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TEST REPORT

Engineering Recommendation G99

Issue 1 – Amendment 9

Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

Shenzhen SOFARSOLAR Co., Ltd.

For the unit(s) **SOFAR 100KTLX-G4, SOFAR 110KTLX-G4, SOFAR 125KTLX-G4, SOFAR 125KTLX-G4-A**

Test report no. **221129BWA146-EG-UK-001**

Date **2023-04-25**

ilac-MRA ACCREDITED Certificate # 5200.02

Guangdong HuaChuang Technology Service Co., Ltd.
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Test report number.....:	**221129BWA146-EG-UK-001**
Date of issue.....:	2023-04-25
Total number of pages.....:	88
Testing laboratory .....:	**Guangdong HuaChuang Technology Service Co., Ltd.**
Address.....:	Room 815, No.122, Houjie Road (West), Houjie Town, Dongguan City, Guangdong, 523960 P.R. China
Testing location / address.....:	Same as above
Applicant's name .....:	**Shenzhen SOFARSOLAR Co., Ltd.**
Address.....:	11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City, P.R. China
Test specification	
Standard .....:	Engineering Recommendation G99 Issue 1 – Amendment 9 3 October 2022 Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019
Test report form number.....:	EREC G99_v1.0
Test report form(s) originator.....:	Guangdong HuaChuang Technology Service Co., Ltd.
Master TRF.....:	Dated 2022-02-01
Test item description.....:	Device Category: **Inverter** Device Type: **PV**
Trademark .....:	SOFAR
Model / Type reference.....:	SOFAR 100KTLX-G4, SOFAR 110KTLX-G4, SOFAR 125KTLX-G4, SOFAR 125KTLX-G4-A
Technical data .....:	See section 3.1 on p.8
Dates of testing.....:	2022-12-01 - 2023-03-10

Tested / Report prepared by

Allen

Allen Zhang (Test engineer)

GUANGDONG HUACHUANG TECHNOLOGY SERVICE CO., LTD HUA CHUANG REPORT

Approved by

Lukes

Lukes Lin (Project manager)

Contents

1 General information of test report

1.1 Important Note

General disclaimer

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1.2 Revision history

Revision	Date	Editor	Modification / Change	Status
221129BWA146-EG-UK-001	2023-04-25	Allen Zhang	Initial report was written	Active

2 General remarks for documentation

The test results presented in this report relate only to the object(**s**) tested.

Throughout this report a ☐ comma ',' / ☒ point '.' is used as decimal separator and a ☐ point '.' / ☒ comma ',' as thousands separator.

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

n	Nominal value
max	Maximum value
Lx	index of phase x
LxLy	phase-to-phase voltages of phase x and phase y

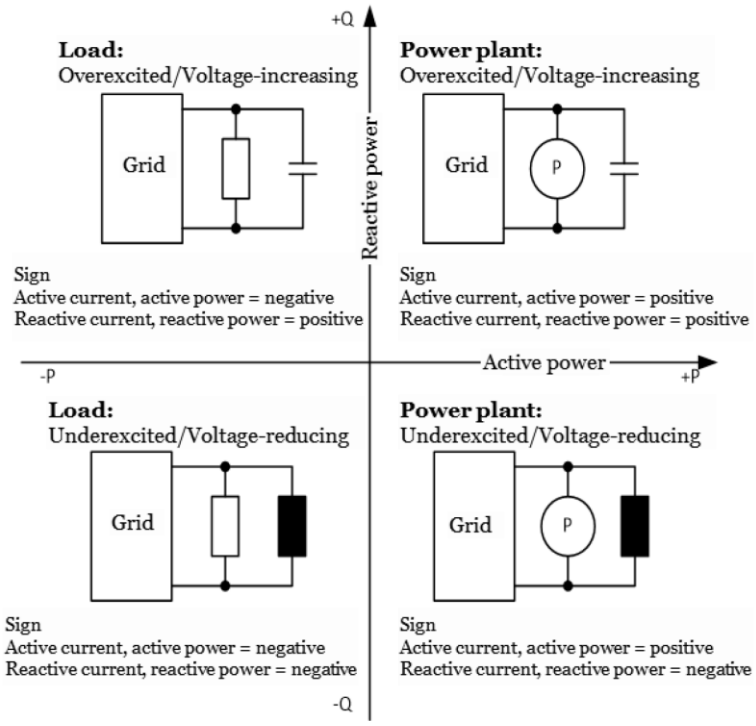
Abbreviations

AC	:	Alternating Current
DC	:	Direct Current
EUT	:	Equipment Under Test
LV	:	Low Voltage
MP	:	Measurement Point
MPP	:	Maximum Power Point
MV	:	Medium Voltage
PGF	:	Power Generating Facility
PGM	:	Power Generating Module
PGU	:	Power Generating Unit
P_{max}	:	Registered Capacity
PPM	:	Power Park Module
PWHD	:	Partial Weighted Harmonic Distortion
THD	:	Total Harmonic Distortion
PWHD	:	Partial Weighted Harmonic Distortion

Direction definition of P and Q

in this test report, the regarded system of the voltage and current vectors is the active sign convention system:

- If the inverter feeds to the grid the active power is measured with positive sign.
- If the inverter injects reactive power / current with leading power factor the reactive power / current is marked “leading” or “inductive” (under-excited) or has a negative sign.
- If the inverter injects reactive power / current with lagging power factor the reactive power / current is marked “lagging” or “capacitive” (over-excited) or has a positive sign.



3 General product information

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, Guangdong Province, P.R. China

3.1 Technical data of the unit(s)

Unit / Type ..... :	**SOFAR 100KTLX-G4**	**SOFAR 110KTLX-G4**	**SOFAR 125KTLX-G4**	**SOFAR 125KTLX-G4-A**
Hardware version (tested) ..... :	V001			
Software version (tested) ..... :	V000001			
Max. DC input voltage [V]..... :	1100			
Operating MPPT voltage range [V] ..... :	180 ~ 1000			
Input DC current [A]..... :	max. 10 * 40A			
Nominal output AC voltage [V] ..... :	230/400 (3~ + N + PE, 50/60 Hz)			
Output AC current [A] ..... :	max. 145.0	max. 159.5	max. 181.2	
Nominal active output power P_n [kW] .... :	100	100	110	125
Registered Capacity [1] P_{max} [kW]	100	100	110	125
Max. apparent power [kVA] ..... :	100	110	125	125

Note:

- The Power Park Modules (Generating Units):
  SOFAR 110KTLX-G4 and *SOFAR 125KTLX-G4*
  are designed to be capable of operating within the range ±0.95 Power Factor at Registered Capacity.
  Max. operating range of Power Factor at Registered Capacity:
  - *SOFAR 110KTLX-G4*: 0.909 lagging to 0.909 leading
  - *SOFAR 125KTLX-G4:* 0.880 lagging to 0.880 leading
- For Power Park Module (Generating Unit) *SOFAR 100KTLX-G4* and *SOFAR 125KTLX-G4-A* to meet the requirement:
  "*When operating at **Registered Capacity** the **Power Generating Module** shall be capable of operating at a **Power Factor** within the range 0.95 lagging to 0.95 leading relative to the voltage waveform*"
  - a semi-permanent active power reduction to a value
    - *SOFAR 100KTLX-G4*: $P_{max} \leq 95$ kW
    - *SOFAR 125KTLX-G4-A*: $P_{max} \leq 118.75$ kW

    can be applied by software (the parameter setting needs to follow the manufacturer's guidance).
  - or this need to be considered in the Power Generating Module design
  - or otherwise agreed with the DNO
- Setting range of the Power Factor:
  0.800 lagging to 0.800 leading

[1] In this report, the stated values of "registered capacity" related to single Generating Unit.

Datasheet of the generating units:

Datasheet	SOFAR 100KTLX-G4	SOFAR 110KTLX-G4	SOFAR 125KTLX-G4	SOFAR 125KTLX-G4-A
Input (DC)				
Max. input voltage	1100V			
Rated input voltage	625V			
Start-up voltage	200V			
MPPT operating voltage range	180V~1000V			
Number of MPP trackers	10			
Number for DC inputs	20			
Max. input MPPT current	10*40A			
Max. input short circuit current	10*50A			
Output(AC)				
Rated output power	100kW	100kW	110kW	125kW
AC output power	100kVA@45℃ / 90kVA@50℃	110kVA@45℃ / 100kVA@50℃	125kVA@45℃ / 110kVA@50℃	125kVA@45℃ / 110kVA@50℃
Max. Output current	152A@380V / 145A@400V / 139.2A@415V	167.2A@380V / 159.5A@400V / 153.1A@415V	190A@380V / 181.2A@400V / 174A@415V	190A@380V / 181.2A@400V / 174A@415V
Rated grid voltage	3/N/PE, 380V / 400V / 415V			
Grid voltage range	310~480V			
Rated frequency	50/60Hz			
Grid frequency range	45~55Hz/55~65Hz			
Active power adjustable range	0~100%			
THDi	<1%(@100%P)			
Power factor	1 default (+/-0.8 adjustable)			
Efficiency				
Max efficiency	98.60%			
European efficiency	98.30%			

Protection	
DC reverse polarity protection	Yes
Anti-islanding protection	Yes
Leakage current protection	Yes
Ground fault monitoring	Yes
PV-array string fault monitoring	Yes
DC switch	Yes
PID recovery	Yes
AFCI	Yes
SPD	PV: type II standard AC: type II Standard
General Data	
Ambient temperature range	-30℃~+60℃
Topology	Transformerless
Degree of protection	IP66
Allowable relative humidity range	0~100%
Max. operating altitude	4000m(>3000m derating)
Weight	75kg
Cooling	Smart air cooling
Dimension (W × H × D)	970*695*325mm
Display	LCD & Bluetooth +APP
Communication	RS485 / WiFi

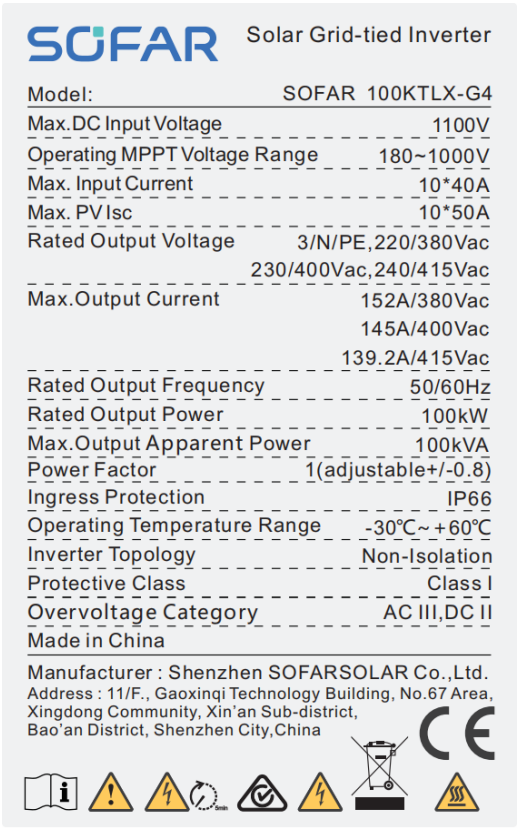
Equipment mobility	:	Permanent connection
Operating condition	:	Continuous
Class of equipment	:	Class I
Protection against ingress of water	:	IP66 according to EN 60529
Mass of equipment [kg]	:	75kg
Type of internal transformer	:	No internal transformer (transformerless)

3.2 Description of the differences of the models within the product series

The units of units in der series are identical hardware platform.

The implemented control and firmware are identical in all units. There is no difference regarding AC behaviour between the PGU-types apart from the power rating deviation and current limitation of each unit.

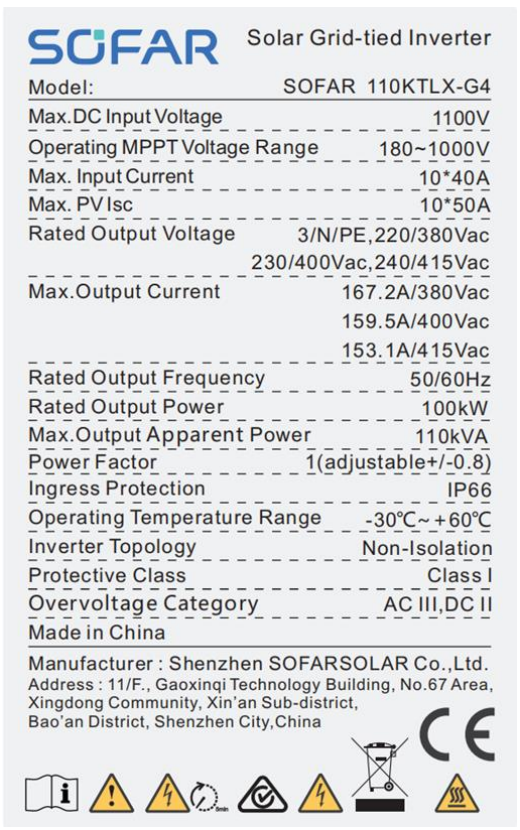
3.3 Copy of marking plate


SOFAR Solar Grid-tied Inverter

Model:	SOFAR 100KTLX-G4
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	180~1000V
Max. Input Current	10*40A
Max. PV Isc	10*50A
Rated Output Voltage	3/N/PE,220/380Vac 230/400Vac,240/415Vac
Max.Output Current	152A/380Vac 145A/400Vac 139.2A/415Vac
Rated Output Frequency	50/60Hz
Rated Output Power	100kW
Max.Output Apparent Power	100kVA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP66
Operating Temperature Range	-30℃~+60℃
Inverter Topology	Non-Isolation
Protective Class	Class I
Overvoltage Category	AC III,DC II

Made in China

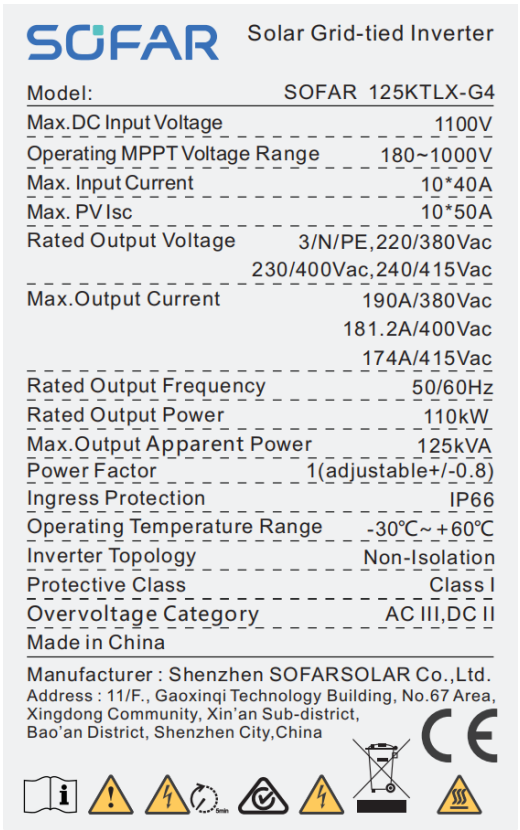
Manufacturer : Shenzhen SOFARSOLAR Co.,Ltd.
Address : 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City,China


SOFAR Solar Grid-tied Inverter

Model:	SOFAR 110KTLX-G4
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	180~1000V
Max. Input Current	10*40A
Max. PV Isc	10*50A
Rated Output Voltage	3/N/PE,220/380Vac 230/400Vac,240/415Vac
Max.Output Current	167.2A/380Vac 159.5A/400Vac 153.1A/415Vac
Rated Output Frequency	50/60Hz
Rated Output Power	100kW
Max.Output Apparent Power	110kVA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP66
Operating Temperature Range	-30℃~+60℃
Inverter Topology	Non-Isolation
Protective Class	Class I
Overvoltage Category	AC III,DC II

Made in China

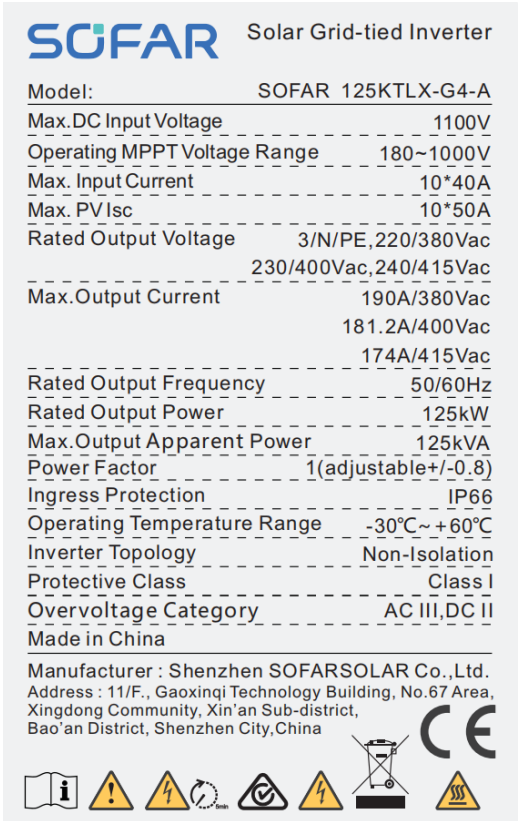
Manufacturer : Shenzhen SOFARSOLAR Co.,Ltd.
Address : 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City,China


SOFAR Solar Grid-tied Inverter

Model:	SOFAR 125KTLX-G4
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	180~1000V
Max. Input Current	10*40A
Max. PV Isc	10*50A
Rated Output Voltage	3/N/PE,220/380Vac 230/400Vac,240/415Vac
Max.Output Current	190A/380Vac 181.2A/400Vac 174A/415Vac
Rated Output Frequency	50/60Hz
Rated Output Power	110kW
Max.Output Apparent Power	125kVA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP66
Operating Temperature Range	-30℃~+60℃
Inverter Topology	Non-Isolation
Protective Class	Class I
Overvoltage Category	AC III,DC II

Made in China

Manufacturer : Shenzhen SOFARSOLAR Co.,Ltd.
Address : 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City,China


SOFAR Solar Grid-tied Inverter

Model:	SOFAR 125KTLX-G4-A
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	180~1000V
Max. Input Current	10*40A
Max. PV Isc	10*50A
Rated Output Voltage	3/N/PE,220/380Vac 230/400Vac,240/415Vac
Max.Output Current	190A/380Vac 181.2A/400Vac 174A/415Vac
Rated Output Frequency	50/60Hz
Rated Output Power	125kW
Max.Output Apparent Power	125kVA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP66
Operating Temperature Range	-30℃~+60℃
Inverter Topology	Non-Isolation
Protective Class	Class I
Overvoltage Category	AC III,DC II

Made in China

Manufacturer : Shenzhen SOFARSOLAR Co.,Ltd.
Address : 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City,China

Note:

The marking plates shown above may be only a draft. The use of certification marks on products must be approved by the respective NCBs to which these marks belong.

The marking plate is attached to the side surface or the back of the enclosure and is visible after installation.

3.4 Description of the power circuit

The input and output are protected by varistors to Earth. The unit is providing EMI filtering at the PV input and output toward mains. The unit does not provide galvanic separation from input to output (transformerless).

The output is switched off redundantly by the high-power switching bridge and two relays. This assures that the opening of the output circuit will also operate in case of a single error.

The internal control is redundant built. It consists of Microcontroller Main DSP (U71) and slave DSP (U80).

The Main DSP (U71) control the relays by switching signals; measures the 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 slave DSP (U80) is measuring the grid voltage, grid frequency and residual current, also can switch off the relays independently, and communicate with Main DSP (U71) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Main DSP(U71). The Main DSP(U71) 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 battery and the mains. All the relays are tested before each start up.

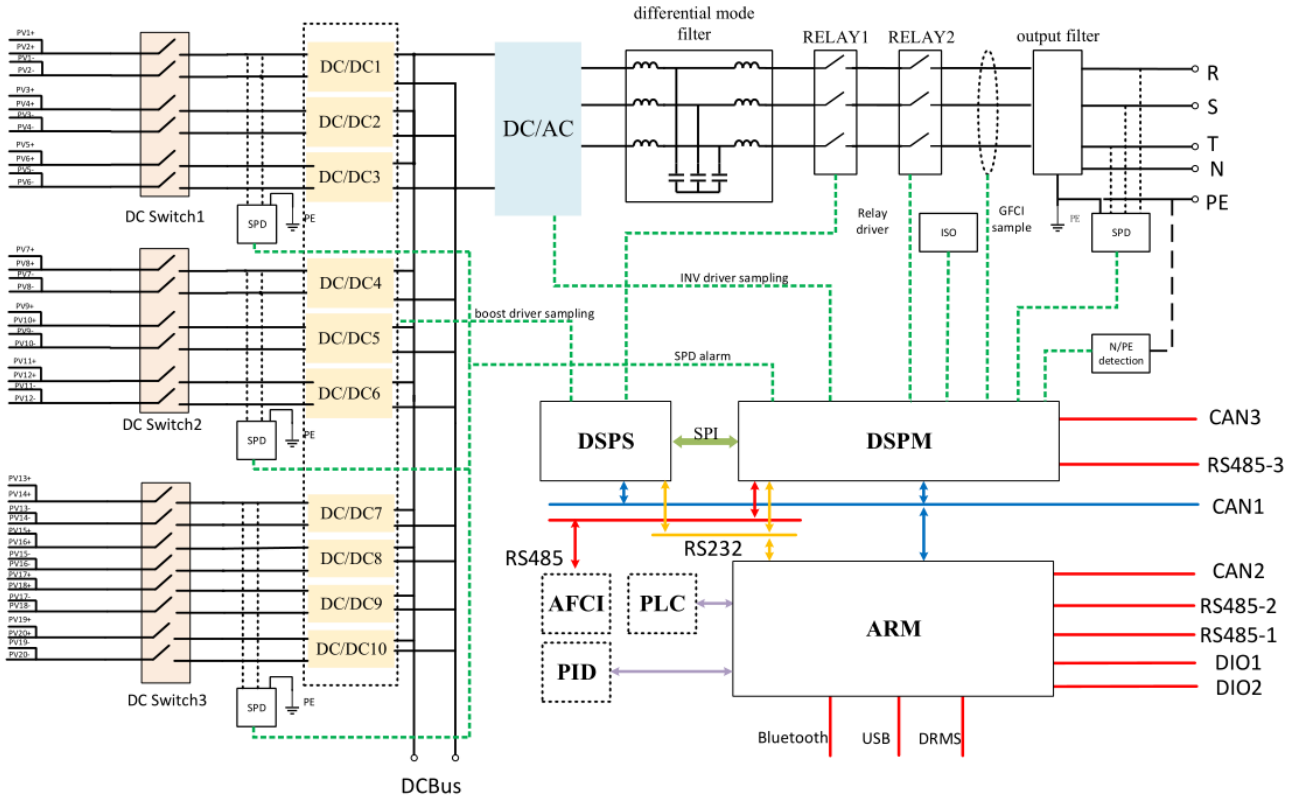


Figure 1 – Block diagram of the power circuit

4 General remarks for testing

4.1 PGM categories

According to definition of the standard the PGUs considered in this test report are Type A generating units or components of a Type B Power Generation Module:

Type A	Type B	Type C	Type D
Voltage level at connection point <110kV			Voltage level at connection point ≥110kV
0.8 kW ≤ P_{max} < 1 MW	1 MW ≤ P_{max} < 10 MW	10 MW ≤ P_{max} < 50 MW	P_{max} ≥ 50 MW
☒	☒	☐	☐

4.2 Energy Conversion Technology

Domestic CHP (1)	Photovoltaic (2) *	Fuel Cells (3)	Hydro (4)	Wind (5)	Electricity Storage devices (6)
☐	☒	☐	☐	☐	☐

Type testing was carried out according to EREC G99, Annex A.7.

The following Additional Technology Requirements according to (depending on the selection in the table above):

(1) A.7.3.1.

(2) A.7.3.2.

(3) A.7.3.3.

(4) A.7.3.4.

(5) A.7.3.5.

(6) A.7.3.6.

have been taken into account.

Measurement results documented according to EREC G99, Form A2-3.

Note:

* Connection scenario:

☒ Photovoltaic Power Park Module connected to the DNO's Distribution Network via an Inverter

☐ Hybrid converter:

Photovoltaic Power Park Module with DC coupled storage unit connected to the DNO's Distribution Network via an Inverter (corresponding case EREC G99, Figure 6.6).

In this case the Registered Capacity is based on the Inverter rating. The storage unit has no compliance effect, compliance based on the inverter.

The Electricity Storage exceptions according to EREC G99, section A.4.2 do not apply to the Inverter.

4.3 Exceptions

According to EREC G99, Annex A.4:

☐ **Emerging Technology**

the following sections of EREC G99 do not apply:

- 11.2.1 (frequency withstand capability)
- 11.2.2 (rate of change of frequency)
- 11.2.3 (constant Active Power output)
- 11.2.4 (Limited Frequency Sensitive Mode – Overfrequency)
- 10.6.7 (Interface Protection settings).

☐ **Electricity Storage devices commissioned before 01 September 2022**

the following sections of EREC G99 do not apply:

- Type A - less than 1 MW
  - 11.2.3 (constant Active Power output)
  - 11.2.4 (Limited Frequency Sensitive Mode – Over frequency)
- Type B - 1 MW or greater but less than 10 MW
  - 12.2.3 (constant Active Power output)
  - 12.2.4 (Limited Frequency Sensitive Mode – Over frequency)
  - 12.3.1 – 12.3.1.7 inclusive, 12.3.4 and 12.6 (Fault Ride Through, Fast Fault Current injection)
- Type C and Type D - 10 MW or greater and / or with a Connection Point at greater than 110 kV
  - 13.2.3 (constant Active Power output)
  - 13.2.4 (Limited Frequency Sensitive Mode – Over frequency)
  - 13.2.5 (Limited Frequency Sensitive Mode – Under frequency)
  - 13.2.6 (Frequency Sensitive Mode)
  - 13.3 – 13.3.1.11 inclusive, 13.3.4 and 13.6 (Fault Ride Through, Fast Fault Current injection)

☐ **Infrequent Short-Term Parallel Operation**

the following sections of EREC G99 do not apply:

- Type A - less than 1 MW
  - All of Section 11
- Type B - 1 MW or greater but less than 10 MW
  - All of Section 12
- Type C and Type D - 10 MW or greater and / or with a Connection Point at greater than 110 kV
  - All of Section 13

☒ • **Other**

No exceptions.

4.4 Scope of measurements

Date of receipt of test items ..... : 2022-12-01

Date(s) of performance of tests ..... : 2022-12-01 - 2023-03-10

During the test period stated above following environmental data were recorded:

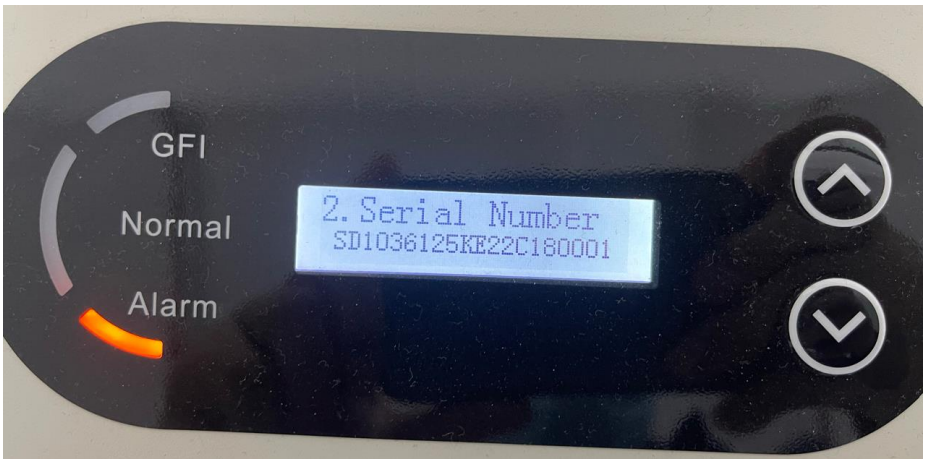
- Temperature: 19.8 ~ 24.6°C
- Rel. humidity: 40.2 ~ 59.6%RH
- Air pressure: 999.3 ~ 1004.1 hPa

Test items	Type A Testing requirements (Section EREC G99) / Tests completed	Type B Testing requirements (Section EREC G99) / Tests completed	Types C & D Testing requirements (Section EREC G99) / Tests completed	Section in this test report
1. Operating Range	10.3.4, 11.2.1, 11.2.2 / ☒	10.3.4, 12.2.1, 12.2.2 / ☒	10.3.4, 13.2.1, 13.2.2 / ☐	6.1
Power quality				
2. Harmonics	A.7.1.4.1, 9.4.3 / ☒	9.4.3 / ☒	9.4.3 / ☐	6.2
3. Voltage Fluctuation and Flicker	A.7.1.4.3, 9.4.2 / ☒	9.4.2 / ☒	9.4.2 / ☐	6.3
4. DC injection	A.7.1.4.4, 9.4.6 / ☒	9.4.6 / ☒	9.4.6 / ☐	6.4
5. Power Factor (PF)	A.7.1.4.2, 11.1.5 / ☒	☐	☐	6.5
6. Voltage control capability	☐	12.4 / ☐	13.4 / ☐	6.6
7. Reactive power capability	☐	12.5 / ☐	13.5 / ☐	6.7
Interface protection				
8. Frequency protection trip and ride through tests	A.7.1.2.1, A.7.1.2.3, 10 / ☒	10 / ☒	10 / ☐	6.8.1
9. Voltage protection trip and ride through tests	A.7.1.2.1, A.7.1.2.2, 10 / ☒	10 / ☒	10 / ☐	6.8.2
10. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	A.7.1.2.4, A.7.1.2.6, 10 / ☒	10 / ☒	10 / ☐	6.8.3, 6.8.4, 6.8.5
11. Automatic reconnection	A.7.1.2.5, 10.3.5 / ☒	10.3.3, 10.3.4, 10.3.5 / ☒	10.3.3, 10.3.4, 10.3.5 / ☐	6.8.6, 6.11
Frequency capability				
12. LFSM-O Test	A.7.1.3, 11.2.4/ ☒	12.2.4 / ☒	13.2.4 / ☐	6.9
13. Output power with falling frequency	A.7.2.3 / 11.2.3 ☐	12.2.3 / ☐	13.2.3 / ☐	Test not performed and not documented in this report.
14. LFSM-U	☐	☐	13.2.5 / ☐	Test not performed and not documented in this report.

Test items	Type A Testing requirements (Section EREC G99) / Tests completed	Type B Testing requirements (Section EREC G99) / Tests completed	Types C & D Testing requirements (Section EREC G99) / Tests completed	Section in this test report
15. Active power setpoint	☐	12.1.3 / ☐	13.1.3 / ☐	6.10
16. Fault Level Contribution	A.7.1.5, 9.7 / ☒	9.7 / ☒	9.7 / ☐	6.12
17. Fault ride through	☐	12.3 / ☐	13.3 / ☐	6.13
18. FFCI	☐	12.6 / ☐	13.6 / ☐	6.13
19. Self-monitoring Solid State Switch	A.7.1.6, 9.7.9 / ☐	9.7.9 / ☐	9.7.9 / ☐	6.14
20. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	15.2.1 / ☐	15.2.1 / ☐	15.2.1 / ☐	6.15
21. Logic Interface (input port)	11.1.3 / ☒	12.1.3.5 / ☐	☐	6.16
22. Cyber security	9.1.7 / ☐	9.1.7 / ☐	9.1.7 / ☐	6.17
23. Fault recording & system monitoring capability	☐	☐	C.6 / ☐	Test not performed and not documented in this report.

Note:

- The tests were performed on EUT *SOFAR 125KTLX-G4-A* which provides the highest current / power
- The product was tested on
    - Serial No.: SD1036125KE22C180001
    - Hardware Version: V001
    - Software Version: V000001



- Measurement done at output terminals of the EUT, see Figure 3, Figure 4 and Figure 5.
- According to EREC G99, section 15.6.1 the following applies:
  since the rated power of *SOFAR 100KTLX-G4, SOFAR 110KTLX-G4* and *SOFAR 125KTLX-G4* is between $1/\sqrt{10}\cdot P_{n,\ SOFAR\ 125KTLX-G4-A}$ and $2\cdot P_{n,\ SOFAR\ 125KTLX-G4-A}$, a family approach to type testing is acceptable.
- A transfer of measurement results from the *SOFAR 125KTLX-G4-A* to other units in the product series according to EREC G99, section 15.6.2 is allowed (for details see section *5 Assessment overview*.)
- Technical justification for transferability of measurement results:
  see section 3.2 on p.10.

4.5 Reference values

Reference values for the p.u. or percentage calculations:

	SOFAR 100KTLX-G4	SOFAR 110KTLX-G4	SOFAR 125KTLX-G4	SOFAR 125KTLX-G4-A
Registered Capacity [2] P_{max} [kW]	100.0	100.0	110.0	125.0
Rated voltage (phase-to-neutral), U_n [V]	230			
Rated current, I_n [3] [A]	145.0	145.0	159.5	181.2

4.6 Measurement setup

Tests documented in this test report were performed using the following test configuration:

☐ Measurements in the field on real grid

☐ Test bench tests on real grid

☒ Test bench tests on an AC grid simulator

The PGU is connected on the DC-side to a PV-simulator and on the AC-side to an AC-grid simulator. The AC-grid simulator is operated with nominal conditions of U_n = 230 (phase-to-neutral) and f_n = 50 Hz unless stated otherwise by the applied test requirement.

Available primary power is modified by adapting the short circuit current (I_{sc}) value of the I-V curve. Following example shows a PV-curve (I_{sc} = 210.975 A, U_{oc} = 725.74 V) simulated according to EN50530:

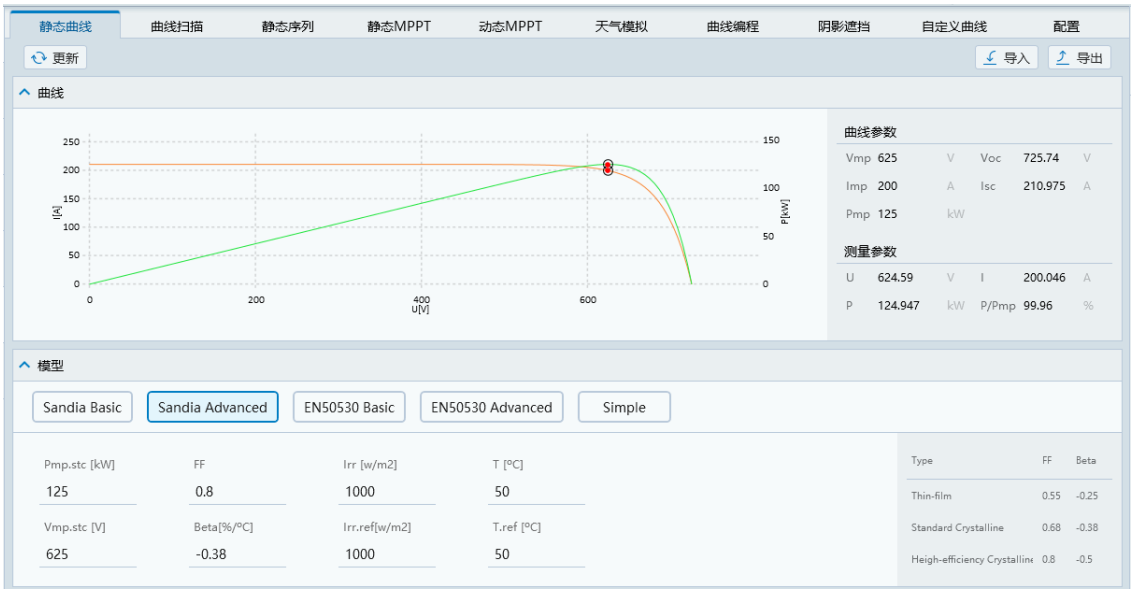


Figure 2 – DC characteristics for testing

The measurement setups are shown in Figure 3 Figure 4 and Figure 5. The specific test and measurement devices are stated in section 4.7.

[2] In this report, the stated values of "registered capacity" related to single Generating Unit.

[3] The rated current stated in this report is calculated based on the "registered capacity" and the rated voltage.

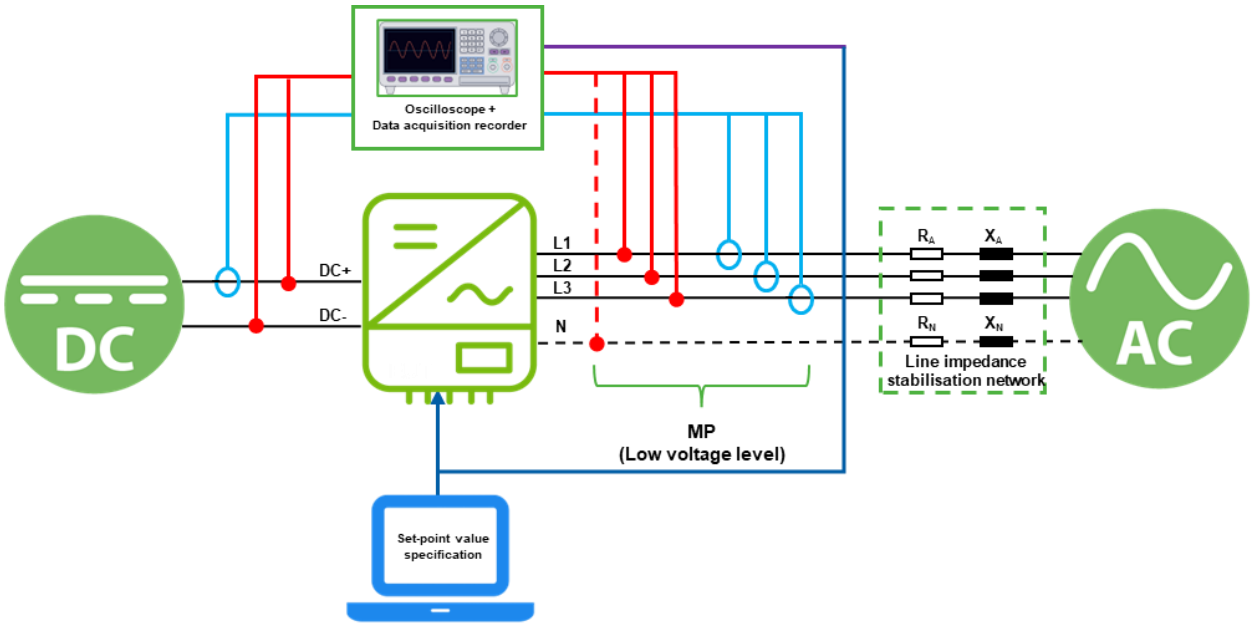


Figure 3 – Measurement setup used for tests except Loss of Mains and Short Circuit test

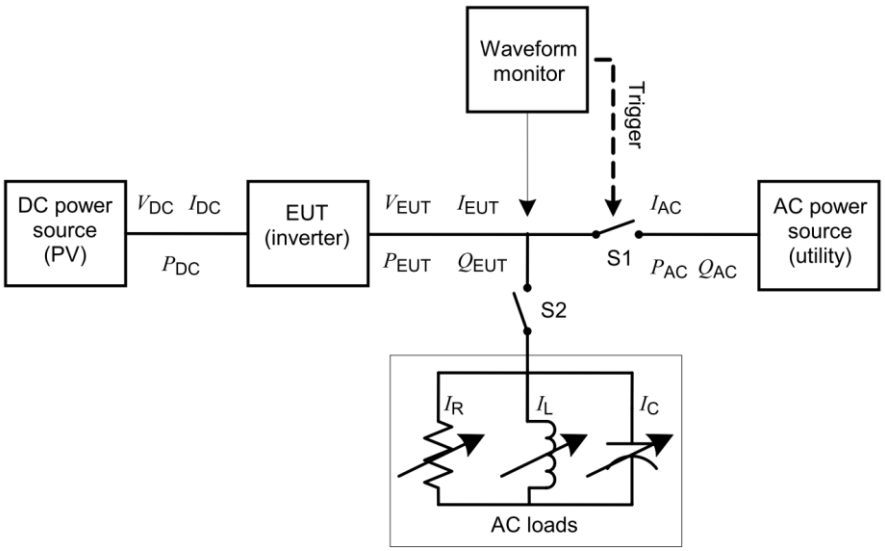


Figure 4 – Test circuit for Loss of Mains according to *IEC 62116:2014*

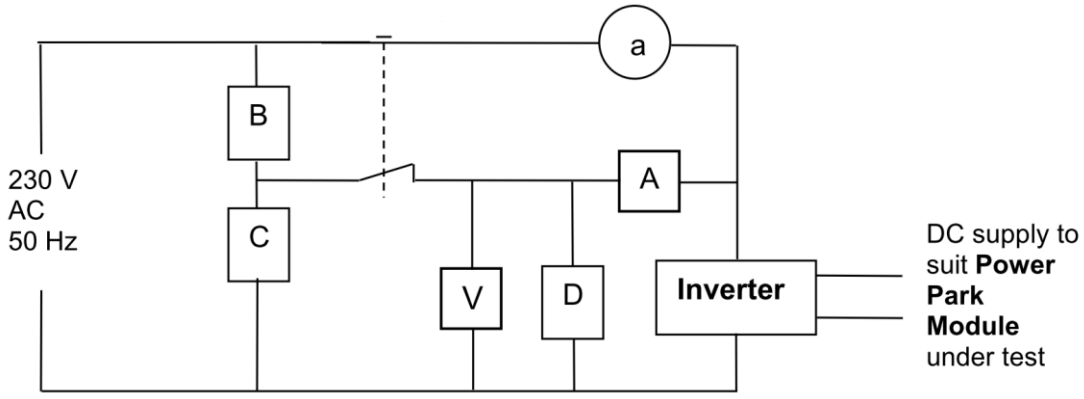


Figure 5 – Short circuit test circuit according to *EREC G99, Figure A.7.5*

4.7 Measurement equipment

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
DC power supply [4]	--	ACTION	PRD2006	B1022D0059	--
	--	ACTION	PRD2006	B1022E0224	--
	--	ACTION	PRD2006	B1022E0110	--
	--	ACTION	PRD2006	B1022E0259	--
AC Simulator [4]	--	ACTION	PRE2020S	B1022K0209	--
	--	ACTION	PRE2020S	B1022K0194	--
	--	ACTION	PRE2020S	B1022K0195	--
	--	ACTION	PRE2020S	B1022K0210	--
	--	ACTION	PRE2020S	B1022K0213	--
Oscilloscope	--	SIGLENT	SDS5034X	SDS5XEAC3R0011	2023-12-01
	--	TEKTRONIX	MDO34	C045110	2023-12-01
Power analyser	HC-ENG-003	DEWESOFT	SIRIUSi-HS-4xHV-4xLV	DB20123915	2023-09-05
Current sensor	HC-ENG-019	LEM	IT 400-S	82021060080	2023-09-05
	HC-ENG-020	LEM	IT 400-S	82021060081	2023-09-05
	HC-ENG-021	LEM	IT 400-S	82021060082	2023-09-05
	HC-ENG-022	LEM	IT 400-S	82021060084	2023-09-05
Digital hygrometer	HC-ENG-002	Jiangsu Jingchuang Electric Co., Ltd.	GSP-8A	CMA215000031	2023-08-31

Note:

All measurement equipment was used within the calibration period. Copy of calibration certificates are available at the laboratory for reference.

[4] The AC simulator and DC sources do not need to be calibrated, since the AC voltage and current is measured and determined using the calibrated oscilloscope and power analyser.

5 Assessment overview

Possible test case verdicts:

Test item does meet the requirement.....: P (Pass)

Test item does not meet the requirement....: F (Fail)

Test case does not apply to the test object...: N/A

Test case is not rated .....: N/R

Reference to declaration documents.....: R/D

Items	Technical requirements (Section EREC G99)			Remark / Transfer of measurement results *	Verdict
1. Operating Range	☒	Type A:	10.3.4, 11.2.1, 11.2.2	See section 6.1 / The verified operating range of the *SOFAR 125KTLX-G4-A* can be applied to other units in the product series directly.	P
	☒	Type B:	10.3.4, 12.2.1, 12.2.2		
	☐	Type C/D:	10.3.4, 13.2.1, 13.2.2		
2. Harmonics	☒	Type A:	9.4.3	See section 6.2. Final assessment needs to be done by the NO / The percentage harmonics results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	N/R
	☒	Type B:	9.4.3		
	☐	Type C/D:	9.4.3		
3. Voltage Fluctuation and Flicker	☒	Type A:	9.4.2	See section 6.3. Final assessment needs to be done by the NO / The Flicker results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	N/R
	☒	Type B:	9.4.2		
	☐	Type C/D:	9.4.2		
4. DC injection	☒	Type A:	9.4.6	See section 6.4 / The percentage DC injection of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	9.4.6		
	☐	Type C/D:	9.4.6		
5. Power Factor (PF)	☒	Type A:	11.1.5	See section 6.5 / The Power Factor results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☐	Type B:	---		
	☐	Type C/D:	---		
6. Voltage control capability	☐	Type A:	---	Test not performed. The PGM provides different Reactive Power and voltage control modes. Control mode used and control point need be agreed with the DNO. For details see section 6.6)	N/A
	☒	Type B:	12.4		
	☐	Type C/D:	13.4		
7. Reactive power capability	☐	Type A:	---	Test not performed. Confirmation of compliance with EREC G99, section 12.5 requires a simulation study in accordance with B.4.2. Manufacturer declaration provided. For details see section 6.7.	N/A
	☒	Type B:	12.5		
	☐	Type C/D:	13.5		

Items	Technical requirements (Section EREC G99)			Remark / Transfer of measurement results *	Verdict
8. Frequency protection trip and ride through tests	☒	Type A:	10	See section 6.8.1 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	10		
	☐	Type C/D:	10		
9. Voltage protection trip and ride through tests	☒	Type A:	10	See section 6.8.2 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	10		
	☐	Type C/D:	10		
10. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	☒	Type A:	10	See section 6.8.3, 6.8.4 and 6.8.5 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	10		
	☐	Type C/D:	10		
11. Automatic reconnection	☒	Type A:	10.3.5	See section 6.8.6, 6.11 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	10.3.3, 10.3.4, 10.3.5		
	☐	Type C/D:	10.3.3, 10.3.4, 10.3.5		
12. LFSM-O Test	☒	Type A:	11.2.4	See section 6.9 / The determined droops of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly. If required, compliance with EREC G99, section 12.2.4 shall be confirmed by a simulation study.	P
	☒	Type B:	12.2.4		
	☐	Type C/D:	13.2.4		
13. Output power with falling frequency	☒	Type A:	11.2.3	Test not performed and not documented in this report. Test not required for Inverter Connected PGM. Due to the technology used, requirement can be met.	N/A
	☒	Type B:	12.2.3		
	☐	Type C/D:	13.2.3		
14. LFSM-U	☐	Type A:	---	Test not performed and not documented in this report.	N/A
	☐	Type B:	---		
	☐	Type C/D:	13.2.5		
15. Active power setpoint	☐	Type A:	---	Manufacturer declaration provided. For details see section 6.10.	R/D
	☒	Type B:	12.1.3		
	☐	Type C/D:	13.1.3		
16. Fault Level Contribution	☒	Type A:	9.7	See section 6.12 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly.	P
	☒	Type B:	9.7		
	☐	Type C/D:	9.7		
17. Fault ride through	☐	Type A:	---	Test not performed. Confirmation of compliance with EREC G99, section 12.3 & 12.6 requires a simulation study in accordance with B.4.4. Manufacturer declaration provided. For details see section 6.13.	N/A
	☒	Type B:	12.3		
	☐	Type C/D:	13.3		

Items	Technical requirements (Section EREC G99)			Remark / Transfer of measurement results *	Verdict
18. FFCI	☐	Type A:	---	Test not performed. Confirmation of compliance with EREC G99, section 12.3 & 12.6 requires a simulation study in accordance with B.4.4. Manufacturer declaration provided. For details see section 6.13.	N/A
	☒	Type B:	12.6		
	☐	Type C/D:	13.6		
12. Self-monitoring Solid State Switch	☒	Type A:	9.7.9	See section 6.14 / ---	N/A
	☒	Type B:	9.7.9		
	☐	Type C/D:	9.7.9		
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	☒	Type A:	15.2.1	See section 6.15 / ---	N/A
	☒	Type B:	15.2.1		
	☐	Type C/D:	15.2.1		
14. Logic Interface (input port)	☒	Type A:	11.1.3	See section 6.16 / The measurement results of the *SOFAR 125KTLX-G4-A* can be considered as worst case results and applied to other units in the product series directly. The high-level description of logic interface applies to the whole product series.	P
	☒	Type B:	(12.1.3.5)		
	☐	Type C/D:	---		
15. Cyber security	☒	Type A:	9.1.7	See section 6.17 / Manufacturer's declaration provided. See *Annex 2 - Manufacturer's declaration regarding Cyber Security*.	R/D
	☒	Type B:	9.1.7		
	☐	Type C/D:	9.1.7		

Note:

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed.

* According to EREC G99, section 15.6.2 the following applies:

All absolute values (e.g. operating range tests) shall be transferred directly in the compliance forms of an assumed compliant Generating Unit of the same family. ***All relative results related to design Active Power or current (e.g. power quality fluctuation and flicker) from the tested Generating Unit shall be transferred to the compliance form of a Generating Unit in the same family according to the ratio of the respective nameplate rating (W) of the tested Generating Unit and the assumed compliant Generating Unit****. For the avoidance of doubt, the Manufacturer shall register each Generating Unit in the family on the Energy Networks Association Type Test register.*

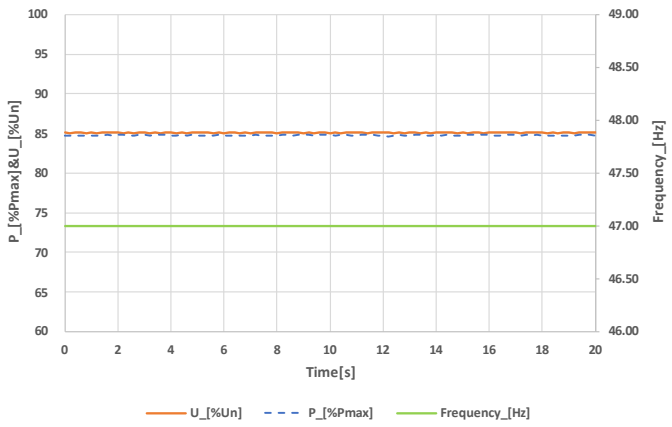
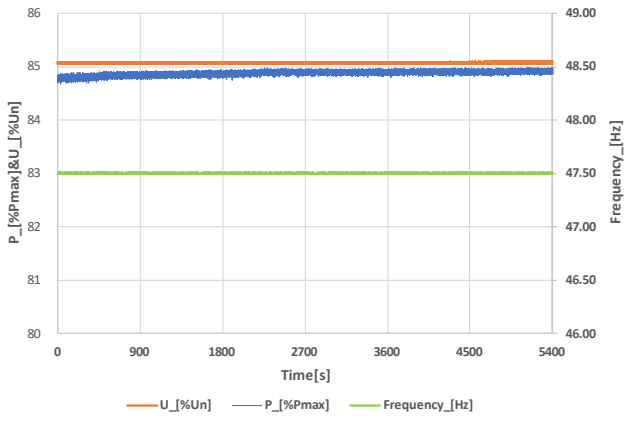
Since the tests were performed on EUT *SOFAR 125KTLX-G4-A* which provides the highest current / power, in this report the *relative results* of EUT *SOFAR 125KTLX-G4-A* are considered as worst case results and applied to other units in the product series directly.

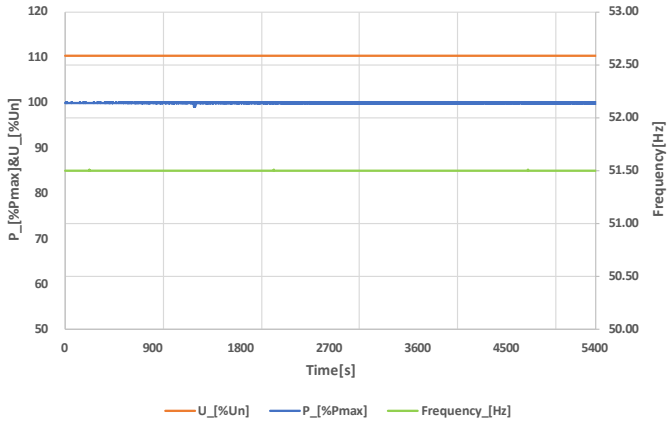
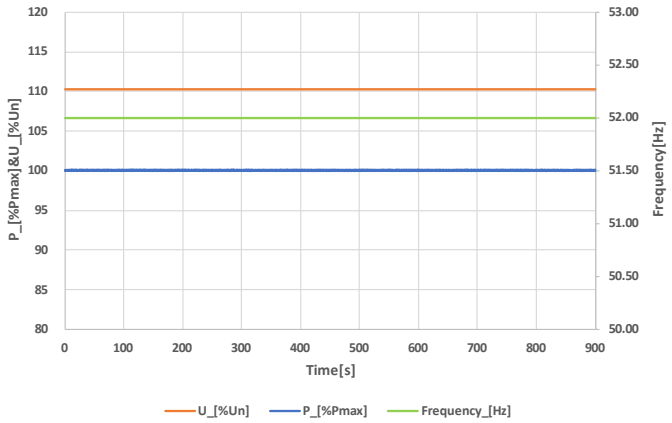
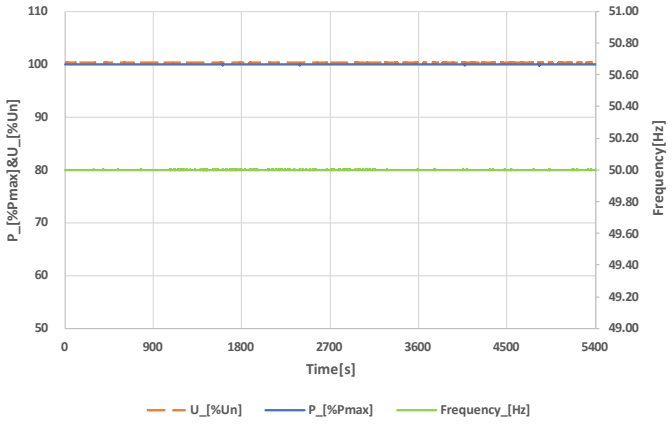
6 Measurement results

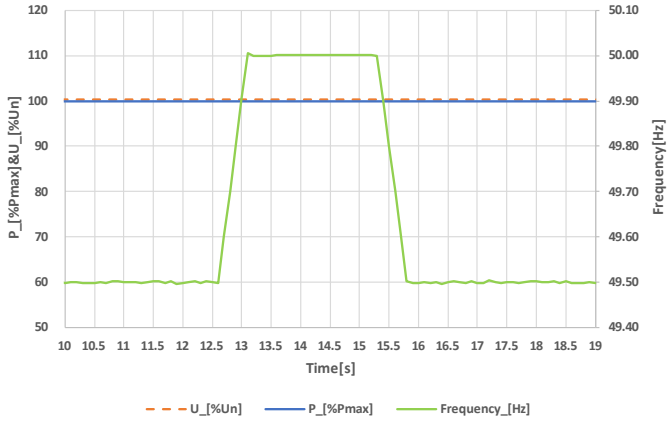
A2-3 Compliance Verification Report –Tests for Type A Inverter Connected Power Generating Modules – test record

Note:
in this report, form A2-3 is used for test recording. Tests for type B PGM are recorded and marked accordingly.

6.1 Operating Range

Tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence. Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time. The Interface Protection shall be disabled during the tests. In case of a PV Power Park Module the PV primary source may be replaced by a DC source. In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source. Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred. Note that the value of voltage stated in brackets assumes a LV connection. This should be adjusted for HV as required.	
Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Pass, no disconnection occurs. 
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Pass, no disconnection occurs. 

Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Pass, no disconnection occurs. 
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Pass, no disconnection occurs. 
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Pass, no disconnection occurs. 
Test 6 RoCoF withstand Confirm that the Power Generating Module is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	Pass, no disconnection occurs.



6.2 Power Quality – Harmonics

Note:

Registered Capacity of the Power Park Modules (Generating Units) considered in this report > 50kW, comparison of the test results with the limit values according to BS EN 610000-3-12 for reference only.

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Module**s, measurements for all phases should be provided.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12								
Power Generating Module rating per phase (rpp)			41.667		kVA		Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).			three phases					
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in % [5]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.1107	0.0887	0.0850	0.061	0.049	0.047	8%	8%
3	0.2102	0.0642	0.2525	0.116	0.035	0.139	21.6%	Not stated
4	0.0529	0.0359	0.0381	0.029	0.020	0.021	4%	4%
5	0.4388	0.4732	0.4193	0.242	0.261	0.231	10.7%	10.7%
6	0.0310	0.0314	0.0280	0.017	0.017	0.015	2.67%	2.67%
7	0.2319	0.1772	0.1791	0.128	0.098	0.099	7.2%	7.2%
8	0.0373	0.0357	0.0364	0.021	0.020	0.020	2%	2%

[5] The percentage values of harmonic currents (for both partial load and full load tests) were calculated using the formula:
Harmonic % = Measured Value (A) x 23/rating per phase (kVA)
according to Form A2-3, which corresponding to a reference current equal to rated current of the inverter.

Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
9	0.0764	0.0311	0.0751	0.042	0.017	0.041	3.8%	Not stated
10	0.0290	0.0256	0.0263	0.016	0.014	0.015	1.6%	1.6%
11	0.1085	0.1069	0.0929	0.060	0.059	0.051	3.1%	3.1%
12	0.0222	0.0225	0.0233	0.012	0.012	0.013	1.33%	1.33%
13	0.0871	0.0867	0.0853	0.048	0.048	0.047	2%	2%
14	0.0301	0.0285	0.0290	0.017	0.016	0.016	---	---
15	0.0386	0.0308	0.0378	0.021	0.017	0.021	---	---
16	0.0271	0.0239	0.0252	0.015	0.013	0.014	---	---
17	0.1950	0.1978	0.1913	0.108	0.109	0.106	---	---
18	0.0213	0.0204	0.0205	0.012	0.011	0.011	---	---
19	0.1006	0.0919	0.1067	0.056	0.051	0.059	---	---
20	0.0219	0.0243	0.0242	0.012	0.013	0.013	---	---
21	0.0371	0.0257	0.0319	0.020	0.014	0.018	---	---
22	0.0278	0.0219	0.0255	0.015	0.012	0.014	---	---
23	0.2860	0.2887	0.2705	0.158	0.159	0.149	---	---
24	0.0217	0.0180	0.0252	0.012	0.010	0.014	---	---
25	0.0941	0.1042	0.1009	0.052	0.058	0.056	---	---
26	0.0220	0.0209	0.0290	0.012	0.012	0.016	---	---
27	0.0375	0.0223	0.0370	0.021	0.012	0.020	---	---
28	0.0205	0.0185	0.0200	0.011	0.010	0.011	---	---
29	0.1702	0.1934	0.1667	0.094	0.107	0.092	---	---
30	0.0163	0.0253	0.0287	0.009	0.014	0.016	---	---
31	0.2164	0.2052	0.1753	0.119	0.113	0.097	---	---
32	0.0239	0.0240	0.0313	0.013	0.013	0.017	---	---
33	0.0449	0.0294	0.0521	0.025	0.016	0.029	---	---
34	0.0218	0.0151	0.0211	0.012	0.008	0.012	---	---
35	0.0581	0.0494	0.0520	0.032	0.027	0.029	---	---
36	0.0203	0.0292	0.0252	0.011	0.016	0.014	---	---
37	0.2251	0.1862	0.1979	0.124	0.103	0.109	---	---
38	0.0215	0.0274	0.0221	0.012	0.015	0.012	---	---
39	0.0366	0.0223	0.0321	0.020	0.012	0.018	---	---
40	0.0233	0.0160	0.0173	0.013	0.009	0.010	---	---
THD [6]	--	--	--	0.434	0.413	0.411	23%	13%
PWHD [7]	--	--	--	1.524	1.466	1.409	23%	22%

[6] THD = Total Harmonic Distortion, order 2 - 40 according to BS EN 61000- 3-12 considered. The stated values in the results table are in %.

[7] PWHD = Partial Weighted Harmonic Distortion, order 14 - 40 according to BS EN 61000- 3-12 considered. The stated values in the results table are in %.

Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in % [5]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.2164	0.1786	0.1621	0.119	0.099	0.089	8%	8%
3	0.1127	0.1708	0.3965	0.062	0.094	0.219	21.6%	Not stated
4	0.0850	0.0657	0.0527	0.047	0.036	0.029	4%	4%
5	0.4568	0.5690	0.5990	0.252	0.314	0.331	10.7%	10.7%
6	0.0632	0.0628	0.0466	0.035	0.035	0.026	2.67%	2.67%
7	0.5936	0.6119	0.4824	0.328	0.338	0.266	7.2%	7.2%
8	0.0488	0.0535	0.0455	0.027	0.030	0.025	2%	2%
9	0.1505	0.0830	0.1127	0.083	0.046	0.062	3.8%	Not stated
10	0.0478	0.0485	0.0536	0.026	0.027	0.030	1.6%	1.6%
11	0.5899	0.7086	0.6113	0.326	0.391	0.337	3.1%	3.1%
12	0.0450	0.0491	0.0466	0.025	0.027	0.026	1.33%	1.33%
13	0.3712	0.4033	0.2879	0.205	0.223	0.159	2%	2%
14	0.0559	0.0530	0.0465	0.031	0.029	0.026	---	---
15	0.0660	0.0601	0.0798	0.036	0.033	0.044	---	---
16	0.0387	0.0443	0.0432	0.021	0.024	0.024	---	---
17	0.3867	0.4265	0.3976	0.213	0.235	0.219	---	---
18	0.0460	0.0443	0.0364	0.025	0.024	0.020	---	---
19	0.1530	0.1597	0.1820	0.084	0.088	0.100	---	---
20	0.0580	0.0521	0.0631	0.032	0.029	0.035	---	---
21	0.0845	0.0558	0.0931	0.047	0.031	0.051	---	---
22	0.0385	0.0399	0.0357	0.021	0.022	0.020	---	---
23	0.6390	0.6132	0.6231	0.353	0.339	0.344	---	---
24	0.0504	0.0487	0.0469	0.028	0.027	0.026	---	---
25	0.2919	0.3090	0.3381	0.161	0.171	0.187	---	---
26	0.0474	0.0408	0.0466	0.026	0.023	0.026	---	---
27	0.0671	0.0741	0.0971	0.037	0.041	0.054	---	---
28	0.0363	0.0361	0.0398	0.020	0.020	0.022	---	---
29	0.3661	0.3251	0.3515	0.202	0.179	0.194	---	---
30	0.0490	0.0399	0.0551	0.027	0.022	0.030	---	---
31	0.3691	0.3599	0.3706	0.204	0.199	0.205	---	---
32	0.0492	0.0360	0.0459	0.027	0.020	0.025	---	---
33	0.0711	0.0792	0.0719	0.039	0.044	0.040	---	---
34	0.0397	0.0480	0.0520	0.022	0.027	0.029	---	---
35	0.1635	0.1404	0.1642	0.090	0.078	0.091	---	---
36	0.0354	0.0320	0.0386	0.020	0.018	0.021	---	---
37	0.3124	0.3055	0.3441	0.172	0.169	0.190	---	---
38	0.0506	0.0494	0.0582	0.028	0.027	0.032	---	---
39	0.0615	0.0811	0.0682	0.034	0.045	0.038	---	---
40	0.0479	0.0475	0.0487	0.026	0.026	0.027	---	---
THD [6]	--	--	--	0.830	0.877	0.859	23%	13%
PWHD [7]	--	--	--	2.953	2.884	3.025	23%	22%

Power Generating Module tested to IEC 61000-4-30 and IEC 61000-4-7 for EREC G5 assessment			
Test location:	(Tests performed in laboratory environment) Guangdong HuaChuang Technology Service Co., Ltd. (see *Testing location* on p.2)		
Test start date:	2023-01-30	Test end date:	2023-01-30
Test setup:	See *Figure 3*		
Point of Evaluation:	At output terminals of the EUT (low-voltage level, 400Vac)		
Background harmonic:	Stable AC source (see *4.7 Measurement equipment*) used for testing. Background harmonic can be ignored.		
Instruments:	Power quality analyzer used for testing met IEC 61000-4-30 Class A (see *4.7 Measurement equipment*)		
Transducers:	No voltage transducers used for measurement		
Evaluation method:	Evaluation in compliance with IEC 61000-4-7		
Limits:	The limit values given in the following results table derived from EREC G5, Table 1, 2 & 13. This is based on a simplified consideration of the test setup / PoE and is for reference only, the final assessment is made by the NO.		
Results:	The stated harmonics in the following results table are maximum values over all 3 phases and all datasets. Measurements of harmonics of all 3 phases are available at the laboratory for reference.		

Current Harmonics

Harmonics

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
Order	I_h [%I_n]												
2	0.059	0.034	0.085	0.066	0.062	0.061	0.071	0.084	0.104	0.109	0.119	0.119	---
3	0.212	0.184	0.163	0.147	0.143	0.139	0.137	0.126	0.103	0.128	0.219	0.219	---
4	0.101	0.058	0.091	0.055	0.046	0.029	0.030	0.037	0.042	0.043	0.047	0.101	---
5	0.464	0.237	0.161	0.227	0.245	0.261	0.311	0.392	0.359	0.394	0.331	0.464	---
6	0.061	0.022	0.034	0.038	0.036	0.017	0.020	0.025	0.030	0.033	0.035	0.061	---
7	0.400	0.185	0.062	0.121	0.130	0.128	0.093	0.151	0.124	0.188	0.338	0.400	---
8	0.116	0.038	0.094	0.058	0.055	0.021	0.017	0.022	0.028	0.025	0.030	0.116	---
9	0.055	0.068	0.051	0.056	0.071	0.042	0.042	0.043	0.052	0.047	0.083	0.083	---
10	0.092	0.038	0.032	0.030	0.026	0.016	0.017	0.021	0.025	0.026	0.030	0.092	---
11	0.430	0.090	0.082	0.055	0.057	0.060	0.106	0.203	0.186	0.239	0.391	0.430	---
12	0.067	0.022	0.028	0.033	0.027	0.013	0.016	0.021	0.025	0.022	0.027	0.067	---
13	0.366	0.101	0.045	0.036	0.051	0.048	0.091	0.191	0.164	0.181	0.223	0.366	---
14	0.099	0.052	0.076	0.049	0.040	0.017	0.014	0.015	0.023	0.024	0.031	0.099	---
15	0.048	0.050	0.031	0.035	0.051	0.021	0.026	0.032	0.029	0.068	0.044	0.068	---
16	0.090	0.024	0.055	0.034	0.029	0.015	0.015	0.019	0.025	0.026	0.024	0.090	---
17	0.263	0.092	0.036	0.070	0.060	0.109	0.185	0.249	0.172	0.173	0.235	0.263	---
18	0.065	0.019	0.028	0.037	0.024	0.012	0.015	0.019	0.024	0.024	0.025	0.065	---
19	0.264	0.068	0.035	0.048	0.044	0.059	0.101	0.174	0.138	0.142	0.100	0.264	---
20	0.078	0.033	0.042	0.030	0.025	0.013	0.014	0.015	0.026	0.034	0.035	0.078	---
21	0.042	0.043	0.031	0.041	0.051	0.020	0.021	0.025	0.028	0.045	0.051	0.051	---
22	0.104	0.022	0.032	0.030	0.022	0.015	0.016	0.018	0.026	0.025	0.022	0.104	---
23	0.223	0.189	0.092	0.082	0.069	0.159	0.219	0.224	0.186	0.251	0.353	0.353	---
24	0.053	0.018	0.044	0.046	0.020	0.014	0.016	0.019	0.025	0.028	0.028	0.053	---

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
25	0.182	0.185	0.102	0.060	0.034	0.058	0.114	0.132	0.118	0.149	0.187	0.187	---
26	0.092	0.021	0.027	0.025	0.017	0.016	0.019	0.022	0.026	0.024	0.026	0.092	---
27	0.035	0.054	0.029	0.039	0.070	0.021	0.022	0.025	0.031	0.037	0.054	0.070	---
28	0.058	0.021	0.023	0.029	0.016	0.011	0.012	0.014	0.023	0.022	0.022	0.058	---
29	0.147	0.083	0.132	0.081	0.086	0.107	0.130	0.082	0.112	0.206	0.202	0.206	---
30	0.042	0.018	0.042	0.043	0.014	0.016	0.021	0.019	0.025	0.029	0.030	0.043	---
31	0.108	0.074	0.073	0.044	0.033	0.119	0.160	0.138	0.132	0.181	0.205	0.205	---
32	0.079	0.017	0.030	0.029	0.014	0.017	0.021	0.026	0.028	0.026	0.027	0.079	---
33	0.027	0.053	0.027	0.031	0.068	0.029	0.034	0.029	0.035	0.044	0.044	0.068	---
34	0.052	0.016	0.036	0.028	0.012	0.012	0.013	0.016	0.022	0.021	0.029	0.052	---
35	0.087	0.079	0.057	0.048	0.071	0.032	0.058	0.119	0.103	0.098	0.091	0.119	---
36	0.032	0.018	0.028	0.028	0.012	0.016	0.022	0.022	0.027	0.028	0.021	0.032	---
37	0.077	0.102	0.056	0.063	0.057	0.124	0.142	0.106	0.098	0.147	0.190	0.190	---
38	0.049	0.017	0.025	0.025	0.013	0.015	0.016	0.018	0.026	0.029	0.032	0.049	---
39	0.024	0.034	0.030	0.028	0.042	0.020	0.025	0.024	0.031	0.038	0.045	0.045	---
40	0.046	0.020	0.034	0.025	0.010	0.013	0.016	0.017	0.022	0.024	0.027	0.046	---
41	0.069	0.050	0.052	0.027	0.030	0.074	0.118	0.161	0.158	0.144	0.134	0.161	---
42	0.026	0.018	0.025	0.025	0.014	0.014	0.016	0.019	0.025	0.024	0.020	0.026	---
43	0.057	0.042	0.065	0.066	0.066	0.068	0.061	0.036	0.059	0.089	0.080	0.089	---
44	0.042	0.017	0.031	0.018	0.011	0.012	0.012	0.015	0.026	0.028	0.032	0.042	---
45	0.020	0.037	0.021	0.019	0.024	0.014	0.020	0.019	0.024	0.028	0.032	0.037	---
46	0.047	0.020	0.028	0.022	0.009	0.010	0.011	0.011	0.018	0.021	0.025	0.047	---
47	0.060	0.055	0.031	0.025	0.025	0.090	0.128	0.137	0.134	0.140	0.149	0.149	---
48	0.021	0.021	0.017	0.029	0.010	0.007	0.012	0.016	0.021	0.024	0.025	0.029	---
49	0.057	0.061	0.023	0.042	0.049	0.022	0.032	0.066	0.075	0.077	0.096	0.096	---
50	0.044	0.018	0.027	0.019	0.009	0.010	0.011	0.015	0.019	0.017	0.018	0.044	---
51	0.018	0.035	0.018	0.014	0.019	0.011	0.018	0.020	0.021	0.023	0.023	0.035	---
52	0.038	0.019	0.015	0.015	0.010	0.009	0.008	0.009	0.014	0.016	0.018	0.038	---
53	0.042	0.055	0.033	0.028	0.032	0.075	0.091	0.076	0.084	0.104	0.118	0.118	---
54	0.018	0.024	0.014	0.024	0.010	0.008	0.011	0.013	0.017	0.022	0.025	0.025	---
55	0.043	0.052	0.023	0.028	0.046	0.039	0.073	0.085	0.069	0.088	0.123	0.123	---
56	0.041	0.021	0.018	0.021	0.009	0.008	0.009	0.012	0.017	0.016	0.013	0.041	---
57	0.018	0.027	0.015	0.014	0.019	0.013	0.015	0.016	0.022	0.024	0.017	0.027	---
58	0.031	0.020	0.014	0.015	0.008	0.008	0.008	0.009	0.014	0.013	0.013	0.031	---
59	0.032	0.046	0.025	0.024	0.030	0.050	0.045	0.031	0.054	0.068	0.070	0.070	---
60	0.020	0.028	0.021	0.021	0.016	0.015	0.015	0.017	0.018	0.043	0.044	0.044	---
61	0.037	0.028	0.019	0.026	0.041	0.040	0.061	0.054	0.047	0.074	0.102	0.102	---
62	0.031	0.017	0.012	0.021	0.009	0.007	0.008	0.009	0.013	0.016	0.014	0.031	---
63	0.016	0.021	0.018	0.013	0.016	0.010	0.013	0.014	0.018	0.020	0.019	0.021	---
64	0.023	0.019	0.019	0.015	0.008	0.009	0.008	0.009	0.013	0.013	0.011	0.023	---
65	0.035	0.024	0.020	0.020	0.027	0.030	0.022	0.027	0.041	0.042	0.046	0.046	---
66	0.013	0.021	0.012	0.021	0.010	0.008	0.011	0.012	0.015	0.017	0.016	0.021	---
67	0.030	0.020	0.016	0.023	0.035	0.057	0.079	0.056	0.036	0.045	0.061	0.079	---
68	0.022	0.011	0.013	0.017	0.010	0.010	0.012	0.013	0.014	0.016	0.015	0.022	---
69	0.013	0.015	0.015	0.013	0.027	0.012	0.017	0.020	0.023	0.020	0.023	0.027	---
70	0.023	0.014	0.016	0.016	0.009	0.009	0.012	0.013	0.018	0.016	0.014	0.023	---
71	0.030	0.018	0.012	0.011	0.020	0.031	0.072	0.071	0.055	0.047	0.058	0.072	---
72	0.015	0.014	0.014	0.018	0.009	0.007	0.009	0.016	0.022	0.023	0.018	0.023	---
73	0.032	0.020	0.012	0.018	0.024	0.045	0.047	0.050	0.075	0.132	0.127	0.132	---
74	0.021	0.011	0.014	0.012	0.009	0.008	0.008	0.010	0.020	0.021	0.019	0.021	---

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
75	0.014	0.013	0.013	0.010	0.018	0.009	0.014	0.016	0.027	0.038	0.037	0.038	---
76	0.022	0.012	0.012	0.014	0.008	0.007	0.008	0.011	0.022	0.023	0.022	0.023	---
77	0.035	0.022	0.015	0.013	0.015	0.035	0.062	0.076	0.089	0.147	0.135	0.147	---
78	0.012	0.012	0.012	0.017	0.009	0.006	0.007	0.010	0.017	0.021	0.023	0.023	---
79	0.029	0.023	0.013	0.014	0.019	0.026	0.020	0.033	0.049	0.066	0.123	0.123	---
80	0.020	0.013	0.013	0.010	0.008	0.006	0.006	0.008	0.013	0.015	0.021	0.021	---
81	0.013	0.013	0.013	0.009	0.012	0.009	0.011	0.013	0.015	0.025	0.044	0.044	---
82	0.020	0.010	0.011	0.010	0.008	0.007	0.007	0.007	0.015	0.014	0.019	0.020	---
83	0.022	0.019	0.016	0.014	0.014	0.036	0.045	0.041	0.053	0.076	0.130	0.130	---
84	0.011	0.012	0.010	0.015	0.009	0.006	0.008	0.009	0.013	0.013	0.013	0.015	---
85	0.019	0.021	0.012	0.015	0.019	0.021	0.039	0.048	0.044	0.043	0.028	0.048	---
86	0.019	0.012	0.010	0.010	0.007	0.006	0.007	0.009	0.011	0.011	0.010	0.019	---
87	0.011	0.014	0.011	0.010	0.010	0.010	0.010	0.014	0.014	0.017	0.022	0.022	---
88	0.018	0.009	0.013	0.010	0.008	0.007	0.006	0.008	0.017	0.011	0.013	0.018	---
89	0.023	0.020	0.017	0.013	0.014	0.029	0.028	0.028	0.044	0.054	0.074	0.074	---
90	0.012	0.012	0.009	0.011	0.008	0.007	0.008	0.009	0.016	0.013	0.013	0.016	---
91	0.021	0.018	0.011	0.017	0.021	0.030	0.051	0.046	0.040	0.048	0.042	0.051	---
92	0.018	0.011	0.010	0.009	0.008	0.007	0.009	0.009	0.014	0.011	0.009	0.018	---
93	0.011	0.013	0.010	0.010	0.012	0.010	0.011	0.012	0.014	0.016	0.017	0.017	---
94	0.023	0.020	0.023	0.021	0.021	0.021	0.020	0.022	0.033	0.015	0.015	0.033	---
95	0.018	0.019	0.013	0.012	0.014	0.021	0.024	0.029	0.036	0.043	0.052	0.052	---
96	0.010	0.013	0.010	0.011	0.008	0.007	0.007	0.008	0.011	0.013	0.013	0.013	---
97	0.016	0.018	0.011	0.015	0.020	0.037	0.045	0.033	0.038	0.046	0.064	0.064	---
98	0.015	0.012	0.012	0.011	0.009	0.007	0.008	0.008	0.011	0.011	0.010	0.015	---
99	0.009	0.012	0.010	0.010	0.013	0.010	0.011	0.011	0.015	0.017	0.018	0.018	---
100	0.014	0.011	0.012	0.010	0.009	0.007	0.007	0.008	0.023	0.010	0.009	0.023	---
THD_I [%I_n]	1.087	0.569	0.443	0.432	0.443	0.507	0.647	0.777	0.715	0.863	1.041	1.087	---

Interharmonics

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
f [Hz]	I_h [%I_n]												
75	0.085	0.068	0.109	0.171	0.199	0.203	0.237	0.272	0.318	0.357	0.401	0.401	---
125	0.054	0.146	0.281	0.354	0.331	0.089	0.072	0.083	0.101	0.110	0.123	0.354	---
175	0.065	0.166	0.158	0.158	0.098	0.047	0.049	0.056	0.068	0.074	0.084	0.166	---
225	0.175	0.282	0.308	0.334	0.364	0.081	0.057	0.060	0.066	0.066	0.073	0.364	---
275	0.175	0.082	0.143	0.135	0.189	0.050	0.053	0.055	0.059	0.060	0.058	0.189	---
325	0.158	0.077	0.147	0.112	0.126	0.038	0.037	0.043	0.047	0.054	0.062	0.158	---
375	0.146	0.094	0.117	0.160	0.239	0.066	0.033	0.034	0.034	0.029	0.030	0.239	---
425	0.063	0.208	0.335	0.359	0.455	0.081	0.029	0.032	0.034	0.034	0.035	0.455	---
475	0.061	0.135	0.094	0.071	0.097	0.035	0.025	0.026	0.032	0.029	0.032	0.135	---
525	0.159	0.128	0.073	0.115	0.131	0.047	0.027	0.029	0.032	0.028	0.035	0.159	---
575	0.151	0.062	0.131	0.118	0.154	0.028	0.025	0.027	0.032	0.029	0.028	0.154	---
625	0.154	0.077	0.046	0.038	0.053	0.027	0.024	0.030	0.031	0.024	0.028	0.154	---
675	0.137	0.218	0.194	0.188	0.200	0.049	0.024	0.029	0.032	0.028	0.029	0.218	---
725	0.061	0.216	0.226	0.286	0.316	0.061	0.019	0.019	0.026	0.021	0.023	0.316	---
775	0.053	0.072	0.137	0.162	0.168	0.039	0.018	0.020	0.027	0.020	0.022	0.168	---
825	0.120	0.121	0.163	0.163	0.176	0.045	0.022	0.023	0.026	0.021	0.021	0.176	---
875	0.108	0.090	0.109	0.111	0.116	0.022	0.021	0.024	0.027	0.021	0.021	0.116	---
925	0.117	0.095	0.118	0.099	0.080	0.019	0.031	0.020	0.027	0.025	0.025	0.118	---

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
975	0.105	0.144	0.156	0.164	0.141	0.036	0.017	0.031	0.040	0.033	0.038	0.164	---
1025	0.046	0.119	0.113	0.129	0.145	0.037	0.014	0.016	0.023	0.018	0.020	0.145	---
1075	0.040	0.065	0.093	0.098	0.114	0.039	0.013	0.017	0.023	0.018	0.020	0.114	---
1125	0.074	0.093	0.099	0.140	0.139	0.041	0.017	0.017	0.022	0.019	0.022	0.140	---
1175	0.070	0.075	0.076	0.087	0.086	0.018	0.016	0.017	0.022	0.019	0.023	0.087	---
1225	0.070	0.087	0.102	0.094	0.087	0.016	0.013	0.016	0.023	0.023	0.023	0.102	---
1275	0.065	0.096	0.094	0.092	0.085	0.026	0.013	0.016	0.024	0.022	0.022	0.096	---
1325	0.037	0.055	0.048	0.058	0.051	0.023	0.011	0.014	0.017	0.014	0.016	0.058	---
1375	0.029	0.038	0.051	0.052	0.043	0.031	0.011	0.014	0.017	0.014	0.016	0.052	---
1425	0.054	0.060	0.073	0.078	0.079	0.034	0.012	0.014	0.018	0.019	0.022	0.079	---
1475	0.050	0.064	0.055	0.058	0.056	0.014	0.012	0.012	0.020	0.020	0.023	0.064	---
1525	0.049	0.050	0.047	0.049	0.050	0.016	0.012	0.015	0.018	0.018	0.019	0.050	---
1575	0.049	0.067	0.052	0.055	0.054	0.025	0.012	0.015	0.019	0.018	0.019	0.067	---
1625	0.030	0.042	0.049	0.054	0.053	0.022	0.010	0.011	0.014	0.012	0.014	0.054	---
1675	0.026	0.030	0.038	0.048	0.036	0.022	0.009	0.011	0.014	0.012	0.014	0.048	---
1725	0.038	0.060	0.050	0.049	0.043	0.023	0.010	0.013	0.016	0.017	0.019	0.060	---
1775	0.037	0.063	0.044	0.036	0.032	0.011	0.010	0.011	0.018	0.018	0.020	0.063	---
1825	0.034	0.033	0.026	0.025	0.028	0.015	0.011	0.012	0.015	0.017	0.016	0.034	---
1875	0.038	0.058	0.055	0.058	0.047	0.024	0.012	0.013	0.016	0.016	0.017	0.058	---
1925	0.023	0.051	0.054	0.051	0.045	0.023	0.009	0.012	0.012	0.011	0.012	0.054	---
1975	0.021	0.041	0.034	0.032	0.028	0.015	0.009	0.010	0.014	0.012	0.013	0.041	---
2025	0.031	0.056	0.033	0.026	0.030	0.015	0.010	0.012	0.015	0.015	0.015	0.056	---
2075	0.030	0.046	0.028	0.031	0.025	0.011	0.009	0.012	0.016	0.016	0.016	0.046	---
2125	0.027	0.040	0.030	0.029	0.038	0.018	0.011	0.013	0.014	0.014	0.015	0.040	---
2175	0.030	0.048	0.033	0.050	0.035	0.021	0.013	0.016	0.018	0.016	0.021	0.050	---
2225	0.021	0.039	0.039	0.038	0.025	0.021	0.009	0.009	0.015	0.017	0.017	0.039	---
2275	0.020	0.043	0.043	0.032	0.026	0.015	0.008	0.010	0.011	0.010	0.012	0.043	---
2325	0.027	0.049	0.034	0.029	0.026	0.017	0.009	0.011	0.013	0.015	0.014	0.049	---
2375	0.026	0.036	0.029	0.029	0.028	0.011	0.009	0.010	0.014	0.015	0.015	0.036	---
2425	0.025	0.041	0.036	0.031	0.036	0.009	0.007	0.010	0.013	0.012	0.015	0.041	---
2475	0.027	0.043	0.023	0.029	0.023	0.016	0.008	0.010	0.014	0.014	0.017	0.043	---
2525	0.021	0.032	0.036	0.029	0.021	0.016	0.007	0.008	0.010	0.010	0.010	0.036	---
2575	0.017	0.037	0.030	0.030	0.031	0.018	0.007	0.007	0.010	0.009	0.010	0.037	---
2625	0.022	0.041	0.032	0.030	0.028	0.021	0.008	0.009	0.012	0.013	0.014	0.041	---
2675	0.020	0.037	0.034	0.031	0.027	0.011	0.008	0.008	0.013	0.014	0.016	0.037	---
2725	0.020	0.032	0.032	0.031	0.027	0.010	0.008	0.010	0.012	0.013	0.015	0.032	---
2775	0.025	0.034	0.026	0.027	0.026	0.013	0.008	0.010	0.012	0.014	0.016	0.034	---
2825	0.018	0.030	0.030	0.030	0.027	0.013	0.007	0.008	0.009	0.009	0.010	0.030	---
2875	0.015	0.032	0.021	0.024	0.026	0.016	0.006	0.007	0.009	0.009	0.010	0.032	---
2925	0.018	0.037	0.027	0.031	0.026	0.018	0.007	0.008	0.012	0.012	0.015	0.037	---
2975	0.017	0.037	0.026	0.027	0.024	0.011	0.008	0.008	0.013	0.019	0.020	0.037	---
3025	0.018	0.029	0.022	0.027	0.021	0.012	0.010	0.011	0.012	0.015	0.016	0.029	---
3075	0.020	0.025	0.024	0.021	0.029	0.014	0.008	0.010	0.012	0.014	0.016	0.029	---
3125	0.015	0.025	0.031	0.027	0.022	0.013	0.006	0.007	0.008	0.009	0.010	0.031	---
3175	0.014	0.032	0.024	0.027	0.019	0.011	0.006	0.007	0.008	0.008	0.009	0.032	---
3225	0.017	0.028	0.027	0.036	0.024	0.018	0.007	0.009	0.011	0.012	0.014	0.036	---
3275	0.016	0.024	0.028	0.025	0.028	0.011	0.007	0.008	0.013	0.013	0.016	0.028	---
3325	0.015	0.030	0.029	0.024	0.025	0.015	0.010	0.011	0.014	0.014	0.014	0.030	---
3375	0.017	0.021	0.021	0.023	0.027	0.023	0.010	0.012	0.015	0.014	0.016	0.027	---
3425	0.013	0.019	0.022	0.025	0.022	0.026	0.009	0.011	0.011	0.011	0.011	0.026	---

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
3475	0.013	0.029	0.028	0.028	0.026	0.018	0.010	0.011	0.012	0.010	0.010	0.029	---
3525	0.017	0.020	0.022	0.022	0.023	0.020	0.011	0.015	0.017	0.016	0.017	0.023	---
3575	0.015	0.020	0.020	0.017	0.023	0.014	0.011	0.015	0.019	0.016	0.017	0.023	---
3625	0.014	0.024	0.018	0.020	0.021	0.013	0.009	0.014	0.019	0.023	0.026	0.026	---
3675	0.015	0.020	0.017	0.020	0.022	0.020	0.009	0.014	0.020	0.023	0.030	0.030	---
3725	0.013	0.019	0.019	0.020	0.020	0.017	0.008	0.013	0.018	0.018	0.019	0.020	---
3775	0.013	0.023	0.025	0.021	0.020	0.014	0.008	0.011	0.018	0.016	0.017	0.025	---
3825	0.016	0.018	0.021	0.019	0.018	0.016	0.008	0.011	0.018	0.024	0.028	0.028	---
3875	0.014	0.025	0.021	0.017	0.021	0.012	0.008	0.010	0.017	0.024	0.028	0.028	---
3925	0.013	0.018	0.018	0.017	0.017	0.010	0.007	0.009	0.014	0.015	0.023	0.023	---
3975	0.014	0.019	0.020	0.021	0.023	0.015	0.007	0.009	0.013	0.014	0.021	0.023	---
4025	0.013	0.022	0.018	0.018	0.020	0.013	0.007	0.009	0.011	0.011	0.017	0.022	---
4075	0.013	0.021	0.020	0.017	0.018	0.014	0.007	0.008	0.011	0.010	0.015	0.021	---
4125	0.015	0.018	0.020	0.020	0.018	0.017	0.007	0.008	0.012	0.011	0.015	0.020	---
4175	0.013	0.024	0.020	0.016	0.018	0.012	0.007	0.008	0.011	0.010	0.013	0.024	---
4225	0.013	0.018	0.018	0.016	0.016	0.011	0.008	0.009	0.011	0.009	0.010	0.018	---
4275	0.014	0.017	0.019	0.020	0.021	0.015	0.007	0.009	0.011	0.010	0.010	0.021	---
4325	0.012	0.019	0.016	0.017	0.019	0.013	0.007	0.008	0.010	0.009	0.009	0.019	---
4375	0.013	0.021	0.022	0.020	0.018	0.013	0.006	0.008	0.011	0.008	0.009	0.022	---
4425	0.014	0.017	0.017	0.019	0.018	0.015	0.007	0.008	0.011	0.010	0.009	0.019	---
4475	0.013	0.018	0.017	0.016	0.015	0.011	0.007	0.008	0.011	0.009	0.009	0.018	---
4525	0.012	0.018	0.019	0.017	0.018	0.012	0.007	0.008	0.011	0.009	0.009	0.019	---
4575	0.014	0.016	0.017	0.017	0.019	0.015	0.007	0.008	0.010	0.009	0.009	0.019	---
4625	0.012	0.017	0.015	0.016	0.017	0.013	0.007	0.008	0.009	0.008	0.008	0.017	---
4675	0.013	0.019	0.023	0.023	0.018	0.014	0.009	0.010	0.013	0.008	0.009	0.023	---
4725	0.013	0.016	0.018	0.018	0.018	0.014	0.008	0.009	0.012	0.009	0.008	0.018	---
4775	0.013	0.017	0.016	0.015	0.015	0.011	0.007	0.008	0.010	0.009	0.008	0.017	---
4825	0.012	0.017	0.017	0.016	0.017	0.011	0.007	0.008	0.010	0.009	0.009	0.017	---
4875	0.013	0.015	0.017	0.017	0.018	0.014	0.007	0.008	0.010	0.009	0.008	0.018	---
4925	0.011	0.016	0.017	0.017	0.016	0.012	0.006	0.007	0.009	0.007	0.008	0.017	---
4975	0.011	0.017	0.020	0.021	0.017	0.013	0.007	0.007	0.011	0.007	0.007	0.021	---

Voltage Harmonics													
Harmonics													
P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
Order	V_h [%V_n]												
2	0.012	0.016	0.026	0.025	0.021	0.021	0.019	0.015	0.013	0.029	0.015	0.029	1.600
3	0.048	0.028	0.079	0.133	0.167	0.189	0.204	0.216	0.224	0.231	0.239	0.239	4.000
4	0.017	0.009	0.014	0.022	0.024	0.024	0.023	0.021	0.021	0.031	0.016	0.031	1.000
5	0.076	0.027	0.021	0.076	0.116	0.147	0.173	0.196	0.205	0.216	0.224	0.224	4.000
6	0.016	0.012	0.005	0.009	0.016	0.019	0.020	0.020	0.020	0.021	0.018	0.021	0.500
7	0.068	0.031	0.012	0.031	0.065	0.092	0.107	0.118	0.132	0.141	0.142	0.142	4.000
8	0.027	0.012	0.016	0.008	0.008	0.011	0.013	0.014	0.016	0.029	0.016	0.029	0.400
9	0.043	0.017	0.009	0.012	0.026	0.046	0.065	0.081	0.095	0.103	0.113	0.113	1.200
10	0.026	0.015	0.015	0.010	0.004	0.006	0.010	0.012	0.014	0.027	0.016	0.027	0.400
11	0.104	0.027	0.011	0.020	0.016	0.011	0.027	0.047	0.063	0.081	0.111	0.111	3.000
12	0.019	0.013	0.011	0.012	0.008	0.004	0.005	0.007	0.011	0.015	0.013	0.019	0.200
13	0.099	0.032	0.022	0.039	0.040	0.030	0.022	0.027	0.028	0.036	0.052	0.099	2.500
14	0.028	0.011	0.014	0.013	0.011	0.006	0.004	0.004	0.008	0.024	0.010	0.028	0.200
15	0.028	0.015	0.017	0.024	0.031	0.031	0.027	0.020	0.010	0.025	0.026	0.031	0.500
16	0.027	0.008	0.010	0.008	0.008	0.005	0.003	0.004	0.008	0.022	0.011	0.027	0.200
17	0.077	0.020	0.015	0.014	0.027	0.037	0.043	0.046	0.028	0.021	0.031	0.077	1.600
18	0.021	0.006	0.008	0.009	0.008	0.008	0.007	0.004	0.006	0.012	0.007	0.021	0.200
19	0.089	0.025	0.016	0.020	0.032	0.039	0.034	0.033	0.031	0.030	0.022	0.089	1.500
20	0.027	0.010	0.009	0.007	0.008	0.007	0.006	0.005	0.007	0.021	0.009	0.027	0.200
21	0.017	0.014	0.014	0.019	0.024	0.030	0.030	0.028	0.026	0.024	0.020	0.030	0.200
22	0.034	0.007	0.007	0.006	0.006	0.005	0.005	0.005	0.007	0.017	0.006	0.034	0.200
23	0.074	0.050	0.017	0.014	0.022	0.048	0.061	0.060	0.049	0.060	0.075	0.075	1.200
24	0.021	0.010	0.010	0.010	0.006	0.008	0.009	0.007	0.008	0.013	0.007	0.021	0.200
25	0.068	0.055	0.017	0.008	0.020	0.019	0.012	0.012	0.020	0.022	0.030	0.068	1.000
26	0.035	0.008	0.008	0.007	0.007	0.006	0.007	0.008	0.009	0.019	0.014	0.035	0.200
27	0.014	0.026	0.018	0.017	0.025	0.025	0.027	0.028	0.028	0.028	0.027	0.028	0.200
28	0.022	0.008	0.007	0.007	0.006	0.007	0.005	0.004	0.007	0.015	0.006	0.022	0.200
29	0.052	0.034	0.027	0.015	0.024	0.037	0.043	0.036	0.043	0.058	0.056	0.058	0.862
30	0.017	0.008	0.011	0.011	0.005	0.006	0.006	0.006	0.008	0.013	0.007	0.017	0.200
31	0.044	0.028	0.022	0.016	0.026	0.020	0.026	0.030	0.028	0.023	0.023	0.044	0.806
32	0.031	0.006	0.008	0.008	0.005	0.005	0.005	0.007	0.009	0.016	0.009	0.031	0.200
33	0.021	0.021	0.019	0.020	0.021	0.019	0.024	0.026	0.029	0.026	0.021	0.029	0.200
34	0.023	0.006	0.010	0.008	0.005	0.004	0.003	0.005	0.010	0.014	0.009	0.023	0.200
35	0.041	0.035	0.009	0.008	0.017	0.015	0.020	0.025	0.032	0.031	0.017	0.041	0.714
36	0.015	0.008	0.010	0.009	0.004	0.005	0.006	0.007	0.009	0.014	0.007	0.015	0.200
37	0.037	0.039	0.013	0.014	0.014	0.031	0.039	0.035	0.028	0.035	0.039	0.039	0.676
38	0.020	0.007	0.007	0.008	0.005	0.007	0.006	0.006	0.009	0.015	0.010	0.020	0.200
39	0.015	0.014	0.012	0.012	0.016	0.018	0.019	0.018	0.019	0.017	0.016	0.019	0.200
40	0.020	0.008	0.011	0.008	0.005	0.005	0.005	0.006	0.009	0.013	0.009	0.020	0.200
41	0.030	0.021	0.018	0.012	0.015	0.027	0.038	0.045	0.040	0.033	0.027	0.045	0.610
42	0.013	0.008	0.026	0.009	0.016	0.014	0.006	0.006	0.011	0.015	0.008	0.026	0.200
43	0.025	0.020	0.022	0.021	0.017	0.025	0.034	0.028	0.020	0.028	0.026	0.034	0.581
44	0.018	0.012	0.011	0.007	0.006	0.006	0.005	0.006	0.025	0.027	0.021	0.027	0.200
45	0.011	0.019	0.016	0.008	0.011	0.015	0.018	0.019	0.017	0.014	0.015	0.019	0.200
46	0.021	0.008	0.009	0.007	0.004	0.004	0.004	0.004	0.010	0.013	0.011	0.021	0.200
47	0.027	0.023	0.012	0.011	0.012	0.029	0.041	0.042	0.037	0.036	0.035	0.042	0.532
48	0.015	0.009	0.006	0.009	0.006	0.005	0.005	0.006	0.009	0.022	0.009	0.022	0.200

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
49	0.028	0.023	0.018	0.019	0.022	0.018	0.012	0.015	0.019	0.022	0.026	0.028	0.510
50	0.020	0.008	0.010	0.008	0.006	0.006	0.005	0.005	0.008	0.018	0.007	0.020	0.200
51	0.011	0.022	0.015	0.010	0.011	0.014	0.016	0.013	0.013	0.011	0.009	0.022	0.200
52	0.019	0.008	0.007	0.008	0.007	0.008	0.007	0.004	0.007	0.013	0.007	0.019	0.200
53	0.029	0.022	0.010	0.013	0.018	0.025	0.031	0.030	0.029	0.036	0.041	0.041	0.472
54	0.016	0.011	0.006	0.011	0.013	0.011	0.007	0.005	0.009	0.027	0.009	0.027	0.200
55	0.028	0.026	0.010	0.014	0.016	0.014	0.016	0.021	0.021	0.025	0.033	0.033	0.455
56	0.019	0.011	0.009	0.013	0.011	0.009	0.007	0.005	0.008	0.021	0.007	0.021	0.200
57	0.013	0.017	0.014	0.014	0.014	0.013	0.013	0.012	0.011	0.012	0.010	0.017	0.200
58	0.018	0.008	0.009	0.009	0.006	0.004	0.004	0.004	0.007	0.014	0.008	0.018	0.200
59	0.038	0.041	0.034	0.036	0.040	0.046	0.045	0.042	0.045	0.057	0.062	0.062	0.424
60	0.018	0.016	0.016	0.015	0.014	0.013	0.014	0.013	0.021	0.102	0.094	0.102	0.200
61	0.019	0.014	0.010	0.009	0.017	0.022	0.031	0.021	0.015	0.024	0.031	0.031	0.410
62	0.016	0.012	0.007	0.009	0.005	0.005	0.004	0.004	0.007	0.026	0.009	0.026	0.200
63	0.014	0.014	0.014	0.009	0.008	0.008	0.009	0.009	0.011	0.012	0.012	0.014	0.200
64	0.012	0.013	0.009	0.007	0.005	0.005	0.004	0.004	0.007	0.016	0.008	0.016	0.200
65	0.021	0.016	0.013	0.008	0.011	0.013	0.011	0.013	0.019	0.017	0.016	0.021	0.385
66	0.014	0.011	0.007	0.009	0.006	0.004	0.005	0.005	0.008	0.032	0.010	0.032	0.200
67	0.020	0.010	0.010	0.008	0.011	0.017	0.025	0.020	0.016	0.018	0.027	0.027	0.373
68	0.013	0.007	0.007	0.009	0.006	0.006	0.006	0.005	0.008	0.028	0.007	0.028	0.200
69	0.013	0.015	0.010	0.008	0.012	0.008	0.009	0.009	0.012	0.012	0.013	0.015	0.200
70	0.013	0.007	0.008	0.007	0.005	0.004	0.004	0.005	0.009	0.014	0.007	0.014	0.200
71	0.014	0.010	0.009	0.007	0.010	0.011	0.025	0.024	0.021	0.018	0.024	0.025	0.352
72	0.010	0.007	0.007	0.008	0.004	0.004	0.004	0.006	0.009	0.016	0.008	0.016	0.200
73	0.013	0.013	0.011	0.007	0.010	0.021	0.023	0.019	0.028	0.050	0.045	0.050	0.342
74	0.013	0.007	0.007	0.006	0.005	0.004	0.004	0.004	0.009	0.029	0.009	0.029	0.200
75	0.019	0.014	0.009	0.006	0.009	0.007	0.008	0.009	0.013	0.017	0.015	0.019	0.200
76	0.012	0.007	0.007	0.006	0.004	0.003	0.004	0.005	0.010	0.013	0.010	0.013	0.200
77	0.022	0.010	0.009	0.006	0.007	0.015	0.027	0.032	0.034	0.055	0.048	0.055	0.325
78	0.013	0.008	0.006	0.008	0.005	0.004	0.004	0.005	0.008	0.011	0.009	0.013	0.200
79	0.021	0.010	0.008	0.006	0.008	0.012	0.009	0.012	0.019	0.026	0.045	0.045	0.316
80	0.011	0.008	0.007	0.006	0.005	0.004	0.004	0.004	0.008	0.026	0.010	0.026	0.200
81	0.010	0.010	0.007	0.006	0.007	0.007	0.007	0.007	0.010	0.014	0.024	0.024	0.200
82	0.011	0.007	0.006	0.005	0.004	0.004	0.004	0.004	0.008	0.010	0.010	0.011	0.200
83	0.016	0.010	0.008	0.008	0.008	0.017	0.022	0.019	0.024	0.033	0.057	0.057	0.301
84	0.008	0.007	0.006	0.008	0.006	0.004	0.005	0.005	0.008	0.012	0.007	0.012	0.200
85	0.010	0.010	0.007	0.007	0.009	0.009	0.016	0.020	0.019	0.018	0.016	0.020	0.294
86	0.012	0.007	0.006	0.006	0.005	0.004	0.004	0.005	0.007	0.023	0.008	0.023	0.200
87	0.008	0.008	0.007	0.006	0.006	0.006	0.007	0.008	0.009	0.011	0.013	0.013	0.200
88	0.011	0.006	0.007	0.006	0.005	0.004	0.004	0.005	0.010	0.009	0.009	0.011	0.200
89	0.014	0.012	0.010	0.008	0.008	0.015	0.014	0.013	0.021	0.024	0.033	0.033	0.281
90	0.009	0.007	0.006	0.007	0.005	0.005	0.005	0.005	0.009	0.015	0.009	0.015	0.200
91	0.013	0.011	0.006	0.008	0.011	0.014	0.024	0.022	0.020	0.021	0.012	0.024	0.275
92	0.012	0.007	0.007	0.006	0.005	0.005	0.005	0.006	0.009	0.018	0.007	0.018	0.200
93	0.008	0.008	0.007	0.007	0.007	0.007	0.007	0.008	0.010	0.011	0.010	0.011	0.200
94	0.014	0.012	0.013	0.012	0.012	0.011	0.011	0.011	0.016	0.010	0.010	0.016	0.200
95	0.012	0.012	0.009	0.008	0.008	0.012	0.012	0.015	0.019	0.020	0.022	0.022	0.263
96	0.008	0.008	0.007	0.007	0.005	0.005	0.005	0.005	0.008	0.015	0.009	0.015	0.200
97	0.011	0.013	0.007	0.008	0.011	0.020	0.026	0.020	0.021	0.024	0.027	0.027	0.258
98	0.010	0.008	0.008	0.007	0.005	0.005	0.005	0.005	0.009	0.014	0.008	0.014	0.200

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
99	0.007	0.009	0.007	0.007	0.008	0.007	0.008	0.009	0.011	0.012	0.010	0.012	0.200
100	0.009	0.007	0.008	0.006	0.006	0.005	0.005	0.005	0.014	0.010	0.009	0.014	0.200
THD_V [%V_n]	0.311	0.175	0.147	0.197	0.254	0.306	0.348	0.374	0.395	0.451	0.460	0.460	5.000

Interharmonics

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
f [Hz]	V_h [%V_n]												
75	0.020	0.020	0.021	0.021	0.021	0.021	0.026	0.020	0.022	0.023	0.021	0.026	0.360
125	0.008	0.009	0.012	0.014	0.013	0.007	0.009	0.007	0.010	0.010	0.009	0.014	0.360
175	0.009	0.015	0.012	0.012	0.008	0.006	0.006	0.006	0.009	0.009	0.007	0.015	0.360
225	0.026	0.027	0.022	0.020	0.020	0.006	0.005	0.004	0.008	0.009	0.006	0.027	0.360
275	0.028	0.011	0.015	0.013	0.016	0.005	0.005	0.005	0.009	0.010	0.008	0.028	0.360
325	0.030	0.011	0.016	0.013	0.012	0.004	0.004	0.004	0.008	0.009	0.006	0.030	0.360
375	0.029	0.014	0.015	0.020	0.025	0.007	0.005	0.005	0.008	0.010	0.006	0.029	0.360
425	0.015	0.033	0.044	0.044	0.051	0.009	0.005	0.005	0.008	0.008	0.007	0.051	0.360
475	0.015	0.024	0.016	0.012	0.010	0.005	0.005	0.005	0.009	0.009	0.007	0.024	0.360
525	0.041	0.023	0.010	0.017	0.013	0.006	0.005	0.004	0.008	0.009	0.008	0.041	0.360
575	0.041	0.013	0.021	0.018	0.021	0.005	0.005	0.005	0.008	0.009	0.008	0.041	0.360
625	0.044	0.016	0.010	0.012	0.011	0.005	0.005	0.005	0.008	0.008	0.005	0.044	0.360
675	0.040	0.046	0.033	0.028	0.028	0.008	0.005	0.005	0.008	0.010	0.007	0.046	0.360
725	0.019	0.047	0.038	0.047	0.048	0.009	0.004	0.004	0.008	0.008	0.006	0.048	0.360
775	0.016	0.014	0.023	0.025	0.024	0.006	0.004	0.004	0.008	0.008	0.005	0.025	0.360
825	0.036	0.026	0.026	0.022	0.022	0.007	0.005	0.005	0.008	0.008	0.006	0.036	0.360
875	0.034	0.021	0.019	0.020	0.020	0.005	0.005	0.005	0.008	0.008	0.007	0.034	0.360
925	0.039	0.022	0.022	0.018	0.015	0.005	0.006	0.005	0.008	0.008	0.006	0.039	0.360
975	0.036	0.034	0.030	0.030	0.023	0.006	0.005	0.006	0.009	0.010	0.007	0.036	0.360
1025	0.016	0.029	0.021	0.022	0.026	0.007	0.004	0.004	0.008	0.008	0.005	0.029	0.360
1075	0.014	0.017	0.020	0.019	0.021	0.008	0.004	0.004	0.008	0.008	0.005	0.021	0.360
1125	0.024	0.023	0.020	0.027	0.024	0.008	0.005	0.005	0.008	0.008	0.006	0.027	0.360
1175	0.025	0.020	0.015	0.016	0.016	0.005	0.005	0.005	0.008	0.007	0.006	0.025	0.360
1225	0.026	0.022	0.024	0.021	0.019	0.004	0.004	0.004	0.008	0.008	0.006	0.026	0.360
1275	0.025	0.026	0.022	0.019	0.017	0.006	0.004	0.005	0.009	0.010	0.007	0.026	0.360
1325	0.014	0.015	0.011	0.011	0.011	0.005	0.004	0.004	0.007	0.008	0.007	0.015	0.360
1375	0.011	0.011	0.013	0.012	0.009	0.007	0.004	0.004	0.008	0.008	0.005	0.013	0.360
1425	0.019	0.017	0.018	0.018	0.017	0.008	0.004	0.004	0.008	0.007	0.006	0.019	0.360
1475	0.019	0.018	0.013	0.013	0.012	0.004	0.004	0.004	0.008	0.008	0.007	0.019	0.360
1525	0.019	0.014	0.013	0.013	0.013	0.005	0.004	0.004	0.008	0.008	0.005	0.019	0.360
1575	0.019	0.019	0.014	0.013	0.013	0.006	0.004	0.005	0.009	0.008	0.006	0.019	0.360
1625	0.012	0.013	0.013	0.014	0.014	0.006	0.003	0.004	0.008	0.007	0.005	0.014	0.360
1675	0.011	0.009	0.011	0.014	0.009	0.006	0.004	0.004	0.008	0.007	0.005	0.014	0.360
1725	0.015	0.018	0.014	0.014	0.011	0.007	0.004	0.004	0.008	0.007	0.006	0.018	0.360
1775	0.015	0.019	0.013	0.010	0.009	0.004	0.004	0.004	0.008	0.008	0.006	0.019	0.360
1825	0.014	0.010	0.008	0.008	0.008	0.005	0.004	0.004	0.008	0.008	0.005	0.014	0.360
1875	0.016	0.018	0.015	0.016	0.013	0.007	0.004	0.005	0.008	0.008	0.006	0.018	0.360
1925	0.010	0.016	0.015	0.014	0.013	0.007	0.004	0.004	0.008	0.007	0.005	0.016	0.360
1975	0.009	0.013	0.011	0.012	0.008	0.005	0.004	0.004	0.008	0.008	0.006	0.013	0.360
2025	0.013	0.018	0.011	0.009	0.010	0.008	0.005	0.005	0.008	0.008	0.006	0.018	0.360
2075	0.013	0.016	0.010	0.034	0.008	0.006	0.006	0.007	0.009	0.008	0.007	0.034	0.360
2125	0.012	0.014	0.016	0.009	0.028	0.027	0.011	0.012	0.009	0.009	0.007	0.028	0.360

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
2175	0.013	0.020	0.010	0.017	0.011	0.007	0.017	0.019	0.013	0.009	0.013	0.020	0.360
2225	0.010	0.022	0.012	0.012	0.010	0.009	0.005	0.006	0.018	0.020	0.016	0.022	0.360
2275	0.011	0.016	0.014	0.010	0.008	0.005	0.005	0.006	0.009	0.008	0.007	0.016	0.360
2325	0.015	0.018	0.011	0.010	0.009	0.006	0.004	0.004	0.009	0.009	0.008	0.018	0.360
2375	0.016	0.013	0.009	0.010	0.009	0.004	0.004	0.005	0.008	0.009	0.006	0.016	0.360
2425	0.015	0.015	0.012	0.010	0.012	0.004	0.004	0.004	0.009	0.008	0.006	0.015	0.360
2475	0.014	0.015	0.008	0.011	0.009	0.005	0.004	0.004	0.009	0.009	0.007	0.015	0.360
2525	0.010	0.012	0.013	0.010	0.008	0.005	0.004	0.004	0.008	0.008	0.005	0.013	0.220
2575	0.009	0.014	0.011	0.011	0.010	0.006	0.004	0.004	0.008	0.009	0.005	0.014	0.220
2625	0.011	0.016	0.012	0.010	0.010	0.008	0.004	0.004	0.008	0.009	0.006	0.016	0.220
2675	0.010	0.014	0.012	0.011	0.010	0.005	0.004	0.004	0.009	0.011	0.007	0.014	0.220
2725	0.009	0.012	0.012	0.011	0.009	0.004	0.004	0.005	0.008	0.009	0.007	0.012	0.220
2775	0.012	0.013	0.010	0.011	0.010	0.005	0.004	0.005	0.009	0.010	0.008	0.013	0.220
2825	0.009	0.012	0.012	0.012	0.010	0.005	0.004	0.005	0.008	0.009	0.006	0.012	0.220
2875	0.008	0.013	0.008	0.010	0.010	0.007	0.004	0.004	0.008	0.010	0.007	0.013	0.220
2925	0.017	0.021	0.019	0.020	0.019	0.018	0.016	0.018	0.021	0.025	0.027	0.027	0.220
2975	0.011	0.016	0.012	0.013	0.012	0.009	0.009	0.009	0.013	0.037	0.033	0.037	0.220
3025	0.009	0.012	0.009	0.011	0.009	0.007	0.009	0.008	0.010	0.016	0.015	0.016	0.220
3075	0.010	0.011	0.010	0.009	0.011	0.006	0.005	0.005	0.009	0.012	0.009	0.012	0.220
3125	0.008	0.011	0.013	0.011	0.009	0.006	0.004	0.004	0.008	0.011	0.006	0.013	0.220
3175	0.008	0.014	0.010	0.011	0.008	0.006	0.004	0.004	0.008	0.010	0.006	0.014	0.220
3225	0.010	0.012	0.012	0.015	0.009	0.008	0.005	0.005	0.009	0.010	0.008	0.015	0.220
3275	0.009	0.011	0.012	0.011	0.012	0.005	0.004	0.005	0.009	0.014	0.007	0.014	0.220
3325	0.008	0.013	0.012	0.010	0.010	0.007	0.005	0.006	0.009	0.010	0.007	0.013	0.220
3375	0.009	0.009	0.009	0.009	0.011	0.009	0.005	0.006	0.010	0.011	0.008	0.011	0.220
3425	0.008	0.009	0.010	0.011	0.009	0.010	0.005	0.005	0.008	0.012	0.006	0.012	0.220
3475	0.008	0.013	0.012	0.012	0.011	0.008	0.005	0.005	0.009	0.009	0.006	0.013	0.220
3525	0.009	0.009	0.010	0.011	0.010	0.009	0.005	0.007	0.010	0.011	0.008	0.011	0.220
3575	0.009	0.009	0.010	0.008	0.011	0.006	0.005	0.007	0.010	0.010	0.008	0.011	0.220
3625	0.007	0.011	0.009	0.010	0.010	0.006	0.005	0.006	0.010	0.011	0.011	0.011	0.220
3675	0.009	0.009	0.009	0.009	0.011	0.009	0.005	0.006	0.010	0.013	0.013	0.013	0.220
3725	0.008	0.010	0.009	0.010	0.009	0.008	0.004	0.006	0.010	0.013	0.009	0.013	0.220
3775	0.008	0.011	0.013	0.010	0.010	0.007	0.005	0.006	0.009	0.010	0.009	0.013	0.220
3825	0.009	0.009	0.010	0.009	0.009	0.008	0.005	0.006	0.010	0.013	0.012	0.013	0.220
3875	0.009	0.013	0.011	0.008	0.010	0.006	0.005	0.006	0.010	0.012	0.011	0.013	0.220
3925	0.008	0.009	0.010	0.009	0.009	0.006	0.004	0.005	0.009	0.010	0.010	0.010	0.220
3975	0.009	0.010	0.011	0.011	0.012	0.008	0.005	0.006	0.009	0.011	0.010	0.012	0.220
4025	0.008	0.011	0.010	0.009	0.010	0.007	0.004	0.005	0.009	0.012	0.008	0.012	0.220
4075	0.008	0.011	0.011	0.010	0.009	0.008	0.005	0.006	0.009	0.008	0.008	0.011	0.220
4125	0.009	0.010	0.010	0.010	0.009	0.009	0.005	0.005	0.009	0.011	0.008	0.011	0.220
4175	0.008	0.013	0.011	0.009	0.010	0.007	0.006	0.006	0.009	0.008	0.007	0.013	0.220
4225	0.008	0.010	0.010	0.009	0.009	0.006	0.005	0.006	0.009	0.009	0.006	0.010	0.220
4275	0.009	0.009	0.011	0.011	0.012	0.008	0.006	0.006	0.010	0.011	0.007	0.012	0.220
4325	0.008	0.011	0.009	0.010	0.010	0.007	0.005	0.006	0.009	0.011	0.006	0.011	0.220
4375	0.008	0.012	0.012	0.011	0.010	0.008	0.005	0.005	0.009	0.008	0.006	0.012	0.220
4425	0.009	0.010	0.010	0.010	0.010	0.008	0.005	0.006	0.010	0.010	0.007	0.010	0.220
4475	0.009	0.011	0.010	0.009	0.009	0.007	0.005	0.006	0.009	0.008	0.006	0.011	0.220
4525	0.008	0.011	0.012	0.010	0.010	0.007	0.005	0.005	0.009	0.009	0.007	0.012	0.220
4575	0.009	0.009	0.010	0.010	0.011	0.008	0.005	0.006	0.009	0.010	0.007	0.011	0.220
4625	0.008	0.010	0.009	0.010	0.010	0.007	0.005	0.005	0.009	0.010	0.005	0.010	0.220

P [%P_{max}]	0 - 5	10	20	30	40	50	60	70	80	90	100	Max.	**Limit**
4675	0.008	0.012	0.013	0.013	0.010	0.008	0.006	0.006	0.010	0.009	0.006	0.013	0.220
4725	0.009	0.010	0.011	0.011	0.010	0.008	0.005	0.006	0.009	0.010	0.006	0.011	0.220
4775	0.009	0.011	0.010	0.009	0.009	0.007	0.005	0.006	0.009	0.009	0.006	0.011	0.220
4825	0.008	0.011	0.011	0.010	0.010	0.007	0.005	0.006	0.009	0.010	0.009	0.011	0.220
4875	0.009	0.009	0.010	0.011	0.011	0.008	0.005	0.006	0.009	0.010	0.007	0.011	0.220
4925	0.008	0.010	0.011	0.011	0.010	0.007	0.005	0.005	0.009	0.009	0.006	0.011	0.220
4975	0.008	0.011	0.013	0.014	0.010	0.008	0.005	0.006	0.009	0.009	0.007	0.014	0.220

6.3 Power Quality – Voltage fluctuations and Flicker

Note:

Registered Capacity of the Power Park Modules (Generating Units) considered in this report > 50kW, comparison of the test results with the limit values according to BS EN 610000-3-11 for reference only.

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC P28.

The standard test impedance is 0.4 Ω for a single-phase **Power Generating Module** (and for a two-phase unit in a three-phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two-phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d_{max} normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X 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 duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date	2022-12-22	Test end date	2023-02-16
Test location	Guangdong HuaChuang Technology Service Co., Ltd. (see *Testing location* on p.2)		

		Starting			Stopping			Running	
	Phase no.	d_{max} [%]	d_c [%]	d(t) [ms]	d_{max} [%]	d_c [%]	d(t) [ms]	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	L1	0.662	0.353	0.000	0.482	0.359	0.000	0.045	0.043
	L2	0.592	0.350	0.000	0.416	0.328	0.000	0.116	0.110
	L3	0.107	0.020	0.000	0.110	0.019	0.000	0.182	0.172
	Overall worst case	0.662	0.353	0.000	0.482	0.359	0.000	0.182	0.172
Normalised to standard impedance	L1	0.662	0.353	0.000	0.482	0.359	0.000	0.045	0.043
	L2	0.592	0.350	0.000	0.416	0.328	0.000	0.116	0.110
	L3	0.107	0.020	0.000	0.110	0.019	0.000	0.182	0.172
	Overall worst case	0.662	0.353	0.000	0.482	0.359	0.000	0.182	0.172

Normalised to required maximum impedance	L1	--	--	--	--	--	--	--	--
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	--	--	--	--	--	--	--	--
Limits set under BS EN 61000-3-11		4	3.3	500 (3.3%)	4	3.3	500 (3.3%)	1.0	0.65

Test Impedance	R:	0.24	X:	0.15
Standard Impedance	R:	☒ 0.24 * ☐ 0.4 ^	X:	☒ 0.15 * ☐ 0.25 ^
Maximum Impedance	R:	--	X:	--

*	☒ three-phase **Power Generating Module**s	☐	split single phase **Power Generating Module**s
^	☐ single phase **Power Generating Module**	☐	**Power Generating Module**s using two phases on a three-phase system

Power Generating Module tested to IEC 61000-4-30, IEC 61400-21 and IEC 61000-4-15 for EREC P28 assessment			
Test location:	(Tests performed in laboratory environment) Guangdong HuaChuang Technology Service Co., Ltd. (see *Testing location* on p.2)		
Test start date:	2023-01-12	Test end date:	2023-02-01
Test setup:	See *Figure 3*		
Background flicker:	Stable AC source (see *4.7 Measurement equipment*) used for testing. Background flicker can be ignored.		
Instruments:	Power quality analyzer used for testing met IEC 61000-4-30 Class A (see *4.7 Measurement equipment*)		
Testing method:	According to IEC 61400-21		
Evaluation method:	Using flickermeter in accordance with IEC 61000-4-15		
Results:	The stated results in the following results table are maximum values over all 3 phases and all datasets. Measurement results of all 3 phases are available at the laboratory for reference.		

Flicker measurements				
Test conditions:				
Reactive power setpoint:		Q = 0		
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:		20		
Grid impedance angle, ψ_k	30°	50°	70°	85°
Power level [%P_{max}]	Flicker coefficient, c(ψ_k, P)			
0 - 5	0.46	0.43	0.39	0.35
10	0.27	0.26	0.25	0.24
20	0.28	0.26	0.25	0.25
30	0.27	0.27	0.26	0.26

40	0.26	0.26	0.26	0.26
50	0.25	0.24	0.23	0.23
60	0.25	0.24	0.24	0.23
70	0.29	0.26	0.25	0.24
80	0.25	0.24	0.23	0.23
90	0.25	0.24	0.23	0.23
100	0.43	0.37	0.29	0.24
Max. Flicker coefficient, $c(\psi_k, P)$	0.46	0.43	0.39	0.35
Max. Short-term flicker, P_{st}	0.02	0.02	0.02	0.02

Test conditions:				
Reactive power setpoint:		PF = 0.95 (lagging)		
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:		20		
Grid impedance angle, ψ_k	30°	50°	70°	85°
Power level [%P_{max}]	Flicker coefficient, $c(\psi_k, P)$			
0 - 5	0.55	0.66	0.73	0.77
10	0.39	0.52	0.62	0.65
20	0.51	0.71	0.85	0.91
30	0.69	0.99	1.19	1.27
40	0.86	1.28	1.58	1.69
50	1.04	1.57	1.93	2.07
60	1.27	1.88	2.31	2.48
70	1.42	2.14	2.64	2.86
80	1.57	2.40	3.00	3.25
90	1.79	2.71	3.37	3.64
100	1.87	2.85	3.56	3.85
Max. Flicker coefficient, $c(\psi_k, P)$	1.87	2.85	3.56	3.85
Max. Short-term flicker, P_{st}	0.09	0.14	0.18	0.19

Test conditions:				
Reactive power setpoint:		PF = 0.95 (leading)		
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:		20		
Grid impedance angle, ψ_k	30°	50°	70°	85°
Power level [%P_{max}]	Flicker coefficient, $c(\psi_k, P)$			
0 - 5	0.52	0.66	0.75	0.77
10	0.40	0.51	0.59	0.62
20	0.53	0.72	0.86	0.91
30	0.71	1.01	1.22	1.30
40	0.85	1.28	1.58	1.70
50	1.05	1.59	1.97	2.12
60	1.22	1.87	2.33	2.51

70	1.41	2.17	2.72	2.93
80	1.68	2.51	3.12	3.35
90	1.81	2.76	3.47	3.76
100	1.83	2.84	3.58	3.88
Max. Flicker coefficient, $c(\psi_k, P)$	1.83	2.84	3.58	3.88
Max. Short-term flicker, P_{st}	0.09	0.14	0.18	0.19

RVC measurements				
Test conditions:				
Reactive power setpoint:	Q = 0			
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:	20			
Case of switching operation	Switch-on at $P_{available}$ < 10%P_{max}			
Max. no of switching operations, N_{10}	20			
Max. number of switching operations, N_{120}	240			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.02	0.02	0.02	0.02
Voltage change factor, $k_u(\psi_k)$	0.16	0.12	0.11	0.09
Maximum inrush current factor k_{imax}	0.026			
Case of switching operation	Switch-on at $P_{available}$ = 100%P_{max}			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.04	0.03	0.02	0.02
Voltage change factor, $k_u(\psi_k)$	0.95	0.72	0.46	0.19
Maximum inrush current factor k_{imax}	0.027			
Case of switching operation	Switching from 10%P_{max} to 100%P_{max}			
Max. no of switching operations, N_{10}	---			
Max. number of switching operations, N_{120}	---			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.03	0.02	0.02	0.02
Voltage change factor, $k_u(\psi_k)$	0.18	0.14	0.10	0.07
Maximum inrush current factor k_{imax}	0.026			
Case of switching operation	Service shutdown at $P_{available}$ = 100%P_{max}			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.88	0.67	0.38	0.15
Voltage change factor, $k_u(\psi_k)$	0.96	0.73	0.46	0.23
Maximum inrush current factor k_{imax}	0.004			
Test conditions:				

Reactive power setpoint:	PF = 0.95 (lagging)			
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:	20			
Case of switching operation	Switch-on at $P_{available} < 10\%P_{max}$			
Max. no of switching operations, N_{10}	20			
Max. number of switching operations, N_{120}	240			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.03	0.03	0.03	0.02
Voltage change factor, $k_u(\psi_k)$	0.17	0.18	0.14	0.10
Maximum inrush current factor k_{imax}	0.026			
Case of switching operation	Switch-on at $P_{available} = 100\%P_{max}$			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.06	0.09	0.11	0.11
Voltage change factor, $k_u(\psi_k)$	1.05	0.93	0.71	0.50
Maximum inrush current factor k_{imax}	0.032			
Case of switching operation	Switching from $10\%P_{max}$ to $100\%P_{max}$			
Max. no of switching operations, N_{10}	---			
Max. number of switching operations, N_{120}	---			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.20	0.18	0.14	0.12
Voltage change factor, $k_u(\psi_k)$	0.97	0.86	0.68	0.48
Maximum inrush current factor k_{imax}	0.012			
Case of switching operation	Service shutdown at $P_{available} = 100\%P_{max}$			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.97	0.86	0.66	0.45
Voltage change factor, $k_u(\psi_k)$	1.07	0.94	0.73	0.52
Maximum inrush current factor k_{imax}	0.004			

Test conditions:				
Reactive power setpoint:	PF = 0.95 (leading)			
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis:	20			
Case of switching operation	Switch-on at $P_{available} < 10\%P_{max}$			
Max. no of switching operations, N_{10}	20			
Max. number of switching operations, N_{120}	240			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.03	0.02	0.02	0.02
Voltage change factor, $k_u(\psi_k)$	0.14	0.11	0.07	0.08
Maximum inrush current factor k_{imax}	0.026			

Case of switching operation	Switch-on at $P_{available}$ = 100%P_{max}			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.06	0.08	0.10	0.11
Voltage change factor, $k_u(\psi_k)$	0.78	0.50	0.17	0.29
Maximum inrush current factor k_{imax}	0.033			
Case of switching operation	Switching from 10%P_{max} to 100%P_{max}			
Max. no of switching operations, N_{10}	---			
Max. number of switching operations, N_{120}	---			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.17	0.13	0.11	0.11
Voltage change factor, $k_u(\psi_k)$	0.70	0.48	0.17	0.24
Maximum inrush current factor k_{imax}	0.016			
Case of switching operation	Service shutdown at $P_{available}$ = 100%P_{max}			
Max. no of switching operations, N_{10}	1			
Max. number of switching operations, N_{120}	12			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0.68	0.41	0.13	0.22
Voltage change factor, $k_u(\psi_k)$	0.77	0.49	0.18	0.28
Maximum inrush current factor k_{imax}	0.005			

6.4 Power Quality – DC injection

The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / V_{phase} *. The % DC injection should not be greater than 0.25%.

Test power level	10%	55%	100%
Recorded DC value in Amps	0.048	0.074	0.146
as % of rated AC current	0.009	0.014	0.027
Limit [%]	0.25	0.25	0.25

Note:

* Calculation is the same for 1 phase and 3 phase devices:

- Base current = Registered Capacity (W) / 230 (V)

- % DC injection = Recorded DC value (A) / Base current (A) *100

6.5 Power Factor

The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.999	0.999	0.999
Power Factor Limit	>0.95	>0.95	>0.95

Note:

See also "*Note"* on Power Factor on p.8.

6.6 Voltage control capability

Note:

Test not performed. Confirmation of compliance with EREC G99, section 12.5 requires a simulation study in accordance with B.4.2.

The PGM provides different Reactive Power and voltage control modes (see Annex 6). Control mode used and control point need be agreed with the DNO.

6.7 Reactive power capability

Note:

Test not performed. Confirmation of compliance with EREC G99, section 12.5 requires a simulation study in accordance with B.4.2.

The PGM provides different Reactive Power and voltage control modes, e.g.:

- Settable Q-parameter
- Settable cosφ-set-parameter
- Configurable cosφ(P)-characteristic line
- Configurable Q(U) - characteristic line

Control mode used and control point need be agreed with the DNO.

6.8 Protection

The Interface Protection setting information can be displayed in one or more of the following ways:

☐ A display on a screen which can be read

☒ A display on an electronic device which can communicate with the Power Generating Module and confirm that it is the correct device by means of a Identification number / name permanently fixed to the device and visible on the electronic device screen at the same time as the settings

☐ Display of all settings including nominal voltage and current outputs, alongside the identification number / name of the device, permanently fixed to the Power Generating Module

☐ Other (Give a detailed description!)

Note:

The protection device considered in this report is the integrated protection relay / generating unit switch in the Power Generating Modules.

Type integrated interface switch:

Hongfa HF167F-200

(alternative type: Churod CHAR-112A200C or Zettler AZSR1200-1AE-12D).

Manufacturer Data:

The integrated Interface Protection in the Power Generating Modules considered in this report is capable of measuring voltage to an accuracy of ±1.5% of the nominal value and of measuring frequency to ± 0.2% of the nominal value across its operating range of voltage, frequency and temperature (-30°C ~ +60°C).

(See also subsections 6.8.1 ~ 6.8.5 below)

6.8.1 Protection – Frequency tests

These tests should be carried out in accordance with the Annex A.7.1.2.3. For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.46	20.050	47.7 Hz 30 s	No trip occurred
U/F stage 2	47 Hz	0.5 s	46.98	0.537	47.2 Hz 19.5 s	No trip occurred
					46.8 Hz 0.45 s	No trip occurred
O/F	52 Hz	0.5 s	51.98	0.525	51.8 Hz 120.0 s	No trip occurred
					52.2 Hz 0.45 s	No trip occurred

Note:

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.

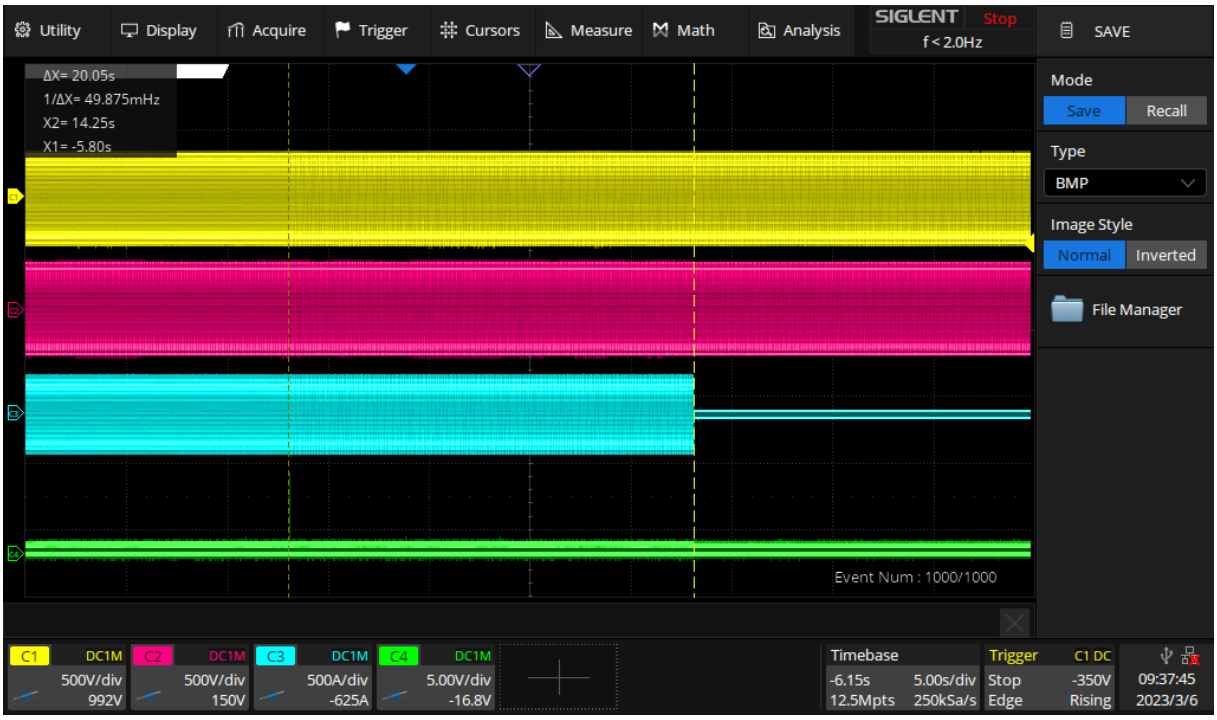


Figure 6 – Test U/F stage 1 (Trip test)

Figure 7 – Test U/F stage 2 (Trip test)

Figure 8 – Test OF (Trip test)

6.8.2 Protection – Voltage tests

These tests should be carried out in accordance with Annex A.7.1.2.2. For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Note that the value of voltage stated below assumes a **LV** connection This should be adjusted for **HV** taking account of the VT ratio as required.

Function		Setting		Trip test		“No trip tests”	
		Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	L1-N	0.8 pu (184 V)	2.5 s	184.16 V	2.535 s	188 V 5.0 s	No trip occurred
	L2-N			183.93 V	2.535 s		No trip occurred
	L3-N			182.25 V	2.535 s		No trip occurred
						180 V 2.45 s	No trip occurred
O/V stage 1	L1-N	1.14 pu (262.2 V)	1.0 s	261.81 V	1.020 s	258.2 V 5.0 s	No trip occurred
	L2-N			263.06 V	1.022 s		No trip occurred
	L3-N			261.90 V	1.028 s		No trip occurred
O/V stage 2	L1-N	1.19 pu (273.7 V)	0.5 s	273.52 V	0.533 s	269.7 V 0.95 s	No trip occurred
	L2-N			273.73 V	0.519 s		No trip occurred
	L3-N			272.54 V	0.517 s		No trip occurred
						277.7 V 0.45 s	No trip occurred

Note:

for voltage tests 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.

Figure 9 – Test U/V (Trip test, L1-N)

Figure 10 – Test U/V (Trip test, L2-N)

Figure 11 – Test U/V (Trip test, L3-N)

Figure 12 – Test O/V stage 1 (Trip test, L1-N)

Figure 13 – Test O/V stage 1 (Trip test, L2-N)

Figure 14 – Test O/V stage 1 (Trip test, L3-N)

Figure 15 – Test O/V stage 2 (Trip test, L1-N)

Figure 16 – Test O/V stage 2 (Trip test, L2-N)

Figure 17 – Test O/V stage 2 (Trip test, L3-N)

6.8.3 Protection – Loss of Mains test

These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
The following sub set of tests should be recorded in the following table.						
Test Power and imbalance	33% -5%Q (Test 22)	66% -5%Q (Test 12)	100% -5%P (Test 5)	33% +5%Q (Test 31)	66% +5%Q (Test 21)	100% +5%P (Test 10)
Trip time [s]	0.201	0.269	0.263	0.187	0.234	0.358
Trip time limit [s]	0.5 [8]					
Note: For full testing according to BS EN 62116 see *Annex 1 - Loss of Mains test according to BS EN 62116*.						

6.8.4 Loss of Mains Protection, Vector Shift Stability test

This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.			
The following sub set of tests should be recorded in the following table.			
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	No trip occurred
Negative Vector Shift	50.5 Hz	- 50 degrees	No trip occurred

[8] If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

Figure 18 – Positive Step Change (+50 degrees)

Figure 19 – Negative Step Change (-50 degrees)

6.8.5 Loss of Mains Protection, RoCoF Stability test

This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.			
The following sub set of tests should be recorded in the following table.			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hz/s	2.1 s	No trip occurred
51.0 Hz to 49.0 Hz	-0.95 Hz/s	2.1 s	No trip occurred

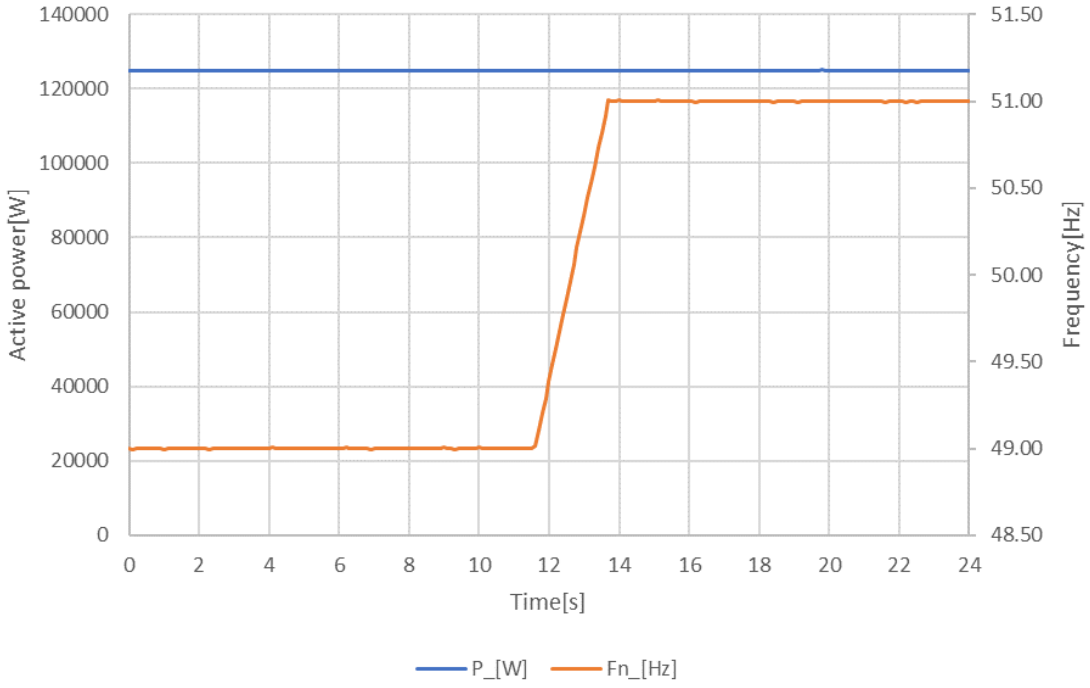


Figure 20 – Positive Frequency Drift (+0.95 Hz/s)

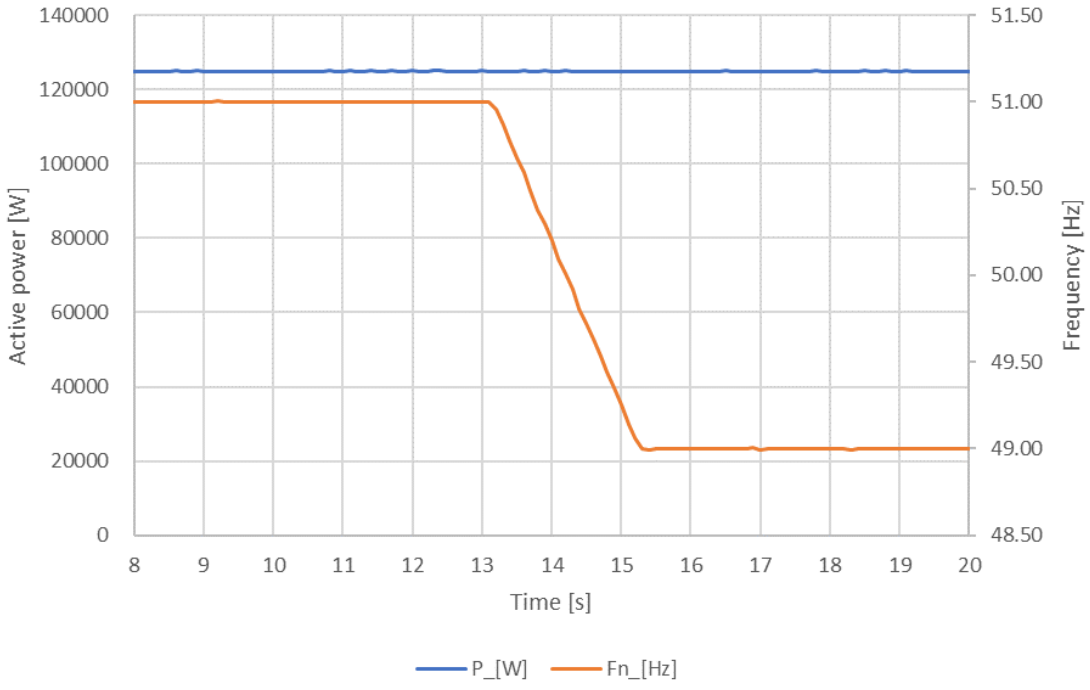


Figure 21 – Negative Frequency Drift (-0.95 Hz/s)

6.8.6 Automatic reconnection

See section 6.11.

6.9 Limited Frequency Sensitive Mode – Overfrequency test

Note:

For PGM type B application, confirmation of compliance with EREC G99, section 12.2.4 requires a simulation study in accordance with B.4.5.

The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. This test should be carried out in accordance with Annex A.7.1.3, which also contains the measurement tolerances.				
Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.				**N** *
Alternatively, test results should be noted below:				
Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	125013	50.00	126500	---
Step b) 50.45Hz ± 0.05Hz	123691	50.45		9.46% 1)
Step c) 50.70Hz ± 0.10Hz	117513	50.70		10.12% 2)
Step d) 51.15Hz ± 0.05Hz	106225	51.15		9.97% 3)
Step e) 50.70Hz ± 0.10Hz	117515	50.70		9.96% 4)
Step f) 50.45Hz ± 0.05Hz	123687	50.45		10.13% 5)
Step g) 50.00Hz ± 0.01Hz	124987	50.00		---
	1st Droop (calculated using frequency and power between steps d) & b))			10.02%
	2nd Droop (calculated using frequency and power between steps f) & d))			10.02%
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	62504	50.00	68750	---
Step b) 50.45Hz ± 0.05Hz	61349	50.45		10.82% 1)
Step c) 50.70Hz ± 0.10Hz	55141	50.70		10.07% 2)
Step d) 51.15Hz ± 0.05Hz	43563	51.15		9.72% 3)
Step e) 50.70Hz ± 0.10Hz	55199	50.70		9.67% 4)

Step f) 50.45Hz ± 0.05Hz	61334	50.45		10.19% [5)]
Step g) 50.00Hz ± 0.01Hz	124961	50.00		---
	1st Droop (calculated using frequency and power between steps d) & b))			9.84%
	2nd Droop (calculated using frequency and power between steps f) & d))			9.85%

Note:

* Test according to Annex A.7.1.3. Frequency/time plots attached (see Figure 22 & Figure 23)

1) Droop calculated using frequency and power between steps b) & threshold frequency of 50.4 Hz

2) Droop calculated using frequency and power between steps c) & b)

3) Droop calculated using frequency and power between steps d) & c)

4) Droop calculated using frequency and power between steps e) & d)

5) Droop calculated using frequency and power between steps f) & e)

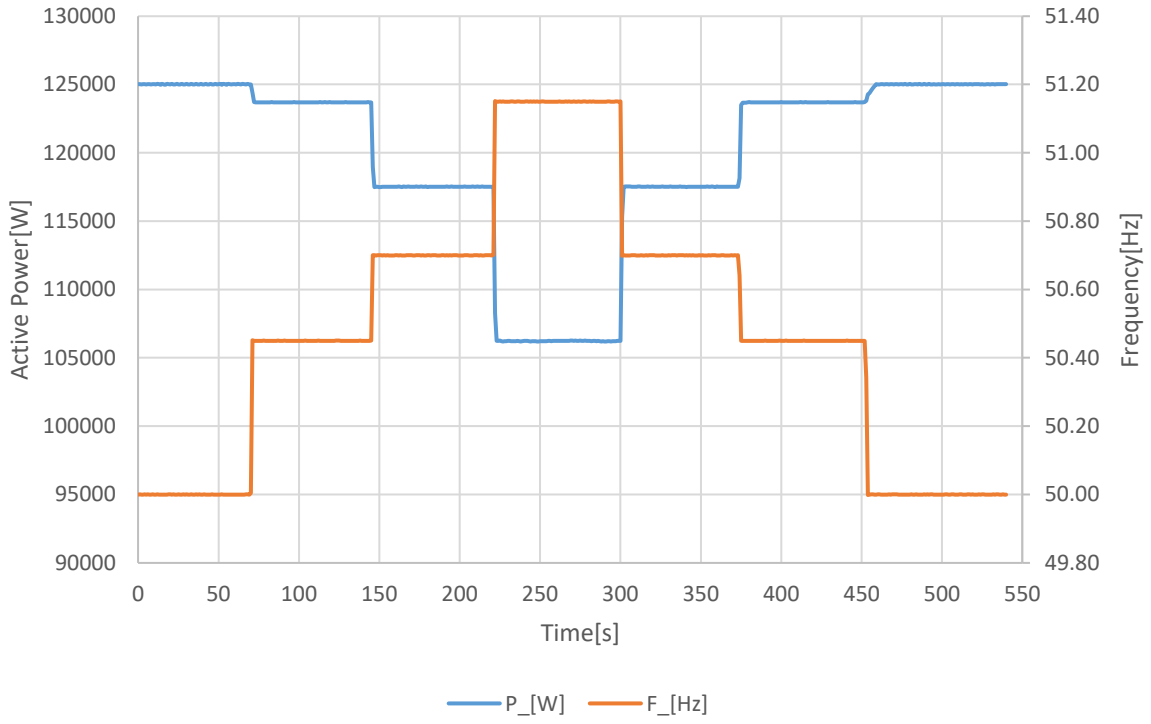


Figure 22 – Test sequence at Registered Capacity >80%

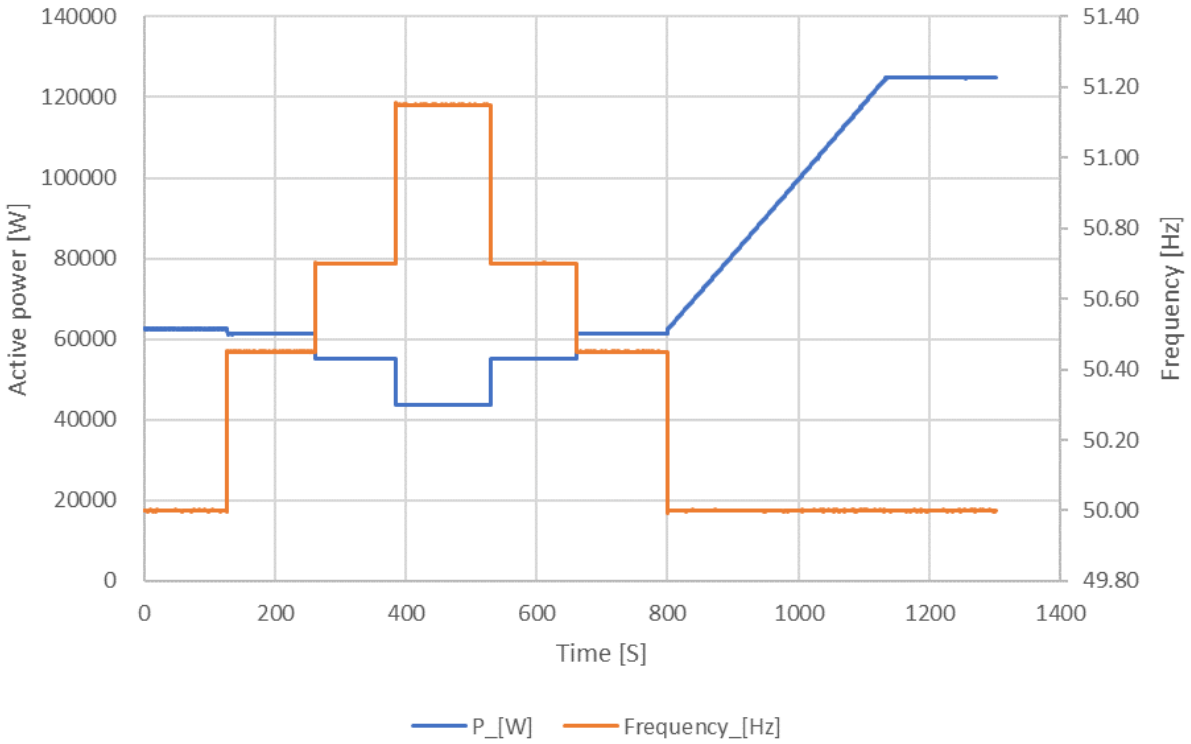


Figure 23 – Test sequence at Registered Capacity 40% - 60%

6.10 Active power setpoint

Note:

Test not performed.

Manufacturer Data:

The units in the product series are equipped with different communication interfaces to reduce the active power output on instruction of the DNO, e.g. by connecting of an Radio Ripple Control Receiver. Active Power reduction between 1.0 pu of Registered Capacity Active Power and zero is possible.

6.11 Protection – Re-connection timer

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
60	113	At 1.16 pu (266.2 V **LV** connection)	At 0.78 pu (180.0 V **LV** connection)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No reconnection occurred	No reconnection occurred	No reconnection occurred	No reconnection occurred

6.12 Fault level contribution

These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms	L1: 35.6 L2: 29.1 L3: 38	L1: 88.8 L2: 98.1 L3: 104.3
100ms	L1: 10 L2: 10 L3: 9	L1: 4.0 L2: 2.7 L3: 3.9
250ms	L1: 10 L2: 9 L3: 10	L1: 4.1 L2: 2.3 L3: 3.8
500ms	L1: 10 L2: 9 L3: 9	L1: 4.0 L2: 2.0 L3: 4.0
Time to trip	0.012	In seconds

6.13 Fault Ride Through and Fast Fault Current Injection

Note:

Test not performed. Confirmation of compliance with EREC G99, section 12.3 & 12.6 requires a simulation study in accordance with B.4.4.

Manufacturer Data:

The Power Park Modules (Generating Units) considered in this report provide Fault Ride Through capability according to EREC G99, Figure 12.5 and are capable of provide grid support by Injection of Fast Fault Current according to EREC G99, section 12.6.

6.14 Self-Monitoring solid state switching

No specified test requirements. Refer to Annex A.7.1.6.	
It has been verified that in the event of the solid-state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	NA
Note: The PGU used electromechanical relay to disconnect from the grid. No solid-state switching device available.	

6.15 Wiring functional tests

If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	NA
Note: Tests carried out in laboratory, specifically designed plugs and sockets used.	

6.16 Logic interface (input port)

Confirm that an input port is provided and can be used to shut down the module	Yes
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes
Note: For details see “Additional comments.” Below.	

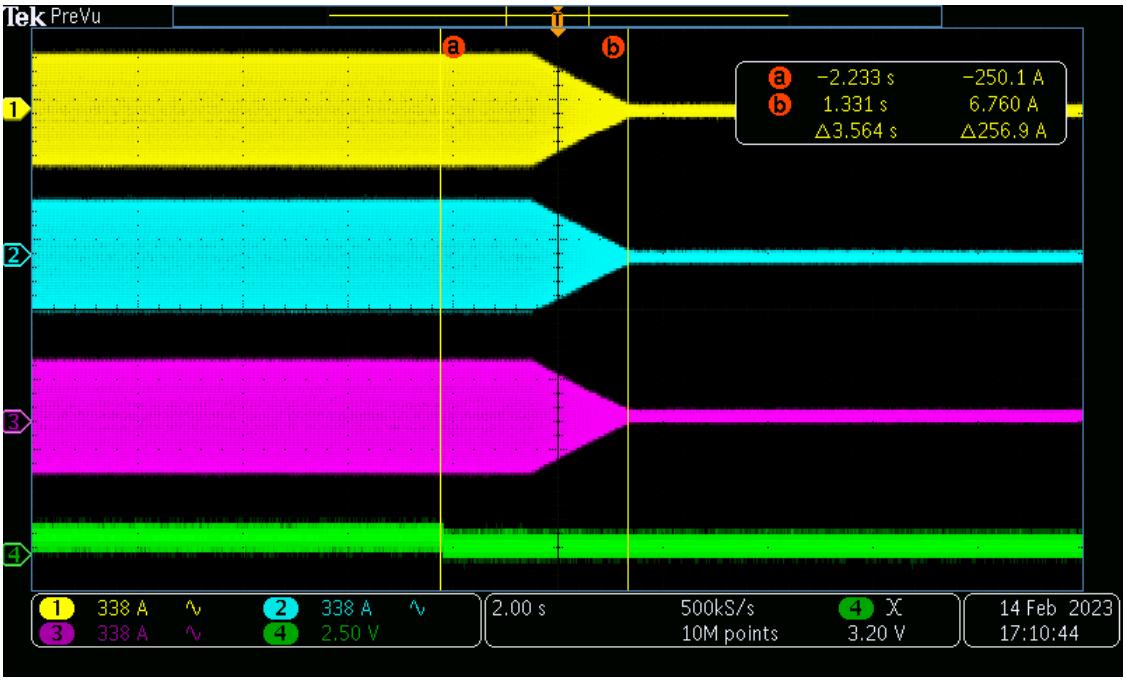


Figure 24 – Test ceasing active power output using logic interface

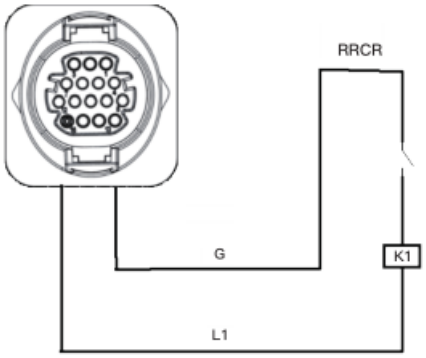
6.17 Cyber security

Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7.	Yes. Manufacturer's declaration provided. See *Annex 2 - Manufacturer's declaration regarding Cyber Security*.

Additional comments.

High level description of logic interface:

The PGU equipped with a logic interface for ceasing active power output within 5 s following an instruction being received. The following is a possible configuration (if another configuration is required, this can be agreed with the manufacturer):



where RRCR = Radio Ripple Control Receiver.

The signal from the Power Generating Module that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V)

Function description of the terminal:

PIN	Pin name	Description	Connected to (RRCR)
9	L1	Relay contact 1 input	K1 – Relay 1 output
13	G	GND	K1 – Relay 1 output

Relay status: close is 1, open is 0

L1	Active Power	Power drop rate	cos(ϕ)
1	0%	<5 seconds	1
0	100%	/	1

Annex 1 - Loss of Mains test according to BS EN 62116

No.	P_{EUT} [a] (% of EUT rating)	Reactive load (% of Q_L in 6.1d)1))	P_{AC} [b] (% of nominal)	Q_{AC} [c] (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC}	Remarks [d]
1	100	100	0	0	417	124400	0.999	887.7	Test A at BL
2	66	66	0	0	417	82600	0.999	599.2	Test B at BL
3	33	33	0	0	354	41200	0.999	340.3	Test C at BL
4	100	100	-5	-5	310	122750	1.008	875.4	Test A at IB
5	100	100	-5	0	263	122850	1.022	888.1	Test A at IB
6	100	100	-5	+5	229	123050	1.041	876.6	Test A at IB
7	100	100	0	-5	255	126250	0.986	910.0	Test A at IB
8	100	100	0	+5	237	125900	1.020	889.0	Test A at IB
9	100	100	+5	-5	242	128350	0.964	884.4	Test A at IB
10	100	100	+5	0	358	128950	0.977	866.4	Test A at IB
11	100	100	+5	+5	193	128200	0.999	897.0	Test A at IB
12	66	66	0	-5	269	82400	0.971	608.5	Test B at IB
13	66	66	0	-4	271	82550	0.985	598.3	Test B at IB
14	66	66	0	-3	289	82650	0.987	606.3	Test B at IB
15	66	66	0	-2	235	82550	0.990	602.6	Test B at IB
16	66	66	0	-1	316	82550	0.992	609.9	Test B at IB
17	66	66	0	1	352	82900	1.002	602.5	Test B at IB
18	66	66	0	2	258	82650	1.004	602.2	Test B at IB
19	66	66	0	3	375	82650	1.009	604.2	Test B at IB
20	66	66	0	4	280	82600	1.012	611.7	Test B at IB
21	66	66	0	5	234	82500	1.015	599.7	Test B at IB
22	33	33	0	-5	201	40950	0.973	336.1	Test B at IB
23	33	33	0	-4	249	40950	0.983	330.4	Test B at IB
24	33	33	0	-3	318	41000	0.990	335.5	Test B at IB
25	33	33	0	-2	249	41000	0.994	335.3	Test B at IB
26	33	33	0	-1	208	41000	0.998	336.8	Test B at IB
27	33	33	0	1	301	41050	1.005	337.0	Test B at IB
28	33	33	0	2	236	41000	1.010	335.0	Test B at IB
29	33	33	0	3	319	41000	1.015	335.5	Test B at IB
30	33	33	0	4	312	41050	1.024	336.5	Test B at IB
31	33	33	0	5	187	41050	1.030	342.8	Test B at IB

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

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

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

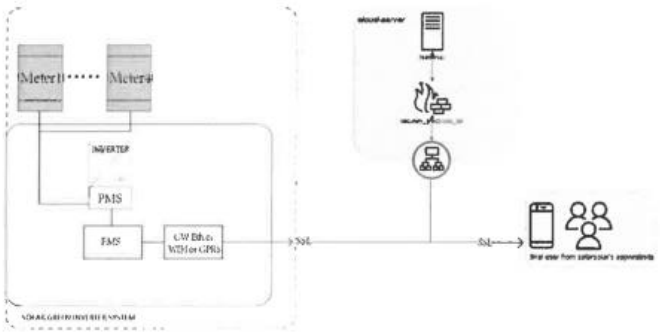
[d] BL: balance condition, IB: imbalance condition.

Annex 2 - Manufacturer's declaration regarding Cyber Security

SOFAR SOLAR

Shenzhen SOFARSOLAR Co., Ltd.
11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City, China

1) The Sofar Solar Inverter include a system of internal and external logic communications as summarized in the following scheme:



where the main components involved and their main functions are explained in the following table:

acronym/ name	*meaning*	*function*	*location*
PMS	Power Management System	monitoring and management of power fluxes through the inverter, execution of EMS's commands or local logic functions depending on grid parameters values. Note: The PMS performs operational safety functions aimed at prevent physical damage/harm, typically by interrupting currents and/or opening contacts on some inverter ports when voltage, current or temperature limits are violated; no safety operation performed by PMS can be compromised/skypped by commands/signals originating outside the inverter.	inverter
EMS	Energy Management System	monitoring of all field's measures, calculus of power and currents for every component of the system, reception of external commands, transmission of commands to PMS. Note: No operational safety function aimed at preventing physical damage/harm is performed by the EMS; no operation performed by EMS can force the operational safety functions performed by PMS and electrical protections.	monitor board

GW	Gate-Way	transmission of data to cloud server, reception of commands/settings from external stakeholder.	Collector
Meter	External Power Meter(s) (one to four)	*included in the supply*: meter at the PCC, and possible meter at AC port of third party generator/inverter, for power measures	PCC; third party inverter

2) All communications between internal components of the Sofar solar Inverter, and between EMS and supplied External Power Meter(s), take place via appropriate serial lines (RS485, SCI) and are not directly connected to any device or system outside the Sofar solar Inverter.

3) The only communication port between the device and the outside is constituted by the Gate-Way layer of a logic board on the machine, the communication between Sofar solar Inverter and the outside world can take place via RS485 line, WiFi to the customer's request.

4) The direct recipients/senders of communications with the Sofar solar Inverter is the in-cloud server of Sofar Green Inverter - the communication is made secure by the use of TSL(Transport Layer Security) technology on collector, and by the use of SSL(Secure Sockets Layer) technology on Final User's device side and Installer/Sofar service web-tools side.

5) All communications between the in-cloud server and the subjects/parties are cyber-protected by SSL technology.

6) The cyber-security assessment of the Sofar Green Inverter was performed according to the ETSI EN 303 645 standard, and it is reported according to the Table B.1 form of the same standard:

EN 303 645 v2.1.1 (2020-06) Table B.1: Implementation of provisions for consumer IoT security			
Clause number and title			
Reference	Status	Support	Detail
5.1 No universal default passwords			
Provision 5.1-1	M C (1)	N/A	Device do not permit final user's login.
Provision 5.1-2	M C (2)	N/A	
Provision 5.1-3	M	N/A	
Provision 5.1-4	M C (8)	N/A	
Provision 5.1-5	M C (5)	N/A	
5.2 Implement a means to manage reports of vulnerabilities			
Provision 5.2-1	M	Y	
Provision 5.2-2	R	Y	
Provision 5.2-3	R	Y	
5.3 Keep software updated			
Provision 5.3-1	R	Y	
Provision 5.3-2	M C (5)	Y	
Provision 5.3-3	M C (12)	Y	

SOFAR SOLAR

Provision 5.3-4	R C (12)	Y	
Provision 5.3-5	R C (12)	N	The manufacturer manages the updates of the systems by means of remote automatisms, selectively by type of machine or by activating special functions at the request of the user
Provision 5.3-6	R C (9, 12)	N	
Provision 5.3-7	M C (12)	Y	
Provision 5.3-8	M C (12)	Y	
Provision 5.3-9	R C (12)	N	See note at 5.3-5
Provision 5.3-10	M (11, 12)	Y	
Provision 5.3-11	R C (12)	Y	
Provision 5.3-12	R C (12)	N	The device failed to notify the user
Provision 5.3-13	M	Y	
Provision 5.3-14	R C (3, 4)	Y	
Provision 5.3-15	R C (3, 4)	N	
Provision 5.3-16	M	Y	
5.4 Securely store sensitive security parameters			
Provision 5.4-1	M	Y	
Provision 5.4-2	M C (10)	Y	
Provision 5.4-3	M	N/A	Hard-coded identity not used in source code
Provision 5.4-4	M	N	No unique key parameters are provided for the device
5.5 Communicate securely			
Provision 5.5-1	M	Y	
Provision 5.5-2	R	N	
Provision 5.5-3	R	N	
Provision 5.5-4	R	Y	
Provision 5.5-5	M	Y	
Provision 5.5-6	R	Y	
Provision 5.5-7	M	Y	
Provision 5.5-8	M	Y	
5.6 Minimize exposed attack surfaces			
Provision 5.6-1	M	Y	

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Provision 5.6-2	M	Y	
Provision 5.6-3	R	Y	
Provision 5.6-4	M C (13)	N/A	No debug interface accessible
Provision 5.6-5	R	Y	
Provision 5.6-6	R	Y	
Provision 5.6-7	R	Y	
Provision 5.6-8	R	N	The device don't have the access control mechanism
Provision 5.6-9	R	Y	
5.7 Ensure software integrity			
Provision 5.7-1	R	N	The device don't have the hardware root of trust
Provision 5.7-2	R	N	The device don't have the ability to be in administration mode
5.8 Ensure that personal data is secure			
Provision 5.8-1	R	N/A	No personal data transit through the device
Provision 5.8-2	M	Y	
Provision 5.8-3	M	Y	
5.9 Make systems resilient to outages			
Provision 5.9-1	R	Y	
Provision 5.9-2	R	Y	
Provision 5.9-3	R	Y	
5.10 Examine system telemetry data			
Provision 5.10-1	R C (6)	Y	
5.11 Make it easy for users to delete user data			
Provision 5.11-1	M	N/A	No user/personal data are stored in the device
Provision 5.11-2	R	N/A	
Provision 5.11-3	R	N/A	
Provision 5.11-4	R	N/A	
5.12 Make installation and maintenance of devices easy			
Provision 5.12-1	R	Y	
Provision 5.12-2	R	Y	
Provision 5.12-3	R	Y	
5.13 Validate input data			
Provision 5.13-1	M	Y	
6 Data protection provisions for consumer IoT			
Provision 6.1	M	N/A	No user/personal data are stored in the device
Provision 6.2	M C (7)	N/A	
Provision 6.3	M	N/A	
Provision 6.4	R C (6)	N/A	
Provision 6.5	M C (6)	N/A	

Conditions:

SOFAR SOLAR

1) passwords are used; 2) pre-installed passwords are used; 3) software components are not updateable; 4) the device is constrained; 5) the device is not constrained; 6) telemetry data being collected; 7) personal data is processed on the basis of consumers' consent; 8) the device allowing user authentication; 9) the device supports automatic updates and/or update notifications; 10) a hard-coded unique per device identity is used for security purposes; 11) updates are delivered over a network interface; 12) an update mechanism is implemented; 13) a debug interface is physically accessible.

Status' Column:	
M	Mandatory provision
R	Recommended provision
M C	Mandatory and conditional provision
R C	Recommended and conditional provision

Support' Column:	
Y	Implemented
N	Not implemented
N/A	Not applicable

Date:2022-08-08

Name: Feng Feng

Title: Product manager

Manufacture Seal

Annex 3 - CE declaration

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Test Verification of Conformity

Verification Number: 221201097GZU-VOC001

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

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

Applicant Name & Address:	Shenzhen SOFARSOLAR Co., Ltd. 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City, China
Product Description:	Solar Grid-tied Inverter
Models/Type References:	SOFAR 100KTLX-G4, SOFAR 110KTLX-G4, SOFAR 125KTLX-G4, SOFAR 125KTLX-G4-A
Ratings & Principle Characteristics:	See Appendix
Brand Name(s):	SOFAR
Standard(s)/Directive(s):	ETSI EN 300 328 V2.2.2 (2019-07) ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-17 V3.2.4 (2020-09) EN 62479:2010 EN IEC 61000-6-4:2019 EN IEC 61000-6-2:2019 Radio Equipment Directive (2014/53/EU) – Article 3.1(a)(health), 3.1(b) & article 3.2
Verification Issuing Office Name & Address:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, China
Date of Tests:	07 December 2022 to 07 January 2023
Test Report Number(s):	221201097GZU-001,002,003,004

Additional information in Appendix.

Strong Yao

Signature

Name: Strong Yao
Position: Manager
Date: 06 February 2023

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APPENDIX: Test Verification of Conformity

This is an Appendix to Test Verification of Conformity Number: 221201097GZU-VOC001

Model	SOFAR 100KTLX-G4	SOFAR 110KTLX-G4	SOFAR 125KTLX-G4	SOFAR 125KTLX-G4-A
Input (DC)				
Max. input voltage	1100V			
Rated input voltage	625V			
Start-up voltage	200V			
MPPT operating voltage range	180V~1000V			
Full power MPPT voltage range	500-850V			
Number of MPP trackers	10			
Number for DC inputs	20			
Max. input MPPT current	10*40A			
Max. input short-circuit current	10*50A			
Single MPPT Max Power	24kW			
Rated output power	100kW	100kW	110kW	125kW
Max. apparent power （AC output power）	100kVA@45℃ / 90kVA@50℃	110kVA@45℃ / 100kVA@50℃	125kVA@45℃ / 110kVA@50℃	
Max. Output current	152A@380V / 145A@400V / 139.2A@415V	167.2A@380V / 159.5A@400V / 153.1A@415V	190A@380V / 181.2A@400V / 174A@415V	
Rated output voltage	3/N/PE，380V / 400V / 415V			
Output voltage range	310~480V			
Rated output frequency	50/60Hz			
Output frequency range	45Hz~55Hz/55Hz~65Hz			
Active power adjustable range	0~100%			
THDi	<1%(@100%P)			
Power factor	1 (+/-0.8 adjustable)			

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APPENDIX: Test Verification of Conformity

This is an Appendix to Test Verification of Conformity Number: 221201097GZU-VOC001

Model	SOFAR 100KTLX-G4	SOFAR 110KTLX-G4	SOFAR 125KTLX-G4	SOFAR 125KTLX-G4-A
Input (DC)				
Max. input voltage	1100V			
Rated input voltage	625V			
Start-up voltage	200V			
MPPT operating voltage range	180V~1000V			
Full power MPPT voltage range	500-850V			
Number of MPP trackers	10			
Number for DC inputs	20			
Max. input MPPT current	10*40A			
Max. input short-circuit current	10*50A			
Single MPPT Max Power	24kW			
Rated output power	100kW	100kW	110kW	125kW
Max. apparent power （AC output power）	100kVA@45℃ / 90kVA@50℃	110kVA@45℃ / 100kVA@50℃	125kVA@45℃ / 110kVA@50℃	
Max. Output current	152A@380V / 145A@400V / 139.2A@415V	167.2A@380V / 159.5A@400V / 153.1A@415V	190A@380V / 181.2A@400V / 174A@415V	
Rated output voltage	3/N/PE，380V / 400V / 415V			
Output voltage range	310~480V			
Rated output frequency	50/60Hz			
Output frequency range	45Hz~55Hz/55Hz~65Hz			
Active power adjustable range	0~100%			
THDi	<1%(@100%P)			
Power factor	1 (+/-0.8 adjustable)			

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Test Verification of Conformity

Verification Number: 221215051GZU -VOC001

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

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

Applicant Name & Address:	Shenzhen SOFARSOLAR Co., Ltd. 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City, China
Product Description:	Solar Grid-tied Inverter
Ratings & Principle Characteristics:	See Appendix: Test Verification of Conformity
Models/Type References:	SOFAR 100KTLX-G4, SOFAR 110KTLX-G4 SOFAR 125KTLX-G4, SOFAR 125KTLX-G4-A
Brand Name:	SOFAR SOLAR
Relevant Standards/Directives:	IEC/EN 62109-1: 2010 Safety of power converters for use in photovoltaic power systems – Part 1: General requirements IEC/EN 62109-2: 2011 Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters Low Voltage Directive 2014/35/EU
Verification Issuing Office Name & Address:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch. Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, China
Date of Tests:	15 Dec 2022 – 03 Jan 2023
Test Report Number(s):	221215051GZU-001, 221215051GZU-002

Additional information in Appendix.

Jason Fu

Signature

Name: Jason Fu
Position: Supervisor
Date: 13 January 2023

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APPENDIX: Test Verification of Conformity

This is an Appendix to Test Verification of Conformity Number: 221215051GZU -VOC001.

Ratings & Principle Characteristics:

Model	SOFAR 100KTLX-G4	SOFAR 110KTLX-G4	SOFAR 125KTLX-G4	SOFAR 125KTLX-G4-A
Max. DC input Voltage	1100Vdc			
Operating MPPT voltage range	180Vdc – 1000Vdc			
Max. Input current	40A*10			
PV Isc	50A*10			
Nominal AC output voltage	3/N/PE 230Vac/400Vac			
Nominal AC output Frequency	50/60Hz			
Max. AC output current	145A	159.5A	181.2A	181.2A
Rated Output power	100.0KW	100.0KW	110.0KW	125.0KW
Max.Output Power	100.0KVA	110.0KVA	125.0KVA	125.0KVA
Power factor	1(adjustable +/-0.8)			
Safety level	Class I			
Ingress Protection	IP 66			
Operation Ambient Temperature	-30℃ - 60℃			
Software version	V000001			

Jason Fu

Signature

Name: Jason Fu
Position: Supervisor
Date: 13 January 2023

Annex 4 - Proof of conformity of the protection relay

Relay model: HF167F-200

Zertifikat *Certificate*

TÜVRheinland®

Zertifikat Nr. *Certificate No.*
R 50374273

Blatt *Sheet*
0004

Ihr Zeichen *Client Reference*	Unser Zeichen *Our Reference*	Ausstellungsdatum *Date of Issue*
S.H.	01-SDW-50075325 004	31.05.2019 *(day/mo/yr)*

Genehmigungsinhaber *License Holder*
Xiamen Hongfa Electroacoustic
Co., Ltd.
No. 91-101, Sunban South Rd.
Jimei North Ind. District
Xiamen, Fujian 361021
P. R. China

Fertigungsstätte *Manufacturing Plant*
Zhangzhou Hongfa Electroacoustic
Co., Ltd.
Gangyuan Industrial District,
Chenxiang, Changtai,
Zhangzhou, Fujian
P. R. China

Prüfzeichen *Test Mark*
TÜVRheinland CERTIFIED
Type Approved
Safety
Regular Production
Surveillance
www.tuv.com
ID 1419045470

Geprüft nach *Tested acc. to*
EN 61810-1:2015
IEC 61810-1:2015

Zertifiziertes Produkt (Geräteidentifikation)
Certified Product (Product Identification)

Lizenzentgelte - Einheit
License Fee - Unit

Relay (Electromechanical Elementary Relays)

as page 0001

Additional Ratings for
Type Designation : HF167F-200/X-H3Fq;HF172F-200/x-H3Fq

Contact Loads	: Max.800VAC 50Hz; 55A(Making:0,5s) 200A(Loading:9s) 55A(Breaking:0,5s)	Max.830VAC 50Hz 55A (Making:0,1s) 200A(Loading:0,8s) 55A (Breaking:0,1s)	2
Electrical Endurance:	6 000 cylces	30 000 cylces	
Duty factor	: 10s on/9s off	1s on/9s off	

2

ANLAGE (Appendix): 1,1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde und es bestätigt die Konformität des Produktes mit den oben genannten Standards und Prüfgrundlagen. Zusätzliche Anforderungen in Ländern, in denen das Produkt in Verkehr gebracht werden soll, müssen zusätzlich betrachtet werden. Die Herstellung des zertifizierten Produktes wird überwacht.
This certificate is based on our Testing and Certification Regulation and states the conformity of the product with the standards and testing requirements as indicated above. Any additional requirements in countries where the product is going to be marketed have to be considered additionally. The manufacturing of the certified product is subject to surveillance.

TÜV Rheinland LGA Products GmbH, Tillystraße 2, 90431 Nürnberg
Tel.: +49 221 806-1371 e-mail: cert-validity@de.tuv.com
Fax: +49 221 806-3935 http://www.tuv.com/safety

Zertifizierungsstelle
TÜV Rheinland LGA Products GmbH TÜVRheinland Prüfzertifizierungsstelle
Jie Zhang

TÜVRheinland®
DIN CERTCO

TÜVRheinland®

Certificate No.	R 50374273 0001-0004	Our Reference	01-SDW-50075325 004	Appendix No.	1.1

Constructional Data Form (CDF) for Electromechanical Elementary Relays Page 4 of 4

TYPE NOMENCLATURE:

HF167F-200/x-H3Fq; HF172F-200/x-H3Fq

x	stands for	Rated Coil Voltage DC Coil (VDC): 6; 9; 12; 24
H	stands for	Contact Form H: 1 Make
3	stands for	Contact material: 3: AgNi
F	stands for	Insulation Classification per UL standards F: CLASS F
q	stands for	Special Code

TÜV Rheinland Group		License holder	
21.05.2019		Sandy Huang	Xiamen Hongfa Electroacoustic Co., Ltd.
Date	Signature	Name	Company Stamp and Signature

Relay model: CHAR -112A200C

Zertifikat *Certificate*

TÜVRheinland®

Zertifikat Nr. *Certificate No.*
R 50499133

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0001

Ihr Zeichen *Client Reference*	Unser Zeichen *Our Reference*	Ausstellungsdatum	*Date of Issue*
	05-RBI-CN21X803 001	03.06.2021	*(day/mo/yr)*

Genehmigungsinhaber *License Holder*
Dongguan Churod Electronics
Co., Ltd.
Unit20, Xingui Road
Lin Village, TangXia Town
DongGuan
Guangdong
P.R. China

Fertigungsstätte *Manufacturing Plant*
Refer to latest revision
of the annex list of factories

Prüfzeichen *Test Mark*
TÜVRheinland CERTIFIED
Type Approved
Safety
Regular Production
Surveillance
www.tuv.com
ID 1111237944

Geprüft nach *Tested acc. to*
EN 61810-1:2015
IEC 61810-1:2015

Zertifiziertes Produkt (Geräteidentifikation)
Certified Product (Product Identification)

Lizenzentgelte - Einheit
License Fee - Unit

Relay (Electromechanical Elementary Relays)

7

Type Designation : CHAR-1xxAyyCz, aaa
xx = 09, 12, or 24 (yy=75/90)
xx = 06, 09, 12, 24, 48 (yy=200/250/270)
yy = 75, 90, 200, 250 or 270
z = L or Blank (yy=200/250/270)
a = 0-9, A-Z, a-z or blank

Trademark : Churod (Logo)
Rated Coil Power : 1.92W (yy=75/90)
4.0W (yy=200/250/270)

Rated Coil Voltage :
DC 9V, 12V, 24V (yy=75/90)
DC 6V, 9V, 12V, 24V, 48V (yy=200/250/270)
Ambient Temperauture : -40°C to 85°C
Coil Insulation : Class F
Rated Contact Load : see appendix 1.0
Electrical Endurance : 30,000 cycles at 360 cycles/h
Duty factor : 10%

Continued on page 0002

7

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde und es bestätigt die Konformität des Produktes mit den oben genannten Standards und Prüfgrundlagen. Zusätzliche Anforderungen in Ländern, in denen das Produkt in Verkehr gebracht werden soll, müssen zusätzlich betrachtet werden. Die Herstellung des zertifizierten Produktes wird überwacht.
This certificate is based on our Testing and Certification Regulation and states the conformity of the product with the standards and testing requirements as indicated above. Any additional requirements in countries where the product is going to be marketed have to be considered additionally. The manufacturing of the certified product is subject to surveillance.

Zertifizierungsstelle

TÜV Rheinland LGA Products GmbH, Tillystraße 2, 90431 Nürnberg
Tel.: +49 221 806-1371 e-mail: cert-validity@de.tuv.com
Fax: +49 221 806-3935 http://www.tuv.com/safety

Zertifikat *Certificate*

TÜVRheinland®

Zertifikat Nr. *Certificate No.*
R 50499133

Blatt *Sheet*
0002

Ihr Zeichen *Client Reference*	Unser Zeichen *Our Reference*	Ausstellungsdatum *Date of Issue*
	05-RBI-CN21X803 001	03.06.2021 *(day/mo/yr)*

Genehmigungsinhaber *License Holder*
Dongguan Churod Electronics
Co., Ltd.
Unit20, Xingui Road
Lin Village, TangXia Town
DongGuan
Guangdong
P.R. China

Fertigungsstätte *Manufacturing Plant*
Refer to latest revision
of the annex list of factories

Prüfzeichen *Test Mark*

TÜVRheinland CERTIFIED
Type Approved
Safety
Regular Production
Surveillance
www.tuv.com
ID 1111237944

Geprüft nach *Tested acc. to*
EN 61810-1:2015
IEC 61810-1:2015

Zertifiziertes Produkt (Geräteidentifikation)
Certified Product (Product Identification)

Lizenzentgelte - Einheit
License Fee - Unit

Relay (Electromechanical Elementary Relays)

Continuation from page 0001

Mechanical Endurance :
1,000,000 cycles at 1,800 cycles/h (yy=75/90)
1,000,000 cycles at 9,000 cycles/h (yy=200/250/270)
Insulation between
coil and contact : Basic Insulation
Type of interruption : Micro-disconnection

Remark : The labelling requirements acc. to EU Directive 2001/95 have to be observed for distribution within the EEA.

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde und es bestätigt die Konformität des Produktes mit den oben genannten Standards und Prüfgrundlagen. Zusätzliche Anforderungen in Ländern, in denen das Produkt in Verkehr gebracht werden soll, müssen zusätzlich betrachtet werden. Die Herstellung des zertifizierten Produktes wird überwacht.
This certificate is based on our Testing and Certification Regulation and states the conformity of the product with the standards and testing requirements as indicated above. Any additional requirements in countries where the product is going to be marketed have to be considered additionally. The manufacturing of the certified product is subject to surveillance.

TÜV Rheinland LGA Products GmbH, Tillystraße 2, 90431 Nürnberg
Tel.: +49 221 806-1371 e-mail: cert-validity@de.tuv.com
Fax: +49 221 806-3935 http://www.tuv.com/safety

TÜV Rheinland LGA Products GmbH Zertifizierungsstelle TÜVRheinland

G. YIE

Anlage Fertigungsstättenliste
/Attachment List of Factories

TÜVRheinland®

R 50499133 0001

1 Dongguan Churod Electronics
Co., Ltd.
Unit20, Xingui Road
Lin Village, TangXia Town
DongGuan
Guangdong
P.R. China

2 Churod Electronics (Wuhu) Co., Ltd.
Industrial Avenue, XinWu Economic
Development Zone, WuHu County
WuHu
Anhui
P.R. China

Dieser Anhang ersetzt den Vorgänger vom/
This annex replaces the previous annex dated

Datum / Date 03.06.2021

TÜV Rheinland LGA Products GmbH Zertifizierungsstelle Certification Body TÜVRheinland

10/020 d 04.06 ® TÜV, TUEV and TUV are registered trademarks. Utilisation and application requires prior approval.

Relay model: AZSR1200-1AE-12D

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. B 088793 0013 Rev. 00

Holder of Certificate: **ZETTLER RELAY (XIAMEN) CO.,LTD**
5F, No.6, Xinjing Road, Xinyang Industrial Zone
Haicang District
361028 Xiamen, Fujian
PEOPLE'S REPUBLIC OF CHINA

Certification Mark:

Product: **Relay, all-or-nothing**
(All or nothing relay)

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: 64100180594501

Valid until: 2023-12-27

Date, 2018-12-28 (Boris Ouyang)

A4 / 07.17

Page 1 of 3
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

Product Service

CERTIFICATE

No. B 088793 0013 Rev. 00

Model(s): **AZSR1160 series, AZSR1180 series, AZSR1200 series**

[Description the rule of the designation of the relay:

AZSR1160 - 1A E - 6 D XXX
I II III IV V VI

I – Basic series designation
AZSR1160: AZSR1160 series
AZSR1180: AZSR1180 series
AZSR1200: AZSR1200 series
II – Contact Configuration
1A: Single pole normally open
III – Contact material
E: $AgSnO_2$
IV – Coil Voltage
6: 6V; 9: 9V; 12: 12V, 24: 24V; 48: 48V.
V – Nature of coil voltage
D: DC
VI – Special client code
Nil: no special client code
000-999 or aaa- zzz or AAA- ZZZ: range of code number (does not affect the construction).

Note: The contact materials are $AgSnO_2$ and Cu, the thickness of $AgSnO_2$ for the contact is 0.8±0.3mm and that of $AgSnO_2$ and Cu for the contact is 1.5±0.2mm.]

Parameters:

Rated voltage(s) of the coil(s):	DC 6V; 9V; 12V; 24V, 48V;
Rated power of the coil(s):	3W
Type of load:	Resistive load
Rated voltage(s) of the contacts:	See Load circuit rating table
Rated current(s) of the contacts:	See Load circuit rating table
Electrical endurance/number of cycles:	See Load circuit rating table
Mechanical endurance/number of cycles:	1 000 000
Type of interruption:	Micro- disconnection
Type of insulation between coil(s) and contacts:	Basic insulation
Pollution degree:	2
Categories of enviromental protection(RT):	RTII
Rated impulse withstand voltage(s):	6kV
Ambient temperature range:	-40°C to +85°C

A4 / 07.17

Product Service

CERTIFICATE

No. B 088793 0013 Rev. 00

Load circuit rating table

Rated current(s) of the contacts (A)	Rated voltages of the contacts (VAC)	Cycles	Ambient temperature (°C)	Duty Factor	On/Off (s)
160A	690	1000	85	10%	1.0/9.0
Making 60A(0.1s), Carrying 160A(0.8s), Breaking 60A(0.1s)	690	30000	85	10%	1.0/9.0
200A	920	50	85	10%	1.0/9.0
Making 40A(0.1s), Carrying 200A(0.8s), Breaking 40A(0.1s)	920	30000	85	10%	1.0/9.0

Tested according to: EN 61810-1:2015

Production Facility(ies): 088793

A4 / 07.17

China

Choose certainty.
Add value.

TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch
5F, Communication Building,163 Pingyun Rd, Huangpu Ave. West Guangzhou, Guangdong, P. R. China

ZETTLER RELAY (XIAMEN) CO.,LTD
5F, No.6, Xinjing Road, Xinyang Industrial Zone
Haicang District
361028 Xiamen, Fujian
PEOPLE'S REPUBLIC OF CHINA

Your reference/letter of	Our reference/name	Tel. extension/e-mail	Fax extension
		+86 20 3815 3209	+86 20 38320478

Subject: Your TÜV SÜD CERTIFICATE

Dear Sir or Madame,

We are pleased to send you your below listed certificate(s) , which entitle you to label your certified product(s) with the respective certification mark as applicable.

Certificate No.	Product	Model
B 088793 0013 Rev. 00	Relay, all-or-nothing	AZSR1160 series, AZSR1180 series, AZSR1200 series

Further, we like to remind you on following information, which are applicable to all certificate holders:

- As a certificate holder, you have contractual obligations to the related TÜV SÜD certification body as outlined in global "Testing and Certification Regulations" of TÜV SÜD, which you can receive from us or download at: http://www.tuv-sud.cn/cn-en/terms-and-conditions.
- If the products listed on the certificate will be exported to European Market, the name of the certificate holder (manufacturer) and the name and address of the importer or authorized representative based within the European Economic Area must be clearly affixed on the product or where that is not possible, on the packaging or in a document accompanying the product.
- The annual license fee will be **8** units for maintaining the validity of the certificate.
- To ensure that the validity of the certificate is not jeopardized, please inform us about any change in your production or of the product itself (this also includes changes to the user manual or rating label)
- If you want to stop the renewal of the above listed certificate(s) for the following year, please inform TÜV SÜD in writing by September 30 of the current year. If not received on time, the annual fee of the following year is to be paid and the cancellation will be done the year after.

If you have any question regarding your certificate(s) or the proper use of the certification mark on your products, please do not hesitate to contact us.

Yours sincerely,

TÜV SÜD Certification and Testing (China)
Co., Ltd Guangzhou Branch

GCN_TPS_F_00.01 – Rev. 0

HSBC Bank (China) Company Limited
Guangzhou Branch
Account No.:
629-129339-011 (RMB)
009-129339-055 (USD)
SWIFT Code: HSBCCNSHGZH

General Manager:
Mr. Likun Huang

Telephone: +86 20 3832 0668
Telefax : +86 20 3832 0478
www.tuv-sud.cn

TÜV SÜD Certification and Testing (China)
Co., Ltd Guangzhou Branch
5F, Communication Building,
163 Pingyun Rd, Huangpu Ave. West
Guangzhou, Guangdong, P. R. China
510656

Annex 5 - EMC Test Report

intertek
Total Quality. Assured.

CNAS 中国认可 检测 TESTING CNAS L0220

Shenzhen SOFARSOLAR Co., Ltd.

TEST REPORT

SCOPE OF WORK
EMC TESTING– See page 2

REPORT NUMBER
221201097GZU-004

ISSUE DATE **[REVISED DATE]**

06-February-2023 [----------]

PAGES
50

DOCUMENT CONTROL NUMBER
EN IEC 61000-6-2, 6-4-a

intertek
Total Quality. Assured.

Room 02, & 101/E201/E301/
E401/E501/E601/E701/E801 of
Room 01 1-8/F., No. 7-2. Caipin
Road, Science City, GETDD,
Guangzhou, Guangdong, China
Telephone: +86 20 8213 9688
Facsimile: +86 20 3205 7538
www.intertek.com.cn

TEST REPORT

Applicant Name & Address	:	Shenzhen SOFARSOLAR Co., Ltd. 11/F., Gaoxinqi Technology Building, No.67 Area, Xingdong Community, Xin'an Sub-district, Bao'an District, Shenzhen City, China.
Manufacturing Site	:	Dongguan SOFAR SOLAR Co., Ltd 1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City,Guangdong,China.
Intertek Report No:		221201097GZU-004

Test standards

EN IEC 61000-6-4:2019/IEC 61000-6-4:2018
EN IEC 61000-6-2:2019/IEC 61000-6-2:2016

Sample Description

Product	:	Solar Grid-tied Inverter
Model No.	:	SOFAR 100KTLX-G4, SOFAR 110KTLX-G4, SOFAR 125KTLX-G4, SOFAR 125KTLX-G4-A
Electrical Rating	:	See page 6 to 7
Serial No.		Not Labeled
Date Received	:	01 December 2022
Date Test Conducted	:	07 December 2022 to 07 January 2023

Prepared and Checked By

Guitar Huang

Sr. Project Engineer

Approved By:

Sky Zhu

Team Leader

intertek
Total Quality. Assured.

Intertek Report No.:
221201097GZU-004

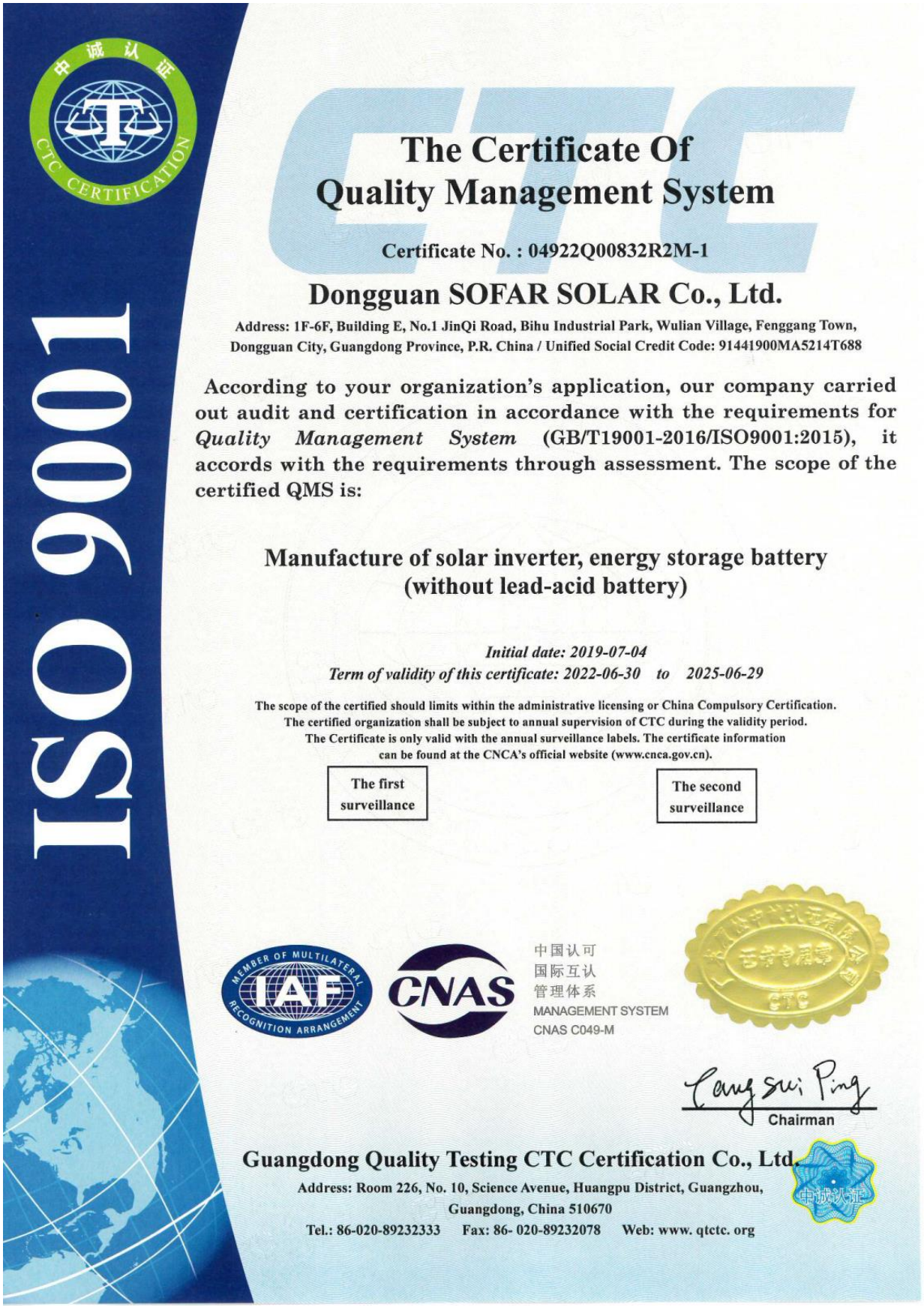
TEST REPORT

1. TEST RESULTS SUMMARY

Test Item	Standard	Result
Continuous conducted disturbance voltage	EN IEC 61000-6-4:2019 Reference: CISPR 16-2-1:2014 + A1:2017	Pass
Discontinuous conducted disturbance voltage	EN IEC 61000-6-4:2019 Reference: CISPR 14-1:2016	N/A
Emission at Telecommunications /network Ports	EN IEC 61000-6-4:2019 Reference: CISPR 32:2015	N/A
Radiated emission (30 MHz–1000 MHz)	EN IEC 61000-6-4:2019 Reference: CISPR 16-2-3:2016	Pass
Radiated emission (1 GHz–6 GHz)	EN IEC 61000-6-4:2019 Reference: CISPR 16-2-3:2016	N/A
ESD immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-2:2009	Pass
Inject current immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-6:2014	Pass
Surge immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-5:2014	Pass
EFT immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-4:2012	Pass
Radiated EM filed immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-3:2006 +A1:2008+A2:2010	Pass
Voltage dips and interruption immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-34:2007	Pass
Power frequency magnetic field immunity	EN IEC 61000-6-2:2019 Reference: EN 61000-4-8:2010	Pass

Remark:
1. The symbol “N/A” in above table means Not Applicable.
2. When determining the test results, measurement uncertainty of tests has been considered.
3. Harmonics and Flicker are not required.

Annex 6 - ISO 9001 certificate



ISO 9001

The Certificate Of Quality Management System

Certificate No. : 04922Q00832R2M-1

Dongguan SOFAR SOLAR Co., Ltd.

Address: 1F-6F, Building E, No.1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China / Unified Social Credit Code: 91441900MA5214T688

According to your organization's application, our company carried out audit and certification in accordance with the requirements for *Quality Management System* (GB/T19001-2016/ISO9001:2015), it accords with the requirements through assessment. The scope of the certified QMS is:

Manufacture of solar inverter, energy storage battery (without lead-acid battery)

Initial date: 2019-07-04

Term of validity of this certificate: 2022-06-30 to 2025-06-29

The scope of the certified should limits within the administrative licensing or China Compulsory Certification.
The certified organization shall be subject to annual supervision of CTC during the validity period.
The Certificate is only valid with the annual surveillance labels. The certificate information can be found at the CNCA's official website (www.cnca.gov.cn).

The first surveillance	The second surveillance

中国认可
国际互认
管理体系
MANAGEMENT SYSTEM
CNAS C049-M

Chairman

Guangdong Quality Testing CTC Certification Co., Ltd.

Address: Room 226, No. 10, Science Avenue, Huangpu District, Guangzhou, Guangdong, China 510670

Tel.: 86-020-89232333 Fax: 86- 020-89232078 Web: www. qtctc. org

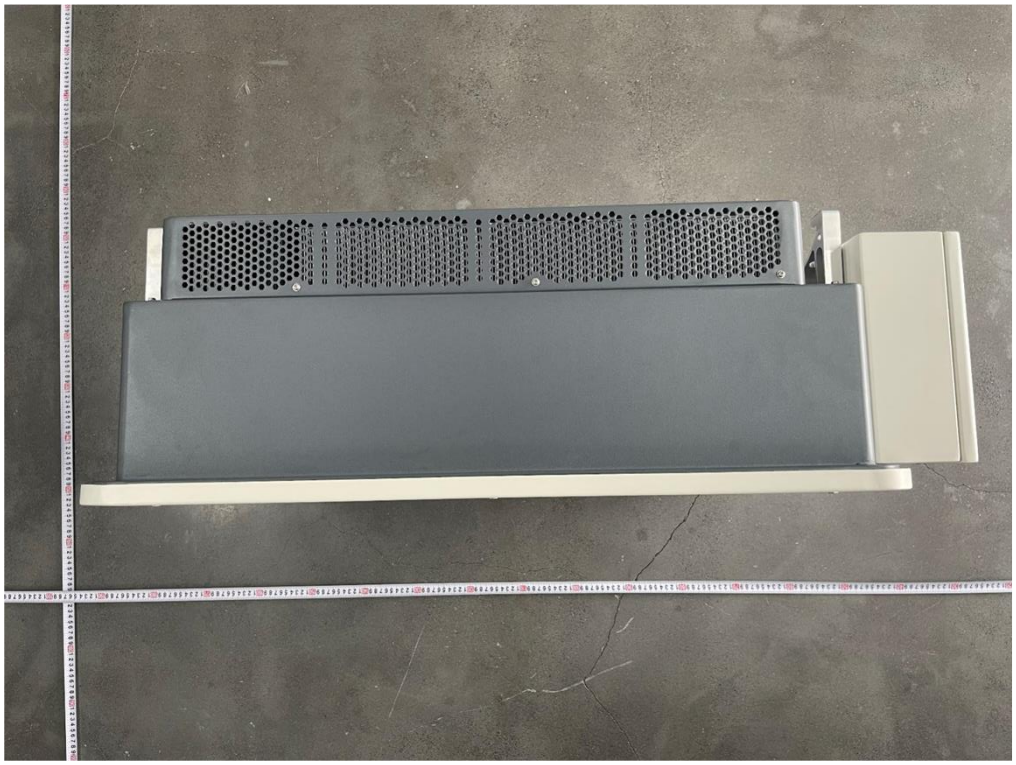
Annex 7 - Photo of the unit

Enclosure front view

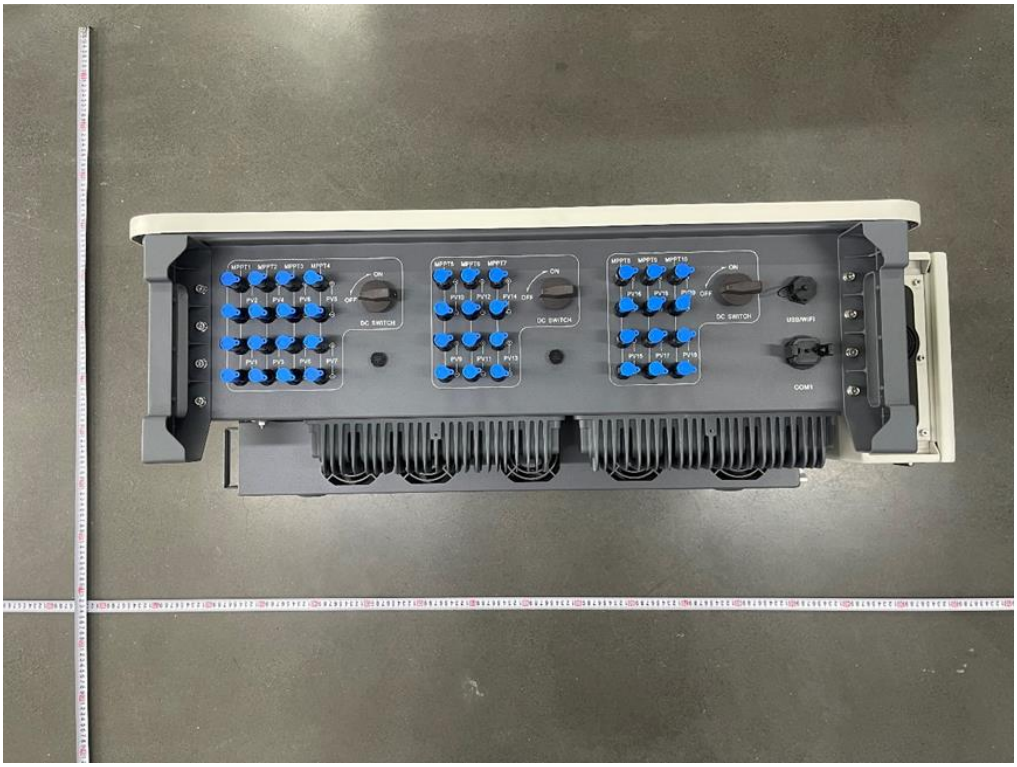
Enclosure side view-1

Enclosure side view-2

Enclosure top view



Enclosure bottom view



Enclosure rear view

»»»» **End of Test Report** ««««