

FCC Measurement/Technical Report on

NINA-B5

NINA-B501

FCC ID XPYNINAB5

IC: 8595A-NINAB5

Test Report Reference: MDE_UBLOX_2306_FCC_03

Test Laboratory:

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Deutsche
Akkreditierungsstelle
D-PL-12140-01-01
D-PL-12140-01-02
D-PL-12140-01-03

Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization

Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15. 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

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz

Note:

The tests were selected and performed with reference to the FCC Public Notice "Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules, 558074 D01 15.247 Meas Guidance v05r02, 2019-04-02". ANSI C63.10–2013 is applied.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for DTS (e.g. WLAN 2.4 GHz, BT LE) equipment from FCC and IC

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5 & AMD 1 & AMD 2: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-247 Issue 3: 5.2 (a)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-247 Issue 3: 5.4 (d)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 5 & AMD 1 & AMD 2: 6.13 / 8.9/8.10; RSS-247 Issue 3: 5.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 5 & AMD 1 & AMD 2: 6.13 / 8.9/8.10; RSS-247 Issue 3: 5.5
Band edge compliance	§ 15.247 (d)	RSS-247 Issue 3: 5.5
Power density	§ 15.247 (e)	RSS-247 Issue 3: 5.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 5 & AMD 1 & AMD 2: 8.3
Receiver spurious emissions	-	-

1.3 MEASUREMENT SUMMARY

47 CFR CHAPTER I FCC PART 15 § 15.207
Subpart C §15.247

Conducted Emissions at AC Mains
 The measurement was performed according to ANSI C63.10, chapter 6.2 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Operating mode, Connection to AC mains worst case, via ancillary/auxiliary equipment	-	-	N/P	N/P

47 CFR CHAPTER I FCC PART 15 § 15.247 (a) (2)
Subpart C §15.247

Occupied Bandwidth (6 dB)
 The measurement was performed according to ANSI C63.10, chapter 11.8.1 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency				
Bluetooth LE 1 Mbps, high	-	-	N/P	N/P
Bluetooth LE 1 Mbps, low	-	-	N/P	N/P
Bluetooth LE 1 Mbps, mid	-	-	N/P	N/P
Bluetooth LE 2 Mbps, high	-	-	N/P	N/P
Bluetooth LE 2 Mbps, low	-	-	N/P	N/P
Bluetooth LE 2 Mbps, mid	-	-	N/P	N/P

47 CFR CHAPTER I FCC PART 15 IC RSS-Gen & IC TRC-43; Ch. 6.7 & Ch. 8
Subpart C §15.247

Occupied Bandwidth (99%)
 The measurement was performed according to ANSI C63.10, chapter 6.9.3 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency				
Bluetooth LE 1 Mbps, high	-	-	N/A	N/P
Bluetooth LE 1 Mbps, low	-	-	N/A	N/P
Bluetooth LE 1 Mbps, mid	-	-	N/A	N/P
Bluetooth LE 2 Mbps, high	-	-	N/A	N/P
Bluetooth LE 2 Mbps, low	-	-	N/A	N/P
Bluetooth LE 2 Mbps, mid	-	-	N/A	N/P

47 CFR CHAPTER I FCC PART 15 § 15.247 (b) (3)
Subpart C §15.247

Peak Power Output
 The measurement was performed according to ANSI C63.10, chapter 11.9.1.3 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency, Measurement method				
Bluetooth LE 1 Mbps, high, conducted	-	-	N/P	N/P
Bluetooth LE 1 Mbps, low, conducted	-	-	N/P	N/P
Bluetooth LE 1 Mbps, mid, conducted	-	-	N/P	N/P
Bluetooth LE 2 Mbps, high, conducted	-	-	N/P	N/P
Bluetooth LE 2 Mbps, low, conducted	-	-	N/P	N/P
Bluetooth LE 2 Mbps, mid, conducted	-	-	N/P	N/P

47 CFR CHAPTER I FCC PART 15 § 15.247 (d)
Subpart C §15.247

Spurious RF Conducted Emissions
 The measurement was performed according to ANSI C63.10, chapter 11.11 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency				
Bluetooth LE 1 Mbps, high	-	-	N/P	N/P
Bluetooth LE 1 Mbps, low	-	-	N/P	N/P
Bluetooth LE 1 Mbps, mid	-	-	N/P	N/P

47 CFR CHAPTER I FCC PART 15 § 15.247 (d)
Subpart C §15.247

Transmitter Spurious Radiated Emissions
 The measurement was performed according to ANSI C63.10, chapter 6.4, 6.5, 6.6.5 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency, Measurement range				
Bluetooth LE 1 Mbps, high, 1 GHz - 26 GHz	S01_AC02	2023-10-31	Passed	Passed
Bluetooth LE 1 Mbps, high, 30 MHz - 1 GHz	S01_AC02	2023-12-17	Passed	Passed
Bluetooth LE 1 Mbps, low, 1 GHz - 26 GHz	S01_AC02	2024-02-14	Passed	Passed
Bluetooth LE 2 Mbps, low, 30 MHz - 1 GHz	-	-	N/P	N/P
Bluetooth LE 2 Mbps, mid, 1 GHz - 26 GHz	-	-	N/P	N/P
Bluetooth LE 2 Mbps, mid, 30 MHz - 1 GHz	-	-	N/P	N/P
Bluetooth LE 1 Mbps, mid, 9 kHz - 30 MHz	S01_AC02	2023-10-09	Passed	Passed

47 CFR CHAPTER I FCC PART 15 § 15.247 (d)
Subpart C §15.247

Band Edge Compliance Conducted
 The measurement was performed according to ANSI C63.10, chapter 11.11 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency, Band Edge				
Bluetooth LE 1 Mbps, high, high	-	-	N/P	N/P
Bluetooth LE 1 Mbps, low, low	-	-	N/P	N/P
Bluetooth LE 2 Mbps, high, high	-	-	N/P	N/P
Bluetooth LE 2 Mbps, low, low	-	-	N/P	N/P

47 CFR CHAPTER I FCC PART 15 § 15.247 (d)
Subpart C §15.247

Band Edge Compliance Radiated
 The measurement was performed according to ANSI C63.10, chapter 6.6.5 **Final Result**

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency, Band Edge				
Bluetooth LE 1 Mbps, high, high	S01_AC02	2023-10-31	Passed	Passed
Bluetooth LE 2 Mbps, high, high	S01_AC02	2023-10-31	Passed	Passed

47 CFR CHAPTER I FCC PART 15 § 15.247 (e)
Subpart C §15.247

Power Density
 The measurement was performed according to ANSI C63.10, chapter 11.10.2 **Final Result**

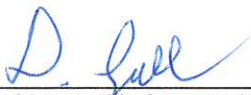
OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency				
Bluetooth LE 1 Mbps, high	-	-	N/P	N/P
Bluetooth LE 1 Mbps, low	-	-	N/P	N/P
Bluetooth LE 1 Mbps, mid	-	-	N/P	N/P
Bluetooth LE 2 Mbps, high	-	-	N/P	N/P
Bluetooth LE 2 Mbps, low	-	-	N/P	N/P
Bluetooth LE 2 Mbps, mid	-	-	N/P	N/P

N/A: Not applicable
 N/P: Not performed.

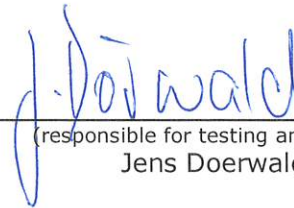
2 REVISION HISTORY / SIGNATURES

Report version control			
Version	Release date	Change Description	Version validity
initial	2024-02-28	--	valid
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COMMENT: This report contains only spot checks of radiated spurious emissions and radiated Band edge to add an external antenna. The conducted measurements are referenced in the test report MDE_UBLOX_2306_FCC_02



(responsible for accreditation scope)
Daniel Gall



(responsible for testing and report)
Jens Doerwald



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3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

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

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no: DAkKS D-PL-12140-01-01 | -02 | -03
FCC Designation Number: DE0015
FCC Test Firm Registration: 929146
ISED CAB Identifier DE0007; ISED#: 3699A

Responsible for accreditation scope: Daniel Gall
Report Template Version: 2023-09-29

3.2 PROJECT DATA

Responsible for testing and report: Jens Doerwald
Employees who performed the tests: documented internally at 7Layers
Date of Report: 2024-02-28
Testing Period: 2023-10-09 to 2024-02-14

3.3 APPLICANT DATA

Company Name: u-blox AG
Address: Zürcherstrasse 68
8800 Thalwil
Switzerland
Contact Person: Filip Kruzela

3.4 MANUFACTURER DATA

Company Name: please see Applicant Data

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Stand-alone Bluetooth 5.3 low energy module. The radio includes Bluetooth low energy, and IEEE 802.15.4 with Thread®, Matter™ and Zigbee™.
Product name	NINA-B5
Type	NINA-B501
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	3.3 V (nominal)
Antenna / Gain	3.0 dBi
Tested Modulation Type	GFSK
General product description	NINA-B5 is a small size radio module intended for OEM integration utilizing Bluetooth 5.3 low energy, and IEEE 802.15.4 with Thread®, Matter™ and Zigbee™. All 2.4 GHz RF-signals share the same RF path, and the module cannot transmit e.g. BLE and 802.15.4 signals simultaneously.
Specific product description for the EUT	<p>NINA-B5 product is sold as Open CPU, tailored for OEMs who wish to embed their own application on top of the available radio modes. NINA-B5 modules are offered in two hardware versions, with antenna pin named as NINA-B501, and integrated PCB Trace antenna named as NINA-B506.</p> <p>The NINA-B501 does not have the internal antenna. The antenna pin is available as a module pin to connect to an external antenna or antenna connector. The antenna pin connects to the RF signal directly. The PCB outline is 10.0 x 11.6 mm.</p> <p>The NINA-B506 has an integrated PCB trace antenna on the PCB. The integrated antenna connects to the RF signal directly. The PCB outline is 10.0 x 15.0 mm.</p>
EUT ports (connected cables during testing):	USB
Tested datarates	1 Mbps: GFSK 2 Mbps: GFSK
Special software used for testing	Tx/Rx radio test software
Used output power	Max Power set with power code '31'

4.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
Sample#4	DE1015181ac02	Sample with UFL-pin connector BLE 10 dBm
Sample Parameter	Value	
Serial No.	AY45464DE000EF60400	
HW Version	04	
SW Version	Test FW from an example called 'connectivity_test' in NXP MCUXpresso SDK v2.12.5	
Comment		

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

4.3 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.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
-	- , - , - , - , -	-

4.4 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.

Device	Details (Manufacturer, Type Model, HW, SW, S/N)	Description
AUX1	- , - , - , - , -	Unshielded USB cable
AUX2	Dell, Latitude E7270, 2016, -, 14393036990	Laptop computer with prepared scripts controlling the EUT
AUX3	ABRACON, PRO-EX-296, -, -, -	2.4GHz : Wi-Fi/BT External Antenna

4.5 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	Combination of EUTs	Description and Rationale
S01_AC02	Sample#4 + AUX1 + AUX2 + AUX3	Setup for radiated measurements

4.6 OPERATING MODES / TEST CHANNELS

This chapter describes the operating modes of the EUTs used for testing.

BT LE Test Channels:
Channel:
Frequency [MHz]

2.4 GHz ISM		
2400 - 2483.5 MHz		
low	mid	high
0	19	39
2402	2440	2480

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:

ANSI C63.10, chapter 6.4, 6.5, 6.6.5

5.1.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The measurements were performed according the following sub-chapters of ANSI C63.10:

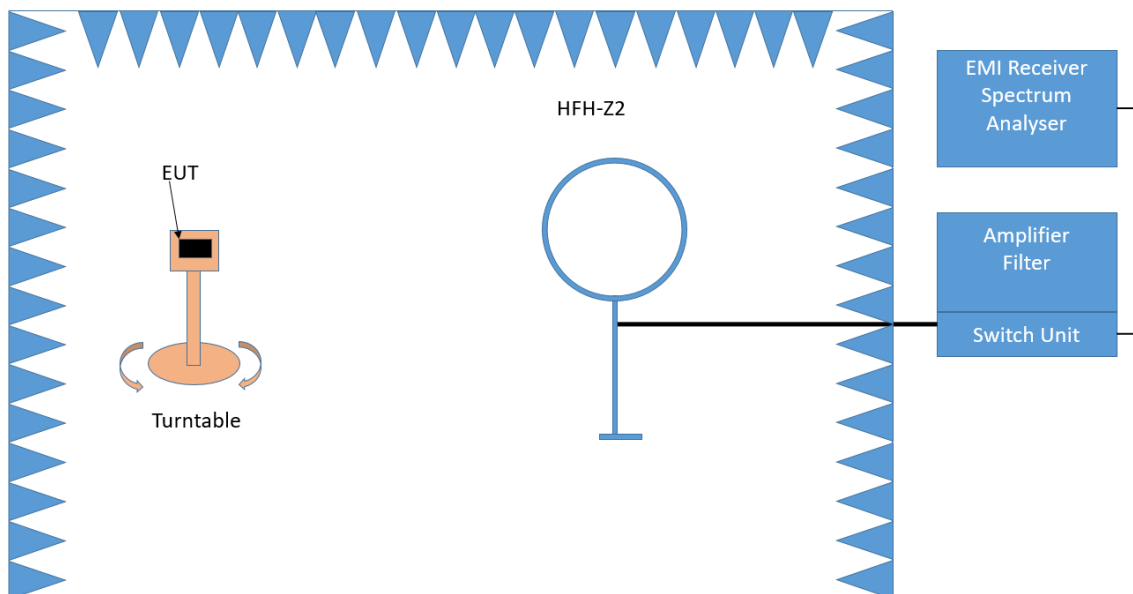
- < 30 MHz: Chapter 6.4
- 30 MHz – 1 GHz: Chapter 6.5
- > 1 GHz: Chapter 6.6 (procedure according 6.6.5 used)

The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered.

Below 1 GHz:

The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

1. Measurement up to 30 MHz



Test Setup; Spurious Emission Radiated (SAC), 9 kHz – 30 MHz

The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement

- Anechoic chamber
- Antenna distance: 3 m
- Antenna height: 1 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 - 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF-Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

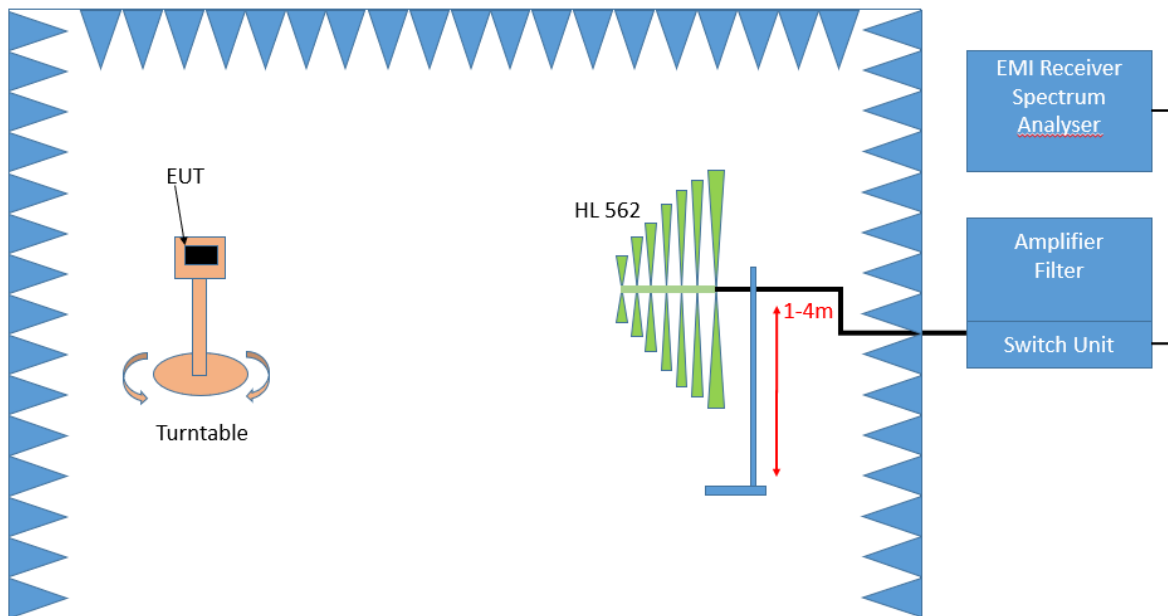
Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

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.

- Detector: Quasi-Peak (9 kHz - 150 kHz, Peak / Average 150 kHz- 30 MHz)
- Frequency range: 0.009 - 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF-Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz



Test Setup; Spurious Emission Radiated (SAC), 30 MHz- 1GHz

Step 1: Preliminary scan

This is a preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 - 1000 MHz
- Frequency steps: 30 kHz

- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: -180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 4 m
- Height variation step size: 1.5 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: Adjustment 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 slowly vary by 360° . 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 will also slowly vary between 1 – 4 meter. 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: 360°
- Height variation range: 1 – 4 m
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector

With the settings determined in step 2, the final measurement will be performed:

EMI receiver settings for step 3:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

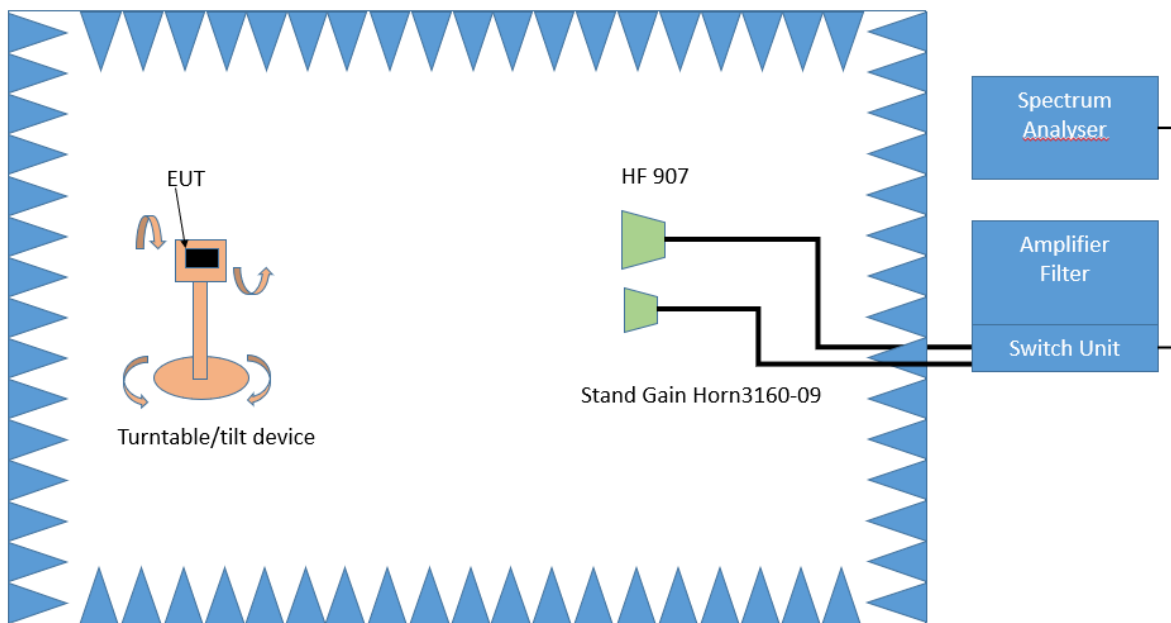
After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

Above 1 GHz:

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.

All steps were performed with one height (1.5 m) of the receiving antenna only.

3. Measurement above 1 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

Step 1:

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.

The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

Spectrum analyser settings:

- Detector: Peak, Average
- RBW = 1 MHz
- VBW = 3 MHz

Step 2:

The turn table azimuth will slowly vary by $\pm 22.5^\circ$.

The elevation angle will slowly vary by $\pm 45^\circ$

Spectrum analyser settings:

- Detector: Peak

Step 3:

Spectrum analyser settings for step 3:

- Detector: Peak / CISPR Average
- Measured frequencies: in step 1 determined frequencies
- RBW = 1 MHz
- VBW = 3 MHz
- Measuring time: 1 s

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)

... 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)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 – 26000	500@3m	3	54.0@3m
26000 – 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§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)

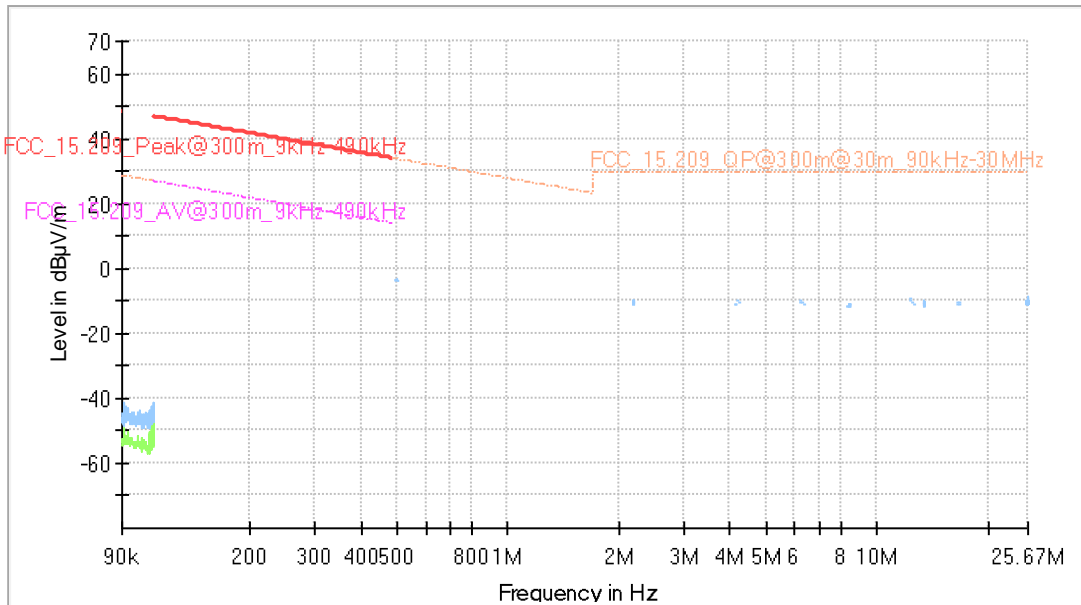
5.1.3 TEST PROTOCOL

Ch.		Applied duty cycle correction (AV): 0 dB		Applied duty cycle correction (AV) [dB]:		0.0		
Ch. No.	Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
0	2402	1329.718	34.3	AV	1000	54.0	19.7	RB
0	2402	1329.718	53.7	PEAK	1000	74.0	20.3	RB
0	2402	4786.325	35.2	AV	1000	54.0	18.8	RB
0	2402	4786.325	56.4	PEAK	1000	74.0	17.6	RB
0	2402	4804.038	40.7	AV	1000	54.0	13.3	RB
0	2402	4804.038	50.4	PEAK	1000	74.0	23.6	RB
39	2480	323.68	19.36	QP	120	46.0	26.6	RB
39	2480	995.55	37.65	QP	120	54.0	16.4	RB
39	2480	2483.583	38.9	AV	1000	54.0	15.1	RB
39	2480	2483.583	51.5	PEAK	1000	74.0	22.5	RB
39	2480	2483.83	40	AV	1000	54.0	14.0	RB
39	2480	2483.83	52.8	PEAK	1000	74.0	21.2	RB
39	2480	4960.038	47.1	AV	1000	54.0	6.9	RB
39	2480	4960.038	54.1	PEAK	1000	74.0	19.9	RB
39	2480	4960.363	46.9	AV	1000	54.0	7.1	RB
39	2480	4960.363	54.7	PEAK	1000	74.0	19.3	RB
39	2480	12399.07	44.4	AV	1000	54.0	9.6	RB
39	2480	12399.07	53.9	PEAK	1000	74.0	20.1	RB

Remark: Please see next sub-clause for the measurement plot.

5.1.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

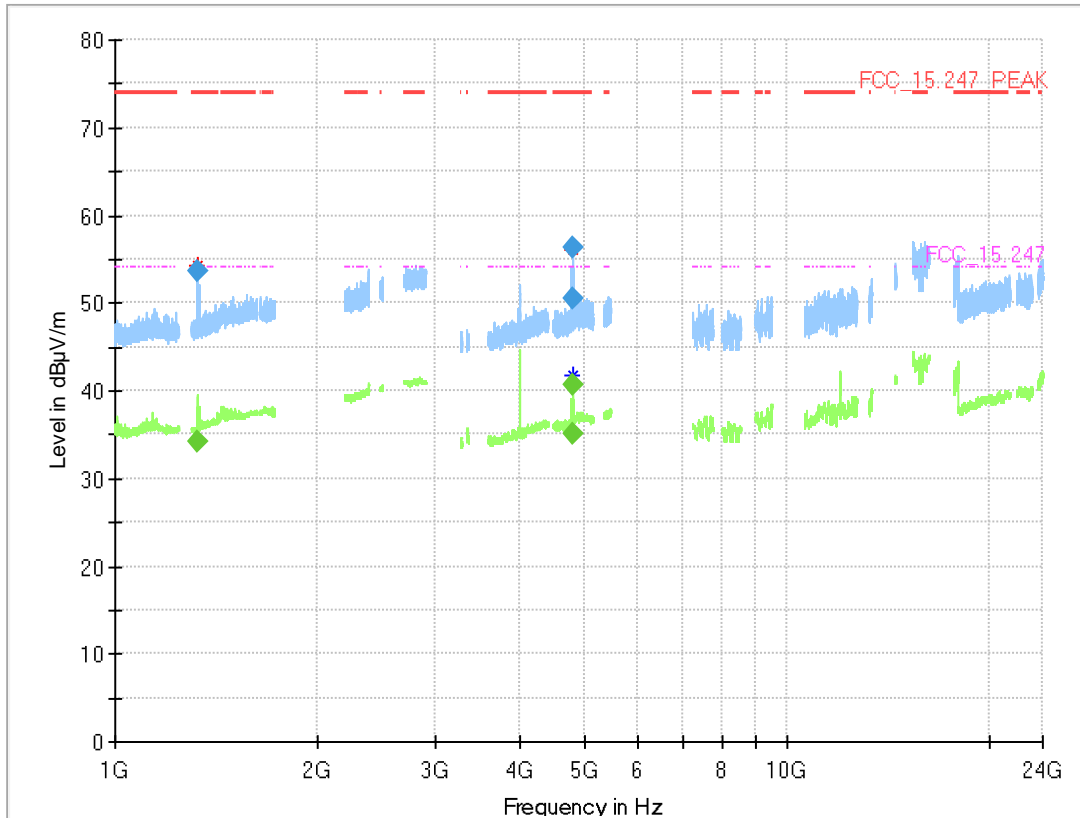
Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = mid, measurement range 9 KHz – 30 MHz



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---	---	---	---	---	---

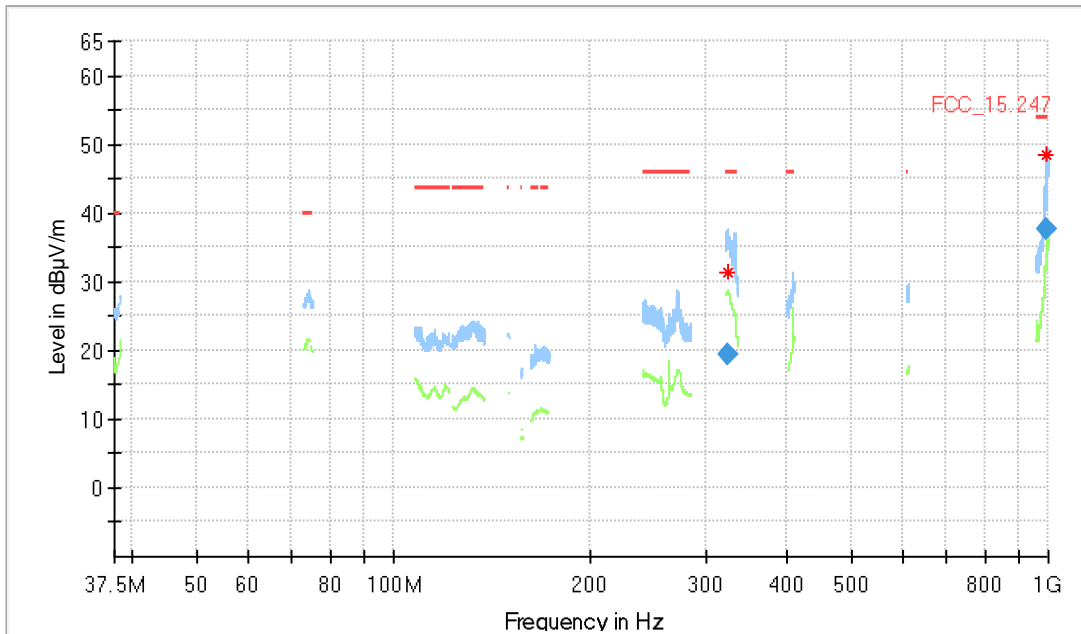
Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = low, measurement range 1 GHz – 24 GHz



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
1329.718	---	34.3	54.00	19.74	1000.0	1000.000	150.0	V	-7.0	105.0	3.3
1329.718	53.7	---	74.00	20.26	1000.0	1000.000	150.0	V	-7.0	105.0	3.3
4786.325	---	35.2	54.00	18.81	1000.0	1000.000	150.0	V	32.0	105.0	6.3
4786.325	56.4	---	74.00	17.65	1000.0	1000.000	150.0	V	32.0	105.0	6.3
4804.038	---	40.7	54.00	13.29	1000.0	1000.000	150.0	H	121.0	86.0	6.1
4804.038	50.4	---	74.00	23.57	1000.0	1000.000	150.0	H	121.0	86.0	6.1

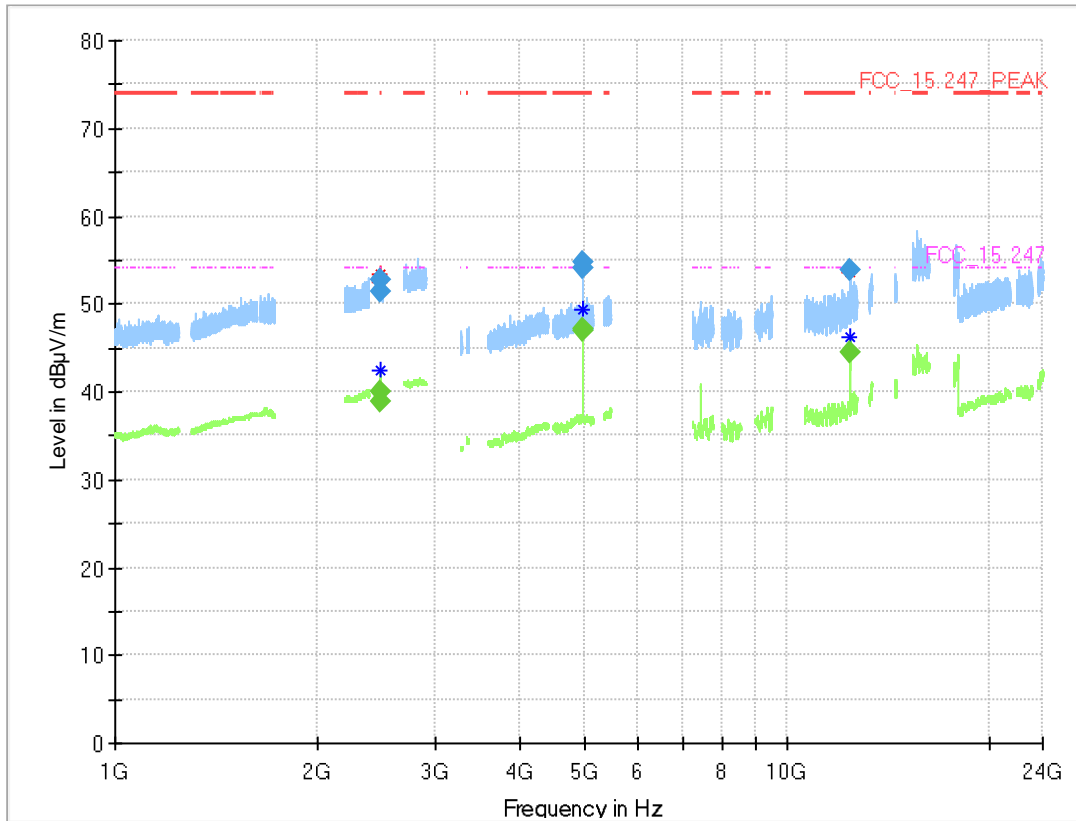
Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, measurement range 30 MHz – 1 GHz



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
323.680000	19.36	46.00	26.64	1000.0	120.000	356.0	H	275.0	14.6
995.550000	37.65	54.00	16.35	1000.0	120.000	110.0	V	267.0	26.1

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, measurement range 1 GHz – 24 GHz



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2483.583	---	38.9	54.00	15.11	1000.0	1000.000	150.0	V	-71.0	92.0	7.8
2483.583	51.5	---	74.00	22.50	1000.0	1000.000	150.0	V	-71.0	92.0	7.8
2483.830	---	40.0	54.00	14.01	1000.0	1000.000	150.0	V	-101.0	101.0	7.8
2483.830	52.8	---	74.00	21.21	1000.0	1000.000	150.0	V	-101.0	101.0	7.8
4960.038	---	47.1	54.00	6.90	1000.0	1000.000	150.0	H	120.0	98.0	5.9
4960.038	54.1	---	74.00	19.93	1000.0	1000.000	150.0	H	120.0	98.0	5.9
4960.363	---	46.9	54.00	7.13	1000.0	1000.000	150.0	H	117.0	75.0	5.9
4960.363	54.7	---	74.00	19.26	1000.0	1000.000	150.0	H	117.0	75.0	5.9
12399.070	---	44.4	54.00	9.57	1000.0	1000.000	150.0	V	0.0	84.0	-4.7
12399.070	53.9	---	74.00	20.11	1000.0	1000.000	150.0	V	0.0	84.0	-4.7

5.1.5 TEST EQUIPMENT USED

- Radiated Emissions FAR 2.4 GHz FCC
- Radiated Emissions SAC H-Field
- Radiated Emissions SAC up to 1 GHz

5.2 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:

ANSI C63.10, chapter 6.6.5

5.2.1 TEST DESCRIPTION

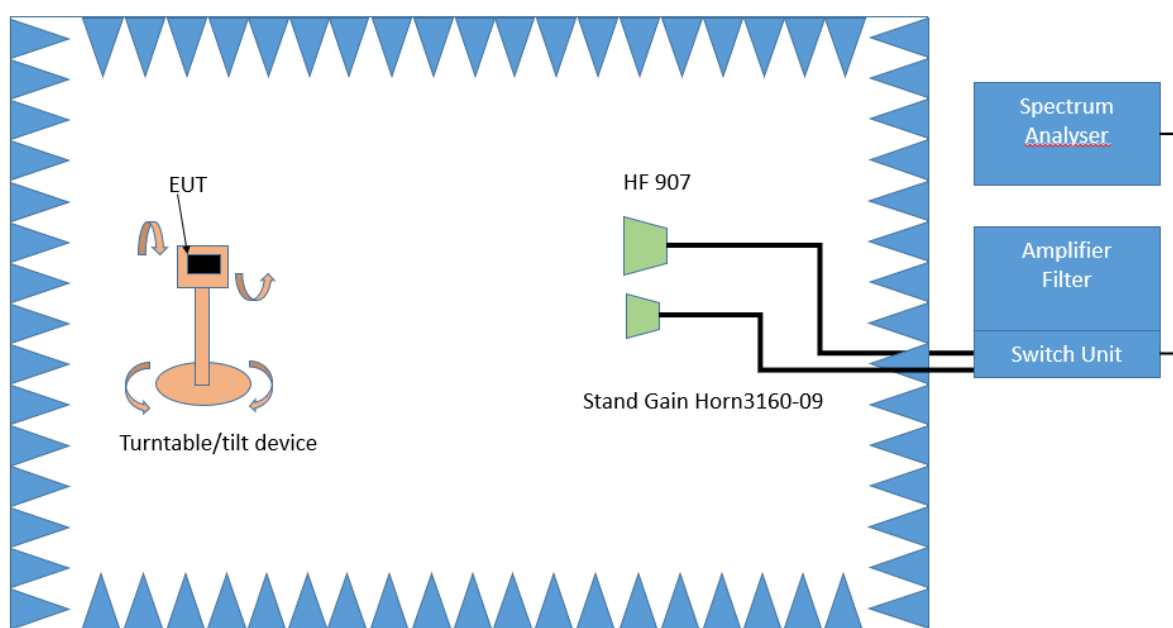
The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The measurements were performed according the following sub-chapter of ANSI C63.10:

- Chapter 6.10.5

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.

All steps were performed with one height (1.5 m) of the receiving antenna only (procedure according ANSI C63.10, chapter 6.6.5).

3. Measurement above 1 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

Step 1:

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.

The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

Spectrum analyser settings:

- Detector: Peak, Average
- RBW = 1 MHz
- VBW = 3 MHz

Step 2:

The turn table azimuth will slowly vary by $\pm 22.5^\circ$.
The elevation angle will slowly vary by $\pm 45^\circ$
Spectrum analyser settings:
- Detector: Peak

Step 3:

Spectrum analyser settings for step 3:

- Detector: Peak / CISPR Average
- Measured frequencies: in step 1 determined frequencies
- RBW = 1 MHz
- VBW = 3 MHz
- Measuring time: 1 s

5.2.2 TEST REQUIREMENTS / LIMITS

For band edges connected to a restricted band, the limits are specified in Section 15.209(a)

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

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§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: $\text{Limit (dBµV/m)} = 20 \log (\text{Limit (µV/m)}/1µV/m)$

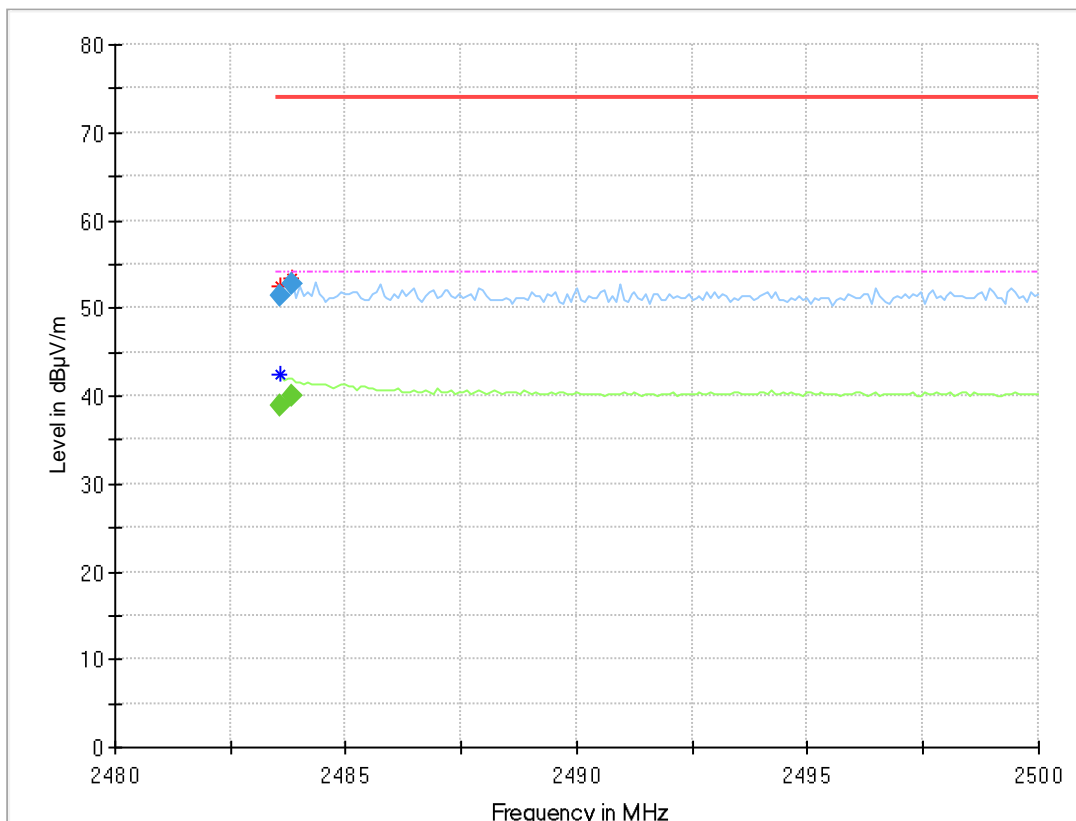
5.2.3 TEST PROTOCOL

Ambient temperature:		23 - 25 °C							
Air Pressure:		990 - 1024 hPa							
Humidity:		30 - 40 %							
BT LE 1 Mbit/s				Applied duty cycle correction (AV) [dB]:					
Applied duty cycle correction (AV): 0 dB									
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]		
39	2480	2483.5	38.9	AV	1000	54.0	15.1		
39	2480	2483.5	51.5	PEAK	1000	74.0	22.5		
39	2480	2483.5	40	AV	1000	54.0	14.0		
39	2480	2483.5	52.8	PEAK	1000	74.0	21.2		
BT LE 2 Mbit/s				Applied duty cycle correction (AV) [dB]:					
Applied duty cycle correction (AV): 0 dB									
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]		
39	2480	2483.5	42.9	AV	1000	54.0	11.1		
39	2480	2483.5	54.8	PEAK	1000	74.0	19.2		

Remark: Please see next sub-clause for the measurement plot.

5.2.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, Band Edge = high

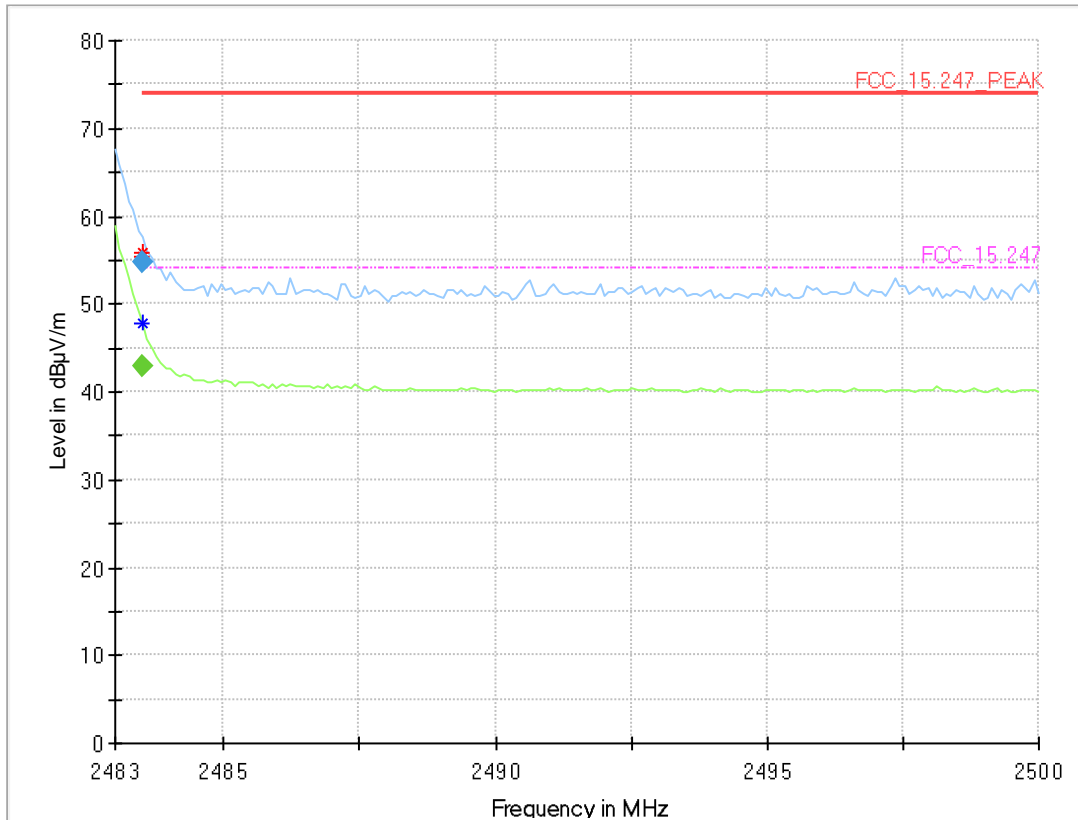


Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2483.583	---	38.9	54.00	15.11	1000.0	1000.000	150.0	V	-71.0	92.0	7.8
2483.583	51.5	---	74.00	22.50	1000.0	1000.000	150.0	V	-71.0	92.0	7.8
2483.830	---	40.0	54.00	14.01	1000.0	1000.000	150.0	V	-101.0	101.0	7.8
2483.830	52.8	---	74.00	21.21	1000.0	1000.000	150.0	V	-101.0	101.0	7.8

4960.038	---	47.1	54.00	6.90	1000.0	1000.000	150.0	H	120.0	98.0	5.9
4960.038	54.1	---	74.00	19.93	1000.0	1000.000	150.0	H	120.0	98.0	5.9
4960.363	---	46.9	54.00	7.13	1000.0	1000.000	150.0	H	117.0	75.0	5.9
4960.363	54.7	---	74.00	19.26	1000.0	1000.000	150.0	H	117.0	75.0	5.9
12399.070	---	44.4	54.00	9.57	1000.0	1000.000	150.0	V	0.0	84.0	-4.7
12399.070	53.9	---	74.00	20.11	1000.0	1000.000	150.0	V	0.0	84.0	-4.7

Radio Technology = Bluetooth LE 2 Mbps, Operating Frequency = high, Band Edge = high



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2483.510	---	42.9	54.00	11.14	1000.0	1000.000	150.0	V	-101.0	81.0	7.8
2483.510	54.8	---	74.00	19.15	1000.0	1000.000	150.0	V	-101.0	105.0	7.8

5.2.5 TEST EQUIPMENT USED

- Radiated Emissions FAR 2.4 GHz FCC

Test Equipment

5.3 TEST EQUIPMENT HARDWARE

- 1 Radiated Emissions FAR 2.4 GHz FCC
 Radiated emission tests for 2.4 GHz ISM devices in a fully anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2021-10 2023-12	2023-12 2025-12
1.2	Innco Systems CO3000	Controller for bore sight mast FAC		CO3000/1460/54740522/P	N/A	N/A
1.3	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq		N/A*)	N/A*)
1.4	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	N/A	N/A
1.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
1.6	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785	N/A*)	N/A*)
1.7	FSW43	Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	103779	2023-04	2025-04
1.8	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
1.9	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronik GmbH	00083069	N/A*)	N/A*)
1.10	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright Instruments GmbH	09	N/A*)	N/A*)
1.11	MA3000/0800-XP-ET-compact	Bore Sight Antenna Mast			N/A	N/A
1.12	TT 1.5 WI	Turn Table	Maturo GmbH	-	N/A	N/A
1.13	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008	N/A*)	N/A*)
1.14	Opus 20 THI (8120.00)	ThermoHygro Datalogger	Lufft Mess- und Regeltechnik GmbH	115.0318.0802.033	2023-08	2025-08
1.15	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709	N/A	N/A
1.16	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324	N/A*)	N/A*)
1.17	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2021-09	2024-09

- 2 Radiated Emissions SAC H-Field
 Radiated emission tests in the H-Field in a semi anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515	N/A	N/A
2.2	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
2.3	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603	2022-01	2024-01
2.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	undefined, undefined	none	N/A	N/A
2.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
2.6	Opus10 THI (8152.00)	T/H Logger 10	Lufft Mess- und Regeltechnik GmbH	12488	2023-12	2025-12
2.7	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
2.8	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99	N/A	N/A
2.9	HFH2-Z2	Loop Antenna + 3 Axis Tripod	Rohde & Schwarz GmbH & Co. KG	829324/006	2021-01	2024-01
2.10	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100321	2023-10	2024-10

3 Radiated Emissions SAC up to 1 GHz
Radiated emission tests up to 1 GHz in a semi anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515	N/A	N/A
3.2	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
3.3	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603	2022-01	2024-01
3.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	undefined, undefined	none	N/A	N/A
3.5	HL 562 ULTRALOG	Biconical-log- per antenna (30 MHz - 3 GHz) with HL 562E biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2021-09	2024-09
3.6	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.7	Opus10 THI (8152.00)	T/H Logger 10	Lufft Mess- und Regeltechnik GmbH	12488	2023-12	2025-12
3.8	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
3.9	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99	N/A	N/A
3.10	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100321	2023-10	2024-10
3.11	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/1192 0513	N/A	N/A

N/A*): internally validated before use.

The calibration interval is the time interval between "Last Calibration" and "Calibration Due"

5.4 TEST EQUIPMENT SOFTWARE

Semi-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
INNCO Mast Controller	1.02.62
MATURO Mast Controller	12.19
MATURO Turn-Table Controller	30.10
Fully-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
MATURO Turn-Unit Controller	11.10
MATURO Mast Controller	12.10
MATURO Turntable Controller	12.11
INNCO Mast Controller	1.02.62
TS 8997	
WMC32 Measurement Software	11.40.00
Conducted AC Emissions:	
Software	Version
EMC32 Measurement Software	10.60.20

6 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.

6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency MHz	Corr. dB	LISN insertion loss ESH3- Z5 dB	cable loss (incl. 10 dB atten- uator) 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

$$U_{\text{LISN}} \text{ (dB } \mu\text{V)} = U \text{ (dB } \mu\text{V)} + \text{Corr. (dB)}$$

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.

6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency MHz	AF HFH-Z2) dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-40 dB/ decade) dB	d _{Limit} (meas. distance (limit) m	d _{used} (meas. distance (used) 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

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction = $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values

6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

($d_{Limit} = 3\text{ m}$)

Frequency MHz	AF R&S HL562 dB (1/m)	Corr. dB
30	18.6	0.6
50	6.0	0.9
100	9.7	1.2
150	7.9	1.6
200	7.6	1.9
250	9.5	2.1
300	11.0	2.3
350	12.4	2.6
400	13.6	2.9
450	14.7	3.1
500	15.6	3.2
550	16.3	3.5
600	17.2	3.5
650	18.1	3.6
700	18.5	3.6
750	19.1	4.1
800	19.6	4.1
850	20.1	4.4
900	20.8	4.7
950	21.1	4.8
1000	21.6	4.9

cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-20 dB/ decade) dB	d_{Limit} (meas. distance (limit) m	d_{used} (meas. distance (used) m
0.29	0.04	0.23	0.02	0.0	3	3
0.39	0.09	0.32	0.08	0.0	3	3
0.56	0.14	0.47	0.08	0.0	3	3
0.73	0.20	0.59	0.12	0.0	3	3
0.84	0.21	0.70	0.11	0.0	3	3
0.98	0.24	0.80	0.13	0.0	3	3
1.04	0.26	0.89	0.15	0.0	3	3
1.18	0.31	0.96	0.13	0.0	3	3
1.28	0.35	1.03	0.19	0.0	3	3
1.39	0.38	1.11	0.22	0.0	3	3
1.44	0.39	1.20	0.19	0.0	3	3
1.55	0.46	1.24	0.23	0.0	3	3
1.59	0.43	1.29	0.23	0.0	3	3
1.67	0.34	1.35	0.22	0.0	3	3
1.67	0.42	1.41	0.15	0.0	3	3
1.87	0.54	1.46	0.25	0.0	3	3
1.90	0.46	1.51	0.25	0.0	3	3
1.99	0.60	1.56	0.27	0.0	3	3
2.14	0.60	1.63	0.29	0.0	3	3
2.22	0.60	1.66	0.33	0.0	3	3
2.23	0.61	1.71	0.30	0.0	3	3

($d_{Limit} = 10\text{ m}$)

Frequency MHz	AF R&S HL562 dB (1/m)	Corr. dB
30	18.6	-9.9
50	6.0	-9.6
100	9.7	-9.2
150	7.9	-8.8
200	7.6	-8.6
250	9.5	-8.3
300	11.0	-8.1
350	12.4	-7.9
400	13.6	-7.6
450	14.7	-7.4
500	15.6	-7.2
550	16.3	-7.0
600	17.2	-6.9
650	18.1	-6.9
700	18.5	-6.8
750	19.1	-6.3
800	19.6	-6.3
850	20.1	-6.0
900	20.8	-5.8
950	21.1	-5.6
1000	21.6	-5.6

cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-20 dB/ decade) dB	d_{Limit} (meas. distance (limit) m	d_{used} (meas. distance (used) m
0.29	0.04	0.23	0.02	-10.5	10	3
0.39	0.09	0.32	0.08	-10.5	10	3
0.56	0.14	0.47	0.08	-10.5	10	3
0.73	0.20	0.59	0.12	-10.5	10	3
0.84	0.21	0.70	0.11	-10.5	10	3
0.98	0.24	0.80	0.13	-10.5	10	3
1.04	0.26	0.89	0.15	-10.5	10	3
1.18	0.31	0.96	0.13	-10.5	10	3
1.28	0.35	1.03	0.19	-10.5	10	3
1.39	0.38	1.11	0.22	-10.5	10	3
1.44	0.39	1.20	0.19	-10.5	10	3
1.55	0.46	1.24	0.23	-10.5	10	3
1.59	0.43	1.29	0.23	-10.5	10	3
1.67	0.34	1.35	0.22	-10.5	10	3
1.67	0.42	1.41	0.15	-10.5	10	3
1.87	0.54	1.46	0.25	-10.5	10	3
1.90	0.46	1.51	0.25	-10.5	10	3
1.99	0.60	1.56	0.27	-10.5	10	3
2.14	0.60	1.63	0.29	-10.5	10	3
2.22	0.60	1.66	0.33	-10.5	10	3
2.23	0.61	1.71	0.30	-10.5	10	3

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction = $-20 * \text{LOG} (d_{Limit} / d_{used})$

Linear interpolation will be used for frequencies in between the values in the table.

Tables show an extract of values.

6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency MHz	AF R&S HF907 dB (1/m)	Corr. dB
1000	24.4	-19.4
2000	28.5	-17.4
3000	31.0	-16.1
4000	33.1	-14.7
5000	34.4	-13.7
6000	34.7	-12.7
7000	35.6	-11.0

cable loss 1 (relay + cable inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit, atten- uator & pre-amp) dB	cable loss 4 (to receiver) dB
0.99	0.31	-21.51	0.79
1.44	0.44	-20.63	1.38
1.87	0.53	-19.85	1.33
2.41	0.67	-19.13	1.31
2.78	0.86	-18.71	1.40
2.74	0.90	-17.83	1.47
2.82	0.86	-16.19	1.46

Frequency MHz	AF R&S HF907 dB (1/m)	Corr. dB
3000	31.0	-23.4
4000	33.1	-23.3
5000	34.4	-21.7
6000	34.7	-21.2
7000	35.6	-19.8

cable loss 1 (relay inside chamber) dB	cable loss 2 (inside chamber) dB	cable loss 3 (outside chamber) dB	cable loss 4 (switch unit, atten- uator & pre-amp) dB	cable loss 5 (to receiver) dB	used for FCC 15.247
0.47	1.87	0.53	-27.58	1.33	
0.56	2.41	0.67	-28.23	1.31	
0.61	2.78	0.86	-27.35	1.40	
0.58	2.74	0.90	-26.89	1.47	
0.66	2.82	0.86	-25.58	1.46	

Frequency MHz	AF R&S HF907 dB (1/m)	Corr. dB
7000	35.6	-57.3
8000	36.3	-56.3
9000	37.1	-55.3
10000	37.5	-56.2
11000	37.5	-55.3
12000	37.6	-53.7
13000	38.2	-53.5
14000	39.9	-56.3
15000	40.9	-54.1
16000	41.3	-54.1
17000	42.8	-54.4
18000	44.2	-54.7

cable loss 1 (relay inside chamber) dB	cable loss 2 (High Pass) dB	cable loss 3 (pre- amp) dB	cable loss 4 (inside chamber) dB	cable loss 5 (outside chamber) dB	cable loss 6 (to receiver) dB
0.56	1.28	-62.72	2.66	0.94	1.46
0.69	0.71	-61.49	2.84	1.00	1.53
0.68	0.65	-60.80	3.06	1.09	1.60
0.70	0.54	-61.91	3.28	1.20	1.67
0.80	0.61	-61.40	3.43	1.27	1.70
0.84	0.42	-59.70	3.53	1.26	1.73
0.83	0.44	-59.81	3.75	1.32	1.83
0.91	0.53	-63.03	3.91	1.40	1.77
0.98	0.54	-61.05	4.02	1.44	1.83
1.23	0.49	-61.51	4.17	1.51	1.85
1.36	0.76	-62.36	4.34	1.53	2.00
1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

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.

6.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

Frequency MHz	AF EMCO 3160-09 dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (pre- amp) dB	cable loss 3 (inside chamber) dB	cable loss 4 (switch unit) dB	cable loss 5 (to receiver) 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

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

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.

6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

Frequency GHz	AF EMCO 3160-10 dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-20 dB/ decade) dB	d _{Limit} (meas. distance (limit) m	d _{used} (meas. distance (used) m
26.5	43.4	-11.2	4.4				-9.5	3	1.0
27.0	43.4	-11.2	4.4				-9.5	3	1.0
28.0	43.4	-11.1	4.5				-9.5	3	1.0
29.0	43.5	-11.0	4.6				-9.5	3	1.0
30.0	43.5	-10.9	4.7				-9.5	3	1.0
31.0	43.5	-10.8	4.7				-9.5	3	1.0
32.0	43.5	-10.7	4.8				-9.5	3	1.0
33.0	43.6	-10.7	4.9				-9.5	3	1.0
34.0	43.6	-10.6	5.0				-9.5	3	1.0
35.0	43.6	-10.5	5.1				-9.5	3	1.0
36.0	43.6	-10.4	5.1				-9.5	3	1.0
37.0	43.7	-10.3	5.2				-9.5	3	1.0
38.0	43.7	-10.2	5.3				-9.5	3	1.0
39.0	43.7	-10.2	5.4				-9.5	3	1.0
40.0	43.8	-10.1	5.5				-9.5	3	1.0

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

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.

distance correction = $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

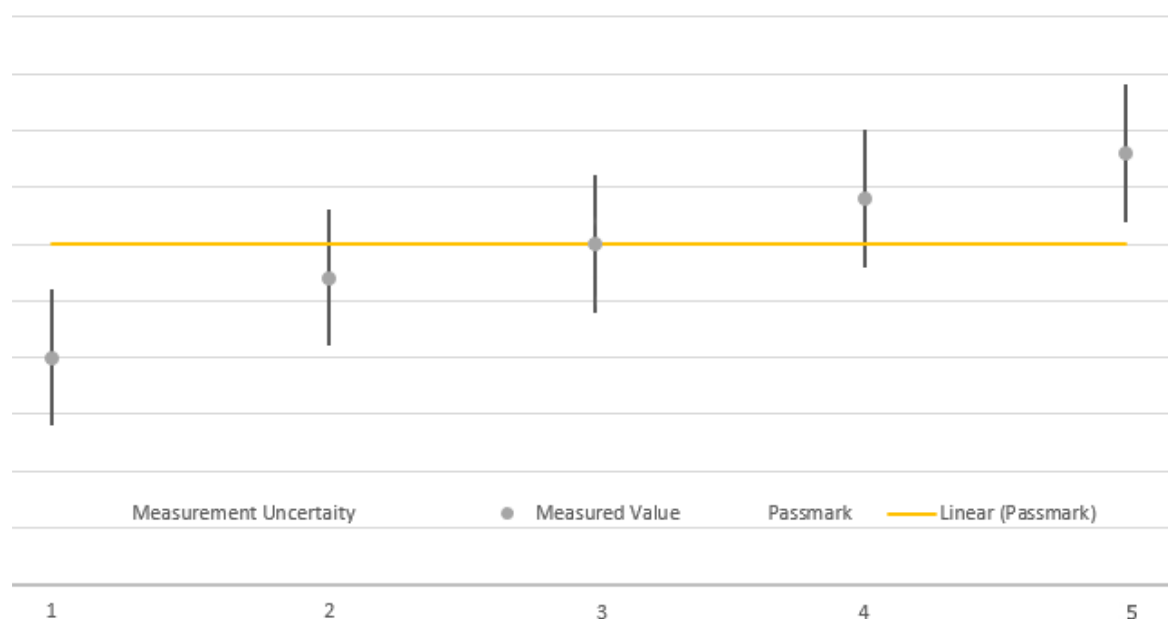
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

7 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

The measurement uncertainties for all parameters are calculated with an expansion factor (coverage factor) $k = 1.96$. This means, that the true value is in the corresponding interval with a probability of 95 %.



The verdicts in this test report are given according the above diagram:

Case	Measured Value	Uncertainty Range	Verdict
1	below pass mark	below pass mark	Passed
2	below pass mark	within pass mark	Passed
3	on pass mark	within pass mark	Passed
4	above pass mark	within pass mark	Failed
5	above pass mark	above pass mark	Failed

That means, the laboratory applies, as decision rule (see ISO/IEC 17025:2017), the so-called shared risk principle.



8 PHOTO REPORT

Please see separate photo report.

*****END OF TEST REPORT*****