



TEST REPORT

BNetzA-CAB-02/21-102

Test report no.: 1-5168/17-02-14-B

Testing laboratory

CTC advanced GmbH

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Accredited Testing Laboratory:

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

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

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

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

Test Item

Kind of test item: Personal Protection System (PPS)

Model name: CRS101

FCC ID: RFD-CRS101

Frequency: 5.925 GHz to 7.250 GHZ

Antenna: Integrated antenna

Power supply: 9 V to 36 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:

Karsten Gerdal
Lab Manager
Radio Communications & EMC

Test performed:

Benedikt Gerber
Lab Manager
Radio Communications & EMC

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2 General information

2.1 Notes and disclaimer

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

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This test report replaces the test report with the number 1-5168/17-02-14-A and dated 2019-03-29.

2.2 Application details

| | |
|------------------------------------|------------------|
| Date of receipt of order: | 2017-12-07 |
| Date of receipt of test item: | 2018-01-09 |
| Start of test: | 2018-01-09 |
| End of test: | 2019-02-18 |
| Person(s) present during the test: | Mr. Beat Sigrist |

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 |

| 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 +50 °C during high temperature tests -20 °C during low temperature tests |
| Relative humidity content | : | | 55 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | V_{nom} V_{max} V_{min} | 12 V DC, by external power supply 36 V 9 V |

5 Test item

5.1 General description

| | | |
|----------------------------|---|---------------------------------------------------------|
| Kind of test item | : | Personal Protection System (PPS) |
| Type identification | : | CRS101 |
| S/N serial number | : | 172 |
| HW hardware status | : | Rev-0.4 Rev-0.5 (used for retest of §15.250 (d) (2)) |
| SW software status | : | SW 0.1.7, Build 486M_bqt |
| Frequency band | : | 5.925 GHz to 7.250 GHz |
| Type of radio transmission | : | Pulse |
| Use of frequency spectrum | : | |
| Type of modulation | : | BPSK / BPM |
| Number of channels | : | 1 |
| Antenna | : | Integrated antenna |
| Power supply | : | 9 V to 36 V DC, by external power supply |
| Temperature range | : | -20°C to +50°C |

5.2 Additional information

A special test mode is used with a cycle time of 1ms:

To set up the EUT in transmitter test mode, the following commands were sent via serial interface

| |
|---------------------------------|
| Channel 7 |
| 1. <i>\$radio,init,1,7,70</i> |
| 2. <i>\$radio,cf,w,1000,200</i> |

Transmitter test mode parameters:

| | |
|------------------|----------------------|
| Channel | 7 |
| Center frequency | 6489.6 MHz |
| Power Setting | 70 (program setting) |
| Cycle time | 1000 ms |
| Pulse length | 200 ms |

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: 1-5168/17-02-14_AnnexA
1-5168/17-02-14_AnnexB
1-5168/17-02-14_AnnexC

A declaration of the manufacturer is included in test report: 1-5168/17-02-14_AnnexD

6 Description of the test setup

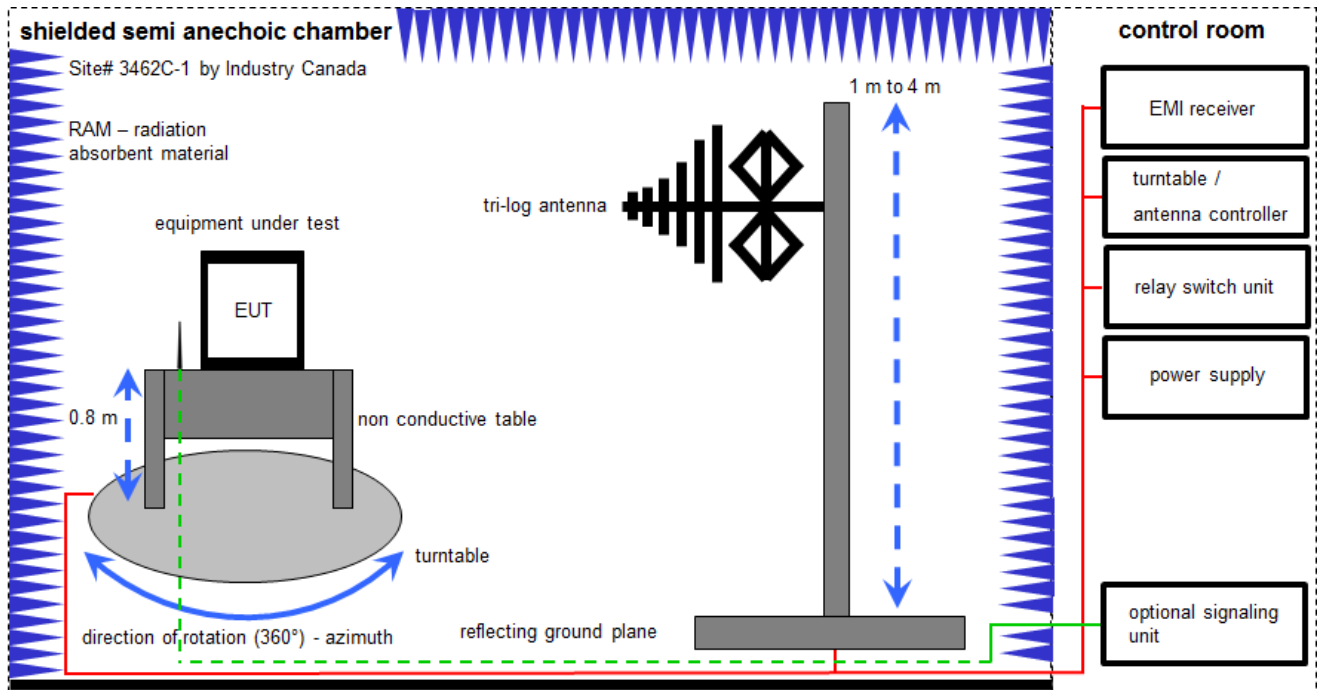
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements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

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

Agenda: Kind of Calibration

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

6.1 Shielded semi anechoic chamber



Measurement distance: tri-log antenna 10 meter

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

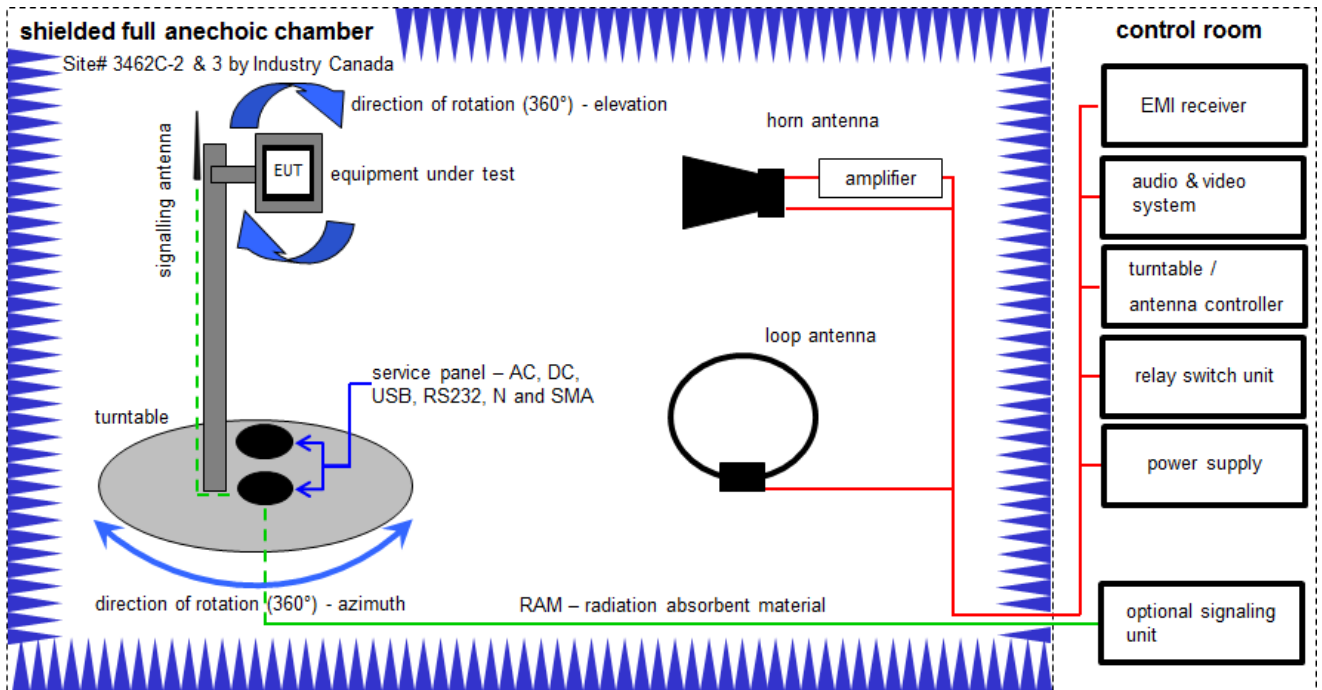
Example calculation:

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

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|---------------------------------------------------|------------------|-------------------------------|-----------------|-----------|---------------------|--------------------------|--------------------------|
| 1 | 45 | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | 50 | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2920A04466 | 300000580 | ne | -/- | -/- |
| 3 | 93 | Meßkabine 1 | HF-Absorberhalle | MWB AG 300023 | | 300000551 | ne | -/- | -/- |
| 4 | n. a. | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 15.12.2017 12.12.2018 | 14.12.2018 11.12.2019 |
| 5 | n. a. | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | vKI! | 15.01.2018 | 14.01.2020 |
| 6 | n. a. | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 7 | n. a. | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 8 | n. a. | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 9 | n. a. | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 371 | 300003854 | vKI! | 24.11.2017 | 23.11.2020 |

6.2 Shielded fully anechoic chamber



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

$$FS = UR + CA + AF$$

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

Example calculation:

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

$$OP = AV + D - G + CA$$

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

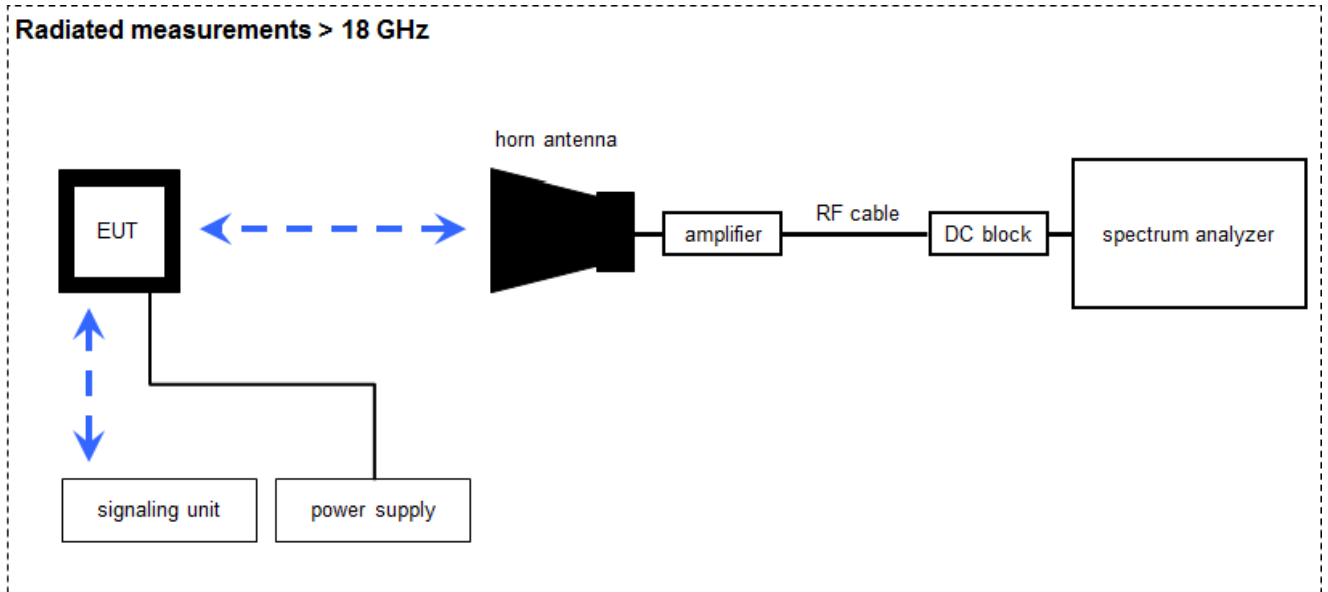
Example calculation:

$$OP \text{ [dBm]} = -39.0 \text{ [dBm]} + 57.0 \text{ [dB]} - 12.0 \text{ [dBi]} + (-36.0) \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration | |
|-----|------------|-----------|------------------------------------------------|--------------|------------|------------|---------------------|------------------|------------------|------------|
| 1 | 1 | n. a. | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2818A03450 | 300001040 | vIKI! | 12.12.2017 | 11.12.2020 |
| 2 | 2 | n. a. | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 3 | 3 | 19 | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3697 | 300001605 | vIKI! | 14.02.2017 | 13.02.2019 |
| 4 | 135 | | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 8812-3089 | 300000307 | vIKI! | 07.07.2017 | 06.07.2019 |
| 5 | 4 | n. a. | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | -/- | -/- |
| 6 | 5 | n. a. | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | | | |
| 7 | | n. a. | Signal- and Spectrum Analyzer | FSW26 | R&S | 101455 | 300004528 | k | 20.12.2017 | 19.12.2018 |

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

$$FS = UR + CA + AF$$

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

Example calculation:

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

$$OP = AV + D - G + CA$$

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

Example calculation:

$$OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 \mu W)$$

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|-----------------------------------------------|----------------------------|----------------------|------------|-----------|---------------------|------------------|------------------|
| 1 | 1 | CR 79 Std. Gain Horn Antenna 26.5-40.0 GHz | V637 | Narda | 7911 | 300001751 | ne | -/- | -/- |
| 2 | 2 | A027 Std. Gain Horn Antenna 18.0-26.5 GHz | 638 | Narda | | 300000486 | k | 13.12.2017 | 12.12.2019 |
| 3 | 3 | n. a. Spectrum Analyzer 20 Hz - 50 GHz | FSU50 | R&S | 200012 | 300003443 | k | 28.10.2016 | 27.10.2018 |
| 4 | 4 | n. a. PXA Spectrum Analyzer 3Hz to 50GHz | N9030A PXA Signal Analyzer | Agilent Technologies | US51350267 | 300004338 | k | 05.03.2018 | 04.03.2019 |
| 5 | 5 | n. a. Broadband LNA 18-50 GHz | CBL18503070PN | CERNEX | 25240 | 300004948 | ev | -/- | -/- |
| 6 | n. a. | Signal- and Spectrum Analyzer | FSW26 | R&S | 101455 | 300004528 | k | 20.12.2017 | 19.12.2018 |

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 $\pm 45^\circ$ and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8 Measurement uncertainty

| Test case | Uncertainty |
|---------------------------------------------------------------------|---------------------------------------------------------|
| Equivalent isotropically radiated power (e.i.r.p.) | Conducted value ± 1 dB Radiated value ± 3 dB |
| Permitted range of operating frequencies | ± 100 kHz |
| Conducted unwanted emissions in the spurious domain (up to 40 GHz) | ± 1 dB |
| Radiated unwanted emissions in the spurious domain (up to 40 GHz) | ± 3 dB |
| Conducted unwanted emissions in the spurious domain (40 to 50 GHz) | ± 4 dB |
| Radiated unwanted emissions in the spurious domain (40 to 50 GHz) | ± 4 dB |
| Conducted unwanted emissions in the spurious domain (50 to 300 GHz) | ± 5 dB |
| Radiated unwanted emissions in the spurious domain (50 to 300 GHz) | ± 5 dB |
| DC and low frequency voltages | ± 3 % |
| Temperature | ± 1 °C |
| Humidity | ± 3 % |

9 Summary of measurement results

| | |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | No deviations from the technical specifications were ascertained |
| <input type="checkbox"/> | There were deviations from the technical specifications ascertained |
| <input 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 47 Part 15 | see table | 2019-05-29 | -/- |

| Test specification clause | Test case | Temperature conditions | Power source | Pass | Fail | NA | NP | Remark |
|--------------------------------|-----------------------|------------------------|--------------|-------------------------------------|--------------------------|--------------------------|--------------------------|----------|
| §15.250 (a) | 10 dB Bandwidth | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| §15.250 (d) (1)-(5) §15.209 | TX Radiated Emissions | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |

Note: NA = Not Applicable; NP = Not Performed

10 Measurement results

10.1 10 dB - Bandwidth

Description:

(a) *UWB bandwidth.* For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M .

Measurement:

| Measurement parameter | |
|-----------------------|----------|
| Detector: | Peak |
| Video bandwidth: | 50 MHz |
| Resolution bandwidth: | 80 MHz |
| Trace-Mode: | Max Hold |

Test Setup: 7.3

Limits:

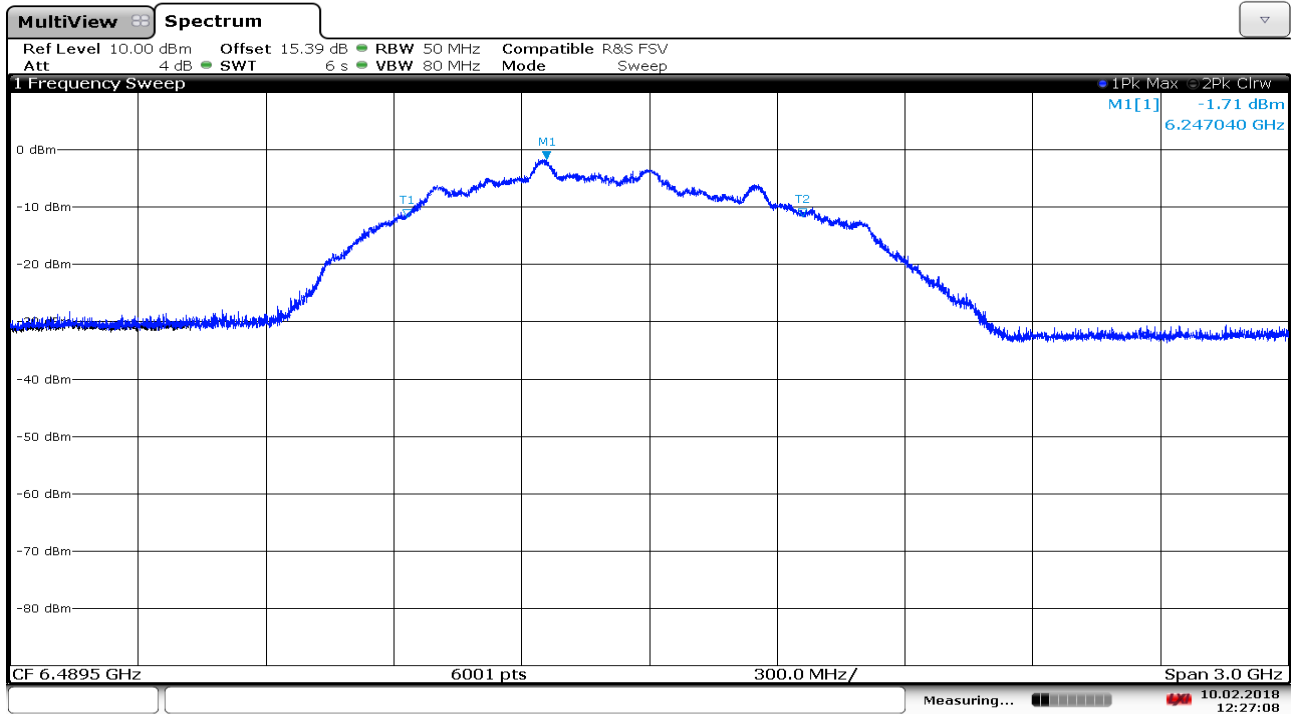
| |
|----------|
| >500 MHz |
|----------|

Results:

| Temperature | Channel | Lower -10 dB point [GHz] | Higher -10 dB point [GHz] | UWB bandwidth [MHz] |
|-------------|---------|--------------------------|---------------------------|---------------------|
| 22 °C | 7 | 5.82661 | 6.9589 | 1130 |

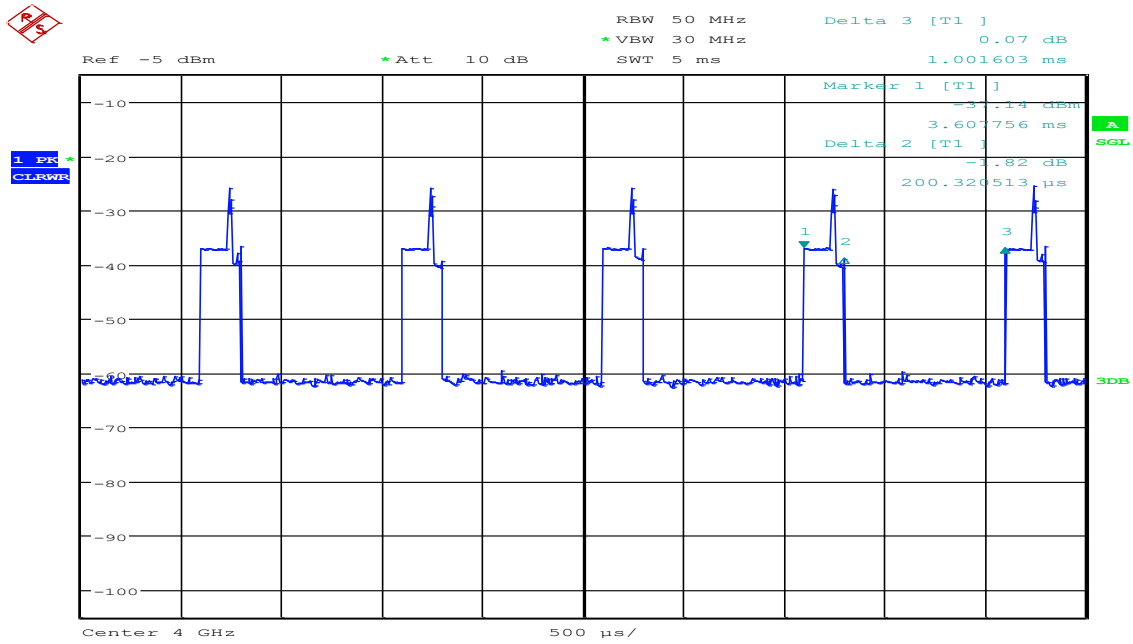
Verdict: Compliant

Plot 1: Channel 7, 10 dB down



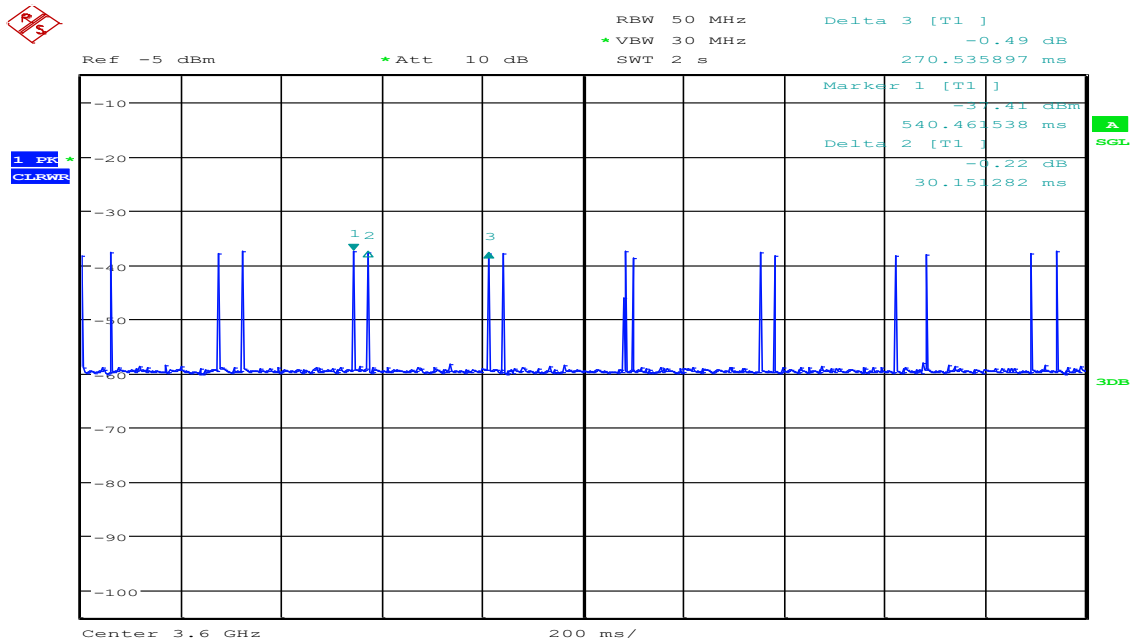
12:27:08 10.02.2018

Plot 2: Duty Cycle, test mode



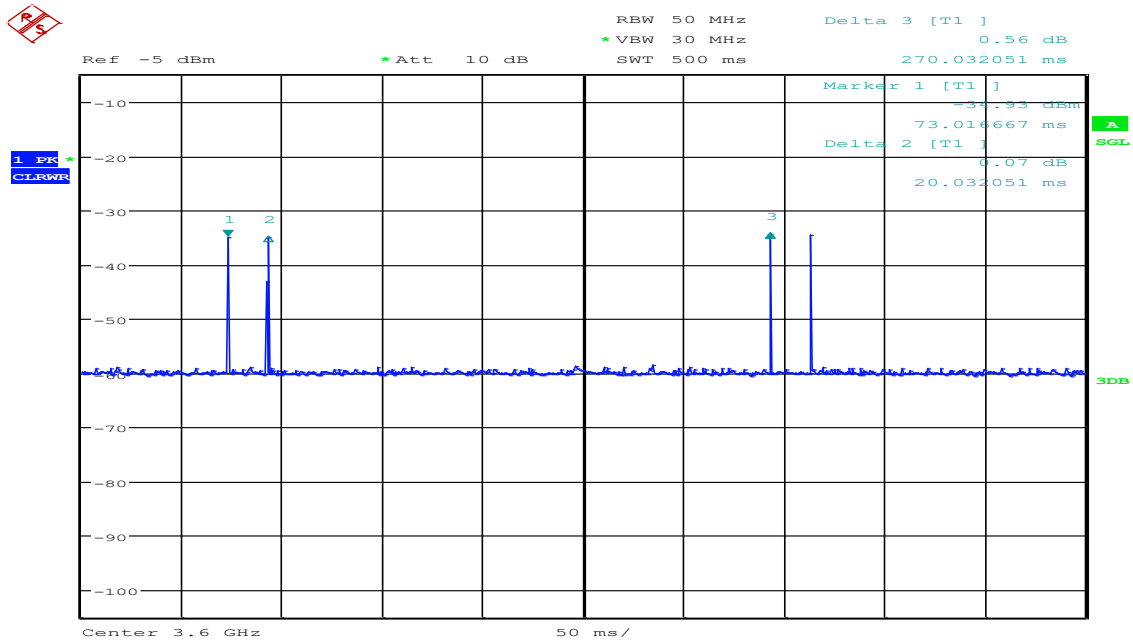
Date: 13.MAR.2018 14:03:03

Plot 3: Duty Cycle, normal mode



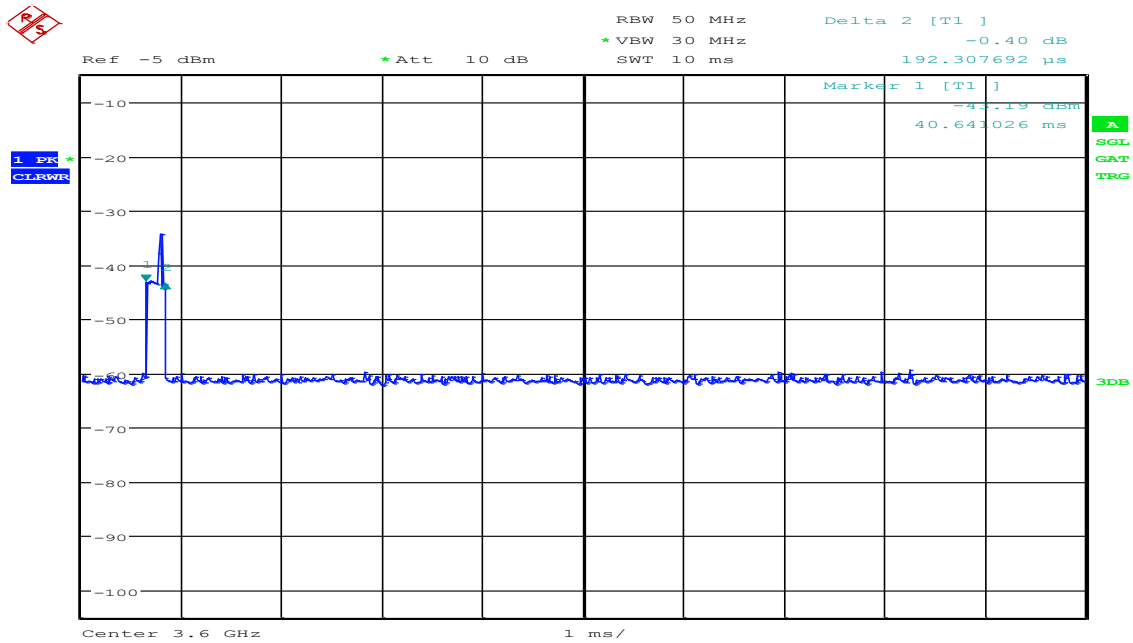
Date: 13.MAR.2018 13:42:08

Plot 4: Duty Cycle, normal mode



Date: 13.MAR.2018 13:42:52

Plot 5: Duty Cycle, normal mode



Date: 13.MAR.2018 13:50:55

10.2 TX Radiated Emissions

Description:

Measurement of the radiated spurious emissions in transmit mode.

Measurement:

§15.209 / §15.250 (d) (4):

| Average Measurement parameter | |
|-------------------------------|------------|
| Detector: | Peak/QPeak |
| Sweep time: | 1 s |
| Number of points | 8001 |
| Resolution bandwidth: | 120kHz |
| Video bandwidth: | ≥ RBW |
| Trace-Mode: | Max Hold |

§15.250 (d) (1):

| Average Measurement parameter | |
|-------------------------------|------------|
| Detector: | RMS |
| Sweep time: | 1 ms/pt |
| Number of points | 1001/10001 |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Trace-Mode: | Max Hold |

§15.250 (d) (2):

| Average Measurement parameter | |
|-------------------------------|----------|
| Detector: | RMS |
| Sweep time: | 1 ms/pt |
| Number of points | 10001 |
| Resolution bandwidth: | 1 kHz |
| Video bandwidth: | 3 kHz |
| Trace-Mode: | Max Hold |

§15.250 (d) (3):

| Peak Measurement parameter | |
|----------------------------|-----------|
| Detector: | Max Peak |
| Sweep time: | 1 s |
| Resolution bandwidth: | 50 MHz |
| Video bandwidth: | 80 MHz |
| Span: | Zero span |
| Trace-Mode: | Max Hold |

Emission limits below 960 MHz (§15.209):

| Frequency (MHz) | Field strength ($\mu\text{V/m}$) | Measurement distance (m) |
|-----------------|------------------------------------|--------------------------|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 (29.5 dB $\mu\text{V/m}$) | 30 |
| 30 – 88 | 100 (40 dB $\mu\text{V/m}$) | 3 |
| 88 – 216 | 150 (43.5 dB $\mu\text{V/m}$) | 3 |
| 216 – 960 | 200 (46 dB $\mu\text{V/m}$) | 3 |
| > 960 | 500 (54 dB $\mu\text{V/m}$) | 3 |

UWB-emission-Limits:

FCC CFR 47:

§15.519 (c)

The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following RMS average limits based on measurements using a 1 MHz resolution bandwidth:

| Frequency in MHz | EIRP in dBm |
|------------------|-------------|
| 960 to 1610 | -75.3 |
| 1610 to 1990 | -63.3 |
| 1990 to 3100 | -61.3 |
| 3100 to 10600 | -41.3 |
| Above 10600 | -61.3 |

§15.519 (d)

In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

| Frequency in MHz | EIRP in dBm |
|------------------|-------------|
| 1164 to 1240 | -85.3 |
| 1559 to 1610 | -85.3 |

(e) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_m . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

Result:

| | Channel | Frequency in MHz | Max e.i.r.p. / dBm | | Plot |
|--------------------|---------|------------------|--------------------|------------|------|
| | | | average value | peak value | |
| Max E.I.R.P | 7 | 6489.5 | -41.80 | -3.29 | 9,10 |

Emissions outside the band:

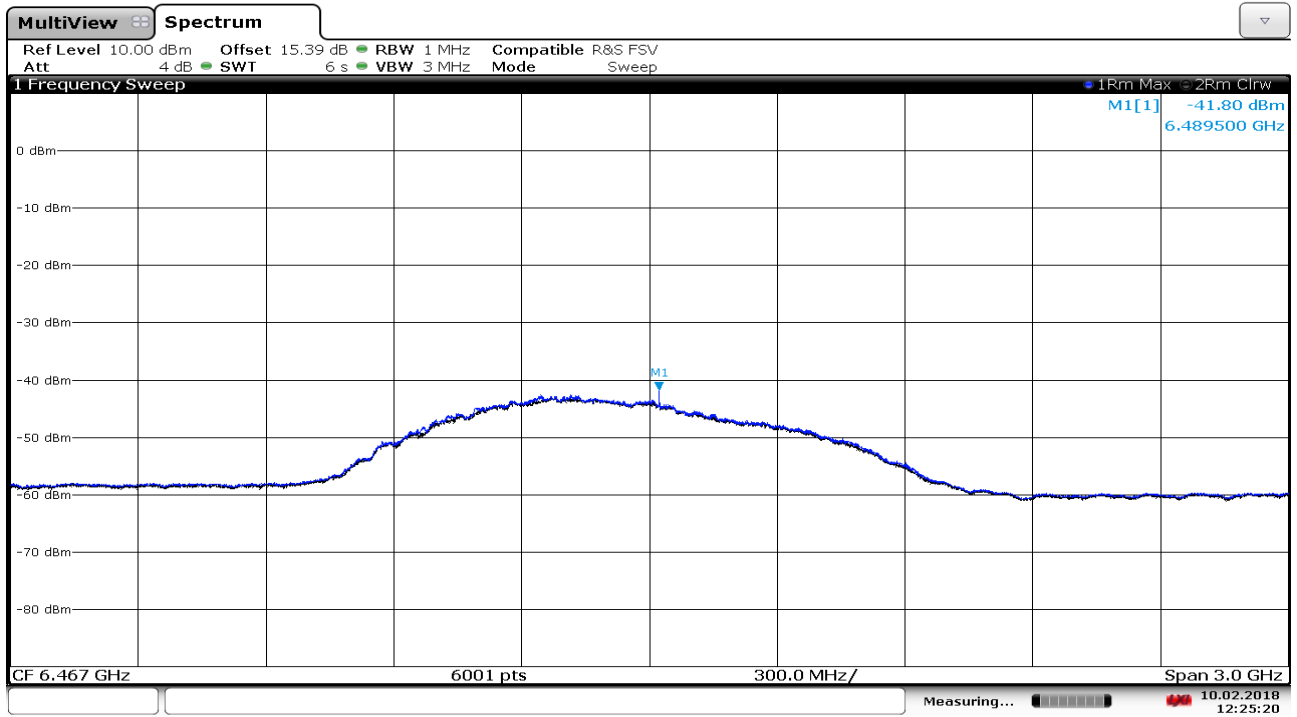
| Channel | Frequency in GHZ | Detector | Filter type | Bandwidth | Level in dBm | Limit in dBm | Margin in dB |
|---------|------------------|----------|-------------|-----------|--------------|--------------|--------------|
| 7 | 1.84285 | RMS | 6 dB | 1 MHz | -75.3 | -63.3 | 12 |
| 7 | 2.07337 | RMS | 6 dB | 1 MHz | -74.8 | -61.3 | 13.5 |
| 7 | 3.99359 | RMS | 6 dB | 1 MHz | -70.2 | -41.3 | 28.9 |
| 7 | 4.11842 | RMS | 6 dB | 1 MHz | -70.6 | -41.3 | 29.3 |
| 7 | 12.97900 | RMS | 6 dB | 1 MHz | -64.1 | -61.3 | 2.8 |
| 7 | 1.5744 | RMS | 6 dB | 1 kHz | -83.0 | -85.3 | -2.3* |

*please refer to chapter 10.4 of this test report for further documentation

For emissions below 1 GHz, please refer to plots 10 to 11.

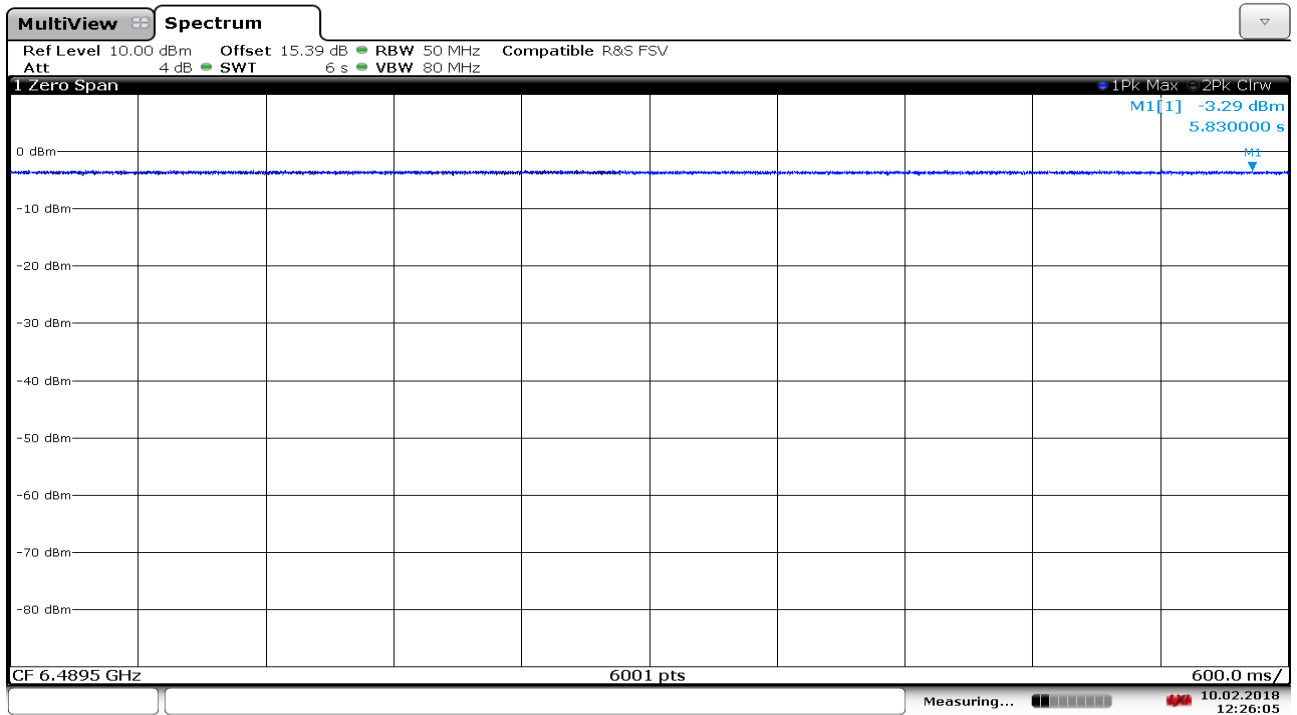
Verdict: **complies**

Plot 6: Channel 7, RMS power



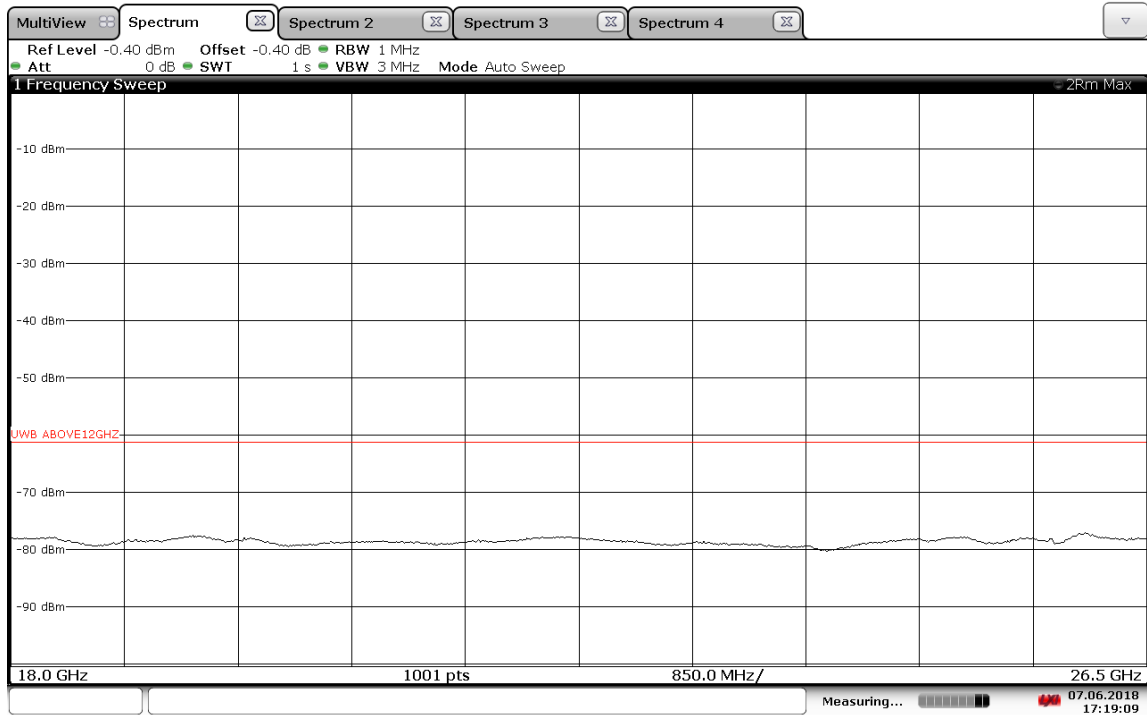
12:25:21 10.02.2018

Plot 7: Channel 7, Peak power



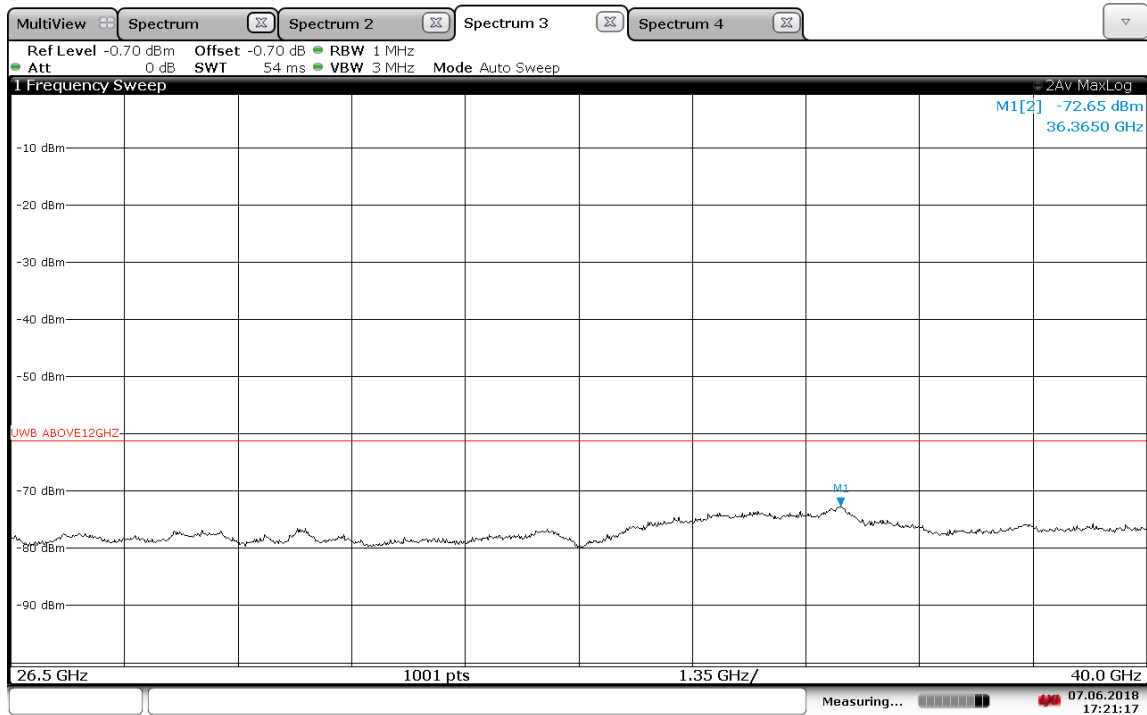
12:26:05 10.02.2018

Plot 8: Channel 7, 18 GHz – 26.5 GHz



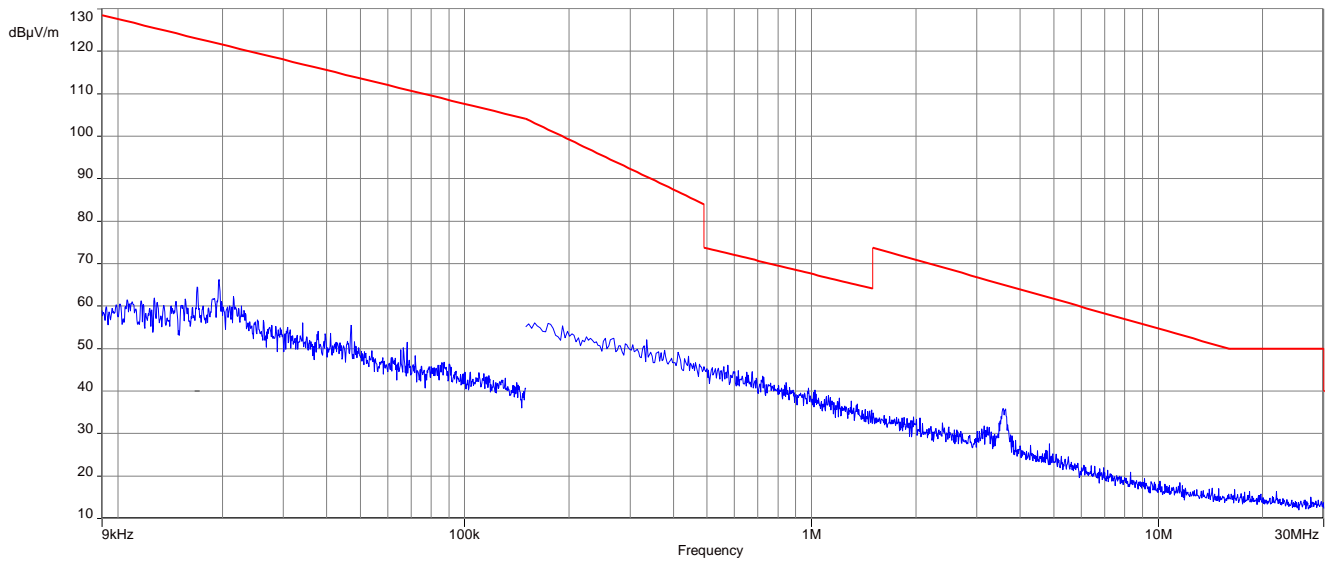
17:19:09 07.06.2018

Plot 9: Channel 7, 26.5 GHz –40 GHz

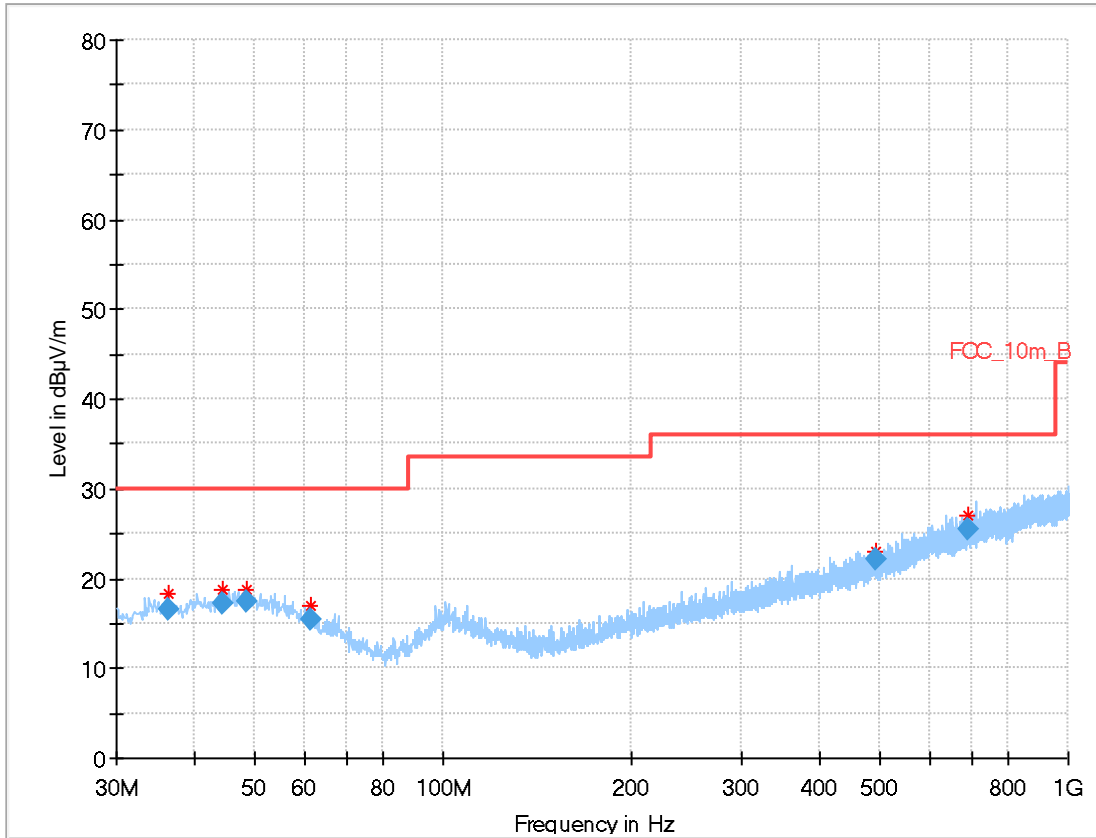


17:21:18 07.06.2018

Plot 10: Channel 7, 15.209, TX Magnetic



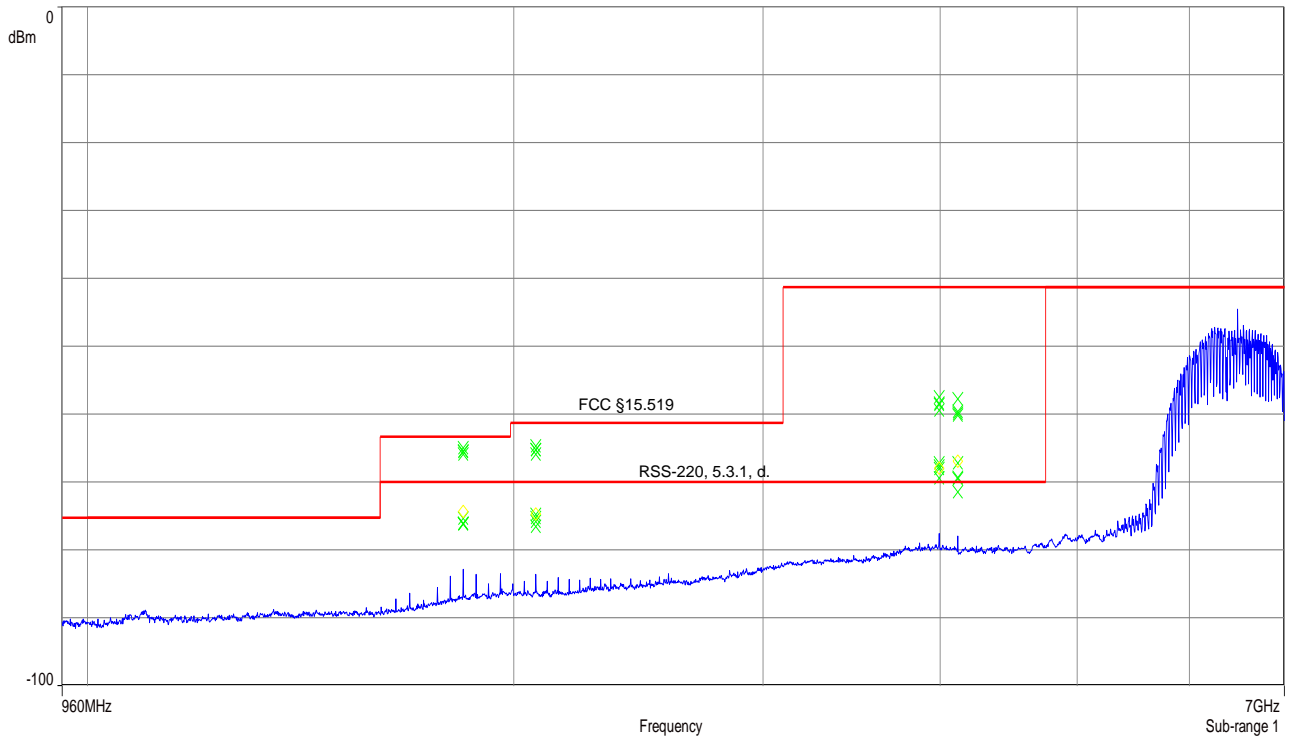
Plot 11: Channel 7, 15.209, 30 MHz – 1 GHz



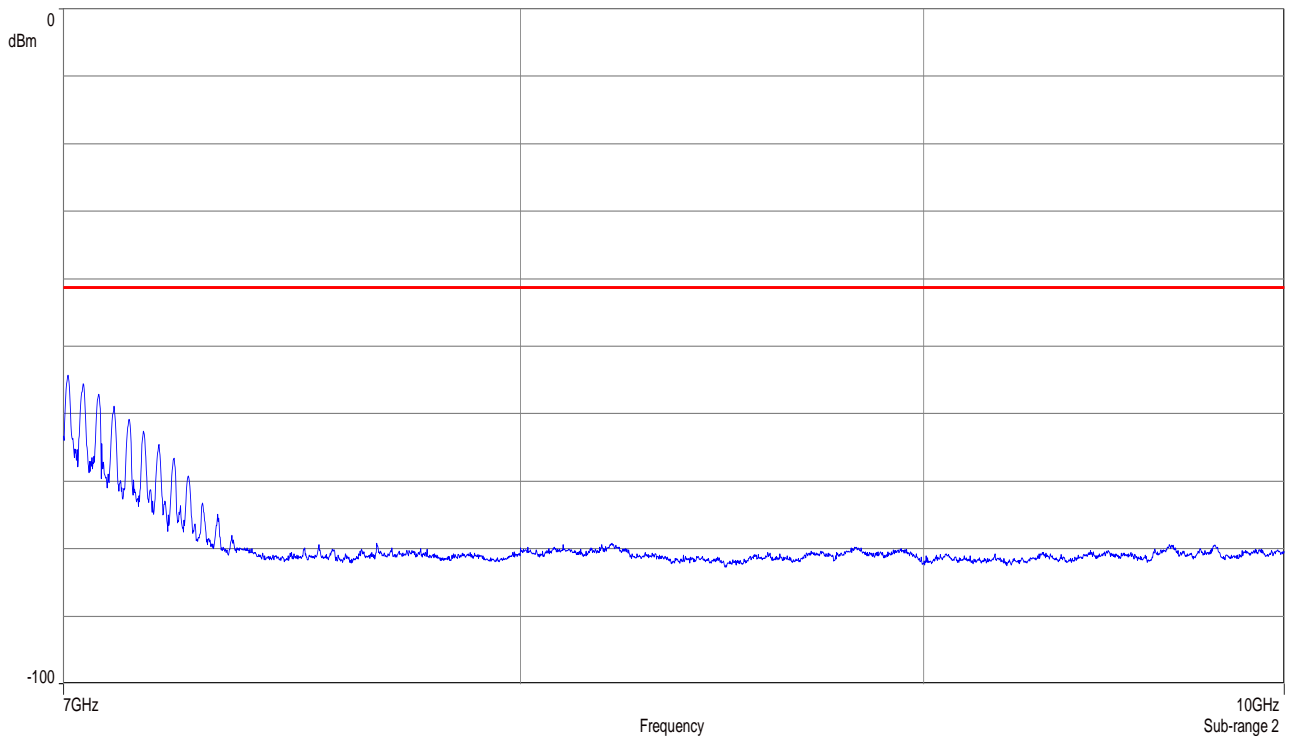
Final Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 36.336 | 16.54 | 30.0 | 13.46 | 1000 | 120 | 170.0 | H | 143.0 | 12.8 |
| 44.256 | 17.11 | 30.0 | 12.89 | 1000 | 120 | 170.0 | H | 180.0 | 13.6 |
| 48.486 | 17.44 | 30.0 | 12.56 | 1000 | 120 | 170.0 | V | 249.0 | 13.7 |
| 61.323 | 15.46 | 30.0 | 14.54 | 1000 | 120 | 98.0 | V | 59.0 | 11.6 |
| 492.963 | 22.03 | 36.0 | 13.97 | 1000 | 120 | 170.0 | H | 198.0 | 18.6 |
| 689.800 | 25.41 | 36.0 | 10.59 | 1000 | 120 | 98.0 | V | -6.0 | 21.5 |

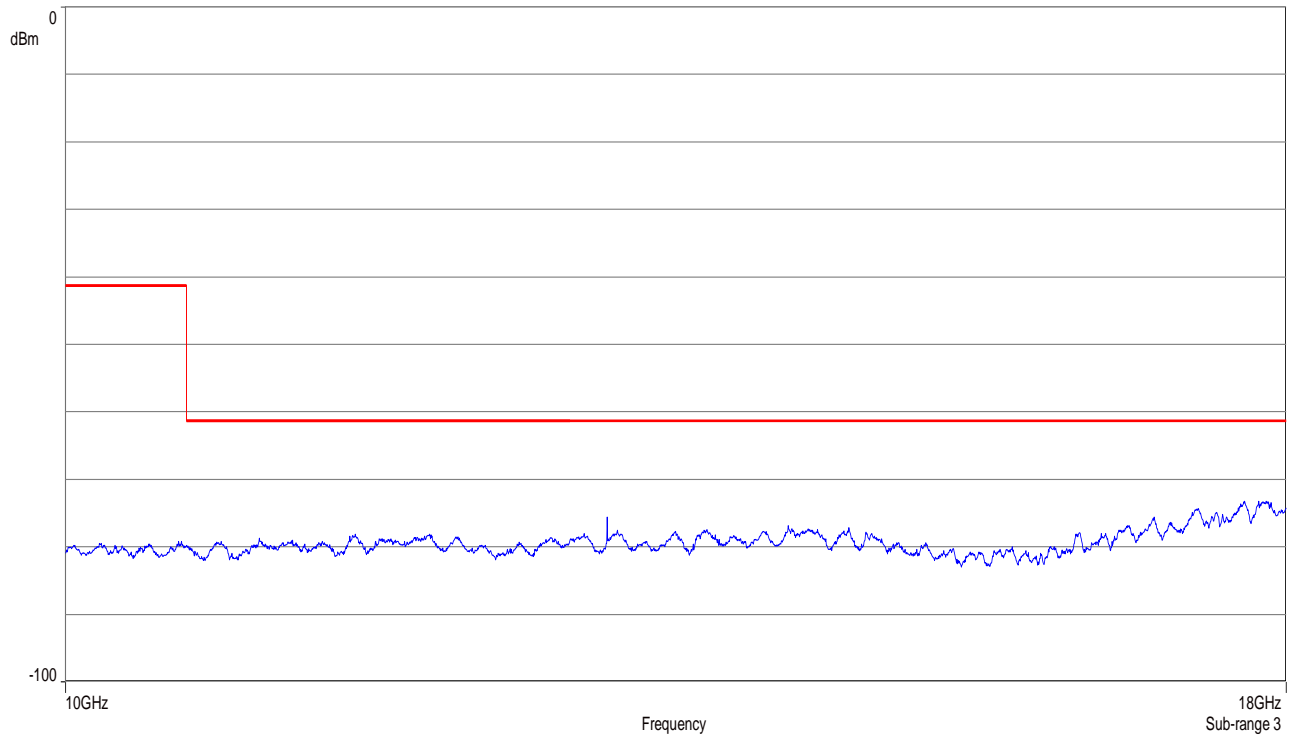
Plot 12: Channel 7, 960 MHz – 7 GHz



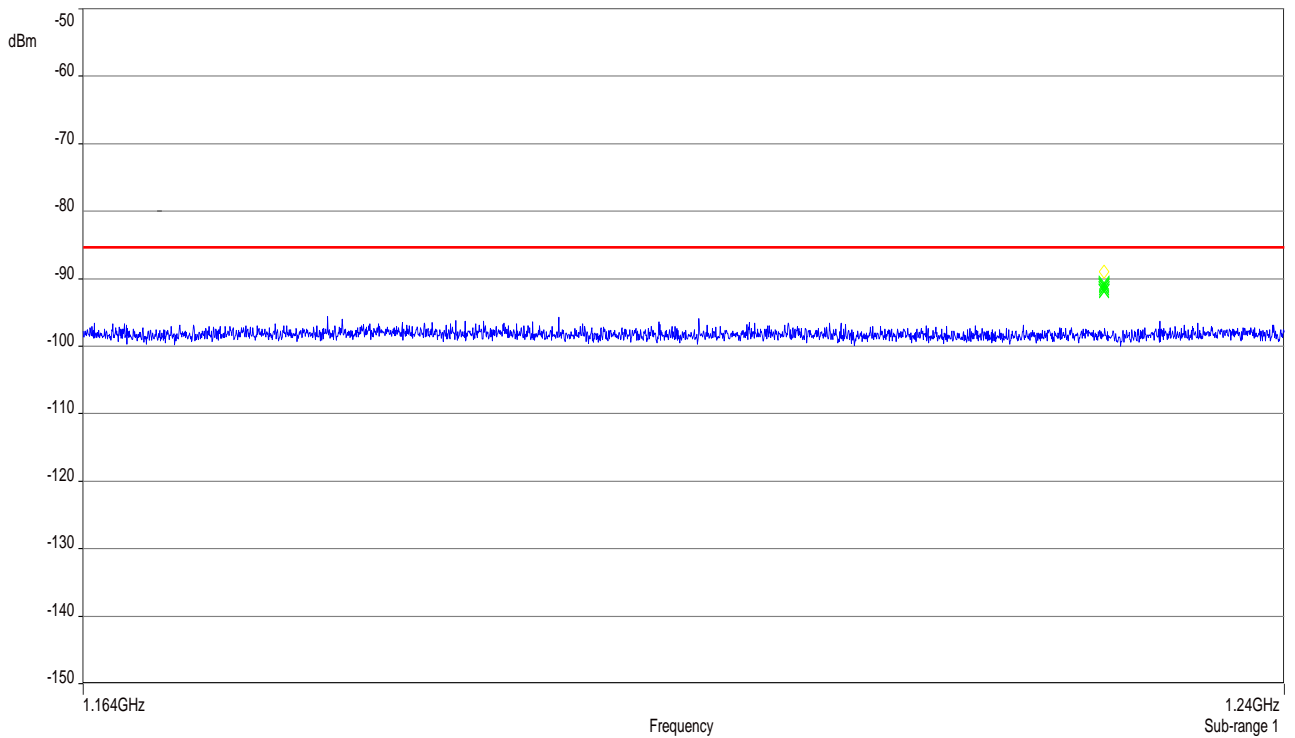
Plot 13: Channel 7, 7 GHz – 10 GHz



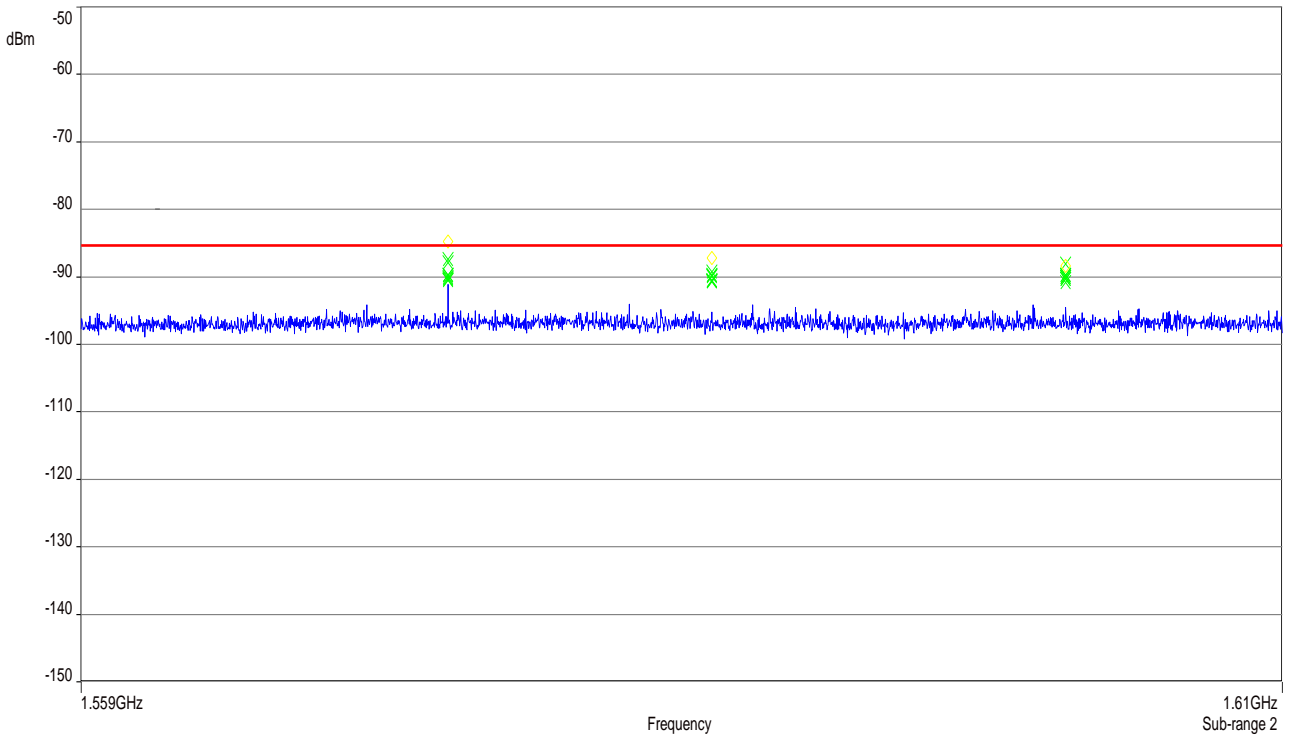
Plot 14: Channel 7, 10 GHz – 18 GHz



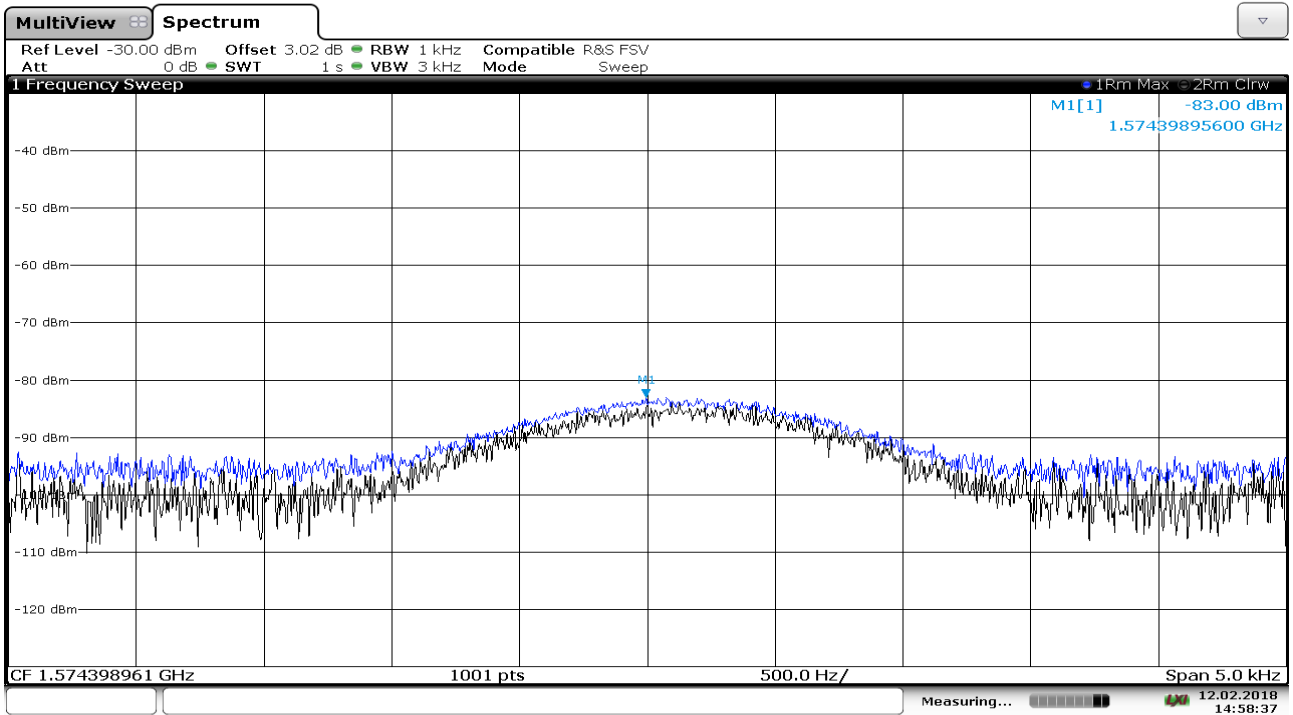
Plot 15: Channel 7, 1.164 GHz – 1.240 GHz



Plot 16: Channel 7, 1.559 GHz – 1.610 GHz



Plot 17: Channel 7, 1.5744 GHz, ABOVE LIMIT



14:58:38 12.02.2018

10.3 Modification of the EUT

Description:

In order to reduce the emissions of the tests according to §15-250 (d)(2) modifications on the PCB-Layout have been performed. Said test is repeated with a modified production sample.

Fotos of the both EUT variants are included in the corresponding annexes (see chapter 5.2).

Measurement

§15.519 (d):

| Average Measurement parameter | |
|-------------------------------|----------|
| Detector: | RMS |
| Sweep time: | 1 ms/pt |
| Number of points | 10001 |
| Resolution bandwidth: | 1 kHz |
| Video bandwidth: | 3 kHz |
| Trace-Mode: | Max Hold |

UWB-emission-Limits:

§15.250 (d) (2)

In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

| Frequency in MHz | EIRP in dBm |
|------------------|-------------|
| 1164 to 1240 | -85.3 |
| 1559 to 1610 | -85.3 |

Declaration of manufacturer:

Annex D of this test report shows the statement of the manufacturer to assure that the modification is applied to all future products.

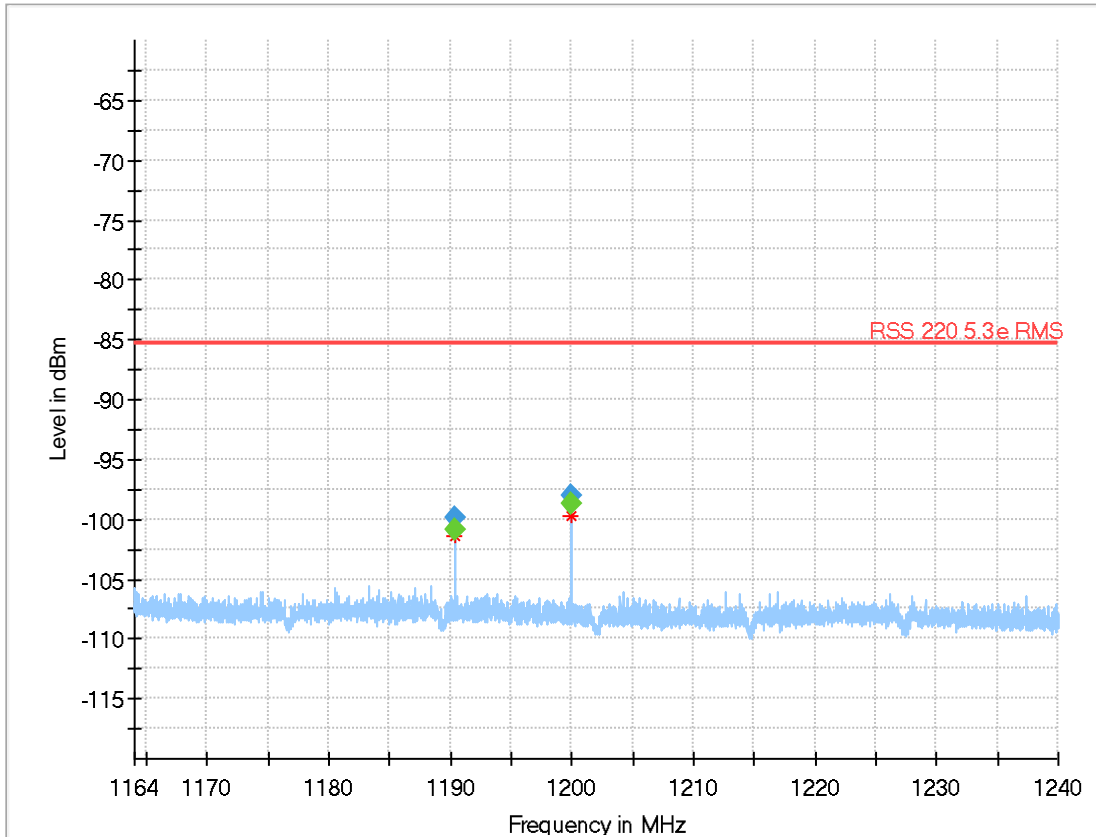
Result:

The measurement is passed. For the detailed measurement results, please refer to the plots below.

Verdict: complies

Plot 18: Channel 7, 1.164 GHz – 1.240 GHz

Full Spectrum

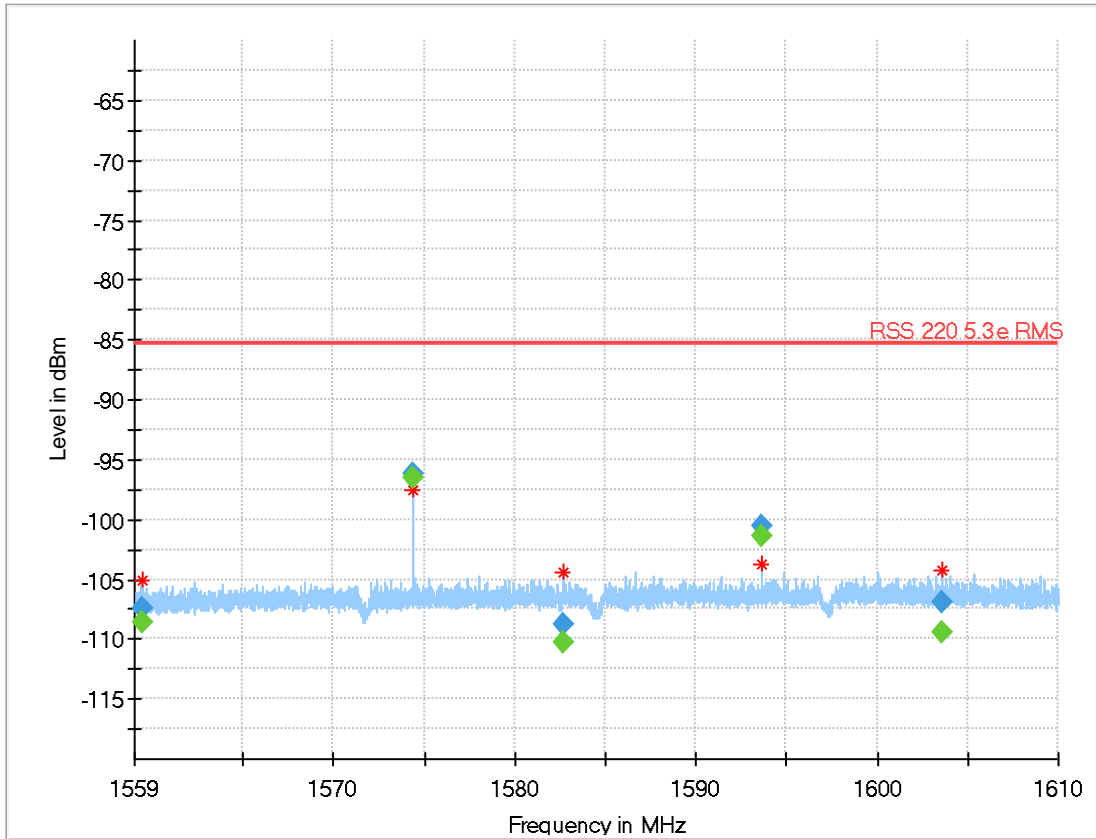


Final Result

| Frequency (MHz) | MaxPeak (dBm) | RMS (dBm) | Limit (dBm) | Margin (dB) | Bandwidth (kHz) | distance (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|---------------|-----------|-------------|-------------|-----------------|---------------|-----|---------------|-----------------|------------|
| 1190.3997 | -99.85 | --- | --- | --- | 1.000 | 100.0 | H | 0.0 | 0.0 | -143.9 |
| 1190.3997 | --- | -100.85 | -85.30 | 15.55 | 1.000 | 100.0 | H | 0.0 | 0.0 | -143.9 |
| 1199.9999 | -98.10 | --- | --- | --- | 1.000 | 100.0 | V | 119.0 | 0.0 | -144.0 |
| 1199.9999 | --- | -98.67 | -85.30 | 13.37 | 1.000 | 100.0 | V | 119.0 | 0.0 | -144.0 |

Plot 19: Channel 7, 1.559 GHz – 1.610 GHz

Full Spectrum



Final Result

| Frequency (MHz) | MaxPeak (dBm) | RMS (dBm) | Limit (dBm) | Margin (dB) | Bandwidth (kHz) | distance (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|---------------|-----------|-------------|-------------|-----------------|---------------|-----|---------------|-----------------|------------|
| 1574.3997 | -96.26 | --- | --- | --- | 1.000 | 100.0 | V | 111.0 | 60.0 | -142.6 |
| 1574.3997 | --- | -96.61 | -85.30 | 11.31 | 1.000 | 100.0 | V | 111.0 | 60.0 | -142.6 |
| 1593.5996 | -100.53 | --- | --- | --- | 1.000 | 100.0 | V | 339.0 | 90.0 | -142.3 |
| 1593.5996 | --- | -101.39 | -85.30 | 16.09 | 1.000 | 100.0 | V | 339.0 | 90.0 | -142.3 |

11 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 |

12 Document history

| Version | Applied changes | Date of release |
|---------|---------------------------------------------------------|-----------------|
| -/- | Initial release | 2019-02-22 |
| -A | minor editorial changes | 2019-03-29 |
| -B | Applicant, Manufacturer and Product information changed | 2019-05-29 |

13 Accreditation Certificate

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

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