ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-21375-01-03 D-PL-21375-01-05

INGENIEURBÜRO LENHARDT

# Test Report

***Test report no.:*** 20084422-18460-2
***Date of issue:*** *2021-03-17*

**Test result:** The test item **- passed -** and complies with the listed standards.

## Applicant
*Veoneer US, Inc.*

## Manufacturer
*Veoneer US, Inc.*

## Test Item
*77V125CRN*

## Radio Frequency Testing according to:

47 CFR Part 95
RSS-Gen Issue 5
RSS-251 Issue 2

| | | |
|---|---|---|
| Tested by<br>(name, function, signature) | *B.Sc. Piotr Sardyko*<br>*Lab Manager Radio* | signature |
| Approved by<br>(name, function, signature) | *Dr.-Ing. Harald Ansorge*<br>*Managing Director* | signature |

| Applicant and Test item details | |
|---|---|
| **Applicant** | Veoneer US, Inc.<br>26360 American Drive<br>Southfield, MI, USA<br>+1 248 223 0600 |
| **Manufacturer** | Veoneer US, Inc.<br>26360 American Drive<br>Southfield, MI, USA<br>+1 248 223 0600 |
| **Test item description** | 77 GHz Corner Radar Sensor |
| **Model/Type reference** | 77V125CRN |
| **FCC ID** | WU877V125CRN |
| **IC** | 8436B-77V125CRN |

## Disclaimer and Notes

The content of this rest report relates to the mentioned test sample(s) only.
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Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

Decision rule: Binary Statement for Simple Acceptance Rule according ILAC-G8:09/2019

# 1 TABLE OF CONTENTS

# 2 GENERAL INFORMATION

## 2.1 Administrative details

| | |
|---|---|
| Testing laboratory | **IBL-Lab GmbH**<br>Heinrich-Hertz-Allee 7<br>66386 Sankt Ingbert / Germany<br>Fon: +49 6894 38938-0<br>Fax: +49 6894 38938-99<br>URL: www.ib-lenhardt.de<br>E-Mail: info@ib-lenhardt.de |
| Accreditation | The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018.<br><br>Scope of testing and registration number:<br>• Electromagnetic Compatibility and Telecommunication (FCC requirements) D-PL-21375-01-03<br>• Telekommunikation (TK) D-PL-21375-01-05<br><br>Website DAkkS: https://www.dakks.de/<br><br>The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement |
| Date of receipt of test samples | 2021-01-18 |
| Start – End of tests | 2021-01-20 – 2021-03-02 |

## 2.2 Possible verdicts of the results

| | |
|---|---|
| Test sample meets the requirements | P (PASS) – the measured value is below the acceptance limit, AL = TL |
| Test sample does not meet the requirements | F (FAIL) – the measured value is above the acceptance limit, AL = TL |
| Test case does not apply to the test sample | N/A (Not applicable) |
| Test case not performed | N/P (Not performed) |

## 2.3 Observations

No additional observations other than the reported observations within this test report have been made.

## 2.4 Opinions and Interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

## 2.5 Revision History

**1 Initial Version**

## 2.6 Further documents

List of further applicable documents belonging to the present test report:
Measurement plots (separate document): 20084422-18460-2_Annex A
Test setup photographs (separate document): 20084422-18460-2_Annex B

| | |
|---|---|
| EUT photographs (separate document): | 20084422-18460-2_Annex C |

## 2.7 Formula for determination of correction values ($E_c$)

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

$E_C$ = Electrical field – corrected value
$E_R$ = Receiver reading
M = Margin
$L_T$ = Limit
AF = Antenna factor
$C_L$ = Cable loss
$D_F$ = Distance correction factor (if used)
$G_A$ = Gain of pre-amplifier (if used)

All units are dB-units, positive margin means value is below limit.

## 2.8 Software/Firmware used for measurements

All measurements were done directly with spectrum analyzer.
For the frequency range 9 kHz – 18 MHz R&S ESW 26 was used (please see chapter 8).
(Instrument) Firmware Version: **1.70**
For the frequency range 18 Hz – 330 GHz R&S FSW 50 was used (please see chapter 8).
(Instrument) Firmware Version: **4.61**

# 3 ENVIRONMENTAL & TEST CONDITIONS

| 3.1 Environmental conditions | |
|---|---|
| Temperature | 20°C ± 5°C |
| Relative humidity | 25-75 % r.H. |
| Barometric Pressure | 860-1060 mbar |
| Power supply | DC power supply: 8 – 16 V |

# 4 TEST STANDARDS AND REFERENCES

| Test standard (accredited) | |
|---|---|
| 47 CFR Part 95 | --- |

| Test standard (not accredited) | Description |
|---|---|
| RSS-Gen Issue 5<br>RSS-251 Issue 2 | ---<br>--- |

| Reference | Description |
|---|---|
| **---** | --- |

# 5 EQUIPMENT UNDER TEST (EUT)

## 5.1 Product Description*

The product described here is part of a family of radars offered by Veoneer. They are intended for automotive use, operating in the 76-77 GHz band. This variant is intended for corner radar applications.
The radars are integrated into a vehicle to enhance vehicle safety systems. They can be integrated as a standalone sensor or sensors, or as part of more complex system that also may include cameras, lidar, and other type of sensors to provide features like Automatic Cruise Control, Automatic Emergency Break, Free Space Detections and other Autonomous Driving functions.

*: declared by the applicant

## 5.2 Technical Data of Equipment*

| | |
|---|---|
| Main function | Corner Radar Sensor |
| Transmit frequency | 76 GHz to 77 GHz |
| Antenna polarization | vertical |
| Type of modulation | fast chirp FMCW |
| Bandwidth | < 1000 MHz |
| Antenna Type | Integrated |
| Power supply | DC power supply: 8 – 16 V |
| Temperature | -40° C to +85° C |
| Emission classification | 925MQ0N |
| Interfaces | CAN/CAN-FD |
| EUT sample type | Pre-Production |

*: declared by the applicant

## 5.3 Test Item (Equipment Under Test) Description*

| Short designation | EUT Name | EUT Description | Serial number | Hardware status | Software status |
|---|---|---|---|---|---|
| EUT A | 77V125CRN | Corner Radar Sensor | 20014 | 20/35.00 | R255_33_12D50_172 |
| EUT B | 77V125CRN | Corner Radar Sensor | 20008 | 20/35.00 | R255_33_13D50_172 |
| EUT C | 77V125CRN | Corner Radar Sensor | 0033 | 20/35.11 | R255_33_13D50_172 |
| EUT D | 77V125CRN | Corner Radar Sensor | 0045 | 20/35.11 | R255_33_12D50_172 |

*: declared by the applicant. According to customers information EUTs A and B are the same devices as EUTs C and D. The difference between them is that some components in EUTs C and D were replaced through the components of the same type but from different manufacturer to reduce the costs, with minor PCB layout changes.

## 5.4 Auxiliary Equipment (AE) Description

| AE short designation | EUT Name (if available) | EUT Description | Serial number (if available) | Software (if used) |
|---|---|---|---|---|
| AE 1 | - | Cable for power supply with CAN interface | - | - |

## 5.5 Test Item Operating Modes Description*

| EUT operating mode no. | Description of operating modes | Additional information |
|---|---|---|
| op. 1 | Continuously transmitting and receiving mode | FMCW modulation (normal mode). Rear mode. See also Chapter 7.2. for description. |
| op. 2 | Continuously transmitting and receiving mode | FMCW modulation (normal mode). Front mode. See also Chapter 7.2. for description. |

*: declared by the applicant

## 5.6 Test Item Set-ups Description

| | | |
|---|---|---|
| set. 1 | EUT A + AE 1 | EUT operating mode 1 |
| set. 2 | EUT B + AE 1 | EUT operating mode 2 |
| set. 3 | EUT C + AE 1 | EUT operating mode 2 |
| set. 4 | EUT D + AE 1 | EUT operating mode 1 |

## 5.7 Test conditions

| Temperatur, [°C] | | Voltage, [V] | |
|---|---|---|---|
| Tnom | 20 ± 5 | Vnom | 12 |
| Tmin | -40 | Vmin | 8 |
| Tmax | 85 | Vmax | 16 |

## 5.8 Additional Information

| | |
|---|---|
| **Test items differences** | According to customers information EUTs A and B are the same devices as EUTs C and D. The difference between them is that some components in EUTs C and D were replaced through the components of the same type but from different manufacturer to reduce the costs, with minor PCB changes. The EUTs can work in two modes, front and rear. Mean/ peak power and occupied bandwidth was measured with normal temperature and voltage for both modes. EUT A had the higher antenna power as EUT B. EUT C had the higher antenna power as EUT D. For EUT A full scope measurements were done. For EUT C maximum peak power EIRP / peak EIRP spectral density / maximum power EIRP/ average EIRP, modulation characteristics, occupied bandwidth and frequency stability was measured with normal temperature and extreme/nominal voltage. Field strength of emissions (radiated spurious) test was done for EUT C in full size. |
| **Additional application considerations to test a component or sub-assembly** | None |

# 6 SUMMARY OF TEST RESULTS

| Test specification |
|---|
| 47 CFR Part 95, RSS-Gen Issue 5, RSS-251 Issue 2 |

| Test cases | References & Limits | | Test conditions (temperature and voltage) | EUT set-up | EUT operating mode | Result |
|---|---|---|---|---|---|---|
| | Standard | Test Limit | | | | |
| Peak EIRP spectral density / average EIRP | FCC §95.3367 (a) (b) | 50 dBm (Average)<br>55 dBm (Peak) | Nominal and extreme | 1,3 | 1,2 | Pass |
| | RSS-251 (Section 8 and 9) | 50 dBm (Average)<br>55 dBm (Peak) | Nominal | 2,4 | 1,2 | |
| Modulation characteristics | FCC §2.1047 (d) | - | - | - | - | Pass |
| | RSS-251 (Section 6b) | - | | | | |
| Occupied bandwidth | FCC §95.3379 (b) | 76 GHz - 81 GHz | Nominal and extreme | 1,3 | 1,2 | Pass |
| | RSS-251 (Section 7) | 76 GHz - 81 GHz | Nominal | 2,4 | 1,2 | |
| Field strength of emissions (band edge) | FCC §95.3379 (a)(2)(i) | 600 pW/cm² ~ -1.7 dBm | Nominal | 1,3 | 1,2 | Pass |
| | RSS-251 (Section 10) | lower BE: 0 dBm<br>upper BE: -30 dBm | | | | |
| Field strength of emissions (radiated spurious) | FCC §95.3379 (a) | Please see Chapter 7.5. | Nominal | 1,3 | 1,2 | Pass |
| | RSS-251 (Section 10) | Please see Chapter 7.5. | | | | |
| Frequency stability | FCC §95.3379 (b) | - | Nominal and extreme | 1,3 | 1,2 | Pass |
| | RSS-251 (Section 11) | RSS-251 (Subsection 11.2) | Nominal | 2,4 | 1,2 | |

| Comments and observations |
|---|
| According to customer information all test items use the same software and hardware. The EUT can work in two modes, front and rear. Mean/ peak power and occupied bandwidth was measured with normal temperature for both modes. Full scope measurement was done only for the mode with the highest power. Here it is Rear mode. |

# 7 TEST RESULTS

## 7.1 The maximum peak power EIRP / peak EIRP spectral density. The maximum power EIRP/ average EIRP.

**Test equipment (Please see Chapter 8 for exact information of test equipment)**

Radiated: A13, Cab1, Cab2, (C2), H2, M1, P1, R2

**Reference**

FCC/RSS See section 1.1.
ANSI C63.10-2013

**Limits**

See Chapter 6 in the report.

**Test procedure**

All measurements were done accoding to ANSI C63.10-2013. For spectrum analyzer settings please see plots in Annex A. For measurement set-up please see photos in Annex C.

| Results* | | | | Verdict |
|---|---|---|---|---|
| Setup / Op. Mode / RBW** | Nominal condition | | | |
| | Peak detector, max peak search (marker) [dBm] | Peak detector, max peak search (marker frequency) [GHz] | RMS detector, channel power measurement [dBm] | |
| Set. 1 / Op. 1 / Tnom/ Vnom, RBW= 1 MHz | 22.91 | 76.4865 | 23 | **Pass** |
| Set. 1 / Op. 1 / Tnom/ Vnom, RBW= 5 MHz | 28.48 | 76.2155 | - | **Pass** |
| Set. 2 / Op. 2 / Tnom/ Vnom, RBW= 1 MHz | 21.56 | 76.5775 | 21.16 | **Pass** |
| Set. 2 / Op. 2 / Tnom/ Vnom, RBW= 5 MHz | 27.78 | 76.2255 | - | **Pass** |
| Set. 3 / Op. 2 / Tnom/ Vnom, RBW= 1 MHz | 22.22 | 76.4945 | 22.15 | **Pass** |
| Set. 3 / Op. 2 / Tnom/ Vnom, RBW= 5 MHz | 27.62 | 76.2525 | - | **Pass** |
| Set. 4 / Op. 1 / Tnom/ Vnom, RBW= 1 MHz | 22.62 | 76.4305 | 21.52 | **Pass** |
| Set. 4 / Op. 1 / Tnom/ Vnom, RBW= 5 MHz | 27.32 | 76.1945 | - | **Pass** |
| Extreme conditions | | | | |
| Set. 1 / Op. 1 Tnom/ Vmin, RBW= 1 MHz | 22.91 | 76.5055 | 22.91 | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmin, RBW= 5 MHz | 28.45 | 76.2115 | - | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmax, RBW= 1 MHz | 22.53 | 76.5715 | 22.83 | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmax, RBW= 5 MHz | 28.44 | 76.2155 | - | **Pass** |
| Set. 1 / Op. 1 Tmin/ Vnom, RBW= 1 MHz | 23.86 | 76.5685 | 23.77 | **Pass** |
| Set. 1 / Op. 1 Tmin/ Vnom, RBW= 5 MHz | 29.64 | 76.2565 | - | **Pass** |
| Set. 1 / Op. 1 Tmax/ Vnom, RBW= 1 MHz | 22.45 | 76.5125 | 22.24 | **Pass** |
| Set. 1 / Op. 1 Tmax/ Vnom, RBW= 5 MHz | 28 | 76.2105 | - | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmin, RBW= 1 MHz | 22.28 | 76.4315 | 21.85 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmin, RBW= 5 MHz | 27.59 | 76.03394 | - | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmax, RBW= 1 MHz | 21.92 | 76.5145 | 21.76 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmax, RBW= 5 MHz | 27.59 | 76.2035 | - | **Pass** |

* Please see Annex A „Measurement plots“ for results.
** For parameter explanation please see Chapter 5.

## 7.2 Modulation characteristics

**Test equipment (Please see Chapter 8 for exact information of test equipment)**

Radiated: A13, Cab1, Cab2, H2, M1, P1, R2

**Reference**

FCC/RSS See section 1.1.

**Description:**

**FCC §2.1047 (d)**: Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

**RSS-251 (Section 6b)**: Non-pulsed radar (e.g. frequency modulated continuous wave (FMCW)): modulation type (i.e. sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

**Results**

For start/ stop frequency and occupied bandwidth pls. see also Chapter 7.3.

**The applicant supplied following information about wave form and sweep characteristics:**

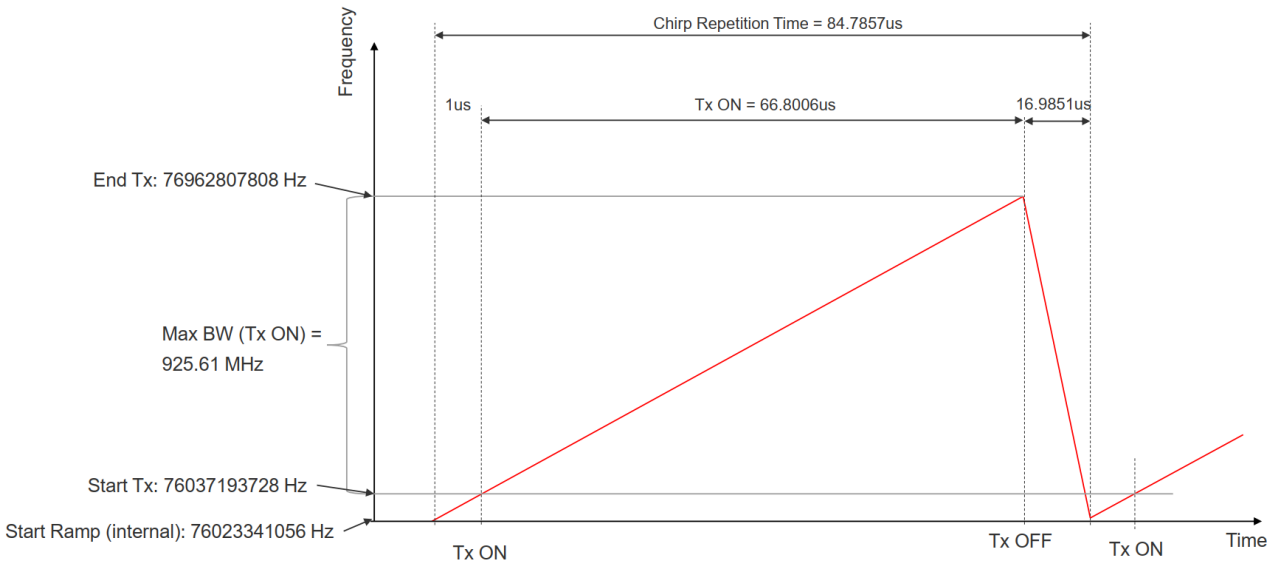
In normal operation, within one cycle, different combination of antenna are used in a sequence.

▪ Sequence 1 (Sum): Tx1 and Tx2 are ON at the same time and in phase → Peak of power is around ±40 degree from sensor boresight

▪ Sequence 2 (Delta): Tx1 and Tx2 are ON at the same time but out of phase → peak of power is at about 30 degree (for 85 degree phasenshift, front mode) and -15 degree (for 258 degree phasenshift, rear mode) from boresight.

Radar cycle: 50ms.

| Sequence (Mode for measurement) | Tx used | Number of ramps in a burst | Tx ON time [ms] | Tx ON Duty Cycle [%] |
|---|---|---|---|---|
| Normal | According to each sequence | 32 | 2.138 | 42.75 |
| Sequence 1 (Mode 1) | Tx1 and Tx2 ON at the same time and in phase | 16 | 1.069 | 21.38 |
| Sequence 2 (Mode 2) | Tx1 and Tx2 ON at the same time and out of phase | 16 | 1.069 | 21.38 |



## 7.3 Occupied bandwidth

**Test equipment (Please see Chapter 8 for exact information of test equipment)**

Radiated: A13, Cab1, Cab2, (C2), H2, M1, P1, R2

**Reference**

FCC/RSS See section 1.1.
ANSI C63.10-2013

**Limits**

See Chapter 6 in the report.

**Test procedure**

All measurements were done accoding to ANSI C63.10-2013. For spectrum analyzer settings please see plots in Annex A. For measurement set-up please see photos in Annex C.

**Results***

| Nominal conditions | | | | Verdict |
|---|---|---|---|---|
| Setup / Op. Mode / RBW** | $f_{Lowest}$, [GHz] | $f_{Highest}$, [GHz] | 99 % Occ. bandwidth [MHz] | |
| Set. 1 / Op. 1 / Tnom/ Vnom, RBW= 1 MHz | 76.03869 | 76.95558 | 916.895 | **Pass** |
| Set. 1 / Op. 1 / Tnom/ Vnom, RBW= 5 MHz | 76.03574 | 76.95784 | 922.099 | **Pass** |
| Set. 2 / Op. 2 / Tnom/ Vnom, RBW= 1 MHz | 76.0375 | 76.95501 | 917.510 | **Pass** |
| Set. 2 / Op. 2 / Tnom/ Vnom, RBW= 5 MHz | 76.03443 | 76.95743 | 923.004 | **Pass** |
| Set. 3 / Op. 2 / Tnom/ Vnom, RBW= 1 MHz | 76.03766 | 76.95588 | 918.223 | **Pass** |
| Set. 3 / Op. 2 / Tnom/ Vnom, RBW= 5 MHz | 76.03379 | 76.95824 | 924.450 | **Pass** |
| Set. 4 / Op. 1 / Tnom/ Vnom, RBW= 1 MHz | 76.0379 | 76.95544 | 917.536 | **Pass** |
| Set. 4 / Op. 1 / Tnom/ Vnom, RBW= 5 MHz | 76.03387 | 76.95769 | 923.814 | **Pass** |
| Extreme conditions | | | | |
| Set. 1 / Op. 1 Tnom/ Vmin, RBW= 1 MHz | 76.03856 | 76.95557 | 917.004 | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmin, RBW= 5 MHz | 76.03569 | 76.95787 | 922.177 | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmax, RBW= 1 MHz | 76.03857 | 76.95549 | 916.913 | **Pass** |
| Set. 1 / Op. 1 Tnom/ Vmax, RBW= 5 MHz | 76.0357 | 76.95785 | 922.141 | **Pass** |
| Set. 1 / Op. 1 Tmin/ Vnom, RBW= 1 MHz | 76.04125 | 76.95816 | 916.903 | **Pass** |
| Set. 1 / Op. 1 Tmin/ Vnom, RBW= 5 MHz | 76.03881 | 76.96051 | 921.697 | **Pass** |
| Set. 1 / Op. 1 Tmax/ Vnom, RBW= 1 MHz | 76.03746 | 76.95406 | 916.607 | **Pass** |
| Set. 1 / Op. 1 Tmax/ Vnom, RBW= 5 MHz | 76.03551 | 76.9565 | 920.988 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmin, RBW= 1 MHz | 76.03754 | 76.95598 | 918.437 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmin, RBW= 5 MHz | 76.03394 | 76.95822 | 924.276 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmax, RBW= 1 MHz | 76.03752 | 76.95590 | 918.379 | **Pass** |
| Set. 3 / Op. 2 Tnom/ Vmax, RBW= 5 MHz | 76.03383 | 76.9582 | 924.371 | **Pass** |

* Please see Annex A „Measurement plots“ for results.
** For parameter explanation please see Chapter 5.

## 7.4 Field strength of emissions (band edge)

**Test equipment (Please see Chapter 8 for exact information of test equipment)**

Radiated: A13, Cab1, Cab2, H2, M1, P1, R2

**Reference**

FCC/RSS See section 1.1.
ANSI C63.10-2013

**Limits**

See Chapter 6 in the report.

**Test procedure**

All measurements were done accoding to ANSI C63.10-2013. For spectrum analyzer settings please see plots in Annex A. For measurement set-up please see photos in Annex C.

**Results***

| Op./ Set.** | Frequency [GHz] | Detector | Test distance [m] | Level [dBm] | Limit [dBm]*** | Margin [dB] | Verdict |
|---|---|---|---|---|---|---|---|
| Op.1, Set.1, Tnom, Vnom | 75-76 | RMS | 1 | -37.25 | -30 | 7.25 | **Pass** |
| Op.1, Set.1, Tnom, Vnom | 77-78 | RMS | 1 | -39.12 | -30 | 9.12 | **Pass** |
| Op.2, Set.3, Tnom, Vnom | 75-76 | RMS | 1 | -38.17 | -30 | 8.17 | **Pass** |
| Op.2, Set.3, Tnom, Vnom | 77-78 | RMS | 1 | -39.85 | -30 | 9.85 | **Pass** |

* Please see Annex A „Measurement diagrams“ for results.
** For parameter explanation please see Chapter 5.
*** Worst case.

## 7.5 Radiated field strength of emissions

| |
|---|
| **Test equipment (Please see Chapter 8 for exact information of test equipment)** |
| **Frequency range 9 kHz – 30 MHz** |
| Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex C) |
| Radiated: A1, C1, M1, P1, R1 |
| |
| **Frequency range 30 MHz – 1 GHz** |
| Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex C) |
| Radiated: A2, C1, M1, P1, R1 |
| |
| **Frequency range 1 GHz – 8 GHz** |
| Measurement in a fully anechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex C) |
| Radiated: A3, Amp1, C1, M1, P1, R1 |
| |
| **Frequency range 8 GHz – 12.4 GHz** |
| Measurement in a fully anechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex C) |
| Radiated: A3, Amp1, C1, M1, P1, R1 |
| |
| **Frequency range 12.4 GHz – 18 GHz** |
| Measurement in a fully anechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex C) |
| Radiated: A8, Amp1, C1, M1, P1, R1 |
| |
| **Frequency range 18 GHz – 26.5 GHz** |
| Measurement distance- 0.5 m |
| Radiated: A9, Cab3, M1, P1, R2 |
| |
| **Frequency range 26.5 GHz – 40 GHz** |
| Measurement distance- 0.5 m |
| Radiated: A10, Cab3, M1, P1, R2 |
| |
| **Frequency range 40 GHz – 50 GHz** |
| Measurement distance- 0.42 m |
| Radiated: A11, Cab3, M1, P1, R2 |
| |
| **Frequency range 40 GHz – 50 GHz** |
| Measurement distance- 0.42 m |
| Radiated: A11, Cab3, M1, P1, R2 |
| |
| **Frequency range 50 GHz – 60 GHz** |
| Measurement distance- 0.14 m |
| Radiated: A12, Cab1, Cab2, H1, M1, P1, R2 |
| |

| |
|---|
| **Frequency range 60 GHz – 84 GHz** |
| Measurement distance- 0.5 m |
| Radiated: A13, Cab1, Cab2, H2, M1, P1, R2 |
| |
| **Frequency range 84 GHz – 110 GHz** |
| Measurement distance- 0.11 m |
| Radiated: A14, Cab1, Cab2, F1, H3, M1, P1, R2 |
| |
| **Frequency range 110 GHz – 170 GHz** |
| Measurement distance- 0.11 m |
| Radiated: A15, Cab1, Cab2, H4, M1, P1, R2 |
| |
| **Frequency range 170 GHz – 220 GHz** |
| Measurement distance- 0.11 m |
| Radiated: A16, Cab1, Cab2, H5, M1, P1, R2 |
| |
| **Frequency range 220 GHz – 330 GHz** |
| Measurement distance- 0.11 m |
| Radiated: A17, Cab1, Cab2, H6, M1, P1, R2 |
| |
| **Test procedure**<br>All measurements were done accoding to ANSI C63.10-2013. For spectrum analyzer settings please see plots in Annex A. For measurement set-up please see photos in Annex C. |
| |
| **Limits below 40 GHz**<br>According to FCC 15.209: |

| **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 |

* Correction factor used due to measurement distance of 3 m

**Limits above 40 GHz**

| | | |
|---|---|---|
| Limits, EIRP in dBm | FCC §95.3379 (a) | 40 GHz – 200 GHz: 600 pW/cm$^2$ ~ -1.7 dBm<br>200 GHz – 231 GHz: 1000 pW/cm$^2$ ~ 0.5 dBm |
| | RSS-251 (Section 10) | 40 GHz – 162 GHz*: -30 dBm<br>Here 73.5 GHz – 76 GHz:<br>0 dBm |
| Limit conversion (pW/cm$^2$ to dBm ): | P[dBm]=10*log(4*pi*d$^2$*P[W/m$^2$])<br>d- distance of the limit defined in W/m$^2$. Here: 3 m.<br>---<br>600 pW/cm$^2$: P[dBW]=10*log(4*pi*(3m)$^2$*6*10$^{-6}$W/m$^2$)<br>600 pW/cm$^2$: P[dBW]= -31.7 dBW<br>P[dBm] = P[dBW] + 30<br>600 pW/cm$^2$: P[dBm]= -31.7 dBW + 30 | |

| | |
|---|---|
| | 600 pW/cm$^2$: P[dBm]= -1.7 dBm<br>----------<br>1000 pW/cm$^2$: P[dBW]=10*log(4*pi*(3m)$^2$*1*10$^{-5}$W/m$^2$)<br>1000 pW/cm$^2$: P[dBW]= -29.5 dBW<br>P[dBm] = P[dBW] + 30<br>1000 pW/cm$^2$: P[dBm]= -29.5 dBW + 30<br>1000 pW/cm$^2$: P[dBm]= +0.5 dBm |

**Calculation of the boundary near/far field:**
The aperture dimensions of the antenna shall be small enough so that the measurement distance in m is equal to or greater than the Rayleigh (**far-field**) distance (i.e., $R_m = 2D^2 / \lambda$), where $D$ is the largest dimension of the antenna aperture in m and $\lambda$ is the free-space wavelength in m at the frequency of measurement.

| Antenna name | Antenna frequency range, [GHz] | D, [m] | Highest frequency in the measurement, [GHz] | Boundary for near/far field, [m] |
|---|---|---|---|---|
| 20240-20 | 17.6-26.7 | 0.052 | 26.5 | 0.48 |
| 22240-20 | 26.4-40.1 | 0.0342 | 40 | 0.31 |
| 23240-20 | 33-50.1 | 0.028 | 50 | 0.26 |
| 25240-20 | 49.9-75.8 | 0.0185 | 60 | 0.14 |
| 26240-20 | 60.5-91.5 | 0.015 | 90 | 0.14 |
| 27240-20 | 73.8-114 | 0.0124 | 110 | 0.11 |
| 29240-20 | 114-173 | 0.0085 | 170 | 0.08 |
| 30240-20 | 145-220 | 0.0068 | 220 | 0.07 |
| 32240-20 | 217-330 | 0.000446 | 243 | 0.000322 |

**Results***

| Op./ Set. | Frequency, [GHz] | Test distance [m] | Level [dBµV/m/ dBm] | Limit [dBµV/m/ dBm] | Margin [dB] | Verdict |
|---|---|---|---|---|---|---|
| Op.1, Set.1, ANT HOR | 0.000009 – 0.03 | 3 | 20.79 | 29.54 | 8.75 | **Pass** |
| Op.1, Set.1, ANT VER | 0.000009 – 0.03 | 3 | 20.75 | 29.54 | 8.79 | **Pass** |
| Op.1, Set.1 | 0.03-1 | 3 | 38.97 | 54 | 15.03 | **Pass** |
| Op.1, Set.1 | 1-8 | 3 | 48.24 | 54 | 5.74 | **Pass** |
| Op.1, Set.1 | 8-12.4 | 3 | 48.26 | 54 | 7.27 | **Pass** |
| Op.1, Set.1 | 12.4-18 | 1 | 46.73 | 54 | 7.27 | **Pass** |
| Op.1, Set.1 | 18-26.5 | 0.5 | 38.48 | 54 | 15.52 | **Pass** |
| Op.1, Set.1 | 26.5-40 | 0.5 | 45.09 | 54 | 8.91 | **Pass** |
| Op.1, Set.1 | 40-50 | 0.42 | -42.61 | -30 / -1.7 | 12.61 | **Pass** |
| Op.1, Set.1 | 50-60 | 0.14 | -45.2 | -30 / -1.7 | 15.2 | **Pass** |
| Op.1, Set.1 | 60-75 | 0.5 | -32.02 | -30 / -1.7 | 2.02 | **Pass** |
| Op.1, Set.1 | 75-76 | 1 | -37.25 | -30 / -1.7 | 7.25 | **Pass** |
| Op.1, Set.1 | 77-78 | 1 | -39.12 | -30 / -1.7 | 9.12 | **Pass** |
| Op.1, Set.1 | 78-84 | 0.5 | -31.37 | -30 / -1.7 | 1.37 | **Pass** |
| Op.1, Set.1 | 90-110 | 0.11 | -35.26 | -30 / -1.7 | 5.26 | **Pass** |
| Op.1, Set.1 | 110-170 | 0.11 | -34.96 | -30 / -1.7 | 4.96 | **Pass** |
| Op.1, Set.1 | 170-220 | 0.11 | -21.24 | -1.7 / 0.5 | 19.54 | **Pass** |
| Op.1, Set.1 | 220-325 | 0.11 | -18.23 | 0.5 | 18.73 | **Pass** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Op.2, Set.3, ANT HOR | 0.000009 – 0.03 | 3 | 20.34 | 29.54 | 9.2 | **Pass** |
| Op.2, Set.3, ANT VER | 0.000009 – 0.03 | 3 | 20.94 | 29.54 | 8.6 | **Pass** |
| Op.2, Set.3 | 0.03-1 | 3 | 38.99 | 54 | 15.01 | **Pass** |
| Op.2, Set.3 | 1-8 | 3 | 48.45 | 54 | 5.55 | **Pass** |
| Op.2, Set.3 | 8-12.4 | 3 | 48.12 | 54 | 5.88 | **Pass** |
| Op.2, Set.3 | 12.4-18 | 1 | 51.83 | 54 | 2.17 | **Pass** |
| Op.2, Set.3 | 18-26.5 | 0.5 | 38.21 | 54 | 15.79 | **Pass** |
| Op.2, Set.3 | 26.5-40 | 0.5 | 44.66 | 54 | 9.34 | **Pass** |
| Op.2, Set.3 | 40-50 | 0.42 | -41.63 | -30 / -1.7 | 11.63 | **Pass** |
| Op.2, Set.3 | 50-60 | 0.14 | -42.26 | -30 / -1.7 | 12.26 | **Pass** |
| Op.2, Set.3 | 60-75 | 0.5 | -33.93 | -30 / -1.7 | 3.93 | **Pass** |
| Op.2, Set.3 | 75-76 | 1 | -38.17 | -30 / -1.7 | 8.17 | **Pass** |
| Op.2, Set.3 | 77-78 | 1 | -39.85 | -30 / -1.7 | 9.85 | **Pass** |
| Op.2, Set.3 | 78-84 | 0.5 | -35.02 | -30 / -1.7 | 5.02 | **Pass** |
| Op.2, Set.3 | 84-110 | 0.11 | -33.97 | -30 / -1.7 | 3.97 | **Pass** |
| Op.2, Set.3 | 110-170 | 0.11 | -34.05 | -30 / -1.7 | 4.05 | **Pass** |
| Op.2, Set.3 | 170-220 | 0.11 | -21.84 | -1.7 / 0.5 | 20.14 | **Pass** |
| Op.2, Set.3 | 220-325 | 0.11 | -17.82 | 0.5 | 18.32 | **Pass** |
| All Readings are Peak detector. The average measurement was not performed when peak measured data was under the limit of average detection. | | | | | | |

## 7.6 Frequency stability

**Test equipment (Please see Chapter 8 for exact information of test equipment)**

Radiated: A13, Cab1, Cab2, C2, H2, M1, P1, R2

**Reference**

FCC/RSS See section 1.1.
ANSI C63.10-2013

**Limits**

See Chapter 6 in the report.

**Test procedure**

All measurements were done accoding ANSIC63.10-2013. Measurement distance- 1 m. For spectrum analyser settings please see plots in Annex A. For measurement set-up please see photos in Annex C.

| Conditions No | Temperature [°C] | Voltage [V] |
|---|---|---|
| 1 | Nominal* | Nominal* |
| 2 | Nominal* | $V_{min}$* |
| 3 | Nominal* | $V_{max}$* |
| 4 | $T_{min}$* | Nominal* |
| 5 | -30 | Nominal* |
| 6 | -20 | Nominal* |
| 7 | -10 | Nominal* |
| 8 | 0 | Nominal* |
| 9 | 10 | Nominal* |
| 10 | 20 | Nominal* |
| 11 | 30 | Nominal* |
| 12 | 40 | Nominal* |
| 13 | 50 | Nominal* |
| 14 | 60 | Nominal* |
| 15 | 70 | Nominal* |
| 16 | 80 | Nominal* |
| 17 | $T_{max}$* | Nominal* |

* Please see Chapter 5 for parameter explanation.

**Results**

| Nominal conditions | | | |
|---|---|---|---|
| Setup / Op. Mode: | $f_{Lowest}$, [GHz] | $f_{Highest}$, [GHz] | Verdict |
| Set. 1 / Op. 1 / 1 m / EUT A, RBW= 1 MHz | 76.03869 | 76.95558 | **Pass** |
| Set. 3 / Op. 2 / TnomVnom, RBW= 1 MHz | 76.03766 | 76.95588 | |
| Extreme conditions | | | |
| Set. 1/ Op. 1/ Tmax/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03746 | 76.95406 | **Pass** |
| Set. 1/ Op. 1/ T80°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03784 | 76.95464 | **Pass** |
| Set. 1/ Op. 1/ T70°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03761 | 76.95447 | **Pass** |
| Set. 1/ Op. 1/ T60°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03732 | 76.95447 | **Pass** |
| Set. 1/ Op. 1/ T50°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03737 | 76.95459 | **Pass** |

| | | | |
|---|---|---|---|
| Set. 1/ Op. 1/ T40°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03841 | 76.95517 | **Pass** |
| Set. 1/ Op. 1/ T30°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03882 | 76.95555 | **Pass** |
| Set. 1/ Op. 1/ Tnom/ Vmin/ EUT A/ 1m, RBW= 1 MHz | 76.03856 | 76.95557 | **Pass** |
| Set. 1/ Op. 1/ Tnom/ Vmax/ EUT A/ 1m, RBW= 1 MHz | 76.03857 | 76.95549 | **Pass** |
| Set. 1/ Op. 1/ T10°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03912 | 76.95596 | **Pass** |
| Set. 1/ Op. 1/ T0°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03922 | 76.95628 | **Pass** |
| Set. 1/ Op. 1/ T-10°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.03906 | 76.95612 | **Pass** |
| Set. 1/ Op. 1/ T-20°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.04043 | 76.95906 | **Pass** |
| Set. 1/ Op. 1/ T-30°C/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.04037 | 76.95840 | **Pass** |
| Set. 1/ Op. 1/ Tmin/ Vnom/ EUT A/ 1m, RBW= 1 MHz | 76.04125 | 76.95816 | **Pass** |
| Set. 3/ Op. 2/ Tnom/ Vmin/ EUT A/ 1m, RBW= 1 MHz | 76.03754 | 76.95598 | **Pass** |
| Set. 3/ Op. 2/ Tnom/ Vmax/ EUT A/ 1m, RBW= 1 MHz | 76.03752 | 76.95590 | **Pass** |

**Remark**: For graphical results for conditions No 1, 2, 3, 4, 13 (see table above) pls. see annex A to this test report (Power density with Peak Detector). The operating frequency was observed at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT was energized. There were no essential changes in operating frequency. So only one pair of values was recorded for each specified temperature.

# 8 MEASUREMENT EQUIPMENT

| No | Equipment | Type | Manufacturer | Serial No. | Int. No. | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|
| **Antennas** (**A**): | | | | | | | |
| 1. | Active Loop Antenna | HFH2-Z2E | Rohde & Schwarz | 100108 | LAB000150 | 2020-03-25 | 2021-03-25 |
| 2. | Ultrabroadband antenna | HL562E | Rohde & Schwarz | 102005 | LAB000150 | 2020-07-05 | 2021-07-05 |
| 3. | Double-Ridged Waveguide Horn Antenna | HF-907 | Rohde & Schwarz | 102899 | LAB000151 | 2020-04-23 | 2021-04-23 |
| 4. | Rod Antenna | - | - | - | LAB000290 | - | - |
| 5. | Horn Antenna (2.6 GHz – 3.95 GHz) | PE9863/SF-10 | Pasternack | - | LAB000312 | 2021-01-13 | - |
| 6. | Horn Antenna (3.95 GHz – 5.85 GHz) | PE9861/SF-10 | Pasternack | - | LAB000264 | 2020-09-29 | - |
| 7. | Horn Antenna (10 GHz – 15 GHz) | PE9855 SF-20 | Pasternack | - | LAB000263 | 2020-09-29 | - |
| 8. | Horn Antenna (12.4 GHz – 18 GHz) | 62-HA20-A-SMF | TTE Europe | - | LAB000282 | 2020-09-29 | - |
| 9. | Horn Antenna (17.6 GHz – 26.7 GHz) | 20240-20 | Flann Microwave Ltd | 266402 | LAB000127 | 2020-06-29 | - |
| 10. | Horn Antenna (26.4 GHz – 40.1 GHz) | 22240-20 | Flann Microwave Ltd | 270447 | LAB000129 | 2020-06-29 | - |
| 11. | Horn Antenna (33 GHz – 50.1 GHz) | 23240-20 | Flann Microwave Ltd | 273430 | LAB000132 | 2020-07-01 | - |
| 12. | Horn Antenna (49.9 GHz – 75.8 GHz) | 25240-20 | Flann Microwave Ltd | 272860 | LAB000133 | 2020-07-01 | - |
| 13. | Horn Antenna (60.5 GHz – 91.5 GHz) | 26240-20 | Flann Microwave Ltd | 273417 | LAB000135 | 2020-07-01 | - |
| 14. | Horn Antenna (73.8 GHz – 114 GHz) | 27240-20 | Flann Microwave Ltd | 273368 | LAB000138 | 2020-07-01 | - |
| 15. | Horn Antenna (114 GHz – 173 GHz) | 29240-20 | Flann Microwave Ltd | 273382 | LAB000139 | 2020-07-01 | - |
| 16. | Horn Antenna (145 GHz – 220 GHz) | 30240-20 | Flann Microwave Ltd | 273390 | LAB000178 | 2020-08-01 | - |
| 17. | Horn Antenna (217 GHz – 330 GHz) | 32240-20 | Flann Microwave Ltd | 273469 | LAB000152 | 2020-08-01 | - |
| **Amplifiers** (**Amp**): | | | | | | | |
| 1. | Pre-Amplifier | BBV 9718 C | Schwarzbeck Mess-Elektronik OHG | 84 | LAB000169 | - | - |
| 2. | Low noise amplifier | BZ-01000900-111550-202320 | B&Z Technologies | 24336 | LAB000296 | - | - |
| 3. | Low noise amplifier | BZ-08001800-180855-202020 | B&Z Technologies | 22105 | LAB000297 | - | - |
| 4. | Low noise amplifier | BZ-18004000-270845-252525 | B&Z Technologies | 22449 | LAB000298 | - | - |
| **RF Cables** (**Cab**): | | | | | | | |
| 1. | Coaxial cable | LU7-022-1000 | Rosenberger | 33 | LAB000153 | - | - |
| 2. | Coaxial cable | LU7-022-1000 | Rosenberger | 34 | LAB000153 | - | - |
| 3. | Coaxial cable | SF101/1.5m | Huber & Suhner | 503987/1 | LAB000165 | - | - |
| **Chambers** (**C**): | | | | | | | |
| 1. | Semi/Fully Anecoic Chamber | SAC5 | Albatross Projects GmbH | 20168.PRB | LAB000235 | 2020-06-24 | 2021-06-24 |
| 2. | Climatic chamber | T-65/50 | CTS GmbH | 204002 | LAB000110 | 2020-06-01 | 2021-06-01 |
| 3. | Shielding Cover | CMU-Z11 | Rohde & Schwarz | 100876 | LAB000039 | - | - |
| **Filter** (**F**): | | | | | | | |
| 1. | High-pass filter (84 GHz – 110 GHz) | 10-WHPF-84.5-UG387 | TTE | - | LAB000299 | - | - |
| **Harmonic mixers** (**H**): | | | | | | | |

| No | Equipment | Type | Manufacturer | Serial No. | Int. No. | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|
| 1. | Harmonic Mixer | FS-Z75 | Rohde & Schwarz | 102015 | LAB000112 | 2020-03-26 | 2021-03-26 |
| 2. | Harmonic Mixer | FS-Z90 | Rohde & Schwarz | 102020 | LAB000113 | 2020-03-25 | 2021-03-25 |
| 3. | Harmonic Mixer | FS-Z110 | Rohde & Schwarz | 102000 | LAB000114 | 2020-03-26 | 2021-03-26 |
| 4. | Harmonic Mixer | FS-Z170 | Rohde & Schwarz | 100996 | LAB000126 | 2019-11-11 | 2020-11-11 |
| 5. | Harmonic Mixer | FS-Z220 | Rohde & Schwarz | 101039 | LAB000116 | 2020-03-23 | 2021-03-23 |
| 6. | Harmonic Mixer | FS-Z325 | Rohde & Schwarz | 101015 | LAB000117 | 2020-06-18 | 2021-06-18 |
| **Multimeters** (**M**): | | | | | | | |
| 1. | Multimeter | U1242B | Keysight | MY59240021 | LAB000187 | 2020-06-24 | 2021-06-24 |
| 2. | Multimeter | U1242B | Keysight | MY59160026 | LAB000018 | 2020-06-24 | 2021-06-24 |
| **Power Supply** (**P**): | | | | | | | |
| 1. | Power Supply | PS 2042-10 B | Elektro-Automatic GmbH | 2878350263 | LAB000190 | - | - |
| 2. | Power Supply | E3640A | Agilent | MY40005693 | LAB000036 | - | - |
| **Receivers and Spectrumanalyzers** (**R**): | | | | | | | |
| 1. | Test Receiver | ESW-26 | Rohde & Schwarz | 101481 | LAB000236 | 2020-06-03 | 2021-06-03 |
| 2. | Spectrum Analyzer 2 Hz – 50 GHz | FSW-50 | Rohde & Schwarz | 101450 | LAB000111 | 2020-05-05 | 2021-05-05 |

# 9 MEASUREMENT UNCERTAINTIES

| Test case | Measurement uncertainty* |
|---|---|
| Power Output radiated | ≤ ± 6 dB |
| Radiated emissions of transmitters | ≤ ± 6 dB |
| Frequency measurements | ± 100 kHz |
| DC and low frequency voltages | ± 3 % |
| Temperature | ± 1 °C |

The expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 %.

## END OF TEST REPORT

# Annex A

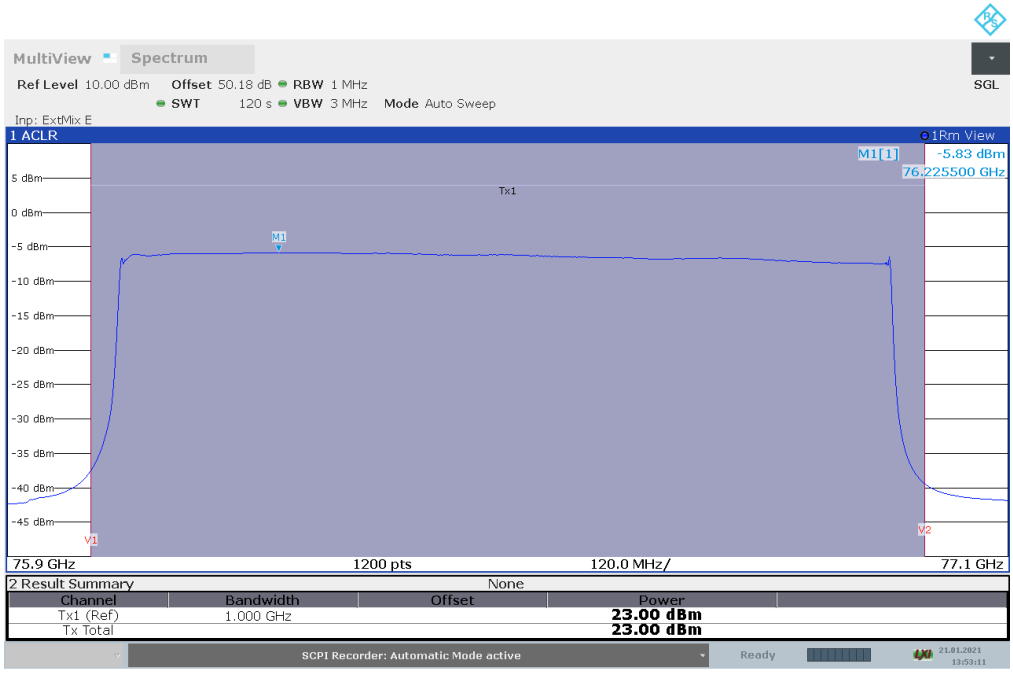
Measurement plots

part of / in addition to

***Test report no.:*** 20084422-18460-2

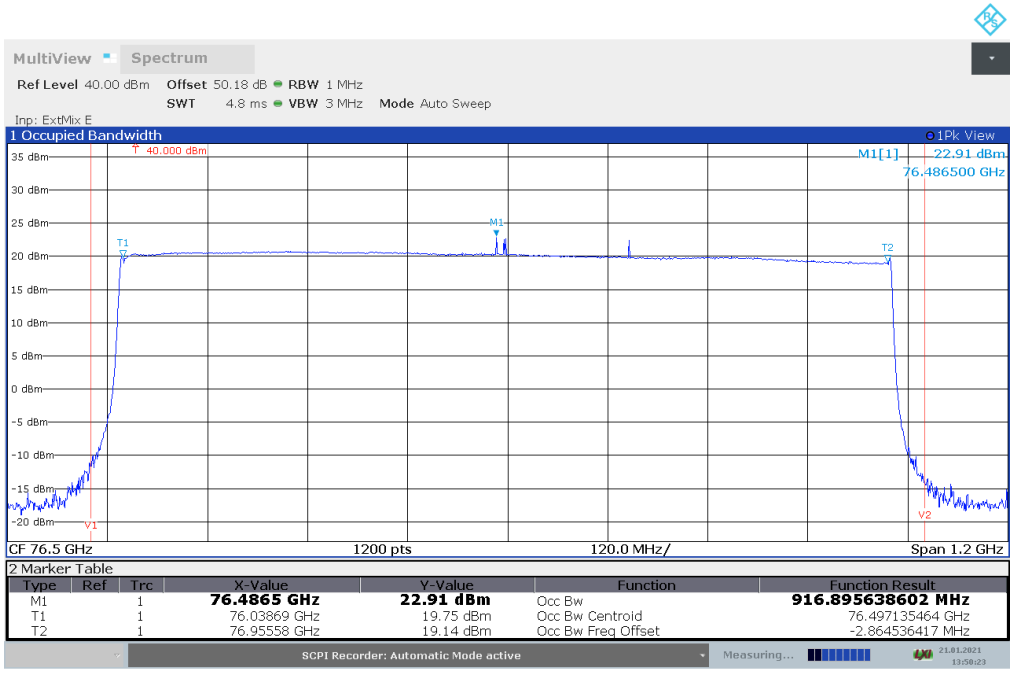
**Table of contents:**

# 1 The maximum peak power EIRP / peak EIRP spectral density. The maximum power EIRP/ average EIRP



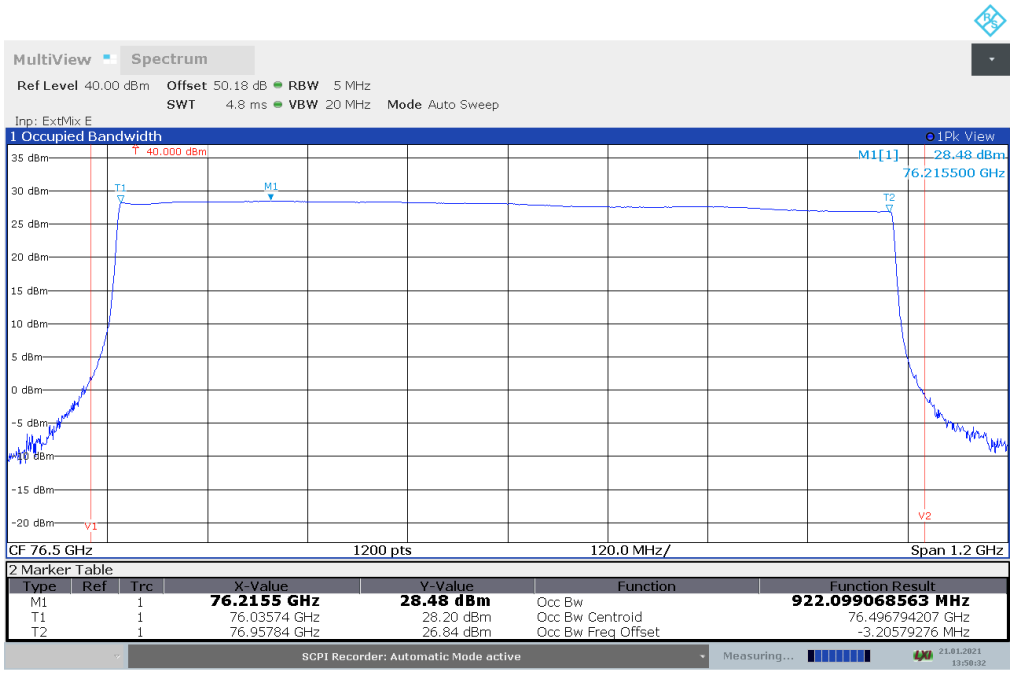

13:53:11 21.01.2021

## 1.1 RMS Detector, Set-up 1, $T_{nom}/V_{nom}$

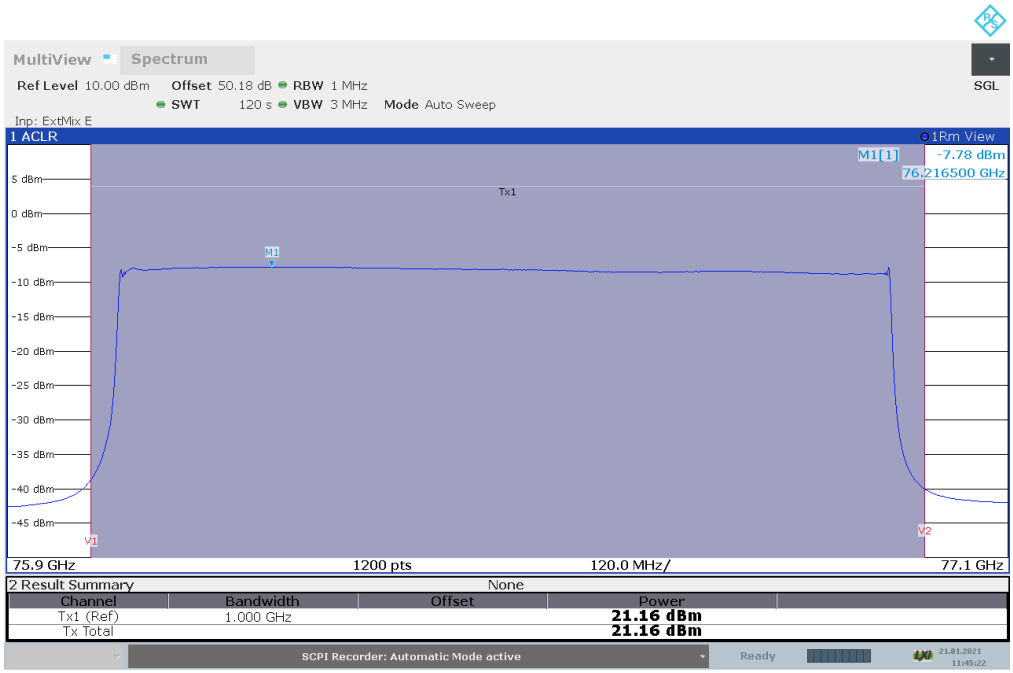



13:50:23 21.01.2021

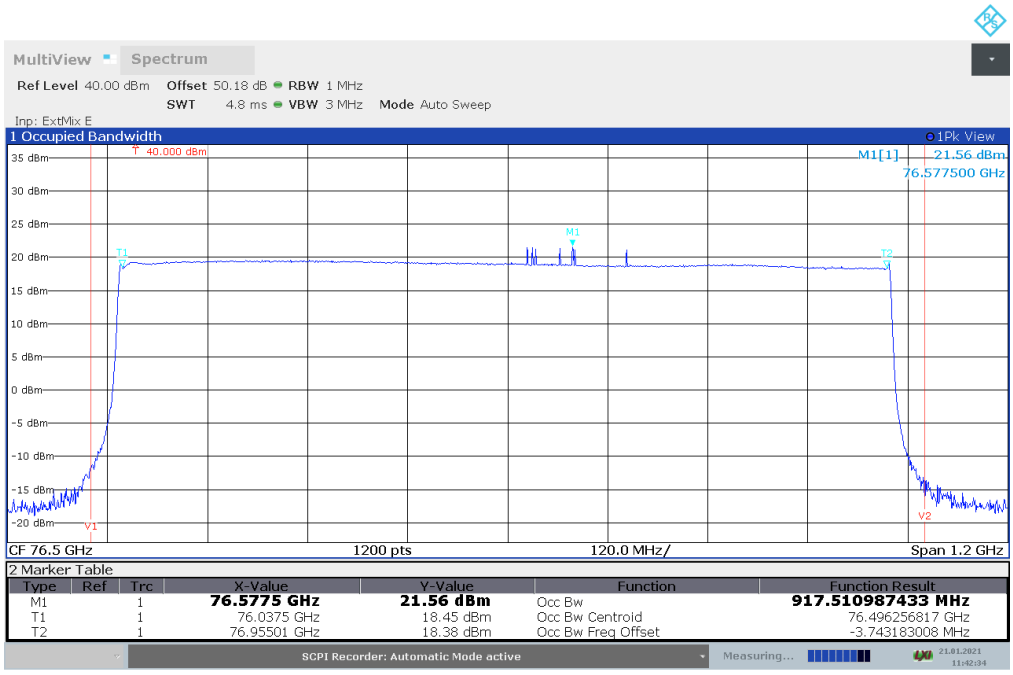
## 1.2 Peak Detector, Set-up 1, RBW=1 MHz, $T_{nom}/V_{nom}$




## 1.3 Peak Detector, Set-up 1, RBW=5 MHz, $T_{nom}/V_{nom}$

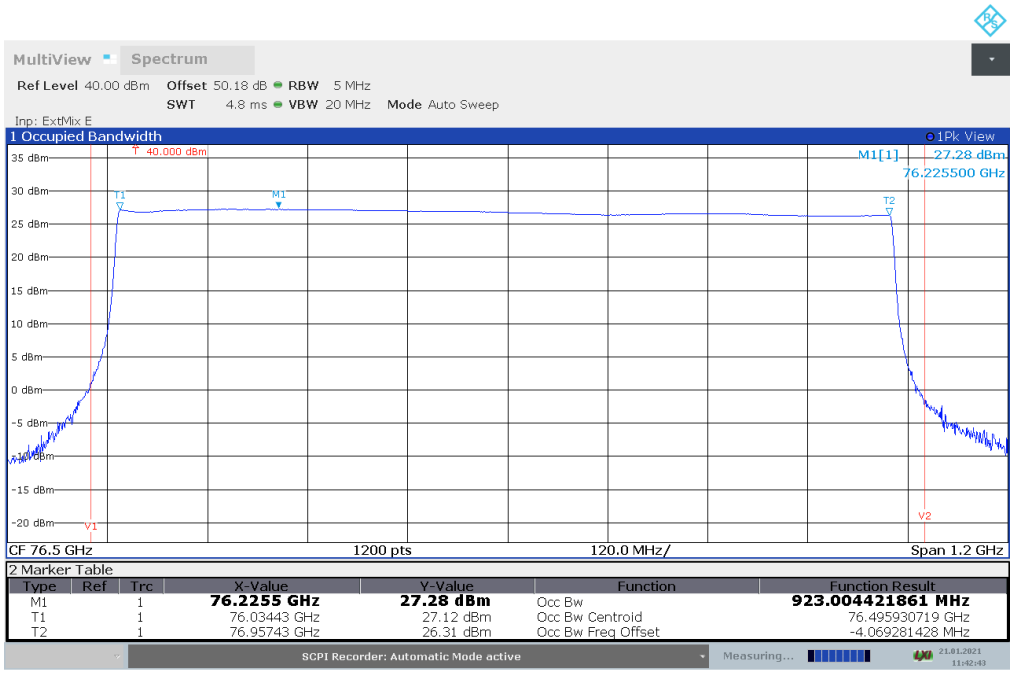



## 1.4 RMS Detector, Set-up 2, $T_{nom}/V_{nom}$



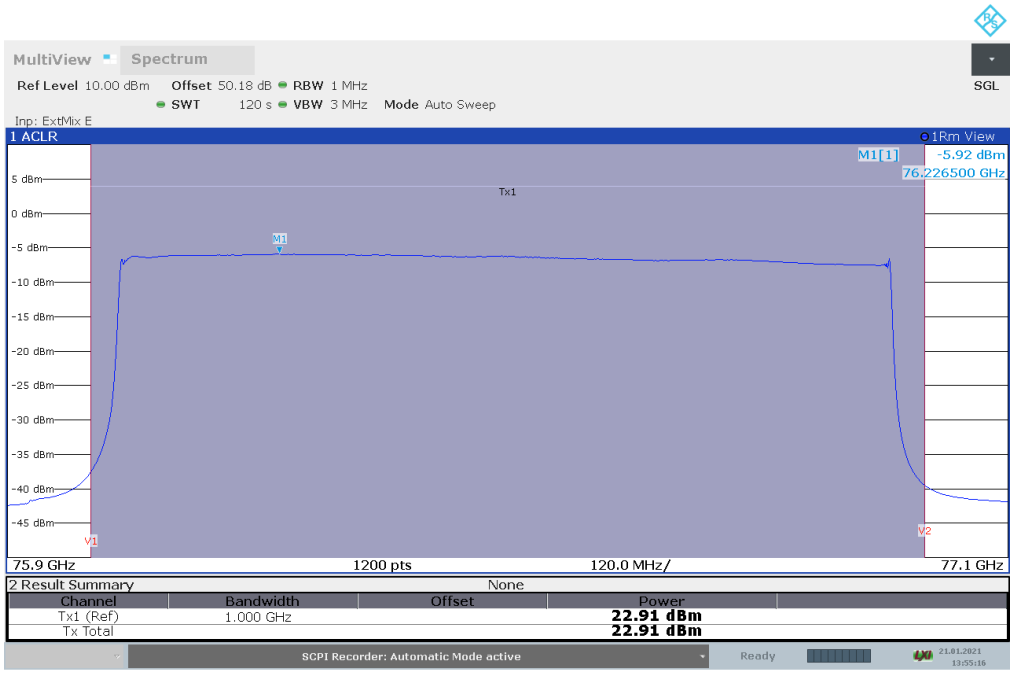

11:42:35 21.01.2021

## 1.5 Peak Detector, Set-up 2, RBW=1 MHz, $T_{nom}/V_{nom}$



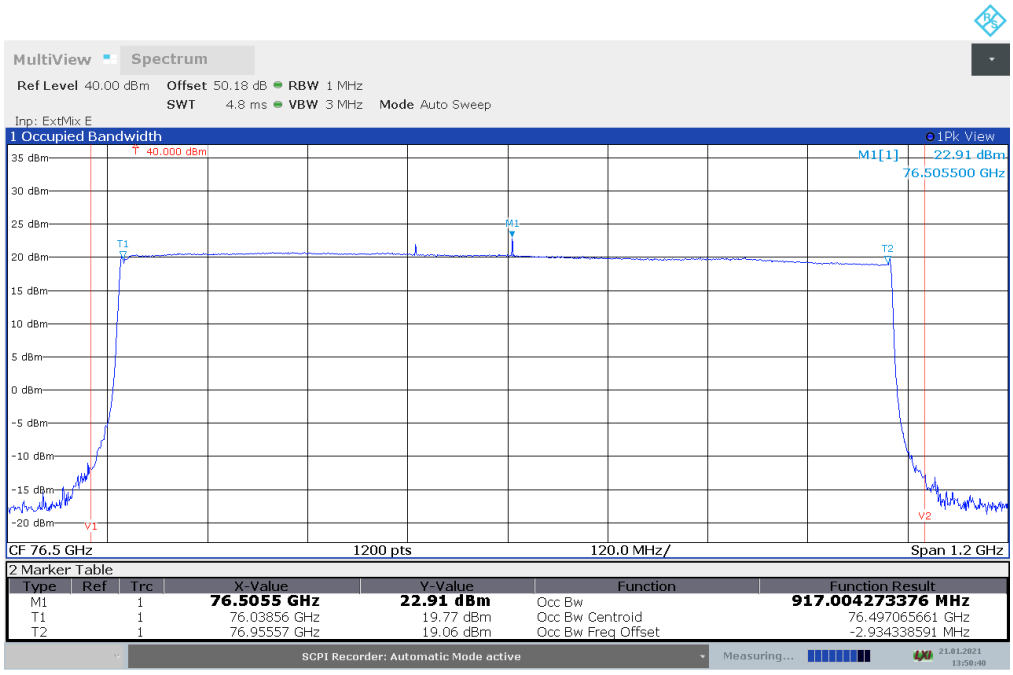

11:42:43 21.01.2021

## 1.6 Peak Detector, Set-up 2, RBW=5 MHz, $T_{nom}/V_{nom}$



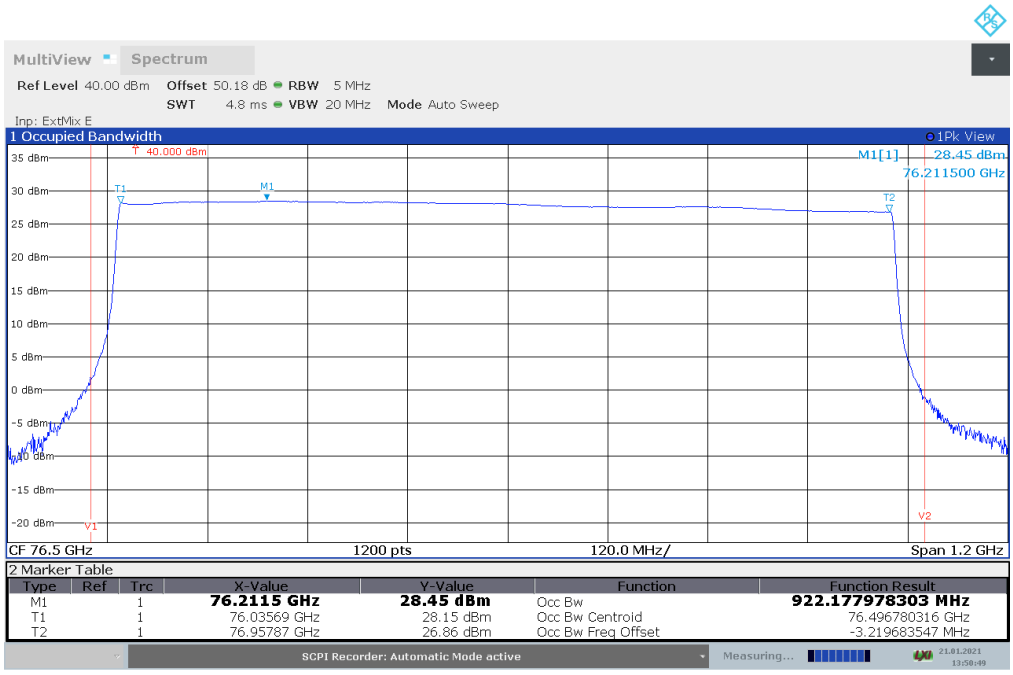

13:55:16 21.01.2021

## 1.7 RMS Detector, Set-up 1, $T_{nom}/V_{min}$

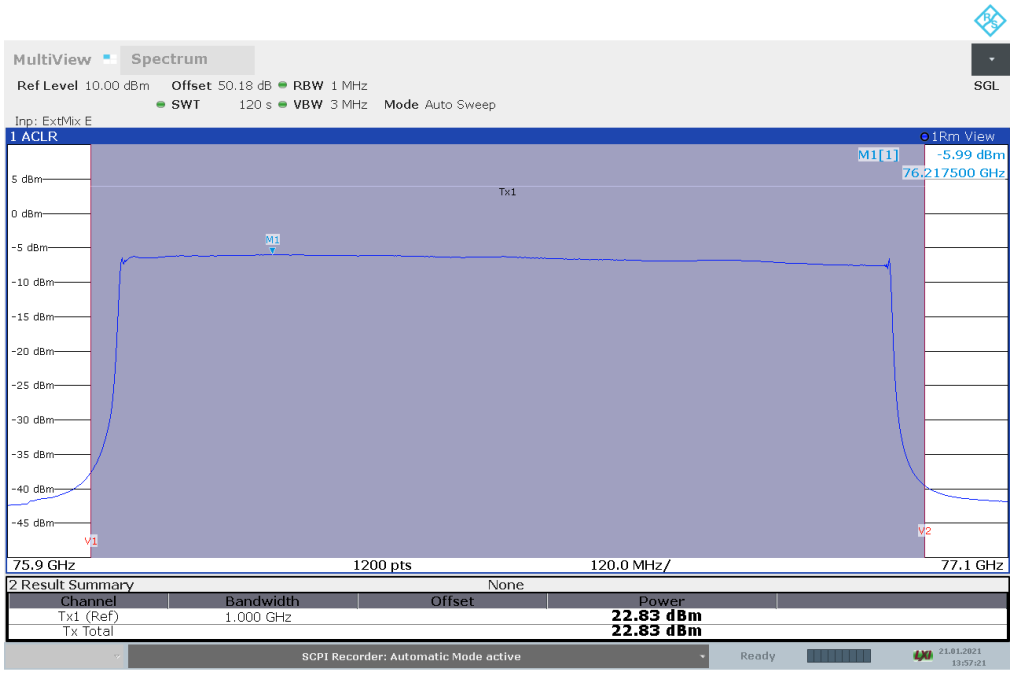



13:50:40 21.01.2021

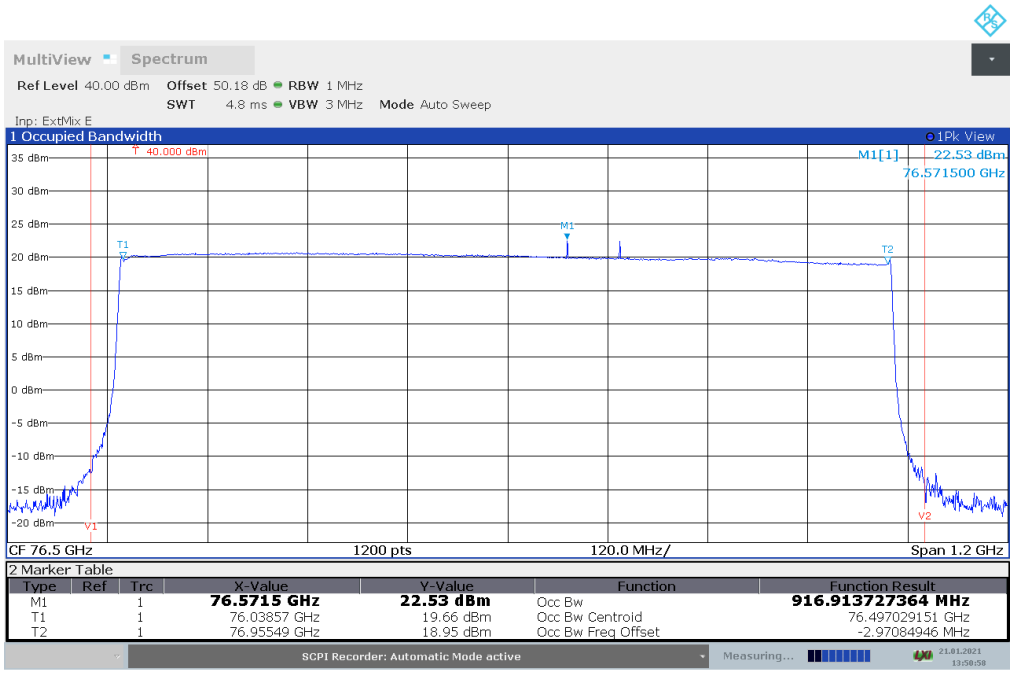
## 1.8 Peak Detector, Set-up 1, RBW=1 MHz, $T_{nom}/V_{min}$




## 1.9 Peak Detector, Set-up 1, RBW=5 MHz, $T_{nom}/V_{min}$

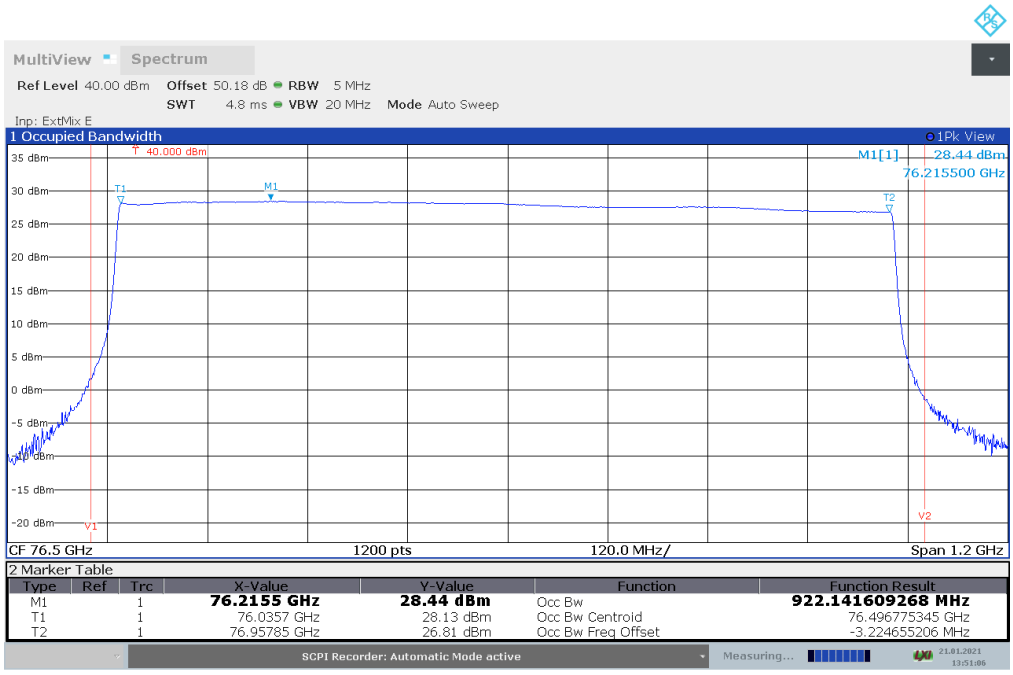



## 1.10 RMS Detector, Set-up 1, $T_{nom}/V_{max}$



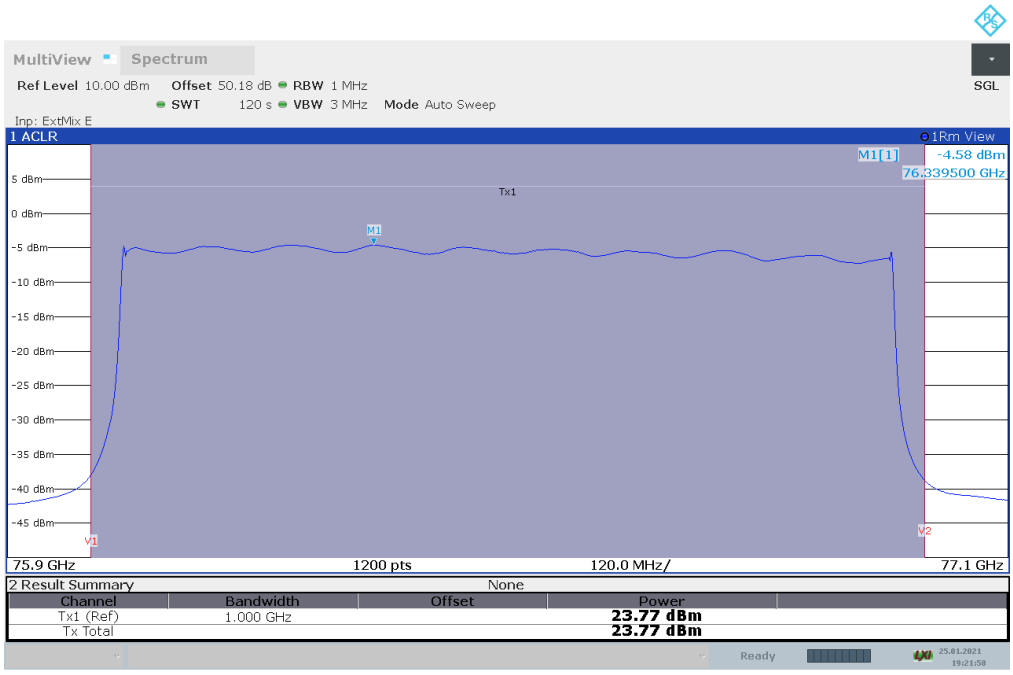

13:50:58 21.01.2021

## 1.11 Peak Detector, Set-up 1, RBW=1 MHz, $T_{nom}/V_{max}$



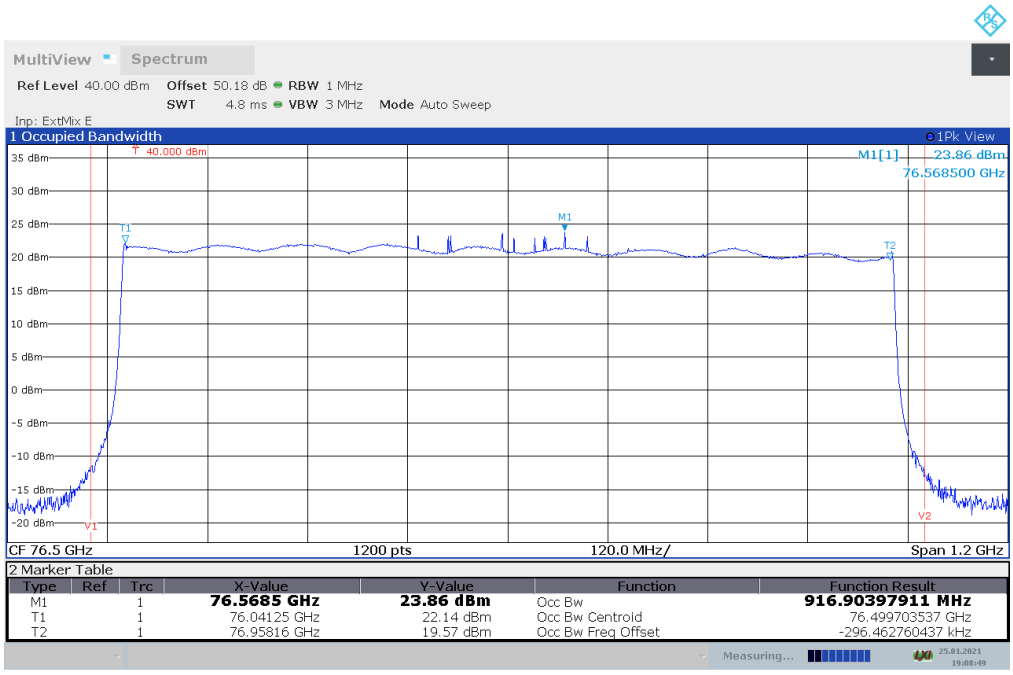

13:51:06 21.01.2021

## 1.12 Peak Detector, Set-up 1, RBW=5 MHz, $T_{nom}/V_{max}$



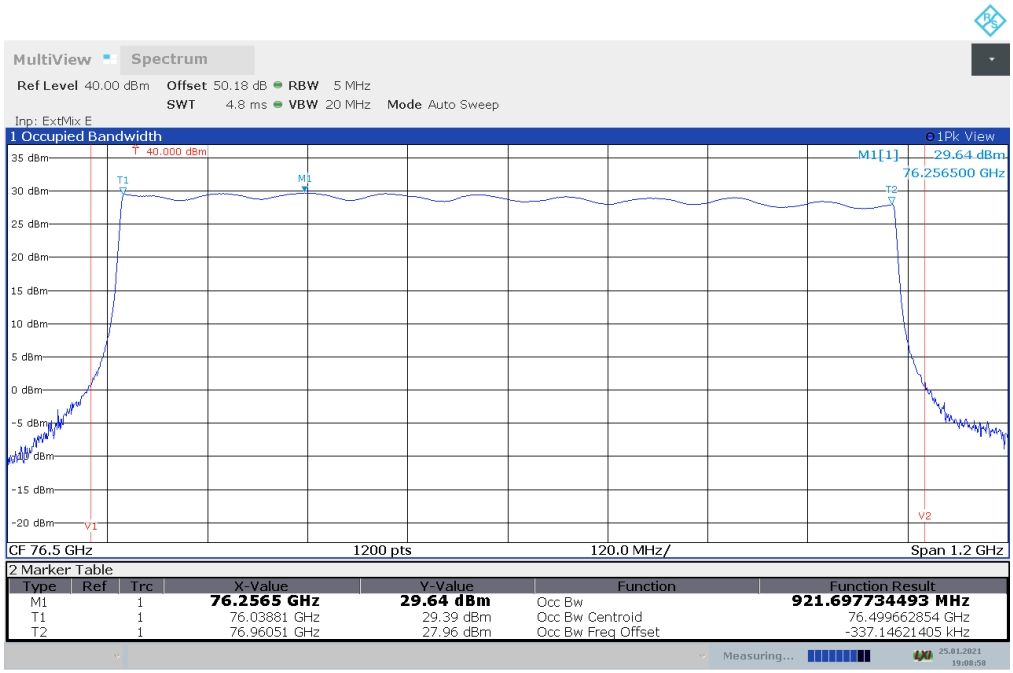

19:21:58 25.01.2021

## 1.13 RMS Detector, Set-up 1, $T_{min}/V_{nom}$

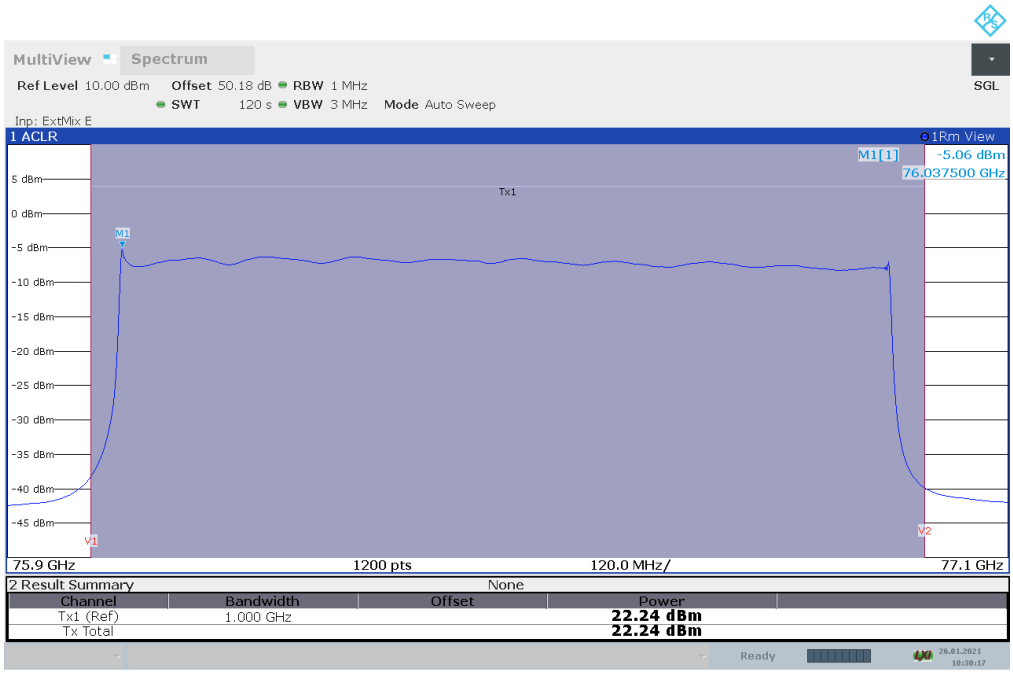



19:08:49 25.01.2021

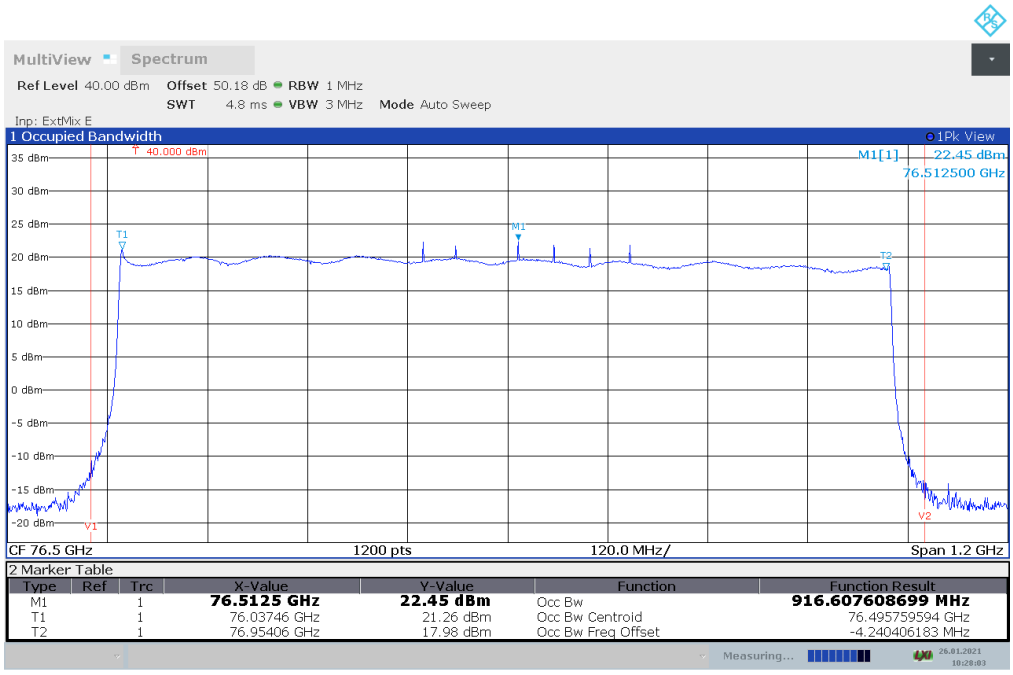
## 1.14 Peak Detector, Set-up 1, RBW=1 MHz, $T_{min}/V_{nom}$



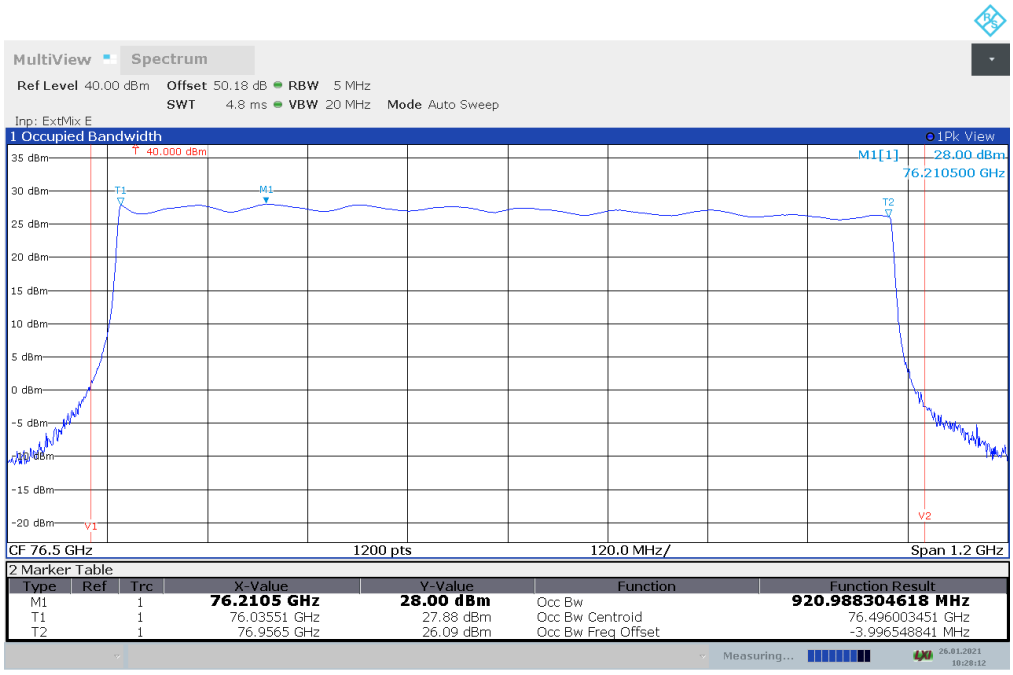

## 1.15 Peak Detector, Set-up 1, RBW=5 MHz, $T_{min}/V_{nom}$



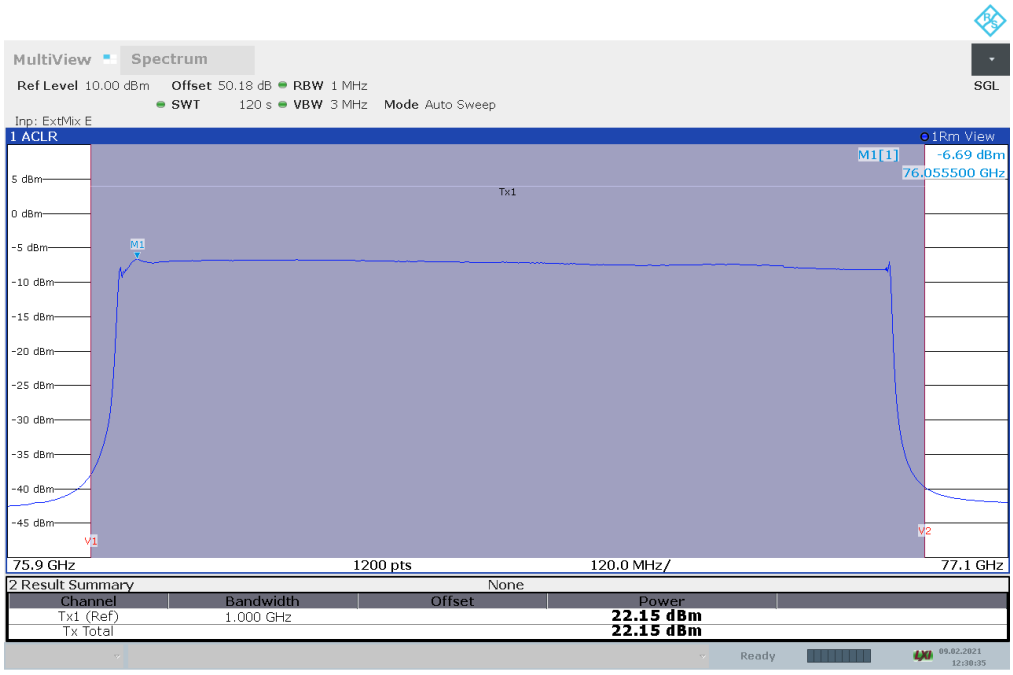

## 1.16 RMS Detector, Set-up 1, $T_{max}/V_{nom}$




## 1.17 Peak Detector, Set-up 1, RBW=1 MHz, $T_{max}/V_{nom}$

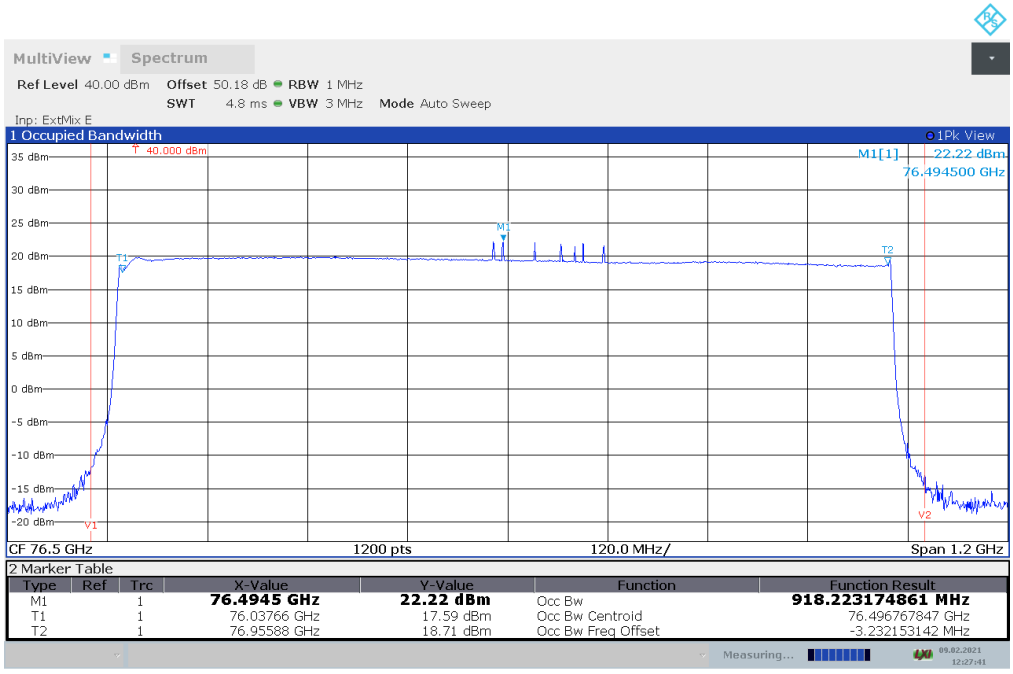



## 1.18 Peak Detector, Set-up 1, RBW=5 MHz, $T_{max}/V_{nom}$



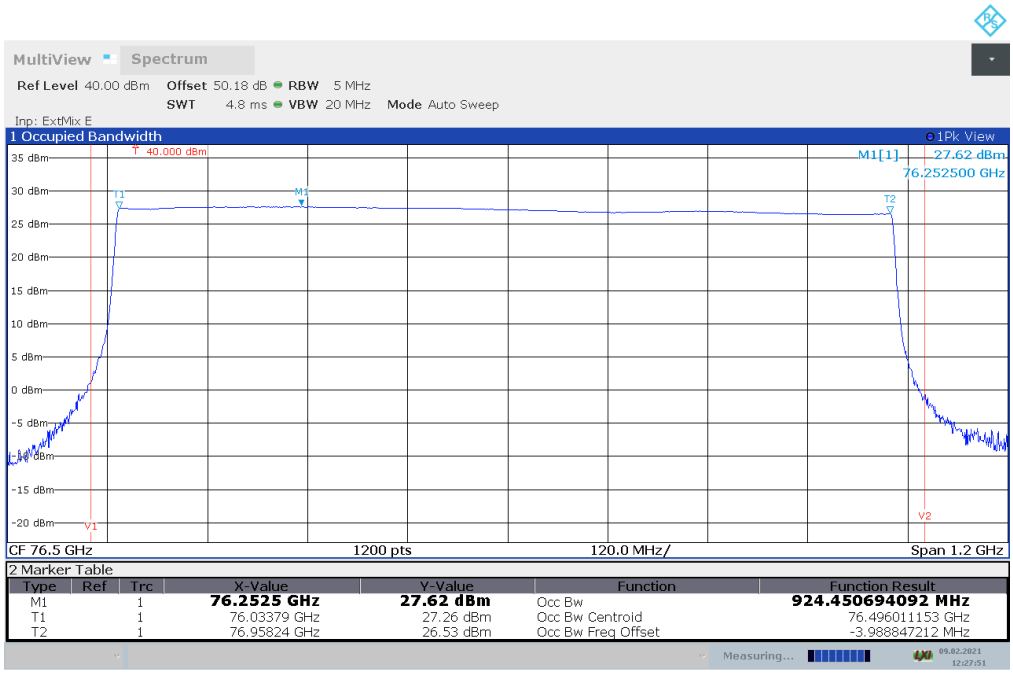

12:30:36 09.02.2021

## 1.19 RMS Detector, Set-up 3, $T_{nom}/V_{nom}$



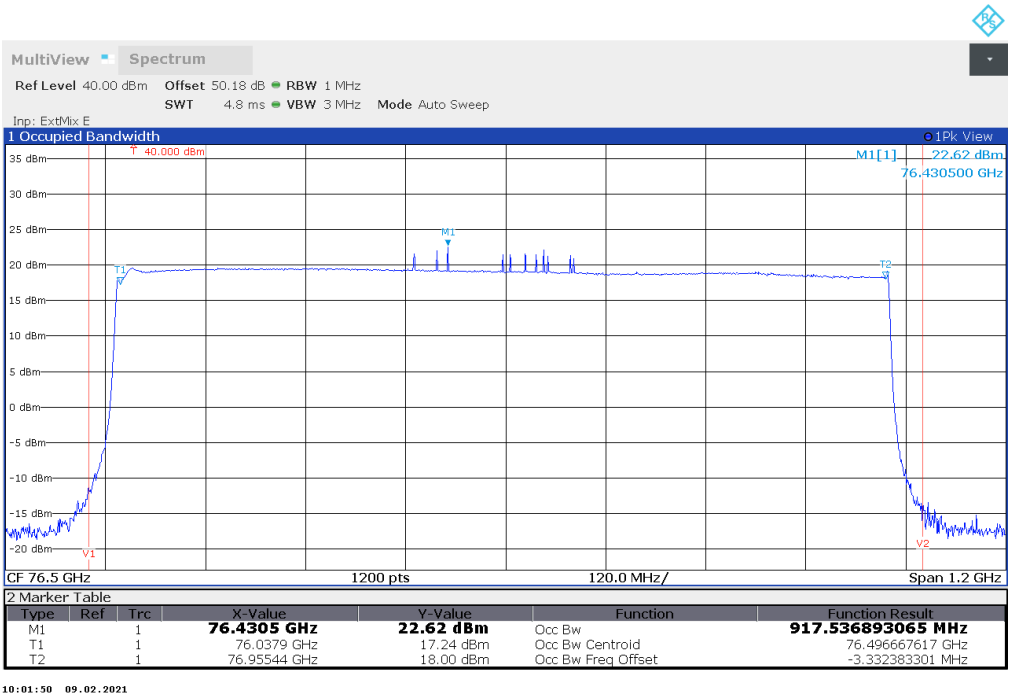

12:27:42 09.02.2021

## 1.20 Peak Detector, Set-up 3, RBW=1 MHz, $T_{nom}/V_{nom}$



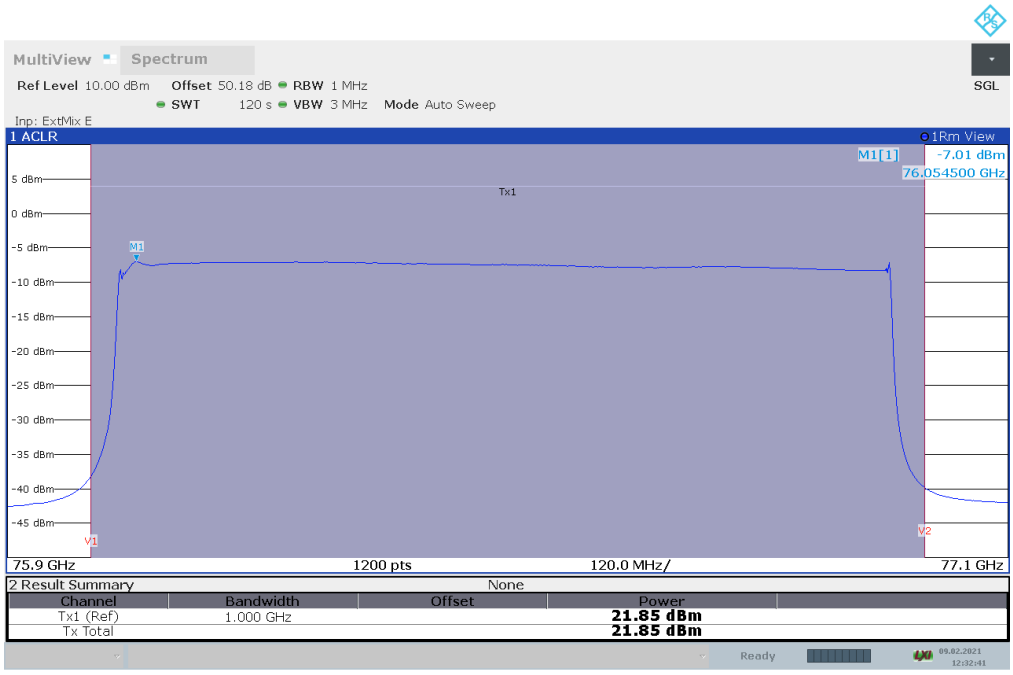

## 1.21 Peak Detector, Set-up 3, RBW=5 MHz, $T_{nom}/V_{nom}$


## 1.22 RMS Detector, Set-up 4, $T_{nom}/V_{nom}$



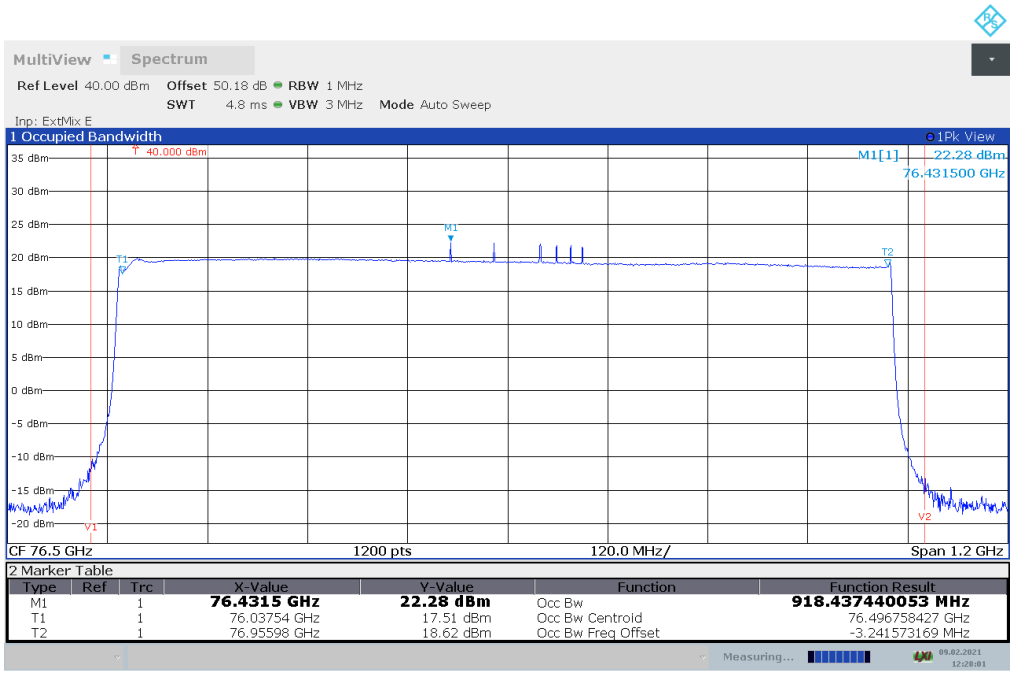

## 1.23 Peak Detector, Set-up 4, RBW=1 MHz, $T_{nom}/V_{nom}$


## 1.24 Peak Detector, Set-up 4, RBW=5 MHz, $T_{nom}/V_{nom}$



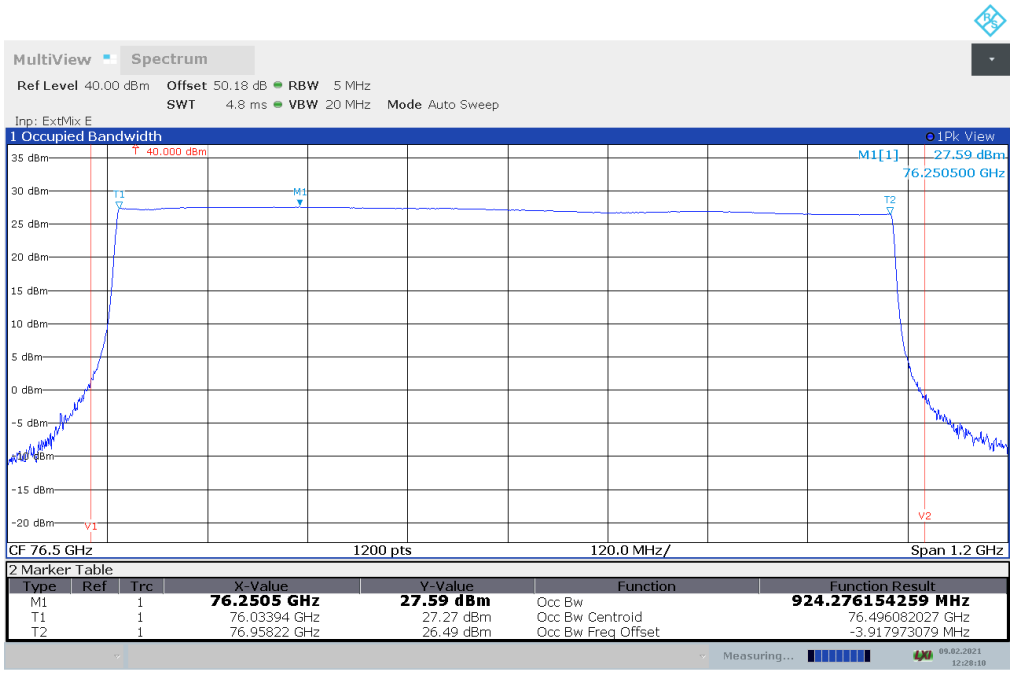

12:32:42 09.02.2021

## 1.25 RMS Detector, Set-up 3, $T_{nom}/V_{min}$

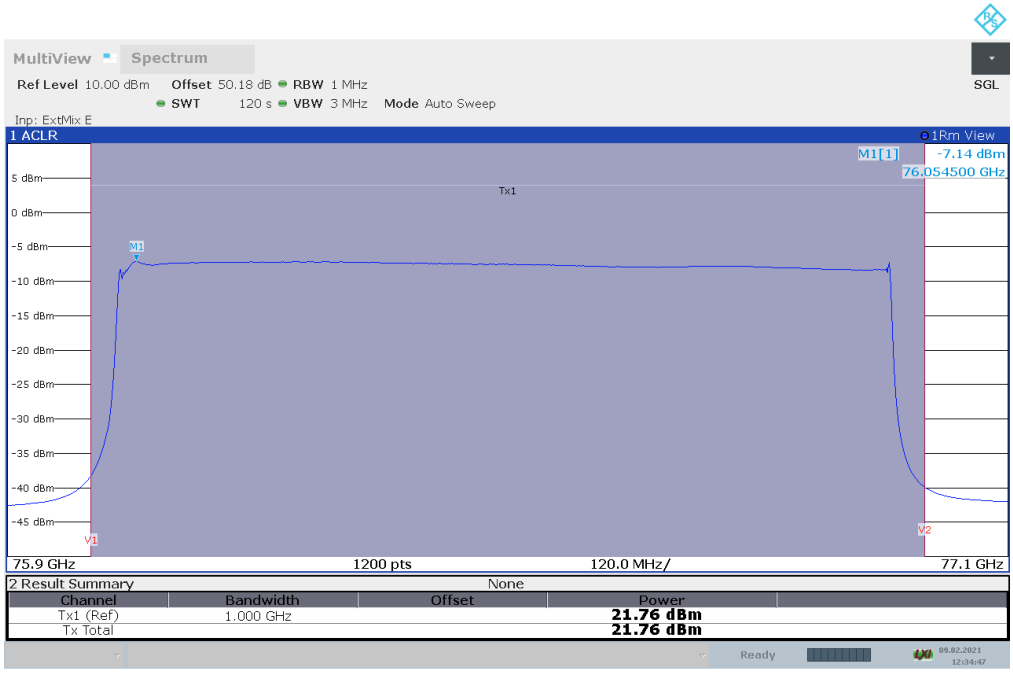



12:28:01 09.02.2021

## 1.26 Peak Detector, Set-up 3, RBW=1 MHz, $T_{nom}/V_{min}$

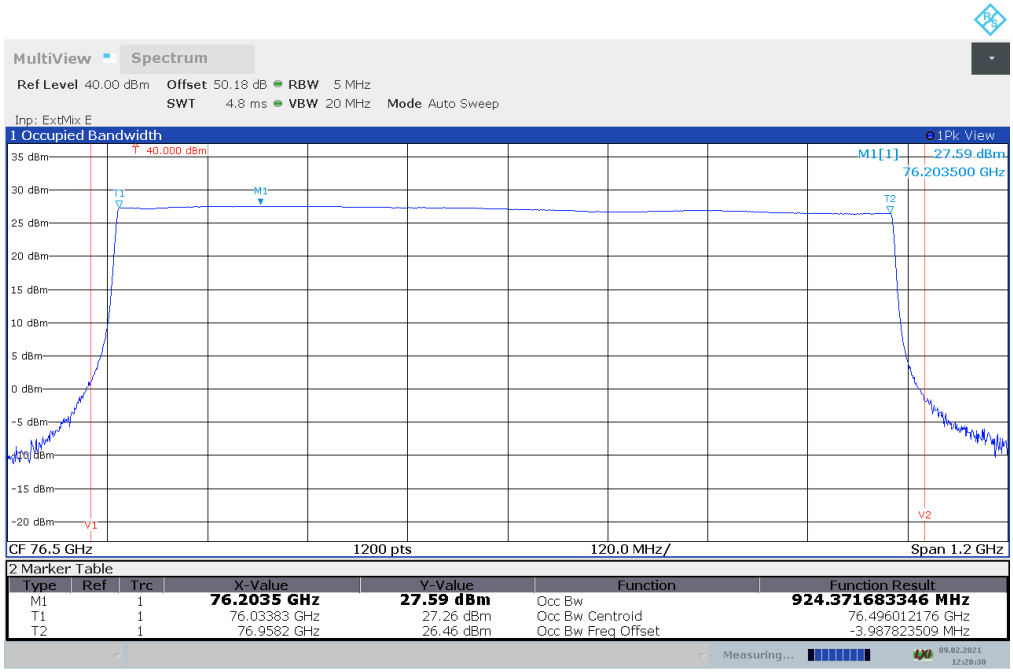



## 1.27 Peak Detector, Set-up 3, RBW=5 MHz, $T_{nom}/V_{min}$




## 1.28 RMS Detector, Set-up 3, $T_{nom}/V_{max}$


## 1.29 Peak Detector, Set-up 3, RBW=1 MHz, $T_{nom}/V_{max}$




## 1.30 Peak Detector, Set-up 3, RBW=5 MHz, $T_{nom}/V_{max}$

# 2 Modulation characteristics

## 2.1 Peak Detector, Set-up 1, $T_{nom}/V_{nom}$

See diagram 1.2 and 1.3

## 2.2 Peak Detector, Set-up 2, $T_{nom}/V_{nom}$

See diagram 1.5 and 1.6

## 2.3 Peak Detector, Set-up 1, $T_{nom}/V_{min}$

See diagram 1.8 and 1.9

## 2.4 Peak Detector, Set-up 1, $T_{nom}/V_{max}$

See diagram 1.11 and 1.12

## 2.5 Peak Detector, Set-up 1, $T_{min}/V_{nom}$

See diagram 1.14 and 1.15

## 2.6 Peak Detector, Set-up 1, $T_{max}/V_{nom}$

See diagram 1.17 and 1.18

## 2.7 Peak Detector, Set-up 3, $T_{nom}/V_{nom}$

See diagram 1.20 and 1.21

## 2.8 Peak Detector, Set-up 4, $T_{nom}/V_{nom}$

See diagram 1.23 and 1.24

## 2.9 Peak Detector, Set-up 3, $T_{nom}/V_{min}$

See diagram 1.26 and 1.27

## 2.10 Peak Detector, Set-up 3, $T_{nom}/V_{max}$

See diagram 1.29 and 1.30

# 3 Occupied bandwidth

## 3.1 Peak Detector, Set-up 1, $T_{nom}/V_{nom}$

See diagram 1.2 and 1.3

## 3.2 Peak Detector, Set-up 2, $T_{nom}/V_{nom}$

See diagram 1.5 and 1.6

## 3.3 Peak Detector, Set-up 1, $T_{nom}/V_{min}$

See diagram 1.8 and 1.9

## 3.4 Peak Detector, Set-up 1, $T_{nom}/V_{max}$

See diagram 1.11 and 1.12

## 3.5 Peak Detector, Set-up 1, $T_{min}/V_{nom}$

See diagram 1.14 and 1.15

## 3.6 Peak Detector, Set-up 1, $T_{max}/V_{nom}$

See diagram 1.17 and 1.18

## 3.7 Peak Detector, Set-up 3, $T_{nom}/V_{nom}$

See diagram 1.20 and 1.21

## 3.8 Peak Detector, Set-up 4, $T_{nom}/V_{nom}$

See diagram 1.23 and 1.24

## 3.9 Peak Detector, Set-up 3, $T_{nom}/V_{min}$

See diagram 1.26 and 1.27

## 3.10 Peak Detector, Set-up 3, $T_{nom}/V_{max}$

See diagram 1.29 and 1.30

# 4 Field strength of emissions (band edge)

## 4.1 RMS Detector, low edge, set-up 1

See diagram 5.14

## 4.2 RMS Detector, high edge, set-up 1

See diagram 5.15

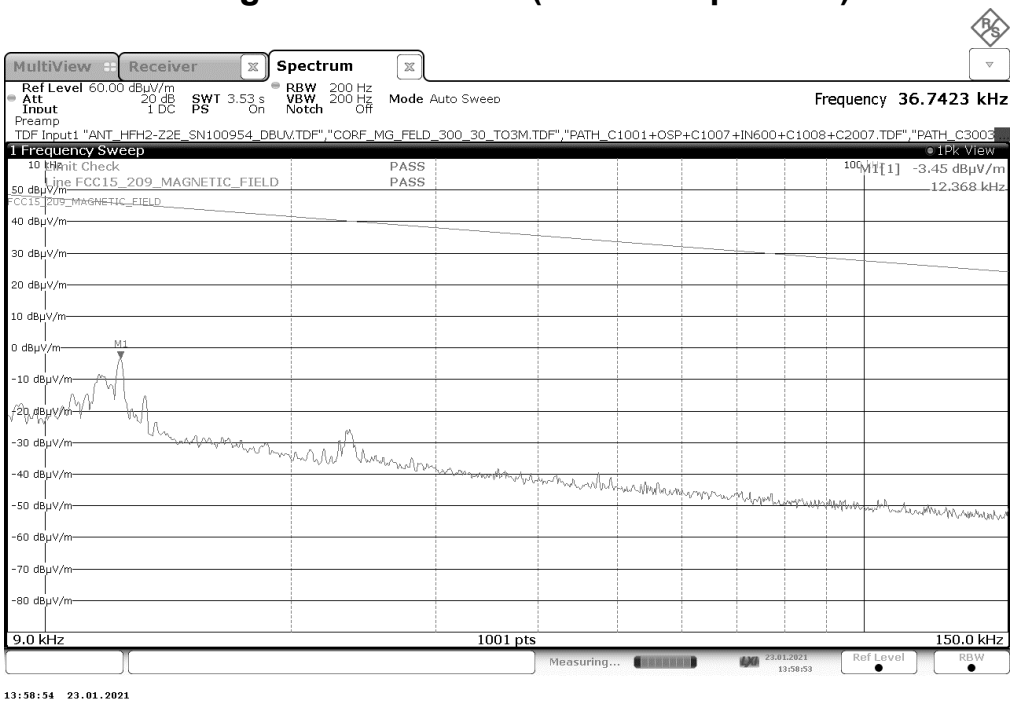
## 4.3 RMS Detector, low edge, set-up 3

See diagram 5.34.

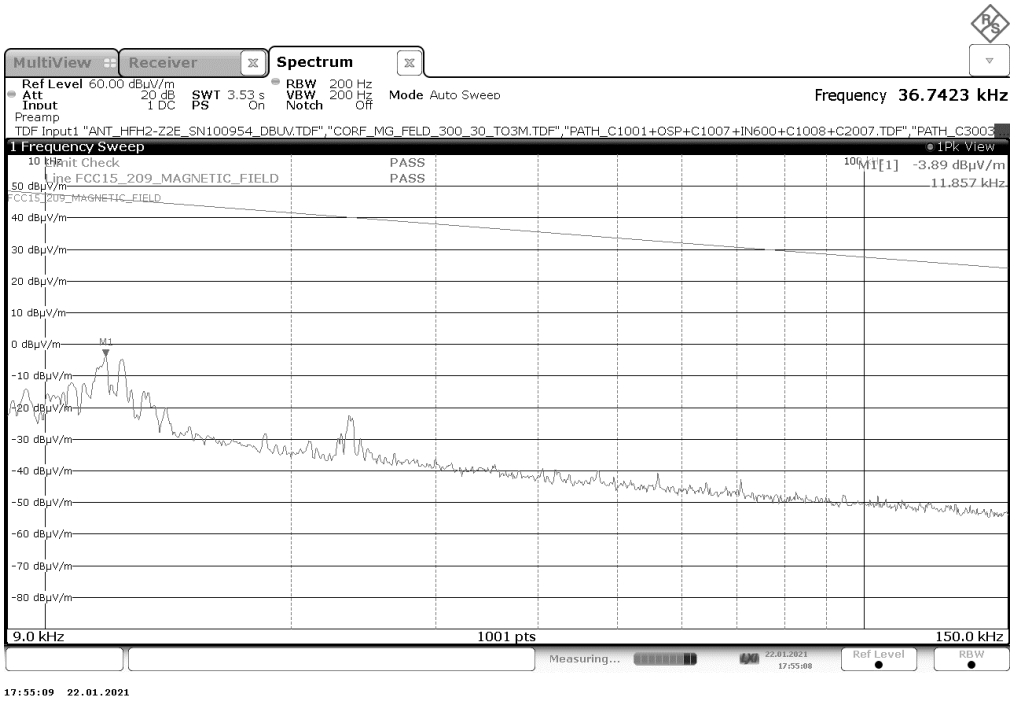
## 4.4 RMS Detector, high edge, set-up 3

See diagram 5.35.

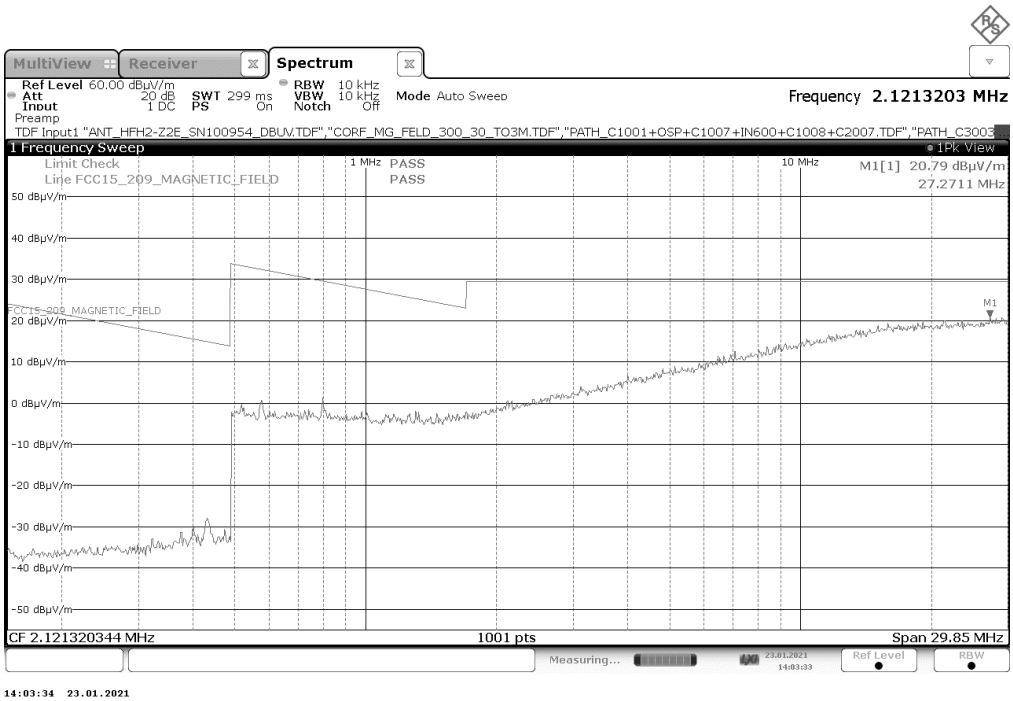
# 5 Field strength of emissions (radiated spurious)




## 5.1 9 kHz – 150 kHz, ANT HOR, Set-up 1

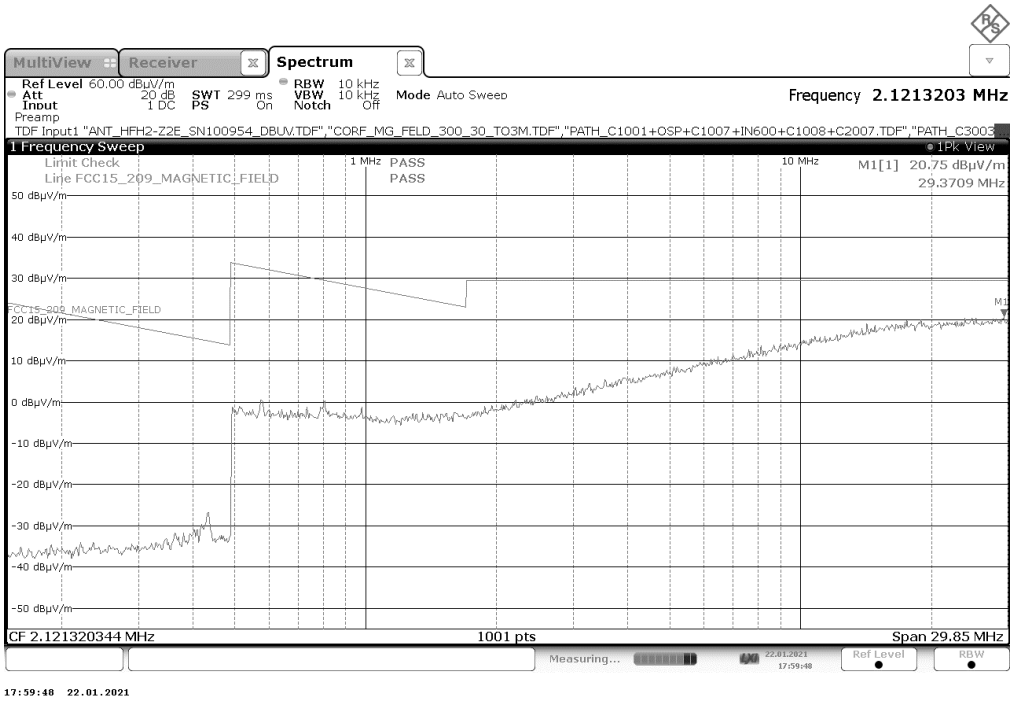



## 5.2 9 kHz – 150 kHz, ANT VER, Set-up 1



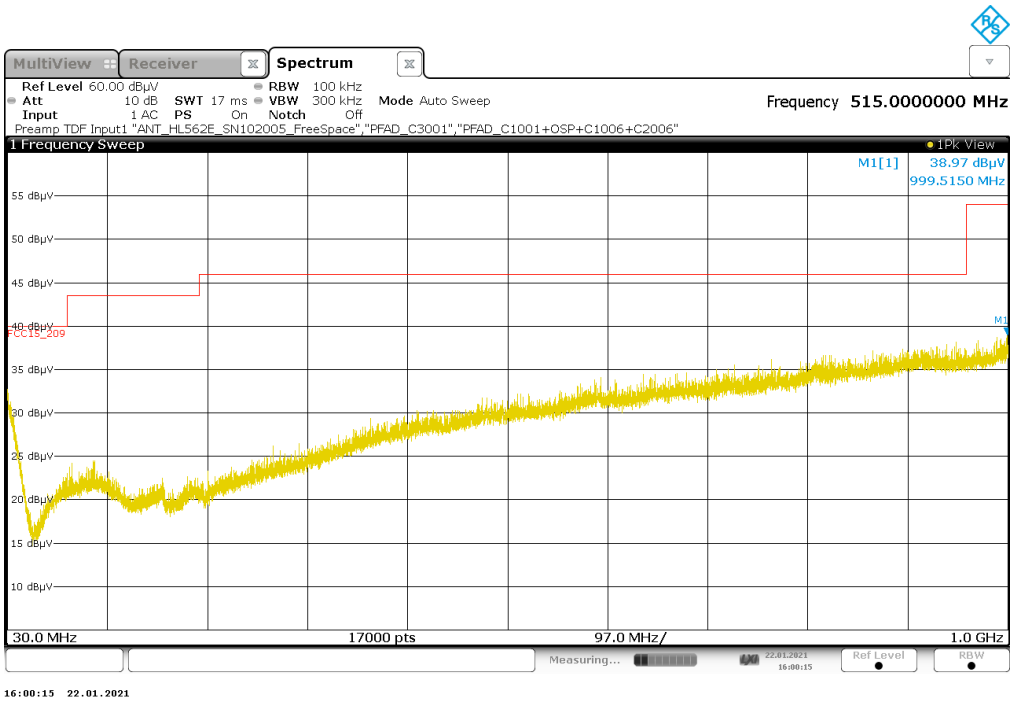

14:03:34 23.01.2021

## 5.3 150 kHz – 30 MHz, ANT HOR, Set-up 1

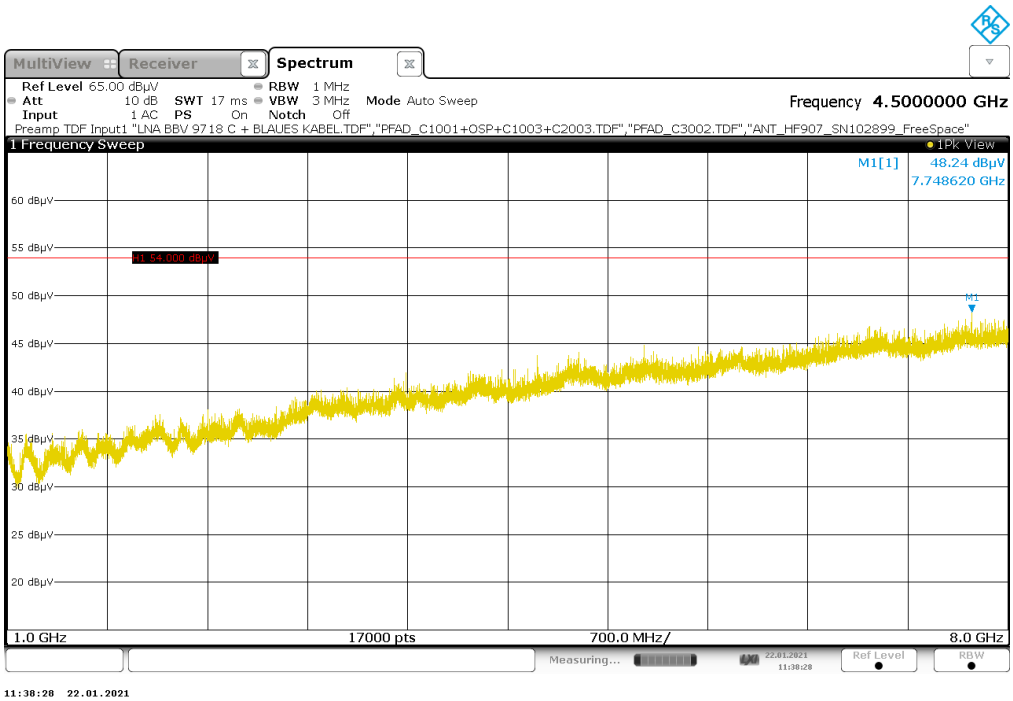



17:59:48 22.01.2021

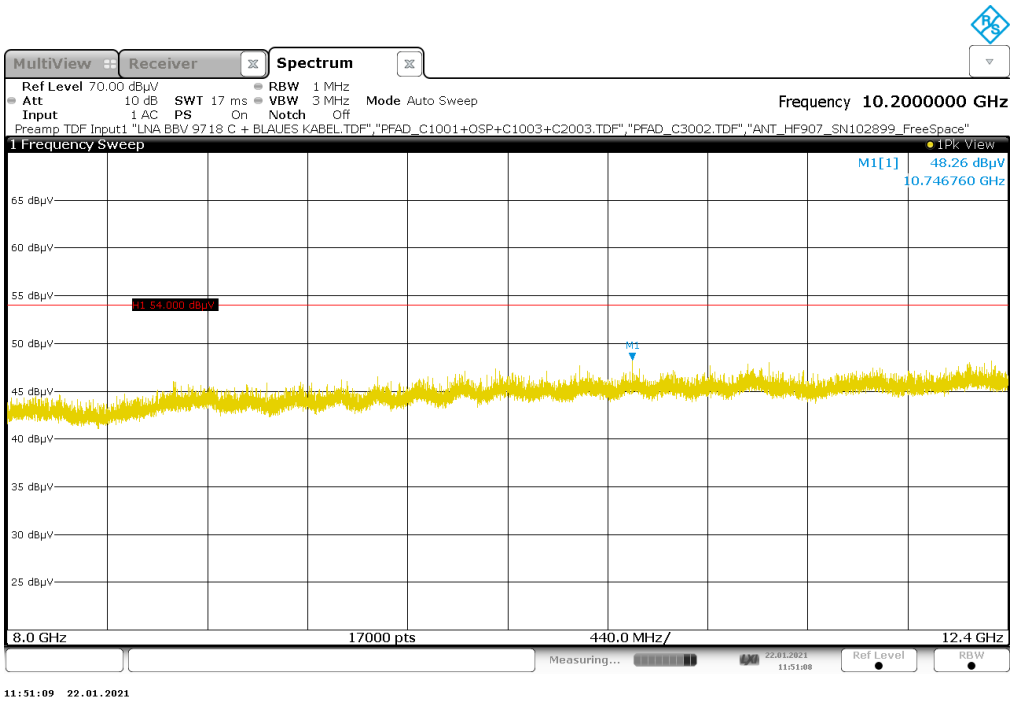
## 5.4 150 kHz – 30 MHz, ANT VER, Set-up 1




## 5.5 30 MHz – 1 GHz, , Set-up 1

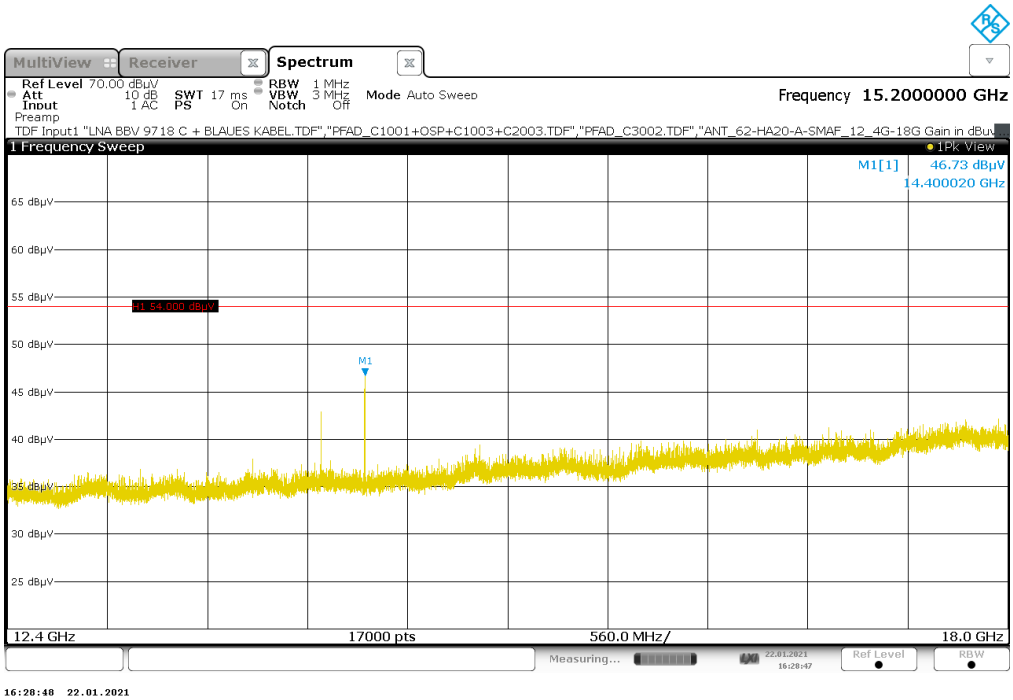



## 5.6 1 GHz – 8 GHz, Set-up 1



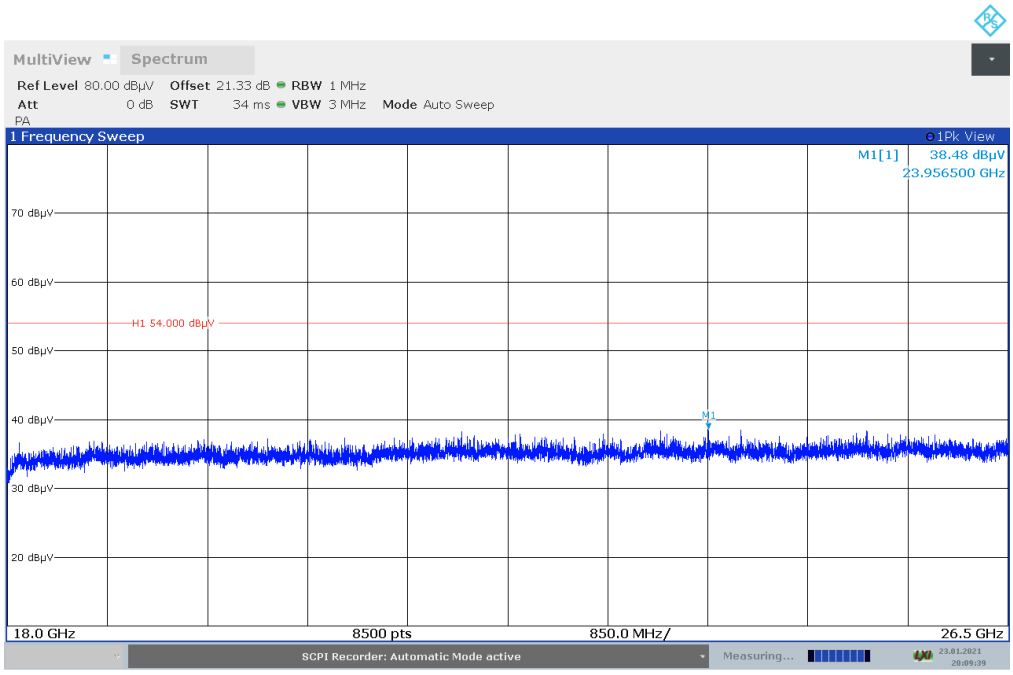

11:51:09 22.01.2021

## 5.7 8 GHz – 12.4 GHz, Set-up 1



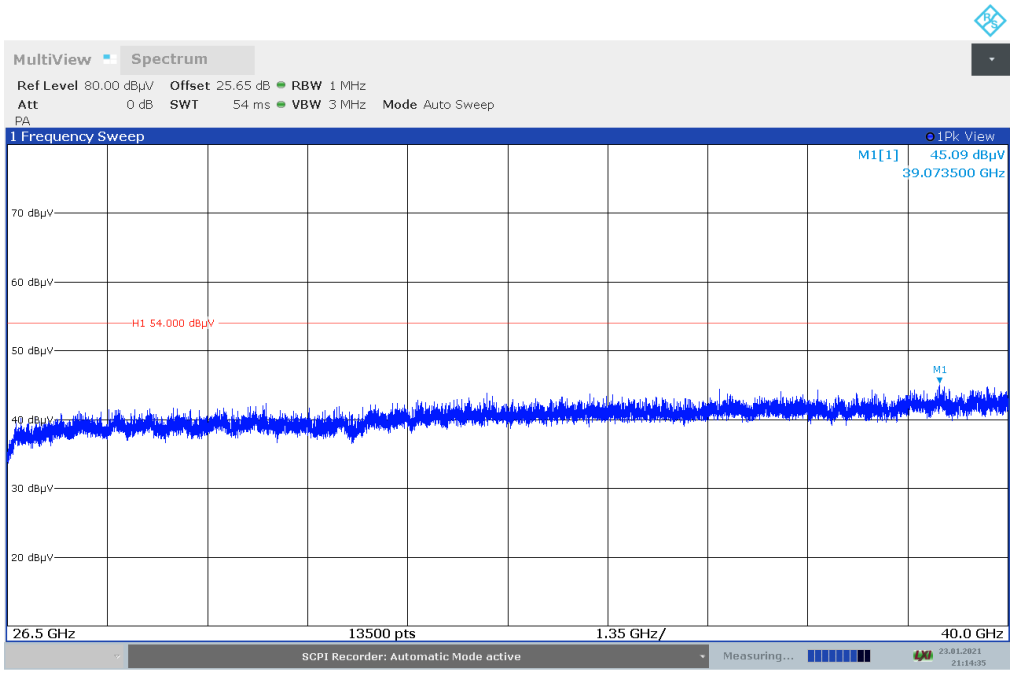

16:28:48 22.01.2021

## 5.8 12.4 GHz – 18 GHz, Set-up 1



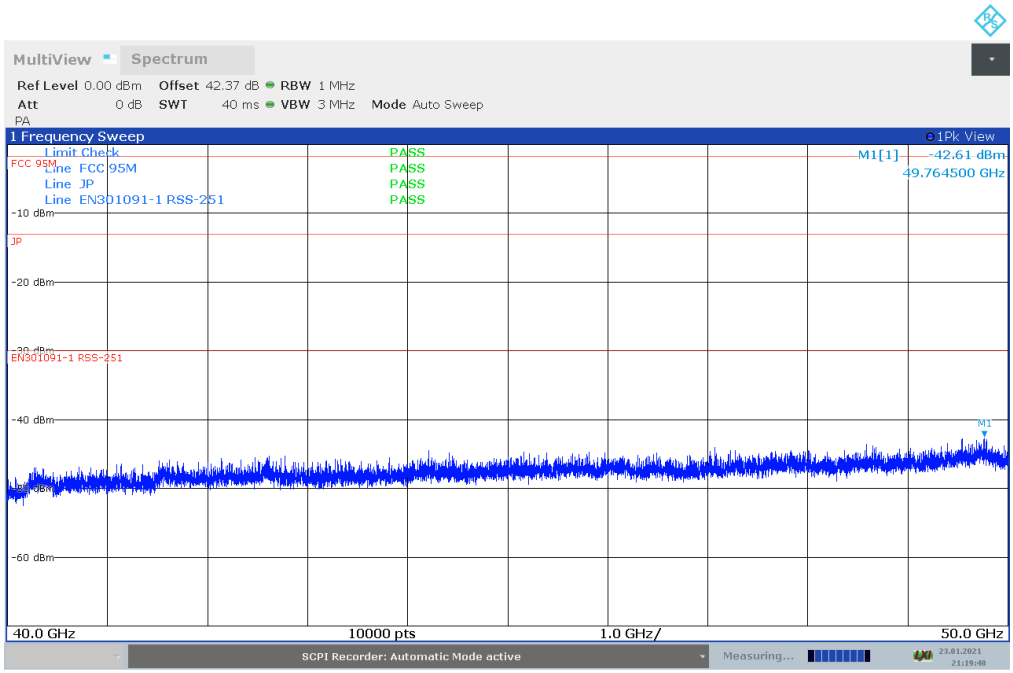

20:09:39 23.01.2021

## 5.9 18 GHz – 26.5 GHz, Set-up 1



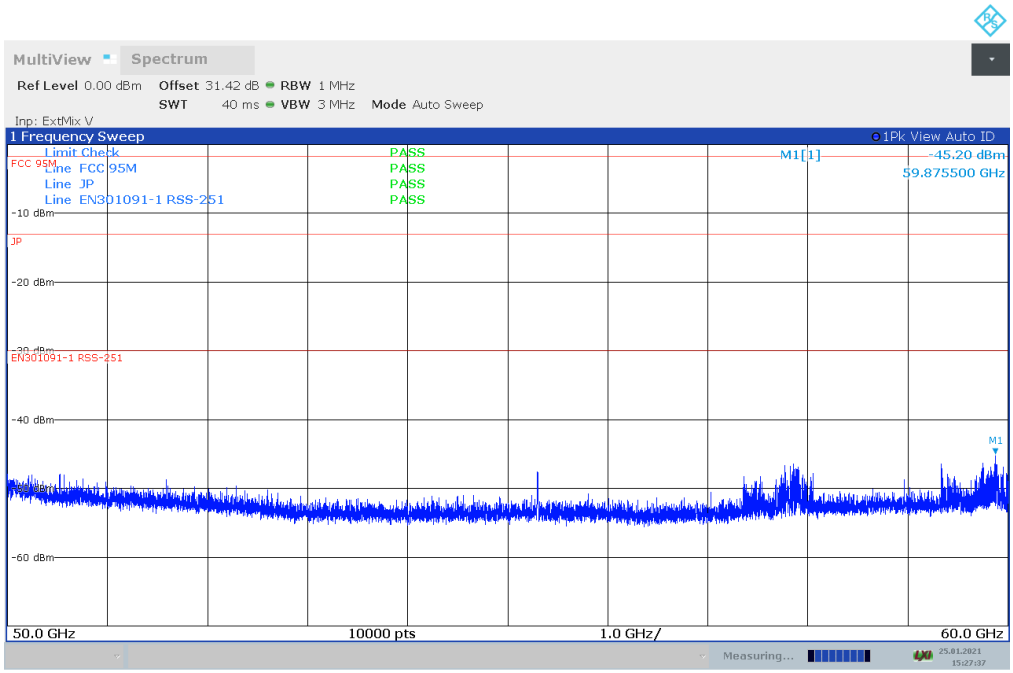

21:14:36 23.01.2021

## 5.10 26.5 GHz – 40 GHz, Set-up 1



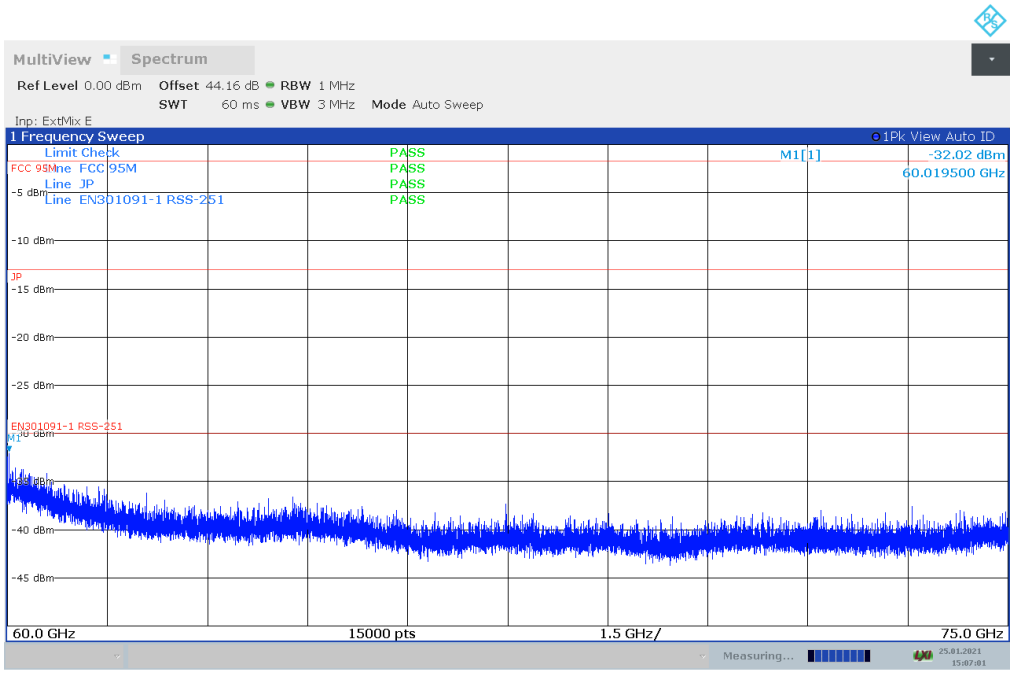

21:19:48 23.01.2021

## 5.11 40 GHz – 50 GHz, Set-up 1



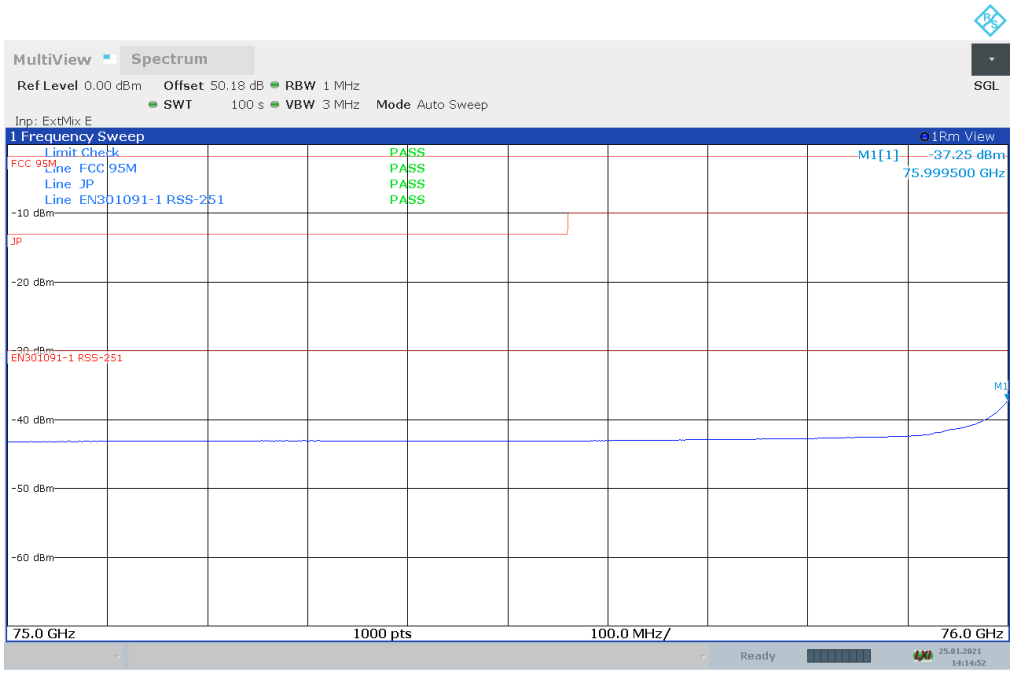

15:27:38 25.01.2021

## 5.12 50 GHz – 60 GHz, Set-up 1



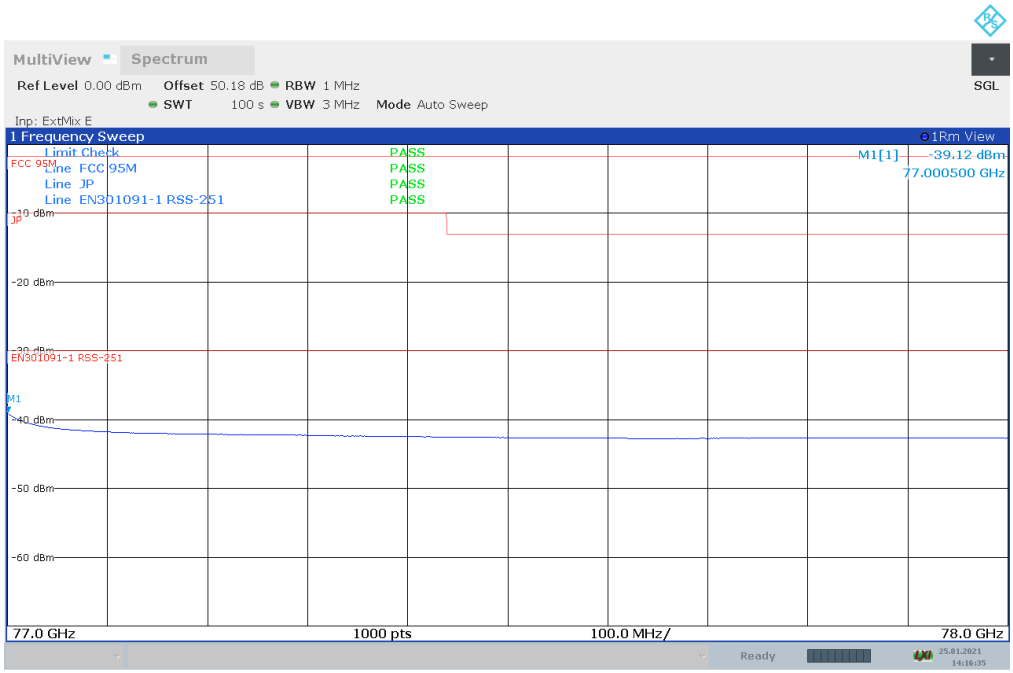

15:07:02 25.01.2021

## 5.13 60 GHz – 75 GHz, Set-up 1



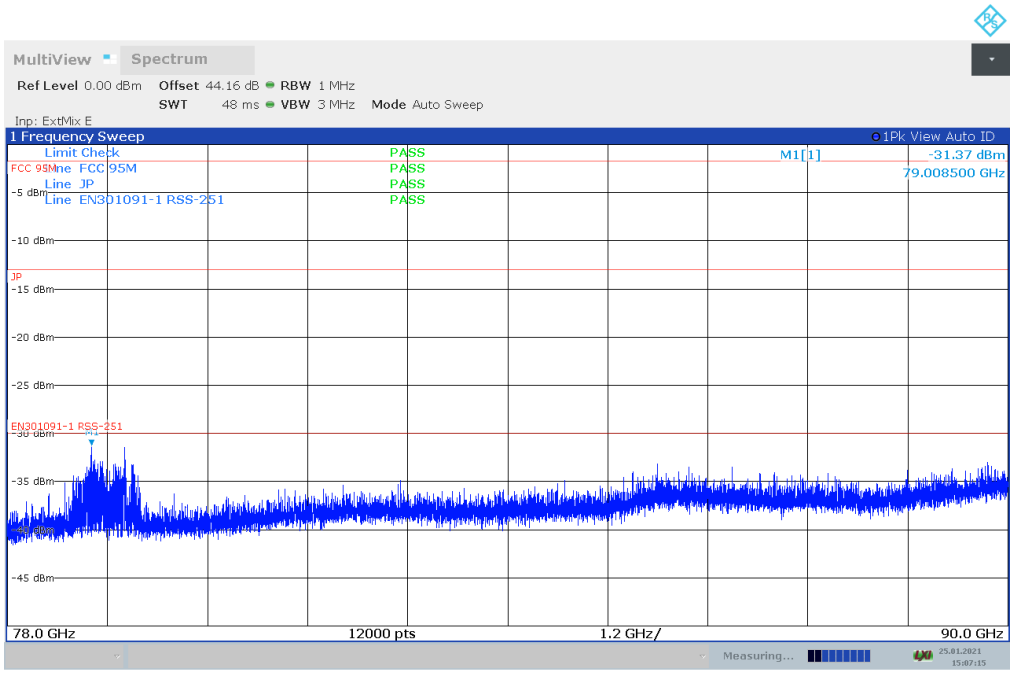

14:14:53 25.01.2021

## 5.14 75 GHz – 76 GHz, Set-up 1



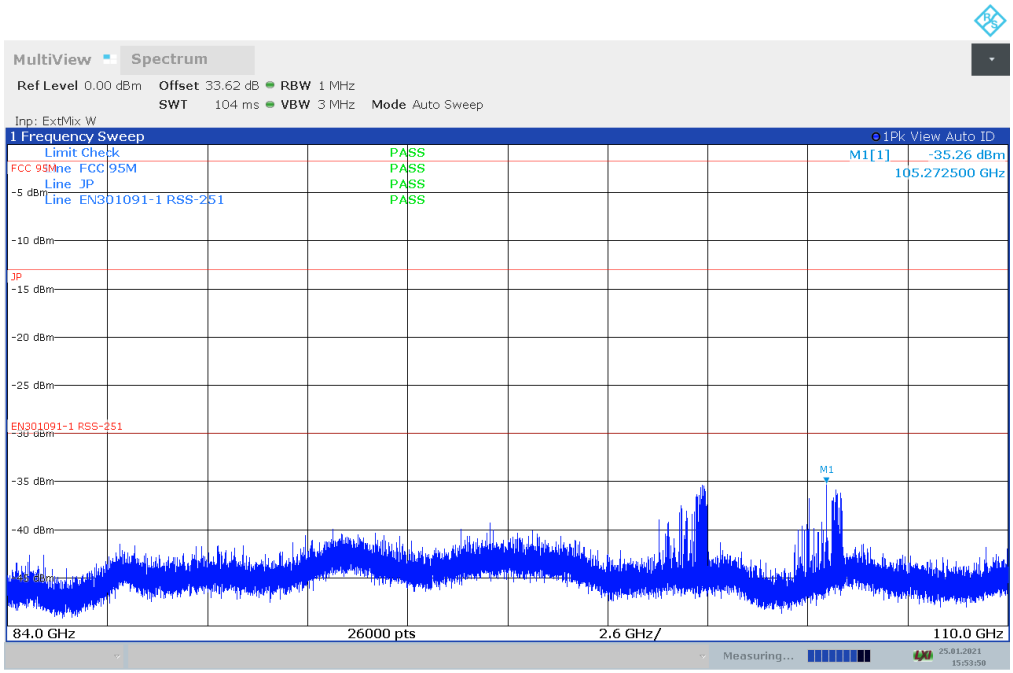

14:16:36 25.01.2021

## 5.15 77 GHz – 78 GHz, Set-up 1



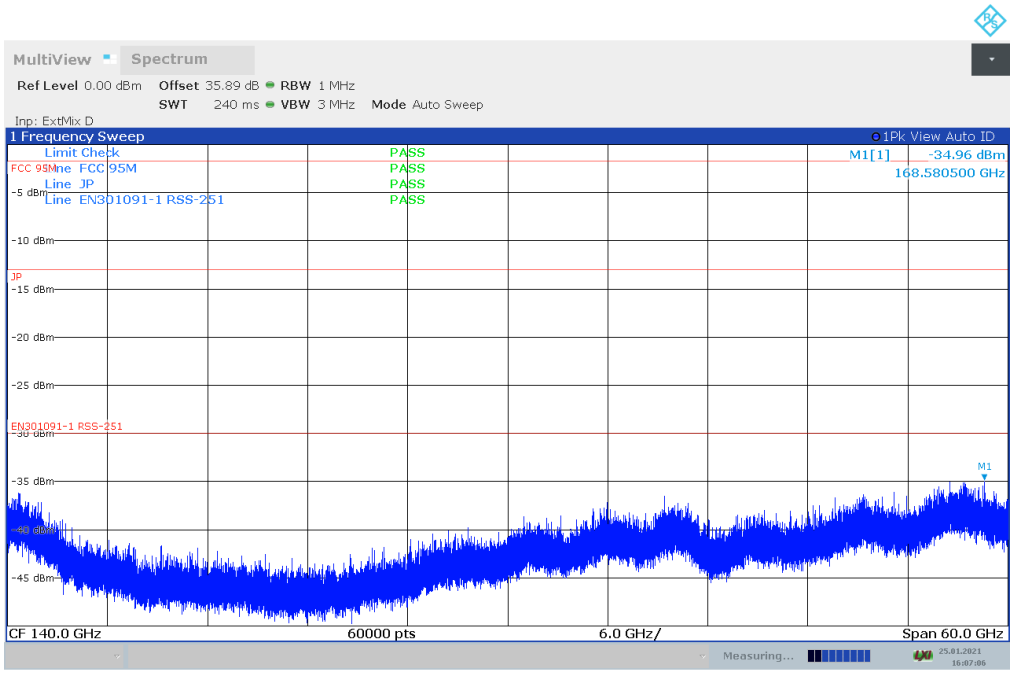

15:07:15 25.01.2021

## 5.16 78 GHz – 90 GHz, Set-up 1



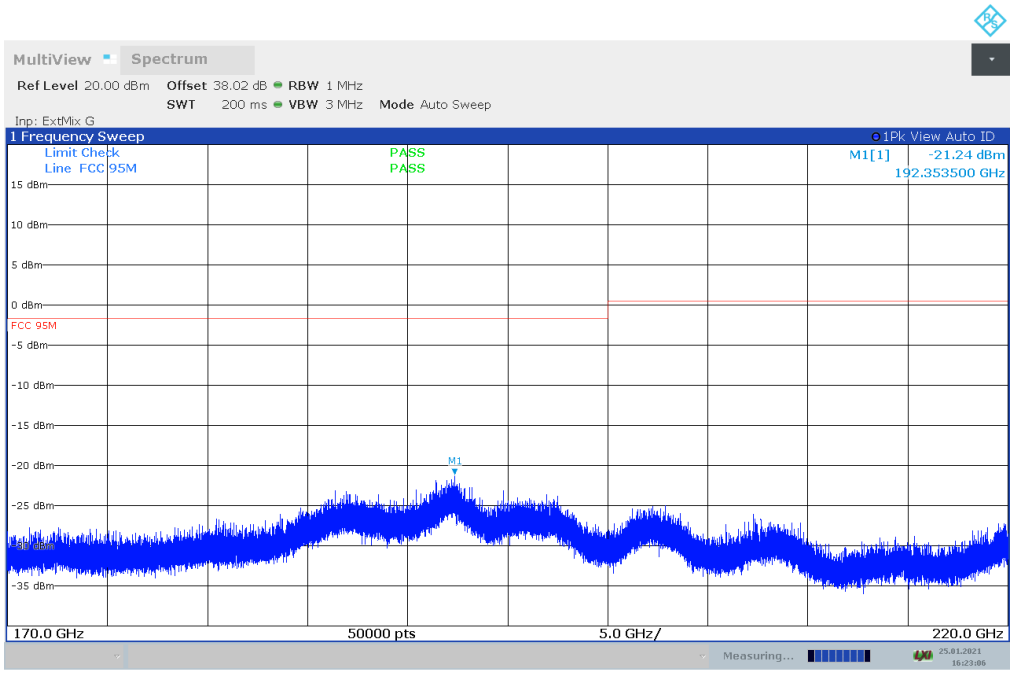

15:53:50 25.01.2021

## 5.17 84 GHz – 110 GHz, Set-up 1



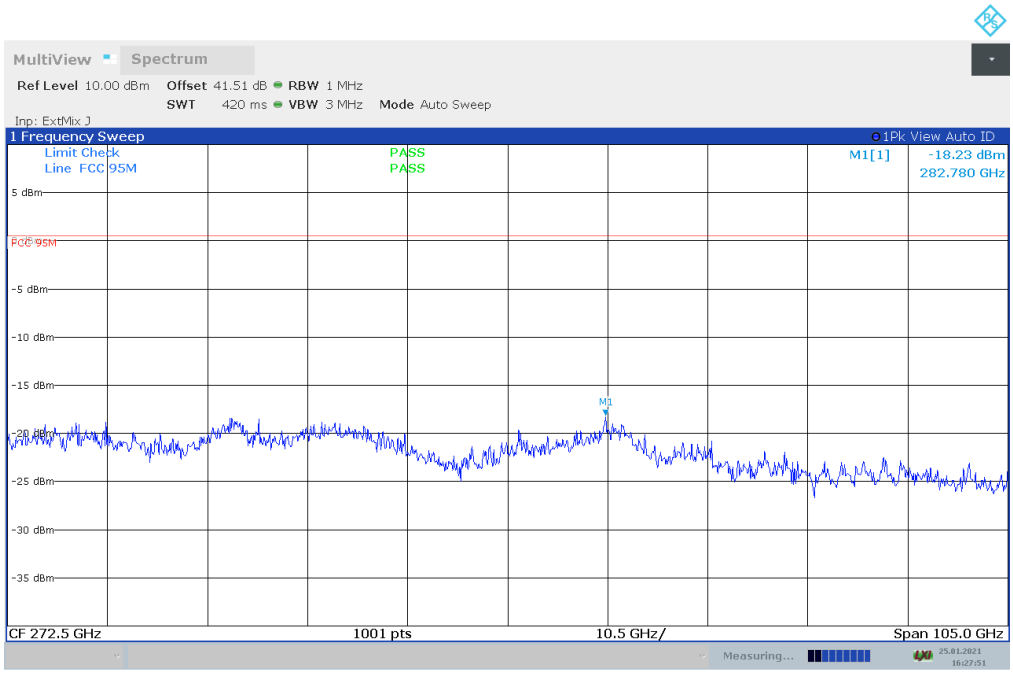

16:07:06 25.01.2021

## 5.18 110 GHz – 170 GHz, Set-up 1



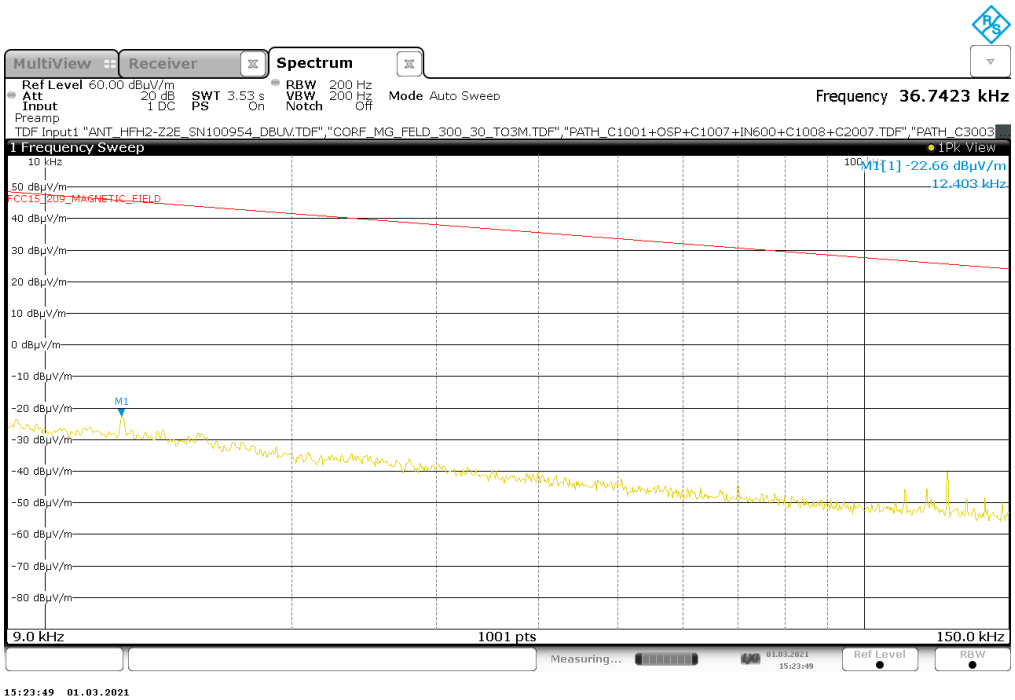

16:23:06 25.01.2021

## 5.19 170 GHz – 220 GHz, Set-up 1



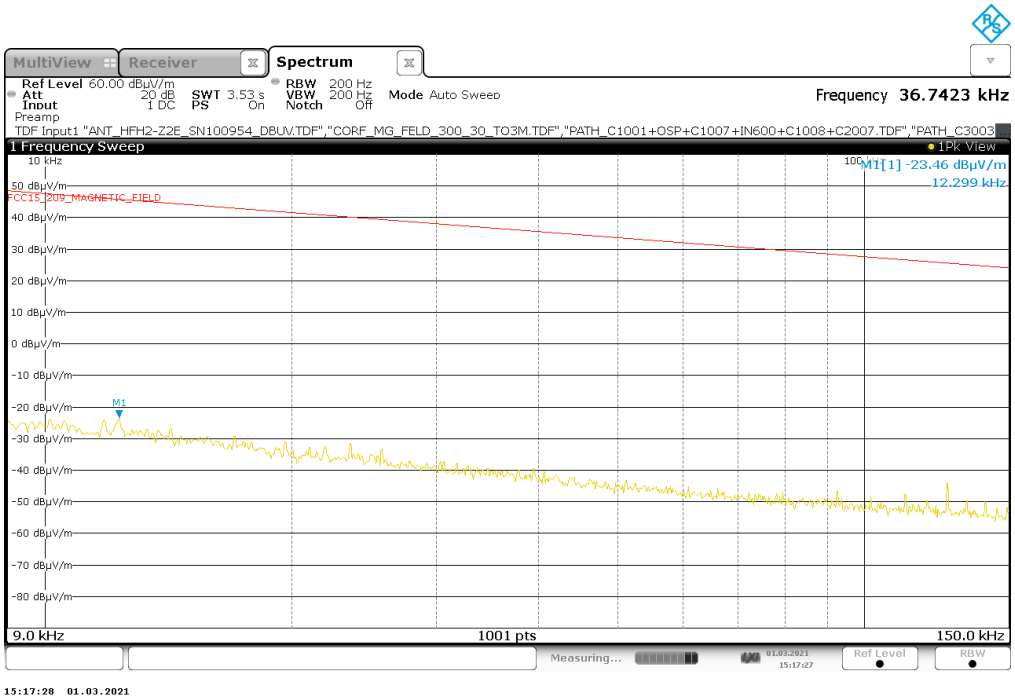

16:27:51 25.01.2021

## 5.20 220 GHz – 325 GHz, Set-up 1



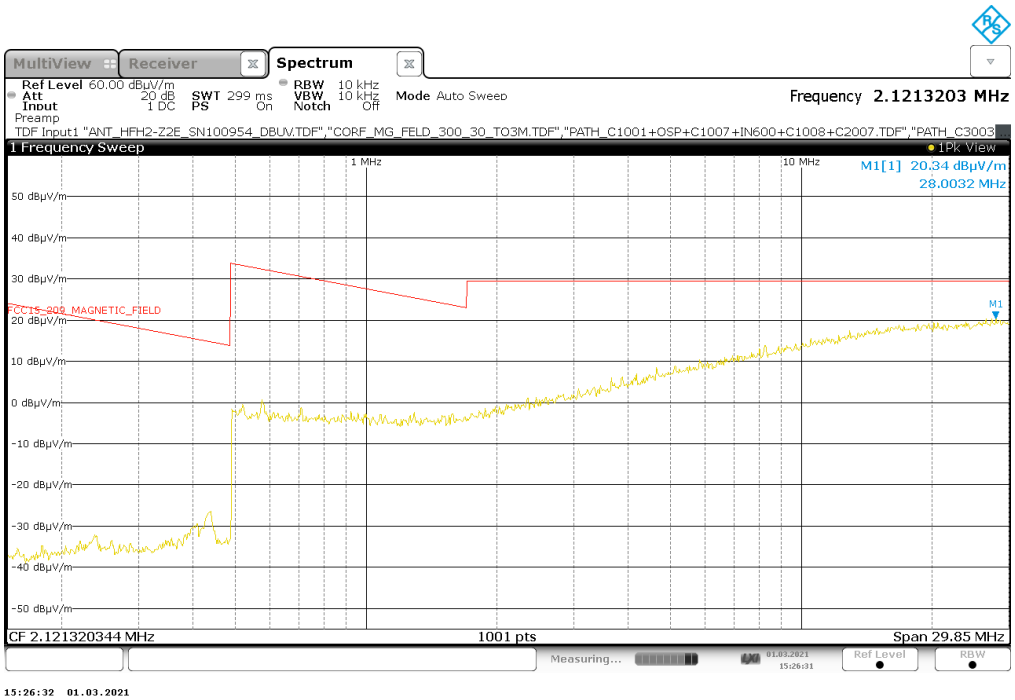

15:23:49 01.03.2021

## 5.21 9 kHz – 150 kHz, ANT HOR, Set-up 2

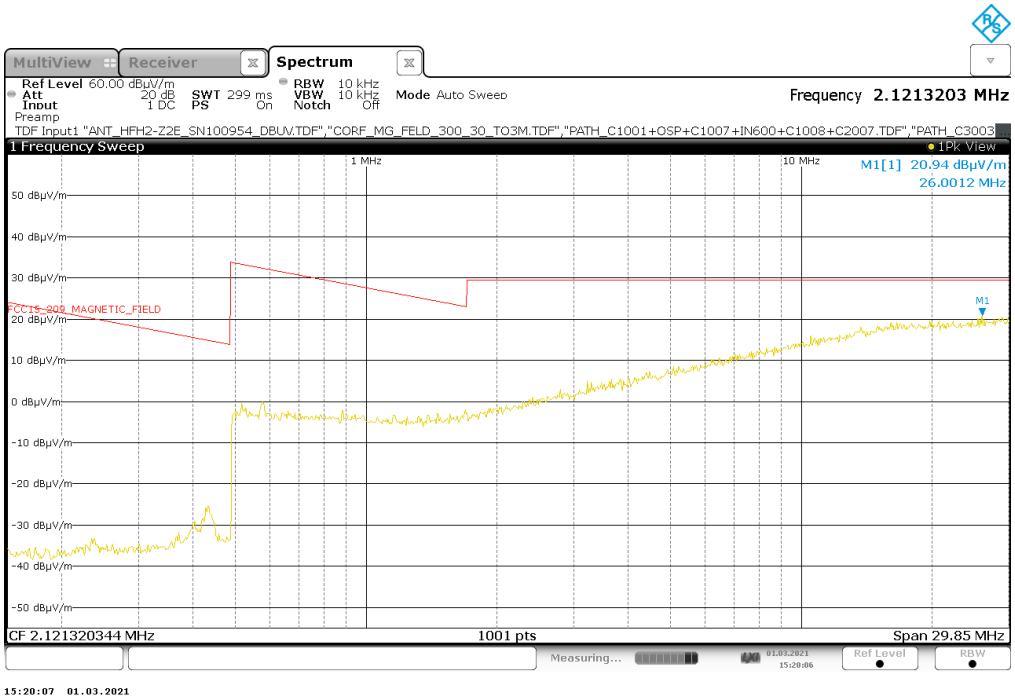



15:17:28 01.03.2021

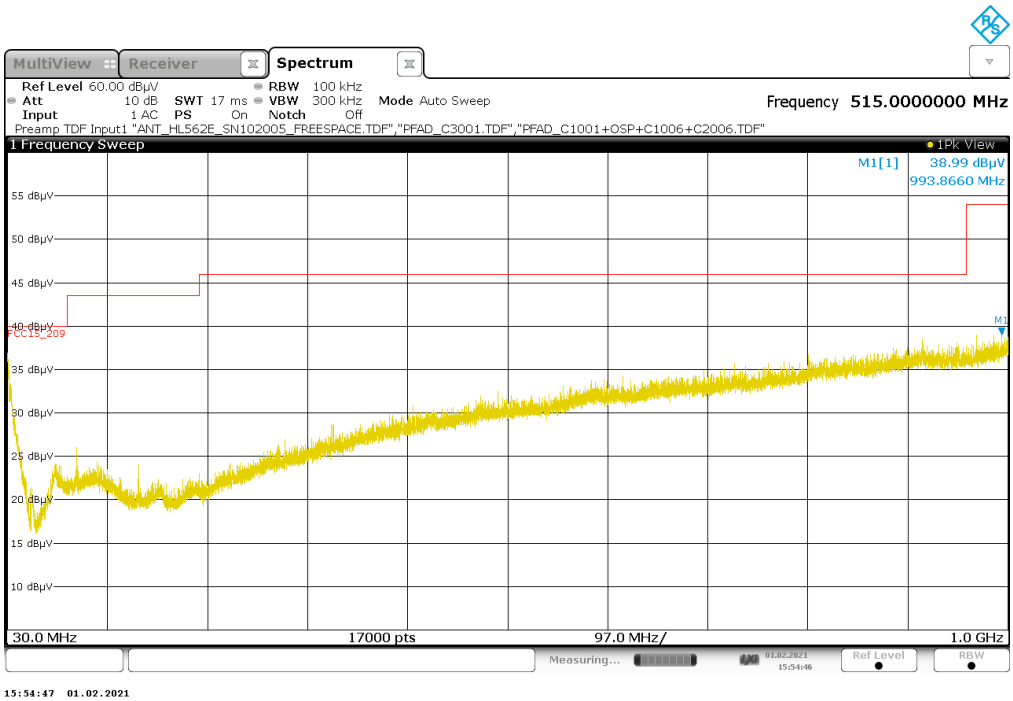
## 5.22 9 kHz – 150 kHz, ANT VER, Set-up 2




## 5.23 150 kHz – 30 MHz, ANT HOR, Set-up 2

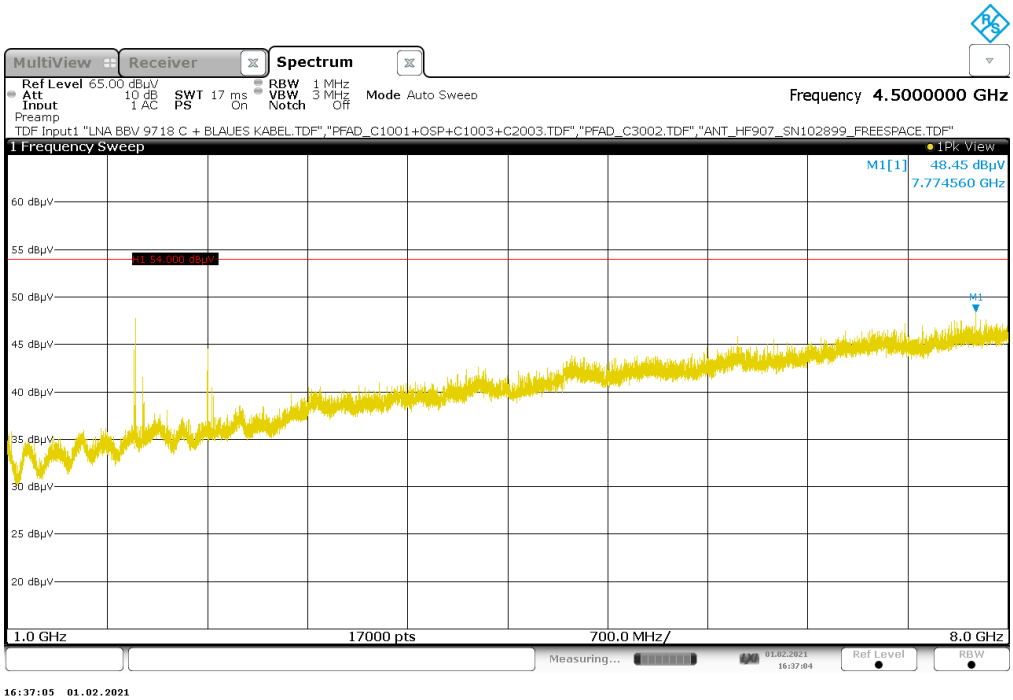



## 5.24 150 kHz – 30 MHz, ANT VER, Set-up 2



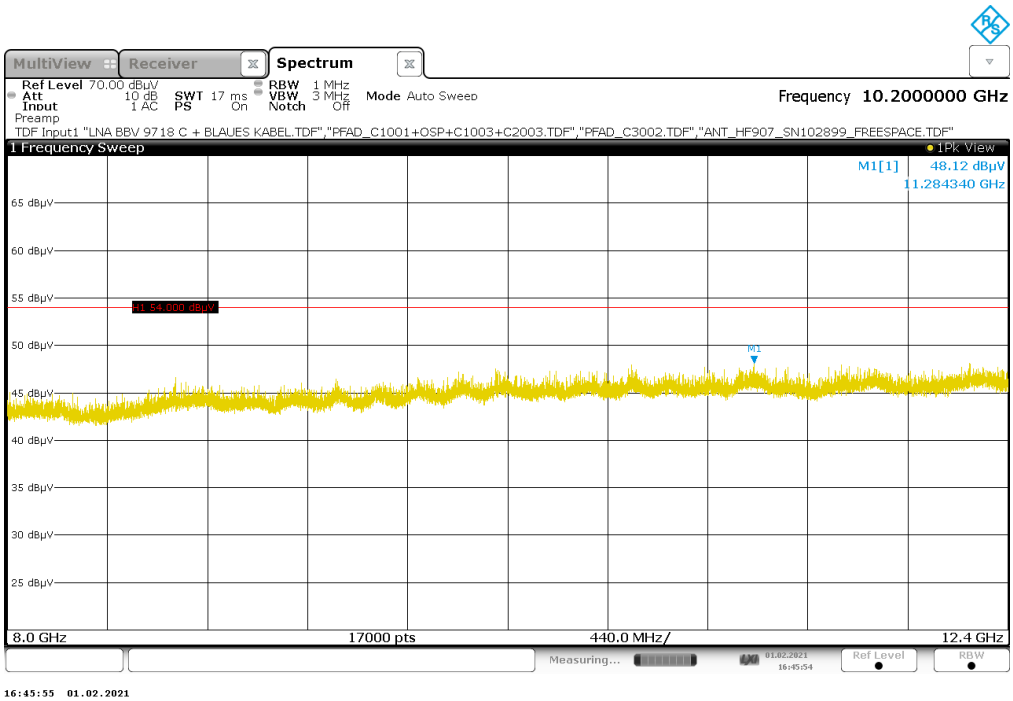

15:54:47 01.02.2021

## 5.25 30 MHz – 1 GHz, Set-up 2

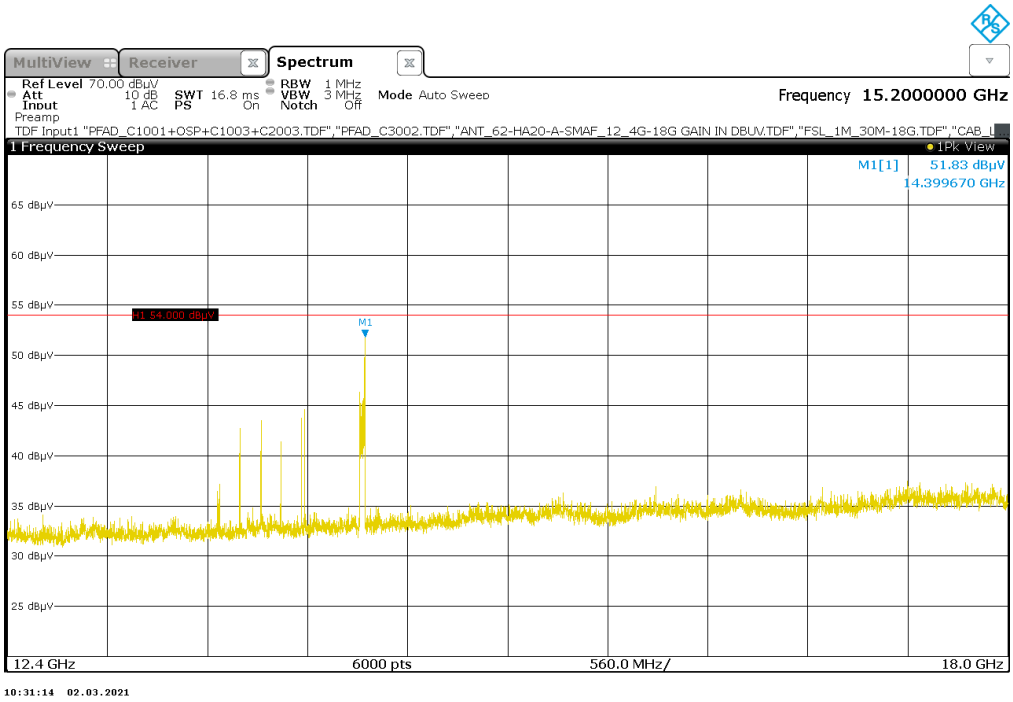



16:37:05 01.02.2021

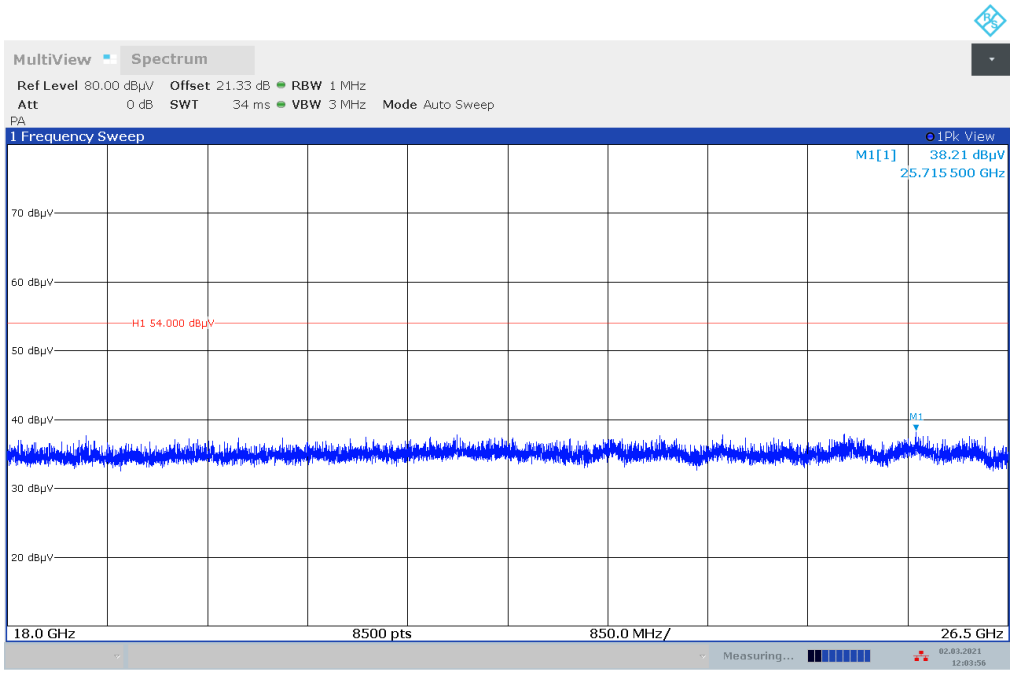
## 5.26 1 GHz – 8 GHz, Set-up 2




## 5.27 8 GHz – 12.4 GHz, Set-up 2

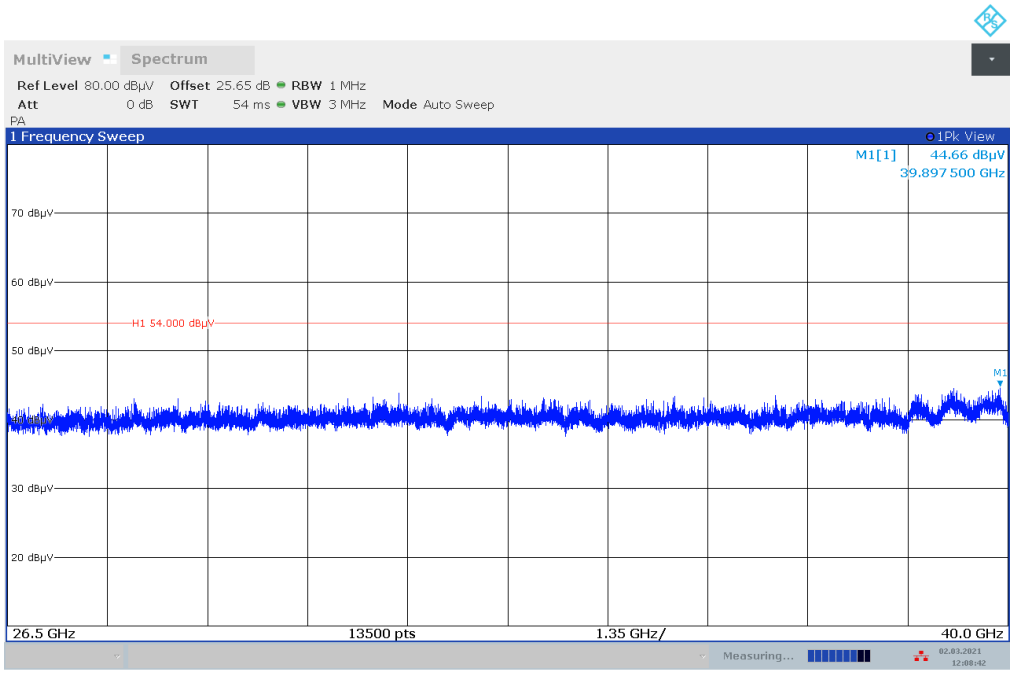



## 5.28 12.4 GHz – 18 GHz, Set-up 2



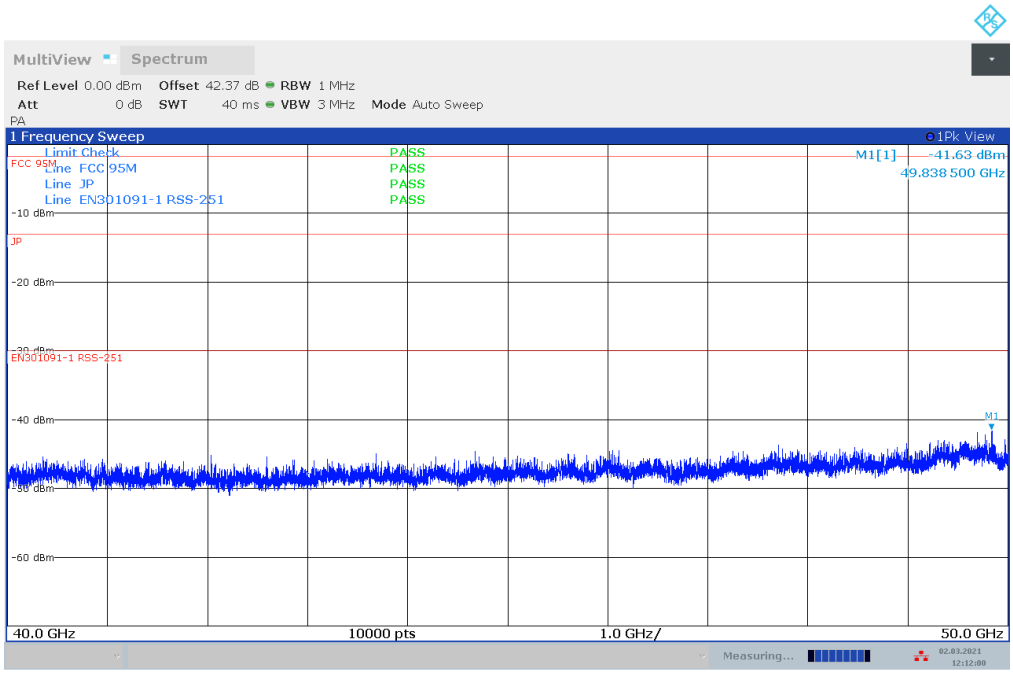

12:03:56 02.03.2021

## 5.29 18 GHz – 26.5 GHz, Set-up 2



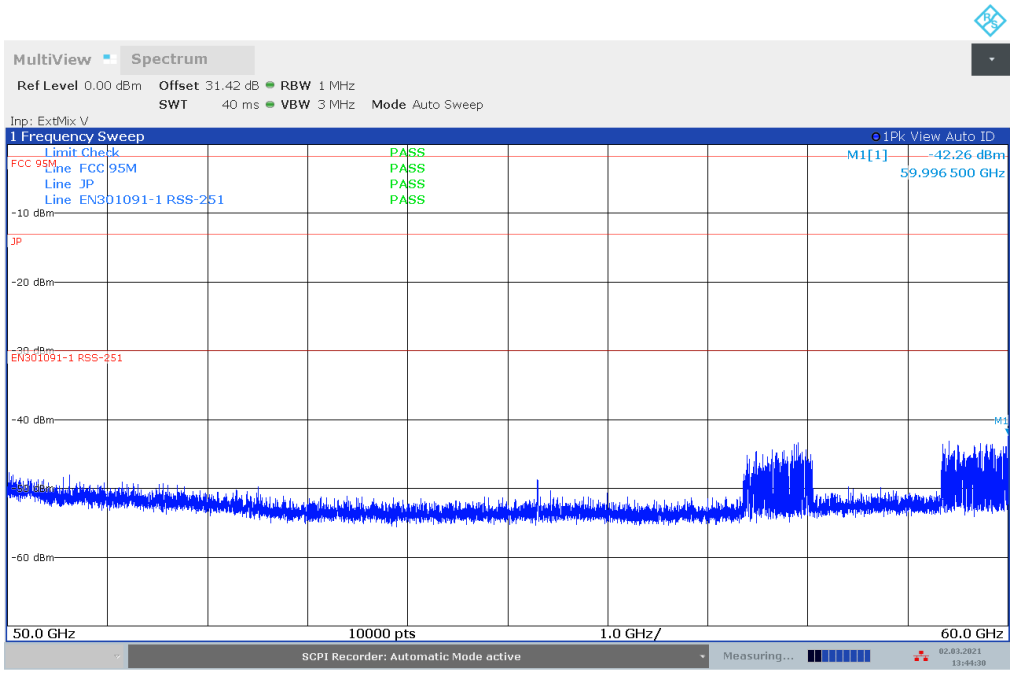

12:08:42 02.03.2021

## 5.30 26.5 GHz – 40 GHz, Set-up 2



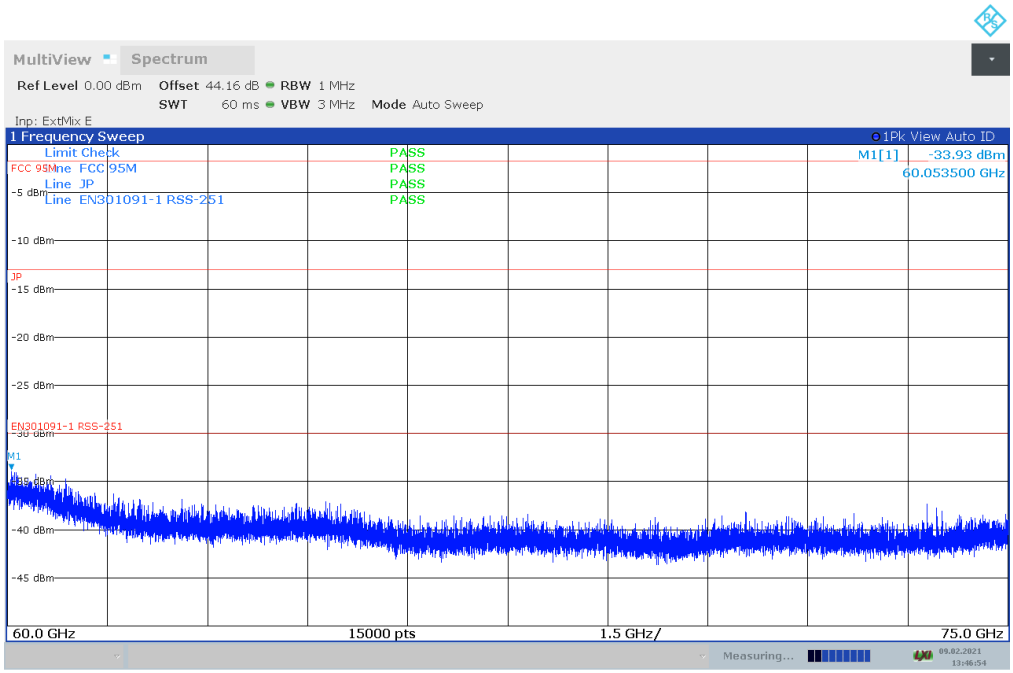

12:12:00 02.03.2021

## 5.31 40 GHz – 50 GHz, Set-up 2



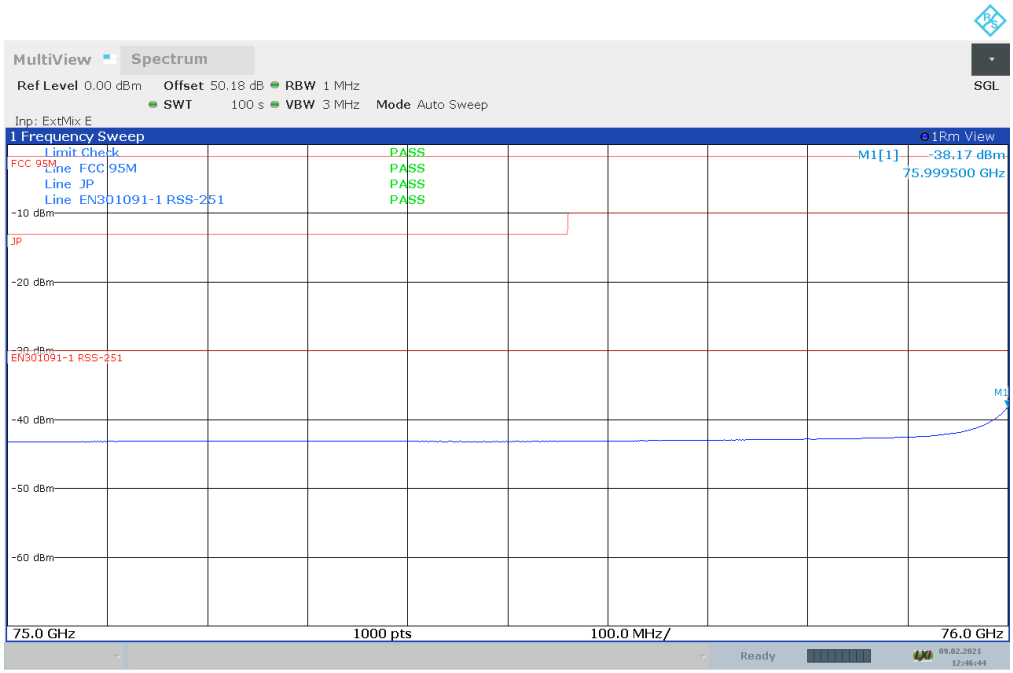

13:44:30 02.03.2021

## 5.32 50 GHz – 60 GHz, Set-up 2



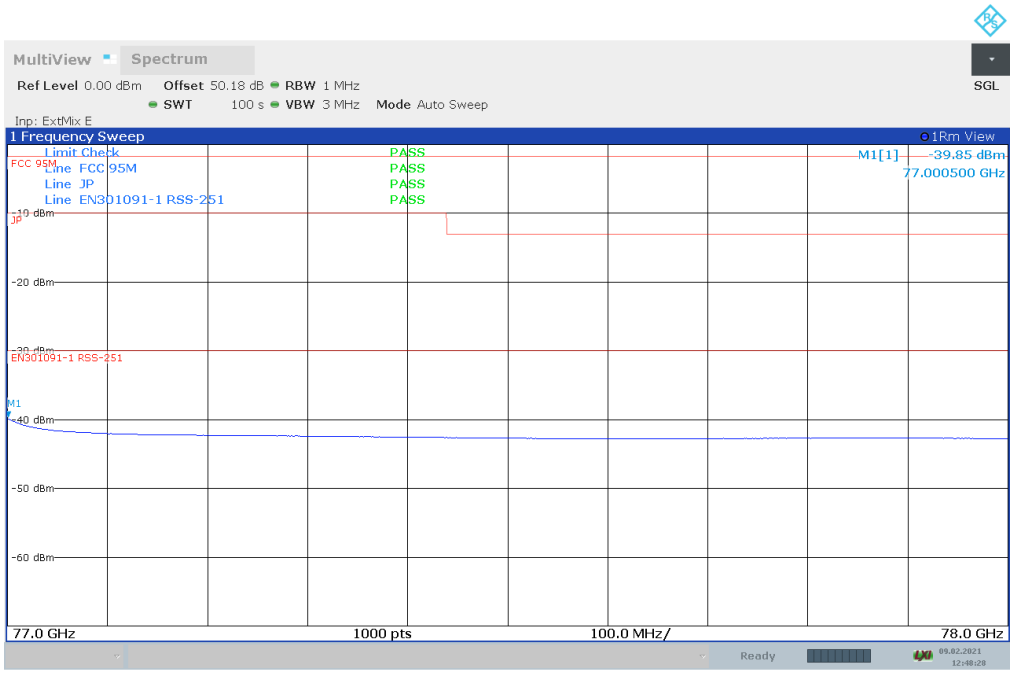

13:46:55 09.02.2021

## 5.33 60 GHz – 75 GHz, Set-up 2



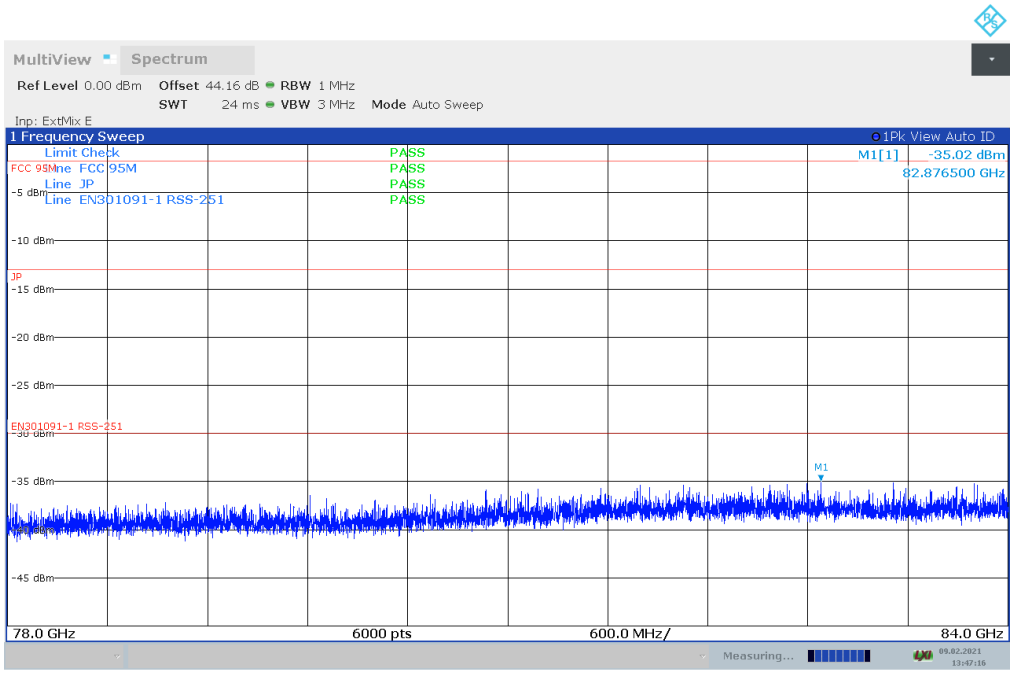

12:46:45 09.02.2021

## 5.34 75 GHz – 76 GHz, Set-up 2



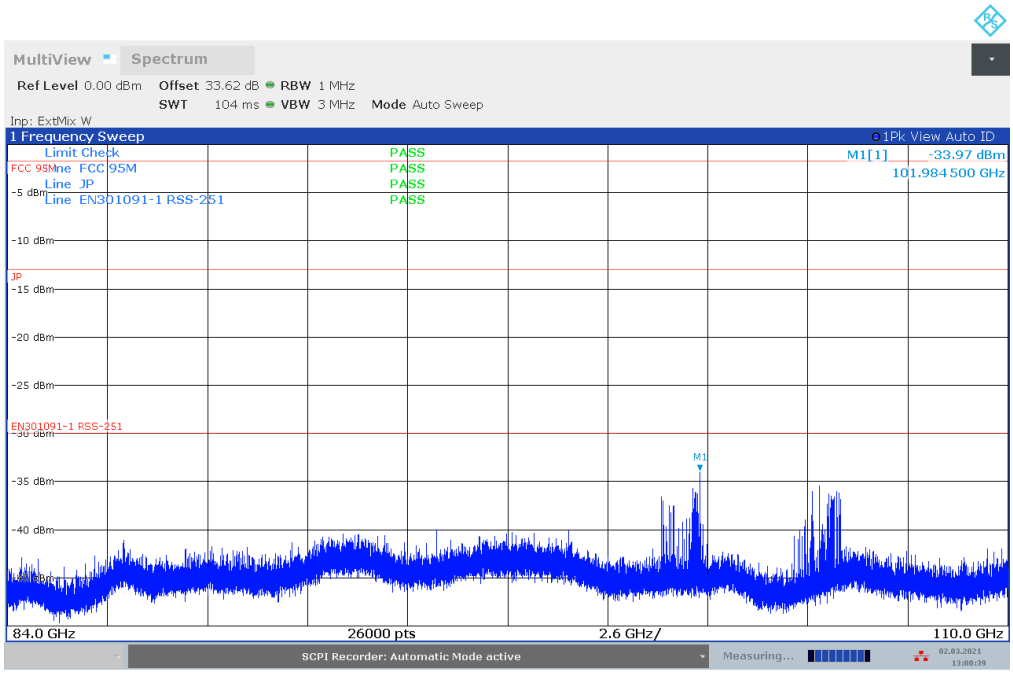

12:48:28 09.02.2021

## 5.35 77 GHz – 78 GHz, Set-up 2



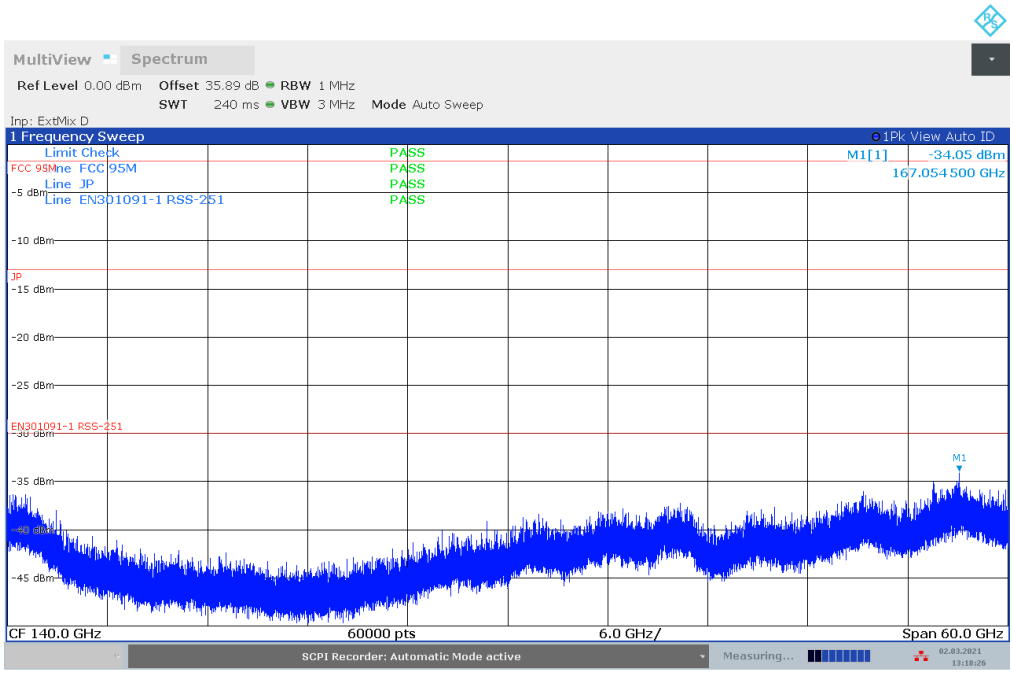

13:47:16 09.02.2021

## 5.36 78 GHz – 84 GHz, Set-up 2



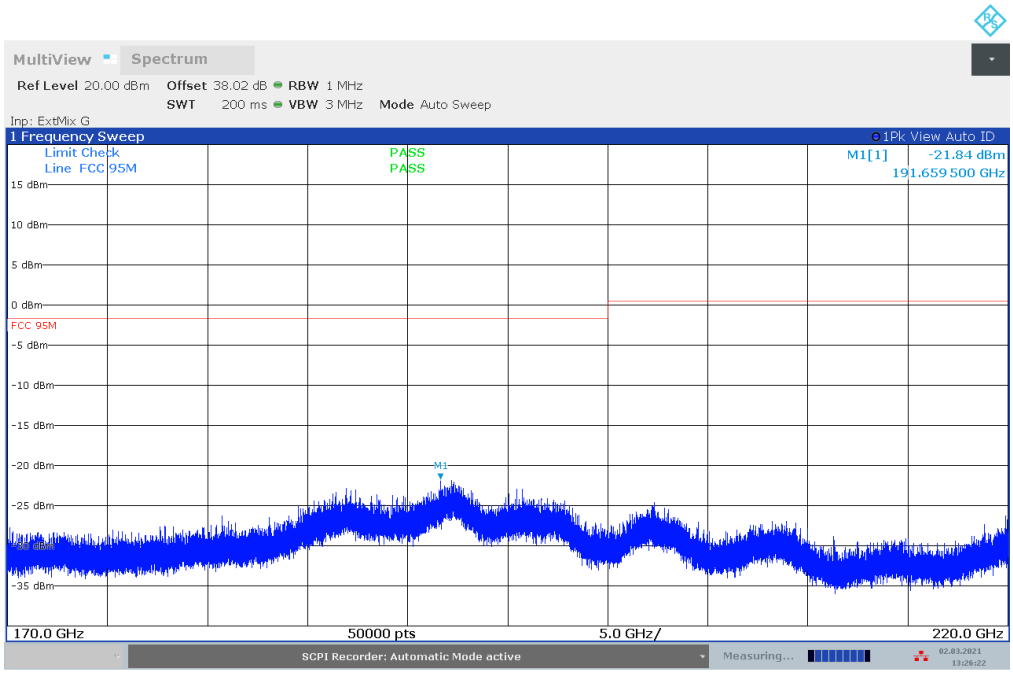

13:00:39 02.03.2021

## 5.37 84 GHz – 110 GHz, Set-up 2



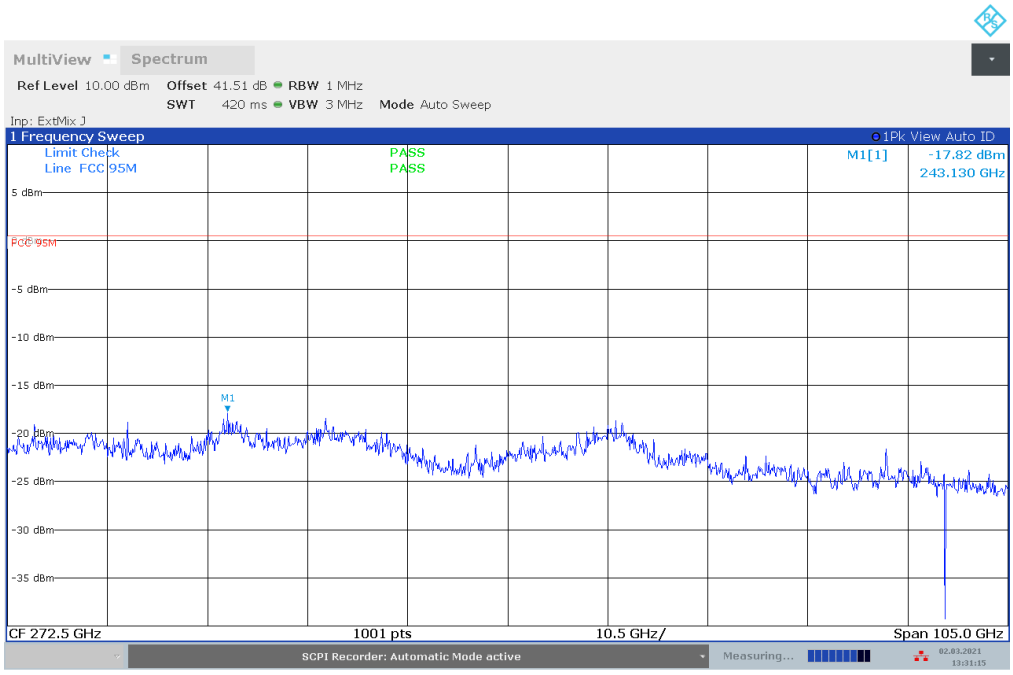

13:10:26 02.03.2021

## 5.38 110 GHz – 170 GHz, Set-up 2




13:26:22 02.03.2021

## 5.39 170 GHz – 220 GHz, Set-up 2




13:31:16 02.03.2021

## 5.40 220 GHz – 325 GHz, Set-up 2

# 6 Frequency stability

## 6.1 Peak Detector, Set-up 1, $T_{nom}/V_{nom}$

See diagram 1.2 and 1.3

## 6.2 Peak Detector, Set-up 1, $T_{nom}/V_{min}$

See diagram 1.8 and 1.9

## 6.3 Peak Detector, Set-up 1, $T_{nom}/V_{max}$

See diagram 1.11 and 1.12

## 6.4 Peak Detector, Set-up 1, $T_{min}/V_{nom}$

See diagram 1.14 and 1.15

## 6.5 Peak Detector, Set-up 1, $T_{max}/V_{nom}$

See diagram 1.17 and 1.18

## 6.6 Peak Detector, Set-up 3, $T_{nom}/V_{nom}$

See diagram 1.20 and 1.21

## 6.7 Peak Detector, Set-up 4, $T_{nom}/V_{nom}$

See diagram 1.23 and 1.24

## 6.8 Peak Detector, Set-up 3, $T_{nom}/V_{min}$

See diagram 1.26 and 1.27

## 6.9 Peak Detector, Set-up 3, $T_{nom}/V_{max}$

See diagram 1.29 and 1.30