
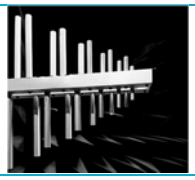
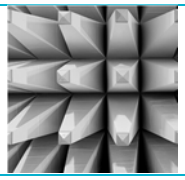

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# TEST REPORT

**Test report no.: 1-1241/16-01-06**

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01

## Testing laboratory


**CTC advanced GmbH**
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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-12076-01-01

## Applicant


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77761 Schiltach / GERMANY
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Fax: -/-
Contact: Michael Fischer
e-mail: M.Fischer@vega.com
Phone: +49 7836 50-328


## Manufacturer


**VEGA Grieshaber KG**
Am Hohenstein 113
77761 Schiltach / 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 1 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices |
| RSS - Gen Issue 4 | Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus |

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

## Test Item

| | |
|---|---|
| **Kind of test item:** | **External radio communication unit for level sensors and point level detection sensors** |
| **Model name:** | **PLICSMOBILE T81** |
| **FCC ID:** | **O6QPMT8X** |
| **IC:** | **3892A-PMT8X** |
| Frequency: | DTS band 2400 MHz to 2483.5 MHz |
| Technology tested: | Bluetooth® LE |
| Antenna: | External multi band dipole antenna BMLPVDB800/1900S-NL (PCTEL) |
| Power supply: | 24.0 V DC by external power supply |
| Temperature range: | -20°C to +55°C |

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

## Test report authorized:

cn=Stefan Boes, o=CTC advanced GmbH, ou=BOE-161129, email=Stefan.Boes@ctcadvanced.com, c=DE
2017.02.23 09:47:50 +01'00'

Stefan Bös
Lab Manager
Radio Communications & EMC

## Test performed:

cn=Marco Bertolino, o=CTC advanced GmbH, ou=BTL-161128, email=Marco.Bertolino@ctcadvanced.com, c=DE
2017.02.23 08:47:02 +01'00'

Marco Bertolino
Lab Manager
Radio Communications & EMC

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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.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
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In no case this test report can be considered as a Letter of Approval.

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.

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2016-10-25 |
| Date of receipt of test item: | 2016-10-25 |
| Start of test: | 2016-10-25 |
| End of test: | 2017-02-06 |
| Person(s) present during the test: | Mr. Tobias Müller |

## 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 1 | May 2015 | 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 | v03r05 | 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 | : | $T_{nom}$<br>$T_{max}$<br>$T_{min}$ | +22 °C during room temperature tests<br>No test under extreme conditions performed.<br>No test under extreme conditions performed. |
| Relative humidity content | : | | 52 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | $V_{nom}$<br>$V_{max}$<br>$V_{min}$ | 24.0 V DC by external power supply<br>No test under extreme conditions performed.<br>No test under extreme conditions performed. |

# 5 Test item

## 5.1 General description

| | | |
|---|---|---|
| Kind of test item | : | External radio communication unit for level sensors and point level detection sensors |
| Type identification | : | PLICSMOBILE T81 |
| HMN | : | -/- |
| PMN | : | PLICSMOBILE T81 |
| HVIN | : | PMT81R<br>PMT81D<br>PMT81W |
| FVIN | : | -/- |
| S/N serial number | : | No serial number! |
| HW hardware status | : | 1-01-00 |
| SW software status | : | 0-06-12 |
| Frequency band | : | DTS band 2400 MHz to 2483.5 MHz<br>(lowest channel 2402 MHz; highest channel 2480 MHz) |
| Type of radio transmission<br>Use of frequency spectrum | :<br>: | DSSS |
| Type of modulation | : | GFSK |
| Number of channels | : | 40 |
| Antenna | : | External multi band dipole antenna BMLPVDB800/1900S-NL (PCTEL) |
| Power supply | : | 24.0 V DC by external power supply |
| Temperature range | : | -20°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: 1-1241/16-01-01_AnnexA
1-1241/16-01-01_AnnexB
1-1241/16-01-01_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).

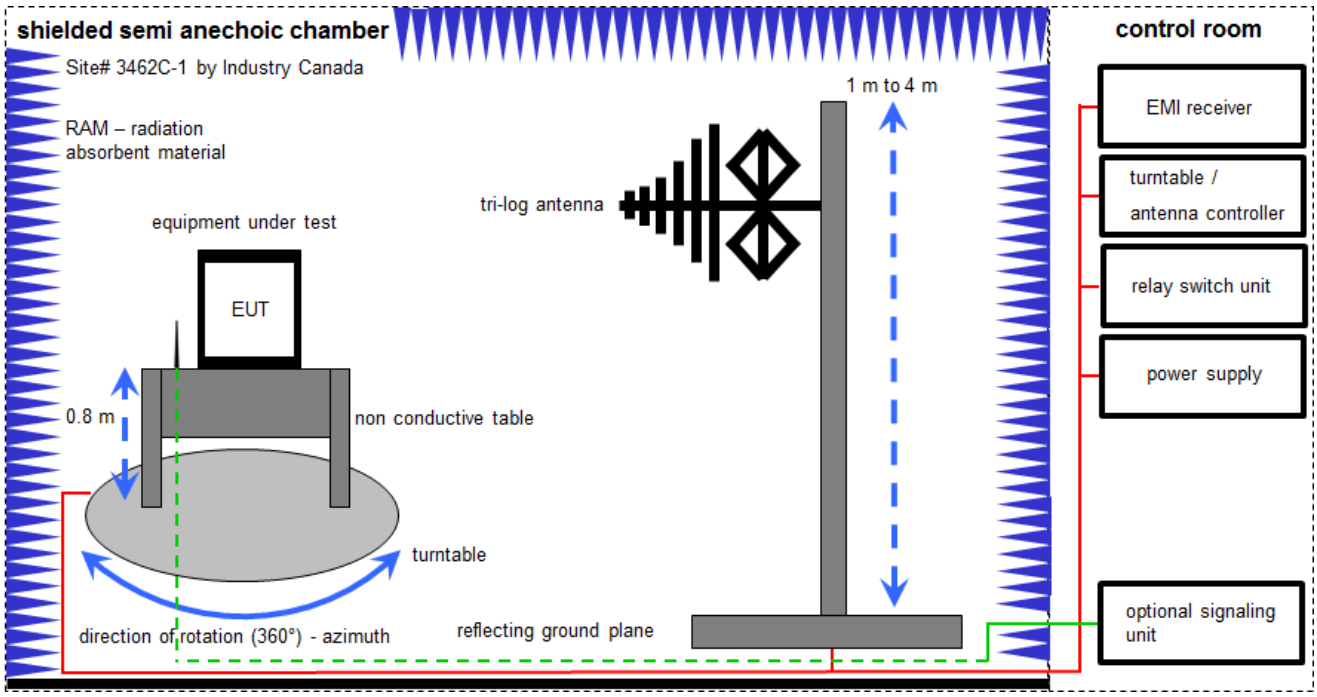
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**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 |
| vlkl! | 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 9 kHz 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 confirmed with 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

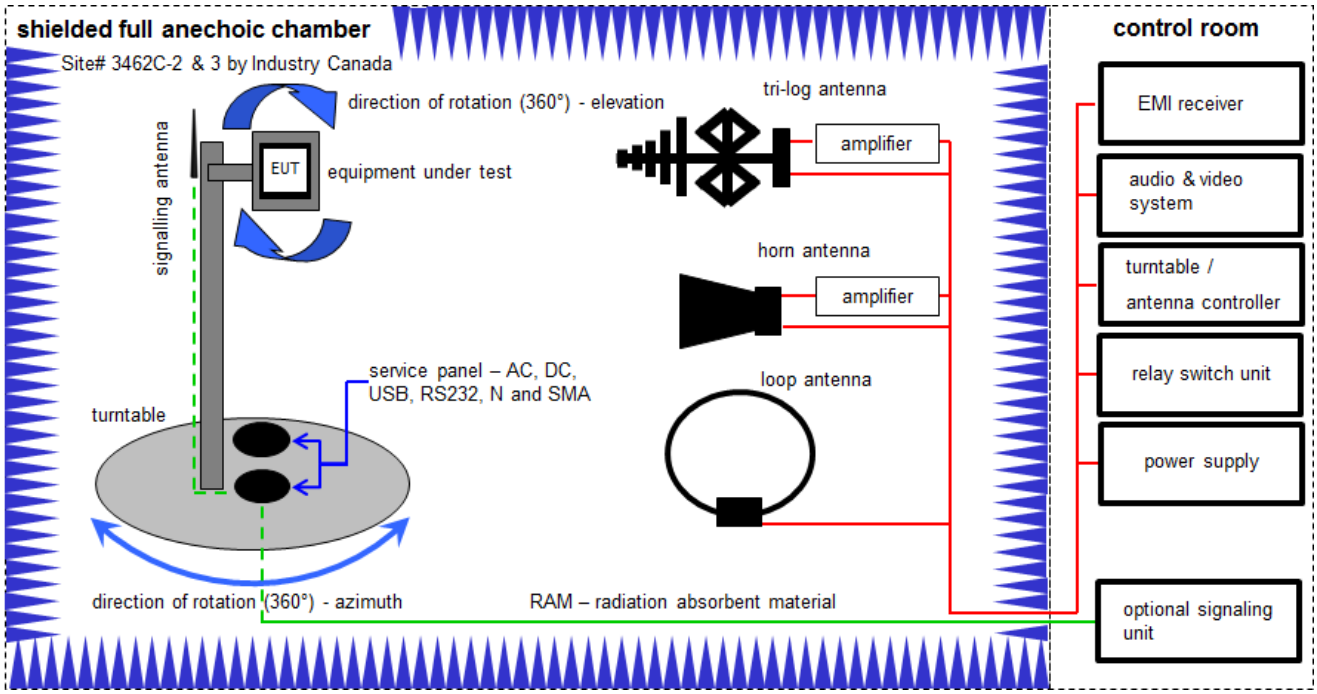
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

*Example calculation:*
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/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 | 08.03.2016 | 08.03.2017 |
| 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: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter / 1 meter

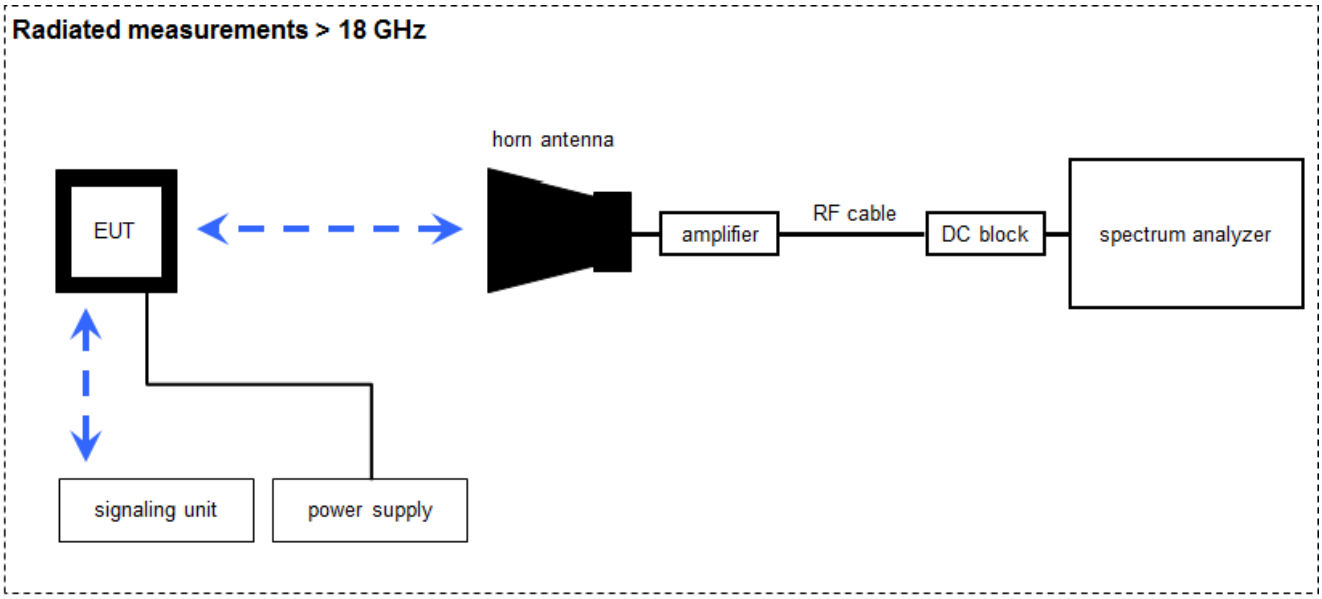
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

*Example calculation:*
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A, B, C | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2818A03450 | 300001040 | Ve | 20.01.2015 | 20.01.2018 |
| 2 | A | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 8812-3088 | 300001032 | vlKl! | 20.05.2015 | 20.05.2017 |
| 3 | A, B, C | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 4 | A, B, C | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | -/- | -/- |
| 5 | C | Active Loop Antenna 10 kHz to 30 MHz | 6502 | EMCO/2 | 8905-2342 | 300000256 | k | 24.06.2015 | 24.06.2017 |
| 6 | A | Band Reject filter | WRCG2400/2483-2375/2505-50/10SS | Wainwright | 11 | 300003351 | ev | -/- | -/- |
| 7 | B | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck | 371 | 300003854 | vlKl! | 29.10.2014 | 29.10.2017 |
| 8 | A, B | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22049 | 300004481 | ev | -/- | -/- |
| 9 | A | Broadband Amplifier 5-13 GHz | CBLU5135235 | CERNEX | 22010 | 300004491 | ev | -/- | -/- |
| 10 | A, B, C | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000037 | 300004509 | ne | -/- | -/- |
| 11 | A, B, C | EMI Test Receiver 9kHz-26,5GHz | ESR26 | R&S | 101376 | 300005063 | vlKl! | 13.09.2016 | 13.03.2018 |

## 6.3 Radiated measurements > 18 GHz




Measurement distance: horn antenna 50 cm

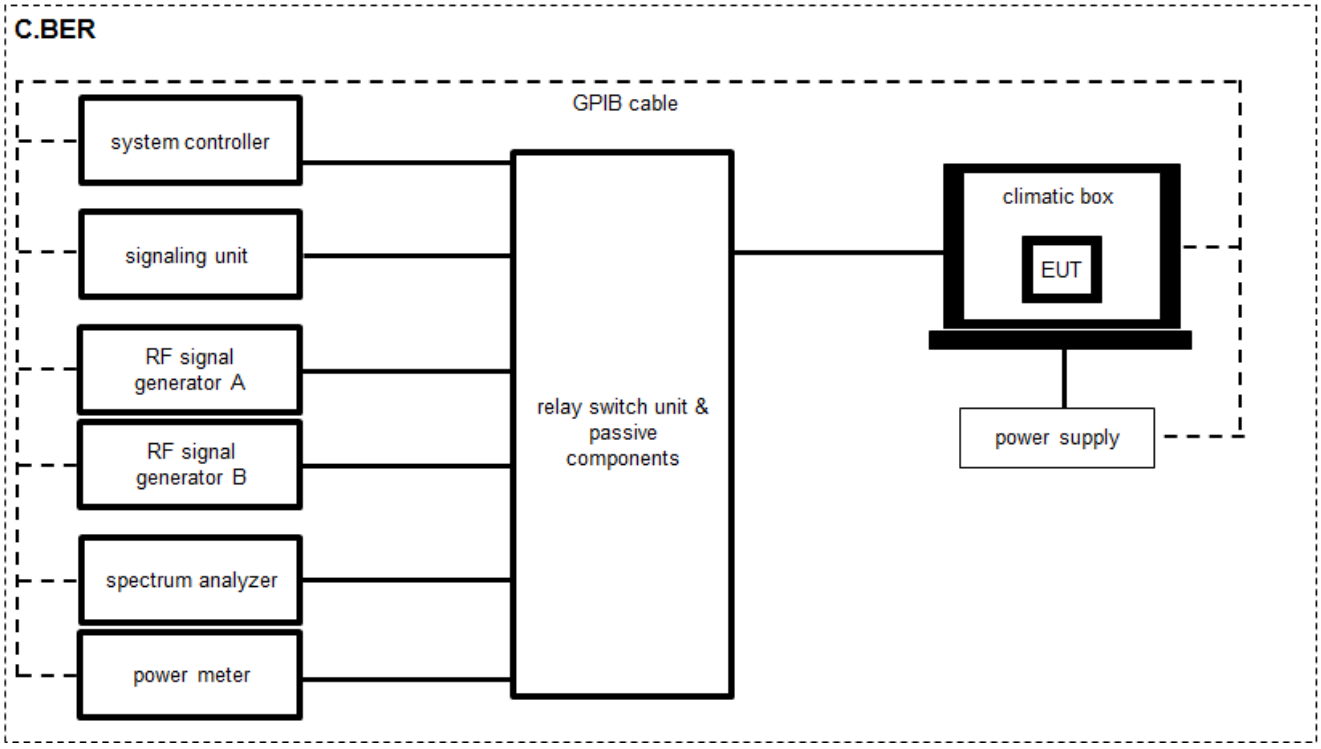
FS = $U_R$ + CA + AF
(FS-field strength; $U_R$-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

*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 | Std. Gain Horn Antenna 18.0 to 26.5 GHz | 638 | Narda | -/- | 300000486 | k | 10.09.2015 | 10.09.2017 |
| 2 | A | Signal Analyzer 40 GHz | FSV40 | R&S | 101042 | 300004517 | k | 21.01.2016<br>25.01.2017 | 21.01.2017<br>24.01.2018 |
| 3 | A | Amplifier 2-40 GHz | JS32-02004000-57-5P | MITEQ | 1777200 | 300004541 | ev | -/- | -/- |
| 4 | A | RF-Cable | ST18/SMAm/SMAm/48 | Huber & Suhner | Batch no. 600918 | 400001182 | ev | -/- | -/- |
| 5 | A | RF-Cable | ST18/SMAm/SMm/48 | Huber & Suhner | Batch no. 127377 | 400001183 | ev | -/- | -/- |
| 6 | A | DC-Blocker 0.1-40 GHz | 8141A | Inmet | Batch no. 127377 | 400001185 | ev | -/- | -/- |
| 7 | A | Signal Analyzer 40 GHz | FSV40 | R&S | 101353 | 300004819 | k | 19.09.2016 | 19.09.2017 |

## 6.4 Conducted measurements C.BER system




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

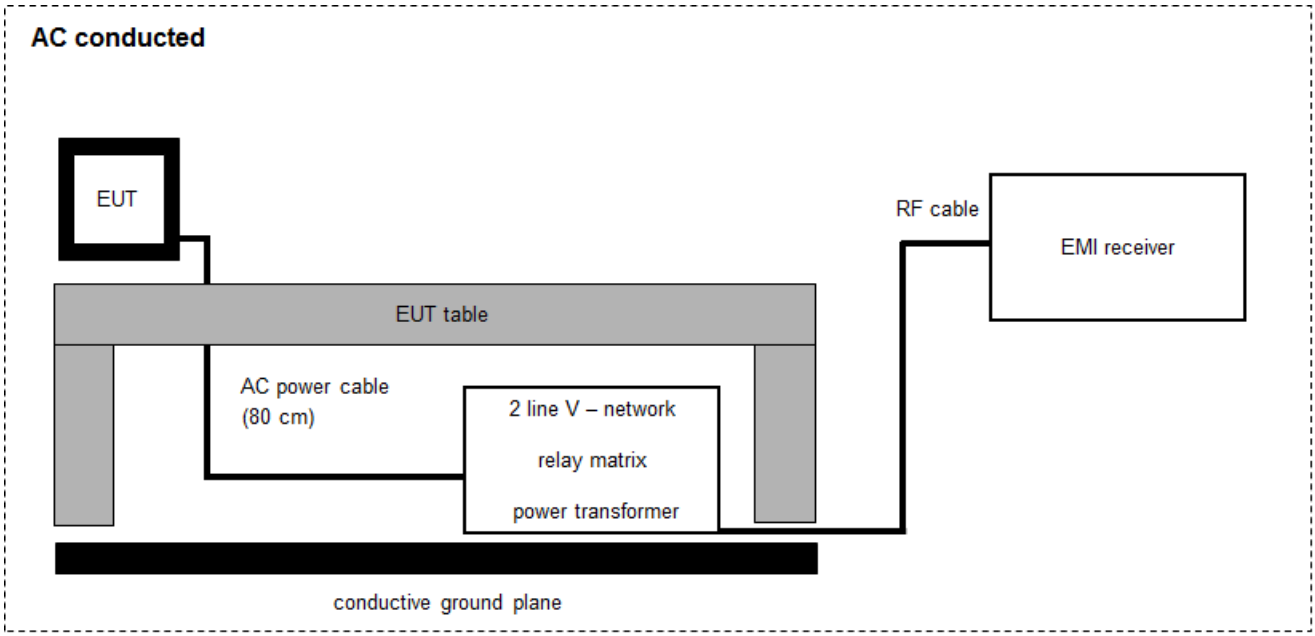
*Example calculation:*
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Switch / Control Unit | 3488A | HP | -/- | 300001691 | ne | -/- | -/- |
| 2 | A | Frequency Standard (Rubidium Frequency Standard) | MFS (Rubidium) | R&S (Datum) | 002 | 300002681 | Ve | 29.01.2015 | 29.01.2017 |
| 3 | A | Directional Coupler | 101020010 | Krytar | 70215 | 300002840 | ev | -/- | -/- |
| 4 | A | DC-Blocker | 8143 | Inmet Corp. | none | 300002842 | ne | -/- | -/- |
| 5 | A | Powersplitter | 6005-3 | Inmet Corp. | none | 300002841 | ev | -/- | -/- |
| 6 | A | USB/GPIB interface | 82357B | Agilent Technologies | MY52103346 | 300004390 | ne | -/- | -/- |
| 7 | A | Wideband Power Sensor, 50 MHz to 18 GHz | NRP-Z81 | R&S | 102585 | 300004863 | k | 25.01.2016 | 25.01.2017 |
| 8 | A | Messplatzrechner | Tecline | F+W | 102585 | 300003580 | ne | -/- | -/- |
| 9 | A | RF-Cable | ST18/SMAm/SMAm/ 72 | Huber & Suhner | Batch no. 605505 | 400001187 | ev | -/- | -/- |
| 10 | A | RF-Cable | Sucoflex 104 | Huber & Suhner | 147636/4 | 400001188 | ev | -/- | -/- |
| 11 | A | RF-Cable | ST18/SMAm/SMAm/ 48 | Huber & Suhner | Batch no. 699866 | 400001189 | ev | -/- | -/- |
| 12 | A | RF-Cable | ST18/SMAm/SMAm/ 48 | Huber & Suhner | Batch no. 14844 | 400001190 | ev | -/- | -/- |
| 13 | A | Signal Analyzer 30GHz | FSV30 | R&S | 103170 | 300004855 | k | 25.01.2016 | 25.01.2017 |

**NOTE:** All conducted measurements have been performed in 2016-11.

## 6.5 AC conducted




FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

*Example calculation:*
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Two-line V-Network (LISN) 9 kHz to 30 MHz | ESH3-Z5 | R&S | 893045/004 | 300000584 | k | 02.02.2016 | 02.02.2017 |
| 2 | A | RF-Filter-section | 85420E | HP | 3427A00162 | 300002214 | k | 27.11.2006 | -/- |
| 3 | A | Hochpass 150 kHz | EZ-25 | R&S | 100010 | 300003798 | ev | 08.04.2008 | -/- |
| 4 | A | MXE EMI Receiver 20 Hz to 26,5 GHz | N9038A | Agilent Technologies | MY51210197 | 300004405 | k | 16.08.2016 | 16.08.2017 |
| 5 | A | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | Ve | 02.02.2016 | 02.02.2018 |

**NOTE:** Measurements has been performed in 2016-11.

# 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, 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 height is 1.5 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 premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- 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.

## 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 ± 45° 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 | ± 3 dB |
| Spectrum bandwidth | ± 21.5 kHz absolute; ± 15.0 kHz relative |
| Maximum output power | ± 1 dB |
| Detailed conducted spurious emissions @ the band edge | ± 1 dB |
| Band edge compliance radiated | ± 3 dB |
| Spurious emissions conducted | ± 3 dB |
| Spurious emissions radiated below 30 MHz | ± 3 dB |
| Spurious emissions radiated 30 MHz to 1 GHz | ± 3 dB |
| Spurious emissions radiated 1 GHz to 12.75 GHz | ± 3.7 dB |
| Spurious emissions radiated above 12.75 GHz | ± 4.5 dB |
| Spurious emissions conducted below 30 MHz (AC conducted) | ± 2.6 dB |

# 9 Summary of measurement results

| | |
|---|---|
| ☒ | No deviations from the technical specifications were ascertained |
| ☐ | There were deviations from the technical specifications ascertained |
| ☐ | 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 1 | See table! | 2017-02-23 | -/- |

| 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 (4) | System gain | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(e)<br>RSS - 247 / 5.2 (2) | Power spectral density | KDB 558074<br>DTS clause: 10.6 | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(a)(2)<br>RSS - 247 / 5.2 (1) | DTS bandwidth – 6 dB bandwidth | KDB 558074<br>DTS clause: 8.1 | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| RSS Gen clause 4.6.1 | Occupied bandwidth | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(b)(3)<br>RSS - 247 / 5.4 (4) | Maximum output power | KDB 558074<br>DTS clause: 9.1.1 | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5 | Detailed spurious emissions @ the band edge - conducted | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.205<br>RSS - 247 / 5.5<br>RSS - Gen | Band edge compliance radiated | KDB 558074<br>DTS clause: 13.3.2 | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5 | TX spurious emissions conducted | KDB 558074<br>DTS clause: 11.1 & 11.2 11.3 | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.209(a)<br>RSS - Gen | Spurious emissions radiated below 30 MHz | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| 15.247(d)<br>RSS - 247 / 5.5<br>§15.109<br>RSS - Gen | Spurious emissions radiated 30 MHz to 1 GHz | -/- | Nominal | Nominal | -/- | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5<br>§15.109<br>RSS - Gen | Spurious emissions radiated above 1 GHz | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.107(a)<br>§15.207 | Conducted emissions below 30 MHz (AC conducted) | -/- | Nominal | Nominal | GFSK | ☒ | ☐ | ☐ | ☐ | -/- |

**Note:** C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

## 10 Additional comments

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| | |
|---|---|
| Reference documents: | Bluetooth® Core Specification (up to 4.1)<br><br>Customer Questionnaire 1-1241-16-1<br><br>BMLPVDB800 1900S-HE-MOT1 |
| Special test descriptions: | The radiated spurious emissions have been performed with two different EUT covers: plastic and metallic cover. |
| Configuration descriptions: | TX tests: were performed with LE packets (37 byte payload) and static PRBS pattern.<br>RX/Standby tests: BT enabled, TX Idle<br>Tested frequencies: lowest: 2402 MHz<br>middle: 2440 MHz<br>- highest: 2480 MHz |
| Test mode: | ☒ Bluetooth LE Test mode enabled (EUT is controlled over CBT)<br><br>☐ Special software is used. EUT is transmitting pseudo random data by itself |
| Antennas and transmit operating modes: | ☒ Operating mode 1 (single antenna)<br>- *Equipment with 1 antenna,*<br>- *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,*<br>- *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*<br><br>☐ Operating mode 2 (multiple antennas, no beamforming)<br>- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*<br><br>☐ Operating mode 3 (multiple antennas, with beamforming)<br>- *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.* |

# 11 Measurement results

## 11.1 System gain

**Measurement:**

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For normal Bluetooth® devices, the GFSK modulation is used.

| 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 sub clause 6.2 B (radiated)<br>See sub clause 6.4 A (conducted) |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

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

**Results:**

| $T_{nom}$ | $V_{nom}$ | 2402 MHz | 2440 MHz | 2480 MHz |
|---|---|---|---|---|
| Conducted power [dBm]<br>Measured with GFSK modulation | | -6.6 | -6.9 | -5.2 |
| Radiated power [dBm]<br>Measured with GFSK modulation | | -1.0 | -1.0 | -0.7 |
| Gain [dBi]<br>Calculated | | 5.6 | 5.9 | 4.6 |

## 11.2 Power spectral density

**Description:**

Measurement of the power spectral density of a digital modulated system.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 3 kHz |
| Video bandwidth | 10 kHz |
| Span | ≥ EBW |
| Trace mode | Max hold |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

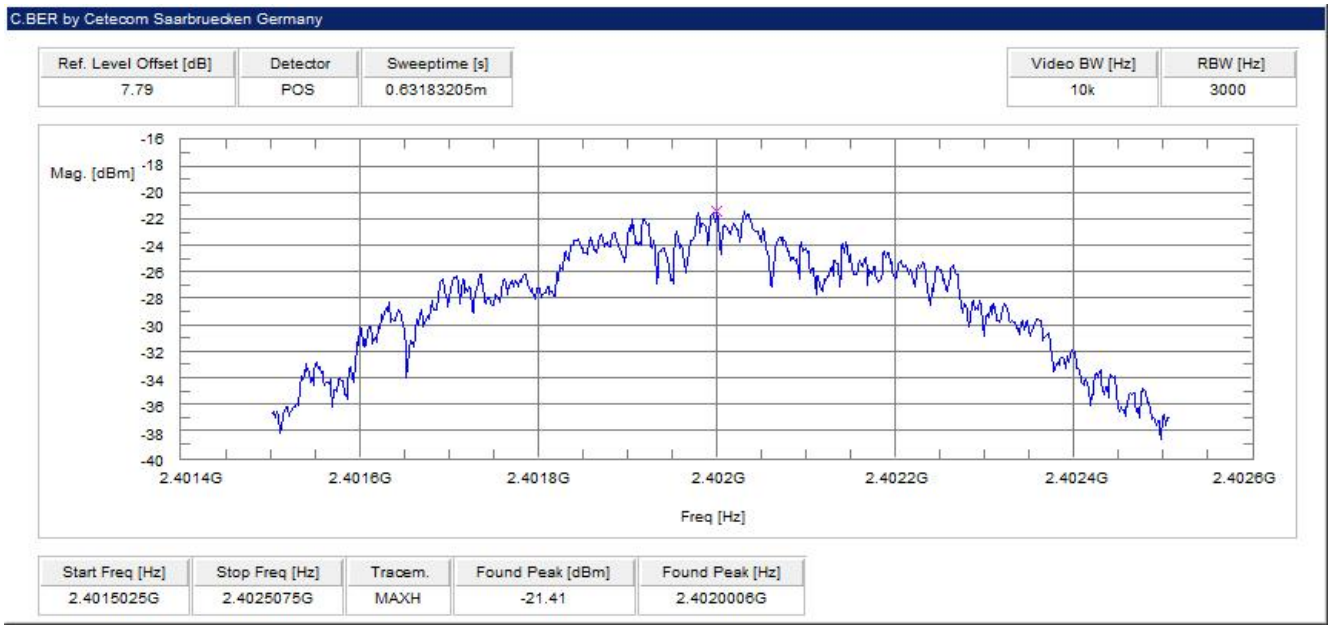
| FCC | IC |
|---|---|
| Power spectral density | |
| For digitally modulated systems the transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration. | |

**Results:**

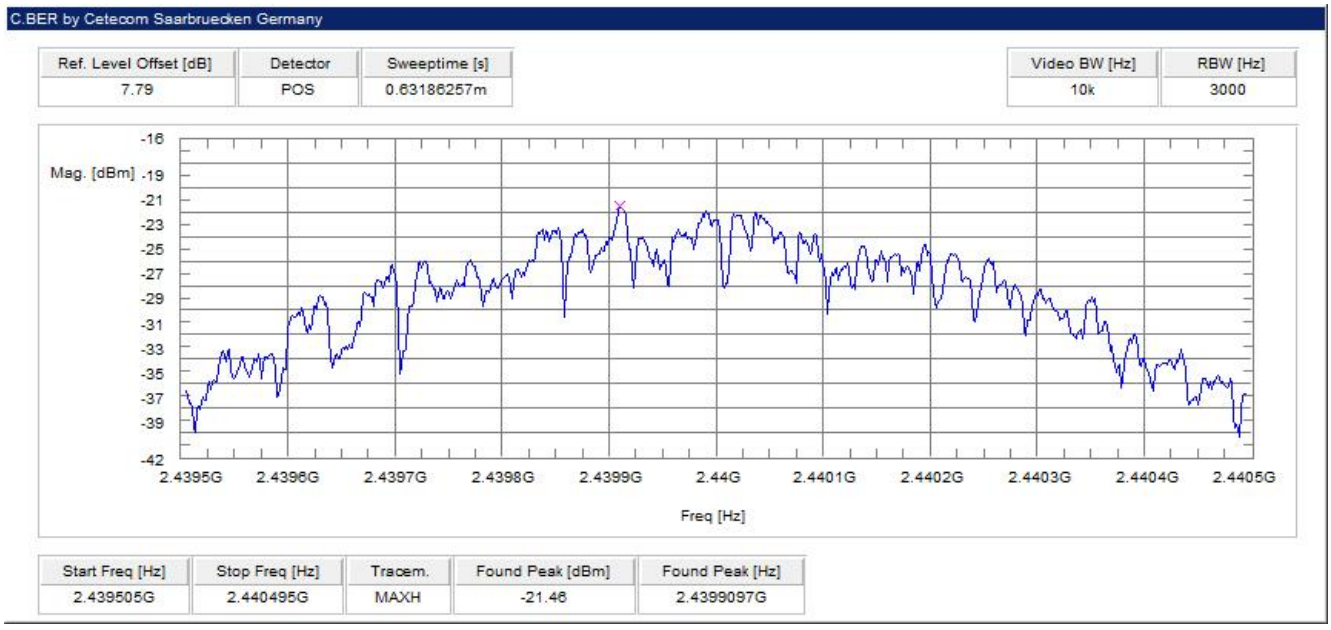
| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **Power spectral density [dBm / 3kHz]** | -21.41 | -21.46 | -19.04 |

**Plots:**

**Plot 1:** lowest channel




**Plot 2:** mid channel



**Plot 3:** highest channel

## 11.3 DTS bandwidth – 6 dB bandwidth

**Description:**

Measurement of the 6 dB bandwidth of the modulated signal.

| Measurement parameters | |
|---|---|
| **According to DTS clause: 8.1** | |
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 100 kHz |
| Video bandwidth | 300 kHz |
| Span | 5 MHz |
| Measurement procedure | Using 3 marker (max + 2x-6dB) |
| Trace mode | Max hold (allow trace to stabilize) |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

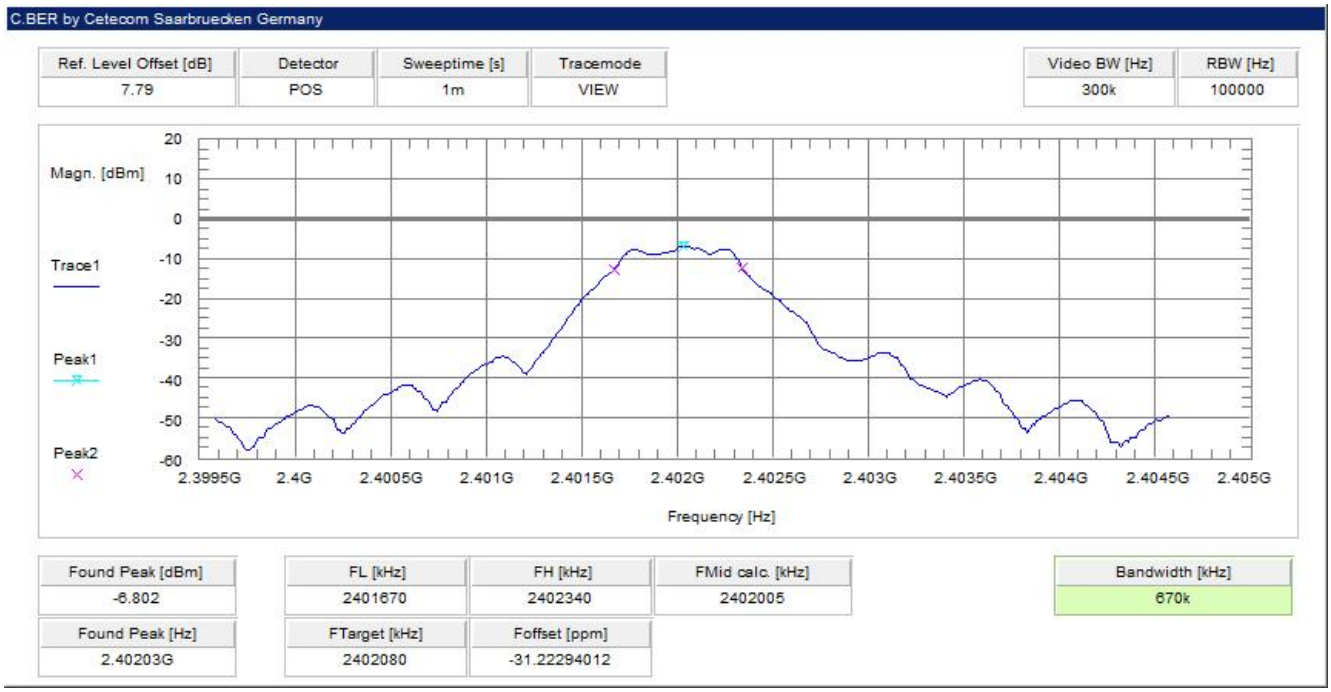
| FCC | IC |
|---|---|
| DTS bandwidth – 6 dB bandwidth | |
| Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz. | |

**Results:**

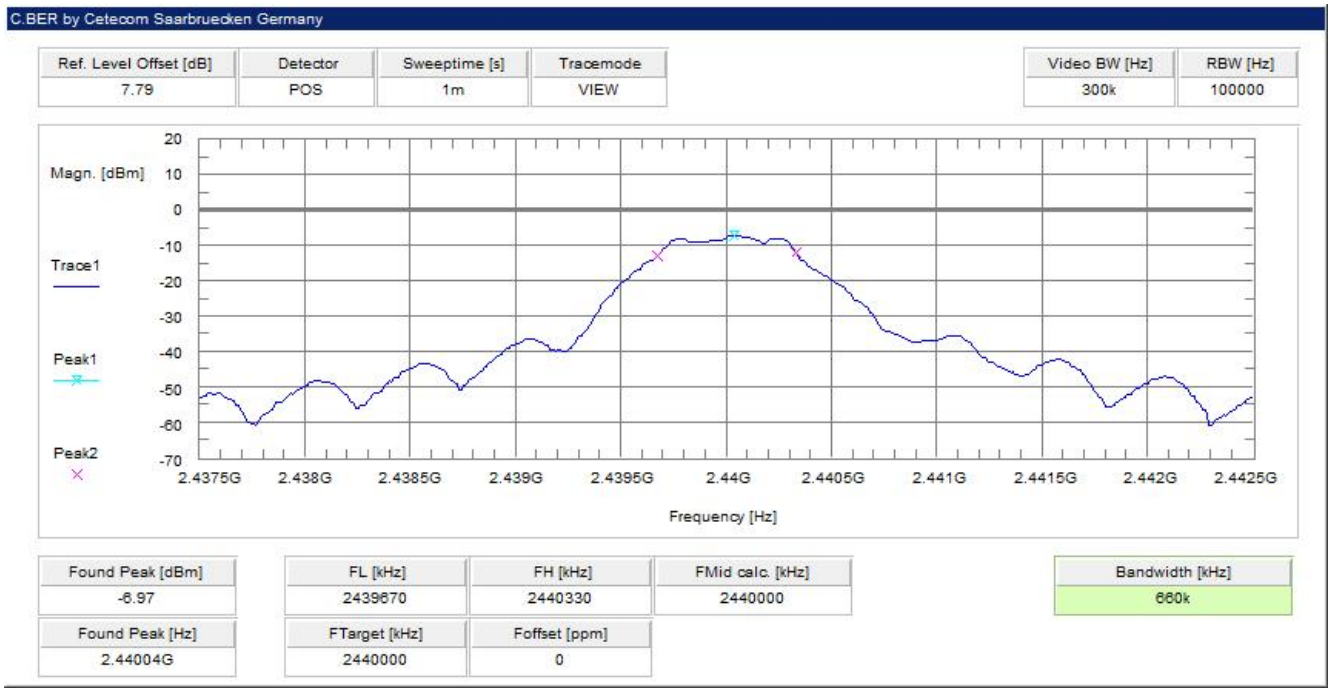
| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **6 dB bandwidth [kHz]** | 670 | 660 | 670 |

**Plots:**

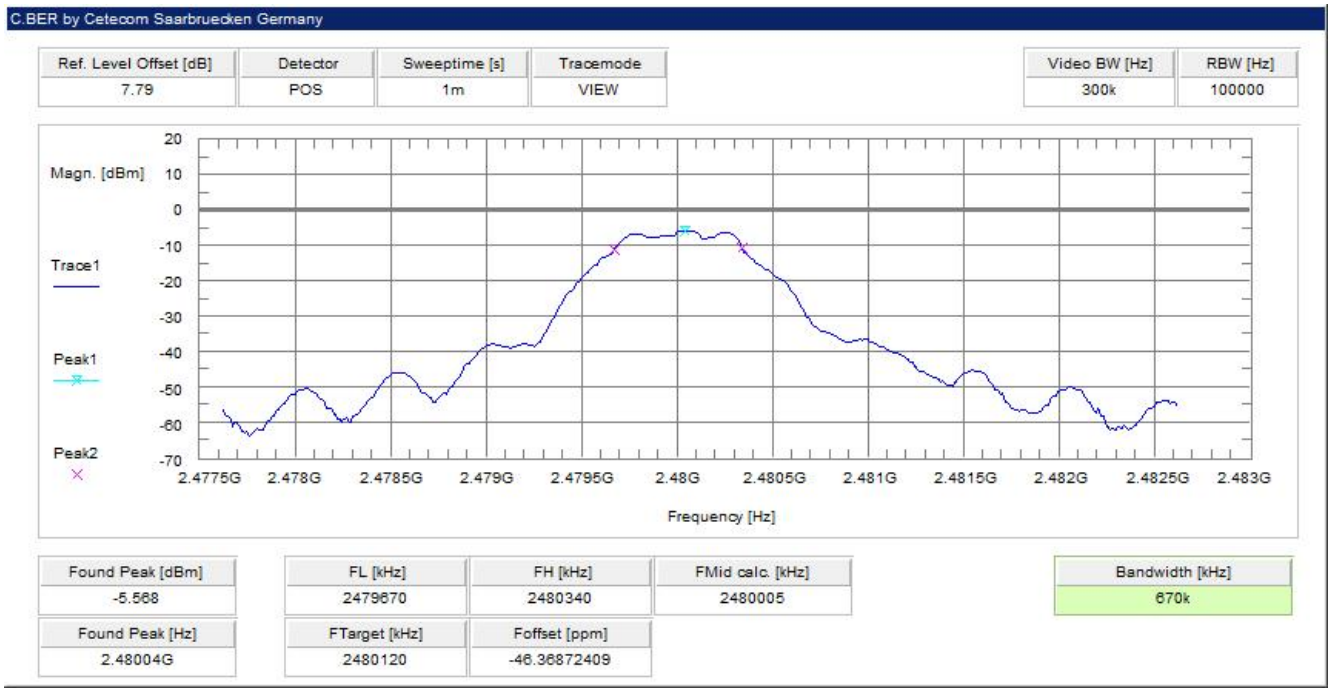
**Plot 1:** lowest channel




**Plot 2:** mid channel



**Plot 3:** highest channel



## 11.4 Occupied bandwidth – 99% emission bandwidth

**Description:**

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 30 kHz |
| Video bandwidth | 100 kHz |
| Span | 5 MHz |
| Measurement procedure | Measurement of the 99% bandwidth using the integration function of the analyzer |
| Trace mode | Max hold (allow trace to stabilize) |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Usage:**

| -/- | IC |
|---|---|
| Occupied bandwidth – 99% emission bandwidth | |
| OBW is necessary for emission designator | |

**Results:**

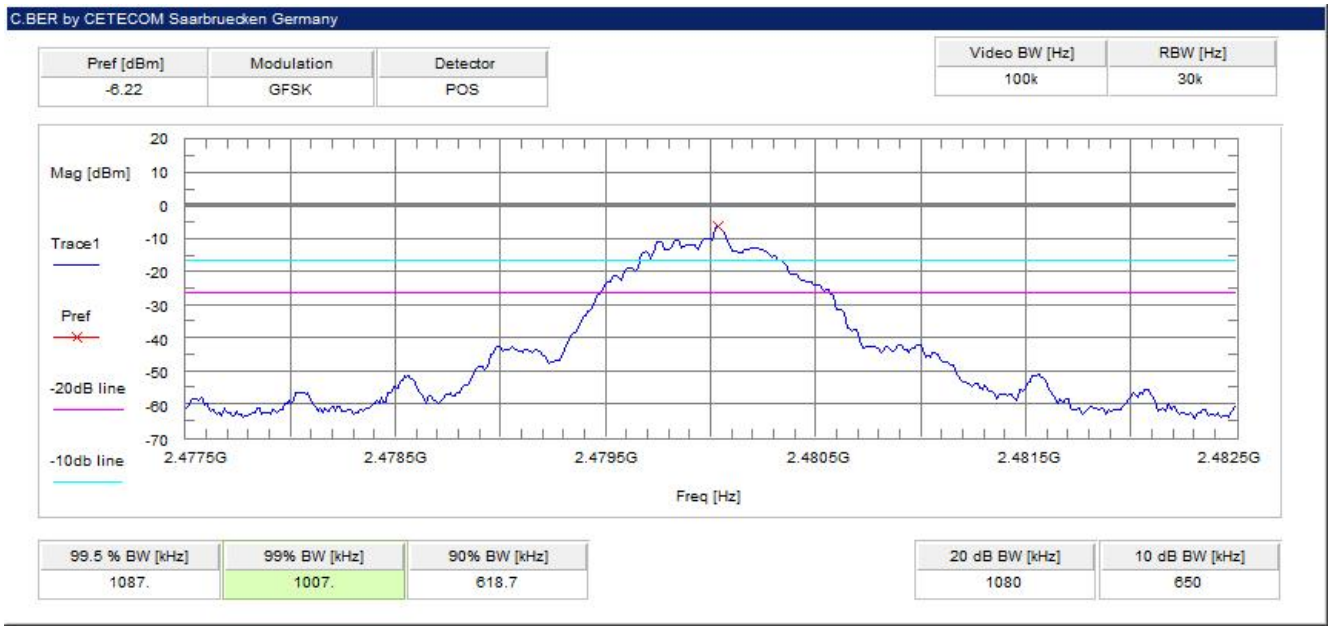
| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **99% bandwidth [kHz]** | 1027 | 1007 | 1007 |

**Plots:**

**Plot 1:** lowest channel


**Plot 2:** mid channel

**Plot 3:** highest channel



## 11.5 Maximum output power

**Description:**

Measurement of the maximum output power conducted and radiated. EUT in single channel mode.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 3 MHz |
| Video bandwidth | 10 MHz |
| Span | 10 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

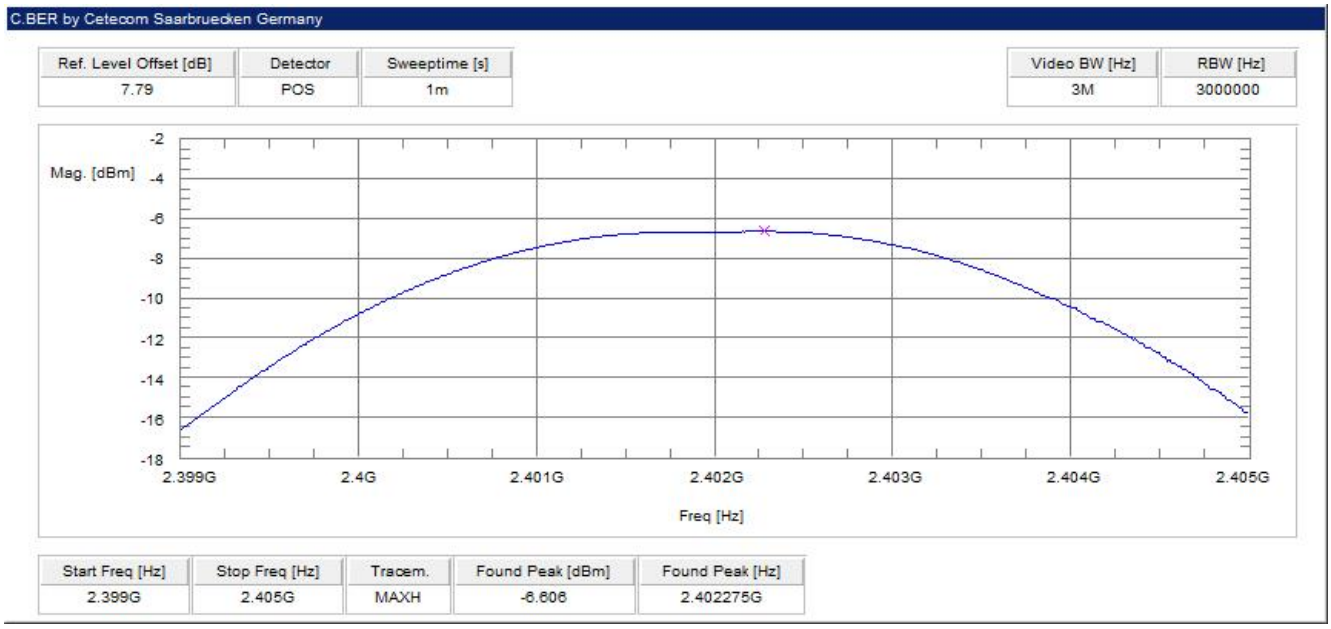
| FCC | IC |
|---|---|
| Maximum output power | |
| [Conducted: 0.125 W – antenna gain max. 6 dBi]<br>Systems using more than 75 hopping channels:<br>Conducted: 1.0 W – antenna gain max. 6 dBi | |

**Results:**

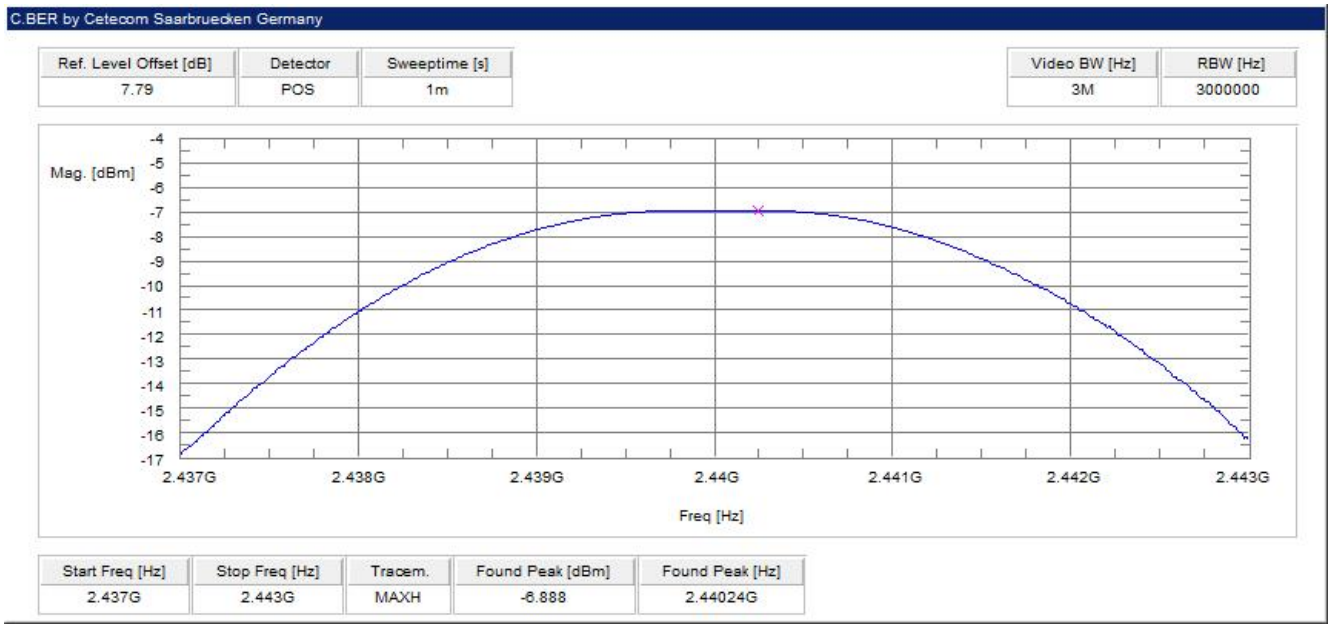
| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **Maximum output power conducted [dBm]** | -6.61 | -6.89 | -5.24 |

**Plots:**

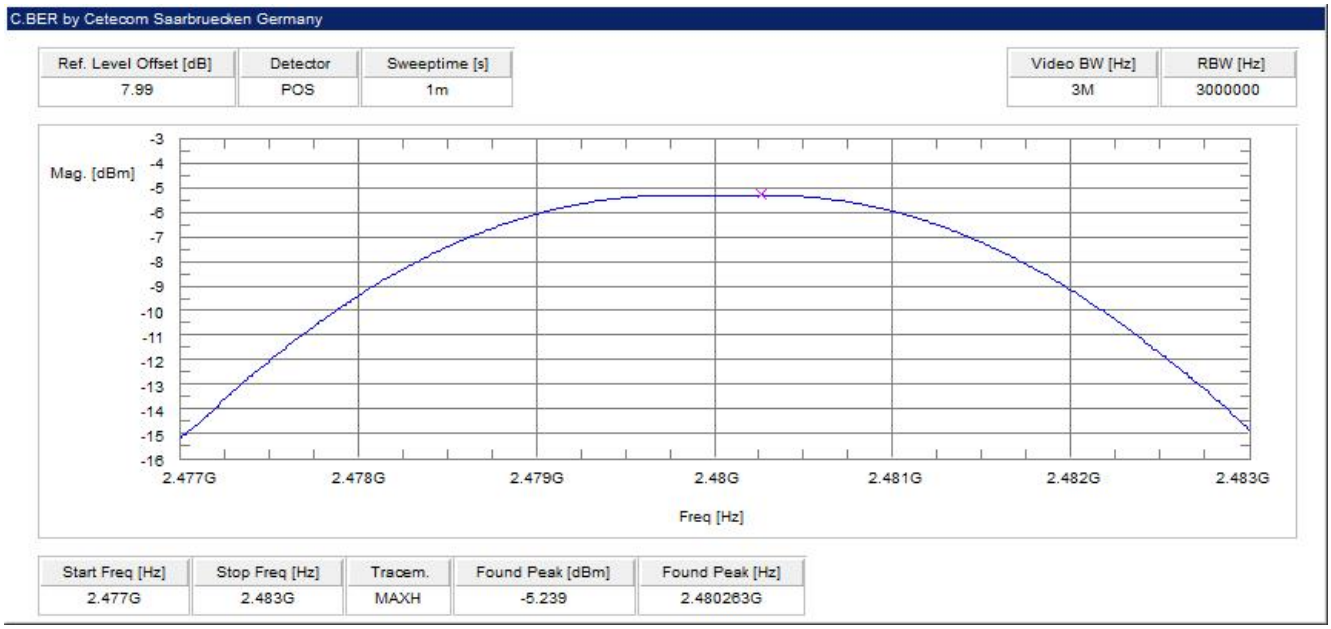
**Plot 1:** lowest channel




**Plot 2:** mid channel



**Plot 3:** highest channel



## 11.6 Detailed spurious emissions @ the band edge - conducted

**Description:**

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 100 kHz |
| Video bandwidth | 300 kHz / 500 kHz |
| Span | Lower Band Edge: 2395 – 2405 MHz<br>Upper Band Edge: 2478 – 2489 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

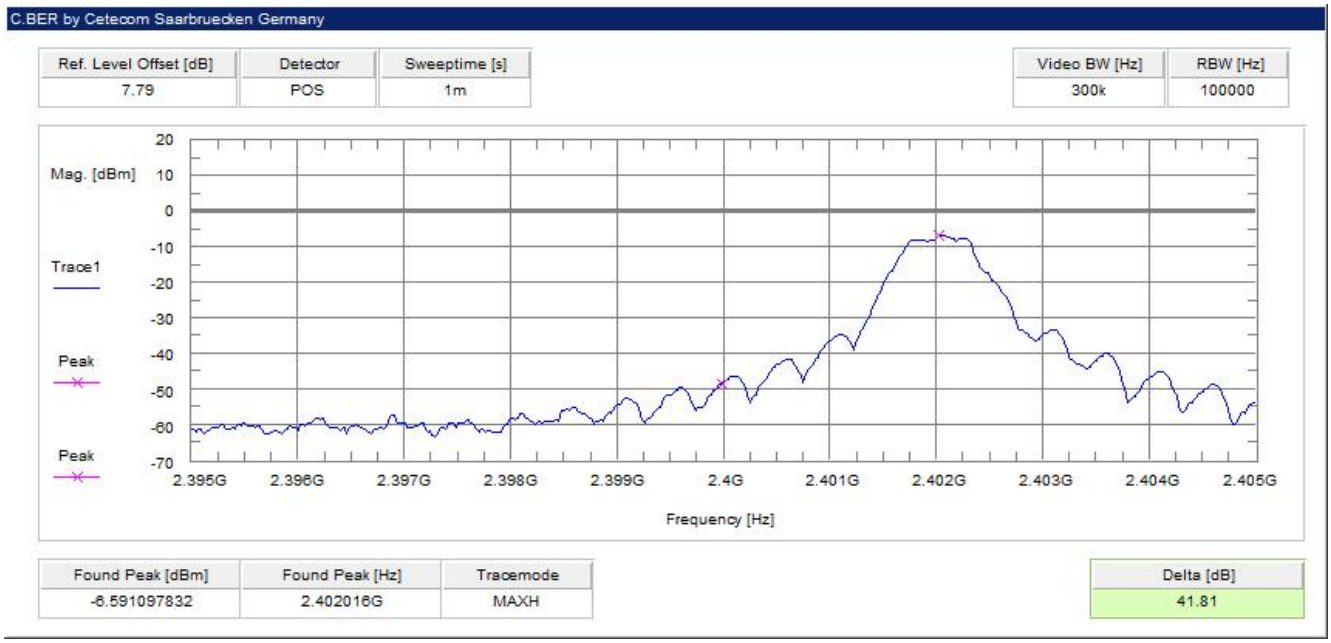
| FCC | IC |
|---|---|
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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. | |

**Result:**

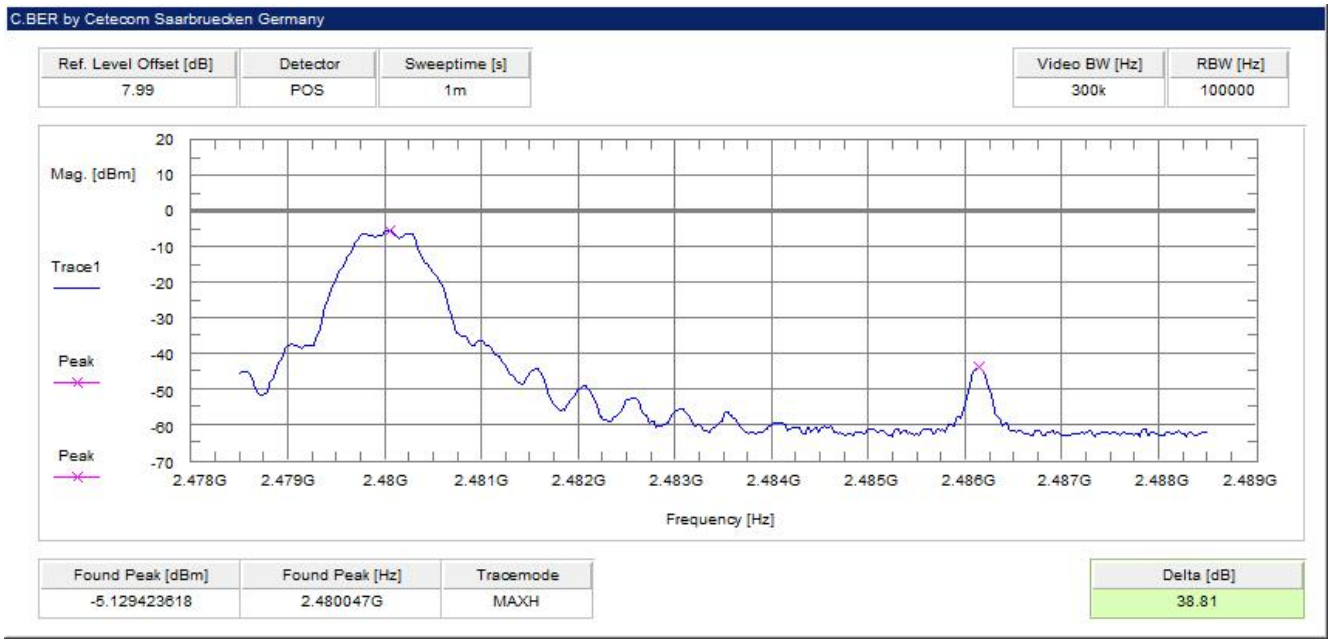
| Scenario | Spurious band edge conducted [dB] |
|---|---|
| Modulation | GFSK |
| Lower band edge – hopping off | > 20 dB |
| Upper band edge – hopping off | > 20 dB |

**Plots:**

**Plot 1:** Lower band edge




**Plot 2:** Upper band edge



## 11.7 Band edge compliance radiated

**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 single channel mode and the transmit frequency 2402 MHz for the lower restricted band and 2480 MHz for the upper restricted band. Measurement distance is 3m.

| Measurement parameters | |
|---|---|
| Detector | Peak / RMS |
| Sweep time | Auto |
| Resolution bandwidth | 1 MHz |
| Video bandwidth | 3 MHz |
| Span | Lower Band: 2300 – 2400 MHz<br>Upper Band: 2480 – 2500 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.2 B |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

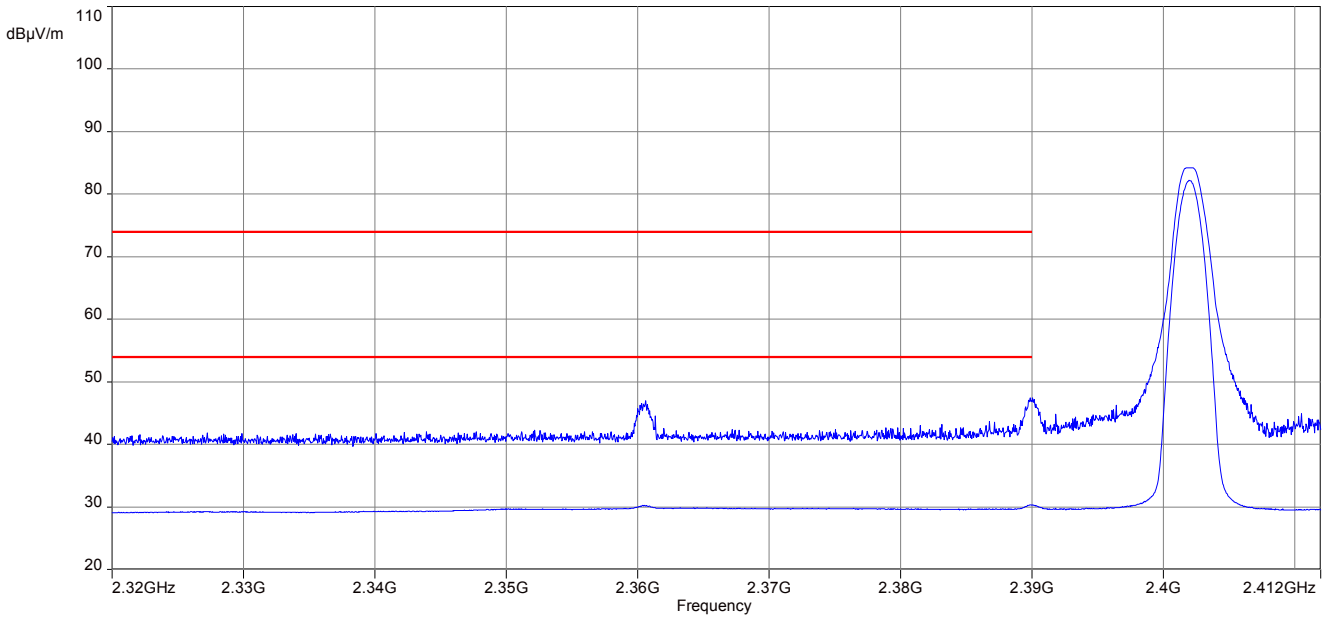
| FCC | IC |
|---|---|
| Band edge compliance radiated | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below 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 Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)). | |
| 54 dBµV/m AVG<br>74 dBµV/m Peak | |

**Result:**

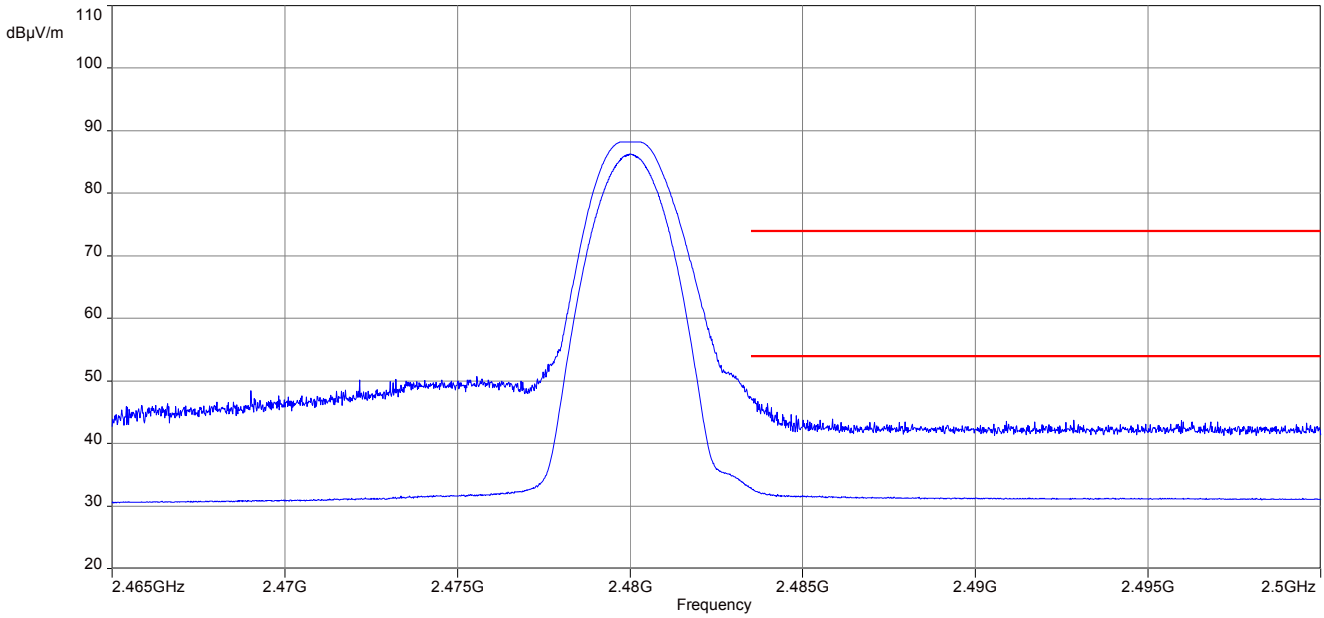
| Scenario | Band edge compliance radiated [dBµV/m] |
|---|---|
| Modulation | GFSK |
| Lower restricted band | < 54 AVG / < 74 PP |
| Upper restricted band | < 54 AVG / < 74 PP |

**Plots:**

**Plot 1:** Lower restricted band




**Plot 2:** Upper restricted band



## 11.8 TX spurious emissions conducted

**Description:**

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 100 kHz |
| Video bandwidth | 300 kHz or 500 kHz |
| Span | 9 kHz to 25 GHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

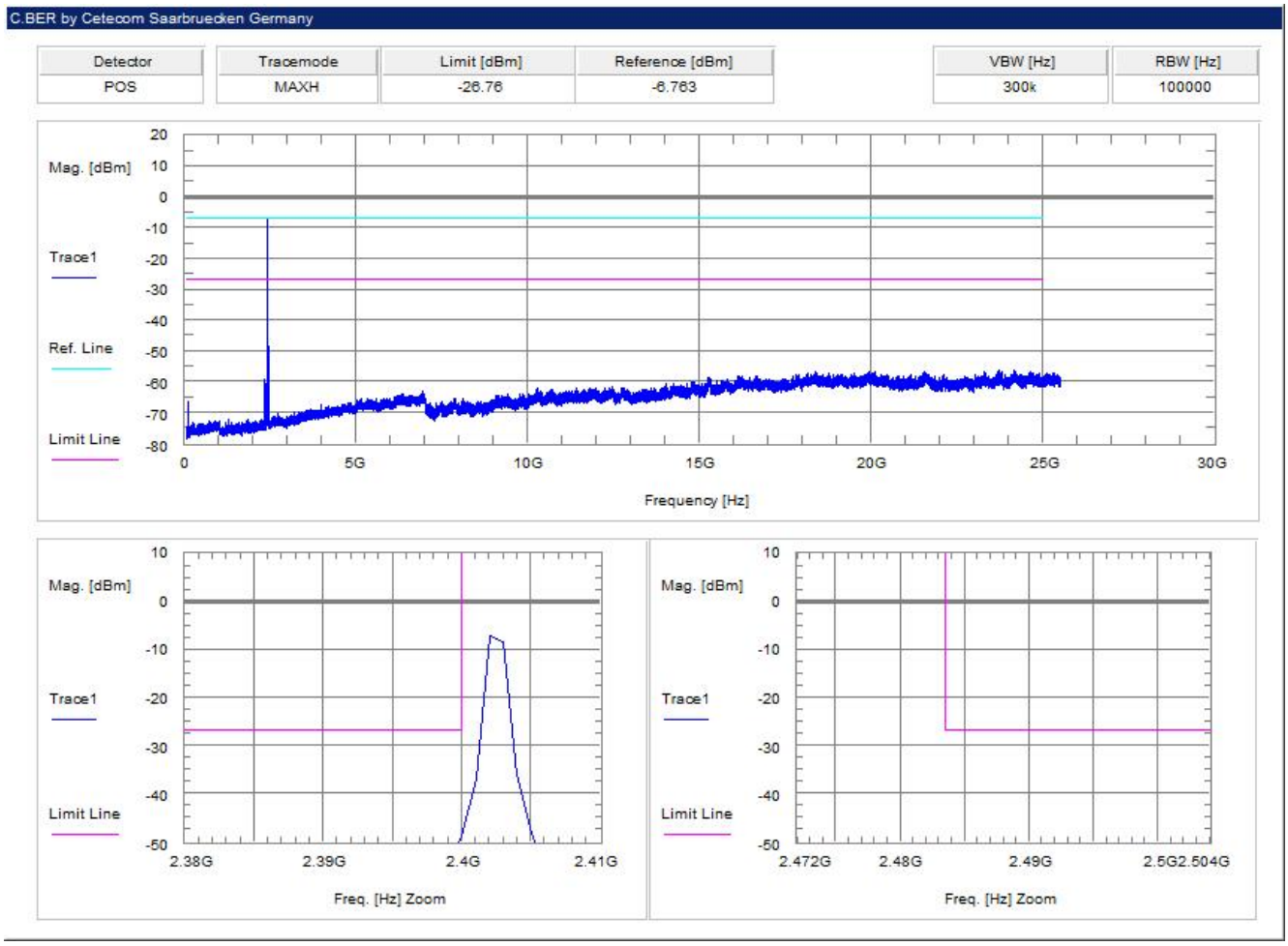
| FCC | IC |
|---|---|
| TX spurious emissions conducted | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below 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 | |

**Results:**

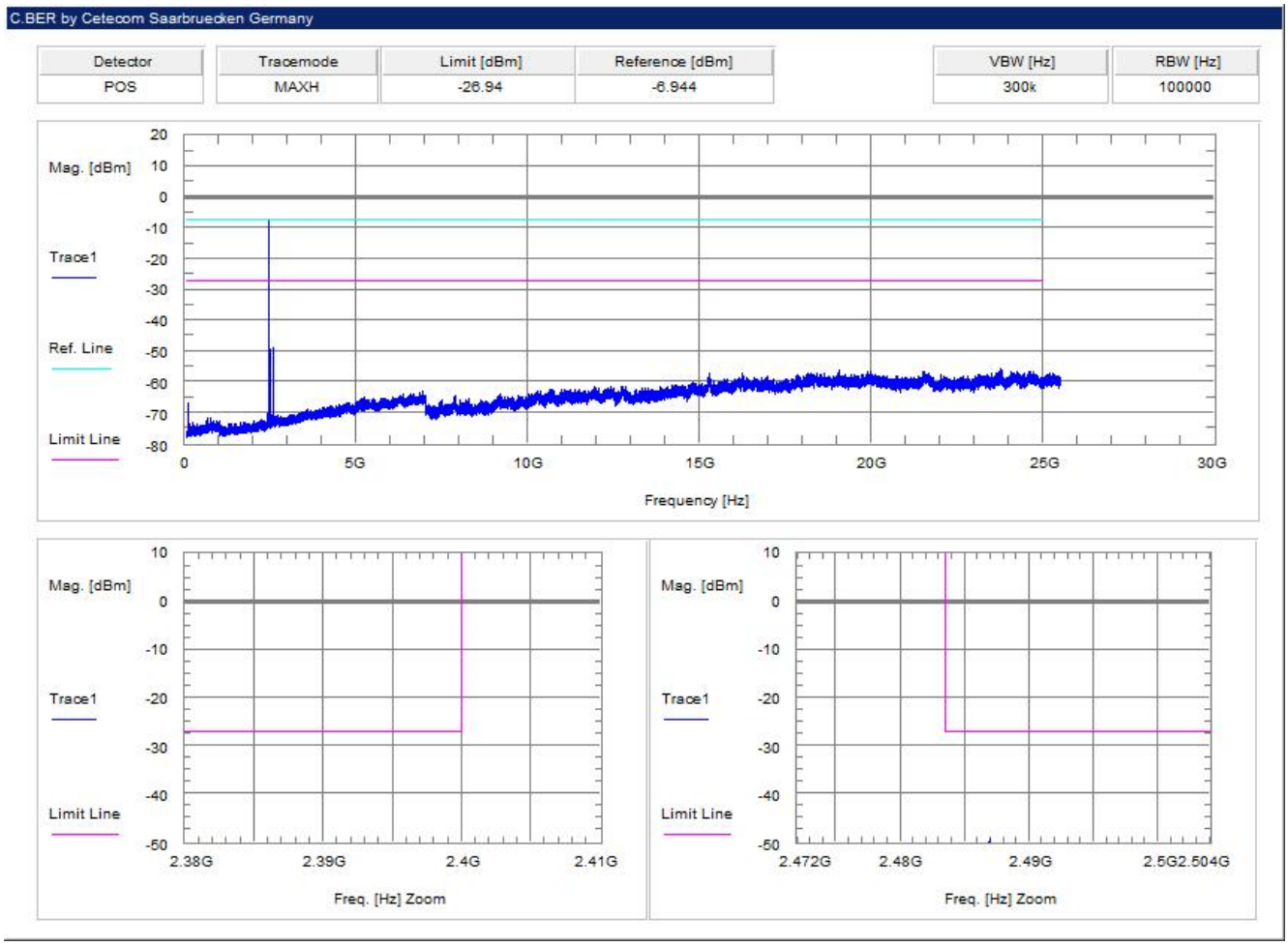
| TX spurious emissions conducted | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| f [MHz] | | amplitude of emission [dBm] | limit max. allowed emission power | actual attenuation below frequency of operation [dB] | results |
| 2402 | | -6.8 | 30 dBm | | Operating frequency |
| *All detected emissions are compliant with the -20 dBc limit!* | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |
| 2440 | | -6.9 | 30 dBm | | Operating frequency |
| *All detected emissions are compliant with the -20 dBc limit!* | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |
| 2480 | | -5.2 | 30 dBm | | Operating frequency |
| *All detected emissions are compliant with the -20 dBc limit!* | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |

**Plots:**

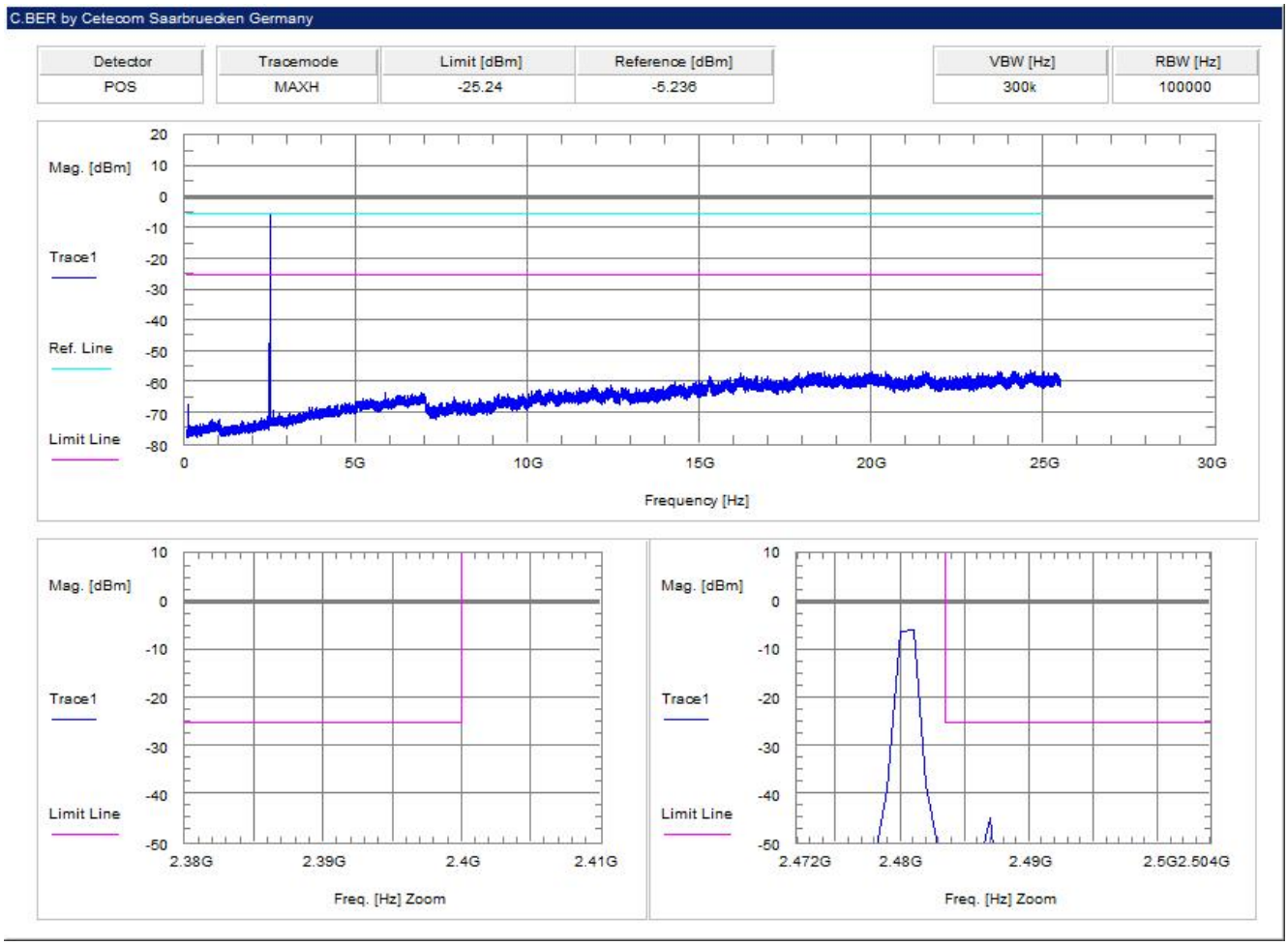
**Plot 1:** lowest channel



**Plot 2:** mid channel



**Plot 3:** highest channel



## 11.9 Spurious emissions radiated below 30 MHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

| Measurement parameters | |
|---|---|
| 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: 30 kHz |
| Span | 9 kHz to 30 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.2 C |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated below 30 MHz | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

**Results:** Plastic cover

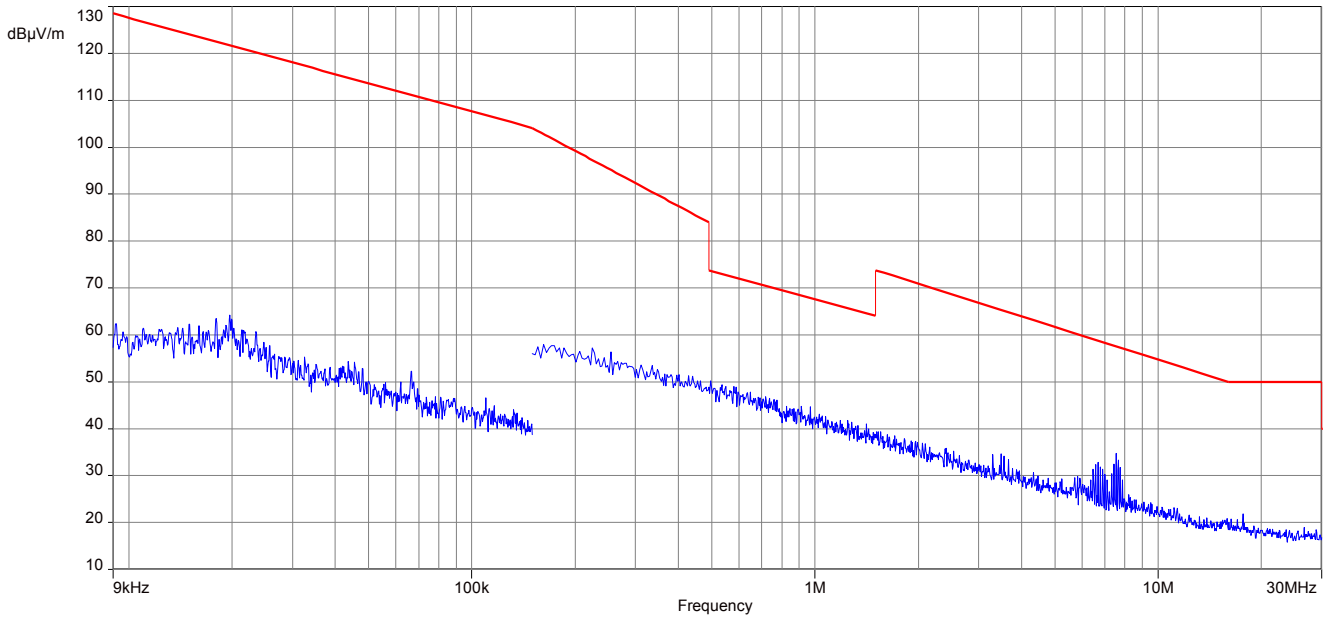
| TX spurious emissions radiated below 30 MHz [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | |
| | | |
| | | |

**Results:** Metallic cover

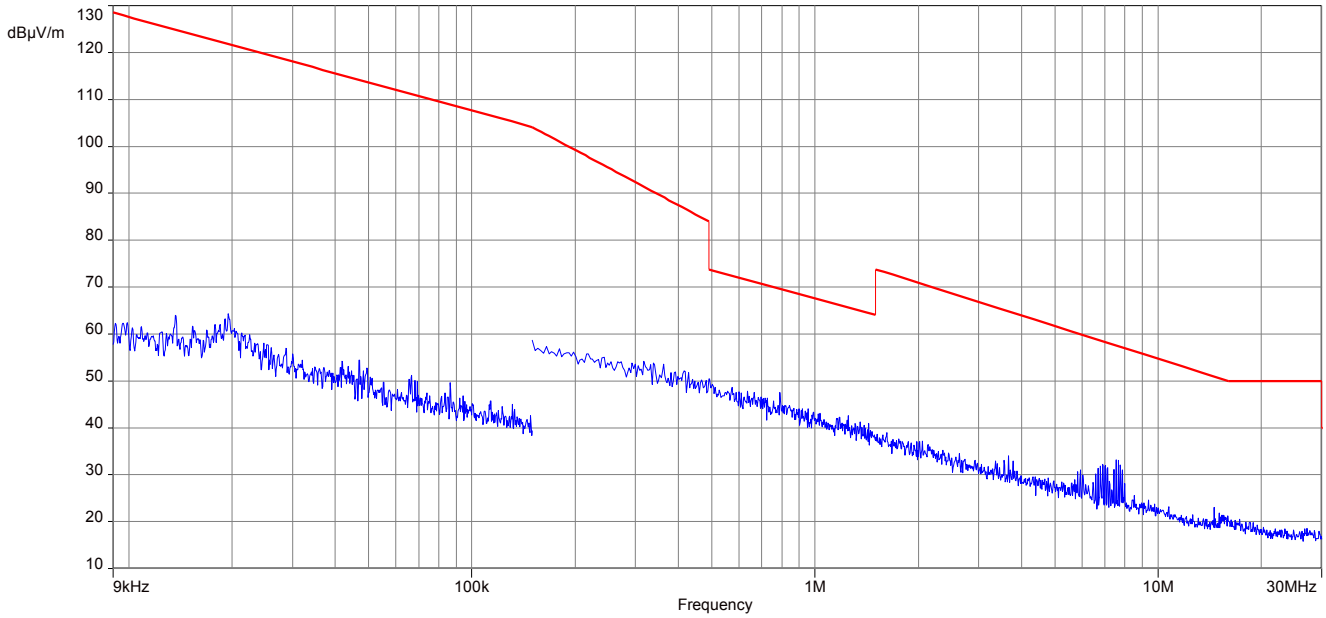
| TX spurious emissions radiated below 30 MHz [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | |
| | | |
| | | |

**Plots:** Plastic cover

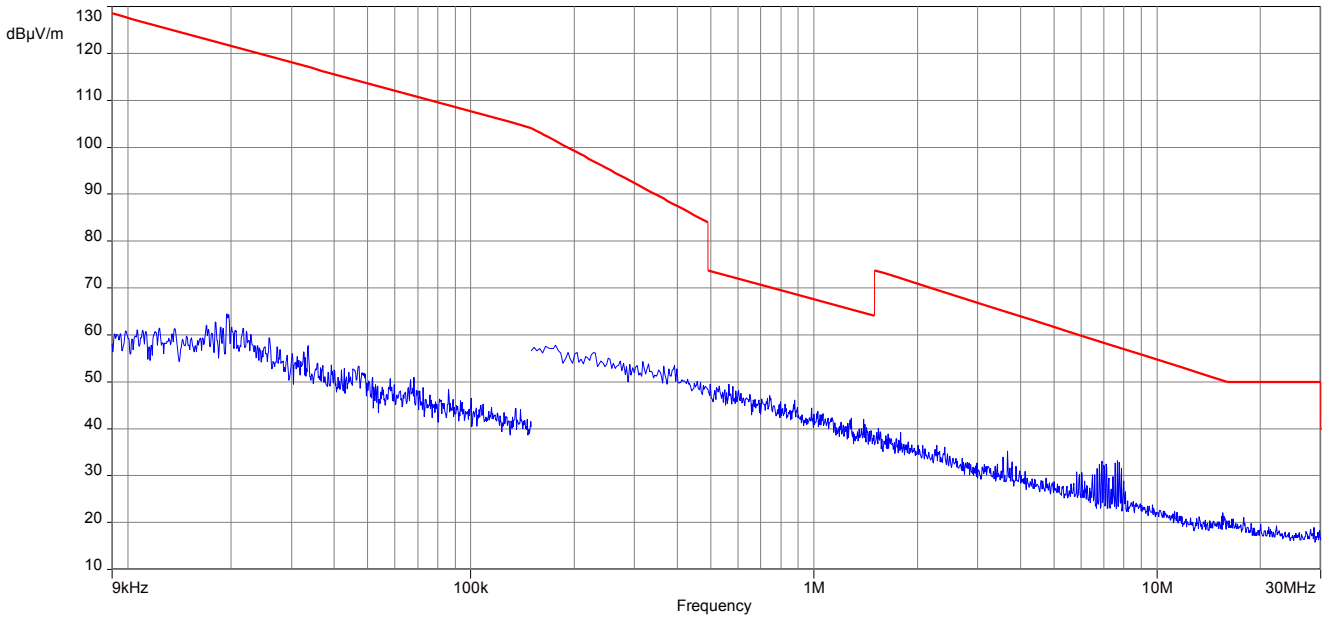
**Plot 1:** 9 kHz to 30 MHz, 2402 MHz, transmit mode




**Plot 2:** 9 kHz to 30 MHz, 2440 MHz, transmit mode

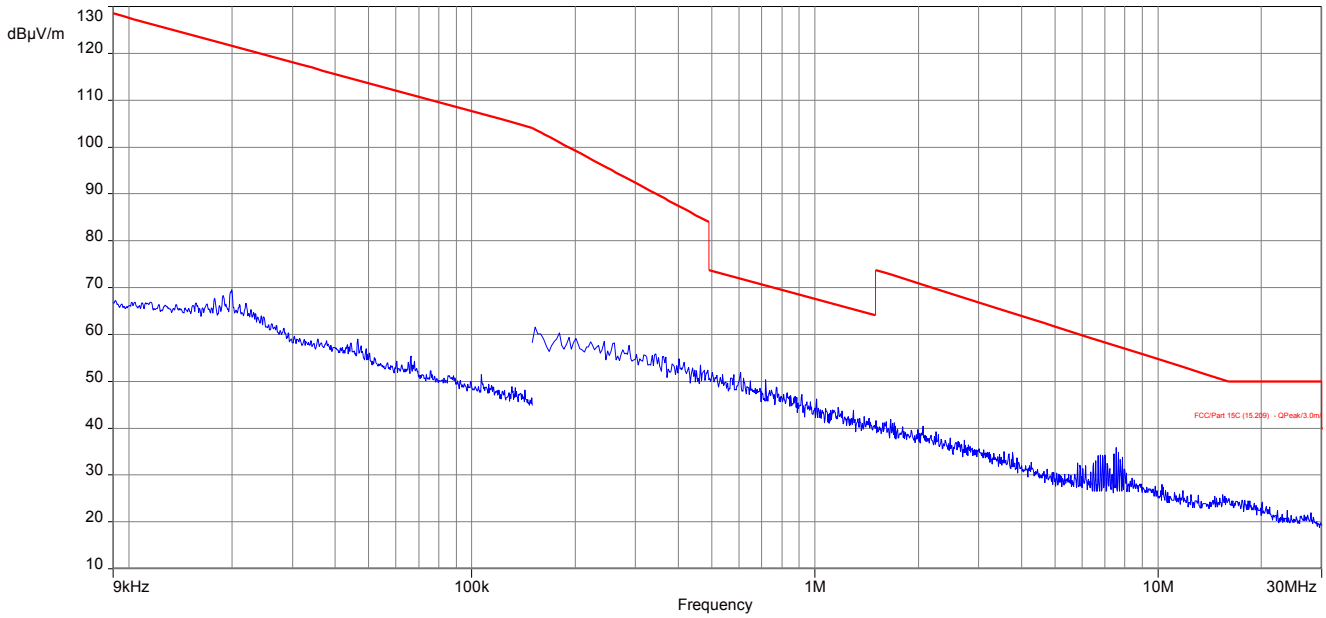


**Plot 3:** 9 kHz to 30 MHz, 2480 MHz, transmit mode

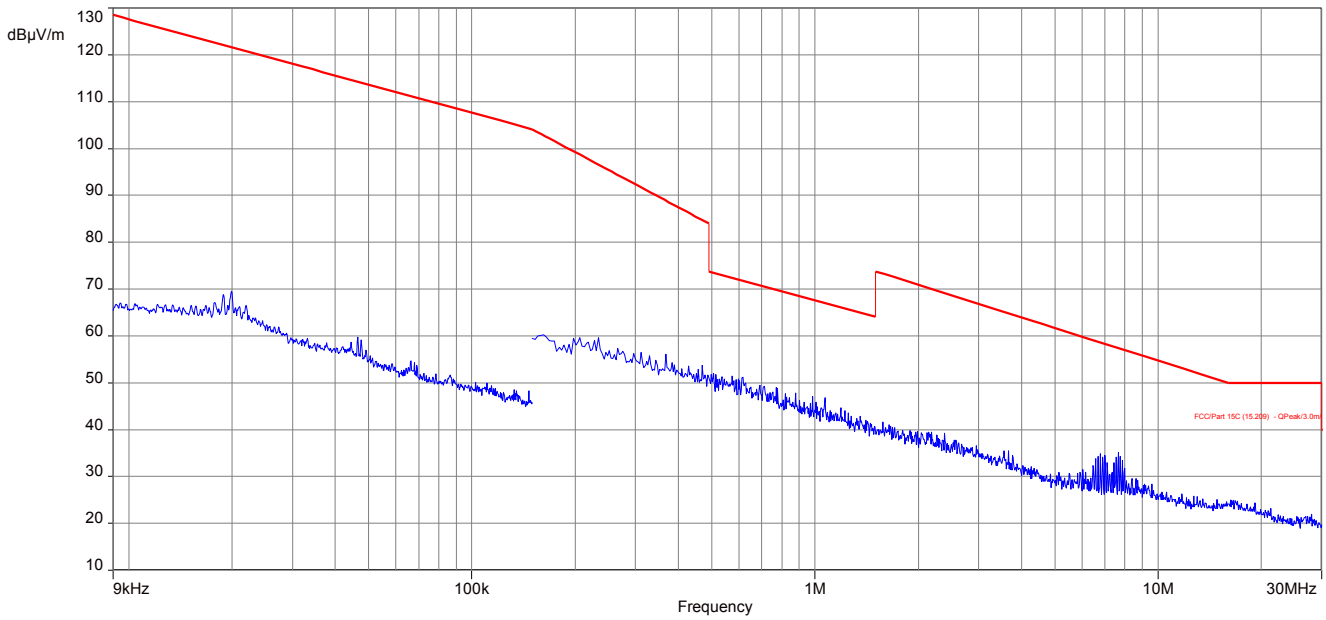


**Plots:** Metallic cover

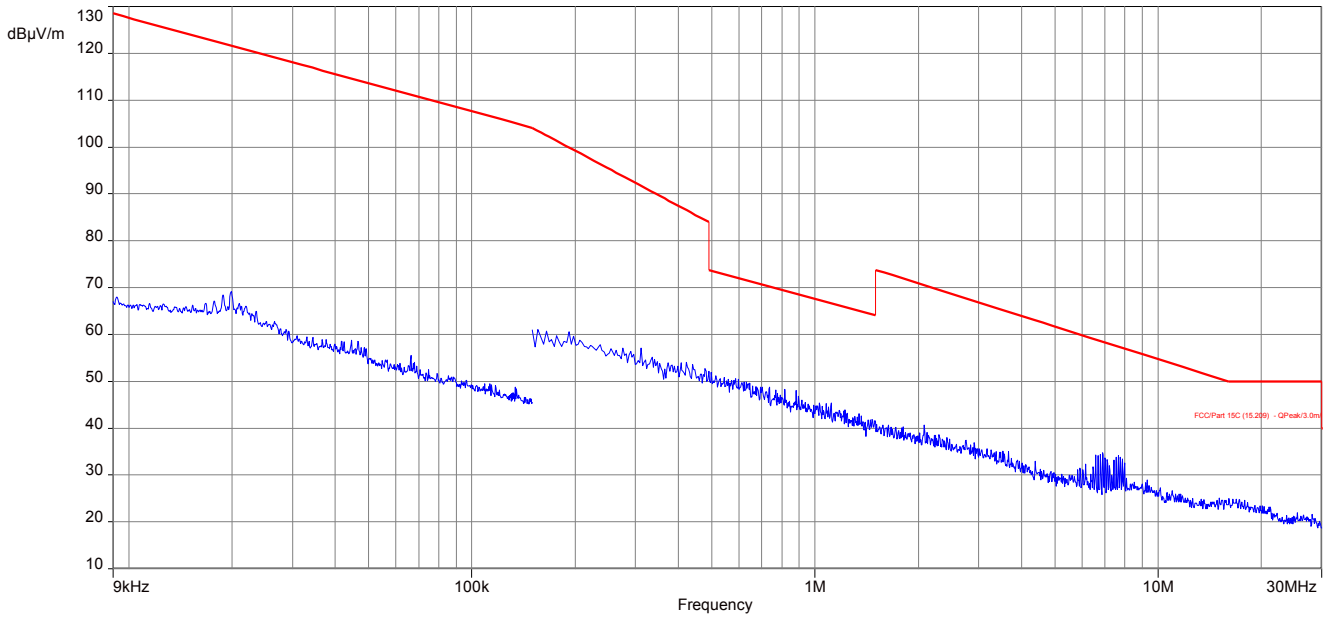
**Plot 1:** 9 kHz to 30 MHz, 2402 MHz, transmit mode




**Plot 2:** 9 kHz to 30 MHz, 2440 MHz, transmit mode



**Plot 3:** 9 kHz to 30 MHz, 2480 MHz, transmit mode



## 11.10 Spurious emissions radiated 30 MHz to 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The measurement is performed in the mode with the highest output power.

| Measurement parameters | |
|---|---|
| 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 |
| Measured modulation | GFSK |
| Test setup | See sub clause 6.1 A |
| Measurement uncertainty | See sub clause 8 |

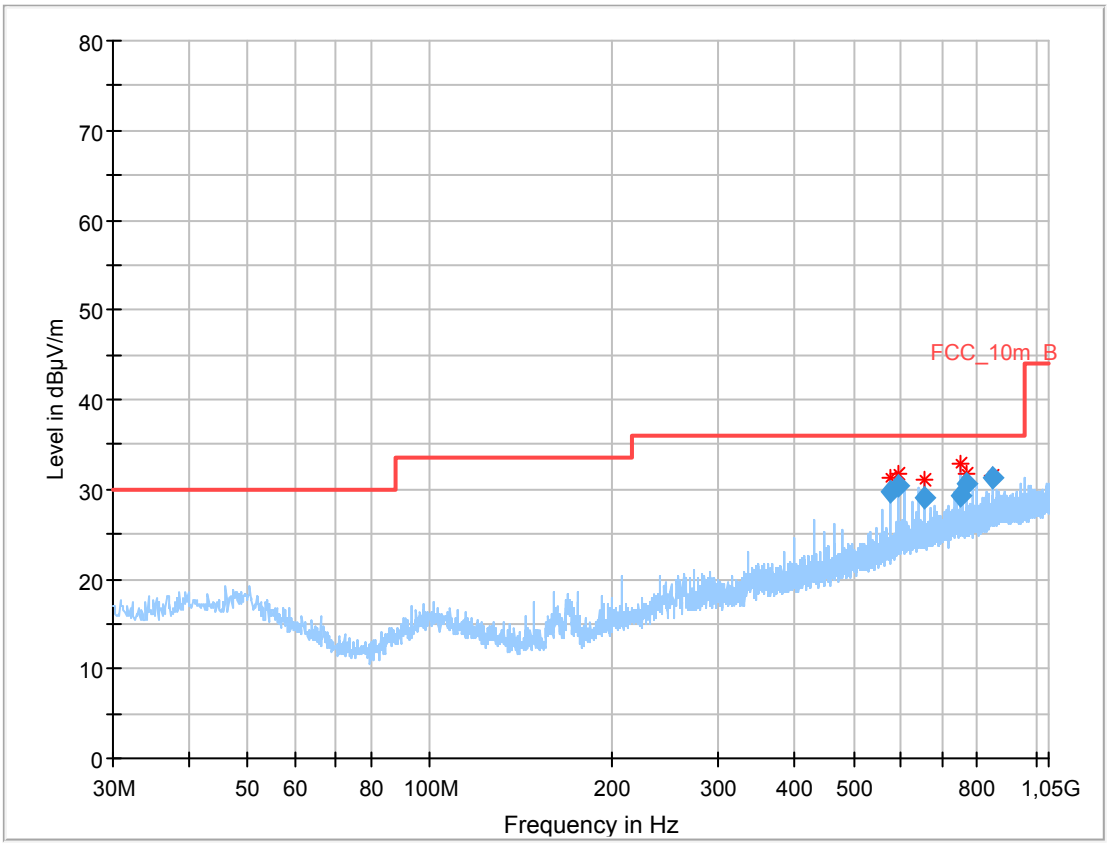
The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated | | |
| 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)). | | |
| §15.209 | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 30 - 88 | 30.0 | 10 |
| 88 – 216 | 33.5 | 10 |
| 216 – 960 | 36.0 | 10 |
| Above 960 | 54.0 | 3 |

**Plots:** Transmit mode, Plastic cover

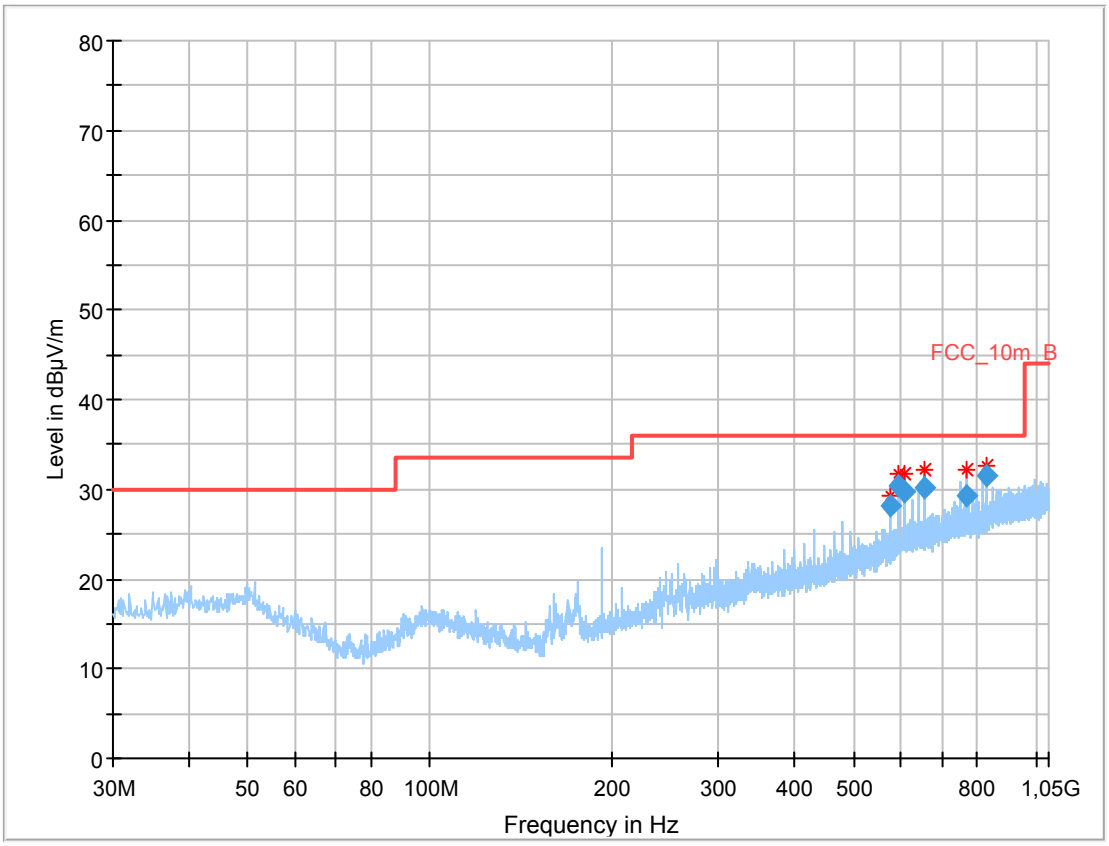
**Plot 1:** 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization




**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 576.039450 | 29.77 | 36.00 | 6.23 | 1000.0 | 120.000 | 179.0 | H | 24.0 | 20.0 |
| 592.006350 | 30.41 | 36.00 | 5.59 | 1000.0 | 120.000 | 100.0 | H | 16.0 | 20.5 |
| 656.001450 | 29.12 | 36.00 | 6.88 | 1000.0 | 120.000 | 101.0 | H | 54.0 | 21.2 |
| 751.997250 | 29.27 | 36.00 | 6.73 | 1000.0 | 120.000 | 101.0 | H | 0.0 | 22.7 |
| 768.012300 | 30.51 | 36.00 | 5.49 | 1000.0 | 120.000 | 98.0 | H | 340.0 | 22.7 |
| 847.994100 | 31.35 | 36.00 | 4.65 | 1000.0 | 120.000 | 101.0 | H | 175.0 | 23.4 |

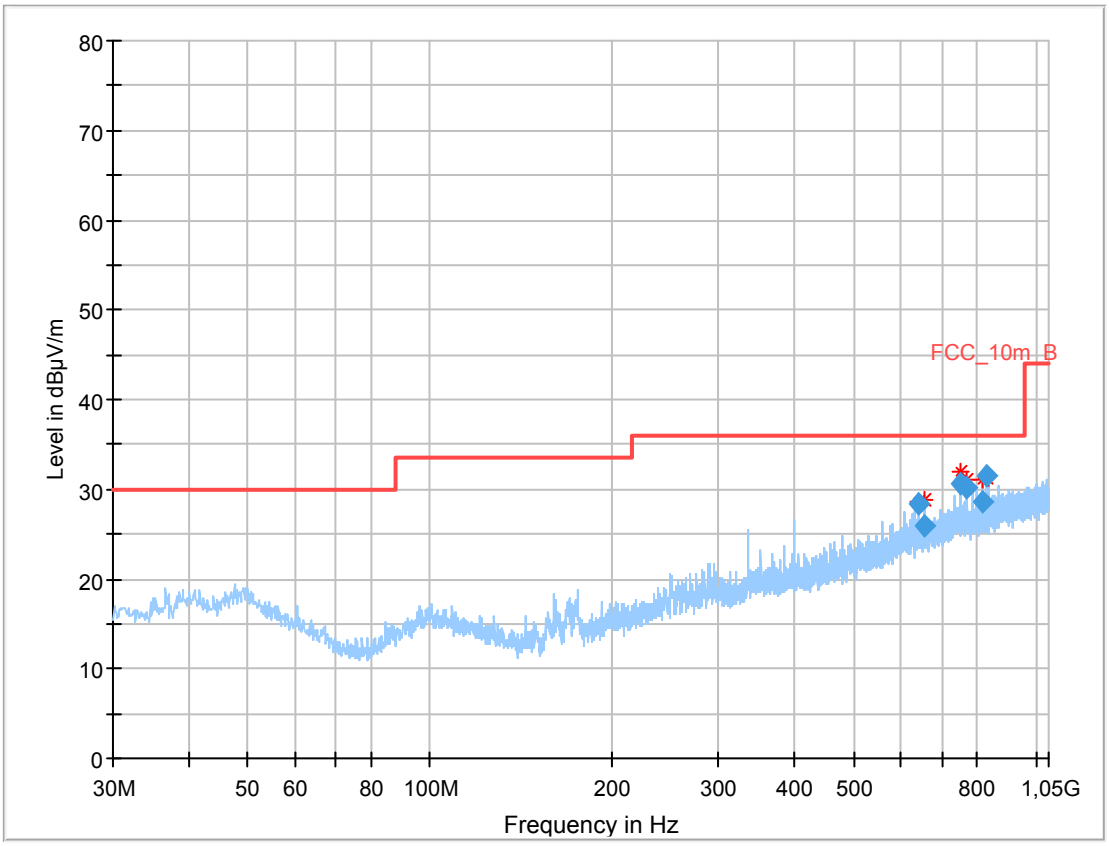
**Plot 2:** 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization




**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 575.995800 | 28.20 | 36.00 | 7.80 | 1000.0 | 120.000 | 185.0 | H | 338.0 | 20.0 |
| 592.014150 | 30.34 | 36.00 | 5.66 | 1000.0 | 120.000 | 101.0 | H | 43.0 | 20.5 |
| 608.020500 | 29.67 | 36.00 | 6.33 | 1000.0 | 120.000 | 100.0 | H | 31.0 | 20.8 |
| 656.008650 | 30.25 | 36.00 | 5.75 | 1000.0 | 120.000 | 98.0 | H | 16.0 | 21.2 |
| 768.017700 | 29.17 | 36.00 | 6.83 | 1000.0 | 120.000 | 98.0 | H | 326.0 | 22.7 |
| 832.021650 | 31.57 | 36.00 | 4.43 | 1000.0 | 120.000 | 101.0 | H | 153.0 | 23.2 |

**Plot 3:** 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

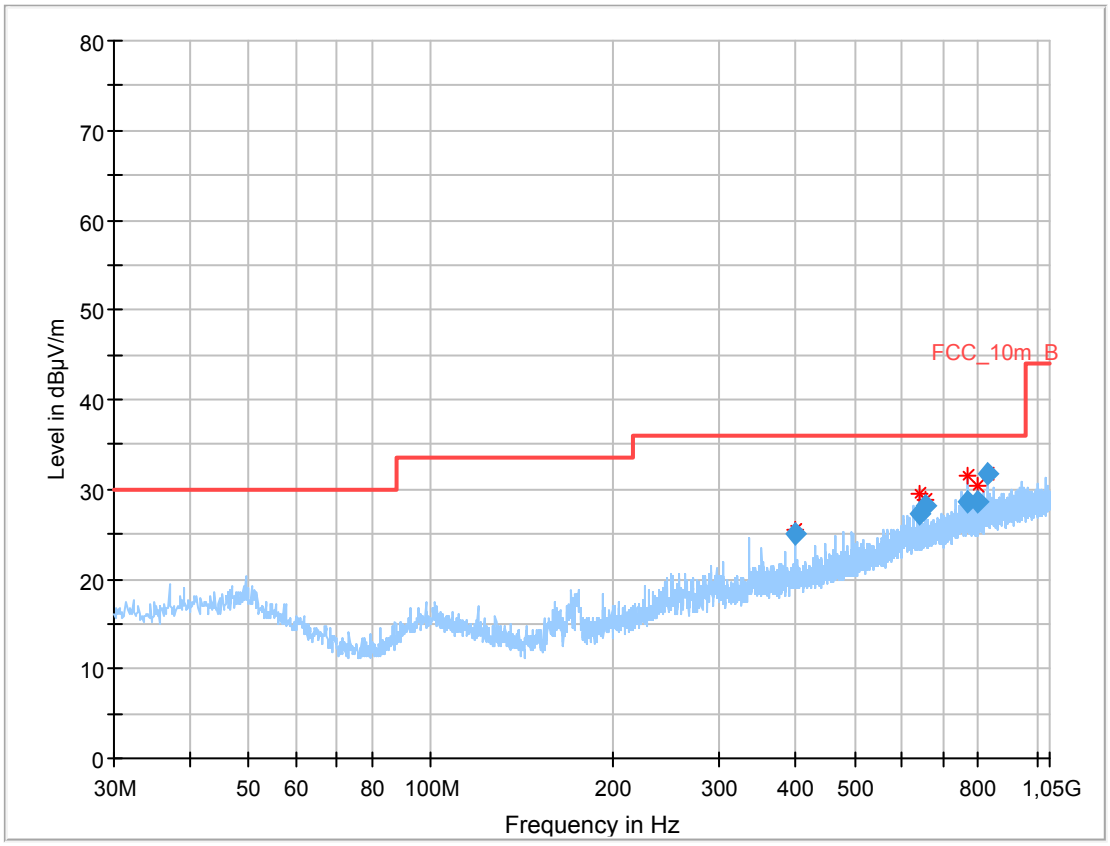



**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 640.017300 | 28.37 | 36.00 | 7.63 | 1000.0 | 120.000 | 101.0 | H | 37.0 | 21.0 |
| 655.986150 | 26.00 | 36.00 | 10.00 | 1000.0 | 120.000 | 101.0 | H | 52.0 | 21.2 |
| 752.001750 | 30.66 | 36.00 | 5.34 | 1000.0 | 120.000 | 98.0 | H | 37.0 | 22.7 |
| 767.996250 | 30.19 | 36.00 | 5.81 | 1000.0 | 120.000 | 98.0 | H | 25.0 | 22.7 |
| 816.041250 | 28.55 | 36.00 | 7.45 | 1000.0 | 120.000 | 98.0 | H | 37.0 | 23.0 |
| 832.010100 | 31.40 | 36.00 | 4.60 | 1000.0 | 120.000 | 101.0 | H | 155.0 | 23.2 |

**Plots:** Receiver mode, Plastic cover

**Plot 1:** 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization

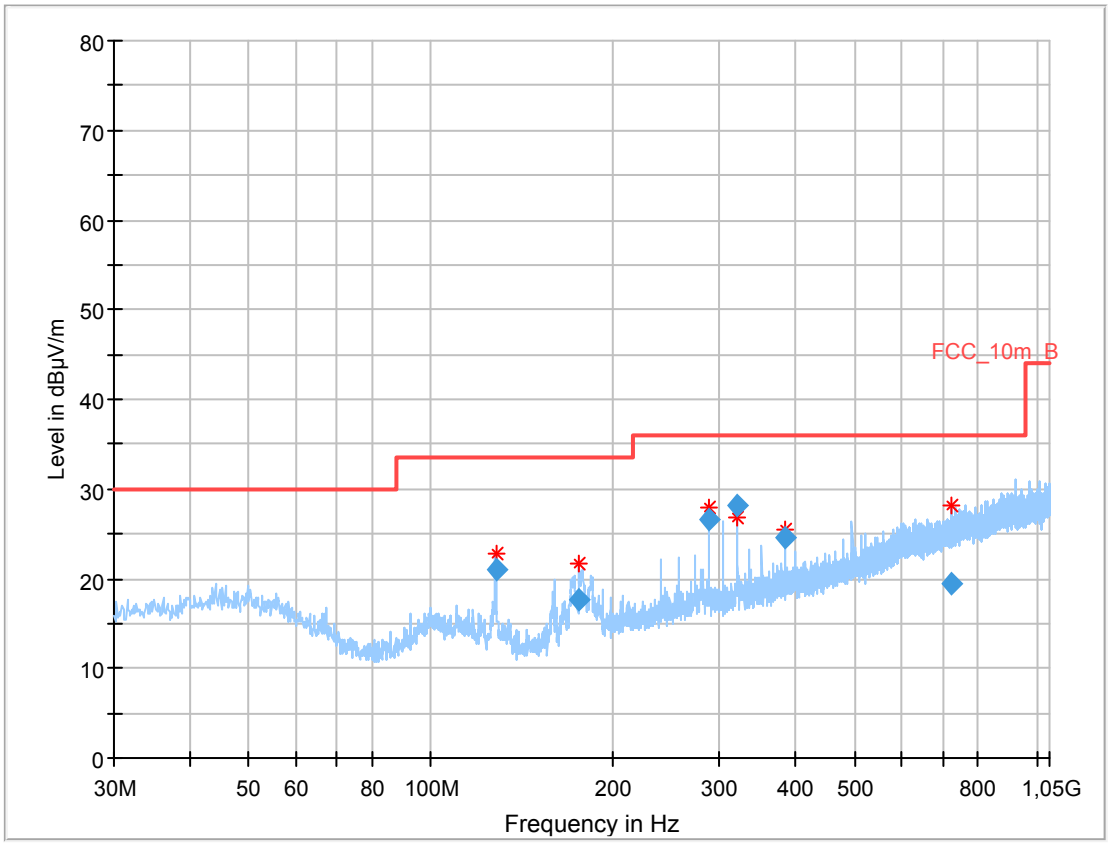



**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 400.019850 | 25.13 | 36.00 | 10.87 | 1000.0 | 120.000 | 185.0 | H | 2.0 | 16.9 |
| 640.023300 | 27.17 | 36.00 | 8.83 | 1000.0 | 120.000 | 98.0 | H | 2.0 | 21.0 |
| 656.015550 | 28.24 | 36.00 | 7.76 | 1000.0 | 120.000 | 101.0 | H | 28.0 | 21.2 |
| 768.010800 | 28.66 | 36.00 | 7.34 | 1000.0 | 120.000 | 101.0 | H | 201.0 | 22.7 |
| 800.032650 | 28.57 | 36.00 | 7.43 | 1000.0 | 120.000 | 98.0 | H | 50.0 | 22.7 |
| 832.011450 | 31.83 | 36.00 | 4.17 | 1000.0 | 120.000 | 101.0 | H | 154.0 | 23.2 |

**Plots:** Transmit mode, Metallic cover

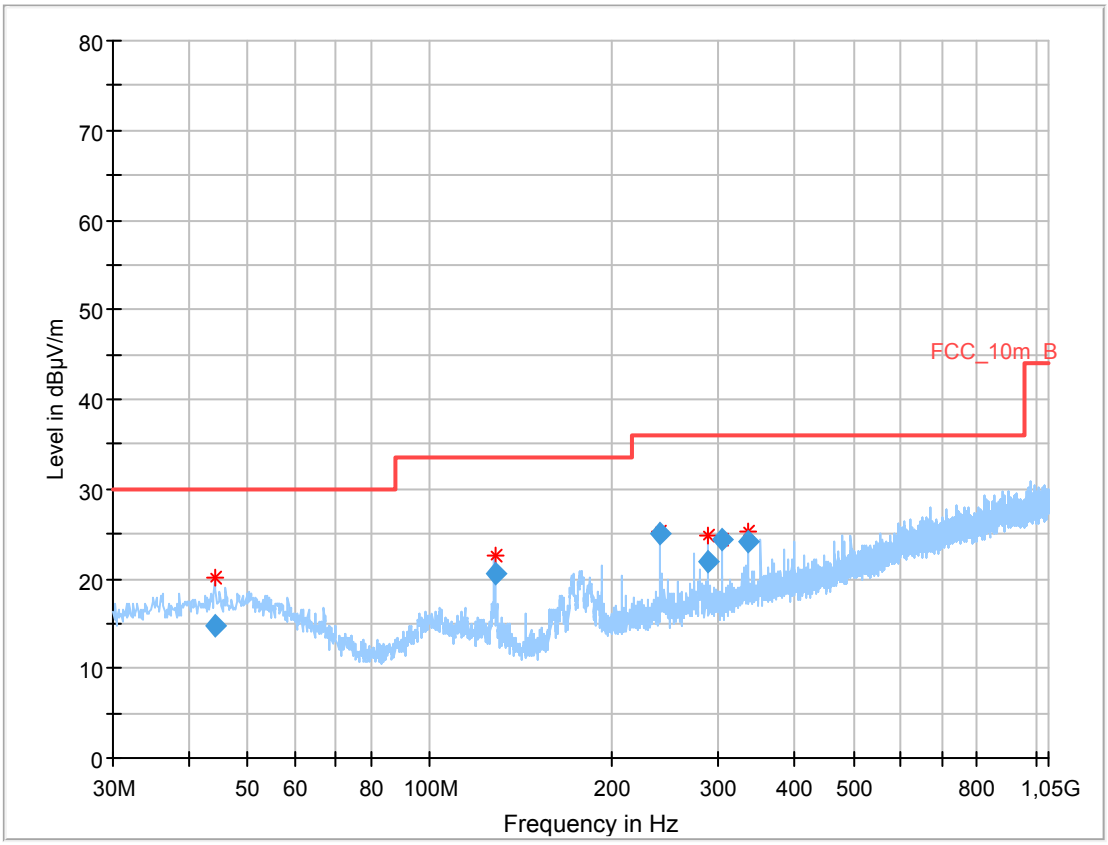
**Plot 1:** 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization




**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 128.004300 | 21.11 | 33.50 | 12.39 | 1000.0 | 120.000 | 98.0 | V | 70.0 | 9.7 |
| 175.995600 | 17.68 | 33.50 | 15.82 | 1000.0 | 120.000 | 98.0 | V | 349.0 | 10.7 |
| 287.985900 | 26.69 | 36.00 | 9.31 | 1000.0 | 120.000 | 98.0 | V | 35.0 | 14.2 |
| 320.005800 | 28.15 | 36.00 | 7.85 | 1000.0 | 120.000 | 98.0 | V | 0.0 | 15.1 |
| 384.009150 | 24.66 | 36.00 | 11.34 | 1000.0 | 120.000 | 98.0 | V | 349.0 | 16.6 |
| 720.967200 | 19.35 | 36.00 | 16.65 | 1000.0 | 120.000 | 185.0 | H | 141.0 | 22.0 |

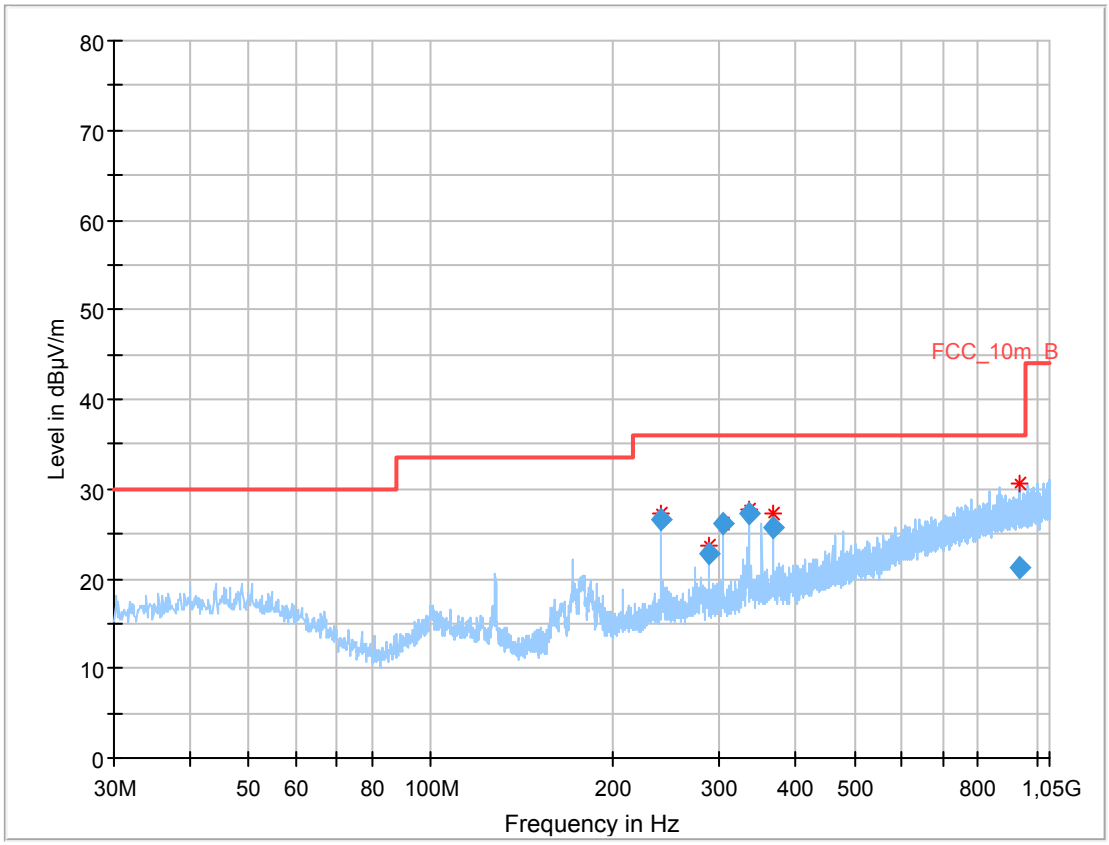
**Plot 2:** 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization




**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 44.239800 | 14.77 | 30.00 | 15.23 | 1000.0 | 120.000 | 101.0 | V | 145.0 | 13.6 |
| 128.017650 | 20.66 | 33.50 | 12.84 | 1000.0 | 120.000 | 101.0 | V | 353.0 | 9.7 |
| 239.984700 | 25.01 | 36.00 | 10.99 | 1000.0 | 120.000 | 98.0 | V | 102.0 | 13.1 |
| 287.995650 | 21.90 | 36.00 | 14.10 | 1000.0 | 120.000 | 98.0 | V | 296.0 | 14.2 |
| 304.001850 | 24.40 | 36.00 | 11.60 | 1000.0 | 120.000 | 98.0 | V | 334.0 | 14.5 |
| 336.019950 | 24.20 | 36.00 | 11.80 | 1000.0 | 120.000 | 98.0 | V | 74.0 | 15.6 |

**Plot 3:** 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

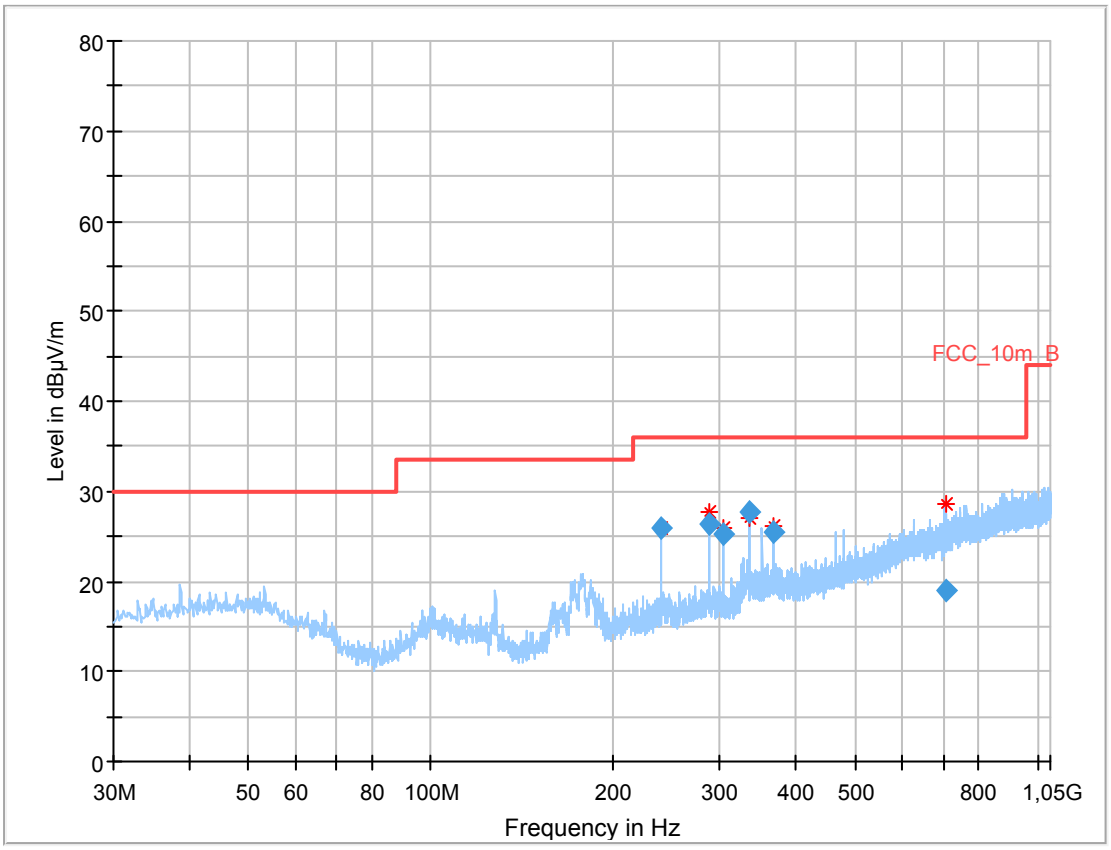



**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 240.007650 | 26.56 | 36.00 | 9.44 | 1000.0 | 120.000 | 98.0 | V | 50.0 | 13.1 |
| 288.004800 | 22.89 | 36.00 | 13.11 | 1000.0 | 120.000 | 98.0 | V | 304.0 | 14.2 |
| 303.998250 | 26.06 | 36.00 | 9.94 | 1000.0 | 120.000 | 98.0 | V | 329.0 | 14.5 |
| 336.006600 | 27.18 | 36.00 | 8.82 | 1000.0 | 120.000 | 98.0 | V | 8.0 | 15.6 |
| 368.019300 | 25.67 | 36.00 | 10.33 | 1000.0 | 120.000 | 98.0 | V | 29.0 | 16.3 |
| 937.566600 | 21.28 | 36.00 | 14.72 | 1000.0 | 120.000 | 98.0 | H | 107.0 | 24.3 |

**Plots:** Receiver mode, Metallic cover

**Plot 1:** 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization




**Final_Result:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 240.004350 | 25.98 | 36.00 | 10.02 | 1000.0 | 120.000 | 98.0 | V | 81.0 | 13.1 |
| 287.997000 | 26.43 | 36.00 | 9.57 | 1000.0 | 120.000 | 98.0 | V | 305.0 | 14.2 |
| 303.998550 | 25.14 | 36.00 | 10.86 | 1000.0 | 120.000 | 101.0 | V | 353.0 | 14.5 |
| 335.998800 | 27.64 | 36.00 | 8.36 | 1000.0 | 120.000 | 98.0 | V | 18.0 | 15.6 |
| 367.986000 | 25.48 | 36.00 | 10.52 | 1000.0 | 120.000 | 98.0 | V | 2.0 | 16.3 |
| 704.252550 | 18.90 | 36.00 | 17.10 | 1000.0 | 120.000 | 98.0 | V | 252.0 | 21.7 |

## 11.11 Spurious emissions radiated above 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The measurement is performed in the mode with the highest output power.

| Measurement parameters | |
|---|---|
| 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 |
| Measured modulation | GFSK |
| Test setup | See sub clause 6.2 A (1 GHz - 18 GHz)<br>See sub clause 6.3 A (18 GHz - 26 GHz) |
| Measurement uncertainty | See sub clause 8 |

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated | | |
| 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)). | | |
| §15.209 | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| Above 960 | 54.0 (Average) | 3 |
| Above 960 | 74.0 (Peak) | 3 |

**Results:** Transmitter mode, plastic cover

| TX spurious emissions radiated [dBµV/m] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2402 MHz | | | 2440 MHz | | | 2480 MHz | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | | | | | | | |
| 2304.6 | Peak | 50.2 | 2552.6 No RB! | Peak | 54.8 | 2552.9 No RB! | Peak | 54.7 |
| | AVG | -/- | | AVG | -/- | | AVG | -/- |
| 2360.6 | Peak | 52.3 | -/- | Peak | -/- | -/- | Peak | -/- |
| | AVG | -/- | | AVG | -/- | | AVG | -/- |
| -/- | Peak | -/- | -/- | Peak | -/- | -/- | Peak | -/- |
| | AVG | -/- | | AVG | -/- | | AVG | -/- |

No RB: Not in rescricted band

**Results:** Receiver mode, plastic cover

| RX spurious emissions radiated [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | |
| | Peak | |
| | AVG | |

**Results:** Transmitter mode, metallic cover

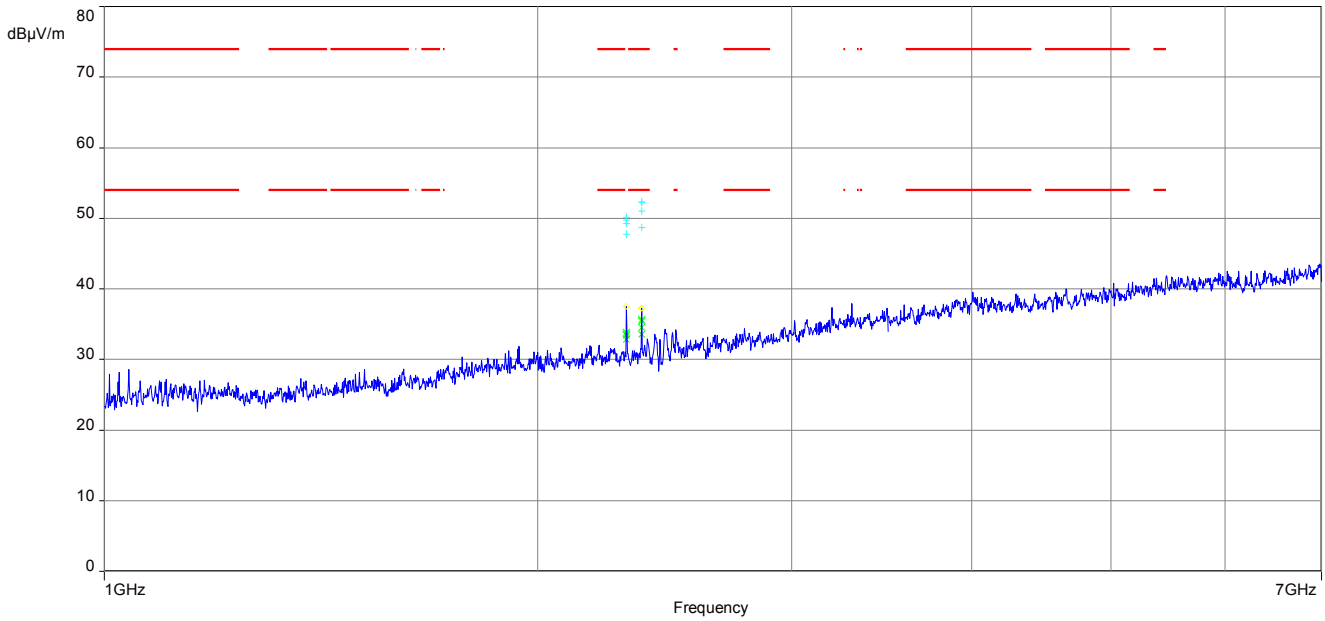
| TX spurious emissions radiated [dBµV/m] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2402 MHz | | | 2440 MHz | | | 2480 MHz | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | | | | | | | |
| Same behavior like the plastic cover. | | | Same behavior like the plastic cover. | | | Same behavior like the plastic cover. | | |
| -/- | Peak | -/- | -/- | Peak | -/- | -/- | Peak | -/- |
| | AVG | -/- | | AVG | -/- | | AVG | -/- |
| -/- | Peak | -/- | -/- | Peak | -/- | -/- | Peak | -/- |
| | AVG | -/- | | AVG | -/- | | AVG | -/- |

**Results:** Receiver mode, metallic cover

| RX spurious emissions radiated [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| Same behavior like the plastic cover. | | |
| | Peak | |
| | AVG | |

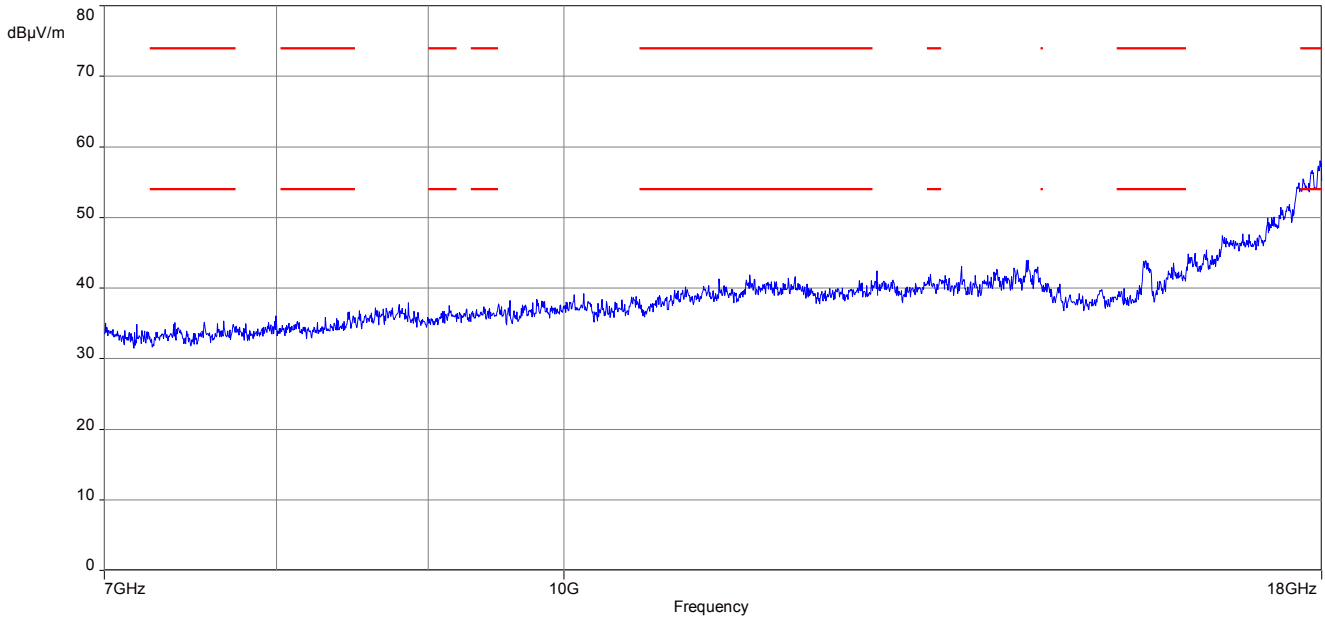
**Plots:** Transmitter mode, plastic cover

**Plot 1:** 1 GHz to 7 GHz, TX mode, 2402 MHz, vertical & horizontal polarization

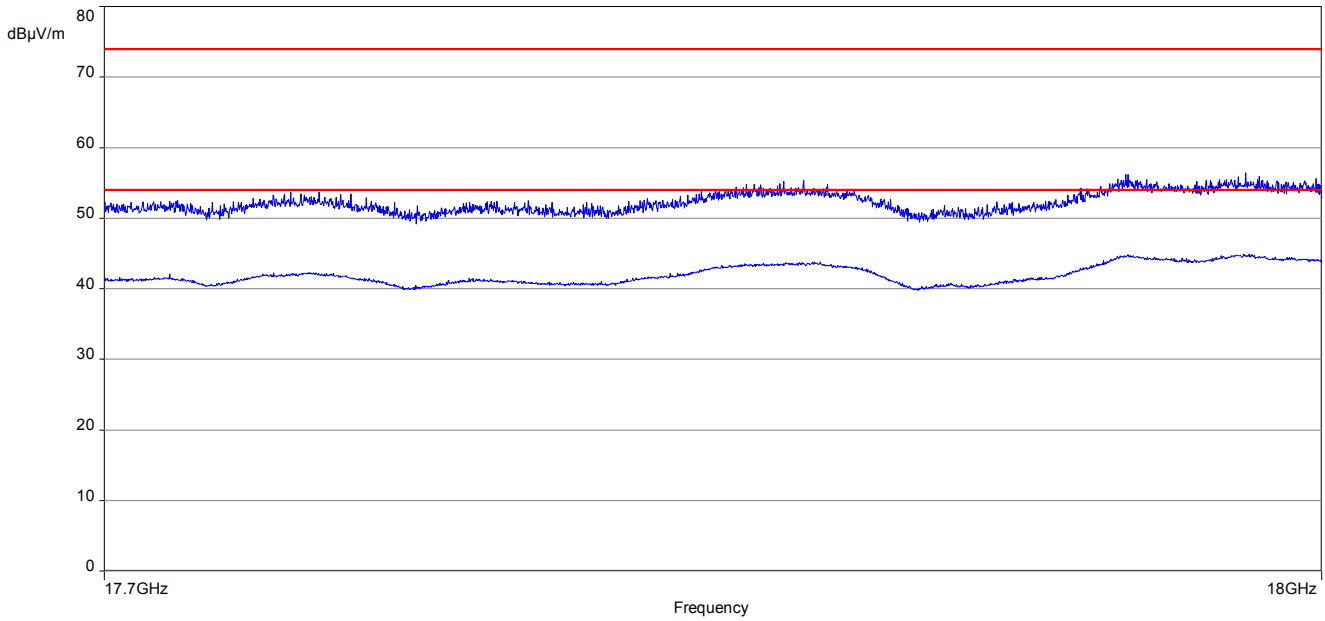



The carrier signal is notched with a 2.4 GHz band rejection filter.

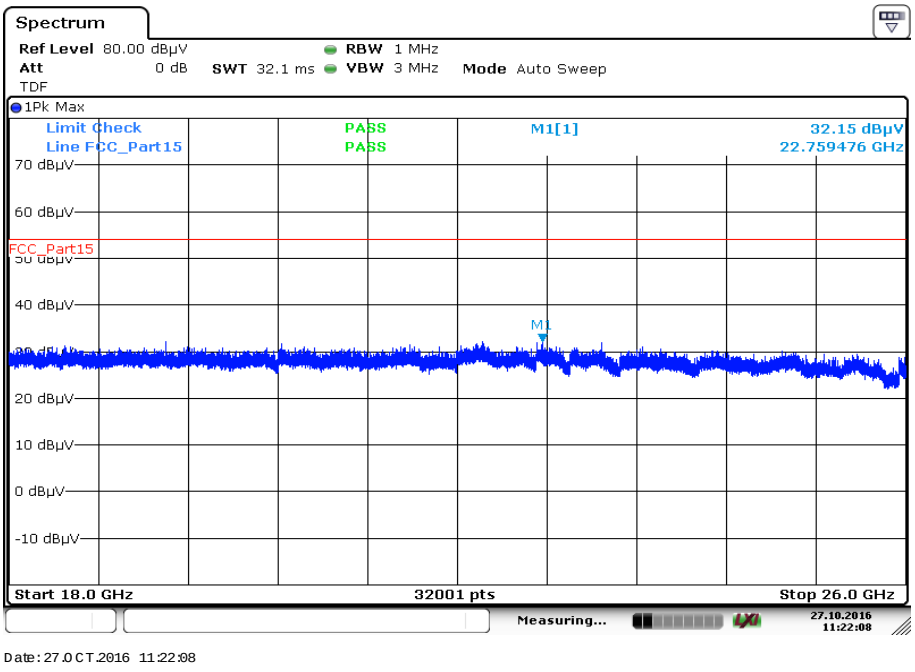
**Plot 2:** 7 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization



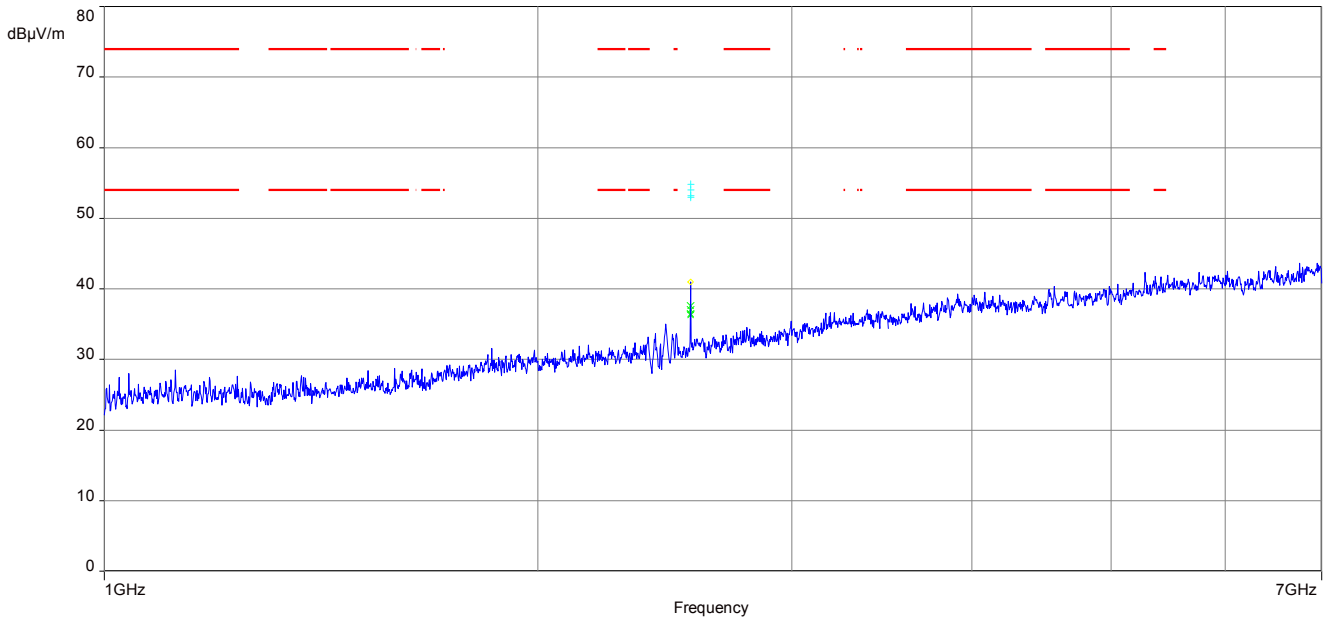
**Plot 3:** 17.7 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization




**Plot 4:** 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization

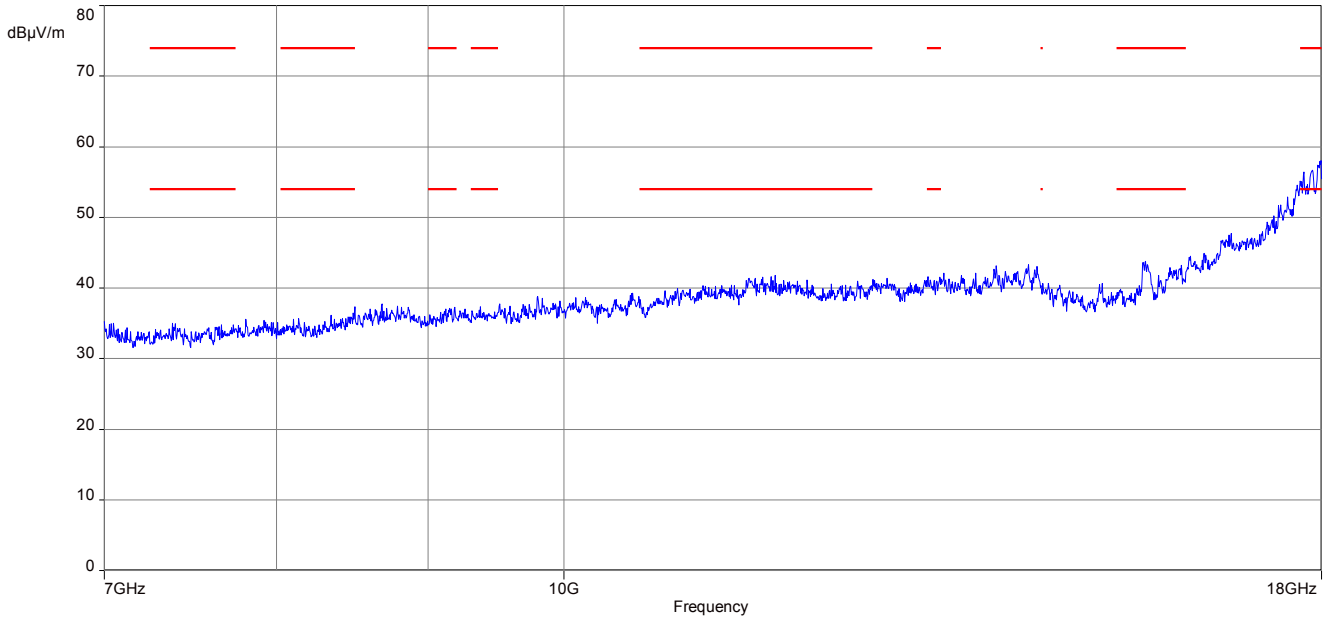


**Plot 5:** 1 GHz to 7 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

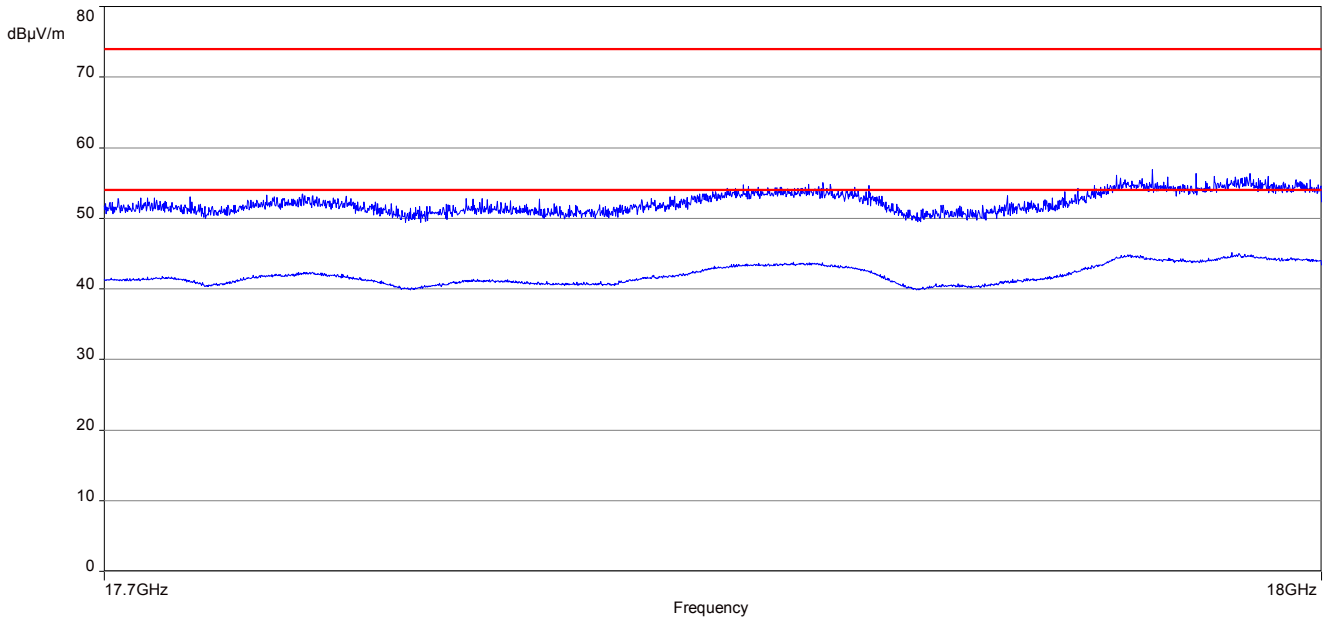



The carrier signal is notched with a 2.4 GHz band rejection filter.

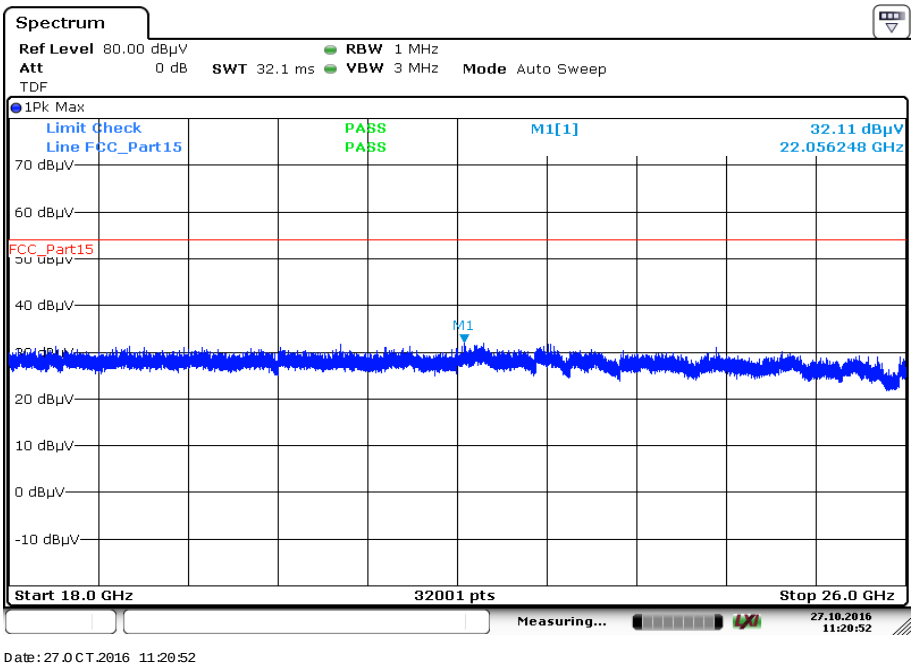
**Plot 6:** 7 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization



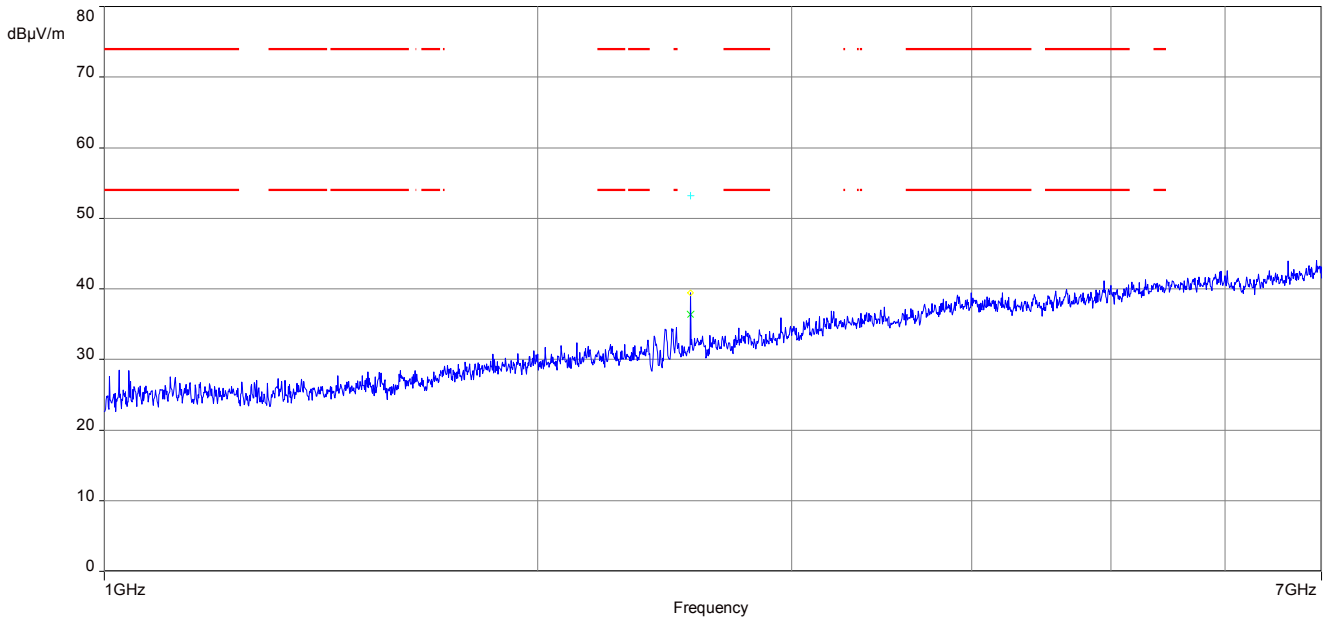
**Plot 7:** 17.7 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization




**Plot 8:** 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

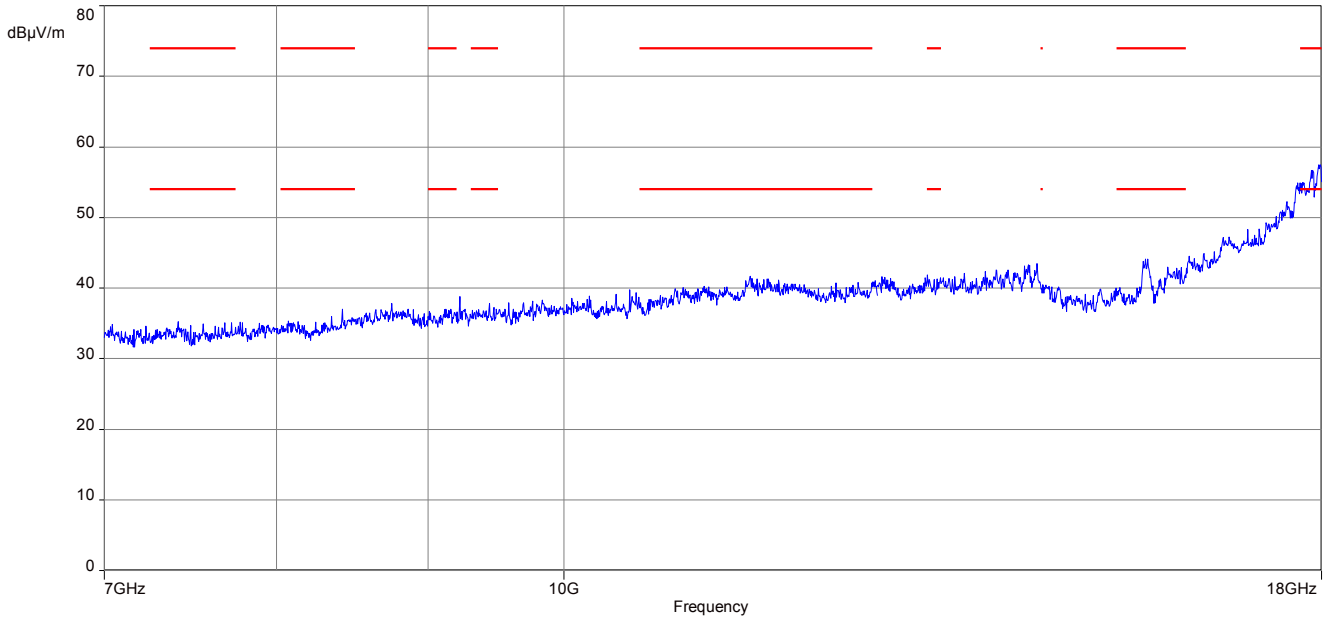


**Plot 9:** 1 GHz to 7 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

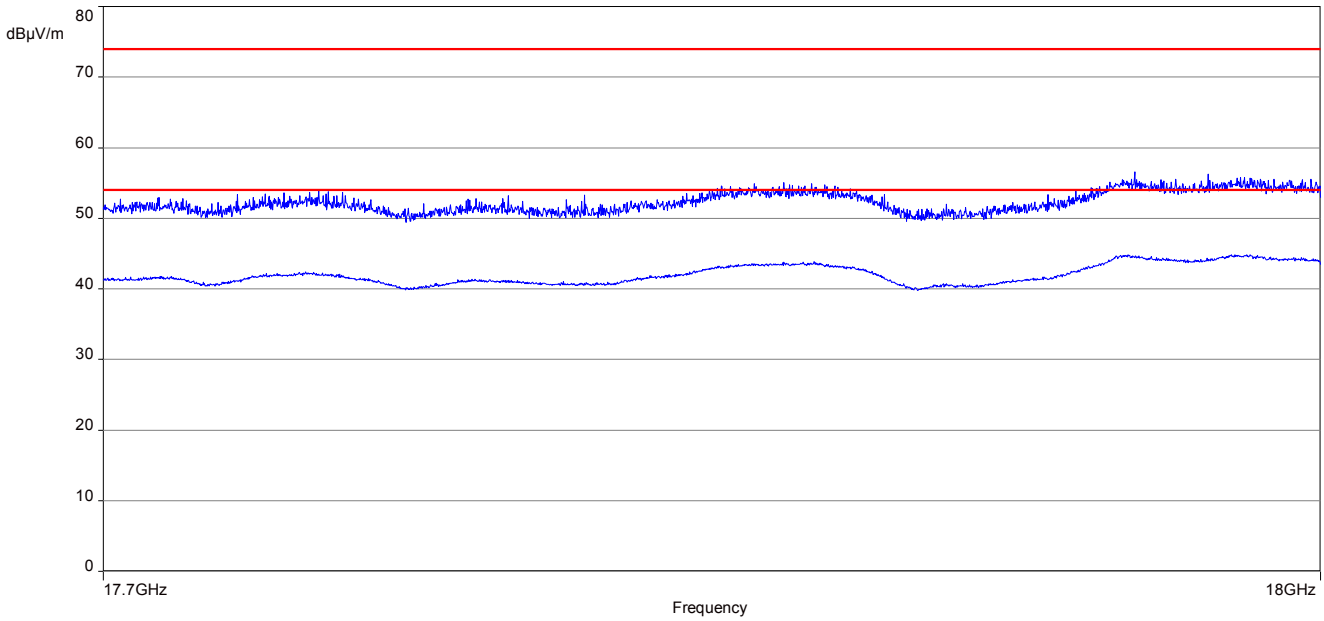



The carrier signal is notched with a 2.4 GHz band rejection filter.

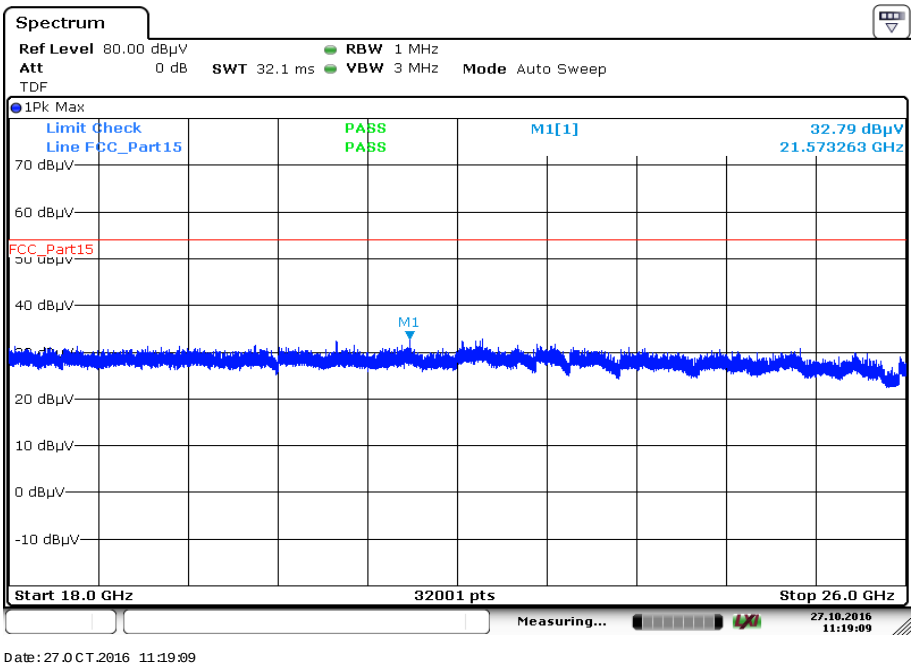
**Plot 10:** 7 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



**Plot 11:** 17.7 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

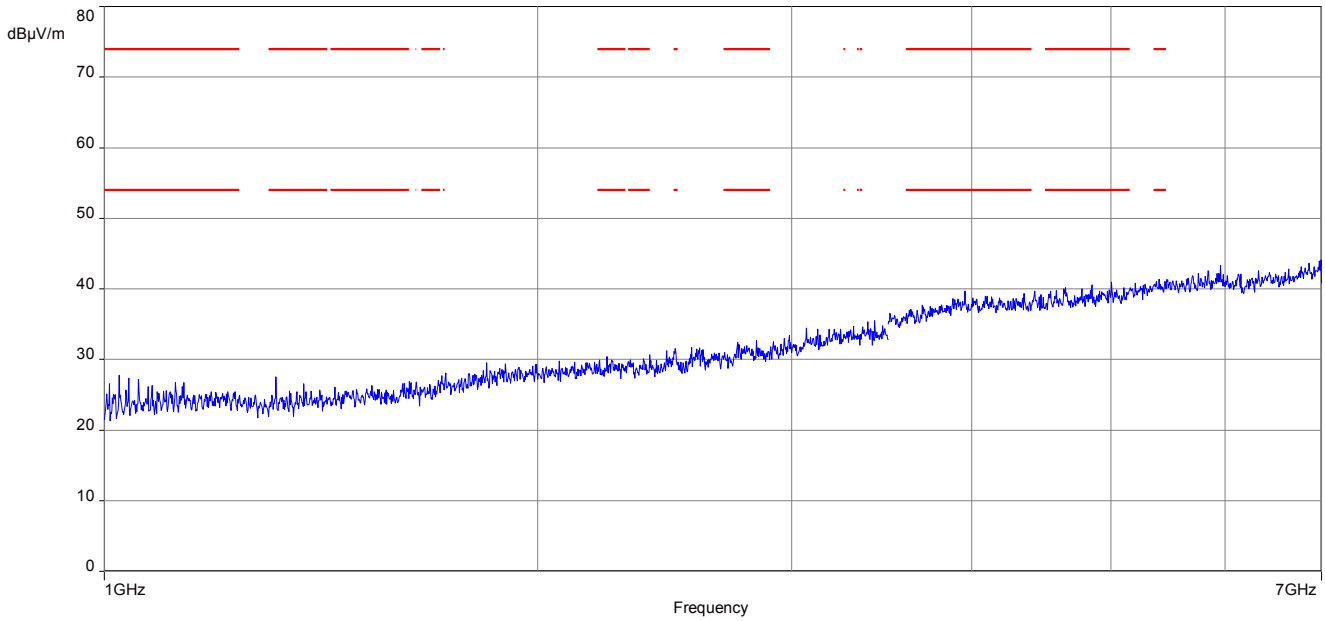



**Plot 12:** 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

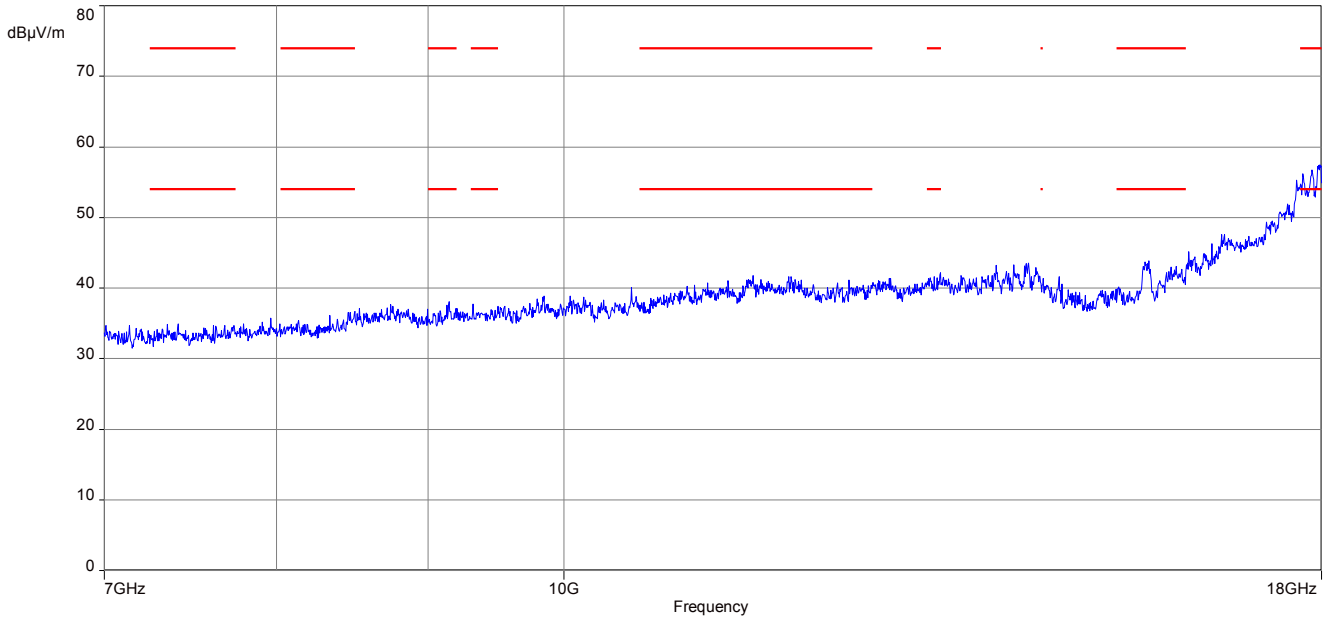


**Plots:** Receiver mode, plastic cover

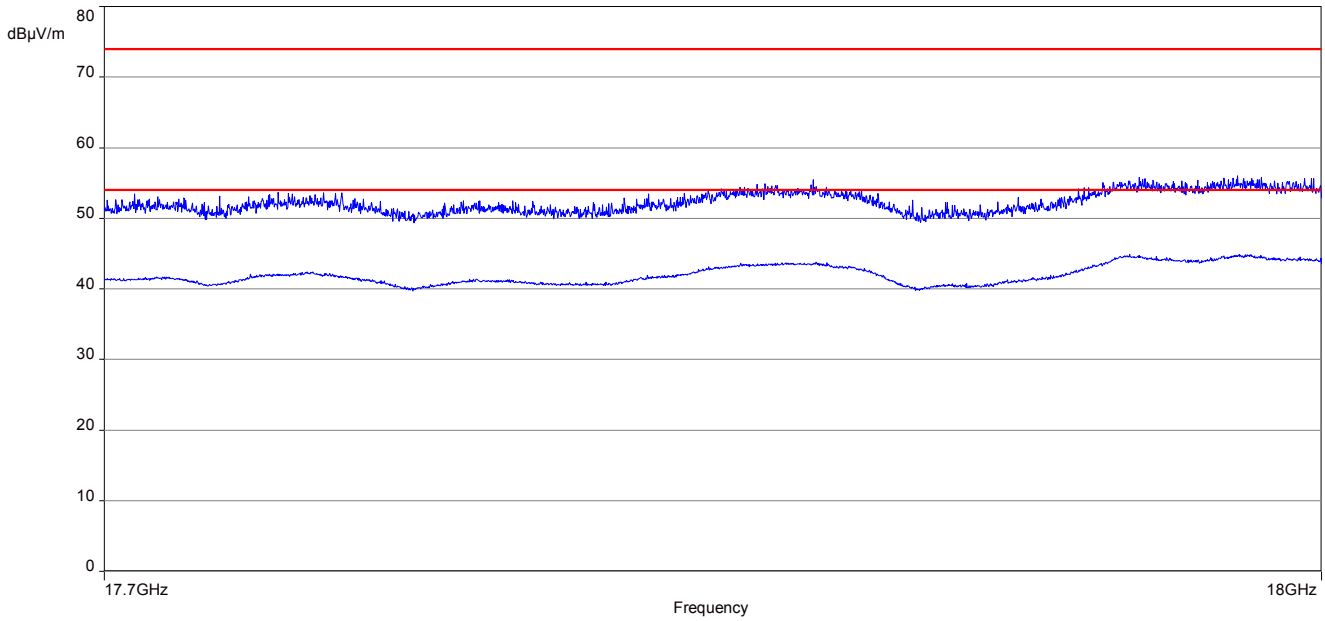
**Plot 1:** 1 GHz to 7 GHz, RX / idle – mode, vertical & horizontal polarization



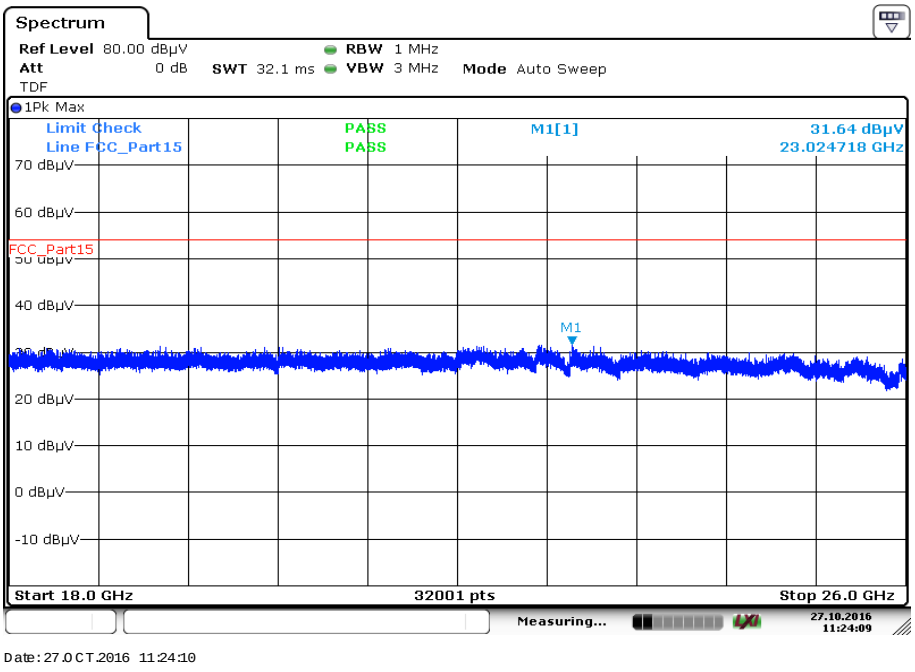

**Plot 2:** 7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



**Plot 3:** 17.7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization

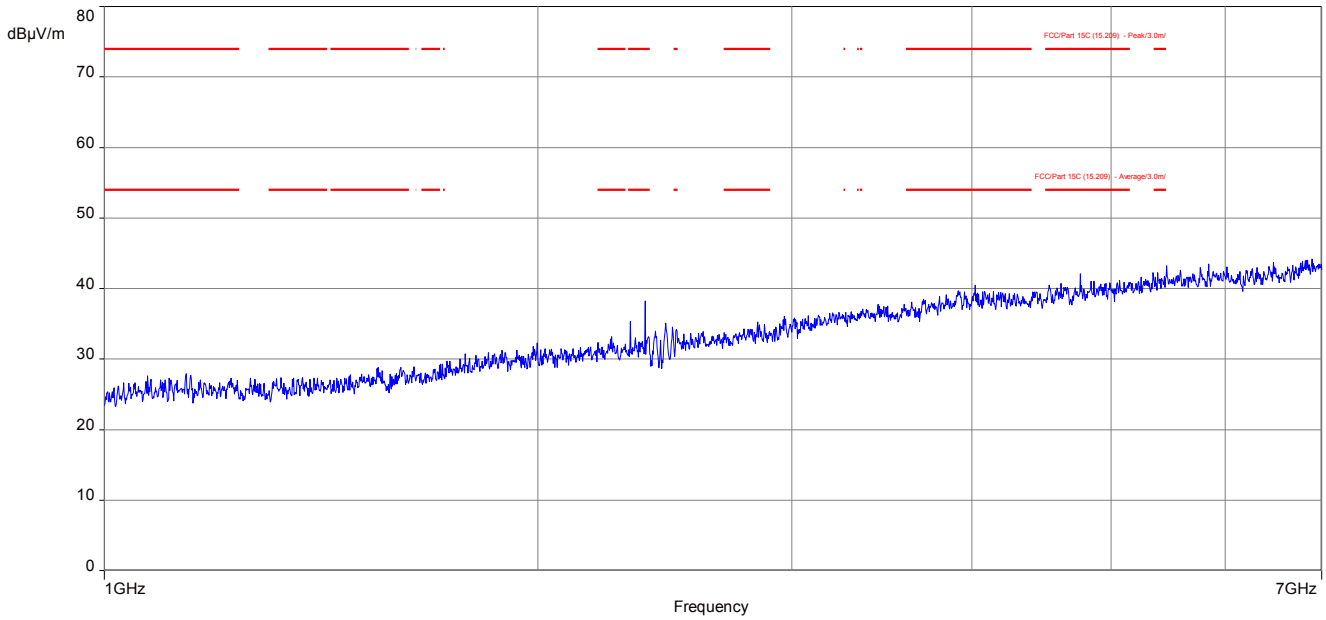



**Plot 4:** 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization



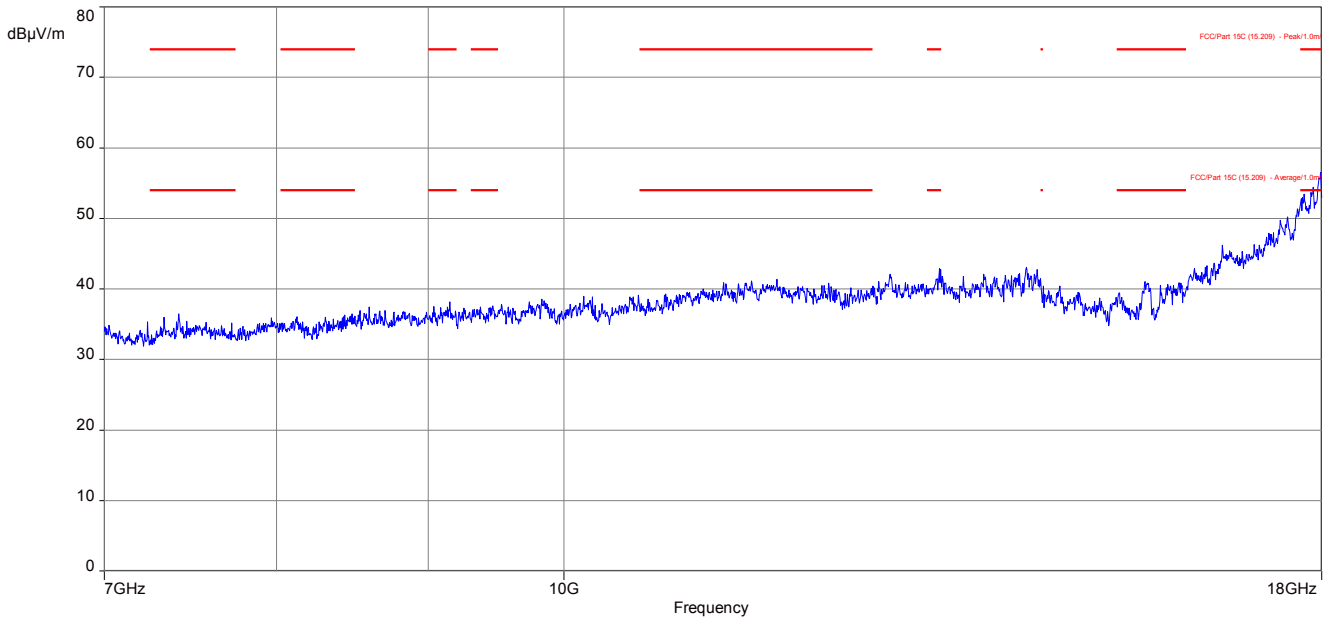
**Plots:** Transmitter mode, metallic cover

**Plot 1:** 1 GHz to 7 GHz, TX mode, 2402 MHz, vertical & horizontal polarization

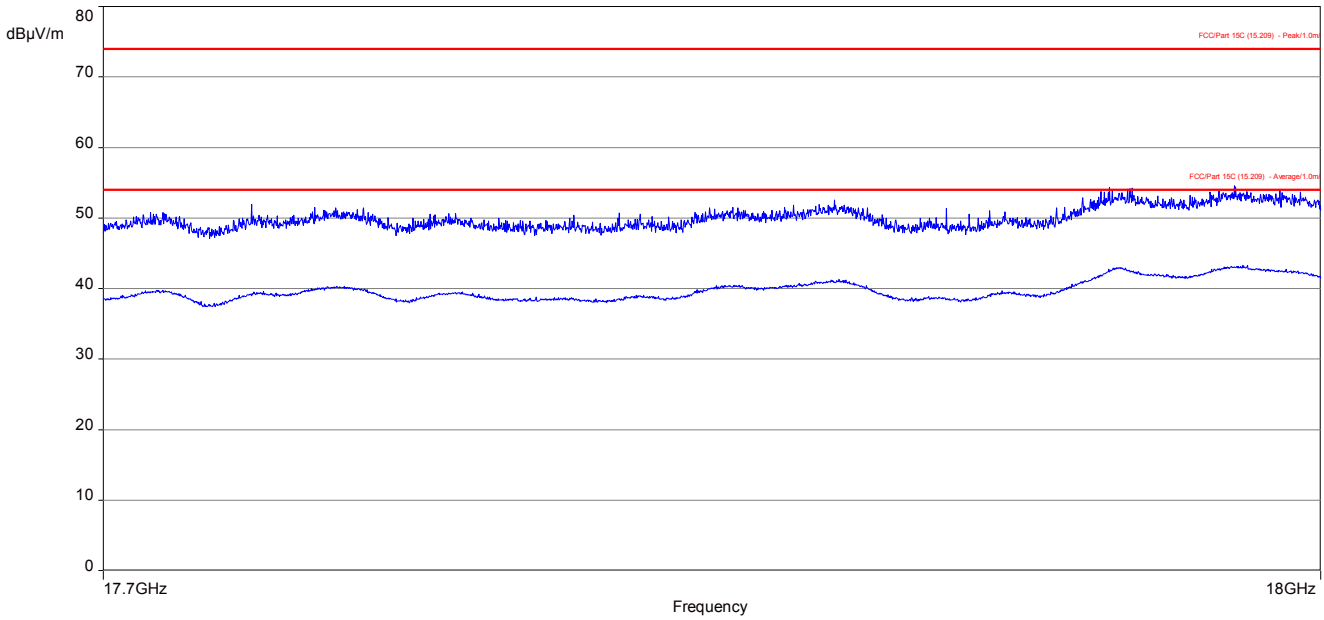



The carrier signal is notched with a 2.4 GHz band rejection filter.

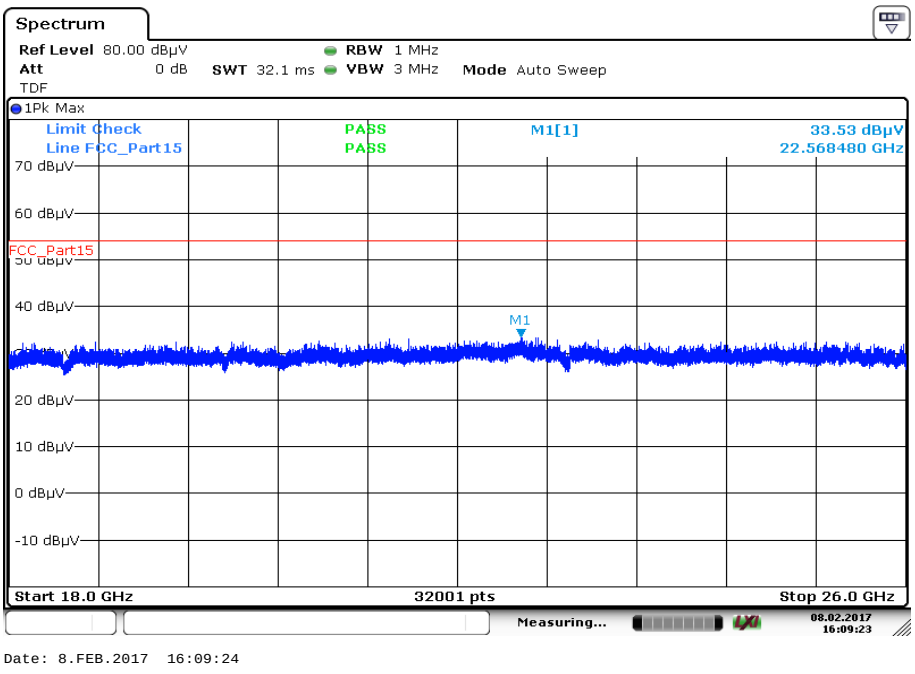
**Plot 2:** 7 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization



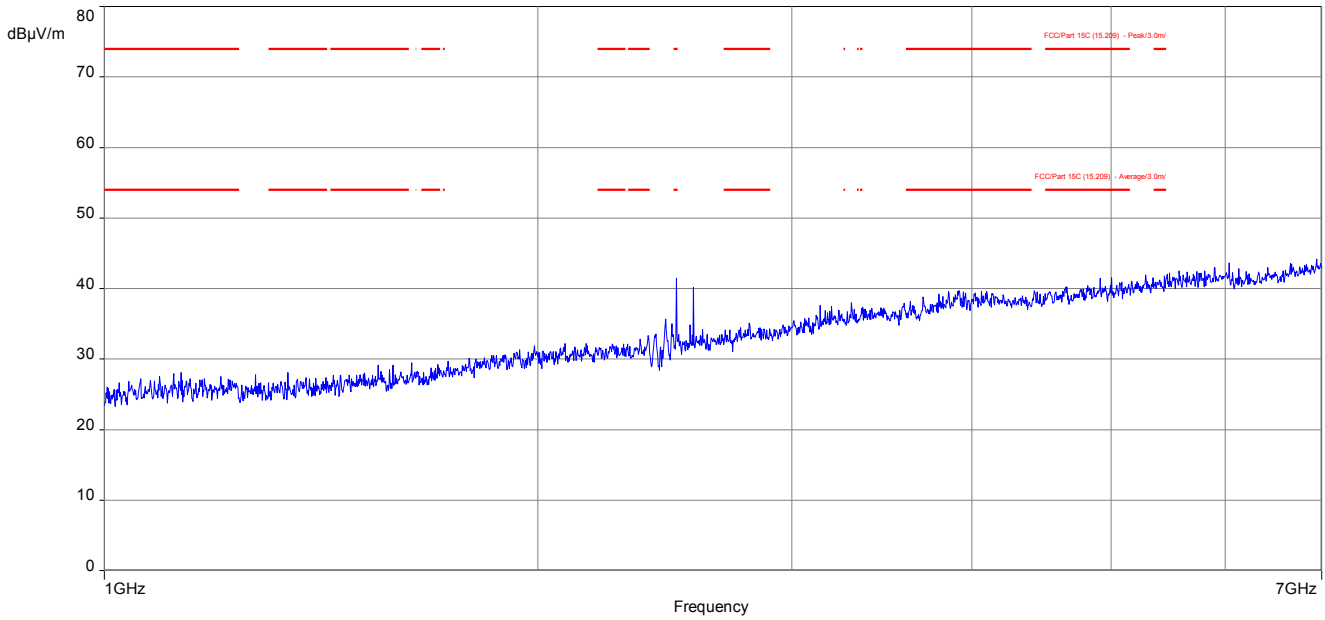
**Plot 3:** 17.7 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization




**Plot 4:** 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization

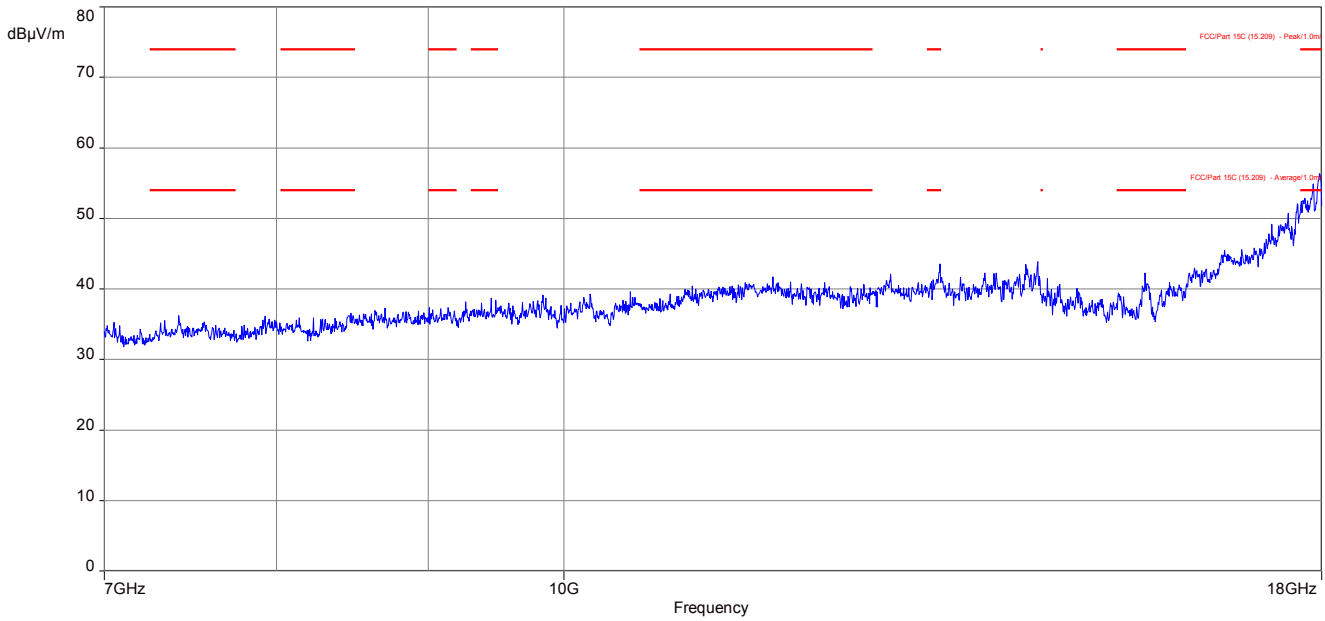


**Plot 5:** 1 GHz to 7 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

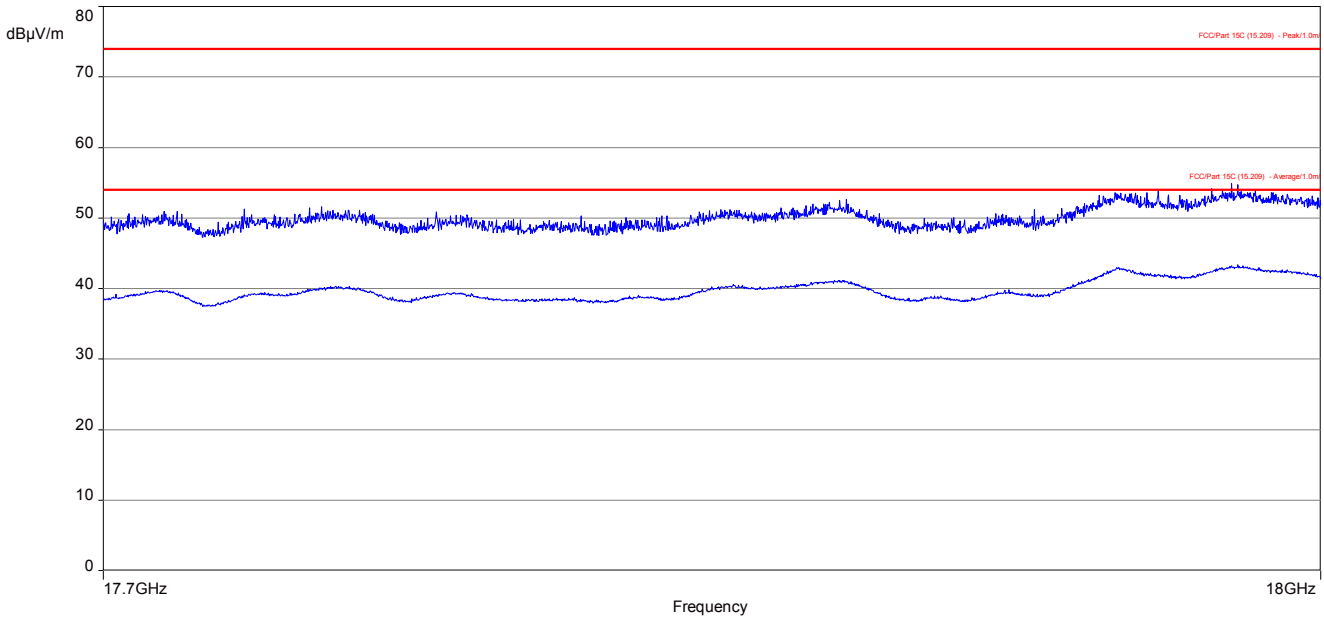



The carrier signal is notched with a 2.4 GHz band rejection filter.

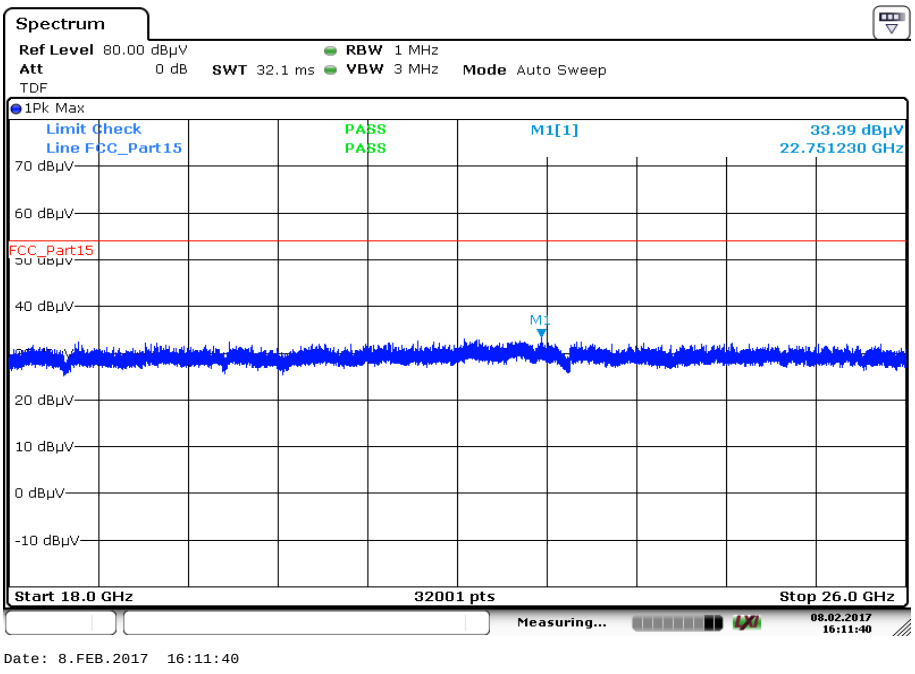
**Plot 6:** 7 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization



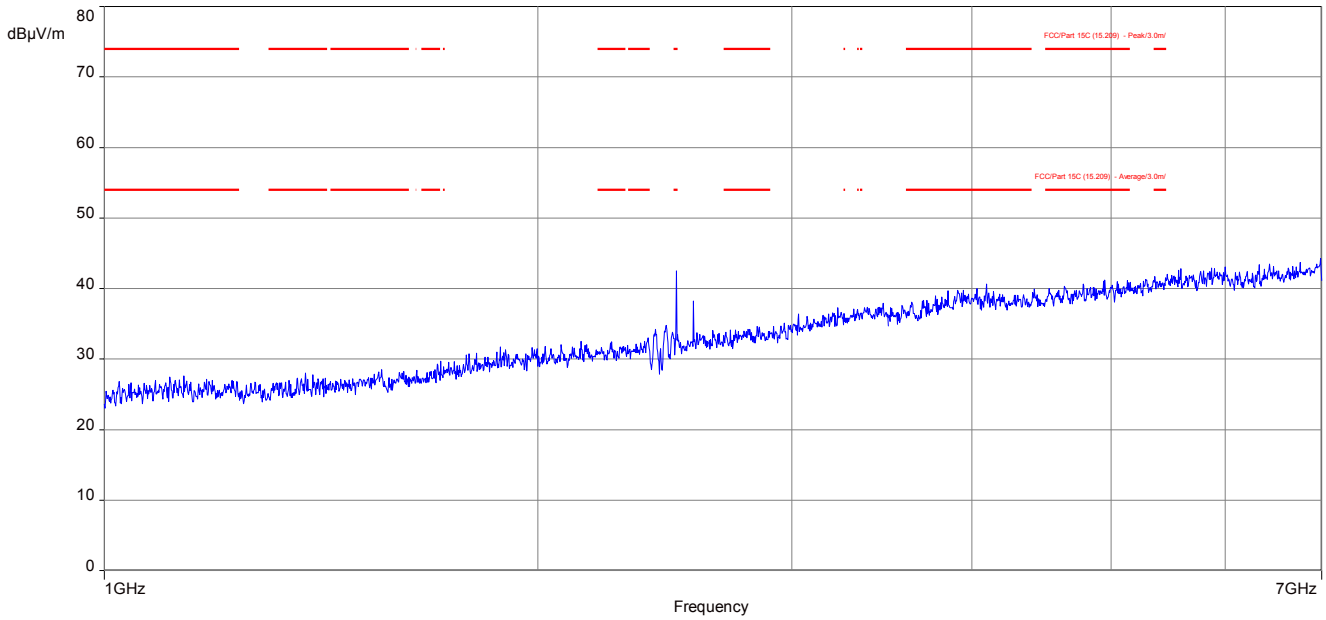
**Plot 7:** 17.7 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization




**Plot 8:** 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

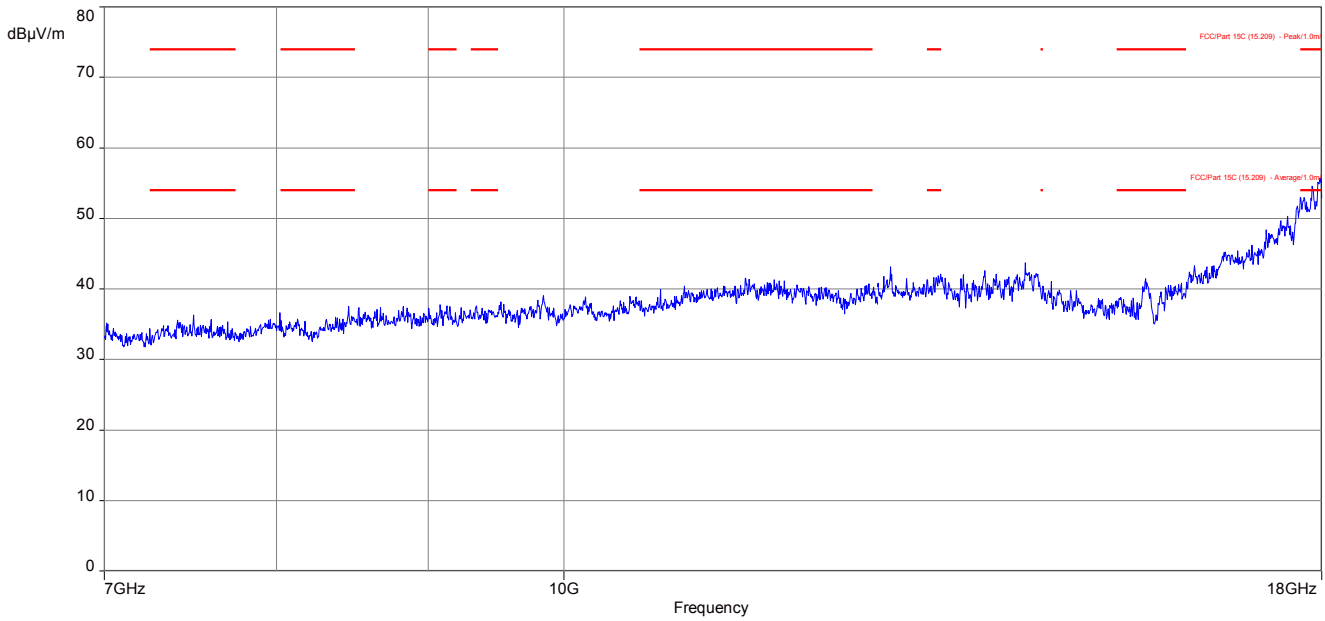


**Plot 9:** 1 GHz to 7 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

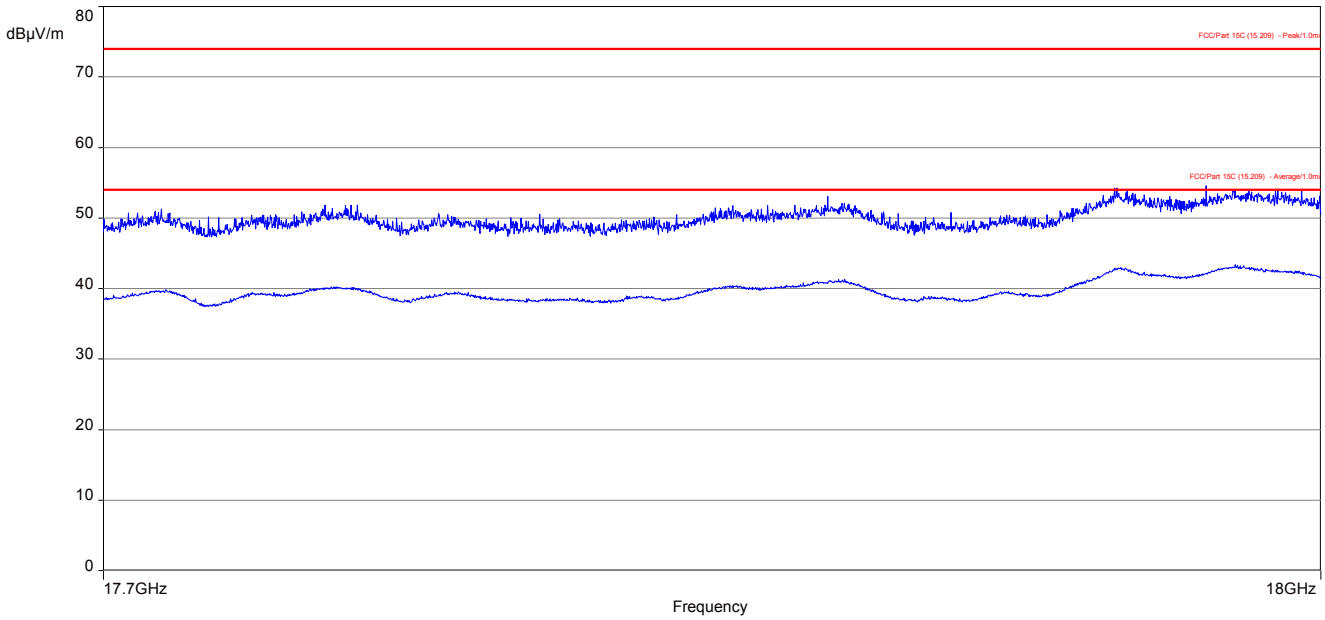



The carrier signal is notched with a 2.4 GHz band rejection filter.

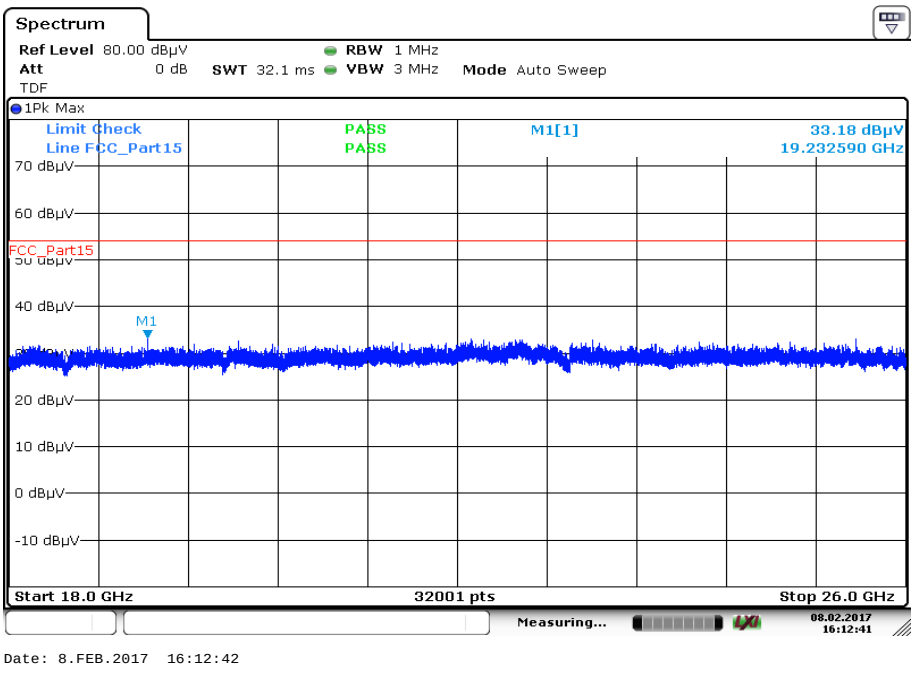
**Plot 10:** 7 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



**Plot 11:** 17.7 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

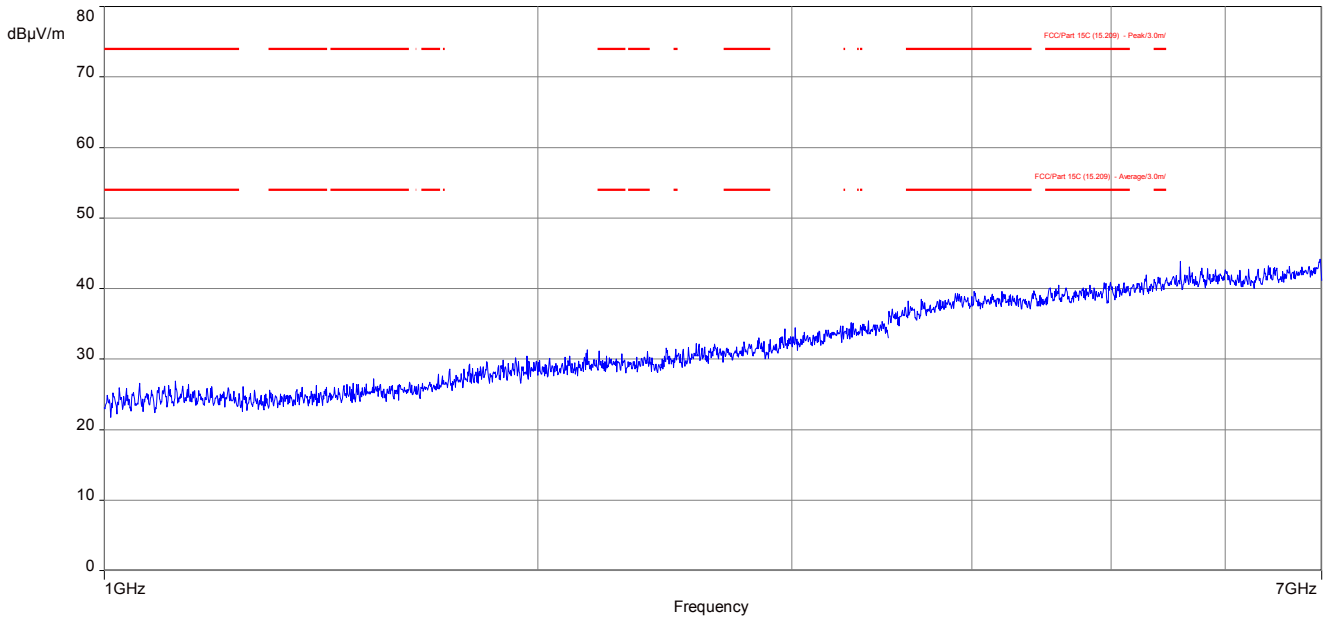



**Plot 12:** 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

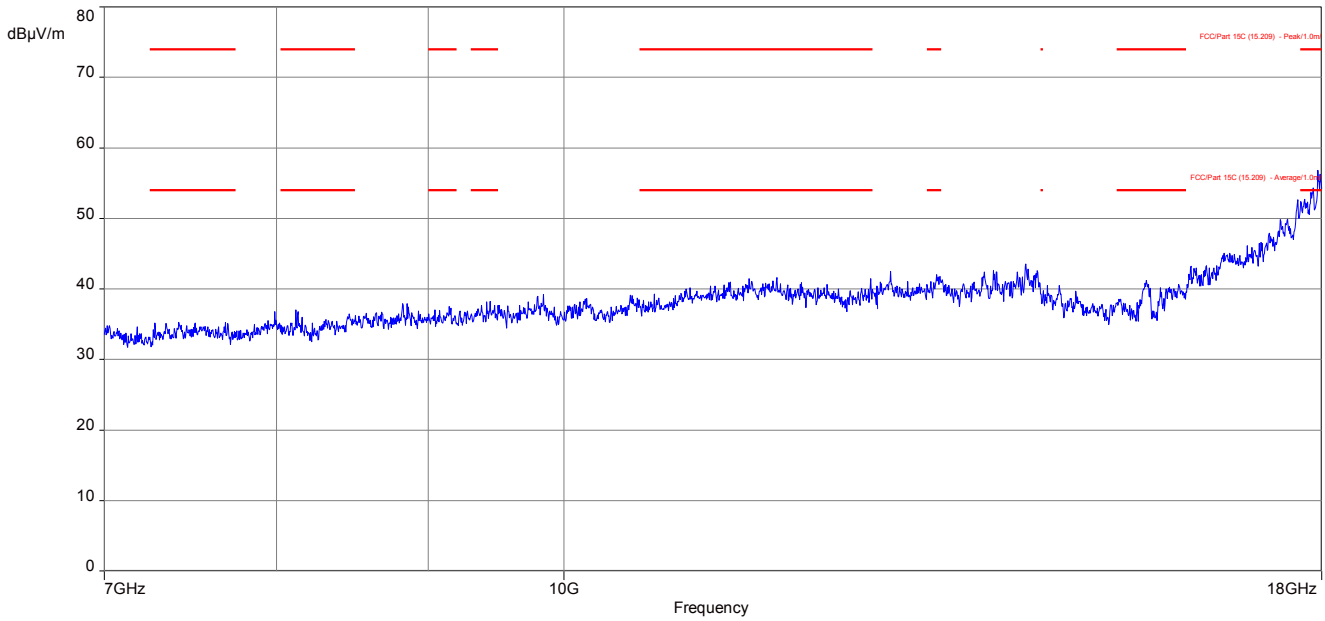


**Plots:** Receiver mode, metallic cover

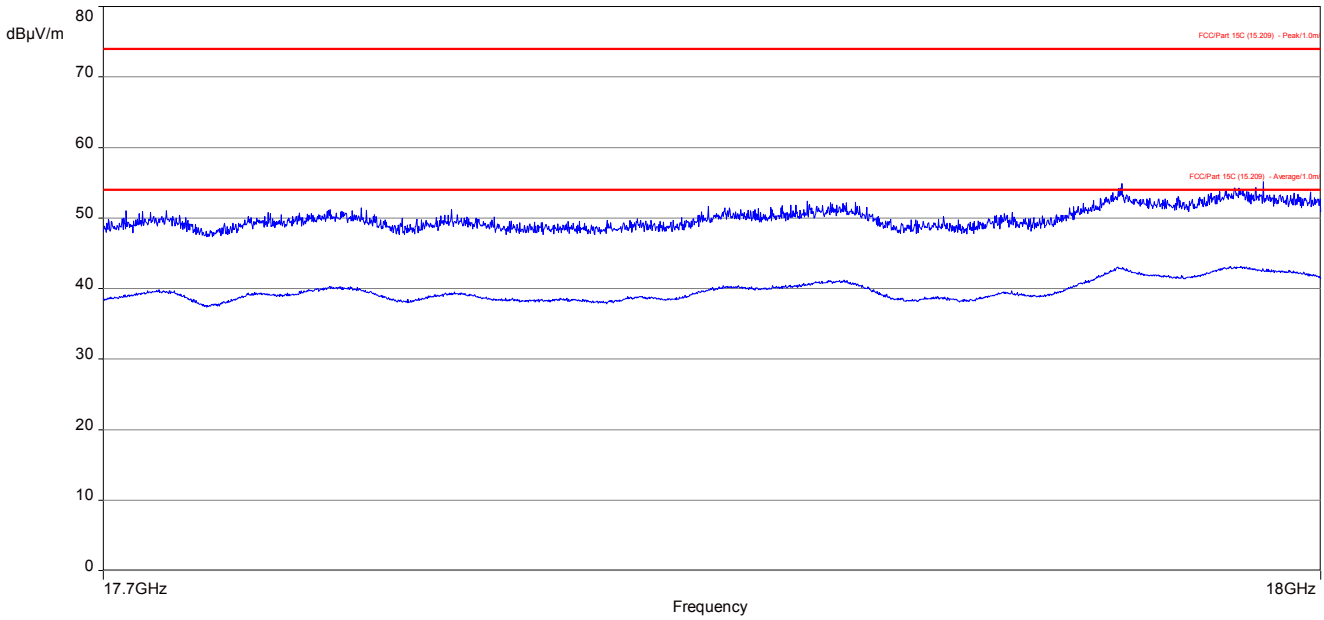
**Plot 1:** 1 GHz to 7 GHz, RX / idle – mode, vertical & horizontal polarization



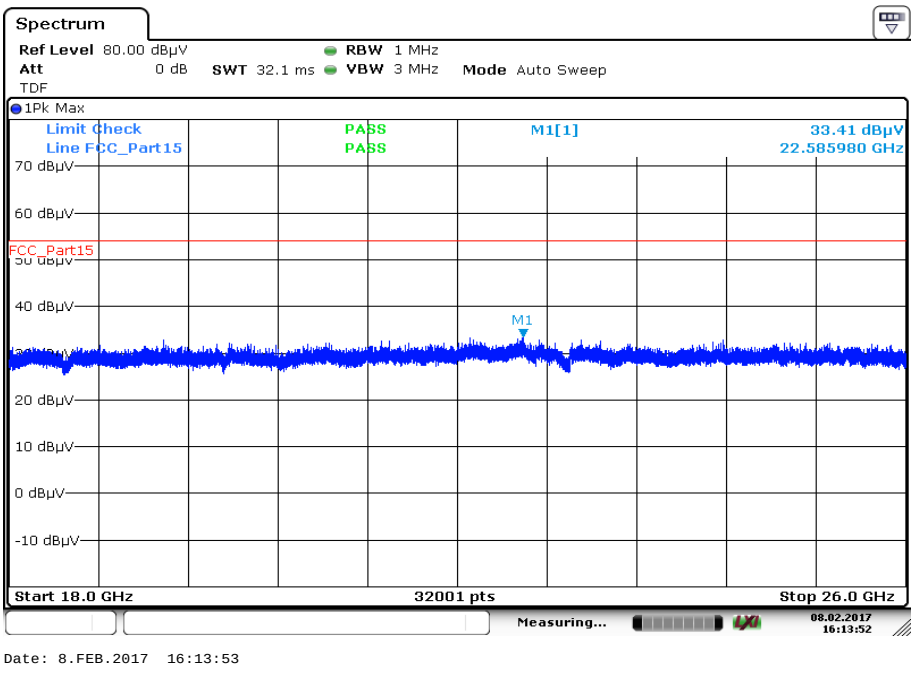

**Plot 2:** 7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



**Plot 3:** 17.7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization




**Plot 4:** 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization



## 11.12 Spurious emissions conducted below 30 MHz (AC conducted)

**Description:**

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequency is 2440 MHz. This measurement is representative for all channels and modes. If critical peaks are found frequency 2402 MHz and 2480 MHz will be measured too. The measurement is performed in the mode with the highest output power. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

| Measurement parameters | |
|---|---|
| Detector | Peak - Quasi peak / average |
| 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 sub clause 6.5. A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions conducted < 30 MHz | | |
| Frequency (MHz) | Quasi-peak (dBµV/m) | Average (dBµV/m) |
| 0.15 – 0.5 | 66 to 56* | 56 to 46* |
| 0.5 – 5 | 56 | 46 |
| 5 – 30.0 | 60 | 50 |

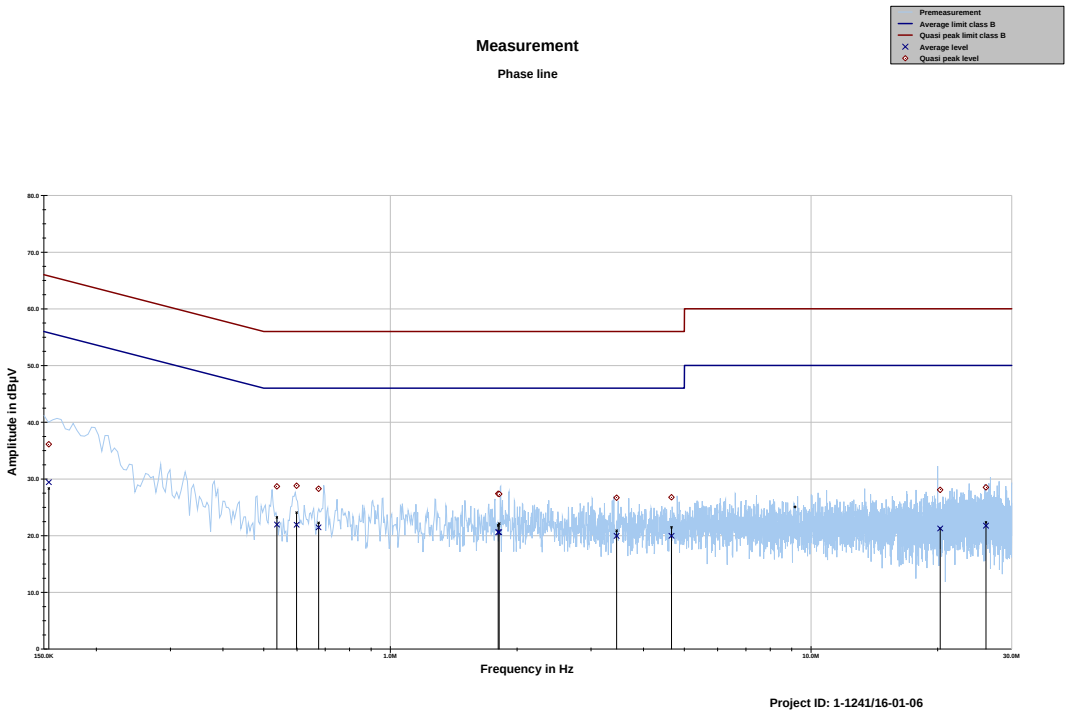
*Decreases with the logarithm of the frequency

**Results:**

| Spurious emissions conducted < 30 MHz [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| See table below the plots. | | |
| | | |
| | | |

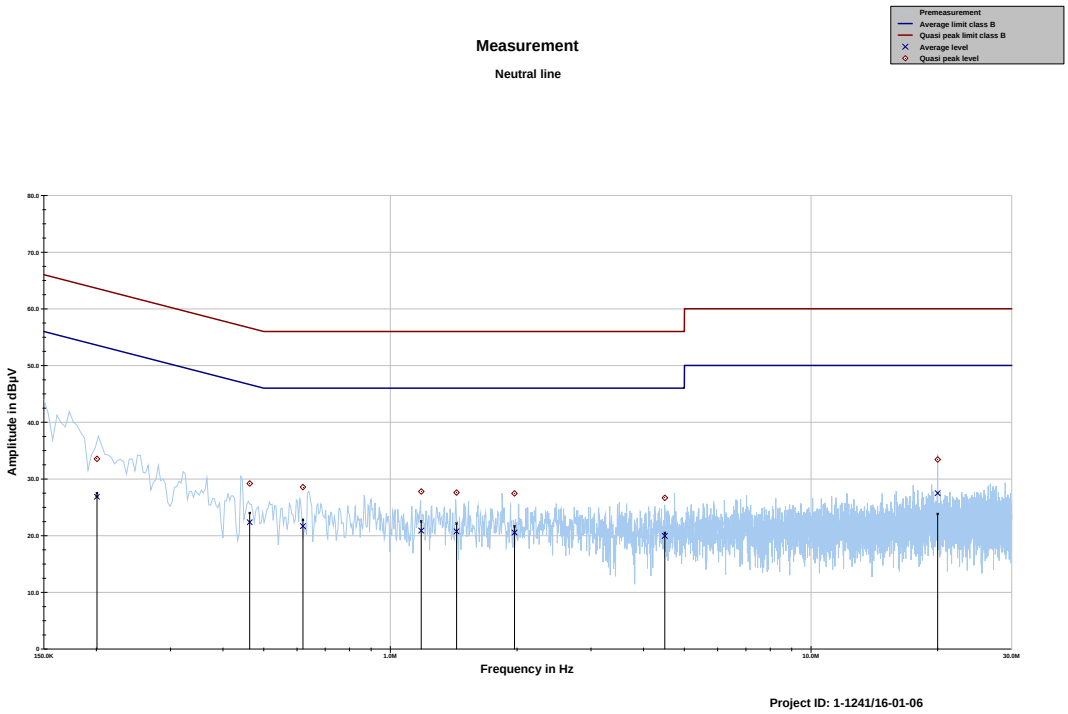
**Plots:**

**Plot 1:** 150 kHz to 30 MHz, phase line




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| | | | | | | |
| **0.154129** | 36.12 | 29.65 | 65.774 | 29.41 | 26.47 | 55.882 |
| **0.537245** | 28.68 | 27.32 | 56.000 | 21.95 | 24.05 | 46.000 |
| **0.598527** | 28.80 | 27.20 | 56.000 | 21.91 | 24.09 | 46.000 |
| **0.675194** | 28.27 | 27.73 | 56.000 | 21.47 | 24.53 | 46.000 |
| **1.804234** | 27.41 | 28.59 | 56.000 | 20.61 | 25.39 | 46.000 |
| **1.814881** | 27.34 | 28.66 | 56.000 | 20.61 | 25.39 | 46.000 |
| **3.449528** | 26.69 | 29.31 | 56.000 | 19.96 | 26.04 | 46.000 |
| **4.660442** | 26.77 | 29.23 | 56.000 | 19.96 | 26.04 | 46.000 |
| **20.283461** | 28.07 | 31.93 | 60.000 | 21.27 | 28.73 | 50.000 |
| **26.052370** | 28.51 | 31.49 | 60.000 | 21.76 | 28.24 | 50.000 |

**Plot 2:** 150 kHz to 30 MHz, neutral line




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| | | | | | | |
| **0.200566** | 33.53 | 30.05 | 63.587 | 26.86 | 27.70 | 54.555 |
| **0.462975** | 29.18 | 27.45 | 56.639 | 22.37 | 24.69 | 47.058 |
| **0.619835** | 28.54 | 27.46 | 56.000 | 21.67 | 24.33 | 46.000 |
| **1.184200** | 27.78 | 28.22 | 56.000 | 20.88 | 25.12 | 46.000 |
| **1.435968** | 27.60 | 28.40 | 56.000 | 20.74 | 25.26 | 46.000 |
| **1.973127** | 27.44 | 28.56 | 56.000 | 20.55 | 25.45 | 46.000 |
| **4.491048** | 26.66 | 29.34 | 56.000 | 19.94 | 26.06 | 46.000 |
| **19.999450** | 33.42 | 26.58 | 60.000 | 27.49 | 22.51 | 50.000 |

## 12 Observations

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

## Annex A Document history

| Version | Applied changes | Date of release |
|---|---|---|
| | Initial release | 2017-02-23 |

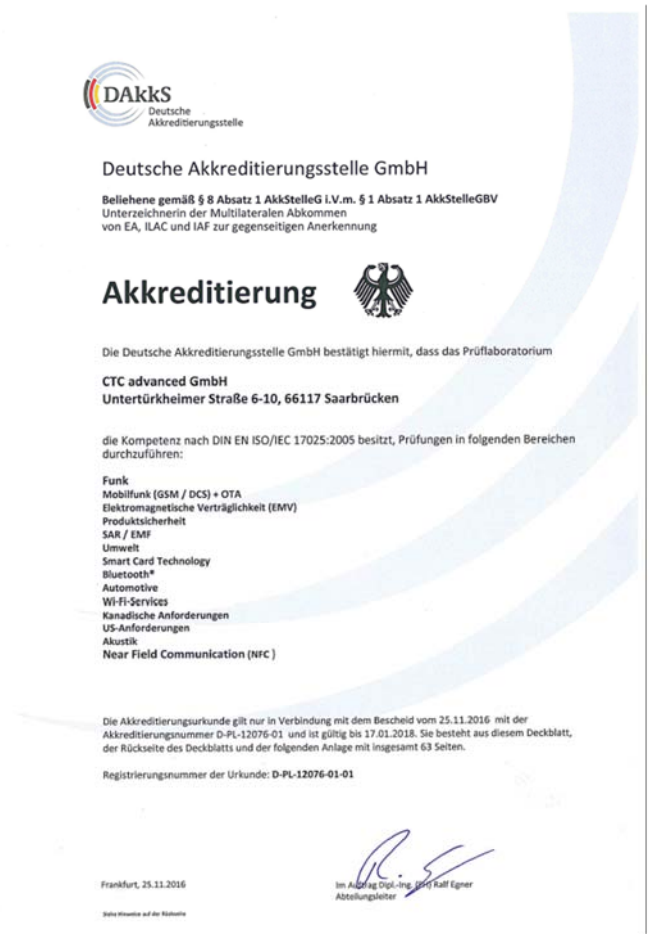
## Annex B Further information

**Glossary**

AVG - Average
DUT - Device under test
EMC - Electromagnetic Compatibility
EN - European Standard
EUT - Equipment under test
ETSI - European Telecommunications Standard Institute
FCC - Federal Communication Commission
FCC ID - Company Identifier at FCC
HW - Hardware
IC - Industry Canada
Inv. No. - Inventory number
N/A - Not applicable
PP - Positive peak
QP - Quasi peak
S/N - Serial number
SW - Software
PMN - Product marketing name
HMN - Host marketing name
HVIN - Hardware version identification number
FVIN - Firmware version identification number

## Annex C Accreditation Certificate

Front side of certificate



DAkkS
Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

**Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV**
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

**Akkreditierung**

Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium

**CTC advanced GmbH**
**Untertürkheimer Straße 6-10, 66117 Saarbrücken**

die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen:

**Funk**
**Mobilfunk (GSM / DCS) + OTA**
**Elektromagnetische Verträglichkeit (EMV)**
**Produktsicherheit**
**SAR / EMF**
**Umwelt**
**Smart Card Technology**
**Bluetooth***
**Automotive**
**Wi-Fi-Services**
**Kanadische Anforderungen**
**US-Anforderungen**
**Akustik**
**Near Field Communication (NFC)**

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 25.11.2016 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten.

Registrierungsnummer der Urkunde: **D-PL-12076-01-01**

Frankfurt, 25.11.2016

Im Auftrag Dipl.-Ing. (FH) Ralf Egner
Abteilungsleiter

Back side of certificate

Deutsche Akkreditierungsstelle GmbH

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10117 Berlin

Standort Frankfurt am Main
Europa-Allee 52
60327 Frankfurt am Main

Standort Braunschweig
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38116 Braunschweig

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