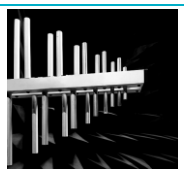
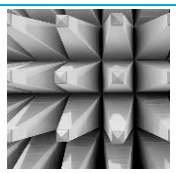

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-6484/18-01-02-E**

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

## Testing laboratory


**CTC advanced GmbH**
Untertuerkheimer Strasse 6 – 10
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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

## Applicant


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283 Rue Louis Néel - Part technologique Pré Roux
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## Manufacturer


**Adeunis**
283 Rue Louis Néel - Part technologique Pré Roux
38920 Crolles / FRANCE


## Test standard/s

| | |
|---|---|
| FCC - Title 47 CFR Part 15 | FCC - 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:** | **LoRa Module** |
| **Model name:** | **ARF8133A** |
| **FCC ID:** | **U3Z-ARF8133** |
| **IC:** | **7016A-ARF8133** |
| Frequency band: | ISM band 902 MHz – 928 MHz |
| Technology tested: | Long Range Wide Area Network |
| Antenna: | External dipole (3dBi) or PCB antenna (0dBi +/-2dB) |
| Power supply: | 3.3 V DC by external power supply |
| Temperature: | -20°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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Christoph Schneider
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**Test performed:**

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2020.04.06 05:59:58 +02'00'

Tobias Wittenmeier
Testing Manager
Radio Communications

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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.

**This test report replaces the test report with the number 1-6484/18-01-02-D and dated 2020-03-27.**

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2018-04-26 |
| Date of receipt of test item: | 2019-05-09 |
| Start of test: | 2019-04-03 |
| End of test: | 2020-04-02 |
| Person(s) present during the test: | -/- |

## 2.3 Test laboratories sub-contracted

None

# 3 Test standard/s and references

| Test standard | Date | Description |
|---|---|---|
| FCC - Title 47 CFR Part 15 | | FCC - 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 5 | April 2018 | Spectrum Management and Telecommunications Radio Standards Specification<br>- General Requirements for Compliance of Radio Apparatus |

| Guidance | Version | Description |
|---|---|---|
| DTS: KDB 558074 D01 | v05r01 | GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES |
| 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 tests under extreme conditions required.<br>No tests under extreme conditions required. |
| Relative humidity content | : | | 55 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | $V_{nom}$<br>$V_{max}$<br>$V_{min}$ | 3.3 V DC by external power supply<br>No tests under extreme conditions required.<br>No tests under extreme conditions required. |

# 5 Test item

## 5.1 General description

| | | |
|---|---|---|
| Kind of test item | : | LoRa Module |
| Type identification | : | ARF8133A |
| HMN | : | n/A |
| PMN | : | LoRaWAN Module |
| HVIN | : | ARF8133A |
| FVIN | : | V01.07.01 |
| S/N serial number | : | Evaluation board |
| Hardware status | : | No information available |
| Software status | : | No information available |
| Firmware status | : | No information available |
| Frequency band | : | ISM band 902 MHz – 928 MHz |
| Type of radio transmission<br>Use of frequency spectrum | :<br>: | DTS and Hybrid mode |
| Number of channels | : | Hybrid mode: 64<br>DTS mode: 8 |
| Antenna | : | External dipole (3dBi) or PCB antenna (0dBi +/-2dB) |
| Power supply | : | 3.3 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: 1-6484/18-01-02_AnnexA
1-6484/18-01-02_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).

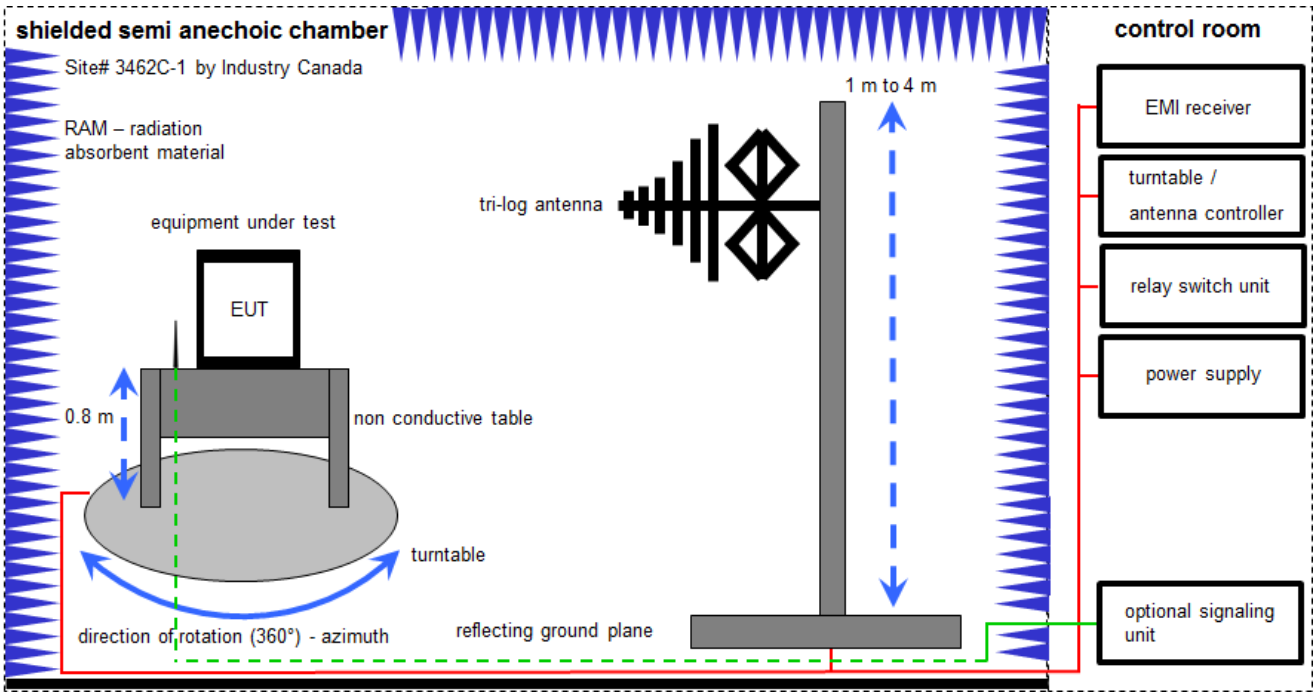
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**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 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
EMC32 software version: 10.30.0

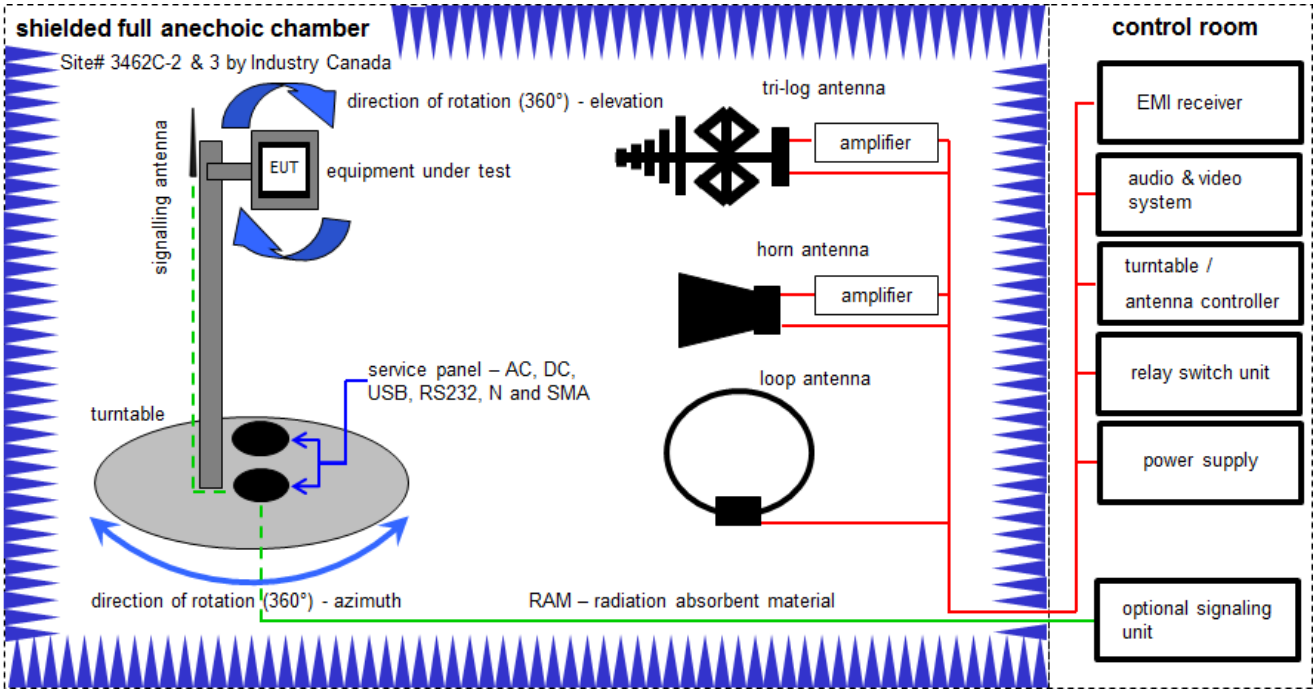
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

*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 | Meßkabine 1 | HF-Absorberhalle | MWB AG 300023 | | 300000551 | ne | -/- | -/- |
| 3 | A | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 21.05.2019 | 20.05.2020 |
| 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 Mess - Elektronik | 371 | 300003854 | vIKI! | 24.11.2017 | 23.11.2020 |

## 6.2 Shielded fully anechoic chamber




Measurement distance: tri-log antenna and 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)

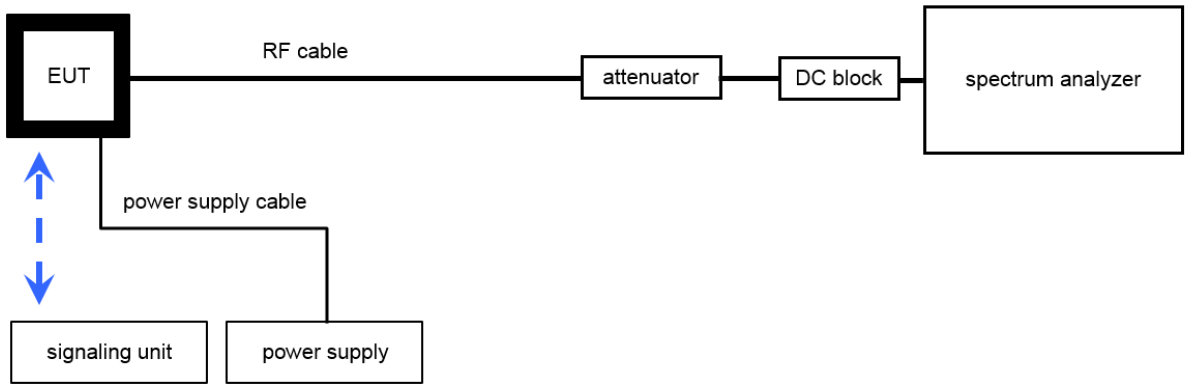
*Example calculation:*
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | C | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3697 | 300001605 | vIKI! | 27.02.2019 | 26.02.2021 |
| 2 | A | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | vIKI! | 13.06.2019 | 12.06.2021 |
| 3 | A,B,C | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2920A04590 | 300001041 | vIKI! | 14.12.2017 | 13.12.2020 |
| 4 | C | Highpass Filter | WHK1.1/15G-10SS | Wainwright | 37 | 400000148 | ne | -/- | -/- |
| 5 | B | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 318 | 300003696 | vIKI! | 23.05.2017 | 22.05.2020 |
| 6 | C | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22051 | 300004483 | ev | -/- | -/- |
| 7 | A,B,C | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000032 | 300004510 | ne | -/- | -/- |
| 8 | A,B,C | Computer | Intel Core i3 3220/3,3 GHz, Prozessor | | 2V2403033A54 21 | 300004591 | ne | -/- | -/- |
| 9 | A,B,C | NEXIO EMV-Software | BAT EMC V3.16.0.49 | EMCO | | 300004682 | ne | -/- | -/- |
| 10 | A,B,C | Anechoic chamber | | TDK | | 300003726 | ne | -/- | -/- |
| 11 | A, B, C | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 11.12.2019 | 10.12.2020 |

## 6.3 Conducted measurements

**Conducted measurements normal conditions**



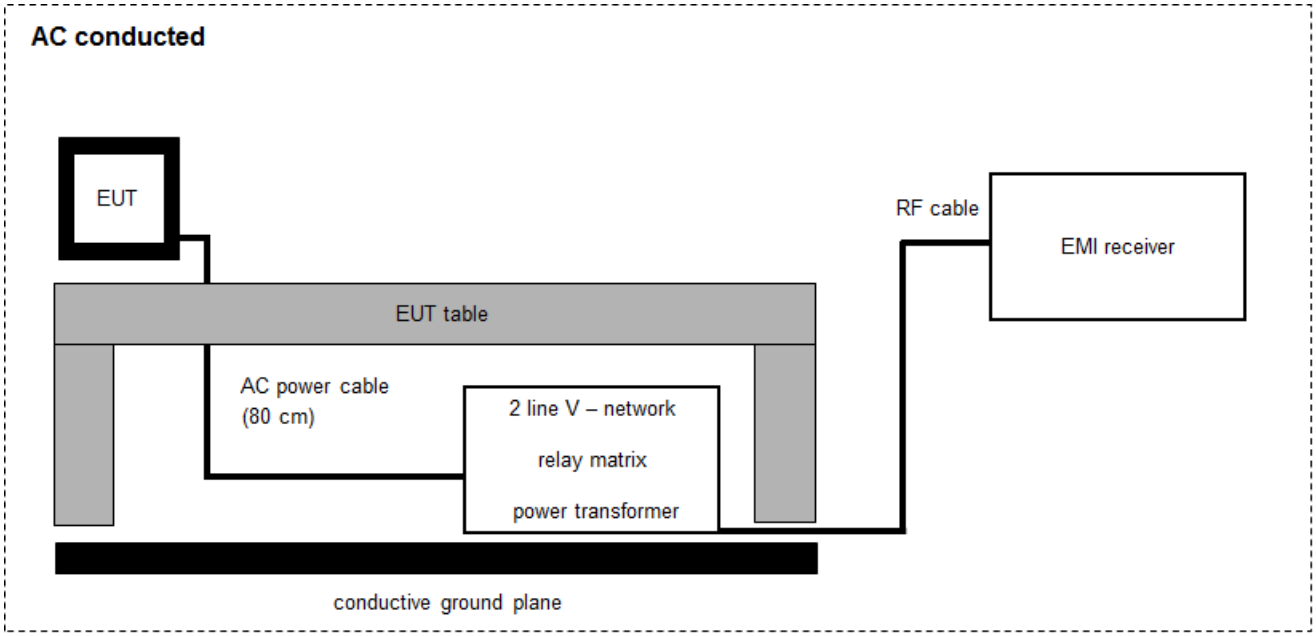

OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

*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 | Power Supply | 2X30V | Zentro | 870008 | 300000830 | NK! | -/- | -/- |
| 2 | A | Signal- and Spectrum Analyzer 2 Hz - 26 GHz | FSW26 | R&S | 101455 | 300004528 | k | 12.12.2019 | 11.12.2020 |
| 3 | A | Coaxial Attenuator | WA23-20-34 | Weinschel Ass | B4661 | 400001130 | ev | -/- | -/- |
| 4 | A | RF-Cable SRD021 No. 1 | Enviroflex 316 D | Huber & Suhner | | 400001311 | ev | -/- | -/- |

## 6.4 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 | 892475/017 | 300002209 | vIKI! | 11.12.2019 | 10.12.2021 |
| 2 | A | RF-Filter-section | 85420E | HP | 3427A00162 | 300002214 | NK! | -/- | -/- |
| 3 | A | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 10.12.2019 | 09.12.2020 |
| 4 | A | Hochpass 150 kHz | EZ-25 | R&S | 100010 | 300003798 | ev | -/- | -/- |

# 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 ± 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 12.75 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.

# 8 Measurement uncertainty

| Measurement uncertainty | |
|---|---|
| **Test case** | **Uncertainty** |
| Antenna gain | ± 3 dB |
| Carrier frequency separation | ± 21.5 kHz |
| Number of hopping channels | -/- |
| 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 |

# 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. The content and verdict of the performed test cases are listed below. |

## 9.1 Part 1: DTS

| Test specification clause | Test case | Temperature conditions | Power source voltages | Mode | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|---|
| §15.247(b)(4) RSS 210 / A8.4(2) | Antenna gain | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(e) RSS - 247 / 5.2 (b) | Power spectral density | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(a)(2) RSS Gen clause 4.6.1 | Spectrum bandwidth 6dB bandwidth | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(b)(3) RSS - 247 / 5.4 (d) | Maximum output power | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.205 RSS - 247 / 5.5 RSS - Gen | Band edge compliance conducted | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.205 RSS - 247 / 5.5 RSS - Gen | Band edge compliance radiated | Nominal | Nominal | -/- | ☒ | ☐ | ☐ | ☐ | -/- |
| §§15.247(d) RSS - 247 / 5.5 | TX spurious emissions conducted | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d) RSS-210 / A8.5 | TX spurious emissions radiated | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.109 RSS-Gen. | RX spurious emissions radiated | Nominal | Nominal | RX | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.209(a) RSS-Gen | TX spurious emissions radiated < 30 MHz | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.107(a) §15.207 | Conducted emissions below 30 MHz (AC conducted) | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |

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

## 9.2 Part 2: Hybrid mode

| Test specification clause | Test case | Temperature conditions | Power source voltages | Mode | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|---|
| §15.247(b)(4) RSS - 247 / 5.4 (d) | Antenna gain | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(a)(1) RSS - 247 / 5.1 (b) | Carrier frequency separation | Nominal | Nominal | TX hopping | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(a)(1) RSS - 247 / 5.1 (a) | Spectrum bandwidth | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(f) RSS - 247 / 5.2 (b) | Power spectral density | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(b)(3) RSS - 247 / 5.4 (b) | Maximum output power | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d) RSS - 247 / 5.5 | Detailed spurious emissions @ the band edge - conducted | Nominal | Nominal | TX hopping | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d) RSS - 247 / 5.5 | Spurious emissions conducted | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(f) RSS - 247 / 5.1 (d) | Time of occupancy (dwell time) | Nominal | Nominal | TX hopping | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d) RSS-210 / A8.5 | TX spurious emissions radiated | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.209(a) RSS-Gen | TX spurious emissions radiated < 30 MHz | Nominal | Nominal | TX single channel | ☒ | ☐ | ☐ | ☐ | -/- |

# 10 RF measurements

## 10.1 Additional comments

Reference documents: None

Special test descriptions: The EUT uses a Long Range Wide Area Network (LoRaWAN) technology with a combination of a hybrid system and a DTS system. Both systems were tested.
The AC conducted emission was performed with a HCPS-27.0-2250 power supply.

Configuration descriptions: **DTS mode:** 8 channels with 500 kHz nominal bandwidth and 1600 kHz channel spacing:

| | |
|---|---|
| lowest channel | 903.0 MHz, |
| middle channel | 907.8 MHz, |
| highest channel | 914.2 MHz |

These channels were tested in part 1 of this test report.

**Hybrid mode:** 64 channels with a nominal bandwidth of 125 kHz:

| | |
|---|---|
| lowest channel | 902.3 MHz, |
| middle channel | 908.5 MHz, |
| highest channel | 914.9 MHz. |

These channels were tested in part 2 of this test report.
**NOTE:** In hybrid mode the minimum number of hopping channels is 8. In this mode the minimum channel separation and bandwidths stay the same as in the mode with 64 channels. Also the device also comply with the dwell time requirements while using 8 channels:
The time slot length: 164.81 ms
Average time of occupancy: 329.62 ms
Hops in 3.2 second: 2

Test mode: ☒ Special software is used.
EUT is transmitting pseudo random data by itself

# 11 Measurement results Part 1 DTS

## 11.1 Antenna gain

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 1 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 6.3 A (conducted) |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

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

**Results:**

| | | Low channel | Middle channel | High channel |
|---|---|---|---|---|
| Conducted power [dBm] | | 16.59 dBm | 16.87 dBm | 17.02 dBm |
| dipole antenna | Radiated power [dBm] | 20.05 dBm | 20.35 dBm | 20.25 dBm |
| | Gain [dBi] Calculated | 3.46 dBi | 3.48 dBi | 3.23 dBi |
| PCB antenna | Radiated power [dBm] | 19.15 dBm | 20.35 dBm | 19.15 dBm |
| | Gain [dBi] Calculated | 2.56 dBi | 3.48 dBi | 2.13 dBi |

## 11.2 Maximum output power

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Span: | 5 MHz |
| Trace mode: | Max Hold |
| Measurement method | According to ANSI C63.10-2013<br>11.9.1.1 RBW ≥ DTS bandwidth |
| Used equipment: | See sub clause 6.3 A (conducted) |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

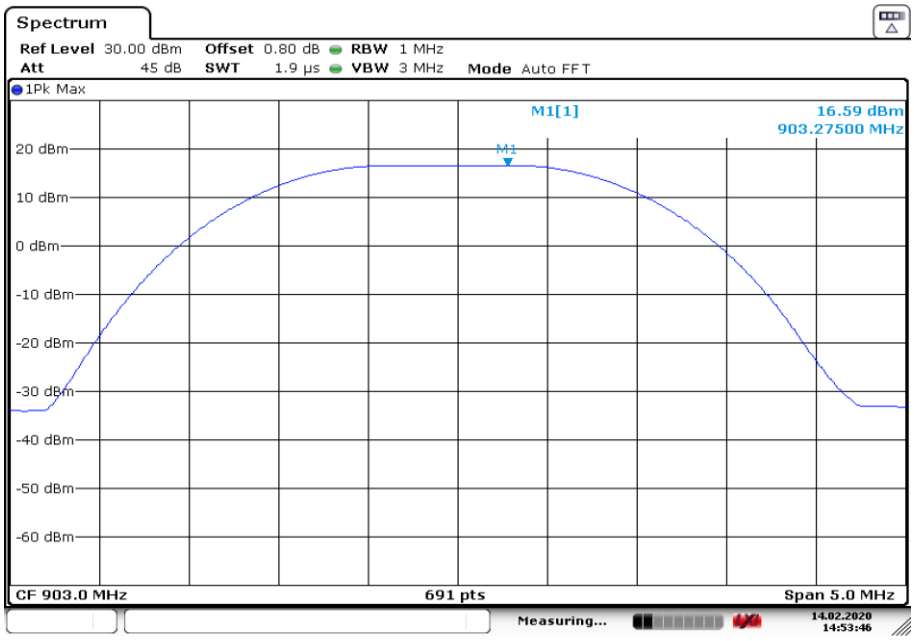
| FCC | IC |
|---|---|
| 1 watt (30 dBm) Maximum Output Power Conducted | |

**Result:**

| Test Conditions | | Maximum Output Power Conducted [dBm] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 16.59 | 16.87 | 17.02 |

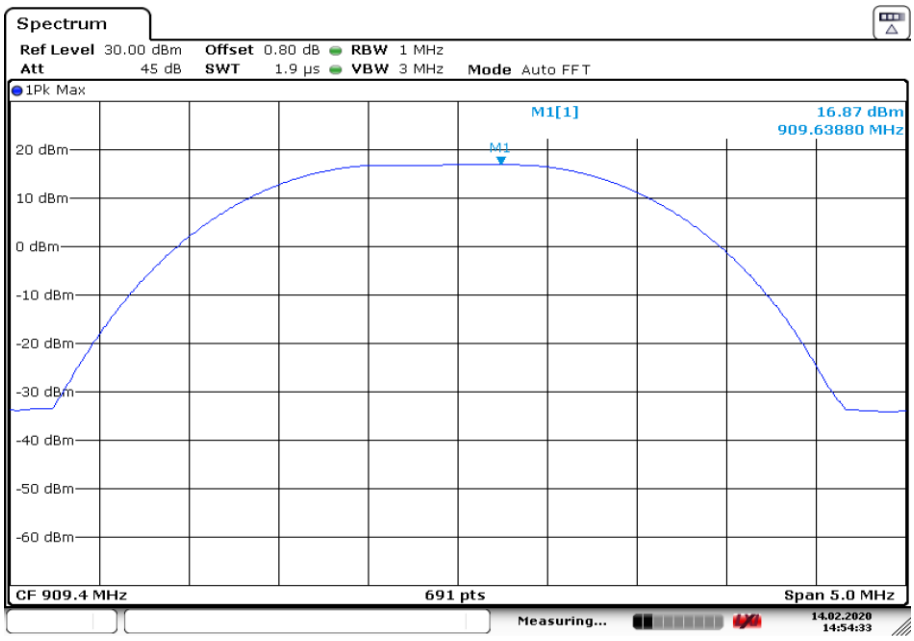
**Plots:**

Plot 1: Low Channel



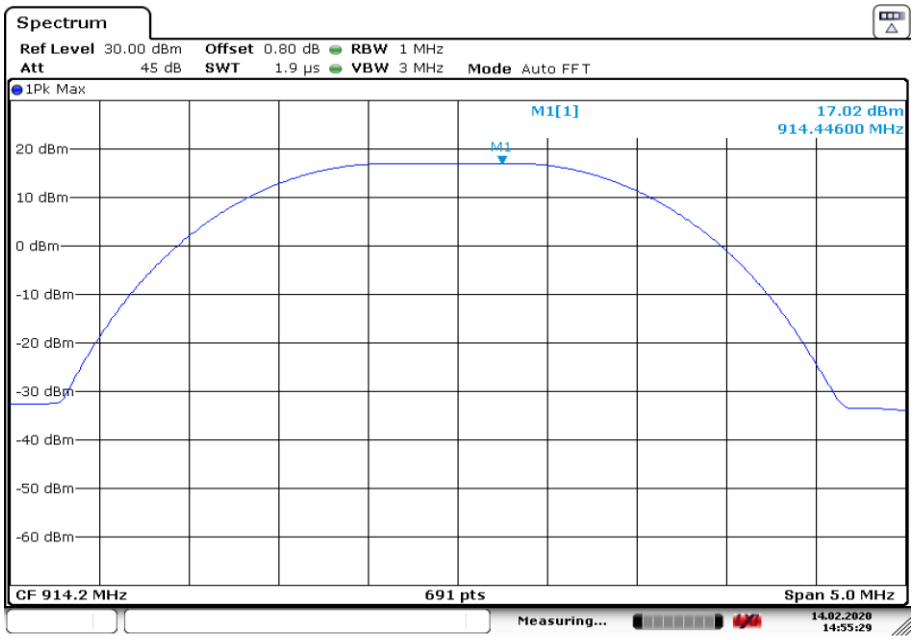

Date: 14.FEB.2020 14:53:46

Plot 2: Middle Channel




Date: 14.FEB.2020 14:54:33

Plot 3: High Channel



## 11.3 Power spectral density

**Description:**

Measurement of the power spectral density of a digital modulated system. The measurement is repeated at the lowest, middle and highest channel.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | 30 ms |
| Video bandwidth: | 10 kHz |
| Resolution bandwidth: | 3 kHz |
| Span: | 1.5 MHz |
| Trace mode: | Max Hold |
| Measurement method | According to ANSI C63.10-2013 11.10.2 Method PKPSD (peak PSD) |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

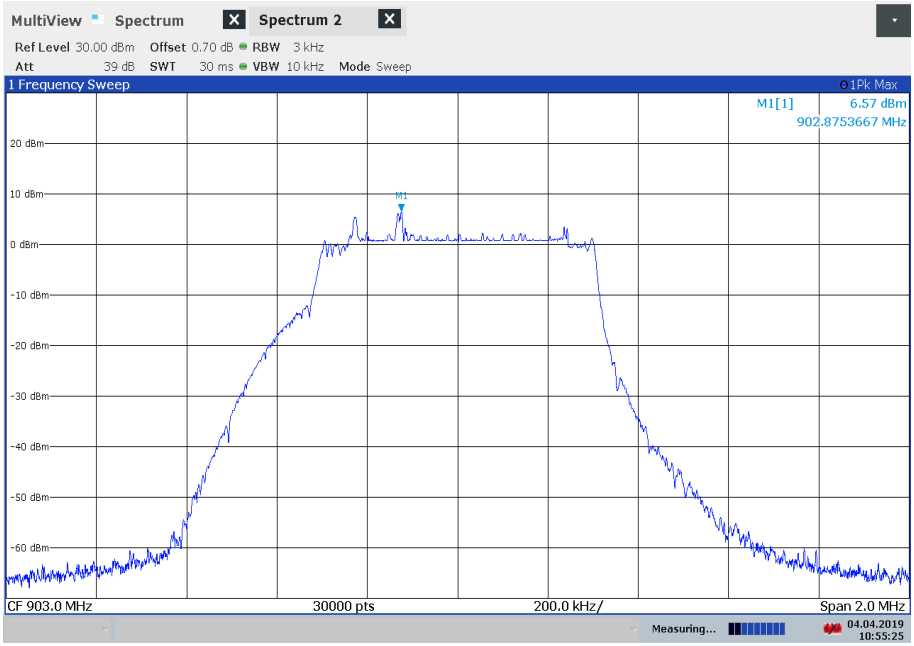
| FCC | IC |
|---|---|
| Power Spectral Density | |
| The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.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

**Results:**

| Modulation | Power Spectral density [dBm/3kHz] | | |
|---|---|---|---|
| Channel | Lowest | Middle | Highest |
| | 6.6 | 6.9 | 7.1 |

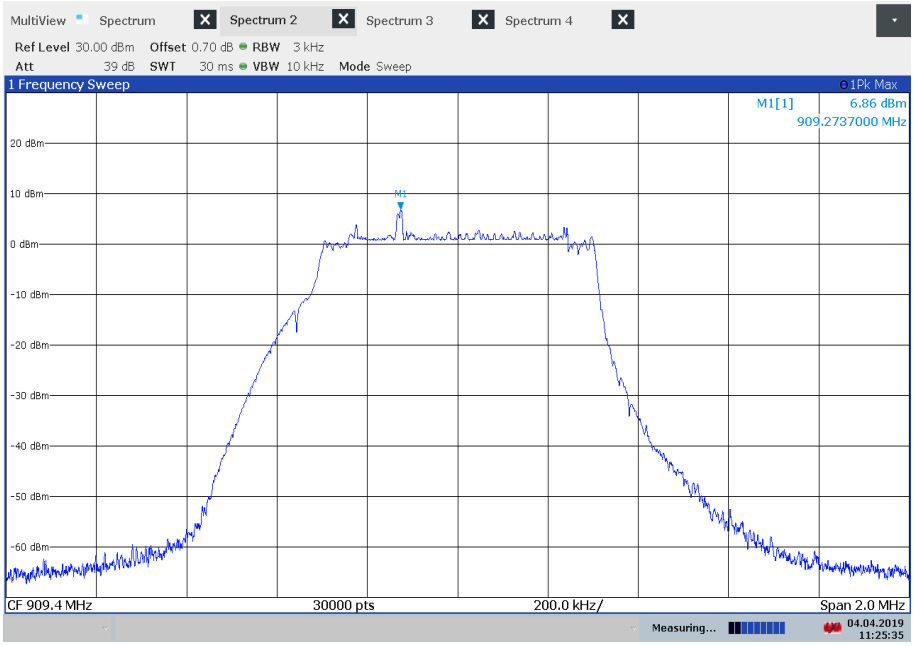
## Plots:

Plot 1: Low Channel



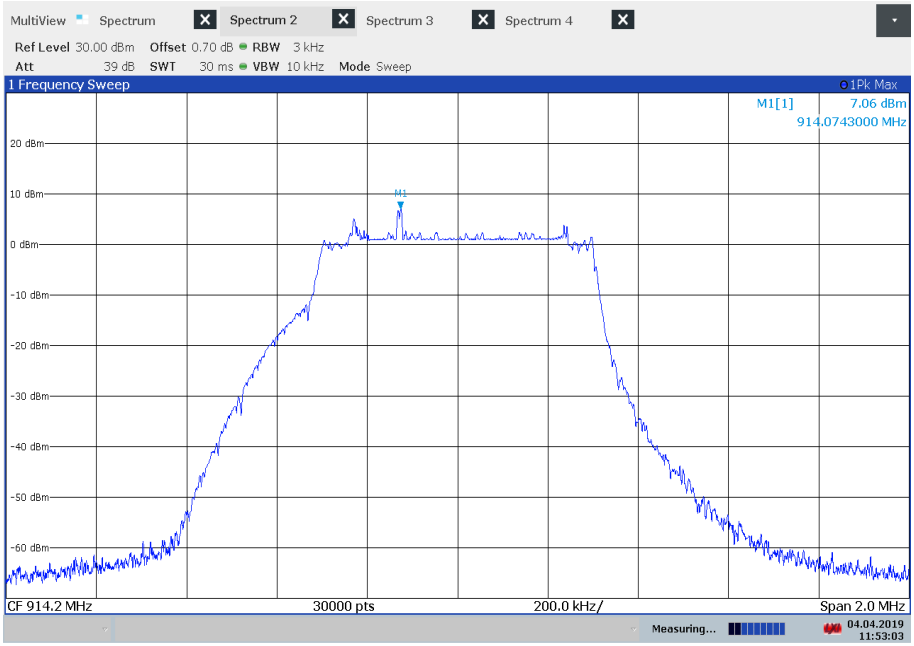

10:55:25 04.04.2019

Plot 2: Middle Channel




11:25:35 04.04.2019

Plot 3: High Channel




11:53:03 04.04.2019

## 11.4 Spectrum bandwidth – 6 dB bandwidth and 99% bandwidth

**Description:**

Measurement of the 6 dB bandwidth of the modulated signal.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 300 kHz |
| Resolution bandwidth: | 100 kHz |
| Span: | See plots |
| Trace mode: | Max Hold |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| Spectrum Bandwidth – 6 dB Bandwidth | |
| The minimum 6 dB bandwidth shall be at least 500 kHz. | |

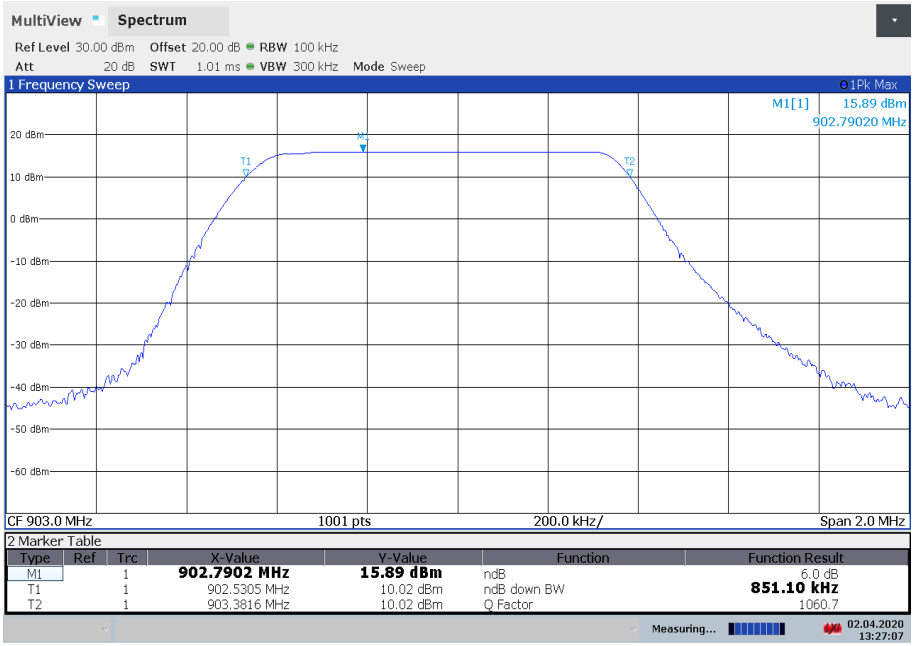
**Results:**

| Test Conditions | | 6-dB BANDWIDTH [kHz] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 851.1 | 843.2 | 851.1 |

| Test Conditions | | 99% BANDWIDTH [kHz] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 887.5 | 870.6 | 885.8 |

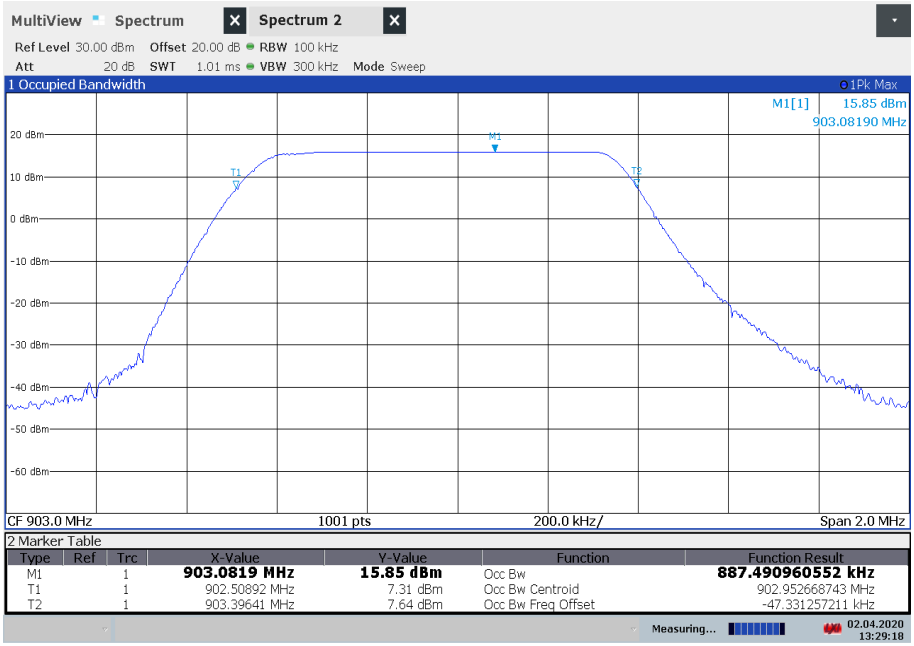
## Plots:

Plot 1: Low Channel, 6 dB-BW



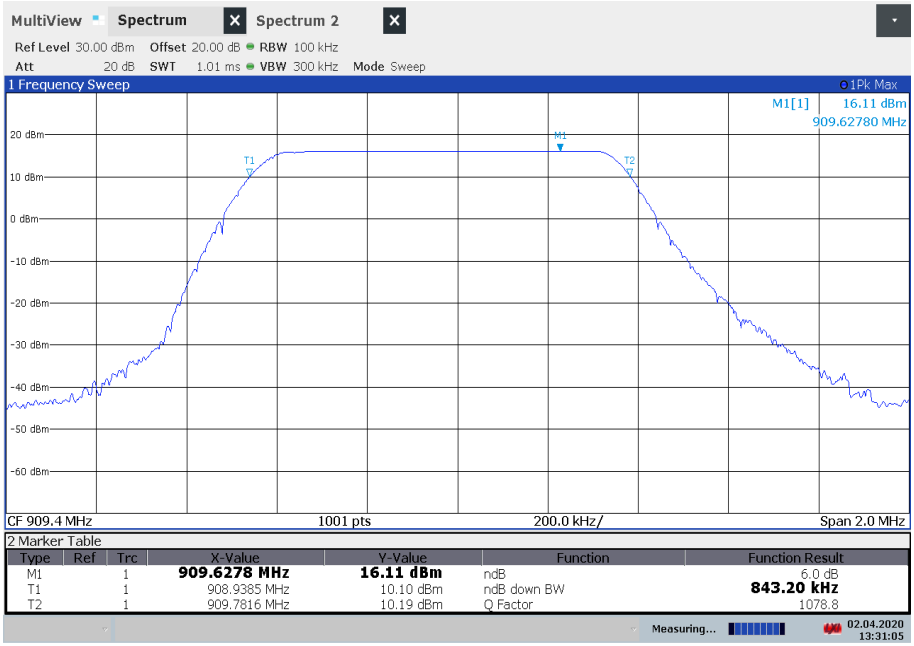

13:27:07 02.04.2020

Plot 2: Low Channel, 99%OBW



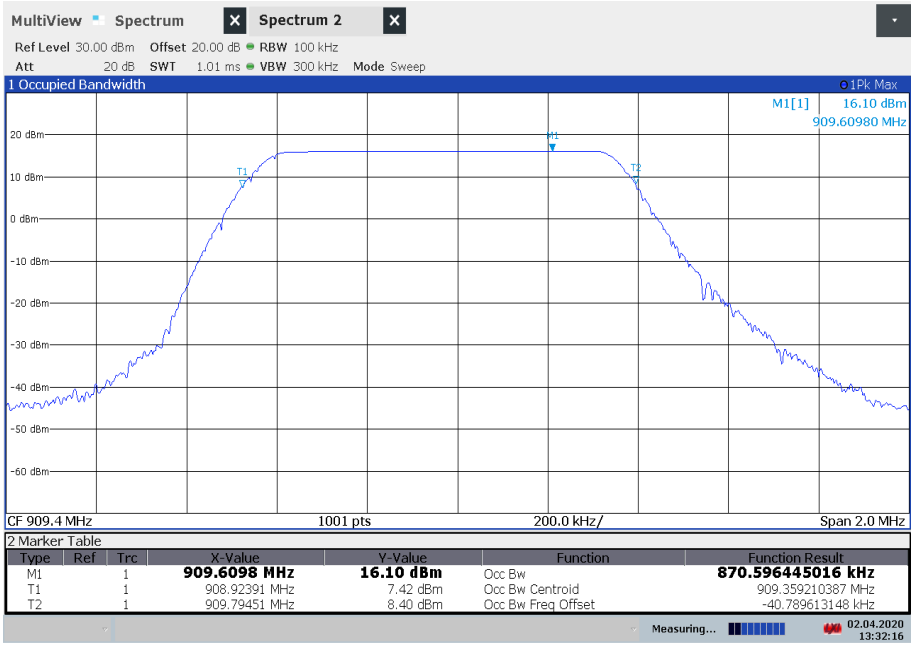

13:29:18 02.04.2020

Plot 3: Middle Channel, 6 dB-BW



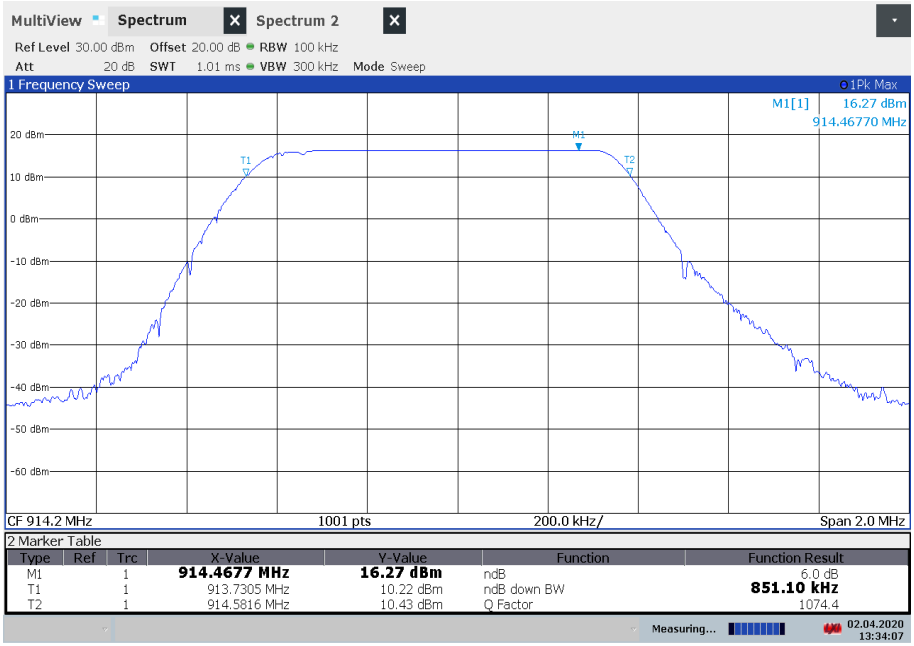

13:31:06 02.04.2020

Plot 4: Middle Channel, 99%OBW



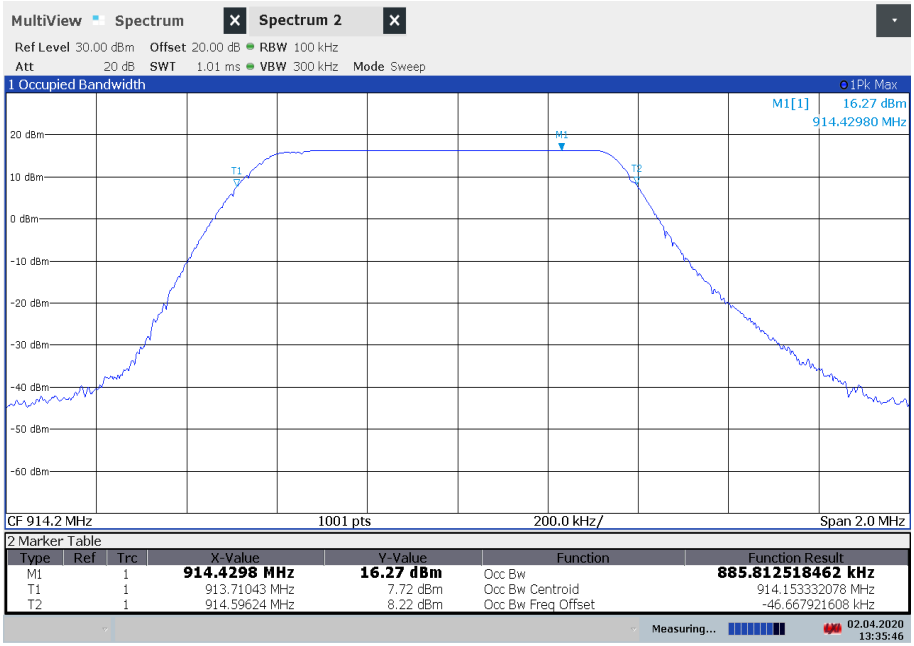

13:32:16 02.04.2020

Plot 5: High Channel, 6 dB-BW




13:34:07 02.04.2020

Plot 6: High Channel, 99%OBW




13:35:46 02.04.2020

## 11.5 Detailed spurious emissions @ the band edge – conducted and radiated

**Description:**

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

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 100 kHz |
| Video bandwidth | 300 kHz |
| Span | Lower Band Edge: 902 MHz<br>Upper Band Edge: 928 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

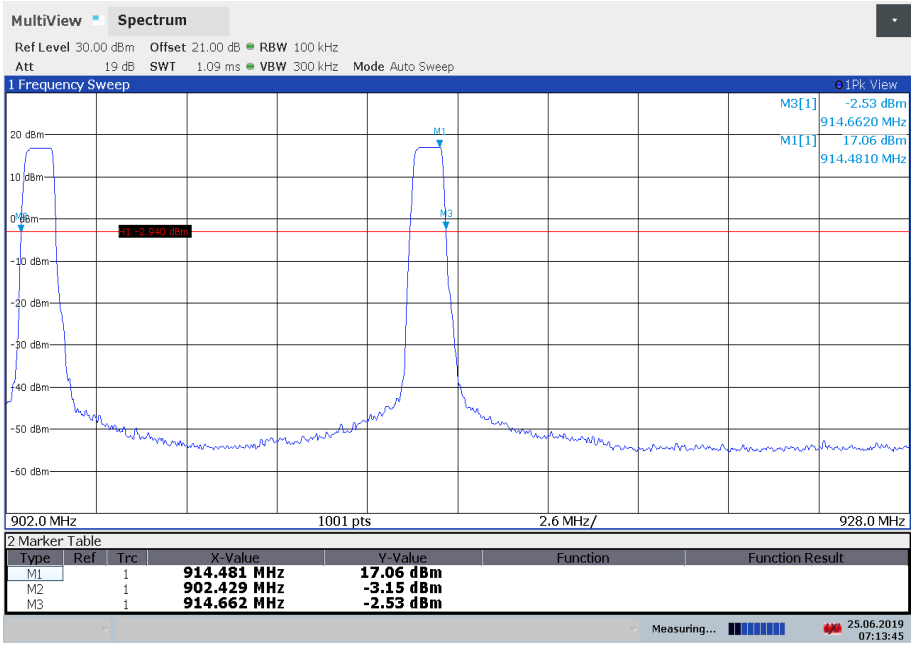
| FCC | IC |
|---|---|
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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.<br><br>RSS-247, Issue 2: 5.5 Unwanted emissions: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. | |

**Results conducted:**

| Scenario | Spurious band edge conducted [dB] | | |
|---|---|---|---|
| Modulation | lowest channel | middle channel | highest channel |
| Lower band edge – single channel mode | > 20 dB | > 20 dB | > 20 dB |
| Upper band edge – single channel mode | > 20 dB | > 20 dB | > 20 dB |

## Plots:

**Plot 1:** lowest and highest channel




07:13:45 25.06.2019

**Results radiated:**

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| [1]0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614 | 5.35 - 5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960 - 1240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1300 - 1427 | 8.025 - 8.5 |
| 4.17725 - 4.17775 | 37.5 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.6 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2690 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | ([2]) |
| 13.36 - 13.41 | | | |

## 11.6 Spurious Emissions Conducted

**Description:**

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 300 kHz |
| Resolution bandwidth: | 100 kHz |
| Span: | 9 kHz to 12.75 GHz |
| Trace mode: | Max Hold |
| Used equipment: | See chapter 6.3 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

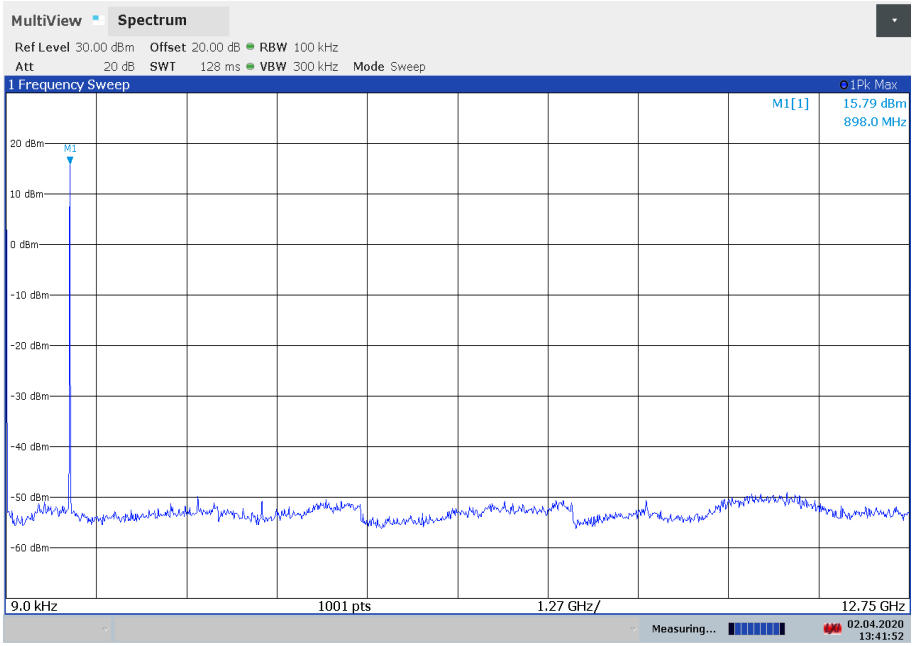
| FCC | IC |
|---|---|
| TX spurious emissions conducted | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below 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. | RSS-247, Issue 2: 5.5 Unwanted emissions: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. |

**Result:**

| Emission Limitation | | | | | |
|---|---|---|---|---|---|
| Frequency [MHz] | | Amplitude of emission [dBm] | Limit max. allowed emission power | actual attenuation below frequency of operation [dB] | Results |
| 903.0 | | 15.8 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |
| 909.4 | | 16.1 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |
| 914.2 | | 16.2 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |

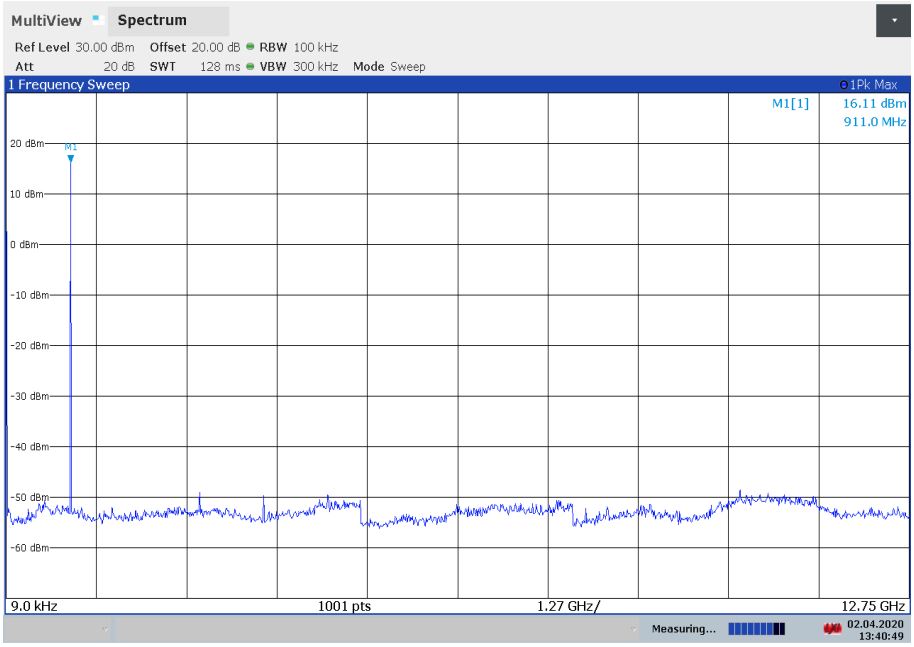
## Plots:

Plot 1: Low channel, 9 kHz – 12.75 GHz



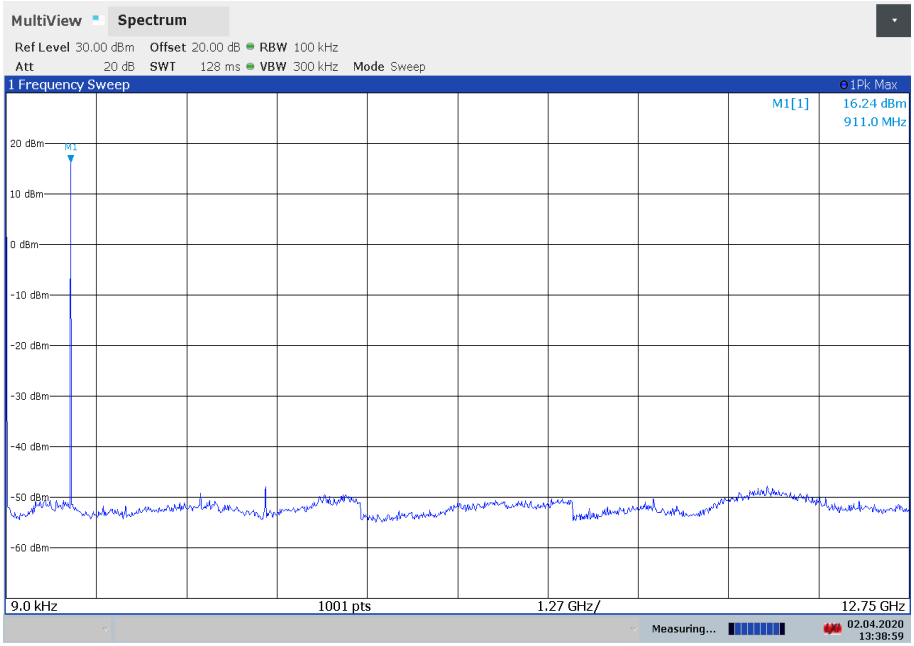

13:41:53 02.04.2020

Plot 2: Middle channel, 9 kHz – 12.75 GHz




13:40:49 02.04.2020

Plot 3: High channel, 9 kHz – 12.75 GHz




13:39:00 02.04.2020

## 11.7 Spurious Emissions Radiated < 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 channels are lowest channel; middle channel and highest channel. 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:**

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

**Limits:**

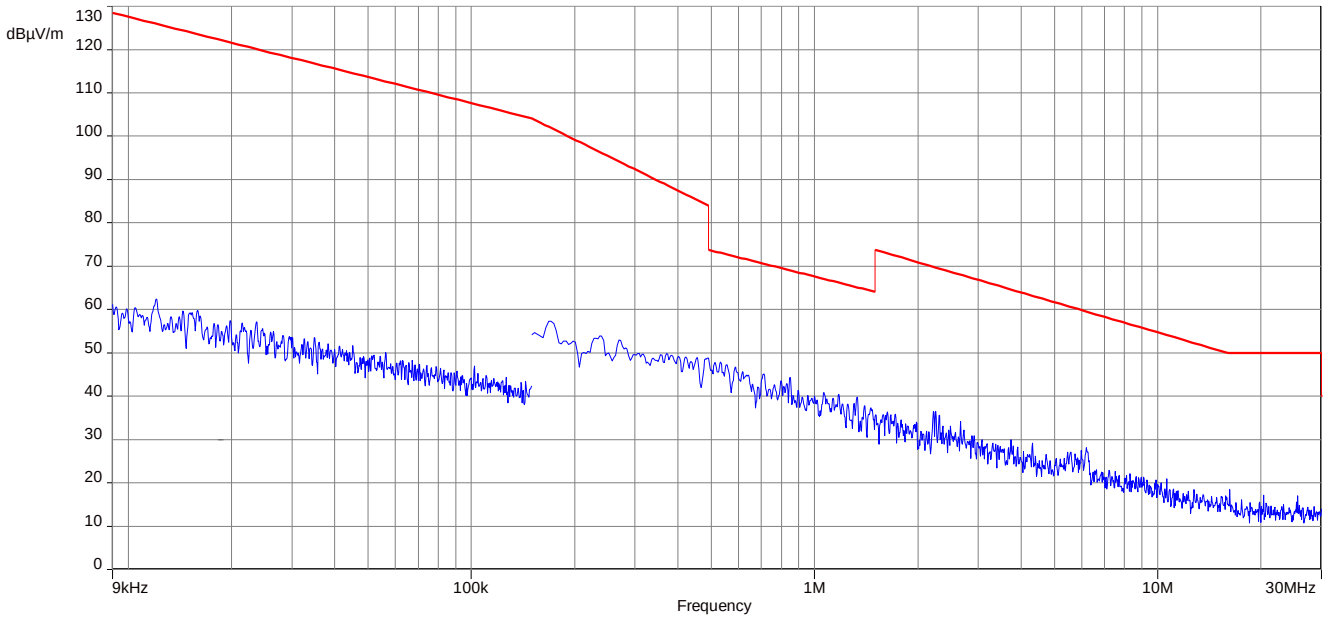
| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated < 30 MHz | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

**Result:**

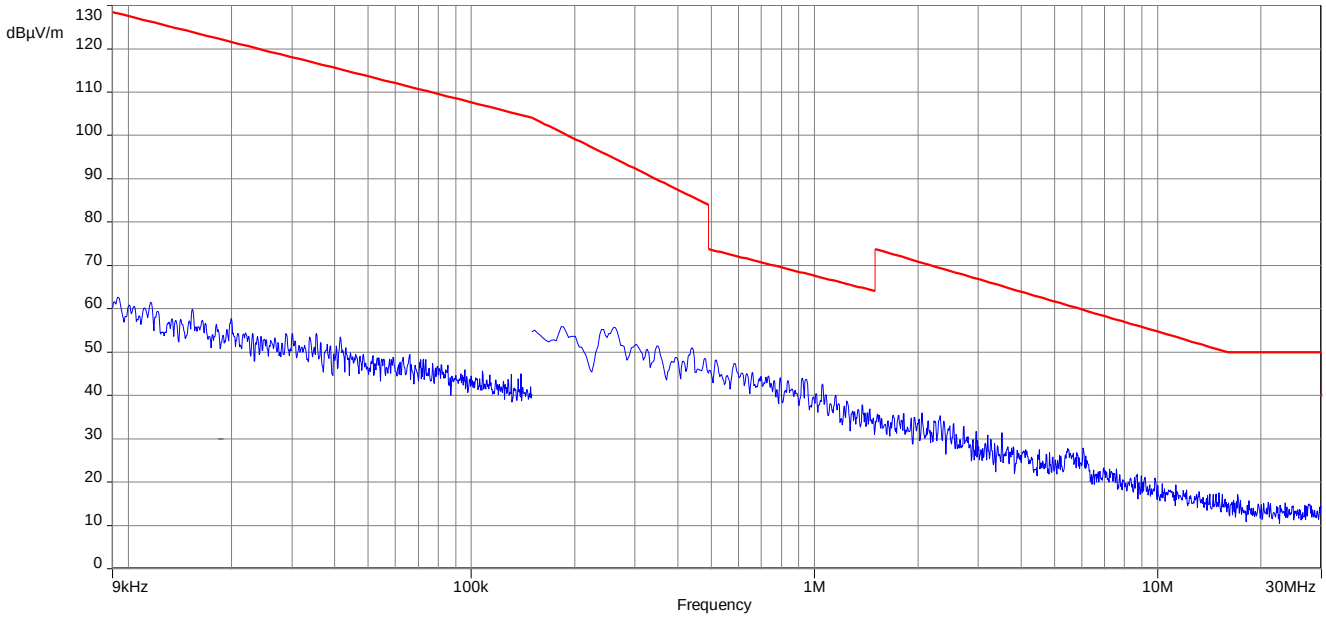
| SPURIOUS EMISSIONS LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| Frequency [MHz] | Detector | Level [dBµV/m] | Frequency [MHz] | Detector | Level [dBµV/m] | Frequency [MHz] | Detector | Level [dBµV/m] |
| All emissions were more than 10 dB below the limit. | | | | | | | | |

**Plots EUT with dipole antenna:**

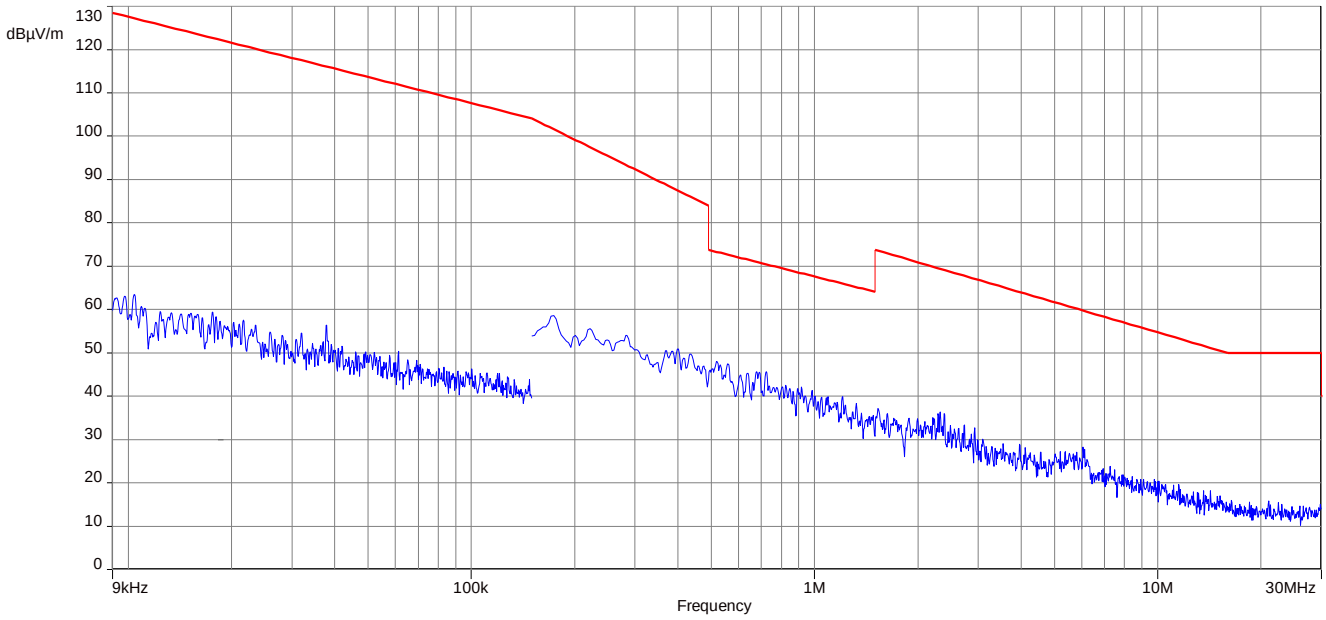
Plot 1: TX-Mode low channel




Plot 2: TX-Mode mid channel

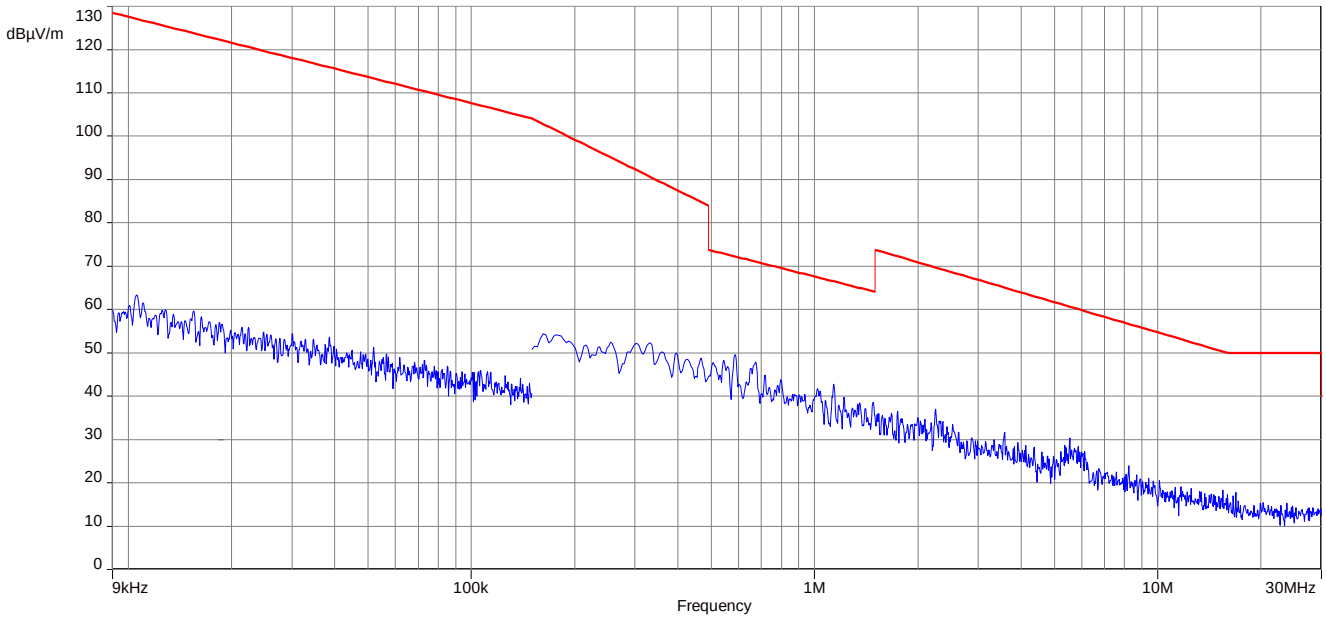


Plot 3: TX-Mode high channel

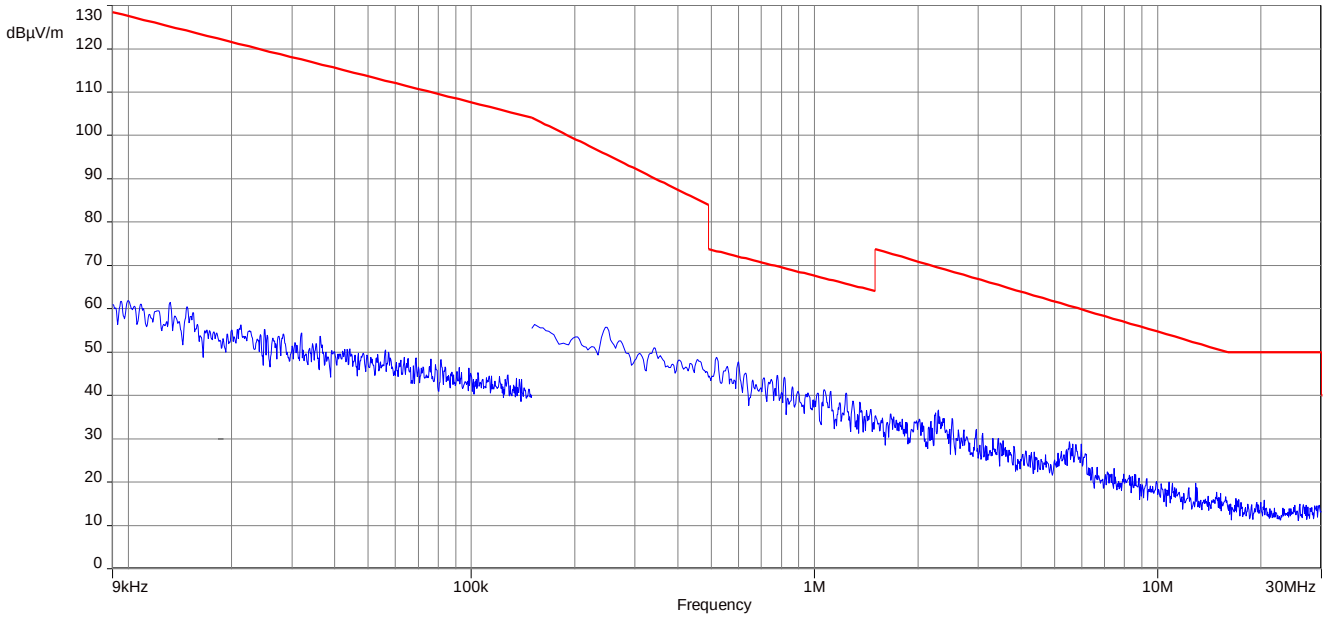


## Plots EUT with PCB antenna:

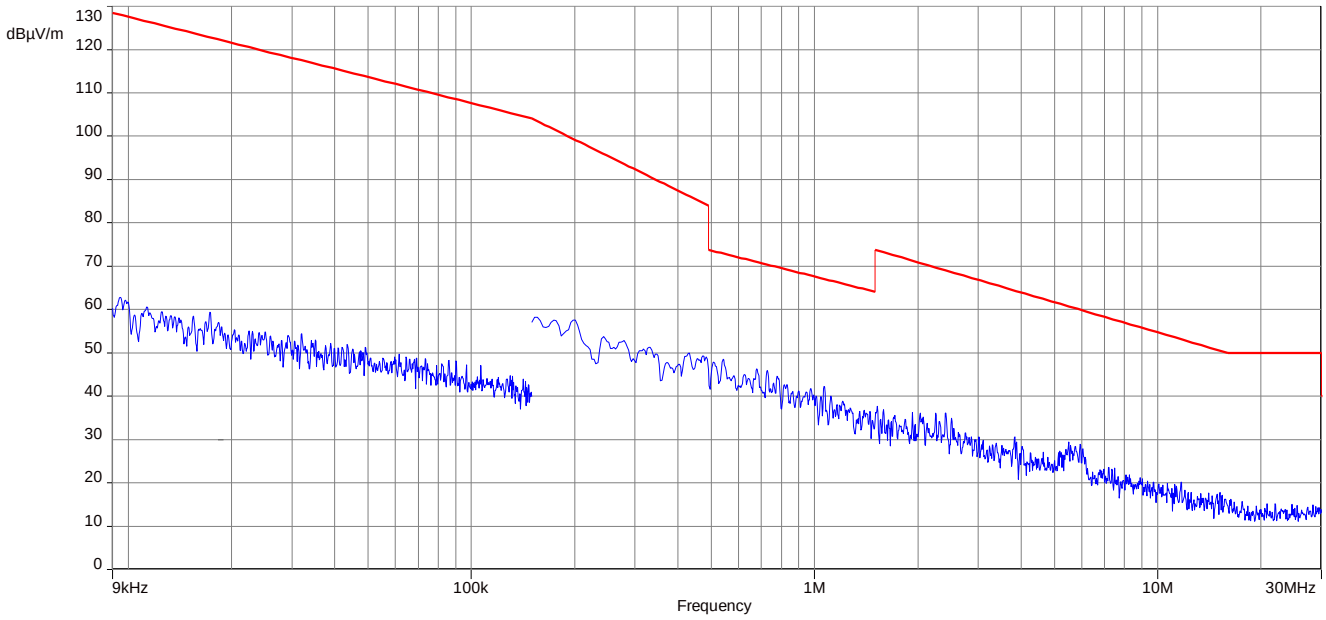
Plot 1: TX-Mode low channel




Plot 2: TX-Mode mid channel



Plot 3: TX-Mode high channel



## 11.8 Spurious Emissions Radiated > 30 MHz

### 11.8.1 Spurious emissions radiated 30 MHz to 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector | Peak / Quasi Peak |
| Sweep time | Auto |
| Resolution bandwidth | 3 x VBW |
| Video bandwidth | 120 kHz |
| Span | 30 MHz to 1 GHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.1 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

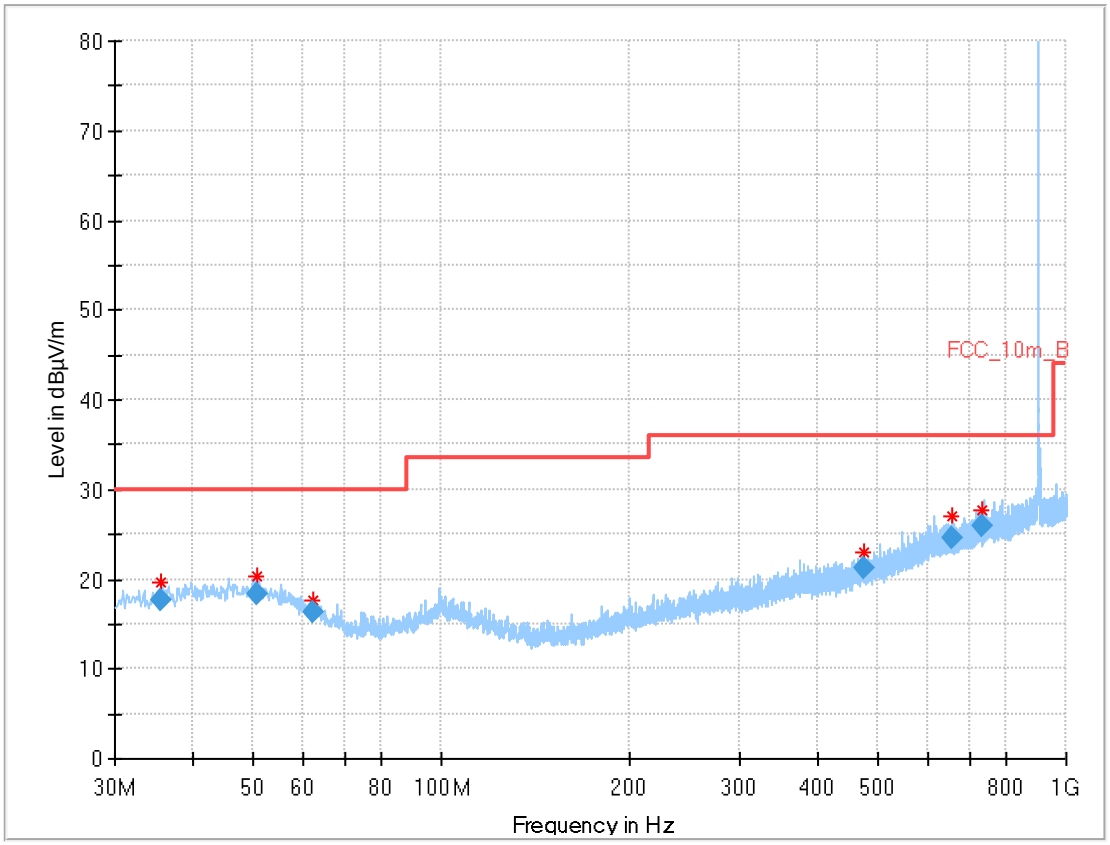
| FCC | | IC |
|---|---|---|
| Band-edge Compliance of conducted and radiated emissions | | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §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 |
| 30 - 88 | 30.0 | 10 |
| 88 – 216 | 33.5 | 10 |
| 216 – 960 | 36.0 | 10 |
| Above 960 | 54.0 | 3 |

**Result:**

See result table below the plots.

**Plots EUT with dipole antenna:**

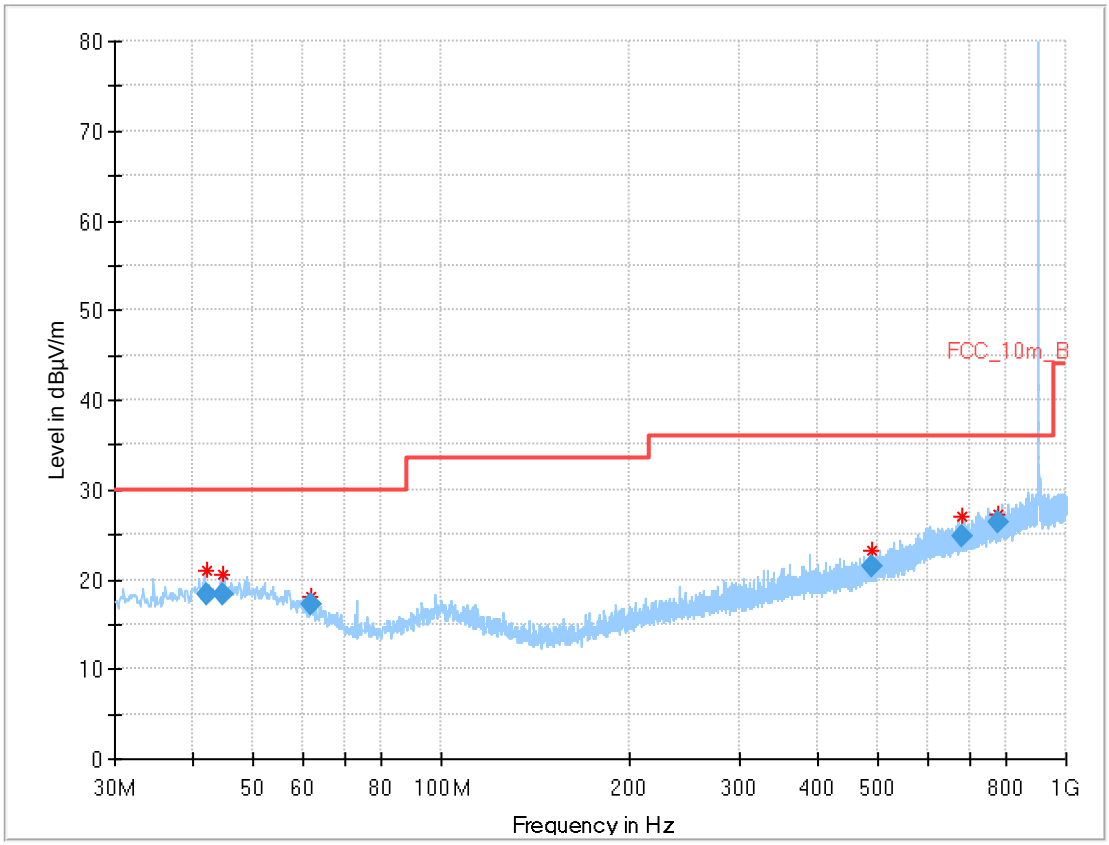
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)




**Final_Result**

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 35.526 | 17.57 | --- | 30.0 | 12.43 | 1000 | 120 | 101.0 | H | 51.0 | 14 |
| 50.501 | 18.40 | --- | 30.0 | 11.60 | 1000 | 120 | 160.0 | V | 135.0 | 15 |
| 62.291 | 16.34 | --- | 30.0 | 13.66 | 1000 | 120 | 160.0 | H | 238.0 | 12 |
| 475.289 | 21.18 | --- | 36.0 | 14.82 | 1000 | 120 | 160.0 | V | 292.0 | 18 |
| 658.269 | 24.63 | --- | 36.0 | 11.37 | 1000 | 120 | 160.0 | H | 44.0 | 21 |
| 733.030 | 25.88 | --- | 36.0 | 10.12 | 1000 | 120 | 160.0 | V | 75.0 | 22 |

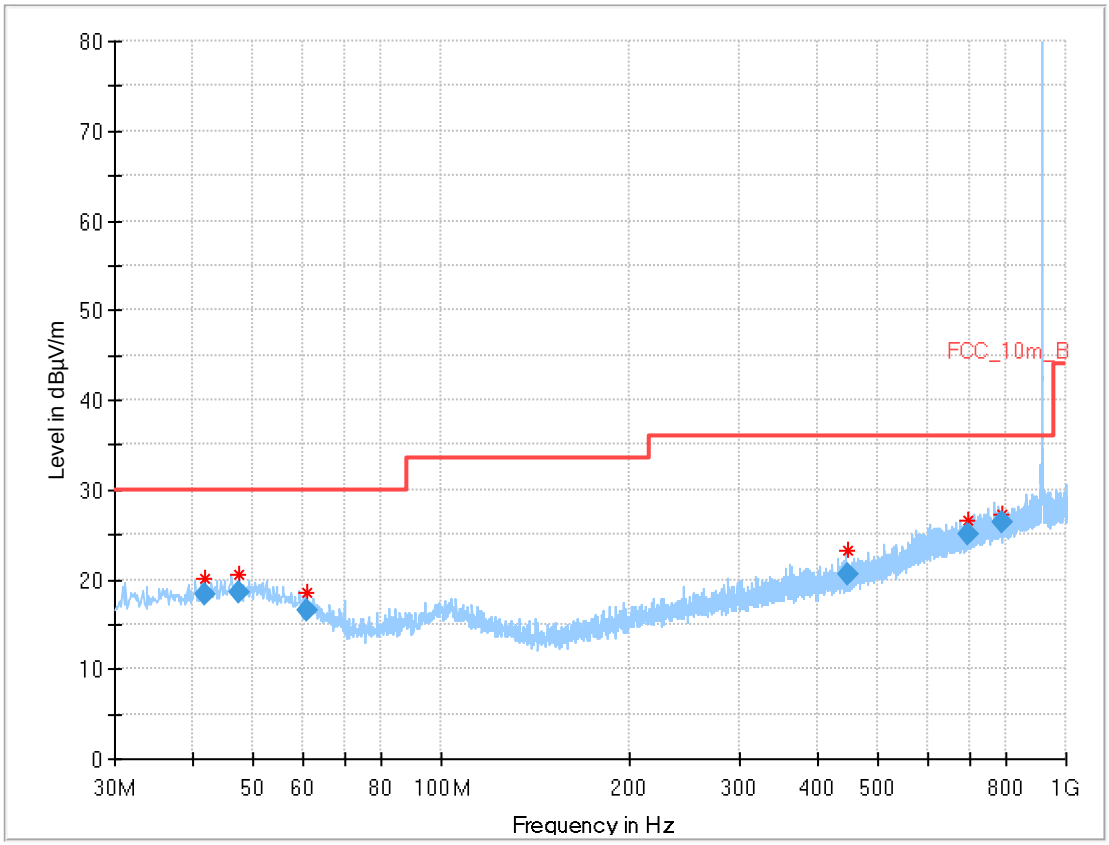
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 42.013 | 18.28 | --- | 30.0 | 11.72 | 1000 | 120 | 160.0 | V | 211.0 | 15 |
| 44.577 | 18.25 | --- | 30.0 | 11.75 | 1000 | 120 | 101.0 | H | 291.0 | 15 |
| 62.003 | 17.13 | --- | 30.0 | 12.87 | 1000 | 120 | 101.0 | V | 304.0 | 13 |
| 487.166 | 21.53 | --- | 36.0 | 14.47 | 1000 | 120 | 160.0 | V | 349.0 | 18 |
| 678.912 | 24.88 | --- | 36.0 | 11.12 | 1000 | 120 | 160.0 | H | 314.0 | 21 |
| 775.715 | 26.30 | --- | 36.0 | 9.70 | 1000 | 120 | 160.0 | H | 193.0 | 22 |

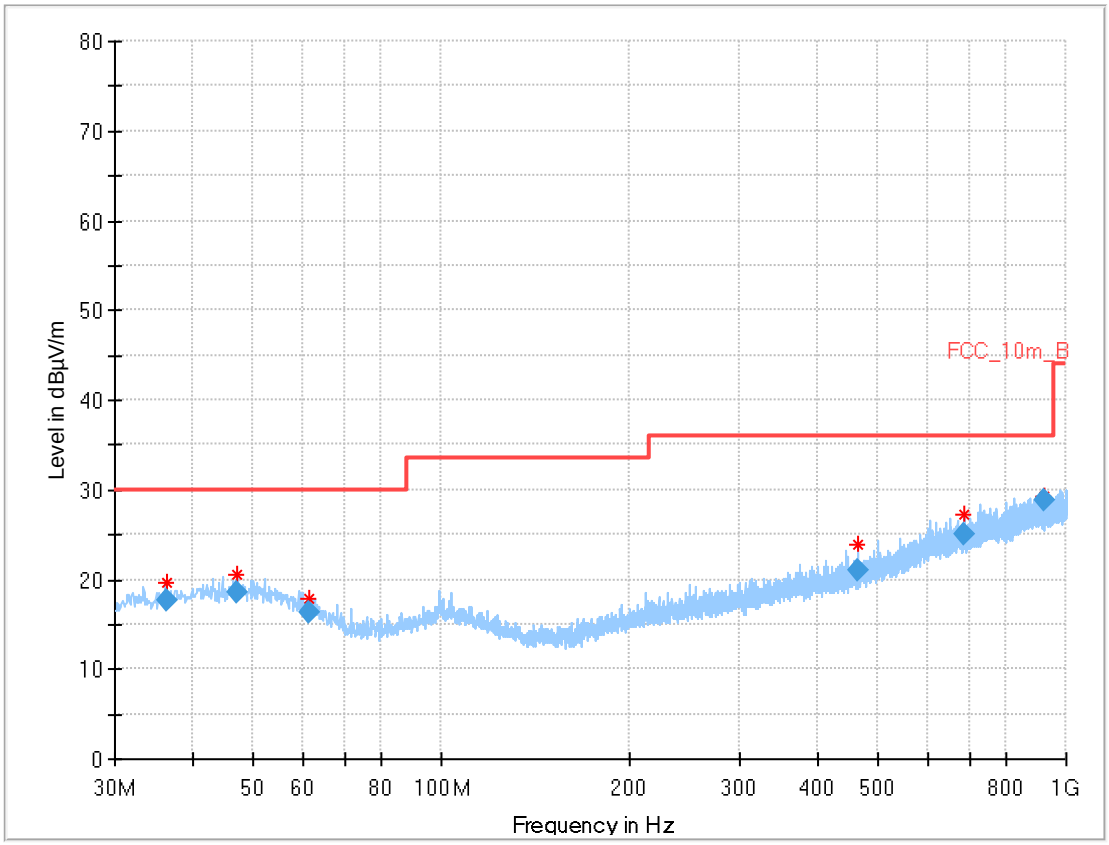
Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 41.786 | 18.23 | --- | 30.0 | 11.77 | 1000 | 120 | 101.0 | V | 108.0 | 15 |
| 47.267 | 18.59 | --- | 30.0 | 11.41 | 1000 | 120 | 160.0 | H | 180.0 | 15 |
| 60.883 | 16.45 | --- | 30.0 | 13.55 | 1000 | 120 | 101.0 | V | 278.0 | 13 |
| 445.692 | 20.60 | --- | 36.0 | 15.40 | 1000 | 120 | 160.0 | H | 319.0 | 17 |
| 697.951 | 25.10 | --- | 36.0 | 10.90 | 1000 | 120 | 160.0 | H | 355.0 | 21 |
| 786.973 | 26.40 | --- | 36.0 | 9.60 | 1000 | 120 | 100.0 | V | 82.0 | 22 |

Plot 4: 30 MHz – 1 GHz, horizontal & vertical polarisation (RX-Mode, valid for both antenna types)

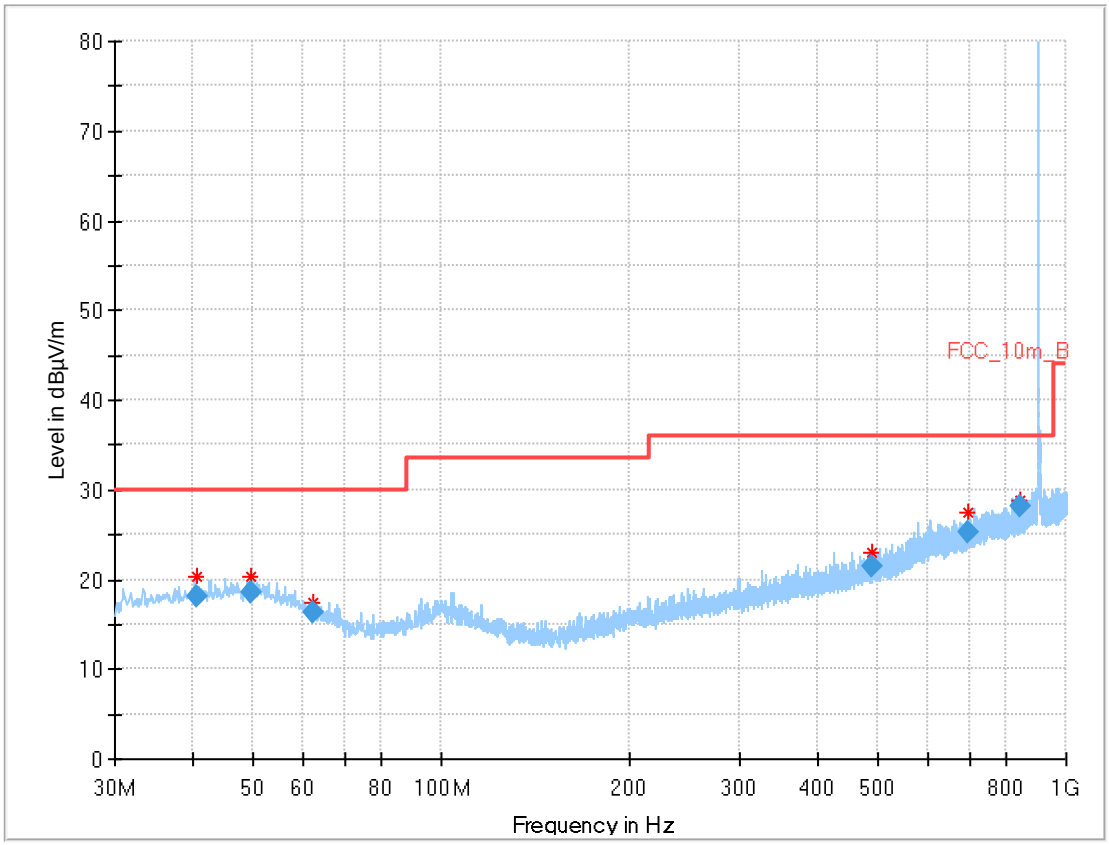



## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.264 | 17.73 | --- | 30.0 | 12.27 | 1000 | 120 | 101.0 | V | 150.0 | 14 |
| 47.029 | 18.54 | --- | 30.0 | 11.46 | 1000 | 120 | 160.0 | H | 242.0 | 15 |
| 61.198 | 16.36 | --- | 30.0 | 13.64 | 1000 | 120 | 101.0 | H | 249.0 | 13 |
| 464.593 | 20.96 | --- | 36.0 | 15.04 | 1000 | 120 | 160.0 | H | 302.0 | 18 |
| 686.535 | 24.95 | --- | 36.0 | 11.05 | 1000 | 120 | 160.0 | H | 68.0 | 21 |
| 920.605 | 28.92 | --- | 36.0 | 7.08 | 1000 | 120 | 98.0 | V | 71.0 | 24 |

**Plots EUT with PCB antenna:**

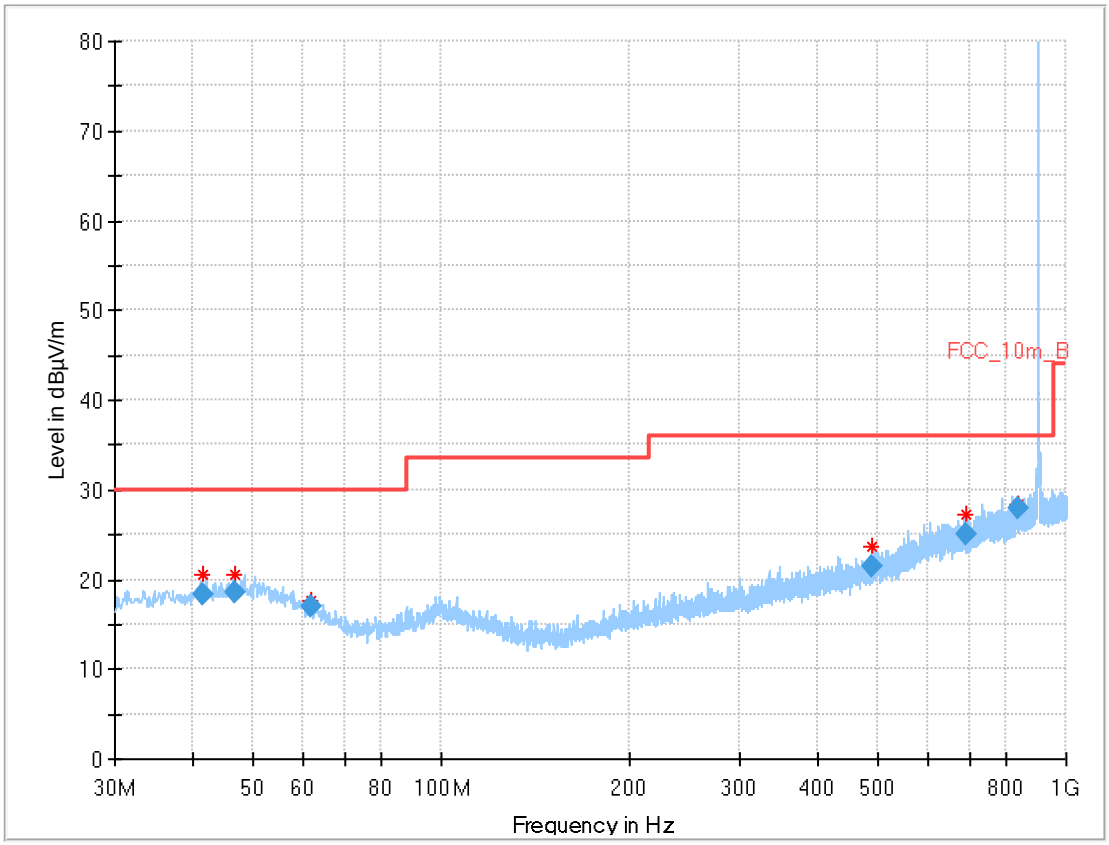
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)




**Final_Result**

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.505 | 18.00 | --- | 30.0 | 12.00 | 1000 | 120 | 98.0 | V | 20.0 | 14 |
| 49.564 | 18.44 | --- | 30.0 | 11.56 | 1000 | 120 | 101.0 | H | 0.0 | 15 |
| 62.505 | 16.31 | --- | 30.0 | 13.69 | 1000 | 120 | 100.0 | V | 276.0 | 12 |
| 487.471 | 21.53 | --- | 36.0 | 14.47 | 1000 | 120 | 98.0 | V | 162.0 | 18 |
| 696.184 | 25.19 | --- | 36.0 | 10.81 | 1000 | 120 | 98.0 | H | 69.0 | 21 |
| 843.183 | 28.12 | --- | 36.0 | 7.88 | 1000 | 120 | 160.0 | V | 20.0 | 23 |

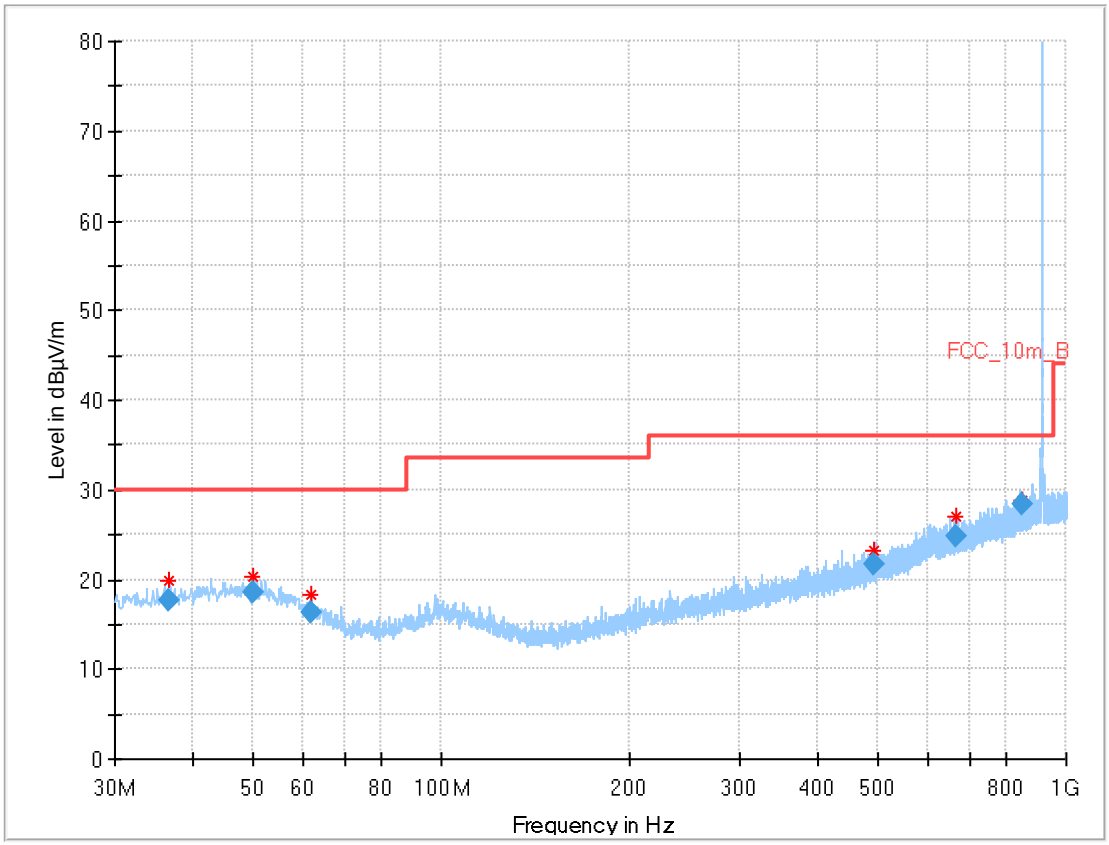
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 41.646 | 18.27 | --- | 30.0 | 11.73 | 1000 | 120 | 160.0 | H | 150.0 | 14 |
| 46.824 | 18.58 | --- | 30.0 | 11.42 | 1000 | 120 | 98.0 | V | 355.0 | 15 |
| 61.992 | 16.91 | --- | 30.0 | 13.09 | 1000 | 120 | 160.0 | V | 83.0 | 13 |
| 490.082 | 21.49 | --- | 36.0 | 14.51 | 1000 | 120 | 160.0 | V | 256.0 | 18 |
| 689.867 | 24.96 | --- | 36.0 | 11.04 | 1000 | 120 | 160.0 | H | 0.0 | 21 |
| 840.717 | 28.04 | --- | 36.0 | 7.96 | 1000 | 120 | 160.0 | V | 296.0 | 23 |

Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.639 | 17.73 | --- | 30.0 | 12.27 | 1000 | 120 | 101.0 | V | 242.0 | 14 |
| 49.932 | 18.48 | --- | 30.0 | 11.52 | 1000 | 120 | 101.0 | V | 355.0 | 15 |
| 61.914 | 16.35 | --- | 30.0 | 13.65 | 1000 | 120 | 98.0 | V | 340.0 | 13 |
| 492.756 | 21.61 | --- | 36.0 | 14.39 | 1000 | 120 | 160.0 | V | 0.0 | 18 |
| 664.436 | 24.75 | --- | 36.0 | 11.25 | 1000 | 120 | 160.0 | H | 289.0 | 21 |
| 852.822 | 28.38 | --- | 36.0 | 7.62 | 1000 | 120 | 160.0 | H | 118.0 | 23 |

## 11.8.2 Spurious emissions radiated above 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. 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 12.75 GHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.2 C (1 GHz – 12.75 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 | 3 |

**Result:**

For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205. According to FCC Public Notice DA 00-705 (ANSI C63.10) the average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor:

**F = 20*log (dwell time/100 ms)**

One pulse train is higher than 100 ms so the correction factor is 0 (see plots in chapter 12.4)

**Results with dipole antenna:**

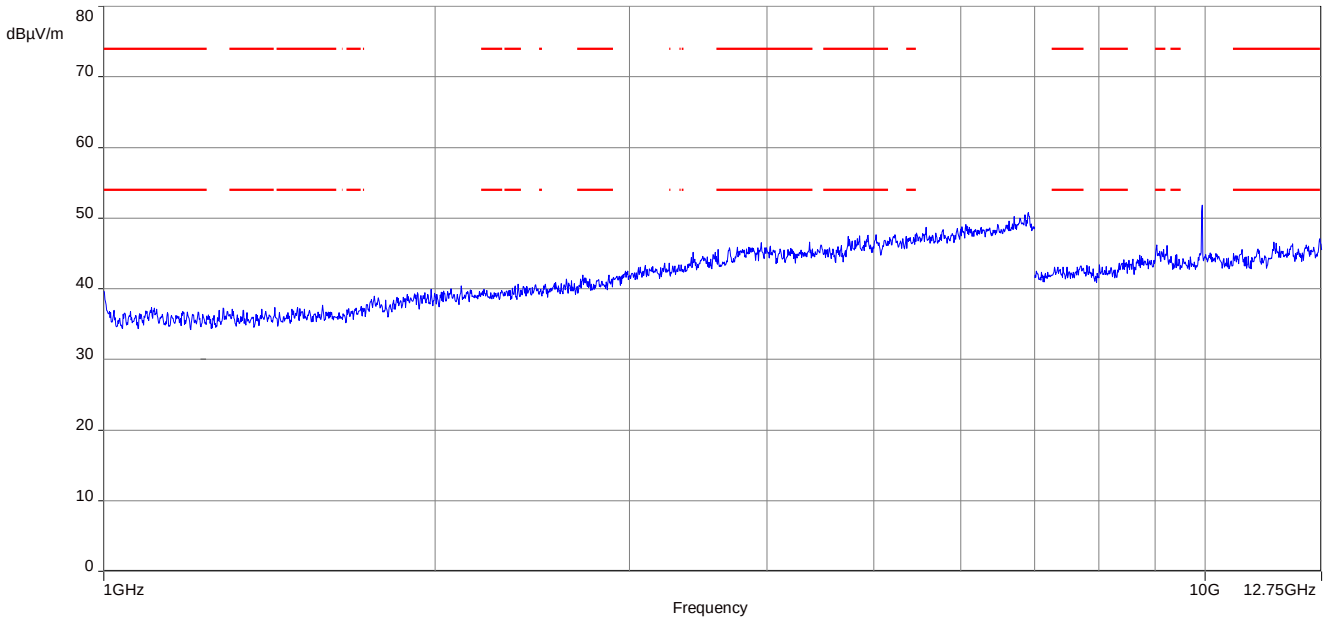
| TX spurious emissions radiated | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more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

**Results with PCB antenna:**

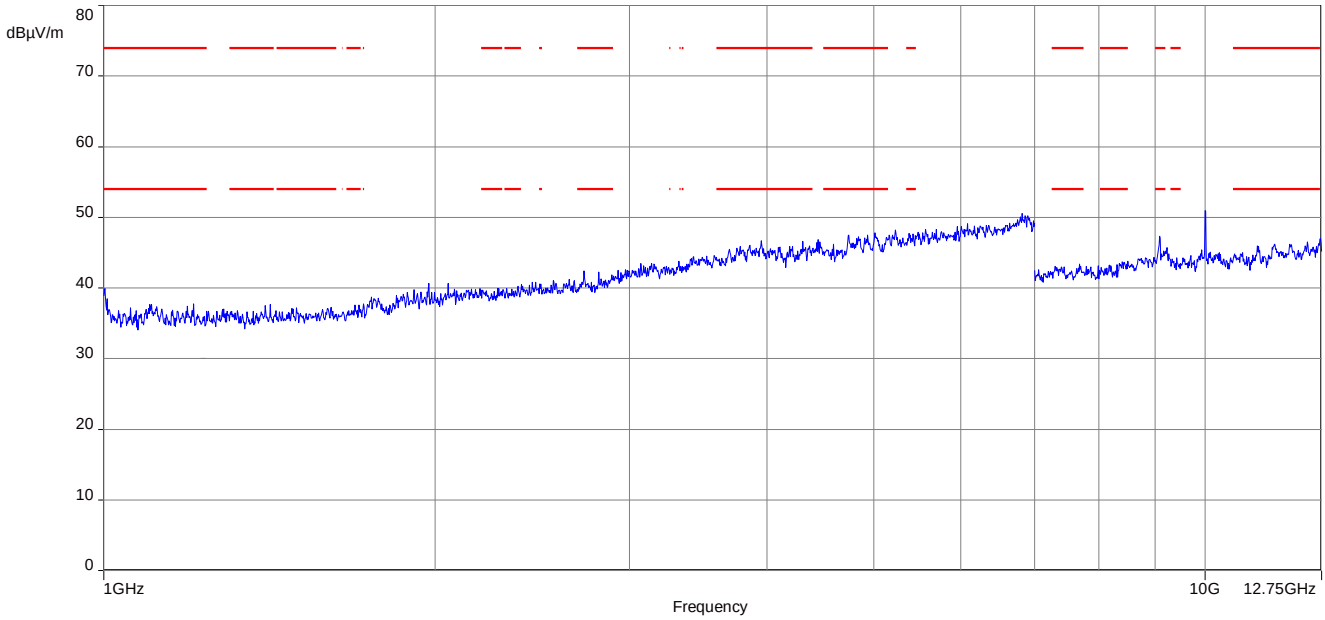
| TX spurious emissions radiated | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| 9031 | Peak | 51.7 | 9093 | Peak | 53.8 | 9144 | Peak | 54.2 |
| | AVG | 48.6 | | AVG | 50.8 | | AVG | 51.1 |

## Plots: Dipole antenna

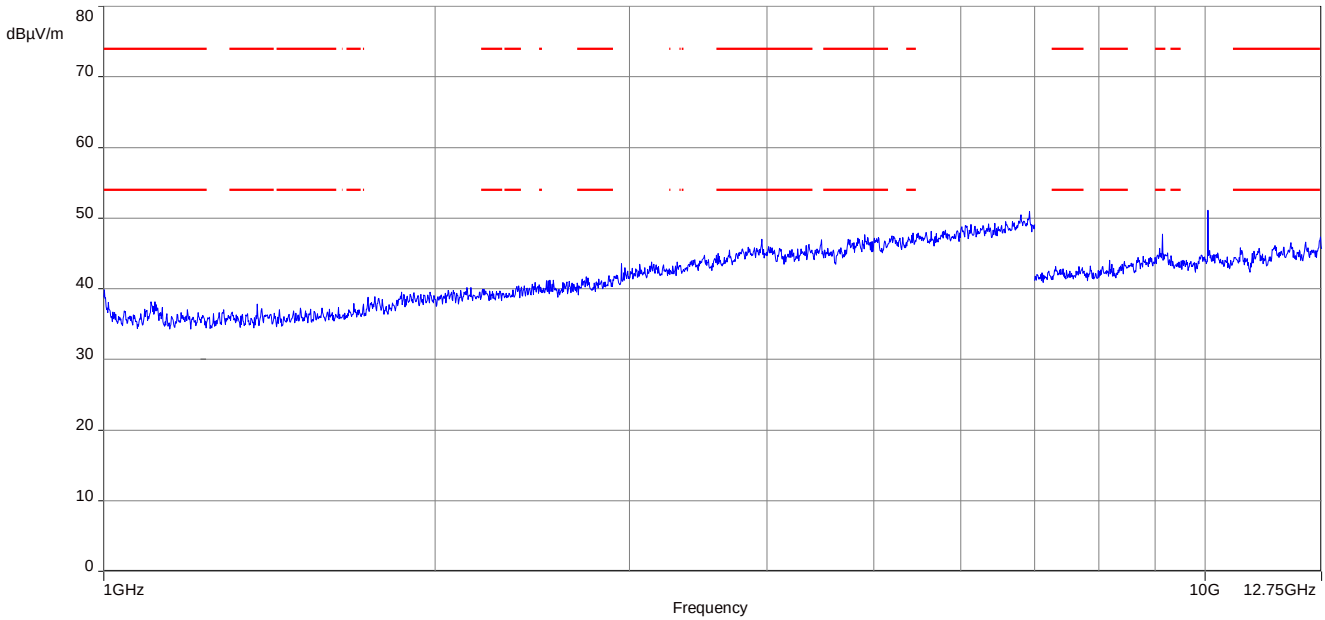
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



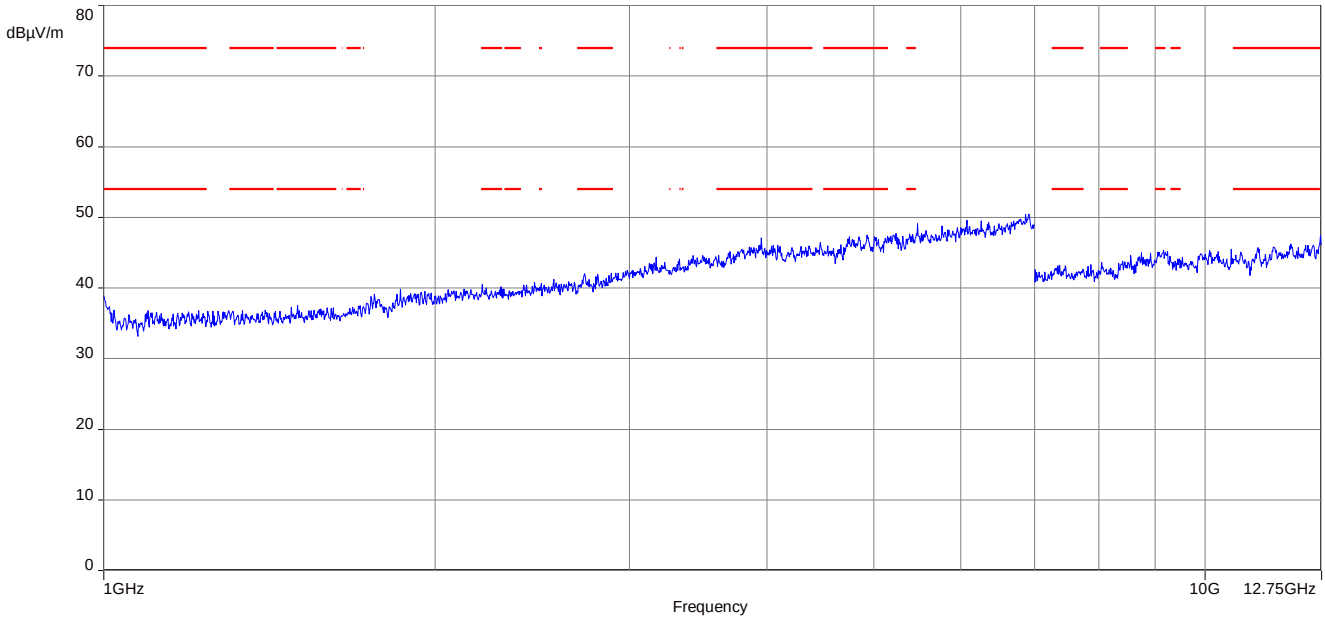

Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)

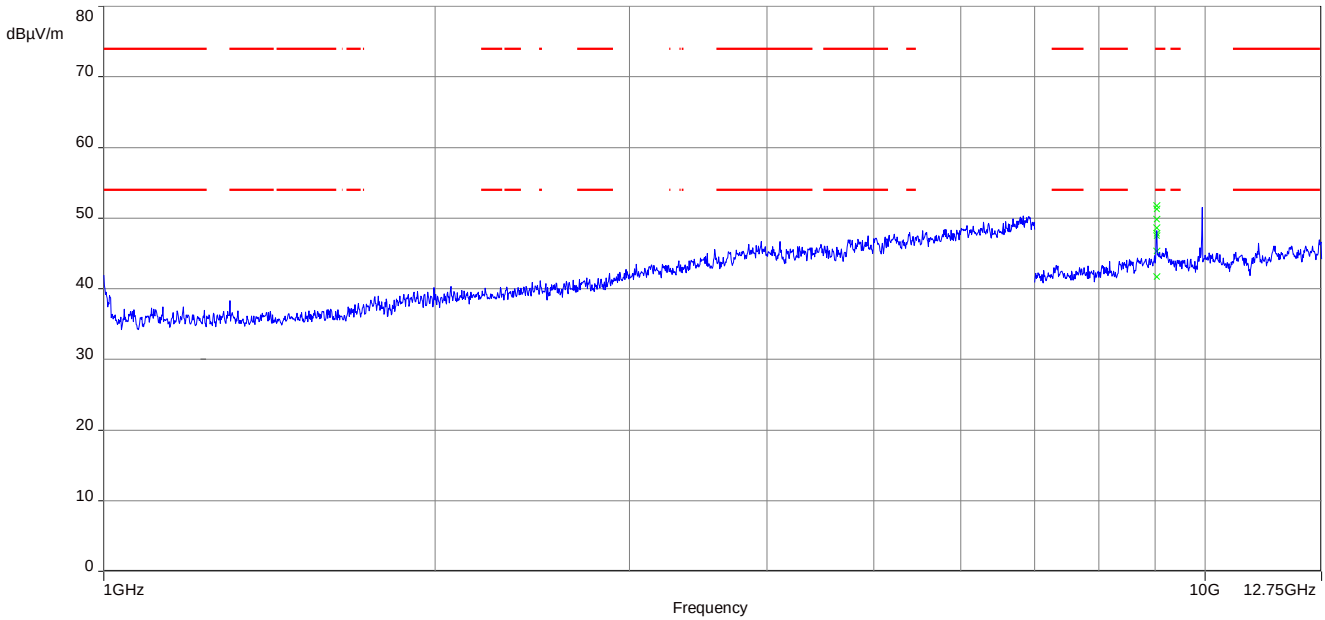



Plot 4: 1GHz – 12.75 GHz, RX-Mode, horizontal & vertical polarisation, valid for both antenna types

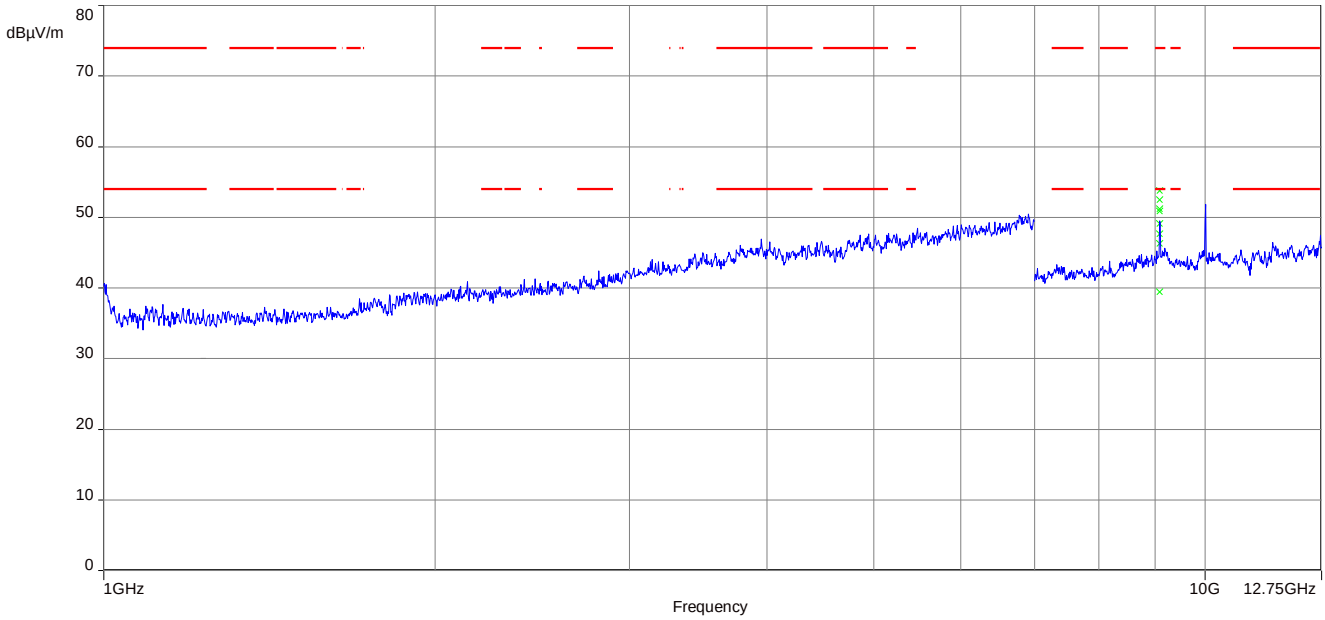


## Plots: PCB antenna

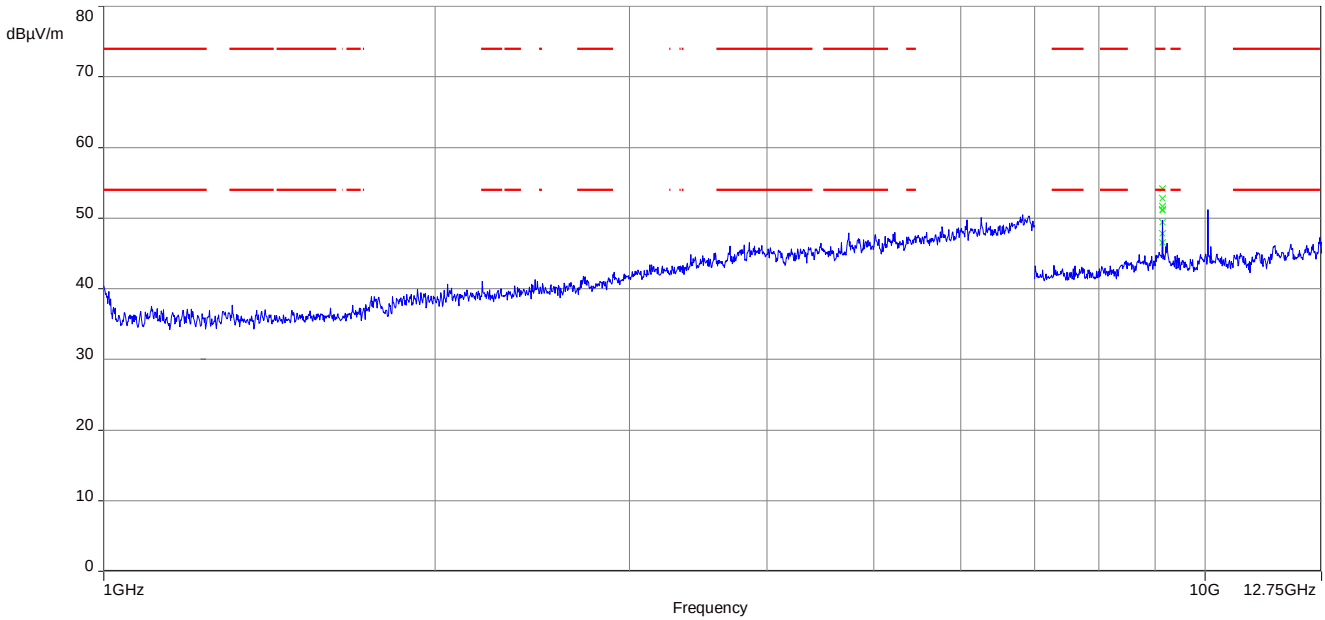
Plot 1: Low Channel




Plot 2: Middle Channel



Plot 3: High Channel



## 11.9 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 914.2 MHz. This measurement is representative for all channels and modes. 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 6.4 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 |

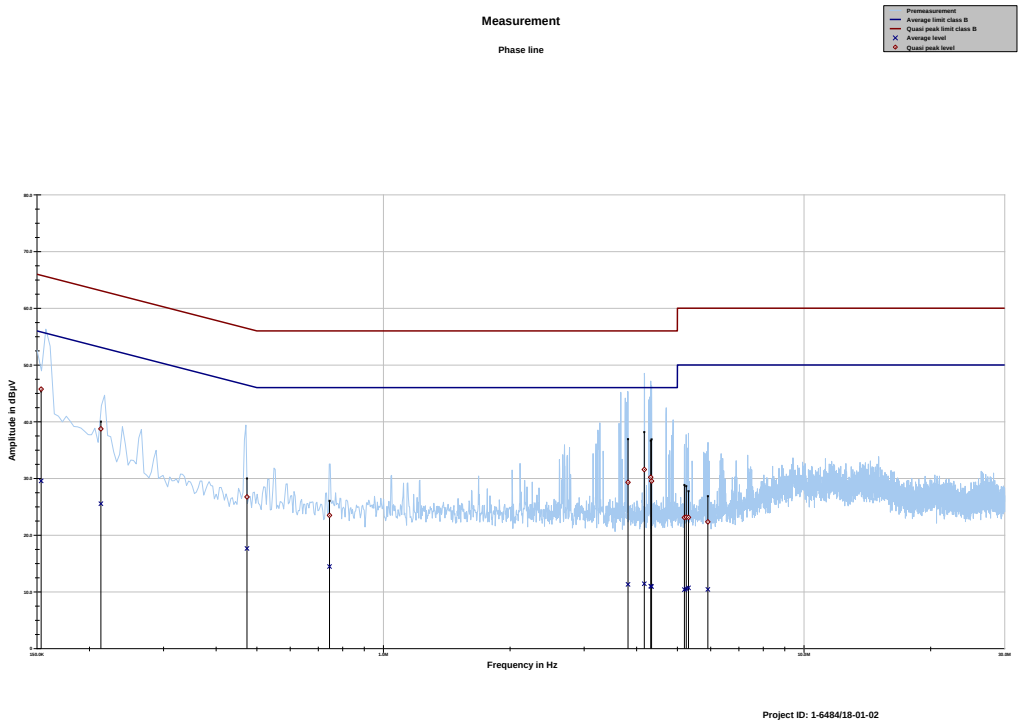
*Decreases with the logarithm of the frequency

**Results:**

| Spurious emissions conducted < 30 MHz [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| No emissions detected | | |
| | | |
| | | |

**Plots:**

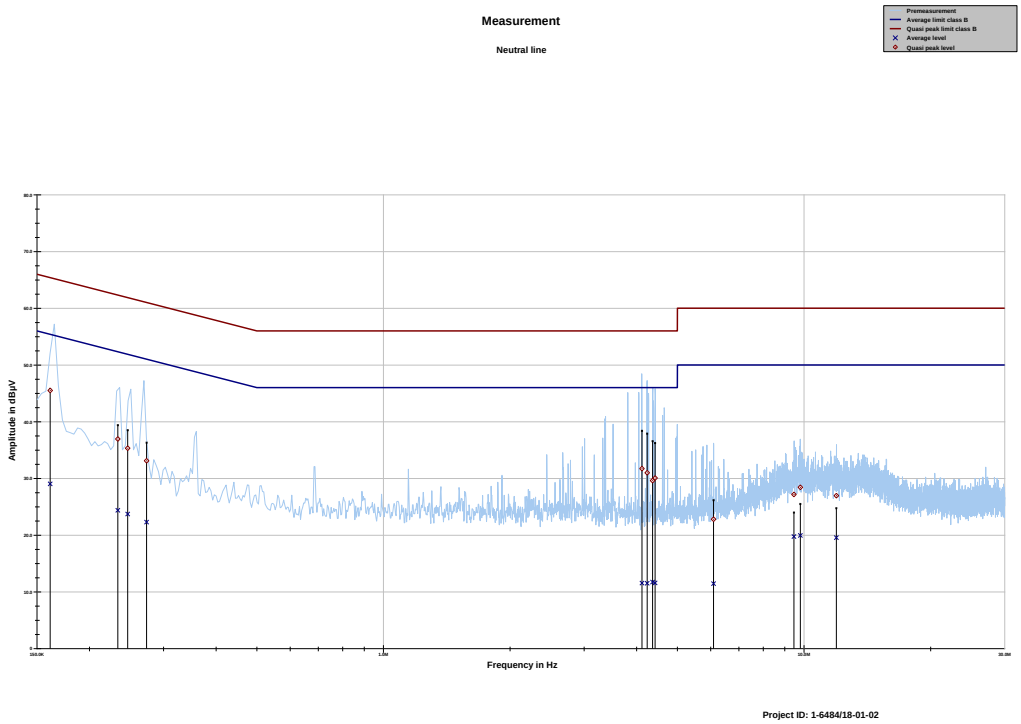
**Plot 1:** 150 kHz to 30 MHz, phase line




**Final results:**

| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| **0.153488** | 45.75 | 20.06 | 65.809 | 29.56 | 26.35 | 55.900 |
| **0.212920** | 38.73 | 24.36 | 63.091 | 25.54 | 28.66 | 54.202 |
| **0.473819** | 26.74 | 29.70 | 56.447 | 17.65 | 29.10 | 46.748 |
| **0.744432** | 23.49 | 32.51 | 56.000 | 14.46 | 31.54 | 46.000 |
| **3.816743** | 29.30 | 26.70 | 56.000 | 11.31 | 34.69 | 46.000 |
| **4.172309** | 31.56 | 24.44 | 56.000 | 11.42 | 34.58 | 46.000 |
| **4.320931** | 30.20 | 25.80 | 56.000 | 11.00 | 35.00 | 46.000 |
| **4.341956** | 29.53 | 26.47 | 56.000 | 10.93 | 35.07 | 46.000 |
| **5.195328** | 23.09 | 36.91 | 60.000 | 10.40 | 39.60 | 50.000 |
| **5.248244** | 23.18 | 36.82 | 60.000 | 10.56 | 39.44 | 50.000 |
| **5.313075** | 23.13 | 36.87 | 60.000 | 10.71 | 39.29 | 50.000 |
| **5.909193** | 22.34 | 37.66 | 60.000 | 10.42 | 39.58 | 50.000 |

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




**Final results:**

| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| **0.161283** | 45.50 | 19.90 | 65.398 | 29.04 | 26.63 | 55.678 |
| **0.233584** | 36.94 | 25.38 | 62.321 | 24.37 | 29.24 | 53.612 |
| **0.246501** | 35.33 | 26.55 | 61.874 | 23.72 | 29.52 | 53.243 |
| **0.273440** | 33.10 | 27.91 | 61.013 | 22.30 | 30.17 | 52.473 |
| **4.118482** | 31.73 | 24.27 | 56.000 | 11.54 | 34.46 | 46.000 |
| **4.238900** | 30.99 | 25.01 | 56.000 | 11.51 | 34.49 | 46.000 |
| **4.364841** | 29.61 | 26.39 | 56.000 | 11.72 | 34.28 | 46.000 |
| **4.424972** | 30.07 | 25.93 | 56.000 | 11.58 | 34.42 | 46.000 |
| **6.095754** | 22.81 | 37.19 | 60.000 | 11.44 | 38.56 | 50.000 |
| **9.465415** | 27.17 | 32.83 | 60.000 | 19.74 | 30.26 | 50.000 |
| **9.802768** | 28.43 | 31.57 | 60.000 | 19.95 | 30.05 | 50.000 |
| **11.938395** | 26.96 | 33.04 | 60.000 | 19.55 | 30.45 | 50.000 |

# 12 Measurement results Part 2 Hybrid mode

## 12.1 Antenna gain

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 1 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 6.3 A (conducted) |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

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

**Results:**

| | | Low channel | Middle channel | High channel |
|---|---|---|---|---|
| Conducted power | | 16.49 dBm | 16.84 dBm | 17.04 dBm |
| dipole antenna | Radiated power | 19.65 dBm | 20.35 dBm | 20.25 dBm |
| | Gain Calculated | 3.16 dBi | 3.51 dBi | 3.21 dBi |
| PCB antenna | Radiated power | 20.45 dBm | 20.95 dBm | 20.15 dBm |
| | Gain Calculated | 3.96 dBi | 4.11 dBi | 3.11 dBi |

## 12.2 Maximum Output Power

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | RMS |
| Sweep time: | 300 s |
| Resolution bandwidth: | 3 kHz |
| Video bandwidth: | 10 kHz |
| Span: | 200 kHz |
| Trace-Mode: | Single sweep |
| Measurement method | According to ANSI C63.10-2013 11.9.2.2.3 Method AVGSA-1A (alternative) |
| Used equipment: | See chapter 6.3 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

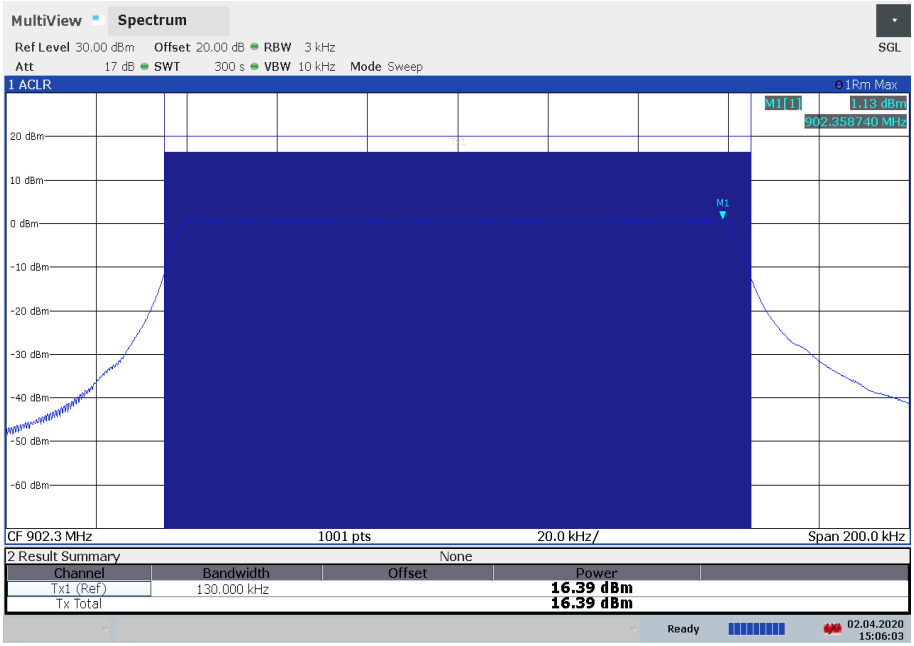
| FCC | IC |
|---|---|
| Maximum Output Power Conducted | |
| For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section. | |

**Result:**

| Test Conditions | | Maximum Output Power Conducted [dBm] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 16.4 | 16.6 | 16.7 |

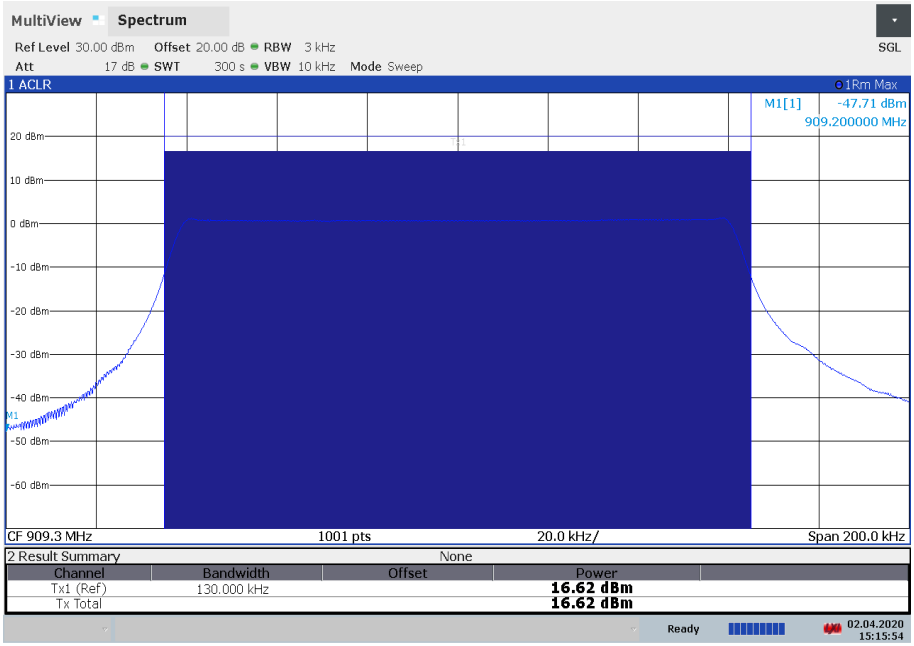
## Plots:

Plot 1: Low Channel



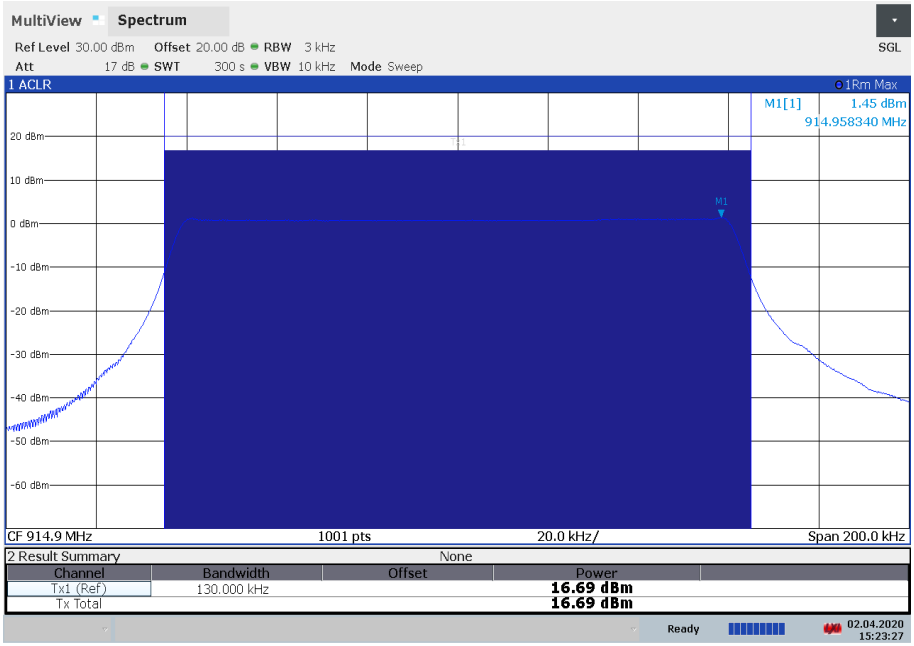

15:06:04 02.04.2020

Plot 2: Middle Channel




15:15:55 02.04.2020

Plot 3: High Channel




15:23:27 02.04.2020

## 12.3 Power spectral density

**Description:**

Measurement of the power spectral density of a digital modulated system. The measurement is repeated at the lowest, middle and highest channel.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | RMS |
| Sweep time: | 100 s |
| Video bandwidth: | 10 kHz |
| Resolution bandwidth: | 3 kHz |
| Span: | 200 kHz |
| Trace mode: | Max Hold |
| Measurement method | According to ANSI C63.10-2013 11.10.4 Method AVGPSD-1A (alternative) |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

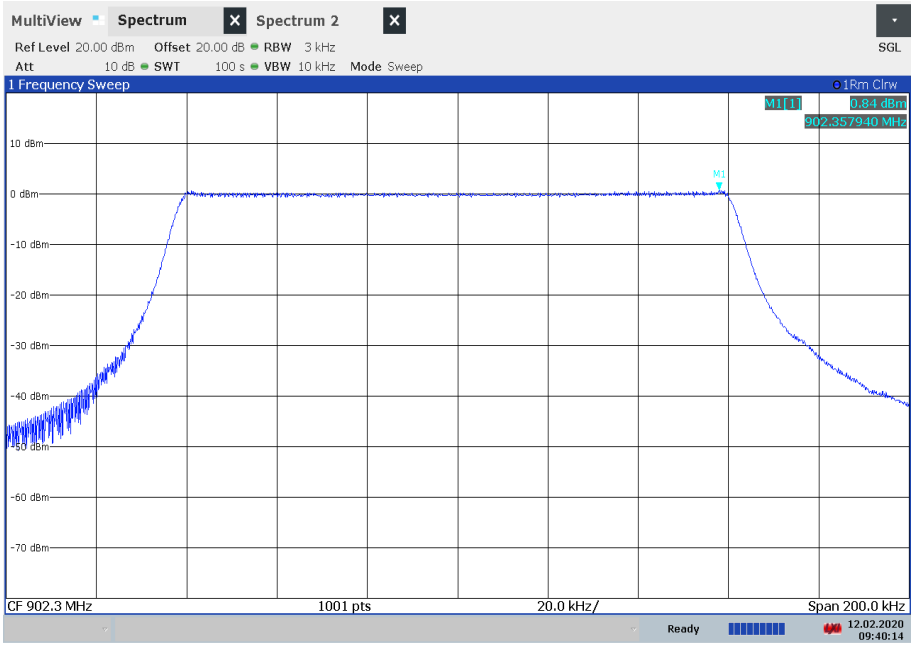
| FCC | IC |
|---|---|
| Power Spectral Density | |
| The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. | |

**Results:**

| Modulation | Power Spectral density [dBm/3kHz] | | |
|---|---|---|---|
| Channel | Lowest | Middle | Highest |
| | 0.84 | 0.91 | 1.05 |

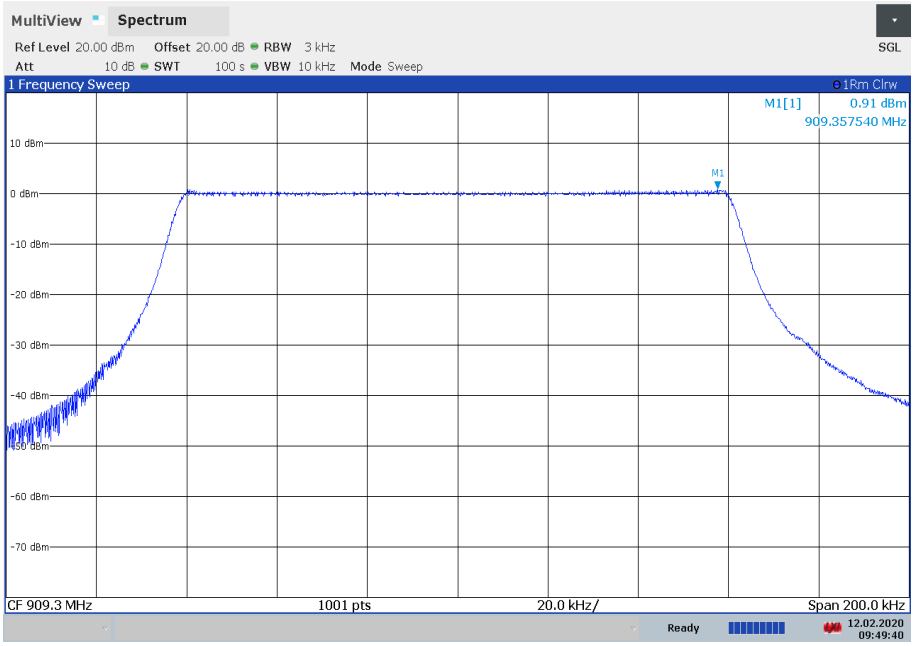
## Plots:

Plot 1: Low Channel



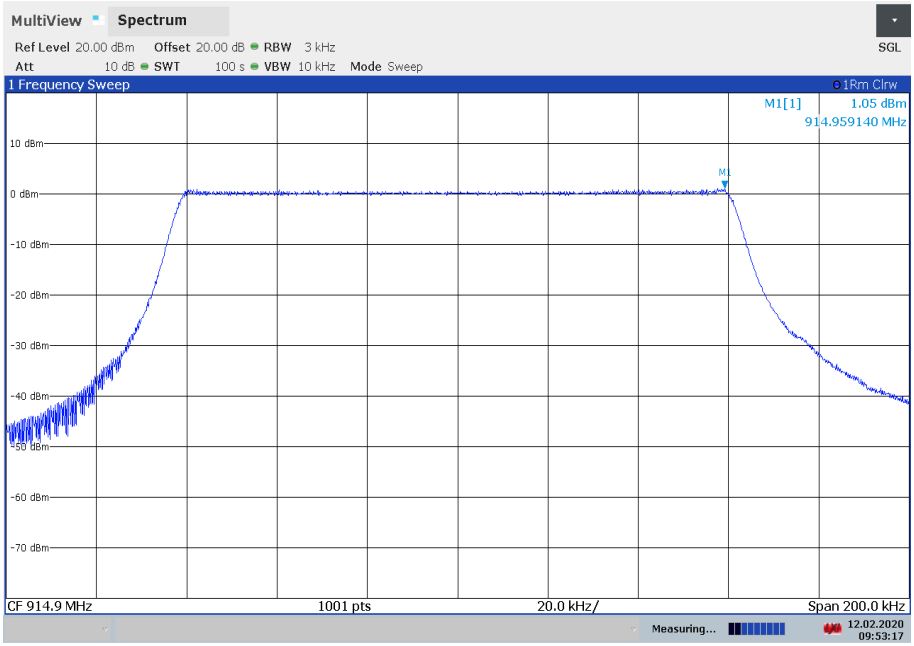

09:40:15 12.02.2020

Plot 2: Middle Channel




09:49:41 12.02.2020

Plot 3: High Channel




09:53:18 12.02.2020

## 12.4 Average Time of Occupancy (dwell time)

**Measurement:**

The measurement is performed in zero span mode to show that none of the 64 used channels is allocated more than 0.4 seconds within a 25.6 seconds interval (64 channels times 0.4s).

**Limits:**

| FCC | IC |
|---|---|
| **Average time of occupancy** | |
| For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4 | |

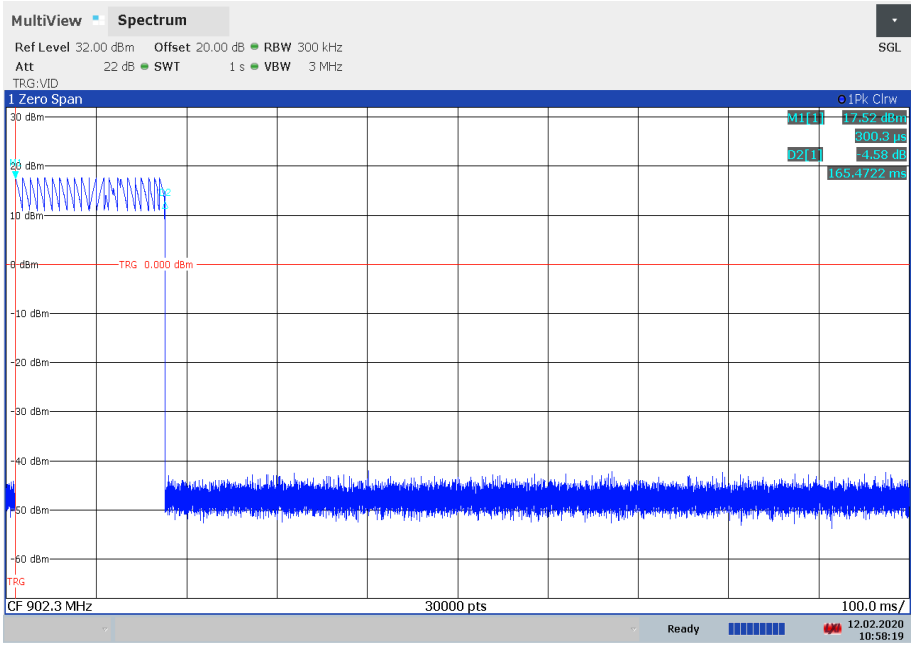
**Result:** The time slot length is = 165.47 ms
Number of hops / channel @ 25.6s = 2

Within 25.6 s period, the average time of occupancy in 20 s: 330.94 ms

→ The average time of occupancy = **330.94 ms**

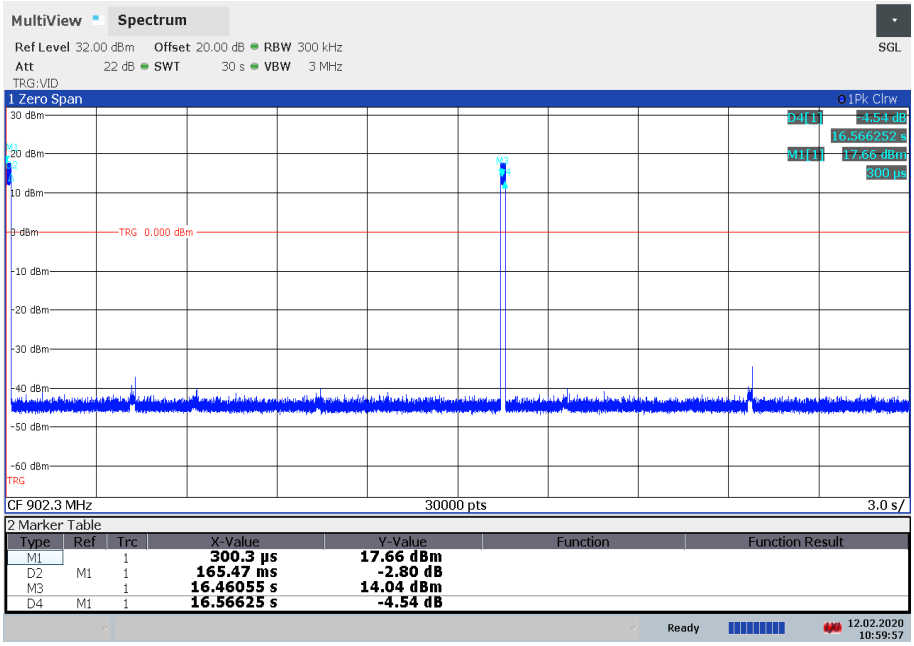
## Plots:

Plot 1: Time slot length = 330.94 ms




10:58:20 12.02.2020

Plot 2: hops / channel @ 20s = 2




10:59:58 12.02.2020

## 12.5 Carrier Frequency Separation

**Description:**

Measurement of the carrier frequency separation of a hopping system. EUT in hopping mode.

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | See plots |
| Video bandwidth | See plots |
| Span | See plots |
| Trace mode | Max hold |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

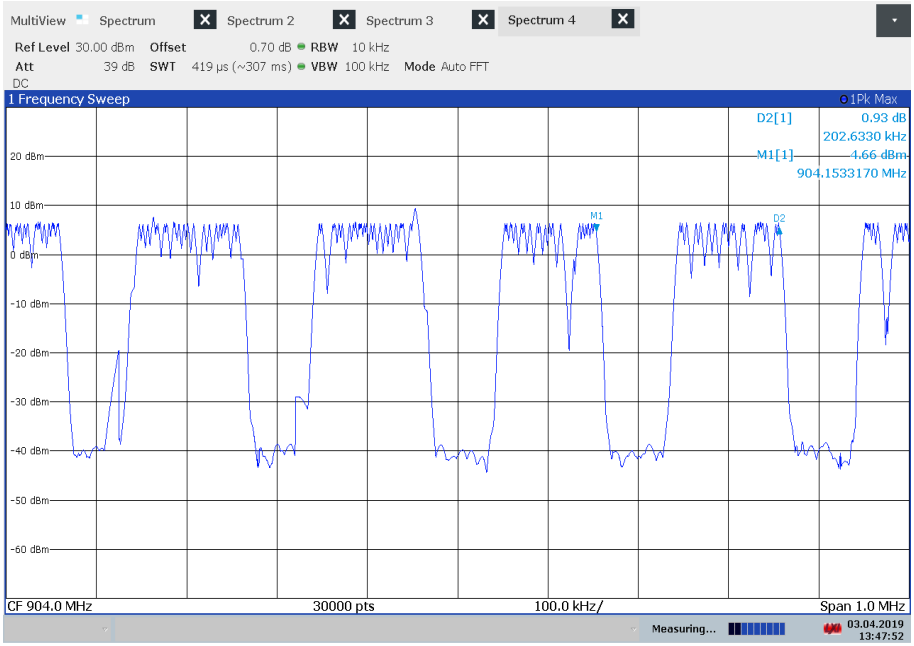
**Limits:**

| FCC | IC |
|---|---|
| Carrier frequency separation | |
| Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater. The two-thirds of the 20 dB bandwidth for IC is only valid for the ISM band 2400 – 2483.5 MHz. | |

**Result:** The channel separation is 202.6 kHz.

## Plots:

Plot 1: Frequency separation




13:47:52 03.04.2019

## 12.6 Spectrum bandwidth

**Description:**

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the “Measurement Guidelines” (DA 00-705, March 30, 2000). EUT in single channel mode.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 5 kHz |
| Video bandwidth | 100 kHz |
| Span | See plots |
| Trace mode | Max hold |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| None | |

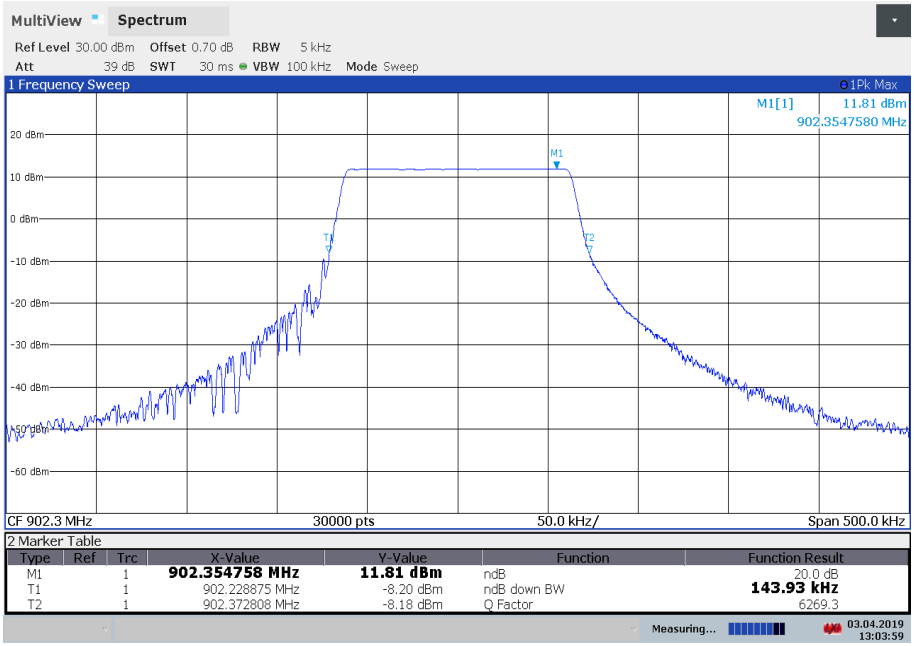
**Result:**

| Test Conditions | | 20dB BANDWIDTH [kHz] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 143.93 | 143.75 | 143.70 |

| Test Conditions | | 99% BANDWIDTH [kHz] | | |
|---|---|---|---|---|
| | | Low channel | Middle channel | High channel |
| $T_{nom}$ | $V_{nom}$ | 123.54 | 129.49 | 129.54 |

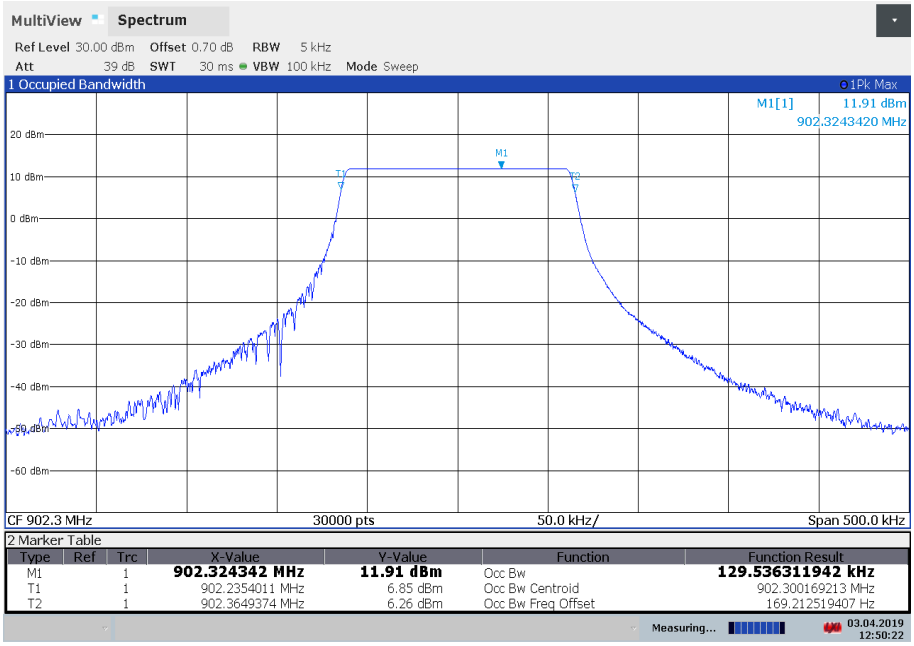
## Plots:

Plot 1: Low Channel, 20 dB-BW



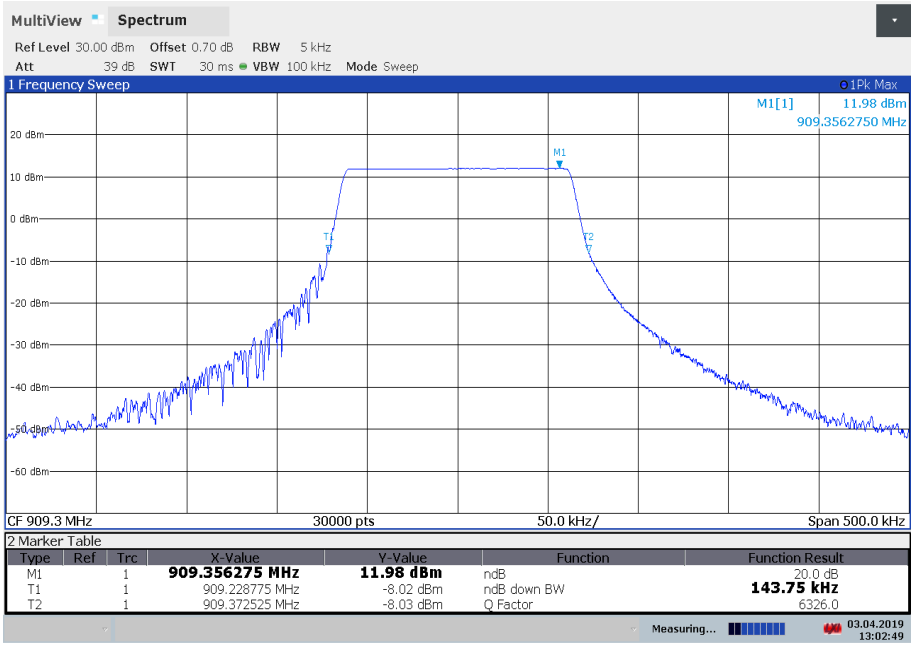

13:04:00 03.04.2019

Plot 2: Low Channel, 99%OBW



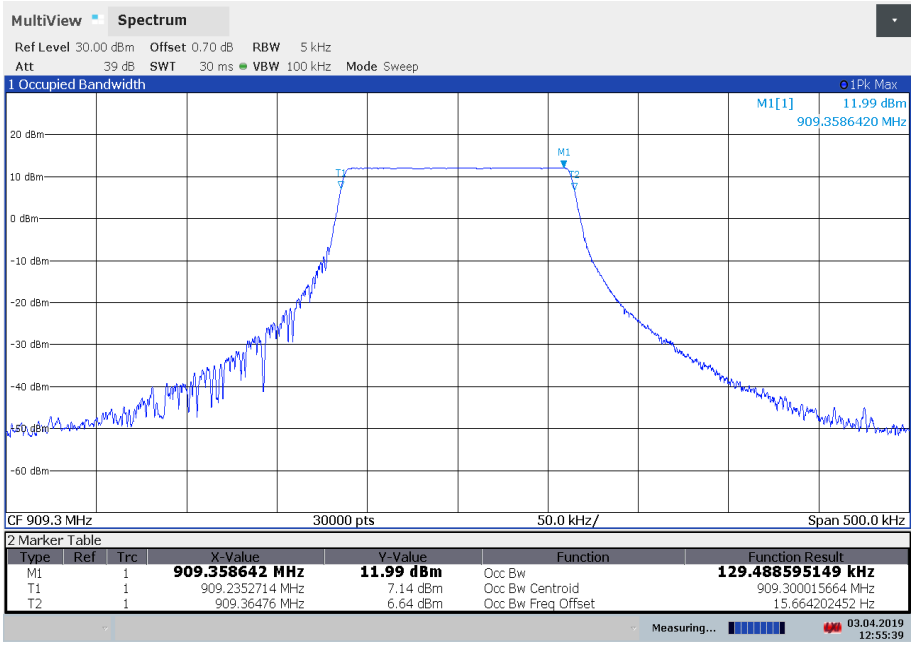

12:50:22 03.04.2019

Plot 3: Middle Channel, 20 dB-BW



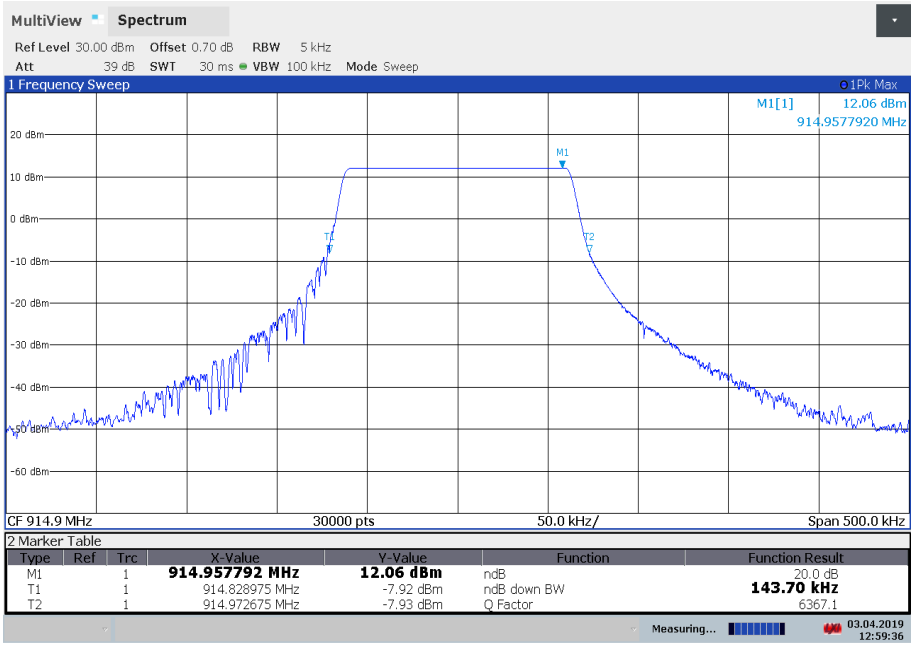

13:02:50 03.04.2019

Plot 4: Middle Channel, 99%OBW



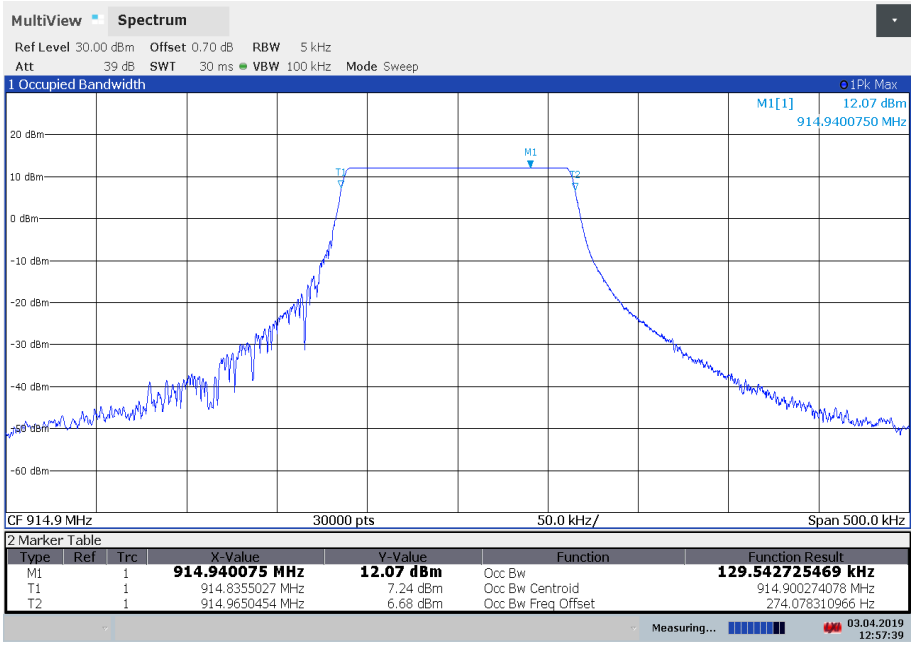

12:55:40 03.04.2019

Plot 5: High Channel, 20 dB-BW




12:59:37 03.04.2019

Plot 6: High Channel, 99%OBW




12:57:39 03.04.2019

## 12.7 Detailed spurious emissions @ the band edge – conducted and radiated

**Description:**

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

| Measurement parameters | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 100 kHz |
| Video bandwidth | 300 kHz |
| Span | Lower Band Edge: 902 MHz<br>Upper Band Edge: 928 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.3 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

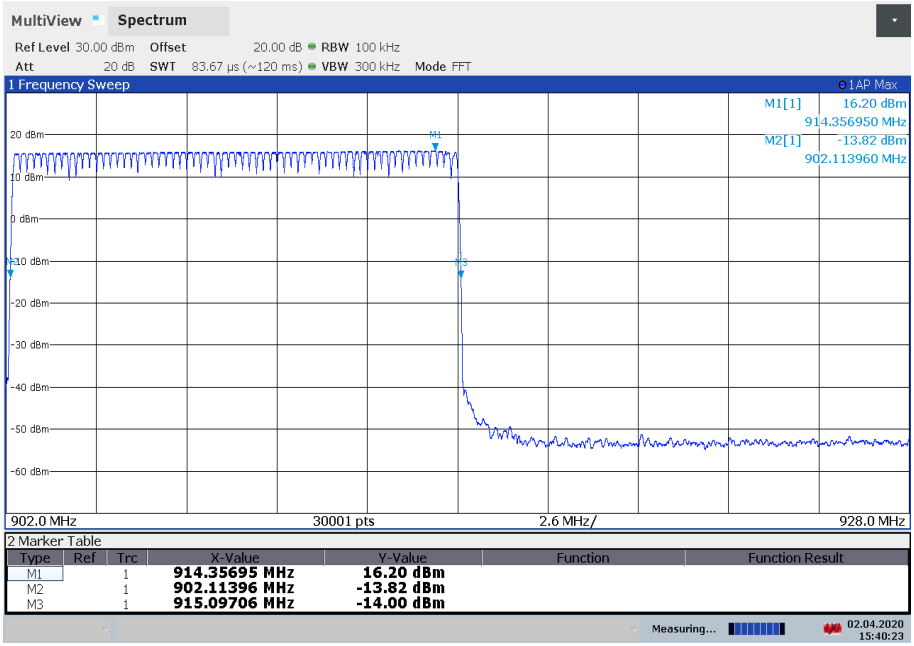
| FCC | IC |
|---|---|
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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.<br><br>RSS-247, Issue 2: 5.5 Unwanted emissions: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. | |

**Results conducted:**

| Scenario | Spurious band edge conducted | |
|---|---|---|
| Modulation | lowest channel | highest channel |
| Lower band edge – hopping on | > 30 dB | > 30 dB |
| Upper band edge – hopping off | > 30 dB | > 30 dB |

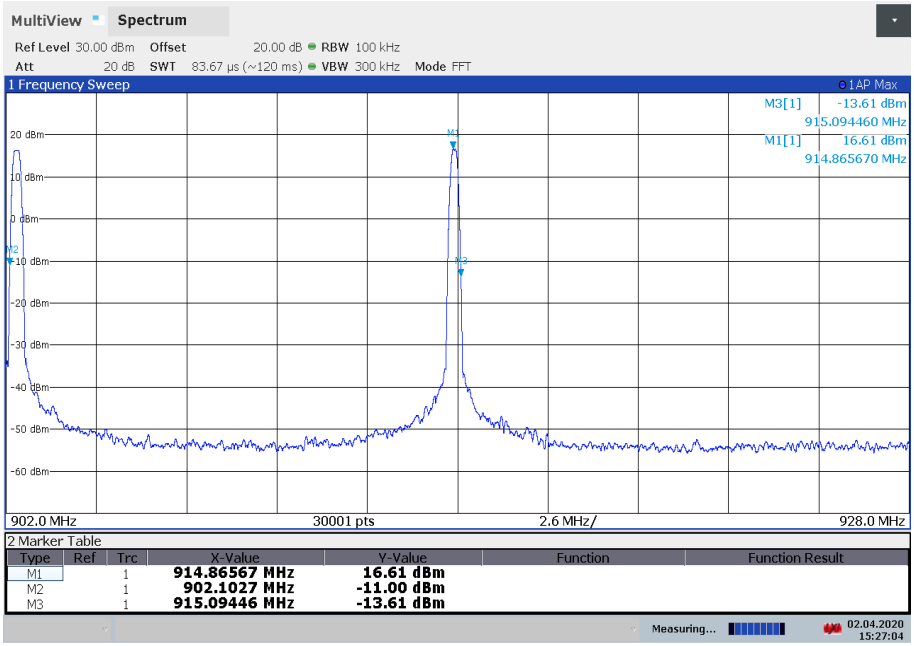
## Plots:

**Plot 1:** 30 dB – hopping on




15:40:24 02.04.2020

**Plot 2:** 30 dB – hopping off




15:27:04 02.04.2020

**Results radiated:**

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| [1]0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614 | 5.35 - 5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960 - 1240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1300 - 1427 | 8.025 - 8.5 |
| 4.17725 - 4.17775 | 37.5 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.6 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2690 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | ([2]) |
| 13.36 - 13.41 | | | |

## 12.8 Spurious Emissions Conducted

**Description:**

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 1 MHz |
| Resolution bandwidth: | 100 kHz |
| Span: | 9 kHz to 12.75 GHz |
| Trace-Mode: | Max Hold |
| Used equipment: | See chapter 6.3 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

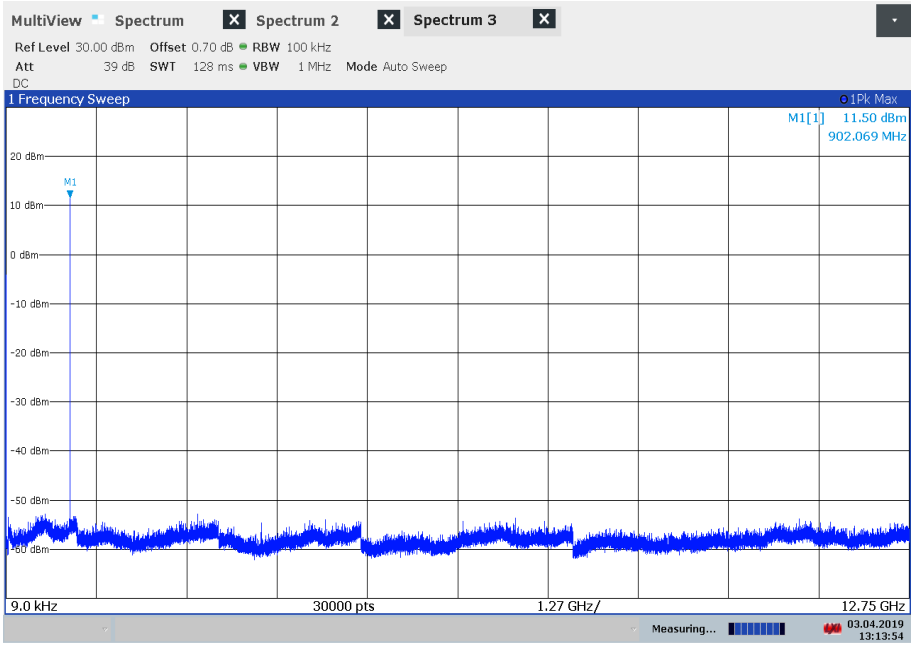
| FCC | IC |
|---|---|
| TX spurious emissions conducted | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below 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.<br><br>RSS-247, Issue 2: 5.5 Unwanted emissions: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. | |

**Result:**

| Emission Limitation | | | | | |
|---|---|---|---|---|---|
| Frequency [MHz] | | Amplitude of emission [dBm] | Limit max. allowed emission power | actual attenuation below frequency of operation [dB] | Results |
| 902.1 | | 11.5 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |
| 909.3 | | 11.8 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |
| 914.8 | | 11.9 | 24 dBm | | Operating frequency |
| | | | -20 dBc | No emissions detected! | |

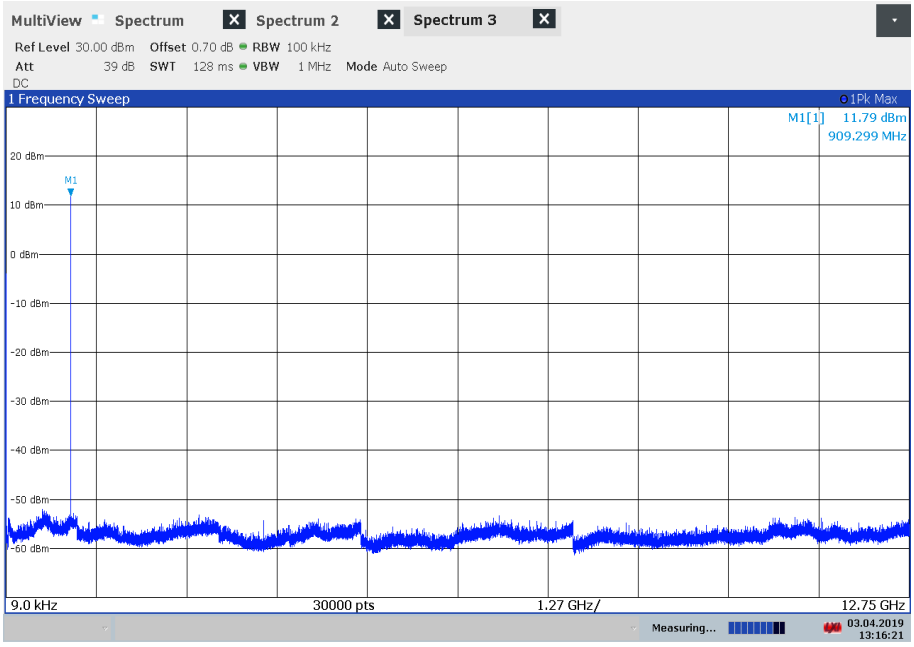
## Plots:

Plot 1: Low channel, 9 kHz – 12.75 GHz



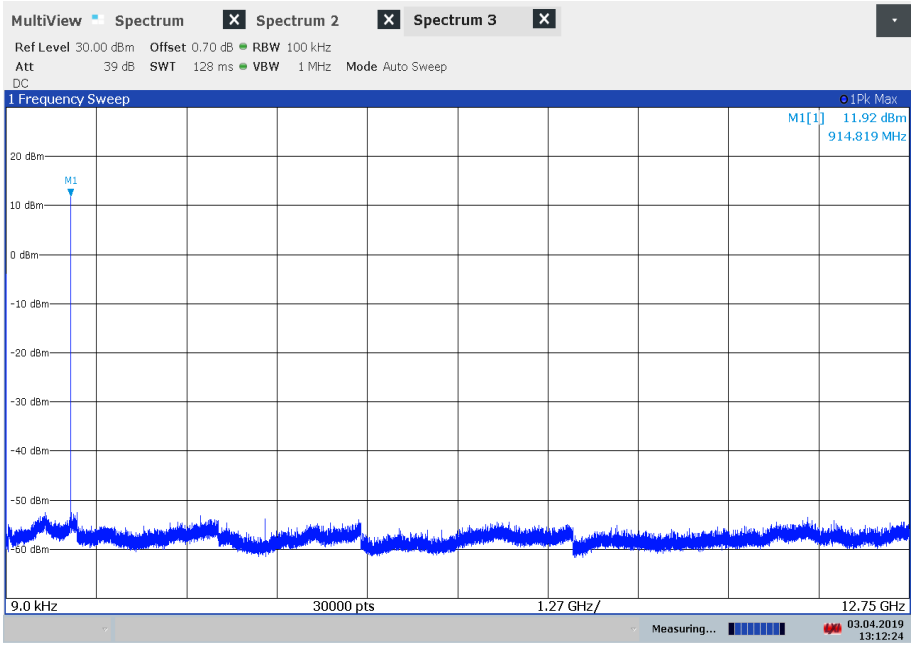

13:13:55 03.04.2019

Plot 2: Middle channel, 9 kHz – 12.75 GHz




13:16:22 03.04.2019

Plot 3: High channel, 9 kHz – 12.75 GHz




**13:12:24 03.04.2019**

## 12.9 Spurious Emissions Radiated < 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 channels are low, middle and high channel. 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:**

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

**Limits:**

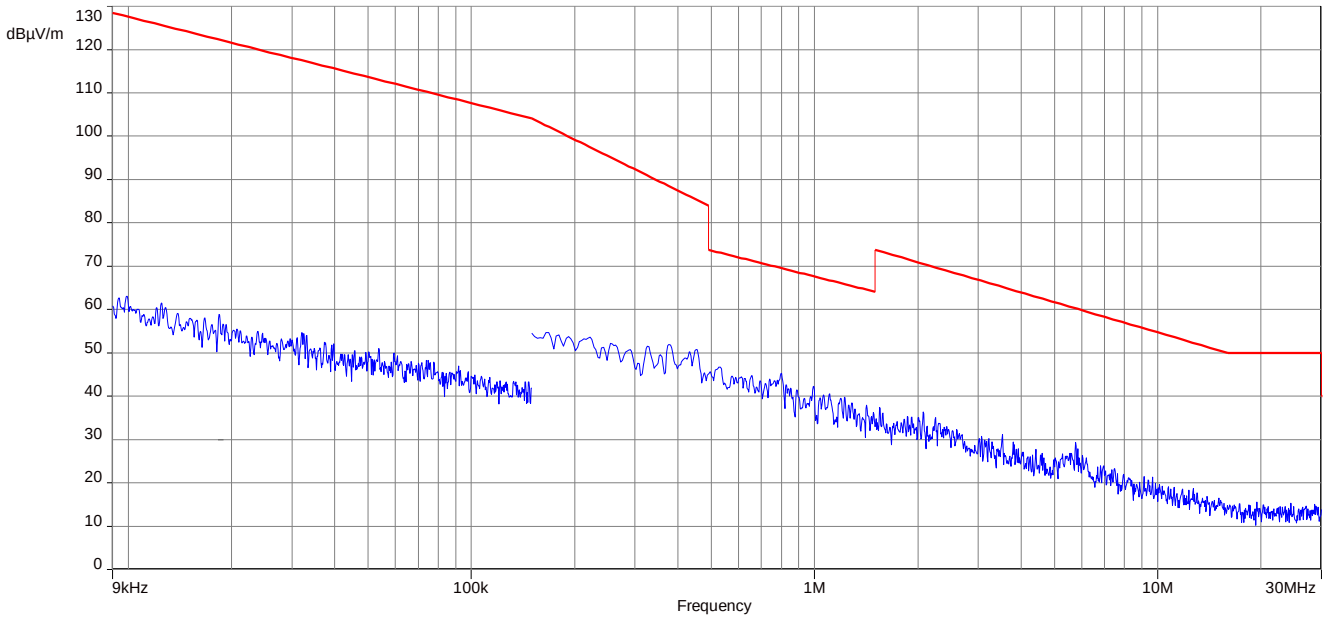
| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated < 30 MHz | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

**Result:**

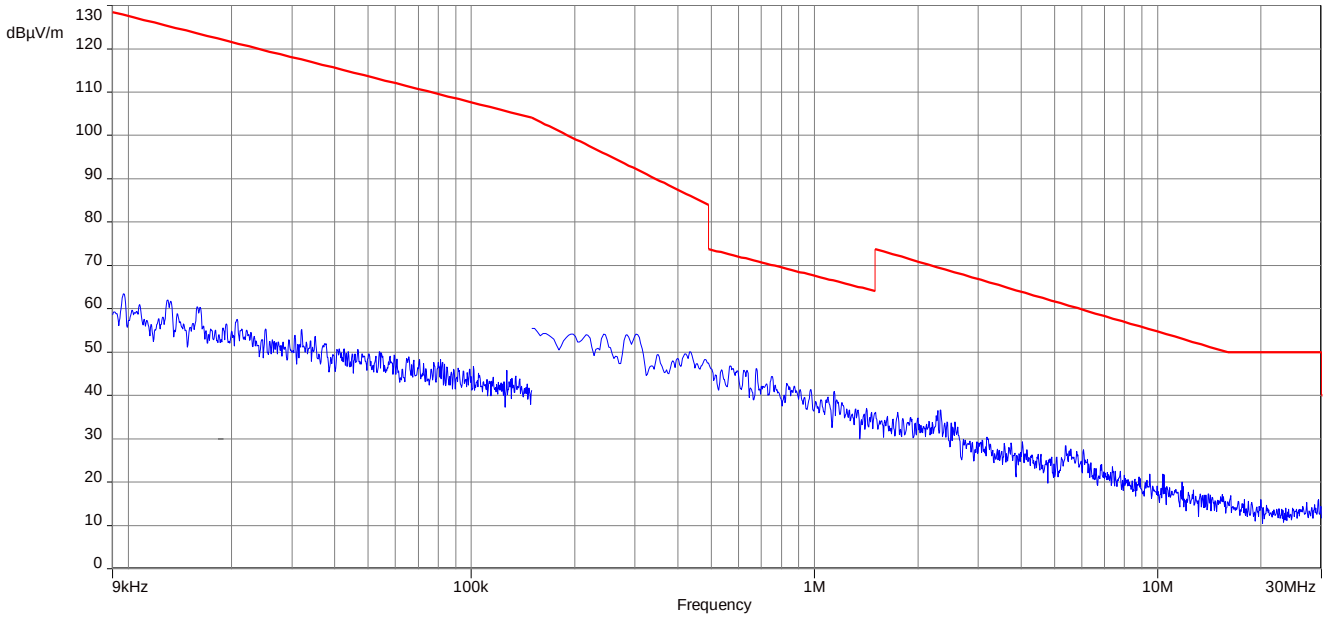
| SPURIOUS EMISSIONS LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| Frequency [MHz] | Detector | Level [dBµV/m] | Frequency [MHz] | Detector | Level [dBµV/m] | Frequency [MHz] | Detector | Level [dBµV/m] |
| All emissions were more than 10 dB below the limit. | | | | | | | | |

## Plots EUT with dipole antenna:

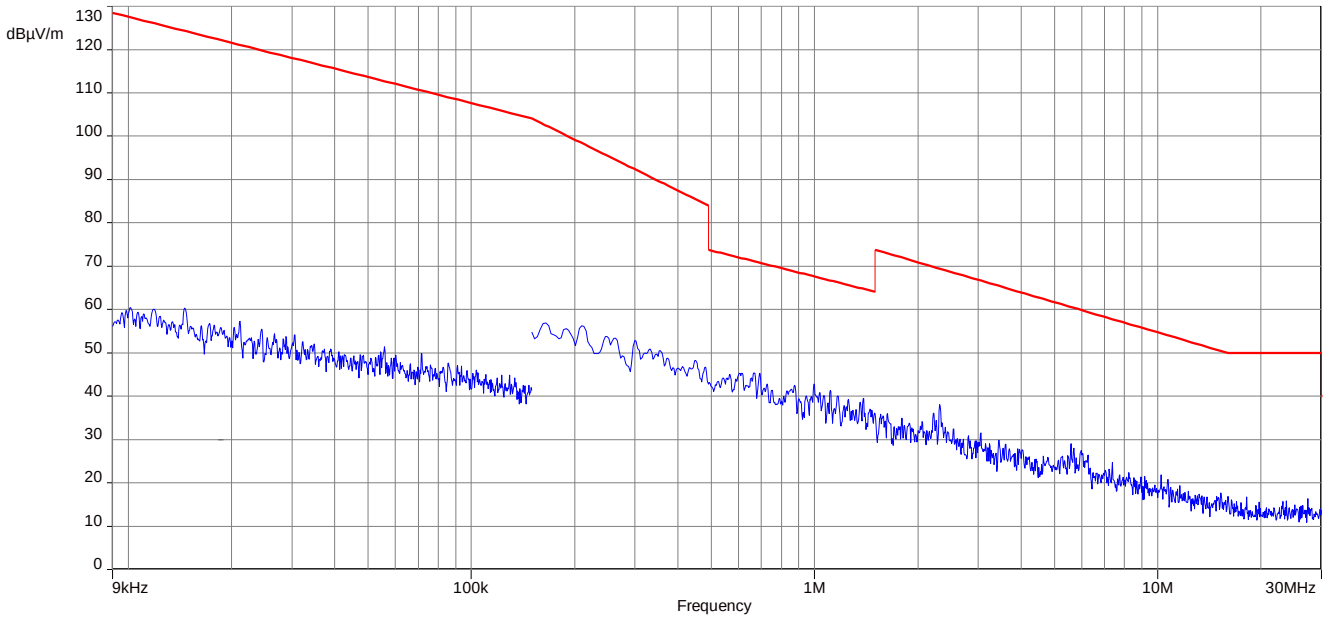
Plot 1: TX-Mode low channel




Plot 2: TX-Mode mid channel

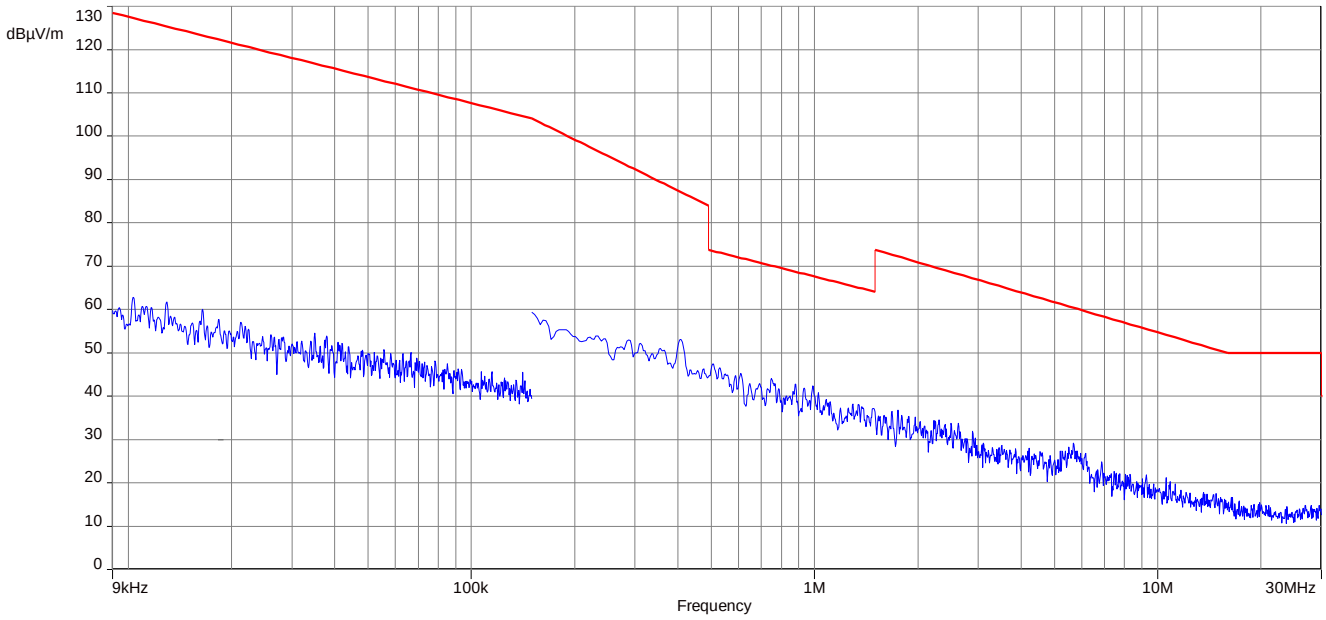


Plot 3: TX-Mode high channel

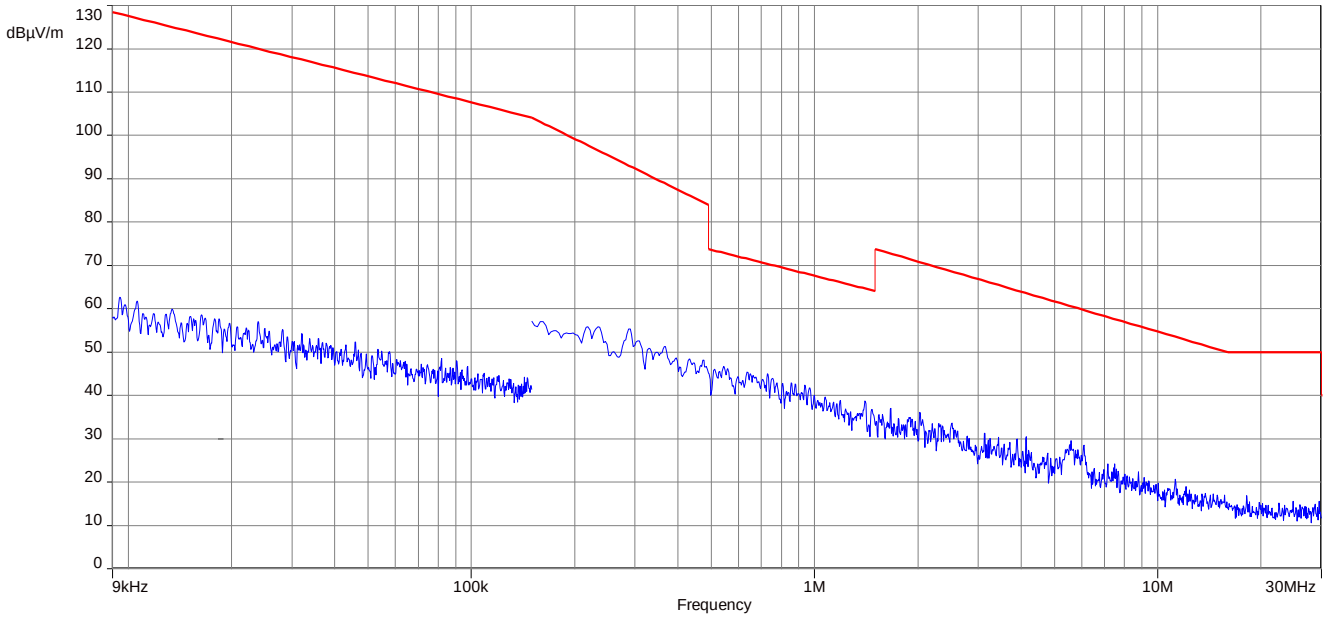


## Plots EUT with PCB antenna:

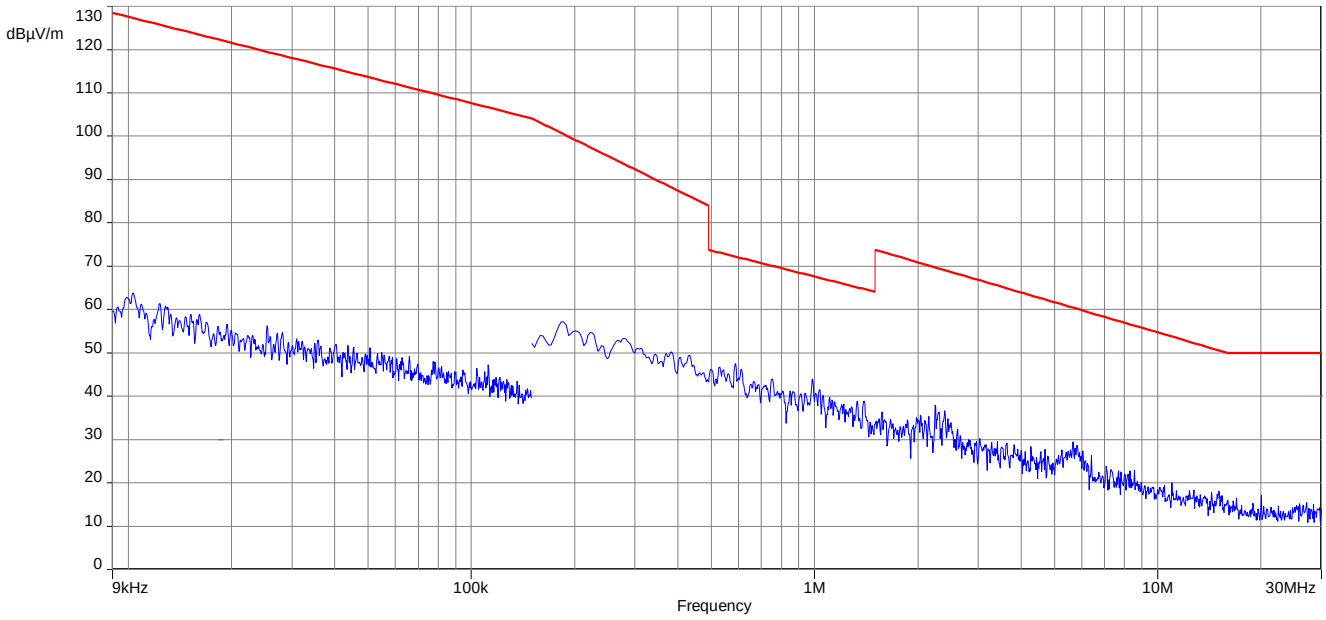
Plot 1: TX-Mode low channel




Plot 2: TX-Mode mid channel



Plot 3: TX-Mode high channel



## 12.10 Spurious Emissions Radiated > 30 MHz

### 12.10.1 Spurious emissions radiated 30 MHz to 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector | Peak / Quasi Peak |
| Sweep time | Auto |
| Resolution bandwidth | 3 x VBW |
| Video bandwidth | 120 kHz |
| Span | 30 MHz to 1 GHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.1 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

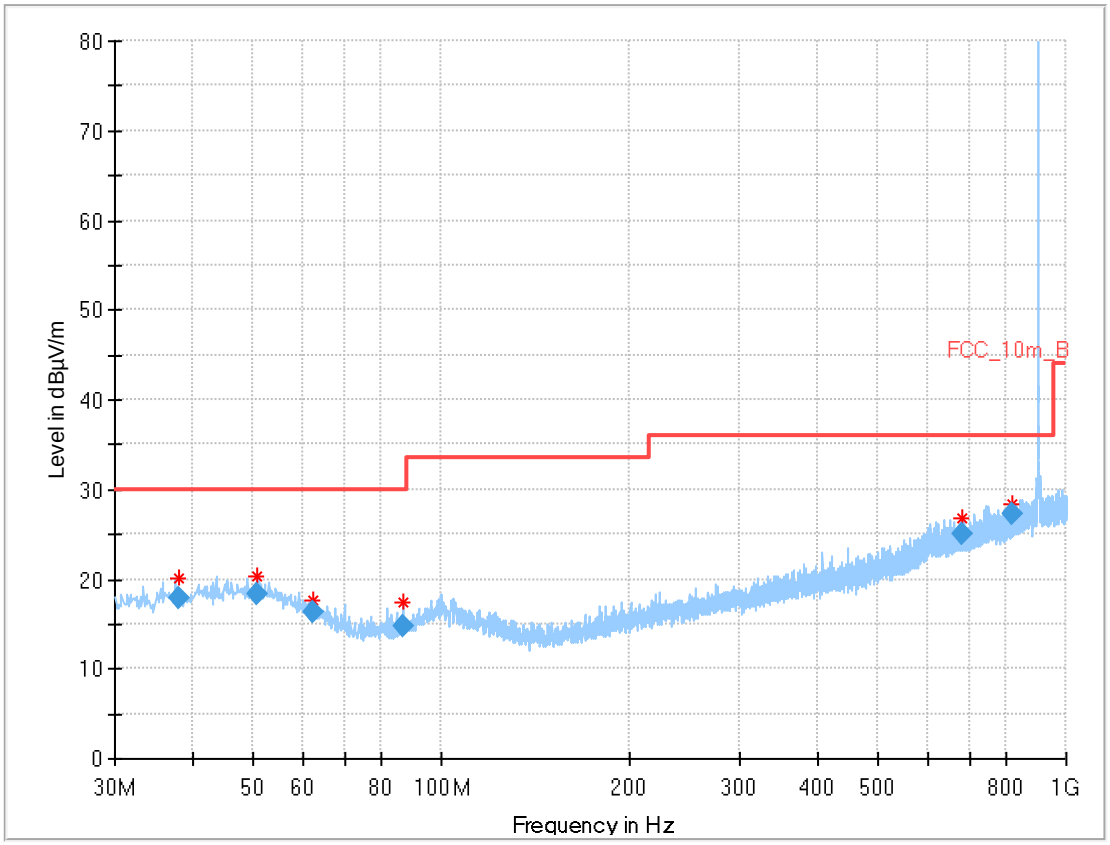
| FCC | | IC |
|---|---|---|
| Band-edge Compliance of conducted and radiated emissions | | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §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 |
| 30 - 88 | 30.0 | 10 |
| 88 – 216 | 33.5 | 10 |
| 216 – 960 | 36.0 | 10 |
| Above 960 | 54.0 | 3 |

**Result:**

See result table below the plots.

**Plots EUT with dipole antenna:**

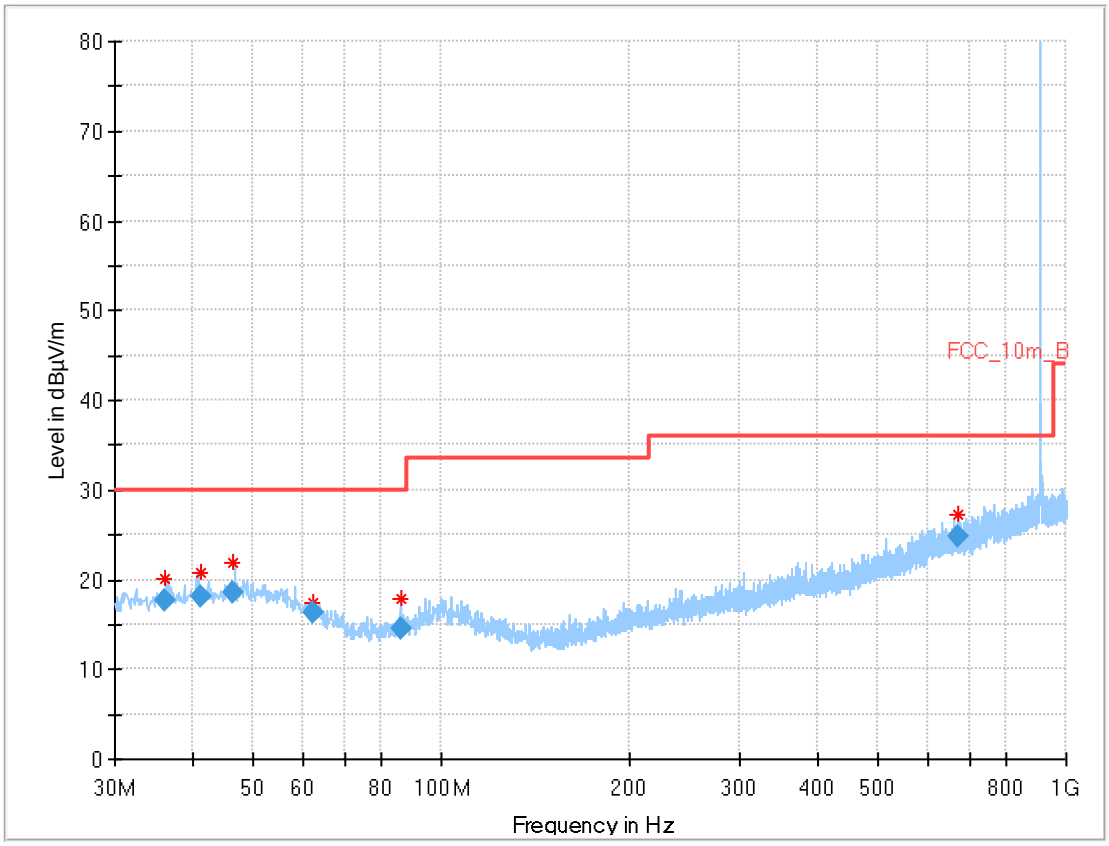
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)




**Final_Result**

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 38.055 | 17.83 | --- | 30.0 | 12.17 | 1000 | 120 | 101.0 | V | 1.0 | 14 |
| 50.856 | 18.41 | --- | 30.0 | 11.59 | 1000 | 120 | 160.0 | H | 185.0 | 15 |
| 62.448 | 16.32 | --- | 30.0 | 13.68 | 1000 | 120 | 160.0 | V | 234.0 | 12 |
| 86.817 | 14.80 | --- | 30.0 | 15.20 | 1000 | 120 | 98.0 | V | 121.0 | 11 |
| 680.687 | 24.92 | --- | 36.0 | 11.08 | 1000 | 120 | 160.0 | V | 16.0 | 21 |
| 819.498 | 27.32 | --- | 36.0 | 8.68 | 1000 | 120 | 160.0 | V | 355.0 | 23 |

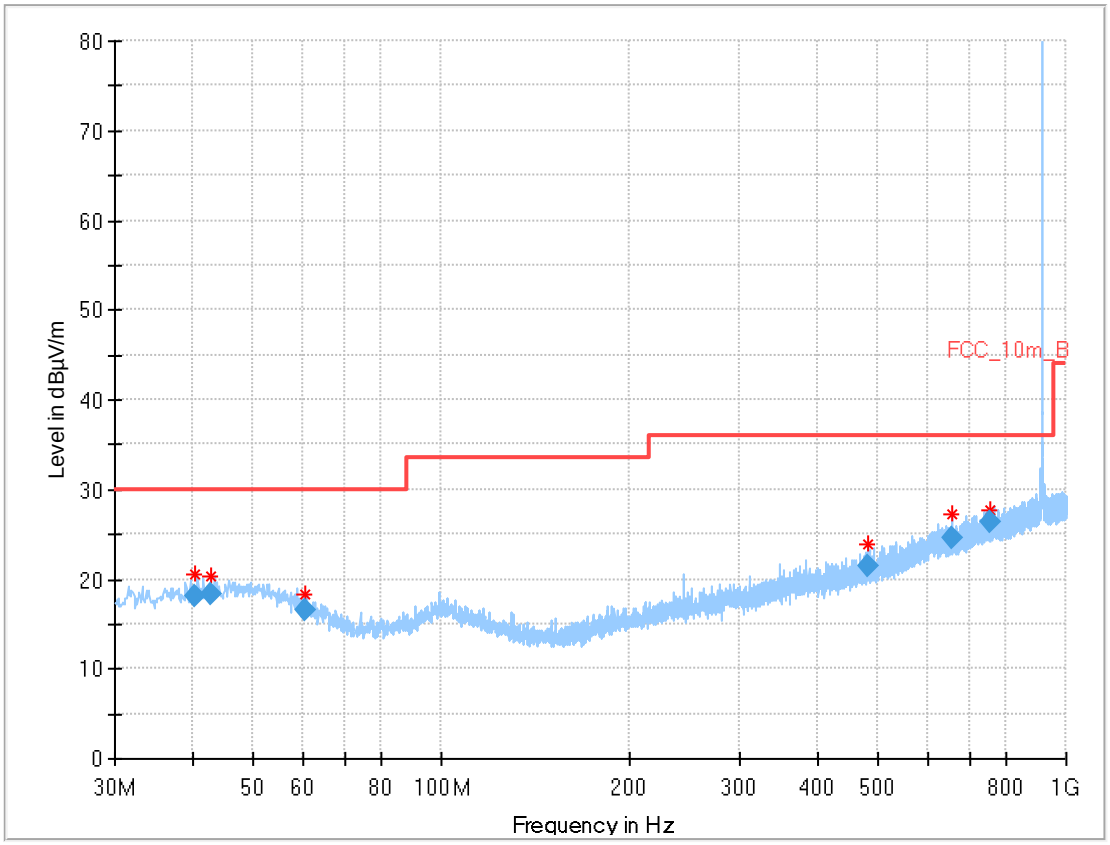
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.046 | 17.69 | --- | 30.0 | 12.31 | 1000 | 120 | 101.0 | H | 0.0 | 14 |
| 41.077 | 18.16 | --- | 30.0 | 11.84 | 1000 | 120 | 101.0 | V | 353.0 | 14 |
| 46.211 | 18.52 | --- | 30.0 | 11.48 | 1000 | 120 | 98.0 | V | 353.0 | 15 |
| 62.205 | 16.31 | --- | 30.0 | 13.69 | 1000 | 120 | 101.0 | H | 238.0 | 12 |
| 85.911 | 14.60 | --- | 30.0 | 15.40 | 1000 | 120 | 160.0 | V | 319.0 | 11 |
| 672.904 | 24.83 | --- | 36.0 | 11.17 | 1000 | 120 | 160.0 | H | 20.0 | 21 |

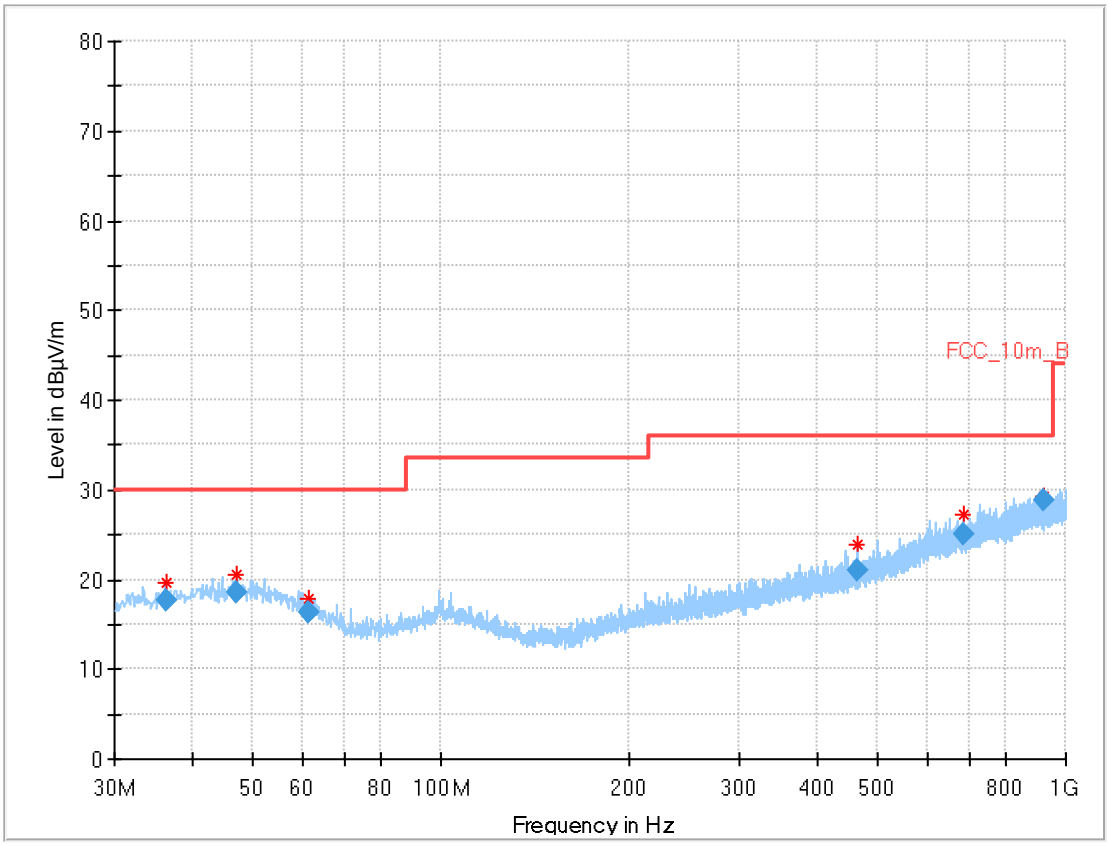
Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.327 | 18.02 | --- | 30.0 | 11.98 | 1000 | 120 | 101.0 | H | 302.0 | 14 |
| 42.766 | 18.26 | --- | 30.0 | 11.74 | 1000 | 120 | 160.0 | H | 41.0 | 15 |
| 60.634 | 16.47 | --- | 30.0 | 13.53 | 1000 | 120 | 100.0 | H | 48.0 | 13 |
| 481.717 | 21.41 | --- | 36.0 | 14.59 | 1000 | 120 | 160.0 | V | 13.0 | 18 |
| 654.394 | 24.55 | --- | 36.0 | 11.45 | 1000 | 120 | 160.0 | V | 327.0 | 21 |
| 755.610 | 26.27 | --- | 36.0 | 9.73 | 1000 | 120 | 98.0 | V | 47.0 | 22 |

Plot 4: 30 MHz – 1 GHz, horizontal & vertical polarisation (RX-Mode, valid for both antenna types)

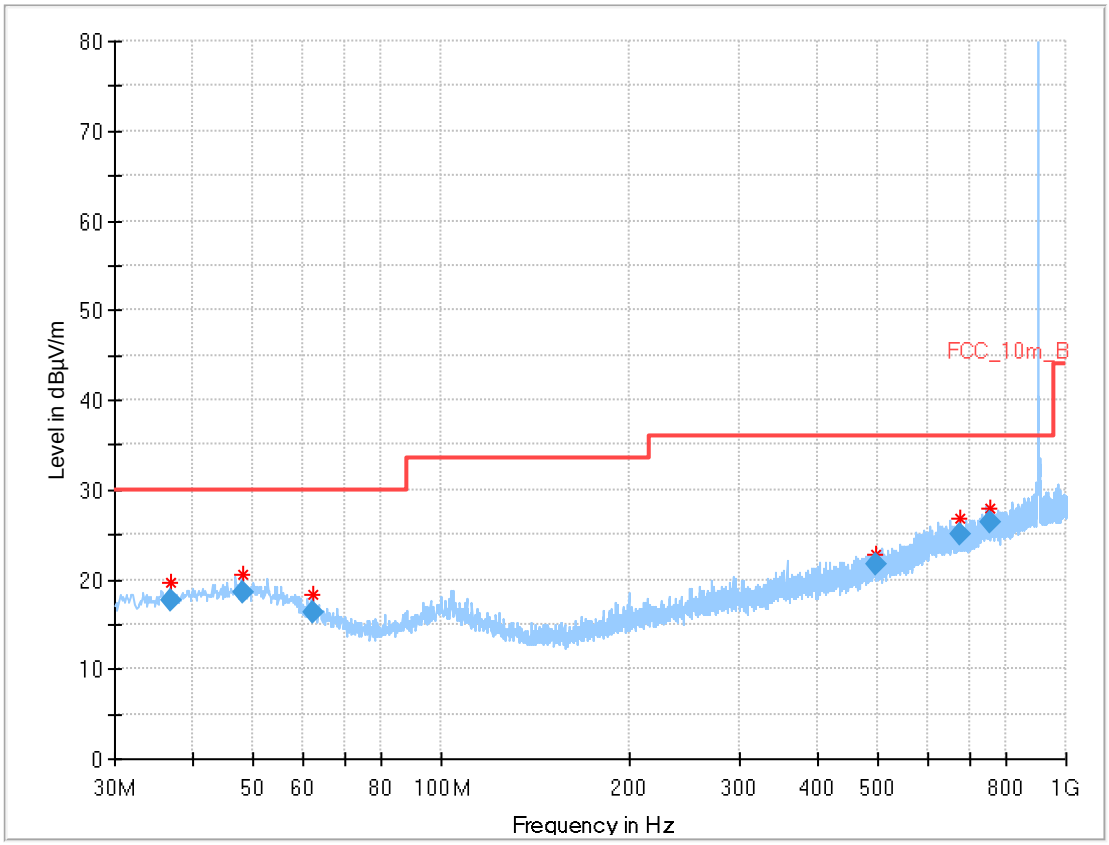



## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.264 | 17.73 | --- | 30.0 | 12.27 | 1000 | 120 | 101.0 | V | 150.0 | 14 |
| 47.029 | 18.54 | --- | 30.0 | 11.46 | 1000 | 120 | 160.0 | H | 242.0 | 15 |
| 61.198 | 16.36 | --- | 30.0 | 13.64 | 1000 | 120 | 101.0 | H | 249.0 | 13 |
| 464.593 | 20.96 | --- | 36.0 | 15.04 | 1000 | 120 | 160.0 | H | 302.0 | 18 |
| 686.535 | 24.95 | --- | 36.0 | 11.05 | 1000 | 120 | 160.0 | H | 68.0 | 21 |
| 920.605 | 28.92 | --- | 36.0 | 7.08 | 1000 | 120 | 98.0 | V | 71.0 | 24 |

**Plots EUT with PCB antenna:**

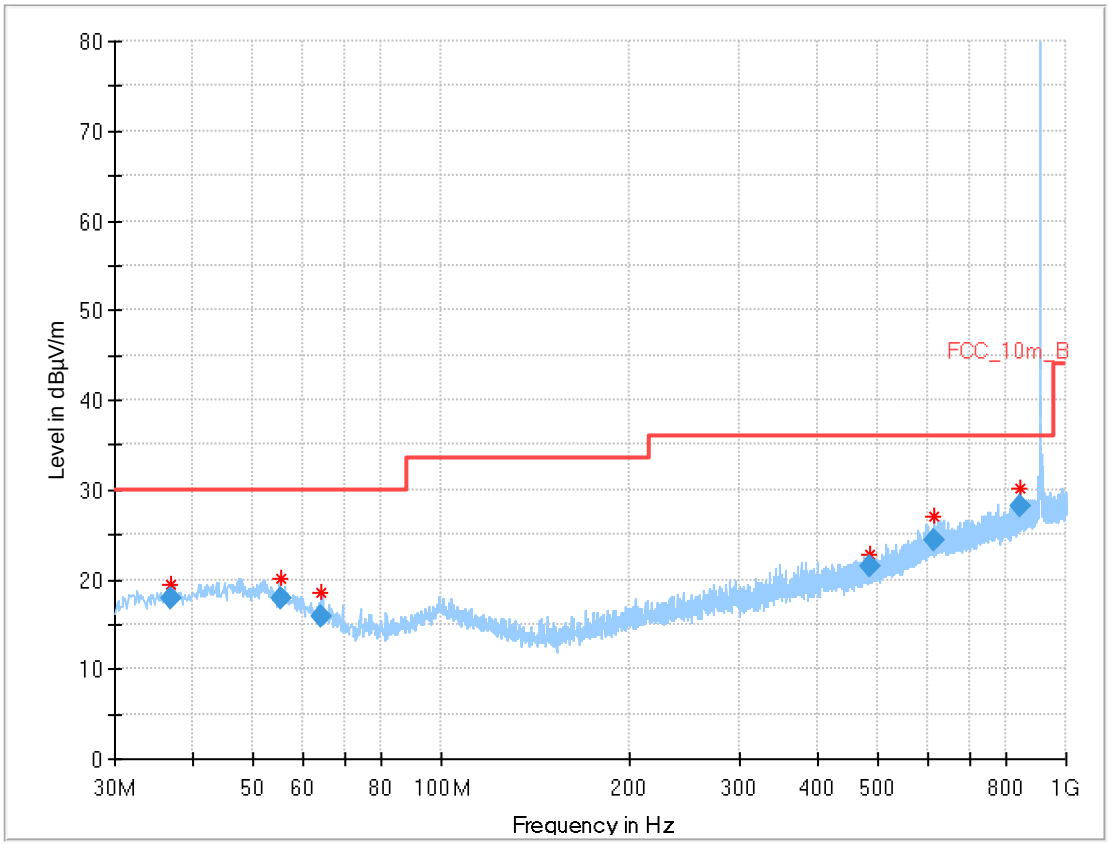
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)




**Final_Result**

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.813 | 17.76 | --- | 30.0 | 12.24 | 1000 | 120 | 101.0 | H | 0.0 | 14 |
| 48.122 | 18.56 | --- | 30.0 | 11.44 | 1000 | 120 | 160.0 | V | 327.0 | 15 |
| 62.166 | 16.37 | --- | 30.0 | 13.63 | 1000 | 120 | 100.0 | H | 0.0 | 13 |
| 496.108 | 21.66 | --- | 36.0 | 14.34 | 1000 | 120 | 160.0 | V | 282.0 | 18 |
| 677.306 | 24.96 | --- | 36.0 | 11.04 | 1000 | 120 | 98.0 | H | 53.0 | 21 |
| 753.312 | 26.28 | --- | 36.0 | 9.72 | 1000 | 120 | 101.0 | H | 161.0 | 22 |

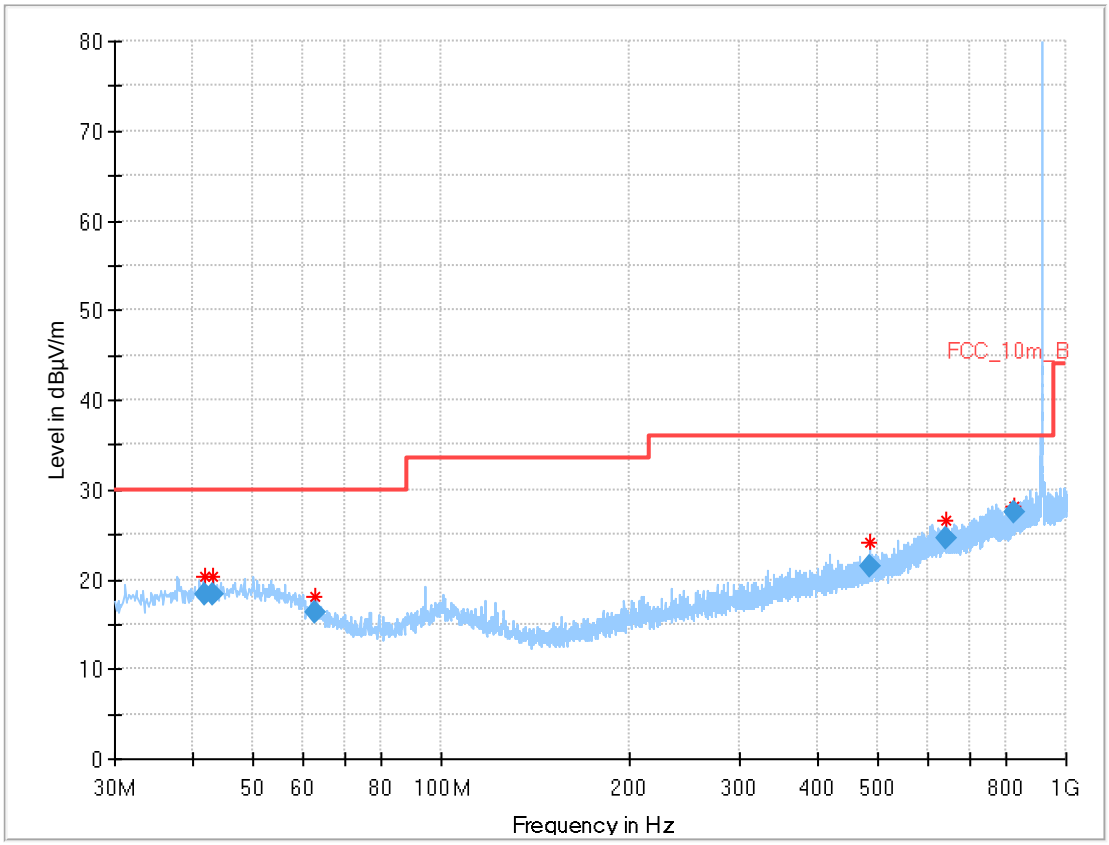
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.982 | 17.80 | --- | 30.0 | 12.20 | 1000 | 120 | 98.0 | V | 1.0 | 14 |
| 55.312 | 17.78 | --- | 30.0 | 12.22 | 1000 | 120 | 101.0 | H | 165.0 | 14 |
| 64.368 | 15.92 | --- | 30.0 | 14.08 | 1000 | 120 | 160.0 | V | 86.0 | 12 |
| 484.113 | 21.41 | --- | 36.0 | 14.59 | 1000 | 120 | 160.0 | V | 315.0 | 18 |
| 613.980 | 24.30 | --- | 36.0 | 11.70 | 1000 | 120 | 98.0 | H | 288.0 | 20 |
| 842.456 | 28.12 | --- | 36.0 | 7.88 | 1000 | 120 | 160.0 | V | 355.0 | 23 |

Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 41.772 | 18.25 | --- | 30.0 | 11.75 | 1000 | 120 | 98.0 | V | 344.0 | 15 |
| 42.925 | 18.25 | --- | 30.0 | 11.75 | 1000 | 120 | 160.0 | V | 160.0 | 15 |
| 62.659 | 16.29 | --- | 30.0 | 13.71 | 1000 | 120 | 160.0 | H | 95.0 | 12 |
| 486.140 | 21.44 | --- | 36.0 | 14.56 | 1000 | 120 | 160.0 | H | 12.0 | 18 |
| 641.526 | 24.53 | --- | 36.0 | 11.47 | 1000 | 120 | 160.0 | V | 267.0 | 21 |
| 828.377 | 27.54 | --- | 36.0 | 8.46 | 1000 | 120 | 98.0 | H | 19.0 | 23 |

## 12.10.2 Spurious emissions radiated above 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. 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 12.75 GHz |
| Trace mode | Max hold |
| Test setup | See sub clause 6.2 C (1 GHz – 12.75 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 | 3 |

**Result:**

For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205. According to FCC Public Notice DA 00-705 (ANSI C63.10) the average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor:

**F = 20*log (dwell time/100 ms)**

One pulse train is higher than 100 ms so the correction factor is 0 (see plots in chapter 12.4)

**Results with dipole antenna:**

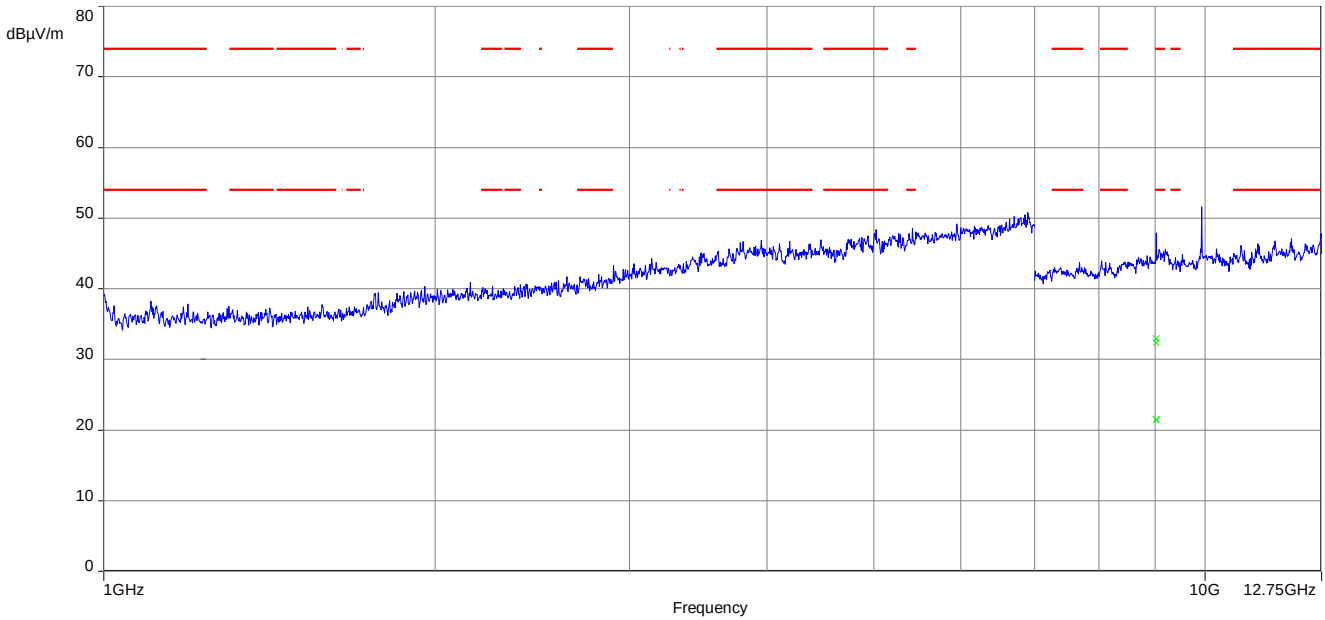
| TX spurious emissions radiated | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more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

**Results with PCB antenna:**

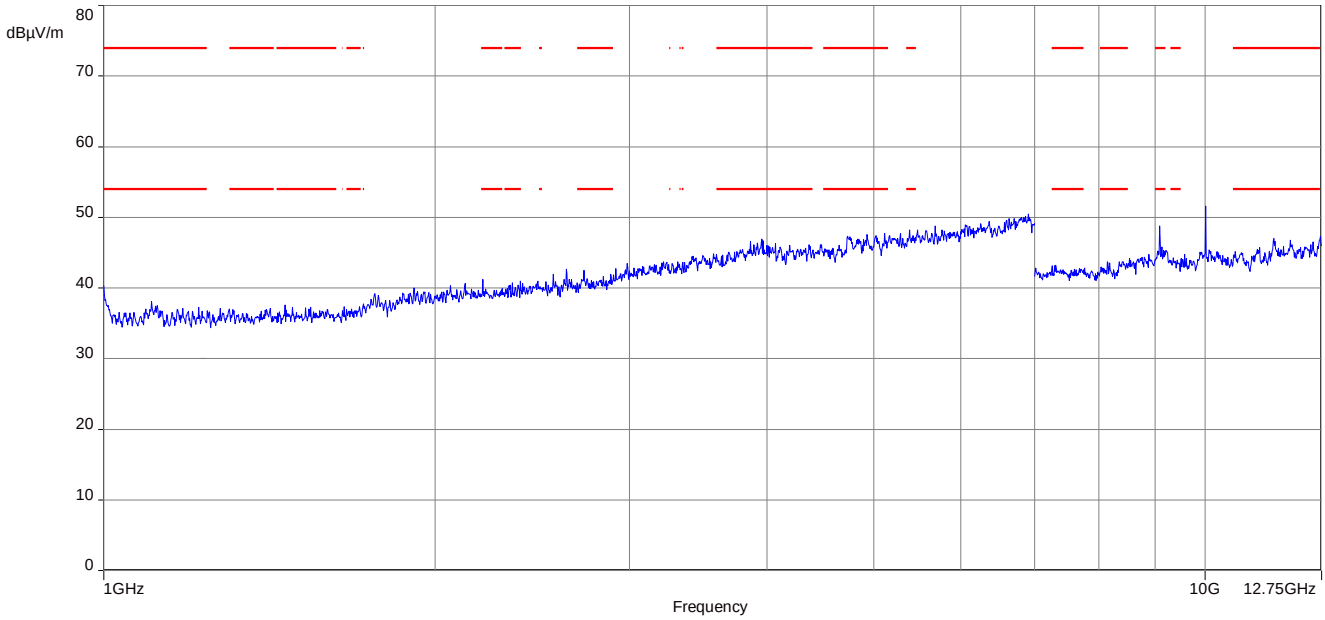
| TX spurious emissions radiated | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| 9023 | Peak | 52.0 | 9094 | Peak | 53.2 | 9142 | Peak | 54.4 |
| | AVG | 48.7 | | AVG | 50.1 | | AVG | 51.5 |

**Plots EUT with dipole antenna:**

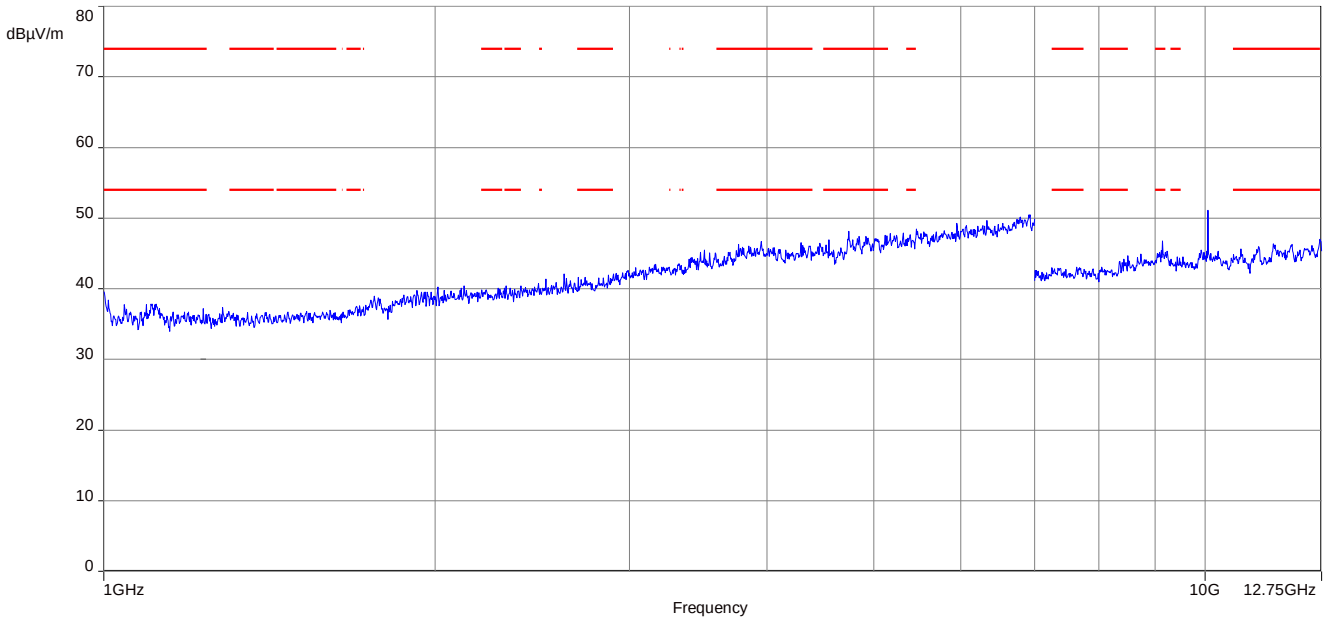
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



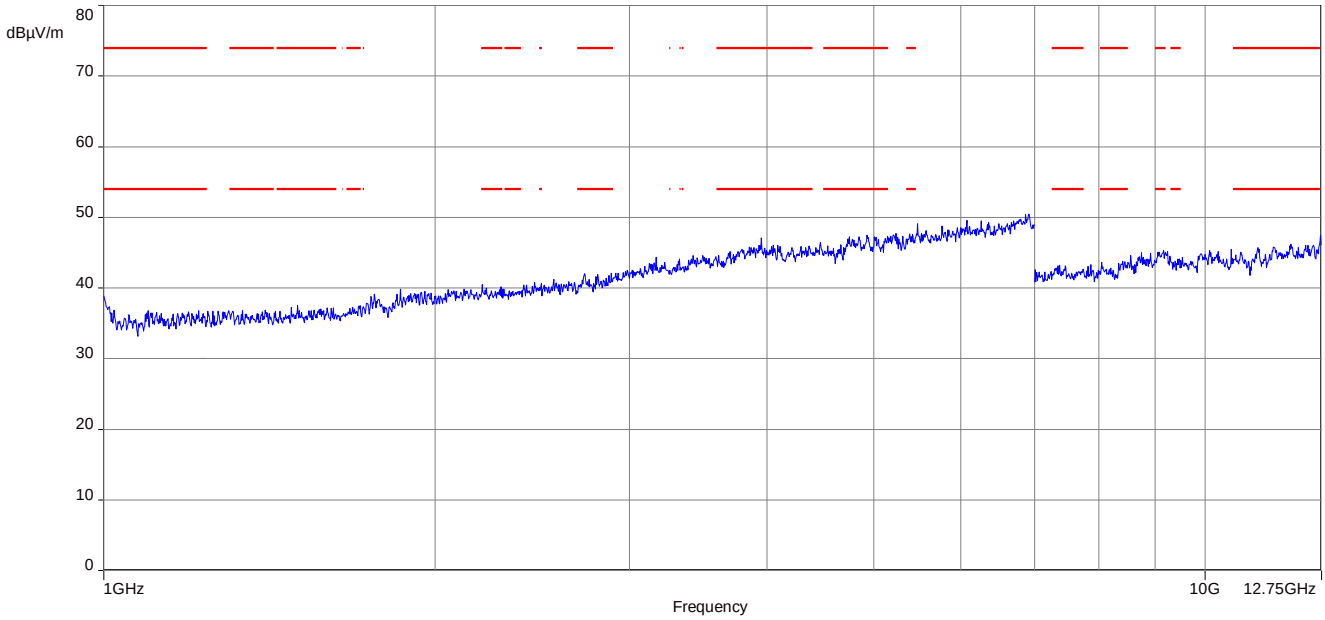

Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)

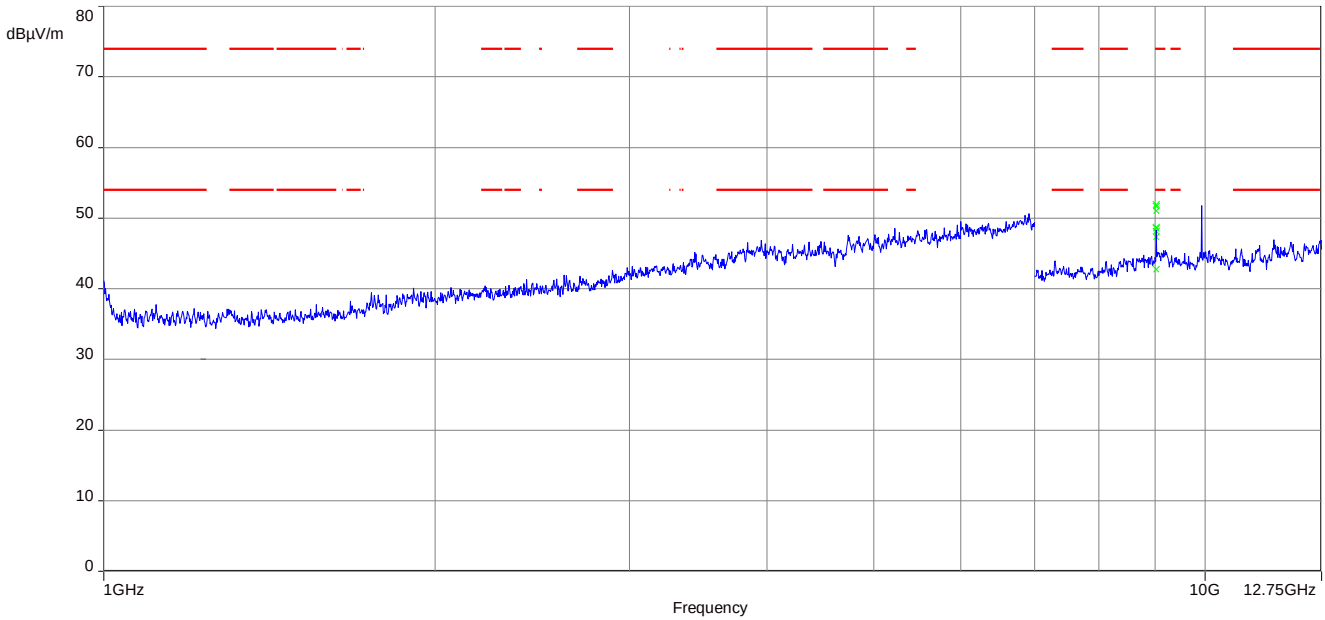



Plot 4: 1GHz – 12.75 GHz, RX-Mode, horizontal & vertical polarisation (valid for both antenna types)

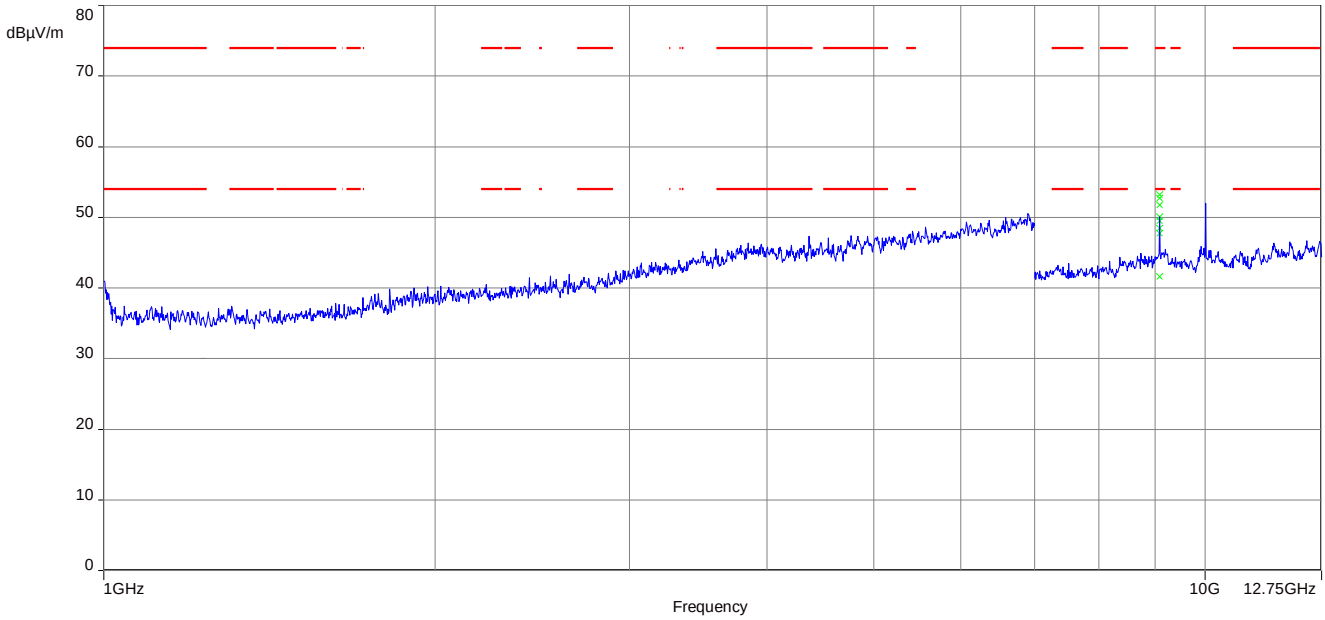


## Plots EUT with PCB antenna:

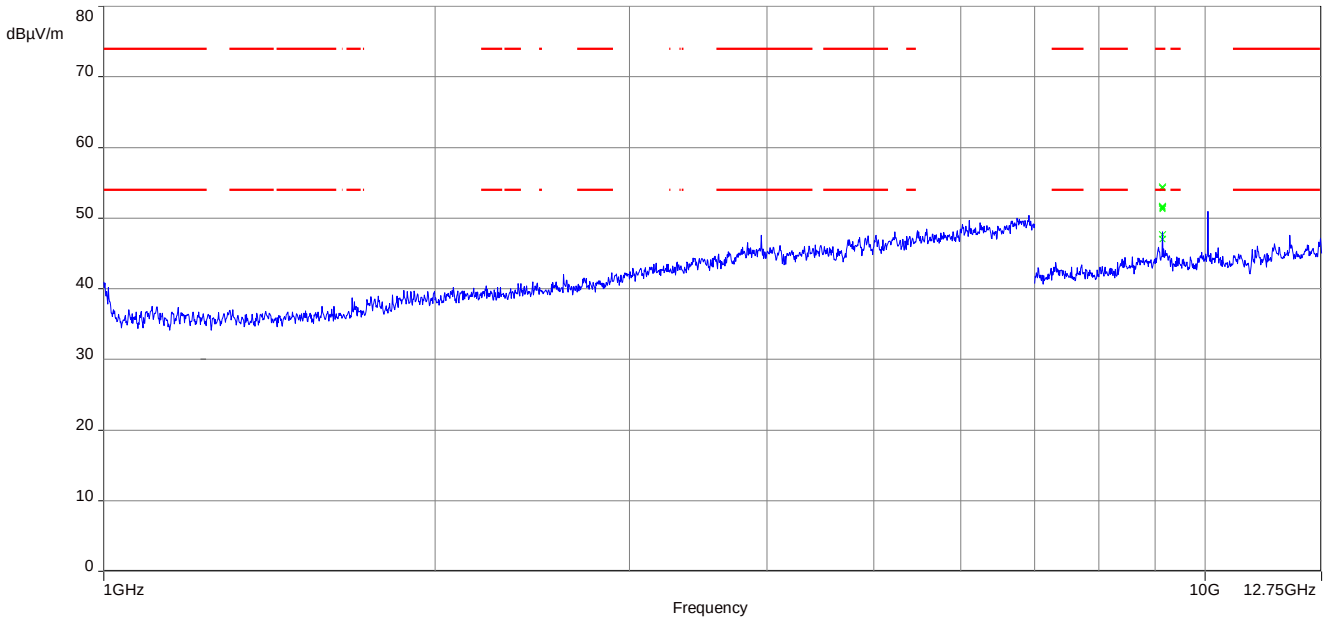
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)




Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)



# 13 Observations

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

# Annex A Glossary

| | |
|---|---|
| **EUT** | Equipment under test |
| **DUT** | Device under test |
| **UUT** | Unit under test |
| **GUE** | GNSS User Equipment |
| **ETSI** | European Telecommunications Standards Institute |
| **EN** | European Standard |
| **FCC** | Federal Communications Commission |
| **FCC ID** | Company Identifier at FCC |
| **IC** | Industry Canada |
| **PMN** | Product marketing name |
| **HMN** | Host marketing name |
| **HVIN** | Hardware version identification number |
| **FVIN** | Firmware version identification number |
| **EMC** | Electromagnetic Compatibility |
| **HW** | Hardware |
| **SW** | Software |
| **Inv. No.** | Inventory number |
| **S/N or SN** | Serial number |
| **C** | Compliant |
| **NC** | Not compliant |
| **NA** | Not applicable |
| **NP** | Not performed |
| **PP** | Positive peak |
| **QP** | Quasi peak |
| **AVG** | Average |
| **OC** | Operating channel |
| **OCW** | Operating channel bandwidth |
| **OBW** | Occupied bandwidth |
| **OOB** | Out of band |
| **DFS** | Dynamic frequency selection |
| **CAC** | Channel availability check |
| **OP** | Occupancy period |
| **NOP** | Non occupancy period |
| **DC** | Duty cycle |
| **PER** | Packet error rate |
| **CW** | Clean wave |
| **MC** | Modulated carrier |
| **WLAN** | Wireless local area network |
| **RLAN** | Radio local area network |
| **DSSS** | Dynamic sequence spread spectrum |
| **OFDM** | Orthogonal frequency division multiplexing |
| **FHSS** | Frequency hopping spread spectrum |
| **GNSS** | Global Navigation Satellite System |
| **$C/N_0$** | Carrier to noise-density ratio, expressed in dB-Hz |

## Annex B Document history

| Version | Applied changes | Date of release |
|---|---|---|
| -/- | Initial release | 2020-02-12 |
| A | PSD and timing measurements for hybrid mode added | 2020-02-18 |
| B | Updated customer information | 2020-02-18 |
| C | Updated antenna gain measurements | 2020-02-20 |
| D | Hybrid Mode added, FHSS mode removed, editorial changes | 2020-03-27 |
| E | Several plots and measurement results replaced | 2020-04-02 |

## Annex C Accreditation Certificate – D-PL-12076-01-04

| first page | last page |
|---|---|
| DAkkS Deutsche Akkreditierungsstelle<br>Deutsche Akkreditierungsstelle GmbH<br>**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<br>**Accreditation**<br>The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory<br>**CTC advanced GmbH**<br>**Untertürkheimer Straße 6-10, 66117 Saarbrücken**<br>is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:<br>**Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards**<br>The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 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 7 pages.<br>Registration number of the certificate: **D-PL-12076-01-04**<br>Frankfurt am Main, 11.01.2019<br>Dipl.-Biol. Uwe Zimmermann<br>Head of Division<br>See notes overleaf. | Deutsche Akkreditierungsstelle GmbH<br>Office Berlin<br>Spittelmarkt 10<br>10117 Berlin<br>Office Frankfurt am Main<br>Europa-Allee 52<br>60327 Frankfurt am Main<br>Office Braunschweig<br>Bundesallee 100<br>38116 Braunschweig<br>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.<br>No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS.<br>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.<br>The up-to-date state of membership can be retrieved from the following websites:<br>EA: www.european-accreditation.org<br>ILAC: www.ilac.org<br>IAF: www.iaf.nu |

**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**

https://www.dakks.de/as/ast/d/D-PL-12076-01-04.pdf

## Annex D Accreditation Certificate – D-PL-12076-01-05

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| DAkkS Deutsche Akkreditierungsstelle<br><br>Deutsche Akkreditierungsstelle GmbH<br><br>**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<br><br>**Accreditation**<br><br>The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory<br><br>**CTC advanced GmbH**<br>**Untertürkheimer Straße 6-10, 66117 Saarbrücken**<br><br>is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:<br><br>**Telecommunication (FCC Requirements)**<br><br>The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 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 5 pages.<br><br>Registration number of the certificate: **D-PL-12076-01-05**<br><br>Frankfurt am Main, 11.01.2019<br>Dipl.-Biol. Uwe Zimmermann<br>Head of Division<br><br>See notes overleaf. | Deutsche Akkreditierungsstelle GmbH<br><br>Office Berlin<br>Spittelmarkt 10<br>10117 Berlin<br><br>Office Frankfurt am Main<br>Europa-Allee 52<br>60327 Frankfurt am Main<br><br>Office Braunschweig<br>Bundesallee 100<br>38116 Braunschweig<br><br>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.<br><br>No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS.<br><br>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.<br><br>The up-to-date state of membership can be retrieved from the following websites:<br>EA: www.european-accreditation.org<br>ILAC: www.ilac.org<br>IAF: www.iaf.nu |

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