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TEST REPORT

Test report no.: 1-4545/17-01-02-A



DAkkS
Deutsche
Akreditierungsstelle
D-PL-12076-01-01

Testing laboratory

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Accredited Testing Laboratory:

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

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

Applicant

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Manufacturer

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Test standard/s

| | |
|-------------------|--|
| 47 CFR Part 15 | Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 247 Issue 2 | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |

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

Test Item

Kind of test item: SNT Base station
Model name: SBS-T3-902
FCC ID: 2ACK7SBST3902
IC: 12204A-SBST3902
Frequency: 902 MHz – 928 MHz
Technology tested: proprietary
Antenna: External rod antenna
Power supply: 10.5 V to 14.0 V DC by power supply
Temperature range: -20°C to +55°C



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

Test report authorized:

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1 Table of contents

| | | |
|---------|---|----|
| 1 | Table of contents | 2 |
| 2 | General information | 3 |
| 2.1 | Notes and disclaimer | 3 |
| 2.2 | Application details | 3 |
| 2.3 | Test laboratories sub-contracted | 3 |
| 3 | Test standard/s and references | 4 |
| 4 | Test environment | 5 |
| 5 | Test item | 5 |
| 5.1 | General description | 5 |
| 5.2 | Additional information | 5 |
| 6 | Description of the test setup | 6 |
| 6.1 | Shielded semi anechoic chamber | 7 |
| 6.2 | Shielded fully anechoic chamber | 8 |
| 6.3 | Radiated measurements > 18 GHz | 9 |
| 7 | Sequence of testing | 10 |
| 7.1 | Sequence of testing radiated spurious 9 kHz to 30 MHz | 10 |
| 7.2 | Sequence of testing radiated spurious 30 MHz to 1 GHz | 11 |
| 7.3 | Sequence of testing radiated spurious 1 GHz to 18 GHz | 12 |
| 7.4 | Sequence of testing radiated spurious above 18 GHz | 13 |
| 8 | Measurement uncertainty | 14 |
| 9 | Summary of measurement results | 15 |
| 10 | RF measurements | 16 |
| 10.1 | Additional comments | 16 |
| 11 | Measurement results | 17 |
| 11.1 | Spurious Emissions Radiated < 30 MHz | 17 |
| 11.2 | Spurious Emissions Radiated > 30 MHz | 21 |
| 11.2.1 | Spurious emissions radiated 30 MHz to 1 GHz | 21 |
| 11.2.2 | Spurious emissions radiated above 1 GHz | 28 |
| 12 | Observations | 36 |
| Annex A | Glossary | 37 |
| Annex B | Document history | 38 |
| Annex C | Accreditation Certificate | 38 |

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 1-4545/17-01-02 and dated 2017-09-26.

2.2 Application details

| | |
|------------------------------------|------------|
| Date of receipt of order: | 2017-07-20 |
| Date of receipt of test item: | 2017-07-21 |
| Start of test: | 2017-07-21 |
| End of test: | 2017-09-21 |
| Person(s) present during the test: | -/- |

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

| Test standard | Date | Description |
|-------------------|---------------|---|
| 47 CFR Part 15 | -/- | Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 247 Issue 2 | February 2017 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| 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} T _{max} T _{min} | +22 °C during room temperature tests No tests under extreme conditions required No tests under extreme conditions required |
| Relative humidity content | : | | 55 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | V _{nom} V _{max} V _{min} | 12.0 V DC by power supply No tests under extreme conditions required No tests under extreme conditions required |

5 Test item

5.1 General description

| | | |
|----------------------------|---|--|
| Kind of test item | : | SNT Base station |
| Type identification | : | SBS-T3-902 |
| HMN | : | -/- |
| PMN | : | SBS-T3 |
| HVIN | : | SBS-T3-902 |
| FVIN | : | TAPOS v4.2 |
| S/N serial number | : | Base station: 00005F21-K2 |
| HW hardware status | : | V3.0_0.a, V3.0_1.a (second mother board V3.0_0.b, V3.0_1.b) |
| FW software status | : | TAPOS v4.2 |
| Frequency band | : | 902 MHz – 928 MHz |
| Type of radio transmission | : | FHSS |
| Use of frequency spectrum | : | |
| Type of modulation | : | DBPSK |
| Number of channels | : | Two hopping tables with 50 channels each |
| Antenna | : | External rod antenna |
| Antenna Gain | : | Max. 2.0 dBi (according datasheet) |
| Power supply | : | 10.5 V to 14.0 V DC by 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:

1-4545/17-01-02_AnnexA

1-4545/17-01-02_AnnexB

1-4545/17-01-02_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).

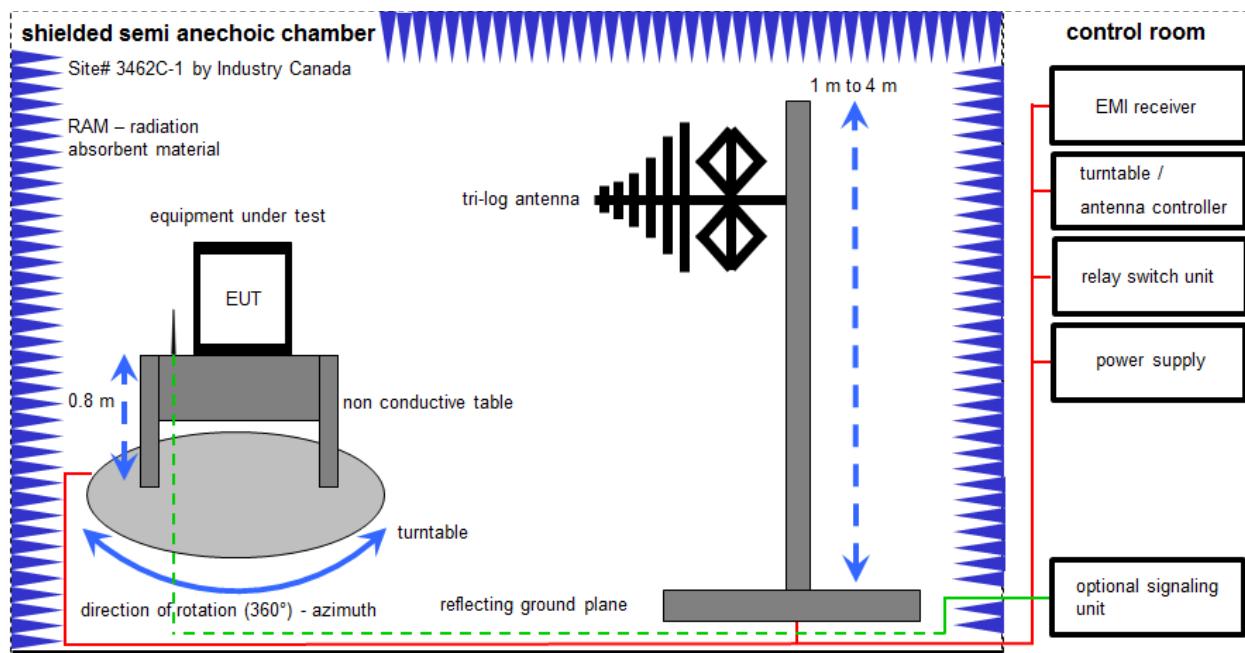
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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



Measurement distance: tri-log antenna 10 meter

$$FS = UR + CL + AF$$

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

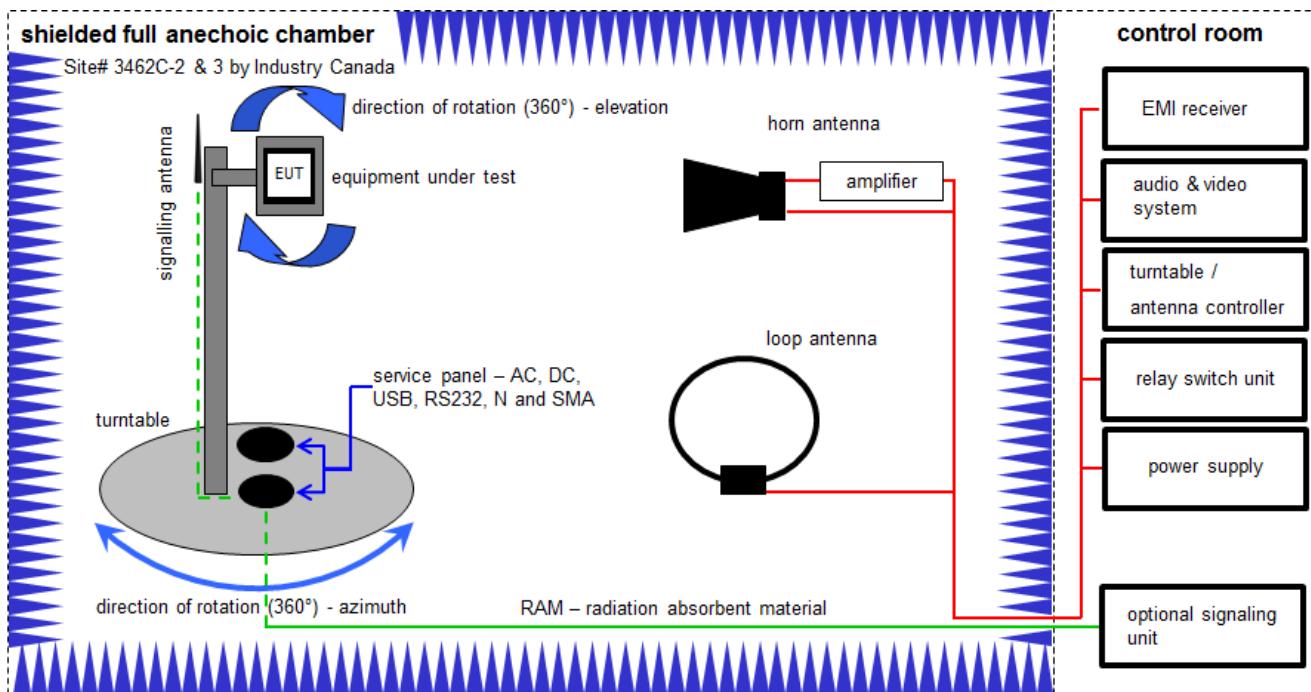
Example calculation:

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

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|---|------------------|---------------|-----------------|-----------|---------------------|------------------|------------------|
| 1 | A | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | A | Meßkabine 1 | HF-Absorberhalle | MWB AG 300023 | | 300000551 | ne | -/- | -/- |
| 3 | A | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 01.02.2017 | 31.01.2018 |
| 4 | A | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | Ve | -/- | -/- |
| 5 | A | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 6 | A | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 7 | A | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 8 | A | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck | 295 | 300003787 | k | 25.04.2016 | 25.04.2018 |
| 9 | A | Spectrum-Analyzer | FSU26 | R&S | 200809 | 300003874 | k | 31.01.2017 | 30.01.2018 |

6.2 Shielded fully anechoic chamber



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

FS = UR + CA + AF

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

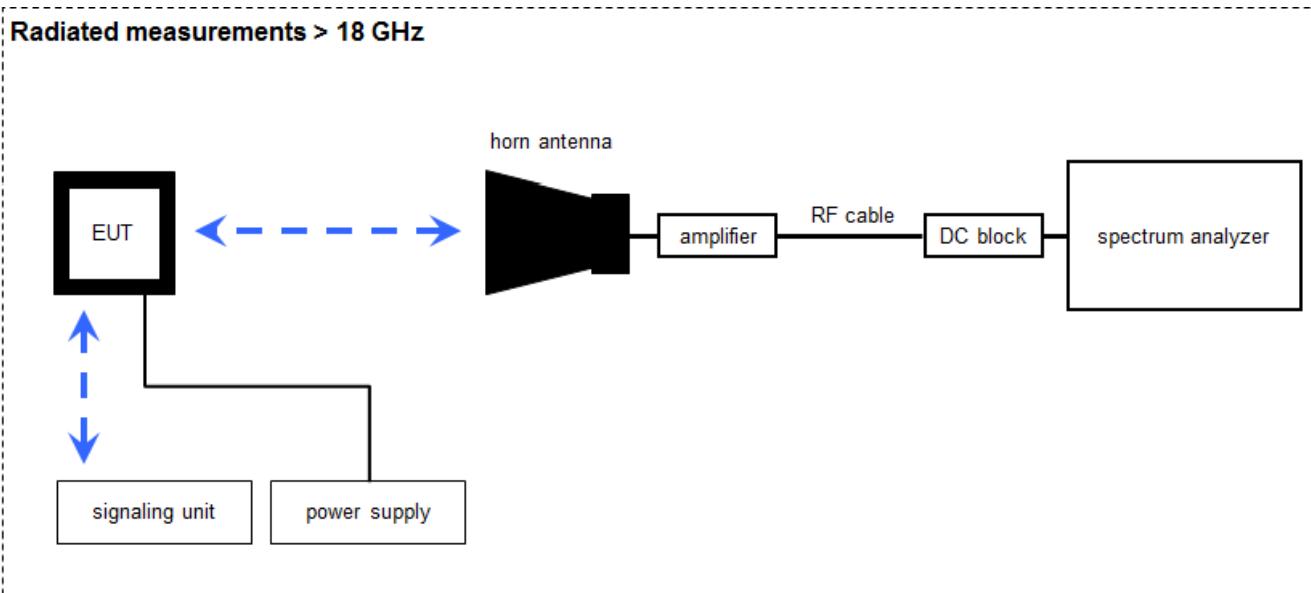
Example calculation:

FS [dB μ V/m] = 40.0 [dB μ V/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dB μ V/m] (71.61 μ V/m)

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|--|-----------------|--------------|------------|-----------|---------------------|------------------|------------------|
| 1 | A, B | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 2 | A | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3697 | 300001605 | vIKI! | 14.02.2017 | 13.02.2019 |
| 3 | A, B | Switch / Control Unit | 3488A | HP | -/- | 300000199 | ne | -/- | -/- |
| 4 | B | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | k | 07.07.2017 | 06.07.2019 |
| 5 | A, B | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 31.01.2017 | 30.01.2018 |
| 6 | A | Highpass Filter | WHK1.1/15G-10SS | Wainwright | 3 | 300003255 | ev | -/- | -/- |
| 7 | A | Highpass Filter | WHKX7.0/18G-8SS | Wainwright | 19 | 300003790 | ne | -/- | -/- |
| 8 | A | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22049 | 300004481 | ev | -/- | -/- |

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

$$FS = U_R + CA + AF$$

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

Example calculation:

$$FS [dB\mu V/m] = 40.0 [dB\mu V/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dB\mu V/m] (6.79 \mu V/m)$$

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|--|---------|--------------|---------------|-----------|---------------------|------------------|------------------|
| 1 | A | Microwave System Amplifier, 0.5-26.5 GHz | 83017A | HP | 00419 | 300002268 | ev | -/ | -/ |
| 2 | A | Signal Analyzer 40 GHz | FSV40 | R&S | 101042 | 300004517 | k | 25.01.2017 | 24.01.2018 |
| 3 | A | Horn Antenna 18,0-40,0 GHz | LHAF180 | Microw.Devel | 39180-103-022 | 300001748 | k | 22.05.2015 | 22.05.2018 |

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.

Premereasurement*

- 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°.
- 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.

Premereasurement

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

Final measurement

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

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premereasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8 Measurement uncertainty

| Measurement uncertainty | |
|---|--|
| Test case | Uncertainty |
| Antenna gain | ± 3 dB |
| 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

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

| TC Identifier | Description | Verdict | Date | Remark |
|---------------|-----------------------------------|---------|------------|------------|
| RF-Testing | CFR Part 15 RSS - 247, Issue 2 | Passed | 2017-10-23 | See Note 1 |

| Test specification clause | Test case | Temperature conditions | Power source voltages | Mode | C | NC | NA | NP | Remark |
|---|---|------------------------|-----------------------|-----------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|--|
| §15.247(b)(4) RSS - 247 / 5.4 (a) | Antenna gain | Nominal | Nominal | CW | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(a)(1) RSS - 247 / 5.1 (c) | Carrier frequency separation | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(a)(1) RSS - 247 / 5.1 (c) | Number of hopping channels | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(a)(1) (iii) RSS - 247 / 5.1 (c) | Time of occupancy (dwell time) | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(a)(1) RSS - 247 / 5.1 (c) | Spectrum bandwidth of a FHSS system bandwidth | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(b)(1) RSS - 247 / 5.4 (a) | Maximum output power | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(d) RSS - 247 / 5.5 | Detailed spurious emissions @ the band edge - conducted | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.205 RSS - 247 / 5.5 RSS - Gen | Band edge compliance radiated | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.247(d) RSS - 247 / 5.5 | Spurious emissions conducted | Nominal | Nominal | DBPSK | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | -/- |
| §15.209(a) RSS - Gen | Spurious emissions radiated below 30 MHz | Nominal | Nominal | DBPSK | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | -/- |
| §15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen | Spurious emissions radiated 30 MHz to 1 GHz | Nominal | Nominal | DBPSK / RX mode | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | -/- |
| §15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen | Spurious emissions radiated above 1 GHz | Nominal | Nominal | DBPSK / RX mode | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | -/- |
| §15.107(a) §15.207 | Conducted emissions below 30 MHz (AC conducted) | Nominal | Nominal | -/- | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | EUT ceases transmitting after connecting the charger |

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

Note 1: rad. Emission only, see test report 1-1899/16-01-08 for further information.

10 RF measurements

10.1 Additional comments

Reference documents: Test report 1-1899/16-01-08

Special test descriptions: Only Spurious emissions were measured.

In normal mode it is possible to choose between two different hopping tables.

Hopping table 1:

| Channel # | Frequency (MHz) | Channel # | Frequency (MHz) |
|-----------|-----------------|-----------|-----------------|
| 1 | 902.8 | 26 | 917.8 |
| 2 | 905.2 | 27 | 918.1 |
| 3 | 913.9 | 28 | 911.8 |
| 4 | 902.5 | 29 | 906.7 |
| 5 | 903.7 | 30 | 906.1 |
| 6 | 903.1 | 31 | 909.4 |
| 7 | 917.5 | 32 | 913.6 |
| 8 | 906.4 | 33 | 914.5 |
| 9 | 907.0 | 34 | 915.7 |
| 10 | 904.3 | 35 | 908.8 |
| 11 | 904.0 | 36 | 907.9 |
| 12 | 908.5 | 37 | 914.8 |
| 13 | 910.0 | 38 | 907.6 |
| 14 | 904.6 | 39 | 917.2 |
| 15 | 913.0 | 40 | 914.2 |
| 16 | 911.2 | 41 | 908.2 |
| 17 | 905.5 | 42 | 909.7 |
| 18 | 902.2 | 43 | 910.3 |
| 19 | 904.9 | 44 | 915.4 |
| 20 | 903.4 | 45 | 909.1 |
| 21 | 905.8 | 46 | 910.9 |
| 22 | 907.3 | 47 | 913.3 |
| 23 | 912.4 | 48 | 915.1 |
| 24 | 911.5 | 49 | 912.1 |
| 25 | 912.7 | 50 | 910.6 |

hopping table 2:

| Channel # | Frequency (MHz) | Channel # | Frequency (MHz) |
|-----------|-----------------|-----------|-----------------|
| 1 | 912.4 | 26 | 927.4 |
| 2 | 914.8 | 27 | 927.7 |
| 3 | 924.7 | 28 | 922.6 |
| 4 | 912.1 | 29 | 917.5 |
| 5 | 913.3 | 30 | 915.7 |
| 6 | 912.7 | 31 | 920.2 |
| 7 | 927.1 | 32 | 924.4 |
| 8 | 917.2 | 33 | 925.3 |
| 9 | 917.8 | 34 | 926.5 |
| 10 | 913.9 | 35 | 919.6 |
| 11 | 913.6 | 36 | 918.7 |
| 12 | 919.3 | 37 | 925.6 |
| 13 | 920.8 | 38 | 918.4 |
| 14 | 914.2 | 39 | 926.8 |
| 15 | 923.8 | 40 | 925.0 |
| 16 | 922.0 | 41 | 919.0 |
| 17 | 915.1 | 42 | 920.5 |
| 18 | 911.8 | 43 | 921.1 |
| 19 | 914.5 | 44 | 926.2 |
| 20 | 913.0 | 45 | 919.9 |
| 21 | 915.4 | 46 | 921.7 |
| 22 | 918.1 | 47 | 924.1 |
| 23 | 923.2 | 48 | 925.9 |
| 24 | 922.3 | 49 | 922.9 |
| 25 | 923.5 | 50 | 921.4 |

Frequencies tested:

For hopping table 1: 902.2 MHz, 910.0 MHz, 918.1 MHz

For hopping table 2: 911.8 MHz, 920.5 MHz, 927.7 MHz

Test mode:



Special software is used.

EUT is transmitting pseudo random data by itself

11 Measurement results

11.1 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

| Measurement parameter | |
|--------------------------|--|
| Detector: | Peak / Quasi Peak |
| Sweep time: | Auto |
| Video bandwidth: | F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz |
| Resolution bandwidth: | F < 150 kHz: 1 kHz 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:

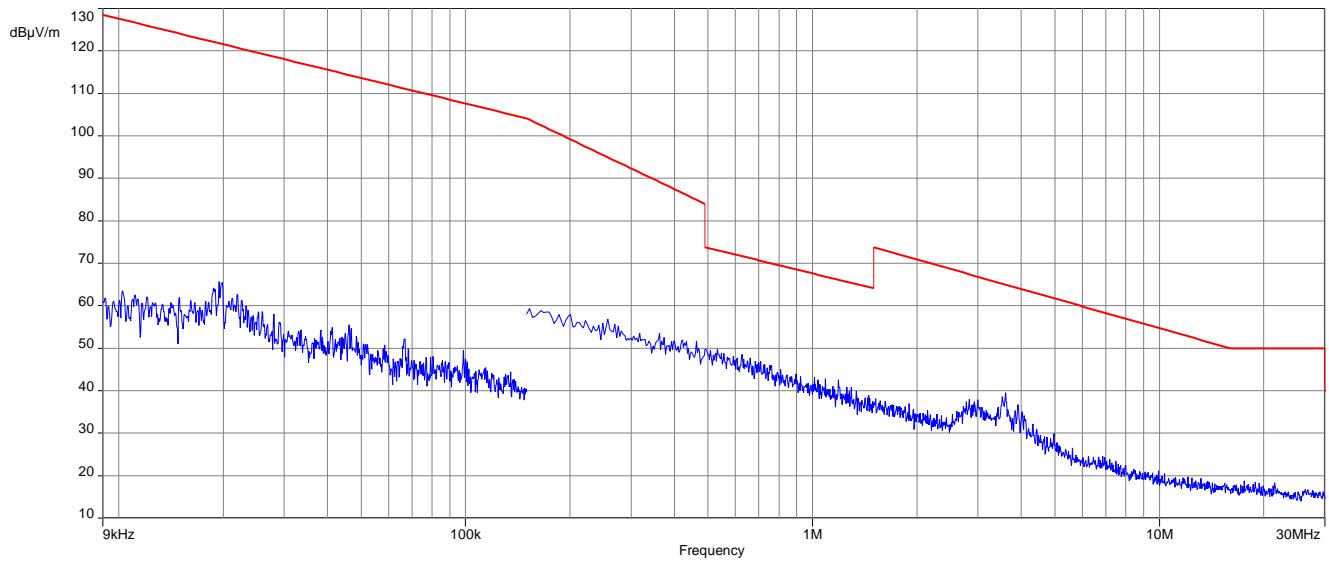
| FCC | IC | |
|---|-------------------------------|----------------------|
| TX spurious emissions radiated < 30 MHz | | |
| Frequency (MHz) | Field strength (dB μ V/m) | Measurement distance |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

Result:

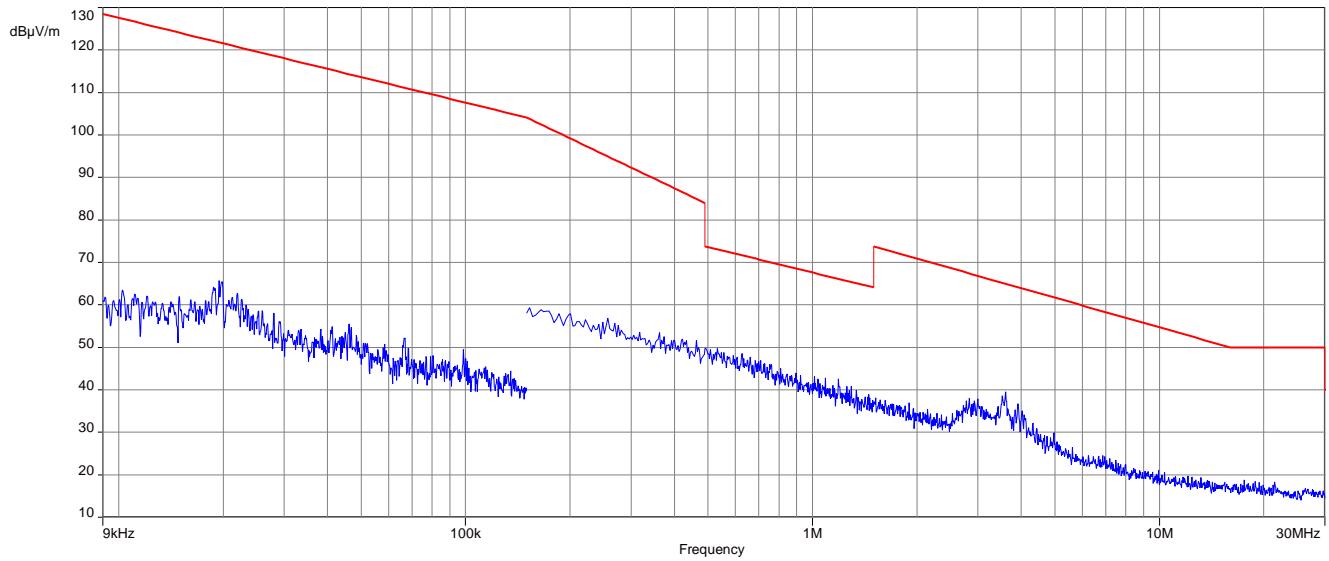
| SPURIOUS EMISSIONS LEVEL [dB μ V/m] | | | | | | | | |
|---|----------|----------------------|-----------------|----------|----------------------|-----------------|----------|----------------------|
| Lowest channel | | | Middle channel | | | Highest channel | | |
| Frequency [MHz] | Detector | Level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

Plots:

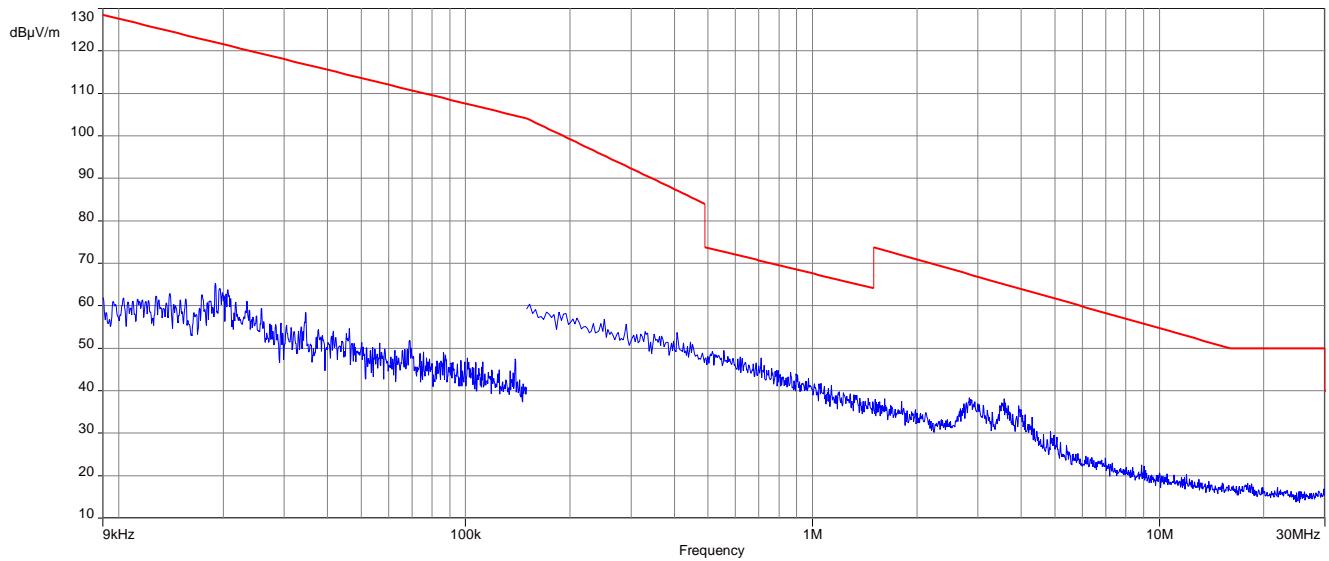
Plot 1: 902.2 MHz



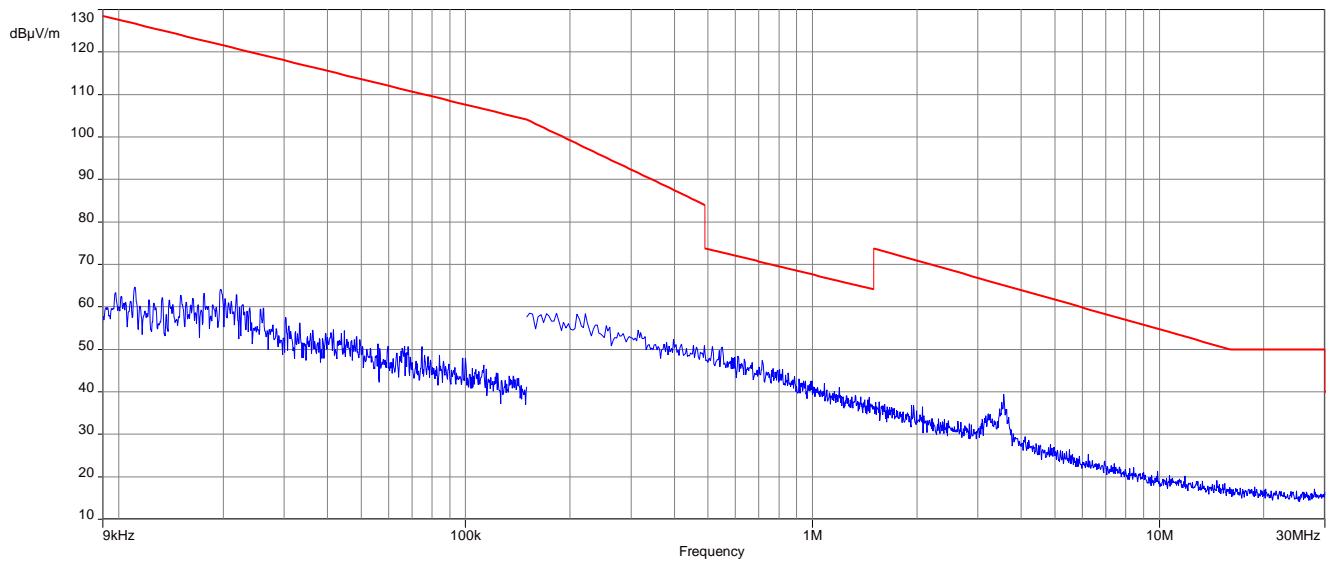
Plot 2: 910.0 MHz



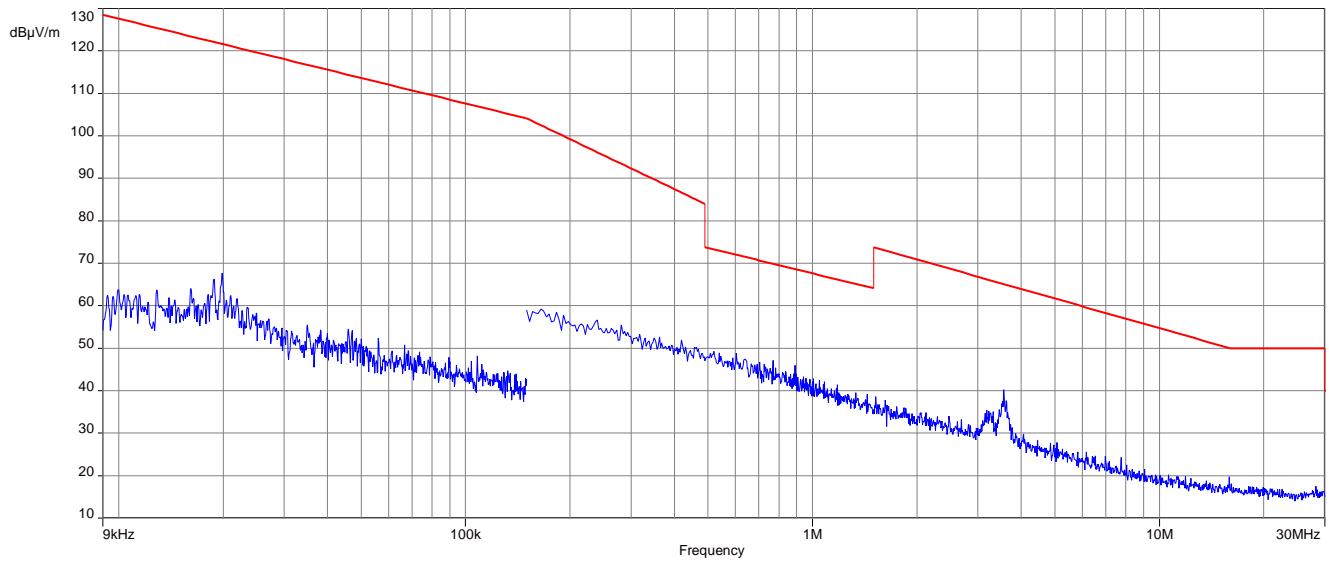
Plot 3: 918.1 MHz



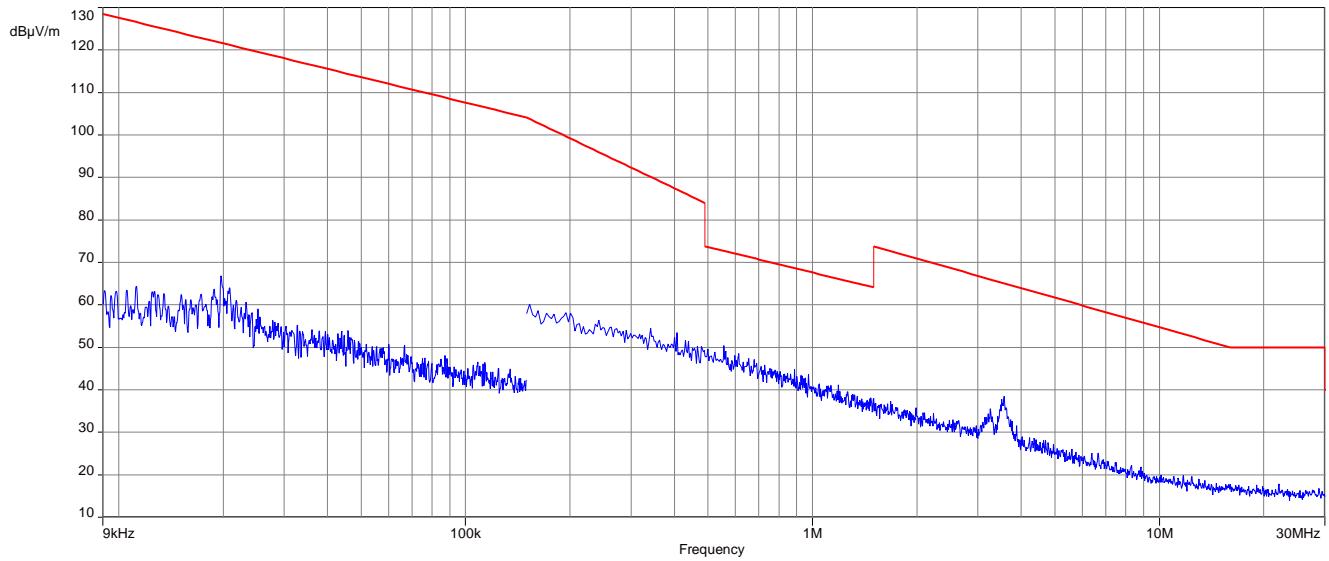
Plot 4: 911.8 MHz



Plot 5: 920.5 MHz



Plot 6: 927.7 MHz



11.2 Spurious Emissions Radiated > 30 MHz

11.2.1 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 |
| Measured modulation | DBPSK |
| Test setup | See sub clause 6.1 A |
| Measurement uncertainty | See sub clause 8 |

Limits:

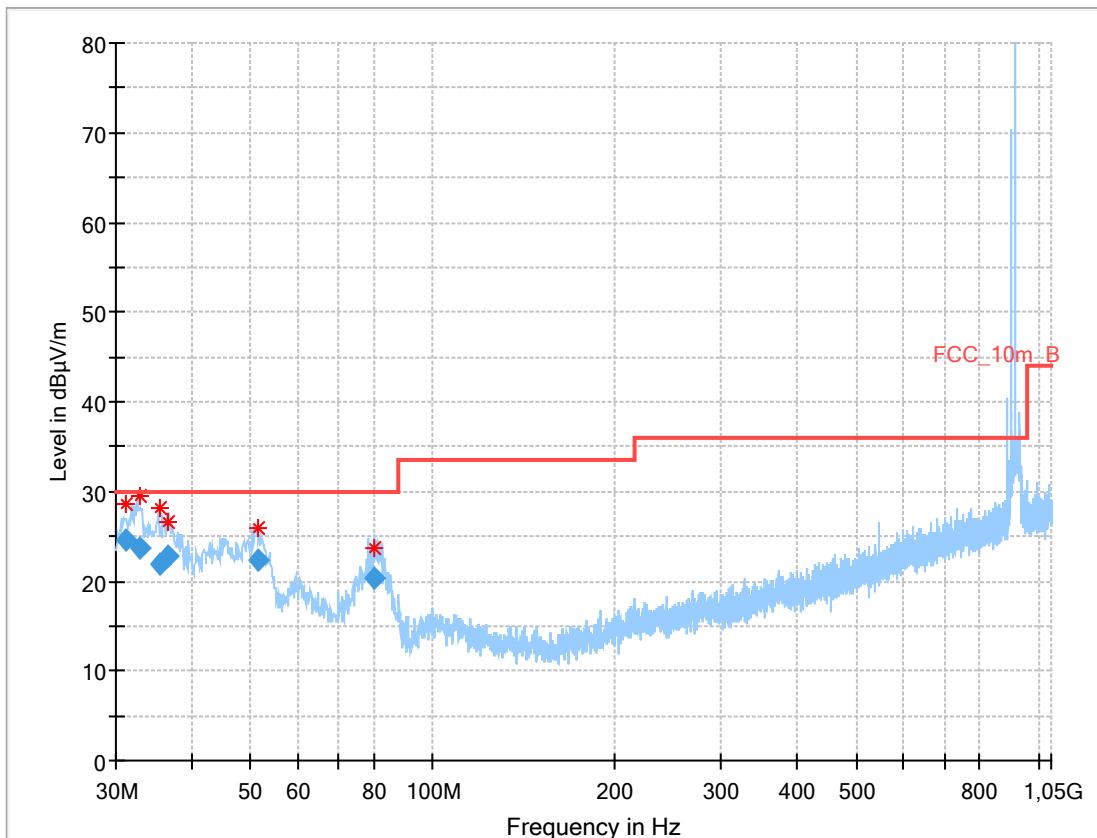
| FCC | IC | | | | | | | | | | | | | | | |
|--|-------------------------------|----------------------|-------------------------------|----------------------|---------|------|----|----------|------|----|-----------|------|----|-----------|------|---|
| Band-edge Compliance of conducted and radiated emissions | | | | | | | | | | | | | | | | |
| 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)). | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th>Frequency (MHz)</th><th>Field Strength (dBμV/m)</th><th>Measurement distance</th></tr> </thead> <tbody> <tr> <td>30 - 88</td><td>30.0</td><td>10</td></tr> <tr> <td>88 - 216</td><td>33.5</td><td>10</td></tr> <tr> <td>216 - 960</td><td>36.0</td><td>10</td></tr> <tr> <td>Above 960</td><td>54.0</td><td>3</td></tr> </tbody> </table> | | Frequency (MHz) | Field Strength (dB μ V/m) | Measurement distance | 30 - 88 | 30.0 | 10 | 88 - 216 | 33.5 | 10 | 216 - 960 | 36.0 | 10 | Above 960 | 54.0 | 3 |
| Frequency (MHz) | Field Strength (dB μ V/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.

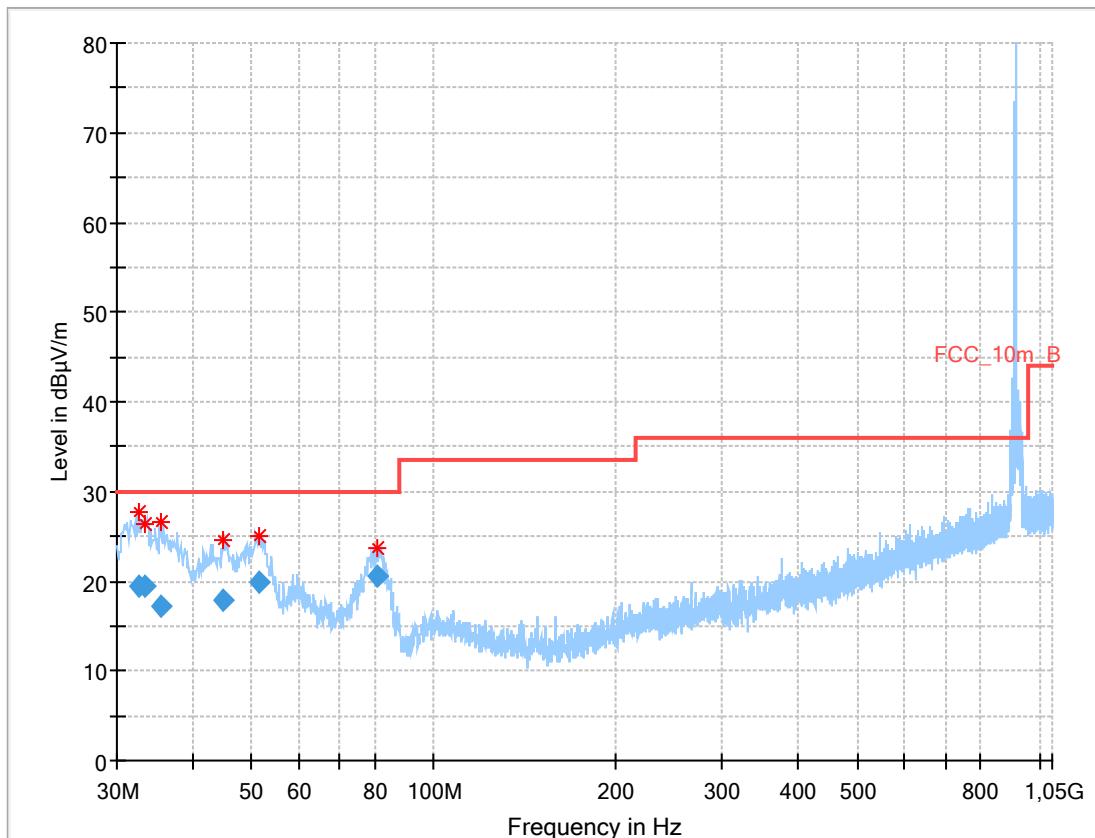
Plots:

Plot 1: 902.2 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



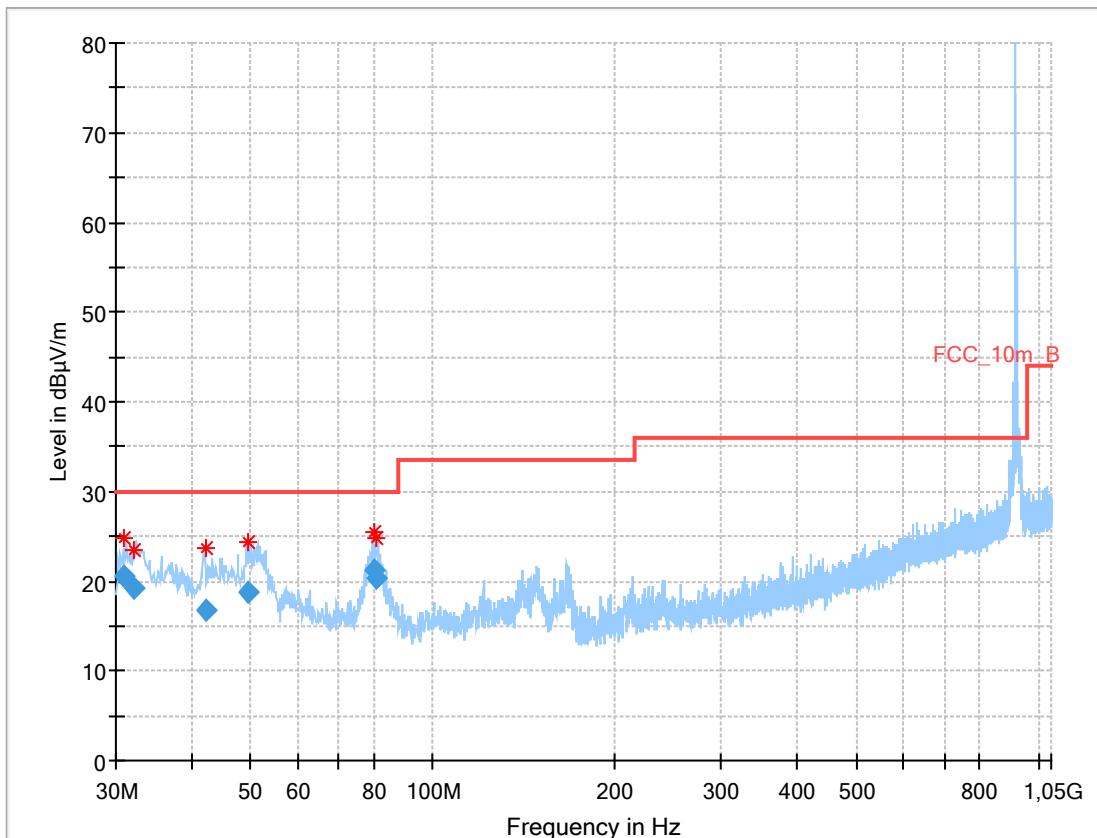
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 31.271 | 24.48 | 30.0 | 5.52 | 1000 | 120 | 100.0 | V | 280.0 | 12.1 |
| 32.931 | 23.67 | 30.0 | 6.33 | 1000 | 120 | 170.0 | V | 171.0 | 12.3 |
| 35.552 | 21.87 | 30.0 | 8.13 | 1000 | 120 | 100.0 | V | 10.0 | 12.7 |
| 36.568 | 22.89 | 30.0 | 7.11 | 1000 | 120 | 100.0 | V | -9.0 | 12.8 |
| 51.430 | 22.42 | 30.0 | 7.58 | 1000 | 120 | 98.0 | V | 10.0 | 13.5 |
| 79.920 | 20.23 | 30.0 | 9.77 | 1000 | 120 | 170.0 | V | 261.0 | 8.1 |

Plot 2: 910.0 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



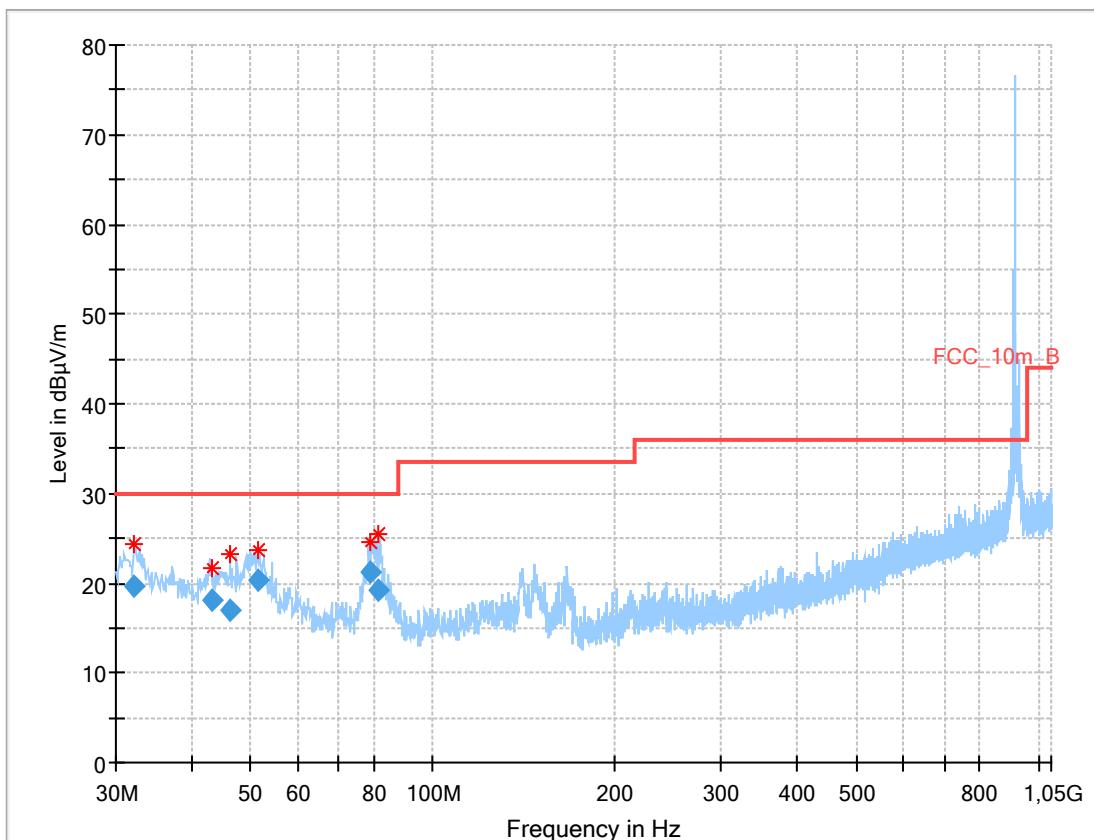
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 32.506 | 19.51 | 30.0 | 10.49 | 1000 | 120 | 101.0 | V | 10.0 | 12.3 |
| 33.305 | 19.53 | 30.0 | 10.47 | 1000 | 120 | 170.0 | V | 100.0 | 12.4 |
| 35.360 | 17.25 | 30.0 | 12.75 | 1000 | 120 | 98.0 | V | 91.0 | 12.7 |
| 45.038 | 17.83 | 30.0 | 12.17 | 1000 | 120 | 101.0 | V | 10.0 | 13.6 |
| 51.599 | 19.88 | 30.0 | 10.12 | 1000 | 120 | 98.0 | V | 100.0 | 13.5 |
| 80.576 | 20.47 | 30.0 | 9.53 | 1000 | 120 | 170.0 | V | 280.0 | 8.2 |

Plot 3: 918.1 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



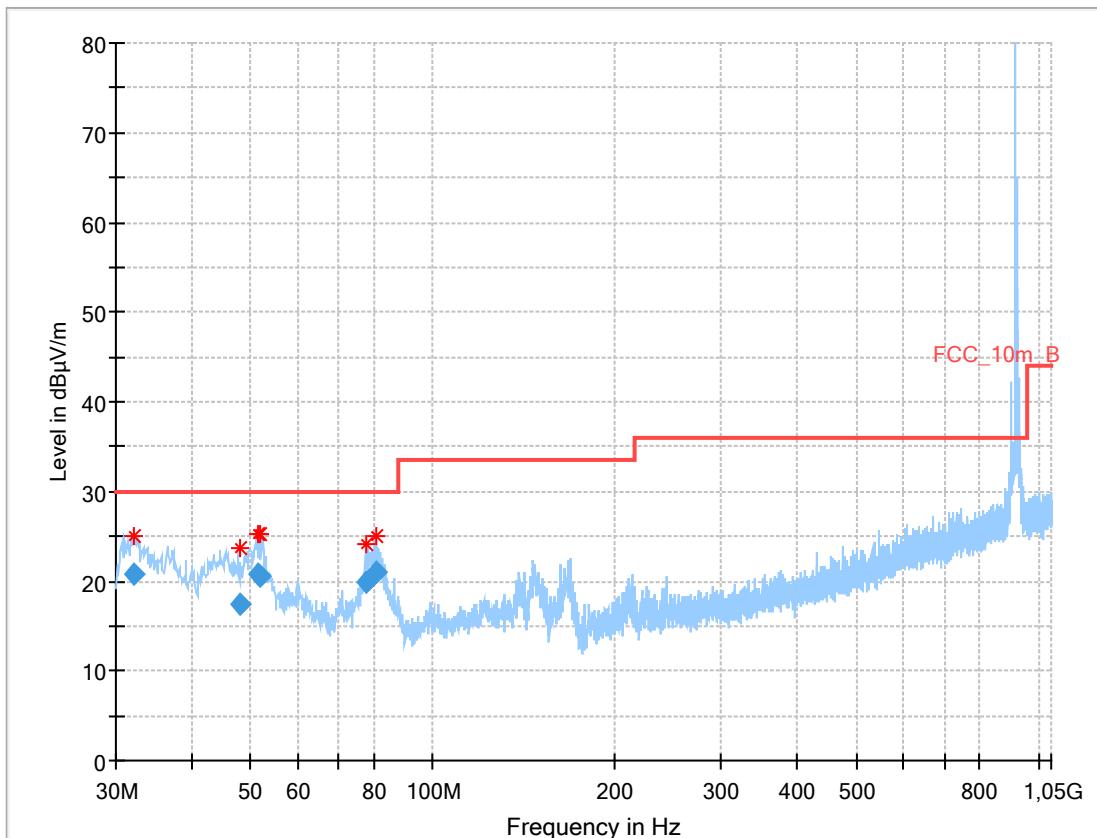
| Frequency (MHz) | QuasiPeak (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------------|----------------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 30.855 | 20.55 | 30.0 | 9.45 | 1000 | 120 | 98.0 | V | 280.0 | 12.0 |
| 32.038 | 19.21 | 30.0 | 10.79 | 1000 | 120 | 101.0 | V | 100.0 | 12.2 |
| 42.383 | 16.82 | 30.0 | 13.18 | 1000 | 120 | 98.0 | V | 91.0 | 13.4 |
| 49.616 | 18.71 | 30.0 | 11.29 | 1000 | 120 | 98.0 | V | 181.0 | 13.7 |
| 80.166 | 21.26 | 30.0 | 8.74 | 1000 | 120 | 170.0 | V | 190.0 | 8.1 |
| 80.675 | 20.43 | 30.0 | 9.57 | 1000 | 120 | 101.0 | V | 91.0 | 8.2 |

Plot 4: 911.8 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



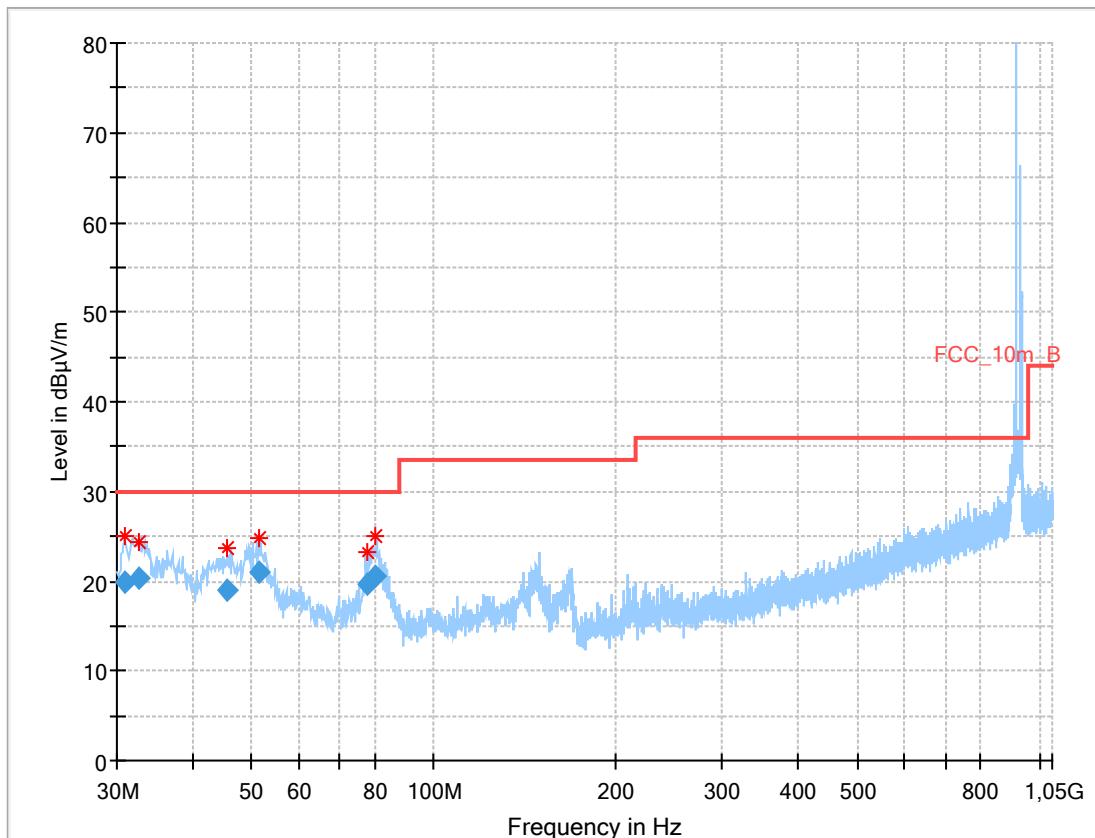
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 32.102 | 19.58 | 30.0 | 10.42 | 1000 | 120 | 170.0 | V | 1.0 | 12.2 |
| 43.163 | 18.03 | 30.0 | 11.97 | 1000 | 120 | 98.0 | V | 190.0 | 13.5 |
| 46.367 | 16.97 | 30.0 | 13.03 | 1000 | 120 | 170.0 | V | 1.0 | 13.7 |
| 51.571 | 20.30 | 30.0 | 9.70 | 1000 | 120 | 98.0 | V | 100.0 | 13.5 |
| 78.605 | 21.12 | 30.0 | 8.88 | 1000 | 120 | 170.0 | V | 271.0 | 8.3 |
| 81.538 | 19.30 | 30.0 | 10.70 | 1000 | 120 | 101.0 | V | 100.0 | 8.3 |

Plot 5: 920.5 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 32.115 | 20.74 | 30.0 | 9.26 | 1000 | 120 | 170.0 | V | 4.0 | 12.2 |
| 47.954 | 17.53 | 30.0 | 12.47 | 1000 | 120 | 98.0 | V | -10.0 | 13.7 |
| 51.391 | 20.81 | 30.0 | 9.19 | 1000 | 120 | 98.0 | V | -9.0 | 13.6 |
| 51.886 | 20.58 | 30.0 | 9.42 | 1000 | 120 | 101.0 | V | 81.0 | 13.5 |
| 77.738 | 19.87 | 30.0 | 10.13 | 1000 | 120 | 170.0 | V | 280.0 | 8.4 |
| 80.723 | 20.90 | 30.0 | 9.10 | 1000 | 120 | 170.0 | V | 100.0 | 8.2 |

Plot 6: 927.7 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 30.896 | 19.92 | 30.0 | 10.08 | 1000 | 120 | 170.0 | V | -10.0 | 12.0 |
| 32.571 | 20.38 | 30.0 | 9.62 | 1000 | 120 | 170.0 | V | 81.0 | 12.3 |
| 45.692 | 18.93 | 30.0 | 11.07 | 1000 | 120 | 100.0 | V | 280.0 | 13.6 |
| 51.368 | 20.92 | 30.0 | 9.08 | 1000 | 120 | 98.0 | V | 10.0 | 13.6 |
| 77.707 | 19.59 | 30.0 | 10.41 | 1000 | 120 | 170.0 | V | 190.0 | 8.4 |
| 80.159 | 20.46 | 30.0 | 9.54 | 1000 | 120 | 170.0 | V | 10.0 | 8.1 |

11.2.2 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 26 GHz |
| Trace mode | Max hold |
| Measured modulation | DBPSK |
| Test setup | See sub clause 6.2 A (1 GHz – 18 GHz) See sub clause 6.3 A (18 GHz – 26 GHz) |
| Measurement uncertainty | See sub clause 8 |

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

Limits:

ANSI C63.10 – FCC Public Notice DA 00-705

If the dwell time of the hopping signal is less than 100 ms (per channel), the reading may be adjusted by a factor: $F = 20\log(\text{dwell time}/100 \text{ ms})$

| 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 (dB μ V/m) | Measurement distance |
| Above 960 | 54.0 (average) 74.0 (peak) | 3 |

Result:

For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205.
If the dwell time of the hopping signal is less than 100 ms (per channel), the reading may be adjusted by a factor:

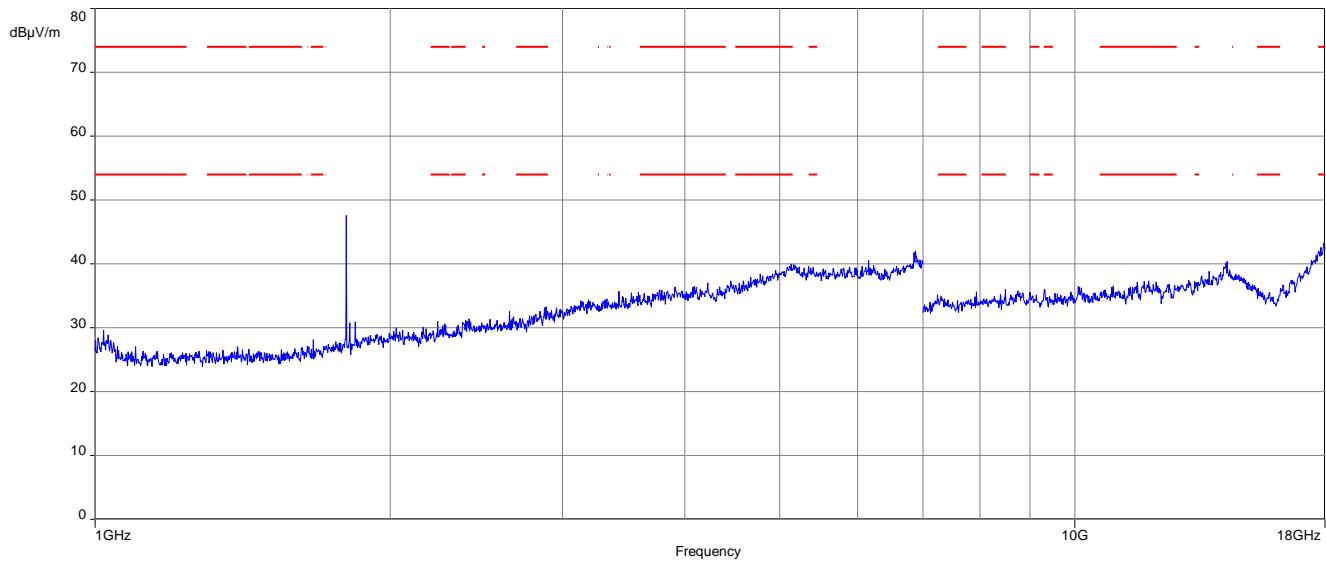
$$F = 20 \log (\text{dwell time}/100 \text{ ms})$$

One pulse train is higher than 100 ms so the correction factor is 0.

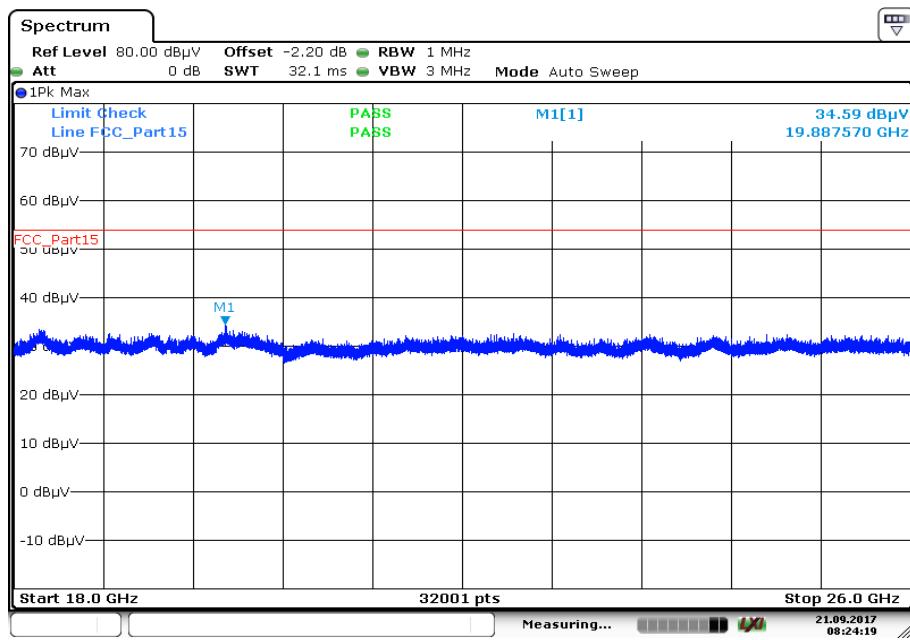
| TX spurious emissions radiated [dB μ V/m] | | | | | |
|---|----------|----------------------|--|----------|----------------------|
| -/- | | | -/- | | |
| F [MHz] | Detector | Level [dB μ V/m] | F [MHz] | Detector | Level [dB μ V/m] |
| -/- | | | -/- | | |
| No peaks closer 10 dB to the limit detected. | | | No peaks closer 10 dB to the limit detected. | | |
| -/- | | | -/- | | |
| -/- | Peak | | -/- | Peak | |
| | AVG | | | AVG | |
| -/- | | | -/- | | |
| -/- | Peak | | -/- | Peak | |
| | AVG | | | AVG | |
| -/- | | | -/- | | |
| -/- | Peak | | -/- | Peak | |
| | AVG | | | AVG | |

Plots:

Plot 1: 902.2 MHz, 1 GHz – 18 GHz, horizontal & vertical polarisation

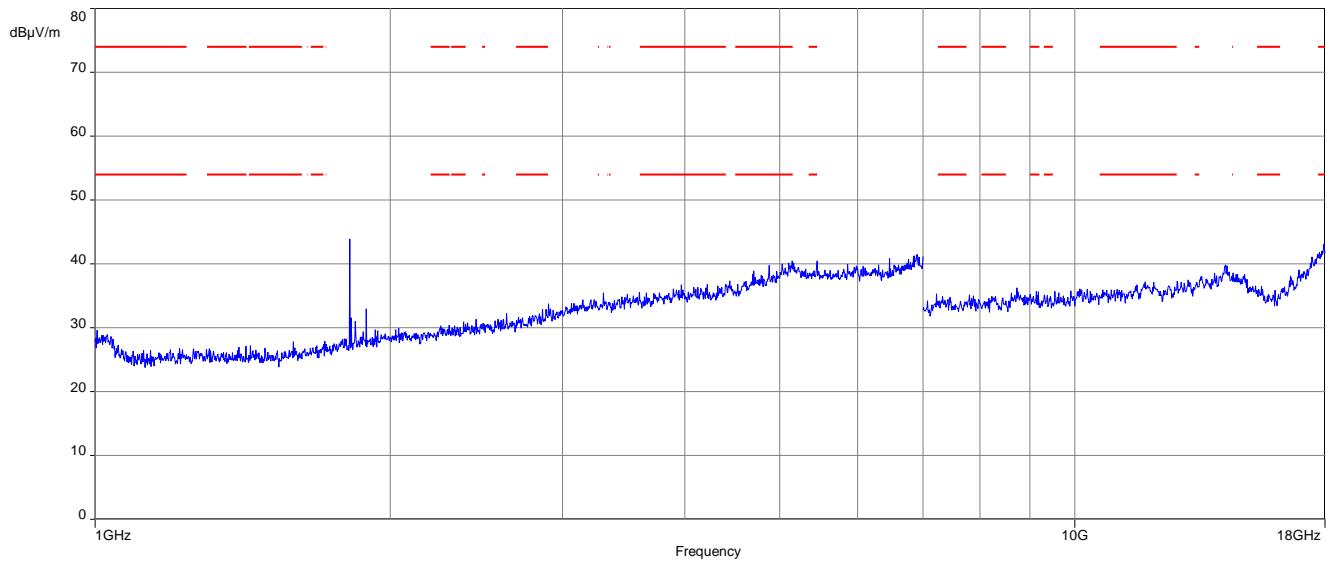


Plot 2: 902.2 MHz, 18 GHz – 26 GHz, horizontal & vertical polarisation

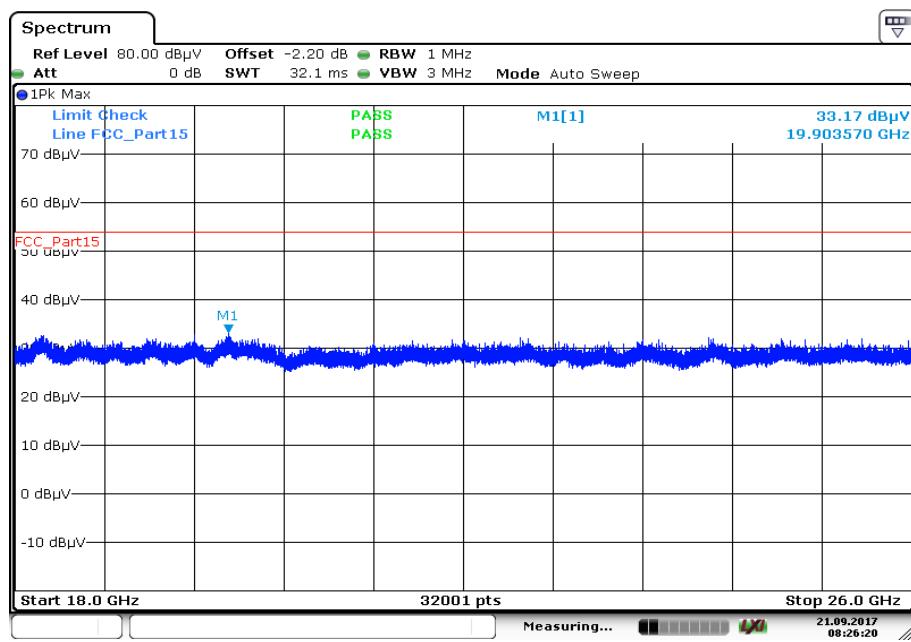


Date: 21.SEP.2017 08:24:19

Plot 3: 910.0 MHz, 1 GHz – 18 GHz, horizontal & vertical polarisation

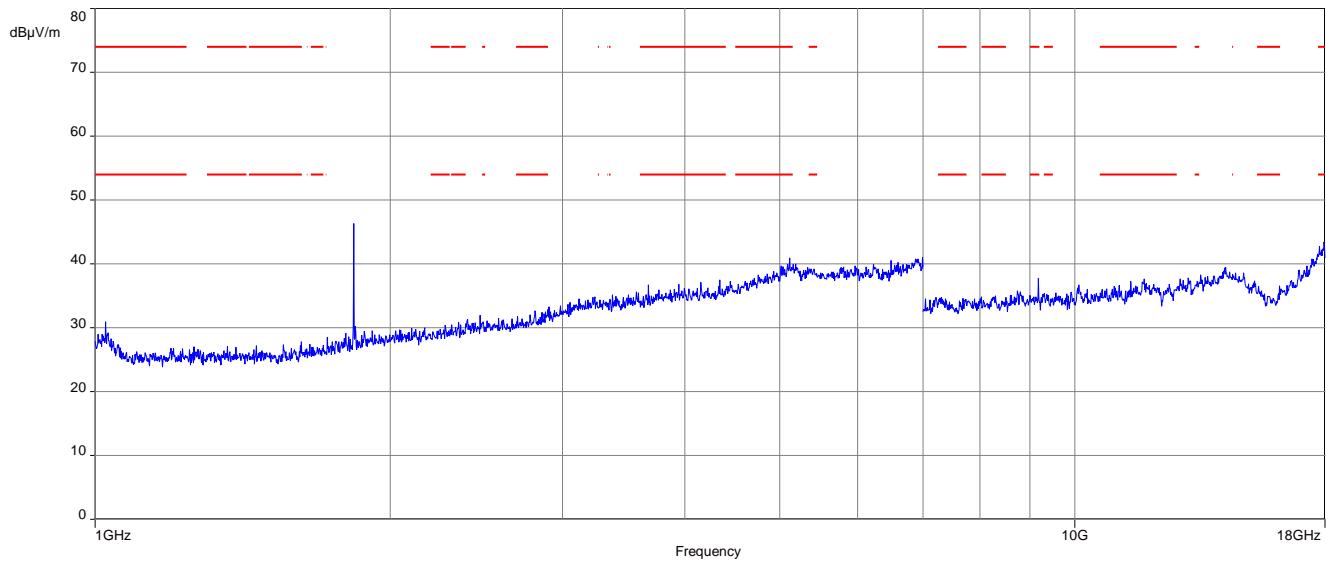


Plot 4: 910.0 MHz, 18 GHz – 26 GHz, horizontal & vertical polarisation

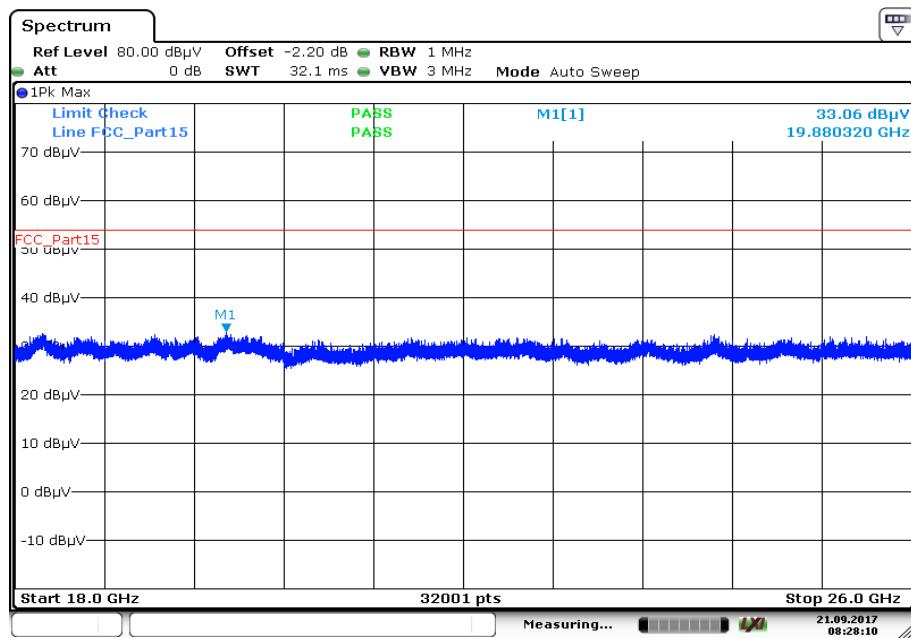


Date: 21.SEP.2017 08:26:20

Plot 5: 918.1 MHz 1 GHz – 18 GHz, horizontal & vertical polarisation

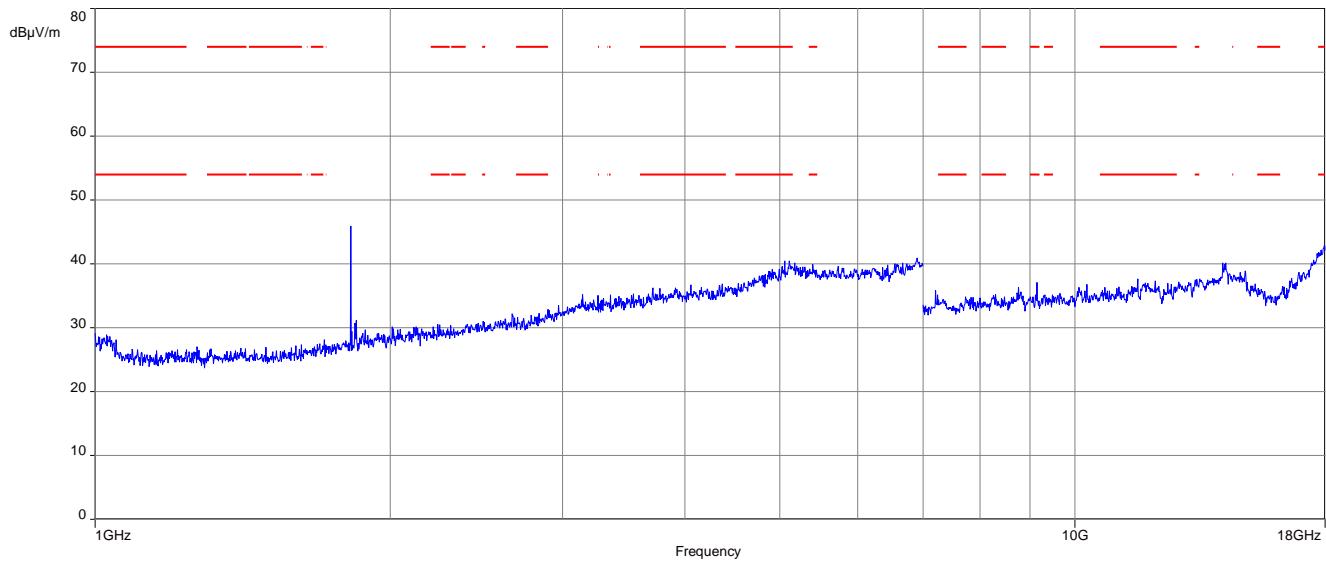


Plot 6: 918.1 MHz 18 GHz – 26 GHz, horizontal & vertical polarisation

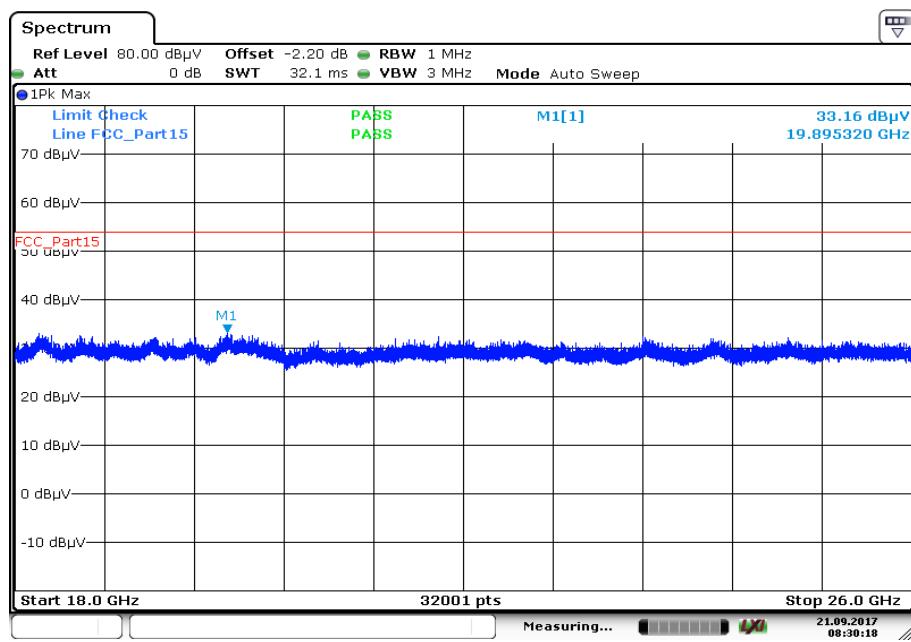


Date: 21.SEP.2017 08:28:11

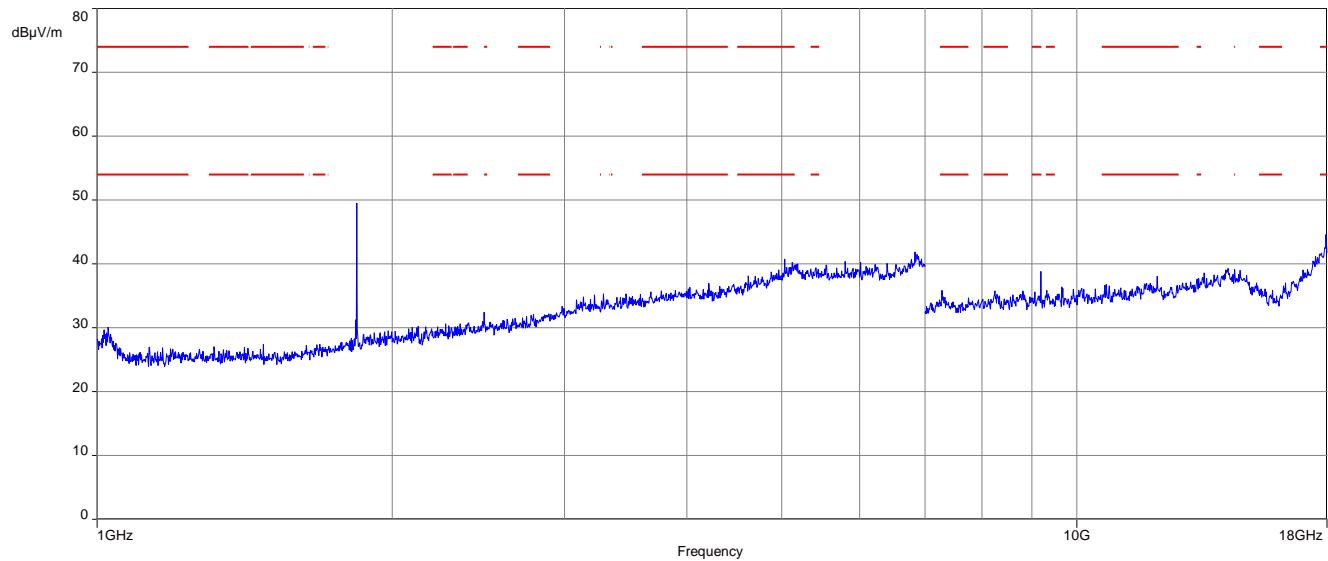
Plot 7: 911.8 MHz, 1 GHz – 18 GHz, horizontal & vertical polarisation



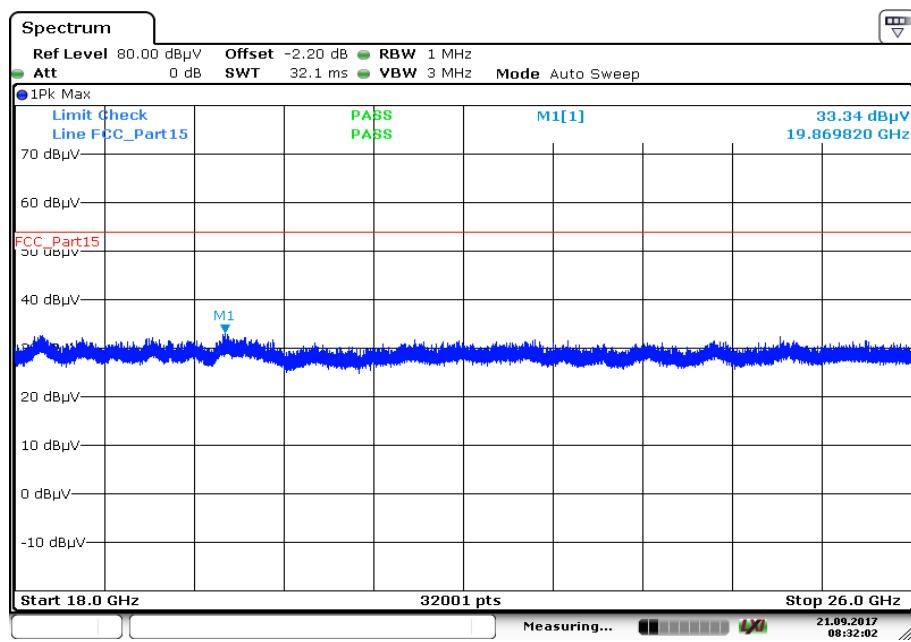
Plot 8: 911.8 MHz, 18 GHz – 26 GHz, horizontal & vertical polarisation



Plot 9: 920.5 MHz, 1 GHz – 18 GHz, horizontal & vertical polarisation

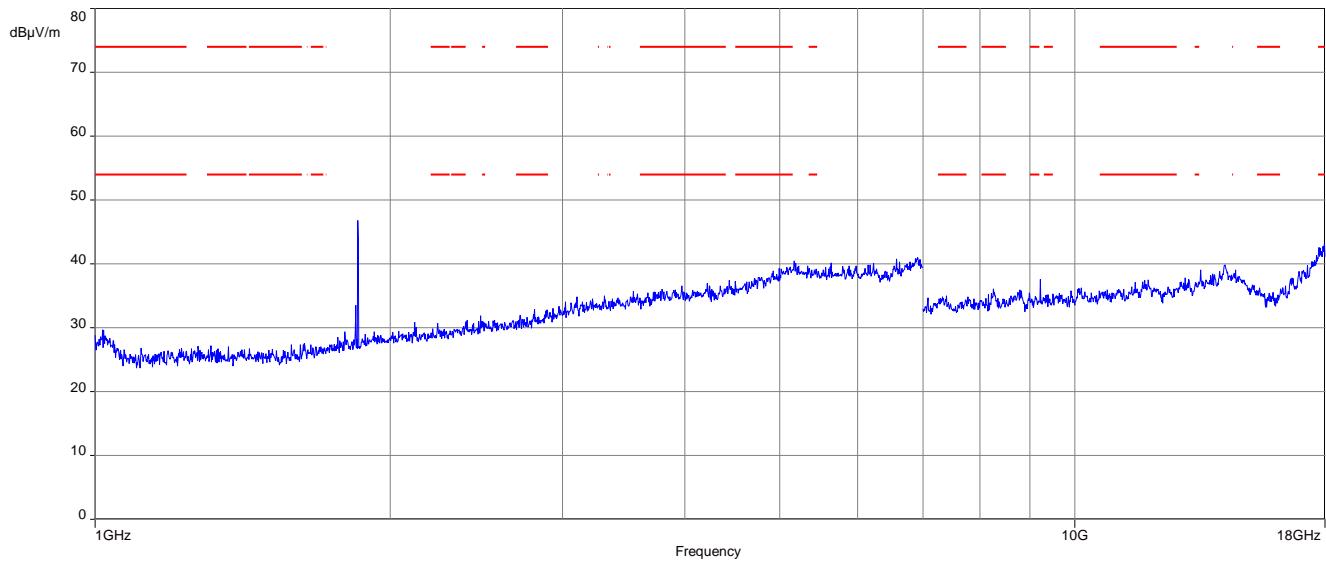


Plot 10: 920.5 MHz, 18 GHz – 26 GHz, horizontal & vertical polarisation

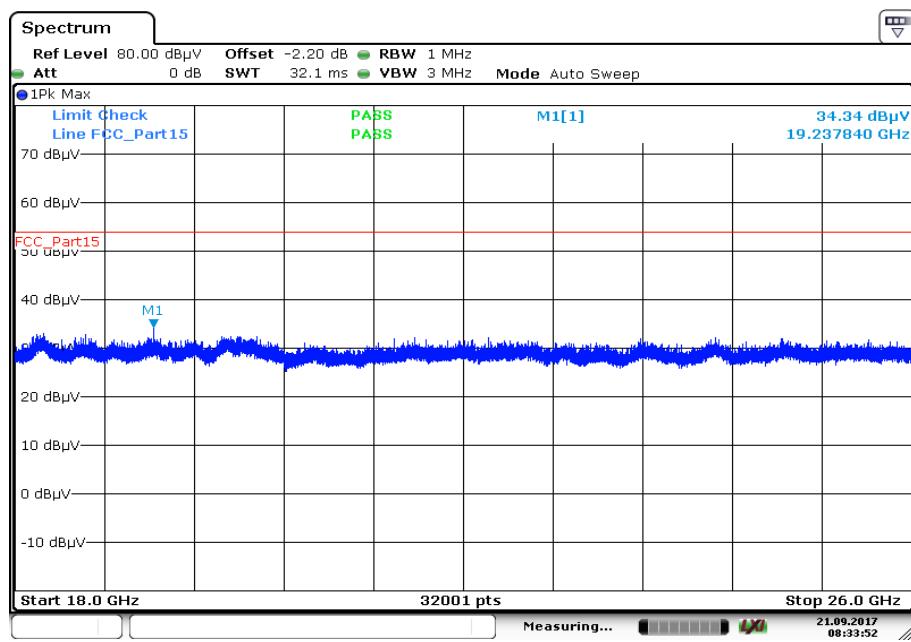


Date: 21.SEP.2017 08:32:03

Plot 11: 927.7 MHz 1 GHz – 18 GHz, horizontal & vertical polarisation



Plot 12: 927.7 MHz 18 GHz – 26 GHz, horizontal & vertical polarisation



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/N₀ | Carrier to noise-density ratio, expressed in dB-Hz |

Annex B Document history

| Version | Applied changes | Date of release |
|---------|-------------------|-----------------|
| -/- | Initial release | 2017-09-26 |
| A | Editorial changes | 2017-10-23 |

Annex C Accreditation Certificate

| first page | last page |
|---|--|
| <p>DAkkS Deutsche Akkreditierungsstelle</p> <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV Unterzeichnerin der Multilateralen Abkommen von EA, ILAC und IAF zur gegenseitigen Anerkennung</p> <p>Akkreditierung </p> <p>Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken</p> <p>die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen:</p> <p>Funk Mobilfunk (GSM / DCS) + OTA Elektromagnetische Verträglichkeit (EMV) Produktsicherheit SAR / EMF Umwelt Smart Card Technology Bluetooth® Automotive Wi-Fi-Services Kanadische Anforderungen US-Anforderungen Akustik Near Field Communication (NFC)</p> <p>Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 25.11.2016 mit der Akkreditierungsnr. D-PL-12076-01, und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten.</p> <p>Registrierungsnummer der Urkunde: D-PL-12076-01-01</p> <p>Frankfurt, 25.11.2016 Im Auftrag Dipl.-Ing. (FH) Ralf Egner Abteilungsleiter Sehr Hinweise auf der Rückseite</p>  | <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Standort Berlin Spittelmarkt 10 10117 Berlin</p> <p>Standort Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main</p> <p>Standort Braunschweig Bundesallee 100 38116 Braunschweig</p> <p>Die auszugsweise Veröffentlichung der Akkreditierungsurkunde bedarf der vorherigen schriftlichen Zustimmung der Deutsche Akkreditierungsstelle GmbH (DAkkS). Ausgenommen davon ist die separate Weiterverbreitung des Deckblattes durch die umseitig genannte Konformitätsbewertungsstelle in unveränderter Form.</p> <p>Es darf nicht der Anschein erweckt werden, dass sich die Akkreditierung auch auf Bereiche erstreckt, die über den durch die DAkkS bestätigten Akkreditierungsbereich hinausgehen.</p> <p>Die Akkreditierung erfolgte gemäß des Gesetzes über die Akkreditierungsstelle (AkkStelleG) vom 31. Juli 2009 (BGBl. I, S. 2625) sowie der Verordnung (EG) Nr. 765/2008 des Europäischen Parlaments und des Rates vom 9. Juli 2008 über die Vorschriften für die Akkreditierung und Marktüberwachung im Zusammenhang mit der Vermarktung von Produkten (Abl. L 218 vom 9. Juli 2008, S. 30).</p> <p>Die DAkkS ist Unterzeichnerin der Multilateralen Abkommen zur gegenseitigen Anerkennung der European co-operation for Accreditation (EA), des International Accreditation Forum (IAF) und der International Laboratory Accreditation Cooperation (ILAC). Die Unterzeichner dieser Abkommen erkennen ihre Akkreditierungen gegenseitig an.</p> <p>Der aktuelle Stand der Mitgliedschaft kann folgenden Webseiten entnommen werden: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu</p> |

Note: The current certificate including 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-12076-01-01.pdf>

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