KEMA Labs

KEMA TYPE TEST CERTIFICATE OF ENVIRONMENTAL PERFORMANCE

Object Remote terminal unit **1070-20**

Type RTU194-F02-CP22-IA21-IB21-PA03-PB03-D02
RTU194-F02-CP22-IA23-IB21-PA03-PB03-D02

Serial No. TEL-6311-1045
TEL-6311-1046
TEL-6311-1047
TEL-6396-1098

Rated input voltage	110 - 220 Vac 110 - 220 Vdc	Ethernet ports (SFP-copper)	3 not installed
Mechanical class	1	Optical ports	3 installed
Device reliability class	1	Serial ports	4
EMC immunity location	G/H/P	EMC emission class	A

Manufacturer Controles S.A.,
Av. Rivera 3314, 11300, Montevideo, Uruguay *)

Client Controles S.A.,
Av. Rivera 3314, 11300, Montevideo, Uruguay

Tested by KEMA B.V.,
Klingelbeekseweg 195, Arnhem, The Netherlands

Date of tests 8 October 2019 to 21 May 2020

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 applicable 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 180 pages in total.

KEMA B.V.

Bas Verhoeven
Director, High-Voltage Laboratory

Arnhem, 23 June 2020

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 2ehavior 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	23 June 2020	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
Functional requirements[1]	N/T [1)]
Product safety	Passed
Electromagnetic compatibility (EMC)	Passed
Burden tests	Passed
Climatic environmental conditions	Passed
Mechanical environmental conditions	Passed
Enclosure protection	Passed

[1)] Not Tested, the test object has been subjected to the environmental type test program only.

During the testing period the following changes on the test object were made:

- change 1: the GIO input circuits have been modified to comply with the EMC conducted disturbance inducted by radio-frequency fields immunity requirements;
- change 2: the GIO creepage distances have been increased to comply with the product safety distance creepage requirements;
- change 3; the dimensions of the enclosure have been changed to comply with the dimension requirements for 19” enclosures;
- change 4; the ventilation hole size and pattern at the bottom side of the enclosure has been modified to comply with the product safety fire enclose requirement;
- change 5; the user manual has been updated to reflect essential technical data according the documentation requirements;
- change 6; the plastic overlays (front and rear) have been modified to comply with the product safety markings requirements.

The changes on the test object have been documented in more detail in chapter 19 “Photographs of changes of the test object”.

2 IDENTIFICATION OF THE OBJECT TESTED

2.1 Ratings/characteristics of the object tested

Rated auxillary voltage	110 – 220 Vac
Input voltage range	88 - 250 Vac
Rated auxillary voltage	110 – 220 Vdc
Input voltage range	88 -250 Vdc
Output contact continuous current 24/48 Vdc option 21/22	6 A
Output contact continuous current 110 Vdc option 21/22	5 A
Output contact continuous current 220 Vdc option 21/22	1,5 A
Output contact continuous current 24/48 Vdc option 23	10 A
Output contact continuous current 110 Vdc option 23	10 A
Output contact continuous current 220 Vdc option 23	10 A
Number of ethernet ports (copper SFP)	3 not installed
Number of optical ports (optical SFP)	3
Number of serial ports	4
Number of digital inputs	80
Number of digital outputs	20
Voltage inputs (3 ph)	2
Current inputs (3 ph)	2
Timing input IRIG-B	1 pps
Sensitive current inputs	8
Maximum operating temperature	+70 °C
Minimum operating temperature	-20 °C
Maximum storage temperature	+85 °C
Minimum storage temperature	-40 °C

Classification

IP-class	IP 2x	
Mechanical class	1	
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	see TRF E132067-A139-CB-1
Pollution degree	2	see TRF E132067-A139-CB-1
Insulation type	Basic/reinforced/double/functional	see TRF E132067-A139-CB-1

2.2 Description of the object tested

Manufacturer (as stated by the client)	Controles, Montevideo, Uruguay
Type	RTU194-F02-CP22-IA21-IB21-PA03-PB03-D02 RTU194-F02-CP22-IA23-IB21-PA03-PB03-D02
Object	Remote terminal unit

IED RTU194, Sample A.1, Serial No. TEL-6311-1045

Slot	Module	Serial No.
1	RTU194-FUE2	TEL-5903-0004
2	RTU194-CPU22	TEL-6262-0123 TEL-6125-0855
3	RTU194-GIO IA: IB:	 TEL-5900-1780 (21-BOR) TEL-5900-1781 (21-BOR)
4	RTU194-POT PA: PB:	 TEL-6077-1910 TEL-6077-1911
5	RTU194-DIS2	TEL-5899-0062

IED RTU194, Sample A.2, Serial No. TEL-6311-1046

Slot	Module	Serial No.
1	RTU194-FUE2	TEL-5903-0064
2	RTU194-CPU22	TEL-6262-0124 TEL-6125-0857
3	RTU194-GIO IA: IB:	 TEL-6263-2027 (23-BOR) TEL-5900-1786 (21-BOR)
4	RTU194-POT PA: PB:	 TEL-5901-1888 TEL-5901-1889
5	RTU194-DIS2	TEL-5899-0004

IED RTU194, Sample A.3, Serial No. TEL-6311-1047 (with no overvoltage suppressors mounted)

Slot	Module	Serial No.
1	RTU194-FUE2	TEL-6312-0178
2	RTU194-CPU22	TEL-6262-0125 TEL-6125-0858
3	RTU194-GIO IA: IB:	 TEL-5900-1905 (21-BOR) TEL-5900-1906 (21-BOR)
4	RTU194-POT PA: PB:	 TEL-5901-1768 TEL-5901-1769
5	RTU194-DIS2	TEL-6078-0122

IED RTU194, Sample A.4, Serial No. TEL-6396-1098

Slot	Module	Serial No.
1	RTU194-FUE2	TEL-6261-0173
2	RTU194-CPU22 MPX module	TEL-6262-0176 TEL-6242-0885
3	RTU194-GIO IA: IB:	 TEL-6263-2124 (23-BOR) TEL-5900-1782 (21-BOR)
4	RTU194-POT PA: PB:	 TEL-6241-2106 TEL-6241-2107
5	RTU194-DIS2	TEL-6240-0174

2.3 Product Information

In this section information and references has been included about:

- circuit/schematic diagrams of all modules and boards;
- PCB drawings of all modules and boards;
- hardware and software versions/revisions of the printed circuit boards in the IED;
- complete list of all modules in each sample including identification codes, module description, hardware versions and software / firmware versions.

2.3.1 RTU194

Product Name	RTU194
Product Model	F02-CP22-IA21-IB21-PA03-PB03-D02-BOR F02-CP22-IA23-IB21-PA03-PB03-D02-BOR
Product Revision	2.0
Bill of Material	RTU194_BOM_F02-CP22-IA21-IB21-PA03-PB03-D02_V2_0.pdf

2.3.2 Module PWR: RTU194-FUE2

Module Name	RTU194-FUE2
Module Model	02
Module Revision	1.0
Firmware/Software/OS	---
PCB Version	1736 V1_0_0
Schematic File	RTU194-FUE2_Schematics_1736V1_0.pdf
PCB File	RTU194-FUE2_PCB_1736V1_0.pdf
Assembly File	RTU194-FUE2_Assembly_1736V1_0.pdf
Bill Of Material File	RTU194-FUE2_BOM_02_V1_0.pdf

2.3.3 Module CPU: RTU194-CPU22

Module Name	RTU194-CPU22
Module Model	01
Module Revision	1.1
Firmware/Software/OS	RTUQM 4.56 QNX 6.5, runtime QNX6-506263
PCB Version	1675 V3_0_0 (Base) 1629 V3_0_0 (MXP)
Schematic Files	RTU194-CPU22_Schematics_1675V3_0.pdf RTU194-MXP_Schematics_1629V3_0.pdf
PCB Files	RTU194-CPU22_PCB_1675V3_0.pdf RTU194-MXP_PCB_1629V3_0.pdf
Assembly File	RTU194-CPU22_Assembly_1675V3_0.pdf RTU194-MXP_Assembly_1629V3_0_0.pdf
Bill Of Material File	RTU194-CPU22_BOM_01_V1_1.pdf

2.3.4 Module IO2: RTU194-GIO

Module Name	RTU194-GIO
Module Model	21-BOR 23-BOR
Module Revision	1.4
Firmware/Software/OS	03.04IO
PCB Version	1482 V3_1_0 (Base) 1483 V3_1_0 (Sidecar)
Schematic Files	RTU194-GIO_Schematics_Base_1482V3_1.pdf RTU194-GIO_Schematics_Sidecar_1483V3_1.pdf
PCB Files	RTU194-GIO_PCB_Base_1482V3_1.pdf RTU194-GIO_PCB_Sidecar_1483V3_1.pdf
Assembly File	RTU194-GIO_Assembly_Base_1482V3_1_0.pdf RTU194-GIO_Assembly_Sidecar_1483V3_1_0.pdf
Bill Of Material File	RTU194-GIO_BOM_21-BOR_V1_4.pdf

2.3.5 Module POT2: RTU194-POT

Module Name	RTU194-POT
Module Model	03-BOR
Module Revision	1.5
Firmware/Software/OS	01.04PC
PCB Version	1521 V2_2_0
Schematic Files	RTU194-POT_Schematics_1521V2_2.pdf
PCB Files	RTU194-POT_PCB_1521V2_2
Assembly File	RTU194-POT_Assembly_1521V2_2.pdf
Bill Of Material File	RTU194-POT_BOM_03-BOR_V1_5.pdf

2.3.6 Module FRENTE: RTU194-DIS2

Module Name	RTU194-DIS2
Module Model	02
Module Revision	1.0
Firmware/Software/OS	03.00
PCB Version	1727 V6_0_1
Schematic Files	RTU194-DIS2_Schematics_1727V6_0_1.pdf
PCB Files	RTU194-DIS2_BOM_02_V1_0.pdf
Assembly File	RTU194-DIS2_Assembly_1727V6_0_1.pdf
Bill Of Material File	RTU194-DIS2_BOM_02_V1_0.pdf

2.4 List of cables

ID	Qty	Length	Cable Name	Description
C.1.S	2	1.5m	RTU194-PE-SHORT	1x6mm^2 - yellow/green
C.1.L	2	10m	RTU194-PE-LONG	1x6mm^2 - yellow/green
C.2.S	2	1.5m	RTU194-PWR-SHORT	3x1.5mm^2 - red, blue, yellow/green
C.2.L	2	10m	RTU194-PWR-LONG	3x1.5mm^2 - red, blue, yellow/green
C.3.S	2	1.5m	RTU194-POT-SHORT	6x4mm^2 white + 4x1.5mm^2 white
C.3.L	2	10m	RTU194-POT-LONG	6x4mm^2 white + 4x1.5mm^2 white
C.4.S	2	1.5m	RTU194-AI-SHORT	4 control cable screened grey Each one has two cores 0.25mm^2
C.4.L	2	10m	RTU194-AI-LONG	4 control cable screened Each one has two cores 0.25mm^2
C.5.S	2	1.5m	RTU194-DO-SHORT	10x1.5mm^2 white
C.5.L	2	10m	RTU194-DO-LONG	10x1.5mm^2 white
C.6.S	2	1.5m	RTU194-DI-SHORT	9x1.5mm^2 white
C.6.L	2	10m	RTU194-DI-LONG	9x1.5mm^2 white
C.7.S	2	1.5m	RTU194-IRIG-SHORT	Control cable screened grey, two cores 0.25mm^2
C.7.L	2	10m	RTU194-IRIG-LONG	Control cable screened grey, two cores 0.25mm^2
C.8.S	2	1.5m	RTU194-COM-SHORT	Control cable screened grey, four cores 0.14mm^2
C.8.L	2	10m	RTU194-COM-LONG	Control cable screened grey, four cores 0.14mm^2
C.9.L	2	10m	RTU194-FO-LONG	Multimode fibre optic Patch LC/SC

2.5 Auxiliary Equipment List

ID	Qty	Description/Function	Manufacturer/ Model	Serial Number	User Manual
B.1	1	Satellite-Synchronized Clock	SEL / SEL 2407	2005201196	2407_IM_20130315.pdf
B.2	2	AC/DC Power Supply	Reign Power / LP 1100D-24MDA	RPL183000118 RPL183000106	LP1100D.pdf
B.3	2	Auxiliary input/output	Controles / RTU194-AUX-01	TEL-6313-0001 TEL-6313-0002	
B.4	2	Auxiliary COM	Controles / RTU115-F01-C01-100-200-300-400-500	TEL-6310-0058 TEL-6310-0059	RTU115_UserManual_R01.pdf
B.5	2	Ethernet Media Converter	TP-LINK / MC100CM(UN) Version 5.0	218A353002169 218A353002188	Media Converter Datasheet.pdf Media Converter Installation Guide.pdf
B.6	1	IP Test Enclosure	Controles / RTU194-IPE	TEL-6314-0001	

2.6 List of drawings

According to the client the following drawings and/or documents numbers refers.
KEMA Labs has not verified these drawings and/or documents.
Drawings have been used for reference/information purpose only.

Refer to paragraph 2.3 of this report for the relevant drawings.

2.7 Photographs of test object

3 GENERAL INFORMATION

3.1 The tests were witnessed by

Name	Company
Santiago Lafon, Francisco Aguerre (8 to 11 October 2019)	Controles, Montevideo, Uruguay

3.2 The tests were carried out by

Name	Company
Mihai Bivolaru (9 to 11 October 2019), Gert van Wee (14 October 2019 to 21 May 2020)	KEMA B.V., Arnhem, The Netherlands

3.3 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.

3.4 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.

3.5 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 Instruments used

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

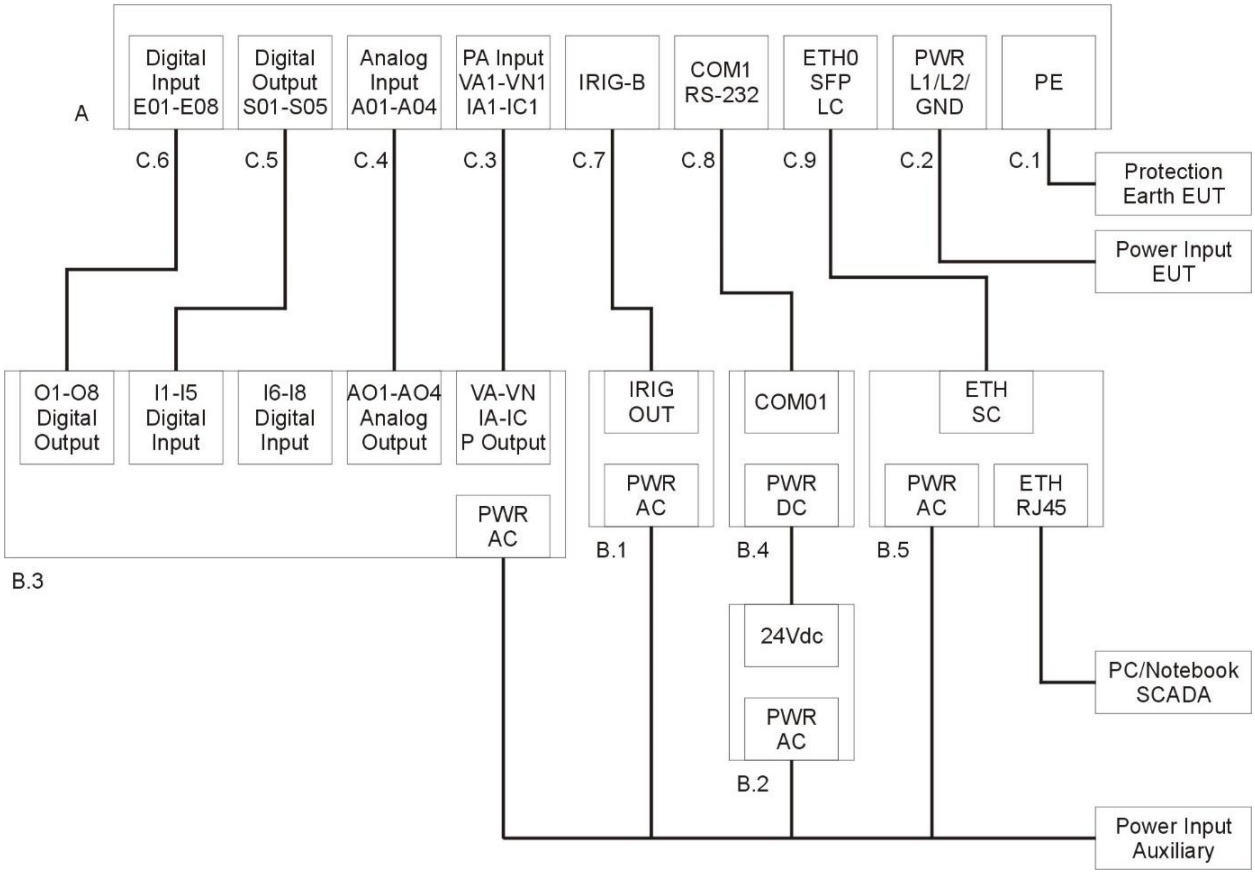
3.7 Standards

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 test object the auxiliary equipment according to the diagram presented below.

4.1 Connection Diagram



4.2 Auxiliary Equipment

B.1 – Satellite-Synchronized Clock SEL-2407

B.1 is used as IRIG-B clock source. To really synchronize to satellite clocks, antenna should be connected, but it has be used without antenna for RTU194 functional IRIB-B input port test purposes (no GPS signal available in the test lab).

B.2 – AC/DC Power Supply LP 1100D-24MDA

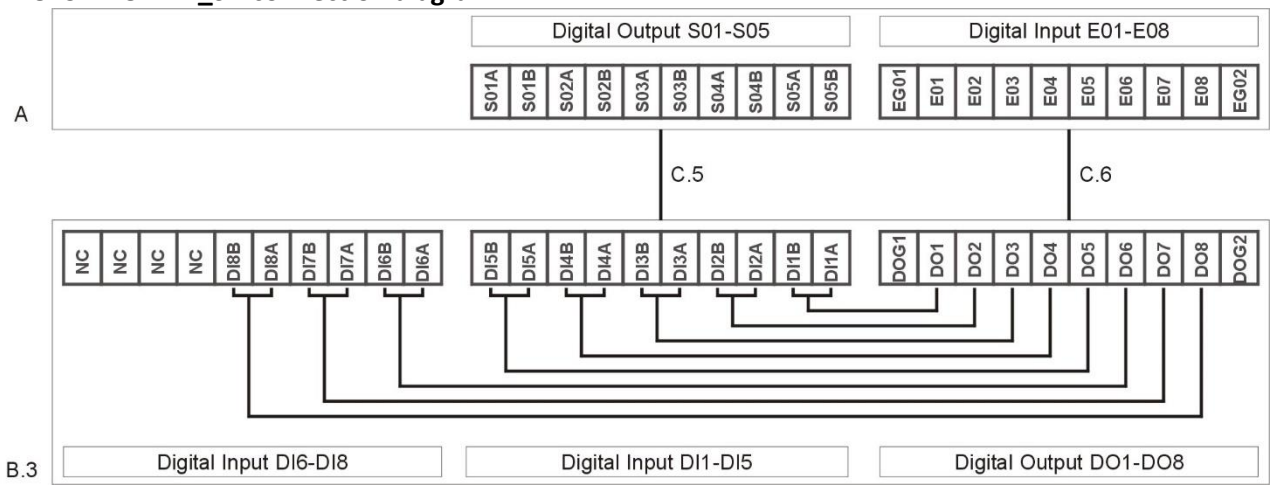
B.2 it's a standard AC/DC switching power supply, required to power B.4.

B.3 – Auxiliary input/output RTU194-AUX-01

This equipment has been developed just to simulate real connections to RTU194. It has three modules:

- RTU194-AUX-ED_SD for digital connections;
- RTU194-AUX-EA for dc current connections;
- RTU194-AUX-POT for ac voltage and current connections.

RTU194-AUX-ED_SD connection diagram:

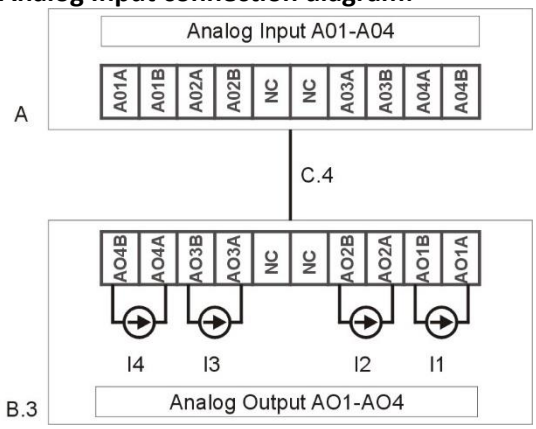


For example, if RTU194 (A) closes digital output S01, digital input E01 will be excited by B.3. It is a loop-back connection.

Related documentation about this module:

- RTU194-AUX-EDSD_BOM_1723V1_0.pdf;
- RTU194-AUX-EDSD_Layout_1723V1_0.pdf;
- RTU194-AUX-EDSD_Schematics_1723V1_0.pdf.

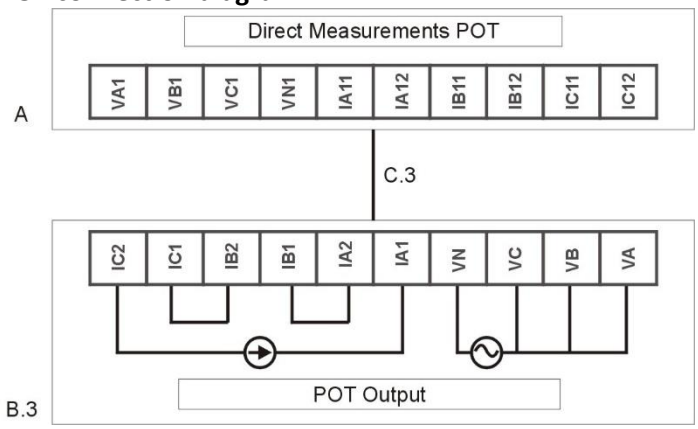
Analog Input connection diagram:



The auxiliary equipment B.3 excites each channel with a different fixed DC current source.
Related documentation about this module:

- RTU194-AUX-EA_BOM_1722V1_0.pdf;
- RTU194-AUX-EA_Layout_1722V1_0.pdf;
- RTU194-AUX-EA_Schematics_1722V1_0.pdf.

POT connection diagram:



The auxiliary equipment B.3 excites all voltage channels in a parallel connection and all current channels in a serial connection.
Related documentation about this module:

- RTU194-AUX-POT_BOM_1721V1_0.pdf;
- RTU194-AUX-POT_Layout_1721V1_0.pdf;
- RTU194-AUX-POT_Schematics_1721V1_0.pdf.

B.4 – RTU115

B.4 is used as an Intelligent Electronic Device (IED) with serial communication port.
It has been configured as IEC 60870-5-101 slave device.

B.5 – Ethernet Media Converter MC100CM

B.5 is provided to enable connection of EUT Ethernet port (100Base-FX) to SCADA PC.

B.6 – IP Test Enclosure

This enclosure is provided to be used for the IP test.

4.3 Performance observation

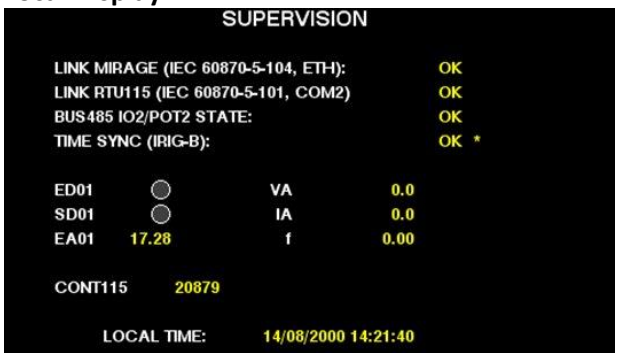
EUT is configured to:

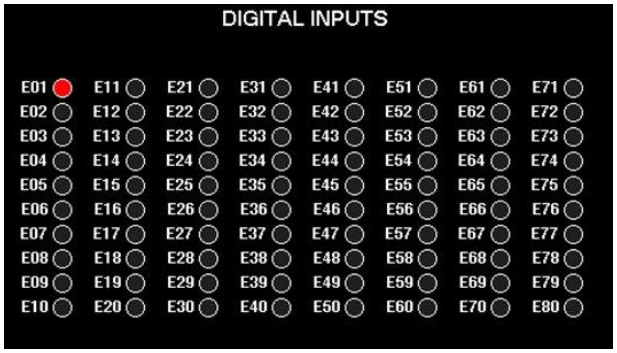
- Communicate as IEC 60870-5-104 slave to SCADA Mirage (Ethernet port test).
- Local operation from Display panel and buttons (Display test).
- Time synchronization with Satellite Synchronized Clock B.2 (IRIB-B port test).
- Communicate as IEC 60870-5-101 master to RTU115 B.4 (COM port test).
- Interconnect some digital input/output with RTU194-AUX B.3. Every change in RTU194 digital outputs SD01-SD05 will return as events in digital inputs ED01-ED05 (Digital input/output test). An internal PLC automatism periodically change digital output SD01.
- Receive and process DC current inputs from RTU194-AUX B.3 (DC current inputs).
- Receive and process AC current/voltage inputs from RTU194-AUX B.3 (AC current/voltage inputs).
- Digital output control for burden test (50% of the outputs activated).

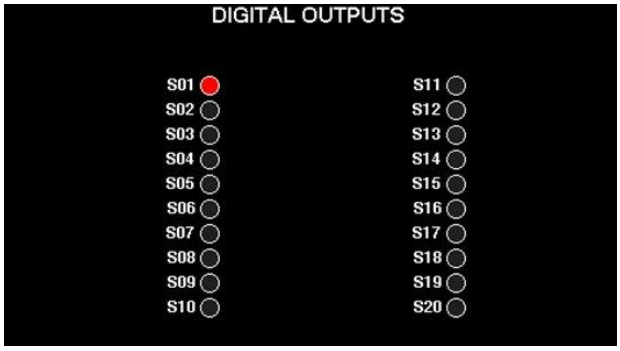
SCADA Mirage screen capture

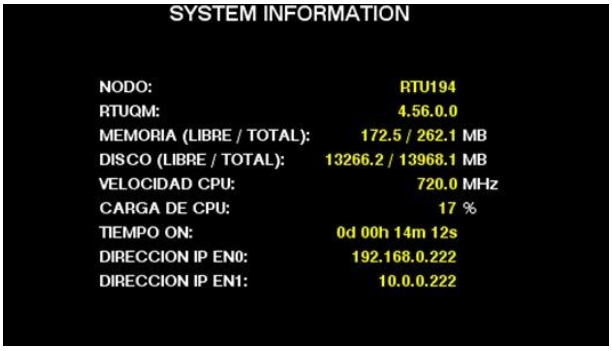
- Project Panel: general static information
- Supervision Panel:
  - Mirage-RTU194 link state.
  - RTU194-RTU115 link state and RTU115 counter value.
  - Bus485 internal state.
  - IRIG-B time state.
  - Display link state and Local/Remote state.
- IO2 A Panel
  - Digital Inputs state from ED01 to ED40.
  - Digital Output state from SD01 to SD10. User can operate them.
  - DC Analog Inputs from EA01 to EA04.
- IO2 B Panel
  - Digital Inputs state from ED41 to ED80.
  - Digital Output state from SD11 to SD20. User can operate them.
  - DC Analog Inputs from EA05 to EA08.
- POT2 A Panel: Voltage RMS, Current RMS and Frequency measurements from PA module.
- POT2 B Panel: Voltage RMS, Current RMS and Frequency measurements from PB module.

Local Display HMI:









- Supervision Panel:
  - Mirage-RTU194 link state.
  - RTU194-RTU115 link state and RTU115 counter value.
  - Bus485 internal state.
  - IRIG-B time state.
  - Local Time.
  - ED01, SD01, EA01, VA1, IA1 and f values.
- Digital Inputs Panel: ED01 to ED80 digital input states.
- Digital Outputs Panel: SD01 to SD20 digital outputs states. User can operate them.
- System Information: general information about CPU, memory, IP address …
- Project Information.
- Institutional Information.

5 RISK ASSESSMENT

Subclause 7.6 in IEC 61850-1 describes that testing a product which is part of a product family shall be considered sufficient to cover the entire product family provided a documented risk assessment is carried out to determine which type tests are valid and which tests need to be repeated on the rest of the product family.

A risk assessment was not required because the type testing concerns a single product type.

6 MARKING AND DOCUMENTATION

Standard and date

Standard	IEC 61850-3, subclause 6.1 and 6.2
Test date	3 March to 21 May 2020

Characteristic test data

Serial number: Sample A.1, Serial No. TEL-6311-1045

Documentation:

- User manual; RTU194_UserManual_R07.pdf
  Document ID: 1248_GEN_09_01
  Issue date: 20/05/2019
  Document revision: 07
  Hardware version: 2.0
- Safety manual; RTU194_SafetyInformation_R06.pdf,
  Document ID: 1248_GEN_09_07
  Issued Date: 16/08/2019
  Document Revision: 06
  Hardware Version: 2.0
- Specification sheet; 1248_GEN_07_01_R14 - Folleto RTU194V2, Rev 14 12/03/19

Observations

- The markings on the front and rear plastic overlays have been changed for the purpose to comply with the markings requirements of the standard. Refer to chapter 16.
- The documentation has been changed for the purpose to comply with the documentation requirments of the standard. The updated revision is revision 07.

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 and markings meet the marking and documentation requirements.

7 PACKAGING

Standard and date

Standard	IEC 61850-3, subclause 6.3
Test date	9 October 2019

Requirement

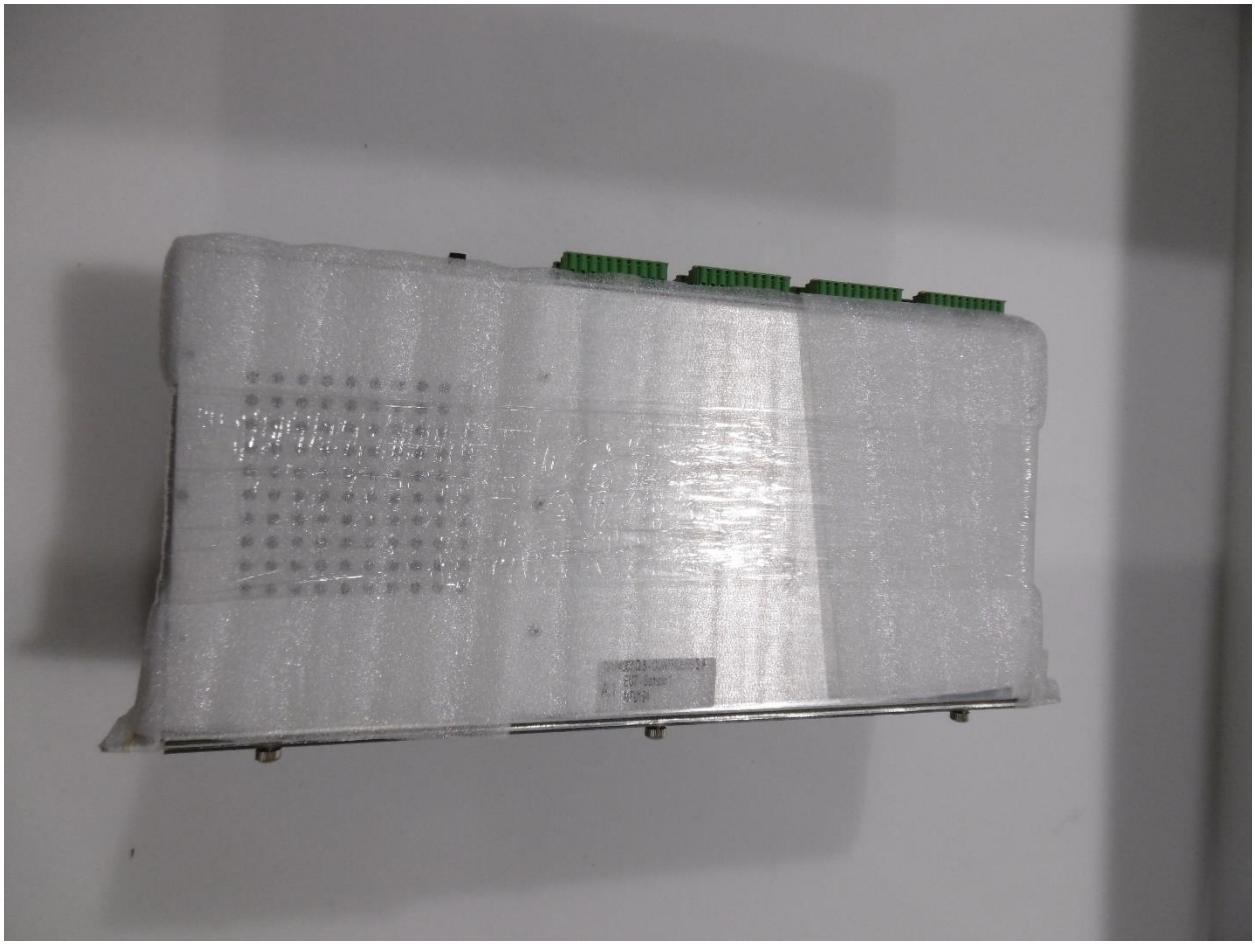
The manufacturer shall ensure that the equipment is suitably packaged to withstand, without damage, reasonable handling and environmental conditions appropriate to the method(s) of transportation to the user's delivery address.

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 the packaging



8 DIMENSIONS OF STRUCTURE

Standard and date

Standard IEC 61850-3, subclause 6.4
{Basic standard IEC 60297-3-101
Test date 14 February, 8 April and 19 May 2020

For 19" enclosures, 4U height;

Item	Unit	Measured	Specified by the manufacturer	Required by IEC 60297-3-101	
rack height	mm	177,00[1)]	-	H1	177,00 ± 0,4 (4U)
width front, over the mounting brackets	mm	482,60[1)]	-	-	482,6 ± 0,4
rack depth	mm	213,94	200,00 ± 0,4	-	-
width inside rack	mm	N/A	-	-	>426,72
width behind the brackets, over the mounting of the bracket	mm	441,97	-	-	≤ 449
rack mounting hole positions	mm	101,25	-	H2	101,60 ± 0,4 (4U)
rack mounting hole positions	mm	37,70[1)]	-	H3	37,70 ± 0,4 (4U)
rack mounting hole positions	mm	N/A	-	H4	76,20 ± 0,4 (6U)
vertical aperture opening for plug-in units	mm	N/A		H5	≥ 156,45 (4U)
Mounting center distance for plug-in units, front panels, backplanes and connector supports.	mm	N/A		H6	166,95 ± 0,2 (4U)
Plug-in unit and printed board guidance height.	mm	N/A		H7	144,65 + 0,5, -0 (4U)
Plug-in unit front panel height.	mm	N/A		H8	173,00 ± 0,15 (4U)
Vertical plug-in unit front panel or backplane onto subrack mounting dimensions	mm	N/A		H9	166,95 ± 0,2 (4U)
Printed board height or plug-in unit into subrack guidance height.	mm	N/A		H10	144,45 +0, -0,3 (4U)
Mounting hole width dimension	mm	10,25	-	-	10,3 ± 0,4
Mounting hole height dimension	mm	10,17	-	-	10,3 ± 0,4
Mounting hole position	mm	13,30	-	-	13,5 ± 0,4

Tolerances
See references to IEC 60297-3-101 in the table above.

Notes
- The manufactures enclosure contents (PCB, modules) are custom made. The enclosure is not to be used for mounting of 19”based modules.

[1)] Compliance checked by inspection of the mechanical drawing.

Observations
The measured/insop dimensions were within the specified dimensions.

Result
The object passed the test.

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 (CT, VT, sensitive current);
- digital inputs (binary inputs);
- contact outputs (binary outputs);
- timing port (IRIG-B);
- data communication (optical, RS232).

9.1.2 Visual and functional inspection

No visual and/or functional inspection is required after the product safety tests. In general, the test object shall remain safe regarding the spread of fire or risk of having an electric shock. Specific assessment/test requirements are listed at each specific test.

9.2 Document references

For the purpose of the safety assessment the report(s) listed have been used for reference purpose whenever applicable;

- Test report IEC 60950-1, TRF E132067-CB-1, issue date 2016-05-12

9.3 Clearances and creepage distances

Standard and date

Standard	IEC 61850-3, subclause 6.6.1
Test date	21 April and 11 May 2020

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
PCB Coating	No

Power supply module (PSU, filter board);

Creepage distances;
Nominal rated insulation voltage or working voltage: ≤**300Vac / 300 Vdc.**

Requirement IEC 61850-3; Category; OVC-III, PD2. IEC 61850-3 refers to IEC 60255-27 Annex C. for creepage and clearance requirements.

Creepage requirement for functional, basic or supplementary insulation.

1. Not coated PCB; creepage distance = 3mm (table C.6).
2. For double or reinforced insulation; creepage distance = 5,5 mm (table C.10).

Clearance requirement for basic functional or supplementary insulation

1. Clearance; 3mm (table C.6).
2. For double or reinforced insulation; clearance distance = 5,5 mm (table C.10).

GIO module (BI and BO);

Creepage distances;
Nominal rated insulation voltage or working voltage: ≤**300Vac (BO) / 300 Vdc (BI).**

Requirement IEC 61850-3; Category; OVC-III, PD2. IEC 61850-3 refers to IEC 60255-27 Annex C. for creepage and clearance requirements.

Creepage requirement for functional, basic or supplementary insulation.

1. Not coated PCB; creepage distance = 3mm (table C.6).
2. For double or reinforced insulation; creepage distance = 5,5 mm (table C.10).

Clearance requirement for basic functional or supplementary insulation

1. Clearance; 3mm (table C.6).
2. For double or reinforced insulation; clearance distance = 5,5 mm (table C.10).

POT module (VT and CT);

Creepage distances;
Nominal rated insulation voltage or working voltage: ≤**300Vac / 300 Vdc.**

Requirement IEC 61850-3; Category; OVC-III, PD2. IEC 61850-3 refers to IEC 60255-27 Annex C. for creepage and clearance requirements.

Creepage requirement for functional, basic or supplementary insulation.

1. Not coated PCB; creepage distance = 3mm (table C.6).
2. For double or reinforced insulation; creepage distance = 5,5 mm (table C.10).

Clearance requirement for basic functional or supplementary insulation

1. Clearance; 3mm (table C.6).
2. For double or reinforced insulation; clearance distance = 5,5 mm (table C.10).

CPU-module (IRIG-B, RS232);

Nominal rated insulation voltage or working voltage: ≤**50Vac / 50 Vdc.**

Requirement IEC 61850-3; Category; OVC-III, PD2. IEC 61850-3 refers to IEC 60255-27 Annex C. for creepage and clearance requirements.

Creepage requirement for functional, basic or supplementary insulation.

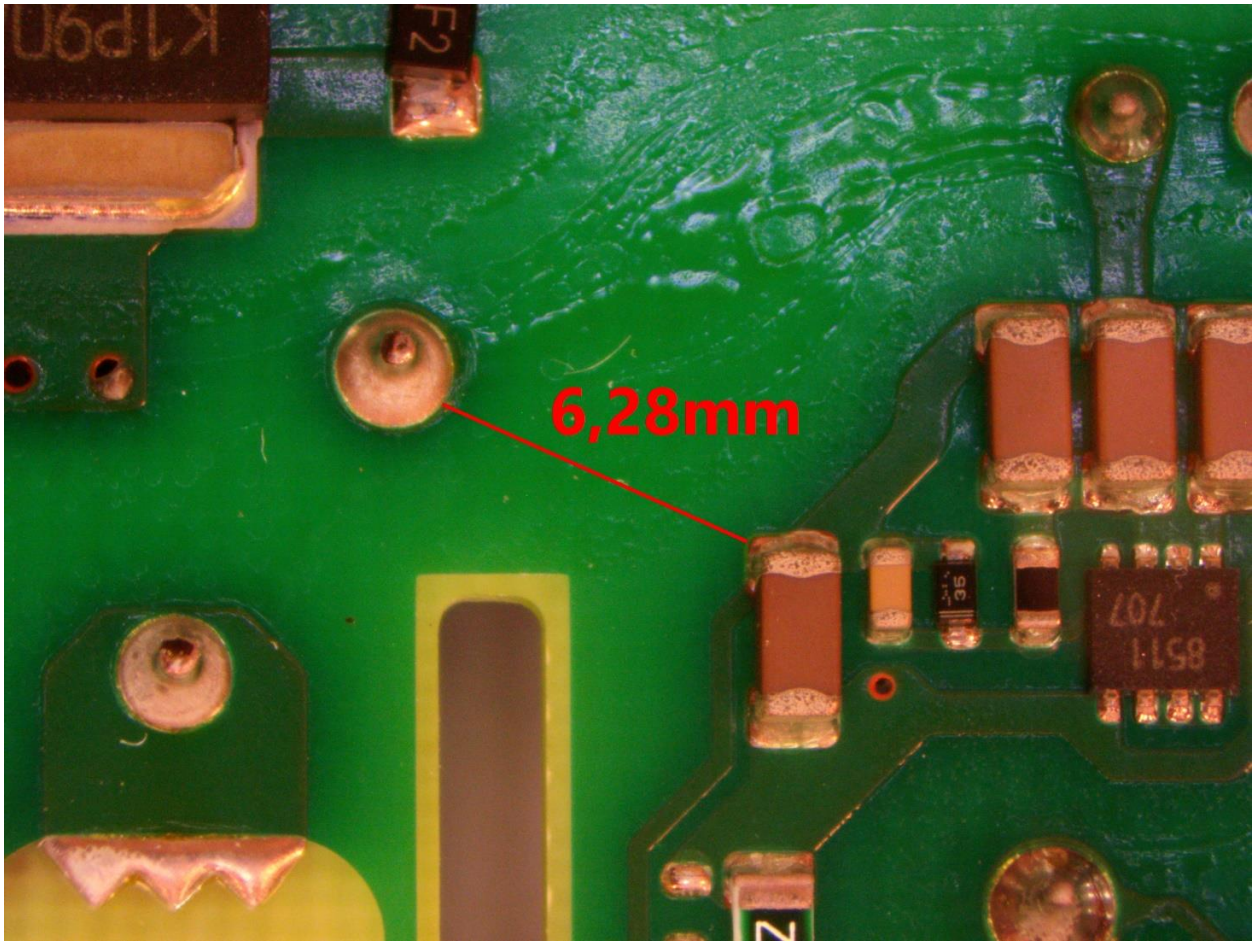
1. Not coated PCB; creepage distance =0,15mm (table C.6).
2. For double or reinforced insulation; creepage distance = 0,5 mm (table C.10).

Clearance requirement for basic functional or supplementary insulation

1. Clearance; 0,15mm (table C.6).
2. For double or reinforced insulation; clearance distance = 0,5 mm (table C.10).

9.3.1 Measurements

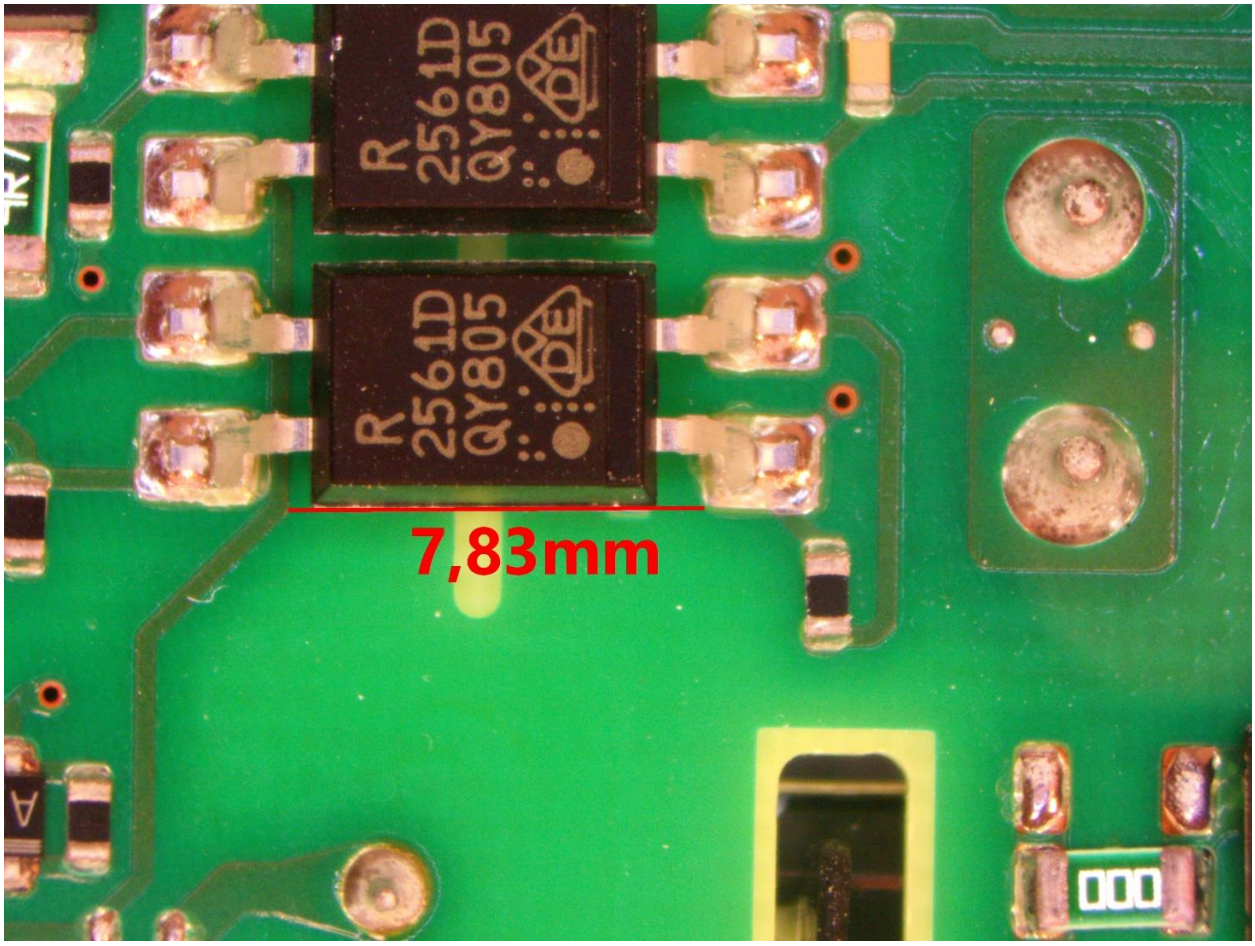
PSU module



Creepage PSU between HLV ELV at air gap

IEC 60255-27 working voltage; 300 V (OVC II, double/reinforced insulation)

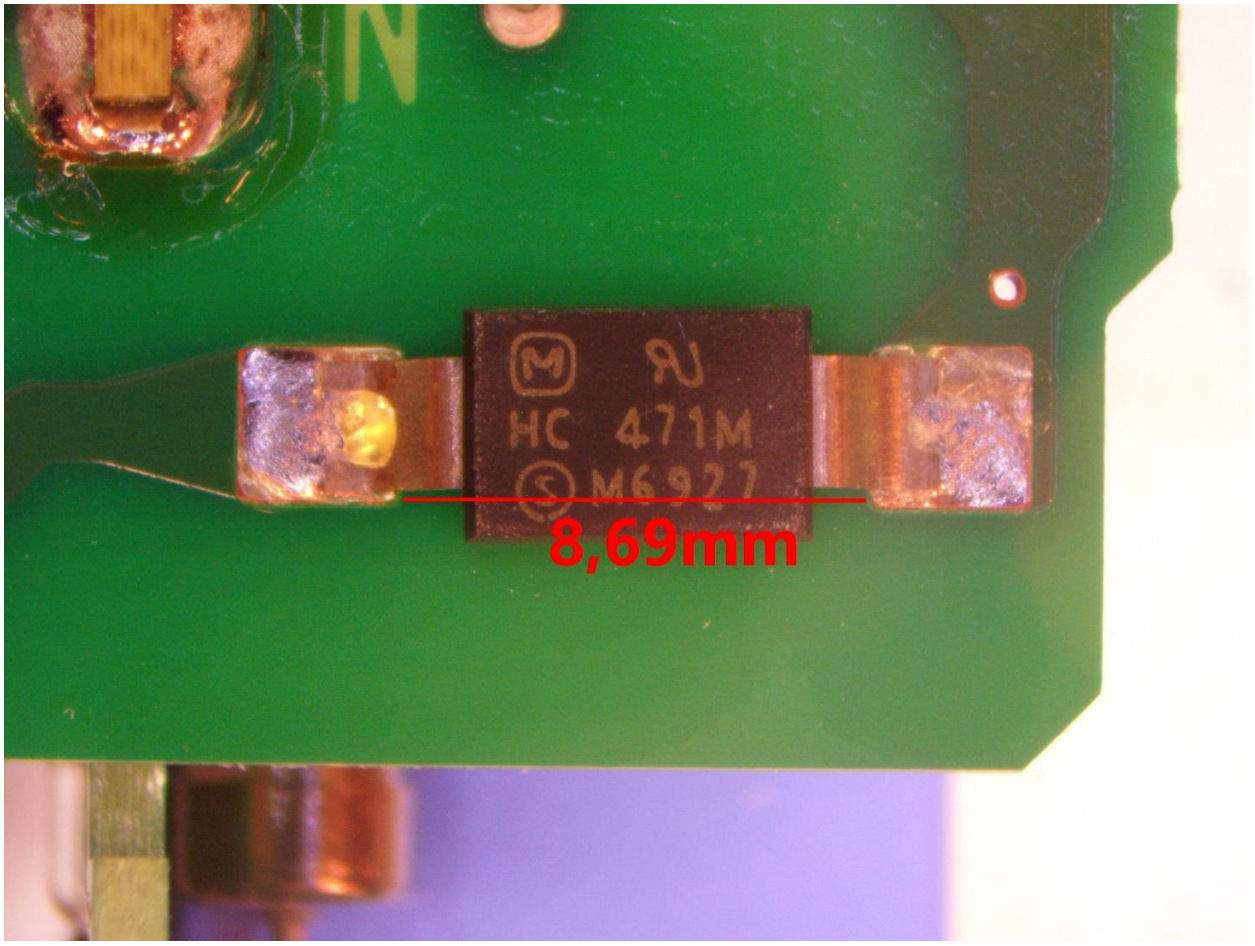
Measurement point	Required mm	Measured mm	Verdict
Primary circuit to secondary circuit	5,50	6,28	PASS



Creepage PSU; accross opto coupler

IEC 60255-27 working voltage; 300 V (OVC II, double/reinforced insulation)

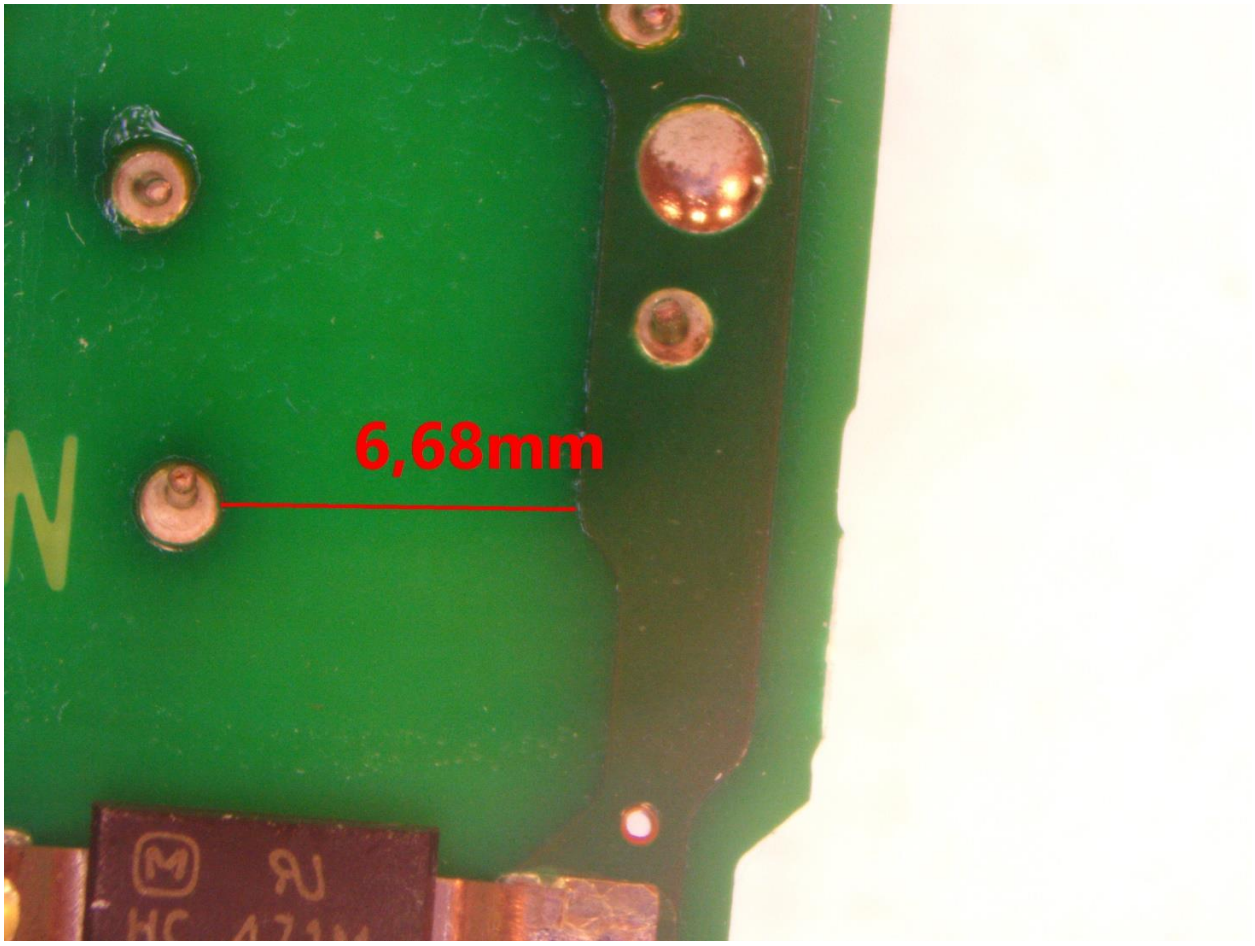
Measurement point	Required mm	Measured mm	Verdict
Primary circuit to secondary circuit; across opto coupler	5,50	7,83	PASS



Creepage PSU module; creepage across transient limiter

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Primary circuit, across transient limiter to PE	3,00	8,69	PASS

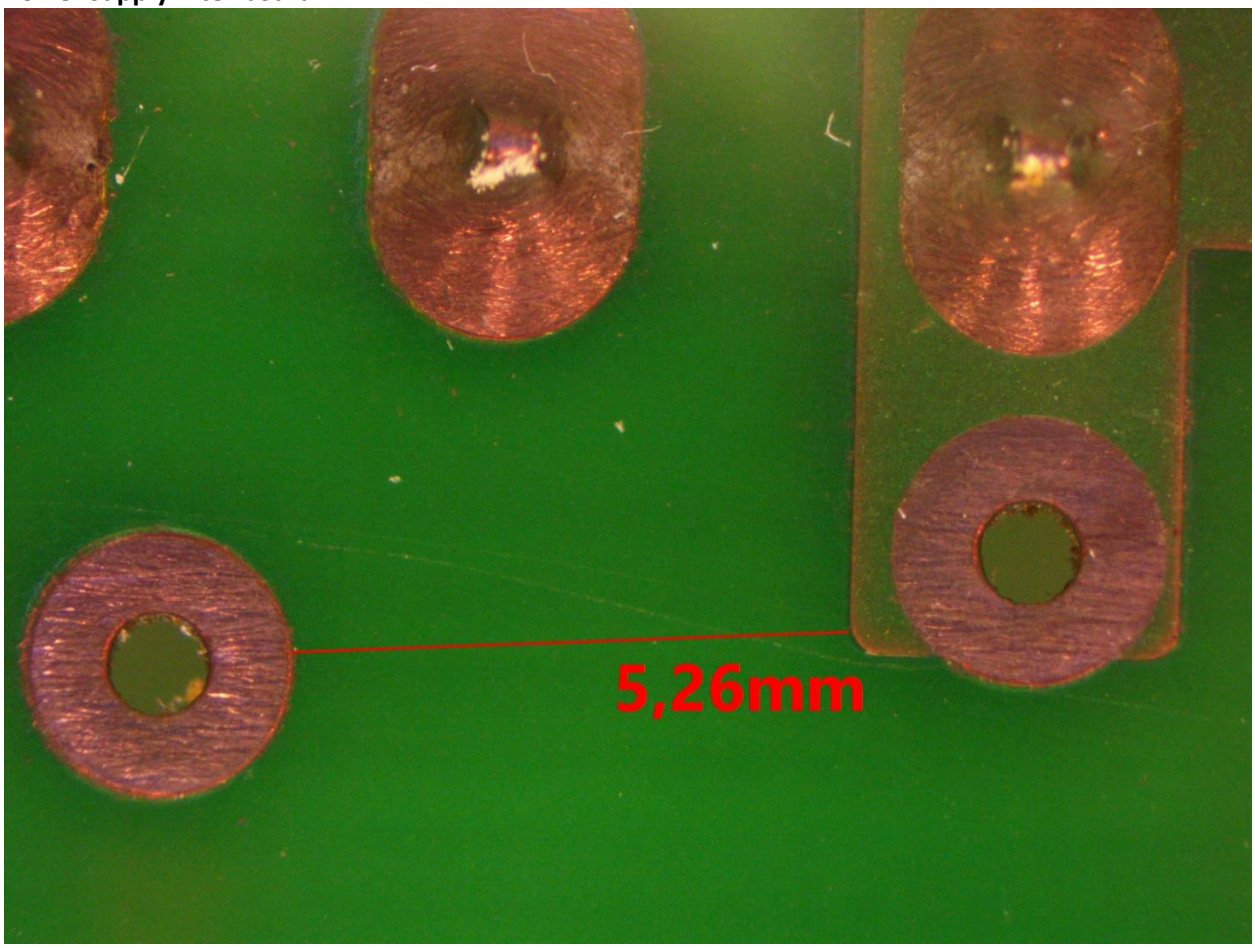


Creepage PSU module; across Y capacitor C107

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Primary circuit, across transient limiter to PE	3,00	6,68	PASS

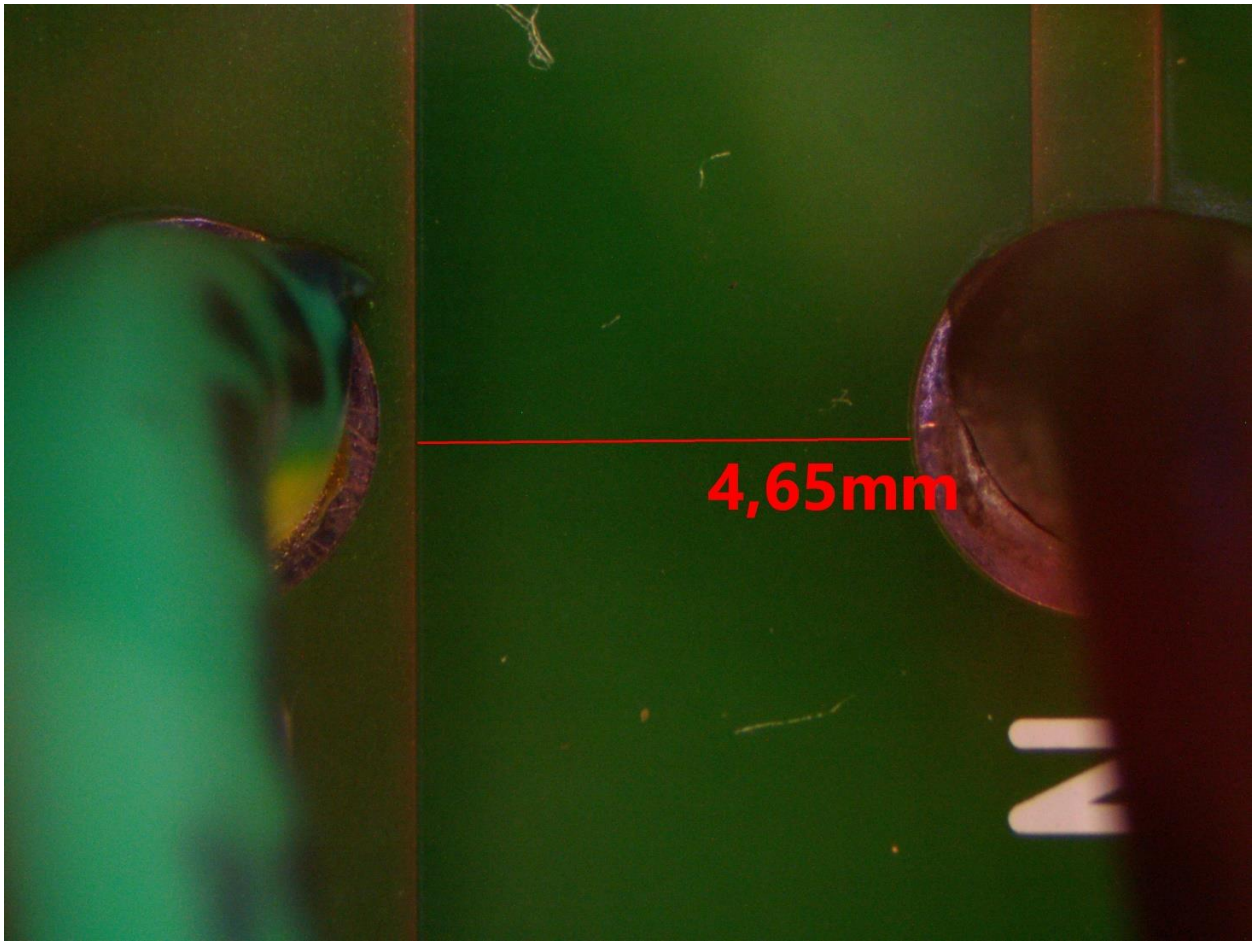
Power supply filter board



Creepage filter board N to PE pcb track

IEC 60255-27 working voltage; 300 V

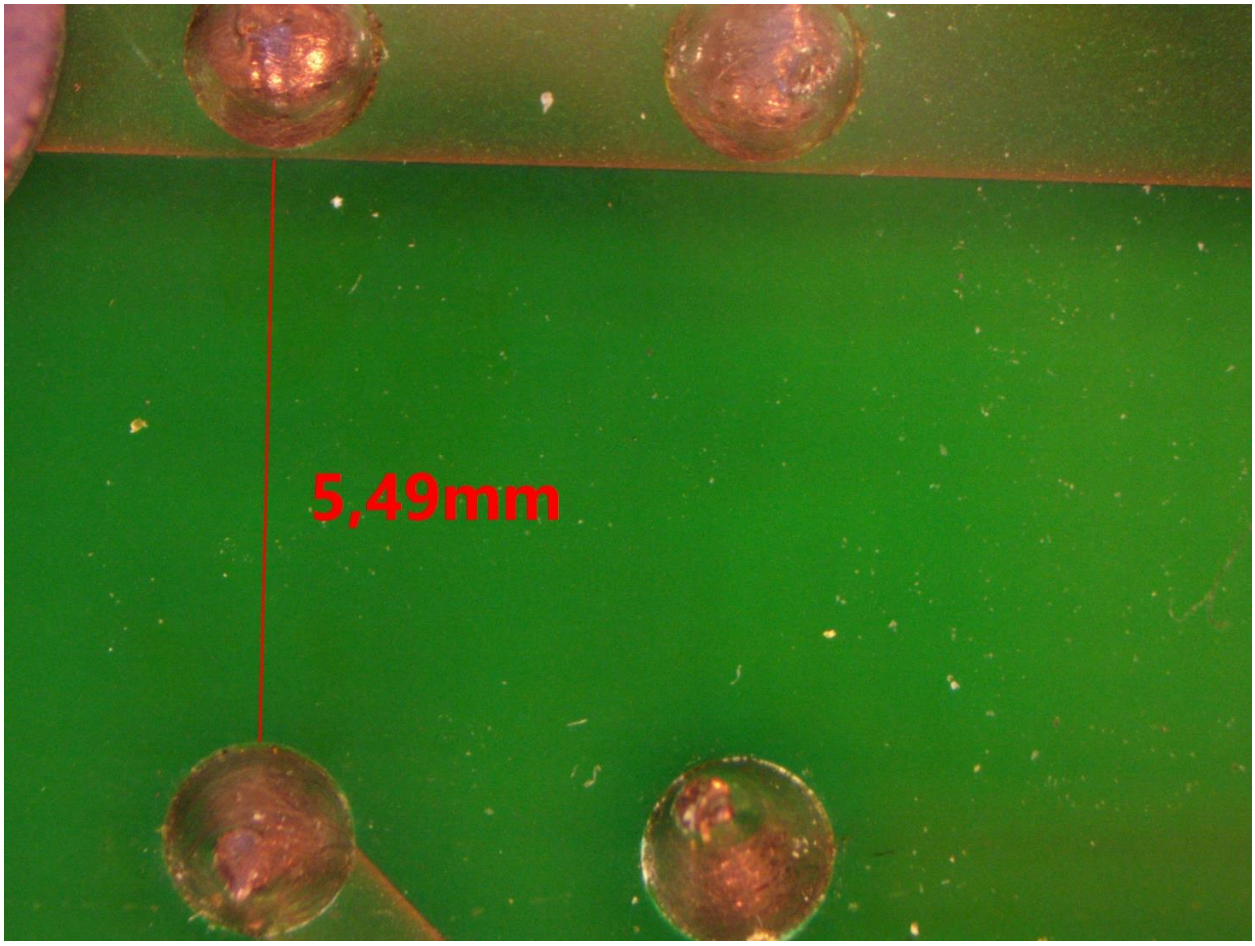
Measurement point	Required mm	Measured mm	Verdict
Primary circuit, Power supply filter board; N to PE tracks	3,00	5,26	PASS



Creepage filter board across the AC mains power input connections

IEC 60255-27 working voltage; 300 V

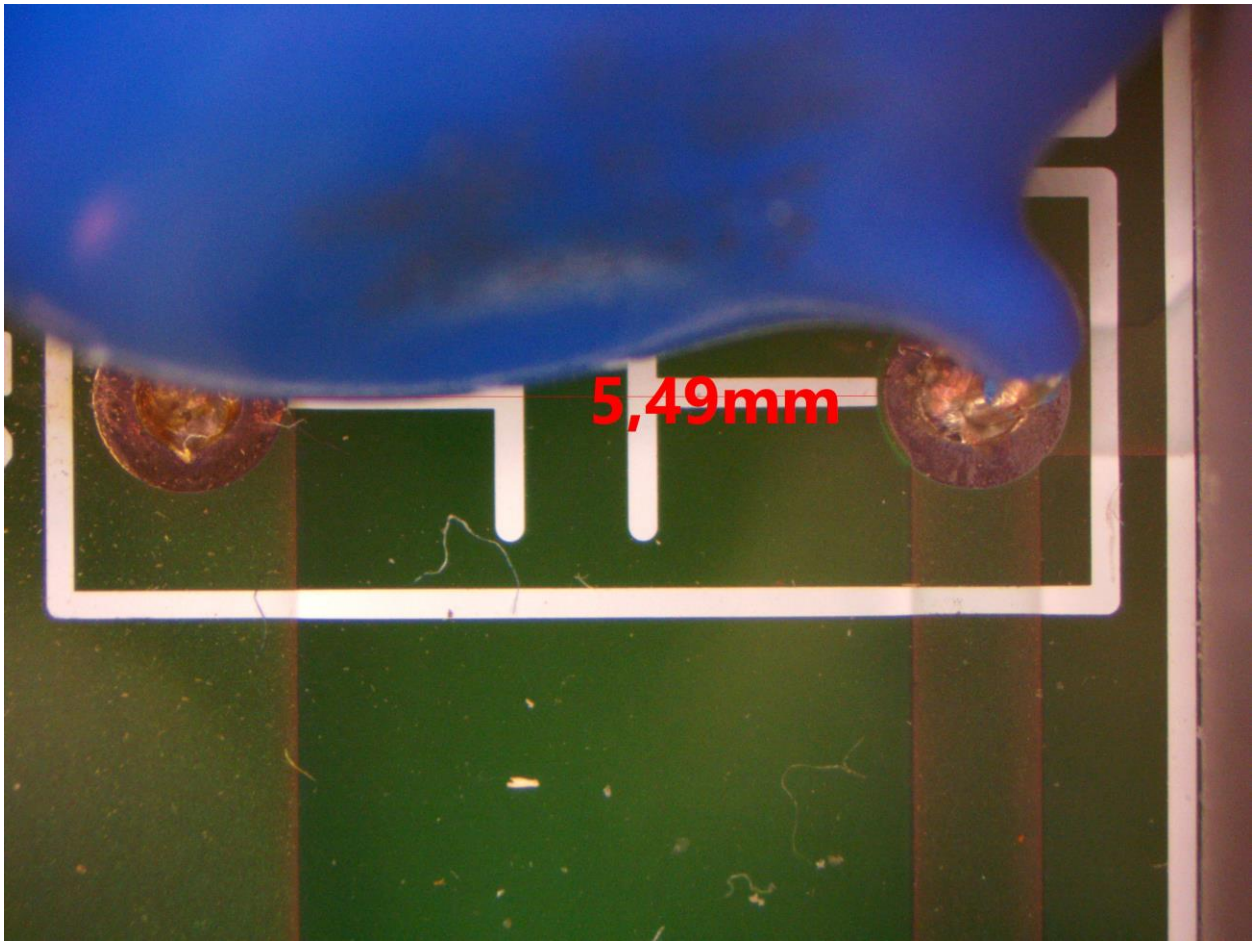
Measurement point	Required mm	Measured mm	Verdict
Primary circuit; between the AC mains power input connections	3,00	4,65	PASS



Creepage filter board, across the filter capacitor C1

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Primary circuit; across the filter capacitor C1	3,00	5,49	PASS

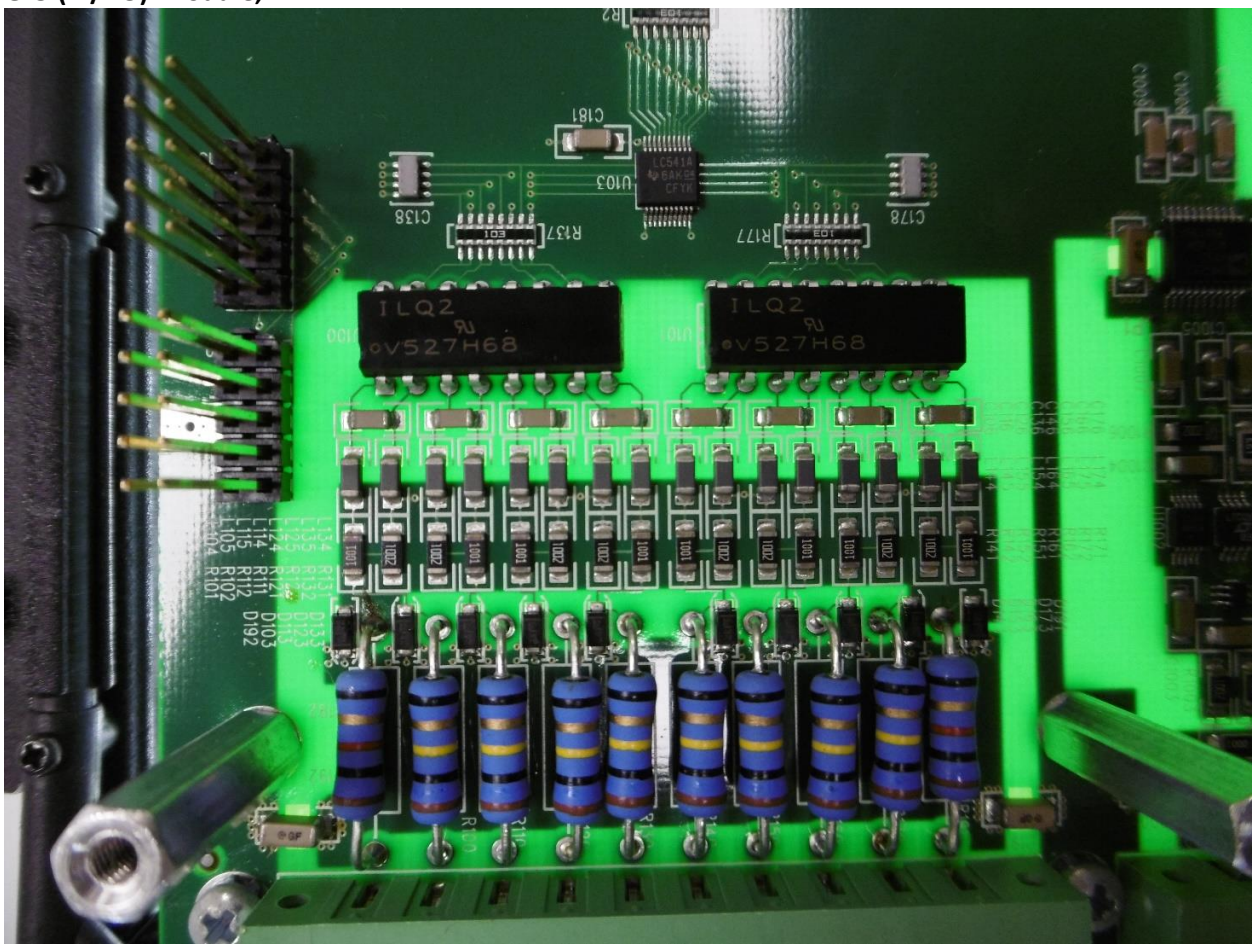


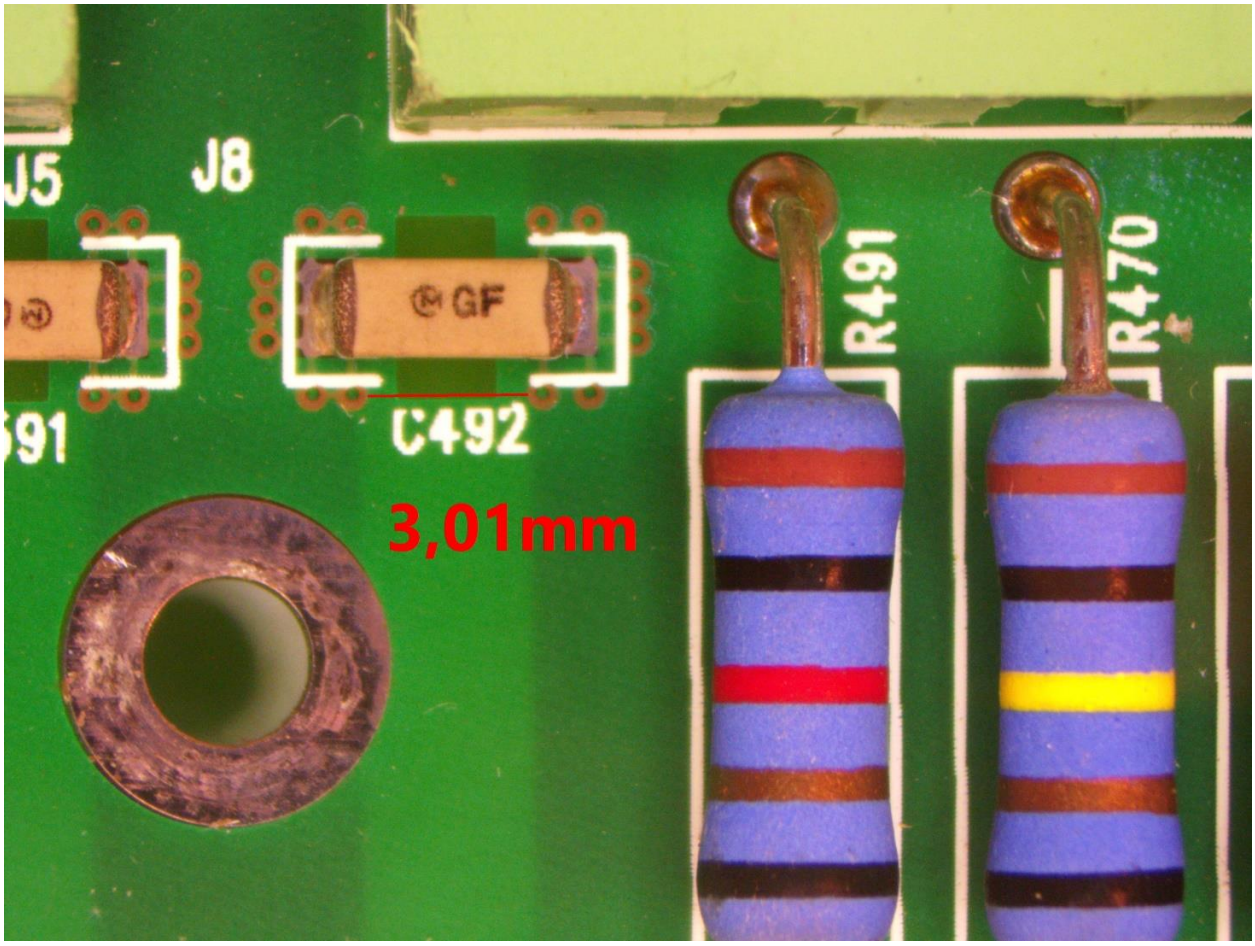
Creepage filter board, across the filter capacitor C2

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Primary circuit; across the filter capacitor C2	3,00	5,49 mm	PASS

GIO (BI/BO) module, BI

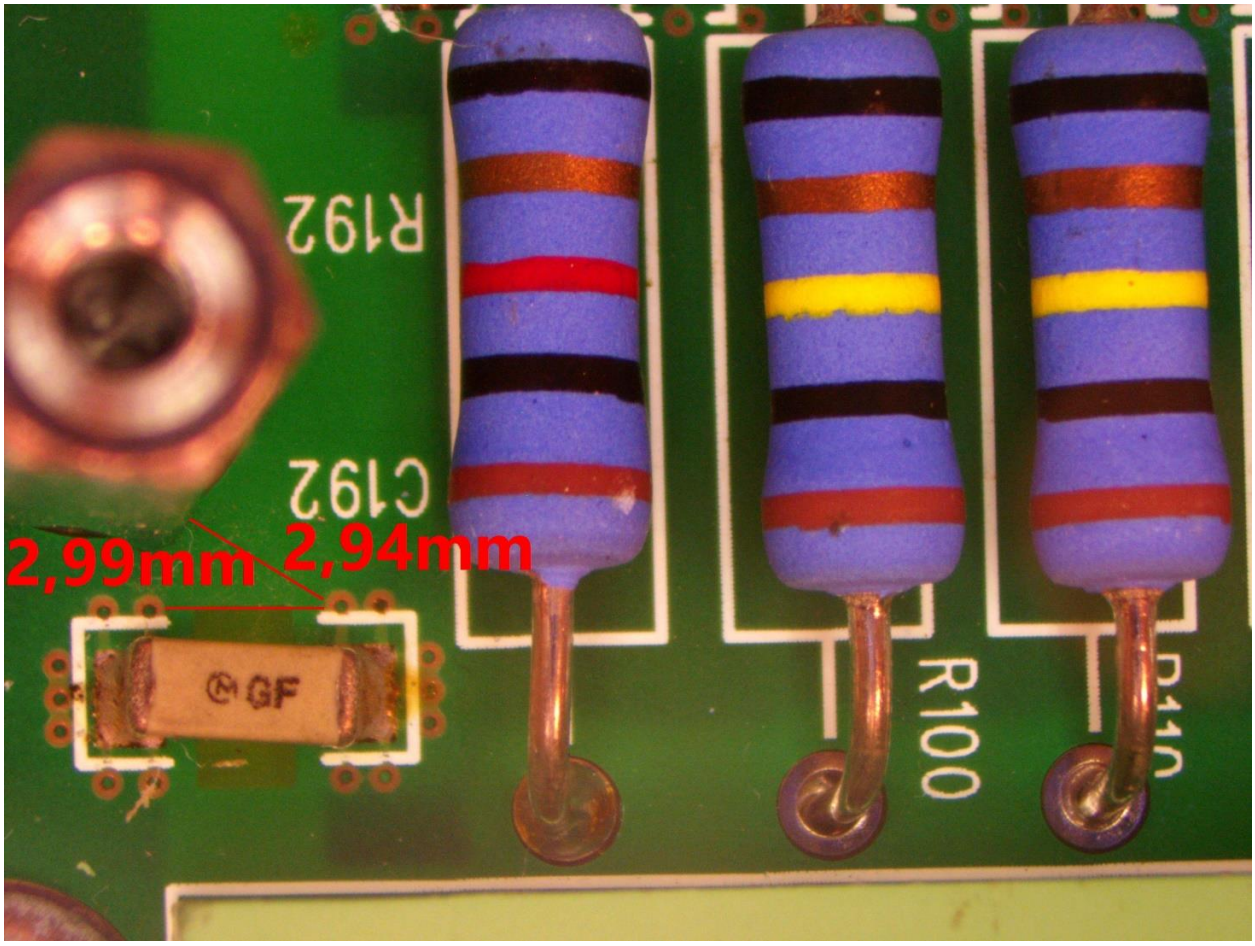




Creepage BI; across C492 (capacitor to GND)

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Binary input; C192 to GND	3,00	3,01	PASS



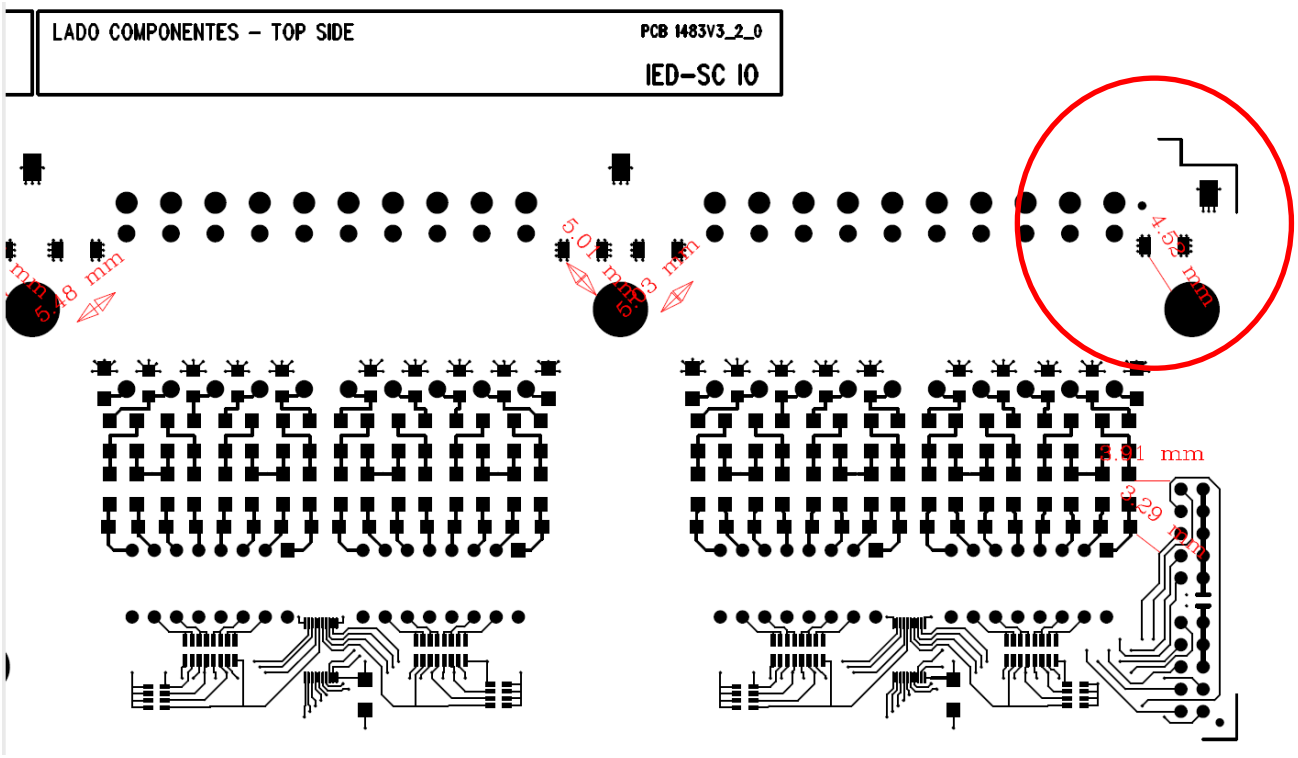
Creepage BI; across C192 and from C192 to GND

IEC 60255-27 working voltage; 300 V

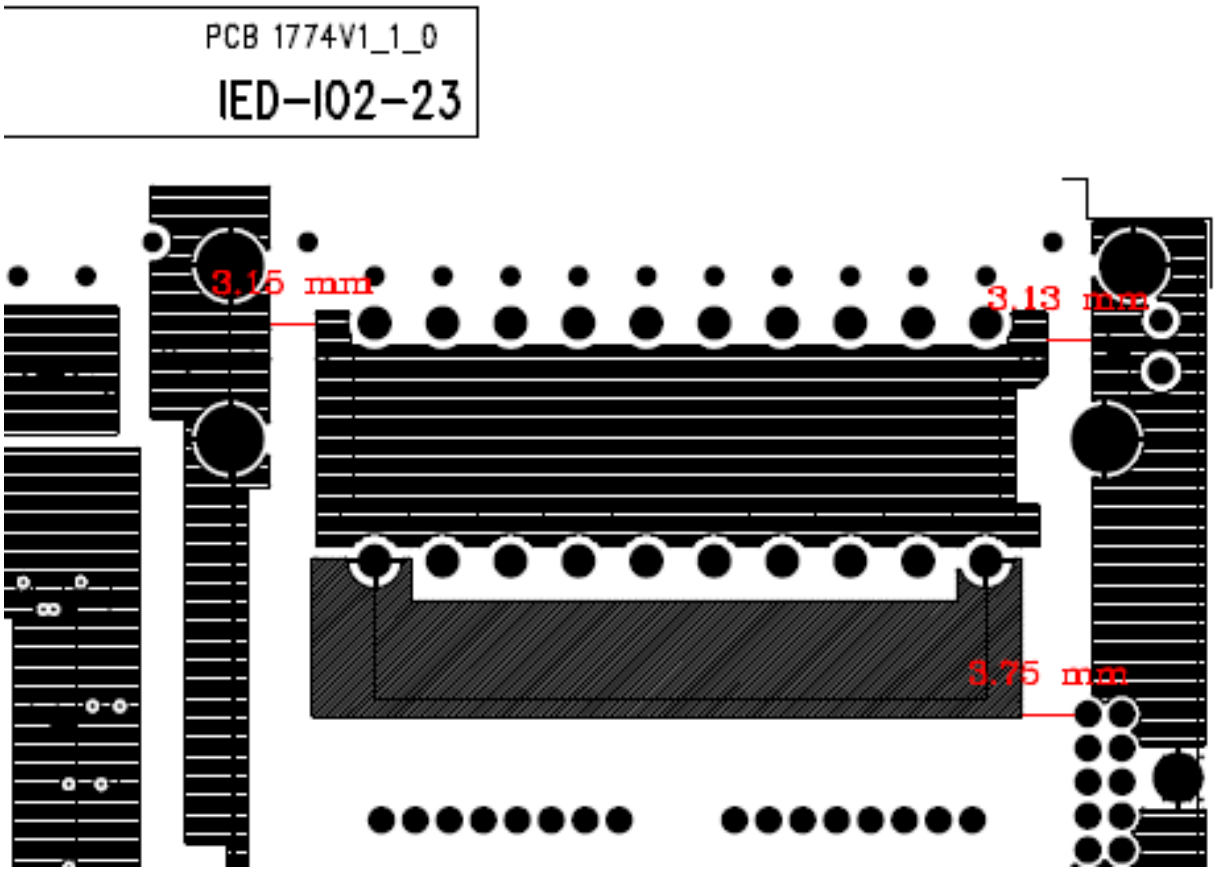
Measurement point	Required mm	Measured mm	Verdict
Binary input; across C192	3,00	2,99	PASS
Binary input; from C192 to GND	3,00	4,52 [1)]	PASS

Note

[1)] new CAD data received; the distance has been increased from 2,94 mm to 4,52 mm.

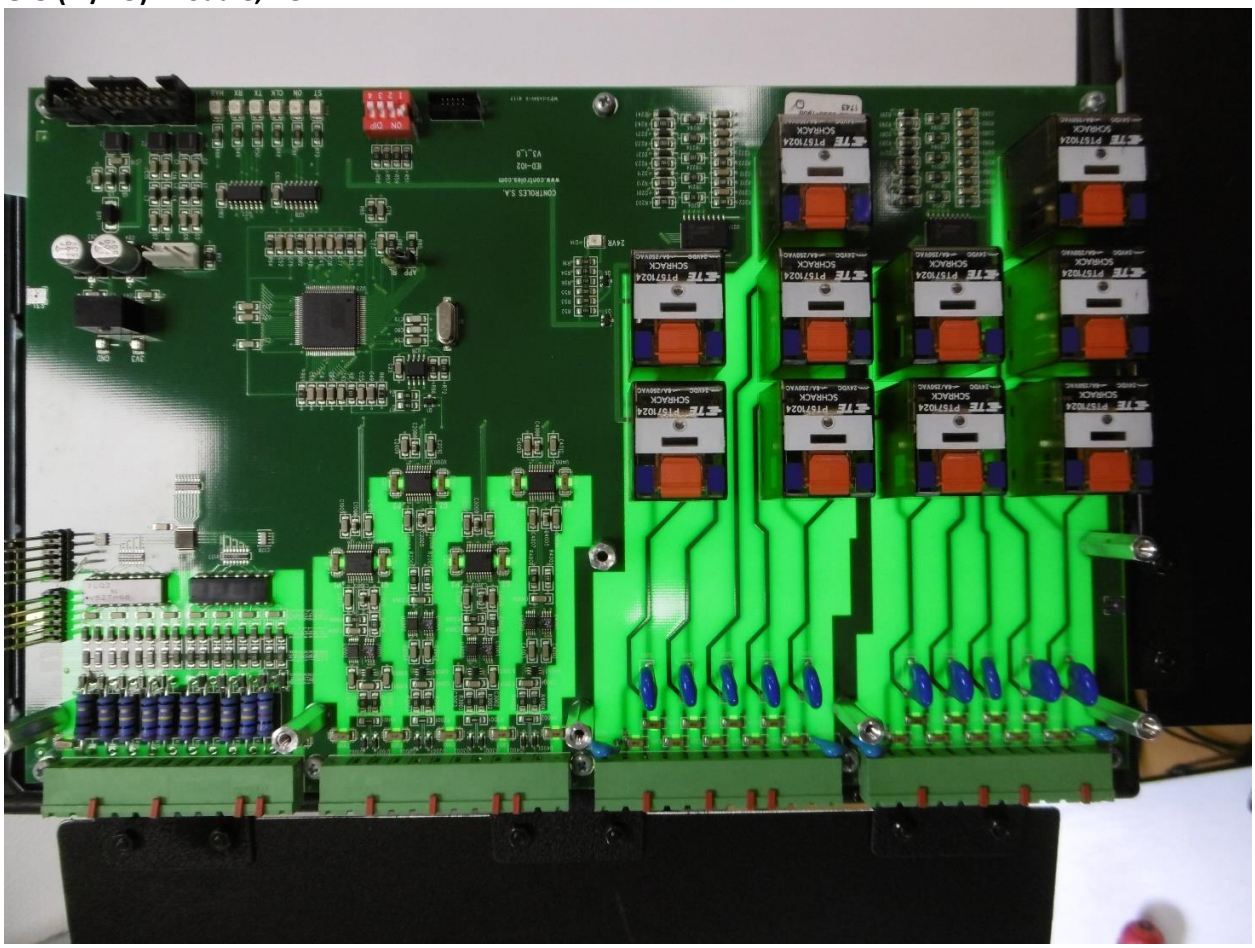


Modified layout GIO 1483 top layer.

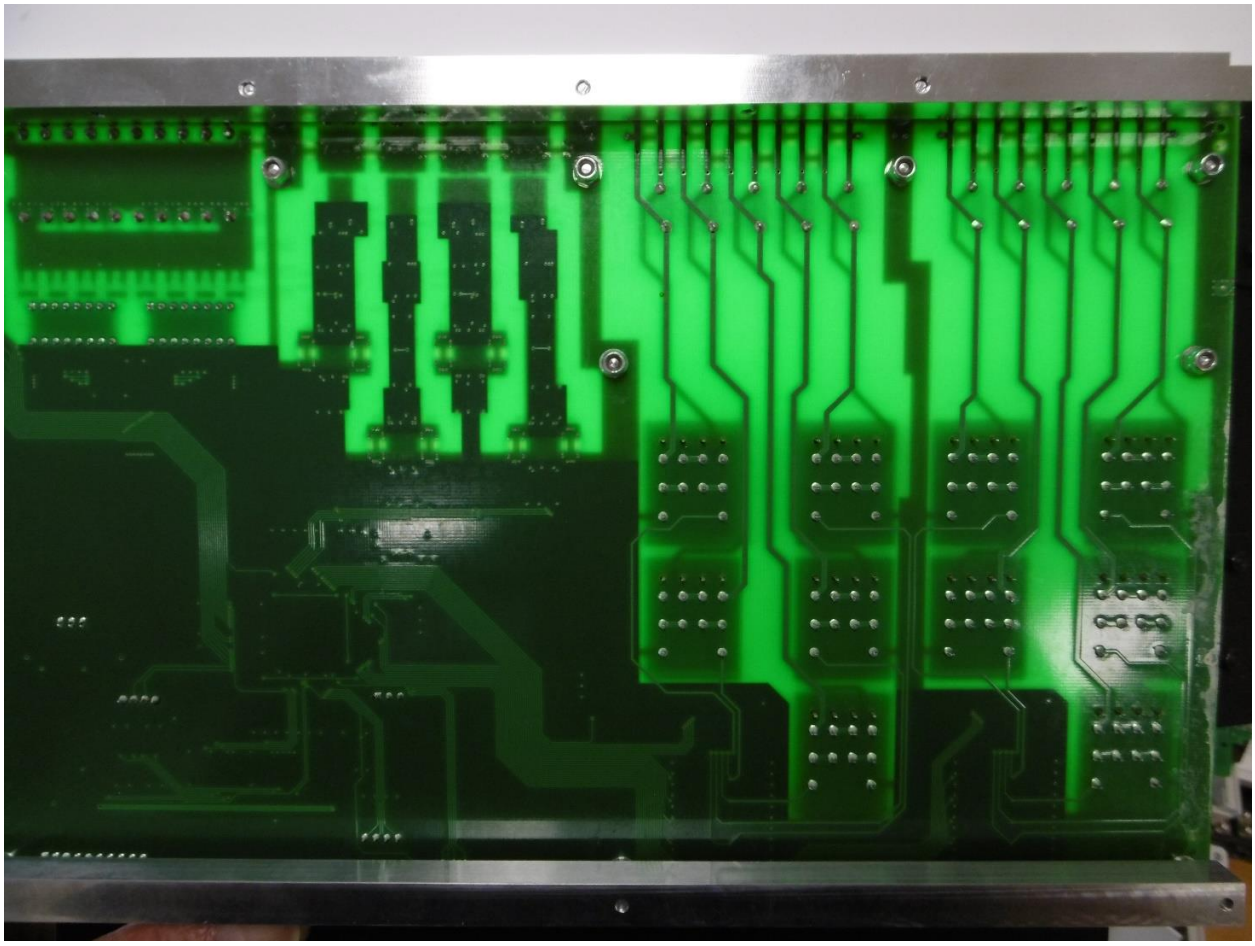


Detailed view BI

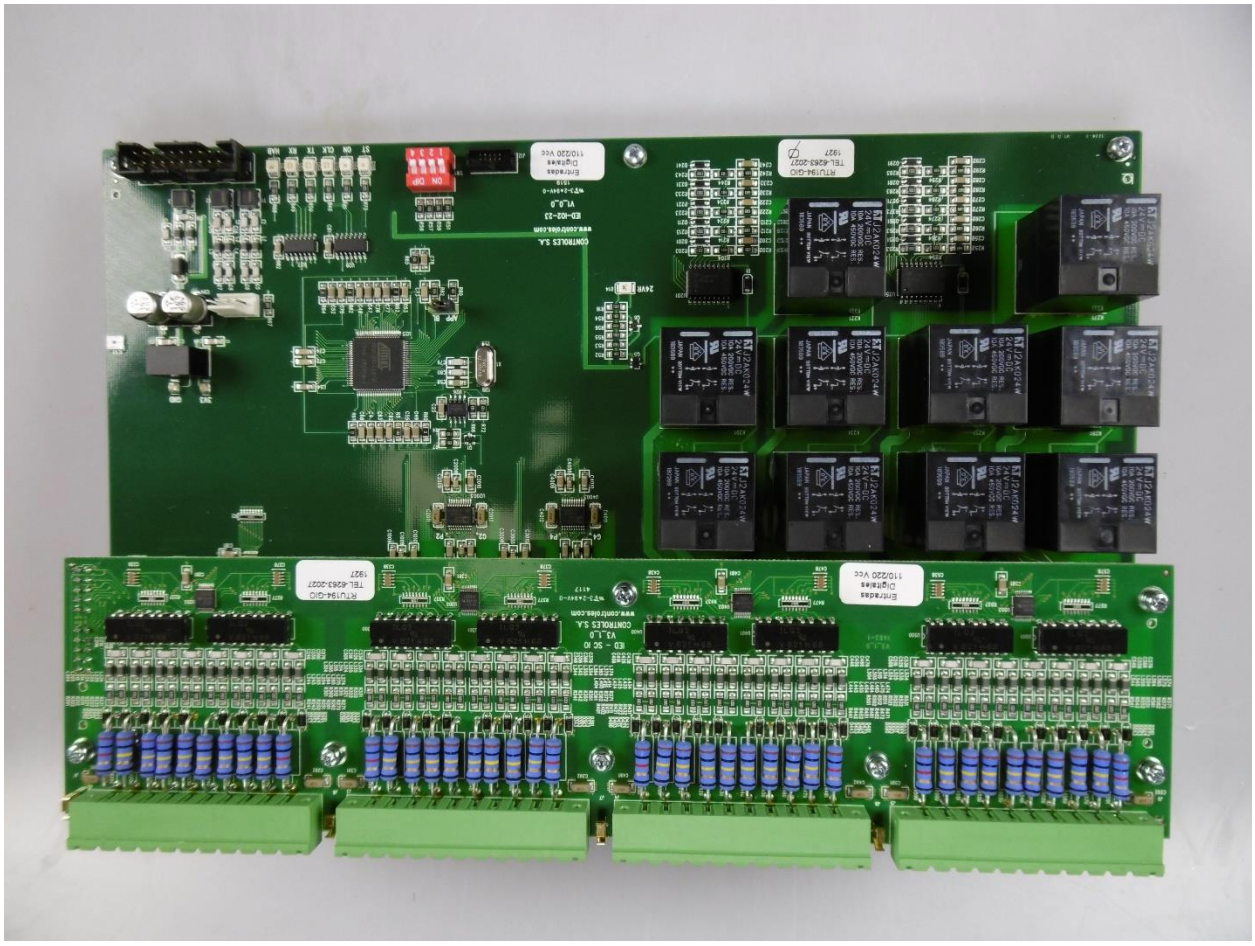
GIO (BI/BO) module, BO



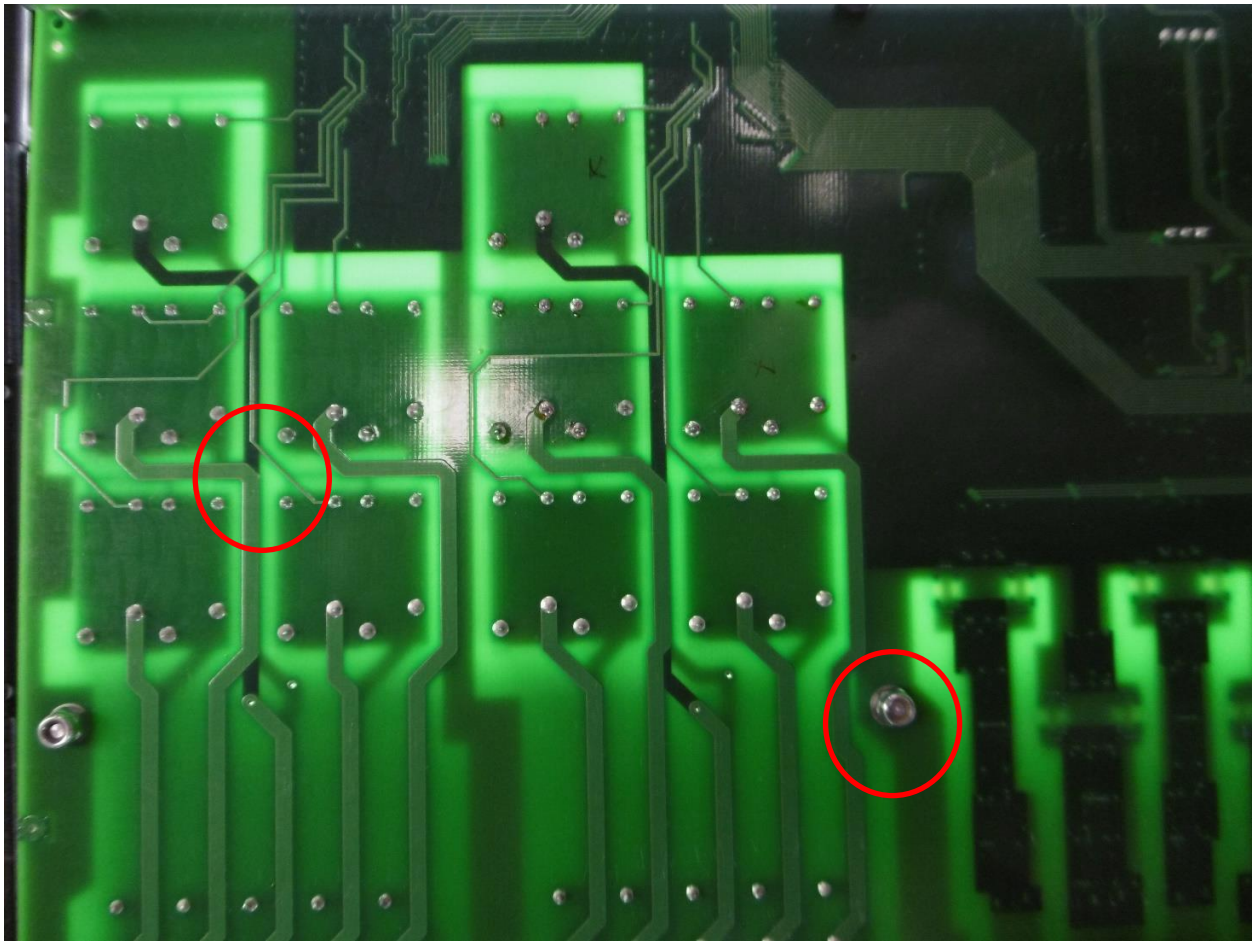
Top view (GIO provided with relays PT571024)



Bottom view (GIO provided with relays PT571024)



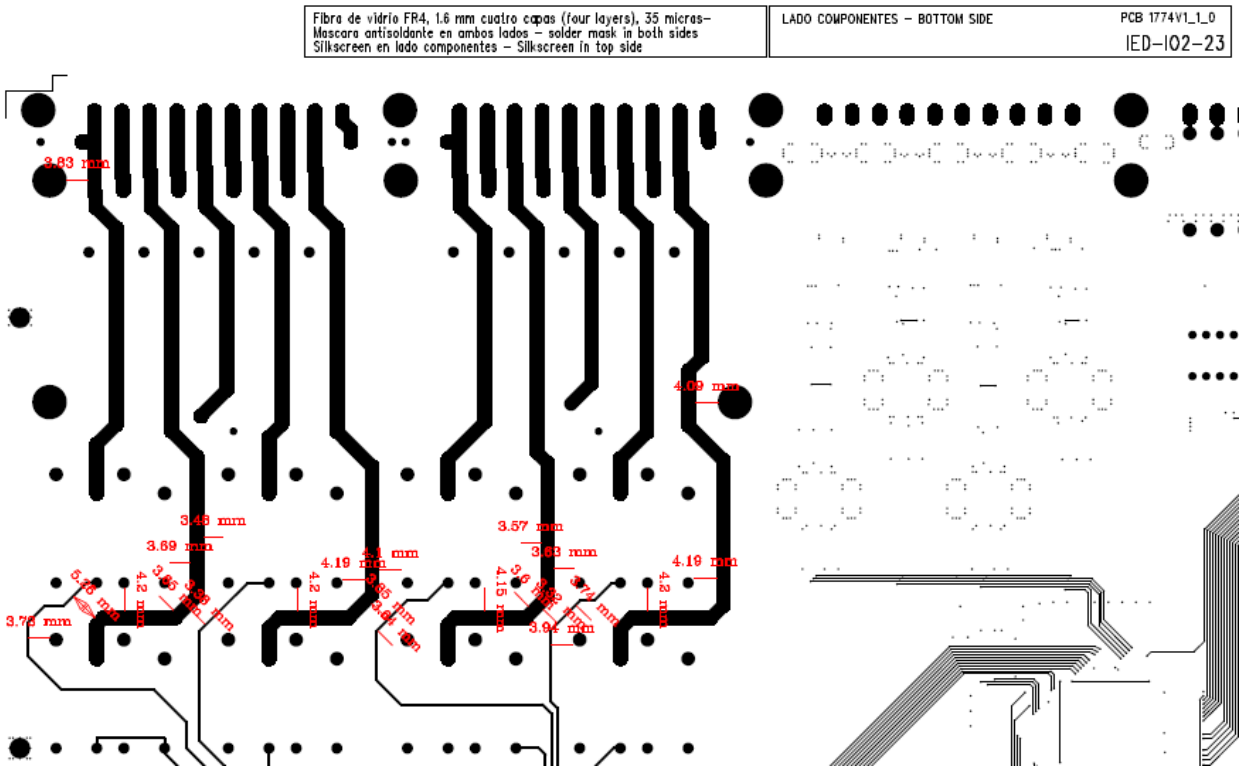
Top view (GIO provided with relays J2AK024W)



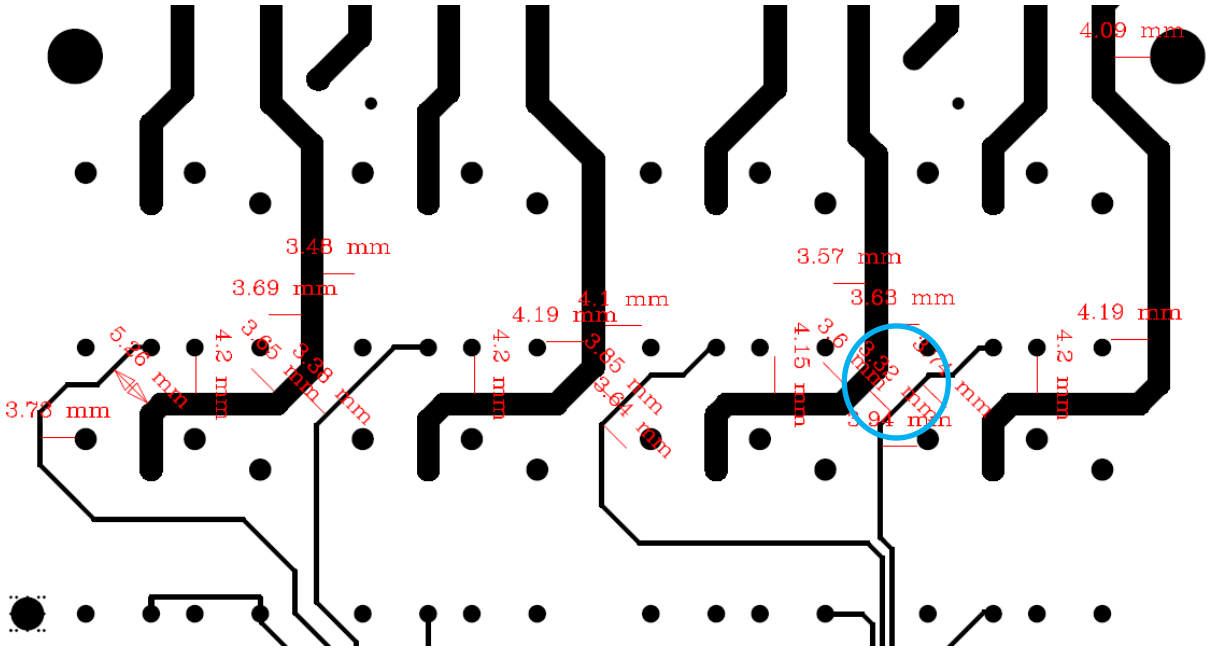
Bottom view (GIO provided with relays J2AK024W), the red circles refer to detailed views and related creepage measurements (PCB before the modification). Some distances were to small. The manufacturer performed a pcb redesign.

Below graphs of the modified pcb design have been presented. Measurements have been performed with the CAD design software.

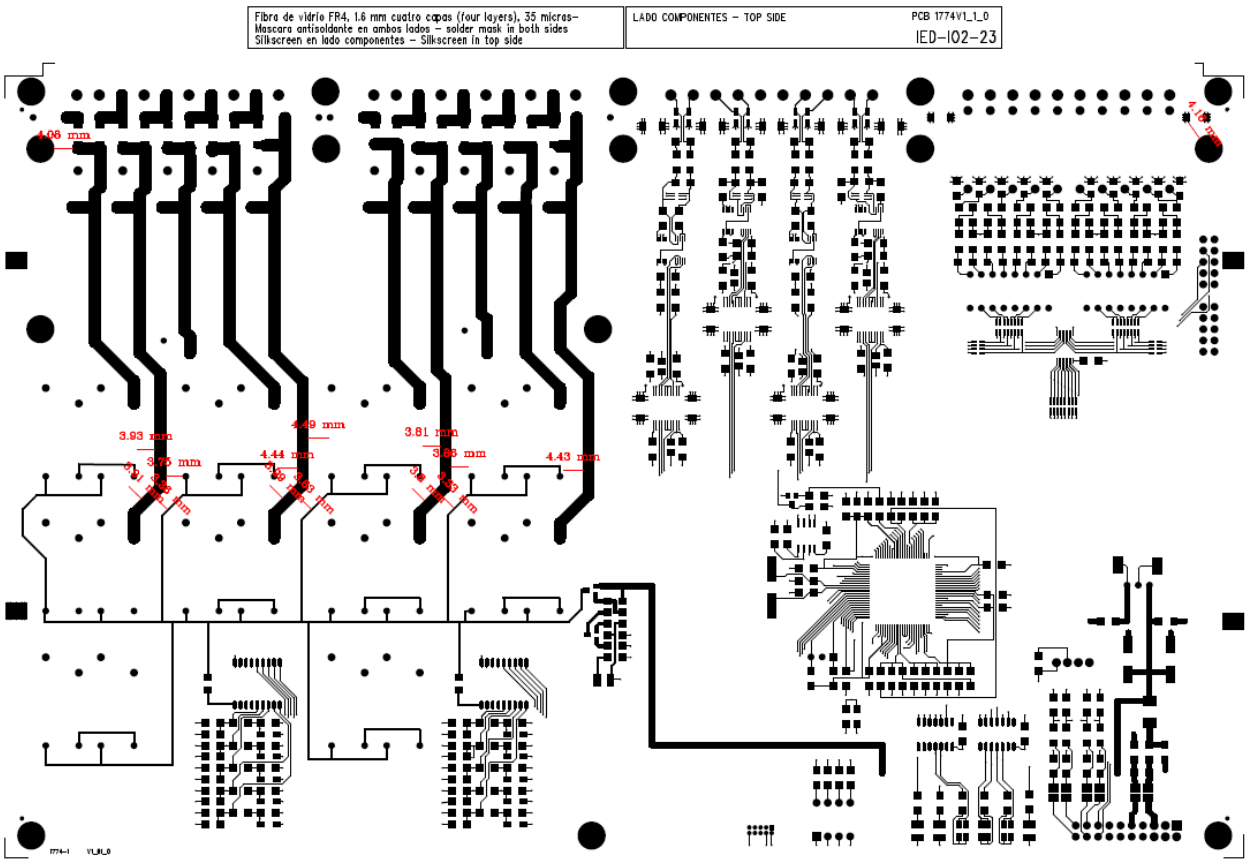
Creepage measurements BO module, variant with relays J2AK024W;



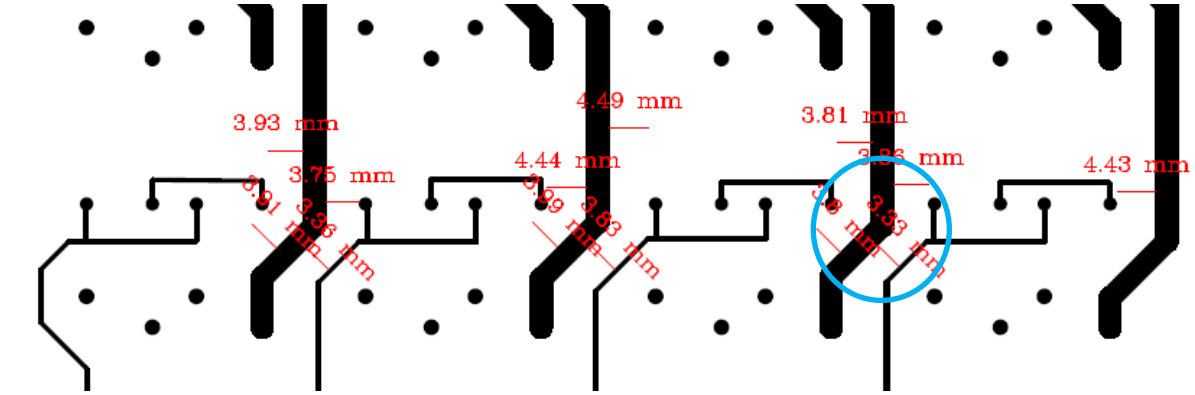
Bottom layer GIO



Detailed view bottom layer GIO, the blue circle indicates the minimum creepage distance.



Top layer GIO



Detailed view top layer GIO, the blue circle indicates the minimum creepage distance.

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Binary output; relay	3,00	3,32 [1)]	PASS

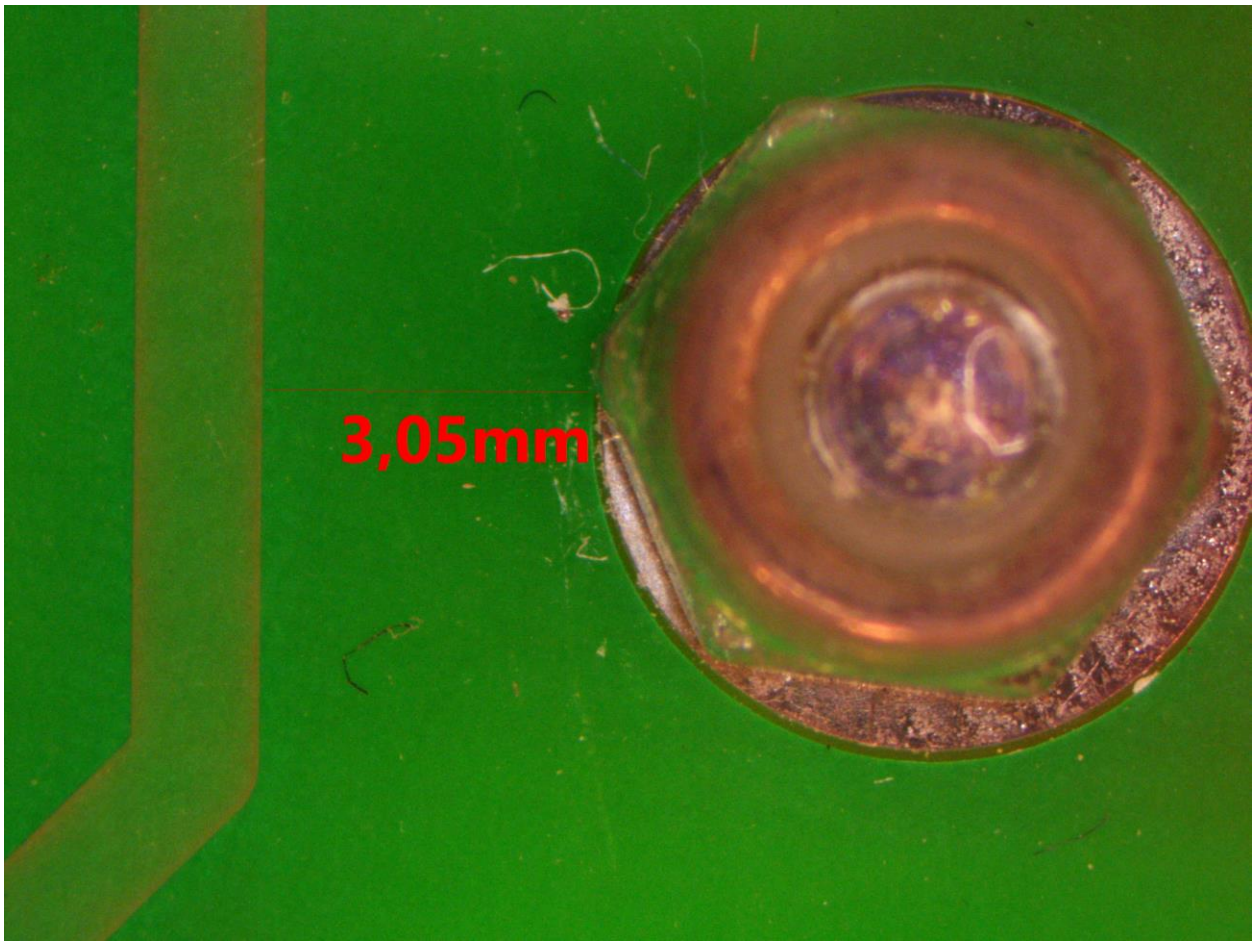
Note

[1)] 3,32 mm is the minimum distance in the modified layout between the independent cicuits, see above detailed view of the measurements (with help of the pcb CAD design software).

Creepage measurements BO module, variant with relays, PT571024/9-1419111-3;

IEC 60255-27 working voltage; 300 V

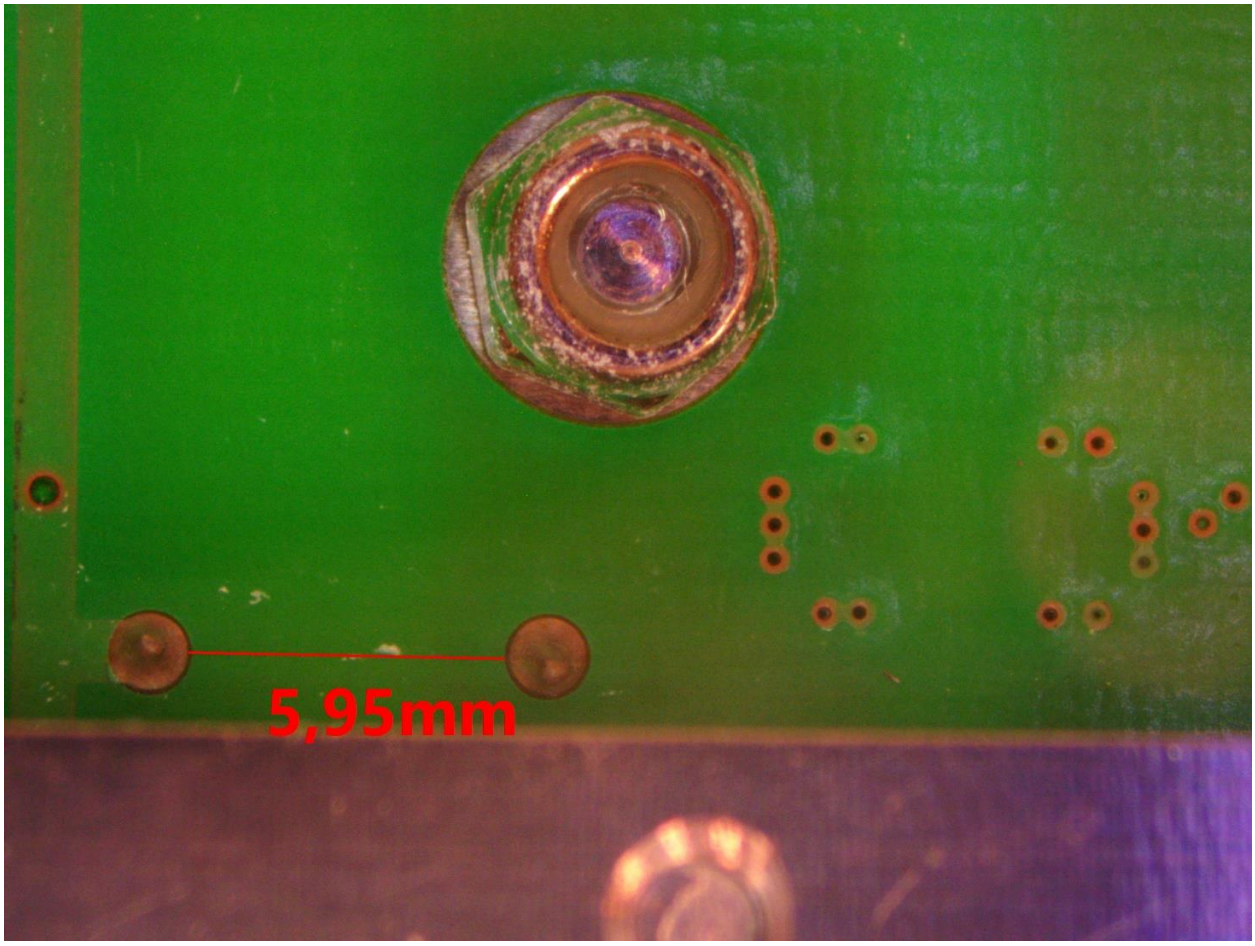
Measurement point	Required mm	Measured mm	Verdict
Binary output; all relays	3,00	3,00	PASS



Detailed view, creepage BO module at relay K291 w.r.t. ground stud.

IEC 60255-27 working voltage; 300 V

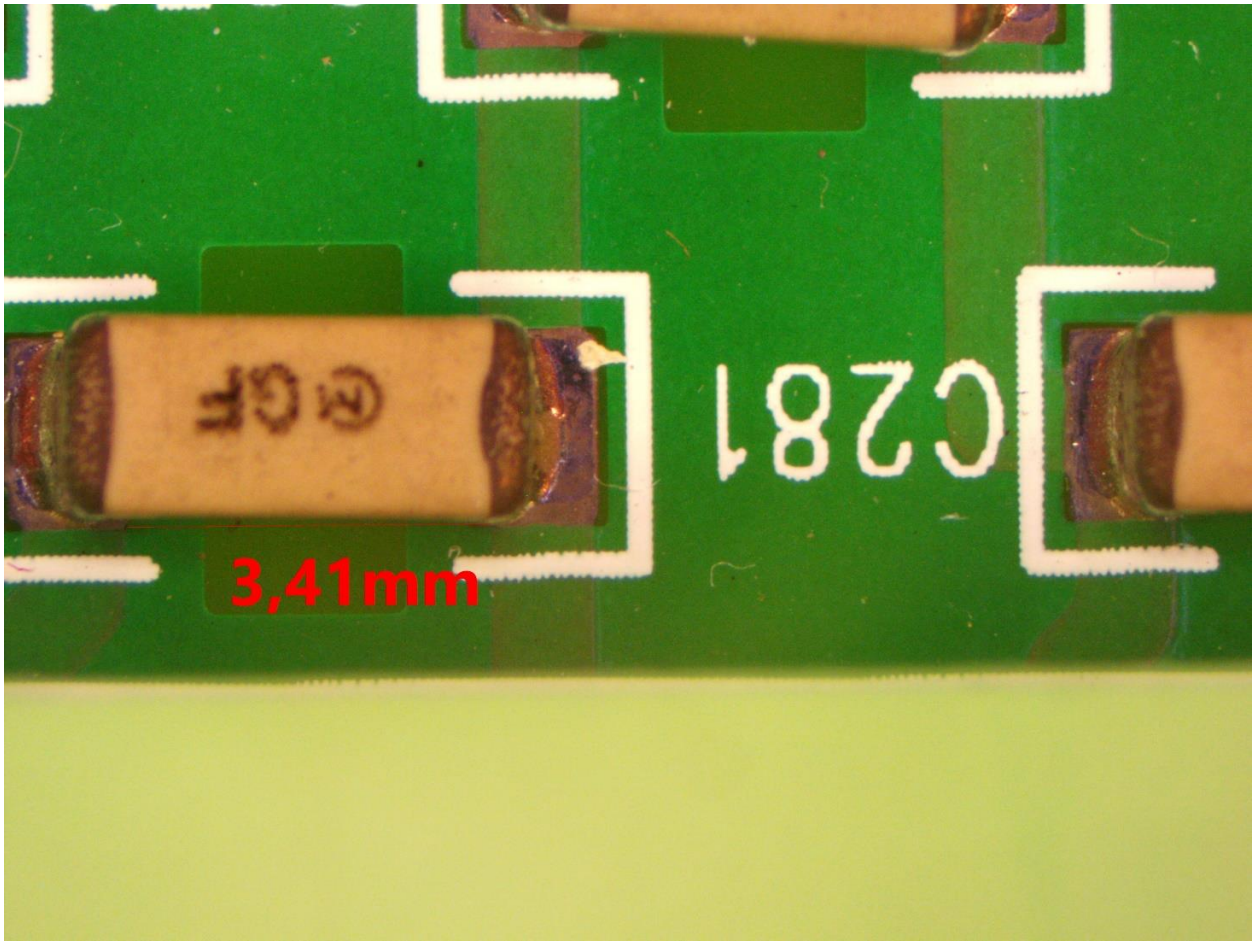
Measurement point	Required mm	Measured mm	Verdict
Binary output; relay K291 w.r.t. GND (mounting stud)	3,00	3,05	PASS



Creepage relay output; across C200 at relay K210

IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Binary output; all relay	3,00	5,95	PASS

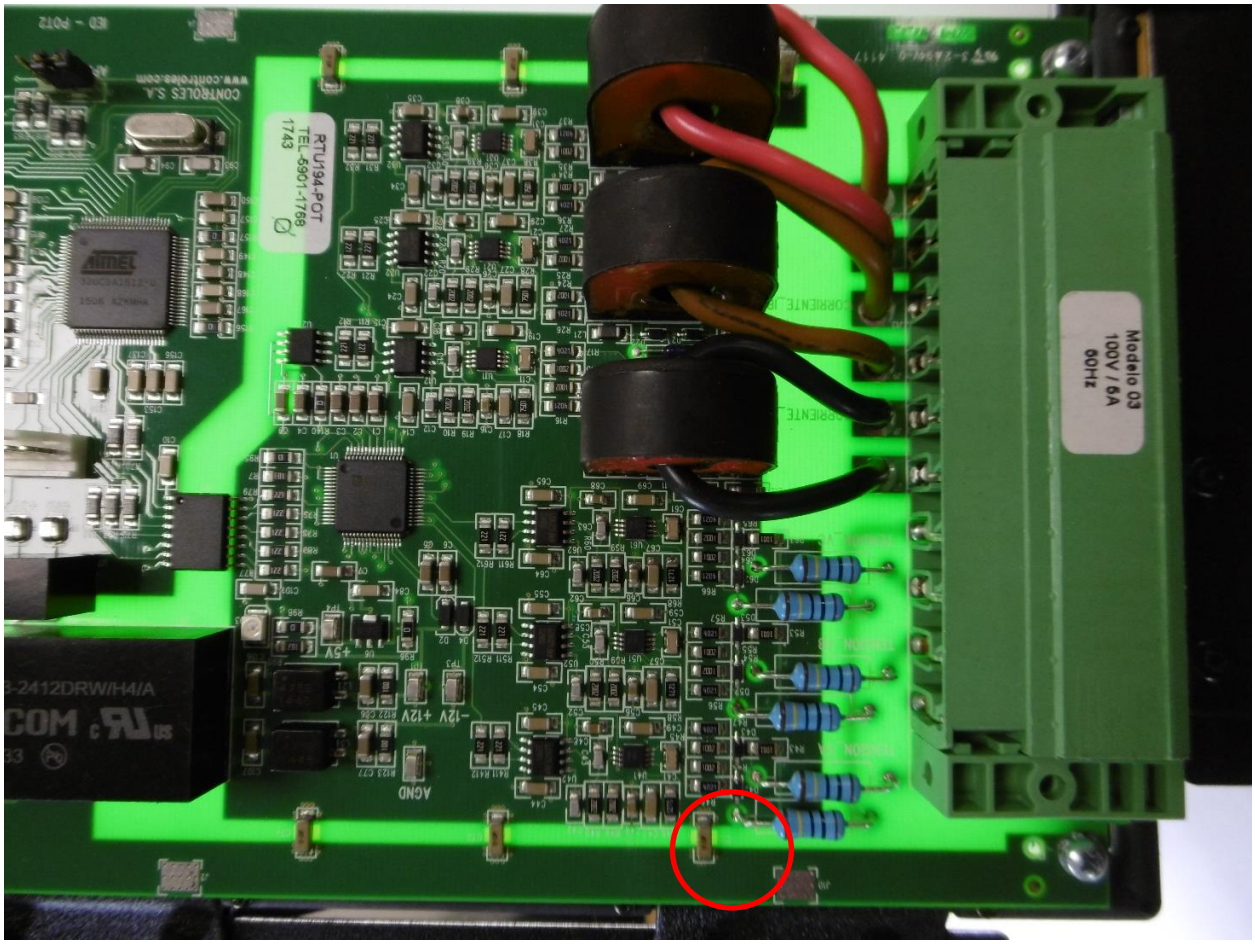


Creepage GIO module; across C281 at relay output

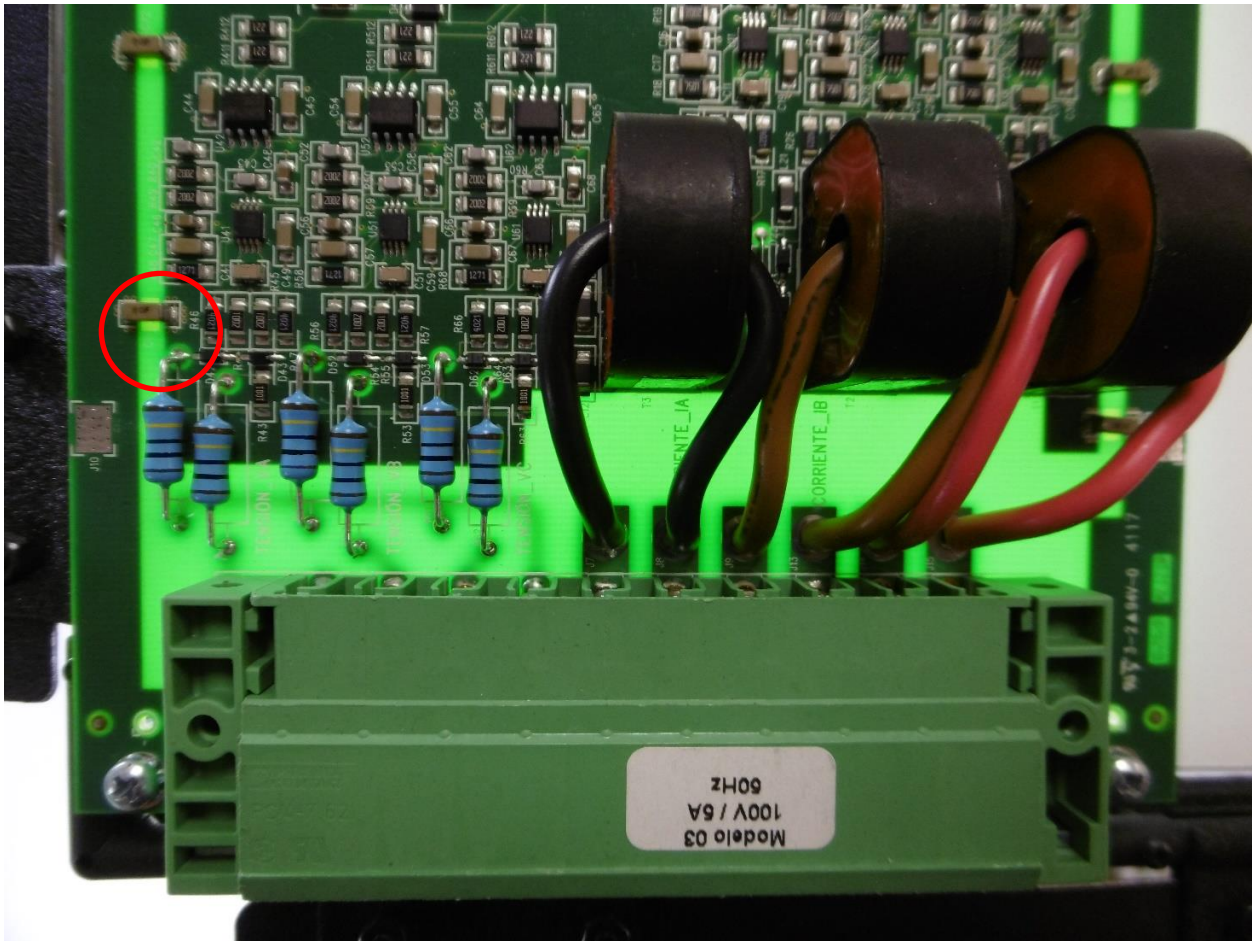
IEC 60255-27 working voltage; 300 V

Measurement point	Required mm	Measured mm	Verdict
Binary output; all relay	3,00	3,41	PASS

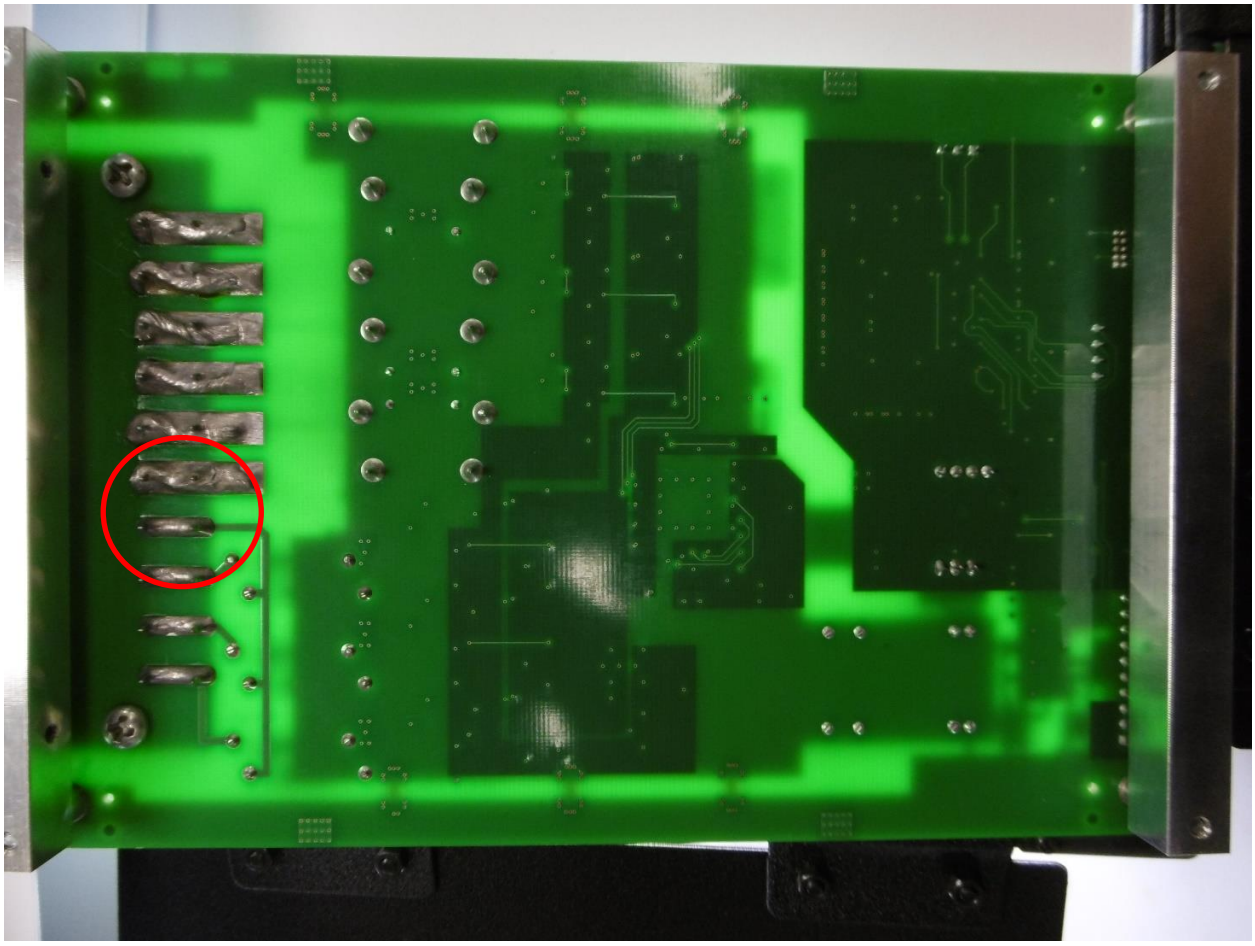
POT module



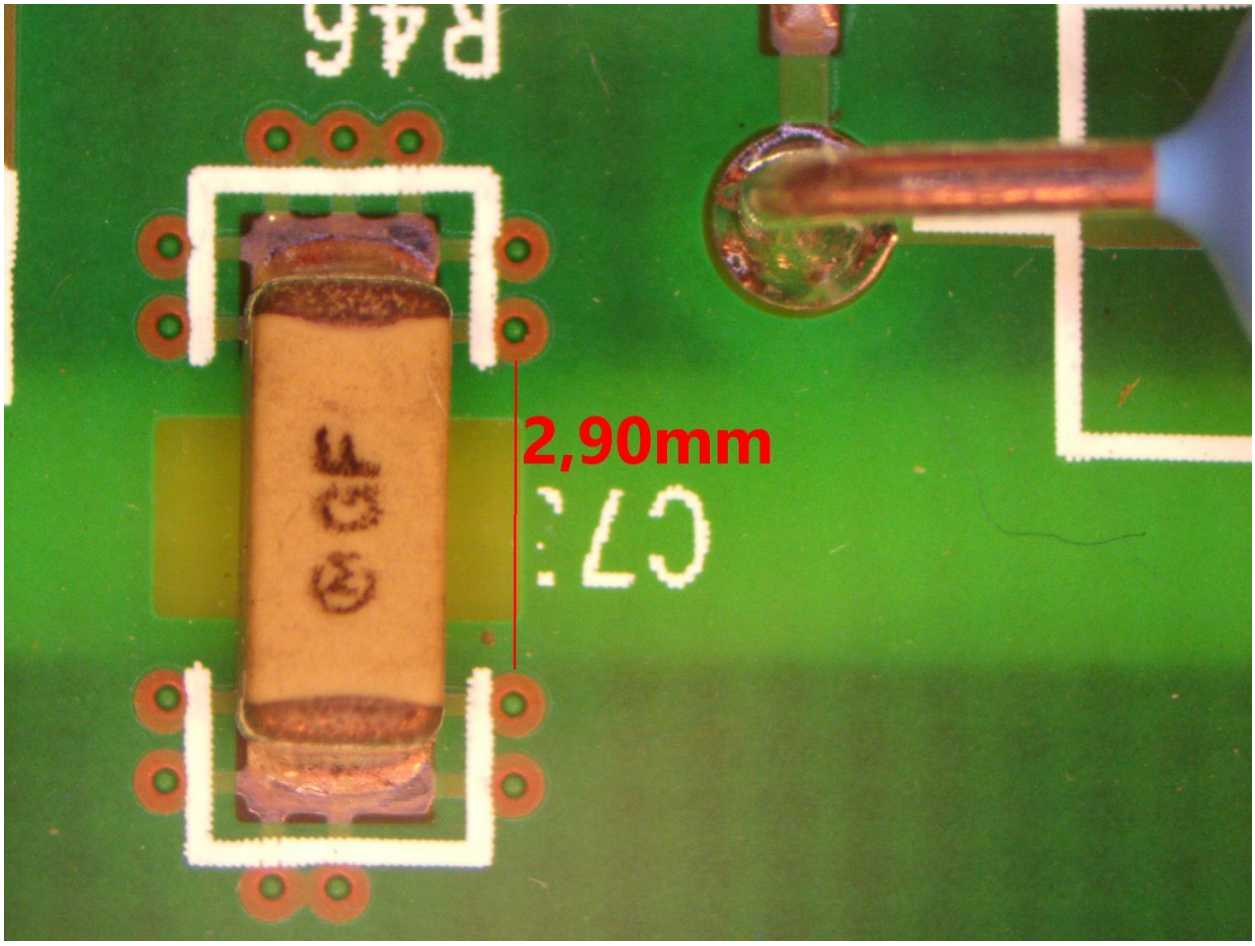
Top view (1)



Top view (2)



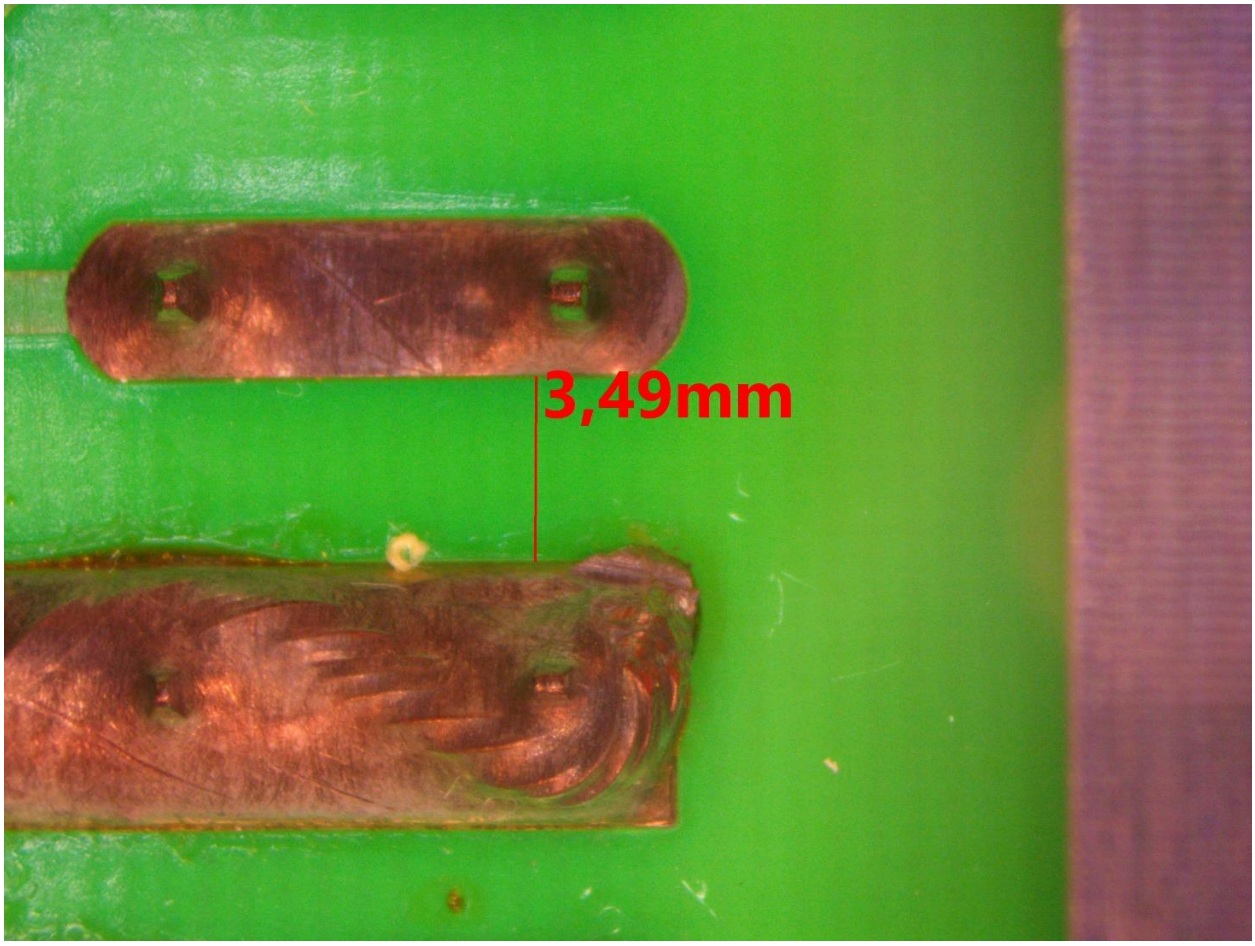
Bottom view



Detailed view, creepage POT module; across C73

IEC 60255-27 working voltage; 100 V

Measurement point	Required mm	Measured mm	Verdict
POT module; C73	0,50	2,90	PASS

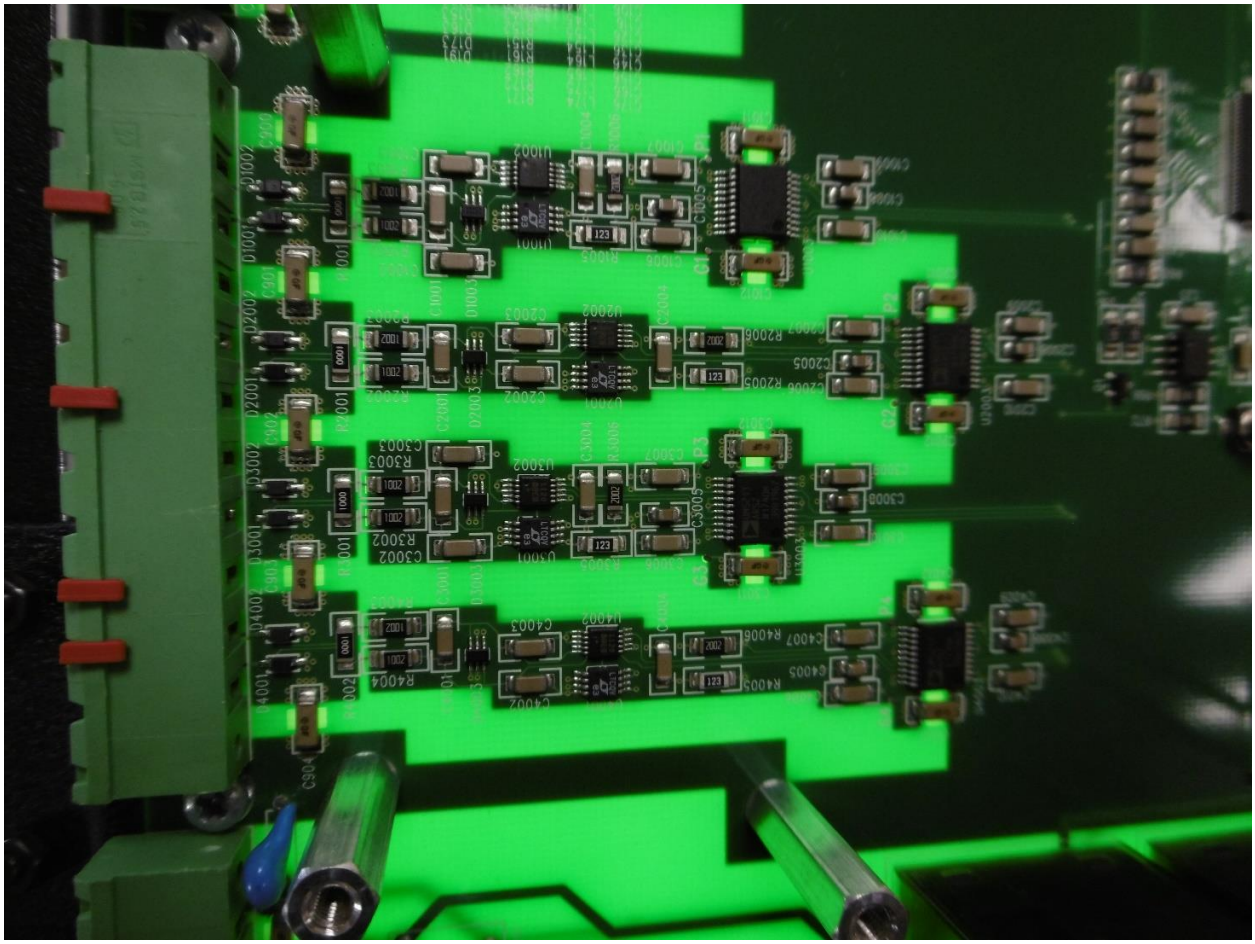


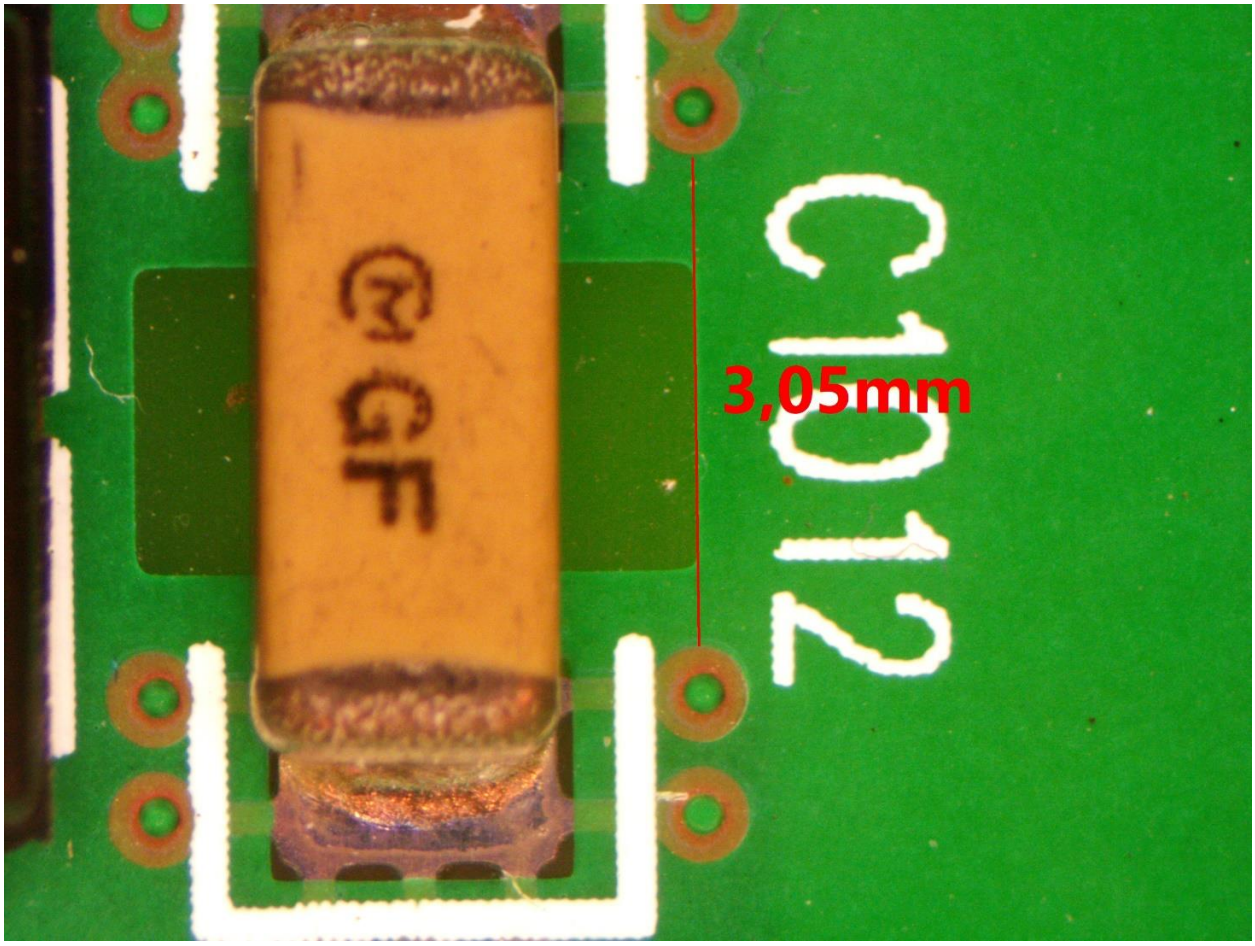
Creepage between CT/VT circuits POT module

IEC 60255-27 working voltage; 100 V

Measurement point	Required mm	Measured mm	Verdict
POT module, between CT and VT circuits	0,50	3,49	PASS

Sensitive current module





Creepage sensitive current module; across C102

IEC 60255-27 working voltage; 50 V

Measurement point	Required mm	Measured mm	Verdict
Sensitive current module; C102	0,15	5,95	PASS

Clearance

The observed clearance is well above the required clearance distance. No measurements required.

“IEC 61850-3 clause 6.6.1.1 General
Where there is any doubt that the required clearance and creepage distances are compliant with the values in the appropriate table from Annex C of IEC 60255-27:2013, measurements shall be made’’.

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

Result
The object passed the test (with a modified GIO pcb design).

9.4 IP rating test

Standard and date

Standard	IEC 61850-3, subclause 6.6.2
Basic standard	IEC 60529
Test date	20 March 2020

Characteristic test data

Serial number Sample A.1, Serial No. TEL-6311-1045

Terminal side	Degree of protection	
	Specification by the manufacturer	Observation
Front	IP 2X	IP 2X
Top	IP 2X	IP 2X
Bottom	IP 2X	IP 2X
Back	IP 2X	IP 2X
Left	IP 2X	IP 2X
Right	IP 2X	IP 2X

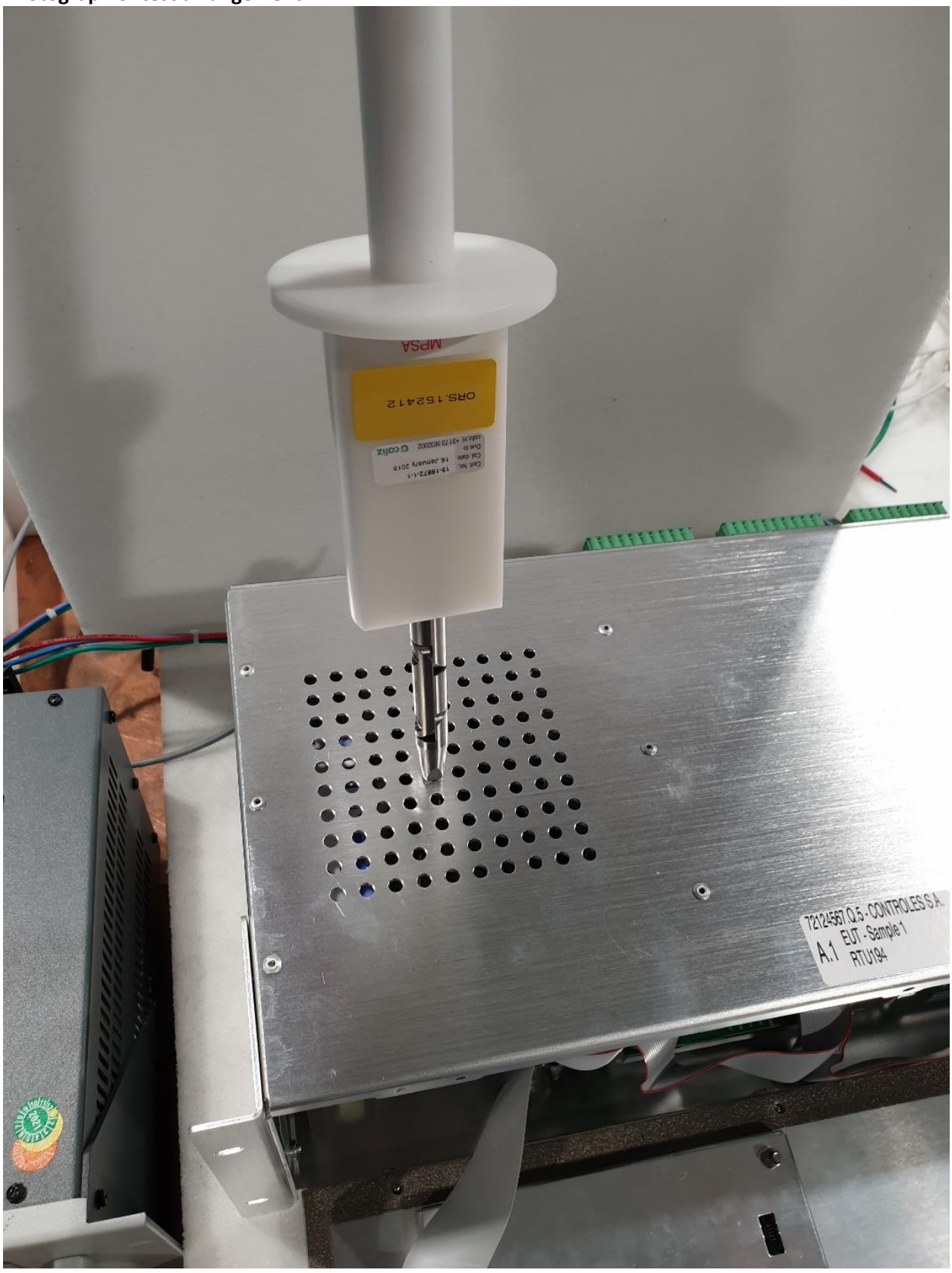
Requirement

- 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.

Photograph of test arrangement



9.5 Impulse voltage test

Standard and date

Standard IEC 61850-3, subclause 6.6.3
Test date 11 March 2020

Environmental conditions

Ambient temperature 20,6 °C Relative humidity 52,2 %
Ambient air pressure 1006 hPa

Characteristic test data

Serial number sample 3 (TEL-6311-1047)
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

Test arrangement		Voltage applied	No. of impulses	Polarity	Observations
Voltage applied to	Tested between	kV			
Power supply	Earth and all others	5	5	Positive	-
				Negative	-
BI; E01-E08/common	Earth and all others	5	5	Positive	-
				Negative	-
BI; E33-E40/common	Earth and all others	5	5	Positive	-
				Negative	-
BI; E73-E80/common	Earth and all others	5	5	Positive	-
				Negative	-
BI; E65-E72/common	Earth and all others	5	5	Positive	-
				Negative	-
BI; E49-E56/common	Earth and all others	5	5	Positive	-
				Negative	-
BO; S01A-S01B	S02A-SO2B	5	5	Positive	-
				Negative	-
BO; S04A-S04B	S05A-S05B	5	5	Positive	-
				Negative	-
BO; S06-S10	Earth and all others	5	5	Positive	-
				Negative	-
BO; S16-S20	Earth and all others	5	5	Positive	-
				Negative	-
A01/A02/A03/A04	Earth and all others	5	5	Positive	-
				Negative	-
A05/A06/A07/A08	Earth and all others	5	5	Positive	-
				Negative	-
A05	A06	5	5	Positive	-
				Negative	-
A07	A08	5	5	Positive	-
				Negative	-

Test arrangement Voltage applied to	Tested between	Voltage applied kV	No. of impulses	Polarity	Observations
VT; VA1/VB1/VC1/VN1 CT; IA11/IA12, IB11/IB12, IC11/IC12 In one group	Earth and all others	5	5	Positive	-
				Negative	-
VT; VA2/VB2/VC2/VN2 In one group	Earth and all others	5	5	Positive	-
				Negative	-
CT; IA21/IA22,	CT; IB21/IB22	5	5	Positive	-
				Negative	-
CT; IB21/IB22,	CT; IC21/IC22	5	5	Positive	-
				Negative	-
IRIG-B port	Earth and all others	1	5	Positive	-
				Negative	-

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.

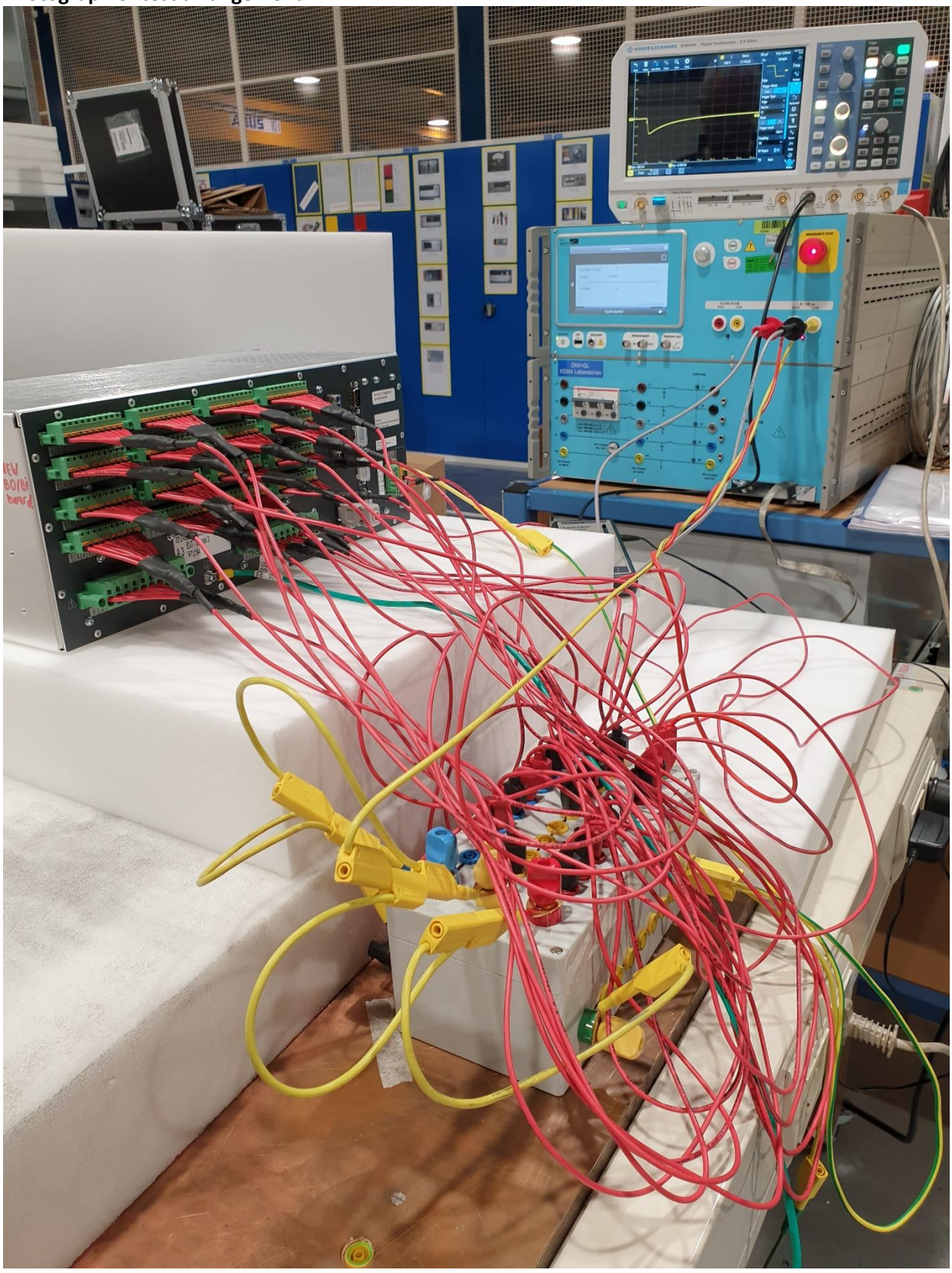
Requirement

- 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



9.6 Dielectric voltage test

Standard and date

Standard IEC 61850-3, subclause 6.6.4
Test date 30 October 2019

Environmental conditions

Ambient temperature 22 °C Relative humidity 30 %
Ambient air pressure 999 hPa

Characteristic test data

Serial number Sample A.3, Serial No. TEL-6311-1047
Frequency 50 Hz
Rated insulation voltage 300 V
Test duration 1 min

Test arrangement		Insulation resistance at 500 Vdc (before the test)	Voltage applied	Insulation resistance at 500 Vdc (after the test)	Observations
Voltage applied to	Tested between	MΩ	kVac	MΩ	
Power supply	Earth and all others	> 550	2	> 550	No discharge No flashover
BI; E01-E08/common	Earth and all others	> 550	2	> 550	No discharge No flashover
BI; E33-E40/common	Earth and all others	> 550	2	> 550	No discharge No flashover
BI; E73-E80/common	Earth and all others	> 550	2	> 550	No discharge No flashover
BI; E65-E72/common	Earth and all others	> 550	2	> 550	No discharge No flashover
BI; E49-E56/common	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S01A-S01B	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S02A-SO2B	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S03A-SO3B	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S04A-SO4B	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S05A-S05B	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S06-S10 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S11-S15 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
BO; S16-S20 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
A01/A02/A03/A04	Earth and all others	> 550	2	> 550	No discharge No flashover
A05/A06/A07/A08	Earth and all others	> 550	2	> 550	No discharge No flashover

Test arrangement		Insulation resistance at 500 Vdc	Voltage applied	Insulation resistance at 500 Vdc	Observations
Voltage applied to	Tested between	(before the test) MΩ	kVac	(after the test) MΩ	
A05	Earth and all others	> 550	2	> 550	No discharge No flashover
A06	Earth and all others	> 550	2	> 550	No discharge No flashover
A07	Earth and all others	> 550	2	> 550	No discharge No flashover
A08	Earth and all others	> 550	2	> 550	No discharge No flashover
VT; VA1/VB1/VC1/VN1 CT; IA11/IA12, IB11/IB12, IC11/IC12 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
VT; VA2/VB2/VC2/VN2 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
CT; IA21/IA22, IB21/IB22, IC21/IC22 In one group	Earth and all others	> 550	2	> 550	No discharge No flashover
CT; IA21/IA22	Earth and all others	> 550	2	> 550	No discharge No flashover
CT; IB21/IB22,	Earth and all others	> 550	2	> 550	No discharge No flashover
CT; IC21/IC22	Earth and all others	> 550	2	> 550	No discharge No flashover
IRIG-B port	Earth and all others	> 550	0,5	> 550	No discharge No flashover

Observations

1. No discharge or flashover observed.
2. The measured insulation resistance value is well above the required values.

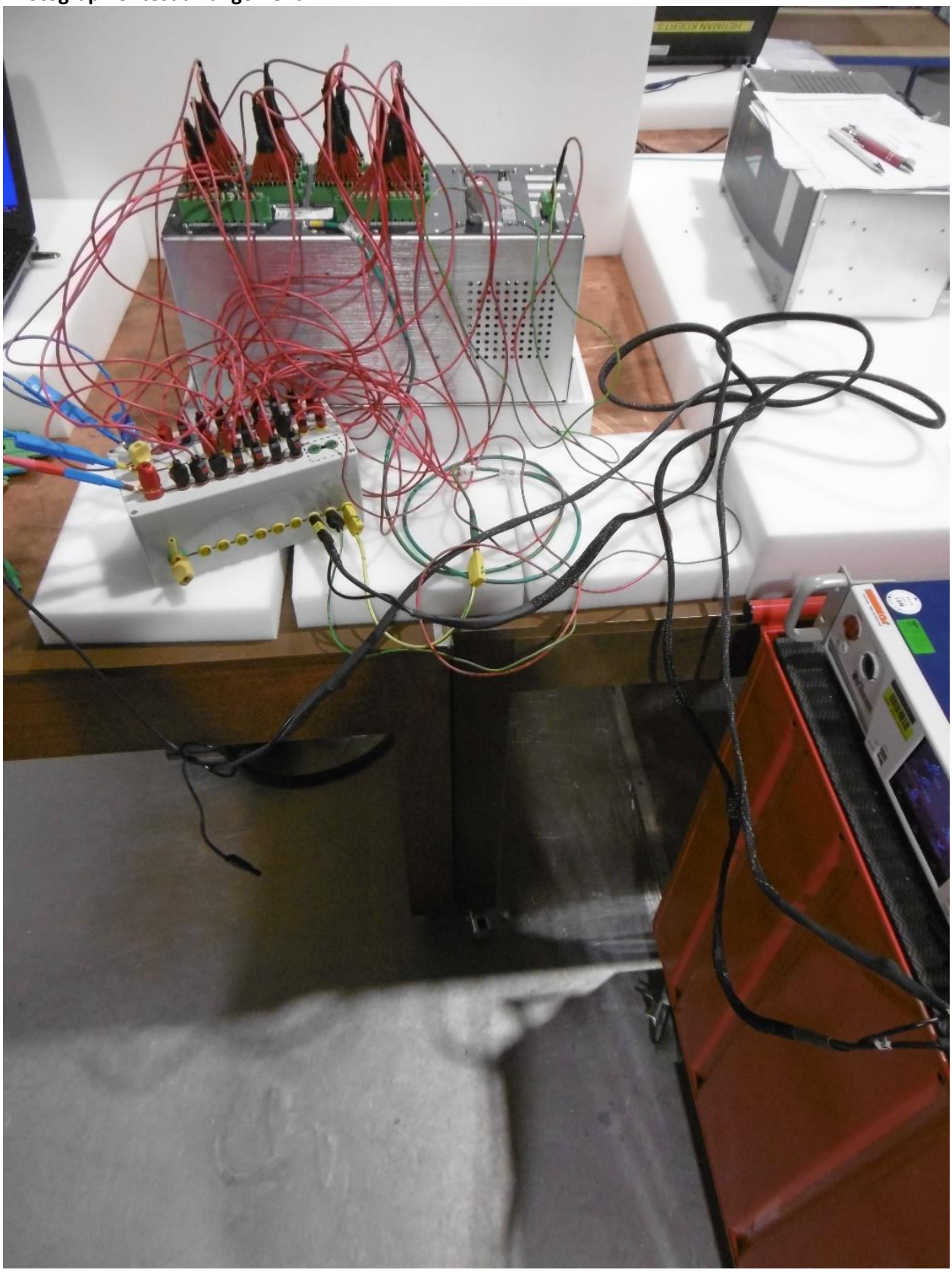
Requirement

- No disruptive discharges or flashovers shall occur.
- For equipment in a new condition, the insulation resistance shall not be less than 100 MΩ at 500 V d.c. After the damp heat type test, the insulation resistance shall not be less than 10 MΩ at 500 Vdc.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement



9.7 Protective bonding resistance

Standard and date

Standard IEC 61850-3, subclause 6.6.5
Test date 30 January 2020

Characteristic test data

Serial number Sample A.3, Serial No. TEL-6311-1047
Test current 20 A
Test voltage ≤ 12 {Vac/Vdc}
Duration of test 60 s

Test point	Measured with respect to Terminal	Resistance Ω
Front screw right	PE on the power supply connector	0,009
Front right 19” bracket	PE on the power supply connector	0,009
Front left 19” bracket	PE on the power supply connector	0,009
Earth terminal rear side	PE on the power supply connector	0,009

Observations

The bonding resistance value is well below the 0,1 Ω.

Requirement

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

Result

The object passed the test.

9.8 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	8 and 15 April and 19 May 2020

Characteristic test data

Serial number	EUT sample 2 (TEL-6311-1046) (with 2 variants of the BI/BO boards)

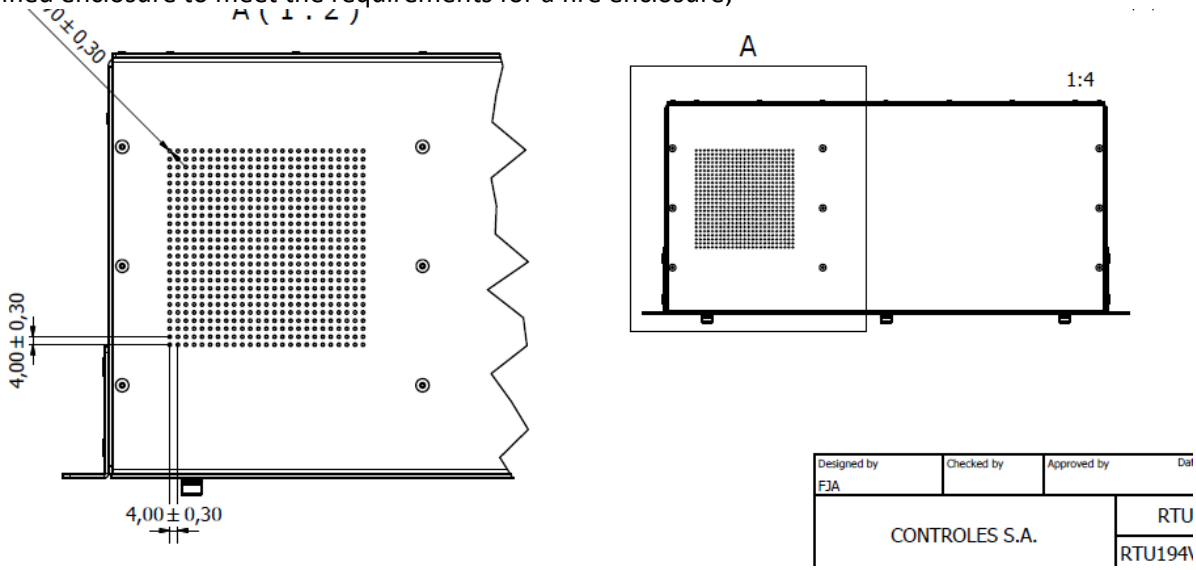
Assessment results

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 have the dimension and spacing according subclause 7.10, table 6.
- 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.

From the CB-scheme report, subclause 1.5.9.2. prerequisite to achieve compliance with the flammability requirements is the application of a fire enclosure.

Modified enclosure to meet the requirements for a fire enclosure;



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

RTU194 - Component Flammability Information 27/08/2019 - R01

Component	Part number	Manufacturer	Certification
Terminal blocks			
GIO module; Feed-through header - MSTB 2,5/10-GF-5,08	1776582	Phoenix Contact	UL94V-0
GIO module; Printed circuit board connector FKC 2,5/10-STF-5,08	1873281	Phoenix Contact	UL94V-0
POT module; Printed-circuit board connector - PC 4/10-G-7,62	1804878	Phoenix Contact	UL94V-0
POT module; Printed-circuit board connector - PC 4/10-ST-7,62	1804988	Phoenix Contact	UL94V-0
FUE module; Feed-through header - MSTB 2,5/ 5-GF-5,08	1776537	Phoenix Contact	UL94V-0
FUE module; Printed-circuit board connector - MSTB 2,5/ 4-ST-5,08 - 1757035	1757035	Phoenix Contact	UL94V-0
Serial port MXP; 9 P sub-D connector male DB9P	182-009-113R531	NorComp	UL94V-0
DB9 cover male	160-000-109R000 (9 pins)	NorComp	UL94-HB75
IRIG Input; 9 P sub-D connector female DB9S	SDS107-PRP2-F09-SN63-11	Sullins	UL94V-0
DB9 cover female	160-000-109R000 (9 pins)	NorComp	UL94-HB75
Display, plastic overlays			
TFT (Thin-Film-Transistor) Color Liquid Crystal Display Module	NHD-4.3-480272EF-ATXL-T	Newhaven Display International, Inc.	UL94-V0
Membrane switch overlay, front and rear foil; textured polyester film, consisting of a base polyester and a flexible chemically bonded, UV-cured textured coating	PET F200	AUTOTEX	UL94-HB75 E93687
Hard Coated Polycarbonate	G/A180 G/A250 G/A380 G/A480 G/A750	AUTOFLEX PC	UL94-HB75 E165805

Materials inside a fire enclosure;
RTU194 - Component Flammability Information
27/08/2019 - R01

Component	Part number	Manufacturer	Certification
General			
PCBs	RTU194-GIO1-1482V3_1_0	U&I	UL94V-0
	RTU194-GIO2-1483V3.1.0	U&I	UL94V-0
	RTU194-POT2-1521V2.2.0	U&I	UL94V-0
	RTU194-CPU2-1675V3_0_0	U&I	UL94V-0
	RTU194-MXP-1629V3.0.0	U&I	UL94V-0
	RTU194-FUE2FLT-1736V1.0.0	U&I	UL94V-0
Binary Outputs - RTU194-IO2			
Output Relays Varistor Filter capacitor	PT571024 S10K275 DE2E3KY102MN3AU02F	TE Connectivity EPCOS/TDK Murata Electronics	UL94V-2 UL94V-0 UL94V-0
Binary Inputs - RTU194-IO2			
Input resistor TVS	ASRM1JA1K00 SMF5.0A	Stackpole Electronics Inc Littelfuse Inc.	UL94V-0 UL94V-0
Analog Inputs - RTU194-IO2			
TVS	SD05C-01FTG	Littelfuse Inc.	UL94V-0
Voltage Inputs - RTU194-POT2			
Input resistor TVS	HVR3700001004FR500 SD05C-01FTG	Vishay Littelfuse Inc.	UL94V-0 UL94V-0
Current Inputs - RTU194-POT2			
Primary wire CT	Standard NM-IEC 60332 wiring CT1267-A1-RC	Mercosur Electrohms	IEC60332 UL94-V0
IRIG Input - RTU194-CPU2			
TVS	SMF5.0A	Littelfuse Inc.	UL94V-0
Serial ports - RTU194-MXP			
TVS	824501900	Wurth Electronics Inc.	UL94V-0
Power Supply Input - RTU194-FUE2			
Varistor	S10K275	EPCOS/TDK	UL94V-0
X Filter Capacitor	BFC233920105	Vishay	UL94V-0
Y Filter Capacitor	C981U103MZVDBA7317	KEMET	UL94V-0
Common mode choke	7448011305	Wurth Electronics Inc.	UL94V-0

Requirement

- 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.

9.9 Single-fault condition

Standard and date

Standard IEC 61850-3, subclause 6.6.7
Test date 30 and 31 March and 1 April 2020

Environmental conditions

Ambient temperature See temperature measurements °C

Characteristic test data

Serial number EUT sample 3 (TEL-6311-1045)
Power supply 88 – 250 Vdc/ac

Circuit	Test	Observations
Power supply 24 V	Short circuit internal voltage +24 V	1
	Max. current on +24 VDC circuit during 2 hours (24 Vdc @ 6,5 A, just before shutdown) The supply shuts down at higher currents > 6,5 A and tries to start up (Hikken) Input voltage 88 Vac (measured input current: 2 A) Efficiency; (23,8 x 6,5/88 x 2) x 100 % = 88 %	2
	Set at I = 9 A, U = 20,7 V; causes max input current	3
Power supply 5V	Short circuit protected	4
Power supply 3V3	Short circuit protected	4
Protective impedance	Short circuit component disconnect component	N/A
Transformers	Short circuit on secondary side	5
Outputs	Short circuit one by one	1,2
Insulation between circuits and parts	Short circuit functional insulation	6
Primary circuits, hazardous non-primary circuits	Short circuit in the Corel 24 Vdc power supply	7
DC input voltage	Reversal of the polarity of the DC input voltage {See also chapter 9.8}	7

Measured temperatures (after temperature stabilisation, > 2 hrs);

- TC1; (attached at the mounting plate on which the power supply has been mounted); 66 °C
- TC2; (ambient); 22 °C
- TC3; (on top of the enclosure), above the power supply; 31 °C

Observations

1. Switched off directly. Tries to startup but shuts down immediately. The supply complies with IEC 60950-1 (CB-report available).
2. Normal functioning. Some smell of a cooked resistor.
3. Switched off directly. Tries to startup but shuts down immediately. Cyclic startup-shutdown for output currents> 6,5A.
4. The data sheets show compliance with IEC 60950-1 or IEC 62368-1.
5. Covered, see CB-scheme TRF.
6. Considered; no single fault test performed on IRIG and RS232 ports because these are low power, low voltage ports.
7. Covered, see CB-scheme report.
8. The supply has been provided with a common AC/DC input. Therefore it can handle polarity reversal inherently.

Requirement

- 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 (CT, VT, sensitive current);
- digital inputs (binary inputs);
- contact outputs (binary outputs);
- timing port (IRIG-B);
- data communication (optical, RS232).

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 state of contact outputs;
- unintentional change of state of the binary input inputs;
- loss of timing information;
- 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

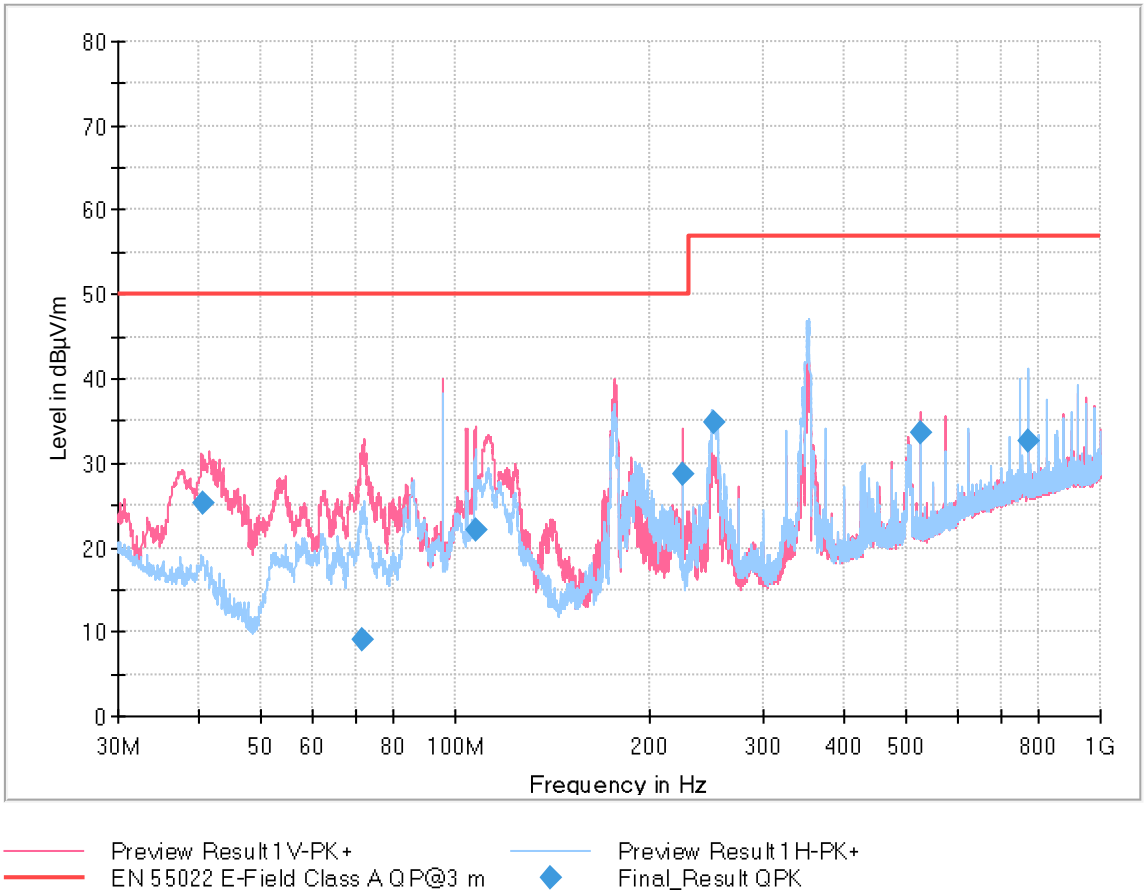
Standard and date

Standard	IEC 61850-3, subclause 6.7.4
Basic standard	CISPR 22
Test date	4 December 2019

Characteristic test data

Serial number	Sample A.4 TEL-6396-1098
Power supply	110 - 220 Vac
	110 - 220 Vdc

Power supply voltage of 230 Vac with horizontal and vertical antenna polarisation, in the frequency range 30Mhz – 1GHz (red = vertical, blue = horizontal)

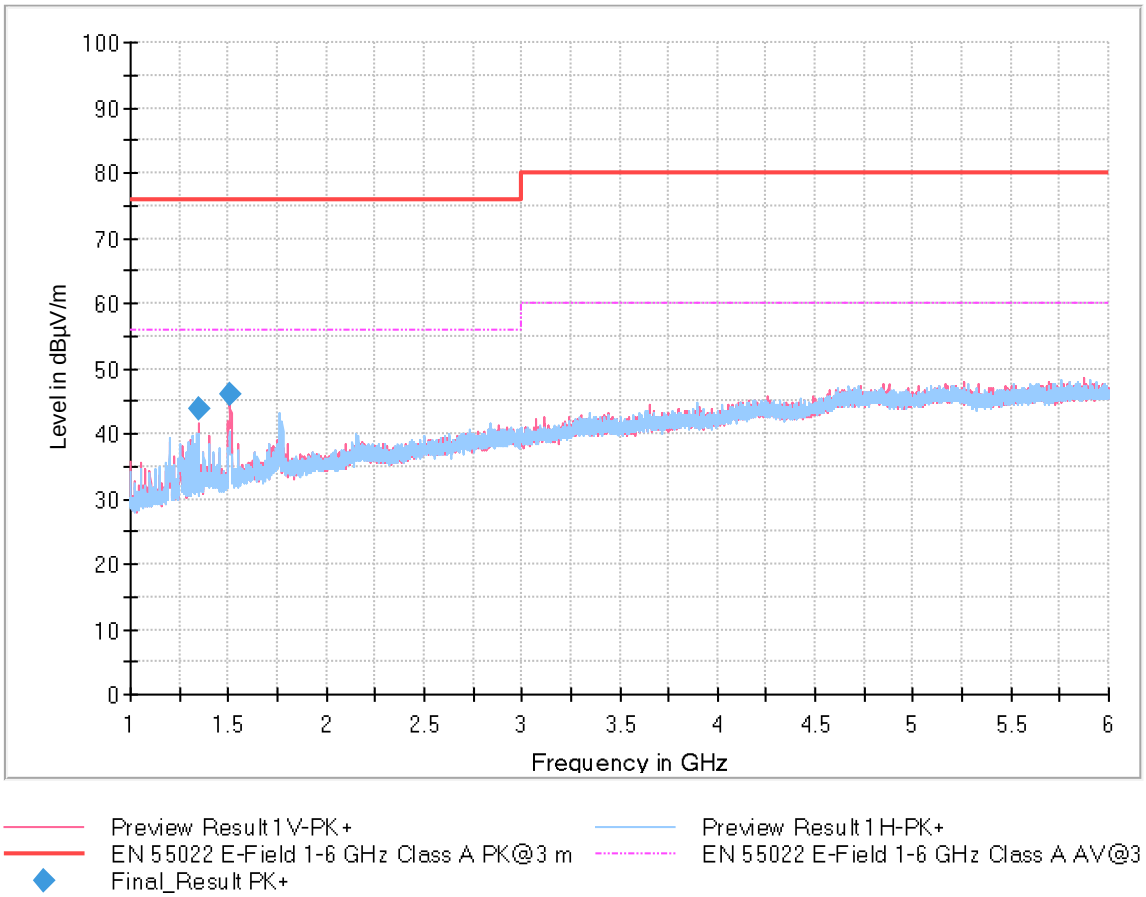


Final result (30 – 1000 MHz)

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg
40,710	25,39	50,00	24,61	1000,0	120,000	100,0	V	104,0
71,670	9,10	50,00	40,90	1000,0	120,000	312,0	V	155,0
107,220	22,13	50,00	27,87	1000,0	120,000	108,0	V	98,0
225,000	28,70	50,00	21,30	1000,0	120,000	158,0	V	248,0
250,770	34,73	57,00	22,27	1000,0	120,000	117,0	H	244,0
525,000	33,57	57,00	23,44	1000,0	120,000	103,0	V	314,0
774,990	32,62	57,00	24,38	1000,0	120,000	100,0	H	55,0

The limits are;
At 3 m measurement distance
30 to 230 MHz; 50 dBuV/m QP
230 to 1000 MHz; 57 dBuV/m QP

Power supply voltage of 230 Vac 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	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB/m
1350,000	43,96	76,00	32,04	1000,0	1000,000	107,0	V	173,0	-0,2
1510,000	46,17	76,00	29,83	1000,0	1000,000	104,0	V	148,0	1,0

The limits are;
1000 to 3000 MHz; 76 dBuV/m PK
1000 to 3000 MHz; 56 dBuV/m AV
3000 to 6000 MHz; 80 dBuV/m PK
3000 to 6000 MHz; 60 dBuV/m AV

Remarks
The pre-scan shows the power supply input voltage has negligible influence on the radiated emission. Therefore the final test has been performed at 230 Vac.

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.

Photograph of test arrangement

Radiated emission measurement setup 30 – 1000 MHz.

Radiated emission measurement setup 1000 – 6000 MHz.

10.3 Conducted emission

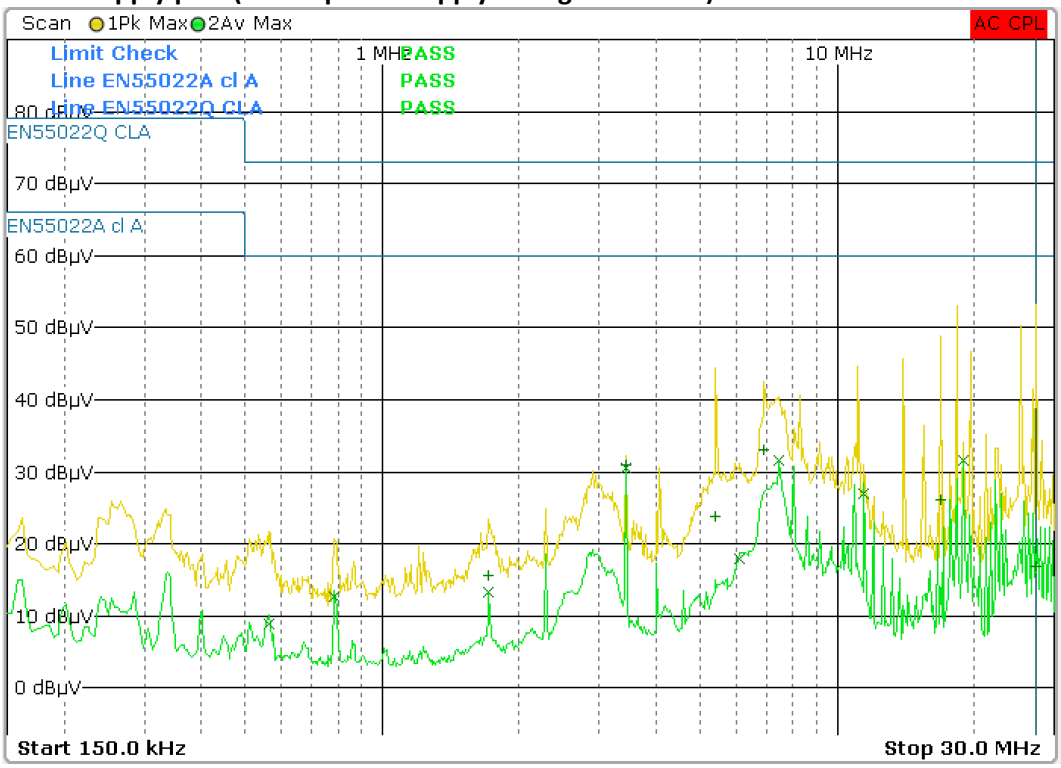
Standard and date

Standard	IEC 61850-3, subclause 6.7.4
Basic standard	CISPR 22
Test date	28 February 2020

Characteristic test data

Serial number	Sample A.4 TEL-6396-1098
Power supply	88-250 Vac
	88-250 Vdc

Power supply port (with a power supply voltage of 88 Vac)



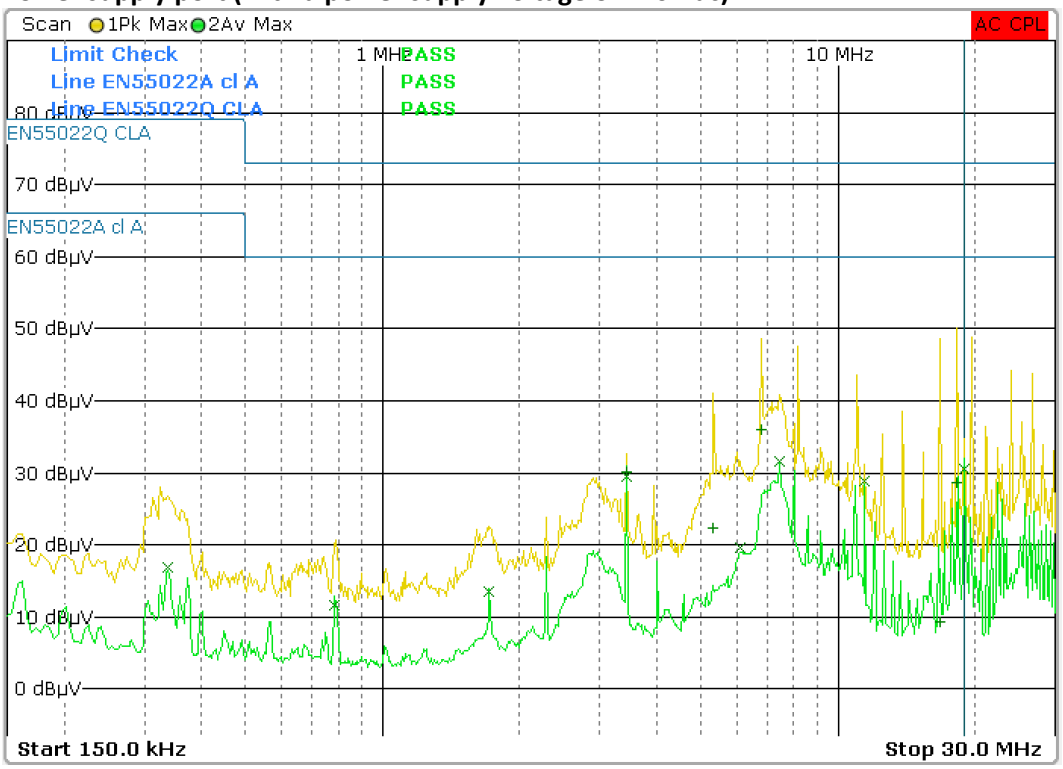
Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	566.000000000 kHz	8.87	L1	Average	-51.13
2	786.000000000 kHz	12.65	L1	Average	-47.35
1	1.714000000 MHz	15.71	N	Quasi Peak	-57.29
2	1.718000000 MHz	13.26	L1	Average	-46.74
1	3.438000000 MHz	31.06	L1	Quasi Peak	-41.94
2	3.438000000 MHz	30.47	L1	Average	-29.53
1	5.398000000 MHz	23.89	L1	Quasi Peak	-49.11
2	6.110000000 MHz	17.99	L1	Average	-42.01
1	6.906000000 MHz	33.01	N	Quasi Peak	-39.99
2	7.446000000 MHz	31.63	N	Average	-28.37
2	11.454000000 MHz	26.89	N	Average	-33.11
1	16.850000000 MHz	26.14	N	Quasi Peak	-46.86
2	18.902000000 MHz	31.53	N	Average	-28.47
1	27.318000000 MHz	16.94	N	Quasi Peak	-56.06

Note

The decimal separator is decimal point in the above table of results.

Power supply port (with a power supply voltage of 110 Vac)



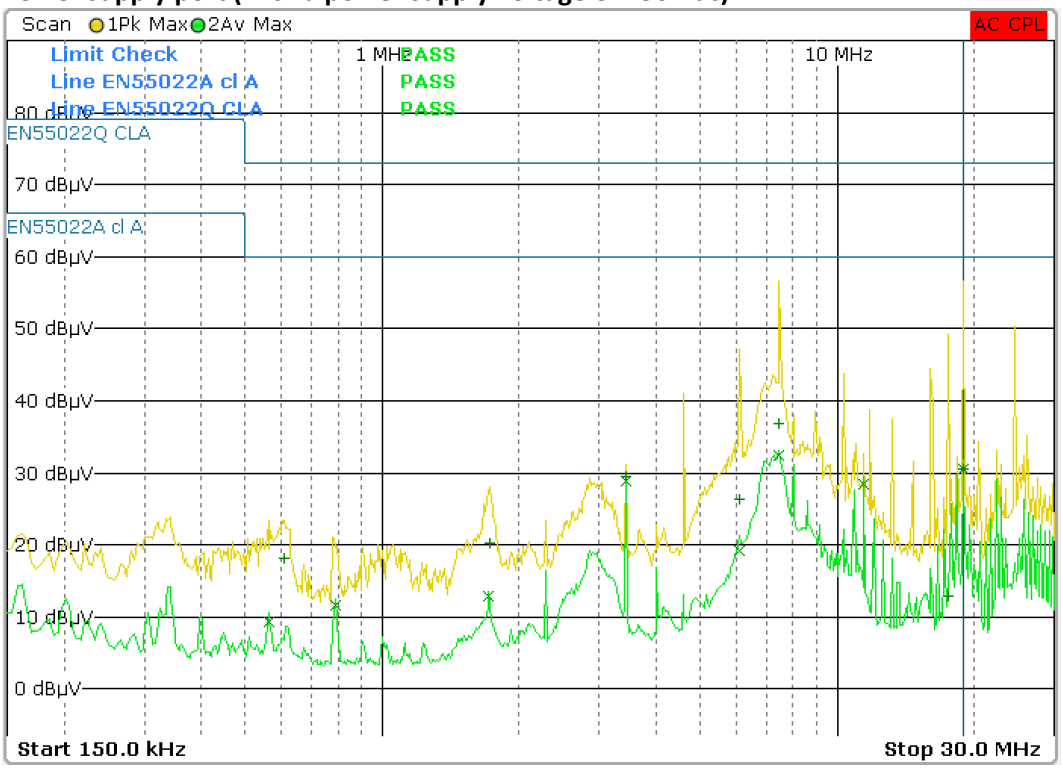
Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	338.000000000 kHz	16.87	L1	Average	-49.13
2	786.000000000 kHz	11.63	L1	Average	-48.37
2	1.718000000 MHz	13.57	L1	Average	-46.43
1	3.438000000 MHz	30.11	L1	Quasi Peak	-42.89
2	3.438000000 MHz	29.53	L1	Average	-30.47
1	5.314000000 MHz	22.26	N	Quasi Peak	-50.74
2	6.118000000 MHz	19.68	L1	Average	-40.32
1	6.814000000 MHz	36.01	N	Quasi Peak	-36.99
2	7.446000000 MHz	31.66	L1	Average	-28.34
2	11.458000000 MHz	28.92	N	Average	-31.08
1	16.754000000 MHz	9.28	N	Quasi Peak	-63.72
1	18.246000000 MHz	28.58	N	Quasi Peak	-44.42
2	18.906000000 MHz	30.60	N	Average	-29.40

Note

The decimal separator is decimal point in the above table of results.

Power supply port (with a power supply voltage of 250 Vac)



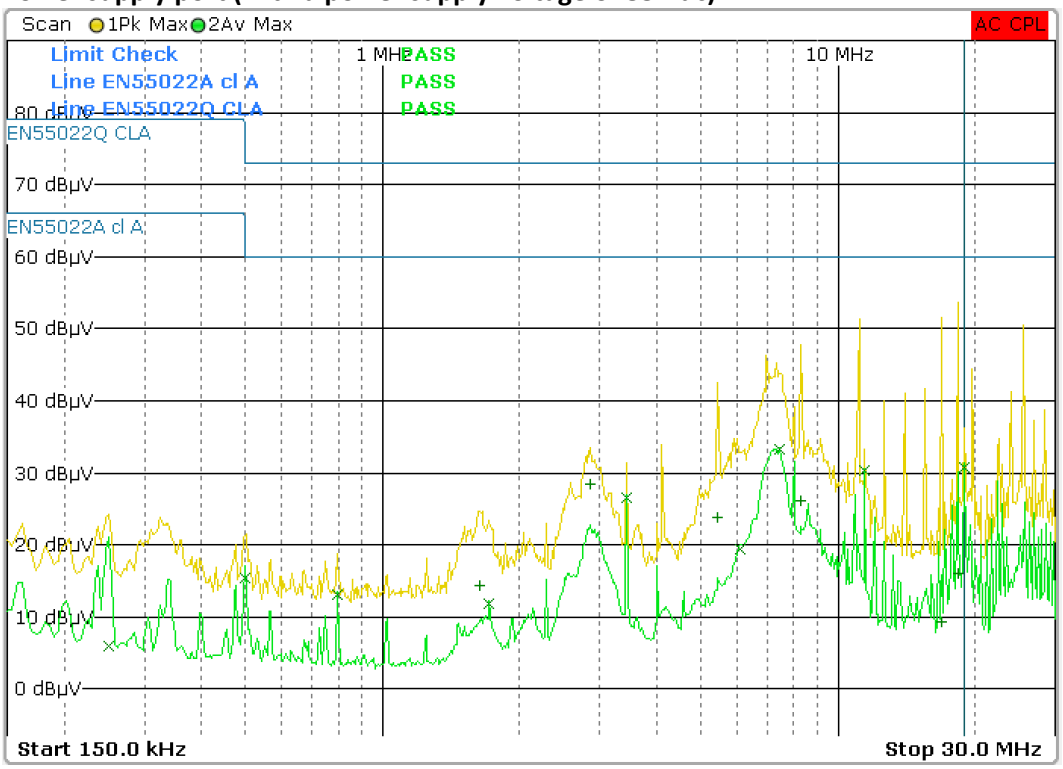
Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	562.000000000 kHz	9.23	L1	Average	-50.77
1	610.000000000 kHz	18.21	L1	Quasi Peak	-54.79
2	790.000000000 kHz	11.65	L1	Average	-48.35
2	1.718000000 MHz	12.94	L1	Average	-47.06
1	1.722000000 MHz	20.18	N	Quasi Peak	-52.82
1	3.438000000 MHz	29.43	L1	Quasi Peak	-43.57
2	3.438000000 MHz	28.83	L1	Average	-31.17
1	6.106000000 MHz	26.26	L1	Quasi Peak	-46.74
2	6.106000000 MHz	19.17	N	Average	-40.83
2	7.450000000 MHz	32.54	L1	Average	-27.46
1	7.462000000 MHz	36.88	N	Quasi Peak	-36.12
2	11.462000000 MHz	28.43	N	Average	-31.57
1	17.534000000 MHz	12.94	N	Quasi Peak	-60.06
1	18.906000000 MHz	30.52	N	Quasi Peak	-42.48
2	18.914000000 MHz	30.49	N	Average	-29.51

Note

The decimal separator is decimal point in the above table of results.

Power supply port (with a power supply voltage of 88 Vdc)



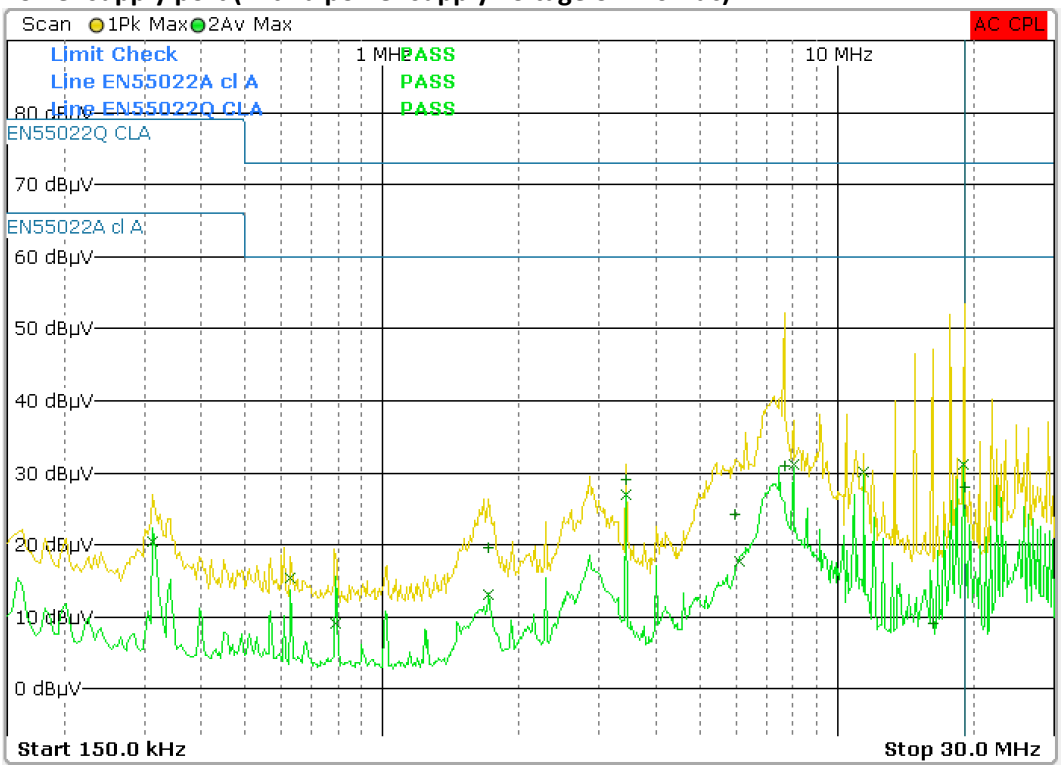
Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	250.000000000 kHz	5.91	N	Average	-60.09
2	498.000000000 kHz	15.32	L1	Average	-50.68
2	794.000000000 kHz	13.12	L1	Average	-46.88
1	1.634000000 MHz	14.43	L1	Quasi Peak	-58.57
2	1.718000000 MHz	11.76	L1	Average	-48.24
1	2.866000000 MHz	28.39	N	Quasi Peak	-44.61
2	3.438000000 MHz	26.62	N	Average	-33.38
1	5.446000000 MHz	23.79	L1	Quasi Peak	-49.21
2	6.118000000 MHz	19.36	L1	Average	-40.64
2	7.454000000 MHz	33.35	N	Average	-26.65
1	8.302000000 MHz	26.18	N	Quasi Peak	-46.82
2	11.466000000 MHz	30.29	N	Average	-29.71
1	16.886000000 MHz	9.23	L1	Quasi Peak	-63.77
1	18.382000000 MHz	16.11	N	Quasi Peak	-56.89
2	18.918000000 MHz	30.84	N	Average	-29.16

Note

The decimal separator is decimal point in the above table of results.

Power supply port (with a power supply voltage of 110 Vdc)



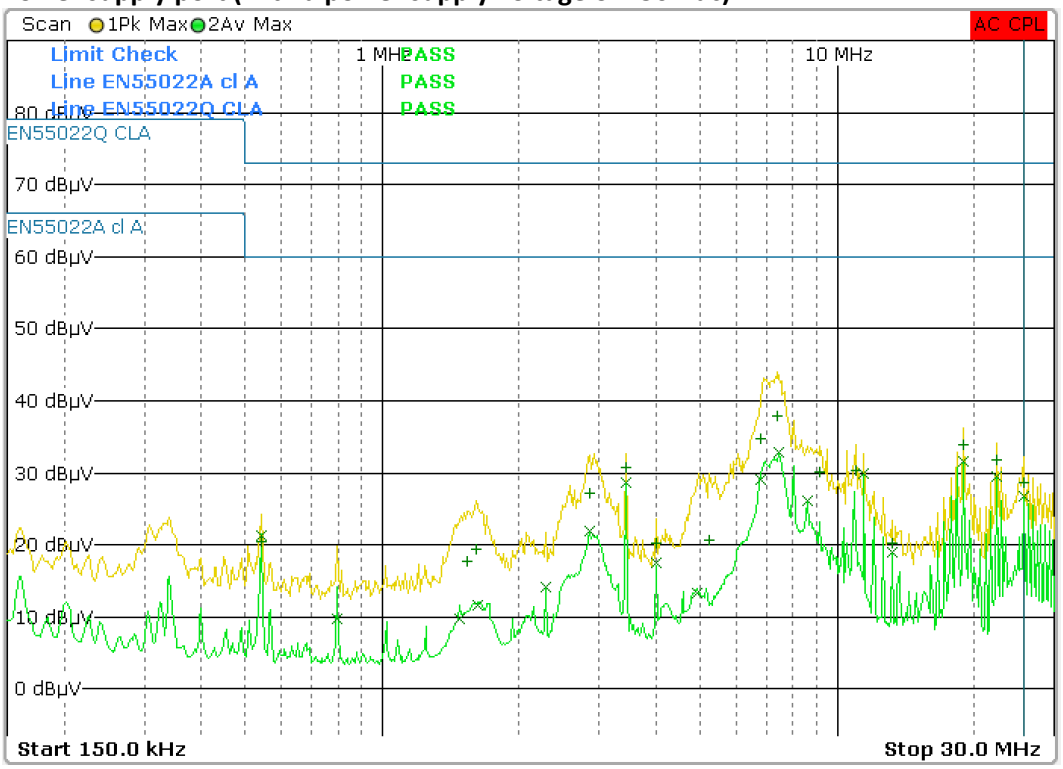
Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	314.000000000 kHz	20.51	L1	Average	-45.49
2	630.000000000 kHz	15.46	L1	Average	-44.54
2	790.000000000 kHz	9.05	L1	Average	-50.95
1	1.718000000 MHz	19.70	N	Quasi Peak	-53.30
2	1.718000000 MHz	13.13	L1	Average	-46.87
1	3.442000000 MHz	29.02	L1	Quasi Peak	-43.98
2	3.442000000 MHz	26.91	L1	Average	-33.09
1	5.986000000 MHz	24.15	N	Quasi Peak	-48.85
2	6.102000000 MHz	17.81	L1	Average	-42.19
1	7.654000000 MHz	30.88	L1	Quasi Peak	-42.12
2	8.026000000 MHz	31.11	N	Average	-28.89
2	11.466000000 MHz	30.04	N	Average	-29.96
1	16.234000000 MHz	9.12	N	Quasi Peak	-63.88
2	18.922000000 MHz	31.10	N	Average	-28.90
1	19.106000000 MHz	28.08	N	Quasi Peak	-44.92

Note

The decimal separator is decimal point in the above table of results.

Power supply port (with a power supply voltage of 250 Vdc)



Final result

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB
2	541.500000000 kHz	21.34	L1	Average	-38.66
1	543.750000000 kHz	20.40	L1	Quasi Peak	-52.60
2	795.750000000 kHz	9.71	L1	Average	-50.29
2	1.477500000 MHz	9.79	L1	Average	-50.21
1	1.542750000 MHz	17.66	L1	Quasi Peak	-55.34
1	1.612500000 MHz	19.43	L1	Quasi Peak	-53.57
2	1.628250000 MHz	11.57	L1	Average	-48.43
2	2.292000000 MHz	14.15	L1	Average	-45.85
1	2.863500000 MHz	27.08	L1	Quasi Peak	-45.92
2	2.868000000 MHz	21.90	L1	Average	-38.10
1	3.439500000 MHz	30.71	L1	Quasi Peak	-42.29
2	3.439500000 MHz	28.60	L1	Average	-31.40
1	4.013250000 MHz	20.33	L1	Quasi Peak	-52.67
2	4.013250000 MHz	17.51	L1	Average	-42.49
2	4.915500000 MHz	13.31	L1	Average	-46.69
1	5.253000000 MHz	20.59	L1	Quasi Peak	-52.41
2	6.785250000 MHz	29.02	L1	Average	-30.98
1	6.789750000 MHz	34.80	L1	Quasi Peak	-38.20
1	7.408500000 MHz	37.84	N	Quasi Peak	-35.16
2	7.453500000 MHz	32.85	N	Average	-27.15
2	8.598750000 MHz	26.15	N	Average	-33.85
1	9.174750000 MHz	30.10	N	Quasi Peak	-42.90
1	11.017500000 MHz	30.44	L1	Quasi Peak	-42.56
2	11.465250000 MHz	29.95	N	Average	-30.05
1	13.186500000 MHz	20.18	N	Quasi Peak	-52.82
2	13.186500000 MHz	19.02	N	Average	-40.98
1	18.917250000 MHz	33.94	N	Quasi Peak	-39.06
2	18.917250000 MHz	31.55	N	Average	-28.45
1	22.357500000 MHz	31.87	N	Quasi Peak	-41.13
2	22.357500000 MHz	29.46	N	Average	-30.54
1	25.795500000 MHz	28.56	N	Quasi Peak	-44.44
2	25.797750000 MHz	26.68	N	Average	-33.32

Note
The decimal separator is decimal point in the above table of results.

The limits are;
0,15 to 0,5 MHz; 79 dBuV QP
0,15 to 0,5 MHz; 66 dBuV AV
0,5 to 30 MHz; 73 dBuV QP
0,5 to 30 MHz; 60 dBuV AV

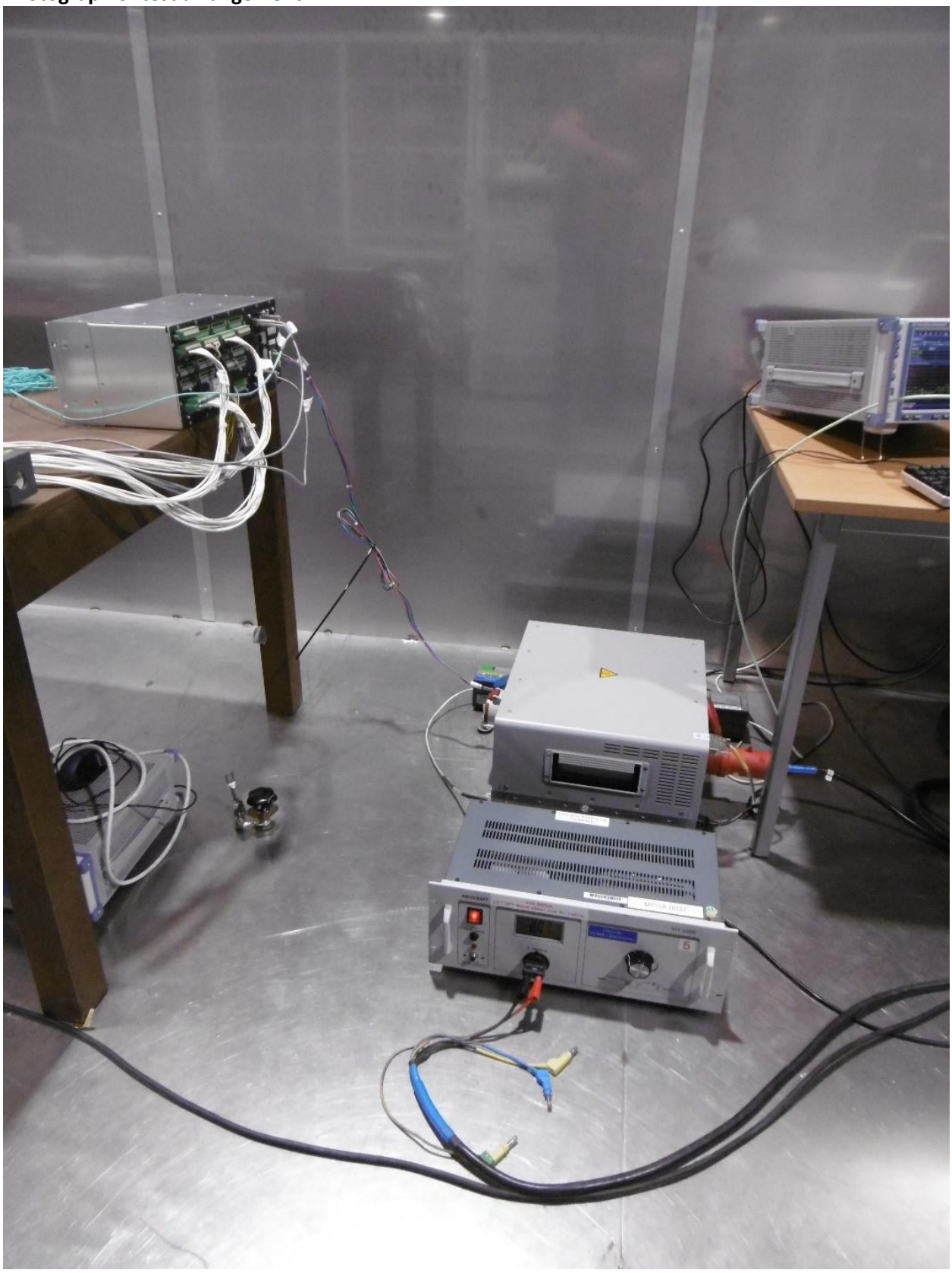
Remarks
The emission measurements have been conducted while half of the binary outputs of the test object were energized.

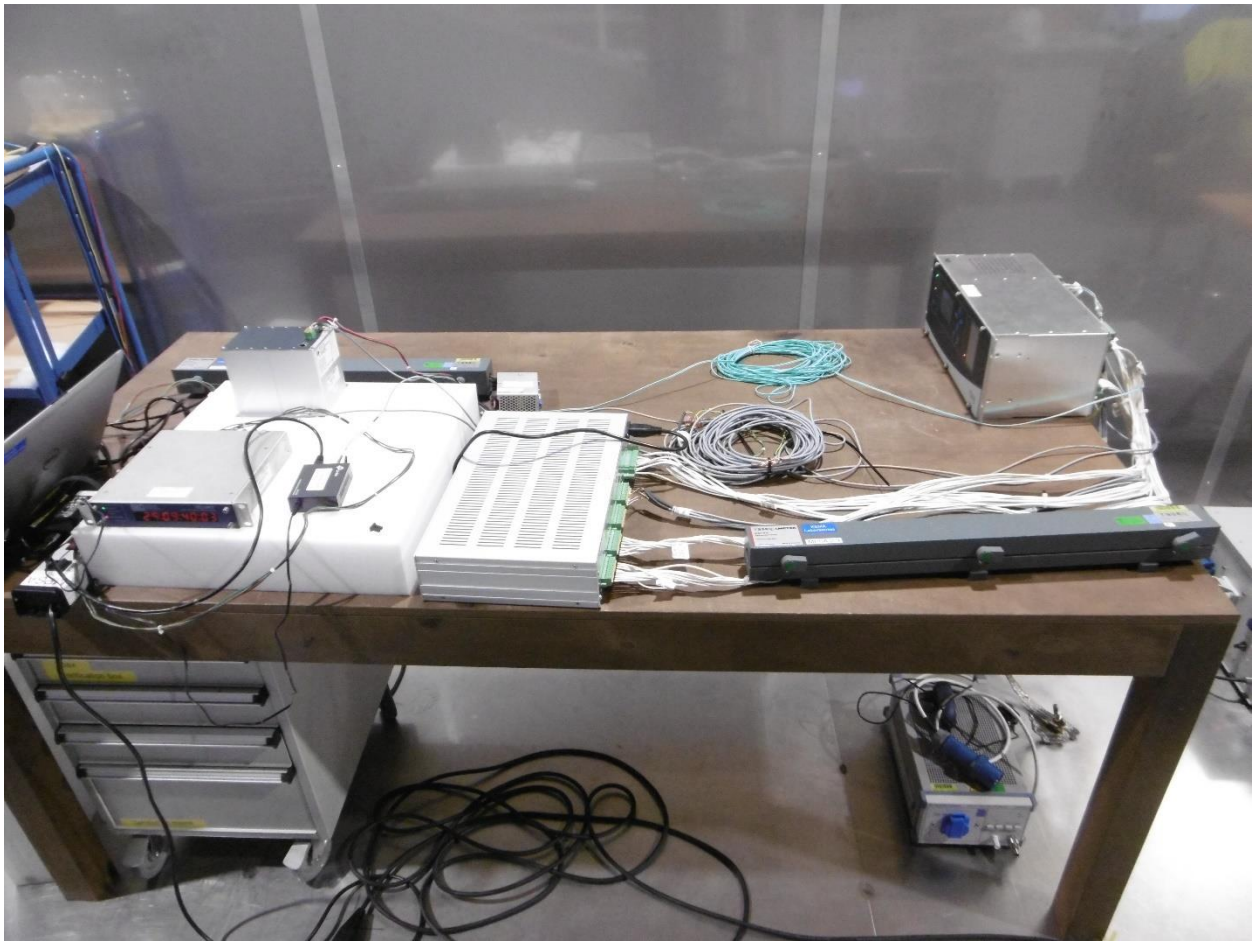
Telecommunication port
The test object has not been provided with copper ethernet ports.

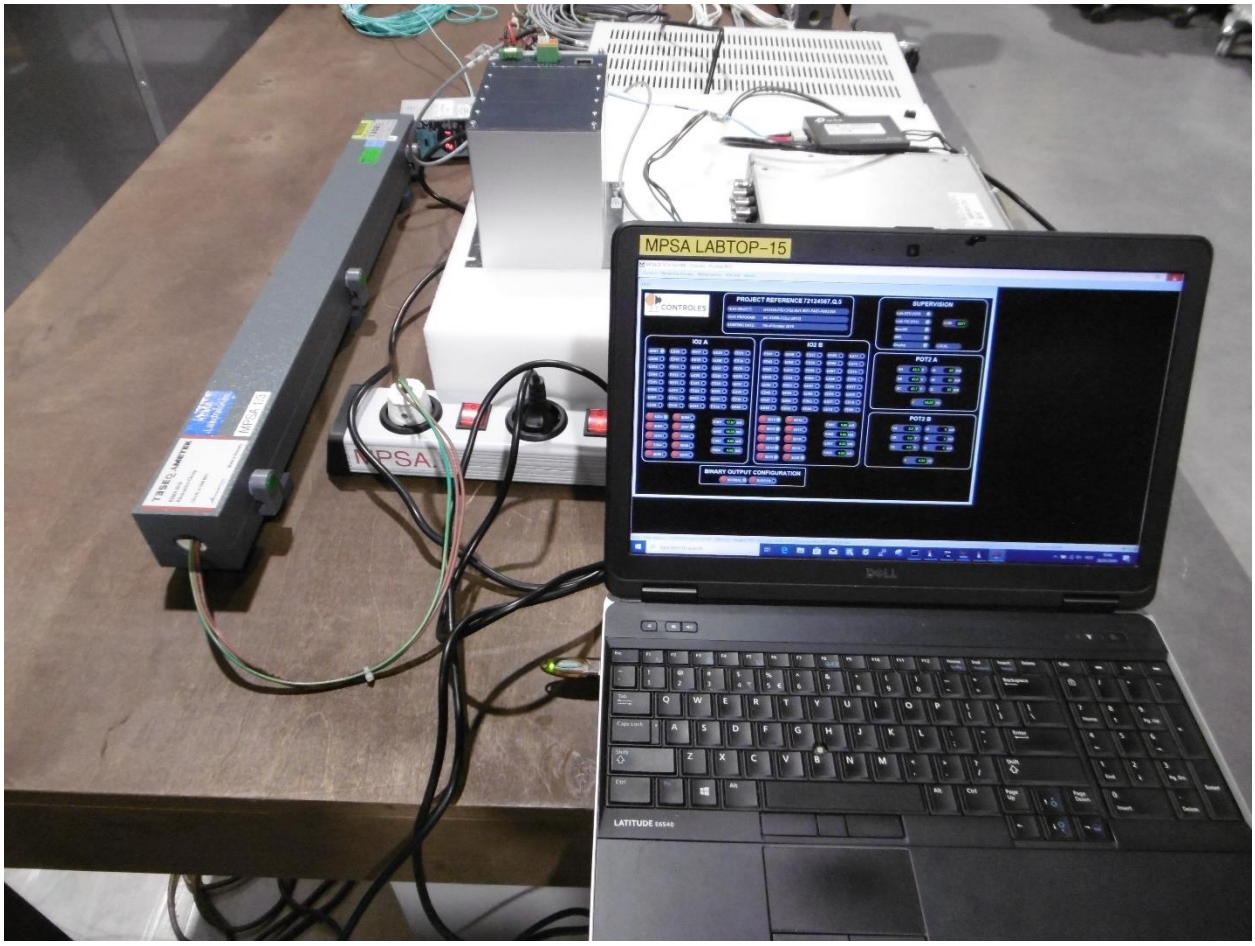
Requirement
The conducted emission shall not exceed the limits for class A equipment, specified in the standard CISPR 22.

Result
The object passed the test.

Photograph of test arrangement






MPSA LABTOP-15
PROJECT REFERENCE 72124597.0.5
SUPERVISION
IO2 A
IO2 B
POT2 A
POT2 B
BINARY OUTPUT CONFIGURATION
LATITUDE E6540

10.4 Electrostatic discharge

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-2
Test date	31 January 2020

Environmental conditions

Ambient temperature	20,5 °C	Relative humidity	49,8 %
Ambient air pressure	999 hPa		

Characteristic test data

Serial number	Sample A.4 TEL-6396-1098
Power supply	230 Vac

Method	Test voltage kV	See photographs on next pages	Polarity	Observations
Air discharges	2, 4, 8	1	+ and -	1, 2
Contact discharges	6	1	+ and -	1
Indirect contact	6	VCP right of object	+ and -	1
		HCP under object	+ and -	1

Observations

1. No degradation of performance observed.
2. Light ionisation at the LEDs and display but no discharge (8 kV).

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

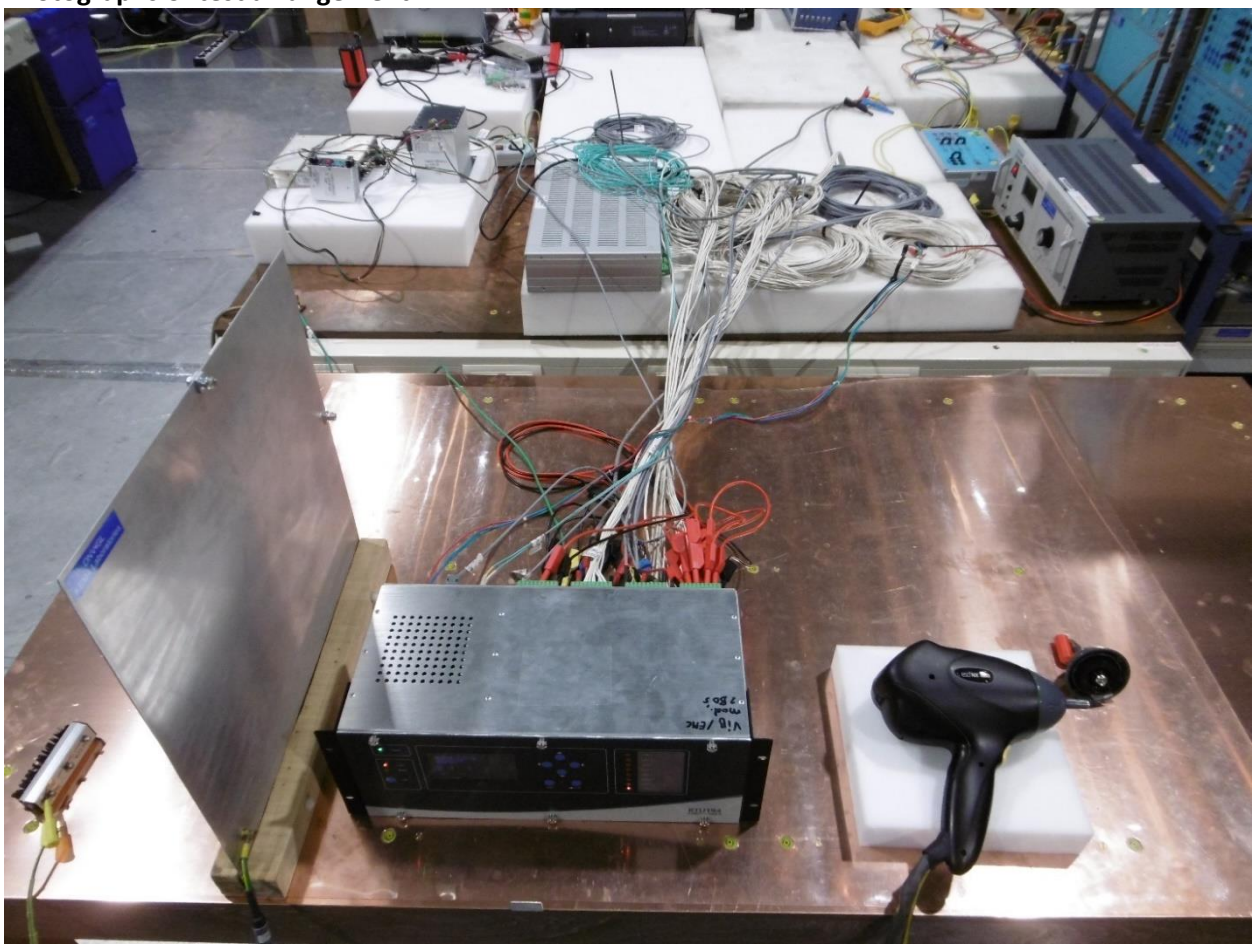
The object passed the test.

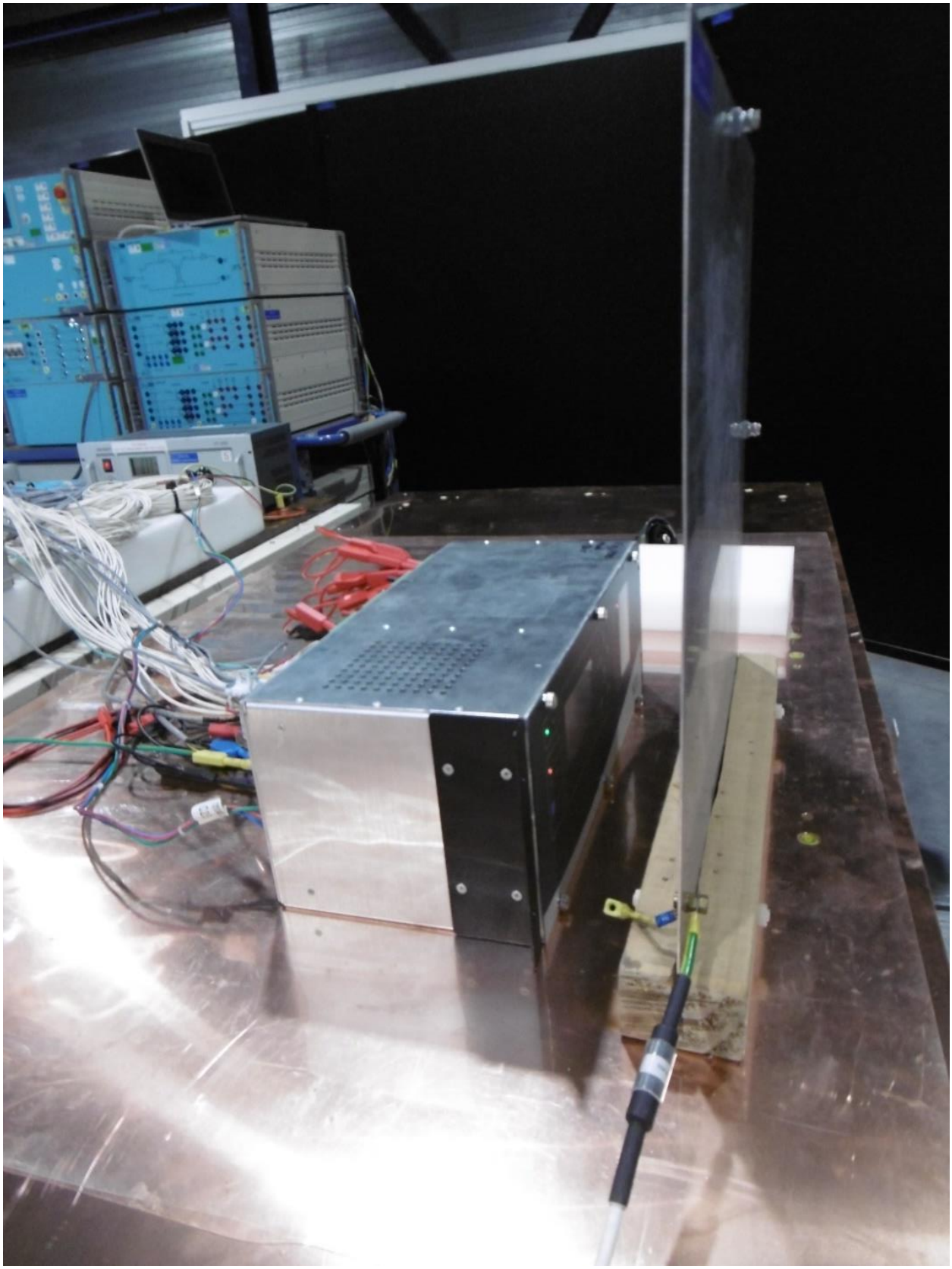
Photographs of test points

Photo 1; discharge positions

- On foil; AD
- On metal parts; CD

Photographs of test arrangement





Application of ESD on the VCP, front side.

10.5 Radiated interference

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-3
Test date	4 and 5 December 2019

Characteristic test data

Serial number	Sample A.4 TEL-6396-1098
Amplitude modulated	80 % AM (1 kHz)
Dwell time	0,5 s
Spot frequencies	10 s

Frequency sweep

Direction	Test level V/m	Sweep rate	Frequency sweep MHz	Observations
Front side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 3000	-
Rear side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 3000	-
Right and left side of EUT (horizontal & vertical polarization)	10	≤ 1%	80 – 3000	-

Spot frequencies

Direction	Test level V/m	Duty cycle	Spot frequencies MHz	Observations
Front side of EUT (horizontal & vertical polarization)	10	100%	80; 160; 380; 450; 900; 1850; 2150	-
Rear side of EUT (horizontal & vertical polarization)	10	100%	80; 160; 380; 450; 900; 1850; 2150	-
Right and left side of EUT (horizontal & vertical polarization)	10	100%	80; 160; 380; 450; 900; 1850; 2150	-

Observations

No degradation of performance observed.

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

10.6 Electrical fast transient

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-4
Test date 8 October 2019

Characteristic test data

Serial number Sample A.2, Serial No. TEL-6311-1046
Polarity positive and negative
Test duration 1 min

Circuit	Terminals	Coupling	Test voltage kV	Repetition frequency kHz	Observations
Power supply	L, N, PE	CM (CDN)	4	5	1
				100	1
RS232 port to RTU115	COM1	CM (CCC)	4	5	1
				100	1
IRIG-B	IRIG-B	CM (CCC)	4	5	1
				100	1
Relay outputs	S01A/B – S05A/B	CM (CCC)	4	5	1
				100	1
Relay outputs	S06A/B – S10A/B	CM (CCC)	4	5	1
				100	1
Relay outputs	S11A/B - S15A/B	CM (CCC)	4	5	1
				100	1
Relay outputs	S16A/B - S20A/B	CM (CCC)	4	5	1
				100	1
Digital inputs ED05 active	E01 – E08 (and common EG01 and EG02	CM (CCC)	4	5	1
				100	1
Digital inputs ED61 active	E57 – E64 (and common EG71 and EG72	CM (CCC)	4	5	1
				100	1
Digital inputs ED37 active	E33 – E40 (and common EG41 and EG42	CM (CCC)	4	5	1
				100	1
Sensitive DC current input	Channel A01A/A01B	CM (CCC)	4	5	1
				100	1
Sensitive DC current input	Channel A04A/A04B	CM (CCC)	4	5	1
				100	1
Sensitive DC current input	Channel A07A/A07B	CM (CCC)	4	5	1
				100	1
CT input	IA11/12, IB11/12, IC11/12	CM (CCC)	4	5	1
				100	1
VT input	VA1, VB1, VC1, VN1	CM (CCC)	4	5	1
				100	1
Earth port	PE	CM (CDN/CCC)	4	5	2
				100	2

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

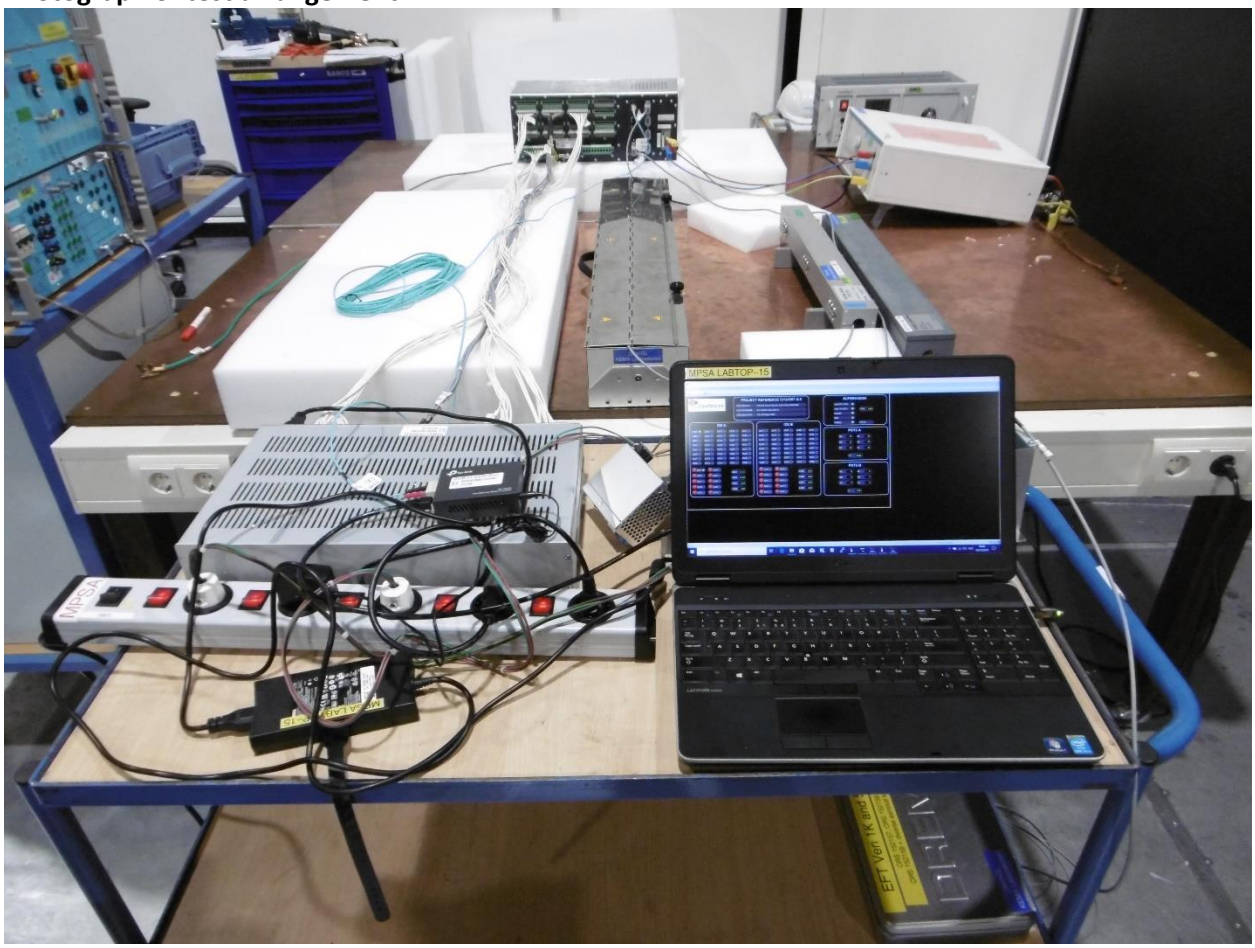
Note
Fast transients at 100 kHz is optional.

Observations
1. No degradation of performance observed.
2. IRIG-B timing signal lost but recovers after removal of the disturbance. With CCC coupling no degradation of performance observed.

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



10.7 Slow damped oscillatory wave

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-18
Test date 9 October 2019

Characteristic test data

Serial number Sample A.2, Serial No. TEL-6311-1046
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	Terminals	Coupling	Test voltage kV	Observations
Power supply	L, N, PE	CM	2,5	-
		DM	1,0	-
Digital inputs ED 01 active	EG01; E01	CM	2,5	-
		DM	1,0	-
Digital inputs ED 01 active	EG01; E04	CM	2,5	-
		DM	1,0	-
Digital inputs ED 49 active	EG01; E04	CM	2,5	-
		DM	1,0	-
Relay outputs	EG91; E73	CM	2,5	-
		DM	1,0	-
Relay outputs	EG42; E40	CM	2,5	-
		DM	1,0	-
Relay outputs	EG31; E25	CM	2,5	-
		DM	1,0	-
Current input (sensitive) IO 2B	A05A; A05B	CM[1)]	2,5	-
		N/A	-	-
Current input (sensitive) IO 2B	A07A; A07B	CM[1)]	2,5	-
		N/A	-	-
Current input (sensitive) IO 2A	A02A; A02B	CM[1)]	2,5	-
		N/A	-	-
CT input Pot 2A	IB11; IB12	CM	2,5	-
		DM	1,0	-
CT input Pot 2A	IC11; IC12	CM	2,5	-
		DM	1,0	-
CT input Pot 2B	IC21; IC22	CM	2,5	-
		DM	1,0	-
VT input Pot 2A	VA1; VN1	CM	2,5	-
		DM	1,0	-
VT input Pot 2B	VB2; VN2	CM	2,5	-
		DM	1,0	-
VT input Pot 2B	VA2; VN2	CM	2,5	-
		DM	1,0	-
IRIG-B	IRIG-B	CM[1)]	2,5	1
		DM	N/A	-

Circuit	Terminals	Coupling	Test voltage kV	Observations
COM1	RS 232	CM[1)]	2,5	1
		DM	N/A	-

Note
[1)]injected on the shield

Observations
1. IRIG-B timing signal lost but recovers after removal of the disturbance.

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

10.8 Surge

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-5
Test date	30 and 31 January 2020, 3, 7, 10 and 11 February 2020 and 18 March 2020

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098	
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
Application of the surge transient on AC supplied ports (AC power port, CT and VT ports)	five positive and five negative pulses each at 0 °, 90 °, 180 ° and 270 °	
Repetition rate	1 surge/min	

Circuit	Terminals	Coupling	Test voltage kV	Observations
Power supply	L, N, PE	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
CT	IA21/IA22; IB21/IB22; IC21/IC22; PE/GND	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
VT	VA; VB; VC; VN	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
BI	E36; EG	LL	0,5/1/2	-
		LE	0,5/1/2/4	1
BI	E79; EG	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
BI	E22; EG	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
BO	S15A; S15B	LL	0,5/1/2	-
		LE	0,5/1/2/4	-
IRIG-B	Signal; GND Cable shield	LL	0,5	-
		LE	0,5/1	-
RS232	RX; TX; GND Cable shield	LL	0,5	-
		LE	0,5/1	-
Low level current input EA01/EA04	A; B Cable shield	LL	0,5	2
		LE	0,5/1	-

Observations

1. The surge current increased for surge transients from +2500 V upto and including +4000 V. No breakdown. BI remains operational.
2. Current reading on input EA04 goes to 14,89 mA and returns to 14,86 with some delay (approx. 1s).

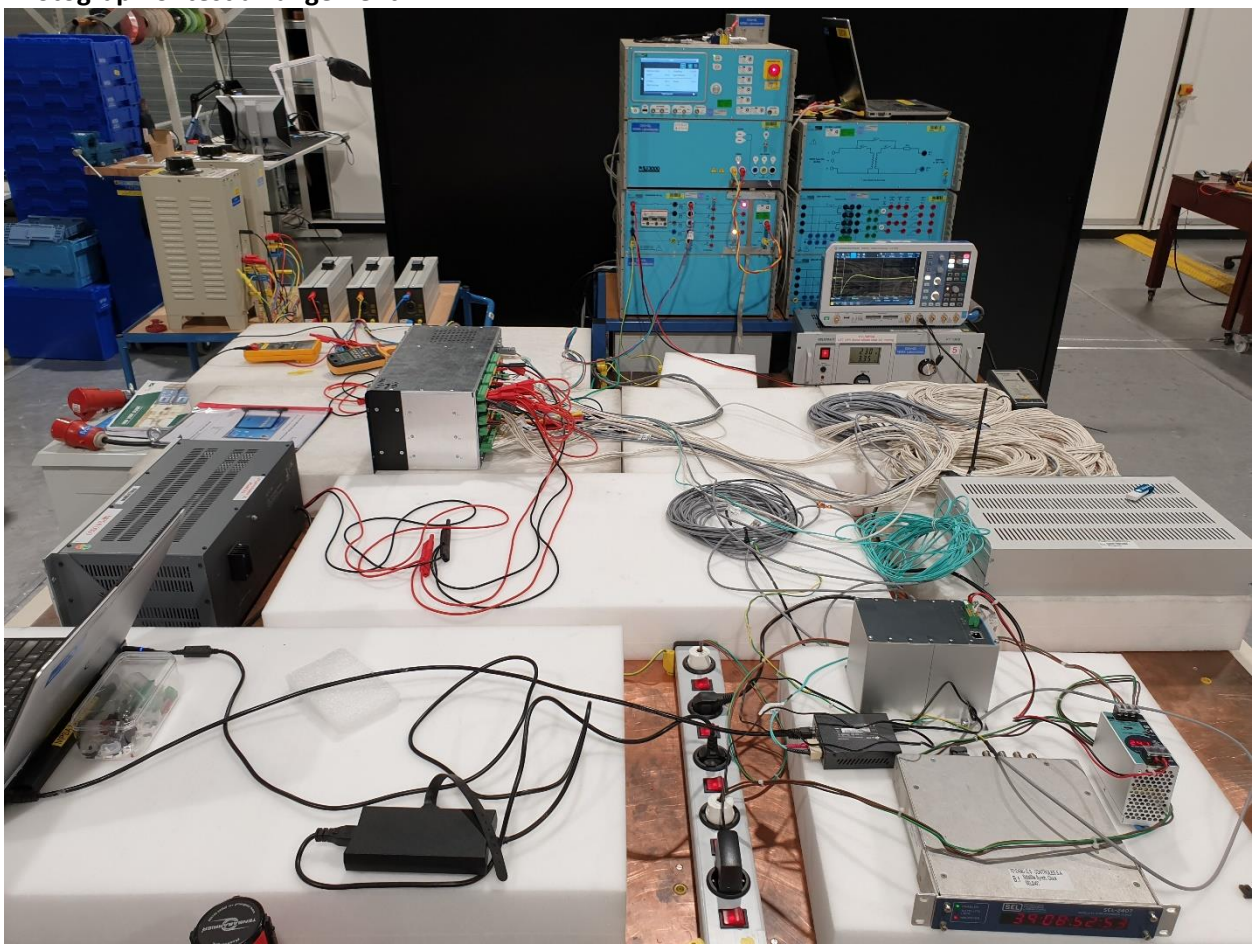
Requirement

- 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.

Photograph of test arrangement



10.9 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	10 and 11 October 2019 and 1 and 29 April 2020

Characteristic test data

Serial number	Sample A.2, Serial No. TEL-6311-1046
Source impedance	150 Ω
Amplitude modulated	80 % AM (1 kHz)
Sweep rate	1 %
Dwell time (frequency sweep)	0,7 s
Spot frequencies	10 s

Frequency sweep

Circuit	Terminals	Test level V	CDN	Frequency sweep MHz	Observations
VT input Pot 2A	VA1;VB1;VC1;VN1	10	M4N	0,15 - 80	-
IRIG-B	IRIG-B	10	S9	0,15 - 80	-
RS 232	RS 232	10	S9	0,15 - 80	-
CT input Pot 2A	IA11;IA12;IB11;IB12; IC11;IC12	10	M4N	0,15 - 80	-
Digital inputs IO 2A	EG01 and E01-E07	10	AF8	0,15 - 80	-
Digital inputs IO 2A	EG21;E22	10	AF2	0,15 - 80	-
Digital inputs IO 2A	EG31;E32	10	AF2	0,15 - 80	-
Current input (sensitive) IO2A	A01A;A01B	10	EM-clamp	0,15 - 80	-
Current input (sensitive) IO2A	A02A;A02B	10	EM-clamp	0,15 - 80	-
Power supply	L,N	10	M2	0,15 - 80	-
Relay outputs	S15A/S15B	10	AF2	0,15 - 80	-

The test object has been modified to meet the requirements for conducted disturbances induced by EM-fields. Refer to chapter 16.

Observations

No degradation of performance observed during and after the test.

Spot frequencies

Circuit	Terminals	Test level V	CDN	Frequency sweep MHz	Observations
VT input Pot 2A	VA1;VB1;VC1;VN1	10	M4N	27, 68	-
IRIG-B	IRIG-B	10	M4N	27, 68	-
RS 232	RS 232	10	M4N	27, 68	-
CT input Pot 2A	IA11;IA12;IB11;IB12; IC11;IC12	10	M4N	27, 68	-
Digital inputs IO 2A	EG11;ED09	10	M2	27, 68	-
Digital inputs IO 2A	EG11;ED19	10	M2	27, 68	-
Digital inputs IO 2B	EG61;ED49	10	M2	27, 68	-
Current input (sensitive) IO2A	A01A;A01B	10	AF2	27, 68	-
Current input (sensitive) IO2A	A02A;A02B	10	AF2	27, 68	-
Power supply	L,N	10	M2	27, 68	-
Relay outputs	S01A; to S05B	10	Clamp	27, 68	-
Relay outputs	S11A; to S15B	10	Clamp	27, 68	-
Relay outputs	S16A; to S20B	10	Clamp	27, 68	-

Observations

No degradation of performance observed during and after the test.

Requirement

- The object shall comply with reliability class 2 of chapter 7.5 of the standard.
- No changes in the states of the electrical, mechanical, or communication status outputs occur. This includes alarms, status outputs, or targets.
- During the tests, SCADA analog values shall not change by more than 2 % of full-scale values. After the test, accuracy shall revert to the manufacturer-claimed accuracy.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

Photograph of test arrangement

10.10 Power frequency magnetic field

Standard and date

Standard	IEC 61850-3, subclause 6.7.3
Basic standard	IEC 61000-4-8
Test date	27 January 2020

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Power supply	230 Vac
Frequency	50 Hz

Direction	Test level A/m	Duration s	Observations
Horizontal longitudinal (x)	150 [1)]	Continuous	-
	1000	3 s	-
Horizontal transversal (y)	150 [1)]	Continuous	-
	1000	3 s	-
Vertical (z)	150 [1)]	Continuous	-
	1000	3 s	-

[1)] Test performed with a field strenght level of 150 A/m in stead of required 100 A/m (3 minutes per direction).

Observations

No degradation of performance observed.

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

10.11 Mains frequency voltage immunity

Standard and date

Standard IEC 61850-3, subclause 6.7.3
Basic standard IEC 61000-4-16
Test date 28 January 2020

Characteristic test data

Serial number Sample A.4, Serial No. TEL-6396-1098
Frequency 50 / 60 Hz

Power supply ports

Circuit	Terminals	Coupling	Test voltage V	Time seconds	Frequency Hz	Coupling resistor Ω	Coupling capacitor µF	Observations
Power supply input	L, N w.r.t PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
-	-	CM	30	60	50 / 60	100	1	
		CM	300	1	50 / 60	100	1	

Rated power supply input voltage; 110 Vdc
Short duration test also tested with a power supply voltage of 88 Vdc.

Binary input ports (110/220 Vdc version), energized at rated voltage (110 vdc)

Circuit	Terminals	Coupling	Test voltage V	Time[2] seconds	Frequency Hz	Coupling resistor Ω	Coupling capacitor µF	Observations
BI	E01-E08 [1] /EG02 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E09/EG02 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E16/EG02 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E22/EG21 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E32/EG31 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E36/EG41 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E79/EG82 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E50/EG61 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-
BI	E86/EG81 to PE	CM	30	60	50 / 60	100	1	-
		CM	300	1	50 / 60	100	1	-

[1] Connector E01 – E08 fully tested (50/60 Hz)
[2] Short duration tested at Uin= 50 Vdc (set point just above lower threshold).

Observations

No degradation of performance observed.

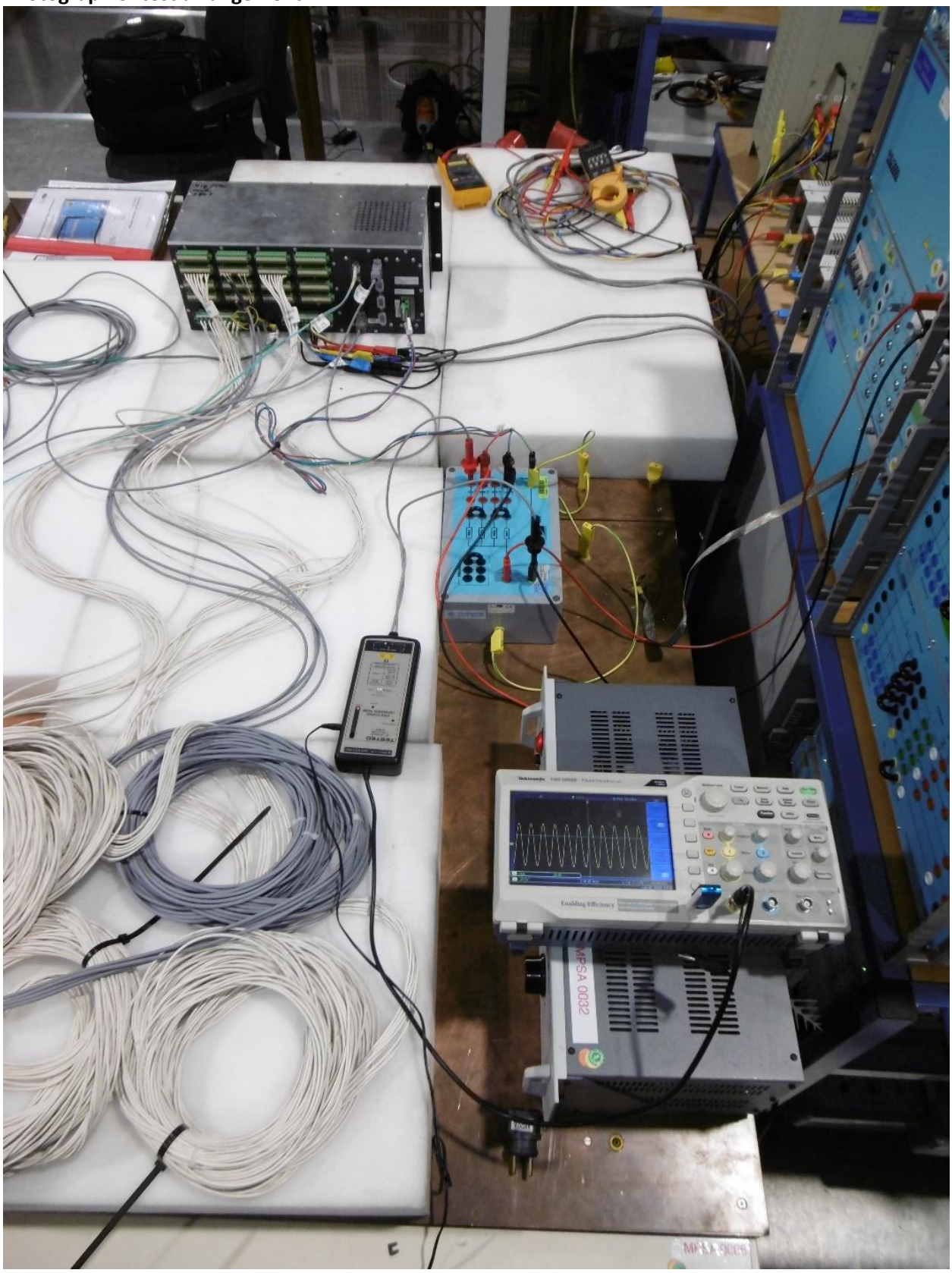
Requirement

- The object shall comply with acceptance criteria A of IEC 60255-26, Table 23.
- 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 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 and IEC 61000-4-29
Test date	11 October 2019

DC-power supply input

Characteristic test data

Serial number	Sample A.2, Serial No. TEL-6311-1046
Time	0,1 s
Power supply input	110 - 220 Vdc

Note

Half of the binary outputs were energised during the test.

DC-Voltage dips

Power supply voltage Vdc	Dip %	Residual voltage V	Observations
110	60	44	-
110	30	77	-
220	60	88	-
220	30	154	-

Observations

No degradation of performance observed.

Characteristic test data

Serial number	Sample A.2, Serial No. TEL-6311-1046
Interruption time	0,05 s
Power supply input	110 - 220 Vdc

DC-Voltage interruptions

Power supply voltage Vdc	Interruption %	Impedance	Observations
110	100	High	-
220	100	High	-
110	100	Low	-
220	100	Low	-

Observations

No degradation of performance observed.

AC-power supply input

Characteristic test data

Serial number	Sample A.2, Serial No. TEL-6311-1046
Dip	30 % 1 cycle
Dip	60 % 50 cycles
Power supply input	110 - 220 Vac

Note

Half of the binary outputs were energised during the test.

AC-voltage dips

Power supply voltage Vac	Dip %	Cycles	Residual voltage Vac	Observations
110	60	50	44	-
110	30	1	77	-
220	60	50	88	-
220	30	1	154	-

Observations

No degradation of performance observed.

Characteristic test data

Serial number	Sample A.2, Serial No. TEL-6311-1046
Interruption time	100 % 5 cycle/ 50 cycles
Power supply input	110 - 220 Vac

AC-voltage interruptions

Power supply voltage Vac	Interruption %	Cycles	Observations
110	100	5 / 50	1
220	100	5 / 50	1

Observations

1. During 50 cycles voltage interrupt duration the EUT restarts. The manufacturer declares the test object is not intended for connection to the public power network. Therefore the result (50 cycles interruption) shall be considered as informative.

Requirement

- 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

10.13 Voltage ripple on DC power supply voltage

Standard and date

Standard	IEC 61850-3, subclause 6.15
Basic standard	IEC 61000-4-17
Test date	28 January 2020

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Auxiliary power supply input voltage	110-220 Vdc
Auxiliary power supply input voltage range	88 – 250 Vdc
Rated power frequency	50 Hz

Power supply voltage Vdc	Test frequency Hz	Ripple V/%	See oscillogram on next pages	Observations
88	100	11/10	1	-
110	100	11/10	2	-
220	100	22/10	3	-
250	100	22/10	4	-

Observations

No degradation of performance observed.

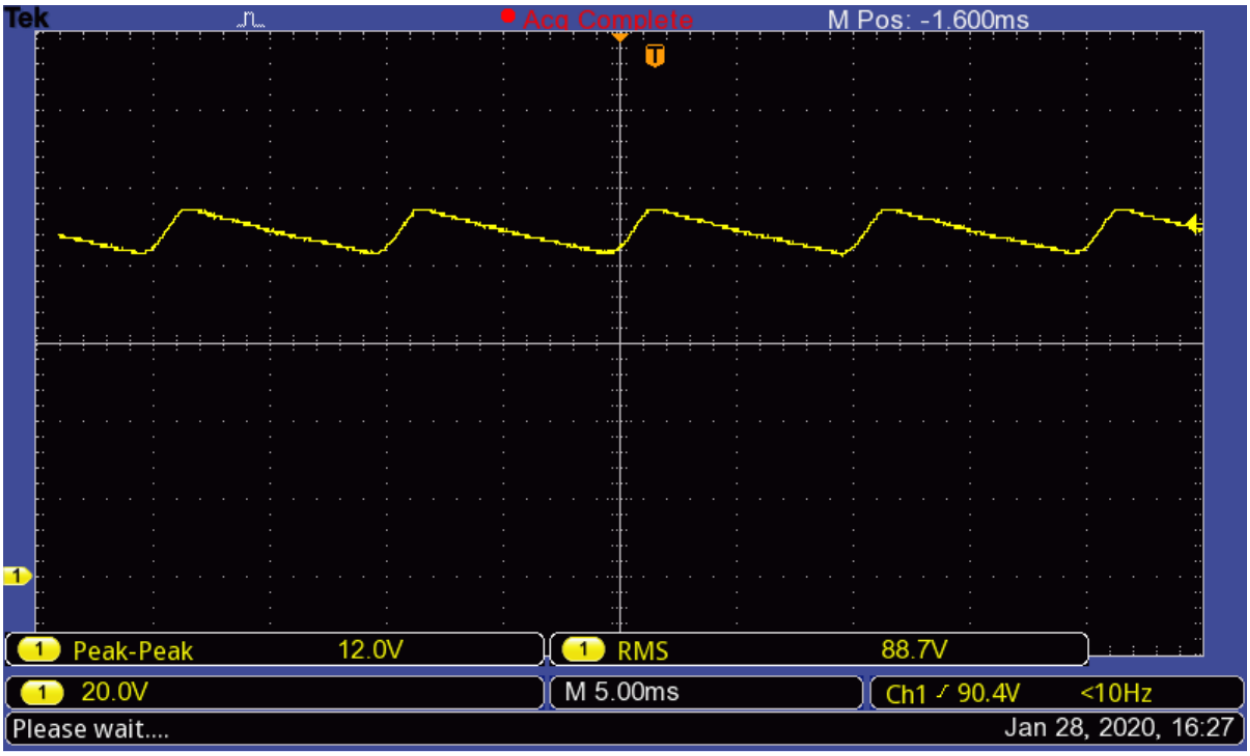
Requirement

- 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.

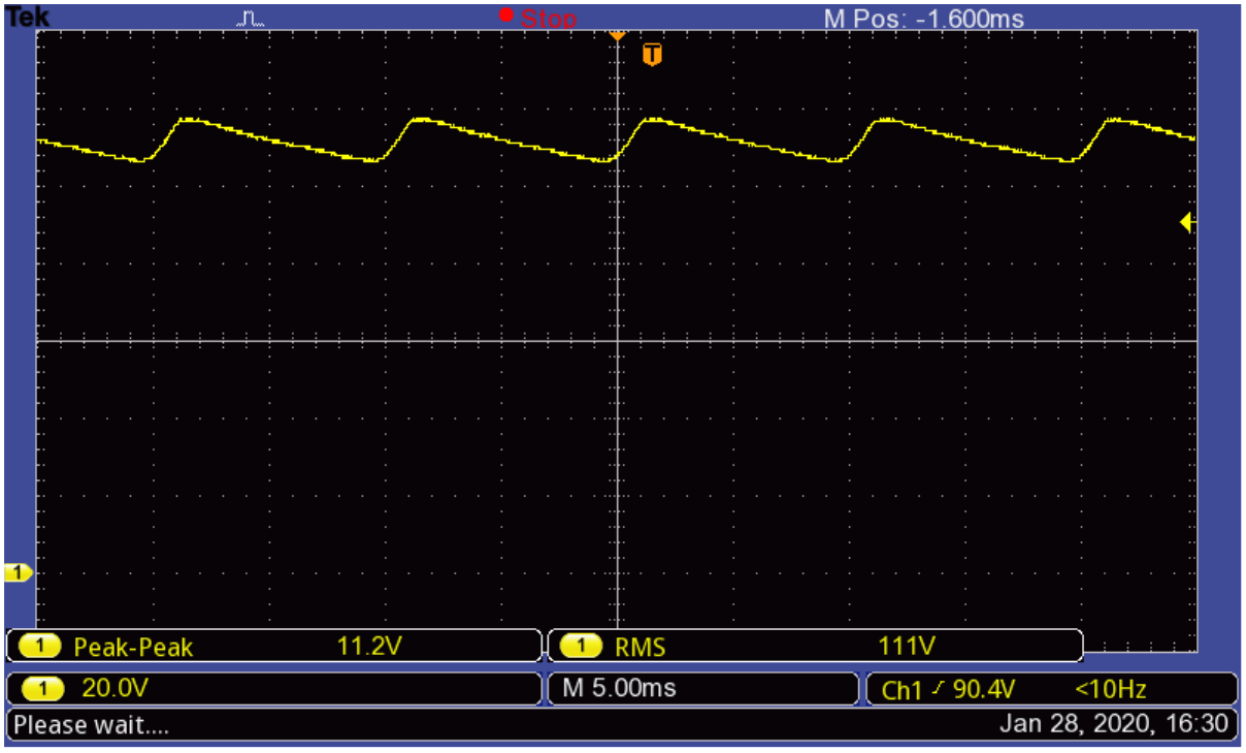
Result

The object passed the test.

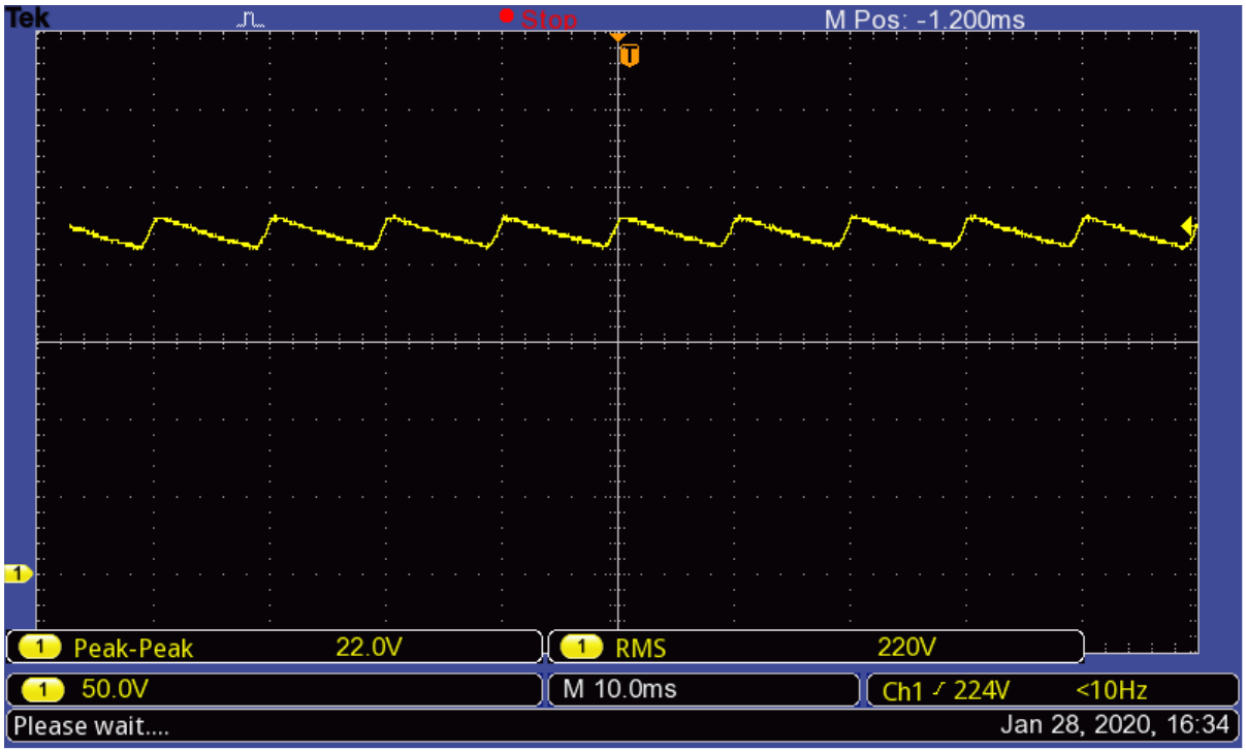
Oscillogram 1: 88 Vdc at 100 Hz



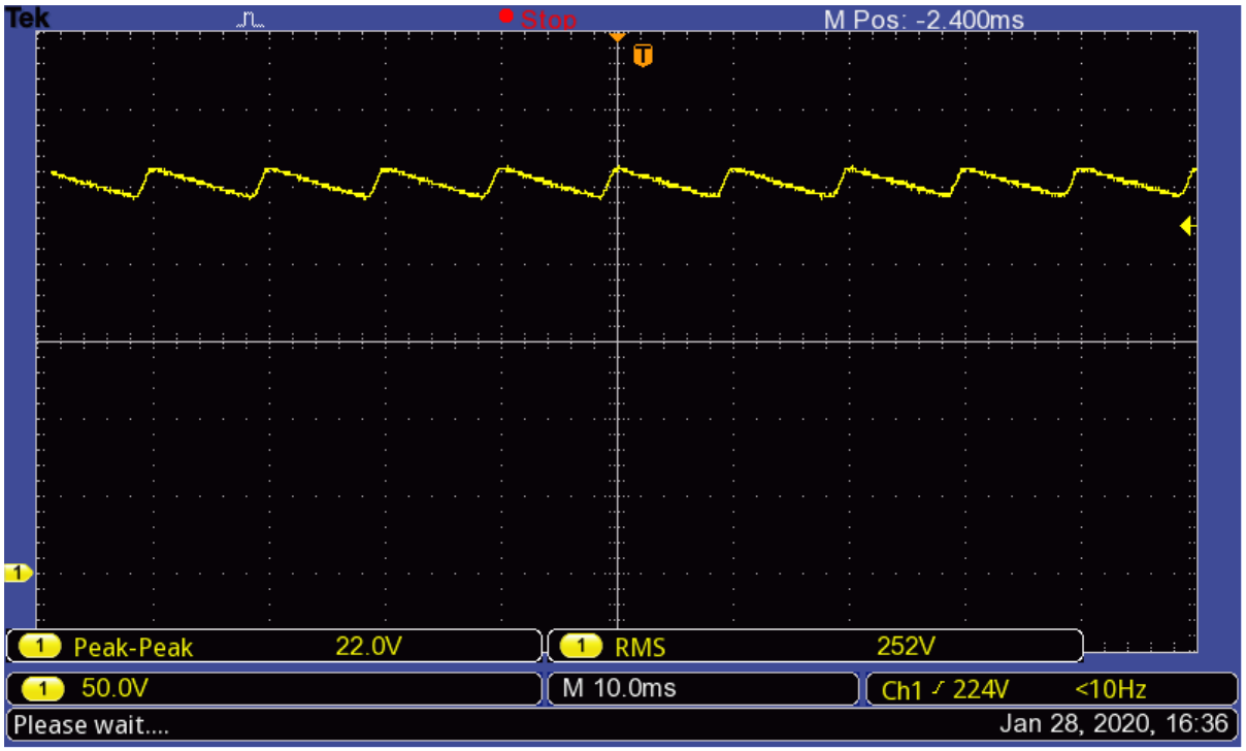
Oscillogram 2: 110 Vdc at 100 Hz



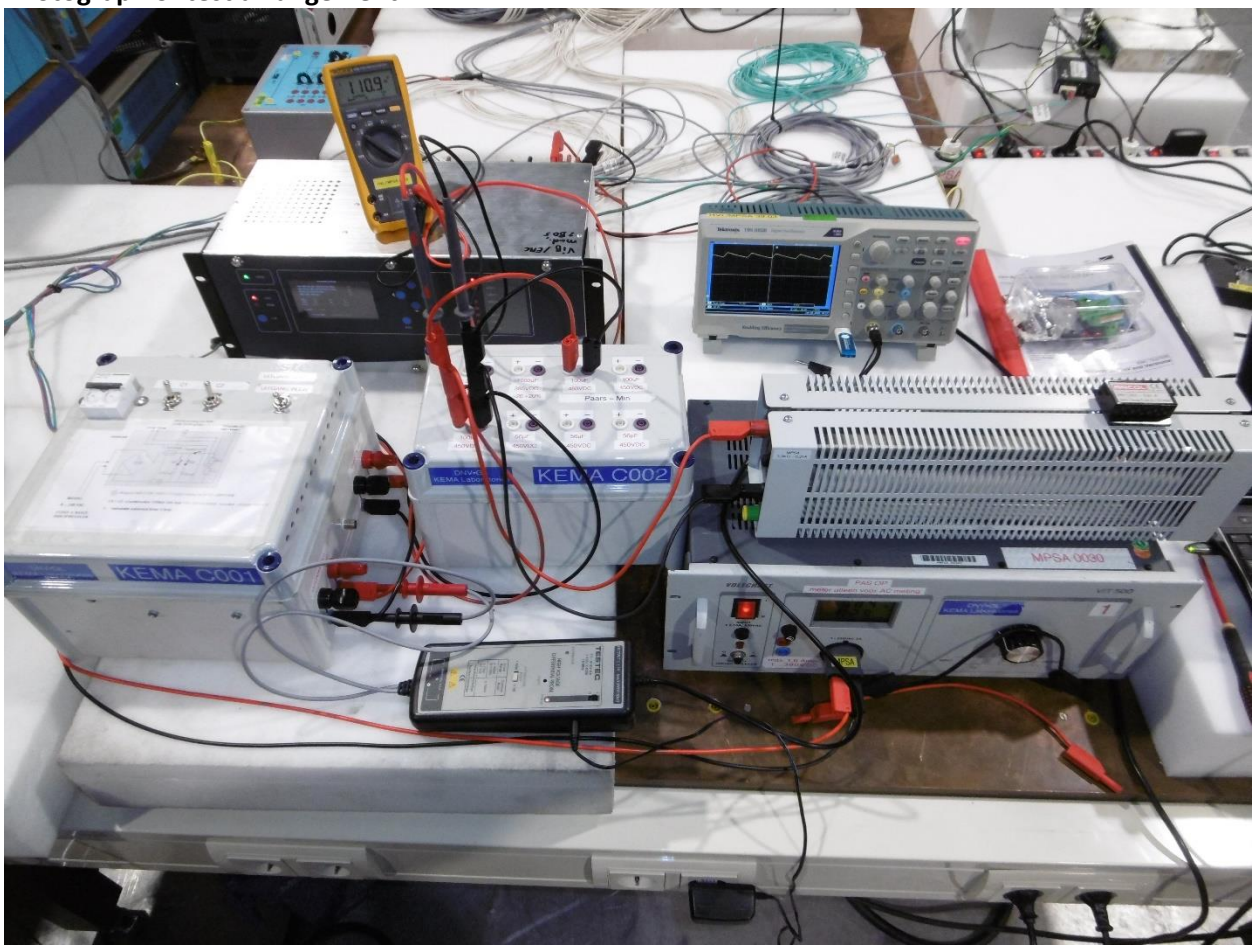
Oscillogram 3: 220 Vdc at 100 Hz



Oscillogram 4: 250 Vdc at 100 Hz



Photograph of test arrangement



11 ENERGIZING QUANTITIES

11.1 Burden for AC power supply

Standard and date

Standard IEC 61850-3, subclause 6.8.1
Test date 28 January 2020

Characteristic test data

Serial number Sample A.4, Serial No. TEL-6396-1098
Number of measurements 5 (issue maximum value)
Rated input energizing voltage 110 - 220 Vac

Power input voltage Vac/Vdc / load [1)]	Specified maximum burden VA	Measured maximum burden VA	Observations
1x PSU: 110 Vac/ 50 % load	50	0,267 A / 110,70 (29,55 VA)	-
1x PSU: 110 Vac/ quiescent load	50	0,203 A/ 112 V (22,73 VA)	-
1x PSU: 220 Vac/ 50 % load	50	0,268 / 220 V (58,96 VA)	1
1x PSU: 220 Vac/ quiescent load	50	0,244 / 220 V (53,68 VA)	1

[1)] half of the binary outputs has been energized.

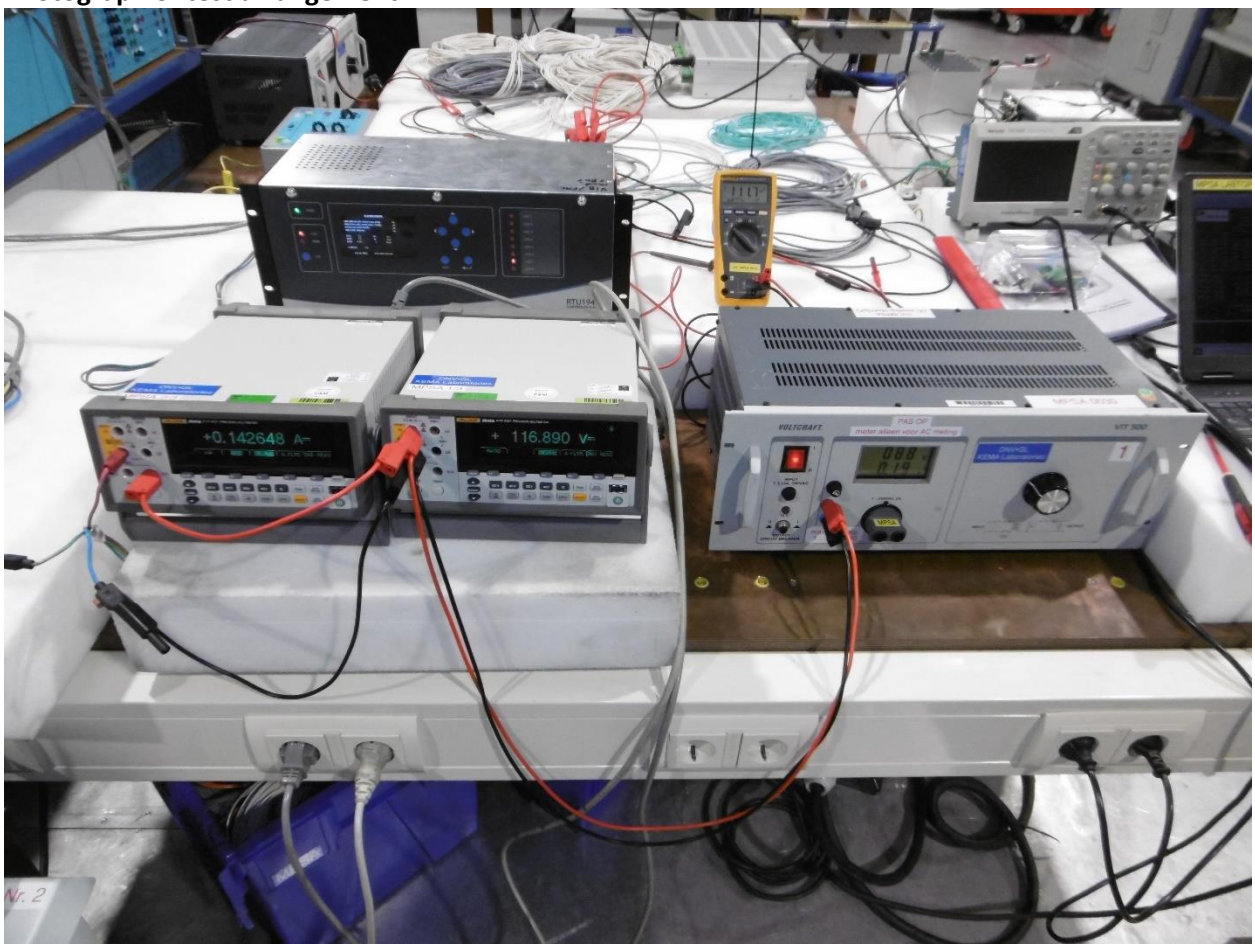
Observations

1. The specified burde of 50 VA has been exceeded. The manufacturer changed the specified burden value to 65 VA (W).

Result

The object passed the test.

Photograph of test arrangement



11.2 Burden for DC power supply

Standard and date

Standard IEC 61850-3, subclause 6.8.2
Test date 29 January 2020

Characteristic test data

Serial number Sample A.4, Serial No. TEL-6396-1098
Number of measurements 5 (issue maximum value)
Rated input voltage 110-220 Vdc

Power input voltage Vdc / load	Specified maximum burden W	Measured maximum burden W	Observations
1x PSU: 110 Vdc / quiescent load	50	0,144 A ,110 V (15,84 W)	1, 2
1x PSU: 110 Vdc / 50 % load	50	0,220 A ,110 V (24,2 W)	1, 2
2x PSU: 220 Vdc / quiescent load	50	0,075 A, 220 V (16,50 W)	1, 2
2x PSU: 220 Vdc / 50 % load	50	0,110 A, 220 V (24,20 W)	1, 2

Observations

1. The test object meets the initial specified maximum burden requirement.
2. The measured burden (DC) is much lower than the specified burden.

Result

The object passed the test.

11.3 Inrush current

Standard and date

Standard IEC 61850-3, subclause 6.8.1.2 and 6.8.2.2
Test date 29 January 2020

Characteristic test data

Serial number sample A.4, Serial No. TEL-6396-1098
Number of measurements 5 (issue maximum value)

The rated power supply voltage is;
110 Vdc and 220 Vdc, 110 Vac and 220 Vac
The voltage range is:
88 – 250 Vac (110 - 20 % -- 230 + 10%)

Power input voltage Vac/Vdc	Measured Peak current A	Measured Power up duration ms	Observations
110 Vdc	63	2,5 - 4	-
220 Vdc	146	2,5	-
110 Vac	4,5	300	1
230 Vac[1)]	7,7	1100	1

Note

[1)] The rated upper supply voltage is 220 Vac. The measurement however has been performed with a power supply voltage of 230 Vac.

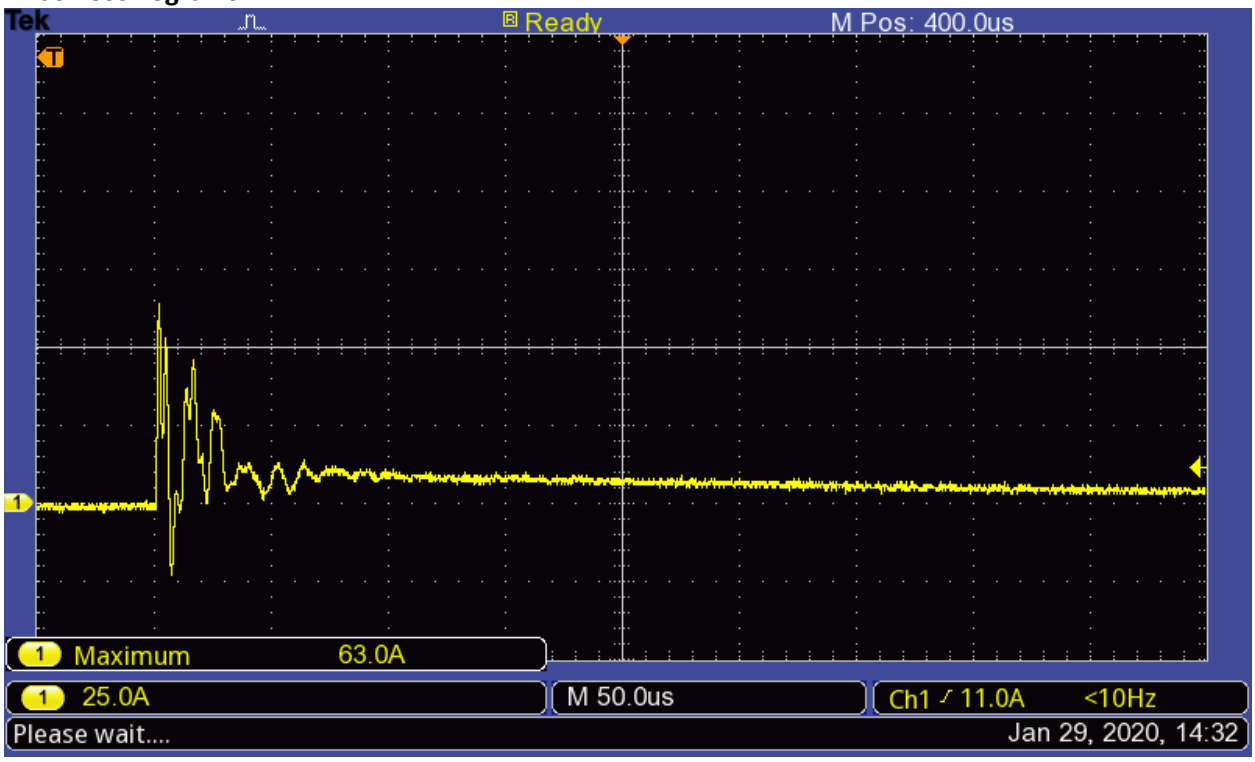
Observations

1. The start-up of the power supply takes much more time when powered with AC.

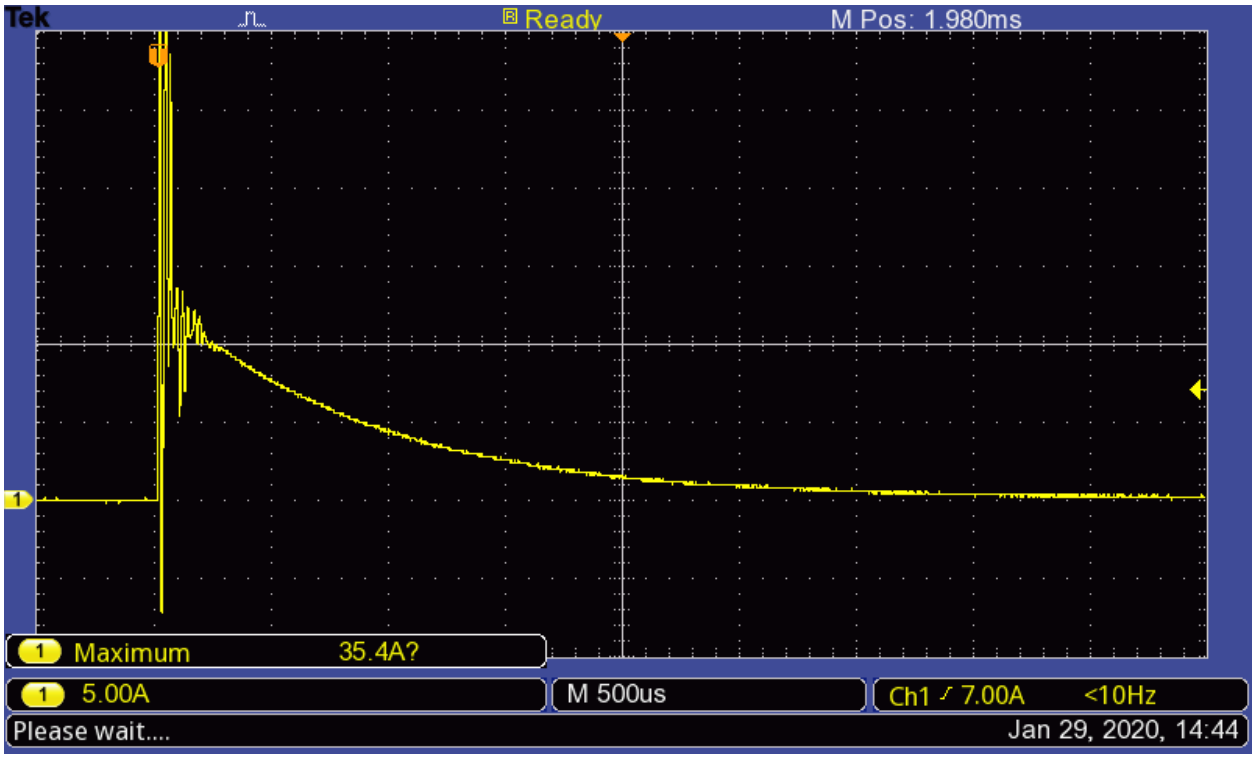
Result

The results are for information only.

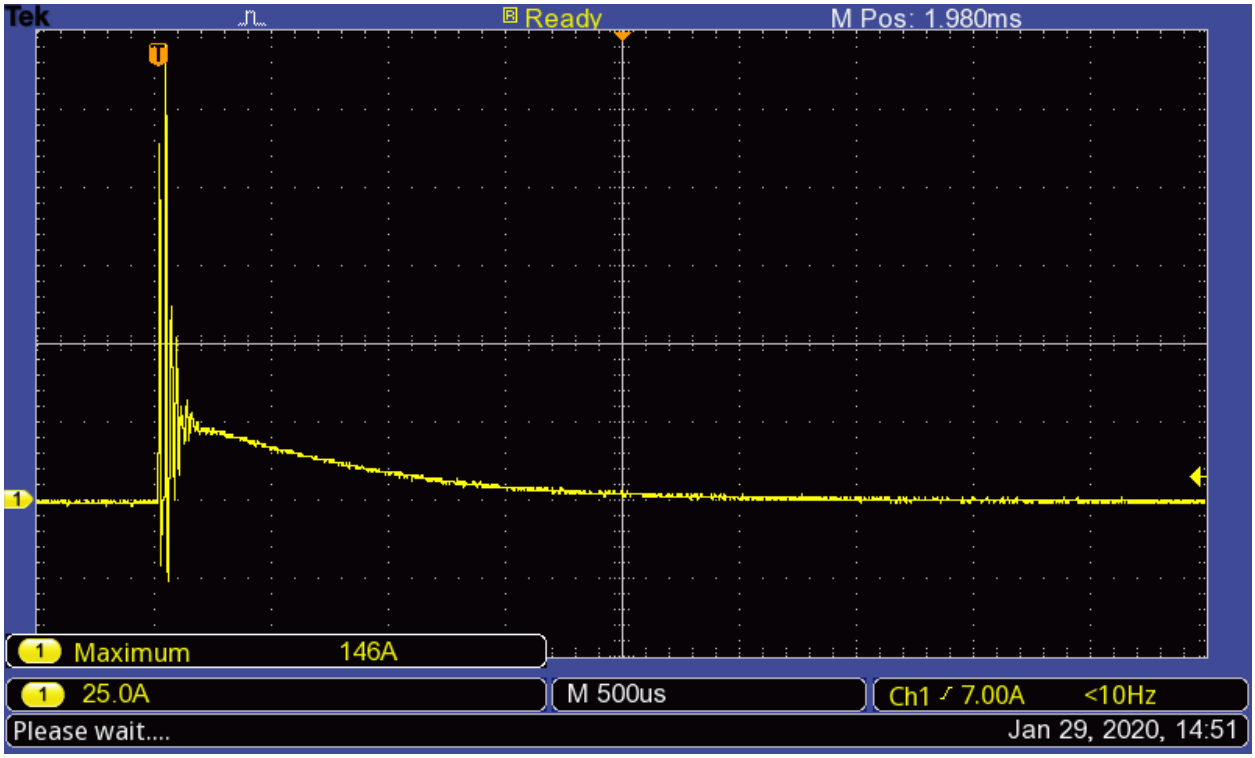
Inrush oscillograms



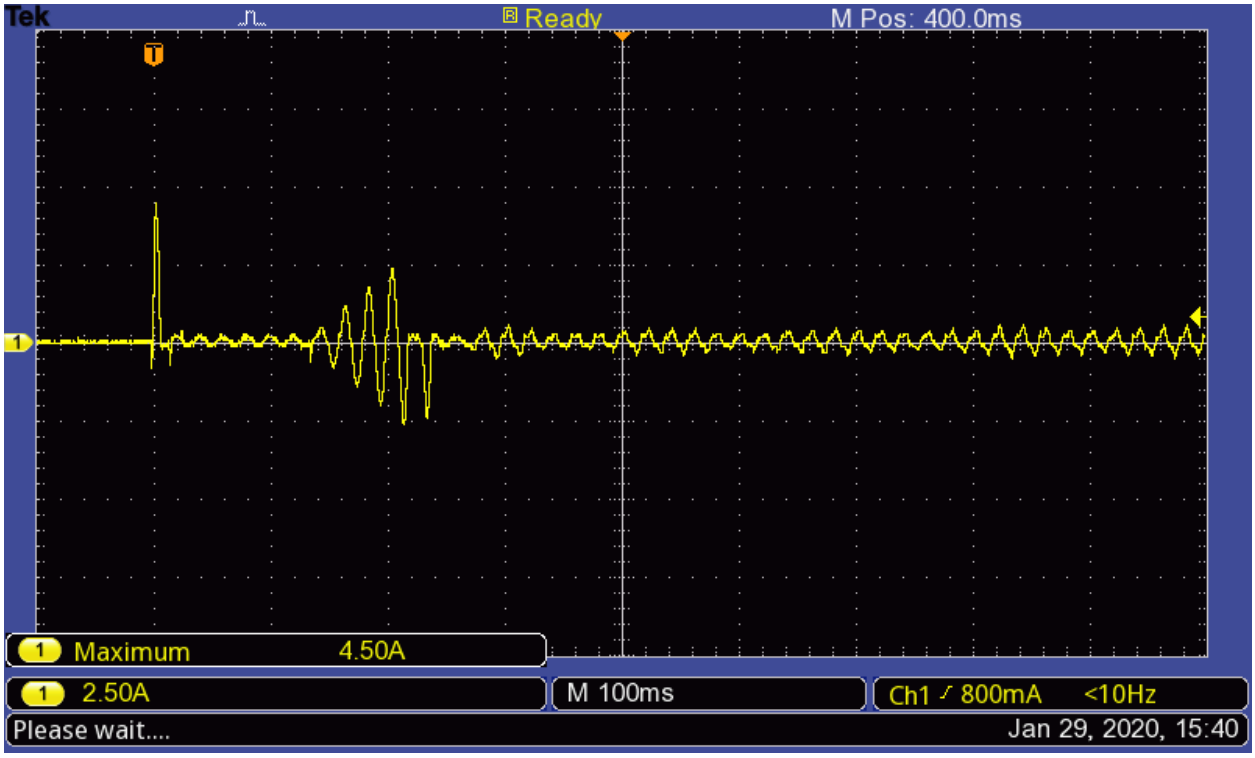
Inrush graph while powered by 110 Vdc



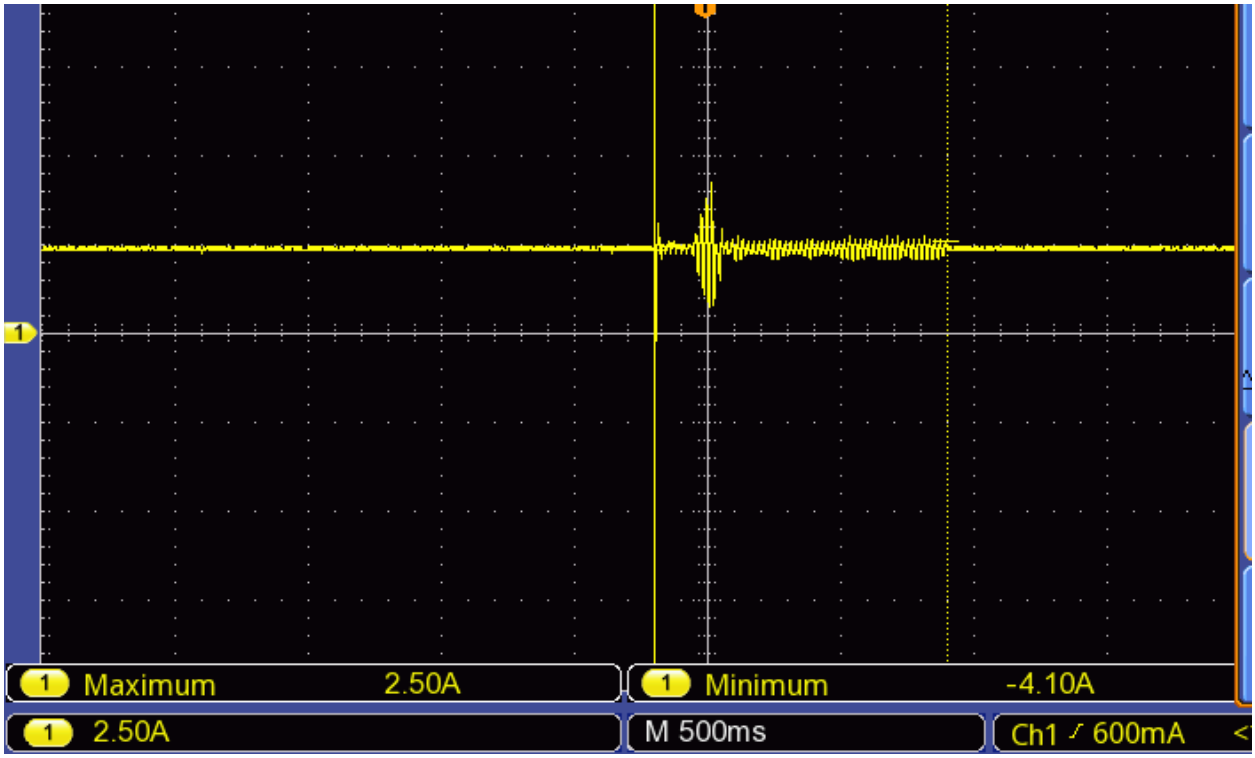
Inrush and power up duration graph while powered by 110 Vdc. The peak current has not been measured correctly because the amplitude of the signal is out of range.



Inrush and power up duration graph while powered by 220 Vdc



Inrush and power up duration graph while powered by 110 Vac



Inrush and power up duration graph while powered by 230 Vac

11.4 Burden for binary input

Standard and date

Standard IEC 61850-3, subclause 6.8.3
Test date 29 January 2020

Characteristic test data

Serial number Sample A.4, Serial No. TEL-6396-1098
Number of measurements 5 (issue maximum value)
Rated input voltage 110-220 Vdc
The test object has been provided with binary inputs corresponding to option 21/23.

Binary input voltage Vdc	Measured Current mA	Calculated burden W	Specified burden W	Observations -
220	2,50	0,55	< 0,6	-
110	1,08	0,12	< 0,15	-
60	0,58	0,035	-	-
48	0,46	0,0022	-	-

Observations

The test object meets the specification for burden of the binary input.

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 (CT, VT, sensitive current);
- digital inputs (binary inputs);
- contact outputs (binary outputs);
- timing port (IRIG-B);
- data communication (optical, RS232).

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 state of contact outputs;
- unintentional change of state of the binary input inputs;
- loss of timing information;
- 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	8 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
Type of test	Bd
Operating conditions	energized
Power supply	230 Vac
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/current	16		-

Observations

No degradation of performance observed.

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.

12.3.2 Cold test - operational

Standard and date

Standard	IEC 61850-3, subclause 6.9.3.2
Basic standard	IEC 60068-2-1
Test date	9 october 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
Type of test	Ad
Operating conditions	energized
Power supply	230 Vac
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	-20	-
Correct function at rated load/current	16		-

Observations

No degradation of performance observed.

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 {1/2} 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	10 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
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

Before and after the test no degration of performance observed.

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.

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	11 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
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	-40	-

Observations

Before and after the test no degration of performance observed.

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.

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	22 and 23 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
Type of test	Nb
Operating conditions	energized
Power supply	230 Vac
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. -20	-
			Max. 70	-

Observations

No degradation of performance observed.

Requirement

- After the climate tests 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	11 to 21 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
Type of test	Cab
Operating conditions	energized
Power supply	230 Vac
Relative humidity	93 %

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

Observations

No degradation of performance observed.

Requirement

- After climate tests 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.
- After the climatic 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	24 to 30 October 2019

Characteristic test data

Serial number	Sample A.3, Serial No. TEL-6311-1047
Type of test	Db
Operating conditions	energized
Power supply	230 Vac

Test procedure	Duration of exposure h	Operating temperature °C	Humidity %	Observations
Pre-conditioning	1	25	60	-
Correct function	96	25	93	-
		40	97	-

Observations

No degradation of performance has been observed.

Requirement

- After the climate tests 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.
- After the climatic 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.

12.4 Measurement of insulation resistance

Standard and date

Standard IEC 61850-3, subclause 6.9.2.2
Test date 7 and 30 October 2019

Characteristic test data

Serial number Sample A.3, Serial No. TEL-6311-1047
Test voltage 500 Vdc

Before/after the climatic tests

Test arrangement		Insulation resistance at 500 Vdc	Insulation resistance at 500 Vdc	Observations
Voltage applied to	Tested between	(before the climate test) MΩ	(after the climate test) MΩ	
Power supply	Earth and all others	> 550	> 550	-
BI; E01-E08/common	Earth and all others	> 550	> 550	-
BI; E33-E40/common	Earth and all others	> 550	> 550	-
BI; E73-E80/common	Earth and all others	> 550	> 550	-
BI; E65-E72/common	Earth and all others	> 550	> 550	-
BI; E49-E56/common	Earth and all others	> 550	> 550	-
BO; S01A-S01B	Earth and all others	> 550	> 550	-
BO; S02A-SO2B	Earth and all others	> 550	> 550	-
BO; S03A-SO3B	Earth and all others	> 550	> 550	-
BO; S04A-SO4B	Earth and all others	> 550	> 550	-
BO; S05A-S05B	Earth and all others	> 550	> 550	-
BO; S06-S10 In one group	Earth and all others	> 550	> 550	-
BO; S11-S15 In one group	Earth and all others	> 550	> 550	-
BO; S16-S20 In one group	Earth and all others	> 550	> 550	-
A01/A02/A03/A04	Earth and all others	> 550	> 550	-
A05/A06/A07/A08	Earth and all others	> 550	> 550	-
A05	Earth and all others	> 550	> 550	-
A06	Earth and all others	> 550	> 550	-
A07	Earth and all others	> 550	> 550	-

Test arrangement		Insulation resistance at 500 Vdc	Insulation resistance at 500 Vdc	Observations
Voltage applied to	Tested between	(before the climate test) MΩ	(after the climate test) MΩ	
A08	Earth and all others	> 550	> 550	-
VT; VA1/VB1/VC1/VN1 CT; IA11/IA12, IB11/IB12, IC11/IC12 In one group	Earth and all others	> 550	> 550	-
VT; VA2/VB2/VC2/VN2 In one group	Earth and all others	> 550	> 550	-
CT; IA21/IA22, IB21/IB22, IC21/IC22 In one group	Earth and all others	> 550	> 550	-
CT; IA21/IA22	Earth and all others	> 550	> 550	-
CT; IB21/IB22,	Earth and all others	> 550	> 550	-
CT; IC21/IC22	Earth and all others	> 550	> 550	-
IRIG-B port	Earth and all others	> 550	> 550	-

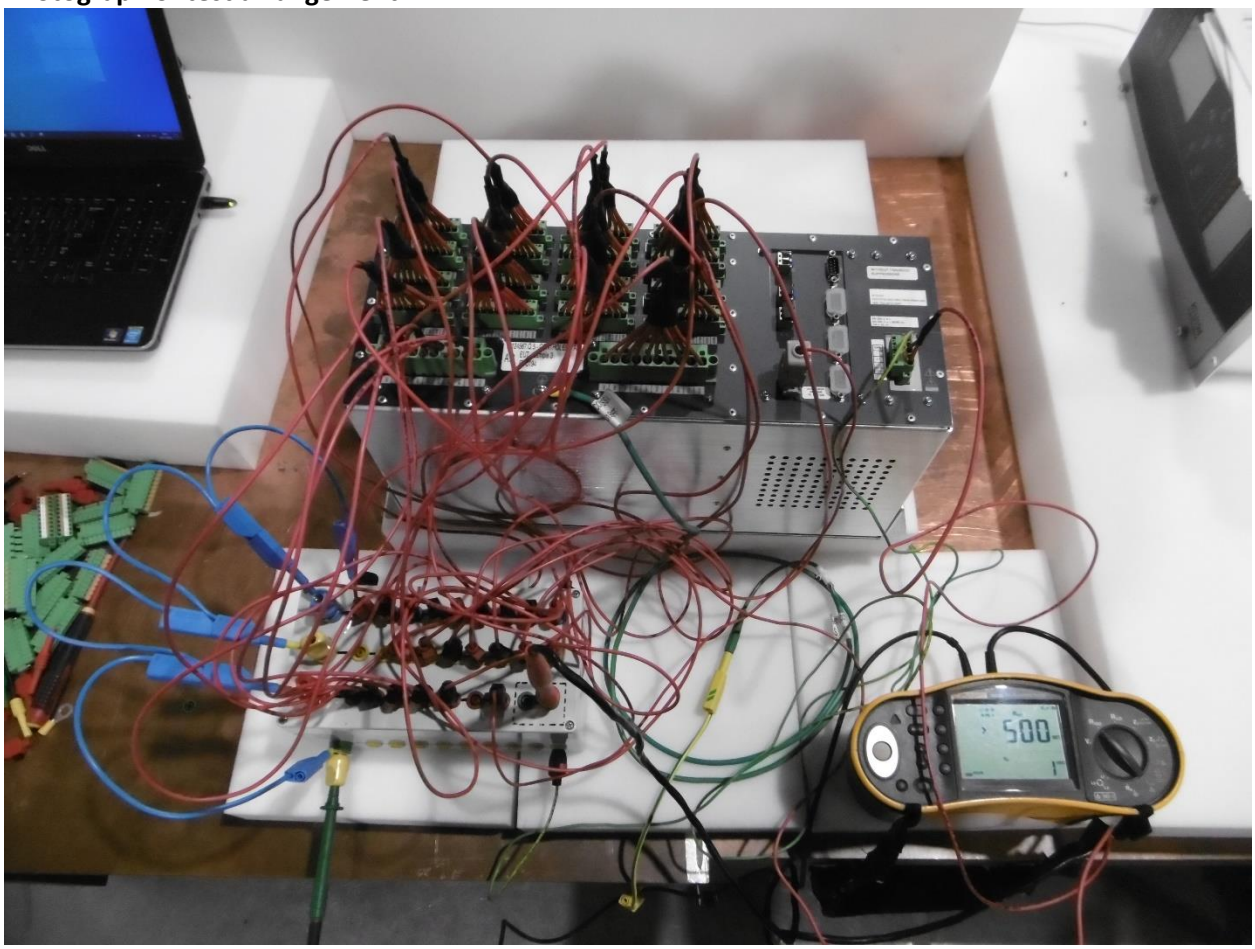
Note
The insulation measurement results after the dielectric strength test can be found in the next paragraph.

Observations
The measured insulation resistance value is well above the required values.

Requirement
- For equipment in a new condition, the insulation resistance shall not be less than 100 MΩ at 500 V d.c. After the damp heat type test, the insulation resistance shall not be less than 10 MΩ at 500 V d.c..
- No visual or functional inspection required.

Result
The object passed the test.

Photograph of test arrangement



12.5 Dielectric voltage test after climate tests

Standard and date

Standard IEC 61850-3, subclause 6.6.4
Test date 30 October 2019

Environmental conditions

Ambient temperature 22 °C Relative humidity 30 %
Ambient air pressure 999 hPa

Characteristic test data

Serial number Sample A.3, Serial No. TEL-6311-1047
Duration of test 1 min

Test arrangement		Insulation resistance at 500 Vdc	Voltage applied	Insulation resistance at 500 Vdc	Observations
Voltage applied to	Tested between	(before the test) MΩ	kVac	(after the test) MΩ	
Power supply	Earth and all others	> 550	2	> 550	1, 2
BI; E01-E08/common	Earth and all others	> 550	2	> 550	1, 2
BI; E33-E40/common	Earth and all others	> 550	2	> 550	1, 2
BI; E73-E80/common	Earth and all others	> 550	2	> 550	1, 2
BI; E65-E72/common	Earth and all others	> 550	2	> 550	1, 2
BI; E49-E56/common	Earth and all others	> 550	2	> 550	1, 2
BO; S01A-S01B	Earth and all others	> 550	2	> 550	1, 2
BO; S02A-SO2B	Earth and all others	> 550	2	> 550	1, 2
BO; S03A-SO3B	Earth and all others	> 550	2	> 550	1, 2
BO; S04A-SO4B	Earth and all others	> 550	2	> 550	1, 2
BO; S05A-S05B	Earth and all others	> 550	2	> 550	1, 2
BO; S06-S10 In one group	Earth and all others	> 550	2	> 550	1, 2
BO; S11-S15 In one group	Earth and all others	> 550	2	> 550	1, 2
BO; S16-S20 In one group	Earth and all others	> 550	2	> 550	1, 2
A01/A02/A03/A04	Earth and all others	> 550	2	> 550	1, 2
A05/A06/A07/A08	Earth and all others	> 550	2	> 550	1, 2
A05	Earth and all others	> 550	2	> 550	1, 2
A06	Earth and	> 550	2	> 550	1, 2

Test arrangement		Insulation resistance at 500 Vdc	Voltage applied	Insulation resistance at 500 Vdc	Observations
Voltage applied to	Tested between	(before the test) MΩ	kVac	(after the test) MΩ	
	all others				
A07	Earth and all others	> 550	2	> 550	1, 2
A08	Earth and all others	> 550	2	> 550	1, 2
VT; VA1/VB1/VC1/VN1 CT; IA11/IA12, IB11/IB12, IC11/IC12 In one group	Earth and all others	> 550	2	> 550	1, 2
VT; VA2/VB2/VC2/VN2 In one group	Earth and all others	> 550	2	> 550	1, 2
CT; IA21/IA22, IB21/IB22, IC21/IC22 In one group	Earth and all others	> 550	2	> 550	1, 2
CT; IA21/IA22	Earth and all others	> 550	2	> 550	1, 2
CT; IB21/IB22,	Earth and all others	> 550	2	> 550	1, 2
CT; IC21/IC22	Earth and all others	> 550	2	> 550	1, 2
IRIG-B port	Earth and all others	> 550	0,5	> 550	1, 2

Observations

1. No discharge or flashover observed.
2. The measured insulation resistance value is well above the required values.

Requirement

- No disruptive discharges or flashovers shall occur.
- For equipment in a new condition, the insulation resistance shall not be less than 100 MΩ at 500 V d.c. After the damp heat type test, the insulation resistance shall not be less than 10 MΩ at 500 Vdc.
- The visual and functional inspection shall not reveal any defects or malfunctions.

Result

The object passed the test.

12.6 Protective bonding resistance test after damp-heat environmental test

Standard and date

Standard IEC 61850-3, subclause 6.9.2.4
Test date 30 January 2020

Characteristic test data

Serial number Sample A.3, Serial No. TEL-6311-1047
Test current 20 A
Test voltage ≤ 12 Vac/Vdc
Duration of test 60 s

Test point	Measured with respect to Terminal	Resistance Ω
Front screw right	PE on the power supply connector	0,009
Front right 19” bracket	PE on the power supply connector	0,009
Front left 19” bracket	PE on the power supply connector	0,009
Earth terminal rear side	PE on the power supply connector	0,009

Observations

The bonding resistance value is well below the 0,1 Ω.

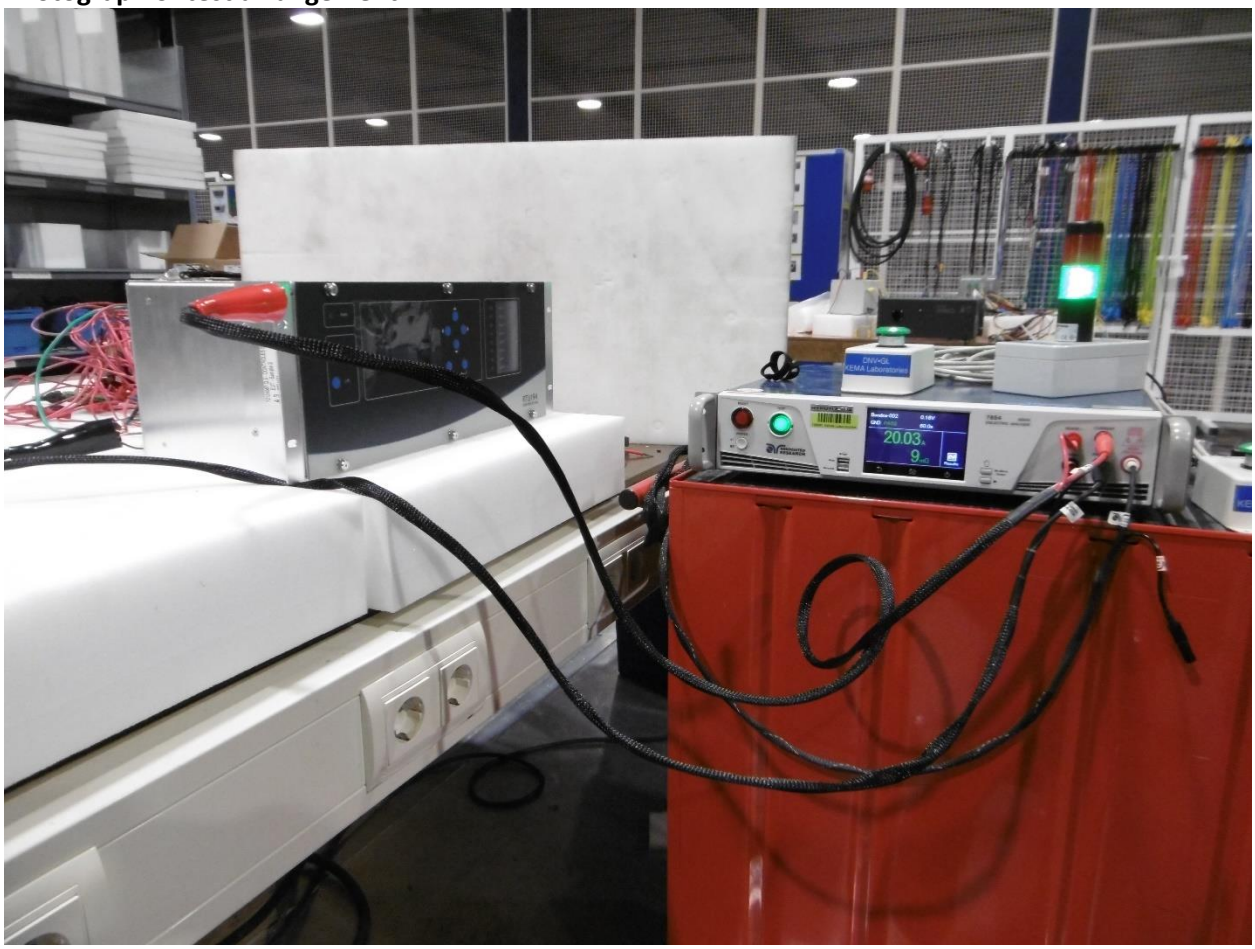
Requirement

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

Result

The object passed the test.

Photograph of test arrangement



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 (CT, VT, sensitive current);
- digital inputs (binary inputs);
- contact outputs (binary outputs);
- timing port (IRIG-B);
- data communication (optical, RS232).

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:

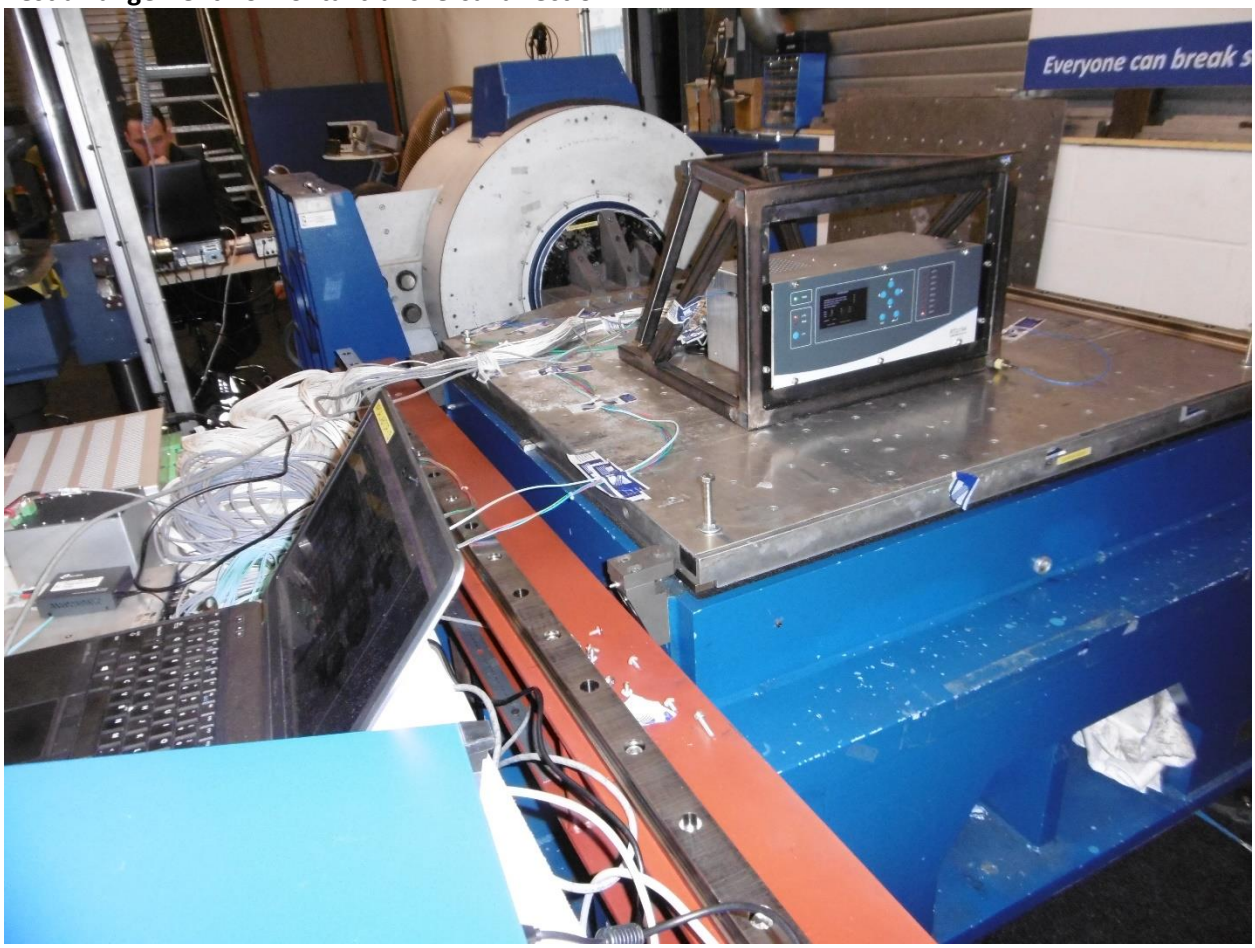
- alarm indications on display and LED's;
- error messages reported in the maintenance computer;
- unintentional change of state of contact outputs;
- unintentional change of state of the binary input inputs;
- loss of timing information;
- there shall be no degradation of performance below the claimed 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

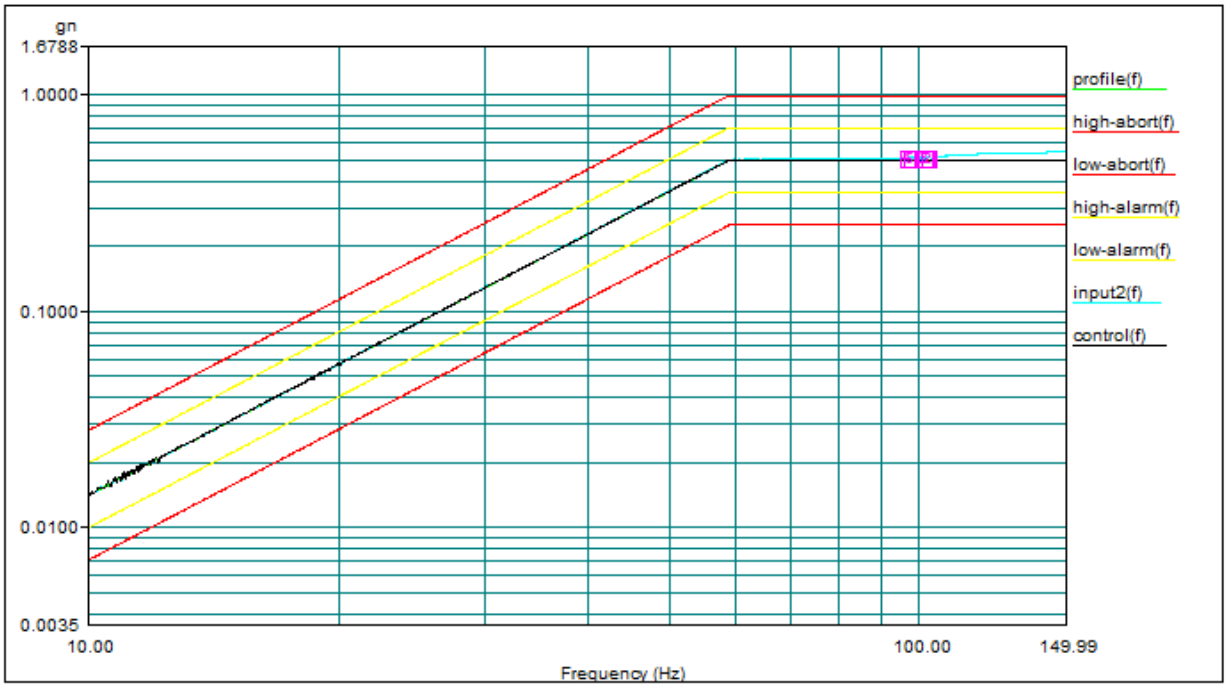
Standard and date

Standard	IEC 61850-3, subclause 6.10.1
Basic standard	IEC 60255-21-1
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	energized
Auxiliary power supply input	230 Vac
Frequency range	10 to 150 Hz
Displacement	0,035 mm
Acceleration	0,5 g
Number of sweep cycles in each axis	1
Number of axis	3

Vibration response test graph



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 1 or 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

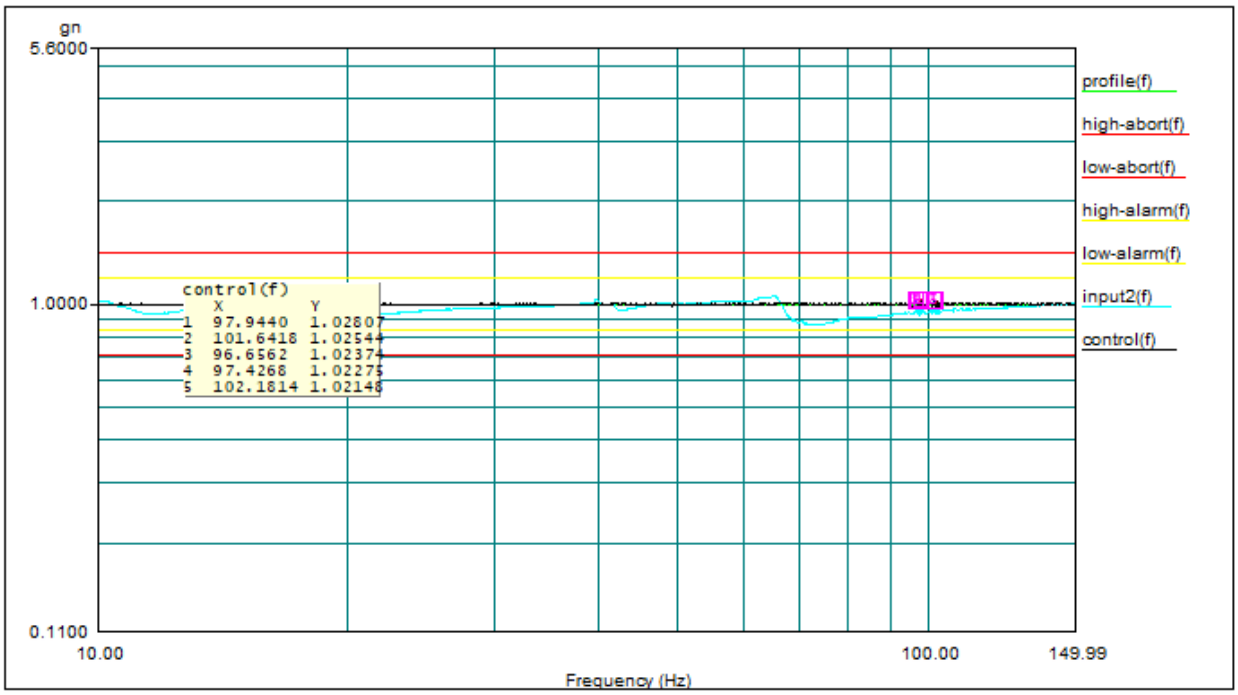
Standard and date

Standard	IEC 61850-3, subclause 6.10.1
Basic standard	IEC 60255-21-1
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	non-energized
Frequency range	10 to 150 Hz
Acceleration	1 g
Number of sweep cycles in each axis	20
Number of axis	3

Vibration endurance test graph



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 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

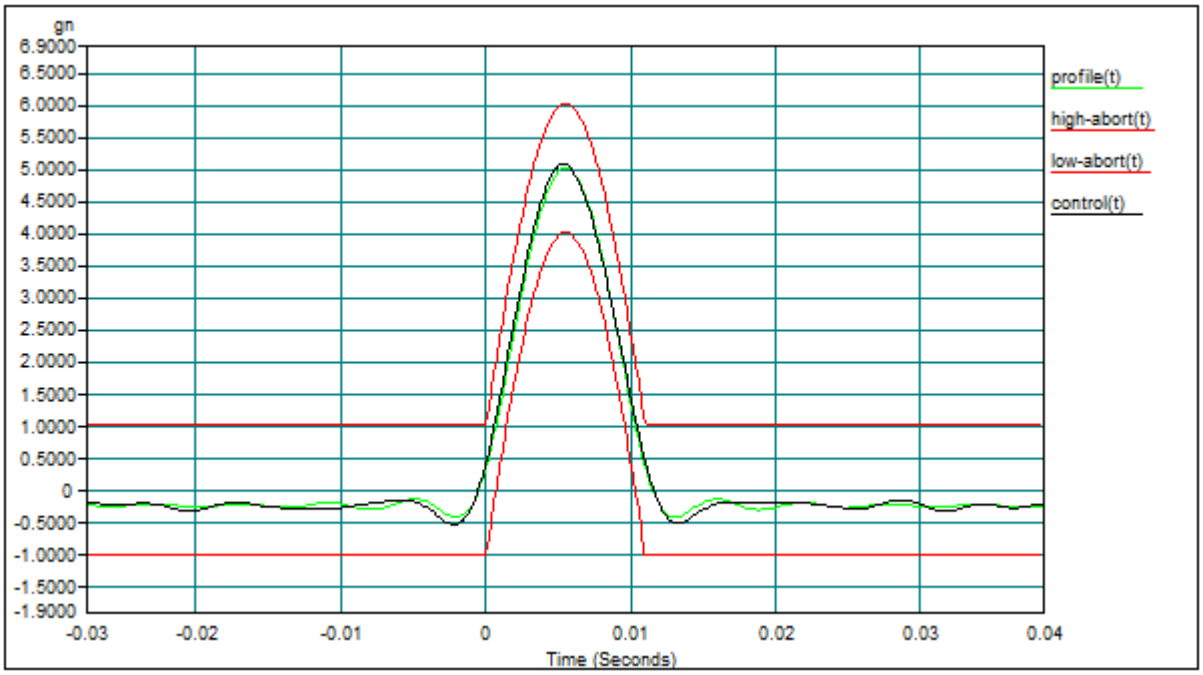
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	energized
Power supply	230 Vac
Acceleration	5 g
Duration of pulses	11 ms
Number of pulses in each axis	6
Number of axis	3

Shock response test graph



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 1 or 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

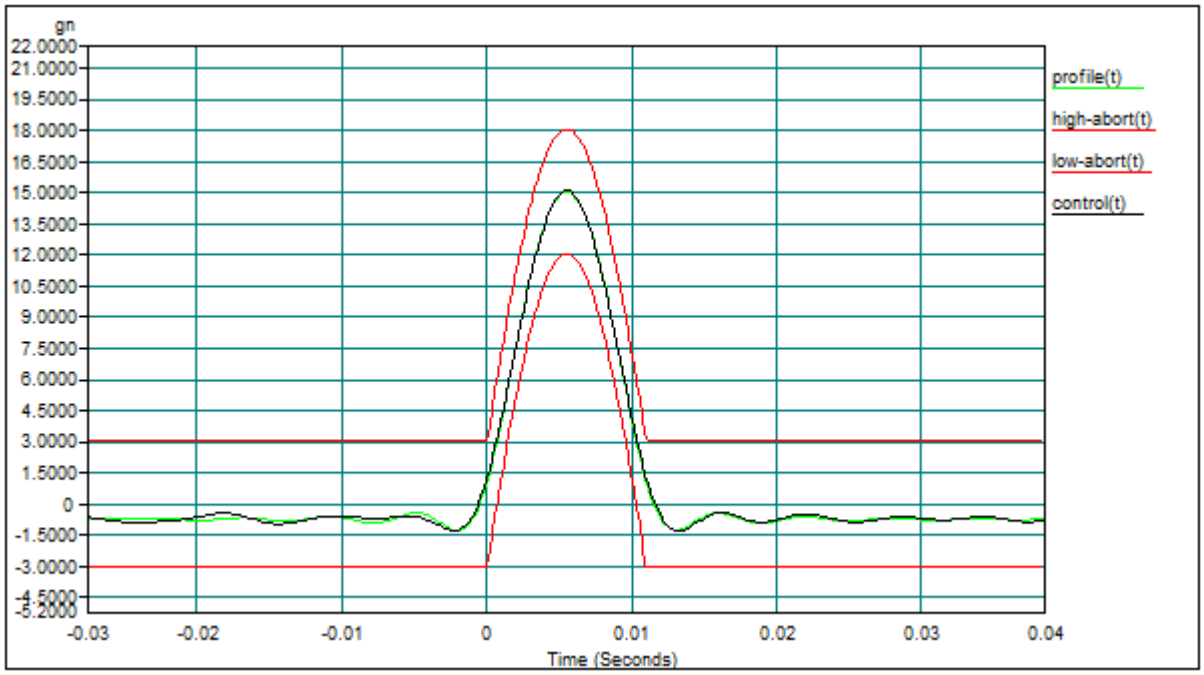
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	non-energized
Acceleration	15 g
Duration of pulses	11 ms
Number of pulses in each axis	6
Number of axis	3

Shock withstand test graph



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

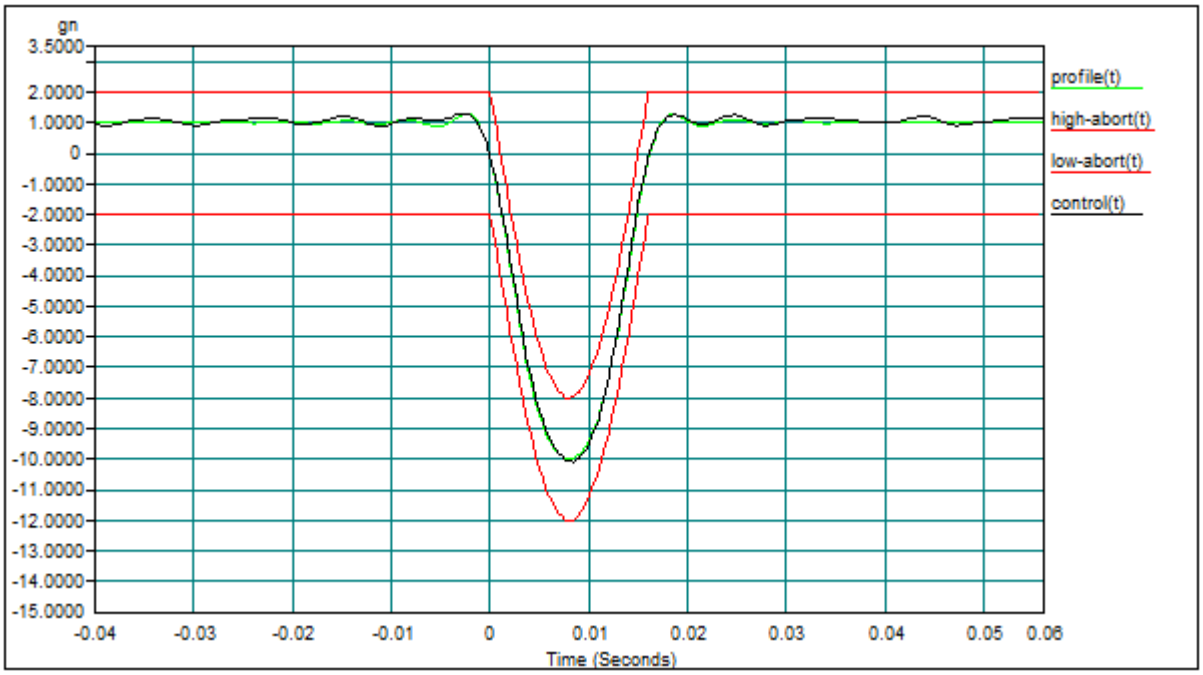
Standard and date

Standard	IEC 61850-3, subclause 6.10.2
Basic standard	IEC 60255-21-2
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	non-energized
Acceleration	10 g
Duration of pulses	16 ms
Number of pulses in each axis	2000
Number of axis	3

Bump test graph



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 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

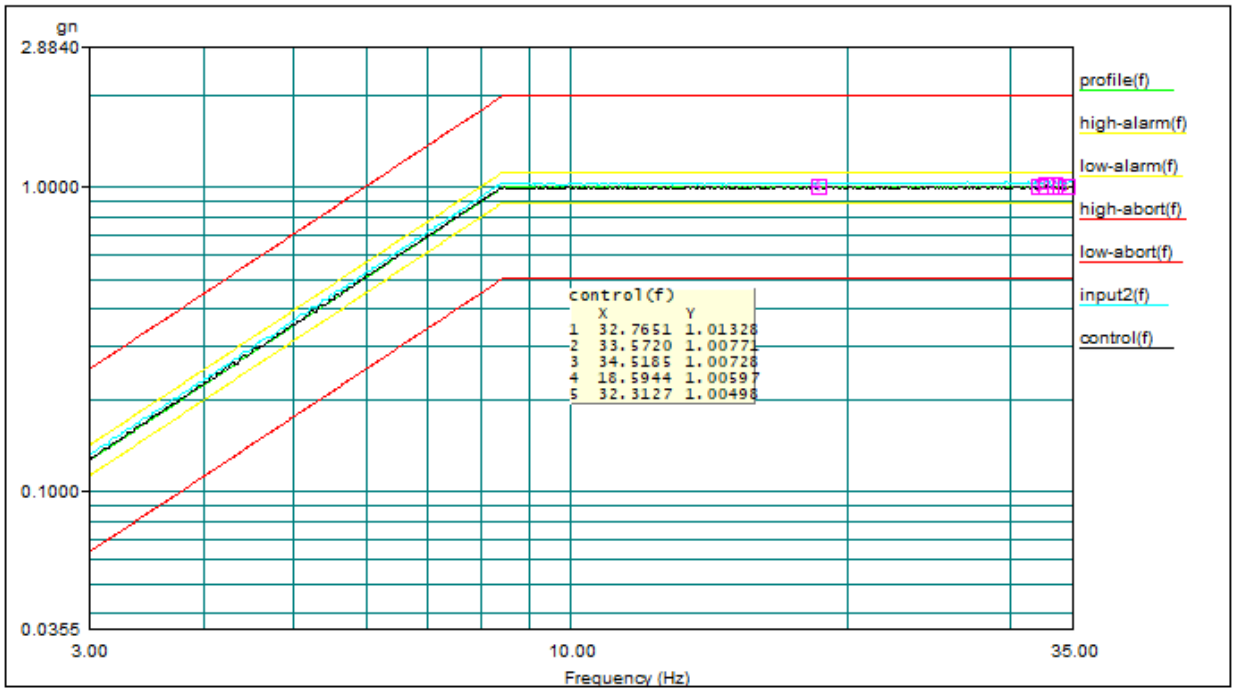
Standard and date

Standard	IEC 61850-3, subclause 6.10.3
Basic standard	IEC 60255-21-2
Test date	16 to 18 December 2019

Characteristic test data

Serial number	Sample A.4, Serial No. TEL-6396-1098
Test object	energized
Power supply input	230 Vac
Frequency range	1 to 35 Hz
Cross-over frequency	8 to 9 Hz
Displacement horizontal axis (x)	3,5 mm
Displacement vertical axis (y)	1,5 mm
Acceleration horizontal axis (x)	1,0 g
Acceleration vertical axis (y)	0,5 g
Number of sweep cycles in each axis	1
Number of axis	3

Single axis sine sweep seismic test graph



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 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 20 March 2020

Terminal side	Degree of protection	
	Specification by the manufacturer	Observation
Front	IP 2X	IP 2X
Top	IP 2X	IP 2X
Bottom	IP 2X	IP 2X
Back	IP 2X	IP 2X
Left	IP 2X	IP 2X
Right	IP 2X	IP 2X

Requirement

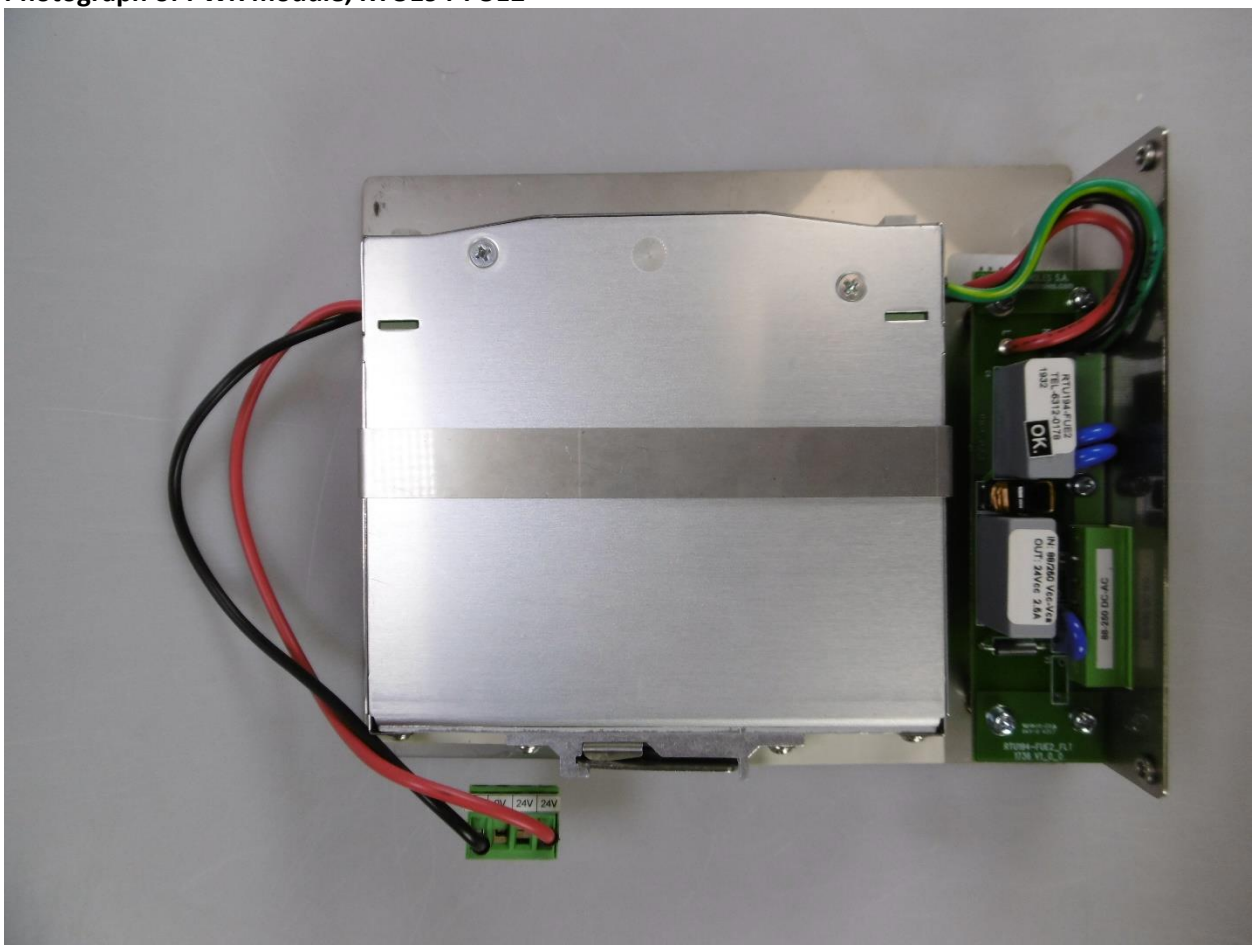
- The test finger shall not touch hazardous live parts.
- The test finger voltage or energy shall not exceed the safe limits for normal operational use.
- No visual or functional inspection required.

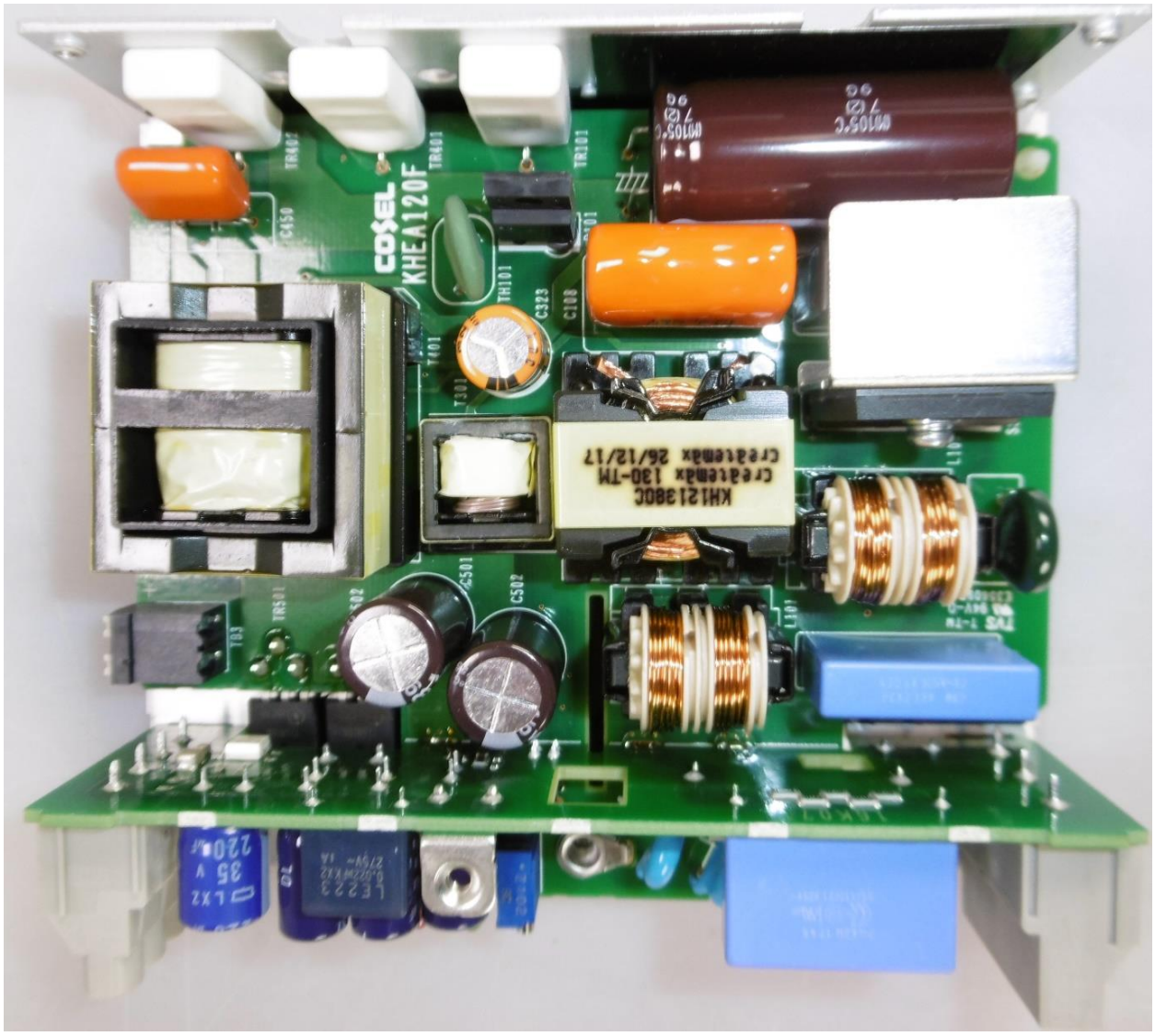
Result

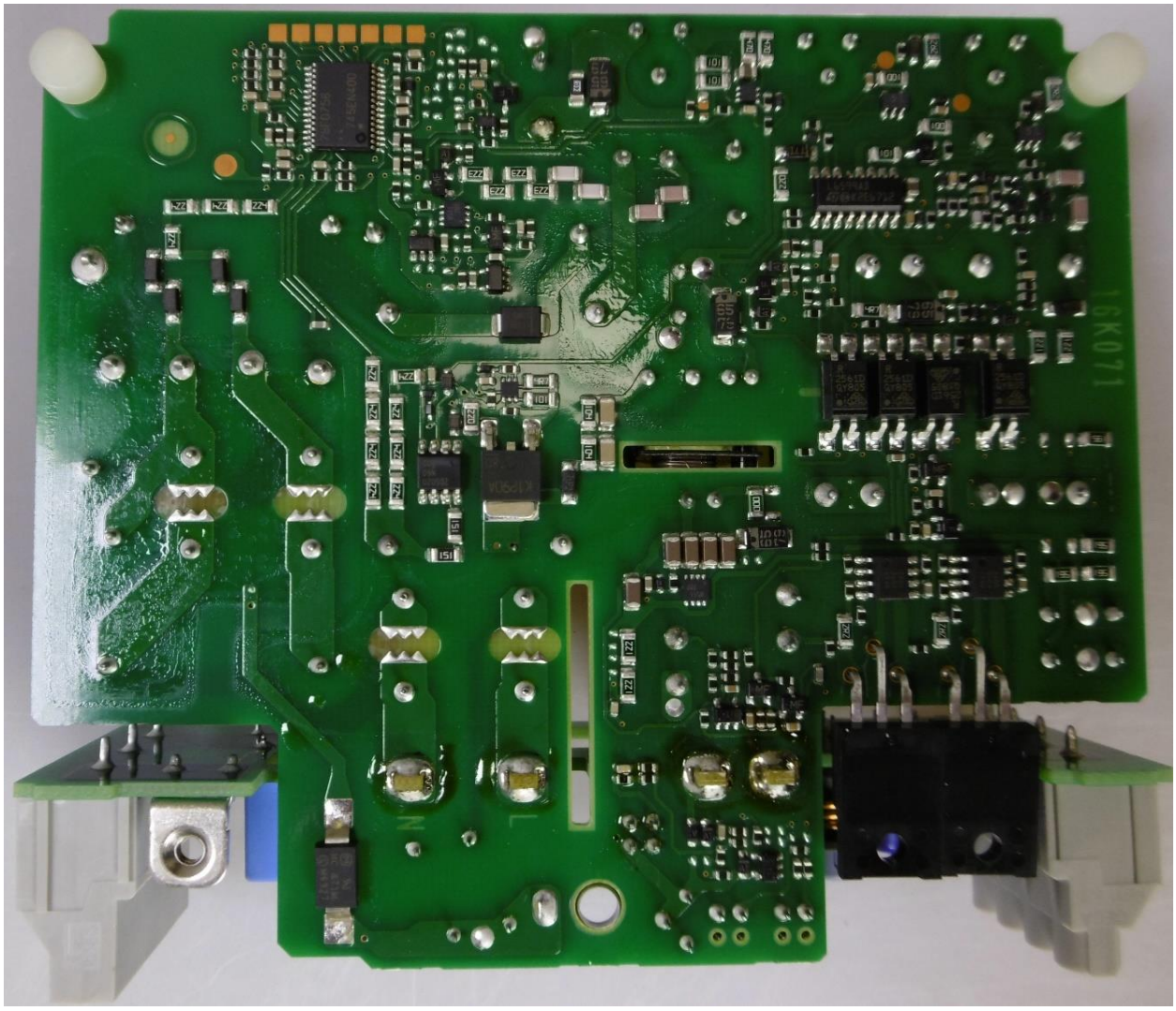
The object passed the test.

15 PHOTOGRAPHS OF PRINTBOARDS

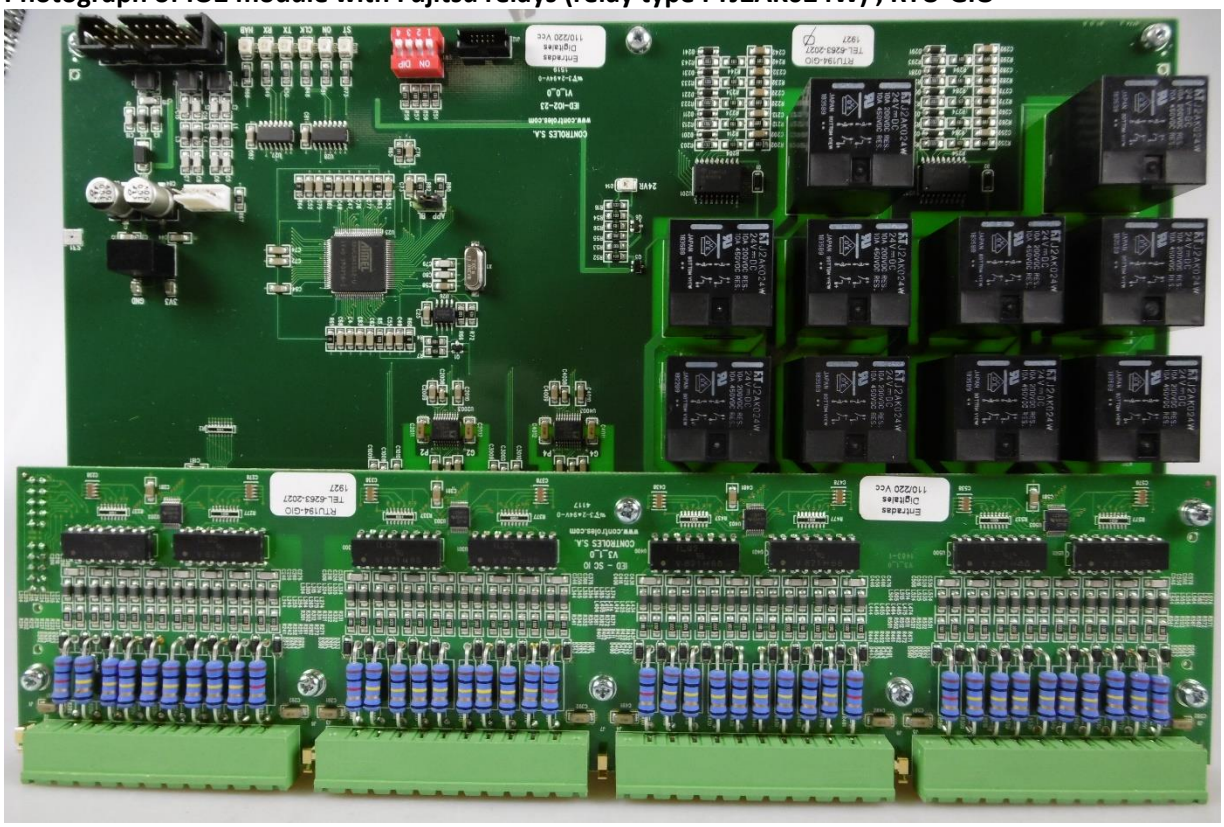
Photograph of PWR module; RTU194-FUE2



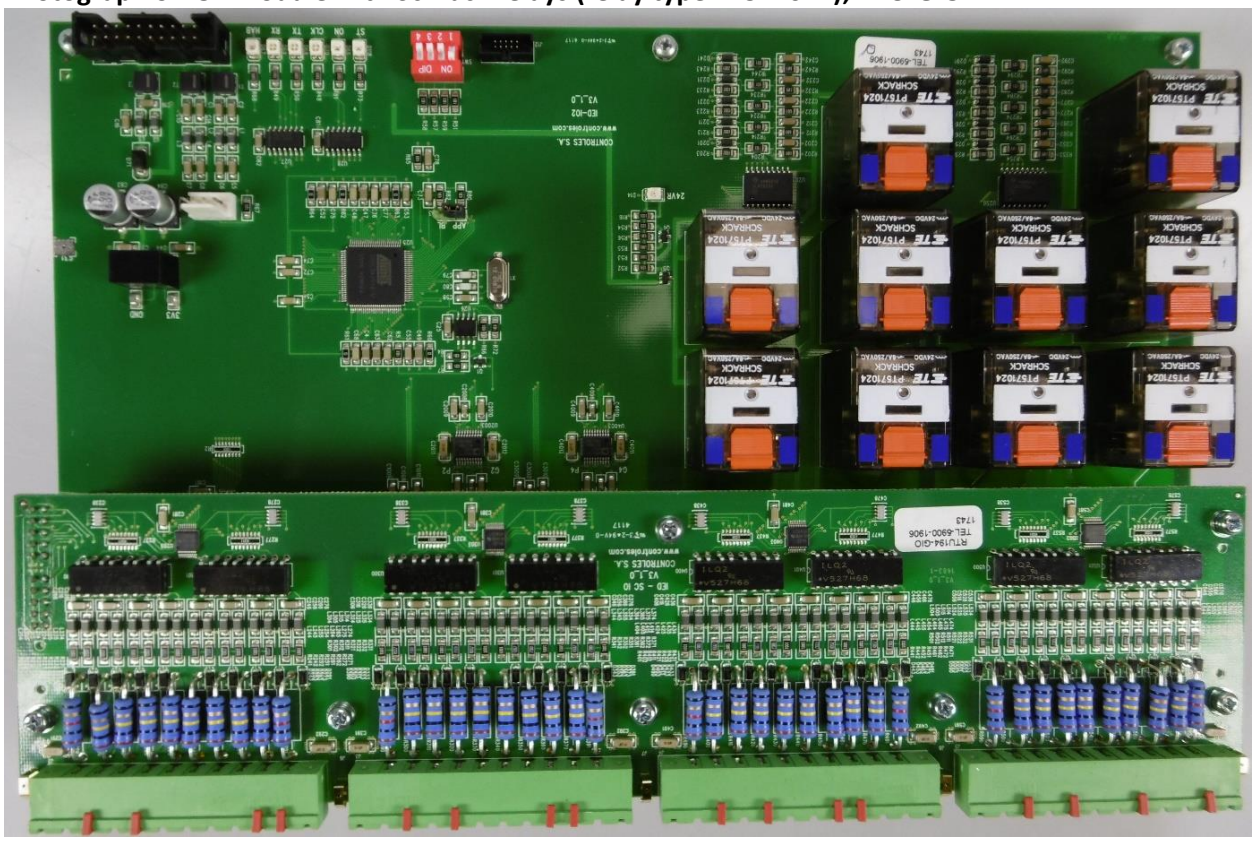

COSEL
KHEA120F
KH1213BOC
Cre8temAx 130-TM
Cre8temAx 26/12/17



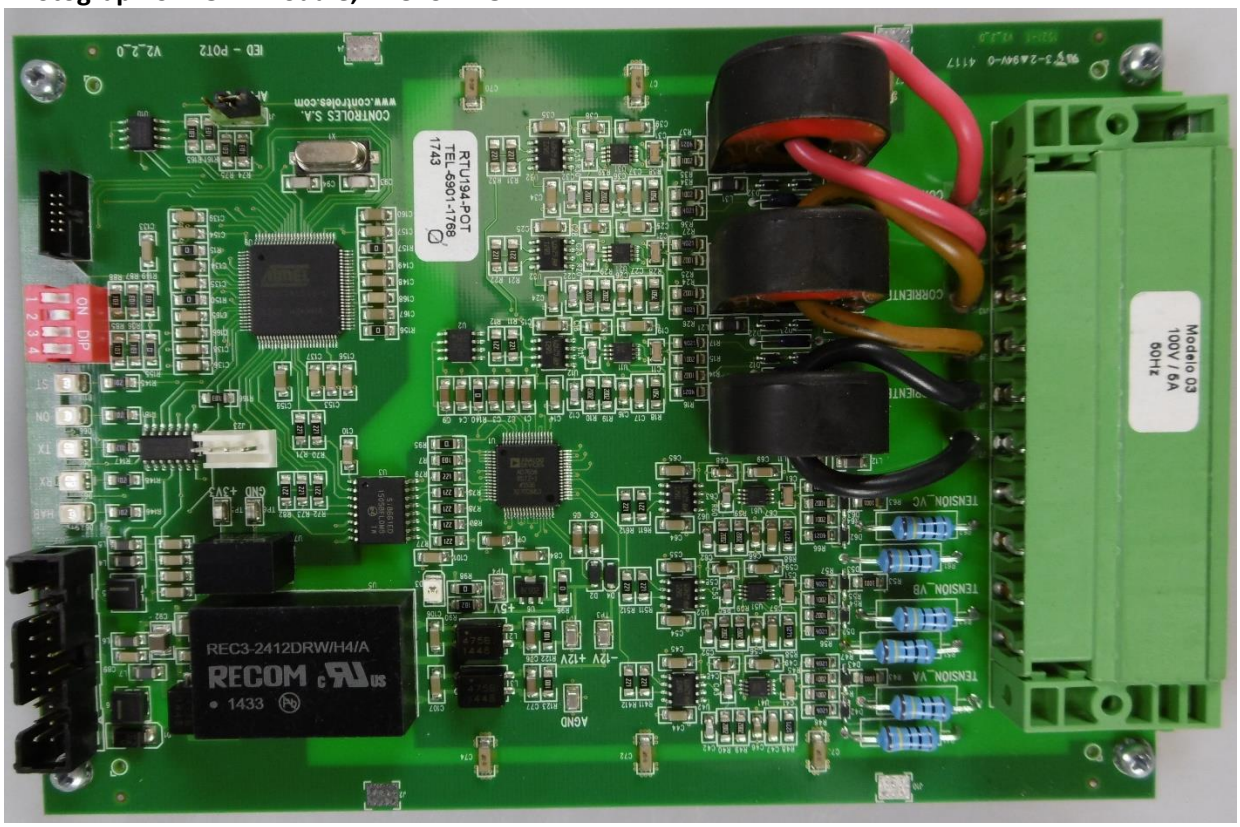
Photograph of IO2 module with Fujitsu relays (relay type FTJ2AK024W) ; RTU-GIO



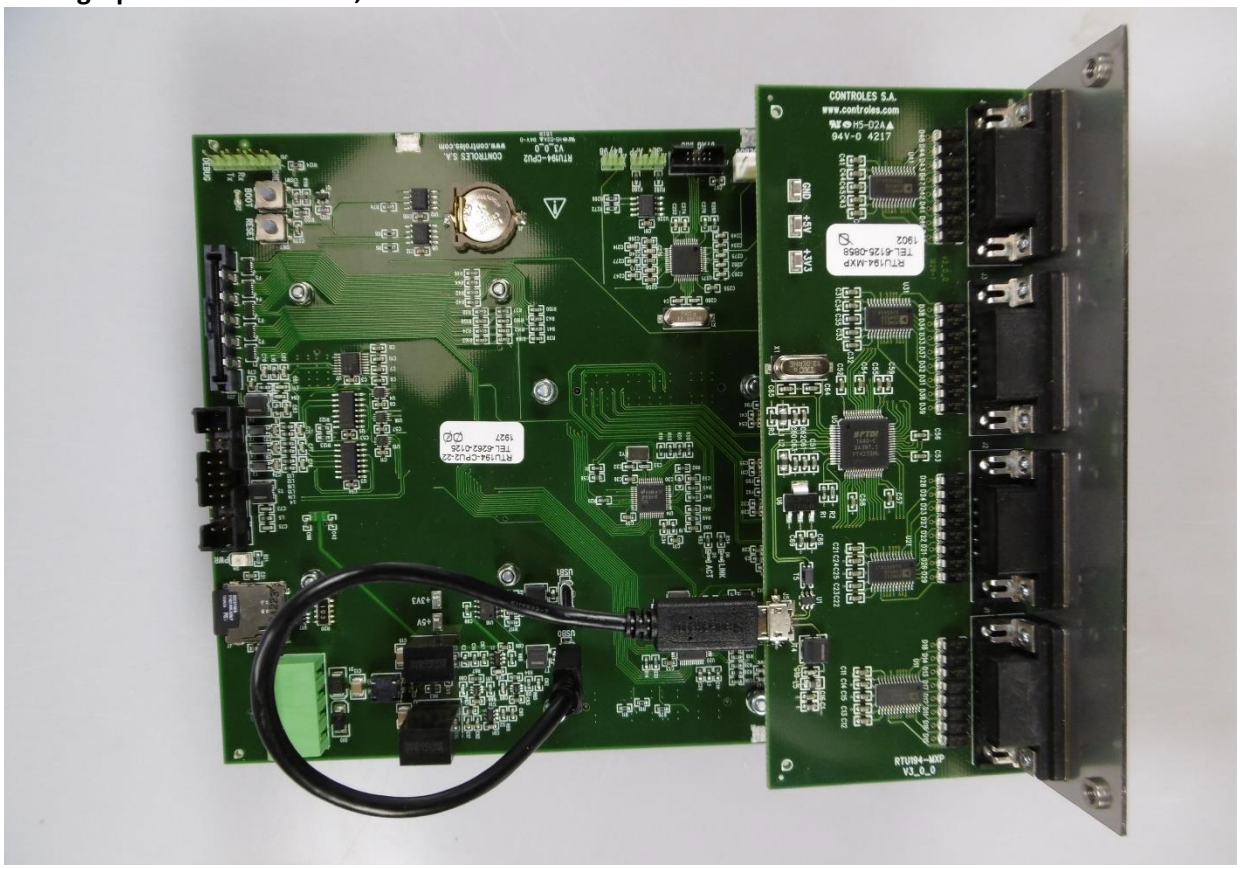
Photograph of IO2 module with Schrack relays (relay type PT571024); RTU-GIO

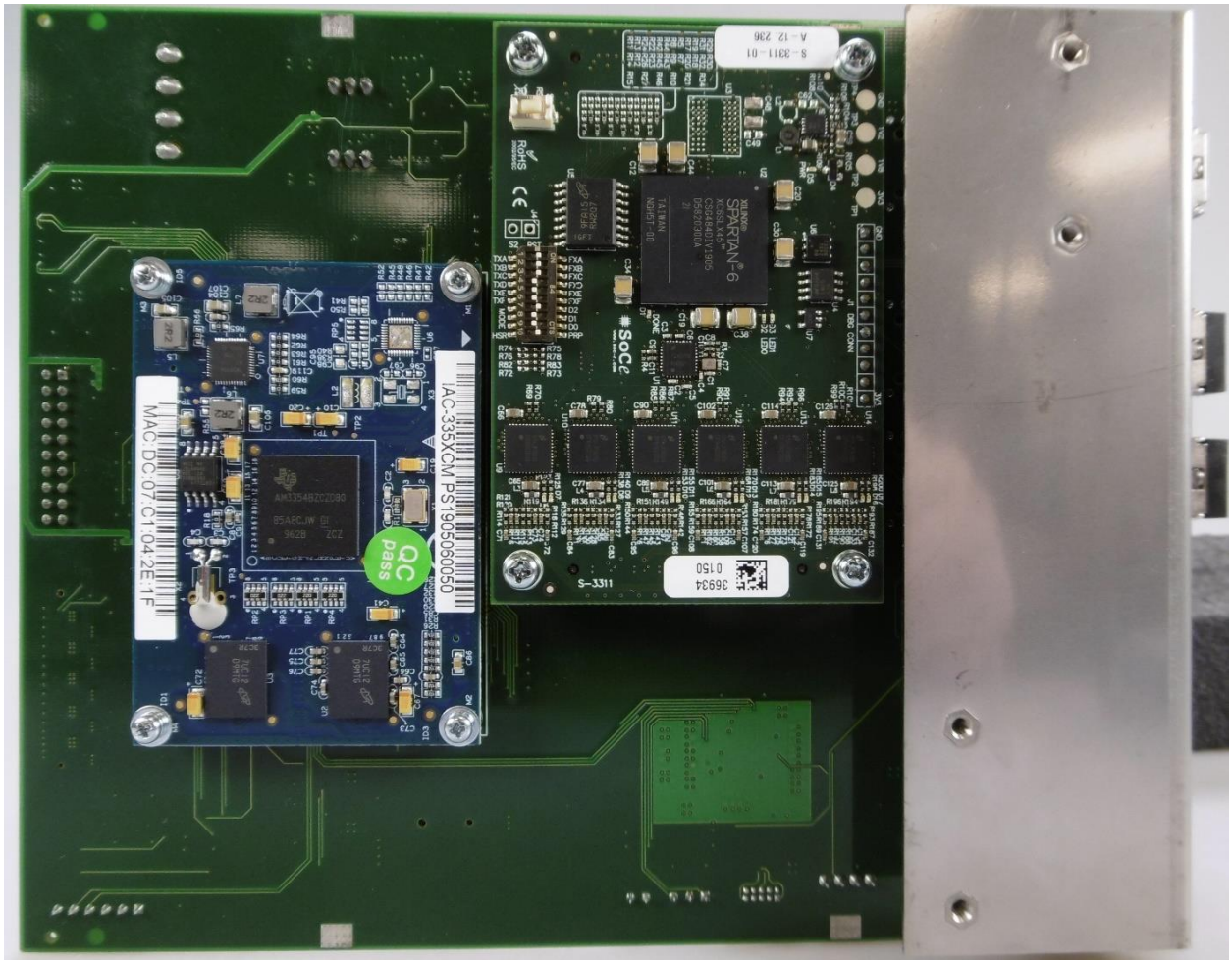


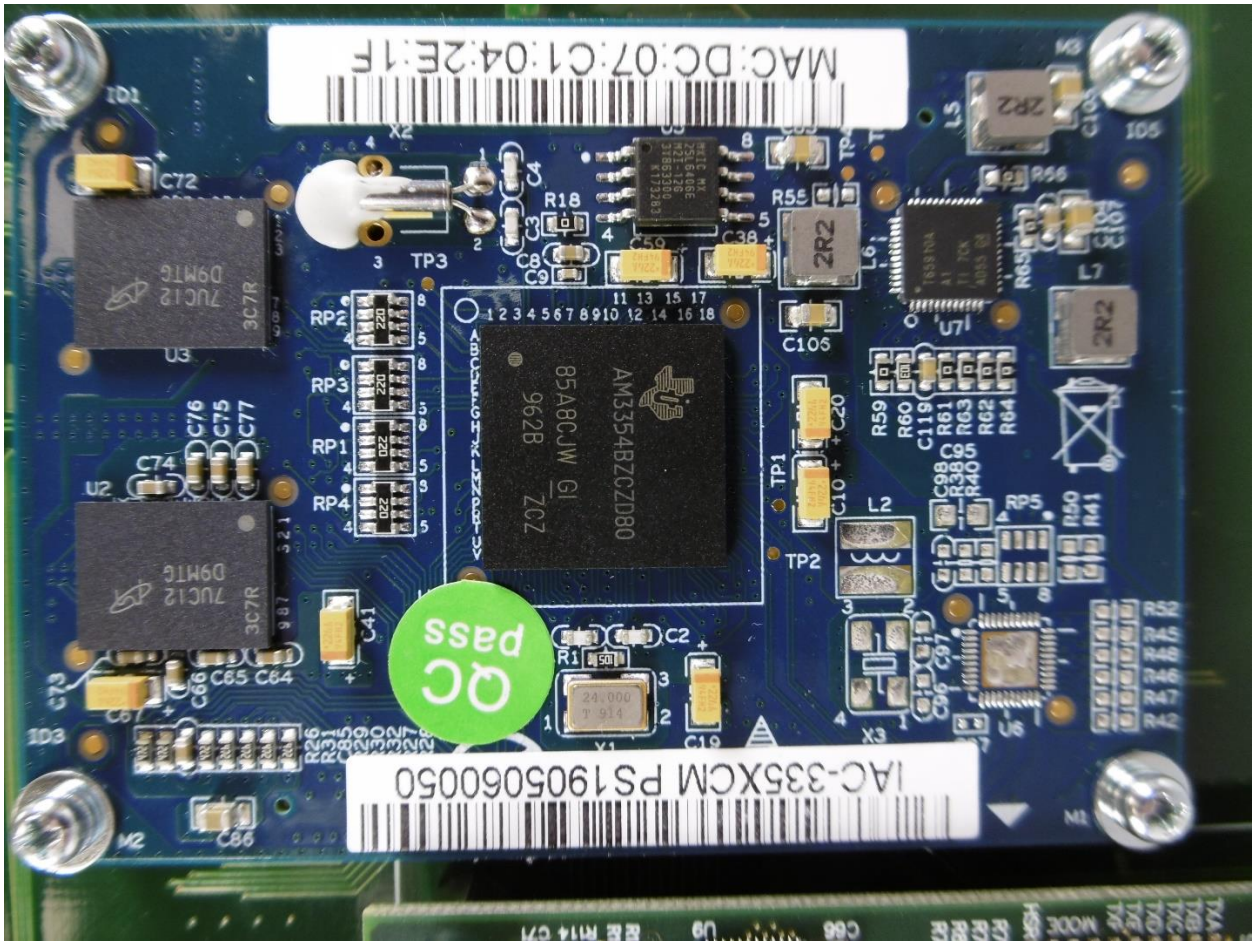
Photograph of POT2 module; RTU194-POT

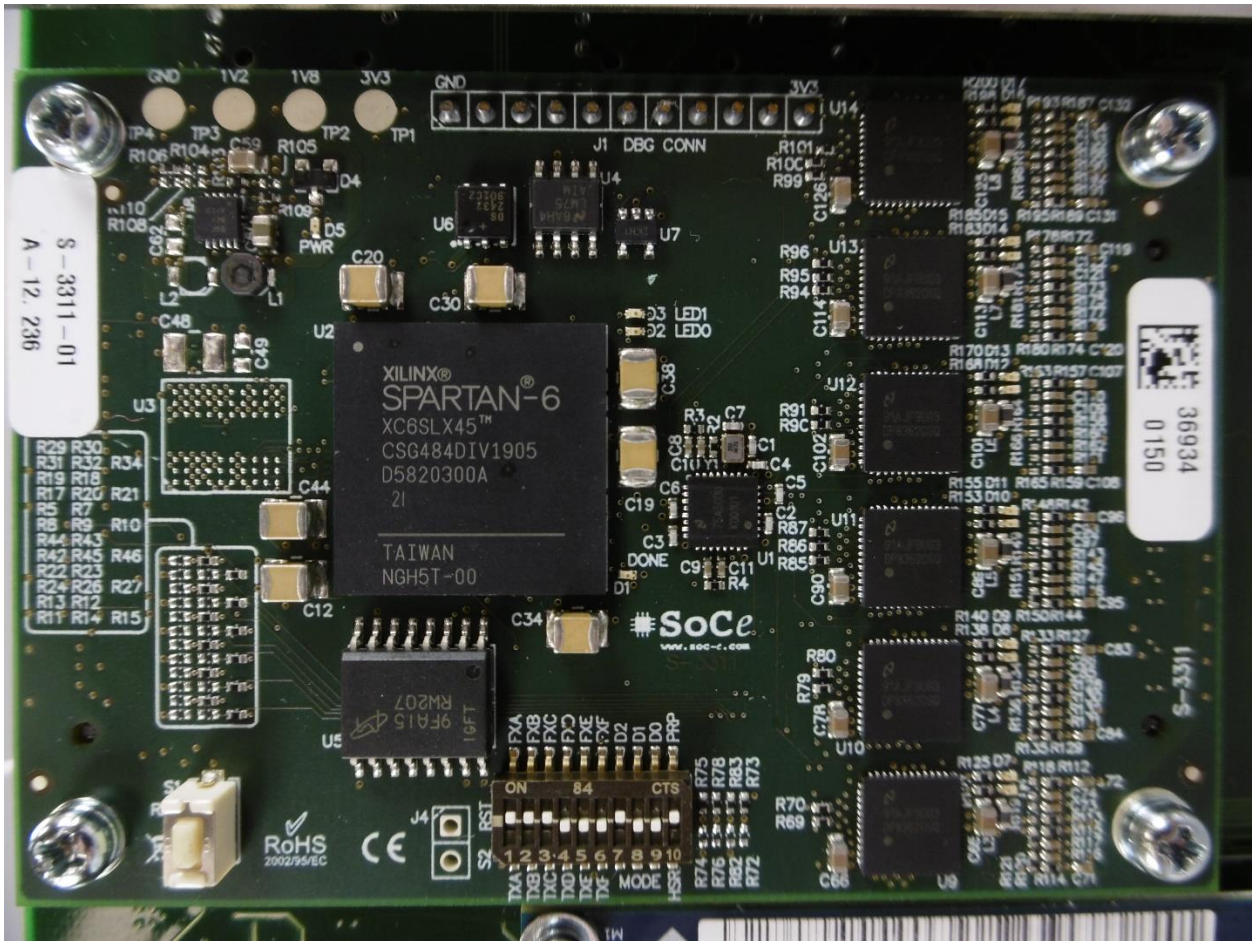


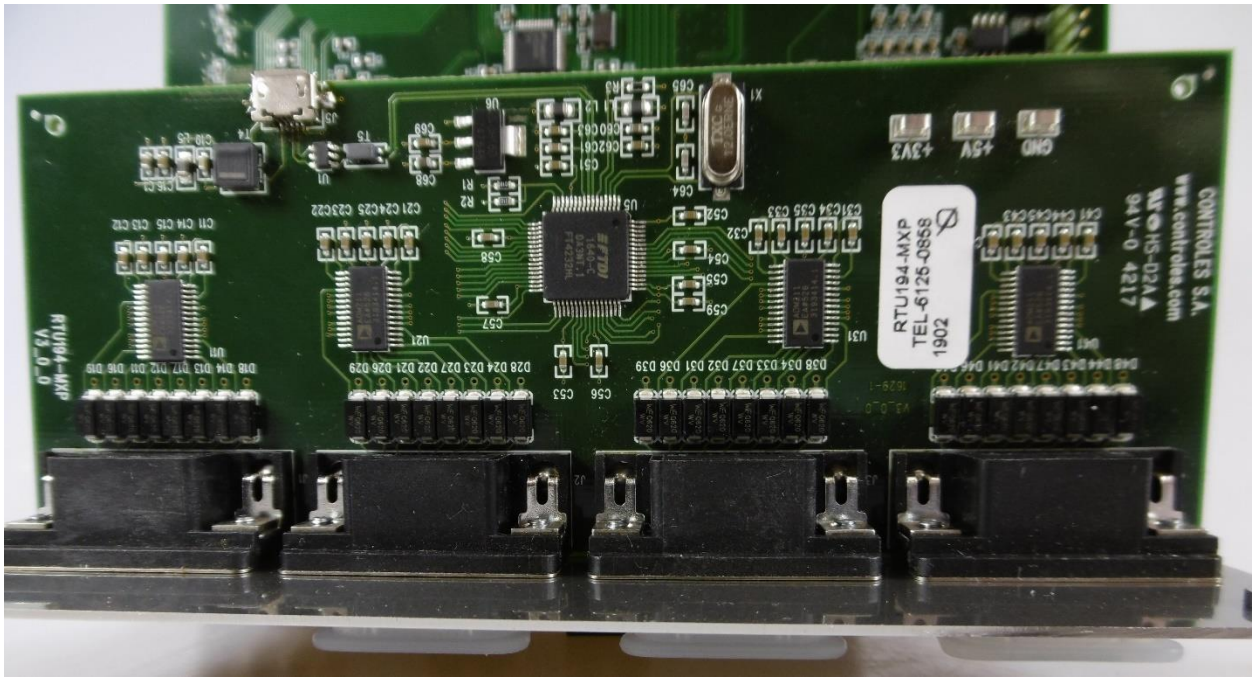
Photographs of CPU module; RTU-CPU22



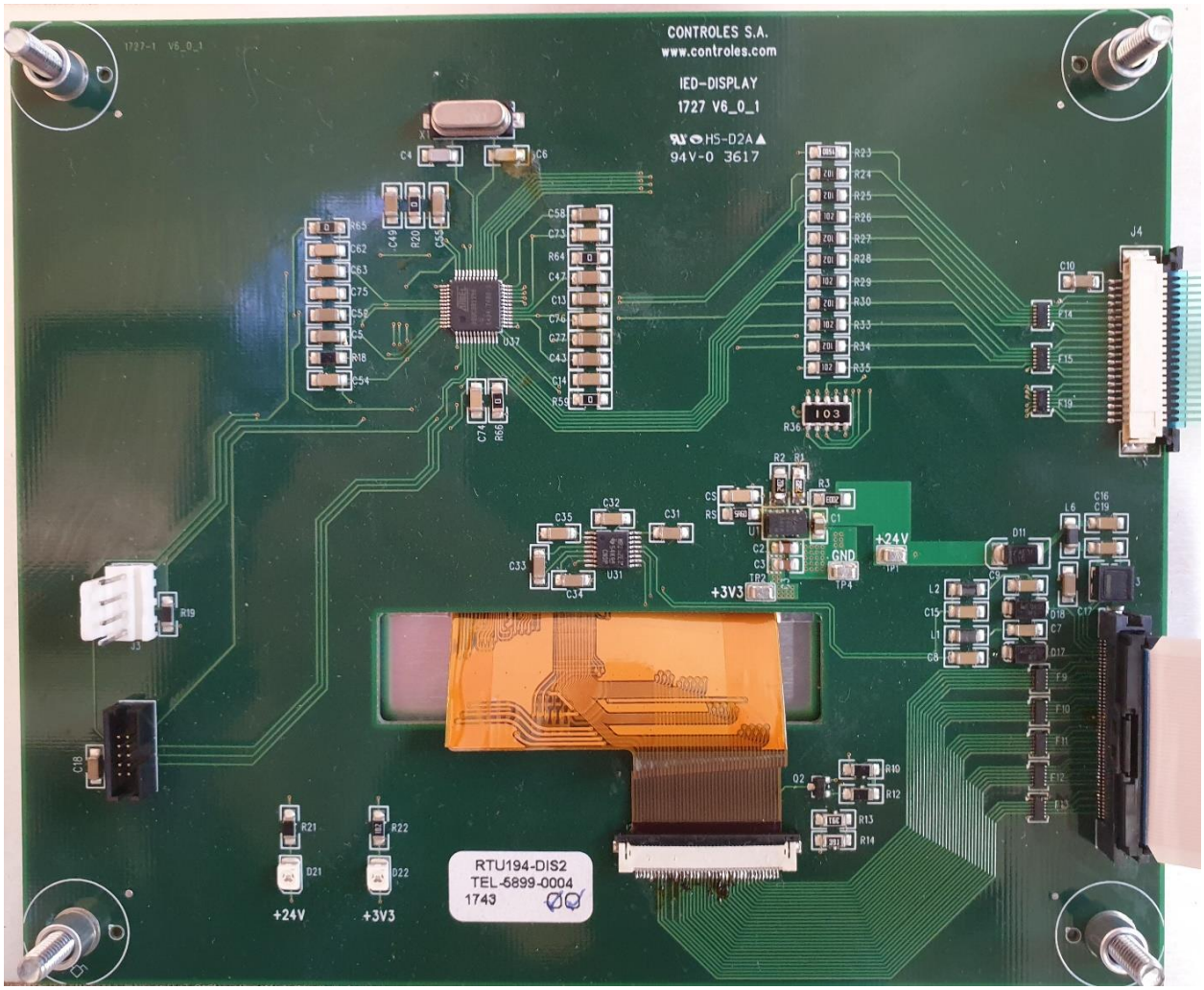

IAC-335XCM PS1905060050
MAC DC:07:C1:04:2E:1F
QC pass
S-3311
SPARTAN-6
SoC2

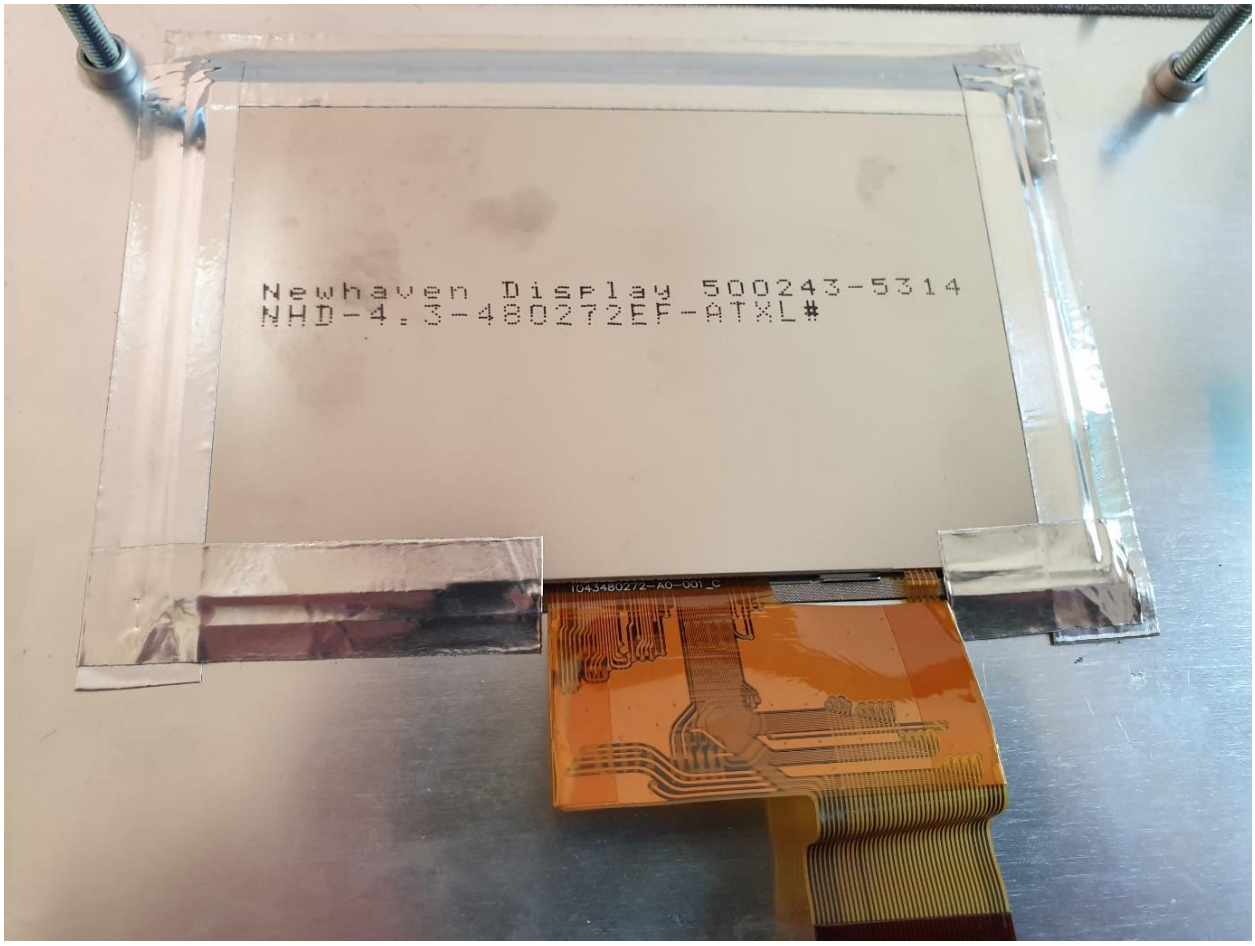

MAC:DC:07:C1:04:2E:1F
IAC-335XCM PS1905060050
AM3354BZCZD80
85A8CJW GI
962B ZCZ
pass


XILINX®
SPARTAN®-6
XC6SLX45™
CSG484DIV1905
D5820300A
TAIWAN
NGH5T-00
J1 DBG CONN
#SoCe
RoHS
S-3311-01
A-12.236
36934
0150


RTU194-MXP
TEL-6125-0858
1902
CONTROLES S.A.

Photographs of FRENTE module; RTU194-DIS2


CONTROLES S.A.
www.controles.com
IED-DISPLAY
1727 V6_0_1
94V-0 3617
RTU194-DIS2
TEL-6899-0004
1743
+24V
+3V3
GND


Newhaven Display 500243-5314
NHD-4.3-480272EF-ATXL#

16 PHOTOGRAPHS OF CHANGES TO THE TEST OBJECT

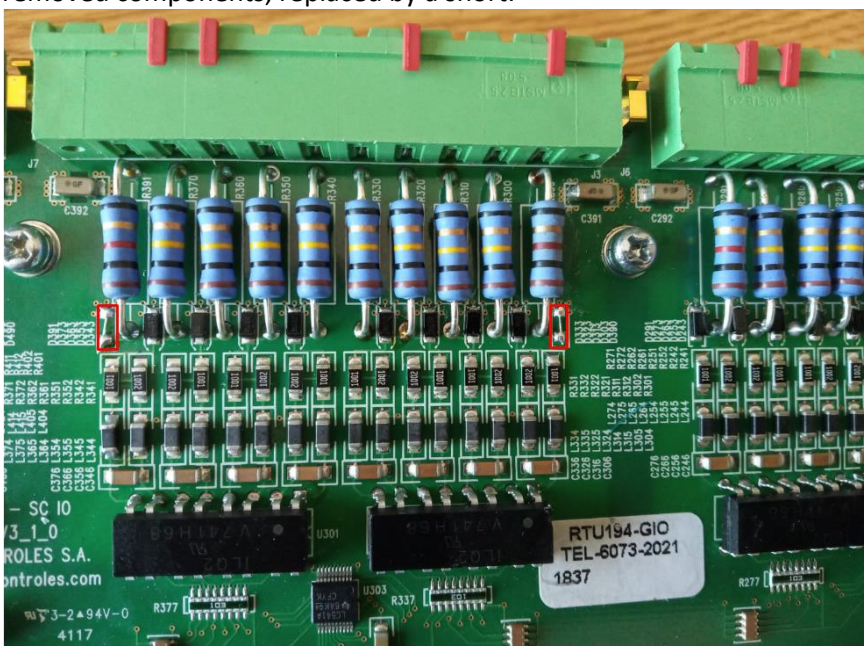
During the testing period the following changes on the test object were made:

Change 1: the GIO input circuits have been modified to comply with the EMC conducted disturbance inducted by radio-frequency fields immunity requirements.

For compliance, TVS diodes connected to the common return of each digital input block have to be removed and their pads shorted out. The following table shows the reference designator of the components to be removed.

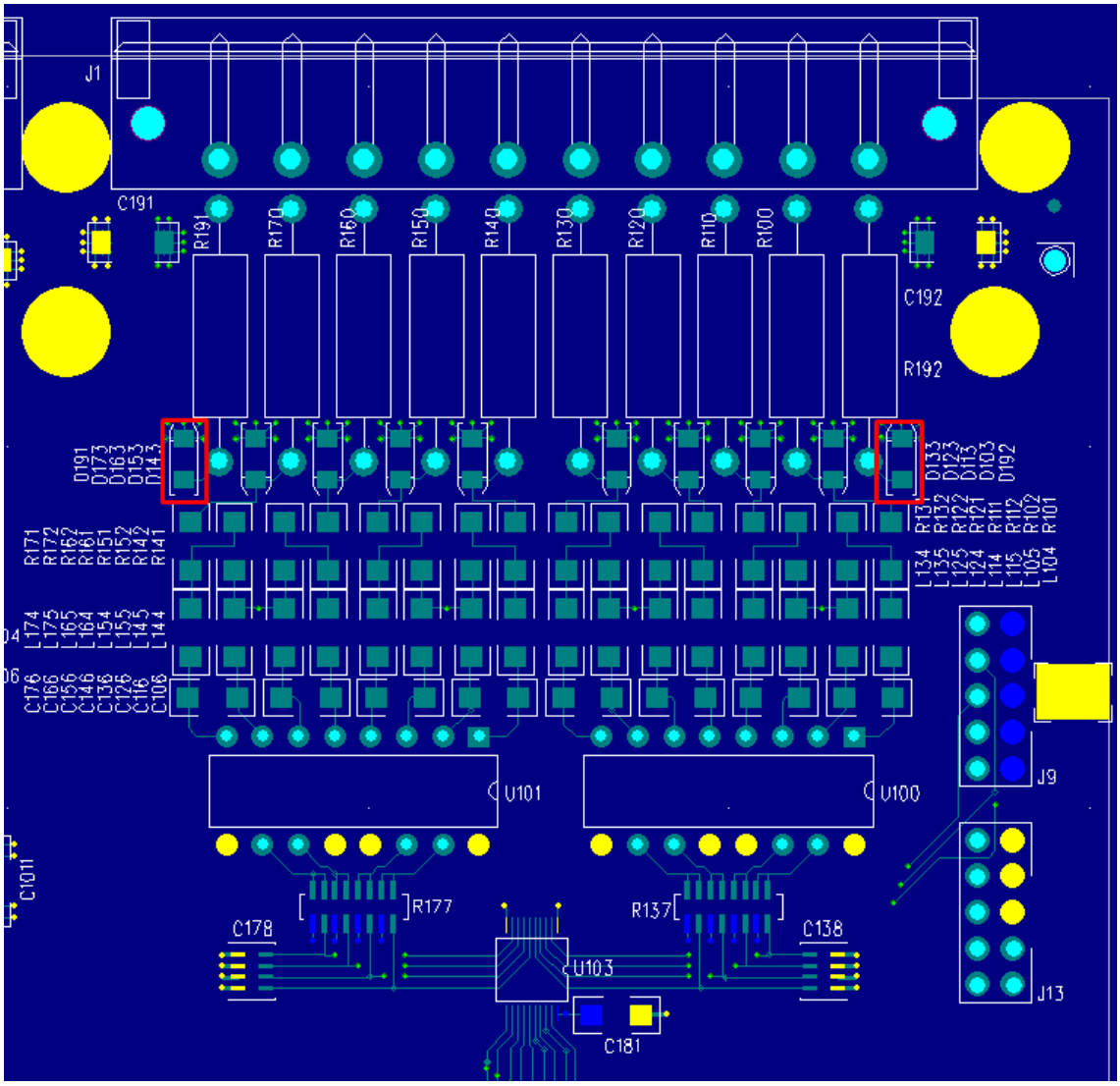
Component	Location
D192	Main board digital input block
D191	Main board digital input block
D291	Daughter board digital input block 1
D292	Daughter board digital input block 1
D390	Daughter board digital input block 2
D391	Daughter board digital input block 2
D490	Daughter board digital input block 3
D491	Daughter board digital input block 3
D590	Daughter board digital input block 4
D591	Daughter board digital input block 4

Below some pictures showing the modification are presented. Notice the red square indicating the removed components, replaced by a short.

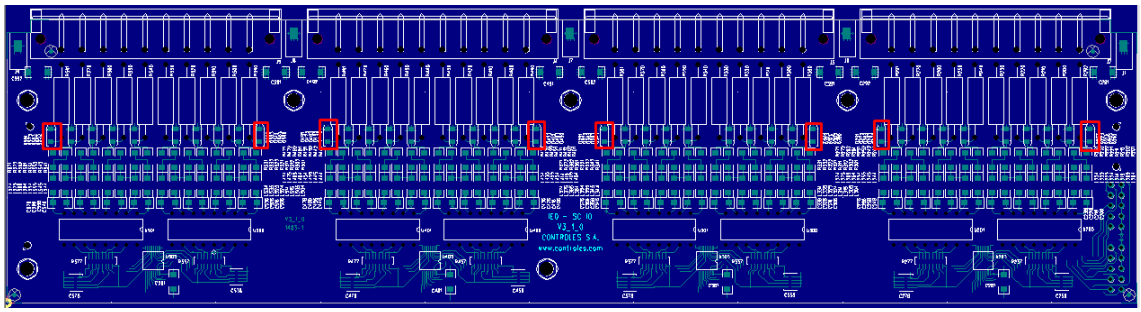


Below the PCB design files (for both the main board and daughter board) have been presented to indicate the components to be removed by a short. Notice the red squares:

MAIN BOARD

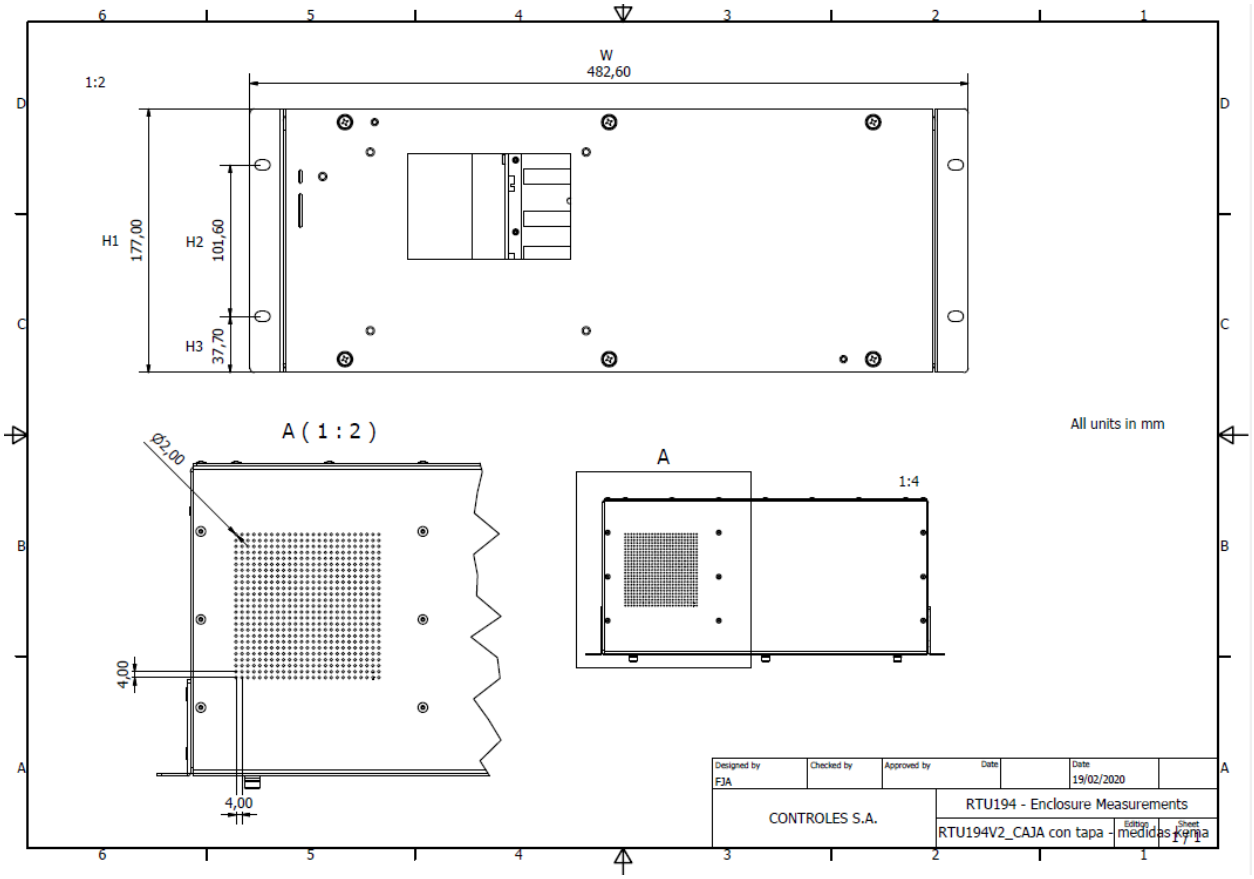


DAUGHTER BOARD



Change 2: the GIO creepage distances have been increased to comply with the product safety distance creepage requirements. Refer to chapter 9.3.

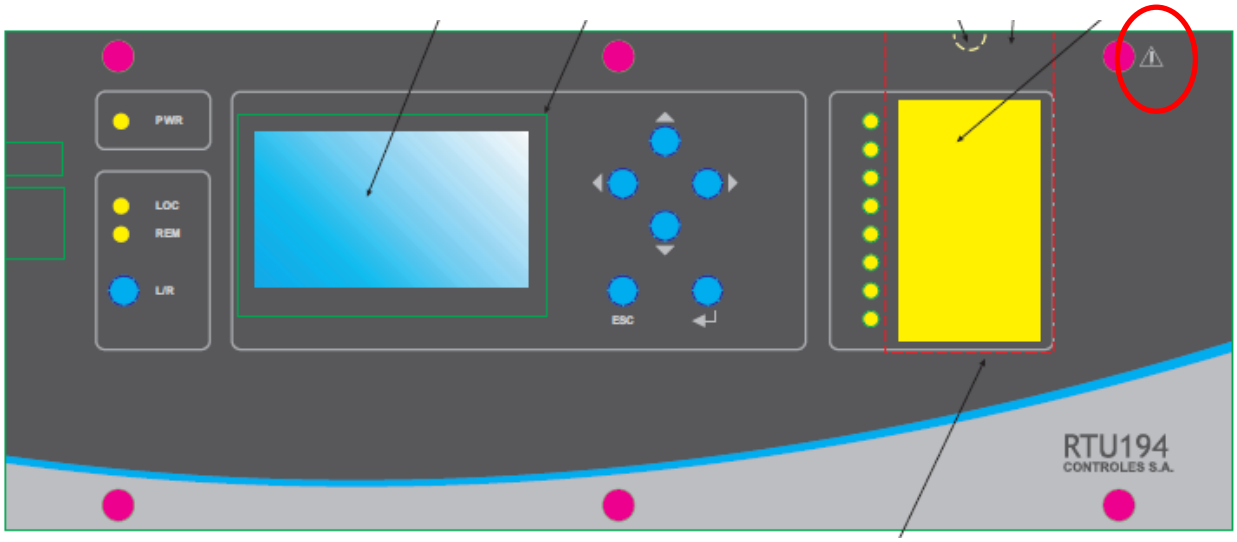
Change 3; the dimensions of the enclosure have been changed to comply with the dimension requirements for 19” enclosures



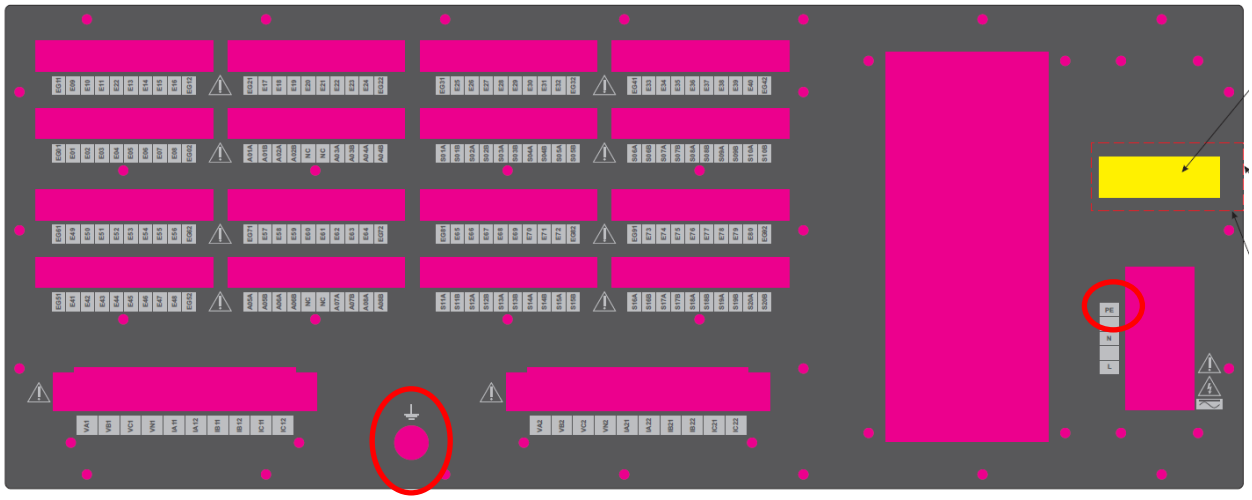
Change 4; the ventilation hole size and pattern at the bottom side of the enclosure has been modified to comply with the product safety fire enclose requirements. Refer to chapter 9.8 for detailed information about the modification of the ventilation hole size and pattern.

Change 5; the user manual has been updated to reflect essential technical data according the documentation requirements. Reference to this user manual can be found in chapter 6.

Change 6; the plastic overlays (front and rear) have been modified to comply with the product safety markings requirements.



Front side plastic overlay; warning marking added because the front panel can be opened without use of a tool giving access to hazardous live circuits.



Rear side plastic overlay; functional earth and PE markings changed.

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

Description	Manufacturer	Type	Inventory nr.
Fast transient burst tester	**EM Test**	**EFT500**	**105169**
Capacitive coupling clamp	EM Test		106168
ESD tester	**EM-Test**	**NX30.1**	**152004**
Test head	EM-Test	CONTACT	152011
Test head	EM-Test	AIT	152012
resistors	EM-Test	2 x 470 k 2 x 470k	152013 152014
Oscillatory wave test system including	**EMC partner**	**MIG0603OMI**	**150022**
CDN	EMC partner	CDN2000-06-25	150023
CDN-KIT1000 ED.3	EMC partner	CN-U / DN-HF DN-LF1 / DN-LF2	152146
H-field antenna	EMC partner	MF1000-3	151495
Continues wave simulator including	**EM Test**	**CWS500N1.1**	**151165**
50 ohm attenuator	EM Test	ATT 6/75	151158
CDN M1	Luthi	CDN M1	151180
CDN M2/M3	Luthi	CDN M2/M3	151164
CDN M2/M3	Luthi	CDN M2/M3	151179
CDN M4 N	Luthi	CDN M4 N	151160
CDN M4 N	Luthi	CDN M4 N	151178
CDN S9	Luthi	CDN S9	151161
CDN S8 RJ45	Luthi	CDN S8 RJ45	151181
CDN AF2	Luthi	CDN AF2	151162
CDN AF8		CDN AF8	
Injection clamp		EM101	151159
HF absorbing clamp		FTC101	151168
HF absorbing clamp		FTC101	151156
HF absorbing clamp		FTC101	151157
Immunity tester, including	**EMC partner**	**IMU3000**	**152084**
CDN	EMC partner	CDN 3000A-08-32	152089
CDN	EMC partner	PS3-0204	
CDN	EMC partner	CN16	152208
DOW and impulse tester	**EMC-partner**	**DOW3000**	**152090**
Insulation tester	FLUKE	1503	150150
Dielectric 50Hz AC Voltage test	SQS Electronic	HA3300D	105156

Conducted RF emission test equipment			
Description	Manufacturer	Type	Inventory nr.
Measurement receiver	Rohde & Schwarz	ESR	151944
LISN (AMN)	Rohde & Schwarz	ENV432	151954
LISN (AAN) S8 RJ45	Lüthi	S8 RJ45	151181
Connection cable	Pasternack	PE343-300CM	152430

18.2 Mechanical tests

Description	Manufacturer	Type	Serial number
ICP Accelerometer	PCB Piezotronics	353B34	173953
Electric-dynamic shaker	Tira	TV59355/AIT-440 TGT model48XXL	036/07
ICP Accelerometer	PCB Piezotronics	353B34	6419
ICP Accelerometer	PCB Piezotronics	353B18	175664
Shaker control system	Dactron	Laser	4816833
Signal conditioner	PCB Piezotronics	482C16	428
Monitoring of the environmental conditions	Novasina	ClimaLog 40	1206059

18.3 Climate tests

Description	Manufacturer	Type	ORS number
Climate room	Espec	ARS-1100	152503

18.4 Measurement equipment

Description	Manufacturer	Type	ORS number
Digital multimeter	Hewlett Packard	972A	105257
Oscilloscope	Rohde & Schwarz	RTB2002	152140
Oscilloscope	Rohde & Schwarz	RTB2002	152287
Oscilloscope	Rohde & Schwarz	RTB2004	152142
Current probe	Tektronix	TCP A300&303	151982 151983
EFT Veri1K	EMC Partner	Veri1K EFT	152157
EFT Veri50	EMC Partner	Veri50 EFT	152158
Multimeter	Fluke	8846A	152266
Multimeter	Fluke	8846A	152265
Multimeter	Fluke	8846A	152264
Multimeter	Keysight	34465A	152269
Multimeter	Keysight	34465A	152268
Multimeter	Keysight	34465A	152267
Multimeter 179	Fluke	179	152027
Multimeter	Fluke	179	152028
AC/DC clamp meter	Fluke	353	150336
Current probe	Hioki	3283	150412
Differential probe	Testec	TT-SI9010A	151822
Dielectric analyser	Hypotultra	7854	152281