

## TEST REPORT

Test report no.: 1-5394/17-01-02

### Testing laboratory

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**Accredited Testing Laboratory:**

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

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### Manufacturer

**Sennheiser electronic GmbH & Co. KG**

Am Labor 1

30900 Wedemark / GERMANY

### Test standard/s

47 CFR Part 15

Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

RSS - 247 Issue 2

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence - Exempt Local Area Network (LE-LAN) Devices

For further applied test standards please refer to section 3 of this test report.

### Test Item

**Kind of test item:** Wireless Microphone Bodypack

**Model name:** SK D1

**FCC ID:** DMOSK2G4WE

**IC:** 2099A-SK2G4WE

DTS band 2400 MHz to 2483.5 MHz

Frequency: Lowest channel: 2403MHz,

Middle channel: 2443MHz,

Highest channel: 2481MHz

Technology tested: Proprietary digital audio transmission

Antenna: 2 Integrated PCB antennas

Power supply: 1.8 V to 4.7 V DC by Li-Ion or 2x AA batteries

Temperature range: -10°C to +55°C



This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

### Test report authorized:



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Lab Manager  
Radio Communications & EMC

### Test performed:



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## 2 General information

### 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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### 2.2 Application details

|                                    |            |
|------------------------------------|------------|
| Date of receipt of order:          | 2017-11-23 |
| Date of receipt of test item:      | 2017-11-27 |
| Start of test:                     | 2017-11-29 |
| End of test:                       | 2018-01-25 |
| Person(s) present during the test: | -/-        |

### 2.3 Test laboratories sub-contracted

None

### 3 Test standard/s and references

| Test standard     | Date          | Description                                                                                                                                               |
|-------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47 CFR Part 15    | -/-           | Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices                                                                 |
| RSS - 247 Issue 2 | February 2017 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices                            |
| RSS - Gen Issue 4 | November 2014 | Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus |

| Guidance            | Version | Description                                                                                                                                                         |
|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DTS: KDB 558074 D01 | V04     | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247                                                       |
| ANSI C63.4-2014     | -/-     | American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz |
| ANSI C63.10-2013    | -/-     | American national standard of procedures for compliance testing of unlicensed wireless devices                                                                      |

## 4 Test environment

|                           |   |                                                          |                                                                                                                     |
|---------------------------|---|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Temperature               | : | T <sub>nom</sub><br>T <sub>max</sub><br>T <sub>min</sub> | +22 °C during room temperature tests<br>+55 °C during high temperature tests<br>-10 °C during low temperature tests |
| Relative humidity content | : |                                                          | 35 %                                                                                                                |
| Barometric pressure       | : |                                                          | 1002 hpa                                                                                                            |
| Power supply              | : | V <sub>nom</sub><br>V <sub>max</sub><br>V <sub>min</sub> | 3.0 V DC by Li-Ion or 2x AA batteries<br>4.7 V<br>1.8 V                                                             |

## 5 Test item

### 5.1 General description

|                            |   |                                                                                                                     |
|----------------------------|---|---------------------------------------------------------------------------------------------------------------------|
| Kind of test item          | : | Wireless Microphone Bodypack                                                                                        |
| Type identification        | : | SK D1                                                                                                               |
| HMN                        | : | -/-                                                                                                                 |
| PMN                        | : | Evolution wireless D1                                                                                               |
| HVIN                       | : | SK D1                                                                                                               |
| FVIN                       | : | 2.5.0                                                                                                               |
| S/N serial number          | : | Rad. 1367115486<br>Cond. 1487116785                                                                                 |
| HW hardware status         | : | V2.0                                                                                                                |
| SW software status         | : | 2.5.0                                                                                                               |
| Frequency band             | : | DTS band 2400 MHz to 2483.5 MHz<br>Lowest channel: 2403MHz,<br>Middle channel: 2443MHz,<br>Highest channel: 2481MHz |
| Type of radio transmission | : | DTS                                                                                                                 |
| Use of frequency spectrum  | : |                                                                                                                     |
| Type of modulation         | : | GFSK                                                                                                                |
| Number of channels         | : | 40                                                                                                                  |
| Antenna                    | : | 2 Integrated PCB antennas                                                                                           |
| Power supply               | : | 1.8 V to 4.7 V DC by Li-Ion or 2x AA batteries                                                                      |
| Temperature range          | : | -10°C to +55°C                                                                                                      |

### 5.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup- and EUT-photos are included in test report:

1-5394/17-01-01\_AnnexA  
 1-5394/17-01-01\_AnnexB  
 1-5394/17-01-01\_AnnexD

## 6 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

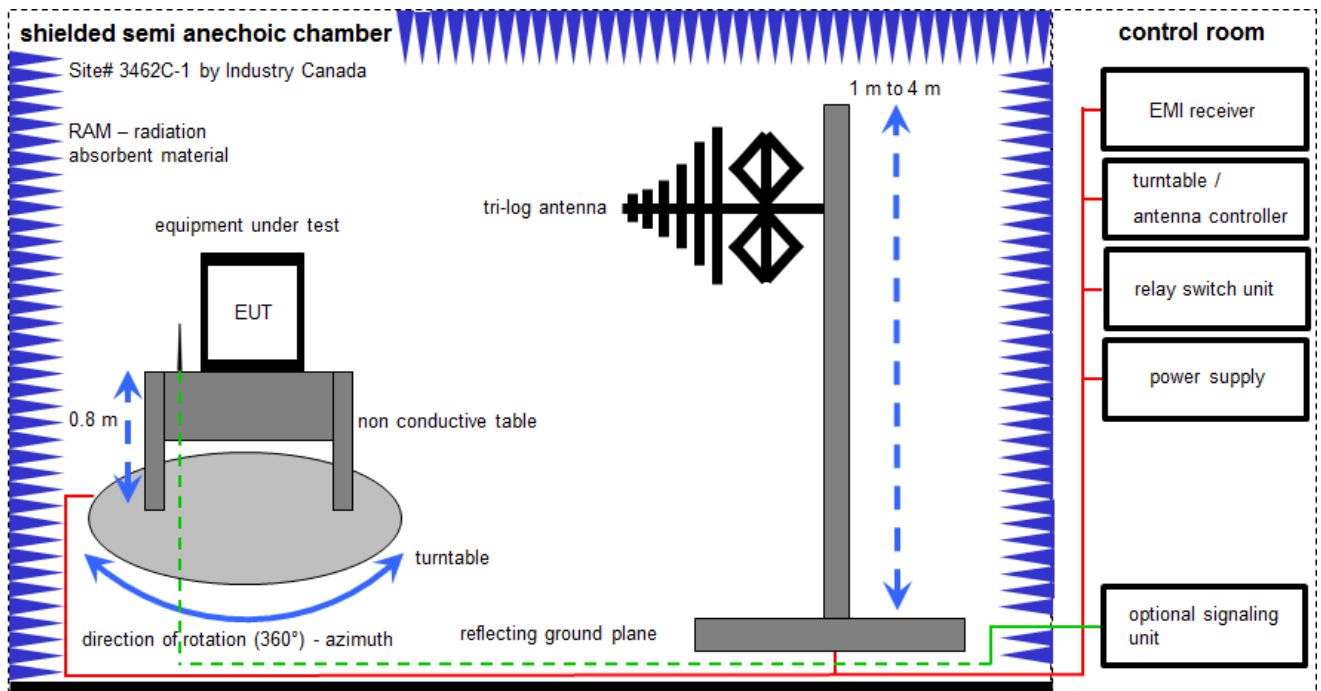
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

### **Agenda:** Kind of Calibration

|      |                                            |     |                                                      |
|------|--------------------------------------------|-----|------------------------------------------------------|
| k    | calibration / calibrated                   | EK  | limited calibration                                  |
| ne   | not required (k, ev, izw, zw not required) | zw  | cyclical maintenance (external cyclical maintenance) |
| ev   | periodic self verification                 | izw | internal cyclical maintenance                        |
| Ve   | long-term stability recognized             | g   | blocked for accredited testing                       |
| vlk! | Attention: extended calibration interval   |     |                                                      |
| NK!  | Attention: not calibrated                  | *)  | next calibration ordered / currently in progress     |

## 6.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter

$$FS = UR + CL + AF$$

(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

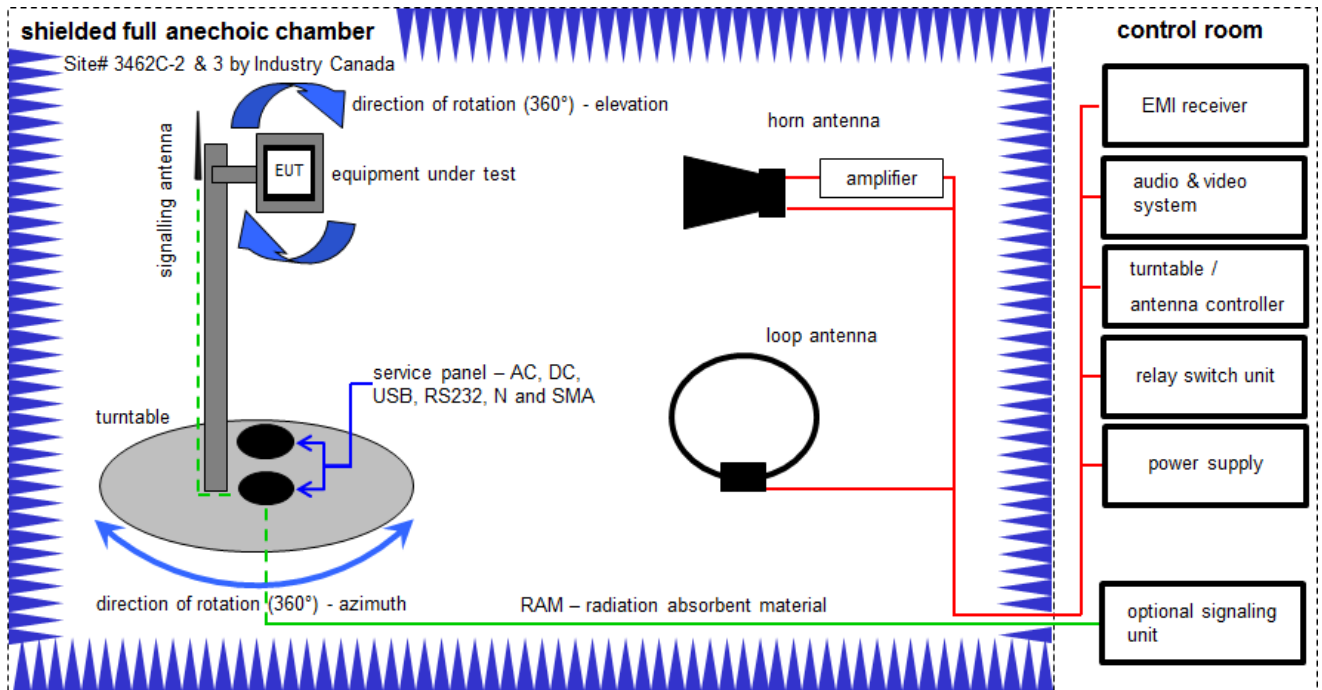
*Example calculation:*

$$FS [dB\mu V/m] = 12.35 [dB\mu V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB\mu V/m] (35.69 \mu V/m)$$

### Equipment table:

| No. | Lab / Item | Equipment                                    | Type         | Manufacturer | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|----------------------------------------------|--------------|--------------|------------|-----------|---------------------|------------------|------------------|
| 1   | A          | Switch-Unit                                  | 3488A        | HP           | 2719A14505 | 300000368 | ev                  | -/-              | -/-              |
| 2   | A          | DC power supply, 60Vdc, 50A, 1200 W          | 6032A        | HP           | 2920A04466 | 300000580 | ne                  | -/-              | -/-              |
| 3   | A          | EMI Test Receiver                            | ESCI 3       | R&S          | 100083     | 300003312 | k                   | 01.02.2017       | 31.01.2018       |
| 4   | A          | Antenna Tower                                | Model 2175   | ETS-Lindgren | 64762      | 300003745 | izw                 | -/-              | -/-              |
| 5   | A          | Positioning Controller                       | Model 2090   | ETS-Lindgren | 64672      | 300003746 | izw                 | -/-              | -/-              |
| 6   | A          | Turntable Interface-Box                      | Model 105637 | ETS-Lindgren | 44583      | 300003747 | izw                 | -/-              | -/-              |
| 7   | A          | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163     | Schwarzbeck  | 295        | 300003787 | k                   | 25.04.2016       | 25.04.2018       |

## 6.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

$$FS = UR + CA + AF$$

(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

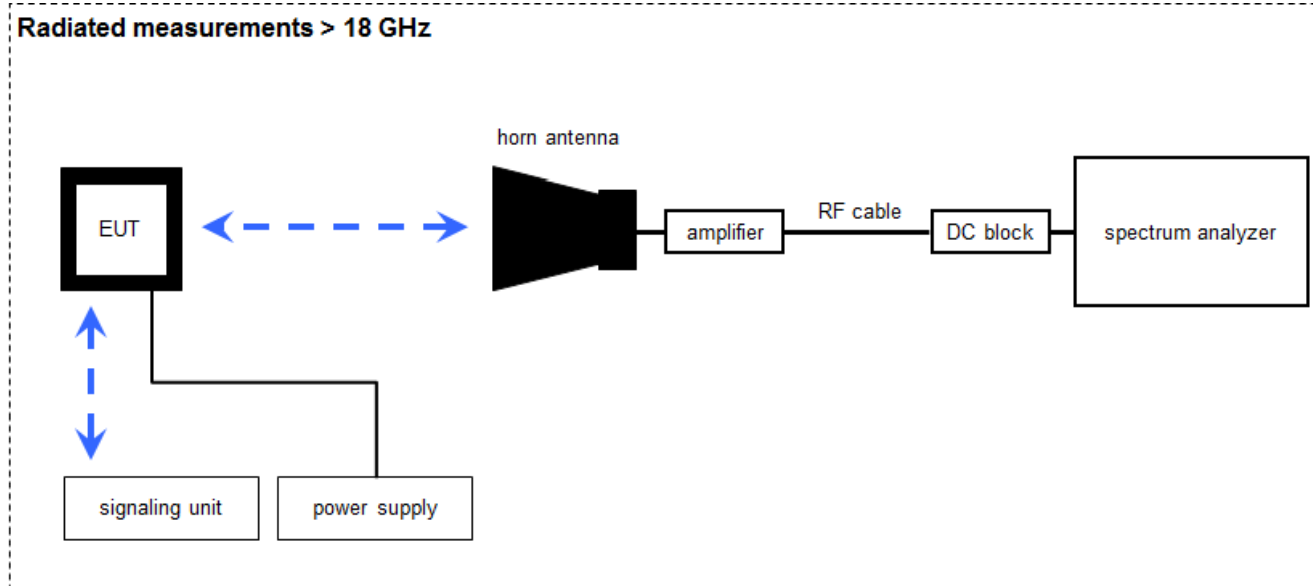
Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-35.8) \text{ [dB]} + 32.9 \text{ [dB/m]} = 37.1 \text{ [dB}\mu\text{V/m]} \text{ (71.61 } \mu\text{V/m)}$$

### Equipment table:

| No. | Lab / Item | Equipment                                      | Type                            | Manufacturer         | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|------------------------------------------------|---------------------------------|----------------------|------------|-----------|---------------------|------------------|------------------|
| 1   | A          | Active Loop Antenna 9 kHz to 30 MHz            | 6502                            | EMCO                 | 2210       | 300001015 | k                   | 07.07.2017       | 06.07.2019       |
| 2   | A+B        | Anechoic chamber                               | FAC 3/5m                        | MWB / TDK            | 87400/02   | 300000996 | ev                  | -/-              | -/-              |
| 3   | B          | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115                            | EMCO                 | 9107-3697  | 300001605 | vKII                | 14.02.2017       | 13.02.2019       |
| 4   | A+B        | Switch / Control Unit                          | 3488A                           | HP                   | *          | 300000199 | ne                  | -/-              | -/-              |
| 5   | B          | Band Reject filter                             | WRCG2400/2483-2375/2505-50/10SS | Wainwright           | 11         | 300003351 | ev                  | -/-              | -/-              |
| 6   | A+B        | EMI Test Receiver 20Hz- 26,5GHz                | ESU26                           | R&S                  | 100037     | 300003555 | k                   | 31.01.2017       | 30.01.2018       |
| 7   | B          | Highpass Filter                                | WHKX7.0/18G-8SS                 | Wainwright           | 19         | 300003790 | ne                  | -/-              | -/-              |
| 8   | B          | Broadband Amplifier 0.5-18 GHz                 | CBLU5184540                     | CERNEX               | 22049      | 300004481 | ev                  | -/-              | -/-              |
| 9   | A+B        | 4U RF Switch Platform                          | L4491A                          | Agilent Technologies | MY50000037 | 300004509 | ne                  | -/-              | -/-              |
| 10  | A+B        | NEXIO EMV-Software                             | BAT EMC V3.16.0.49              | EMCO                 | -/-        | 300004682 | ne                  | -/-              | -/-              |
| 11  | A+B        | PC                                             | ExOne                           | F+W                  | -/-        | 300004703 | ne                  | -/-              | -/-              |
| 12  | B          | Highpass Filter (Chebyshev)                    | WHKX10-4432.5-4925-18000-40SS   | Wainwright           | 1          | 300005028 | ev                  | -/-              | -/-              |
| 13  | B          | RF-Amplifier                                   | AMF-6F06001800-30-10P-R         | NARDA-MITEQ Inc      | 2011572    | 300005241 | ev                  | -/-              | -/-              |

### 6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

FS = UR + CA + AF

(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:

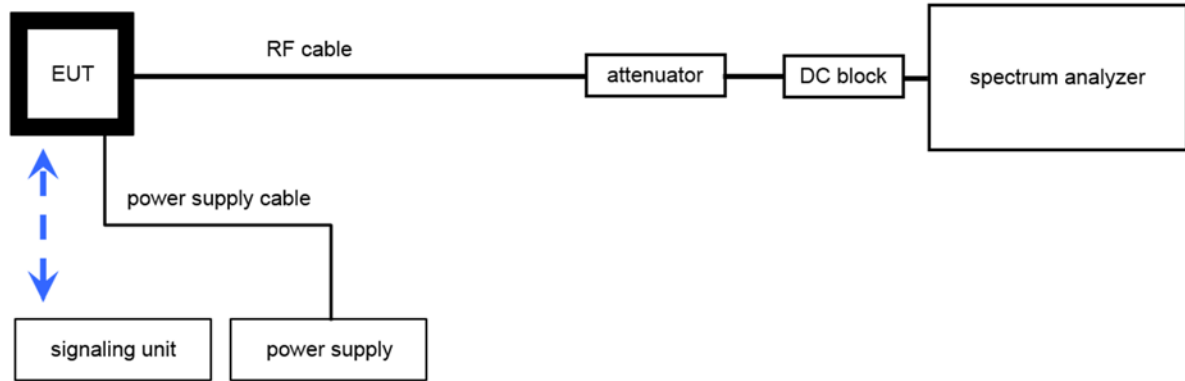
FS [dBμV/m] = 40.0 [dBμV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBμV/m] (6.79 μV/m)

#### Equipment table:

| No. | Lab / Item | Equipment                  | Type                | Manufacturer   | Serial No.       | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|----------------------------|---------------------|----------------|------------------|-----------|---------------------|------------------|------------------|
| 1   | A          | Horn Antenna 18,0-40,0 GHz | LHAF180             | Microw.Devel   | 39180-103-022    | 300001748 | k                   | 22.05.2015       | 22.05.2018       |
| 2   | A          | Amplifier 2-40 GHz         | JS32-02004000-57-5P | MITEQ          | 1777200          | 300004541 | ev                  | -/-              | -/-              |
| 3   | A          | RF-Cable                   | ST18/SMAm/SMAm/48   | Huber & Suhner | Batch no. 600918 | 400001182 | ev                  | -/-              | -/-              |
| 4   | A          | RF-Cable                   | ST18/SMAm/SMAm/48   | Huber & Suhner | Batch no. 127377 | 400001183 | ev                  | -/-              | -/-              |
| 5   | A          | Signal Analyzer 40 GHz     | FSV40               | R&S            | 101353           | 300004819 | k                   | 19.09.2016       | 18.09.2018       |

## 6.4 Conducted measurements

### Conducted measurements normal conditions



$$OP = AV + CA$$

(OP-output power; AV-analyzer value; CA-loss signal path)

#### Example calculation:

$$OP \text{ [dBm]} = 6.0 \text{ [dBm]} + 11.7 \text{ [dB]} = 17.7 \text{ [dBm]} \text{ (58.88 mW)}$$

#### Equipment table:

| No. | Lab / Item | Equipment                                      | Type              | Manufacturer    | Serial No.      | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|------------------------------------------------|-------------------|-----------------|-----------------|-----------|---------------------|------------------|------------------|
| 1   | A          | Signal Analyzer 40 GHz                         | FSV40             | R&S             | 101353          | 300004819 | k                   | 19.09.2016       | 18.09.2018       |
| 2   | A          | Open Switch and Control Unit and Power Sensors | OSP120 incl. B157 | R&S             | 101274, 100877  | 300004825 | ne                  | -/-              | -/-              |
| 3   | A          | RF-Cable WLAN-Tester Analyzer                  | ST18/SMAm/SMAm/36 | Huber & Suhner  | Batch no. 54876 | 400001220 | ev                  | -/-              | -/-              |
| 4   | A          | Power Supply                                   | HMP2020           | Rohde & Schwarz | 102219          | 300005264 | ne                  | -/-              | -/-              |

## **7 Sequence of testing**

### **7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz**

#### **Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

#### **Premeasurement\***

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

#### **Final measurement**

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

\*)Note: The sequence will be repeated three times with different EUT orientations.

## 7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position  $\pm 45^\circ$  and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

### 7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

#### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

#### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

#### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 7.4 Sequence of testing radiated spurious above 18 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

### Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

### Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

**8 Measurement uncertainty**

| Measurement uncertainty                                  |                                         |
|----------------------------------------------------------|-----------------------------------------|
| Test case                                                | Uncertainty                             |
| Antenna gain                                             | $\pm 3$ dB                              |
| Power spectral density                                   | $\pm 1.5$ dB                            |
| DTS bandwidth                                            | $\pm 100$ kHz (depends on the used RBW) |
| Occupied bandwidth                                       | $\pm 100$ kHz (depends on the used RBW) |
| Maximum output power                                     | $\pm 1.5$ dB                            |
| Detailed spurious emissions @ the band edge - conducted  | $\pm 1.5$ dB                            |
| Band edge compliance radiated                            | $\pm 3$ dB                              |
| Spurious emissions conducted                             | $\pm 3$ dB                              |
| Spurious emissions radiated below 30 MHz                 | $\pm 3$ dB                              |
| Spurious emissions radiated 30 MHz to 1 GHz              | $\pm 3$ dB                              |
| Spurious emissions radiated 1 GHz to 12.75 GHz           | $\pm 3.7$ dB                            |
| Spurious emissions radiated above 12.75 GHz              | $\pm 4.5$ dB                            |
| Spurious emissions conducted below 30 MHz (AC conducted) | $\pm 2.6$ dB                            |

## 9 Summary of measurement results

|                                     |                                                                                                                          |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/>            | No deviations from the technical specifications were ascertained                                                         |
| <input type="checkbox"/>            | There were deviations from the technical specifications ascertained                                                      |
| <input checked="" type="checkbox"/> | This test report is only a partial test report.<br>The content and verdict of the performed test cases are listed below. |

| TC Identifier | Description                       | Verdict    | Date       | Remark                                                     |
|---------------|-----------------------------------|------------|------------|------------------------------------------------------------|
| RF-Testing    | CFR Part 15<br>RSS - 247, Issue 2 | See table! | 2018-03-05 | Reduced test plan<br>according customers<br>specification! |

| Test specification clause                | Test case                                           | Guideline                                             | Temperature conditions | Power source voltages | Mode | C                                   | NC                       | NA                       | NP                                  | Remark |
|------------------------------------------|-----------------------------------------------------|-------------------------------------------------------|------------------------|-----------------------|------|-------------------------------------|--------------------------|--------------------------|-------------------------------------|--------|
| §15.247(b)(4)<br>RSS - 247 / 5.4 (f)(ii) | Antenna gain                                        | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.35                                   | Duty cycle                                          | -/-                                                   | Nominal                | Nominal               | GFSK | -/-                                 |                          |                          |                                     | -/-    |
| §15.247(e)<br>RSS - 247 / 5.2 (b)        | Power spectral density                              | KDB 558074<br>DTS clause: 10.2                        | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |
| §15.247(a)(2)<br>RSS - 247 / 5.2 (a)     | DTS bandwidth                                       | KDB 558074<br>DTS clause: 8.1                         | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |
| RSS Gen<br>clause 4.6.1                  | Occupied bandwidth                                  | -/-                                                   | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |
| §15.247(b)(3)<br>RSS - 247 / 5.4 (d)     | Maximum output power                                | KDB 558074<br>DTS clause: 9.1.1                       | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.247(d)<br>RSS - 247 / 5.5            | Detailed spurious emissions @ the band edge – cond. | -/-                                                   | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |
| §15.205<br>RSS - 247 / 5.5<br>RSS - Gen  | Band edge compliance cond..                         | KDB 558074<br>DTS clause: 13.3.2<br>and clause 12.2.2 | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.247(d)<br>RSS - 247 / 5.5            | TX spurious emissions cond.                         | KDB 558074<br>DTS clause: 11.1<br>& 11.2 11.3         | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |
| §15.209(a)<br>RSS-Gen                    | TX spurious emissions rad. below 30 MHz             | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.247(d)<br>RSS - 247 / 5.5<br>RSS-Gen | TX spurious emissions rad. 30 MHz to 1 GHz          | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.247(d)<br>RSS - 247 / 5.5<br>RSS-Gen | TX spurious emissions rad. above 1 GHz              | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.109<br>RSS-Gen                       | RX spurious emissions rad. 30 MHz to 1 GHz          | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.109<br>RSS-Gen                       | RX spurious emissions rad. above 1 GHz              | -/-                                                   | Nominal                | Nominal               | GFSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | -/-    |
| §15.107(a)<br>§15.207                    | Conducted emissions < 30 MHz                        | -/-                                                   | Nominal                | Nominal               | GFSK | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/-    |

### Notes:

|          |           |           |               |           |                |           |               |
|----------|-----------|-----------|---------------|-----------|----------------|-----------|---------------|
| <b>C</b> | Compliant | <b>NC</b> | Not compliant | <b>NA</b> | Not applicable | <b>NP</b> | Not performed |
|----------|-----------|-----------|---------------|-----------|----------------|-----------|---------------|

## 10 Additional comments

Reference documents: Test mode instructions: Anleitung-Testmode.pdf

Special test descriptions: None

Configuration descriptions: The DUT is configured via a GUI based software provide by the manufacturer. Power settings were fix programmed and could not be changed.

Provided channels: 0 to 39 (2403 MHz to 2481 MHz)

## 11 Additional EUT parameter

- Test mode:
- ☐ No test mode available  
Iperf was used to ping another device with the largest support packet size
  - ☒ Test mode available  
Special software is used.  
EUT is transmitting pseudo random data by itself
- Modulation types:
- ☒ GFSK
  - ☐ Frequency Hopping Spread Spectrum (FHSS)
- Antennas and transmit operating modes:
- ☐ Operating mode 1 (single antenna)
    - Equipment with 1 antenna,
    - Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,
    - Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)
  - ☒ Operating mode 2 (multiple antennas, no beamforming)
    - Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.
  - ☐ Operating mode 3 (multiple antennas, with beamforming)
    - Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.  
In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

## 12 Measurement results

### 12.1 Testability check

#### Description:

Comparison of the first assessment with the current product based on the performance and decision of the test ability.

#### Measurement:

| Measurement parameters  |                   |
|-------------------------|-------------------|
| Detector                | Peak              |
| Sweep time              | Auto              |
| Resolution bandwidth    | 3 MHz             |
| Video bandwidth         | 3 MHz             |
| Span                    | 5 MHz             |
| Trace mode              | Max hold          |
| Test setup              | See chapter 6.4 A |
| Measurement uncertainty | See chapter 8     |

#### Limits:

|                                   |
|-----------------------------------|
| Main report value -2 dB / +1.5 dB |
|-----------------------------------|

#### Results:

| T <sub>nom</sub>                                                                | V <sub>nom</sub> | lowest channel | middle channel | highest channel |
|---------------------------------------------------------------------------------|------------------|----------------|----------------|-----------------|
| GFSK mode                                                                       |                  |                |                |                 |
| Conducted power / dBm<br>Main report 1-5735/12-01-16-A<br>Sum (Ant1 & Ant2)     |                  | 16.0           | 16.2           | 15.8            |
| Conducted power / dBm<br>Test ability check – delta sample<br>Sum (Ant1 & Ant2) |                  | 17.1           | 17.2           | 16.9            |

## 12.2 Antenna gain

### Description:

The antenna gain of the complete system is calculated by the difference of radiated power (@ 3 MHz) in EIRP and the conducted power (@ 3 MHz) of the module.

### Measurement:

| Measurement parameter   |                                                               |
|-------------------------|---------------------------------------------------------------|
| Detector                | Peak                                                          |
| Sweep time              | Auto                                                          |
| Resolution bandwidth    | 3 MHz                                                         |
| Video bandwidth         | 10 MHz                                                        |
| Trace mode              | Max hold                                                      |
| Test setup              | See chapter 6.4 A (conducted)<br>See chapter 6.2 B (radiated) |
| Measurement uncertainty | See chapter 8                                                 |

### Limits:

| FCC                                                               | IC |
|-------------------------------------------------------------------|----|
| 6 dBi / > 6 dBi output power and power density reduction required |    |

### Results:

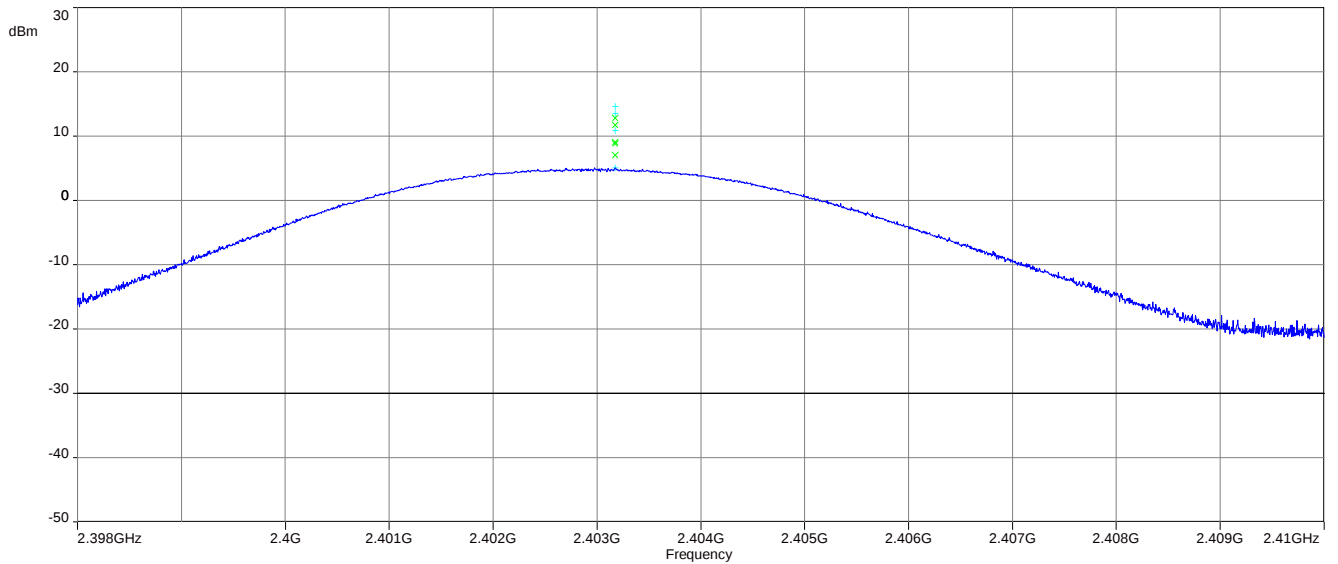
| antenna port 1                                         | lowest channel | middle channel | highest channel |
|--------------------------------------------------------|----------------|----------------|-----------------|
| Conducted power / dBm<br>Measured with GFSK modulation | 17.4           | 17.4           | 17.0            |
| Radiated power / dBm<br>Measured with GFSK modulation  | 15.2           | 15.8           | 16.1            |
| Gain / dBi<br>Calculated                               | -2.2           | -1.6           | -0.9            |

### Results:

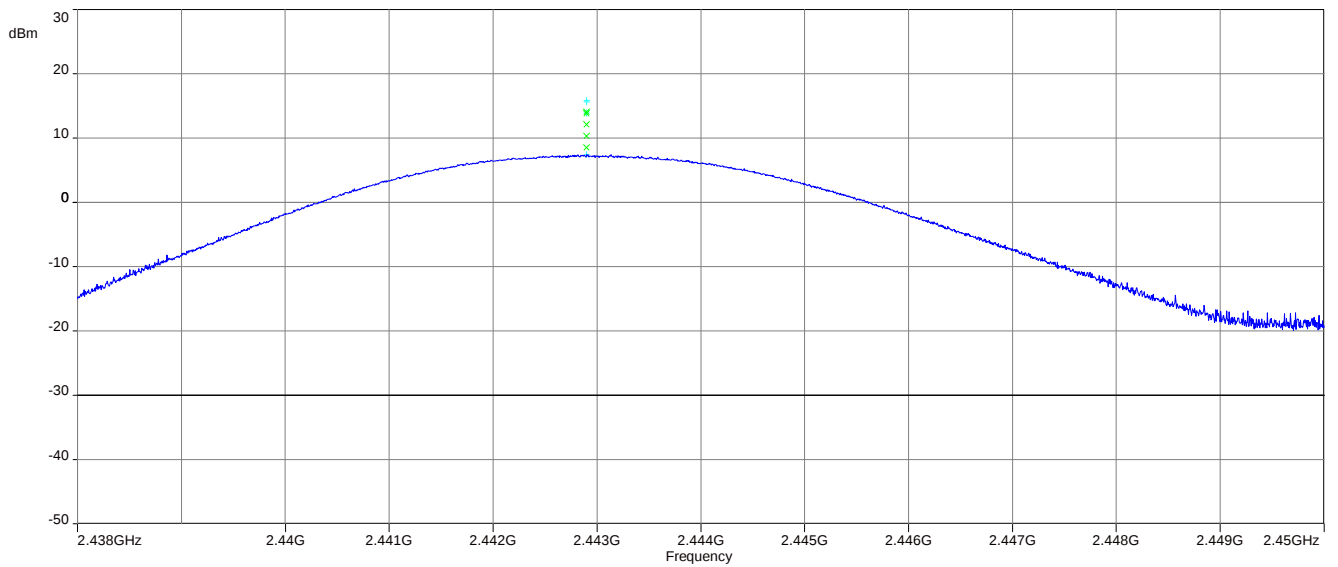
| antenna port 2                                         | lowest channel | middle channel | highest channel |
|--------------------------------------------------------|----------------|----------------|-----------------|
| Conducted power / dBm<br>Measured with GFSK modulation | 16.6           | 16.7           | 16.6            |
| Radiated power / dBm<br>Measured with GFSK modulation  | 14.6           | 15.9           | 15.6            |
| Gain / dBi<br>Calculated                               | -2.0           | -0.8           | -1.0            |

**Plots:** GFSK – mode; antenna port 1 (radiated)

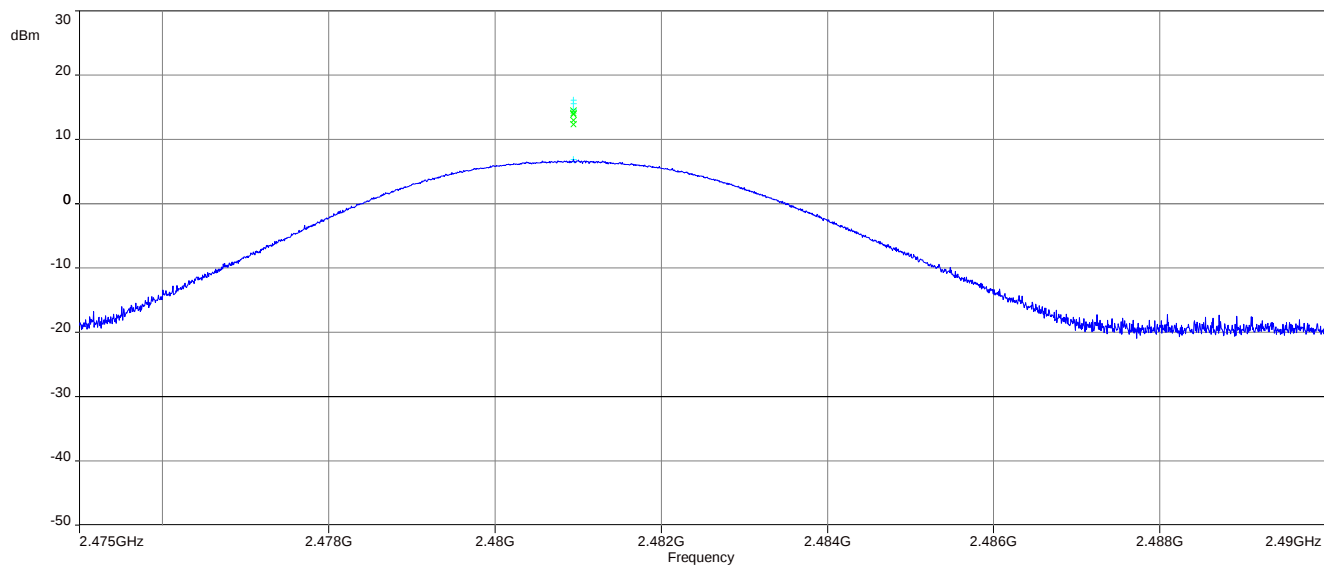
**Plot 1:** Lowest channel



**Plot 2:** Middle channel

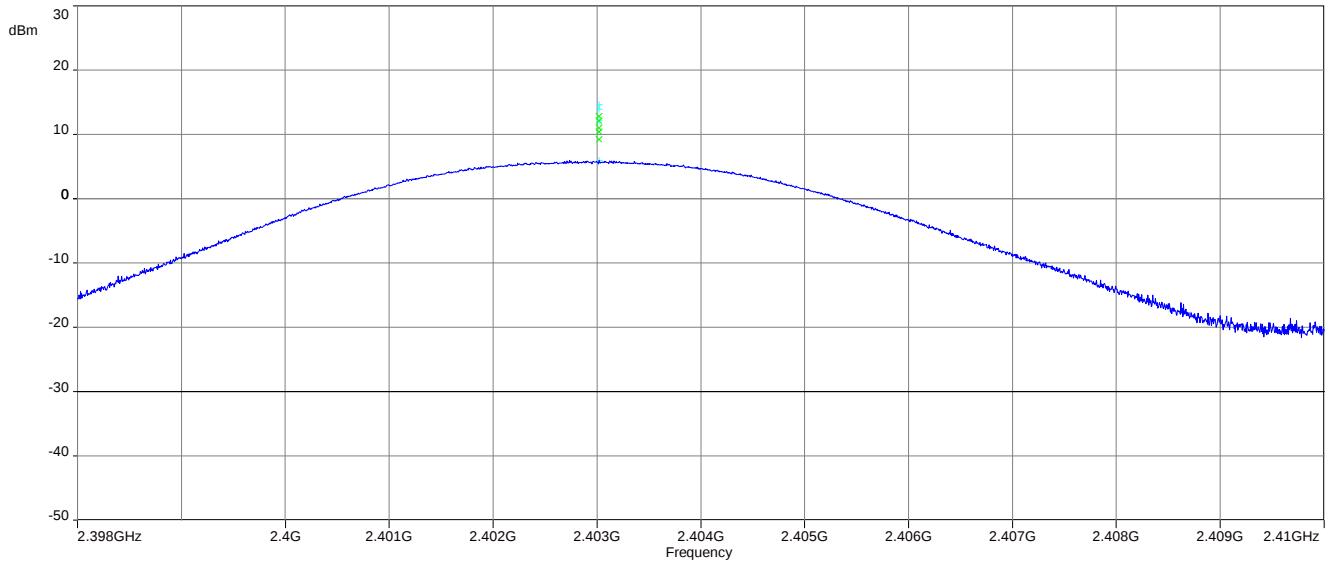


**Plot 3: Highest channel**

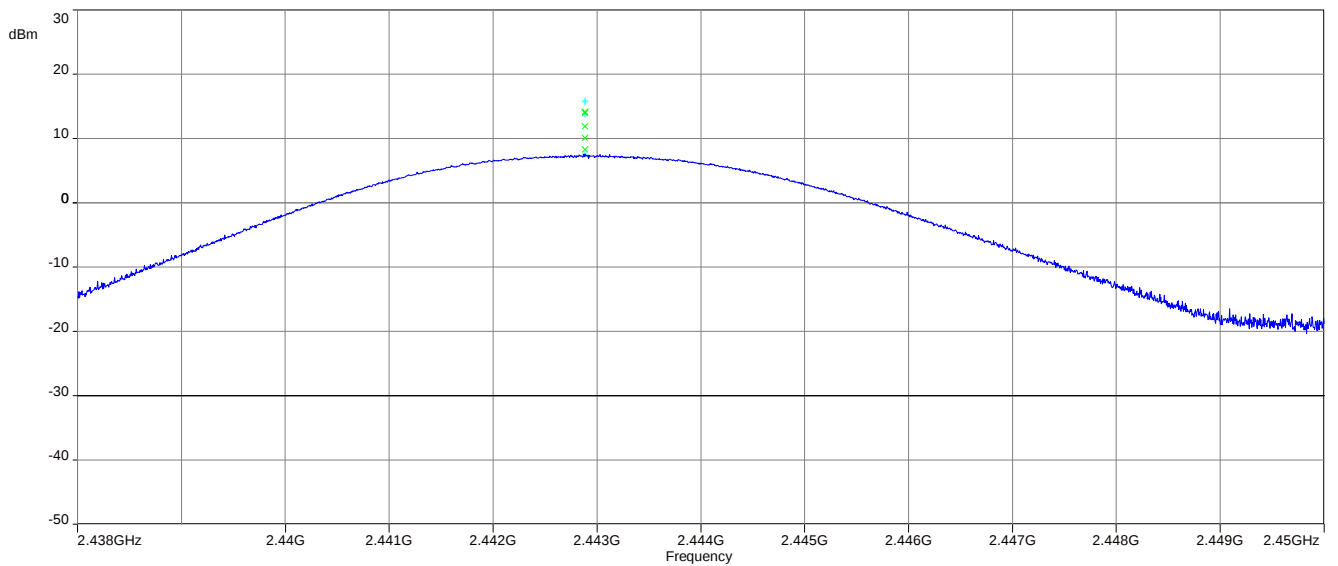


**Plots:** GFSK – mode; antenna port 2 (radiated)

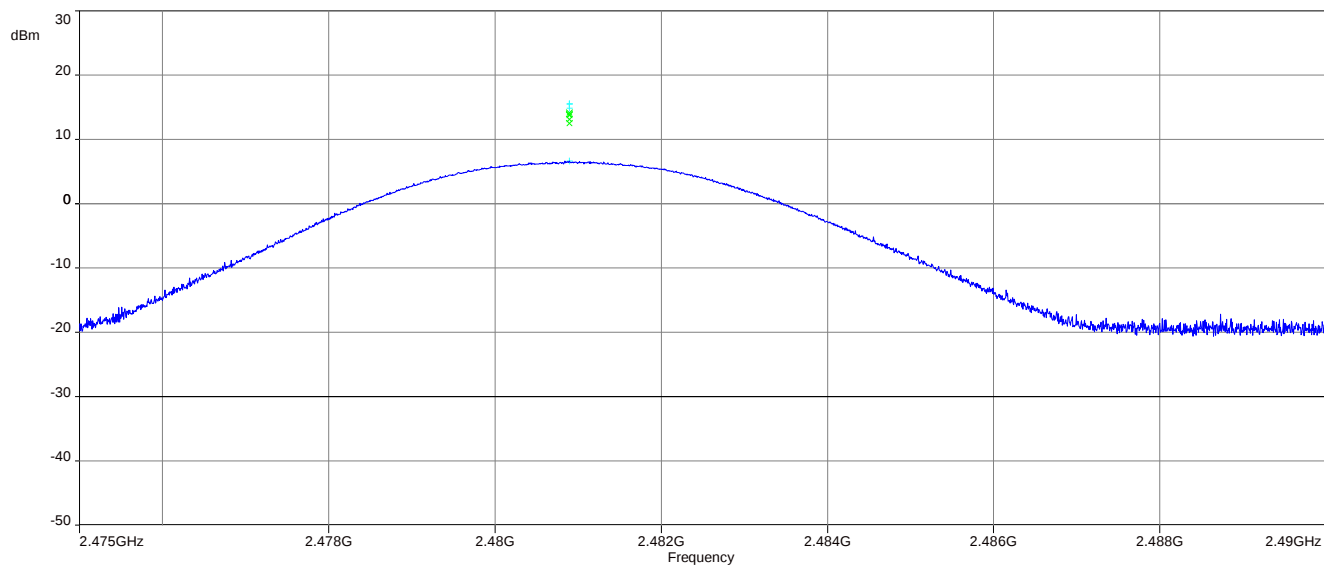
**Plot 1:** Lowest channel



**Plot 2:** Middle channel



**Plot 3: Highest channel**



## 12.3 Maximum output power

### Description:

Measurement of the maximum conducted peak output power. The measurements are performed using the data rate identified in the previous chapter.

### Measurement:

| Measurement parameter          |                   |
|--------------------------------|-------------------|
| According to DTS clause: 9.1.1 |                   |
| Detector                       | Peak              |
| Sweep time                     | Auto              |
| Resolution bandwidth           | 3 MHz             |
| Video bandwidth                | 10 MHz            |
| Trace mode                     | Max hold          |
| Test setup                     | See chapter 6.4 A |
| Measurement uncertainty        | See chapter 8     |

### Limits:

| FCC                                                         | IC |
|-------------------------------------------------------------|----|
| Conducted 1.0 W / 30 dBm with an antenna gain of max. 6 dBi |    |

### Results:

| antenna port 1         | maximum output power / dBm |                |                 |
|------------------------|----------------------------|----------------|-----------------|
|                        | lowest channel             | middle channel | highest channel |
| Output power conducted | 17.4                       | 17.4           | 17.0            |

| antenna port 2         | maximum output power / dBm |                |                 |
|------------------------|----------------------------|----------------|-----------------|
|                        | lowest channel             | middle channel | highest channel |
| Output power conducted | 16.6                       | 16.7           | 16.6            |

## 12.4 Duty cycle

### Description:

Measurement of the timing behavior.

### Measurement:

| Measurement parameter   |                                |
|-------------------------|--------------------------------|
| Detector                | Peak                           |
| Sweep time              | Depends on the signal see plot |
| Resolution bandwidth    | 10 MHz                         |
| Video bandwidth         | 10 MHz                         |
| Trace mode              | Max hold                       |
| Test setup              | See chapter 6.4 A              |
| Measurement uncertainty | See chapter 8                  |

### Limits:

| FCC            | IC |
|----------------|----|
| No limitation! |    |

### Results:

| T <sub>nom</sub> | V <sub>nom</sub> | lowest channel | middle channel | highest channel |
|------------------|------------------|----------------|----------------|-----------------|
| GFSK Modulation  |                  | 54.6 %         | 54.7%          | 54.6%           |

Duty Cycle correction factor as per DTS clause 13.3.2:

$$10 \log (1/x) = 10 \log (1/0.546) = \mathbf{2.6 \text{ dB}}$$

where x is the duty cycle

## 12.5 Band edge compliance conducted

### Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to the lowest channel for the lower restricted band and to the highest channel for the upper restricted band. The measurement is repeated for all modulations. Measurement distance is 3 meter.

### Measurement:

|                         | Measurement parameter for peak measurements | Measurement parameter for average measurements                                    |
|-------------------------|---------------------------------------------|-----------------------------------------------------------------------------------|
|                         |                                             | According to DTS clause: 13.3.2                                                   |
| Detector                | Peak                                        | RMS                                                                               |
| Sweep time              | Auto                                        | Auto                                                                              |
| Resolution bandwidth    | 1 MHz                                       | 100 kHz                                                                           |
| Video bandwidth         | 1 MHz                                       | 300 kHz                                                                           |
| Span                    | See plot                                    | 2 MHz                                                                             |
| Trace mode              | Max. hold                                   | RMS Average over 101 sweeps                                                       |
| Analyzer function       | -/-                                         | Band power function<br>(Compute the power by integrating the spectrum over 1 MHz) |
| Test setup              | See chapter 6.4 A                           |                                                                                   |
| Measurement uncertainty | See chapter 8                               |                                                                                   |

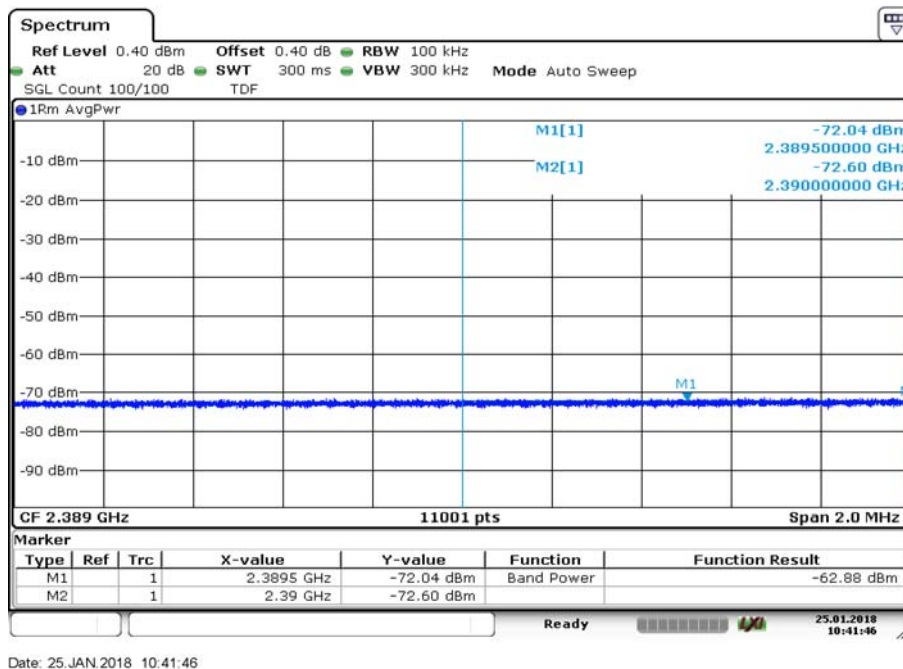
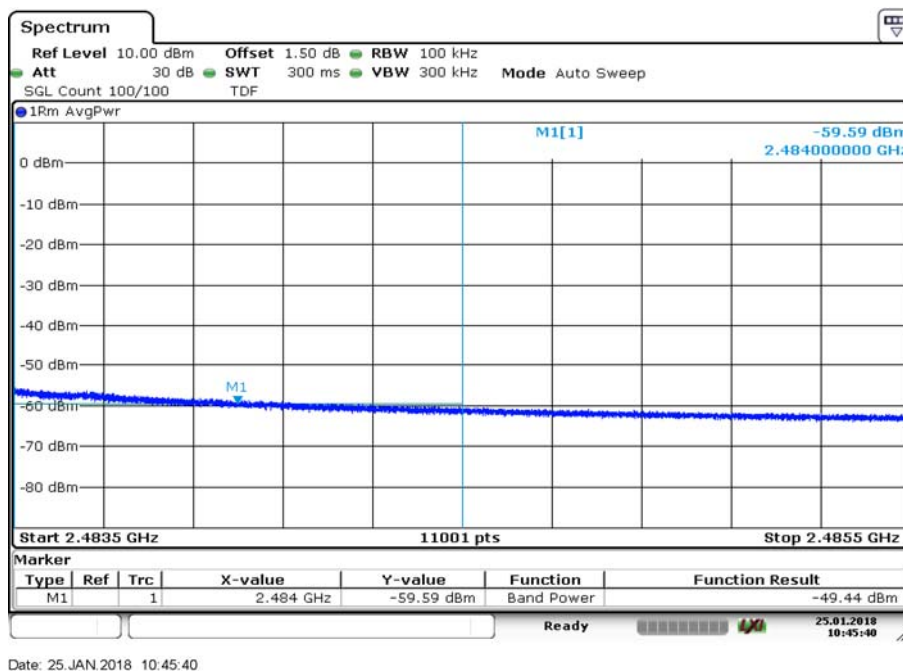
### Limits:

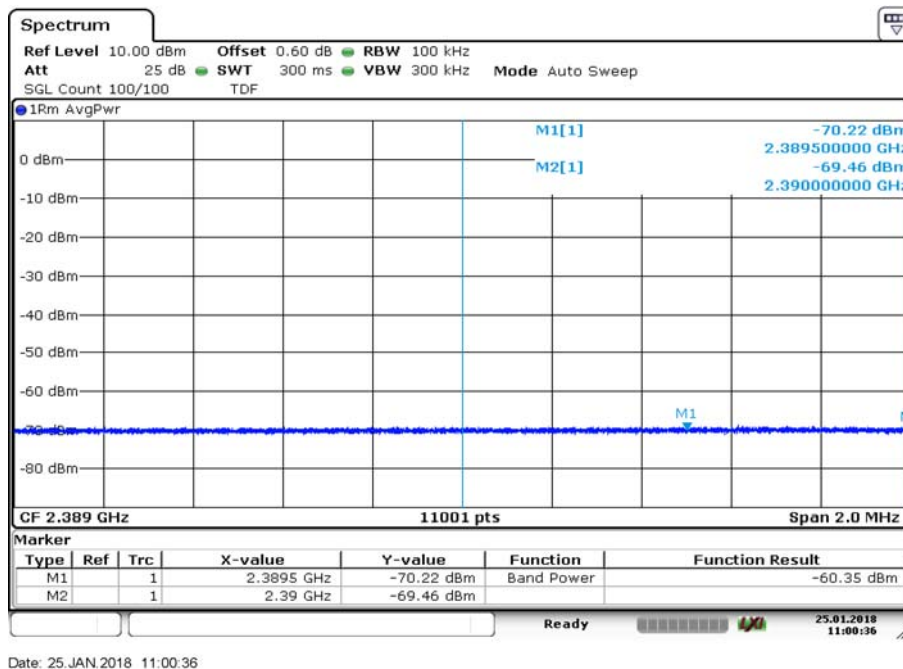
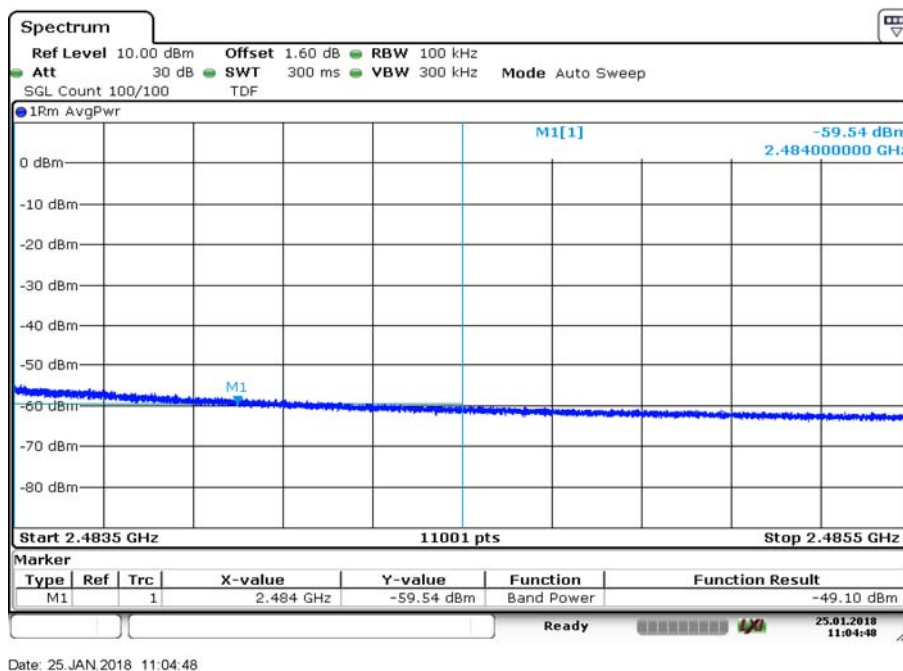
| FCC                                                                                                    | IC |
|--------------------------------------------------------------------------------------------------------|----|
| 74 dBµV/m @ 3 m (Peak)<br>54 dBµV/m @ 3 m (AVG)<br>-41.2 dBm (if measured according DTS clause 13.3.2) |    |

### Results:

| band edge compliance conducted / dBm |           |           |     |
|--------------------------------------|-----------|-----------|-----|
|                                      | Antenna 1 | Antenna 2 | -/- |
| Lower band edge                      | -62.9     | -49.4     | -/- |
| Upper band edge                      | -60.4     | -49.1     | -/- |

Note: Antenna gain as well as duty cycle correction factor is considered with the Reference Level Offset

**Plots:** GFSK - Antenna 1**Plot 1:** lower band edge**Plot 2:** upper band edge

**Plots:** GFSK - Antenna 2**Plot 1:** lower band edge**Plot 2:** upper band edge

## 12.6 Spurious emissions radiated below 30 MHz

### Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The limits are recalculated to a measurement distance of 3 m with 40 dB/decade according CFR Part 2.

### Measurement:

| Measurement parameter   |                                            |
|-------------------------|--------------------------------------------|
| Detector                | Peak / Quasi Peak                          |
| Sweep time              | Auto                                       |
| Resolution bandwidth    | F < 150 kHz: 200 Hz<br>F > 150 kHz: 9 kHz  |
| Video bandwidth         | F < 150 kHz: 1 kHz<br>F > 150 kHz: 100 kHz |
| Span                    | 9 kHz to 30 MHz                            |
| Trace mode              | Max Hold                                   |
| Test setup              | See chapter 6.2 A                          |
| Measurement uncertainty | See chapter 8                              |

### Limits:

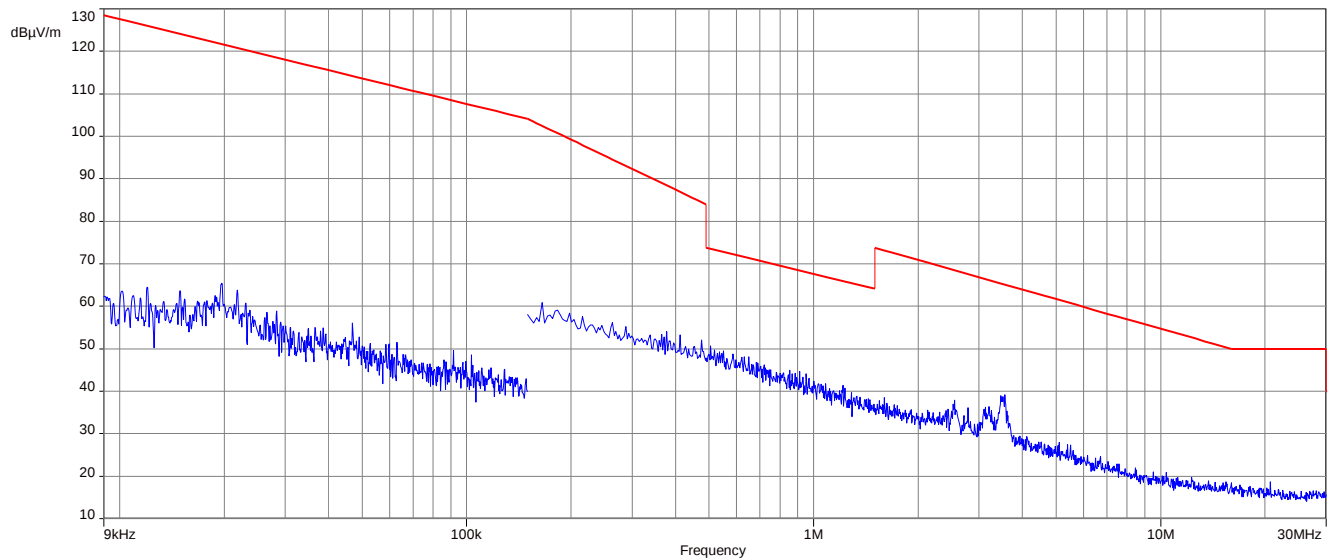
| FCC             |                                   | IC                       |
|-----------------|-----------------------------------|--------------------------|
| Frequency / MHz | Field Strength / (dB $\mu$ V / m) | Measurement distance / m |
| 0.009 – 0.490   | 2400/F(kHz)                       | 300                      |
| 0.490 – 1.705   | 24000/F(kHz)                      | 30                       |
| 1.705 – 30.0    | 30                                | 30                       |

### Results:

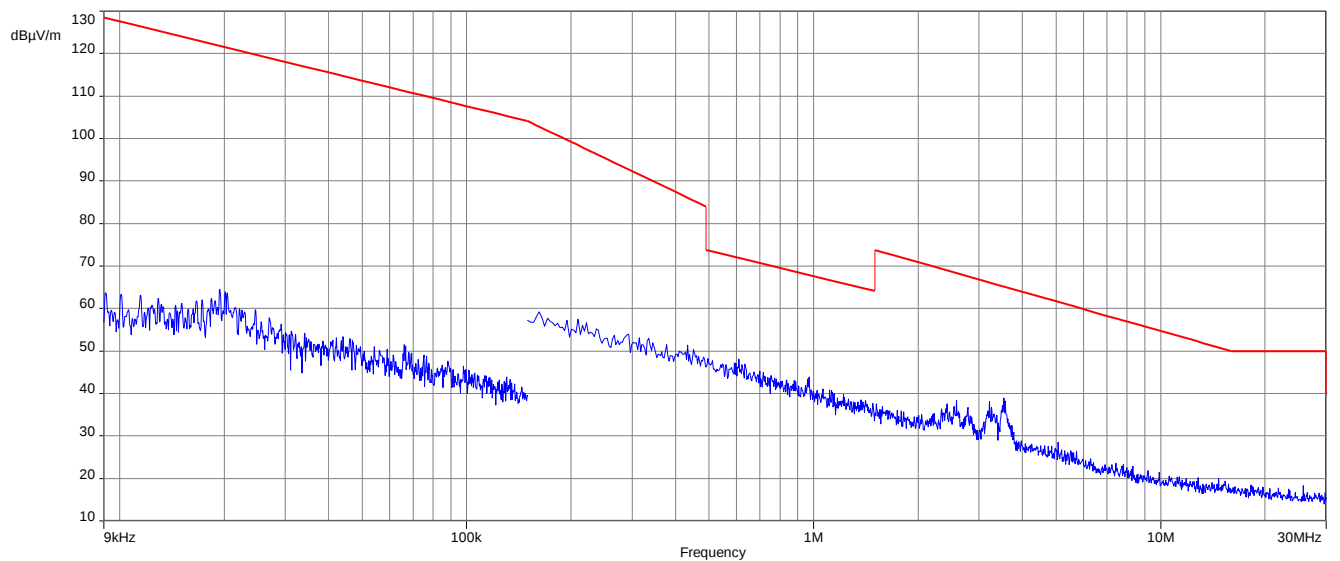
| TX spurious emissions radiated < 30 MHz / (dB $\mu$ V / m) @ 3 m |          |                          |
|------------------------------------------------------------------|----------|--------------------------|
| Frequency / MHz                                                  | Detector | Level / (dB $\mu$ V / m) |
| All detected peaks are more than 20 dB below the limit.          |          |                          |

**Plots:** GFSK (Antenna 1)

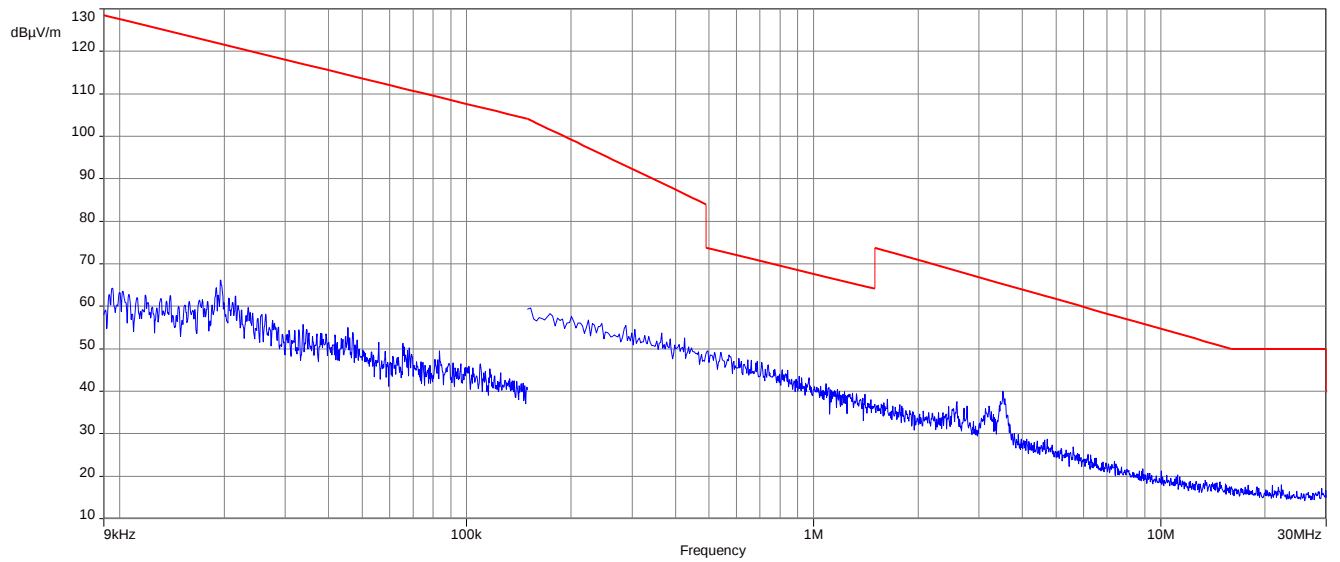
**Plot 1:** 9 kHz to 30 MHz, lowest channel



**Plot 2:** 9 kHz to 30 MHz, middle channel

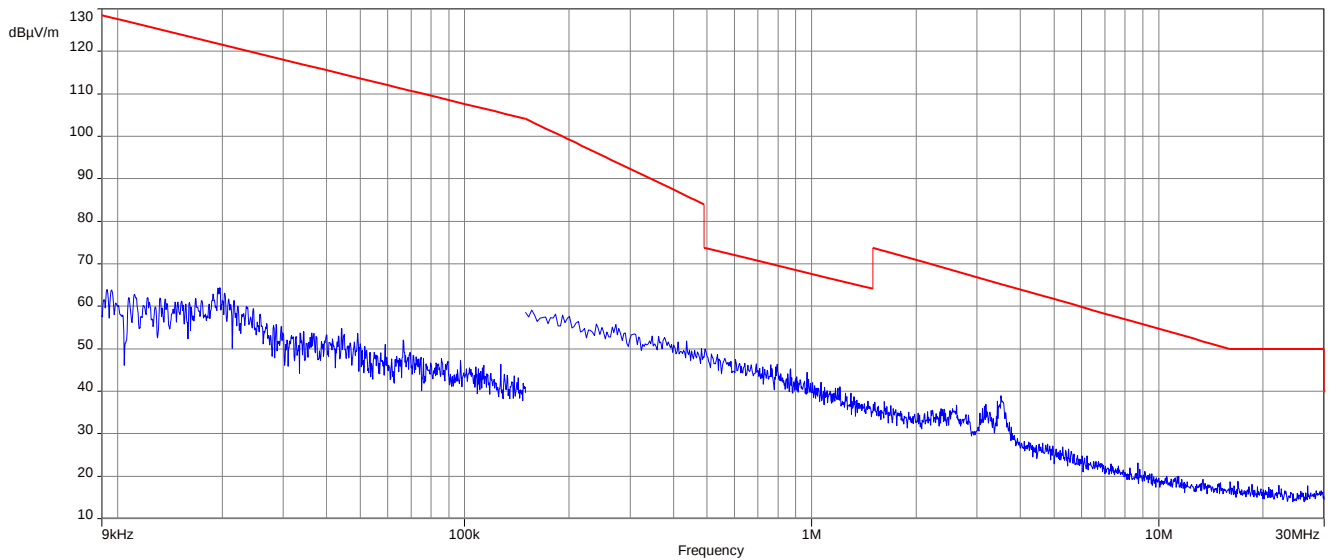


**Plot 3:** 9 kHz to 30 MHz, highest channel

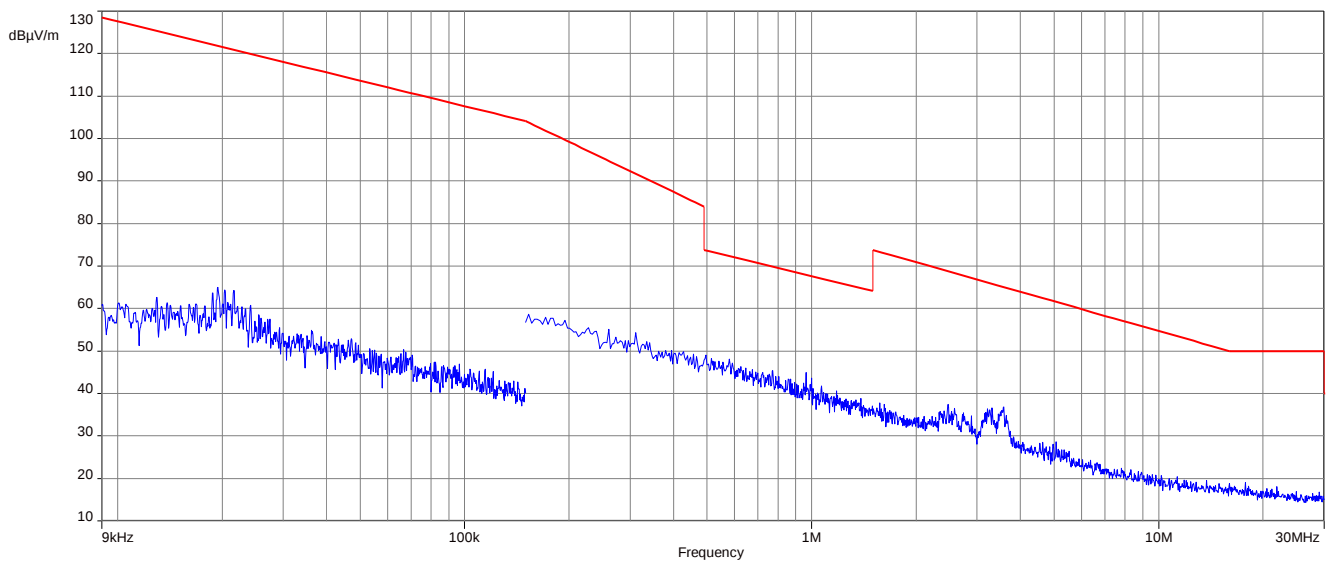


**Plots:** GFSK (Antenna 2)

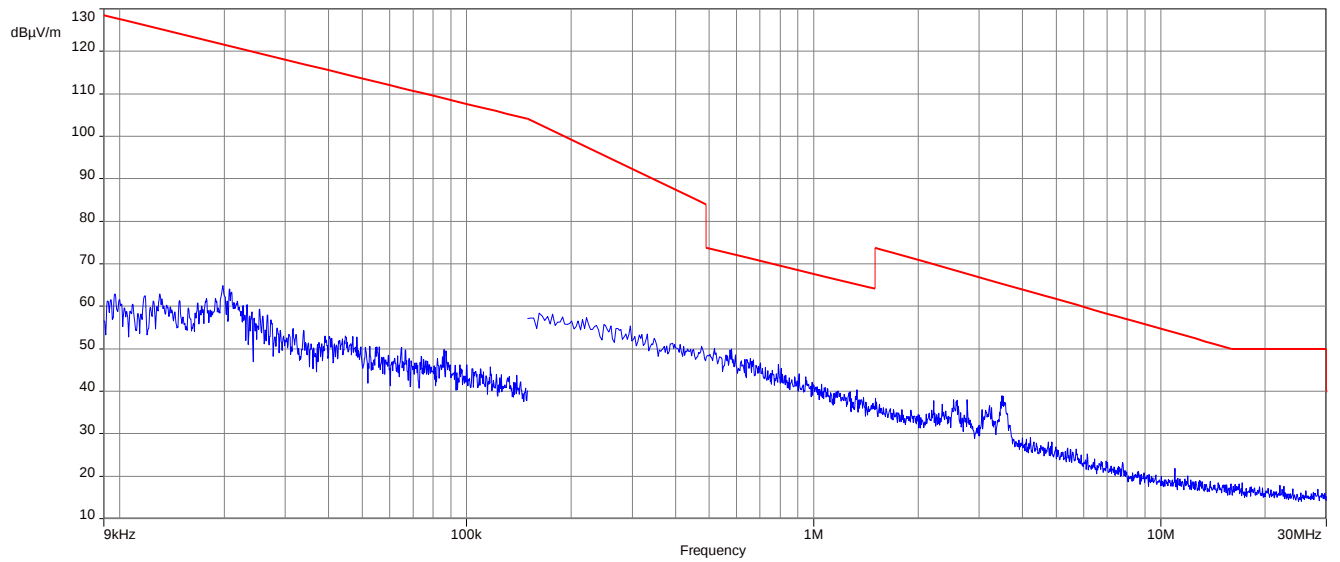
**Plot 1:** 9 kHz to 30 MHz, lowest channel



**Plot 2:** 9 kHz to 30 MHz, middle channel



**Plot 3:** 9 kHz to 30 MHz, highest channel



## 12.7 Spurious emissions radiated 30 MHz to 1 GHz

### Description:

Measurement of the radiated spurious emissions and cabinet radiations below 1 GHz.

### Measurement:

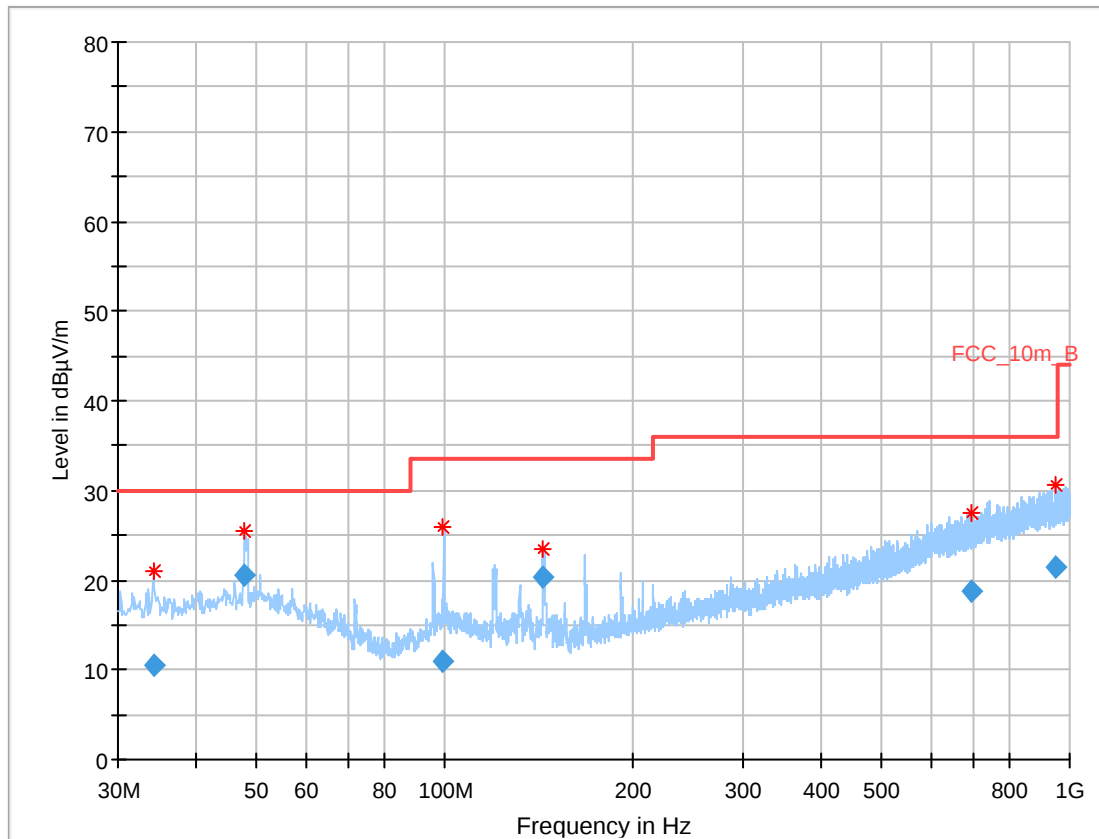
| Measurement parameter   |                   |
|-------------------------|-------------------|
| Detector                | Peak / Quasi Peak |
| Sweep time              | Auto              |
| Resolution bandwidth    | 120 kHz           |
| Video bandwidth         | 3 x RBW           |
| Span                    | 30 MHz to 1 GHz   |
| Trace mode              | Max Hold          |
| Test setup              | See chapter 6.1 A |
| Measurement uncertainty | See chapter 8     |

### Limits:

| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             | IC                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------|
| <p>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. 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 §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).</p> |                             |                          |
| Frequency / MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Field Strength / (dBµV / m) | Measurement distance / m |
| 30 – 88                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 30.0                        | 10                       |
| 88 – 216                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 33.5                        | 10                       |
| 216 – 960                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 36.0                        | 10                       |

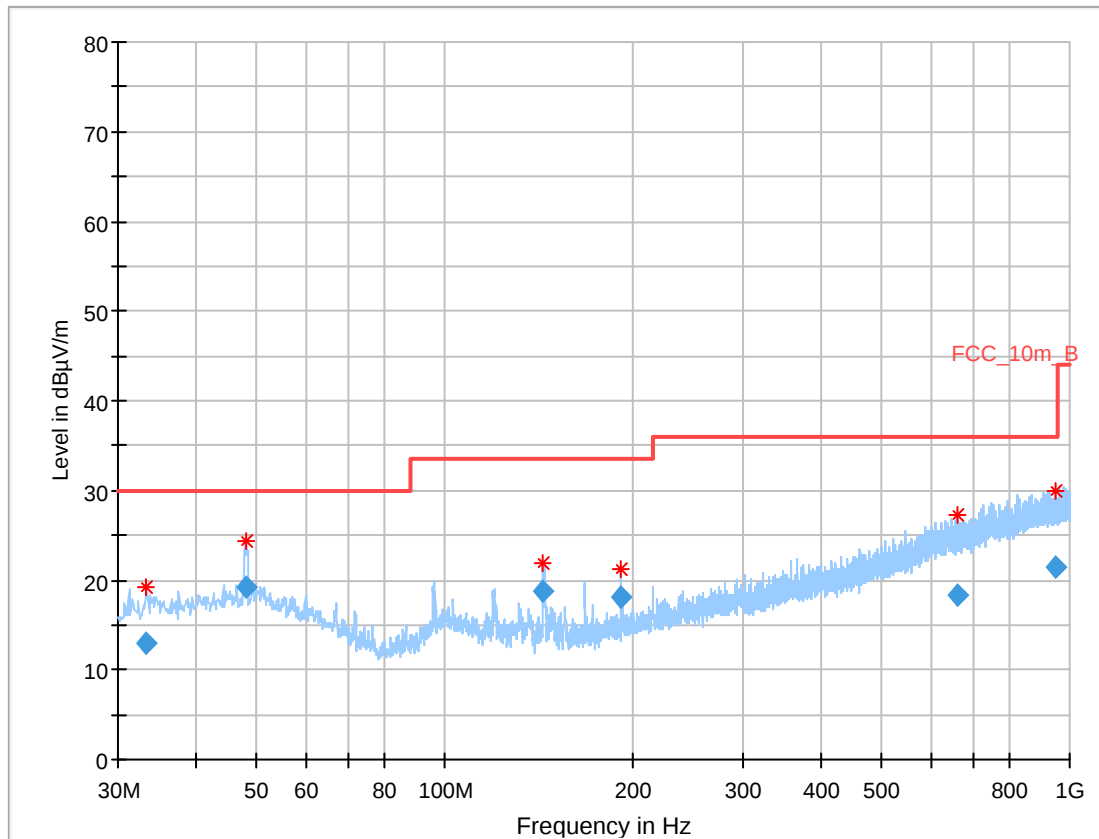
**Plot:** GFSK (Antenna 1)

**Plot 1:** 30 MHz to 1 GHz, vertical & horizontal polarization, lowest channel

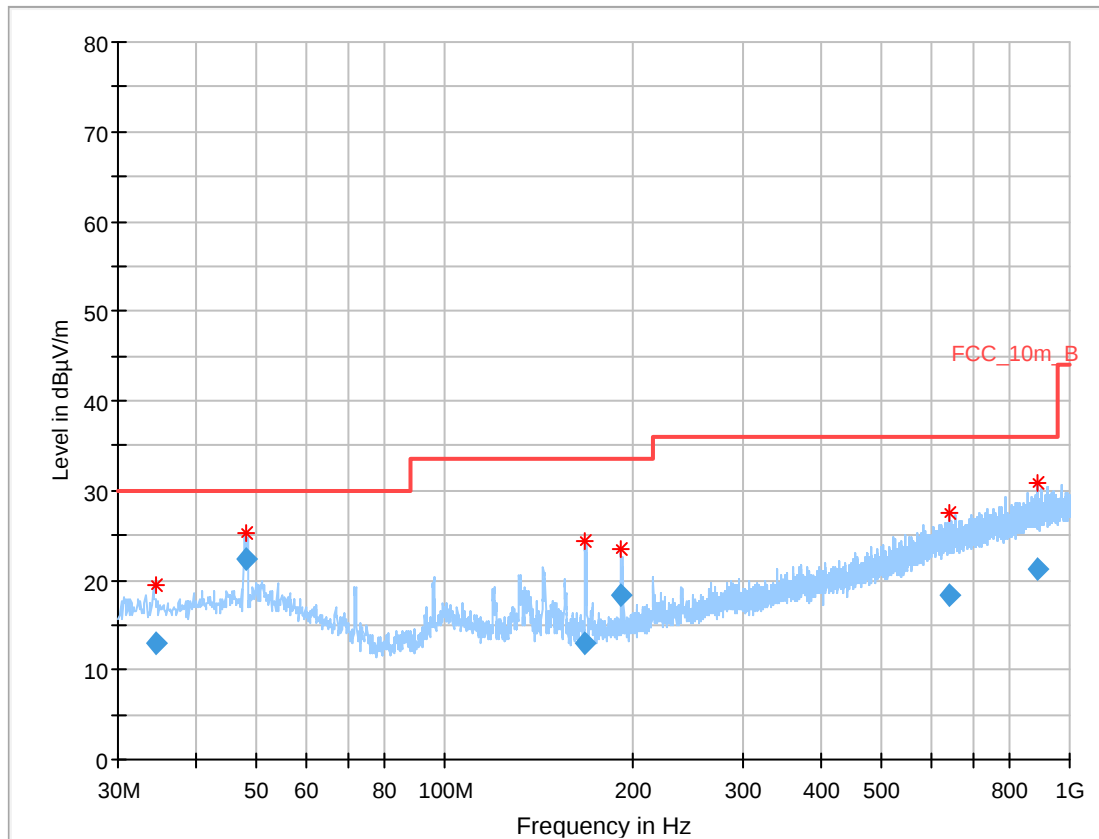


### Final results:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 34.354          | 10.43              | 30.0           | 19.57       | 1000            | 120             | 101.0       | V   | 172.0         | 12.6       |
| 47.856          | 20.65              | 30.0           | 9.35        | 1000            | 120             | 98.0        | V   | 342.0         | 13.7       |
| 99.502          | 10.91              | 33.5           | 22.59       | 1000            | 120             | 101.0       | V   | 117.0         | 12.0       |
| 143.806         | 20.32              | 33.5           | 13.18       | 1000            | 120             | 98.0        | V   | -4.0          | 9.0        |
| 694.549         | 18.84              | 36.0           | 17.16       | 1000            | 120             | 170.0       | V   | 105.0         | 21.5       |
| 950.272         | 21.52              | 36.0           | 14.48       | 1000            | 120             | 101.0       | H   | 347.0         | 24.3       |

**Plot 2:** 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel**Final results:**

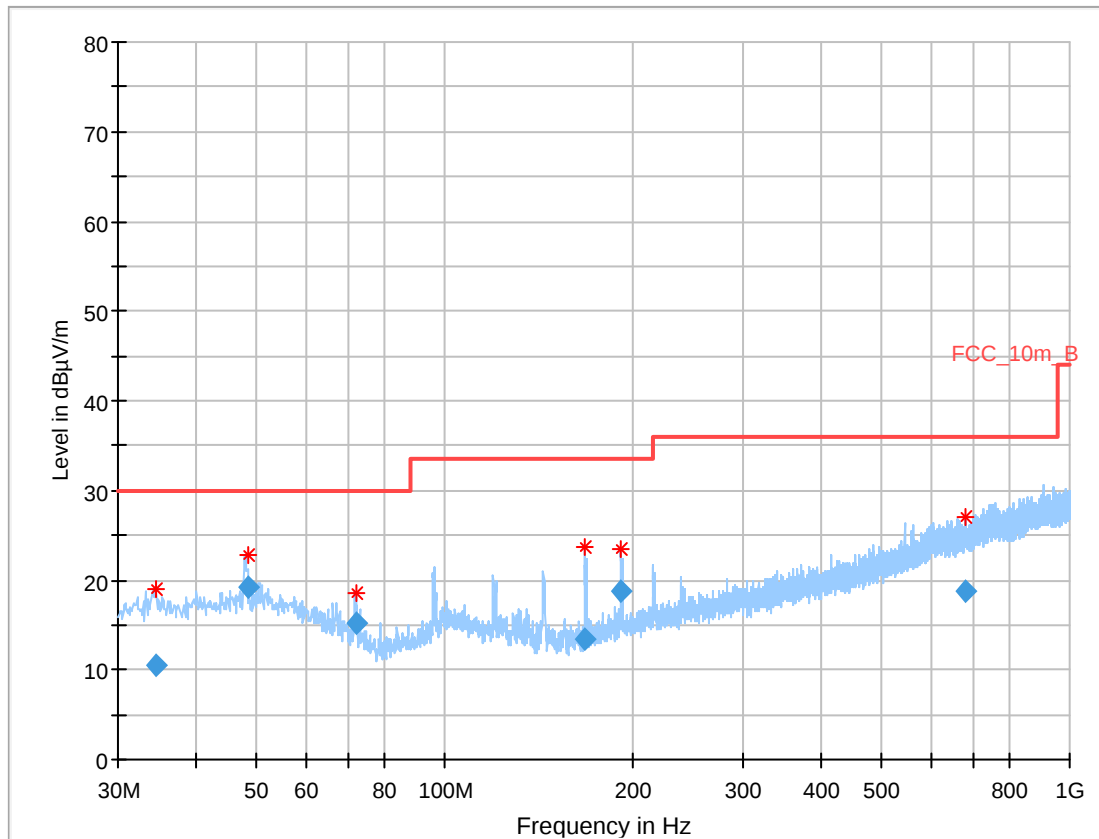
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 33.172          | 12.96              | 30.0           | 17.04       | 1000            | 120             | 101.0       | V   | 353.0         | 12.4       |
| 48.055          | 19.24              | 30.0           | 10.76       | 1000            | 120             | 98.0        | V   | 65.0          | 13.7       |
| 143.658         | 18.81              | 33.5           | 14.69       | 1000            | 120             | 98.0        | V   | -6.0          | 9.0        |
| 191.327         | 18.02              | 33.5           | 15.48       | 1000            | 120             | 98.0        | V   | 200.0         | 11.5       |
| 662.969         | 18.42              | 36.0           | 17.58       | 1000            | 120             | 98.0        | H   | 53.0          | 21.2       |
| 950.034         | 21.51              | 36.0           | 14.49       | 1000            | 120             | 101.0       | H   | -9.0          | 24.3       |

**Plot 3:** 30 MHz to 1 GHz, vertical & horizontal polarization, highest channel**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 34.623          | 12.97              | 30.0           | 17.03       | 1000            | 120             | 100.0       | V   | 350.0         | 12.6       |
| 47.980          | 22.45              | 30.0           | 7.55        | 1000            | 120             | 98.0        | V   | 198.0         | 13.7       |
| 167.946         | 12.91              | 33.5           | 20.59       | 1000            | 120             | 98.0        | V   | 33.0          | 10.2       |
| 191.712         | 18.36              | 33.5           | 15.14       | 1000            | 120             | 170.0       | V   | 65.0          | 11.5       |
| 641.822         | 18.32              | 36.0           | 17.68       | 1000            | 120             | 170.0       | V   | 244.0         | 21.1       |
| 887.765         | 21.34              | 36.0           | 14.66       | 1000            | 120             | 101.0       | V   | 285.0         | 24.0       |

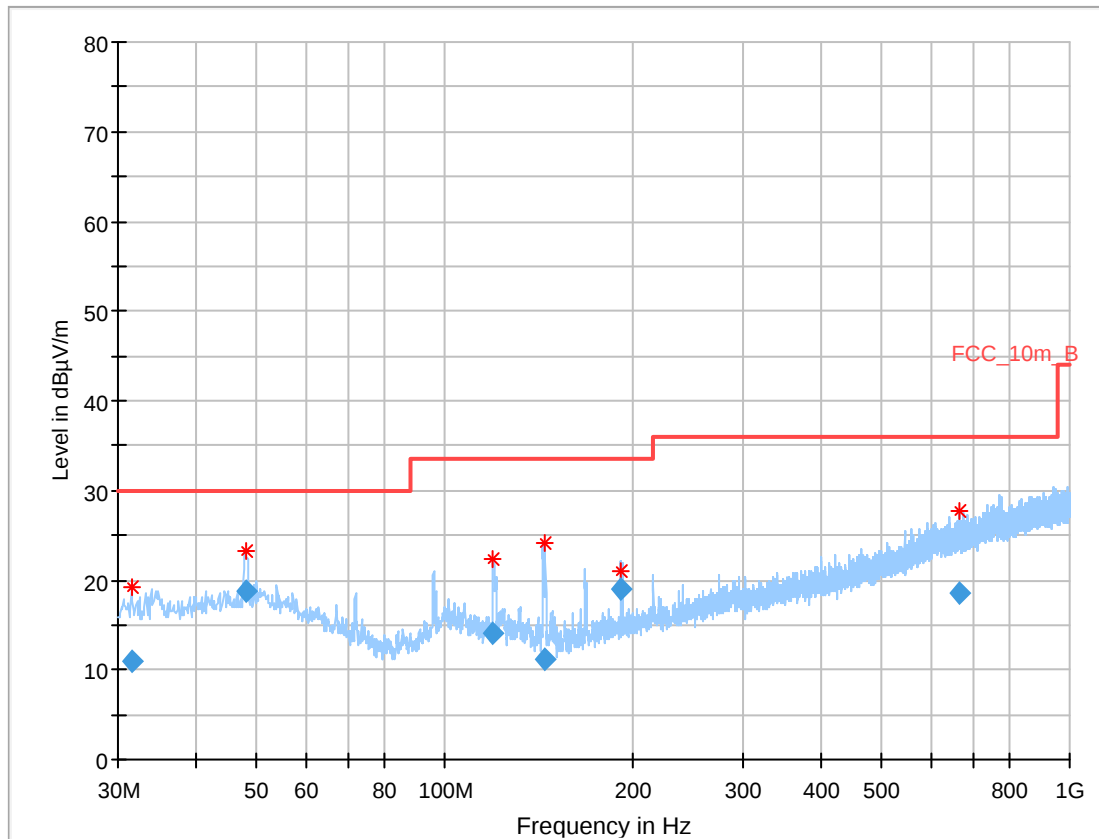
**Plot:** GFSK (Antenna 2)

**Plot 1:** 30 MHz to 1 GHz, vertical & horizontal polarization, lowest channel

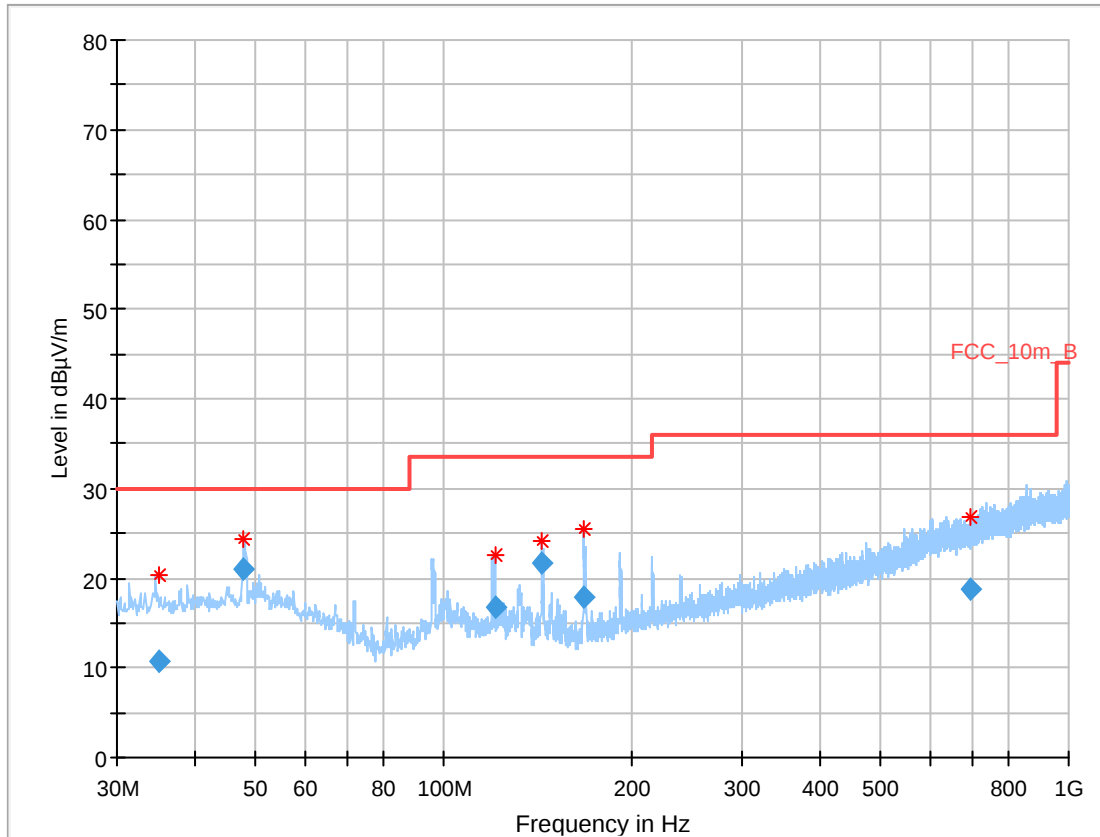


### Final results:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 34.413          | 10.46              | 30.0           | 19.54       | 1000            | 120             | 101.0       | V   | 341.0         | 12.6       |
| 48.316          | 19.16              | 30.0           | 10.84       | 1000            | 120             | 101.0       | V   | 341.0         | 13.7       |
| 71.993          | 15.10              | 30.0           | 14.90       | 1000            | 120             | 170.0       | V   | 331.0         | 9.4        |
| 167.972         | 13.51              | 33.5           | 19.99       | 1000            | 120             | 98.0        | V   | 192.0         | 10.2       |
| 191.489         | 18.68              | 33.5           | 14.82       | 1000            | 120             | 101.0       | V   | 264.0         | 11.5       |
| 681.177         | 18.76              | 36.0           | 17.24       | 1000            | 120             | 170.0       | H   | 126.0         | 21.4       |

**Plot 2:** 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel**Final results:**

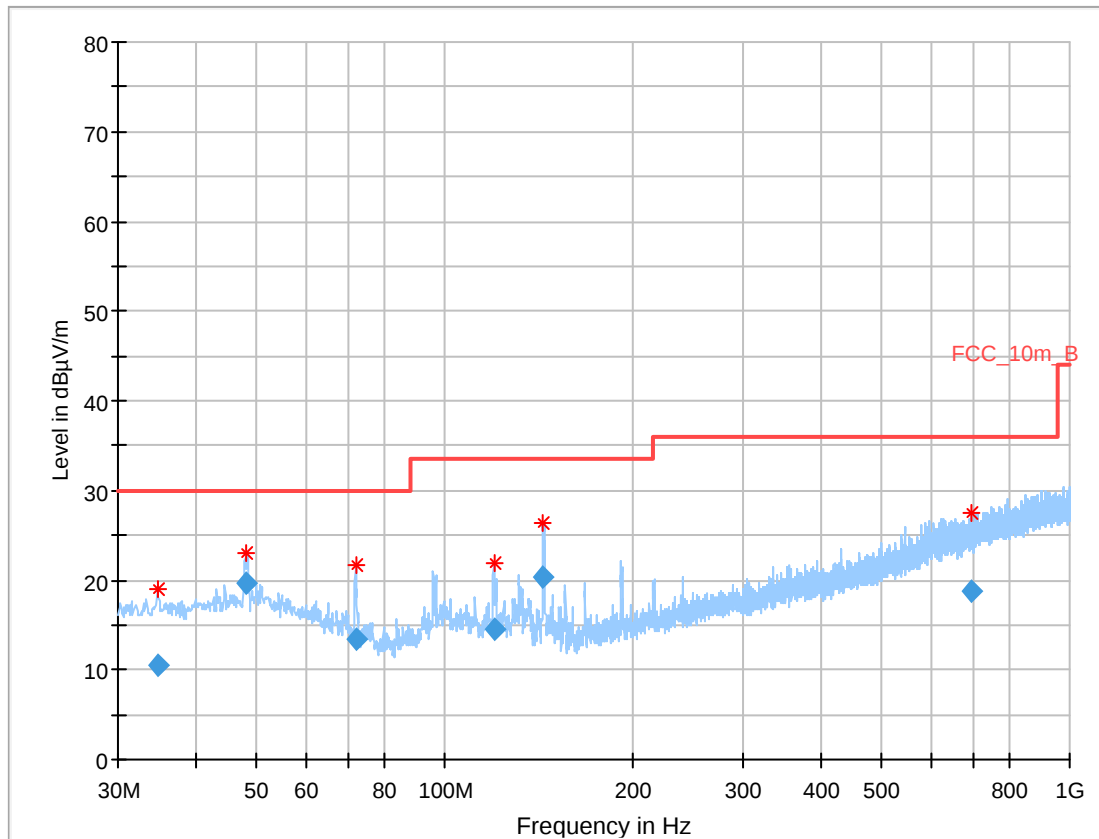
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 31.618          | 11.06              | 30.0           | 18.94       | 1000            | 120             | 98.0        | V   | 232.0         | 12.1       |
| 47.967          | 18.84              | 30.0           | 11.16       | 1000            | 120             | 98.0        | V   | 0.0           | 13.7       |
| 119.710         | 14.06              | 33.5           | 19.44       | 1000            | 120             | 170.0       | V   | 172.0         | 10.3       |
| 144.145         | 11.22              | 33.5           | 22.28       | 1000            | 120             | 98.0        | V   | 153.0         | 9.0        |
| 191.391         | 18.98              | 33.5           | 14.52       | 1000            | 120             | 170.0       | V   | 266.0         | 11.5       |
| 667.271         | 18.57              | 36.0           | 17.43       | 1000            | 120             | 98.0        | V   | 182.0         | 21.3       |

**Plot 3:** 30 MHz to 1 GHz, vertical & horizontal polarization, highest channel**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 35.045          | 10.69              | 30.0           | 19.31       | 1000            | 120             | 170.0       | V   | 345.0         | 12.7       |
| 47.901          | 20.92              | 30.0           | 9.08        | 1000            | 120             | 98.0        | V   | 169.0         | 13.7       |
| 120.698         | 16.85              | 33.5           | 16.65       | 1000            | 120             | 170.0       | V   | 344.0         | 10.2       |
| 143.528         | 21.70              | 33.5           | 11.80       | 1000            | 120             | 98.0        | V   | 16.0          | 9.0        |
| 167.966         | 17.79              | 33.5           | 15.71       | 1000            | 120             | 98.0        | V   | 204.0         | 10.2       |
| 695.128         | 18.83              | 36.0           | 17.17       | 1000            | 120             | 170.0       | H   | 298.0         | 21.5       |

**Plot:** RX / Idle mode (Antenna 1)

**Plot 1:** 30 MHz to 1 GHz, vertical & horizontal polarization

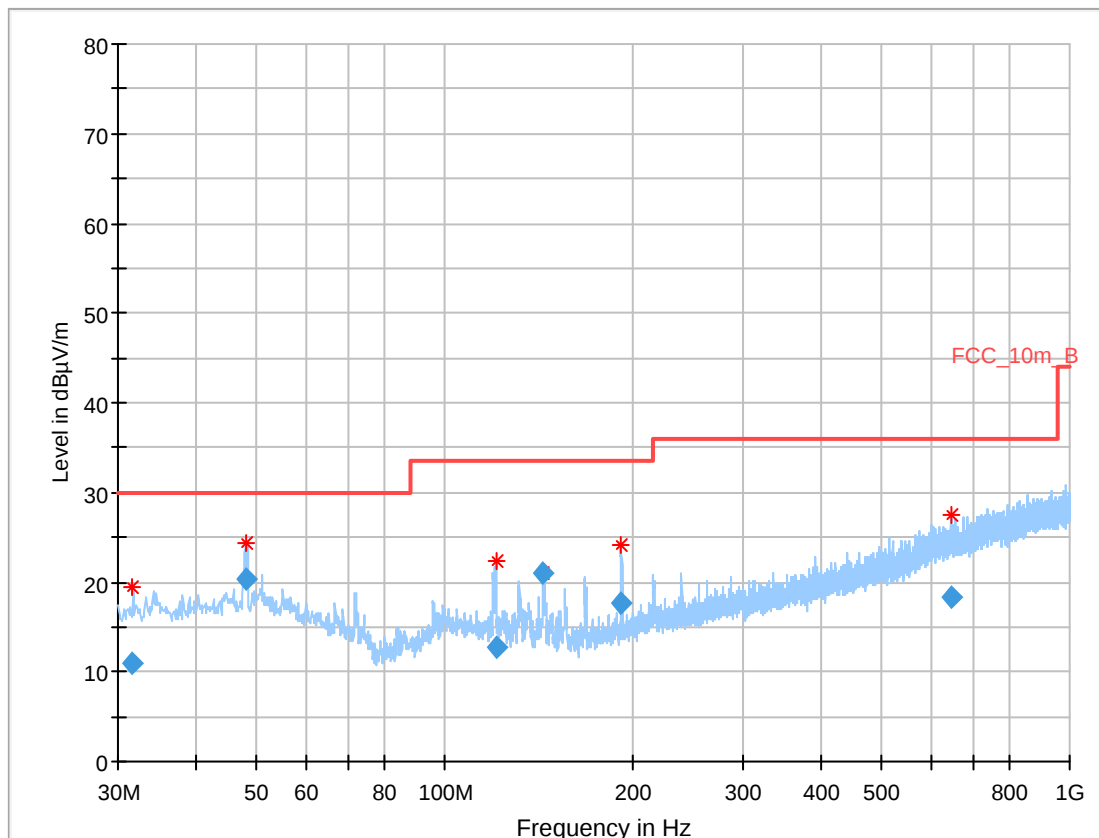


### Final results:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 34.898          | 10.41              | 30.0           | 19.59       | 1000            | 120             | 101.0       | V   | 179.0         | 12.6       |
| 47.992          | 19.75              | 30.0           | 10.25       | 1000            | 120             | 170.0       | V   | 10.0          | 13.7       |
| 72.088          | 13.31              | 30.0           | 16.69       | 1000            | 120             | 101.0       | V   | 110.0         | 9.4        |
| 120.022         | 14.49              | 33.5           | 19.01       | 1000            | 120             | 101.0       | V   | 116.0         | 10.3       |
| 144.011         | 20.44              | 33.5           | 13.06       | 1000            | 120             | 101.0       | V   | 331.0         | 9.0        |
| 694.861         | 18.85              | 36.0           | 17.15       | 1000            | 120             | 170.0       | H   | 243.0         | 21.5       |

**Plot:** RX / Idle mode (Antenna 2)

**Plot 1:** 30 MHz to 1 GHz, vertical & horizontal polarization



#### Final results:

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 31.624          | 10.97              | 30.0           | 19.03       | 1000            | 120             | 102.0       | V   | 347.0         | 12.1       |
| 47.968          | 20.41              | 30.0           | 9.59        | 1000            | 120             | 98.0        | V   | 189.0         | 13.7       |
| 120.712         | 12.76              | 33.5           | 20.74       | 1000            | 120             | 170.0       | V   | 0.0           | 10.2       |
| 143.978         | 20.95              | 33.5           | 12.55       | 1000            | 120             | 100.0       | V   | 85.0          | 9.0        |
| 191.501         | 17.71              | 33.5           | 15.79       | 1000            | 120             | 98.0        | V   | 111.0         | 11.5       |
| 644.769         | 18.33              | 36.0           | 17.67       | 1000            | 120             | 170.0       | H   | 182.0         | 21.1       |

## 12.8 Spurious emissions radiated above 1 GHz

### Description:

Measurement of the radiated spurious emissions above 1 GHz in transmit mode and receiver / idle mode.

### Measurement:

| Measurement parameter   |                           |
|-------------------------|---------------------------|
| Detector                | Peak / RMS                |
| Sweep time              | Auto                      |
| Resolution bandwidth    | 1 MHz                     |
| Video bandwidth         | 3 x RBW                   |
| Span                    | 1 GHz to 26 GHz           |
| Trace mode              | Max Hold                  |
| Test setup              | See chapter 6.2 B & 6.3 A |
| Measurement uncertainty | See chapter 8             |

### Limits:

| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             | IC                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------|
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. 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 §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). |                             |                          |
| Frequency / MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Field Strength / (dBµV / m) | Measurement distance / m |
| Above 960                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 54.0 (AVG)                  | 3                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 74.0 (peak)                 |                          |

**Results:** GFSK (Antenna 1)

| TX spurious emissions radiated / dBµV/m @ 3 m       |          |                |                |          |                |                 |          |                |
|-----------------------------------------------------|----------|----------------|----------------|----------|----------------|-----------------|----------|----------------|
| lowest channel                                      |          |                | middle channel |          |                | highest channel |          |                |
| f / MHz                                             | Detector | Level / dBµV/m | f / MHz        | Detector | Level / dBµV/m | f / MHz         | Detector | Level / dBµV/m |
| 1593                                                | Peak     | 50.3           | 7329           | Peak     | 52.1           | 4961            | Peak     | 55.3           |
|                                                     | AVG      | 34.4           |                | AVG      | 43.8           |                 | AVG      | 47.4           |
| 7209                                                | Peak     | 55.1           | -/-            | Peak     | -/-            | 7441            | Peak     | 52.5           |
|                                                     | AVG      | 47.5           |                | AVG      | -/-            |                 | AVG      | 43.6           |
| For peak emissions results > 18 GHz see plots below |          |                |                |          |                |                 |          |                |

**Results:** GFSK (Antenna 2)

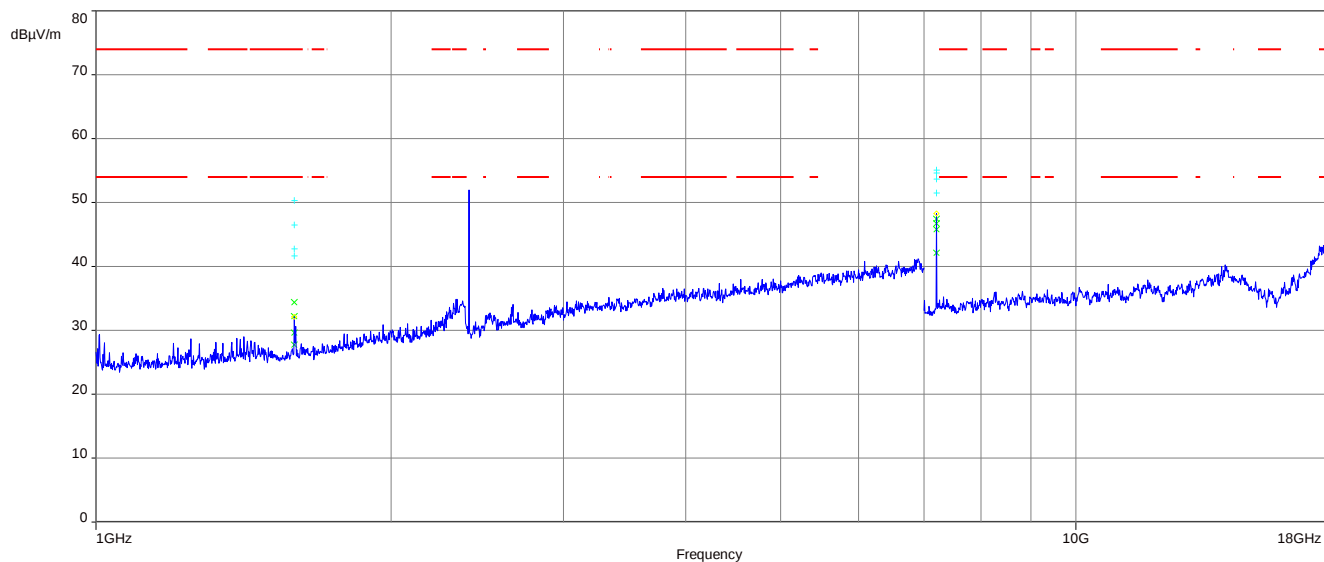
| TX spurious emissions radiated / dBµV/m @ 3 m       |          |                |                |          |                |                 |          |                |
|-----------------------------------------------------|----------|----------------|----------------|----------|----------------|-----------------|----------|----------------|
| lowest channel                                      |          |                | middle channel |          |                | highest channel |          |                |
| f / MHz                                             | Detector | Level / dBµV/m | f / MHz        | Detector | Level / dBµV/m | f / MHz         | Detector | Level / dBµV/m |
| 4805                                                | Peak     | 51.7           | 7330           | Peak     | 53.9           | 4961            | Peak     | 54.5           |
|                                                     | AVG      | 41.2           |                | AVG      | 45.1           |                 | AVG      | 48.1           |
| 7209                                                | Peak     | 58.8           |                | Peak     |                | 7441            | Peak     | 60.1           |
|                                                     | AVG      | 51.6           |                | AVG      |                |                 | AVG      | 53.9           |
| For peak emissions results > 18 GHz see plots below |          |                |                |          |                |                 |          |                |

**Results:** RX / idle – mode (Antenna 1)

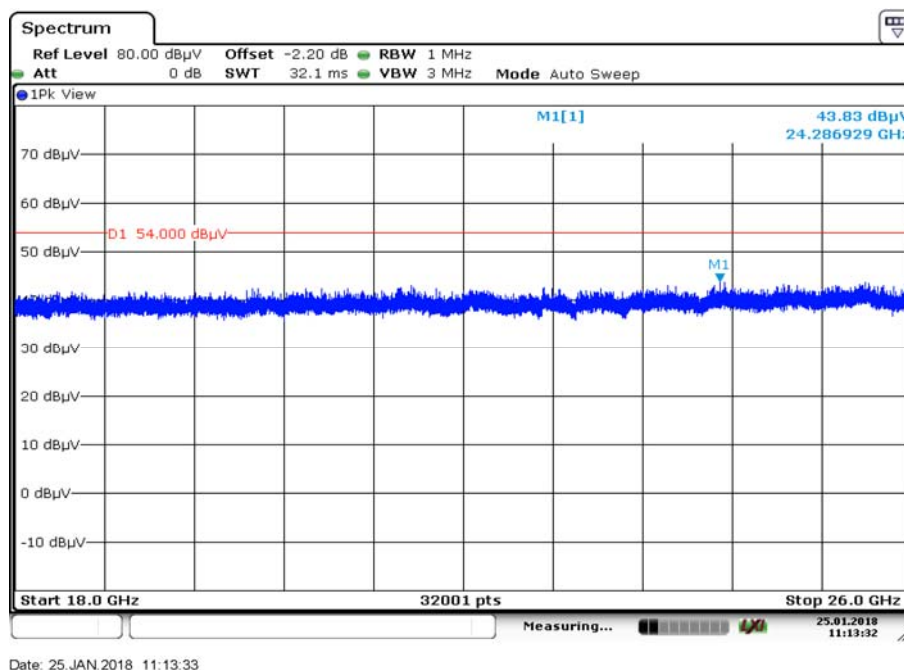
| TX spurious emissions radiated / dB $\mu$ V/m @ 3 m         |          |                      |
|-------------------------------------------------------------|----------|----------------------|
| f / MHz                                                     | Detector | Level / dB $\mu$ V/m |
| All detected emissions are more than 10 dB below the limit. |          |                      |
| For peak emissions results > 18 GHz see plots below         |          |                      |

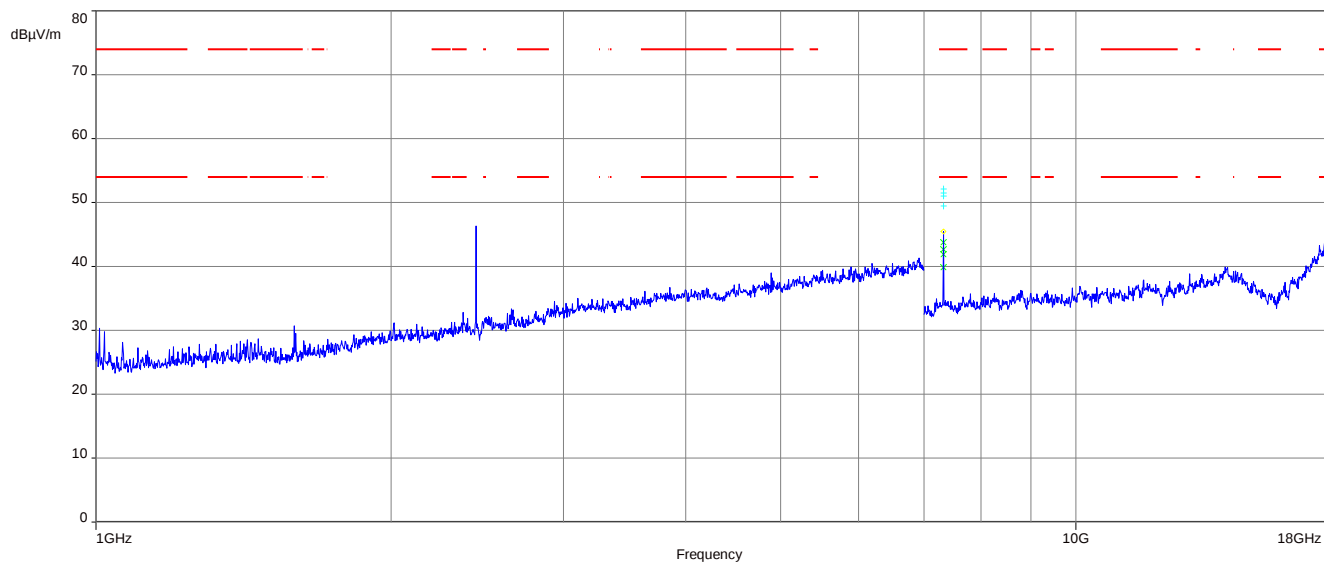
**Results:** RX / idle – mode (Antenna 2)

| TX spurious emissions radiated / dB $\mu$ V/m @ 3 m         |          |                      |
|-------------------------------------------------------------|----------|----------------------|
| f / MHz                                                     | Detector | Level / dB $\mu$ V/m |
| All detected emissions are more than 10 dB below the limit. |          |                      |
| For peak emissions results > 18 GHz see plots below         |          |                      |

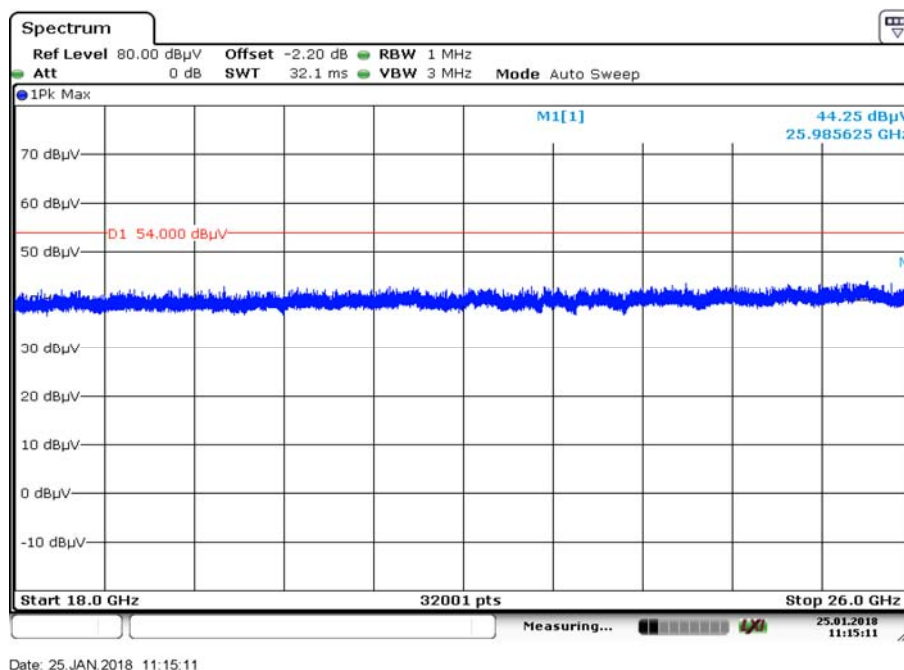
**Plots:** Antenna 1**Plot 1:** Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

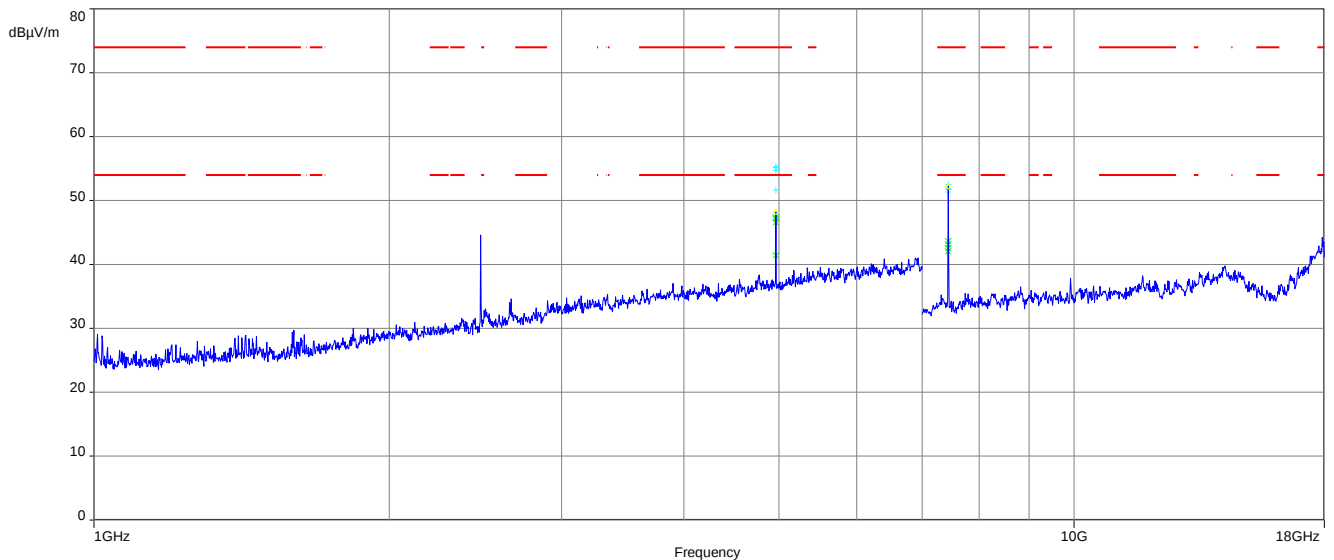
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 3:** Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

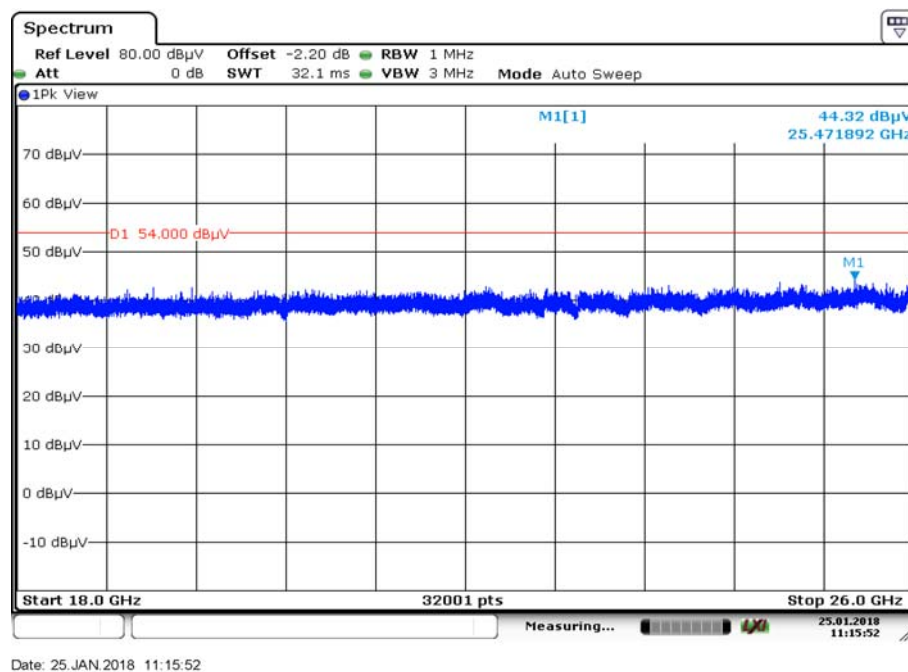
**Plot 4:** Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

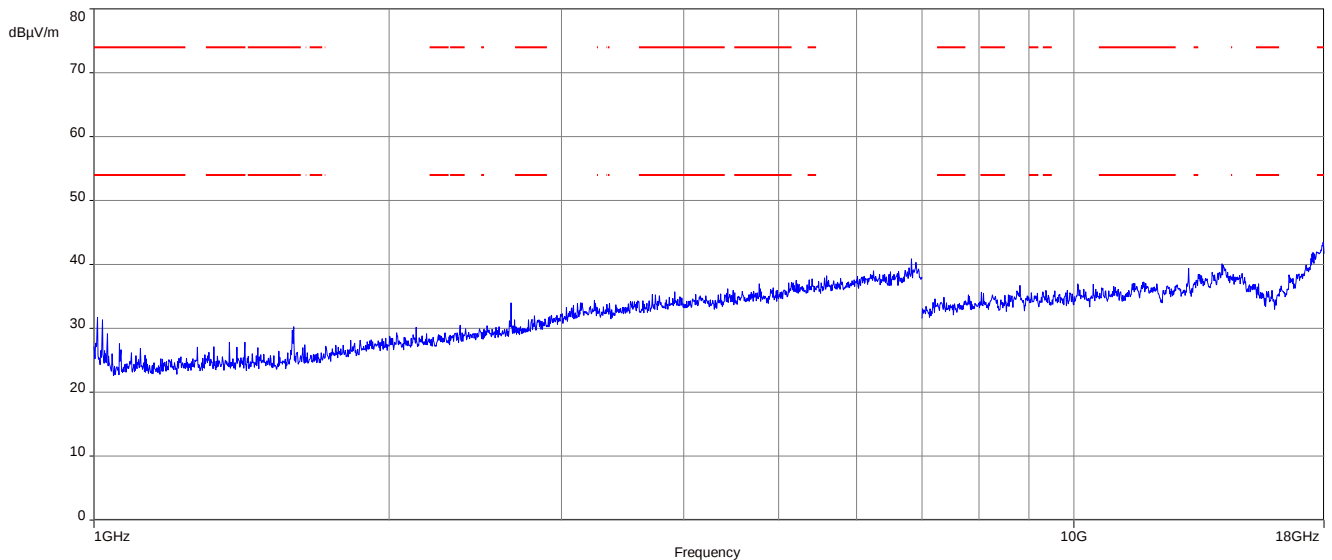
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 6:** Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization

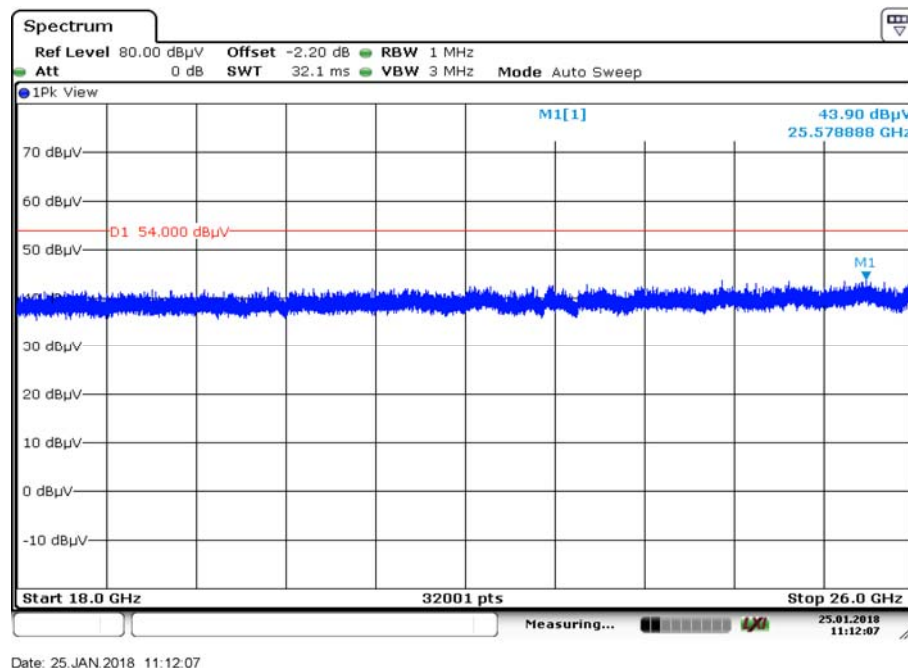
**Plot 7:** Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

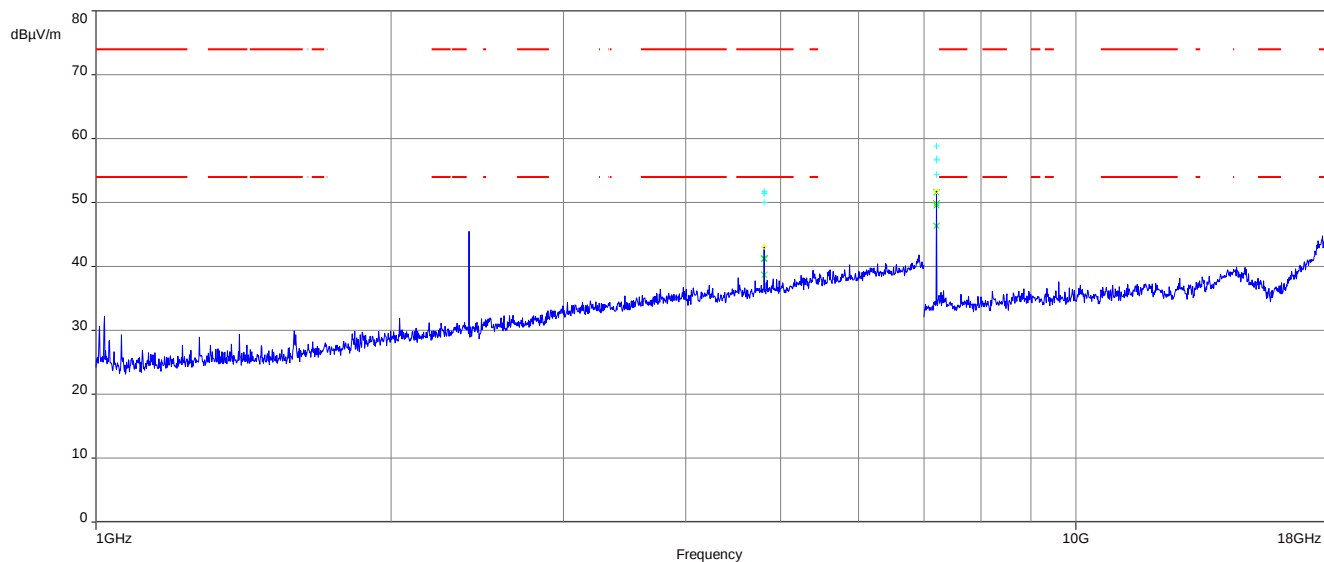
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 9:** Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

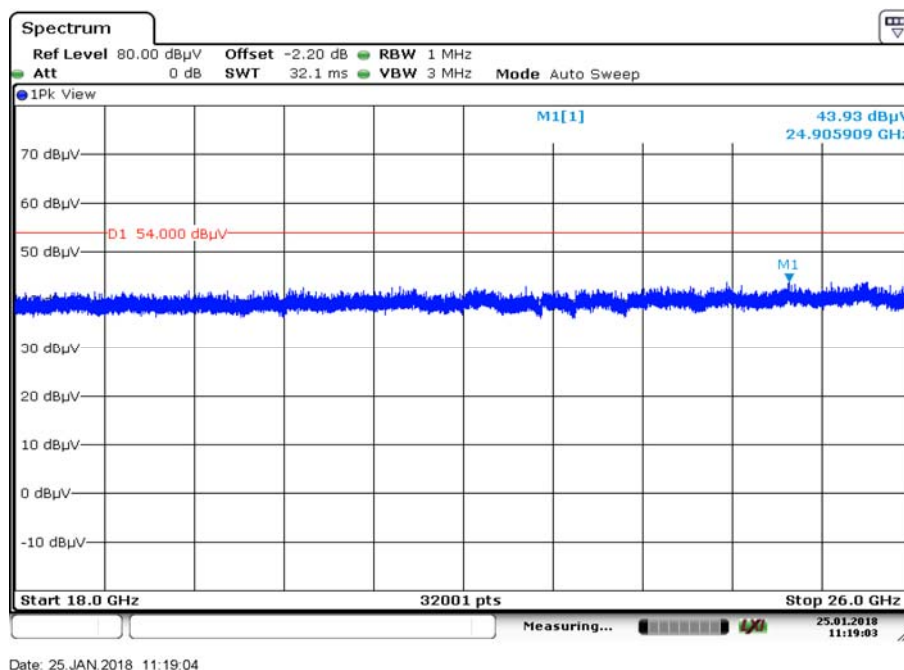
**Plot 10:** Rx-Mode, 1 GHz to 18 GHz, vertical & horizontal polarization

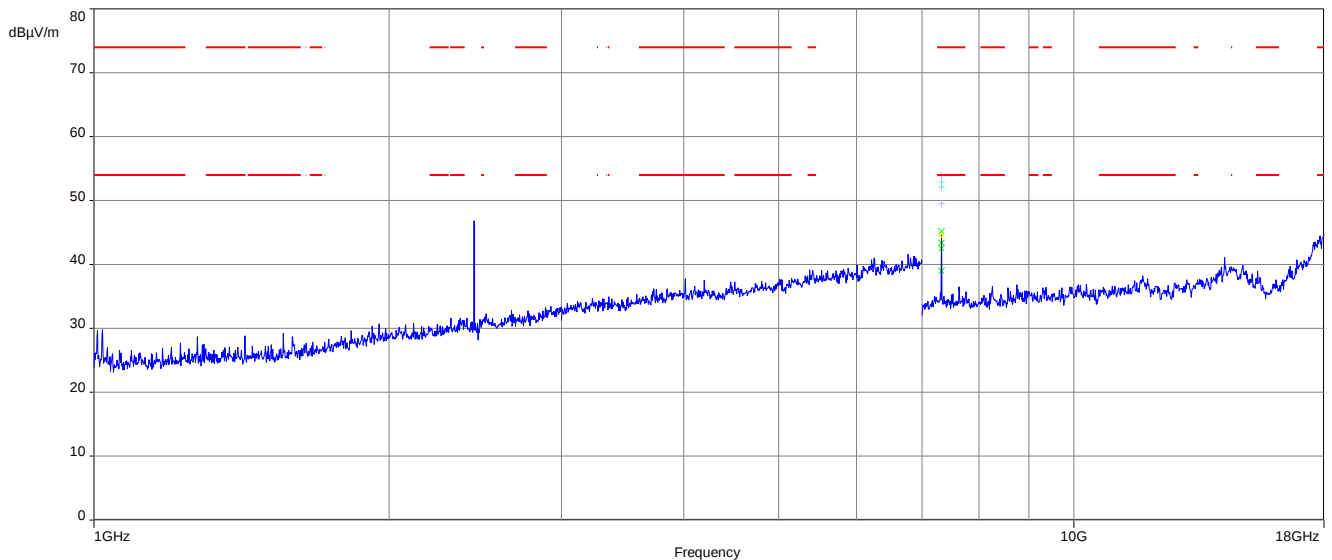
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 3:** Rx-Mode, 18 GHz to 26 GHz, vertical & horizontal polarization

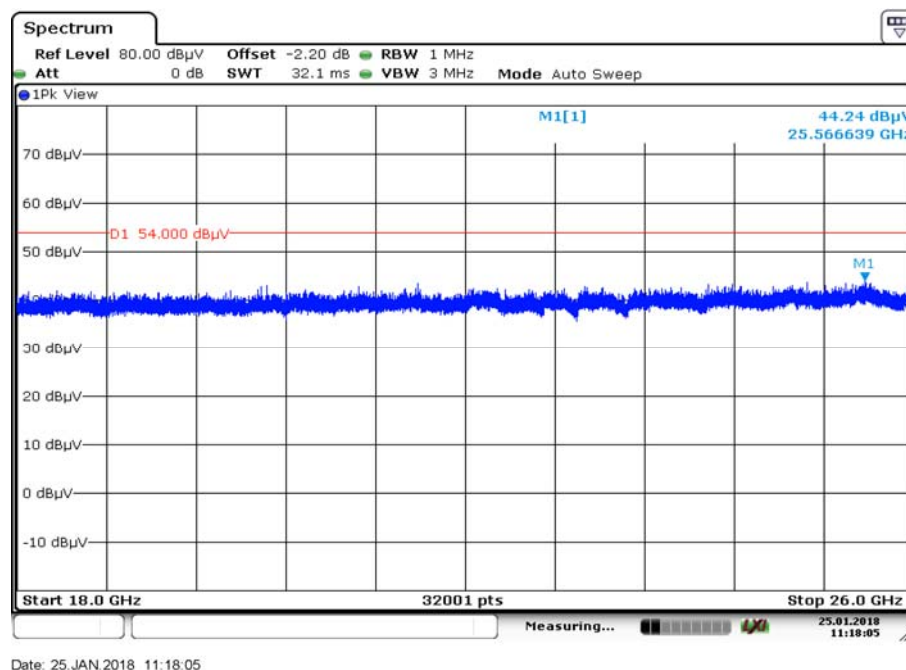
**Plots:** Antenna 2**Plot 1:** Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

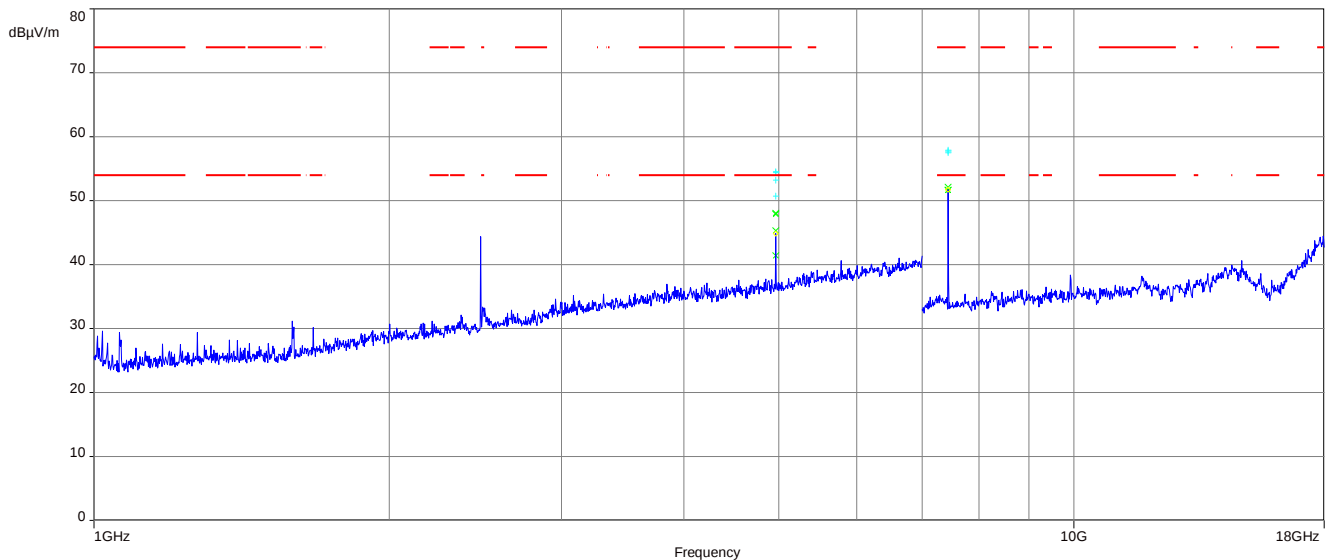
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 3:** Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

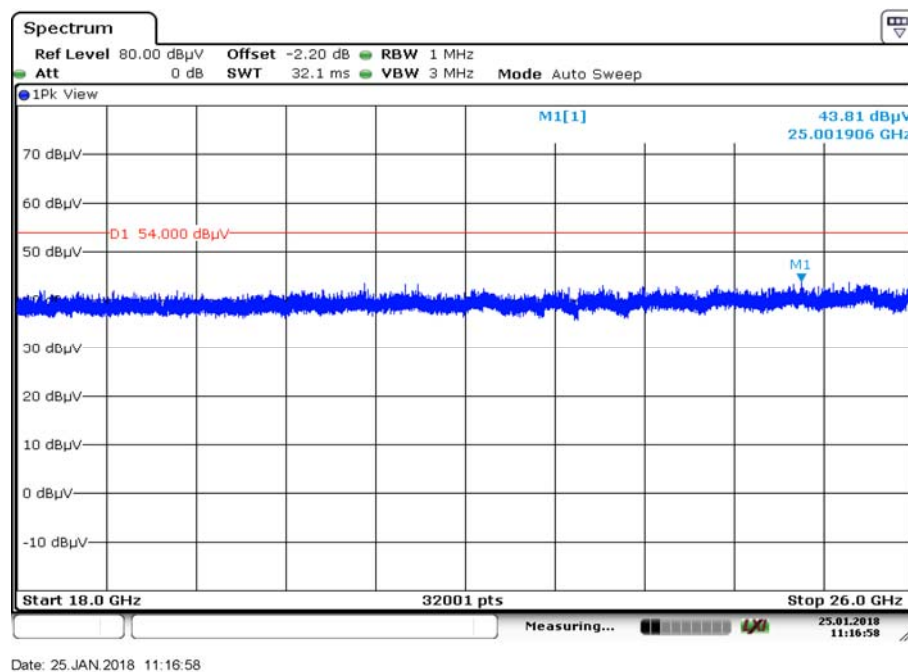
**Plot 4:** Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

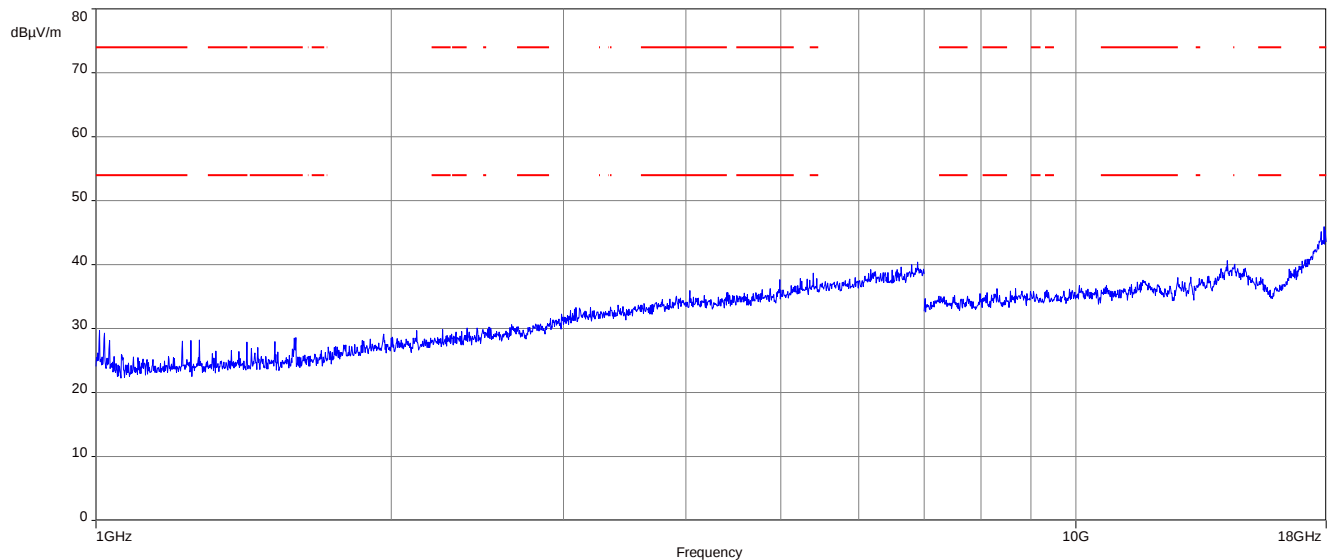
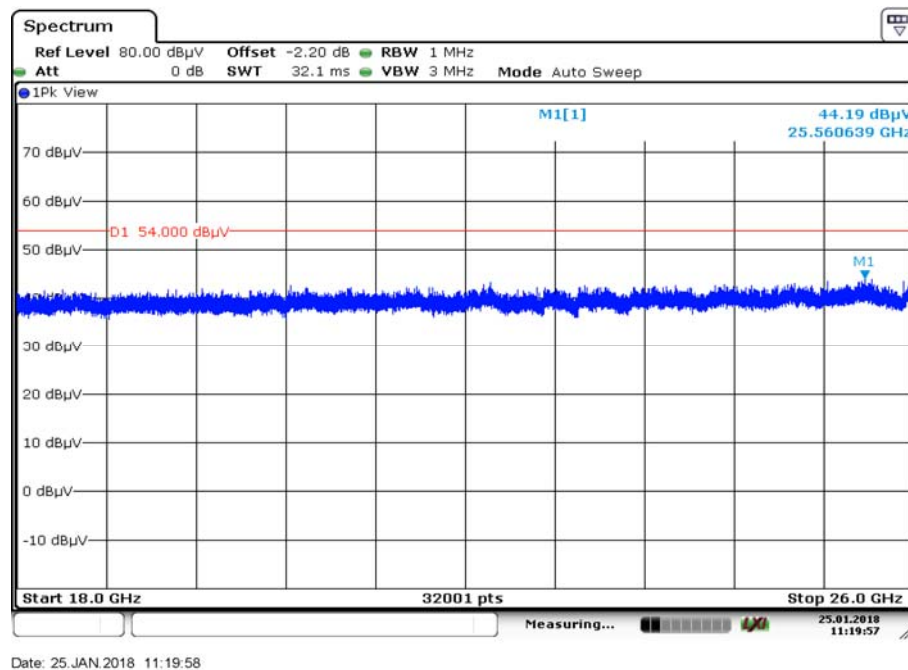
The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 6:** Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization

**Plot 7:** Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 9:** Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

**Plot 10:** Rx-Mode, 1 GHz to 18 GHz, vertical & horizontal polarization**Plot 3:** Rx-Mode, 18 GHz to 26 GHz, vertical & horizontal polarization

### 13 Observations

No observations except those reported with the single test cases have been made.

### Annex A Glossary

|                  |                                        |
|------------------|----------------------------------------|
| <b>EUT</b>       | Equipment under test                   |
| <b>DUT</b>       | Device under test                      |
| <b>UUT</b>       | Unit under test                        |
| <b>FCC</b>       | Federal Communications Commission      |
| <b>FCC ID</b>    | Company Identifier at FCC              |
| <b>IC</b>        | Industry Canada                        |
| <b>PMN</b>       | Product marketing name                 |
| <b>HMN</b>       | Host marketing name                    |
| <b>HVIN</b>      | Hardware version identification number |
| <b>FVIN</b>      | Firmware version identification number |
| <b>EMC</b>       | Electromagnetic Compatibility          |
| <b>HW</b>        | Hardware                               |
| <b>SW</b>        | Software                               |
| <b>Inv. No.</b>  | Inventory number                       |
| <b>S/N or SN</b> | Serial number                          |
| <b>C</b>         | Compliant                              |
| <b>NC</b>        | Not compliant                          |
| <b>NA</b>        | Not applicable                         |
| <b>NP</b>        | Not performed                          |
| <b>PP</b>        | Positive peak                          |
| <b>QP</b>        | Quasi peak                             |
| <b>AVG</b>       | Average                                |
| <b>OC</b>        | Operating channel                      |
| <b>OCW</b>       | Operating channel bandwidth            |
| <b>OBW</b>       | Occupied bandwidth                     |
| <b>OOB</b>       | Out of band                            |
| <b>DFS</b>       | Dynamic frequency selection            |
| <b>CAC</b>       | Channel availability check             |
| <b>OP</b>        | Occupancy period                       |
| <b>NOP</b>       | Non occupancy period                   |
| <b>DC</b>        | Duty cycle                             |
| <b>PER</b>       | Packet error rate                      |
| <b>CW</b>        | Clean wave                             |
| <b>MC</b>        | Modulated carrier                      |

## Annex B Document history

| Version | Applied changes | Date of release |
|---------|-----------------|-----------------|
| -/-     | Initial release | 2018-03-05      |

## Annex C Accreditation Certificate

| first page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | last page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV<br/>Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition</p> <p><b>Accreditation</b></p>  <p>The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory<br/><b>CTC advanced GmbH</b><br/>Untertürkheimer Straße 6-10, 66117 Saarbrücken</p> <p>is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:<br/><b>Telecommunication</b></p> <p>The accreditation certificate shall only apply in connection with the notice of accreditation of 02.06.2017 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 43 pages.</p> <p>Registration number of the certificate: D-PL-12076-01-03</p> <p>Frankfurt, 02.06.2017</p>  <p>Dipl.-Ing. (FH) Ralf Heiser<br/>Head of Division</p> <p>See notes on back.</p> | <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Office Berlin<br/>Spittelmarkt 10<br/>10117 Berlin</p> <p>Office Frankfurt am Main<br/>Europa-Allee 52<br/>60327 Frankfurt am Main</p> <p>Office Braunschweig<br/>Bundesallee 100<br/>38116 Braunschweig</p> <p>The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkKS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf.</p> <p>No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkKS.</p> <p>The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkKS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.</p> <p>The up-to-date state of membership can be retrieved from the following websites:<br/>EA: <a href="http://www.european-accreditation.org">www.european-accreditation.org</a><br/>ILAC: <a href="http://www.ilac.org">www.ilac.org</a><br/>IAF: <a href="http://www.iaf.nu">www.iaf.nu</a></p> |

**Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkKS or may be received by CTC advanced GmbH on request**

<http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf>