

Test laboratory accredited according to ISO 17025 by the Swiss Accreditation Service SAS

Registration number  
Numéro d'accréditation  
Akkreditierungsnummer

**STS 0001**

Schweizerischer Prüfstellendienst  
Service suisse d'essai  
Swiss testing service



Report:	<b>Electromagnetic Compatibility</b>	Report no:	<b>18-EL-0356.E03</b>
Test item description:	<b>NetModule Router NB2800</b>	Date of test:	May 9 to 11, 2016 November 11 to 14, 2016 April 28, 2017 October 19 – 31, 2018 February 21, 2019 March 25 – 26, 2019
Applicant:	<b>NetModule AG Maulbeerstrasse 10 3011 Bern, SWITZERLAND</b>	Model/Type reference:	<b>NB2800</b>
Manufacturer:	<b>NetModule AG</b>	Serial no:	see § 8.1

Standards		Result
EN 50121-3-2 : 2015 IEC 62236-3-2 : 2008	Railway applications - EMC - Part 3-2: Rolling stock - Apparatus	Pass
EN 55022 : 2010 CISPR 22 : 2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	Pass
EN 55032 : 2015 CISPR 32 : 2015	Electromagnetic compatibility of multimedia equipment - Emission requirements	Pass
EN 55024 : 2010 CISPR 24 : 2010	Information technology equipment - Immunity characteristics - Limits and methods of measurement	Pass
EN 55035:2017 CISPR 35:2016	Electromagnetic compatibility of multimedia equipment - Immunity requirements	Pass
EN 61000-6-2 : 2005 IEC 61000-6-2 : 2016	EMC - Part 6-2: Generic standards - Immunity for industrial environments	Pass
EN 61000-6-3 : 2007 + A1 IEC 61000-6-3 : 2006 + A1	EMC - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	Pass
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	Pass
EN 301 489-7 V1.3.1	Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)	Pass
EN 301 489-17 V2.2.1	Part 17: Specific conditions for Broadband Data Transmission Systems	Pass
EN 301 489-24 V1.5.1	Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) for Mobile and portable (UE) radio and ancillary equipment	Pass
CFR 47 Part 15 - B: 2016	Code of Federal Regulations - Title 47 - Telecommunication, Part 15, Subpart B: "Unintentional Radiators"	Pass

Test performed by

*Mr. Daniel Rufer*  
*EMC Test-Engineer*



Reviewed by

*Mr. André Aubry*  
*EMC Test-Engineer*



*Zürich, 2019-04-16*

(Issue Date)

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

## Contents

	Page
FOREWORD .....	3
1. SUMMARY OF TEST RESULTS (EN 61000-6-2/3) .....	4
2. SUMMARY OF TEST RESULTS (EN 55022/32 / EN 55024/35) .....	5
3. SUMMARY OF TEST RESULTS (EN 50121-3-2) .....	6
4. SUMMARY OF TEST RESULTS (FCC) .....	6
5. SUMMARY OF TEST RESULTS (EN 301 489-X) .....	7
6. APPLIED STANDARDS .....	8
7. APPLICANT .....	9
8. EQUIPMENT UNDER TEST .....	10
8.1 Identification .....	10
8.2 Product Family .....	11
8.3 Pictures of the EUT .....	13
8.4 Classification .....	17
8.5 Ports .....	18
9. TEST CONDITIONS .....	19
9.1 Climatic conditions, location and date .....	19
9.2 Test facility and methodology .....	19
9.3 Attendant Persons .....	19
9.4 Test Configuration .....	19
9.5 Operating Conditions .....	22
9.6 Monitoring of the EUT .....	22
9.7 Auxiliary Equipment .....	23
9.8 Performance Criteria .....	25
10. EMISSION TESTS .....	26
10.1 Interference Voltage (V-LISN) .....	26
10.2 Interference Voltage (Shielded Cables) .....	52
10.3 Interference Voltage (Antenna Ports) .....	56
10.4 Radiated Electromagnetic Field (30 – 1000 MHz) .....	60
10.5 Radiated Electromagnetic Field (1 – 6 GHz) .....	73
10.6 Radiated Emission - Electromagnetic Field - FCC .....	80
10.7 Radiated Electromagnetic Field – FCC (1 – 18 GHz) .....	82
11. IMMUNITY TESTS .....	88
11.1 Immunity to Electrostatic Discharge (ESD) (EN 61000-4-2) .....	88
11.2 Immunity to Electromagnetic Fields (EN 61000-4-3) .....	95
11.3 Immunity to Fast Electric Transients (EN 61000-4-4) .....	101
11.4 Immunity to Surge (EN 61000-4-5 : 1.2/50 µs) .....	104
11.5 Immunity to Conducted Disturbances Induced by RF Fields (EN 61000-4-6) .....	109
12. MEASUREMENT UNCERTAINTY .....	116
13. MODIFICATIONS ON THE EUT .....	117

## Foreword

This test report has been updated with EUT 5 because of a new extension module added to the EUT. Therefore this report replaces completely the former version Eurofins Electrosuisse 18-EL-0356.E01, dated 2018-12-18.

## 1. Summary of Test Results (EN 61000-6-2/3)

§	Test Type		Result
<b>10</b>	<b>Emission</b>		<b>EN 61000-6-3</b>
10.1	Interference voltage	EN 55016-2-1 CISPR 16-2-1	<b>PASS</b>
10.2	Common mode at telecommunication ports	EN 55022 CISPR 22	<b>PASS</b>
10.4	Radiated electromagnetic field	EN 55016-2-3 CISPR 16-2-3	<b>PASS</b>
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	<b>Not applicable <sup>1</sup></b>
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	<b>Not applicable <sup>1</sup></b>
<b>11</b>	<b>Immunity</b>		<b>EN 61000-6-2</b>
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	<b>PASS</b>
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	<b>PASS</b>
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	<b>PASS</b>
11.4	Surges	EN 61000-4-5 IEC 61000-4-5	<b>PASS</b>
11.5	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	<b>PASS</b>
--	Magnetic fields (industrial frequencies)	EN 61000-4-8 IEC 61000-4-8	<b>Not tested <sup>2</sup></b>
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	<b>Not applicable <sup>1</sup></b>

1. No AC Mains port

2. Does not contain any devices susceptible to magnetic fields.

## 2. Summary of Test Results (EN 55022/32 / EN 55024/35)

§	Test Type	Result
<b>10</b>	<b>Emission</b>	<b>EN 55022/32</b>
10.1	Interference voltage EN 55022 CISPR 22	<b>PASS</b>
10.2	Common mode at telecom. ports EN 55022 CISPR 22	<b>PASS</b>
10.4	Radiated electromagnetic field EN 55022 CISPR 22	<b>PASS</b>
--	Harmonics EN 61000-3-2 IEC 61000-3-2	<b>Not applicable <sup>1</sup></b>
--	Voltage fluctuations (flicker) EN 61000-3-3 IEC 61000-3-3	<b>Not applicable <sup>1</sup></b>
<b>11</b>	<b>Immunity</b>	<b>EN 55024/35</b>
11.1	Electrostatic discharges EN 61000-4-2 IEC 61000-4-2	<b>PASS</b>
11.2	Electromagnetic fields EN 61000-4-3 IEC 61000-4-3	<b>PASS</b>
11.3	Fast electric transients (Burst) EN 61000-4-4 IEC 61000-4-4	<b>PASS</b>
11.4	Surges EN 61000-4-5 IEC 61000-4-5	<b>PASS</b>
11.5	Radio frequency common mode EN 61000-4-6 IEC 61000-4-6	<b>PASS</b>
--	Magnetic fields (industrial frequencies) EN 61000-4-8 IEC 61000-4-8	<b>Not tested <sup>2</sup></b>
--	Voltage dips and interruptions EN 61000-4-11 IEC 61000-4-11	<b>Not applicable <sup>1</sup></b>

1. No AC mains port

2. Does not contain any devices susceptible to magnetic fields.

### 3. Summary of Test Results (EN 50121-3-2)

§	Test Type	Result
<b>10</b>	<b>Emission</b>	<b>EN 50121-3-2</b>
10.1	Interference voltage EN 55016-2-1 CISPR 16-2-1	<b>PASS</b>
10.4	Radiated electromagnetic field EN 55016-2-3 CISPR 16-2-3	<b>PASS</b>
<b>11</b>	<b>Immunity</b>	<b>EN 50121-3-2</b>
11.1	Electrostatic discharges EN 61000-4-2 IEC 61000-4-2	<b>PASS</b>
11.2	Electromagnetic fields EN 61000-4-3 IEC 61000-4-3	<b>PASS</b>
11.3	Fast electric transients (Burst) EN 61000-4-4 IEC 61000-4-4	<b>PASS</b>
11.4	Surges EN 61000-4-5 IEC 61000-4-5	<b>PASS</b>
11.5	Radio frequency common mode EN 61000-4-6 IEC 61000-4-6	<b>PASS</b>

### 4. Summary of Test Results (FCC)

§	Test Type	Result
<b>10</b>	<b>Emission</b>	<b>CFR 47</b>
--	Conducted emission CFR 47 § 15.107 (Class B)	<b>Not applicable <sup>1</sup></b>
10.6	Radiated emission – EM-field CFR 47 § 15.109 (Class B)	<b>PASS</b>

1. No AC mains port

## 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.

§	Test Type	Result
<b>10</b>	<b>Emission</b>	<b>EN 301 489-x mobile equipment</b>
10.1	Interference voltage EN 55022 CISPR 22	<b>PASS</b>
10.2	Common mode at telecom. ports EN 55022 CISPR 22	<b>PASS</b>
10.4	Radiated electromagnetic field EN 55022 CISPR 22	<b>PASS</b>
--	Harmonics EN 61000-3-2 IEC 61000-3-2	<b>Not applicable <sup>1</sup></b>
--	Voltage fluctuations (flicker) EN 61000-3-3 IEC 61000-3-3	<b>Not applicable <sup>1</sup></b>
<b>11</b>	<b>Immunity</b>	<b>EN 301 489-x mobile equipment</b>
11.1	Electrostatic discharges EN 61000-4-2 IEC 61000-4-2	<b>PASS</b>
11.2	Electromagnetic fields EN 61000-4-3 IEC 61000-4-3	<b>PASS</b>
11.3	Fast electric transients (Burst) EN 61000-4-4 IEC 61000-4-4	<b>PASS</b>
11.4	Surges EN 61000-4-5 IEC 61000-4-5	<b>PASS</b>
11.5	Radio frequency common mode EN 61000-4-6 IEC 61000-4-6	<b>PASS</b>
--	Voltage dips and interruptions EN 61000-4-11 IEC 61000-4-11	<b>Not applicable <sup>1</sup></b>

1. No AC Mains port

## 6. Applied Standards

EN 50121-3-2 : 2015 IEC 62236-3-2 : 2008	Railway applications – Electromagnetic compatibility Part 3-2: Rolling stock – Apparatus
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 55024 : 2010 CISPR 24 : 2010	Information technology equipment Immunity characteristics – Limits and methods of measurement
EN 55035:2017 CISPR 35:2016	Electromagnetic compatibility of multimedia equipment - Immunity requirements
EN 55014-1:2006 + A1 +A2 CISPR 14-1:2005 + A1 +A2	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus. Part 1: Emission
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 + A2 IEC 61000-4-3 : 2006 + A1 + A2	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 : 2006 IEC 61000-4-5 : 2005	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 61000-6-2 : 2005 IEC 61000-6-2 : 2016	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-3 : 2007 + A1:2011 IEC 61000-6-3 : 2006 + A1:2010	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
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	Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) for Mobile and portable (UE) radio and ancillary equipment
CFR 47 Part 15 Subpart B : 2016	Code of Federal Regulations - Title 47 - Telecommunication, Part 15, Subpart B: "Unintentional Radiators"



## 7. Applicant

<i>Client name and address</i>	NetModule AG Maulbeerstrasse 10 3011 Bern SWITZERLAND
<i>Contact Person</i>	Mr. Michael Enz
<i>Telephone</i>	+41 31 985 25 93
<i>E-mail</i>	michael.enz@netmodule.com

## 8. Equipment Under Test

### 8.1 Identification

<i>Manufacturer name and address</i>	NetModule AG Maulbeerstrasse 10 3011 Bern SWITZERLAND
<i>Production country</i>	Switzerland
<i>Trade mark</i>	NetModule
<i>Test item description</i>	NetModule Router NB2800
<i>Product description</i>	The EUT is a versatile router for a multiplicity of communication interfaces (wired and radio interfaces). It is intended to be used especially in vehicle and railway applications.
<i>Model/type reference</i>	NB2800
<i>Serial number</i>	EUT 1: 00112BFFDE03 EUT 2: 00112B013DC2 EUT 3: 00112B01DD18 EUT 4: 00112B01DD1E EUT 5: 00112B0223AB
<i>Hardware identification</i>	EUT 1: NBHW_17_Mainboard_Rev.1.1 with Patch 1-11 EUT 2: NBHW_17_Mainboard_Rev.1.2 EUT 3: Mainboard Revision 1.42 with Patch 1, Huawei ME909u Modules, mPCIe-PTT Module #17 EUT 4: Mainboard Revision 1.42 with Patch 1, NetModule Mod-L210 & Mod-L210-M8G , mPCIe-PTT Module #13 EUT 5: NBHW_17_Mainboard_Rev.1.43
<i>Software version</i>	EUT 1: 3.8.52.102 EUT 2: 4.0.0.103 EUT 3: 99.99.99.99 (2018-10-25) EUT 4: 99.99.99.99 (2018-10-25) EUT 5: 4.2.0.103
<i>Highest frequency</i>	CPU Clock: 1.33 GHz PCI Express: 2.5 GHz DDR3L SDRAM: 800 MHz USB2.0: 480 MHz USB3.0: 5 GHz SATA: 6 GHz DC/DC Converter (Main): < 1 MHz
<i>Supply</i>	12 – 48 VDC, 1.7 A, 20 W
<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 Product Family

Tested Equipment	Covered Variants	Explanation <sup>1)</sup>
NB2800-2LWacDf-G NB2800-2LWacC-G NB2800-2LWacAp-G NB2800-2LWac2D-G	NB2800- H <sub>1</sub> ...H <sub>n</sub> -S <sub>1</sub> ...S <sub>n</sub>	<p>All covered NB2800 variants contain the same Mainboard, have the same case and the same form factor.</p> <p>They can host up to four communication and other interface modules. These modules can even include a GPS module. There can be up to 9 antenna connectors.</p> <p>The wireless communication modules applied have been CE and FCC certified in an independent way of the tested equipment.</p> <p>'H<sub>1</sub>...H<sub>n</sub>' is a sequence of the following letters that identify the communication modules included:</p> <p>R: none, router only  Ed: 2G = GPRS/EDGE  U: 3G+ = 2G+UMTS/HSPA/HSPA+  L: 4G = 3G+ + LTE  La: LTE 450MHz  Lb: LTE US  Lc: LTE Advanced Asia  Ld: LTE Advanced Europe  Ca: CDMA450  Ga: GNSS Advanced  Gr: GSM-R  Ge: GNSS  W: WLAN a/b/g/n Client &amp; Access Point  Wac : WiFi a/b/g/n/ac 2.4 / 5 GHz  Js: SMA Connector  A: Audio in/out  Ap: PTT-Audio  C: CAN-bus  Sa: RS-485 (on the same module as CAN)  I: IBIS-bus  Sb: RS-232 (on the same module as IBIS)  2D: Digital in/out  Da: Data Storage 32 GB  Db: Data Storage 64 GB  Dc: Data Storage 128 GB  Dd: Data Storage 256 GB  De: Data Storage 512 GB  Df: Data Storage 1 TB  ... (more to follow)</p> <p>'S<sub>1</sub>...S<sub>n</sub>' indicate the software options activated:</p> <p>G: GPS  V: Voice gateway  M: Mobile IP (Client)  S: Server</p> <p>The following NB2800 variants are currently available or planned:</p> <p>NB2800-R  NB2800-Wac-  NB2800-2Wac-  NB2800-UA-  NB2800-UWacA-  NB2800-UWac-  NB2800-U2Wac-  NB2800-2U-  NB2800-2UWac-  NB2800-L-  NB2800-LDa-</p>

		NB2800-L- NB2800-LLa- NB2800-LWac- NB2800-LWacA- NB2800-LWacC- NB2800-LWacSb- NB2800-LWacDb- NB2800-LWacCDa- NB2800-LWacCDb- NB2800-LWacCGeDf- NB2800-LWacI- NB2800-LdWac- NB2800-LdWacC- NB2800-LWac2CDf- NB2800-L2Wac- NB2800-L2WacC- NB2800-L2WacDb- NB2800-Ld2Wac- NB2800-Ld2WacC- NB2800-LdWac2CDf- NB2800-2L- NB2800-2LWac- NB2800-2LWacC- NB2800-2LWacAp- NB2800-2LWacA- NB2800-2LWacGa- NB2800-2LWacJs- NB2800-2LWacGe- NB2800-2LWacDf- NB2800-2L2Wac- NB2800-2L2WacDf- NB2800-2LdWacGe- NB2800-2LWac2D- NB2800-2Ld2Wac- NB2800-2Ld2WacDf- NB2800-3L- NB2800-3LWac- NB2800-3LdWac- NB2800-4LJs- NB2800-4L-
--	--	---

1) according to information of the customer and not verified by Eurofins

### 8.3 Pictures of the EUT



NB2800, rear view



NB2800, front view



NB2800, rear view



Type plate EUT 1

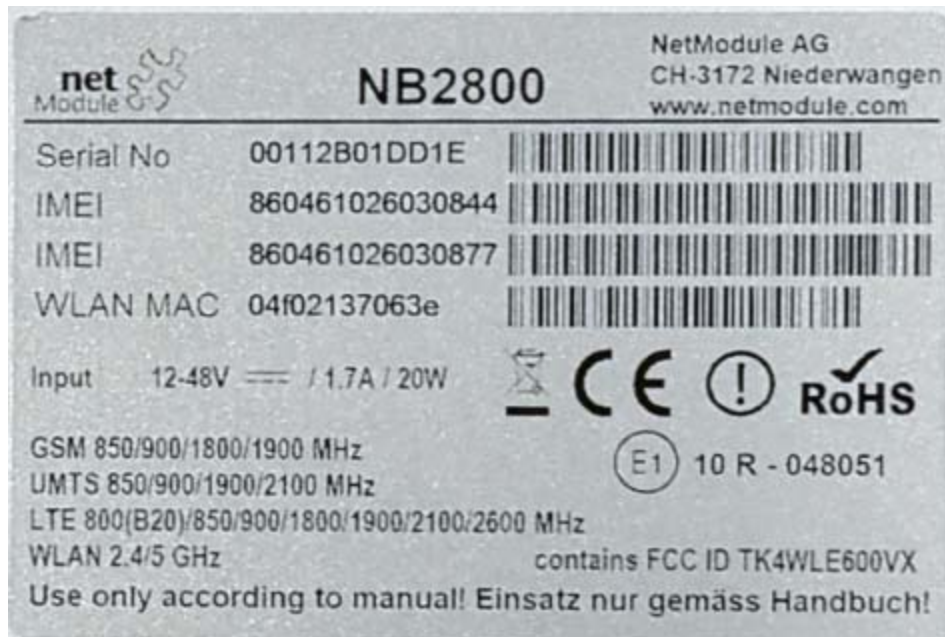


Type plate EUT 2

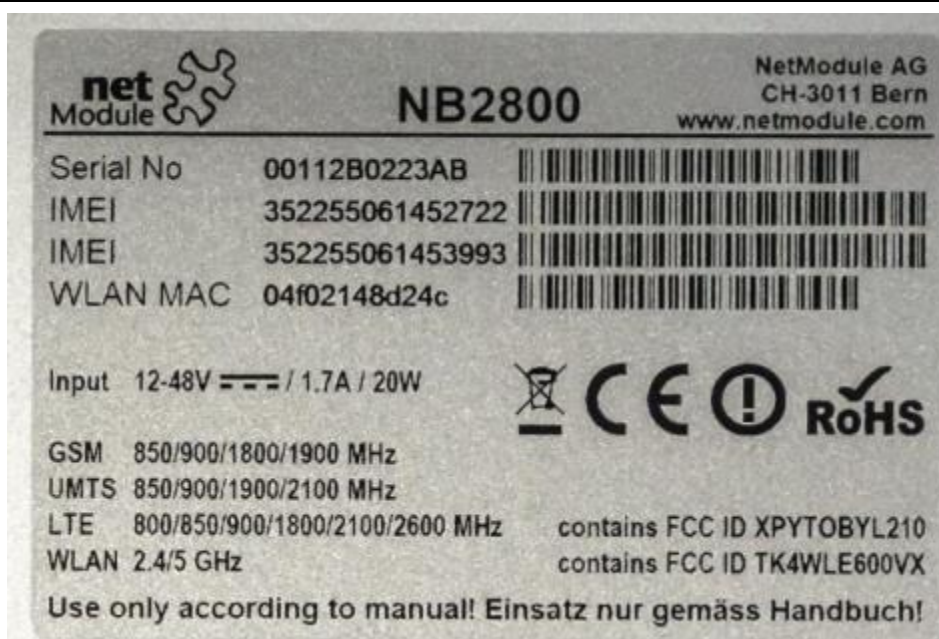




Type plate EUT 3



Type plate EUT 4



Type plate EUT 5



## 8.4 Classification

EN 50121-3-2	<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 55022/32 CISPR 22/32	<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 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
EN 301 489-24	<input type="checkbox"/> UTRA (Universal Terrestrial Radio Access, DSSS) <input type="checkbox"/> E-UTRA (Evolved Universal Terrestrial Radio Access) <input checked="" type="checkbox"/> EU (User Equipment)
CFR 47 Part 15	<input type="checkbox"/> Unintentional radiator (Subpart B) <input type="checkbox"/> Class A digital device <input checked="" type="checkbox"/> Class B digital device <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 40 GHz, whichever is lower). <input type="checkbox"/> Intentional radiator (Subpart C) <input type="checkbox"/> The highest fundamental frequency of the EUT is less than 10 GHz (measurement shall be made up to the tenth harmonic or 40 GHz, whichever is lower). <input type="checkbox"/> The highest fundamental frequency of the EUT is between 10 GHz and 30 GHz (measurement shall be made up to the fifth harmonic or 100 GHz, whichever is lower). <input type="checkbox"/> The highest fundamental frequency of the EUT is above 30 GHz (measurement shall be made up to the fifth harmonic or 200 GHz, whichever is lower).

## 8.5 Ports

Port	Cable		Remarks
	Max. length	Screen	
DC Supply	Not defined	unshielded	Power supply 12 - 48 VDC (Pins 1 and 2) and Ignition (Pin 3)
USB	< 3 m	shielded	
Ethernet 1	< 100 m	shielded	Ethernet ports, can be used for LAN/WAN
Ethernet 2	< 100 m	shielded	Ethernet ports, can be used for LAN/WAN
CAN	< 1000 m	shielded	
PTT-Audio	< 30 m	shielded	Audio & 1x Din & 1x Dout
Mobile 1	< 30 m	shielded	2 FAKRA coding D jacks for MIMO LTE antenna
Mobile 2	< 30 m	shielded	2 FAKRA coding D jacks for MIMO LTE antenna
GNSS	< 30 m	shielded	FAKRA coding C jack for GNSS antenna
RS-232	< 10 m		Non-isolated serial RS-232 interface (Pins 4 to 6) which can be used for console administration, serial device server or other serial based communication applications.
WLAN1	< 30 m	shielded	2 FAKRA coding I jacks for MIMO WLAN antenna
Digital I/O	< 30 m	unshielded	

## 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	May 9 to 11, 2016	25 ± 3 °C	980 ± 30 hPa	38 ± 5 %
	November 11 & 14, 2016	23 ± 3 °C	980 ± 30 hPa	30 ± 5 %
	April 28, 2017	24 ± 3 °C	980 ± 30 hPa	35 ± 5 %
	October 19, 22 & 31, 2018	23 ± 3 °C	980 ± 30 hPa	35 ± 5 %
	February 21, 2019	23 ± 3 °C	980 ± 30 hPa	35 ± 5 %
	March 25 & 26, 2019	24 ± 3 °C	980 ± 30 hPa	35 ± 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

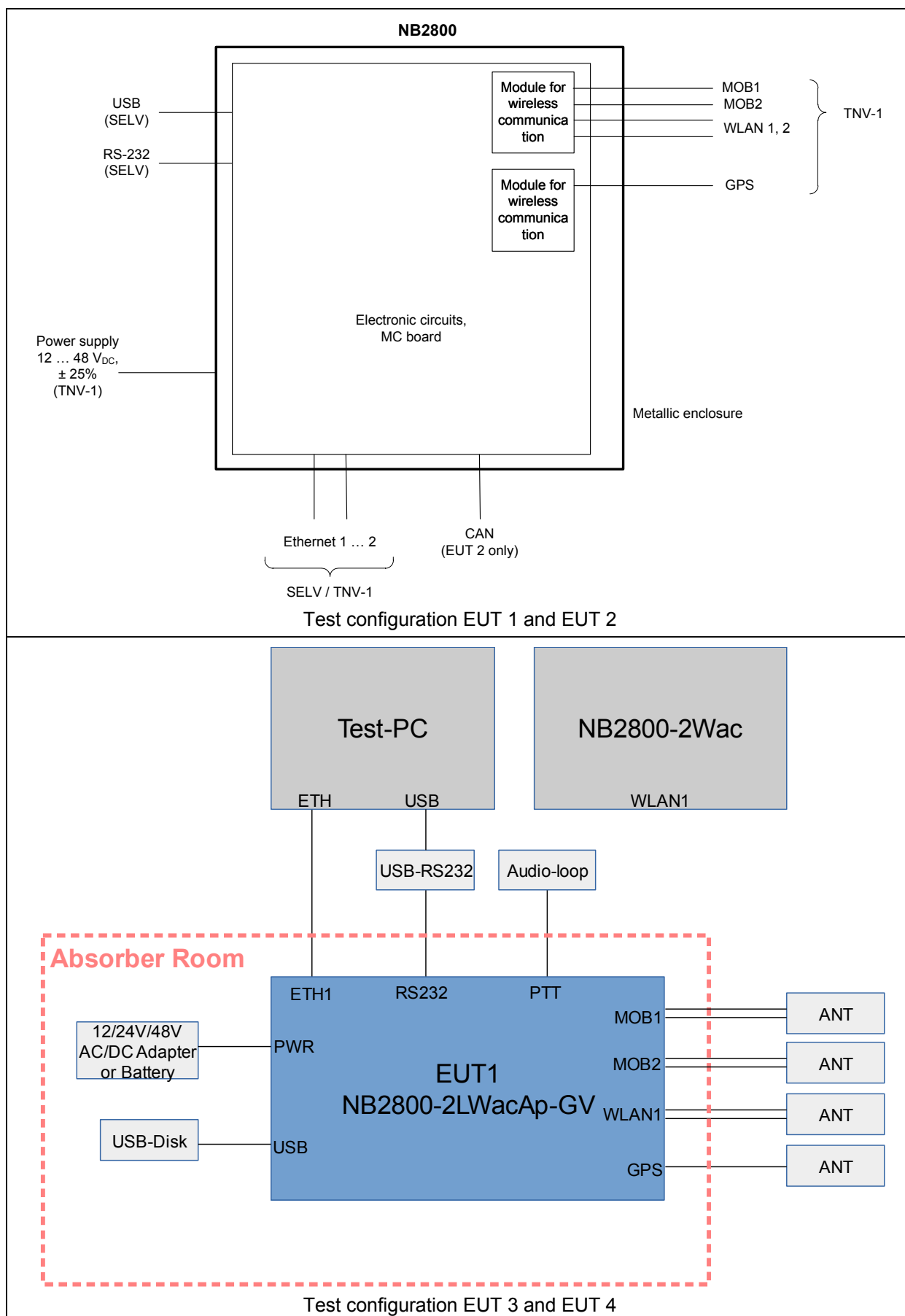
#### Test Engineer(s):

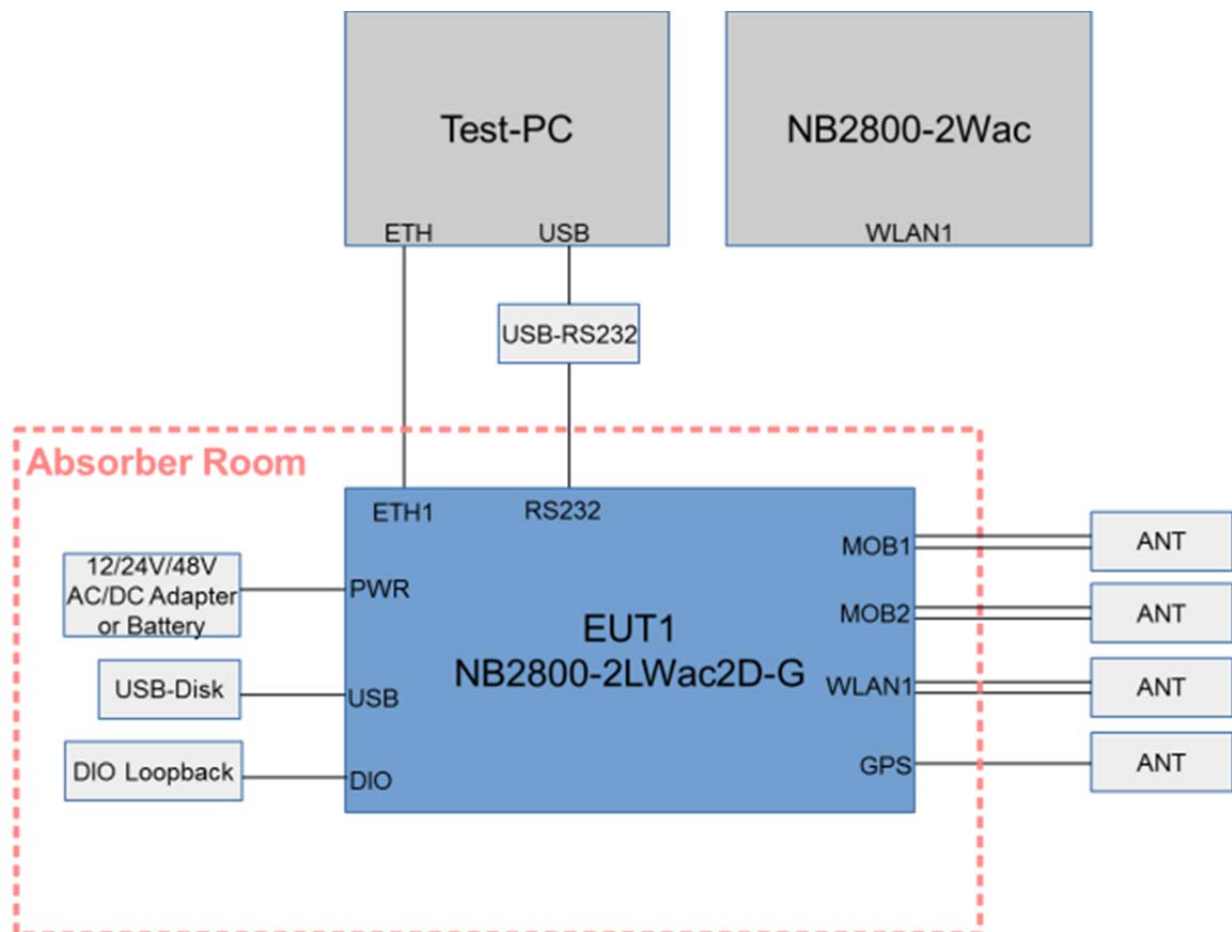
Mr. Daniel Rufer  
Mr. Konrad Ritter

#### Other(s):

Name	Company
Mr. Alexander Ott	NetModule AG
Mr. Raffael Rohrer	NetModule AG

### 9.4 Test Configuration





Test configuration EUT 5

## 9.5 Operating Conditions

**Normal mode EUT 1:**

- Ping over WLAN 1
- Ping over WWAN 1 & 2 (UMTS/LTE)
- Ping over Ethernet 1
- Access to SSD disc
- Access with serial connection
- Ping to USB-Stick

**Normal mode EUT 2:**

- Ping over CAN

**Normal mode EUT 3 and EUT 4:**

- Ping over WLAN 1
- Ping over WWAN 1 & 2 (UMTS/LTE)
- Ping over Ethernet 1
- Access with serial connection
- Ping to USB-Stick
- 1 kHz & 2.5 kHz Audio-Out loopback to Audio-In
- Relay on-off continuously switching every 1 second

**Normal mode EUT 5:**

- Ping over WLAN 1
- Ping over WWAN 1 & 2 (UMTS/LTE)
- Ping over Ethernet 1
- Access with serial connection
- Relay on-off continuously switching every 1 second

powered with 24 VDC unless otherwise specified

## 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 & FFT of Audio Loopback Signal (except EUT 5)

## 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.

### EUT 1:

<b>Product</b>	<b>Brand</b>	<b>Model No.</b>	<b>ID</b>	<b>Remarks</b>
DC Power Supply 12 VDC	Oltronix	B202	Q3506	RE, CE
DC Power Supply 12 VDC	Oltronix	B603D	Q2722	RE, CE
Power supply	Hameg	HM8143	Q10152/53	RI, CI, Burst
Power supply	Wayne Kerr	AP7030A	Q8186	Surge, ESD
Test-PC / Notebook	Dell	E5430	B2DT3X1	
USB-to-RS232 Adapter	MOXA	USB UPORT 1150I	--	
WWAN Antenna	n/a	Antenna-Roof-2L DL-9	A140812300036	
GPS Antenna	REEL	C70ZAR 0300 00 03 03 PWN1	02 1501	
WLAN Antenna	--	Antenna-Roof-2W	--	
SMA - FAKRA Adapter	--	--	--	
SIM	Swisscom	--	--	
SIM	Salt	--	--	
USB-Stick	Silica	--	--	8 GB

### EUT 2:

<b>Product</b>	<b>Brand</b>	<b>Model No.</b>	<b>ID</b>	<b>Remarks</b>
DC Power Supply 24 VDC	Oltronix	B603D	--	RE, RI
Batteries 2x 12 VDC	Power Sonic	PS-12170 B	--	CE, CI, Burst, Surge, ESD
Test-PC / Notebook	Dell	E5430	B2DT3X1	
USB-to-CAN Adapter	IXXAT	USB-to-CAN compact	HW242181	

*EUT 3, EUT 4 and EUT 5:*

<b>Product</b>	<b>Brand</b>	<b>Model No.</b>	<b>ID</b>	<b>Remarks</b>
Batteries	Panasonic	--	--	
Test-PC / Notebook	Dell	E5430	B2DT3X1	
USB-to-RS232 Adapter	MOXA	USB UPORT 1150I	--	
WWAN Antenna	n/a	Antenna-Roof-2L DL-9	A140812300036	
GPS Antenna	REEL	C70ZAR 0300 00 03 03 PWN1	02 1501	
WLAN Antenna	--	Antenna-Roof-2W	--	
SMA – FAKRA Adapter	--	--	--	
SIM 1 & 2	Swisscom	--	--	
USB-Stick	--	--	--	8 GB
Router	NetModule	NB2800-2LWacAp-G	SN 00112B01DD18	



## 9.8 Performance Criteria

General requirements:	Requirements according to the EUT:
<p style="text-align: center;"><b>Criterion A:</b></p> <p>The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed.</p>	
<p>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.</p>	<p><i>No transmission loss LAN, WWAN (LTE/UMTS), RS232, WLAN and USB, CAN (EUT 2 only), Relay continuously switching, signal-to-noise ratio higher 40 dB</i></p> <p><i>During the test: short interruptions of the communication LED's may flicker</i></p> <p><i>After the test the EUT shall operate as in normal mode</i></p>
<p style="text-align: center;"><b>Criterion C:</b></p> <p>Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.</p>	
	<p><i>No specific requirements</i></p>

## 10. Emission Tests

### 10.1 Interference Voltage (V-LISN)

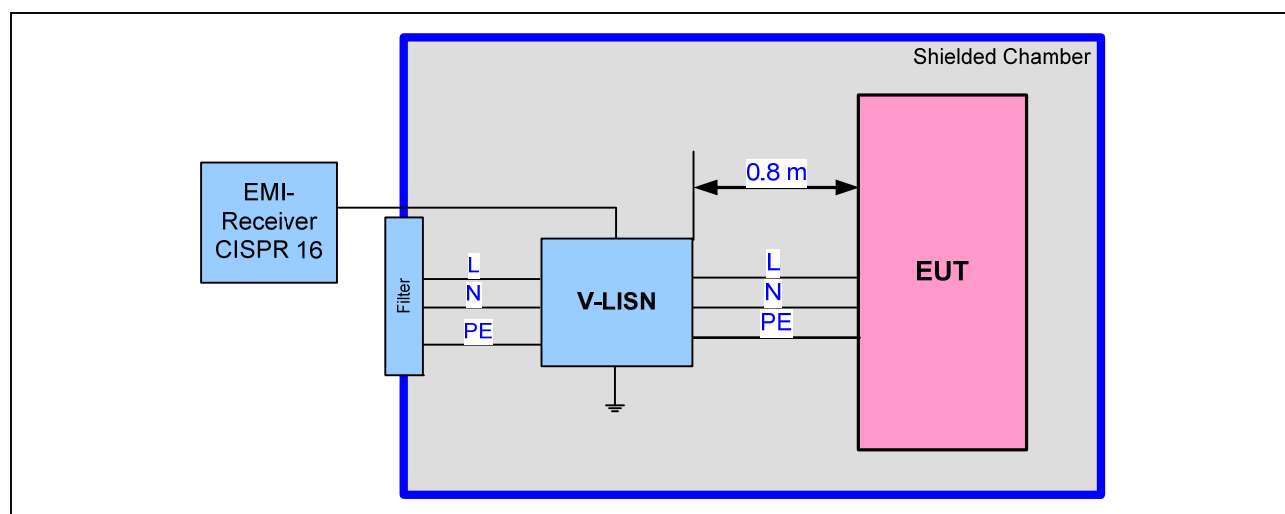
**Test site:** shielded room

**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 peak values are recorded continuously. Values that exceed the average limit shall be re-measured with the average and quasi peak detector of the receiver.

**Modifications:** none

#### Test Setup



#### Test Equipment

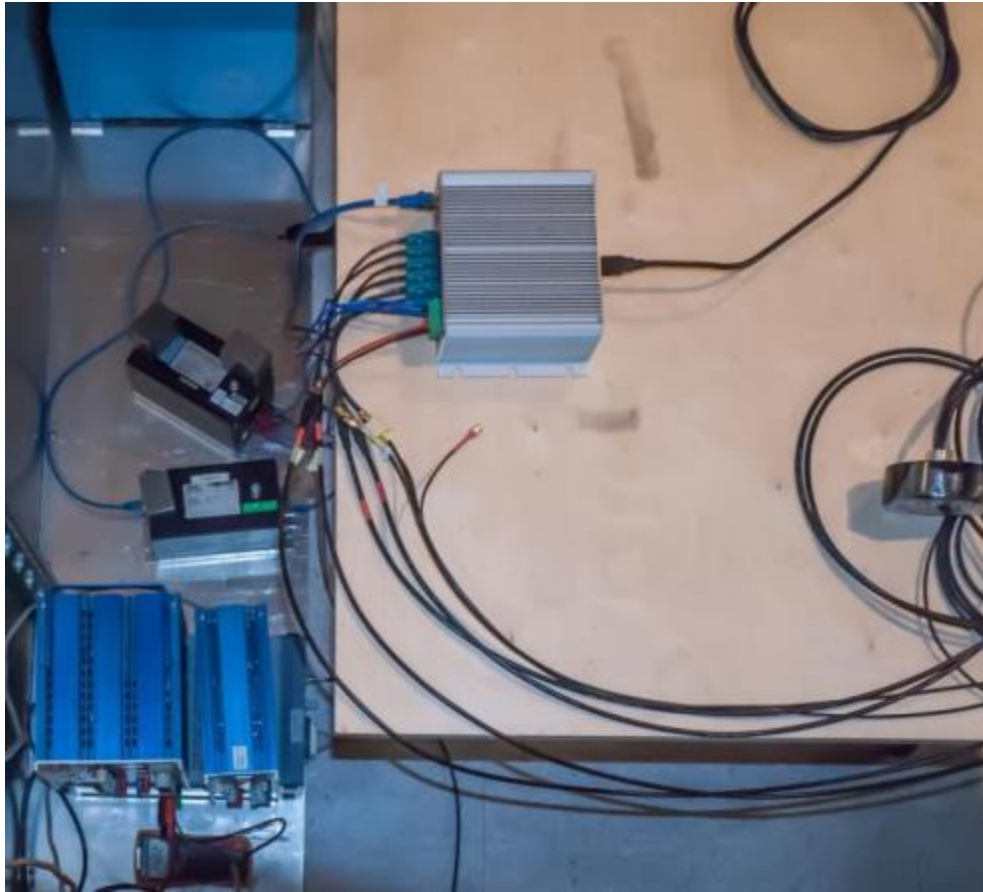
EUT 1 and EUT 2

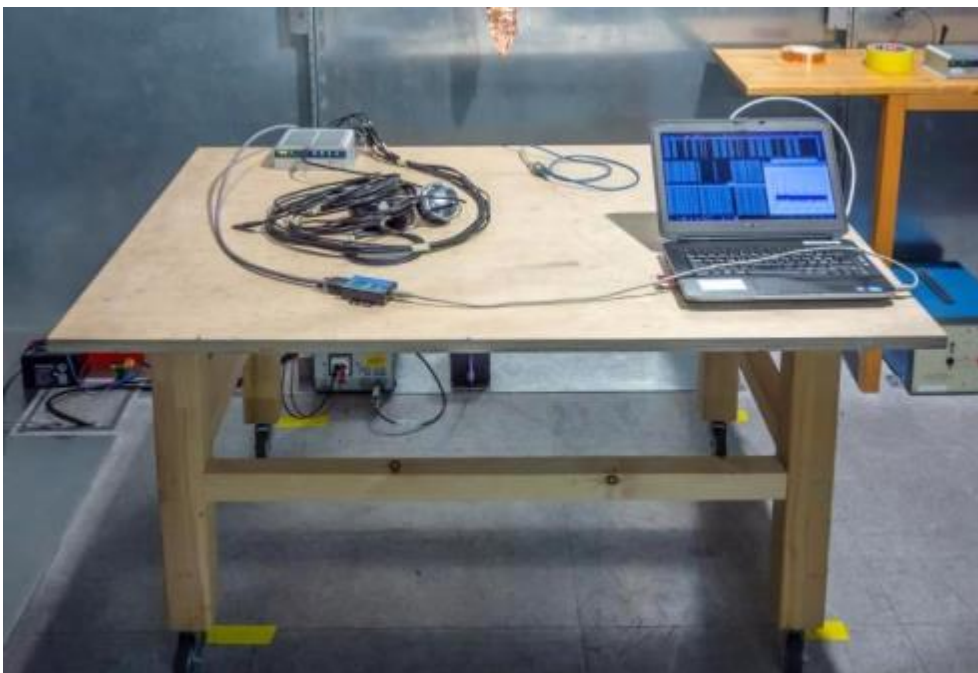
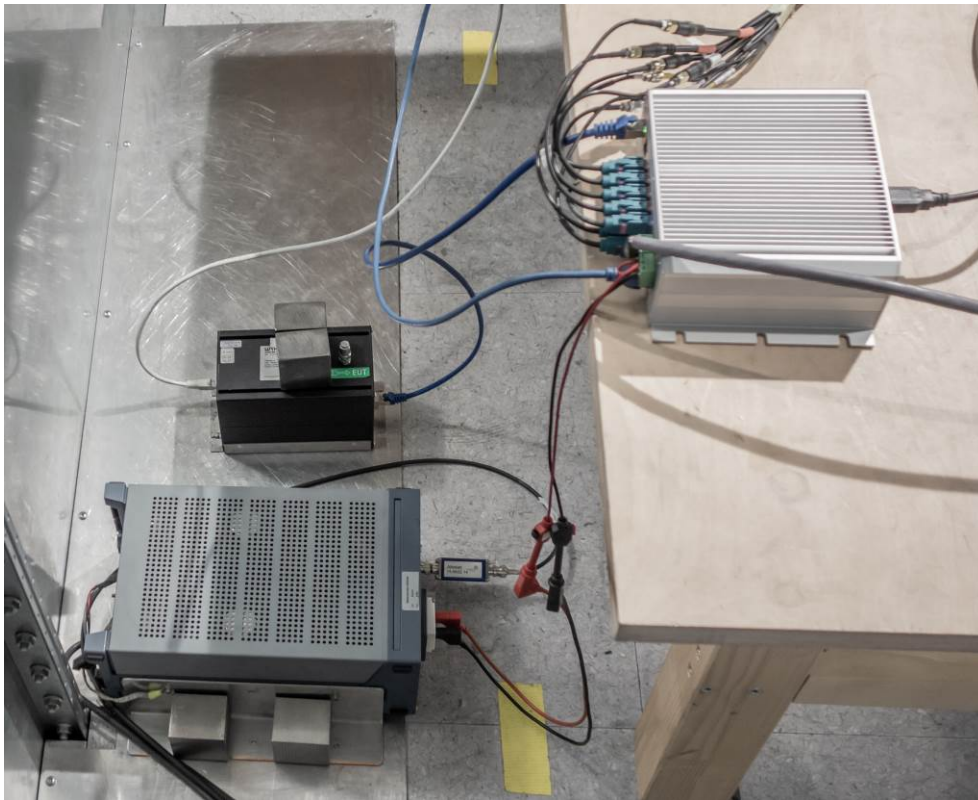
Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESR 7	15.6637.06
EMI Receiver	Hewlett Packard	8546A	OA9715
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	CDN S8 RJ45	13.6632.07
CDN (Decoupling)	EM Test	CDN AF4	H10171
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

EUT 3,4 and EUT 5

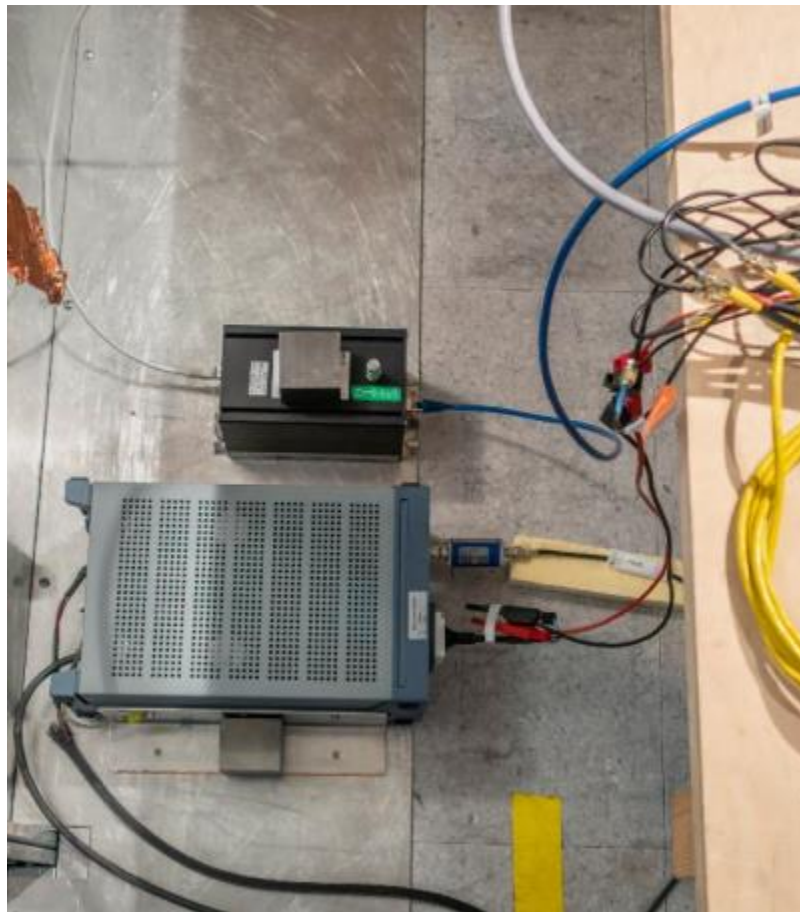
Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU 8	OA10193
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
V-Network	EMCO	3825	H4537
V-Network	Schwarzbeck	NNLA 8120	H5562
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

### Photos of the Setup – EUT 1 and EUT 2



**Photos of the Setup – EUT 3 and EUT 4**

### Photos of the Setup – EUT 5

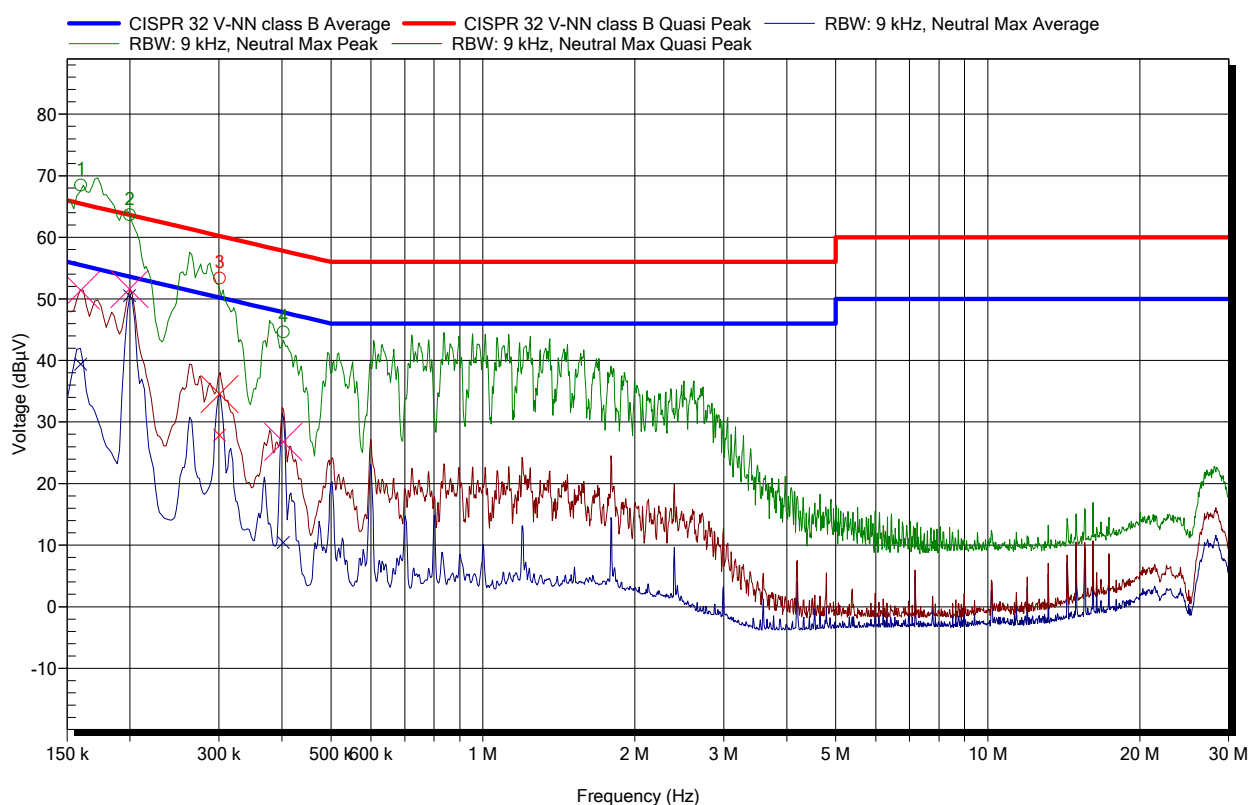




## Measurement Results

Diagram 1:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	60 VDC
<b>Test date, time</b>	10.05.2016 08:43:00
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

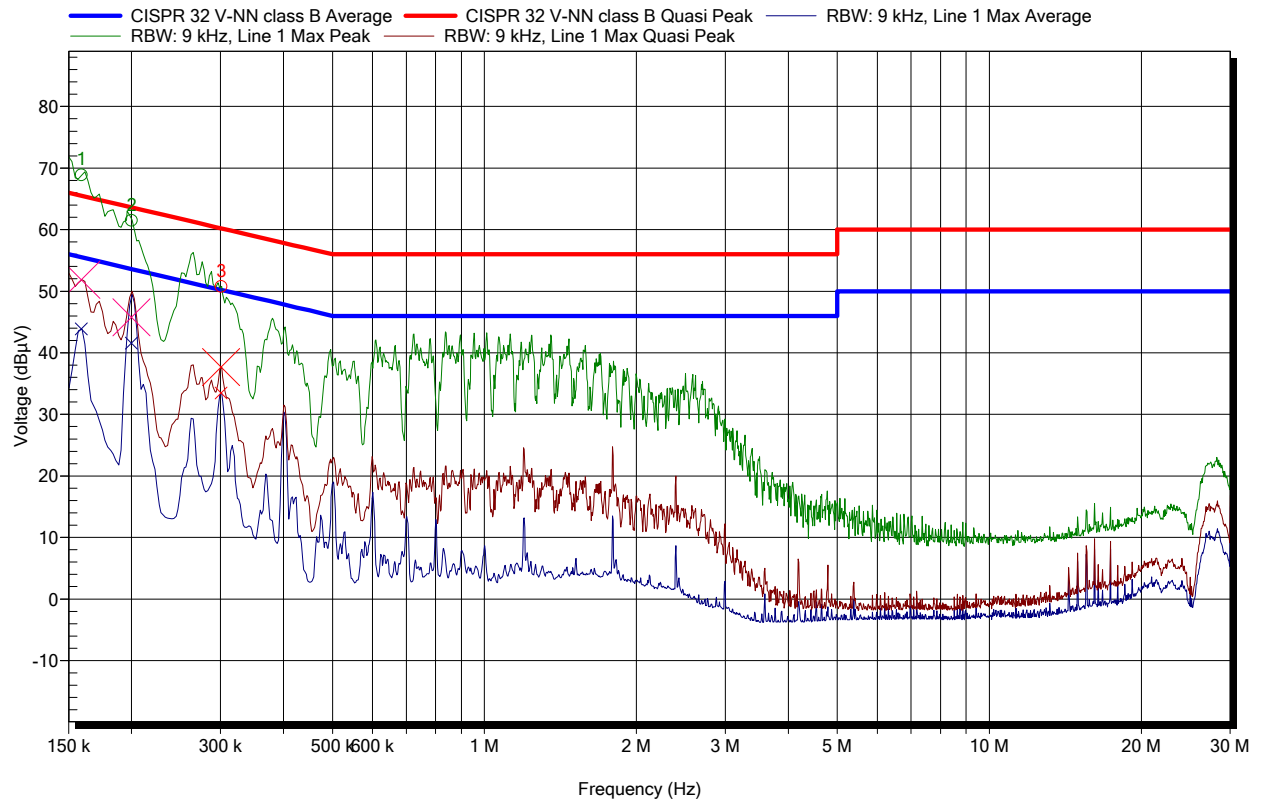


## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159.794 kHz	68.49 dBμV	39.38 dBμV	-16.09 dB	51.4 dBμV	-14.07 dB	Pass
2	199.5 kHz	63.65 dBμV	50.49 dBμV	-3.14 dB	51.57 dBμV	-12.06 dB	Pass
3	300.749 kHz	53.39 dBμV	27.84 dBμV	-22.38 dB	34.54 dBμV	-25.68 dB	Pass
4	402.407 kHz	44.63 dBμV	10.43 dBμV	-37.37 dB	26.8 dBμV	-31 dB	Pass

Diagram 2:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	60 VDC
<b>Test date, time</b>	10.05.2016 08:46:51
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

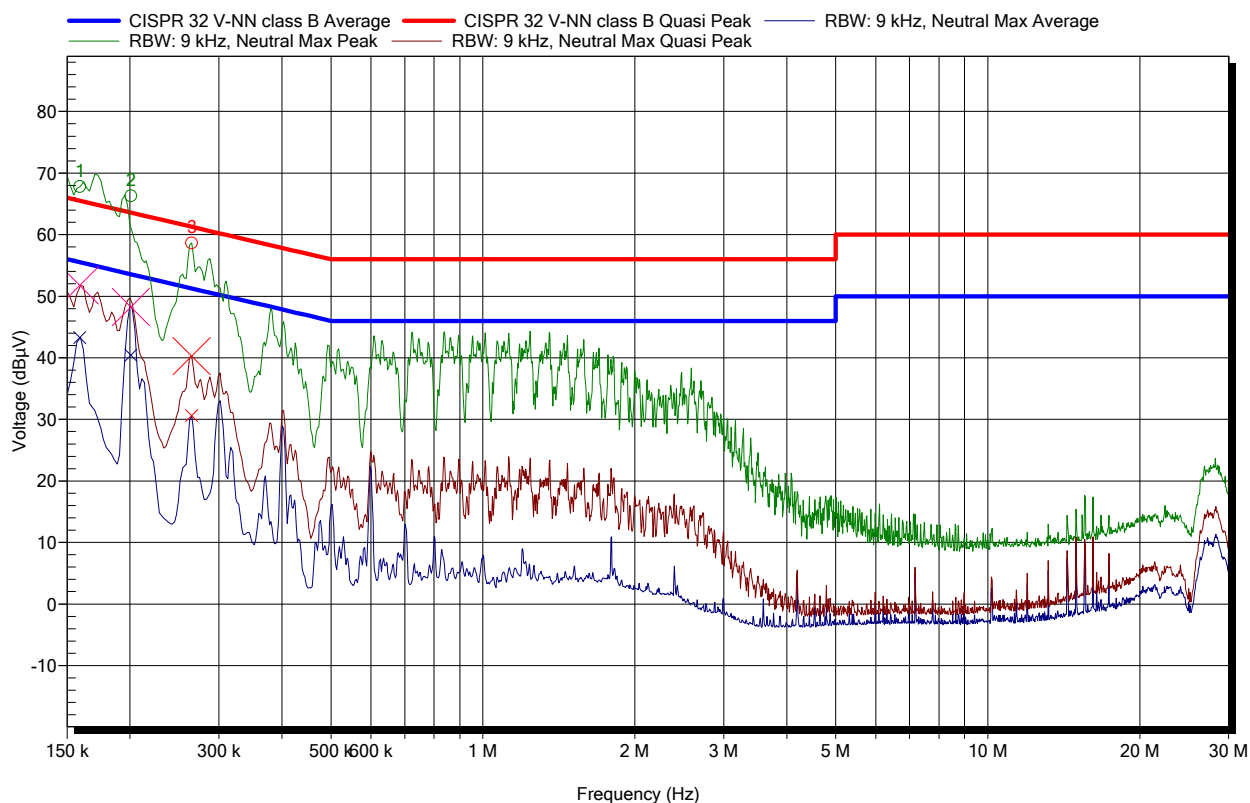


### Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	68.89 dBμV	43.9 dBμV	-11.61 dB	51.87 dBμV	-13.64 dB	Pass
2	199.999 kHz	61.49 dBμV	41.58 dBμV	-12.03 dB	45.77 dBμV	-17.84 dB	Pass
3	300.75 kHz	50.77 dBμV	33.47 dBμV	-16.75 dB	37.7 dBμV	-22.52 dB	Pass

Diagram 3:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	10.05.2016 08:49:17
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms



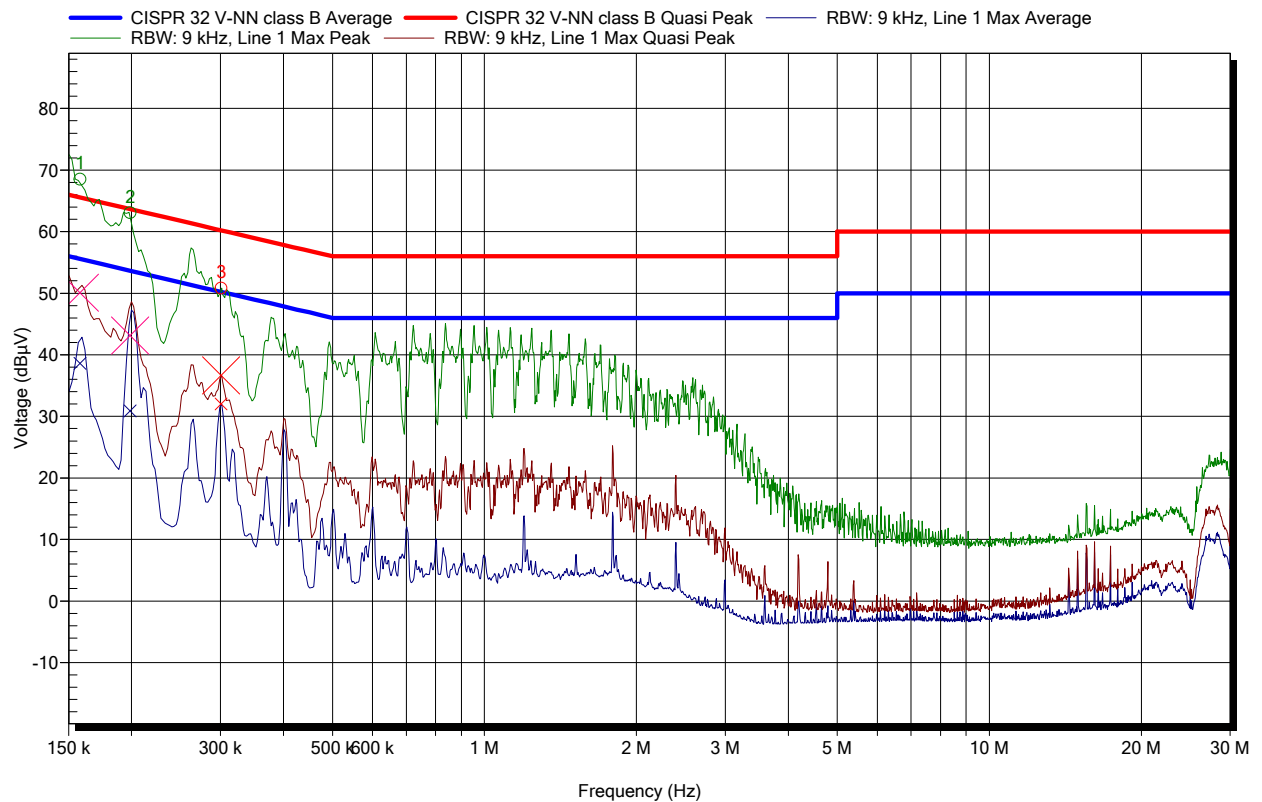
### Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	67.85 dBμV	43.28 dBμV	-12.23 dB	51.73 dBμV	-13.78 dB	Pass
2	200.802 kHz	66.34 dBμV	40.4 dBμV	-13.17 dB	48.27 dBμV	-15.3 dB	Pass
3	264.75 kHz	58.64 dBμV	30.6 dBμV	-20.68 dB	40.28 dBμV	-21 dB	Pass



Diagram 4:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	10.05.2016 08:50:25
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

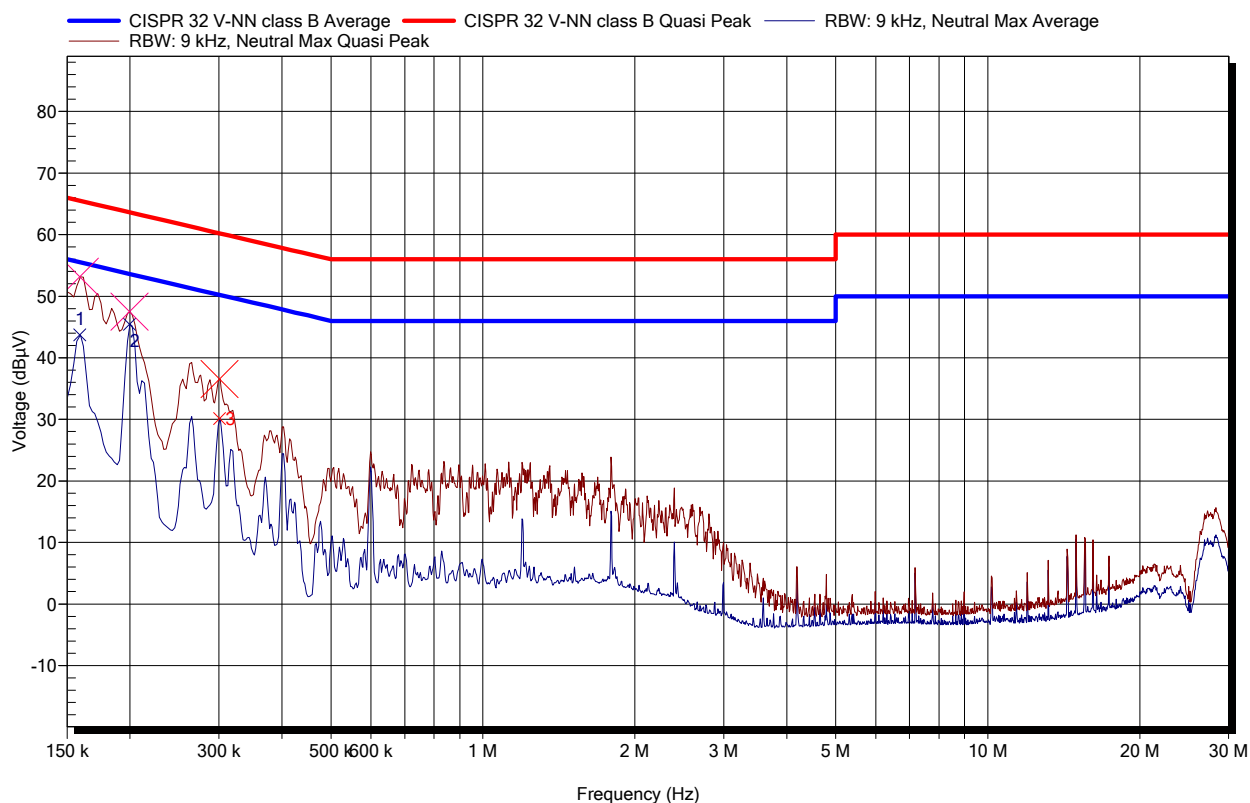


### Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	157.958 kHz	68.55 dBμV	38.57 dBμV	-17 dB	50.08 dBμV	-15.49 dB	Pass
2	198.59 kHz	63.08 dBμV	30.86 dBμV	-22.81 dB	43.13 dBμV	-20.54 dB	Pass
3	300.75 kHz	50.86 dBμV	32 dBμV	-18.22 dB	36.66 dBμV	-23.56 dB	Pass

Diagram 5:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	36 VDC
<b>Test date, time</b>	10.05.2016 08:51:42
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

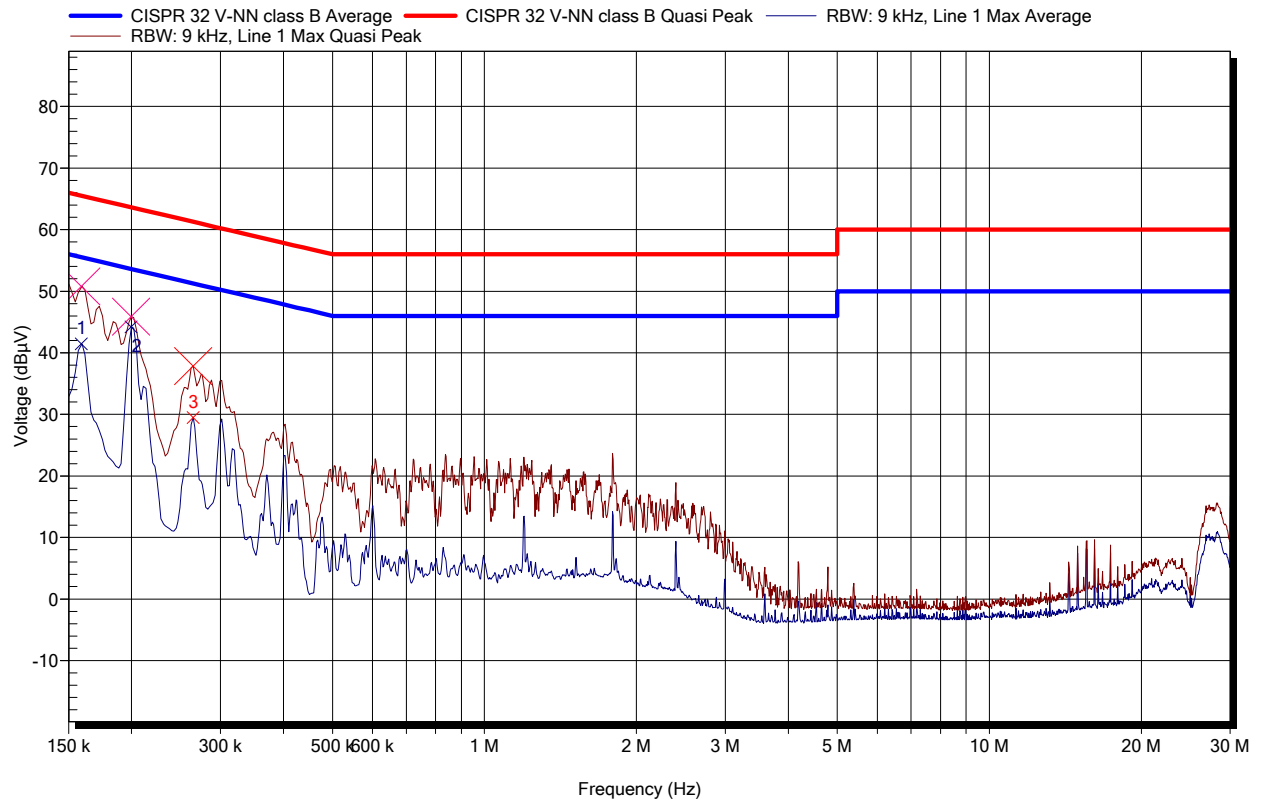


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	43.71 dBμV	-11.8 dB	53.18 dBμV	-12.33 dB	Pass
2	199.5 kHz	45.43 dBμV	-8.2 dB	47.47 dBμV	-16.16 dB	Pass
3	300.75 kHz	30.14 dBμV	-20.08 dB	36.52 dBμV	-23.7 dB	Pass

Diagram 6:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	36 VDC
<b>Test date, time</b>	10.05.2016 08:52:29
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

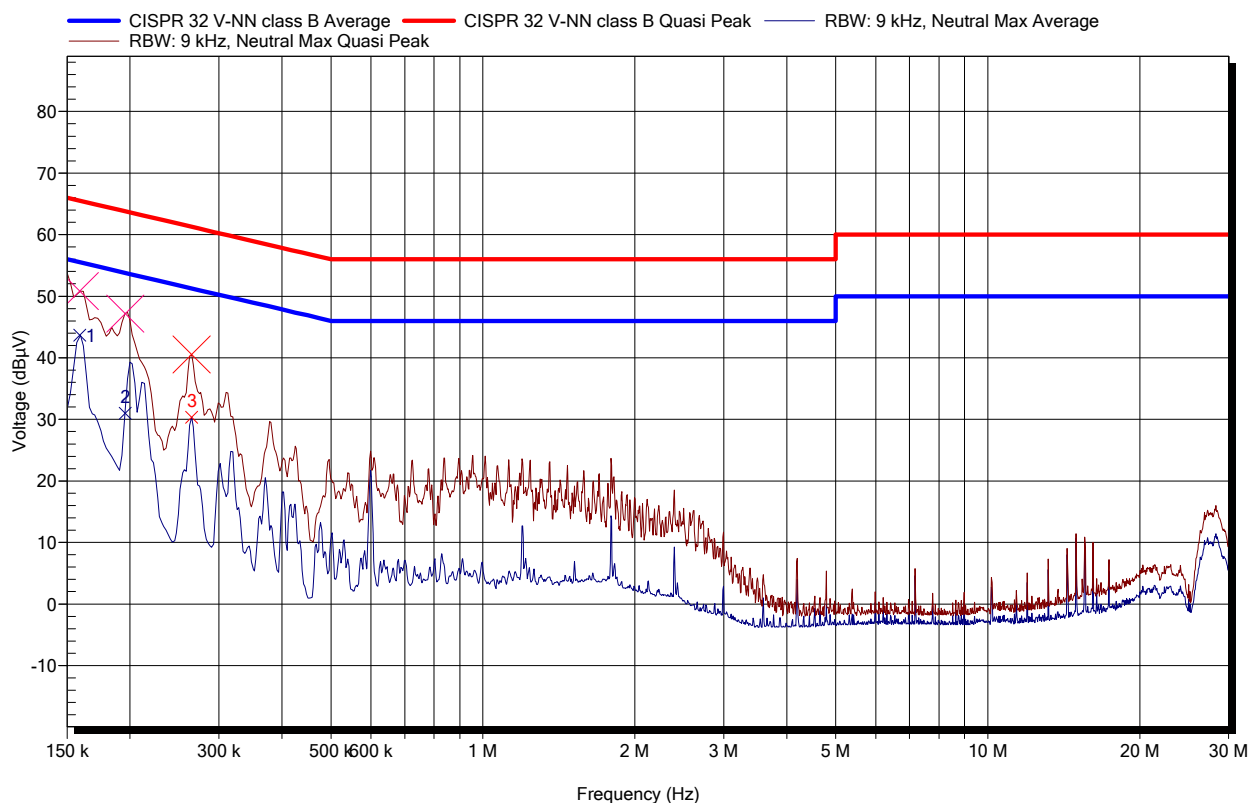


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	41.45 dBµV	-14.06 dB	50.76 dBµV	-14.75 dB	Pass
2	199.5 kHz	44.21 dBµV	-9.42 dB	45.87 dBµV	-17.76 dB	Pass
3	264.75 kHz	29.49 dBµV	-21.79 dB	37.83 dBµV	-23.45 dB	Pass

Diagram 7:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	10.05.2016 08:53:38
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

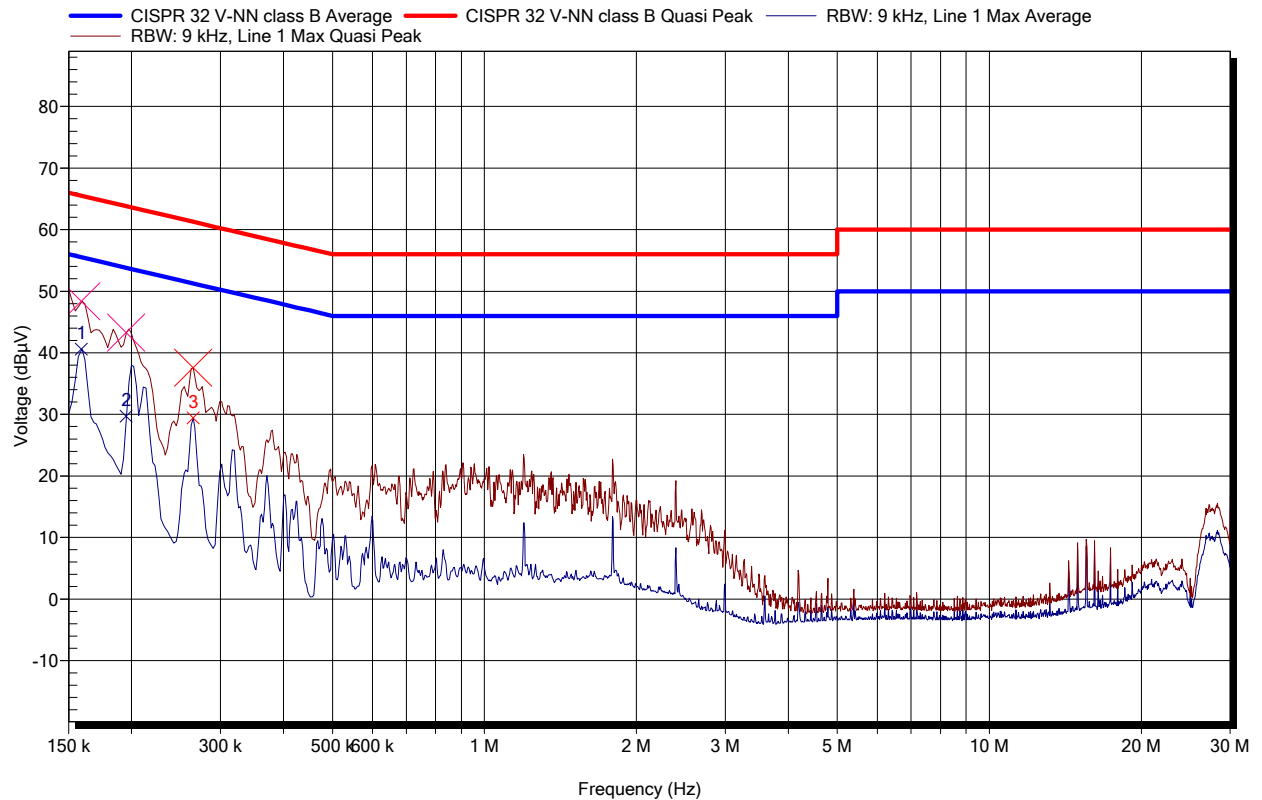


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	43.65 dBμV	-11.86 dB	50.82 dBμV	-14.69 dB	Pass
2	195.679 kHz	31.02 dBμV	-22.78 dB	47.2 dBμV	-16.6 dB	Pass
3	264.75 kHz	30.33 dBμV	-20.95 dB	40.52 dBμV	-20.76 dB	Pass

Diagram 8:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	10.05.2016 08:54:23
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

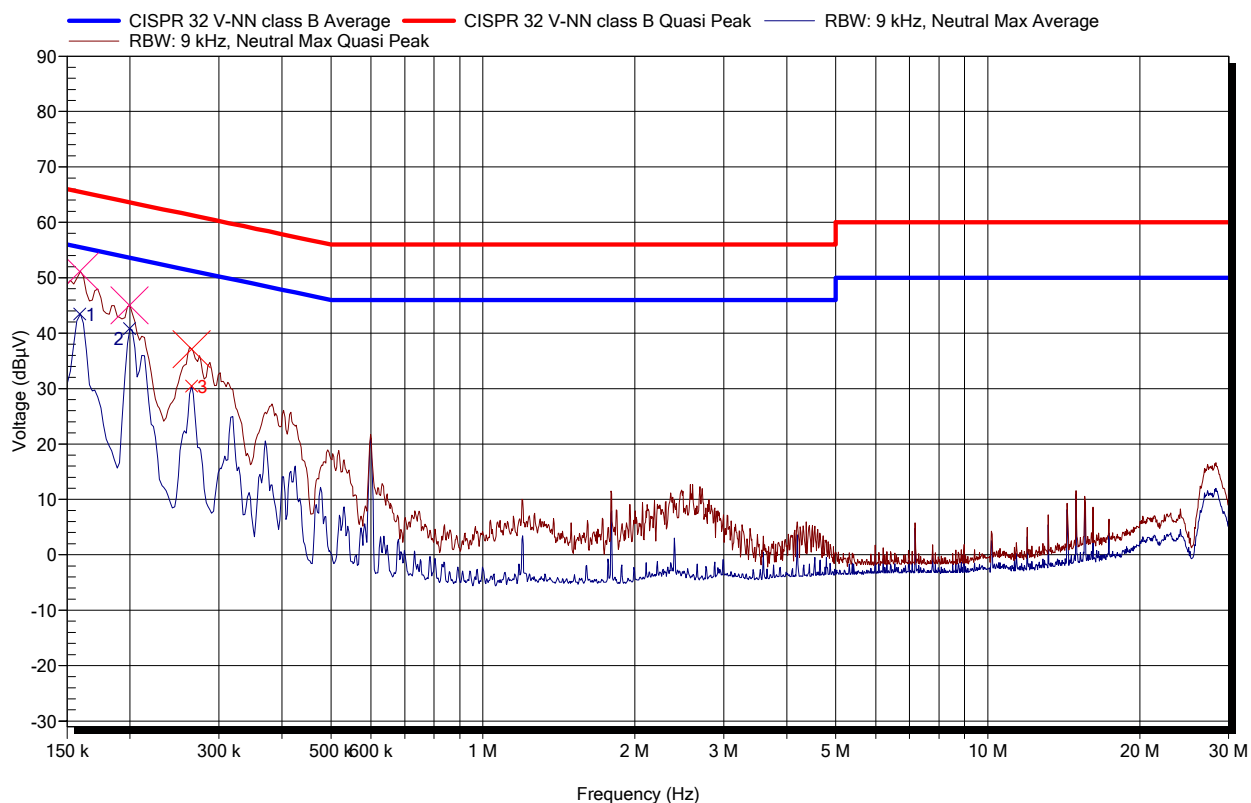


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	40.59 dBμV	-14.92 dB	48.37 dBμV	-17.14 dB	Pass
2	195 kHz	29.72 dBμV	-24.1 dB	43.29 dBμV	-20.53 dB	Pass
3	264.75 kHz	29.41 dBμV	-21.87 dB	37.57 dBμV	-23.71 dB	Pass

Diagram 9:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	10.05.2016 09:05:06
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

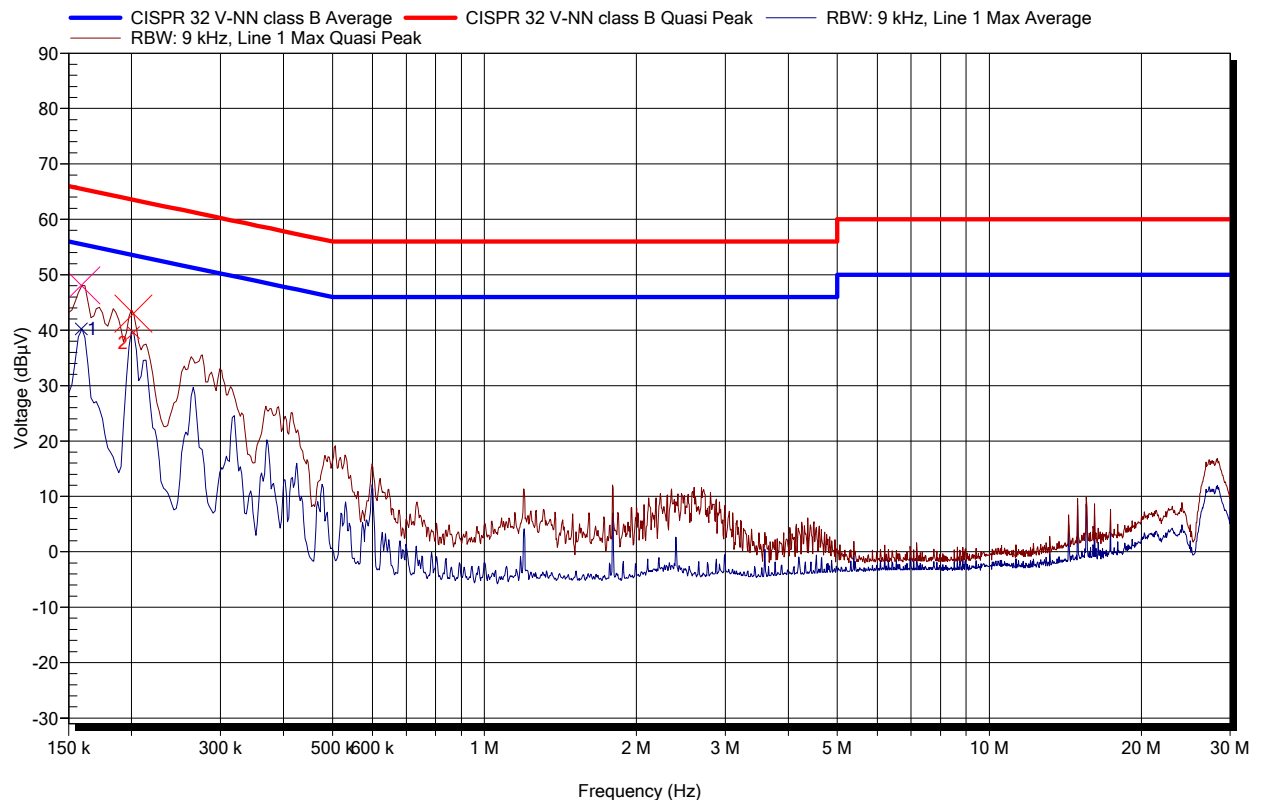


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	43.49 dBμV	-12.02 dB	51.15 dBμV	-14.36 dB	Pass
2	199.5 kHz	40.82 dBμV	-12.81 dB	45.01 dBμV	-18.62 dB	Pass
3	264.75 kHz	30.48 dBμV	-20.8 dB	37.12 dBμV	-24.16 dB	Pass

Diagram 10:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	10.05.2016 09:05:51
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms

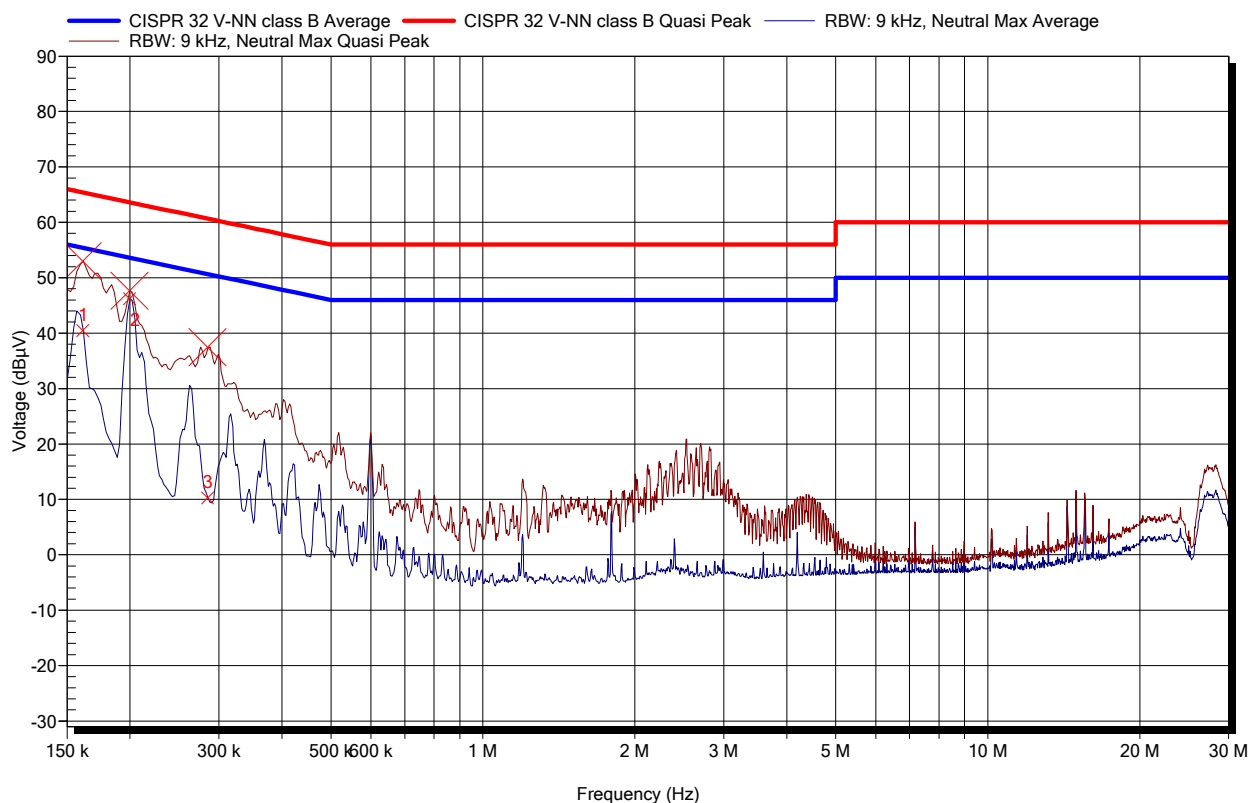


### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159 kHz	40.21 dBμV	-15.3 dB	48.07 dBμV	-17.44 dB	Pass
2	201.75 kHz	39.58 dBμV	-13.96 dB	42.98 dBμV	-20.56 dB	Pass

Diagram 11:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	9.3 VDC with Hameg Q10152
<b>Test date, time</b>	10.05.2016 09:22:07
<b>Interface / Line under test</b>	Minus (N)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms



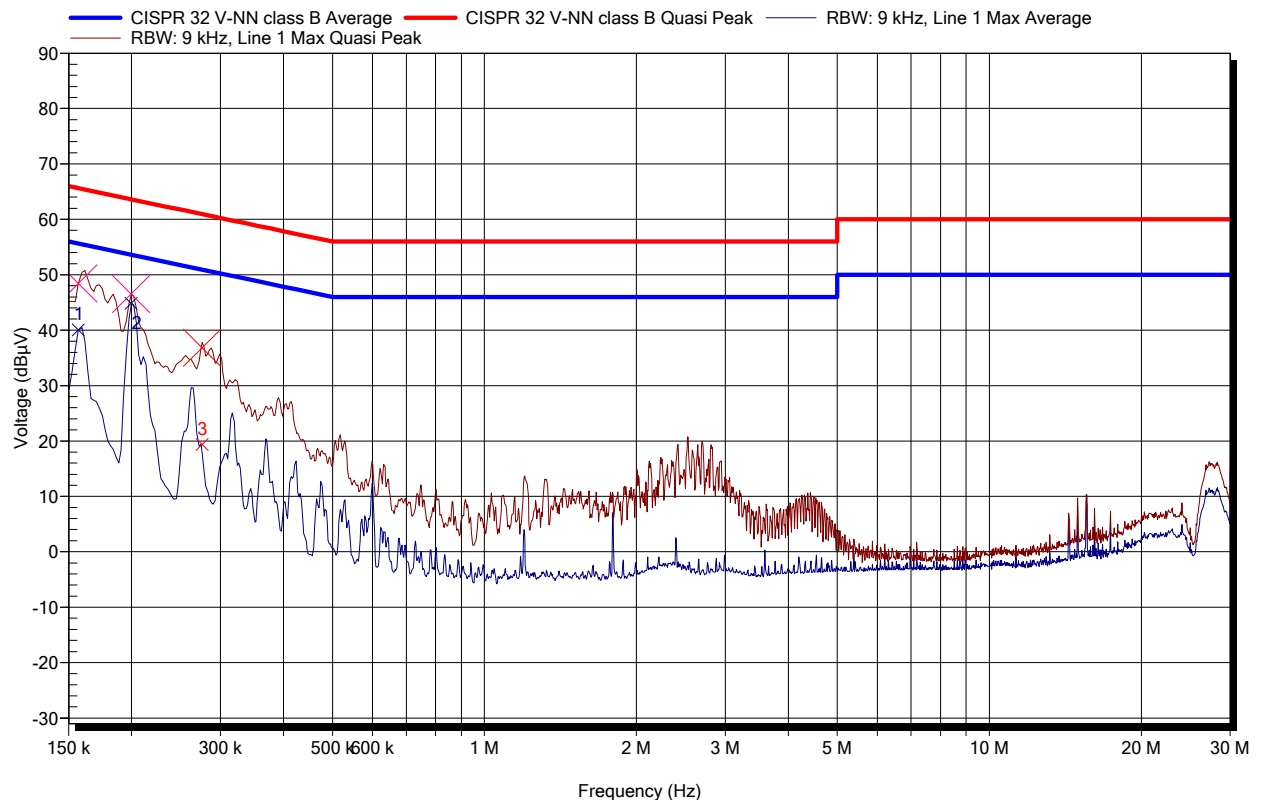
## Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	161.25 kHz	40.47 dBμV	-14.93 dB	52.98 dBμV	-12.42 dB	Pass
2	199.5 kHz	46.23 dBμV	-7.4 dB	47.68 dBμV	-15.95 dB	Pass
3	285 kHz	10.28 dBμV	-40.39 dB	37.48 dBμV	-23.19 dB	Pass



Diagram 12:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	9.3 VDC with Hameg Q10152
<b>Test date, time</b>	10.05.2016 09:23:13
<b>Interface / Line under test</b>	Plus (L)
<b>Transducer</b>	PE7627 V-LISN 1Ph+N 16A Rohde & Schwarz ESH3-Z5
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 5 ms



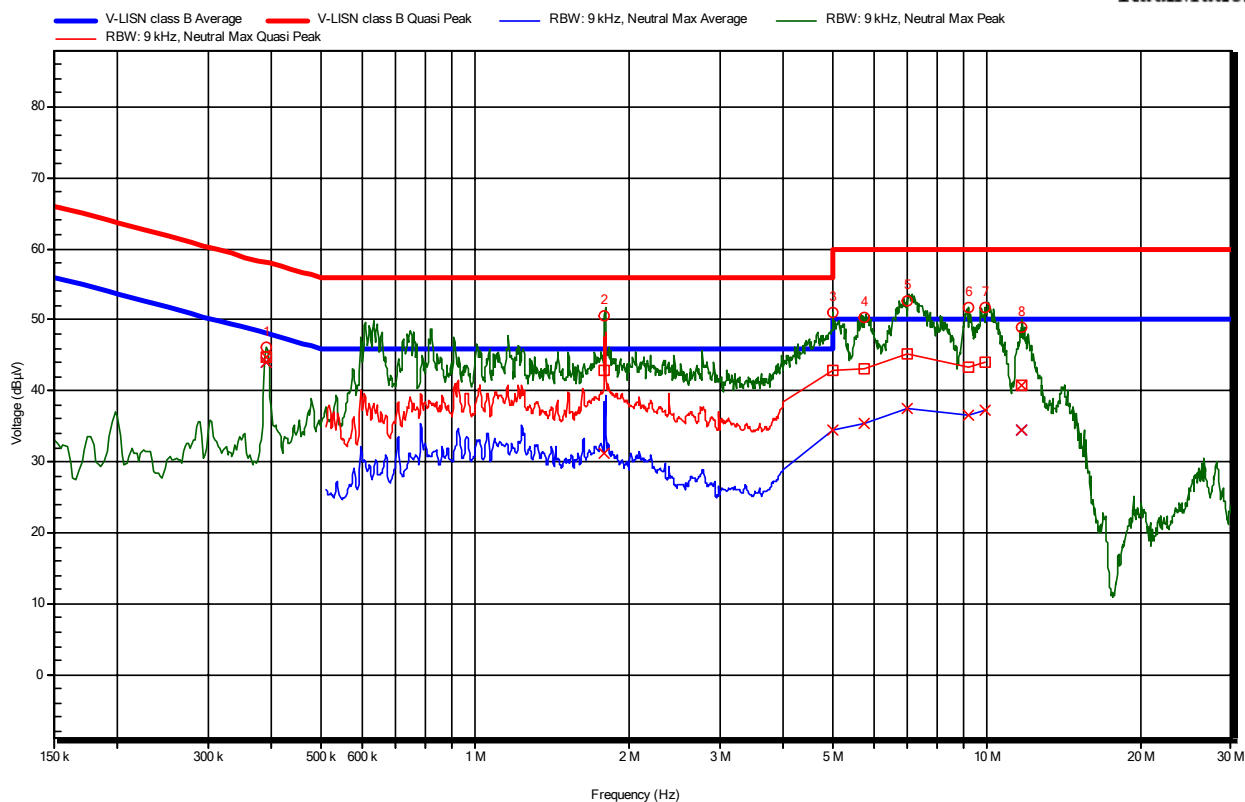
### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	156.75 kHz	40.02 dBμV	-15.61 dB	48.41 dBμV	-17.22 dB	Pass
2	199.5 kHz	44.86 dBμV	-8.77 dB	46.53 dBμV	-17.1 dB	Pass
3	275.848 kHz	19.4 dBμV	-31.54 dB	36.8 dBμV	-24.14 dB	Pass

Diagram 13:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	31.10.2018 16:19:42
<b>Interface under test</b>	Minus(N), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



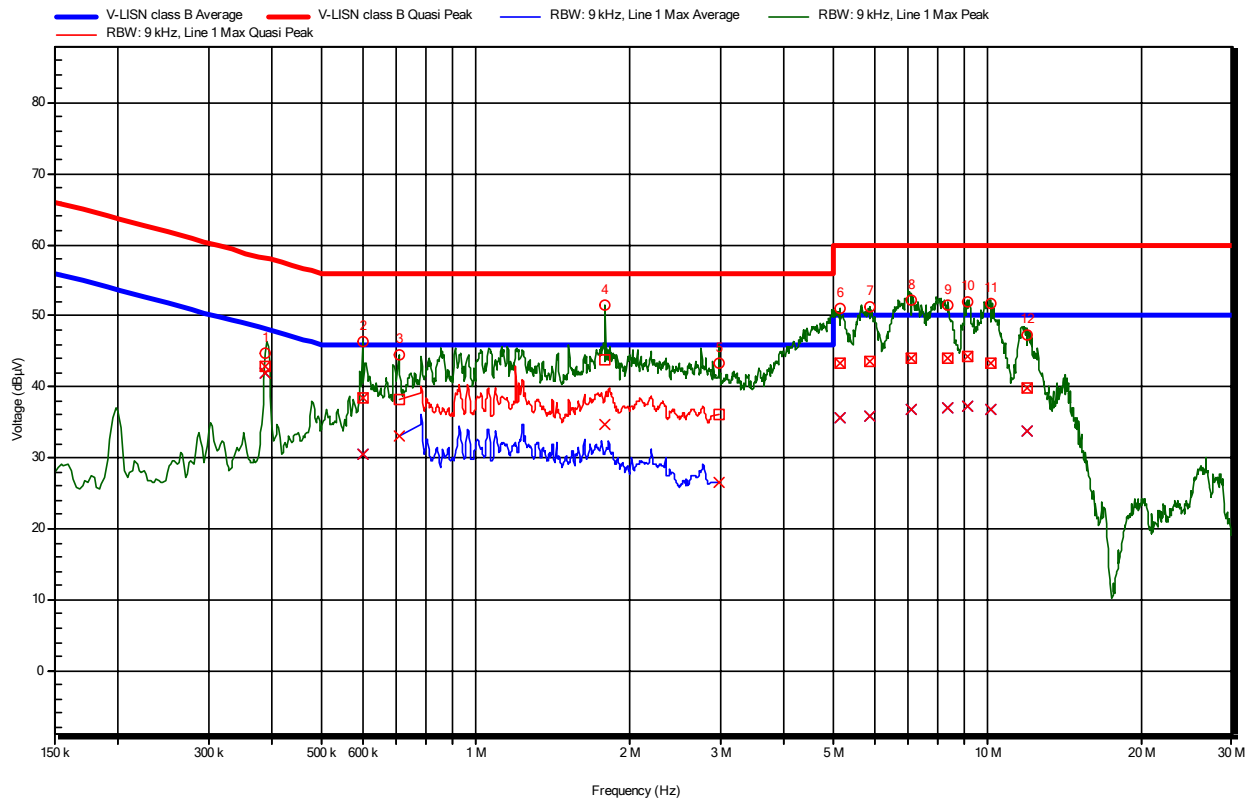
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	390.75 kHz	46.2 dBμV	44 dBμV	-4.1 dB	44.7 dBμV	-13.4 dB	Pass
2	1.793 MHz	50.6 dBμV	31.2 dBμV	-14.8 dB	43 dBμV	-13.0 dB	Pass
3	5.006 MHz	50.9 dBμV	34.6 dBμV	-15.4 dB	42.9 dBμV	-17.1 dB	Pass
4	5.737 MHz	50.4 dBμV	35.5 dBμV	-14.5 dB	43 dBμV	-17.0 dB	Pass
5	6.997 MHz	52.6 dBμV	37.4 dBμV	-12.6 dB	45.1 dBμV	-14.9 dB	Pass
6	9.195 MHz	51.6 dBμV	36.5 dBμV	-13.5 dB	43.4 dBμV	-16.6 dB	Pass
7	9.929 MHz	51.8 dBμV	37.4 dBμV	-12.6 dB	44.1 dBμV	-15.9 dB	Pass
8	11.722 MHz	48.8 dBμV	34.5 dBμV	-15.5 dB	40.8 dBμV	-19.2 dB	Pass

Diagram 14:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	31.10.2018 16:28:21
<b>Interface under test</b>	Plus(P), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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



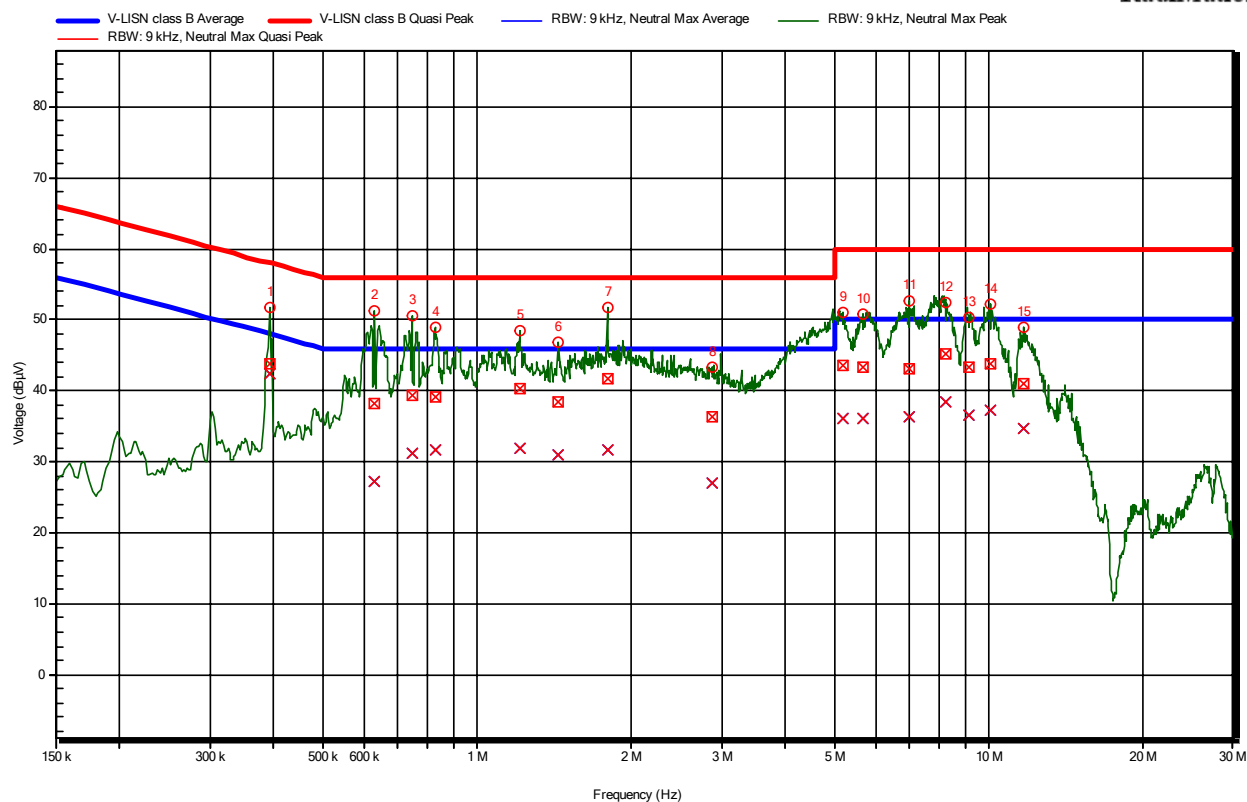
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	388.5 kHz	44.7 dBμV	42 dBμV	-6.1 dB	42.9 dBμV	-15.2 dB	Pass
2	600 kHz	46.4 dBμV	30.4 dBμV	-15.6 dB	38.5 dBμV	-17.5 dB	Pass
3	708 kHz	44.4 dBμV	33.2 dBμV	-12.8 dB	38.2 dBμV	-17.8 dB	Pass
4	1.793 MHz	51.4 dBμV	34.7 dBμV	-11.3 dB	43.9 dBμV	-12.1 dB	Pass
5	2.987 MHz	43.2 dBμV	26.4 dBμV	-19.6 dB	36.1 dBμV	-19.9 dB	Pass
6	5.154 MHz	51 dBμV	35.6 dBμV	-14.4 dB	43.4 dBμV	-16.6 dB	Pass
7	5.888 MHz	51.2 dBμV	35.8 dBμV	-14.2 dB	43.6 dBμV	-16.4 dB	Pass
8	7.089 MHz	52.2 dBμV	36.8 dBμV	-13.2 dB	44 dBμV	-16.0 dB	Pass
9	8.333 MHz	51.5 dBμV	36.9 dBμV	-13.1 dB	44 dBμV	-16.0 dB	Pass
10	9.11 MHz	51.9 dBμV	37.2 dBμV	-12.8 dB	44.2 dBμV	-15.8 dB	Pass
11	10.172 MHz	51.8 dBμV	36.9 dBμV	-13.1 dB	43.4 dBμV	-16.6 dB	Pass
12	11.981 MHz	47.3 dBμV	33.8 dBμV	-16.2 dB	39.9 dBμV	-20.1 dB	Pass

Diagram 15:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	31.10.2018 16:38:40
<b>Interface under test</b>	Minus(N), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



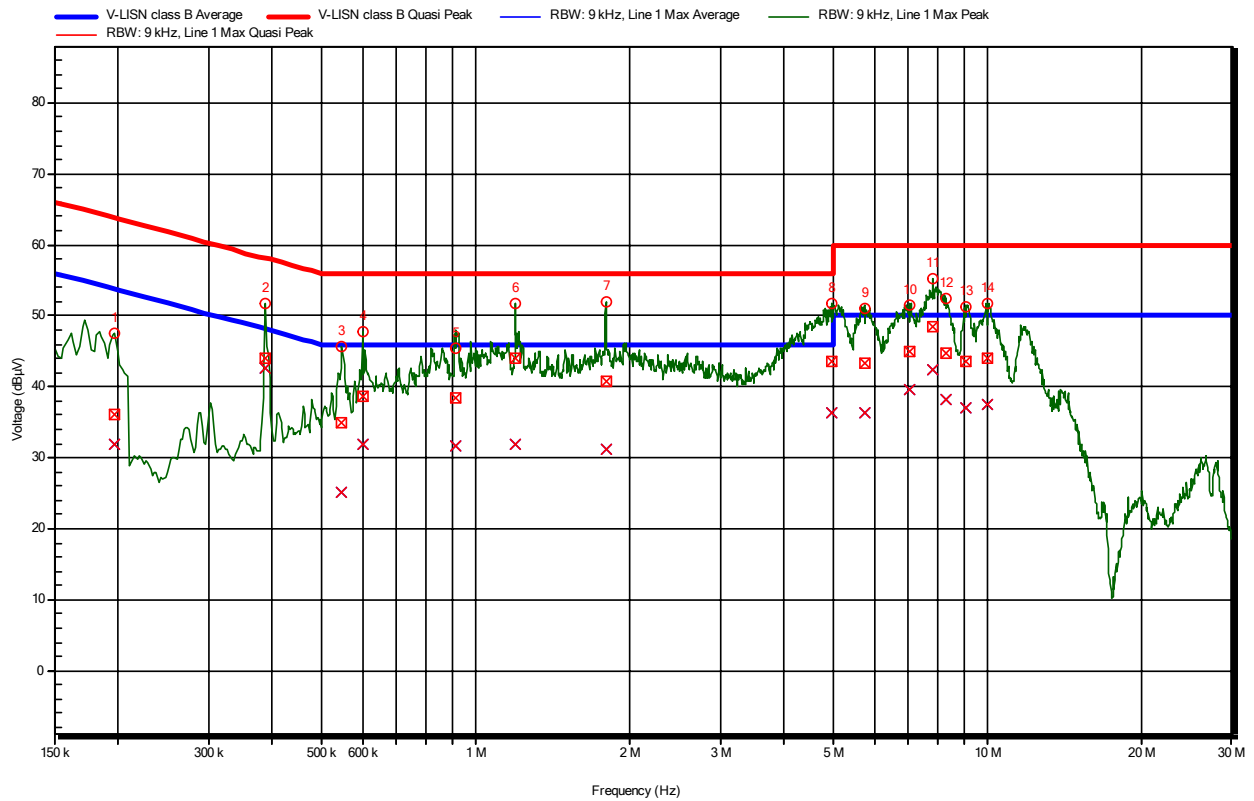
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	393 kHz	51.8 dBμV	42.3 dBμV	-5.7 dB	43.8 dBμV	-14.2 dB	Pass
2	631.5 kHz	51.2 dBμV	27.3 dBμV	-18.7 dB	38.3 dBμV	-17.7 dB	Pass
3	746.25 kHz	50.6 dBμV	31.2 dBμV	-14.8 dB	39.4 dBμV	-16.6 dB	Pass
4	827.25 kHz	49 dBμV	31.6 dBμV	-14.4 dB	39.1 dBμV	-16.9 dB	Pass
5	1.212 MHz	48.4 dBμV	31.9 dBμV	-14.1 dB	40.3 dBμV	-15.7 dB	Pass
6	1.444 MHz	46.8 dBμV	30.9 dBμV	-15.1 dB	38.3 dBμV	-17.7 dB	Pass
7	1.795 MHz	51.7 dBμV	31.6 dBμV	-14.4 dB	41.7 dBμV	-14.3 dB	Pass
8	2.879 MHz	43.2 dBμV	26.9 dBμV	-19.1 dB	36.3 dBμV	-19.7 dB	Pass
9	5.197 MHz	50.9 dBμV	36 dBμV	-14.0 dB	43.6 dBμV	-16.4 dB	Pass
10	5.674 MHz	50.7 dBμV	36.2 dBμV	-13.8 dB	43.4 dBμV	-16.6 dB	Pass
11	6.968 MHz	52.6 dBμV	36.3 dBμV	-13.7 dB	43.2 dBμV	-16.8 dB	Pass
12	8.214 MHz	52.3 dBμV	38.3 dBμV	-11.7 dB	45.1 dBμV	-14.9 dB	Pass
13	9.157 MHz	50.3 dBμV	36.5 dBμV	-13.5 dB	43.2 dBμV	-16.8 dB	Pass
14	10.037 MHz	52.3 dBμV	37.3 dBμV	-12.7 dB	43.9 dBμV	-16.1 dB	Pass
15	11.729 MHz	48.9 dBμV	34.8 dBμV	-15.2 dB	41 dBμV	-19.0 dB	Pass

Diagram 16:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	31.10.2018 16:47:10
<b>Interface under test</b>	Plus(L), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



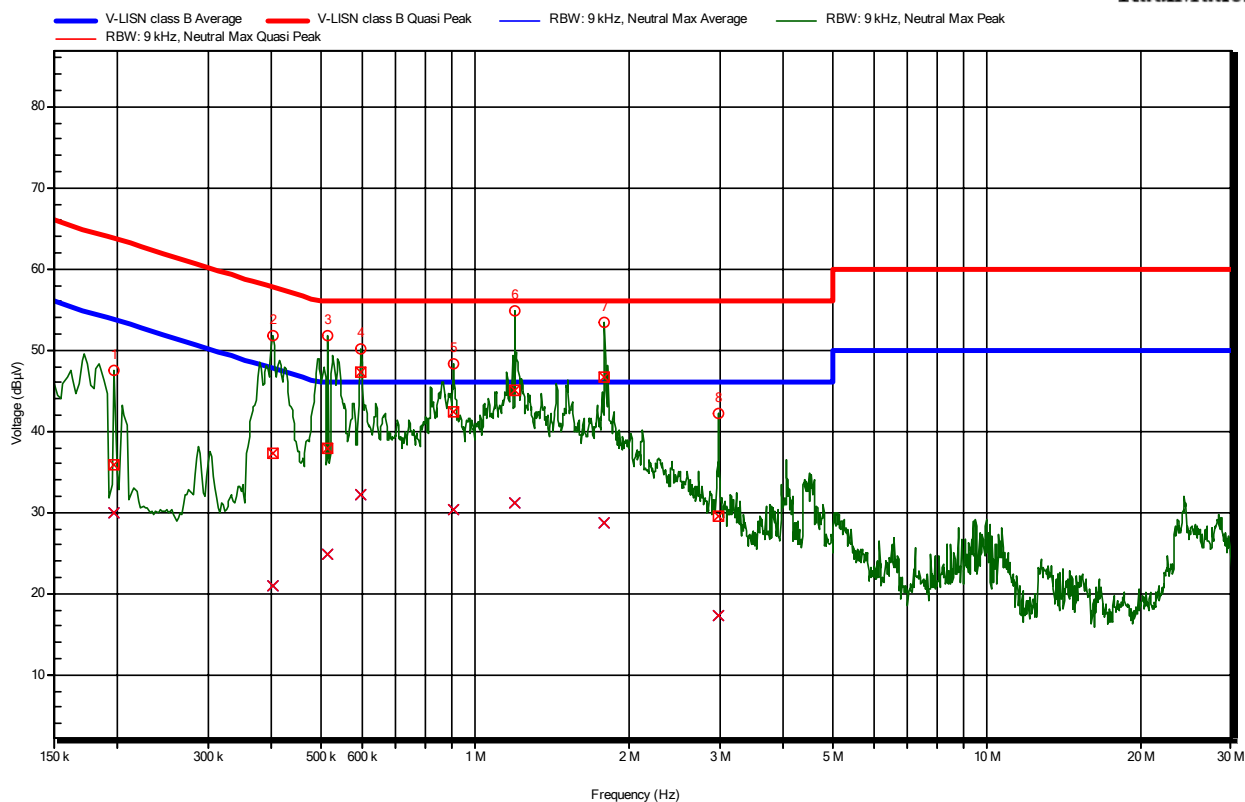
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	197.25 kHz	47.6 dBµV	31.9 dBµV	-21.8 dB	36.2 dBµV	-27.5 dB	Pass
2	388.5 kHz	51.6 dBµV	42.6 dBµV	-5.5 dB	44 dBµV	-14.1 dB	Pass
3	548.25 kHz	45.7 dBµV	25 dBµV	-21.0 dB	35 dBµV	-21.0 dB	Pass
4	600 kHz	47.7 dBµV	31.8 dBµV	-14.2 dB	38.7 dBµV	-17.3 dB	Pass
5	915 kHz	45.4 dBµV	31.6 dBµV	-14.4 dB	38.5 dBµV	-17.5 dB	Pass
6	1.196 MHz	51.8 dBµV	31.9 dBµV	-14.1 dB	44 dBµV	-12.0 dB	Pass
7	1.795 MHz	52 dBµV	31.3 dBµV	-14.7 dB	40.7 dBµV	-15.3 dB	Pass
8	4.974 MHz	51.7 dBµV	36.3 dBµV	-9.7 dB	43.5 dBµV	-12.5 dB	Pass
9	5.759 MHz	51.1 dBµV	36.3 dBµV	-13.7 dB	43.4 dBµV	-16.6 dB	Pass
10	7.028 MHz	51.4 dBµV	39.7 dBµV	-10.3 dB	44.9 dBµV	-15.1 dB	Pass
11	7.811 MHz	55.2 dBµV	42.5 dBµV	-7.5 dB	48.5 dBµV	-11.5 dB	Pass
12	8.284 MHz	52.4 dBµV	38.1 dBµV	-11.9 dB	44.8 dBµV	-15.2 dB	Pass
13	9.076 MHz	51.2 dBµV	37 dBµV	-13.0 dB	43.5 dBµV	-16.5 dB	Pass
14	10.019 MHz	51.6 dBµV	37.4 dBµV	-12.6 dB	43.9 dBµV	-16.1 dB	Pass

Diagram 17:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	31.10.2018 16:00:17
<b>Interface under test</b>	Minus(N), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



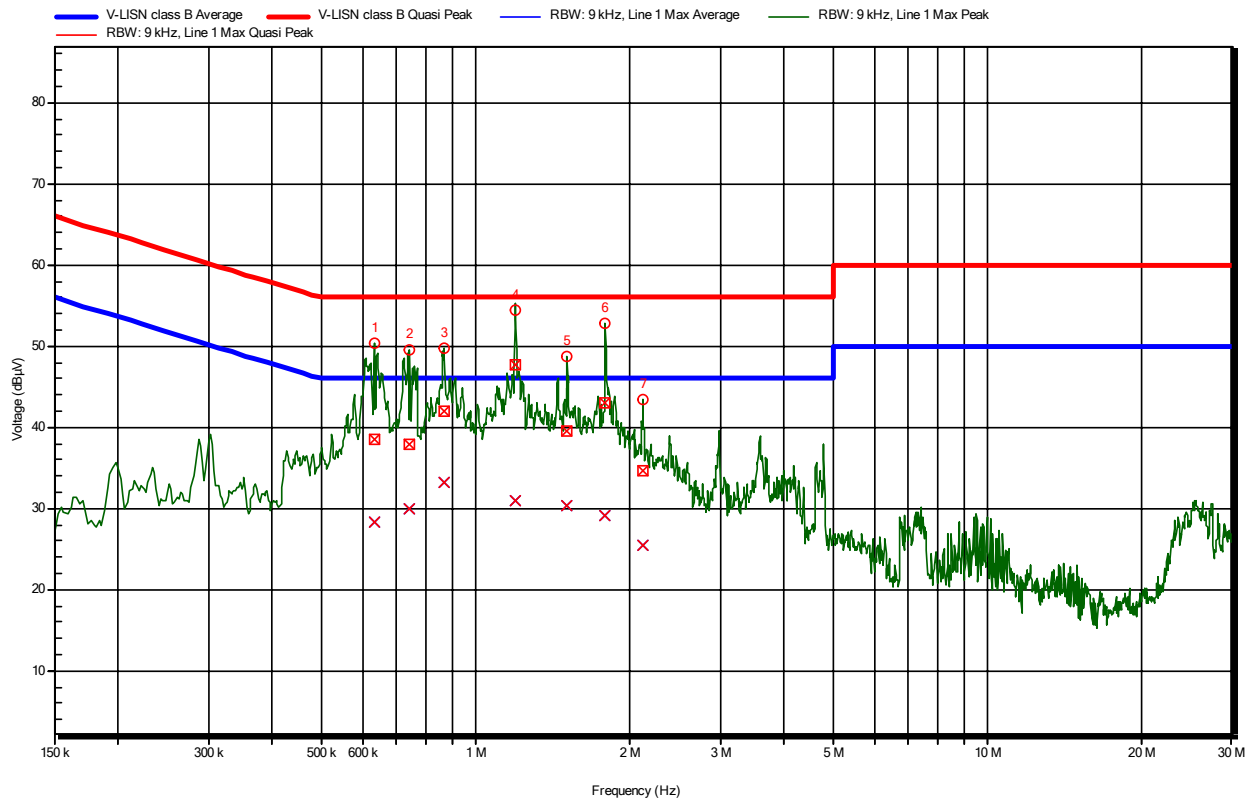
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	197.25 kHz	47.6 dBμV	30 dBμV	-23.8 dB	36 dBμV	-27.8 dB	Pass
2	402 kHz	51.7 dBμV	20.9 dBμV	-26.9 dB	37.3 dBμV	-20.5 dB	Pass
3	516.75 kHz	51.7 dBμV	24.9 dBμV	-21.1 dB	38 dBμV	-18.0 dB	Pass
4	597.75 kHz	50.1 dBμV	32.2 dBμV	-13.8 dB	47.2 dBμV	-8.8 dB	Pass
5	908.25 kHz	48.2 dBμV	30.4 dBμV	-15.6 dB	42.3 dBμV	-13.7 dB	Pass
6	1.194 MHz	54.8 dBμV	31.3 dBμV	-14.7 dB	45 dBμV	-11.0 dB	Pass
7	1.793 MHz	53.4 dBμV	28.7 dBμV	-17.3 dB	46.6 dBμV	-9.4 dB	Pass
8	2.99 MHz	42.1 dBμV	17.3 dBμV	-28.7 dB	29.5 dBμV	-26.5 dB	Pass

Diagram 18:

<b>EUT</b>	EUT 4
<b>Verdict</b>	Pass, Class B
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	31.10.2018 16:05:00
<b>Interface under test</b>	Plus(L), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



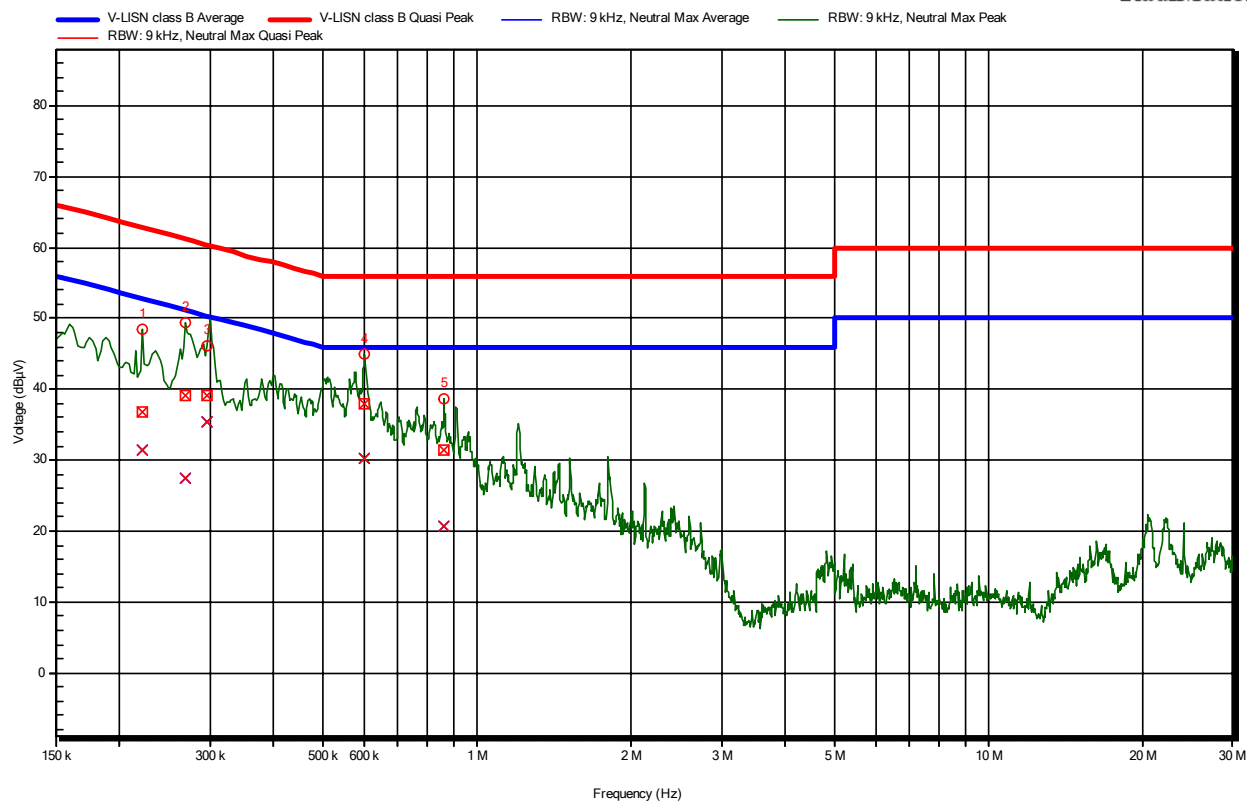
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	633.75 kHz	50.4 dBμV	28.3 dBμV	-17.7 dB	38.6 dBμV	-17.4 dB	Pass
2	744 kHz	49.6 dBμV	30 dBμV	-16.0 dB	37.9 dBμV	-18.1 dB	Pass
3	865.5 kHz	49.7 dBμV	33.1 dBμV	-12.9 dB	41.9 dBμV	-14.1 dB	Pass
4	1.196 MHz	54.5 dBμV	31 dBμV	-15.0 dB	47.7 dBμV	-8.3 dB	Pass
5	1.511 MHz	48.8 dBμV	30.4 dBμV	-15.6 dB	39.4 dBμV	-16.6 dB	Pass
6	1.793 MHz	52.8 dBμV	29.2 dBμV	-16.8 dB	43 dBμV	-13.0 dB	Pass
7	2.119 MHz	43.4 dBμV	25.5 dBμV	-20.5 dB	34.6 dBμV	-21.4 dB	Pass

Diagram 19:

<b>EUT</b>	EUT 5
<b>Verdict</b>	Pass, Class B
<b>Notes</b>	Ferrite clamp used on RS232
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	26.03.2019 09:03:23
<b>Line under test</b>	Minus(N), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



## Detected peaks

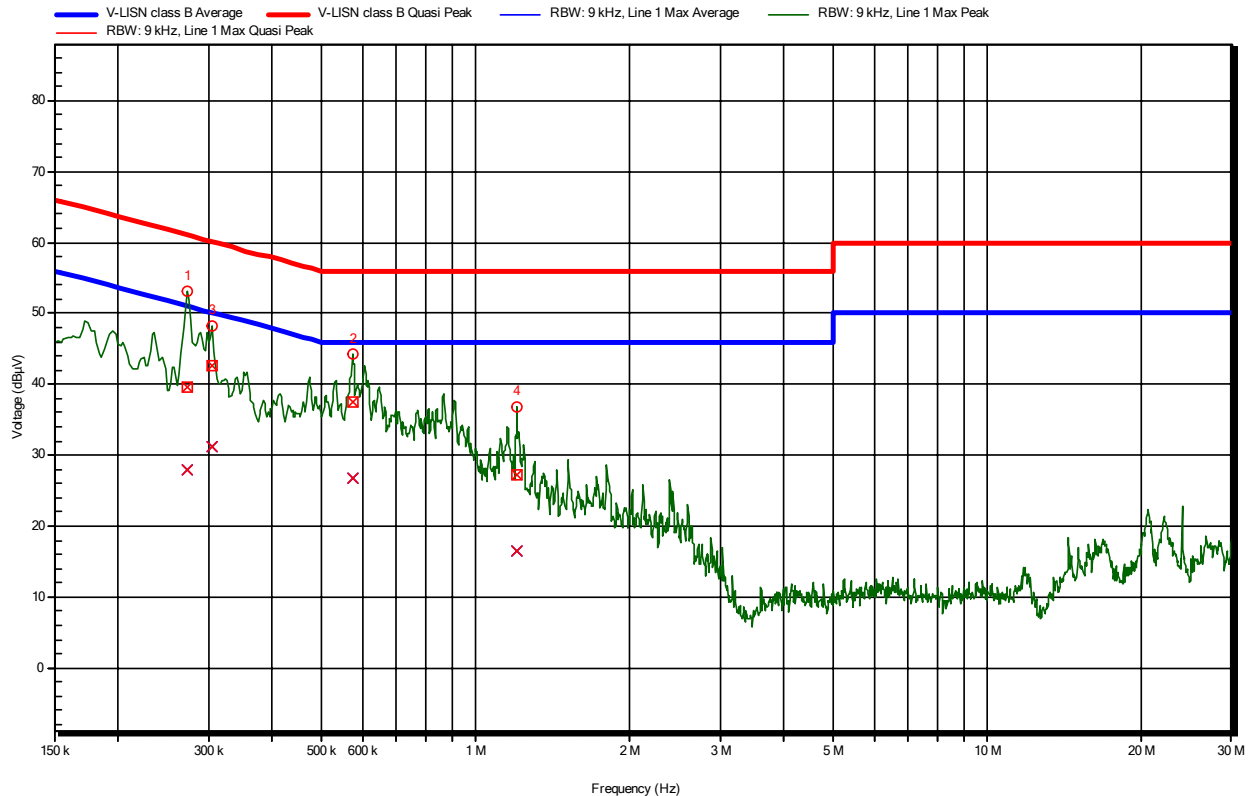
Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	222 kHz	48.5 dBμV	31.4 dBμV	-21.4 dB	36.8 dBμV	-26.0 dB	Pass
2	269.25 kHz	49.3 dBμV	27.5 dBμV	-23.7 dB	39.2 dBμV	-21.9 dB	Pass
3	296.25 kHz	46.1 dBμV	35.5 dBμV	-14.9 dB	39.1 dBμV	-21.3 dB	Pass
4	602.25 kHz	45 dBμV	30.3 dBμV	-15.7 dB	37.9 dBμV	-18.1 dB	Pass
5	861 kHz	38.6 dBμV	20.7 dBμV	-25.3 dB	31.4 dBμV	-24.6 dB	Pass



Diagram 20:

<b>EUT</b>	EUT 5
<b>Verdict</b>	Pass, Class B
<b>Notes</b>	Ferrite clamp used on RS232
<b>Mode of operation</b>	12 VDC
<b>Test date, time</b>	26.03.2019 08:57:31
<b>Line under test</b>	Plus(L), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation

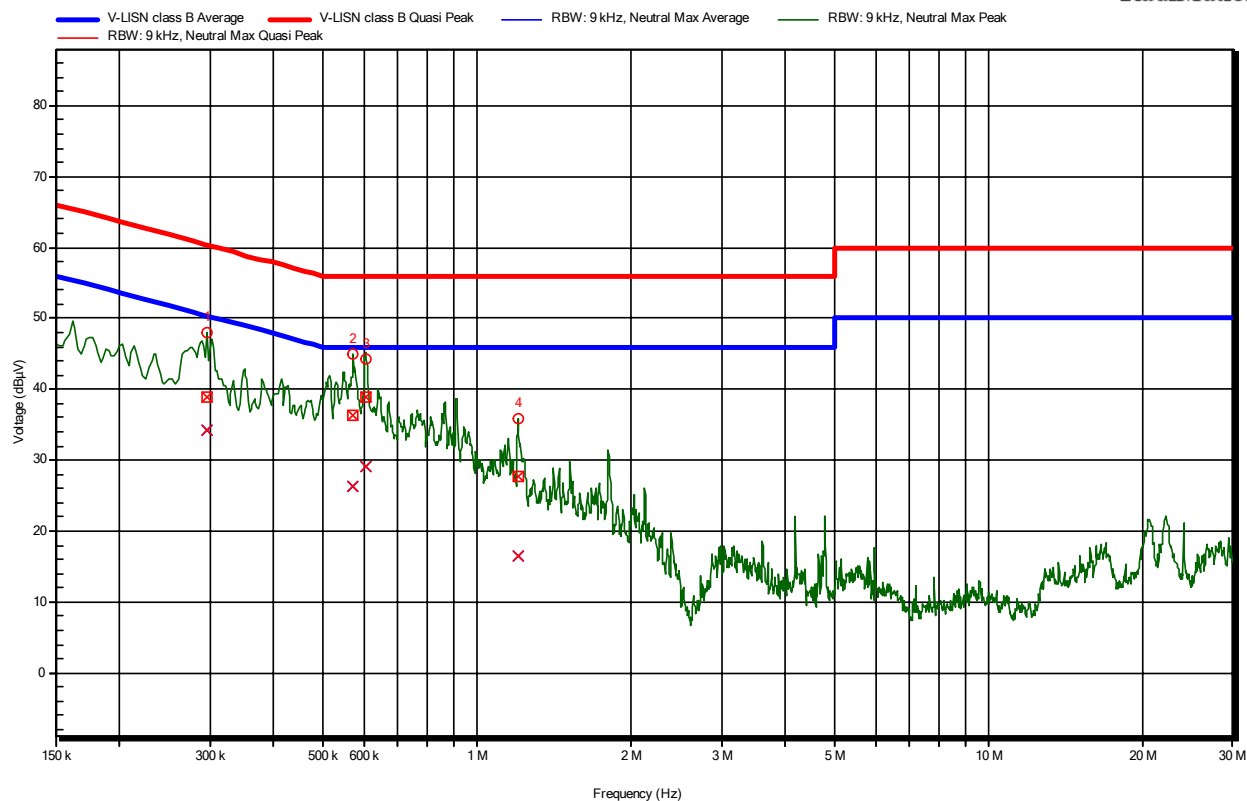
**Detected peaks**

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	273.75 kHz	53 dBµV	27.9 dBµV	-23.1 dB	39.6 dBµV	-21.4 dB	Pass
2	575.25 kHz	44.3 dBµV	26.8 dBµV	-19.2 dB	37.6 dBµV	-18.4 dB	Pass
3	305.25 kHz	48.2 dBµV	31.3 dBµV	-18.8 dB	42.7 dBµV	-17.4 dB	Pass
4	1.205 MHz	36.8 dBµV	16.6 dBµV	-29.4 dB	27.2 dBµV	-28.8 dB	Pass

Diagram 21:

<b>EUT</b>	EUT 5
<b>Verdict</b>	Pass, Class B
<b>Notes</b>	Ferrite clamp used on RS232
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	26.03.2019 09:10:40
<b>Line under test</b>	Minus(N), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation



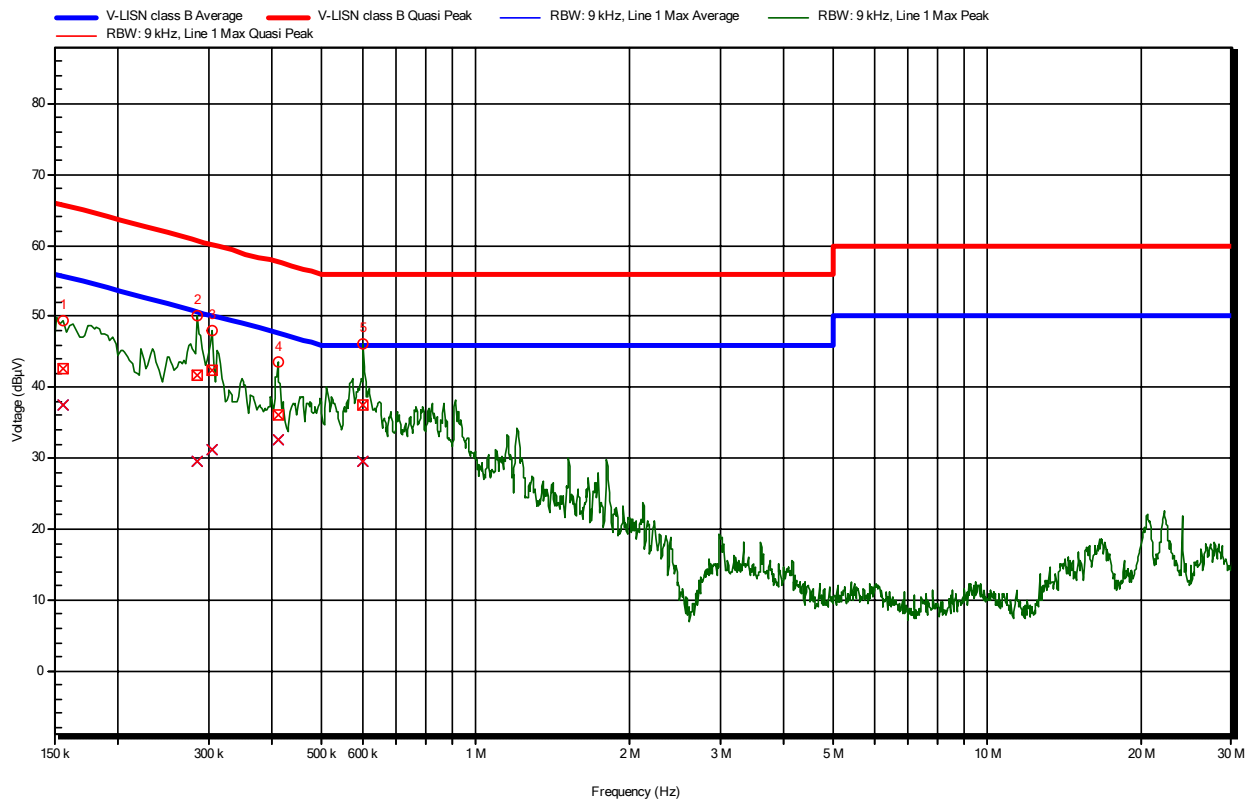
## Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	296.25 kHz	47.9 dBμV	34.3 dBμV	-16.1 dB	38.8 dBμV	-21.5 dB	Pass
2	573 kHz	45.1 dBμV	26.2 dBμV	-19.8 dB	36.4 dBμV	-19.6 dB	Pass
3	606.75 kHz	44.3 dBμV	29 dBμV	-17.0 dB	38.8 dBμV	-17.2 dB	Pass
4	1.205 MHz	36 dBμV	16.6 dBμV	-29.4 dB	27.8 dBμV	-28.2 dB	Pass

Diagram 22:

<b>EUT</b>	EUT 5
<b>Verdict</b>	Pass, Class B
<b>Notes</b>	Ferrite clamp used on RS232
<b>Mode of operation</b>	48 VDC
<b>Test date, time</b>	26.03.2019 09:14:59
<b>Line under test</b>	Plus(L), DC-Port
<b>Transducer</b>	V-LISN Rohde & Schwarz ESH3-Z5 - PE7627
<b>Measurement settings</b>	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: 20 ms

RadiMation

**Detected peaks**

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	156.75 kHz	49.3 dBµV	37.5 dBµV	-18.2 dB	42.5 dBµV	-23.1 dB	Pass
2	285 kHz	50.1 dBµV	29.5 dBµV	-21.2 dB	41.8 dBµV	-18.9 dB	Pass
3	305.25 kHz	48.1 dBµV	31.2 dBµV	-18.9 dB	42.3 dBµV	-17.8 dB	Pass
4	411 kHz	43.5 dBµV	32.7 dBµV	-14.9 dB	36.1 dBµV	-21.6 dB	Pass
5	602.25 kHz	46.1 dBµV	29.5 dBµV	-16.5 dB	37.4 dBµV	-18.6 dB	Pass

## 10.2 Interference Voltage (Shielded Cables)

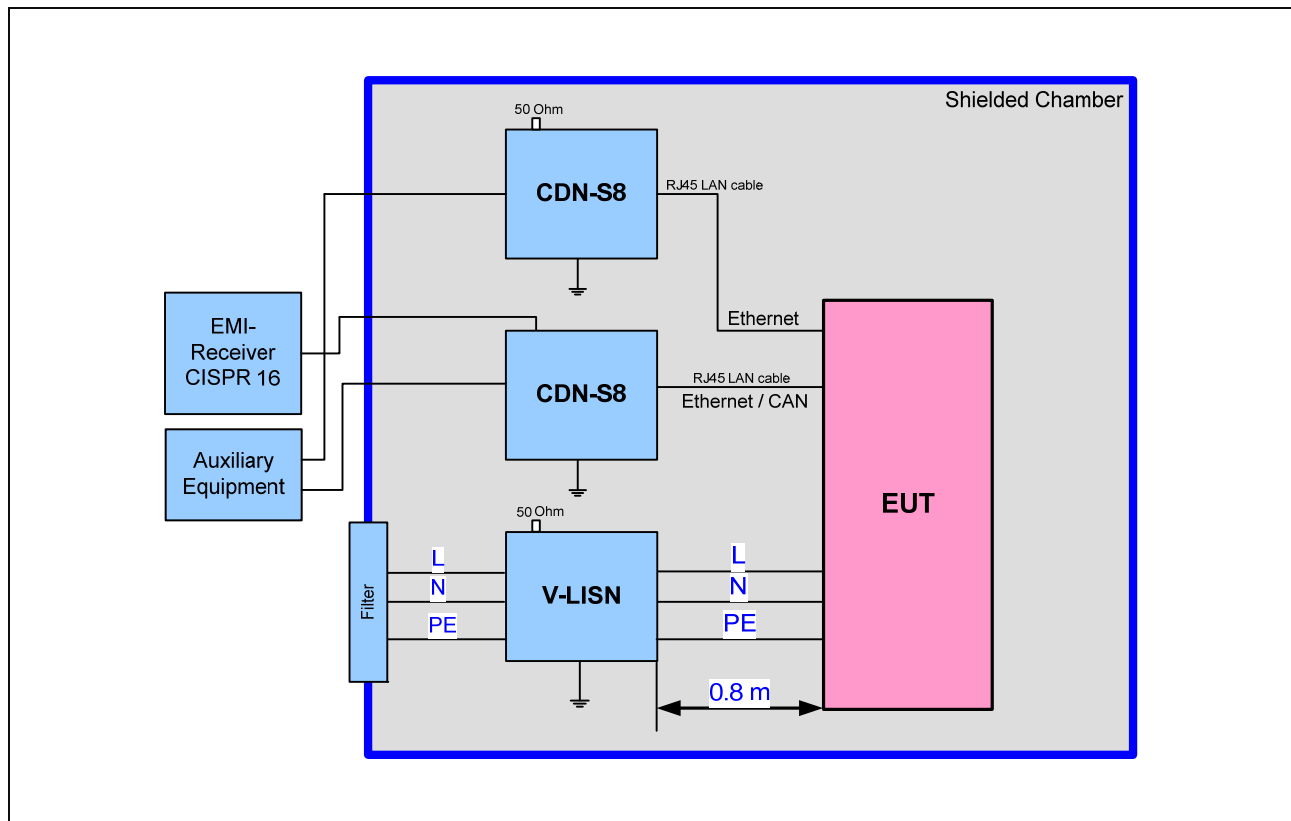
**Test site:** shielded room

**Meas. uncertainty:** see chapter 12

**Measuring method:** The conducted disturbance is measured using a EMI receiver and a line coupling device network (CDN-S8). The measurement of the voltage on the shield of the cable against the earth is carried out successively. The peak values are recorded continuously. Values that exceed the average limit shall be re-measured with the average and quasi peak detector of the receiver.

**Modifications:** none

### Test Setup



### Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESR 7	15.6637.06
EMI Receiver	Hewlett Packard	8546A	OA9715
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	CDN S8 RJ45	13.6632.07 13.6632.08
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

**Photos of the Setup**

EUT 1 see chapter 10.1

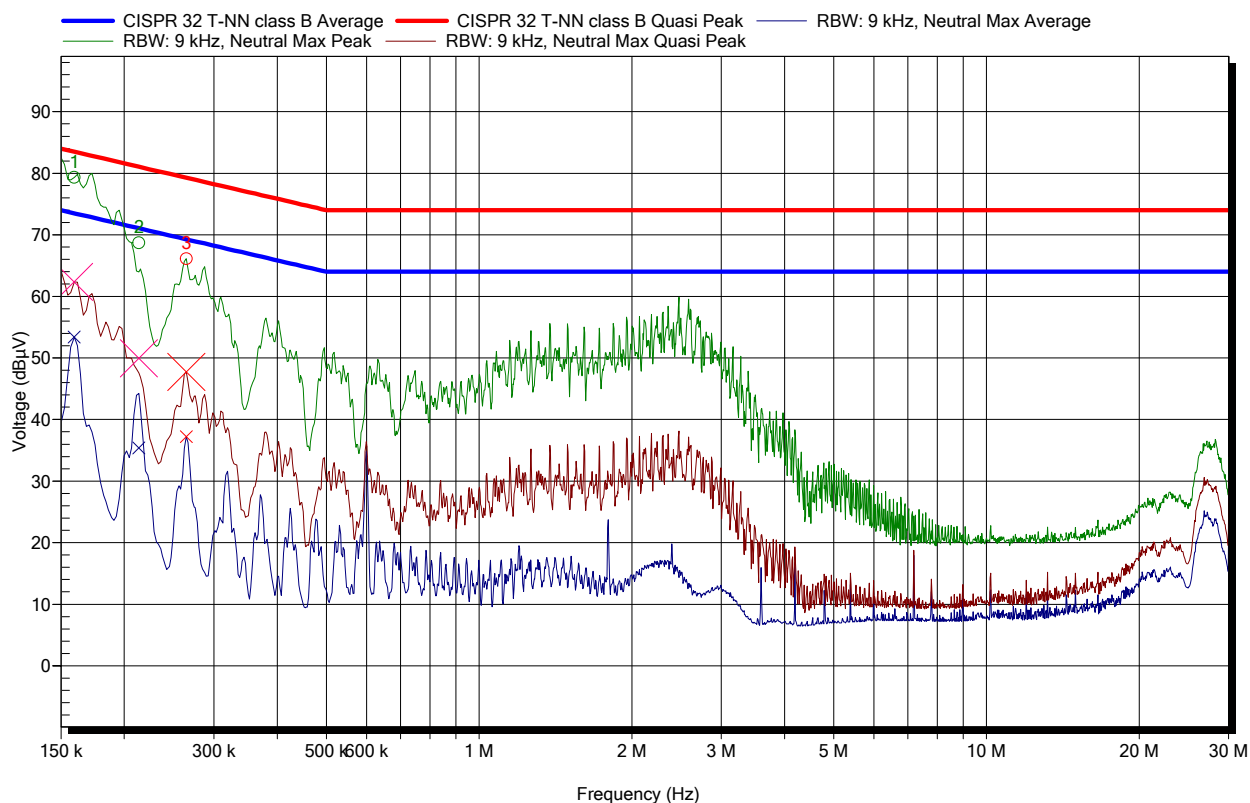
EUT 2:



## Measurement Results

Diagram 23:

<b>EUT</b>	EUT 1
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	Normal mode, 24 VDC
<b>Test date, time</b>	10.05.2016 08:59:49
<b>Interface / Line under test</b>	LAN
<b>Transducer</b>	ISN_RJ45
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 0 dB, Measure time: 1 s,

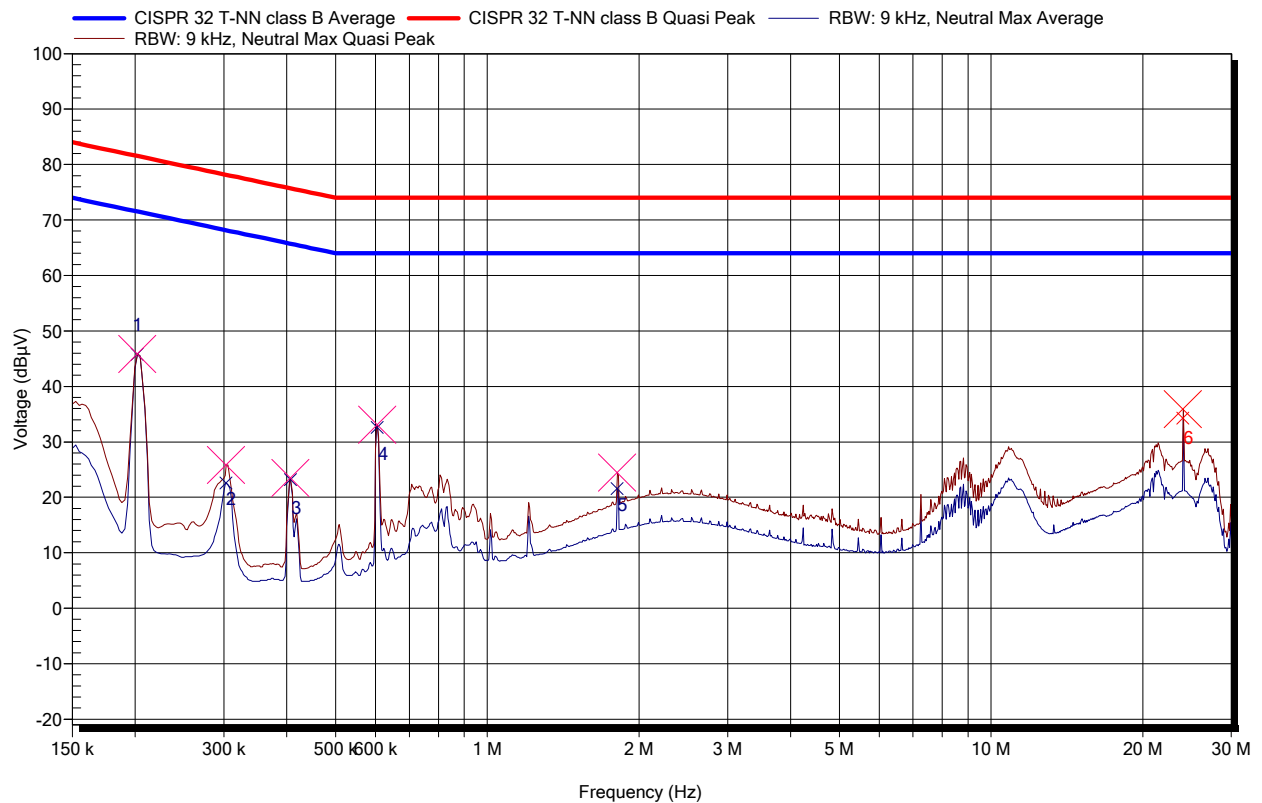


### Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	159.089 kHz	79.32 dBμV	53.37 dBμV	-20.14 dB	62.37 dBμV	-21.14 dB	Pass
2	213.495 kHz	68.73 dBμV	35.4 dBμV	-35.67 dB	49.93 dBμV	-31.14 dB	Pass
3	264.75 kHz	66.1 dBμV	37.21 dBμV	-32.07 dB	47.71 dBμV	-31.57 dB	Pass

Diagram 24:

<b>EUT</b>	EUT 2
<b>Verdict, Test</b>	Pass, Class B
<b>Mode of operation</b>	24 VDC with Batteries
<b>Test date, time</b>	14/11/2016 10:59:49
<b>Interface / Line under test</b>	CAN
<b>Transducer</b>	LAN LISN_13.6632.08
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 9 kHz, VBW: 30 kHz, Sweep time: Auto [120 ms], Step freq: Linear: 2.25 kHz steps, Attenuator: 10 dB, Internal preamp: 0 dB, Measure time: 1 s,



### Detected peaks

Peak Number	Frequency	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	201.75 kHz	45.81 dBμV	-25.73 dB	45.84 dBμV	-35.7 dB	Pass
2	303 kHz	22.6 dBμV	-45.56 dB	25.84 dBμV	-52.32 dB	Pass
3	406.5 kHz	23.19 dBμV	-42.53 dB	23.49 dBμV	-52.23 dB	Pass
4	604.5 kHz	32.62 dBμV	-31.38 dB	33.12 dBμV	-40.88 dB	Pass
5	1.811 MHz	21.6 dBμV	-42.4 dB	24.45 dBμV	-49.55 dB	Pass
6	24 MHz	34.31 dBμV	-29.69 dB	35.88 dBμV	-38.12 dB	Pass

### 10.3 Interference Voltage (Antenna Ports)

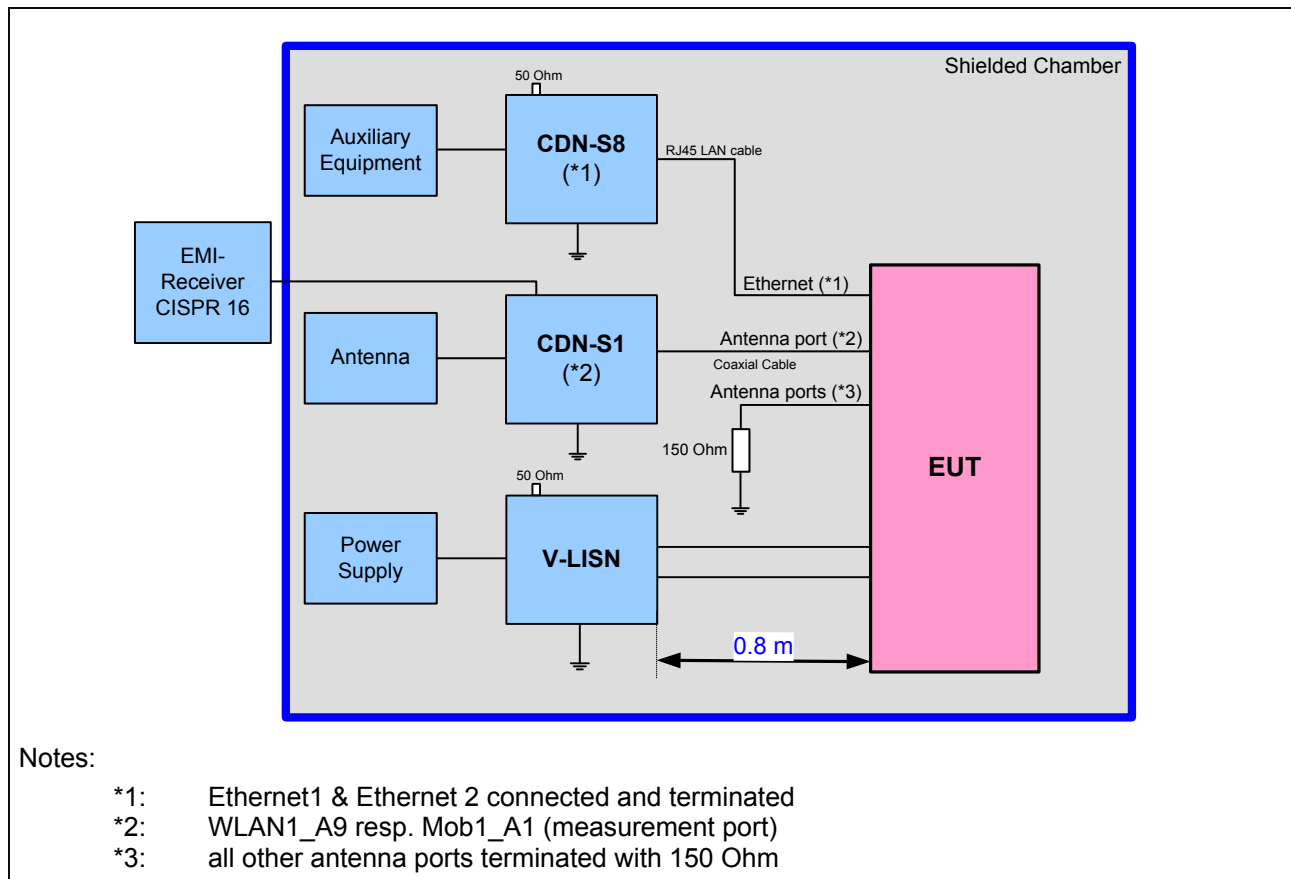
**Test site:** shielded room

**Meas. uncertainty:** see chapter 12

**Measuring method:** The conducted disturbance is measured using a EMI receiver and a line coupling device network (CDN-S1). The measurement of the voltage on the shield of the cable against the earth is carried out successively. The peak values are recorded continuously. Values that exceed the average limit shall be re-measured with the average and quasi peak detector of the receiver.

**Modifications:** none

#### Test Setup

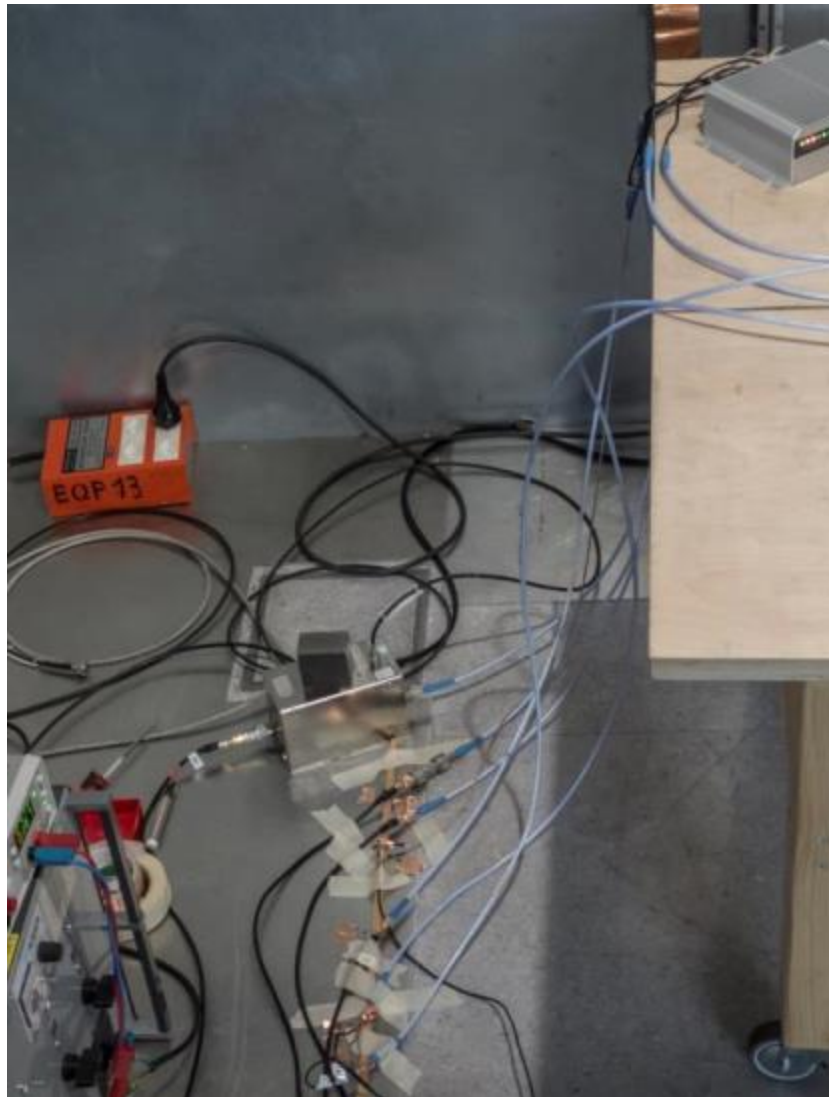


#### Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU 8	OA10193
CDN (measurement port)	EM Test	CDN S1	H7679
V-Network (decoupling)	Rohde & Schwarz	ESH3-Z5	PE7627
CDN (decoupling)	EM Test	CDN S8 RJ45	13.6632.07
CDN (decoupling)	EM Test	CDN S8 RJ45	13.6632.08
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02



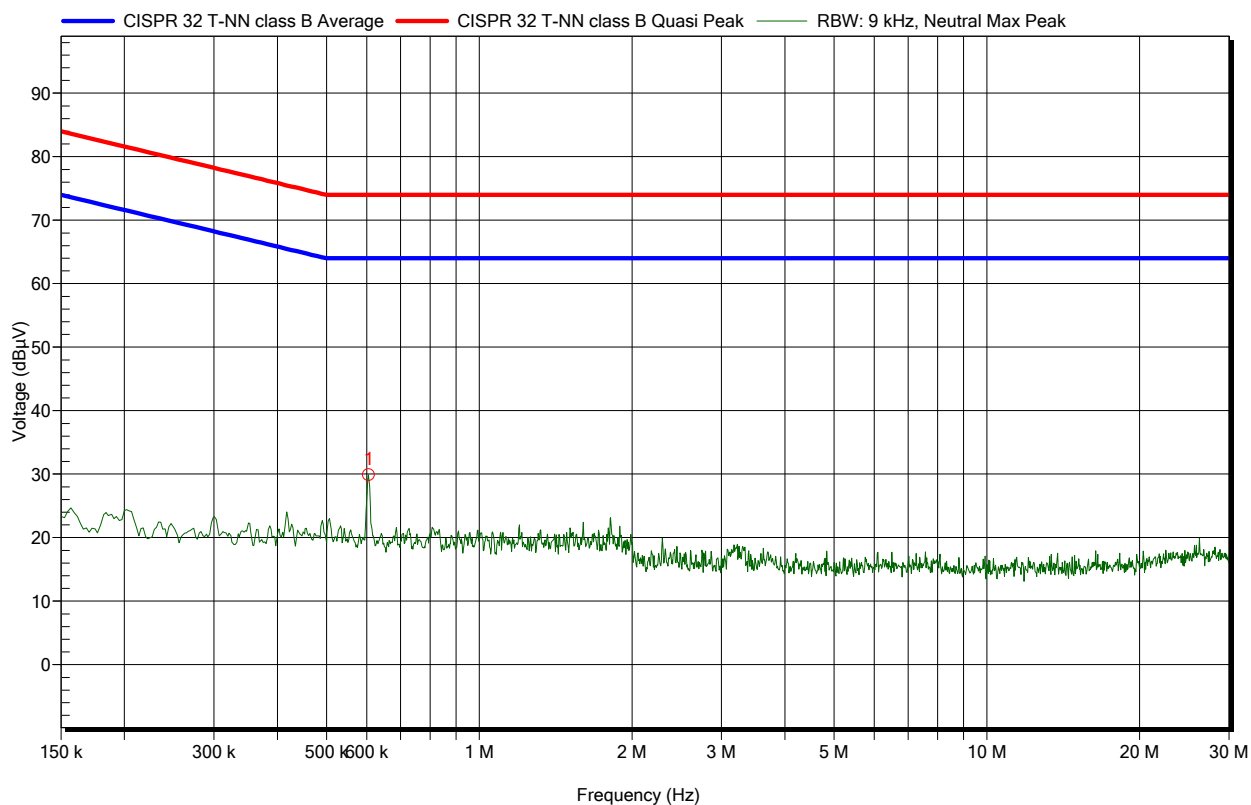
## Photos of the Setup



## Measurement Results

Diagram 25:

<b>EUT</b>	EUT 2
<b>Verdict, Test</b>	Pass, CISPR 32 & EN 55032, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	28.04.2017 10:07:02
<b>Interface / Line under test</b>	Antenna port Mob1_A1
<b>Transducer</b>	ISN S1
<b>Measurement settings</b>	Radimation Version: 2016.2.8, RBW: 9 kHz, VBW: 30 kHz, Sweep time: 10 ms, Step freq: Linear: 2.25 kHz steps, Attenuator: 10 dB, Internal preamp: 0 dB, Measure time: 10 ms,

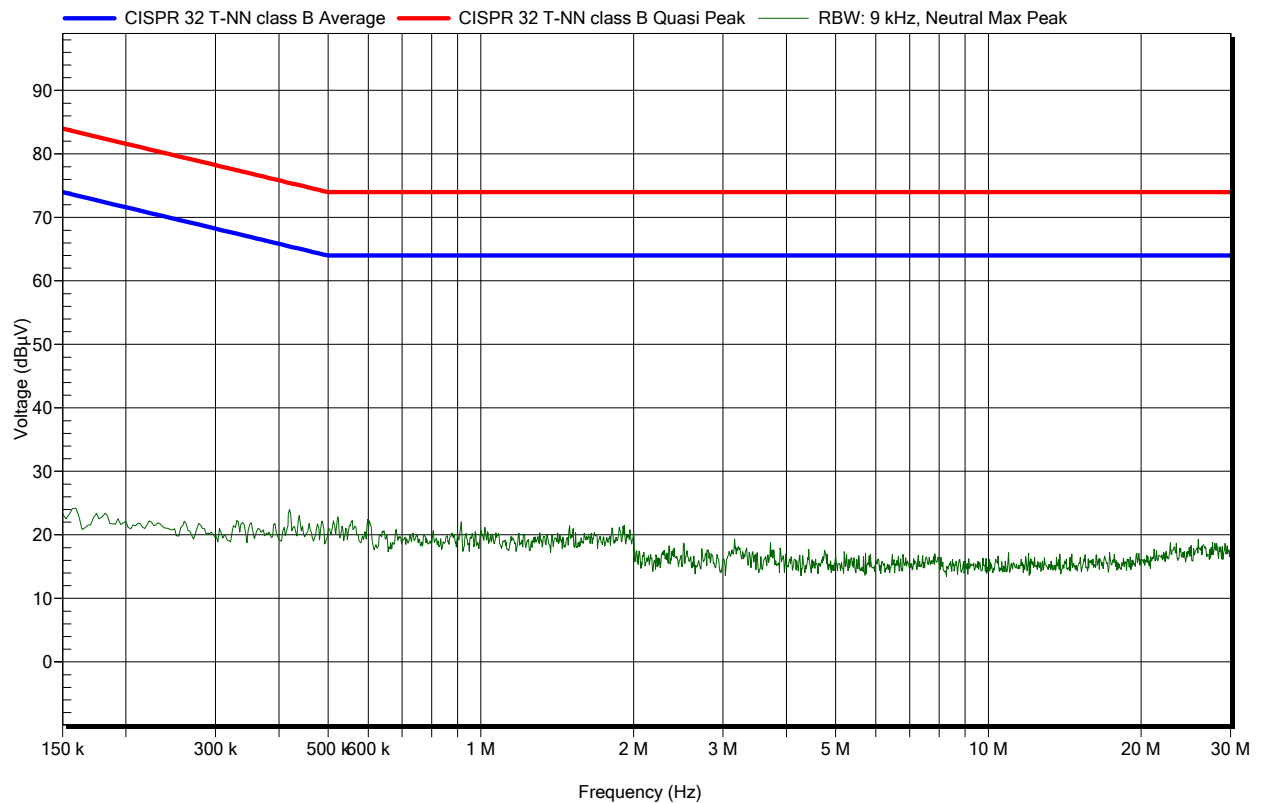


## Detected peaks

Peak Number	Frequency	Peak
1	604.5 kHz	29.9 dBμV

Diagram 26:

<b>EUT</b>	EUT 2
<b>Verdict, Test</b>	Pass, CISPR 32 & EN 55032, Class B
<b>Mode of operation</b>	24 VDC
<b>Test date, time</b>	28.04.2017 10:08:51
<b>Interface / Line under test</b>	Antenna port WLAN1_A9
<b>Transducer</b>	ISN S1
<b>Measurement settings</b>	Radimation Version: 2016.2.8, RBW: 9 kHz, VBW: 30 kHz, Sweep time: 10 ms, Step freq: Linear: 2.25 kHz steps, Attenuator: 10 dB, Internal preamp: 0 dB, Measure time: 10 ms,



## 10.4 Radiated Electromagnetic Field (30 – 1000 MHz)

**Test site:** semi-anechoic chamber (hybrid)

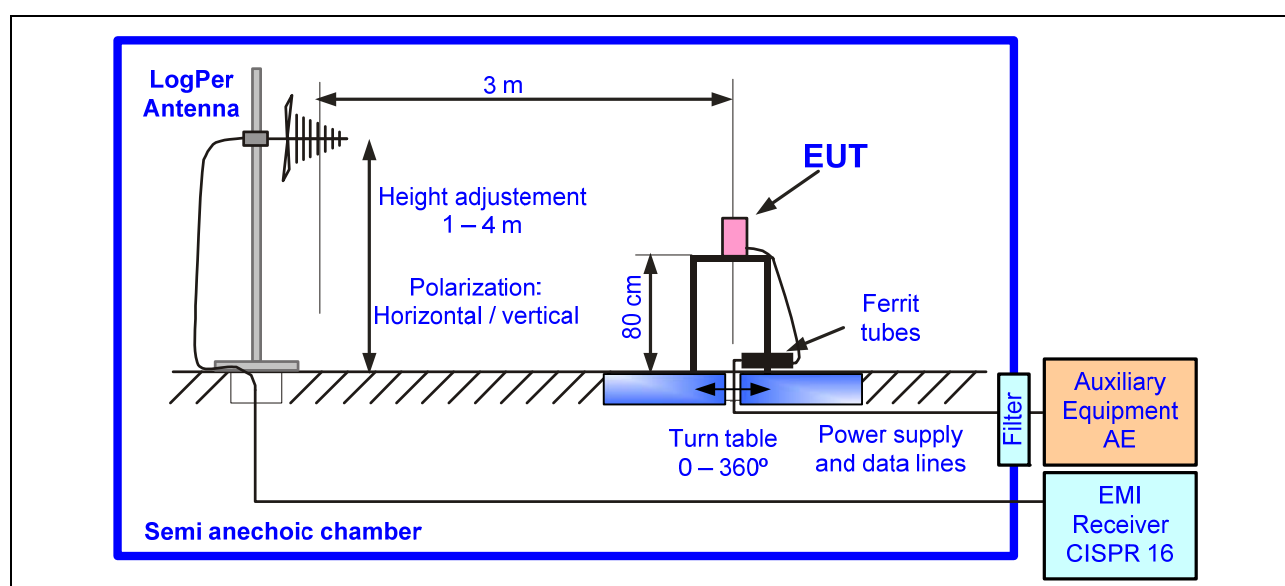
**Distance:** 3 m

**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

EUT 1 and EUT 2

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU8	OA 10193
Antenna LogPer	Chase	CBL 6112B	H9695
Coaxial Cable	Huber & Suhner	Sucoflex 106	H10010, H10011, H10016, H10145

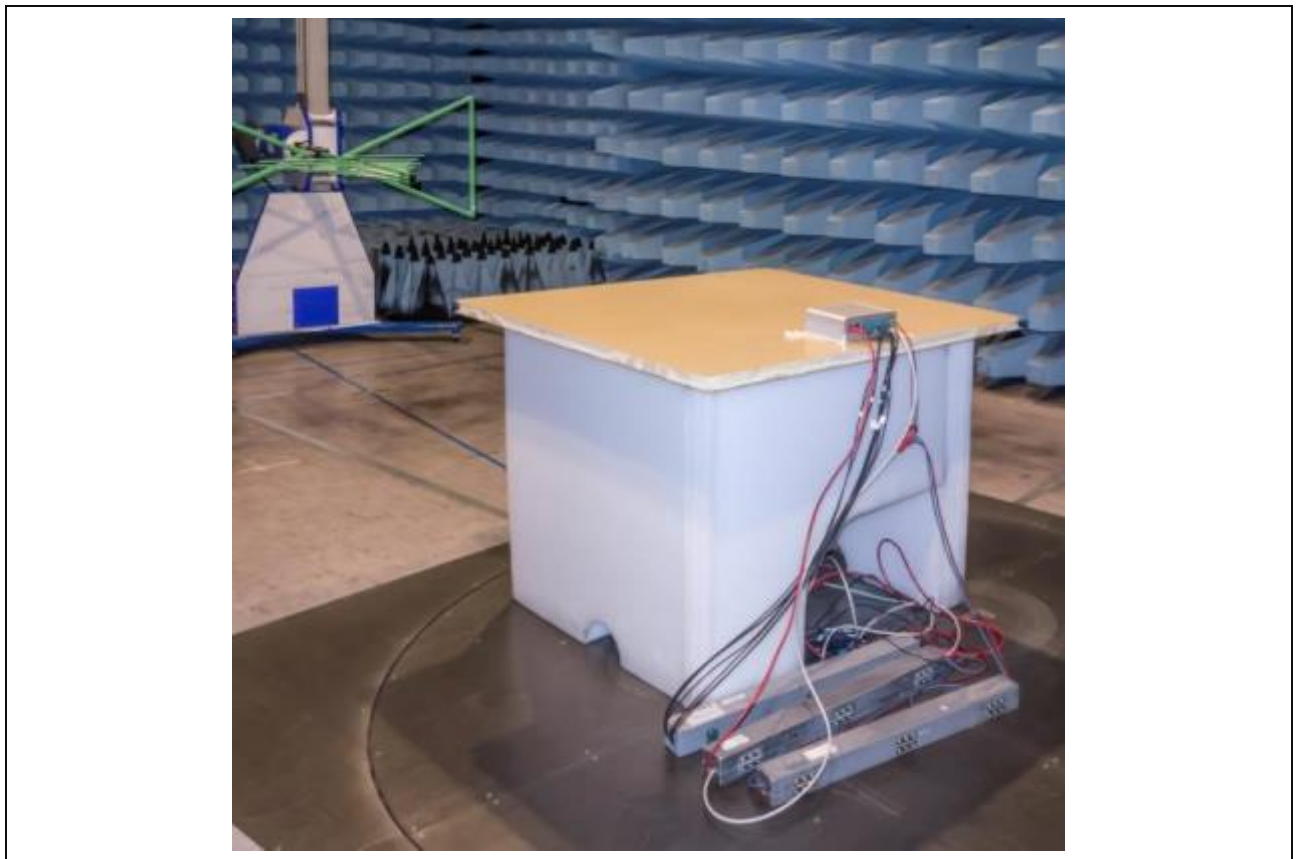
EUT 3, 4 and EUT 5

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

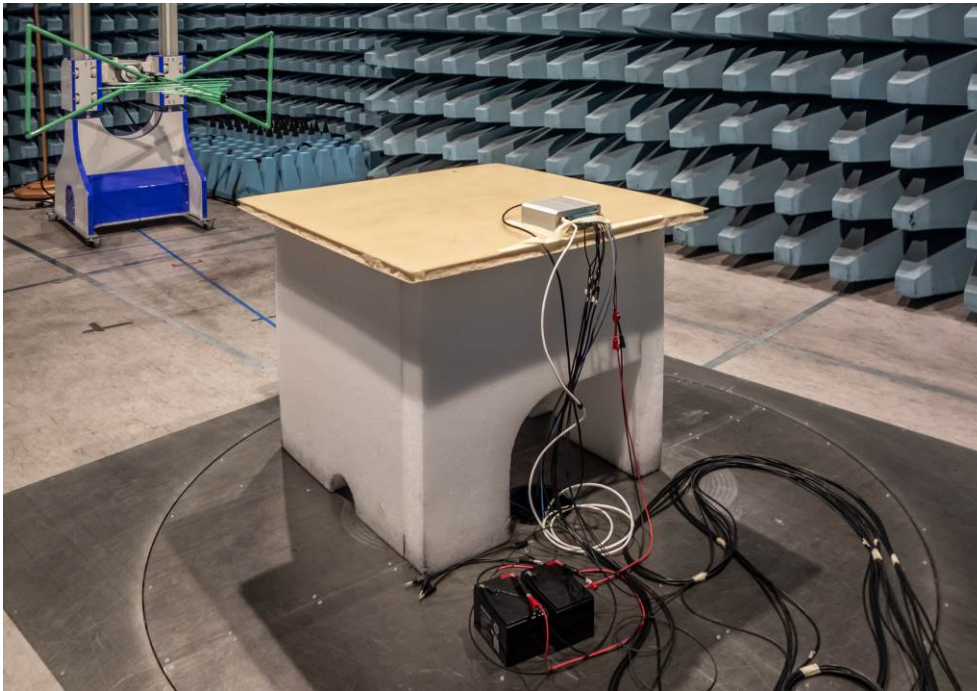
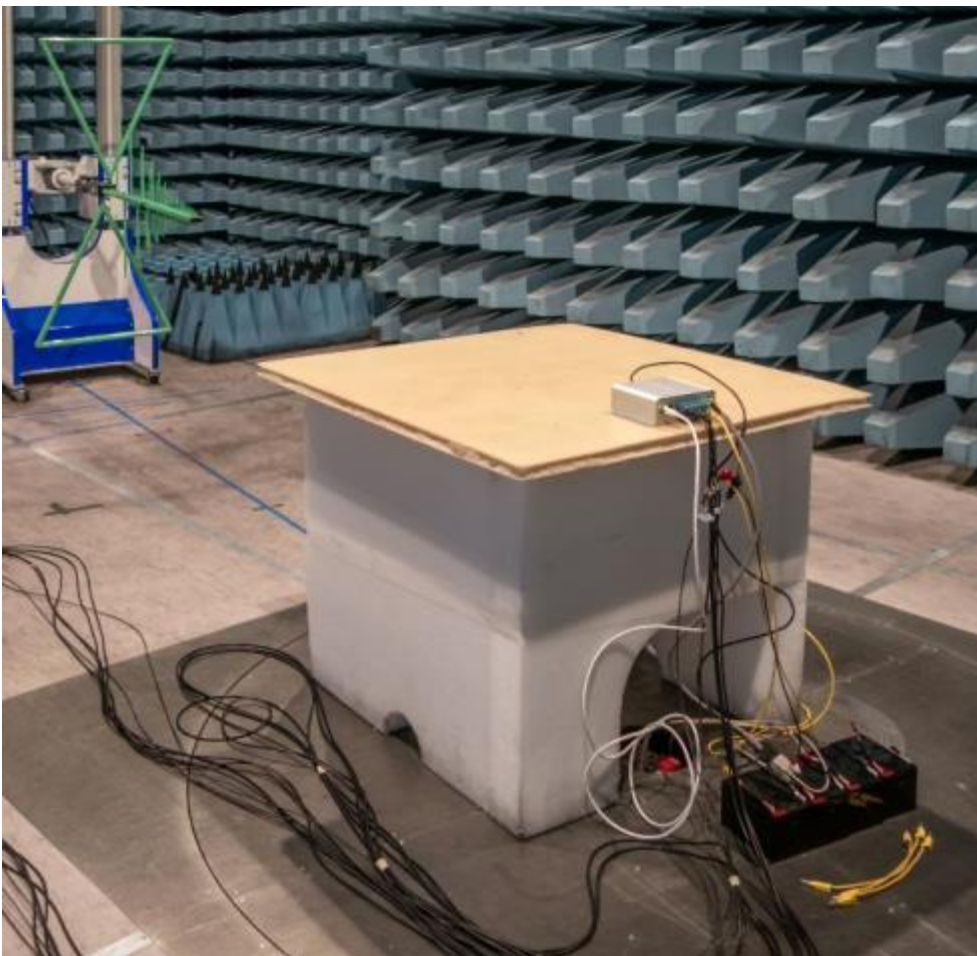
### Photos of the Setup – EUT 1



### Photos of the Setup – EUT 2



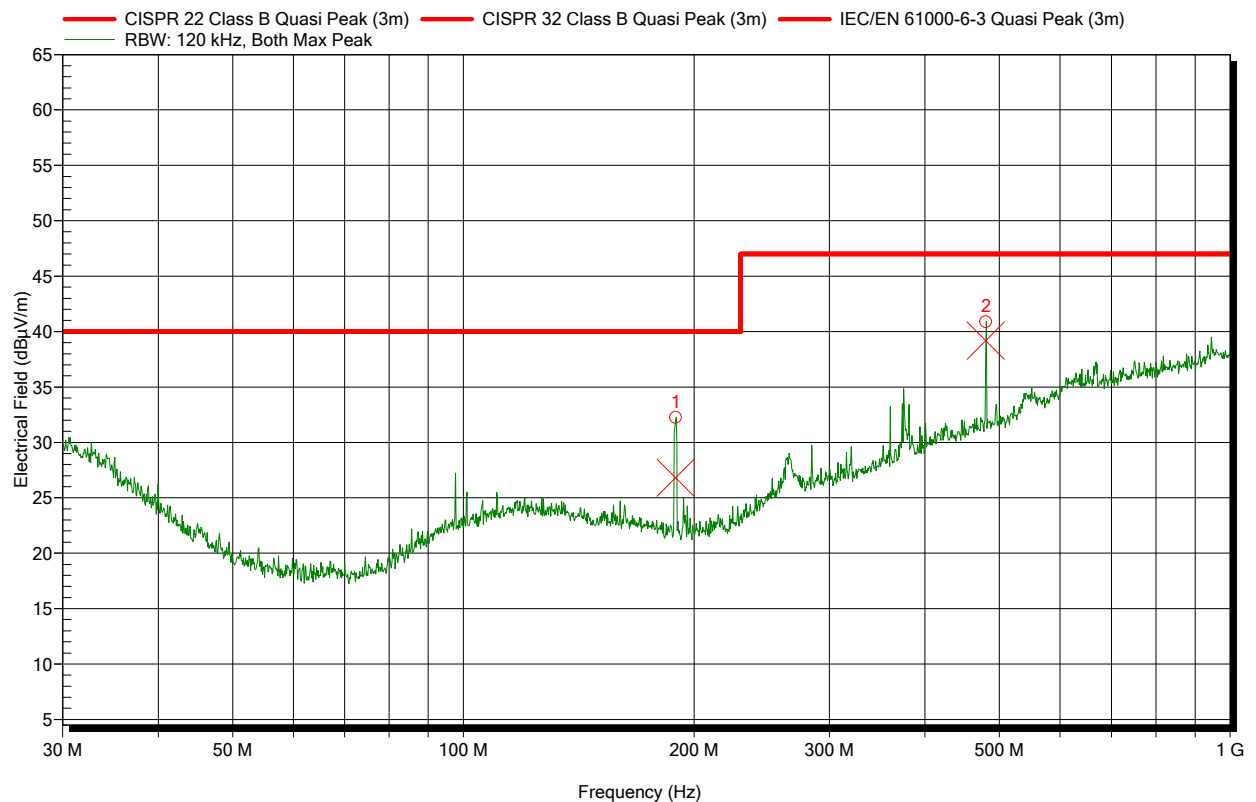


**Photos of the Setup – EUT 3 and EUT 4****Photos of the Setup – EUT 5**

## Measurement Results

Diagram 27:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 10:04:17		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 120 kHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 30 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 5 ms		

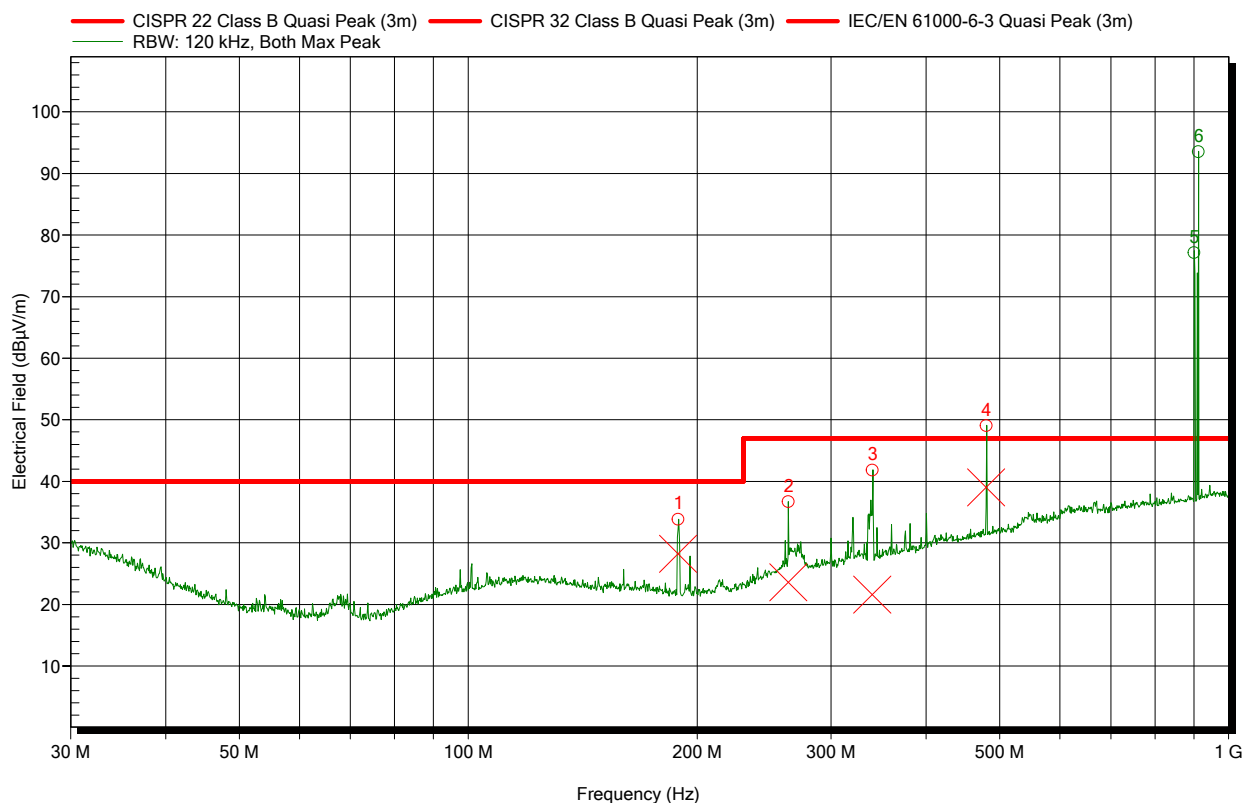


### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	189.12 MHz	32.26 dBμV/m	26.8 dBμV/m	-13.2 dB	Pass	120 Degree	1 m	Vertical
2	480 MHz	40.9 dBμV/m	39.17 dBμV/m	-7.83 dB	Pass	180 Degree	1 m	Vertical

Diagram 28:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 48 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 10:39:13		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 120 kHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 30 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 5 ms		



### Detected peaks

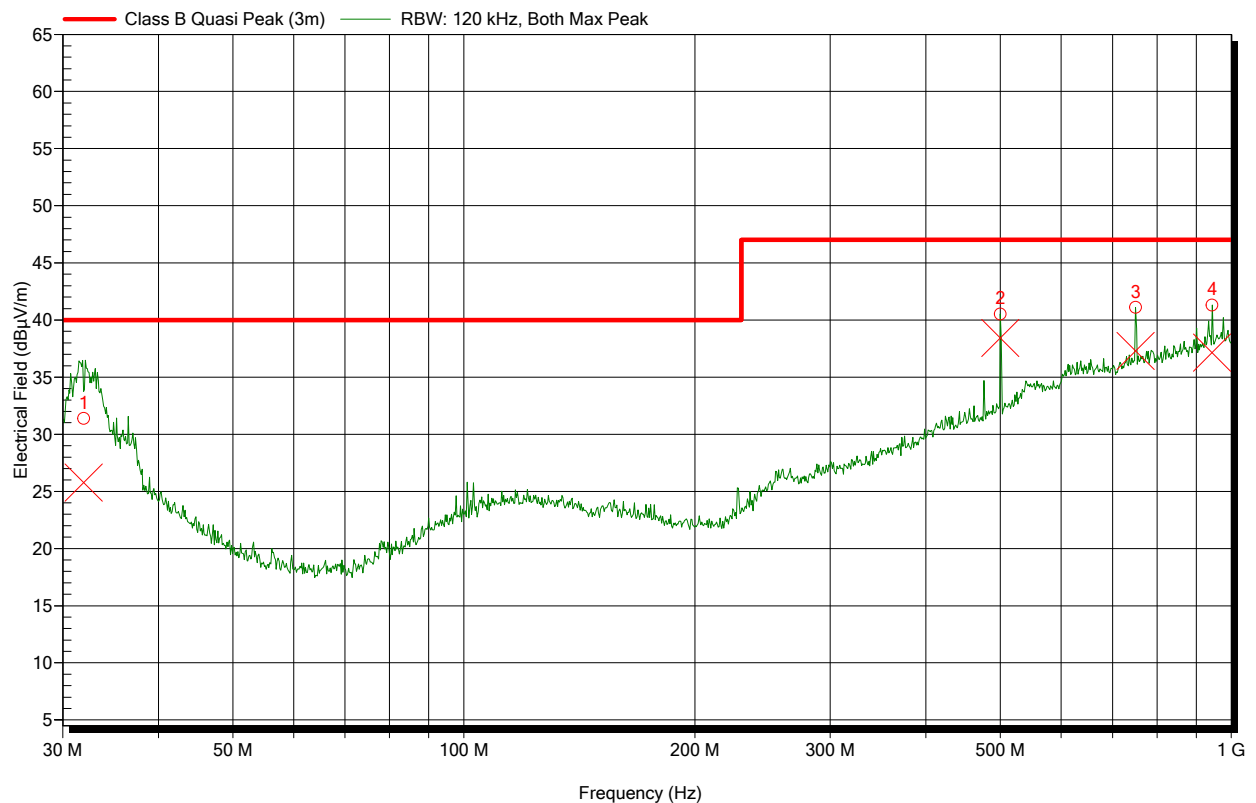
Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	188.76 MHz	33.82 dBµV/m	28.22 dBµV/m	-11.78 dB	Pass	0 Degree	1 m	Vertical
2	263.46 MHz	36.7 dBµV/m	23.58 dBµV/m	-23.42 dB	Pass	240 Degree	1 m	Horizontal
3	339.99 MHz	41.83 dBµV/m	21.61 dBµV/m	-25.39 dB	Pass	330 Degree	1 m	Vertical
4	479.97 MHz	49.06 dBµV/m	39.03 dBµV/m	-7.97 dB	Pass	180 Degree	1 m	Vertical
5	900.39 MHz	77.17 dBµV/m	--	--	Note	300 Degree	2 m	Horizontal
6	911.79 MHz	93.54 dBµV/m	--	--	Note	0 Degree	1 m	Horizontal

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



Diagram 29:

<b>EUT</b>	EUT 2		
<b>Verdict, Test</b>	Pass, Class B CISPR 22, 32 & IEC 61000-6-3		
<b>Mode of operation</b>	see chapter 9.5, 24 VDC		
<b>Test date, time</b>	11/11/2016 12:16:02		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: 1 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 10 ms		

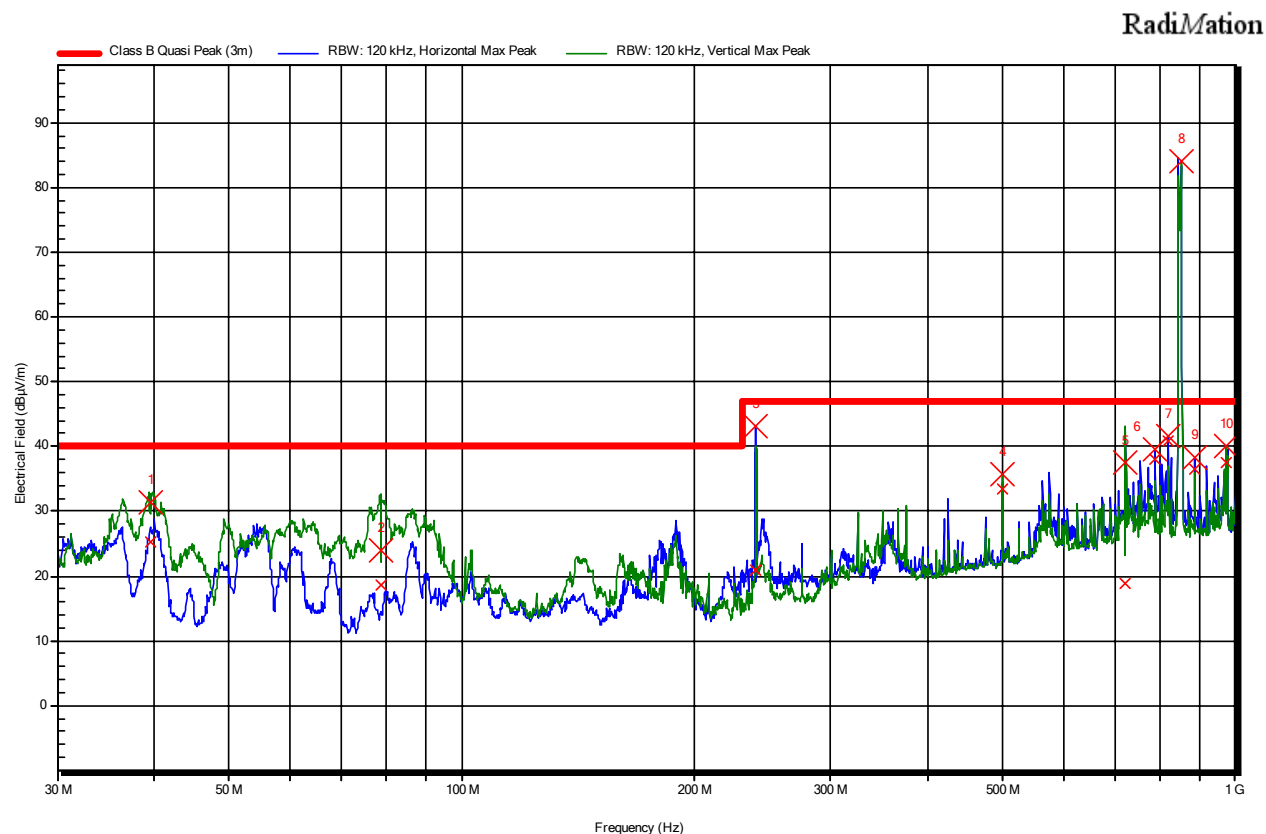


### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	31.95 MHz	31.38 dBµV/m	25.78 dBµV/m	-14.22 dB	Pass	30 Degree	4 m	Vertical
2	500.01 MHz	40.51 dBµV/m	38.42 dBµV/m	-8.58 dB	Pass	210 Degree	1 m	Vertical
3	750 MHz	41.09 dBµV/m	37.3 dBµV/m	-9.7 dB	Pass	150 Degree	2 m	Horizontal
4	943.77 MHz	41.32 dBµV/m	37.14 dBµV/m	-9.86 dB	Pass	60 Degree	3 m	Horizontal

Diagram 30:

<b>EUT</b>	EUT 3		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	19.10.2018 10:26:02		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [50.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		



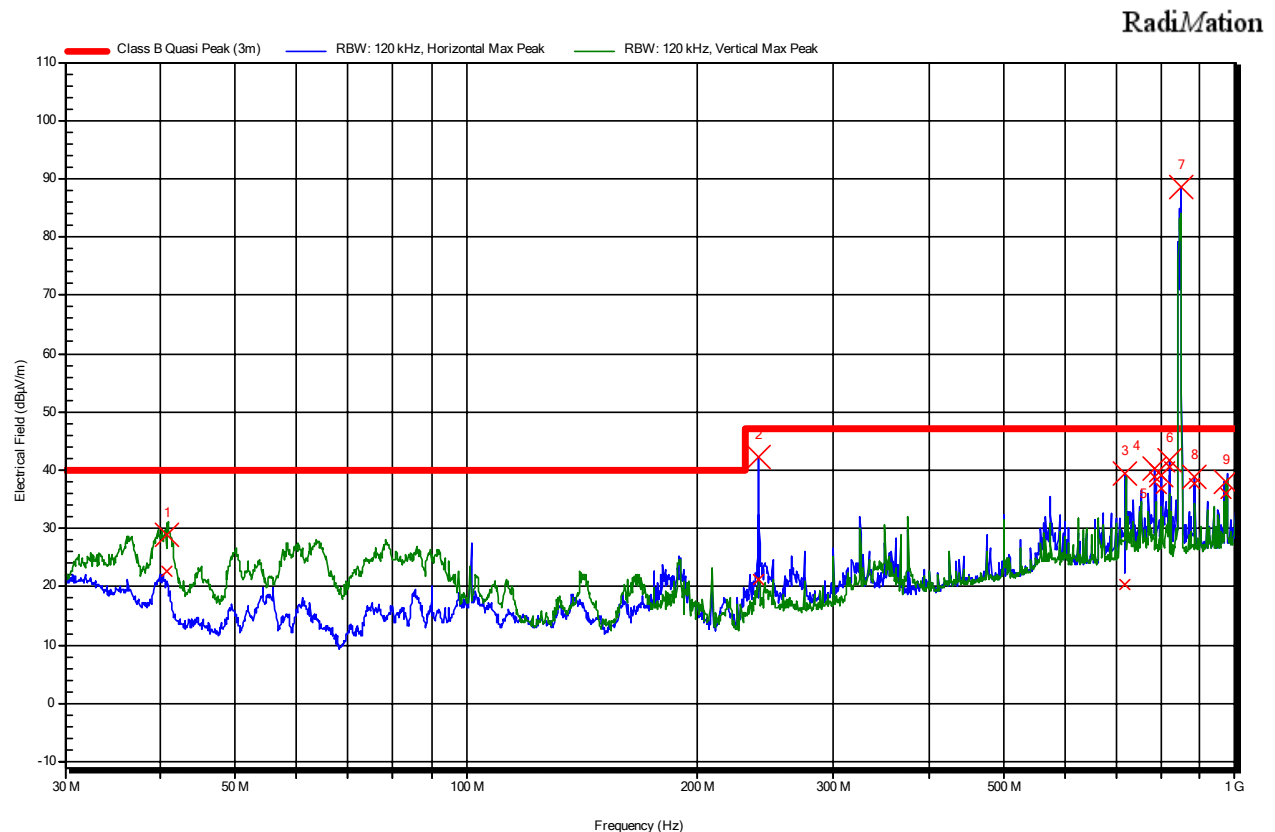
### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	39.6 MHz	31.5 dBµV/m	25.2 dBµV/m	-14.8 dB	Pass	300 Degree	1 m	Vertical
2	78.78 MHz	23.9 dBµV/m	18.5 dBµV/m	-21.5 dB	Pass	90 Degree	2 m	Vertical
3	240 MHz	43.2 dBµV/m	21 dBµV/m	-26.0 dB	Pass	240 Degree	2 m	Horizontal
4	500.01 MHz	35.6 dBµV/m	33.4 dBµV/m	-13.6 dB	Pass	240 Degree	1 m	Vertical
5	719.97 MHz	37.6 dBµV/m	19 dBµV/m	-28.0 dB	Pass	90 Degree	1 m	Vertical
6	787.5 MHz	39.4 dBµV/m	38.1 dBµV/m	-8.9 dB	Pass	120 Degree	1 m	Horizontal
7	820.32 MHz	41.7 dBµV/m	40.7 dBµV/m	-6.3 dB	Pass	270 Degree	1 m	Horizontal
8	850.17 MHz	84.1 dBµV/m	--	--	Note	120 Degree	1 m	Vertical
9	885.93 MHz	38.3 dBµV/m	36.5 dBµV/m	-10.5 dB	Pass	150 Degree	2 m	Horizontal
10	975 MHz	40.2 dBµV/m	37.6 dBµV/m	-9.4 dB	Pass	210 Degree	4 m	Vertical

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

Diagram 31:

<b>EUT</b>	EUT 3		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 24 VDC		
<b>Test date, time</b>	19.10.2018 10:49:57		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		

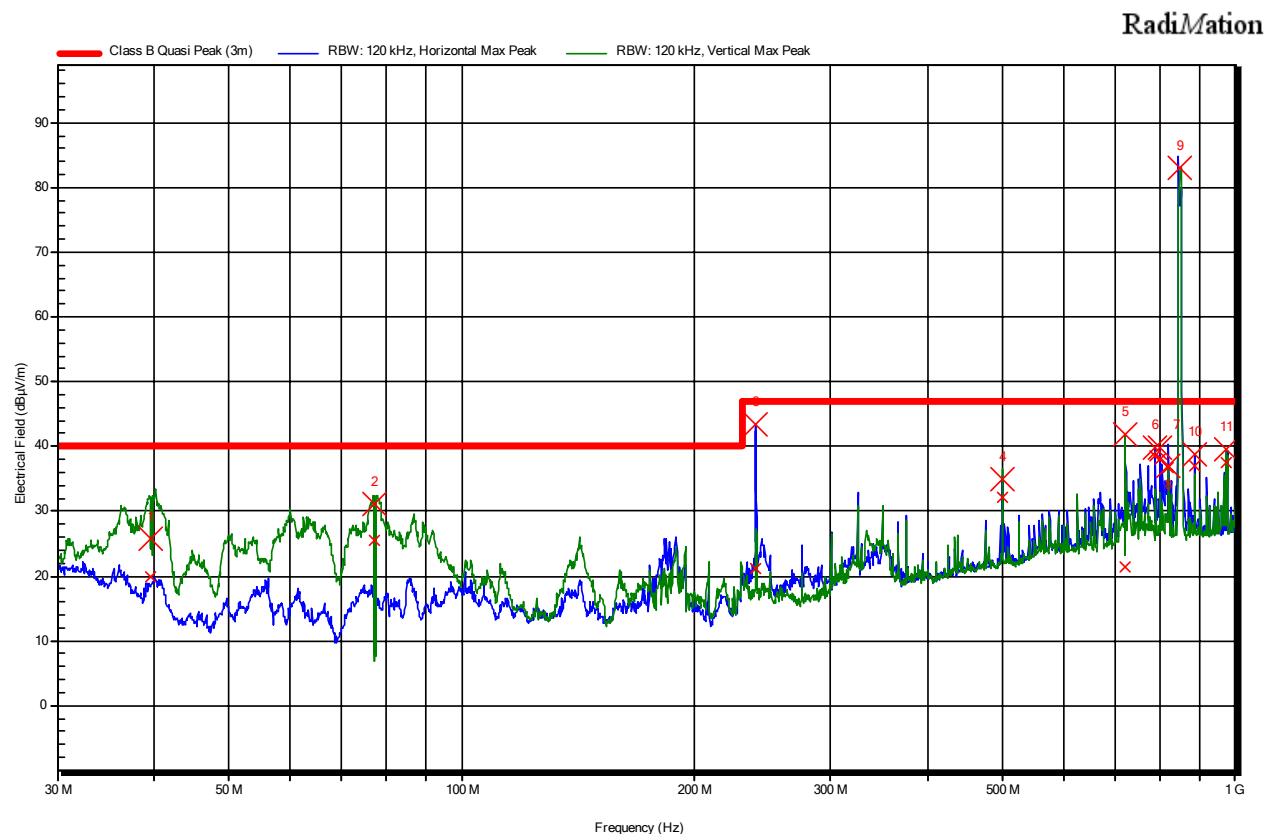
**Detected peaks**

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	40.68 MHz	29 dBµV/m	22.8 dBµV/m	-17.2 dB	Pass	330 Degree	2 m	Vertical
2	240 MHz	42.3 dBµV/m	21.1 dBµV/m	-25.9 dB	Pass	300 Degree	3 m	Horizontal
3	720.03 MHz	39.5 dBµV/m	20.4 dBµV/m	-26.6 dB	Pass	270 Degree	4 m	Horizontal
4	787.5 MHz	40.2 dBµV/m	38.9 dBµV/m	-8.1 dB	Pass	120 Degree	1 m	Horizontal
5	799.98 MHz	39 dBµV/m	37 dBµV/m	-10.0 dB	Pass	120 Degree	1 m	Horizontal
6	820.32 MHz	41.8 dBµV/m	40.7 dBµV/m	-6.3 dB	Pass	270 Degree	1 m	Horizontal
7	849.18 MHz	88.6 dBµV/m	--	--	Note	330 Degree	3 m	Horizontal
8	885.93 MHz	39 dBµV/m	37.7 dBµV/m	-9.3 dB	Pass	150 Degree	1 m	Horizontal
9	975 MHz	38 dBµV/m	35.9 dBµV/m	-11.1 dB	Pass	270 Degree	2 m	Vertical

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

Diagram 32:

<b>EUT</b>	EUT 3		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 48 VDC		
<b>Test date, time</b>	19.10.2018 11:22:03		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		



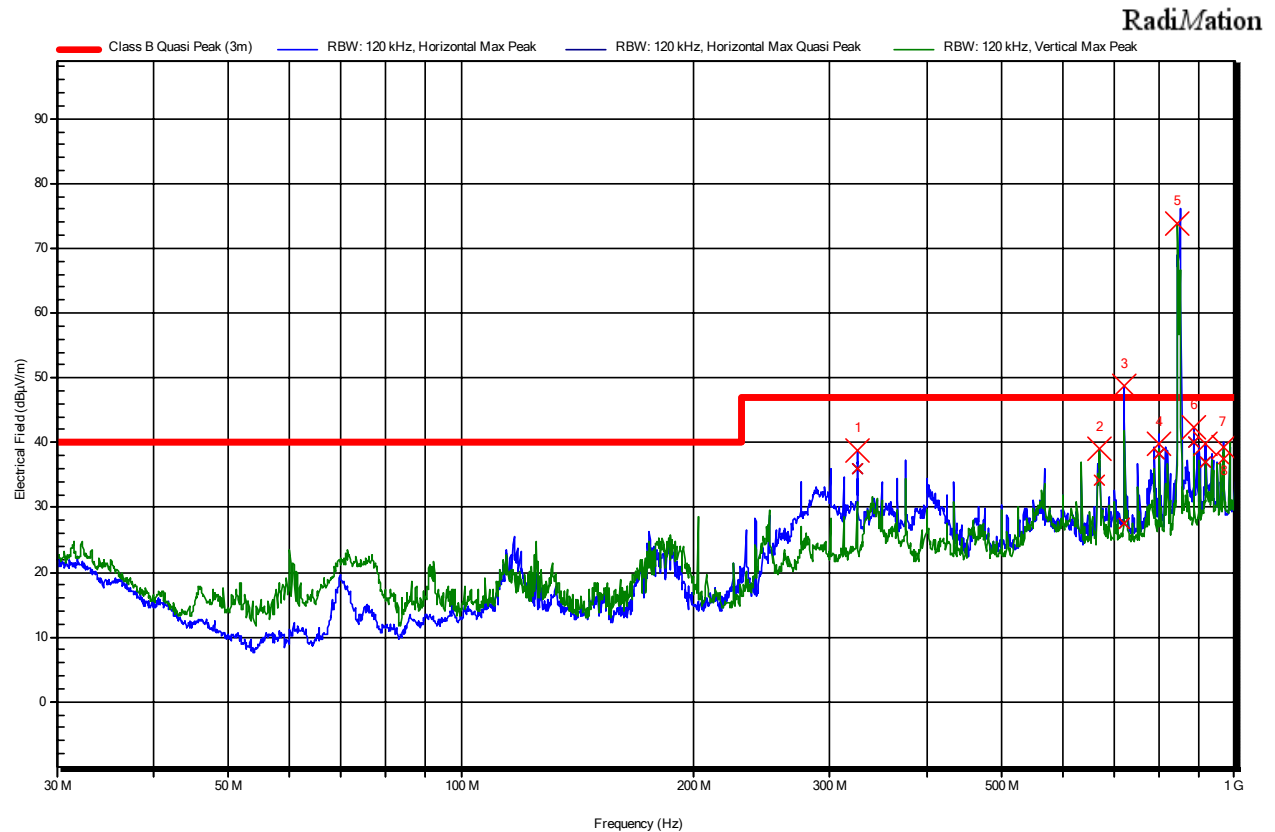
### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	39.72 MHz	25.7 dBµV/m	19.9 dBµV/m	-20.1 dB	Pass	330 Degree	1 m	Vertical
2	77.28 MHz	31.1 dBµV/m	25.6 dBµV/m	-14.4 dB	Pass	60 Degree	2 m	Vertical
3	240 MHz	43.4 dBµV/m	21.2 dBµV/m	-25.8 dB	Pass	210 Degree	1 m	Horizontal
4	499.98 MHz	34.9 dBµV/m	32.1 dBµV/m	-14.9 dB	Pass	240 Degree	2 m	Horizontal
5	720 MHz	41.7 dBµV/m	21.5 dBµV/m	-25.5 dB	Pass	150 Degree	4 m	Vertical
6	787.5 MHz	39.9 dBµV/m	38.5 dBµV/m	-8.5 dB	Pass	120 Degree	1 m	Horizontal
7	799.98 MHz	39.7 dBµV/m	38 dBµV/m	-9.0 dB	Pass	270 Degree	1 m	Horizontal
8	820.32 MHz	37.1 dBµV/m	36.7 dBµV/m	-10.3 dB	Pass	210 Degree	1 m	Horizontal
9	848.43 MHz	83 dBµV/m	--	--	Note	180 Degree	3 m	Vertical
10	885.93 MHz	38.8 dBµV/m	37 dBµV/m	-10.0 dB	Pass	150 Degree	1 m	Horizontal
11	975 MHz	39.6 dBµV/m	37.4 dBµV/m	-9.6 dB	Pass	180 Degree	2 m	Vertical

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

Diagram 33:

<b>EUT</b>	EUT 4		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	31.10.2018 09:59:30		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 50 ms		



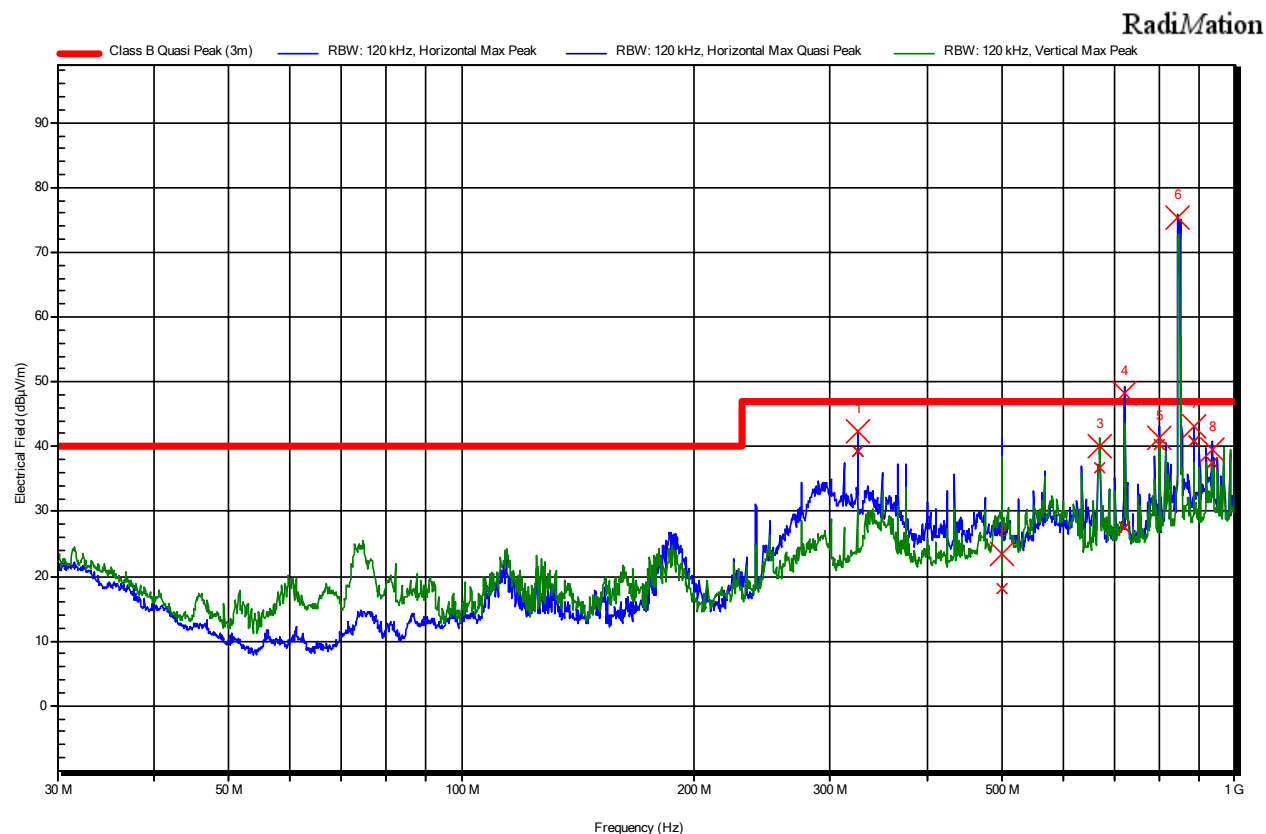
### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	324.99 MHz	38.8 dBµV/m	35.9 dBµV/m	-11.1 dB	Pass	270 Degree	1 m	Horizontal
2	669.84 MHz	39.2 dBµV/m	34.1 dBµV/m	-12.9 dB	Pass	330 Degree	2 m	Vertical
3	720 MHz	48.7 dBµV/m	27.6 dBµV/m	-19.4 dB	Pass	60 Degree	1 m	Horizontal
4	799.98 MHz	39.9 dBµV/m	38.3 dBµV/m	-8.7 dB	Pass	90 Degree	1 m	Horizontal
5	844.2 MHz	73.8 dBµV/m	--	--	Note	330 Degree	4 m	Vertical
6	885.93 MHz	42.3 dBµV/m	40.1 dBµV/m	-6.9 dB	Pass	240 Degree	1 m	Horizontal
7	918.75 MHz	39.8 dBµV/m	37.1 dBµV/m	-9.9 dB	Pass	240 Degree	1 m	Horizontal
8	966.66 MHz	39.3 dBµV/m	37.6 dBµV/m	-9.4 dB	Pass	240 Degree	3 m	Vertical

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

Diagram 34:

<b>EUT</b>	EUT 4		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 24 VDC		
<b>Test date, time</b>	31.10.2018 09:31:29		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 50 ms		



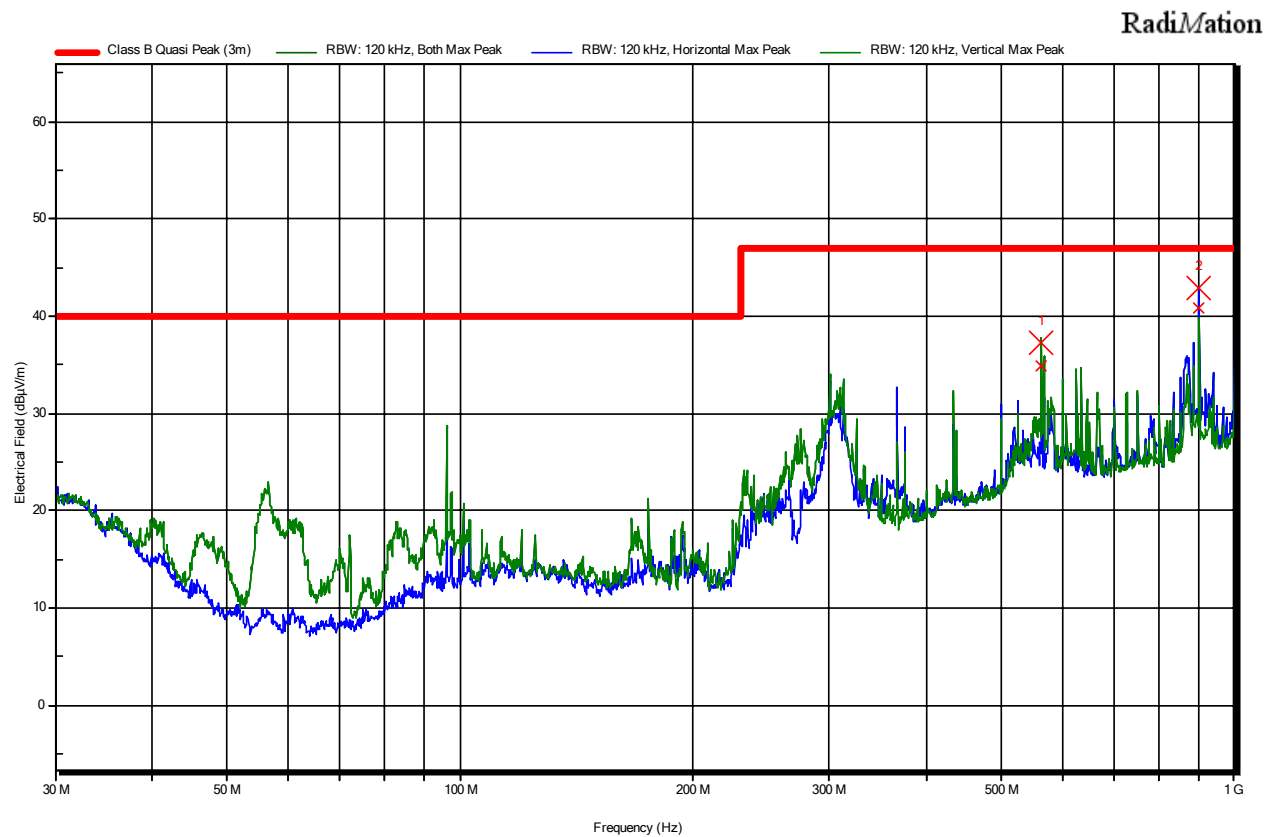
### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	324.99 MHz	42.5 dBμV/m	39.4 dBμV/m	-7.6 dB	Pass	270 Degree	1 m	Horizontal
2	500.01 MHz	23.4 dBμV/m	18.1 dBμV/m	-28.9 dB	Pass	0 Degree	1 m	Vertical
3	669.84 MHz	40 dBμV/m	36.8 dBμV/m	-10.2 dB	Pass	240 Degree	1 m	Vertical
4	720 MHz	48.4 dBμV/m	27.6 dBμV/m	-19.4 dB	Pass	90 Degree	1 m	Horizontal
5	799.98 MHz	41.3 dBμV/m	40.3 dBμV/m	-6.7 dB	Pass	330 Degree	1 m	Vertical
6	844.74 MHz	75.3 dBμV/m	--	--	Note	90 Degree	1 m	Horizontal
7	885.93 MHz	43.1 dBμV/m	40.9 dBμV/m	-6.1 dB	Pass	240 Degree	1 m	Horizontal
8	937.5 MHz	39.7 dBμV/m	37.4 dBμV/m	-9.6 dB	Pass	210 Degree	2 m	Horizontal

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

Diagram 35:

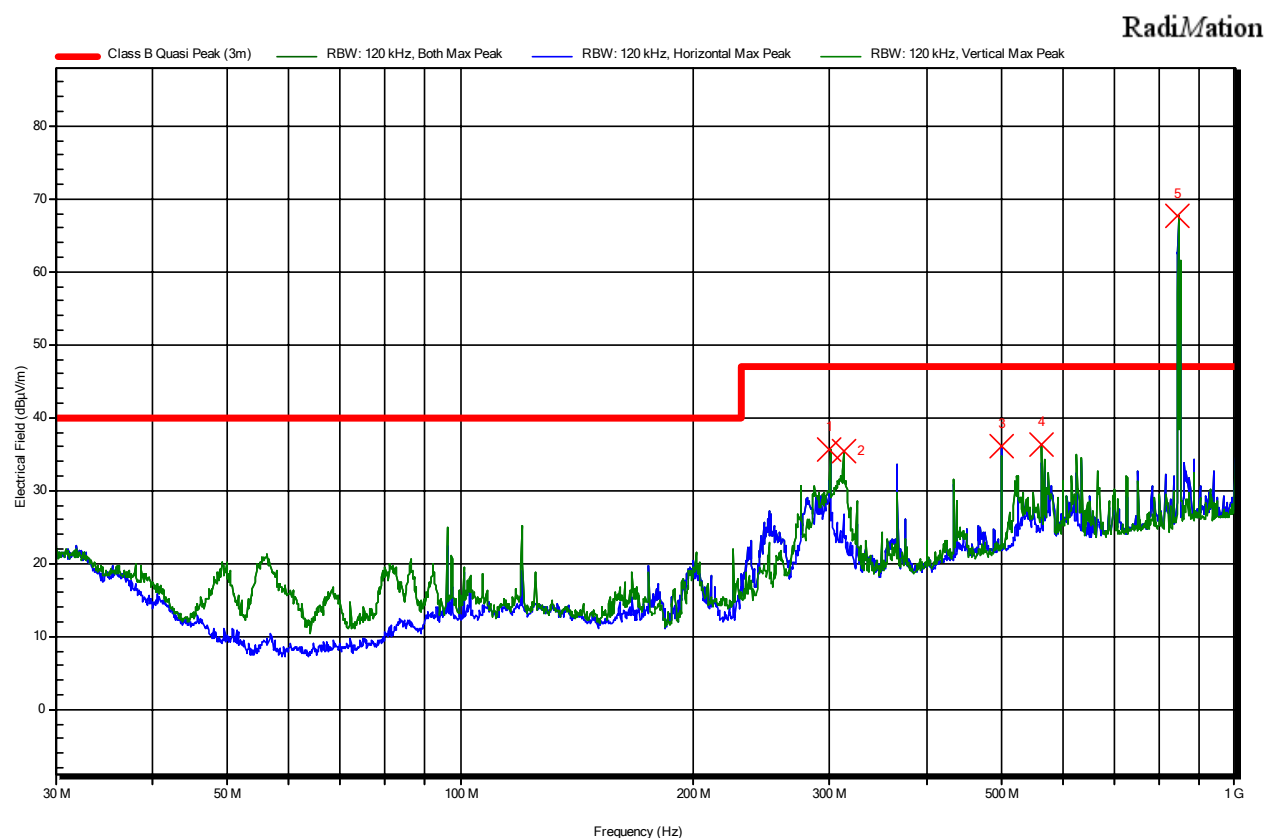
<b>EUT</b>	EUT 5		
<b>Verdict</b>	Pass according CISPR 32, Class B		
<b>Note</b>	USB cable removed		
<b>Mode of operation</b>	12 VDC		
<b>Test date, time</b>	25.03.2019 12:35:39		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		

**Detected peaks**

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	562.5 MHz	37.2 dBμV/m	34.8 dBμV/m	-12.2 dB	Pass	30 Degree	1 m	Vertical
2	900 MHz	42.9 dBμV/m	40.9 dBμV/m	-6.1 dB	Pass	180 Degree	2 m	Horizontal

Diagram 36:

<b>EUT</b>	EUT 5		
<b>Verdict</b>	Pass according CISPR 32, Class B		
<b>Note</b>	USB cable removed		
<b>Mode of operation</b>	48 VDC		
<b>Test date, time</b>	25.03.2019 11:24:49		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2017.1.6, RBW: 120 kHz, VBW: 300 kHz, Sweep time: 10 ms, Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		



### Detected peaks

Peak Number	Frequency	Peak	Status	Angle	Height	Polarization
1	300 MHz	35.7 dBμV/m	Pass	60 Degree	1 m	Vertical
2	312.51 MHz	35.3 dBμV/m	Pass	270 Degree	2 m	Vertical
3	500.01 MHz	36 dBμV/m	Pass	300 Degree	1 m	Horizontal
4	562.5 MHz	36.4 dBμV/m	Pass	90 Degree	1 m	Vertical
5	845.52 MHz	67.6 dBμV/m	Note	90 Degree	4 m	Vertical

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



## 10.5 Radiated Electromagnetic Field (1 – 6 GHz)

**Test site:** semi-anechoic chamber (hybrid)

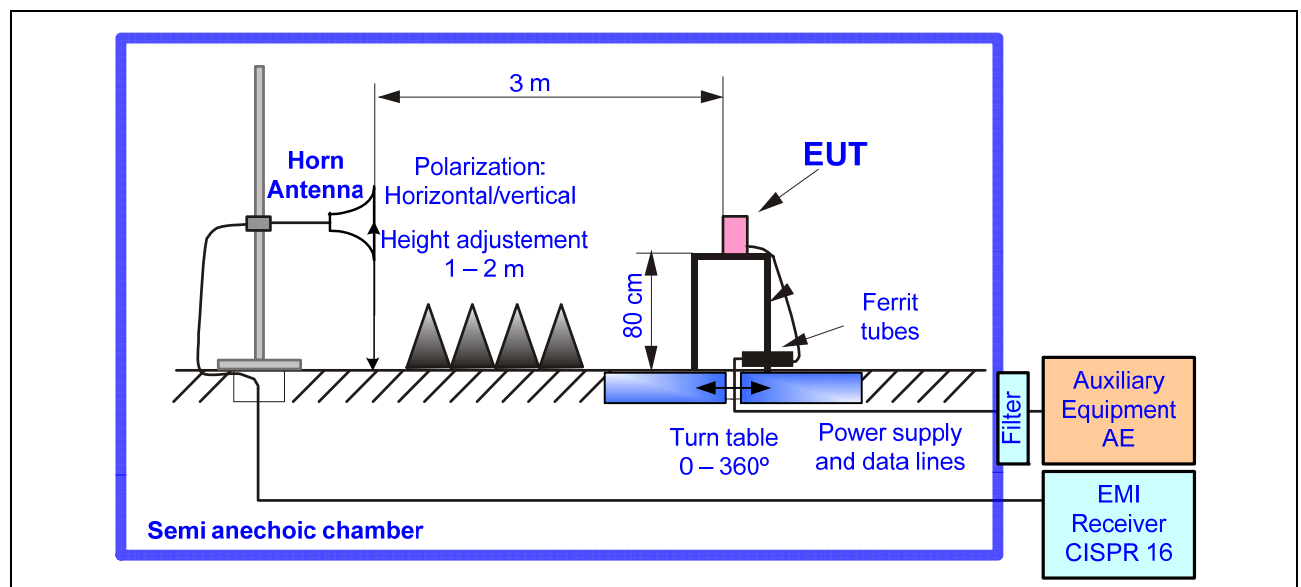
**Distance:** 3 m

**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

EUT 1 and EUT 2

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU8	OA 10193
Horn Antenna	EMCO	3115	H9353
Coaxial Cable	Huber & Suhner	Sucoflex 106	H10010, H10011, H10016, H10145

EUT 3, 4 and EUT 5

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 – EUT 1



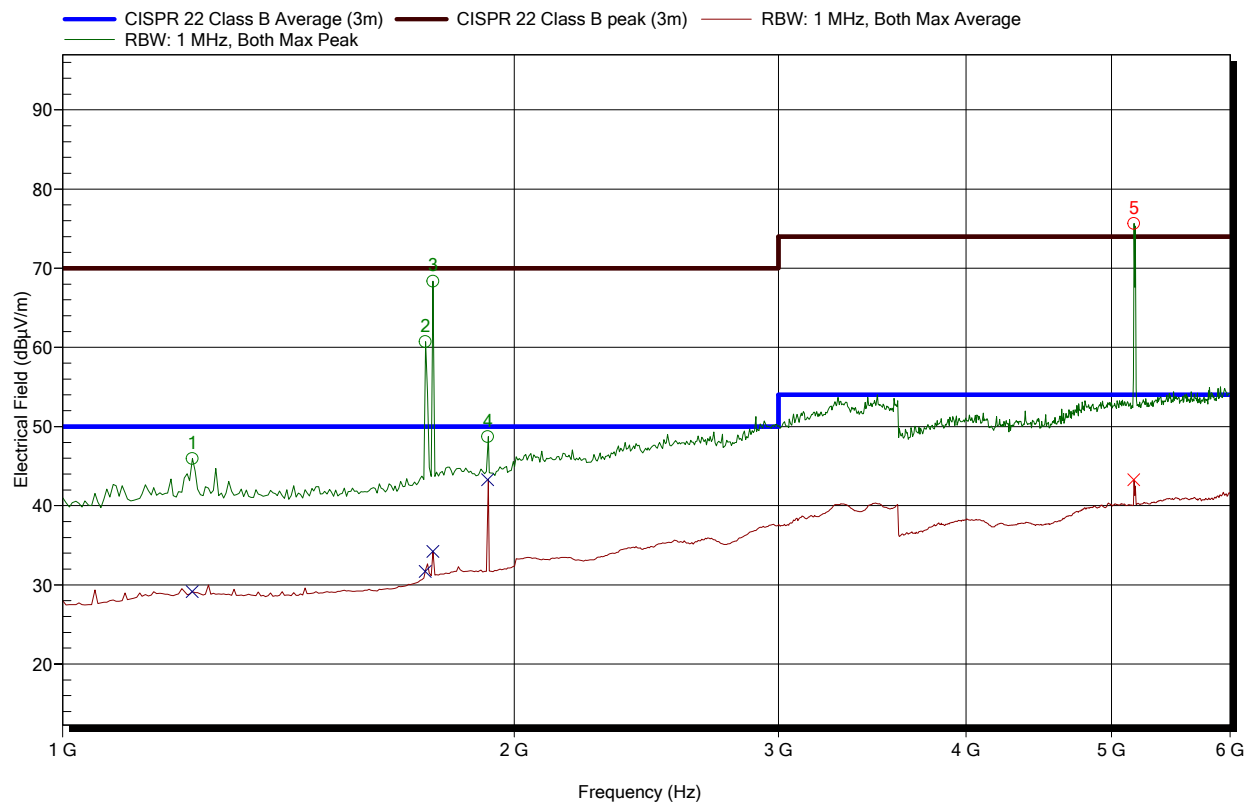
Photos of the Setup – EUT 2



## Measurement Results

Diagram 37:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	normal mode, 48 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 11:00:16		
<b>Antenna height</b>	1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 1 MHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 5 MHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 20 ms		



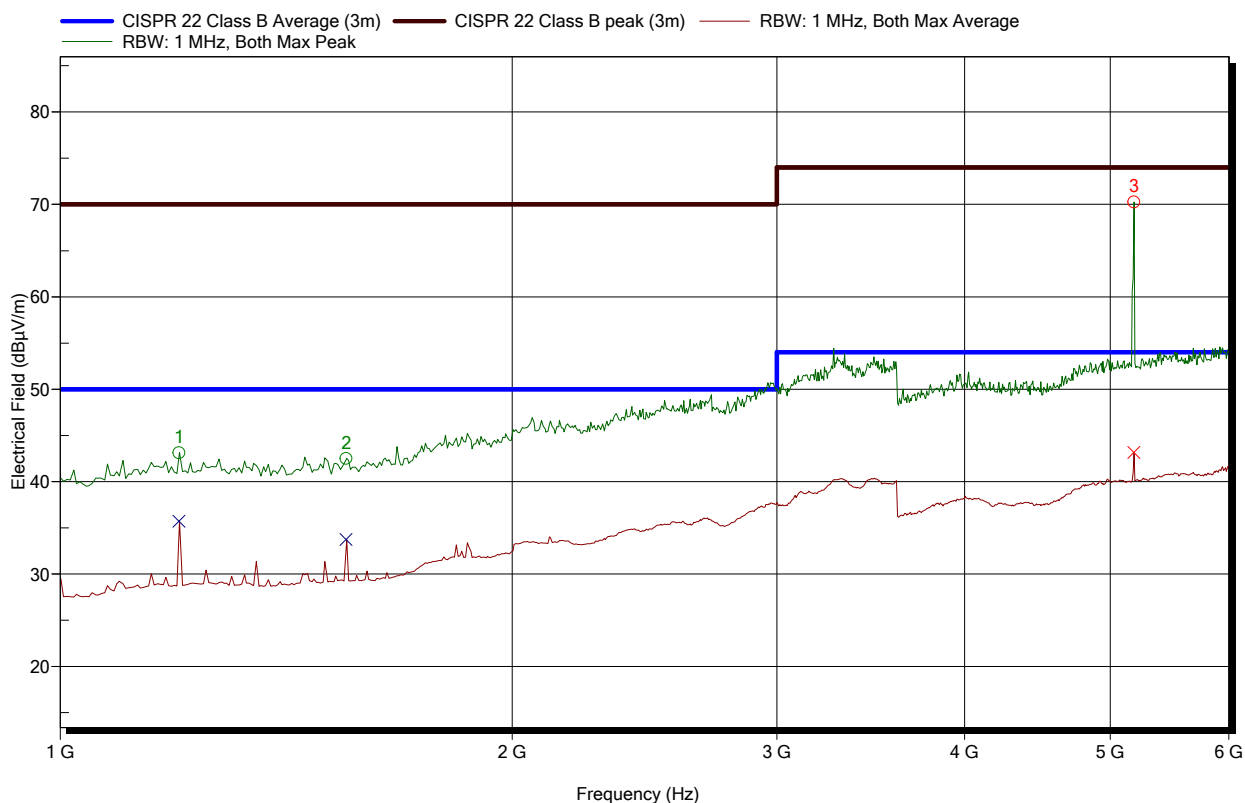
### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	1.22 GHz	45.95 dBμV/m	-24.05 dB	29.16 dBμV/m	-20.84 dB	Pass	300 Degree	1 m	Vertical
2	1.745 GHz	60.73 dBμV/m	-9.27 dB	31.71 dBμV/m	-18.29 dB	Note	180 Degree	1 m	Vertical
3	1.765 GHz	68.37 dBμV/m	-1.63 dB	34.21 dBμV/m	-15.79 dB	Note	60 Degree	1 m	Vertical
4	1.92 GHz	48.72 dBμV/m	-21.28 dB	43.3 dBμV/m	-6.7 dB	Note	270 Degree	1 m	Vertical
5	5.175 GHz	75.65 dBμV/m	1.65 dB	43.26 dBμV/m	-10.74 dB	Note	210 Degree	1 m	Horizontal

Note: Mobile and WLAN frequencies, exclusion band according ETSI EN 301 489-17/-24 applies

Diagram 38:

<b>EUT</b>	EUT 2		
<b>Verdict, Test</b>	Pass, Class B CISPR 22 & 32		
<b>Mode of operation</b>	normal mode, 24 VDC		
<b>Test date, time</b>	11/11/2016 12:55:51		
<b>Antenna height</b>	1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 1 MHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 5 MHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 10 ms		



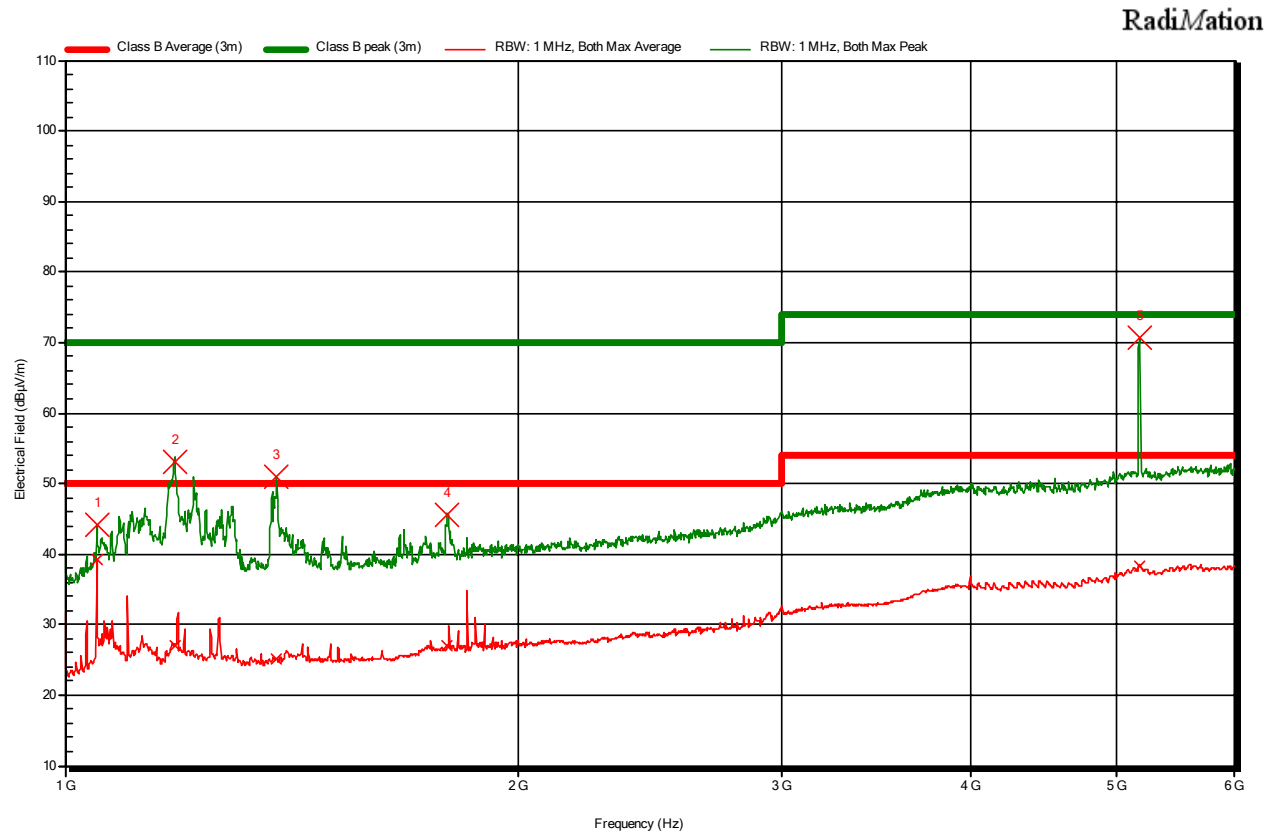
### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	1.2 GHz	43.14 dBμV/m	-26.86 dB	35.71 dBμV/m	-14.29 dB	Pass	30 Degree	1 m	Vertical
2	1.55 GHz	42.51 dBμV/m	-27.49 dB	33.74 dBμV/m	-16.26 dB	Pass	150 Degree	1 m	Vertical
3	5.185 GHz	70.28 dBμV/m	-3.72 dB	43.14 dBμV/m	-10.86 dB	Note	120 Degree	1 m	Horizontal

Note: WLAN frequencies, exclusion band according ETSI EN 301 489-17 applies

Diagram 39:

<b>EUT</b>	EUT 3		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	19.10.2018 12:04:02		
<b>Antenna height</b>	1 m - 1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	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: 50 ms		

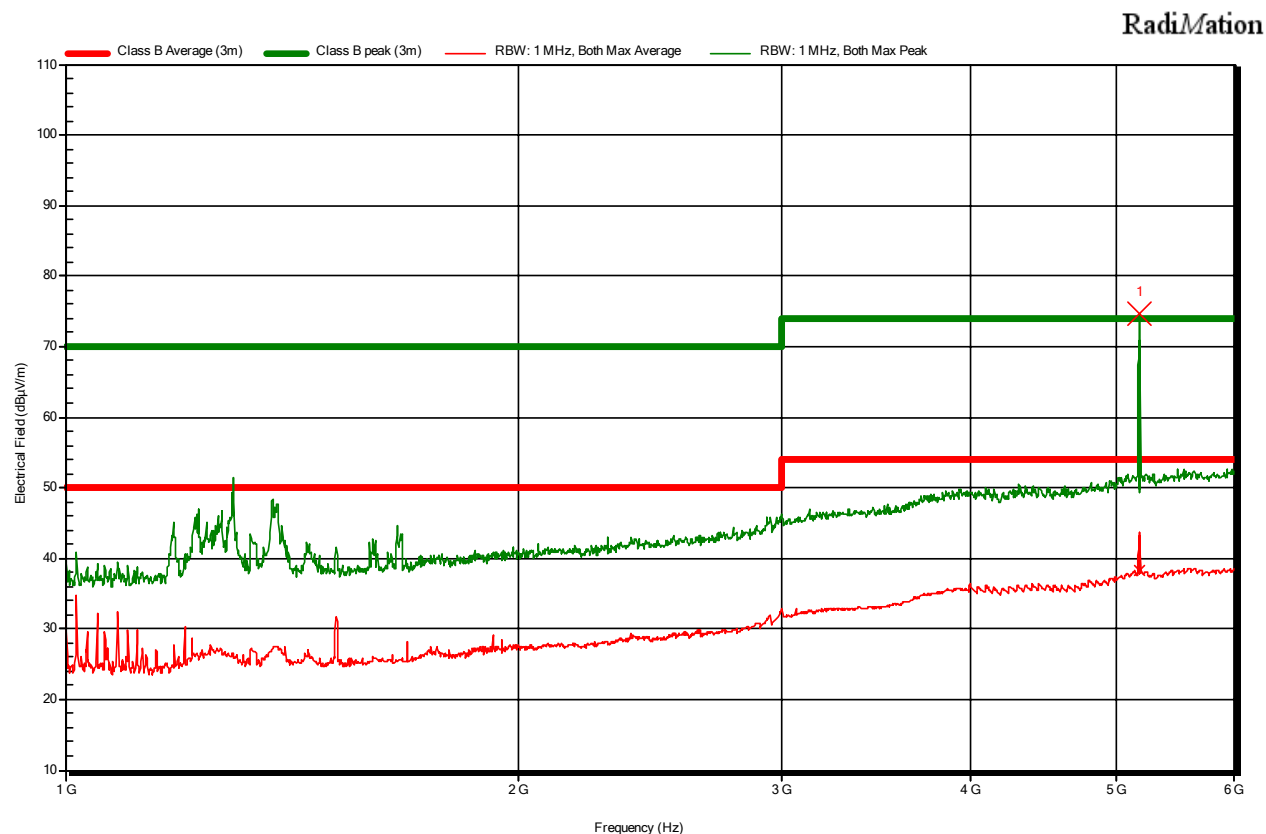
**Detected peaks**

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Polarization
1	1.05 GHz	44.1 dBµV/m	-25.9 dB	39.3 dBµV/m	-10.7 dB	Pass	315 Degree	Vertical
2	1.183 GHz	53.2 dBµV/m	-16.8 dB	27 dBµV/m	-23.0 dB	Pass	345 Degree	Vertical
3	1.382 GHz	51 dBµV/m	-19.0 dB	25 dBµV/m	-25.0 dB	Pass	225 Degree	Vertical
4	1.796 GHz	45.6 dBµV/m	-24.4 dB	27 dBµV/m	-23.0 dB	Pass	60 Degree	Vertical
5	5.186 GHz	70.6 dBµV/m	-3.4 dB	38.2 dBµV/m	-15.8 dB	Note	135 Degree	Horizontal

Note: WLAN frequencies, exclusion band according ETSI EN 301 489-17 applies

Diagram 40:

<b>EUT</b>	EUT 4		
<b>Verdict, Test</b>	Pass, according CISPR 32 Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	31.10.2018 10:16:37		
<b>Antenna height</b>	1 m - 2 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	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: 20 ms		



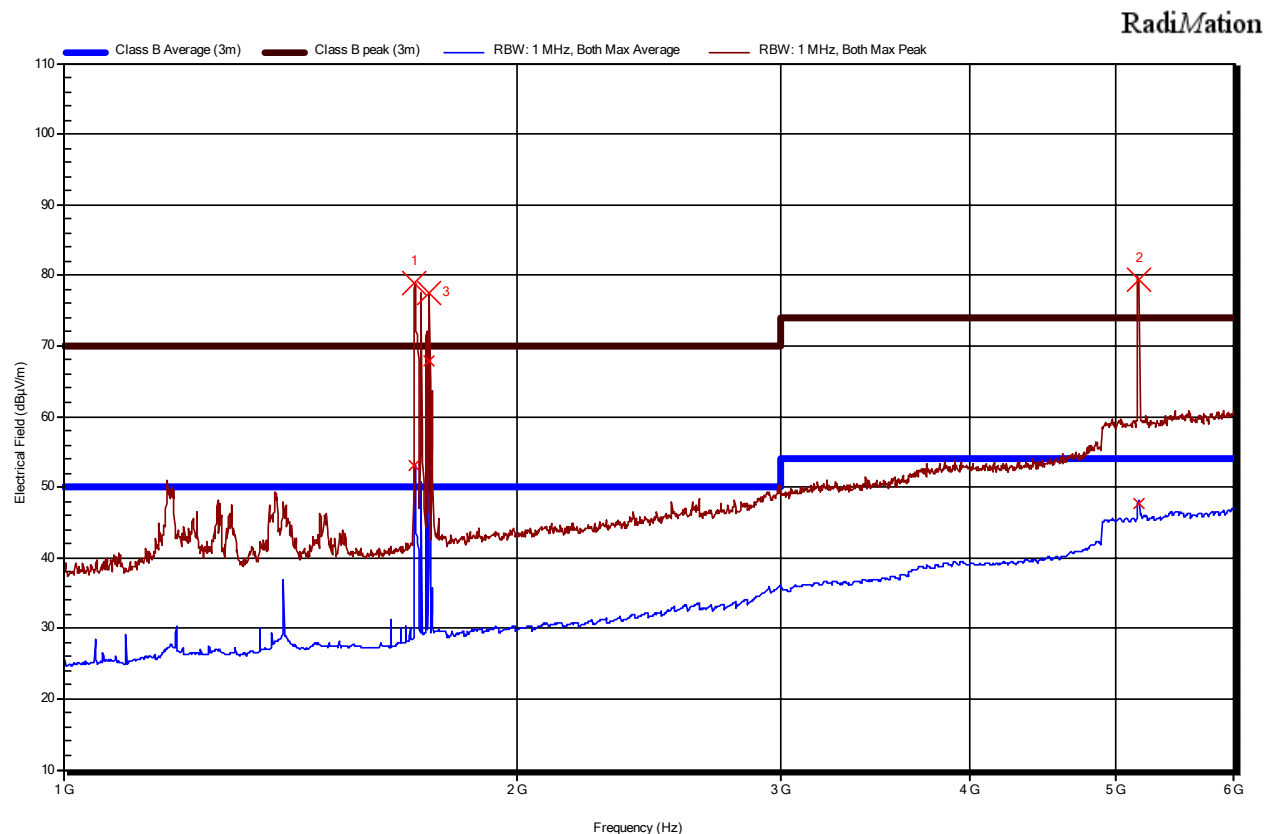
### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	5.188 GHz	74.7 dBμV/m	0.7 dB	38.4 dBμV/m	-15.6 dB	Note	150 Degree	2 m	Horizontal

Note: WLAN frequencies, exclusion band according ETSI EN 301 489-17 applies

Diagram 41:

<b>EUT</b>	EUT 5		
<b>Verdict</b>	Pass according CISPR 32, Class B		
<b>Note</b>	USB cable removed		
<b>Mode of operation</b>	12 VDC		
<b>Test date, time</b>	25.03.2019 12:56:52		
<b>Antenna height</b>	1 m - 2 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	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: 20 ms		

**Detected peaks**

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	1.712 GHz	78.9 dBμV/m	8.9 dB	53.1 dBμV/m	3.1 dB	Note 1	60 Degree	1 m	Vertical
2	5.179 GHz	79.4 dBμV/m	5.4 dB	47.7 dBμV/m	-6.3 dB	Note 2	150 Degree	1 m	Horizontal
3	1.75 GHz	77.4 dBμV/m	7.4 dB	67.8 dBμV/m	17.8 dB	Note 1	60 Degree	1 m	Vertical

**Notes:**

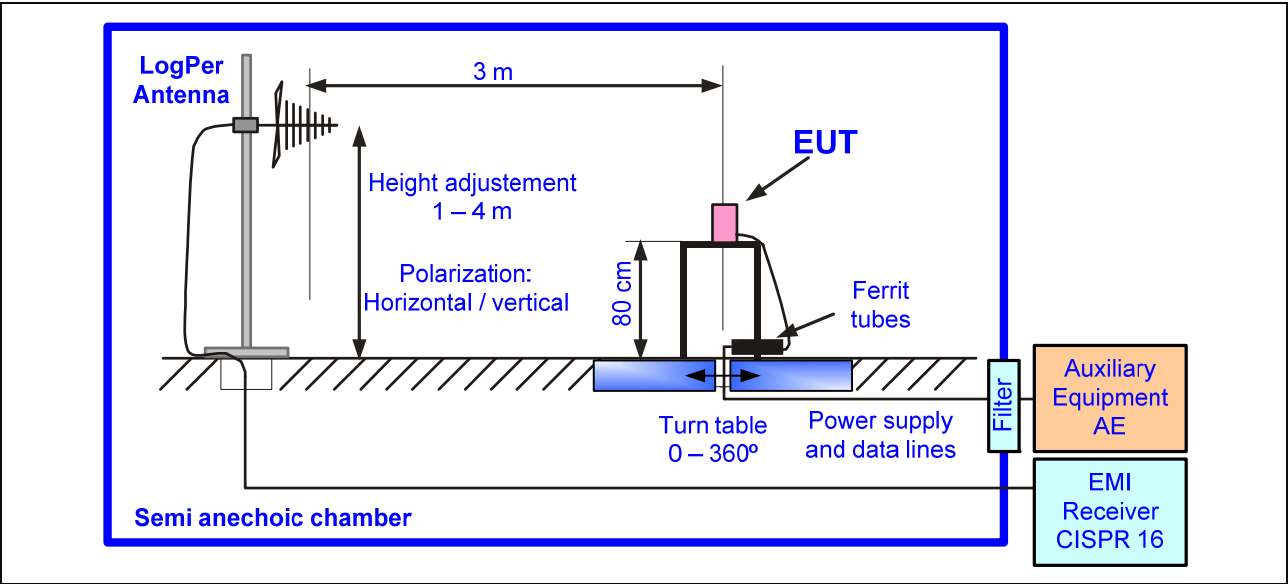
- 1) LTE frequencies, exclusion band according ETSI EN 301 489-52 applies
- 2) WLAN frequencies, exclusion band according ETSI EN 301 489-17 applies

10.6 Radiated Emission - Electromagnetic Field - FCC

**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 spectrum analyzer and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarizations. The turning table is operated through 360° during the measurements. 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 on the graph. The values exceeding a limit shall be re-measured manually using a receiver.

None

Test Setup



Test Equipment

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU8	OA 10193
Antenna LogPer	Chase	CBL 6112B	H9695
Coaxial Cable	Huber & Suhner	Sucoflex 106	H10010, H10011, H10016, H10145

Photos of the Setup

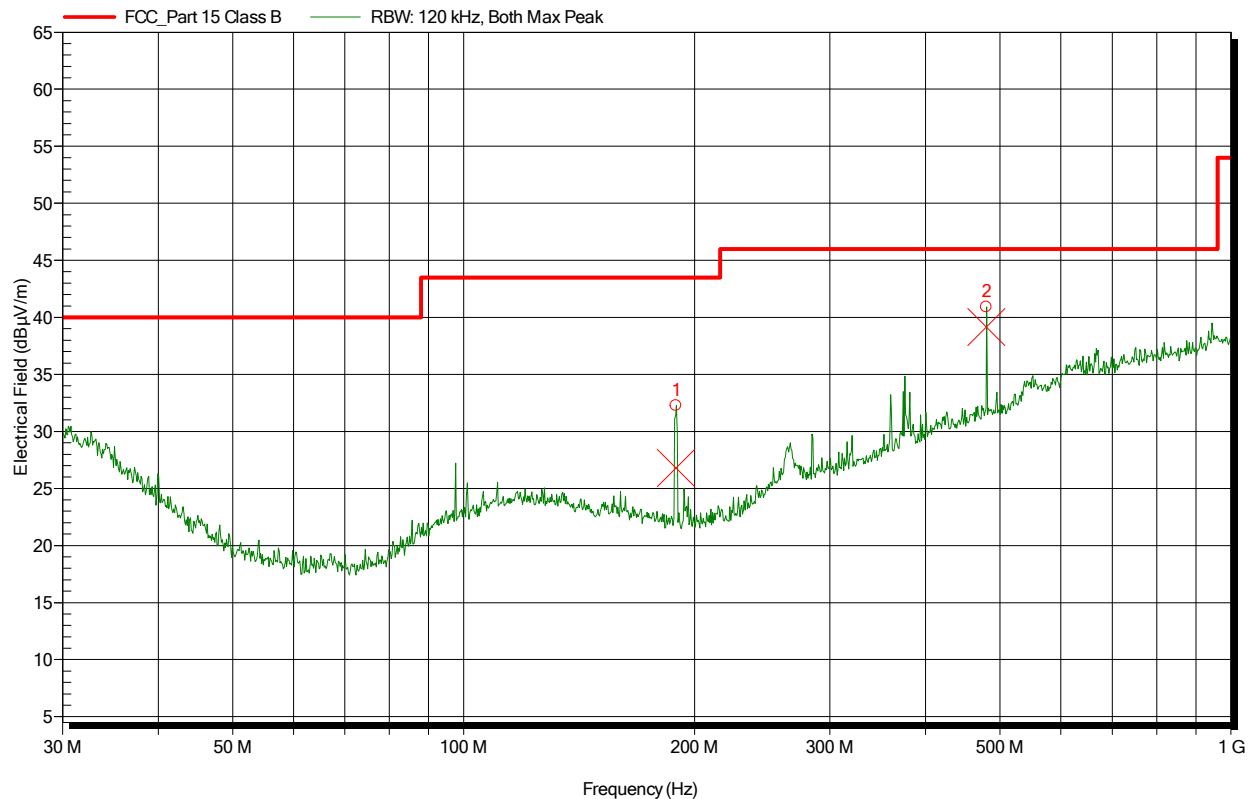
see chapter 10.4 & 10.5



**Measurement Results**

Diagram 42:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 10:04:17		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 120 kHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 30 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 5 ms		

**Detected peaks**

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	189.12 MHz	32.26 dBμV/m	26.8 dBμV/m	-16.7 dB	Pass	120 Degree	1 m	Vertical
2	480 MHz	40.9 dBμV/m	39.17 dBμV/m	-6.83 dB	Pass	180 Degree	1 m	Vertical

## 10.7 Radiated Electromagnetic Field – FCC (1 – 18 GHz)

**Test site:** semi-anechoic chamber (hybrid)

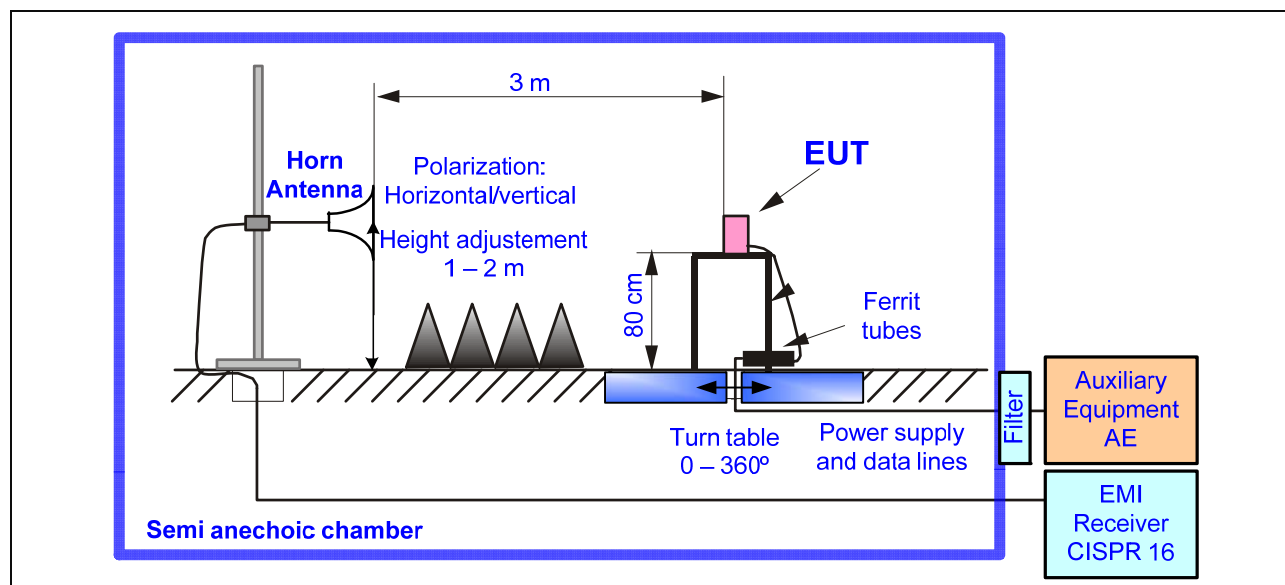
**Distance:** 3 m

**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 4 m in height. The measurements are performed with horizontal and vertical polarizations.

**Modifications:** none

### Test Setup



### Test Equipment

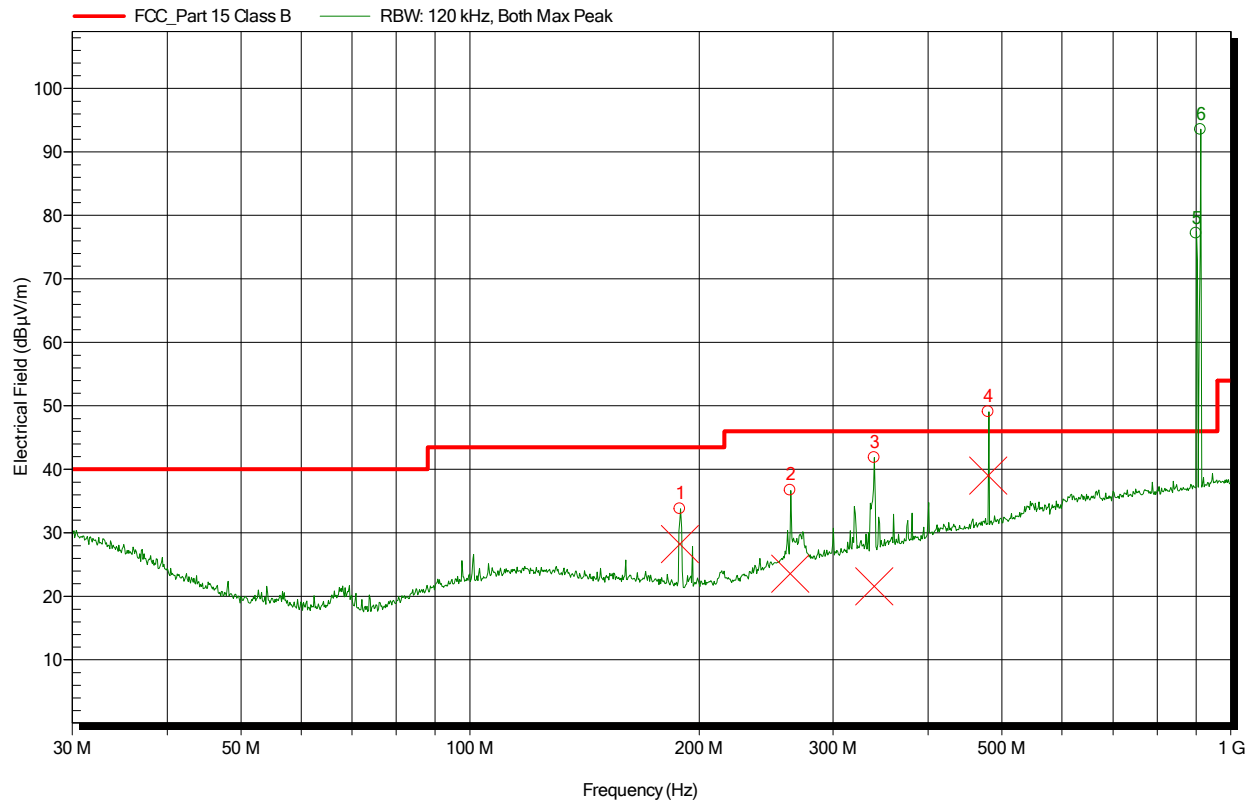
Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESW26	17.6632.05
Horn Antenna	EMCO	3115	H9353
Coaxial Cable	Huber & Suhner	Sucoflex 106	17.6632.03, 17.6632.04, 18.6632.02

### Photos of the Setup

see chapter 10.5

Diagram 43:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 48 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 10:39:13		
<b>Antenna height</b>	1 m - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 120 kHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 30 kHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 5 ms		



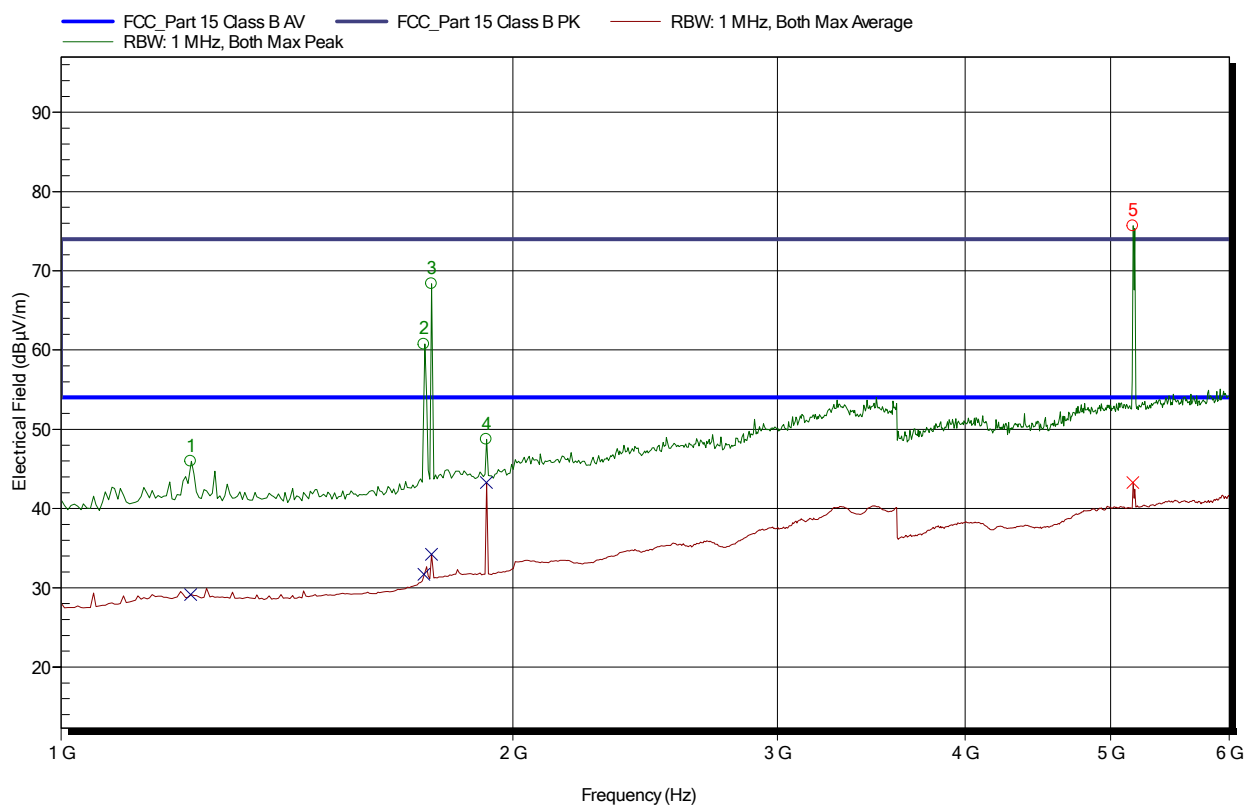
### Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	188.76 MHz	33.82 dBμV/m	28.22 dBμV/m	-15.28 dB	Pass	0 Degree	1 m	Vertical
2	263.46 MHz	36.7 dBμV/m	23.58 dBμV/m	-22.42 dB	Pass	240 Degree	1 m	Horizontal
3	339.99 MHz	41.83 dBμV/m	21.61 dBμV/m	-24.39 dB	Pass	330 Degree	1 m	Vertical
4	479.97 MHz	49.06 dBμV/m	39.03 dBμV/m	-6.97 dB	Pass	180 Degree	1 m	Vertical
5	900.39 MHz	77.17 dBμV/m	--	--	Note	300 Degree	2 m	Horizontal
6	911.79 MHz	93.54 dBμV/m	--	--	Note	0 Degree	1 m	Horizontal

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

Diagram 44:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	normal mode, 48 VDC, USB2-Stick		
<b>Test date, time</b>	09.05.2016 11:00:16		
<b>Antenna height</b>	1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2015.1.11, RBW: 1 MHz, VBW: 1 MHz, Sweep time: Auto [0 ms], Step freq: Linear: 5 MHz steps, Attenuator: Auto [10 dB], Internal preamp: 20 dB, Measure time: 20 ms		



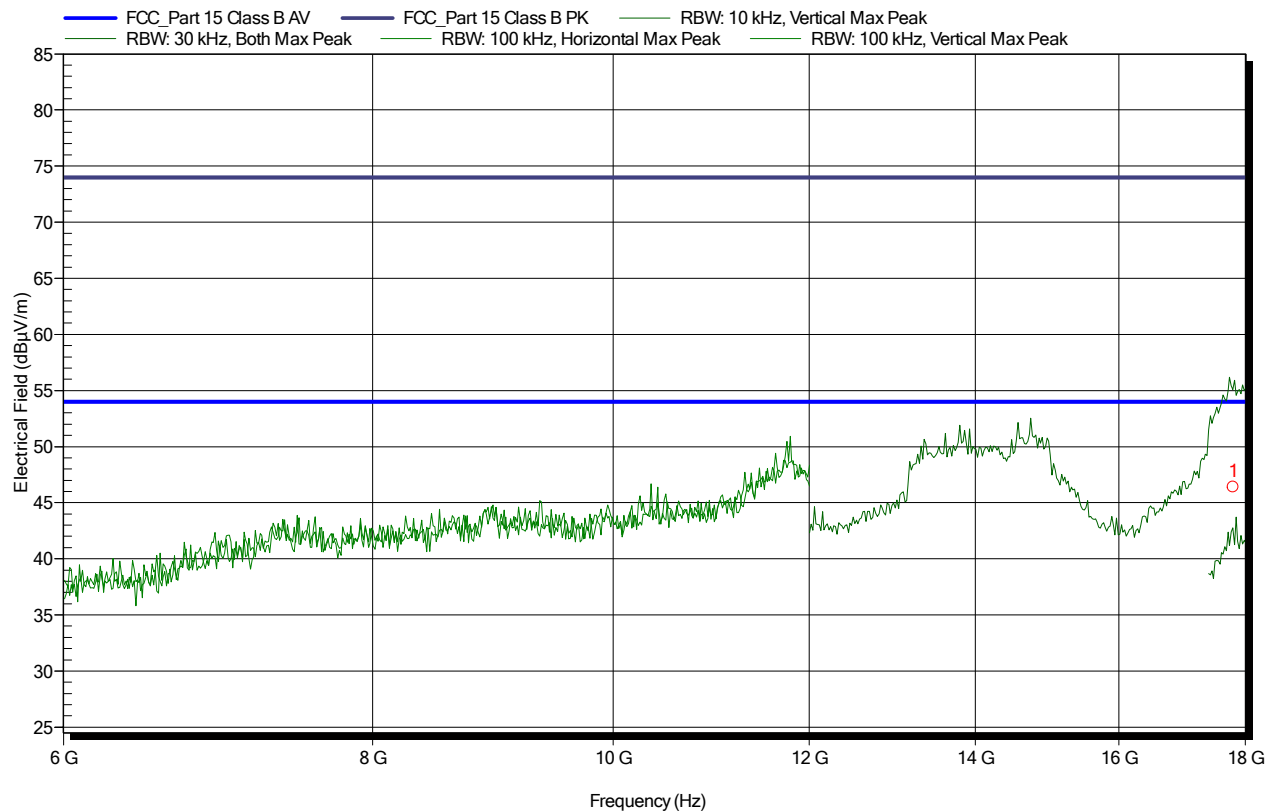
### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	1.22 GHz	45.95 dBμV/m	-28.05 dB	29.16 dBμV/m	-24.84 dB	Pass	300 Degree	1 m	Vertical
2	1.745 GHz	60.73 dBμV/m	-13.27 dB	31.71 dBμV/m	-22.29 dB	Note	180 Degree	1 m	Vertical
3	1.765 GHz	68.37 dBμV/m	-5.63 dB	34.21 dBμV/m	-19.79 dB	Note	60 Degree	1 m	Vertical
4	1.92 GHz	48.72 dBμV/m	-25.28 dB	43.3 dBμV/m	-10.7 dB	Note	270 Degree	1 m	Vertical
5	5.175 GHz	75.65 dBμV/m	1.65 dB	43.26 dBμV/m	-10.74 dB	Note	210 Degree	1 m	Horizontal

Note: Mobile and WLAN frequencies, exclusion band according ETSI EN 301 489-17/-24 applies

Diagram 45:

<b>EUT</b>	EUT 1		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	normal mode, 48 VDC, USB2-Stick		
<b>Test date, time</b>	09/05/2016 12:48:03		
<b>Antenna height</b>	1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	Radimation Version: 2014.2.8, RBW: 10 kHz, VBW: 30 kHz, Sweep time: Auto [16 s], Step freq: Fixed step count: 601 steps per Band, Attenuator: 0 dB, Internal preamp: 0 dB, Measure time: Auto [120 ms]		

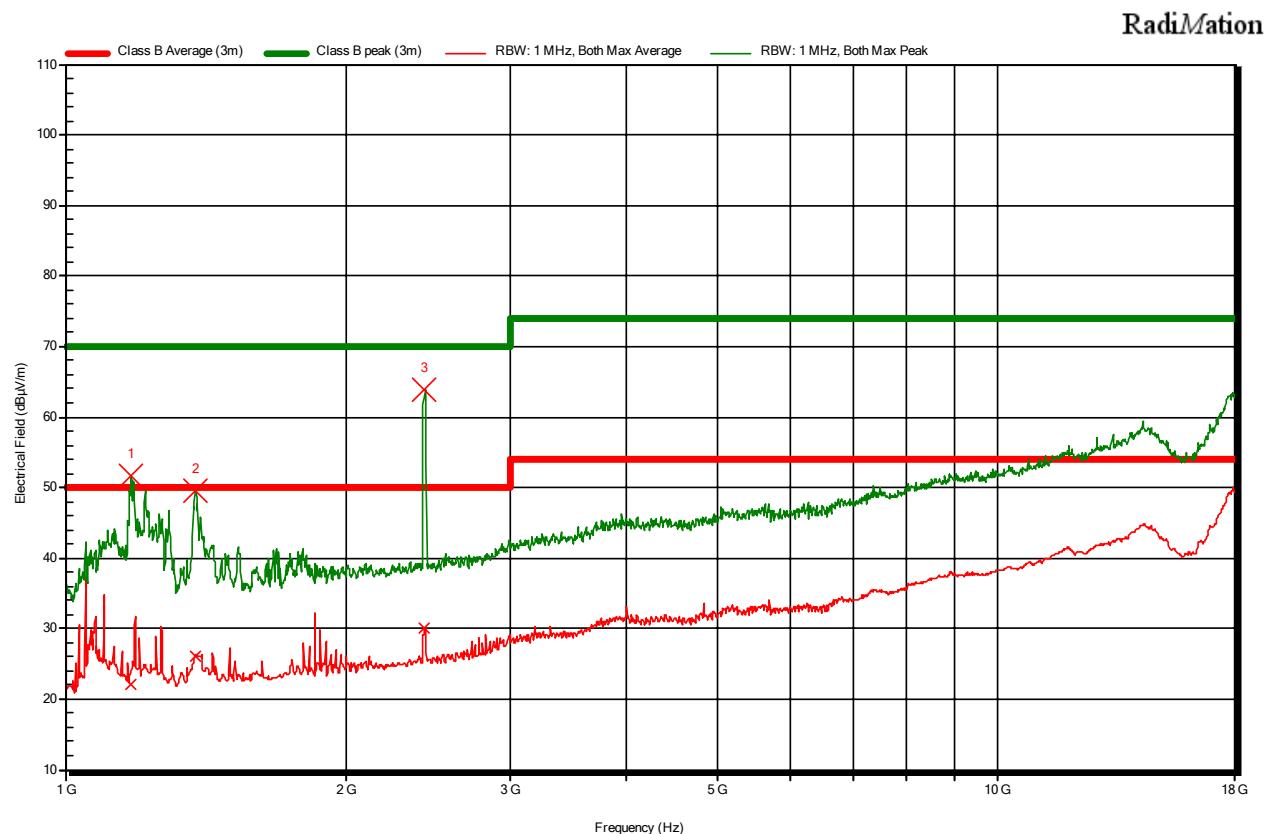


### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Status	Angle	Height	Polarization
1	17.789 GHz	46.4 dBμV/m	-27.6 dB	Pass	180 Degree	1 m	Vertical

Diagram 46:

<b>EUT</b>	EUT 3		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	19.10.2018 12:53:35		
<b>Antenna height</b>	1 m - 1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	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: 20 ms		



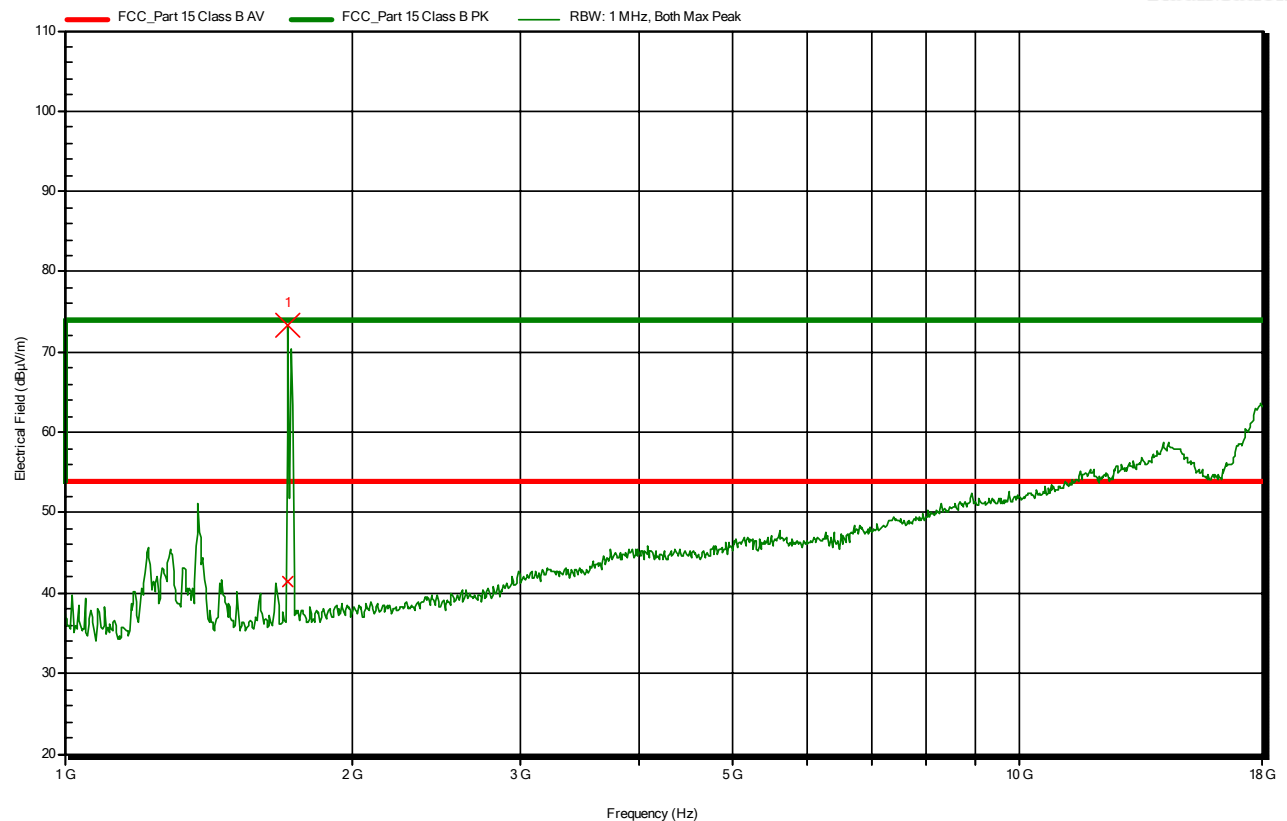
### Detected peaks

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Polarization
1	1.176 GHz	51.6 dB $\mu$ V/m	-18.4 dB	22.1 dB $\mu$ V/m	-27.9 dB	Pass	330 Degree	Horizontal
2	1.377 GHz	49.5 dB $\mu$ V/m	-20.5 dB	26 dB $\mu$ V/m	-24.0 dB	Pass	240 Degree	Vertical
3	2.431 GHz	63.8 dB $\mu$ V/m	-6.2 dB	30.1 dB $\mu$ V/m	-19.9 dB	Pass	165 Degree	Horizontal

Diagram 47:

<b>EUT</b>	EUT 4		
<b>Verdict, Test</b>	Pass, Class B		
<b>Mode of operation</b>	see chapter 9.5, 12 VDC		
<b>Test date, time</b>	31.10.2018 10:51:23		
<b>Antenna height</b>	1 m - 1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 360 Degree	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	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: 20 ms		

RadiMation

**Detected peaks**

Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	1.714 GHz	73.4 dBμV/m	-0.6 dB	41.4 dBμV/m	-12.6 dB	Pass	120 Degree	1 m	Horizontal

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

## 11. Immunity Tests

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

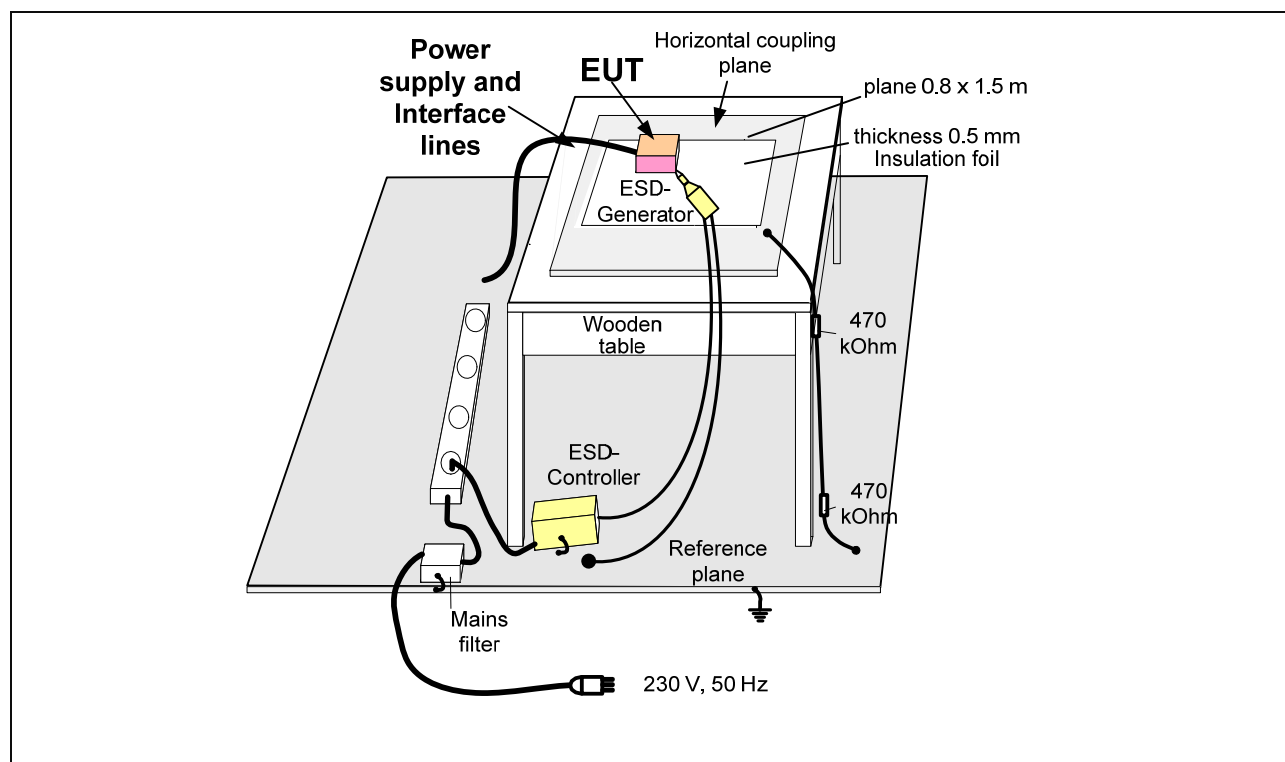
**Introduction:** The aim of this test is to determine the reaction of the material to electrostatic discharges (ESD) produced for example by walking on a carpet made of synthetic fiber. The humidity of the air has an influence on the discharge time and therefore on the severity of the discharge that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



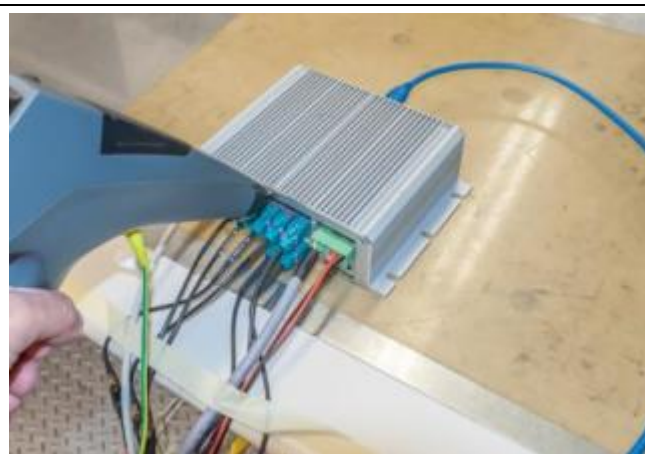
#### Test Equipment

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



**Photos of the Setup****Photos of the Test – EUT 1**

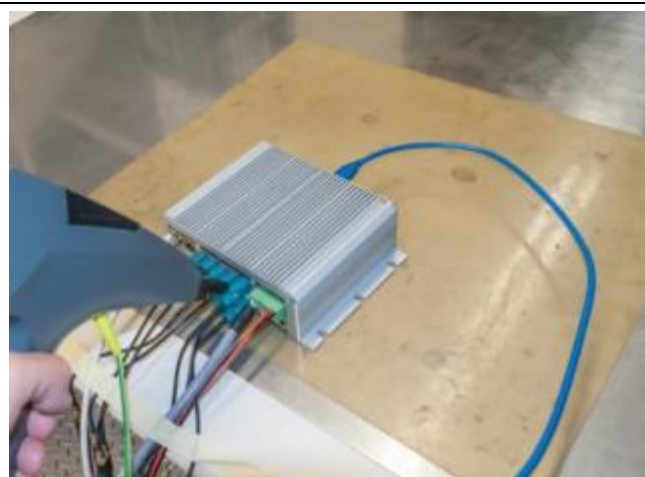
Horizontal Coupling Plane



Direct Coupling to enclosure

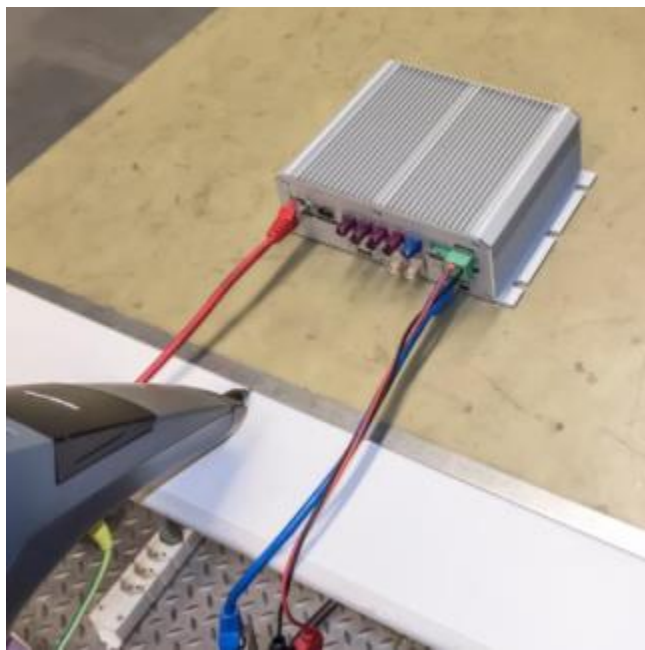


Air Discharge on LED's

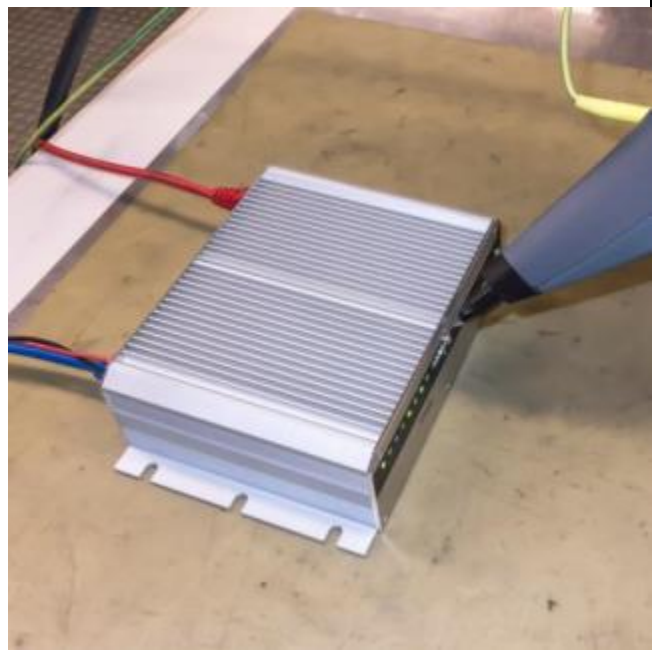


Air Discharge on connectors

## Photos of the Test – EUT 2



Horizontal Coupling Plane



Direct Coupling to enclosure



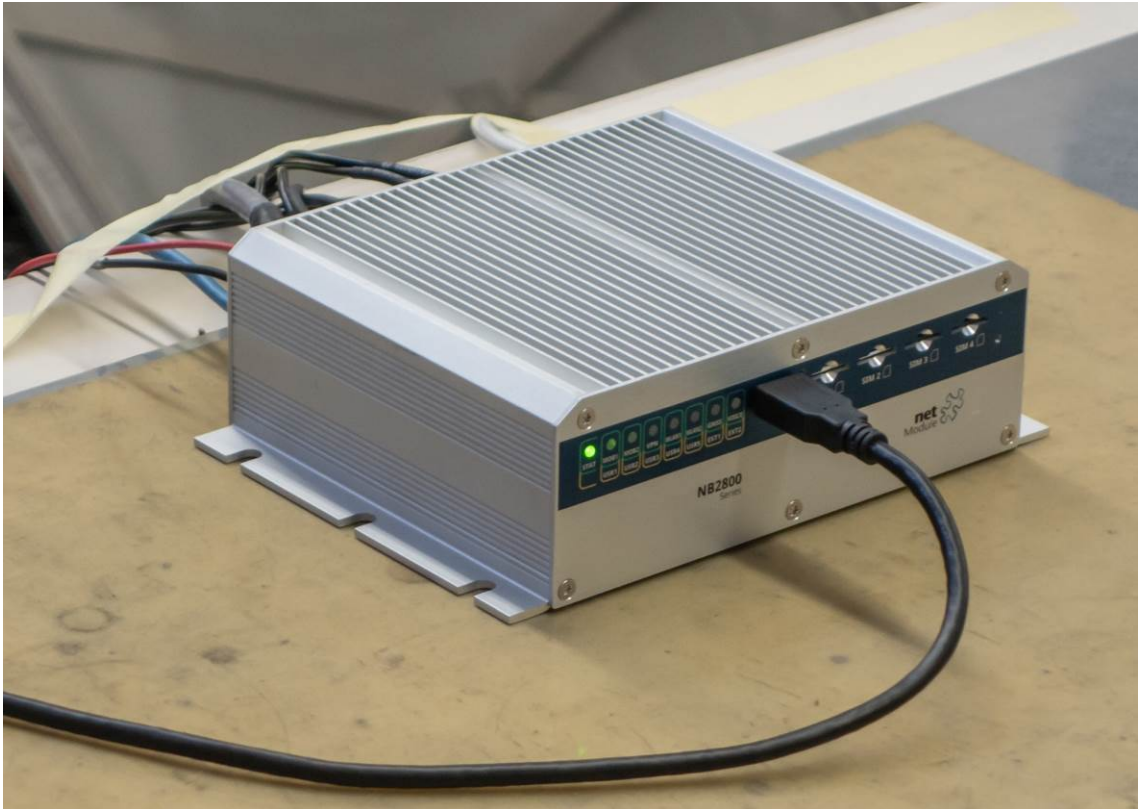
Air Discharge on connectors



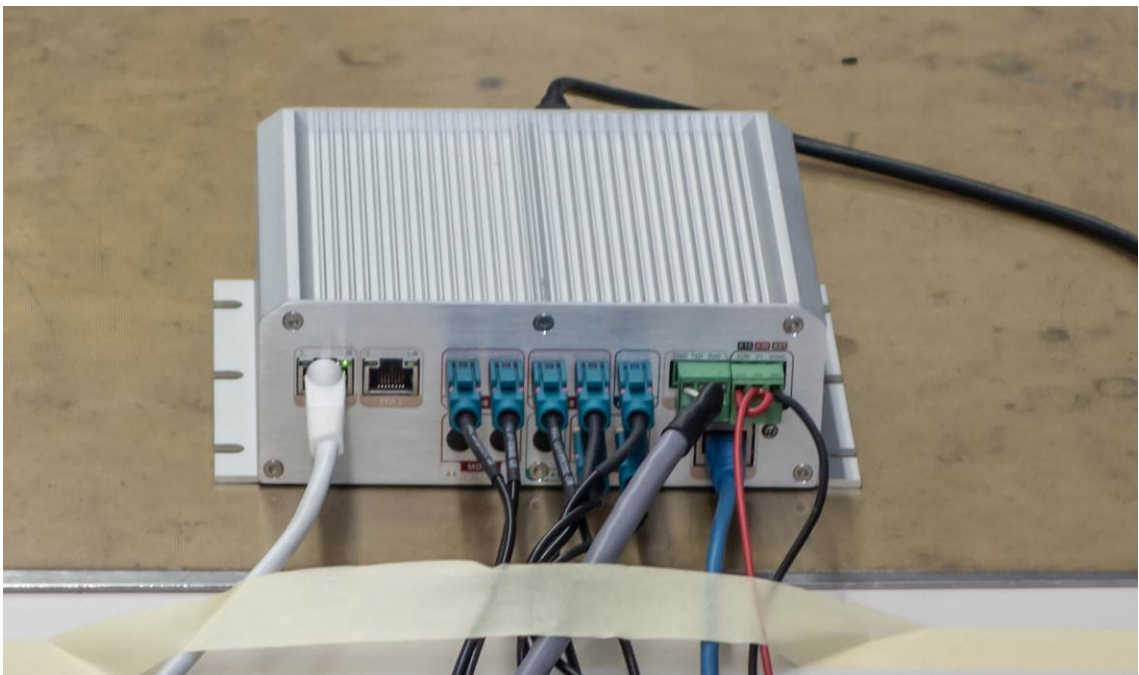
Air Discharge on CAN connector



### Photos of the Test – EUT 3



*Front*



*Rear*

**Test Results**

*Equipment:* EUT 1, EUT 2, EUT 3, EUT 4  
*Cables connected:* All, see chapter 9.4  
*Operating mode:* Active, 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	±8 kV	±6 kV	10	B
EN 61000-6-2	±8 kV	±4 kV	10	B
EN 55024	±8 kV	±4 kV	25	B
EN 55035	±8 kV	±4 kV	10	B
EN 301 489-1	±8 kV	±4 kV	10	B

**Protocol of the Test - EUT 1**

Indirect Discharges:

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

Direct Discharges:

Level [kV]	No of discharges (for each level)	Discharge	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
± 6	10	Contact	No errors occurred	A	Pass
± 2; ± 4; ± 8	10	Air	No errors occurred	A	Pass
Tested points: Contact: Metallic parts, Screws, Connectors (Ethernet) Air: LED's, SIM-Slots, Cables (DC-Port, USB)					

**Protocol of the Test - EUT 2**

Indirect Discharges:

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

Direct Discharges:

Level [kV]	No of discharges (for each level)	Discharge	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
± 6	10	Contact	No errors occurred	A	Pass
± 2; ± 4; ± 8	10	Air	No errors occurred	A	Pass
Tested points: Contact: Metallic parts, Screws, Connectors (Ethernet, CAN, Antenna) Air: LED's, SIM-Slots, Cables (DC-Port, USB)					

**Protocol of the Test - EUT 3**

Indirect Discharges:

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

Direct Discharges:

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

Tested points:

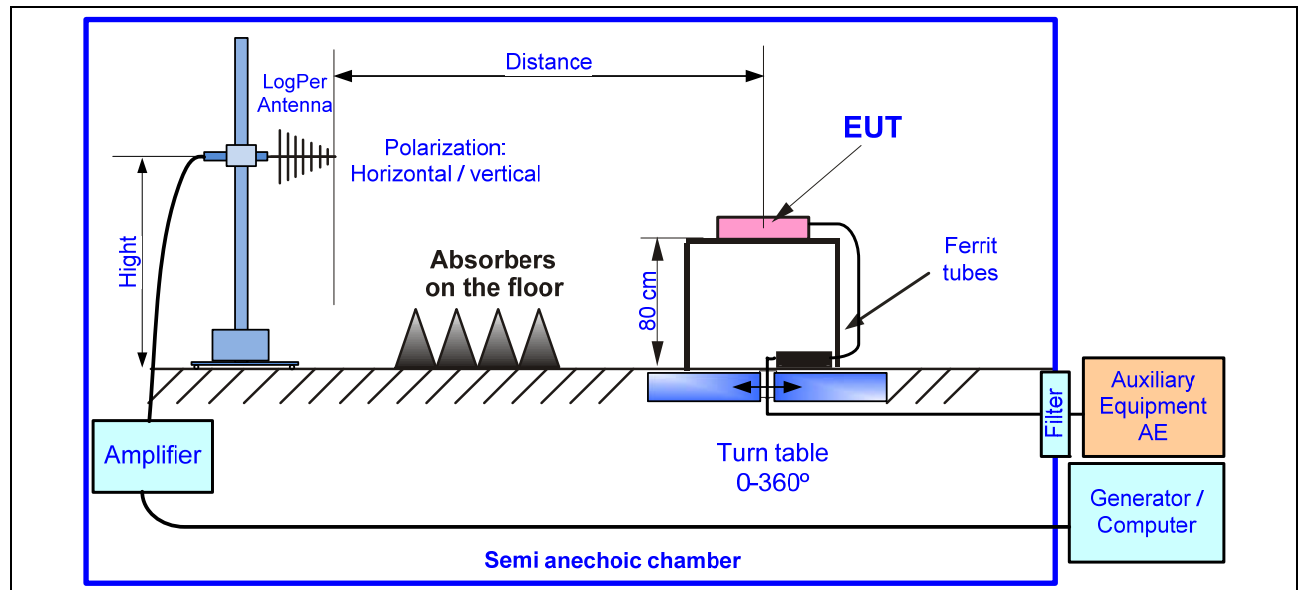
Contact: Metallic parts, Screws, Connectors (Ethernet, CAN, Antenna)

Air: LED's, SIM-Slots, Cables (DC-Port, USB)

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

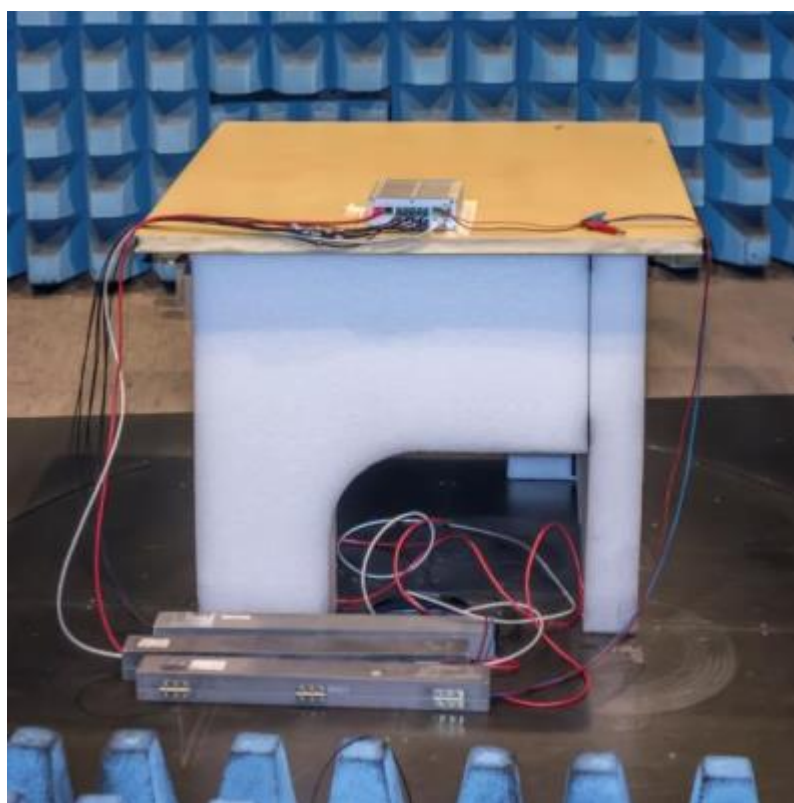
- Introduction:** The aim of this test is to evaluate the performance of the equipment when in the presence of electromagnetic fields created by the transmission of radio or television, by cellular phones or by any other system producing electromagnetic radiation in continuous waves
- Meas. uncertainty:**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



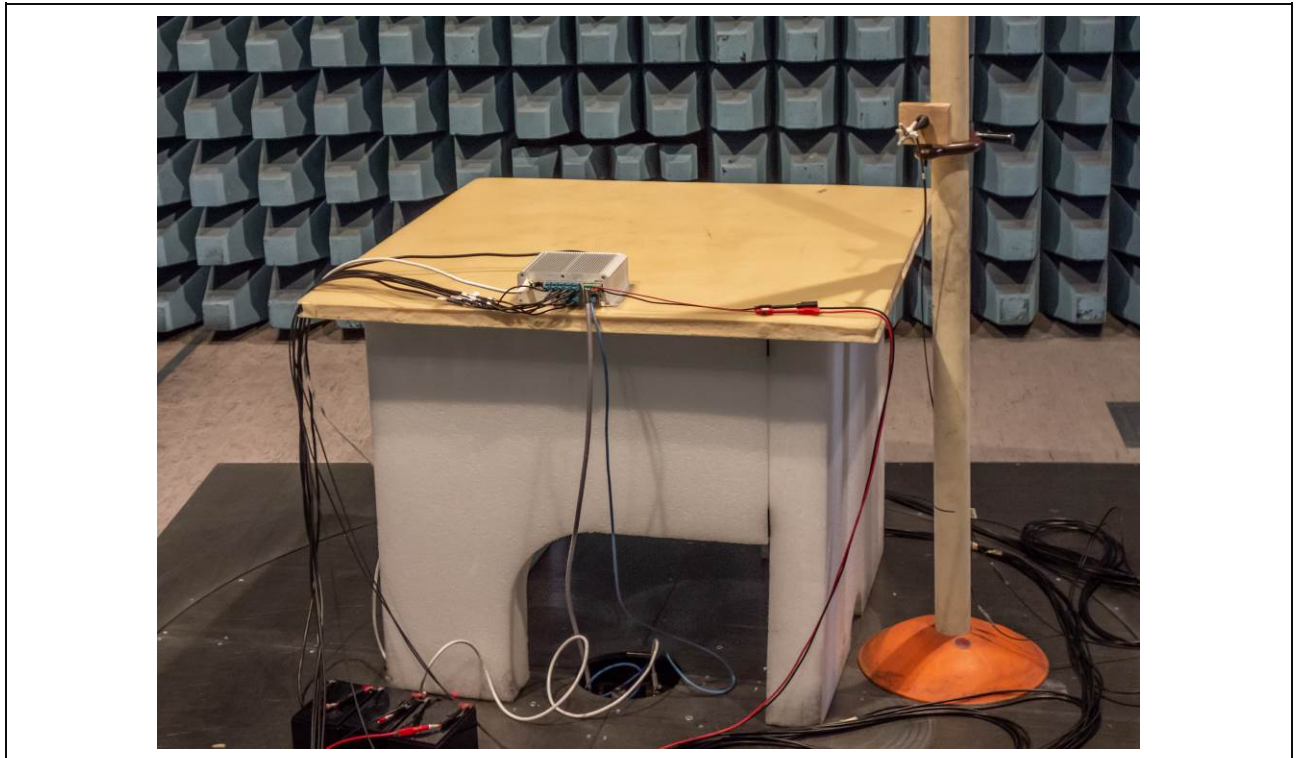
### Test Equipment

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 – EUT 1****Photos of the Setup – EUT 2**



**Photos of the Setup – EUT 3 and EUT 4**



**Photos of the Setup – EUT 3 and EUT 5**



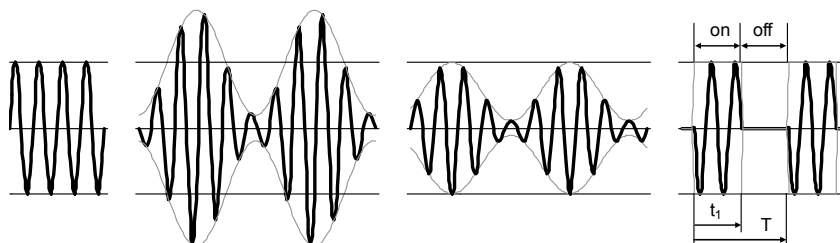
**Test Results**

**Equipment:** EUT 1, EUT 2, EUT 3, EUT 4, EUT 5  
**Cables connected:** All, see chapter 9.4  
**Operating mode:** Active, 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
EN 55024	80 – 1000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
EN 55035	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 61000-6-2	80 – 1000 MHz	10 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1400 – 2000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %		A
	2000 – 2700 MHz	1 V/m	AM, 1 kHz, 80 %	1 %		A
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

Exclusion band according to ETSI EN 301 489-17 ETSI EN 301 489-7 and ETSI EN 301 489-24

**Protocol of the Test – EUT 1**

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

**Protocol of the Test – EUT 2**

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
1000 - 6000	10	horizontal	Front, 0°	No errors occurred	A	Pass
	10	vertical	Front, 0°	No errors occurred	A	Pass

**Protocol of the Test – EUT 3**

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, 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, 270°	No errors occurred	A	Pass
	10	vertical	Side, 270°	No errors occurred	A	Pass

**Protocol of the Test – EUT 4**

Frequency [MHz]	E [V/m]	Polarization	Direction	Result, Observation Behavior of EUT	Fulfilled criterion	Verdict
80 - 1000	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
1000 - 6000	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

**Protocol of the Test – EUT 5**

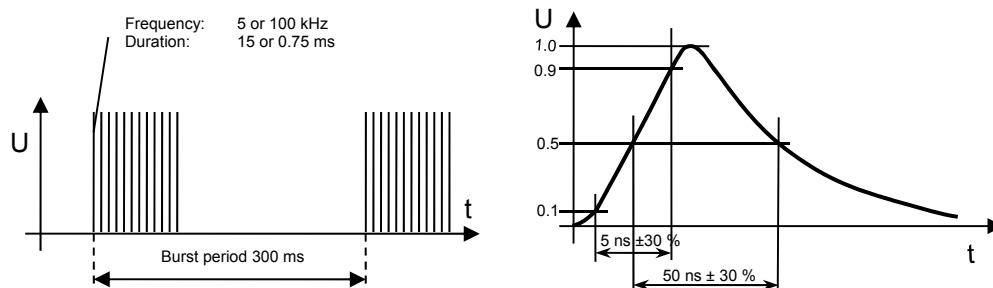
Frequency [MHz]	E [V/m]	Polarization	Direction	Result, Observation Behavior of EUT	Fulfilled criterion	Verdict
80 - 1000	20	horizontal	Side, 90°	No errors occurred	A	Pass
	20	vertical	Side, 90°	No errors occurred	A	Pass
	20	horizontal	Back, 180°	No errors occurred	A	Pass
	20	vertical	Back, 180°	No errors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

### 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  $\Omega$ -Load

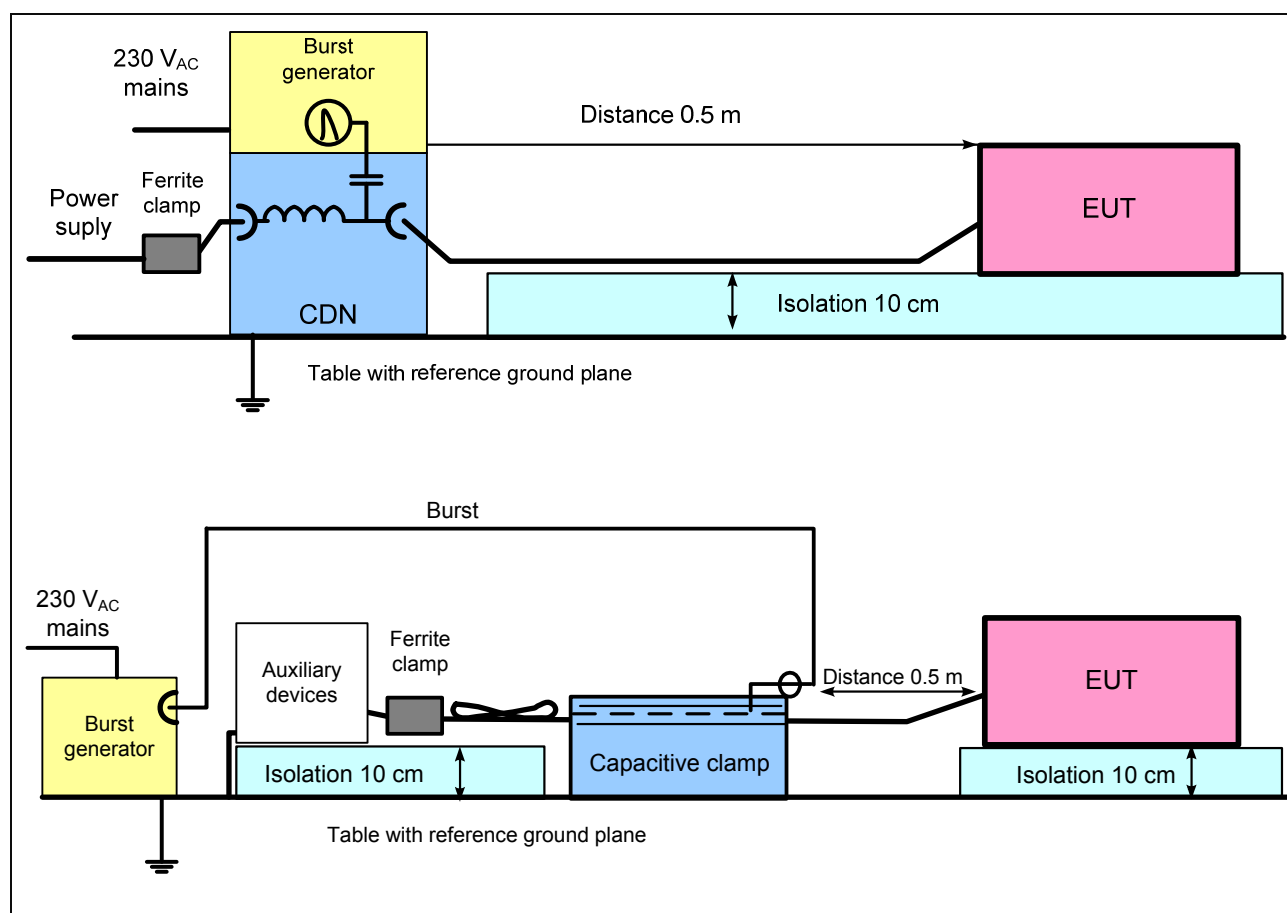
#### Meas. uncertainty:

see chapter 12

#### Test method:

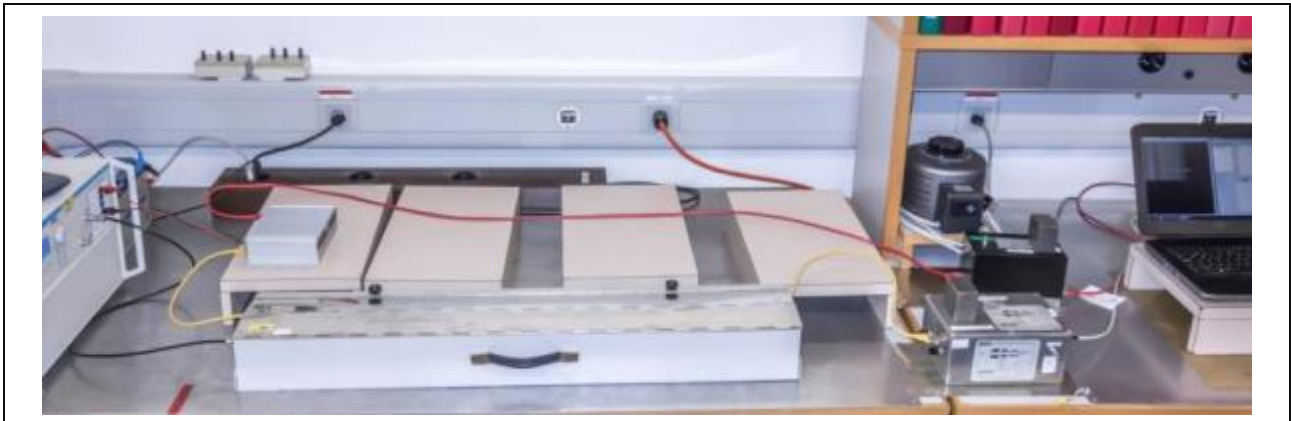
The transient coupling is carried out using a coupling network for the supply cables and a capacitive coupling clamp for the other cables. The two voltage polarities and all the intermediate levels are tested.

### 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

**Photos of the Setup – EUT 1****Photos of the Setup – EUT 2****Photos of the Setup – EUT 3**

## Test Results

**Equipment:** EUT 1, EUT 2, EUT 3  
**Cables connected:** All, see chapter 9.4  
**Operating mode:** Active, 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	±2.0 kV	.....	±2.0 kV	.....	5 kHz	A
EN 55024	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B
EN 55035	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B
EN 61000-6-2	±2.0 kV	±2.0 kV	±1.0 kV	.....	5 kHz	B
EN 301 489-1	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B

## Protocol of the Test – EUT 1

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
DC-Port	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
RS-232	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
Ethernet 1	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
USB	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
Antennas	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

Note : All antenna cables tested together

## Protocol of the Test – EUT 2

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
CAN	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

## Protocol of the Test – EUT 3

Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
PTT-Port	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

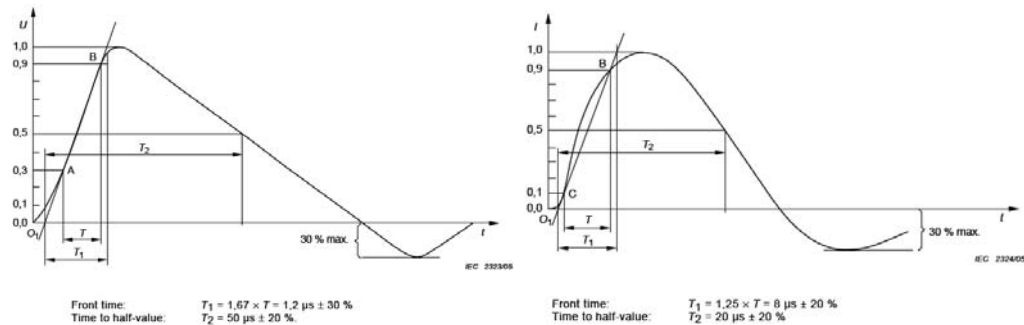


## 11.4 Immunity to Surge (EN 61000-4-5 : 1.2/50 $\mu$ s)

### Introduction:

The aim of the test is to determine the immunity of the material submitted to non-repetitive transient overvoltage created by lightning.

### Impulses:



### Open-circuit voltage

see chapter 12

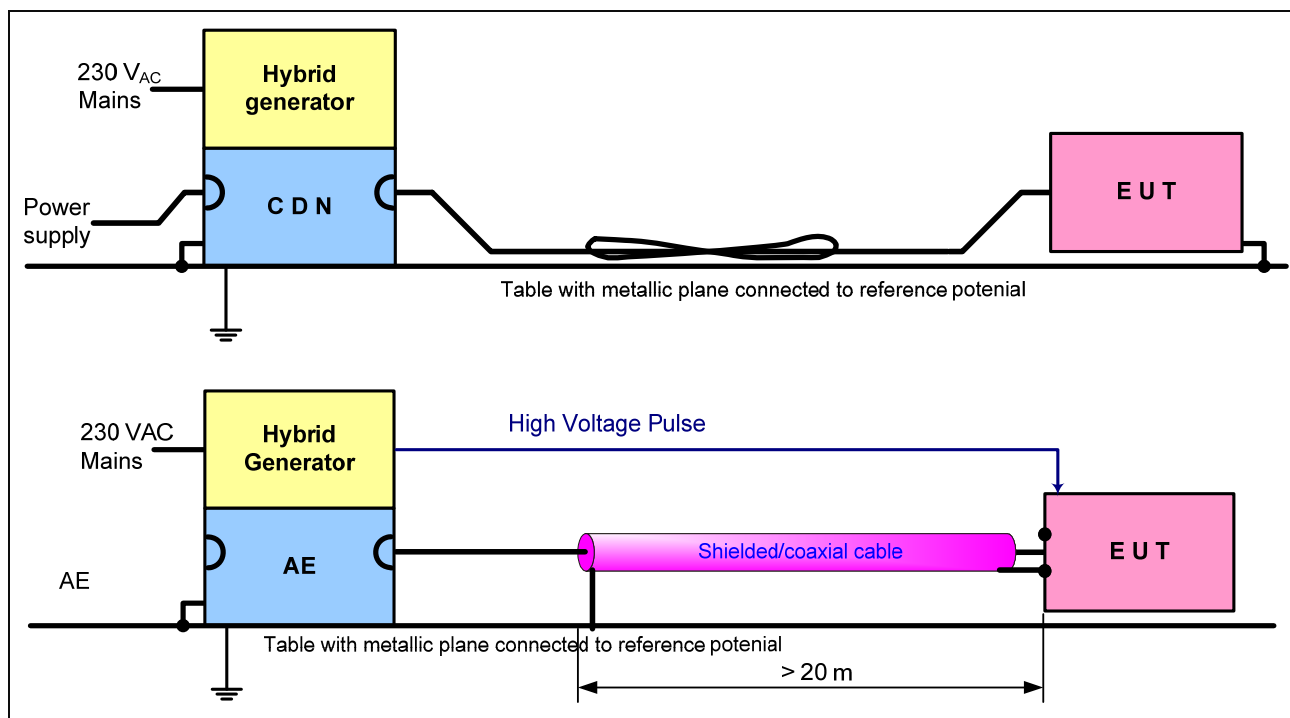
### Short-circuit current

### Meas. uncertainty:

### Measuring method:

The impulses are coupled using the coupling network where the supply lines and unshielded cables are concerned. The shielded cables are coupled directly. The two polarities and different phase angles are tested for all the test levels up until the specified level.

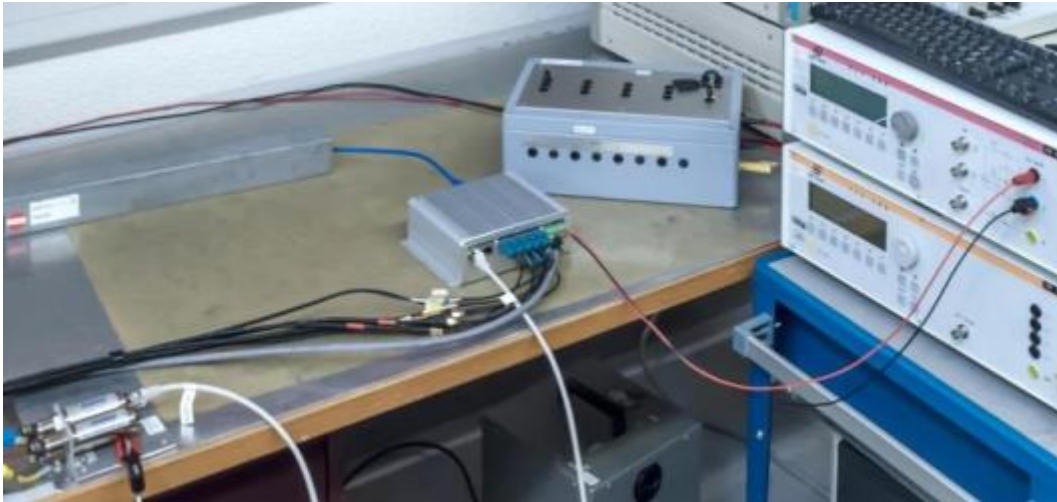
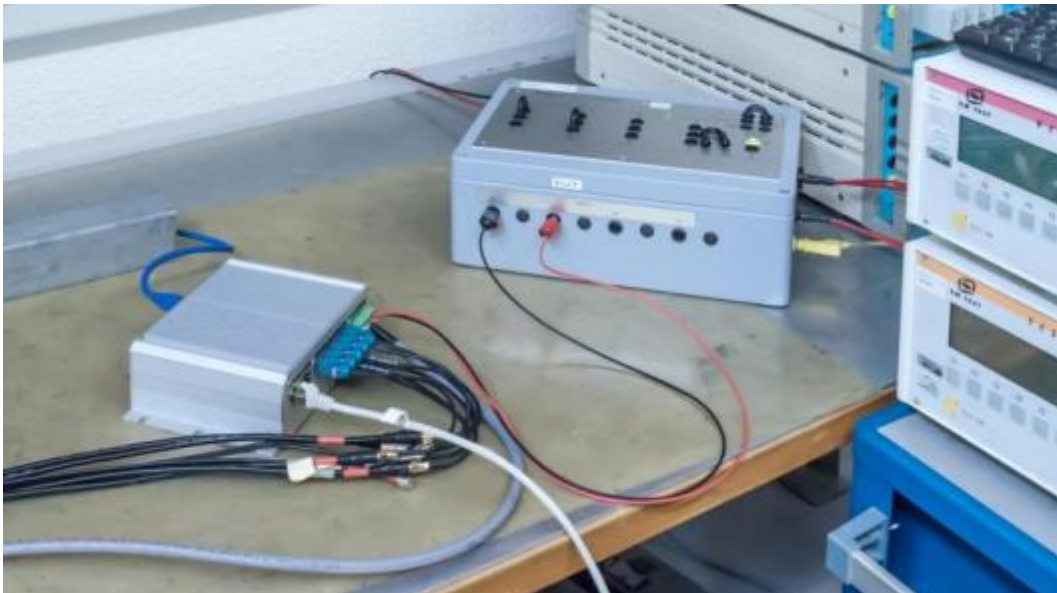
## Test Setup



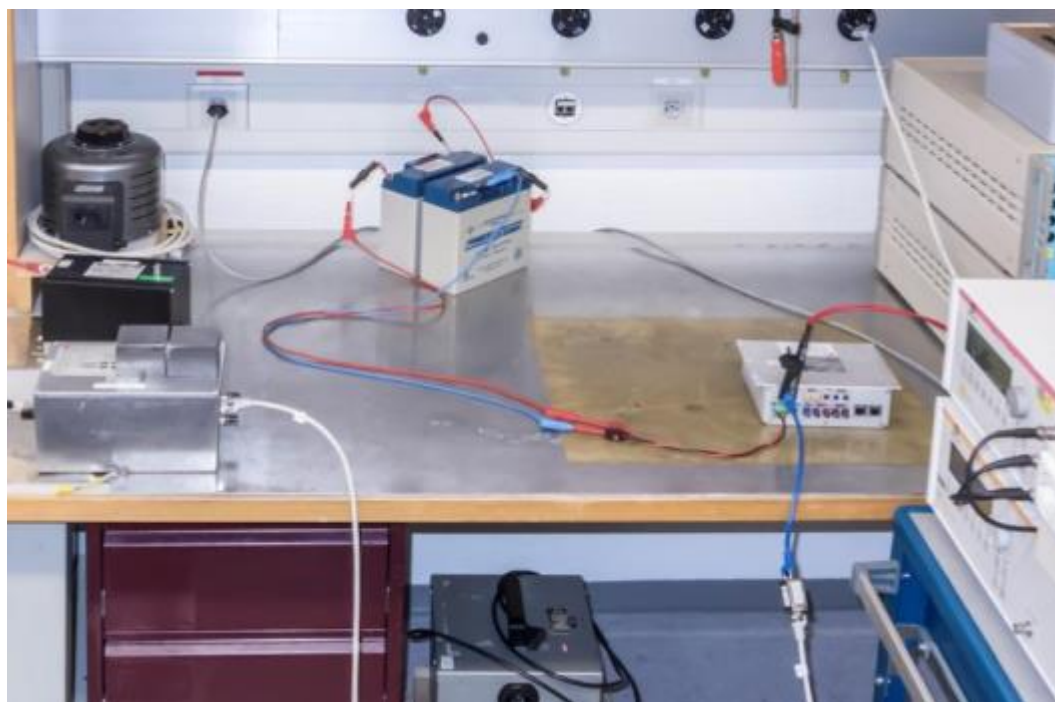
## Test Equipment

Device Type	Brand	Type	ID
Surge Generator	EM Test	VCS 500	PE 7239
Coupling/Decoupling Network	EM Test	CNV 504N	15.6632.13



**Photos of the Setup – EUT 1***Coupling to DC-Port with 2/12  $\Omega$* *Coupling to DC-Port with 42  $\Omega$* *Coupling to Shield (Ethernet)*

## Photos of the Setup – EUT2



*Coupling to Shield (CAN)*

**Test Results**

**Equipment:** EUT 1, EUT 2  
**Cables connected:** All, see chapter 9.4  
**Operating mode:** Active, see chapter 9.5  
**Observation of EUT:** see chapter 9.6  
**Modifications:** Modifications needed, see chapter 13  
**Test site:** laboratory

**Requirements**

Standard	Required Level AC-Supply		Required Level DC-Supply		Required Level Signal		Performance Criterion
	L – N 2 Ω+18 μF	L, N – PE 12 Ω+9 μF	L1 – L2 2 Ω+18 μF	L1, L2 – PE 12 Ω+9 μF	L1 – L2 42 Ω+0.5 μF	L1, L2 – PE 42 Ω+0.5 μF	
EN 61000-6-2	±1.0 kV	±2.0 kV	±0.5 kV	±0.5 kV	---	±1.0 kV	B
EN 55024	±1.0 kV	±2.0 kV	±0.5 kV	--	±0.5 kV	±1.0 kV	B
EN 55035	±1.0 kV	±2.0 kV	---	±0.5 kV	--	±1.0 kV	B
EN 301 489-1	±1.0 kV	±2.0 kV	---	---	---	Note 1	B

Standard	Required Level Battery referenced ports, auxiliary AC power input ports		Required Level Signal and communication, process measurement and control ports		Performance Criterion
	L1 – L2 42 Ω+0.5 μF	L1, L2 – PE 42 Ω+0.5 μF	L1 – L2 42 Ω+0.5 μF	L1, L2 – PE 42 Ω+0.5 μF	
EN 50121-3-2	±1.0 kV	±2.0 kV	--	--	B

**Protocol of the Test – EUT 1**

Tests on DC Power Ports according EN 61000-6-2 + 55024:

Tested port	Level [kV]	Coupling mode	Coupling network	Number of pulses	Remarks	Fulfilled criterion	Verdict
DC-Port @ 24 VDC	±0.5	L1(+)- L2(-)	2 Ω + 18 μF	5 (Note 1)	No errors observed	A	Pass
	±0.5	L1(+)- PE L2(-)- PE	12 Ω + 9 μF	5 (Note 1)	No errors observed	A	Pass
DC-Port @ 48 VDC	±0.5	L1(+)- L2(-)	2 Ω + 18 μF	5 (Note 1)	No errors observed	A	Pass
	±0.5	L1(+)- PE L2(-)- PE	12 Ω + 9 μF	5 (Note 1)	No errors observed	A	Pass

Tests on DC Power Ports according EN 50121-3-2:

Tested port	Level [kV]	Coupling mode	Coupling network	Number of pulses	Remarks	Fulfilled criterion	Verdict
DC-Port @ 48 VDC	±1.0	L1(+)- L2(-)	42 Ω + 0.5 μF	5 (Note 1)	No errors observed	A	Pass
	±1.0; ±2.0	L1(+)- PE L2(-)- PE	42 Ω + 0.5 μF	5 (Note 1)	No errors observed	A	Pass

Test on LAN ports with shielded cable:

Tested port	Level [kV]	Coupling mode	Coupling network	Number of pulses	Remarks	Fulfilled Criterion	Verdict
Ethernet 1	±0.5; ±1.0	Screen – PE	2 Ω	5 (Note 1)	No errors observed	A	Pass

Notes:

- 1) Number of pulses for each voltage level and each polarity
- 2) 24 V Supplied via lead-acid accumulator (PS-12170 B, 12 V, 17 Ah)

**Protocol of the Test – EUT 2**

Test on CAN port with shielded cable:

Tested port	Level [kV]	Coupling mode	Coupling network	Number of pulses	Remarks	Fulfilled Criterion	Verdict
CAN	±0.5; ±1.0	Screen – PE	2 Ω	5	No errors observed	A	Pass

## 11.5 Immunity to Conducted Disturbances Induced by RF Fields (EN 61000-4-6)

### Introduction:

The object of this test is to determine the immunity of equipment when subjected to conducted disturbances coming from intended radiofrequency transmitters. These disturbances can be found as common mode currents on the conductors and the screens of the cables.

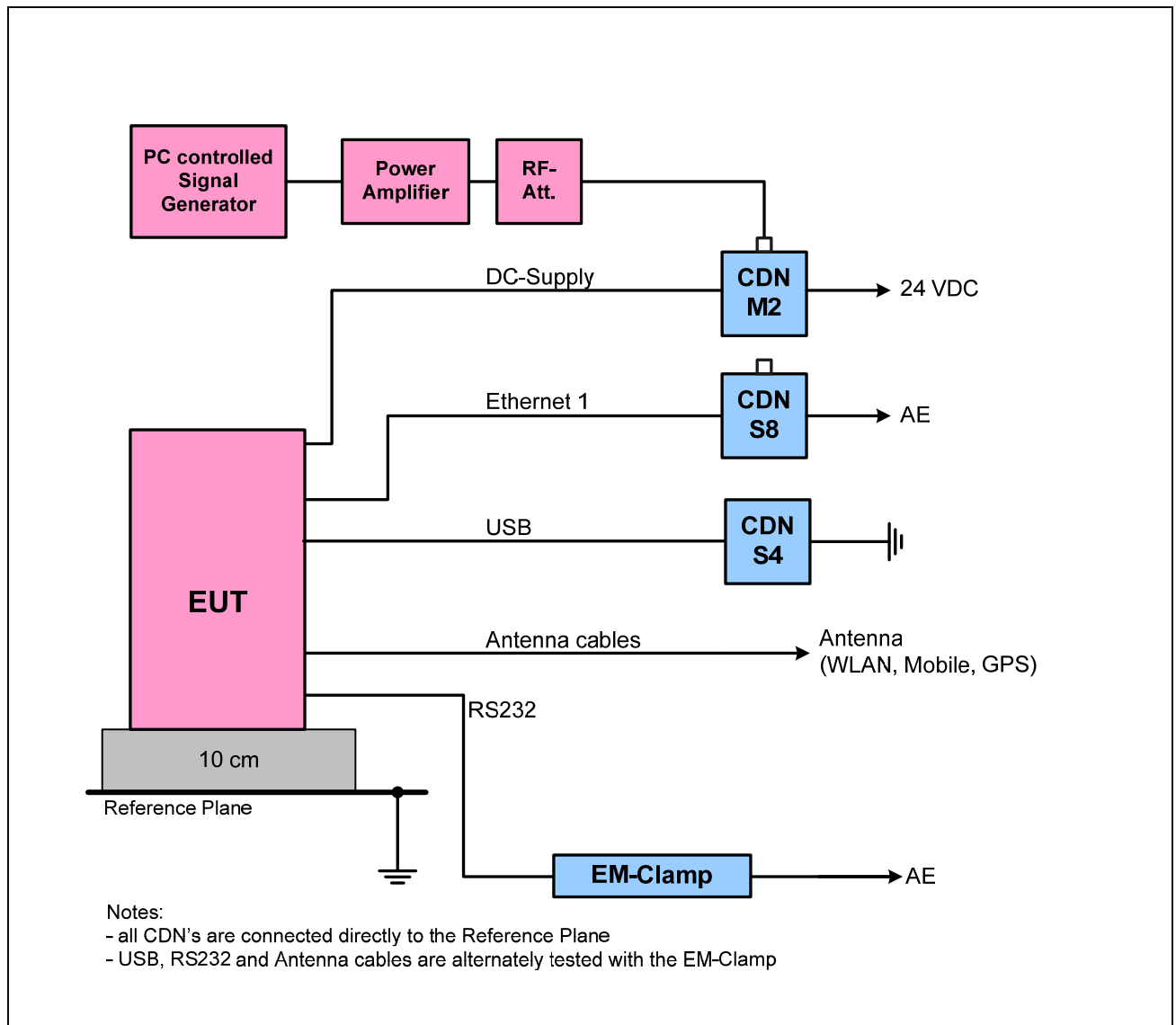
### Meas. uncertainty:

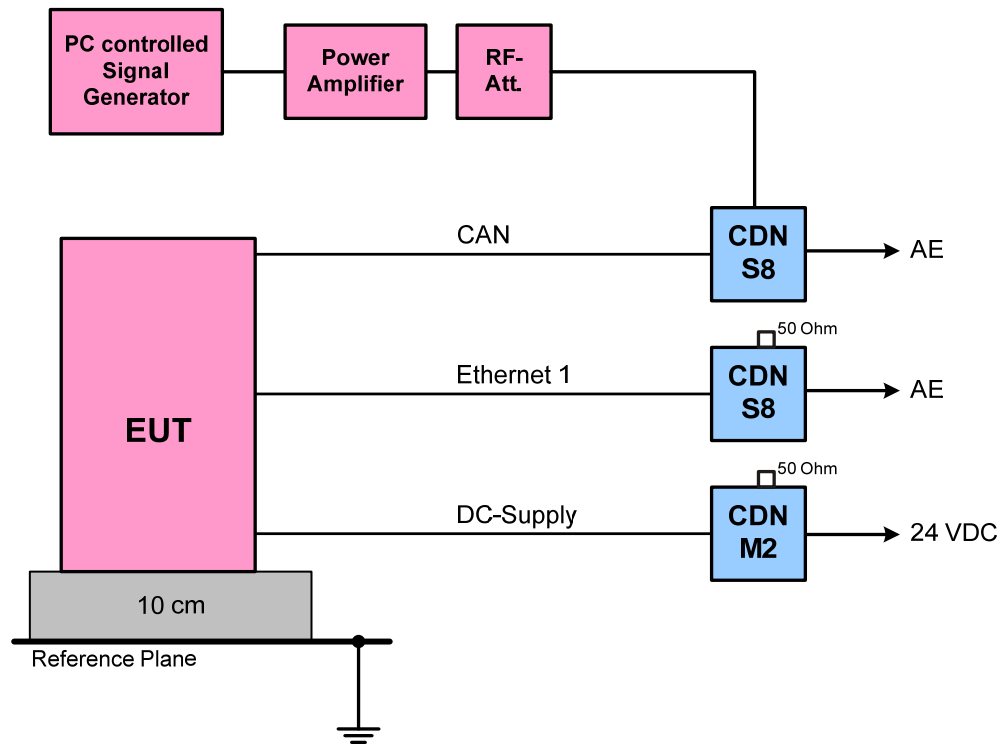
see chapter 12

### Measuring method:

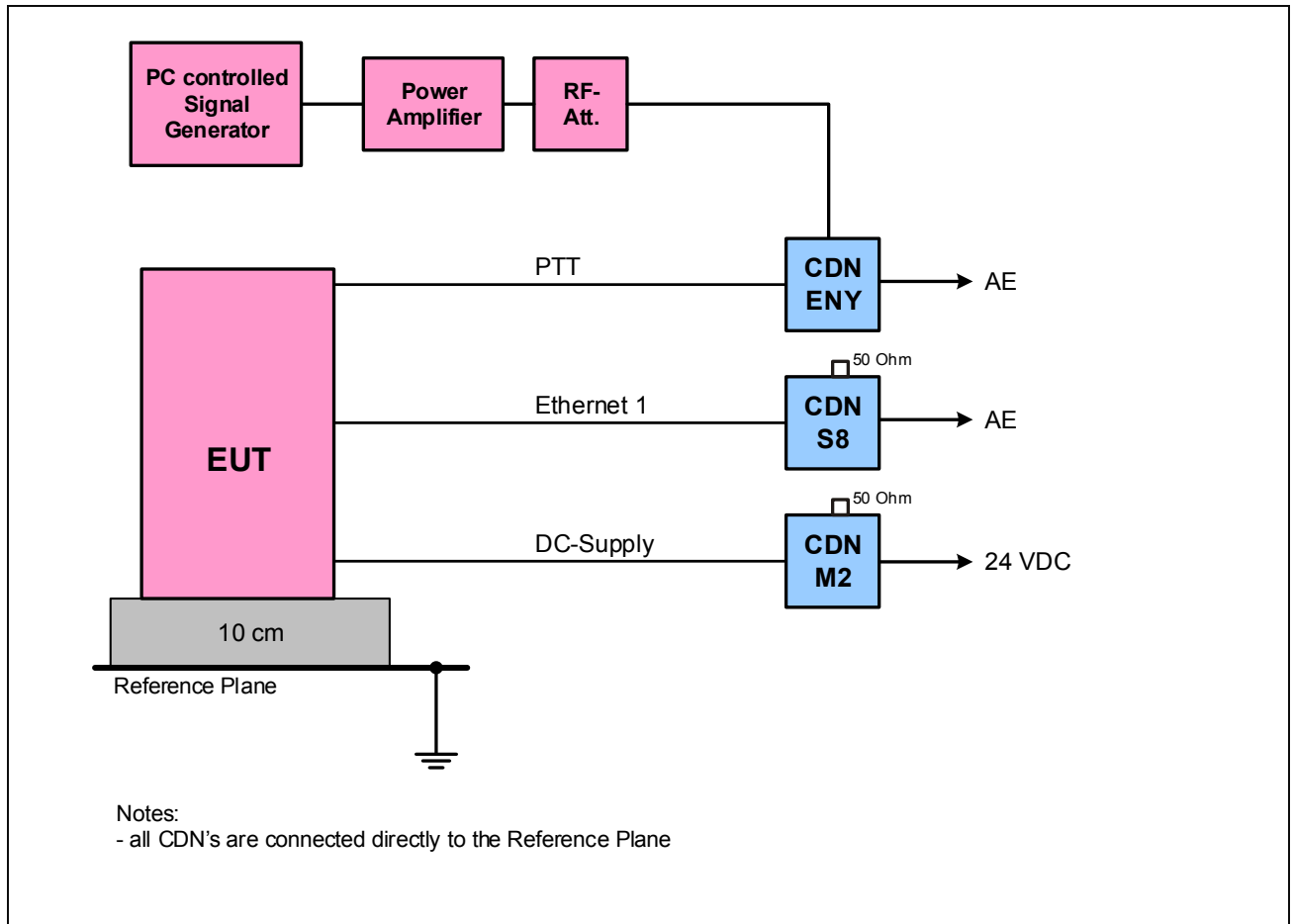
The HF voltage is injected on the cables using different coupling/decoupling networks. All connected cables shall be provided with the appropriate coupling and decoupling devices. The voltage is calibrated without the equipment under test. The Dwell time is depending on the reaction time of the tested equipment.

### Test Setup EUT 1



**Test Setup EUT 2****Notes:**

- all CDN's are connected directly to the Reference Plane

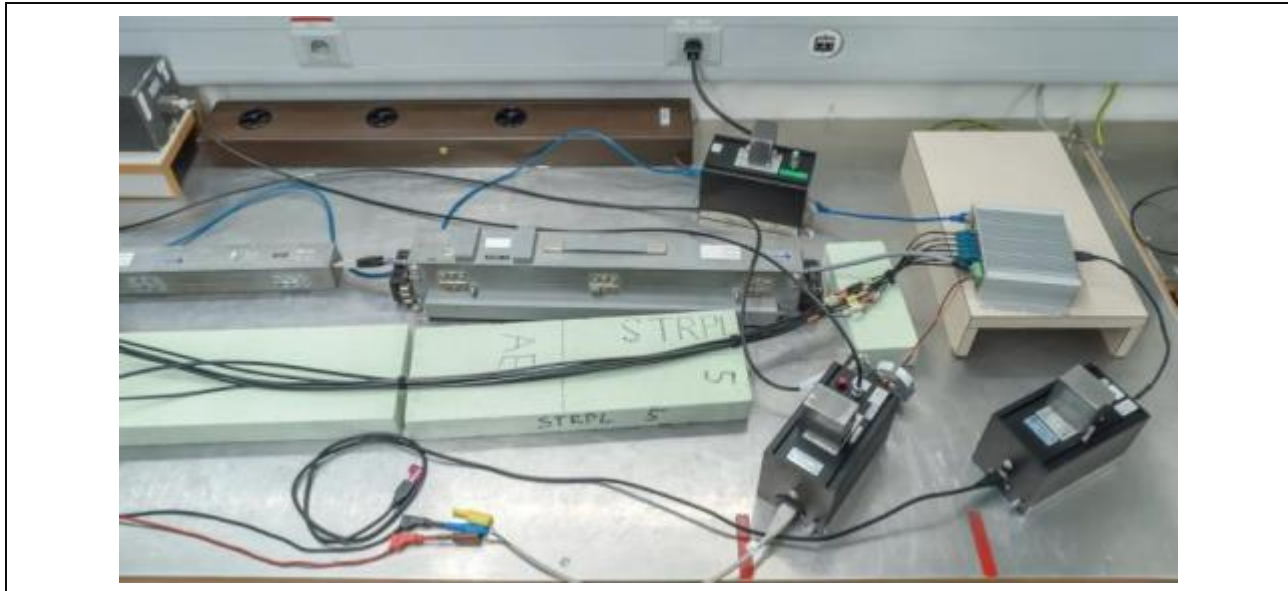
**Test Setup EUT 4**



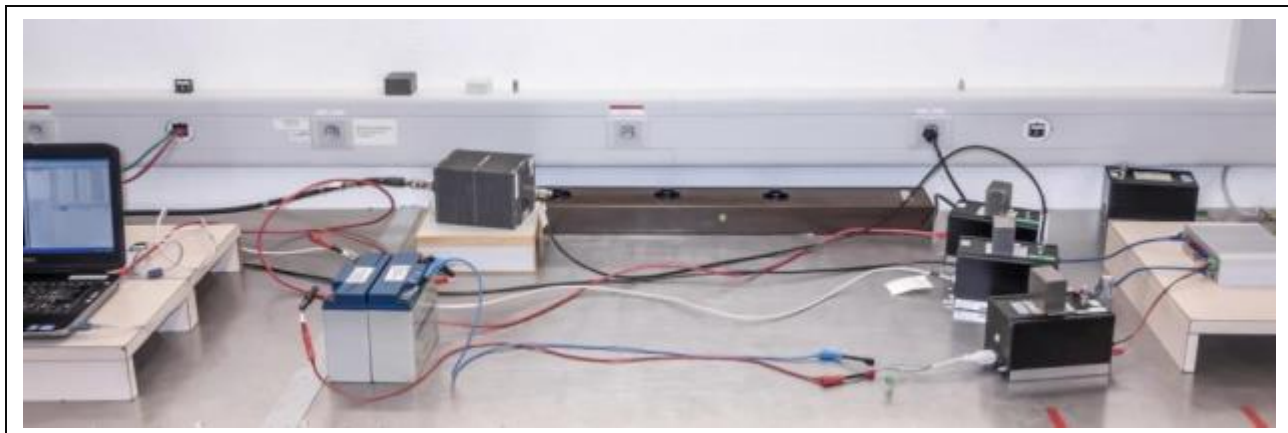
## Test Equipment

Device Type	Brand	Type	ID
Signal Generator	Marconi	2024	GF7839
Amplifier	Amplifier Research	150A250	V10108
Current sensor	Fischer	F-55	H10123
Sensor power meter	Gigatronik	8541	IV9490
Sensor power meter	RadiPower	RPR2006C	18.6632.09
Injection device	EM-Test	CDN M2/3	H10166
Injection device	EM-Test	CDN S4 (USB)	H10173
Injection device	Lüthi	CDS S8 (RJ45)	13.6632.07 13.6632.08
Injection device	Rohde & Schwarz	ENY81-CA6	16.6632.02
Injection device	EM-Test	EM 100 FTC101	H4844 H6979

## Photos of the Setup – EUT 1

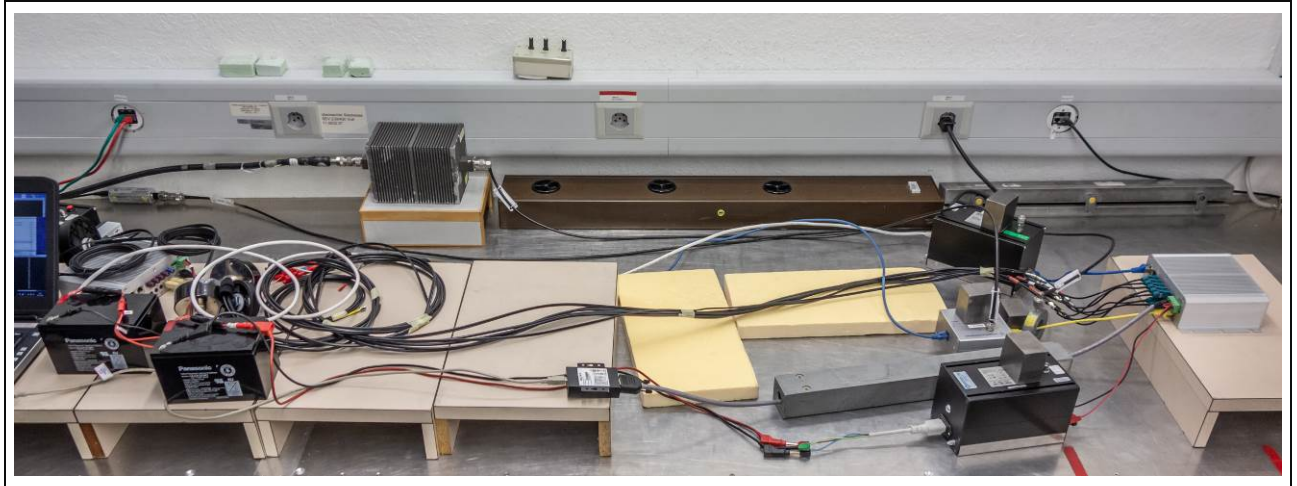


## Photos of the Setup – EUT 2





### Photos of the Setup – EUT 4



## Test Results

**Equipment:** EUT 1, EUT 2, EUT 3, EUT 4  
**Cables connected:** All, see chapter 9.4  
**Operating mode:** Active, see chapter 9.5  
**Observation of EUT:** see chapter 9.6  
**Modifications:** none  
**Test site:** laboratory

## Requirements

Standard	Frequency range	Required level	Modulation	Freq. step	Dwell time	Performance crit.
EN 50121-3-2	0.15 – 80 MHz	10 V <sub>EMF</sub>	AM, 1 kHz, 80 %	1 %	1 s	A
EN 55024	0.15 – 80 MHz	3 V <sub>EMF</sub>	AM, 1 kHz, 80%	1 %	1 s	A
EN 55035	0.15 – 10 MHz 10 – 30 MHz 30 – 80 MHz	3 V <sub>EMF</sub> 3 – 1 V <sub>EMF</sub> 1 V <sub>EMF</sub>	AM, 1 kHz, 80 %	1 %	1 s	A
EN 61000-6-2	0.15 – 80 MHz	10 V <sub>EMF</sub>	AM, 1 kHz, 80 %	1 %	1 s	A
EN 301 489-1	0.15 – 80 MHz	3 V <sub>EMF</sub>	AM, 1 kHz, 80 %	1 %	1 s	A

Dwell time:

1 s

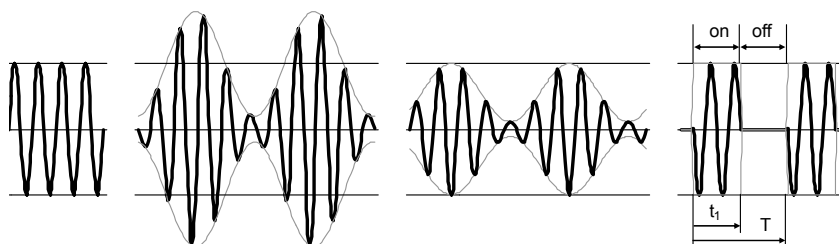
Signal modulation:

☐ CW

☒ AM

☐ AM

☐ PM



**Protocol of the Test – EUT 1**

Coupling	CDN	Terminated(50 $\Omega$ )	Freq. [MHz]	Level [V]	Remarks	Fulfilled criterion	Verdict
DC-Port	M2	Ethernet, S8	0.15 – 80	15	no errors occurred	A	Pass
Ethernet 1	S8	DC-Mains, M2	0.15 – 80	15	no errors occurred	A	Pass
RS-232	EM100	DC-Mains, M2	0.15 – 80	10	no errors occurred	A	Pass
USB	EM100	DC-Mains, M2	0.15 – 80	15	no errors occurred	A	Pass
Antennas	EM100	DC-Mains, M2	0.15 – 80	10	no errors occurred	A	Pass

**Protocol of the Test – EUT 2**

Coupling	CDN	Terminated(50 $\Omega$ )	Freq. [MHz]	Level [V]	Remarks	Fulfilled criterion	Verdict
CAN	S8	DC-Mains, M2	0.15 – 80	15	no errors occurred	A	Pass

**Protocol of the Test – EUT 4**

Coupling	CDN	Terminated(50 $\Omega$ )	Freq. [MHz]	Level [V]	Remarks	Fulfilled criterion	Verdict
PTT Port	ENY81-CA6	DC-Mains, M2	0.15 – 80	10	no errors occurred	A	Pass

## 12. Measurement Uncertainty

Conducted emission	Estimated uncertainty of the measurement results: (normal distribution, k=2)	MAINS/ DC 150 kHz – 30 MHz	± 3.3 dB
	Maximum uncertainty defined by the standard:		± 3.4 dB
	Estimated uncertainty of the measurement results: (normal distribution, k=2)	Current Clamp 150 kHz – 30 MHz	± 2.7 dB
	Maximum uncertainty defined by the standard:		± 2.9 dB
	Estimated uncertainty of the measurement results: (normal distribution, k=2)	Wire Network ports 150 k – 30 MHz	± 4.9 dB
	Maximum uncertainty defined by the standard:		± 5.0 dB
Radiated emission	Estimated uncertainty of the measurement results for 30 – 200 MHz: (normal distribution, k=2)		± 4.5 dB
	Maximum uncertainty defined by the standard for 200 – 1000 MHz:		± 6.3 dB
	Estimated uncertainty of the measurement results for 200 – 1000 MHz:(normal distribution, k=2)		± 2.7 dB
	Maximum uncertainty defined by the standard for 30 – 200 MHz:		± 6.3 dB
	Estimated uncertainty of the measurement results for 1 – 6 GHz:(normal distribution, k=2)		± 5.1 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 <sub>o</sub> : (normal distribution)		± 9.0 %
	Duration of the voltage interruption t <sub>e</sub> : (rectangular distribution)		± 5.0 %
	Phase φ <sub>o</sub> :(rectangular distribution)		± 2.8 %
Voltage fluctuation	Output voltage U <sub>o</sub> : (normal distribution)		± 9 %
	Duration of the voltage fluctuation t <sub>o</sub> : (rectangular distribution)		± 20 %

## 13. Modifications on the EUT

To pass the surge test the following modification had to be made (EUT 1).

Supply Input:

- Changed R1905 from 249k to 300k
- Changed R1901 from 12m to 0R (Bypassed)
- Added 1n Capacitor to GATE Pin of U1900
- Added 56p Capacitor to R1906 (Base of Q1900)

Power Supplies:

- Added 10n Capacitor to UVLO of 5V Converter