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Registration number: **STS 0001**

Schweizerischer Prüfstellendienst
Service suisse d'essai
Swiss testing service



FCC Registration No.: **761065**

Report:	<i>Electromagnetic Compatibility</i>	Report no:	<i>18-EL-0075.E03</i>
Test item description:	<i>Router NB3711-L2Wac-G-AE</i>	Date of test:	<i>March 13 – 20, April 10 – 11, May 28, 2018</i>
Applicant:	<i>NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND</i>	Model/Type reference:	<i>NB3711-L2Wac-G-AE</i>
Manufacturer:	<i>NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND</i>	Serial no:	<i>00112B01B58A 00112B01B580</i>
Trade mark:	<i>NetModule</i>		

Standards		Result
EN 50121-3-2:2015 IEC 62236-3-2:2008	Railway applications - EMC - Part 3-2: Rolling stock - Apparatus	See § 2
EN 50155:2007 IEC 60571:2012	Railway applications – Electronic equipment used on rolling stock	See § 3
EN 55032:2015 CISPR 32:2015	Electromagnetic compatibility of multimedia equipment - Emission requirements	See § 4
EN 55035:2017 CISPR 35:2016	Electromagnetic compatibility of multimedia equipment - Immunity requirements	See § 4
EN 61000-6-3:2007 + A1 IEC 61000-6-3:2006 IEC 61000-6-3:2006/AMD1:2010	EMC - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	See § 1
EN 301 489-1 V1.9.2	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 1: Common technical requirements	See § 5

DRAFT EN 301 489-1 V2.2.0	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1 (b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU	See § 5
EN 301 489-7 V1.3.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)	See § 5
EN 301 489-17 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems	See § 5
EN 301 489-24 V1.5.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) for Mobile and portable (UE) radio and ancillary equipment	See § 5

The EUT fulfils the requirements of the above mentioned standards without any modifications.

Test performed by

Mr. Daniel Rufer
EMC Test-Engineer



Reviewed by

Mr. Pascal Treichler
Head Lab Zürich



Zürich, 2018-05-31

(Issue Date)

The present document results from tests on one specimen and does not prejudice to the conformity of all the manufactured products.

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Foreword

The EUT is a variant of the NB3710 (see test report 15-EL-0061.E02) but with a different CPU Module (same as NB3800 (16-EL-0088.E01)).

The interfaces and the power supply of the EUT is identical to those of the NB3710. Therefore the EUT has been only tested partially.

1. Summary of Test Results (EN/IEC 61000-6-3)

§	Test Type		Result
10	Emission		EN/IEC 61000-6-3
10.1	Interference voltage	EN 55016-2-1 CISPR 16-2-1	PASS
10.2	Common mode at telecommunication ports	EN 55022 CISPR 22	PASS
10.3	Radiated electromagnetic field	EN 55016-2-3 CISPR 16-2-3	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	Not applicable ¹
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	Not applicable ¹

1. No AC Mains port. Powered with 24 VDC

2. Summary of Test Results (EN 50121-3-2 / IEC 62236-3-2)

§	Test Type		Result
10	Emission		EN 50121-3-2 IEC 62236-3-2
10.1	Interference voltage	EN 55011 CISPR 11	PASS
10.3	Radiated electromagnetic field	EN 55011 CISPR 11	PASS
11	Immunity		EN 50121-3-2 IEC 62236-3-2
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
--	Surges	EN 61000-4-5 IEC 61000-4-5	Not applicable ¹
--	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	Not applicable ¹

1. Not tested, see test report 15-EL-0061.E02

3. Summary of Test Results (EN 50155 / IEC 60571)

§	Test Type		Result
10	Emission		EN 50155 IEC 60571
10.1	Interference voltage	EN 55011 CISPR 11	PASS
10.3	Radiated electromagnetic field	EN 55011 CISPR 11	PASS
11	Immunity		EN 50155 IEC 60571
--	Visual inspection	EN 50155 §12.2.1	Not tested ¹
--	Performance test	EN 50155 §12.2.2	Not tested ¹
--	Supply overvoltages	EN 50155 §12.2.6	Not tested ¹
--	Surges, electrostatic discharge and transient burst susceptibility tests	EN 50155 §12.2.7	Not tested ¹
--	Radio interference test	EN 50155 §12.2.8	Not tested ¹
--	Insulation test	EN 50155 §12.2.9	Not tested ¹

1. Not tested, see test report 15-EL-0061.E02

4. Summary of Test Results (EN 55032/CISPR 32 & EN 55035/CISPR 35)

§	Test Type		Result
10	Emission		EN 55032 CISPR 32
--	Conducted Emission from AC Mains Power Ports	EN 55032 CISPR 32	N/A ¹
10.2	Conducted Emission from Wired Network Ports	EN 55032 CISPR 32	PASS
10.2	Conducted Emission from Antenna Ports		PASS
--	Conducted Emission from Optical Fibre Ports (with metallic shield or tension members)		N/A ²
10.3 10.4	Radiated electromagnetic field	EN 55032 CISPR 32	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	N/A ¹
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	N/A ¹
11	Immunity		EN 55035 CISPR 35
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
--	Surges	EN 61000-4-5 IEC 61000-4-5	Not applicable ³
--	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	Not tested ⁴
--	Magnetic fields (industrial frequencies)	EN 61000-4-8 IEC 61000-4-8	N/A ⁴
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	N/A ¹

1. No AC Mains port. Powered with 24 VDC
2. No optical fibre with metallic shield or tension members
3. Not connected to outdoor cables
4. Not tested, see test report 15-EL-0061.E02
5. Does not contain any devices susceptible to magnetic fields.

5. Summary of Test Results (EN 301 489-X)

The EUT contains CE approved radio modules. The modules have been tested by the radio manufacturer and were found to comply with the applicable RADIO ETSI standards 301 489-X.

However, during the EMC immunity tests the exclusion bands were considered, see results in the next pages. The Emission tests were carried out in the intended operation mode of the EUT.

§	Test Type		Result
10	Emission		EN 301 489-x mobile equipment
10.1	Interference voltage	EN 55032 CISPR 32	PASS
10.2	Common mode at telecom. ports	EN 55032 CISPR 32	PASS
10.3	Radiated electromagnetic field	EN 55032 CISPR 32	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	N/A ¹
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	N/A ¹
11	Immunity		EN 301 489-x mobile equipment
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
--	Surges	EN 61000-4-5 IEC 61000-4-5	Not tested ²
--	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	Not tested ²
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	N/A ¹

1. No AC Mains port. Powered with 24 VDC

2. Not tested, see test report 15-EL-0061.E02

6. Applied Standards

EN 50121-3-2:2015 IEC 62236-3-2:2008	Railway applications – Electromagnetic compatibility Part 3-2: Rolling stock – Apparatus
EN 50155:2007 IEC 60571:2012	Railway applications – Electronic equipment used on rolling stock
EN 55022:2010 CISPR 22:2008	Information technology equipment Radio disturbance characteristics – Limits and methods of measurement
EN 55032:2015 CISPR 32:2015	Electromagnetic compatibility of multimedia equipment - Emission requirements
EN 55035:2017 CISPR 35:2016	Electromagnetic compatibility of multimedia equipment - Immunity requirements
EN 55016-2-1:2014 CISPR 16-2-1:2014	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements
EN 55016-2-3:2010 CISPR 16-2-3:2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements
EN 61000-4-2:2009 IEC 61000-4-2:2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3:2006 + A1: 2008 + A2: 2010 IEC 61000-4-3:2006 IEC 61000-4-3:2006/AMD2:2010	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4:2012 IEC 61000-4-4:2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5:2014 IEC 61000-4-5:2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
EN 61000-4-6:2014 IEC 61000-4-6:2013	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-6-3:2007 + A1: 2011 IEC 61000-6-3:2006 IEC 61000-6-3:2006/AMD1:2010	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 301 489-1 V1.9.2:2011	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 1: Common technical requirements
DRAFT EN 301 489-1 V2.2.0	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1 (b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU
EN 301 489-7 V1.3.1:2005	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
EN 301 489-17 V2.2.1:2012	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems
EN 301 489-24 V1.5.1:2010	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment

7. Applicant

<i>Client name and address</i>	NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND
<i>Contact Person</i>	Urs Gruetter
<i>Telephone</i>	+41 31 985 25 19
<i>E-mail</i>	urs.gruetter@netmodule.com

8. Equipment Under Test

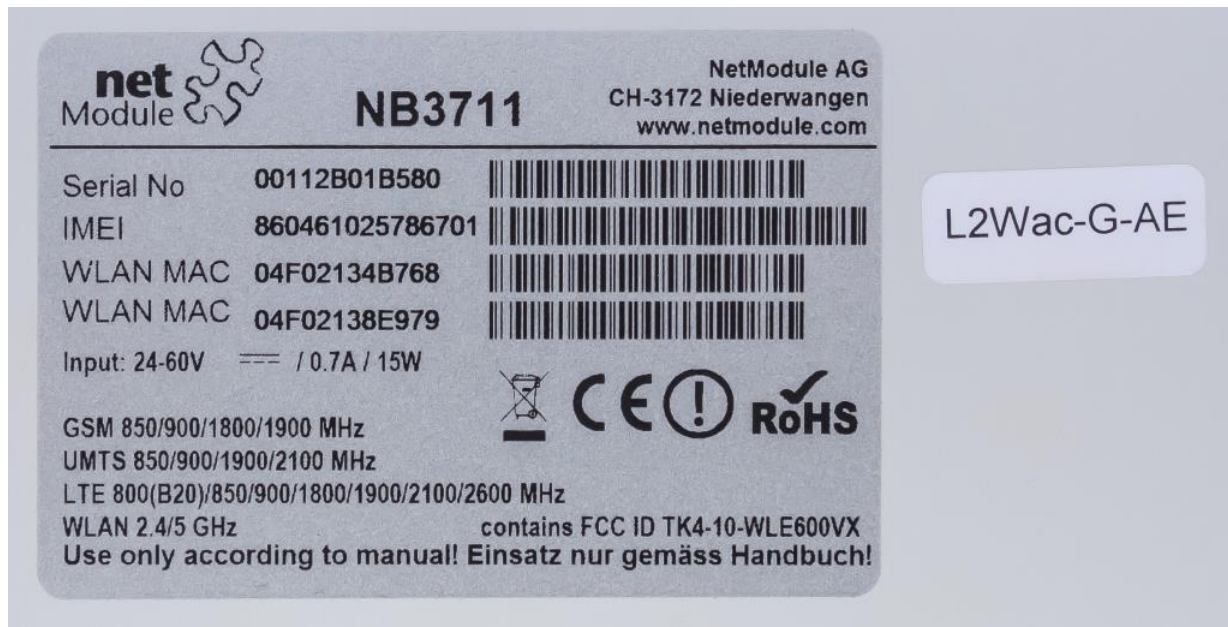
8.1 Identification

<i>Manufacturer name and address</i>	NetModule AG Meriedweg 11 3172 Niederwangen bei Bern
<i>Production country</i>	SWITZERLAND
<i>Trade mark</i>	NetModule
<i>Test item description</i>	Router NB3711-L2Wac-G-AE
<i>Product description</i>	The EUT is a versatile router with multiple communication interfaces (wired and radio interfaces). The EUT is targeted for public transport (railway or vehicle) applications.
<i>Model/type reference</i>	NB3711-L2Wac-G-AE
<i>Serial number</i>	EUT 1: 00112B01B58A EUT 2: 00112B01B580
<i>Hardware identification</i>	NB3711-L2Wac-G-AE_TLB-20180222
<i>Software version</i>	NRSW 4.1.0.101
<i>Highest frequency</i>	CPU Clock: 1.33 GHz DDR3L SDRAM: 800 MHz PCI Express: 2.5 GHz Ethernet: 125 MHz eMMC: 48 MHz USB 2.0: 480 MHz USB 3.0: 5 GHz DC/DC Converter (Main): < 1 MHz
<i>Supply</i>	24 to 60 VDC; -30 % / +5 %; P = 15 W
<i>Dimension</i>	Width: 165 mm; height: 84.7 mm; depth 104 mm
<i>Weight</i>	~ 1.2 kg
<i>Technical documentation</i>	None. The equipment is completely identified by the above-mentioned information. NetModule AG assures the traceability of the documentation and is responsible for the product identification.

8.2 Pictures of the EUT



8.3 Marking Plate



8.4 Classification

EN 50121-3-2 IEC 62236-3-2	<input checked="" type="checkbox"/> Mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe) <input type="checkbox"/> Accessible to passengers and operational staff (not maintenance)
EN 55032 CISPR 32	<input type="checkbox"/> Class A (suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes) Such equipment should not be restricted in its sale but the following warning shall be included in the instructions for use: <i>Warning: This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.</i> <input checked="" type="checkbox"/> Class B (suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes) <input type="checkbox"/> The highest frequency of the internal sources of the EUT is less than 108 MHz (measurement shall be made up to 1 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz (measurement shall be made up to 2 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz (measurement shall be made up to 5 GHz). <input checked="" type="checkbox"/> The highest frequency of the internal sources of the EUT is above 1 GHz (measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less).
EN 61000-6-3 IEC 61000-6-3	<input type="checkbox"/> The highest frequency of the internal sources of the EUT is less than 108 MHz (measurement shall be made up to 1 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz (measurement shall be made up to 2 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz (measurement shall be made up to 5 GHz). <input checked="" type="checkbox"/> The highest frequency of the internal sources of the EUT is above 1 GHz (measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less).
EN 301 489	<input type="checkbox"/> Radio and ancillary equipment for fixed use (e.g. base station equipment) <input checked="" type="checkbox"/> Radio and ancillary equipment for vehicular use (e.g. mobile equipment) <input type="checkbox"/> Radio and ancillary equipment for portable use (portable equipment) <input type="checkbox"/> Ancillary equipment

8.5 Ports

Port	Cable. length	Cable Type	Screen	Remark
Power	Not defined	2 wires	No	24 VDC Power Supply
Digital I/O	< 30m	4x 2Wires M12	No	Not connected
Ethernet 1	< 100m	M12	Yes	Fast Ethernet Interface
Ethernet 2	< 100m	M12	Yes	Fast Ethernet Interface (not used)
Ethernet 3	< 100m	M12	Yes	Fast Ethernet Interface (not used)
Ethernet 4	< 100m	M12	Yes	Fast Ethernet Interface (not used)
Ethernet 5	< 100m	M12	Yes	Fast Ethernet Interface (not used)
4G.1 (A1) 4G.2 (A5)	< 30m	TNC Coax	Yes	LTE Interface, connected to multiband-antenna
GNSS (A3)	< 30m	TNC Coax	Yes	Not connected
MOBIB (A2)	< 30m	TNC Coax	Yes	WiFi Interface 1, connected to multiband-antenna
iWLAN (A4)	< 30m	TNC Coax	Yes	Wifi Interface 2, connected to multiband-antenna
USB	< 3m	USB Type A	Yes	Service port, not connected

9. Test Conditions

9.1 Climatic conditions, location and date

Location	Date	Temp	Pressure [QFE]	Rel. humidity
Eurofins Electrosuisse Product Testing AG, Albisriederstrasse 199 8047 Zürich SWITZERLAND	March 26, 2018	24 ± 3 °C	980 ± 30 hPa	35 ± 5 %
	April 10–11, 2018	25 ± 3 °C	980 ± 30 hPa	35 ± 5 %
	May 28, 2018	25 ± 3 °C	980 ± 30 hPa	40 ± 5 %

9.2 Test facility and methodology

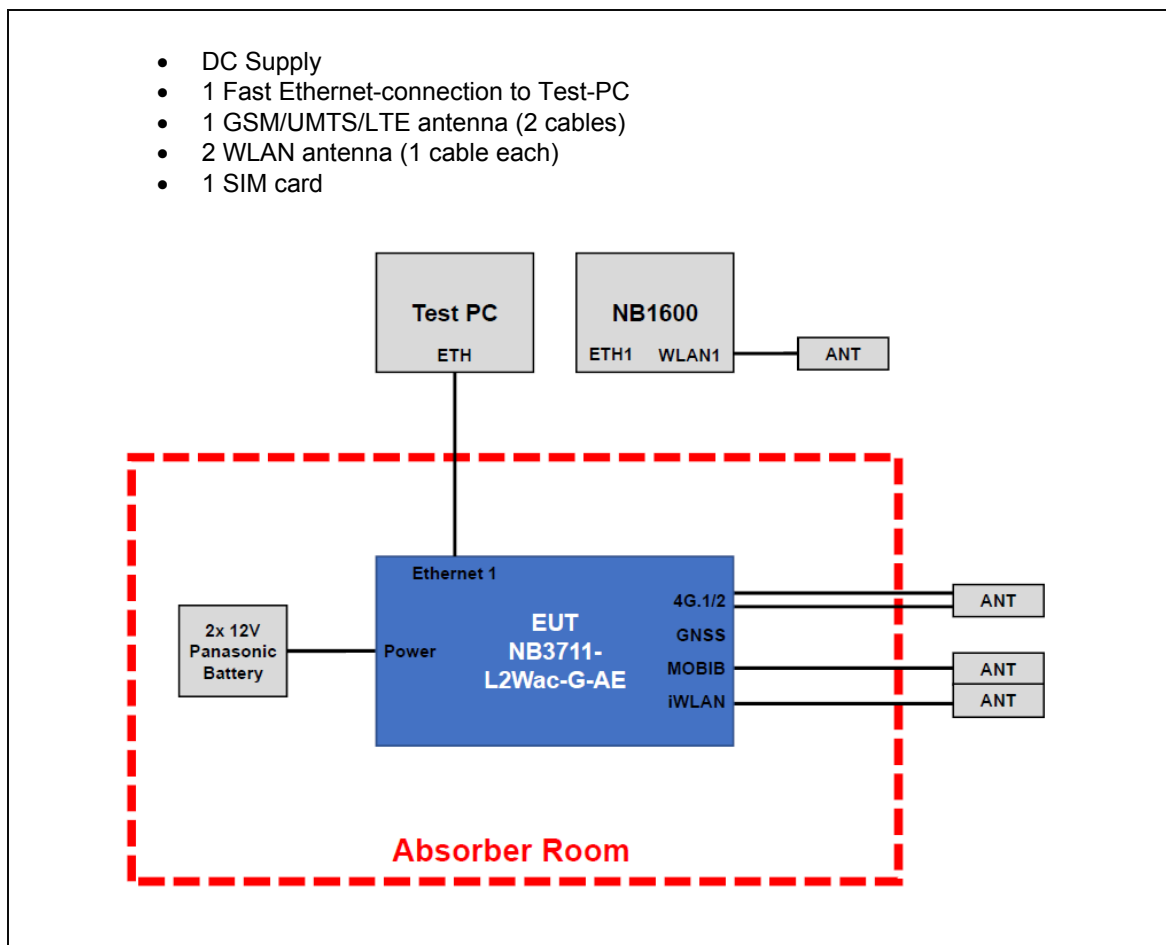
Conducted and radiated measurements are performed according to the ANSI C63.4 (2014) procedure.

9.3 Attendant Persons

Test Engineer(s):

Mr. Daniel Rufer

9.4 Test Configuration



9.5 Operating Conditions

Normal mode:

- Ping over WLAN (iWLAN/MOBIB)
- Ping over WWAN (4G.1/2)
- Ping over Ethernet 1 cable

powered with 24 VDC unless otherwise noted

9.6 Monitoring of the EUT

The performance of the EUT during the test is monitored as following:

Monitor of all Ping-Outputs on the Test-PC

9.7 Auxiliary Equipment

The following pieces of equipment are used for the monitoring of the EUT or are necessary for the EUT but they are not part of the EUT.

Product	Brand	Model No.	ID	Remarks
Laptop	Fujitsu Siemens	Lifebook E series	Eurofins	Pulse Tests
Laptop	Dell	E5430	NetModule	Emission Tests
Router	NetModule	NB1600-LcW	NetModule	--
Batteries 2/4x 12 V	Panasonic	--	Eurofins	Emission Tests

9.8 Performance Criteria

General requirements:	Requirements according to the EUT:
<p style="text-align: center;">Criterion A:</p> <div> <div data-bbox="298 344 875 432">The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed.</div> <div data-bbox="875 344 1451 378">No transmission loss of LAN, WWAN; WLAN</div> </div>	
<p style="text-align: center;">Criterion B:</p> <div> <div data-bbox="298 512 875 684">The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed.</div> <div data-bbox="875 512 1451 735"> <p>During the test:</p> <ul style="list-style-type: none"> - Short interruptions of the communication allowed - LED's may flicker <p>After the test:</p> <ul style="list-style-type: none"> - EUT shall operate as in normal mode </div> </div>	
<p style="text-align: center;">Criterion C:</p> <div> <div data-bbox="298 823 875 911">Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.</div> <div data-bbox="875 823 1451 856">- No specific requirements</div> </div>	

10. Emission Tests

10.1 Interference Voltage (V-LISN)

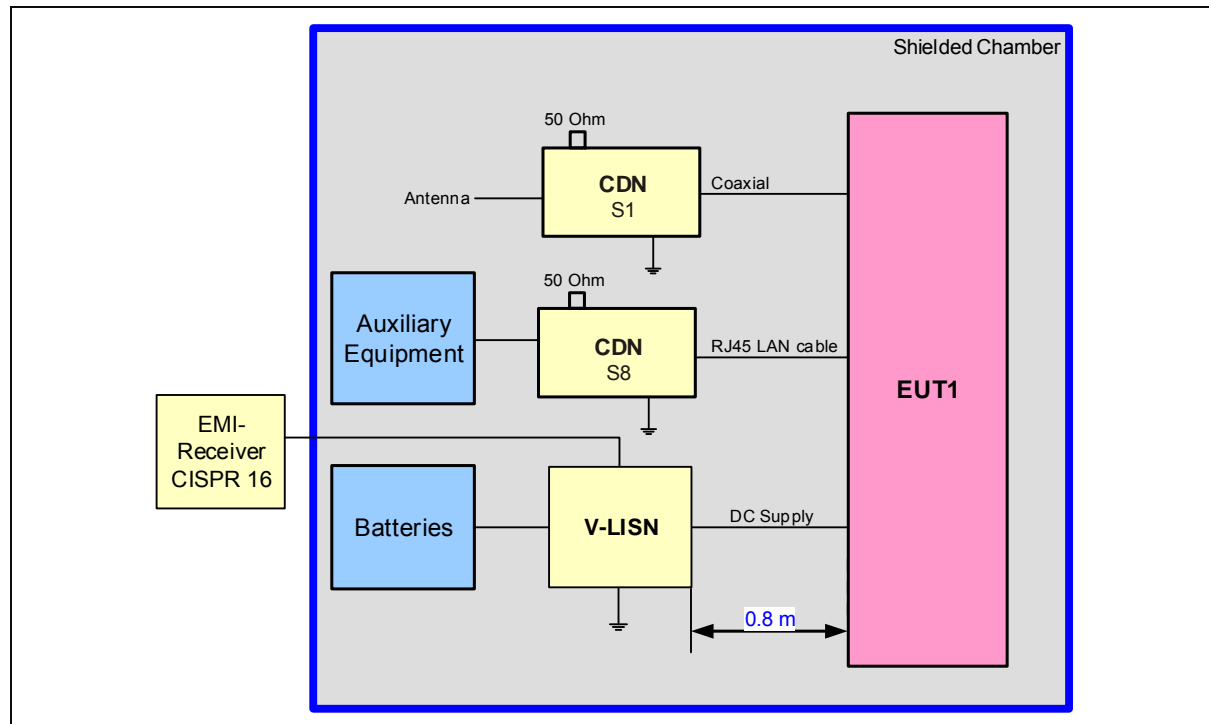
Test site: shielded room

Meas. uncertainty: see chapter 12

Measuring method: The conducted disturbance is measured using a EMI receiver and a line impedance substitution network (LISN). The measurement of the voltage against the earth is carried out successively. The average and quasi peak values are recorded continuously using the EMI receiver in time domain mode.

Modifications: none

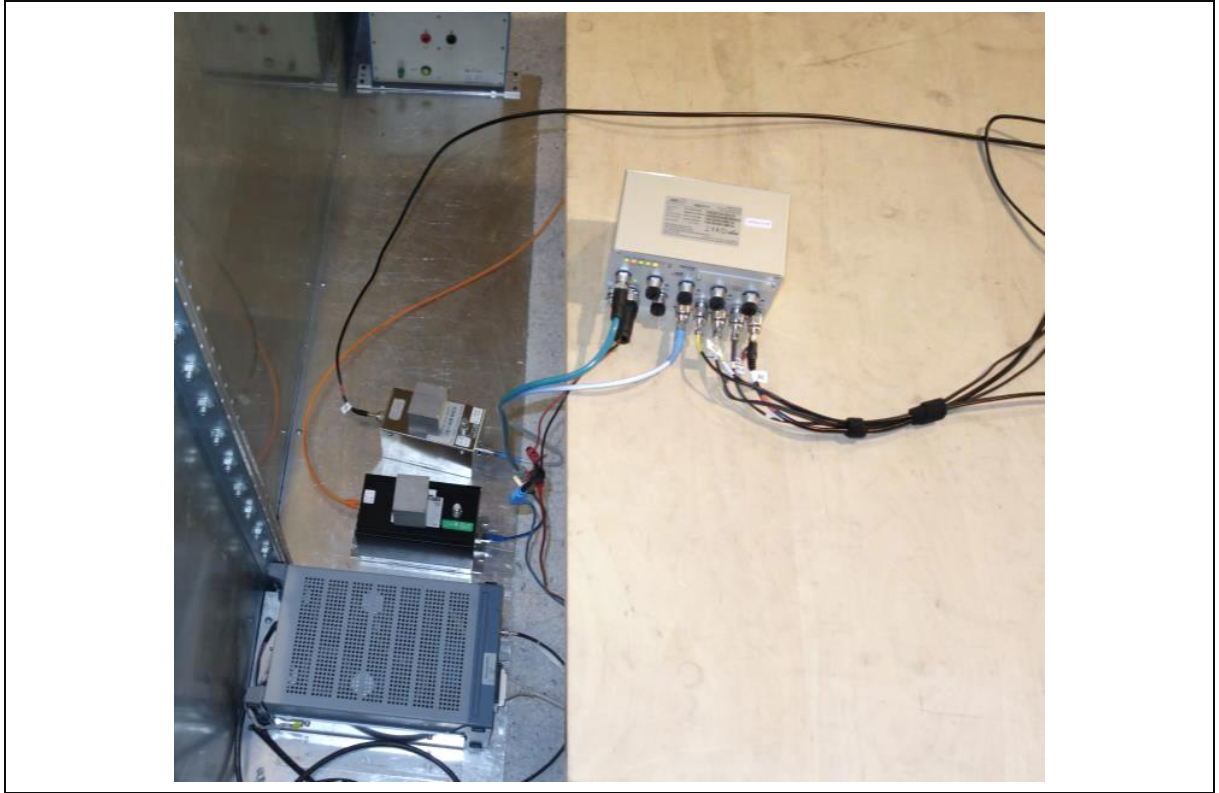
Test Setup



Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU 8	OA10193
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	CDN S8 RJ45	13.6632.07
CDN	Lüthi	CDN S1 Coax	H7679
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

Photos of the Setup

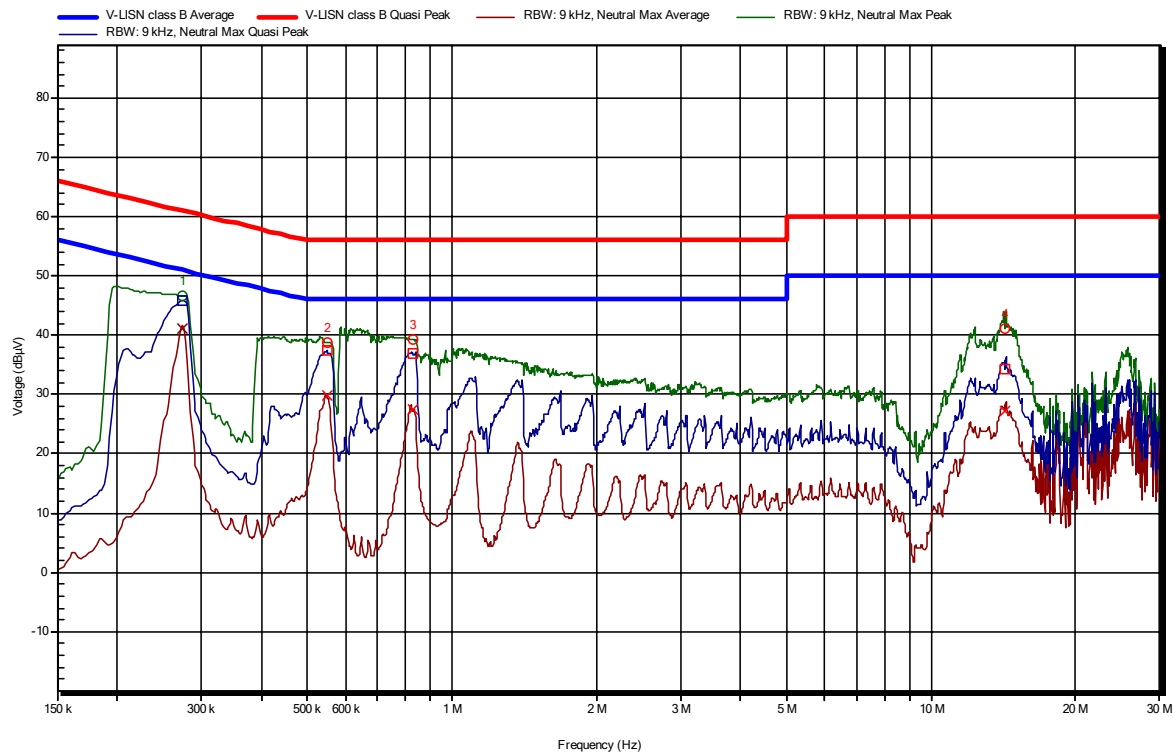


Measurement Results

Diagram 1

EUT	EUT 2
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.04.2018 15:35:12
Line under test	Power, Minus-Port
Transducer	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
Measurement settings	Radiation Version: 2017.1.6, RBW: 9 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 0 dB, Measure time: 1 s

RadiMation



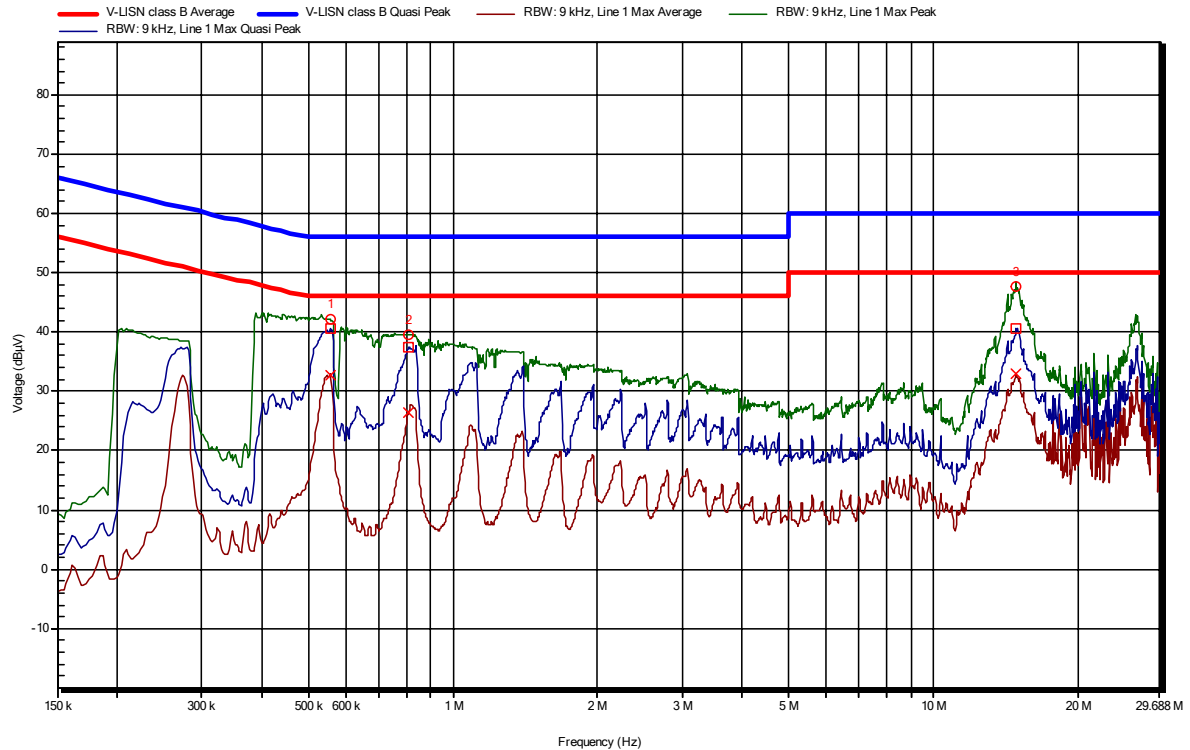
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	273.41 kHz	46.7 dBµV	41.1 dBµV	-9.9 dB	45.8 dBµV	-15.2 dB	Pass
2	548.843 kHz	38.8 dBµV	29.7 dBµV	-16.3 dB	37.4 dBµV	-18.6 dB	Pass
3	829.5 kHz	39.2 dBµV	27.4 dBµV	-18.6 dB	36.9 dBµV	-19.1 dB	Pass
4	14.246 MHz	41.1 dBµV	27.3 dBµV	-22.7 dB	34.3 dBµV	-25.7 dB	Pass

Diagram 2

EUT	EUT 2
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.04.2018 15:48:35
Line under test	Power, Plus-Port
Transducer	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
Measurement settings	Radimation Version: 2017.1.6, RBW: 9 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 0 dB, Measure time: 1 s

RadiMation

**Detected peaks**

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	555 kHz	42.1 dBµV	32.7 dBµV	-13.3 dB	40.7 dBµV	-15.3 dB	Pass
2	809.25 kHz	39.5 dBµV	26.5 dBµV	-19.5 dB	37.5 dBµV	-18.5 dB	Pass
3	14.901 MHz	47.7 dBµV	32.9 dBµV	-17.1 dB	40.5 dBµV	-19.5 dB	Pass

10.2 Interference Voltage (LAN- & Coaxial-Cable)

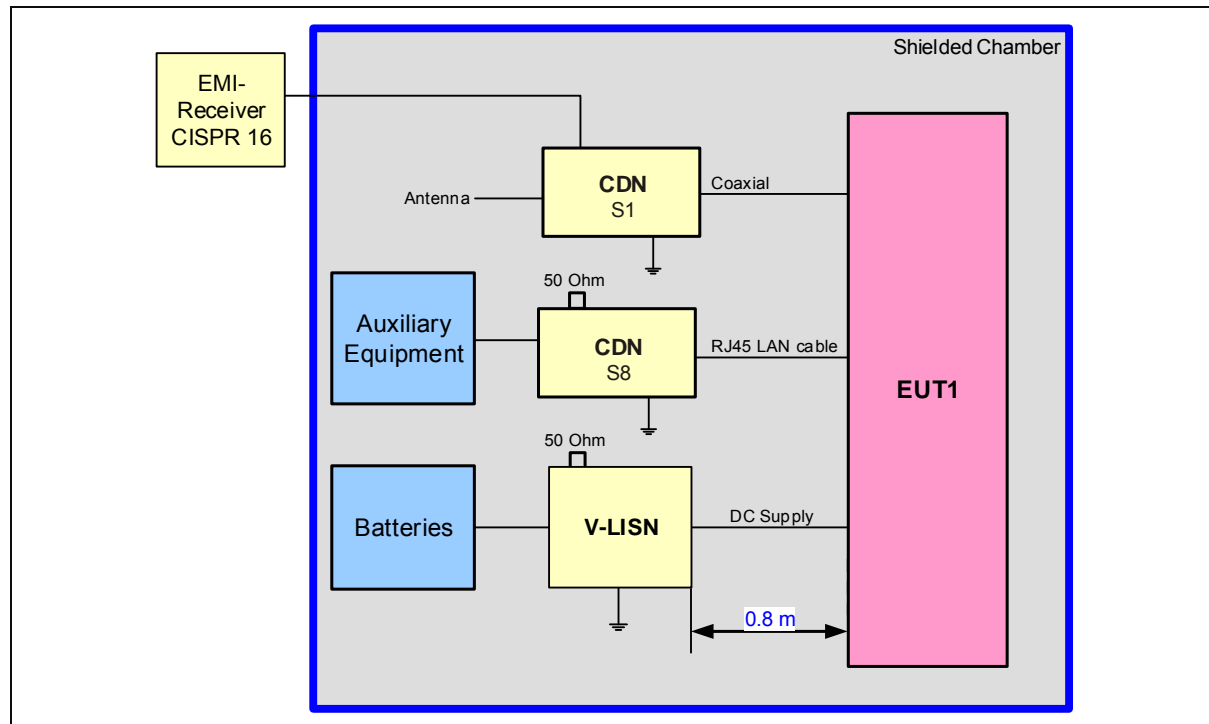
Test site: shielded room

Meas. uncertainty: see chapter 12

Measuring method: The conducted disturbance is measured using a EMI receiver and a line coupling device network (CDN-Sx) for shielded Cables. The measurement of the voltage on the shield of the cable (CDN-Sx) against the earth is carried out successively. The average and quasi peak values are recorded continuously using the EMI receiver in time domain mode.

Modifications: none

Test Setup



Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU 8	OA10193
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	CDN S8 RJ45	13.6632.07
CDN	Lüthi	CDN S1 Coax	H7679
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

Photos of the Setup

See chapter 10.1

Measurement Results

Diagram 3

EUT	EUT 2
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.04.2018 15:51:13
Line under test	Ethernet 1
Transducer	CDN-S8
Measurement settings	Radimation Version: 2017.1.6, RBW: 9 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 0 dB, Measure time: 100 ms

RadiMation

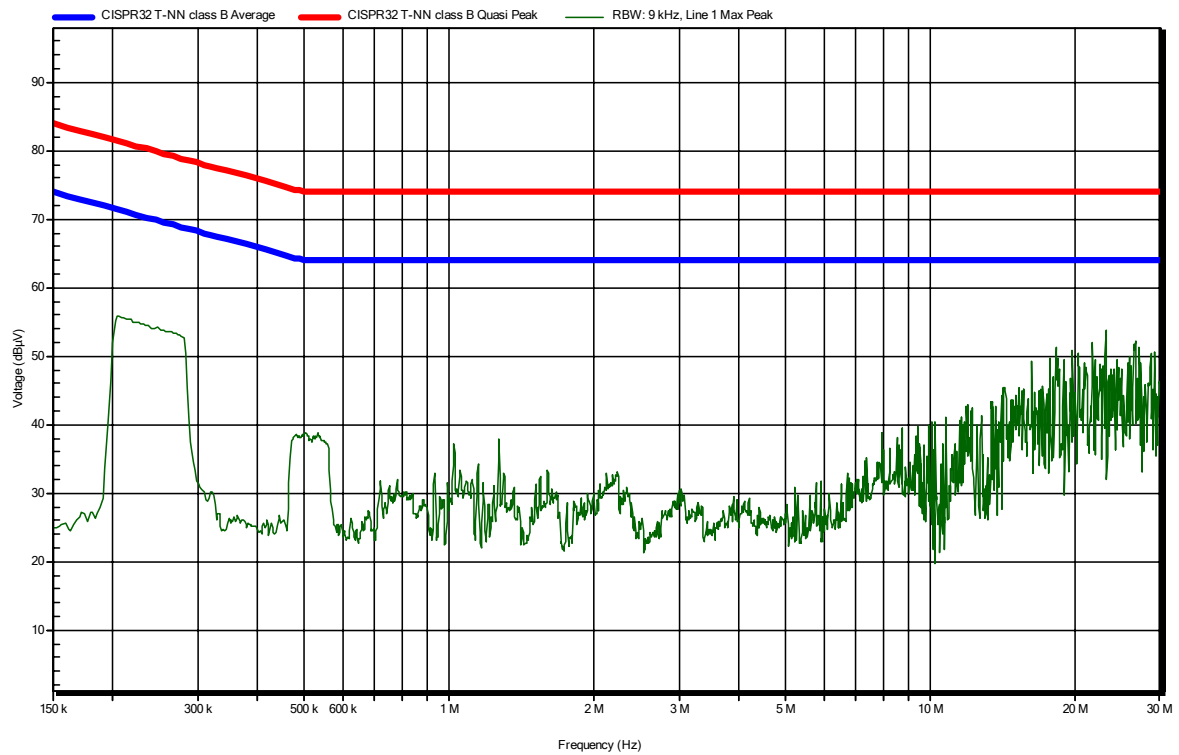
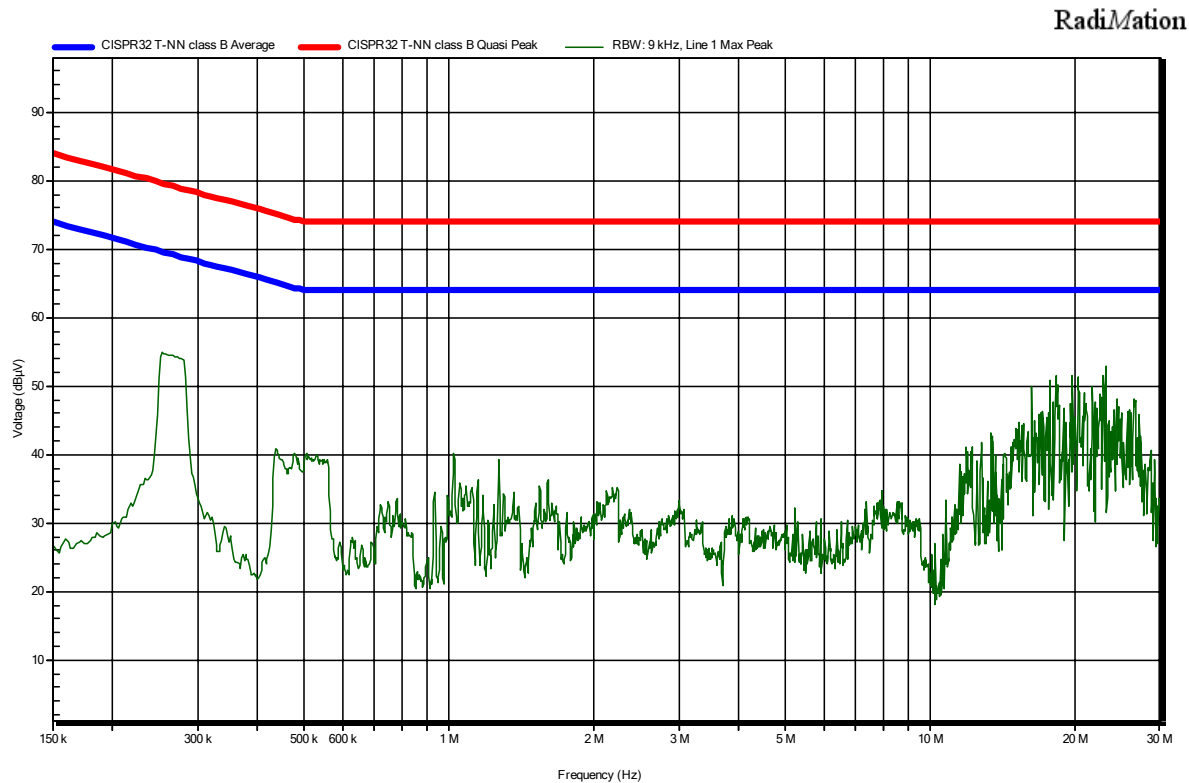


Diagram 4

EUT	EUT 2
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.04.2018 15:55:36
Line under test	Antenna A1
Transducer	CDN-S1
Measurement settings	Radimation Version: 2017.1.6, RBW: 9 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 0 dB, Measure time: 10 ms



10.3 Radiated Electromagnetic Field (30 – 1000 MHz)

Test site: semi-anechoic chamber (hybrid)

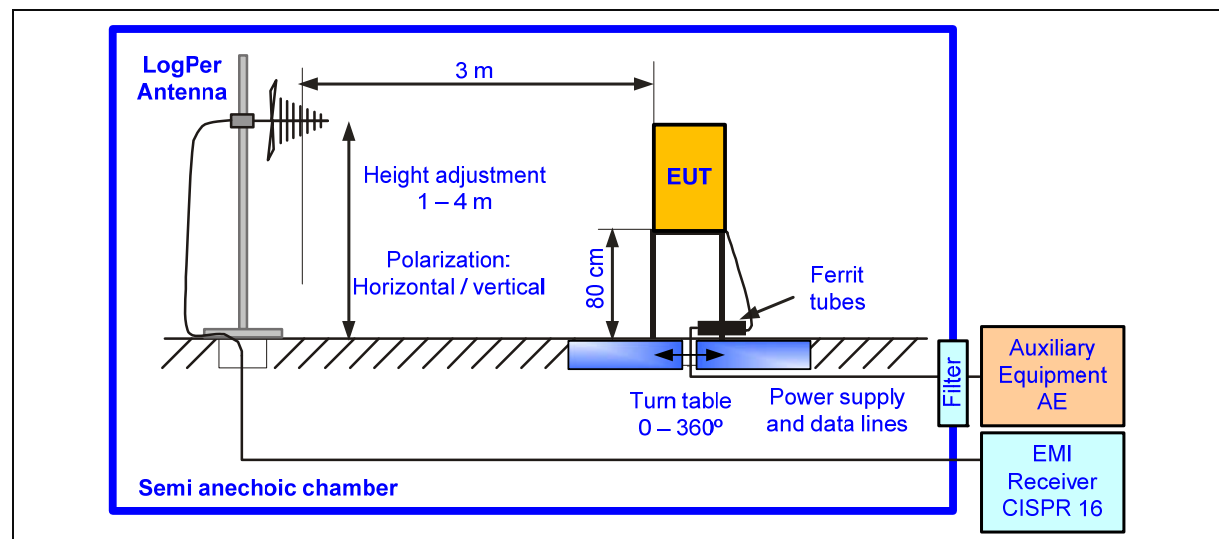
Distance: 3 m

Meas. uncertainty: see chapter 12

Measuring method: The electromagnetic disturbance radiated by the equipment is measured using a EMI receiver and a wide band antenna. The turning table is operated through 360° during the measurements with steps of 30°. The antenna is moved from 1 to 4 m in height with steps of 1 m. The measurements are performed with horizontal and vertical polarizations. The recordings are carried out taking into account the maximum value of all the disturbances appearing while the apparatus is under test. The peak values are recorded continuously. The values exceeding a limit shall be re-measured with the quasi peak detector of the receiver.

Modifications: none

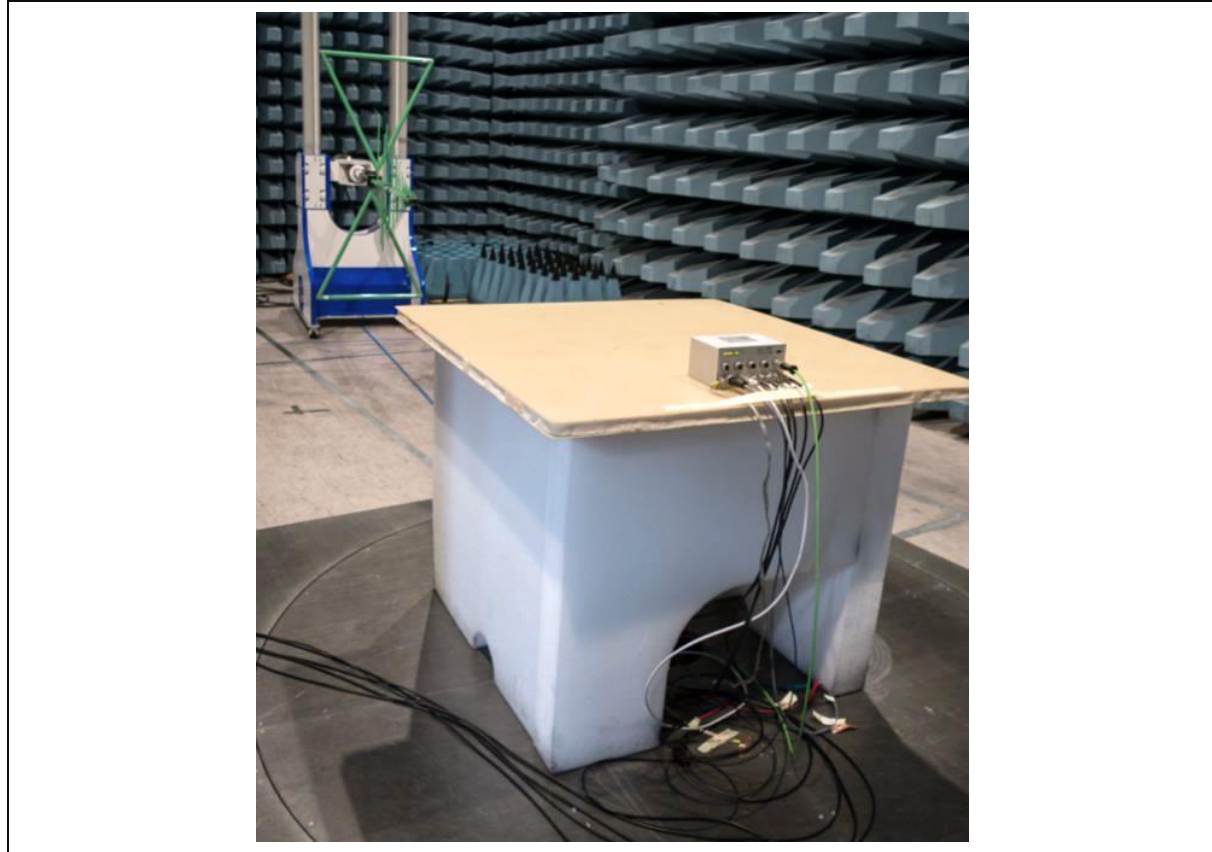
Test Setup



Test Equipment

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESW26	17.6632.05
Antenna LogPer	Chase	CBL 6112B	H9728
Coaxial Cable	Huber & Suhner	Sucoflex 106	17.6632.03, 17.6632.04, 18.6632.02

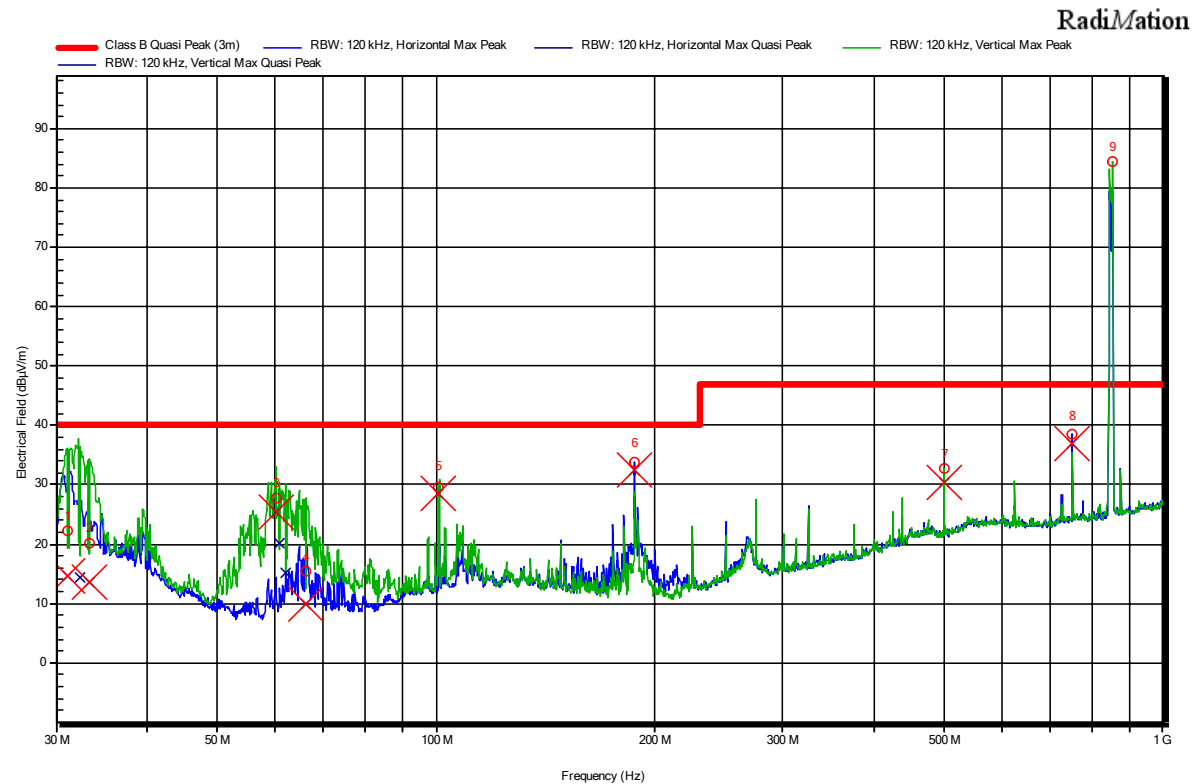
Photos of the Setup



Measurement Results

Diagram 5

EUT	EUT 2		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	24 VDC		
Test date, time	28.05.2018 14:28:33		
Antenna height	1 m - 4 m	Antenna polarization	Vertical/Horizontal
EUT position	0 Degree to 360 Degree	Antenna distance	3 m
Measurement settings	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 50 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 10 ms		



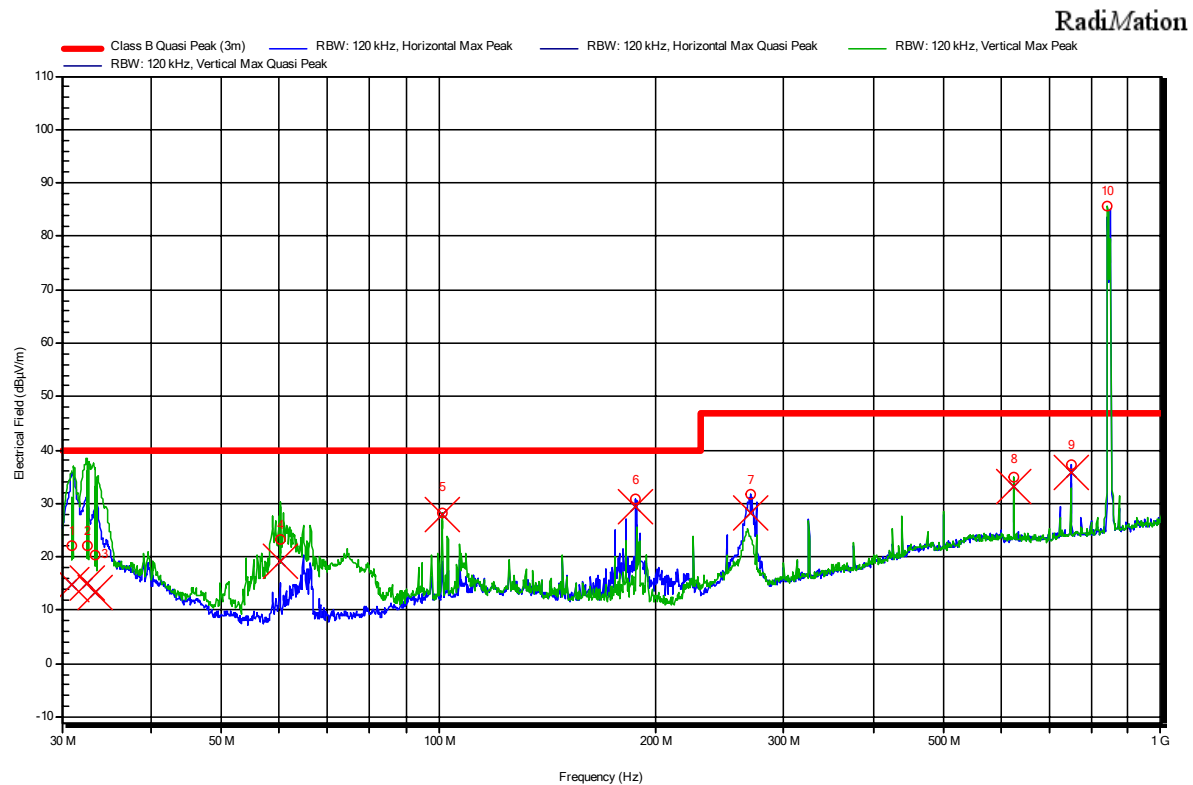
Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	31.2 MHz	22.2 dB μ V/m	14.7 dB μ V/m	-25.3 dB	Pass	240 Degree	1 m	Vertical
2	33.33 MHz	20.1 dB μ V/m	13.6 dB μ V/m	-26.4 dB	Pass	240 Degree	1 m	Vertical
3	60.21 MHz	27.7 dB μ V/m	25.3 dB μ V/m	-14.7 dB	Pass	90 Degree	3 m	Vertical
4	66.27 MHz	15.4 dB μ V/m	9.9 dB μ V/m	-30.1 dB	Pass	90 Degree	3 m	Vertical
5	100.89 MHz	29.6 dB μ V/m	28.6 dB μ V/m	-11.4 dB	Pass	150 Degree	1 m	Vertical
6	187.5 MHz	33.8 dB μ V/m	32.4 dB μ V/m	-7.6 dB	Pass	90 Degree	2 m	Horizontal
7	500.01 MHz	32.7 dB μ V/m	30.5 dB μ V/m	-16.5 dB	Pass	270 Degree	1 m	Vertical
8	750 MHz	38.4 dB μ V/m	37 dB μ V/m	-10.0 dB	Pass	150 Degree	1 m	Horizontal
9	851.4 MHz	84.5 dB μ V/m	--	--	Note	--	--	--

Note: UMTS, exclusion band according ETSI EN 301 489-24 applies

Diagram 6

EUT	EUT 2		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	48 VDC		
Test date, time	28.05.2018 13:59:00		
Antenna height	1 m - 4 m	Antenna polarization	Vertical/Horizontal
EUT position	0 Degree to 360 Degree	Antenna distance	3 m
Measurement settings	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 50 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 10 ms		

**Detected peaks**

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	31.05 MHz	22 dBµV/m	14.7 dBµV/m	-25.3 dB	Pass	90 Degree	1 m	Vertical
2	32.61 MHz	22.1 dBµV/m	15.2 dBµV/m	-24.8 dB	Pass	90 Degree	1 m	Vertical
3	33.45 MHz	20.4 dBµV/m	13.4 dBµV/m	-26.6 dB	Pass	210 Degree	1 m	Vertical
4	60.21 MHz	23.3 dBµV/m	19.2 dBµV/m	-20.8 dB	Pass	150 Degree	2 m	Vertical
5	100.89 MHz	28.3 dBµV/m	27.9 dBµV/m	-12.1 dB	Pass	180 Degree	1 m	Vertical
6	187.5 MHz	30.9 dBµV/m	29.4 dBµV/m	-10.6 dB	Pass	90 Degree	2 m	Horizontal
7	269.91 MHz	31.7 dBµV/m	28.1 dBµV/m	-18.9 dB	Pass	240 Degree	1 m	Horizontal
8	624.99 MHz	34.8 dBµV/m	33 dBµV/m	-14.0 dB	Pass	330 Degree	1 m	Vertical
9	750 MHz	37.4 dBµV/m	35.8 dBµV/m	-11.2 dB	Pass	150 Degree	1 m	Horizontal
10	842.58 MHz	85.5 dBµV/m	--	--	Note	--	--	--

Note: UMTS, exclusion band according ETSI EN 301 489-24 applies

10.4 Radiated Electromagnetic Field (1 – 6 GHz)

Test site: semi-anechoic chamber (hybrid)

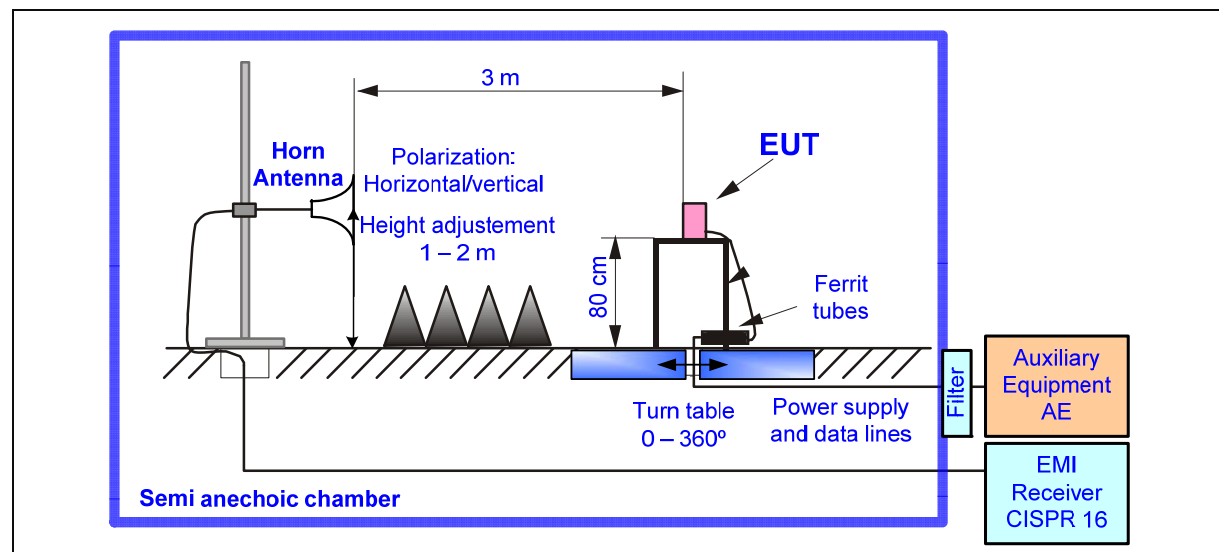
Distance: 3 m

Meas. uncertainty: see chapter 12

Measuring method: The electromagnetic disturbance radiated by the equipment is measured using a EMI receiver and a wide band antenna. The turning table is operated through 360° during the measurements with steps of 30°. The antenna is moved from 1 to 2 m in height with steps of 1 m. The measurements are performed with horizontal and vertical polarizations. The recordings are carried out taking into account the maximum value of all the disturbances appearing while the apparatus is under test. The peak values are recorded continuously. The values exceeding a limit shall be re-measured with the quasi peak detector of the receiver.

Modifications: none

Test Setup



Test Equipment

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESW26	17.6632.05
Horn Antenna	EMCO	3115	H9353
Coaxial Cable	Huber & Suhner	Sucoflex 106	17.6632.03, 17.6632.04, 18.6632.02

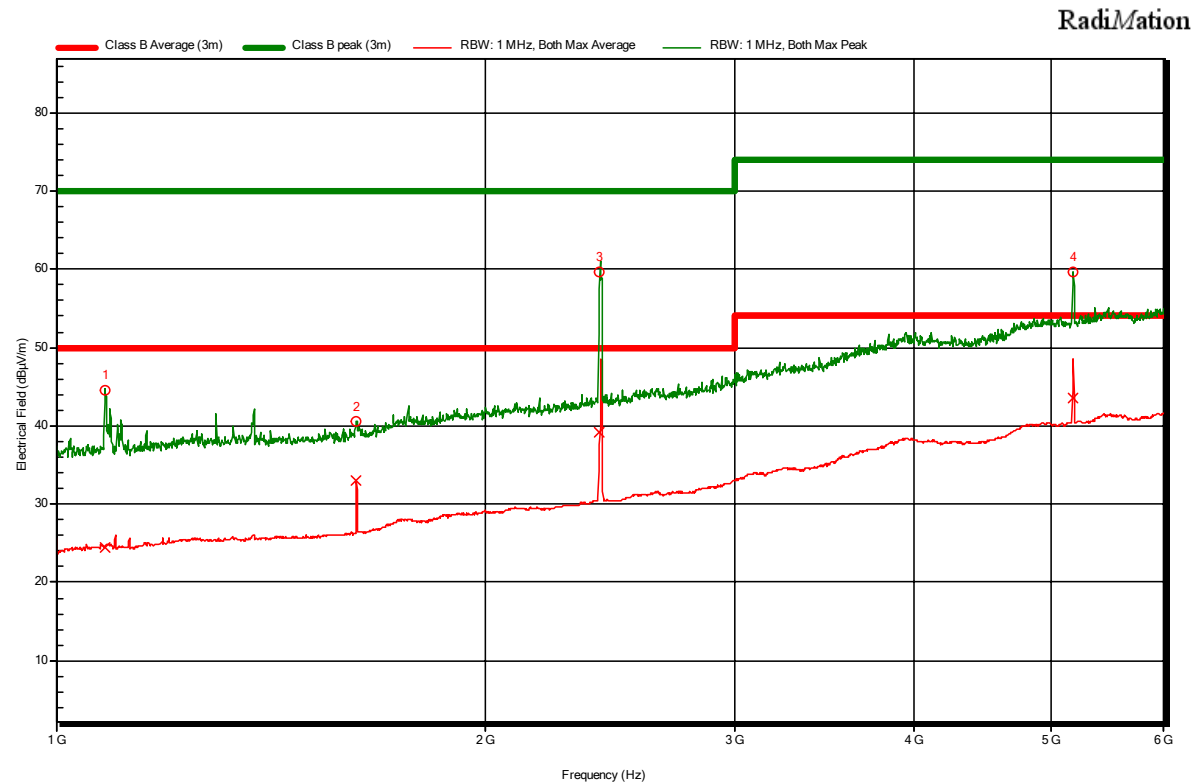
Photos of the Setup



Measurement Results

Diagram 7

EUT	EUT 2		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	24 VDC		
Test date, time	12.03.2018 15:04:31		
Antenna height	1 m - 2 m	Antenna polarization	Vertical/Horizontal
EUT position	0 Degree to 360 Degree	Antenna distance	3 m
Measurement settings	Radimation Version: 2017.1.6, RBW: 1 MHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 250 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 5 ms		



Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Polarization
1	1.083 GHz	44.5 dBµV/m	-25.5 dB	24.5 dBµV/m	-25.5 dB	Pass	330 Degree	Vertical
2	1.625 GHz	40.7 dBµV/m	-29.3 dB	33.1 dBµV/m	-16.9 dB	Pass	300 Degree	Vertical
3	2.409 GHz	59.7 dBµV/m	-10.3 dB	39.2 dBµV/m	-10.8 dB	Pass	90 Degree	Vertical
4	5.176 GHz	59.7 dBµV/m	-14.3 dB	43.6 dBµV/m	-10.4 dB	Pass	180 Degree	Vertical

11. Immunity Tests

11.1 Immunity to Electrostatic Discharge (ESD) (EN 61000-4-2)

Introduction: The aim of this test is to determine the reaction of the material to electrostatic discharges (ESD) produced for example by walking on a carpet made of synthetic fiber. The humidity of the air has an influence on the discharge time and therefore on the severity of the discharge that could appear.

Coupling: 150 pF / 330 Ohm

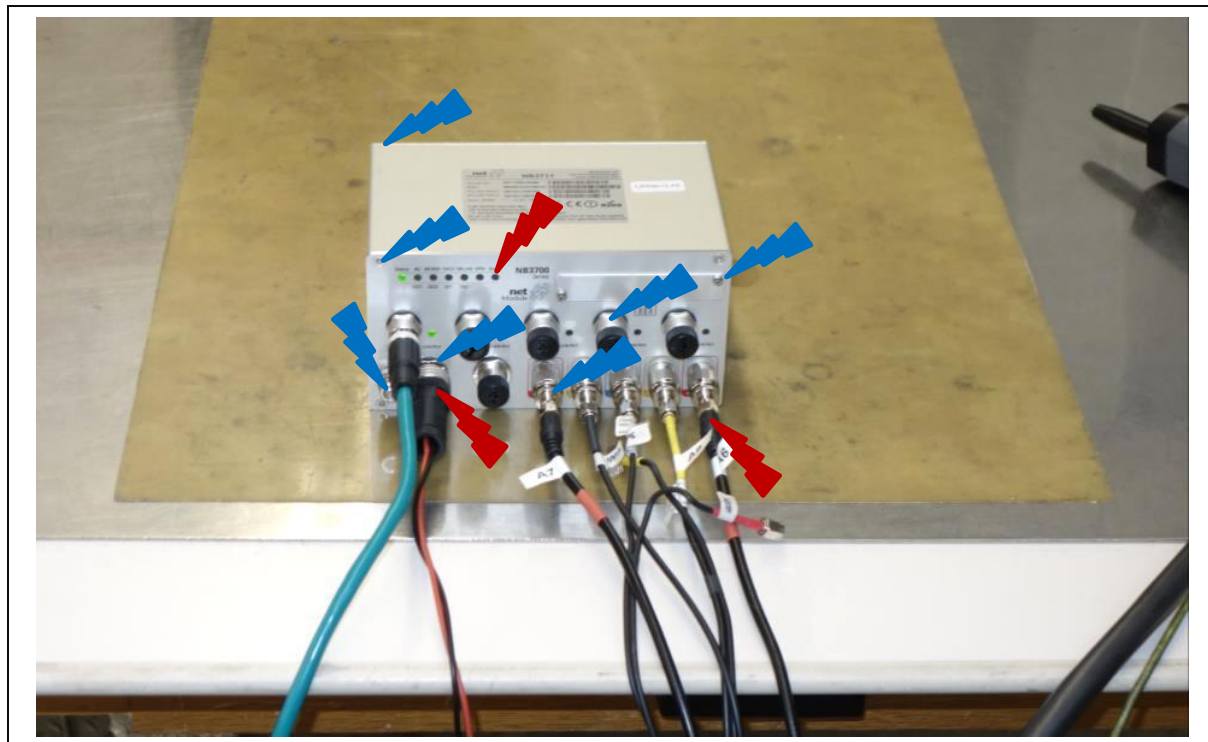
Meas. uncertainty: see chapter 12

Test method: All the points accessible to the operator are tested successively. Contact discharges are carried out on conducting surfaces as well as indirect discharges on a vertical or horizontal coupling plate. Air discharges are carried out on insulated surfaces. A minimum of 10 discharges for each voltage level and polarity are applied to each test point.

Test Equipment

Device Type	Brand	Type	ID
ESD Generator	EM-Test	ESD N30	PE10238

Photos of the Setup



Test Results

Equipment: EUT 2
Cables connected: See chapter 9.4
Operating mode: See chapter 9.5
Observation of EUT: See chapter 9.6
Modifications: none
Test site: laboratory

Requirements

Standard	Required Level Air Discharge	Required Level Contact Discharge	Impulses per Point, Level and Polarity	Performance Criterion
EN 50121-3-2 IEC 62236-3-2	±8 kV	±6 kV	10	B
EN 55035 CISPR 35	±8 kV	±4 kV	10	B
EN 301 489-1	±8 kV	±4 kV	10	B

Protocol of the Test – Indirect Discharges

Level [kV]	No of discharges (for each level)	Discharge	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
± 2; ± 4; ± 6	10	HCP	No errors occurred	A	Pass

Protocol of the Test – Direct Discharges

Level [kV]	No of discharges (for each level)	Discharge	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
± 2; ± 4; ± 6	10	Contact	No errors occurred	A	Pass
± 2; ± 4; ± 8	10	Air	No errors occurred	A	Pass
Tested points: Enclosure, Connectors, LED's					

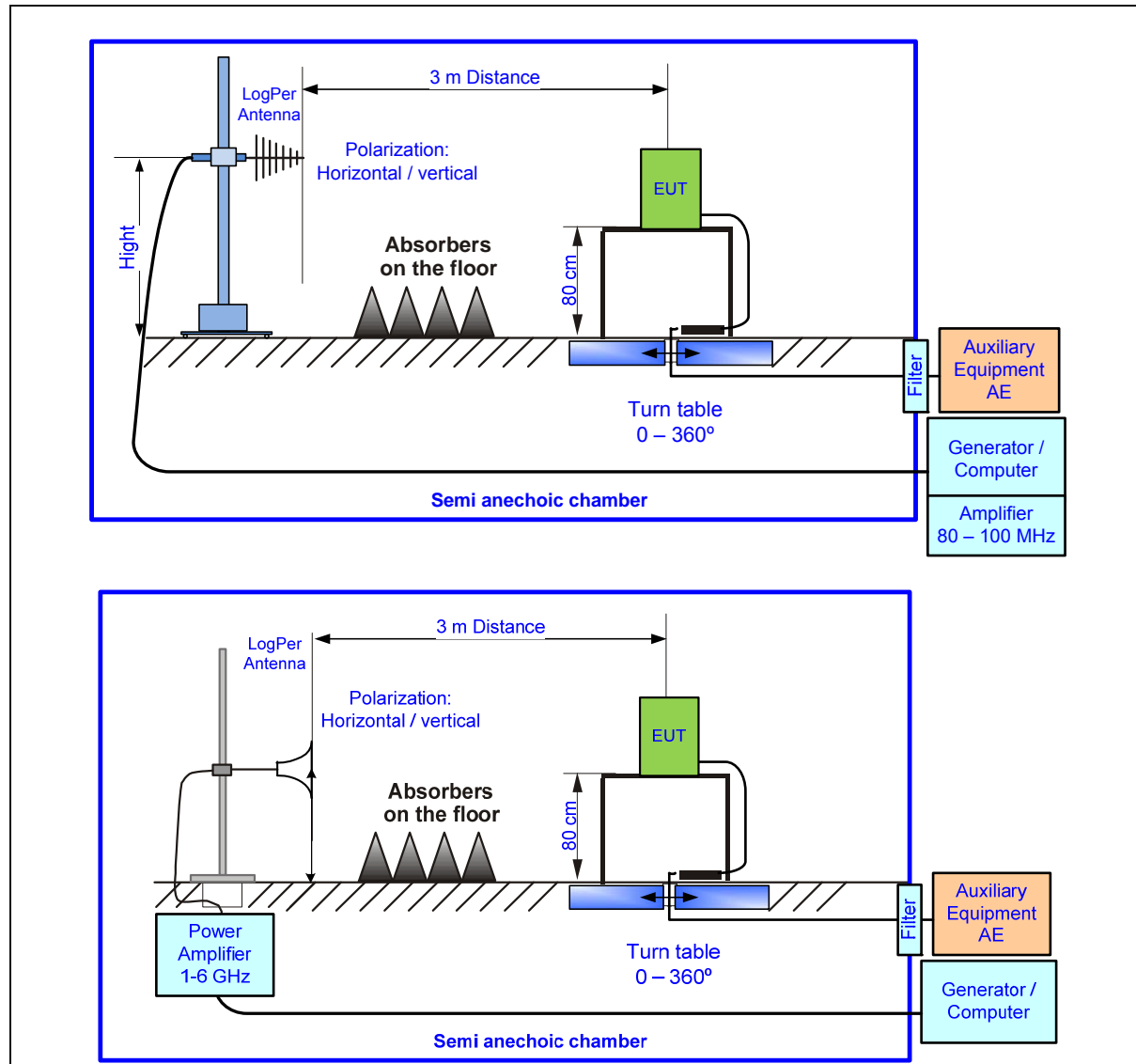
11.2 Immunity to Electromagnetic Fields (EN 61000-4-3)

Introduction: The aim of this test is to evaluate the performance of the equipment when in the presence of electromagnetic fields created by the transmission of radio or television, by cellular phones or by any other system producing electromagnetic radiation in continuous waves

Meas. Uncertainty: see chapter 12

Test method: The field is emitted from one or different antennas placed successively in vertical and then in horizontal polarization. The field is calibrated without the EUT using an isotropic probe.

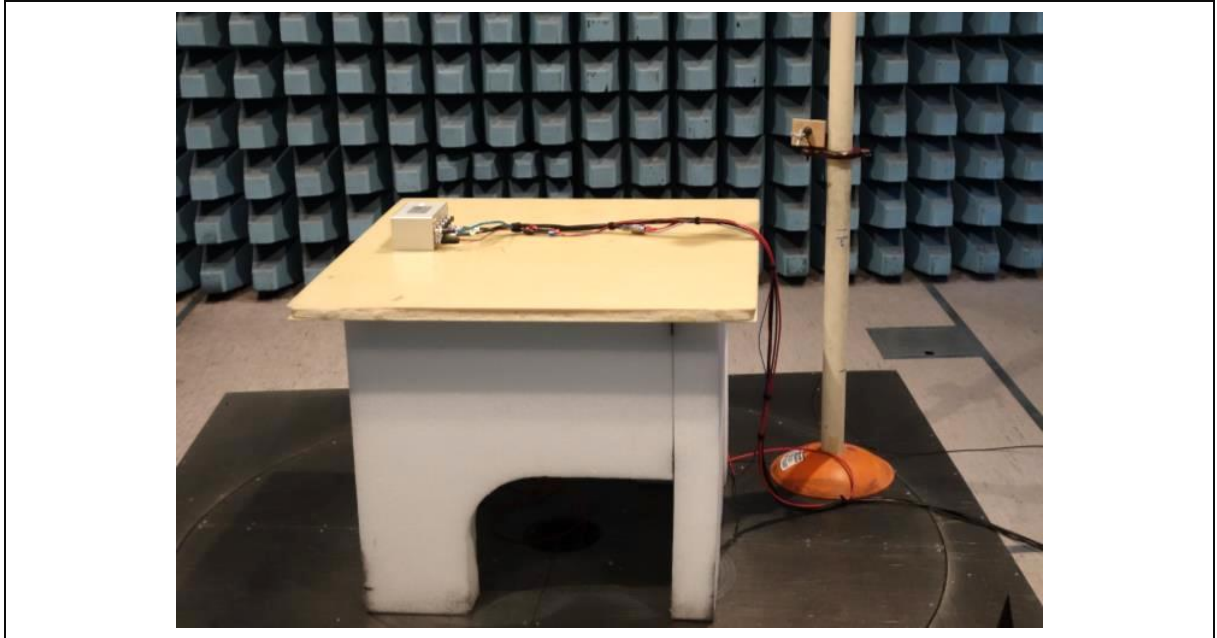
Test Setup



Test Equipment

Device Type	Brand	Type	ID
Signal Generator	AnaPico	APSin 6010	13.6632.14
Amplifier 80 – 1000 MHz	Amplifier Research	750W1000	14.6632.04
Amplifier 1 – 6 GHz	Amplifier Research	50S1G6	14.6632.01
Antenna	Amplifier Research	AT 6080	H10192
Field Sensor	Narda S.T.S	EP 601	14.6632.02

Photos of the Setup



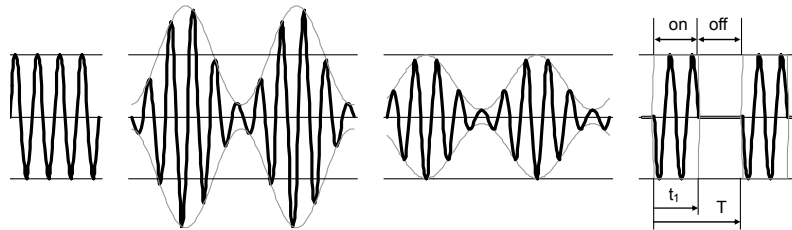
Test Results

Equipment: EUT 2
Cables connected: See chapter 9.4
Operating mode: See chapter 9.5
Observation of EUT: See chapter 9.6
Modifications: none
Test site: semi-anechoic chamber (hybrid)

Requirements

Standard	Frequency Range	Required Level	Modulation	Freq. step	Dwell time	Performance Criterion
EN 50121-3-2	80 – 1000 MHz	20 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1400 – 2000 MHz	10 V/m	AM, 1 kHz, 80 %	1 %		A
	2000 – 2700 MHz	5 V/m	AM, 1 kHz, 80 %	1 %		A
	5100 – 6000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %		A
IEC 62236-3-2	80 – 1000 MHz	20 V/m	AM, 1 kHz, 80%	1 %	1 s	A
	1400 – 2100 MHz	10 V/m	AM, 1 kHz, 80 %	1 %		A
	2100 – 2500 MHz	5 V/m	AM, 1 kHz, 80 %	1 %		A
EN 55035 CISPR 35	80 – 1000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1800 MHz \pm 1%	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	2600 MHz \pm 1%					
	3500 MHz \pm 1%					
EN 301 489-1	80 – 1000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1000 – 6000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %		A

Modulation:

☐ CW☒ AM (normal)☐ AM (const. peak)☐ PM

Dwell time:

1 s

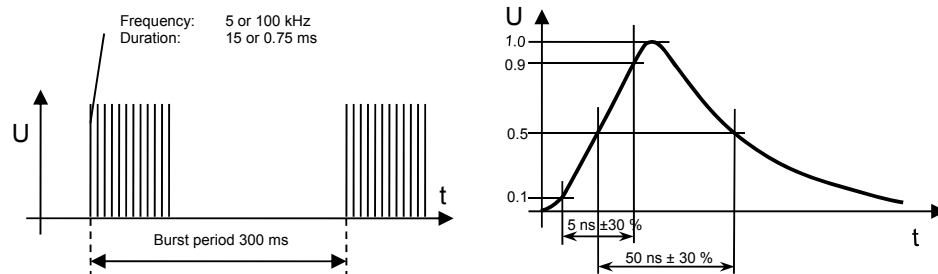
Protocol of the Test

Frequency [MHz]	E [V/m]	Polarization	Direction	Result, Observation Behavior of EUT	Fulfilled criterion	Verdict
80 – 1000	20	horizontal	Front, 0°	No errors occurred	A	Pass
	20	vertical	Front, 0°	No errors occurred	A	Pass
	20	horizontal	Side, 90°	No errors occurred	A	Pass
	20	vertical	Side, 90°	No errors occurred	A	Pass
	20	horizontal	Back, 180°	No errors occurred	A	Pass
	20	vertical	Back, 180°	No errors occurred	A	Pass
	20	horizontal	Side, 270°	No errors occurred	A	Pass
	20	vertical	Side, 270°	No errors occurred	A	Pass
1000 – 6000	10	horizontal	Front, 0°	No errors occurred	A	Pass
	10	vertical	Front, 0°	No errors occurred	A	Pass
	10	horizontal	Side, 90°	No errors occurred	A	Pass
	10	vertical	Side, 90°	No errors occurred	A	Pass
	10	horizontal	Back, 180°	No errors occurred	A	Pass
	10	vertical	Back, 180°	No errors occurred	A	Pass
	10	horizontal	Side, 270°	No errors occurred	A	Pass
	10	vertical	Side, 270°	No errors occurred	A	Pass

11.3 Immunity to Fast Electric Transients (EN 61000-4-4)

Introduction: The test is intended to demonstrate the immunity when subjected to types of transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc.). This test is also known as “burst”.

Pulse:



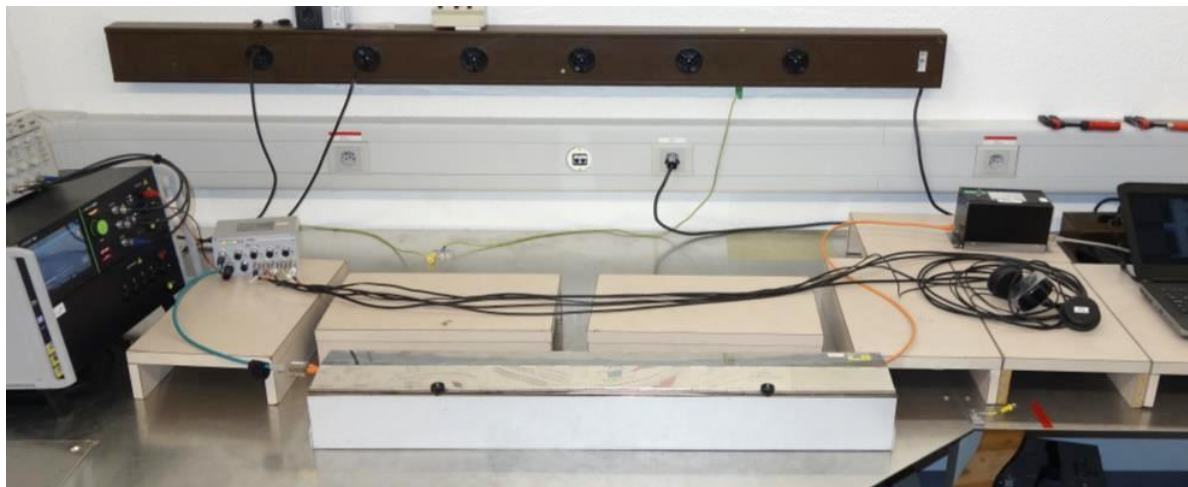
Open-circuit voltage

Voltage in a 50 Ω -Load

Meas. uncertainty: see chapter 12

Test method: The transient coupling is carried out using a coupling network for the supply cables and a capacitive coupling clamp for the other cables. The two voltage polarities and all the intermediate levels are tested.

Test Setup



Test Equipment

Device Type	Brand	Type	ID
Burst Generator	EM-Test	EFT500M4S1	PE10105
Burst Generator	EM-Test	Compact NX5	17.6632.01
Capacitive Coupling Clamp	EM-Test	EM-Test HFK	H9360

Test Results

Equipment: EUT 2
Cables connected: See chapter 9.4
Operating mode: See chapter 9.5
Observation of EUT: See chapter 9.6
Modifications: none
Test site: laboratory

Requirements

Standard	Required Level AC Supply	Required Level DC Supply	Required Level Signal	Protection. Earth	Burst Frequency	Performance Criterion
EN 50121-3-2 IEC 62236-3-2	±2.0 kV	.....	±2.0 kV	.....	5 kHz	A
EN 55035 CISPR 35	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B
EN 301 489-1	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B

Overview Ports

Port	Cable. length	Test Applicability	Remark
Power	Not defined	Yes	24 VDC Power Supply
Digital I/O	< 30m	No	Not connected
Ethernet 1	< 100m	Yes	--
Ethernet 2	< 100m	No	not used
Ethernet 3	< 100m	No	not used
Ethernet 4	< 100m	No	not used
Ethernet 5	< 100m	No	not used
Antenna Ports	< 30m	No	--
USB	< 3m	No	Service port, not connected

Protocol of the Test

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
DC Port (with Earth connection)	2.0 kV	60 s	5 kHz	direct	no errors occurred	A	Pass
	2.0 kV	60 s	100 kHz	direct	no errors occurred	A	Pass
DC Port (without Earth connection)	2.0 kV	60 s	5 kHz	direct	no errors occurred	A	Pass
	2.0 kV	60 s	100 kHz	direct	no errors occurred	A	Pass

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
Ethernet 1 (with Earth connection)	2.0 kV	60 s	5 kHz	clamp	no errors occurred	A	Pass
	2.0 kV	60 s	100 kHz	clamp	no errors occurred	A	Pass

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
Enclosure*	2.0 kV	60 s	5 kHz	direct	no errors occurred	A	Pass
	2.0 kV	60 s	100 kHz	direct	no errors occurred	A	Pass

* Informatively tested

12. Measurement Uncertainty

Conducted emission	Estimated uncertainty of the measurement results: (normal distribution, k=2)		± 2.8 dB
	Maximum uncertainty defined by the standard:		± 3.6 dB
Radiated emission	Estimated uncertainty of the measurement results for 30 – 230 MHz: (normal distribution, k=2)		± 3.4 dB
	Estimated uncertainty of the measurement results for 230 – 1000 MHz:(normal distribution, k=2)		± 2.2 dB
	Maximum uncertainty defined by the standard for 30 – 230 MHz:		± 5.2 dB
	Maximum uncertainty defined by the standard for 230 – 1000 MHz:		± 5.2 dB
	Estimated uncertainty of the measurement results for 1 – 6 GHz:(normal distribution, k=2)		± 4.8 dB
	Maximum uncertainty defined by the standard for 1 – 6 GHz:		± 5.2 dB
Electrostatic discharge	The measurement uncertainties are within the requirements of EN 61000-4-2 with a confidence level of 95 %.		/
Radiated immunity	The Uncertainty of measurement instrumentation is: (normal distribution, k=2)		± 2.4 dB
Fast transients	The measurement uncertainties are within the requirements of EN 61000-4-4 with a confidence level of 95 %.		/
Conducted radio frequency	The Uncertainty of measurement instrumentation is: (normal distribution, k=2)	CDN	± 1.51 dB
		EM clamp and direct injection	± 3.3 dB
		Current clamp	± 3.4 dB
Slow transients surge	The measurement uncertainties are within the requirements of EN 61000-4-5 with a confidence level of 95 %.		/
Power frequency magnetic field	The uncertainty of the measurement is: (normal distribution)		± 16 %
Voltage dips and interruptions	Output voltage U_o : (normal distribution)		± 9.0 %
	Duration of the voltage interruption t_e : (rectangular distribution)		± 5.0 %
	Phase ϕ_o :(rectangular distribution)		± 2.8 %
Voltage fluctuation	Output voltage U_o : (normal distribution)		± 9 %