TEST REPORT

Engineering recommendation G99/1

Requirements for the connection of generation equipment in parallel with public distribution networks

Report reference number ..... :	**PVUK200511N080-2**
Date of issue ..... ……..:	2021-01-11
Total number of pages ..... ……..:	69
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 A2LA 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 ..... :	G99/1-6:2020
	For Type A inverter connected Power Generating Modules
Test Report Form No. ..... :	G99/1 VER.2
TRF Originator ..... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF ..... :	Dated 2020-03-07
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**
Input DC voltage [V]..... :	1000Vd.c. Max.		
MPP DC voltage range [V]..... :	140-1000Vd.c.		
Input DC current [A] ..... :	Max.26,0A / 26,0A		
Isc PV [A] ..... :	36,0A / 36,0A		
Output AC voltage [V] ..... :	3/N/PE, 380 / 400Va.c., 50/60Hz		
Max. Output AC current [A]..... :	3 * 23,9	3 * 27,1	3 * 31,9
Rated Output power [kW] ..... :	15,0	17,0	20,0
Max Output power [kVA]..... :	16,5	18,7	22,0

Ratings..... :	**SOFAR 22KTLX-G3**	**SOFAR 24KTLX-G3**
Input DC voltage [V]..... :	1000Vd.c. Max.	
MPP DC voltage range [V]..... :	140-1000Vd.c.	
Input DC current [A] ..... :	Max.26,0A / 26,0A	
Isc PV [A] ..... :	36,0A / 36,0A	
Output AC voltage [V] ..... :	3/N/PE, 380 / 400Va.c., 50/60Hz	
Max. Output AC current [A]..... :	3 * 35,1	3 * 38,3
Rated Output power [kW] ..... :	22,0	24,0
Max Output power [kVA]..... :	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) ..... :	Jack Shi 
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**
2021-01-11	Jack Shi	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. 22,0 kg for SOFAR 17KTLX-G3, SOFAR 20KTLX-G3, SOFAR 22KTLX-G3; Approx. 20,0 kg for SOFAR 15KTLX-G3; Approx. 23,0 kg for 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 2021-01-10

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 G99/1. 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 comma is used as the decimal separator.

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 plate

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 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 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 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 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

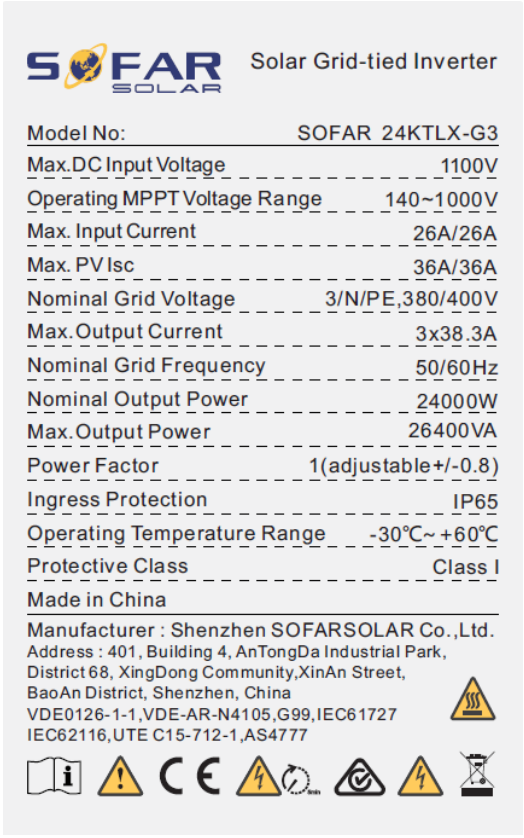
SOFAR SOLAR Solar Grid-tied Inverter

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

Copy of marking plate



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:

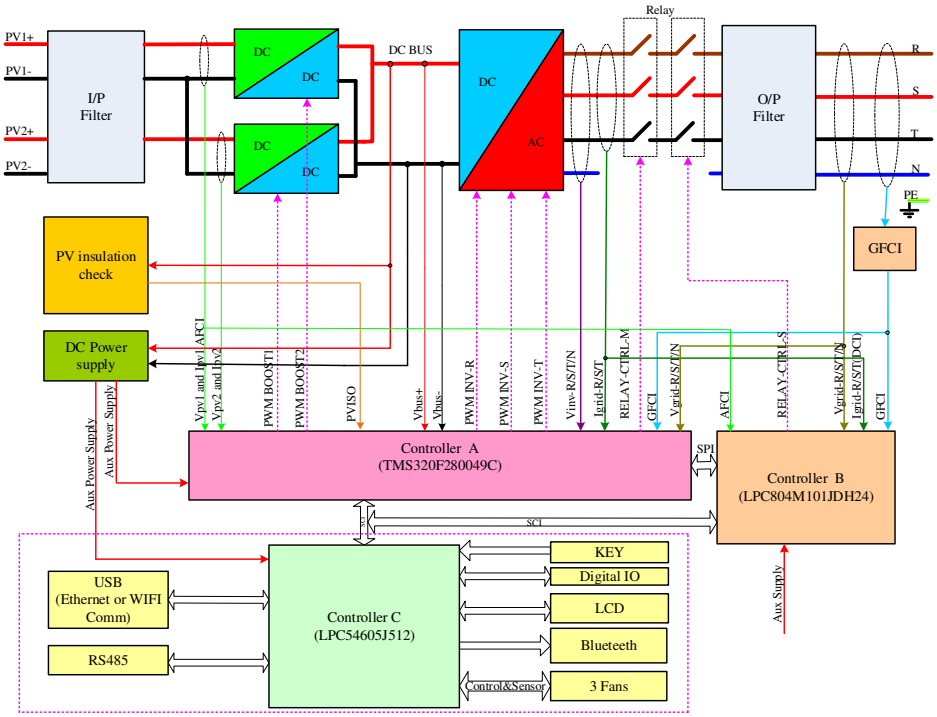


Figure 1 – Block diagram

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..

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)			
MOSFET (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 15KTLX-G3 and SOFAR 24KTLX-G3 are valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it's use the identical hardware and software construction except output power derated by software.

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7	**Requirements for Type Testing Power Generating Modules**		
A.7.1	**Power Park Module Requirements**		
A.7.1.1	**Certification & Type Testing Generating Unit Requirements**		
A.7.1.2	Type Verification Functional Testing of the Interface Protection		**P**
A.7.1.2.1	Disconnection times		**P**
A.7.1.2.2	Over / Under Voltage	see Table A.7.1.2.2	**P**
A.7.1.2.3	Over / Under Frequency	see Table A.7.1.2.3	**P**
A.7.1.2.4	Loss of Mains Protection	see Table A.7.1.2.4	**P**
A.7.1.2.5	Re-connection	see Table A.7.1.2.5	**P**
A.7.1.2.6	Frequency Drift and Step Change Stability test	see Table A.7.1.2.6	**P**
A.7.1.3	Limited Frequency Sensitive Mode – Over (LFSM-O)	see Table A.7.1.3	**P**
A.7.1.4.1	Harmonics	see Table A.7.1.4.1	**P**
A.7.1.4.2	Power Factor	see Table A.7.1.4.1	**P**
A.7.1.4.3	Voltage Flicker	see Table A.7.1.4.3	**P**
A.7.1.4.4	DC Injection	see Table A.7.1.4.4	**P**
A.7.1.5	Short Circuit Current Contribution	see Table A.7.1.5	**P**
A.7.1.6	Self-Monitoring - Solid State Disconnection		**N/A**
A.7.2.3	Power Output with Falling Frequency	see Table A.7.2.3	**P**

G99-1 Type A Test Results:

A.7.1.2 Type Verification Functional Testing of the Interface Protection Functional safety - fault condition tests according DIN V VDE V 0126-1-1								P
	ambient temperature [°C] :				24°C			
	model/type of power supply :				DC: 61250H-1000S AC: 61845			
	manufacturer of power supply :				CHROMA			
	rated markings of power supply :				DC: 0-1500V, 15KW AC: 0-300V, 45KW			

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
PV inverter current monitoring defect R3	Short	230V 35A	850V 29A	10min.	--	230V 0,1A	850V <1A	Inverter disconnected from grid immediately. Error message:" HwPVOCP". No damaged. No hazard.
PV current monitoring defect R852	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" HwPVOCP". No damaged.No hazard
PV inverter current monitoring defect U1 pin1-3	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" HwPVOCP". No damaged.No hazard.
Relay detect RL1	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.
Relay detect RL2	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.
Relay detect RL3	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.
Relay detect RL4	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.
Relay detect RL5	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.

Relay detect RL6	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter did not start-up. Error message:" RelayTestFail". No damage.No hazard.
AC Voltage monitoring defect R56	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
AC Voltage monitoring defect R58	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
AC Voltage monitoring defect R95	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
AC Voltage monitoring defect R96	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
AC Voltage monitoring defect R97	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
AC Voltage monitoring defect R101	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
AC Voltage monitoring defect R102	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
AC Voltage monitoring defect R103	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
ISO detect R168	short before start-up	230V 0,1A	850V 0,1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R169	short before start-up	230V 0,1A	850V 0,1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R22	Open before start-up	230V 0,1A	850V 0,1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R23	short before start-up	230V 0,1A	850V 0,1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.

ISO detect R186	Open before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R188	Short before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R193	Open before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R194	Short before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R174	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R175	Short before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R212	Open before start-up	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO detect R207	Short before start-up	230V 35A	850V 29A	10min.	--	230V 35A	850V 29A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
GFCI monitoring defect R421	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect R426	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect C275	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect C270	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect R413	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.

GFCI protect U5-D pin12-14	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect U5-C pin10-8	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect C252	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
GFCI protect R411	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" AFCIFault". No damaged.No hazard.
PV voltage monitor defect R515	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvOVP" No damaged.No hazard.
PV voltage monitor defect R517	Open	230V 17A	850V 15A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvUVP" No damaged.No hazard.
PV voltage monitor defect R522	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvOVP" No damaged.No hazard.
PV voltage monitor defect R524	Open	230V 17A	850V 15A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvUVP" No damaged.No hazard.
PV voltage monitor defect R529	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvOVP" No damaged.No hazard.
PV voltage monitor defect R531	Open	230V 17A	850V 15A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvUVP" No damaged.No hazard.
PV voltage monitor defect R538	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvOVP" No damaged.No hazard.
PV voltage monitor defect R540	Open	230V 17A	850V 15A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" InvUVP" No damaged.No hazard.

Bus voltage detect R547	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R549	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R552	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R554	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R557	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R559	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R562	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Bus voltage detect R564	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" VbusRmsUnbalance". No damaged.No hazard.
Grid voltage monitor defect R601	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R602	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.

Grid voltage monitor defect R589	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
Grid voltage monitor defect R590	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R597	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
Grid voltage monitor defect R596	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R569	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
Grid voltage monitor defect R836	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R574	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
Grid voltage monitor defect R839	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R578	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.
Grid voltage monitor defect R841	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
Grid voltage monitor defect R583	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridOVP". No damaged.No hazard.

Grid voltage monitor defect R587	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" GridUVP". No damaged.No hazard.
BUS voltage monitoring defect R613	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" BUS voltage is low". No damaged.No hazard.
BUS voltage monitoring defect R614	Short	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" Inverter bus hardware overvoltage". No damaged.No hazard.
ISO monitoring defect R189	Open before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO monitoring defect R510	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO monitoring defect R799	Open before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
ISO monitoring defect R801	Short before start-up	230V <1A	850V <1A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" IsoFault". No damaged.No hazard.
Communic ationdefect U13 pin82	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" BluetoothFault". No damaged.No hazard.
Communic ationdefect U13 pin95	Open	230V 35A	850V 29A	10min.	--	230V <1A	850V <1A	Inverter disconnected from grid immediately. Error message:" BluetoothFault". No damaged.No hazard.
The errors in the control circuit simulate that the safety is even ensured during single fault. The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.								

Operating Range		**P**
Setting values	Over-voltage [V]:	253,0
	Under-voltage [V]:	195,5
	Over-frequency [Hz]:	52,00
	Under-frequency [Hz]:	47,00

- Test 1: U = 195,5 V; f = 47,0 Hz; P = 1,00 Sn; cosφ = 1; at least 20 s
- Test 2: U = 195,5 V; f = 47,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 3: U = 253,0 V; f = 51,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 4: U = 253,0 V; f = 52,0 Hz; P = 1,00 Sn; cosφ = 1; at least 15 mins
- Test 5: U = 230,0 V; f = 50,0 to 50,5 Hz;RoCoF=1Hz/s; P = 1,00 Sn; cosφ = 1

Test sequence	Voltage [V]	Frequency [Hz]	Output power [W]	Cos φ [1]
Test 1	195,88	47,00	23,845	0,995
Test 2	195,84	47,50	23,846	0,996
Test 3	253,39	51,50	23,969	0,999
Test 4	253,18	52,00	23,974	0,998
Test5	230,31	50,50	24,025	0,999

Note:

During the tests the interface protection was disabled.

Operation at reduced power is allowed during test 1 and test 2, equal to the maximum power that can be supplied on reaching the maximum output current limit (P ≥ 0,85 Sn).

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

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

A.7.1.2.2 Over / Under Voltage

Table 10.1 Settingd for long term parallel Operation

P

Test: L1 to N

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V (0,8 pu)	2,5s	183,4V	2,602s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V (1,14 pu)	1,0s	263,3V	1,102	258,2V / 5,0s	No trip
O/V stage 2	273,7V (1,19 pu)	0,5s	275,3V	0,608	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Test: L2 to N

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V (0,8 pu)	2,5s	183,3V	2,622s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V (1,14 pu)	1,0s	263,2V	1,110s	258,2V / 5,0s	No trip
O/V stage 2	273,7V (1,19 pu)	0,5s	275,2V	0,614	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Test: L3 to N

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V (0,8 pu)	2,5s	183,6V	2,602s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V (1,14 pu)	1,0s	263,5V	1,114s	258,2V / 5,0s	No trip
O/V stage 2	273,7V (1,19 pu)	0,5s	275,6	0,616	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

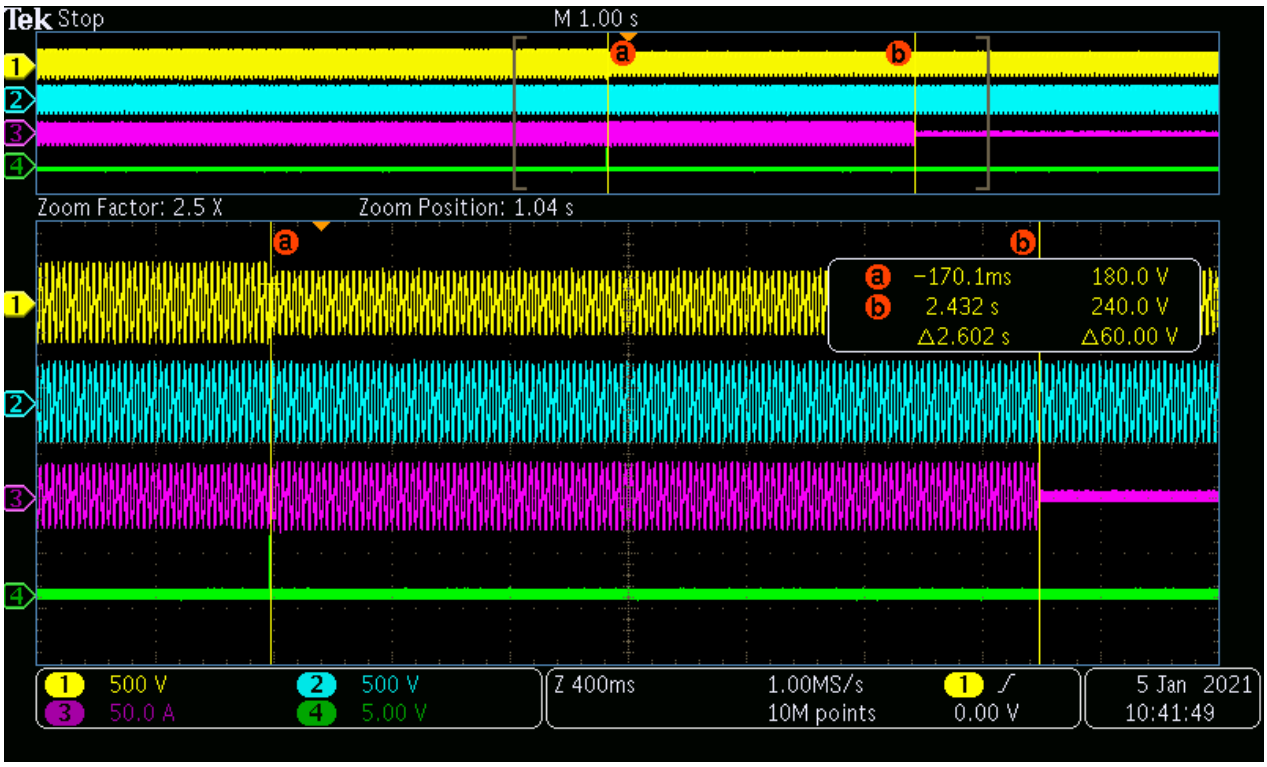
Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0.5 s.

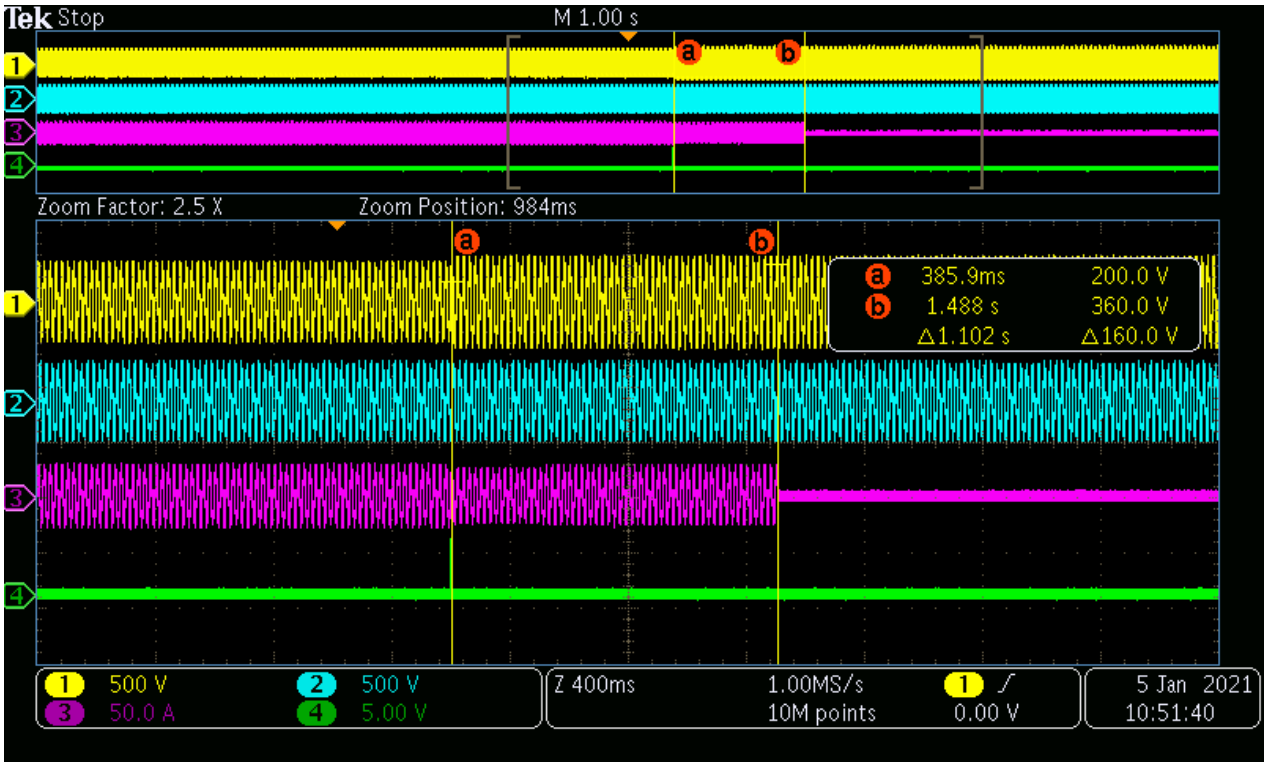
The Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

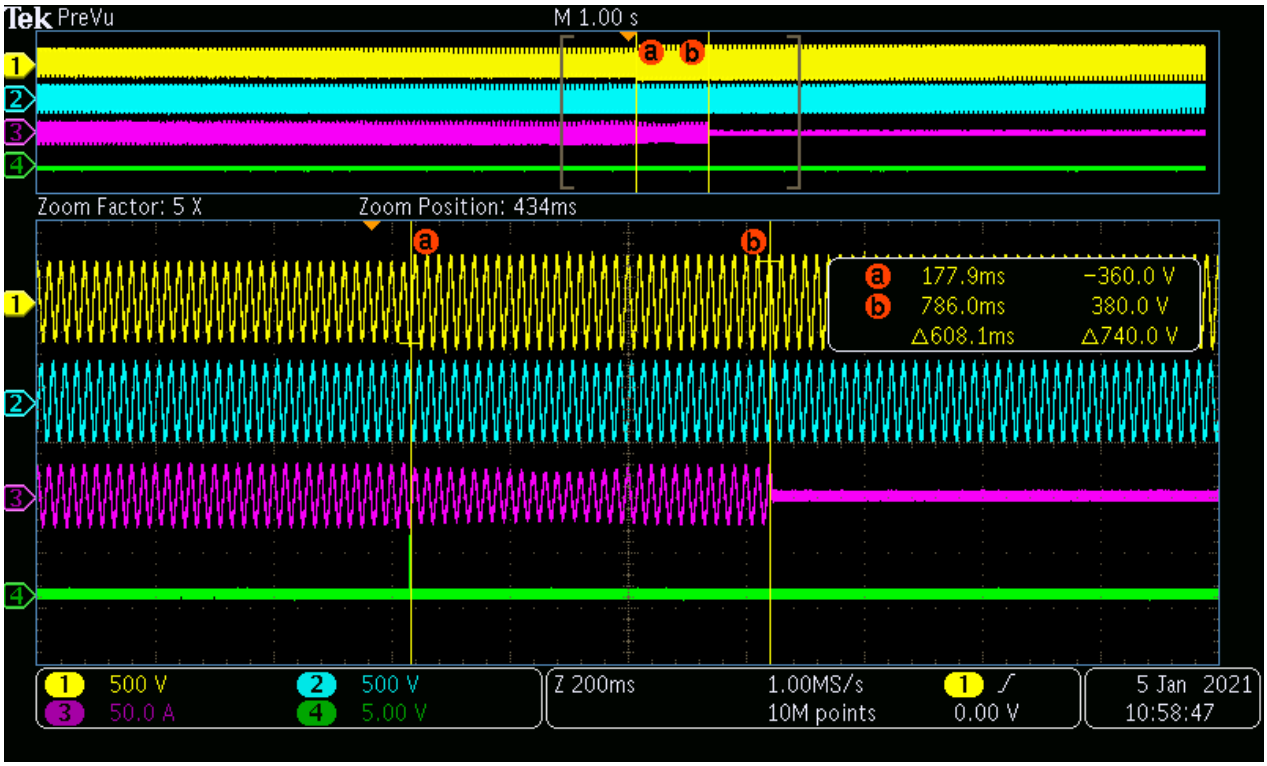
U/V / L1 phase



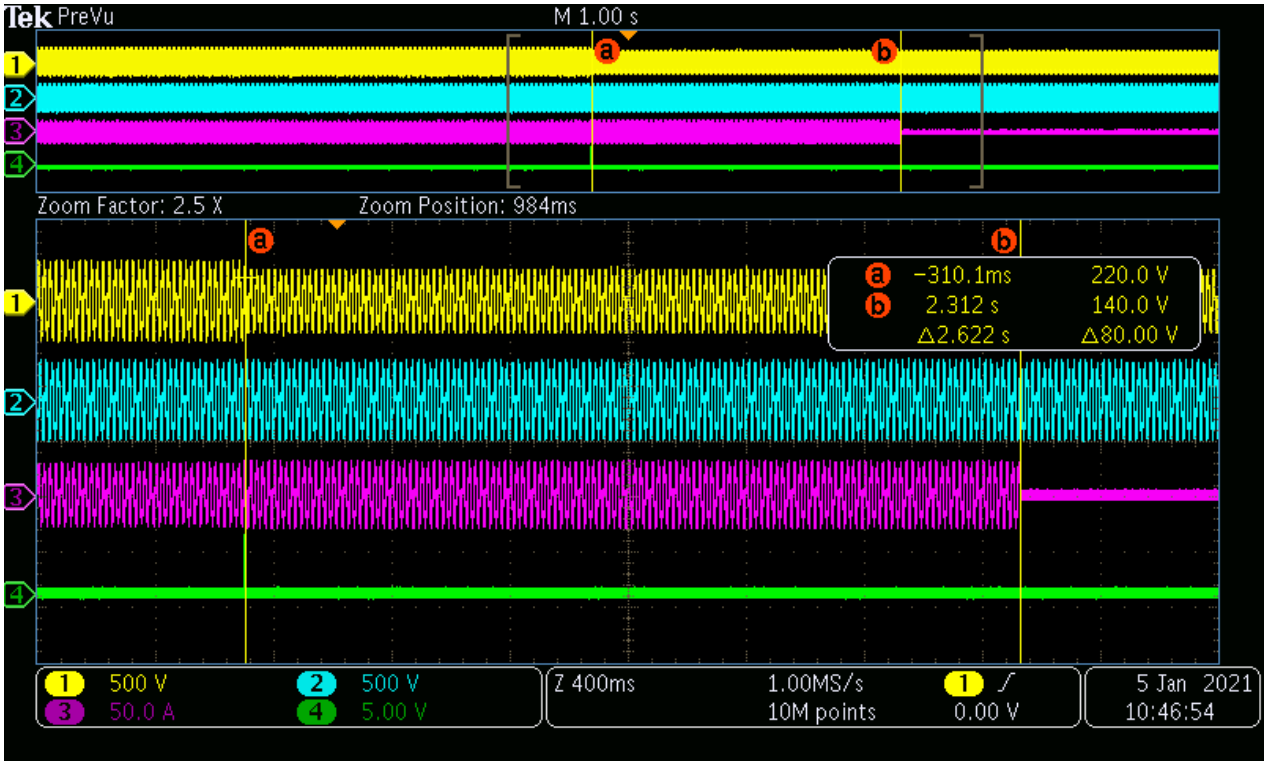
O/V stage 1 / L1 phase



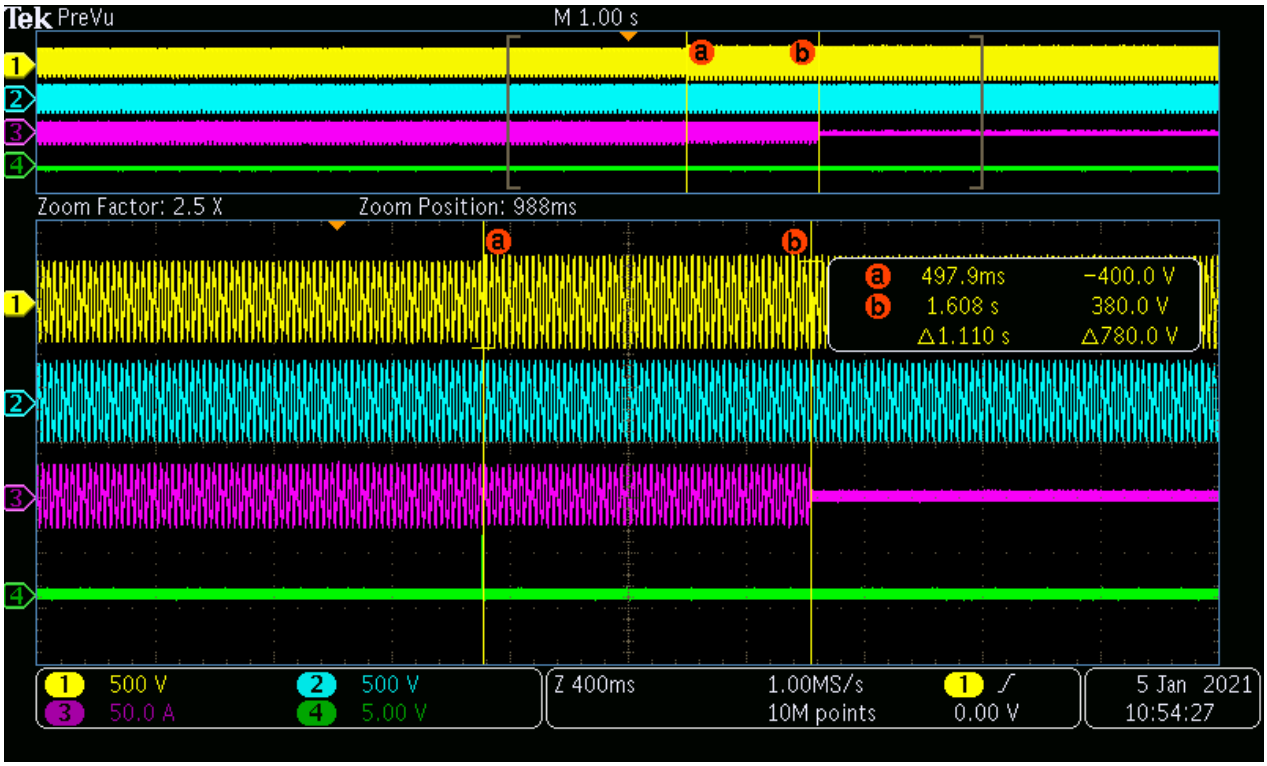
O/V stage 2 / L1 phase



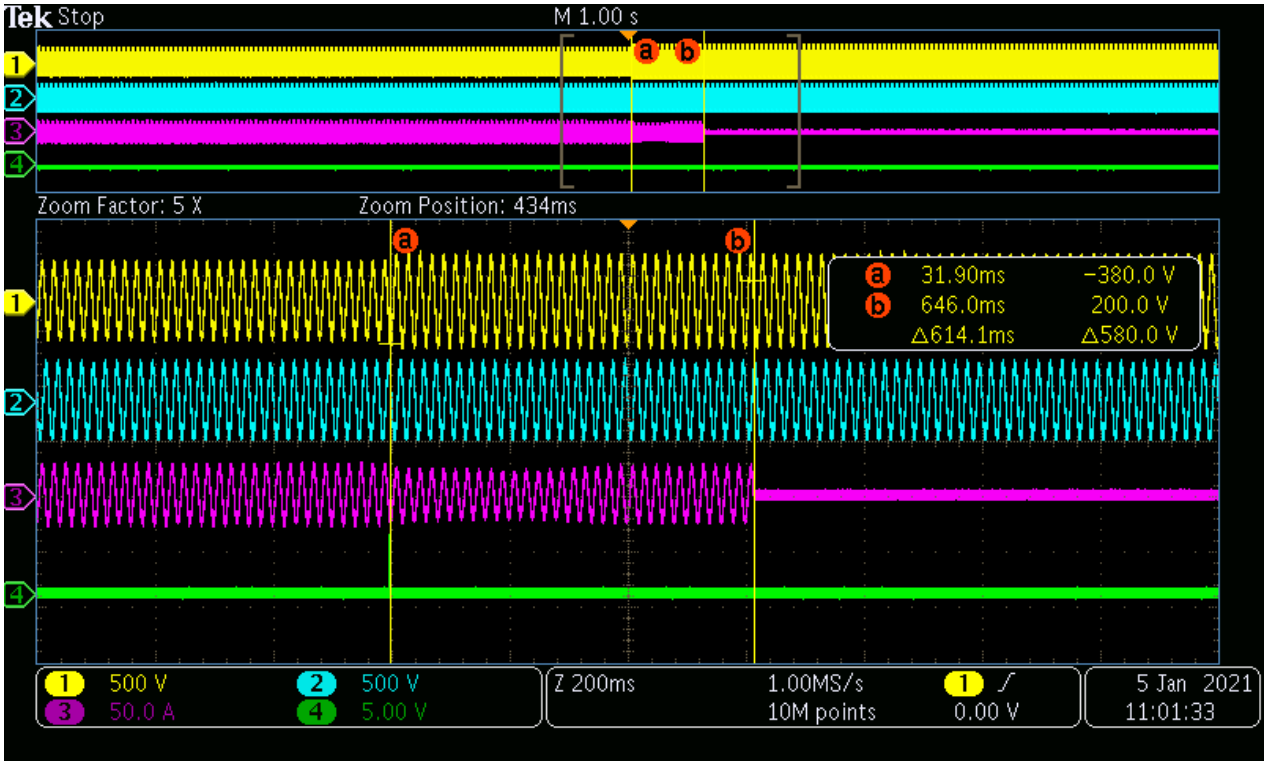
U/V / L2 phase



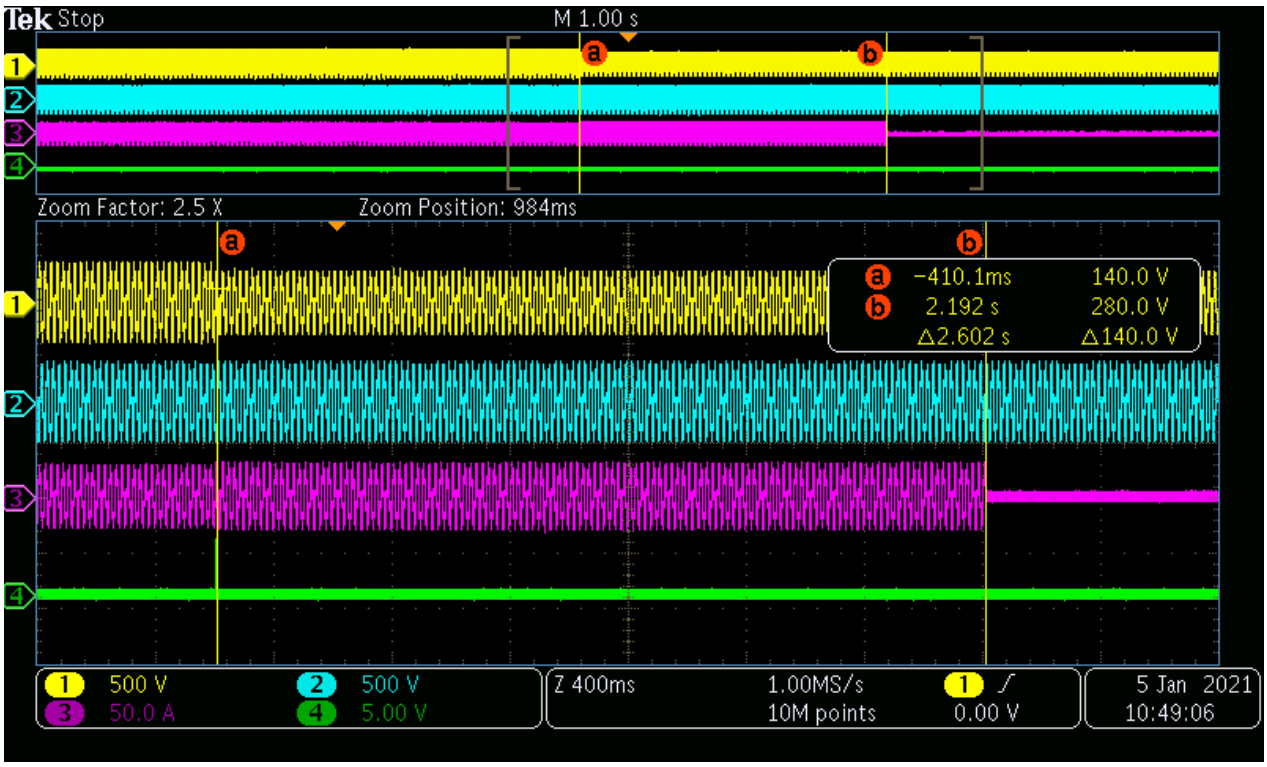
O/V stage 1 / L2 phase



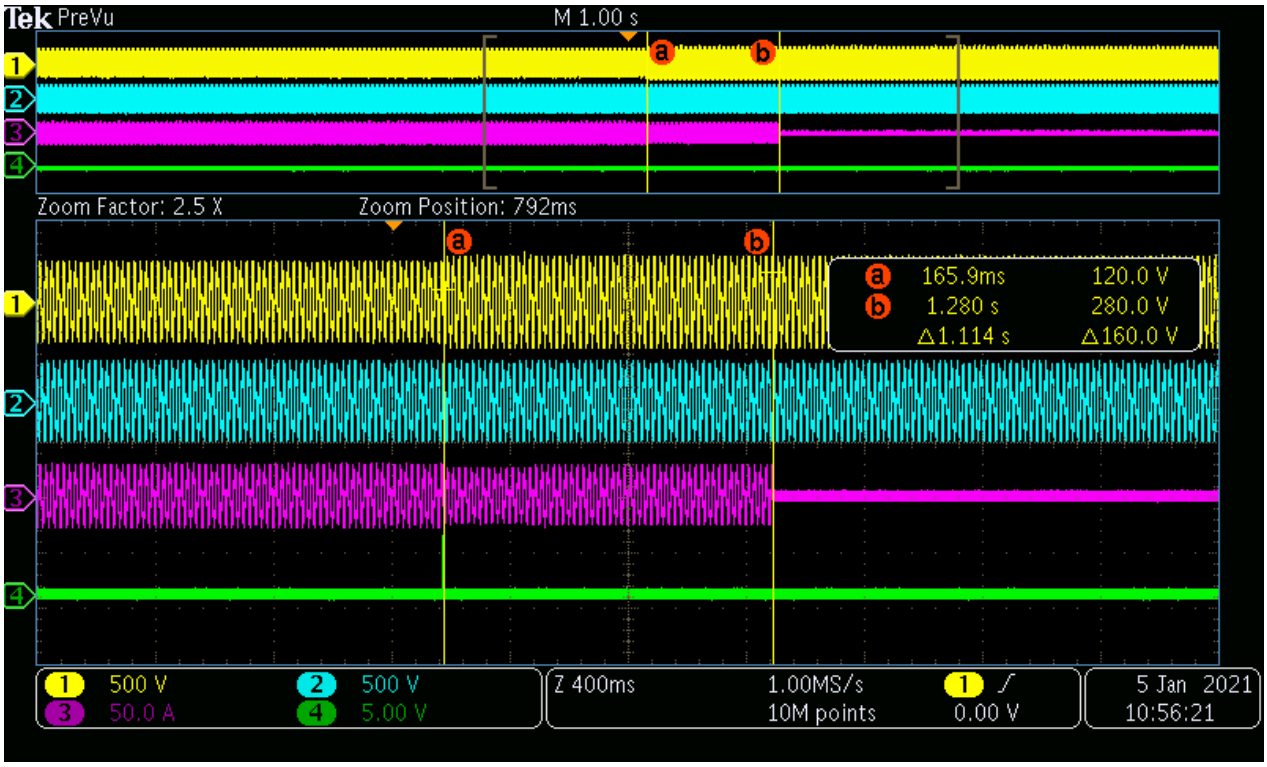
O/V stage 2 / L2 phase



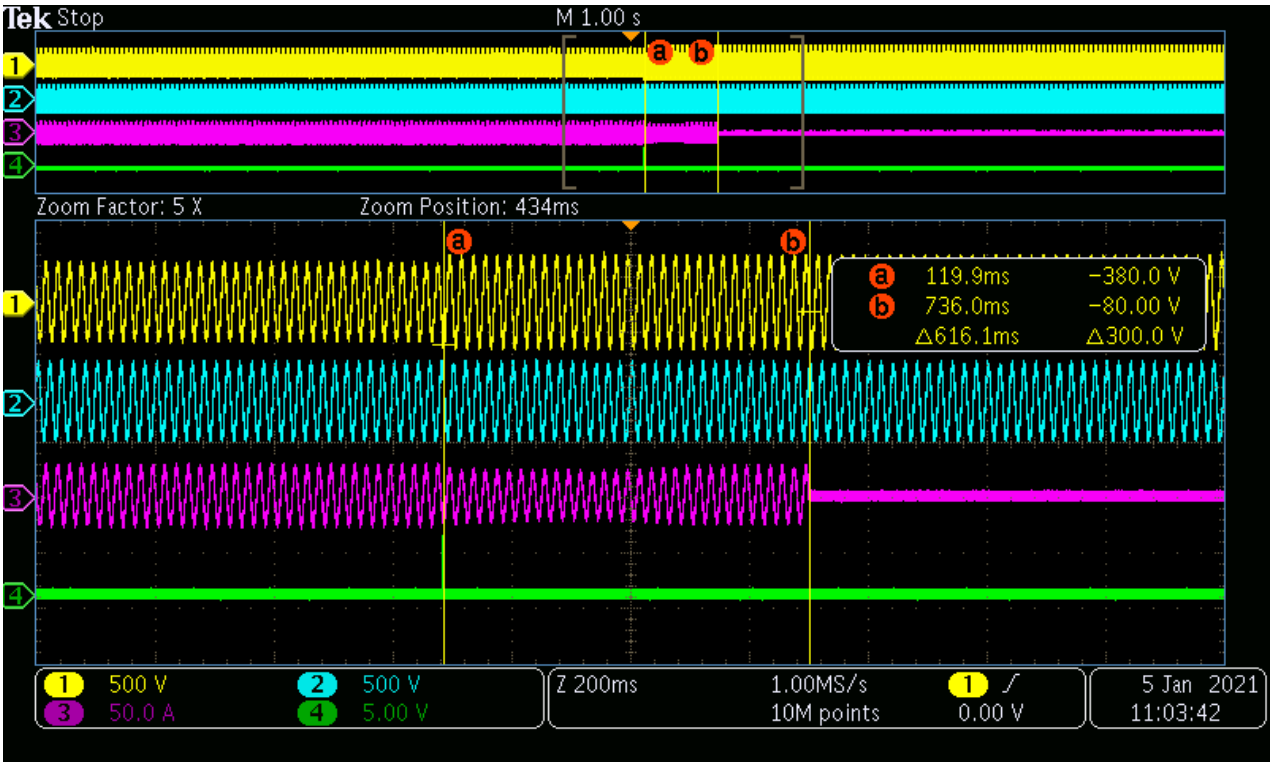
U/V / L3 phase



O/V stage 1 / L3 phase



O/V stage 2 / L3 phase



A.7.1.2.3 Over / Under Frequency						P
Test:						
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20,0s	47,48Hz	20,10s	47,7Hz / 30s	No trip
U/F stage 2	47,0Hz	0,5s	46,90Hz	0,614s	47,2Hz / 19,5s	No trip
					46,8 Hz / 0,45s	No trip
O/F	52,0Hz	0,5s	52,00Hz	0,628s	51,8Hz / 120s	No trip
					52,2 Hz / 0,45s	No trip

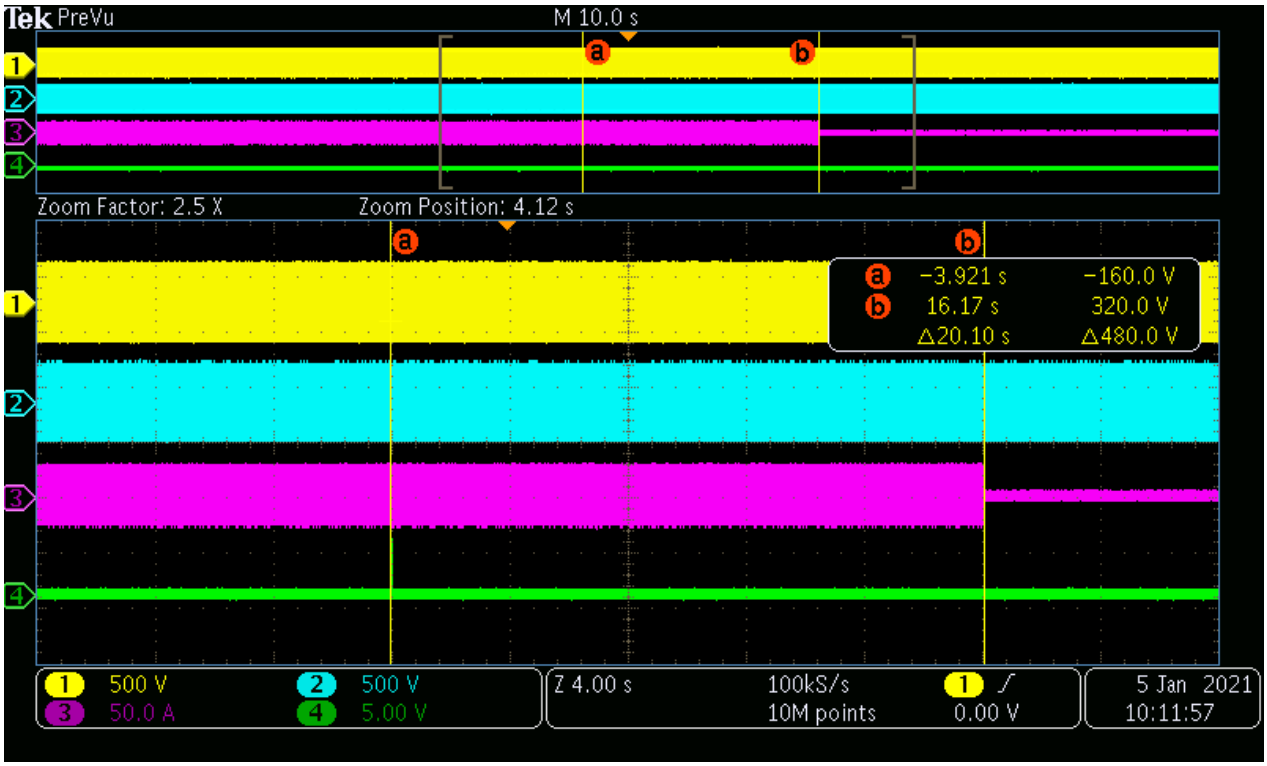
Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0.5 s.

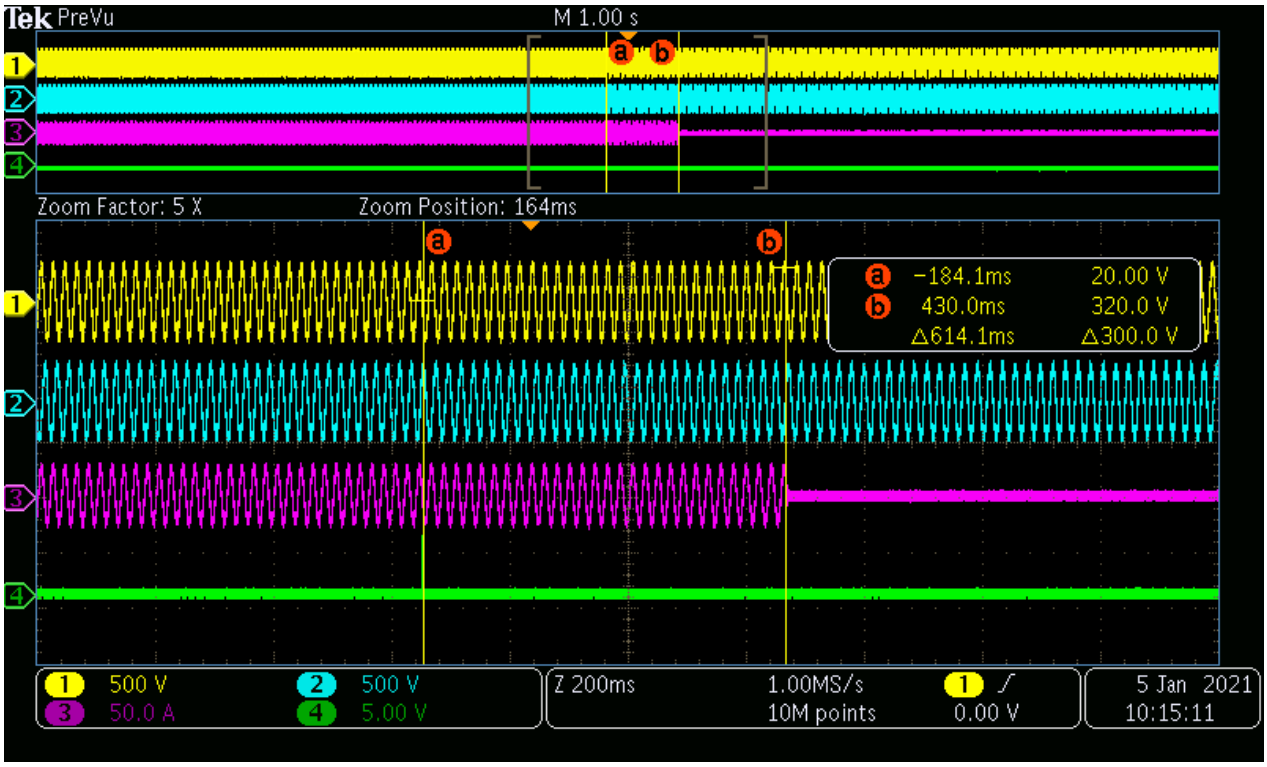
For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

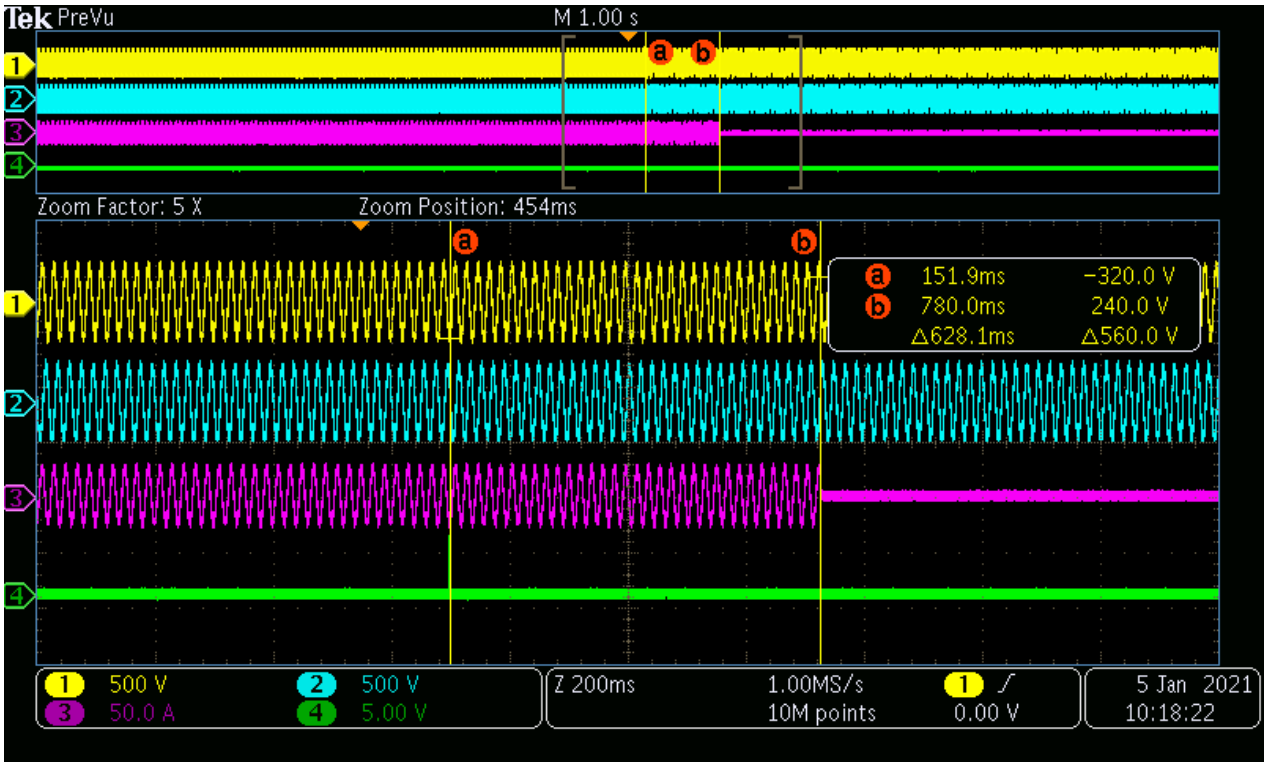
U/F stage 1



U/F stage 2



O/F


Tek PreVu
M 1.00 s
Zoom Factor: 5 X
Zoom Position: 454ms
a 151.9ms -320.0 V
b 780.0ms 240.0 V
Δ628.1ms Δ560.0 V
1 500 V
2 500 V
3 50.0 A
4 5.00 V
Z 200ms
1.00MS/s
10M points
1 ⎍
0.00 V
5 Jan 2021
10:18:22

A.7.1.2.4 Loss of mains protection according BS EN 62116

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)

P

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

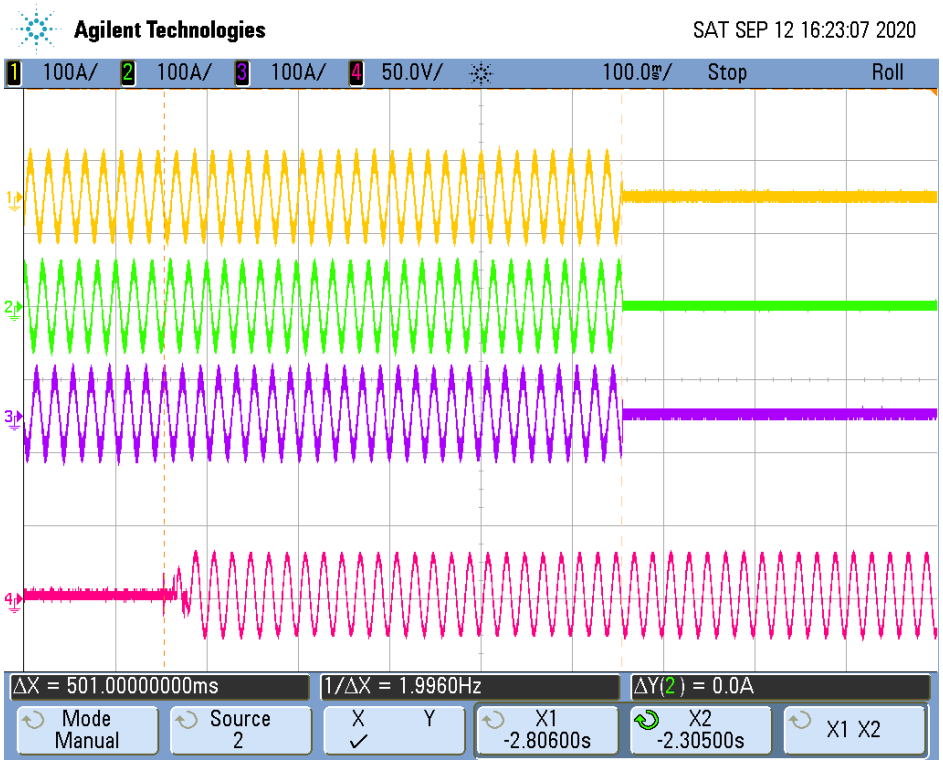
No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
1	100	100	0	0	8,005	734	1,001	**501***	Test A at BL
2	100	100	-5	-5	8,005	734	1,027	449	Test A at IB
3	100	100	-5	0	8,005	734	1,054	379	Test A at IB
4	100	100	-5	+5	8,005	734	1,080	437	Test A at IB
5	100	100	0	-5	8,005	734	0,976	438	Test A at IB
6	100	100	0	+5	8,005	734	1,026	395	Test A at IB
7	100	100	+5	-5	8,005	734	0,930	397	Test A at IB
8	100	100	+5	0	8,005	734	0,954	469	Test A at IB
9	100	100	+5	+5	8,005	734	0,977	416	Test A at IB

Parameter at 0%	L= 21,01 mH	R= 6,61 Ω	C= 482,16 µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

Note:
Note for technologies which have a substantial shut down time this can be added to the 0.5 seconds in establishing that the trip occurred in less than 0.5s. Maximum shut down time could therefore be up to 1.0 seconds for these technologies.
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) BL: Balance condition, IB: Imbalance condition.
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = >90% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,9 × (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.
* Additional shut down time included in above results is 1 ms
The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load and 100% nominal power



A.7.1.2.4 Loss of mains protection according BS EN 62116

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT output = 50 % – 66 %)

P

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

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)	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
11	66	66	0	-5	5,036	470	0,974	413	Test B at IB
10	66	66	0	-4	5,036	470	0,979	481	Test B at IB
9	66	66	0	-3	5,036	470	0,985	469	Test B at IB
8	66	66	0	-2	5,036	470	0,990	463	Test B at IB
7	66	66	0	-1	5,036	470	0,995	384	Test B at IB
1	66	66	0	0	5,036	470	1,000	**511***	Test B at BL
2	66	66	0	1	5,036	470	1,005	480	Test B at IB
3	66	66	0	2	5,036	470	1,010	500	Test B at IB
4	66	66	0	3	5,036	470	1,015	484	Test B at IB
5	66	66	0	4	5,036	470	1,019	489	Test B at IB
6	66	66	0	5	5,036	470	1,024	474	Test B at IB

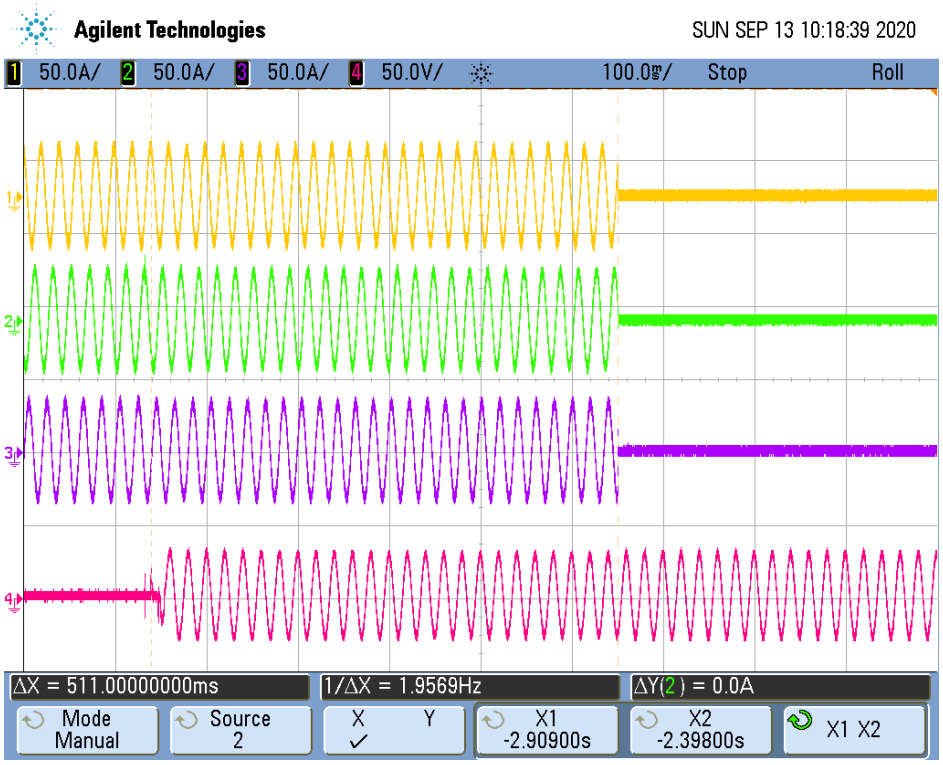
Parameter at 0%	L= 31,74 mH	R= 9,97 Ω	C= 319,27 µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

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) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 50 % – 66 % of maximum
EUT input voltage 5) = 50 % of rated input voltage range, ±10 %
5) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % 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.
** Additional shut down time included in above results is 11 ms
The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power

derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 1% reactive load and 66% nominal power



A.7.1.2.4 Loss of mains protection according BS EN 62116

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT output = 25 % – 33 %)

P

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

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)	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
11	33	33	0	-5	2,635	206	0,977	411	Test B at IB
10	33	33	0	-4	2,635	206	0,982	487	Test B at IB
9	33	33	0	-3	2,635	206	0,987	368	Test B at IB
8	33	33	0	-2	2,635	206	0,992	418	Test B at IB
7	33	33	0	-1	2,635	206	0,997	410	Test B at IB
1	33	33	0	0	2,635	206	1,002	**497**	Test B at BL
2	33	33	0	1	2,635	206	1,007	372	Test B at IB
3	33	33	0	2	2,635	206	1,012	439	Test B at IB
4	33	33	0	3	2,635	206	1,017	348	Test B at IB
5	33	33	0	4	2,635	206	1,022	455	Test B at IB
6	33	33	0	5	2,635	206	1,027	414	Test B at IB

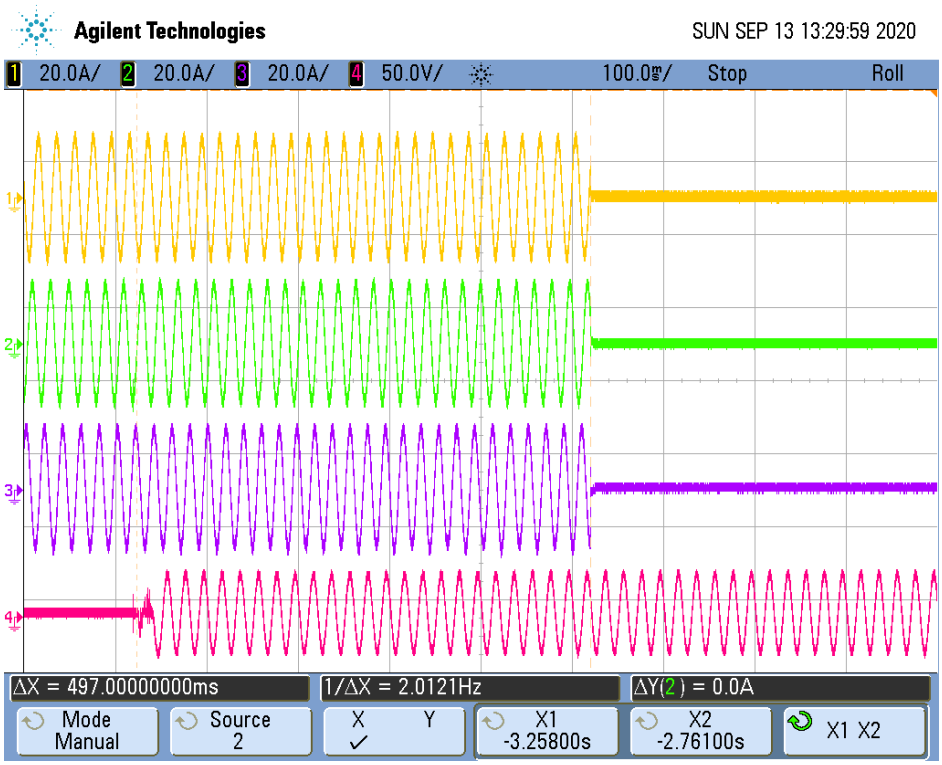
Parameter at 0%	L= 102,05 mH	R= 32,06 Ω	C= 99,28 µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

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) BL: Balance condition, IB: Imbalance condition.
Condition C:
EUT output power PEUT = 25 % – 33 % 5) of maximum
EUT input voltage 6) = <10 % of rated input voltage range
5) Or minimum allowable EUT output level if greater than 33 %.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,1 × (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 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 1 reactive load and 33% nominal power



A.7.1.2.5 Reconnection	P

Test:

Test should prove that the reconnection sequence starts after a minimum delay of 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 1.

Under Voltage	
Time delay setting	Measured delay
20s	88s
Over Voltage	
Time delay setting	Measured delay
20s	88s
Under Frequency	
Time delay setting	Measured delay
20s	88s
Over Frequency	
Time delay setting	Measured delay
20s	88s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the SSEG does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

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

A.7.1.2.6 Frequency Drift and Step Change Stability test	P

Test:

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49,0Hz	+50 degrees		No trip
Negative Vector Shift	50,0Hz	-50 degrees		No trip
Positive Frequency drift	49,0Hz	+0,95Hz/sec	51,0Hz	No trip
Negative Frequency drift	51,0Hz	-0,95Hz/sec	49,0Hz	No trip

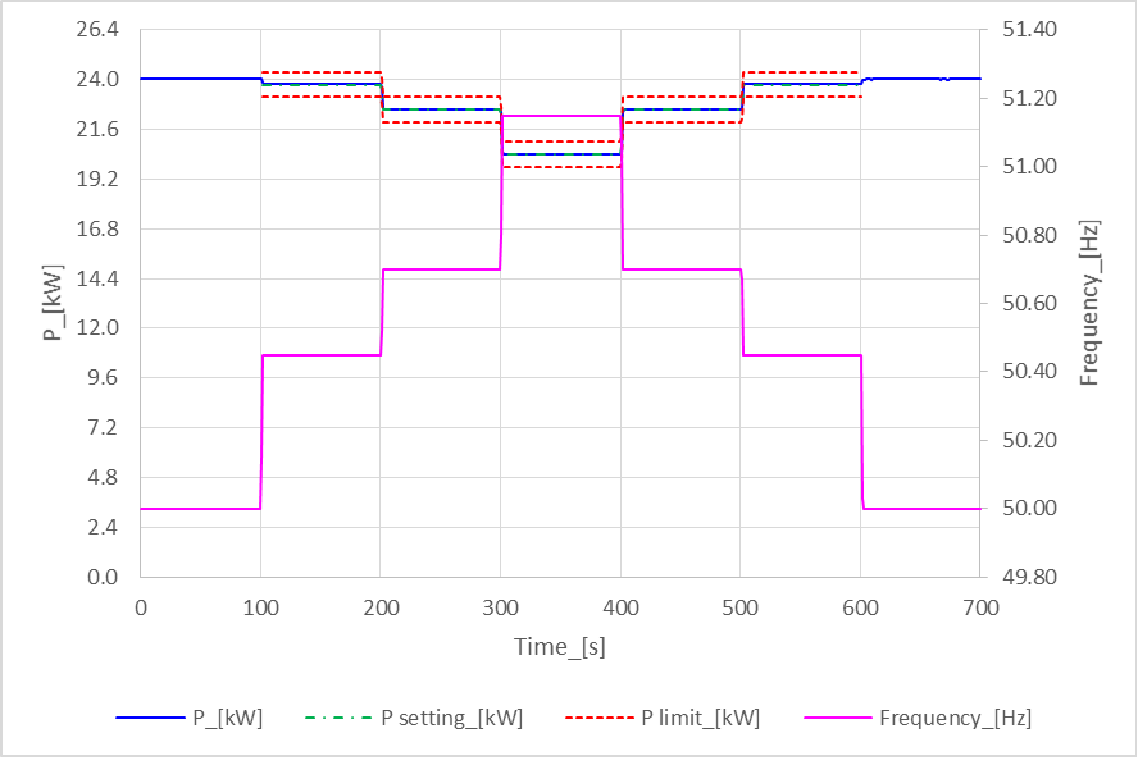
Note:
Manufacturers considering new designs should allow for the RoCoF where stability is required to be increased to, up to 2Hz per second, as proposed in the new European network codes, which are expected to come into force over the period 2014/2015. Under these conditions RoCoF will cease to be an effective loss of mains protection and is unlikely to be permitted in future revisions of this document.

For the step change test the SSEG should be operated with a measureable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 seconds to complete the test. The SSEG should not trip during this test.

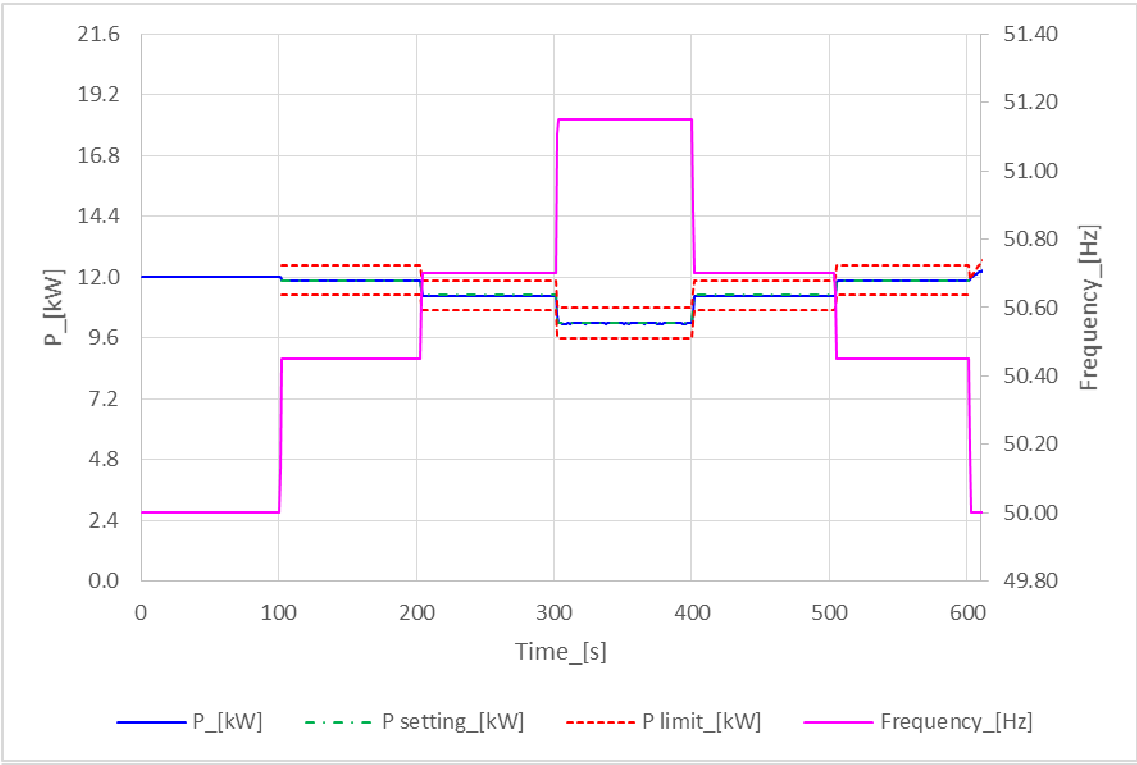
For frequency drift tests the SSEG should be operated with a measureable output at the start frequency and then the frequency changed in a ramp function at 0,95Hz per second to the end frequency. On reaching the end frequency it should be maintained for a period of at least10 seconds. The SSEG should not trip during this test.

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

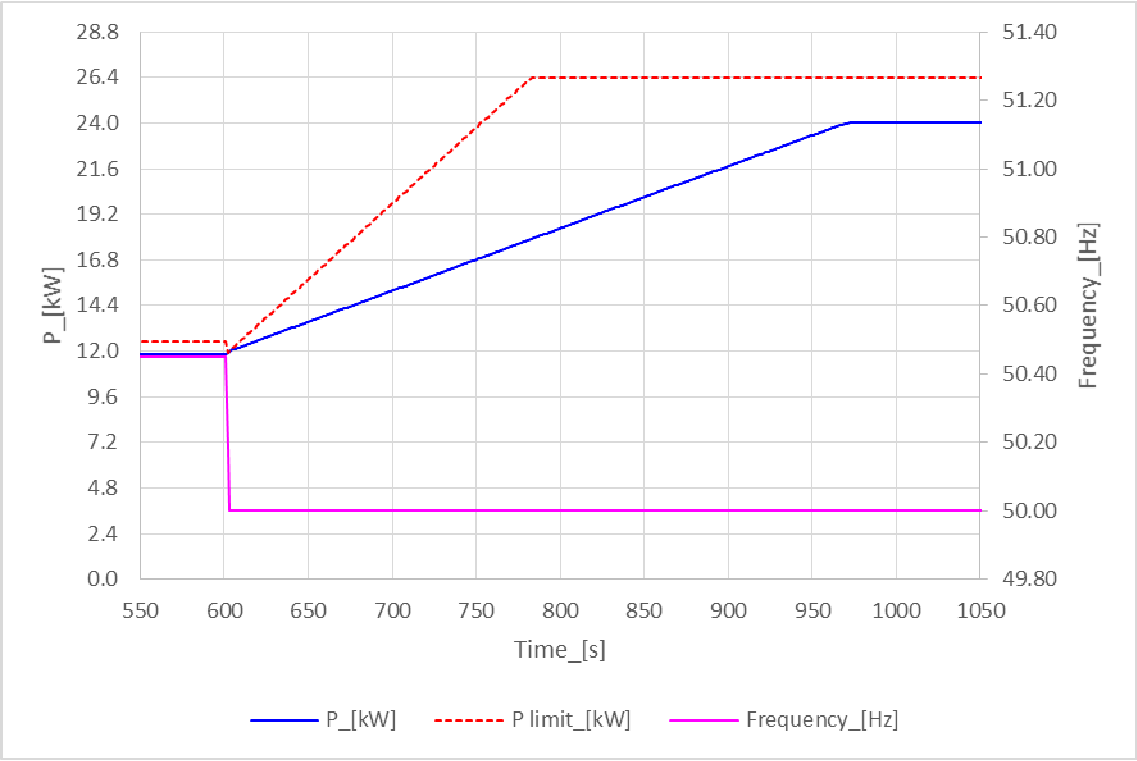
A.7.1.3 Power response to over-frequency							P
Test:							
1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_M [kW]:	N/A	23,782	22,581	20,419	22,581	23,782	N/A
P_{E60} [kW]:	24,022	23,770	22,580	20,413	22,580	23,772	24,019
$\Delta P_{E60}/P_M$ [%]:	N/A	-0,050	-0,004	-0,025	-0,004	-0,042	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_M [kW]:	N/A	11,909	11,307	10,225	11,307	11,909	N/A
P_{E60} [kW]:	12,029	11,850	11,253	10,170	11,253	11,850	12,029
$\Delta P_{E60}/P_M$ [%]:	N/A	-0,246	-0,225	-0,229	-0,225	-0,246	N/A
Limit $\Delta P/P_{1min}$:	2,5 % of P_M						
Graph of Measurement 1.: Active power output > 80% P_n							



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



Graph of power gradient:



Test:

The test is conducted for two powers. First, the test must start at a power > 80% P_n ("Measurement 1"), and in a second test, for a power between 40% to 60% P_n ("Measurement 2"). In the second test, after freezing of the P_M, the available active power output must be increased to a value > 80% P_n, and after the network frequency of 50,4 Hz 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:

For f = 50,4 Hz, the value of the P_M active power currently being generated is "frozen".

a) For adjustable micro-generators when:

1) the active power reduces between measuring points b) and f) given above with the set gradient P_M per Hz for a increasing frequency (or rises for a frequency decreasing again).

2) the maximum active power gradient occurring in point is less than the configured maximum active power per minute

3) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P_n by more than ± 10%.

4) the settling time is equal or below 2 s with an intentional delay set to zero

b) For partly adjustable micro-generators

1) when they behave as in a) within their adjustment range, and

2) when, outside the adjustable range, the power fed in on leaving the adjustment range remains constant until shutdown. Shutdown must be no later than at 51,5 Hz.

The droop values should between 8,52% and 12,82%.

Note:

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 15KTLX-G3_L1 phase

Generating Unit rating per phase (rpp)	5,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,523 kW		100% of rated output 5,011 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	10,955	--	21,713	--	--
2th	0,015	0,137	0,026	0,237	1
3th	0,044	0,402	0,105	0,958	4
4th	0,011	0,100	0,013	0,119	1
5th	0,076	0,694	0,232	2,118	4
6th	0,005	0,046	0,008	0,073	1
7th	0,056	0,511	0,184	1,680	4
8th	0,004	0,037	0,006	0,055	1
9th	0,012	0,110	0,016	0,146	4
10th	0,003	0,027	0,005	0,046	0,5
11th	0,034	0,310	0,089	0,812	2
12th	0,002	0,018	0,004	0,037	0,5
13th	0,025	0,228	0,019	0,173	2
14th	0,002	0,018	0,004	0,037	0,5
15th	0,005	0,046	0,024	0,219	2
16th	0,002	0,018	0,003	0,027	0,5
17th	0,016	0,146	0,047	0,429	1,5
18th	0,002	0,018	0,004	0,037	0,5
19th	0,010	0,091	0,065	0,593	1,5
20th	0,002	0,018	0,004	0,037	0,5
21th	0,007	0,064	0,009	0,082	1,5
22th	0,002	0,018	0,004	0,037	0,5
23th	0,014	0,128	0,019	0,173	0,6
24th	0,002	0,018	0,005	0,046	0,5
25th	0,009	0,082	0,041	0,374	0,6
26th	0,002	0,018	0,004	0,037	0,5
27th	0,005	0,046	0,009	0,082	0,6
28th	0,002	0,018	0,004	0,037	0,5
29th	0,012	0,110	0,036	0,329	0,6
30th	0,002	0,018	0,004	0,037	0,5
31th	0,009	0,082	0,046	0,420	0,6
32th	0,002	0,018	0,004	0,037	0,5
33th	0,002	0,018	0,007	0,064	0,6
34th	0,002	0,018	0,003	0,027	--
35th	0,011	0,100	0,043	0,393	--
36th	0,001	0,009	0,004	0,037	--
37th	0,016	0,146	0,030	0,274	--
38th	0,002	0,018	0,003	0,027	--
39th	0,003	0,027	0,005	0,046	--
40th	0,002	0,018	0,004	0,037	--
41th	0,008	0,073	0,034	0,310	--
42th	0,002	0,018	0,003	0,027	--
43th	0,017	0,155	0,021	0,192	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
44th	0,002	0,018	0,008	0,073	--
45th	0,004	0,037	0,004	0,037	--
46th	0,003	0,027	0,005	0,046	--
47th	0,007	0,064	0,034	0,310	--
48th	0,003	0,027	0,005	0,046	--
49th	0,013	0,119	0,013	0,119	--
50th	0,002	0,018	0,003	0,027	--
THD_[%]	--	1,125	--	3,253	23
PWHD_[%]	--	2,325	--	6,619	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 15KTLX-G3_L2 phase

Generating Unit rating per phase (rpp)	5,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,525 kW		100% of rated output 5,020 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	10,959	--	21,749	--	--
2th	0,010	0,091	0,016	0,146	1
3th	0,009	0,082	0,032	0,292	4
4th	0,007	0,064	0,009	0,082	1
5th	0,064	0,584	0,215	1,963	4
6th	0,005	0,046	0,006	0,055	1
7th	0,052	0,475	0,167	1,524	4
8th	0,003	0,027	0,004	0,037	1
9th	0,003	0,027	0,010	0,091	4
10th	0,003	0,027	0,004	0,037	0,5
11th	0,030	0,274	0,080	0,730	2
12th	0,002	0,018	0,003	0,027	0,5
13th	0,024	0,219	0,026	0,237	2
14th	0,002	0,018	0,004	0,037	0,5
15th	0,003	0,027	0,015	0,137	2
16th	0,002	0,018	0,003	0,027	0,5
17th	0,016	0,146	0,060	0,548	1,5
18th	0,002	0,018	0,003	0,027	0,5
19th	0,009	0,082	0,072	0,657	1,5
20th	0,002	0,018	0,003	0,027	0,5
21th	0,003	0,027	0,011	0,100	1,5
22th	0,002	0,018	0,003	0,027	0,5
23th	0,014	0,128	0,024	0,219	0,6
24th	0,002	0,018	0,004	0,037	0,5
25th	0,009	0,082	0,051	0,466	0,6
26th	0,002	0,018	0,004	0,037	0,5
27th	0,004	0,037	0,011	0,100	0,6
28th	0,002	0,018	0,003	0,027	0,5
29th	0,013	0,119	0,038	0,347	0,6
30th	0,002	0,018	0,003	0,027	0,5
31th	0,012	0,110	0,059	0,539	0,6
32th	0,001	0,009	0,003	0,027	0,5
33th	0,003	0,027	0,005	0,046	0,6
34th	0,001	0,009	0,003	0,027	--
35th	0,011	0,100	0,039	0,356	--
36th	0,002	0,018	0,003	0,027	--
37th	0,017	0,155	0,032	0,292	--
38th	0,001	0,009	0,003	0,027	--
39th	0,003	0,027	0,006	0,055	--
40th	0,001	0,009	0,003	0,027	--
41th	0,007	0,064	0,033	0,301	--
42th	0,002	0,018	0,003	0,027	--
43th	0,018	0,164	0,022	0,201	--
44th	0,002	0,018	0,004	0,037	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,004	0,037	0,005	0,046	--
46th	0,003	0,027	0,005	0,046	--
47th	0,006	0,055	0,032	0,292	--
48th	0,003	0,027	0,005	0,046	--
49th	0,015	0,137	0,011	0,100	--
50th	0,002	0,018	0,003	0,027	--
THD_[%]	--	0,943	--	2,967	23
PWHD_[%]	--	2,415	--	7,180	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 15KTLX-G3_L3 phase

Generating Unit rating per phase (rpp)	5,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,527 kW		100% of rated output 5,023 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	10,958	--	21,753	--	--
2th	0,009	0,082	0,017	0,155	1
3th	0,052	0,475	0,085	0,776	4
4th	0,005	0,046	0,006	0,055	1
5th	0,054	0,493	0,225	2,054	4
6th	0,003	0,027	0,005	0,046	1
7th	0,039	0,356	0,171	1,561	4
8th	0,003	0,027	0,004	0,037	1
9th	0,017	0,155	0,023	0,210	4
10th	0,002	0,018	0,004	0,037	0,5
11th	0,028	0,256	0,049	0,447	2
12th	0,002	0,018	0,003	0,027	0,5
13th	0,021	0,192	0,031	0,283	2
14th	0,002	0,018	0,004	0,037	0,5
15th	0,006	0,055	0,010	0,091	2
16th	0,002	0,018	0,003	0,027	0,5
17th	0,015	0,137	0,068	0,621	1,5
18th	0,002	0,018	0,003	0,027	0,5
19th	0,010	0,091	0,078	0,712	1,5
20th	0,002	0,018	0,003	0,027	0,5
21th	0,003	0,027	0,006	0,055	1,5
22th	0,002	0,018	0,003	0,027	0,5
23th	0,013	0,119	0,021	0,192	0,6
24th	0,002	0,018	0,004	0,037	0,5
25th	0,008	0,073	0,048	0,438	0,6
26th	0,002	0,018	0,005	0,046	0,5
27th	0,004	0,037	0,006	0,055	0,6
28th	0,002	0,018	0,003	0,027	0,5
29th	0,011	0,100	0,031	0,283	0,6
30th	0,002	0,018	0,004	0,037	0,5
31th	0,012	0,110	0,054	0,493	0,6
32th	0,002	0,018	0,003	0,027	0,5
33th	0,003	0,027	0,005	0,046	0,6
34th	0,002	0,018	0,003	0,027	--
35th	0,010	0,091	0,038	0,347	--
36th	0,002	0,018	0,003	0,027	--
37th	0,017	0,155	0,031	0,283	--
38th	0,002	0,018	0,003	0,027	--
39th	0,003	0,027	0,007	0,064	--
40th	0,002	0,018	0,003	0,027	--
41th	0,008	0,073	0,030	0,274	--
42th	0,002	0,018	0,003	0,027	--
43th	0,019	0,173	0,024	0,219	--
44th	0,002	0,018	0,006	0,055	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,004	0,037	0,004	0,037	--
46th	0,003	0,027	0,005	0,046	--
47th	0,007	0,064	0,032	0,292	--
48th	0,003	0,027	0,005	0,046	--
49th	0,014	0,128	0,012	0,110	--
50th	0,002	0,018	0,003	0,027	--
THD_[%]	--	0,951	--	3,086	23
PWHD_[%]	--	2,395	--	7,064	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 24KTLX-G3_L1 phase

Generating Unit rating per phase (rpp)	8,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,4,037 kW		100% of rated output 8,015 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	17,529	--	34,726	--	--
2th	0,024	0,137	0,042	0,240	1
3th	0,071	0,405	0,168	0,958	4
4th	0,017	0,097	0,021	0,120	1
5th	0,122	0,696	0,368	2,099	4
6th	0,009	0,051	0,013	0,074	1
7th	0,090	0,513	0,294	1,677	4
8th	0,006	0,034	0,009	0,051	1
9th	0,019	0,108	0,025	0,143	4
10th	0,005	0,029	0,007	0,040	0,5
11th	0,055	0,314	0,142	0,810	2
12th	0,005	0,029	0,006	0,034	0,5
13th	0,041	0,234	0,031	0,177	2
14th	0,004	0,023	0,007	0,040	0,5
15th	0,006	0,034	0,040	0,228	2
16th	0,003	0,017	0,005	0,029	0,5
17th	0,026	0,148	0,075	0,428	1,5
18th	0,003	0,017	0,005	0,029	0,5
19th	0,016	0,091	0,102	0,582	1,5
20th	0,004	0,023	0,006	0,034	0,5
21th	0,011	0,063	0,014	0,080	1,5
22th	0,003	0,017	0,005	0,029	0,5
23th	0,022	0,126	0,030	0,171	0,6
24th	0,004	0,023	0,007	0,040	0,5
25th	0,014	0,080	0,065	0,371	0,6
26th	0,004	0,023	0,008	0,046	0,5
27th	0,009	0,051	0,015	0,086	0,6
28th	0,003	0,017	0,006	0,034	0,5
29th	0,020	0,114	0,057	0,325	0,6
30th	0,003	0,017	0,007	0,040	0,5
31th	0,015	0,086	0,074	0,422	0,6
32th	0,003	0,017	0,006	0,034	0,5
33th	0,004	0,023	0,011	0,063	0,6
34th	0,003	0,017	0,005	0,029	--
35th	0,018	0,103	0,069	0,394	--
36th	0,003	0,017	0,005	0,029	--
37th	0,026	0,148	0,048	0,274	--
38th	0,003	0,017	0,005	0,029	--
39th	0,006	0,034	0,008	0,046	--
40th	0,003	0,017	0,006	0,034	--
41th	0,013	0,074	0,054	0,308	--
42th	0,002	0,011	0,005	0,029	--
43th	0,027	0,154	0,033	0,188	--
44th	0,003	0,017	0,005	0,029	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,006	0,034	0,006	0,034	--
46th	0,006	0,034	0,007	0,040	--
47th	0,011	0,063	0,055	0,314	--
48th	0,005	0,029	0,008	0,046	--
49th	0,021	0,120	0,024	0,137	--
50th	0,011	0,063	0,004	0,023	--
THD_[%]	--	1,134	--	3,236	23
PWHD_[%]	--	2,388	--	6,595	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 24KTLX-G3_L2 phase

Generating Unit rating per phase (rpp)	8,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 4,040 kW		100% of rated output 8,029 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	17,536	--	34,786	--	--
2th	0,016	0,091	0,025	0,143	1
3th	0,015	0,086	0,052	0,297	4
4th	0,011	0,063	0,014	0,080	1
5th	0,103	0,588	0,342	1,951	4
6th	0,008	0,046	0,009	0,051	1
7th	0,083	0,474	0,266	1,517	4
8th	0,005	0,029	0,006	0,034	1
9th	0,005	0,029	0,017	0,097	4
10th	0,005	0,029	0,005	0,029	0,5
11th	0,048	0,274	0,127	0,725	2
12th	0,004	0,023	0,005	0,029	0,5
13th	0,038	0,217	0,043	0,245	2
14th	0,004	0,023	0,006	0,034	0,5
15th	0,005	0,029	0,025	0,143	2
16th	0,003	0,017	0,005	0,029	0,5
17th	0,026	0,148	0,095	0,542	1,5
18th	0,003	0,017	0,004	0,023	0,5
19th	0,014	0,080	0,114	0,650	1,5
20th	0,003	0,017	0,005	0,029	0,5
21th	0,005	0,029	0,017	0,097	1,5
22th	0,003	0,017	0,004	0,023	0,5
23th	0,022	0,126	0,038	0,217	0,6
24th	0,004	0,023	0,007	0,040	0,5
25th	0,014	0,080	0,081	0,462	0,6
26th	0,004	0,023	0,007	0,040	0,5
27th	0,006	0,034	0,018	0,103	0,6
28th	0,003	0,017	0,005	0,029	0,5
29th	0,021	0,120	0,061	0,348	0,6
30th	0,003	0,017	0,006	0,034	0,5
31th	0,020	0,114	0,094	0,536	0,6
32th	0,002	0,011	0,004	0,023	0,5
33th	0,005	0,029	0,008	0,046	0,6
34th	0,002	0,011	0,005	0,029	--
35th	0,017	0,097	0,063	0,359	--
36th	0,003	0,017	0,005	0,029	--
37th	0,027	0,154	0,052	0,297	--
38th	0,002	0,011	0,004	0,023	--
39th	0,004	0,023	0,009	0,051	--
40th	0,003	0,017	0,005	0,029	--
41th	0,011	0,063	0,053	0,302	--
42th	0,003	0,017	0,005	0,029	--
43th	0,029	0,165	0,035	0,200	--
44th	0,003	0,017	0,004	0,023	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,006	0,034	0,008	0,046	--
46th	0,006	0,034	0,007	0,040	--
47th	0,009	0,051	0,052	0,297	--
48th	0,005	0,029	0,007	0,040	--
49th	0,025	0,143	0,018	0,103	--
50th	0,004	0,023	0,004	0,023	--
THD_[%]	--	0,946	--	2,953	23
PWHD_[%]	--	2,432	--	7,168	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: SOFAR 24KTLX-G3_L3 phase

Generating Unit rating per phase (rpp)	8,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 4,041 kW		100% of rated output 8,036 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	17,534	--	34,792	--	--
2th	0,016	0,091	0,030	0,171	1
3th	0,084	0,479	0,136	0,776	4
4th	0,008	0,046	0,010	0,057	1
5th	0,086	0,491	0,357	2,037	4
6th	0,005	0,029	0,008	0,046	1
7th	0,063	0,359	0,273	1,557	4
8th	0,005	0,029	0,006	0,034	1
9th	0,027	0,154	0,037	0,211	4
10th	0,004	0,023	0,006	0,034	0,5
11th	0,045	0,257	0,078	0,445	2
12th	0,004	0,023	0,005	0,029	0,5
13th	0,033	0,188	0,049	0,280	2
14th	0,004	0,023	0,006	0,034	0,5
15th	0,009	0,051	0,016	0,091	2
16th	0,004	0,023	0,005	0,029	0,5
17th	0,024	0,137	0,108	0,616	1,5
18th	0,003	0,017	0,005	0,029	0,5
19th	0,016	0,091	0,124	0,707	1,5
20th	0,003	0,017	0,005	0,029	0,5
21th	0,005	0,029	0,009	0,051	1,5
22th	0,004	0,023	0,005	0,029	0,5
23th	0,021	0,120	0,033	0,188	0,6
24th	0,004	0,023	0,007	0,040	0,5
25th	0,013	0,074	0,076	0,434	0,6
26th	0,004	0,023	0,008	0,046	0,5
27th	0,006	0,034	0,009	0,051	0,6
28th	0,003	0,017	0,006	0,034	0,5
29th	0,017	0,097	0,050	0,285	0,6
30th	0,003	0,017	0,006	0,034	0,5
31th	0,020	0,114	0,086	0,491	0,6
32th	0,003	0,017	0,005	0,029	0,5
33th	0,005	0,029	0,008	0,046	0,6
34th	0,003	0,017	0,005	0,029	--
35th	0,015	0,086	0,060	0,342	--
36th	0,003	0,017	0,005	0,029	--
37th	0,028	0,160	0,050	0,285	--
38th	0,003	0,017	0,005	0,029	--
39th	0,005	0,029	0,010	0,057	--
40th	0,003	0,017	0,005	0,029	--
41th	0,012	0,068	0,048	0,274	--
42th	0,003	0,017	0,005	0,029	--
43th	0,031	0,177	0,039	0,222	--
44th	0,003	0,017	0,004	0,023	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,006	0,034	0,007	0,040	--
46th	0,005	0,029	0,007	0,040	--
47th	0,011	0,063	0,051	0,291	--
48th	0,005	0,029	0,006	0,034	--
49th	0,023	0,131	0,024	0,137	--
50th	0,012	0,068	0,004	0,023	--
THD_[%]	--	0,957	--	3,070	23
PWHD_[%]	--	2,461	--	7,044	23

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 are valid for the SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

A.7.1.4.2 Power factor				P
Test:				
SOFAR 15KTLX-G3				
Output power	216,2 V	230 V	253,20 V	
20%	0,996	0,996	0,995	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
50%	0,999	0,999	0,998	
75%	0,999	0,999	0,999	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	
SOFAR 24KTLX-G3				
Output power	216,2 V	230 V	253,20 V	
20%	0,996	0,996	0,995	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
50%	0,999	0,999	0,999	
75%	0,999	0,999	0,999	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

Note:
The power factor capability of the SSEG shall conform to EN 50438. When operating at Registered Capacity the SSEGshall operate at apower factor within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the DNO eg for power factor improvement.

The test set up shall be such that the Inverter supplies full load to the DNO's Distribution System via the power factor (pf) meter and the variac as shown below in figure A5. The Inverter pf should be within the limits given in 5.6, for three test voltages 230 V –6%, 230V and 230 V +10%.

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 same as in hardware and just power derated by software.

A.7.1.4.3 Voltage Flicker	P

SOFAR 15KTLX-G3

	Phase	Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,188	0,087	--	0,154	0,099	--	0,058	0,053
	L2	0,188	0,087	--	0,154	0,099	--	0,058	0,053
	L3	0,188	0,087	--	0,154	0,099	--	0,058	0,053
Normalised to standard impedance	L1	0,111	0,004	--	0,117	0,009	--	0,142	0,140
	L2	0,111	0,004	--	0,117	0,009	--	0,142	0,140
	L3	0,111	0,004	--	0,117	0,009	--	0,142	0,140
Normalised to required maximum impedance	L1	0,001	0,001	--	0,001	0,001	--	0,053	0,050
	L2	0,001	0,001	--	0,001	0,001	--	0,053	0,050
	L3	0,001	0,001	--	0,001	0,001	--	0,053	0,050
Limits set under BS EN 61000-3-11		4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			
Standard impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			
Maximum Impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			

SOFAR 24KTLX-G3

	Phase	Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,159	0,114	--	0,090	0,144	--	0,044	0,032
	L2	0,159	0,114	--	0,090	0,144	--	0,044	0,032
	L3	0,159	0,114	--	0,090	0,144	--	0,044	0,032
Normalised to standard impedance	L1	0,119	0,010	--	0,001	0,001	--	0,139	0,137
	L2	0,119	0,010	--	0,001	0,001	--	0,139	0,137
	L3	0,119	0,010	--	0,001	0,001	--	0,139	0,137
Normalised to required maximum impedance	L1	0,001	0,001	--	0,001	0,001	--	0,048	0,046
	L2	0,001	0,001	--	0,001	0,001	--	0,048	0,046
	L3	0,001	0,001	--	0,001	0,001	--	0,048	0,046
Limits set under BS EN 61000-3-11		4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			

Standard impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			
Maximum Impedance**	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			

Note:

* Applies to three phase and split single phase Generating Units

^ Applies to single phase Generating Units and Generating Units using two phases on a three phase system

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation ouput is 0,98 or above.

Normalised value = Measured value*reference source resistance/measured source resistance at test point.

Single phase unit reference source resistance is 0,4Ω

Two phase units in a three phase system reference source resistance 0,4Ω

Two phase units in a split phase system reference source resistance is 0,24Ω

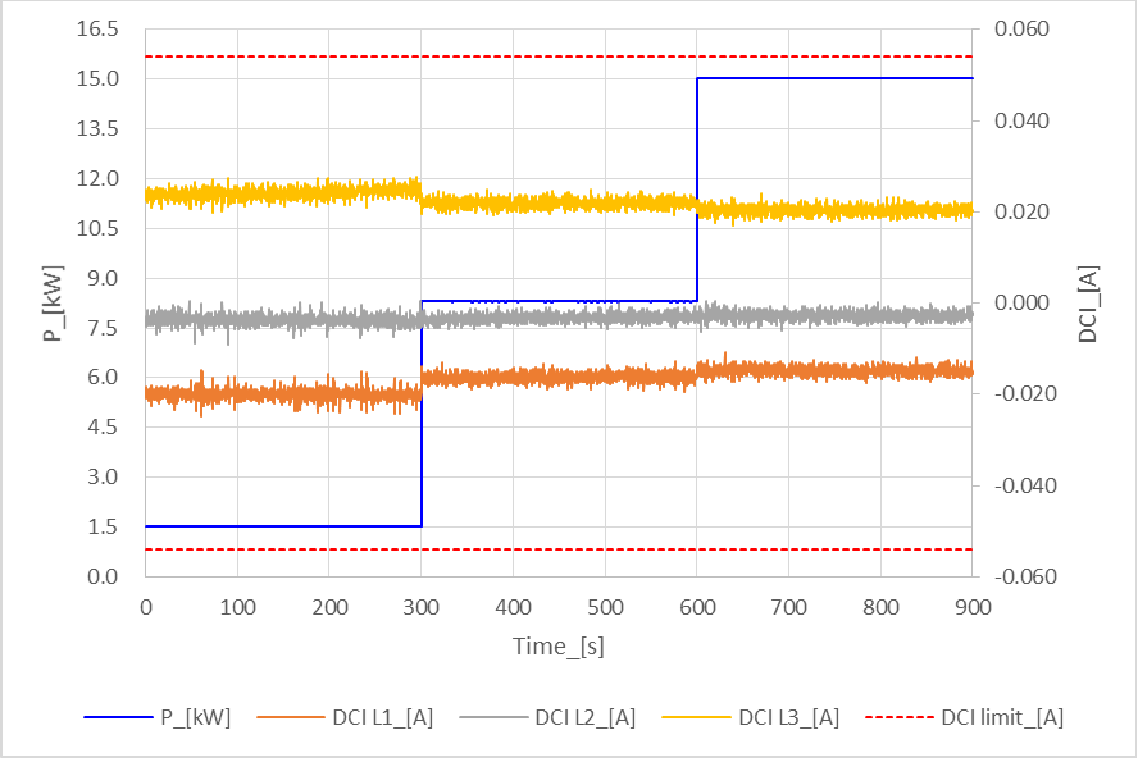
Three phase units reference source resistance is 0,24Ω

Where the power factor of the output is under 0,98 then the Xl to R ratio of the test impedance should be close to that of the Standard impedance.

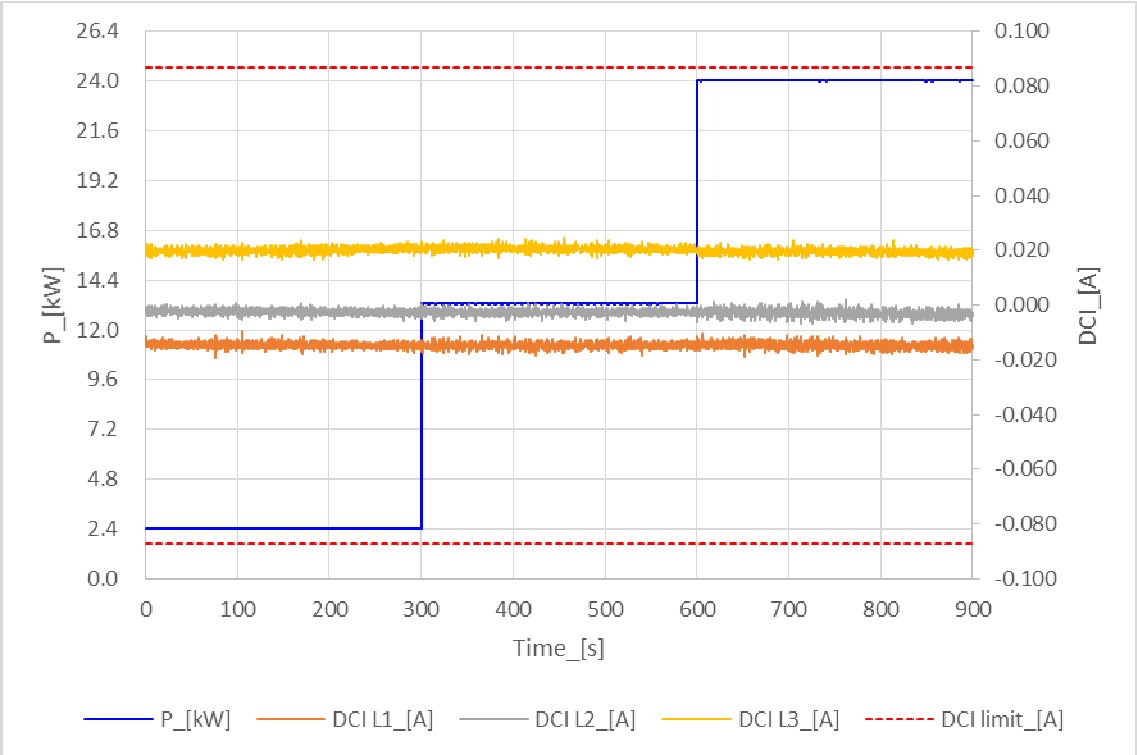
The stopping test should be a trip from full load operation.

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 same as in hardware and just power derated by software.

A.7.1.4.4 DC injection			P
SOFAR 15KTLX-G3			
Test level power	10%	55%	100%
Abs, Max, DC (mA), L1 phase	27,8	19,4	-10,9
As % of rated AC current, L1 phase	0,13	0,09	-0,05
Abs, Ave, DC (mA) , L1 phase	24,2	16,3	-14,8
As % of rated AC current, L1 phase	0,11	0,07	-0,07
Abs, Max, DC (mA), L2 phase	9,2	5,8	0,5
As % of rated AC current, L2 phase	0,04	0,03	0,00
Abs, Ave, DC (mA) , L2 phase	3,7	3,2	-2,7
As % of rated AC current, L2 phase	0,02	0,01	-0,01
Abs, Max, DC (mA), L3 phase	27,8	25,0	24,1
As % of rated AC current, L3 phase	0,13	0,12	0,11
Abs, Ave, DC (mA) , L3 phase	24,2	21,9	20,4
As % of rated AC current, L3 phase	0,11	0,10	0,09
Limit	0,25%	0,25%	0,25%



A.7.1.4.4 DC injection			P
SOFAR 24KTLX-G3			
Test level power	10%	55%	100%
Abs, Max, DC (mA), L1 phase	23,5	18,5	-10,3
As % of rated AC current, L1 phase	0,07	0,05	-0,03
Abs, Ave, DC (mA) , L1 phase	20,0	14,6	-14,7
As % of rated AC current, L1 phase	0,06	0,04	-0,04
Abs, Max, DC (mA), L2 phase	5,7	6,0	2,1
As % of rated AC current, L2 phase	0,02	0,02	0,01
Abs, Ave, DC (mA) , L2 phase	2,4	2,6	-2,9
As % of rated AC current, L2 phase	0,01	0,01	-0,01
Abs, Max, DC (mA), L3 phase	23,5	24,5	23,6
As % of rated AC current, L3 phase	0,07	0,07	0,07
Abs, Ave, DC (mA) , L3 phase	20,1	20,6	19,5
As % of rated AC current, L3 phase	0,06	0,06	0,06
Limit	0,25%	0,25%	0,25%



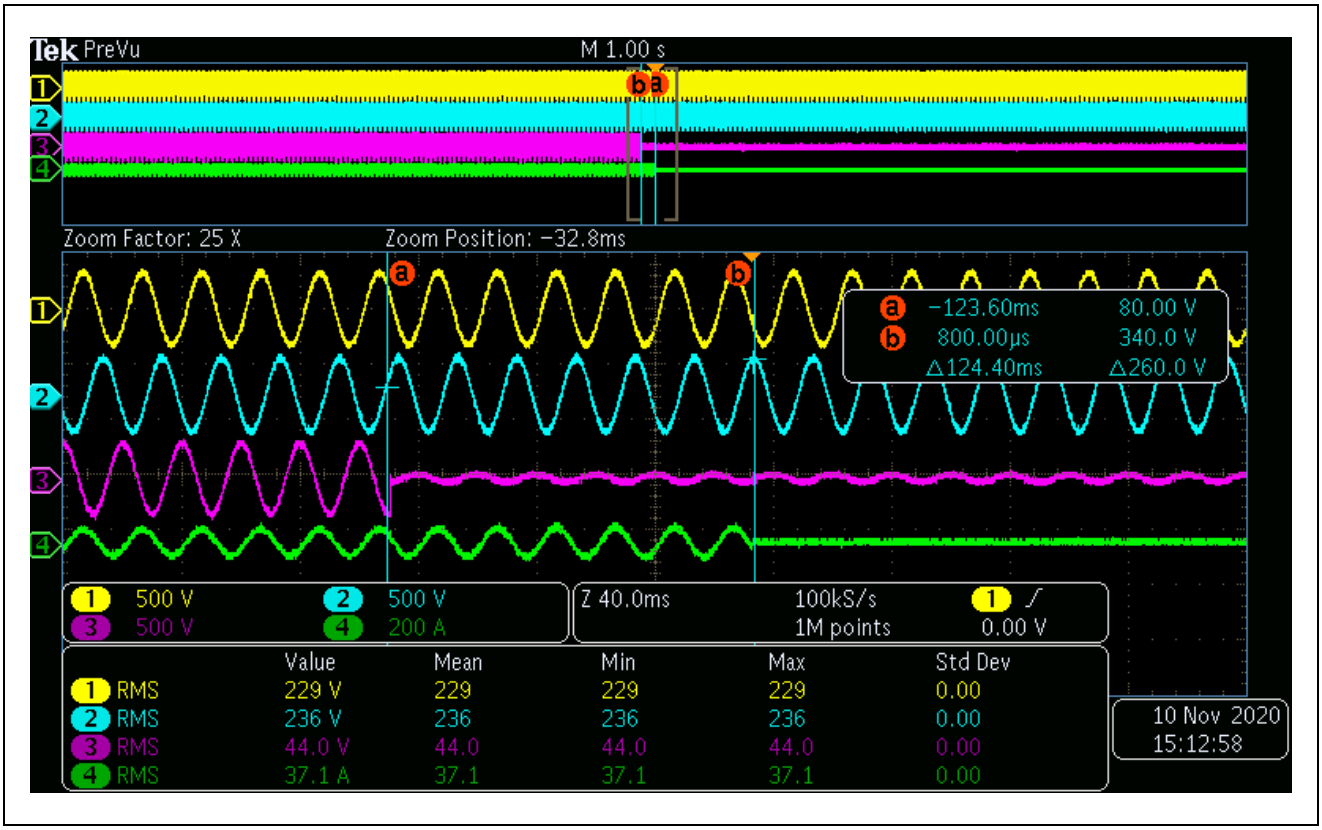
Note:
The level of DC injection from the Inverter-connected PV generator in to the DNO's Distribution System shall not exceed the levels specified in 5.5 when measured during operation at three levels, 20%, 50%, 75% and 100% of rating with a tolerance of plus or minus 5%.

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 same as in hardware and just power derated by software.

A.7.1.5 Short Circuit Current Contribution for Inverters					P
L1 to N					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	42,4V	28,8A
Initial Value of aperiodic current	A	N/A	100ms	37,1V	13,7A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	38,2V	9,80A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	34,9V	7,75A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,013s	In seconds
L2 to N					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	30,2V	24,4A
Initial Value of aperiodic current	A	N/A	100ms	28,9V	11,8A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	29,2V	8,35A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	29,1V	6,91A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,011s	In seconds
L3 to N					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	44,0V	37,1A
Initial Value of aperiodic current	A	N/A	100ms	62,7V	36,0A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	38,8V	37,4A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	33,1V	26,3A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,124s	In seconds

Note:
The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix 4) including the time taken for the Inverter to trip.

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

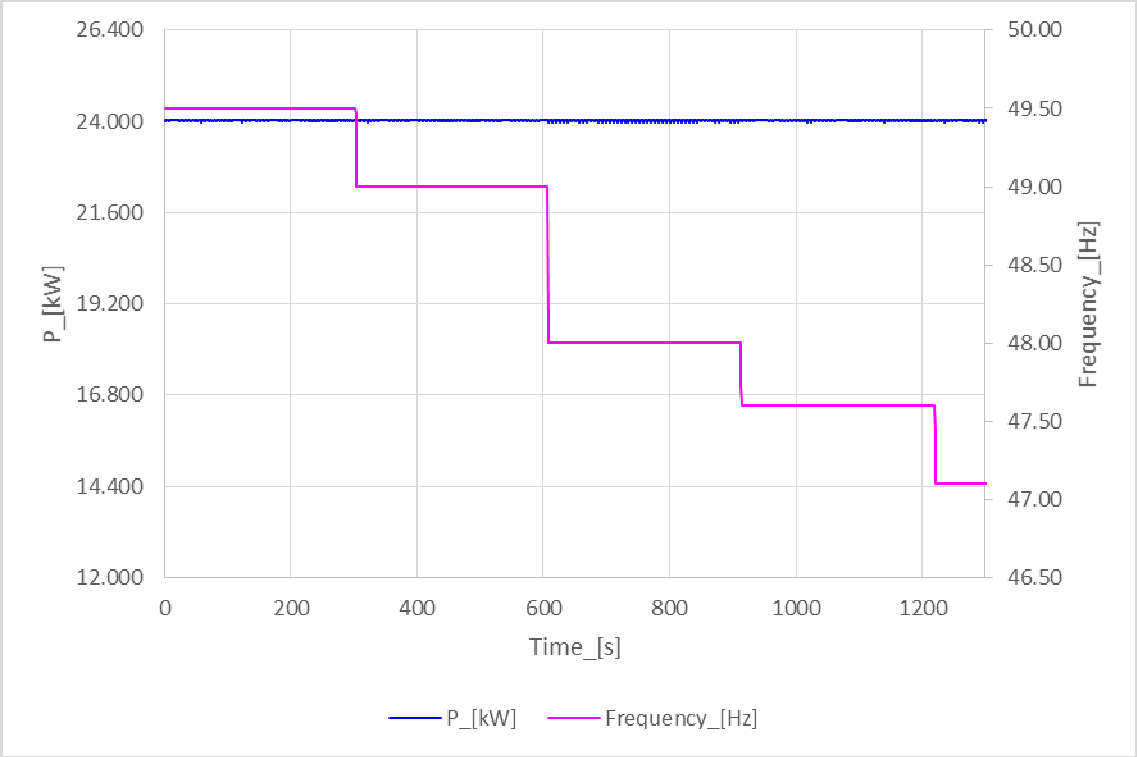

Tek PreVu
M 1.00 s
Zoom Factor: 25 X
Zoom Position: -32.8ms
a -123.60ms 80.00 V
b 800.00µs 340.0 V
Δ124.40ms Δ260.0 V
1 500 V
2 500 V
3 500 V
4 200 A
Z 40.0ms
100kS/s
1M points
1 0.00 V
Value Mean Min Max Std Dev
1 RMS 229 V 229 229 229 0.00
2 RMS 236 V 236 236 236 0.00
3 RMS 44.0 V 44.0 44.0 44.0 0.00
4 RMS 37.1 A 37.1 37.1 37.1 0.00
10 Nov 2020
15:12:58

A.7.1.6 Self Monitoring – Solid state Disconnection.	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the SSEG, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note: Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).	

Wiring fuctional tests: If required by para 15.2.1.	N/A
Confirm that the relevant test schedule is attached (test to be undertaken at time of commissioning)	N/A

Logic Interface (Input port)	P
Confirm that an input port is provided and can be used to shut down the module.	Yes

A.7.2.3 Power Output with Falling Frequency	P



Criteria:
The frequency should then be set to 49,5 Hz for 5 minutes. The output should remain at 100% of Registered Capacity.
The frequency should then be set to 49,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 99% of Registered Capacity.
The frequency should then be set to 48,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 97% of Registered Capacity.
The frequency should then be set to 47,6 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 96.2% of Registered Capacity.
The frequency should then be set to 47,1 Hz and held at this frequency for 20 s. The Active Power output must not be below 95.0% of Registered Capacity and the Synchronous Power Generating Module must not trip in less than the 20s of the test.

The tests had been performed on the SOFAR 24KTLX-G3 are valid for the SOFAR 15KTLX-G3, SOFAR 17KTLX-G3, SOFAR 20KTLX-G3 and SOFAR 22KTLX-G3 since it is same as in hardware and just power derated by software.

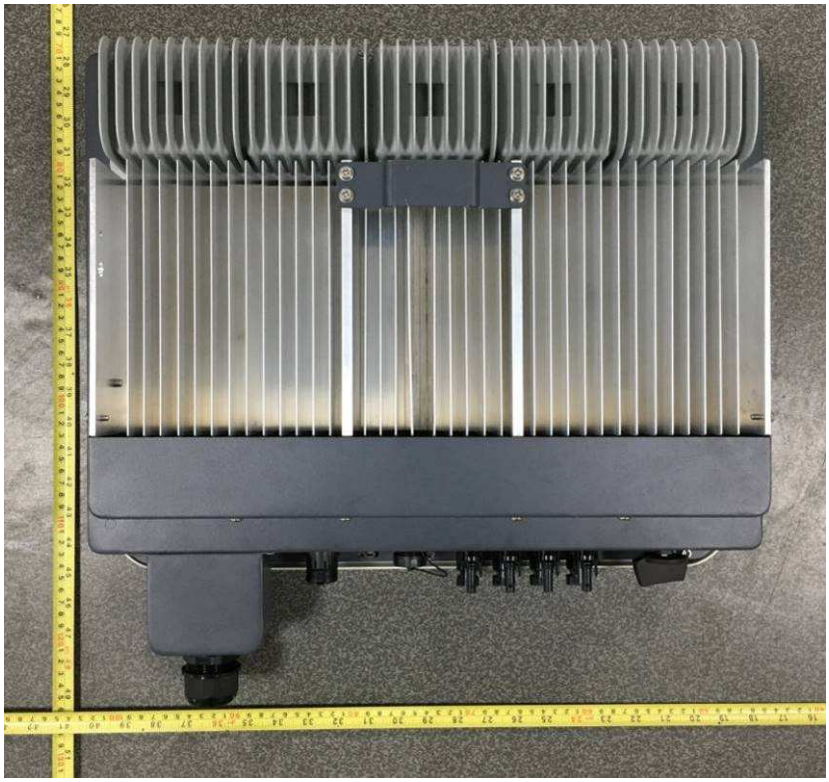
Annex No. 1

Pictures of the unit

EUT Photo

General view – 1 of Front

General view – 1 of Rear



EUT Photo

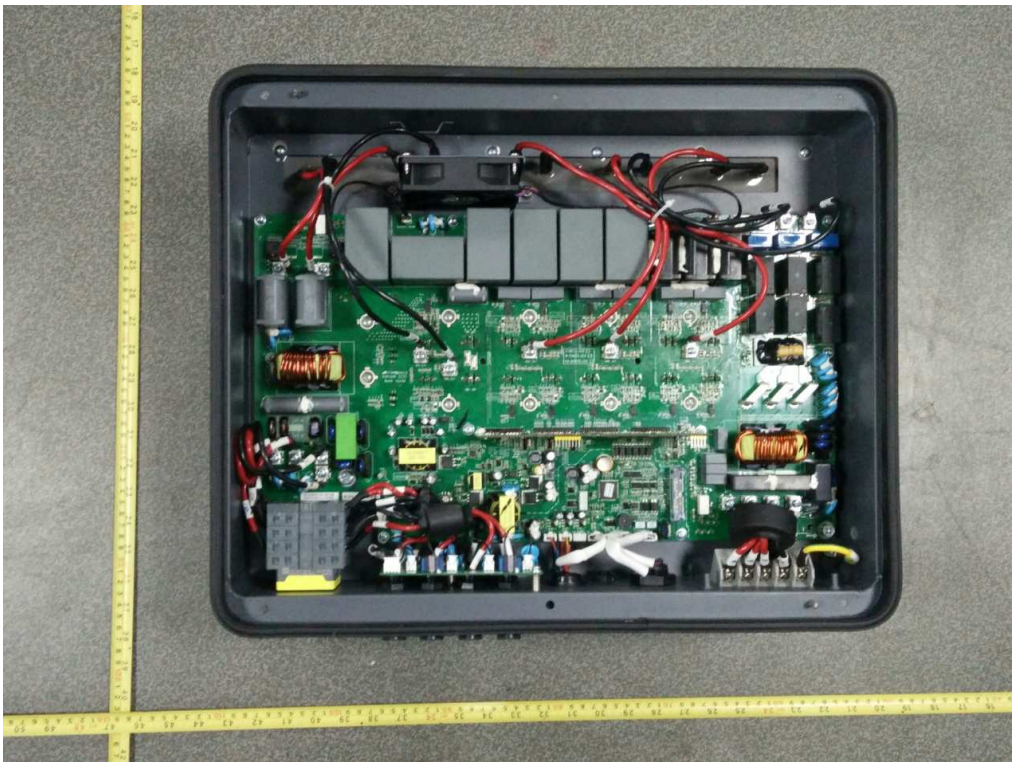
General view – 1 of Bottom
SOFAR 15KTLX-G3, SOFAR 17KTLX-G3

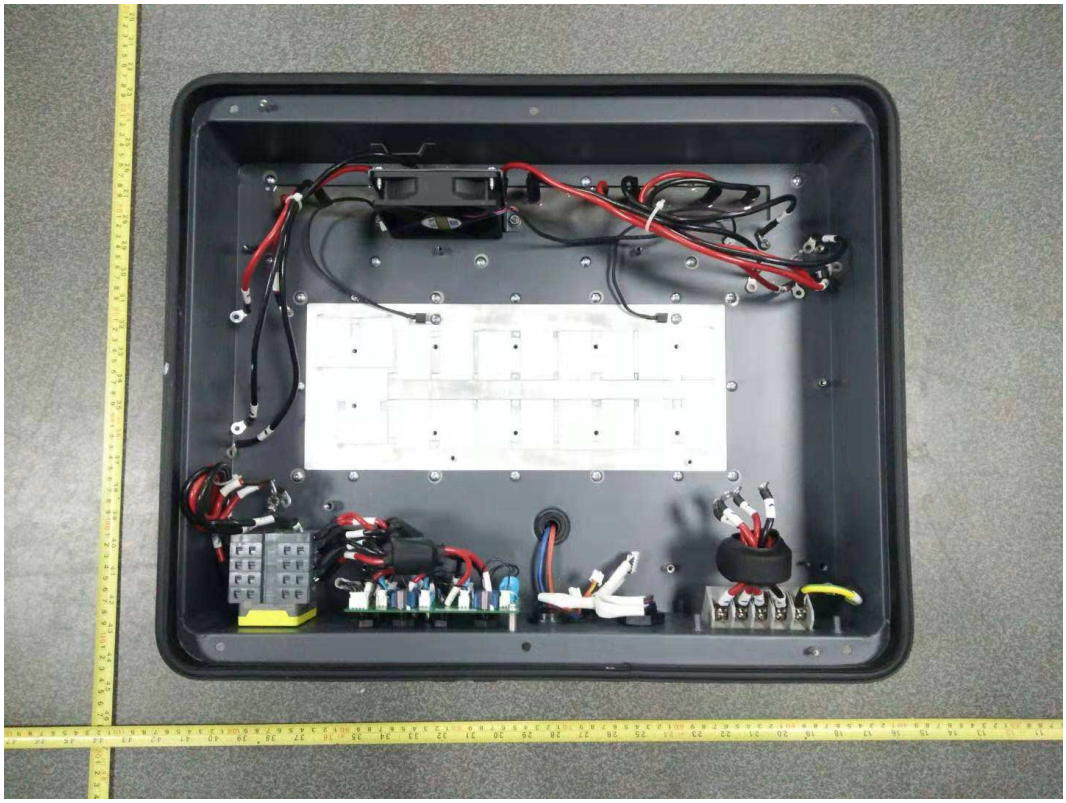
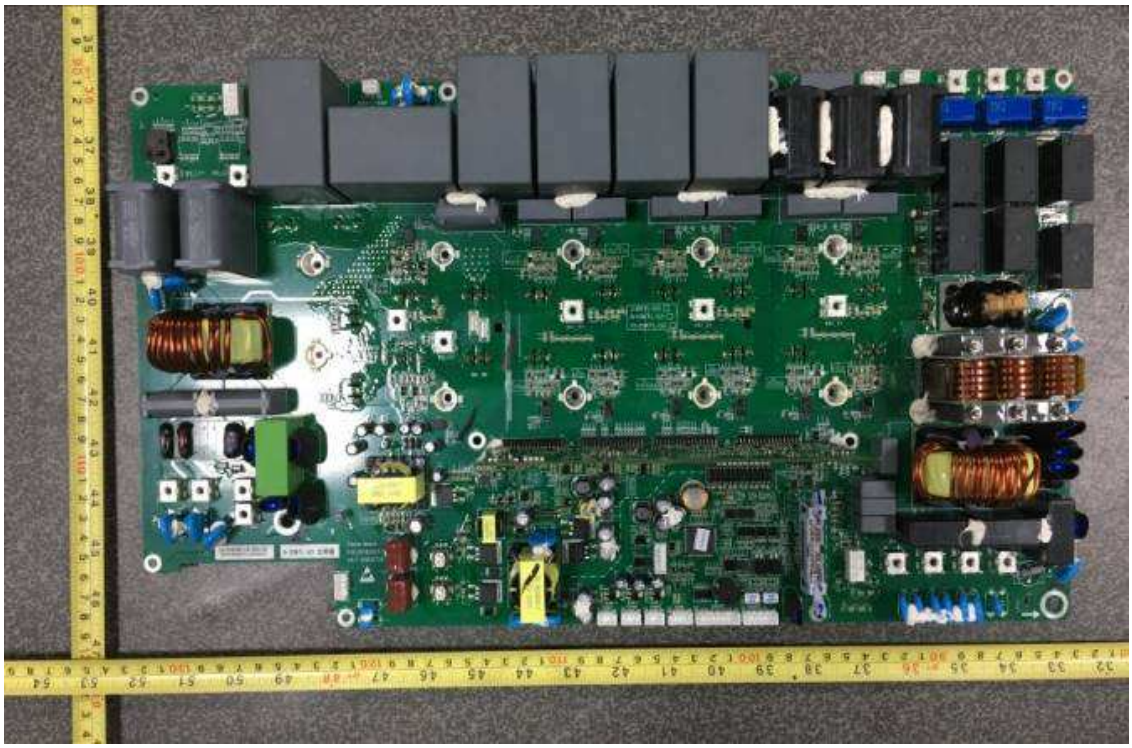
General view – 1 of Bottom
SOFAR 20KTLX-G3, SOFAR 22KTLX-G3, SOFAR 24KTLX-G3

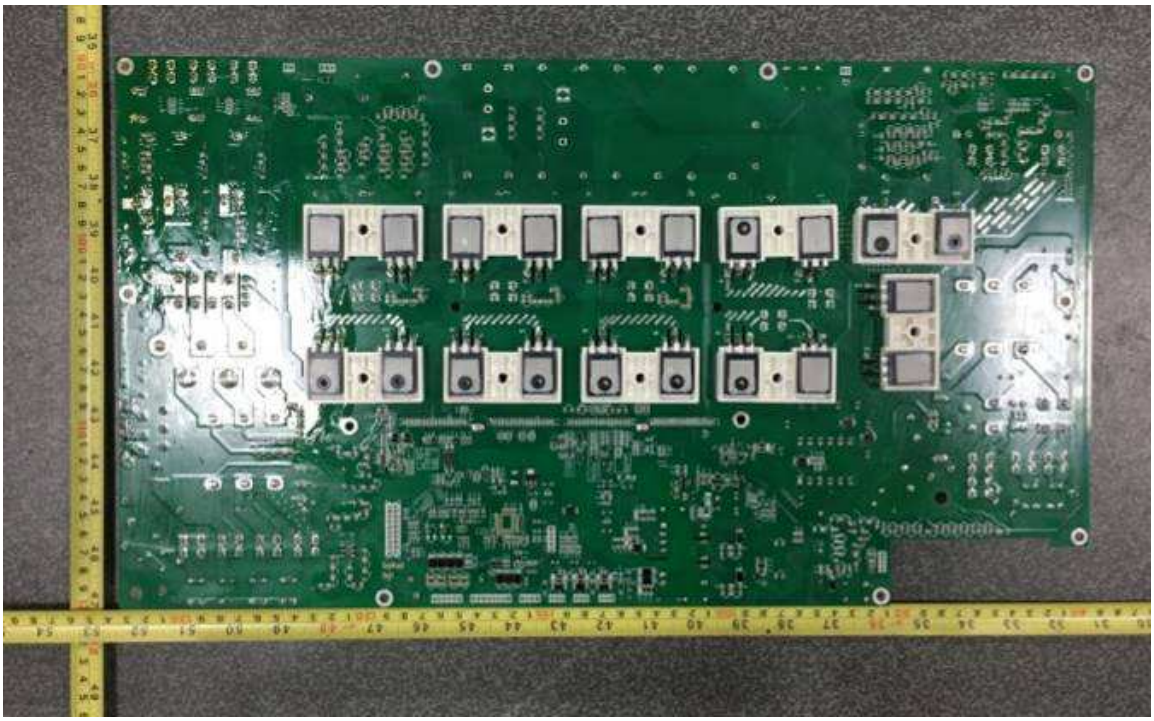
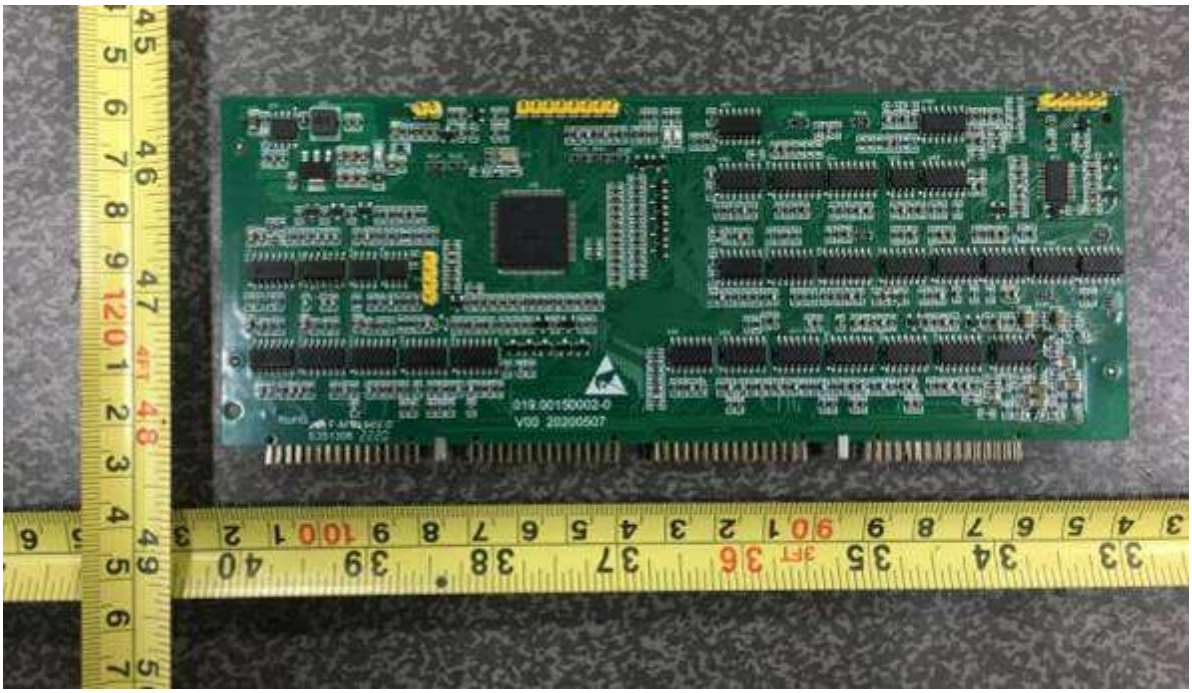
EUT Photo

General view – 1 of Side

Internal view – 1

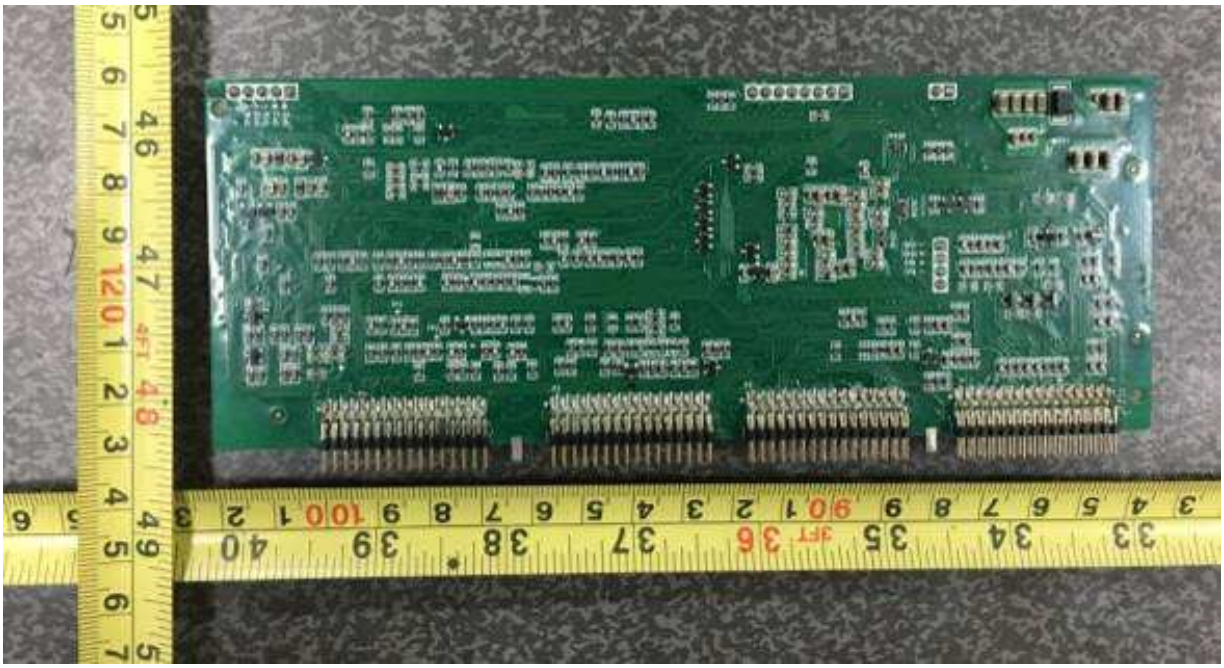


EUT Photo
Internal view – 2

General view – 1 of Power board


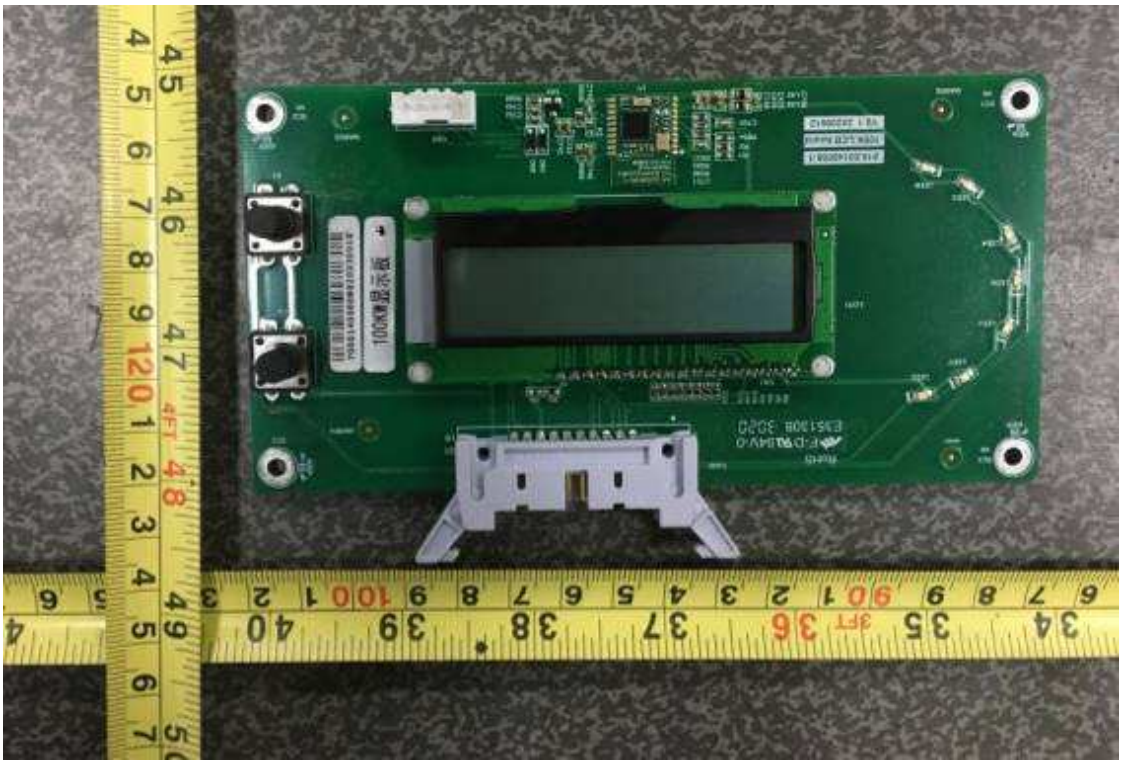
EUT Photo
General view – 2 of Power board 
General view – 1 of Control board 

EUT Photo

General view – 2 of Control board

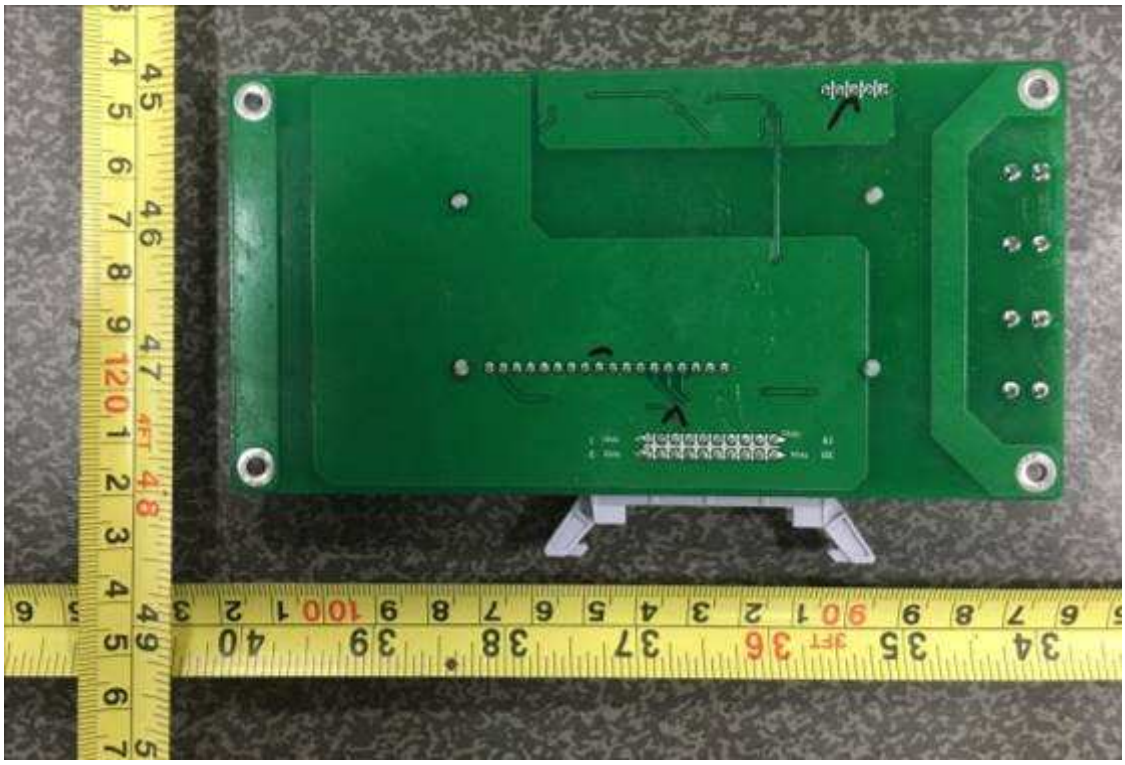


General view – 1 of LCD panel



EUT Photo

General view – 2 of LCD panel



General view of Grouding point

Annex No. 2

Test Equipment list

Dates of performance test: 2020-05-11 to 2021-01-10

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	
Four Channel Digital Phosphor Oscilloscope	A4089003DG	Tektronix	DPO4104B	C010624	Mar. 05, 2021
Eight Channel Digital Phosphor Oscilloscope	A4089017DG	YOKOGAWA	DL850	91N726247	Sep. 23, 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	C8202909082002110001	Mar. 02, 2021
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