

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

Registration number: **STS 0001**

Schweizerischer Prüfstellendienst
Service suisse d'essai
Swiss testing service



Report:	<i>Electromagnetic Compatibility</i>	Report no:	<i>19CH-00862.E01</i>
Test item description:	<i>NetModule Router NB2800</i>	Date of test:	<i>December 9 to 13, 2019</i>
Applicant:	<i>NetModule AG Maulbeerstrasse 10, 3011 Bern, SWITZERLAND</i>	Model/Type reference:	<i>NB2810 2LWacCDf-G</i>
Manufacturer:	<i>NetModule AG</i>	Serial no:	<i>000000088888</i>

		Result
EN 55032:2015 CISPR 32:2015	Electromagnetic compatibility of multimedia equipment - Emission requirements	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 IEC 61000-6-3:2006/AMD1:2010	EMC - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	Pass
EN 50121-3-2:2015 IEC 62236-3-2:2008	Railway applications - EMC - Part 3-2: Rolling stock - Apparatus	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
DRAFT EN 301 489-1 V2.2.0	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1 (b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU	Pass
EN 301 489-7 V1.3.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)	Pass
EN 301 489-17 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems	Pass
EN 301 489-24 V1.5.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) for Mobile and portable (UE) radio and ancillary equipment	Pass
CFR 47 Part 15 - B: 2016	Code of Federal Regulations - Title 47 - Telecommunication, Part 15, Subpart B: "Unintentional Radiators"	Pass ¹

The equipment fulfils the requirements of the above mentioned standard(s) without modification(s).

EUT has been completely tested in 18-EL-0356.E03, issued 2019-04-16. Therefore the radiated immunity tests has only been performed on 2 sides.

Remark 1: FCC has been informatively tested.

Test performed by

Mr. Daniel Rufer
EMC Test-Engineer



Reviewed by

Mr. Urs Isler
EMC Test-Engineer



Zürich, 2020-02-24

(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
1. SUMMARY OF TEST RESULTS (EN 55032/CISPR 32 & EN 55035/CISPR 35).....	4
2. SUMMARY OF TEST RESULTS (EN/IEC 61000-6-2/3).....	5
3. SUMMARY OF TEST RESULTS (EN 50121-3-2 / IEC 62236-3-2).....	6
4. SUMMARY OF TEST RESULTS (EN 301 489-X).....	7
5. SUMMARY OF TEST RESULTS (FCC / CANADA).....	8
6. APPLIED STANDARDS	9
7. APPLICANT.....	10
8. EQUIPMENT UNDER TEST	10
8.1 Identification.....	10
8.2 Product Family.....	11
8.3 Pictures of the EUT	13
8.4 Classification.....	14
8.5 Ports	15
9. TEST CONDITIONS.....	16
9.1 Climatic conditions, location and date	16
9.2 Test facility and methodology	16
9.3 Attendant Persons	16
9.4 Test Configuration	17
9.5 Operating Conditions	17
9.6 Monitoring of the EUT.....	17
9.7 Auxiliary Equipment.....	18
9.8 Performance Criteria	19
10. EMISSION TESTS.....	20
10.1 Interference Voltage (V-LISN).....	20
10.2 Interference Voltage (Wired Network and Antenna Ports).....	28
10.3 Radiated Electromagnetic Field (30 – 1000 MHz).....	32
10.4 Radiated Electromagnetic Field (1 – 6 GHz).....	36
10.5 Radiated Emission – Electromagnetic Field – FCC	38
10.6 Radiated Electromagnetic Field – FCC (1 – 18 GHz)	40
11. IMMUNITY TESTS	42
11.1 Immunity to Electrostatic Discharge (ESD) (EN 61000-4-2)	42
11.2 Immunity to Electromagnetic Fields (EN 61000-4-3).....	45
11.3 Immunity to Fast Electric Transients (EN 61000-4-4)	49
11.4 Immunity to Surge (EN 61000-4-5 : 1.2/50 µs).....	52
11.5 Immunity to Conducted Disturbances Induced by RF Fields (EN 61000-4-6)	55
12. MEASUREMENT UNCERTAINTY	58

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

§	Test Type		Result
10	Emission		EN 55032 CISPR 32
--	Conducted Emission from AC Mains Power Ports	EN 55032 CISPR 32	Not applicable ²
10.1 10.2	Conducted Emission from Wired Network Ports	EN 55032 CISPR 32	PASS
10.2	Conducted Emission from Antenna Ports	EN 55032 CISPR 32	PASS
--	Conducted Emission from Optical Fibre Ports (with metallic shield or tension members)	EN 55032 CISPR 32	Not applicable ¹
10.3 10.4	Radiated electromagnetic field	EN 55032 CISPR 32	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	Not applicable ²
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	Not applicable ²
11	Immunity		EN 55035 CISPR 35
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
11.4	Surges	EN 61000-4-5 IEC 61000-4-5	PASS
11.5	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	PASS ³
--	Magnetic fields (industrial frequencies)	EN 61000-4-8 IEC 61000-4-8	Not applicable ⁴
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	Not applicable ²

1. Does not contain any Optical Fibre Ports

2. No AC Mains port

3. Partly tested, see respective paragraph for details

4. Does not contain any devices susceptible to magnetic fields

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

§	Test Type		Result
10	Emission		EN/IEC 61000-6-3
10.1	Interference voltage	EN 55016-2-1 CISPR 16-2-1	PASS
10.2	Common mode at telecommunication ports	EN 55022 CISPR 22	PASS
10.3 10.4	Radiated electromagnetic field	EN 55016-2-3 CISPR 16-2-3	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	Not applicable ¹
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	Not applicable ¹
11	Immunity		EN/IEC 61000-6-2
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
11.4	Surges	EN 61000-4-5 IEC 61000-4-5	PASS
11.5	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	PASS ²
--	Magnetic fields (industrial frequencies)	EN 61000-4-8 IEC 61000-4-8	Not applicable ³
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	Not applicable ¹

1. No AC Mains port
2. Partly tested, see respective paragraph for details
3. Does not contain any devices susceptible to magnetic fields

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

§	Test Type		Result
Emission			EN 50121-3-2 IEC 62236-3-2
10.1 10.2	Interference voltage	EN 55011 CISPR 11	PASS
10.3 10.4	Radiated electromagnetic field	EN 55011 CISPR 11	PASS
Immunity			EN 50121-3-2 IEC 62236-3-2
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS ¹
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
11.4	Surges	EN 61000-4-5 IEC 61000-4-5	PASS
11.5	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	PASS

1. Partly tested, see respective paragraph for details

4. 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.

§	Test Type		Result
10	Emission		EN 301 489-x
10.1	Interference voltage	EN 55032 CISPR 32	PASS
10.2	Common mode at telecom. ports	EN 55032 CISPR 32	PASS
10.3 10.4	Radiated electromagnetic field	EN 55032 CISPR 32	PASS
--	Harmonics	EN 61000-3-2 IEC 61000-3-2	Not applicable ¹
--	Voltage fluctuations (flicker)	EN 61000-3-3 IEC 61000-3-3	Not applicable ¹
11	Immunity		EN 301 489-x
11.1	Electrostatic discharges	EN 61000-4-2 IEC 61000-4-2	PASS
11.2	Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	PASS ²
11.3	Fast electric transients (Burst)	EN 61000-4-4 IEC 61000-4-4	PASS
11.4	Surges	EN 61000-4-5 IEC 61000-4-5	PASS
11.5	Radio frequency common mode	EN 61000-4-6 IEC 61000-4-6	PASS
--	Voltage dips and interruptions	EN 61000-4-11 IEC 61000-4-11	Not applicable ¹
--	Automotive pulses	ISO 7637-1 ISO 7637-2	Not applicable ³

1. No AC Mains port

2. Partly tested, see respective paragraph for details

3. Not tested in this report, see 16-EL-0105.E05, issued 2016-12-01, for automotive pulses

5. Summary of Test Results (FCC / Canada)

§	Test Type		Result
10	Emission		CFR 47 (FCC) ICES-003 (Industry Canada)
10.1	Conducted emission	CFR 47 § 15.107 (Class B) ICES-003 §5.3 (Class B)	PASS
10.5 10.6	Radiated emission – EM-field	CFR 47 § 15.109 (Class B) ICES-003 §5.5 (Class B)	PASS

Remarks:

This measurements were performed according CIPSR 32 methods.

The EUT contains FCC approved radio modules. It has been informatively tested as unintentional radiator (Subpart B).

6. Applied Standards

EN 50121-3-2:2016 IEC 62236-3-2:2018	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 55035:2017 CISPR 35:2016	Electromagnetic compatibility of multimedia equipment - Immunity requirements
EN 55016-2-1:2014 CISPR 16-2-1:2014	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements
EN 55016-2-3:2010 CISPR 16-2-3:2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements
EN 61000-4-3:2006 + A1: 2008 + A2: 2010 IEC 61000-4-3:2006 IEC 61000-4-3:2006/AMD2:2010	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4:2012 IEC 61000-4-4:2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5:2014 IEC 61000-4-5:2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
EN 61000-4-6:2014 IEC 61000-4-6:2013	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-6-2:2005 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 IEC 61000-6-3:2006/AMD1:2010	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 301 489-1 V1.9.2:2011	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 1: Common technical requirements
DRAFT EN 301 489-1 V2.2.0	Electromagnetic compatibility and Radio spectrum Matters (ERM); EMC standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1 (b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU
EN 301 489-7 V1.3.1:2005	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
EN 301 489-9 V1.4.1:2007	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 9: Specific conditions for wireless microphones, similar Radio Frequency (RF) audio link equipment, cordless audio and in-ear monitoring devices
EN 301 489-17 V2.2.1:2012	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems
EN 301 489-24 V1.5.1:2010	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
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. Urs Grütter
<i>Telephone</i>	+41 31 985 25 19
<i>E-mail</i>	urs.gruetter@netmodule.com

8. Equipment Under Test

8.1 Identification

<i>Manufacturer name and address</i>	NetModule AG Maulbeerstrasse 10 3011 Bern
<i>Production country</i>	SWITZERLAND
<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>	EUT 1: NB2810 2LWacCDf-G
<i>Serial number</i>	000000088888
<i>Hardware identification</i>	NBHW_17_Mainboard_2xM12_PCB_1.1.2_SCH_1.1.2
<i>Software version</i>	4.3.0.104
<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.

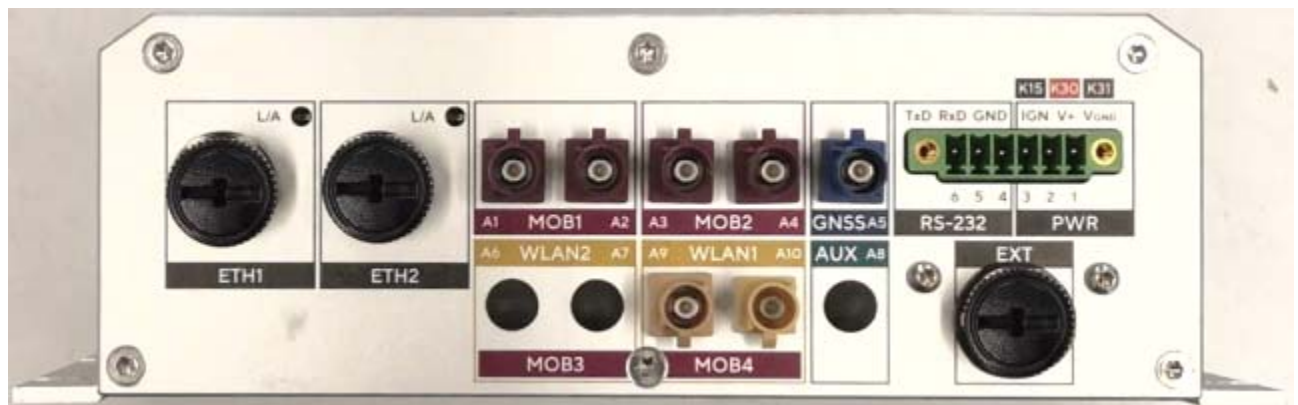
8.2 Product Family

Tested Equipment	Covered Variants	Explanation ¹⁾
NB2810-2LWacCDf-G	NB2810-H ₁ ...H _n -S ₁ ...S _n	<p>All covered NB2810 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>'H₁...H_n' 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 & 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>'S₁...S_n' indicate the software options activated:</p> <p>G: GPS V: Voice gateway M: Mobile IP (Client) S: Server</p> <p>The following NB2810 variants are currently available or planned:</p> <p>NB2810-R NB2810-Wac- NB2810-2Wac- NB2810-UA- NB2810-UWacA- NB2810-UWac- NB2810-U2Wac- NB2810-2U- NB2810-2UWac- NB2810-L- NB2810-LDa-</p>

		NB2810-L- NB2810-LLa- NB2810-LWac- NB2810-LWacA- NB2810-LWacC- NB2810-LWacSb- NB2810-LWacDb- NB2810-LWacCDa- NB2810-LWacCDb- NB2810-LWacCGeDf- NB2810-LWacI- NB2810-LdWac- NB2810-LdWacC- NB2810-LWac2CDf- NB2810-L2Wac- NB2810-L2WacC- NB2810-L2WacDb- NB2810-Ld2Wac- NB2810-Ld2WacC- NB2810-LdWac2CDf- NB2810-2L- NB2810-2LWac- NB2810-2LWac2D- NB2810-2LWacC- NB2810-2LWacCDf- NB2810-2LWacAp- NB2810-2LWacA- NB2810-2LWacGa- NB2810-2LWacJs- NB2810-2LWacGe- NB2810-2LWacDf- NB2810-2L2Wac- NB2810-2L2WacDf- NB2810-2LdWacGe- NB2810-2Ld2Wac- NB2810-2Ld2WacDf- NB2810-3L- NB2810-3LWac- NB2810-3LdWac- NB2810-4LJs- NB2810-4L-
--	--	---

*) According information of customer and not verified by Eurofins

8.3 Pictures of the EUT



Type label:



8.4 Classification

EN 55032 CISPR 32	<input type="checkbox"/> Class A (suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes) Such equipment should not be restricted in its sale but the following warning shall be included in the instructions for use: <i>Warning: This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.</i> <input checked="" type="checkbox"/> Class B (suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes) <input type="checkbox"/> The highest frequency of the internal sources of the EUT is less than 108 MHz (measurement shall be made up to 1 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz (measurement shall be made up to 2 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz (measurement shall be made up to 5 GHz). <input checked="" type="checkbox"/> The highest frequency of the internal sources of the EUT is above 1 GHz (measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less).
EN 61000-6-3 IEC 61000-6-3	<input type="checkbox"/> The highest frequency of the internal sources of the EUT is less than 108 MHz (measurement shall be made up to 1 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz (measurement shall be made up to 2 GHz). <input type="checkbox"/> The highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz (measurement shall be made up to 5 GHz). <input checked="" type="checkbox"/> The highest frequency of the internal sources of the EUT is above 1 GHz (measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less).
EN 50121-3-2 IEC 62236-3-2	<input checked="" type="checkbox"/> Mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe) <input type="checkbox"/> Accessible to passengers and operational staff (not maintenance) <input type="checkbox"/> If the highest internal frequency of the EUT is less than 108 MHz, the measurement shall only be made up to 1 GHz. <input checked="" type="checkbox"/> If the highest internal frequency of the EUT is 800 MHz, the measurement shall be made up to 6 GHz.
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)
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).

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	
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

9. Test Conditions

9.1 Climatic conditions, location and date

<i>Location:</i>	Eurofins Electric & Electronic Product Testing AG Albisriederstrasse 199 8047 Zürich SWITZERLAND
<i>Date of the Tests:</i>	December 9 to 13, 2019
<i>Temperature:</i>	22 ± 3 °C
<i>Pressure [QFE]:</i>	980 ± 30 hPa
<i>Rel. humidity:</i>	30 ± 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

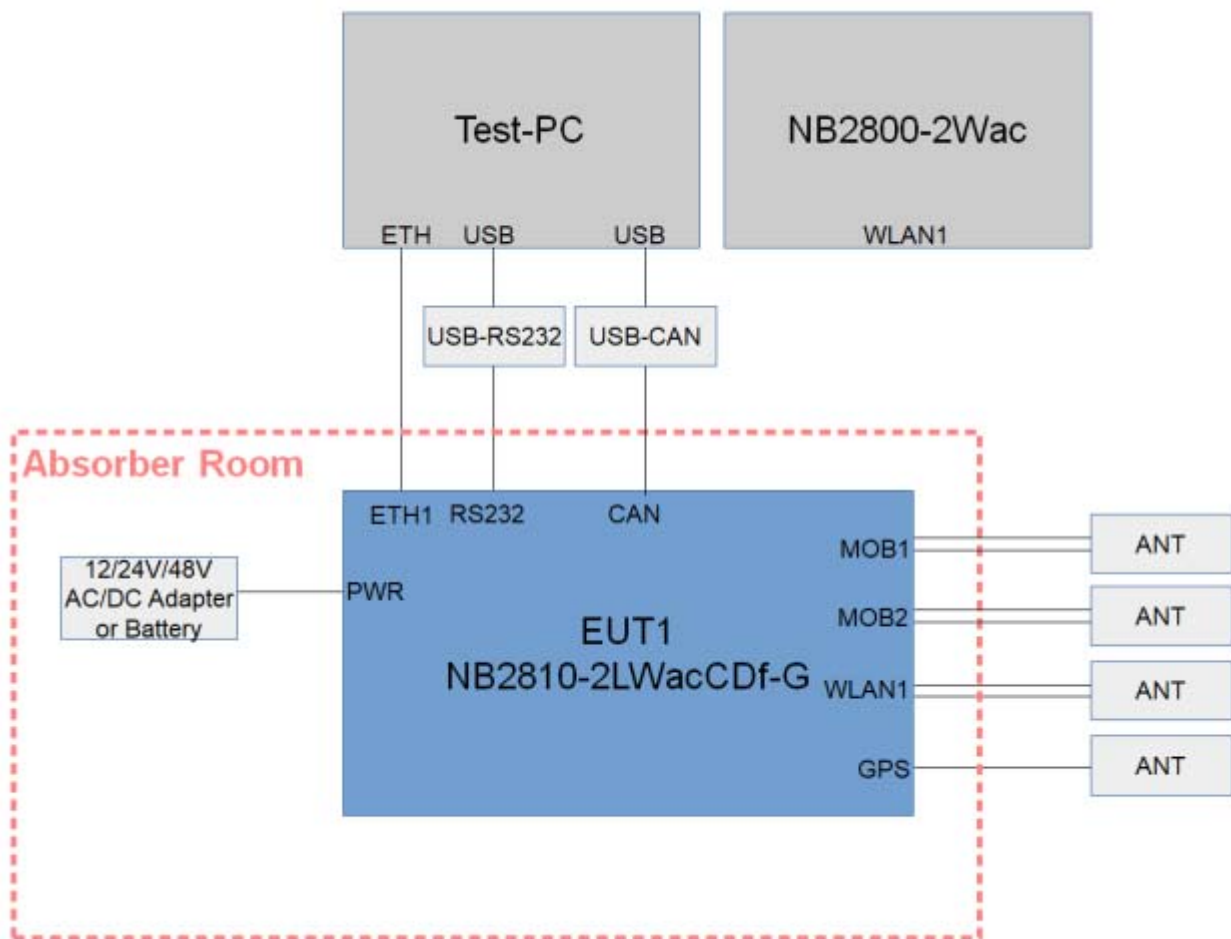
Test Engineer(s):

Mr. Daniel Rufer

Other(s):

Name	Company
Mr. Raffael Rohrer	NetModule AG

9.4 Test Configuration



9.5 Operating Conditions

Ping over WLAN 1
 Ping over WWAN 1 & 2 (UMTS/LTE)
 Ping over Ethernet 1
 Loop back ping over CAN
 read and write to SSD disc
 Access to serial connection

9.6 Monitoring of the EUT

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

Monitoring of all pings on the test computer checked that read and write of ssd is correct.

9.7 Auxiliary Equipment

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

Product	Brand	Model No.	ID
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
Combi Antenna	--	AW10G-DLW	-
USB-to-CAN Adapter	IXXAT	USB-to-CAN compact	B2DT3X1
Router	NetModule	NB2800-2Wac	
SMA- FAKRA Adapter	--	--	--
SIM: 2x Swisscom	--	--	--

9.8 Performance Criteria

General requirements:	Requirements according to the EUT:
<p style="text-align: center;">Criterion A:</p> <div> <div data-bbox="199 376 813 465">The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed.</div> <div data-bbox="849 376 1428 465">No transmission loss LAN, WWAN (LTE/UMTS), RS232, WLAN and CAN correct read and write of SSD</div> </div>	
<p style="text-align: center;">Criterion B:</p> <div> <div data-bbox="199 593 798 772">The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed.</div> <div data-bbox="849 593 1428 750"> <p>During the test:</p> <ul style="list-style-type: none"> - short interruptions of the communication - LED's may flicker <p>After the test the EUT shall operate as in normal mode</p> </div> </div>	
<p style="text-align: center;">Criterion C:</p> <div> <div data-bbox="199 913 813 1003">Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.</div> <div data-bbox="849 913 1145 947">No specific requirements</div> </div>	

10. Emission Tests

10.1 Interference Voltage (V-LISN)

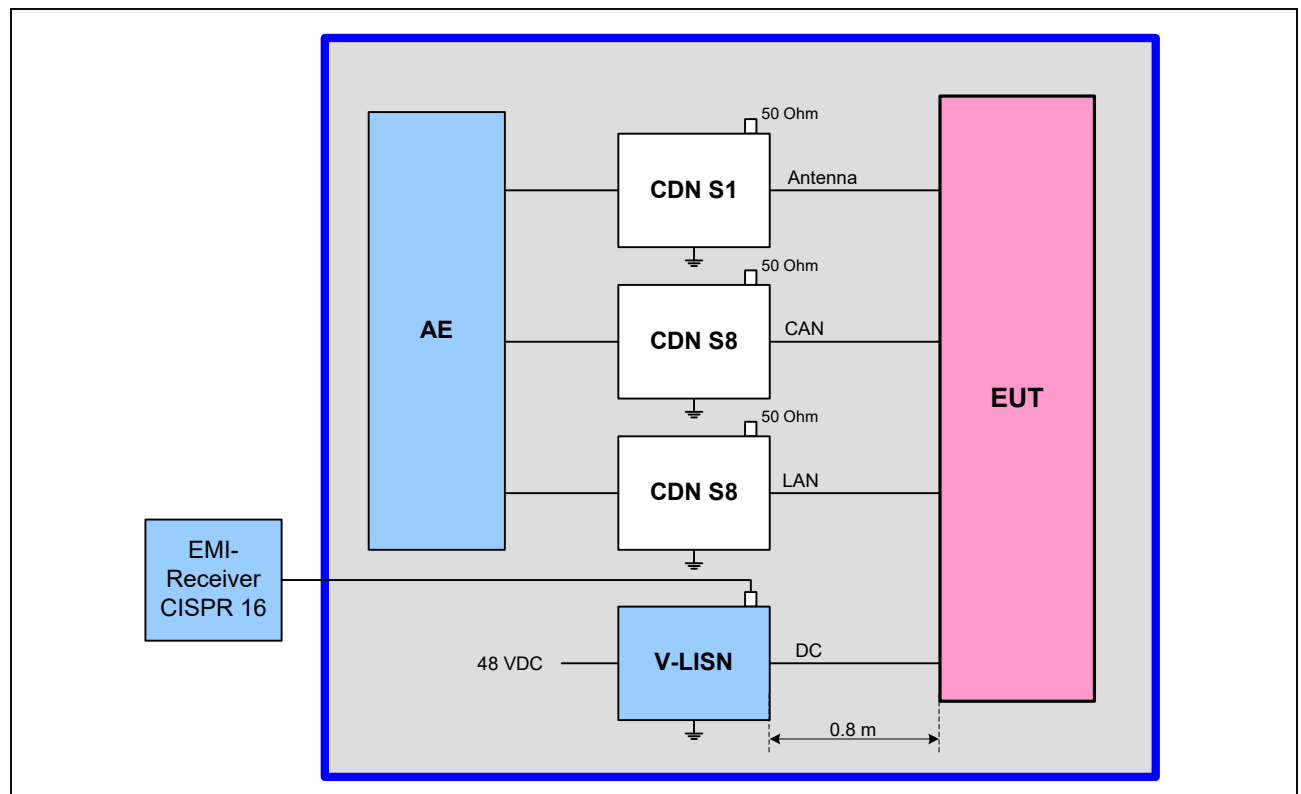
Test site: shielded room

Meas. uncertainty: see chapter 12

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

Modifications: none

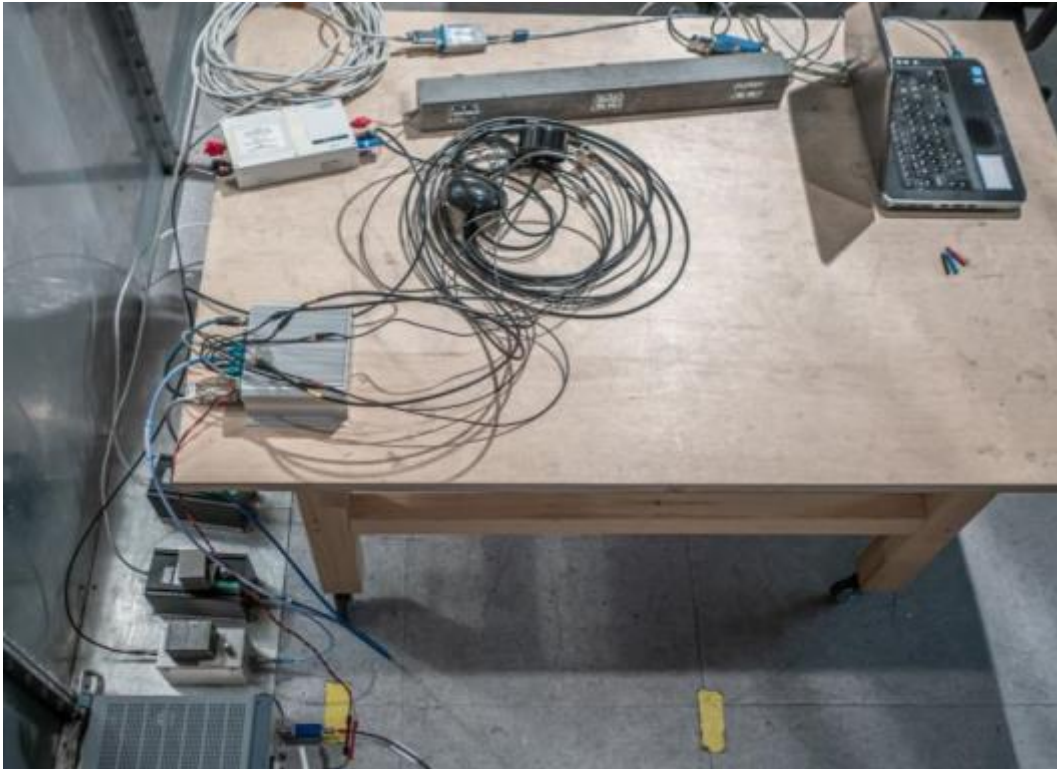
Test Setup



Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU8	OA10193
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	S8 RJ45	13.6632.07 13.6632.08
CDN	Luethi	S1 Coax	H7679
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

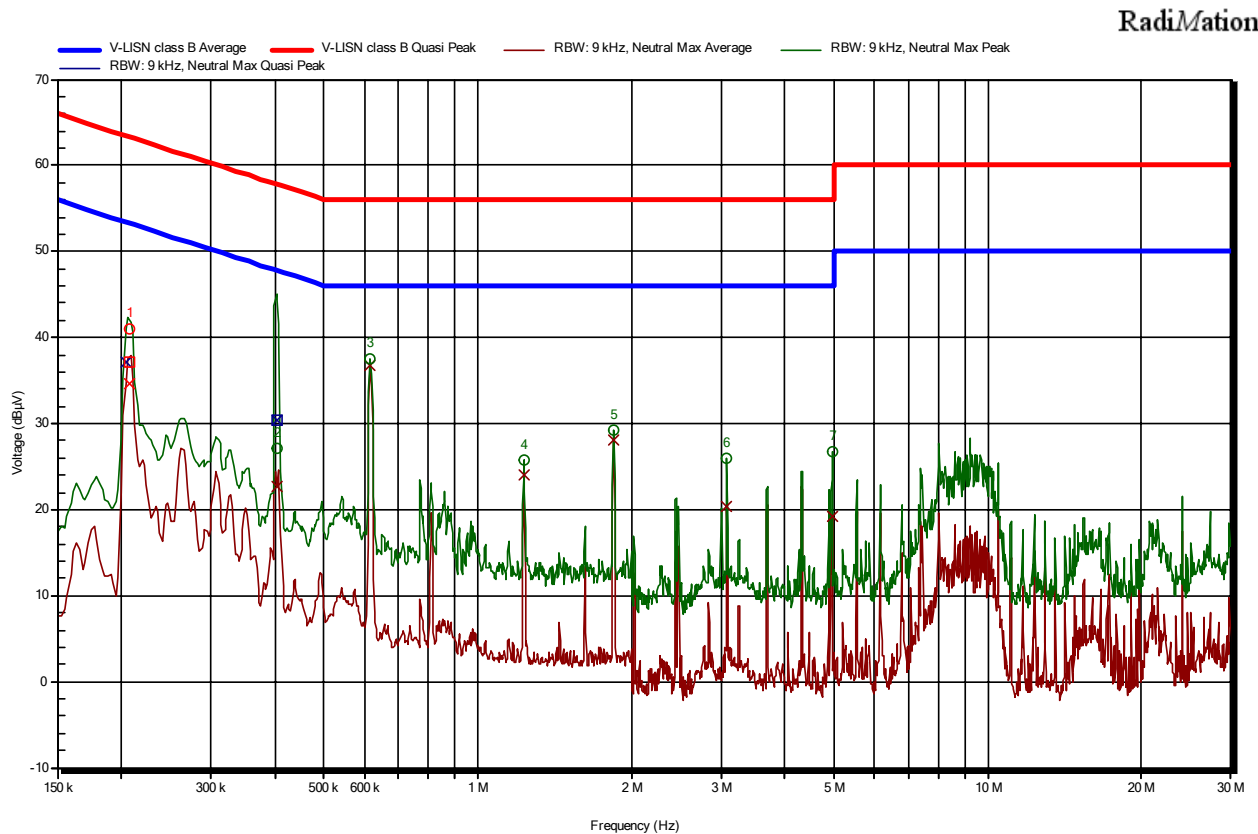
Photos of the Setup



Measurement Results

Diagram 1

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	12 VDC
Test date, time	10.12.2019 08:59:58
Line under test	DC-Port, Minus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radimation Version: 2019.1.5, 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



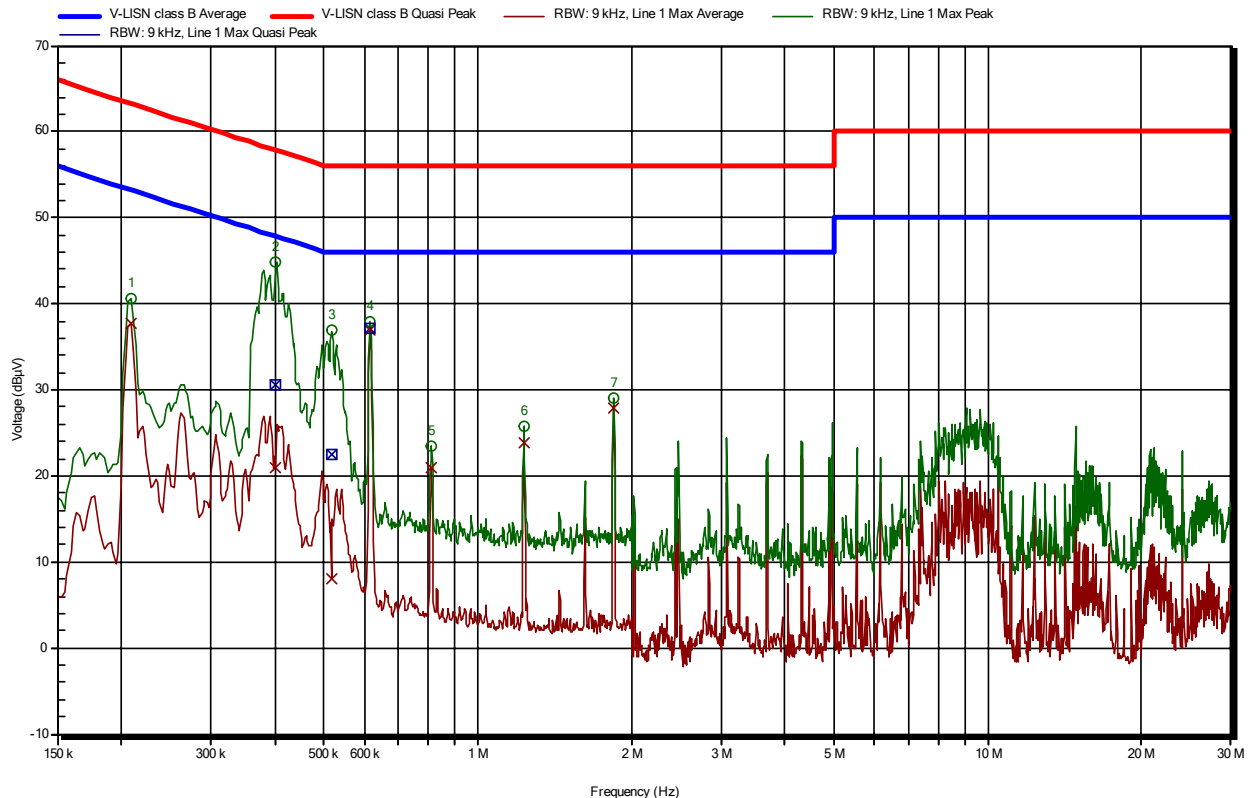
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	207.156 kHz	41.1 dBμV	34.6 dBμV	-18.7 dB	37.2 dBμV	-26.2 dB	Pass
2	404.25 kHz	27 dBμV	22.6 dBμV	-25.2 dB	30.3 dBμV	-27.5 dB	Pass
3	615.75 kHz	37.6 dBμV	36.7 dBμV	-9.3 dB	--	--	Pass
4	1.23 MHz	25.7 dBμV	24 dBμV	-22.0 dB	--	--	Pass
5	1.847 MHz	29.2 dBμV	28.1 dBμV	-17.9 dB	--	--	Pass
6	3.077 MHz	26 dBμV	20.4 dBμV	-25.6 dB	--	--	Pass
7	4.947 MHz	26.8 dBμV	19.2 dBμV	-26.8 dB	--	--	Pass

Diagram 2

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	12 VDC
Test date, time	10.12.2019 09:04:48
Line under test	DC-Port, Plus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radimation Version: 2019.1.5, 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



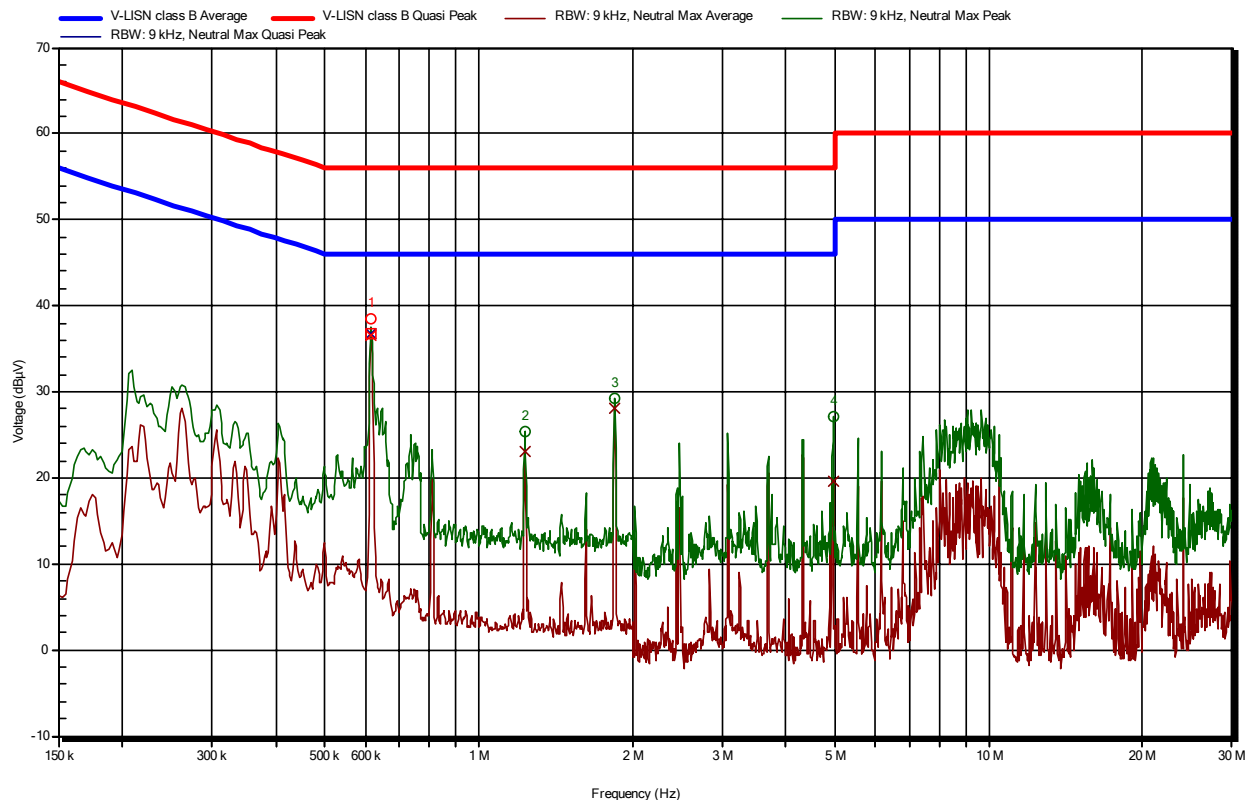
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	208.5 kHz	40.7 dBμV	37.8 dBμV	-15.5 dB	--	--	Pass
2	402 kHz	44.9 dBμV	21 dBμV	-26.8 dB	30.5 dBμV	-27.3 dB	Pass
3	516.75 kHz	36.9 dBμV	8 dBμV	-38.0 dB	22.5 dBμV	-33.5 dB	Pass
4	615.75 kHz	38 dBμV	37 dBμV	-9.0 dB	37.1 dBμV	-18.9 dB	Pass
5	809.25 kHz	23.4 dBμV	21 dBμV	-25.0 dB	--	--	Pass
6	1.23 MHz	25.7 dBμV	23.9 dBμV	-22.1 dB	--	--	Pass
7	1.847 MHz	29 dBμV	27.9 dBμV	-18.1 dB	--	--	Pass

Diagram 3

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	24 VDC
Test date, time	10.12.2019 09:21:06
Line under test	DC-Port, Minus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radiation Version: 2019.1.5, 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



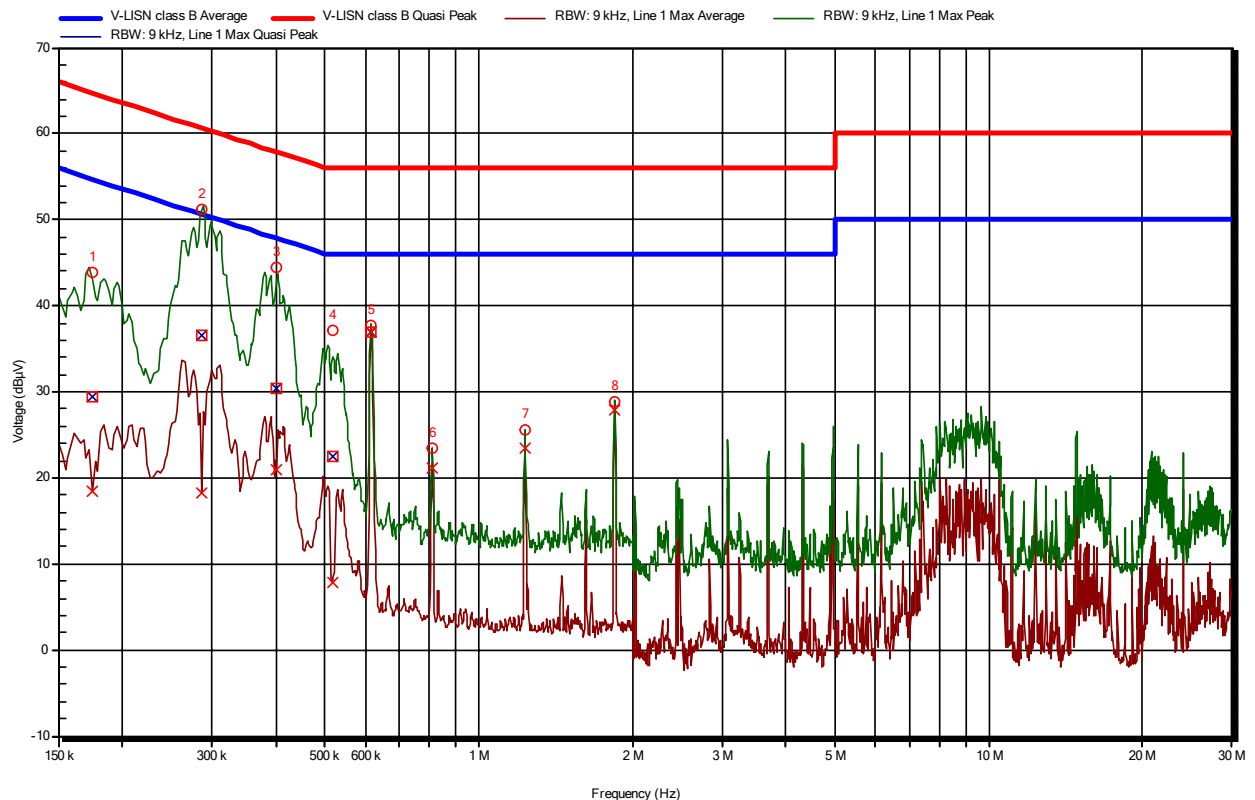
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	615.75 kHz	38.5 dBμV	36.5 dBμV	-9.5 dB	36.8 dBμV	-19.2 dB	Pass
2	1.23 MHz	25.3 dBμV	23.1 dBμV	-22.9 dB	--	--	Pass
3	1.847 MHz	29.3 dBμV	28.2 dBμV	-17.8 dB	--	--	Pass
4	4.947 MHz	27.1 dBμV	19.6 dBμV	-26.4 dB	--	--	Pass

Diagram 4

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	24 VDC
Test date, time	10.12.2019 09:26:05
Line under test	DC-Port, Plus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radiation Version: 2019.1.5, 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



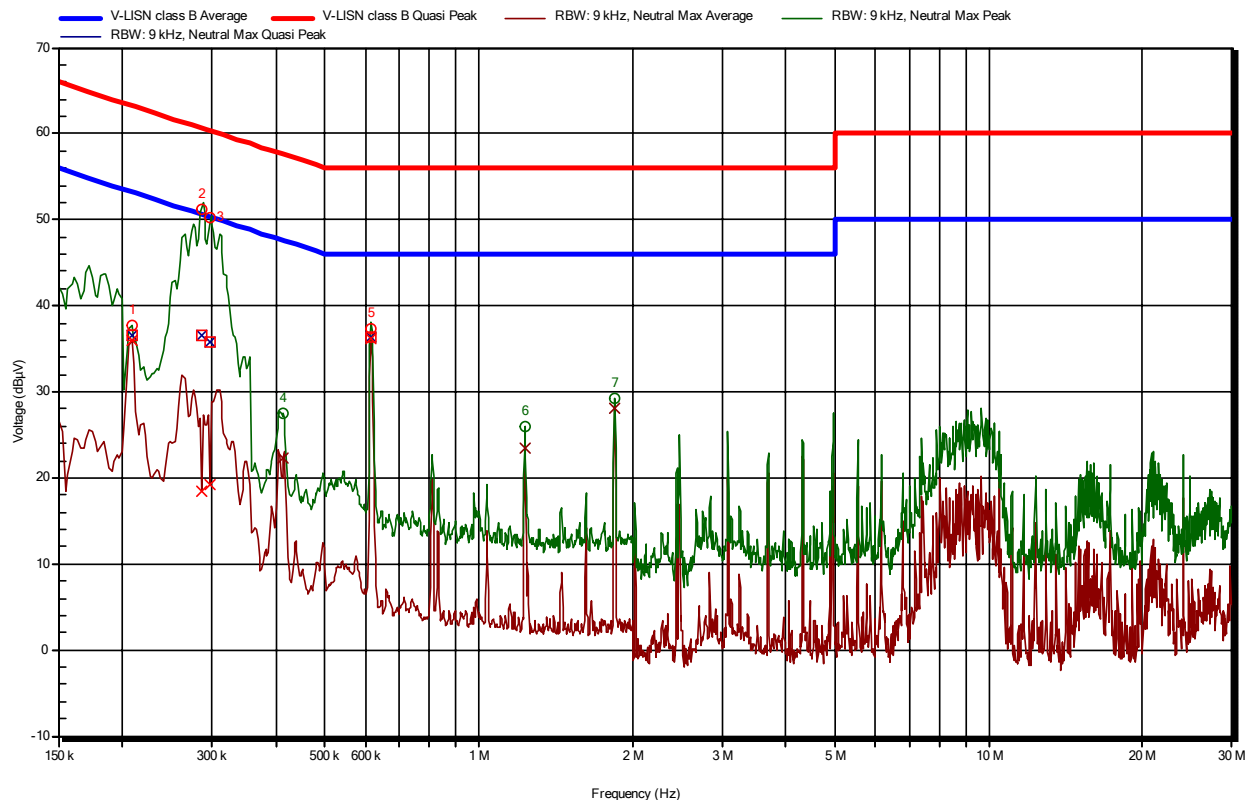
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	174.75 kHz	43.9 dBμV	18.4 dBμV	-36.3 dB	29.3 dBμV	-35.4 dB	Pass
2	287.25 kHz	51.3 dBμV	18.2 dBμV	-32.4 dB	36.6 dBμV	-24.0 dB	Pass
3	402 kHz	44.5 dBμV	21 dBμV	-26.8 dB	30.5 dBμV	-27.3 dB	Pass
4	516.75 kHz	37.2 dBμV	7.9 dBμV	-38.1 dB	22.4 dBμV	-33.6 dB	Pass
5	615.75 kHz	37.7 dBμV	37 dBμV	-9.0 dB	36.9 dBμV	-19.1 dB	Pass
6	809.25 kHz	23.5 dBμV	21 dBμV	-25.0 dB	--	--	Pass
7	1.23 MHz	25.5 dBμV	23.5 dBμV	-22.5 dB	--	--	Pass
8	1.847 MHz	28.9 dBμV	27.9 dBμV	-18.1 dB	--	--	Pass

Diagram 5

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	48 VDC
Test date, time	10.12.2019 09:12:12
Line under test	DC-Port, Minus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radiation Version: 2019.1.5, 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



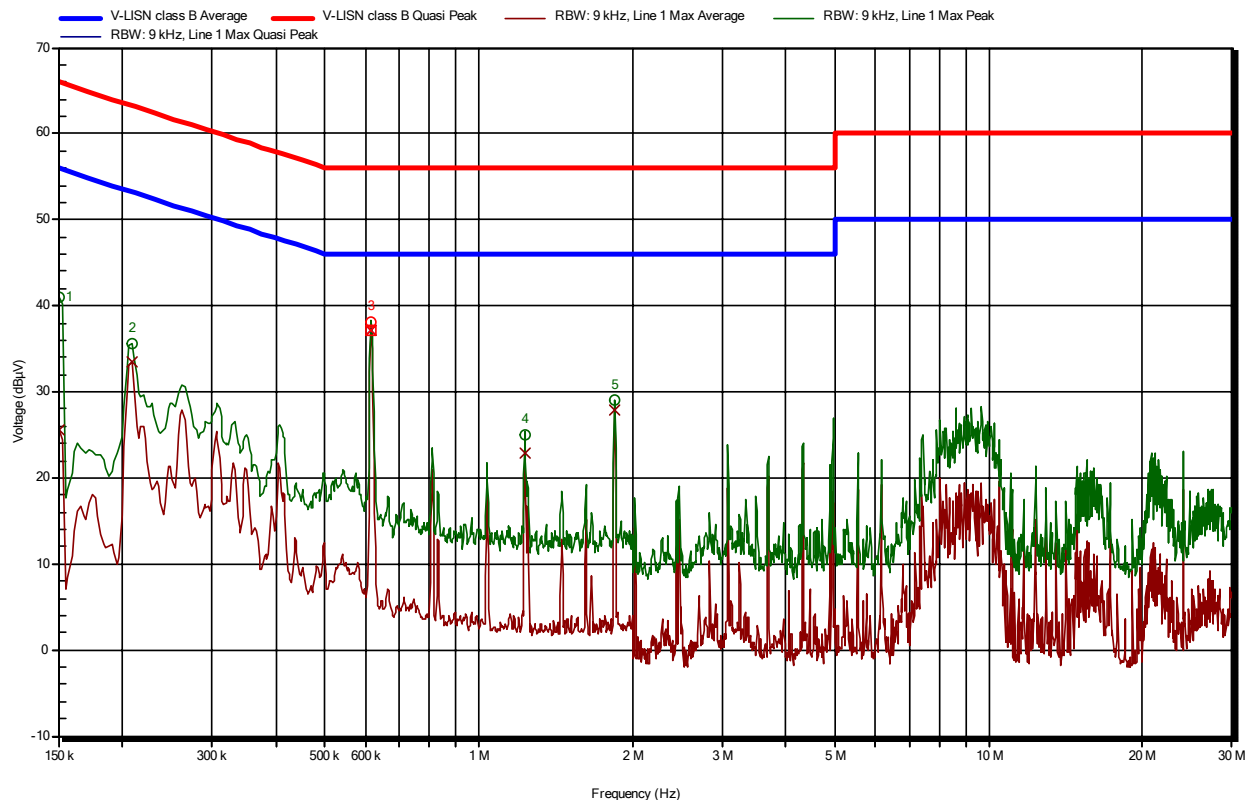
Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Quasi-Peak	Quasi-Peak Difference	Status
1	208.5 kHz	37.7 dBμV	35.9 dBμV	-17.4 dB	36.6 dBμV	-26.7 dB	Pass
2	287.25 kHz	51.2 dBμV	18.4 dBμV	-32.2 dB	36.6 dBμV	-24.0 dB	Pass
3	298.5 kHz	50.3 dBμV	19.2 dBμV	-31.1 dB	35.9 dBμV	-24.4 dB	Pass
4	413.25 kHz	27.5 dBμV	22.2 dBμV	-25.3 dB	--	--	Pass
5	615.75 kHz	37.3 dBμV	36.2 dBμV	-9.8 dB	36.4 dBμV	-19.6 dB	Pass
6	1.23 MHz	26 dBμV	23.4 dBμV	-22.6 dB	--	--	Pass
7	1.847 MHz	29.3 dBμV	28.1 dBμV	-17.9 dB	--	--	Pass

Diagram 6

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B
Mode of operation	48 VDC
Test date, time	10.12.2019 09:16:13
Line under test	DC-Port, Plus
Transducer	VLISN R&S ESH3-Z5 - PE7627
Measurement settings	Radimation Version: 2019.1.5, 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	150 kHz	41 dBμV	25.5 dBμV	-30.5 dB	--	--	Pass
2	208.5 kHz	35.7 dBμV	33.4 dBμV	-19.8 dB	--	--	Pass
3	615.75 kHz	38 dBμV	37.2 dBμV	-8.8 dB	37.1 dBμV	-18.9 dB	Pass
4	1.232 MHz	24.9 dBμV	22.9 dBμV	-23.1 dB	--	--	Pass
5	1.847 MHz	29 dBμV	27.9 dBμV	-18.1 dB	--	--	Pass

10.2 Interference Voltage (Wired Network and Antenna Ports)

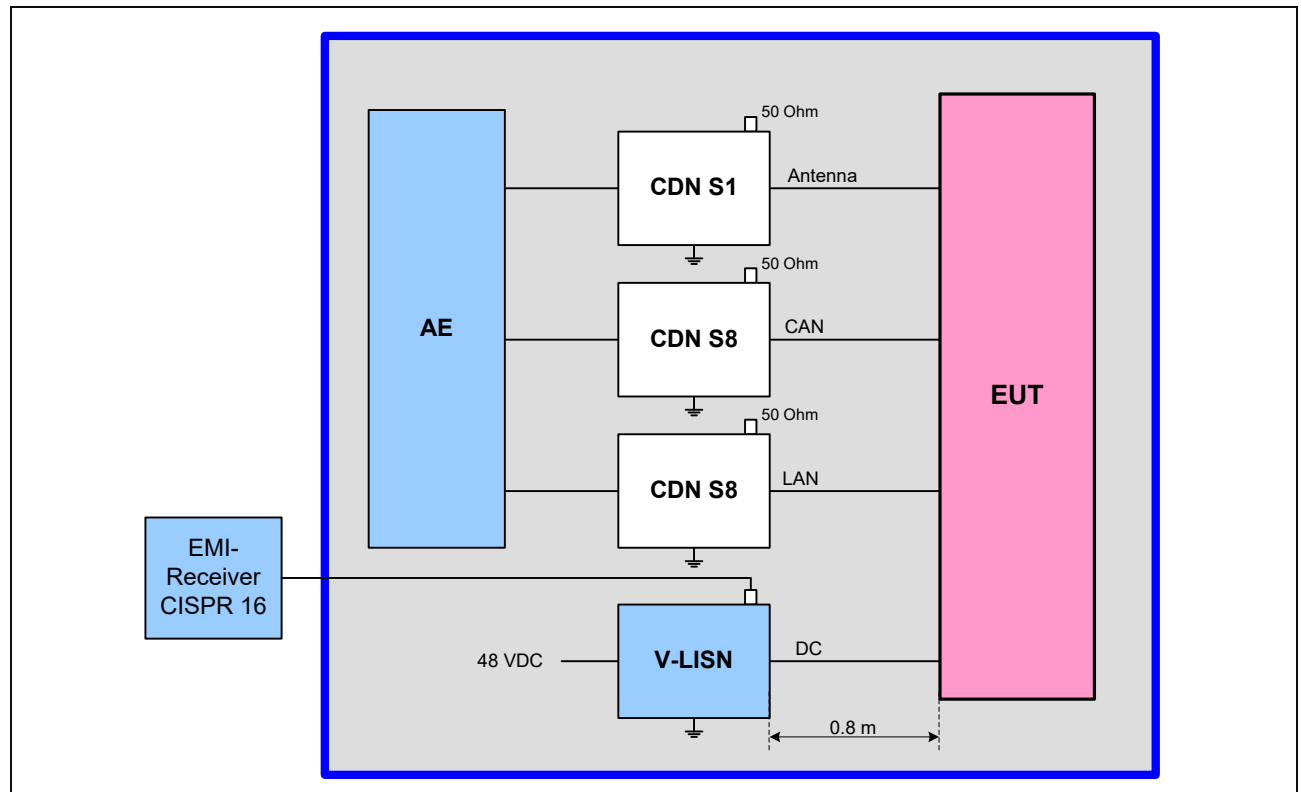
Test site: shielded room

Meas. uncertainty: see chapter 12

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

Modifications: none

Test Setup



Test Equipment

Device Type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESU8	OA10193
V-Network	Rohde & Schwarz	ESH3-Z5	PE7627
CDN	EM Test	S8 RJ45	13.6632.07 13.6632.08
CDN	Luethi	S1 Coax	H7679
Coaxial Cable	Huber & Suhner	RG223/U	H8002+13.6632.02

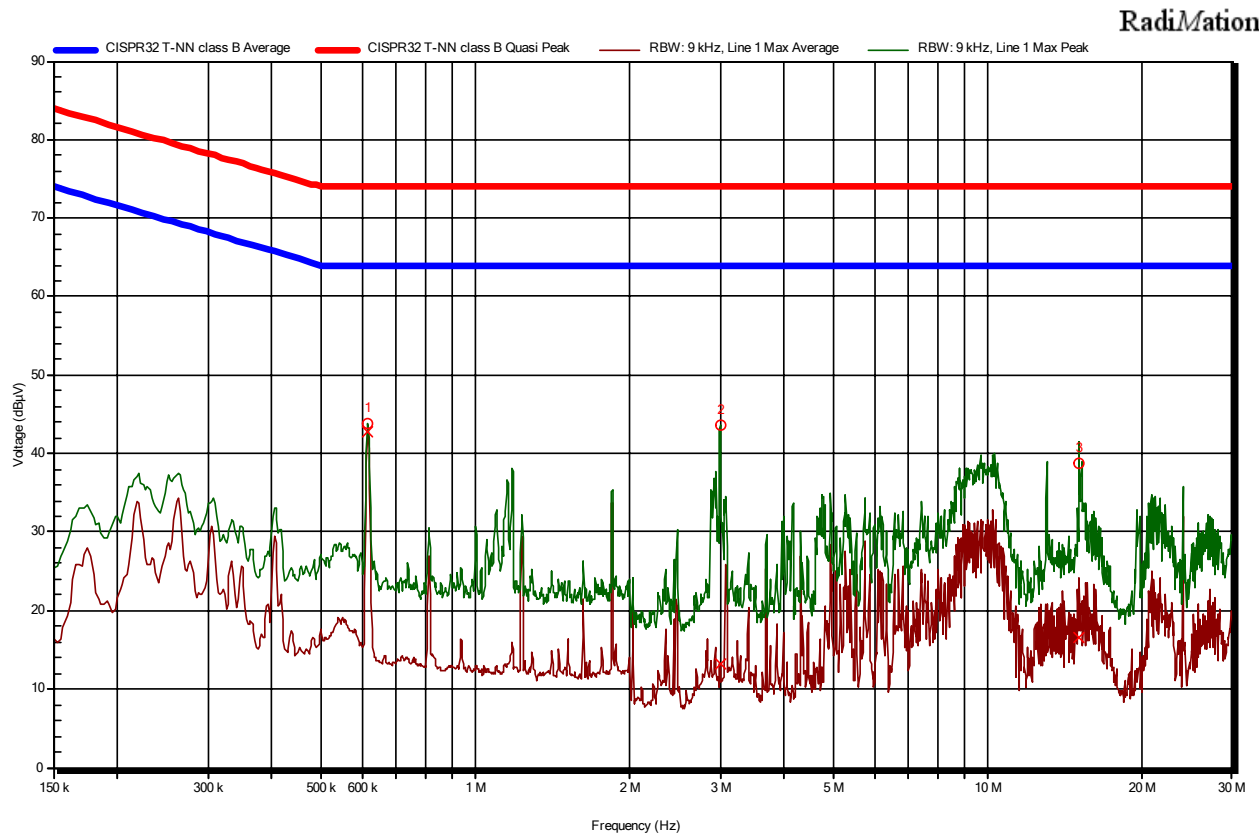
Photos of the Setup

see § 10.1

Measurement Results

Diagram 7

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.12.2019 09:28:55
Line under test	CAN
Transducer	CDN-S8 Lüthi RJ45 - 13.6632.07
Measurement settings	Radimation Version: 2019.1.5, 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

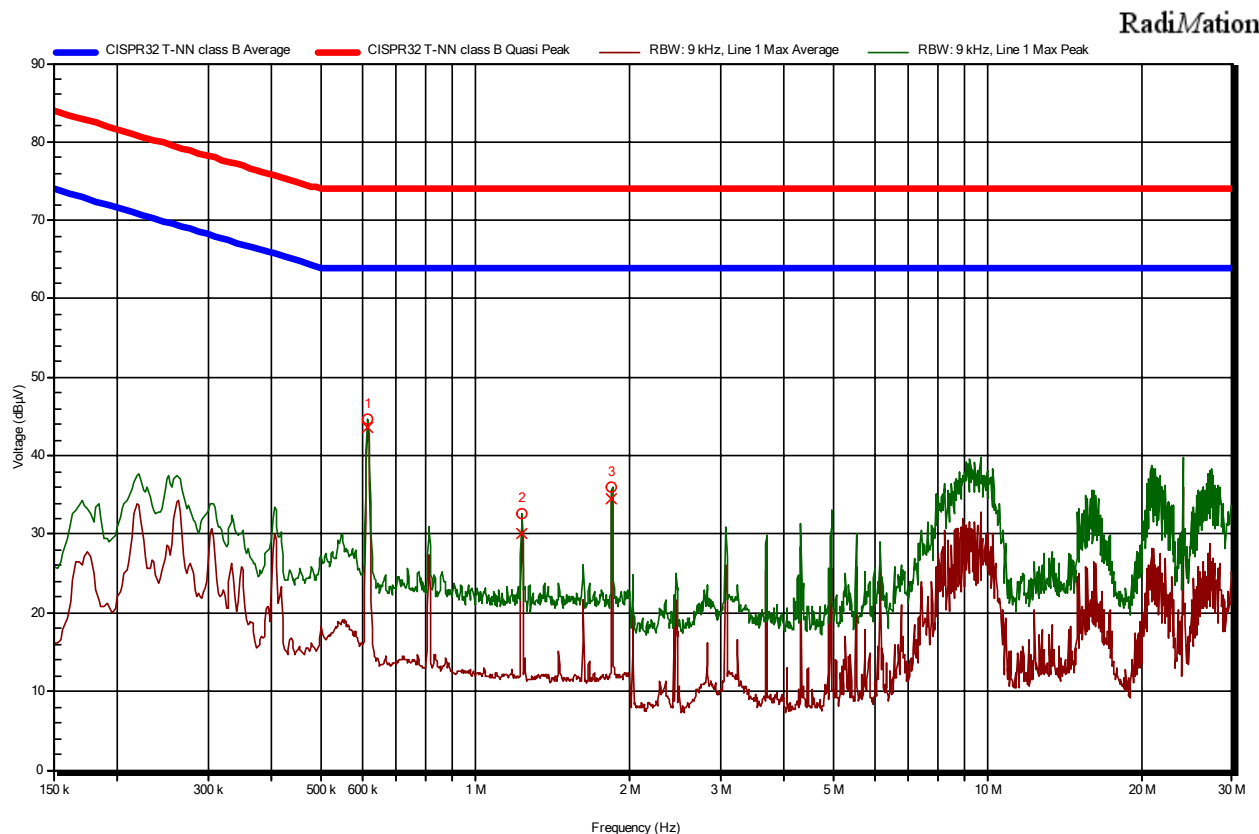


Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Status
1	615.75 kHz	43.9 dBµV	42.8 dBµV	-21.2 dB	Pass
2	3.001 MHz	43.6 dBµV	13.2 dBµV	-50.8 dB	Pass
3	15.005 MHz	38.8 dBµV	16.6 dBµV	-47.4 dB	Pass

Diagram 8

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.12.2019 09:30:21
Line under test	ETH1
Transducer	CDN-S8 Lüthi RJ45 - 13.6632.07
Measurement settings	Radimation Version: 2019.1.5, 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

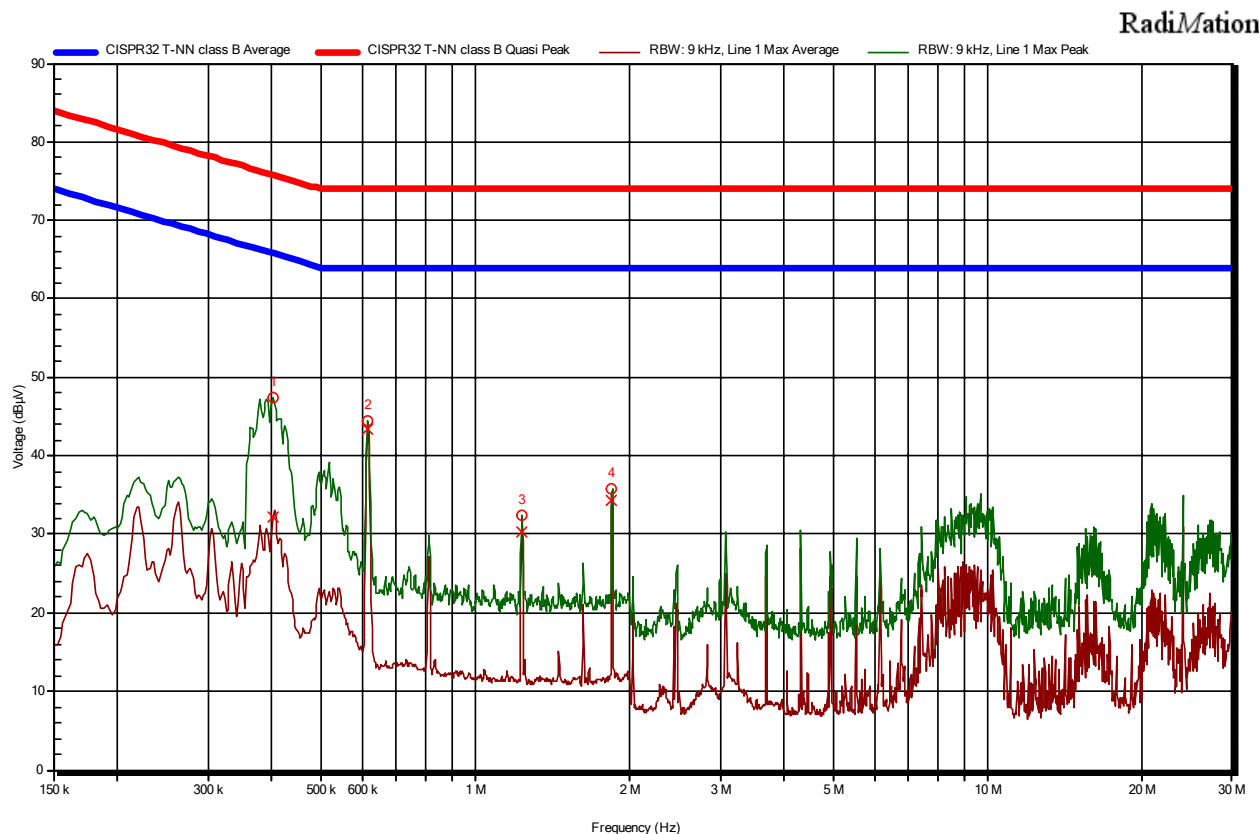


Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Status
1	615.75 kHz	44.7 dBµV	43.7 dBµV	-20.3 dB	Pass
2	1.23 MHz	32.7 dBµV	30.1 dBµV	-33.9 dB	Pass
3	1.847 MHz	36.1 dBµV	34.6 dBµV	-29.4 dB	Pass

Diagram 9

EUT	EUT 1
Verdict	Pass according CISPR 32, Class B
Mode of operation	24 VDC
Test date, time	10.12.2019 09:34:42
Line under test	Mob2, A3
Transducer	CDN-S1 Lüthi Coax - H7679
Measurement settings	Radimation Version: 2019.1.5, 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



Detected peaks

Peak Number	Frequency	Peak	Average	Average Difference	Status
1	402 kHz	47.4 dBµV	32.2 dBµV	-33.6 dB	Pass
2	615.75 kHz	44.5 dBµV	43.3 dBµV	-20.7 dB	Pass
3	1.23 MHz	32.4 dBµV	30.3 dBµV	-33.7 dB	Pass
4	1.847 MHz	35.7 dBµV	34.2 dBµV	-29.8 dB	Pass

10.3 Radiated Electromagnetic Field (30 – 1000 MHz)

Test site: semi-anechoic chamber (hybrid)

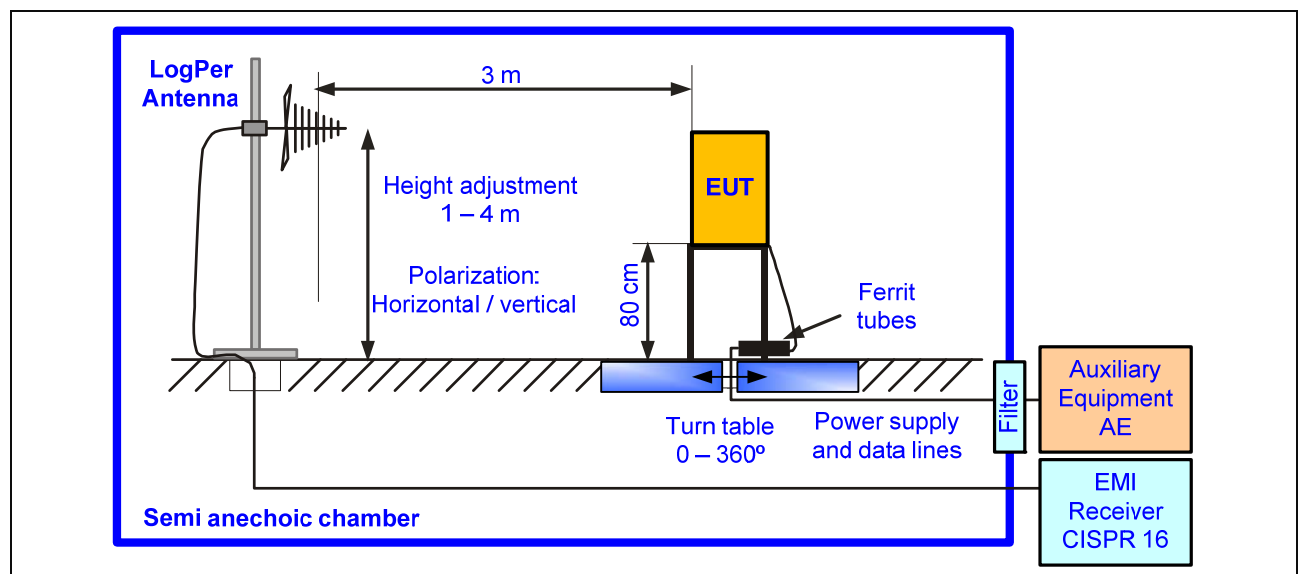
Distance: 3 m

Meas. uncertainty: see chapter 12

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

Modifications: none

Test Setup



Test Equipment

Device type	Brand	Type	ID
EMI Receiver	Rohde & Schwarz	ESW26	17.6632.05
Antenna LogPer	Chase	CBL 6112A	H8675
Coaxial Cable	Huber & Suhner	Sucoflex 106	17.6632.03, 17.6632.04, 18.6632.02

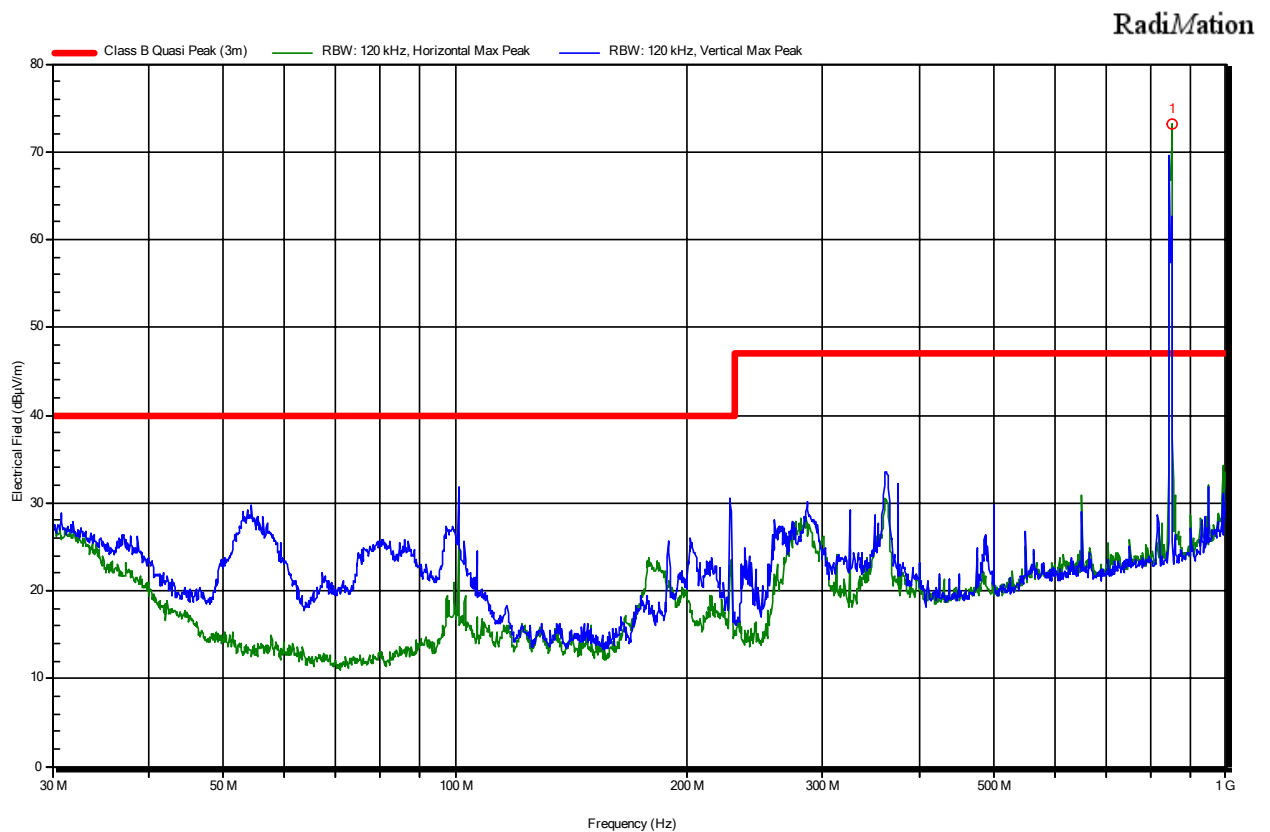
Photos of the Setup



Measurement Results

Diagram 10

EUT	EUT 1		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	12 VDC		
Test date, time	13.12.2019 13:56:00		
Antenna height	1 m - 2 m with 2 steps	Antenna polarization	Horizontal/Vertical
EUT position	0 degrees to 360 degrees	Antenna distance	3 m
Measurement settings	Radimation Version: 2019.1.5, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 30 kHz steps, Attenuator: Auto [10.0 dB], Internal preamp: 20 dB, Measure time: 20 ms		



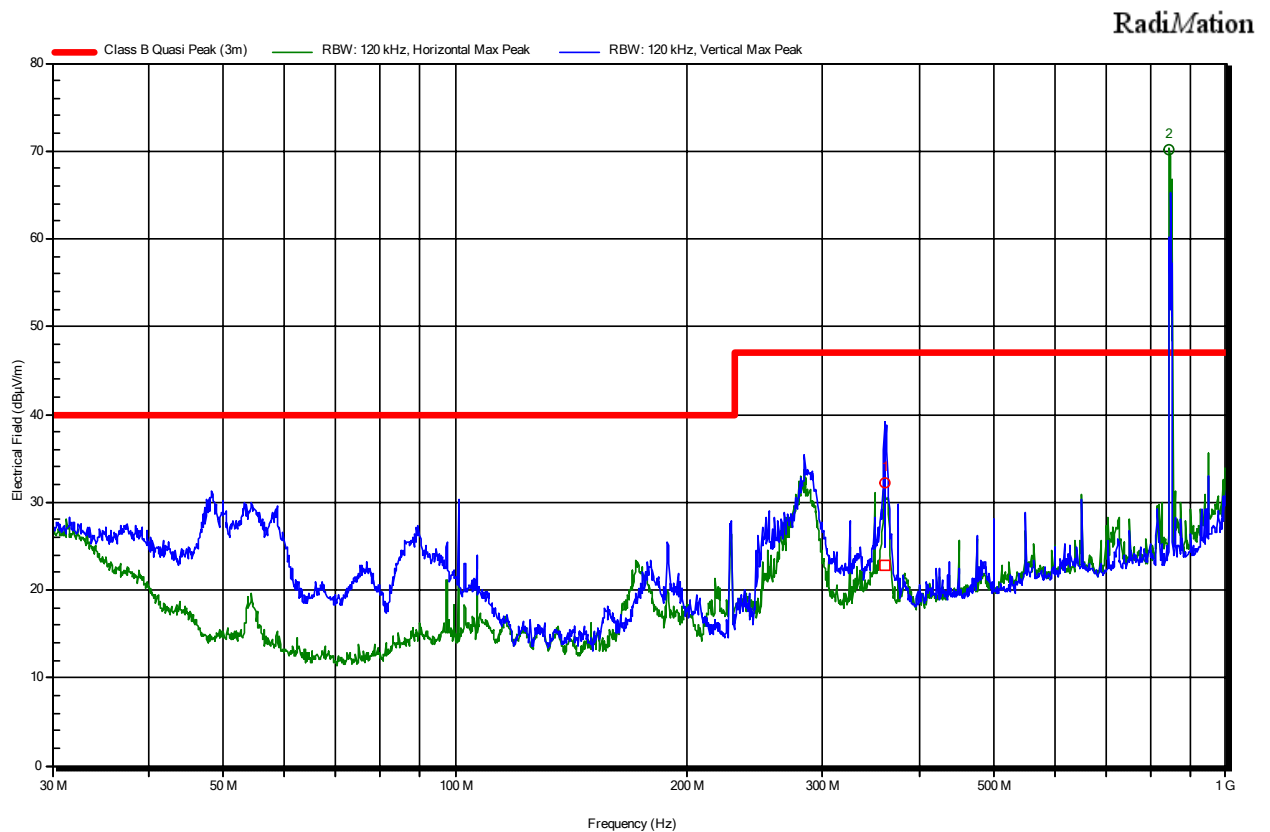
Detected peaks

Peak Number	Frequency	Peak	Angle	Height	Polarization
1	850.2 MHz	73.1 dBµV/m	120 degrees	1 m	Horizontal

Note: Peak 1: LTE, exclusion band according ETSI EN 301 489-24 applies

Diagram 11

EUT	EUT 1		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	48 VDC		
Test date, time	13.12.2019 13:41:55		
Antenna height	1 m - 4 m with 4 steps	Antenna polarization	Horizontal/Vertical
EUT position	0 degrees to 360 degrees	Antenna distance	3 m
Measurement settings	Radimation Version: 2019.1.5, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 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	Angle	Height	Polarization	Status
1	361.86 MHz	32.2 dBµV/m	22.8 dBµV/m	-24.2 dB	285 degrees	3 m	Vertical	Pass
2	845.19 MHz	70.1 dBµV/m	--	--	150 degrees	2 m	Horizontal	Note

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

10.4 Radiated Electromagnetic Field (1 – 6 GHz)

Test site: semi-anechoic chamber (hybrid)

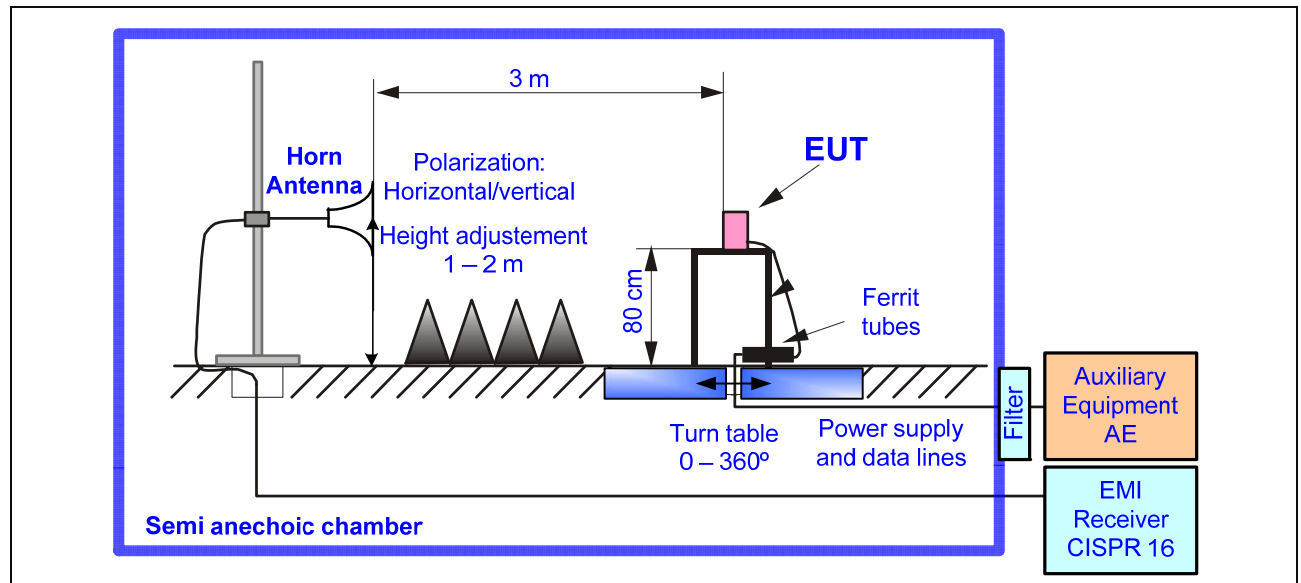
Distance: 3 m

Meas. uncertainty: see chapter 12

Measuring method: The electromagnetic disturbance radiated by the equipment is measured using a EMI receiver and a wide band antenna. The turning table is operated through 360° during the measurements with steps of 30°. The 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

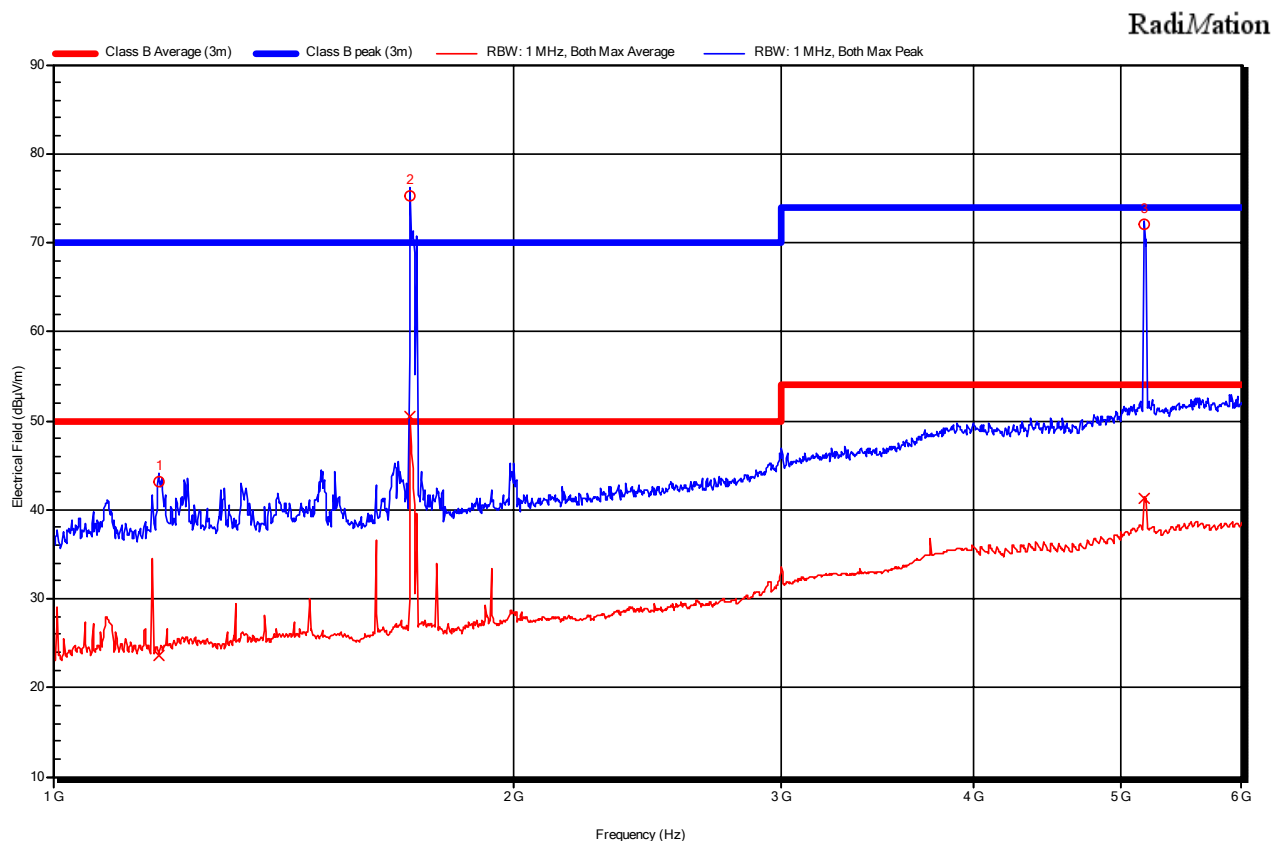
Photos of the Setup

see § 10.3

Measurement Results

Diagram 12

EUT	EUT 1		
Verdict	Pass according CISPR 32, Class B		
Mode of operation	48 VDC		
Test date, time	09.12.2019 12:58:22		
Antenna height	1 m - 2 m with 2 steps	Antenna polarization	Horizontal/Vertical
EUT position	0 degrees to 360 degrees	Antenna distance	3 m
Measurement settings	Radimation Version: 2019.1.5, 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	Angle	Polarization	Status
1	1.173 GHz	43.1 dBµV/m	-26.9 dB	23.6 dBµV/m	-26.4 dB	270 degrees	Horizontal	PASS
2	1.712 GHz	75.3 dBµV/m	--	50.5 dBµV/m	--	210 degrees	Vertical	Note
3	5.174 GHz	72.1 dBµV/m	-1.9 dB	41.2 dBµV/m	-12.8 dB	30 degrees	Vertical	PASS

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

10.5 Radiated Emission – Electromagnetic Field – FCC

Test site: semi-anechoic chamber (hybrid)

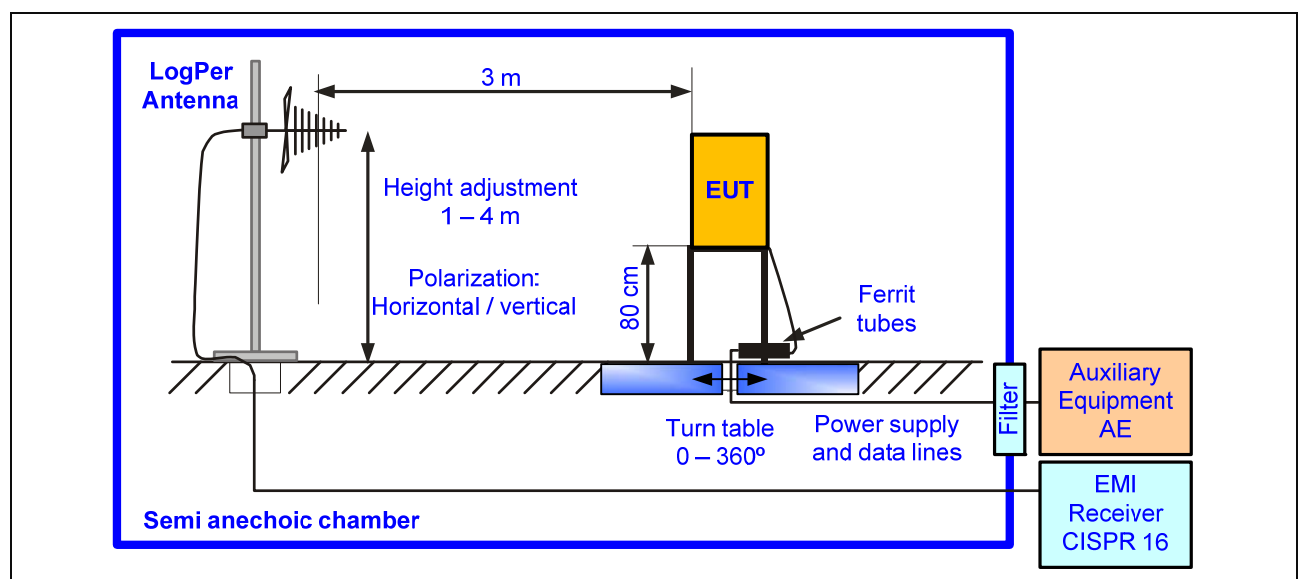
Distance: 3 m

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	ESW26	17.6632.05
Antenna LogPer	Chase	CBL 6112A	H8675
Coaxial Cable	Huber & Suhner	Sucoflex 106	17.6632.03, 17.6632.04, 18.6632.02

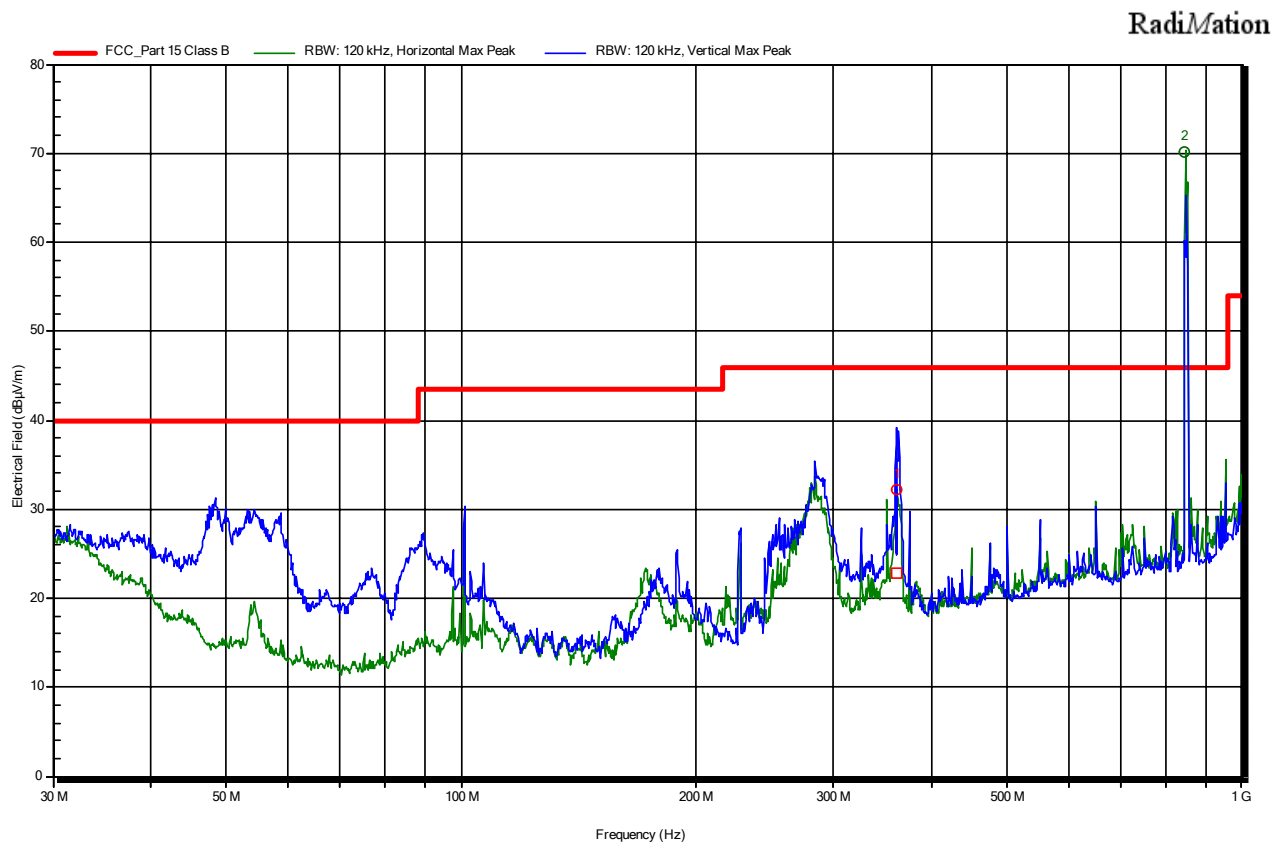
Photos of the Setup

see § 10.3

Measurement Results

Diagram 13

EUT	EUT 1		
Verdict	Pass according FCC Part 15 B		
Mode of operation	48 VDC		
Test date, time	13.12.2019 13:41:55		
Antenna height	1 m - 4 m with 4 steps	Antenna polarization	Horizontal/Vertical
EUT position	0 degrees to 360 degrees	Antenna distance	3 m
Measurement settings	Radimation Version: 2019.1.5, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 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	Angle	Height	Polarization	Status
1	361.86 MHz	32.2 dBμV/m	22.8 dBμV/m	-24.2 dB	285 degrees	3 m	Vertical	Pass
2	845.19 MHz	70.1 dBμV/m	--	--	150 degrees	2 m	Horizontal	Note

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

10.6 Radiated Electromagnetic Field – FCC (1 – 18 GHz)

Test site: semi-anechoic chamber (hybrid)

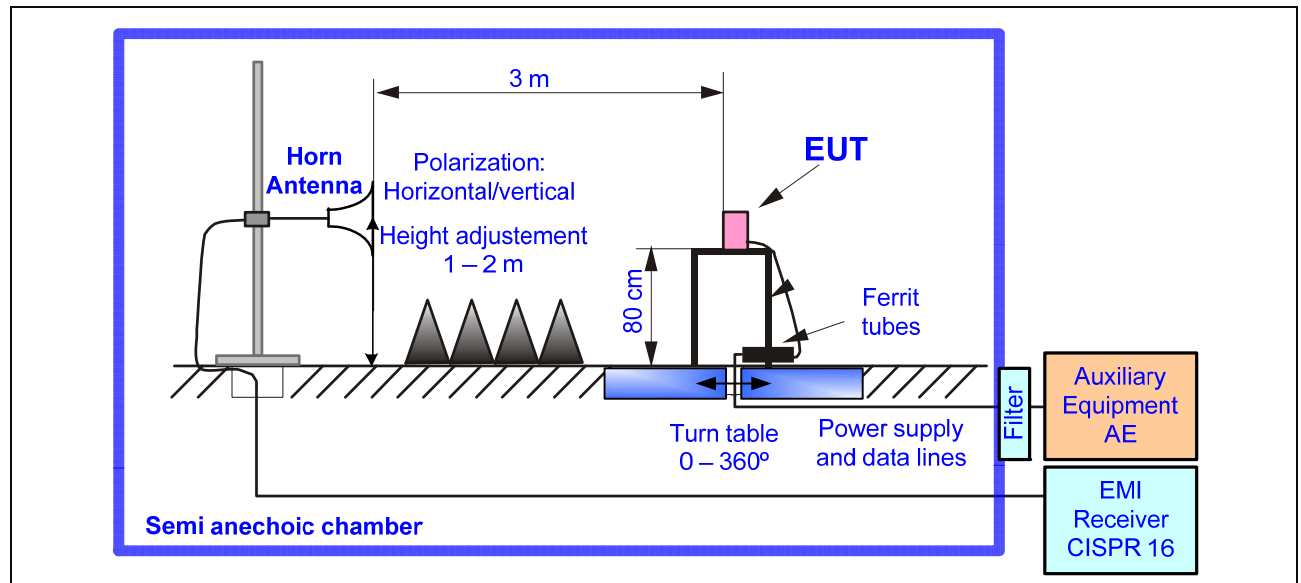
Distance: 3 m

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

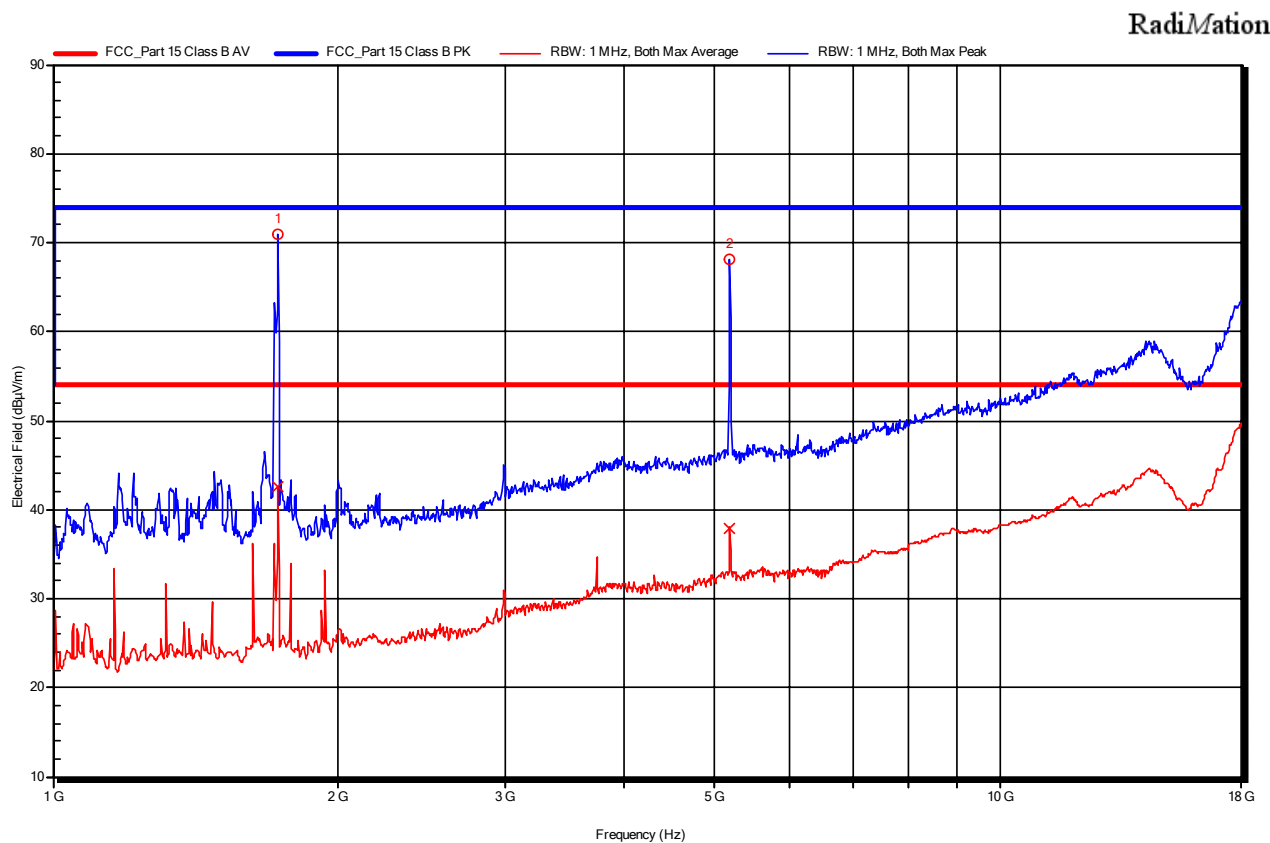
Photos of the Setup

see § 10.3

Measurement Results

Diagram 14

EUT	EUT 1		
Verdict	Pass according CISPR 32, Class B & FCC Part 15 B		
Mode of operation	48 VDC		
Test date, time	09.12.2019 13:36:20		
Antenna height	1 m	Antenna polarization	Horizontal/Vertical
EUT position	0 degrees to 360 degrees	Antenna distance	3 m
Measurement settings	Radimation Version: 2019.1.5, 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

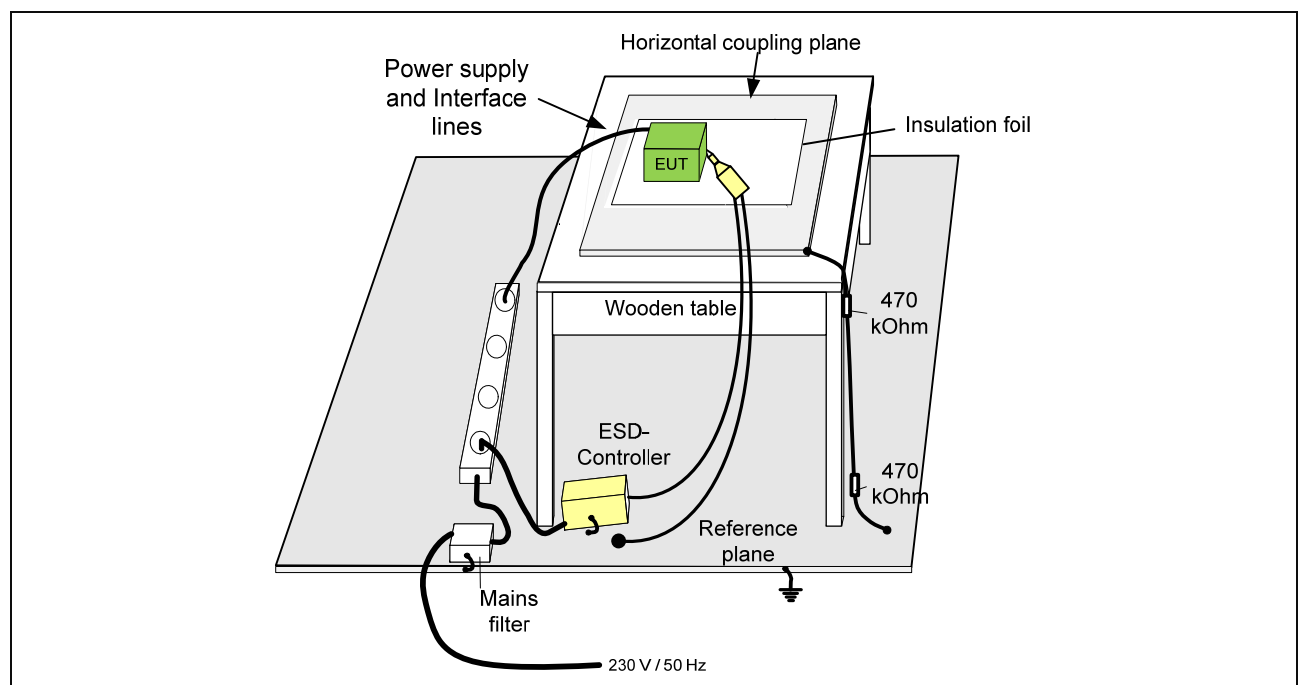
Peak Number	Frequency	Peak	Peak Difference	Average	Average Difference	Angle	Polarization	Status
1	1.728 GHz	70.9 dBμV/m	-3.1 dB	42.6 dBμV/m	-11.4 dB	120 degrees	Vertical	PASS
2	5.173 GHz	68.1 dBμV/m	-5.9 dB	38 dBμV/m	-16.0 dB	90 degrees	Vertical	PASS

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.

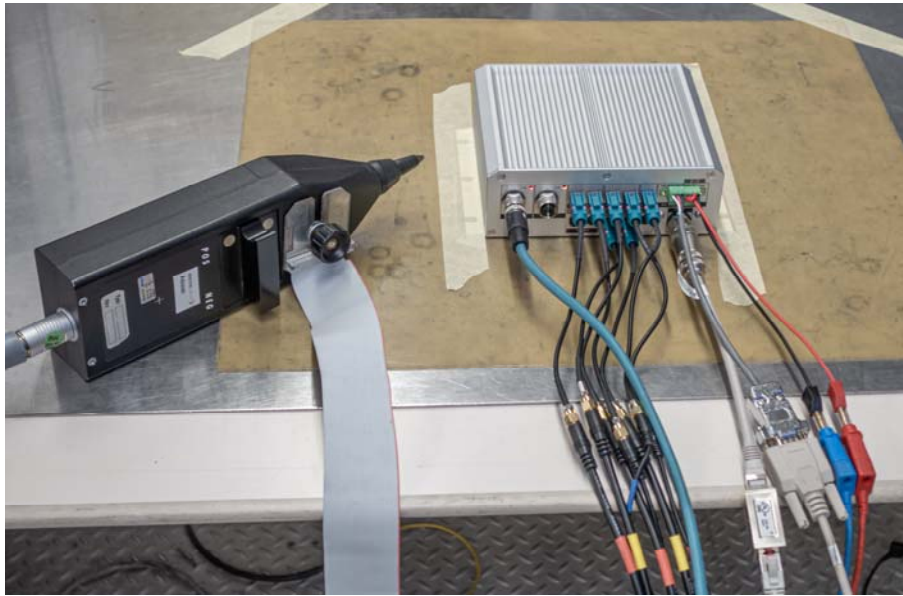
Test Setup



Test Equipment

Device Type	Brand	Type	ID
ESD Generator	EM-Test	ESD 30	PE10238

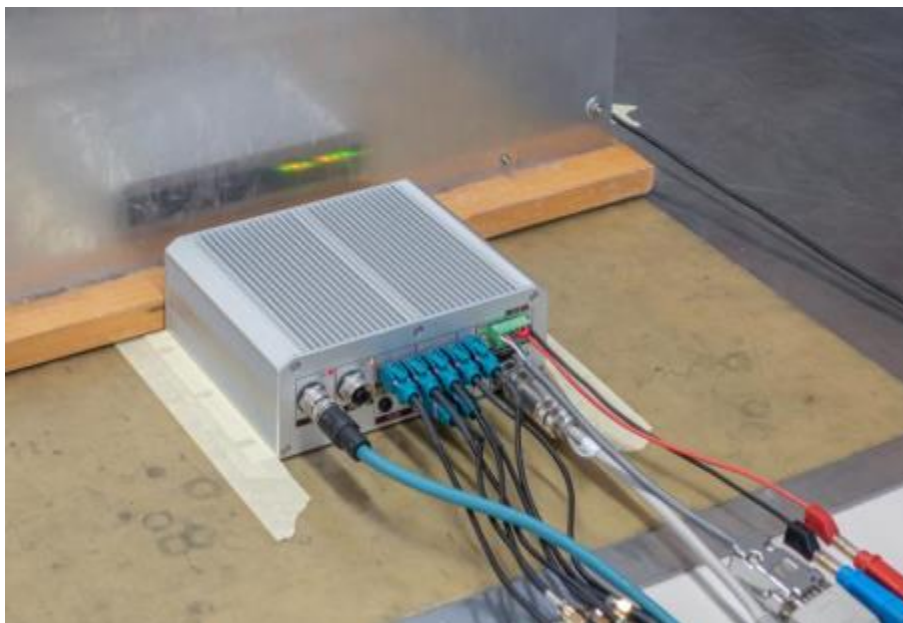
Photos of the Setup



Direct discharge / HCP



Air discharge



VCP

Test Results

Equipment: EUT 1
Cables connected: see chapter 9.4
Operating mode: see chapter 9.5
Observation of EUT: see chapter 9.6
Modifications: none
Test site: laboratory

Requirements

Standard	Required Level Air Discharge	Required Level Contact Discharge	Impulses per Point, Level and Polarity	Performance Criterion
EN 50121-3-2 IEC 62236-3-2	±8 kV	±6 kV	10	B
EN 61000-6-2 IEC 61000-6-2	±8 kV	±4 kV	10	B
EN 55035 CISPR 35	±8 kV	±4 kV	10	B
EN 301 489-1	±8 kV	±4 kV	10	B

Protocol of the Test

Level [kV]	No of discharges (for each level)	Discharge	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
± 2; ± 4; ± 6 (Note 1)	10	VCP	No errors occurred	A	PASS
± 2; ± 4; ± 6	10	HCP	No errors occurred	A	PASS
± 2; ± 4	10	Contact	No errors occurred	A	PASS
± 2; ± 4; ± 8	10	Air	No errors occurred	A	PASS
Tested points: Enclosure, LED's, SIM-Slots, Connectors					

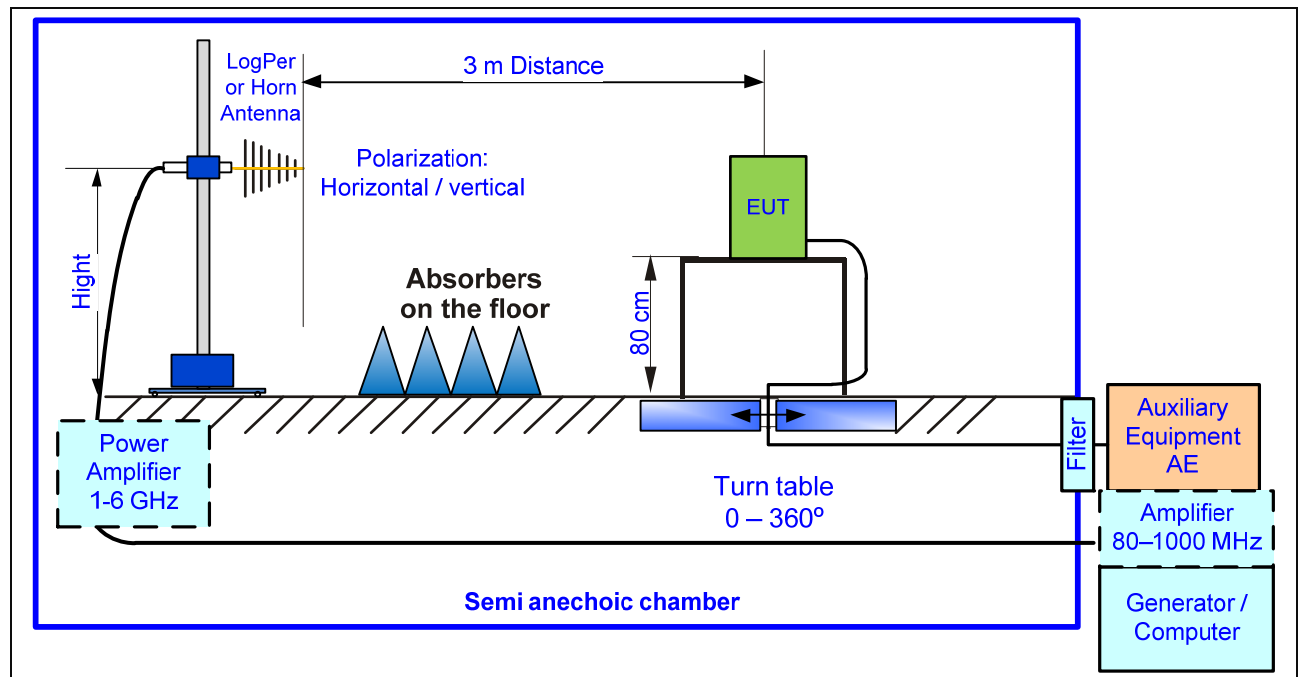
Notes:

- 1) on all sides of the EUT

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



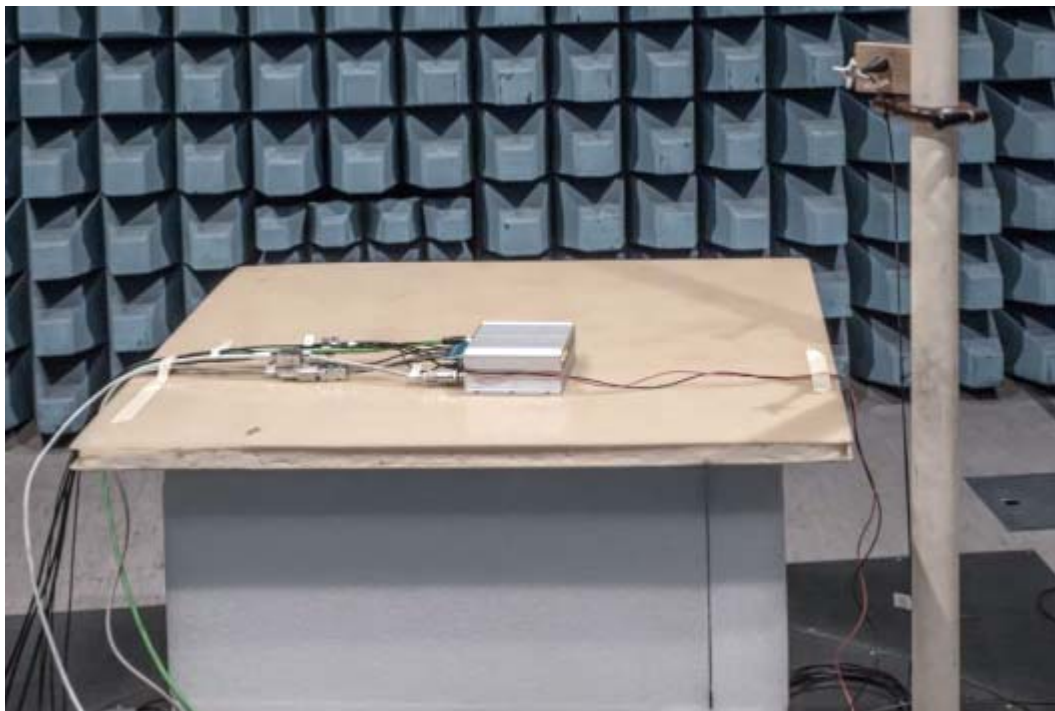
Test Equipment

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



Front side



Rear side

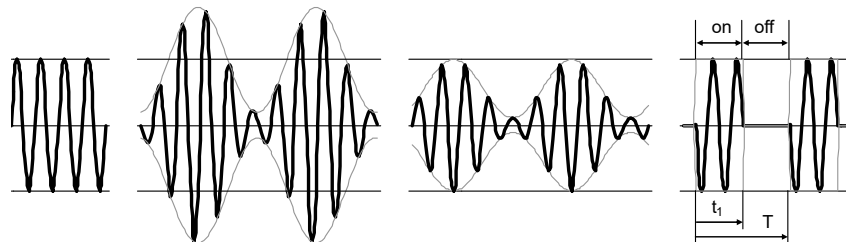
Test Results

Equipment: EUT 1
Cables connected: see chapter 9.4
Operating mode: see chapter 9.5
Observation of EUT: see chapter 9.6
Modifications: none
Test site: semi-anechoic chamber (hybrid)

Requirements

Standard	Frequency Range	Required Level	Modulation	Freq. step	Dwell time	Performance Criterion
EN 50121-3-2	80 – 1000 MHz	20 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1400 – 2000 MHz	10 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	2000 – 2700 MHz	5 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	5100 – 6000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
IEC 62236-3-2	80 – 1000 MHz	20 V/m	AM, 1 kHz, 80%	1 %	1 s	A
	1400 – 2100 MHz	10 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	2100 – 2500 MHz	5 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
EN 55035 CISPR 35	80 – 1000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1800 MHz \pm 1%	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	2600 MHz \pm 1%					
	3500 MHz \pm 1%					
EN 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 %	1 s	A
	2000 – 2700 MHz	1 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
IEC 61000-6-2	80 – 1000 MHz	10 V/m	AM, 1 kHz, 80 %	1 %	1 s	A
	1400 – 6000 MHz	3 V/m	AM, 1 kHz, 80 %	1 %	1 s	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 %	1 s	A

Modulation:

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

Protocol of the Test

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

Remarks:

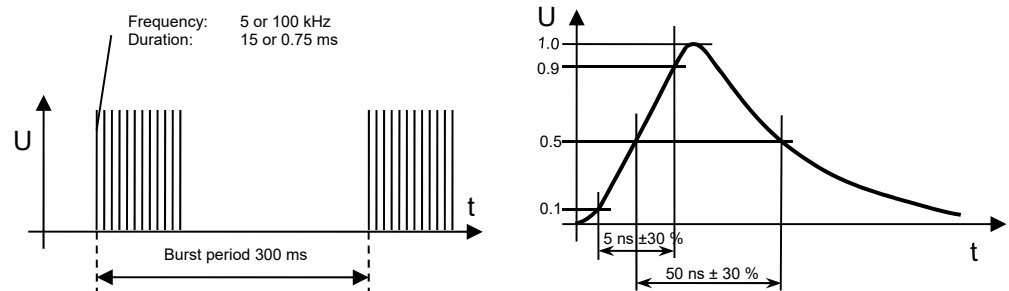
EUT has been completely tested in 18-EL-0356.E03, issued 2019-04-16. Therefore only 2 sides tested for verification.

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:



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 Equipment

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

Photos of the Setup



Test Results

Equipment: EUT 1
Cables connected: see chapter 9.4
Operating mode: see chapter 9.5
Observation of EUT: see chapter 9.6
Modifications: none
Test site: laboratory

Requirements

Standard	Required Level AC Supply	Required Level DC Supply	Required Level Signal	Protection. Earth	Burst Frequency	Performance Criterion
EN 50121-3-2 IEC 62236-3-2	±2.0 kV	.....	±2.0 kV	.....	5 kHz	A
EN 55035 CISPR 35	±1.0 kV	±0.5 kV	±0.5 kV	.....	5 kHz	B
EN 61000-6-2 IEC 61000-6-2	±2.0 kV	±1.0 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

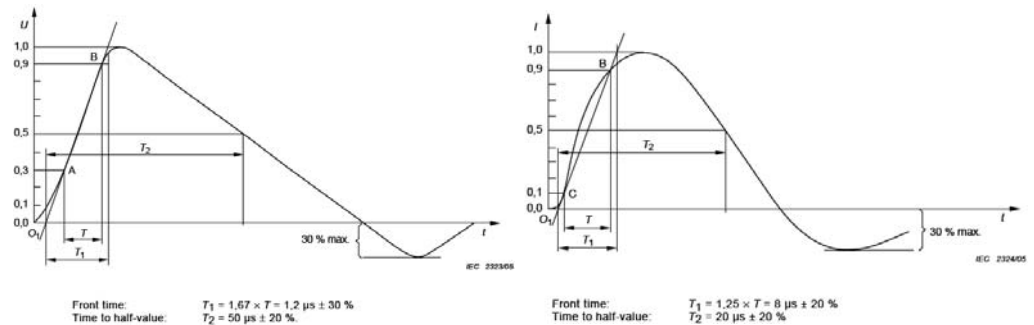
Tested port	Level [kV]	Duration	Frequency	Coupling	Result, Observation, Behavior of EUT	Fulfilled criterion	Verdict
DC Port	2.0 kV	60 s	5 kHz	direct	no errors occurred	A	PASS
	2.0 kV	60 s	100 kHz	direct	no errors occurred	A	PASS
ETH 1	2.0 kV	60 s	5 kHz	clamp	no errors occurred	A	PASS
	2.0 kV	60 s	100 kHz	clamp	no errors occurred	A	PASS
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
RS232	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 μ 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

Short-circuit current

Meas. uncertainty:

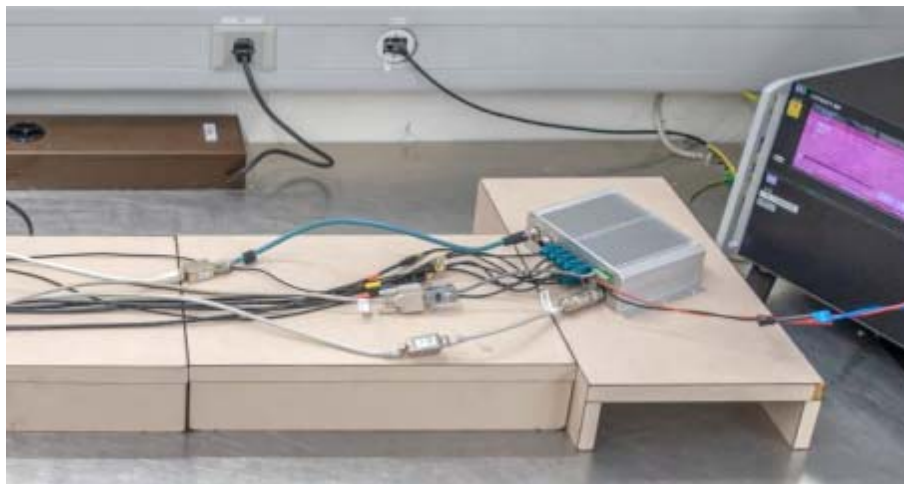
see chapter 12

Measuring method:

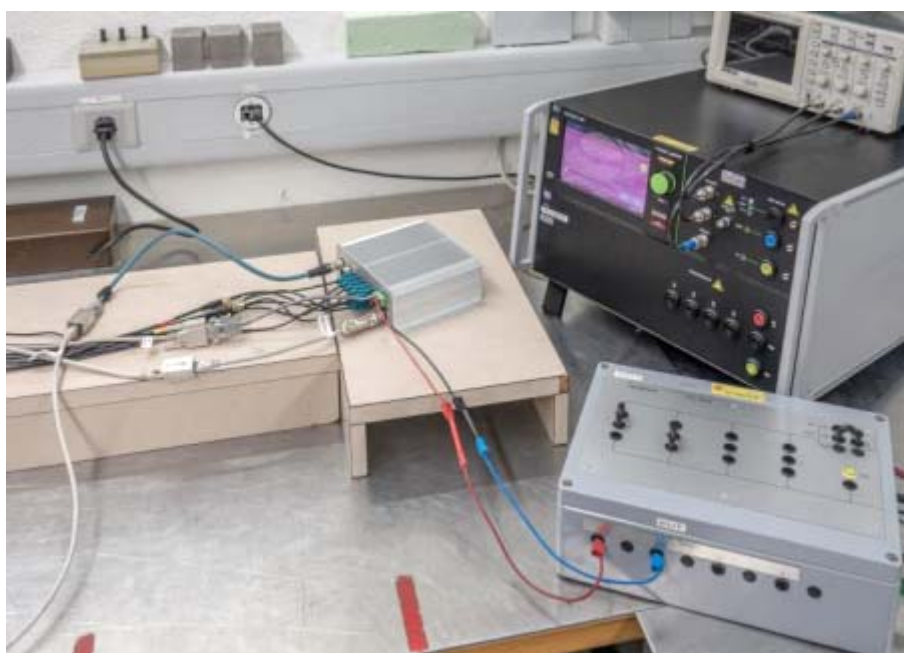
The impulses are coupled using the coupling network where the supply lines and unshielded cables are concerned. The shielded cables are coupled directly. The two polarities and different phase angles are tested for all the test levels up until the specified level.

Test Equipment

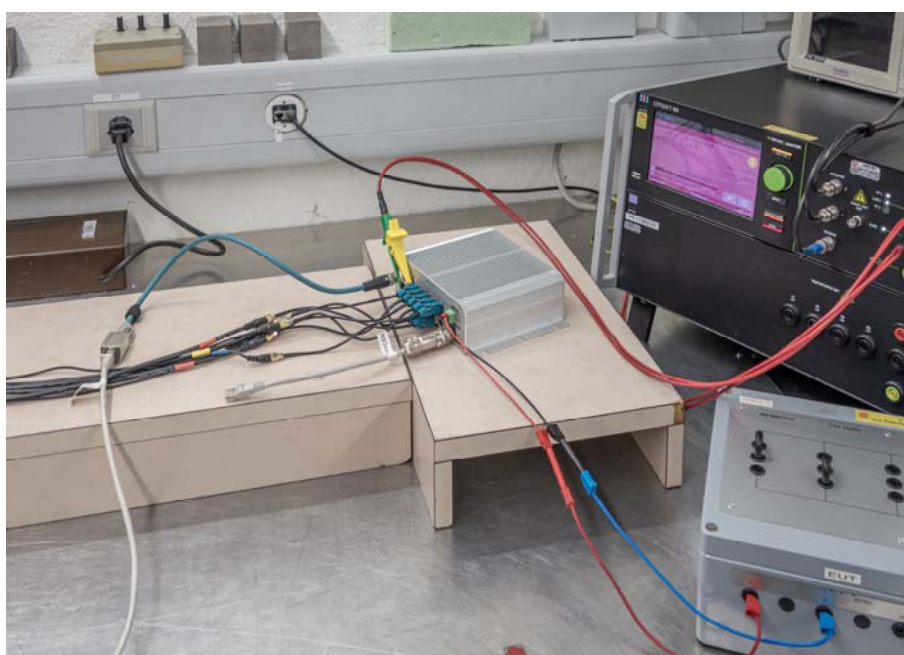
Device Type	Brand	Type	ID
Burst Generator	EM-Test	Compact NX5	17.6632.01
Coupling/Decoupling Network	EM Test	CNV 504N	15.6632.13

Photos of the Setup

Coupling with 2/12 Ohm



Coupling with 42 Ohm



Direct coupling to enclosure

Test Results

Equipment: EUT 1
Cables connected: see chapter 9.4
Operating mode: see chapter 9.5
Observation of EUT: see chapter 9.6
Modifications: none
Test site: laboratory

Requirements

Standard	Required Level AC-Supply		Required Level DC-Supply		Required Level Signal		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 55035 CISPR 35	±1.0 kV	±2.0 kV	---	±0.5 kV	--	±1.0 kV ²⁾	B
EN 61000-6-2	±1.0 kV	±2.0 kV	±0.5 kV	±0.5 kV	---	±1.0 kV	B
IEC 61000-6-2	±1.0 kV	±2.0 kV	±0.5 kV	±1.0 kV	---	±1.0 kV	B
EN 301 489-1	±1.0 kV In telecom centers: ±0.5 kV	±2.0 kV In telecom centers: ±1.0 kV	---	---	---	--	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 IEC 62236-3-2	±1.0 kV	±2.0 kV	--	--	B

Protocol of the Test

Tested port	Level [kV]	Coupling mode	Coupling network	Number of pulses*	Result, Observation, Behavior of EUT	Fulfilled Criterion	Verdict
DC-Port	±0.5	L1 – L2	2 Ω + 18 µF	5	no errors occurred	A	PASS
DC-Port **	±0.5; ±1.0	L1 – L2	42 Ω + 0.5 µF	5	no errors occurred	A	PASS
ETH 1	±0.5; ±1.0	Screen - PE	2 Ω + 18 µF	5	no errors occurred	A	PASS
CAN	±0.5; ±1.0	Screen - PE	2 Ω + 18 µF	5	no errors occurred	A	PASS

* Number of pulses for each voltage level and each polarity

** Powered with 48 VDC, due to CDN CNV 504N not working with 24 VDC

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.

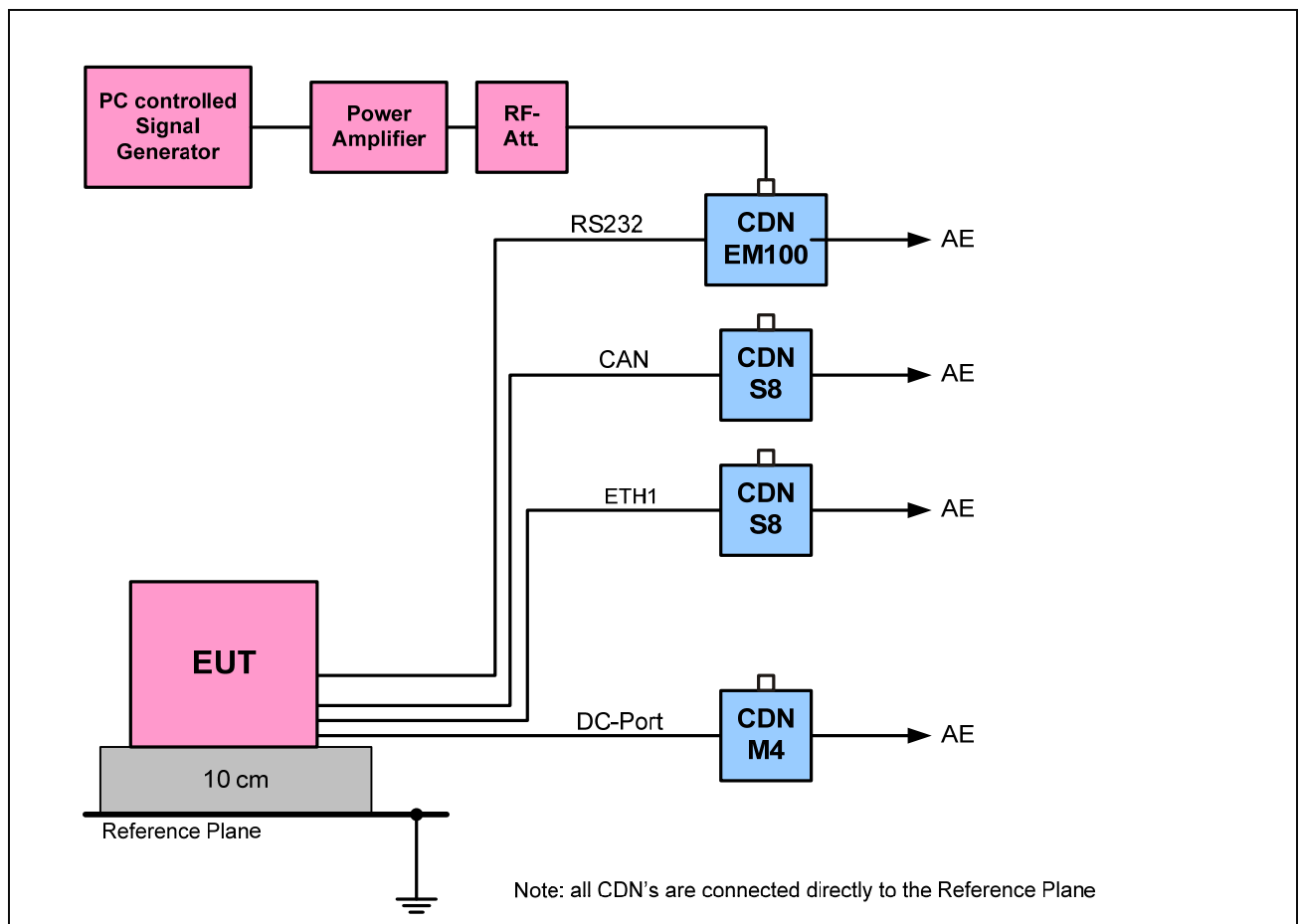
Meas. uncertainty:

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.

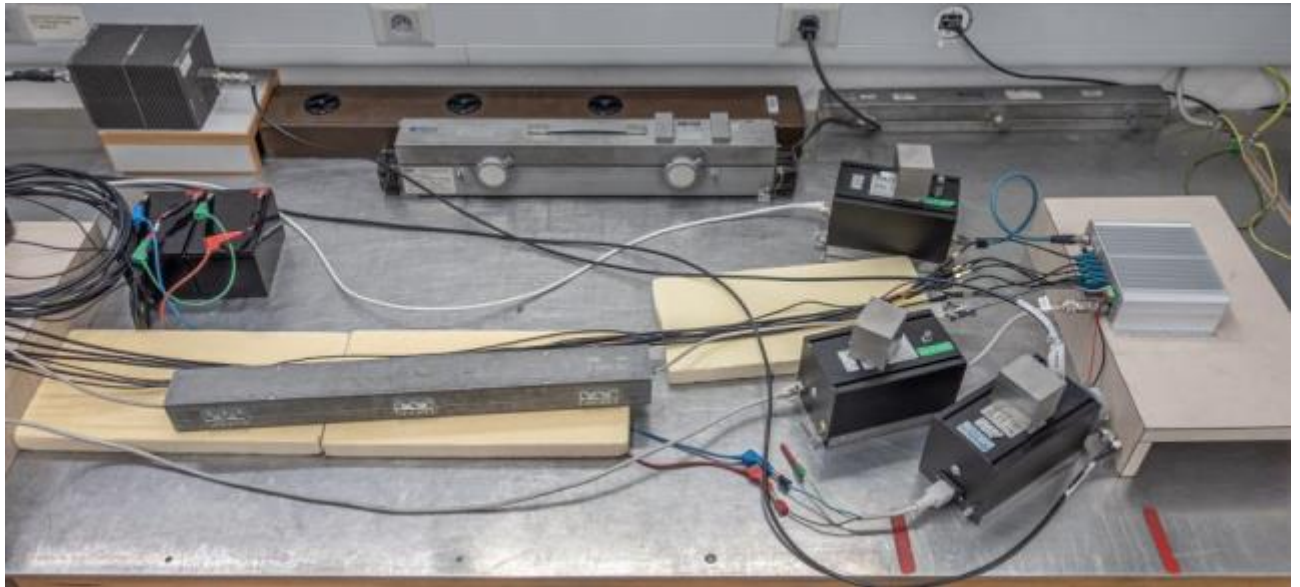
Test Setup



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	RadiPower	RPR2006C	18.6632.09
Injection device	EM-Test	CDN M2/3	H10166
Injection device	Lüthi	CDS S8 (RJ45)	13.6632.07 13.6632.08
Injection device	EM-Test	EM 100 FTC101	H4844 H6979

Photos of the Setup



Test Results

Equipment: EUT 1
Cables connected: Mains, see chapter 9.4
Operating mode: Active, see chapter 9.5
Observation of EUT: Visually, 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 IEC 62236-3-2	0.15 – 80 MHz	10 V _{EMF}	AM, 1 kHz, 80 %	1 %	1 s	A
EN 55035 CISPR 35	0.15 – 10 MHz	3 V _{EMF}	AM, 1 kHz, 80 %	1 %	1 s	A
	10 – 30 MHz	3 – 1 V _{EMF}	AM, 1 kHz, 80 %	1 %	1 s	A
	30 – 80 MHz	1 V _{EMF}	AM, 1 kHz, 80 %	1 %	1 s	A
EN 61000-6-2 IEC 61000-6-2	0.15 – 80 MHz	10 V _{EMF}	AM, 1 kHz, 80 %	1 %	1 s	A
EN 301 489-1	0.15 – 80 MHz	3 V _{EMF}	AM, 1 kHz, 80 % %	1 %	1 s	A

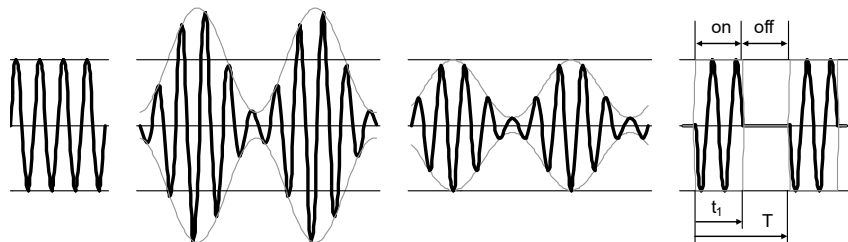
Signal modulation:

☐ CW

☒ AM (normal)

☐ AM (const. peak)

☐ PM



Protocol of the Test

Coupling	CDN	Terminated(50 Ω)	Freq. [MHz]	Level [V]	Remarks	Fulfilled criterion	Verdict
DC-Port	M2	S8, ETH 1	0.15 – 80	15	no errors occurred	A	PASS
ETH 1	S8	M2, DC-Port	0.15 – 80	15	no errors occurred	A	PASS
CAN	S8	S8, ETH 1	0.15 – 80	15	no errors occurred	A	PASS
RS232	EM100	S8, ETH 1	0.15 – 80	15	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 _o : (normal distribution)		± 9.0 %
	Duration of the voltage interruption t _e : (rectangular distribution)		± 5.0 %
	Phase φ _o :(rectangular distribution)		± 2.8 %
Voltage fluctuation	Output voltage U _o : (normal distribution)		± 9 %
	Duration of the voltage fluctuation t _o : (rectangular distribution)		± 20 %