Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-4616/17-02-02-A**

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

## Testing laboratory

**CTC advanced GmbH**
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: http://www.ctcadvanced.com
e-mail: mail@ctcadvanced.com

**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

**ifm electronic gmbh**
Friedrichsstraße 1
45128 Essen / GERMANY
Phone: +49 201 2422-0
Fax: +49 7542 518-561761
Contact: Christoph Ehrhart
e-mail: Christoph.Ehrhart@ifm.com
Phone: +49 7542 518-1761

## Manufacturer

**ifm electronic gmbh**
Friedrichsstraße 1
45128 Essen / GERMANY

## Test standard/s

| | |
|---|---|
| 47 CFR Part 15 | Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 210 Issue 9 | Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment |

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

## Test Item

| | |
|---|---|
| **Kind of test item:** | **13.56 MHz RFID Reader** |
| **Model name:** | **ANT420 / ANT421** |
| **FCC ID:** | **UN6-DTRHFGB** |
| **IC:** | **6799A-DTRHFGB** |
| Frequency: | 13.56 MHz |
| Technology tested: | RFID |
| Antenna: | Integrated antenna |
| Power supply: | 24 V DC by external power supply |
| Temperature range: | -20°C to 50°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:

cn=Christoph Schneider, o=CTC advanced GmbH, ou=SND-161128, email=Christoph.Schneider@ctcadvanced.com, c=DE
2018.06.21 08:23:25 +02'00'

Christoph Schneider
Lab Manager
Radio Communications & EMC

## Test performed:

p.o.

cn=Marco Bertolino, o=CTC advanced GmbH, ou=BTL-161128, email=Marco.Bertolino@ctcadvanced.com, c=DE
2018.06.21 08:40:14 +02'00'

Tobias Wittenmeier
Testing Manager
Radio Communications & EMC

# 1 Table of contents

# 2 General information

## 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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**This test report replaces the test report with the number 1-4616/17-02-02 and dated 2018-06-06.**

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2018-01-24 |
| Date of receipt of test item: | 2018-02-06 |
| Start of test: | 2018-02-08 |
| End of test: | 2018-05-25 |
| Person(s) present during the test: | -/- |

## 2.3 Test laboratories sub-contracted

None

# 3 Test standard/s and references

| Test standard | Date | Description |
|---|---|---|
| 47 CFR Part 15 | | Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 210 Issue 9 | August 2016 | Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment |
| RSS - Gen Issue 5 | April 2018 | General Requirements for Compliance of Radio |

| Guidance | Version | Description |
|---|---|---|
| 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>+50 °C during high temperature tests<br>-20 °C during low temperature tests |
| Relative humidity content | : | | 58 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | $V_{nom}$<br>$V_{max}$<br>$V_{min}$ | 24.0 V DC by power supply<br>28.8 V<br>19.2 V |

# 5 Test item

## 5.1 General description

| | | |
|---|---|---|
| Kind of test item | : | 13.56 MHz RFID Reader |
| Type identification | : | ANT420 / ANT421 |
| HMN | : | -/- |
| PMN | : | ANT420 / ANT421 |
| HVIN | : | ANT420 / ANT421 |
| FVIN | : | -/- |
| S/N serial number | : | Prototype |
| HW hardware status | : | -/- |
| SW software status | : | -/- |
| Frequency band | : | 13.56 MHz |
| Type of modulation | : | ASK |
| Number of channels | : | 1 |
| Antenna | : | Integrated antenna |
| Power supply | : | 24.0 V DC by power supply |
| Temperature range | : | -20°C to +50°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: 1-4616/17-02-01_AnnexA
1-4616/17-02-01_AnnexB
1-4616/17-02-01_AnnexC

# 6 Description of the test setup

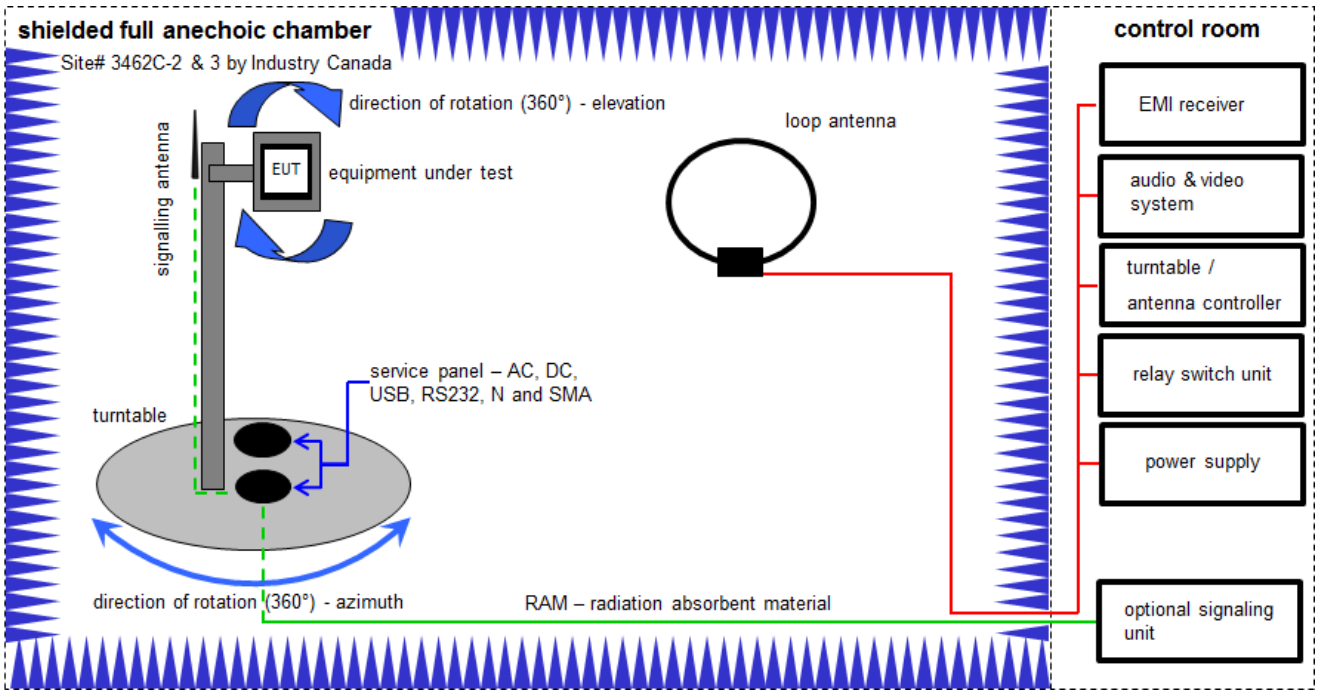
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements 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 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)

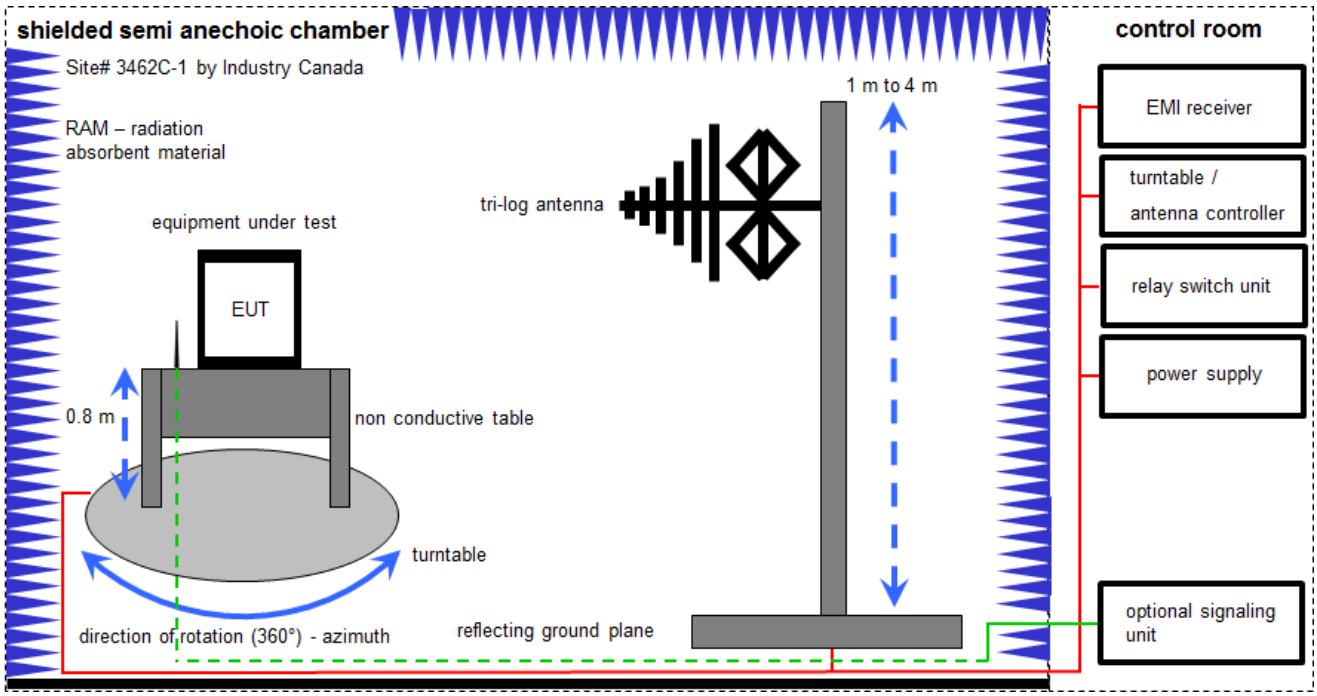
*Example calculation:*
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | k | 07.07.2017 | 06.07.2019 |
| 2 | A, B | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 3 | A, B | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | -/- | -/- |
| 4 | A, B | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 20.12.2017 | 19.12.2018 |
| 5 | B | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22049 | 300004481 | ev | -/- | -/- |
| 6 | A, B | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000037 | 300004509 | ne | -/- | -/- |
| 7 | A, B | NEXIO EMV-Software | BAT EMC V3.16.0.49 | EMCO | | 300004682 | ne | -/- | -/- |
| 8 | A, B | PC | ExOne | F+W | | 300004703 | ne | -/- | -/- |

## 6.2 Shielded semi anechoic chamber

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



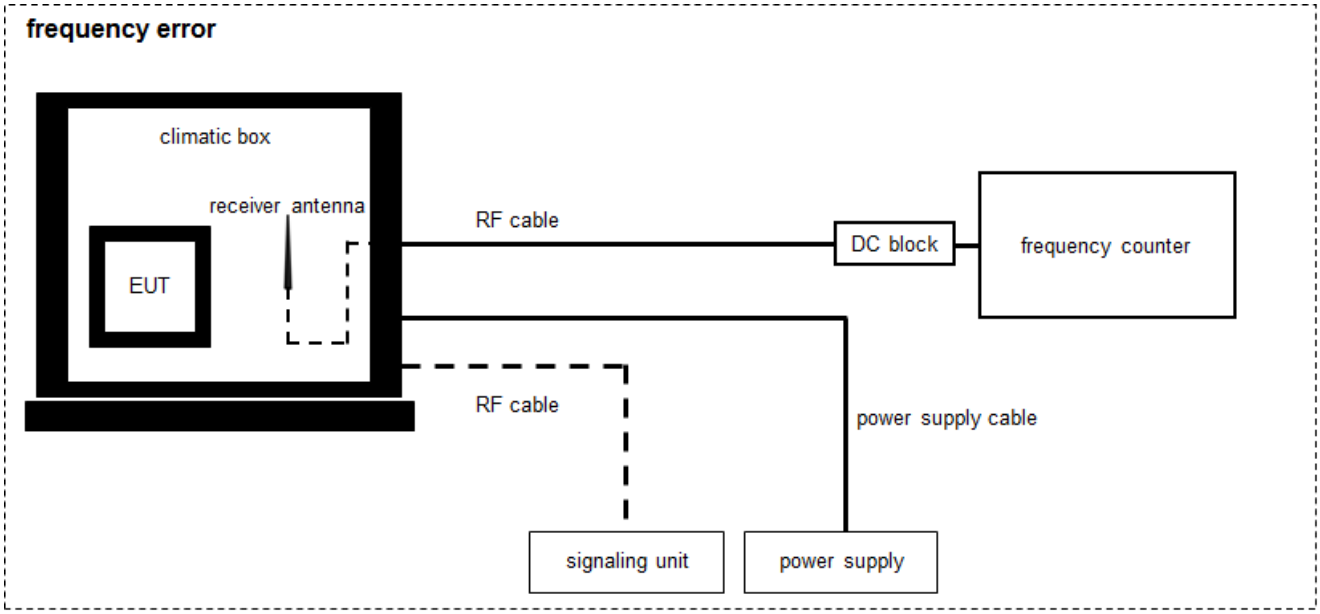

Measurement distance: tri-log antenna 10 meter

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

*Example calculation:*
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 9 | A, B | Semi Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 10 | A, B | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | -/- | -/- |
| 11 | A, B | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 20.12.2017 | 19.12.2018 |
| 12 | B | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22049 | 300004481 | ev | -/- | -/- |
| 13 | A, B | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000037 | 300004509 | ne | -/- | -/- |
| 14 | A, B | NEXIO EMV-Software | BAT EMC V3.16.0.49 | EMCO | | 300004682 | ne | -/- | -/- |
| 15 | A, B | PC | ExOne | F+W | | 300004703 | ne | -/- | -/- |
| 16 | B | TRILOG Broadband Test-Antenna | VULB9163 | Schwarzbeck Mess Elektronik | 01029 | 300005379 | k | 07.04.2017 | 06.04.2020 |

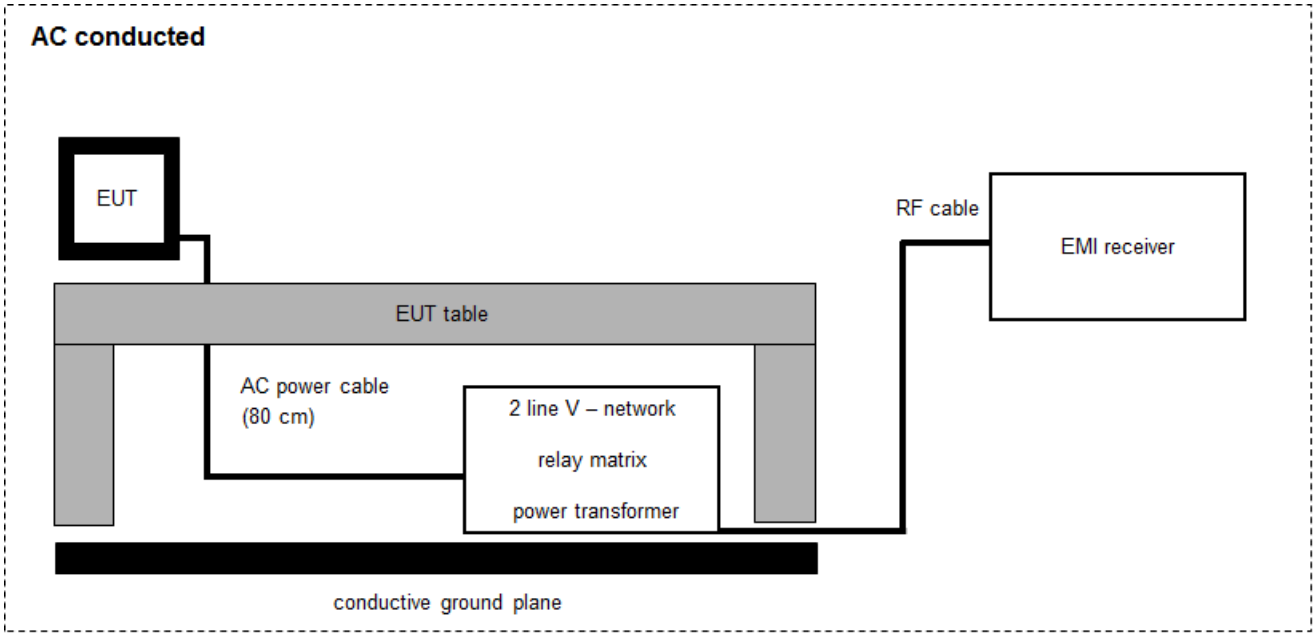
## 6.3 Frequency error




**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Signal- and Spectrum Analyzer | FSW26 | R&S | 101455 | 300004528 | k | 20.12.2017 | 19.12.2018 |
| 2 | A | Loop Antenna | | ZEG TS Steinfurt | | 400001208 | ev | -/- | -/- |
| 3 | A | RF Cable BNC | RG58 | Huber & Suhner | | 400001209 | ev | -/- | -/- |
| 4 | A | Climatic Box | VT 4011 | Voetsch Industrietechnik | 5856623060001 0 | 300005363 | ev | 01.06.2017 | 31.05.2019 |

## 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 | 893045/004 | 300000584 | k | 13.12.2017 | 12.12.2018 |
| 2 | A | RF-Filter-section | 85420E | HP | 3427A00162 | 300002214 | k | 27.11.2006 | -/- |
| 3 | A | EM-Injection Clamp | FCC-203i | emv | 232 | 300000626 | ev | 18.05.2001 | -/- |
| 4 | A | Magnetfeldantenne | MS 100 | EM-Test | ----- | 300002659 | ev | 24.04.2000 | -/- |
| 5 | A | AC-Spannungsquelle variabel | MV2616-V | EM-Test | 0397-12 | 300003259 | vlKl! | 18.12.2017 | 17.12.2019 |
| 6 | A | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | vlKl! | 15.01.2018 | 14.01.2020 |
| 7 | A | Hochpass 150 kHz | EZ-25 | R&S | 100010 | 300003798 | ev | 08.04.2008 | -/- |
| 8 | A | Power Supply | NGSM 32/10 | R&S | 3939 | 400000192 | vlKl! | 31.01.2017 | 30.01.2020 |
| 9 | A | MXE EMI Receiver 20 Hz to 26,5 GHz | N9038A | Agilent Technologies | MY51210197 | 300004405 | k | 18.12.2017 | 17.12.2018 |

# 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.

# 8 Measurement uncertainty

| Measurement uncertainty | |
|---|---|
| **Test case** | **Uncertainty** |
| Occupied bandwidth | ± used RBW |
| Field strength of the fundamental | ± 3 dB |
| Field strength of the harmonics and spurious | ± 3 dB |
| Receiver spurious emissions and cabinet radiations | ± 3 dB |
| Conducted limits | ± 2.6 dB |

## 9 Summary of measurement results

| | |
|---|---|
| ☒ | No deviations from the technical specifications were ascertained |
| ☐ | There were deviations from the technical specifications ascertained |
| ☐ | This test report is only a partial test report. The content and verdict of the performed test cases are listed below. |

| TC Identifier | Description | Verdict | Date | Remark |
|---|---|---|---|---|
| RF-Testing | CFR Part 15<br>RSS 210 Issue 9<br>RSS Gen Issue 5 | See table! | 2018-06-21 | -/- |

| Test specification clause | Test case | Temperature conditions | Power source conditions | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|
| RSS Gen Issue 5 | Occupied bandwidth | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| | | | | | | | | |
| § 15.225 (a) RSS 210 Issue 9 | Field strength of the fundamental | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| | | | | | | | | |
| § 15.209 & § 15.225 (b-d) | Field strength of the harmonics and spurious | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| | | | | | | | | |
| § 15.109 | Receiver spurious emissions and cabinet radiations | Nominal | Nominal | ☐ | ☐ | ☒ | ☐ | -/- |
| | | | | | | | | |
| §15.107 §15.207 | Conducted limits | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| | | | | | | | | |
| § 15.225 (a) RSS 210 Issue 9 | Frequency tolerance | Normal & extreme conditions | Normal & extreme conditions | ☒ | ☐ | ☐ | ☐ | -/- |
| | | | | | | | | |

**Note:**

| | |
|---|---|
| C | Compliant |
| NC | Not compliant |
| NA | Not applicable |
| NP | Not performed |

## 10 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

# 11 Measurement results

## 11.1 Occupied bandwidth

**Measurement:**

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

| Measurement parameters | |
|---|---|
| Detector: | Peak |
| Resolution bandwidth: | 1 % – 5 % of the occupied bandwidth |
| Video bandwidth: | ≥ 3x RBW |
| Trace mode: | Max hold |
| Analyser function: | 99 % power function |
| Used equipment: | See chapter 6.3 |
| Measurement uncertainty: | See chapter 8 |

**Limit:**

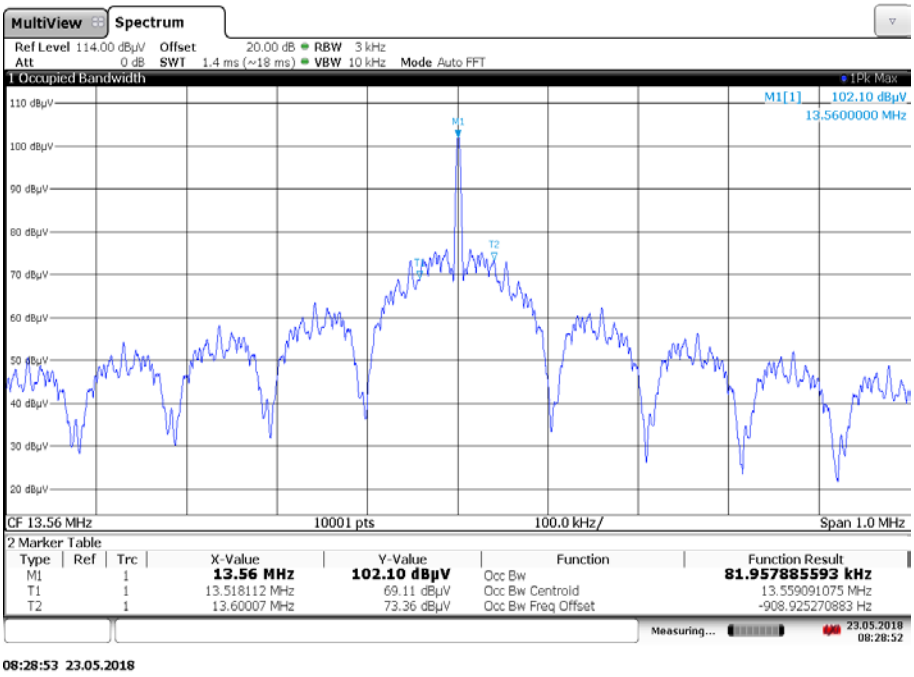
| IC |
|---|
| for RSP-100 test report coversheet only |

**Result:**

| 99% emission bandwidth | |
|---|---|
| ANT20 | 81.95 kHz |
| ANT21 | 80.60 kHz |

**Plot:**

**Plot 1:** ANT420, 99 % emission bandwidth

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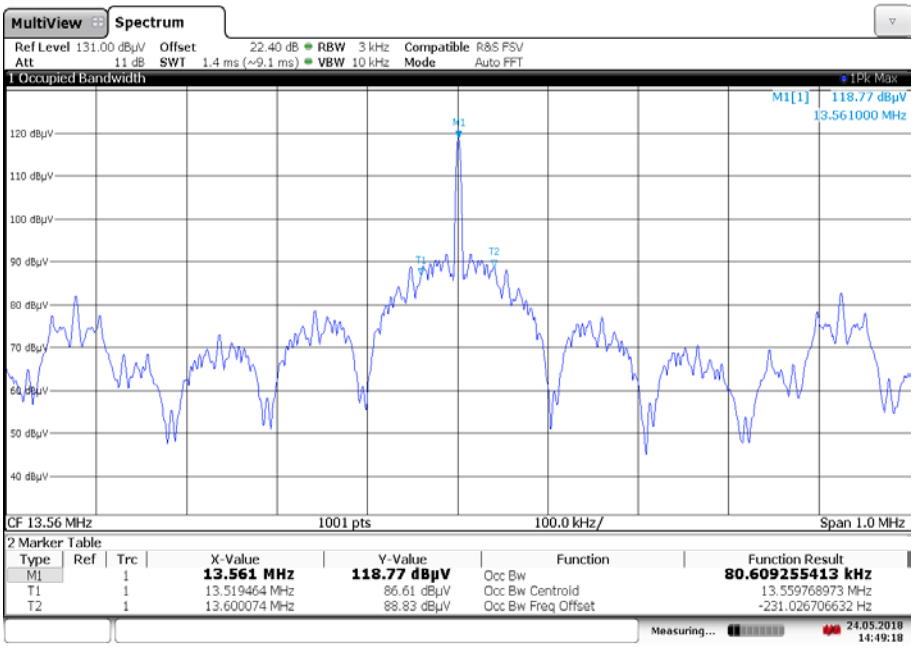
**Plot 2:** ANT421, 99 % emission bandwidth

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## 11.2 Field strength of the fundamental

**Measurement:**

The maximum detected field strength for the carrier signal.

| Measurement parameters | |
|---|---|
| Detector: | Quasi peak / peak (worst case) |
| Resolution bandwidth: | 120 kHz |
| Video bandwidth: | ≥ 3x RBW |
| Trace mode: | Max hold |
| Used equipment: | See chapter 6.2 |
| Measurement uncertainty: | See chapter 8 |

**Limit:**

| FCC & IC | | |
|---|---|---|
| Frequency (MHz) | Field strength (µV/m) | Measurement distance (m) |
| 13.553 to 13.567 | 15,848 (84 dBµV/m) | 30 |

**Recalculation:**

| According to ANSI C63.10 | | |
|---|---|---|
| Frequency | Formula | Correction value |
| 13.56 MHz | $FS_{limit} = FS_{max} - 40\log\left(\frac{d_{nearfield}}{d_{measure}}\right) - 20\log\left(\frac{d_{limit}}{d_{nearfield}}\right)$<br>$FS_{limit}$ is the calculation of field strength at the limit distance, expressed in dBµV/m<br>$FS_{max}$ is the measured field strength, expressed in dBµV/m<br>$d_{near\ field}$ is the λ/2π distance<br>$d_{measure}$ is the distance of the measurement point from EUT<br>$d_{limit}$ is the reference limit distance | -21.4 from 3m to 30m |

**Result:**

| Field strength of the fundamental | | |
|---|---|---|
| Frequency | 13.56 MHz | |
| Distance | @ 3 m | @ 30 m |
| ANT420 | 58.58 dBµV/m | 37.18 dBµV/m |
| ANT421 | 62.11 dBµV/m | 40.71 dBµV/m |

## 11.3 Field strength of the harmonics and spurious

**Measurement:**

The maximum detected field strength for the harmonics and spurious.

| Measurement parameters | |
|---|---|
| Detector: | Quasi peak / average or<br>peak (worst case – pre-scan) |
| Resolution bandwidth: | F < 150 kHz: 200 Hz<br>150 kHz < F < 30 MHz: 9 kHz<br>30 MHz < F < 1 GHz: 120 kHz |
| Video bandwidth: | F < 150 kHz: 1 kHz<br>150 kHz < F < 30 MHz: 100 kHz<br>30 MHz < F < 1 GHz: 300 kHz |
| Trace mode: | Max hold |
| Used equipment: | See chapter 6.1, 6.3 |
| Measurement uncertainty: | See chapter 8 |

**Limit:**

| FCC & IC | | |
|---|---|---|
| Frequency<br>(MHz) | Field strength<br>(dBµV/m) | Measurement distance<br>(m) |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 (29.5 dBµV/m) | 30 |
| 30 – 88 | 100 (40 dBµV/m) | 3 |
| 88 – 216 | 150 (43.5 dBµV/m) | 3 |
| 216 – 960 | 200 (46 dBµV/m) | 3 |

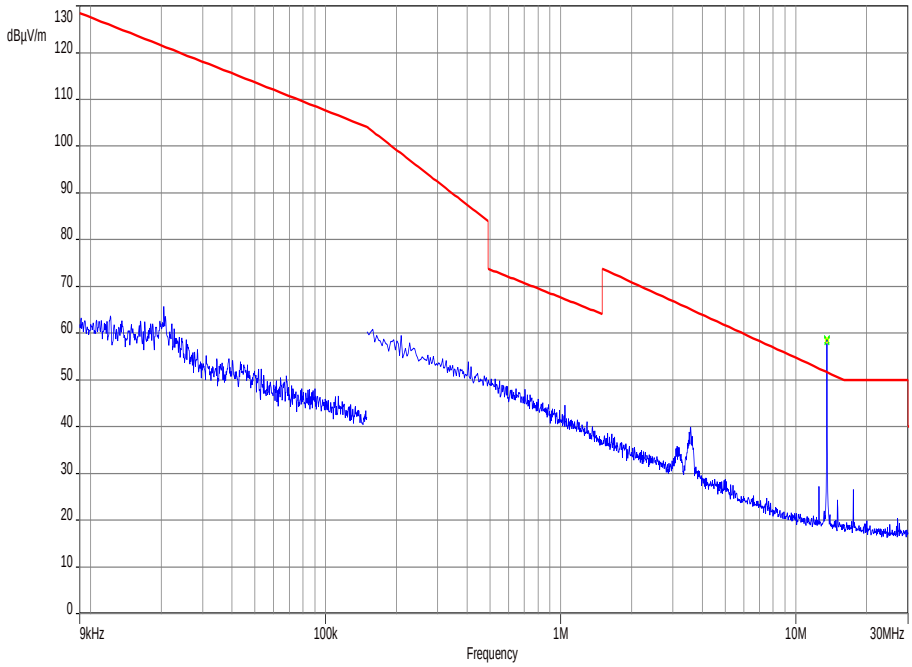
**Note:** For a reduced measurement distance, please take a look at the limit line and the ANSI C63.10-2013 sub clause 6.4 radiated emissions from unlicensed wireless devices below 30 MHz.

**Result:**

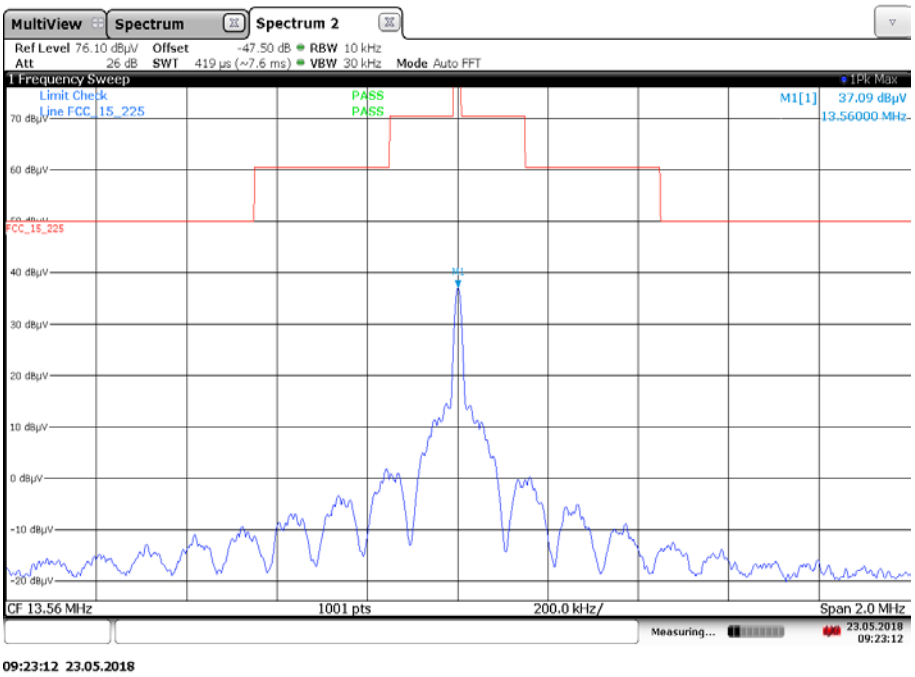
| Detected emissions | | | |
|---|---|---|---|
| Frequency<br>(MHz) | Detector | Resolution bandwidth<br>(kHz) | Detected value<br>(dBµV/m @ 3m) |
| | | | |
| No peak closer 10 dB to the limit detected | | | |

**Plots: ANT420**

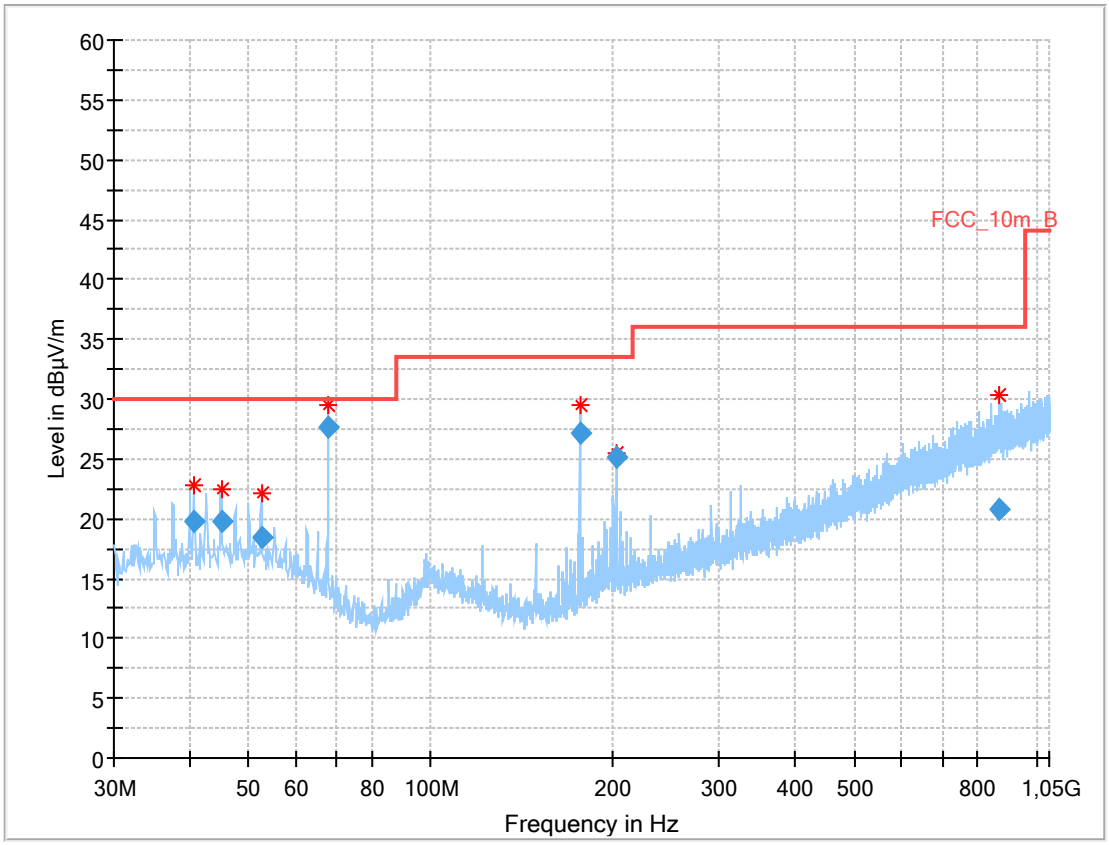
**Plot 1:** 9 kHz – 30 MHz, magnetic emissions




**Plot 2:** Spectrum mask (the limits are recalculated according to the ANSI C63.10-2013 sub clause 6.4)



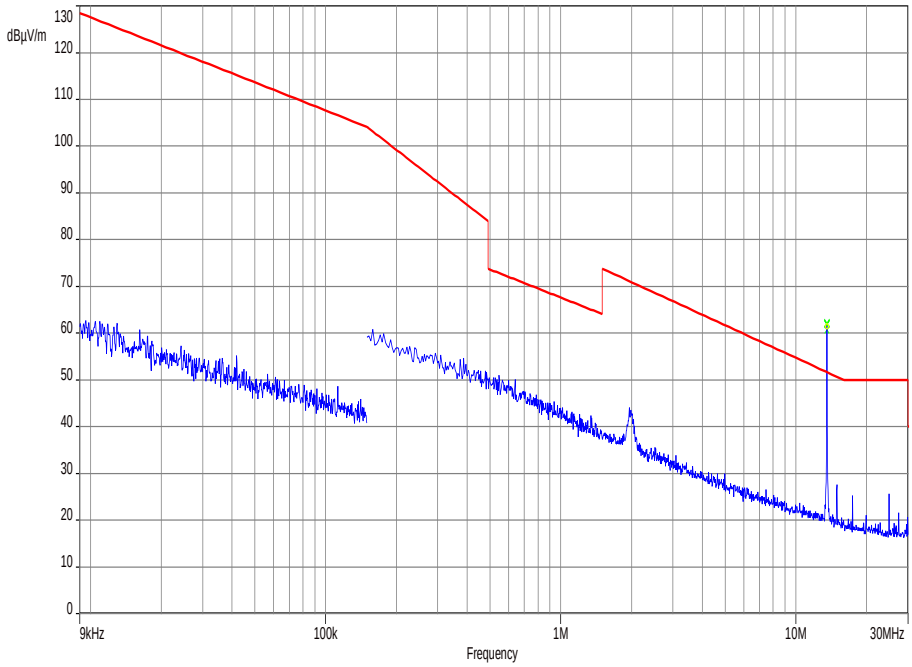
**Plot 3:** 30 MHz – 1 GHz, vertical and horizontal polarization



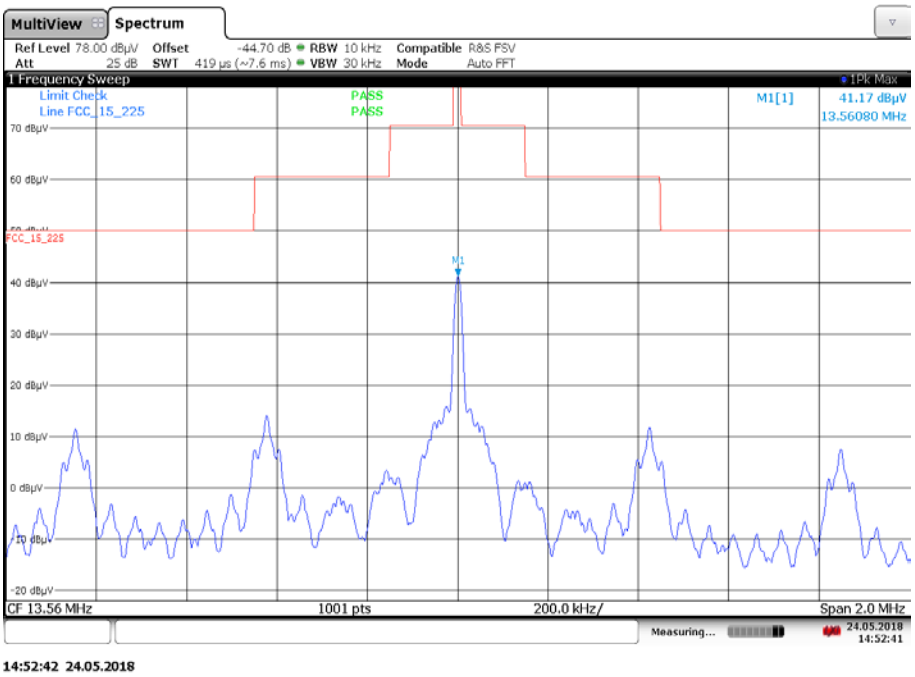

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 40.675 | 19.71 | 30.0 | 10.29 | 1000 | 120 | 100.0 | V | -6.0 | 13.3 |
| 45.296 | 19.71 | 30.0 | 10.29 | 1000 | 120 | 100.0 | V | 150.0 | 13.6 |
| 52.874 | 18.40 | 30.0 | 11.60 | 1000 | 120 | 100.0 | V | 166.0 | 13.4 |
| 67.800 | 27.60 | 30.0 | 2.40 | 1000 | 120 | 100.0 | V | 323.0 | 10.2 |
| 176.279 | 27.22 | 33.5 | 6.28 | 1000 | 120 | 100.0 | V | 210.0 | 10.7 |
| 203.408 | 25.07 | 33.5 | 8.43 | 1000 | 120 | 100.0 | V | 174.0 | 12.0 |
| 869.285 | 20.76 | 36.0 | 15.24 | 1000 | 120 | 200.0 | H | 84.0 | 23.8 |

**Plots: ANT421**

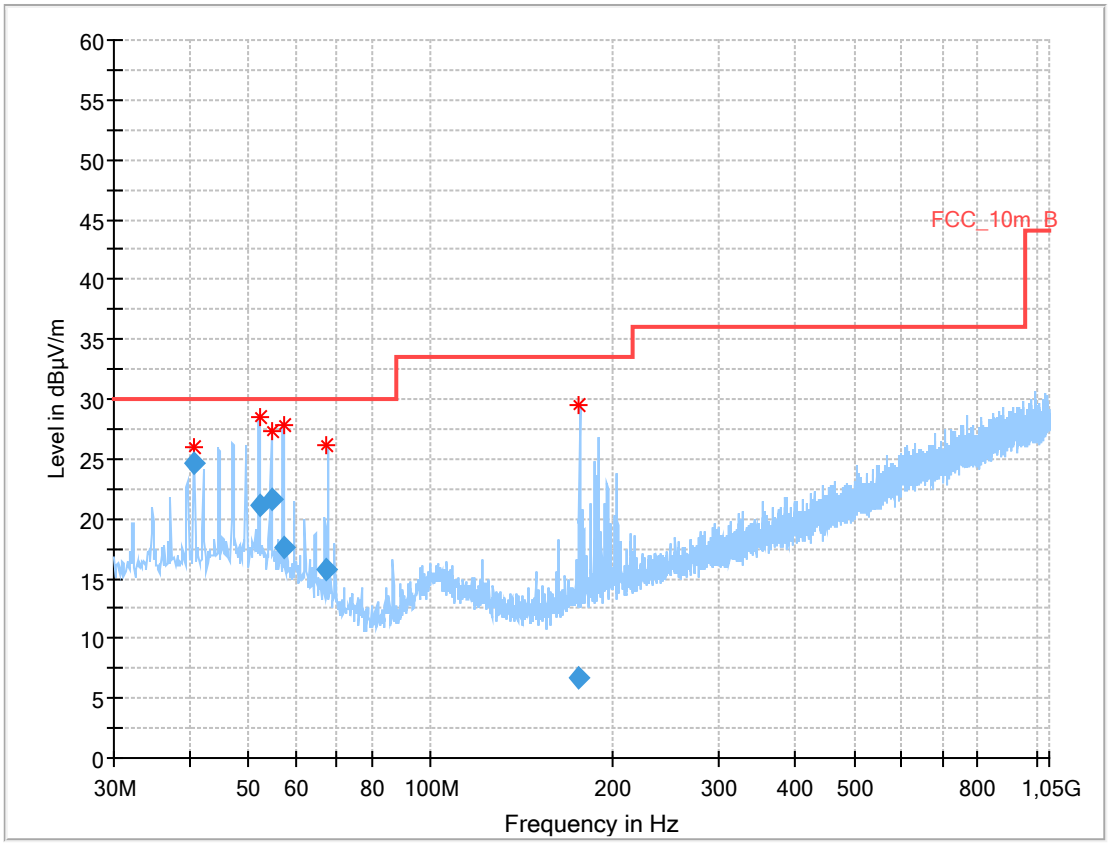
**Plot 1:** 9 kHz – 30 MHz, magnetic emissions




**Plot 2:** Spectrum mask (the limits are recalculated according to the ANSI C63.10-2013 sub clause 6.4)



**Plot 3:** 30 MHz – 1 GHz, vertical and horizontal polarization




| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 40.674 | 24.58 | 30.0 | 5.42 | 1000 | 120 | 100.0 | V | 60.0 | 13.3 |
| 52.244 | 21.17 | 30.0 | 8.83 | 1000 | 120 | 100.0 | V | 211.0 | 13.4 |
| 54.719 | 21.58 | 30.0 | 8.42 | 1000 | 120 | 100.0 | V | 233.0 | 13.1 |
| 57.206 | 17.61 | 30.0 | 12.39 | 1000 | 120 | 100.0 | V | 120.0 | 12.5 |
| 67.143 | 15.83 | 30.0 | 14.17 | 1000 | 120 | 100.0 | V | 188.0 | 10.3 |
| 175.736 | 6.75 | 33.5 | 26.75 | 1000 | 120 | 100.0 | V | 218.0 | 10.6 |

## 11.4 Conducted limits

**Measurement:**

Measurement of the conducted spurious emissions for an intentional radiator that is designed to be connected to the public utility (AC) power line.

| Measurement parameters | |
|---|---|
| Detector: | Quasi peak / average or<br>peak (worst case – pre-scan) |
| 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 |
| Trace mode: | Max hold |
| Used equipment: | See chapter 6.4 A |
| Measurement uncertainty: | See chapter 8 |

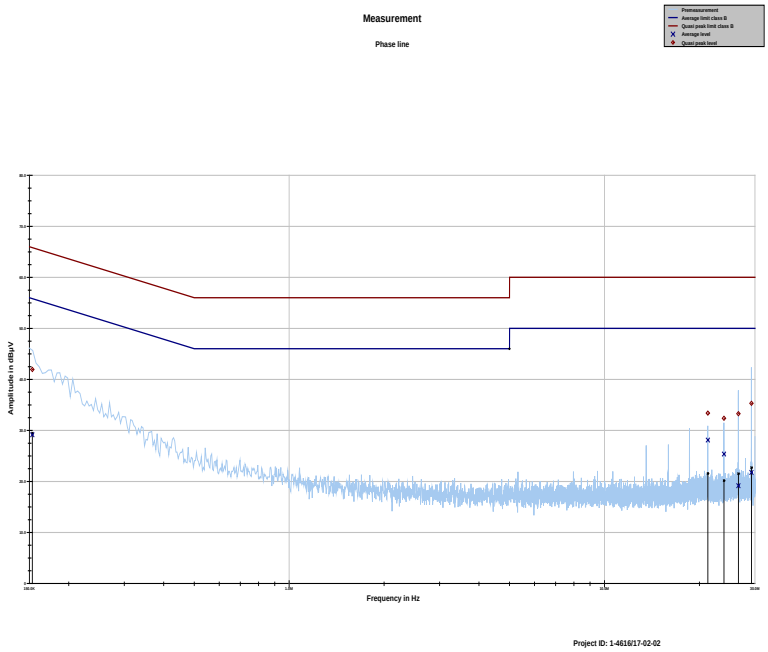
**Limit:**

| FCC & IC | | |
|---|---|---|
| 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 |

**Result:** See table below the plots!

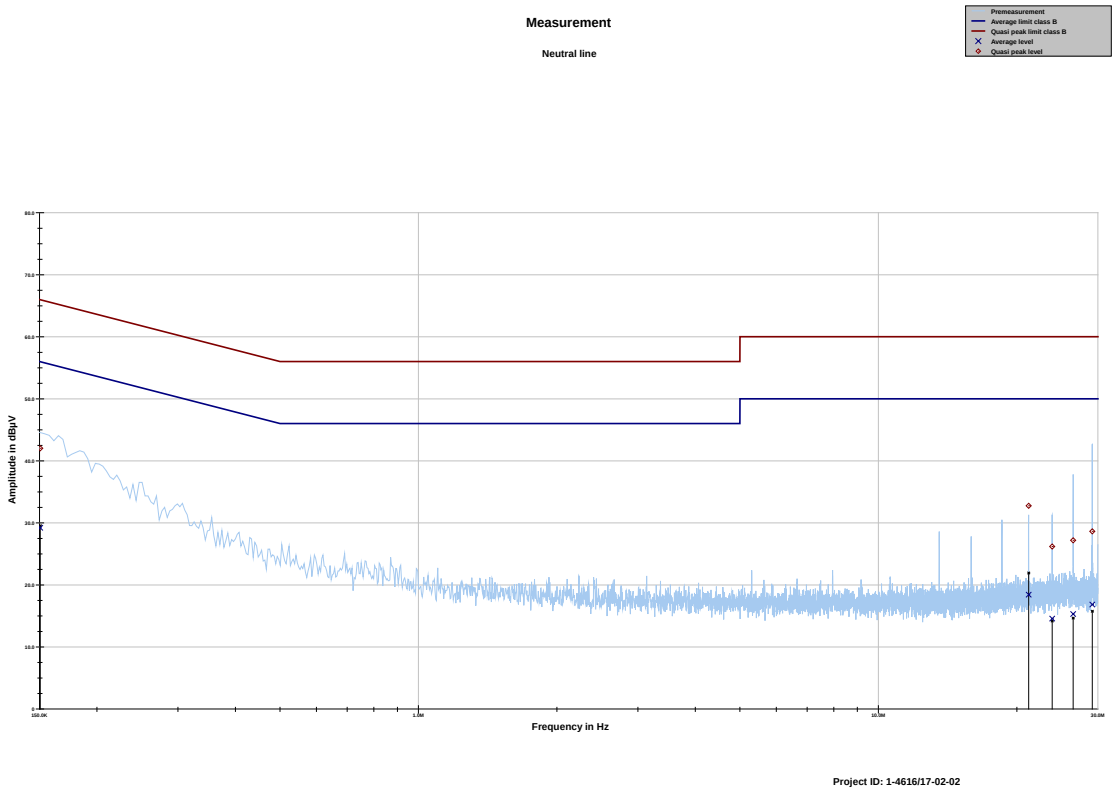
## Plots: ANT420

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




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| 0.153257 | 41.94 | 23.88 | 65.822 | 29.14 | 26.77 | 55.907 |
| 21.271246 | 33.38 | 26.62 | 60 | 28.1 | 21.9 | 50 |
| 23.931529 | 32.37 | 27.63 | 60 | 25.36 | 24.64 | 50 |
| 26.588029 | 33.27 | 26.73 | 60 | 19.16 | 30.84 | 50 |
| 29.247865 | 35.31 | 24.69 | 60 | 21.75 | 28.25 | 50 |

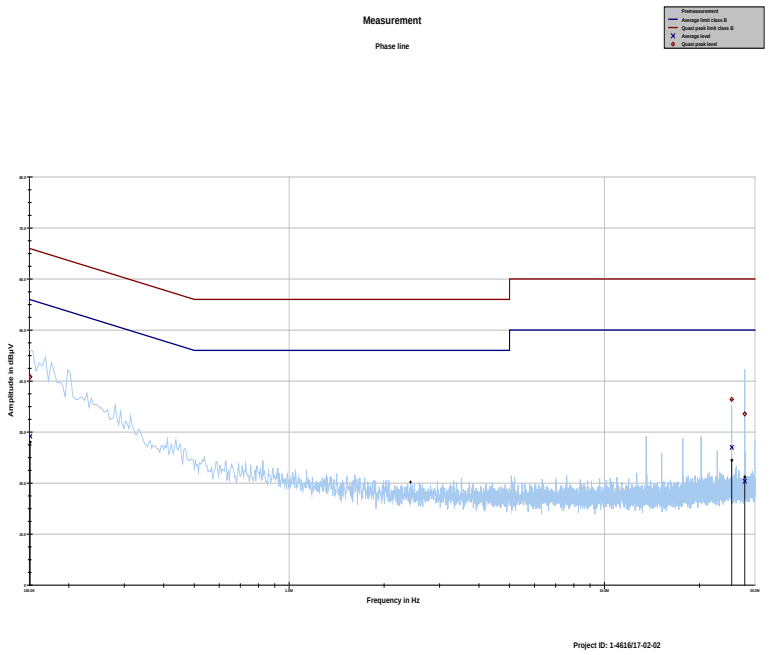
**Plot 2:** 150 kHz to 30 MHz, neutral line




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| 0.150611 | 42.02 | 23.95 | 65.966 | 29.2 | 26.78 | 55.983 |
| 21.224823 | 32.74 | 27.26 | 60 | 18.41 | 31.59 | 50 |
| 23.874256 | 26.19 | 33.81 | 60 | 14.57 | 35.43 | 50 |
| 26.51892 | 27.18 | 32.82 | 60 | 15.31 | 34.69 | 50 |
| 29.178187 | 28.63 | 31.37 | 60 | 16.84 | 33.16 | 50 |

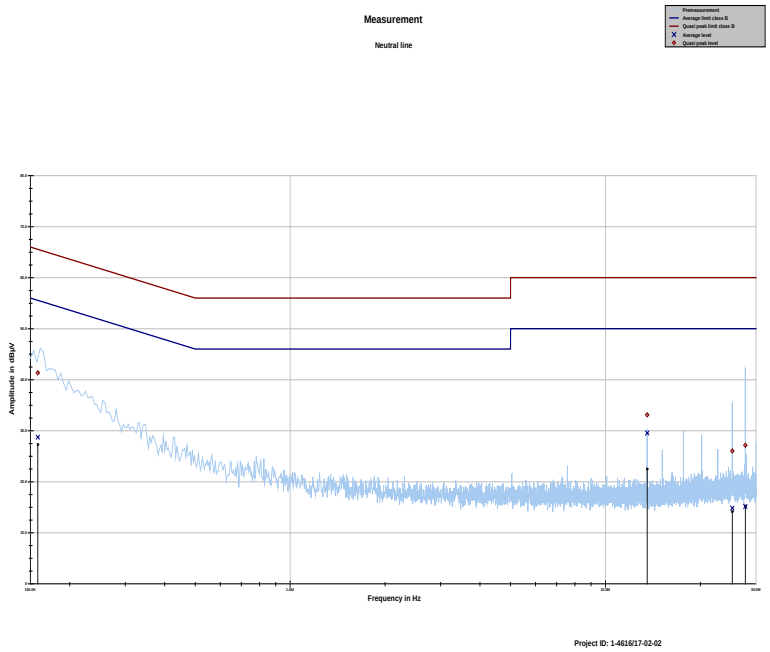
## Plots: ANT421

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




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| 0.150877 | 40.84 | 25.11 | 65.952 | 29.19 | 26.78 | 55.975 |
| 25.325913 | 36.41 | 23.59 | 60 | 27.01 | 22.99 | 50 |
| 27.855371 | 33.57 | 26.43 | 60 | 20.37 | 29.63 | 50 |

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




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| 0.158344 | 41.35 | 24.2 | 65.55 | 28.73 | 27.03 | 55.762 |
| 13.560517 | 33.1 | 26.9 | 60 | 29.54 | 20.46 | 50 |
| 25.249159 | 26.04 | 33.96 | 60 | 14.83 | 35.17 | 50 |
| 27.767101 | 27.15 | 32.85 | 60 | 15.12 | 34.88 | 50 |

## 11.5 Frequency error

**Measurement:**

The maximum detected field strength for the spurious.

| Measurement parameters | |
|---|---|
| Detector: | Peak detector |
| Resolution bandwidth: | 10 Hz |
| Video bandwidth: | > RBW |
| Trace mode: | Max hold |
| Used equipment: | See chapter 6.3 |
| Measurement uncertainty: | See chapter 8 |

**Limit:**

| FCC & IC |
|---|
| The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. (±1.356 kHz)<br><br>Carrier frequency stability shall be maintained to ±0.01% (±100 ppm) |

**Result:** **ANT420**

| Temperature variation | | | |
|---|---|---|---|
| Measured frequency (MHz) | Frequency error (kHz) | Conditions | Result |
| 13.560839 | 0.839 | -20 °C & 100% voltage | compliant |
| 13.560859 | 0.859 | -10 °C & 100% voltage | compliant |
| 13.560859 | 0.859 | 0 °C & 100% voltage | compliant |
| 13.560819 | 0.819 | +10 °C & 100% voltage | compliant |
| 13.560809 | 0.809 | +20 °C & 100% voltage | compliant |
| 13.560779 | 0.779 | +30 °C & 100% voltage | compliant |
| 13.560779 | 0.779 | +40 °C & 100% voltage | compliant |
| 13.560779 | 0.779 | +50 °C & 100% voltage | compliant |

| Voltage variation | | | |
|---|---|---|---|
| Measured frequency (MHz) | Frequency error (kHz) | Conditions | Result |
| 13.560819 | 0.819 | +20 °C & 85% voltage | compliant |
| 13.560809 | 0.809 | +20 °C & 100% voltage | compliant |
| 13.560809 | 0.809 | +20 °C & 115% voltage | compliant |

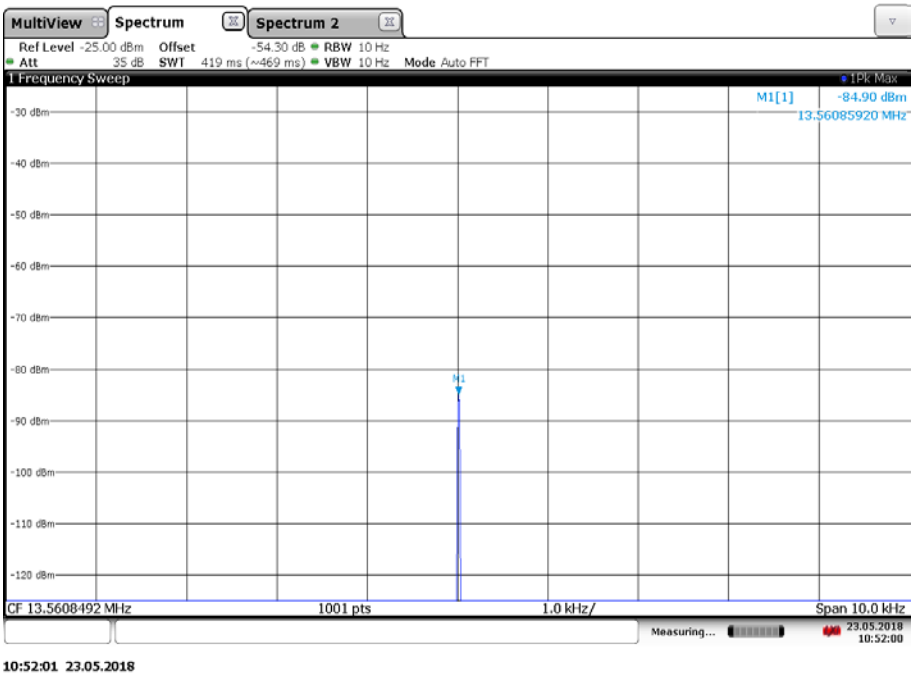
**Result:** **ANT421**

| Temperature variation | | | |
|---|---|---|---|
| Measured frequency (MHz) | Frequency error (kHz) | Conditions | Result |
| 13.560977 | 0.977 | -20 °C & 100% voltage | compliant |
| 13.560974 | 0.974 | -10 °C & 100% voltage | compliant |
| 13.560944 | 0.944 | 0 °C & 100% voltage | compliant |
| 13.560935 | 0.935 | +10 °C & 100% voltage | compliant |
| 13.560872 | 0.872 | +20 °C & 100% voltage | compliant |
| 13.560875 | 0.875 | +30 °C & 100% voltage | compliant |
| 13.560846 | 0.846 | +40 °C & 100% voltage | compliant |
| 13.560847 | 0.847 | +50 °C & 100% voltage | compliant |

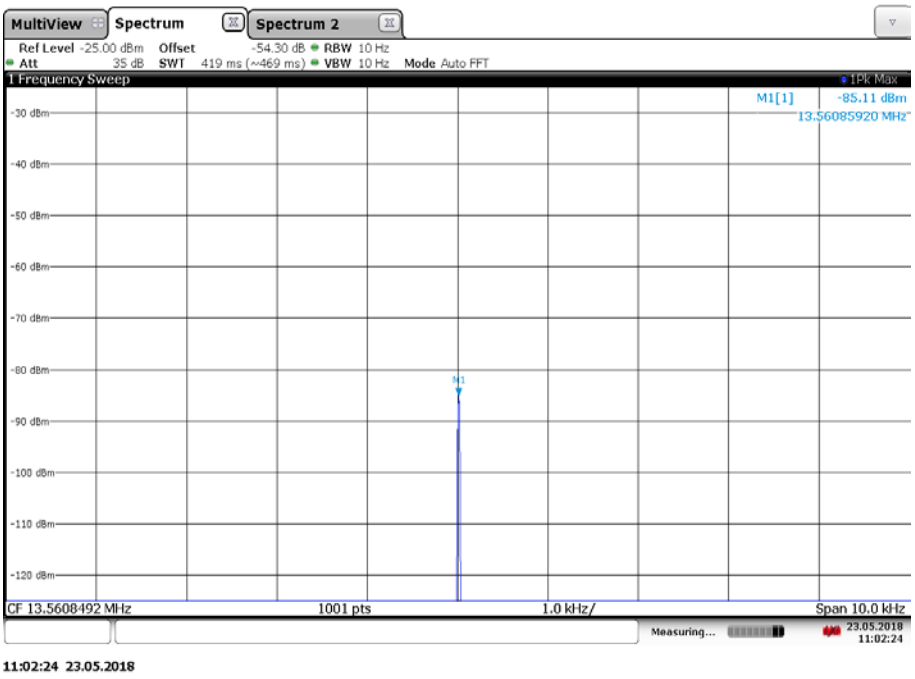
| Voltage variation | | | |
|---|---|---|---|
| Measured frequency (MHz) | Frequency error (kHz) | Conditions | Result |
| 13.560876 | 0.876 | +20 °C & 85% voltage | compliant |
| 13.560872 | 0.872 | +20 °C & 100% voltage | compliant |
| 13.560872 | 0.872 | +20 °C & 115% voltage | compliant |

**Plots: ANT420**

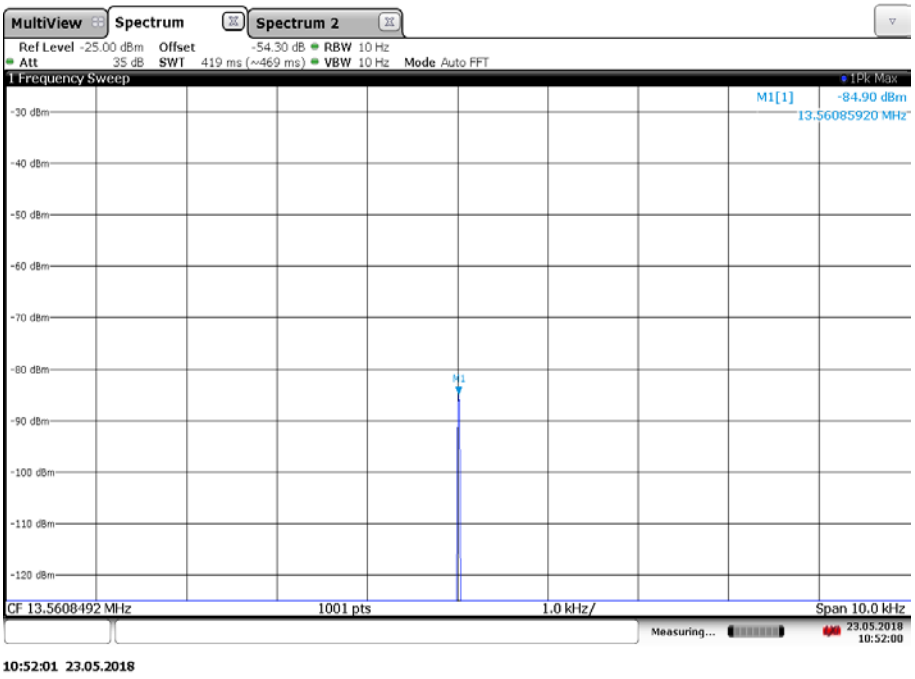
Plot 1: -20° C, $V_{nom}$



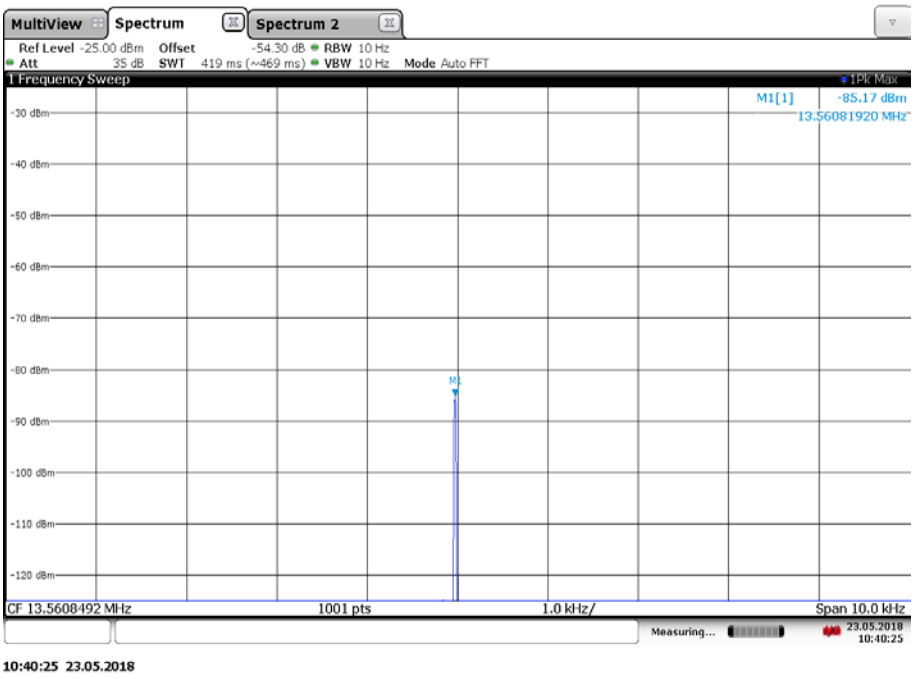

Plot 2: -10° C, $V_{nom}$



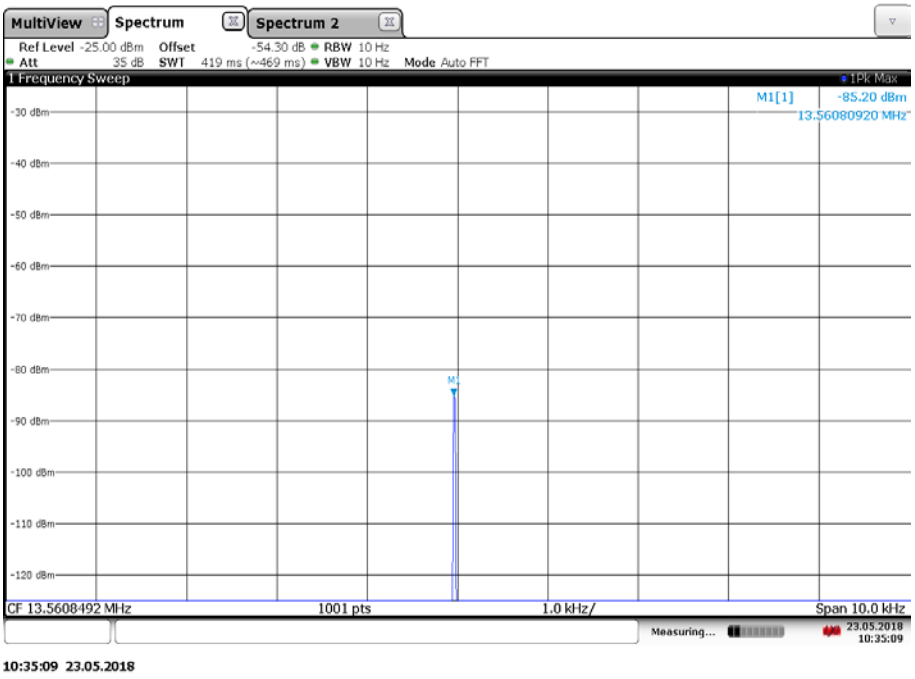
Plot 3: - 0° C, $V_{nom}$



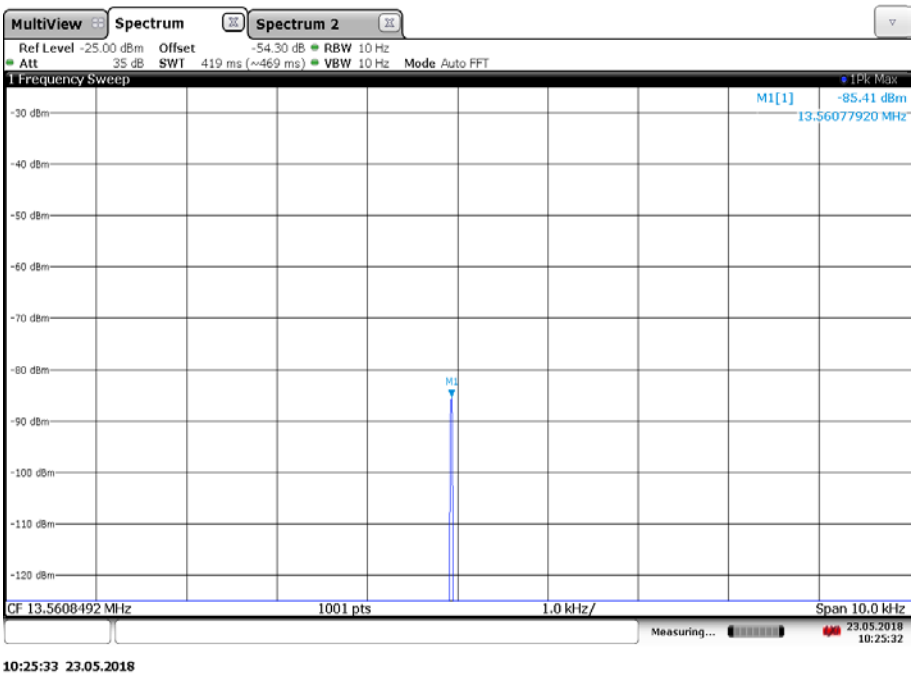

Plot 4: 10° C, $V_{nom}$



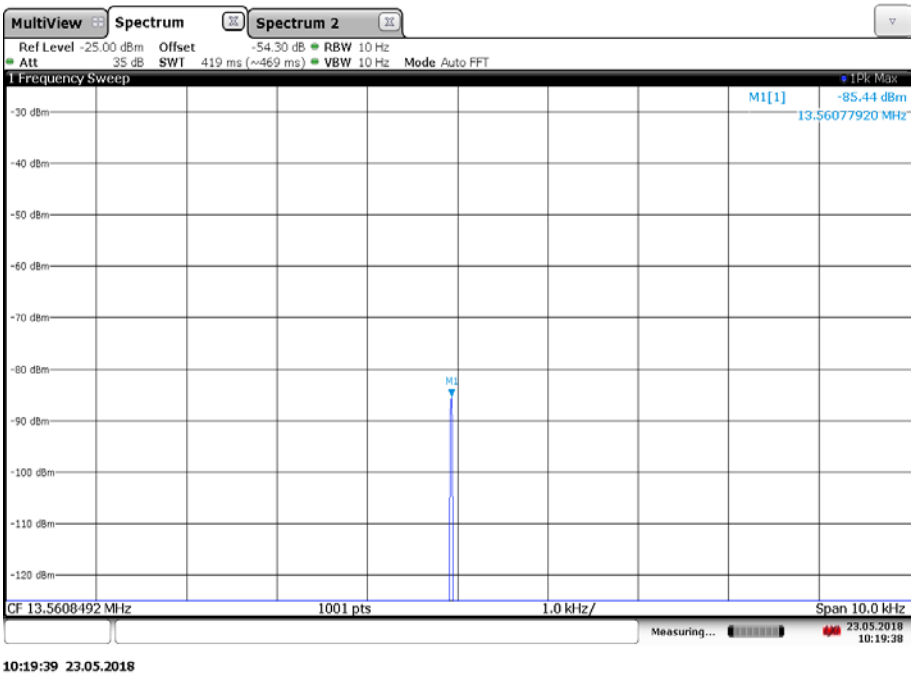
Plot 5: 20° C, $V_{nom}$



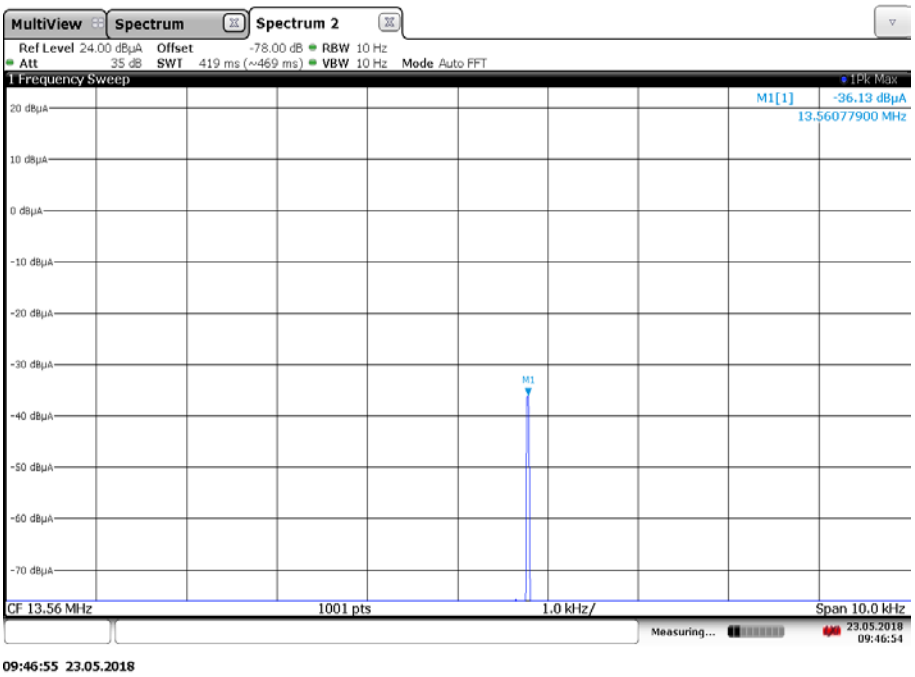

Plot 6: -30° C, $V_{nom}$



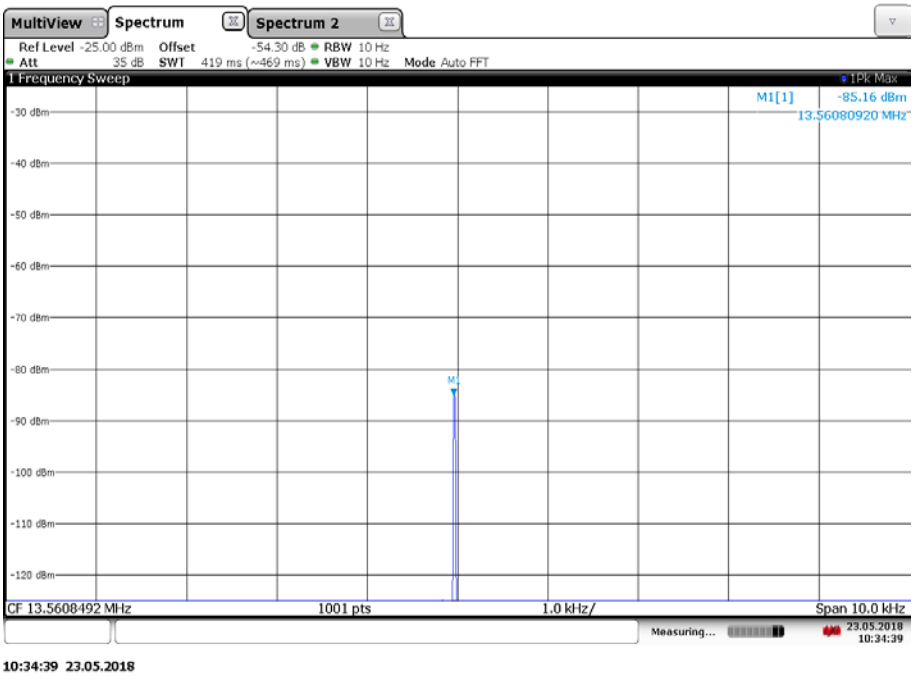
Plot 7: 40° C, $V_{nom}$



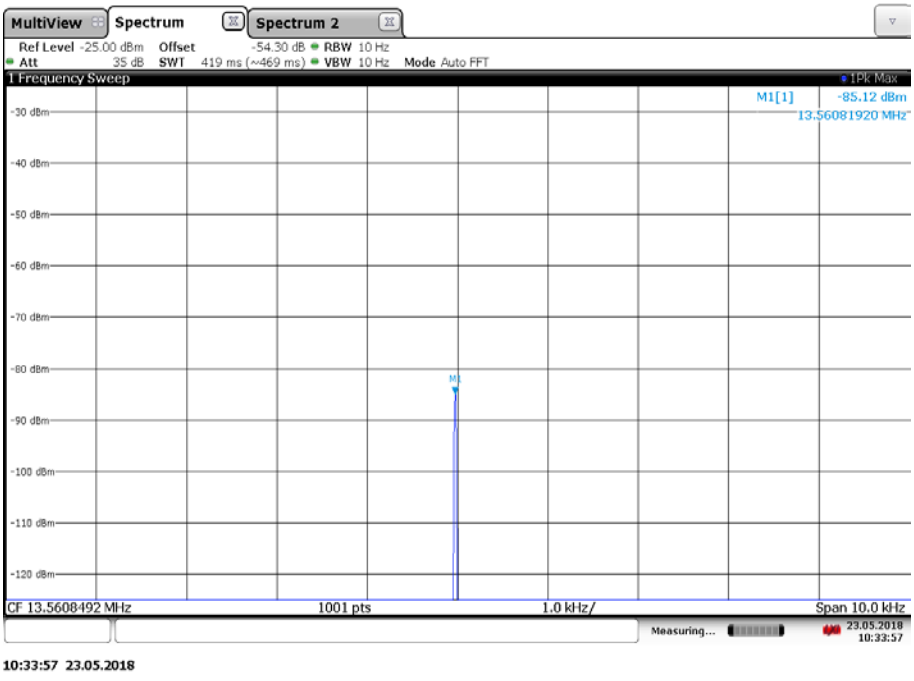

Plot 8: 50° C, $V_{nom}$



Plot 09: 20° C, $V_{high}$

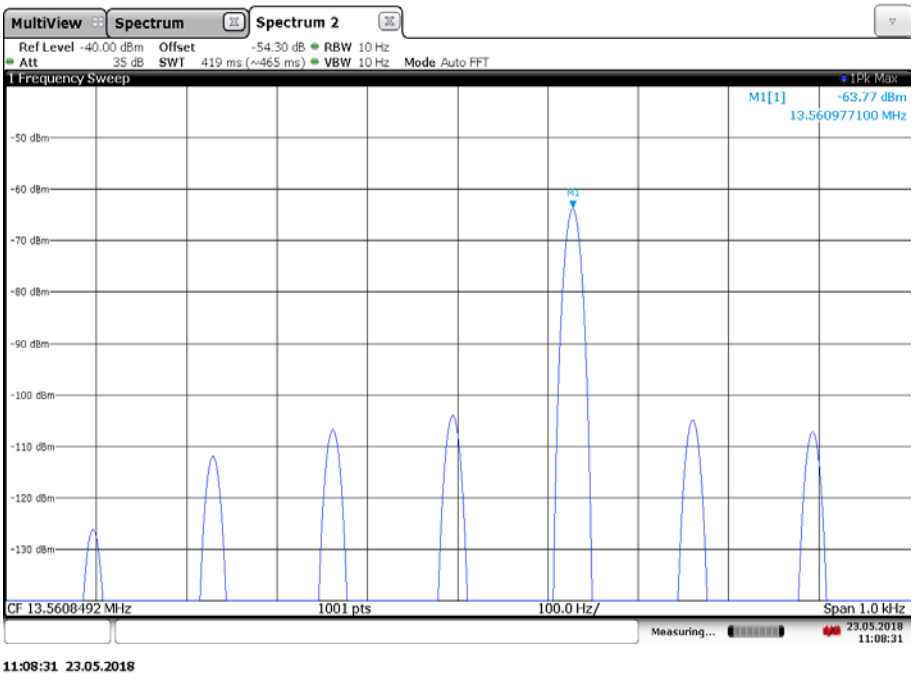



Plot 10: 20° C, $V_{low}$

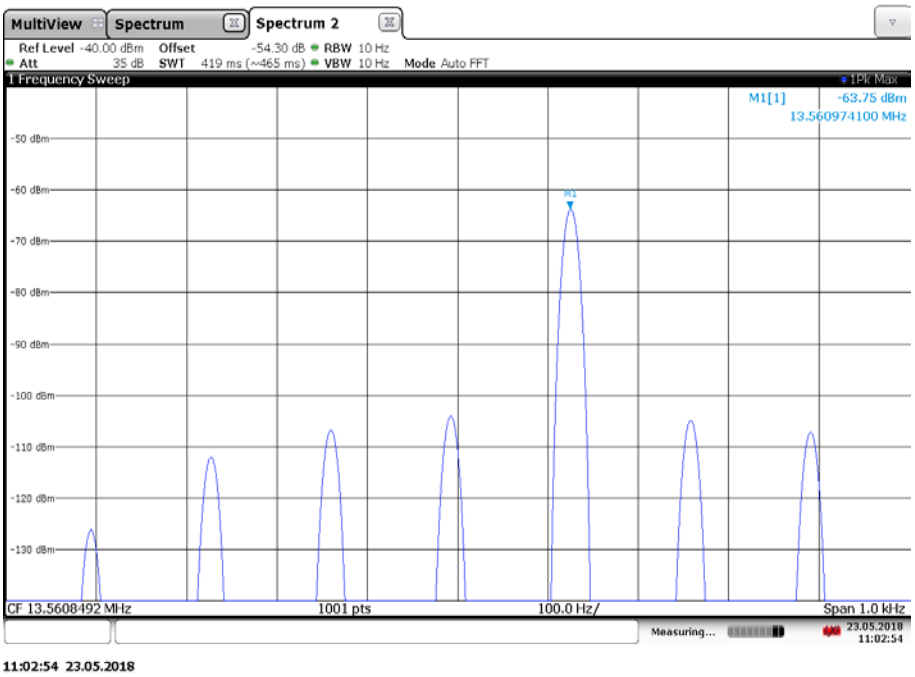


## Plots ANT421

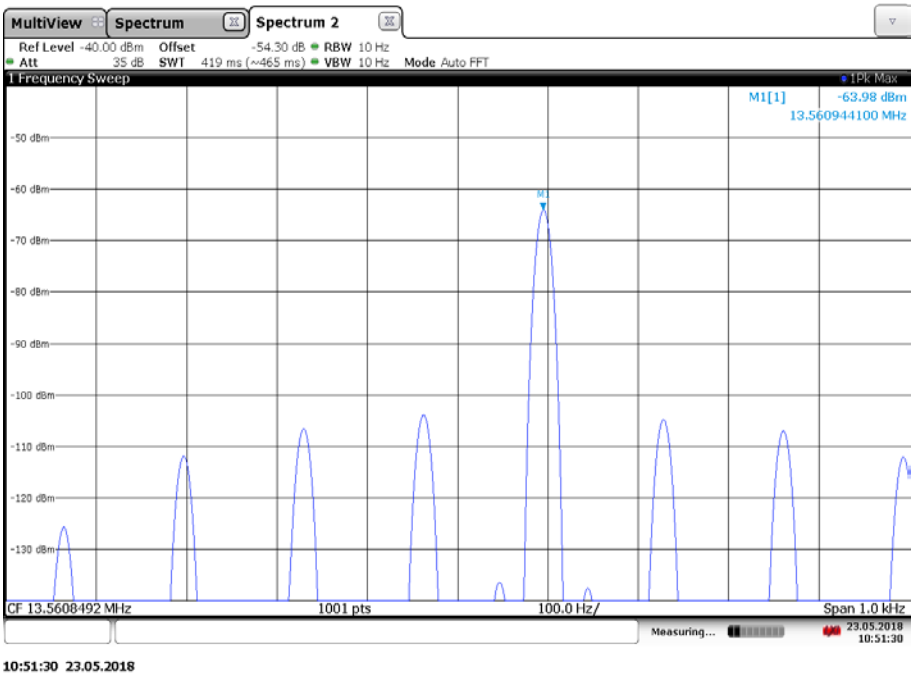
Plot 1: -20° C, $V_{nom}$



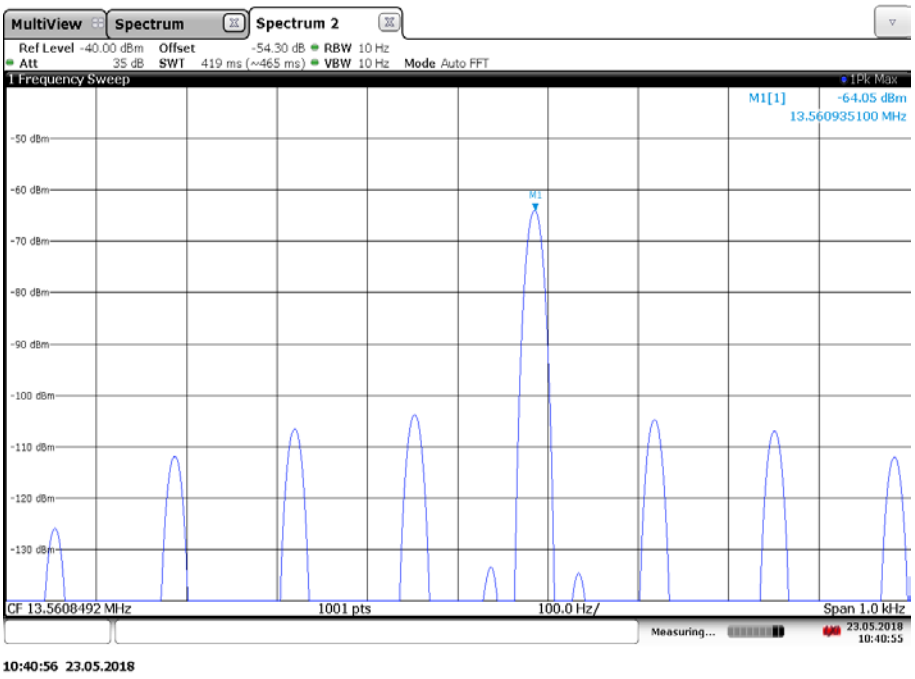

Plot 2: -10° C, $V_{nom}$



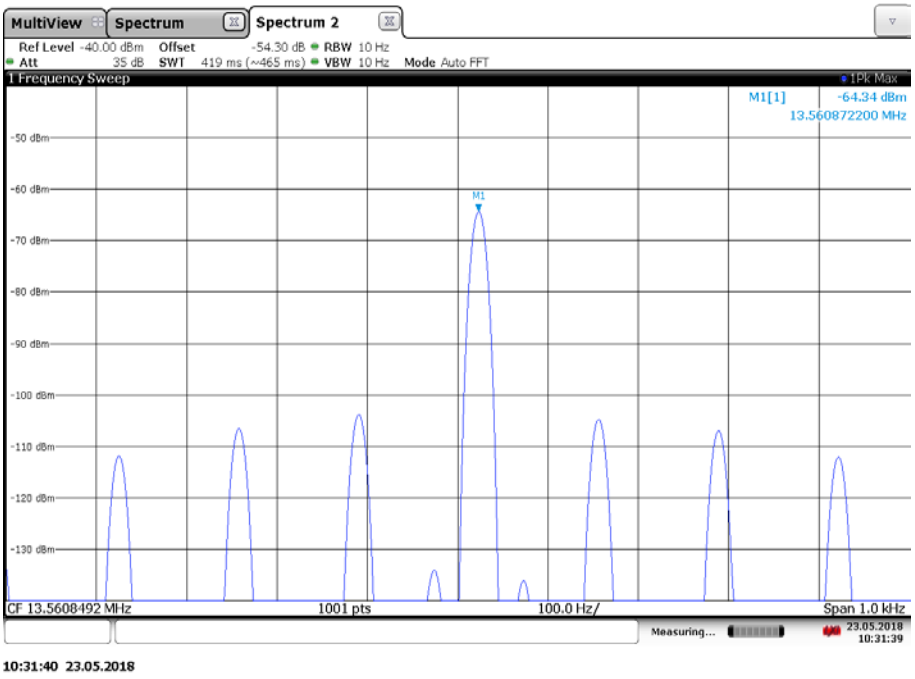
Plot 3: - 0° C, $V_{nom}$



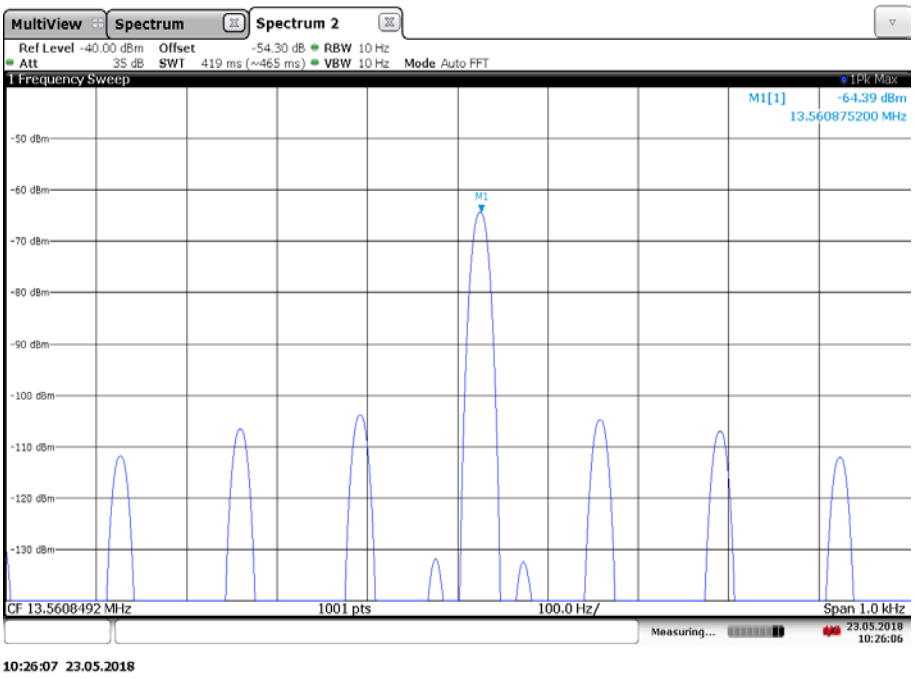

Plot 4: 10° C, $V_{nom}$



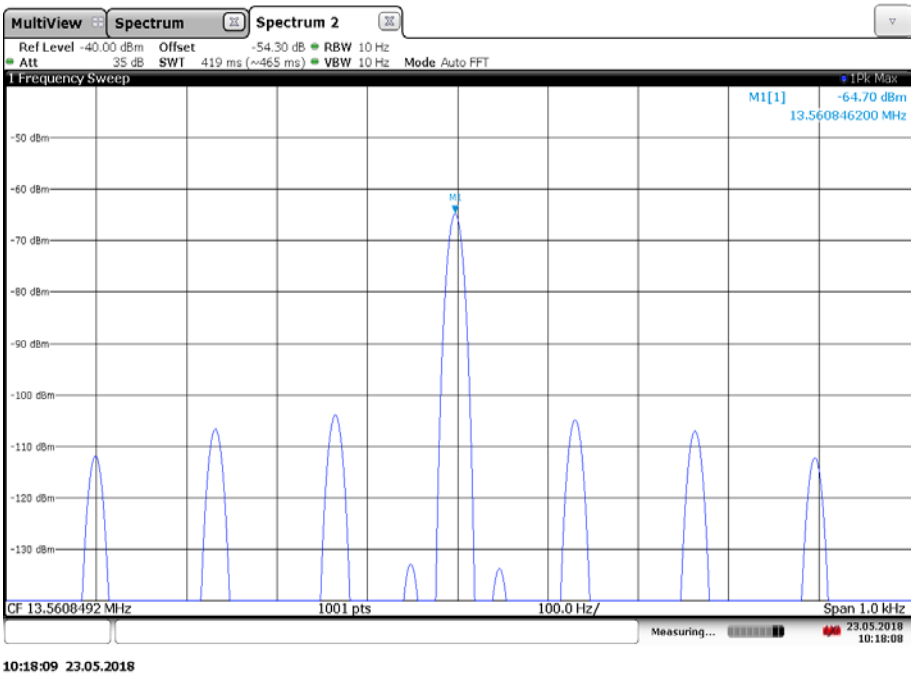
Plot 5: 20° C, $V_{nom}$



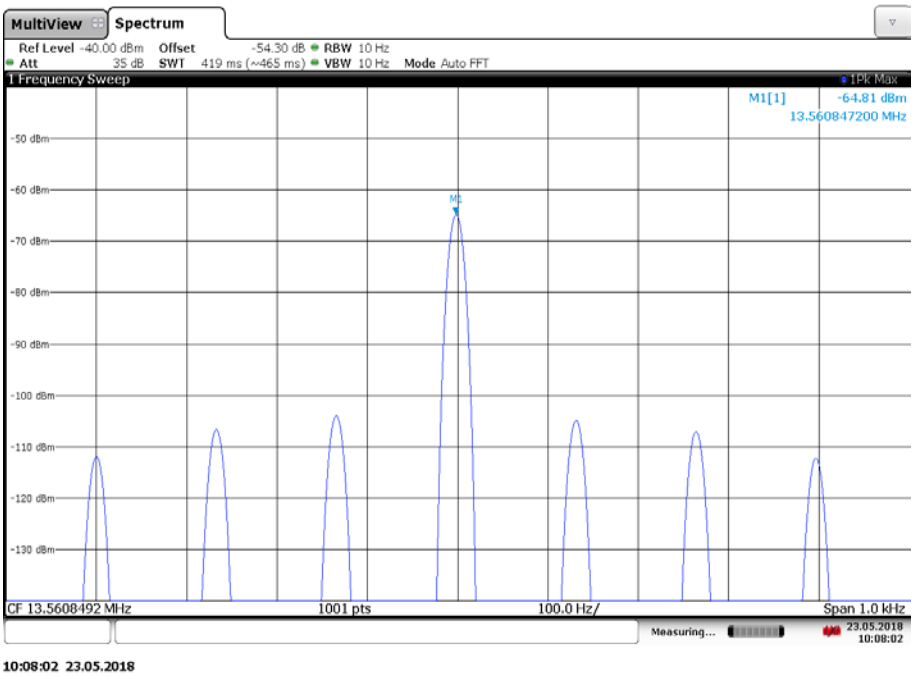

Plot 6: -30° C, $V_{nom}$



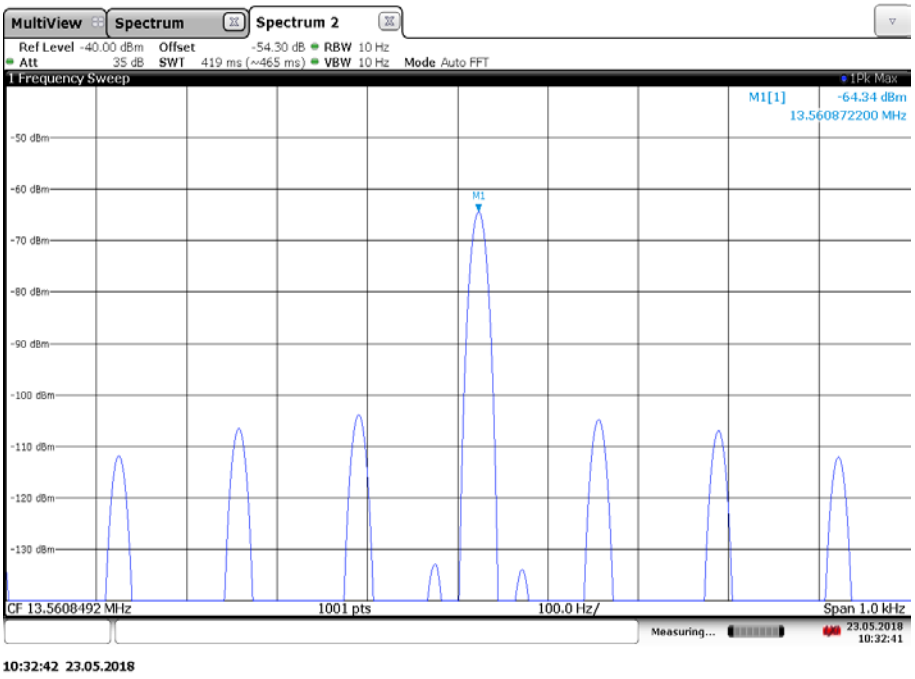
Plot 7: 40° C, $V_{nom}$



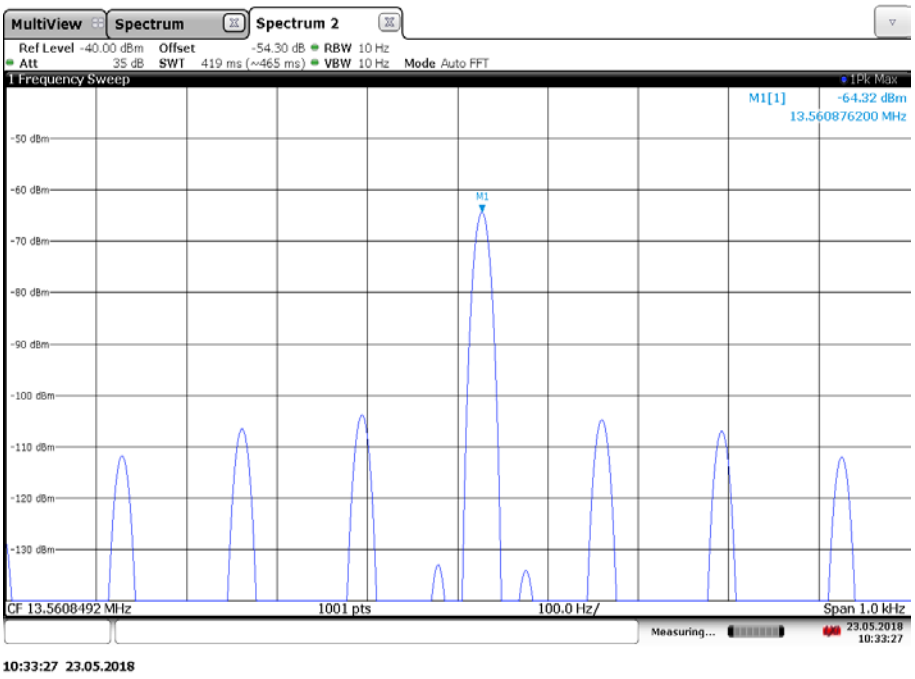

Plot 8: 50° C, $V_{nom}$



Plot 09: 20° C, $V_{high}$




Plot 10: 20° C, $V_{low}$



## 12 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 | 2018-06-06 |
| A | Results for AC conducted measurements added | 2018-06-21 |

## Annex C Accreditation Certificate

| first page | last page |
|---|---|
|  |  |



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

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