



# RF - TEST REPORT

- FCC Part 15.247, RSS-247 -

**Type / Model Name** : c-med° alpha

**Product Description** : Medical wearable for continuous vital signs  
measurement

**Applicant** : Cosinuss GmbH

**Address** : Kistlerhofstraße 60  
81379 München, GERMANY

**Manufacturer** : Cosinuss GmbH

**Address** : Kistlerhofstraße 60  
81379 München, GERMANY

**Test Result** according to the standards  
listed in clause 1 test standards:

**POSITIVE**

**Test Report No. :** T47140-01-00LH

19. July 2021

Date of issue



Deutsche  
Akkreditierungsstelle  
D-PL-12030-01-01  
D-PL-12030-01-02

# Contents

|          |                                                                   |           |
|----------|-------------------------------------------------------------------|-----------|
| <b>1</b> | <b>TEST STANDARDS</b>                                             | <b>3</b>  |
| <b>2</b> | <b>EQUIPMENT UNDER TEST</b>                                       | <b>4</b>  |
| 2.1      | Information provided by the Client                                | 4         |
| 2.2      | Sampling                                                          | 4         |
| 2.3      | General remarks                                                   | 4         |
| 2.4      | Photo documentation of the EUT – Detailed photos see ATTACHMENT A | 4         |
| 2.5      | Equipment type                                                    | 4         |
| 2.6      | Short description of the equipment under test (EUT)               | 4         |
| 2.7      | Variants of the EUT                                               | 4         |
| 2.8      | Operation frequency and channel plan                              | 5         |
| 2.9      | Transmit operating modes                                          | 5         |
| 2.10     | Antennas                                                          | 5         |
| 2.11     | Power supply system utilised                                      | 5         |
| 2.12     | Peripheral devices and interface cables                           | 6         |
| 2.13     | Determination of worst case conditions for final measurement      | 6         |
| <b>3</b> | <b>TEST RESULT SUMMARY</b>                                        | <b>7</b>  |
| 3.1      | Final assessment                                                  | 7         |
| <b>4</b> | <b>TEST ENVIRONMENT</b>                                           | <b>8</b>  |
| 4.1      | Address of the test laboratory                                    | 8         |
| 4.2      | Environmental conditions                                          | 8         |
| 4.3      | Statement of the measurement uncertainty                          | 8         |
| 4.1      | Conformity Decision Rule                                          | 8         |
| 4.2      | Measurement protocol for FCC and ISSED                            | 9         |
| <b>5</b> | <b>TEST CONDITIONS AND RESULTS</b>                                | <b>12</b> |
| 5.1      | EBW and OBW                                                       | 12        |
| 5.2      | Maximum peak conducted output power                               | 19        |
| 5.3      | Power spectral density                                            | 22        |
| 5.4      | Radiated emissions in restricted bands                            | 26        |
| 5.5      | Spurious emissions radiated                                       | 37        |
| 5.6      | Antenna application                                               | 42        |
| <b>6</b> | <b>USED TEST EQUIPMENT AND ACCESSORIES</b>                        | <b>45</b> |

ATTACHMENT A AS SEPARATE SUPPLEMENT

# **1 TEST STANDARDS**

The tests were performed according to following standards:

## **FCC Rules and Regulations Part 15, Subpart A - General (September 2020)**

|                                   |                                               |
|-----------------------------------|-----------------------------------------------|
| Part 15, Subpart A, Section 15.31 | Measurement standards                         |
| Part 15, Subpart A, Section 15.33 | Frequency range of radiated measurements      |
| Part 15, Subpart A, Section 15.35 | Measurement detector functions and bandwidths |

## **FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2020)**

|                                                     |                                                                                    |
|-----------------------------------------------------|------------------------------------------------------------------------------------|
| Part 15, Subpart C, Section 15.203                  | Antenna requirement                                                                |
| Part 15, Subpart C, Section 15.204<br>modifications | External radio frequency power amplifiers and antenna                              |
| Part 15, Subpart C, Section 15.205                  | Restricted bands of operation                                                      |
| Part 15, Subpart C, Section 15.207                  | Conducted limits                                                                   |
| Part 15, Subpart C, Section 15.209                  | Radiated emission limits, general requirements                                     |
| Part 15, Subpart C, Section 15.247                  | Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and<br>5725 - 5850 MHz |

|                   |                                     |
|-------------------|-------------------------------------|
| ANSI C63.10: 2013 | Testing Unlicensed Wireless Devices |
|-------------------|-------------------------------------|

|                                  |                                                                                                                                                                    |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ETSI TR 100 028 V1.3.1: 2001-03, | Electromagnetic Compatibility and Radio Spectrum Matters (ERM);<br>Uncertainties in the Measurement of Mobile Radio Equipment<br>Characteristics—Part 1 and Part 2 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 2 EQUIPMENT UNDER TEST

### 2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

### 2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

### 2.3 General remarks

### 2.4 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

### 2.5 Equipment type

Bluetooth 5.0 Low Energy transceiver, portable equipment

### 2.6 Short description of the equipment under test (EUT)

The EUT is a Bluetooth 5.0 Low Energy wireless device for continuous vital signs measurements. A single PCB antenna is used within the system. The EUT has only one integrated antenna, no temporary connector and no external antenna can be connected.

Radiated and conducted test samples are specially prepared to be connected to a PC and set into test modes by a set of commands in a terminal program.

|                           |                          |                          |
|---------------------------|--------------------------|--------------------------|
| Number of tested samples: | 1 conducted              | 1 radiated               |
| Type:                     | MS01                     | MS01                     |
| Serial number:            | PCB ID 6001501A.002009   | PCB ID 6001501A.002019   |
| Firmware version:         | special testing firmware | special testing firmware |

#### **EUT configuration:**

(The CDF filled by the applicant can be viewed at the test laboratory.)

### 2.7 Variants of the EUT

There are no variants.

## 2.8 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan BT-Standard 802.15.1:

| Channel | Frequency | Channel | Frequency |
|---------|-----------|---------|-----------|
| 37      | 2402      | 18      | 2442      |
| 0       | 2404      | 19      | 2444      |
| 1       | 2406      | 20      | 2446      |
| 2       | 2408      | 21      | 2448      |
| 3       | 2410      | 22      | 2450      |
| 4       | 2412      | 23      | 2452      |
| 5       | 2414      | 24      | 2454      |
| 6       | 2416      | 25      | 2456      |
| 7       | 2418      | 26      | 2458      |
| 8       | 2420      | 27      | 2460      |
| 9       | 2422      | 28      | 2462      |
| 10      | 2424      | 29      | 2464      |
| 38      | 2426      | 30      | 2466      |
| 11      | 2428      | 31      | 2468      |
| 12      | 2430      | 32      | 2470      |
| 13      | 2432      | 33      | 2472      |
| 14      | 2434      | 34      | 2474      |
| 15      | 2436      | 35      | 2476      |
| 16      | 2438      | 36      | 2478      |
| 17      | 2440      | 39      | 2480      |

Note: the marked frequencies are determined for final testing.

## 2.9 Transmit operating modes

The EUT uses GFSK modulation and may provide following data rates:

- 1000 kbps
- 2000 kbps

(kbps = *kilobits per second*)

## 2.10 Antennas

The following antennas shall be used with the EUT:

The EUT has only an integrated PCB antenna, no temporary connector and no external antenna to be connected.

## 2.11 Power supply system utilised

Power supply voltage,  $V_{nom}$  : 3.7 V<sub>DC</sub> Battery

## 2.12 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

|                      |                          |
|----------------------|--------------------------|
| - Device1            | Model : Raspberry Pi 3B+ |
| - WLAN Router        | Model : FRITZ!Box 4020   |
| - Laptop             | Model : MS-16GD          |
| - UART-USB Converter | Model : DLP-USB232R      |
| - USB Mini Cable     | Model : -                |
| - 2x Ethernetcable   | Model : -                |
| - USB Micro Cable    | Model : -                |

## 2.13 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in X position.

The tests are carried out in the following frequency band:

**2400 MHz – 2483.5 MHz**

Preliminary tests are performed to find the worst case mode from all possible combinations between available modulations and data rates. The maximum output power depends on used data rate. The output power is set by firmware from 0 dBm to 4 dBm (P0 to P4) in 1 dB steps.

**For the final test the following channels and test modes are selected:**

| Wireless system      | Available channel | Tested channels | Power setting | Modulation | Modulation type | Data rate |
|----------------------|-------------------|-----------------|---------------|------------|-----------------|-----------|
| 802.15.1<br>BLE V5.0 | 0-39              | 37, 17, 39      | P4            | DSSS       | GFSK            | 1.0 Mbps  |

- TX continuous mode
- RX continuous mode

### 2.13.1 Test jig

No special test jig was used for testing.

### 2.13.2 Test software

The test software for the EUT provides the special test mode RX and the TX continuous mode, modulated. The output power is set by firmware and can not be changed by the user. The EUT was set with test modulation to transmit data during the tests with a maximum duty cycle from an internal packet generator.

### 3 TEST RESULT SUMMARY

Operating in the 2400 MHz – 2483.5 MHz:

| FCC Rule Part | RSS Rule Part     | Description                         | Result          |
|---------------|-------------------|-------------------------------------|-----------------|
| 15.207(a)     | RSS-Gen, 8.8      | AC power line conducted emissions   | not applicable* |
| 15.247(a)(2)  | RSS-247, 6.2.4(1) | -6 dB EBW                           | passed          |
| 15.247(b)(3)  | RSS-247, 6.2.4(1) | Maximum peak conducted output power | passed          |
| 15.247(b)(4)  | -                 | Defacto limit                       | passed          |
| 15.247(d)     | RSS-247, 6.2.4(2) | Out-of-band emission, radiated      | passed          |
| 15.247(d)     | RSS-Gen, 8.9      | Emissions in restricted bands       | passed          |
| 15.247(e)     | RSS-247, 6.2.4(1) | PSD                                 | passed          |
| 15.203        | RSS-Gen, 6.6      | Antenna requirement                 | passed          |
| -             | RSS-Gen, 6.11     | Transmitter frequency stability     | passed          |
| -             | RSS-Gen, 6.6      | 99 % Bandwidth                      | passed          |

The mentioned new RSS Rule Parts in the above table are related to:  
 RSS-Gen, Issue 5 + Amendment 1, March 2019  
 RSS-247, Issue 2, February 2017

\* The EUT is battery powered, therefore AC power line conducted emissions is not applicable.

#### 3.1 Final assessment

The equipment under test fulfills the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 08 March 2021

Testing concluded on : 16 March 2021

Checked by:

Tested by:

\_\_\_\_\_  
 Klaus Gegenfurtner  
 Teamleader Radio

\_\_\_\_\_  
 Lukas Scheuermann  
 Radio Team

## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

**CSA Group Bayern GmbH**  
**Ohmstrasse 1-4**  
**94342 STRASSKIRCHEN**  
**GERMANY**

### 4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15 - 35 °C

Humidity: 30 - 60 %

Atmospheric pressure: 86 - 106 kPa

### 4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor  $k = 2$ . The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

| Measurement Type                | Range                   | Confidence Level (%) | Calculated Uncertainty   |
|---------------------------------|-------------------------|----------------------|--------------------------|
| AC Conducted Spurious Emissions | 0.15 MHz to 30 MHz      | 95%                  | $\pm 3.29 \text{ dB}$    |
| 20 dB Bandwidth                 | Center frequency of EUT | 95%                  | $\pm 2.5 \times 10^{-7}$ |
| 99% Occupied Bandwidth          | Center frequency of EUT | 95%                  | $\pm 2.5 \times 10^{-7}$ |
| Radiated Spurious Emissions     | 9 kHz to 30 MHz         | 95%                  | $\pm 3.53 \text{ dB}$    |
| Radiated Spurious Emissions     | 30 MHz to 1000 MHz      | 95%                  | $\pm 3.71 \text{ dB}$    |
| Radiated Spurious Emissions     | 1000 MHz to 10000 MHz   | 95%                  | $\pm 2.34 \text{ dB}$    |
| Peak conducted output power     | 902 MHz to 928 MHz      | 95%                  | $\pm 0.35 \text{ dB}$    |
| Conducted Spurious Emissions    | 9 kHz to 10000 MHz      | 95%                  | $\pm 2.15 \text{ dB}$    |

### 4.1 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.



## 4.2 Measurement protocol for FCC and ISED

### 4.2.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

**FCC: DE 0011**  
**ISED: DE0009**

### 4.2.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

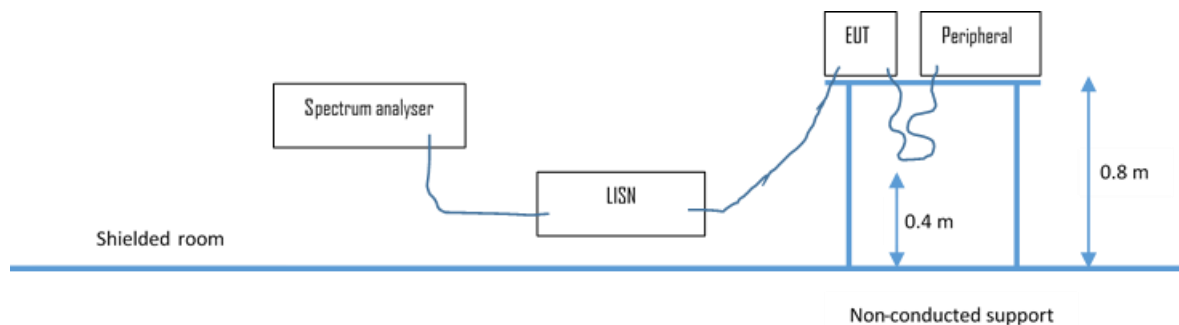
#### 4.2.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

### 4.2.3 Details of test procedures

#### 4.2.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dB $\mu$ V, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dB $\mu$ V and  $\mu$ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

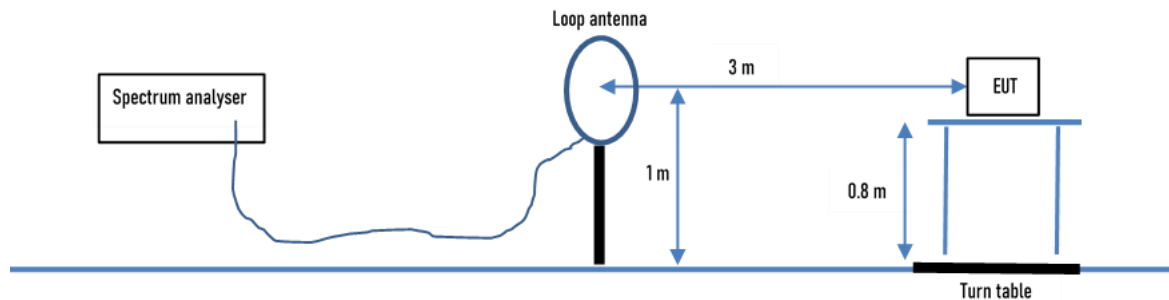
$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50  $\Omega$  / 50  $\mu$ H (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

## 4.2.3.2 Radiated emission

### 4.2.3.2.1 OATS1 test site (9 kHz - 30 MHz):

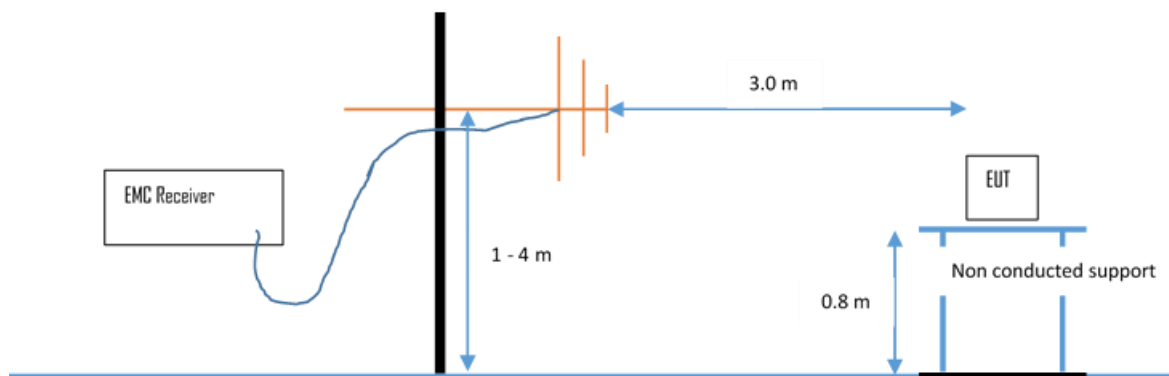
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

### 4.2.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

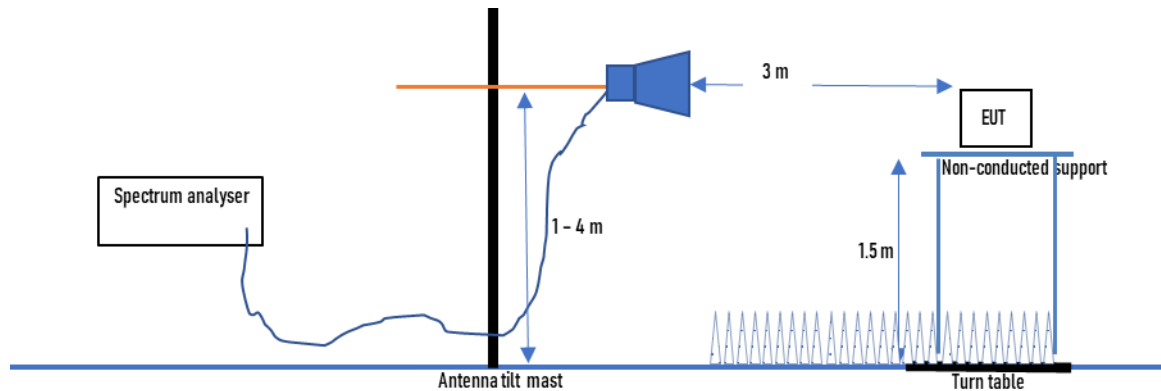
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

| Frequency<br>(MHz) | Level<br>(dBµV) | + | Factor<br>(dB) | = | Level<br>(dBµV/m) | - | Limit<br>(dBµV/m) | = | Delta<br>(dB) |
|--------------------|-----------------|---|----------------|---|-------------------|---|-------------------|---|---------------|
| 719.0              | 75.0            | + | 32.6           | = | 107.6             | - | 110.0             | = | -2.4          |

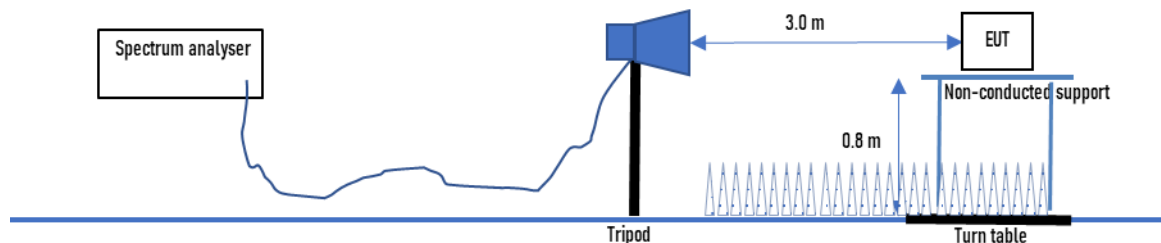
#### 4.2.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

#### 4.2.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit are adopted.

## 5 TEST CONDITIONS AND RESULTS

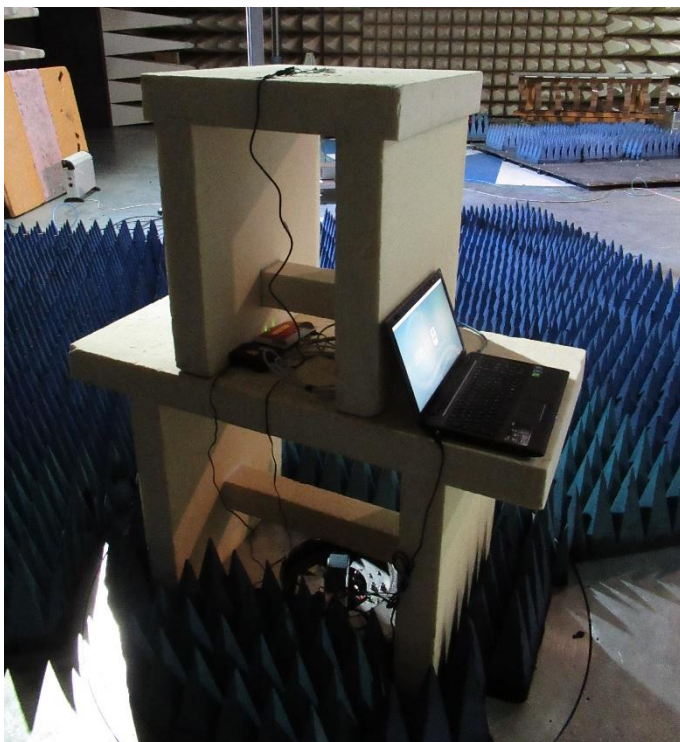
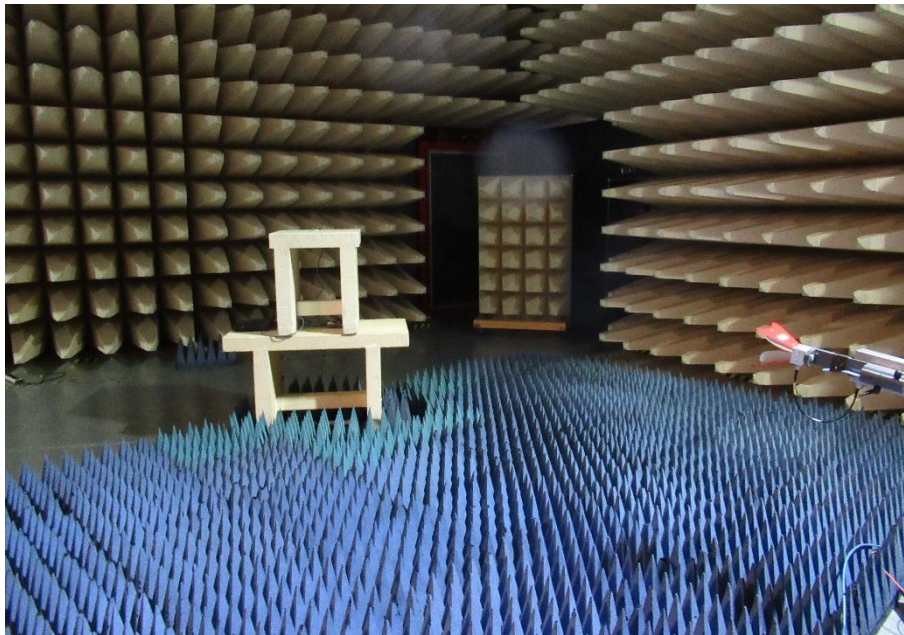
### 5.1 EBW and OBW

For test instruments and accessories used see section 6 Part **MB**.

#### 5.1.1 Description of the test location

Test location: Anechoic chamber 1

#### 5.1.2 Photo documentation of the test set-up





### 5.1.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(2):

Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.1.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Span:  $\geq 2$  EBW;

Spectrum analyser settings for OBW:

RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Span:  $\geq 2$  OBW;

### 5.1.5 Test result

Standard 802.15.1

| EBW, 1 Mbps |                         |                      |                     |
|-------------|-------------------------|----------------------|---------------------|
| Channel     | Channel frequency (MHz) | 6 dB bandwidth (kHz) | Minimum limit (kHz) |
| 37          | 2402                    | 679.3                | 500                 |
| 17          | 2440                    | 679.3                | 500                 |
| 39          | 2480                    | 683.3                | 500                 |

| EBW, 2 Mbps |                         |                      |                     |
|-------------|-------------------------|----------------------|---------------------|
| Channel     | Channel frequency (MHz) | 6 dB bandwidth (kHz) | Minimum limit (kHz) |
| 37          | 2402                    | 1162.8               | 500                 |
| 17          | 2440                    | 1158.8               | 500                 |
| 39          | 2480                    | 1146.9               | 500                 |

| OBW99, 1 Mbps |                         |                      |
|---------------|-------------------------|----------------------|
| Channel       | Channel frequency (MHz) | 99 % bandwidth (kHz) |
| 37            | 2402                    | 1046.1               |
| 17            | 2440                    | 1062.9               |
| 39            | 2480                    | 1067.3               |

| OBW99, 2 Mbps |                         |                      |
|---------------|-------------------------|----------------------|
| Channel       | Channel frequency (MHz) | 99 % bandwidth (kHz) |
| 37            | 2402                    | 2072.1               |
| 17            | 2440                    | 2071.5               |
| 39            | 2480                    | 2077.0               |

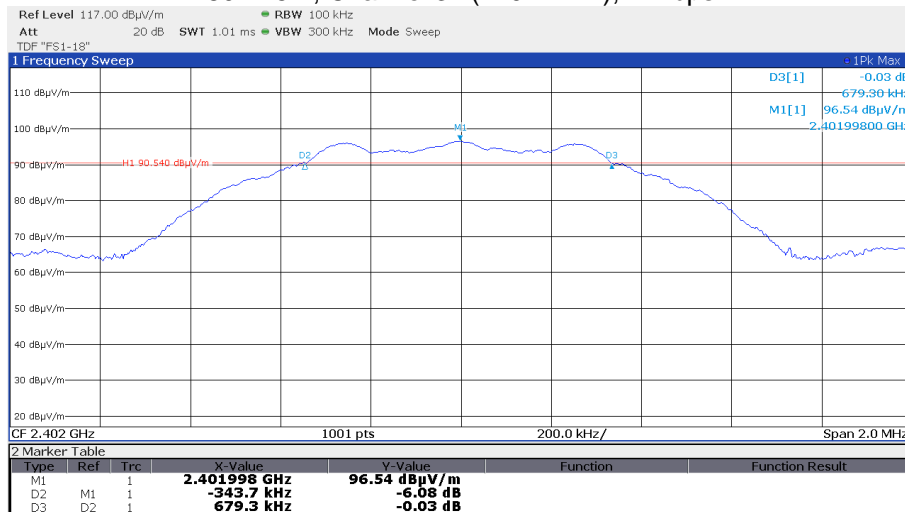
The requirements are **FULFILLED**.

**Remarks:** For detailed test result please see the following test protocols

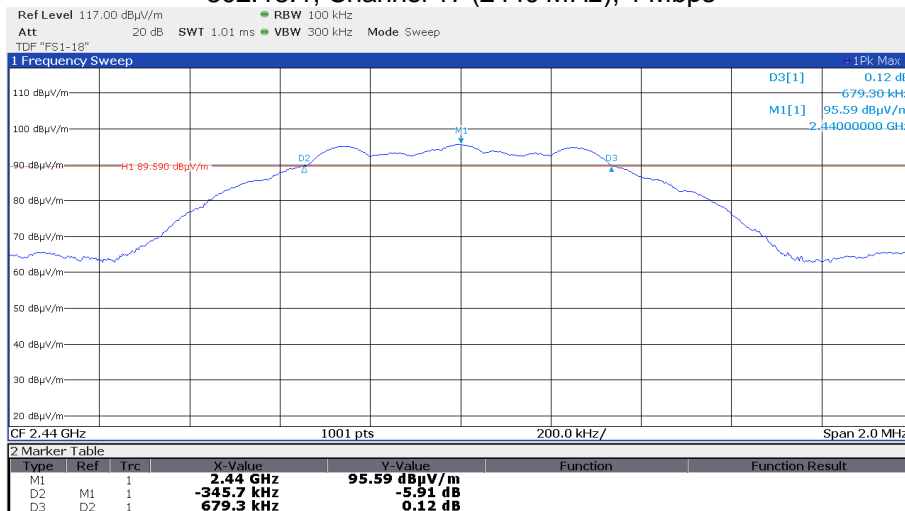
---

## 5.1.6 Test protocols EBW

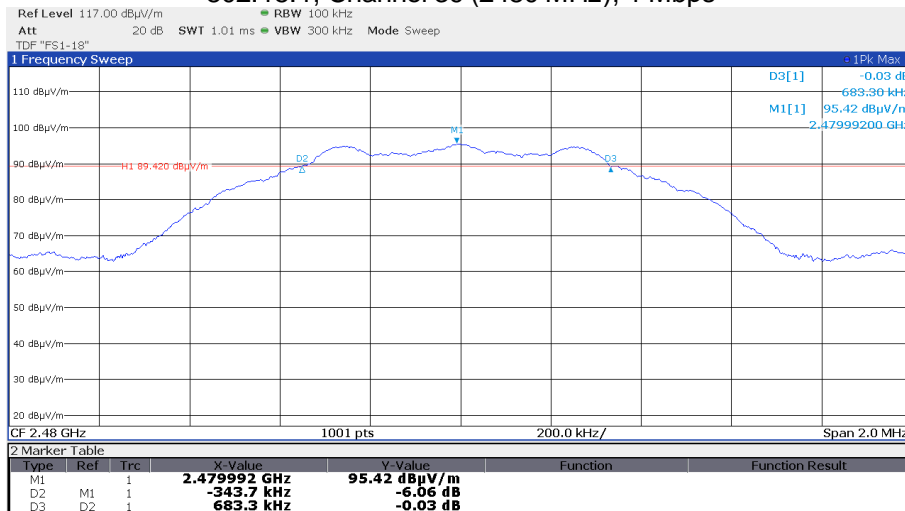
### 802.15.1, Channel 37 (2402 MHz), 1 Mbps



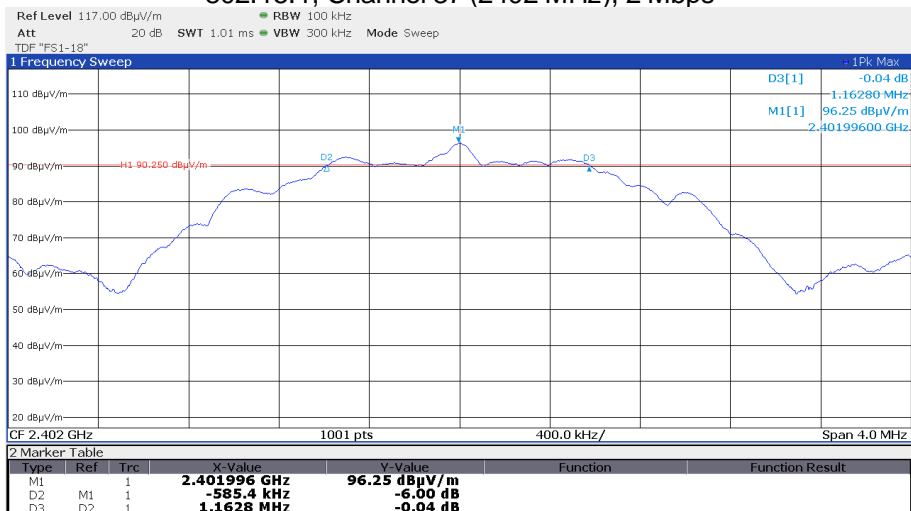
### 802.15.1, Channel 17 (2440 MHz), 1 Mbps



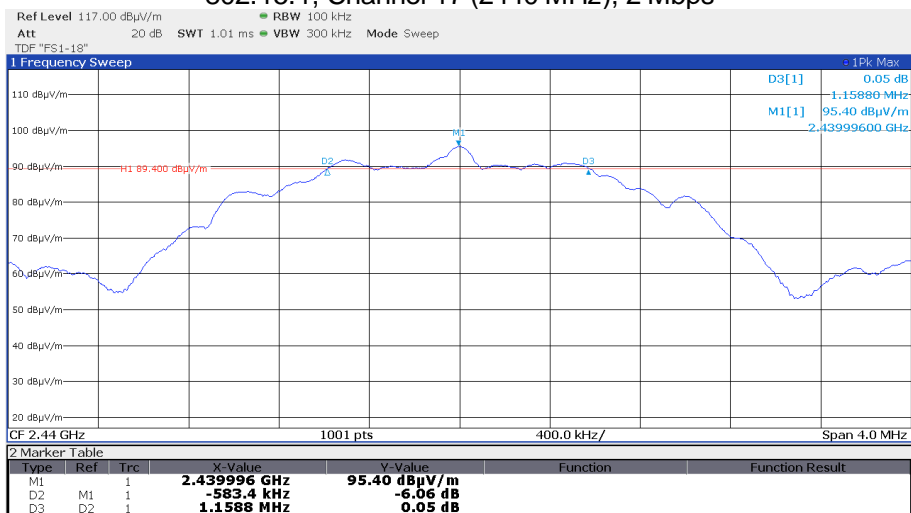
### 802.15.1, Channel 39 (2480 MHz), 1 Mbps



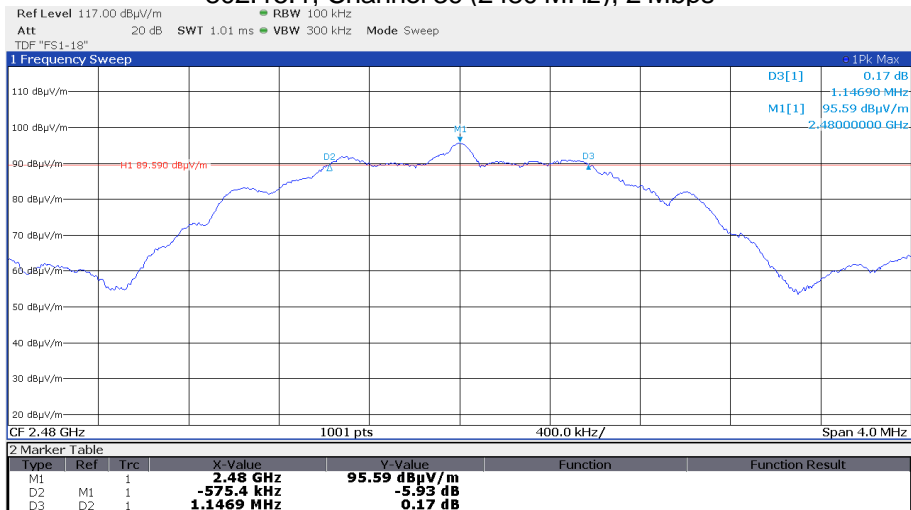
### 802.15.1, Channel 37 (2402 MHz), 2 Mbps



### 802.15.1, Channel 17 (2440 MHz), 2 Mbps



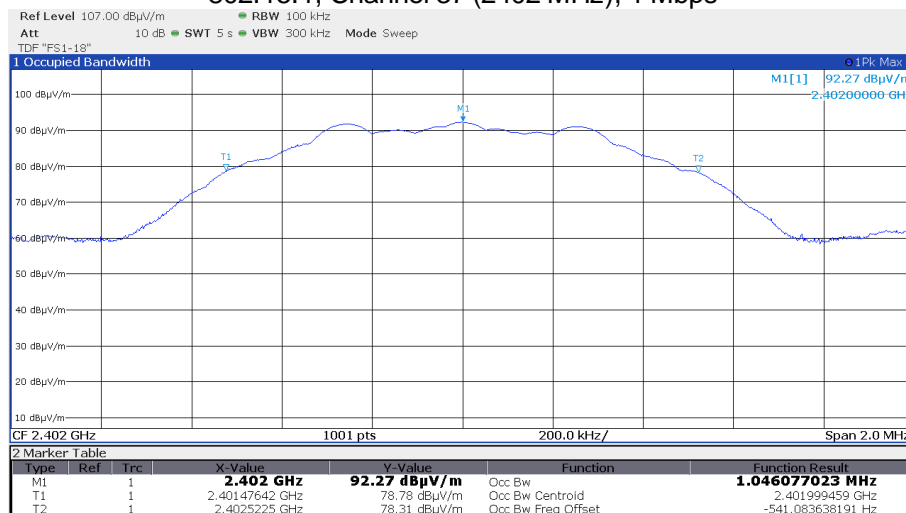
### 802.15.1, Channel 39 (2480 MHz), 2 Mbps



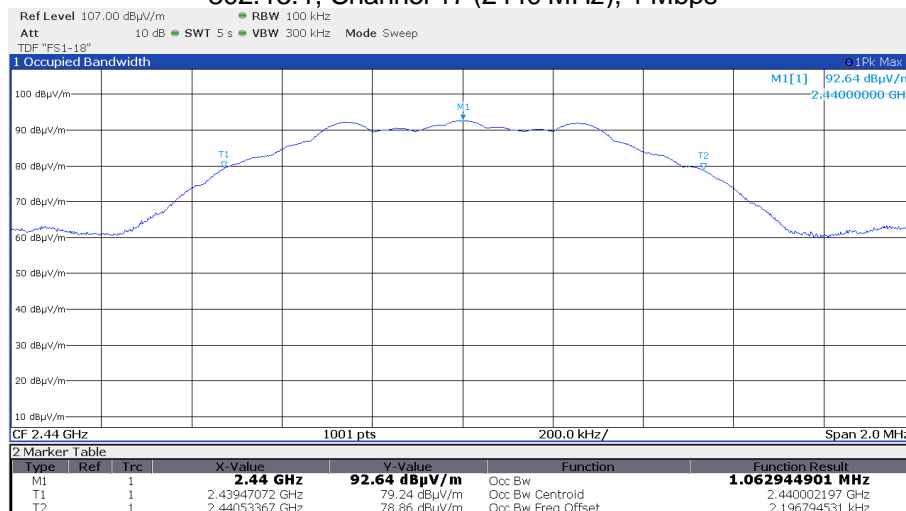


## 5.1.7 Test protocols OBW99

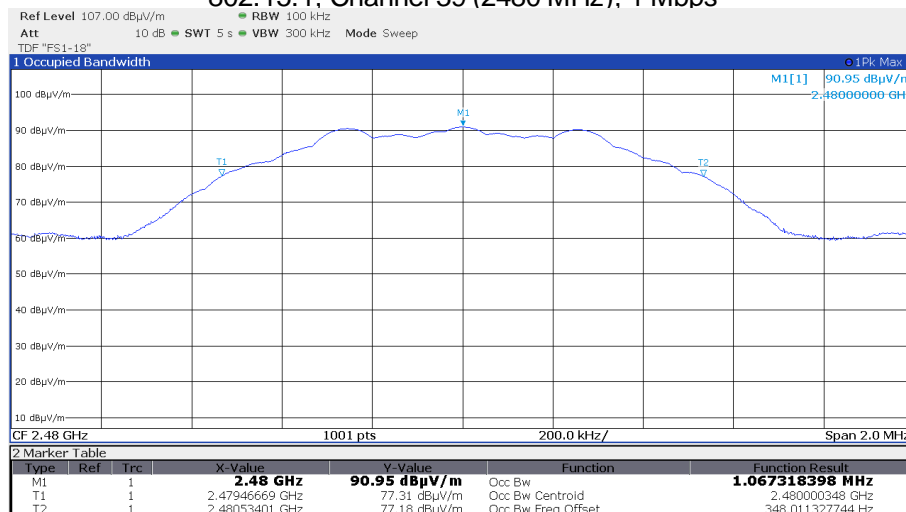
### 802.15.1, Channel 37 (2402 MHz), 1 Mbps



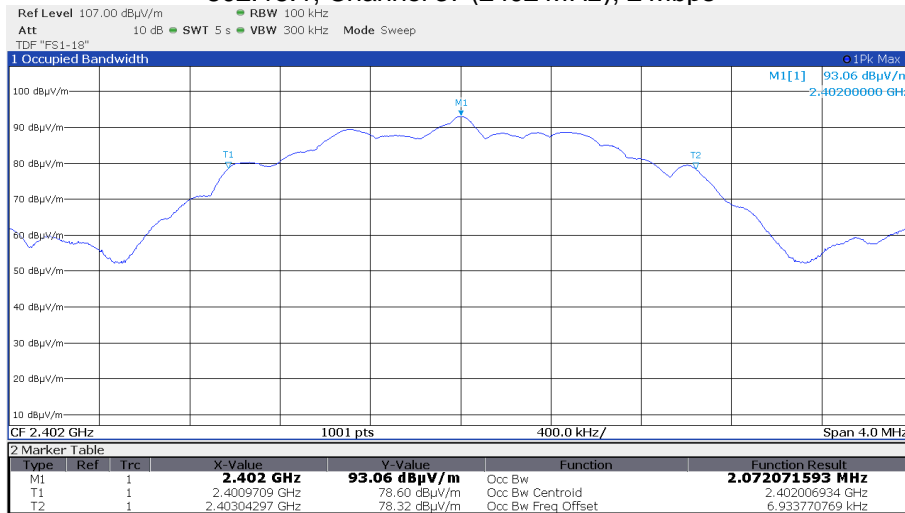
### 802.15.1, Channel 17 (2440 MHz), 1 Mbps



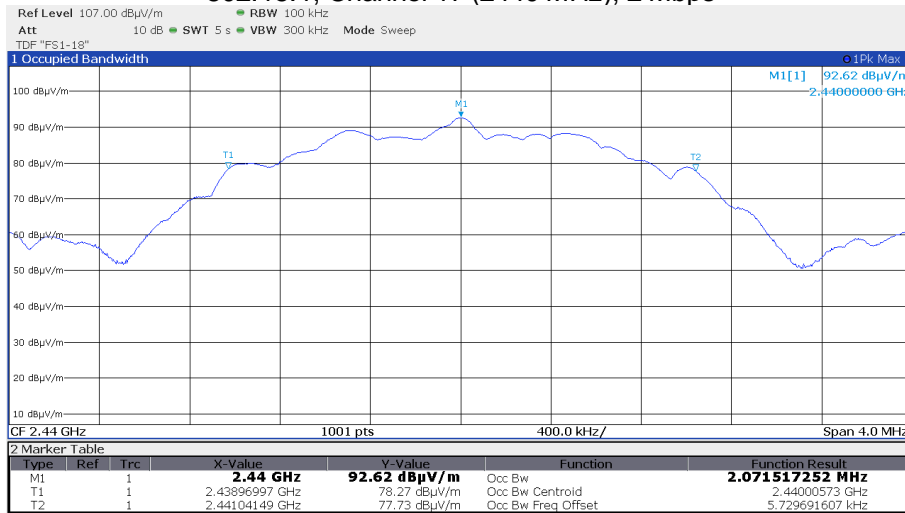
### 802.15.1, Channel 39 (2480 MHz), 1 Mbps



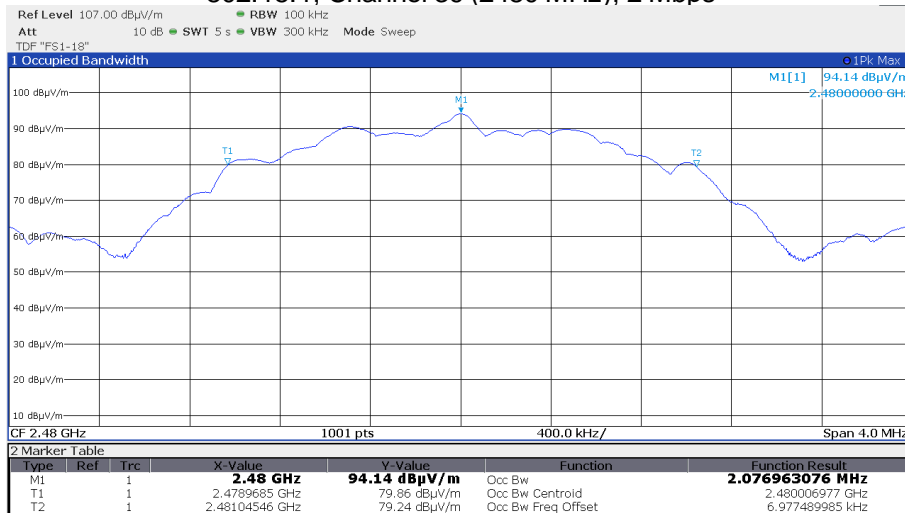
### 802.15.1, Channel 37 (2402 MHz), 2 Mbps



### 802.15.1, Channel 17 (2440 MHz), 2 Mbps



### 802.15.1, Channel 39 (2480 MHz), 2 Mbps



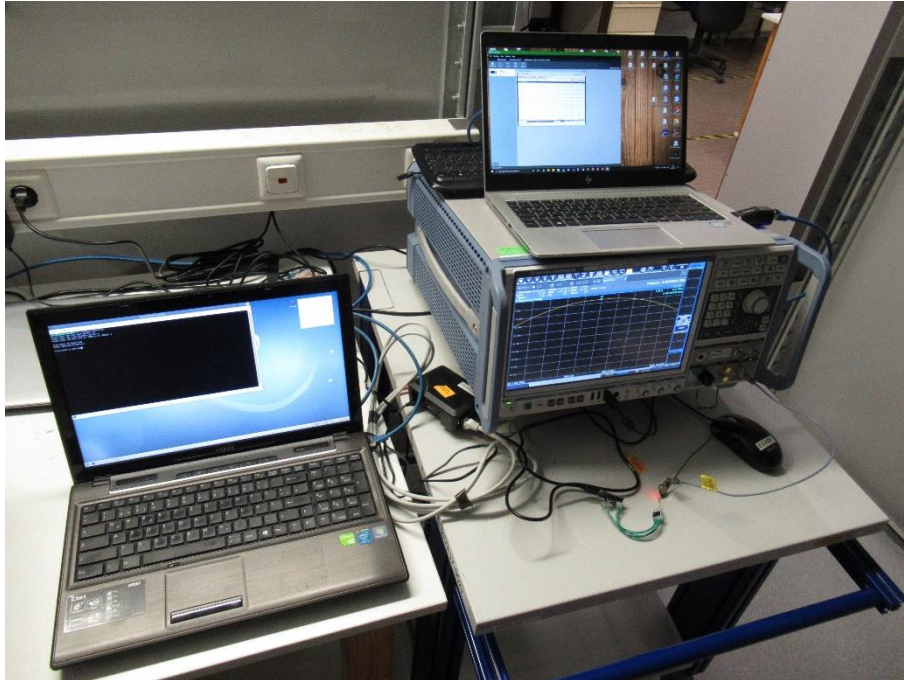
## 5.2 Maximum peak conducted output power

For test instruments and accessories used see section 6 Part **CPC 3**.

### 5.2.1 Description of the test location

Test location:                Shielded Room S4

### 5.2.2 Photo documentation of the test set-up



### 5.2.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):

For systems using digital modulation in the 2400-2483.5 MHz and 5725 – 5850 MHz bands, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

## 5.2.4 Description of Measurement

The maximum peak conducted output power is measured using a spectrum analyser following the procedure set out in ANSI C64.10, item 11.9.1.1. The EUT is set in TX continuous mode while measuring.

$$E = \text{EIRP} - (20 \cdot \log_{10} 3) + 104.8$$

## 5.2.5 Test result

| 802.15.1, 1 Mbps, TX              |                  | Test results conducted      |            |          |                |                |
|-----------------------------------|------------------|-----------------------------|------------|----------|----------------|----------------|
|                                   |                  | Fieldstrength<br>E (dBµV/m) | P<br>(dBm) | P<br>(W) | Limit<br>(dBm) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.5                        | 4.2        | 0.0026   | 30             | -25.8          |
| Middle frequency: CH17, 2440 MHz  |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.4                        | 4.2        | 0.0026   | 30             | -25.8          |
| Highest frequency: CH39, 2480 MHz |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.1                        | 3.9        | 0.0024   | 30             | -26.1          |

| 802.15.1, 2 Mbps, TX              |                  | Test results conducted      |            |          |                |                |
|-----------------------------------|------------------|-----------------------------|------------|----------|----------------|----------------|
|                                   |                  | Fieldstrength<br>E (dBµV/m) | P<br>(dBm) | P<br>(W) | Limit<br>(dBm) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.3                        | 4.1        | 0.0026   | 30             | -25.9          |
| Middle frequency: CH17, 2440 MHz  |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.4                        | 4.2        | 0.0026   | 30             | -25.8          |
| Highest frequency: CH39, 2480 MHz |                  |                             |            |          |                |                |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 99.1                        | 3.9        | 0.0024   | 30             | -26.1          |

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

| Frequency<br>(MHz) | Peak Power Limit |            |
|--------------------|------------------|------------|
|                    | (dBm)            | (Watt)     |
| 902-928            | 30               | 1.0        |
| <b>2400-2483.5</b> | <b>30</b>        | <b>1.0</b> |
| 5725-5850          | 30               | 1.0        |

| 802.15.1, 1 Mbps, TX              |           | Test results radiated       |               |          |                     |                |
|-----------------------------------|-----------|-----------------------------|---------------|----------|---------------------|----------------|
|                                   |           | Fieldstrength<br>E (dBμV/m) | EIRP<br>(dBm) | P<br>(W) | EIRP Limit<br>(dBm) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 93.1                        | -2.1          | 0.0006   | 36                  | -38.1          |
| Middle frequency: CH17, 2440 MHz  |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 95.8                        | 0.6           | 0.0011   | 36                  | -35.4          |
| Highest frequency: CH39, 2480 MHz |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 95.7                        | 0.4           | 0.0011   | 36                  | -35.6          |

| 802.15.1, 2 Mbps, TX              |           | Test results radiated       |               |          |                     |                |
|-----------------------------------|-----------|-----------------------------|---------------|----------|---------------------|----------------|
|                                   |           | Fieldstrength<br>E (dBμV/m) | EIRP<br>(dBm) | P<br>(W) | EIRP Limit<br>(dBm) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 95.7                        | 0.4           | 0.0011   | 36                  | -35.6          |
| Middle frequency: CH17, 2440 MHz  |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 95.9                        | 0.7           | 0.0012   | 36                  | -35.3          |
| Highest frequency: CH39, 2480 MHz |           |                             |               |          |                     |                |
| $T_{nom}$                         | $V_{nom}$ | 95.6                        | 0.3           | 0.0011   | 36                  | -35.7          |

Peak Power Limit according to FCC Part 15, Section 15.247(b)(4):

| Frequency<br>(MHz) | Peak Power Limit |            |
|--------------------|------------------|------------|
|                    | (dBm)            | (Watt)     |
| 902-928            | 36               | 4.0        |
| <b>2400-2483.5</b> | <b>36</b>        | <b>4.0</b> |
| 5725-5850          | 36               | 4.0        |

The requirements are **FULFILLED**.

Remarks: N/A

---

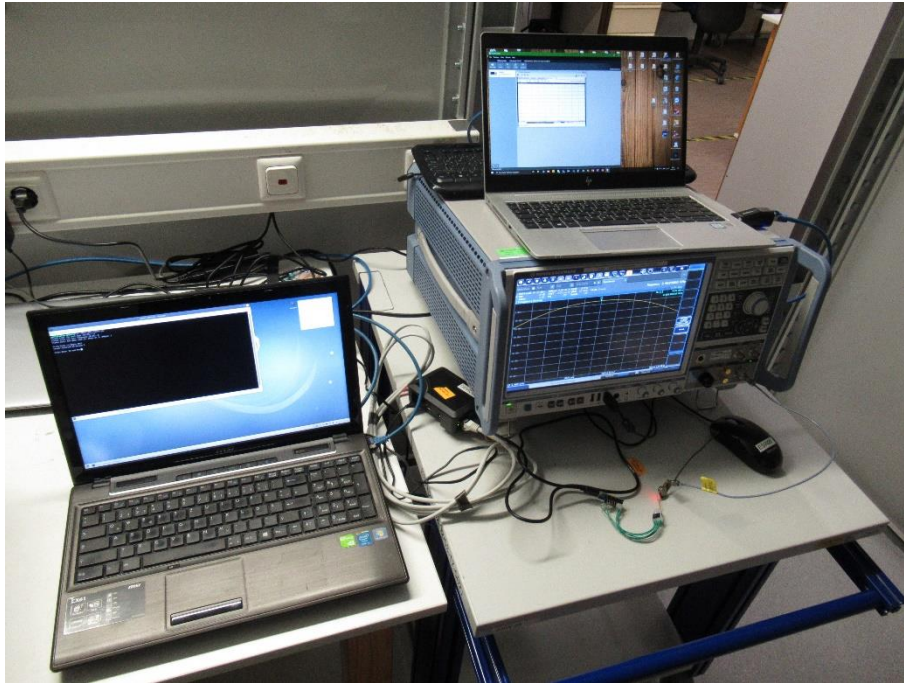
### 5.3 Power spectral density

For test instruments and accessories used see section 6 Part **CPC 3**.

#### 5.3.1 Description of the test location

Test location: Shielded Room S4

#### 5.3.2 Photo documentation of the test set-up



#### 5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(e):

For digitally modulated systems, the power spectral density radiated 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the radiated output power shall be used to determine the power spectral density.

#### 5.3.4 Description of Measurement

The measurement is performed using the procedure set out in ANSI C64.10, item 11.10.21. The power measurement was done as peak power measurement. Therefore, the PKPSD is measured. The max peak was located and with the spectrum analyser and a marker set to peak.  
Spectrum analyser settings:

RBW: 3 kHz, VBW: 10 kHz, Detector: Peak, Sweep time: Auto

### 5.3.5 Test result

| 802.15.1, 1 Mbps, TX              |           | Test results conducted  |                     |                |
|-----------------------------------|-----------|-------------------------|---------------------|----------------|
|                                   |           | PD [Pmax]<br>(dBm/3kHz) | Limit<br>(dBm/3kHz) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -39.9                   | 8.0                 | -47.9          |
| Middle frequency: CH17, 2440 MHz  |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -38.6                   | 8.0                 | -46.6          |
| Highest frequency: CH39, 2480 MHz |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -37.8                   | 8.0                 | -45.8          |

| 802.15.1, 2 Mbps, TX              |           | Test results conducted  |                     |                |
|-----------------------------------|-----------|-------------------------|---------------------|----------------|
|                                   |           | PD [Pmax]<br>(dBm/3kHz) | Limit<br>(dBm/3kHz) | Margin<br>(dB) |
| Lowest frequency: CH37, 2402 MHz  |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -41.6                   | 8.0                 | -49.6          |
| Middle frequency: CH17, 2440 MHz  |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -39.9                   | 8.0                 | -47.9          |
| Highest frequency: CH39, 2480 MHz |           |                         |                     |                |
| $T_{nom}$                         | $V_{nom}$ | -38.7                   | 8.0                 | -46.7          |

Power spectral density limit according to FCC Part 15, Section 15.247(e):

| Frequency<br>(MHz) | Power spectral density limit (EIRP) |
|--------------------|-------------------------------------|
|                    | (dBm/3 kHz)                         |
| 2400 - 2483.5      | 8                                   |

The requirements are **FULFILLED**.

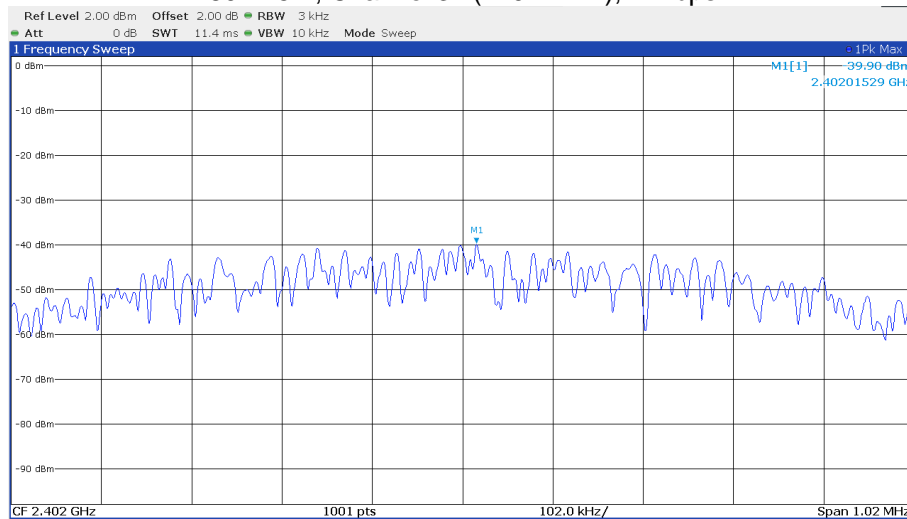
**Remarks:** For detailed test result please see the following test protocols

---

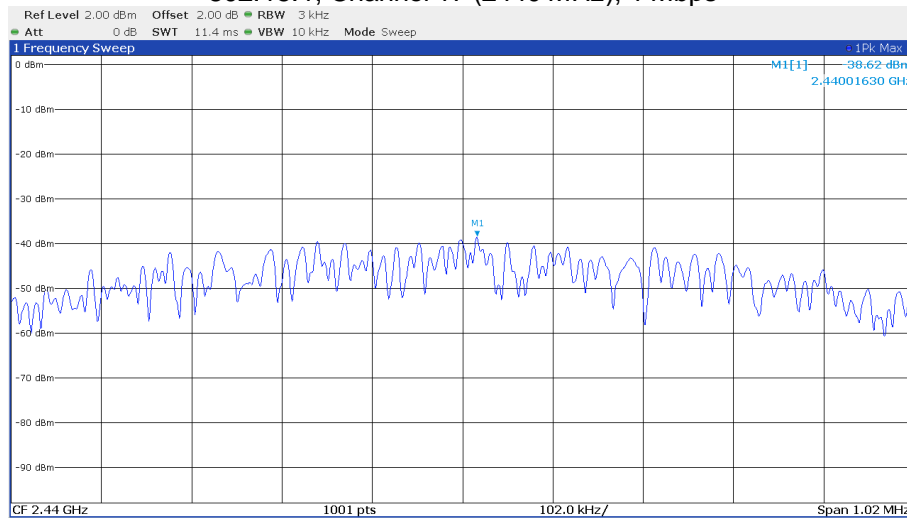


## 5.3.6 Test protocols

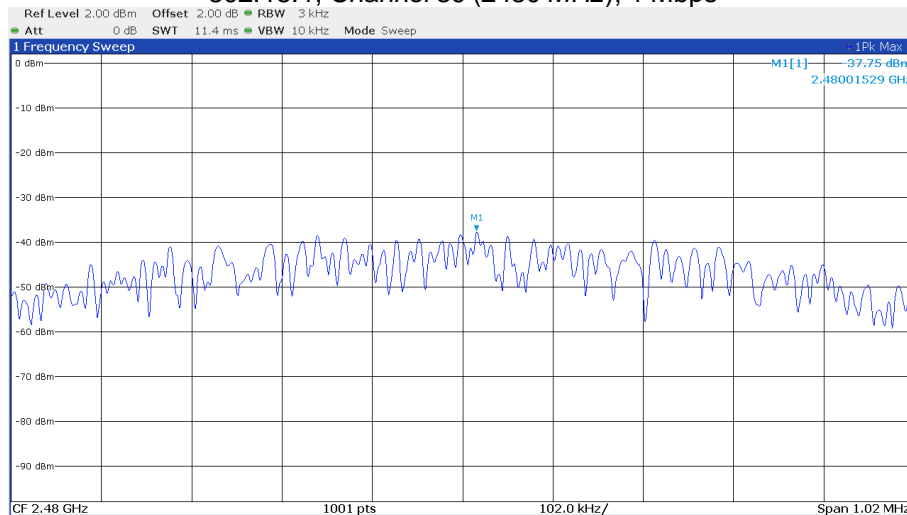
### 802.15.1, Channel 37 (2402 MHz), 1 Mbps



### 802.15.1, Channel 17 (2440 MHz), 1 Mbps

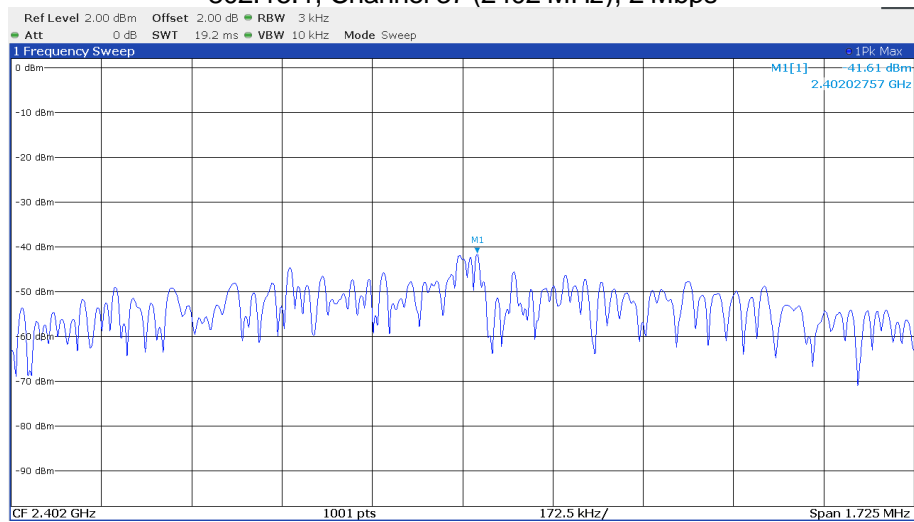


### 802.15.1, Channel 39 (2480 MHz), 1 Mbps

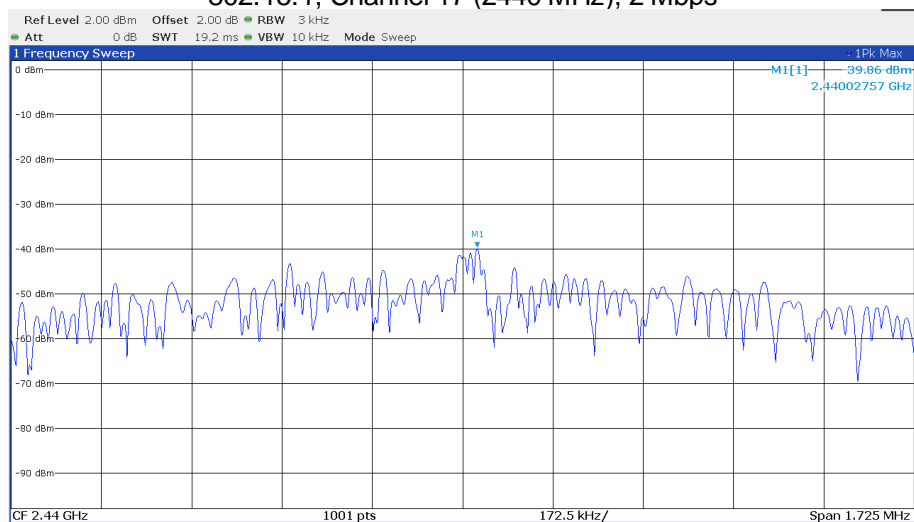




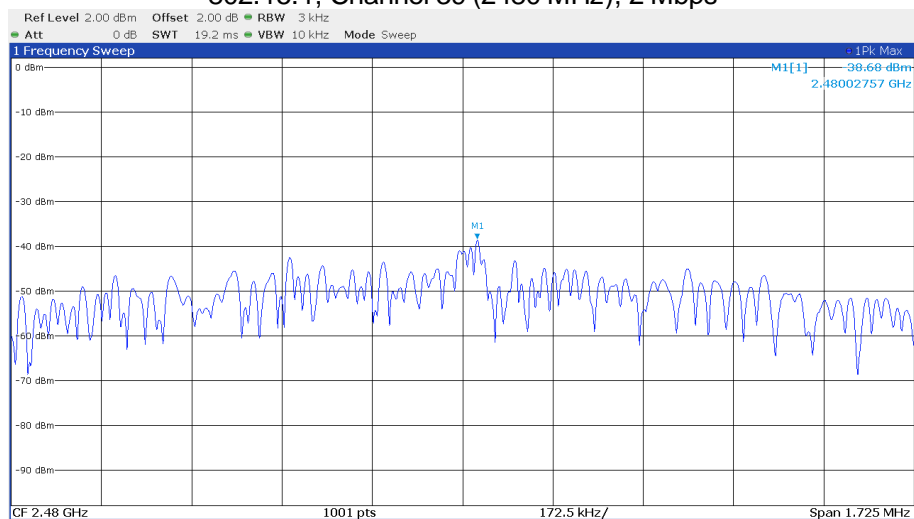
### 802.15.1, Channel 37 (2402 MHz), 2 Mbps



### 802.15.1, Channel 17 (2440 MHz), 2 Mbps



### 802.15.1, Channel 39 (2480 MHz), 2 Mbps



## 5.4 Radiated emissions in restricted bands

For test instruments and accessories used see section 6 Part **SER 2**, **SER 3**.

### 5.4.1 Description of the test location

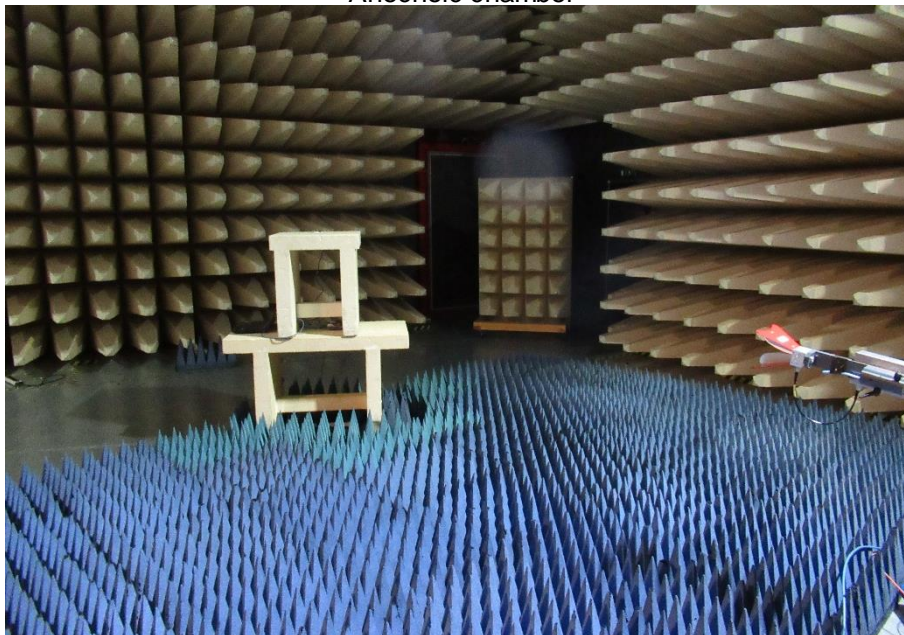
Test location: OATS 1  
Test location: Anechoic chamber 1  
Test distance: 3 m

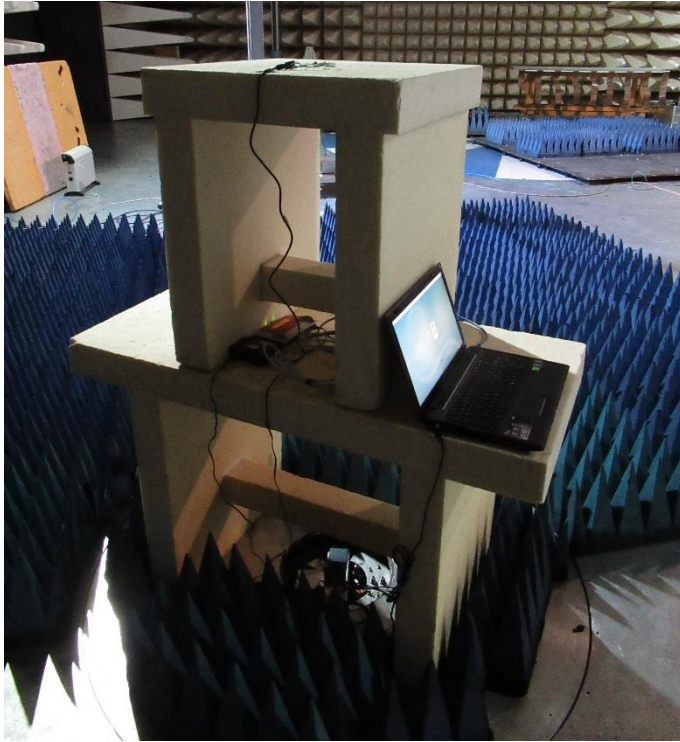
### 5.4.2 Photo documentation of the test set-up

Open area test site



Anechoic chamber





According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

#### 5.4.3 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Test receiver settings for SER2:

RBW: 120 MHz, Detector: Quasi peak, Mes. Time: 1 s,

Spectrum analyser settings for SER3:

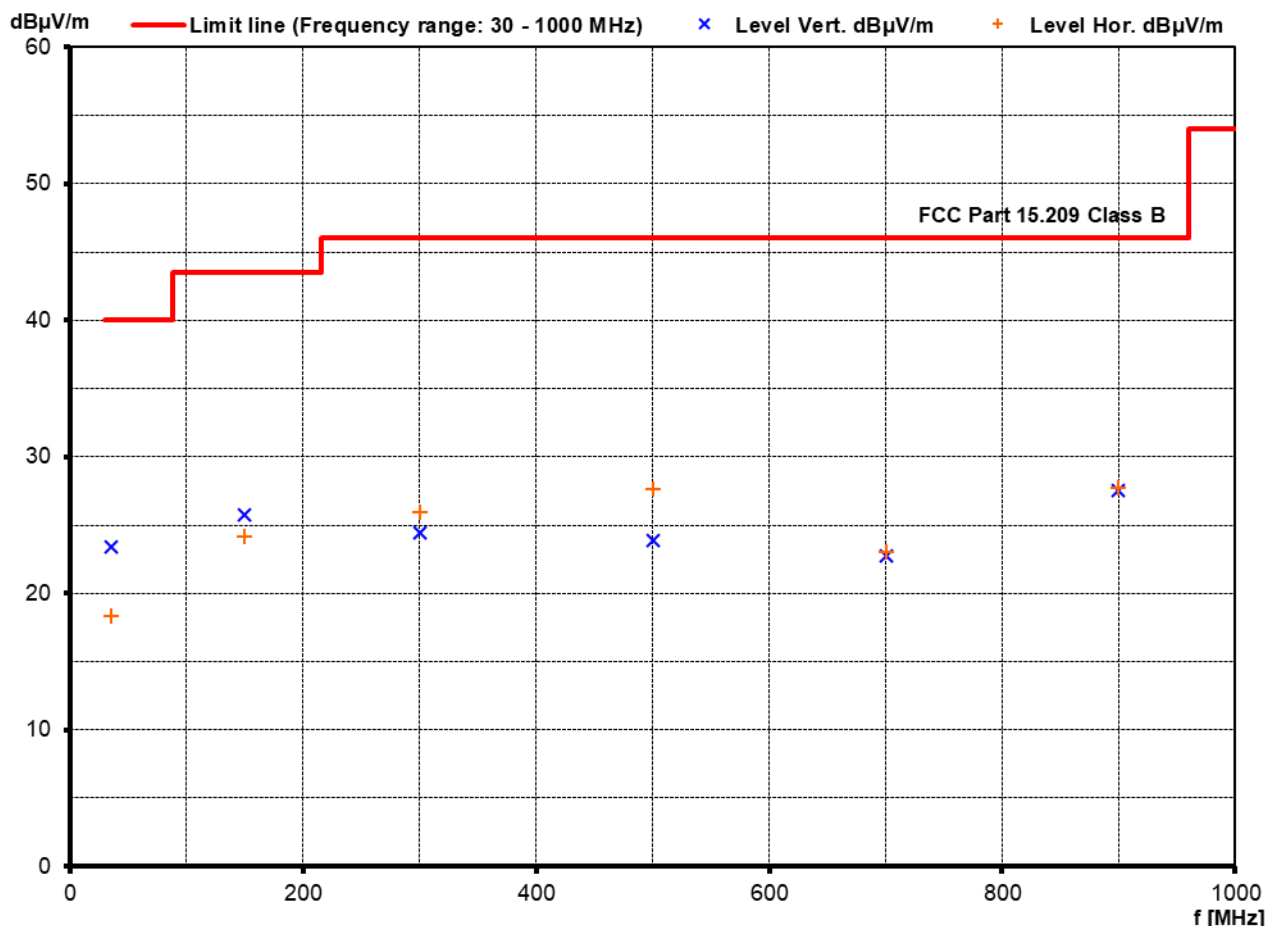
RBW: 1 MHz, VBW: 3 MHz, Detector: Max. peak (blue); RMS (black), Trace: Max. hold, Sweep: Auto

#### 5.4.4 Test result

##### Standard 802.15.1

##### Emissions 30 MHz – 1000 MHz, SER2:

| Frequency (MHz) | Reading Vert. (dBμV) | Reading Hor. (dBμV) | Correct. Vert. (dB) | Correct. Hor. (dB) | Level Vert. (dBμV/m) | Level Hor. (dBμV/m) | Limit (dBμV/m) | Dlimit (dB) |
|-----------------|----------------------|---------------------|---------------------|--------------------|----------------------|---------------------|----------------|-------------|
| 35.00           | 10.2                 | 4.2                 | 13.2                | 14.2               | 23.4                 | 18.4                | 40.0           | -16.6       |
| 150.00          | 9.3                  | 8.                  | 16.5                | 15.7               | 25.8                 | 24.1                | 43.5           | -17.7       |
| 300.00          | 7.2                  | 8.2                 | 17.2                | 17.7               | 24.4                 | 25.9                | 46.0           | -20.1       |
| 500.00          | 1.1                  | 4.6                 | 22.7                | 23.1               | 23.8                 | 27.7                | 46.0           | -18.3       |
| 700.00          | -3.9                 | -4.3                | 26.7                | 27.3               | 22.8                 | 23.0                | 46.0           | -23.0       |
| 900.00          | -2.3                 | -2.5                | 29.8                | 30.2               | 27.5                 | 27.7                | 46.0           | -18.3       |



Note: No emissions below 1 GHz were detected. Results above show noise values of the OATS.

##### Emissions 1 GHz – 26 GHz, SER3:

See test protocols below.



Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

| Frequency<br>(MHz) | Field strength of spurious emissions |                            | Measurement distance<br>(metres) |
|--------------------|--------------------------------------|----------------------------|----------------------------------|
|                    | ( $\mu\text{V/m}$ )                  | $\text{dB}(\mu\text{V/m})$ |                                  |
| 0.009-0.490        | 2400/F (kHz)                         |                            | 300                              |
| 0.490-1.705        | 24000/F (kHz)                        |                            | 30                               |
| 1.705-30           | 30                                   | 29.5                       | 30                               |
| 30-88              | 100                                  | 40                         | 3                                |
| 88-216             | 150                                  | 43.5                       | 3                                |
| 216-960            | 200                                  | 46                         | 3                                |
| Above 960          | 500                                  | 54                         | 3                                |

#### Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

| MHz                 | MHz                   | MHz             | GHz           |
|---------------------|-----------------------|-----------------|---------------|
| 0.090 – 0.110       | 16.42 – 16.423        | 399.9 – 410     | 4.5 – 5.15    |
| 0.495 – 0.505       | 16.69475 – 16.69525   | 608 – 614       | 5.35 – 5.46   |
| 2.1735 – 2.1905     | 16.80425 – 16.80475   | 960 – 1240      | 7.25 – 7.75   |
| 4.125 – 4.128       | 25.5 – 25.67          | 1300 – 1427     | 8.025 – 8.5   |
| 4.17725 – 4.17775   | 37.5 – 38.25          | 1435 – 1626.5   | 9.0 – 9.2     |
| 4.20725 – 4.20775   | 73 – 74.6             | 1645.5 – 1646.5 | 9.3 – 9.5     |
| 6.215 – 6.218       | 74.8 – 75.2           | 1660 – 1710     | 10.6 – 12.7   |
| 6.26775 – 6.26825   | 108 – 121.94          | 1718.8 – 1722.2 | 13.25 – 13.4  |
| 6.31175 – 6.31225   | 123 – 138             | 2200 – 2300     | 14.47 – 14.5  |
| 8.291 – 8.294       | 149.9 – 150.05        | 2310 – 2390     | 15.35 – 16.2  |
| 8.362 – 8.366       | 156.52475 – 156.52525 | 2483.5 – 2500   | 17.7 – 21.4   |
| 8.37625 – 8.38675   | 156.7 – 156.9         | 2690 – 2900     | 22.01 – 23.12 |
| 8.41425 – 8.41475   | 162.0125 – 167.17     | 3260 – 3267     | 23.6 – 24.0   |
| 12.29 – 12.293      | 167.72 – 173.2        | 3332 – 3339     | 31.2 – 31.8   |
| 12.51975 – 12.52025 | 240 – 285             | 3345.8 – 3358   | 36.43 – 36.5  |
| 12.57675 – 12.57725 | 322 – 335.4           | 3600 – 4400     | Above 38.6    |

#### RSS-Gen, Table 6 – Restricted Frequency Bands

| MHz                 | MHz                   | MHz             | GHz           |
|---------------------|-----------------------|-----------------|---------------|
| 0.090 - 0.110       | 12.57675 - 12.57725   | 399.9 - 410     | 7.250 - 7.750 |
| 0.495 - 0.505       | 13.36 - 13.41         | 608 - 614       | 8.025 - 8.500 |
| 2.1735 - 2.1905     | 16.42 - 16.423        | 960 - 1427      | 9.0 - 9.2     |
| 3.020 - 3.026       | 16.69475 - 16.69525   | 1435 - 1626.5   | 9.3 - 9.5     |
| 4.125 - 4.128       | 16.80425 - 16.80475   | 1645.5 - 1646.5 | 10.6 - 12.7   |
| 4.17725 - 4.17775   | 25.5 - 25.67          | 1660 - 1710     | 13.25 - 13.4  |
| 4.20725 - 4.20775   | 37.5 - 38.25          | 1718.8 - 1722.2 | 14.47 - 14.5  |
| 5.677 - 5.683       | 73 - 74.6             | 2200 - 2300     | 15.35 - 16.2  |
| 6.215 - 6.218       | 74.8 - 75.2           | 2310 - 2390     | 17.7 - 21.4   |
| 6.26775 - 6.26825   | 108 - 138             | 2483.5 - 2500   | 22.01 - 23.12 |
| 6.31175 - 6.31225   | 149.9 - 150.05        | 2655 - 2900     | 23.6 - 24.0   |
| 8.291 - 8.294       | 156.52475 - 156.52525 | 3260 - 3267     | 31.2 - 31.8   |
| 8.362 - 8.366       | 156.7 - 156.9         | 3332 - 3339     | 36.43 - 36.5  |
| 8.37625 - 8.38675   | 162.0125 - 167.17     | 3345.8 - 3358   | Above 38.6    |
| 8.41425 - 8.41475   | 167.72 - 173.2        | 3500 - 4400     |               |
| 12.29 - 12.293      | 240 - 285             | 4500 - 5150     |               |
| 12.51975 - 12.52025 | 322 - 335.4           | 5350 - 5460     |               |

The requirements are **FULFILLED**.

**Remarks:** The measurement was performed up to the 10<sup>th</sup> harmonic. For detailed test results please see the following test protocols.

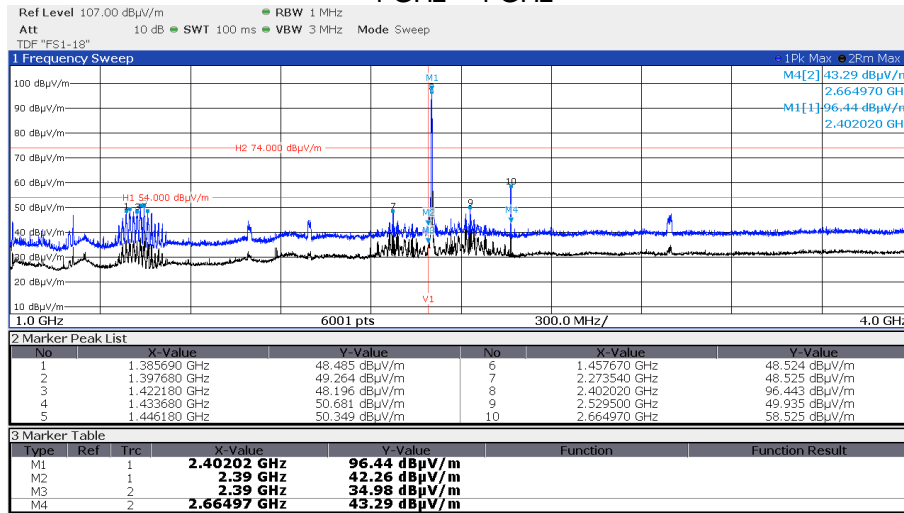
## 5.4.5 Test protocols radiated emissions SER3

Note: *Marker Peak List* shows measured peak values.  
 Marker data in top right corner *MX[1]* shows peak value, *MX[2]* shows RMS value.  
*Marker Table* column Trc: 1 shows peak marker; 2 shows RMS marker.

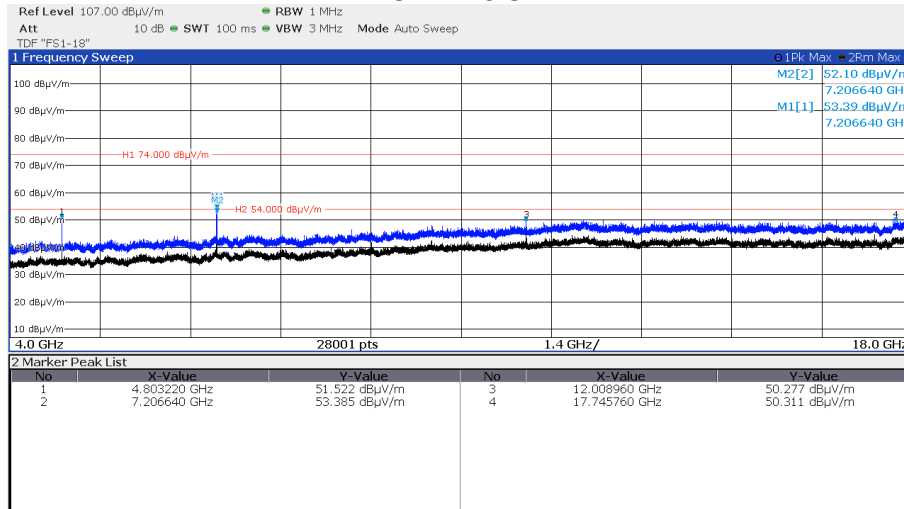
All measured emissions comply with the general limits 74 dB(μV/m) Peak and 54 dB(μV/m) RMS.

### 802.15.1, Channel 37, 1 Mbps

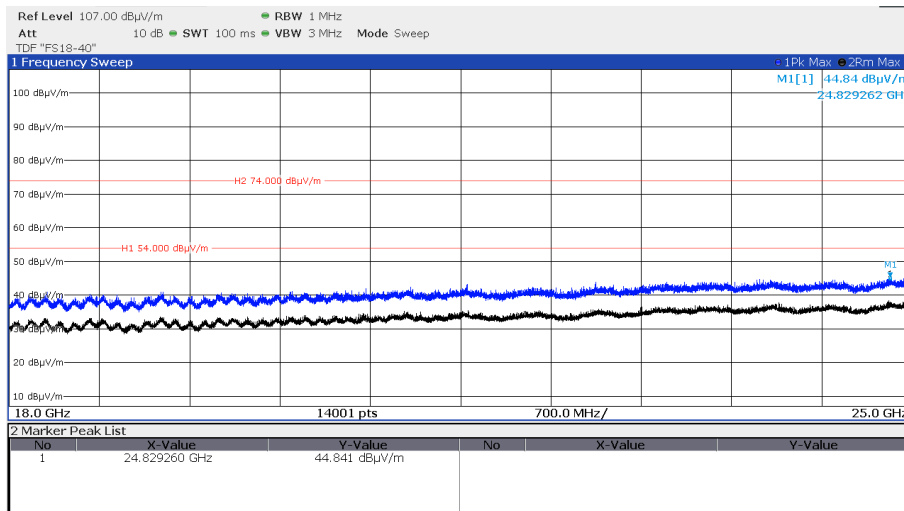
#### 1 GHz – 4 GHz



#### 4 GHz - 18 GHz

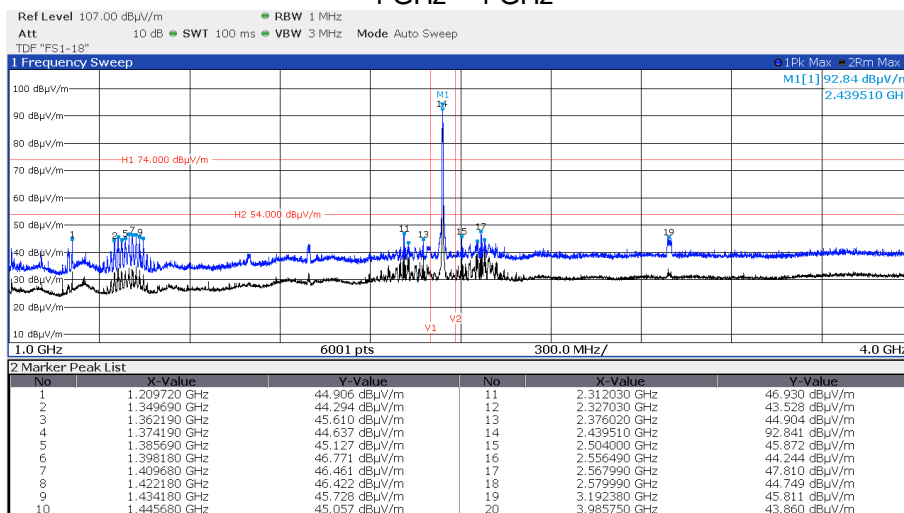


#### 18 GHz – 26 GHz

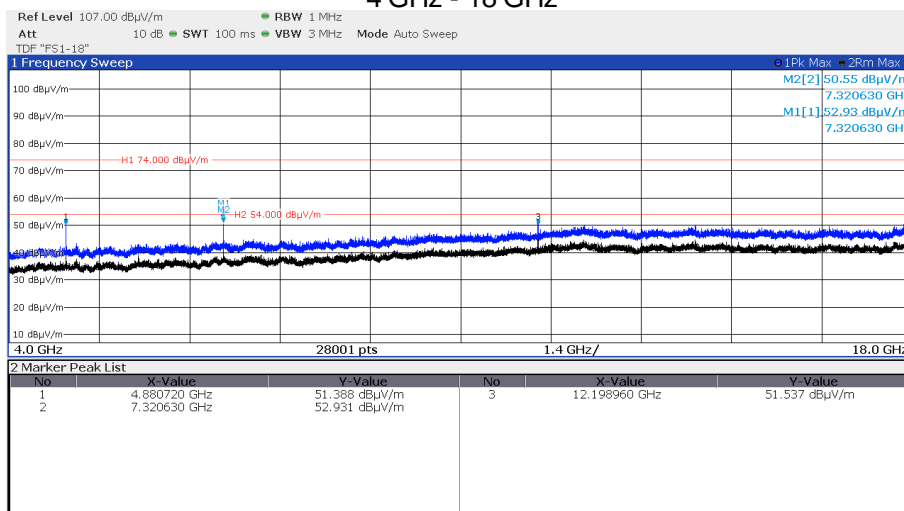


## 802.15.1, Channel 17, 1 Mbps

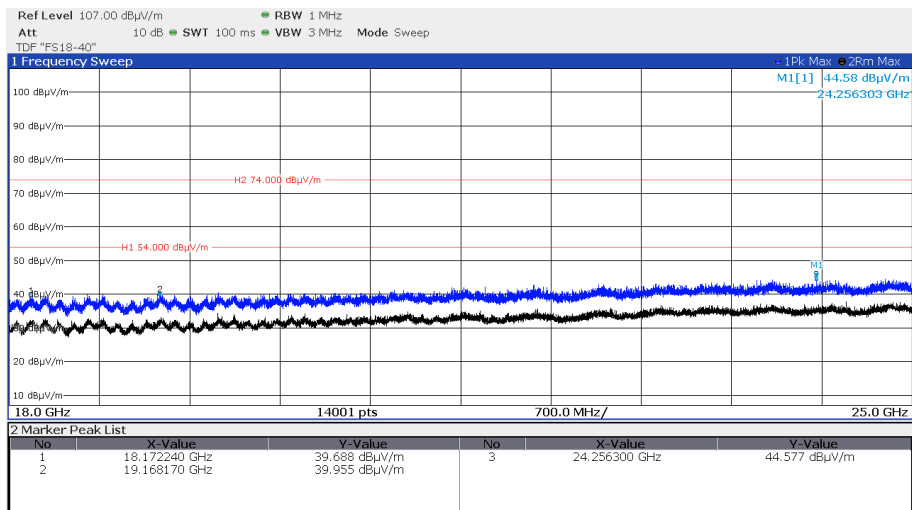
### 1 GHz – 4 GHz



### 4 GHz - 18 GHz



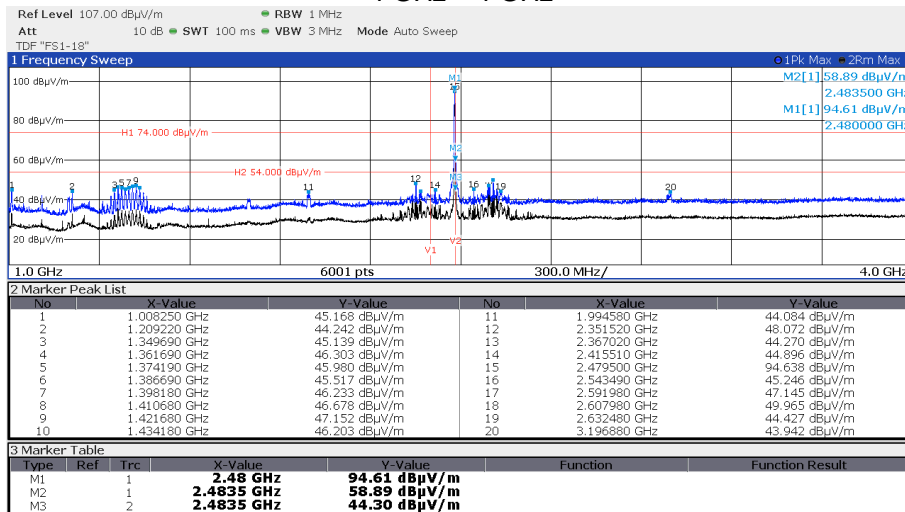
### 18 GHz – 26 GHz



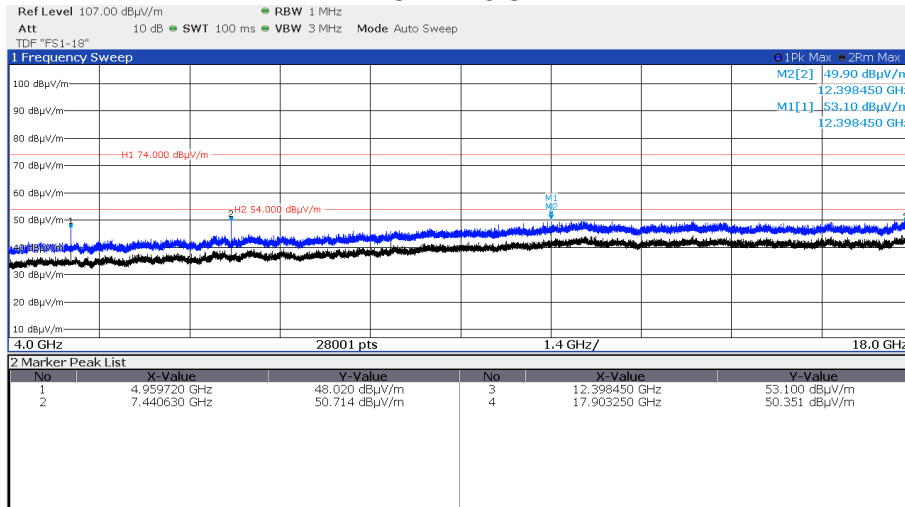


## 802.15.1, Channel 39, 1 Mbps

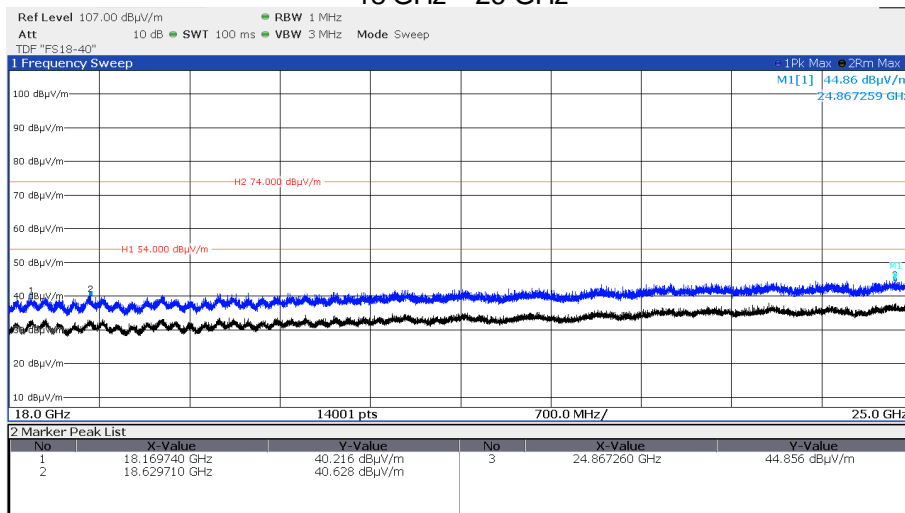
### 1 GHz – 4 GHz



### 4 GHz - 18 GHz

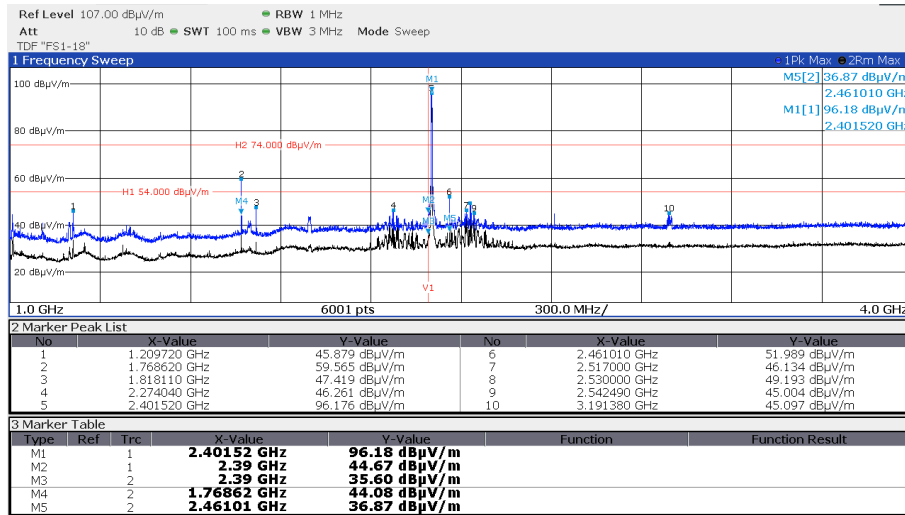


### 18 GHz – 26 GHz

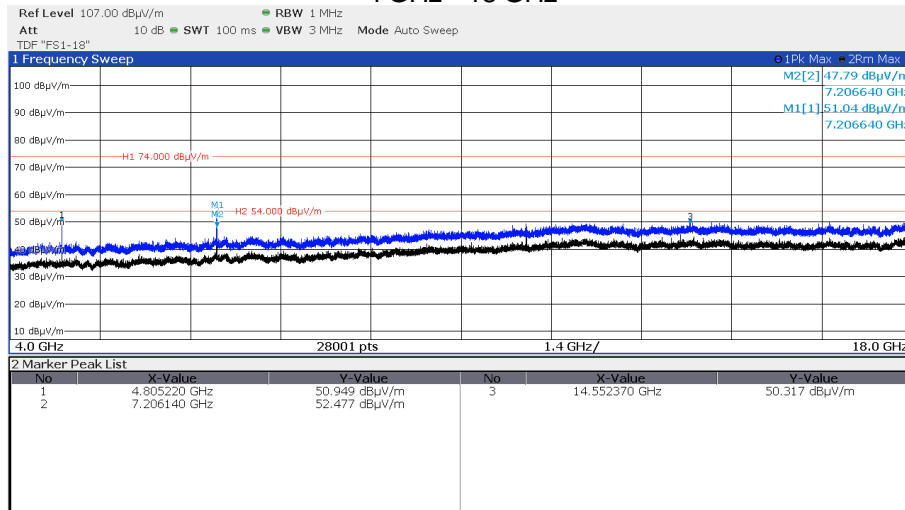


## 802.15.1, Channel 37, 2 Mbps

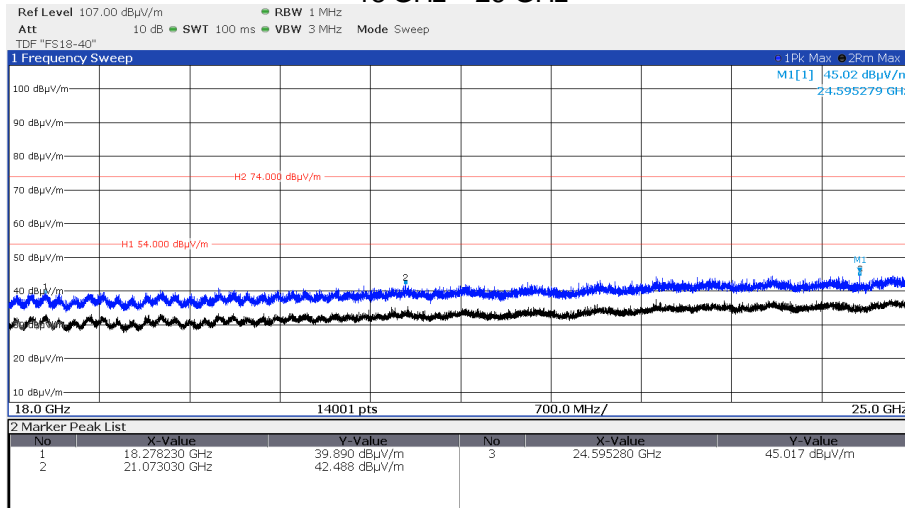
### 1 GHz – 4 GHz



### 4 GHz - 18 GHz

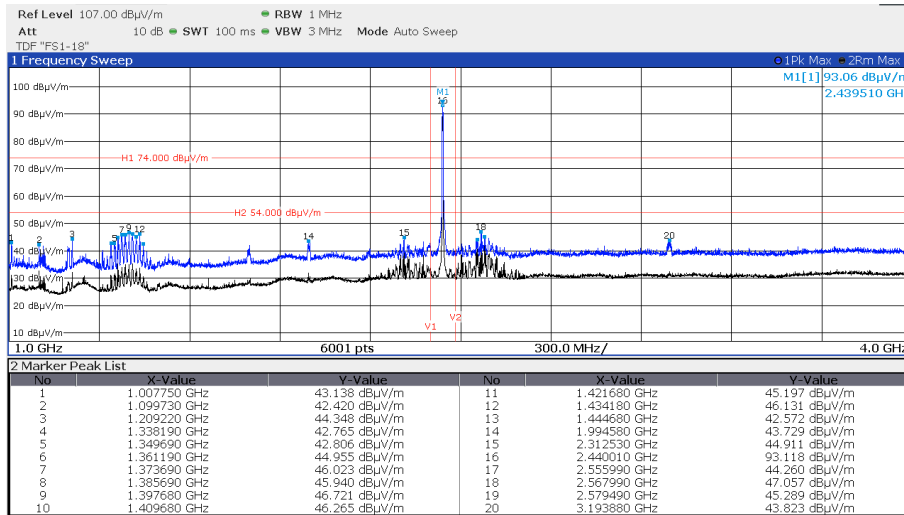


### 18 GHz – 26 GHz

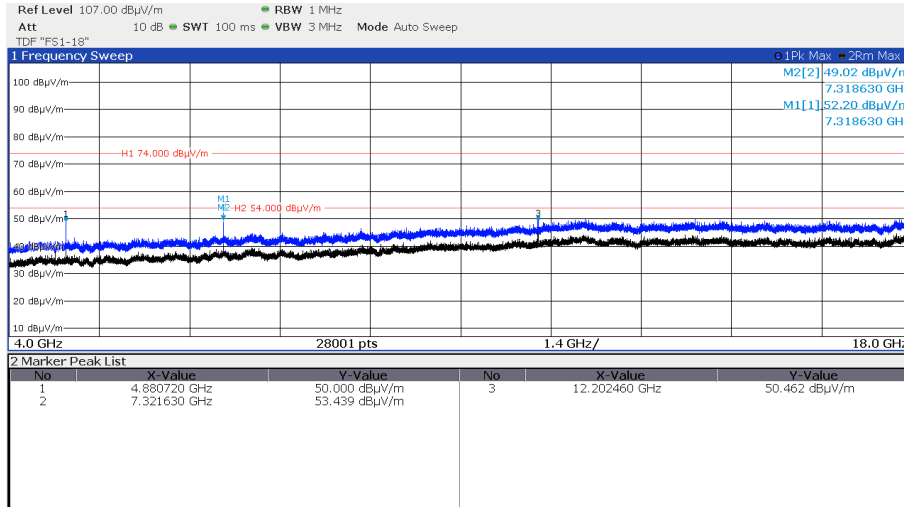


## 802.15.1, Channel 17, 2 Mbps

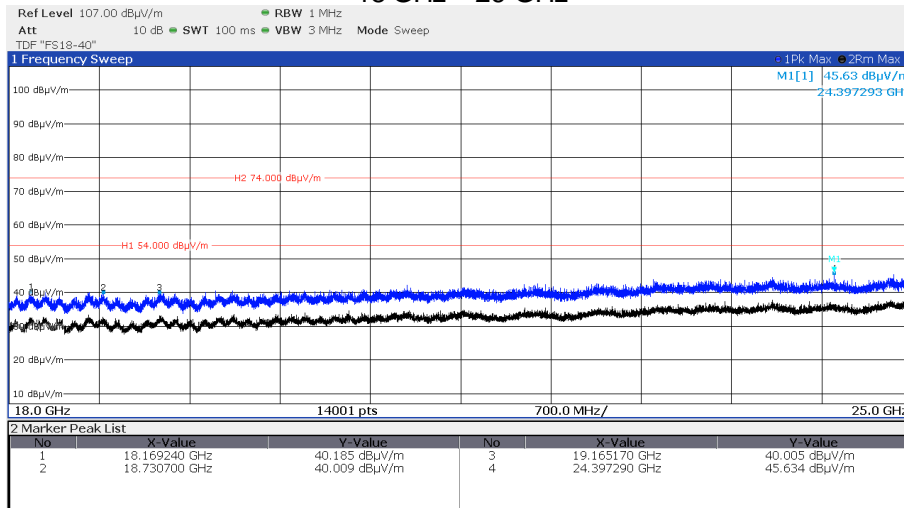
### 1 GHz – 4 GHz



### 4 GHz - 18 GHz

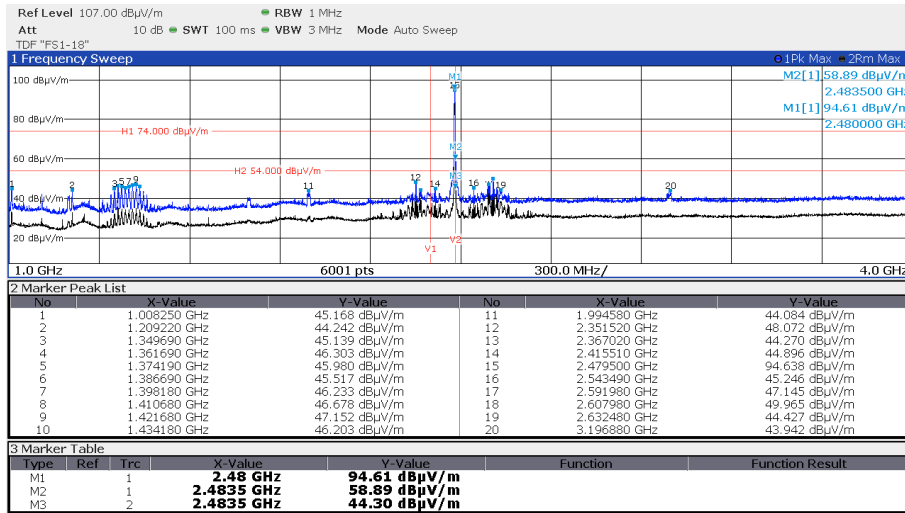


### 18 GHz – 26 GHz

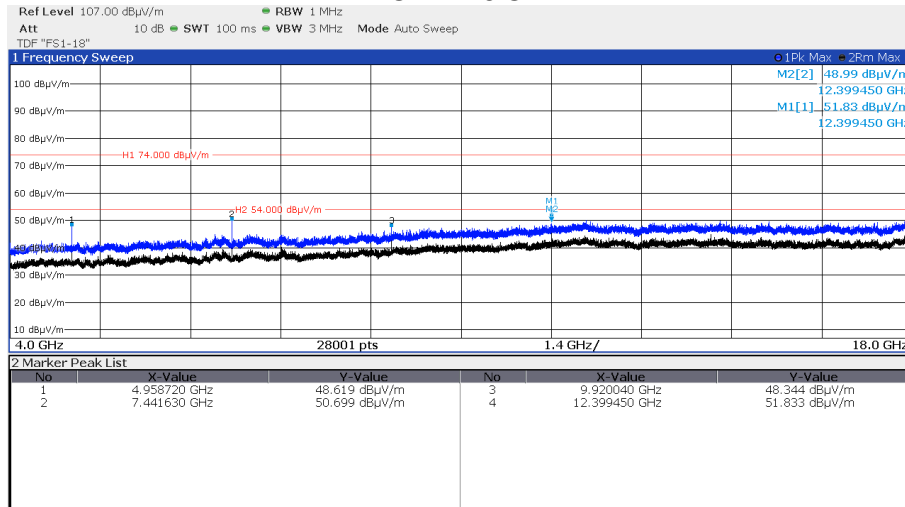


## 802.15.1, Channel 39, 2 Mbps

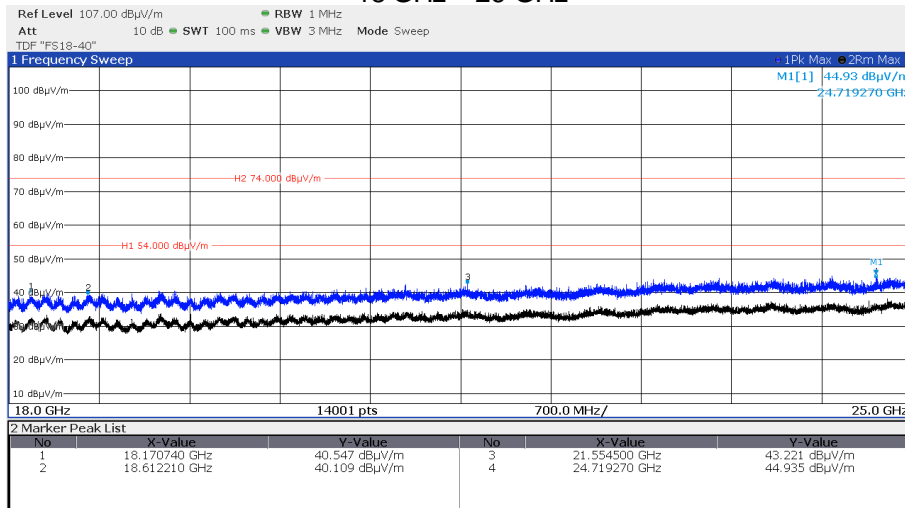
### 1 GHz – 4 GHz



### 4 GHz - 18 GHz



### 18 GHz – 26 GHz



## 5.5 Spurious emissions radiated

For test instruments and accessories used see section 6 Part **SER 2**, **SER 3**.

### 5.5.1 Description of the test location

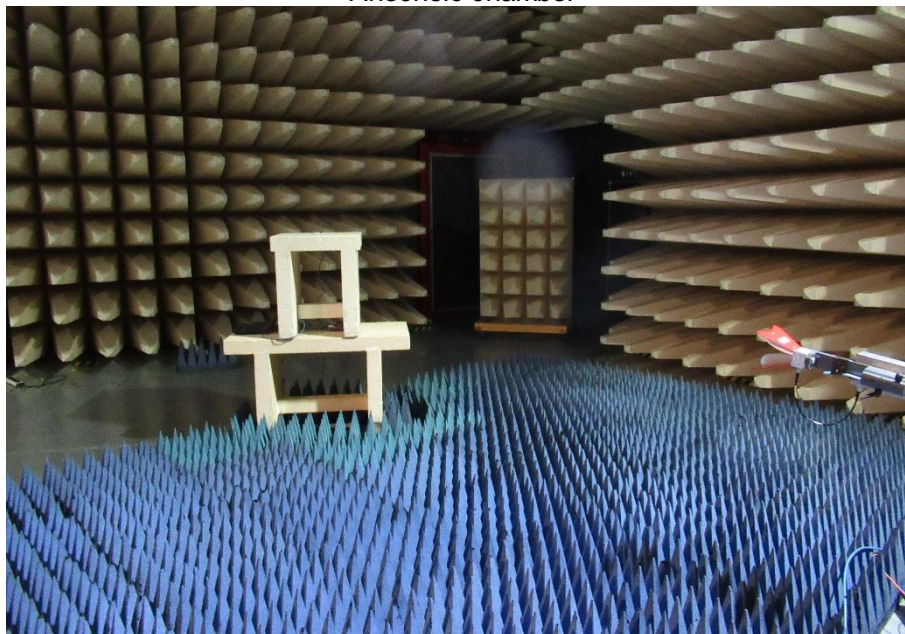
Test location: OATS 1  
Test distance: 3 m

### 5.5.2 Photo documentation of the test set-up

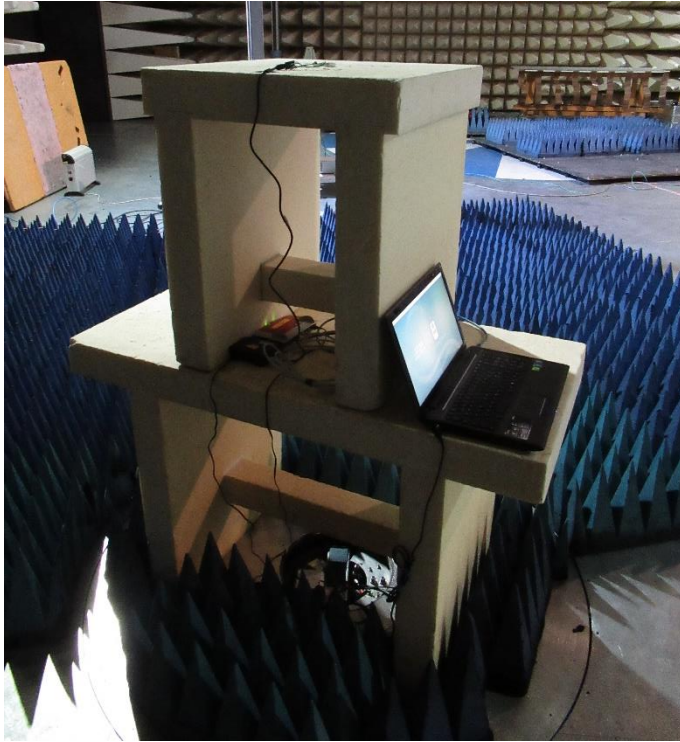
Open area test site



Anechoic chamber







### 5.5.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. 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 limit specified in Section 15.209(a) (see Section 15.205(c)).

### 5.5.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.10. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

Test receiver settings for SER2:

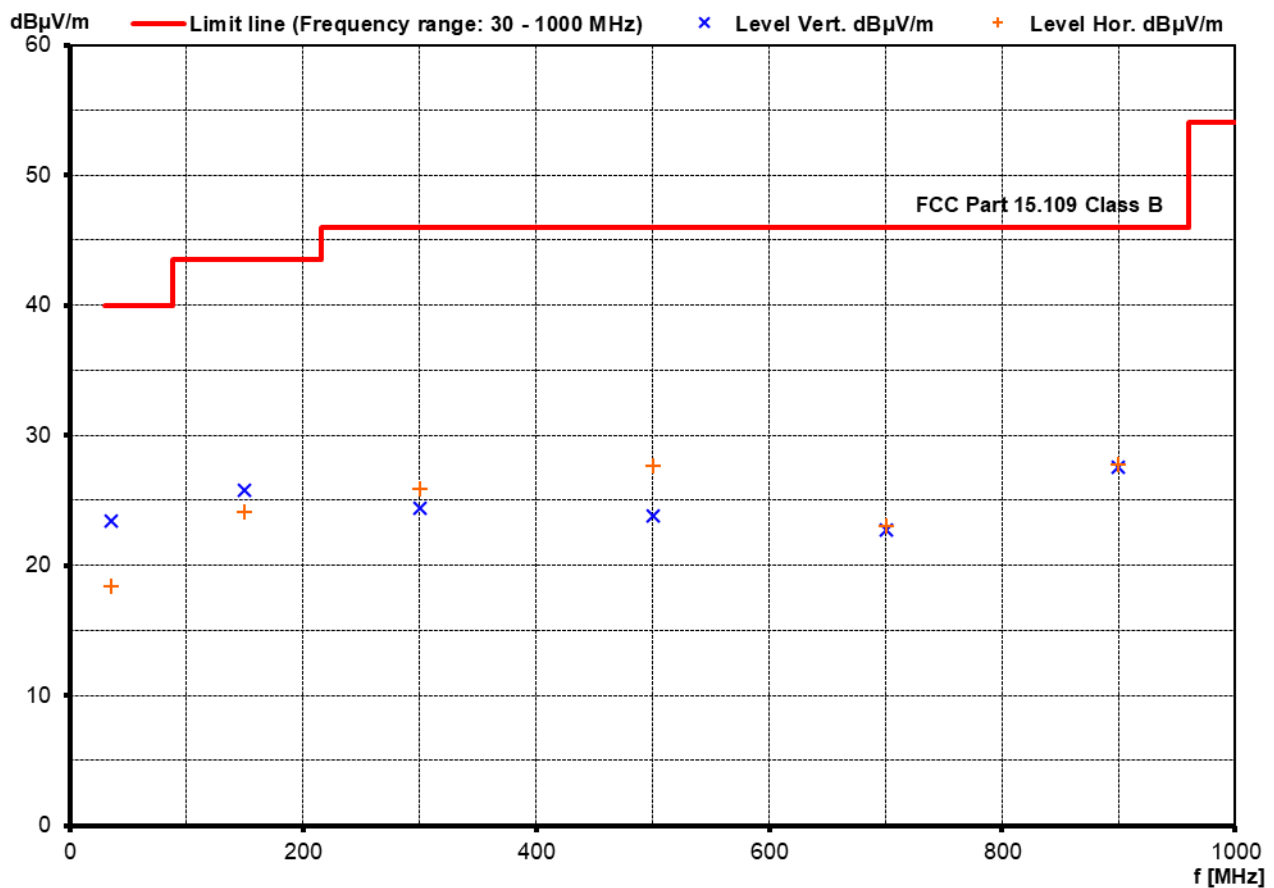
RBW: 120 MHz, Detector: Quasi peak, Mes. Time: 1 s,

Spectrum analyser settings for SER3:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max. peak (blue); RMS (black), Trace: Max. hold, Sweep: Auto

## 5.5.5 Test result

| Frequency (MHz) | Reading Vert. (dBμV) | Reading Hor. (dBμV) | Correct. Vert. (dB) | Correct. Hor. (dB) | Level Vert. (dBμV/m) | Level Hor. (dBμV/m) | Limit (dBμV/m) | Dlimit (dB) |
|-----------------|----------------------|---------------------|---------------------|--------------------|----------------------|---------------------|----------------|-------------|
| 35.00           | 10.2                 | 4.2                 | 13.2                | 14.2               | 23.4                 | 18.4                | 40.0           | -16.6       |
| 150.00          | 9.3                  | 8.4                 | 16.5                | 15.7               | 25.8                 | 24.1                | 43.5           | -17.7       |
| 300.00          | 7.2                  | 8.2                 | 17.2                | 17.7               | 24.4                 | 25.9                | 46.0           | -20.1       |
| 500.00          | 1.1                  | 4.6                 | 22.7                | 23.1               | 23.8                 | 27.7                | 46.0           | -18.3       |
| 700.00          | -3.9                 | -4.3                | 26.7                | 27.3               | 22.8                 | 23.0                | 46.0           | -23.0       |
| 900.00          | -2.3                 | -2.5                | 29.8                | 30.2               | 27.5                 | 27.7                | 46.0           | -18.3       |



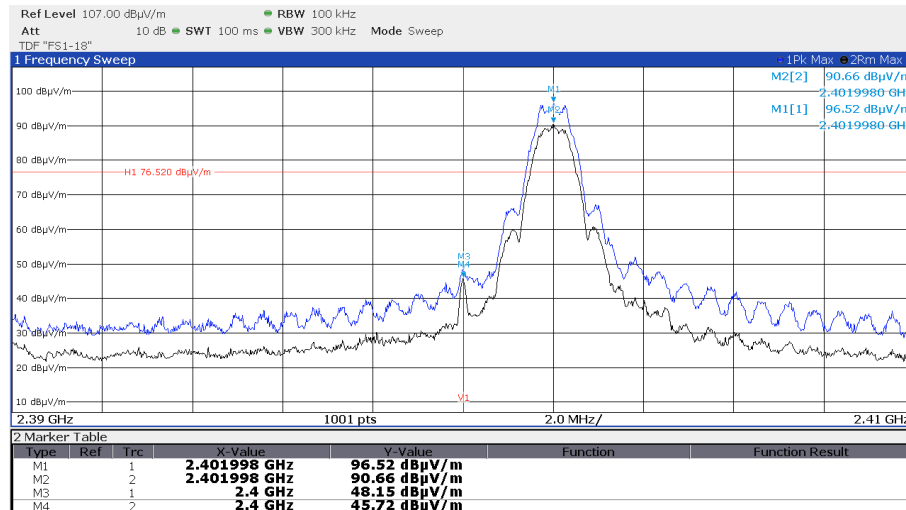
Note: No emissions below 1 GHz were detected. Results above show noise values of the OATS.

### 5.5.5.1 Test Results > 1 GHz

As results of 5.4.5 show compliance of spurious emissions  $\leq 2.39$  GHz and  $\geq 2.4835$  GHz with the stricter general limits, following data shows compliance at the lower band edge at 2.39 GHz to 2.4 GHz to the spurious emission limit.

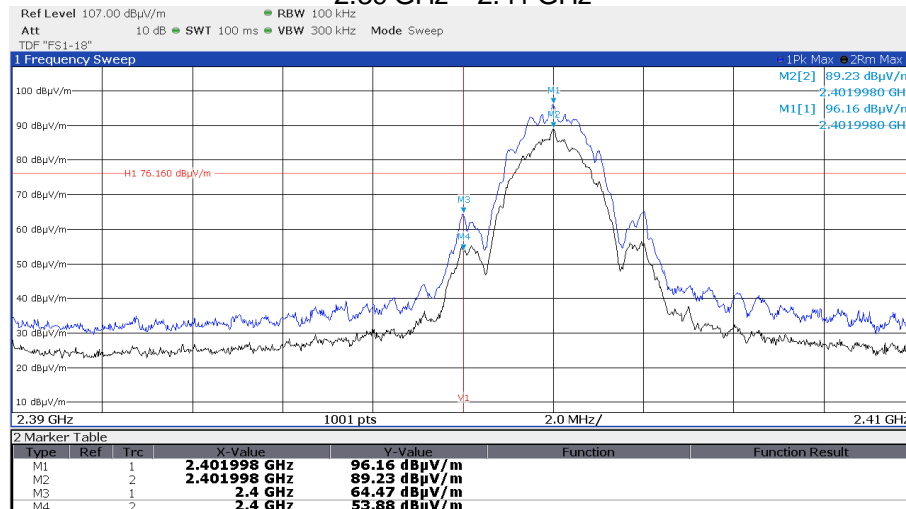
#### 802.15.1, Channel 37, 1 Mbps

2.39 GHz – 2.41 GHz



#### 802.15.1, Channel 37, 2 Mbps

2.39 GHz – 2.41 GHz



#### Note:

Measurements were performed in the frequency range from 1 GHz up to 26 GHz with the analyser settings for restricted band measurements to show compliance for emissions falling into restricted bands, else the band edge compliance is fulfilled. In the frequency ranges from 9 kHz up to 30 MHz and from 18 GHz up to 25 GHz no emission can be detected.

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).



**Limit according to FCC Part 15, Section 15.247(d) for emissions falling not in restricted bands:**

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated 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 an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

| Frequency<br>(MHz) | Spurious emission limit                            |
|--------------------|----------------------------------------------------|
| Below 1000         | 20 dB below the highest level of the desired power |
| Above 1000         | 20 dB below the highest level of the desired power |

The requirements are **FULFILLED**.

**Remarks:**

---



---

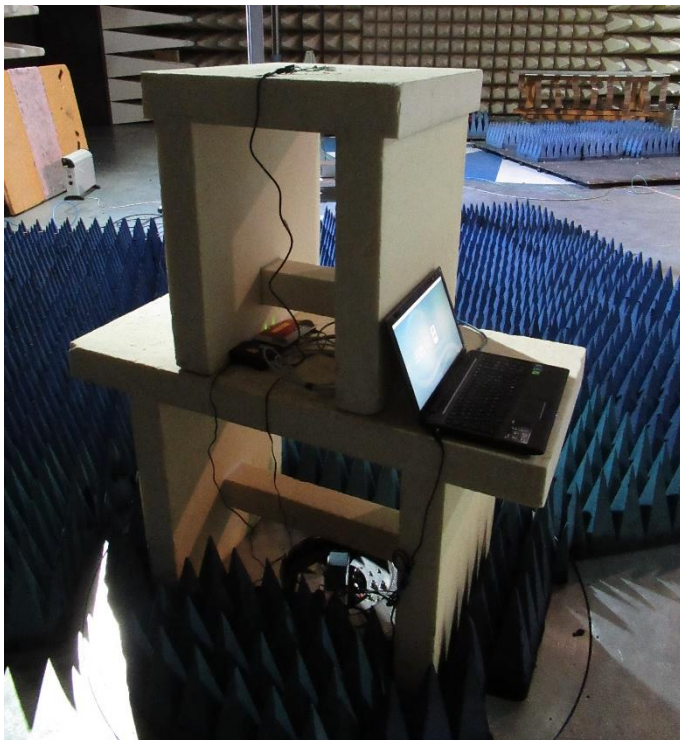
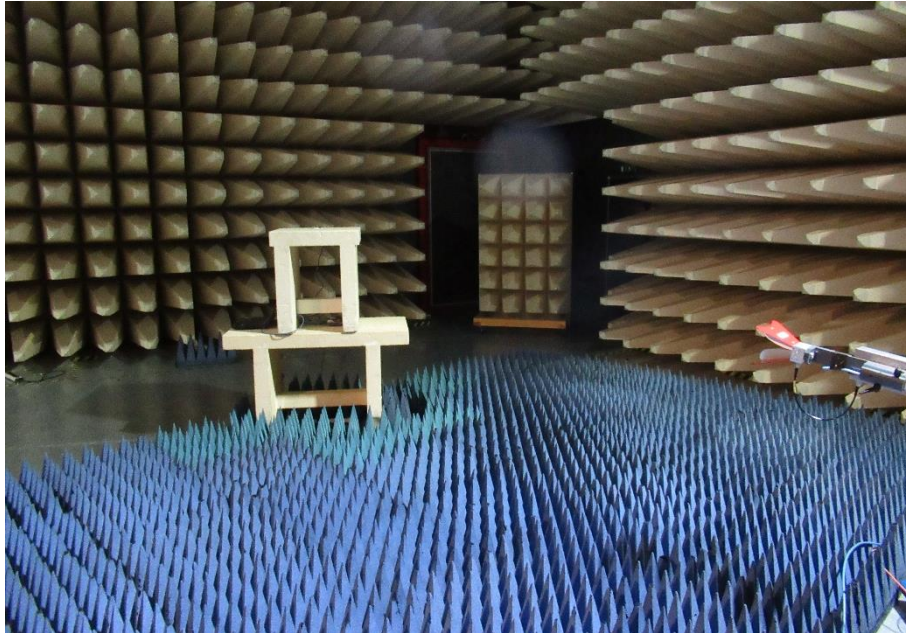
## 5.6 Antenna application

For test instruments and accessories used see section 6 Part **CPR3**.

### 5.6.1 Description of the test location

Test location: Anechoic chamber 1

### 5.6.2 Photo documentation of the test set-up



## Applicable standard

According to FCC Part 15C, Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated antenna. No other antenna can be used with the device. Additional to that a conducted output power measurement was performed. According to the following formula the maximum gain of the antenna was calculated.

$$\text{EIRP} = P + G$$

Where:

EIRP = Equivalent isotropic radiated power

P = Conducted output power

G = Calculated gain of the antenna

## Result:

| 802.15.1, 1 Mbps, TX              |                  | measured<br>conducted<br>Power (dBm) | measured<br>EIRP (dBm) | calculated<br>Antenna<br>Gain (dBi) |
|-----------------------------------|------------------|--------------------------------------|------------------------|-------------------------------------|
| Lowest frequency: CH37, 2402 MHz  |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 4.2                                  | -2.1                   | -6.3                                |
| Middle frequency: CH17, 2440 MHz  |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 4.2                                  | 0.6                    | -3.6                                |
| Highest frequency: CH39, 2480 MHz |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 3.9                                  | 0.4                    | -3.4                                |

| 802.15.1, 2 Mbps, TX              |                  | measured<br>conducted<br>Power (dBm) | measured<br>EIRP (dBm) | calculated<br>Antenna<br>Gain (dBi) |
|-----------------------------------|------------------|--------------------------------------|------------------------|-------------------------------------|
| Lowest frequency: CH37, 2402 MHz  |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 4.1                                  | 0.4                    | -3.7                                |
| Middle frequency: CH17, 2440 MHz  |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 4.2                                  | 0.7                    | -3.5                                |
| Highest frequency: CH39, 2480 MHz |                  |                                      |                        |                                     |
| $T_{\text{nom}}$                  | $V_{\text{nom}}$ | 3.9                                  | 0.3                    | -3.6                                |

**Maximum calculated antenna gain**

**- 3.4 dBi**

The supplied antenna meets the requirements of part 15.203 and 15.204.

### 5.6.3 Antenna requirements

According to FCC Part 15C, Section 15.247(b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**The output power has not to be reduced.**

## 6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

| Test ID | Model Type             | Equipment No.   | Next Calib. | Last Calib. | Next Verif. | Last Verif. |
|---------|------------------------|-----------------|-------------|-------------|-------------|-------------|
| CPC 3   | ESW26                  | 02-02/03-17-002 | 10/02/2022  | 10/02/2021  |             |             |
| CPR 3   | FSW43                  | 02-02/11-15-001 | 02/04/2021  | 02/04/2020  |             |             |
|         | AMF-6D-01002000-22-10P | 02-02/17-15-004 |             |             |             |             |
|         | 3117                   | 02-02/24-05-009 | 18/06/2021  | 18/06/2020  |             |             |
|         | 18N-20                 | 02-02/50-17-003 |             |             |             |             |
|         | BAM 4.5-P              | 02-02/50-17-024 |             |             |             |             |
|         | NCD                    | 02-02/50-17-025 |             |             |             |             |
|         | KK-SF106-2X11N-6,5M    | 02-02/50-18-016 |             |             |             |             |
|         | BAT-EMC 3.19.1.24      | 02-02/68-13-001 |             |             |             |             |
| MB      | FSW43                  | 02-02/11-15-001 | 02/04/2021  | 02/04/2020  |             |             |
|         | AMF-6D-01002000-22-10P | 02-02/17-15-004 |             |             |             |             |
|         | 3117                   | 02-02/24-05-009 | 18/06/2021  | 18/06/2020  |             |             |
|         | 18N-20                 | 02-02/50-17-003 |             |             |             |             |
|         | BAM 4.5-P              | 02-02/50-17-024 |             |             |             |             |
|         | NCD                    | 02-02/50-17-025 |             |             |             |             |
|         | KK-SF106-2X11N-6,5M    | 02-02/50-18-016 |             |             |             |             |
|         | BAT-EMC 3.19.1.24      | 02-02/68-13-001 |             |             |             |             |
| SER 2   | ESVS 30                | 02-02/03-05-006 | 15/07/2021  | 15/07/2020  |             |             |
|         | VULB 9168              | 02-02/24-05-005 | 18/12/2021  | 18/12/2020  |             |             |
|         | NW-2000-NB             | 02-02/50-05-113 |             |             |             |             |
|         | KK-EF393/U-16N-21N20 m | 02-02/50-12-018 |             |             |             |             |
|         | KK-SD_7/8-2X21N-33,0M  | 02-02/50-15-028 |             |             |             |             |
| SER 3   | FSP 40                 | 02-02/11-11-001 | 01/10/2021  | 01/10/2020  |             |             |
|         | FSW43                  | 02-02/11-15-001 | 02/04/2021  | 02/04/2020  |             |             |
|         | AMF-6D-01002000-22-10P | 02-02/17-15-004 |             |             |             |             |
|         | LNA-40-18004000-33-5P  | 02-02/17-20-002 |             |             |             |             |
|         | 3117                   | 02-02/24-05-009 | 18/06/2021  | 18/06/2020  |             |             |
|         | BBHA 9170              | 02-02/24-05-013 | 19/05/2023  | 19/05/2020  | 04/02/2022  | 04/02/2021  |
|         | 18N-20                 | 02-02/50-17-003 |             |             |             |             |
|         | BAM 4.5-P              | 02-02/50-17-024 |             |             |             |             |
|         | NCD                    | 02-02/50-17-025 |             |             |             |             |
|         | KK-SF106-2X11N-6,5M    | 02-02/50-18-016 |             |             |             |             |
|         | KMS116-GL140SE-KMS116- | 02-02/50-20-026 |             |             |             |             |
|         | BAT-EMC 3.19.1.24      | 02-02/68-13-001 |             |             |             |             |

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.