
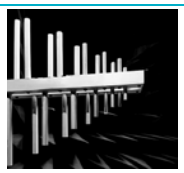
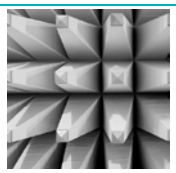

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-9695/19-01-08-A**

## Testing laboratory


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


## Applicant


**Marquardt GmbH**
Schloss-Str. 16
78604 Rietheim-Weilheim / GERMANY
Phone:
Contact: Gerd Siegel
e-mail: Gerd.Siegel@marquardt.de
Phone: +49 (0) 74 24 - 99 1589


## Manufacturer


**Marquardt GmbH**
Schloss-Str. 16
78604 Rietheim-Weilheim / GERMANY


## Test standard/s

| | |
|---|---|
| FCC - Title 47 CFR Part 15 | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 210 Issue 10 | Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment |

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

## Test Item

| | |
|---|---|
| **Kind of test item:** | **Passive Entry Car Key** |
| **Model name:** | **MS5** |
| **FCC ID:** | **IYZMS5** |
| **IC:** | **2701A-MS5** |
| Frequency: | 260 MHz to 470 MHz |
| Technology tested: | Proprietary |
| Antenna: | Integrated antenna |
| Power supply: | 2.5 V to 3.2 V DC by battery |
| Temperature range: | -20°C to +65°C |

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

## Test report authorized:

cn=Christoph Schneider, o=CTC advanced GmbH, ou=SND-161128, email=Christoph.Schneider@ctcadvanced.com, c=DE
2020.03.06 09:31:30 +01'00'

Christoph Schneider
Lab Manager
Radio Communications

## Test performed:

p.o.

cn=Tobias Wittenmeier, o=CTC advanced GmbH, ou=WIT-170519, email=tobias.wittenmeier@ctcadvanced.com, c=DE
2020.03.06 09:53:44 +01'00'

Sumit Kumar
Testing Manager
Radio Communications

# 1 Table of contents

# 2 General information

## 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

**This test report replaces the test report with the number 1-9695/19-01-08 and dated 2020-03-03.**

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2020-02-10 |
| Date of receipt of test item: | 2020-02-13 |
| Start of test: | 2020-02-13 |
| End of test: | 2020-02-17 |
| Person(s) present during the test: | -/- |

## 2.3 Test laboratories sub-contracted

None

## 3 Test standard/s, references and accreditations

| Test standard | Date | Description |
|---|---|---|
| FCC - Title 47 CFR Part 15 | | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |
| RSS - 210 Issue 10 | December 2019 | Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment |
| RSS - Gen Issue 5 | April 2018 | Spectrum Management and Telecommunications Radio Standards Specification<br>- General Requirements for Compliance of Radio Apparatus |

| 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 |

| Accreditation | Description |
|---|---|
| D-PL-12076-01-05 | Telecommunication FCC requirements<br>https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf |

# 4 Test environment

| | | | |
|---|---|---|---|
| Temperature | : | $T_{nom}$<br>$T_{max}$<br>$T_{min}$ | +23 °C during room temperature tests<br>+65 °C during high temperature tests<br>-20 °C during low temperature tests |
| Relative humidity content | : | | 55 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | $V_{nom}$<br>$V_{max}$<br>$V_{min}$ | 3.0 V DC by battery<br>3.2 V<br>2.5 V |

# 5 Test item

## 5.1 General description

| | | |
|---|---|---|
| Kind of test item | : | Passive Entry Car Key |
| Model name | : | MS5 |
| HMN | : | MS5 |
| PMN | : | MS5 |
| HVIN | : | -/- |
| FVIN | : | -/- |
| S/N serial number | : | -/- |
| Hardware status | : | -/- |
| Software status | : | -/- |
| Firmware status | : | -/- |
| Frequency band | : | 260 MHz to 470 MHz<br>Low channel: 433.47 MHz<br>Mid channel 433.92 MHz<br>High channel: 434.37 MHz |
| Type of radio transmission<br>Use of frequency spectrum | :<br>: | Modulated carrier |
| Type of modulation | : | FSK |
| Number of channels | : | 3 |
| Antenna | : | Integrated antenna |
| Power supply | : | 2.5 V to 3.2 V DC by battery |
| Temperature range | : | -20°C to +65°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: 1-9695/19-01-01_AnnexA
1-9695/19-01-01_AnnexA
1-9695/19-01-01_AnnexD

## 6 Description of the test setup

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

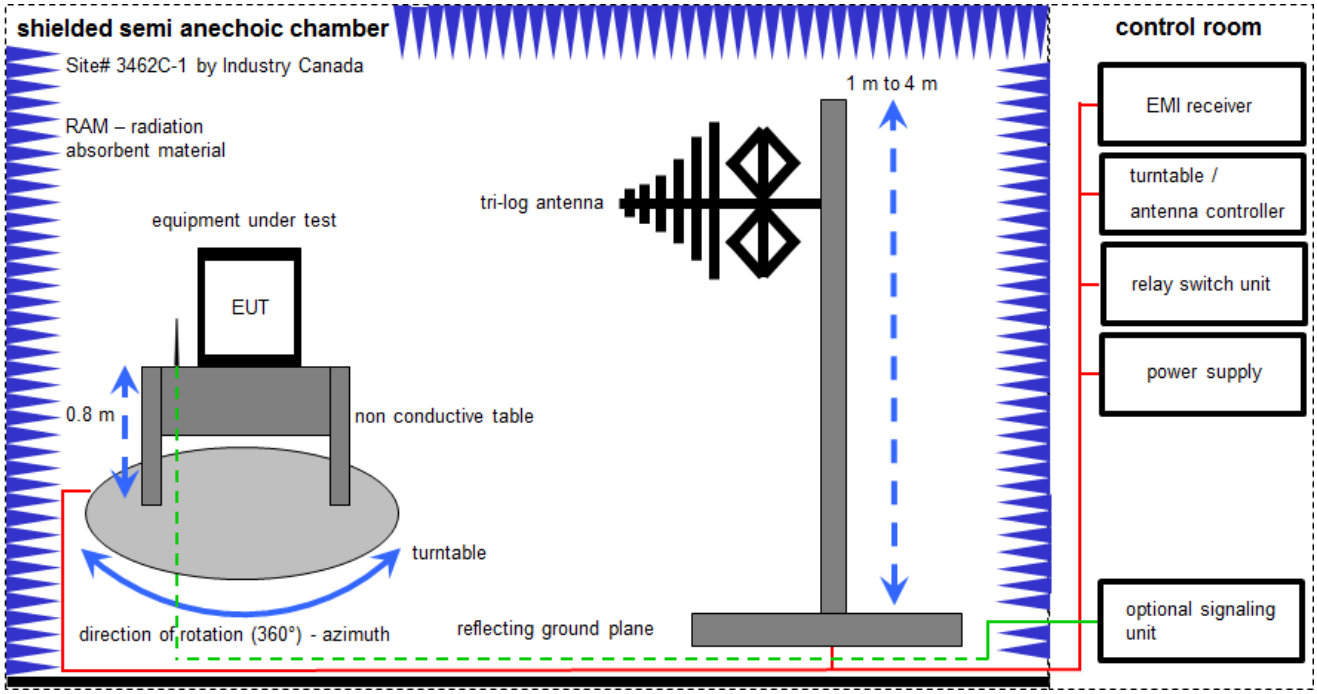
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**Agenda:** Kind of Calibration

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

## 6.1 Shielded semi anechoic chamber

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




Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.30.0

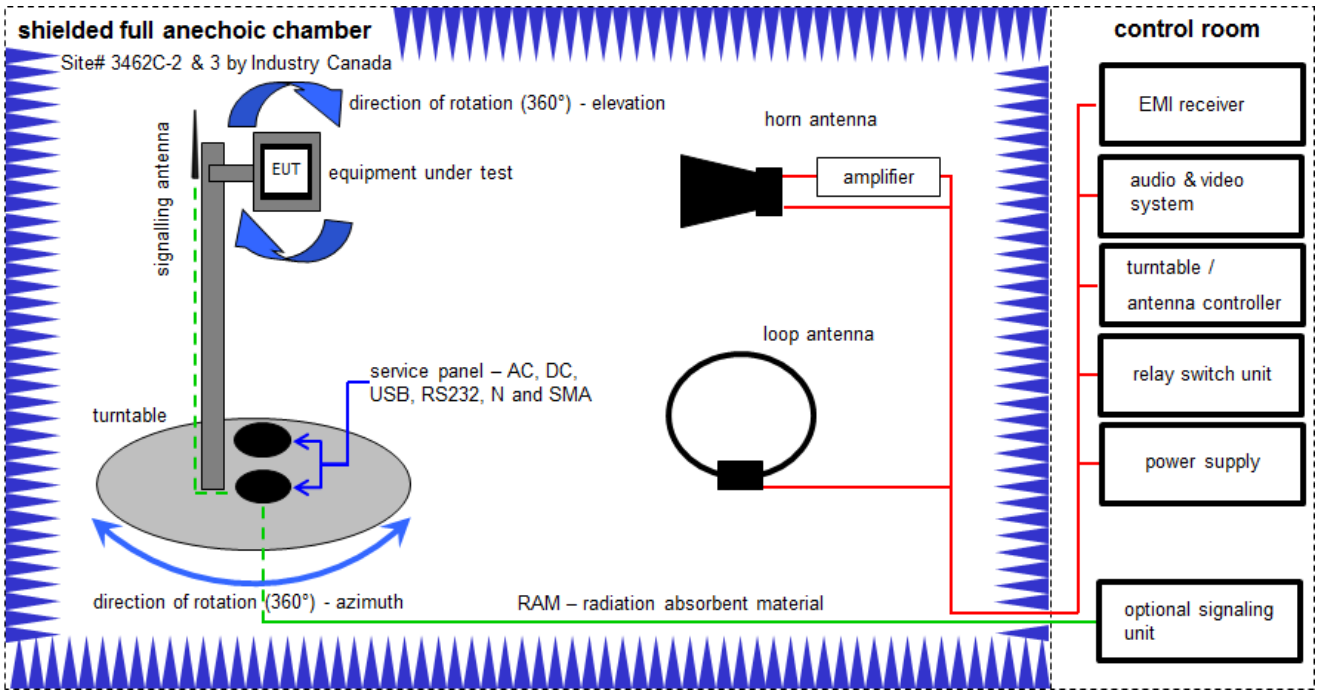
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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

## Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | A | Meßkabine 1 | HF-Absorberhalle | MWB AG 300023 | | 300000551 | ne | -/- | -/- |
| 3 | A | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 4 | A | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 5 | A | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 6 | A | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 295 | 300003787 | vlKl! | 19.02.2019 | 18.02.2021 |
| 7 | A | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 21.05.2019 | 20.05.2020 |

## 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)

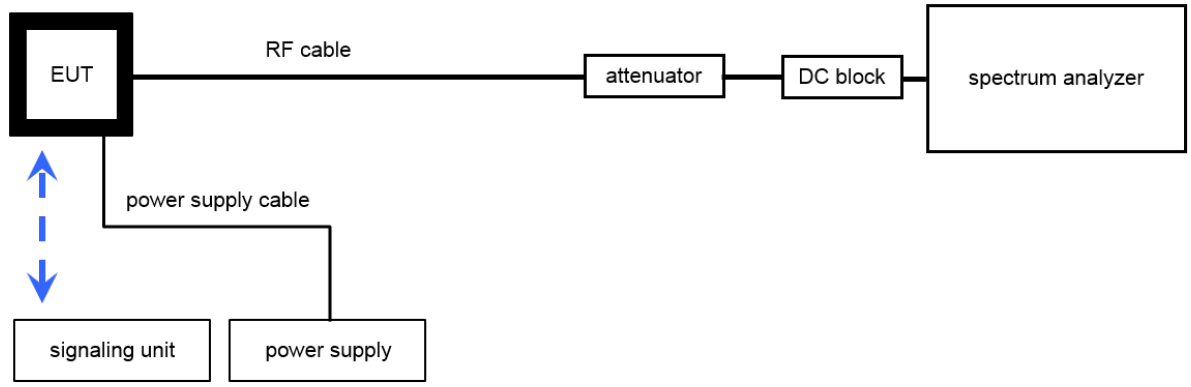
*Example calculation:*
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | vIKI! | 13.06.2019 | 12.06.2021 |
| 2 | B | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3696 | 300001604 | vIKI! | 27.02.2019 | 26.02.2021 |
| 3 | A, B. | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 11.12.2019 | 10.12.2020 |
| 4 | A, B | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000032 | 300004510 | ne | -/- | -/- |
| 5 | A, B | Computer | Intel Core i3 3220/3,3 GHz, Prozessor | | 2V2403033A5421 | 300004591 | ne | -/- | -/- |
| 6 | A, B | NEXIO EMV-Software | BAT EMC V3.19.1.9 | EMCO | | 300004682 | ne | -/- | -/- |
| 7 | A, B. | Anechoic chamber | | TDK | | 300003726 | ne | -/- | -/- |

## 6.3 Conducted measurements

**Conducted measurements normal conditions**




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

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

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Loop Antenna | | ZEG TS Steinfurt | | 400001208 | ev | -/- | -/- |
| 2 | A | RF-Cable SRD021 No. 8 | Enviroflex 316 D | Huber & Suhner | | 400001318 | ev | -/- | -/- |
| 3 | A | Spectrum Analyzer | FSV30 | Rohde & Schwarz | 104365 | 300005923 | k | 17.10.2019 | 16.01.2021 |
| 4 | A | Power Supply 0-20V; 0-5A | 6632B | HP | US37478366 | 400000117 | vlKl! | 12.12.2018 | 11.12.2020 |

# 7 Sequence of testing

## 7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

**Premeasurement***

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

**Final measurement**

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

## 7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

**Premeasurement**

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

**Final measurement**

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

## 7.3 Sequence of testing radiated spurious 1 GHz to 6 GHz

**Setup**

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

**Premeasurement**

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

**Final measurement**

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

# 8 Measurement uncertainty

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

## 9 Summary of measurement results

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

| TC Identifier | Description | Verdict | Date | Remark |
|---|---|---|---|---|
| RF-Testing | CFR Part 15<br>RSS 210, Issue 10<br>RSS-Gen, Issue 4 | See table! | 2020-03-06 | -/- |

| Test specification clause | Test case | Temperature conditions | Power source voltages | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|
| § 15.35 (c)<br>RSS-Gen, Issue 4 | Timing of the transmitter (Duty cycle correction factor) | Nominal | Nominal | | | | | |
| § 15.231 (a) (1)<br>RSS-210 Issue 10 | Switch off time | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| § 15.231 (b) (3) (c)<br>RSS-210 Issue 10 | Emission bandwidth | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| § 15.231 (b)<br>RSS-210 Issue 10 | Fieldstrength of Fundamental | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| § 15.209<br>RSS-210 Issue 10 | Fieldstrength of harmonics and spurious | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| § 15.209<br>RSS-Gen, Issue 4 | Receiver spurious emissions (radiated) | Nominal | Nominal | ☐ | ☐ | ☒ | ☐ | -/- |

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

### 9.1 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

# 10 Measurement results

## 10.1 Timing of the transmitter

**Measurement:**

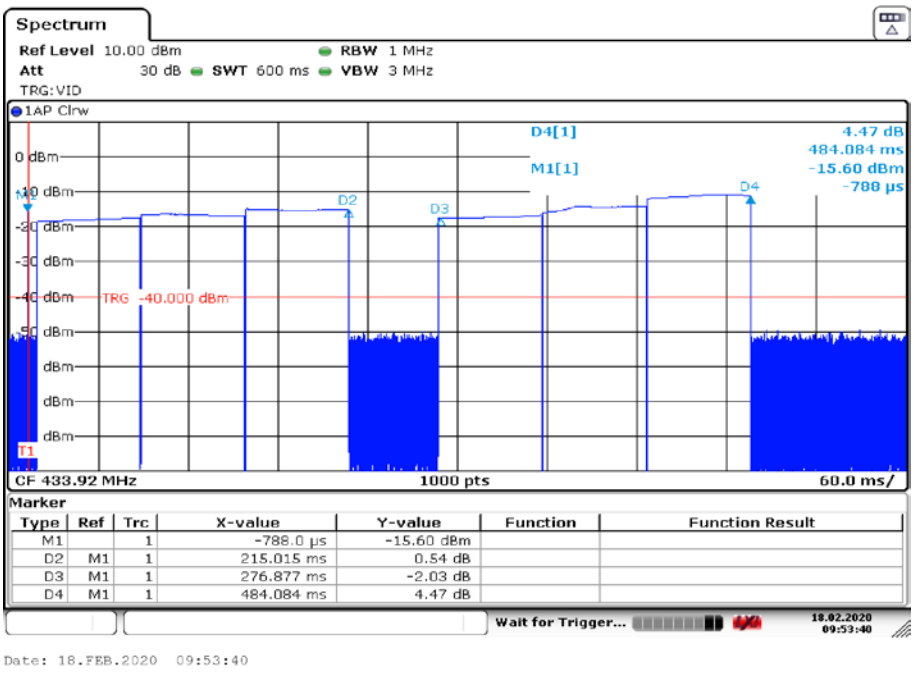
| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | 600 ms |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Span: | Zero |
| Trace-Mode: | Single sweep |
| Test setup: | See chapter 6.3 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

| FCC | IC |
|---|---|
| (c) Unless otherwise specified, e.g. Section 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification. | |

**Result:**

**Plot 1:** Transmit burst




The different power levels results from the different frequencies which are used alternating by the device.

| | | | |
|---|---|---|---|
| Transmit time (Tx on) | = | 215.015 ms | (Plot 1) |
| Tx on + Tx off | > | 100 ms | (Plot 1) |

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is 0 dB.

## 10.2 Switch off time

**Measurement:**

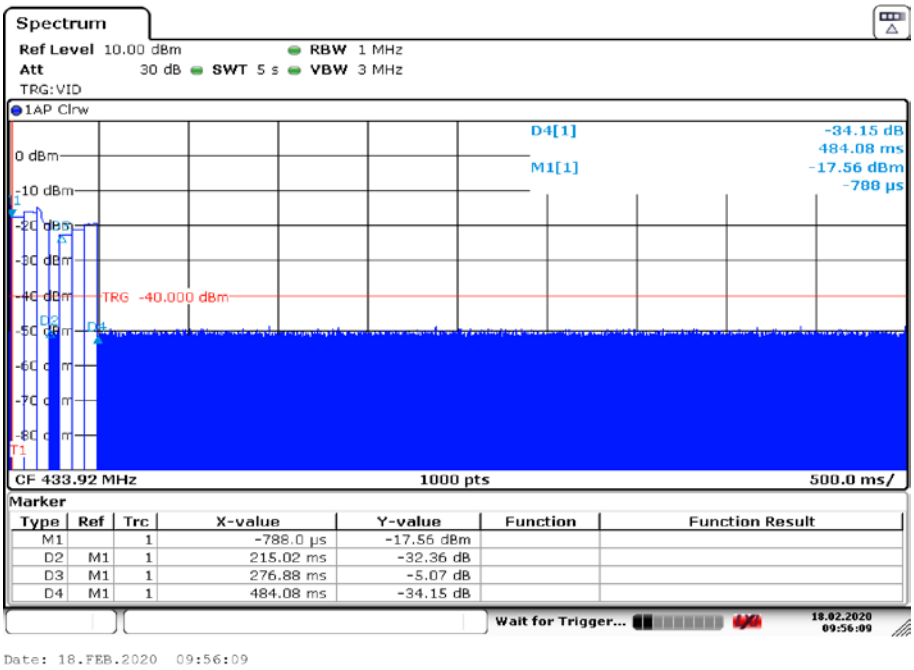
| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | 5 s |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Span: | Zero |
| Trace-Mode: | Single sweep |
| Test setup: | See chapter 6.3 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

| FCC | IC |
|---|---|
| A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. | |

**Results:**

**Plot 1:** TX on time




The EUT automatically ceases transmission within 484.08 ms after releasing the switch.

## 10.3 Emission bandwidth

**Measurement:**

Measurement of the 99 % bandwidth of the modulated signal

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Resolution bandwidth: | 1 % of the span |
| Video bandwidth: | 3 x RBW |
| Span: | 500 kHz |
| Trace-Mode: | Max Hold |
| Test setup | See chapter 6.3 A |
| Measurement Uncertainty: | See chapter 8 |

**Limits:**

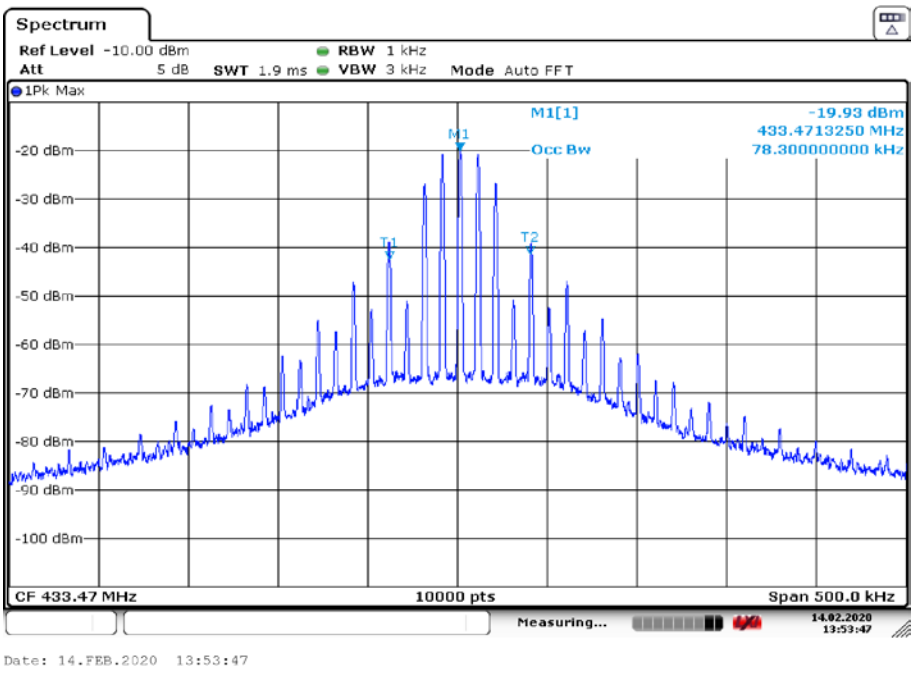
| FCC | IC |
|---|---|
| 433.47 MHz: The OBW shall not be wider than 0.25 % of the center frequency, here maximum 1.0837 MHz. | |
| 433.92 MHz: The OBW shall not be wider than 0.25 % of the center frequency, here maximum 1.0848 MHz. | |
| 434.37 MHz: The OBW shall not be wider than 0.25 % of the center frequency, here maximum 1.0859 MHz. | |

**Result:**

| Channel / MHz | Test conditions | | Signal bandwidth / kHz | |
|---|---|---|---|---|
| | Mode | | OBW 99% | 20 dB-bandwidth |
| 433.47 | $T_{nom}$ | $V_{nom}$ | 78.30 | 77.99 |
| 433.92 | $T_{nom}$ | $V_{nom}$ | 78.25 | 71.15 |
| 434.37 | $T_{nom}$ | $V_{nom}$ | 78.25 | 79.30 |

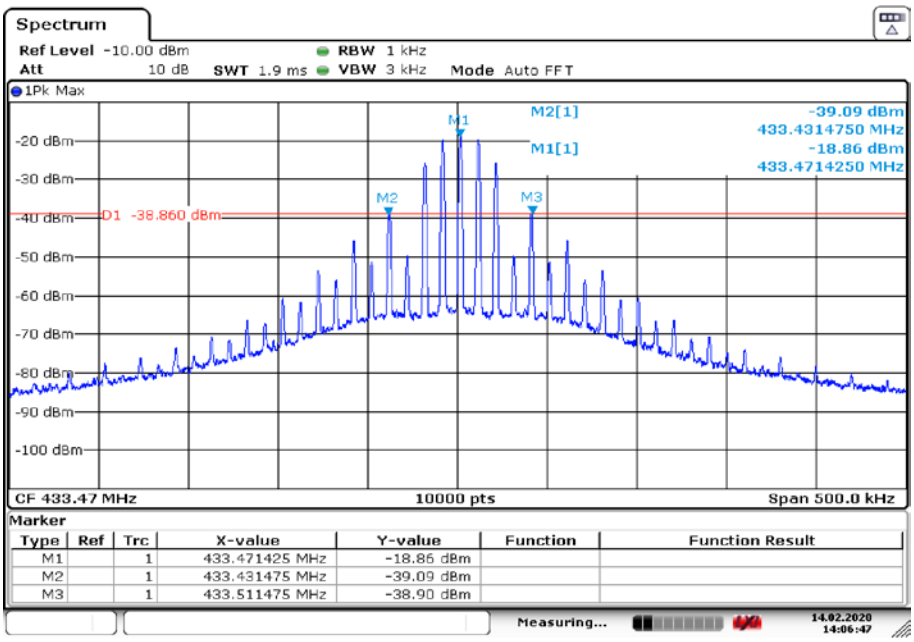
**Plots:**

**Plot 1:** 99% bandwidth, 433.47 MHz



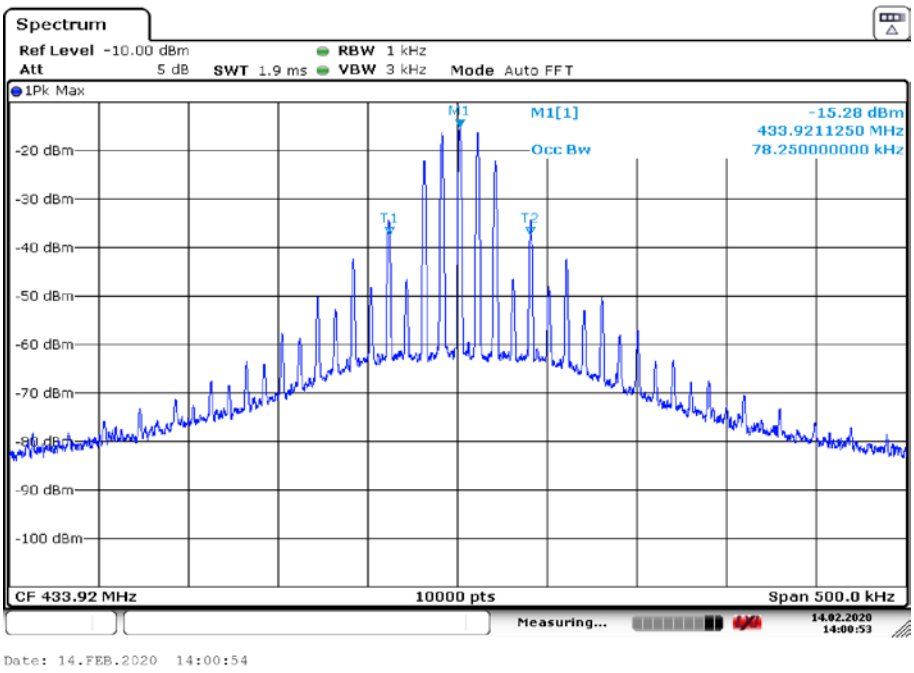

Date: 14.FEB.2020 13:53:47

**Plot 2:** 20 dB bandwidth, 433.47 MHz

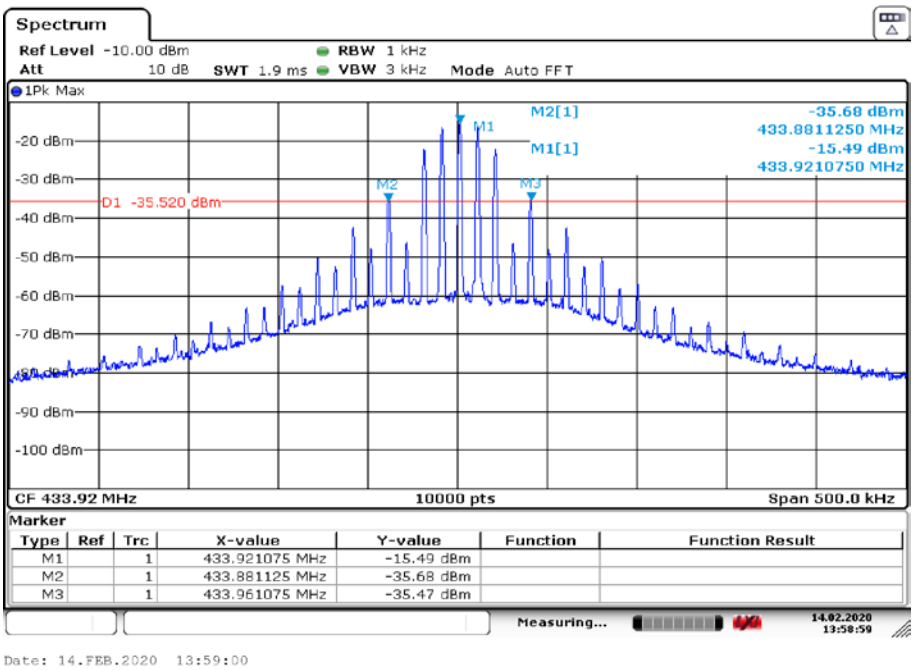



Date: 14.FEB.2020 14:06:48

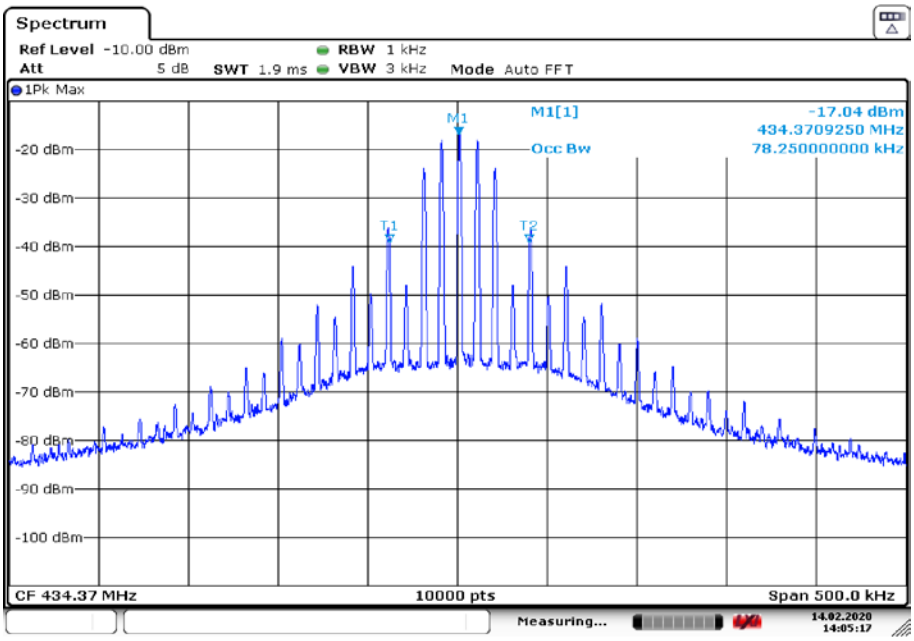
**Plot 3:** 99% bandwidth, 433.92 MHz




**Plot 4:** 20 dB bandwidth, 433.92 MHz

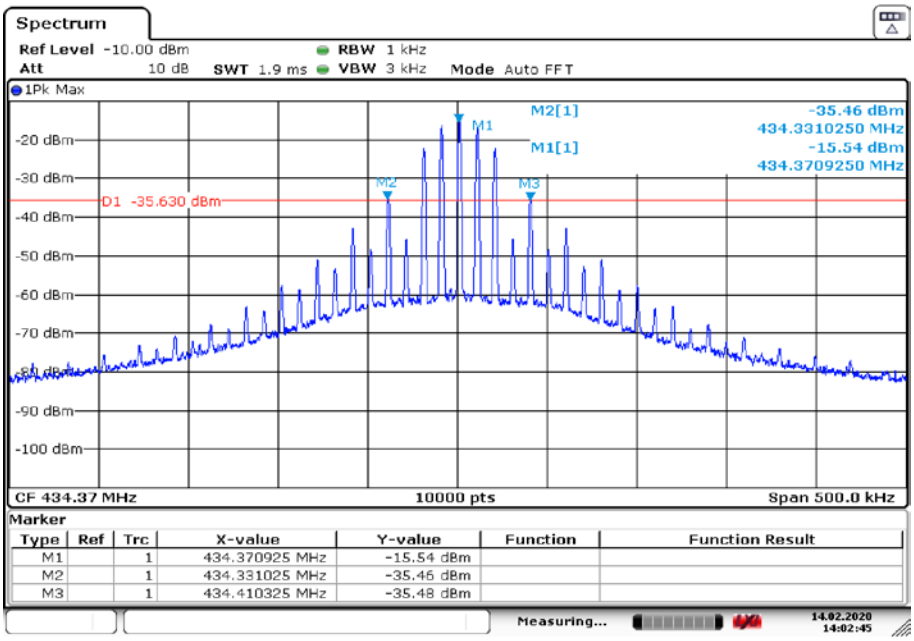


**Plot 5:** 99% bandwidth, 434.37 MHz




Date: 14.FEB.2020 14:05:18

**Plot 6:** 20 dB bandwidth, 434.37 MHz

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## 10.4 Field strength of the fundamental

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak / pulse averaging / quasi peak |
| Sweep time: | Auto |
| Resolution bandwidth: | 120 kHz |
| Video bandwidth: | 3 x RBW |
| Span: | Zero |
| Trace-Mode: | Max. hold |
| Test setup: | See chapter 6.1 A |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

| FCC | IC | |
|---|---|---|
| Field strength of the fundamental.<br>In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following: | | |
| **Fundamental Frequency (MHz)** | **Field strength of Fundamental (µV/m)** | **Measurement distance (m)** |
| 40.66 – 40.70 | 2,250 | 3 |
| 70-130 | 1,250 | 3 |
| 130-174 | 1,250 to 3,750 | 3 |
| 174-260 | 3,750 | 3 |
| 260-470 | 3,750 to 12,500 | 3 |
| Above 470 | 12,500 | 3 |

Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows:

- for the band 130-174 MHz, µV/m at 3 meters = 56.81818(F) - 6136.3636;
- for the band 260-470 MHz, µV/m at 3 meters = 41.6667(F) - 7083.3333.

**Result:**

| Test conditions | Maximum power (dBµV/m at 3 m distance) | | Limit |
|---|---|---|---|
| Channel / MHz | Peak | Average | Average |
| 433.47 | 80.52 | 80.36 | 80.8 |
| 433.92 | 80.34 | 80.17 | 80.8 |
| 434.37 | 79.57 | 79.39 | 80.8 |

*Value recalculated from the peak value with a correction factor of 0 dB acc. Chapter 10.1

## 10.5 Field strength of the harmonics and spurious

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Peak / average / quasi peak |
| Sweep time: | Auto |
| Resolution bandwidth: | 200 Hz / 9 kHz / 120 kHz |
| Video bandwidth: | 3 x RBW |
| Span: | See plots |
| Trace-Mode: | Max. hold |
| Test setup: | See chapter 6.1 A & 6.2 A, B |
| Measurement uncertainty: | See chapter 8 |

**Limits:**

| FCC | | IC |
|---|---|---|
| Field strength of the fundamental.<br>In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following: | | |
| **Fundamental Frequency (MHz)** | **Field strength of spurious (µV/m)** | **Measurement distance (m)** |
| 40.66 – 40.70 | 225 | 3 |
| 70-130 | 125 | 3 |
| 130-174 | 125 to 375 | 3 |
| 174-260 | 375 | 3 |
| 260-470 | 375 to 1,250 | 3 |
| Above 470 | 1,250 | 3 |

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

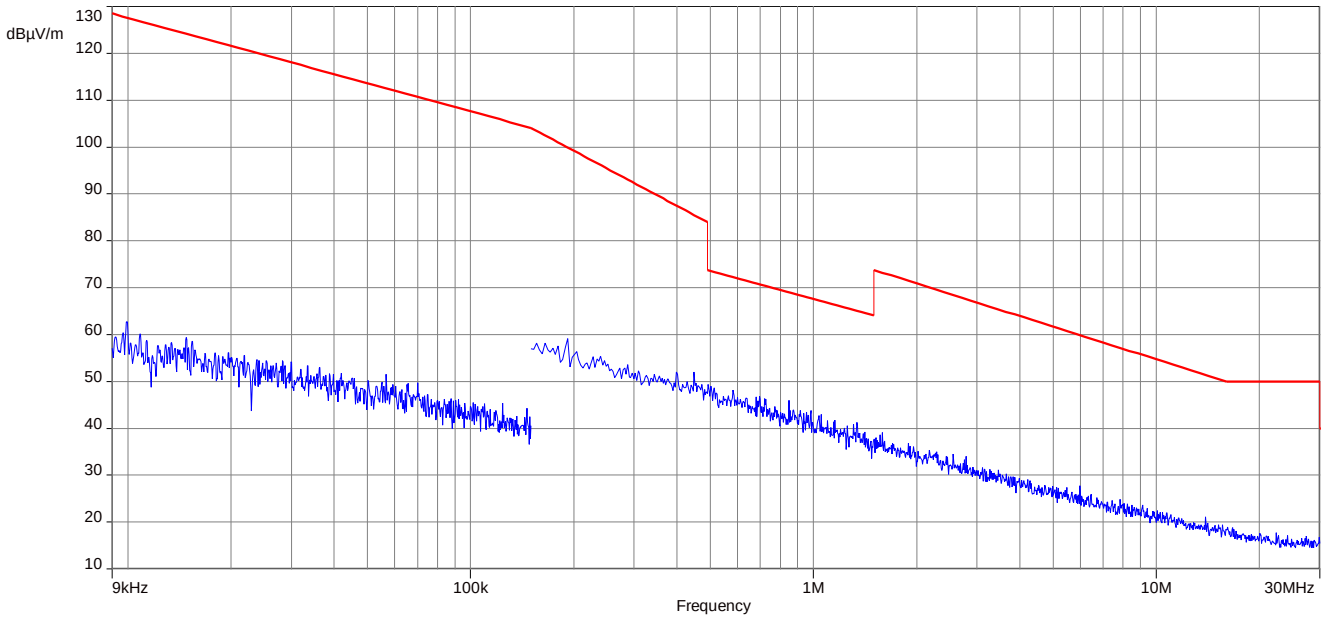
| FCC | | IC |
|---|---|---|
| **Frequency (MHz)** | **Field strength (µV/m)** | **Measurement distance (m)** |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| above 960 | 500 | 3 |

## Results:

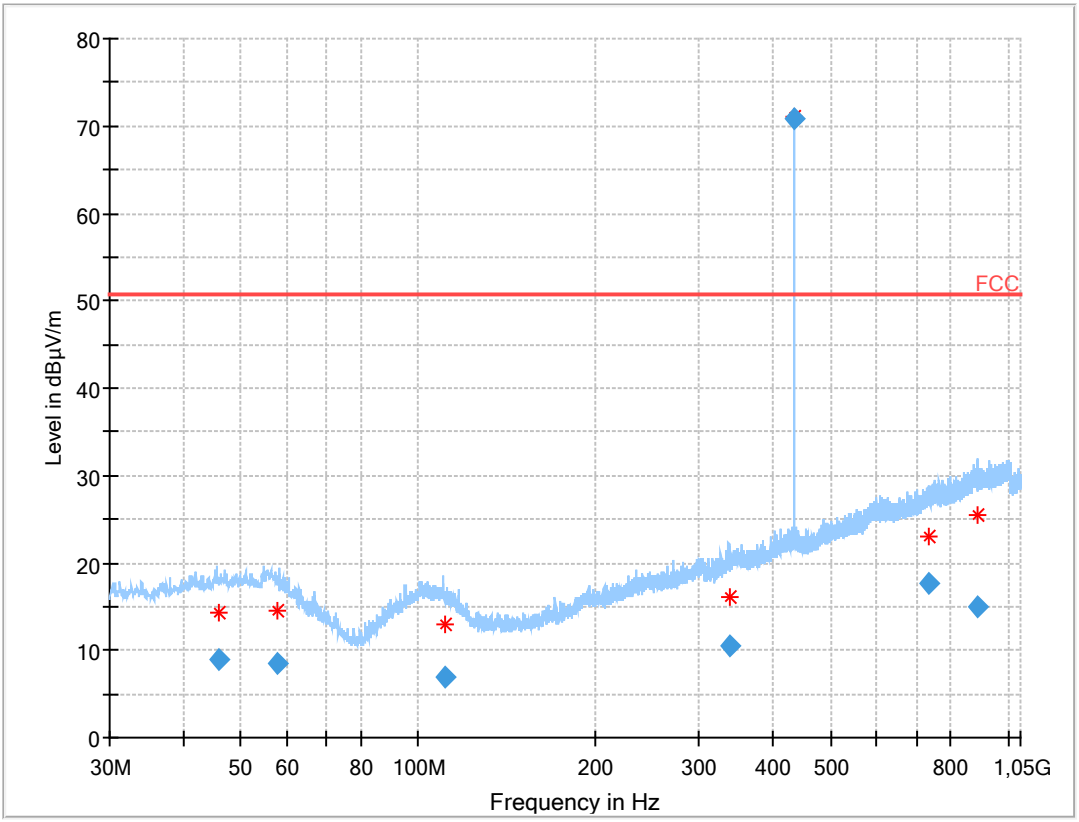
| Fundamental Frequency | Spurious Frequency | Detector | Limit max. allowed [dBµV/m] | Amplitude of emission [dBµV/m] |
|---|---|---|---|---|
| 433.47 MHz | 1300.4 MHz | RMS | 54.0 | 50.59 |
| | 3034.4 MHz | RMS | 60.8 | 51.13 |
| | 4334.8 MHz | RMS | 54.0 | 51.24 |
| | 4768.4 MHz | RMS | 54.0 | 50.09 |
| | 5201.6 MHz | RMS | 60.8 | 50.73 |
| 433.92 MHz | 1301.6 MHz | RMS | 54.0 | 50.08 |
| | 3037.2 MHz | RMS | 60.8 | 50.57 |
| | 4339.2 MHz | RMS | 54.0 | 51.48 |
| | 4773.2 MHz | RMS | 54.0 | 52.52 |
| | 5207.2 MHz | RMS | 60.8 | 52.29 |
| 434.37 MHz | 1303.0 MHz | RMS | 54.0 | 49.88 |
| | 3040.4 MHz | RMS | 60.8 | 52.07 |
| | 4343.6 MHz | RMS | 54.0 | 50.16 |
| | 4778.0 MHz | RMS | 54.0 | 50.73 |
| | 5212.4 MHz | RMS | 60.8 | 52.50 |

**Plots:**

**Plot 1:** 9 kHz to 30 MHz, 433.47 MHz



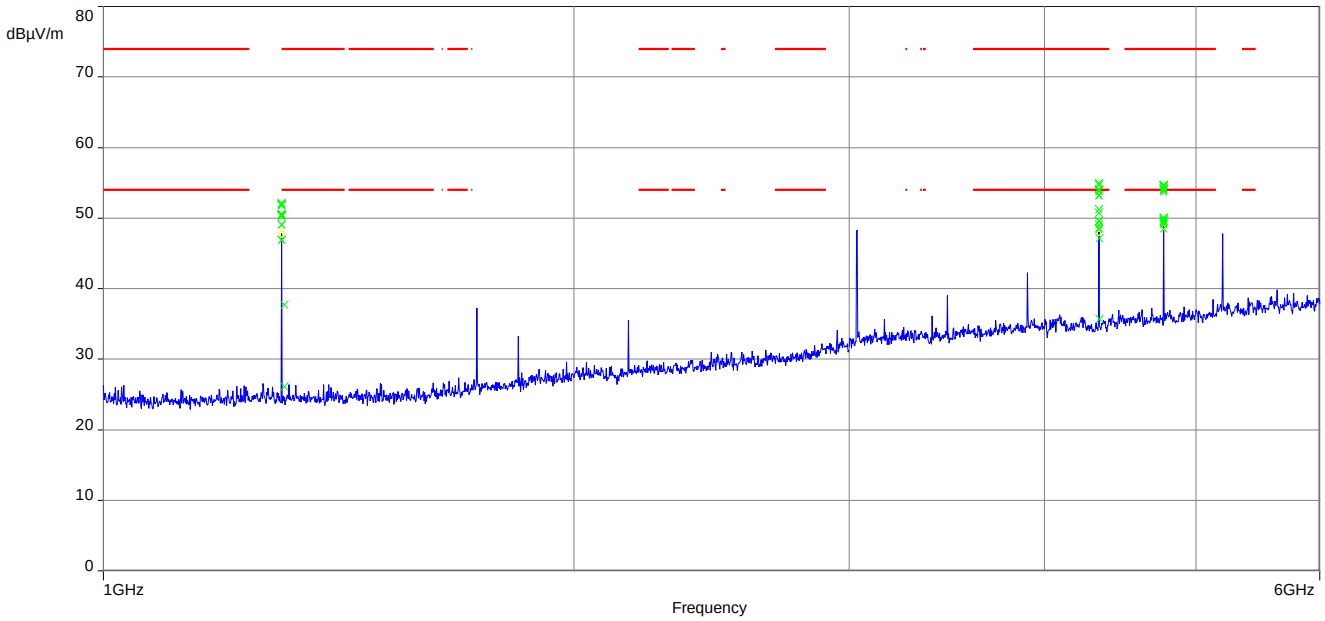
**Plot 2:** 30 MHz to 1000 MHz, vertical & horizontal polarisation, 433.47 MHz



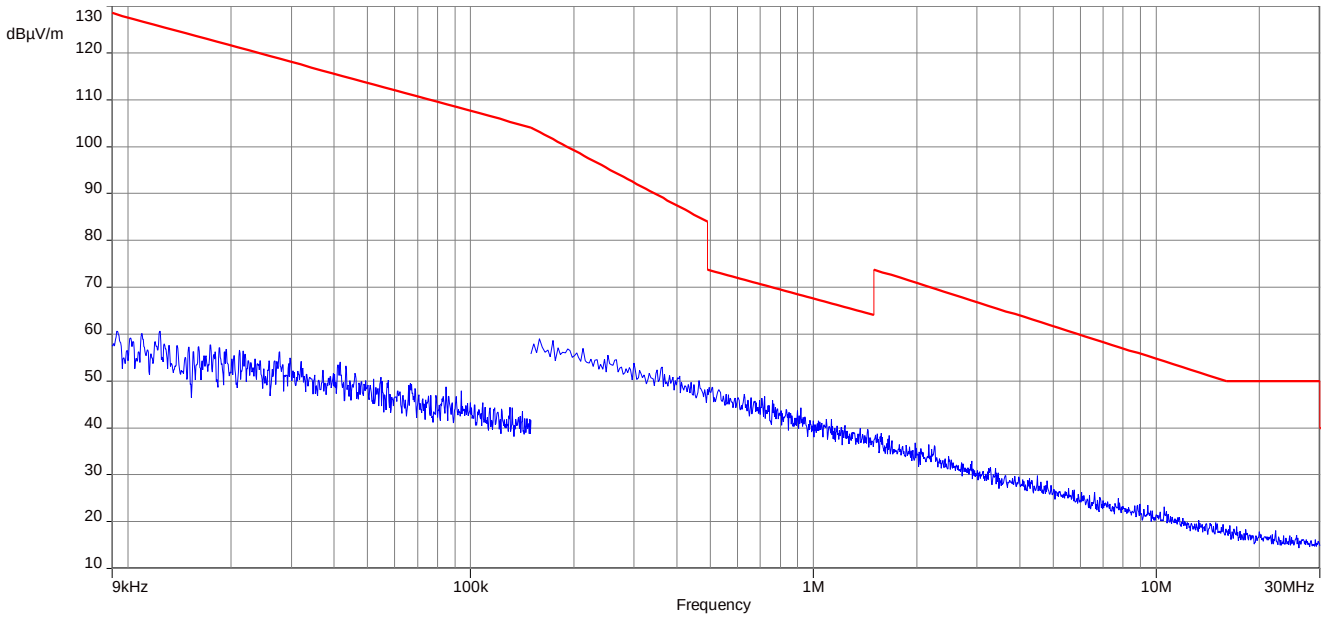

## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 46.099 | 8.84 | 50.7 | 41.9 | 1000 | 120 | 400.0 | H | 90 | 14 |
| 57.945 | 8.46 | 50.7 | 42.2 | 1000 | 120 | 400.0 | H | 251 | 14 |
| 110.811 | 6.99 | 50.7 | 43.7 | 1000 | 120 | 200.0 | H | -45 | 12 |
| 336.939 | 10.49 | 50.7 | 40.2 | 1000 | 120 | 373.0 | H | 45 | 15 |
| 433.461 | 70.09 | 50.7 | -19.4 | 1000 | 120 | 103.0 | V | 99 | 17 |
| 735.467 | 17.76 | 50.7 | 32.9 | 1000 | 120 | 155.0 | H | 270 | 22 |
| 885.184 | 15.03 | 50.7 | 35.7 | 1000 | 120 | 200.0 | V | 90 | 23 |

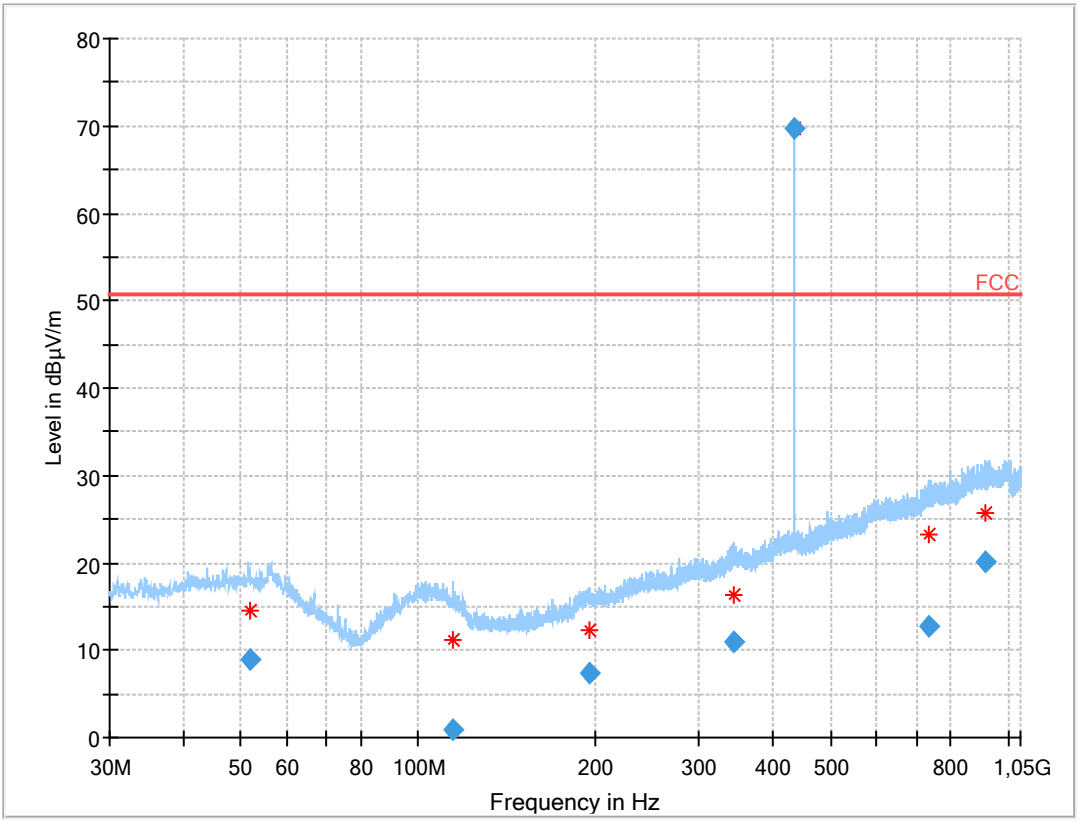
**Plot 3:** 1000 MHz to 6000 MHz, vertical & horizontal polarisation, 433.47 MHz




**Plot 4:** 9 kHz to 30 MHz, 433.92 MHz



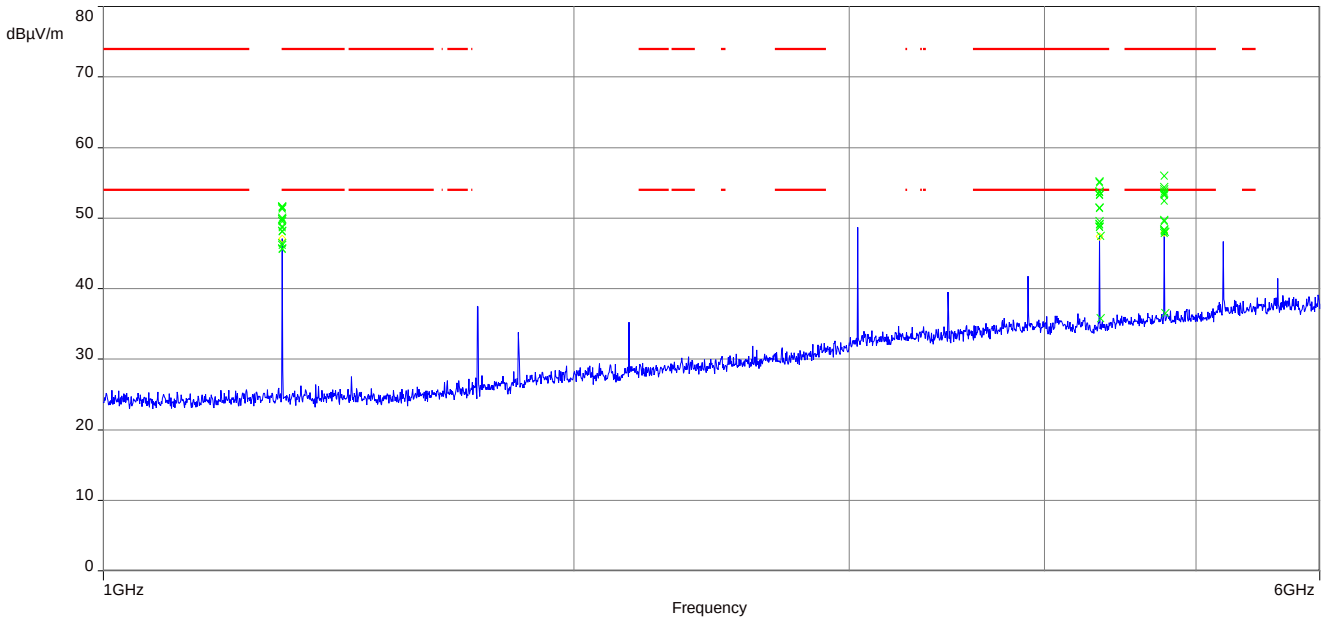
**Plot 5:** 30 MHz to 1000 MHz, vertical & horizontal polarisation, 433.92 MHz



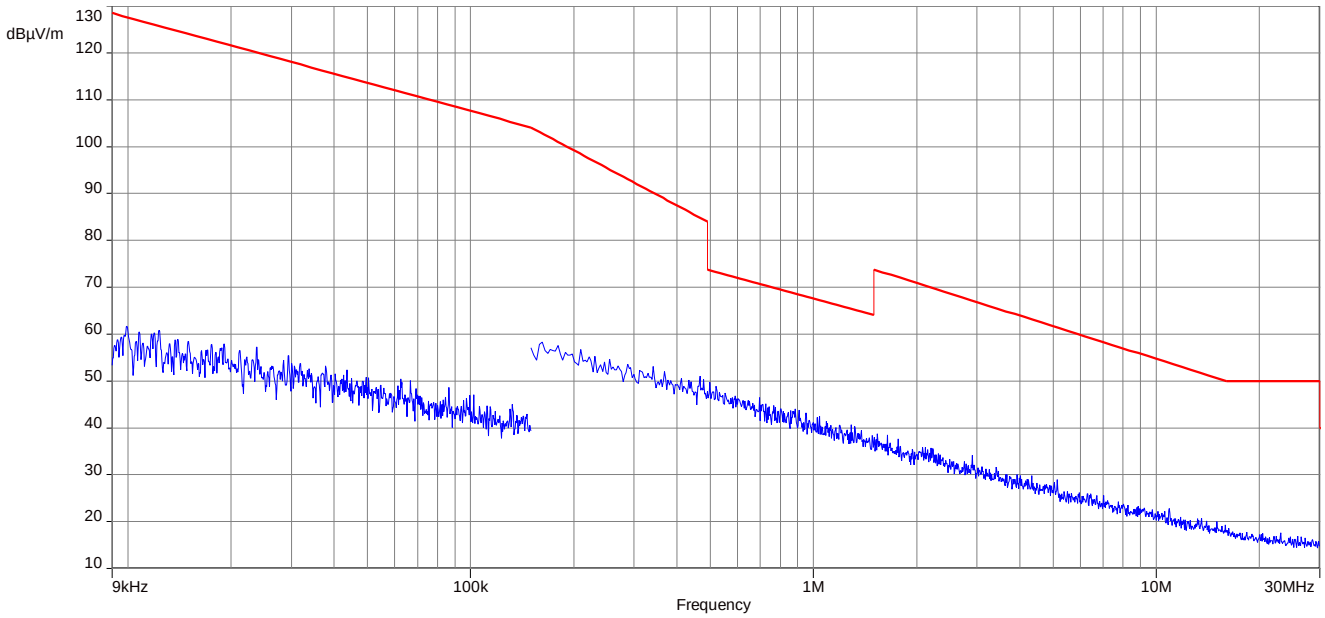

## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 51.917 | 8.83 | 50.7 | 41.9 | 1000 | 120 | 143.0 | H | 341 | 14 |
| 114.136 | 0.88 | 50.7 | 49.8 | 1000 | 120 | 400.0 | V | 90 | 12 |
| 195.200 | 7.47 | 50.7 | 43.2 | 1000 | 120 | 400.0 | V | 135 | 12 |
| 342.567 | 10.86 | 50.7 | 39.8 | 1000 | 120 | 400.0 | V | 76 | 16 |
| 433.906 | 69.91 | 50.7 | -19.2 | 1000 | 120 | 100.0 | V | 100 | 17 |
| 735.107 | 12.64 | 50.7 | 38.1 | 1000 | 120 | 400.0 | V | 180 | 22 |
| 916.445 | 20.22 | 50.7 | 30.5 | 1000 | 120 | 400.0 | H | 135 | 24 |

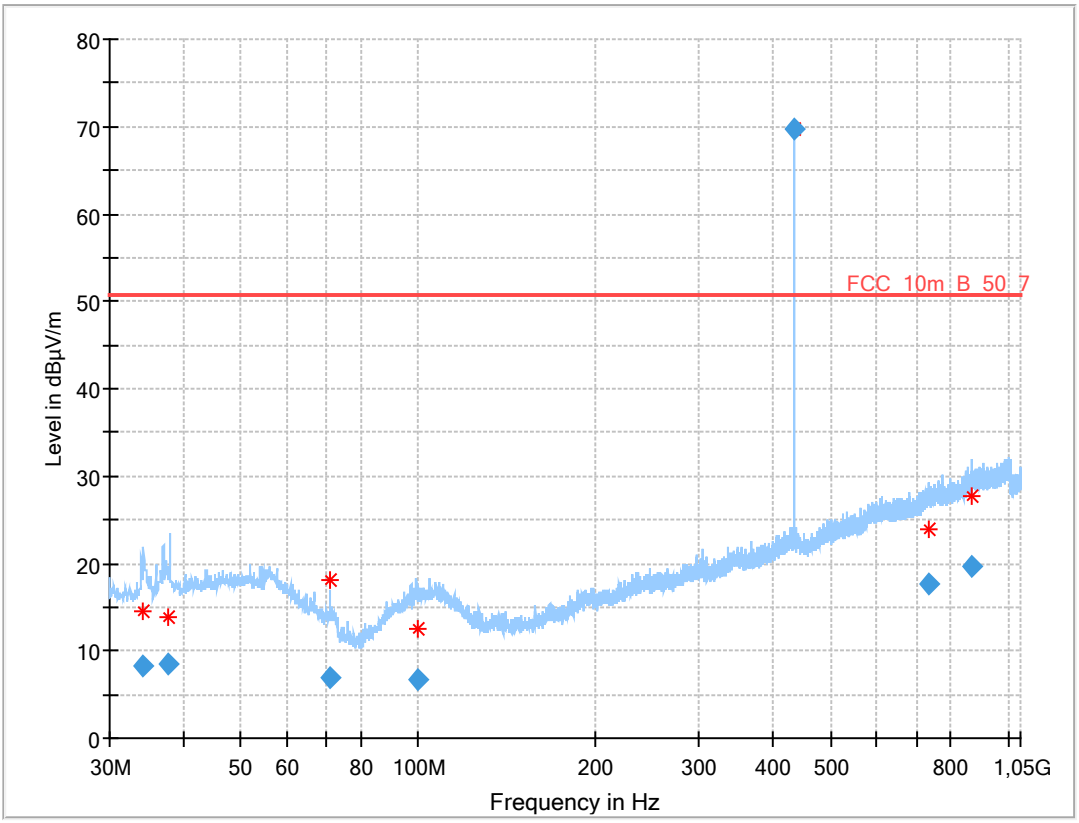
**Plot 6:** 1000 MHz to 6000 MHz, vertical & horizontal polarisation, 433.92 MHz




**Plot 7:** 9 kHz to 30 MHz, 434.37 MHz



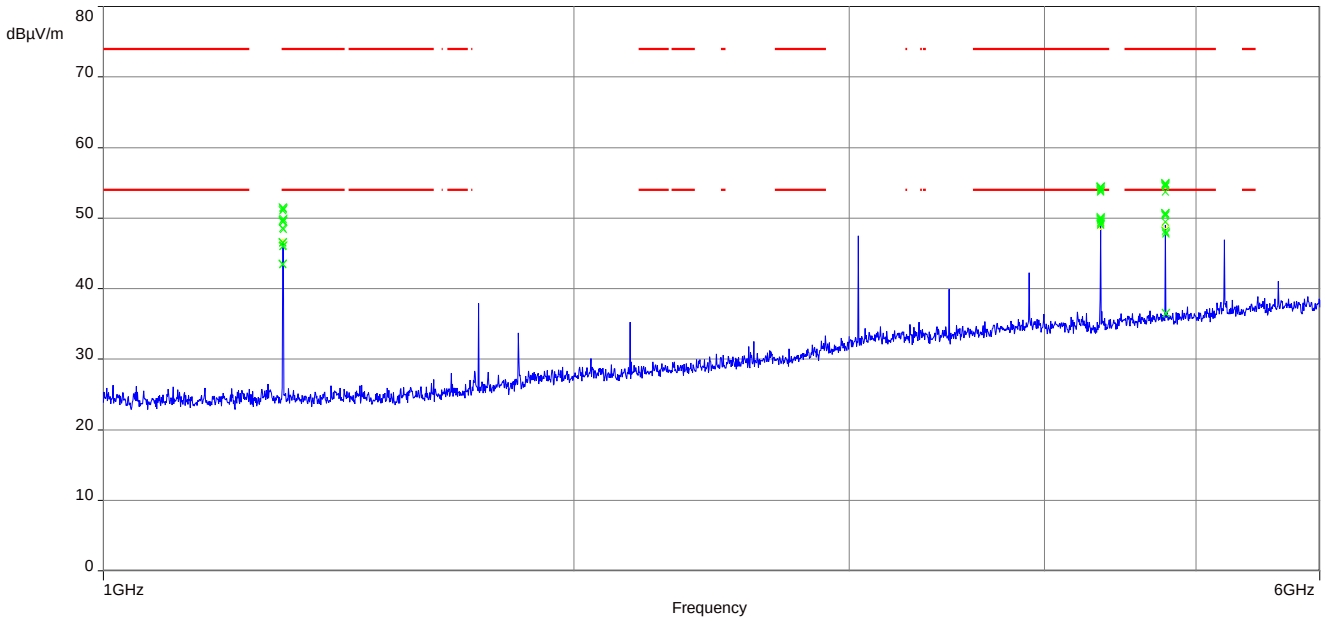
**Plot 8:** 30 MHz to 1000 MHz, vertical & horizontal polarisation, 434.37 MHz




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 34.173 | 8.33 | 50.7 | 42.4 | 1000 | 120 | 128.0 | H | 304 | 12 |
| 37.580 | 8.55 | 50.7 | 42.2 | 1000 | 120 | 182.0 | V | 181 | 13 |
| 70.910 | 6.88 | 50.7 | 43.8 | 1000 | 120 | 100.0 | V | -44 | 9 |
| 99.644 | 6.75 | 50.7 | 44.0 | 1000 | 120 | 333.0 | V | 90 | 12 |
| 434.359 | 69.14 | 50.7 | -18.4 | 1000 | 120 | 100.0 | V | 100 | 17 |
| 733.949 | 17.62 | 50.7 | 33.1 | 1000 | 120 | 301.0 | V | 270 | 22 |
| 868.761 | 19.61 | 50.7 | 31.1 | 1000 | 120 | 104.0 | H | 135 | 23 |

**Plot 9:** 1000 MHz to 6000 MHz, vertical & horizontal polarisation, 434.37 MHz



## 11 Observations

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

## Annex A Glossary

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

## Annex B Document history

| Version | Applied changes | Date of release |
|---|---|---|
| -/- | Initial release | 2020-03-03 |
| A | Updated FCC-ID | 2020-03-06 |

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

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



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

https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf

########## END OF TEST REPORT ##########