
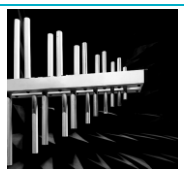
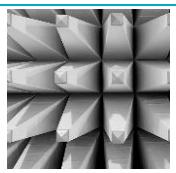

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-7810/19-05-06**

## Testing laboratory


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


**Accredited Testing Laboratory:**
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

## Applicant


**ABITRON Control Systems GmbH**
Wiesnerstr. 20
4950 Altheim / AUSTRIA
Phone: +43 (0) 7723 44 860 700
Contact: Mathias Friedl
e-mail: mathias.friedl@abitronremote.com
Phone: +43 (0) 7723 44860 161


## Manufacturers


**ABITRON Austria GmbH**
Wiesnerstr. 20
4950 Altheim / AUSTRIA

**ABITRON Germany GmbH**
Adalbert-Stifter-Straße 2
D-84085 Langquaid / 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 - 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:** | **RF module** |
| **Model name:** | **MBT-1** |
| **FCC ID:** | **2AC8P-MBT1** |
| **IC:** | **12310A-MBT1** |
| Frequency: | DTS band 2400 MHz to 2483.5 MHz |
| Technology tested: | Bluetooth® LE |
| Antenna: | External antenna |
| Power supply: | 3.6 V DC |
| Temperature range: | -40°C to +70°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:

p.o.

cn=Joerg Warken, o=CTC advanced GmbH, ou=WAK-281116, email=joerg.warken@ctcadvanced.com, c=DE
2020.05.19 17:05:52 +02'00'

Andreas Luckenbill
Head of Department
Radio Communications

## Test performed:

cn=Mihail Dorongovskij, o=CTC advanced GmbH, ou=DOR-281116, email=Mihail.Dorongovskij@ctcadvanced.com, c=DE
2020.05.19 17:01:56 +02'00'

Mihail Dorongovskij
Lab Manager
Radio Communications

# 1 Table of contents



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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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In no case this test report can be considered as a Letter of Approval.

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

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2019-06-11 |
| Date of receipt of test item: | 2020-02-28 |
| Start of test: | 2020-03-02 |
| End of test: | 2020-03-11 |
| 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 - 247 Issue 2 | February 2017 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices |
| RSS - Gen Issue 5 incl. Amendment 1 | March 2019 | Spectrum Management and Telecommunications Radio Standards Specification<br>- General Requirements for Compliance of Radio Apparatus |
| **Guidance** | **Version** | **Description** |
| KDB 558074 D01 | v05r02 | GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES |
| ANSI C63.4-2014 | -/- | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | -/- | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |

| Accreditation | Description |
|---|---|
| D-PL-12076-01-04 | Telecommunication and EMC Canada<br>https://www.dakks.de/as/ast/d/D-PL-12076-01-04.pdf |
| 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>$T_{min}$ | +22 °C during room temperature tests<br>No tests under extreme environmental conditions required.<br>No tests under extreme environmental conditions required. |
| Relative humidity content | : | | 55 % |
| Barometric pressure | : | | 1021 hpa |
| Power supply | : | $V_{nom}$<br><br>$V_{max}$<br>$V_{min}$ | 3.6 V DC by external power supply (conducted)<br>3.6 V DC by Li-Ion battery (radiated)<br>No tests under extreme environmental conditions required.<br>No tests under extreme environmental conditions required. |

# 5 Test item

## 5.1 General description

| | | |
|---|---|---|
| Kind of test item | : | RF module |
| Model name | : | MBT-1 |
| HMN | : | n/a |
| PMN | : | MBT-1 |
| HVIN | : | MBT-1 |
| FVIN | : | n/a |
| S/N serial number | : | B00002 |
| Hardware status | : | V01.03 |
| Software status | : | Texas Instruments SmartRF Studio 7 v2.16.0 |
| Firmware status | : | Texas Instruments SIMPLELINK-CC13X2-26X2-SDK_3.40.00.02 |
| Frequency band | : | DTS band 2400 MHz to 2483.5 MHz |
| Type of radio transmission<br>Use of frequency spectrum | :<br>: | DSSS |
| Type of modulation | : | GFSK |
| Number of channels | : | 40 |
| Antenna | : | External antenna |
| Power supply | : | 3.1-14.0 V DC |
| Temperature range | : | -40°C to +70°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: 1-7810/19-05-01_AnnexA
1-7810/19-05-01_AnnexB
1-7810/19-05-01_AnnexD

# 6 Sequence of testing

## 6.1 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.

## 6.2 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.

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## 6.3 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.

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## 6.4 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.

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## 7 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).

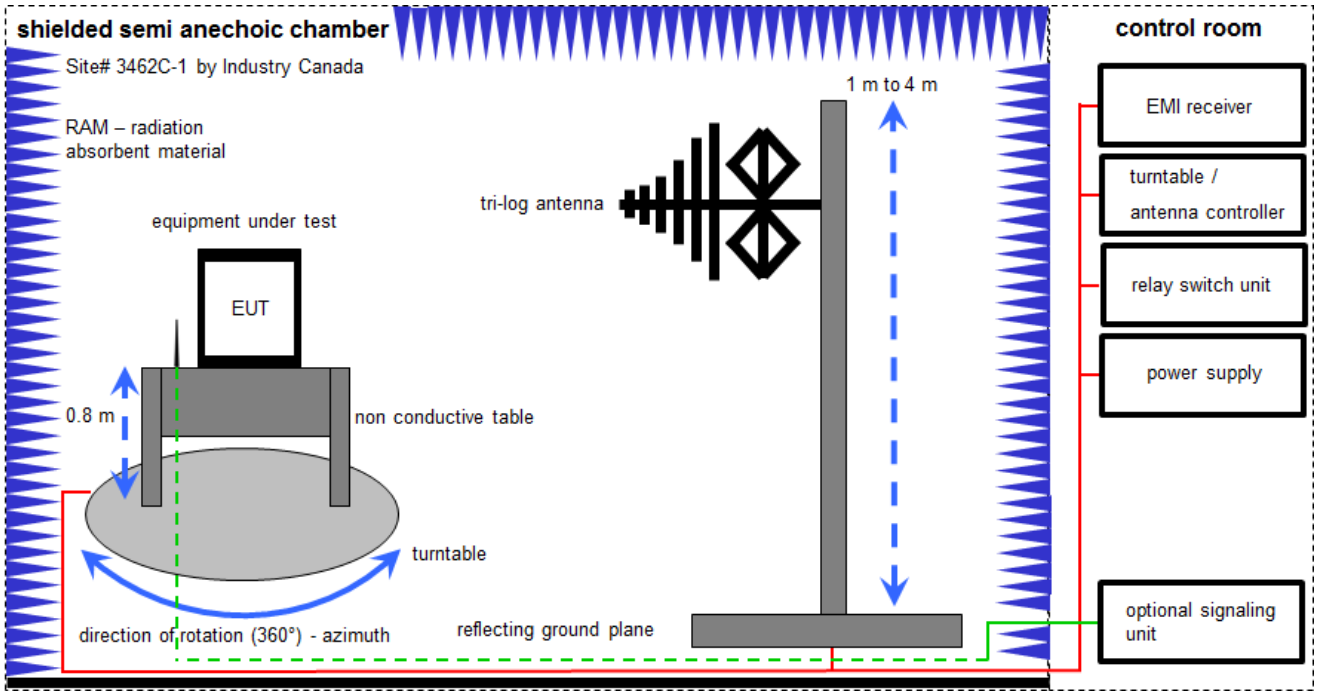
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**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 |

## 7.1 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)

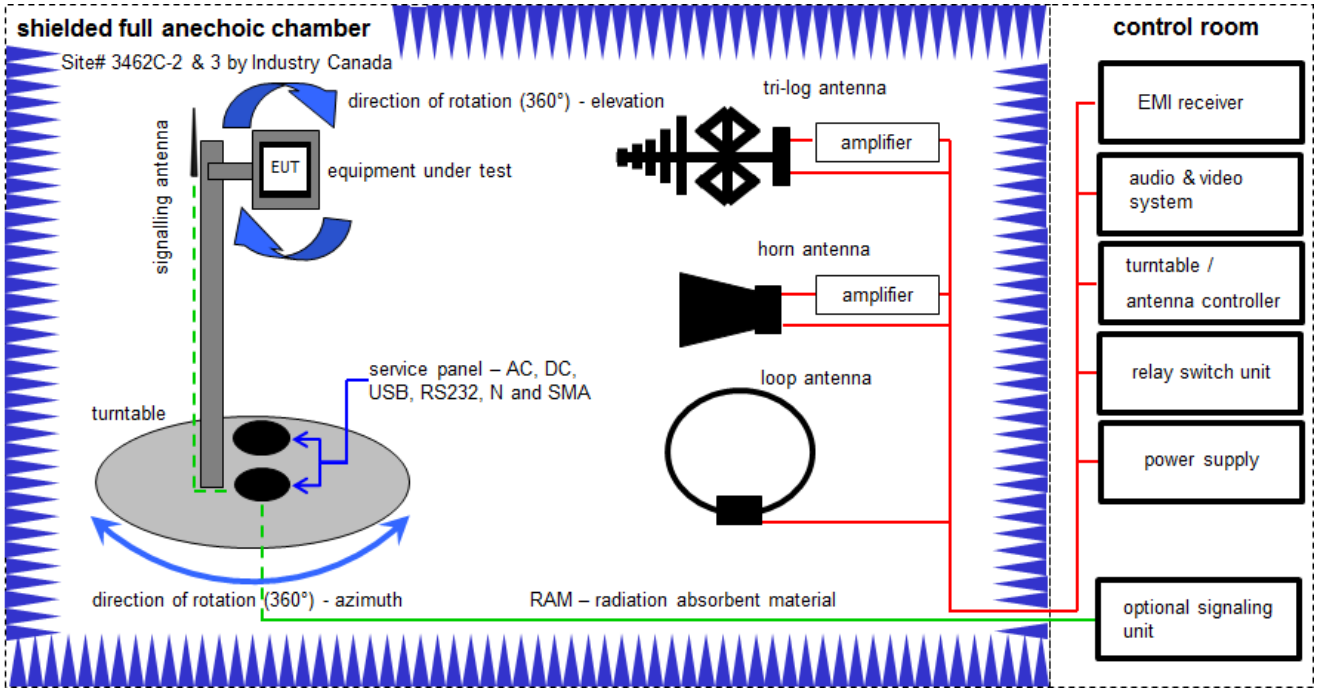
*Example calculation:*
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

**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 | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | vIKI! | 17.01.2020 | 16.01.2022 |
| 4 | A | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 5 | A | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 6 | A | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | A | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 295 | 300003787 | vIKI! | 19.02.2019 | 18.02.2021 |
| 8 | A | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 21.05.2019 | 20.11.2020 |

## 7.2 Shielded fully anechoic chamber




Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter

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

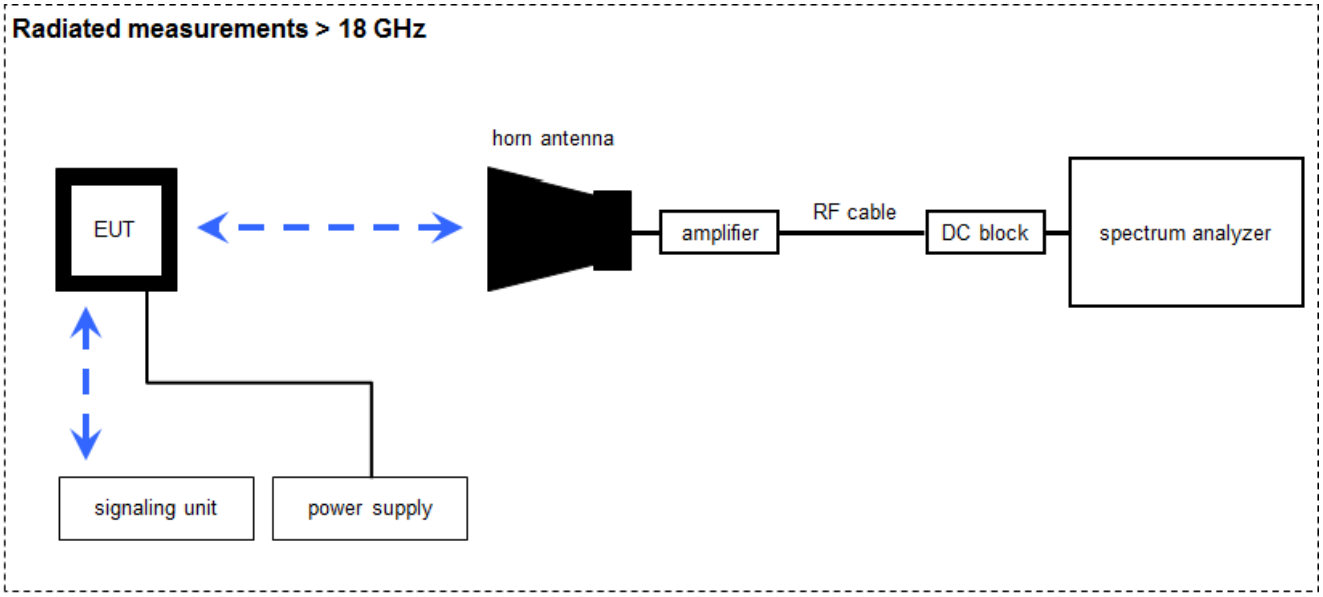
*Example calculation:*
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | C | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | vIKI! | 13.06.2019 | 12.06.2021 |
| 2 | A, B | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3696 | 300001604 | vIKI! | 27.02.2019 | 26.02.2021 |
| 3 | A | Highpass Filter | WHK1.1/15G-10SS | Wainwright | 37 | 400000148 | ne | -/- | -/- |
| 4 | A | Highpass Filter | WHKX7.0/18G-8SS | Wainwright | 18 | 300003789 | ne | -/- | -/- |
| 5 | A | Band Reject Filter | WRCG2400/2483-2375/2505-50/10SS | Wainwright | 26 | 300003792 | ne | -/- | -/- |
| 6 | A | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22051 | 300004483 | ev | -/- | -/- |
| 7 | A, B, C | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000032 | 300004510 | ne | -/- | -/- |
| 8 | A, B, C | Computer | Intel Core i3 3220/3,3 GHz, Prozessor | | 2V2403033A 5421 | 300004591 | ne | -/- | -/- |
| 9 | A | High Pass Filter | VHF-3500+ | Mini Circuits | -/- | 400000193 | ne | -/- | -/- |
| 10 | A, B, C | NEXIO EMV-Software | BAT EMC V3.19.1.19 | EMCO | | 300004682 | ne | -/- | -/- |
| 11 | A, B, C | Anechoic chamber | | TDK | | 300003726 | ne | -/- | -/- |
| 12 | A, B, C | EMI Test Receiver 9kHz-26,5GHz | ESR26 | R&S | 101376 | 300005063 | k | 10.12.2019 | 09.12.2020 |
| 13 | A | RF-Amplifier | AMF-6F06001800-30-10P-R | NARDA-MITEQ Inc | 2011571 | 300005240 | ev | -/- | -/- |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 14 | A | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 01029 | 300005379 | vIKI! | 02.07.2019 | 01.07.2021 |

## 7.3 Radiated measurements > 18 GHz




Measurement distance: horn antenna 50 cm

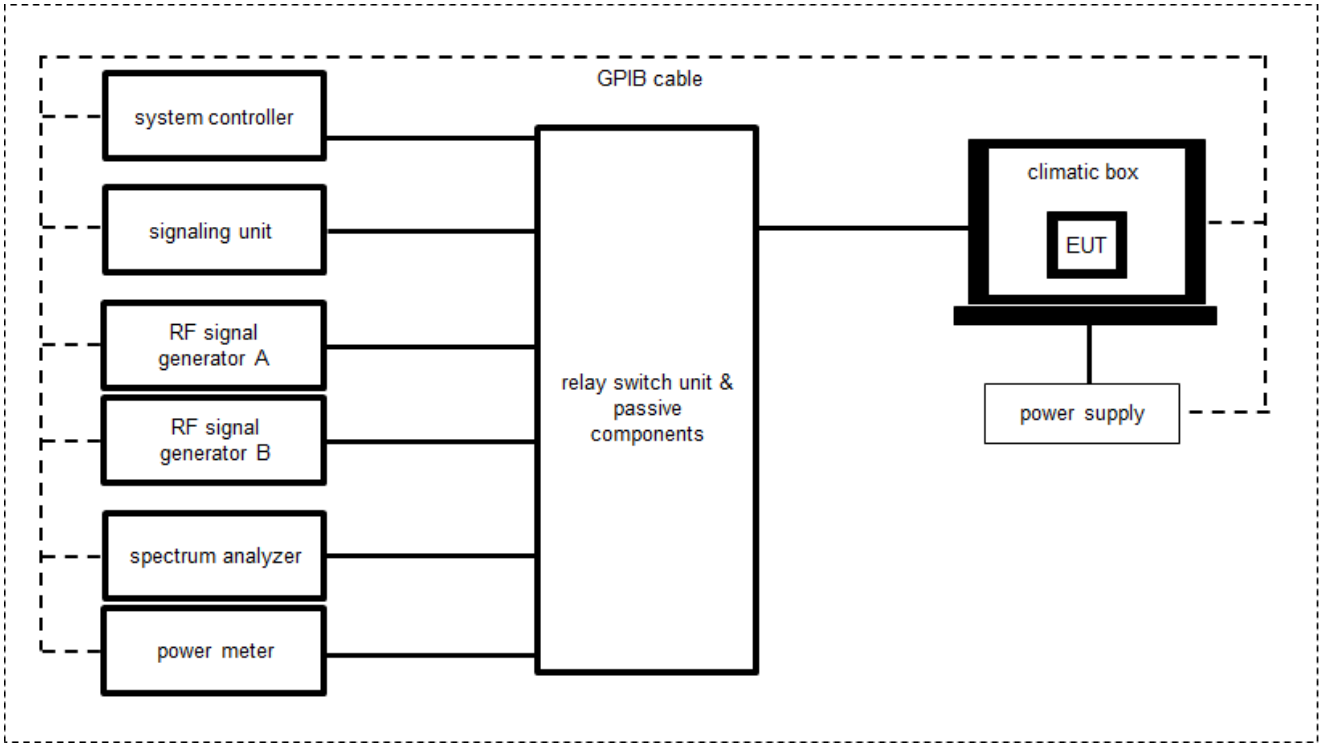
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

*Example calculation:*
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/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 | Horn Antenna 18.0-40.0 GHz | LHAF180 | Microw.Devel | 39180-103-021 | 300001747 | vlKI! | 18.02.2019 | 17.02.2022 |
| 3 | A | Signal Analyzer 40 GHz | FSV40 | R&S | 101042 | 300004517 | k | 17.12.2019 | 16.12.2020 |
| 4 | A | RF-Cable | ST18/SMAm/SMAm /48 | Huber & Suhner | Batch no. 600918 | 400001182 | ev | -/- | -/- |
| 5 | A | RF-Cable | ST18/SMAm/SMAm /48 | Huber & Suhner | Batch no. 127377 | 400001183 | ev | -/- | -/- |
| 6 | A | DC-Blocker 0.1-40 GHz | 8141A | Inmet | -/- | 400001185 | ev | -/- | -/- |

## 7.4 Conducted measurements Bluetooth system



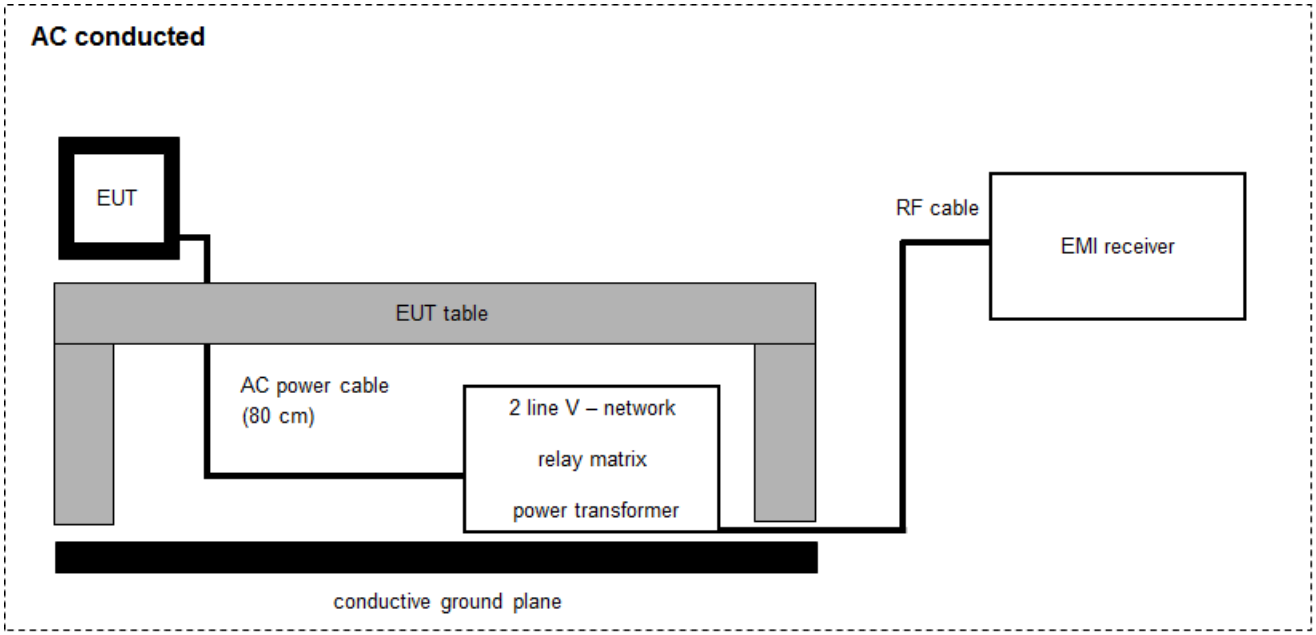

OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

*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 | Hygro-Thermometer | -/-, 5-45C, 20-100rF | Thies Clima | -/- | 400000080 | ev | 11.05.2018 | 10.05.2020 |
| 2 | A | PC Laboratory 19" | Exone i3 | Fröhlich + Walter | 35230157A0370 | 300004646 | ne | -/- | -/- |
| 3 | A | Spectrum Analyzer | FSV30 | Rohde & Schwarz | 103170 | 300004855 | vlKl! | 11.12.2018 | 10.12.2020 |
| 4 | A | USB-GPIB-Interface | 82357B | Agilent Technologies | MY54323070 | 300004852 | ne | -/- | -/- |
| 5 | A | Power Supply DC | HMP2020 | Rohde & Schwarz | 102123 | 300005235 | vlKl! | 11.12.2018 | 10.12.2020 |
| 6 | A | Relay Switch Matrix | RSM-1 | CTC advanced GmbH | 0001 | 400001355 | ev | 07.01.2020 | 06.01.2021 |
| 7 | A | Tester Software RadioStar (C.BER2 for BT Conformance) | Version 1.0.0.X | CTC advanced GmbH | 0001 | 400001380 | ne | -/- | -/- |

## 7.5 AC conducted




FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

*Example calculation:*
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Two-line V-Network (LISN) 9 kHz to 30 MHz | ESH3-Z5 | R&S | 892475/017 | 300002209 | vIKI! | 11.12.2019 | 10.12.2021 |
| 2 | A | RF-Filter-section | 85420E | HP | 3427A00162 | 300002214 | NK! | -/- | -/- |
| 3 | A | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 10.12.2019 | 09.12.2020 |
| 4 | A | Hochpass 150 kHz | EZ-25 | R&S | 100010 | 300003798 | ev | -/- | -/- |

# 8 Measurement uncertainty

| Measurement uncertainty | |
|---|---|
| **Test case** | **Uncertainty** |
| Antenna gain | ± 3 dB |
| 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 |
| Band edge compliance conducted | ± 1.5 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 |
| Spurious emissions conducted below 30 MHz (AC conducted) | ± 2.6 dB |

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# 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 - 247, Issue 2 | See table! | 2020-05-19 | -/- |

| Test specification clause | Test case | Guideline | Temperature conditions | Power source voltages | Mode | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| §15.247(b)(4)<br>RSS - 247 / 5.4 (4) | System gain | -/- | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(e)<br>RSS - 247 / 5.2 (b) | Power spectral density | KDB 558074<br>DTS clause: 8.4 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(a)(2)<br>RSS - 247 / 5.2 (a) | DTS bandwidth – 6 dB bandwidth | KDB 558074<br>DTS clause: 8.2 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| RSS Gen clause 4.6.1 | Occupied bandwidth | -/- | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(b)(3)<br>RSS - 247 / 5.4 (4) | Maximum output power | KDB 558074<br>DTS clause: 8.3.1.1 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5 | Detailed spurious emissions @ the band edge - conducted | KDB 558074<br>DTS clause: 8.5 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.205<br>RSS - 247 / 5.5<br>RSS - Gen | Band edge compliance cond. & rad. | KDB 558074<br>DTS clause: 8.7.2 or 8.7.3 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5 | TX spurious emissions conducted | KDB 558074<br>DTS clause: 8.5 | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.209(a)<br>RSS - Gen | Spurious emissions radiated below 30 MHz | -/- | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |
| 15.247(d)<br>RSS - 247 / 5.5<br>§15.109<br>RSS - Gen | Spurious emissions radiated 30 MHz to 1 GHz | -/- | Nominal | Nominal | 1 Msps S8 coded RX mode | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.247(d)<br>RSS - 247 / 5.5<br>§15.109<br>RSS - Gen | Spurious emissions radiated above 1 GHz | -/- | Nominal | Nominal | 1 Msps S8 coded RX mode | ☒ | ☐ | ☐ | ☐ | -/- |
| §15.107(a)<br>§15.207 | Conducted emissions below 30 MHz (AC conducted) | -/- | Nominal | Nominal | 1 Msps S8 coded | ☒ | ☐ | ☐ | ☐ | -/- |

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

## 10 Additional comments

*The Bluetooth® word mark and logos are owned by the Bluetooth SIG Inc. and any use of such marks by CTC advanced GmbH is under license.*

Reference documents: 1-7810_19-05-06_log1_conducted.pdf

Special test descriptions: Power settings 6 was used for all tests.
The AC conducted emission test was performed with a reference power supply (Power Supply HCPS-27.0-2250).
The radiated tests were performed with an external FLX 2412 antenna with plate.

Configuration descriptions:

| Bluetooth Low Energy | |
|---|---|
| Longest Supported payload (37 – 255 Byte) | Tx: 255, RX: 255 |
| LE 1M PHY supported | No |
| LE 2M PHY supported | No |
| Stable Modulation Index supported (SMI) | No |
| LE Coded PHY supported (S=2) | No |
| LE Coded PHY supported (S=8) | Yes |

Test mode:

☐ Bluetooth LE Test mode enabled
(EUT is controlled by CMW)

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

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)

- *Equipment with 1 antenna,*
- *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,*
- *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*

☐ Operating mode 2 (multiple antennas, no beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*

☐ Operating mode 3 (multiple antennas, with beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.*
  *In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.*

# 11 Measurement results

## 11.1 System gain

**Measurement:**

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

| Measurement parameters (radiated) | |
|---|---|
| Detector | Peak |
| Sweep time | Auto |
| Resolution bandwidth | 3 MHz |
| Video bandwidth | 3 MHz |
| Span | 5 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 7.2 B |
| Measurement uncertainty | See sub clause 8 |

| Measurement parameters (conducted) | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>Common2G4 Peak Output Power conducted 3MHz_3MHz |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| 6 dBi / > 6 dBi output power and power density reduction required | |

**Results:**

| $T_{nom}$ | $V_{nom}$ | 2402 MHz | 2440 MHz | 2480 MHz |
|---|---|---|---|---|
| Conducted power [dBm]<br>Measured with GFSK modulation (1 Msps S8 coded) | | 5.2 | 4.8 | 4.4 |
| Radiated power [dBm]<br>Measured with GFSK modulation (1 Msps S8 coded) | | 7.6 | 5.1 | 3.5 |
| Gain [dBi]<br>Calculated | | 2.5 | 0.3 | -0.9 |

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## 11.2 Power spectral density

**Description:**

Measurement of the power spectral density of a digital modulated system.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 Peak Power Spectral Density DTS |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

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

**Results:**

| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **Power spectral density [dBm / 3kHz] 1 Msps S8 coded** | -0.9 | -1.3 | -1.5 |

## 11.3 DTS bandwidth – 6 dB bandwidth

**Description:**

Measurement of the 6 dB bandwidth of the modulated signal.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 Bandwidth 6dB DTS |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| DTS bandwidth – 6 dB bandwidth | |
| Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band.<br>The minimum 6 dB bandwidth shall be at least 500 kHz. | |

**Results:**

| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **6 dB bandwidth [kHz]<br>1 Msps S8 coded** | 756 | 735 | 768 |

## 11.4 Occupied bandwidth – 99% emission bandwidth

**Description:**

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 Bandwidth 99PCT |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Usage:**

| -/- | IC |
|---|---|
| Occupied bandwidth – 99% emission bandwidth | |
| OBW is necessary for emission designator | |

**Results:**

| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **99% bandwidth [kHz]<br>1 Msps S8 coded** | 1096 | 1080 | 1102 |

## 11.5 Maximum output power

**Description:**

Measurement of the maximum output power conducted. EUT in single channel mode.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 Maximum Peak Conducted Output Power DTS |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| Maximum output power | |
| Conducted: 1.0 W – antenna gain max. 6 dBi | |

**Results:**

| | Frequency | | |
|---|---|---|---|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| **Maximum output power conducted [dBm] 1 Msps S8 coded** | 5.2 | 4.8 | 4.4 |

## 11.6 Detailed spurious emissions @ the band edge - conducted

**Description:**

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

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 TX Spurious Conduced |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. | |

**Results:**

| Scenario | Spurious band edge conducted [dB] |
|---|---|
| Data rate | 1 Msps S8 coded |
| Lower band edge | > 20 dB |
| Upper band edge | > 20 dB |

## 11.7 Band edge compliance conducted

**Description:**

Measurement of the radiated band edge compliance with a conducted test setup.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 Restricted Band Edge Conducted Peak DTS |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| -41.26 dBm | |

**Results:**

| | band edge compliance / dBm (gain calculation) |
|---|---|
| Data rate | 1 Msps S8 coded |
| Max. lower band edge power conducted | -61.1 |
| Antenna gain / dBi | 2.5 |
| Max. lower band edge power radiated | -58.6 |
| | |
| Max. upper band edge power conducted | -57.7 |
| Antenna gain / dBi | -0.9 |
| Max. upper band edge power radiated | -58.6 |

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## 11.8 TX spurious emissions conducted

**Description:**

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

| Measurement parameters | |
|---|---|
| External result file | 1-7810_19-05-06_log1_conducted.pdf<br>FCC Part 15.247 TX Spurious Conduced |
| Test setup | See sub clause 7.4 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC |
|---|---|
| TX spurious emissions conducted | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required | |

**Results:** 1 Msps S8 coded

| TX spurious emissions conducted | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| f [MHz] | | amplitude of emission [dBm] | limit max. allowed emission power | actual attenuation below frequency of operation [dB] | results |
| 2402 | | 1.6 | 30 dBm | | Operating frequency |
| All detected emissions are compliant with the -20 dBc limit! | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |
| 2440 | | 1.2 | 30 dBm | | Operating frequency |
| All detected emissions are compliant with the -20 dBc limit! | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |
| 2480 | | 0.9 | 30 dBm | | Operating frequency |
| All detected emissions are compliant with the -20 dBc limit! | | | -20 dBc | | compliant |
| | | | | | |
| | | | | | |

## 11.9 Spurious emissions radiated below 30 MHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

| Measurement parameters | |
|---|---|
| Detector | Peak / Quasi peak |
| Sweep time | Auto |
| Resolution bandwidth | F < 150 kHz: 200 Hz<br>F > 150 kHz: 9 kHz |
| Video bandwidth | F < 150 kHz: 1 kHz<br>F > 150 kHz: 30 kHz |
| Span | 9 kHz to 30 MHz |
| Trace mode | Max hold |
| Test setup | See sub clause 7.2 C |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

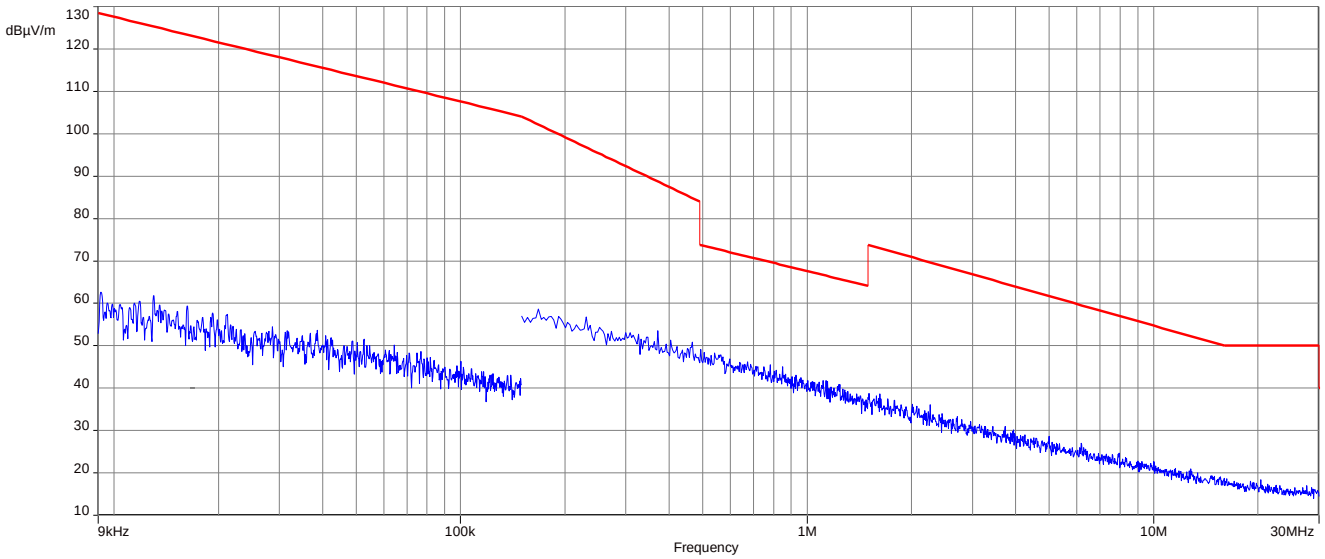
| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated below 30 MHz | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

**Results:**

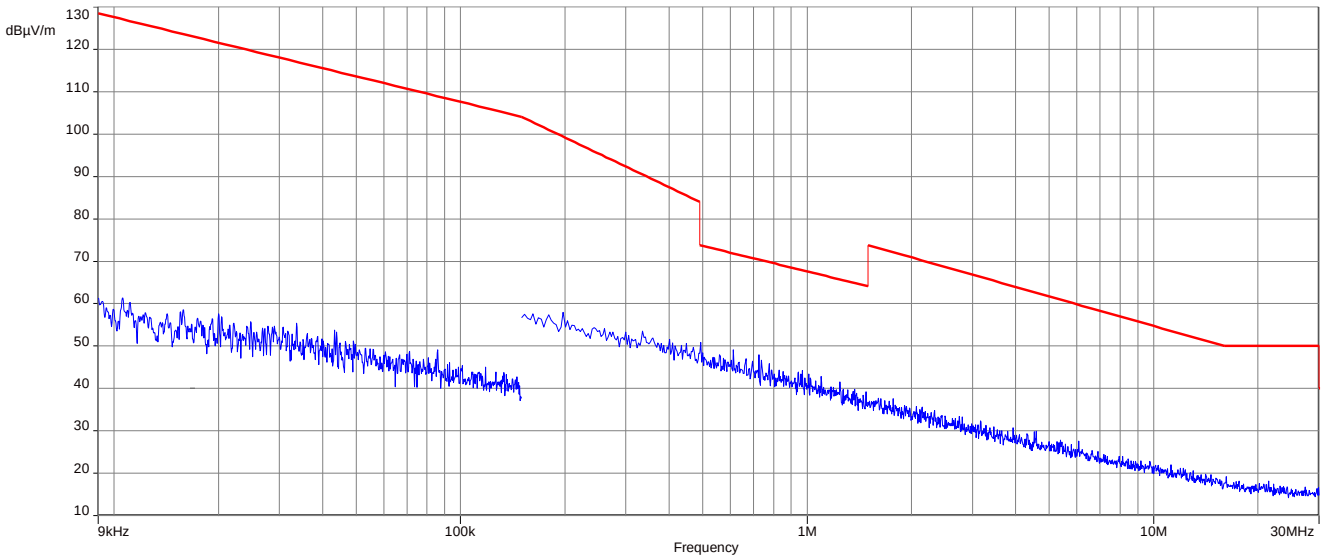
| TX spurious emissions radiated below 30 MHz [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | |
| | | |
| | | |

**Plots:**

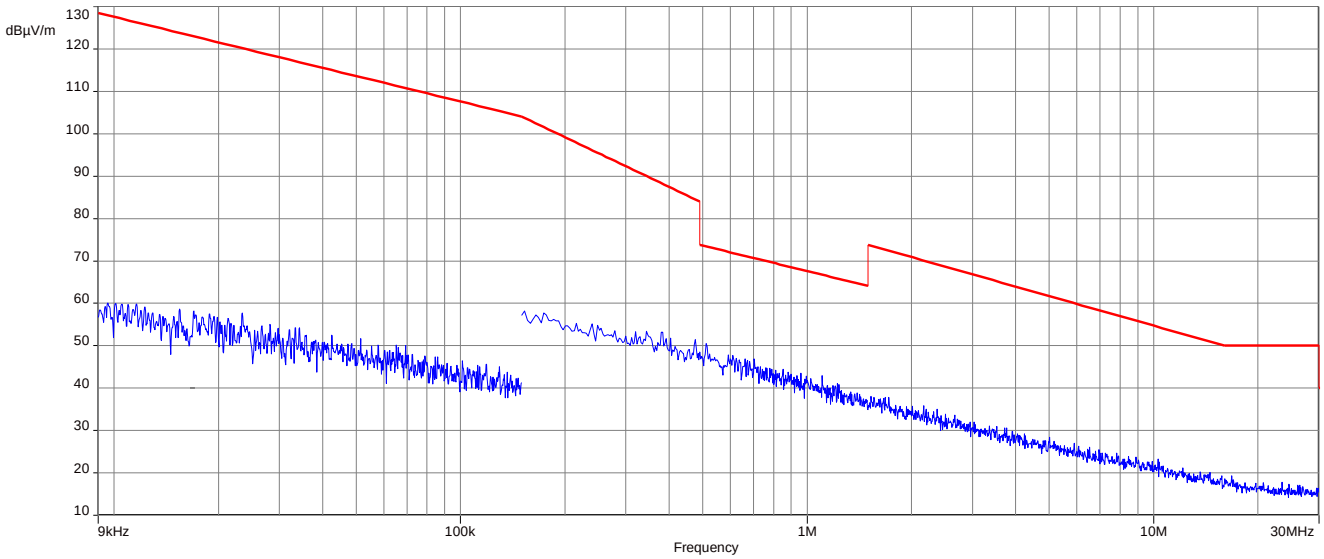
**Plot 1:** 9 kHz to 30 MHz, 2402 MHz, transmit mode, 1 Msps S8 coded




**Plot 2:** 9 kHz to 30 MHz, 2440 MHz, transmit mode, 1 Msps S8 coded



**Plot 3:** 9 kHz to 30 MHz, 2480 MHz, transmit mode, 1 Msps S8 coded



## 11.10 Spurious emissions radiated 30 MHz to 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

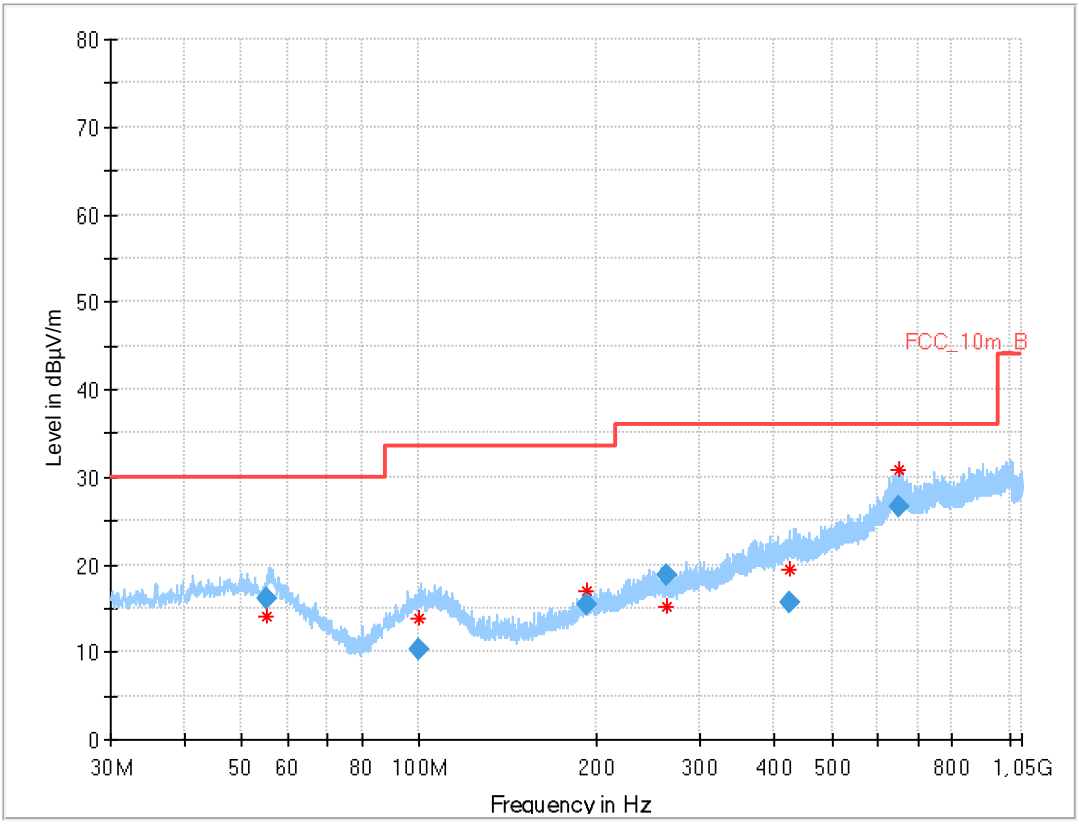
| Measurement parameters | |
|---|---|
| Detector | Peak / Quasi Peak |
| Sweep time | Auto |
| Resolution bandwidth | 120 kHz |
| Video bandwidth | 3 x RBW |
| Span | 30 MHz to 1 GHz |
| Trace mode | Max hold |
| Measured modulation | GFSK |
| Test setup | See sub clause 7.1 A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | IC | |
|---|---|---|
| TX spurious emissions radiated | | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). | | |
| §15.209 | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| 30 - 88 | 30.0 | 10 |
| 88 – 216 | 33.5 | 10 |
| 216 – 960 | 36.0 | 10 |
| Above 960 | 54.0 | 3 |

**Plots:** Transmit mode

**Plot 1:** 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps S8 coded




**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 55.325 | 16.04 | 30.0 | 14.0 | 1000 | 120 | 170.0 | H | 202 | 15 |
| 100.197 | 10.21 | 33.5 | 23.3 | 1000 | 120 | 119.0 | V | 157 | 13 |
| 191.977 | 15.51 | 33.5 | 18.0 | 1000 | 120 | 170.0 | H | 292 | 11 |
| 263.182 | 18.75 | 36.0 | 17.3 | 1000 | 120 | 170.0 | H | 247 | 13 |
| 425.543 | 15.67 | 36.0 | 20.3 | 1000 | 120 | 110.0 | H | 269 | 17 |
| 651.332 | 26.51 | 36.0 | 9.5 | 1000 | 120 | 157.0 | H | 292 | 21 |

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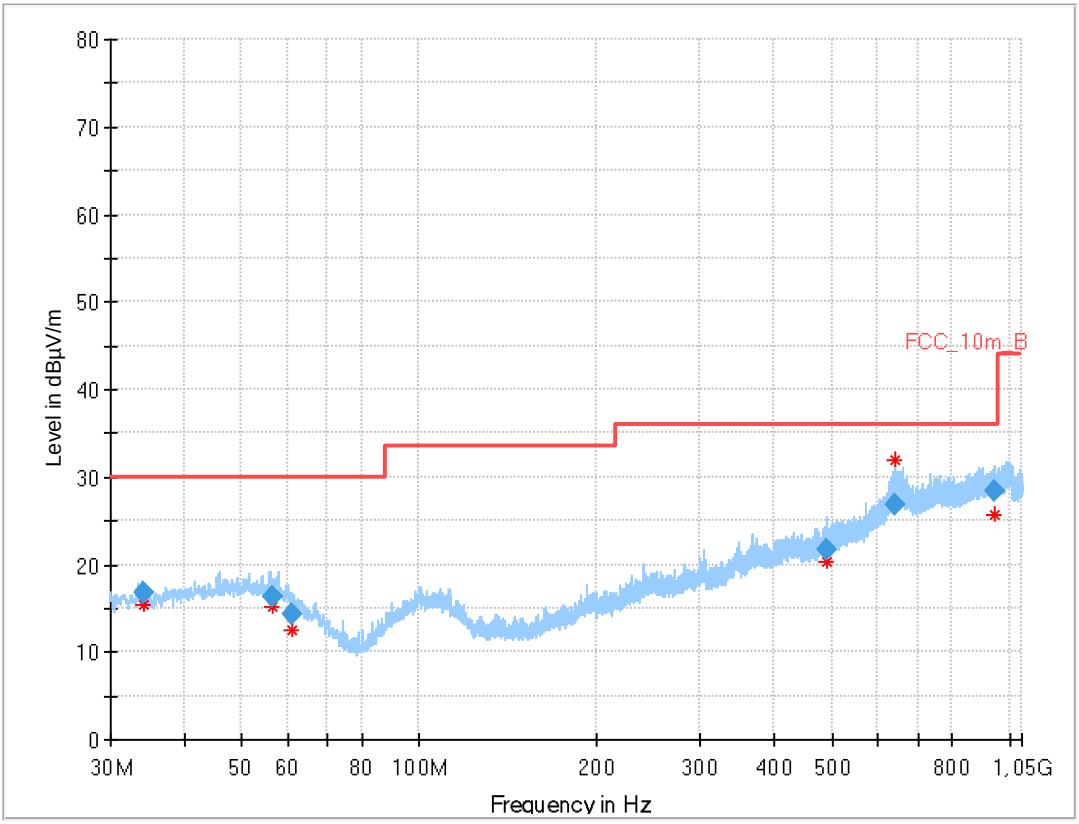
**Plot 2:** 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps S8 coded




**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 34.049 | 16.73 | 30.0 | 13.3 | 1000 | 120 | 170.0 | H | 247 | 12 |
| 56.340 | 16.38 | 30.0 | 13.6 | 1000 | 120 | 155.0 | H | -13 | 15 |
| 60.857 | 14.23 | 30.0 | 15.8 | 1000 | 120 | 170.0 | V | 247 | 13 |
| 489.132 | 21.59 | 36.0 | 14.4 | 1000 | 120 | 154.0 | H | 247 | 18 |
| 639.403 | 26.71 | 36.0 | 9.3 | 1000 | 120 | 114.0 | H | 112 | 20 |
| 946.728 | 28.29 | 36.0 | 7.7 | 1000 | 120 | 170.0 | V | 67 | 24 |

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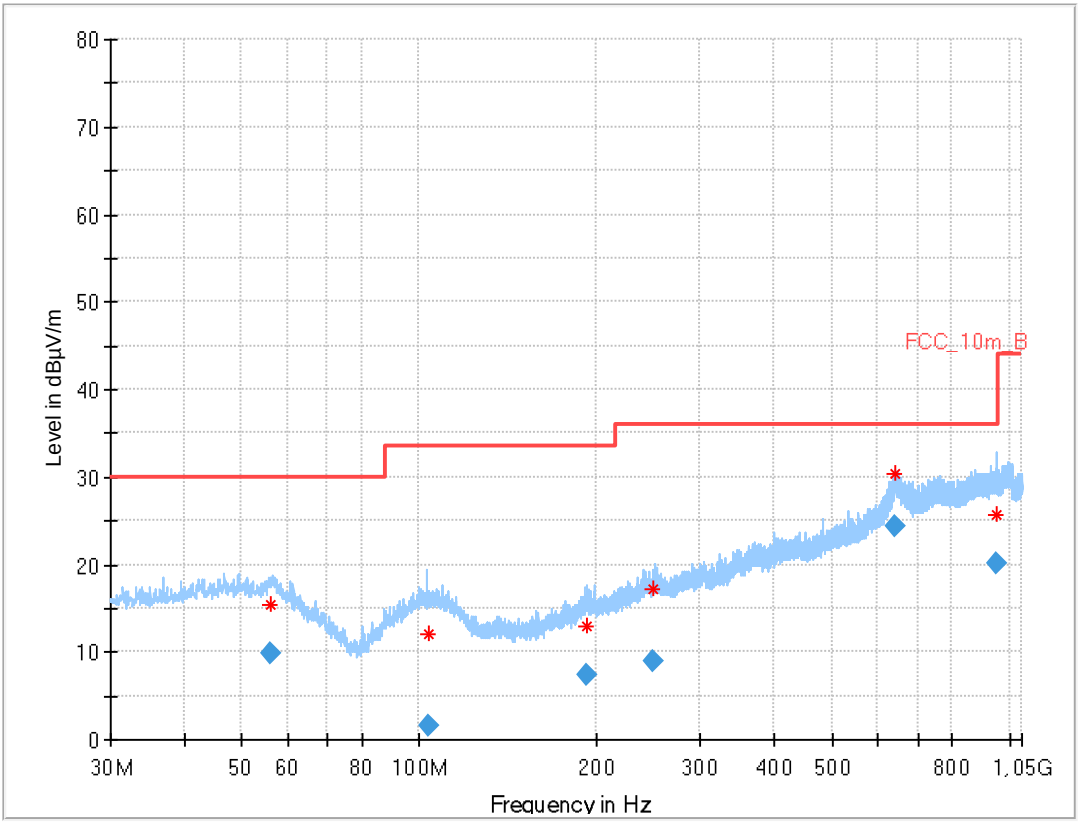
**Plot 3:** 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps S8 coded

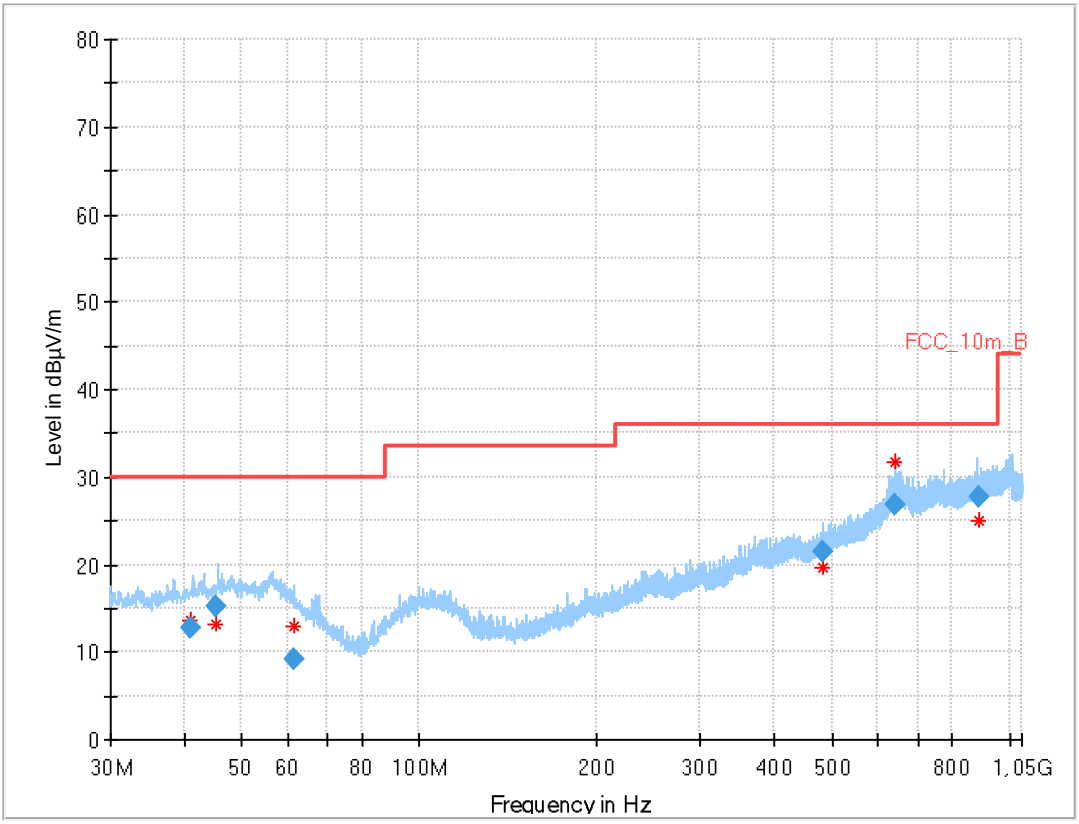



**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 55.994 | 9.74 | 30 | 20.26 | 1000 | 120 | 154.0 | V | 260 | 15 |
| 103.608 | 1.52 | 33.5 | 31.98 | 1000 | 120 | 102.0 | H | 280 | 13 |
| 192.231 | 7.38 | 33.5 | 26.12 | 1000 | 120 | 150.0 | H | 170 | 11 |
| 249.824 | 8.97 | 36 | 27.03 | 1000 | 120 | 170.0 | H | 80 | 13 |
| 640.050 | 24.29 | 36 | 11.71 | 1000 | 120 | 119.0 | H | 280 | 20 |
| 950.138 | 20.09 | 36 | 15.91 | 1000 | 120 | 170.0 | H | -10 | 24 |

**Plots:** Receiver mode

**Plot 1:** 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization




**Final results:**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 41.069 | 12.64 | 30.0 | 17.4 | 1000 | 120 | 170.0 | H | 247 | 14 |
| 45.118 | 15.27 | 30.0 | 14.7 | 1000 | 120 | 131.0 | V | -22 | 14 |
| 61.240 | 9.09 | 30.0 | 20.9 | 1000 | 120 | 170.0 | H | 272 | 13 |
| 483.656 | 21.48 | 36.0 | 14.5 | 1000 | 120 | 170.0 | H | 247 | 18 |
| 640.524 | 26.75 | 36.0 | 9.3 | 1000 | 120 | 134.0 | H | 112 | 20 |
| 884.920 | 27.79 | 36.0 | 8.2 | 1000 | 120 | 139.0 | H | 165 | 23 |

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## 11.11 Spurious emissions radiated above 1 GHz

**Description:**

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

| 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 | GFSK |
| Test setup | See sub clause 7.2 A (1 GHz - 18 GHz)<br>See sub clause 7.3 A (18 GHz - 26 GHz) |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions radiated | | |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). | | |
| §15.209 | | |
| Frequency (MHz) | Field strength (dBµV/m) | Measurement distance |
| Above 960 | 54.0 (Average) | 3 |
| Above 960 | 74.0 (Peak) | 3 |

**Results:** Transmitter mode, 1 Msps S8 coded

| TX spurious emissions radiated [dBµV/m] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2402 MHz | | | 2440 MHz | | | 2480 MHz | | |
| F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] | F [MHz] | Detector | Level [dBµV/m] |
| 1333 | Peak | 53.8 | 1333 | Peak | 53.8 | 1333 | Peak | 53.8 |
| | AVG | 41.8 | | AVG | 41.8 | | AVG | 41.8 |
| 2354 | Peak | 62.5 | 2296 | Peak | 58.5 | 2296 | Peak | 58.5 |
| | AVG | 50.6 | | AVG | 49.7 | | AVG | 49.7 |
| | Peak | | 2344 | Peak | 60.5 | 2344 | Peak | 60.5 |
| | AVG | | | AVG | 50.3 | | AVG | 50.3 |

**Results:** Receiver mode

| RX spurious emissions radiated [dBµV/m] | | |
|---|---|---|
| F [MHz] | Detector | Level [dBµV/m] |
| All detected emissions are more than 20 dB below the limit. | | |
| | Peak | |
| | AVG | |

**Note:** The limit was recalculated with 20 dB / decade (Part 15.31) for all radiated spurious emissions 30 MHz to 1 GHz from 3 meter limit to a 10 meter distance. (40dB/decade for emissions < 30MHz)

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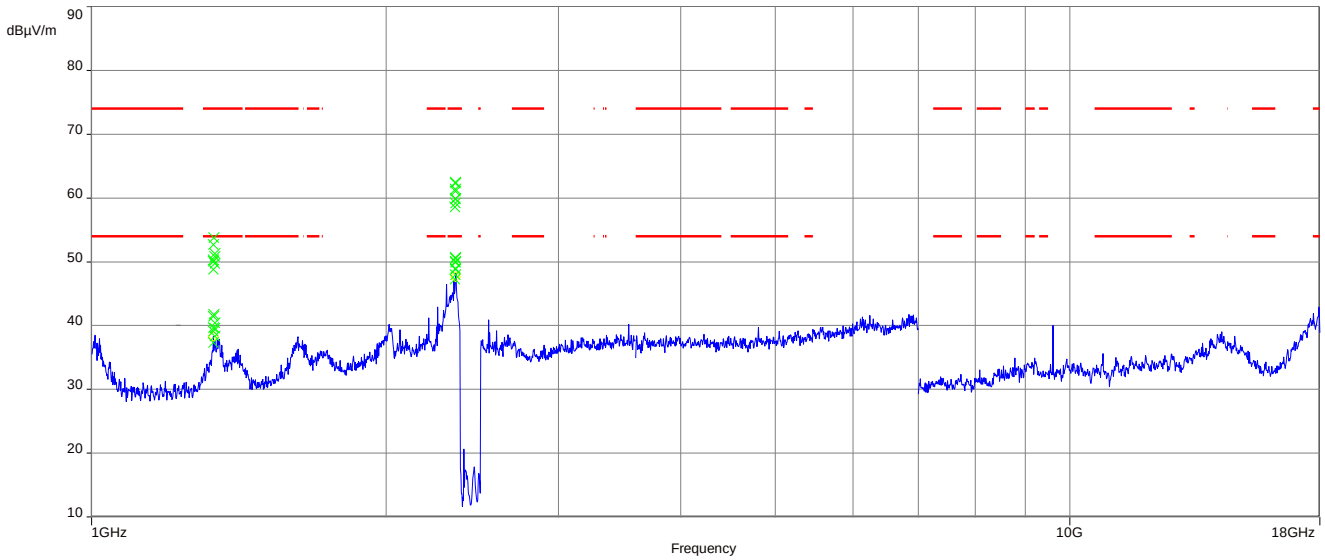
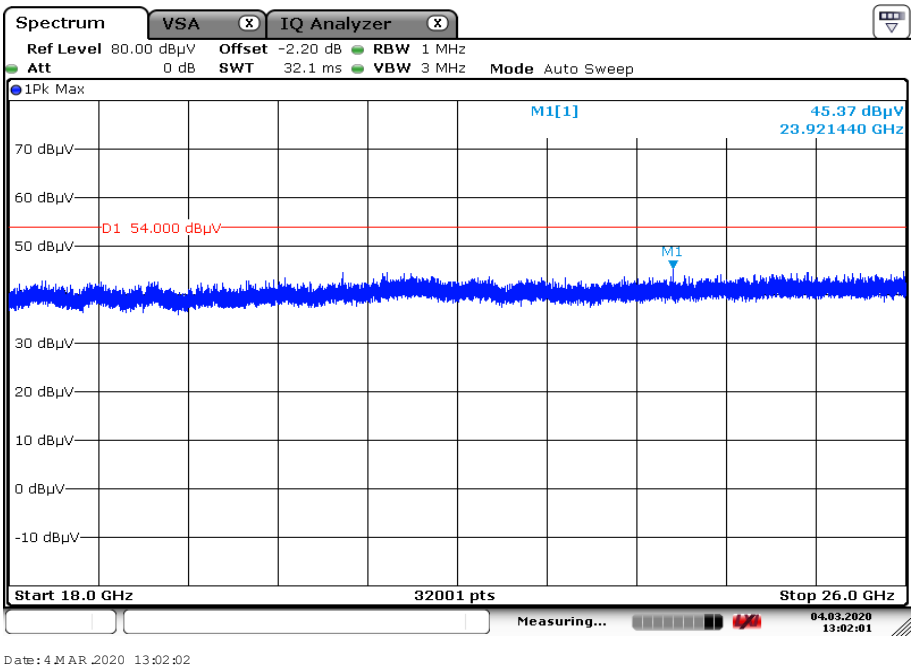
**Plots:** Transmitter mode

**Plot 1:** 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps S8 coded

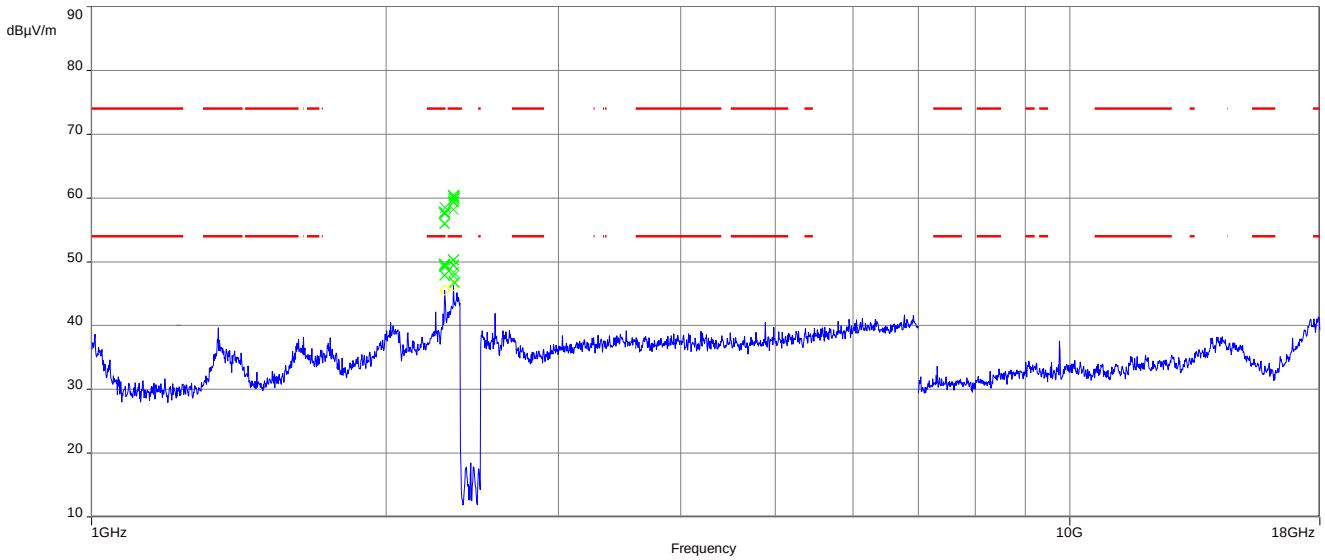



The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 2:** 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps S8 coded

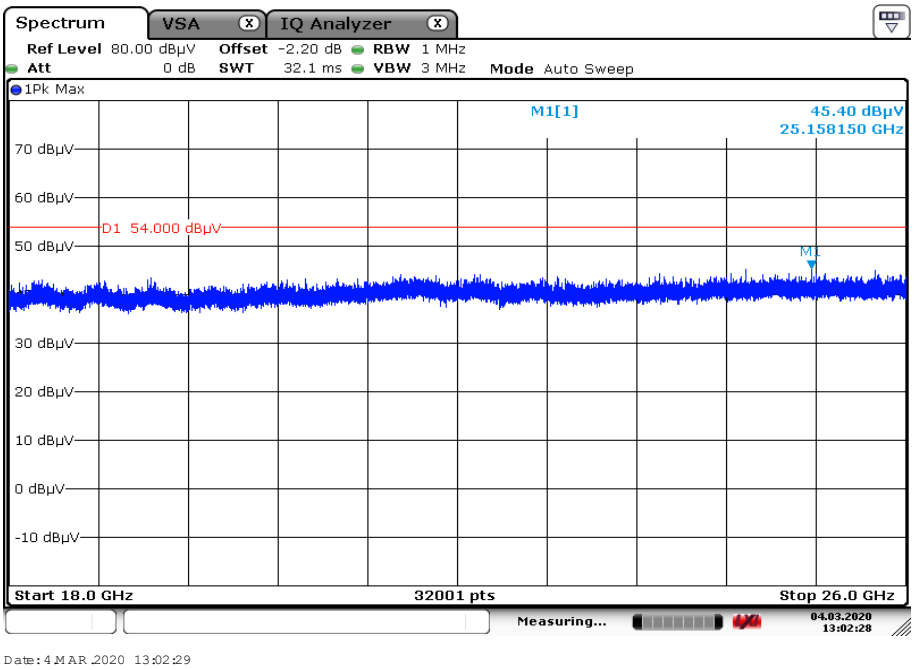


**Plot 3:** 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps S8 coded

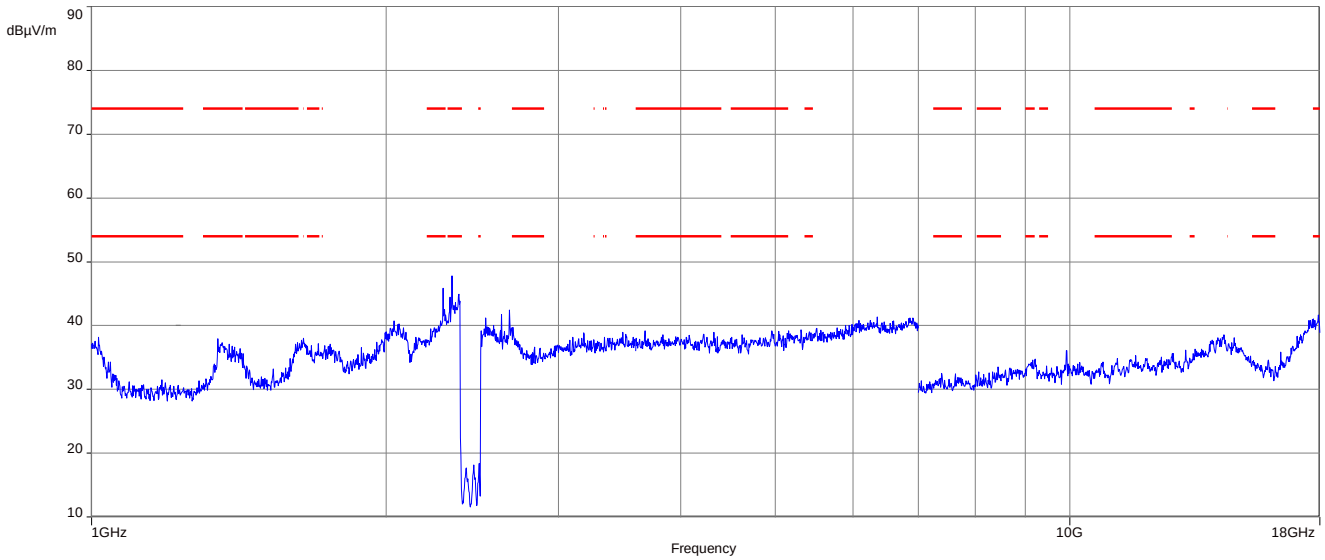



The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 4:** 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps S8 coded

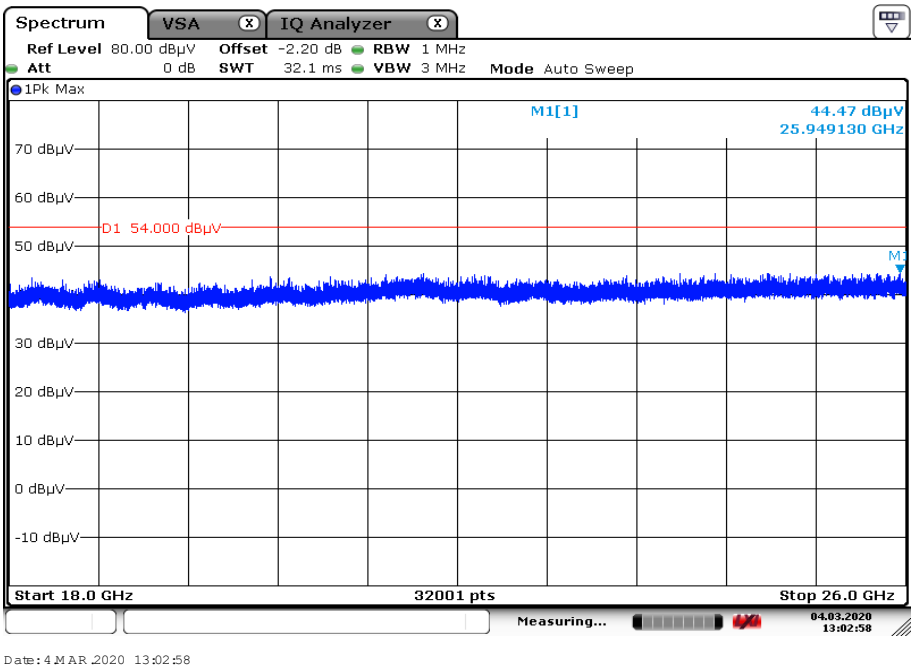


**Plot 5:** 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps S8 coded



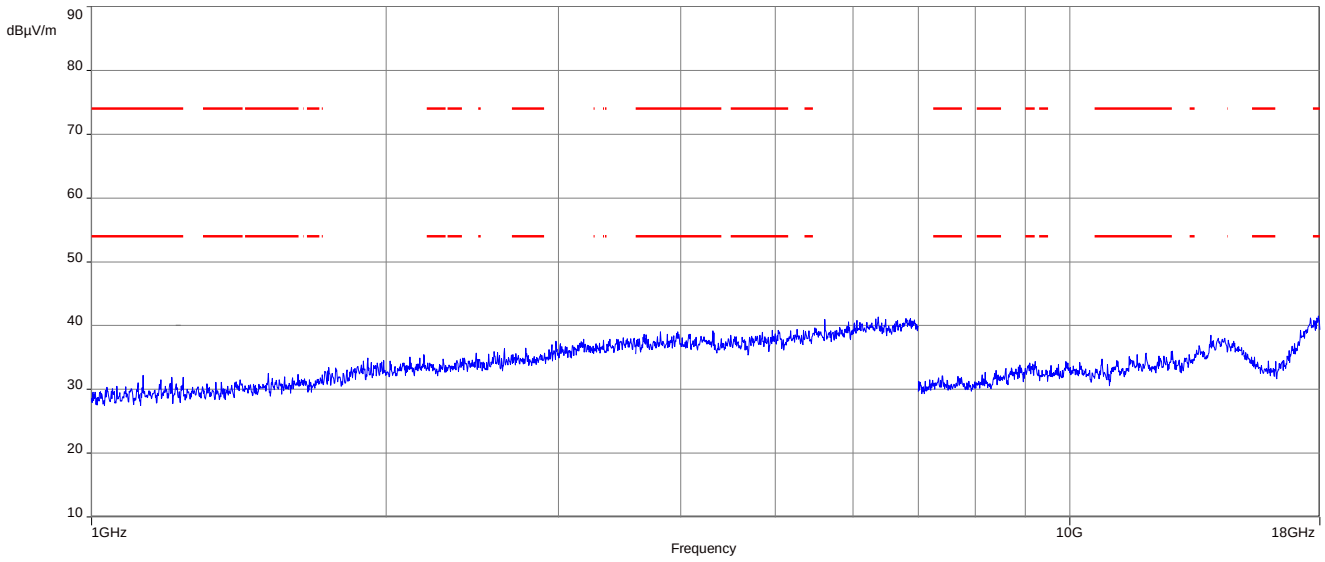

The carrier signal is notched with a 2.4 GHz band rejection filter.

**Plot 6:** 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps S8 coded

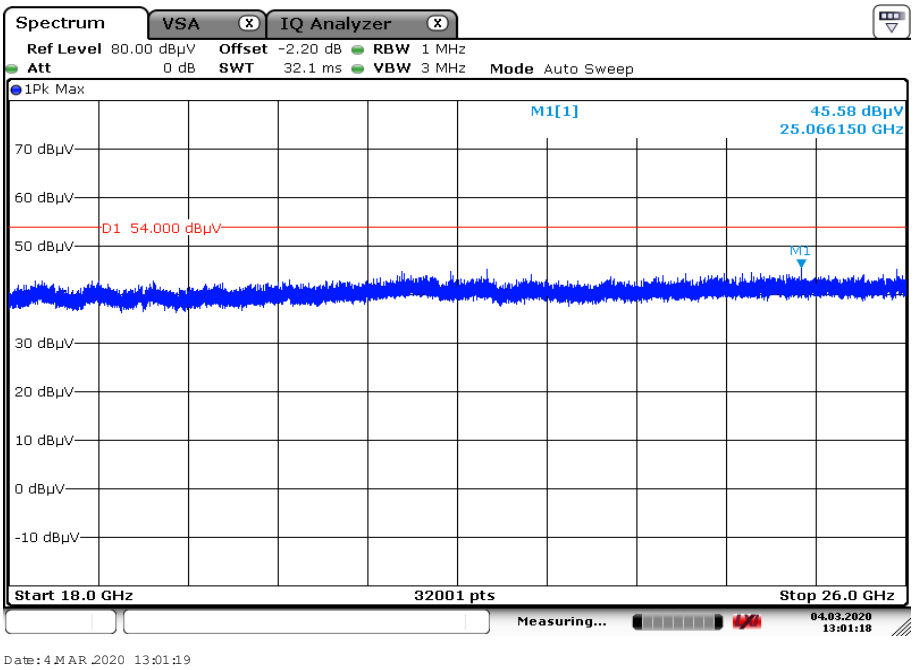


**Plots:** Receiver mode

**Plot 1:** 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization




**Plot 2:** 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization



## 11.12 Spurious emissions conducted below 30 MHz (AC conducted)

**Description:**

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequency is 2440 MHz. This measurement is representative for all channels and modes. If critical peaks are found frequency 2402 MHz and 2480 MHz will be measured too. The measurement is performed in the mode with the highest output power. Both power lines, phase and neutral line, are measured. Found peaks are re-measured with average and quasi peak detection to show compliance to the limits.

| Measurement parameters | |
|---|---|
| Detector | Peak - Quasi peak / average |
| Sweep time | Auto |
| Resolution bandwidth | F < 150 kHz: 200 Hz<br>F > 150 kHz: 9 kHz |
| Video bandwidth | F < 150 kHz: 1 kHz<br>F > 150 kHz: 100 kHz |
| Span: | 9 kHz to 30 MHz |
| Trace mode: | Max hold |
| Test setup | See sub clause 7.5. A |
| Measurement uncertainty | See sub clause 8 |

**Limits:**

| FCC | | IC |
|---|---|---|
| TX spurious emissions conducted < 30 MHz | | |
| Frequency (MHz) | Quasi-peak (dBµV/m) | Average (dBµV/m) |
| 0.15 – 0.5 | 66 to 56* | 56 to 46* |
| 0.5 – 5 | 56 | 46 |
| 5 – 30.0 | 60 | 50 |

*Decreases with the logarithm of the frequency

**Results:**

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

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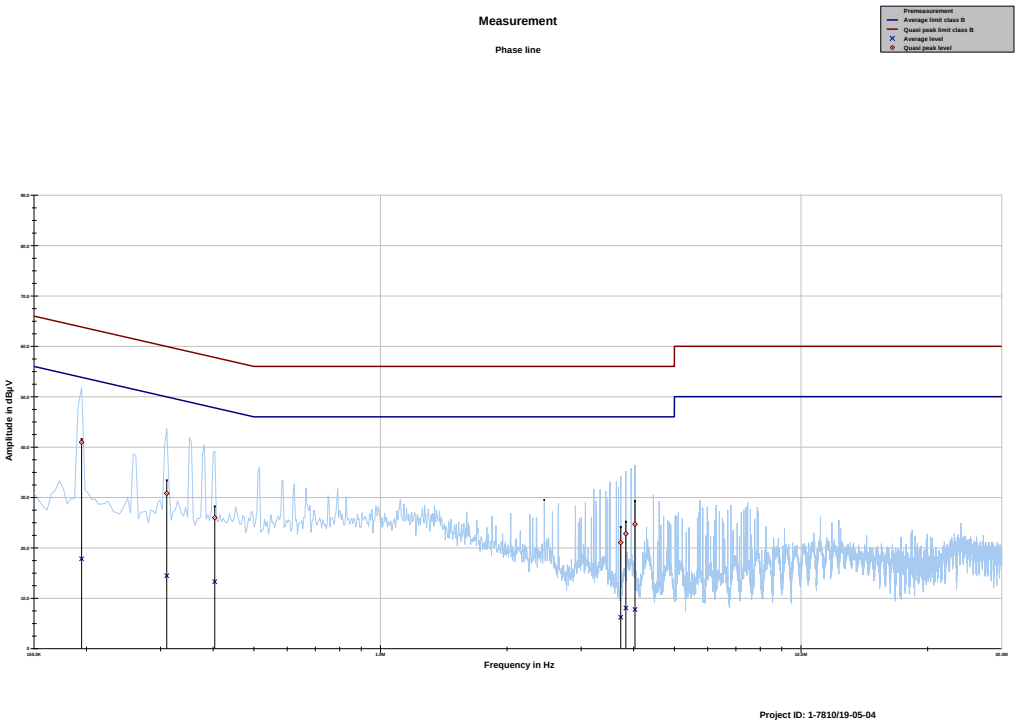
**Plots:**

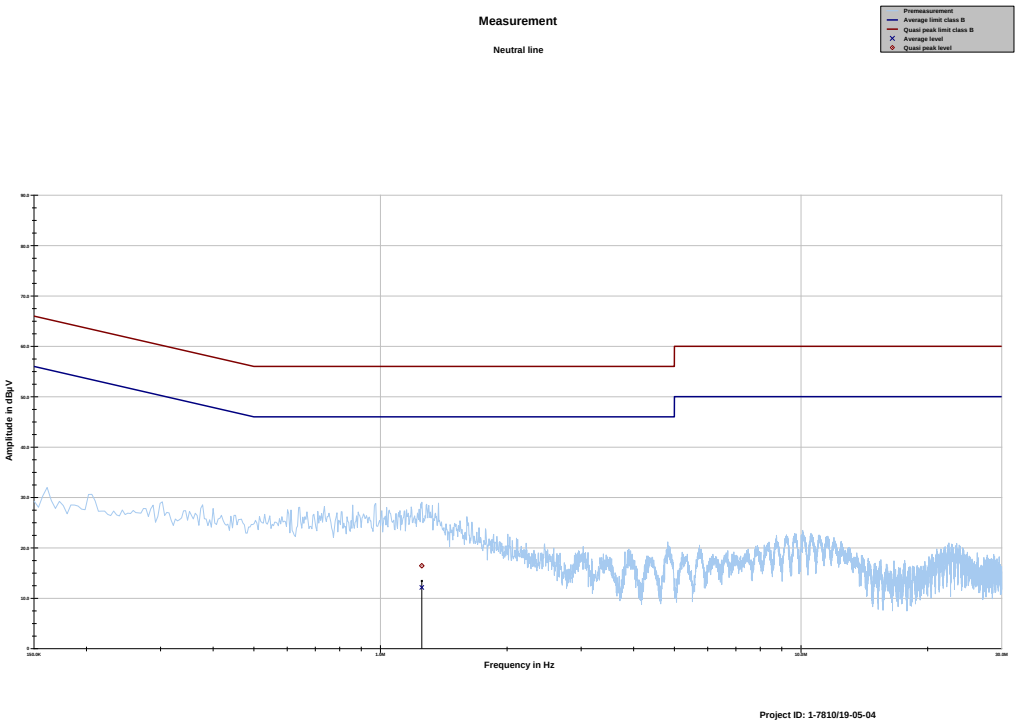
**Plot 1:** 150 kHz to 30 MHz, phase line




**Final results:**

| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| **0.194775** | 40.96 | 22.87 | 63.830 | 17.83 | 36.89 | 54.721 |
| **0.310444** | 30.81 | 29.15 | 59.959 | 14.47 | 36.95 | 51.416 |
| **0.403725** | 25.99 | 31.78 | 57.776 | 13.28 | 35.47 | 48.751 |
| **3.728269** | 21.05 | 34.95 | 56.000 | 6.21 | 39.79 | 46.000 |
| **3.832744** | 22.81 | 33.19 | 56.000 | 8.06 | 37.94 | 46.000 |
| **4.030500** | 24.68 | 31.32 | 56.000 | 7.76 | 38.24 | 46.000 |

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




**Final results:**

| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin Average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| **1.254450** | 16.44 | 39.56 | 56.000 | 12.14 | 33.86 | 46.000 |

## 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 | 2020-05-19 |

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

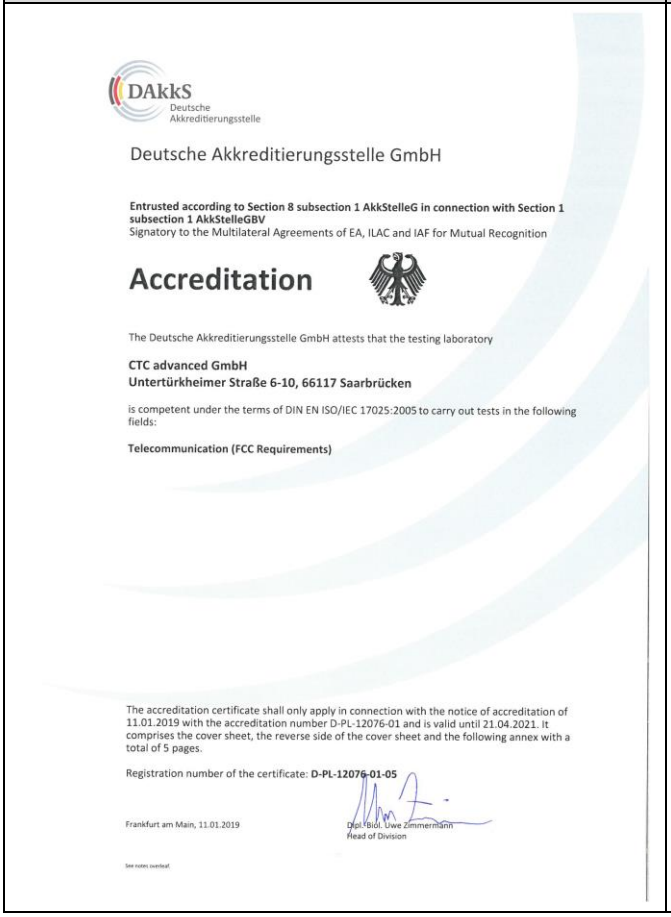
| first page | last page |
|---|---|
|  |  |



**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-12076-01-04.pdf

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

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

DAkkS Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

**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

**Accreditation**

The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory

**CTC advanced GmbH**
**Untertürkheimer Straße 6-10, 66117 Saarbrücken**

is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:

**Telecommunication (FCC Requirements)**

The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 5 pages.

Registration number of the certificate: **D-PL-12076-01-05**

Frankfurt am Main, 11.01.2019

Dipl.-Biol. Uwe Zimmermann
Head of Division

See notes overleaf.

Deutsche Akkreditierungsstelle GmbH

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