

# FCC Measurement/Technical Report on

Hyper-thin Bluetooth IoT edge  
V2.x Battery-free Single-Band

Contains FCC ID: 2AXVQ-WILIOT2SB  
Contains IC: 26623-WILIOT2SB

**Report Reference:** MDE\_WILIOT\_2101\_FCC\_01

## Test Laboratory:

7layers GmbH  
Borsigstrasse 11  
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.

## 7layers GmbH

Borsigstraße 11  
40880 Ratingen, Germany  
T +49 (0) 2102 749 0  
F +49 (0) 2102 749 350

Geschäftsführer/  
Managing Directors:  
Frank Spiller  
Bernhard Retka  
Alexandre Norré-Oudard

Registergericht/registered:  
Düsseldorf HRB 75554  
USt-Id.-Nr./VAT-No. DE203159652  
Steuer-Nr./TAX-No. 147/5869/0385

*a Bureau Veritas  
Group Company*

*www.7layers.com*

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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 (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

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.

Note: ANSI C63.10–2013 is applied.

#### **Summary Test Results:**

**The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.**

1.2. FCC-IC CORRELATION TABLE

**Correlation of measurement requirements for general radio equipment and operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5825 MHz and 24.0 – 34.25 GHz from FCC and IC**

| Measurement   | FCC reference | IC reference  |
|---|---------------|---|
| Conducted emissions on AC Mains   | § 15.207      | RSS-Gen Issue 5: 8.8  |
| Transmitter spurious radiated emissions   | § 15.209      | RSS-Gen Issue 5: 6.13/8.9/8.10;                             |
| Field strength of Fundamental   | § 15.249      | RSS-210 Issue 10: 7.2<br>RSS-210 Issue 10: Annex B.10       |
| Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz. | §15.249       | RSS-Gen Issue 5: 6.12, 8.9<br>RSS-210, Issue 10: Annex B.10 |

1.3. MEASUREMENT SUMMARY /SIGNATURES

| <b>FCC Part 15, Subpart C</b>                          |              | <b>§ 15.207</b>      |                     |
|--|--------------|----------------------|---------------------|
| Conducted emissions (AC power line)                    |              |                      |                     |
| The measurement was performed according to ANSI C63.10 |              |                      |                     |
| <b>OP-Mode</b>   | <b>Setup</b> | <b>Port</b>          | <b>Final Result</b> |
| -  | -            | AC Port (power line) | N/A                 |

| <b>FCC Part 15, Subpart C</b>                          |              | <b>§ 15.249 (a)</b> |                     |
|--|--------------|---------------------|---------------------|
| Field strength of Fundamental / Radiated power output  |              |                     |                     |
| The measurement was performed according to ANSI C63.10 |              |                     |                     |
| <b>OP-Mode, Frequency</b>                              | <b>Setup</b> | <b>Port</b>         | <b>Final Result</b> |
| CW, low  | S01_AB01     | Enclosure           | passed              |
| CW, mid  | S01_AB01     | Enclosure           | passed              |
| CW, high   | S01_AB01     | Enclosure           | passed              |

| <b>FCC Part 15, Subpart C</b>                             |              | <b>§ 15.249 (a), § 15.35 (b), § 15.209</b> |                     |
|---|--------------|--|---------------------|
| Field Strength of Harmonics / Spurious radiated emissions |              |  |                     |
| The measurement was performed according to ANSI C63.10    |              |  |                     |
| <b>OP-Mode, Frequency</b>                                 | <b>Setup</b> | <b>Port</b>                                | <b>Final Result</b> |
| CW, low   | S01_AB01     | Enclosure                                  | passed              |
| CW, mid   | S01_AB01     | Enclosure                                  | passed              |
| CW, high  | S01_AB01     | Enclosure                                  | passed              |

| <b>FCC Part 2, Subpart J</b>                           |              | <b>§ 2.1049</b> |                     |
|--|--------------|-----------------|---------------------|
| Occupied Bandwidth                                     |              |                 |                     |
| The measurement was performed according to ANSI C63.10 |              |                 |                     |
| <b>OP-Mode, Frequency</b>                              | <b>Setup</b> | <b>Port</b>     | <b>Final Result</b> |
| PM, low  | S01_AB01     | Enclosure       | passed              |
| PM, mid  | S01_AB01     | Enclosure       | passed              |
| PM, high   | S01_AB01     | Enclosure       | passed              |

N/A not applicable (the EUT cannot be connected to the AC mains network)

2. REVISION HISTORY / SIGNATURES

| <b>Report version control</b> |                     |                           |                         |
|-------------------------------|---------------------|---------------------------|-------------------------|
| <b>Version</b>                | <b>Release date</b> | <b>Change Description</b> | <b>Version validity</b> |
| initial                       | 2020-06-01          | --                        | valid                   |
|                               |                     |                           |                         |

|   |   |   |
|---|---|---|
| <br>(responsible for accreditation scope)<br>Dipl.-Ing. Marco Kullik | <br>7 layers GmbH, Borsigstr. 11<br>40880 Ratingen, Germany<br>Phone +49 (0)2102 749 0 | <br>(responsible for testing and report)<br>Dipl.-Ing. Robert Machulec |
|---|---|---|

## 2. ADMINISTRATIVE DATA

### 2.1. TESTING LABORATORY

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

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

Laboratory accreditation no: DAKKS D-PL-12140-01-01  
D-PL-12140-01-02  
D-PL-12140-01-03  
FCC Designation Number: DE0015  
FCC Test Firm Registration: 929146  
ISED CAB Identifier: DE0007; ISED#: 3699A  
Responsible for accreditation scope: Dipl.-Ing. Daniel Gall

### 2.2. PROJECT DATA

Responsible for testing and report: Dipl.-Ing. Robert Machulec  
Date of Report: 2021-06-01  
Testing Period: 2021-04-10 to 2021-04-23

### 2.3. APPLICANT DATA

Company Name: Wiliot Inc.  
Address: 13500 Evening Creek Dr N, Suite 120  
San Diego  
United States  
Contact Person: Mr. Roberto Sandre

### 2.4. MANUFACTURER DATA

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

### 3. TEST OBJECT DATA

#### 3.1. GENERAL EUT DESCRIPTION

|   |   |
|---|---|
| Kind of Device<br>product description       | BTLE Transmitter operating in 2400 – 2483.5 MHz ISM frequency band.   |
| Product name                                | Hyper-thin Bluetooth IoT edge   |
| Type  | V2.x Battery-free Single-Band   |
| <b>Declared EUT data by the supplier</b>    |   |
| Voltage Type                                | DC  |
| Normal Voltage                              | 5.0 V (only for testing purposes)   |
| Low Voltage                                 | -   |
| High Voltage                                | -   |
| Normal Temperature                          | 25 °C   |
| Low Temperature                             | -40 °C  |
| High Temperature                            | +85 °C  |
| Specific product<br>description for the EUT | The EUT is tag with a Bluetooth® Low Energy Wireless Micro Controller Unit (MCU) that offers the ability to sense, compute and communicate using Bluetooth wireless communication technology. They do this without the need for a battery, and with a physical design and packaging that allows the integration onto stickers. The EUT is a transmit-only uni-directional device. |
| The EUT provides the<br>following ports:    | Enclosure   |
| Special software used<br>for testing        | Williot Test Mode Host software, provided by the manufacturer   |
| Antenna type / gain                         | Internal PCB loop antenna / -5.4 dBi  |
| Transmitter operating<br>frequencies        | 2402 MHz / 2426 MHz / 2480 MHz  |

**The main components of the EUT are listed and described in Chapter 3.2.**

### 3.2. EUT MAIN COMPONENTS

| Sample Name      | Sample Code                | Description     |
|------------------|----------------------------|-----------------|
| EUT B            | DE1405002ab01              | radiated sample |
| Sample Parameter | Value                      |                 |
| Serial No.       | N/A                        |                 |
| HW Version       | Wiliot_Tag_2.x Single-Band |                 |
| SW Version       | Wiliot_Fw_D1P1             |                 |

### 3.3. 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, OUT Code)  | Reason for using                   |
|--------|---|------------------------------------|
| AUX1   | Laptop, Dell, Latitude E5450, DE1405001AUX1   | Running the test SW                |
| AUX2   | AC/DC Adapter, Dell, DA90PM111, DE1405001AUX2   | Power supply for laptop            |
| AUX3   | Wiliot Debug Board, with USB host and JTAG interface connection to Wiliot Tag, -<br>-, --, -- | Connection to laptop, power supply |

### 3.4. 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, HW, SW, S/N) | Description |
|--------|-------------------------------------|-------------|
| ---    | ---                                 | ---         |



### 3.5. EUT SETUPS

This chapter describes the combination of EUTs and ancillary equipment used for testing.

| Setup No. | Combination of EUTs     | Description        |
|-----------|-------------------------|--------------------|
| S01_AB01  | EUT B, AUX1, AUX2, AUX3 | Used for all tests |

### 3.6. OPERATING MODES / TEST CHANNELS

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

| Op. Mode | Description of Operating Modes | Remarks   |
|----------|--------------------------------|---|
| CW       | Continuous Wave signal         | EUT transmits continuously an unmodulated signal                  |
| PM       | Pulsed Modulated signal        | EUT transmits a modulated signal with maximum possible duty cycle |

**BT LE Test Channels:**

**Channel:**

**Frequency [MHz]**

| low  | mid  | high |
|------|------|------|
| 37   | 38   | 39   |
| 2402 | 2426 | 2480 |

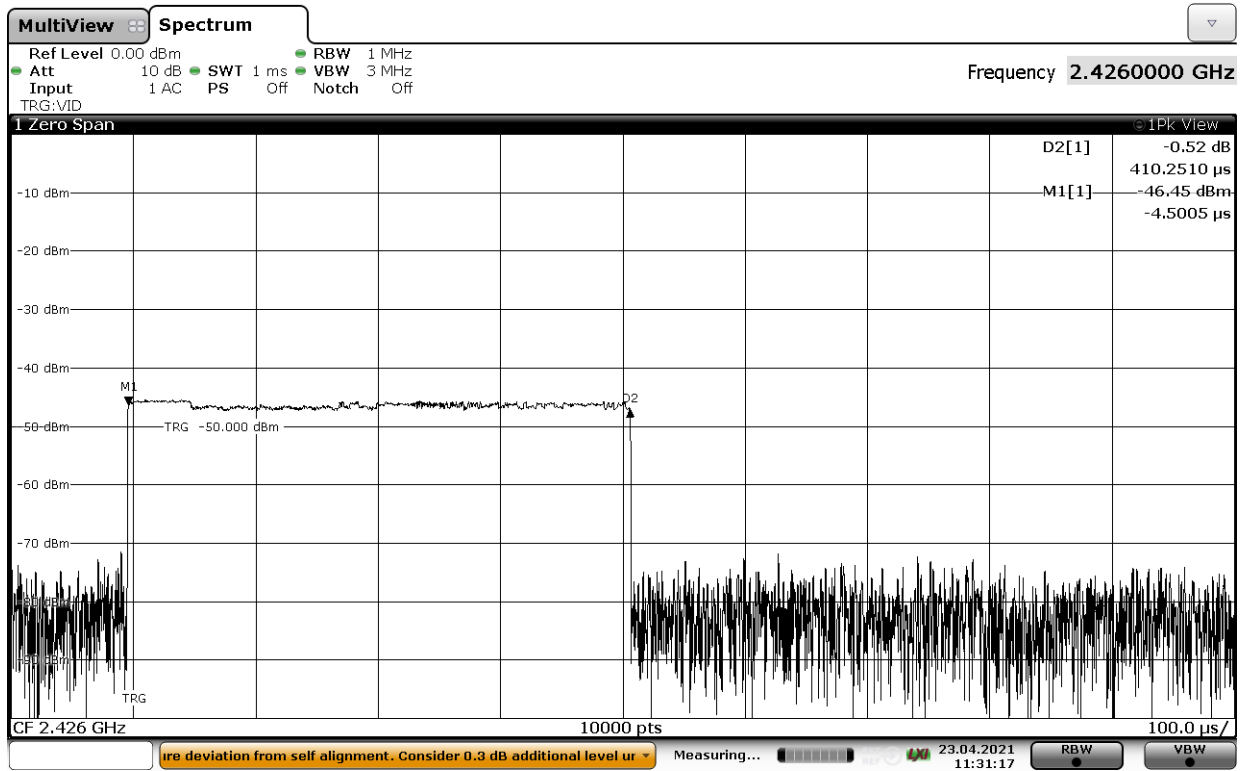
Modulation: GFSK, BT = 0.5, 1 Msym/s

### 3.7. DUTY CYCLE CALCULATION

The calculation of the duty cycle and duty cycle correction value was done according ANSI C63.10: 2013, chapter 7.5, equation (11)

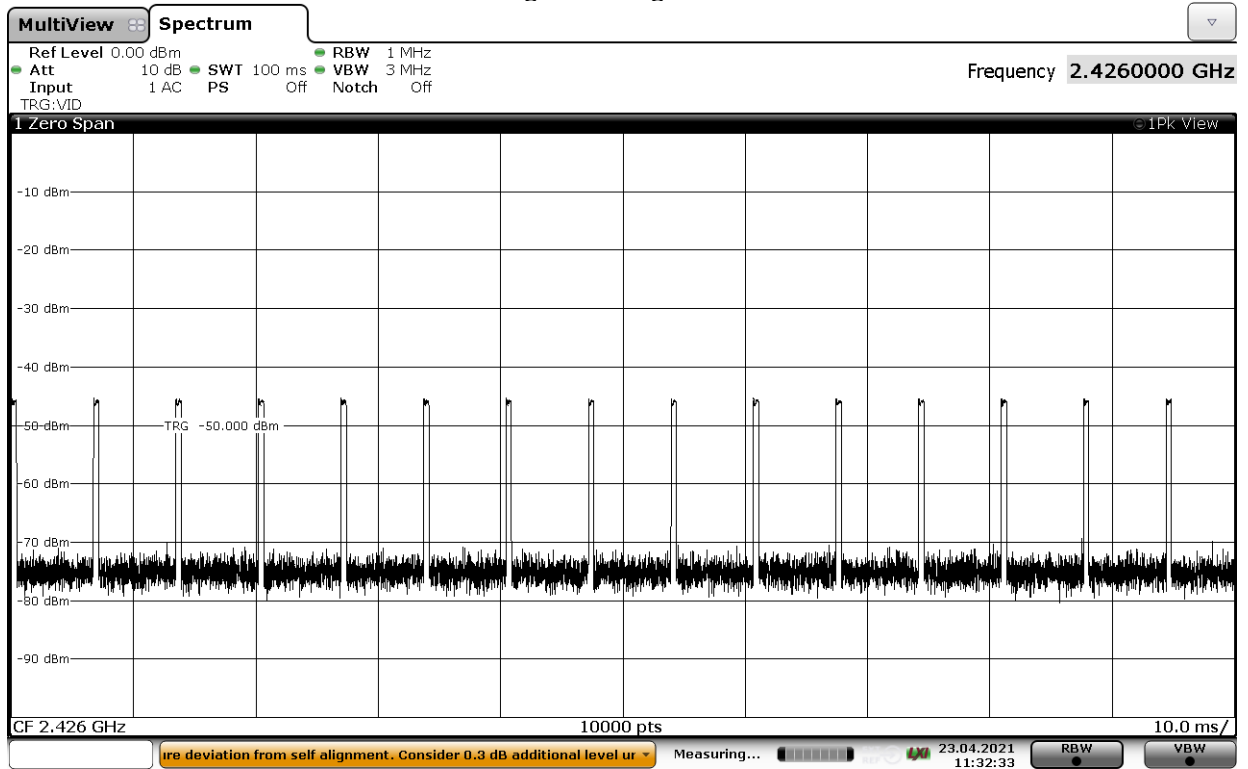
$$DC = 15 * 0.41025 \text{ ms} / 100 \text{ ms} = 0.0615375$$

$$\text{Duty cycle correction factor: } \delta = 20 \text{ LOG}(0.009077) = 20 * (-1,21086) = -24.2 \text{ dB}$$



11:31:17 23.04.2021

### Length of single burst



11:32:34 23.04.2021

### Number of bursts in 100 ms

### 3.8. PRODUCT LABELLING

#### 3.8.1. FCC ID LABEL

Please refer to the documentation of the applicant.

#### 3.8.2. IC LABEL

Please refer to the documentation of the applicant.

#### 3.8.3. LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

#### 4. TEST RESULTS

##### 4.1. FIELD STRENGTH OF FUNDAMENTAL / RADIATED POWER OUTPUT

**Standard** FCC Part 15, Subpart C

**The test was performed according to ANSI C63.10–2013**

##### 4.1.1. TEST DESCRIPTION

Please refer to the description at sub-clause 4.2.1 esp. item no. 3. (Above 1 GHz)

##### 4.1.2. TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

| Fundamental frequency | Field strength of fundamental (millivolts/meter) | Field strength of harmonics (microvolts/meter) |
|-----------------------|--|--|
| 902-928 MHz           | 50 (94.0 dB $\mu$ V/m)                           | 500 (54.0 dB $\mu$ V/m)                        |
| 2400-2483.5 MHz       | 50 (94.0 dB $\mu$ V/m)                           | 500 (54.0 dB $\mu$ V/m)                        |
| 5725-5875 MHz         | 50 (94.0 dB $\mu$ V/m)                           | 500 (54.0 dB $\mu$ V/m)                        |
| 24.0-24.25 GHz        | 250 (108.0 dB $\mu$ V/m)                         | 2500 (68.0 dB $\mu$ V/m)                       |

Used conversion factor: Limit (dB $\mu$ V/m) = 20 log (Limit ( $\mu$ V/m)/1 $\mu$ V/m)

(c) Field strength limits are specified at 3 meters.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

#### 4.1.3. TEST PROTOCOL

Temperature: 22 °C  
Air Pressure: 1007 hPa  
Humidity: 42 %

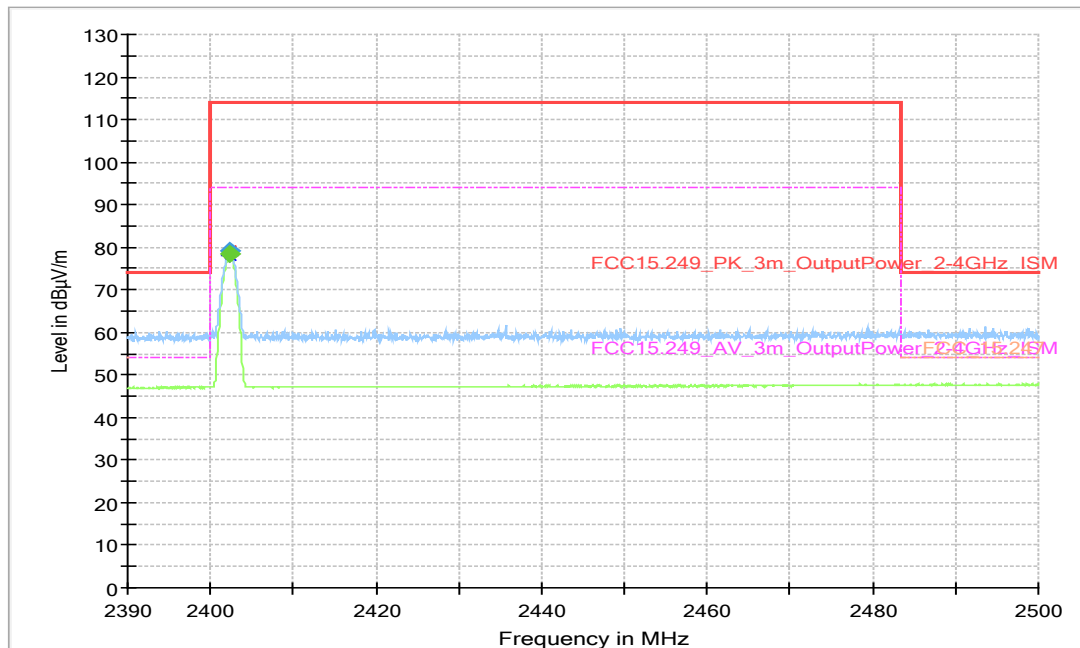
| Op. Mode | Setup    | Port      |
|----------|----------|-----------|
| CW       | S01_AB01 | Enclosure |

| Frequency [MHz] | CAverage (dBμV/m) | Limit [dBμV/m] | Margin to Limit [dB] | Remarks                          |
|-----------------|-------------------|----------------|----------------------|----------------------------------|
| 2402            | 78.4              | 94             | 15.6                 | No duty cycle correction applied |
| 2426            | 78.6              | 94             | 15.4                 | No duty cycle correction applied |
| 2480            | 77.8              | 94             | 16.2                 | No duty cycle correction applied |

Notes: -

#### 4.1.4. MEASUREMENT PLOTS

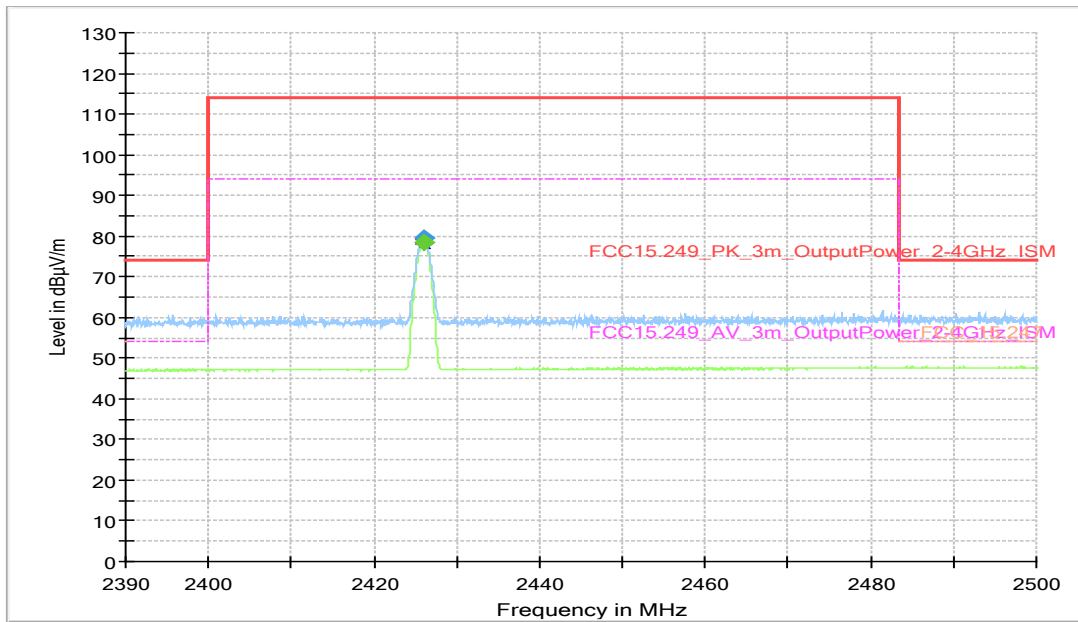
Radio Technology = BTLE, Operating Frequency = Low (S01\_AB01)



#### 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) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|
| 2402.375        | ---              | 78.4              | 93.98          | 15.62       | 1000.0          | 1000.000        | 150.0       | V   | -134.0        | 81.0            | 34.9         |

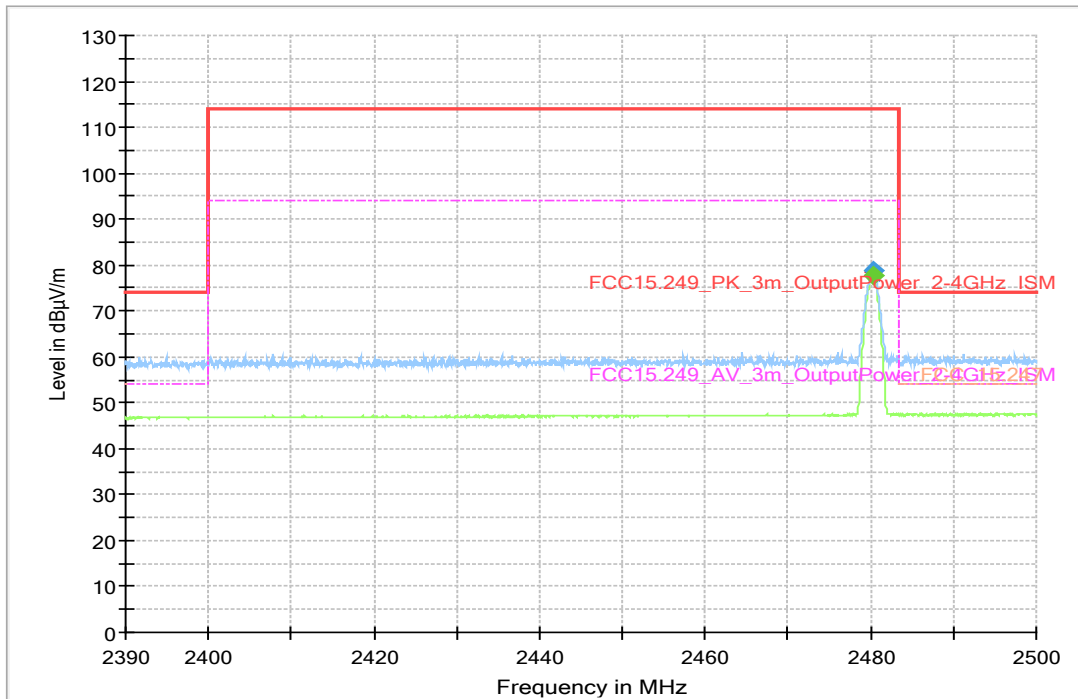
Radio Technology = BTLE, Operating Frequency = Mid (S01\_AB01)



### 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) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|
| 2426.080        | 79.5             | ---               | 113.9          | 34.49       | 1000.0          | 1000.000        | 150.0       | V   | -132.0        | 73.0            | 34.9         |

Radio Technology = BTLE, Operating Frequency = High (S01\_AB01)



**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) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|--------------|
| 2480.255        | ---              | 77.8              | 93.98          | 16.15       | 1000.0          | 1000.000        | 150.0       | V   | -138.0        | 86.0            | 35.2         |

4.1.5. TEST EQUIPMENT USED

- Radiated Emissions

## 4.2. FIELD STRENGTH OF HARMONICS / SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

**The test was performed according to ANSI C63.10–2013**

### 4.2.1. 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-chapters of ANSI C63.10:

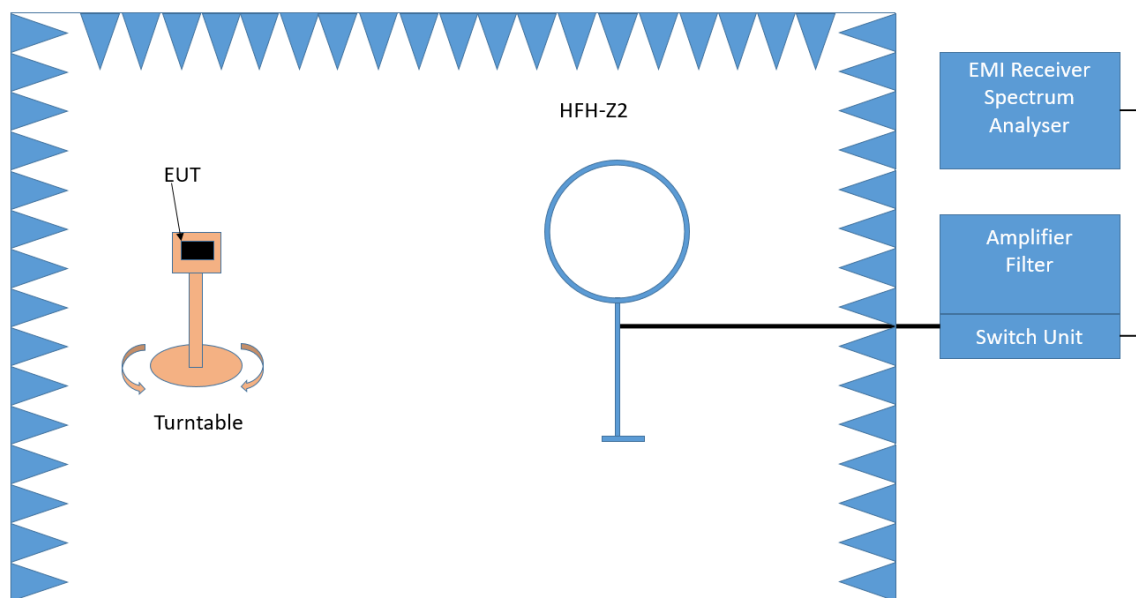
- < 30 MHz: Chapter 6.4
- 30 MHz – 1 GHz: Chapter 6.5
- > 1 GHz: Chapter 6.6 (procedure according 6.6.5 used)

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)

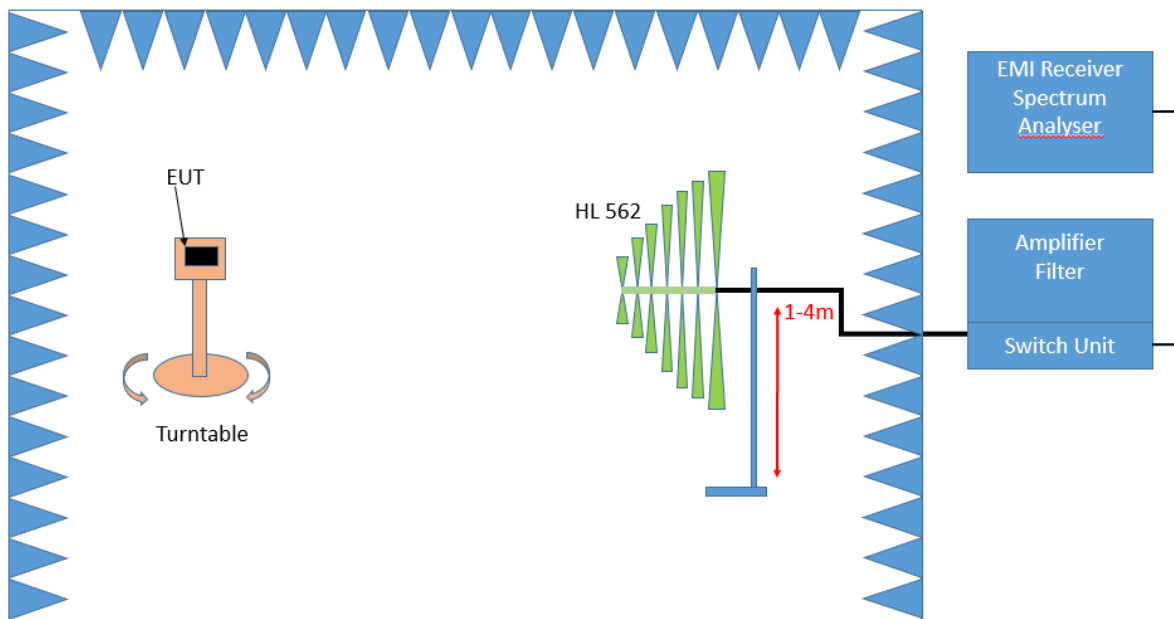
Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

**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:  $-180^{\circ}$  to  $90^{\circ}$
- Turntable step size:  $90^{\circ}$
- 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  $360^{\circ}$ . 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 m. 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:  $360^{\circ}$
- 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:

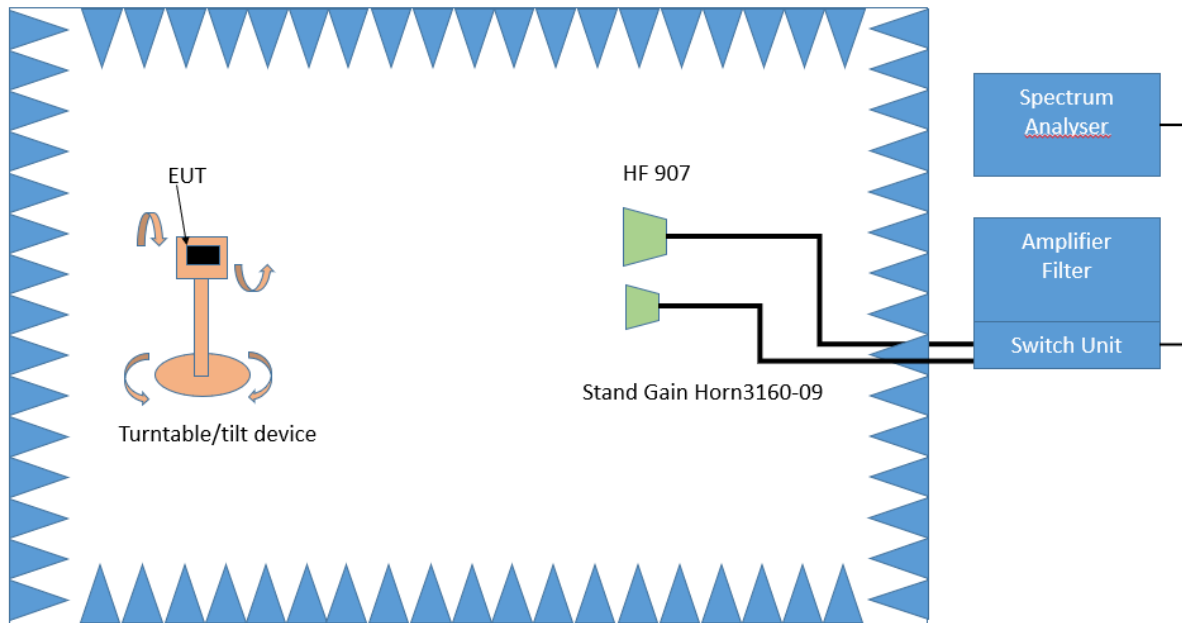
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

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

#### 4.2.2. TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

| Fundamental frequency | Field strength of fundamental (millivolts/meter) | Field strength of harmonics (microvolts/meter) |
|-----------------------|--|--|
| 902-928 MHz           | 50 (94.0 dBµV/m)                                 | 500 (54.0 dBµV/m)                              |
| 2400-2483.5 MHz       | 50 (94.0 dBµV/m)                                 | 500 (54.0 dBµV/m)                              |
| 5725-5875 MHz         | 50 (94.0 dBµV/m)                                 | 500 (54.0 dBµV/m)                              |
| 24.0-24.25 GHz        | 250 (108.0 dBµV/m)                               | 2500 (68.0 dBµV/m)                             |

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

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

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

| Frequency (MHz) | Limit (µV/m)  | Measurement distance (m) | Calculate Limit (dBµV/m @10m) | Limit (dBµV/m) @10m |
|-----------------|---------------|--------------------------|-------------------------------|---------------------|
| 0.009 – 0.49    | 2400/F (kHz)  | 300                      | (48.5 – 13.8) + 59.1 dB       | 107.6 – 72.9        |
| 0.49 – 1.705    | 24000/F (kHz) | 30                       | (33.8 – 23.0) + 19.1 dB       | 52.9 – 42.1         |
| 1.705 – 30      | 30            | 30                       | 29.5 + 19.1 dB                | 39.5                |

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

§15.35(b)

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

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

§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)

§15.35(c):

[...] when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.

As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted [...].

#### 4.2.3. TEST PROTOCOL

##### MEASUREMENT 9 kHz to 30 MHz

Temperature: 23°C  
 Air Pressure: 1011 hPa  
 Humidity: 40 %

| Op. Mode | Setup    | Port      |
|----------|----------|-----------|
| CW       | S01_AB01 | Enclosure |

| Measuring Antenna Polarisation | Spurious Emission Frequency [MHz] | Corrected value [dBµV/m] |      |     | Limit [dBµV/m] |      | Limit [dBµV/m] | Margin to limit [dB] |         |
|--------------------------------|-----------------------------------|--------------------------|------|-----|----------------|------|----------------|----------------------|---------|
|                                |                                   | QP                       | Peak | AV  | QP             | Peak |                | AV                   | QP/Peak |
| X-axis*                        | ---                               | ---                      | ---  | --- | ---            | ---  | ---            | ---                  | ---     |
| Y-axis*                        | ---                               | ---                      | ---  | --- | ---            | ---  | ---            | ---                  | ---     |
| Z-axis*                        | ---                               | ---                      | ---  | --- | ---            | ---  | ---            | ---                  | ---     |

Remark: In step 1 no spurious emissions in the range 20 dB below the limit found.

\* See CISPR16-1-4 for the definition of the axis

MEASUREMENT 30 MHz to 1 GHz

Temperature: 23°C  
 Air Pressure: 1011 hPa  
 Humidity: 40 %

| Op. Mode | Setup    | Port      |
|----------|----------|-----------|
| CW       | S01_AB01 | Enclosure |

Low channel:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 30.000000       | 23.61              | 40.00          | 16.39       | 1000.0          | 120.000         | 115.0       | V   | 119.0         | 19.2         |
| 42.000000       | 17.45              | 40.00          | 22.55       | 1000.0          | 120.000         | 161.0       | V   | 212.0         | 12.4         |
| 48.000000       | 24.31              | 40.00          | 15.69       | 1000.0          | 120.000         | 103.0       | V   | 151.0         | 8.2          |
| 60.000000       | 31.77              | 40.00          | 8.23        | 1000.0          | 120.000         | 149.0       | V   | 1.0           | 4.6          |
| 72.000000       | 33.77              | 40.00          | 6.23        | 1000.0          | 120.000         | 132.0       | V   | -94.0         | 9.0          |
| 84.000000       | 27.39              | 40.00          | 12.61       | 1000.0          | 120.000         | 121.0       | V   | -107.0        | 10.3         |
| 96.000000       | 19.46              | 43.50          | 24.04       | 1000.0          | 120.000         | 104.0       | V   | 29.0          | 10.6         |
| 132.000000      | 22.40              | 43.50          | 21.10       | 1000.0          | 120.000         | 171.0       | H   | 227.0         | 10.3         |
| 144.000000      | 31.74              | 43.50          | 11.76       | 1000.0          | 120.000         | 243.0       | H   | 35.0          | 9.6          |
| 156.000000      | 31.96              | 43.50          | 11.54       | 1000.0          | 120.000         | 197.0       | H   | 31.0          | 9.0          |
| 168.000000      | 31.18              | 43.50          | 12.32       | 1000.0          | 120.000         | 134.0       | V   | -82.0         | 8.9          |
| 180.000000      | 23.95              | 43.50          | 19.55       | 1000.0          | 120.000         | 206.0       | H   | -150.0        | 10.1         |
| 204.000000      | 19.22              | 43.50          | 24.28       | 1000.0          | 120.000         | 105.0       | V   | -74.0         | 9.5          |
| 216.000000      | 17.58              | 43.50          | 25.92       | 1000.0          | 120.000         | 125.0       | V   | -130.0        | 10.1         |
| 240.000000      | 19.91              | 46.00          | 26.09       | 1000.0          | 120.000         | 133.0       | H   | -159.0        | 10.9         |
| 252.000000      | 25.74              | 46.00          | 20.26       | 1000.0          | 120.000         | 118.0       | H   | 39.0          | 11.4         |
| 264.000000      | 24.40              | 46.00          | 21.60       | 1000.0          | 120.000         | 110.0       | H   | 28.0          | 11.6         |

Mid channel:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 30.000000       | 25.38              | 40.00          | 14.62       | 1000.0          | 120.000         | 126.0       | V   | 115.0         | 19.2         |
| 42.000000       | 19.38              | 40.00          | 20.62       | 1000.0          | 120.000         | 100.0       | V   | 216.0         | 12.4         |
| 48.000000       | 22.14              | 40.00          | 17.86       | 1000.0          | 120.000         | 121.0       | V   | 222.0         | 8.2          |
| 60.000000       | 33.75              | 40.00          | 6.25        | 1000.0          | 120.000         | 169.0       | V   | -36.0         | 4.6          |
| 72.000000       | 32.84              | 40.00          | 7.16        | 1000.0          | 120.000         | 152.0       | V   | -105.0        | 9.0          |
| 84.000000       | 26.89              | 40.00          | 13.11       | 1000.0          | 120.000         | 102.0       | V   | -21.0         | 10.3         |
| 120.000000      | 18.28              | 43.50          | 25.22       | 1000.0          | 120.000         | 124.0       | V   | -132.0        | 11.5         |
| 132.000000      | 24.45              | 43.50          | 19.05       | 1000.0          | 120.000         | 228.0       | H   | 48.0          | 10.3         |
| 144.000000      | 29.41              | 43.50          | 14.09       | 1000.0          | 120.000         | 225.0       | H   | 1.0           | 9.6          |
| 156.000000      | 32.51              | 43.50          | 10.99       | 1000.0          | 120.000         | 122.0       | V   | -75.0         | 9.0          |
| 168.000000      | 32.52              | 43.50          | 10.98       | 1000.0          | 120.000         | 102.0       | V   | -100.0        | 8.9          |
| 180.000000      | 23.27              | 43.50          | 20.23       | 1000.0          | 120.000         | 223.0       | H   | -160.0        | 10.1         |
| 204.000000      | 19.81              | 43.50          | 23.69       | 1000.0          | 120.000         | 115.0       | V   | -95.0         | 9.5          |
| 216.000000      | 19.01              | 43.50          | 24.49       | 1000.0          | 120.000         | 106.0       | V   | 36.0          | 10.1         |
| 240.000000      | 21.08              | 46.00          | 24.92       | 1000.0          | 120.000         | 104.0       | H   | -150.0        | 10.9         |
| 252.000000      | 22.34              | 46.00          | 23.66       | 1000.0          | 120.000         | 370.0       | H   | 34.0          | 11.4         |
| 264.000000      | 21.46              | 46.00          | 24.54       | 1000.0          | 120.000         | 324.0       | H   | -1.0          | 11.6         |
| 276.000000      | 21.89              | 46.00          | 24.11       | 1000.0          | 120.000         | 126.0       | H   | 30.0          | 12.1         |
| 288.000000      | 21.56              | 46.00          | 24.44       | 1000.0          | 120.000         | 112.0       | H   | 50.0          | 12.6         |
| 360.000000      | 18.65              | 46.00          | 27.35       | 1000.0          | 120.000         | 108.0       | H   | 11.0          | 14.9         |

High channel:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 30.000000       | 24.11              | 40.00          | 15.89       | 1000.0          | 120.000         | 100.0       | V   | 146.0         | 19.2         |
| 42.000000       | 17.92              | 40.00          | 22.08       | 1000.0          | 120.000         | 133.0       | V   | 225.0         | 12.4         |
| 48.000000       | 20.58              | 40.00          | 19.42       | 1000.0          | 120.000         | 177.0       | V   | 220.0         | 8.2          |
| 60.000000       | 33.09              | 40.00          | 6.91        | 1000.0          | 120.000         | 155.0       | V   | -35.0         | 4.6          |
| 72.000000       | 32.42              | 40.00          | 7.58        | 1000.0          | 120.000         | 114.0       | V   | -102.0        | 9.0          |
| 84.000000       | 26.55              | 40.00          | 13.45       | 1000.0          | 120.000         | 108.0       | V   | -69.0         | 10.3         |
| 120.000000      | 18.34              | 43.50          | 25.16       | 1000.0          | 120.000         | 100.0       | V   | -134.0        | 11.5         |
| 132.000000      | 26.30              | 43.50          | 17.20       | 1000.0          | 120.000         | 212.0       | H   | 38.0          | 10.3         |
| 144.000000      | 30.28              | 43.50          | 13.22       | 1000.0          | 120.000         | 219.0       | H   | 32.0          | 9.6          |
| 156.000000      | 33.37              | 43.50          | 10.13       | 1000.0          | 120.000         | 184.0       | H   | 33.0          | 9.0          |
| 168.000000      | 31.70              | 43.50          | 11.80       | 1000.0          | 120.000         | 125.0       | V   | -96.0         | 8.9          |
| 180.000000      | 30.75              | 43.50          | 12.75       | 1000.0          | 120.000         | 126.0       | V   | -70.0         | 10.1         |
| 192.000000      | 23.25              | 43.50          | 20.25       | 1000.0          | 120.000         | 122.0       | V   | -46.0         | 8.9          |
| 240.000000      | 22.48              | 46.00          | 23.52       | 1000.0          | 120.000         | 147.0       | H   | 28.0          | 10.9         |
| 252.000000      | 23.22              | 46.00          | 22.78       | 1000.0          | 120.000         | 388.0       | H   | 24.0          | 11.4         |
| 264.000000      | 21.73              | 46.00          | 24.27       | 1000.0          | 120.000         | 391.0       | H   | 16.0          | 11.6         |
| 456.030000      | 16.70              | 46.00          | 29.30       | 1000.0          | 120.000         | 124.0       | H   | -103.0        | 17.4         |

MEASUREMENT 1 GHz – 26.5 GHz

Temperature: 22°C  
 Air Pressure: 1007 hPa  
 Humidity: 42 %

| Op. Mode | Setup    | Port      |
|----------|----------|-----------|
| CW       | S01_AB01 | Enclosure |

Low channel:

| Freq. (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) (*) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | RBW (MHz) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) |
|-------------|------------------|----------------------|----------------|-------------|-----------------|-----------|-----|---------------|-----------------|--------------|
| 4804.36     | ---              | 26.8                 | 53.98          | 27.18       | 1000.           | 1         | H   | -179.0        | 8.0             | 4.6          |
| 4804.52     | 53.4             | ---                  | 73.98          | 20.56       | 1000.           | 1         | H   | -177.0        | 0.0             | 4.6          |
| 7207.12     | 58.1             | ---                  | 73.98          | 15.85       | 1000.           | 1         | V   | 48.0          | 68.0            | -14.1        |
| 7207.12     | ---              | 29.4                 | 53.98          | 24.58       | 1000.           | 1         | V   | -49.0         | 68.0            | -14.1        |
| 9608.62     | ---              | 25.5                 | 53.98          | 28.48       | 1000.           | 1         | H   | -101.0        | 0.0             | -11.6        |
| 9608.62     | 52.1             | ---                  | 73.98          | 21.86       | 1000.           | 1         | H   | -101.0        | 0.0             | -11.6        |

Mid channel:

| Freq. (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) (*) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | RBW (MHz) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) |
|-------------|------------------|----------------------|----------------|-------------|-----------------|-----------|-----|---------------|-----------------|--------------|
| 4851.48     | 56.1             | ---                  | 73.98          | 17.87       | 1000.           | 1         | H   | 146.0         | -2.0            | 4.4          |
| 4851.48     | ---              | 28.1                 | 53.98          | 25.88       | 1000.           | 1         | H   | 136.0         | -5.0            | 4.4          |
| 7278.62     | 59.2             | ---                  | 73.98          | 14.74       | 1000.           | 1         | V   | -46.0         | 85.0            | -13.0        |
| 7278.62     | ---              | 28.1                 | 53.98          | 25.88       | 1000.           | 1         | V   | -49.0         | 68.0            | -13.0        |
| 9703.08     | 54.2             | ---                  | 73.98          | 19.77       | 1000.           | 1         | H   | -84.0         | 6.0             | -11.0        |
| 9703.22     | ---              | 19.1                 | 53.98          | 34.88       | 1000.           | 1         | H   | -94.0         | 22.0            | -11.0        |

High channel:

| Freq. (MHz) | MaxPeak (dB $\mu$ V/m) | Average (dB $\mu$ V/m) (*) | Limit (dB $\mu$ V/m) | Margin (dB) | Meas. Time (ms) | RBW (MHz) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB/m) |
|-------------|------------------------|----------------------------|----------------------|-------------|-----------------|-----------|-----|---------------|-----------------|--------------|
| 4960.20     | ---                    | 26.3                       | 53.98                | 27.68       | 1000.           | 1000.0    | H   | 146.0         | -18.0           | 4.0          |
| 4960.20     | 54.4                   | ---                        | 73.98                | 19.62       | 1000.           | 1000.0    | H   | 139.0         | 6.0             | 4.0          |
| 7441.00     | ---                    | 34.0                       | 53.98                | 19.98       | 1000.           | 1000.0    | V   | 146.0         | 68.0            | -13.6        |
| 7441.00     | 60.6                   | ---                        | 73.98                | 13.38       | 1000.           | 1000.0    | V   | 146.0         | 86.0            | -13.6        |
| 9920.33     | 56.3                   | ---                        | 73.98                | 17.68       | 1000.           | 1000.0    | H   | -83.0         | 4.0             | -11.4        |
| 9920.33     | ---                    | 29.4                       | 53.98                | 33.18       | 1000.           | 1000.0    | H   | -84.0         | -4.0            | -11.4        |

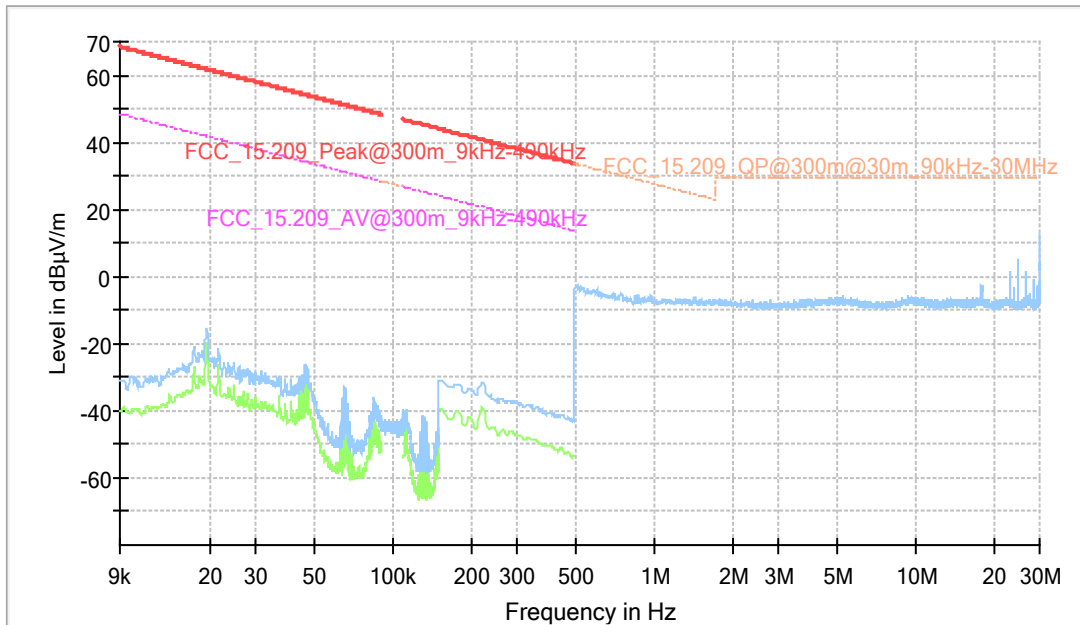
The average value has only been calculated for values, where the measured Max Peak value is above the average limit

(\*) calculated according ANSI C63.10: 2013, chapter 7.5, equation (11), with a duty cycle correction factor:  $\delta = -24.2$  (calculation see chapter 3.7)

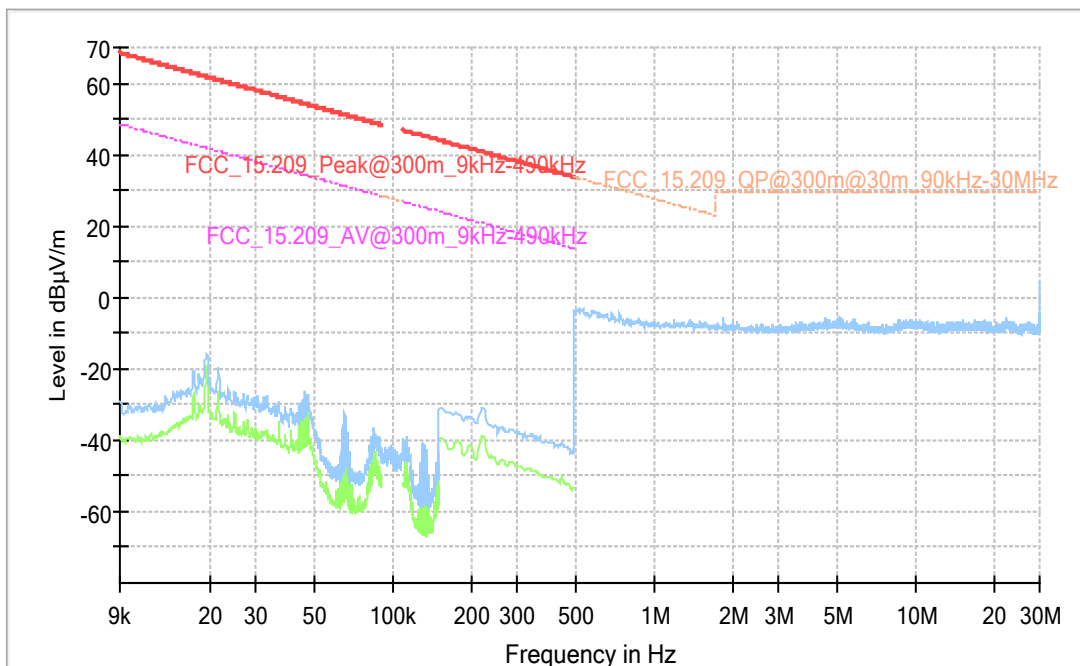


#### 4.2.4. MEASUREMENT PLOTS

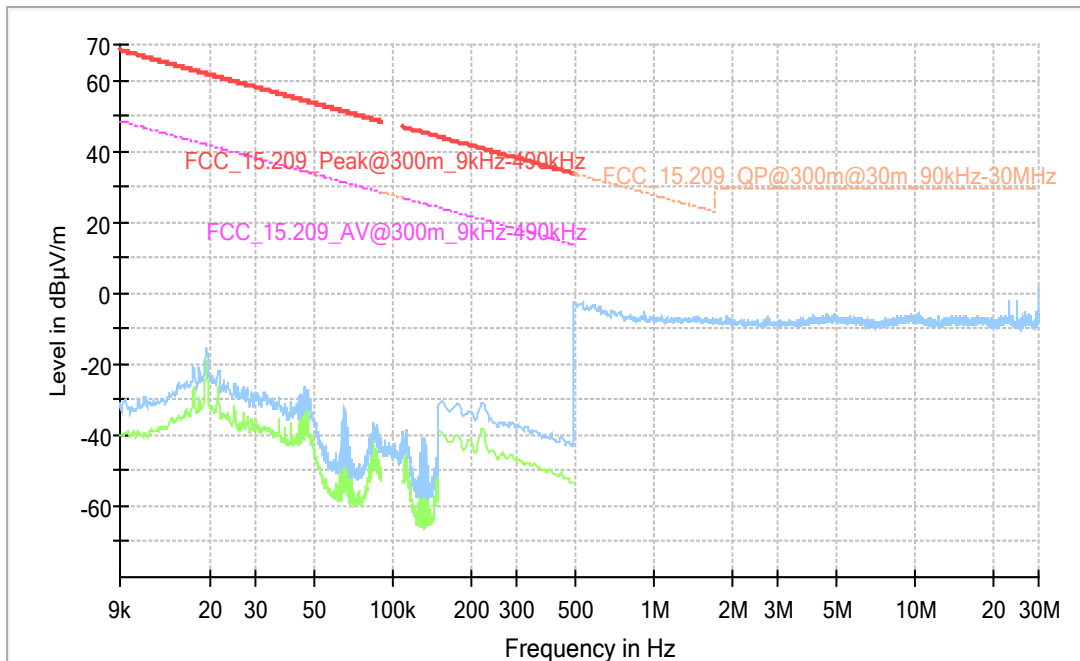
Radio Technology = BTLE, Operating Frequency = Low, Frequency Range 9 kHz – 30 MHz (S01\_AB01)



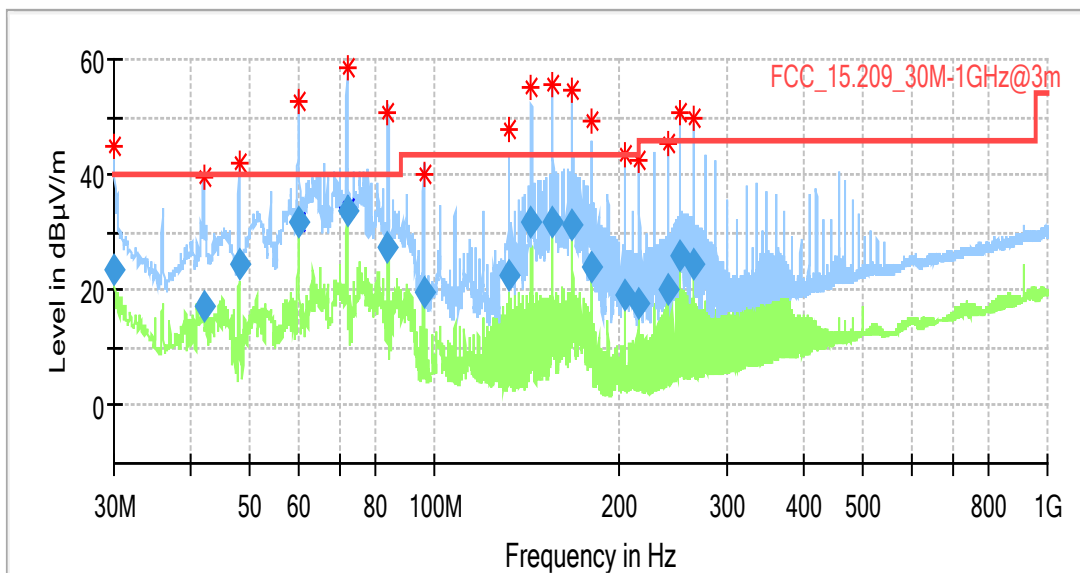
Radio Technology = BTLE, Operating Frequency = Mid, Frequency Range 9 kHz – 30 MHz (S01\_AB01)



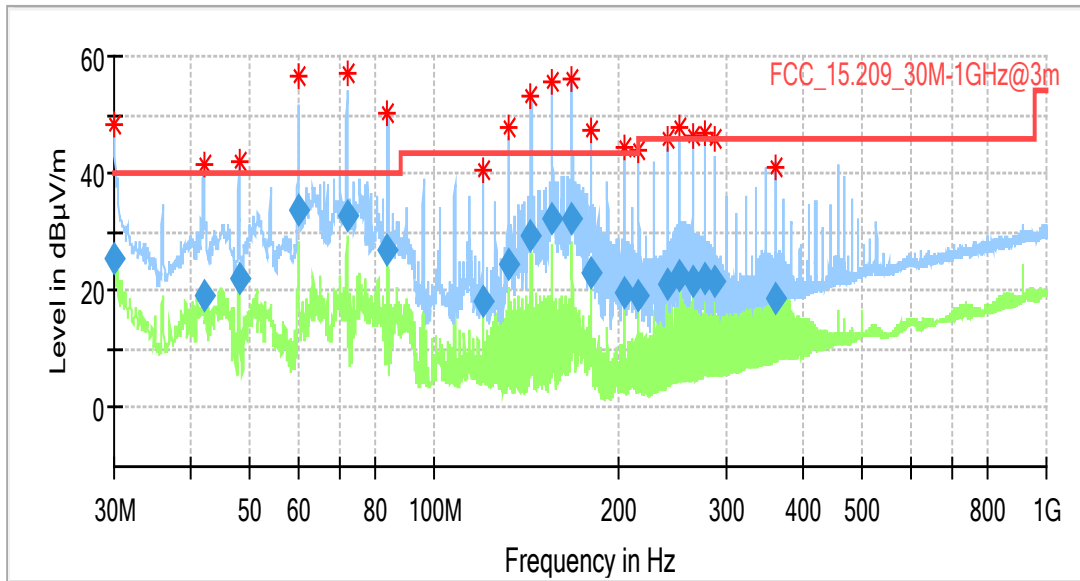
Radio Technology = BTLE, Operating Frequency = High, Frequency Range 9 kHz – 30 MHz (S01\_AB01)



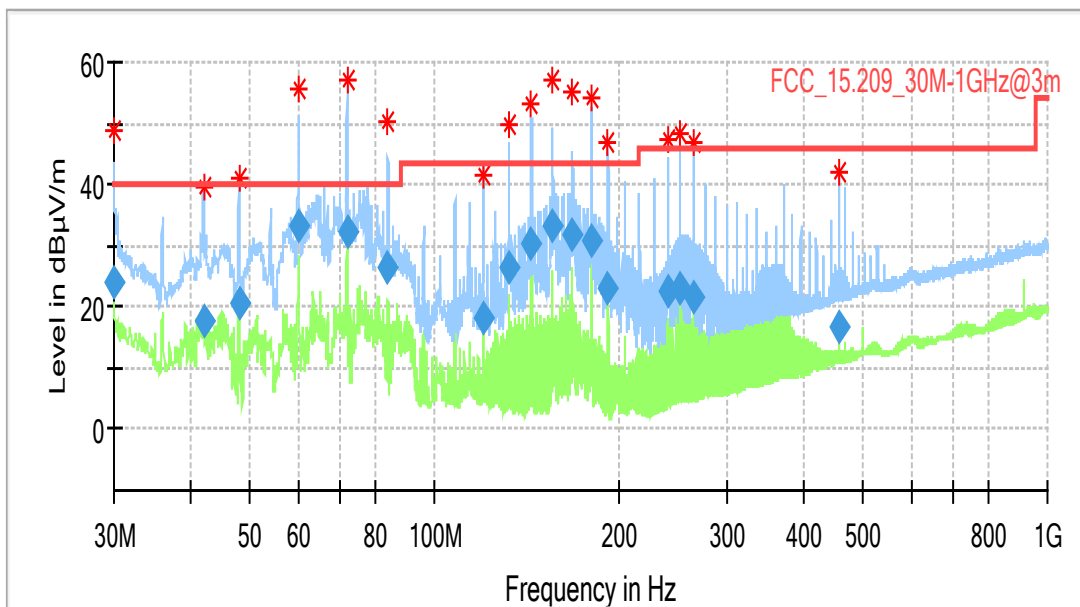
Radio Technology = BTLE, Operating Frequency = Low, Frequency Range 30 MHz – 1 GHz (S01\_AB01)



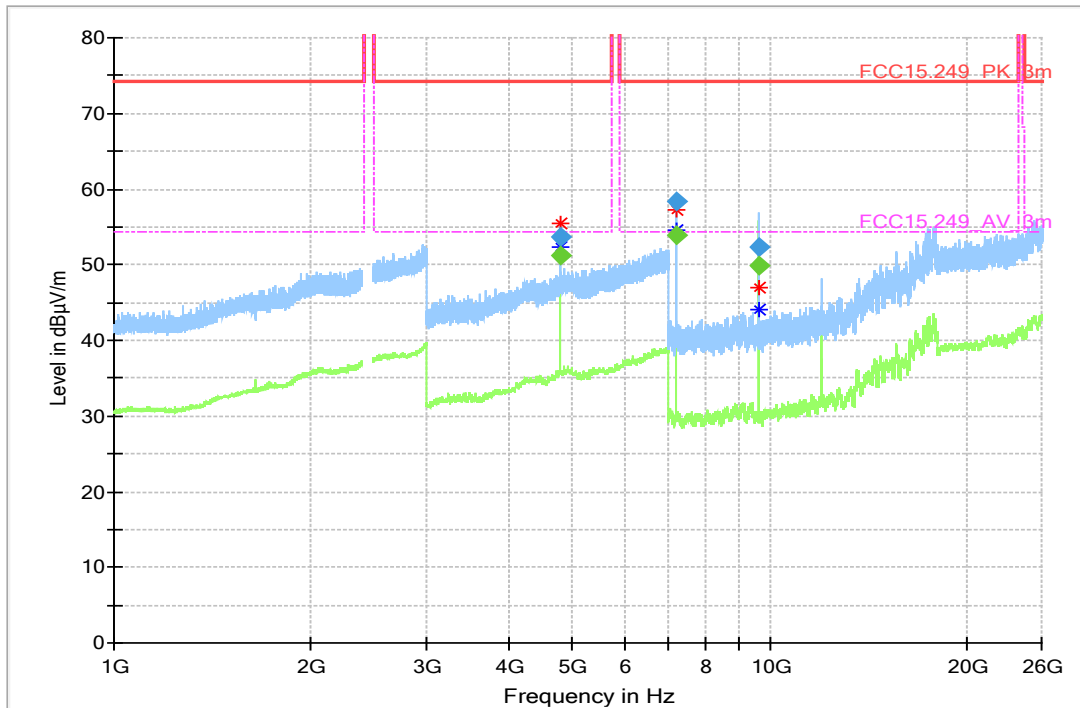
Radio Technology = BTLE, Operating Frequency = Mid, Frequency Range 30 MHz – 1 GHz (S01\_AB01)



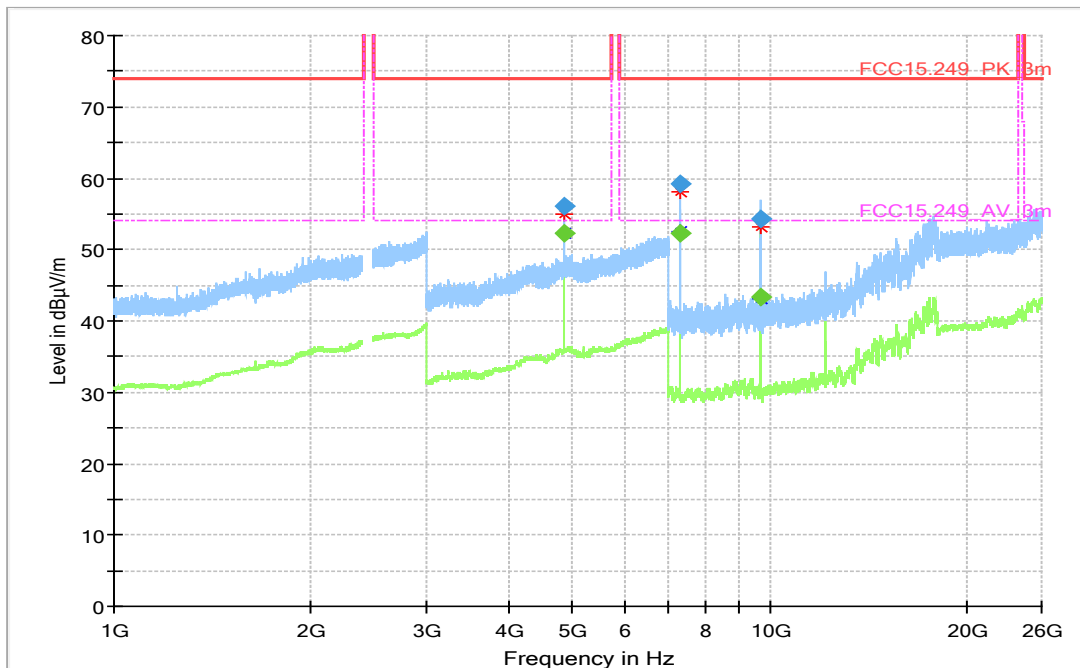
Radio Technology = BTLE, Operating Frequency = High, Frequency Range 30 MHz – 1 GHz (S01\_AB01)



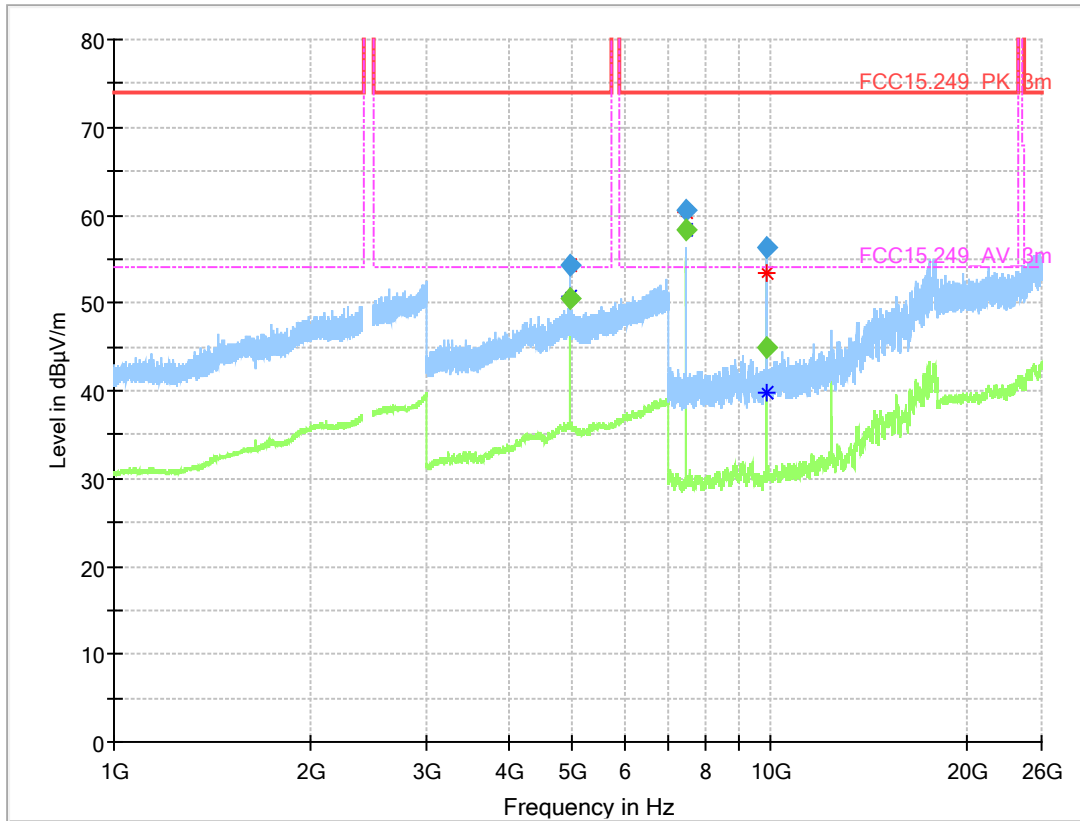
Radio Technology = BTLE, Operating Frequency = Low, Frequency Range 1 – 24.5 GHz (S01\_AB01)



Radio Technology = BTLE, Operating Frequency = Mid, Frequency Range 1 – 24.5 GHz (S01\_AB01)



Radio Technology = BTLE, Operating Frequency = High, Frequency Range 1 – 26.0 GHz (S01\_AB01)



#### 4.2.5. TEST EQUIPMENT USED

- Radiated Emissions

#### 4.3. OCCUPIED BANDWIDTH (99 %)

Standard **FCC Part 15 Subpart C**

**The test was performed according to ANSI C63.10–2013**

##### 4.3.1. 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 spectrum analyser via a broadband antenna. The complete setup and the broadband antenna were located in a shielded box

Analyser settings:

- Resolution Bandwidth (RBW): 1 to 5 % of the OBW
- Video Bandwidth (VBW):  $\geq 3$  times the RBW
- Span: 1.5 to 5 times the OBW
- Trace: Maxhold
- Sweeps: Till stable
- Sweep time: 5 ms
- Detector: Peak

##### 4.3.2. TEST REQUIREMENTS / LIMITS

No applicable limit.

##### 4.3.3. TEST PROTOCOL

Temperature: 23°C  
 Air Pressure: 1011 hPa  
 Humidity: 40 %

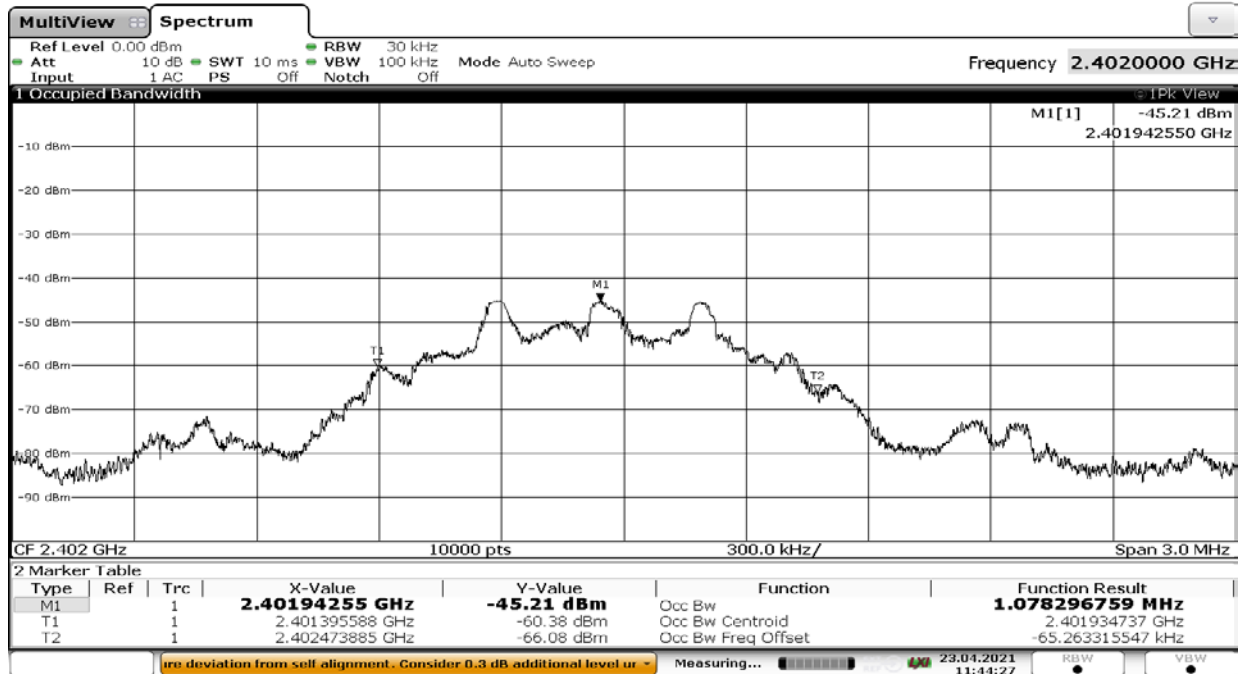
| Op. Mode | Setup    | Port      |
|----------|----------|-----------|
| PM       | S01_AB01 | Enclosure |

| Frequency [MHz] | 99 % OBW [MHz] | Limit [MHz] | Margin to Limit [MHz] | Remarks |
|-----------------|----------------|-------------|-----------------------|---------|
| 2402            | 1.078          | -           | -                     |         |
| 2426            | 1.087          | -           | -                     |         |
| 2480            | 1.123          | -           | -                     |         |

Remark: Please see the measurement plots.

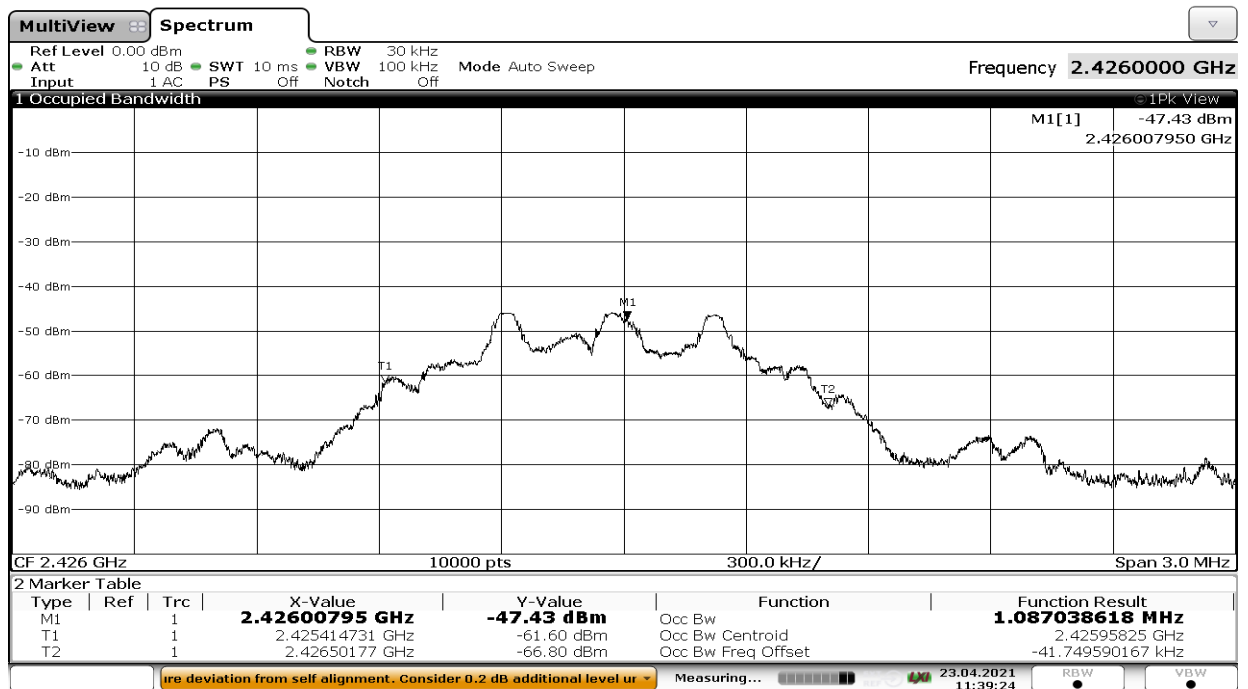
#### 4.3.4. MEASUREMENT PLOTS

Radio Technology = BTLE, Operating Frequency = Low  
(S01\_AB01)



11:44:28 23.04.2021

Radio Technology = BTLE, Operating Frequency = Mid  
(S01\_AB01)



11:39:24 23.04.2021

Radio Technology = BTLE, Operating Frequency = High  
(S01\_AB01)



11:47:00 23.04.2021

#### 4.3.5. TEST EQUIPMENT USED

- R&S TS8997 (only FSV 30)



## 5. TEST EQUIPMENT

- 1 Radiated Emissions  
Lab to perform radiated emission tests

| Ref.No. | Device Name             | Description  | Manufacturer                      | Serial Number      | Last Calibration | Calibration Due |
|---------|-------------------------|--|-----------------------------------|--------------------|------------------|-----------------|
| 1.1     | MFS                     | Rubidium Frequency Normal MFS                                      | Datum GmbH                        | 002                | 2019-10          | 2020-10         |
| 1.2     | N5000/NP                | Filter for EUT, 2 Lines, 250 V, 16 A                               | ETS-LINDGREN                      | 241515             |                  |                 |
| 1.3     | Opus10 TPR (8253.00)    | T/P Logger 13  | Lufft Mess- und Regeltechnik GmbH | 13936              | 2019-05          | 2021-05         |
| 1.4     | ESW44                   | EMI Receiver / Spectrum Analyzer                                   | Rohde & Schwarz GmbH & Co. KG     | 101603             | 2019-12          | 2021-12         |
| 1.5     | Anechoic Chamber 01     | SAC/FAR, 10.58 m x 6.38 m x 6.00 m                                 | Frankonia                         | none               |                  |                 |
| 1.6     | 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         |
| 1.7     | AMF-7D00101800-30-10P-R | Broadband Amplifier 100 MHz - 18 GHz                               | Miteq                             |                    |                  |                 |
| 1.8     | 5HC2700/12750-1.5-KK    | High Pass Filter   | Trilithic                         | 9942012            |                  |                 |
| 1.9     | ASP 1.2/1.8-10 kg       | Antenna Mast   | Maturo GmbH                       | -                  |                  |                 |
| 1.10    | Anechoic Chamber 03     | FAR, 8.80m x 4.60m x 4.05m (l x w x h)                             | Albatross Projects                | P26971-647-001-PRB |                  |                 |
| 1.11    | Fluke 177               | Digital Multimeter 03 (Multimeter)                                 | Fluke Europe B.V.                 | 86670383           | 2020-04          | 2022-04         |
| 1.12    | WRD1920/1980-5/22-5EESD | Tunable Band Reject Filter   | Wainwright Instruments GmbH       | 11                 |                  |                 |
| 1.13    | Opus10 THI (8152.00)    | T/H Logger 10  | Lufft Mess- und Regeltechnik GmbH | 12488              | 2019-06          | 2021-06         |
| 1.14    | foRS232 Unit 2          | Fibre optic link RS232   | PONTIS Messtechnik GmbH           | 4031516037         |                  |                 |
| 1.15    | PONTIS Con4101          | PONTIS Camera Controller   |                                   | 6061510370         |                  |                 |
| 1.16    | OLS-1 R                 | Fibre optic link USB 1.1   | Ingenieurbüro Scheiba             | 018                |                  |                 |
| 1.17    | JS4-18002600-32-5P      | Broadband Amplifier 18 GHz - 26 GHz                                | Miteq                             | 849785             |                  |                 |
| 1.18    | FSW 43                  | Spectrum Analyzer  | Rohde & Schwarz                   | 103779             | 2019-02          | 2021-08         |

| Ref.No. | Device Name                           | Description                                     | Manufacturer                                 | Serial Number | Last Calibration | Calibration Due |
|---------|---------------------------------------|---|--|---------------|------------------|-----------------|
| 1.19    | 3160-09                               | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Electronic GmbH                         | 00083069      |                  |                 |
| 1.20    | foRS232 Unit 1                        | Fibre optic link RS232                          | PONTIS Messtechnik GmbH                      | 4021516036    |                  |                 |
| 1.21    | FSP3                                  | Spectrum Analyzer                               | Rohde & Schwarz GmbH & Co. KG                | 836722/011    |                  |                 |
| 1.22    | WHKX 7.0/18G-8SS                      | High Pass Filter                                | Wainwright Instruments GmbH                  | 09            |                  |                 |
| 1.23    | DS 420S                               | Turn Table 2 m diameter                         | HD GmbH                                      | 420/573/99    |                  |                 |
| 1.24    | 4HC1600/12750-1.5-KK                  | High Pass Filter                                | Trilithic                                    | 9942011       |                  |                 |
| 1.25    | foUSB-M Converter 2                   | Fibre optic link USB 2.0                        | PONTIS Messtechnik GmbH                      | 4471520061    |                  |                 |
| 1.26    | WRCD1879.8-0.2/40-10EE                | Notch Filter Ultra Stable                       | Wainwright Instruments GmbH                  | 16            |                  |                 |
| 1.27    | SMB100A                               | Signal Generator 100 kHz - 40 GHz               | Rohde & Schwarz Vertriebs-GmbH               | 181486        | 2019-11          | 2021-11         |
| 1.28    | JS4-00102600-42-5A                    | Broadband Amplifier 30 MHz - 26 GHz             | Miteq  | 619368        |                  |                 |
| 1.29    | TT 1.5 WI                             | Turn Table                                      | Maturo GmbH                                  | -             |                  |                 |
| 1.30    | HL 562 ULTRALOG                       | Biconical-log-per Antenna (30 MHz - 3 GHz)      | Rohde & Schwarz GmbH & Co. KG                | 100609        | 2019-05          | 2022-05         |
| 1.31    | MA4985-XP-ET                          | Bore Sight Antenna Mast                         | innco systems GmbH                           | none          |                  |                 |
| 1.32    | JUN-AIR Mod. 6-15                     | Air Compressor                                  | JUN-AIR Deutschland GmbH                     | 612582        |                  |                 |
| 1.33    | foEthernet_M                          | Fibre optic link Ethernet / Gb-LAN              | PONTIS Messtechnik GmbH                      | 4841516023    |                  |                 |
| 1.34    | 5HC3500/18000-1.2-KK                  | High Pass Filter                                | Trilithic                                    | 200035008     |                  |                 |
| 1.35    | HFH2-Z2                               | Loop Antenna                                    | Rohde & Schwarz                              | 829324/006    | 2021-01          | 2024-01         |
| 1.36    | Voltcraft M-3860M                     | Digital Multimeter 01 (Multimeter)              | Conrad                                       | IJ096055      |                  |                 |
| 1.37    | ESR 7                                 | EMI Receiver / Spectrum Analyzer                | Rohde & Schwarz                              | 101424        | 2021-01          | 2023-01         |
| 1.38    | SB4-100.OLD20-3T/10 Airwin 2 x 1.5 kW | Air compressor (oil-free)                       | airWin Kompressoren UG                       | 901/00503     |                  |                 |
| 1.39    | UNI-T UT195E                          | True RMS Digital Multimeter                     | UNI-T UNI-TREND TECHNOLOGY (CHINA) CO., LTD. | C190729561    |                  |                 |
| 1.40    | foEthernet_M                          | Fibre optic link Ethernet / Gb-LAN              | PONTIS Messtechnik GmbH                      | 4841516022    |                  |                 |
| 1.41    | JS4-00101800-35-5P                    | Broadband Amplifier 30 MHz - 18 GHz             | Miteq  | 896037        |                  |                 |

| Ref.No. | Device Name             | Description                           | Manufacturer                | Serial Number          | Last Calibration | Calibration Due |
|---------|-------------------------|---------------------------------------|-----------------------------|------------------------|------------------|-----------------|
| 1.42    | AS 620 P                | Antenna Mast (pneumatic polarisation) | HD GmbH                     | 620/37                 |                  |                 |
| 1.43    | 6005D (30 V / 5 A)      | Laboratory Power Supply 120 V 60 Hz   | PeakTech                    | 81062045               |                  |                 |
| 1.44    | TD1.5-10kg              | EUT Tilt Device (Rohacell)            | Maturo GmbH                 | TD1.5-10kg/024/3790709 |                  |                 |
| 1.45    | Innco Systems CO3000    | Controller for bore sight mast SAC    | innco systems GmbH          | CO3000/967/39371016/L  |                  |                 |
| 1.46    | HF 907                  | Double-ridged horn                    | Rohde & Schwarz             | 102144                 | 2018-07          | 2021-07         |
| 1.47    | HF 907-2                | Double-ridged horn                    | Rohde & Schwarz             | 102817                 | 2019-04          | 2022-04         |
| 1.48    | PAS 2.5 - 10 kg         | Antenna Mast                          | Maturo GmbH                 | -                      |                  |                 |
| 1.49    | AFS42-00101800-25-S-42  | Broadband Amplifier 25 MHz - 18 GHz   | Miteq                       | 2035324                |                  |                 |
| 1.50    | WRCA800/960-0.2/40-6EEK | Tunable Notch Filter                  | Wainwright Instruments GmbH | 20                     |                  |                 |
| 1.51    | AM 4.0                  | Antenna Mast 4 m                      | Maturo GmbH                 | AM4.0/180/11920513     |                  |                 |

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

## 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<br>MHz | Corr.<br>dB | LISN<br>insertion<br>loss<br>ESH3-<br>Z5<br>dB | cable<br>loss<br>(incl. 10<br>dB<br>atten-<br>uator)<br>dB |
|------------------|-------------|--|--|
| 0.15             | 10.1        | 0.1  | 10.0   |
| 5                | 10.3        | 0.1  | 10.2   |
| 7                | 10.5        | 0.2  | 10.3   |
| 10               | 10.5        | 0.2  | 10.3   |
| 12               | 10.7        | 0.3  | 10.4   |
| 14               | 10.7        | 0.3  | 10.4   |
| 16               | 10.8        | 0.4  | 10.4   |
| 18               | 10.9        | 0.4  | 10.5   |
| 20               | 10.9        | 0.4  | 10.5   |
| 22               | 11.1        | 0.5  | 10.6   |
| 24               | 11.1        | 0.5  | 10.6   |
| 26               | 11.2        | 0.5  | 10.7   |
| 28               | 11.2        | 0.5  | 10.7   |
| 30               | 11.3        | 0.5  | 10.8   |

#### Sample calculation

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

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.



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

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

| Frequency<br>MHz | AF<br>R&S<br>HL562<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(outside<br>chamber)<br>dB | cable<br>loss 3<br>(switch<br>unit)<br>dB | cable<br>loss 4<br>(to<br>receiver)<br>dB | distance<br>corr.<br>(-20 dB/<br>decade)<br>dB | $d_{Limit}$<br>(meas.<br>distance<br>(limit))<br>m | $d_{used}$<br>(meas.<br>distance<br>(used))<br>m |
|------------------|--------------------------------|-------------|--|---|---|---|--|--|--|
| 30               | 18.6                           | 0.6         | 0.29   | 0.04  | 0.23                                      | 0.02                                      | 0.0  | 3  | 3  |
| 50               | 6.0                            | 0.9         | 0.39   | 0.09  | 0.32                                      | 0.08                                      | 0.0  | 3  | 3  |
| 100              | 9.7                            | 1.2         | 0.56   | 0.14  | 0.47                                      | 0.08                                      | 0.0  | 3  | 3  |
| 150              | 7.9                            | 1.6         | 0.73   | 0.20  | 0.59                                      | 0.12                                      | 0.0  | 3  | 3  |
| 200              | 7.6                            | 1.9         | 0.84   | 0.21  | 0.70                                      | 0.11                                      | 0.0  | 3  | 3  |
| 250              | 9.5                            | 2.1         | 0.98   | 0.24  | 0.80                                      | 0.13                                      | 0.0  | 3  | 3  |
| 300              | 11.0                           | 2.3         | 1.04   | 0.26  | 0.89                                      | 0.15                                      | 0.0  | 3  | 3  |
| 350              | 12.4                           | 2.6         | 1.18   | 0.31  | 0.96                                      | 0.13                                      | 0.0  | 3  | 3  |
| 400              | 13.6                           | 2.9         | 1.28   | 0.35  | 1.03                                      | 0.19                                      | 0.0  | 3  | 3  |
| 450              | 14.7                           | 3.1         | 1.39   | 0.38  | 1.11                                      | 0.22                                      | 0.0  | 3  | 3  |
| 500              | 15.6                           | 3.2         | 1.44   | 0.39  | 1.20                                      | 0.19                                      | 0.0  | 3  | 3  |
| 550              | 16.3                           | 3.5         | 1.55   | 0.46  | 1.24                                      | 0.23                                      | 0.0  | 3  | 3  |
| 600              | 17.2                           | 3.5         | 1.59   | 0.43  | 1.29                                      | 0.23                                      | 0.0  | 3  | 3  |
| 650              | 18.1                           | 3.6         | 1.67   | 0.34  | 1.35                                      | 0.22                                      | 0.0  | 3  | 3  |
| 700              | 18.5                           | 3.6         | 1.67   | 0.42  | 1.41                                      | 0.15                                      | 0.0  | 3  | 3  |
| 750              | 19.1                           | 4.1         | 1.87   | 0.54  | 1.46                                      | 0.25                                      | 0.0  | 3  | 3  |
| 800              | 19.6                           | 4.1         | 1.90   | 0.46  | 1.51                                      | 0.25                                      | 0.0  | 3  | 3  |
| 850              | 20.1                           | 4.4         | 1.99   | 0.60  | 1.56                                      | 0.27                                      | 0.0  | 3  | 3  |
| 900              | 20.8                           | 4.7         | 2.14   | 0.60  | 1.63                                      | 0.29                                      | 0.0  | 3  | 3  |
| 950              | 21.1                           | 4.8         | 2.22   | 0.60  | 1.66                                      | 0.33                                      | 0.0  | 3  | 3  |
| 1000             | 21.6                           | 4.9         | 2.23   | 0.61  | 1.71                                      | 0.30                                      | 0.0  | 3  | 3  |

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

|      |      |      |      |      |      |      |       |    |   |
|------|------|------|------|------|------|------|-------|----|---|
| 30   | 18.6 | -9.9 | 0.29 | 0.04 | 0.23 | 0.02 | -10.5 | 10 | 3 |
| 50   | 6.0  | -9.6 | 0.39 | 0.09 | 0.32 | 0.08 | -10.5 | 10 | 3 |
| 100  | 9.7  | -9.2 | 0.56 | 0.14 | 0.47 | 0.08 | -10.5 | 10 | 3 |
| 150  | 7.9  | -8.8 | 0.73 | 0.20 | 0.59 | 0.12 | -10.5 | 10 | 3 |
| 200  | 7.6  | -8.6 | 0.84 | 0.21 | 0.70 | 0.11 | -10.5 | 10 | 3 |
| 250  | 9.5  | -8.3 | 0.98 | 0.24 | 0.80 | 0.13 | -10.5 | 10 | 3 |
| 300  | 11.0 | -8.1 | 1.04 | 0.26 | 0.89 | 0.15 | -10.5 | 10 | 3 |
| 350  | 12.4 | -7.9 | 1.18 | 0.31 | 0.96 | 0.13 | -10.5 | 10 | 3 |
| 400  | 13.6 | -7.6 | 1.28 | 0.35 | 1.03 | 0.19 | -10.5 | 10 | 3 |
| 450  | 14.7 | -7.4 | 1.39 | 0.38 | 1.11 | 0.22 | -10.5 | 10 | 3 |
| 500  | 15.6 | -7.2 | 1.44 | 0.39 | 1.20 | 0.19 | -10.5 | 10 | 3 |
| 550  | 16.3 | -7.0 | 1.55 | 0.46 | 1.24 | 0.23 | -10.5 | 10 | 3 |
| 600  | 17.2 | -6.9 | 1.59 | 0.43 | 1.29 | 0.23 | -10.5 | 10 | 3 |
| 650  | 18.1 | -6.9 | 1.67 | 0.34 | 1.35 | 0.22 | -10.5 | 10 | 3 |
| 700  | 18.5 | -6.8 | 1.67 | 0.42 | 1.41 | 0.15 | -10.5 | 10 | 3 |
| 750  | 19.1 | -6.3 | 1.87 | 0.54 | 1.46 | 0.25 | -10.5 | 10 | 3 |
| 800  | 19.6 | -6.3 | 1.90 | 0.46 | 1.51 | 0.25 | -10.5 | 10 | 3 |
| 850  | 20.1 | -6.0 | 1.99 | 0.60 | 1.56 | 0.27 | -10.5 | 10 | 3 |
| 900  | 20.8 | -5.8 | 2.14 | 0.60 | 1.63 | 0.29 | -10.5 | 10 | 3 |
| 950  | 21.1 | -5.6 | 2.22 | 0.60 | 1.66 | 0.33 | -10.5 | 10 | 3 |
| 1000 | 21.6 | -5.6 | 2.23 | 0.61 | 1.71 | 0.30 | -10.5 | 10 | 3 |

#### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$   
 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 | AF R&S HF907 | Corr. |
|-----------|--------------|-------|
| MHz       | dB (1/m)     | 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) | cable loss 2 (outside chamber) | cable loss 3 (switch unit, attenuator & pre-amp) | cable loss 4 (to receiver) |  |  |
|---|--------------------------------|--|----------------------------|--|--|
| dB  | dB                             | dB   | 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 | AF R&S HF907 | Corr. |
|-----------|--------------|-------|
| MHz       | dB (1/m)     | 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) | cable loss 2 (inside chamber) | cable loss 3 (outside chamber) | cable loss 4 (switch unit, attenuator & pre-amp) | cable loss 5 (to receiver) | used for FCC 15.247 |
|-------------------------------------|-------------------------------|--------------------------------|--|----------------------------|---------------------|
| dB                                  | dB                            | dB                             | dB   | dB                         |                     |
| 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 | AF R&S HF907 | Corr. |
|-----------|--------------|-------|
| MHz       | dB (1/m)     | 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) | cable loss 2 (High Pass) | cable loss 3 (pre-amp) | cable loss 4 (inside chamber) | cable loss 5 (outside chamber) | cable loss 6 (to receiver) |
|-------------------------------------|--------------------------|------------------------|-------------------------------|--------------------------------|----------------------------|
| dB                                  | dB                       | dB                     | dB                            | dB                             | 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<br>MHz | AF<br>EMCO<br>3160-09<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(pre-<br>amp)<br>dB | cable<br>loss 3<br>(inside<br>chamber)<br>dB | cable<br>loss 4<br>(switch<br>unit)<br>dB | cable<br>loss 5<br>(to<br>receiver)<br>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**

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



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

| Frequency<br>GHz | AF<br>EMCO<br>3160-10<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(outside<br>chamber)<br>dB | cable<br>loss 3<br>(switch<br>unit)<br>dB | cable<br>loss 4<br>(to<br>receiver)<br>dB | distance<br>corr.<br>(-20 dB/<br>decade)<br>dB | d <sub>Limit</sub><br>(meas.<br>distance<br>(limit))<br>m | d <sub>used</sub><br>(meas.<br>distance<br>(used))<br>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

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

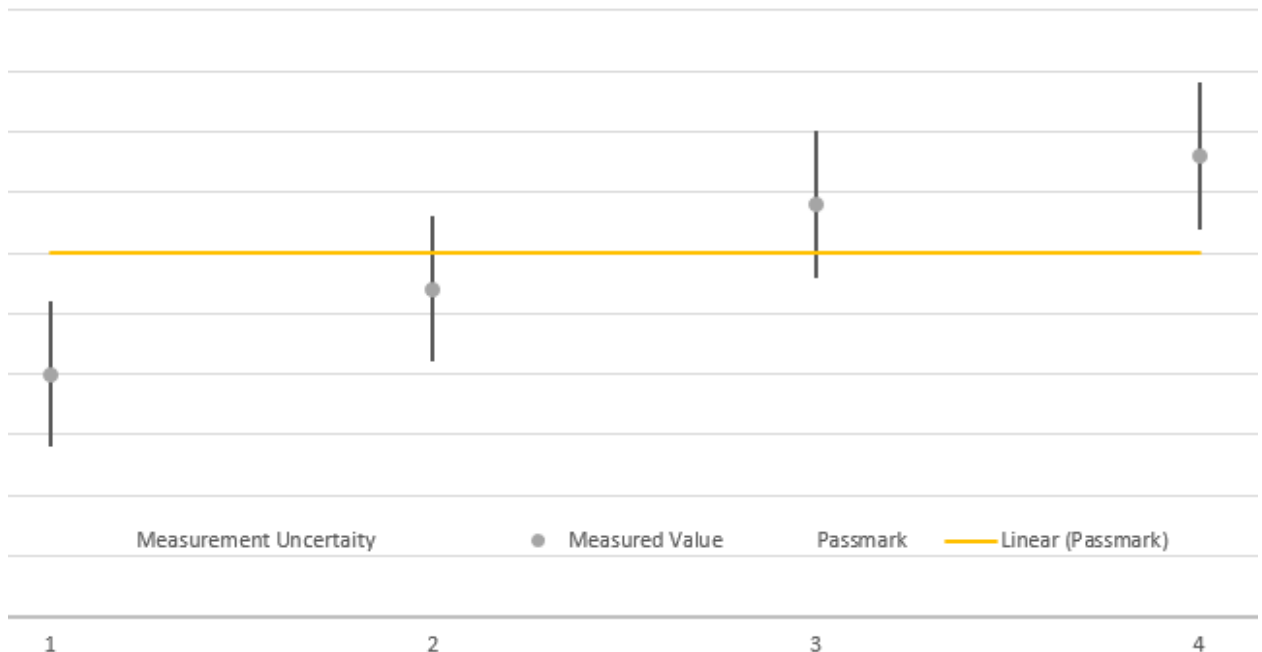
Please see separate photo report.

## 8. MEASUREMENT UNCERTAINTIES

### Measurement Uncertainties

| Parameter   | Uncertainty            |
|---|------------------------|
| Antenna Power, Antenna Power Tolerance                                | $\pm 1.2$ dB           |
| Frequency Tolerance   | $\pm 5.0$ Hz           |
| Transmitter Spurious Emissions, Limit on secondary radiated emissions | $\pm 2.5$ dB           |
| Occupied bandwidth, Spread Bandwidth                                  | $\pm 825$ kHz          |
| Dwell time  | $\pm 30.0$ $\mu$ s     |
| Temperature   | $\pm 0.3$ $^{\circ}$ C |
| Humidity  | $\pm 3\%$              |
| DC and low frequency voltages   | $\pm 1.5\%$ + 2 digits |
| Time  | $\pm 5\%$              |
| Antenna Gain and Pattern  | $\pm 1.8$ 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.