InterLab

FCC Measurement/Technical Report on

WLAN transceiver
WiBear11n-DF1

FCC ID PV7-WIBEAR11N-DF1
IC: 7738A-WB11NDF1

Report Reference: MDE_UBLOX_1624_FCCd

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

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0 Applied Standards and Test Summary

0.1 Applied Standards

Type of Authorization
Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-13 Edition) and 15 (10-1-13 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

Part 15, Subpart E – Unlicensed National Information Infrastructure Devices

§ 15.403 Definitions

§ 15.407 General technical requirements

Note:
The tests were selected and performed with reference to the FCC Public Notice "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D01 General U-NII Test Procedures v01r03, 2013-4-08"

Instead of applying ANSI C63.4–1992 which is referenced in the FCC Public Note, the newer ANSI C63.10–2014 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 FCC-IC Correlation Table

Correlation of measurement requirements for UNII / LE-LAN (e.g. WLAN 5 GHz) equipment

UNII equipment +)

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.403 (i) (26 dB) / § 15.407 (e) (6 dB)	RSS-247 Issue 1: 6.2.1 (1), 6.2.2 (1), 6.2.3 (1) (99%) RSS-247 Issue 1: 6.2.4 (1) (6 dB)
Maximum conducted output power	§ 15.407 (a) (1),(2),(3),(4)	RSS-247 Issue 1: : 6.2.1 (1), 6.2.2 (1), 6.2.3 (1), 6.2.4 (1)
Maximum power spectral density	§ 15.407 (a) (1),(2),(3),(5)	RSS-247 Issue 1: : 6.2.1 (1), 6.2.2 (1), 6.2.3 (1), 6.2.4 (1)
Transmitter undesirable emissions; General Field Strength Limits, Restricted Bands	15.407 (b) § 15.209 (a)	RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-247 Issue 1: : 6.2.1 (2), 6.2.2 (2), 6.2.3 (2), 6.2.4 (2)
Frequency stability	§ 15.407 (g)	RSS-Gen Issue 4: 6.11/8.11
Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS)	§ 15.407 (h)	RSS-247 Issue 1: 6.2.2 (1), 6.2.3 (1), 6.3
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	-

0.3 Measurement Summary / Signatures

FCC Part 15, Subpart C	§ 15.207		
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.4			
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 4	Setup_05	AC Port (power line)	passed

FCC Part 15, Subpart E	§ 15.403 (i)		
26dB Emission bandwidth			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
		Temp.ant.connector	Not performed

FCC Part 15, Subpart E	§ 15.407 (a)(1,2,3,4)		
Maximum Conducted Output Power			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
		Temp.ant.connector	Not performed

FCC Part 15, Subpart E	§ 15.407 (a)(1,2,3,5)		
Peak Power Spectral Density			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
		Temp.ant.connector	Not performed

FCC Part 15, Subpart E	§ 15.407 (a)(6)		
Peak Excursion			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
		Temp.ant.connector	Not performed

FCC Part 15, Subpart E	§ 15.407 (g)		
Frequency Stability			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
		Temp.ant.connector	Passed

FCC Part 15, Subpart E	§ 15.407 (b)(1,2,3,4)		
Undesirable Emissions			
The measurement was performed according to ANSI C63.4			
OP-Mode	**Setup**	**Port**	**Final Result**
a-Mode, CH 36, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 44, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 48, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 52, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 56, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 64, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 100, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 116, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 140, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 36, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 44, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 48, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 52, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 56, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 64, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 100, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 116, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 140, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 38, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 46, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 54, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 62, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 102, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 110, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 134, 40 MHz	Setup_02	Enclosure	Passed

FCC Part 15, Subpart C & E	§ 15.205, § 15.209 § 15.407 (b)(5,6)

General Field Strength Limits; Restricted Bands and
Radiated Emission Limits

The measurement was performed according to ANSI C63.4

OP-Mode	Setup	Port	Final Result
a-Mode, CH 36, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 44, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 48, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 52, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 56, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 64, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 100, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 116, 20 MHz	Setup_02	Enclosure	Passed
a-Mode, CH 140, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 36, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 44, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 48, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 52, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 56, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 64, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 100, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 116, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 140, 20 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 38, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 46, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 54, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 62, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 102, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 110, 40 MHz	Setup_02	Enclosure	Passed
n-Mode, CH 134, 40 MHz	Setup_02	Enclosure	Passed

FCC Part 15, Subpart E	§ 15.407 (h)		
Dynamic Frequency selection			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
-	-	-	Not performed

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2014-03-14	Report reference: MDE_LESSW_1302_FCCb	valid
rev1	2016-05-25	- FCC – IC correlation table updated (references to RSS-247) - Editorial changes - Setup drawing for conducted tests added - Measurement uncertainties added - Customer company name and address updated - Remove of Conducted measurements. - Antenna Factors added	valid

NOTE:
This report is a partial test report. This report should be taken in conjunction with the updated test report referenced by MDE_UBLOX_1624_FCCa.

Responsible for Accreditation Scope: _____ Responsible for Test Report: _____

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716 .

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Thomas Hoell Dipl.-Ing Andreas Petz Dipl.-Ing Marco Kullik
Report Template Version:	2014-03-13

1.2 Project Data

Responsible for testing and report:	Patrick Lomax
Date of Test(s):	2013-12-09 to 2014-02-26
Date of Report:	2016-05-30

1.3 Applicant Data

Company Name:	u-blox Berlin GmbH
Address:	Rudower Chaussee 9 12489 Berlin Germany
Contact Person:	Dr. Daniel Dietterle

1.4 Manufacturer Data

Company Name:	PRETTL Electronics AG
Address:	Robert-Bosch-Straße 10, 01454 Radeberg, Germany
Contact Person:	Kerstin Sauer

2 Test object Data

2.1 General EUT Description

Equipment under Test:	IEEE 802.11a/b/g/n WLAN transceiver
Type Designation:	WiBear11n
Kind of Device: (optional)	Transceiver module
Voltage Type:	DC
Voltage Level:	1.8 V and 3.3 V
Tested Modulation Type:	DBPSK; OFDM:BPSK; OFDM:64-QAM

General product description:

The EUT is industrial universal module, targeted for integration into different Original Equipment Manufacturer products. The module is designed for both - simultaneous and independent operation of the following:
IEEE 802.11a/b/g/n payload data rates for Wireless Local Area Network (WLAN), Bluetooth 3.0+High Speed (HS) and Bluetooth 2.1+EDR. It provides a complete end-to-end solution for low power applications. It includes an integrated MAC/Baseband processor and RF front-end components, and can connect to a host processor via SDIO interface.

Specific product description for the EUT:

The EUT is a dual band WLAN (802.11 a/b/g/n, 2.5 and 5 GHz) and Bluetooth module with one joint antenna connector for WLAN and Bluetooth. In IEEE 802.11n mode it supports 20 MHz and 40 MHz bandwidth channels (both with MCS7), providing 72.2 Mbit/s, and 150 Mbit/s transfer data rates respectively.

The object of this test report is the WLAN transceiver, consequently switched on the IEEE 802.11 a/n modes, working in the 5 GHz bands. In IEEE 802.11n mode, it was tested with 20 MHz and 40 MHz channel bandwidth.

The EUT provides the following ports:

Ports
Enclosure
Antenna connector
DC port
Data port

The main components of the EUT are listed and described in chapter 2.2

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
EUT A (Code: LS000a01)	WLAN transceiver	WiBear11n-DF1	AN00J93172 C43380045 499	C4	14.44.35.p200
Remark: mounted on evaluation board (AUX4), the EUT has no integral antenna.					
EUT B (Code: LS000b01)	WLAN transceiver	WiBear11n-DF1	AN00J93172 C43380045 500	C4	14.44.35.p200
Remark: mounted on evaluation board (AUX5), the EUT has no integral antenna.					
EUT C (Code: LS000s01)	WLAN transceiver	WiBear11n-DF1	AN00J93172 C43380045 520	C4	14.44.35.p200
Remark: mounted on evaluation board (AUX6), the EUT has no integral antenna.					
EUT D (Code: LS000x01)	WLAN transceiver	WiBear11n-DF1	AN00J93172 C43380045 559	C4	14.44.35.p200
Remark: mounted on evaluation board (AUX7), the EUT has no integral antenna.					

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.
–	–	–	–	–	–

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status
AUX1	Laptop Acer TravelMate 5720	Model: 2205	LXTK20603274 4008D6A2000	–	WinXP Prof.EN
AUX2	AC/DC Adapter for AUX1 Acer/LITEON	Model PA-1900-24	870923010AR	Rev A06	–
AUX3	cable & adapter board & SDIO connector to the host PC	Lesswire AG HOST SDIO	SDIO 1	–	–
AUX4	evaluation board with antenna connector and antenna disabled.	EB1 & Antenova A10194 dual-band WLAN/BT antenna	#20	–	–
AUX5	evaluation board with antenna (gain = 4.1 dBi) enabled and antenna connector (open).	EB1 & Antenova A10194 dual-band WLAN/BT antenna	#7	–	–
AUX6	evaluation board with antenna (gain = 4.1 dBi) enabled and antenna connector (open).	EB1 & Antenova A10194 dual-band WLAN/BT antenna	#19	–	–
AUX7	evaluation board with antenna connector and antenna disabled.	EB1 & Antenova A10194 dual-band WLAN/BT antenna	#8	–	–
AUX8	DC Power Supply	Philips PE 1540	WB2045	–	–

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AUX1 to AUX3 + AUX4	setup for the conducted tests
Setup_02	EUT B + AUX1 to AUX3 + AUX5	setup for radiated measurements
Setup_03	EUT C + AUX1 to AUX3 + AUX6	setup for radiated measurements
Setup_04	EUT D + AUX1 to AUX3 + AUX7	setup for the conducted tests
Setup_05	EUT C + AUX1 to AUX3 + AUX6 + AUX8	Setup for the test “Conducted Emissions”

2.6 Operating Modes

2.6.1 Test Channels

UNII-Subband 1 5150 - 5250 MHz			UNII-Subband 2A 5250 - 5350 MHz			UNII-Subband 2C 5470 - 5725 MHz			UNII-Subband 3 5725 - 5825 MHz		
20 MHz Test Channels (Channel No./Frequency [MHz]):											
Bottom	**Middle**	**Top**	**Bottom**	**Middle**	**Top**	**Bottom**	**Middle**	**Top**	**Bottom**	**Middle**	**Top**
36	44	48	52	56	64	100	116	140	-	-	-
5180	5220	5240	5260	5280	5320	5500	5580	5700	-	-	-
40 MHz Test Channels (Channel No./Frequency [MHz]):											
Bottom	**Middle**	**Top**	**Bottom**	**Middle**	**Top**	**Bottom**	**Middle**	**Top**	**Bottom**	**Middle**	**Top**
38	-	46	54	-	62	102	110	134	-	-	-
5190	-	5230	5270	-	5310	5510	5550	5670	-	-	-

COMMENT: Subband 3 not tested!

2.6.2 Datarates

WLAN a-Mode; Channel Bandwidth: 20 MHz ; Data rate: 6 Mbit/s
WLAN n-Mode; Channel Bandwidth: 20 MHz ; Data rate: 72.2 Mbit/s
WLAN n-Mode; Channel Bandwidth: 40 MHz ; Data rate: 150 Mbit/s

2.7 Special software used for testing

Marvell Labtool 8787 software is used to set the EUT into the different operating modes.

2.8 Product labelling

2.8.1 FCC ID label

Please refer to the documentation of the applicant.

2.8.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Conducted emissions (AC power line)

Standard FCC Part 15 Subpart C

The test was performed according to: ANSI C 63.4

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4
The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software ES-K1 from R&S.

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak - Maxhold
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dBµV)	AV Limit (dBµV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

Used conversion factor: Limit (dBµV) = 20 log (Limit (µV)/1µV).

3.1.3 Test Protocol

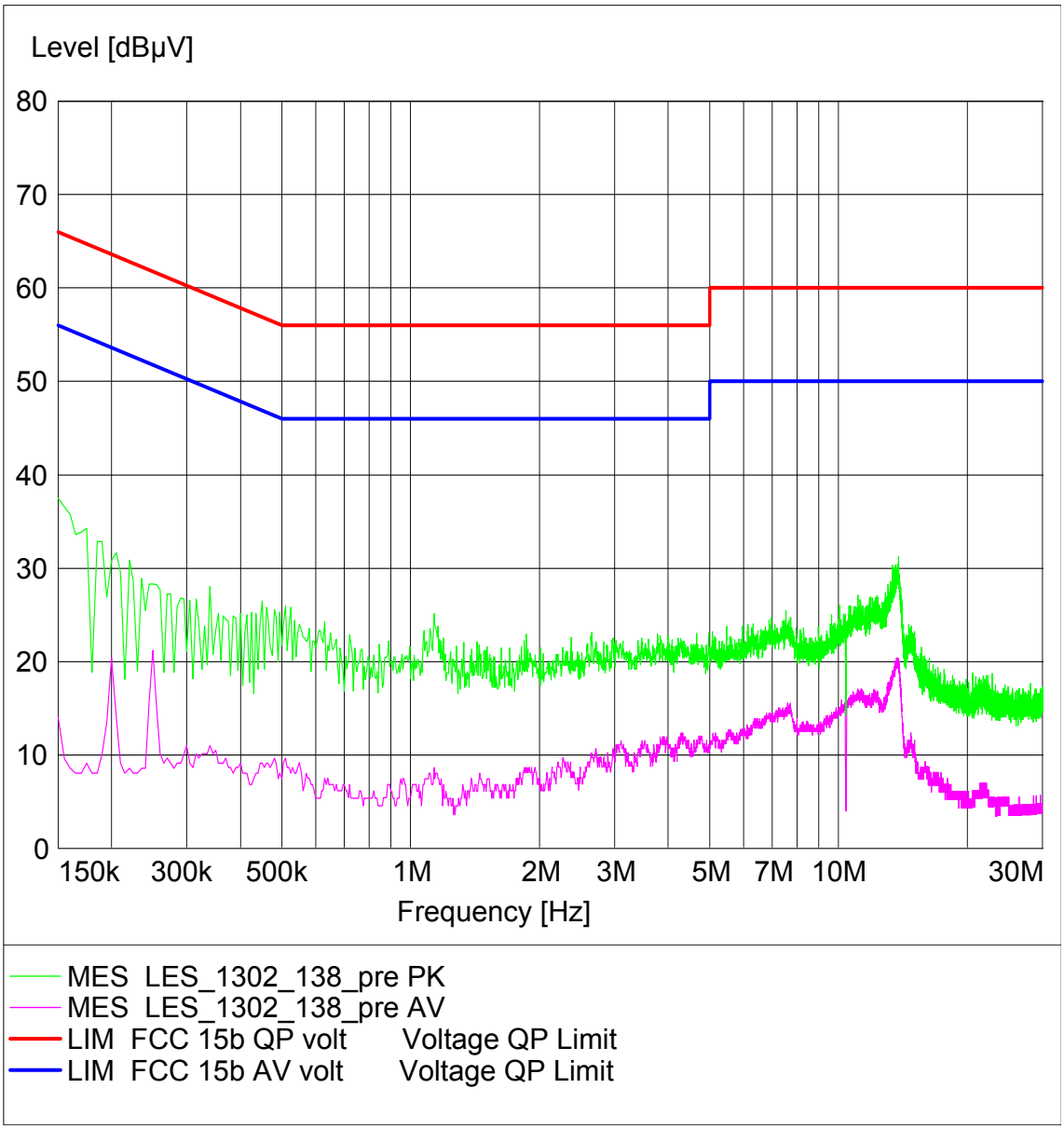
Temperature: 23 °C
Air Pressure: 1013 hPa
Humidity: 37 %

Op. Mode	Setup	Port
Mode 5580 MHz, CH:116, a-mode, 6Mbps	Setup_05	DC Port

Power line	Frequency MHz	Measured value dBµV	Margin dBµV	Remarks
–	–	–	–	–

Remark: No final measurement was performed because no frequencies (peaks) were found within the offset for acceptance analysis during the preliminary scan. Please see annex for the measurement plot.

3.1.4 Measurement Plot (showing the highest value, “worst case”)



3.2 Emission bandwidth (26 dB / 99 %)

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.2.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (widest) emission bandwidth (26 dB and 99%).

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:
- Resolution Bandwidth (RBW): 200 kHz (appr. 1 % of emission bandwidth)
- Video Bandwidth (VBW): 300 kHz
- Detector: Peak
- Trace: Maxhold
- Sweeps: > 200
- Sweeptime: coupled

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.403 (i)
There exists no applicable limits. The test was performed to determine the limits for the “Maximum Conducted Output Power” test case. Therefore no result was applied.

3.2.3 Test Protocol

Ambient temperature: 23 °C
Air Pressure: 1020 hPa
Humidity: 40 %

Not performed

3.2.4 Measurement Plot (showing the highest value, “worst case”)

Not performed

3.3 Maximum conducted output power

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.3.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the output power measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The EUT was connected to spectrum analyser via a short coax cable with a known loss.

Analyser settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Detector: RMS
- Trace: Average
- Sweeps: 100
- Sweeptime: coupled

Note:
The analyser settings are according FCC Public Note “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D01 General UNII Test Procedures v01r03, 2013-4-08”,
method **SA-1**.

3.3.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.407 (a) (1)
For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
Limit: 50 mW (17 dBm) or 4 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.

FCC Part 15, Subpart E, §15.407 (a) (2)
For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
Limit: 250 mW (24 dBm) or 11 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.

FCC Part 15, Subpart E, §15.407 (a) (3)
For systems using digital modulation techniques in the 5.725 – 5.825GHz bands:
Limit: 1 W (30 dBm) or 17 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.

3.3.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1020 hPa
Humidity: 40 %

The antenna gain is excluded in the table.

Ambient temperature: 23 °C
Air Pressure: 1020 hPa
Humidity: 40 %

Not performed

3.3.4 Measurement Plot (showing the highest value, “worst case”)

Not performed

3.4 Peak Power Spectral Density

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.4.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the Peak Power Spectral Density measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The EUT was connected to spectrum analyser via a short coax cable with a known loss.

Analyser settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Detector: RMS
- Trace: Average
- Sweeps: 100
- Sweeptime: coupled
- Marker: Peak

Note:
The analyser settings are according FCC Public Note “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D01 General UNII Test Procedures v01r03, 2013-4-08”,
method **SA-1.**

3.4.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.407 (a) (1)
For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
Limit: 4 dBm/MHz

FCC Part 15, Subpart E, §15.407 (a) (2)
For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
Limit: 11 dBm/MHz

FCC Part 15, Subpart E, §15.407 (a) (3)
For systems using digital modulation techniques in the 5.725 – 5.825GHz bands:
Limit: 17 dBm/MHz

3.4.3 Test Protocol

Ambient temperature: 23 °C
Air Pressure: 1020 hPa
Humidity: 40 %

Not performed

3.4.4 Measurement Plot (showing the highest value, “worst case”)

Not performed

3.5 Peak Excursion

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.5.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the Peak Excursion measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The EUT was connected to spectrum analyser via a short coax cable with a known loss.

Analyser settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Detector: Peak
- Trace: Maxhold
- Sweeps: 200
- Sweeptime: 100 ms
- Marker: Peak

Note:
The analyser settings are according FCC Public Note “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D01 General UNII Test Procedures v01r03, 2013-4-08”,

3.5.2 Test Requirements / Limits

FCC Part 15, Subpart E, § 15.407 (a), (6)

Peak excursion must not exceed 13 dB compared to the Peak Power Spectral Density.

3.5.3 Test Protocol

Ambient temperature: 23 °C
Air Pressure: 1020 hPa
Humidity: 40 %

Not performed

3.5.4 Measurement Plot (showing the highest value, “worst case”)

Not performed

3.6 Frequency Stability

Standard FCC Part 15, Subpart E

3.6.1 Test Description

The Equipment Under Test (EUT) was set up in an temperature chamber to perform the frequency stability test.
The results recorded, were measured while the EUT is transmitting a CW signal on the required frequency.

The EUT was connected to spectrum analyser via a short coax cable with a known loss.

Analyser settings:
- Frequency Counter activated, Resolution 1 Hz

3.6.2 Test Requirements / Limits

FCC Part 15, Subpart E, § 15.407 (g)

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

3.6.3 Test Protocol

Ambient temperature: 23 °C
Air Pressure: 1006 hPa
Humidity: 36 %

UNII-Band	Channel No	Channel Center Frequency [MHz]	Temp [°C]	Voltage [V]	Time [min]	Measured Center Frequency [MHz]	Freq. Error [kHz]
UNII-Subband 2A	52	5260	23	3.3	0	5260.007753	7.8
	52	5260	23	3.3	1	5260.004861	4.9

3.7 Undesirable Emissions / General Field Strength Limits; Restricted Band and Radiated Emission Limits, Band Edge

Standard FCC Part 15, Subpart C & E

The test was performed according to: ANSI C 63.4

3.7.1 Test Description

The radiated emissions measurements were made in a typical installation configuration. The measurement procedure is implemented into the EMI test software ES-K1 from R&S.

1. Measurement up to 30 MHz
The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The Loop antenna HFH2-Z2 is used.
Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 10m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 200 Hz - 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz
Step 1: Preliminary scan
Preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180 to 180°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180 to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):
- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:
- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by ±22.5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by ±25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –22.5° to +22.5° around the determined value
- Height variation range: –0.25 m to +0.25 m around the determined value

Step 4: final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18-25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.
EMI receiver settings:
- Detector: Peak, Average
- RBW = VBW = 1000 kHz
After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

In the frequency range 25 – 40 GHz the measurement was performed conducted.

3.7.2 Test Requirements / Limits

FCC Part 15 Subpart E , §15.407 (b)(1.2.3.4)
FCC Part 15, Subpart C, §15.247 (b)(5,6)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Calculated Limits(dBµV/m @10m)	Limits(dBµV/m @10m)
0.009 – 0.49	2400/F(kHz)	300 59.1 dB	(48.5 – 13.8) + 30 dB	78.5 – 43.8
0.49 – 1.705	24000/F(kHz)	30 19.1 dB	(48.9 – 23.0) + 10 dB	58.9 – 33.0
1.705 – 30	30	30 19.1 dB	29.5 + 10 dB	39.5

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b)
..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

3.7.3 Test Protocol

Limit types:
RB – Emissions falls into a “Restricted Band” according FCC 15.205
UE – “Undesirable Emission Limit” according FCC 15.407
BE – Band Edge Limit

3.7.3.1 Measurement up to 30 MHz

Ambient temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

WLAN a-Mode; 20 MHz; 6 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Limit Type
-	-	-	-	-	-	-	-	-

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

3.7.3.2 Measurement above 30 MHz

Ambient temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

WLAN a-Mode; 20 MHz; 6 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
52	5260	5250.0	87.0	PEAK	1000	88.0	1.0	UE
52	5260	5250.0	63.5	AV	1000	68.0	4.5	UE
48	5240	5250	84.9	PEAK	1000	88.0	3.1	UE
48	5240	5250	61.7	AV	1000	68.0	6.3	UE
100	5500	7333.5	45.2	PEAK	1000	74.0	28.8	RB
100	5500	7333.5	38.6	AV	1000	54.0	15.4	RB
140	5700	7600.0	37.7	AV	1000	54.0	16.3	RB
116	5580	7440.0	43.4	AV	1000	54.0	10.6	RB

WLAN n-Mode; 20 MHz; 72.2 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Limit Type
48	5240	5250.0	86.1	PEAK	1000	88.0	1.9	UE
48	5240	5250.0	48.1	AV	1000	68.0	19.9	UE

WLAN n-Mode; 40 MHz; 150 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Limit Type
-	-	-	-	-	-	-	-	-

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

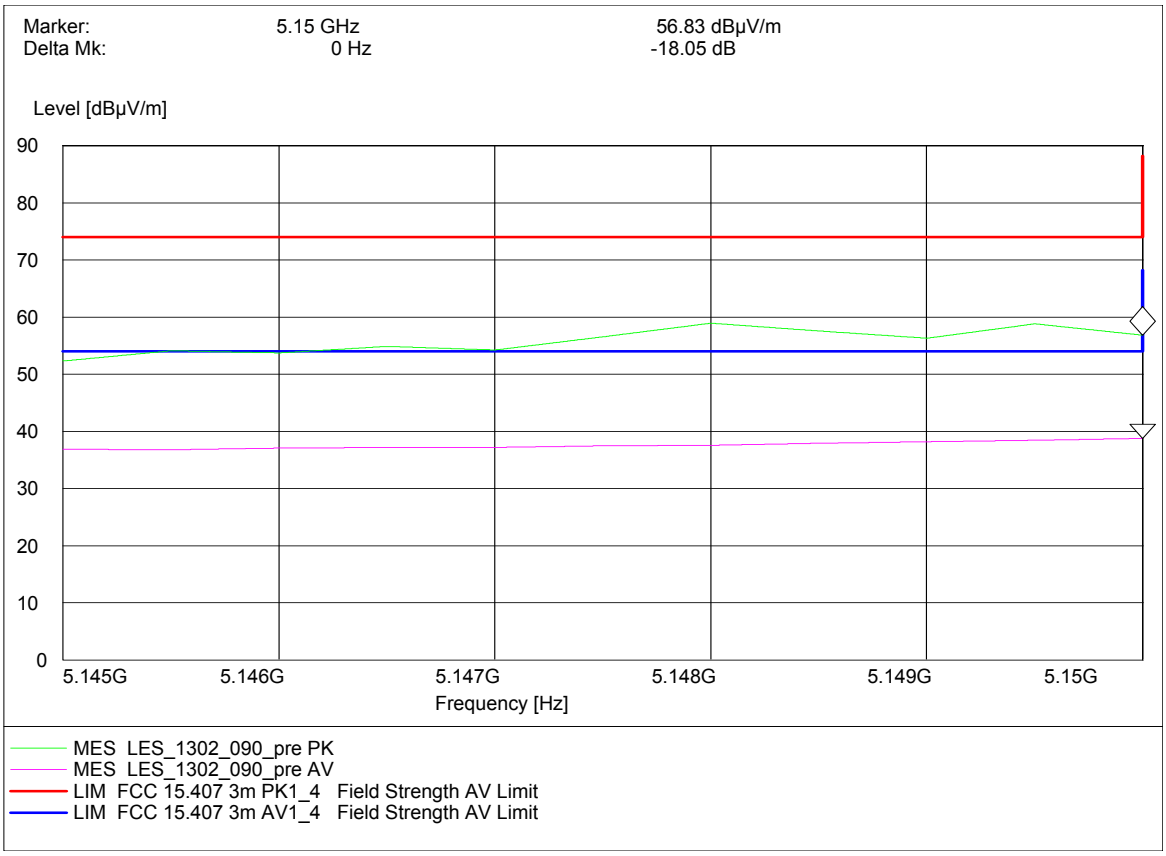
3.7.3.3 Band Edge

Ambient temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

WLAN a-Mode; 20 MHz; 6 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
36	5180	5150.0	56.8	PEAK	1000	74.0	17.2	BE
36	5180	5150.0	38.8	AV	1000	54.0	15.2	BE
64	5320	5350.0	50.80	PEAK	1000	74.0	23.2	BE
64	5320	5350.0	35.5	AV	1000	54.0	18.5	BE
100	5500	5460.0	47.2	PEAK	1000	74.0	26.8	BE
100	5500	5460.0	35.4	AV	1000	54.0	18.6	BE

WLAN n-Mode; 20 MHz; 72.2 Mbit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Limit Type
36	5180	5150.0	46.2	PEAK	1000	74.0	27.8	BE
36	5180	5150.0	34.2	AV	1000	54.0	19.8	BE

3.7.4 Measurement Plot Band Edge (showing the highest value, “worst case”)



4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 2**
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m³

Calibration Details	*Last Execution*	*Next Exec.*
NSA (FCC, IC)	2011/01/10	2014/01/10
NSA (FCC)	2014/01/09	2017/01/09

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Air compressor	none	-	Atlas Copco
Anechoic Chamber	10.58 x 6.38 x 6.00 m³	none	Frankonia

Calibration Details	*Last Execution*	*Next Exec.*
FCC listing 96716 3m Part15/18	2011/01/11	2014/01/10
IC listing 3699A-1 3m	2011/02/07	2014/02/06
FCC listing 96716 3m Part15/18	2014/01/09	2017/01/08

Controller Maturo	MCU	961208	Maturo GmbH
EMC camera	CE-CAM/1	-	CE-SYS
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita

Test Equipment Auxiliary Equipment for Conducted emissions

Lab ID:	**Lab 1**
Manufacturer:	Rohde & Schwarz GmbH & Co.KG
Description:	EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber&Suhner	
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/02/06	2016/02/28
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ENY41	100002	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2013/03/01	2015/03/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/01/10	2016/01/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/01/08	2016/01/31
One-Line V-Network	ESH 3-Z6	100489	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/02/08	2014/02/07
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/11/25	2016/11/24
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standart Calibration		2013/03/01	2015/02/28
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/03/01	2015/02/28

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 2**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Antenna mast	AM 4.0	AM4.0/180/11920513	Maturo GmbH	
Antenna mast	AS 620 P	620/37	HD GmbH	
Biconical Broadband Antenna	SBA 9119	9119-005	Schwarzbeck	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2009/06/04	2014/06/03
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck	
	Standard Calibration		2012/01/18	2015/01/17
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq	
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq	
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/05/18	2015/05/17
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/06/26	2015/06/25
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic	
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170			
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/12/18	2015/12/17
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/10/27	2014/10/26
Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH	
Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH	

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 2, Lab 3**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates	
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates	
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2013/12/04	2015/12/03
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis	
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis	
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH	
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright	
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard		2012/06/13	2015/06/12
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG	

Test Equipment Digital Signalling Devices

Lab ID:	**Lab 1, Lab 2, Lab 3**
Description:	Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/11/24	2014/11/23
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial factory calibration		2012/01/26	2014/01/25
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/11/28	2014/11/27
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	HW/SW Status		*Date of Start*	*Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/12/07	2014/12/06
	HW/SW Status		*Date of Start*	*Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02	
	SW: K62, K69		2008/11/03	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	

Test Equipment Emission measurement devices

Lab ID:	**Lab 1, Lab 2**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Personal Computer	Dell	30304832059	Dell	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2013/05/03	2014/05/02
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2013/04/30	2014/04/29
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	standard calibration		2011/05/12	2014/05/11
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2011/12/05	2013/12/31
	Standard Calibration		2014/01/07	2016/01/31
	HW/SW Status		*Date of Start*	*Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03	

Test Equipment Multimeter 12

Lab ID:	**Lab 4**
Description:	Ex-Tech 520
Serial Number:	05157876

Single Devices for Multimeter 12

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Digital Multimeter 12 (Multimeter)	EX520	05157876	Extech Instruments Corp.	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2013/12/04	2015/12/03

Test Equipment Radio Lab Test Equipment

Lab ID:	**Lab 3**
Description:	Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates
Coax Cable Huber&Suhner	Sucotest 2,0m		Huber&Suhner
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/05/03 2014/05/02
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG
Rubidium Frequency Standard	Datum, Model: MFS	5489/001	Datum-Beverly
	Standard calibration		2013/06/24 2014/06/23
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/04/30 2014/04/29
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/11/25 2014/11/24
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2013/05/06 2016/05/05
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard Calibration		2013/02/12 2015/02/11
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch
	Calibration Details		*Last Execution* *Next Exec.*
	Customized calibration		2012/03/12 2014/03/11

Test Equipment Regulatory Bluetooth RF Test Solution

Lab ID:	**Lab 4**
Description:	Regulatory Bluetooth RF Tests
Type:	Bluetooth RF
Serial Number:	001

Single Devices for Regulatory Bluetooth RF Test Solution

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
ADU 200 Relay Box 7	Relay Box	A04380	Ontrak Control Systems Inc.	
Bluetooth Signalling Unit CBT	CBT	100302	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2013/08/28	2014/08/27
Power Meter NRVD	NRVD	832025/059		
	Standard calibration		2013/08/26	2014/08/25
Power Sensor NRV Z1 A	PROBE	832279/013		
	Standard calibration		2013/08/28	2014/08/27
Power Supply	NGSM 32/10	2725		
	Standard calibration		2013/06/14	2015/06/13
Rubidium Frequency Normal MFS	Datum MFS	002	Datum GmbH	
	Standard calibration		2013/08/27	2014/08/26
Signal Analyser FSIQ26	1119.6001.26	832695/007	Rohde & Schwarz GmbH & Co.KG	
Vector Signal Generator SMIQ03B	SMIQ03B	832870/017		
	Standard calibration		2013/06/21	2016/06/20

Test Equipment Shielded Room 02

Lab ID:	**Lab 1**
Manufacturer:	Frankonia
Description:	Shielded Room for conducted testing
Type:	12 qm
Serial Number:	none

Test Equipment Shielded Room 07

Lab ID:	**Lab 4**
Description:	Shielded Room 4m x 6m

Test Equipment T/H Logger 04

Lab ID:	**Lab 4**
Description:	Lufft Opus10
Serial Number:	7481

Single Devices for T/H Logger 04

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 04 (Environ)	Opus10 THI (8152.00)	7481	Lufft Mess- und Regeltechnik GmbH

Test Equipment Temperature Chamber 01

Lab ID:	**Lab 4**
Manufacturer:	see single devices
Description:	Temperature Chamber KWP 120/70
Type:	Weiss
Serial Number:	see single devices

Single Devices for Temperature Chamber 01

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11

5 Antenna Factors, Cable Loss and Sample Calculations

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

5.1 LISN R&S ESH3-Z5 (150 kHz – 30 MHz)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0,15		10,1	0,1	10,0
5		10,3	0,1	10,2
7		10,5	0,2	10,3
10		10,5	0,2	10,3
12		10,7	0,3	10,4
14		10,7	0,3	10,4
16		10,8	0,4	10,4
18		10,9	0,4	10,5
20		10,9	0,4	10,5
22		11,1	0,5	10,6
24		11,1	0,5	10,6
26		11,2	0,5	10,7
28		11,2	0,5	10,7
30		11,3	0,5	10,8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

5.2 Antenna R&S HFH2-Z2 (9 kHz – 30 MHz)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

5.3 Antenna R&S HL562 (30 MHZ – 1 GHz)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

5.4 Antenna R&S HF907 (1 GHz – 18 GHz)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24,4	-19,4	0,99	0,31	-21,51	0,79		
2000	28,5	-17,4	1,44	0,44	-20,63	1,38		
3000	31,0	-16,1	1,87	0,53	-19,85	1,33		
4000	33,1	-14,7	2,41	0,67	-19,13	1,31		
5000	34,4	-13,7	2,78	0,86	-18,71	1,40		
6000	34,7	-12,7	2,74	0,90	-17,83	1,47		
7000	35,6	-11,0	2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31,0	-23,4	0,47	1,87	0,53	-27,58	1,33	
4000	33,1	-23,3	0,56	2,41	0,67	-28,23	1,31	
5000	34,4	-21,7	0,61	2,78	0,86	-27,35	1,40	
6000	34,7	-21,2	0,58	2,74	0,90	-26,89	1,47	
7000	35,6	-19,8	0,66	2,82	0,86	-25,58	1,46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35,6	-57,3	0,56	1,28	-62,72	2,66	0,94	1,46
8000	36,3	-56,3	0,69	0,71	-61,49	2,84	1,00	1,53
9000	37,1	-55,3	0,68	0,65	-60,80	3,06	1,09	1,60
10000	37,5	-56,2	0,70	0,54	-61,91	3,28	1,20	1,67
11000	37,5	-55,3	0,80	0,61	-61,40	3,43	1,27	1,70
12000	37,6	-53,7	0,84	0,42	-59,70	3,53	1,26	1,73
13000	38,2	-53,5	0,83	0,44	-59,81	3,75	1,32	1,83
14000	39,9	-56,3	0,91	0,53	-63,03	3,91	1,40	1,77
15000	40,9	-54,1	0,98	0,54	-61,05	4,02	1,44	1,83
16000	41,3	-54,1	1,23	0,49	-61,51	4,17	1,51	1,85
17000	42,8	-54,4	1,36	0,76	-62,36	4,34	1,53	2,00
18000	44,2	-54,7	1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

5.5 Antenna EMCO 3160-09 (18 GHz – 26.5 GHz)

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40,2	-23,5	0,72	-35,85	6,20	2,81	2,65
18500	40,2	-23,2	0,69	-35,71	6,46	2,76	2,59
19000	40,2	-22,0	0,76	-35,44	6,69	3,15	2,79
19500	40,3	-21,3	0,74	-35,07	7,04	3,11	2,91
20000	40,3	-20,3	0,72	-34,49	7,30	3,07	3,05
20500	40,3	-19,9	0,78	-34,46	7,48	3,12	3,15
21000	40,3	-19,1	0,87	-34,07	7,61	3,20	3,33
21500	40,3	-19,1	0,90	-33,96	7,47	3,28	3,19
22000	40,3	-18,7	0,89	-33,57	7,34	3,35	3,28
22500	40,4	-19,0	0,87	-33,66	7,06	3,75	2,94
23000	40,4	-19,5	0,88	-33,75	6,92	3,77	2,70
23500	40,4	-19,3	0,90	-33,35	6,99	3,52	2,66
24000	40,4	-19,8	0,88	-33,99	6,88	3,88	2,58
24500	40,4	-19,5	0,91	-33,89	7,01	3,93	2,51
25000	40,4	-19,3	0,88	-33,00	6,72	3,96	2,14
25500	40,5	-20,4	0,89	-34,07	6,90	3,66	2,22
26000	40,5	-21,3	0,86	-35,11	7,02	3,69	2,28
26500	40,5	-21,1	0,90	-35,20	7,15	3,91	2,36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

5.6 Antenna EMCO 3160-10

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26,5	43,4	-11,2	4,4				-15,6	3	0,5
27,0	43,4	-11,2	4,4				-15,6	3	0,5
28,0	43,4	-11,1	4,5				-15,6	3	0,5
29,0	43,5	-11,0	4,6				-15,6	3	0,5
30,0	43,5	-10,9	4,7				-15,6	3	0,5
31,0	43,5	-10,8	4,7				-15,6	3	0,5
32,0	43,5	-10,7	4,8				-15,6	3	0,5
33,0	43,6	-10,7	4,9				-15,6	3	0,5
34,0	43,6	-10,6	5,0				-15,6	3	0,5
35,0	43,6	-10,5	5,1				-15,6	3	0,5
36,0	43,6	-10,4	5,1				-15,6	3	0,5
37,0	43,7	-10,3	5,2				-15,6	3	0,5
38,0	43,7	-10,2	5,3				-15,6	3	0,5
39,0	43,7	-10,2	5,4				-15,6	3	0,5
40,0	43,8	-10,1	5,5				-15,6	3	0,5

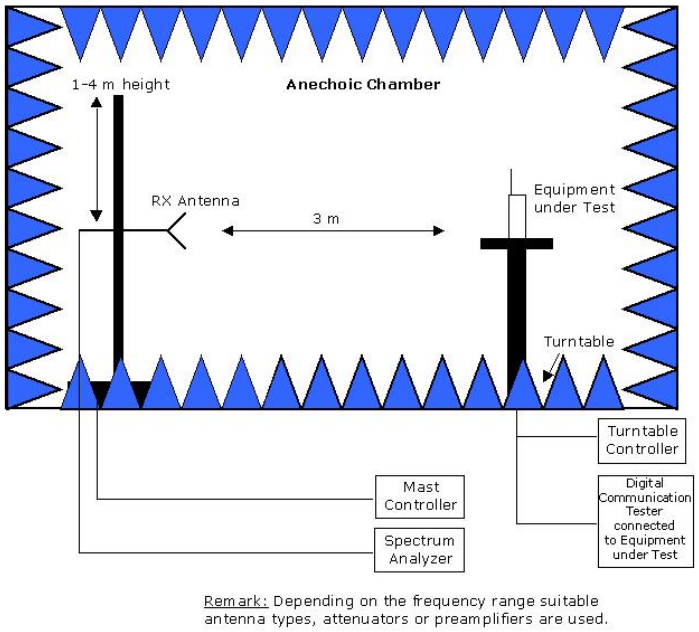
Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolarisation will be used for frequencies in between the values in the table.
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

6 Measurement Uncertainties

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

7 Setup Drawings



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting groundplane.