
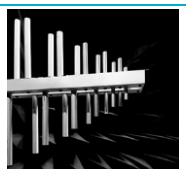
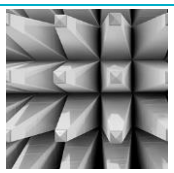

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-3243/21-01-05**

## 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: https://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 (2018-03) 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


**Hans Turck GmbH & Co. KG**
Witzlebenstr. 7
45472 Mülheim an der Ruhr / GERMANY
Phone:
Contact: Matthias Linde
e-mail: matthias.linde@turck.com
Phone: +49 2353 709-6198


## Manufacturer


**Hans Turck GmbH & Co. KG**
Witzlebenstr. 7
45472 Mülheim an der Ruhr / 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 |

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

## Test Item

| | |
|---|---|
| **Kind of test item:** | **Radar Distance Sensor** |
| **Model name:** | **DR15S-M30E-IOL8X2-H1141 / DR15S-M30E-UPN8X2-H1141** |
| **FCC-ID** | **YQ7-DRXXX-M30E** |
| Frequency: | 122 GHz – 123 GHz |
| Technology tested: | FMCW Radar |
| Antenna: | Integrated antenna |
| Power supply: | 24 V DC by external power supply |
| Temperature range: | -25°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:

M. Walla

cn=Meheza Walla, o=CTC advanced GmbH, ou=WAL-200806, email=meheza.walla@ctcadvanced.com, c=DE
2022.03.15 12:31:01 +01'00'

Meheza Walla
Lab Manager
Radio Communications & EMC

## Test performed:

Thomas Vogler

cn=Thomas Vogler, o=CTC advanced GmbH, ou=VOG-211118, email=thomas.vogler@ctcadvanced.com, c=DE
2022.03.15 11:32:27 +01'00'

Thomas Vogler
Lab Manager
Radio Communications & EMC

# 1 Table of contents

# 2 General information

## 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
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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.

## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2021-09-16 |
| Date of receipt of test item: | 2022-01-19 |
| Start of test: | 2022-01-20 |
| End of test: | 2022-02-23 |
| Person(s) present during the test: | -- |

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

## 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 |

| Guidance | Version | Description |
|---|---|---|
| | | |
| ANSI C63.4-2017 | -/- | 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 |
| ANSI C63.26-2015 | -/- | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |

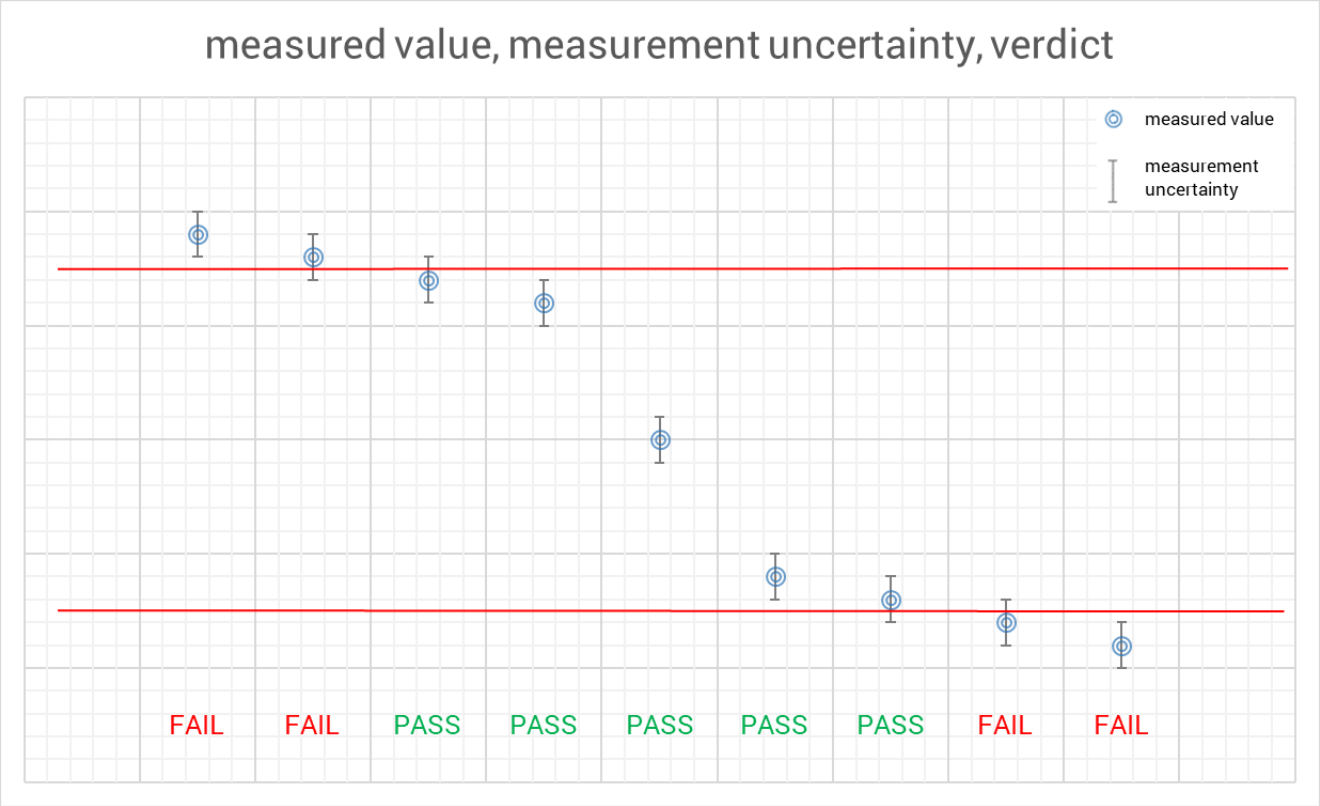
| Accreditation | Description | |
|---|---|---|
| | | |
| D-PL-12076-01-05 | Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf | |

## 4 Test environment

| | | | |
|---|---|---|---|
| Temperature | : | $T_{nom}$<br>$T_{max}$<br>$T_{min}$ | +22 °C during room temperature tests<br>+65 °C during high temperature tests<br>-25 °C during low temperature tests |
| Relative humidity content | : | | 50 % |
| Barometric pressure | : | | 1006 hpa |
| Power supply | : | $V_{nom}$ | 24 V DC by external power supply |

## 5 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong.



# 6 Test item

## 6.1 General description

| | | |
|---|---|---|
| **Kind of test item** | : | Radar Distance Sensor |
| **Model name:** | : | DR15S-M30E-IOL8X2-H1141 / DR15S-M30E-UPN8X2-H1141 |
| **S/N serial number** | : | n.a. |
| **Hardware status** | : | Frontend: LP 7534/0, SL 12869801, ECO 8000606104<br>Backend: LP 7842/0, SL 12896701, ECO 8000777004 |
| **Software status** | : | n.a. |
| **Firmware status** | : | Frontend 2.1.2.0, Backend 1.0.1.0 |
| **Frequency band** | : | 122 GHz – 123 GHz |
| **Type of modulation** | : | FMCW |
| **Number of channels** | : | 1 |
| **Antenna** | : | Integrated antenna |
| **Power supply** | : | 24 V DC by external power supply |
| **Temperature range** | : | -25°C to +65°C |

## 6.2 Additional information

Test setup and EUT photos are included in test report: 1-3243/21-01-01_AnnexA
1-3243/21-01-01_AnnexB
1-3243/21-01-01_AnnexD

# 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 18 GHz

**Setup**

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

**Premeasurement**

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

**Final measurement**

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

## 7.4 Sequence of testing radiated spurious above 18 GHz

**Setup**

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

**Premeasurement**

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

**Final measurement**

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

## 7.5 Sequence of testing radiated spurious above 50 GHz with external mixers

**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 for far field (e.g. 0.25 m).
- The EUT is set into operation.

**Premeasurement**

- The test antenna with external mixer is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.
- Caution is taken to reduce the possible overloading of the external mixer.

**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).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

# 8 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).

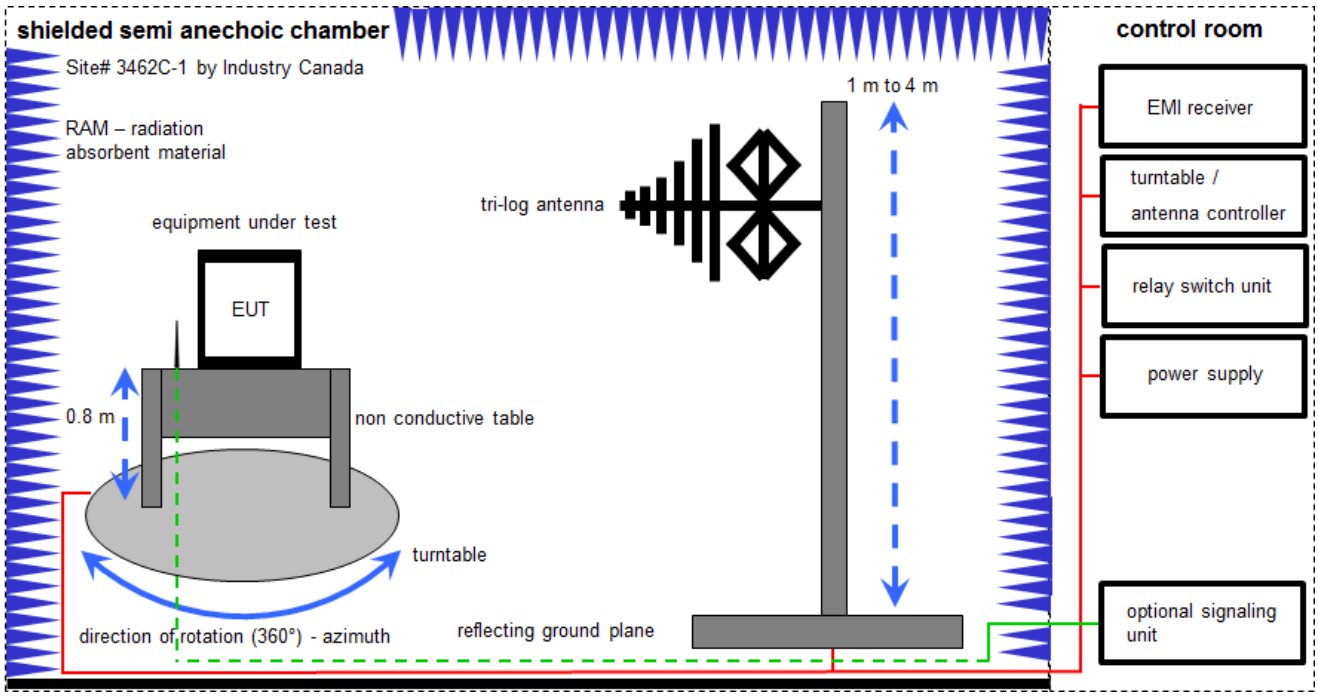
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**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 |

## 8.1 Shielded semi anechoic chamber

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

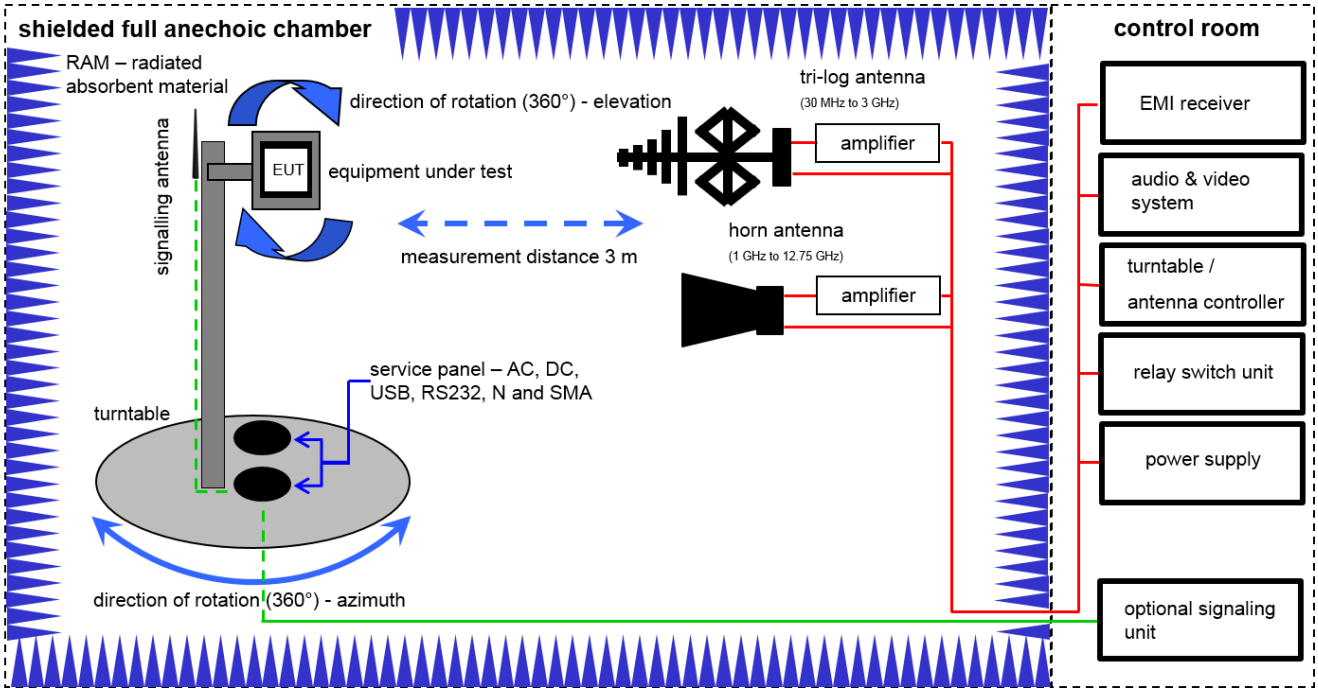



Measurement distance: tri-log antenna 10 meter

**Equipment table:**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | n. a. | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | n. a. | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2920A04466 | 300000580 | ne | -/- | -/- |
| 3 | n. a. | Meßkabine 1 | HF-Absorberhalle | MWB AG 300023 | | 300000551 | ne | -/- | -/- |
| 4 | n. a. | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 09.12.2021 | 31.12.2022 |
| 5 | n. a. | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 6 | n. a. | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 7 | n. a. | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 8 | n. a. | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 01029 | 300005379 | vIKI! | 14.01.2020 | 31.01.2022 |
| 9 | n. a. | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 10 | n. a. | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 08.12.2021 | 31.12.2022 |

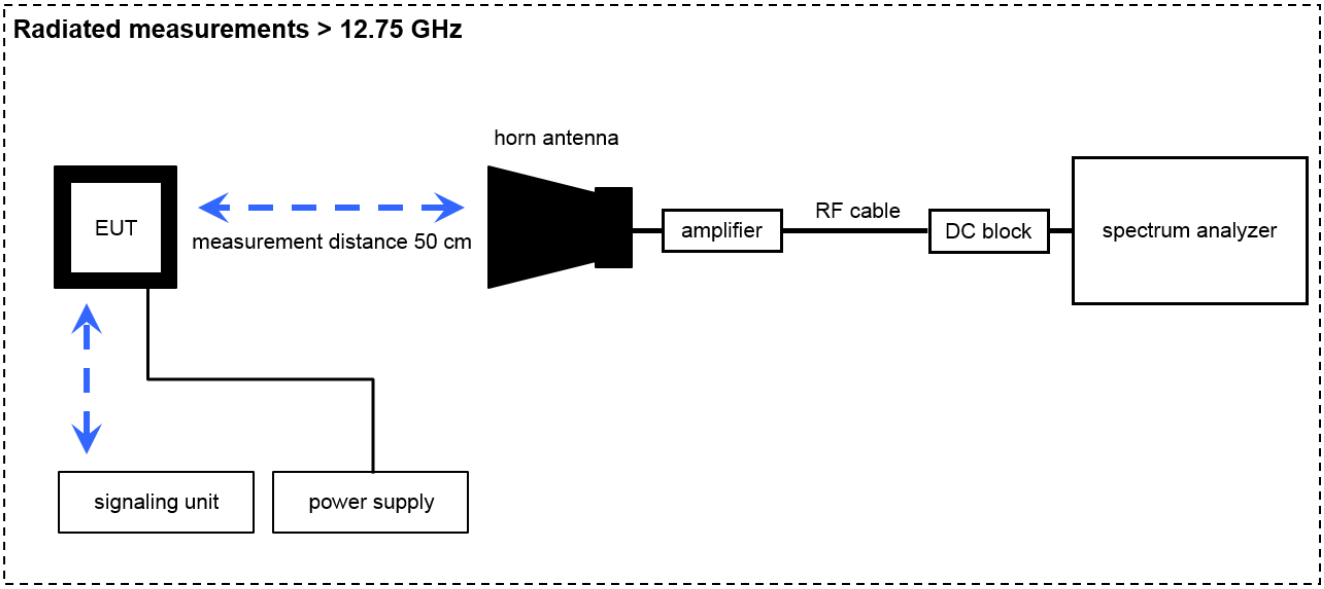
## 8.2 Radiated measurements fully anechoic chamber



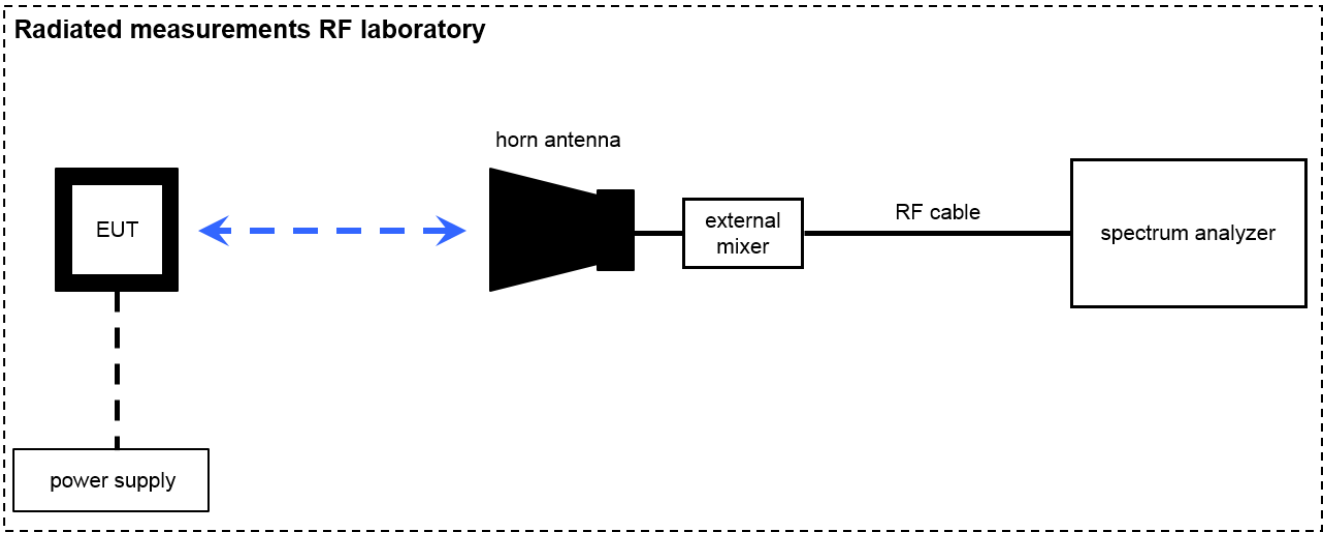

**Equipment table (Chamber C):**

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | n. a. | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2818A03450 | 300001040 | vIKI! | 09.12.2020 | 31.12.2023 |
| 2 | n. a. | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | vIKI! | 01.07.2021 | 30.06.2023 |
| 3 | n. a. | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | -/- | -/- |
| 4 | n. a. | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 318 | 300003696 | vIKI! | 30.09.2021 | 29.09.2023 |
| 5 | n. a. | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3697 | 300001605 | vIKI! | 12.03.2021 | 11.03.2023 |
| 6 | n. a. | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | -/- | -/- |
| 7 | n. a. | Variable isolating transformer | MPL IEC625 Bus Variable isolating transformer | Erfi | 91350 | 300001155 | ne | -/- | -/- |
| 8 | n. a. | EMI Test Receiver 20Hz- 26,5GHz | ESU26 | R&S | 100037 | 300003555 | k | 09.12.2021 | 31.12.2022 |
| 9 | n. a. | Highpass Filter | WHKX7.0/18G-8SS | Wainwright | 19 | 300003790 | ne | -/- | -/- |
| 10 | n. a. | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22049 | 300004481 | ev | -/- | -/- |
| 11 | n. a. | Broadband Amplifier 5-13 GHz | CBLU5135235 | CERNEX | 22010 | 300004491 | ev | -/- | -/- |
| 12 | n. a. | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000037 | 300004509 | ne | -/- | -/- |
| 13 | n. a. | NEXIO EMV-Software | BAT EMC V3.16.0.49 | EMCO | | 300004682 | ne | -/- | -/- |
| 14 | n. a. | PC | ExOne | F+W | | 300004703 | ne | -/- | -/- |
| 15 | n. a. | RF-Amplifier | AMF-6F06001800-30-10P-R | NARDA-MITEQ Inc | 2011572 | 300005241 | ev | -/- | -/- |

## 8.3 Radiated measurements 18 GHz to 50 GHz in test lab

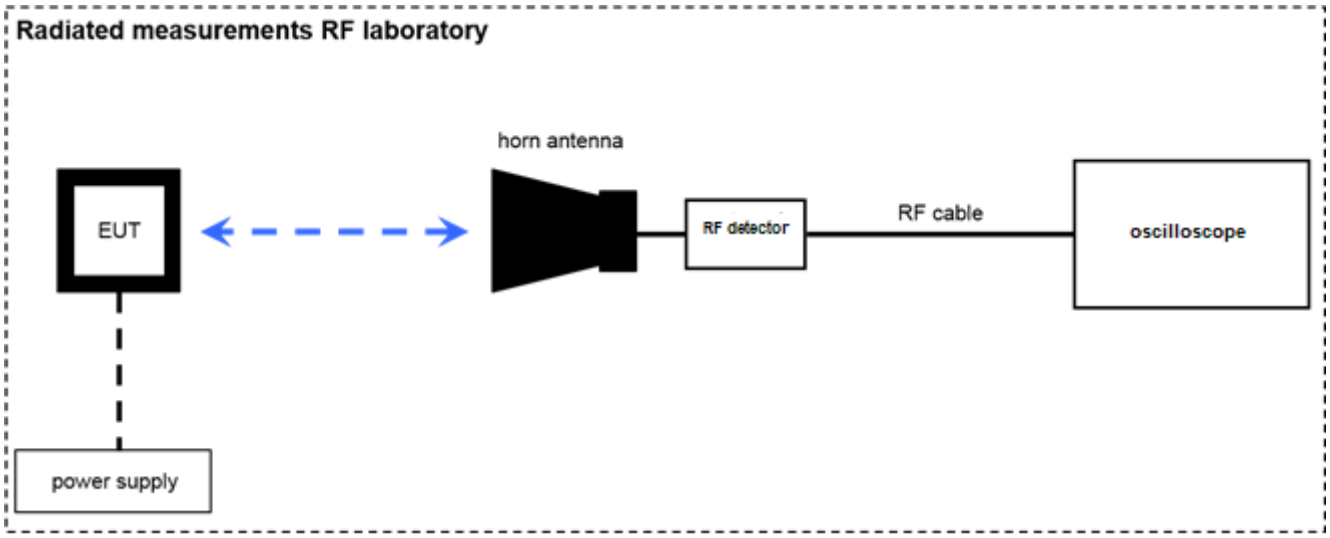



## 8.4 Radiated measurements > 50 GHz in test lab




Note: conversion loss of mixer is already included in analyzer value.

## 8.5 Radiated power measurements using RF detector according to ANSI C63.10-2013

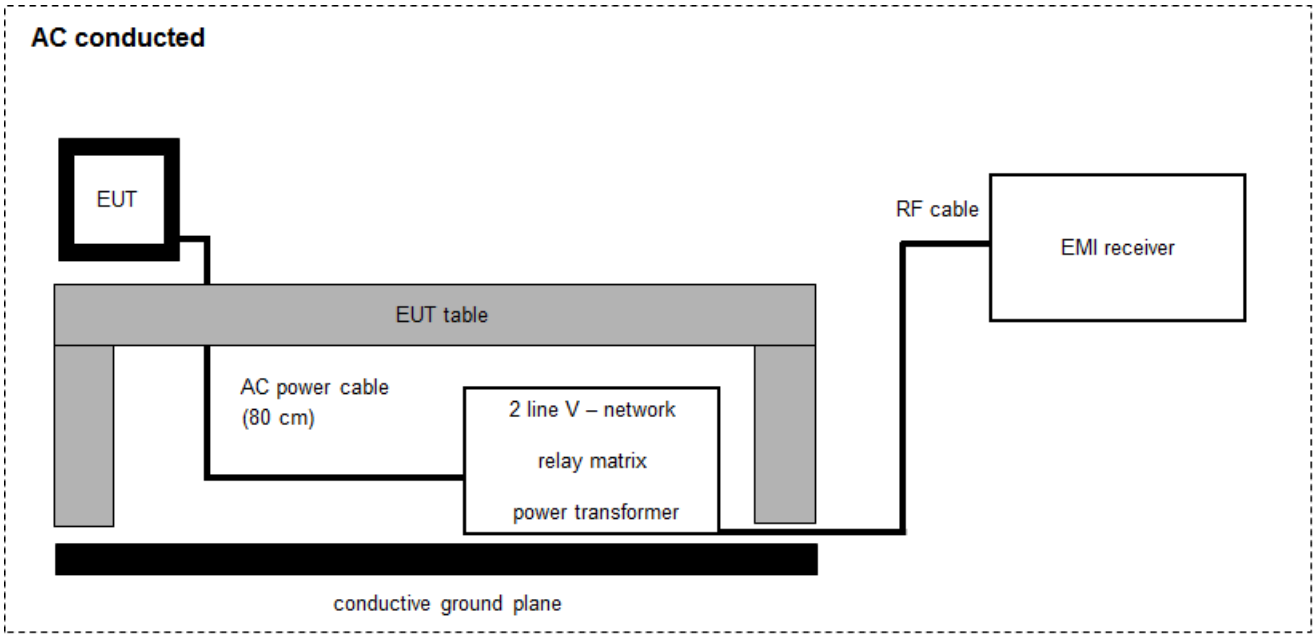



Note: EUT is replaced by reference source for substitution measurement

## Equipment table:

| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | n.a. | Horn Antenna 18,0-40,0 GHz | LHAF180 | Microw.Devel | 39180-103-021 | 300001747 | vIKI! | 18.02.2019 | 17.02.2022 |
| 2 | n.a. | Std. Gain Horn Antenna 33.0-50.1 GHz | 2324-20 | Flann | 57 | 400000683 | ne | -/- | -/- |
| 3 | n. a. | Std. Gain Horn Antenna 49.9-75.8 GHz | 2524-20 | Flann | * | 300001983 | ne | -/- | -/- |
| 4 | n. a. | Std. Gain Horn Antenna 60-90 GHz | COR 60_90 | Thomson CSF | | 300000814 | ne | -/- | -/- |
| 5 | n. a. | Std. Gain Horn Antenna 73.8-112 GHz | 2724-20 | Flann | * | 300001988 | ne | -/- | -/- |
| 6 | n.a. | Std. Gain Horn Antenna 92.3-140 GHz | 2824-20 | Flann | | 300001993 | ne | -/- | -/- |
| 7 | n. a. | Std. Gain Horn Antenna 114-173 GHz | 2924-20 | Flann | * | 300001999 | ne | -/- | -/- |
| 8 | n. a. | Std. Gain Horn Antenna 145-220 GHz | 3024-20 | Flann | * | 300002000 | ne | -/- | -/- |
| 9 | n. a. | Std. Gain Horn Antenna 217-330 GHz | 32240-20 | Flann | 233278 | 300004960 | ne | -/- | -/- |
| 10 | n. a. | Standard Gain Horn 325-500 GHz | 570240-20 | Flann | 273569 | 300006097 | ne | -/- | -/- |
| 11 | n. a. | Harmonic Mixer 3-Port, 50-75 GHz | FS-Z75 | Rohde & Schwarz | 101578 | 300005788 | k | 09.03.2020 | 08.03.2022 |
| 12 | n. a. | Harmonic Mixer 3-Port, 60-90 GHz | FS-Z90 | R&S | 101555 | 300004691 | k | 21.01.2021 | 20.01.2022 |
| 14 | n. a. | Harmonic Mixer 3-Port, 75-110 GHz | FS-Z110 | R&S | 101411 | 300004959 | k | 22.07.2021 | 21.07.2022 |
| 15 | n.a. | Harmonic Mixer 3-port, 90-140 GHz | FS-Z140 | Rohde & Schwarz | 101119 | 300005581 | k | 15.06.2021 | 14.06.2022 |
| 16 | n. a. | Harmonic Mixer 3-Port, 110-170 GHz | FS-Z170 | Radiometer Physics GmbH | 100014 | 300004156 | k | 11.06.2021 | 10.06.2022 |
| 17 | n. a. | Harmonic Mixer 3-Port, 140-220 GHz | SAM-220 | Radiometer Physics GmbH | 200001 | 300004157 | k | 22.07.2021 | 21.07.2022 |
| 18 | n. a. | Harmonic Mixer 3-Port, 220-325 GHz | SAM-325 | Radiometer Physics GmbH | 100002 | 300004158 | k | 22.07.2021 | 21.07.2022 |
| 19 | n.a. | Harmonic Mixer 325-500GHz | FS-Z500 | Radiometer Physics GmbH | 101016 | 300006096 | k | 14.06.2021 | 13.06.2022 |
| 20 | n. a. | Spectrum Analyzer 2 Hz - 85 GHz | FSW85 | R&S | 101333 | 300005568 | k | 30.06.2021 | 29.06.2022 |
| 21 | n.a. | Std. Gain Horn Antenna 90-140 GHz | COR 90_140 | Thomson CSF | | 300000799 | ev | -/- | -/- |
| 22 | n.a. | F-Band Positive Amplitude Detector | SFD-903144-08SF-P1 | Sage Millimeter Inc. | 07354-1 | 300006119 | ev | -/- | -/- |
| 23 | n.a. | SG Extension Module 110 - 170 GHz | E8257DV06 | VDI | US53250018 | 300005540 | ev | -/- | -/- |
| 24 | n.a. | Std. Gain Horn Antenna 114-173 GHz | 2924-20 | Flann | * | 300001999 | ne | -/- | -/- |
| 25 | n.a. | Synthesized Sweeper 10 MHz - 40 GHz | 83640A | HP | 3119A00458 | 300002266 | vIKI! | 10.12.2021 | 31.12.2023 |
| 26 | n.a. | Oscilloscope | DPO5054 | Tektronix | C010174 | 300004169 | vIKI! | 07.12.2021 | 31.12.2023 |

## 8.6 AC power-line conducted emissions




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 | -/- | Two-line V-Network (LISN) 9 kHz to 30 MHz | ESH3-Z5 | R&S | 892475/017 | 300002209 | vIKI! | 14.12.2021 | 31.12.2023 |
| 2 | -/- | RF-Filter-section | 85420E | HP | 3427A00162 | 300002214 | NK! | -/- | -/- |
| 3 | -/- | EMI Test Receiver | ESCI 3 | R&S | 100083 | 300003312 | k | 09.12.2021 | 31.12.2022 |
| 4 | -/- | Hochpass 150 kHz | EZ-25 | R&S | 100010 | 300003798 | ev | -/- | -/- |

# 9 Measurement uncertainty

| Measurement uncertainty | |
|---|---|
| **Test case** | **Uncertainty** |
| Spectrum bandwidth | span/1000 |
| Output power | ± 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 |
| DC and low frequency voltages | ± 3 % |
| Temperature | ± 1 °C |
| Humidity | ± 3 % |

## 10 Far field consideration for measurements above 18 GHz

**Far field distance calculation:**

$D_{ff} = 2 \times D^2/\lambda$

with
$D_{ff}$ Far field distance
D Antenna dimension
λ wavelength

**Spurious emission measurements:**

| Antenna frequency range in GHz | Highest measured frequency in GHz | D in cm | λ in cm | $D_{ff}$ in cm |
|---|---|---|---|---|
| 18-26 | 26 | 3.4 | 1.15 | 20.04 |
| 26-40 | 40 | 2.2 | 0.75 | 12.91 |
| 40-50 | 50 | 2.77 | 0.60 | 25.58 |
| 50-75 | 75 | 1.85 | 0.40 | 17.11 |
| 75-110 | 110 | 1.24 | 0.27 | 11.28 |
| 90 - 140 | 140 | 1.02 | 0.22 | 9.46 |
| 110-170 | 170 | 0.85 | 0.18 | 8.19 |
| 140-220 | 220 | 0.68 | 0.14 | 6.78 |
| 220-325 | 325 | 0.43 | 0.09 | 4.11 |
| 325-500 | 500 | 0.26 | 0.06 | 2.29 |

**In band measurement (EIRP, OBW):**

| Antenna frequency range in GHz | Highest measured frequency in GHz | Antenna dimension in cm | Wavelength in cm | far field distance in cm |
|---|---|---|---|---|
| 110 - 170 | 123 | 1 | 0.24 | 8.33 |

# 11 Measurement results

## 11.1 Summary

| | |
|---|---|
| ☒ | **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 | FCC 47 CFR Part 15 / IC RSS-210 | see below | 2022-03-15 | -/- |

| Test specification clause | Test case | Temperature conditions | Power supply | Pass | Fail | NA | NP | Results (max.) |
|---|---|---|---|---|---|---|---|---|
| §15.215 | Occupied bandwidth | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §15.258(b) (1) / (3) | Maximum E.I.R.P. | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §15.258(c) | Spurious Emissions | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §15.255(d) | Frequency stability | Extreme<br>Nominal | Extreme<br>Nominal | ☒ | ☐ | ☐ | ☐ | complies |

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

# 12 Measurement results

## 12.1 Occupied bandwidth

**Description:**

Measurement of the Bandwidth of the wanted signal.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Pos-Peak |
| Sweep time: | 1 s |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Span: | See plot |
| Trace-Mode: | Max Hold |

**Limits:**

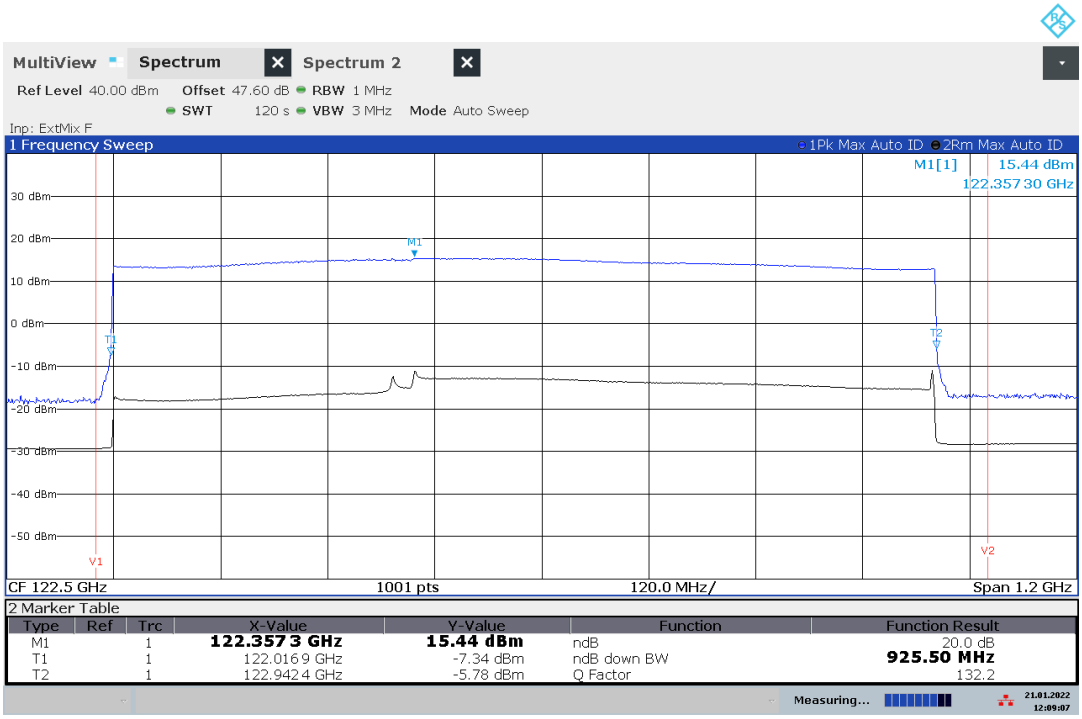
| FCC |
|---|
| CFR Part 15.258 |
| The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following: |
| Frequency range |
| 116 GHz – 123 GHz |

**Measurement results:**

| Test condition<br>$T_{nom}$ / $V_{nom}$ | $F_L$ in GHz | $F_H$ in GHz | Occupied bandwidth in MHz |
|---|---|---|---|
| 20 dB OBW | 122.016 900 | 122.942 400 | 925.5 |
| 99% OBW | 122.024 781 | 122.934 946 | 910.2 |
| Measurement uncertainty | ± span/1000 | | |

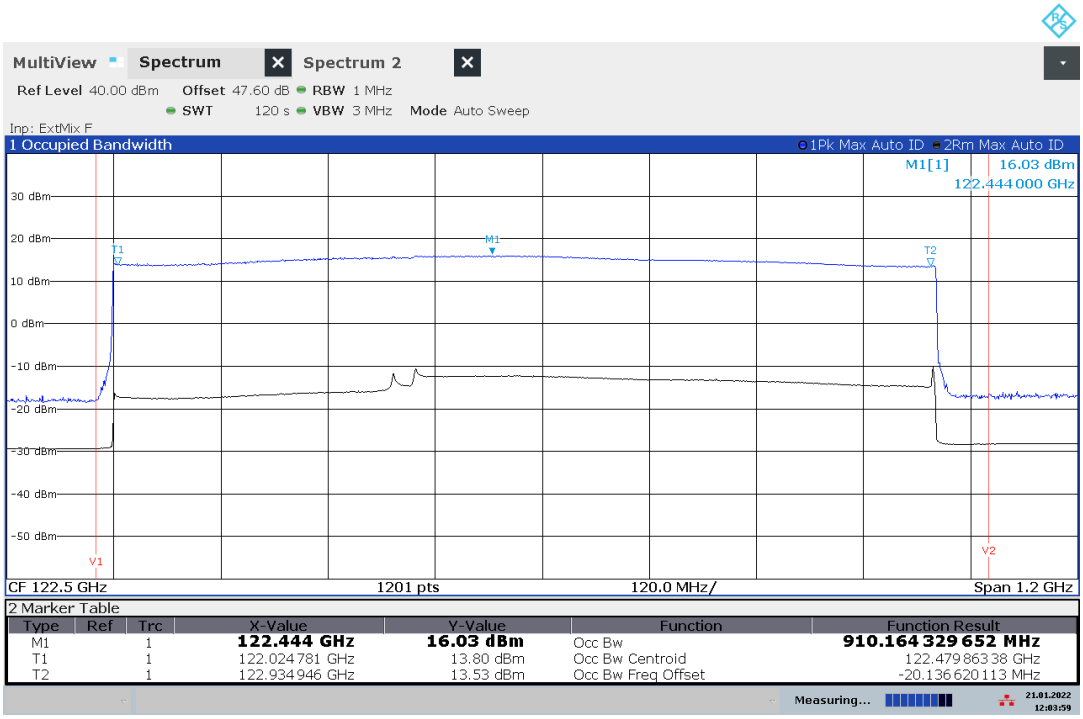
**Result:** **The measurement is passed.**

Plot 1: 20 dB OBW, operating frequency band



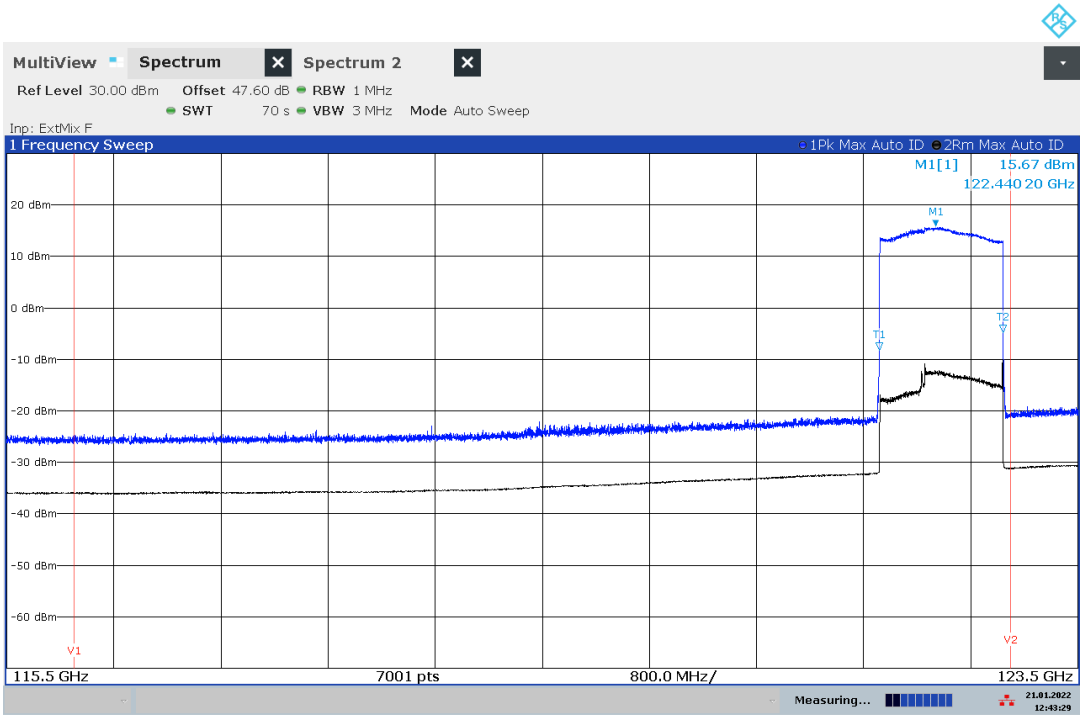

12:09:08 21.01.2022

Plot 2: 99% OBW, operating frequency band



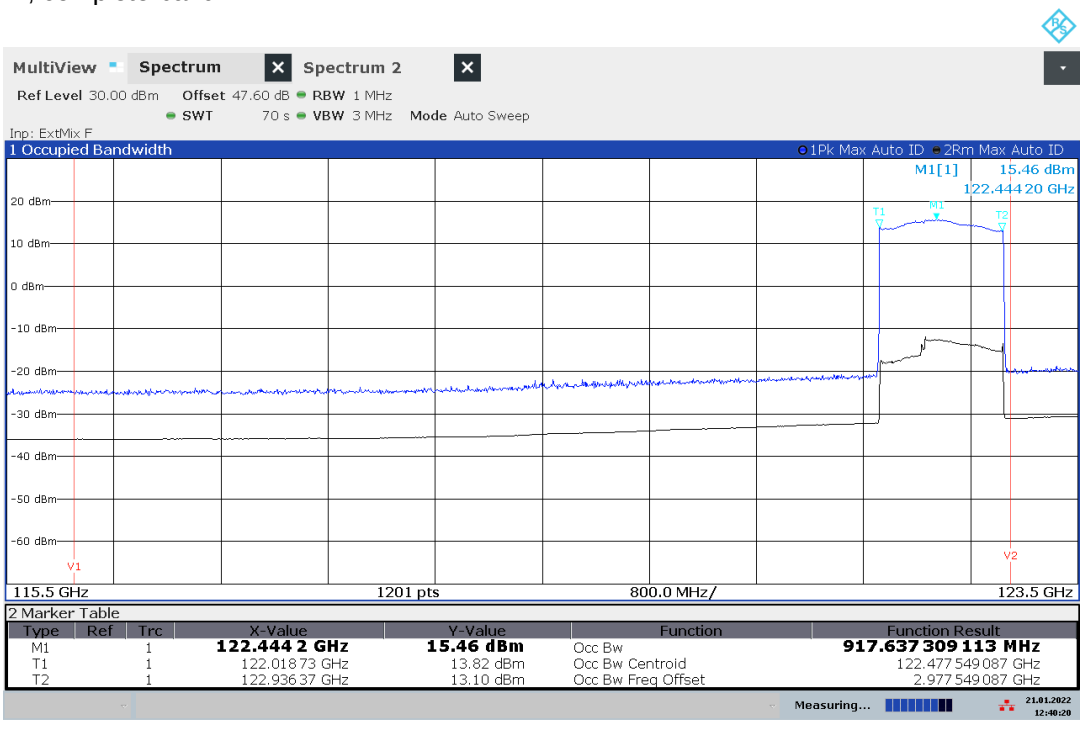

12:03:59 21.01.2022

Plot 3: 20% OBW, complete band




12:43:30 21.01.2022

Plot 4: OBW, complete band




12:40:20 21.01.2022

## 12.2 Maximum E.I.R.P.

**Description:**

Measurement of the maximum radiated e.i.r.p. of the wanted signal.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Pos-Peak (RF-Detector) |
| Video bandwidth: | 10 MHz |
| Trace-Mode: | Max Hold |

**Limits:** **FCC Part 15.258 (b)**

Emission levels within the 116-123 GHz, 174.8-182 GHz, 185-190 GHz and 244-246 GHz bands shall not exceed the following equivalent isotropically radiated power (EIRP) limits as measured during the transmit interval:

The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm.

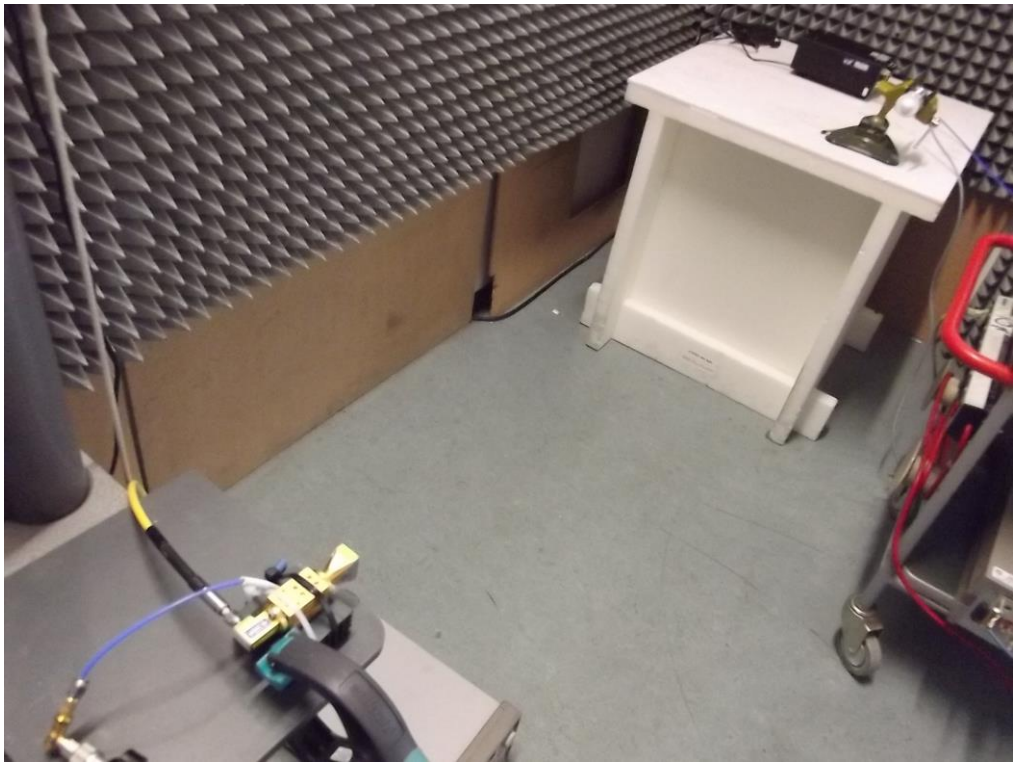
The peak power shall be measured with a detection bandwidth that encompasses the entire occupied bandwidth within the intended band of operation, e.g., 116-123 GHz, 174.8-182 GHz, 185-190 GHz or 244-246 GHz. The average emission levels shall be measured over the actual time period during which transmission occurs.

**Measurement results:**

| Test condition | Max E.I.R.P.<br>10 MHz VBW | Average E.I.R.P.<br>10 MHz VBW |
|---|---|---|
| $T_{nom}$ / $V_{nom}$ | 15.9 dBm | 15.9 dBm |
| Measurement uncertainty | ± 3 dB | |

| Test condition | Duty cycle |
|---|---|
| $T_{nom}$ / $V_{nom}$ | 0.99 |

**Description of the E.I.R.P. measurement by substitution method:**



1) EUT emission measured with RF-detector:
   - Measurement distance: d = 1 m
   - Maximum readout value on oscilloscope: V = 0.59 mV

2) Substitution of EUT by a CW reference source with a frequency of f = 122 GHz and a fixed output power of $P_{ref}$ = 28.4 dBm
   - Readout value on oscilloscope adjusted by far field attenuation, 0.59 mV found at 4.2m distance

3) Calculation of the Max E.I.R.P. of the EUT:
   - Free space loss: FSL(d) = 20 × log(4×π×d×f/c), c: speed of light
   - Max E.I.R.P. = $P_{ref}$ – FSL(4.2 m) + FSL (1 m) = 15.9 dBm

4) Calculation of the Average E.I.R.P. of the EUT:
   - Measured duty cycle of the EUT: 100 %
   - Average E.I.R.P. = Max E.I.R.P. + 10 × log(1) = 15.9 dBm

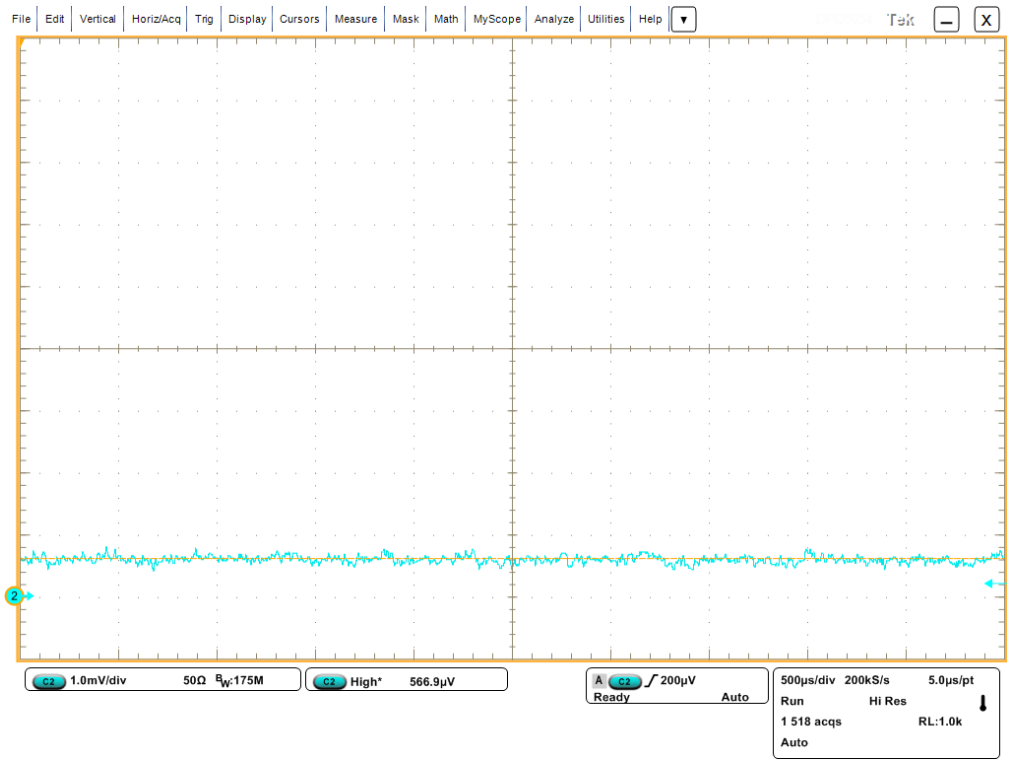
**Setup of the substitution:**

1) Synthesized Sweeper 10 MHz - 40 GHz

2) SG Extension Module 110 - 170 GHz & Std. Gain Horn Antenna 114-173 GHz

3) F-Band Positive Amplitude Detector & Std. Gain Horn Antenna 90-140 GHz

Oscilloscope measurement:



## 12.3 Spurious emissions radiated

**Description:**

Measurement of the radiated spurious emissions.

**Measurement:**

| Measurement parameter | |
|---|---|
| Detector: | Quasi Peak / Pos-Peak / RMS |
| Sweep time: | Auto |
| Resolution bandwidth: | F < 1 GHz: 100 kHz<br>F > 1 GHz: 1 MHz |
| Video bandwidth: | Auto |
| Frequency range: | 30 MHz to 500 GHz |
| Trace-Mode: | Max Hold |

**Limits:** **FCC Part 15.258 / RSS-210**

(c) Spurious emissions shall be limited as follows:

(1) The power density of any emissions outside the band of operation, e.g., 116-123 GHz, 174.8-182 GHz, 185-190 GHz or 244-246 GHz, shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.

| FCC / IC | | |
|---|---|---|
| CFR Part 15.209(a) / RSS-210 / RSS-Gen | | |
| Radiated emission limits | | |
| Frequency (MHz) | Field strength (microvolts/meter) | Measurement distance (meters) |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

(3) Between 40 GHz and the highest frequency specified in § 15.33, the level of these emissions shall not exceed 90 pW/cm$^2$ at a distance of 3 meters.

(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

**Limit conversion:** **ANSI C63.10-2013 9.6**

Power density at the distance specified by the limit: PD [W/m²]
Equivalent isotropically radiated power: EIRP [dBm]
Distance at which the power density limit is specified: d [m]

$EIRP[dBm] = 10 \times \log(4 \times \pi \times d^2 \times PD[W/m^2])$

According to this formula, an emission limit of PD = 90 pW/cm² at a distance of 3 meters corresponds to EIRP = -10 dBm.

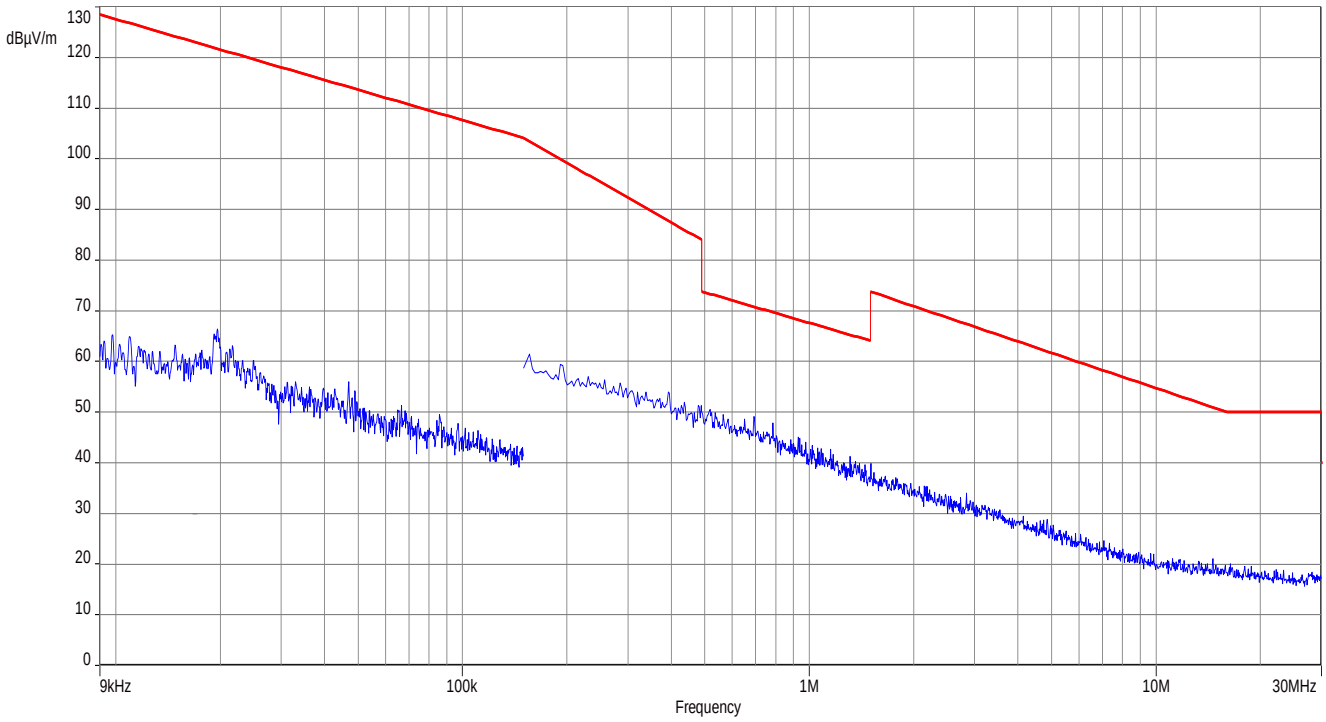
**Measurement results:**

Note:
Measurements were performed in normal operation mode (frequency sweep) and in stopped mode (frequency sweep stopped at three positions within the range of operation: near top, near middle, near bottom) in accordance with §15.31(c), (m).

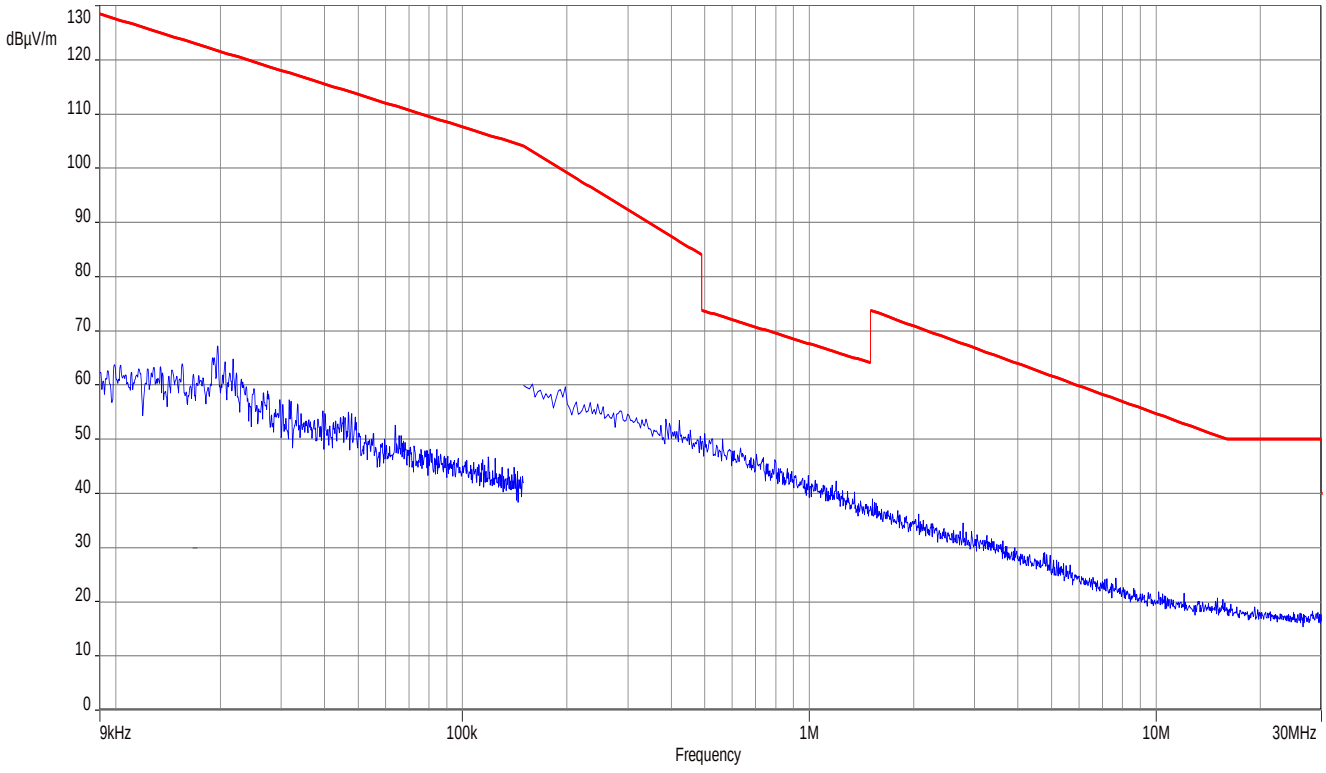
If the results in the cases of the stopped frequency sweep are comparable, only the results with a stop in the middle of the operating frequency range are shown below.

### 12.3.1 Spurious emissions radiated

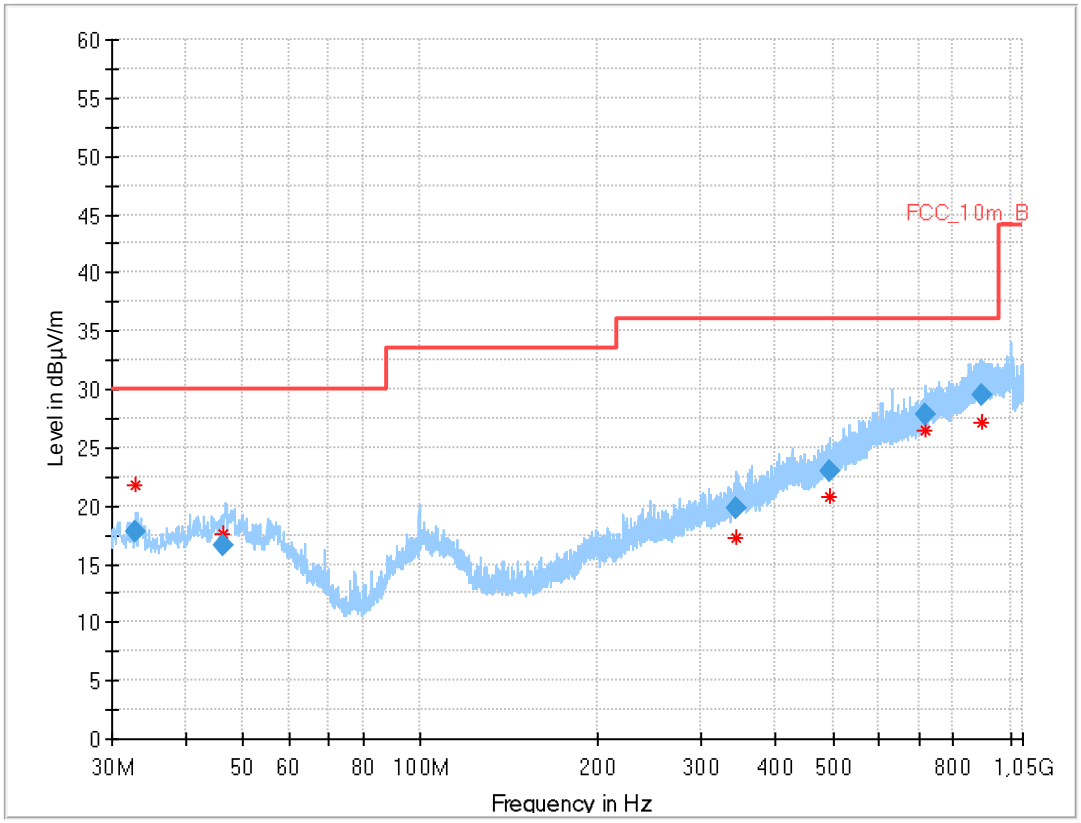
Plot 5: 9 kHz – 30 MHz, normal mode




Plot 6: 9 kHz – 30 MHz, stopped mode (sweep stopped in the middle of the range of operation)



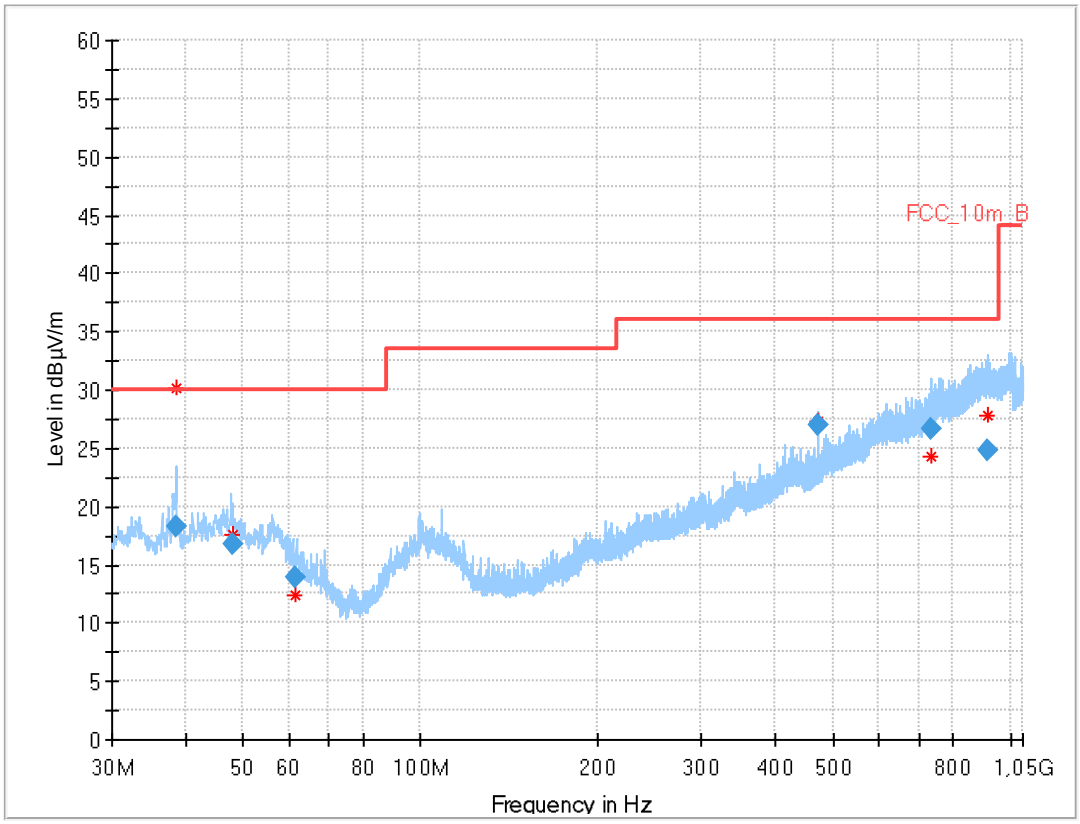
Plot 7: 30 MHz – 1 GHz, stopped mode (sweep stopped at the bottom of the range of operation)




## 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) |
|---|---|---|---|---|---|---|---|---|---|
| 32.939 | 17.75 | 30.0 | 12.3 | 1000 | 120.0 | 152.0 | H | 148 | 13 |
| 46.383 | 16.60 | 30.0 | 13.4 | 1000 | 120.0 | 142.0 | V | -32 | 15 |
| 343.742 | 19.74 | 36.0 | 16.3 | 1000 | 120.0 | 195.0 | V | -37 | 17 |
| 493.614 | 23.03 | 36.0 | 13.0 | 1000 | 120.0 | 191.0 | V | -37 | 20 |
| 719.997 | 27.86 | 36.0 | 8.1 | 1000 | 120.0 | 195.0 | V | -37 | 23 |
| 895.893 | 29.56 | 36.0 | 6.4 | 1000 | 120.0 | 108.0 | V | 113 | 25 |

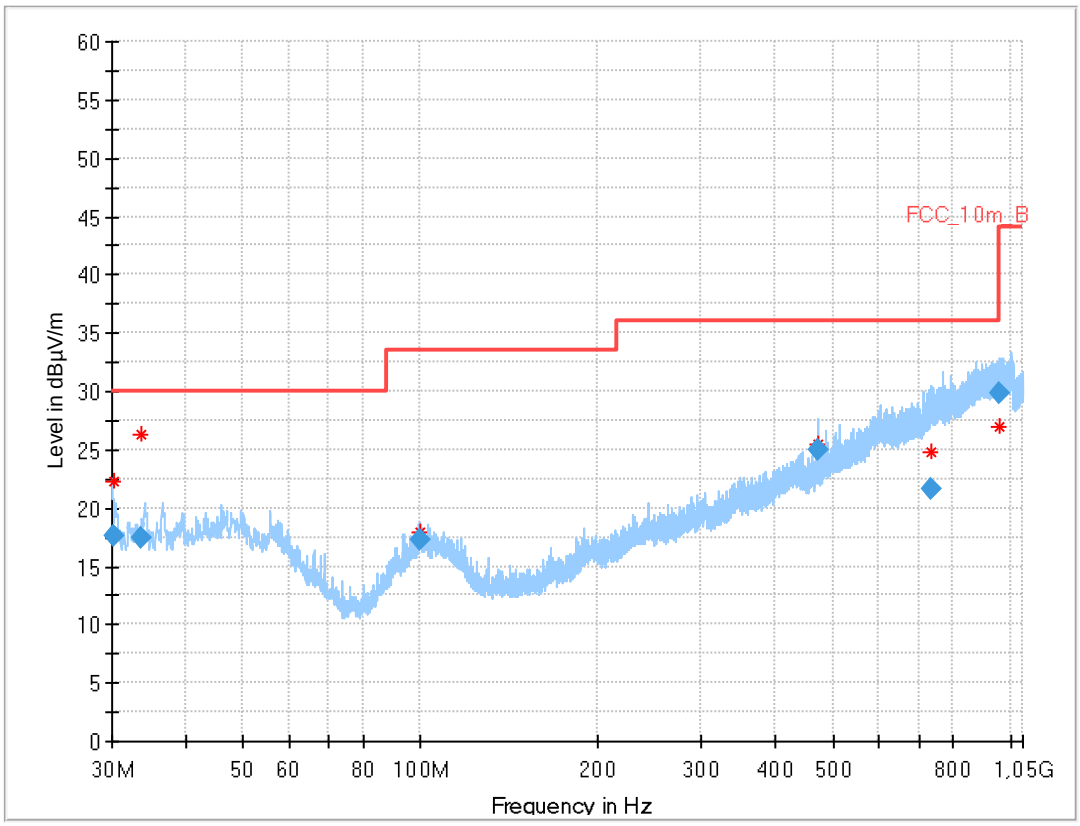
Plot 8: 30 MHz – 1 GHz, stopped mode (sweep stopped in the middle of the range of operation)




## 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) |
|---|---|---|---|---|---|---|---|---|---|
| 38.584 | 18.32 | 30.0 | 11.7 | 1000 | 120.0 | 122.0 | V | 241 | 14 |
| 47.961 | 16.79 | 30.0 | 13.2 | 1000 | 120.0 | 103.0 | V | 232 | 15 |
| 61.372 | 13.88 | 30.0 | 16.1 | 1000 | 120.0 | 195.0 | H | 217 | 12 |
| 472.008 | 26.96 | 36.0 | 9.0 | 1000 | 120.0 | 98.0 | V | 7 | 19 |
| 735.584 | 26.62 | 36.0 | 9.4 | 1000 | 120.0 | 195.0 | H | 209 | 23 |
| 917.263 | 24.87 | 36.0 | 11.1 | 1000 | 120.0 | 104.0 | H | 52 | 26 |

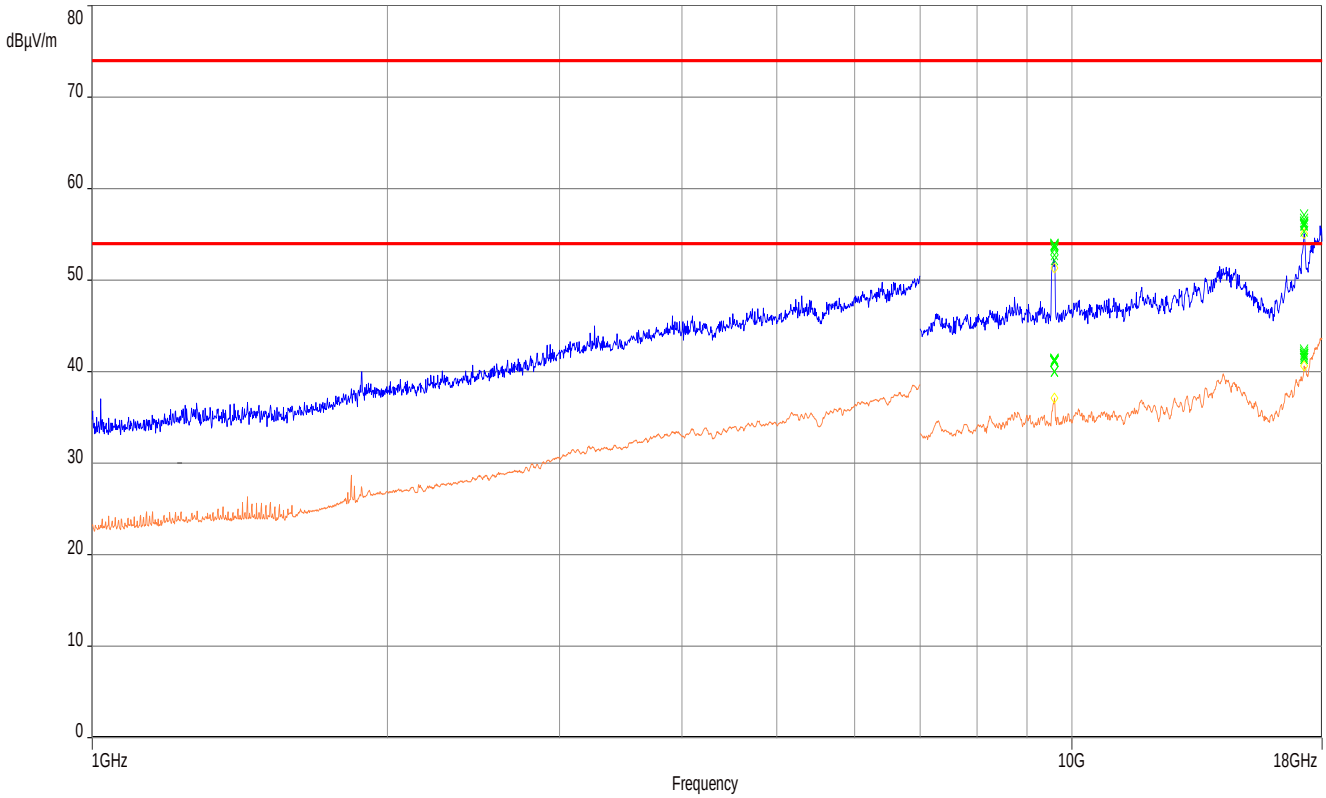
Plot 9: 30 MHz – 1 GHz, stopped mode (sweep stopped at the top of the range of operation)




## Final_Result

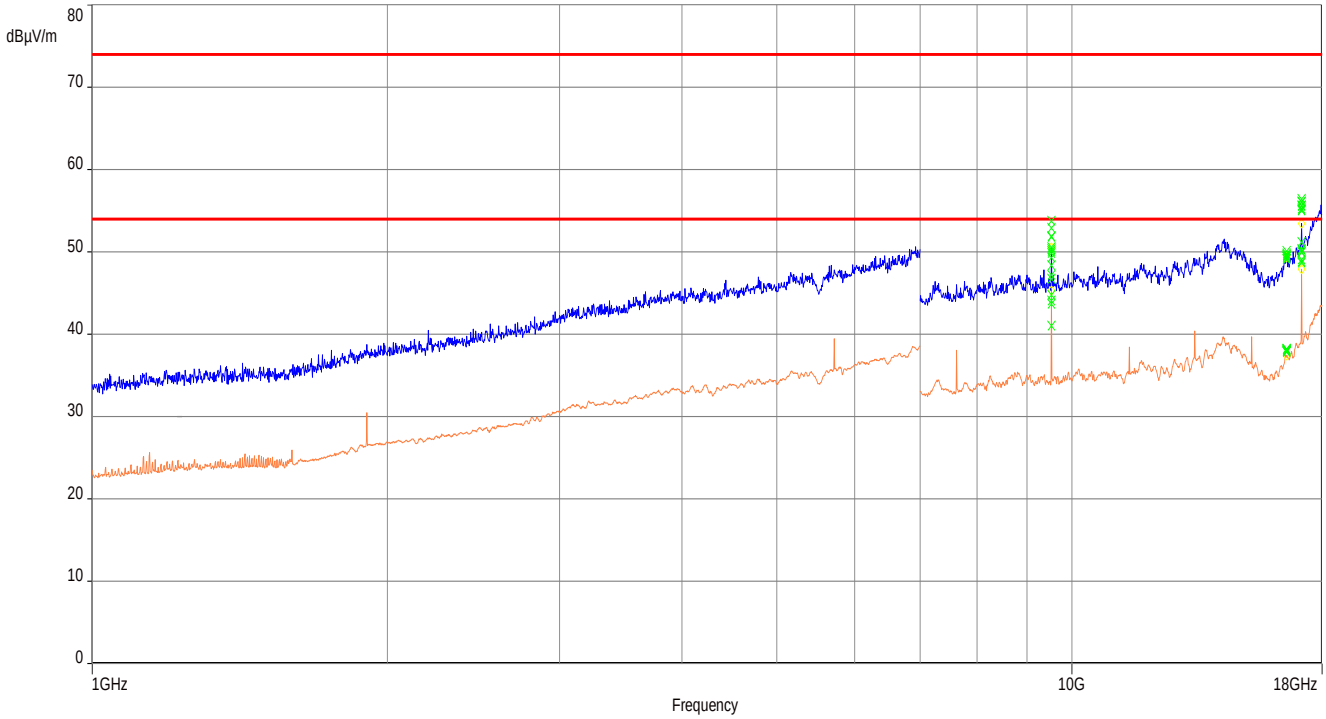
| Frequency (MHz) | QuasiPeak (dBµV/m | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 30.275 | 17.59 | 30.0 | 12.4 | 1000 | 120.0 | 133.0 | H | 232 | 13 |
| 33.537 | 17.37 | 30.0 | 12.6 | 1000 | 120.0 | 147.0 | H | 232 | 13 |
| 99.525 | 17.32 | 33.5 | 16.2 | 1000 | 120.0 | 195.0 | V | -30 | 13 |
| 472.020 | 24.89 | 36.0 | 11.1 | 1000 | 120.0 | 104.0 | V | -37 | 19 |
| 734.446 | 21.57 | 36.0 | 14.4 | 1000 | 120.0 | 195.0 | V | 1 | 23 |
| 958.073 | 29.88 | 36.0 | 6.1 | 1000 | 120.0 | 166.0 | H | 142 | 25 |

Plot 10: 1 GHz – 18 GHz, normal mode



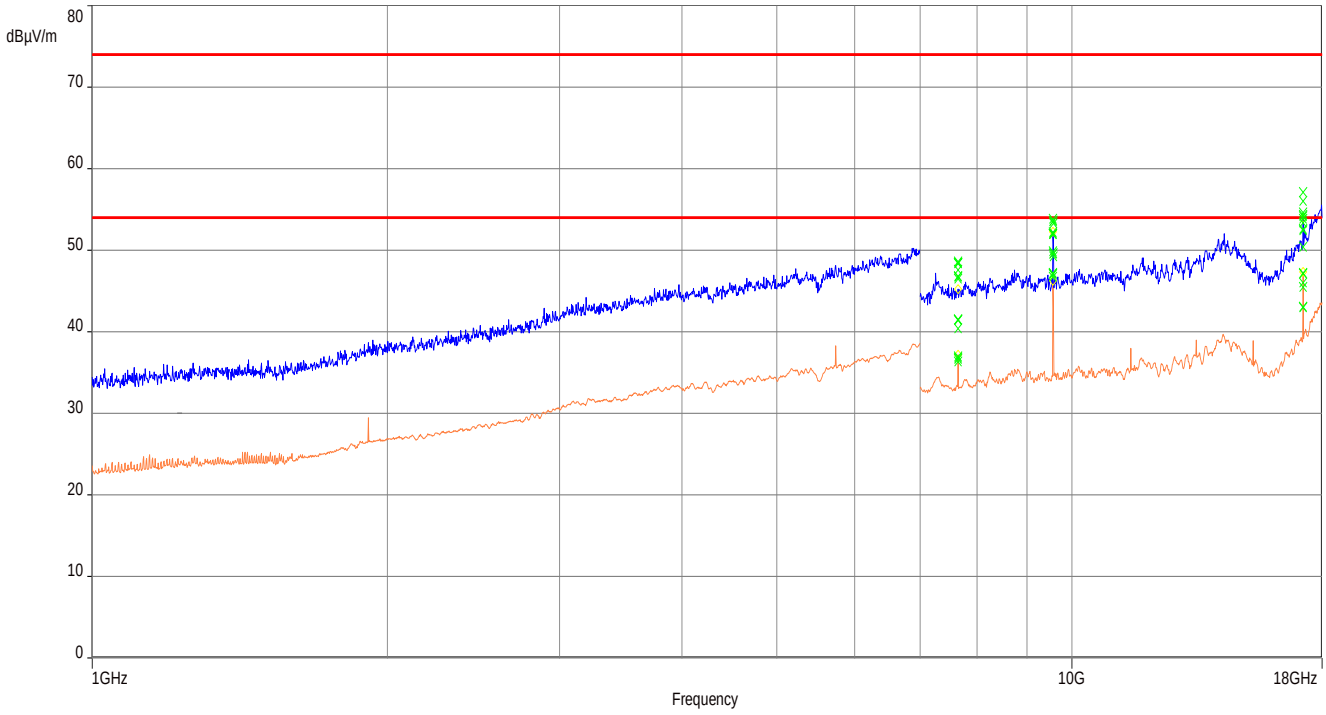

| Frequency (MHz) | Peak (dBµV/m) | Peak Limit (dBµV/m) | Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 9600 | 53.9 | 74 | 20.1 | 41.3 | 54 | 12.7 |
| 17260 | 57.1 | 74 | 16.9 | 42.1 | 54 | 11.9 |

Plot 11: 1 GHz – 18 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



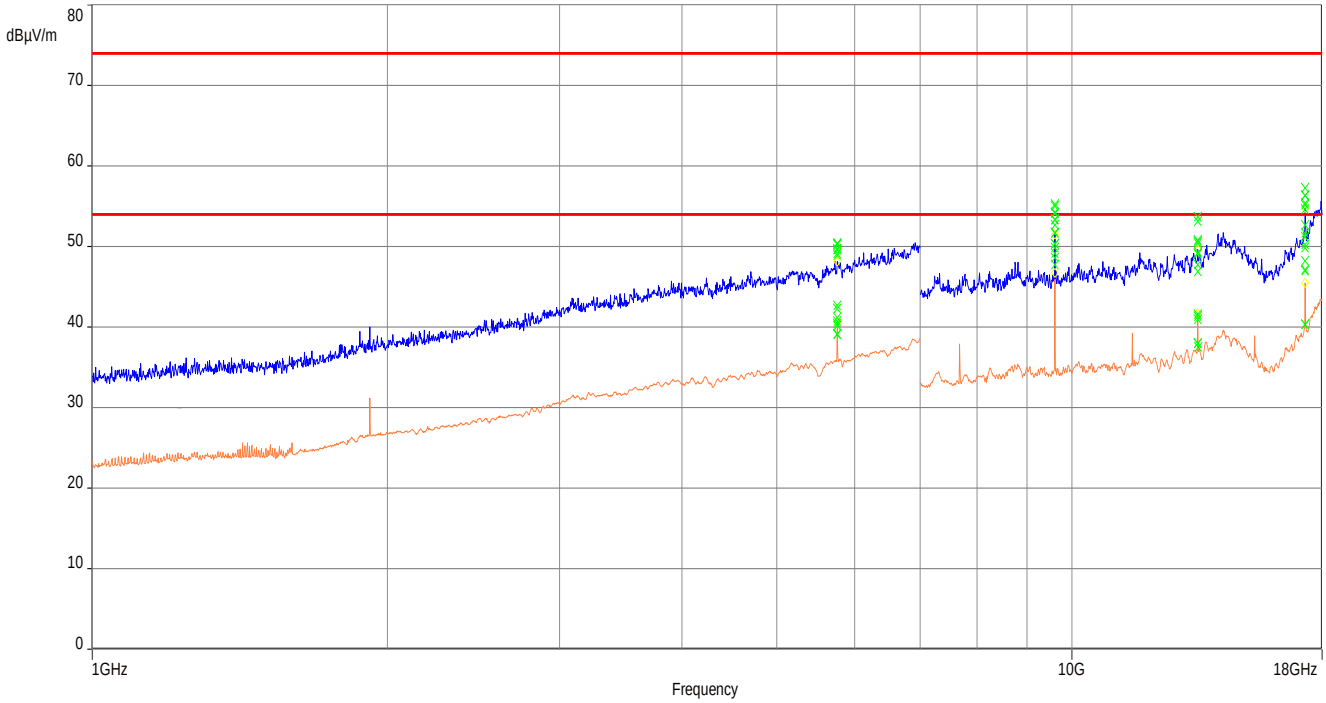

| Frequency (MHz) | Peak (dBµV/m) | Peak Limit (dBµV/m) | Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 9532.6 | 53.7 | 74 | 20.3 | 50.3 | 54 | 3.7 |
| 16566 | 50.1 | 74 | 23.9 | 38.2 | 54 | 15.8 |
| 17158.5 | 56.4 | 74 | 17.6 | 51.2 | 54 | 2.8 |

Plot 12: 1 GHz – 18 GHz, stopped mode (sweep stopped in the middle of the range of operation)



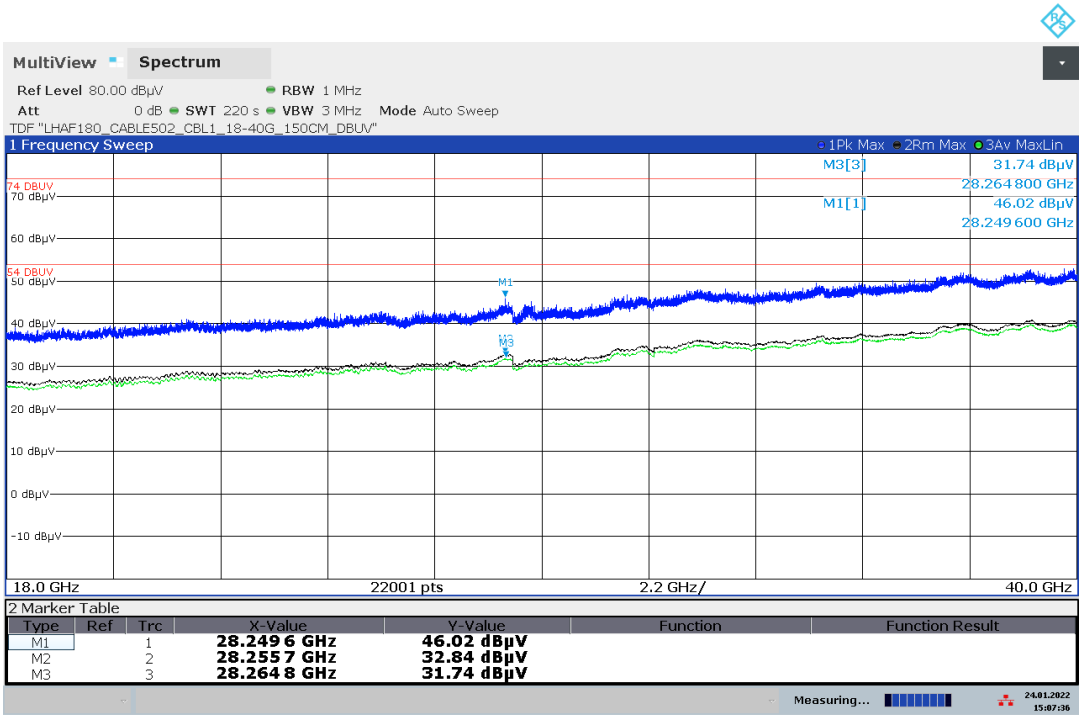

| Frequency (MHz) | Peak (dBµV/m) | Peak Limit (dBµV/m) | Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 7654.9 | 48.6 | 74 | 25.4 | 41.5 | 54 | 12.5 |
| 9568.5 | 53.8 | 74 | 20.2 | 49.8 | 54 | 4.2 |
| 17223 | 57.1 | 74 | 16.9 | 52.5 | 54 | 1.5 |

Plot 13: 1 GHz – 18 GHz, stopped mode (sweep stopped near the top of the range of operation)



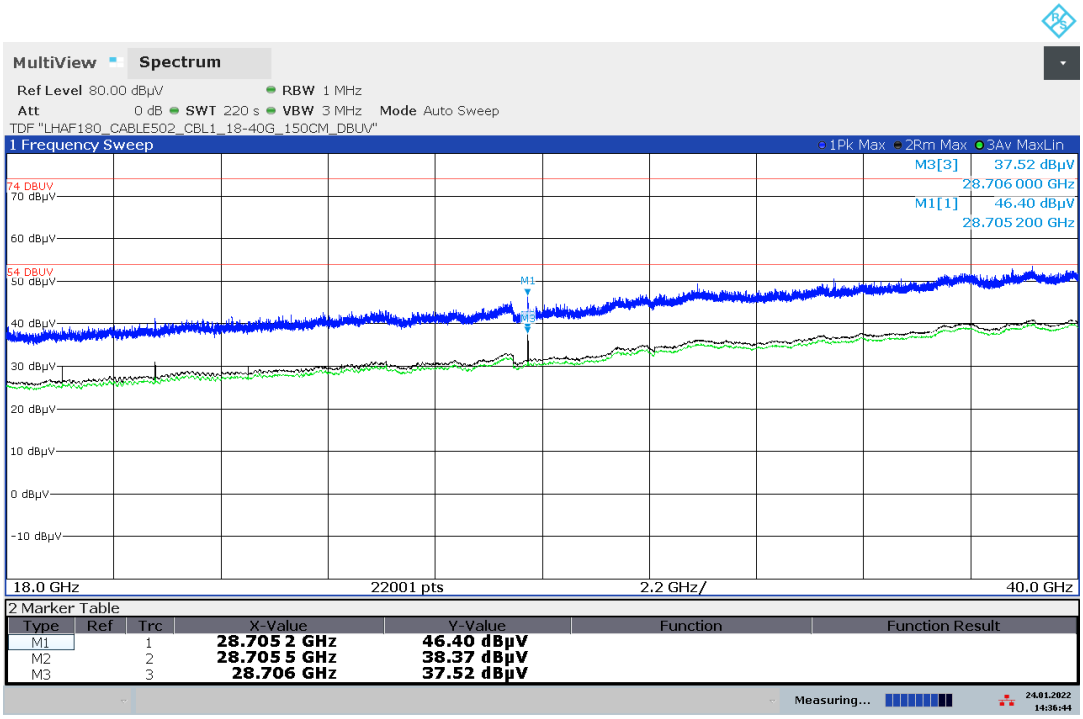

| Frequency (MHz) | Peak (dBµV/m) | Peak Limit (dBµV/m) | Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 5763 | 50.4 | 74 | 23.6 | 42.6 | 54 | 11.4 |
| 9604 | 55.2 | 74 | 18.8 | 51.7 | 54 | 2.3 |
| 13446 | 53.2 | 74 | 20.8 | 47.7 | 54 | 6.3 |
| 17288 | 57.3 | 74 | 16.7 | 51.2 | 54 | 2.8 |

Plot 14: 18 GHz – 40 GHz, normal mode



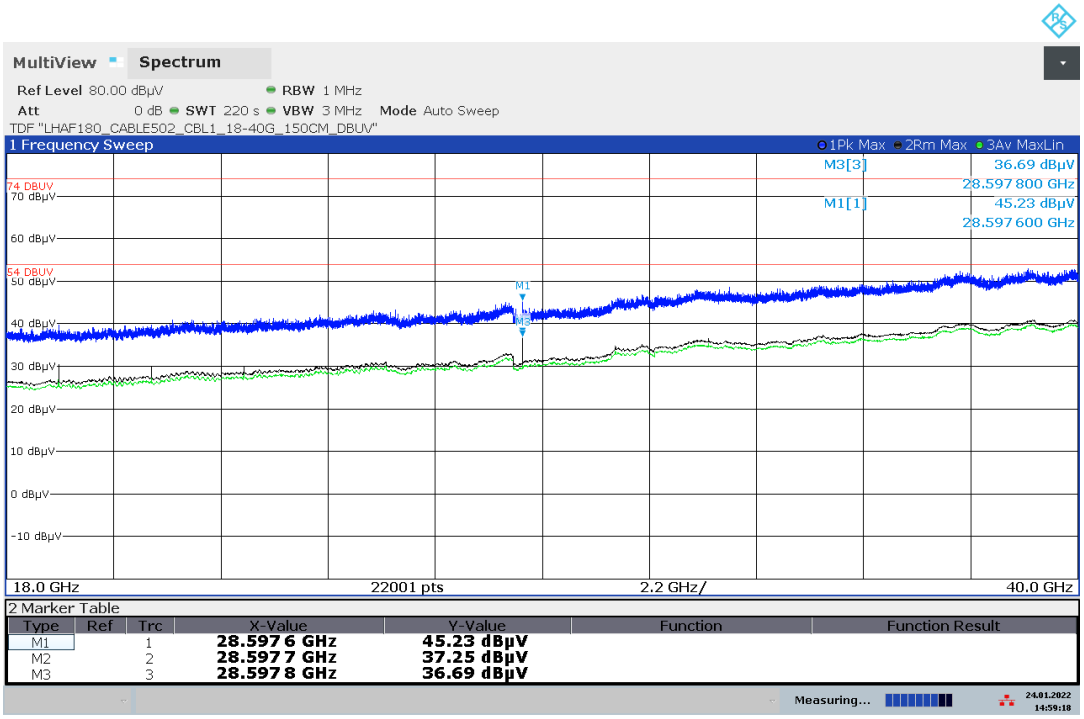

15:07:36 24.01.2022

Plot 15: 18 GHz – 40 GHz, stopped mode (sweep stopped in the middle of the range of operation)



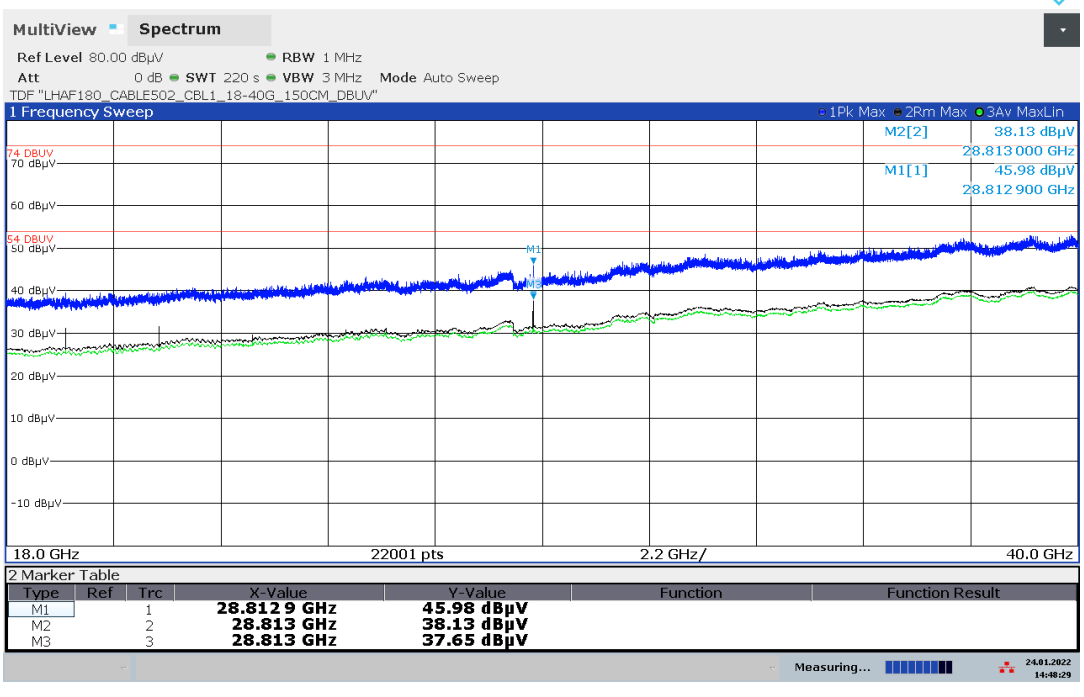

14:36:45 24.01.2022

Plot 16: 18 GHz – 40 GHz, stopped mode (sweep stopped near the bottom edge of the range of operation)



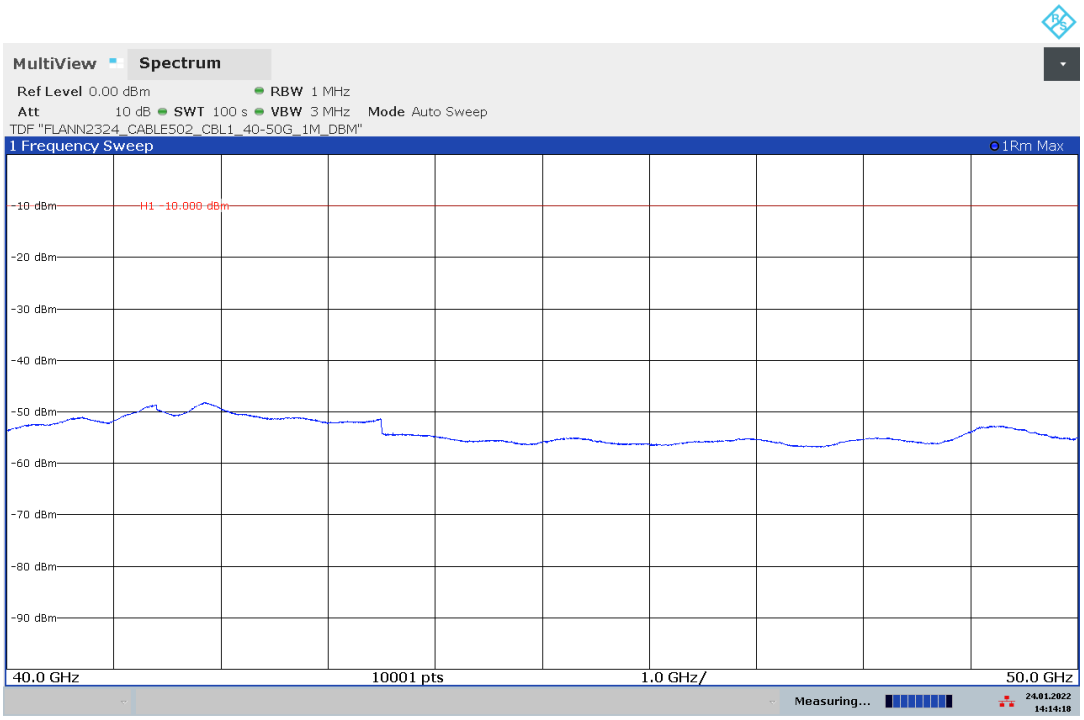

14:59:18 24.01.2022

Plot 17: 18 GHz – 40 GHz, stopped mode (sweep stopped near the top edge of the range of operation)



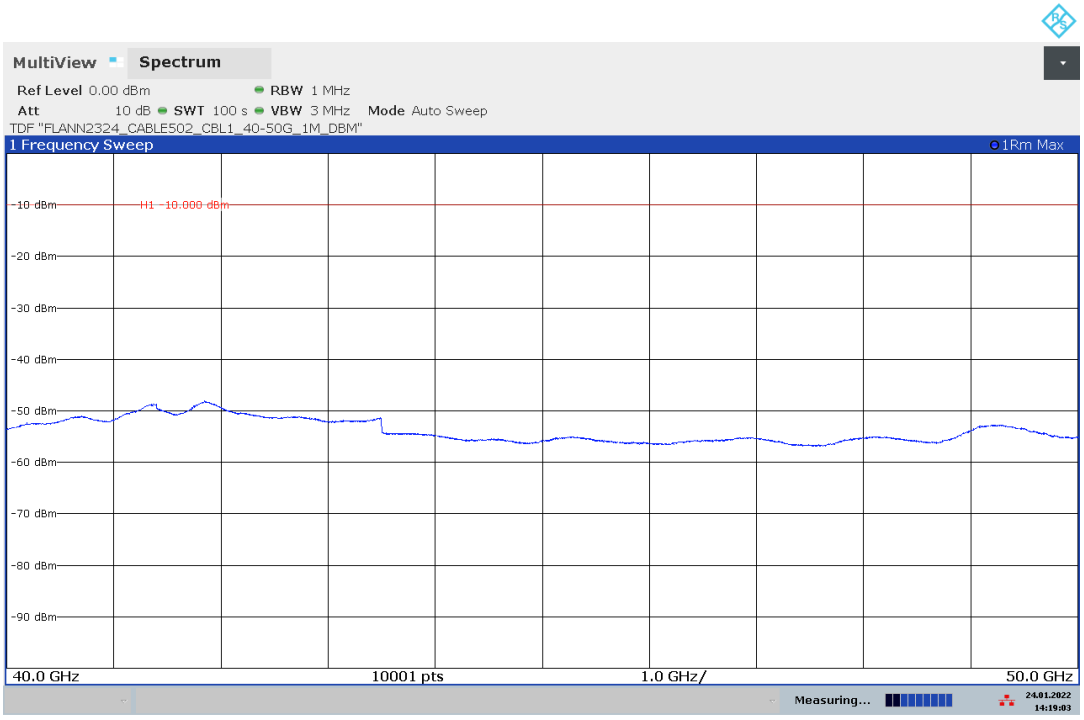

14:48:30 24.01.2022

Plot 18: 40 GHz – 50 GHz, normal mode



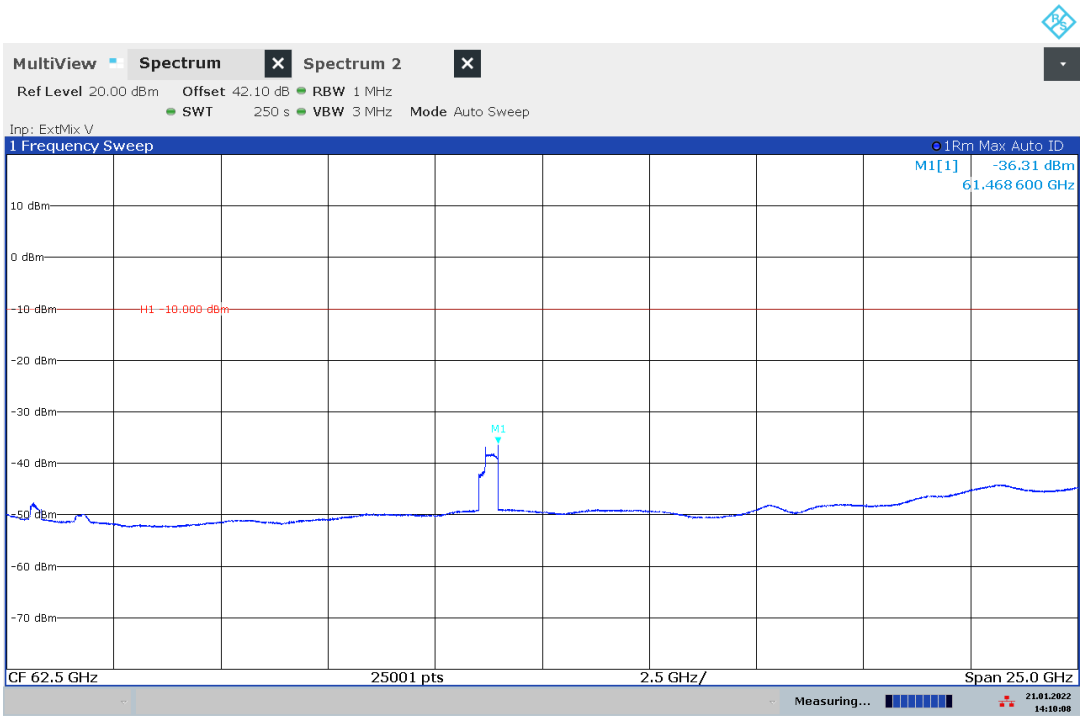

14:14:19 24.01.2022

Plot 19: 40 GHz – 50 GHz, stopped mode (sweep stopped in the middle of the range of operation)



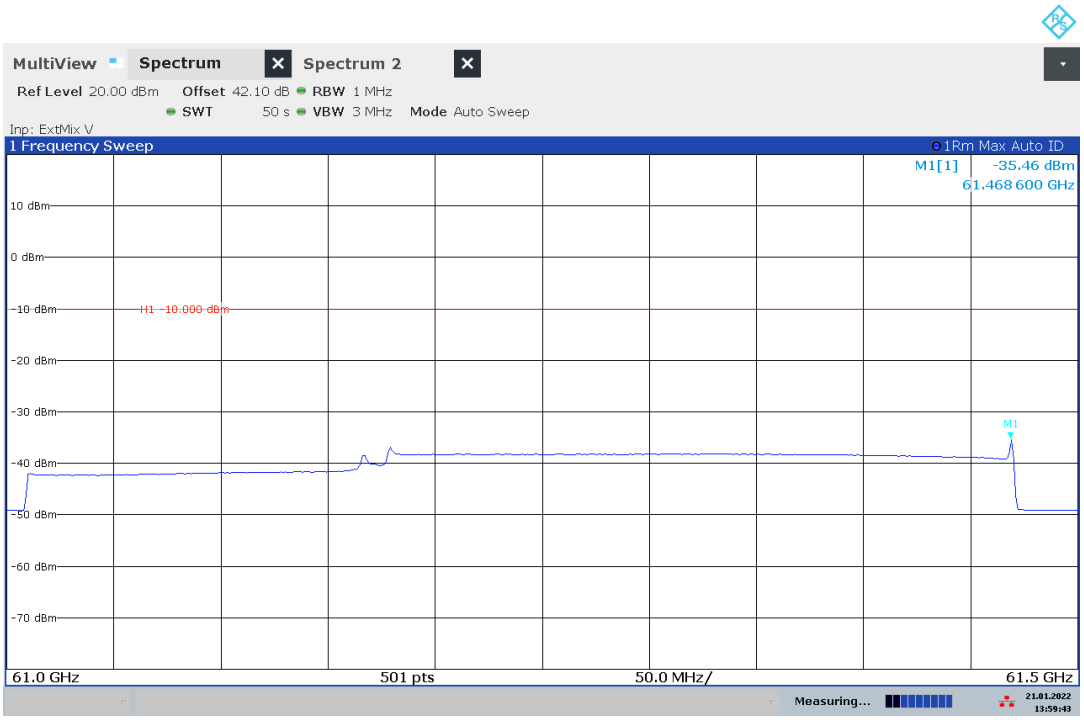

14:19:04 24.01.2022

Plot 20: 50 GHz – 75 GHz, normal mode



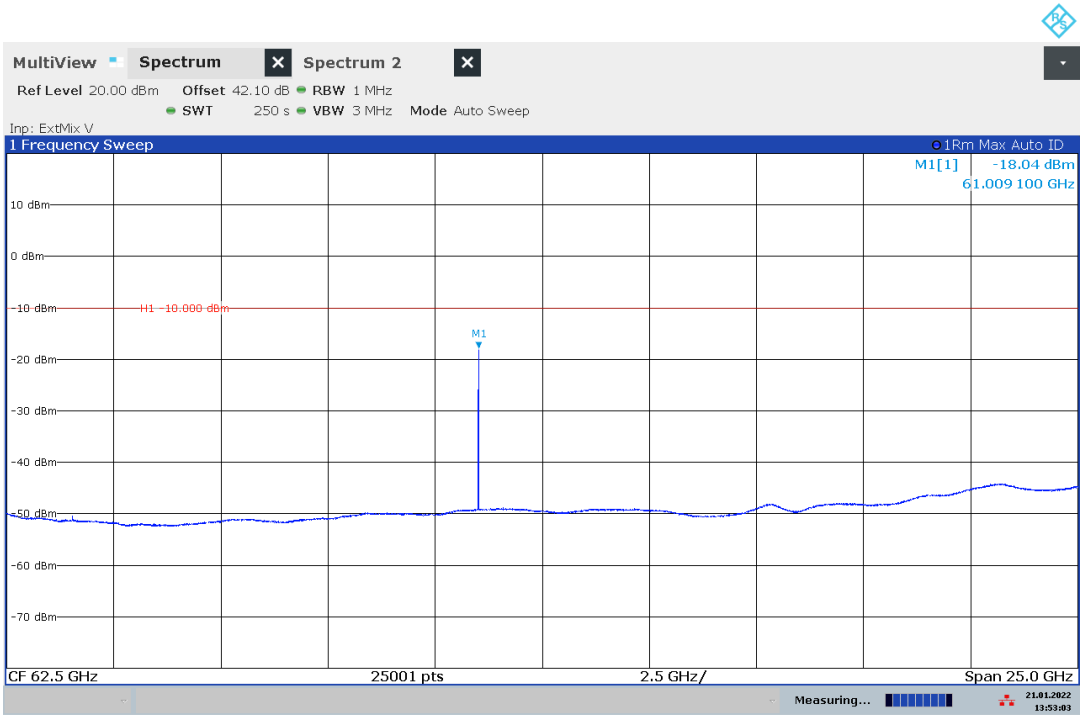

14:10:09 21.01.2022

Plot 21: 50 GHz – 75 GHz, normal mode



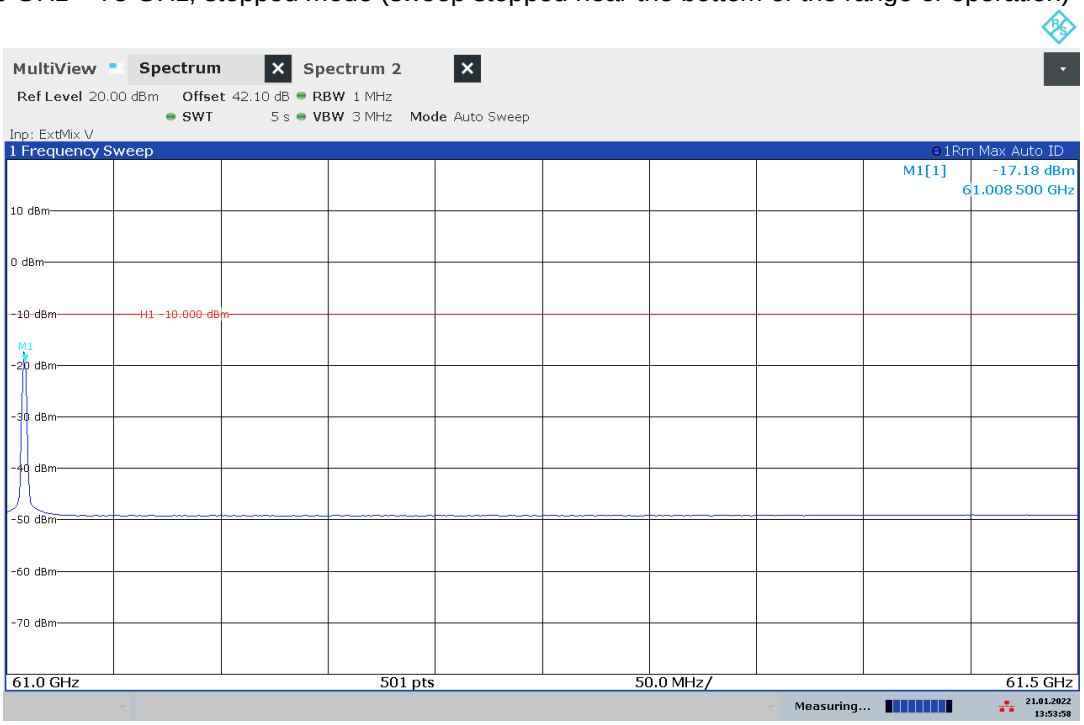

13:59:44 21.01.2022

Plot 22: 50 GHz – 75 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



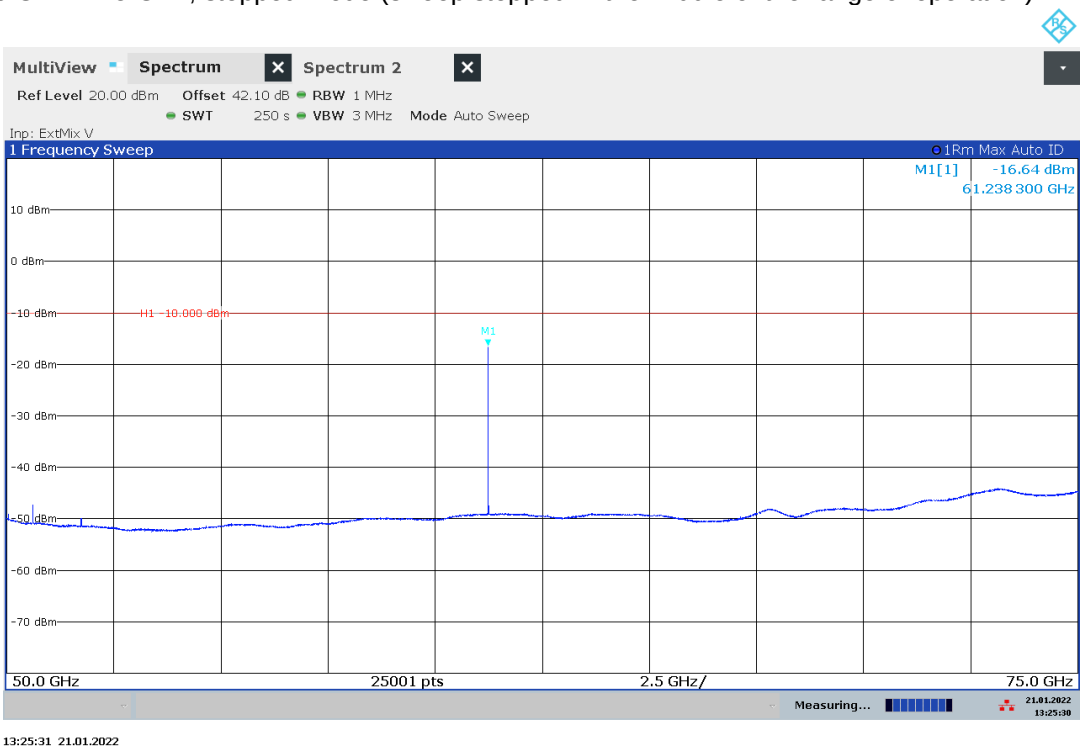

13:53:04 21.01.2022

Plot 23: 50 GHz – 75 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



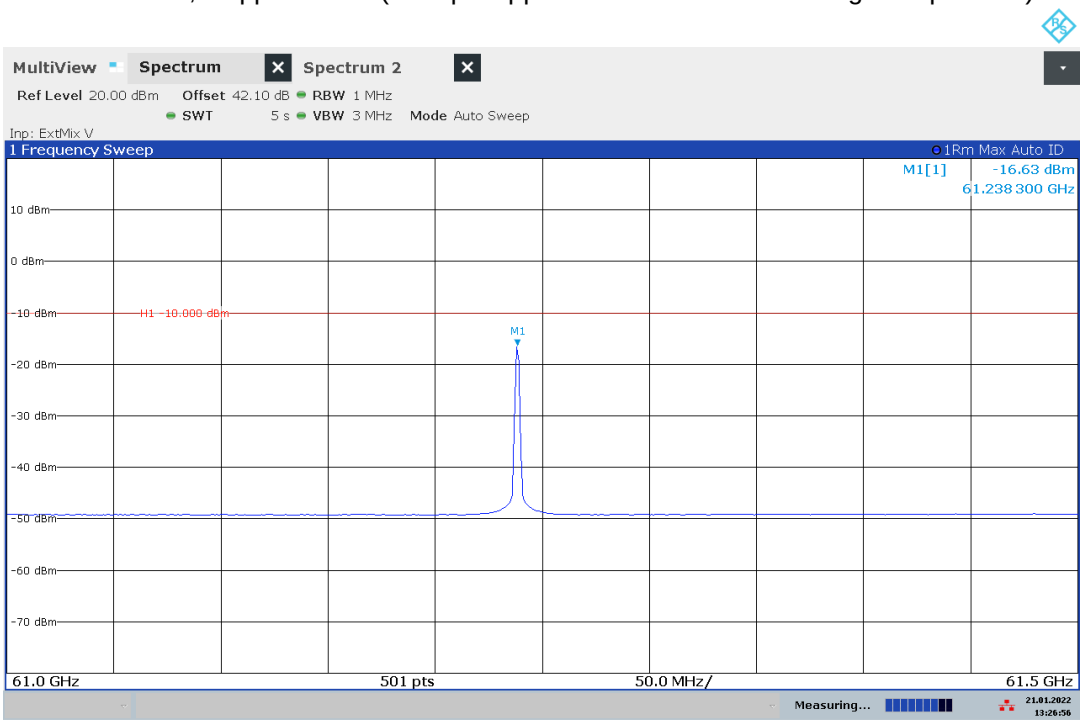

13:53:58 21.01.2022

Plot 24: 50 GHz – 75 GHz, stopped mode (sweep stopped in the middle of the range of operation)



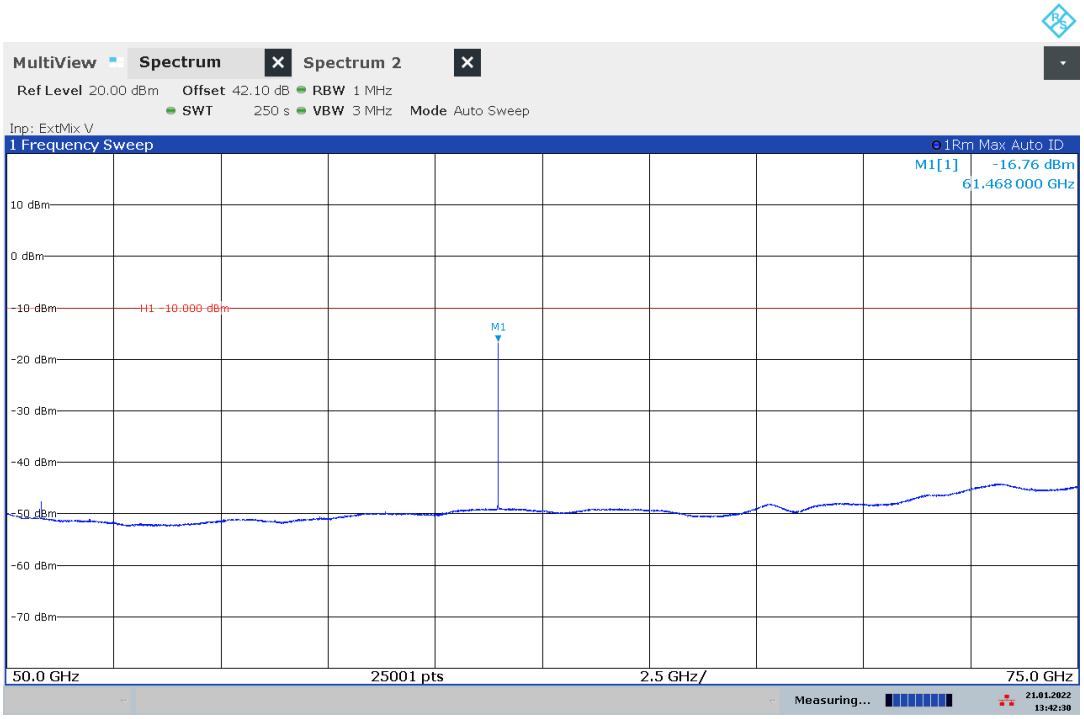

13:25:31 21.01.2022

Plot 25: 50 GHz – 75 GHz, stopped mode (sweep stopped in the middle of the range of operation)



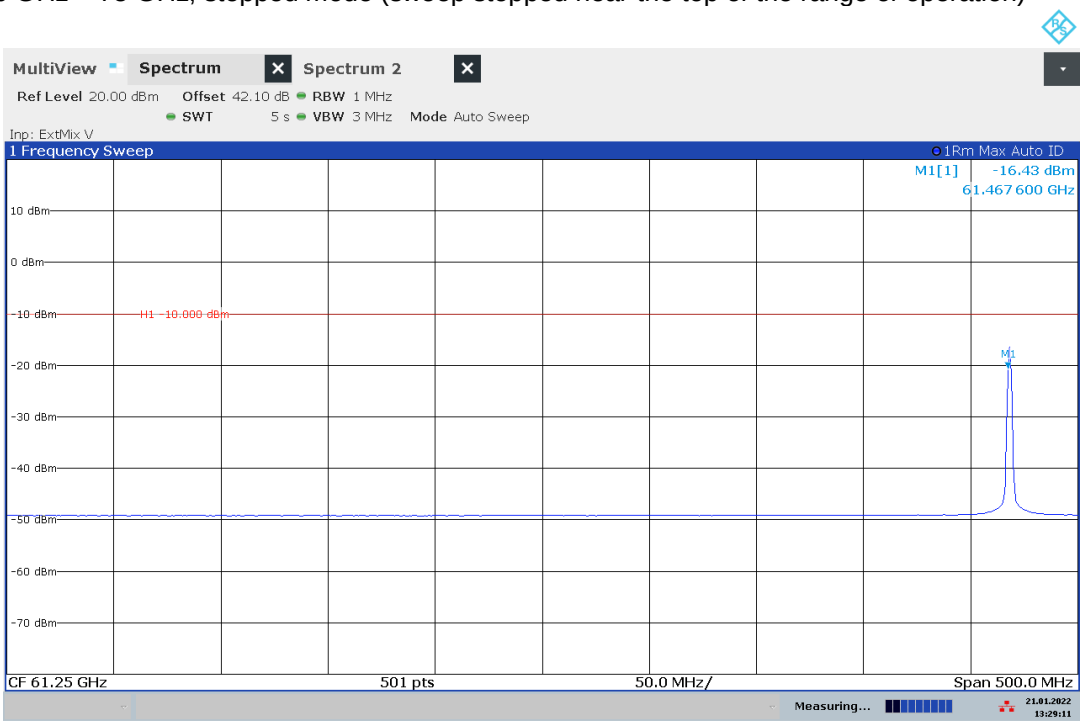

13:26:57 21.01.2022

Plot 26: 50 GHz – 75 GHz, stopped mode (sweep stopped near the top of the range of operation)



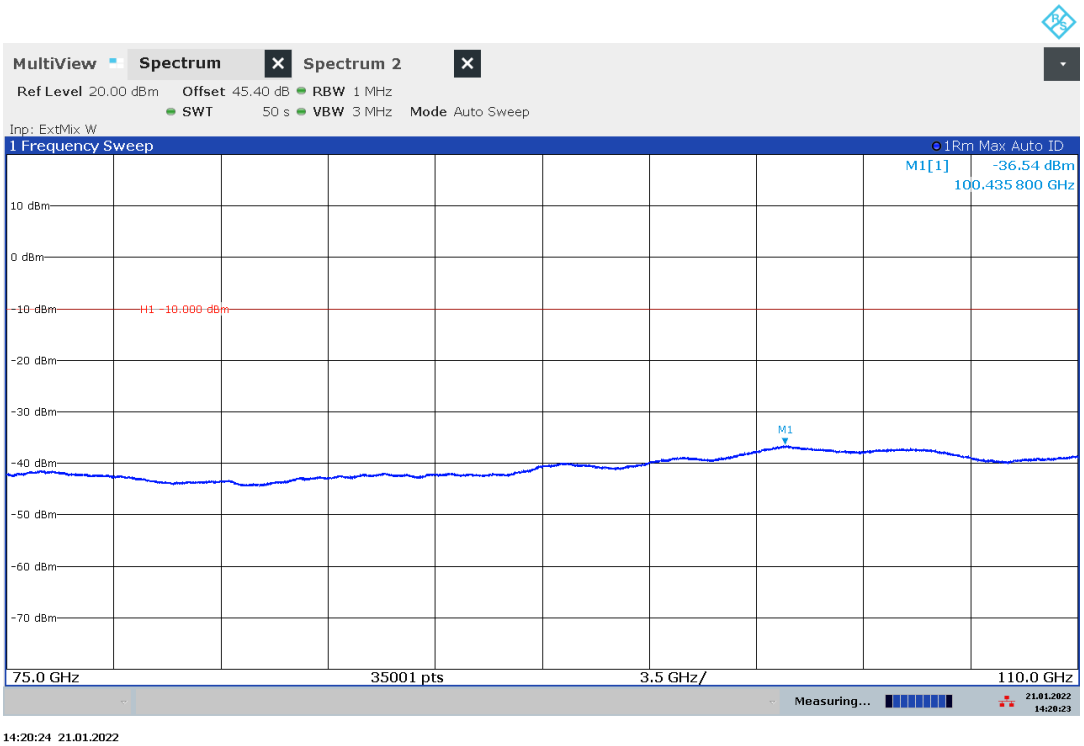

13:42:31 21.01.2022

Plot 27: 50 GHz – 75 GHz, stopped mode (sweep stopped near the top of the range of operation)



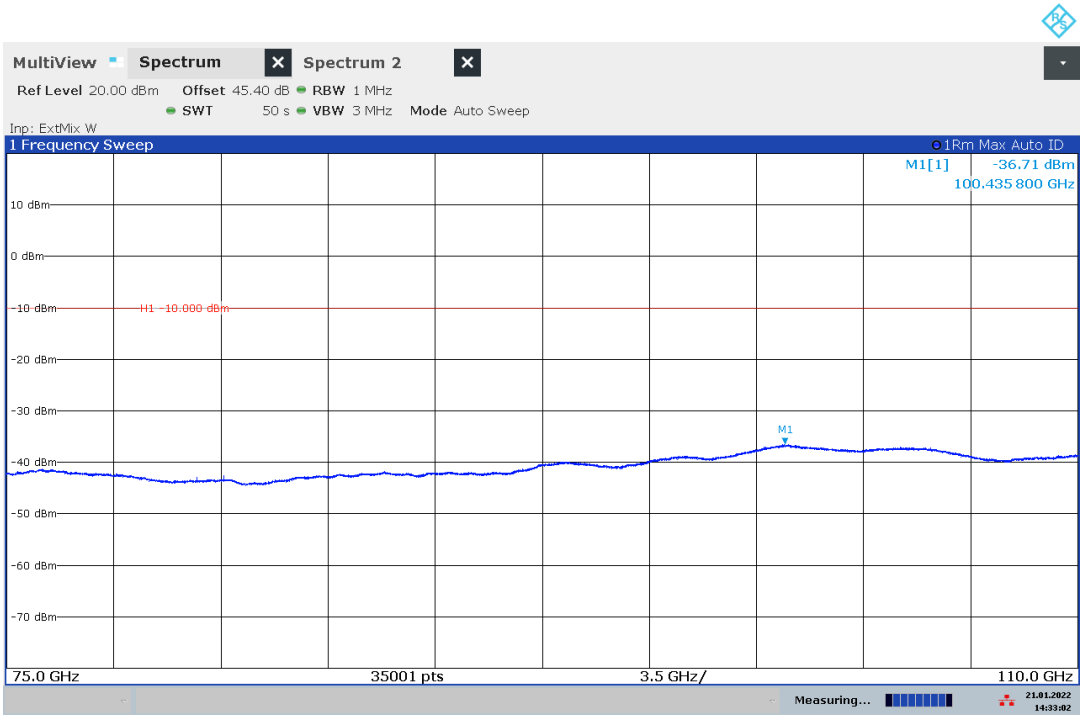

13:29:12 21.01.2022

Plot 28: 75 GHz –110 GHz, normal mode



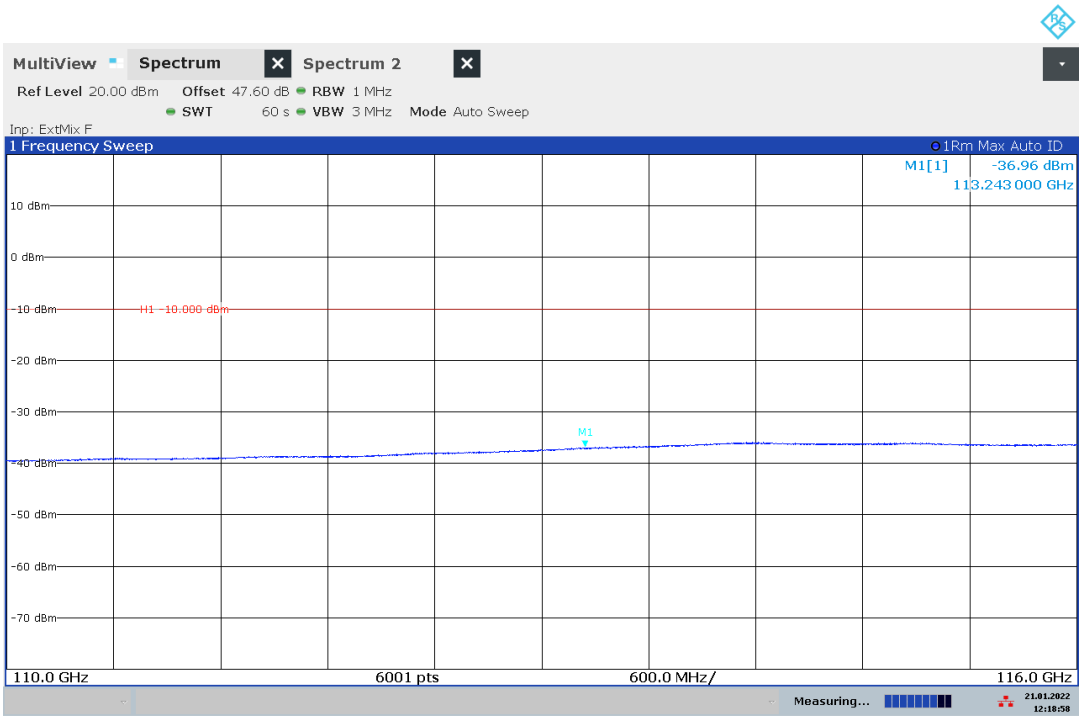

14:20:24 21.01.2022

Plot 29: 75 GHz – 110 GHz, stopped mode (sweep stopped in the middle of the range of operation)



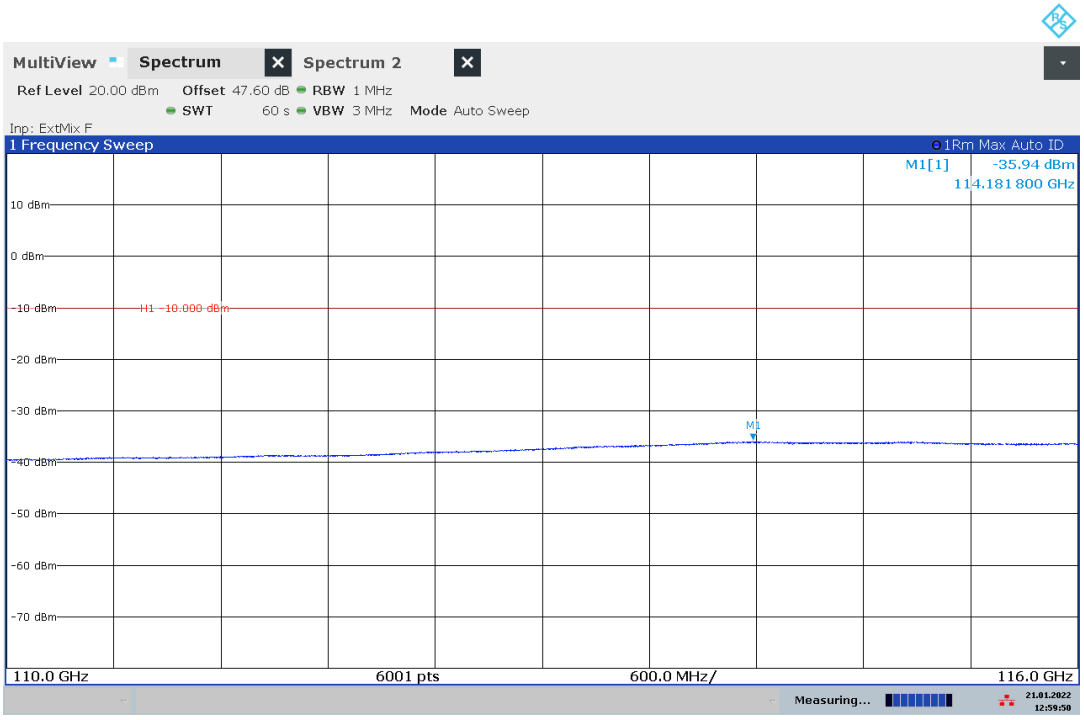

14:33:03 21.01.2022

Plot 30: 110 GHz – 116 GHz, normal mode



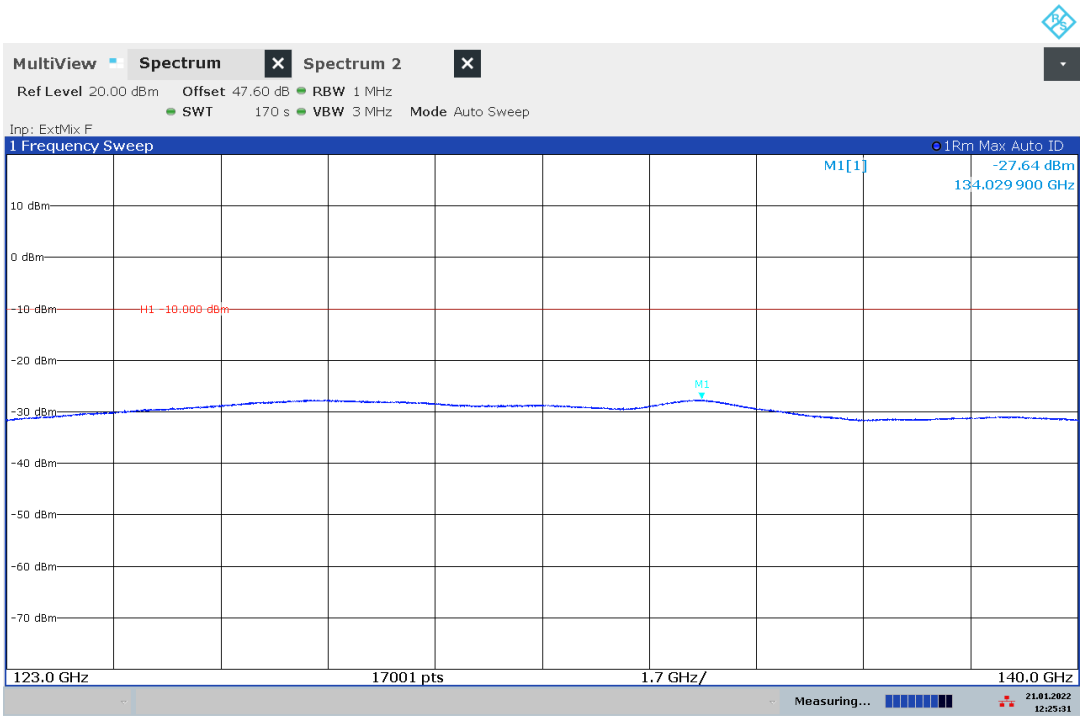

12:18:59 21.01.2022

Plot 31: 110 GHz – 116 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



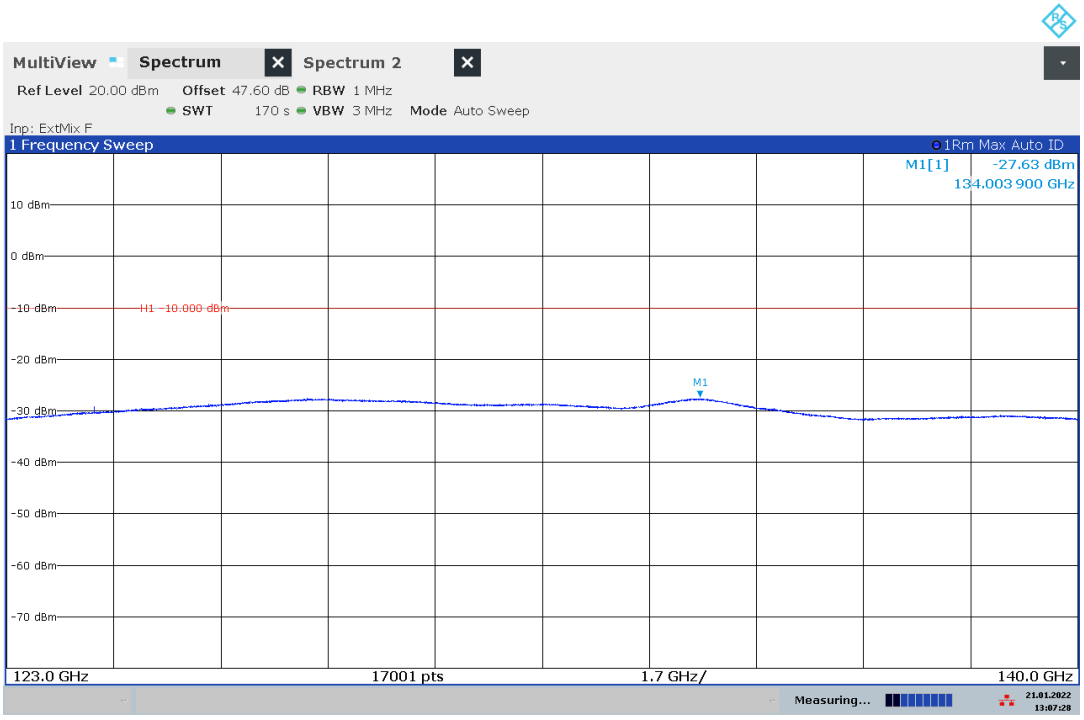

12:59:50 21.01.2022

Plot 32: 123 GHz – 140 GHz, normal mode



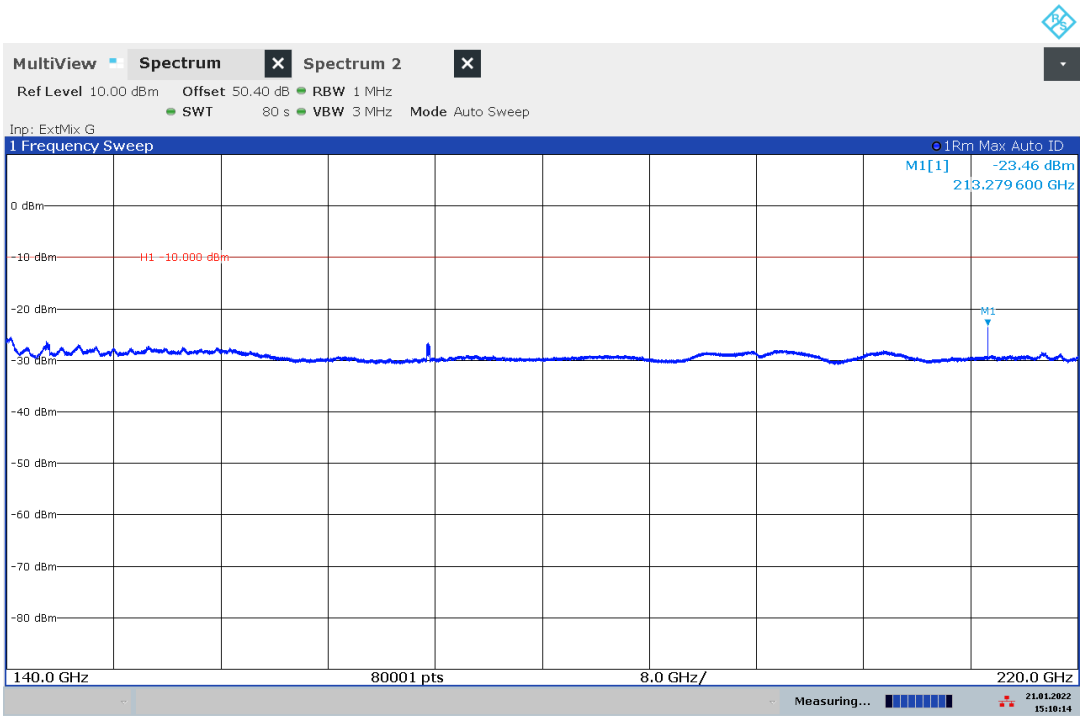

12:25:31 21.01.2022

Plot 33: 123 GHz – 140 GHz, stopped mode (sweep stopped near the top of the range of operation)



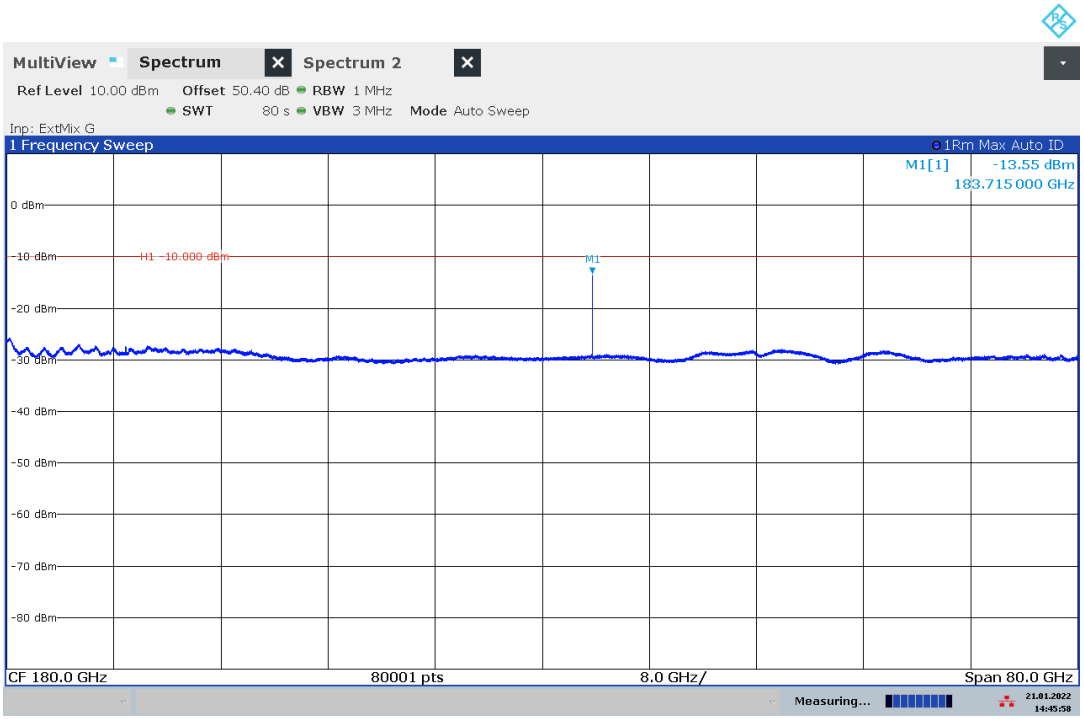

13:07:29 21.01.2022

Plot 34: 140 GHz – 220 GHz, normal mode



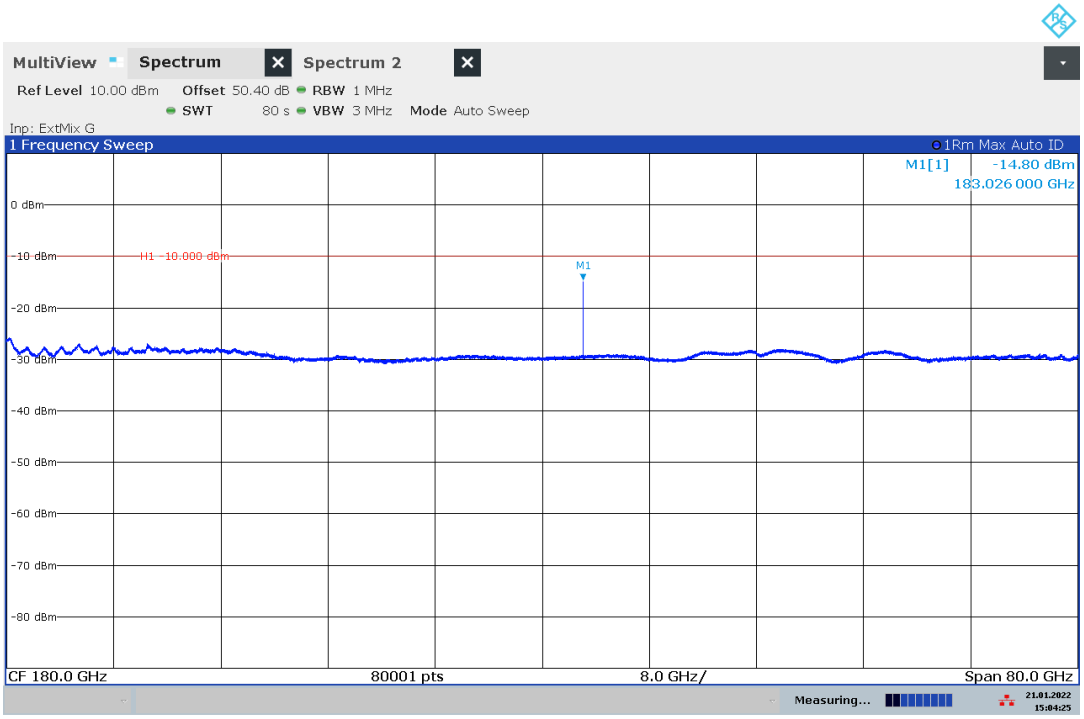

15:10:15 21.01.2022

Plot 35: 140 GHz – 220 GHz, stopped mode (sweep stopped in the middle of the range of operation)



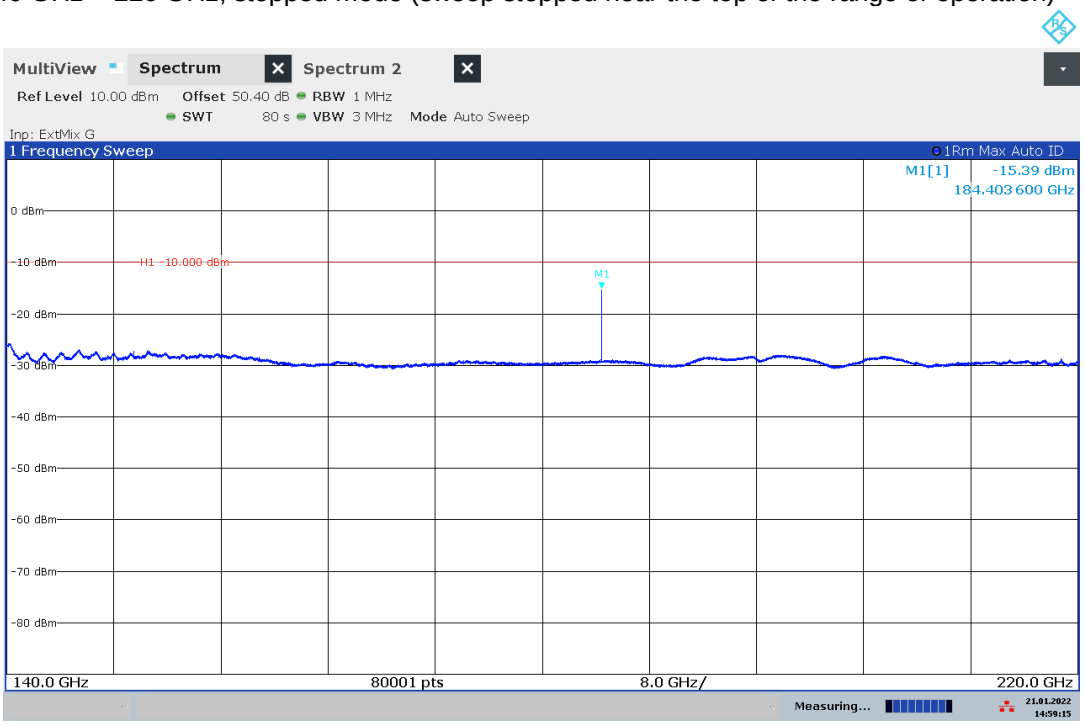

14:45:59 21.01.2022

Plot 36: 140 GHz – 220 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



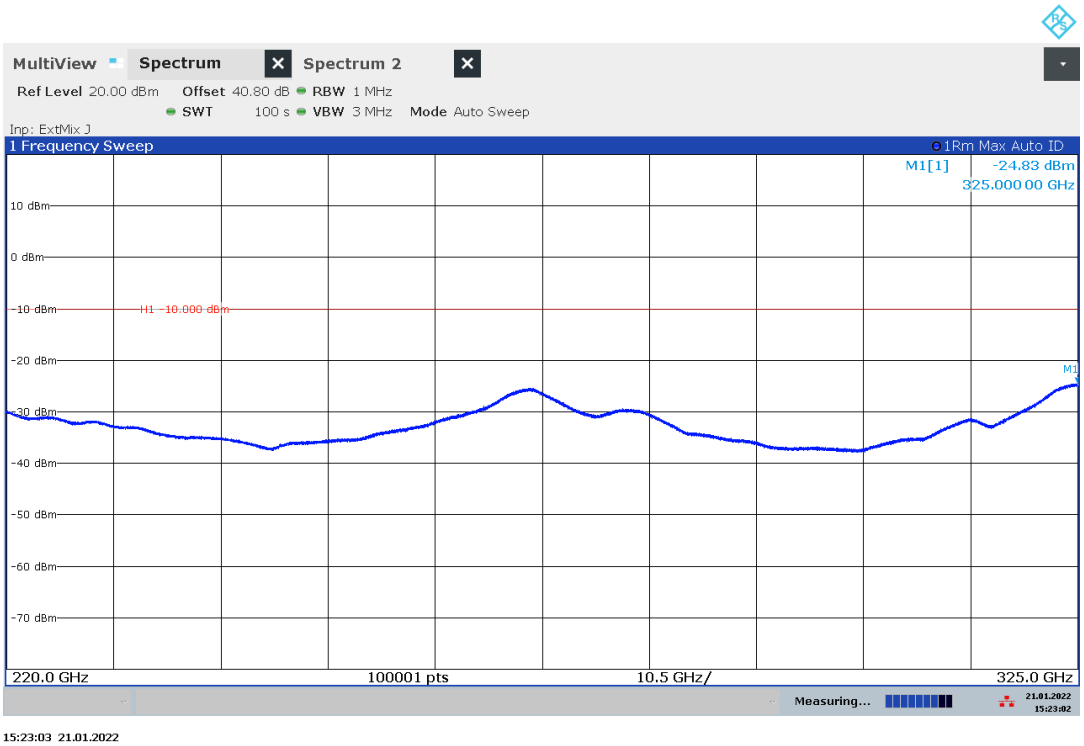

15:04:26 21.01.2022

Plot 37: 140 GHz – 220 GHz, stopped mode (sweep stopped near the top of the range of operation)



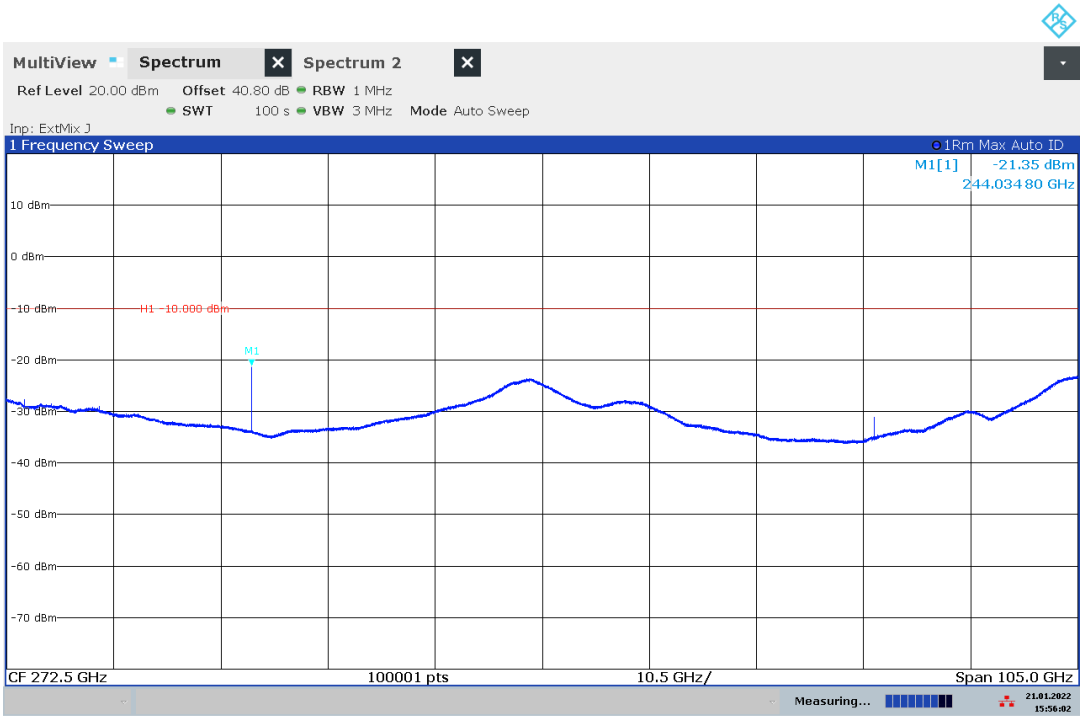

14:59:15 21.01.2022

Plot 38: 220 GHz – 325 GHz, normal mode



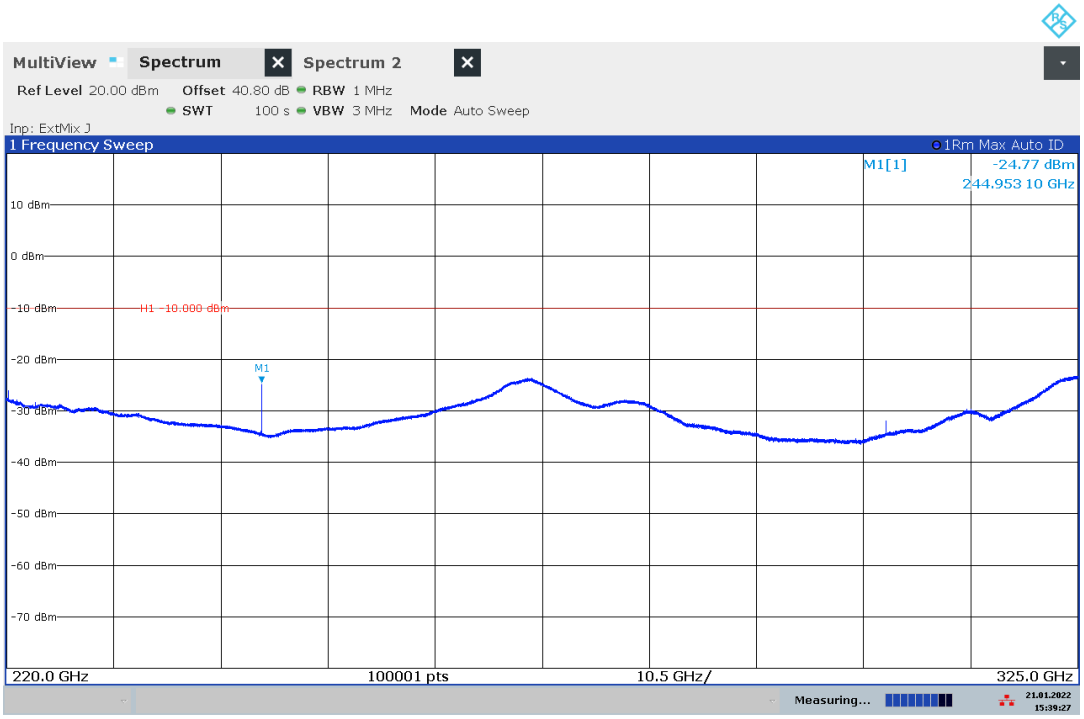

15:23:03 21.01.2022

Plot 39: 220 GHz – 325 GHz, stopped mode (sweep stopped near the bottom of the range of operation)



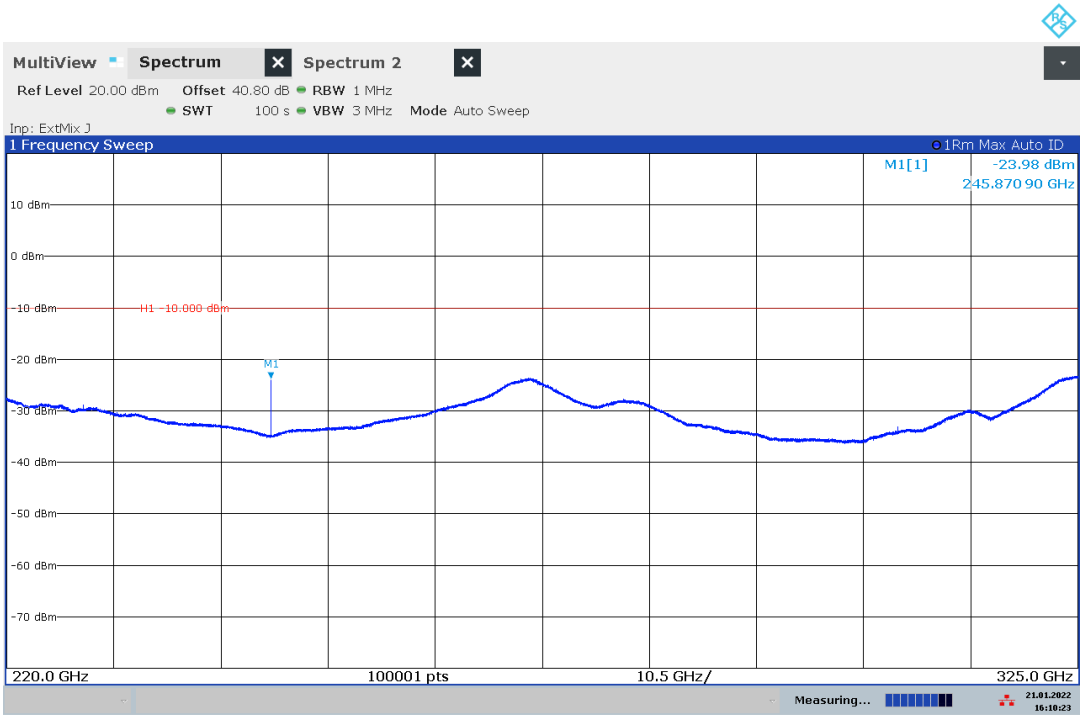

15:56:02 21.01.2022

Plot 40: 220 GHz – 325 GHz, stopped mode (sweep stopped in the middle of the range of operation)



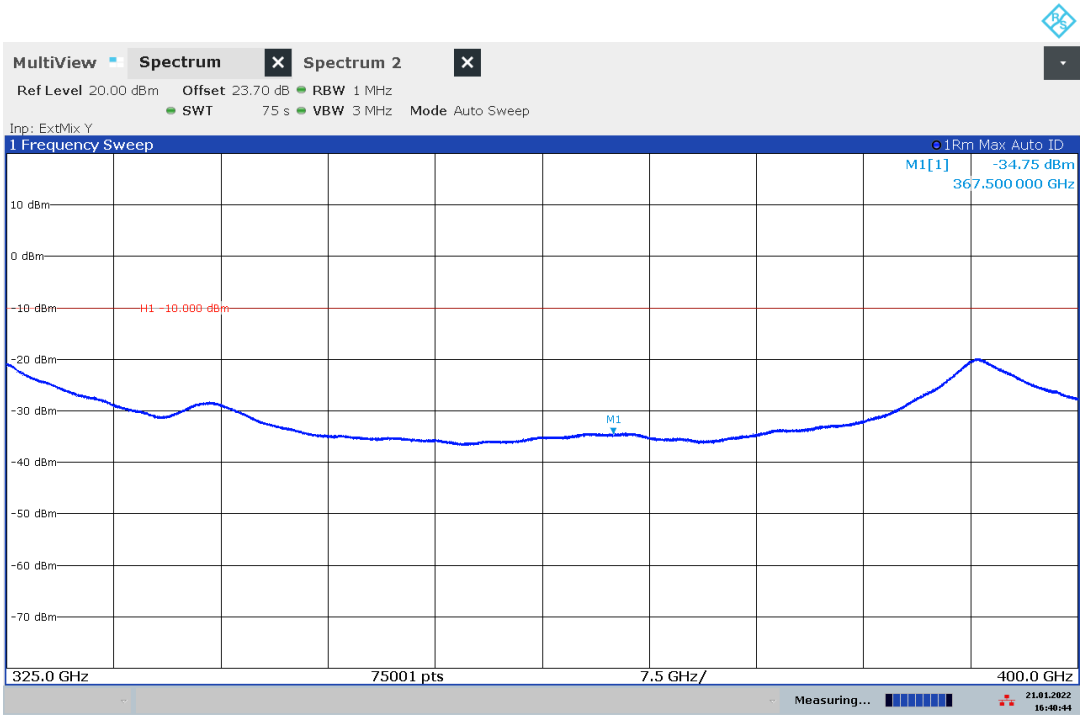

15:39:28 21.01.2022

Plot 41: 220 GHz – 325 GHz, stopped mode (sweep stopped near the top of the range of operation)



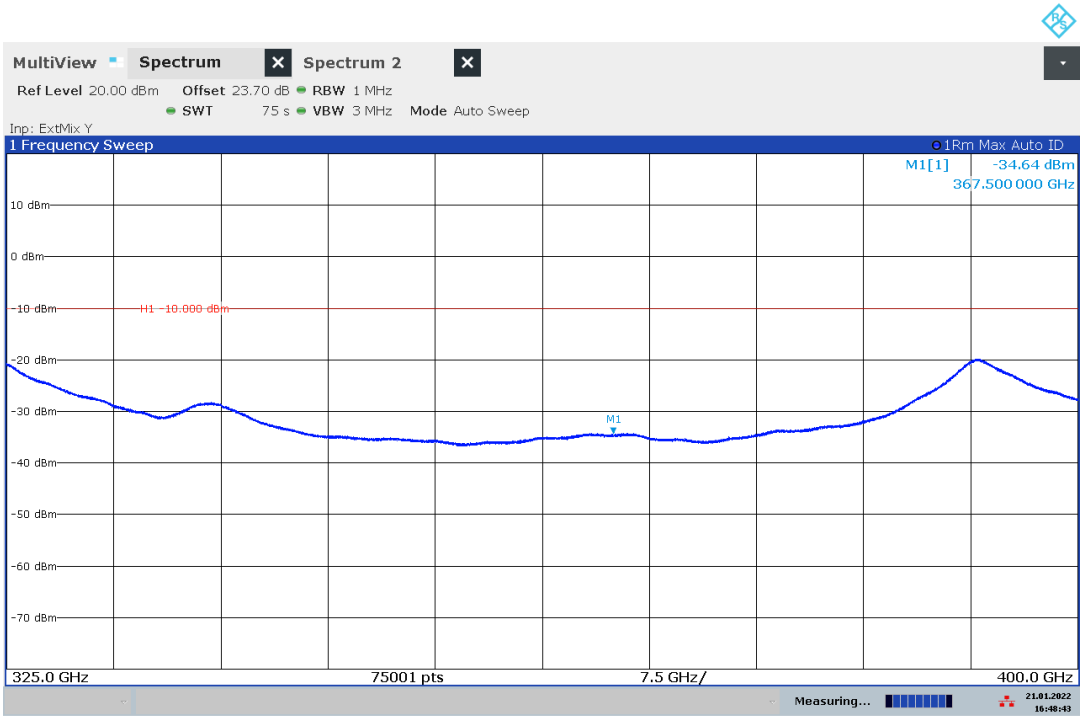

16:10:23 21.01.2022

Plot 42: 325 GHz – 400 GHz, normal mode




16:40:44 21.01.2022

Plot 43: 325 GHz – 400 GHz, stopped mode (sweep stopped in the middle of the range of operation)




16:48:43 21.01.2022

## 12.4 Frequency Stability

**Description:**

§15.215(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

**Measurement:**

$f_C$ is the point in the radiation where the power is at maximum. The frequency points where the power falls 10 dB below the $f_C$ level and above $f_C$ level are designated as $f_L$ and $f_H$ respectively.
The operating frequency range (i.e. the frequency band of operation) is defined as $f_H$ - $f_L$.

| Measurement parameter | |
|---|---|
| Detector: | Peak |
| Sweep time: | 100 s |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Span: | 2 GHz |
| Trace-Mode: | Max Hold |
| Temperature: | -20 °C / +50 °C |
| Voltage: | 20.4 V / 24 V / 27.6 V |

**Limits:**

| FCC |
|---|
| CFR Part 15.258 (d) |
| The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following: |
| **Frequency range** |
| 116 GHz – 123 GHz (regulatory)<br>122 – 123 GHz (EUT) |

**Measurement Results:**

| Test Conditions | Transmitter Frequency Range [GHz] | | Occupied Bandwidth [MHz] |
|---|---|---|---|
| | $f_L$ | $f_H$ | |
| -25 °C / $V_{nom}$ | 122.016 4 | 122.940 6 | 924.20 |
| -20 °C / $V_{nom}$ | 122.016 4 | 122.940 6 | 924.20 |
| -10 °C / $V_{nom}$ | 122.017 4 | 122.941 6 | 924.20 |
| 0 °C / $V_{nom}$ | 122.017 4 | 122.941 6 | 924.20 |
| 10 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 20 °C / $V_{min}$ | 122.017 4 | 122.942 6 | 925.20 |
| 20 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 20 °C / $V_{max}$ | 122.017 4 | 122.942 6 | 925.20 |
| 30 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 40 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 50 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 55 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |
| 65 °C / $V_{nom}$ | 122.017 4 | 122.942 6 | 925.20 |

**Result:** **The measurement is passed.**

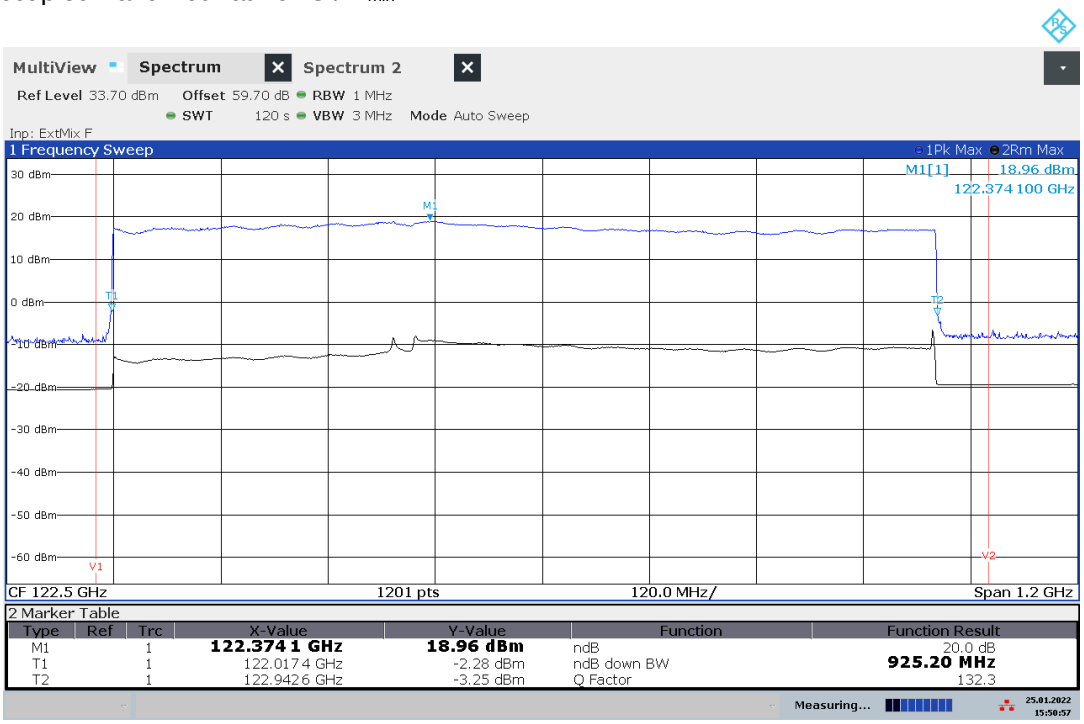
Plot 44: Occupied Bandwidth at -20 °C / $V_{nom}$


16:52:55 25.01.2022

Plot 45: Occupied Bandwidth at +50 °C / $V_{nom}$


17:57:14 25.01.2022

Plot 46: Occupied Bandwidth at 20 °C / $V_{min}$




15:50:57 25.01.2022

Plot 47: Occupied Bandwidth at 20 °C / $V_{max}$


15:48:20 25.01.2022

## 13 Conducted spurious emissions < 30 MHz

**Description:**

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. 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:**

| Measurement parameter | |
|---|---|
| Detector: | Peak - Quasi Peak / Average |
| Sweep time: | Auto |
| Video bandwidth: | F < 150 kHz: 200 Hz<br>F > 150 kHz: 9 kHz |
| Resolution bandwidth: | F < 150 kHz: 1 kHz<br>F > 150 kHz: 100 kHz |
| Span: | 9 kHz to 30 MHz |
| Trace-Mode: | Max Hold |

**Limits:**

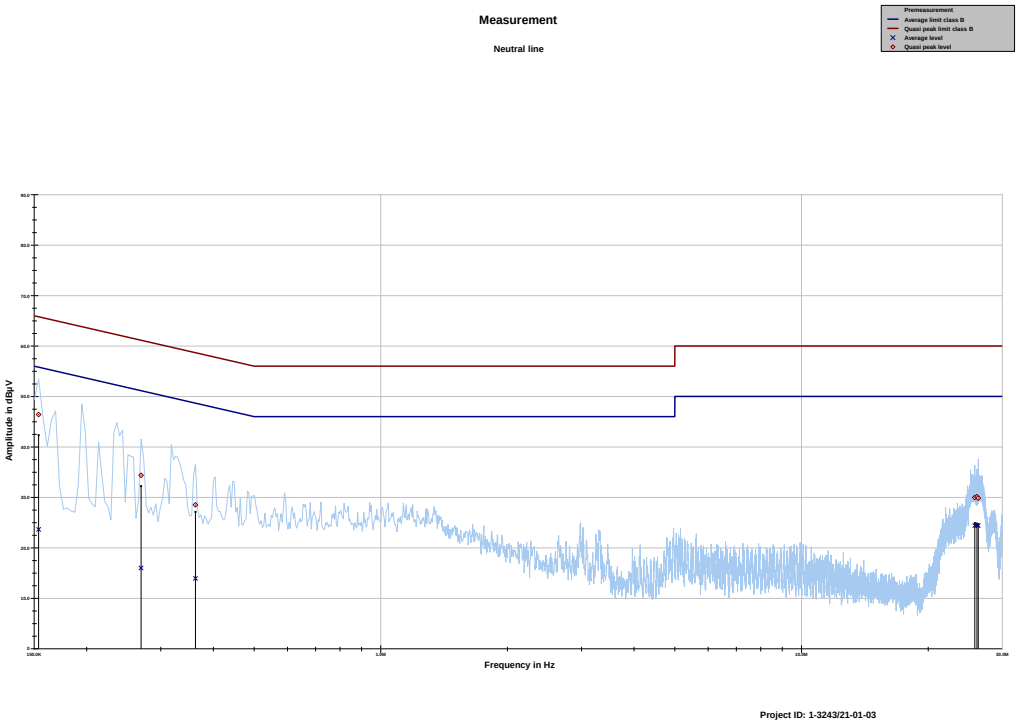
| FCC | | IC |
|---|---|---|
| CFR Part 15.207(a) | | RSS-Gen 8.8 |
| Conducted Spurious Emissions < 30 MHz | | |
| Frequency (MHz) | Quasi-Peak (dBµV/m) | Average (dBµV/m) |
| 0.15 – 0.5 | 79 to 69* (Class A)<br>66 to 56* (Class B) | 79 to 69* (Class A)<br>56 to 46* (Class B) |
| 0.5 – 5 | 73 (Class A)<br>56 (Class B) | 63 (Class A)<br>46 (Class B) |
| 5 – 30.0 | 73 (Class A)<br>60 (Class B) | 63 (Class A)<br>50 (Class B) |

*Decreases with the logarithm of the frequency

**Measurement results:**

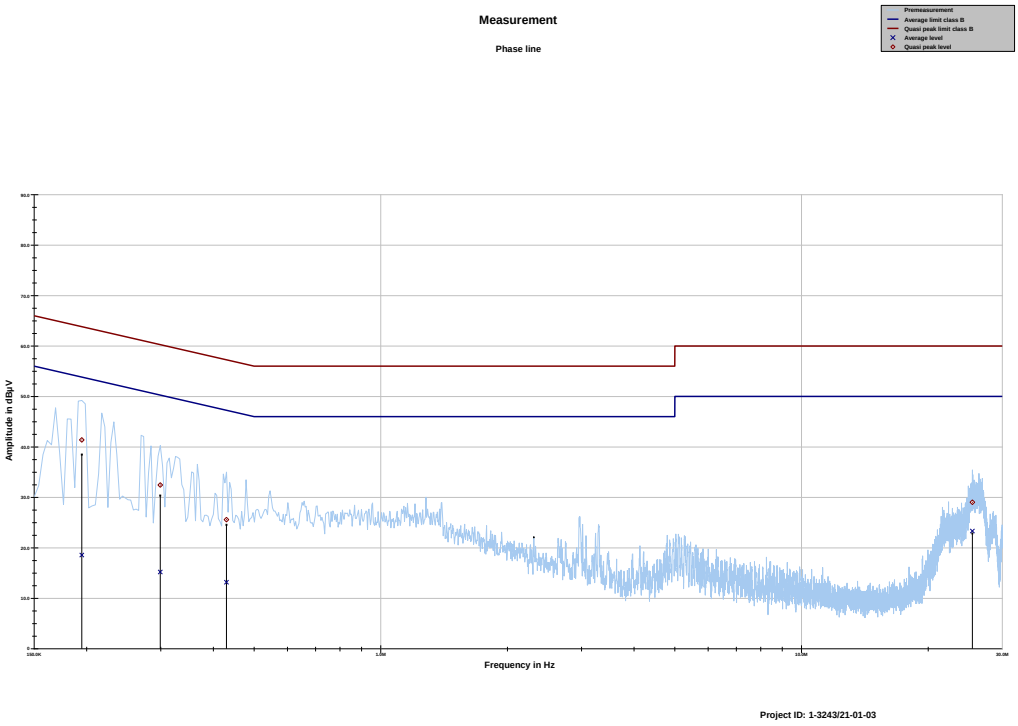
See plots below.

Plot 48: Neutral line




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin Average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| | | | | | | |
| **0.153731** | 46.43 | 19.37 | 65.796 | 23.64 | 32.26 | 55.893 |
| **0.269400** | 34.36 | 26.78 | 61.136 | 15.99 | 36.60 | 52.589 |
| **0.362681** | 28.52 | 30.15 | 58.667 | 13.92 | 36.00 | 49.923 |
| **25.817269** | 29.98 | 30.02 | 60.000 | 24.41 | 25.59 | 50.000 |
| **26.123231** | 30.12 | 29.88 | 60.000 | 24.43 | 25.57 | 50.000 |
| **26.317256** | 29.84 | 30.16 | 60.000 | 24.41 | 25.59 | 50.000 |

Plot 49: Phase line




| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AV |
|---|---|---|---|---|---|---|
| MHz | dBµV | dB | dBµV | dBµV | dB | dBµV |
| | | | | | | |
| **0.194775** | 41.37 | 22.46 | 63.830 | 18.56 | 36.16 | 54.721 |
| **0.299250** | 32.44 | 27.82 | 60.264 | 15.19 | 36.54 | 51.736 |
| **0.429844** | 25.57 | 31.68 | 57.256 | 13.18 | 34.82 | 48.004 |
| **25.477725** | 29.04 | 30.96 | 60.000 | 23.33 | 26.67 | 50.000 |

## 14 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 |

## 15 Document history

| Version | Applied changes | Date of release |
|---|---|---|
| | Initial release - Draft | 2022-03-08 |
| | Initial Release | |

## 16 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-12076-01-05e.pdf

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