

FCC Measurement/Technical Report on

Navigation display module with BT connectivity

JDCP

FCC ID: NT8-JDCP
IC: 3043A-JDCP

Test Report Reference: MDE_VIS_2017_FCC_01

Test Laboratory:

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40880 Ratingen
Germany



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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Table of Contents

| | | |
|----------|--|-----------|
| 1 | Applied Standards and Test Summary | 3 |
| 1.1 | Applied Standards | 3 |
| 1.2 | FCC-IC Correlation Table | 4 |
| 1.3 | Measurement Summary | 5 |
| 2 | Revision History / Signatures | 7 |
| 3 | Administrative Data | 8 |
| 3.1 | Testing Laboratory | 8 |
| 3.2 | Project Data | 8 |
| 3.3 | Applicant Data | 8 |
| 3.4 | Manufacturer Data | 8 |
| 4 | Test object Data | 9 |
| 4.1 | General EUT Description | 9 |
| 4.2 | EUT Main components | 10 |
| 4.3 | Ancillary Equipment | 10 |
| 4.4 | Auxiliary Equipment | 10 |
| 4.5 | EUT Setups | 11 |
| 4.6 | Operating Modes / Test Channels | 11 |
| 4.7 | Product labelling | 11 |
| 5 | Test Results | 12 |
| 5.1 | Occupied Bandwidth (6 dB) | 12 |
| 5.2 | Occupied Bandwidth (99%) | 14 |
| 5.3 | Peak Power Output | 16 |
| 5.4 | Spurious RF Conducted Emissions | 20 |
| 5.5 | Transmitter Spurious Radiated Emissions | 23 |
| 5.6 | Band Edge Compliance Conducted | 31 |
| 5.7 | Band Edge Compliance Radiated | 34 |
| 5.8 | Power Density | 37 |
| 6 | Test Equipment | 41 |
| 7 | Antenna Factors, Cable Loss and Sample Calculations | 45 |
| 7.1 | LISN R&S ESH3-Z5 (150 kHz – 30 MHz) | 45 |
| 7.2 | Antenna R&S HFH2-Z2 (9 kHz – 30 MHz) | 46 |
| 7.3 | Antenna R&S HL562 (30 MHz – 1 GHz) | 47 |
| 7.4 | Antenna R&S HF907 (1 GHz – 18 GHz) | 48 |
| 7.5 | Antenna EMCO 3160-09 (18 GHz – 26.5 GHz) | 49 |
| 7.6 | Antenna EMCO 3160-10 (26.5 GHz – 40 GHz) | 50 |
| 8 | Measurement Uncertainties | 51 |
| 9 | Photo Report | 52 |

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 (10-1-19 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

§ 15.209 Radiated emission limits; general requirements

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

Note 1:

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.

Note 2:

§ 15.207 Conducted limits are not applicable:

The device is not designed to be connected to the public utility (AC) power line.

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 |
|---|-------------------------------|---|
| Occupied bandwidth | § 15.247 (a) (2) | RSS-247 Issue 2: 5.2 (a) |
| Peak conducted output power | § 15.247 (b) (3), (4) | RSS-247 Issue 2: 5.4 (d) |
| Transmitter spurious RF conducted emissions | § 15.247 (d) | RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5 |
| Transmitter spurious radiated emissions | § 15.247 (d); § 15.209 (a) | RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5 |
| Band edge compliance | § 15.247 (d) | RSS-247 Issue 2: 5.5 |
| Power density | § 15.247 (e) | RSS-247 Issue 2: 5.2 (b) |
| Antenna requirement | § 15.203 / 15.204 | RSS-Gen Issue 5: 8.3 |

1.3 MEASUREMENT SUMMARY

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

Final Result

| OP-Mode | Setup | Date | FCC | IC |
|---------------------------------------|--------------|-------------|------------|-----------|
| Radio Technology, Operating Frequency | | | | |
| Bluetooth LE 1 Mbps, high | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, low | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid | S01_AL01 | 2021-03-15 | Passed | Passed |

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

Final Result

| OP-Mode | Setup | Date | FCC | IC |
|---------------------------------------|--------------|-------------|------------|-----------|
| Radio Technology, Operating Frequency | | | | |
| Bluetooth LE 1 Mbps, high | S01_AL01 | 2021-03-15 | N/A | Performed |
| Bluetooth LE 1 Mbps, low | S01_AL01 | 2021-03-15 | N/A | Performed |
| Bluetooth LE 1 Mbps, mid | S01_AL01 | 2021-03-15 | N/A | Performed |

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

Final Result

| OP-Mode | Setup | Date | FCC | IC |
|---|--------------|-------------|------------|-----------|
| Radio Technology, Operating Frequency, Measurement method | | | | |
| Bluetooth LE 1 Mbps, high, conducted | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, low, conducted | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid, conducted | S01_AL01 | 2021-03-15 | Passed | Passed |

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

Final Result

| OP-Mode | Setup | Date | FCC | IC |
|---------------------------------------|--------------|-------------|------------|-----------|
| Radio Technology, Operating Frequency | | | | |
| Bluetooth LE 1 Mbps, high | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, low | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid | S01_AL01 | 2021-03-15 | Passed | Passed |

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

Final Result

| OP-Mode Radio Technology, Operating Frequency, Measurement range | Setup | Date | FCC | IC |
|---|--------------|-------------|------------|-----------|
| Bluetooth LE 1 Mbps, high, 1 GHz - 26 GHz | S01_AG01 | 2021-03-12 | Passed | Passed |
| Bluetooth LE 1 Mbps, high, 30 MHz - 1 GHz | S01_AG01 | 2021-03-13 | Passed | Passed |
| Bluetooth LE 1 Mbps, low, 1 GHz - 26 GHz | S01_AG01 | 2021-03-12 | Passed | Passed |
| Bluetooth LE 1 Mbps, low, 30 MHz - 1 GHz | S01_AG01 | 2021-03-13 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid, 1 GHz - 26 GHz | S01_AG01 | 2021-03-12 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid, 30 MHz - 1 GHz | S01_AG01 | 2021-03-13 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid, 9 kHz - 30 MHz | S01_AG01 | 2021-03-14 | 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

Final Result

| OP-Mode Radio Technology, Operating Frequency, Band Edge | Setup | Date | FCC | IC |
|---|--------------|-------------|------------|-----------|
| Bluetooth LE 1 Mbps, high, high | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, low, low | S01_AL01 | 2021-03-15 | Passed | Passed |

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

Final Result

| OP-Mode Radio Technology, Operating Frequency, Band Edge | Setup | Date | FCC | IC |
|---|--------------|-------------|------------|-----------|
| Bluetooth LE 1 Mbps, high, high | S01_AG01 | 2021-03-12 | 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

Final Result

| OP-Mode Radio Technology, Operating Frequency | Setup | Date | FCC | IC |
|---|--------------|-------------|------------|-----------|
| Bluetooth LE 1 Mbps, high | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, low | S01_AL01 | 2021-03-15 | Passed | Passed |
| Bluetooth LE 1 Mbps, mid | S01_AL01 | 2021-03-15 | Passed | Passed |

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

2 REVISION HISTORY / SIGNATURES

| Report version control | | | |
|------------------------|--------------|--------------------|------------------|
| Version | Release date | Change Description | Version validity |
| initial | 2021-03-24 | -- | valid |
| -- | -- | -- | -- |

COMMENT: -

According to the applicant, the family model JDCP constitutes 5 different models (J1D, J1C1, P4D, D2K/D3K, D2G2/D3G) of which only model J1D was tested. The models are the same hardware (PWB25068) and software (V07.05) and differ slightly from each other in the external design.



(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik



(responsible for testing and report)
M.Sc. Joel Asongwe



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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: Dipl.-Ing. Marco Kullik
Report Template Version: 2021-01-13

3.2 PROJECT DATA

Responsible for testing and report: M.Sc. Joel Asongwe
Employees who performed the tests: documented internally at 7Layers
Date of Report: 2021-03-24
Testing Period: 2021-03-12 to 2021-03-15

3.3 APPLICANT DATA

Company Name: Visteon Corporation
Address: One Village Center Drive
Van Buren Township, MI, 48111,
U.S.A
Contact Person: Heidi Sepanic, Corporative Secretary

3.4 MANUFACTURER DATA

Company Name: please see Applicant Data
Address:
Contact Person:

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

| | |
|--|--|
| Kind of Device product description | Navigation Display Module with BT connectivity for two wheeler vehicle |
| Product name | Navigation display module with BT connectivity |
| Type | JDCP |
| Declared EUT data by the supplier | |
| Voltage Type | DC |
| Voltage Level | 13.5 V |
| Antenna / Gain | Integral / 2.2 dBi |
| Tested Modulation Type | GFSK |
| General product description | A 1.49" TFT with TBT (Turn By Turn navigation) and FOTA feature for 2 wheeler products. The module is customized to suit premium variants for Royal Enfield models. The Module syncs up with mobile app developed by Royal Enfield. The app then transmits the TBT information from mobile to display module via Bluetooth. The SW updates or image changes if any, will be uploaded via FOTA. |
| Specific product description for the EUT | BT-LE transceiver in the 2.4 GHz band. |
| EUT ports (connected cables during testing): | Cable Harness incl. DC |
| Tested datarates | 1 Mbps |
| Special software used for testing | NXP software provided by Applicant |

4.2 EUT MAIN COMPONENTS

| Sample Name | Sample Code | Description |
|------------------|------------------------------|-----------------|
| EUT B | DE1105009ag01 | Radiated Sample |
| Sample Parameter | Value | |
| Serial No. | - | |
| HW Version | PWB25068 | |
| SW Version | V07.05 | |
| Comment | Sample with integral Antenna | |

| Sample Name | Sample Code | Description |
|------------------|--|------------------|
| EUT C | DE1105009al01 | Conducted Sample |
| Sample Parameter | Value | |
| Serial No. | - | |
| HW Version | PWB25068 | |
| SW Version | V07.05 | |
| Comment | Sample with temporary external antenna connector | |

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 |
|--------|--|----------------------|
| AUX 1 | - , - , - , - , - | USB to TTL Converter |

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_AG01 | EUT B, AUX 1, | Radiated setup |
| S01_AL01 | EUT C, AUX 1, | Conducted setup |

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 OCCUPIED BANDWIDTH (6 DB)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.

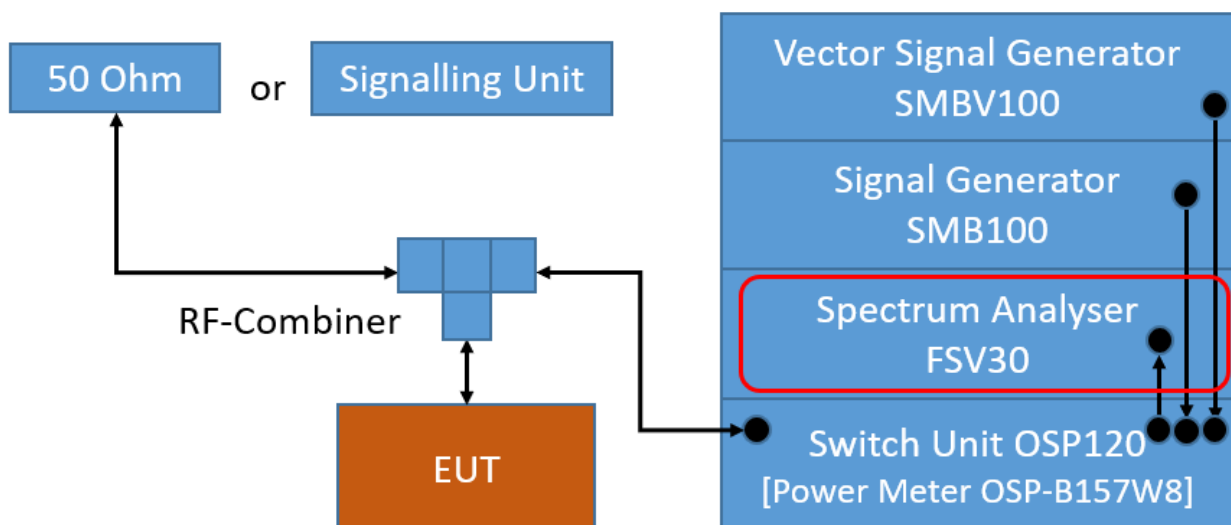
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.

The results recorded were measured with the modulation which produce the worst-case (smallest) emission bandwidth.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.

Analyser settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: Two times nominal bandwidth
- Trace: Maxhold
- Sweeps: Till stable (min. 500, max. 15000)
- Sweptime: Auto
- Detector: Peak



TS8997; Channel Bandwidth

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (a) (2)

Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.1.3 TEST PROTOCOL

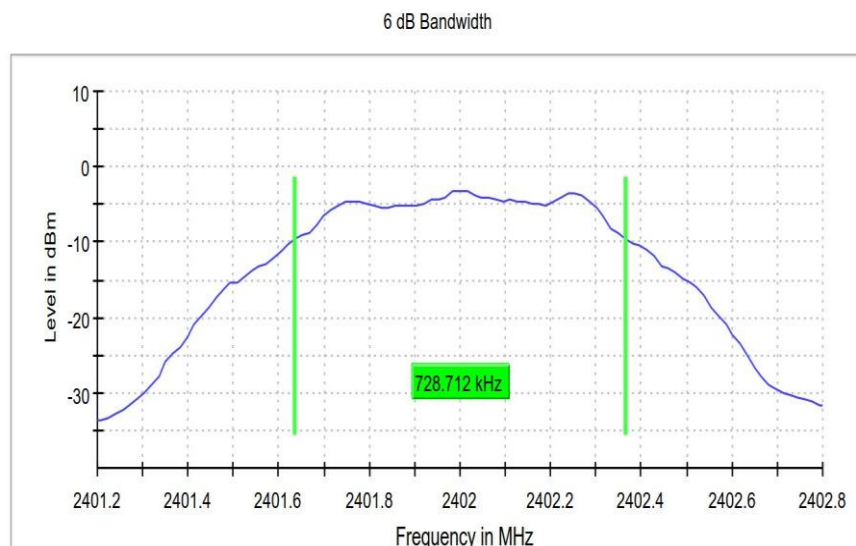
Ambient temperature: 24 °C
 Air Pressure: 1005 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s

| Band / Mode | Channel No. | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit [MHz] | Margin to Limit [MHz] |
|-------------|-------------|-----------------|----------------------|-------------|-----------------------|
| 2.4 GHz ISM | 0 | 2402 | 0.729 | 0.5 | 0.229 |
| | 19 | 2440 | 0.713 | 0.5 | 0.213 |
| | 39 | 2480 | 0.729 | 0.5 | 0.229 |

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 = low (S01_AL01)



5.1.5 TEST EQUIPMENT USED

- R&S TS8997

5.2 OCCUPIED BANDWIDTH (99%)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.2.1 TEST DESCRIPTION

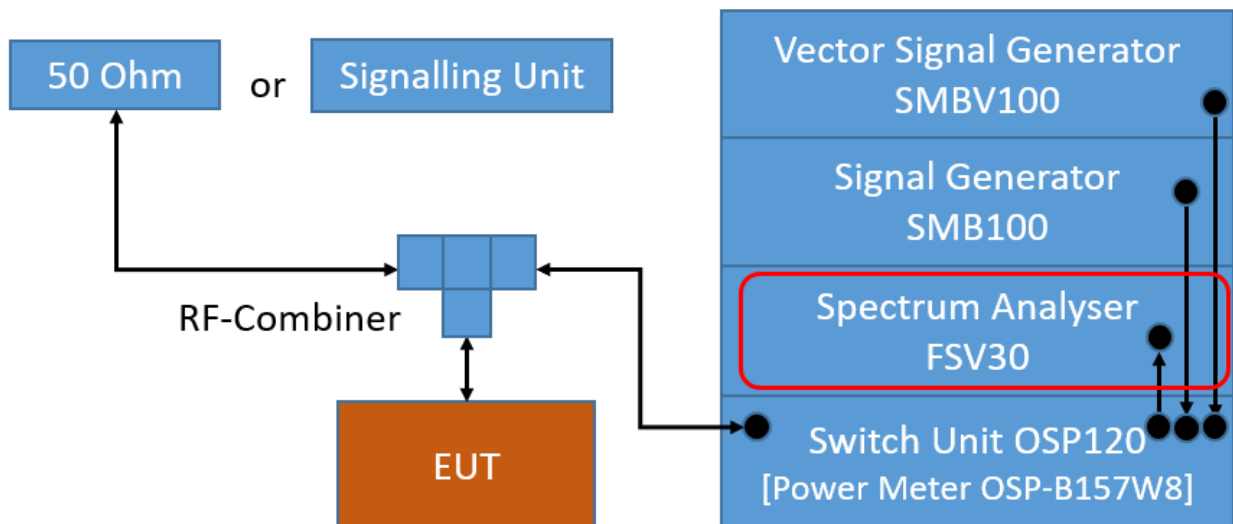
The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.

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 EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.

Analyser settings:

- Resolution Bandwidth (RBW): 1 to 5 % of the OBW
- Video Bandwidth (VBW): ≥ 3 times the RBW
- Span: 1.5 to 5 times the OBW
- Trace: Maxhold
- Sweeps: Till stable (min. 500, max. 75000)
- Sweep time: Auto
- Detector: Peak



TS8997; Channel Bandwidth

5.2.2 TEST REQUIREMENTS / LIMITS

No applicable limit:

5.2.3 TEST PROTOCOL

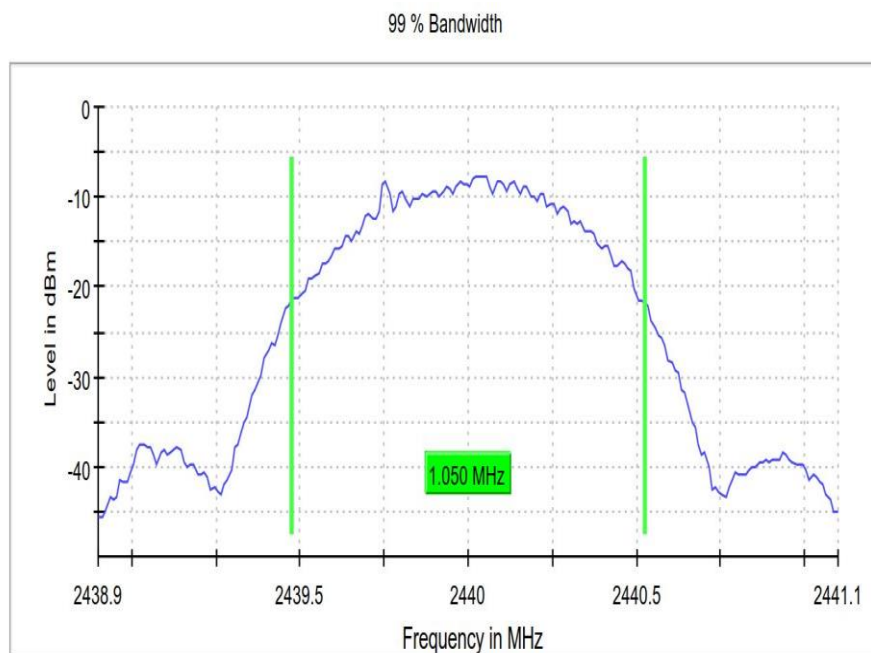
Ambient temperature: 24 °C
 Air Pressure: 1005 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s

| Band | Channel No. | Frequency [MHz] | 99 % Bandwidth [MHz] |
|-------------|-------------|-----------------|----------------------|
| 2.4 GHz ISM | 0 | 2402 | 1.040 |
| | 19 | 2440 | 1.050 |
| | 39 | 2480 | 1.040 |

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 = mid (S01_AL01)



5.2.5 TEST EQUIPMENT USED

- R&S TS8997

5.3 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.3.1 TEST DESCRIPTION

DTS EQUIPMENT:

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

Maximum peak conducted output power (e.g. Bluetooth Low Energy):

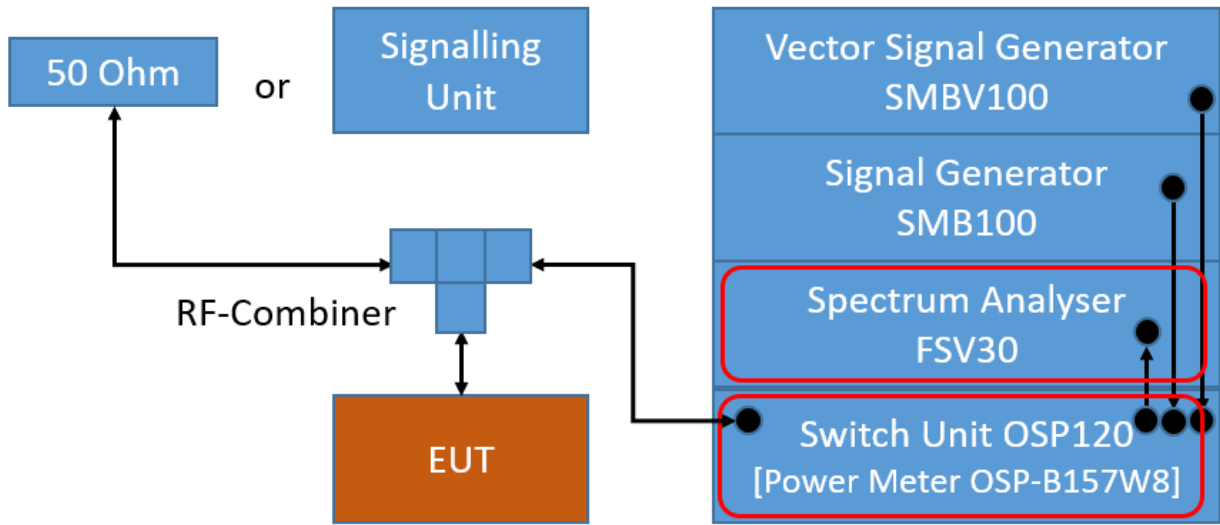
The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered. The reference level of the spectrum analyser was set higher than the output power of the EUT.

Analyser settings:

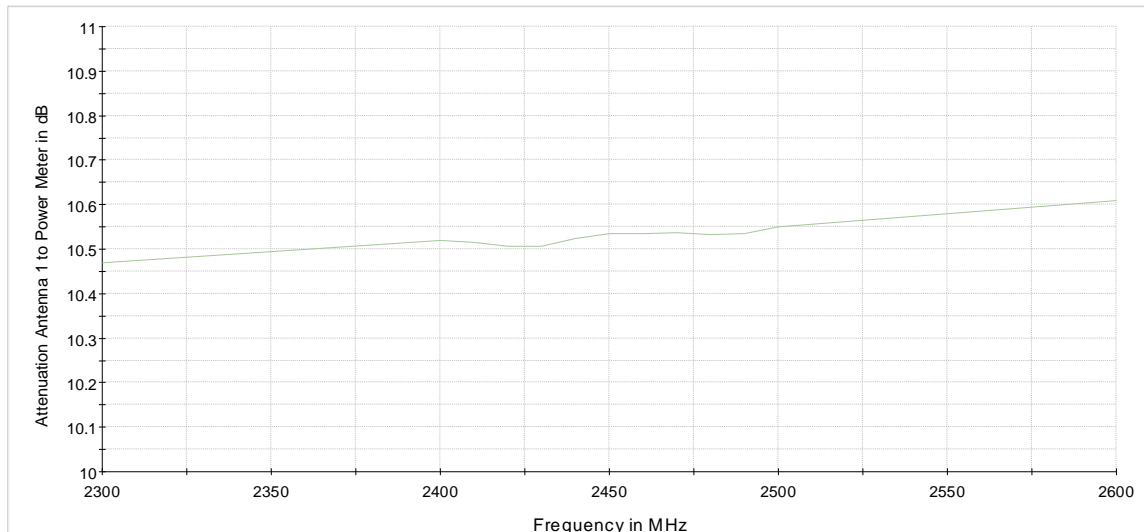
- Resolution Bandwidth (RBW): \geq DTS bandwidth
- Video Bandwidth (VBW): \geq 3 times RBW or maximum of analyzer
- Span: \geq 3 times RBW
- Trace: Maxhold
- Sweeps: Till stable (min. 300, max. 15000)
- Sweep time: Auto
- Detector: Peak

Maximum conducted average output power (e.g. WLAN):

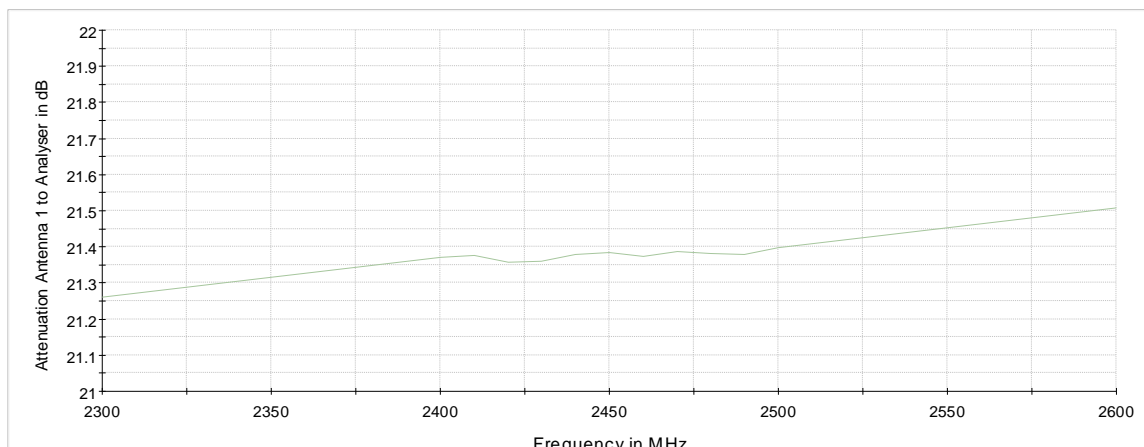
The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered. Measurement is performed using the gated RF average power meter integrated in the OSP 120 module OSP-B157W8 with signal bandwidth >300 MHz.



TS8997; Output Power



Attenuation of the measurement path to Power Meter



Attenuation of the measurement path to Analyser

5.3.2 TEST REQUIREMENTS / LIMITS

DTS devices:

FCC Part 15, Subpart C, §15.247 (b) (3)

For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

==> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Frequency Hopping Systems:

FCC Part 15, Subpart C, §15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

FCC Part 15, Subpart C, §15.247 (b) (2)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)

5.3.3 TEST PROTOCOL

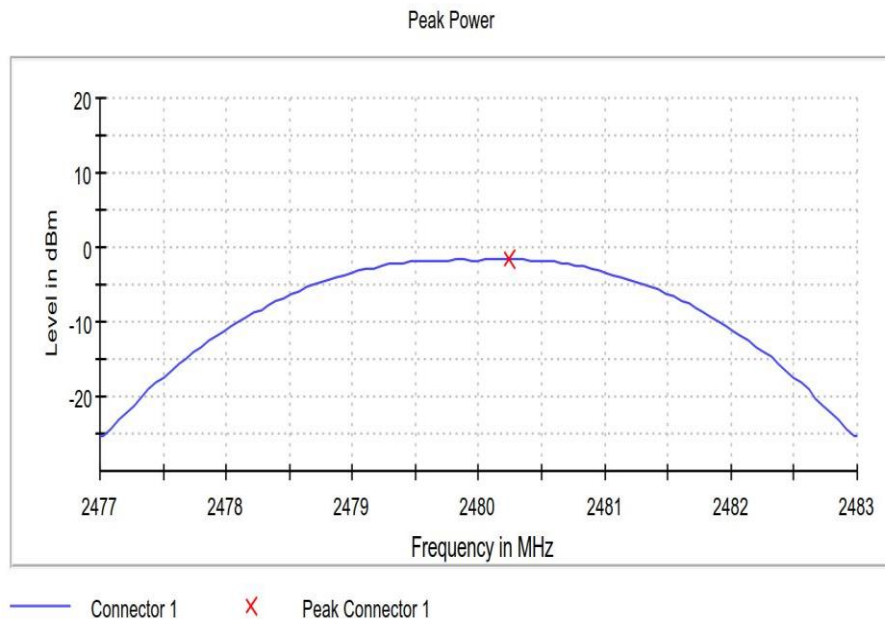
Ambient temperature: 24 °C
 Air Pressure: 1005 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s

| Band | Channel No. | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] | E.I.R.P [dBm] |
|-------------|-------------|-----------------|------------------|-------------|----------------------|---------------|
| 2.4 GHz ISM | 0 | 2402 | -2.2 | 30.0 | 32.2 | 0.0 |
| | 19 | 2440 | -1.9 | 30.0 | 31.9 | 0.3 |
| | 39 | 2480 | -1.2 | 30.0 | 31.2 | 1.0 |

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

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

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high,
 Measurement method = conducted
 (S01_AL01)



5.3.5 TEST EQUIPMENT USED

- R&S TS8997

5.4 SPURIOUS RF CONDUCTED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.4.1 TEST DESCRIPTION

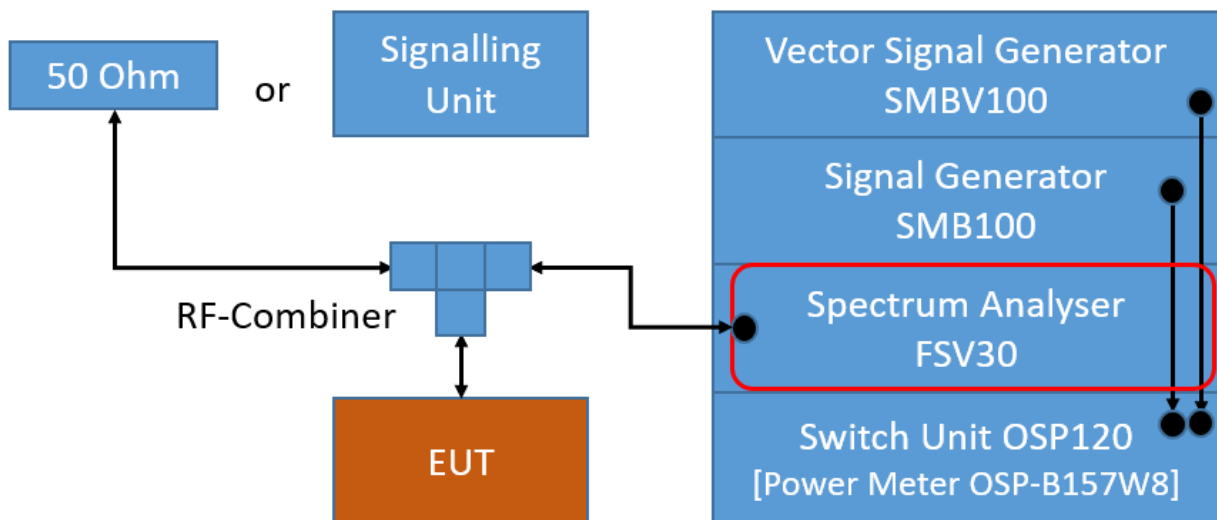
The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.

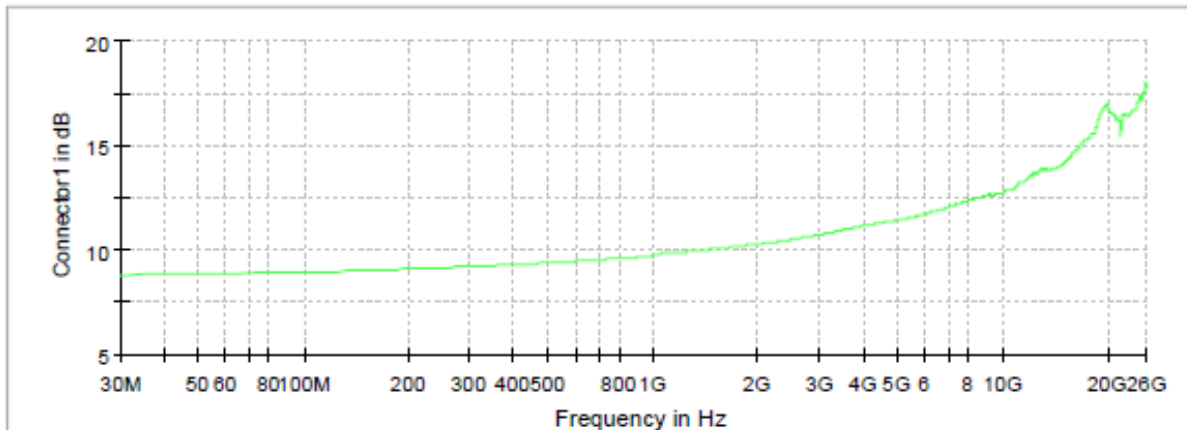
Analyser settings:

- Frequency range: 30 – 26000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Trace: Maxhold
- Sweeps: Till Stable (max. 120)
- Sweep Time: Auto
- Detector: Peak

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance conducted". This value is used to calculate the 20 dBc or 30 dBc limit.



TS8997; Spurious RF Conducted Emissions



Connector1

Attenuation of the measurement part

5.4.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.4.3 TEST PROTOCOL

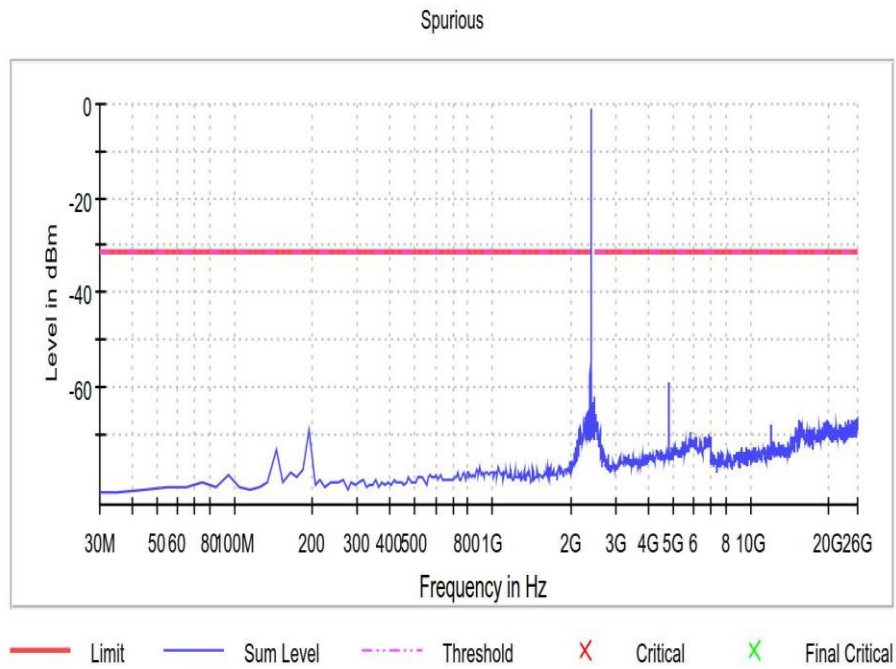
Ambient temperature: 24 °C
 Air Pressure: 1005 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s

| Channel No | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| 0 | 2402 | 2395.0 | -54.2 | PEAK | 100 | -11.3 | -31.3 | 22.9 |
| 19 | 2440 | 4877.1 | -59.2 | PEAK | 100 | -10.1 | -30.1 | 29.1 |
| 39 | 2480 | 2498.5 | -55.5 | PEAK | 100 | -10.9 | -30.9 | 24.6 |

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

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

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = low (S01_AL01)



5.4.5 TEST EQUIPMENT USED

- R&S TS8997

5.5 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.5.1 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:

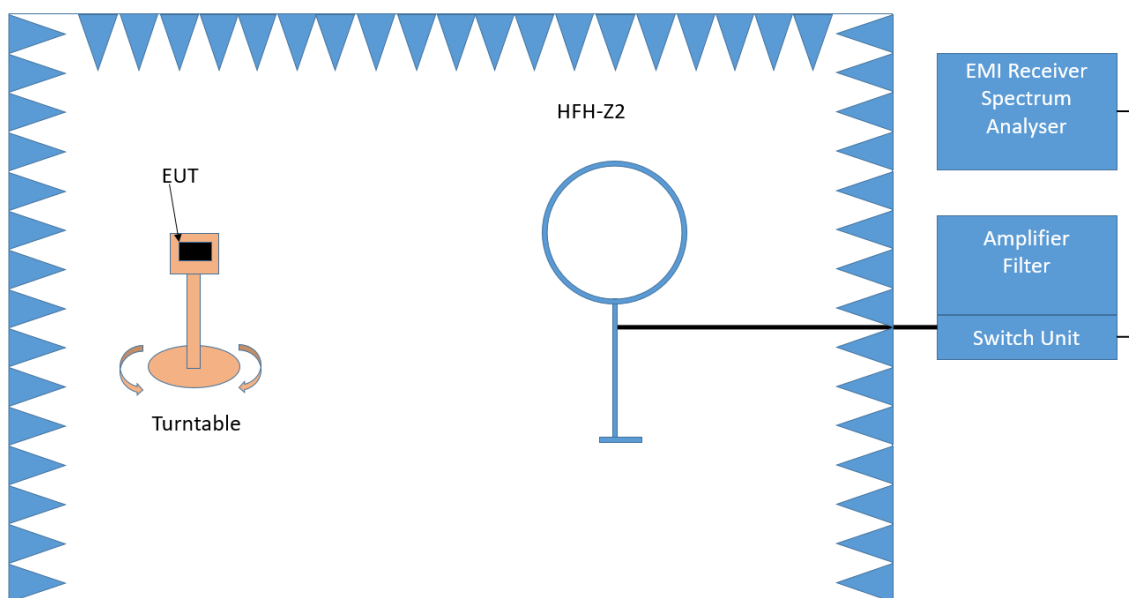
- < 30 MHz: Chapter 6.4
- 30 MHz – 1 GHz: Chapter 6.5
- > 1 GHz: Chapter 6.6 (procedure according 6.6.5 used)

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)

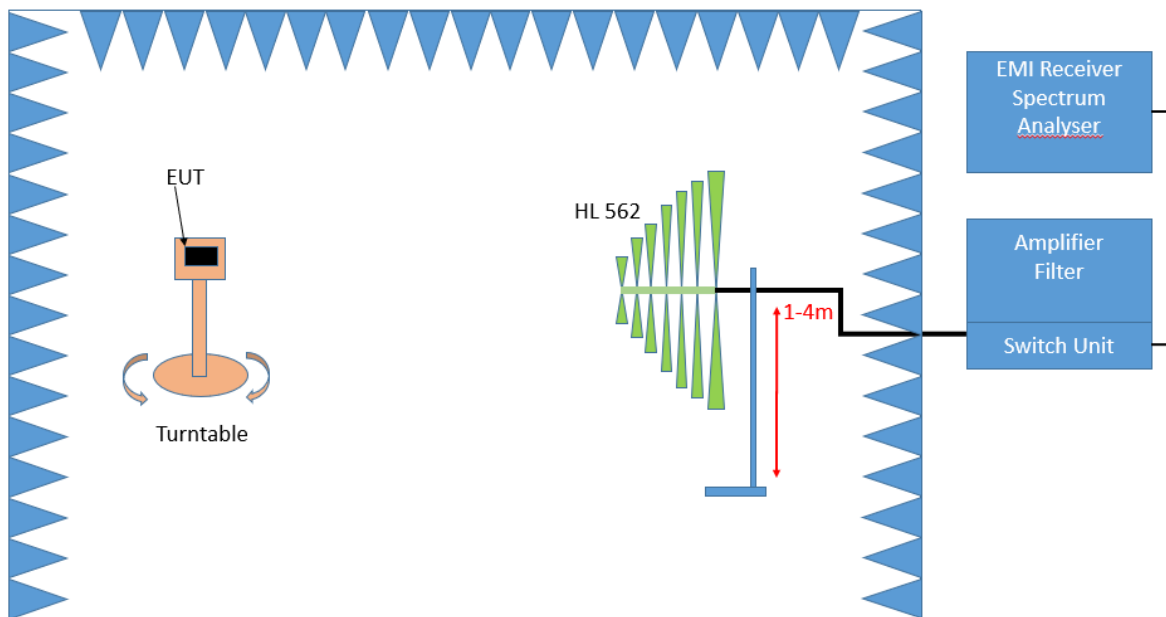
Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

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 $\pm 45^{\circ}$ 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 will also slowly vary by ± 100 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: 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:

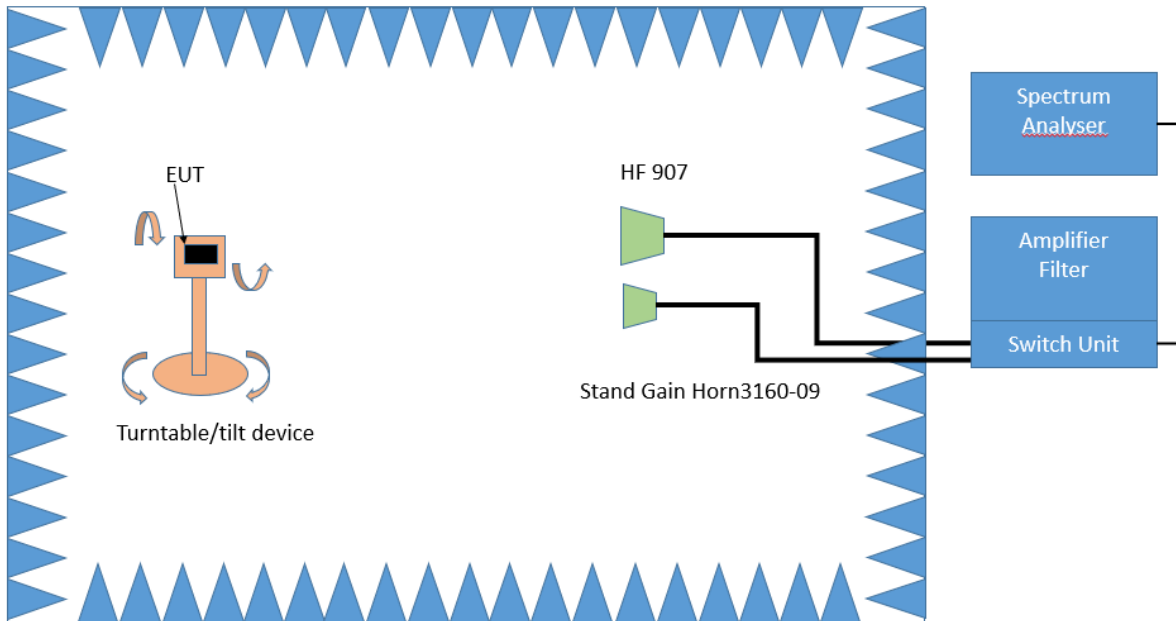
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

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

5.5.2 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 ($\mu\text{V}/\text{m}$) | Measurement distance (m) | Limits ($\text{dB}\mu\text{V}/\text{m}$) |
|------------------|----------------------------------|--------------------------|--|
| 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 ($\mu\text{V}/\text{m}$) | Measurement distance (m) | Limits ($\text{dB}\mu\text{V}/\text{m}$) |
|------------------|----------------------------------|--------------------------|--|
| 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: $\text{Limit (dB}\mu\text{V}/\text{m)} = 20 \log (\text{Limit } (\mu\text{V}/\text{m})/1\mu\text{V}/\text{m})$

5.5.3 TEST PROTOCOL

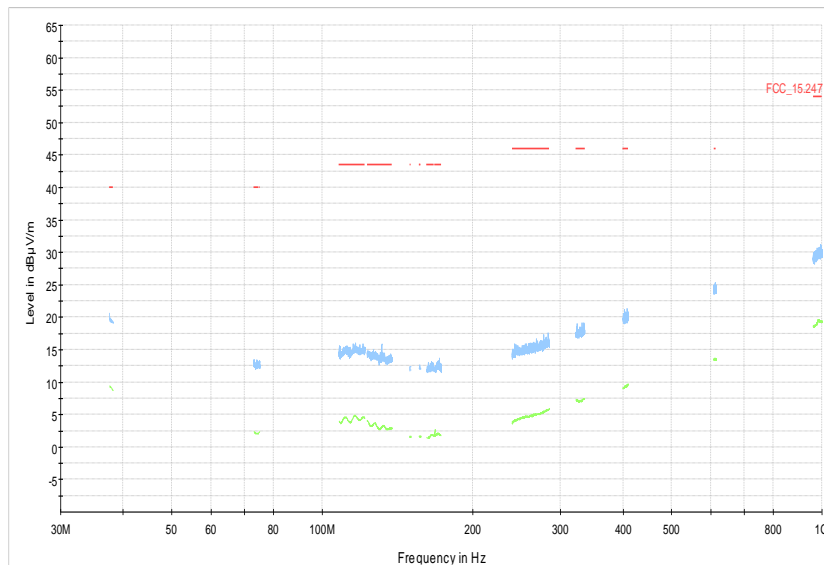
Ambient temperature: 22 - 23 °C
 Air Pressure: 1000 - 1001 hPa
 Humidity: 30 - 33 %
 BT LE 1 Mbit/s
 Applied duty cycle correction (AV): 0 dB

| Ch. No. | Ch. Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] | Limit Type |
|---------|------------------------|----------------------|-------------------------|----------|-----------|----------------|----------------------|------------|
| 0 | 2402 | 4803.9 | 22.4 | AV | 1000 | 54.0 | 31.6 | RB |
| 0 | 2402 | 4804.0 | 51.1 | PEAK | 1000 | 74.0 | 22.9 | RB |
| 0 | 2402 | 16157.8 | 40.4 | AV | 1000 | 54.0 | 13.6 | RB |
| 0 | 2402 | 16157.9 | 55.1 | PEAK | 1000 | 74.0 | 18.9 | RB |
| 0 | 2402 | 192141.0 | 39.1 | AV | 1000 | 54.0 | 14.9 | RB |
| 0 | 2402 | 19214.0 | 55.5 | PEAK | 1000 | 74.0 | 18.5 | RB |
| 19 | 2440 | 4882.0 | 52.2 | PEAK | 1000 | 74.0 | 21.8 | RB |
| 19 | 2440 | 4882.0 | 37.9 | AV | 1000 | 54.0 | 16.1 | RB |
| 19 | 2440 | 7323.0 | 50.4 | AV | 1000 | 54.0 | 3.6 | RB |
| 19 | 2440 | 7323.0 | 67.1 | PEAK | 1000 | 74.0 | 6.9 | RB |
| 19 | 2440 | 15615.0 | 56.2 | PEAK | 1000 | 74.0 | 17.8 | RB |
| 19 | 2440 | 15615.0 | 42.8 | AV | 1000 | 54.0 | 11.2 | RB |
| 19 | 2440 | 17819.3 | 45.3 | AV | 1000 | 54.0 | 8.7 | RB |
| 19 | 2440 | 17819.3 | 61.1 | PEAK | 1000 | 74.0 | 12.9 | RB |
| 39 | 2480 | 2496.0 | 58.7 | PEAK | 1000 | 74.0 | 15.3 | RB |
| 39 | 2480 | 2496.4 | 35.1 | AV | 1000 | 54.0 | 18.9 | RB |
| 39 | 2480 | 4959.6 | 55.1 | PEAK | 1000 | 74.0 | 18.9 | RB |
| 39 | 2480 | 4960.2 | 40.8 | AV | 1000 | 54.0 | 13.2 | RB |
| 39 | 2480 | 7440.0 | 51.1 | AV | 1000 | 54.0 | 2.9 | RB |
| 39 | 2480 | 7440.8 | 68.1 | PEAK | 1000 | 74.0 | 5.9 | RB |
| 39 | 2480 | 19841.8 | 41.0 | AV | 1000 | 54.0 | 13.0 | RB |
| 39 | 2480 | 19842.0 | 58.1 | PEAK | 1000 | 74.0 | 15.9 | RB |

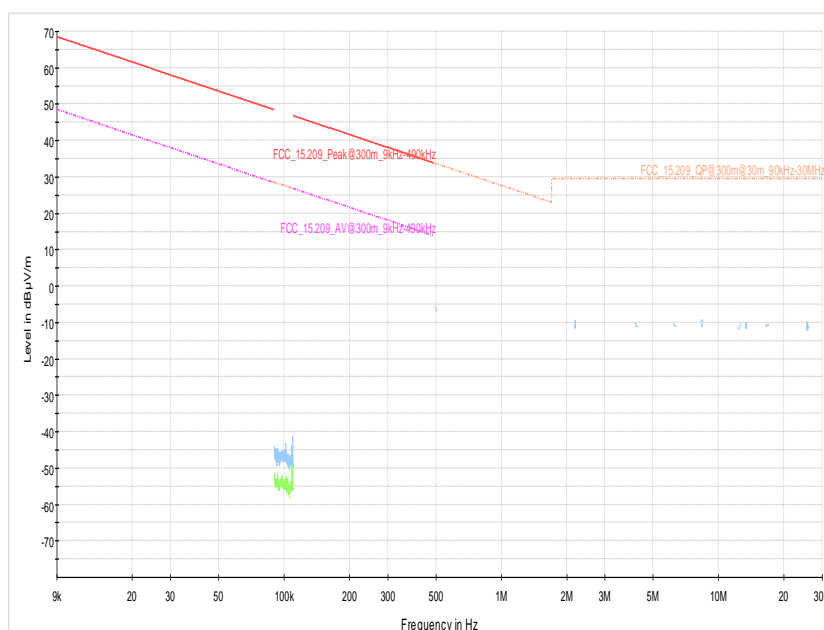
Remark: Please see next sub-clause for the measurement plot.

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

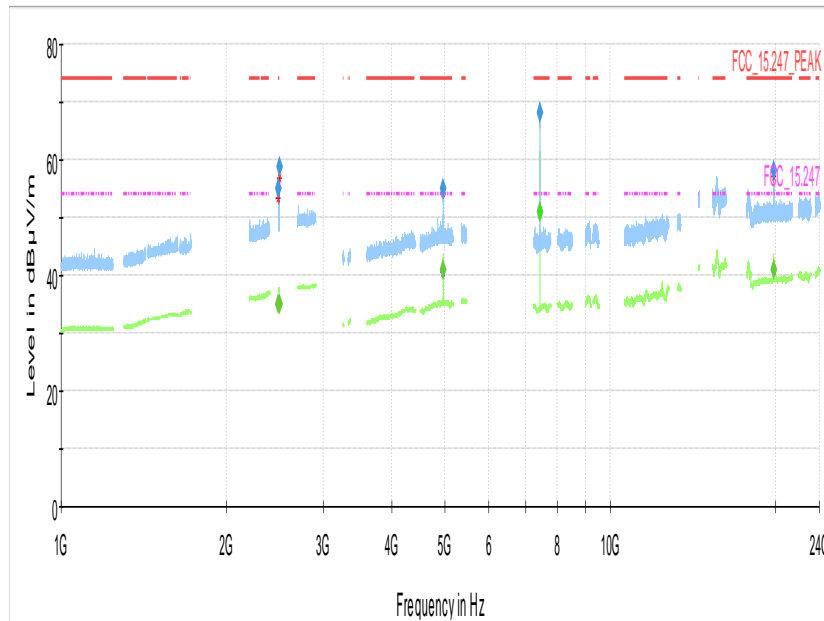
Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = mid, Measurement range = 30 MHz - 1 GHz
(S01_AG01)



Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = mid, Measurement range = 9 kHz - 30 MHz
(S01_AG01)



Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, Measurement range =
 1 GHz - 26 GHz
 (S01_AG01)



5.5.5 TEST EQUIPMENT USED

- Radiated Emissions

5.6 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

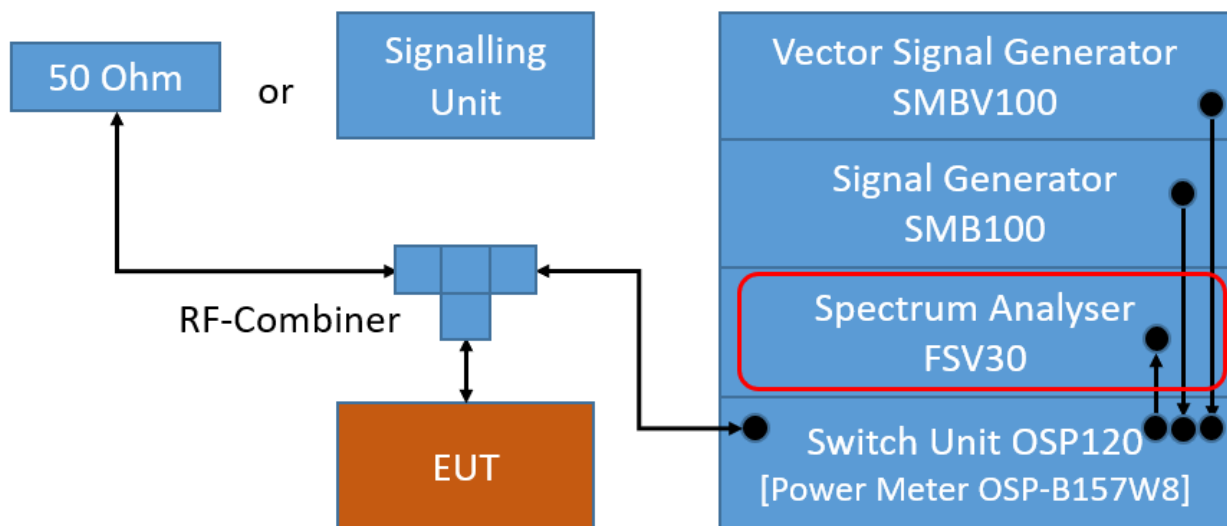
5.6.1 TEST DESCRIPTION

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room. The reference power was measured in the test case "Spurious RF Conducted Emissions".

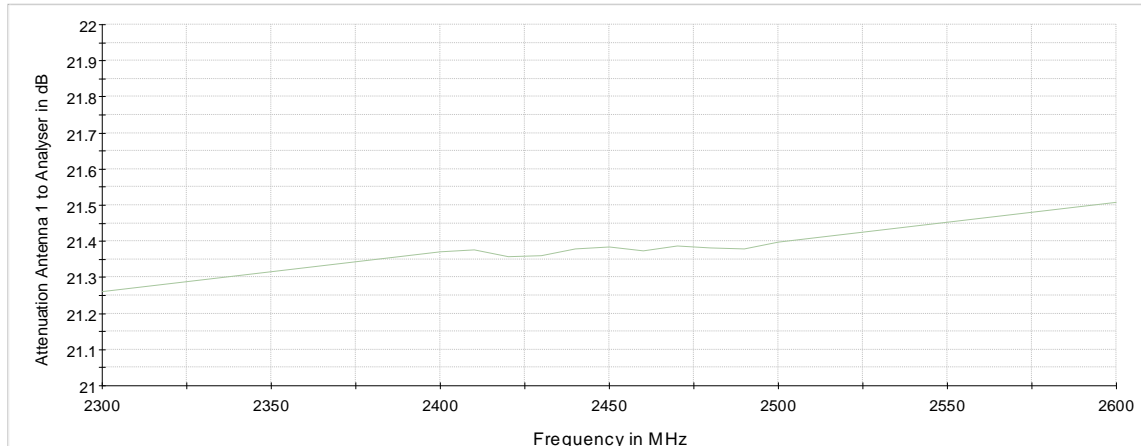
The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.

Analyser settings:

- Lower Band Edge:
Measured range: 2310.0 MHz to 2483.5 MHz
Upper Band Edge
Measured range: 2400.0 MHz to 2500 MHz
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep time: Auto
- Sweeps: Till stable (min. 300, max. 15000)
- Trace: Maxhold



TS8997; Band Edge Conducted



Attenuation of the measurement path

5.6.2 TEST REQUIREMENTS / LIMITS

FCC Part 15.247 (d)

"In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. ...

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. 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))."

For the conducted measurement the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

5.6.3 TEST PROTOCOL

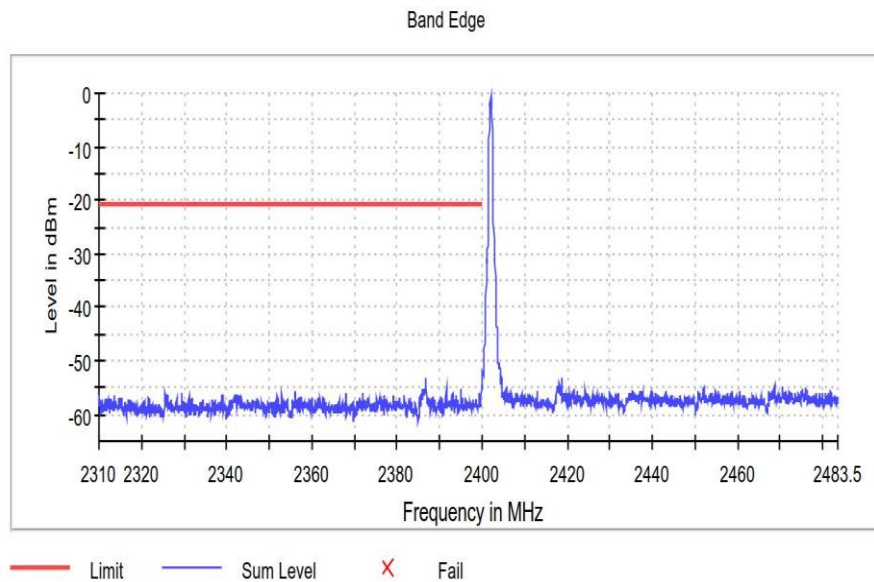
Ambient temperature: 24 °C
Air Pressure: 1005 hPa
Humidity: 31 %
BT LE 1 Mbit/s

| Channel No. | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| 0 | 2402 | 2400.0 | -52.8 | PEAK | 100 | 3.5 | -16.5 | 36.3 |
| 39 | 2480 | 2483.5 | -53.3 | PEAK | 100 | 3.8 | -16.2 | 37.1 |

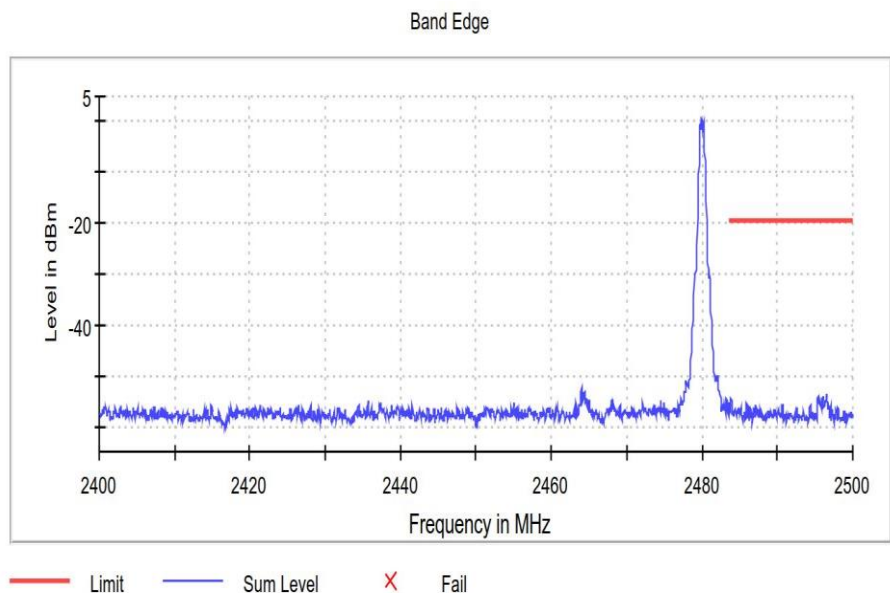
Remark: Please see next sub-clause for the measurement plot.

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

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = low, Band Edge = low (S01_AL01)



Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, Band Edge = high (S01_AL01)



5.6.5 TEST EQUIPMENT USED

- R&S TS8997

5.7 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.7.1 TEST DESCRIPTION

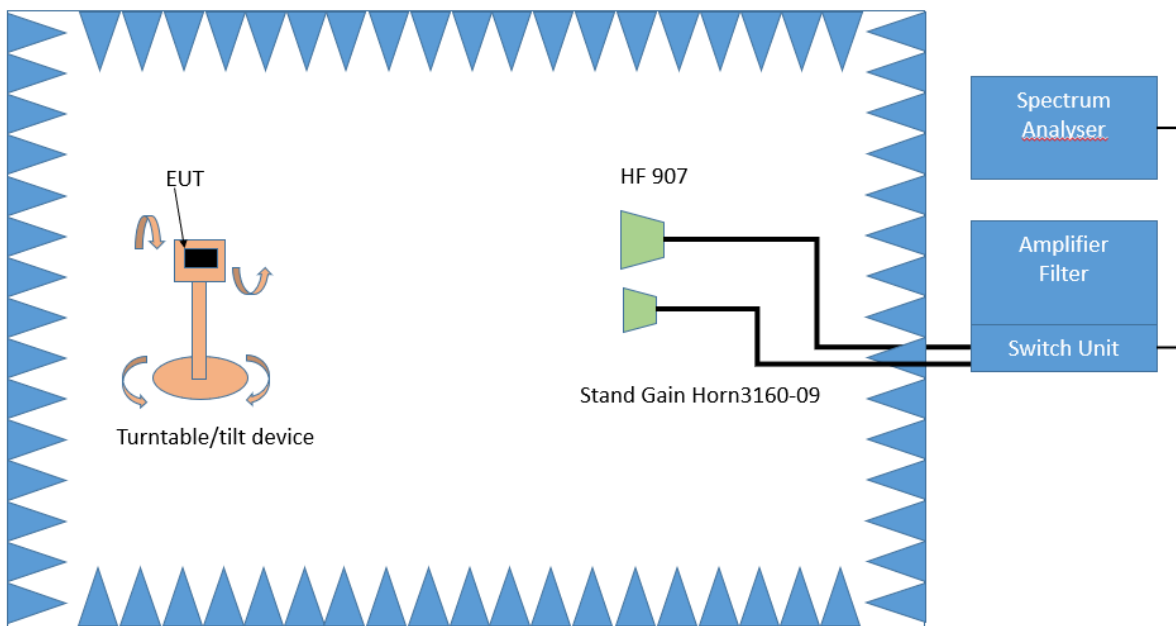
The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The measurements were performed according the following sub-chapter of ANSI C63.10:

- 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

5.7.2 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: $\text{Limit (dB}\mu\text{V/m)} = 20 \log (\text{Limit } (\mu\text{V/m})/1\mu\text{V/m)}$

5.7.3 TEST PROTOCOL

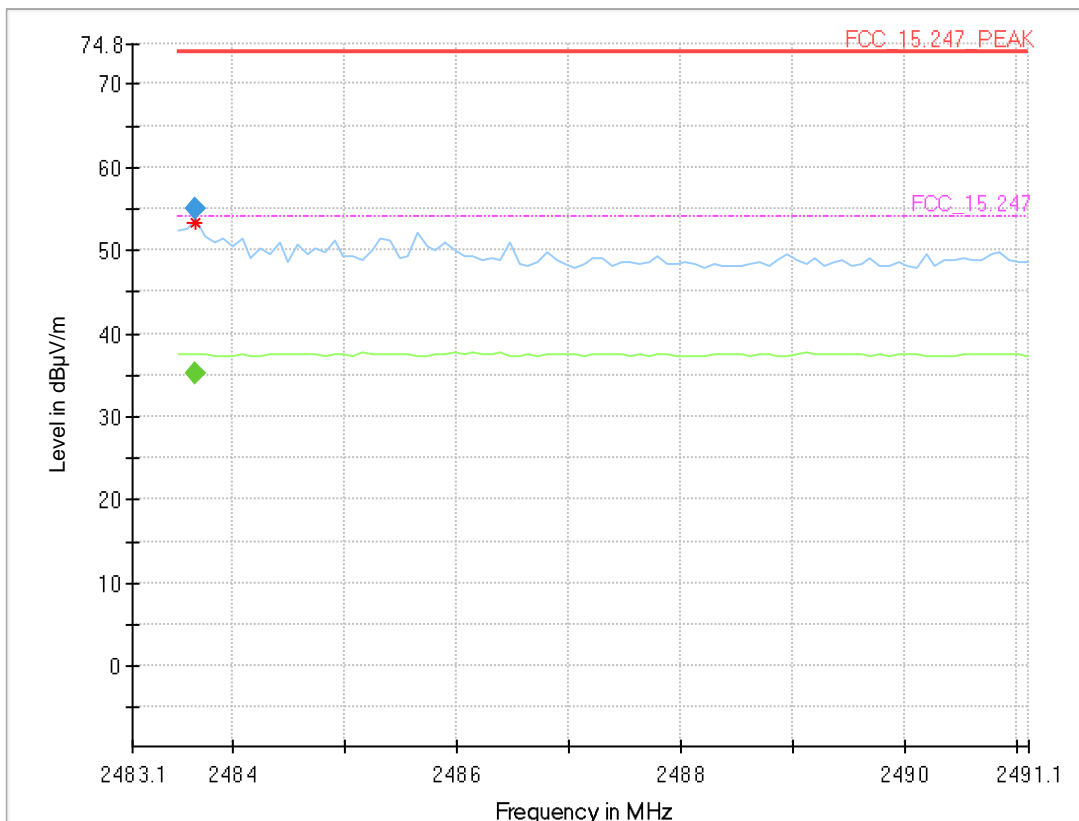
Ambient temperature: 23 °C
 Air Pressure: 1000 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s
 Applied duty cycle correction (AV): 0 dB

| 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 | 55.0 | PEAK | 1000 | 74.0 | 19.0 |
| 39 | 2480 | 2483.5 | 35.1 | AV | 1000 | 54.0 | 18.9 |

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

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

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high, Band Edge = high (S01_AG01)



5.7.5 TEST EQUIPMENT USED

- Radiated Emissions

5.8 POWER DENSITY

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.8.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room to perform the Power Density measurements.

The results recorded were measured with the modulation which produces the worst-case (highest) power density.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.

Maximum Peak Power Spectral Density (e.g. Bluetooth low energy):

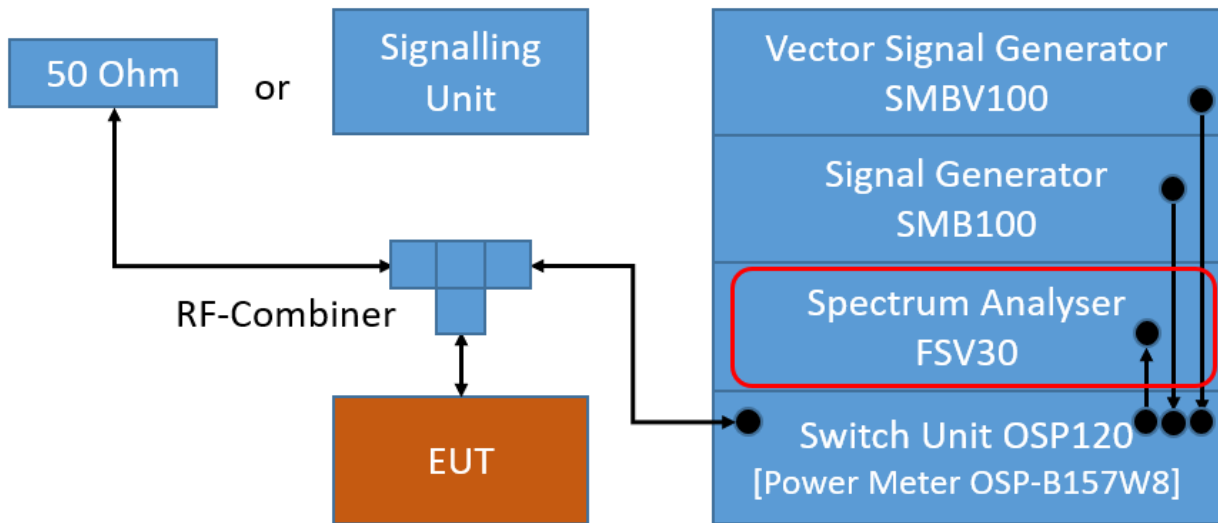
Analyser settings:

- Resolution Bandwidth (RBW): 100 kHz, 10 kHz or 3 kHz
- Video Bandwidth (VBW): ≥ 3 times RBW
- Trace: Maxhold
- Sweeps: Till stable (min. 200, max. 15000)
- Sweeptime: Auto
- Detector: Peak

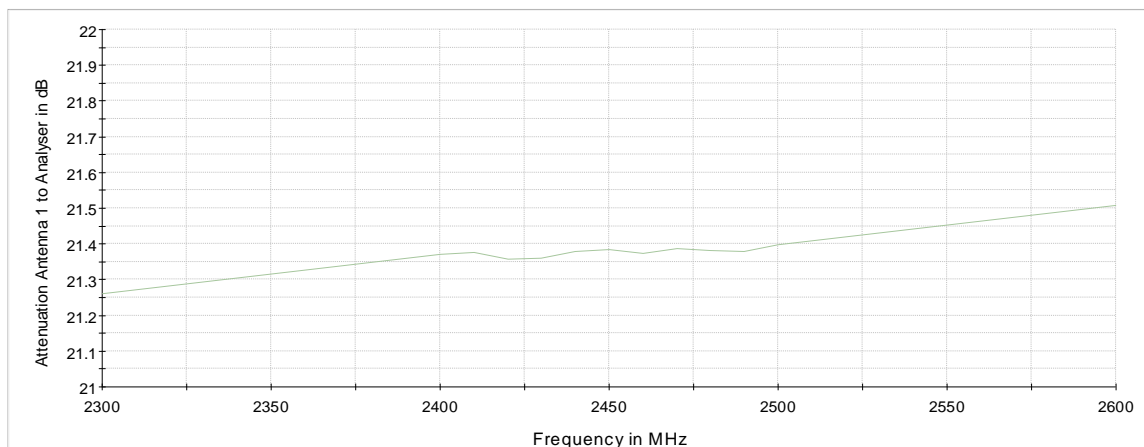
Maximum Average Power Spectral Density (e.g. WLAN):

Analyser settings:

- Resolution Bandwidth (RBW): 100 kHz, 10 kHz or 3 kHz
- Video Bandwidth (VBW): ≥ 3 times RBW
- Sweep Points: ≥ 2 times span / RBW
- Trace: Maxhold
- Sweeps: Till stable (max. 150)
- Sweeptime: \leq Number of Sweep Points x minimum transmission duration
- Detector: RMS



TS8997; Power Spectral Density



Attenuation of the measurement path

5.8.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

...

The same method of determining the conducted output power shall be used to determine the power spectral density.

FCC Part 15, Subpart C, §15.247 (f)

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques.

...

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

5.8.3 TEST PROTOCOL

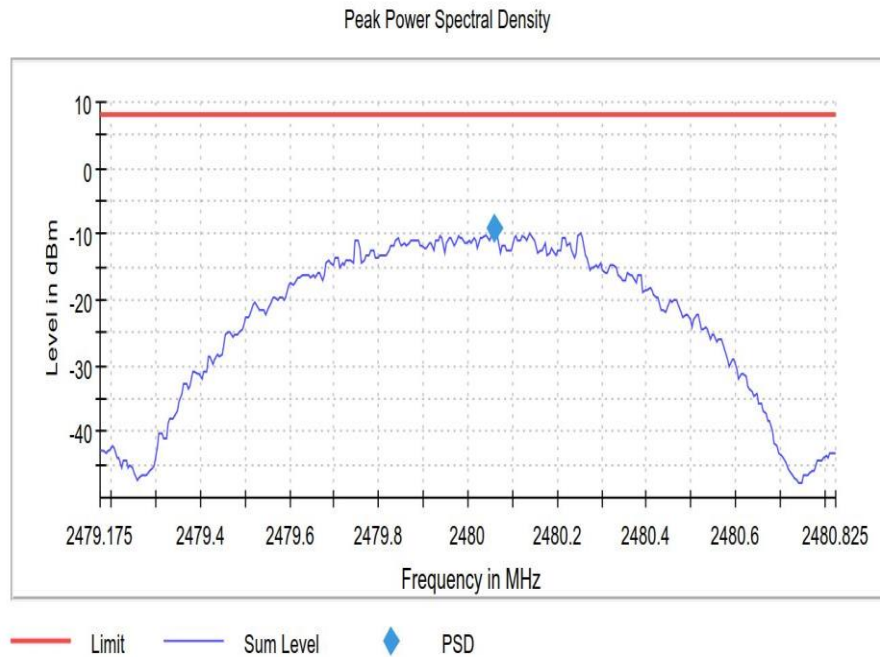
Ambient temperature: 24 °C
 Air Pressure: 1005 hPa
 Humidity: 31 %
 BT LE 1 Mbit/s

| Band | Channel No. | Frequency [MHz] | Power Density [dBm / RBW] | RBW [kHz] | Limit [dBm/3kHz] | Margin to Limit [dB] |
|-------------|-------------|-----------------|---------------------------|-----------|------------------|----------------------|
| 2.4 GHz ISM | 0 | 2402 | -9.4 | 10.0 | 8.0 | 17.4 |
| | 19 | 2440 | -8.7 | 10.0 | 8.0 | 16.7 |
| | 39 | 2480 | -8.6 | 10.0 | 8.0 | 16.6 |

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

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

Radio Technology = Bluetooth LE 1 Mbps, Operating Frequency = high (S01_AL01)



5.8.5 TEST EQUIPMENT USED

- R&S TS8997

6 TEST EQUIPMENT

- 1 R&S TS8997
2.4 and 5 GHz Bands Conducted Test Lab

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|--------------------------------|--|-----------------------------------|----------------|------------------|-----------------|
| 1.1 | SMB100A | Signal Generator 9 kHz - 6 GHz | Rohde & Schwarz | 107695 | 2020-08 | 2023-08 |
| 1.2 | EX520 | Digital Multimeter 12 | Extech Instruments Corp | 05157876 | 2020-04 | 2022-04 |
| 1.3 | FSV30 | Signal Analyzer 10 Hz - 30 GHz | Rohde & Schwarz | 103005 | 2020-05 | 2022-05 |
| 1.4 | Opus10 THI (8152.00) | T/H Logger 15 | Lufft Mess- und Regeltechnik GmbH | 13985 | 2019-06 | 2021-06 |
| 1.5 | NGSM 32/10 | Power Supply | Rohde & Schwarz GmbH & Co. KG | 3456 | 2020-01 | 2022-01 |
| 1.6 | Temperature Chamber KWP 120/70 | Temperature Chamber Weiss 01 | Weiss | 59226012190010 | 2020-05 | 2022-05 |
| 1.7 | SMB100A | Signal Generator 100 kHz - 40 GHz | Rohde & Schwarz Vertriebs-GmbH | 181486 | 2019-11 | 2021-11 |
| 1.8 | Temperature Chamber VT 4002 | Temperature Chamber Vötsch 03 | Vötsch | 58566002150010 | 2020-05 | 2022-05 |
| 1.9 | Opus10 THI (8152.00) | T/H Logger 14 | Lufft Mess- und Regeltechnik GmbH | 13993 | 2019-06 | 2021-06 |
| 1.10 | OSP120 | Contains Power Meter and Switching Unit OSP-B157W8 | Rohde & Schwarz | 101158 | 2018-05 | 2021-05 |

- 2 Radiated Emissions
Lab to perform radiated emission tests

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|--------------------------------------|-----------------------------------|---------------|------------------|-----------------|
| 2.1 | MFS | Rubidium Frequency Normal MFS | Datum GmbH | 002 | 2020-11 | 2021-11 |
| 2.2 | N5000/NP | Filter for EUT, 2 Lines, 250 V, 16 A | ETS-LINDGREN | 241515 | | |
| 2.3 | Opus10 TPR (8253.00) | T/P Logger 13 | Lufft Mess- und Regeltechnik GmbH | 13936 | 2019-05 | 2021-05 |
| 2.4 | ESW44 | EMI Receiver / Spectrum Analyzer | Rohde & Schwarz GmbH & Co. KG | 101603 | 2019-12 | 2021-12 |
| 2.5 | Anechoic Chamber 01 | SAC/FAR, 10.58 m x 6.38 m x 6.00 m | Frankonia | none | 2018-06 | 2021-06 |

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|-------------------------|--|-------------------------------------|--------------------|------------------|-----------------|
| 2.6 | HL 562 ULTRALOG | Biconical-log-per antenna (30 MHz - 3 GHz) with HL 562E biconicals | Rohde & Schwarz GmbH & Co. KG | 830547/003 | 2018-07 | 2021-07 |
| 2.7 | AMF-7D00101800-30-10P-R | Broadband Amplifier 100 MHz - 18 GHz | Miteq | | | |
| 2.8 | 5HC2700/12750-1.5-KK | High Pass Filter | Trilithic | 9942012 | | |
| 2.9 | ASP 1.2/1.8-10 kg | Antenna Mast | Maturo GmbH | - | | |
| 2.10 | Anechoic Chamber 03 | FAR, 8.80m x 4.60m x 4.05m (l x w x h) | Albatross Projects | P26971-647-001-PRB | | |
| 2.11 | Fluke 177 | Digital Multimeter 03 (Multimeter) | Fluke Europe B.V. | 86670383 | 2020-04 | 2022-04 |
| 2.12 | WRD1920/1980-5/22-5EESD | Tunable Band Reject Filter | Wainwright Instruments GmbH | 11 | | |
| 2.13 | TDS 784C | Digital Oscilloscope [SA2] (Aux) | Tektronix | B021311 | | |
| 2.14 | Opus10 THI (8152.00) | T/H Logger 10 | Lufft Mess- und Regeltechnik GmbH | 12488 | 2019-06 | 2021-06 |
| 2.15 | foRS232 Unit 2 | Fibre optic link RS232 | PONTIS Messtechnik GmbH | 4031516037 | | |
| 2.16 | PONTIS Con4101 | PONTIS Camera Controller | | 6061510370 | | |
| 2.17 | NRVD | Power Meter | Rohde & Schwarz GmbH & Co. KG | 828110/016 | 2020-08 | 2021-08 |
| 2.18 | OLS-1 R | Fibre optic link USB 1.1 | Ingenieurbüro Scheiba | 018 | | |
| 2.19 | HF 906 | Double-ridged horn | Rohde & Schwarz | 357357/002 | 2018-09 | 2021-09 |
| 2.20 | JS4-18002600-32-5P | Broadband Amplifier 18 GHz - 26 GHz | Miteq | 849785 | | |
| 2.21 | FSW 43 | Spectrum Analyzer | Rohde & Schwarz | 103779 | 2019-02 | 2021-08 |
| 2.22 | EP 1200/B, NA/B1 | AC Source, Amplifier with integrated variable Oscillator | Spitzenberger & Spies GmbH & Co. KG | B6278 | | |
| 2.23 | 3160-09 | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronik GmbH | 00083069 | | |
| 2.24 | foRS232 Unit 1 | Fibre optic link RS232 | PONTIS Messtechnik GmbH | 4021516036 | | |
| 2.25 | FSP3 | Spectrum Analyzer | Rohde & Schwarz GmbH & Co. KG | 836722/011 | | |
| 2.26 | WHKX 7.0/18G-8SS | High Pass Filter | Wainwright Instruments GmbH | 09 | | |

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|--------------------------------|--|--------------------------------|----------------|------------------|-----------------|
| 2.27 | DS 420S | Turn Table 2 m diameter | HD GmbH | 420/573/99 | | |
| 2.28 | 4HC1600/12750-1.5-KK | High Pass Filter | Trilithic | 9942011 | | |
| 2.29 | foUSB-M Converter 2 | Fibre optic link USB 2.0 | PONTIS Messtechnik GmbH | 4471520061 | | |
| 2.30 | WRCD1879.8-0.2/40-10EE | Notch Filter Ultra Stable | Wainwright Instruments GmbH | 16 | | |
| 2.31 | Temperature Chamber KWP 120/70 | Temperature Chamber Weiss 01 | Weiss | 59226012190010 | 2020-05 | 2022-05 |
| 2.32 | FSIQ26 | Signal Analyser 20 Hz to 26.5 GHz | Rohde & Schwarz GmbH & Co. KG | 840061/005 | 2019-06 | 2021-06 |
| 2.33 | SMB100A | Signal Generator 100 kHz - 40 GHz | Rohde & Schwarz Vertriebs-GmbH | 181486 | 2019-11 | 2021-11 |
| 2.34 | JS4-00102600-42-5A | Broadband Amplifier 30 MHz - 26 GHz | Miteq | 619368 | | |
| 2.35 | TT 1.5 WI | Turn Table | Maturo GmbH | - | | |
| 2.36 | HL 562 ULTRALOG | Biconical-log-per Antenna (30 MHz - 3 GHz) | Rohde & Schwarz GmbH & Co. KG | 100609 | 2019-05 | 2022-05 |
| 2.37 | HF 906 | Double-ridged horn | Rohde & Schwarz | 357357/001 | | |
| 2.38 | foCAN (v 4.0) | Fibre optic link CAN | Audio GmbH (PONTIS EMC) | 492 1607 014 | | |
| 2.39 | MA4985-XP-ET | Bore Sight Antenna Mast | innco systems GmbH | none | | |
| 2.40 | Temperature Chamber VT 4002 | Temperature Chamber Vötsch 03 | Vötsch | 58566002150010 | 2020-05 | 2022-05 |
| 2.41 | A8455-4 | 4 Way Power Divider (SMA) | | - | | |
| 2.42 | VLFX-650+ | Low Pass Filter DC650 MHz | Mini-Circuits | 15542 | | |
| 2.43 | JUN-AIR Mod. 6-15 | Air Compressor | JUN-AIR Deutschland GmbH | 612582 | | |
| 2.44 | foEthernet_M | Fibre optic link Ethernet / Gb-LAN | PONTIS Messtechnik GmbH | 4841516023 | | |
| 2.45 | 5HC3500/18000-1.2-KK | High Pass Filter | Trilithic | 200035008 | | |
| 2.46 | OLS-1 M | Fibre optic link USB 1.1 | Ingenieurbüro Scheiba | 018 | | |
| 2.47 | HFH2-Z2 | Loop Antenna + 3 Axis Tripod | Rohde & Schwarz GmbH & Co. KG | 829324/006 | 2021-01 | 2024-01 |
| 2.48 | Voltcraft M-3860M | Digital Multimeter 01 (Multimeter) | Conrad | IJ096055 | | |
| 2.49 | FSU3 | Spectrum Analyser (20 Hz to 3.6 GHz) | Rohde & Schwarz GmbH & Co. KG | 200046 | | |

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|---------------------------------------|---------------------------------------|--|------------------------|------------------|-----------------|
| 2.50 | ESR 7 | EMI Receiver / Spectrum Analyzer | Rohde & Schwarz | 101424 | 2021-01 | 2023-01 |
| 2.51 | SB4-100.OLD20-3T/10 Airwin 2 x 1.5 kW | Air compressor (oil-free) | airWin Kompressoren UG | 901/00503 | | |
| 2.52 | UNI-T UT195E | True RMS Digital Multimeter | UNI-T UNI-TREND TECHNOLOGY (CHINA) CO., LTD. | C190729561 | | |
| 2.53 | JS4-00101800-35-5P | Broadband Amplifier 30 MHz - 18 GHz | Miteq | 896037 | | |
| 2.54 | AS 620 P | Antenna Mast (pneumatic polarisation) | HD GmbH | 620/37 | | |
| 2.55 | FSU26 | Spectrum Analyser (20 Hz to 26.5 GHz) | Rohde & Schwarz GmbH & Co. KG | 100136 | | |
| 2.56 | 6005D (30 V / 5 A) | Laboratory Power Supply 120 V 60 Hz | PeakTech | 81062045 | | |
| 2.57 | TD1.5-10kg | EUT Tilt Device (Rohacell) | Maturo GmbH | TD1.5-10kg/024/3790709 | | |
| 2.58 | foUSB-M Converter 1 | Fibre optic link USB 2.0 | Audivo GmbH (PONTIS EMC) | 4461520060 | | |
| 2.59 | Innco Systems CO3000 | Controller for bore sight mast SAC | innco systems GmbH | CO3000/967/39371016/L | | |
| 2.60 | NRV-Z1 | Sensor Head B | Rohde & Schwarz GmbH & Co. KG | 827753/006 | 2020-08 | 2021-08 |
| 2.61 | HF 907-2 | Double-ridged horn | Rohde & Schwarz | 102817 | 2019-04 | 2022-04 |
| 2.62 | PAS 2.5 - 10 kg | Antenna Mast | Maturo GmbH | - | | |
| 2.63 | AFS42-00101800-25-S-42 | Broadband Amplifier 25 MHz - 18 GHz | Miteq | 2035324 | | |
| 2.64 | WRCA800/960-0.2/40-6EEK | Tunable Notch Filter | Wainwright Instruments GmbH | 20 | | |
| 2.65 | AM 4.0 | Antenna Mast 4 m | Maturo GmbH | AM4.0/180/11920513 | | |
| 2.66 | HF 907 | Double-ridged horn | Rohde & Schwarz | 102444 | 2018-07 | 2021-07 |
| 2.67 | E4408B | Spectrum Analyser (9 kHz to 26.5 GHz) | Agilent Technologies Deutschland GmbH | MY45103714 | | |

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

7 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.

7.1 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.

7.2 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

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

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

| Frequency | AF R&S HL562 | Corr. |
|-----------|--------------------|-------|
| MHz | dB (1/m) | 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) | 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)) |
|--|---|-------------------------------------|-------------------------------------|--|---|---|
| dB | dB | dB | dB | dB | m | 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 |

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

| | | |
|------|------|------|
| 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 |

| | | | | | | |
|------|------|------|------|-------|----|---|
| 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.

7.4 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.

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

| Frequency MHz | AF EMCO 3160-09 dB (1/m) | Corr. dB |
|------------------|-----------------------------------|-------------|
| 18000 | 40.2 | -23.5 |
| 18500 | 40.2 | -23.2 |
| 19000 | 40.2 | -22.0 |
| 19500 | 40.3 | -21.3 |
| 20000 | 40.3 | -20.3 |
| 20500 | 40.3 | -19.9 |
| 21000 | 40.3 | -19.1 |
| 21500 | 40.3 | -19.1 |
| 22000 | 40.3 | -18.7 |
| 22500 | 40.4 | -19.0 |
| 23000 | 40.4 | -19.5 |
| 23500 | 40.4 | -19.3 |
| 24000 | 40.4 | -19.8 |
| 24500 | 40.4 | -19.5 |
| 25000 | 40.4 | -19.3 |
| 25500 | 40.5 | -20.4 |
| 26000 | 40.5 | -21.3 |
| 26500 | 40.5 | -21.1 |

| 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 |
|--|--|--|---|---|
| 0.72 | -35.85 | 6.20 | 2.81 | 2.65 |
| 0.69 | -35.71 | 6.46 | 2.76 | 2.59 |
| 0.76 | -35.44 | 6.69 | 3.15 | 2.79 |
| 0.74 | -35.07 | 7.04 | 3.11 | 2.91 |
| 0.72 | -34.49 | 7.30 | 3.07 | 3.05 |
| 0.78 | -34.46 | 7.48 | 3.12 | 3.15 |
| 0.87 | -34.07 | 7.61 | 3.20 | 3.33 |
| 0.90 | -33.96 | 7.47 | 3.28 | 3.19 |
| 0.89 | -33.57 | 7.34 | 3.35 | 3.28 |
| 0.87 | -33.66 | 7.06 | 3.75 | 2.94 |
| 0.88 | -33.75 | 6.92 | 3.77 | 2.70 |
| 0.90 | -33.35 | 6.99 | 3.52 | 2.66 |
| 0.88 | -33.99 | 6.88 | 3.88 | 2.58 |
| 0.91 | -33.89 | 7.01 | 3.93 | 2.51 |
| 0.88 | -33.00 | 6.72 | 3.96 | 2.14 |
| 0.89 | -34.07 | 6.90 | 3.66 | 2.22 |
| 0.86 | -35.11 | 7.02 | 3.69 | 2.28 |
| 0.90 | -35.20 | 7.15 | 3.91 | 2.36 |

Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

Table shows an extract of values.

7.6 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.

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

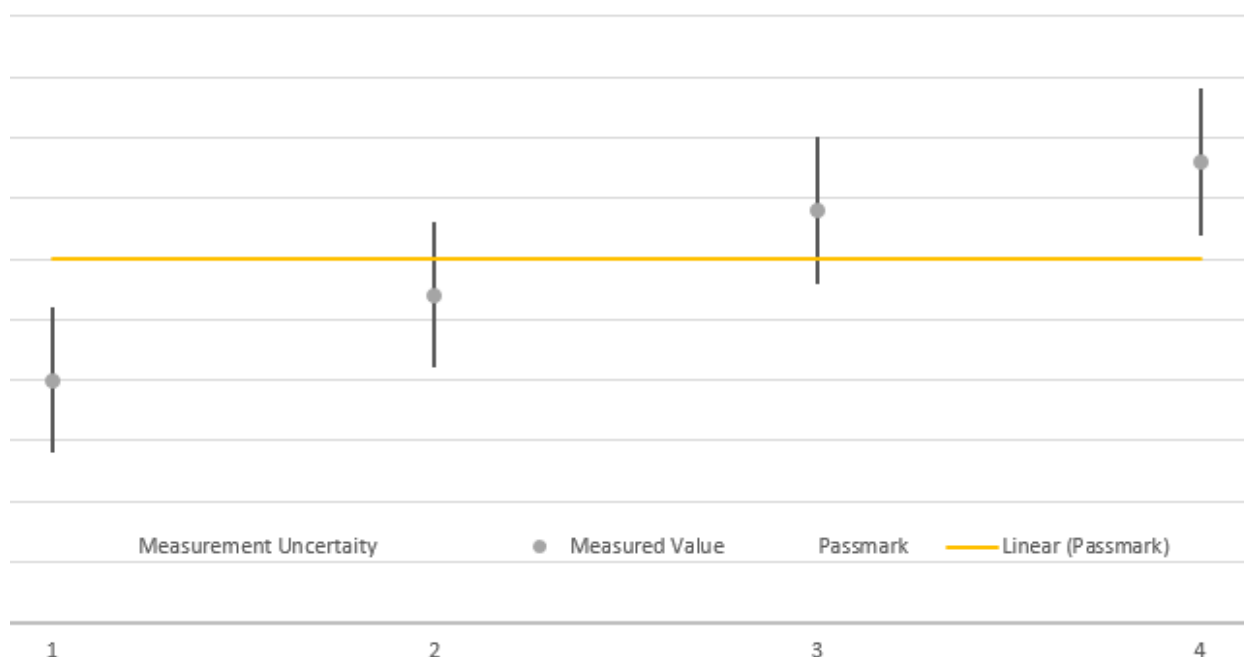
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

8 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 | above pass mark | within pass mark | Failed |
| 4 | 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.

9 PHOTO REPORT

Please see separate photo report.