KEMA Labs

KEMA TYPE TEST CERTIFICATE OF COMPLETE TYPE TESTS

Object	Industrial routing switch		**1364-21**
Type	RedFox-5728-F4G-T24G-LV RedFox-5728-E-F4G-T24G-LV RedFox-5728-F16G-T12G-LV RedFox-5728-E-F16G-T12G-LV	**Serial No.**	001087, 001089, 001090, 001094, 001095

Rated input voltage	24-48 Vdc	Ethernet ports	24/12
Mechanical class	2	Optical ports	4/16
Device reliability class	2	EMC emission class	A
EMC immunity location	G/H/P	Signal ports connections	l/f/h/t

Manufacturer	Westermo Research and Development AB, Metallverksgatan 6, 724 30 Kopparlunden, Sweden *)
Client	Westermo Research and Development AB, Metallverksgatan 6, 724 30 Kopparlunden, Sweden
Tested by	KEMA B.V., Klingelbeekseweg 195, Arnhem, the Netherlands
Date of tests	26 April to 22 July 2021

The object, constructed in accordance with the description, drawings and photographs incorporated in this Certificate, has been subjected to the series of proving tests in accordance with the complete type test requirements of

IEC 61850-3:2013

The results are shown in the record of proving tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above standard(s) and to justify the ratings assigned by the manufacturer as listed on page 8.

This Certificate applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the Manufacturer.
*) as declared by the manufacturer

This Certificate consists of 124 pages in total.

KEMA B.V.

Bas Verhoeven
Director, High-Voltage Laboratory

Arnhem, 30 September 2021

INFORMATION SHEET

1 KEMA Type Test Certificate

A KEMA Type Test Certificate contains a record of a series of (type) tests carried out in accordance with a recognized standard. The object tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by KEMA Labs. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded.
The Certificate contains the essential drawings and a description of the object tested. A KEMA Type Test Certificate signifies that the object meets all the requirements of the named subclauses of the standard. It can be identified by gold-embossed lettering on the cover and a gold seal on its front sheet.
The Certificate is applicable to the object tested only. KEMA Labs is responsible for the validity and the contents of the Certificate. The responsibility for conformity of any object having the same type references as the one tested rests with the manufacturer.
Detailed rules on types of certification are given in KEMA Labs' Certification procedure applicable to KEMA Labs.

2 KEMA Report of Performance

A KEMA Report of Performance is issued when an object has successfully completed and passed a subset (but not all) of test programmes in accordance with a recognized standard. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The report is applicable to the object tested only. A KEMA Report of Performance signifies that the object meets the requirements of the named subclauses of the standard. It can be identified by silver-embossed lettering on the cover and a silver seal on its front sheet.
The sentence on the front sheet of a KEMA Report of Performance will state that the tests have been carried out in accordance with …… The object has complied with the relevant requirements.

3 KEMA Test Report

A KEMA Test Report is issued in all other cases. Reasons for issuing a KEMA Test Report could be:

- Tests were performed according to the client's instructions.
- Tests were performed only partially according to the standard.
- No technical drawings were submitted for verification and/or no assessment of the condition of the object after the tests was performed.
- The object failed one or more of the performed tests.

The KEMA Test Report can be identified by the grey-embossed lettering on the cover and grey seal on its front sheet.
In case the number of tests, the test procedure and the test parameters are based on a recognized standard and related to the ratings assigned by the manufacturer, the following sentence will appear on the front sheet. The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on ..... If the object does not pass the tests such behaviour will be mentioned on the front sheet. Verification of the drawings (if submitted) and assessment of the condition after the tests is only done on client's request.
When the tests, test procedure and/or test parameters are not in accordance with a recognized standard, the front sheet will state the tests have been carried out in accordance with client's instructions.

4 Official and uncontrolled test documents

The official test documents of KEMA Labs are issued in bound form. Uncontrolled copies may be provided as a digital file for convenience of reproduction by the client. The copyright has to be respected at all times.

REVISION OVERVIEW

Rev. No	Date of issue	Reason for issue
0	30 September 2021	First issue

TABLE OF CONTENTS

1 SUMMARY

By order of the client type tests according to IEC 61850-3 have been performed on the test object.

Test / Measurement	Test result
Dimensions of structure and visual inspection	Passed
Product safety	Passed
Electromagnetic compatibility (EMC)	Passed
Burden tests	Passed
Climatic environmental conditions	Passed
Mechanical environmental conditions	Passed
Enclosure protection	Passed
Functional test	Passed

Note
The communication data rate during electrostatic discharge test was 90 Mbit/s. During electrostatic discharge, ports 1 to 4 were equipped with SFP's having a maximum data speed of 155 MB/s. All other environmental tests were performed with communication data rate 900 MB/s and the SFP's had a maximum data speed of 1,25 GB/s.

2 IDENTIFICATION OF THE OBJECT TESTED

2.1 Ratings/characteristics of the object tested

Rated auxillary voltage	24-48 Vdc
Output contact continuous current	80 mA
Number of ethernet ports	24
Number of optical ports	4
Maximum operating temperature	+70 °C
Minimum operating temperature	-40 °C
Maximum storage temperature	+85 °C
Minimum storage temperature	-50 °C

Classification

IP-class	IP 4X
Mechanical class	2
EMC emission class	A
Reliability class	2
EMC immunity location	Power stations/ Medium voltage (MV)/ High-voltage (HV) substations / Protected areas
Signal connections	Local connections/ Field connections/ Connections to HV equipment/ Telecommunication/ Connections within a protected area
Over voltage category	III
Pollution degree	2
Insulation type	Basic/Supplementary

2.2 Description of the object tested

Manufacturer (as stated by the client)	Westermo Research and Development AB, Kopparlunden, Sweden
Type	RedFox-5728-F4G-T24G-LV
Object	Industrial routing switch

IED 001087

Slot	Module	Serial No.	Hardware	Software
1	Power supply board	5013-3220-AE	210406-04098941-00000	-
2	Switch board CPU	5013-3620-01	201215-04001322-00000	WeOS v5.9.2

IED 001089

Slot	Module	Serial No.	Hardware	Software
1	Power supply board	5013-3220-AE	210406-04098940-00000	-
2	Switch board CPU	5013-3620-01	201216-04001332-00000	WeOS v5.9.2

IED 001090

Slot	Module	Serial No.	Hardware	Software
1	Power supply board	5013-3220-AE	210406-04094941-00000	-
2	Switch board CPU	5013-3620-01	201216-04001329-00000	WeOS v5.9.2

IED 001094

Slot	Module	Serial No.	Hardware	Software
1	Power supply board	5013-3220-AE	210505-04121161-00000	-
2	Switch board CPU	5013-3620-01	210517-04116866-00000	WeOS v5.9.2

IED 001095

Slot	Module	Serial No.	Hardware	Software
1	Power supply board	5013-3220-AE	210505-04121157-00000	-
2	Switch board CPU	5013-3620-02	210518-04116865-00000	WeOS v5.9.2

2.3 List of cables

Power input (power supplies) cable

- Type 2x1,5 unshielded
- Length 0,5 m
- Lenght 1 m
- Lenght 5 m

Input/output cable

- Type Lapp OLFLEX 7x1,5 unshielded
- Length 0,5 m
- Lenght 1 m
- Lenght 5 m

Ethernet cable RJ-45

- Type Telegratner 4x2xAWG26/7 PUR LI02YSC11Y shielded CAT 7
- Length 3 m
- Lenght 20 m

Ethernet fibre glass

- Type Hexatronic MM 2x62,5/125 OM1 LC/PC-LC/PC
- Type TDfibreoptik 54LL05
- Length 0,3 m
- Lenght 1 m
- Lenght 5 m
- Lenght 25 m

2.4 List of SFP's

No.	Type	Serial No.	Speed
1	Westermo, MM, 1310nm	1100-0531	155 Mbps
2	Westermo, MM, 1310nm	1100-0547	1,25 Gbps
3	Westermo, SM, 1310nm	1100-0541	1,25 Gbps

2.5 List of drawings

According to the client the following drawings and/or documents number(s) refer(s).
KEMA Labs has not verified these drawings and/or documents.

Drawing no./document no.	Revision
5013-3220-PCBA-C-AE	AE
2011-1032-H	-
2011-1032-MecBot	-
2011-1032-MecTop	-
5013-3620-PCBA-C-02	02
2011-1053-H	-
2011-1053-MecBot	-
2011-1053-MecTop	-

2.6 Photograph of test object

3 GENERAL INFORMATION

3.1 The tests were witnessed by

The tests were carried out without a representative of the client present.

3.2 The tests were carried out by

Name	Company
Mihai Bivolaru	KEMA B.V., Arnhem, the Netherlands

3.3 Reference to other reports

Report No	Tests performed
1028-21	RedFox-5728-F16G-T12G-HVHV and RedFox-5728-F16G-T12G-HV - Kema Type test certificate of complete type test
19-2856	Verification report of the functional and performance test in Westermo, Redfox 5728 for IEC 61850 applications
189574	Input to Safety Evaluation of RedFox 5728-LV-LVLV-01

3.4 Subcontracting

The following tests were subcontracted to DEKRA Certification B.V., Arnhem, the Netherlands:

- Measurement of radiated emission in accordance with IEC 61850-3 and CISPR22.
- Radiated, radio-frequency electromagnetic field immunity test in accordance with IEC 61850-3 and IEC 61000-4-3.

The following tests were subcontracted to Sebert Trillingstechniek B.V., Bergschenhoek, the Netherlands:

- Vibration response and endurance test in accordance with IEC 60255-21-1.
- Shock response and withstand test in accordance with IEC 60255-21-2.
- Bump test in accordance with IEC 60255-21-2.
- Seismic test in accordance with IEC 60255-21-3.

The following tests were subcontracted to DNV GL, INC B.V., Arnhem, the Netherlands:

- Verification of functional performance according to IEC 61850-9-4.

3.5 Measurement uncertainty

A table with measurement uncertainties is enclosed in this certificate. Unless otherwise stated, the measurement uncertainties of the results presented in this certificate are as indicated in that table.

3.6 Laboratorium environmental conditions

Tests have been performed in a controlled laboratory environment, where the environmental conditions are maintained within the applicable ranges.

Ambient temperature	15 °C to 25 °C
Relative Humidity	45% to 75%
Atmospheric pressure	86 kPa (860 mbar) to 106 kPa (1060 mbar)

When a condition has direct influence on a test, the value of the condition will be presented explicitly.

3.7 Instruments used

A detailed list with instruments used is enclosed in this certificate.

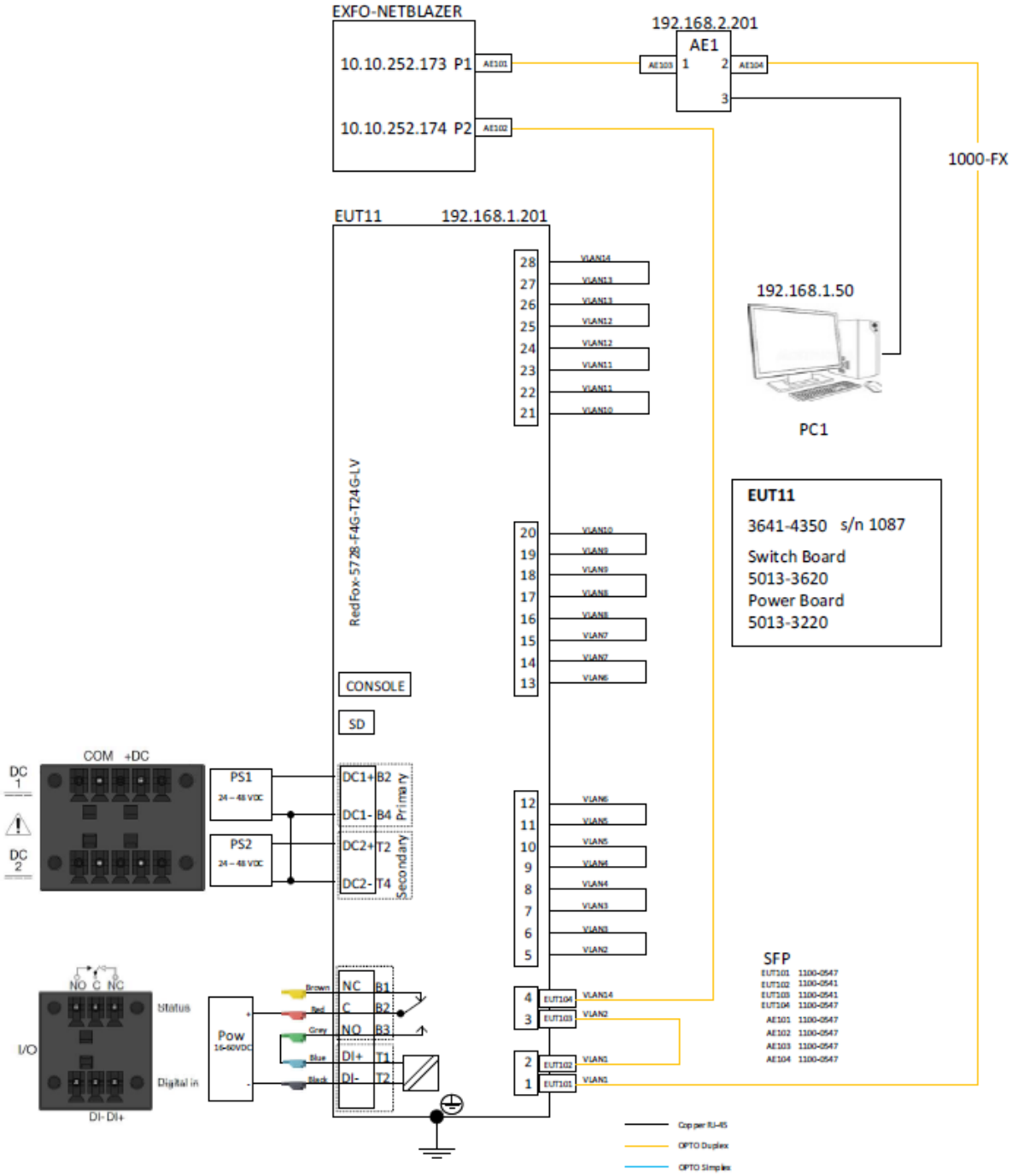
3.8 Standards

The product standard IEC 61850-3 (2013-12) refers to documents, in whole or in part, these documents are normatively referenced to in this product standard and these documents are indispensable for its application. For dated references, only the edition cited applies. For undated references the latest edition of the referenced document (including any amendments) applies. KEMA Labs will use the latest edition of the referenced documents (including any amendments) in all cases, also in the cases reference is made to dated editions.

4 TEST ARRANGEMENT

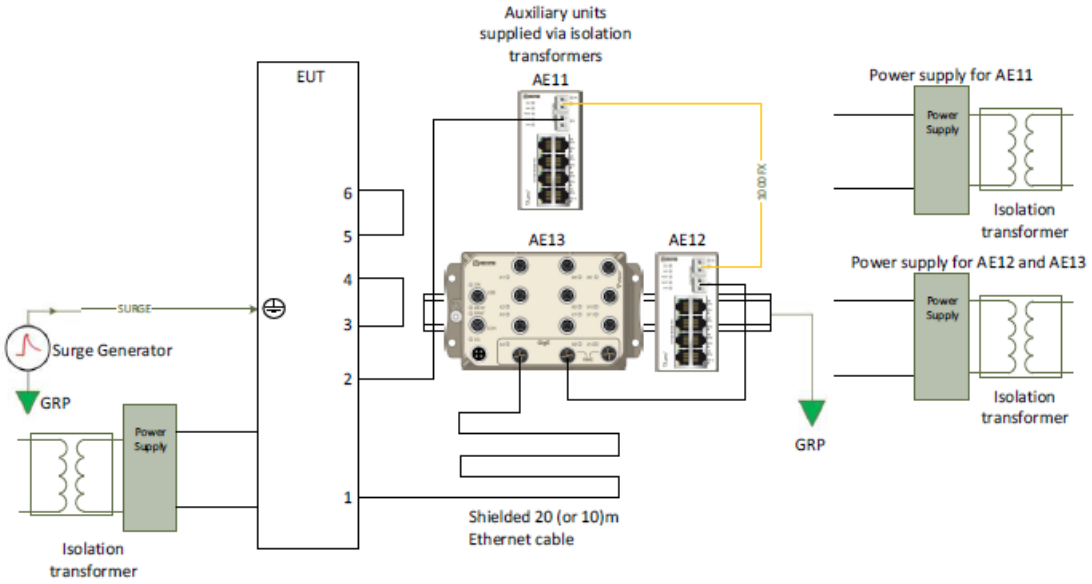
A general test set-up is made by connecting the Ethernet switch to a traffic generator. The Ethernet switch is powered with rated auxiliary voltage. The data stream through the equipment is 90% of the rated traffic speed which is 900 Mb/s respectively 90 Mb/s (during the ESD-test a lower speed has been applied). The Fail-safe relay contact status and the reading/writing to the SD-card has been monitored during the tests.

General test setup for EMC testing



General test setup for test on Ethernet cable shield

The setup shall be used during Surge and Damped Oscillatory Wave test on Ethernet cable shield. The two switches (AE11 and AE12) forms a galvanically isolated bridge and connects the cable shield to GRP (AE13).



5 MARKING AND DOCUMENTATION

Standard and date

Standard	IEC 61850-3, subclause 6.1 and 6.2
Test date	4 June 2021

Characteristic test data

Serial number	001090	
Documentation	Westermo_ug_6641-25001-redfox-5728_revd_prel	Revision d

Requirement

- The markings on the test object shall comply with the requirements of IEC 61850-3, subclause 6.1.
- The documentation of the test object shall comply with the requirements of IEC 61850-3, subclause 6.2.

Result

The provided documentation meets the marking and documentation requirements.

6 PACKAGING

Standard and date

Standard	IEC 61850-3, subclause 6.3
Test date	26 April 2021

Requirement

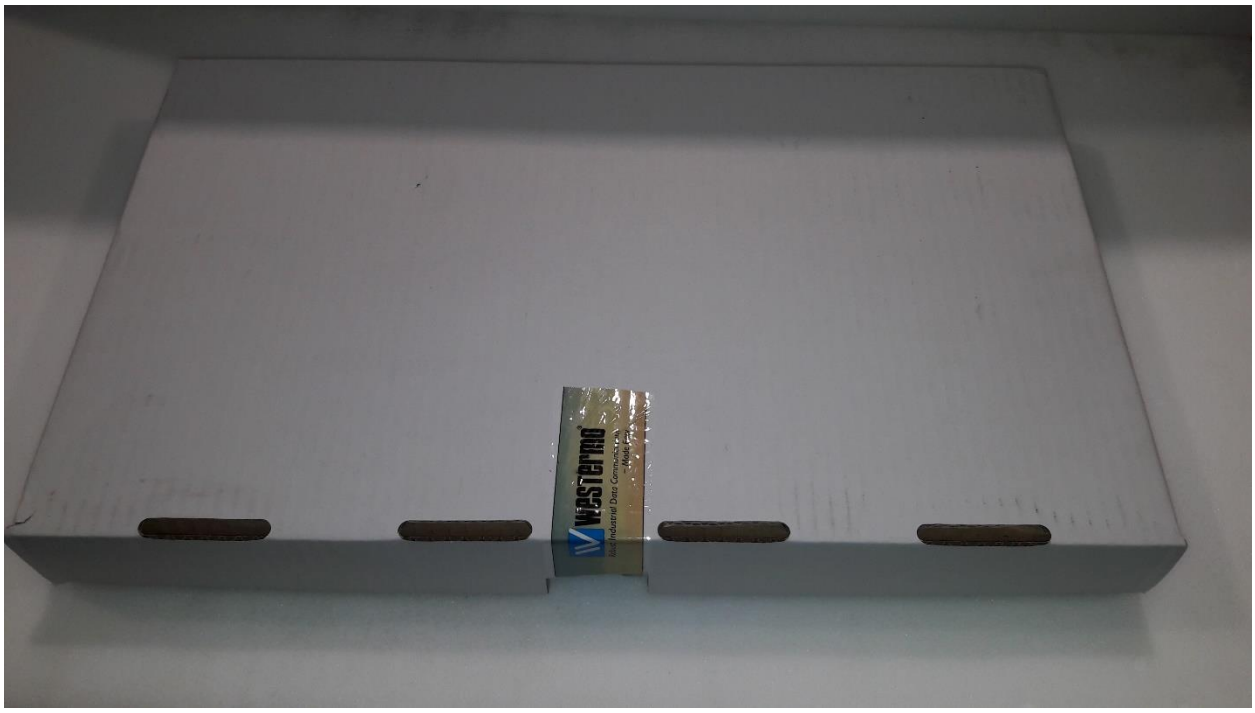
The manufacturer shall ensure that the equipment is suitably packaged to withstand, without damage, reasonable handling and environmental conditions appropriate to the method(s) of transportation to the user's delivery address.

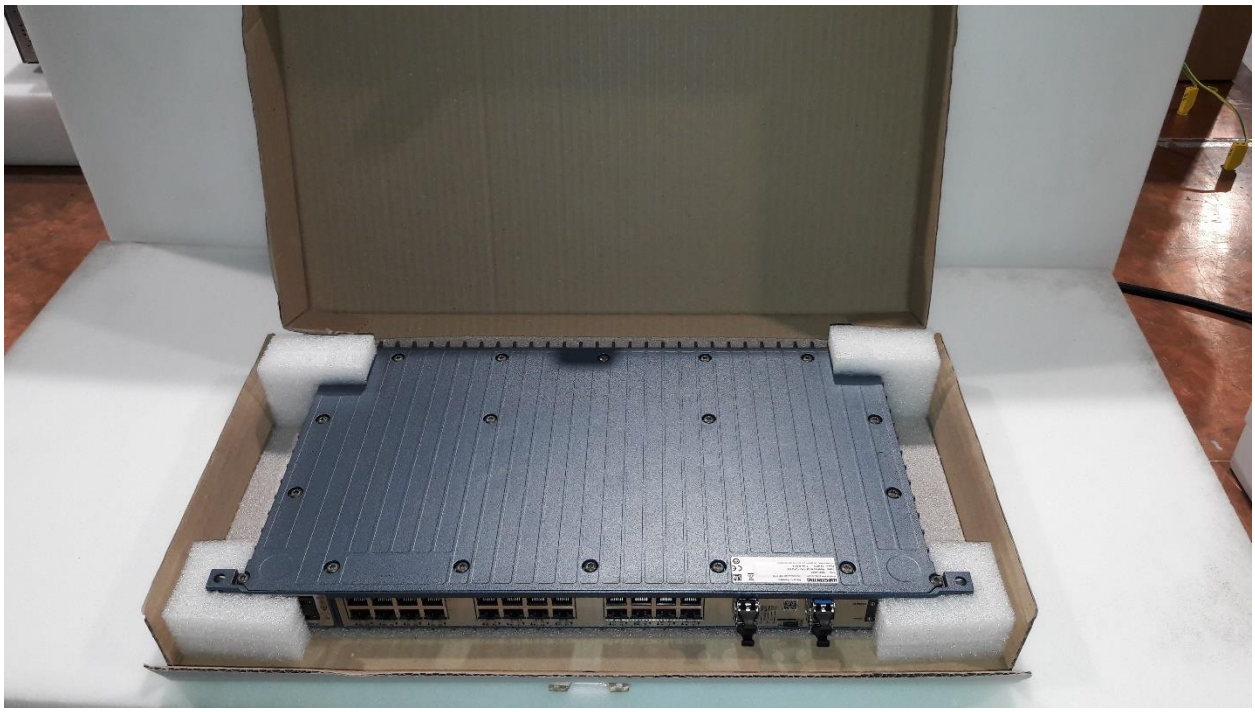
A visual inspection should be made by the user to check that the equipment has not been damaged during transportation.

Result

- The packaging meets the packaging requirements.
- No visual damage to the packaging and the equipment has been observed.

Photograph of test object





7 DIMENSIONS OF STRUCTURE

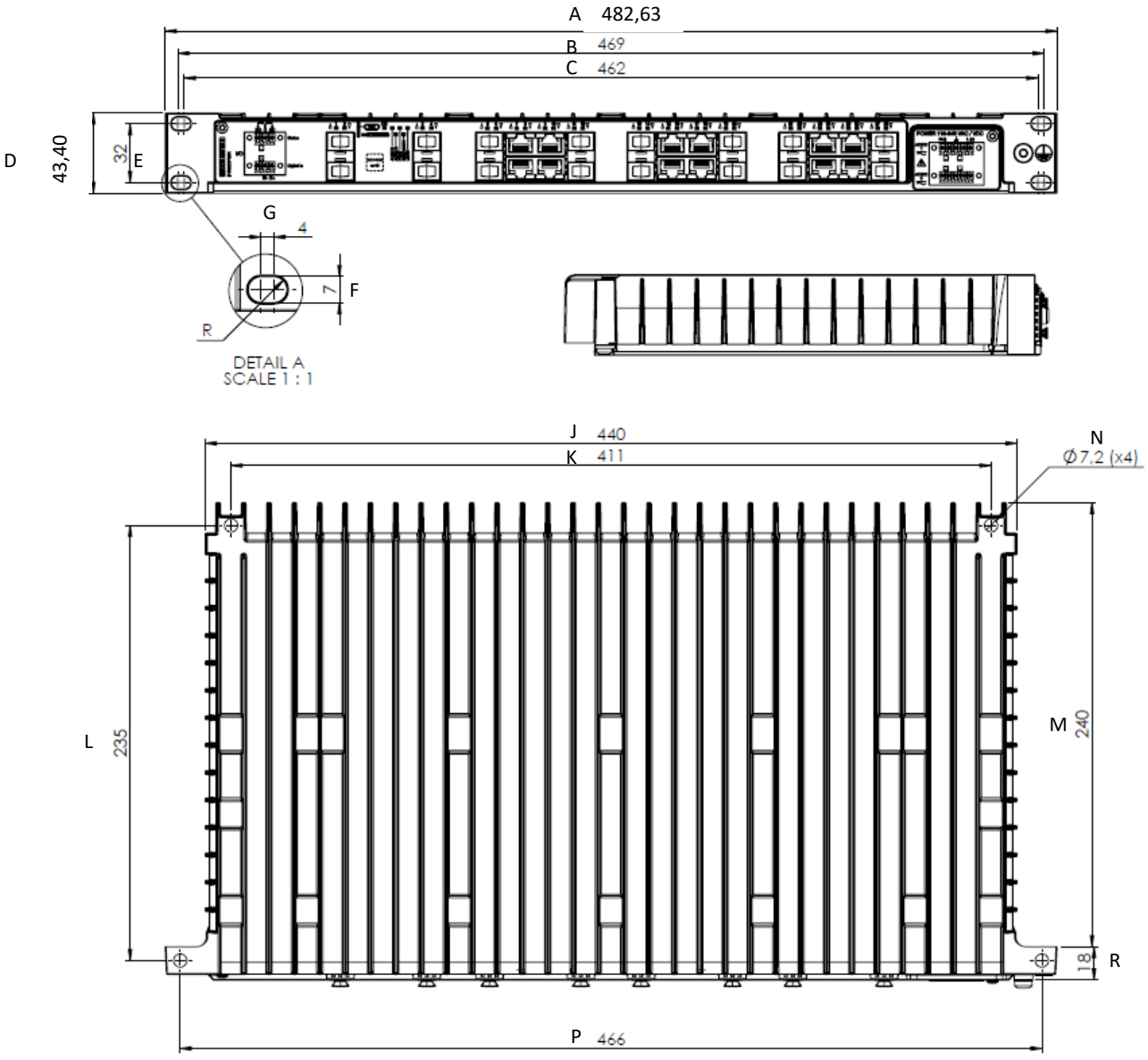
Standard and date

Standard	IEC 61850-3, subclause 6.4
Basic standard	IEC 60297-3-101 only applicable for 19 inch structures

Characteristic test data

Serial number	001095

Dimensions are stated in mm.



For 19” enclosures, 1U height;

Item	Unit	Measured	Specified by the client		Required by IEC 60297-3-101	
Subrack heigth	mm	43,8	D	43,4	H1	-
Width front, over the mounting brackets	mm	482,9	A	482,40	-	482,6 ± 0,4
Rack depth	mm	258,1	-	258	-	-
Width behind the brackets, over the mounting of the bracket	mm	438,6	J	440	-	≤ 449
Rack mounting hole positions	mm	31,8	E	32	H2	-
Rack mounting hole positions	mm	5,5	-	-	H3	-
Rack mounting hole positions	mm	469,8	B	469	-	-
Rack mounting hole positions	mm	463,7	C	462	-	-
Mounting hole dimension	mm	7,2	F	7	-	-
Mounting hole dimension	mm	3,8	G	4	-	-
Mounting hole dimension	mm	10,1	-	-	-	10,3 ± 0,4
Mounting hole position	mm	13,6	-	-	-	13,5 ± 0,4
Rear mounting hole positions	mm	411,0	K	411	-	-
Mounting hole positions in depth	mm	235,1	L	235	-	-
Depth behind mounting bracket	mm	240,2	M	240	-	-
Mounting hole dimension	mm	7,3	N	7,2	-	-
Front mounting hole dimension	mm	466,4	P	466	-	-
Mounting bracket dimension	mm	18,2	R	18	-	-

Observations

-

Result

The object passed the test.

8 FUNCTIONAL PERFORMANCE REQUIREMENTS

Standard and date

Standard	IEC 61850-3, subclause 6.5
Reference	IEC 61850-90-4
Date	6 September 2019

The equipment shall meet the applicable functional performance requirements (GOOSE testing) of the applicable standard.

Result

The object passed the test.

The results can be found in the report with number 19-2856 - Verification report of the functional and performance test in Westermo, Redfox 5728 for IEC 61850 applications.

9 PRODUCT SAFETY

9.1 Inspection

9.1.1 Pre-inspection

The pre-inspection is performed to verify that the test object is in operating state. The pre-inspection is carried out previous to the test procedure.

The communication with the maintenance computer is verified. Signals are simulated to verify the functioning and operation with the specified performance specification for the following inputs and outputs:

- analogue inputs;
- digital inputs;
- contact outputs;
- data communication port(s).

9.1.2 Visual and functional inspection

After each test a visual and functional inspection is carried out as described in this chapter.

The visual inspection is carried out to verify that there is no visual mechanical damage.
There shall be no:

- burning of any components;
- paint blisters on any components;
- discolouration on components;
- deformation of modules or components;
- interruptions or damage on interconnecting cables, wires and connectors.

Functional inspection is carried out to verify the correct operation of the test object.
There shall be no:

- alarm indications on display and LED's;
- error messages reported in the maintenance computer;
- unintentional change of contact outputs;
- there shall be no degradation of performance below the claimed performance according reliability class (1 or 2).

Unless otherwise stated the visual and functional inspection was carried out successfully after each test.

9.2 Clearances and creepage distances

Standard and date

Standard IEC 61850-3, subclause 6.6.1
Test date 28 June 2021

Characteristic test data

Serial number	001090	
PCB Coating	No	
Pollution degree	2	
Overvoltage category	III	
Insulation	Basic/reiforced	
Power supply (tollerance)	24 – 48	Vdc (18 – 60 Vdc)

Clearance

Position	Measurement	Insulation type	PCB-ID	Rated insulation voltage or working voltage V	Clearance distance Required mm	Measured mm
PSU	C92 between PSU primary and PSU secundary	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 9,58
PSU	U8 between PSU primary and PSU secundary	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 6,20
PSU	U23 between PSU primary and enclosure	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 7,02
I/O – CPU board	C1282 between I/O input and SELV (CPU board)	Basic	CPU - 5013-3620-01	50 – 100	0,5	≥ 3,03
I/O – CPU board	U11 between I/O input and SELV (CPU board)	Basic	CPU - 5013-3620-01	50 – 100	0,5	≥ 4,33

Creepage

Position	Measurement	Insulation type	PCB-ID	Rated insulation voltage or working voltage V	Creepage distance Required mm	Measured mm
PSU	C92 between PSU primary and PSU secundary	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 9,58
PSU	U8 between PSU primary and PSU secundary	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 6,20
PSU	U23 between PSU primary and enclosure	Reinforced	PSU - 5013-3220-00	50 – 100	1,5	≥ 7,02
I/O – CPU board	C1282 between I/O input and SELV (CPU board)	Basic	CPU - 5013-3620-01	50 – 100	0,5	≥ 3,03
I/O – CPU board	U11 between I/O input and SELV (CPU board)	Basic	CPU - 5013-3620-01	50 – 100	0,5	≥ 4,33

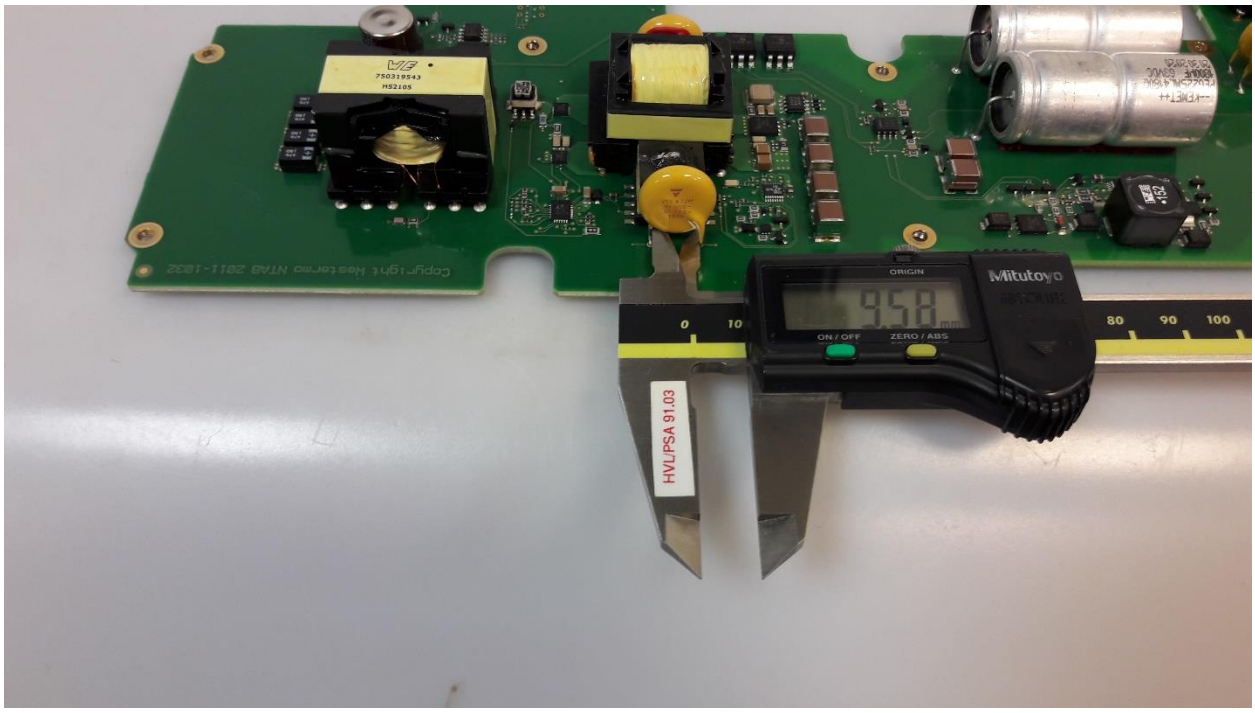
Observations

The clearance and creepage distances meets the requirements of table C.6 and C.10.

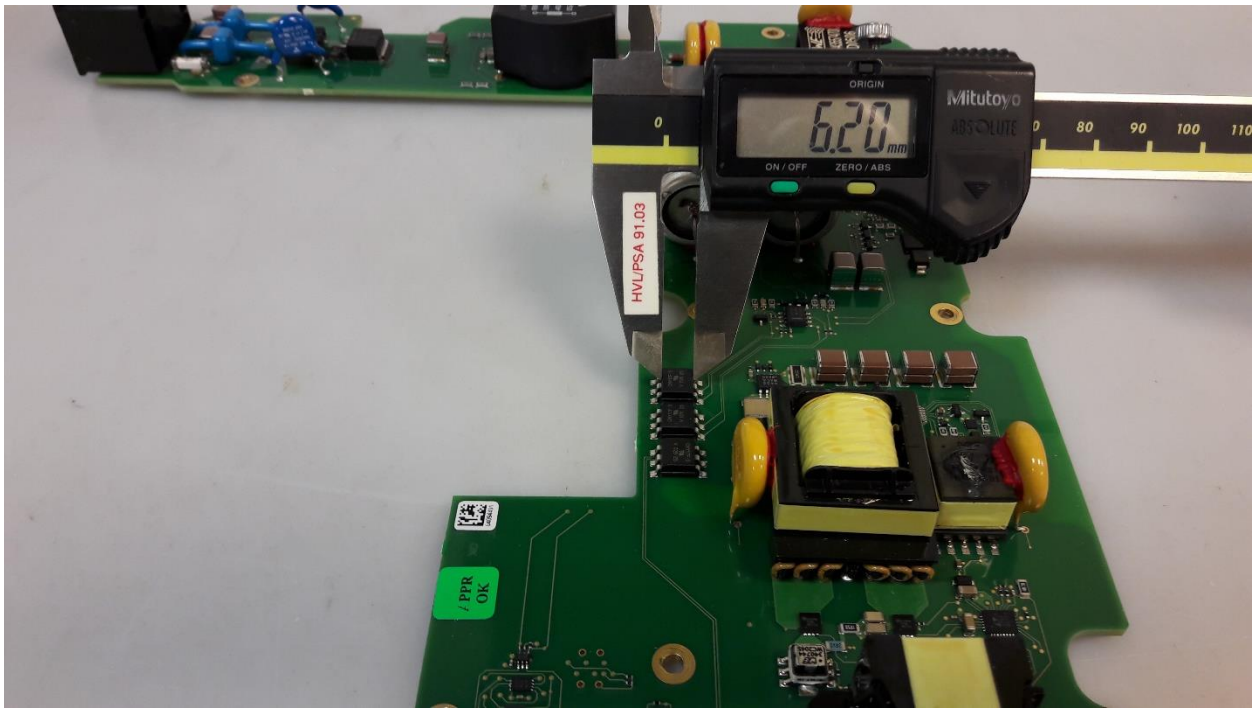
Requirement
The clearance and creepage distances shall meet the requirements to the relevant Table C.3 to C.10 of the IEC 60255-27.

Result
The object passed the test.

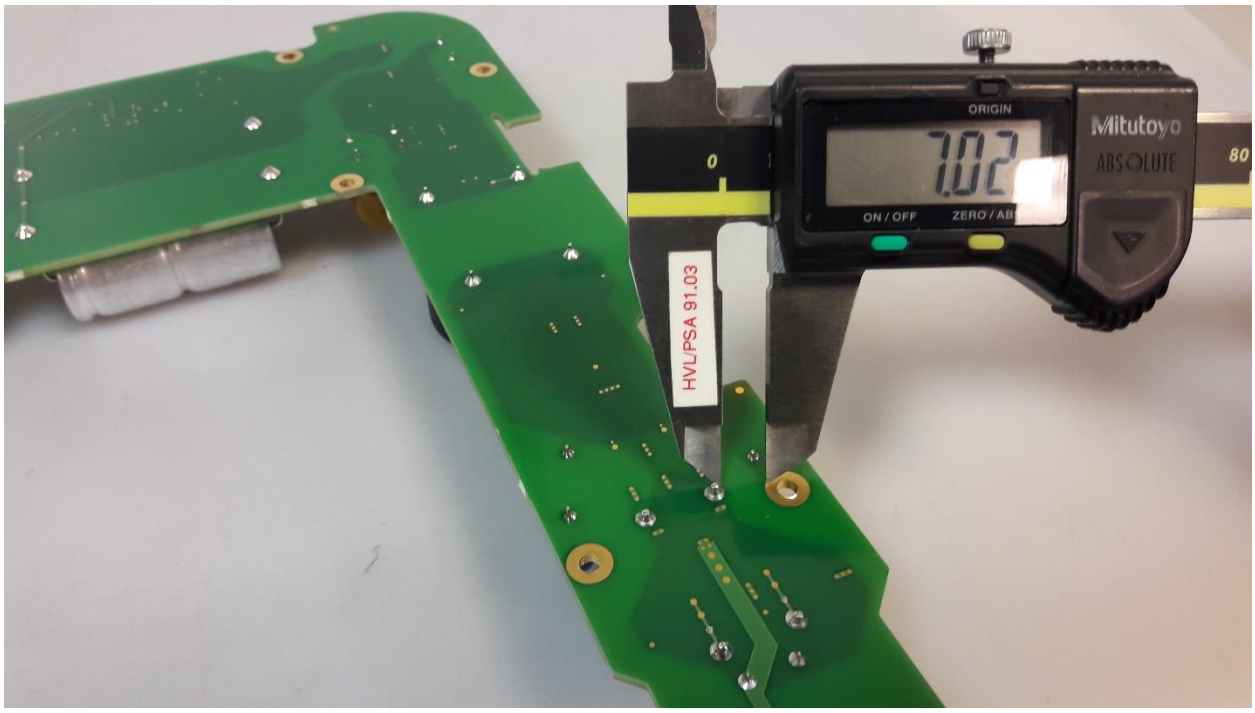
Photograph of clearance across C92



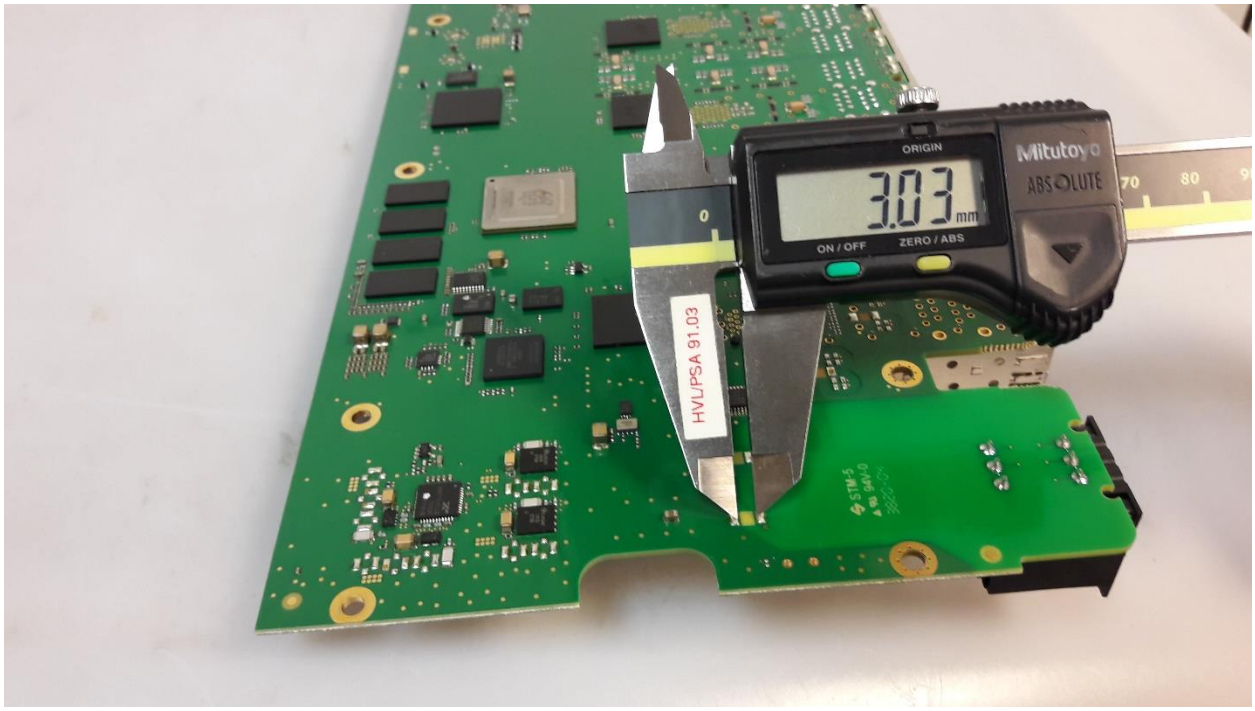
Photograph of clearance across U8



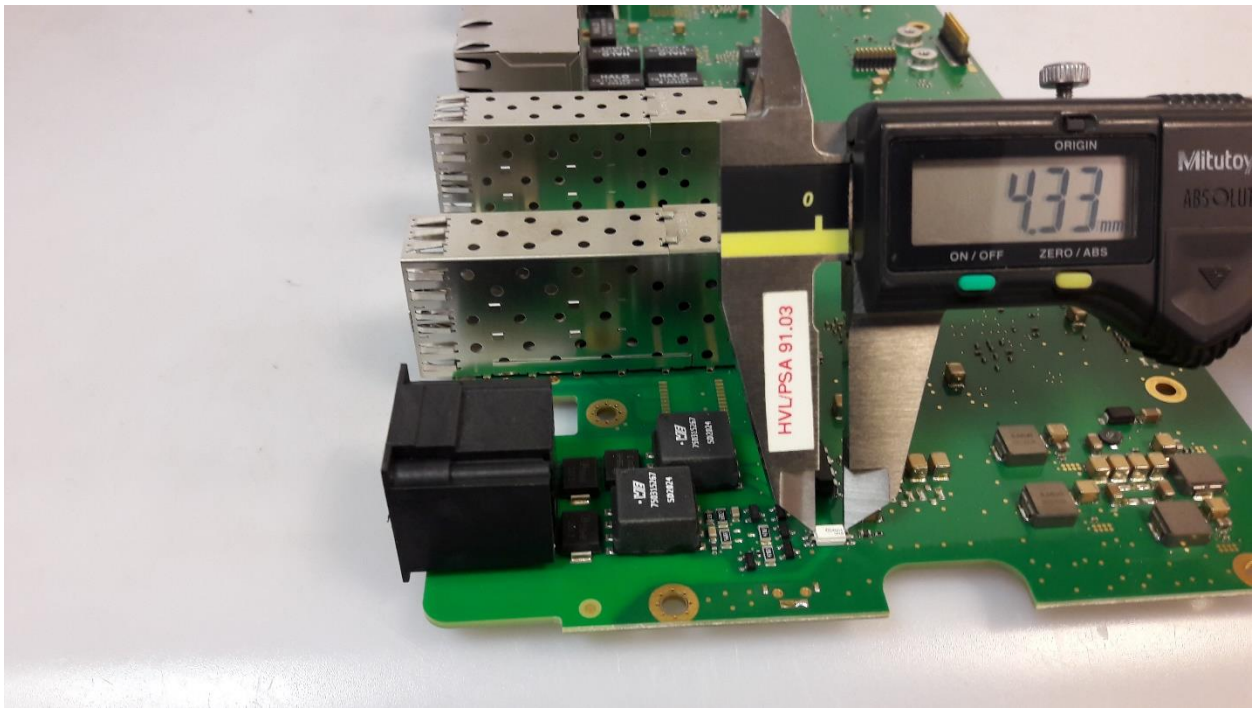
Photograph of clearance U23 to enclosure



Photograph of clearance across C1282



Photograph of clearance across U11



9.3 IP rating test

Standard and date

Standard	IEC 61850-3, subclause 6.6.2
Basic standard	IEC 60529
Test date	01 June 2021

Characteristic test data

Serial number 001090

Terminal side	Degree of protection	
	Specification by the manufacturer	Observation
Front	IP 2X	IP 2X

Requirement

- The test finger shall not touch hazardous live parts.
- The test finger voltage or energy shall not exceed the safe limits for normal operational use.
- No visual or functional inspection required.

Result

The object passed the test.

Photographs of test arrangement

9.4 Impulse voltage test

Standard and date

Standard	IEC 61850-3, subclause 6.6.3
Test date	27 May 2021

Environmental conditions

Ambient temperature	20 °C	Relative humidity	53 %
Ambient air pressure	1014 hPa		

Characteristic test data

Serial number	001090
Time to rise-value	1,2 µs (± 30%)
Time to half-value	50 µs (± 20%)
Source impedance	500 Ω (± 10%)
Insulation resistance	> 0,55 GΩ
Output energy	0,5 J (± 10%)
Pulse interval	≥ 1 s

Voltage applied to Circuit	Terminals	Voltage applied kV	No. of impulses	Polarity	Observations
Power supply DC1	COM; DC+	5,0	5	Positive	-
			5	Negative	-
Power supply DC2	COM; DC+	5,0	5	Positive	-
			5	Negative	-
I/O	NO;C;NC DI+;DI-	5,0	5	Positive	-
			5	Negative	-
RJ45	5	1,0	5	Positive	-
			5	Negative	-
RJ45	16	1,0	5	Positive	-
			5	Negative	-
RJ45	22	1,0	5	Positive	-
			5	Negative	-
RJ45	27	1,0	5	Positive	- -

Note

Each circuit has been tested against all other circuits and earth connected together.
The test has been performed after completion of the climatic tests.

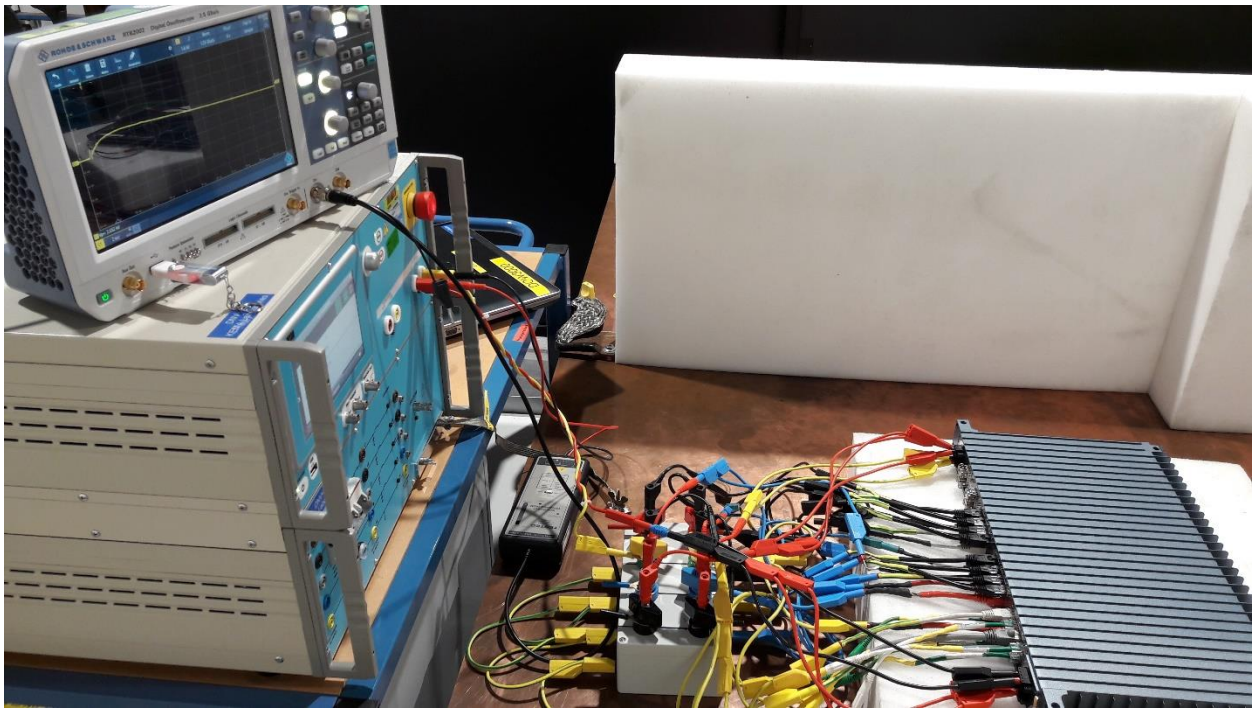
Requirement

- No disruptive discharges or flashovers shall occur.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



9.5 Dielectric voltage test

Standard and date

Standard IEC 61850-3, subclause 6.6.4
Test date 27 June 2021

Environmental conditions

Ambient temperature 20 °C Relative humidity 53 %

Characteristic test data

Serial number 001090
Frequency 50 Hz
Rated insulation voltage 500 V
Test duration 1 min

Test arrangement			Insulation resistance at 500 Vdc (before the test) MΩ	Voltage applied (RMS)	Insulation resistance at 500 Vdc (after the test) MΩ	Observations
Voltage applied to	Tested between	Terminals				
Power supply DC1	Earth and all others	COM; DC+	550	2,8 kVdc	550	-
Power supply DC2	Earth and all others	COM; DC+	550	2,8 kVdc	550	-
I/O	Earth and all others	NO;C;NC DI+;DI-	550	2 kVac	550	-
RJ45	Earth and all others	5	550	1,5 kVac [1)]	550	-
RJ45	Earth and all others	16	550	1,5 kVac [1)]	550	-
RJ45	Earth and all others	22	550	1,5 kVac [1)]	550	-
RJ45	Earth and all others	27	550	1,5 kVac [1)]	550	-

[1)] The required test voltage according to IEC 61850-3 is 0,5 kVac RMS.

Note

Each circuit has been tested against all other circuits and earth connected together
The test has been performed after completion of the climatic tests.

Observations

-

Requirement

- No disruptive discharges or flashovers shall occur.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

9.6 Protective bonding resistance

Standard and date

Standard	IEC 61850-3, subclause 6.6.5
Test date	31 May 2021

Environmental conditions

Ambient temperature	22 °C	Relative humidity	52 %
Ambient air pressure	1020 hPa		

Characteristic test data

Serial number	001090
Test voltage	< 12 Vdc
Test current	8 A
Test duration	60 s

Test point	Terminal	Resistance mΩ
TP1	PE	9
TP2	PE	23
TP3	PE	10

Note: The test has been performed after completion of the climatic tests.

Requirement

- The resistance between the test point and the protective conductor terminal shall not exceed 0,1 Ω.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Test points

9.7 Flammability of insulating materials, components and fire enclosures

Standard and date

Standard	IEC 61850-3, subclause 6.6.6
Basic standard	IEC 60255-27, subclause 10.6.5.2
Test date	23 June 2021

Characteristic test data

Serial number 001090

Assessment results

This object has been provided with a fire enclosure;

- Housing/enclosure is made of metal/plastic having a flammability rating of V1 or better.
- Bottom ventilation holes are covered with a metal screen providing suitable flame barrier.
- Mechanical properties are compliant with IEC 60255-27, subclause 7.10.
- The sides shall have no openings within the area that is included within the inclined line C.
- Materials for components which fill an opening in a fire enclosure, and which are intended to.
- be mounted in that opening shall be of flammability class V-1, or better or pass the flammability test of IEC 60695-11-10.

Materials which fill an opening in the fire enclosure or which are outside the fire enclosure are listed in the table below.

Module	Component	Make / Material	Article no. / Drawing / Document	Specified flammability	Required flammability
-	Enclosure	Westermo/Al Si9 Cu3	9003-0472 9003-0476	-	V-1
RJ45	Connector	Amphenol	RJSAR-8WT-00004	UL94V-0	V-1
RJ45	Connector	Amphenol	RJSAR-4WT-00004	UL94V-0	V-1
SFP	Connector	Molex	754625001	UL94V-0	V-1
IO	Connector	Amphenol	ELVA06100E	UL94V-0	V-1
PSU	Connector	Wurth	69136430EC05	UL94V-0	V-1

Materials inside a fire enclosure;

Module	Component	Make / Material	Article no. / Drawing / Document	Specified flammability	Required flammability
Fire enclosure	TR2, TR3 , Y capacitors	Different manufacturers	-	UL94V-1	V-1
Fire enclosure	PCB	-	2011-1031	UL94V-1	V-1

Requirements

- The object shall comply with the flammability requirements of IEC 60255-27, subclause 7.1. to 7.12.
- No visual or functional inspection required.

Result

The object passed the test.

9.8 Single-fault condition

Standard and date

Standard IEC 61850-3, subclause 6.6.7
Test date 22 June 2021

Environmental conditions

Ambient temperature 22 °C Relative humidity 56 %
Ambient air pressure 1006 hPa

Characteristic test data

Serial number 001090
Power supply 24 – 48 Vdc

Circuit	Test	Observations
Power supply	Max. current (6,6 A) on +3,3 VDC circuit during 2 hours	1
DC input voltage	Reversal of the polarity of the DC input voltage {See also chapter 9.8}	2

Observations

1. The EUT remains operational; temperature monitoring performed on TR2 and TR3 components; the insulation temperature does not exceed the limits (TR2 temperature 38°C an TR3 temperature 43°C).
2. The EUT does not start; no fire risk; no abnormal situation occur.

Requirements

- The test shall not result in the spread of fire or result in an electric shock hazard.
- The test object does not have to be functional after the test.
- No visual or functional inspection required.

Result

The object passed the test.

10 ELECTROMAGNETIC COMPATIBILITY

10.1 Inspection

10.1.1 Pre-inspection

The pre-inspection is performed to verify that the test object is in operational state. The pre-inspection is carried out prior to the test procedure.

The communication with the maintenance computer is verified. Signals are simulated to verify the functioning and operation with the specified performance specification for the following inputs and outputs:

- analogue inputs;
- digital inputs;
- contact outputs;
- data communication.

10.1.2 Visual and functional inspection

After each test a visual and functional inspection is carried out as described in this chapter.

The visual inspection is carried out to verify that there is no visual mechanical damage.
There shall be no burning of any components.

Functional inspection is carried out to verify the correct operation of the test object.
The measurements of analogue input data shall not exceed twice the class index for the measurement.
There shall be no:

- alarm indications on display and LED's;
- error messages reported in the maintenance computer;
- unintentional change of contact outputs;
- there shall be no degradation of performance below the claimed performance according reliability class (1 or 2).

Unless otherwise stated the visual and functional inspection was carried out successfully after each test.

10.2 Radiated emission

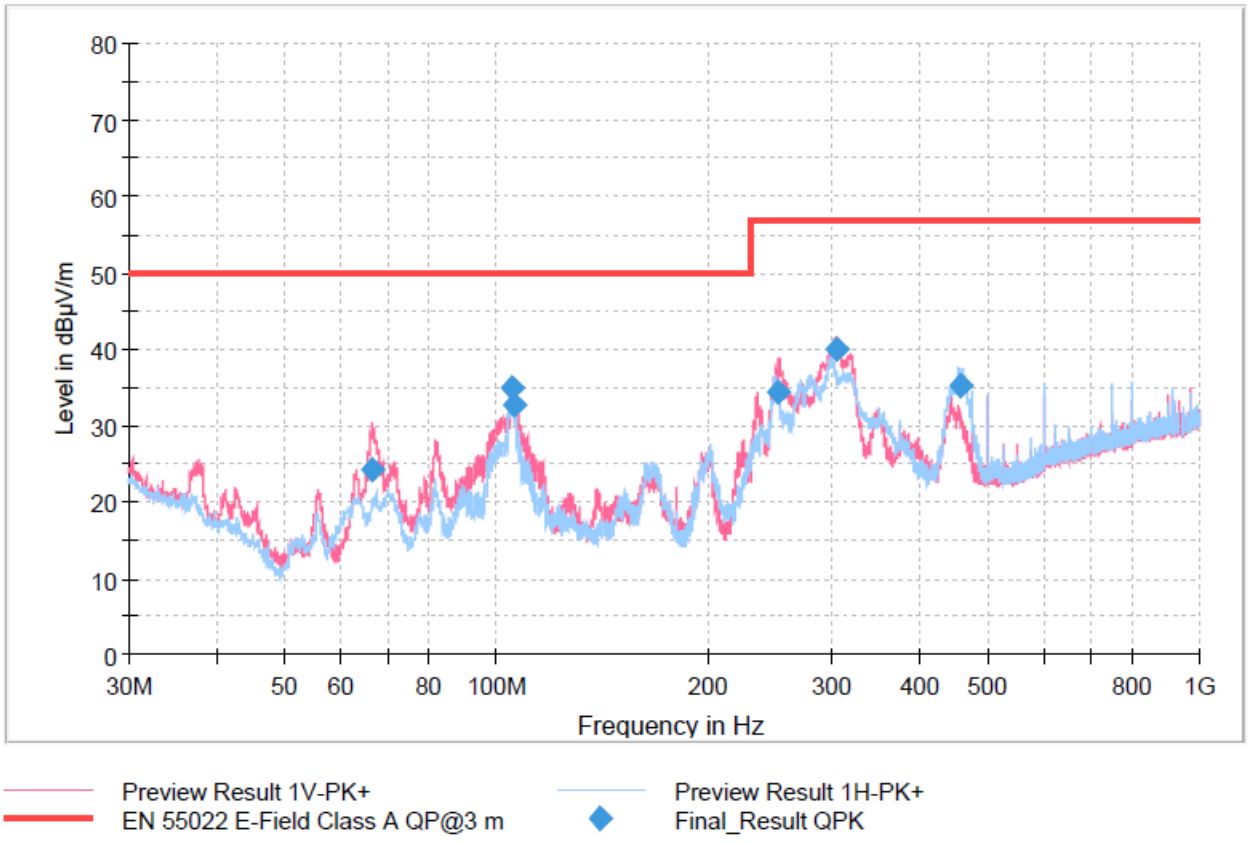
Standard and date

Standard	IEC 61850-3, subclause 6.7.4
Basic standard	CISPR 22
Test date	24 June 2021

Characteristic test data

Serial number	001094
Power supply 1	48 Vdc
Power supply 2	48 Vdc

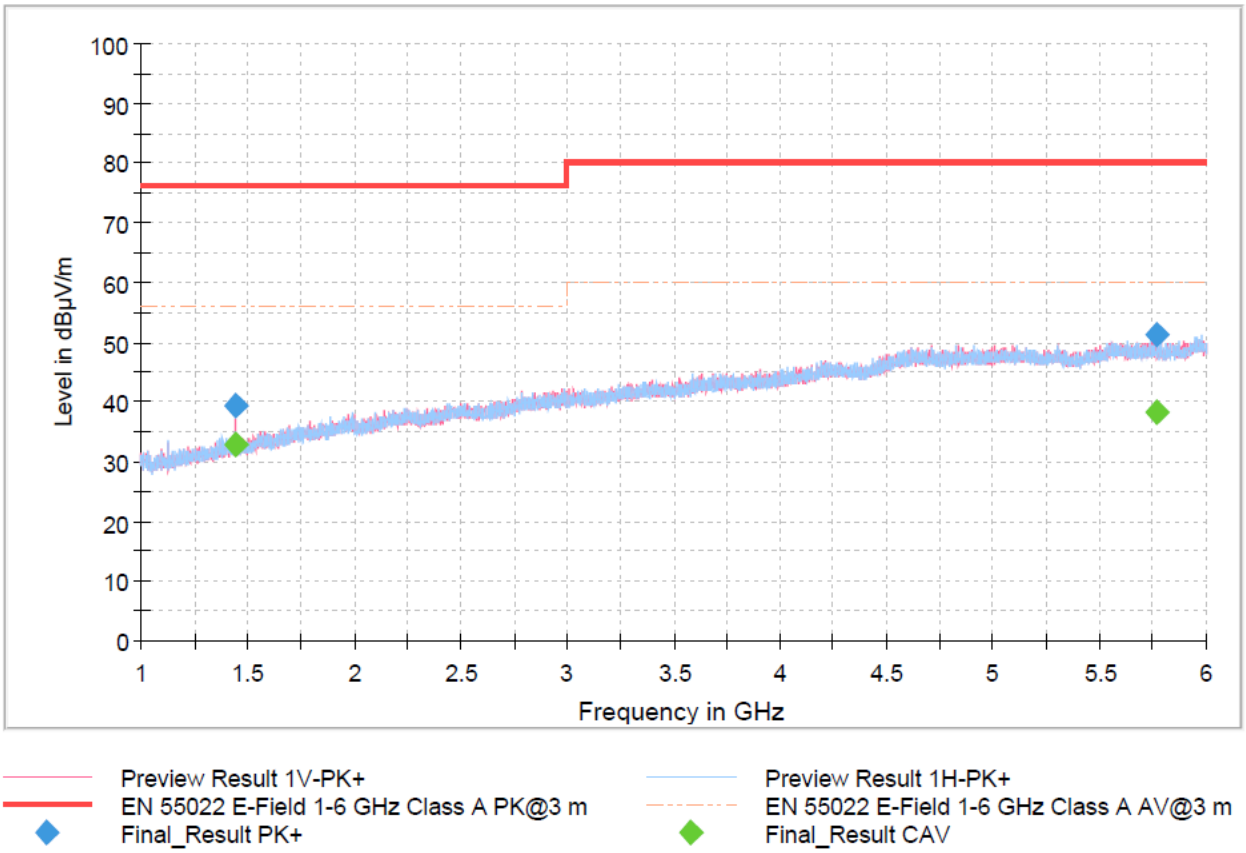
Power supply voltage of 48 Vdc with horizontal and vertical antenna polarisation, in the frequency range 30Mhz – 1GHz (red = vertical, blue = horizontal)



Final result (30 – 1000 MHz)

Frequency MHz	QuasiPeak dBµV/m	Limit at 3m dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
66,747	24,24	50,00	25,76	3000,0	120	178,0	V	201,0
105,255	34,91	50,00	15,09	3000,0	120	263,0	H	162,0
105,909	32,69	50,00	17,31	3000,0	120	107,0	V	99,0
252,264	34,44	57,00	22,56	3000,0	120	104,0	V	-8,0
304,806	39,89	57,00	17,11	3000,0	120	125,0	V	82,0
457,383	35,25	57,00	21,75	3000,0	120	100,0	H	99,0

Power supply voltage of 48 Vdc with horizontal and vertical antenna polarisation, in the frequency range 1 – 6 GHz (red = vertical, blue = horizontal)



Final result (1000 – 6000 MHz)

Frequency MHz	MaxPeak dBµV/m	Average dBµV/m	Limit @ 3 m dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
1440,050	---	32,84	56,00	13,16	2000.0	1000	259,0	V	12,0
1440,050	39,30	---	76,00	36,70	2000.0	1000	259,0	V	12,0
5767,444	---	38,11	60,00	21,89	2000.0	1000	199,0	V	339,0
5767,444	51,39	---	80,00	28,61	2000.0	1000	199,0	V	339,0

Remarks

Quick scans at different voltage levels were performed prior to the test in order to establish the worst case; 48 Vdc had the highest emission level during the prescan and the final measurmets were performed at this voltage.

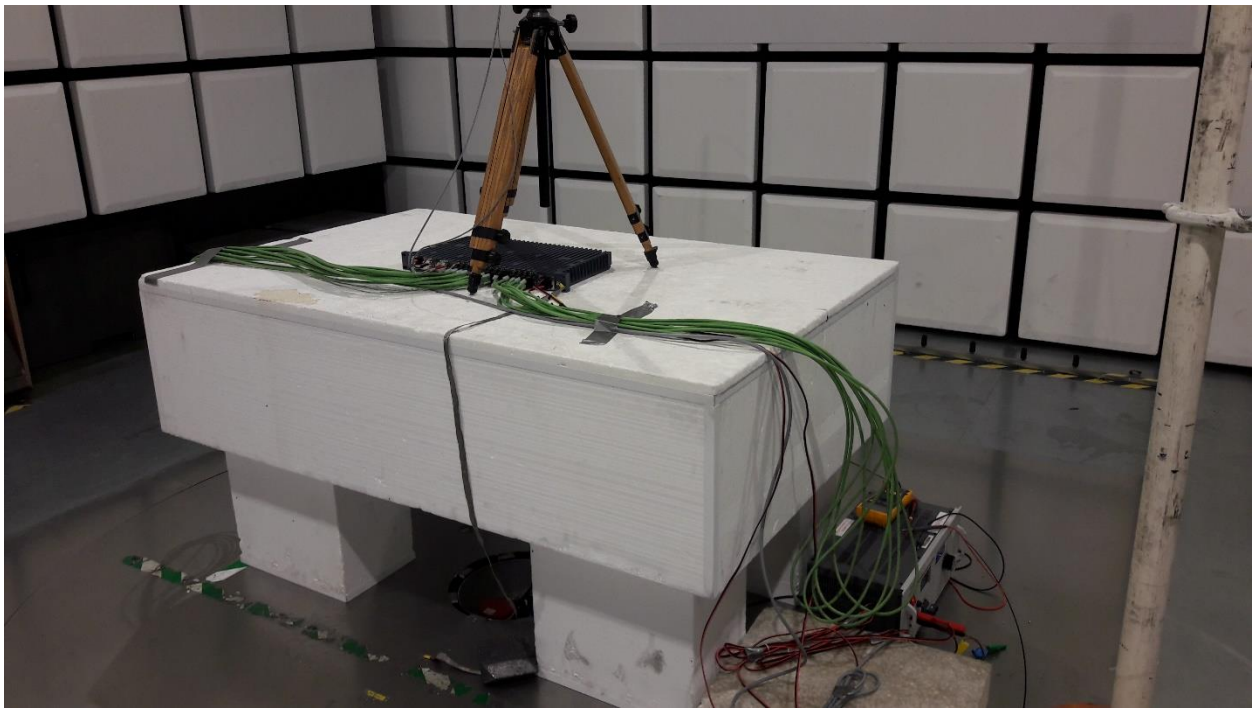
Requirement

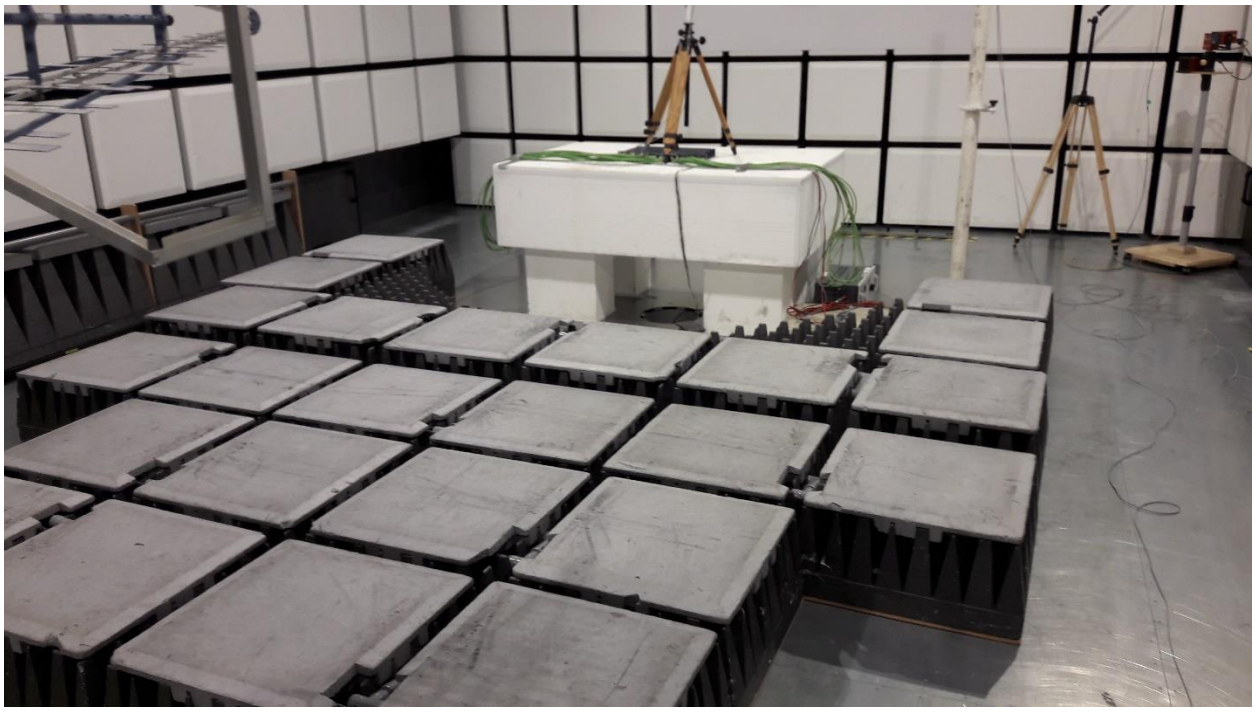
The radiated emission shall not exceed the limits specified in the standard CISPR 22 for class A equipment.

Result

The object passed the test.

Photographs of test arrangement





10.3 Conducted emission

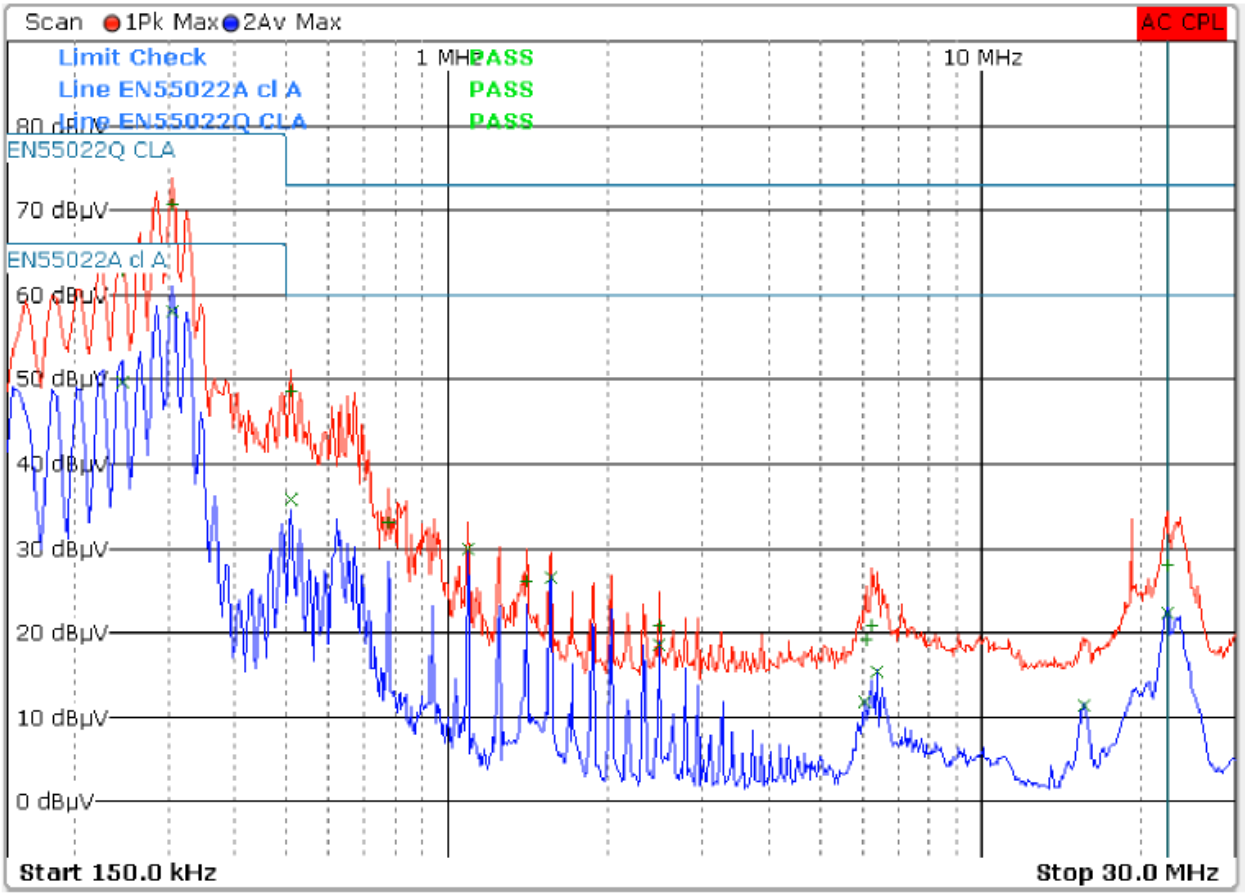
Standard and date

Standard	IEC 61850-3, subclause 6.7.4
Basic standard	CISPR 22
Test date	27 May 2021

Characteristic test data

Serial number	001089
Power supply 1	24 Vdc
Power supply 2	24 Vdc

Power supply port with a power supply voltage of 24 Vdc on DC 1 and DC 2



Final result

Frequency MHz	Level dBuV	Detector AV/QP	Limit dBuV	Delta to limit dB	Meas. Time ms	Line
0,2460	62,94	QP	79,00	-16,06	1000,0	N
0,2460	49,65	AV	66,00	-16,35	1000,0	N
0,3060	70,65	QP	79,00	-8,35	1000,0	N
0,3060	58,01	AV	66,00	-7,99	1000,0	N
0,5100	48,54	QP	73,00	-24,46	1000,0	L1
0,5100	35,85	AV	60,00	-24,15	1000,0	L1
0,7780	33,07	QP	73,00	-39,93	1000,0	N
1,0900	30,02	AV	60,00	-29,98	1000,0	L1
1,4020	26,13	QP	73,00	-46,87	1000,0	N
1,5580	26,61	AV	60,00	-33,39	1000,0	L1
2,4900	20,80	QP	73,00	-52,20	1000,0	L1
2,4900	18,53	AV	60,00	-41,47	1000,0	L1
6,0540	11,95	AV	60,00	-48,05	1000,0	N
6,0900	19,13	QP	73,00	-53,87	1000,0	L1
6,2500	20,92	QP	73,00	-52,08	1000,0	N
6,3820	15,36	AV	60,00	-44,64	1000,0	N
15,5980	11,47	AV	60,00	-48,53	1000,0	N
22,3460	22,36	AV	60,00	-37,64	1000,0	N
22,3500	28,05	QP	73,00	-44,95	1000,0	N

Remarks

-

Telecommunication port P23 - Ethernet

Final result

Frequency MHz	Level dBuV	Detector AV/QP	Limit dBuV	Delta to limit dB	Meas, Time ms
0,1820	58,39	AV	82,38	-24,00	1000,0
0,1820	54,24	QP	95,39	-41,15	1000,0
0,3060	70,17	AV	78,08	-7,91	1000,0
0,3060	66,75	QP	91,08	-24,33	1000,0
0,5140	42,81	QP	87,00	-31,19	1000,0
0,5140	37,56	AV	74,00	-49,44	1000,0
0,8140	36,81	QP	87,00	-37,19	1000,0
1,7540	36,59	QP	87,00	-37,41	1000,0
2,4820	34,87	QP	87,00	-39,13	1000,0
6,1020	36,72	QP	87,00	-37,28	1000,0
6,4260	37,49	QP	87,00	-36,51	1000,0
13,5620	37,71	QP	87,00	-36,29	1000,0
23,8860	35,45	QP	87,00	-38,55	1000,0

Requirement

The conducted emission shall not exceed the limits for class A equipment, specified in the standard CISPR 22.

Result

The object passed the test.

Photograph of test arrangement

10.4 Electrostatic discharge

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-2
Test date	22 June 2021

Environmental conditions

Ambient temperature	22 °C	Relative humidity	56 %
Ambient air pressure	1006 hPa		

Characteristic test data

Serial number	001095
Power supply	48 Vdc

Method	Test voltage kV	See photographs on next pages	polarity	Observations
Air discharges	2, 4, 8	See the blue points	+ and -	-
Contact discharges	6	See red points	+ and -	-
Indirect contact	6	VCP right of object	+ and -	-
		HCP under object	+ and -	-

Observations

-

Remark

The rated link speed of the device for the ESD test was 100 MB/s; the communication troughput was set to 90 % corresponding to 90 MB/s, according to IEC61850-3, profile 3.

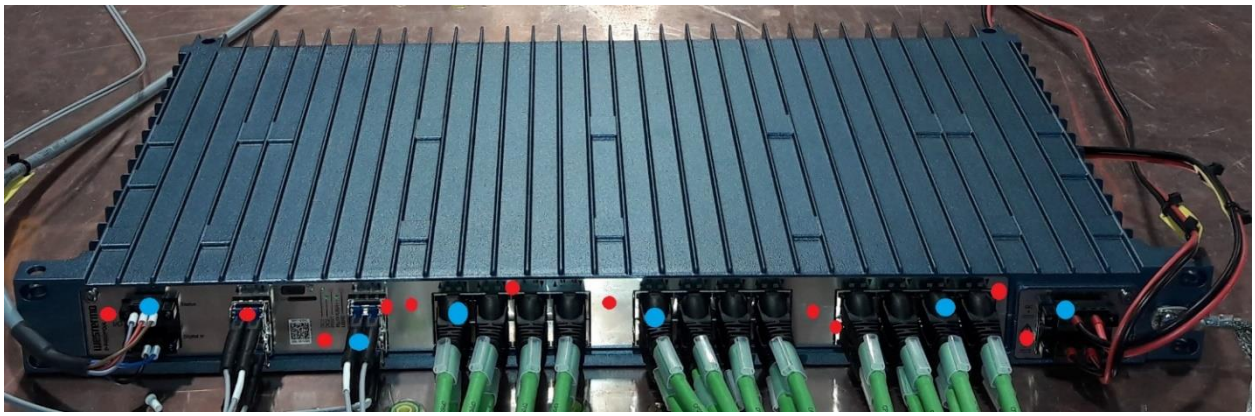
Requirements

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

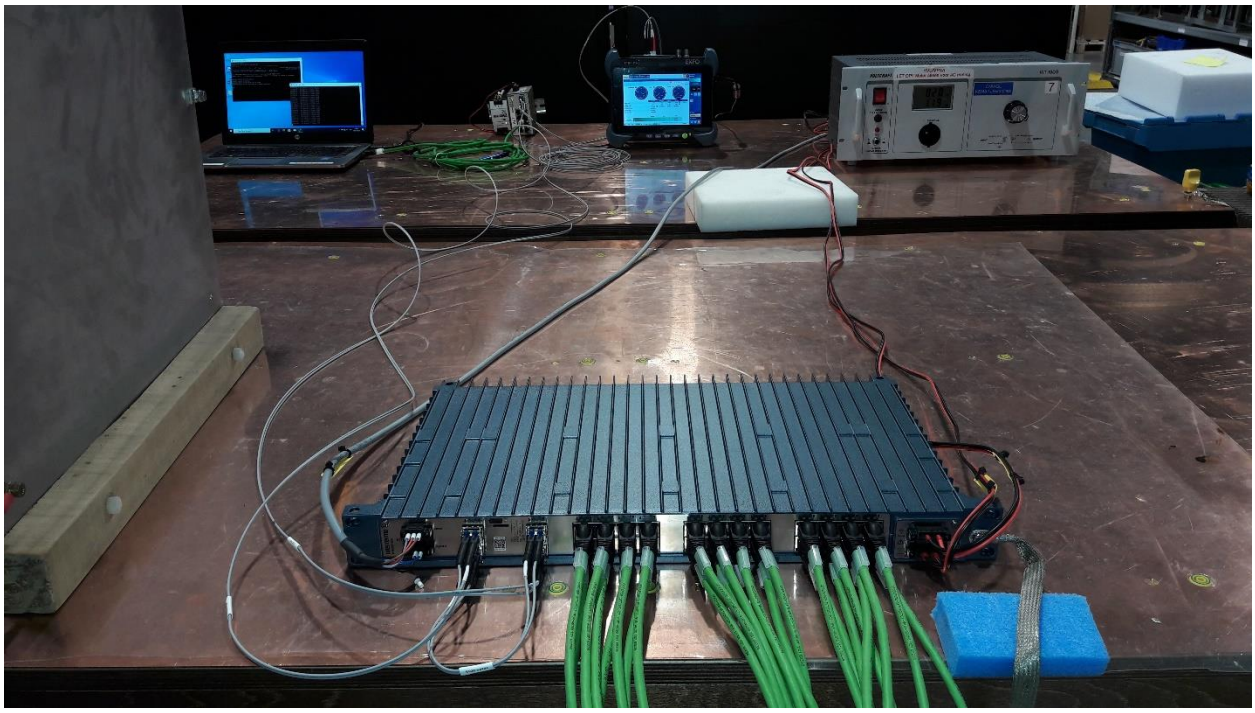
Result

The object passed the test.

Photograph of test points



Photographs of test arrangement



10.4.1 Radiated interference

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-3
Test date 24 June 2021

Characteristic test data

Serial number 001094
Amplitude modulated 80 % AM (1 kHz)
Dwell time 1 s

Frequency sweep

Direction	Test level V/m	Sweep rate	Frequency sweep MHz	Observations
Front side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 6000	-
Left side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 6000	-
Right side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 6000	-
Rear side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 6000	-

Spot frequencies

Direction	Test level V/m	Dwell time s	Frequency MHz	Observations
Front side of EUT (horizontal & vertical polarization)	10	10	80, 160, 380, 450, 900, 1850, 2150	-
Left side of EUT (horizontal & vertical polarization)	10	10	80, 160, 380, 450, 900, 1850, 2150	-
Right side of EUT (horizontal & vertical polarization)	10	10	80, 160, 380, 450, 900, 1850, 2150	-
Rear side of EUT (horizontal & vertical polarization)	10	10	80, 160, 380, 450, 900, 1850, 2150	-

Observations

-

Requirements

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement

10.5 Electrical fast transient

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-4
Test date 06-07 May 2021

Characteristic test data

Serial number 001089
Polarity positive and negative
Test duration 1 minute

Circuit	Terminals	Coupling	Test voltage kV	Repetition frequency kHz	Observations
Power supply DC1	COM; DC+	CM (CDN)	4	5	-
				100	-
Power supply DC2	COM; DC+	CM (CDN)	4	5	-
				100	-
I/O	NO;C;NC	CM (CCC)	4	5	-
				100	-
I/O	DI+;DI-	CM (CCC)	4	5	-
				100	-
RJ45	5	CM (CDN)	4	5	-
				100	-
RJ45	16	CM (CCC)	4	5	-
				100	-
RJ45	22	CM (CCC)	4	5	-
				100	-
RJ45	27	CM (CCC)	4	5	-
				100	-

CM = Common Mode
CDN = Coupling-Decoupling Network
CCC = Capacitive Coupling Clamp

Observations

-

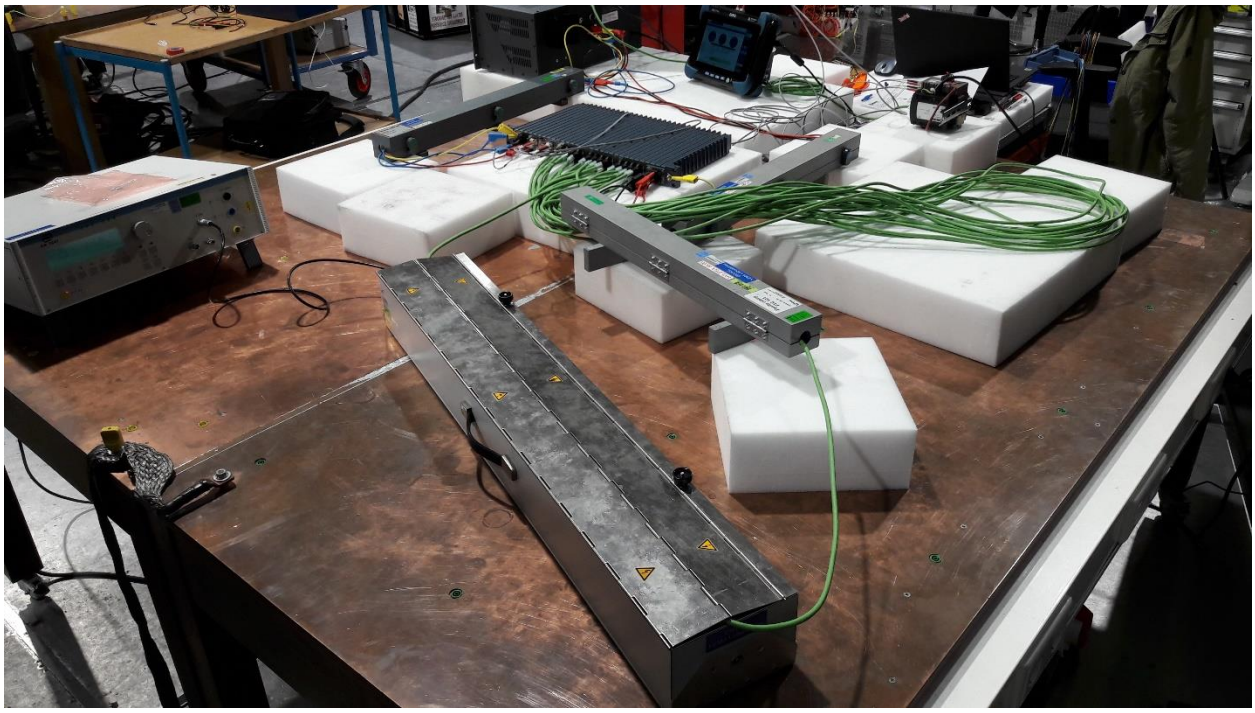
Requirements

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



10.6 Slow damped oscillatory wave

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-18
Test date	04-06 May 2021

Characteristic test data

Serial number	001089	
Voltage oscillation frequency	1	MHz
Voltage rise time	75	ns
Repetition frequency	400	Hz
Output impedance	200	Ω
Polarity of the first half-period		Positive and negative

Circuit/Port	Terminals	Coupling	Test voltage kV	Observations
Power supply DC1	COM; DC+	CM	2,5	-
		DM	1,0	-
Power supply DC2	COM; DC+	CM	2,5	-
		DM	1,0	-
I/O	NO;C;NC	CM	2,5	-
		DM	1,0	-
I/O	DI+;DI-	CM	2,5	-
		DM	1,0	-
RJ45	5	CM[1]	2,5	-
RJ45	16	CM[1]	2,5	-
RJ45	22	CM[1]	2,5	-
RJ45	27	CM[1]	2,5	-

[1)]injected on the shield

Observations

-

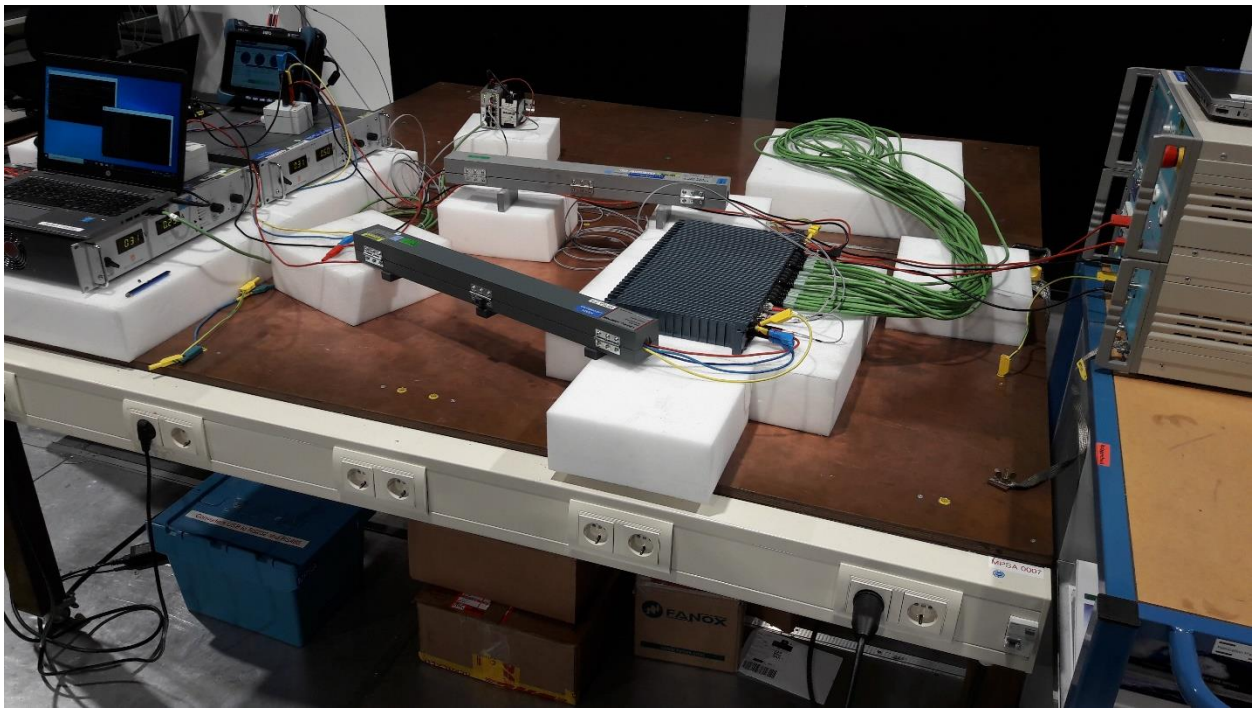
Requirements

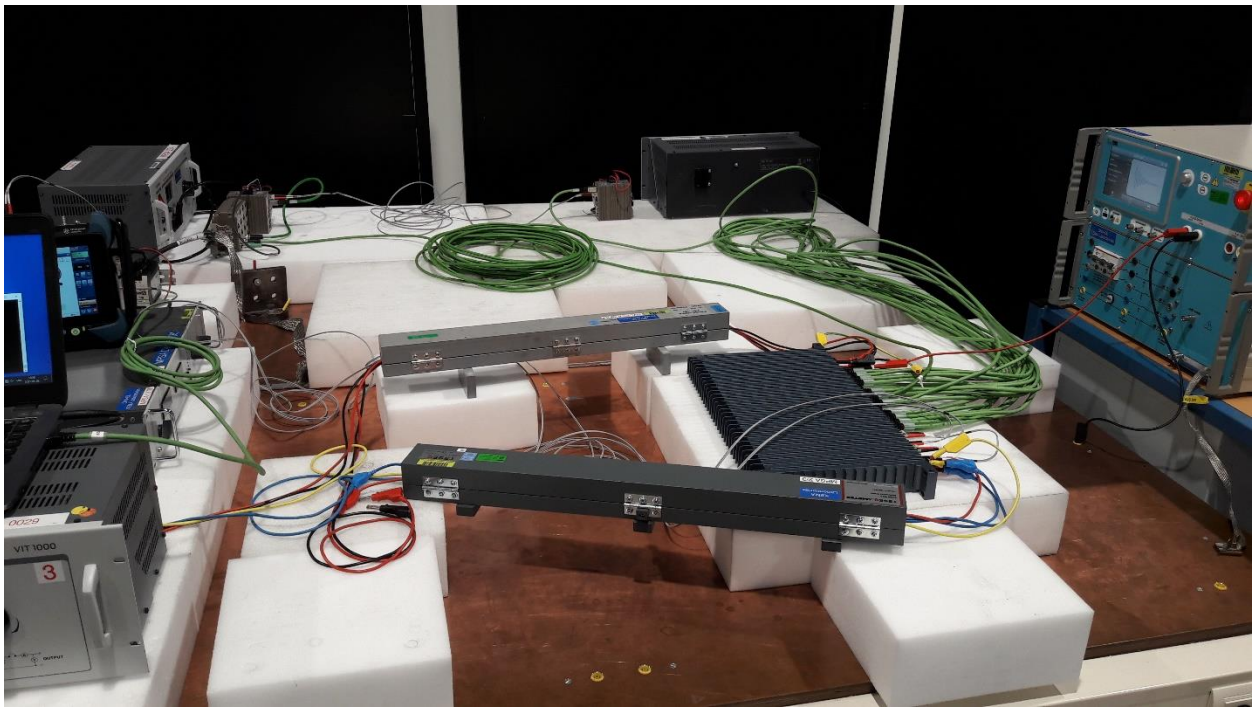
- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photographs of test arrangement





10.7 Surge

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-5
Test date	28,31 May 2021

Characteristic test data

Serial number	001089
Source impedance	2 Ω
Front time (voltage)	1,2 µs
Time to half value (voltage)	50 µs
Front time (current)	8 µs
Time to half value (current)	20 µs

Auxiliary power supply port

Coupling capacitor	18 µF
Coupling resistor	0 Ω
Coupling resistor	10 Ω
Coupling capacitor	9 µF

Input and output ports

Coupling resistor	40 Ω
Coupling capacitor	0,5 µF

Circuit	Terminals	Coupling	Test voltage kV	Observations
Power supply DC1	COM; DC+	LL	0,5/1	-
		LE	1/2	-
Power supply DC2	COM; DC+	LL	0,5/1	-
		LE	1/2	-
I/O	NO;C;NC	LL	0,5/1/2	-
		LE	1/2/4	-
I/O	DI+;DI-	LL	0,5/1/2	-
		LE	1/2/4	-
RJ45	6	LE [1)]	1/2/4	-
RJ45	17	LE [1)]	1/2/4	-
RJ45	24	LE [1)]	1/2/4	-
RJ45	28	LE [1)]	1/2/4	-

[1)] Direct injection on the shield.

Observations

-

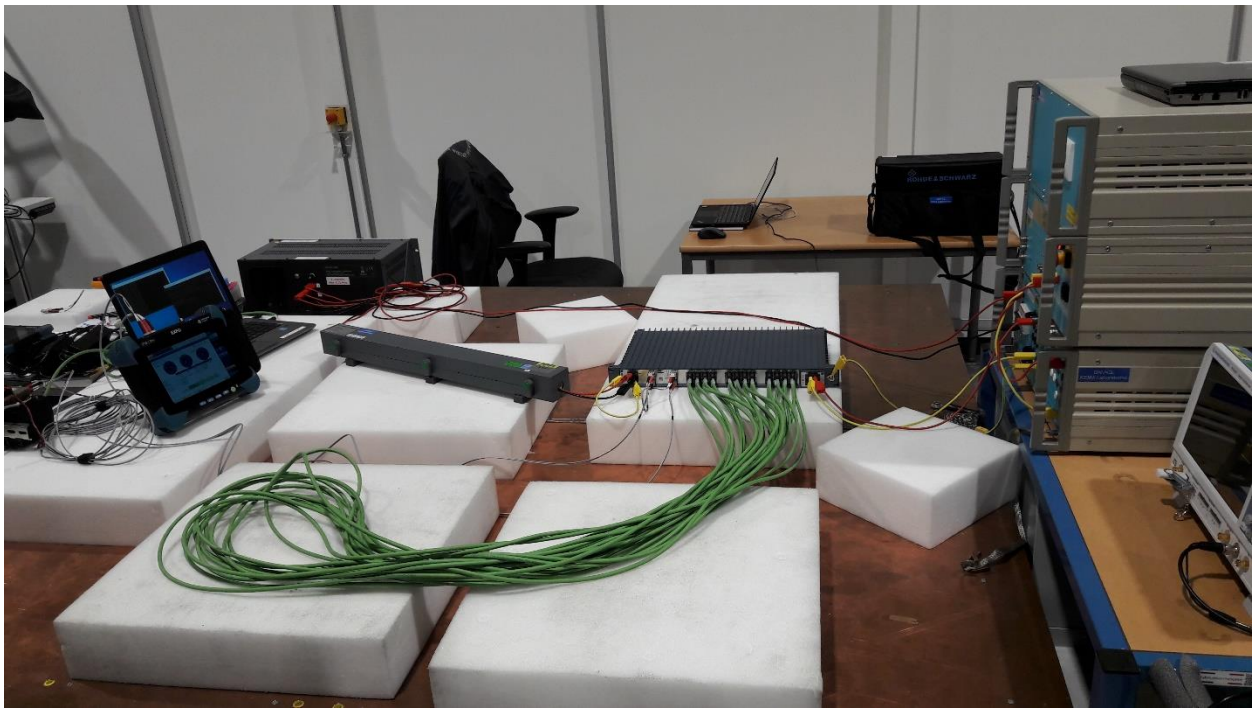
Requirements

- The object shall comply with acceptance criteria class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photographs of test arrangement



10.8 Conducted disturbance induced by radio-frequency fields

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-6
Test date 03 May 2021

Characteristic test data

Serial number 001089
Source impedance 150 Ω
Amplitude modulated 80 % AM (1 kHz)
Sweep rate 1 %
Dwell time (frequency sweep) 1 s

Frequency sweep

Circuit	Terminals	Test level V	CDN	Sweep rate	Frequency sweep MHz	Observations
Power supply DC1	COM; DC+	10	M2	≤ 1 %	0,15 - 80	-
Power supply DC2	COM; DC+	10	M2	≤ 1 %	0,15 - 80	-
I/O	NO;C;NC	10	AF3	≤ 1 %	0,15 - 80	-
I/O	DI+;DI-	10	AF2	≤ 1 %	0,15 - 80	-
RJ45	6	10	S8	≤ 1 %	0,15 - 80	-
RJ45	15	10	S8	≤ 1 %	0,15 - 80	-
RJ45	21	10	S8	≤ 1 %	0,15 - 80	-
RJ45	26	10	S8	≤ 1 %	0,15 - 80	-
RJ45	28	10	S8	≤ 1 %	0,15 - 80	-

Spot frequencies

Circuit	Terminals	Test level V	CDN	Duty cycle %	Spot frequencies MHz	Observations
Power supply DC1	COM; DC+	10	M2	100	27, 68	-
Power supply DC2	COM; DC+	10	M2	100	27, 68	-
I/O	NO;C;NC	10	AF3	100	27, 68	-
I/O	DI+;DI-	10	AF2	100	27, 68	-
RJ45	6	10	S8	100	27, 68	-
RJ45	15	10	S8	100	27, 68	-
RJ45	21	10	S8	100	27, 68	-
RJ45	26	10	S8	100	27, 68	-
RJ45	28	10	S8	100	27, 68	-

Observations

-

Requirement

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement

10.9 Power frequency magnetic field

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-8
Test date	30 April to 03 May 2021

Characteristic test data

Serial number	001089
Power supply	48 Vdc
Frequency	50 Hz

Direction	Test level A/m	Duration s	Observations
Horizontal longitudinal (x)	100	Continuous	-
	1000	1 s	-
Horizontal transversal (y)	100	Continuous	-
	1000	1 s	-
Vertical (z)	100	Continuous	-
	1000	1 s	-

Observations

-

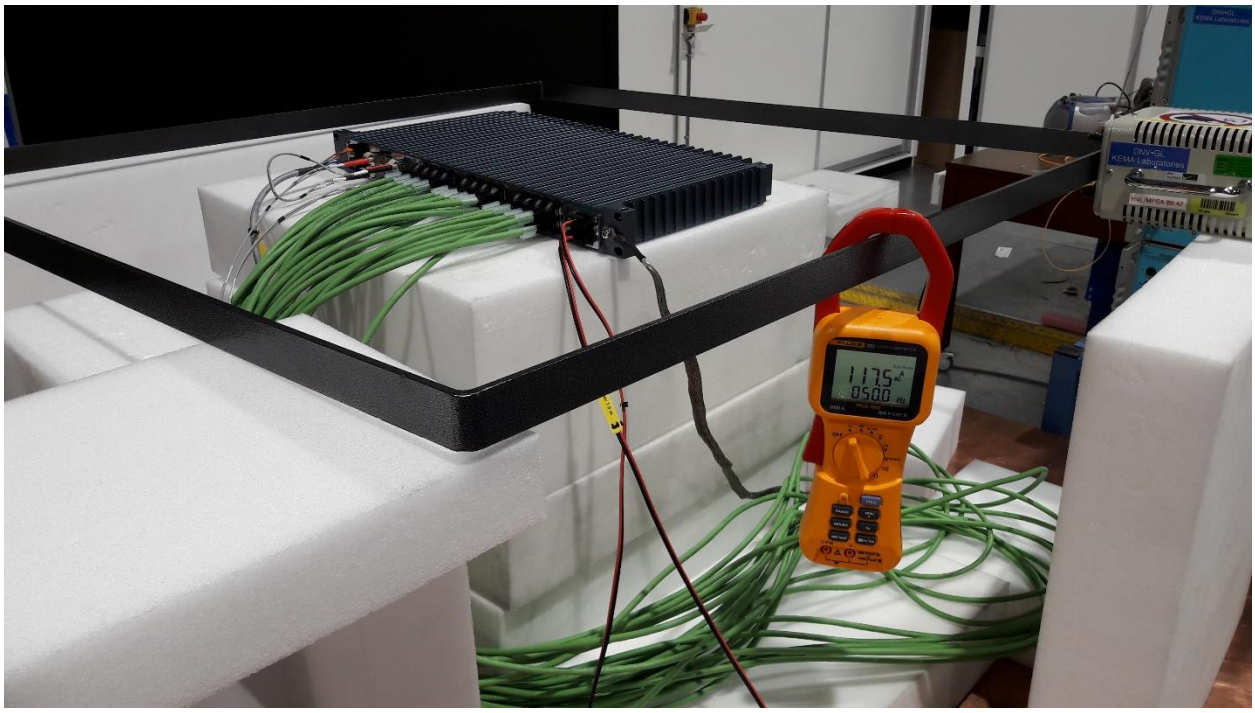
Requirements

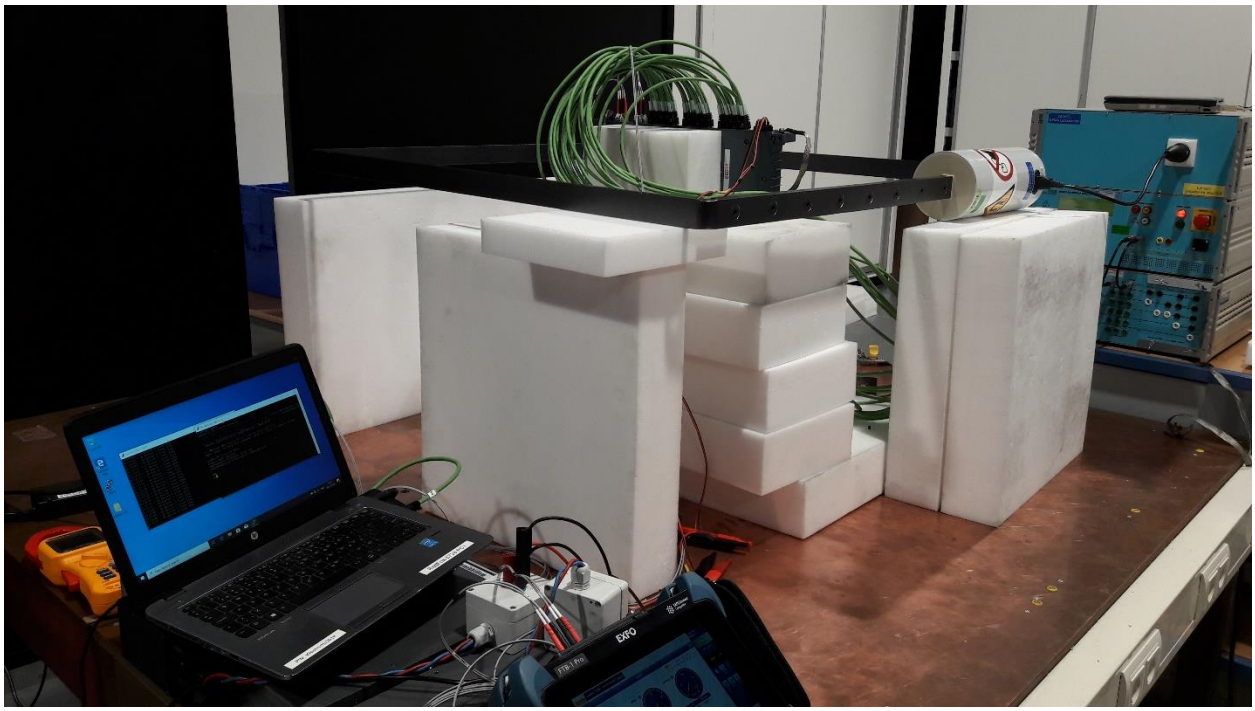
- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

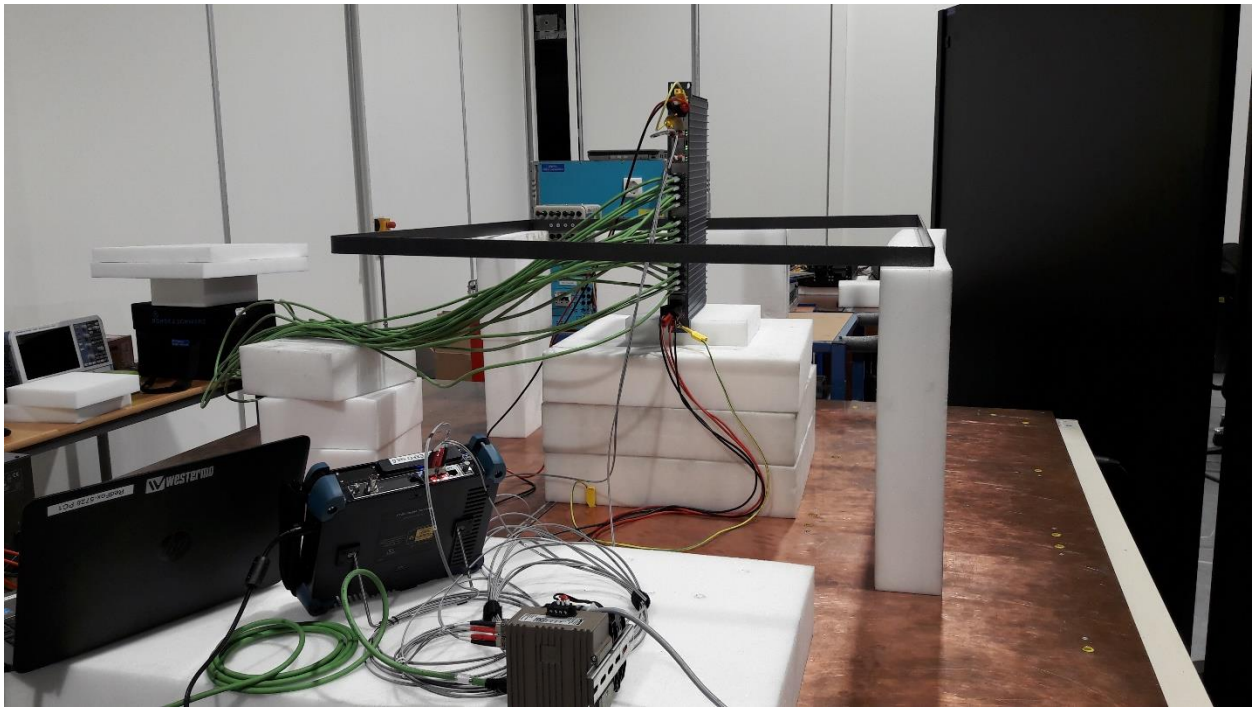
Result

The object passed the test.

Photographs of test arrangement






WESTERVOO

10.10 Mains frequency voltage immunity

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-16
Test date	17 May 2021

Characteristic test data

Serial number	001089
Frequency	50 & 60 Hz

Binary input ports

Circuit	Terminals	Test duration s	Test voltage V	Coupling resistor Ω	Coupling capacitor µF	Observations
I/O	DI+;DI-	60 s	30	200	1,0	-
		1 s	300	200	1,0	-

Observations

-

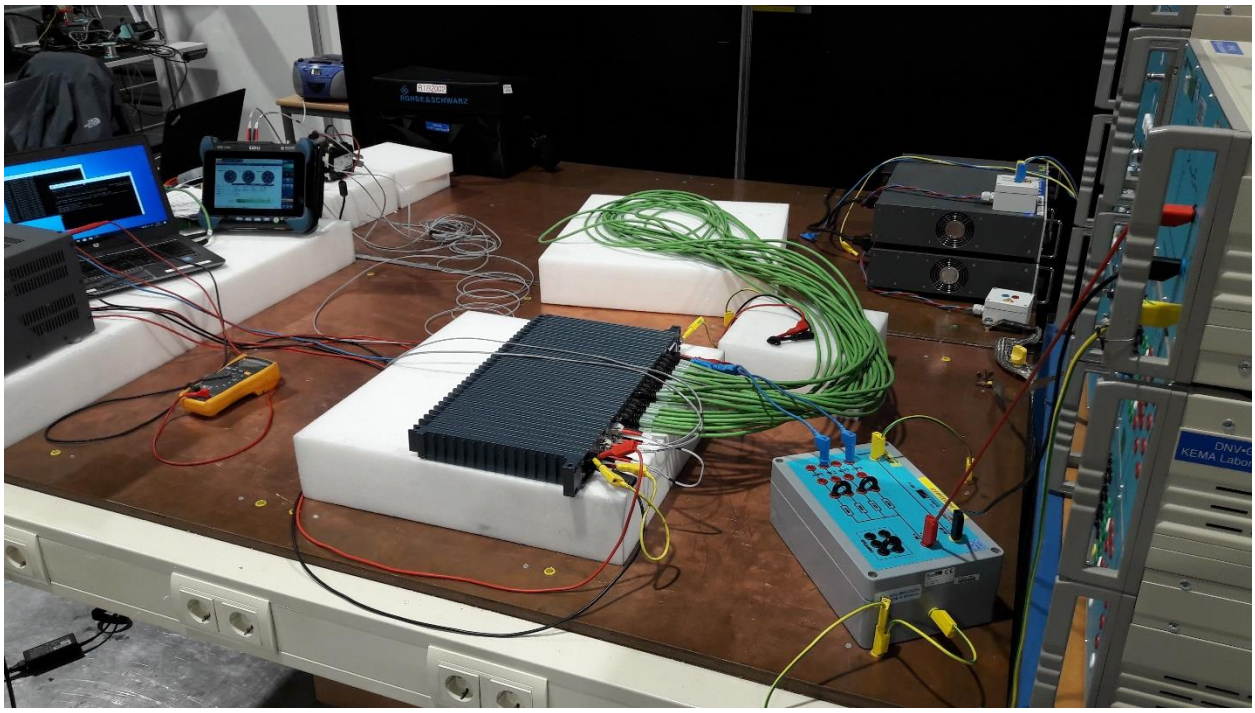
Requirements

- The object shall comply with reliability class 2 of chapter 7.5.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



10.11 Voltage dips and voltage interruptions on power supply voltage

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-11, IEC 61000-4-29
Test date	17 May 2021

Characteristic test data

Serial number	001089
Time	0,1 s
Power supply 1	24 – 48 Vdc
Power supply 2	24 – 48 Vdc

Voltage dips

PSU 1 Vdc	PSU 2	PoE	Dip duration ms	Dip %	Residual voltage PSU 1 Vdc	Observations
$U_{min\ rated}$ 24	Off	-	100	60	9,6	-
$U_{min\ rated}$ 24	Off	-	100	30	16,8	-
$U_{max\ rated}$ 48	Off	-	100	60	19,2	-
$U_{max\ rated}$ 48	Off	-	100	30	33,6	-
$U_{min\ rated}$ 24	On	-	100	60	9,6	-
$U_{min\ rated}$ 24	On	-	100	30	16,8	-
$U_{max\ rated}$ 48	On	-	100	60	19,2	-
$U_{max\ rated}$ 48	On	-	100	30	33,6	-

PSU 2 Vdc	PSU 1	PoE	Dip duration ms	Dip %	Residual voltage PSU 2 Vdc	Observations
$U_{min\ rated}$ 24	Off	-	100	60	9,6	-
$U_{min\ rated}$ 24	Off	-	100	30	16,8	-
$U_{max\ rated}$ 48	Off	-	100	60	19,2	-
$U_{max\ rated}$ 48	Off	-	100	30	33,6	-
$U_{min\ rated}$ 24	On	-	100	60	9,6	-
$U_{min\ rated}$ 24	On	-	100	30	16,8	-
$U_{max\ rated}$ 48	On	-	100	60	19,2	-
$U_{max\ rated}$ 48	On	-	100	30	33,6	-

Observations

-

Characteristic test data

Serial number	001089
Interruption time	0,05 s
Power supply 1	24 – 48 Vdc
Power supply 2	24 – 48 Vdc

Voltage interruptions

PSU 1 Vdc	PSU 2	PoE	interruption duration ms	interruption %	Residual voltage PSU 1 Vdc	Observations
$U_{min\ rated}$ 24 (low impedance)	Off	-	50	100	0	-
$U_{min\ rated}$ 24 (high impedance)	Off	-	50	100	0	-
$U_{max\ rated}$ 48 (low impedance)	Off	-	50	100	0	-
$U_{max\ rated}$ 48 (high impedance)	Off	-	50	100	0	-
$U_{min\ rated}$ 24 (low impedance)	On	-	50	100	0	-
$U_{min\ rated}$ 24 (high impedance)	On	-	50	100	0	-
$U_{max\ rated}$ 48 (low impedance)	On	-	50	100	0	-
$U_{max\ rated}$ 48 (high impedance)	On	-	50	100	0	-

PSU 2 Vdc	PSU 1	PoE	interruption duration ms	interruption %	Residual voltage PSU 2 Vdc	Observations
$U_{min\ rated}$ 24 (low impedance)	Off	-	50	100	0	-
$U_{min\ rated}$ 24 (high impedance)	Off	-	50	100	0	-
$U_{max\ rated}$ 48 (low impedance)	Off	-	50	100	0	-
$U_{max\ rated}$ 48 (high impedance)	Off	-	50	100	0	-
$U_{min\ rated}$ 24 (low impedance)	On	-	50	100	0	-
$U_{min\ rated}$ 24 (high impedance)	On	-	50	100	0	-
$U_{max\ rated}$ 48 (low impedance)	On	-	50	100	0	-
$U_{max\ rated}$ 48 (high impedance)	On	-	50	100	0	-

Observations

-

Requirements

- The object shall comply with the reliability class 2 of chapter 7.5.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement

10.12 Voltage ripple on DC power supply voltage

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-17
Test date	14 May 2021

Characteristic test data

Serial number	001089
Auxiliary power supply input voltage	24 – 48 Vdc (tolerance 18 – 60 Vdc)
Rated power frequency	50 Hz

Power supply voltage Vdc	Test frequency Hz	Ripple V/%	See oscillogram on next pages	Observations
24	100	2,4 / 10	1	-
48	100	4,8 / 10	2	-

Observations

-

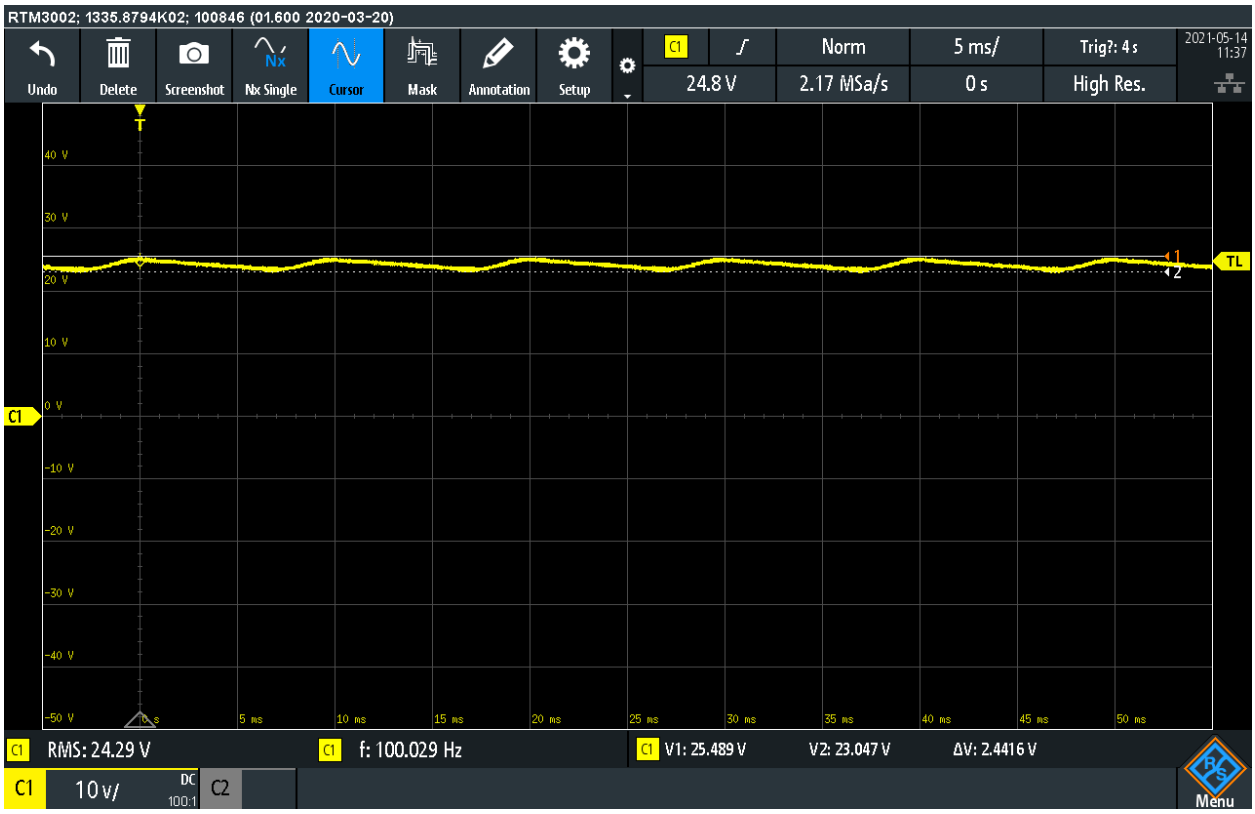
Requirements

- The object shall comply with the required reliability class 2 of chapter 7.5.
- The visual and functional inspection shall not reveal any defects or malfunctions.

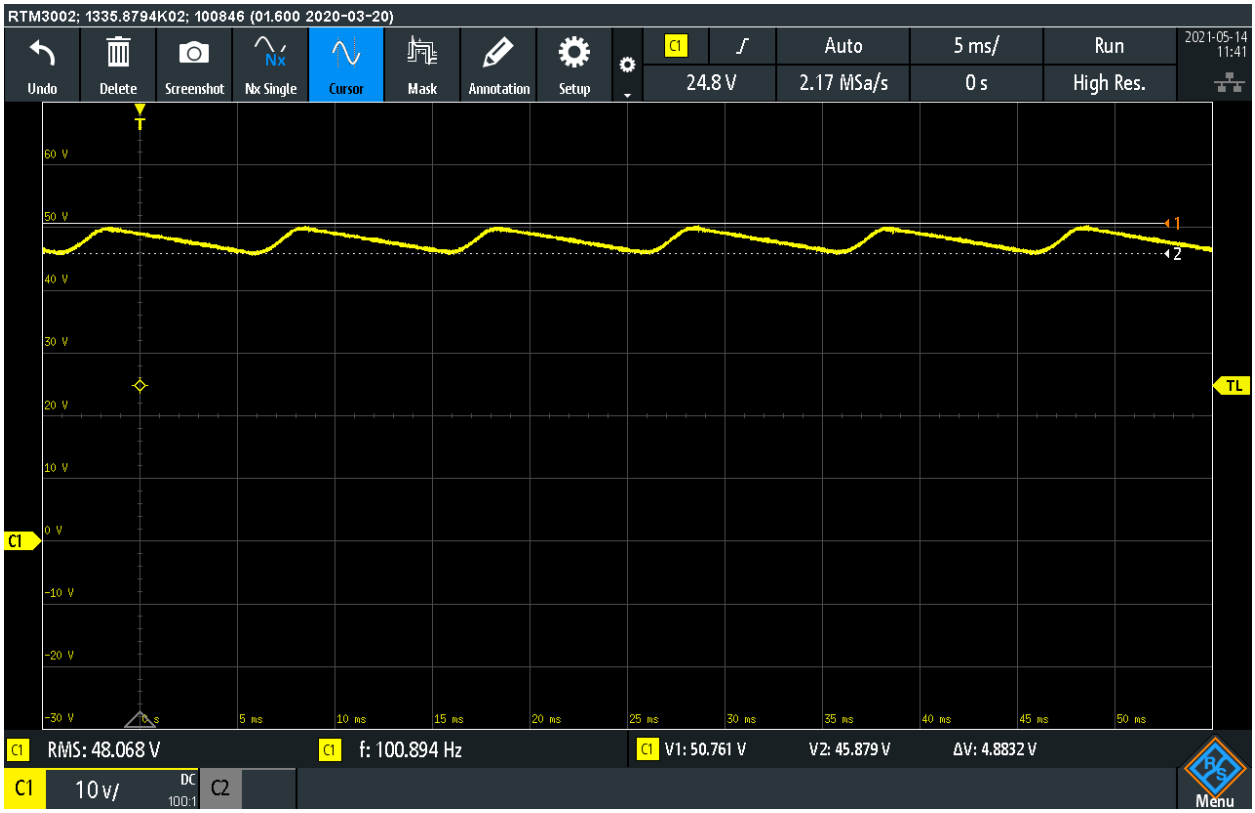
Result

The object passed the test.

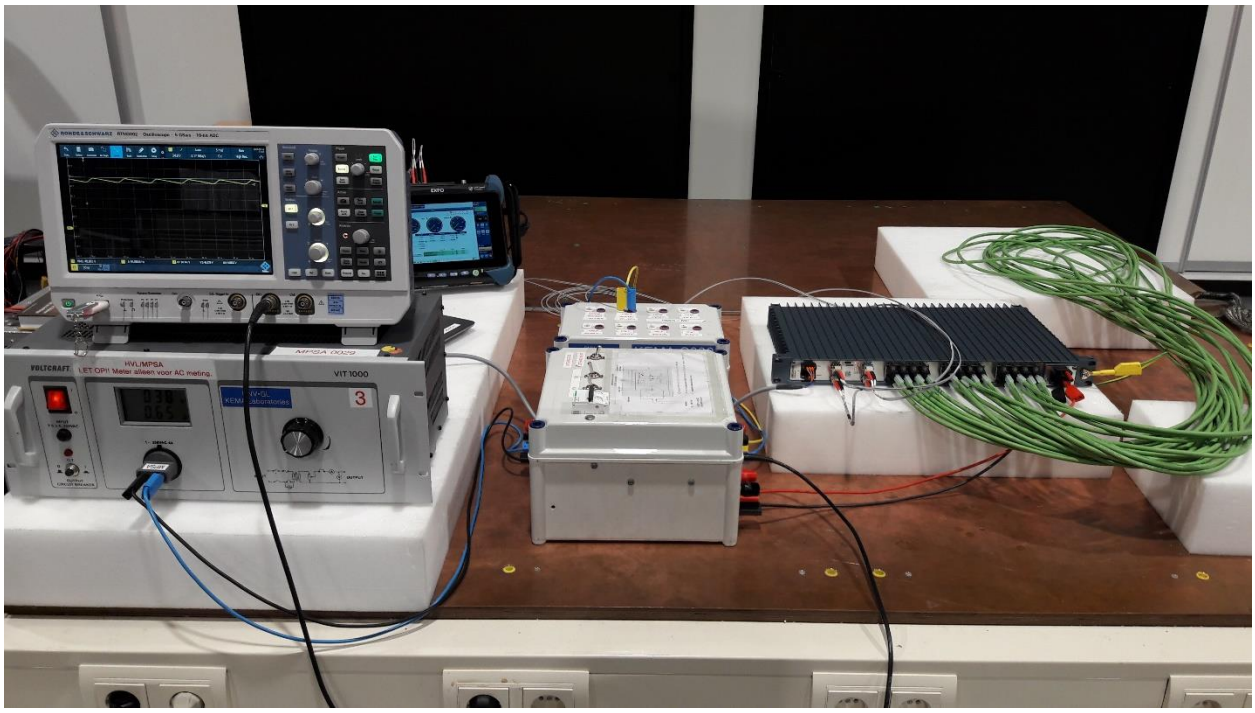
Oscillogram 1: 24Vdc at 100 Hz



Oscillogram 2: 48 Vdc at 100 Hz



Photograph of test arrangement



11 ENERGIZING QUANTITIES

11.1 Burden for DC power supply

Standard and date

Standard IEC 61850-3, subclause 6.8.2
Test date 25 May 2021

Environmental conditions

Ambient temperature 19 °C Relative humidity 56 %
Ambient air pressure 1008 hPa

Characteristic test data

Serial number 001089
Number of measurements 5 (issue maximum value)

Power input voltage Vdc	Measured maximum burden W	Specified maximum burden W	Observations
PSU1: 24,11	23,38	27,36	-
PSU1: 48,45	23,28	27,36	-
PSU2: 24,07	23,58	27,36	-
PSU2: 48,45	23,28	27,36	-

Observations

-

Result

The object passed the test.

Photograph of test arrangement

11.2 Inrush current

Standard and date

Standard IEC 61850-3, subclause 6.8.1.2 and 6.8.2.2
Test date 25 May 2021

Characteristic test data

Serial number 001089
Number of measurements 5 (issue maximum value)

Power input voltage	Measured		Observations
	Peak current	Power up duration	
Vdc	A	ms	
24	55	1,8	-
48	107,3	0,8	-

Observations

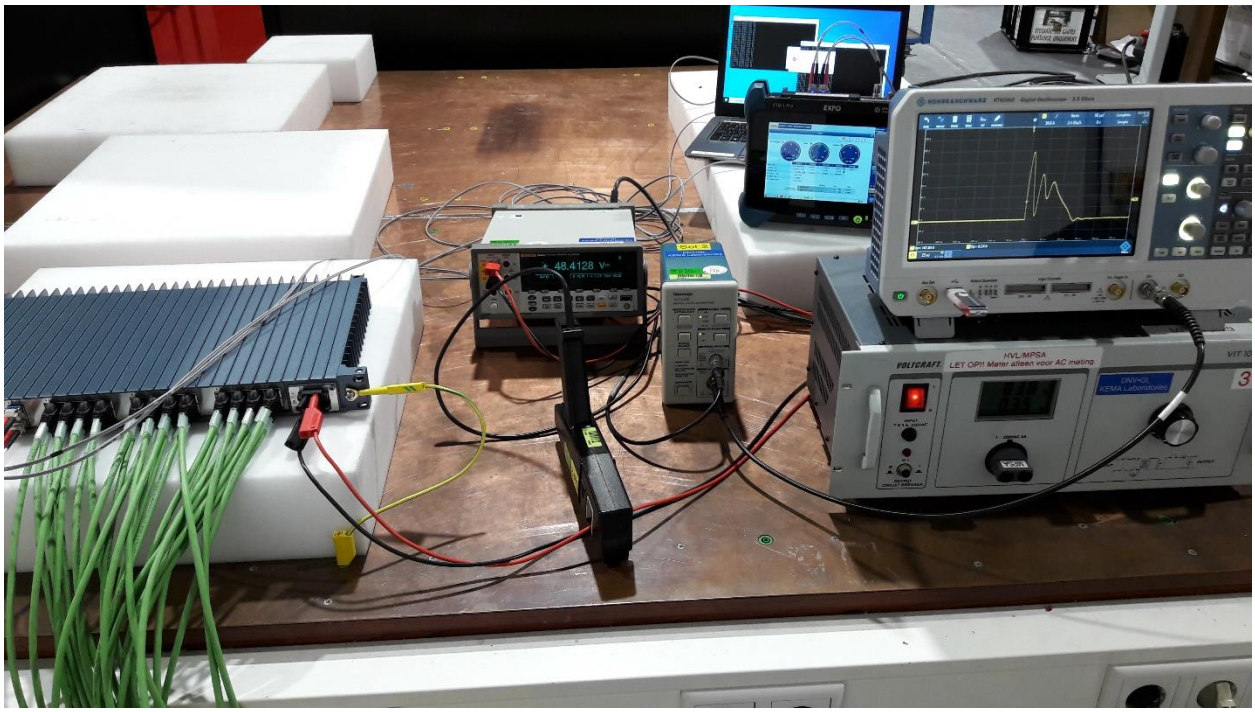
-

Result

The results are for information only.

Photo test arrangement burden

Photo test arrangement inrush



Oscillogram inrush

11.3 Burden for binary input

Standard and date

Standard IEC 61850-3, subclause 6.8.3
Test date 25 May 2021

Characteristic test data

Serial number 001089
Number of measurements 5 (issue maximum value)

Terminals	Power input voltage Vdc	Measured maximum value mW	Specified maximum value mW	Observation
DI+;DI-	8	5,6	174	-
DI+;DI-	60,1	108,3	174	-

Observations

-

Result

The object passed the test.

12 CLIMATIC ENVIRONMENT

12.1 Inspection

12.1.1 Pre-inspection

The pre-inspection is performed to verify that the test object is in operational state. The pre-inspection is carried out prior to the test procedure.

The communication with the maintenance computer is verified. Signals are simulated to verify the functioning and operation with the specified performance specification for the following inputs and outputs:

- analogue inputs;
- digital inputs;
- contact outputs;
- data communication.

12.1.2 Visual and functional inspection

After each test a visual and functional inspection is carried out as described in this chapter.

The visual inspection is carried out to verify that there is no visual mechanical damage.
There shall be no:

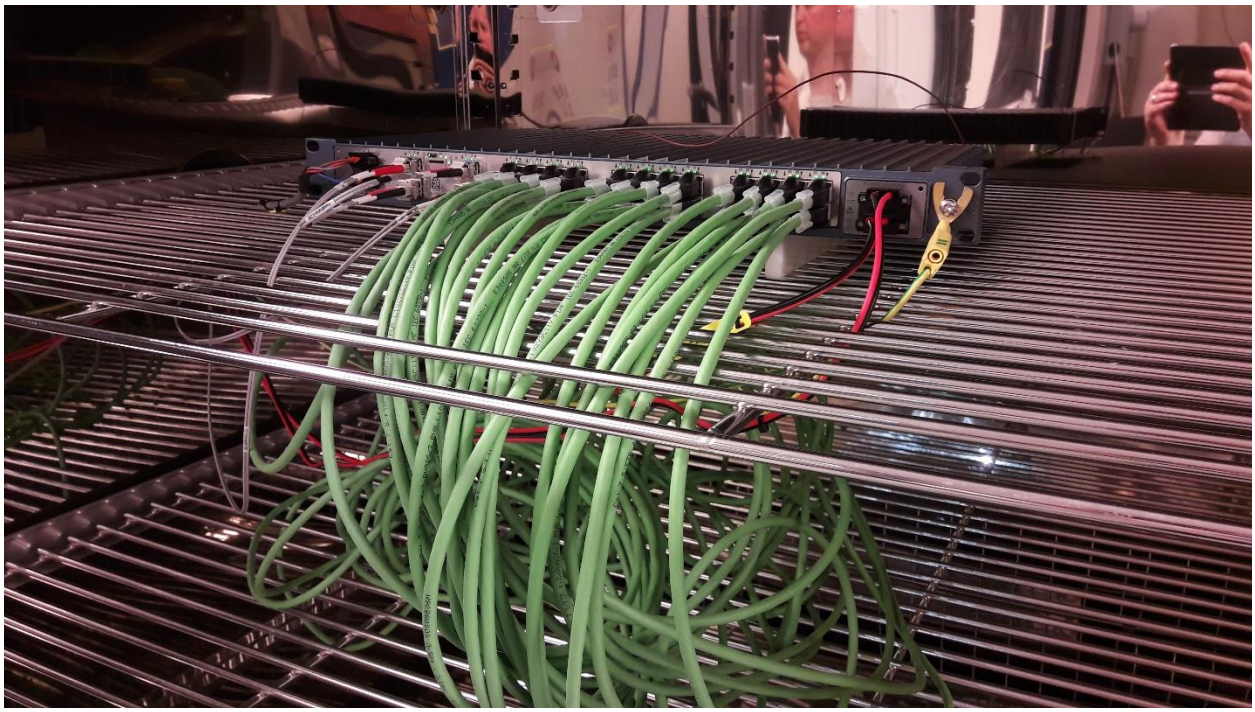
- burning of any components;
- paint blisters on any components;
- discolouration on components;
- deformation of modules or components;
- interruptions or damage on interconnecting cables, wires and connectors.

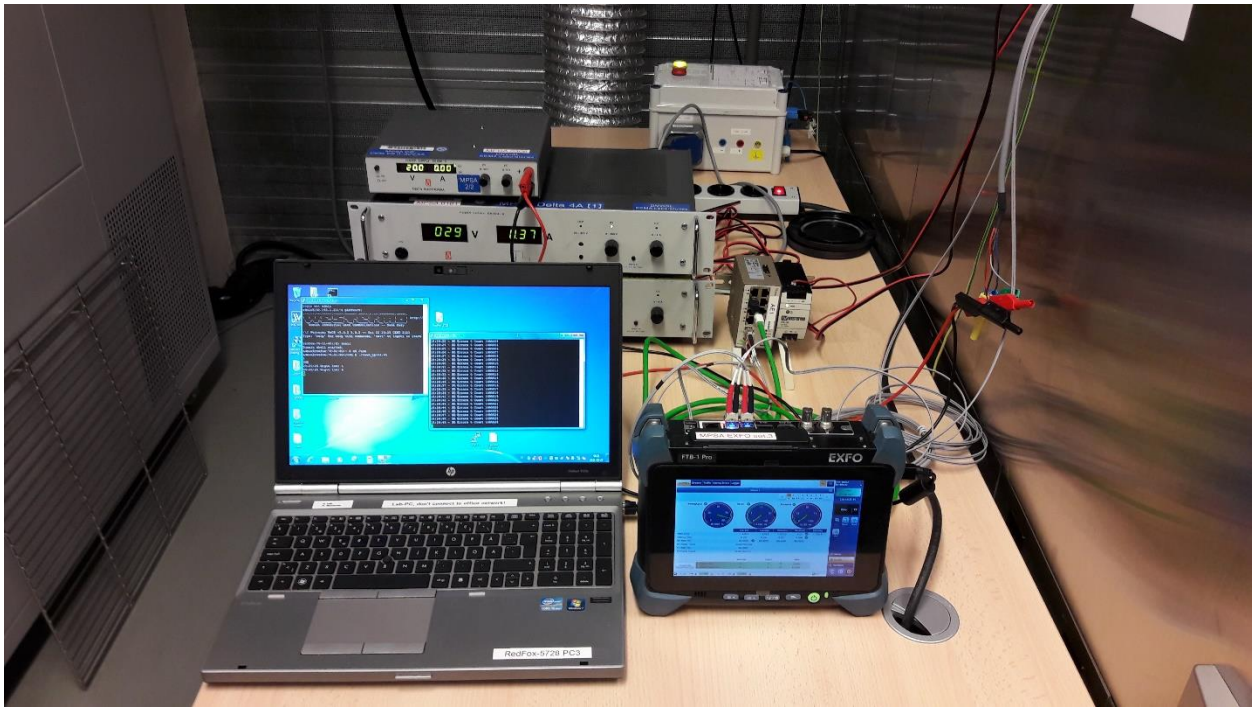
Functional inspection is carried out to verify the correct operation of the test object.
There shall be no:

- alarm indications on display and LED's;
- error messages reported in the maintenance computer;
- unintentional change of contact outputs;
- there shall be no degradation of performance below the claimed performance according reliability class (1 or 2).

Unless otherwise stated the visual and functional inspection was carried out successfully after each test.

12.2 Photograph of test arrangement





12.3 Climatic environmental tests

12.3.1 Dry-heat test - operational

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.1
Basic standard	IEC 60068-2-2
Test date	03 to 04 May 2021

Environmental conditions

Ambient temperature	23 °C	Relative humidity	52 %
Ambient air pressure	1006 hPa		

Characteristic test data

Serial number	001090
Type of test	Bd
Operating conditions	energized
Power supply	24 Vdc
Relative humidity	< 50 %
Maximum rate of change	1 °C/min over a period of 5 min

Test procedure	Duration of exposure h	Operating temperature °C	Observation
Powering up after	1	+70	-
Correct function at rated load	16		-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

12.3.2 Cold test - operational

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.2
Basic standard	IEC 60068-2-1
Test date	04 to 05 May 2021

Environmental conditions

Ambient temperature	23 °C	Relative humidity	50 %
Ambient air pressure	1005 hPa		

Characteristic test data

Serial number	001090
Type of test	Ad
Operating conditions	Energized
Power supply	24 Vdc
Relative humidity	< 50 %
Maximum rate of change	1 °C/min over a period of 5 min

Test procedure	Duration of exposure h	Operating temperature °C	Observation
Powering up after	1	-40	-
Correct function at rated load/current	16		-

Observations

-

Requirement

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

12.3.3 Dry-heat test at maximum storage temperature

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.3
Basic standard	IEC 60068-2-2
Test date	1 and 2 May 2021

Environmental conditions

Ambient temperature	20 °C	Relative humidity	51 %
Ambient air pressure	1008 hPa		

Characteristic test data

Serial number	001090
Type of test	Bb
Operating conditions	non-energized
Power supply	0 V
Relative humidity	< 50 %
Maximum rate of change	1 °C/min over a period of 5 min

Test procedure	Duration of exposure h	Operating temperature °C	Observation
Storage	16	+85	-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

12.3.4 Cold test at minimum storage temperature

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.4
Basic standard	IEC 60068-2-1
Test date	30 April to 1 May 2021

Environmental conditions

Ambient temperature	22 °C	Relative humidity	51 %
Ambient air pressure	1008 hPa		

Characteristic test data

Serial number	001090
Type of test	Ab
Operating conditions	non-energized
Power supply	0 V
Relative humidity	< 50 %
Maximum rate of change	1 °C/min over a period of 5 min

Test procedure	Duration of exposure h	Operating temperature °C	Observations
Storage	16	-50	-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

12.3.5 Change of temperature test

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.5
Basic standard	IEC 60068-2-14
Test date	17 to 19 May 2021

Environmental conditions

Ambient temperature	22 °C	Relative humidity	46 %
Ambient air pressure	1001 hPa		

Characteristic test data

Serial number	001090
Type of test	Nb
Operating conditions	energized
Power supply	24 Vdc
Relative humidity	< 50 %
Maximum rate of change	1 °C/min
Exposure time t_1	3 h
Duration of exposure	5 cycles

Test procedure	Exposure time h	Duration of exposure	Operating temperature °C	Observations
Pre-conditioning	1	-	+22	-
Correct function	3	5	Min. -40	-
			Max. +70	-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

12.3.6 Damp-heat steady-state test

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.6
Basic standard	IEC 60068-2-78
Test date	6 to 17 May 2021

Environmental conditions

Ambient temperature	21 °C	Relative humidity	46 %
Ambient air pressure	1001 hPa		

Characteristic test data

Serial number	001090
Type of test	Cab
Operating conditions	energized
Power supply	24 Vdc
Relative humidity	93 %

Test procedure	Duration of exposure	Operating temperature °C	Humidity %	Observations
Powering up after	1 h	22	50	-
Correct function	10 days	+40	93	-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- A protective bonding resistance test shall be performed.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

12.3.7 Damp heat cyclic (12 h + 12 h) test

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.7
Basic standard	IEC 60068-2-30
Test date	20 to 27 May 2021

Environmental conditions

Ambient temperature	22 °C	Relative humidity	46 %
Ambient air pressure	1003 hPa		

Characteristic test data

Serial number	001090
Type of test	Db
Operating conditions	energized
Power supply	24 Vdc

Test procedure	Duration of exposure (h)	Duration of exposure (cycles)	Operating temperature (°C)	Hunidity (%)	Observations
Pre-conditioning	1	-	+25	60	-
Correct function	12	5	+25	97	-
	12	5	+55	93	-

Observations

-

Requirements

- A dielectric voltage test shall be performed.
- Measurement of insulation resistance should be performed before and after climatic tests and before and after dielectric tests.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

12.4 Measurement of insulation resistance

Standard and date

Standard IEC 61850-3, subclause 6.9.2.2
Test date 29 April and 27 May 2021

Environmental conditions

Ambient temperature 20 °C Relative humidity 53 %
Ambient air pressure 1014 hPa

Characteristic test data

Serial number 001090
Test voltage 500 Vdc

Before climatic tests

Voltage applied to Circuit	Terminals	Insulation resistance at 500 Vdc (MΩ)	Observations
Power supply DC1	COM; DC+	> 550	-
Power supply DC2	COM; DC+	> 550	-
I/O	NO;C;NC DI+;DI-	> 550	-
RJ45	5	> 550	-
RJ45	16	> 550	-
RJ45	22	> 550	-
RJ45	27	> 550	-

Observations

-

After climatic tests

Voltage applied to Circuit	Terminals	Insulation resistance at 500 Vdc (MΩ)	Observations
Power supply DC1	COM; DC+	> 550	-
Power supply DC2	COM; DC+	> 550	-
I/O	NO;C;NC DI+;DI-	> 550	-
RJ45	5	> 550	-
RJ45	16	> 550	-
RJ45	22	> 550	-
RJ45	27	> 550	-

Observations

-

After dielectric tests

Voltage applied to Circuit	Terminals	Insulation resistance at 500 Vdc (MΩ)	Observations
Power supply DC1	COM; DC+	> 550	-
Power supply DC2	COM; DC+	> 550	-
I/O	NO;C;NC DI+;DI-	> 550	-
RJ45	5	> 550	-
RJ45	16	> 550	-
RJ45	22	> 550	-
RJ45	27	> 550	-

Observations

-

Requirements

- The insulation resistance shall not be less than 10 MΩ.
- No visual or functional inspection required.

Result

The object passed the test.

13 MECHANICAL ENVIRONMENTAL CONDITION TESTS

13.1 Inspection

13.1.1 Pre-inspection

The pre-inspection is performed to verify that the test object is in operational state. The pre-inspection is carried out prior to the test procedure.

The communication with the maintenance computer is verified. Signals are simulated to verify the functioning and operation with the specified performance specification for the following inputs and outputs:

- analogue inputs;
- digital inputs;
- contact outputs;
- data communication.

13.1.2 Visual and functional inspection

After each test a visual and functional inspection is carried out as described in this chapter.

The visual inspection is carried out to verify that there is no visual mechanical damage.
There shall be no:

- burning of any components;
- paint blisters on any components;
- discolouration on components;
- deformation of modules or components;
- interruptions or damage on interconnecting cables, wires and connectors.

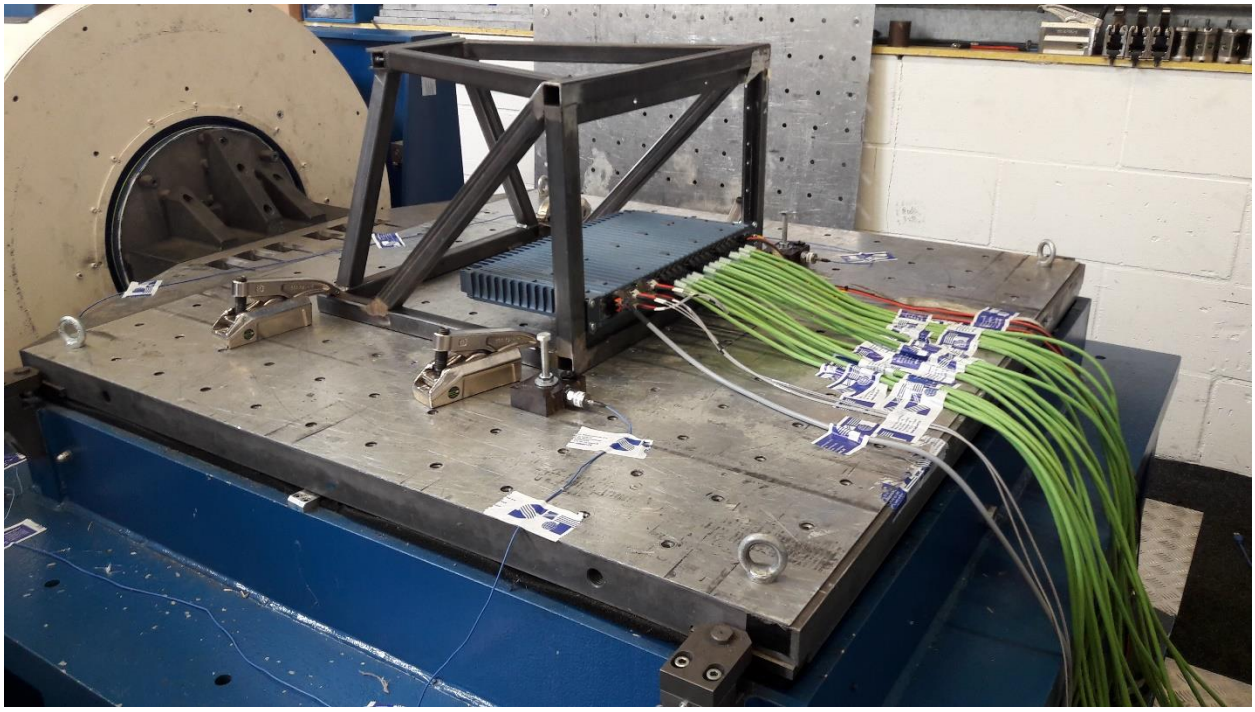
Functional inspection is carried out to verify the correct operation of the test object.
There shall be no:

- alarm indications on display and LED's;
- error messages reported in the maintenance computer;
- unintentional change of contact outputs;
- there shall be no degradation of performance below the claimed performance according reliability class (1 or 2).

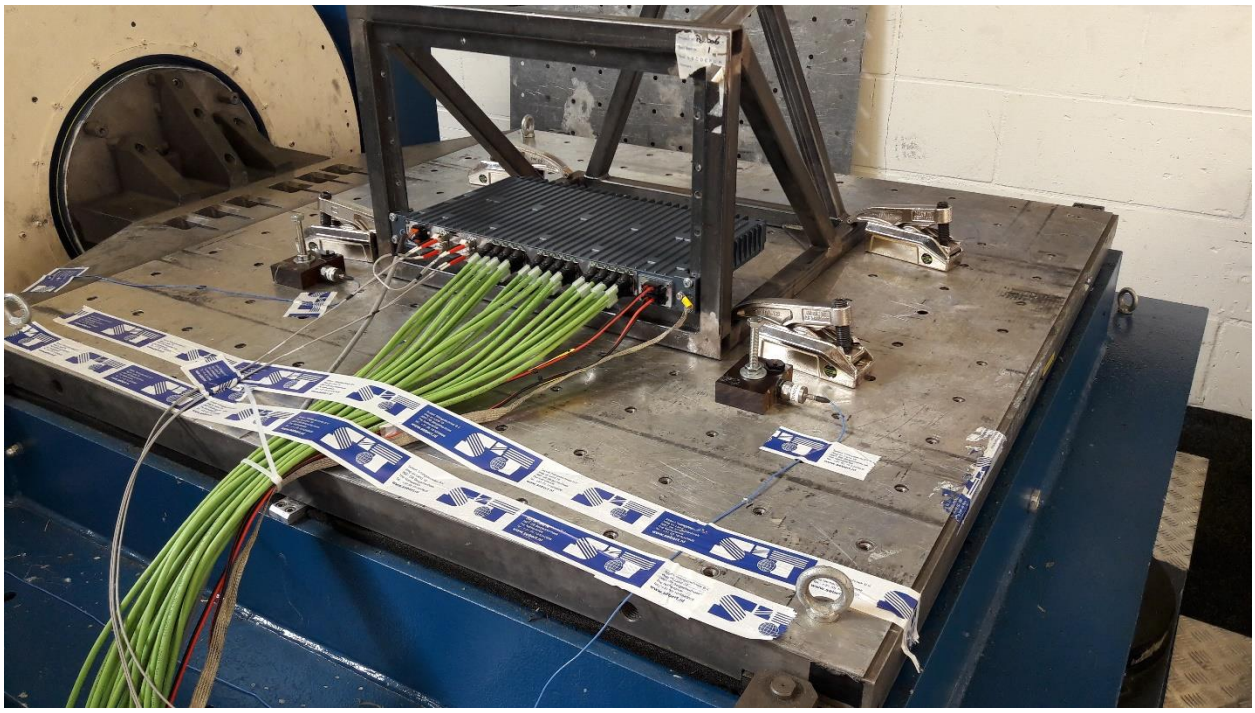
Unless otherwise stated the visual and functional inspection was carried out successfully after each test.

13.2 Photographs of test arrangement

Test arrangement horizontal longitudinal direction



Test arrangement horizontal transversal direction



Test arrangement vertical direction

13.3 Vibration response test

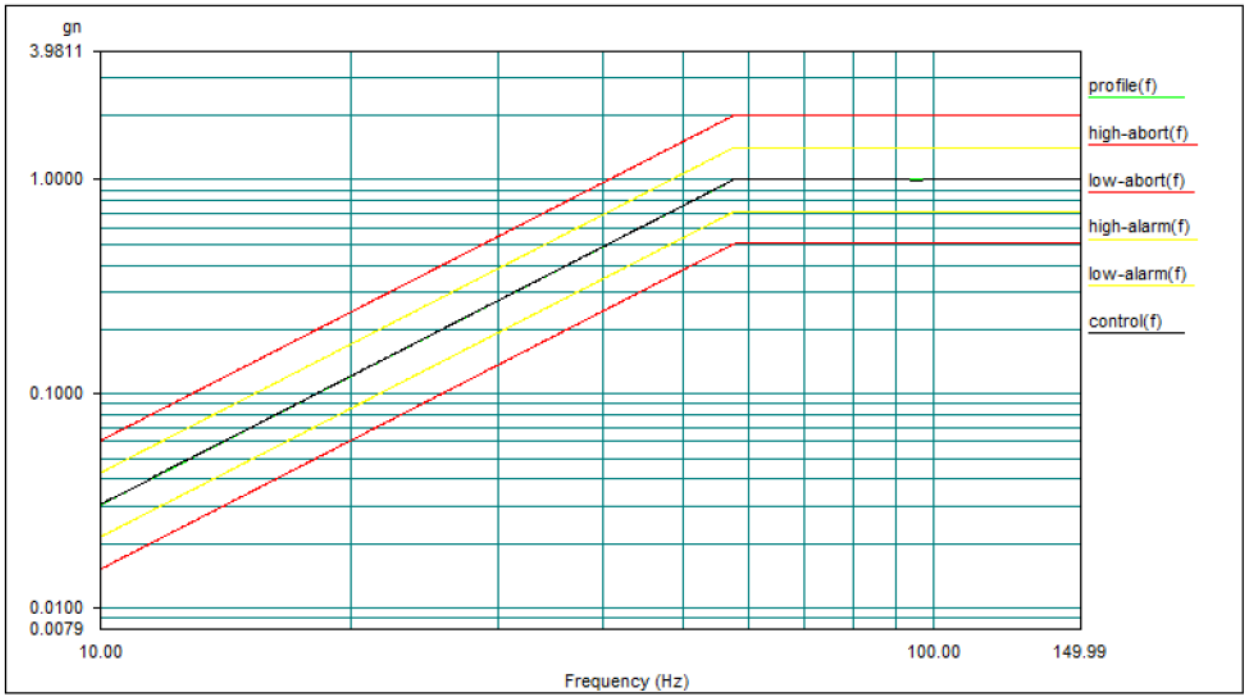
Standard and date

Standard	IEC 61850-3, subclause 6.10.1
Basic standard	IEC 60255-21-1
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	energized
Auxiliary power supply input	24 Vdc
Frequency range	10 to 150 Hz
Displacement	0,075 mm
Acceleration	1,0 g
Number of sweep cycles in each axis	1
Number of axis	3

Vibration response test



Level: 100 % Full Level Time: 00:07:49 Sweep Type: Logarithmic

Frequency: 10.010907 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Observations

- During and after the test, the test object was functional.
- No visual damage or functional errors have been found on the test object.

Observations

- During and after the test, the test object was functional.
- No visual damage or functional errors have been found on the test object.

Requirements

- The object shall be subjected to the class 2 vibration response test parameters (Table 1) of IEC 60255-21-1.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

13.4 Vibration endurance test

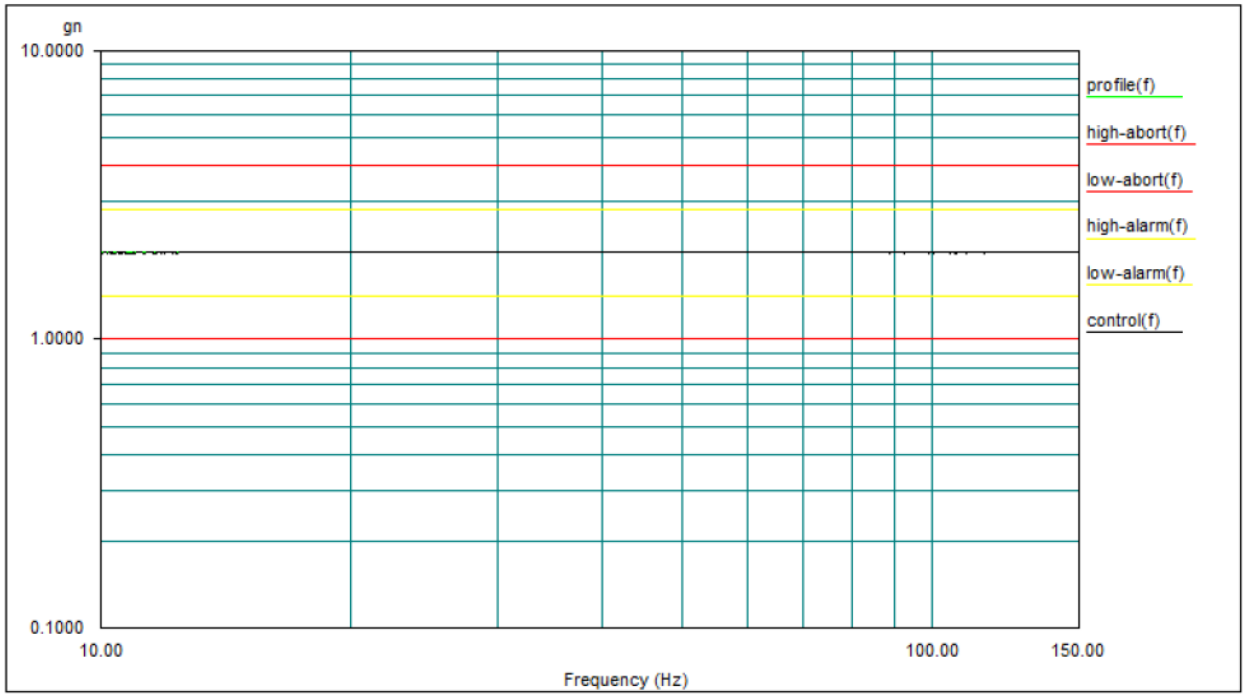
Standard and date

Standard	IEC 61850-3, subclause 6.10.1
Basic standard	IEC 60255-21-1
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	non-energized
Frequency range	10 to 150 Hz
Acceleration	2 g
Number of sweep cycles in each axis	20
Number of axis	3

Vibration endurance test



Level: 100 % Full Level Time: 02:36:18 Sweep Type: Logarithmic
Frequency: 10.014612 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Observation

No visual damage or functional errors have been found on the test object.

Requirements

- The object shall be subjected to the class 2 of the vibration endurance test parameters (Table 2) of IEC 60255-21-1.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

13.5 Shock response test

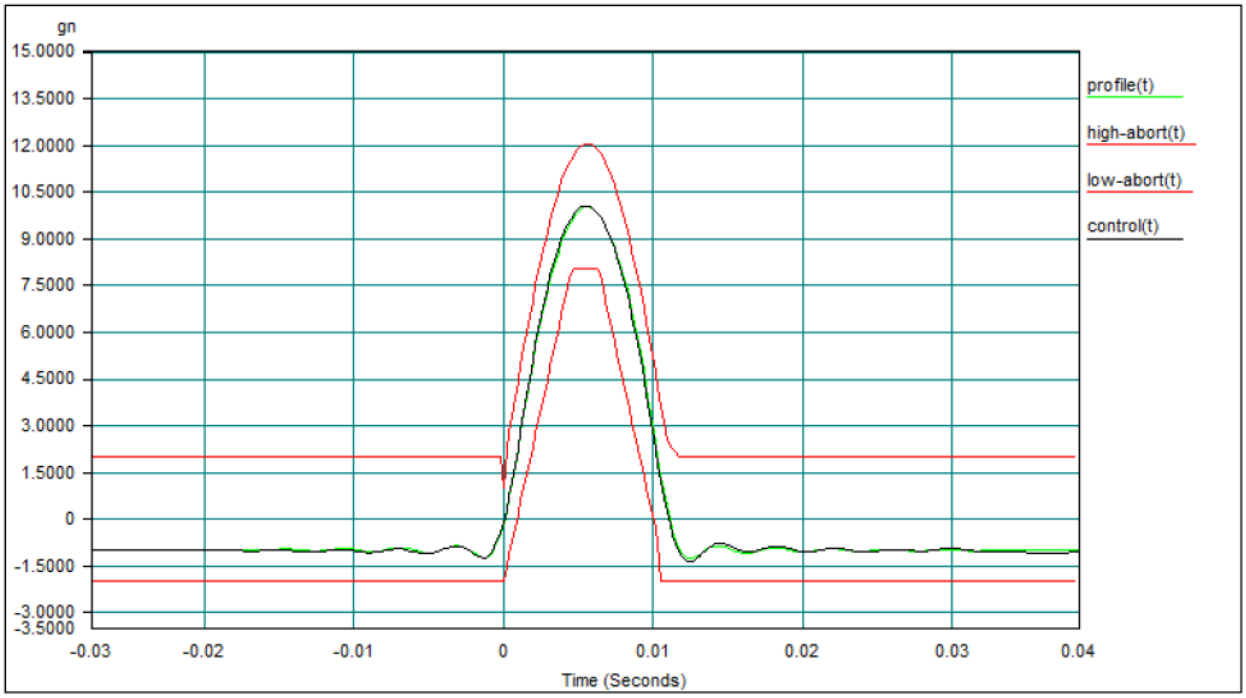
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	energized
Power supply	24 Vdc
Acceleration	10 g
Duration of pulses	11 ms
Number of pulses in each axis	6
Number of axis	3

Shock response test



Level:	100 %	Block Size:	2048	Elapsed Pulses:	13		
Frame Time:	0.400000 Seconds	Control Peak:	10.025709	Control RMS:	1.325894	Full Level Elapsed Pulses:	6
dT:	0.000195 Seconds	Demand Peak:	10.000000	Demand RMS:	1.322645	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	10.000000	Pulse Width:	11.000000 ms		

Observations

- During and after the test, the test object was functional.
- No visual damage or functional errors have been found on the test object.

Requirement

- The object shall be subjected to the class 2 of the shock response test parameters (Table I) of IEC 60255-21-2.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result

The object passed the test.

13.6 Shock withstand test

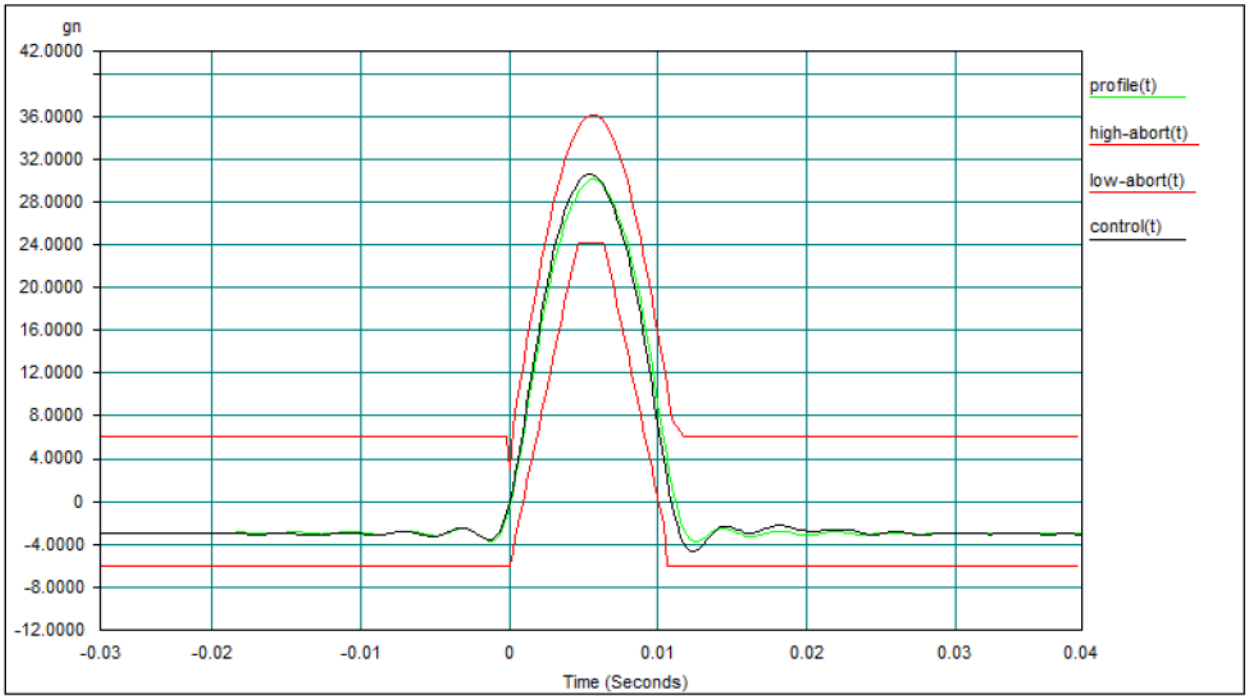
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	non-energized
Acceleration	30 g
Duration of pulses	11 ms
Number of pulses in each axis	6
Number of axis	3

Shock withstand test



Level:	100 %	Block Size:	2048	Elapsed Pulses:	14		
Frame Time:	0.400000 Seconds	Control Peak:	30.469530	Control RMS:	3.994840	Full Level Elapsed Pulses:	6
dT:	0.000195 Seconds	Demand Peak:	29.999998	Demand RMS:	3.967933	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	29.999998	Pulse Width:	11.000000 ms		

Observation

No visual damage or functional errors have been found on the test object.

Requirement

- The object shall be subjected to the class 1 or 2 of the shock withstand test parameters (Table II) of IEC 60255-21-2.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

13.7 Bump test

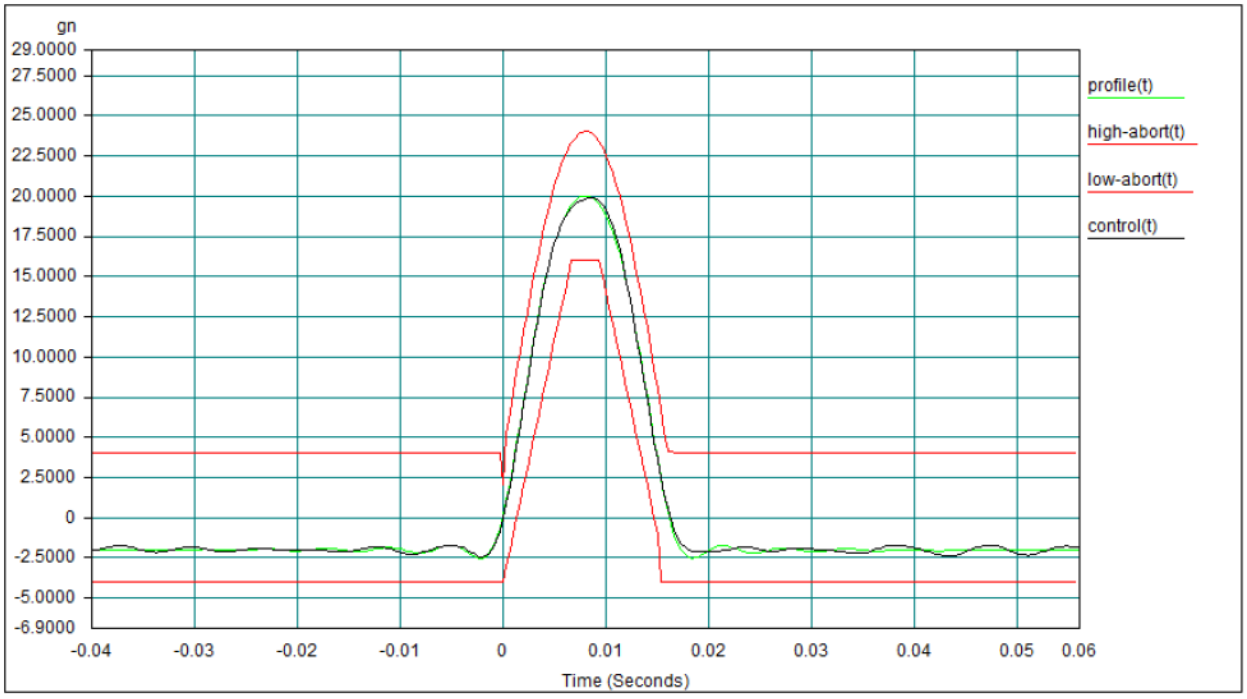
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	non-energized
Acceleration	20 g
Duration of pulses	16 ms
Number of pulses in each axis	2000
Number of axis	3

Bump test



Level:	100 %	Block Size:	2048	Elapsed Pulses:	2007		
Frame Time:	0.682667 Seconds	Control Peak:	19.846727	Control RMS:	2.458557	Full Level Elapsed Pulses:	2000
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.464524	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	16.000000 ms		

Observation

No visual damage or functional errors have been found on the test object.

Requirements

- The object shall be subjected to the class 2 of the bump test parameters (Table III) of IEC 60255-21-2.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

13.8 Single axis sine sweep seismic test

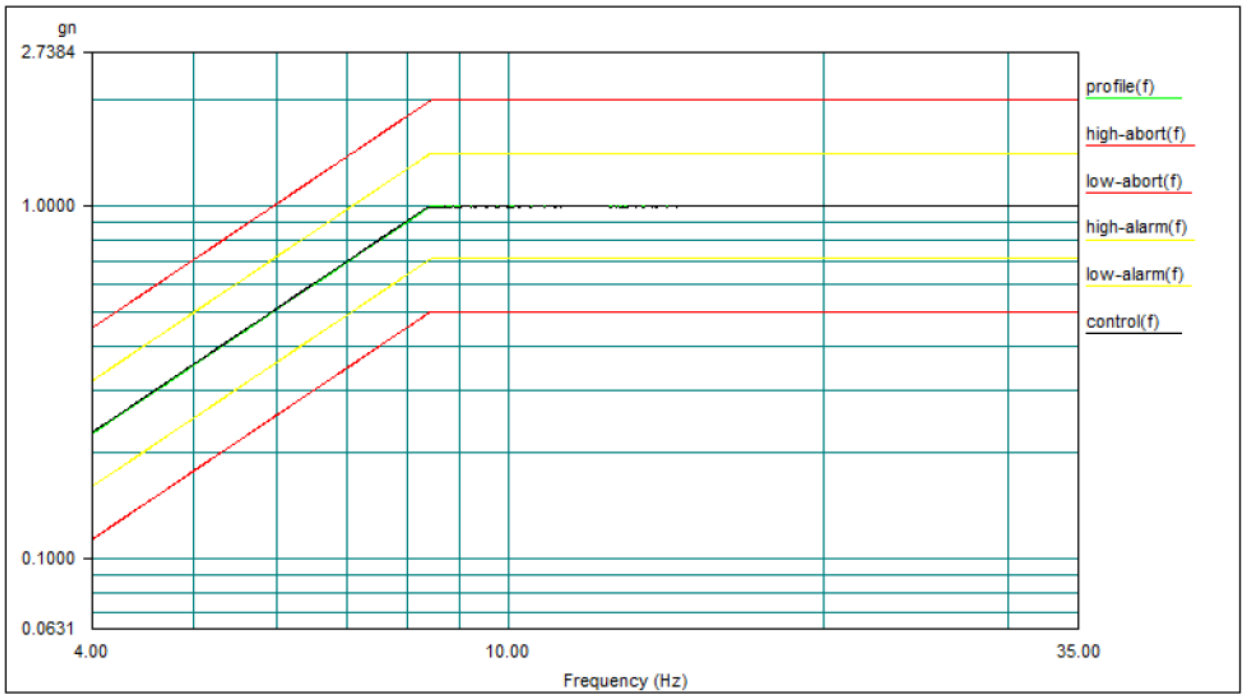
Standard and date

Standard	IEC 61850-3, subclause 6.10.3
Basic standard	IEC 60255-21-2
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	energized
Power supply input	24 Vdc
Frequency range	1 to 35 Hz
Cross-over frequency	8 to 9 Hz
Displacement horizontal axis (x)	7,5 mm
Displacement vertical axis (y)	3,5 mm
Acceleration horizontal axis (x)	2,0 g
Acceleration vertical axis (y)	1,0 g
Number of sweep cycles in each axis	1
Number of axis	3

Single axis sine sweep seismic test in vertical direction

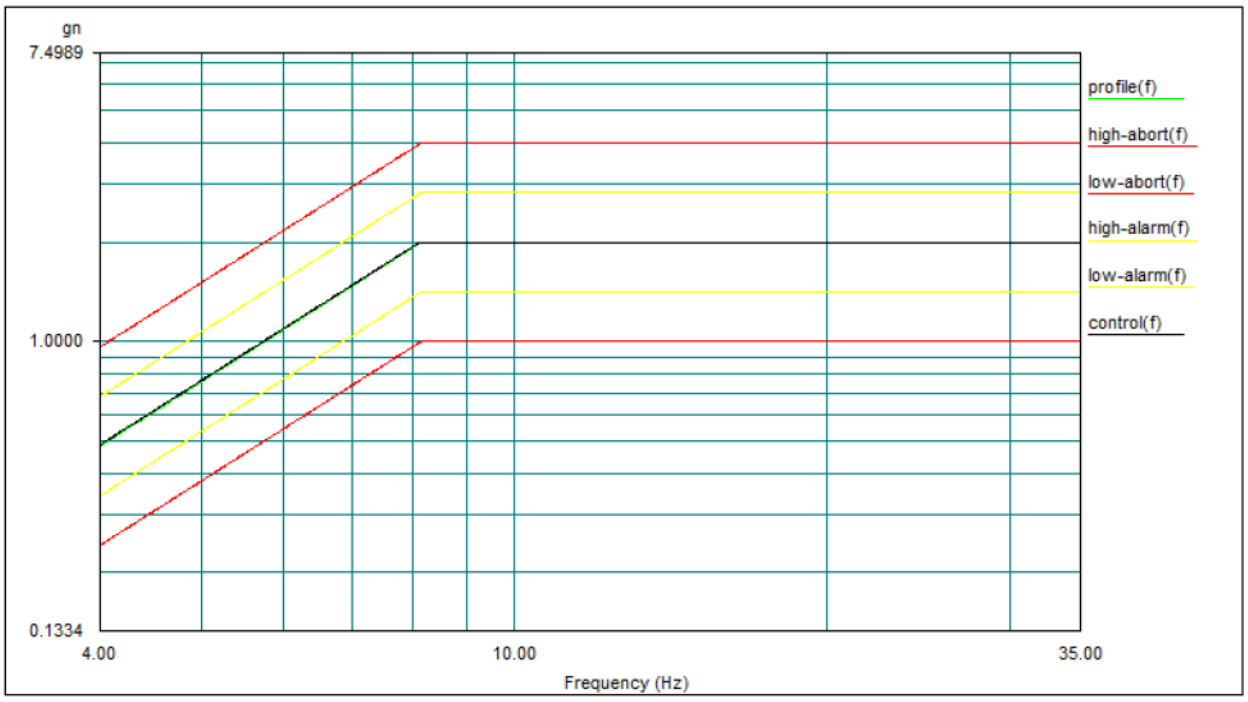


Level: 100 % Full Level Time: 00:06:16 Sweep Type: Logarithmic
Frequency: 4.005304 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Observation

No visual damage or functional errors have been found on the test object.

Single axis sine sweep seismic test in horizontal direction



Level: 100 % Full Level Time: 00:06:16 Sweep Type: Logarithmic
Frequency: 4.004316 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Observation
No visual damage or functional errors have been found on the test object.

Requirement
- The object shall be subjected to the class 2 of the seismic vibration test parameters (Table I) of IEC 60255-21-3.
- The visual and functional inspection shall not reveal any defects or malfunctions.
- The object shall comply with the required reliability class 2 of chapter 7.5.

Result
The object passed the test.

14 ENCLOSURE PROTECTION

Standard and date

Standard	IEC 61850, subclause 6.11
Basic standard	IEC 60529
Test date	01 June 2021

Characteristic test data

Serial number 001090

Terminal side	Degree of protection	
	Specification by the manufacturer	Observation
Front	IP 4X	IP 4X

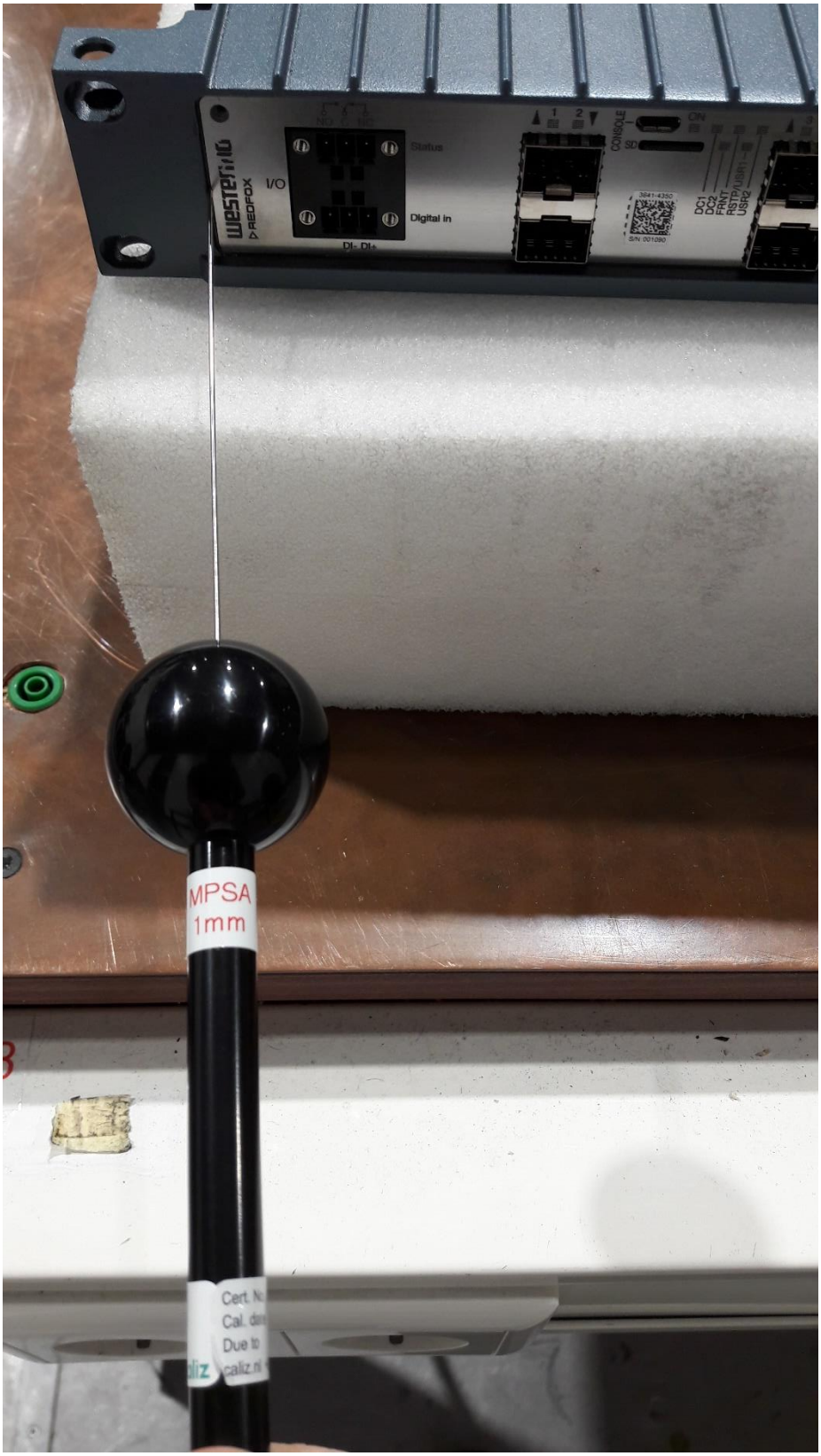
Requirement

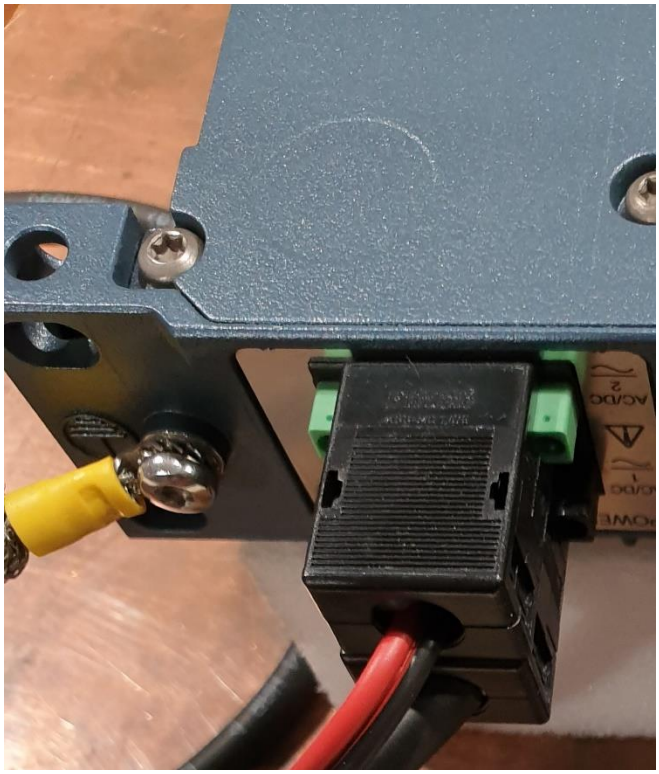
- The 1 mm test wire shall not penetrate the enclosure.
- No visual or functional inspection required.

Result

The object passed the test.

Photographs enclosure protection


Status
I/O
Digital in
DI- DI+
CONSOLE
DC1
DC2
RST
MPSA
1mm

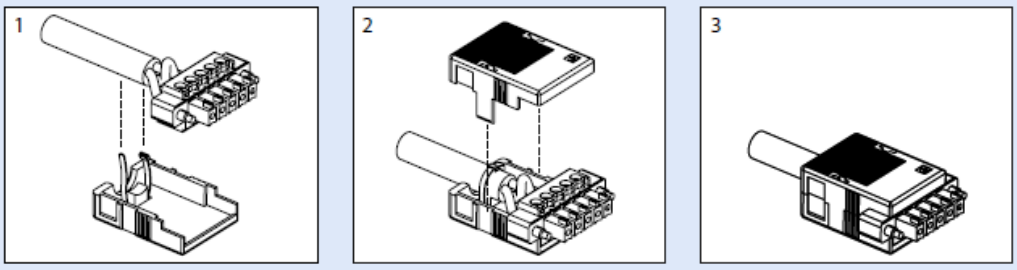


WARNING - PREVENT ACCESS TO HAZARDOUS VOLTAGE CABLE

Apply the protective cap (delivered with the product) on the power cable, according to the illustrated steps below.

To prevent accidentally pulling out wires, make sure the power cable and the wires are firmly attached to the protective cap.

For screw connectors, make sure the screws are properly tightened, as well as routing the wires separately from other wires. For connectors with straps, fasten the cable as strain relief, as well as routing the wires separately.



15 ADDITIONAL TESTS

15.1 Radiated emission FCC

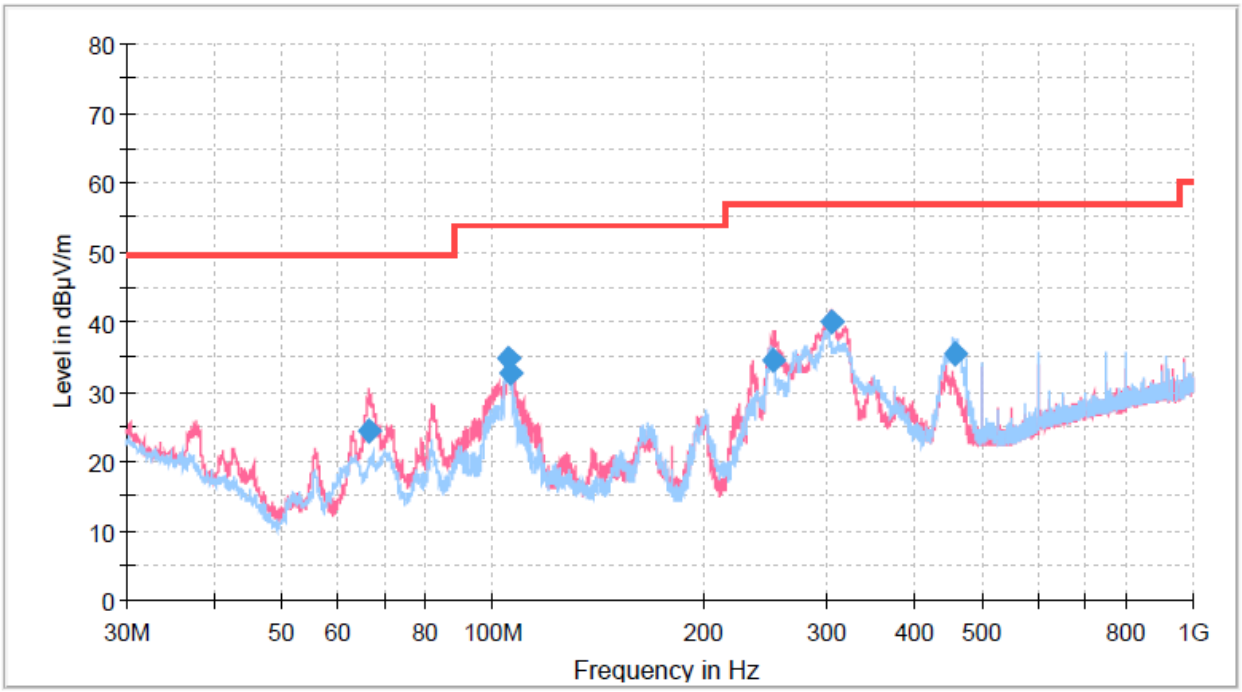
Standard and date

Standard	FCC Part 15b
Basic standard	-
Test date	30 June 2021

Characteristic test data

Serial number	001094
Power supply 1	48 Vdc
Power supply 2	48 Vdc

Power supply voltage of 48 Vdc with horizontal and vertical antenna polarisation, in the frequency range 30Mhz – 1GHz (red = vertical, blue = horizontal)

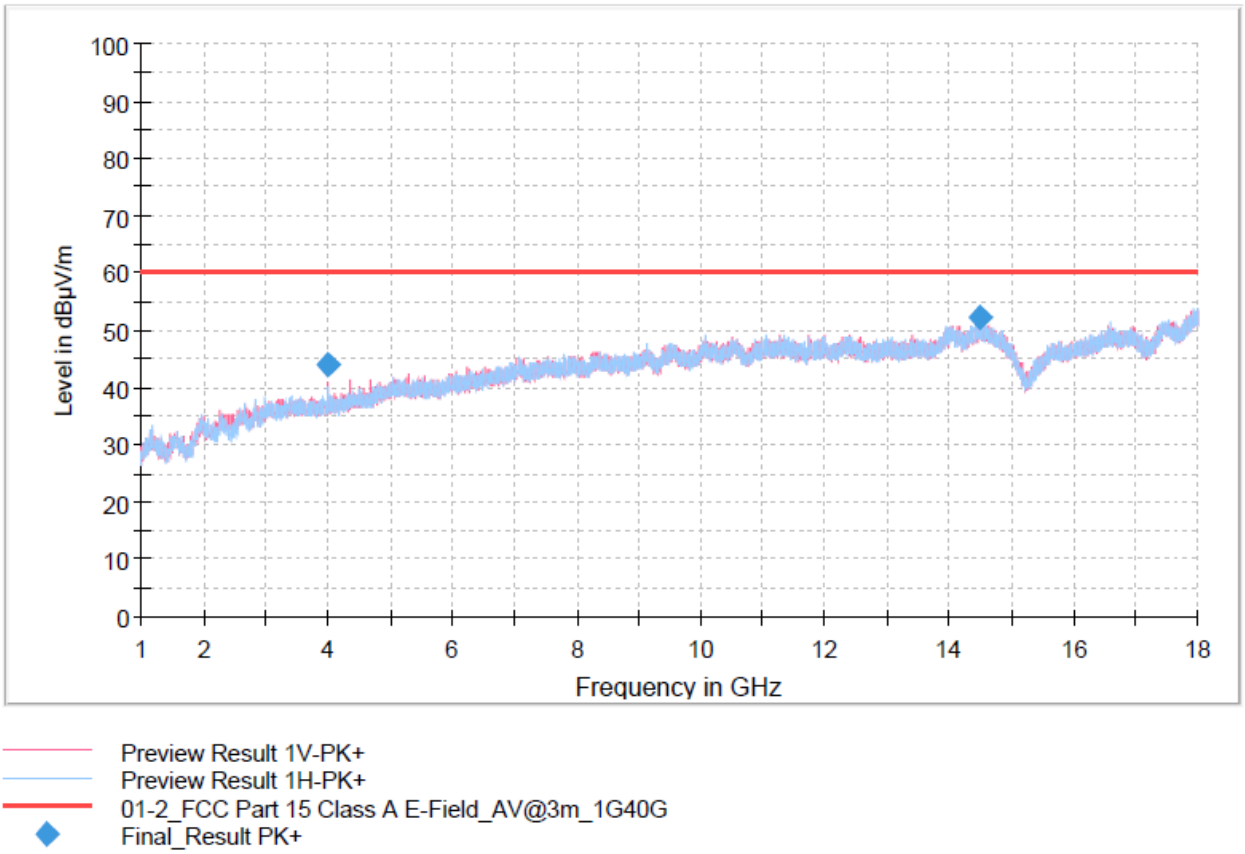


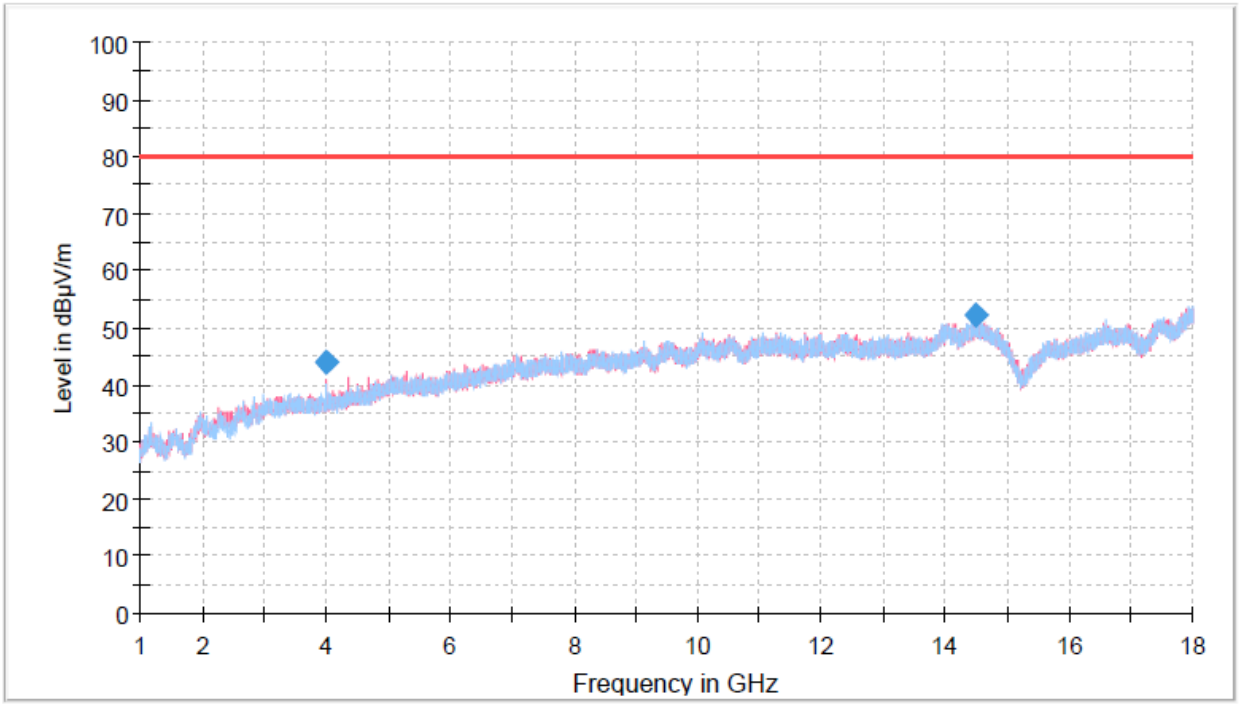
Preview Result 1V-PK+
Preview Result 1H-PK+
02-1_FCC Part 15 Class A E-Field_QP@3m_30M1G
Final_Result QPK

Final result (30 – 1000 MHz)

Frequency MHz	QuasiPeak dBµV/m	Limit at 3m dBµV/m	Margin dB µV/m	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
66,747	24,24	49	24,76	3000,0	120	178,0	V	201,0
105,255	34,91	53,5	18,59	3000,0	120	263,0	H	162,0
105,909	32,69	53,5	20,81	3000,0	120	107,0	V	99,0
252,264	34,44	56,4	21,96	3000,0	120	104,0	V	-8,0
304,806	39,89	56,4	16,51	3000,0	120	125,0	V	82,0
457,383	35,25	56,4	21,15	3000,0	120	100,0	H	99,0

Power supply voltage of 48 Vdc with horizontal and vertical antenna polarisation, in the frequency range 1 – 18 GHz (red = vertical, blue = horizontal)

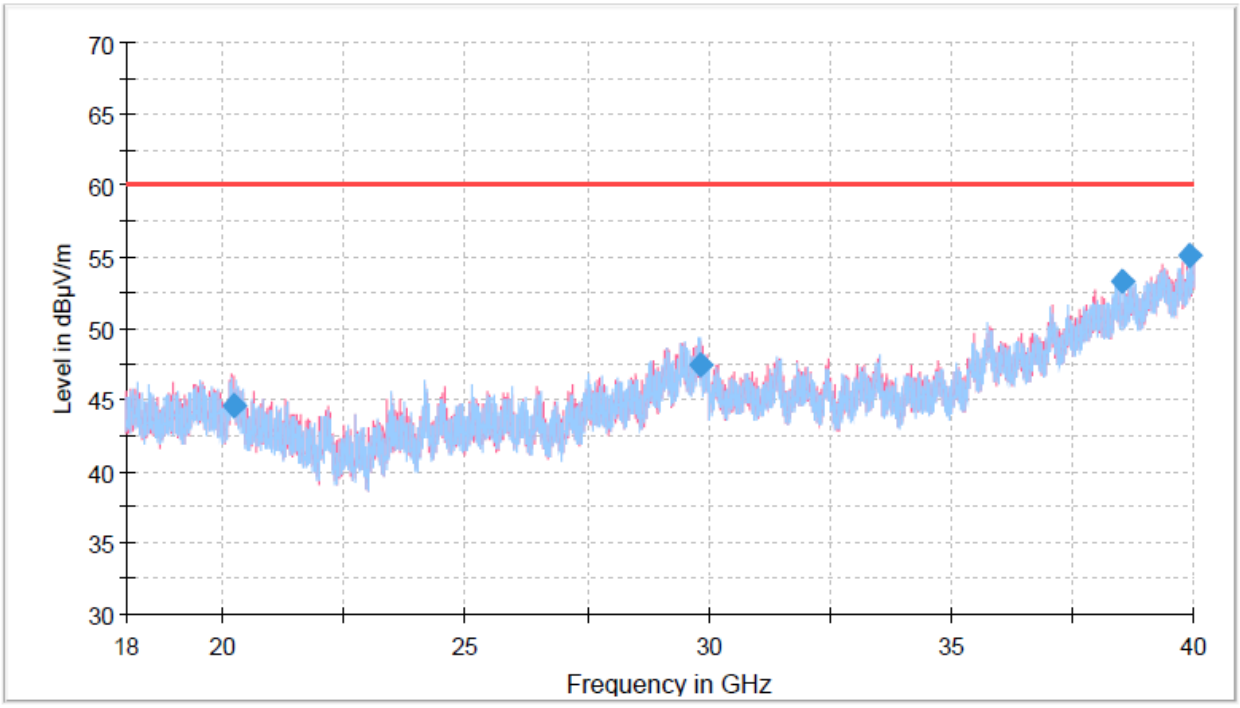




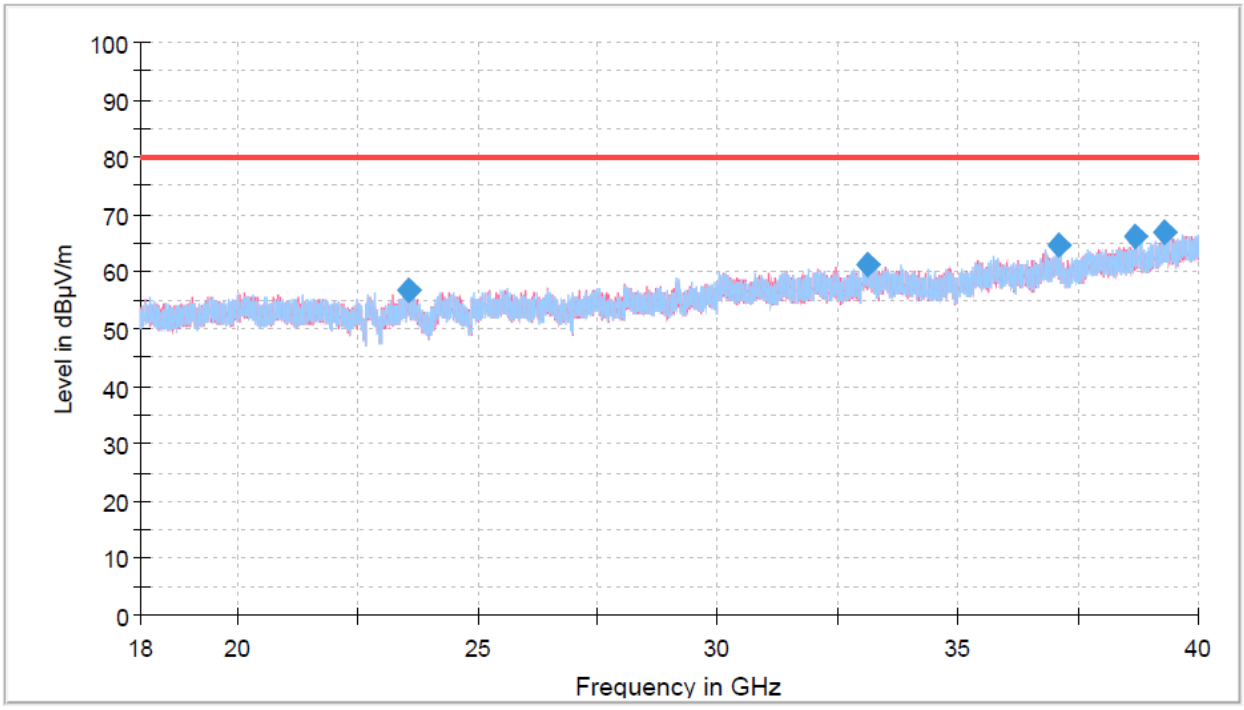
Final result (1000 – 18000 MHz)

Frequency MHz	MaxPeak dBµV/m	Average dBµV/m	Limit @ 3 m dBµV/m	Margin dBµV/m	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
4000,000	---	39,12	59,5	20,38	2000,0	1000	100	V	-31,0
4000,000	44,03	---	79,5	35,47	2000,0	1000	100	V	-31,0
14481,500	---	48,22	59,5	11,18	2000,0	1000	100	V	-181,0
14481,500	52,18	---	79,5	27,32	2000,0	1000	100	V	-181,0

Power supply voltage of 48 Vdc with horizontal and vertical antenna polarisation, in the frequency range 18 – 40 GHz (red = vertical, blue = horizontal)



Preview Result 1V-AVG
Preview Result 1H-AVG
01-2_FCC Part 15 Class A E-Field_AV@3m_1G40G
Final_Result AVG



Preview Result 1V-PK+
Preview Result 1H-PK+
01-1_FCC Part 15 Class A E-Field_PK@3m_1G40G
Final_Result PK+

Final result (18000 – 40000 MHz)

Frequency MHz	MaxPeak dBµV/m	Average dBµV/m	Limit @ 3 m dBµV/m	Margin dBµV/m	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
20210,417	---	44,61	59,5	14,89	2000,0	1000	100,0	V	147,0
23583,265	56,91	---	79,5	22,59	2000,0	1000	100,0	V	262,0
29811,344	---	47,39	59,5	12,11	2000,0	1000	149,0	H	352,0
33130,373	61,46	---	79,5	18,04	2000,0	1000	100,0	V	203,0
37086,813	64,81	---	79,5	14,69	2000,0	1000	100,0	V	7,0
38506,341	---	53,25	59,5	6,25	2000,0	1000	207,0	H	180,0
38708,085	66,11	---	79,5	13,39	2000,0	1000	100,0	V	35,0
39298,660	66,87	---	79,5	12,63	2000,0	1000	396,0	H	159,0
39889,314	---	55,10	59,5	4,4	2000,0	1000	332,0	H	154,0

Remarks

-

Requirement

The radiated emission shall not exceed the limits specified in the standard CISPR 22 for class A equipment.

Result

The object passed the test.

15.2 Fast damped oscillatory wave test

Standard and date

Standard	-
Basic standard	IEC 61000-4-18
Test date	6 May 2021

Characteristic test data

Serial number	001089
Voltage oscillation frequency	10 MHz
Voltage rise time	< 100 ns
Repetition frequency	5000 Hz
Output impedance	200 Ω
Polarity	Positive and negative

Circuit/Port	Terminals	Coupling	Test voltage (kV)	Observations
Power supply DC1	COM; DC+	CM	2,0	-
Power supply DC2	COM; DC+	CM	2,0	-

CM = Common Mode

Observations

-

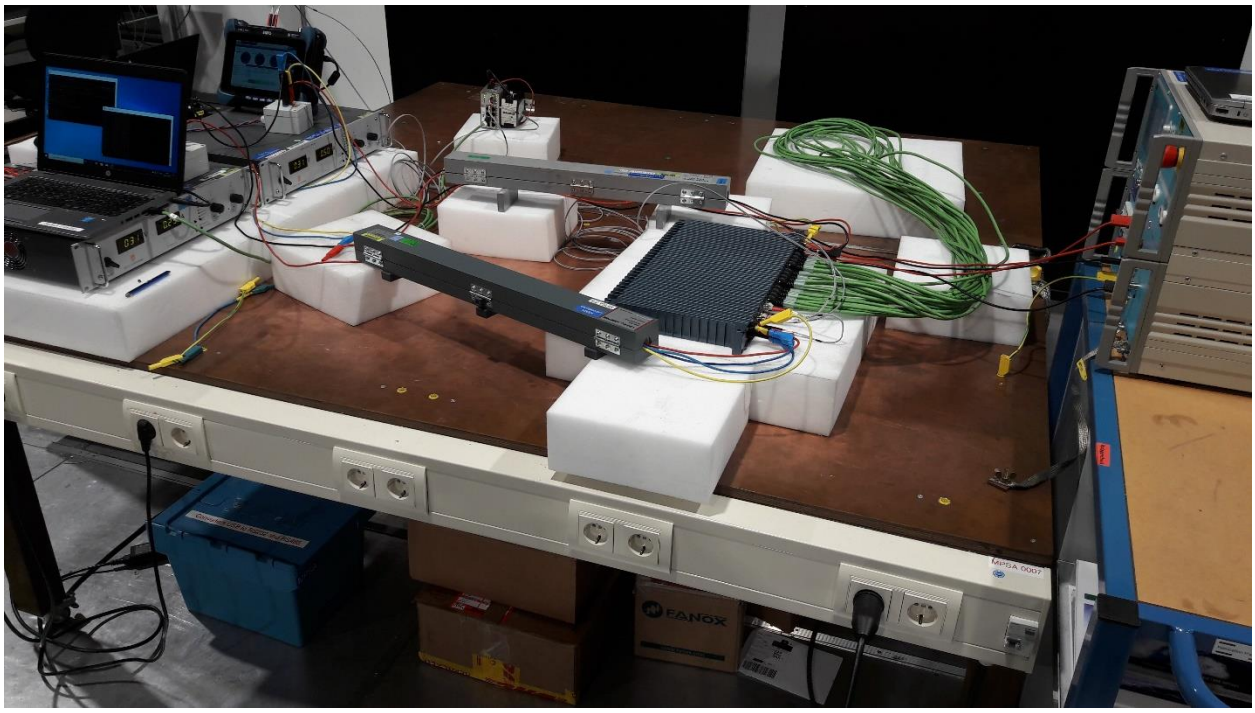
Requirements

- The object shall comply with reliability class 2 of chapter 7.5.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



15.3 Impulse magnetic field

Standard and date

Standard	-
Basic standard	IEC 61000-4-9
Test date	30 April to 3 May 2021

Characteristic test data

Serial number	001089
Power supply	48 Vdc
Source impedance	2 Ω
Front time (voltage)	1,2 µs
Time to half value (voltage)	50 µs
Front time (current)	8 µs
Time to half value (current)	20 µs
Coupling capacitor	18 µF
Coupling resistor	2 Ω
Polarity	5 positive & 5 negative

Direction	Test level (A/m)	Polarity (s)	Observations
Horizontal longitudinal (x)	1000	Positive	-
	1000	Negative	-
Horizontal transversal (y)	1000	Positive	-
	1000	Negative	-
Vertical (z)	1000	Positive	-
	1000	Negative	-

Observations

-

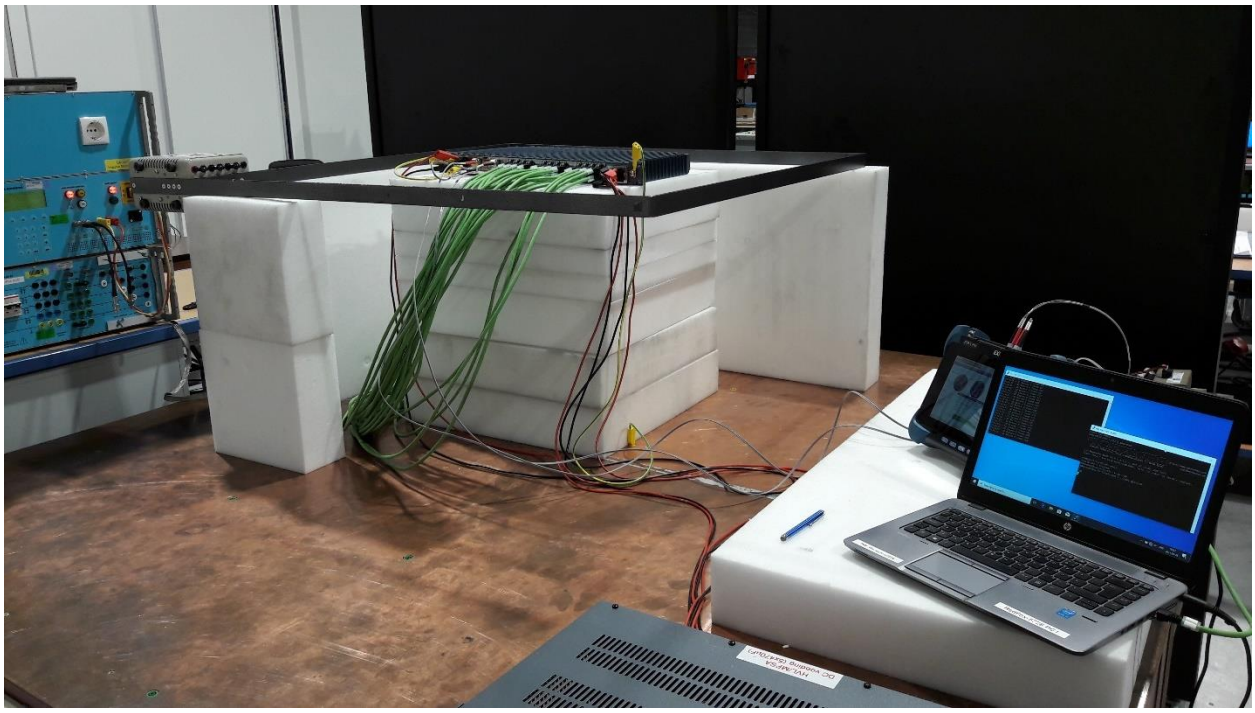
Requirements

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



15.4 Vibration endurance test

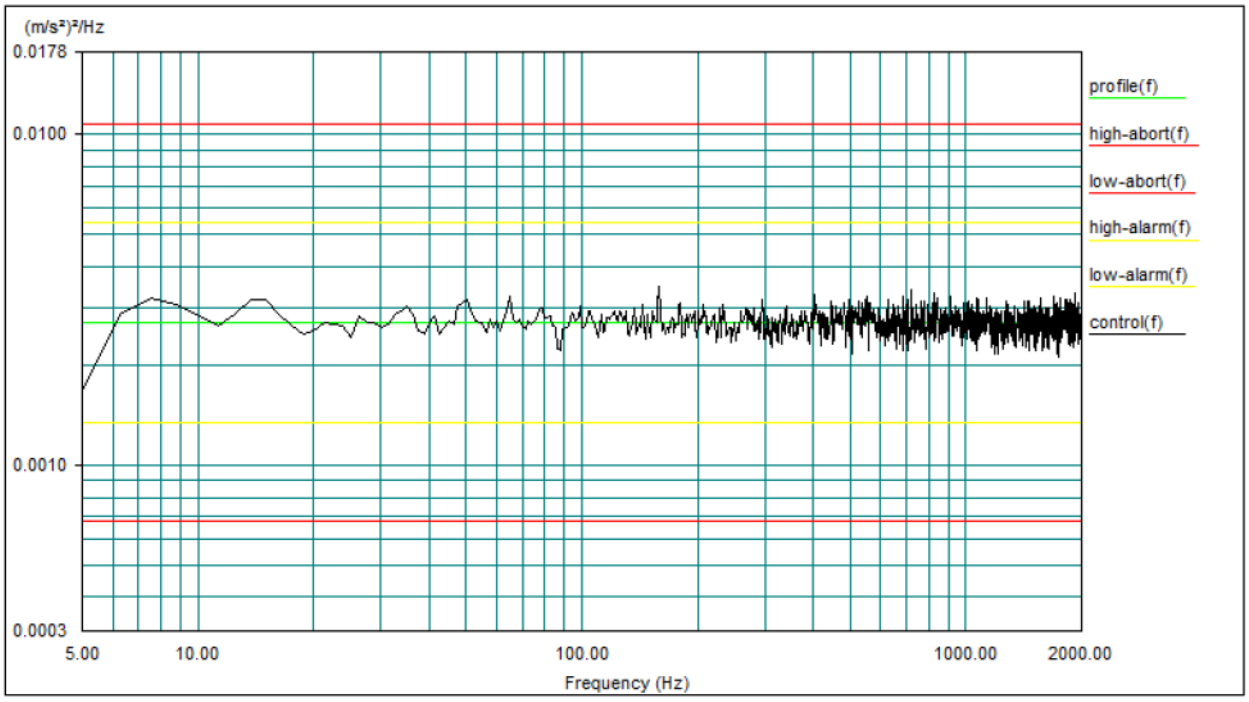
Standard and date

Standard	-
Basic standard	IEC 60068-2-64
Test date	19 to 22 July 2021

Characteristic test data

Serial number	001094
Test object	non-energized
Frequency range	5 to 2000 Hz
Acceleration	2,3 m/s^2
Test duration	1,5 h
Number of axis	3

Vibration endurance test



Level: 100 %
Control RMS: 2.322207 m/s² Full Level Elapsed Time:01:30:00 Lines: 1600 Frame Time: 0.800000 Seconds
Demand RMS: 2.321184 m/s² Remaining Time: 00:00:00 DOF: 154 dF: 1.250000 Hz

Observation

No visual damage or functional errors have been found on the test object.

Requirement

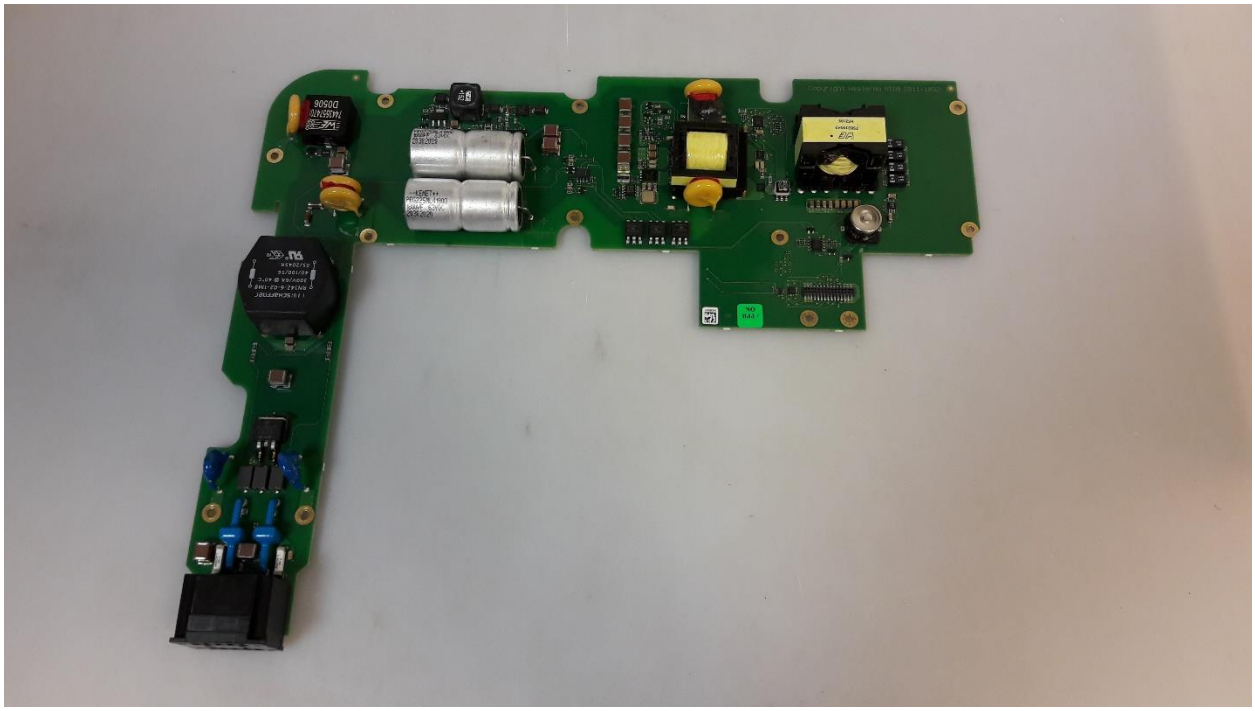
The visual and functional inspection shall not reveal any defects or malfunctions.

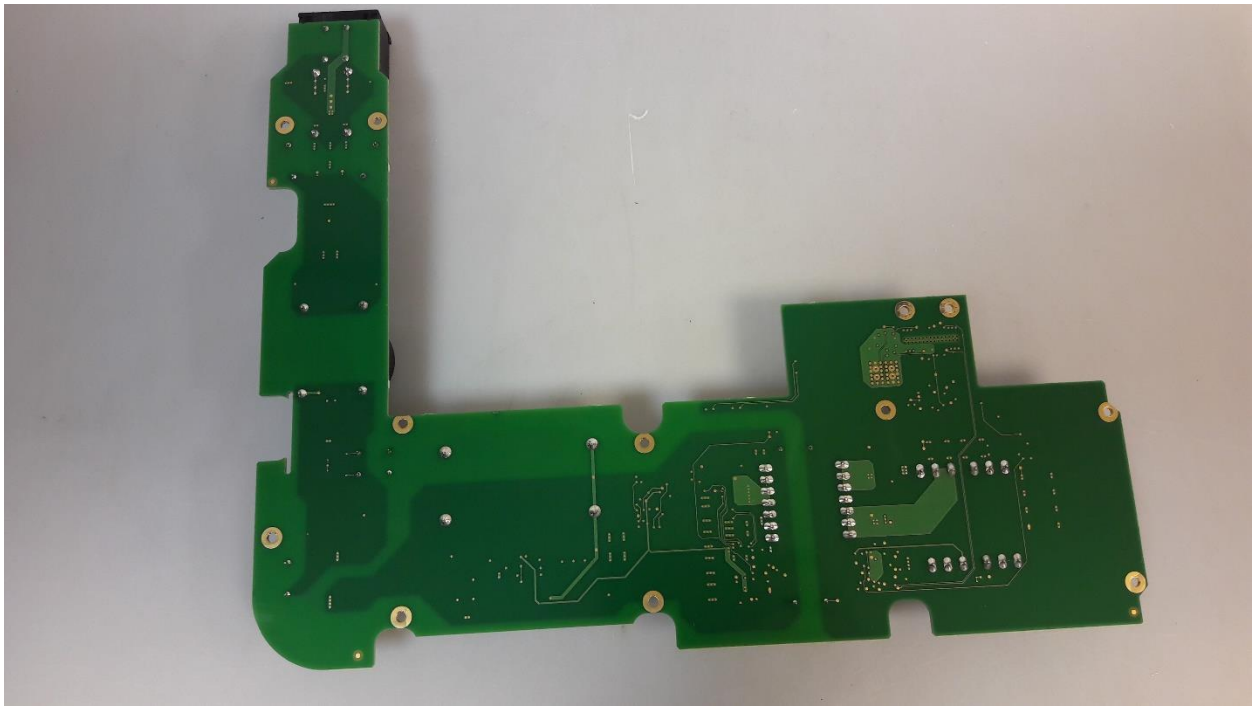
Result

The object passed the test.

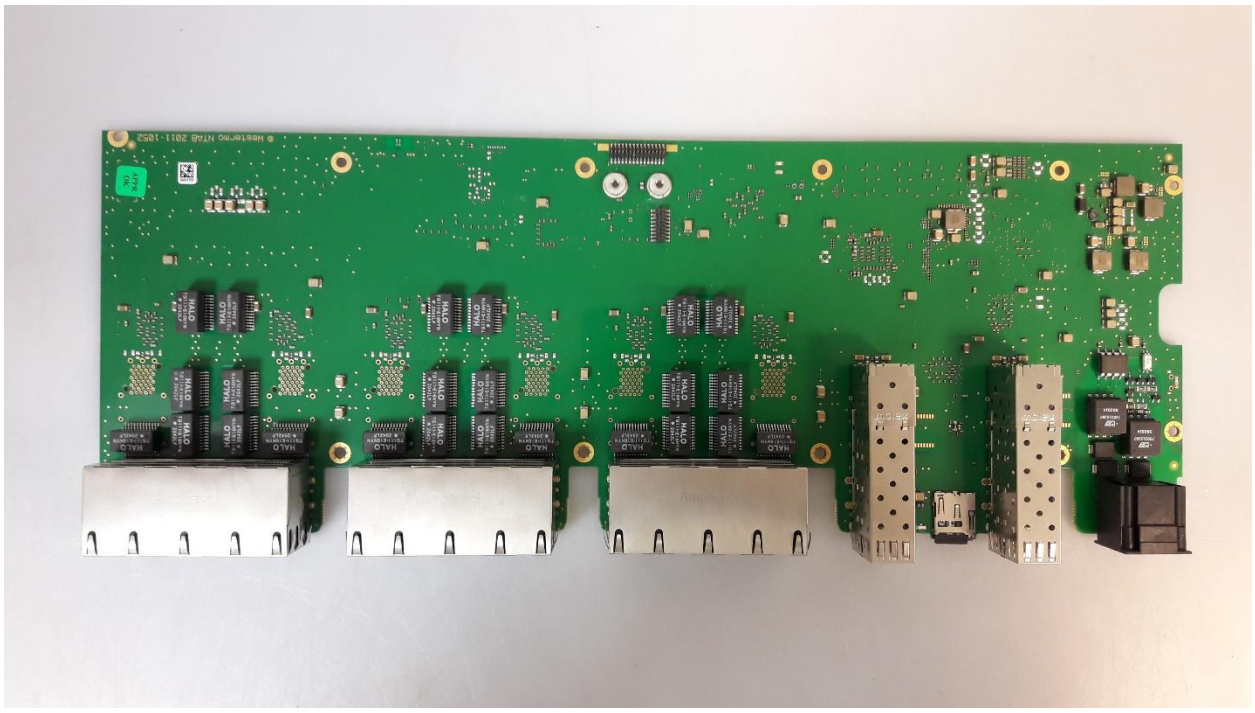
16 PHOTOGRAPHS OF PRINTBOARDS

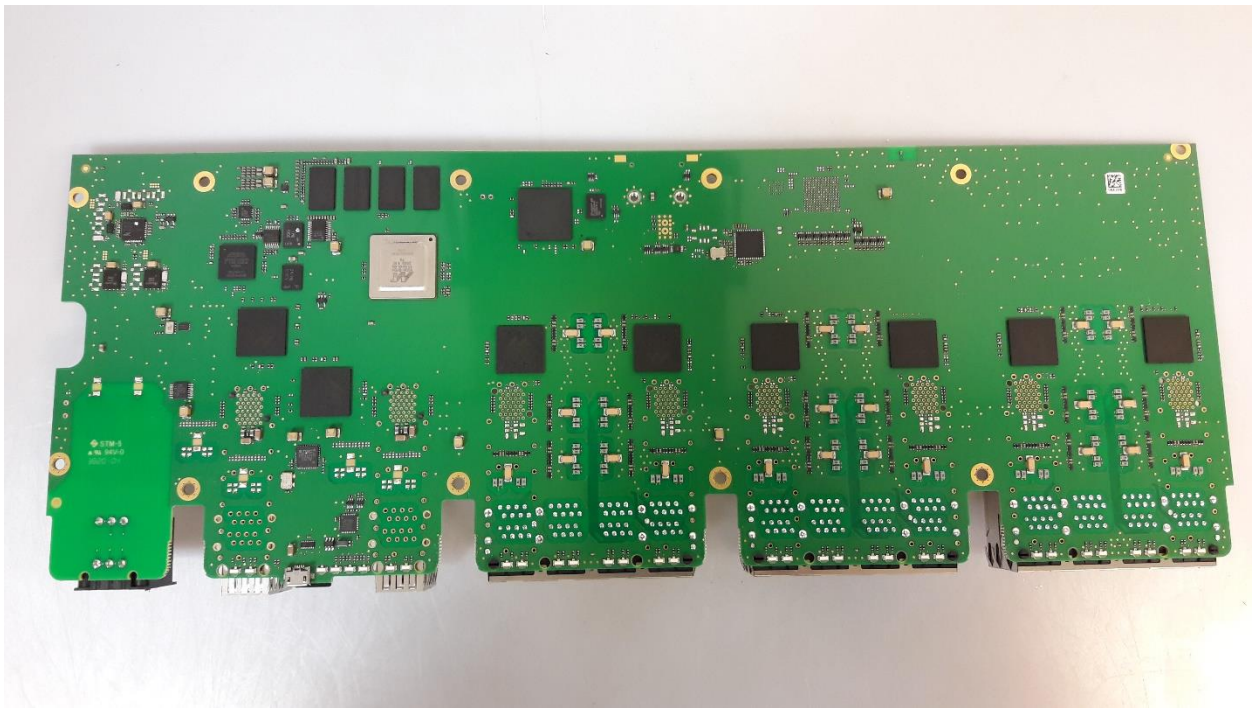
Photographs of power supply board





Photographs of switch board





17 MEASUREMENT UNCERTAINTY

The used climate rooms and EMC test and measurement equipment are calibrated on an annual base.All the parameters are within the tolerances required by the basic (test/measurement) standards, taking into account the measurement uncertainty reported in the calibration certificates.

18 LIST OF INSTRUMENTS USED

18.1 EMC equipment

EMC test equipment			
Description	**Manufacturer**	**Type**	**ORS number**
Electrostatic discharge tester	**EM Test**	**NX30**	**152004**
Air discharge	EM Test	Air	152012
Contact discharge	EM Test	Contact	152011
Bleeding resistors ESD	EM Test	Resistors cable ESD	152013
Bleeding resistors ESD	EMC-Partner	Resistors cable ESD IEEE	152014
Bleeding resistors ESD	EM Test	Resistors cable ESD	122014
Bleeding resistors ESD	EMC-Partner	Resistors cable ESD IEEE	152209
Oscillatory wave test system including	**EMC-Partner**	**MIG0603OMI**	**150022**
CDN	EMC-Partner	CDN2000-06-25	150023
CDN-KIT1000	EMC partner	CN-U / DN-HF DN-LF1 / DN-LF2	89.02
H-field antenna	EMC partner	MF1000-1	151494
H-field antenna	EMC partner	MF1000-3	151495
Continuos wave generator	Teseq	NSG4070	152533
Attenuator	Teseq	ATT 6/150, 50 Ohm attenuator	152552
CDN	Schwarzbeck	CDN AF2	152453
CDN	Schwarzbeck	CDN AF3	152452
CDN	Schwarzbeck	CDN S8 RJ45	152454
CDN	Teseq	CDN M2/M3	152521
CDN	Teseq	CDN M2/M3	152519
CDN	Teseq	CDN M1	152520
CDN S8 RJ45	EM Test	CDN S8 RJ45	151181
HF absorbing clamp	EM Test	FTC101	151168
HF absorbing clamp	EM Test	FTC101	151156
HF absorbing clamp	EM Test	FTC101	151157
HF absorbing clamp	EM Test	FTC101	151168
HF ATTENUATION CLAMP	TESEQ	KEMA 801A	152042
HF ATTENUATION CLAMP	AMETEK CTS	KEMA 801A	152275
HF ATTENUATION CLAMP	AMETEK CTS	KEMA 801A	152276
CDN	EMC-Partner	CN16-1514	151489
Capacitive coupling clamp	EMC-Partner	CN-EFT1000-1568	151497
Insulation tester	FLUKE	1503	150150
Insulation Combitester	FLUKE	1653B	150738
Multi EMC generator	**EMC-Partner**	**IMU3000 F6SRTDVC**	**152084**
CDN	EMC-Partner	CDN3000A-08-32 690V	152089
IEC 61000-4-5 CDN kit	EMC-Partner	1000ED3	152146
Power supply	EMC-Partner	PS3 Pwr1	152087
Power supply	EMC-Partner	PS3 Pwr2	152088
IEC 61000-4-16 extension	EMC-Partner	EXT-TRA3000 C-SHORT	152086
IEC 61000-4-16 CDN	EMC-Partner	CN16	152208
DOW generator	**EMC-Partner**	**DOW3000 S-F-I**	**152090**
EFT tester	EM Test	EFT 500	105169
CDN	EMC-Partner	CN-BALUN	151493
HYPOTULTRA	AR	7854 Dielectric analyzer	152281

Conducted RF-emission test equipment			
Description	**Manufacturer**	**Type**	**ORS number**
Measurement receiver	Rohde & Schwarz	ESR	151944
LISN (AMN)	Rohde & Schwarz	ENV432	151954
LISN (AAN) S8 Rj45	Lüthi	S8 RJ45	151181
Coaxial connection cable N-N	Pasternak	PE343-300CM	152430
Coaxial connection cable N-BNC	-	-	152432

18.2 Climate tests

Description	Manufacturer	Type	ORS number
Climate room	Espec 1	ARS-1100	151962

18.3 Measurement equipment

Measurement equipment			
Description	**Manufacturer**	**Type**	**ORS number**
Oscilloscope	Rohde & Schwarz	RTB2002	152140
Oscilloscope	Rohde & Schwarz	RTM3002	152229
Current probe	Tektronix	TCP A300&303	151942 151937
Differential probe	Testec	TT-SI 9010A	151822
Differential probe	Testec	TT-SI 9010	152277
EFT Veri1K	EMC Partner	Veri1K EFT	152157
EFT Veri50	EMC Partner	Veri50 EFT	152158
Multimeter	Fluke	8846A	152266
Multimeter	Fluke	8846A	152265
Multimeter	Keysight	34465A	152268
Multimeter clamp meter	Fluke	337	104632
Multimeter 179	Fluke	179	152027
Multimeter 179	Fluke	179	152028
Caliper	Mitutoyo	Absolute Digimatic	150735
Caliper	Mitutoyo	Absolute Digimatic (Model no:CD_15CPX)	150011

IP Testing			
Test finger 50 mm	STAHL	Test finger 50mm	152410
Test finger 12 mm	STAHL	Test finger 12 mm	152412
Test finger 2.5 mm	STAHL	Test finger 2.5 mm	152407
Test finger 1 mm	STAHL	Test finger 1mm	152411
Continuity tester	STAHL	MP-100.09B	152413

18.4 Ethernet

Description	Manufacturer	Type	ORS number
Ethernet traffic genrator	EXFO	FTB-1 Pro	129142