DEKRA Testing and Certification (Shanghai) Ltd.
No.250, Jiangchangsan Road, Jing'an District, Shanghai, China
TEL: +86-21-6056 7666 / FAX: +86-21-6056 7555

This report will not be used for social proof function in China market.

Test report No:6209666.50v1.1

TEST REPORT
Electromagnetic Compatibility (EMC)

Identification of item tested	PV Microinverter
Trademark	Solenso
Model and /or type reference	SG1600; SG2000
Ratings	Operating temperature range: - 40 °C to + 65 °C Protective class: I Ingress protection rating: IP67 Power factor range (adjustable): >0,99 (0,8 leading…0,8 lagging) Overvoltage category: III(Mains), II(PV) SG1600: Max input voltage: 65 V, MPPT voltage range: 25-55 V, Max input current: 14*4 A, PV Isc: 25*4 A. Rated grid frequency: 50 Hz, Rated output power: 1600 W, Rated grid voltage: L/N/PE, 230 V, Max output current: 6,96 A. SG2000: Max input voltage: 65 V, MPPT voltage range: 25-55 V, Max input current: 16*4 A, PV Isc: 25*4 A. Rated grid frequency: 50 Hz, Rated output power: 2000 W, Rated grid voltage: L/N/PE, 230 V, Max output current: 8,7 A.
Test Laboratory / address	DEKRA Testing and Certification (Shanghai) Ltd. No.250, Jiangchangsan Road, Jing'an District, Shanghai, China
Applicant´s name / address	Solenso electronic materials Co., LTD. 4F., No. 56, Zili 5th St., Zhongli Dist., Taoyuan City 320, Taiwan, China
Test method requested, standard	EN IEC 61000-6-1:2019 EN IEC 61000-6-3:2021
Verdict Summary	IN COMPLIANCE

Tested by (name / position & signature)	Kaiyuan Dai Project Manager 
Approved by (name / position & signature)	Wency Yang Technical Manager 
Date of issue	2025-01-09
Report template No	TRF_EN61000-6-3_EN61000-6-1_EMC V1.0

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COMPETENCES AND GUARANTEES

DEKRA is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated in the report and it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

GENERAL CONDITIONS

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or Competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA.

UNCERTAINTY

For all measurements where guidance for the calculation of the instrumentation uncertainty of a measurement is specified in EN 55016-4-2 (CISPR 16-4-2), EN/IEC 61000-4 series or a product standard, the measurement instrumentation uncertainty has been calculated and applied in accordance with these standards.

Uncertainties have been calculated according to the DEKRA internal document PROD-P-EMC-M22. The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%. Refer to the Annex 1 for furter information.

The measurement result is considered in conformance with the requirement if it is within the prescribed limit, It is not necessary to calculate the uncertainty associated with the measurement result.

ENVIRONMENTAL CONDITIONS

The climatic conditions during the tests are within the limits specified by the manufacturer for the operation of the EUT and the test equipment. The climatic conditions during the tests were within the following limits:

Ambient temperature	15 °C – 35 °C
Relative Humidity air	30% - 60%
Atmospheric pressure	86 kPa – 106 kPa

If explicitly required in the basic standard or applied product / product family standard the climatic values are recorded and documented separately in this test report.

POSSIBLE TEST CASE VERDICTS

Test case does not apply to test object	N/A
Test object does meet requirement	P (Pass) / PASS
Test object does not meet requirement	F (Fail) / FAIL
Not measured	N/M

DEFINITION OF SYMBOLS USED IN THIS TEST REPORT

☒ Indicates that the listed condition, standard or equipment is applicable for this report/test/EUT.				
☐ Indicates that the listed condition, standard or equipment is not applicable for this report/test/EUT.				
Decimal separator used in this report	☒	Comma (,)	☐	Point (.)

ABBREVIATIONS

For the purposes of the present document, the following abbreviations apply:

EUT : Equipment Under Test
QP : Quasi-Peak
CAV : CISPR Average
AV : Average
CDN : Coupling Decoupling Network
SAC : Semi-Anechoic Chamber
OATS : Open Area Test Site
BW : Bandwidth
AM : Amplitude Modulation
PM : Pulse Modulation
HCP : Horizontal Coupling Plane
VCP : Vertical Coupling Plane
U_N : Nominal voltage
Tx : Transmitter
Rx : Receiver

N/A : Not Applicable
N/M : Not Measured
TEM : Transverse Electromagnetic Mode

DOCUMENT HISTORY

Report nr.	Date	Description
6209666.50	2024-12-02	First release.
6209666.50v1.1	2025-01-09	Correction.

REMARKS AND COMMENTS

The equipment under test (EUT) does meet the essential requirements of the stated standard(s)/test(s).

The test results relate only to the samples tested.

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According to the declaration from manufacturer, the two models have the same material and structure except for the different rated powers.
After review, all test were carried out on the model SG2000. The test results stated in this report are also representative for all models.

1 GENERAL INFORMATION

1.1 General Description of the Item(s)

Description of the item .....:	PV Microinverter
Test Model / Type number.....:	SG2000
Serial number .....:	N/A
Trademark.....:	Solenso
Manufacturer.....:	Solenso electronic materials Co., LTD. 4F., No. 56, Zili 5th St., Zhongli Dist., Taoyuan City 320, Taiwan, China

Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC: 220 – 240 V, 50/60 Hz	☐	☐	☐	☐	☐
	☐	AC: 100 – 240 V, 50/60 Hz	☐	☐	☐	☐	☐
	☒	DC: 25-55 Vdc					
	☐	Battery:					
Rated Power .....:	2000 W						
Clock frequencies .....:	Less than 108 MHz						
Other parameters.....:	Not provided						
Software version .....:	Not provided						
Hardware version.....:	Not provided						
Dimensions in cm (W x H x D)....:	Not provided						
Mounting position.....:	☒	Table top equipment					
	☒	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					
	☐	Other:					

Intended use of the Equipment Under Test (EUT)
The Inverter combines the functions of photovoltaic inverter which converts direct current (DC) electricity from solar panels into alternating current (AC) electricity for use in the home or business environment.

No	Module/parts of test item	Type	Manufacturer

No	Documents as provided by the applicant - Description	File name	Issue date

Modifications to the test item during testing .....:	☒	N/A	☐	Refer to the chapter

Copy of marking plate:
N/A

1.2 The environment(s) in which the EUT is intended to be used

The equipment under test (EUT) is intended to be used in the following environment(s):

☒	Residential (domestic) environment.
☒	Commercial and light-industrial environment.
☐	Industrial environment.

1.3 Test data

Test Location	DEKRA Testing and Certification (Shanghai) Ltd. No. 250, Jiangchangsan Road,Jing'an District, Shanghai, China
Date (receive sample)	2024-08-09
Date (start test)	2024-08-19
Date (finish test)	2024-08-20

1.4 Classification according to EN 55032 (CISPR 32)

For the Equipment Under Test (EUT) the following classification is applicable.

☐	Class A	All ITE equipment that satisfies Class A limits but not Class B limits. Such equipment should not be restricted in its sale but the following warning shall be included in the instruction for use. *Warning - This is a class A product. In a domestic environment this product may cause interference in which case the user may be required to take adequate measures.*
☒	Class B	Equipment intended primarily for use in the domestic environment and may include portable equipment, telecom terminal equipment powered by a telecom network and personal computers and auxiliary connected equipment.

2 DESCRIPTION OF TEST SETUP

2.1 Operating mode(s) used for tests

During the tests the following operating mode(s) has(have) been used.

Operating mode	Operating mode description	Used for testing	
		Emission	Immunity
1	PV supply to Gird	☒	☒
2		☐	☐
3		☐	☐
4		☐	☐
5		☐	☐
6		☐	☐
Supplemental information:			

2.2 Port(s) of the EUT

Port name and description	Connected to / Termination	Cable		
		Length used during test [m]	Attached during test	Shielded
DC input port	DC Source	1,5 m	☒	☐
AC grid port	LV power grid	1,5 m	☒	☐
			☐	☐
			☐	☐
			☐	☐
Supplemental information:				

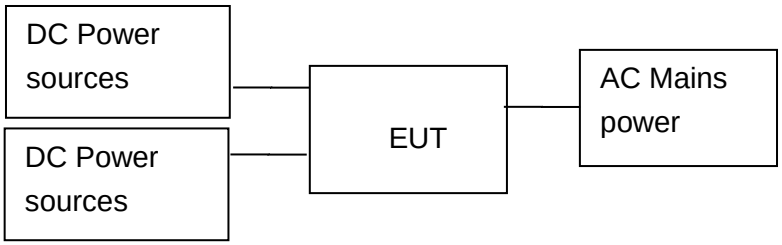
2.3 Support / Auxiliary equipment / unit / software for the EUT

The EUT has been tested with the following auxiliary equipment / unit / software:

Auxiliary equipment / unit / software	Type / Version	Manufacturer	Supplied by
DC Source	IT6018C-1500-40	ITECH	Test Lab
Supplemental information:			

2.4 Test Configuration / Block diagram used for tests

Test Configuration / Block diagram



Cable Type		Cable Description
A	AC Power line	Non-Shielded, 1,5 m
B	DC Power line	Non-Shielded, 1,5 m
C	DC Power line	Non-Shielded, 1,5 m

3 VERDICT SUMMARY SECTION

This chapter presents an overview of standards and results. Refer to the next chapters for details of measured test results and applied test levels.

3.1 Standards

Standard	Year	Description
EN IEC 61000-6-3	2021	Generic standards - Emission standard for residential, commercial and light-industrial environments.
EN 55016-2-1 +A1	2014 2017	Methods of measurement of disturbances and immunity - Conducted disturbance measurements.
EN 55016-2-3	2017	Methods of measurement of disturbances and immunity - Radiated disturbance measurements.
EN 55032 +A1	2015 2020	Electromagnetic compatibility of multimedia equipment - Emission requirements.
EN IEC 55014-1	2021	Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission.
EN IEC 61000-3-2 +A1	2019 2021	Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).
EN 61000-3-3 +A1 +A2	2013 2019 2021	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
EN 61000-3-12	2011	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase.
EN IEC 61000-3-11	2019	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection.
EN IEC 61000-6-1	2019	Generic standards - Immunity for residential, commercial and light-industrial environments.
EN 61000-4-2	2009	Electrostatic discharge immunity test.
EN IEC 61000-4-3	2020	Radiated, radio-frequency, electromagnetic field immunity test.
EN 61000-4-4	2012	Electrical fast transient/burst immunity test.
EN 61000-4-5 +A1	2014 2017	Surge immunity test.
EN 61000-4-6 +AC	2014 2015	Immunity to conducted disturbances, induced by radio-frequency fields.
EN 61000-4-8	2010	Power frequency magnetic field immunity test.
EN IEC 61000-4-11	2020	Voltage dips, short interruptions and voltage variations immunity tests.

3.2 Deviation(s) from the Standard(s) / Test Specification(s)

The following deviation(s) was / were made from the published requirements of the listed standards: N/A.

3.3 Overview of results

EMISSION TESTS – EN IEC 61000-6-3			
Requirement – Test case	**Basic standard(s)**	**Verdict**	**Remark**
Conducted disturbance voltage at AC power port(s)	EN 55016-2-1	PASS	---
Conducted disturbance voltage at DC power port(s)	EN 55016-2-1	PASS	---
Conducted disturbance voltage at Telecommunications / network port(s)	EN 55032, EN 55016-2-1	N/A	See 2)
Radiated electromagnetic disturbances (30 MHz to 1000 MHz)	EN 55016-2-3	PASS	---
Radiated electromagnetic disturbances (above 1 GHz)	EN 55016-2-3	N/A	See 4)
Discontinuous disturbance (clicks) on AC power leads	EN IEC 55014-1	N/A	See 6)
Harmonic current emissions	EN IEC 61000-3-2 EN 61000-3-12	N/A	See 7)
Voltage changes, voltage fluctuations and flicker	EN 61000-3-3 EN IEC 61000-3-11	N/A	See 7)

Supplementary information:

1) The EUT does not have a DC power port.

2) The EUT does not have a telecommunications network port.

3) Since the rated power of the EUT is less then 75 Watts harmonics test is not applicable.

4) The EUT is regarded as a professional equipment with a total rated power greater than 1 KW. The test is not applicable.

5) The highest internal frequency of the EUT is less than 108 MHz.

6) Exemptions from click measurements applicable (clause 4.2.3).

7) There is no AC Mains power terminal.

IMMUNITY TESTS – EN IEC 61000-6-1			
Requirement – Test case	**Basic standard(s)**	**Verdict**	**Remark**
Electrostatic discharge	EN 61000-4-2	PASS	---
Radio-frequency electromagnetic fields	EN 61000-4-3	PASS	---
Fast transients	EN 61000-4-4	PASS	---
Surge transient	EN 61000-4-5	PASS	---
Injected currents (radio-frequency common mode)	EN 61000-4-6	PASS	---
Power frequency magnetic fields	EN 61000-4-8	PASS	---
Voltage dips and short interruptions	EN 61000-4-11	N/A	See 3)

Supplementary information:

1) Applicable only to input ports.

2) Not applicable because no test requirements have been specified for DC/battery powered apparatus.

3) There is no AC Mains power terminal.

4) The test is not applicable as the apparatus does not contain any components susceptible to this low-frequency magnetic fields.

4 EMISSION TEST RESULTS

4.1 **Conducted disturbance voltage – AC power port(s)**	**VERDICT: PASS**

Standard	EN 61000-6-3
Basic standard(s)	EN 55016-2-1

Limits

Frequency range [MHz]	Limit: QP [dB(μV)[1)]]	Limit: AV [dB(μV) [1)]]	IF BW	Detector(s)
0,15 - 0,50	66 – 56 [2)]	56 - 46 [2)]	9 KHz	QP, CAV
0,50 - 5,0	56	46	9 KHz	QP, CAV
5,0 - 30	60	50	9 KHz	QP, CAV

[1)] At the transition frequency, the lower limit applies.
[2)] The limit decreases linearly with the logarithm of the frequency.

Performed measurements

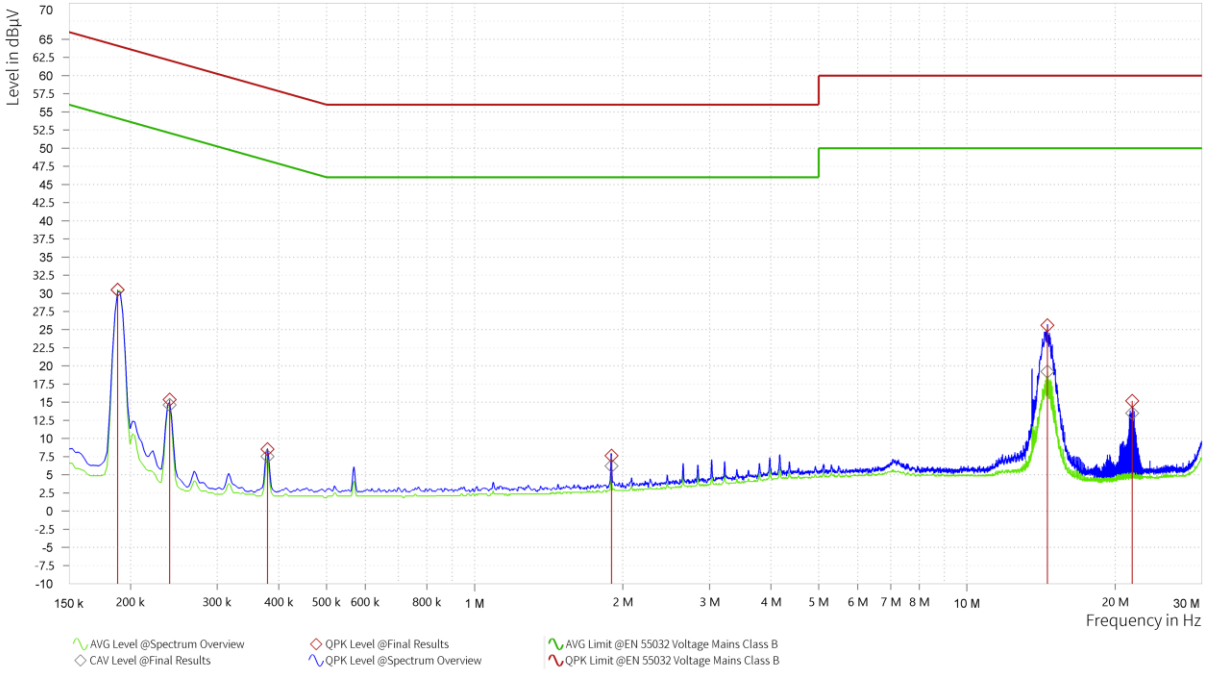
Port under test		Terminal							
☒	AC mains output power	☒	N	☒	L1	☐	L2	☐	L3
☐	Other: DC input power	☐	N	☐	L1	☐	L2	☐	L3

Voltage – Mains [V]	230 Vac			
Frequency – Mains [Hz]	50 Hz			
Test method applied	☒	Artificial mains network		
	☐	Voltage probe		
Test setup	☒	Table top	☐	Artificial hand applied
	☐	Floor standing	☐	Other:
	Refer to the Annex 3 for test setup photo(s).			
Operating mode(s) used	Mode 1			
Remark	---			

See next page.

Measurement data	Port under test	AC mains output power
Operating mode / voltage / frequency used during the test		Mode 1 / 230 Vac / 50 Hz

Line

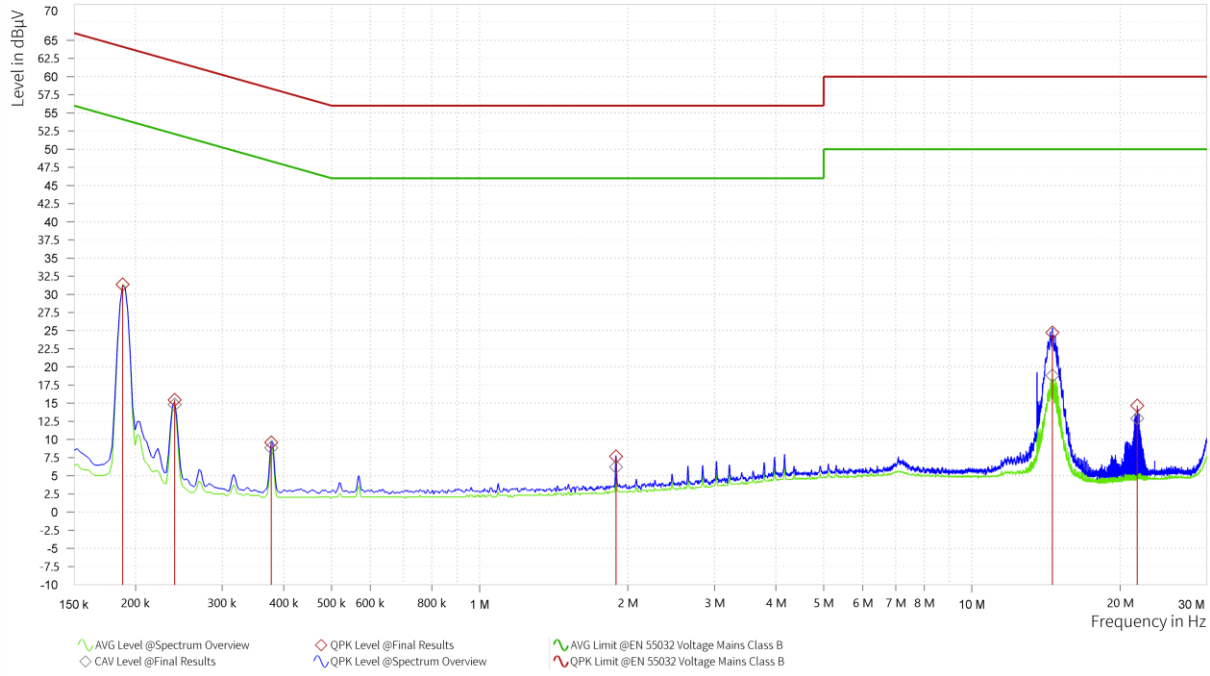


Rg	Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	CAV Level [dBµV]	CAV: AVG Limit [dBµV]	CAV Margin [dB]	Correction [dB]	Line
1	0.188	30.48	64.11	33.63	30.47	54.11	23.64	9.56	L1
1	0.240	15.34	62.10	46.76	14.65	52.10	37.45	9.58	L1
1	0.380	8.51	58.29	49.78	7.54	48.29	40.75	9.60	L1
1	1.896	7.64	56.00	48.36	6.21	46.00	39.79	9.67	L1
1	14.579	25.60	60.00	34.40	19.21	50.00	30.79	9.91	L1
1	21.667	15.20	60.00	44.80	13.51	50.00	36.49	9.88	L1

Remark	1. QPK Level [dBµV]=Reading QPK Level [dBµV] + Correction [dB] 2. CAV Level [dBµV]=Reading CAV Level [dBµV] + Correction [dB] 3. Correction [dB]= AMN VDF [dB] + Cable Loss [dB]

Measurement data	Port under test	AC mains output power
Operating mode / voltage / frequency used during the test		Mode 1 / 230 Vac / 50 Hz

Neture



Rg	Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	CAV Level [dBµV]	CAV: AVG Limit [dBµV]	CAV Margin [dB]	Correction [dB]	Line
1	0.188	31.35	64.11	32.77	31.36	54.11	22.76	9.55	N
1	0.240	15.46	62.10	46.64	14.80	52.10	37.29	9.55	N
1	0.377	9.59	58.34	48.75	8.88	48.34	39.46	9.57	N
1	1.892	7.66	56.00	48.34	6.22	46.00	39.78	9.64	N
1	14.579	24.75	60.00	35.25	18.81	50.00	31.19	9.89	N
1	21.667	14.65	60.00	45.35	12.91	50.00	37.09	9.92	N

Remark	1. QPK Level [dBµV]=Reading QPK Level [dBµV] + Correction [dB] 2. CAV Level [dBµV]=Reading CAV Level [dBµV] + Correction [dB] 3. Correction [dB]= AMN VDF [dB] + Cable Loss [dB]

4.2 Conducted disturbance voltage – DC power port(s) — VERDICT: PASS

Standard	EN 61000-6-3, EN IEC 61000-6-4
Basic standard(s)	EN 55016-2-1

Limits

Frequency range [MHz]	Limit: QP [dB(μV)[1)]]	Limit: AV [dB(μV) [1)]]	IF BW	Detector(s)
0,15 - 0,50	79	66	9 KHz	QP, CAV
0,50 - 30	73	60	9 KHz	QP, CAV

[1)] At the transition frequency, the lower limit applies.

[2)] Applicable only to ports intended for connection to a local DC power network, or a local battery by a connecting cable exceeding a length of 30 m.

Performed measurements

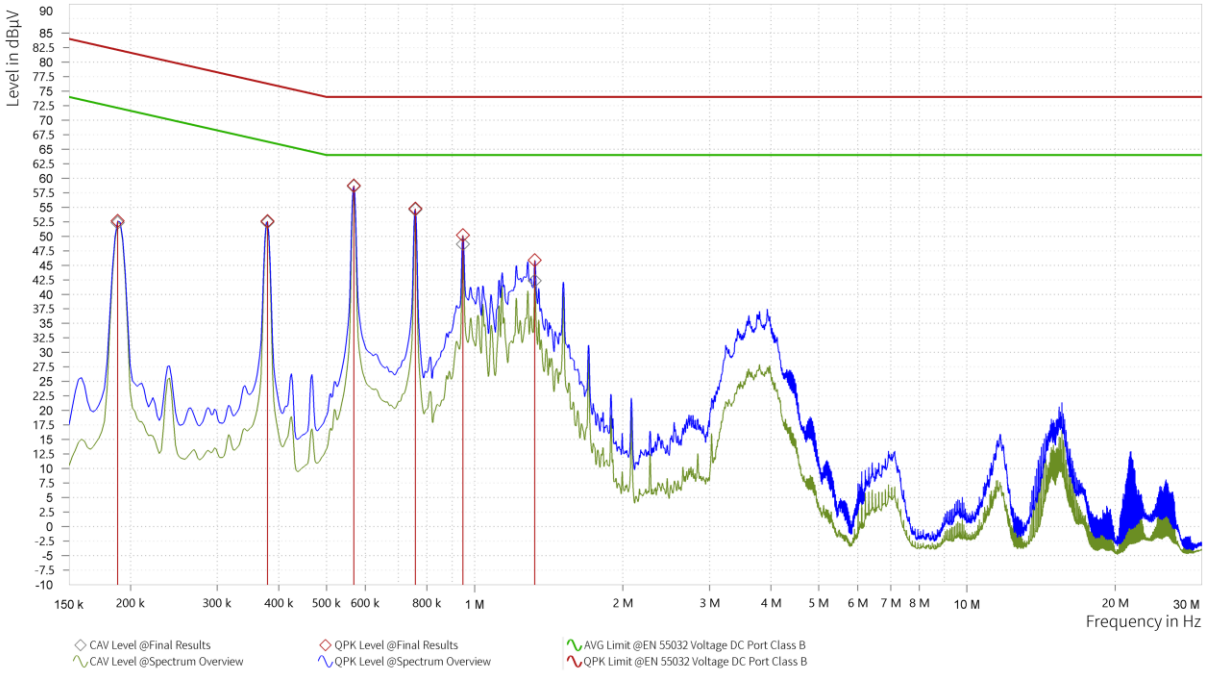
Port under test		Terminal			
☒	DC input power	☒	Positive (+)	☒	Negative (-)
☐	Other:	☐	Positive (+)	☐	Negative (-)

Voltage – Mains [V]	48 Vdc			
Frequency – Mains [Hz]	N/A			
Test method applied	☒	Artificial mains network as specified EN 55016-1-2		
	☐	Artificial Network (AN) as specified in CISPR 25 Annex D		
Test setup	☒	Table top	☐	Artificial hand applied
	☐	Floor standing	☐	Other:
	Refer to the Annex 3 for test setup photo(s).			
Operating mode(s) used	Mode 1			
Remark	---			

See next page.

Measurement data	Port under test	DC input power
Operating mode / voltage	Mode 1 / 48 Vdc	

PV 1- Positive (+)

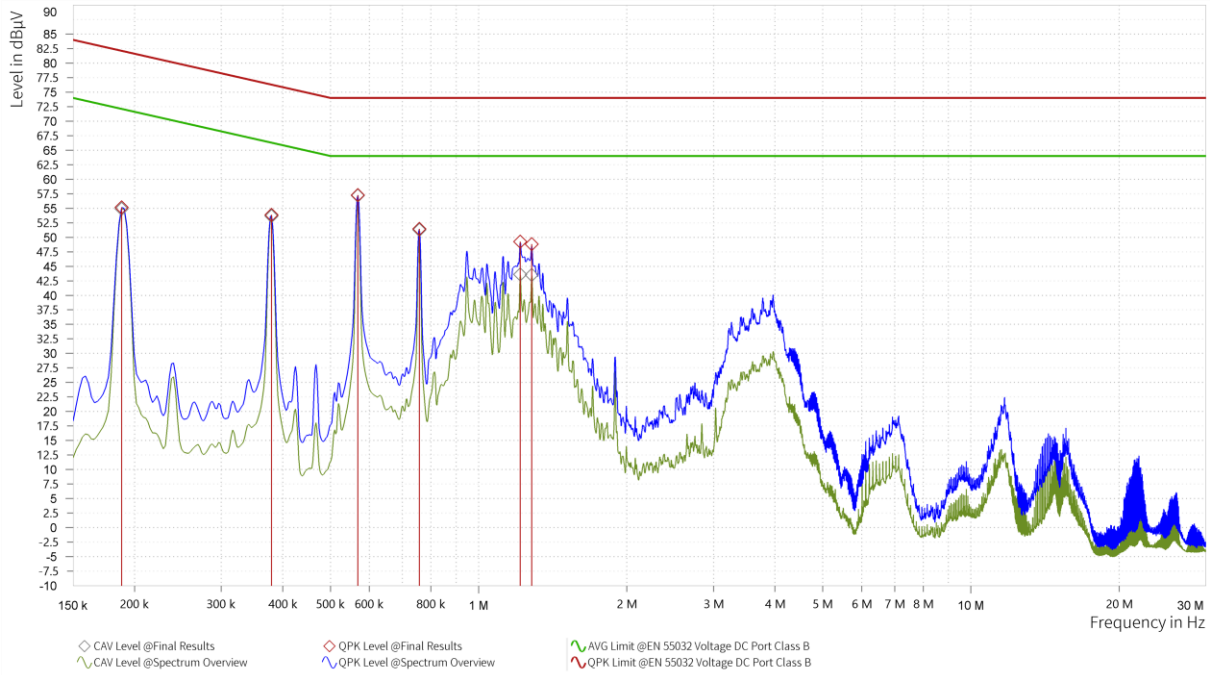


Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	CAV Level [dBµV]	CAV: AVG Limit [dBµV]	CAV Margin [dB]	Correction [dB]	Line
0.188	52.65	82.11	29.46	52.37	72.11	19.74	9.78	Positive
0.380	52.63	76.29	23.66	52.45	66.29	13.84	9.75	Positive
0.569	58.72	74.00	15.28	58.62	64.00	5.38	9.74	Positive
0.758	54.76	74.00	19.24	54.60	64.00	9.40	9.81	Positive
0.947	50.19	74.00	23.81	48.64	64.00	15.36	9.87	Positive
1.325	45.88	74.00	28.12	42.34	64.00	21.66	9.87	Positive

Remark	1. QPK Level [dBµV]=Reading QPK Level [dBµV] + Correction [dB] 2. CAV Level [dBµV]=Reading CAV Level [dBµV] + Correction [dB] 3. Correction [dB]= AMN VDF [dB] + Cable Loss [dB]

Measurement data	Port under test	DC input power
Operating mode / voltage	Mode 1 / 48 Vdc	

PV 1- Negative (-)



Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	CAV Level [dBµV]	CAV: AVG Limit [dBµV]	CAV Margin [dB]	Correction [dB]	Line
0.188	55.14	82.11	26.97	54.91	72.11	17.20	9.83	Negative
0.380	53.86	76.29	22.43	53.67	66.29	12.62	9.78	Negative
0.569	57.27	74.00	16.73	57.17	64.00	6.83	9.74	Negative
0.758	51.44	74.00	22.56	51.27	64.00	12.73	9.82	Negative
1.214	49.25	74.00	24.75	43.62	64.00	20.38	9.90	Negative
1.282	48.84	74.00	25.16	43.53	64.00	20.47	9.90	Negative

Remark	1. QPK Level [dBµV]=Reading QPK Level [dBµV] + Correction [dB] 2. CAV Level [dBµV]=Reading CAV Level [dBµV] + Correction [dB] 3. Correction [dB]= AMN VDF [dB] + Cable Loss [dB]

4.3 **Radiated electromagnetic disturbances (30 – 1000 MHz)**	**VERDICT: PASS**

Standard	EN 61000-6-3, EN IEC 61000-6-4
Basic standard(s)	EN 55016-2-3
Test method	Antenna method according to EN 55016-2-3 standard.
Supplementary information:	

Limits

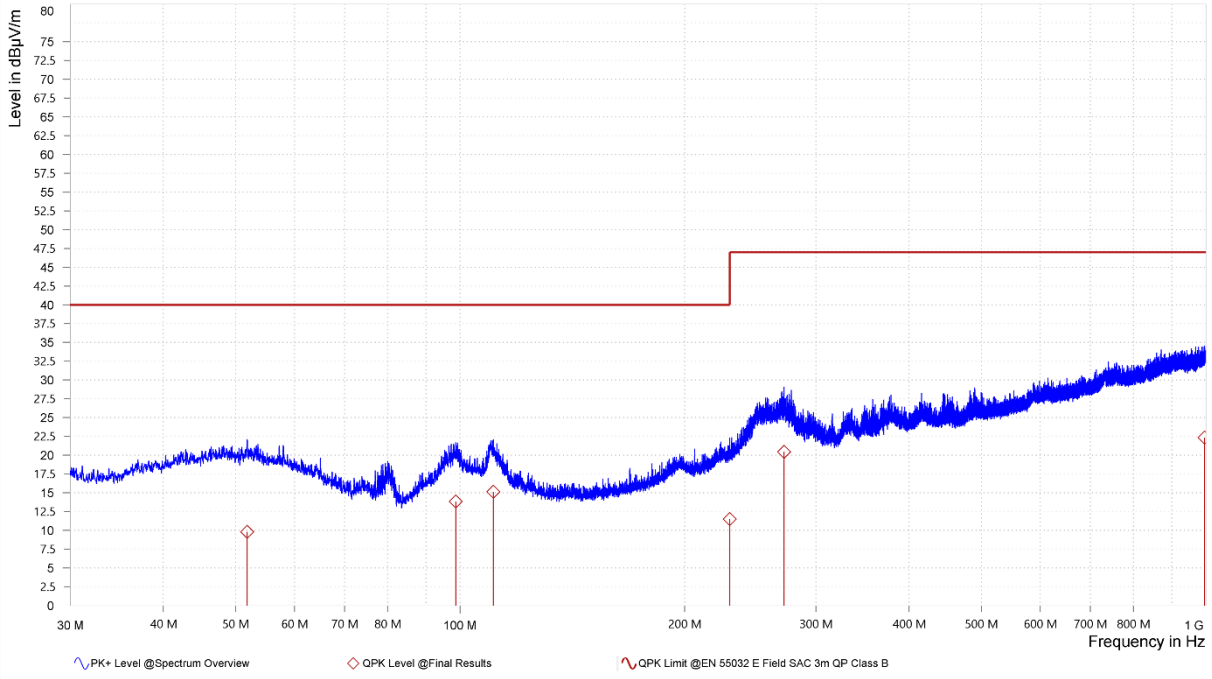
Frequency	Limit: QP [dB(μV/m)[1)]]			IF BW	Detector
[MHz]	@3 m.	@5 m.	@10 m.		
30 - 230	40	36	30	120 KHz	QP
230 - 1000	47	43	37	120 KHz	QP
[1)] At the transition frequency, the lower limit applies.					

Performed measurements

Port under test	Enclosure	
Voltage – Mains [V]	230 Vac and DC 48 V	
Frequency – Mains [Hz]	50 Hz	
Test method applied	☒	OATS or SAC with measurement distance [m]: 3 m.
	☐	OATS or SAC with measurement distance [m]: 5 m.
	☐	OATS or SAC with measurement distance [m]: 10 m.
Test setup	☒	Equipment on a table of 80 cm height
	☐	Equipment on the floor (insulated from ground plane)
	☐	Other:
	Refer to the Annex 3 for test setup photo(s).	
Operating mode(s) used		
Remark	---	

See next page.

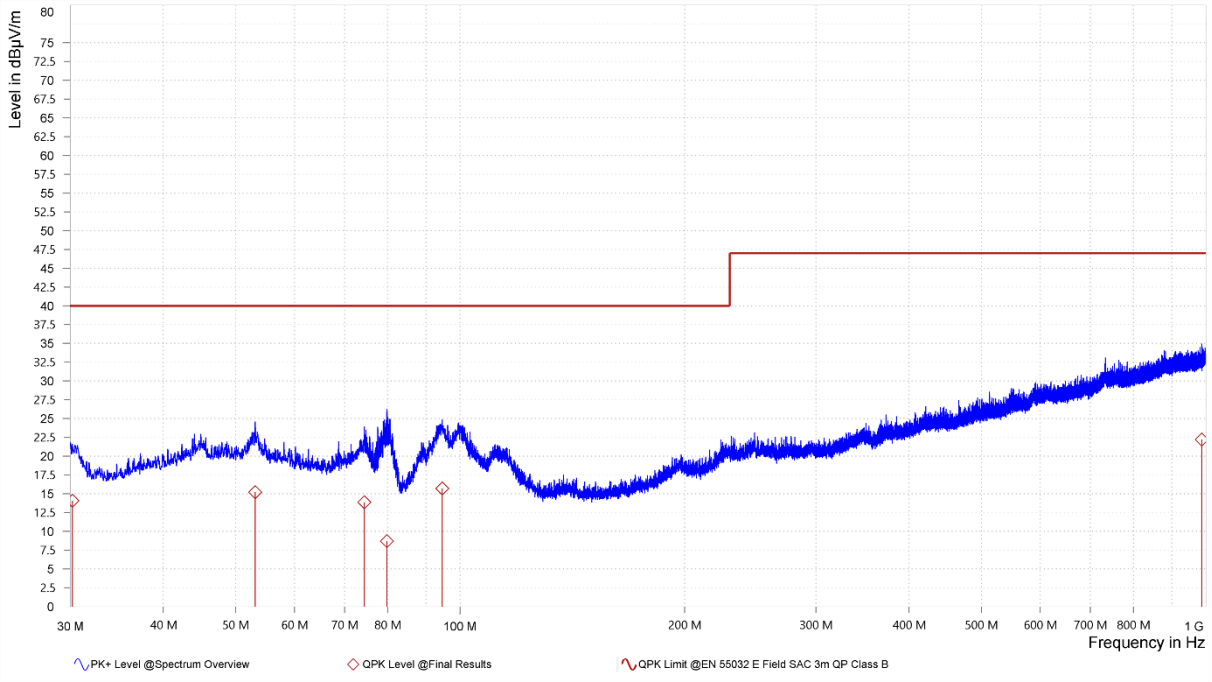
Measurement data	☒	**Horizontal**	☐	**Vertical**
Operating mode / voltage / frequency used during the test		Mode 1 / 230 Vac / 50 Hz and DC 48 V		



Frequency [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	Correction [dB]	Polarization
51.840	9.82	40.00	30.18	21.06	H
98.700	13.85	40.00	26.15	18.93	H
110.820	15.13	40.00	24.87	18.49	H
229.920	11.49	40.00	28.51	19.88	H
271.920	20.46	47.00	26.54	20.61	H
996.330	22.34	47.00	24.66	32.24	H

Remark	1. QPK Level [dBµV/m]=Reading QPK Level [dBµV/m] + Correction [dB/m] 2. Correction [dB/m]=Antenna Factor [dB/m] + Cable Loss [dB]

Measurement data	☐	**Horizontal**	☒	**Vertical**
Operating mode / voltage / frequency used during the test		Mode 1 / 230 Vac / 50 Hz and DC 48 V		



Frequency [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	Correction [dB]	Polarization
30.210	14.09	40.00	25.91	17.37	V
53.130	15.22	40.00	24.78	21.04	V
74.400	13.87	40.00	26.13	15.37	V
79.800	8.69	40.00	31.31	14.26	V
94.650	15.70	40.00	24.30	18.34	V
987.840	22.20	47.00	24.80	32.09	V

Remark	1. QPK Level [dBµV/m]=Reading QPK Level [dBµV/m] + Correction [dB/m] 2. Correction [dB/m]=Antenna Factor [dB/m] + Cable Loss [dB]

5 IMMUNITY TEST RESULTS

5.1 Performance (Compliance) criteria

[Source: EN/IEC 61000-6-1]

Performance criterion A: The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

Performance criterion B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

Performance criterion C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

5.1.1 Performance criteria related to immunity tests

Immunity test	Performance criteria
Electrostatic discharge	B
Radio-frequency electromagnetic fields	A
Fast transients	B
Surge transient	B
Injected currents (radio-frequency common mode)	A
Power frequency magnetic field immunity	A
Voltage dips and short interruptions	B, C

5.1.2 Manufacturer defined performance criteria

Not provided.

5.2 Monitored – Checked Functions / Parameters

During the immunity tests the following functions of the EUT has/have been monitored/checked.

☐	Motor speed	☐	Display data
☐	Switching	☐	Data storage
☐	Standby mode	☐	Sensor functions
☐	Temperature	☐	Audible signals
☐	Power consumption	☒	Others : DC input Voltages and Currents
☐	AC mains input current	☒	Others : AC mains input current
☐	Timing	☐	Others :
☐	Illumination	☐	Others :
Supplementary information :			

Immunity test	**Monitored - Checked function(s)/parameter(s) during / after the test**	**Method**
Electrostatic discharge	Voltages and Currents	Visual /Digital meter
Radio-frequency electromagnetic fields	Voltages and Currents	Camera/Digital meter
Fast transients	Voltages and Currents	Visual /Digital meter
Surge transient	Voltages and Currents	Visual /Digital meter
Injected currents (radio-frequency common mode)	Voltages and Currents	Visual /Digital meter
Power frequency magnetic field immunity	Voltages and Currents	Visual /Digital meter
Supplementary information :		

5.3 **Electrostatic discharge immunity**	**VERDICT: PASS**

Electrostatic discharges (ESD) are the result of persons or objects that accumulate static electricity due to for instance walking on synthetic carpets. The ESD can influence the operation of equipment or damage its electronics, either by a direct discharge or indirectly by coupling or radiation. Both effects are simulated during the tests.

Requirements

Standard	EN IEC 61000-6-1							
Basic standard	EN 61000-4-2							
Port under test	Enclosure							
Air discharges	☒	±2 kV	☒	±4 kV	☒	±8 kV	☐	kV
Contact discharges	☒	±2 kV	☒	±4 kV	☐	±8 kV	☐	kV
Number of discharges	≥ 10 per polarity with ≥ 1 sec interval.							
Performance criterion	B; During the test degradation is allowed. No change of operating state or stored data is allowed. Refer to the chapter 5.1 for details.							

Performed tests

Set-up	☒	Table-top	☐	Floor standing
Ambient temperature [°C]			Relative Humidity air [%]	
Voltage – Mains [V]	230 Vac and 48 Vdc			
Frequency – Mains [Hz]	50 Hz			
Operating mode(s) used	PV supply to Gird			

Test Point (Location of discharge, see also photo)		Test Voltage [kV] & Polarity	Coupling type	# of applied discharges / polarity	Discharge interval [s]
☒	Points on conductive surface as indicated in the picture below.	±2 / ±4	Contact	10	1
☒	Points on non-conductive surface as indicated in the picture below.	±2 / ±4 / ±8	Air	10	1
☒	HCP top side.	±4	Contact	10	1
☒	HCP bottom side.	±4	Contact	10	1
☒	VCP right side.	±4	Contact	10	1
☒	VCP left side.	±4	Contact	10	1
☒	VCP front side.	±4	Contact	10	1
☒	VCP rear side.	±4	Contact	10	1

Observation(s)	During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance or data was observed.

Supplementary information:

5.4	**Radio-frequency electromagnetic fields immunity**	**VERDICT: PASS**

During the test it is verified if the equipment under test (EUT) has sufficient immunity against radiated electromagnetic fields. Industrial electromagnetic sources, walkie-talkies, radio transmitters, television transmitters and telecommunication equipment including cellular telephones and other emitting devices can generate these fields.

Requirements

Standard	EN IEC 61000-6-1			
Basic standard	EN 61000-4-3			
Port under test	Enclosure			
Frequency range	Test level	Modulation	Dwell time	Step size
80 – 1000 MHz	3 V/m	80% AM (1kHz)	≥ 0,5 s	≤ 1%
1400 – 2000 MHz	3 V/m	80% AM (1kHz)	≥ 0,5 s	≤ 1%
2000 – 6000 MHz	3 V/m	80% AM (1kHz)	≥ 0,5 s	≤ 1%
Supplementary information:				

Performed tests

Test method	☒	EN 61000-4-3	☐	EN 61000-4-20
Test set-up	☐	Equipment on the table (0,8 m height)		
(see annex 3 for photo)	☐	Equipment standing on floor (0,05 – 0,15 m height)		

Voltage – Mains [V]	230 V and 48 Vdc	Frequency – Mains [Hz]	50 Hz
Operating mode(s) used	PV supply to Gird		

Frequency range (applied)	Antenna Polarization	Test level (applied)	Modulation (applied)	Dwell time (applied)	Remark
80 – 1000 MHz	H	3 V/m	80% AM (1kHz)	3 s	
(step size 1%)	V	3 V/m	80% AM (1kHz)	3 s	
1400 – 2000 MHz	H	3 V/m	80% AM (1kHz)	3 s	
(step size 1%)	V	3 V/m	80% AM (1kHz)	3 s	
2000 – 6000 MHz	H	3 V/m	80% AM (1kHz)	3 s	
(step size 1%)	V	3 V/m	80% AM (1kHz)	3 s	

Exposed side of the EUT	☒	Front (0°)	☒	Right (90°)	☒	Top
	☒	Rear (180°)	☒	Left (270°)	☒	Bottom

Observation(s)	During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance or data was observed.
Supplementary information:	

5.5 Electrical Fast Transients immunity — VERDICT: PASS

The EFT immunity test simulates disturbances by bursts of very short transients caused for example by switching off loads such as an AC motor or bouncing relay contacts. The transients are likely to disturb electronics but less likely to cause damage.

Requirements

Standard		EN IEC 61000-6-1		
Basic standard		EN 61000-4-4		
Pulse characteristics		5/50 ns		
Port under test		Test level	Repetition frequency	Duration
☒	AC input-output power	± 1000 V ± 2000 V	5 KHz	≥1 min. / polarity
☒	DC input power [2)]	± 500 V ± 1000 V	5 KHz	≥1 min. / polarity
☐	Signal ports [1)]	± 500 V	5 KHz	≥1 min. / polarity

[1)] Only applicable to ports interfacing with cables whose total length may exceed 3 m.

[2)] Not applicable to input ports intended for connection to a battery or a rechargeable battery which must be removed or disconnected from the apparatus for recharging. Apparatus with a DC power input port intended for use with an AC–DC power adaptor shall be tested on the AC power input of the AC- DC power adaptor specified by the manufacturer or, where none is so specified, using a typical AC–DC power adaptor. The test is applicable to DC power input ports intended to be connected permanently to cables longer than 3 m.

Performed tests

Voltage – Mains [V]	230 Vac and 48 Vdc			
Frequency – Mains [Hz]	50 Hz			
Operating mode(s) used	PV supply to Gird			
Test Set-up (see annex 3 for photo)	☒	Equipment standing on floor at (0,1 ± 0,01) m above ground plane		
	☐	Equipment on the table (0,1 ± 0,01) m above ground plane		
	☐	Artificial hand applied. Location refer to chapter 9.		
Coupling	☒	Common mode	☐	Other:

Port under test	Test Voltage &Polarity	Repetition Frequency	Test duration / polarity	Injection method			
AC mains power input	± 1000 V ± 2000 V	5 KHz	2 min.	☒	CDN	☐	Clamp
DC power output	± 500 V ± 1000 V	5 KHz	2 min.	☒	CDN	☐	Clamp
Ethernet / LAN		5 KHz		☐	CDN	☐	Clamp
I / O signal		5 KHz		☐	CDN	☐	Clamp
Observation(s)	During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance or data was observed.						
Supplementary information:							

5.6	**Surge transient immunity**	**VERDICT: PASS**

The surge transient immunity test simulates the surges that are caused by over-voltages due to indirect (induced) lightning transients. The pulse is a slow transient with high-energy contents and due to its long duration may cause damage to an unprotected EUT.

Requirements

Standard		EN 61000-6-1		
Basic standard		EN 61000-4-5		
Pulse characteristics		1,2/50µs Voltage; 8/20µs Current		
Repetition rate		≥ 60 secs. (for each test level and phase angle)		
Number of pulses		5 pulses (at each polarity and phase angle)		
Port		Test level & Polarity & Coupling		Phase angle [°]
		Line to Line [1]	Line to Earth [1]	
☒	AC input-output power	± 1 kV	± 2 kV	0, 90, 180, 270
☒	DC input power [2]	± 0,5 kV	± 1 kV	---

[1] In addition to the specified test level, all lower test levels as detailed in EN 61000-4-5 should also be satisfied.

[2] Not applicable to input ports intended for connection to a battery or a rechargeable battery which must be removed or disconnected from the apparatus for recharging. Apparatus with a DC power input port intended for use with an AC–DC power adaptor shall be tested on the AC power input of the AC–DC power adaptor specified by the manufacturer or, where none is so specified, using a typical AC–DC power adaptor. DC ports, which are not intended to be connected to a DC distribution network are treated as signal ports.

Performed tests

Voltage – Mains [V]	230 Vac and 48 Vdc
Frequency – Mains [Hz]	50 Hz
Operating mode(s) used	PV supply to Gird
Repetition rate	60 secs. (for each test level and phase angle)
Number of pulses	5 pulses (at each polarity and phase angle)

Port under test		Coupling	Test level & Polarity	Phase angle [°]	Remark
☒	AC mains output power	Line to Neutral	±0,5 / ±1 kV	0, 90, 180, 270	
☒	AC mains output power	Line to Earth	±0,5 / ±1 / ±2 kV	0, 90, 180, 270	
☒	DC input power	Neutral to Earth	±0,5 / ±1 kV	0, 90, 180, 270	
Observation(s)		During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance or data was observed.			
Supplementary information: 1. The EUT does not include an earth port.					

5.7	**Injected currents (RF common mode) immunity**	**VERDICT: PASS**

During this test the immunity of the equipment for induced or conducted electromagnetic fields is checked. Fields generated by radio and other transmitters cause RF voltages in long cables like the mains network. This test reproduces these induced disturbing voltages by injecting them to the EUT via the cabling.

Requirements

Standard		EN IEC 61000-6-1			
Basic standard		EN 61000-4-6			
Frequency range		0,15 – 80 MHz			
Port under test		Test level, *Uo*	Modulation	Step size	Dwell time
☒	AC input-output power	3 V	80% AM (1kHz)	≤ 1%	≥ 0,5 s
☒	DC input-output power [1)]	3 V	80% AM (1kHz)	≤ 1%	≥ 0,5 s
☐	Signal port [1)]	3 V	80% AM (1kHz)	≤ 1%	≥ 0,5 s
[1)] Only applicable to ports interfacing with cables whose total length, may exceed 3 m.					

Performed tests

Test method (applied)	Frequency range (applied)	Modulation (applied)	Step size (applied)
EN 61000-4-6	0,15 – 80 MHz	80% AM (1kHz)	1%
Voltage – Mains [V]	230 Vac and 48 Vdc	Frequency – Mains [Hz]	50 Hz
Operating mode(s) used	PV supply to Gird		

Test set-up (see annex 3 for photo)		
	☐	Equipment standing on floor at (0,1 ± 0,01) m above ground plane.
	☐	Equipment on the table (0,1 ± 0,01) m above ground plane.
	☐	Artificial hand applied. Location refer to Annex 3.

Port under test	Test Level (applied	Injection method	Dwell time (applied)	Remark
AC input-output power	3 V	CDN-M3	3 s	
DC input-output power	3 V	CDN-M2	3 s	

Observation(s)	During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance or data was observed.

Supplementary information:

1. During the test the metal enclosure of the EUT was connected to the reference ground plane through CDN-M1, the RF port was terminated with 50 Ohm.

5.8	**Power frequency magnetic field immunity**	**VERDICT: PASS**

Magnetic fields caused by for example nearby mains frequency transformers may disturb equipment with sensitivity for these type of disturbances such as CRT monitors.

Requirements

Standard	EN 61000-6-1
Basic standard	EN 61000-4-8
Port under test	Enclosure
Field strength	3 A/m
Test Frequency	50 / 60 Hz
Notes: Applicable only to apparatus containing devices susceptible to magnetic fields.	

Performed tests

Reason for not performing the test	☐	The test is not applicable as the apparatus does not contain any components susceptible to this low-frequency magnetic fields.
Voltage – Mains [V]	230 Vac and 48 Vdc	
Frequency – Mains [Hz]	50 / 60 Hz	
Operating mode(s) used	1	
Test set-up (see annex 3 for photo)	☒	Single Coil. Dimensions: 1 m x 1 m
	☐	Single Coil. Dimensions: 2 m x 2 m
	☐	Homogeneous field (Helmholtz coil). Dimensions: 1 m x 1 m
	☐	0,1 m above metal surface

Axis under test		Tested Field strength	Test Frequency	Test Duration	Remark
☒	X-axis	3 A/m	50 / 60 Hz	1 min	---
☒	Y-axis	3 A/m	50 / 60 Hz	1 min	---
☒	Z-axis	3 A/m	50 / 60 Hz	1 min	---
Observation(s)		During the test no loss of performance was observed. After the test the EUT functioned as intended. No unacceptable loss of performance was observed.			
Supplementary information:					

6 IDENTIFICATION OF THE EQUIPMENT UNDER TEST

EUT PHOTO

7 ANNEX 1 - MEASUREMENT UNCERTAINTIES

The table(s) below show(s) measurment uncertainties of the EMC test set-ups. The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Emission tests		U_{LAB}	U_{CISPR}
Conducted disturbance using AMN 9 kHz – 150 kHz	Shielded Room No.2 AMN: R&S ENV216	3.0 dB	3.8 dB
Conducted disturbance using AMN 150 kHz – 30 MHz		2.5 dB	3.4 dB
Conducted disturbance using AMN 9 kHz – 150 kHz	Shielded Room No.2 AMN: R&S ENV432	3.2 dB	3.8 dB
Conducted disturbance using AMN 150 kHz – 30 MHz		2.7 dB	3.4 dB
Radiated disturbance in a SAC 30 MHz – 1000 MHz	Horizontal polarization	4.8 dB	6.3 dB
	Vertical polarization	5.4 dB	

Immunity tests		U_{LAB}	$U_{IEC\ (Recommendation)}$
Electrostatic discharge	Rise time (t_r)	12.4 %	≤ 15 %
	Peak current (I_p)	6.4 %	≤ 7 %
	Current at 30 ns (I_{30})	6.4 %	≤ 7 %
	Current at 60 ns (I_{60})	6.4 %	≤ 7 %
Electrical fast transients/burst	Rise time (t_r)	7.2 %	N/A
	Peak voltage (V_p)	6.8 %	
	Pulse width (t_w)	5.4 %	
Surge	Front time (t_f)	4.3 %	N/A
	Peak voltage (V_p)	6.7 %	
	Voltage duration (T_d)	1.3 %	
Conducted disturbances, induced by radio-frequency fields	CDN (v)	1.6 dB	N/A
	EM clamp (v)	3.6 dB	
Power frequency magnetic field	Test level: 1 A/m (I_1)	0.1 A/m	N/A
	Test level: 3 A/m (I_3)	0.3 A/m	
	Test level: 10 A/m (I_{10})	0.8 A/m	
	Test level: 30 A/m (I_{30})	2.1 A/m	
Voltage dips, short interruptions and voltage variations	Time at reduced voltage (t_s)	3.0 %	N/A
	Voltage rising time (t_r)	3.0 %	
	Voltage fall time (t_f)	3.0 %	
	Voltage dips (v)	0.4 %	
Radiated radio-frequency electromagnetic field 80 MHz – 1000 MHz		1.9 dB	N/A
Radiated radio -frequency electromagnetic field 1000 MHz – 6000 MHz		2.0 dB	N/A

8 ANNEX 2 – USED EQUIPMENT

Conducted disturbance -Shielded Room No.2

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
EMI test receiver	R&S	ESR3	102305	2025/06/13
Four-line V-network	R&S	ENV432	101634	2024/11/28
Artificial Mains Network	R&S	ENV216	102747	2024/11/28
Software	R&S	ELEKTRA	4.32.0	N/A

Radiated disturbance (30 MHz to 1000 MHz) -Anechoic Chamber No.1

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
EMI test receiver	R&S	ESR7	102433	2024/11/28
Trilog broadband antenna+Attenuator	SCHWARZBECK	VULB9163/ 6dB	01514	2025/03/12
Open Switch and control unit	R&S	OSP220	102232	N/A
Software	R&S	ELEKTRA	4.20.2	N/A

Electrostatic discharge immunity

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
ESD generator	TESEQ	NSG 438	1870	2024/11/23

Radio-frequency electromagnetic fields immunity (80 MHz~1000 MHz) -Anechoic Chamber No.2

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
Signal generator	R&S	SMB100B	103114	2024/11/28
Broadband Amplifier	R&S	BBA150 BC250	104841	2024/11/28
High Gain Log-periodic antenna	R&S	HL046E	100355	N/A
Open Switch and control unit	R&S	OSP220	102233	N/A
NRP6AN average power sensor	R&S	NRP6AN	101697	2024/11/28
NRP6AN average power sensor	R&S	NRP6AN	101698	2024/11/28
Field probe	LUMILOOP	LSProbe 1.2	531	2025/10/10
Software	R&S	ELEKTRA	4.20.2	N/A

Fast transient immunity

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
Compact immunity test system	TESEQ	NSG-3040-MF	2006/EFT:0535	2025/06/13
EFT/Burst capacitive coupling clamp	TESEQ	CDN 3425	1786	N/A

Surge immunity

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
Compact immunity test system	TESEQ	NSG-3040-MF	2006 /SURGE:1234	2025/06/13
Coupling/Decoupling Network (CDN)	TESEQ	CDN 117-M	35452	N/A

Injected currents immunity

Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
Compact immunity test system	TESEQ	NSG 4070-30	35895	2025/06/13
Coupling/Decoupling Network (CDN)	TESEQ	CDN M016S	34640	2025/06/13
Attenuator	TESEQ	ANT 6050	34847	2025/06/13
EM clamp	TESEQ	KEMZ 801A	35475	2025/06/13

Power frequency magnetic field immunity

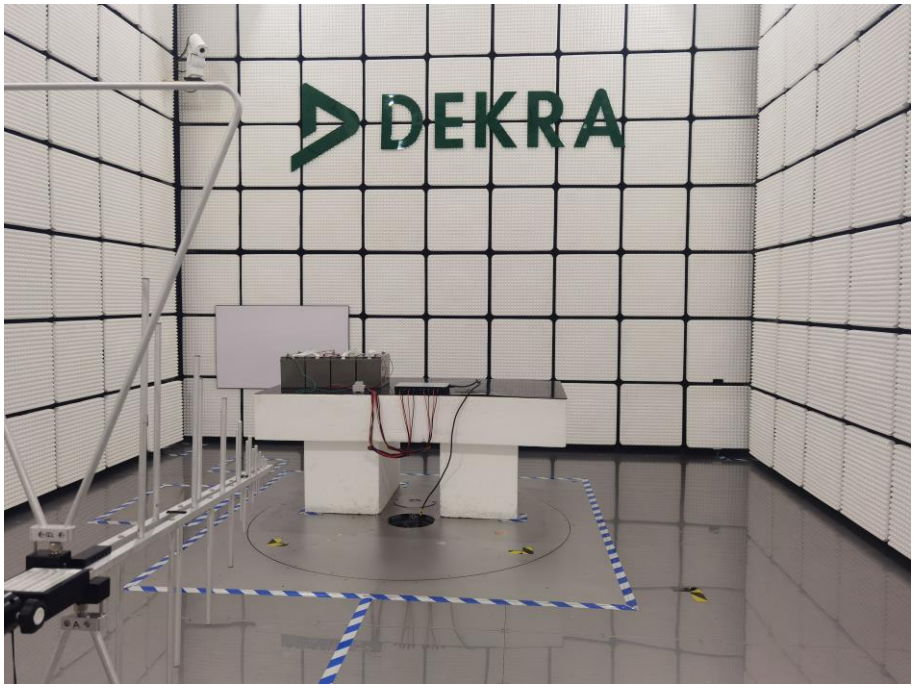
Equipment	Manufacturer	Model No.	Serial No.	Cal. due date
AC power source	EMTEST	Netwave7-400	P2136256253	2025/01/21
Magnetic Field Immunity Loop	FCC	F-1000-4-8/9/10-L-1M	05016	2025/01/14

9 ANNEX 3 - TEST PHOTOS

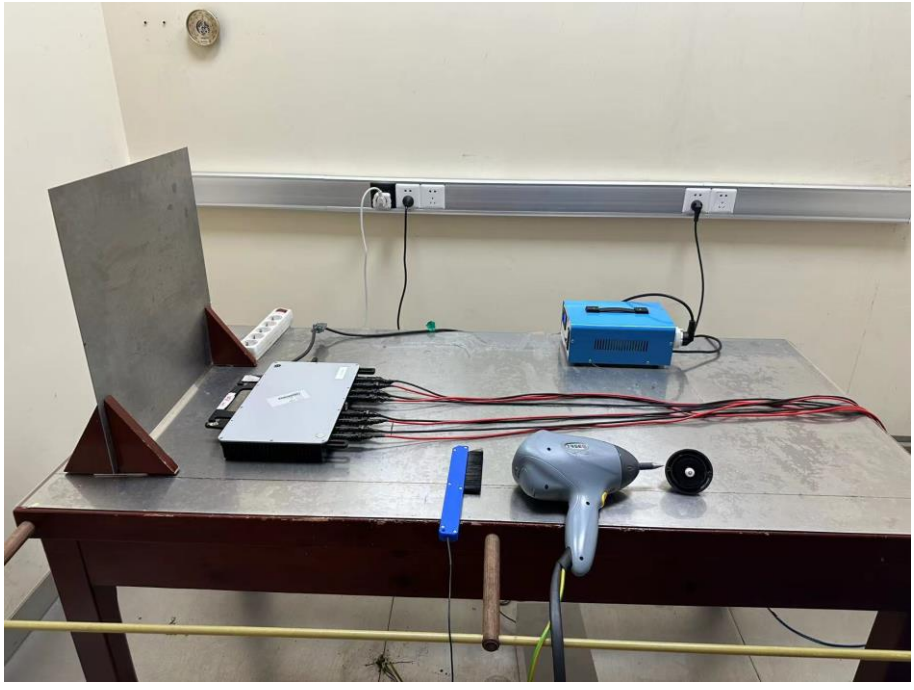
Conducted disturbance voltage at mains output terminals

Conducted disturbance voltage at DC input terminals

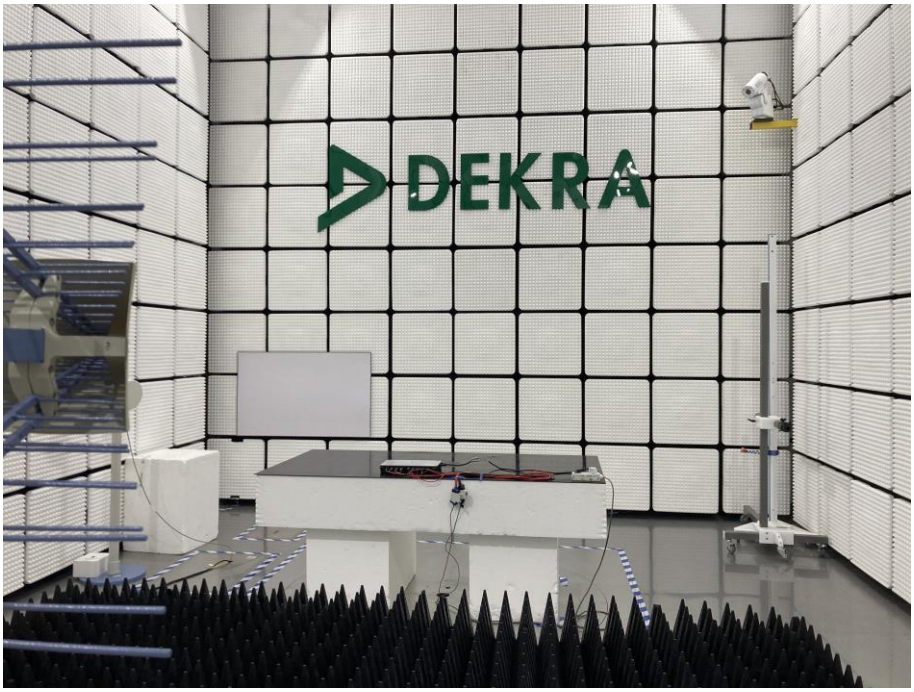
Radiated electromagnetic disturbances (30 MHz to 1000 MHz)



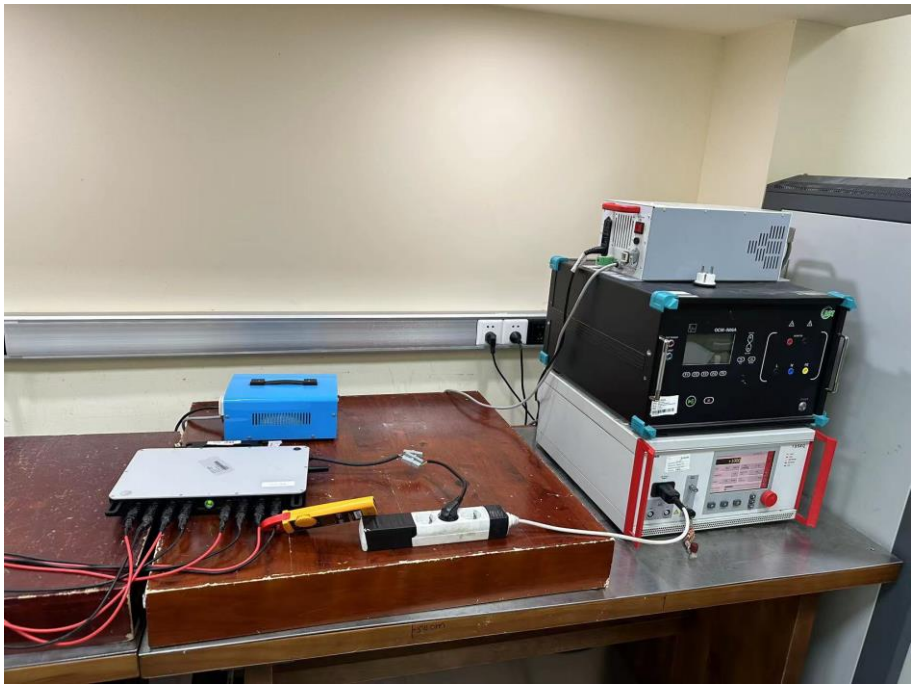
Electrostatic discharge immunity



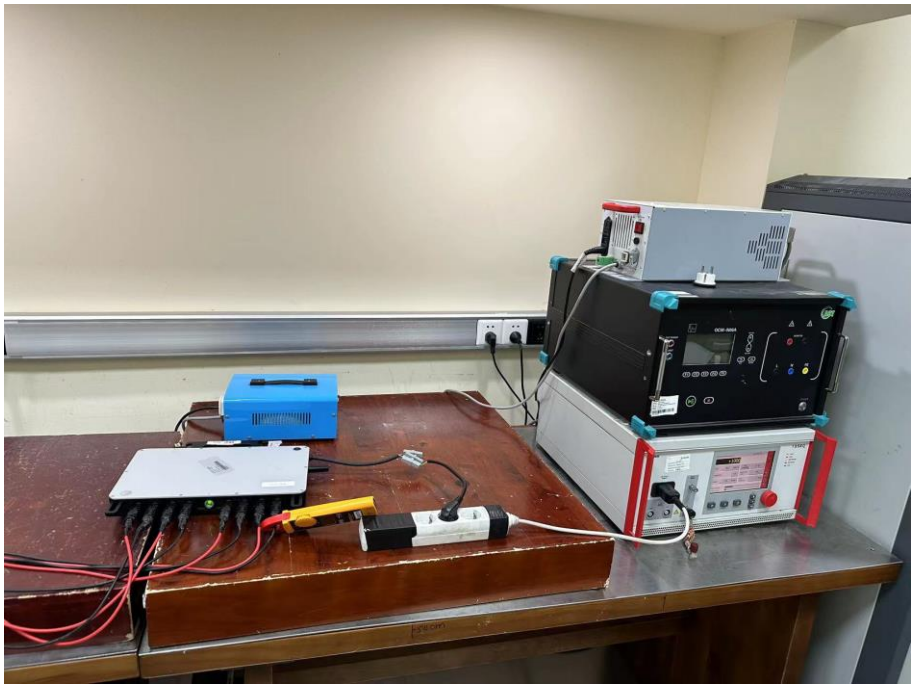
Radiated EM Field Immunity



Electrical fast transient (EFT) / Burst transients immunity



Surge transients immunity



Conducted RF disturbances immunity

Power frequency magnetic field immunity