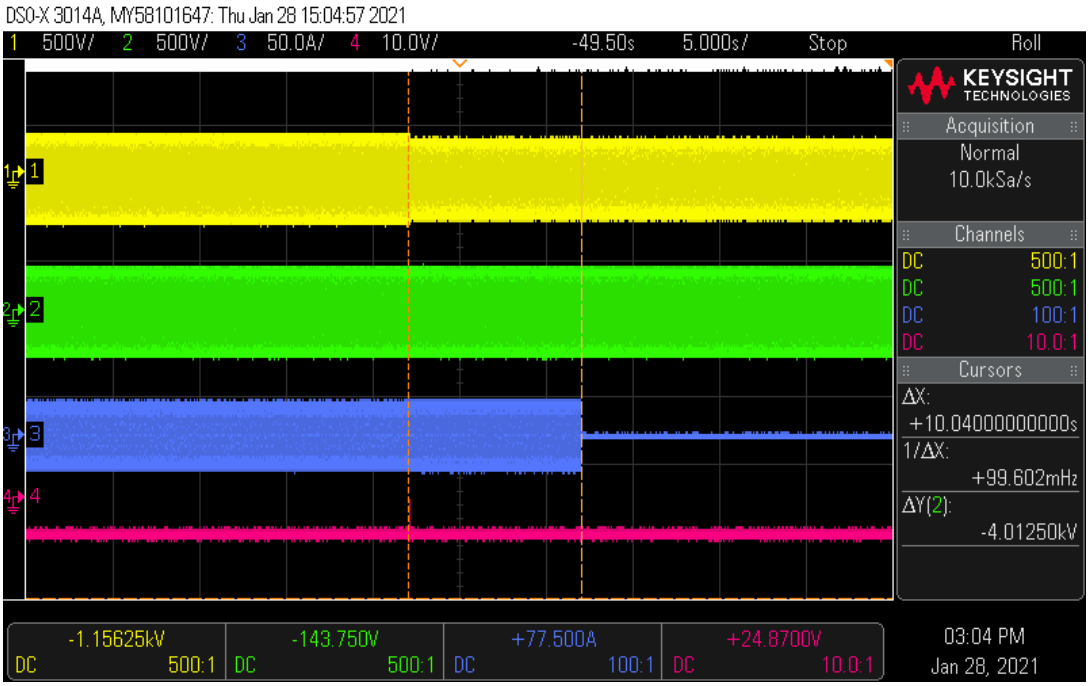
Scope pictures of the disconnection time
Over-voltage - Stage 1 (L1 phase)



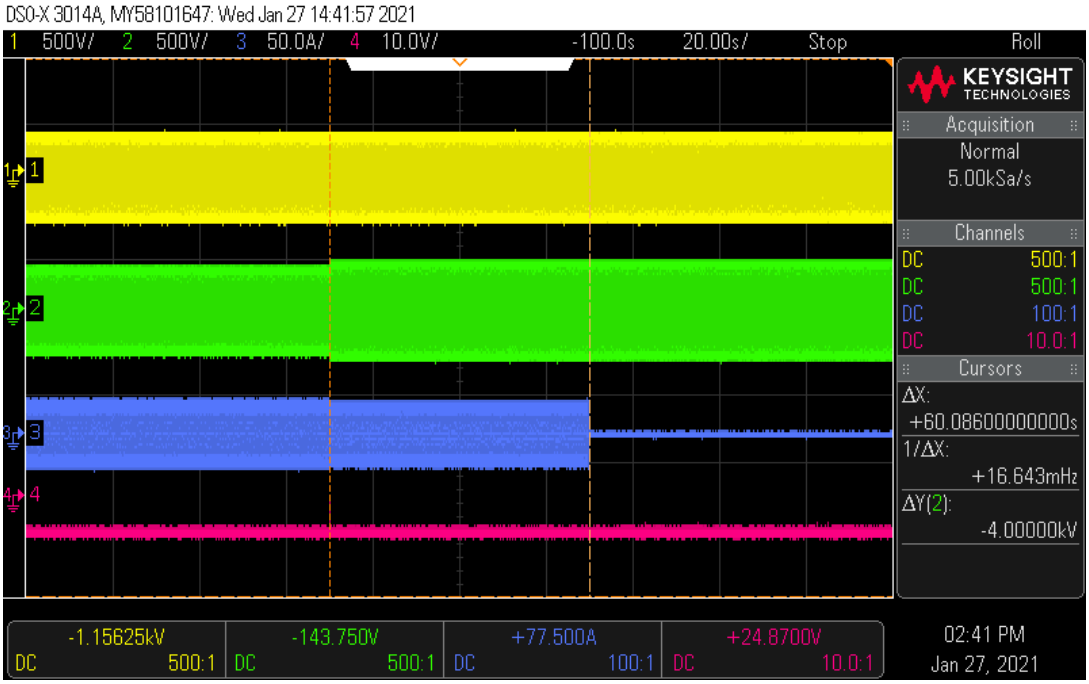
Over-voltage - Stage 2 (L1 phase)



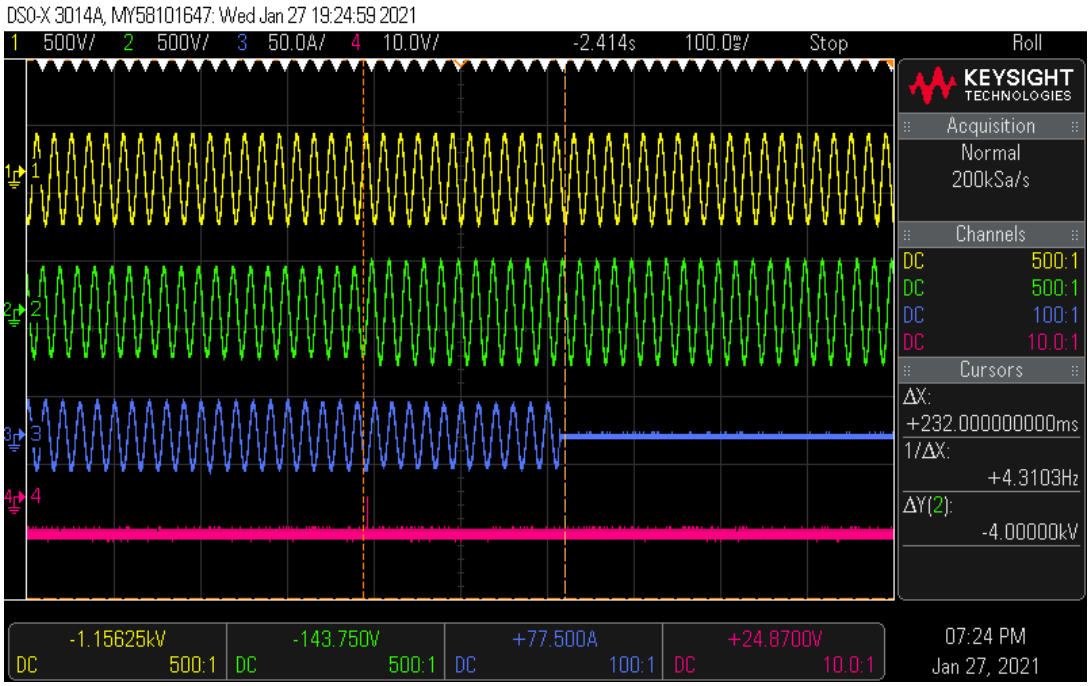
Under-voltage - Stage 1 (L1 phase)



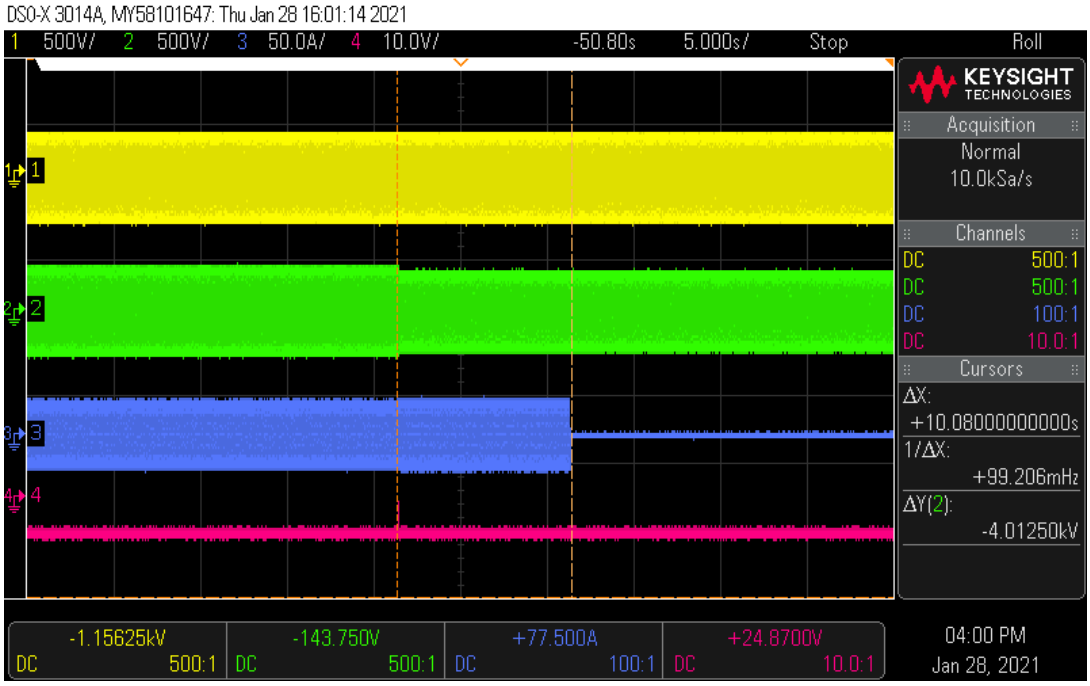
Over-voltage - Stage 1 (L2 phase)



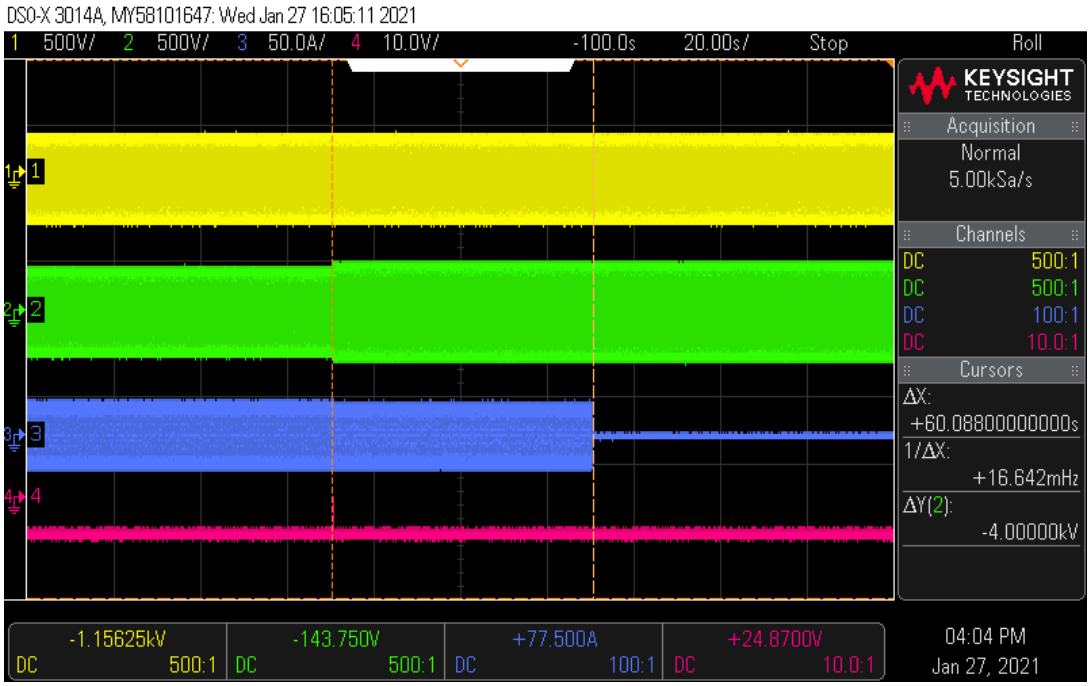
Over-voltage - Stage 2 (L2 phase)



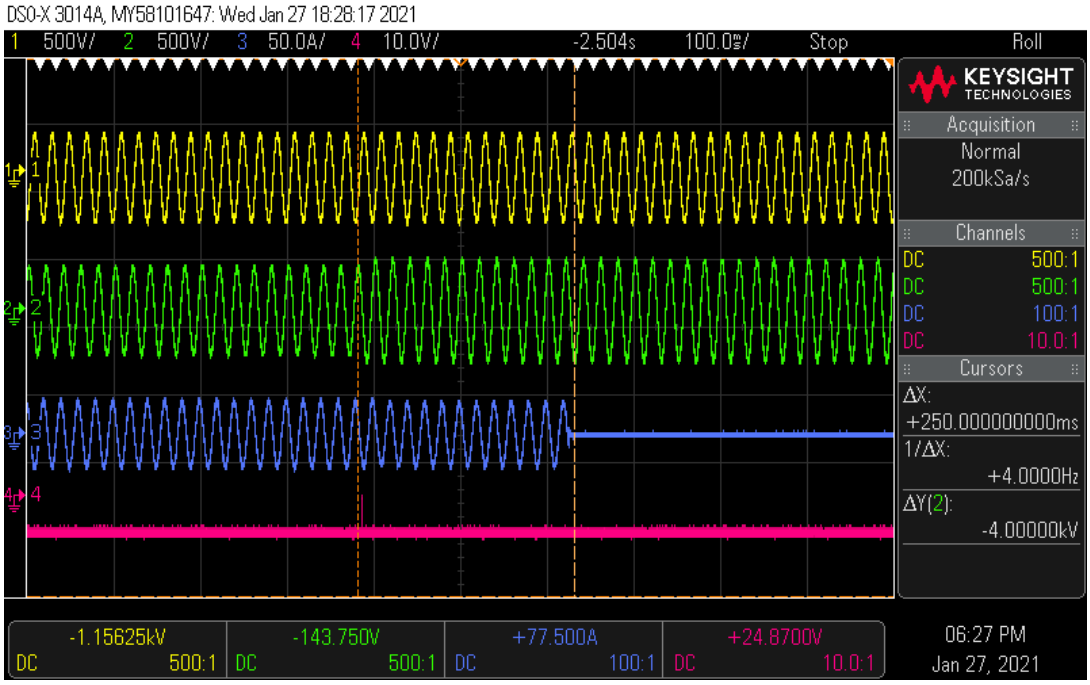
Under-voltage - Stage 1 (L2 phase)



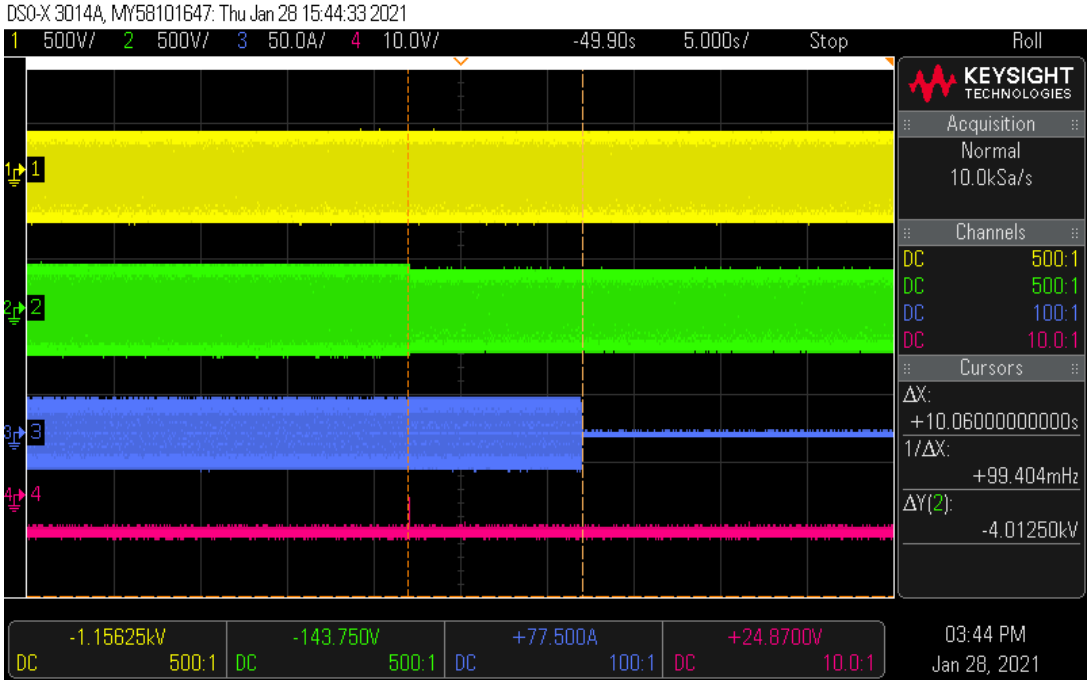
Over-voltage - Stage 1 (L3 phase)



Over-voltage - Stage 2 (L3 phase)



Under-voltage - Stage 1 (L3 phase)



6.3.1 Category A2 PV power plants 6.3.2 Category B PV power plants					P
Test conditions	U_n = 230Vac				
	Under-frequency		**Over-frequency**		
Parameter	**Under-Frequency**	**Time**	**Over-Frequency**	**Time**	
Limit	47,00 Hz	0,2≤ t ≤ 0,3 s	52,00 Hz	0,2≤ t ≤ 0,3 s	
Trip value [Hz]	47,00		52,00		
	47,00		52,00		
	47,00		52,00		
	47,00		52,00		
	47,00		52,00		
Disconnection time [s]	50,00 Hz to 47,40 Hz	0,240	50,00 Hz to 51,60 Hz	0,240	
		0,224		0,230	
		0,246		0,232	
		0,219		0,220	
		0,244		0,242	

Note:

The setting value and the trip value of the frequency may not vary by more than ±0,1 % f_n ,

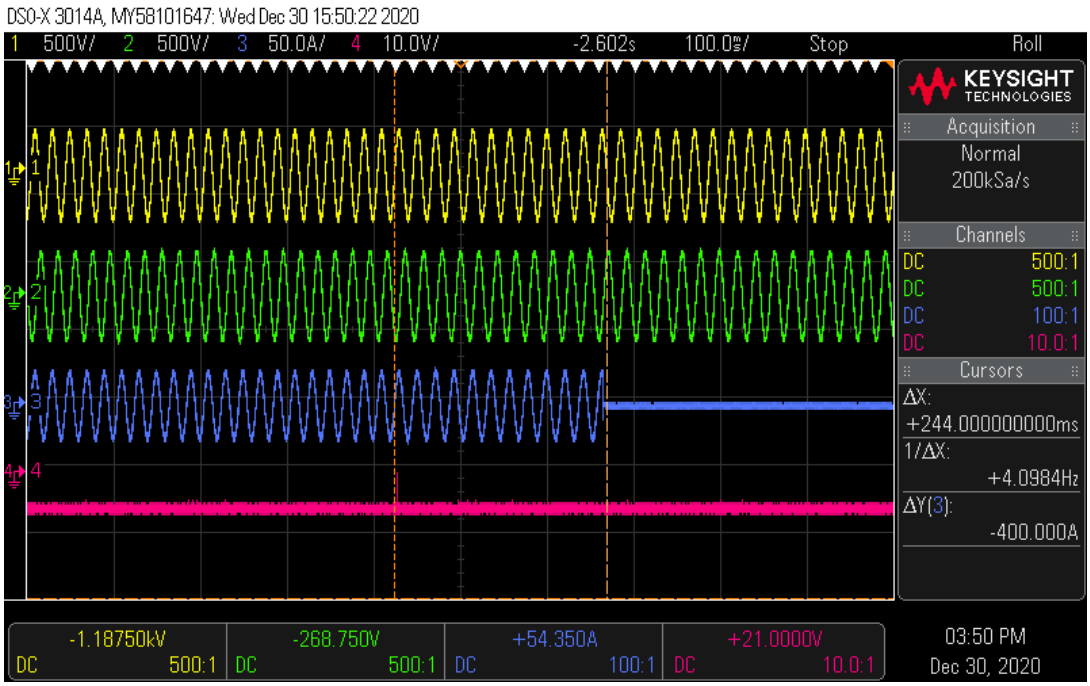
The disconnection time includes disconnect time + operate time of the integrated relay , Therefore limit is give with +100ms according to Table 16 and 17 recommended values.

The oscilloscope pictures below show the measured worst case disconnection times.

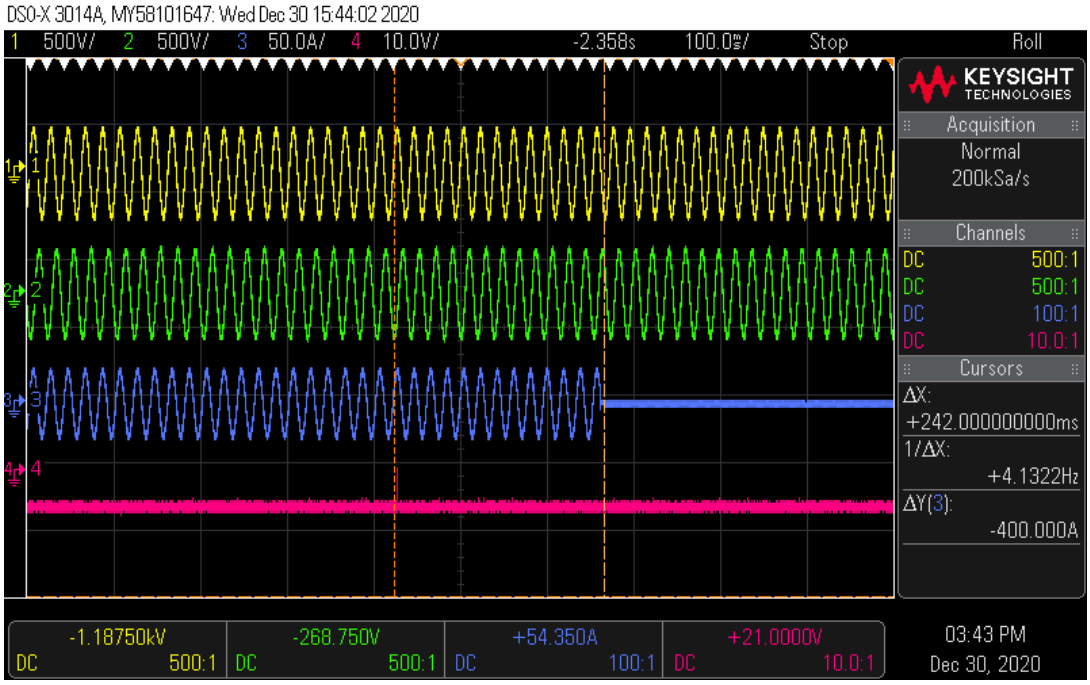
The tests had been performed on the SOFAR 24KTLX-G3 is valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3, since it is identical in hardware and software construction except output power derated by software.

Scope pictures of the disconnection time

Under-frequency



Over-frequency



Loss of Mains (LoM) detection		
Test circuit and parameters		
Parameter	**Symbol**	**Units**
EUT DC Input		
DC voltage	V_{DC}	V
DC Current	I_{DC}	A
DC Power	P_{DC}	W
EUT AC ouput		
AC voltage	V_{EUT}	V
AC current	I_{EUT}	A
Real power	P_{EUT}	W
Reactive power	Q_{EUT}	VAr
Test Load		
Resistive load current	I_R	A
Inductive load current	I_L	A
Capacitive load current	I_C	A
AC (utility) power source		
Utility real power	P_{AC}	W
Utility reactive power	Q_{AC}	VAr
Utility current	I_{AC}	A

Block diagram test circuit IEC 62116:2014

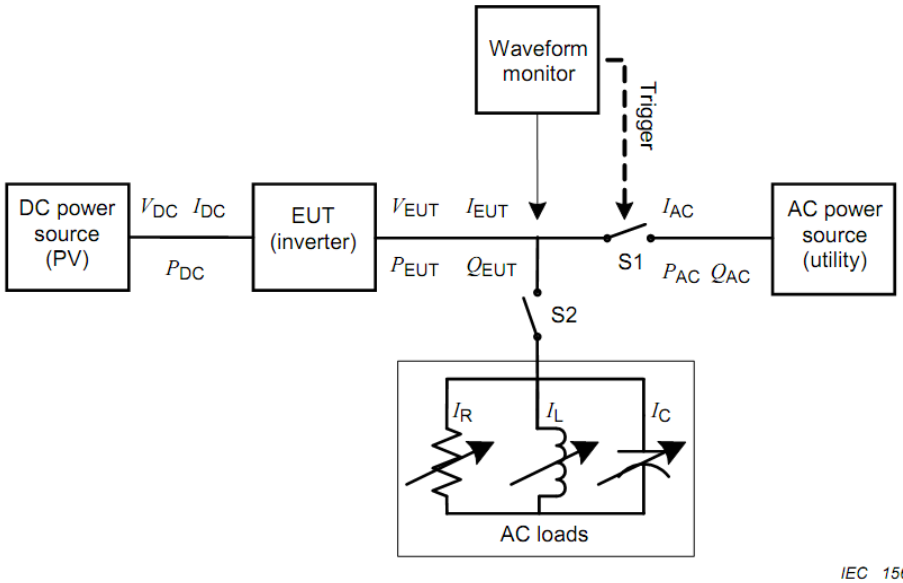


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

Load imbalance (real, reactive load) for test condition A (EUT output = 100%)	**P**

Test :

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	2s (IEC 62116)

No	P_{EUT} [1] [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) [1]	P_{AC} [2] [% of nominal]	Q_{AC} [3] [% of nominal]	I_{AC} [4] [A]	P_{EUT} [W per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks [5]
1	**100**	**100**	**0**	**0**	0,086	8000	695	1,002	501	**BL**
4	100	100	-5	-5	1,846	8000	695	1,028	449	IB
5	100	100	-5	0	1,891	8000	695	1,054	379	IB
6	100	100	-5	+5	1,844	8000	695	1,080	437	IB
7	100	100	0	-5	0,108	8000	695	0,976	438	IB
8	100	100	0	+5	0,107	8000	695	1,026	395	IB
9	100	100	+5	-5	1,802	8000	695	0,930	397	IB
10	100	100	+5	0	1,761	8000	695	0,954	469	IB
11	100	100	+5	+5	1,803	8000	695	0,978	416	IB

Parameter at 0% per phase	L= 21,01 mH	R= 6,61 Ω	C= 482,46 µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

[1] P_{EUT}: EUT output power.

[2] P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility, Nominal is the 0 % test condition value.

[3] Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility, Nominal is the 0 % test condition value.

[4] Fundamental of I_{AC} when RLC is adjusted.

[5] BL: Balance condition, IB: Imbalance condition.

Condition A:

EUT output power P_{EUT} = Maximum [6]

EUT input voltage [6] = >75% of rated input voltage range

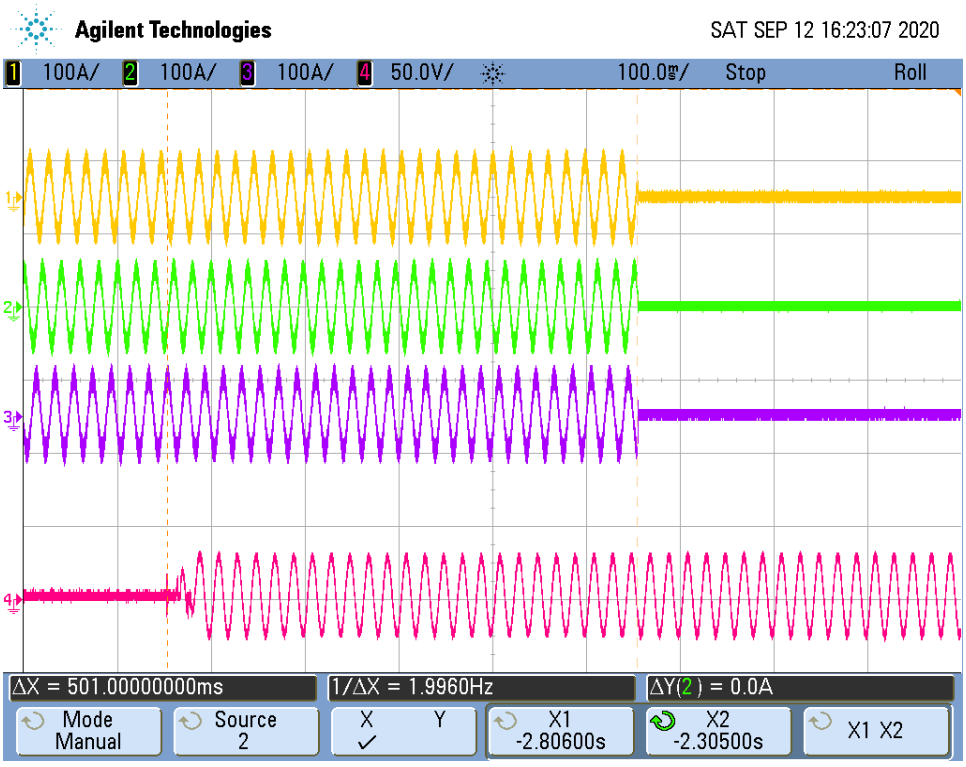
[6] Maximum EUT output power condition should be achieved using the maximum allowable input power, Actual output power may exceed nominal rated output.

[7] Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 75 % of range =X + 0,75 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.

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.

Scope pictures of the disconnection time
Disconnection at No. 1



Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)	**P**

Test :

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	2s (IEC 62116)

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) 1)	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [W per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks 5)
12	66	66	0	-5	0,218	5280	510	0,975	413	IB
13	66	66	0	-4	0,208	5280	510	0,980	481	IB
14	66	66	0	-3	0,200	5280	510	0,985	469	IB
15	66	66	0	-2	0,194	5280	510	0,990	463	IB
16	66	66	0	-1	0,190	5280	510	0,995	384	IB
2	**66**	**66**	**0**	**0**	0,089	5280	510	1,000	511	**BL**
17	66	66	0	1	0,190	5280	510	1,005	480	IB
18	66	66	0	2	0,193	5280	510	1,010	500	IB
19	66	66	0	3	0,199	5280	510	1,015	484	IB
20	66	66	0	4	0,207	5280	510	1,020	489	IB
21	66	66	0	5	0,217	5280	510	1,025	474	IB

Parameter at 0% per phase	L= 31,75 mH	R= 9,98 Ω	C= 319,21 µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) P_{EUT}: EUT output power.

2) P_{AC}: Real power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.

3) Q_{AC}: Reactive power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.

4) Fundamental of I_{AC} when RLC is adjusted.

5) BL: Balance condition, IB: Imbalance condition.

Condition B:

EUT output power P_{EUT} = 50 % – 66 % of maximum

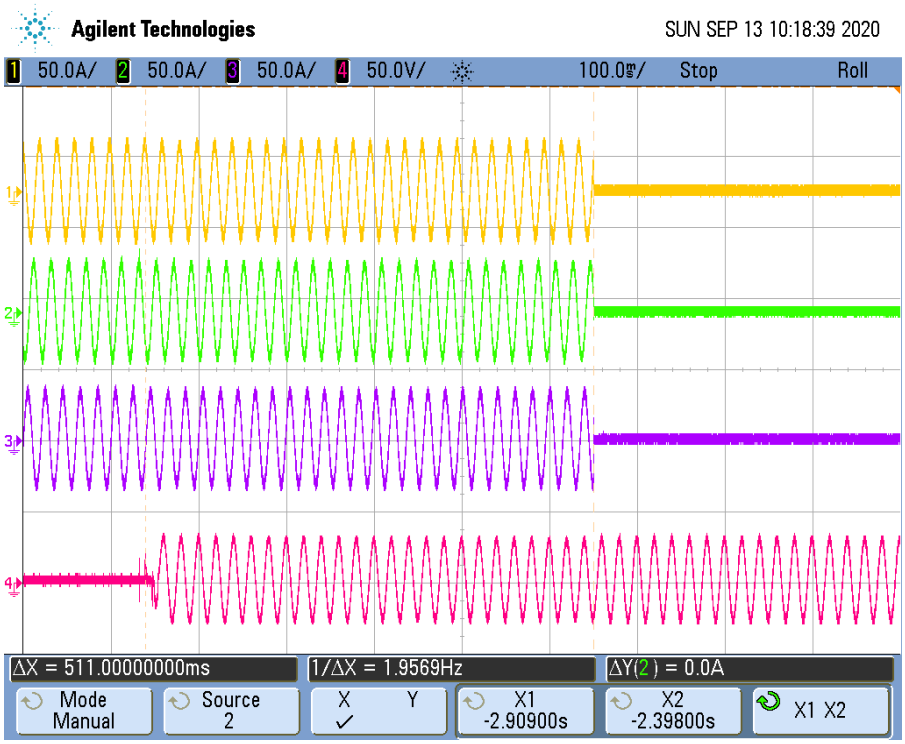
EUT input voltage 6) = 50 % of rated input voltage range, ±10 %

6) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.

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.The test results refer to the original test report PV191016N002-1 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2019-11-04.

Scope pictures of the disconnection time
Disconnection at No. 2



Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	**P**

Test :

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	2s (IEC 62116)

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) 1)	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [W per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks 5)
22	33	33	0	-5	0,511	2640	288	0,974	411	IB
23	33	33	0	-4	0,506	2640	288	0,979	487	IB
24	33	33	0	-3	0,502	2640	288	0,984	368	IB
25	33	33	0	-2	0,499	2640	288	0,989	418	IB
26	33	33	0	-1	0,497	2640	288	0,994	410	IB
3	**33**	**33**	**0**	**0**	0,483	2640	288	0,999	497	**BL**
27	33	33	0	1	0,496	2640	288	1,004	372	IB
28	33	33	0	2	0,498	2640	288	1,009	439	IB
29	33	33	0	3	0,501	2640	288	1,014	348	IB
30	33	33	0	4	0,505	2640	288	1,019	445	IB
31	33	33	0	5	0,510	2640	288	1,024	414	IB

Parameter at 0% per phase	L= 63,71 mH	R= 20,02 Ω	C= 158,85 µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) P_{EUT}: EUT output power.

2) P_{AC}: Real power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.

3) Q_{AC}: Reactive power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.

4) Fundamental of I_{AC} when RLC is adjusted.

5) BL: Balance condition, IB: Imbalance condition.

Condition B:

EUT output power P_{EUT} = 25 % – 33 % 6) of maximum

EUT input voltage 7) = <20 % of rated input voltage range

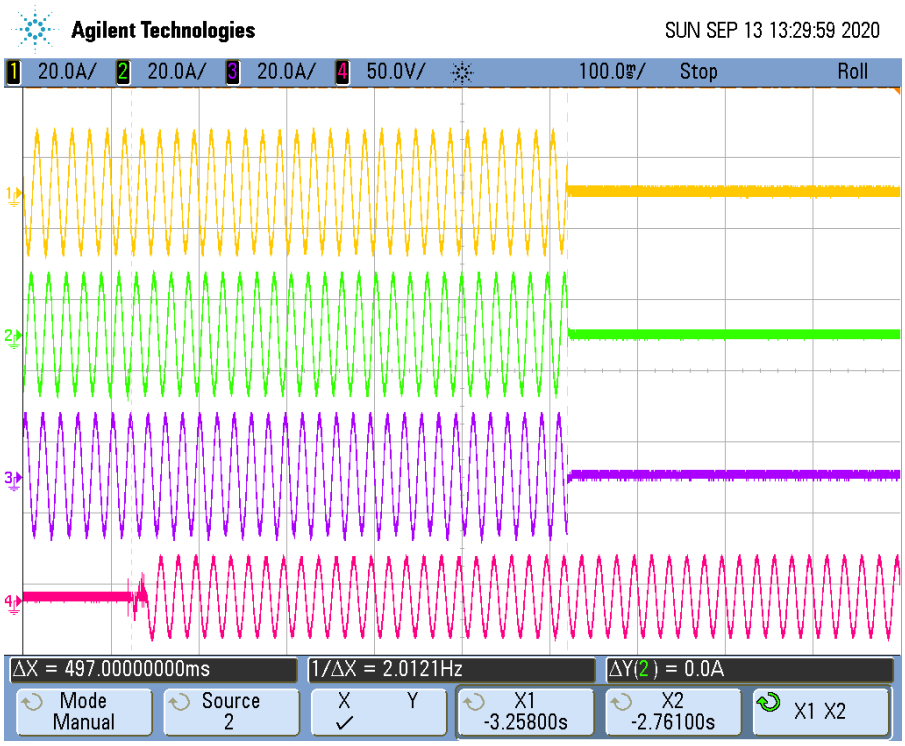
6) Or minimum allowable EUT output level if greater than 33 %.

7) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 20 % of range =X + 0,2 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.

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.

Scope pictures of the disconnection time
Disconnection at No. 3



Annex No. 1

Pictures of the unit

Enclosure front view

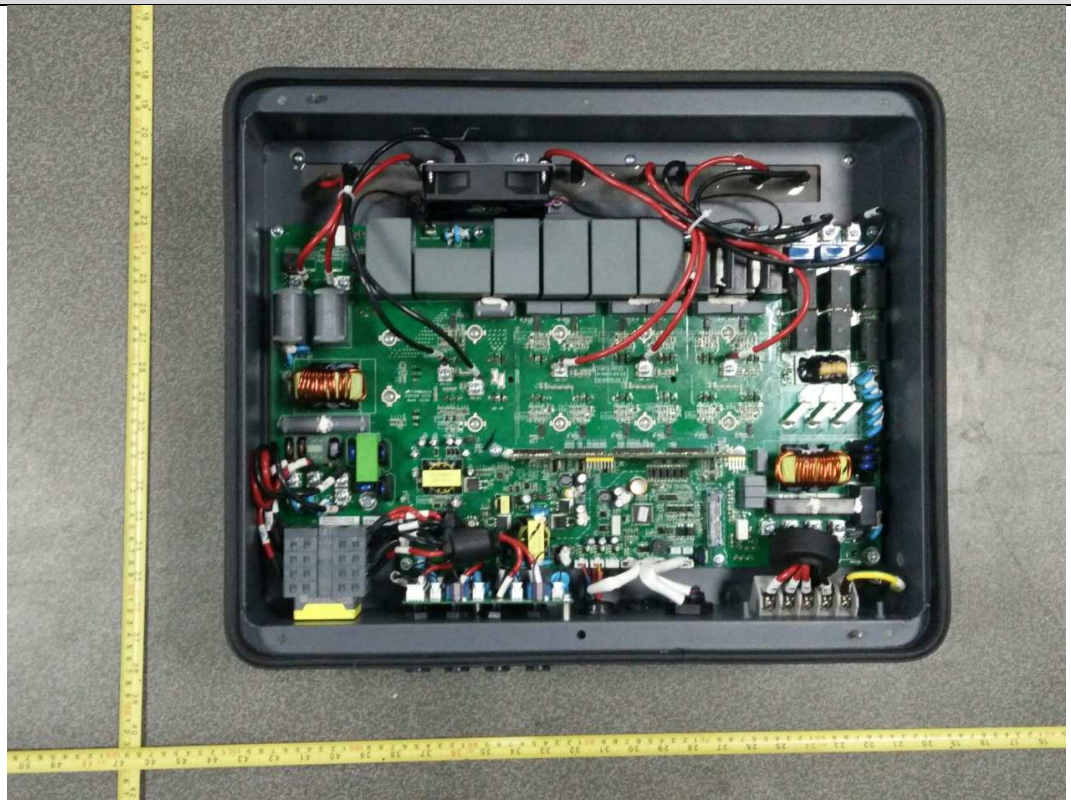
Enclosure side view

Enclosure bottom view
SOFAR 15KTLX-G3, SOFAR 17KTLX-G3

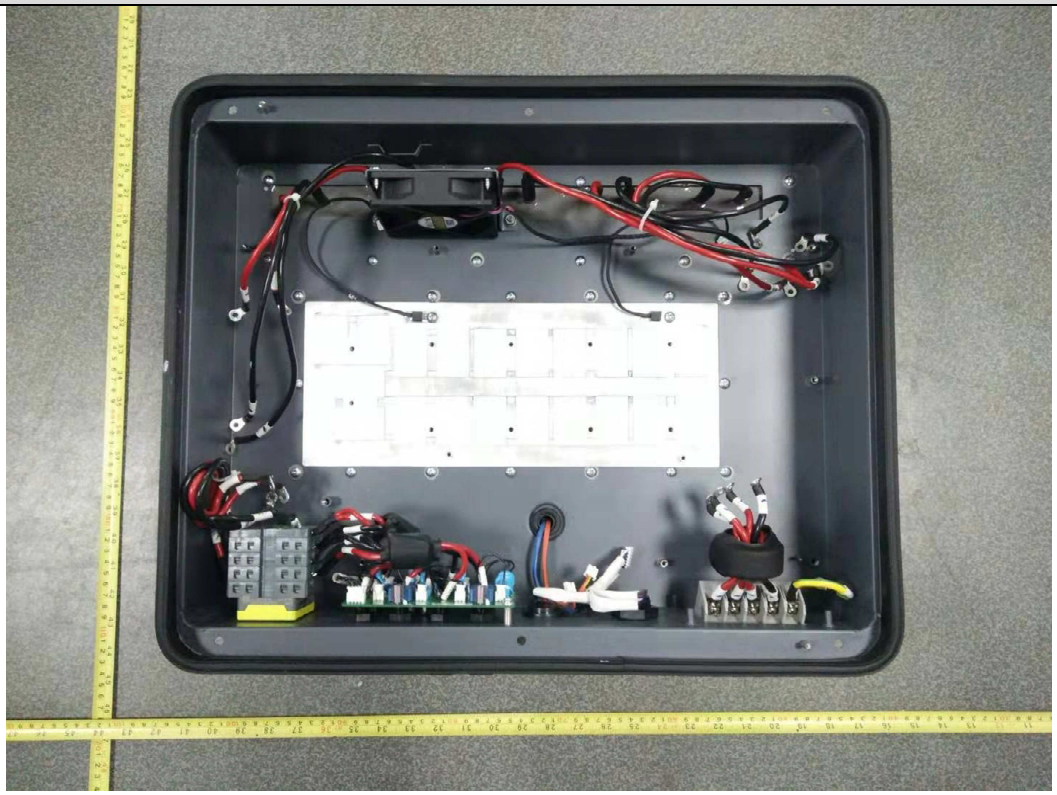
Enclosure bottom view
SOFAR 20KTLX-G3, SOFAR 22KTLX-G3, SOFAR 24KTLX-G3

Enclosure rear view

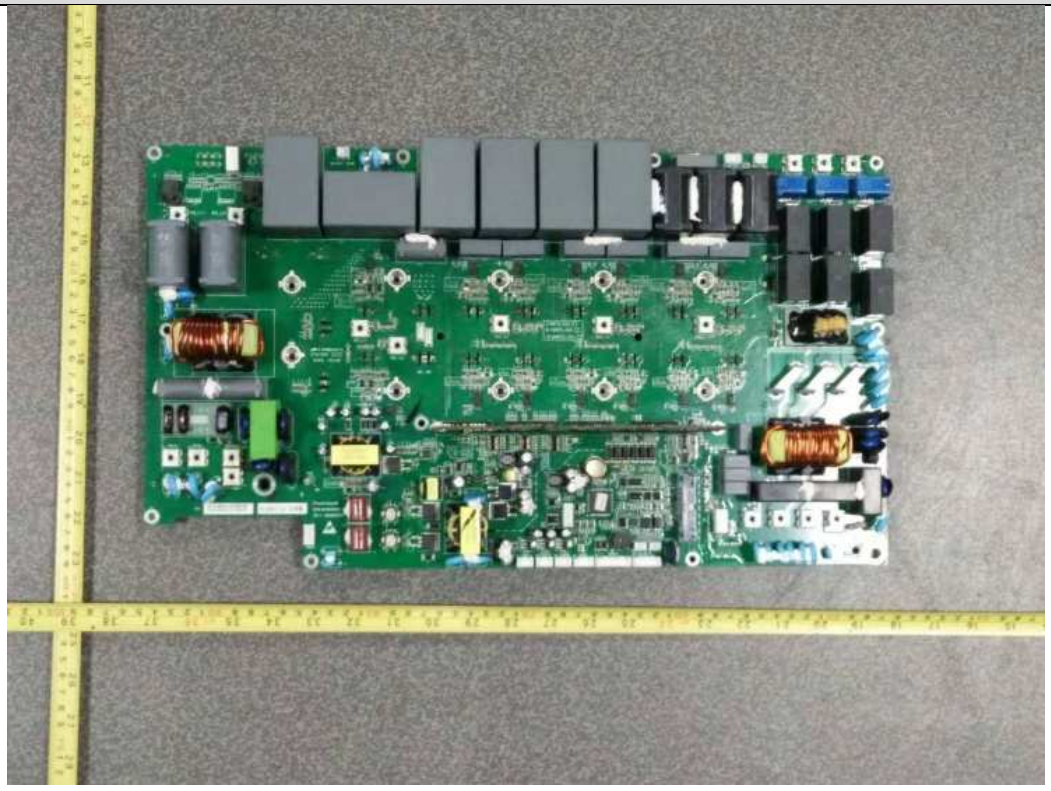
Internal view



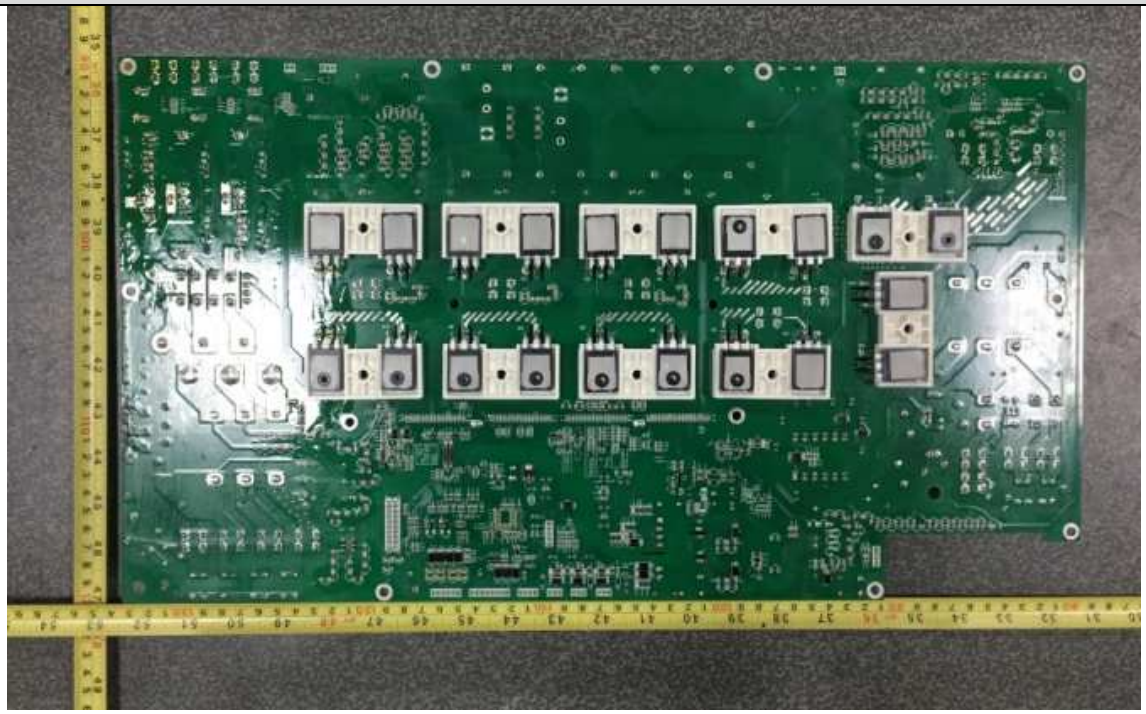
Internal view



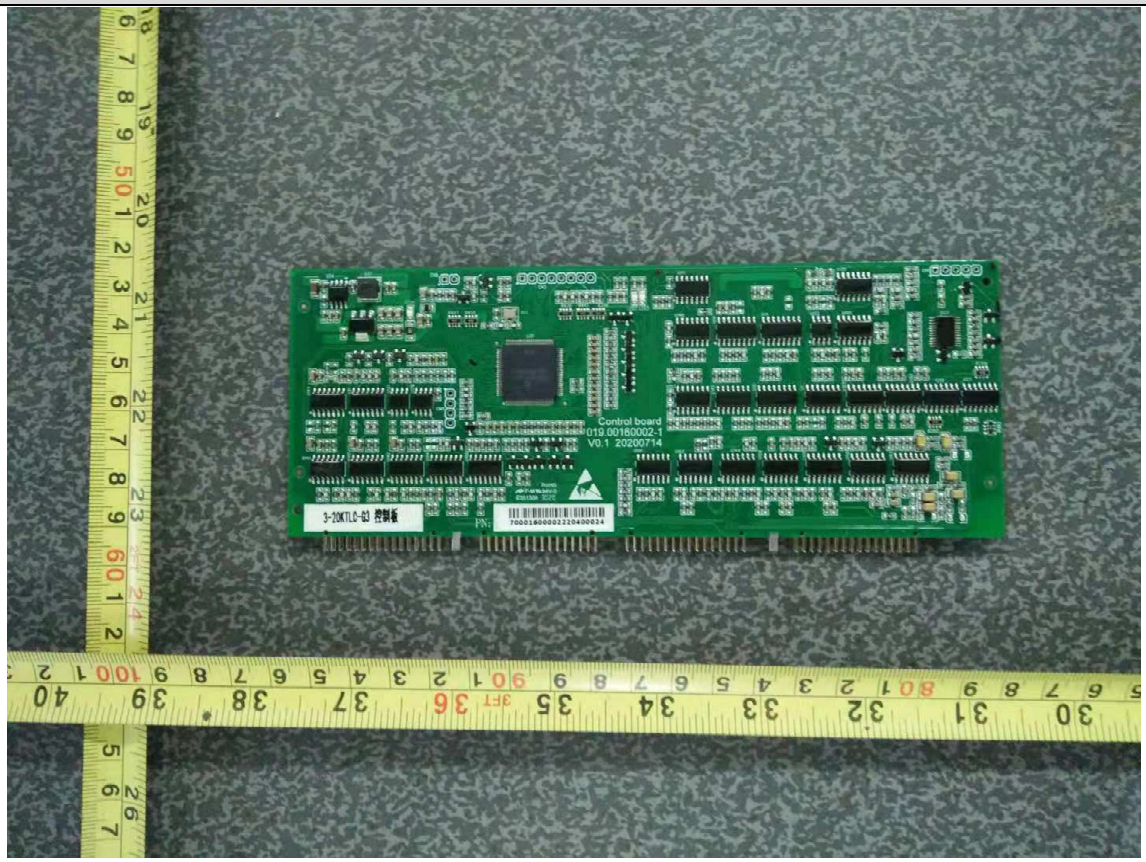
Power board component side view



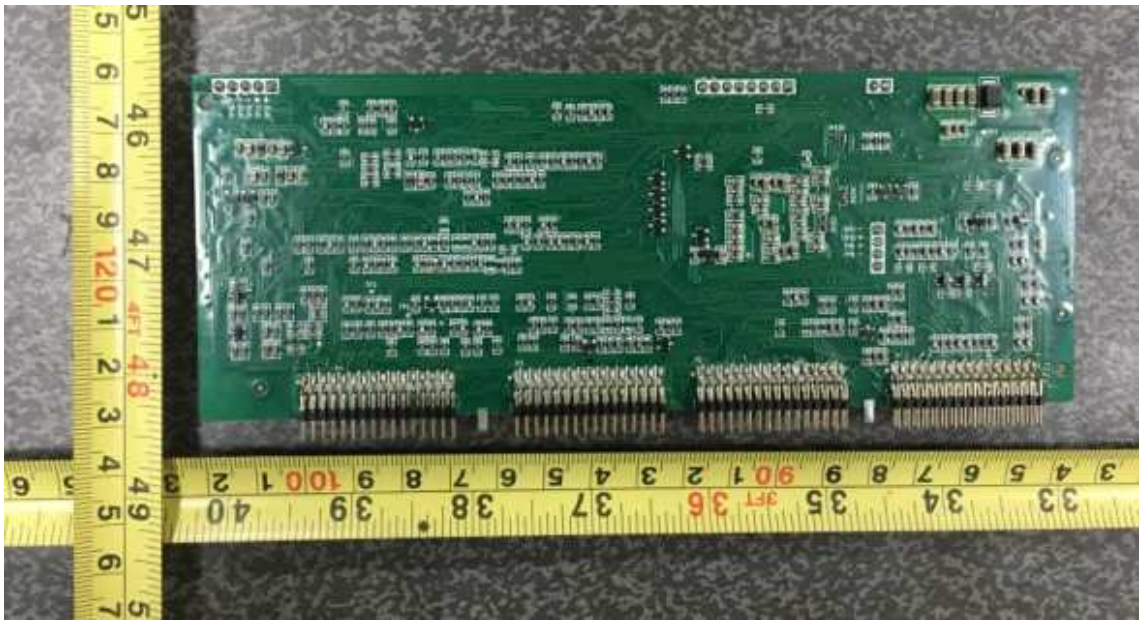
Power board solder side view



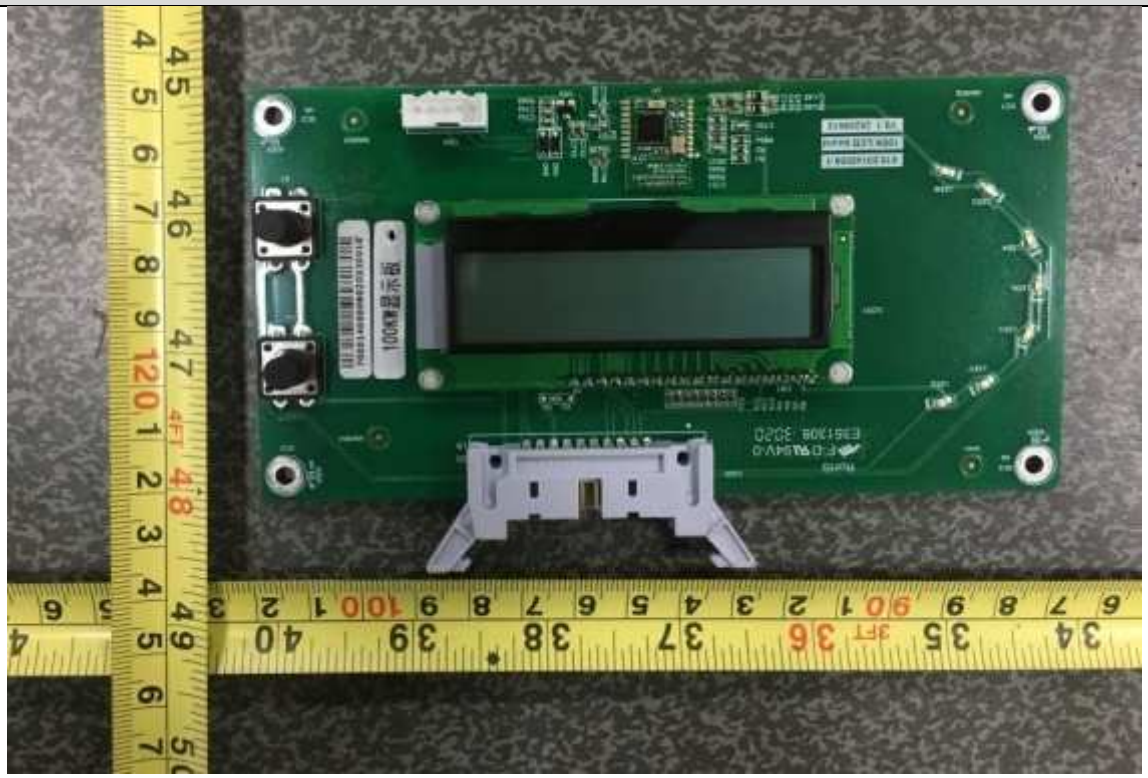
Control board component side view



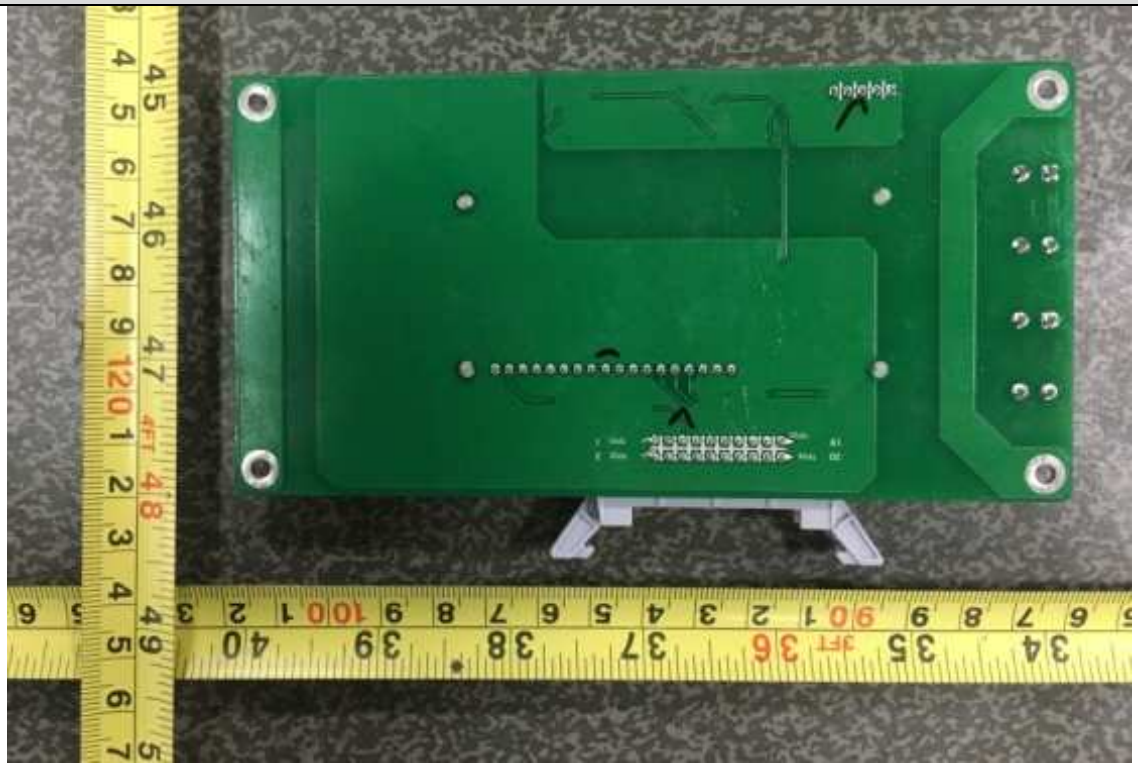
Control board solder side view



LCD board component side view



LCD board solder side view



General view of Grouding point

Annex No. 2

Test Equipment list

Dates of performance test: 2020-05-11 to 2021-02-24

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	
Eight Channel Digital Phosphor Oscilloscope	A4089017DG	YOKOGAWA	DL850	91N726247	Sep. 02, 2021
Oscilloscope probe	A4089008DG	Tektronix	TPP1000	C008230	Aug. 10, 2021
	A4089010DG	Tektronix	TPP1000	C008228	Aug. 10, 2021
	A4089011DG	Tektronix	TPP1000	C008229	Aug. 10, 2021
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Sep. 02, 2021
	A1060008DG	YOKOGAWA	CT200	1130700017	Sep. 02, 2021
	A1060012DG	YOKOGAWA	CT200	1130700018	Sep. 02, 2021
Power Analyser	//	ZLG	PA5000H	C820290908200 2110001	Mar. 02, 2021
Oscilloscope	//	Agilent	DS05014A	MY50070288	Jan. 04, 2022
	//	KEYSIGHT	DSOX3014T	MY59243036	Jan. 04, 2022
Oscilloscope current probe	//	CYBERTEK	CP1000A	C181000922	Jan. 04, 2022
	//	FLUKE	IL000S	C181000925	Jan. 04, 2022
	//	CYBERTEK	CP1000A	C181000929	Jan. 04, 2022
	//	CYBERTEK	CP1000A	C191000141	Jan. 04, 2022
Oscilloscope probe	//	SANHUA	SI-9110	152655	Jan. 04, 2022
	//	SANHUA	SI-9110	111134	Jan. 04, 2022
	//	SANHUA	SI-9110	111539	Jan. 04, 2022