

Report on the FCC and IC Testing of the
APTIV Services Deutschland GmbH
Vehicle Radar. Model: BFLR7
In accordance with CFR 47, Part 95, Subpart M
and
ISED RSS-251, Issue 2

Prepared for: Aptiv Services Deutschland GmbH
Am Technologiepark 1
42119 Wuppertal
Germany

FCC ID: LTQBFLR7
IC: 3659A-BFLR7



Product Service

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Date: 2025-02-05

Document Number: TR-713343793-00 | Revision: 1

| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|----------------------|-----------------|------------|---|
| Project Management | Alex Fink | 2025-02-05 |  SIGN-ID 1014038 |
| Authorised Signatory | Matthias Stumpe | 2025-02-05 |  SIGN-ID 1014331 |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 95, Subpart M and ISED Canada RSS-251. The sample tested was found to comply with the requirements defined in the applied rules.

| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|-----------------|-----------|------------|--|
| Testing | Alex Fink | 2025-02-05 |  SIGN-ID 1014038 |

Laboratory Accreditation
DAkkS Reg. No. D-PL-11321-11-03
DAkkS Reg. No. D-PL-11321-11-04

Laboratory recognition
Registration No. BNetzA-CAB-16/21-15

ISED Canada test site registration
3050A-2

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 95, Subpart M (2023), ISED Canada RSS-251 Issue 2 (2018-06).

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ACCREDITATION

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Summary

| Prüfergebnisse / Test Results | Auftragsnummer / Order No. 454540763 | |
|--|--|--|
| Die Prüfungen wurden nach folgenden Vorschriften durchgeführt: <i>Tests were performed according to:</i> CFR 47, Part 95, Subpart M ISED RSS-251, Issue 2 | | |
| Durchgeführte Prüfung Test performed | | |
| Radiated Power | Pass | |
| Occupied Bandwidth | Pass | |
| Spurious Radiated Emissions | Pass | |
| Frequency Stability | Pass | |

Bemerkungen / Remarks:

Die Prüfergebnisse beziehen sich ausschließlich auf das zur Prüfung vorgestellte Prüfmuster. Ohne schriftliche Genehmigung des Prüflabors darf der Prüfbericht auszugsweise nicht vervielfältigt werden. *The test results relate only to the individual item which has been tested. Without the written approval of the test laboratory this report may not be reproduced in extracts.*

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Annex to Test Report TR-713343793-00 | Revision: 0

Pages: 4

1 Administrative Data

| Application details | |
|------------------------------|---|
| Applicant: | APTIV Services Deutschland GmbH Am Technologiepark 1 42119 Wuppertal Germany |
| Contact person: | Ms. Sabina Pajerska |
| Intercompany contact: | TÜV SÜD Product Service GmbH GMA Straubing |
| | Mr. Thomas Ring |
| Order number: | 454540763 |
| Receipt of EUT: | 2024-09-26 |
| Return of EUT: | --- |
| Date(s) of test: | 2024-10-02 to 2024-10-18 |
| Note(s): | --- |
| Responsible for testing: | Alex Fink |
| Responsible for test report: | Alex Fink |
| Test report checked by: | Matthias Stumpe |

| Report details | |
|----------------|-----------------|
| Report number: | TR-713343793-00 |
| Revision: | 1 |
| Issue date: | 2025-02-05 |

2 Details about the Test Laboratory

Details about the Test Laboratory

| | |
|---|--|
| Company name: | TÜV SÜD Product Service GmbH |
| Address: | Äußere Frühlingstraße 45 D-94315 Straubing Germany |
| Laboratory accreditation: | DAkkS Registration No. D-PL-11321-11-03 DAkkS Registration No. D-PL-11321-11-04 |
| Laboratory recognition: | Registration No. BNetzA-CAB-16/21-15 |
| Industry Canada test site registration: | 3050A-2 |
| Contact: | Mr. Markus Biberger |
| | Phone: +49 9421 5522-0 Fax: +49 9421 5522-99 |

3 Description of the Equipment Under Test

| Equipment characteristics | |
|-----------------------------|--|
| Type designation: | BFLR7 |
| Parts of the system: | Radar ECU |
| Options and accessories: | --- |
| Type of equipment: | Vehicle Radar |
| Serial number: | --- |
| Manufacturer: | APTIV Services Deutschland GmbH |
| Hardware version: | 004.001.000 |
| Software version: | 004_018_001_I430 ATS+4 |
| Communication Protocol: | --- |
| Build status: | --- |
| Power supply: | Battery supply (regulated lead-acid) Nominal: 12.0 V DC Minimum: 6.5 V DC Maximum: 18.0 V DC Nominal frequency: N/A - DC |
| Highest internal frequency: | --- / 76.9 GHz (radio) |

Marking Plate(s)



Technical Description

The Equipment Under Test (EUT) was an Aptiv BFLR7. The EUT operates in the 76 GHz – 77 GHz band. The device employs a dynamic chirp modulated transmit array. Multiple receive antennas are used to determine target angular resolution through digital beam forming. The device is intended to be mounted at the front and rear corners of a vehicle. The EUT's normal operating voltage is DC 12 V

Antenna gain: 15.70 dBi

Modulation characteristics:

b. Non-pulsed radar

The radar is a SFW radar.

Modulation Type: Sawtooth

Sweep Bandwidth: 990 MHz

Sweep rate: 52 GHz/s

Sweep time: 19 ms

Reset time (no transmission): 31 ms

3.1 Modification Record

The table below details modifications made to the EUT during the test programme. The modifications incorporated during each test are recorded on the appropriate test pages.

| <i>Modification State</i> | <i>Description of Modification still fitted to EUT</i> | <i>Modification Fitted By</i> | <i>Date</i> |
|-----------------------------------|--|-------------------------------|----------------|
| Model: BFLR7 - Serial Number: --- | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |

4 Operation Mode and Configuration of EUT

Operation Mode(s)

Continuously Transmitting with modulation - 12.0 V DC power supply

List of ports and cables

| No. | Description | Classification ¹ | Cable type | Cable length used | Cable length maximum ² |
|-----|----------------------|-----------------------------|------------|-------------------|-----------------------------------|
| D1 | DC 12 V supply | dc power | Unshielded | 2 m | < 3 m |
| S1 | Wiring harness (CAN) | signal/control port | Unshielded | 2 m | < 3 m |

List of devices connected to EUT

| No. | Description | Type designation | Serial no. or ID | Manufacturer |
|-----|-------------|------------------|------------------|--------------|
| --- | --- | --- | --- | --- |

List of support devices

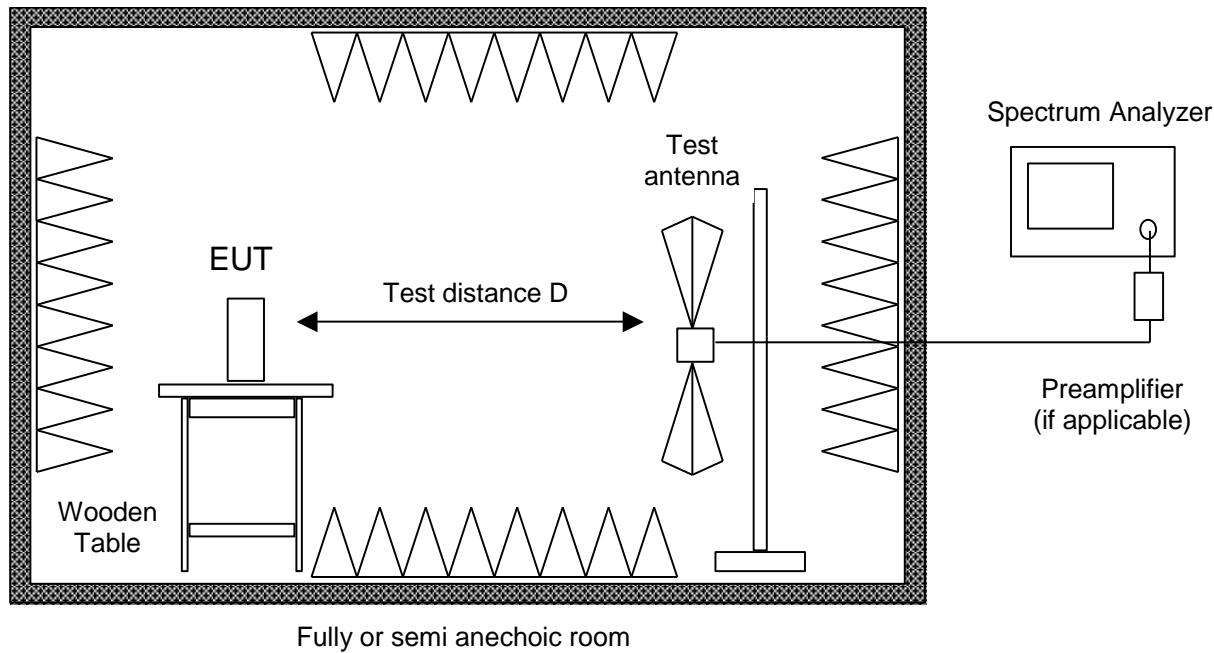
| No. | Description | Type designation | Serial no. or ID | Manufacturer |
|-----|-------------------|------------------|------------------|--------------|
| 1 | CAN/LIN-Interface | --- | --- | Vector |
| 2 | Notebook | --- | --- | Dell |

¹ Ports shall be classified as ac power, dc power or signal/control port.

² As specified by applicant

5 Test Setups

Radiated Emission in Fully or Semi Anechoic Room



Radiated emission in fully or semi anechoic room is measured in the frequency range from 30 MHz to the maximum frequency as specified in CFR 47 Part 15 section 15.33.

Measurements are made in both the horizontal and vertical planes of polarization using a spectrum analyzer with the detector function set to peak and resolution as well as video bandwidth set to 100 kHz (below 1 GHz) or 1 MHz (above 1 GHz).

Testing up to 1 GHz is performed with a linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna"). For testing above 1 GHz horn antennas are used.

All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation factor of 20 dB/decade. If required, preamplifiers are used for the whole frequency range. Special care is taken to avoid overload, using appropriate attenuators and filters, if necessary.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

During testing the EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

For final testing below 1 GHz a semi anechoic room complying with the NSA requirements of ANSI C63.4 for alternative test sites is used (see 0). If prescans are recorded in fully anechoic room they are indicated appropriately.

According to section 13 of KDB558074 the requirement for radiated emissions on the band edges was performed with a reduced bandwidth of 100 kHz instead of 1 MHz.

Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak. This configuration is also used for recording the spectrum of intentional radiators.

Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

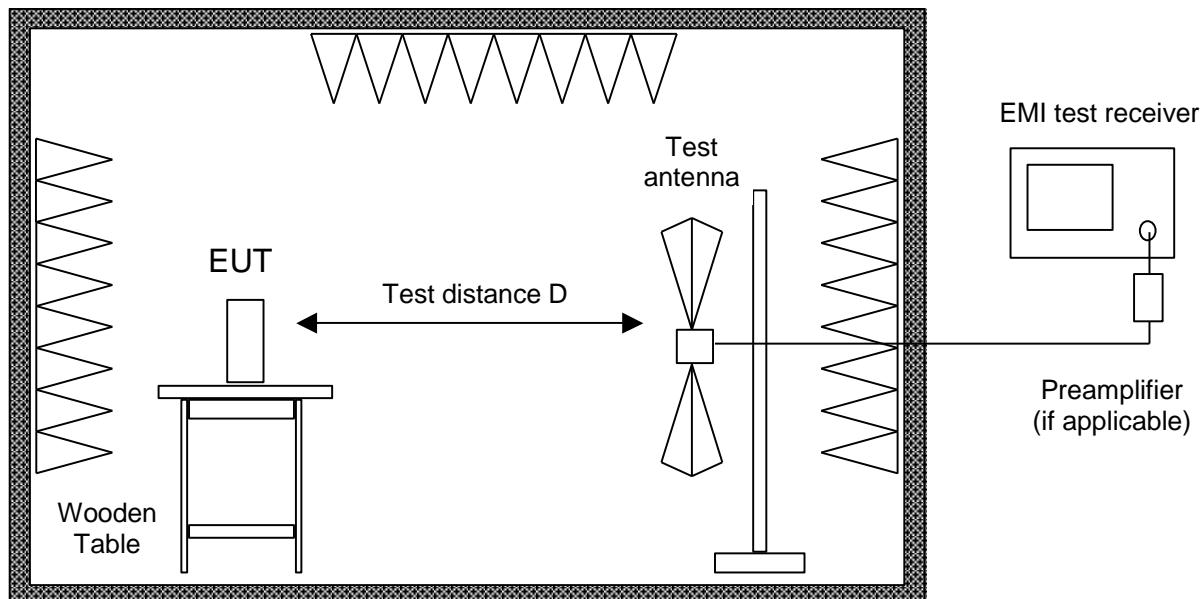
EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

If worst case emission of the EUT cannot be recorded with EUT in standard position and loop antenna in vertical polarization the EUT (or the radiating part of the EUT) is rotated by 90 degrees instead of changing the loop antenna to horizontal polarization. This procedure is selected to minimize the influence of the environment (e.g. effects caused by the floor especially with longer distances).

Final measurement is performed at a test distance D of 30 meters using an open field test site. In case the regulation requires testing at other distances, the result is extrapolated by either making measurements at an additional distance D of 10 meters to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). In cases of very low emissions measurements are performed at shorter distances and results are extrapolated to the required distance. The provisions of CFR 47 Part 15 sections 15.31(d) and (f)(2) apply. According to CFR 47 Part 15 section 15.209(d) final measurement is performed with detector function set to quasi-peak except for the frequency bands 9 to 90 kHz and 110 to 490 kHz where, for non-pulsed operation, average detector is employed.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Radiated Emission at Alternative Test Site



Alternate test site (semi anechoic room)

Radiated emission in the frequency range 30 MHz to 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4 for alternative test sites. A linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used. The measurement bandwidth of the test receiver is set to 120 kHz with quasi-peak detector selected.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Hand-held or body-worn devices are tested in the position producing the highest emission relative to the limit as verified by prescans in fully anechoic room.

If no prescan in a fully anechoic room is used first a peak scan is performed in four positions to get the whole spectrum of emission caused by EUT with the measuring antenna raised and lowered from 1 to 4 m to find table position, antenna height and antenna polarization for the maximum emission levels.

Data reduction is applied to these results to select those levels having less margin than 10 dB to or exceeding the limit using subranges and limited number of maximums. Further maximization is following.

With detector of the test receiver set to quasi-peak final measurements are performed immediately after frequency zoom (for drifting disturbances) and maximum adjustment.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

In cases where prescans in a fully anechoic room are taken (e. g. if EUT is operating for a short time only or battery is discharged quickly) final measurements with quasi-peak detector are performed manually at frequencies indicated by prescan with EUT rotating all around and receiving antenna raising and lowering within 1 meter to 4 meters to find the maximum levels of emission.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

For measuring emissions of intentional radiators and receivers a test distance D of 3 meters is selected. Testing of unintentional radiators is performed at a distance of 10 meters. If limits specified for 3 meters shall be used for measurements performed at 10 meters distance the limits are calculated according to CFR 47 Part 15 section 15.31(d) and (f)(1) using an inverse linear-distance extrapolation factor of 20 dB/decade.

6 Referenced Regulations

| Publication | Title |
|--|---|
| CFR 47, Part 2 | Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communications Commission (FCC) |
| CFR 47, Part 95, Subpart M | Code of Federal Regulations Part 95 (Personal Radio Services), Subpart M (76 – 77 GHz Band Radar Service) of the Federal Communications Commission (FCC) |
| RSS-251, Issue 2 | Vehicular Radar and Airport Fixed or Mobile Radar in the 76 – 81 GHz Frequency band |
| RSS-GEN, Issue 5 + Amendment 1 + Amendment 2 | General Requirements for Compliance of Radio Apparatus |
| ANSI C63.4-2014 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |

7 Measurement Uncertainty Values

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to EN 55016-4-2: 2011 + A1 + A2 + AC and CISPR16-4-2: 2011 + A1 + A2 + Cor1 (UCISPR). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

For a 95% confidence level, the measurement uncertainties for defined systems are:

| Radio Testing | | | |
|---|------|----------------------|------|
| Test Name | kp | Expanded Uncertainty | Note |
| Occupied Bandwidth | 2.0 | ±1.14 % | 2 |
| RF-Frequency error | 1.96 | ±1 · 10-7 | 7 |
| RF-Power, conducted carrier | 2 | ±0.079 dB | 2 |
| RF-Power uncertainty for given BER | 1.96 | +0.94 dB / -1.05 | 7 |
| RF power, conducted, spurious emissions | 1.96 | +1.4 dB / -1.6 dB | 7 |
| RF power, radiated | | | |
| 25 MHz – 4 GHz | 1.96 | +3.6 dB / -5.2 dB | 8 |
| 1 GHz – 18 GHz | 1.96 | +3.8 dB / -5.6 dB | 8 |
| 18 GHz – 26.5 GHz | 1.96 | +3.4 dB / -4.5 dB | 8 |
| 40 GHz – 170 GHz | 1.96 | +4.2 dB / -7.1 dB | 8 |
| Spectral Power Density, conducted | 2.0 | ±0.53 dB | 2 |
| Maximum frequency deviation | | | |
| 300 Hz – 6 kHz | 2 | ±2,89 % | 2 |
| 6 kHz – 25 kHz | 2 | ±0.2 dB | 2 |
| Maximum frequency deviation for FM | 2 | ±2,89 % | 2 |
| Adjacent channel power 25 MHz – 1 GHz | 2 | ±2.31 % | 2 |
| Temperature | 2 | ±0.39 K | 4 |
| (Relative) Humidity | 2 | ±2.28 % | 2 |
| DC- and low frequency AC voltage | | | |
| DC voltage | 2 | ±0.01 % | 2 |
| AC voltage up to 1 kHz | 2 | ±1.2 % | 2 |
| Time | 2 | ±0.6 % | 2 |

| Radio Interference Emission Testing | | | |
|---|----|----------------------|------|
| Test Name | kp | Expanded Uncertainty | Note |
| Conducted Voltage Emission | | | |
| 9 kHz to 150 kHz (50Ω/50µH AMN) | 2 | ± 3.8 dB | 1 |
| 150 kHz to 30 MHz (50Ω/50µH AMN) | 2 | ± 3.4 dB | 1 |
| 100 kHz to 200 MHz (50Ω/5µH AMN) | 2 | ± 3.6 dB | 1 |
| Discontinuous Conducted Emission | | | |
| 9 kHz to 150 kHz (50Ω/50µH AMN) | 2 | ± 3.8 dB | 1 |
| 150 kHz to 30 MHz (50Ω/50µH AMN) | 2 | ± 3.4 dB | 1 |
| Conducted Current Emission | | | |
| 9 kHz to 200 MHz | 2 | ± 3.5 dB | 1 |
| Magnetic Fieldstrength | | | |
| 9 kHz to 30 MHz (with loop antenna) | 2 | ± 3.9 dB | 1 |
| 9 kHz to 30 MHz (large-loop antenna 2 m) | 2 | ± 3.5 dB | 1 |
| Radiated Emission | | | |
| Test distance 1 m (ALSE) | | | |
| 9 kHz to 150 kHz | 2 | ± 4.6 dB | 1 |
| 150 kHz to 30 MHz | 2 | ± 4.1 dB | 1 |
| 30 MHz to 200 MHz | 2 | ± 5.2 dB | 1 |
| 200 MHz to 2 GHz | 2 | ± 4.4 dB | 1 |
| 2 GHz to 3 GHz | 2 | ± 4.6 dB | 1 |
| Test distance 3 m | | | |
| 30 MHz to 300 MHz | 2 | ± 4.9 dB | 1 |
| 300 MHz to 1 GHz | 2 | ± 5.0 dB | 1 |
| 1 GHz to 6 GHz | 2 | ± 4.6 dB | 1 |
| Test distance 10 m | | | |
| 30 MHz to 300 MHz | 2 | ± 4.9 dB | 1 |
| 300 MHz to 1 GHz | 2 | ± 4.9 dB | 1 |
| Radio Interference Power | | | |
| 30 MHz to 300 MHz | 2 | ± 3.5 dB | 1 |
| Harmonic Current Emissions | | | 4 |
| Voltage Changes, Voltage Fluctuations and Flicker | | | 4 |

| Immunity Testing | | | |
|--|------|----------------------|------|
| Test Name | kp | Expanded Uncertainty | Note |
| Electrostatic Discharges | | | 4 |
| Radiated RF-Field | | | |
| Pre-calibrated field level | 2 | +32.2 / -24.3 % | 5 |
| Dynamic feedback field level | 2.05 | +21.2 / -17.5 % | 3 |
| Electrical Fast Transients (EFT) / Bursts | | | 4 |
| Surges | | | 4 |
| Conducted Disturbances, induced by RF-Fields | | | |
| via CDN | 2 | +15.1 / -13.1 % | 6 |
| via EM clamp | 2 | +42.6 / -29.9 % | 6 |
| via current clamp | 2 | +43.9 / -30.5 % | 6 |
| Power Frequency Magnetic Field | 2 | +20.7 / -17.1 % | 2 |
| Pulse Magnetic Field | | | 4 |
| Voltage Dips, Short Interruptions and Voltage Variations | | | 4 |
| Oscillatory Waves | | | 4 |
| Conducted Low Frequency Disturbances | | | |
| Voltage setting | 2 | ± 0.9 % | 2 |
| Frequency setting | 2 | ± 0.1 % | 2 |
| Electrical Transient Transmission in Road Vehicles | | | 4 |

Note 1:

The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of $kp = 2$, providing a level of confidence of $p = 95.45\%$

Note 2:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $kp = 2$, providing a level of confidence of $p = 95.45\%$

Note 3:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $kp = 2.05$, providing a level of confidence of $p = 95.45\%$

Note 4:

It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95% confidence.

Note 5:

The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of $kp = 2$, providing a level of confidence of $p = 95.45\%$

Note 6:

The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of $kp = 2$, providing a level of confidence of $p = 95.45\%$

Note 7:

The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of $kp = 1.96$, providing a level of confidence of $p = 95.45\%$

Note 8:

The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of $kp = 1.96$, providing a level of confidence of $p = 95.45\%$

8 Test Equipment used

| T-ID | Designation | Type | Last Cal. | Next Cal. |
|-------|--------------------------------|------------------|-----------|-----------|
| 18874 | Horn antenna | 3160-07 | | Verified |
| 18875 | Horn antenna | 3160-08 | | Verified |
| 19125 | Horn antenna | 3160-09 | | Verified |
| 19442 | Horn antenna | 3160-10 | | Verified |
| 39897 | EMI test receiver | ESW44 | 2024-04 | 2025-04 |
| 19933 | Double ridged horn antenna | HF907 | 2023-08 | 2025-08 |
| 19946 | Horn antenna | 24240-20 | | Verified |
| 20219 | Signal and Spectrum Analysator | FSV40 for TS8997 | 2024-03 | 2026-03 |
| 22553 | Waveguide mixer | FS-Z170 | 2023-06 | 2026-06 |
| 25849 | Waveguide mixer | FS-Z60 | 2023-06 | 2026-06 |
| 25850 | Waveguide mixer | FS-Z90 | 2023-06 | 2026-06 |
| 25851 | Waveguide mixer | FS-Z110 | 2023-06 | 2026-06 |
| 27898 | Horn antenna | 26240-20 | | Verified |
| 27899 | Horn antenna | 27240-20 | | Verified |
| 36954 | Harmonic Mixer | FS-Z220 | 2023-06 | 2026-06 |
| 36955 | Harmonic Mixer | FS-Z325 | 2023-06 | 2026-06 |
| 37863 | Horn antenna | 30240-20 WG30 | | Verified |
| 37864 | Horn antenna | 32240-20 WG32 | | Verified |
| 38401 | ULTRALOG Antenna | HL562E | 2023-01 | 2026-01 |

Test software for: EMC32 V10.

9 Test Results

| CFR 47, Part 2 | | | |
|--------------------------|-----------------------|-------------|--------------------|
| <i>Section(s)</i> | <i>Test performed</i> | <i>Page</i> | <i>Test Result</i> |
| § 2.202 (a); § 2.1049 | Occupied Bandwidth | 23 | Test passed |

| CFR 47, Part 95, Subpart M, | | | |
|------------------------------------|--------------------------|-------------|--------------------|
| <i>Section(s)</i> | <i>Test performed</i> | <i>Page</i> | <i>Test Result</i> |
| § 95.3367 (a) | Radiated Power – Average | 21 | Test passed |
| § 95.3367 (b) | Radiated Power – Peak | 21 | Test passed |
| § 95.3379 (a) | Spurious Emissions | 25 | Test passed |
| § 95.3379 (b) | Frequency Stability | 36 | Test passed |

ISED RSS-GEN, Issue 5 + Amendment 1 + Amendment 2

| <i>Section(s)</i> | <i>Test performed</i> | <i>Page</i> | <i>Test Result</i> |
|-------------------|-----------------------|-------------|--------------------|
| 6.7 | Occupied Bandwidth | 23 | Test passed |

ISED RSS-251, Issue 2

| <i>Section(s)</i> | <i>Test performed</i> | <i>Page</i> | <i>Test Result</i> |
|-------------------|--|-------------|--------------------|
| 7 | Occupied Bandwidth | 23 | Test passed |
| 8 | Average equivalent isotropically radiated power (e.i.r.p.) | 21 | Test passed |
| 9 | Peak (e.i.r.p.) | 21 | Test passed |
| 10 | Unwanted Emissions | 25 | Test passed |
| 11 | Frequency Stability | 36 | Test passed |

9.1 Radiated Power

| | | |
|--------------|----------------------------------|--|
| Date of Test | 2024-10-02 | Test Result |
| Operator | Alex Fink | <input checked="" type="checkbox"/> Passed |
| Test Site | Semi anechoic room, cabin no. 11 | <input type="checkbox"/> Not Passed |

| | |
|----------------------|---------|
| Barometric pressure: | 989 hPa |
| Relative humidity: | 32 % |
| Ambient temperature: | 23 °C |

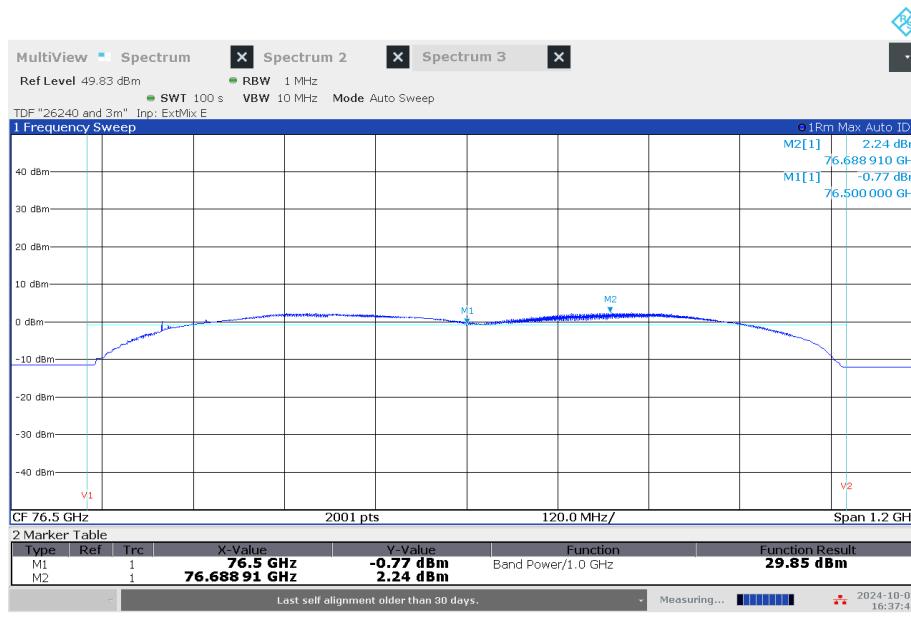
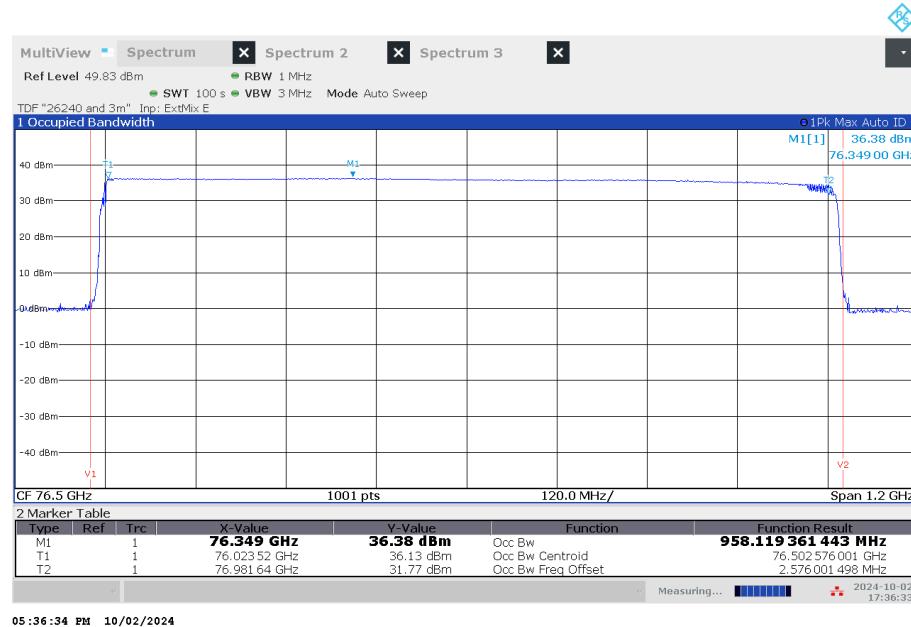
| | |
|-----------------|---|
| Specifications: | Part 95, Subpart M, § 95.3367(a) and (b) RSS-251 Issue 2, Sections 8 and 9 |
| Description: | <p>The fundamental radiated emission limits within the 76 – 81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:</p> <p>Part 95, Subpart M, § 95.3367(a) and (b):</p> <ul style="list-style-type: none"> a) The maximum power (EIRP) within the 76 – 81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW). b) The maximum peak power (EIRP) within the 76 – 81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW. <p>RSS-251 Issue 2, Sections 8 and 9:</p> <ul style="list-style-type: none"> 8) The radar device's total average e.i.r.p. shall not exceed 50 dBm over the occupied bandwidth. 9) The radar device's peak e.i.r.p. spectral density shall not exceed 55 dBm/MHz |
| Operation mode: | Transmitting continuously on frequency with modulation. |
| Comment : | Test was performed as radiated test. The test distance was 3 m. A correction factor and mixer conversion loss table were used to account for the test antenna gain, free-space loss and external mixer loss. |

| Detector | Default mode | Limit | Note |
|-------------------------|--------------|--------|---------|
| Average (peak value) | 2.24 dBm | 50 dBm | 1 |
| Average (band function) | 29.85 dBm | 50 dBm | 2 |
| Peak | 36.38 dBm | 55 dBm | 1 and 2 |

Note(s):

- 1 Applicable for FCC rules
- 2 Applicable for ISED rules

Plots taken during test



Operating mode – Continuously Transmitting - 12.0 V DC power supply

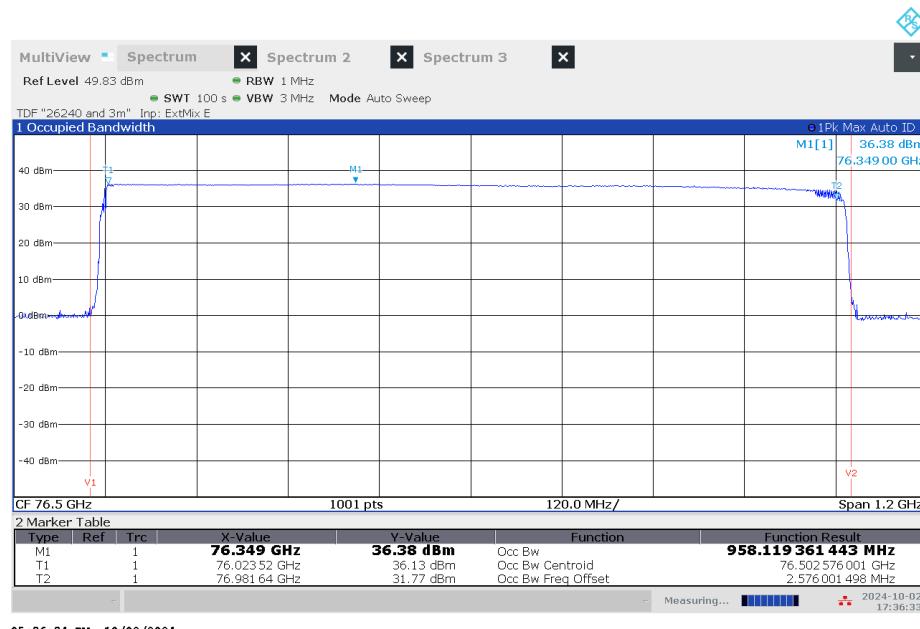
9.2 Occupied Bandwidth

| | | |
|--------------|----------------------------------|--|
| Date of Test | 2024-10-02 | Test Result |
| Operator | Alex Fink | <input checked="" type="checkbox"/> Passed |
| Test Site | Semi anechoic room, cabin no. 11 | <input type="checkbox"/> Not Passed |

| | |
|----------------------|---------|
| Barometric pressure: | 989 hPa |
| Relative humidity: | 32 % |
| Ambient temperature: | 23 °C |

| | |
|-----------------|---|
| Specifications: | CFR 47, Part 2, Clause 2.1049 and 2.202(a) RSS-GEN Issue 4, Section 6.6 RSS-251, Issue 2, Section 7 |
| Description: | The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. |
| Operation mode: | The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. |
| Comment : | Transmitting continuously on frequency with modulation. |

| | <i>Default mode</i> | <i>Limit</i> | <i>Note</i> |
|----------------------------------|---------------------|-----------------------|-------------|
| f_L | 76.02352 GHz | ≥ 76 GHz | NA |
| f_H | 76.98164 GHz | ≤ 77 GHz | |
| 99% bandwidth ($f_H - f_L$) | 958.119361443 MHz | within 76-81 GHz band | NA |
| <i>Note(s):</i> | | | NA |



Operating mode - Continuously Transmitting - 12.0 V DC power supply

9.3 Spurious Radiated Emissions

| | | |
|--------------|--|--|
| Date of Test | 2024-10-02 to 2024-10-08 | Test Result |
| Operator | Alex Fink | <input checked="" type="checkbox"/> Passed |
| Test Site | Fully anechoic room, cabin no. 2 Semi anechoic room, cabin no. 11 | <input type="checkbox"/> Not Passed |

| | |
|----------------------|---------|
| Barometric pressure: | 973 hPa |
| Relative humidity: | 33 % |
| Ambient temperature: | 23 °C |

| | |
|-----------------|--|
| Specifications: | CFR 47, Part 95, Subpart M, § 95.3379(a) RSS-251 Issue 2, Section 10 |
| Description: | The power density of any emissions outside the 76 – 81 GHz band shall consist solely of spurious emissions and shall not exceed the following: Radiated emissions below 40 GHz shall not exceed the field strength as shown in the Table 1. The power density of radiated of radiated emissions outside the 76 – 81 GHz band above 40 GHz shall not exceed the power density as shown in the tables on the next pages. |
| Operation mode: | This test was performed as radiated test in the frequency range 30 MHz to 300 GHz. No significant spurious emissions were observed. The test distance was 3 m in the frequency ranges 30 MHz to 1 GHz and 18 GHz to 40 GHz, 1 m in the frequency ranges 1 GHz to 18 GHz, 40 GHz to 60 GHz and 170 GHz to 220 GHz and 0.5 m in the frequency range 60 GHz to 170 GHz and 220 GHz to 300 GHz. |
| Comment : | See plots for details. |

Sample calculation of field final values:

$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value (dB}\mu\text{V)} + (\text{Antenna Correction Factor (dB/m)} + \text{Cable Correction Factor (dB)})$$

| Radiated emission limits 9 kHz – 40 GHz | | |
|---|-----------------------------|--------------------------|
| Frequency (MHz) | Field strength (μ V/m) | Measurement distance (m) |
| 0.009 – 0.490 | 2400/f(kHz) | 300 |
| 0.490 – 1.705 | 24000/f(kHz) | 30 |
| 1.705 – 30 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| 960 – 40000 | 500 | 3 |

Note(s):

- 1 In the emissions table the tighter limit applies at the band edges.
- 2 The limits are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emission shall not exceed the level of the fundamental frequency.
- 3 The emissions limits shown in the table are based on measurement employing CISPR quasi-peak detector except for the frequency bands 9.0 – 90 kHz, 110.0 – 490 kHz, and above 1 GHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with 1 MHz RBW.

Table 1: Radiated emission limits 9 kHz – 40 GHz

| Radiated emission limits 40 GHz – 231 GHz | | |
|---|-------------------------------------|--------------------------|
| Frequency (GHz) | Power Density (pW/cm ²) | Measurement distance (m) |
| 40 – 200 | 600 | 3 |
| above | 1000 | 3 |

Note(s):

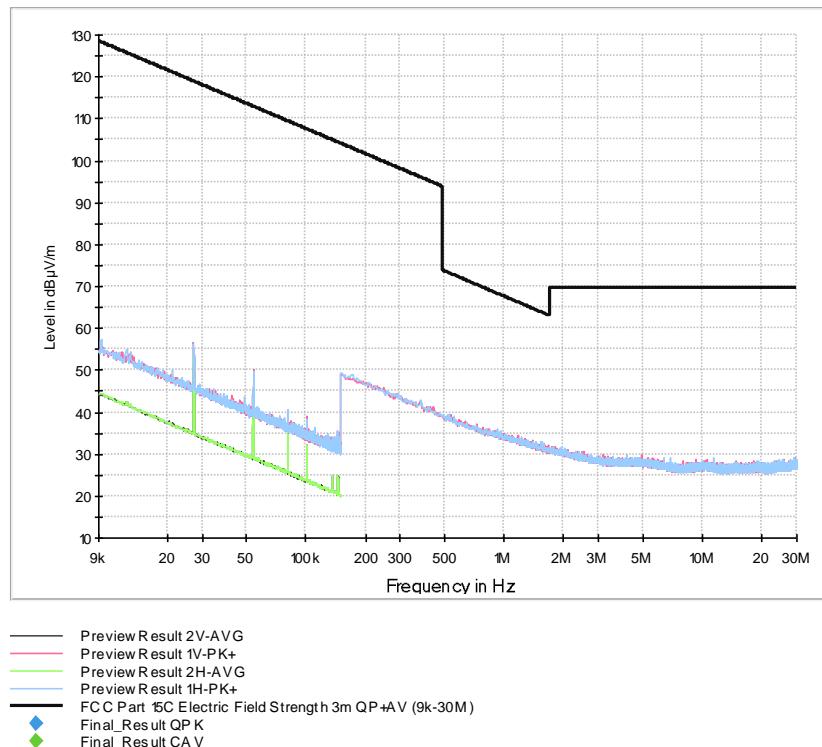
- 1 According to 47 CFR, Part 95, § 95.3379(a)(3) the spectrum shall be investigated up to 231 GHz.
- 2 The power density of 600 pW/cm² corresponds to a transmit power of -1.69 dBm, a field strength of 93.5 dB μ V/m for 3 m distance and 103.1 dB μ V/m for 1 m distance
- 3 The power density of 1000 pW/cm² corresponds to a field strength of 95.8 dB μ V/m for 3 m distance, 105.3 dB μ V/m for 1 m distance and 111.3 dB μ V/m for 0.5 m distance.

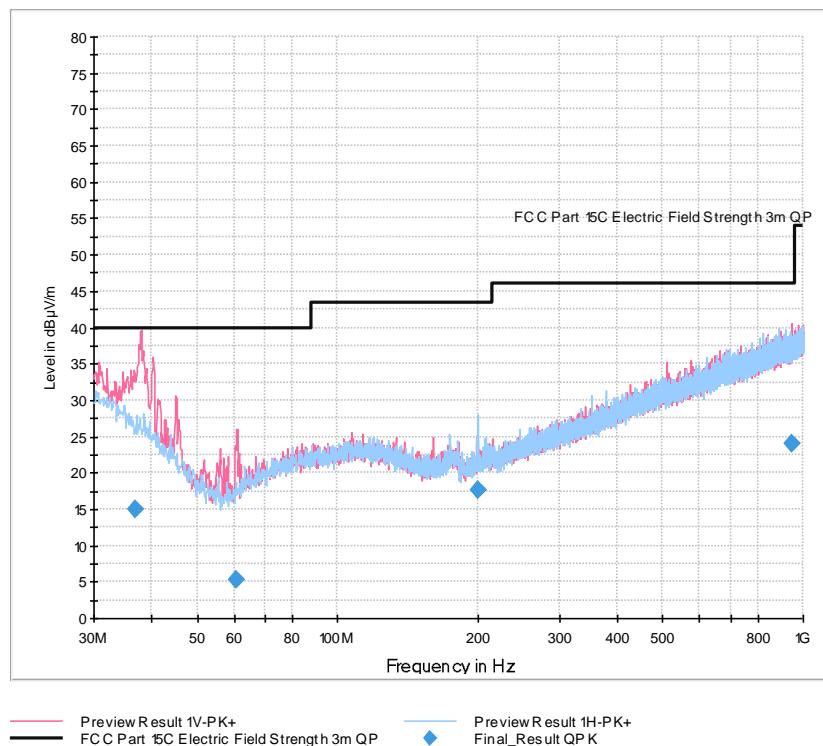
Table 2: FCC Radiated emission limits above 40 GHz

| <i>Radiated emission limits 40 GHz – 162 GHz</i> | | |
|---|---------------------------------|-----------------|
| <i>Frequency (GHz)</i> | <i>Limit (dBm/MHz e.i.r.p.)</i> | <i>Detector</i> |
| 40 – 162 | -30 | RMS |
| <i>Note(s):</i> | | |
| 1 For radar devices that operate solely in the 76 – 76 GHz Band (i.e. the occupied bandwidth is entirely contained in the 76 – 77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5 – 76 GHz band. Outside the 73.5 – 76 GHz band, the unwanted emission limits prescribed above shall apply. | | |

Table 3: ISED Radiated emission limits above 40 GHz

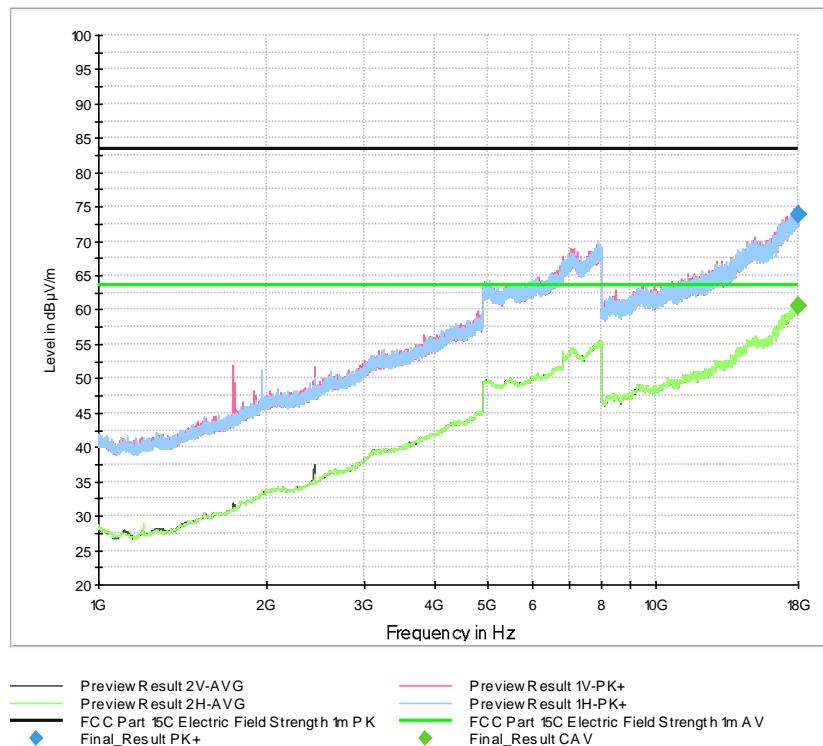
Plots taken during measurement: Continuously Transmitting





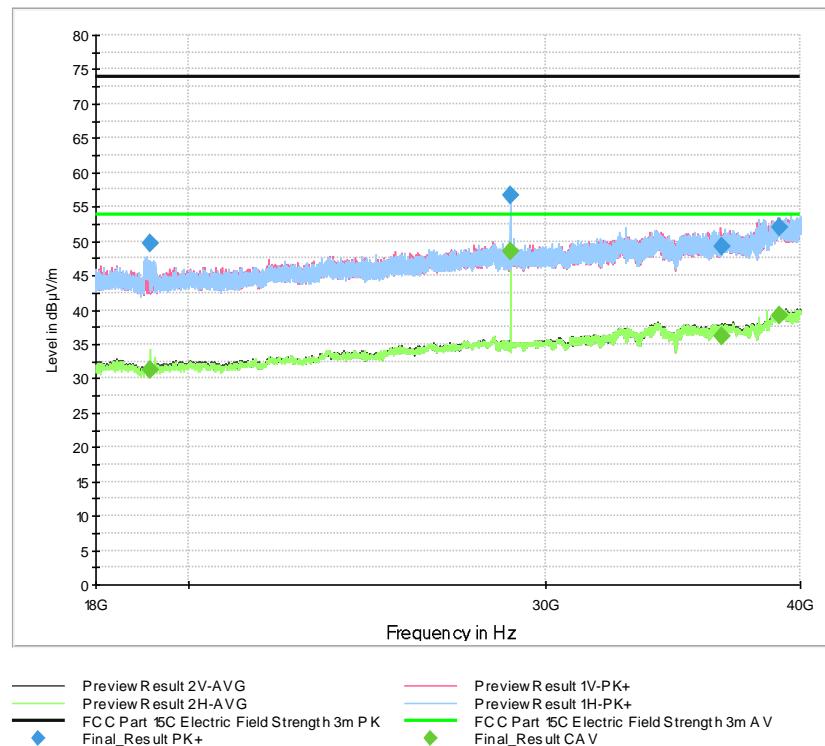
Final Results:

| Frequency MHz | QuasiPeak $\text{dB}\mu\text{V}/\text{m}$ | Limit $\text{dB}\mu\text{V}/\text{m}$ | Margin dB | Meas. Time ms | Bandwidth kHz | Height cm | Pol | Azimuth deg | Corr. dB/m |
|------------------|--|--|--------------|---------------------|------------------|--------------|-----|----------------|-------------------------------|
| 36.994000 | 14.93 | 40.00 | 25.07 | 1000.0 | 120.000 | 323.0 | V | 129.0 | 21.2 |
| 60.756000 | 5.36 | 40.00 | 34.64 | 1000.0 | 120.000 | 281.0 | V | 117.0 | 12.0 |
| 200.004000 | 17.68 | 43.50 | 25.82 | 1000.0 | 120.000 | 175.0 | H | 119.0 | 15.4 |
| 947.359000 | 23.95 | 46.02 | 22.07 | 1000.0 | 120.000 | 373.0 | V | 212.0 | 30.6 |



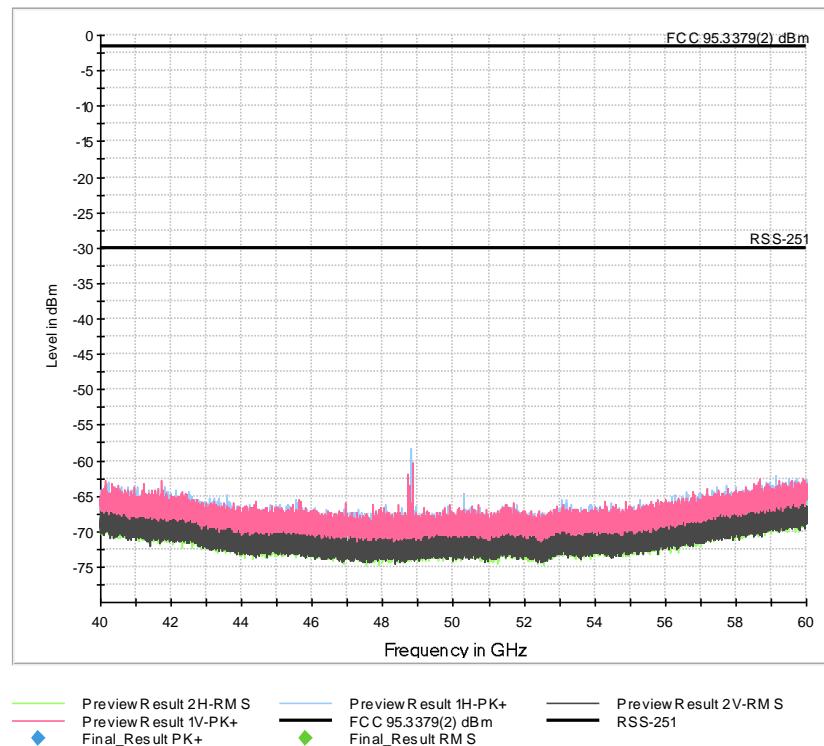
Final Results:

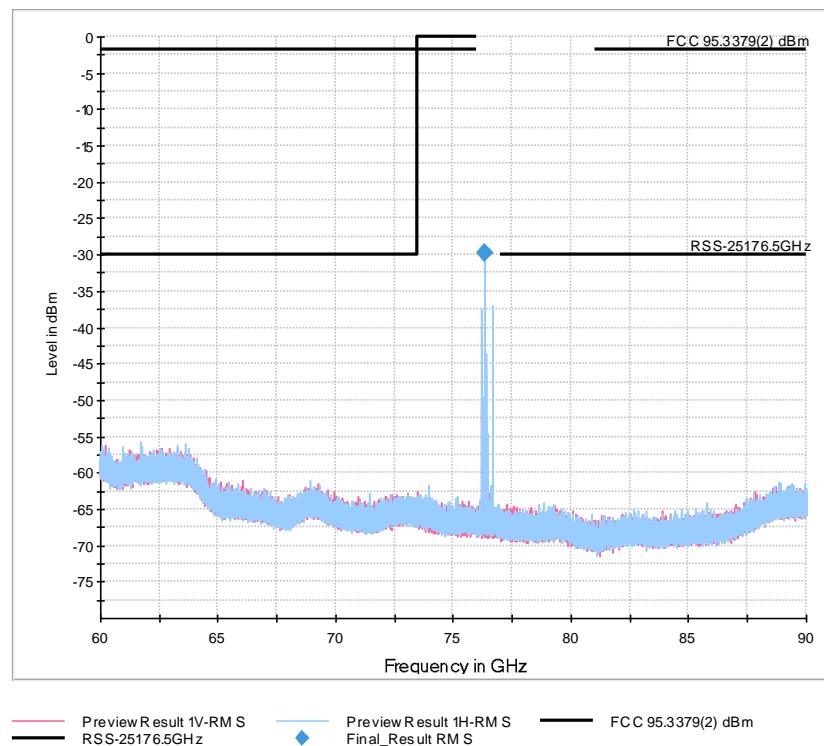
| Frequency MHz | MaxPeak dB μ V/m | CAverage dB μ V/m | Limit dB μ V/m | Margin dB | Meas. Time ms | Bandwidth kHz | Height cm | Pol | Azimuth deg | Corr. dB/m |
|------------------|-------------------------|--------------------------|-----------------------|--------------|---------------------|------------------|--------------|-----|----------------|---------------|
| 17953.250000 | --- | 60.63 | 63.50 | 2.87 | 1000.0 | 1000.000 | 114.0 | H | 45.0 | 59.0 |
| 17953.250000 | 73.86 | --- | 83.50 | 9.64 | 1000.0 | 1000.000 | 114.0 | H | 45.0 | 59.0 |



Final Results:

| Frequency MHz | MaxPeak dB μ V/m | CAverage dB μ V/m | Limit dB μ V/m | Margin dB | Meas. Time ms | Bandwidth kHz | Height cm | Pol | Azimuth deg | Corr. dB/m |
|------------------|-------------------------|--------------------------|-----------------------|--------------|---------------------|------------------|--------------|-----|----------------|---------------|
| 19133.000000 | --- | 31.33 | 53.98 | 22.64 | 1000.0 | 1000.000 | 228.0 | H | 140.0 | 24.5 |
| 19133.000000 | 49.56 | --- | 73.98 | 24.41 | 1000.0 | 1000.000 | 228.0 | H | 140.0 | 24.5 |
| 28799.500000 | 56.62 | --- | 73.98 | 17.36 | 1000.0 | 1000.000 | 252.0 | H | -111.0 | 31.7 |
| 28799.500000 | --- | 48.47 | 53.98 | 5.51 | 1000.0 | 1000.000 | 245.0 | H | -113.0 | 31.7 |
| 36588.250000 | --- | 36.14 | 53.98 | 17.84 | 1000.0 | 1000.000 | 120.0 | V | -101.0 | 33.5 |
| 36588.250000 | 49.18 | --- | 73.98 | 24.80 | 1000.0 | 1000.000 | 120.0 | V | -101.0 | 33.5 |
| 39041.750000 | 52.08 | --- | 73.98 | 21.90 | 1000.0 | 1000.000 | 125.0 | V | -85.0 | 35.3 |
| 39041.750000 | --- | 39.21 | 53.98 | 14.77 | 1000.0 | 1000.000 | 125.0 | V | -85.0 | 35.3 |

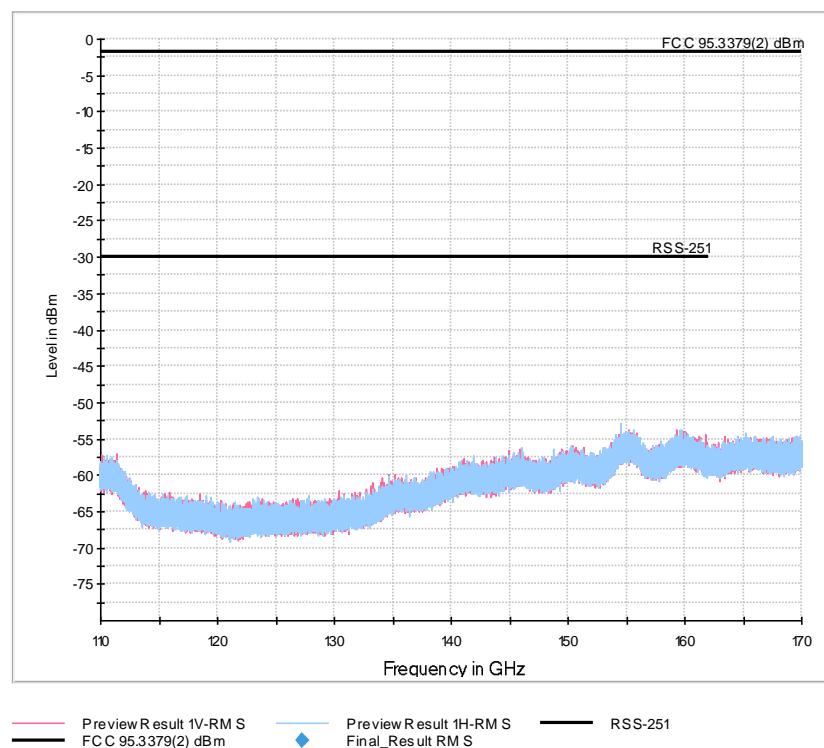
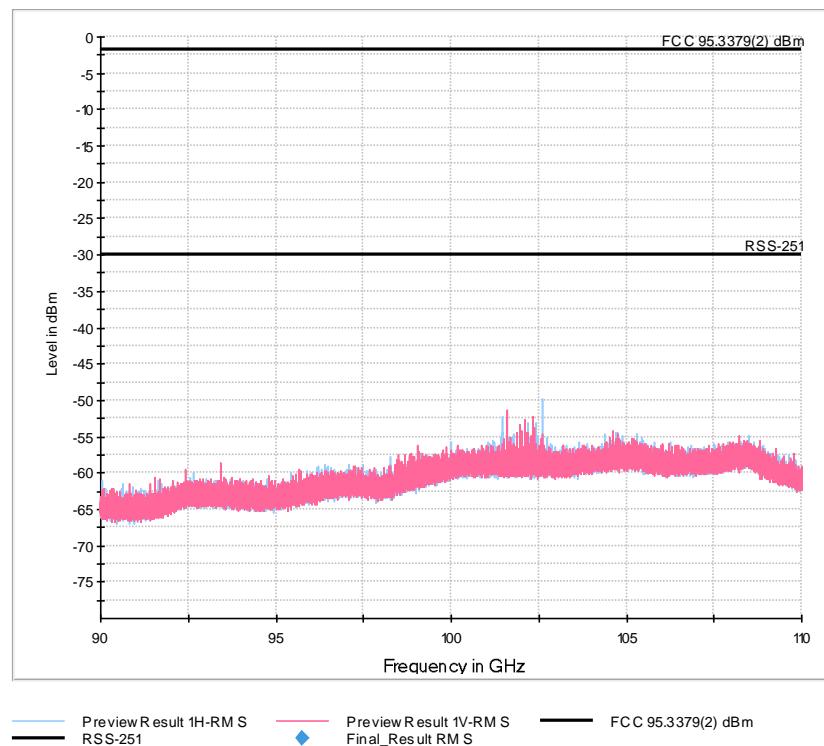


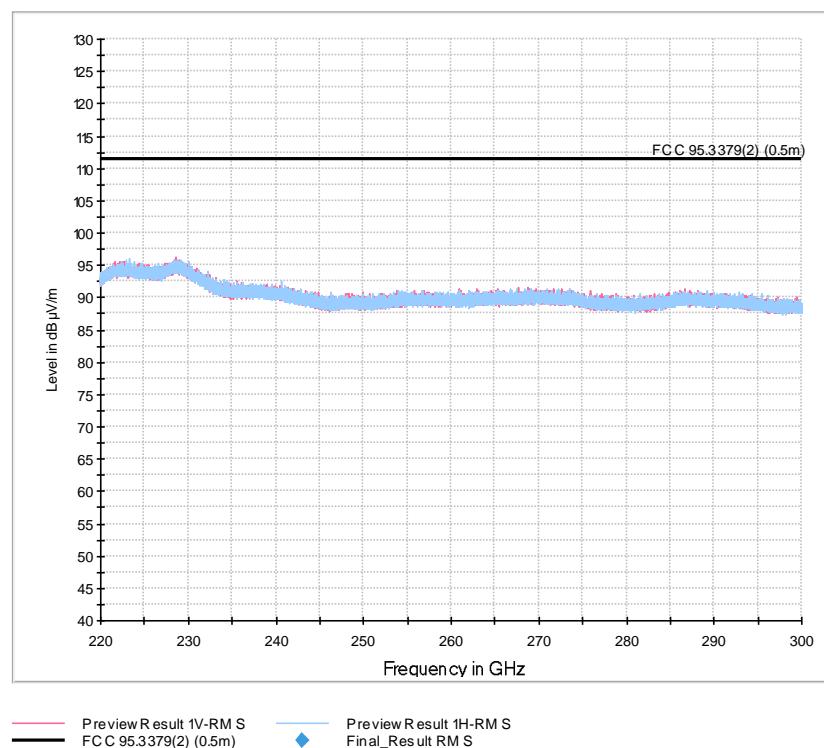
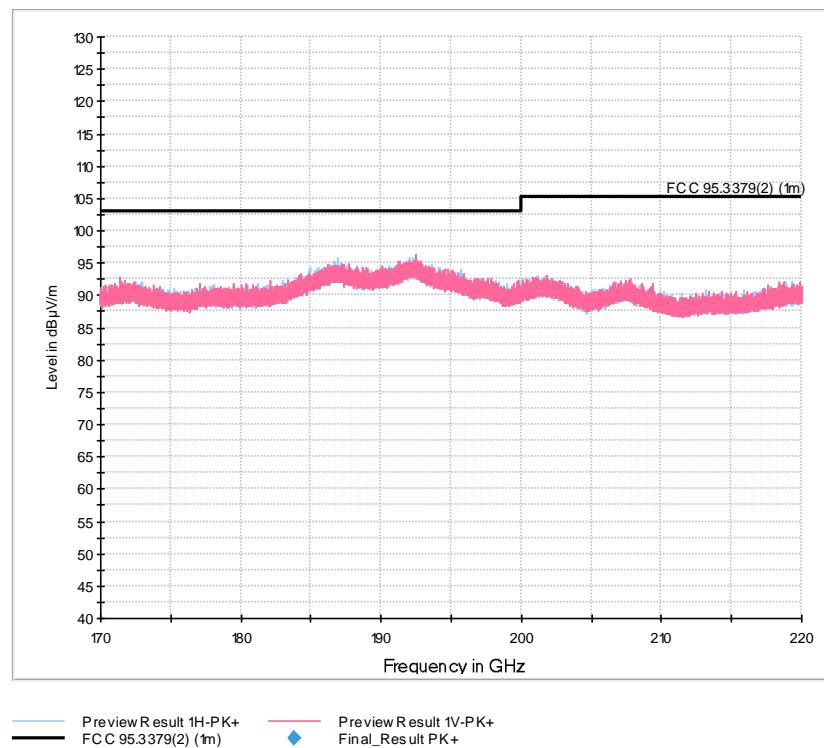


Final Results:

| Frequency MHz | RMS dBm | Limit dBm | Margin dB | Meas. Time ms | Bandwidth kHz | Height cm | Pol | Azimuth deg | Corr. dB |
|------------------|------------|--------------|--------------|------------------|------------------|--------------|-----|----------------|-------------|
| 76344.000000 | -29.72 | #1 | #1 | 2.5 | 1000.000 | 150.0 | H | 51.0 | -87 |

Note #1: intentional radiation



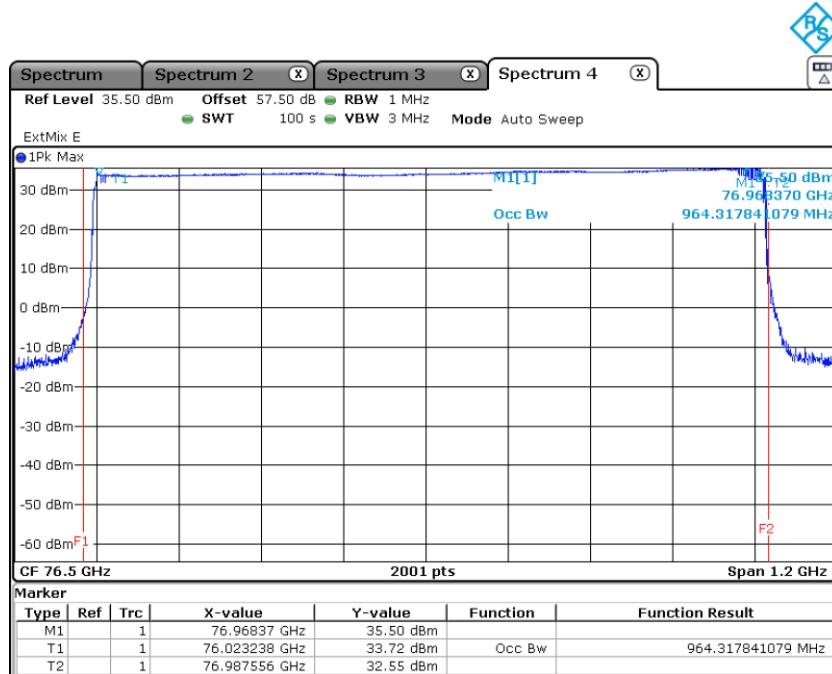


9.4 Frequency Stability

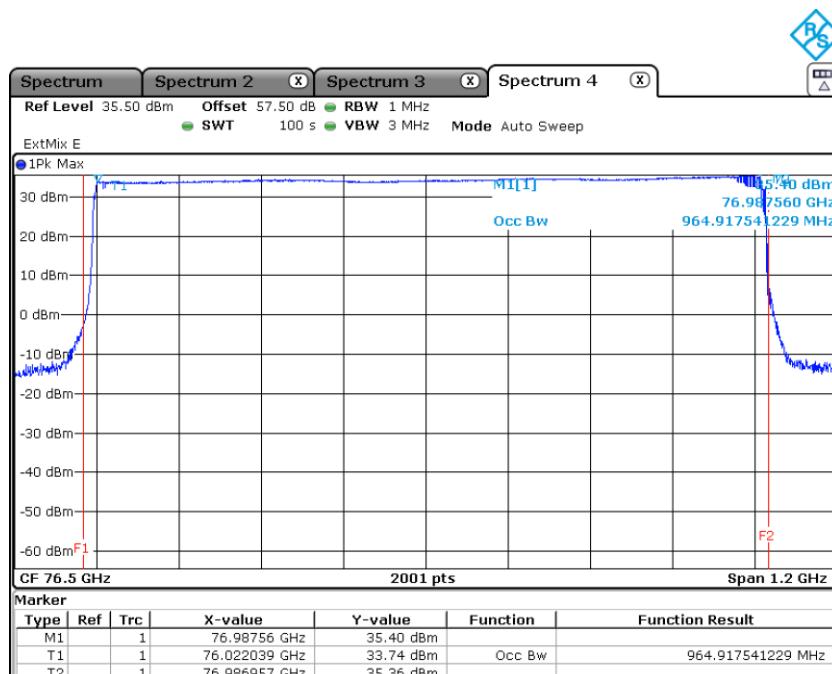
| | | |
|----------------------|--|--|
| Date of Test | 2024-10-16 and 2024-10-17 | Prüfergebnis / Test Result <input checked="" type="checkbox"/> Erfüllt / Passed <input type="checkbox"/> Nicht erfüllt / Not passed |
| Operator | Alex Fink | |
| Test Site | Fully anechoic room, cabin no. 2 Climatic test chamber | |
| Barometric pressure: | 964 hPa | |
| Relative humidity: | 24 % | |
| Ambient temperature: | 24 °C | |
| Specifications: | CFR 47, Part 95, Subpart M, §95.3379(b) RSS-251, Issue 2, Section 11 | |
| Description: | b) 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 °C to 50 °C with a input voltage variation of 85 % to 115 % of rated input voltage unless justification is presented to demonstrate otherwise. | |
| Operation mode: | Transmitting continuously | |
| Comment : | See plots of tests for details. | |

All emissions are within the 76 – 77 GHz frequency band.
See plots for details

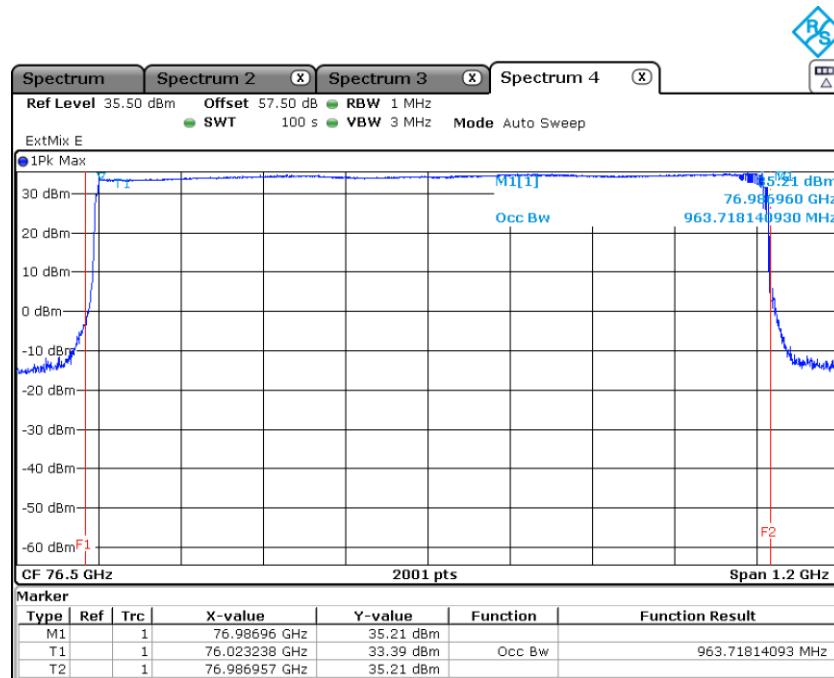
Plots taken during measurement



-40 °C, 12 V

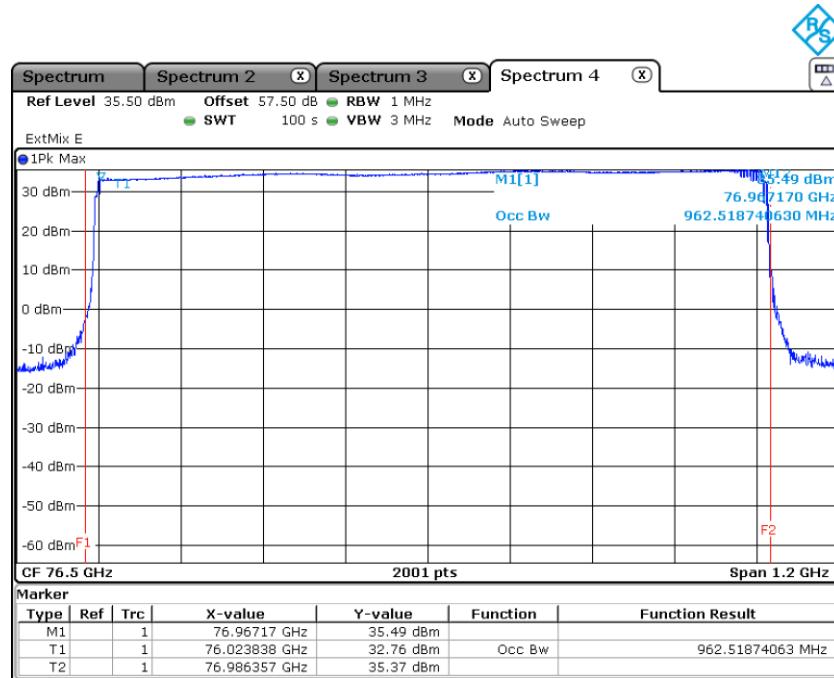


-30 °C, 12 V



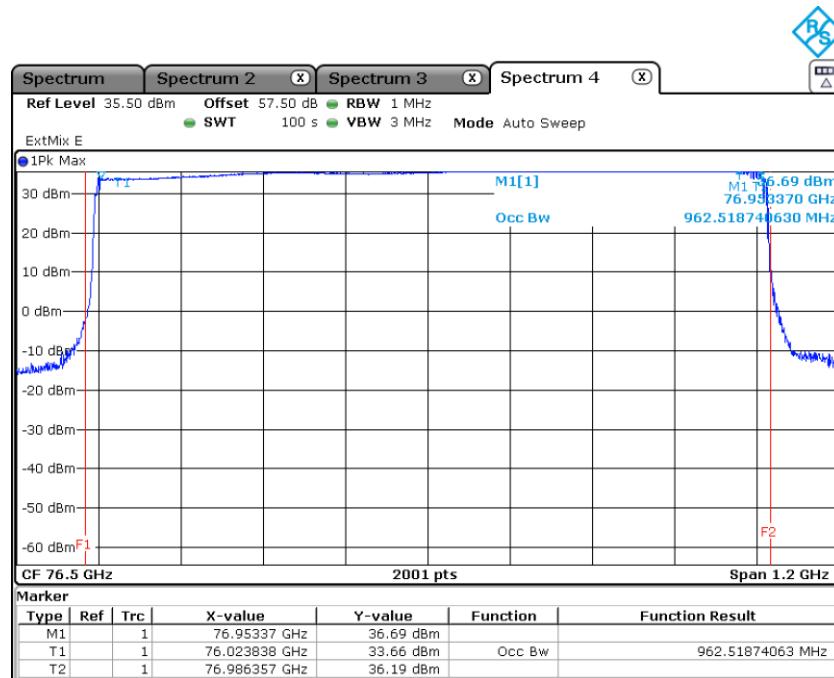
Date: 16.OCT.2024 14:00:35

-20 °C, 12 V



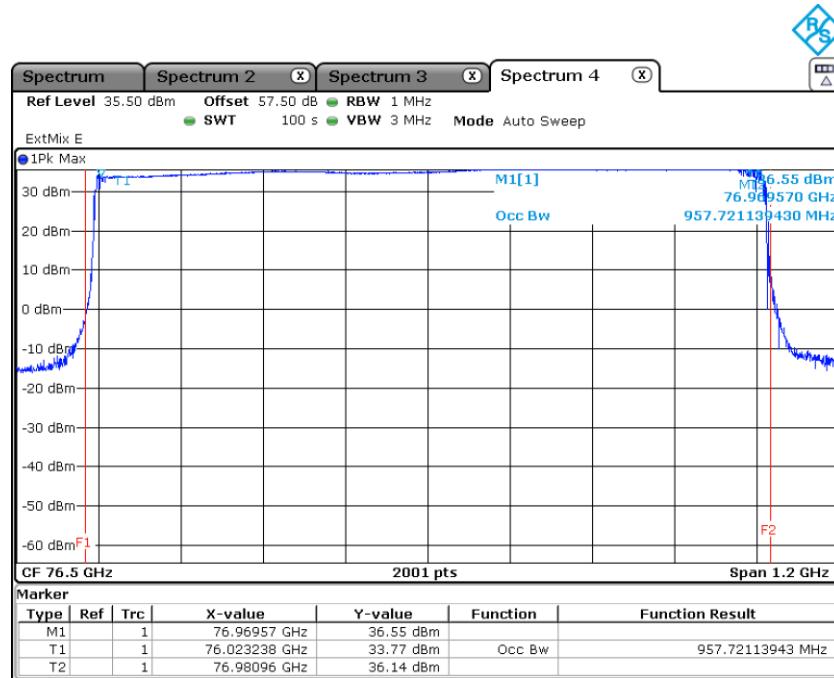
Date: 16.OCT.2024 14:26:10

-10 °C, 12 V



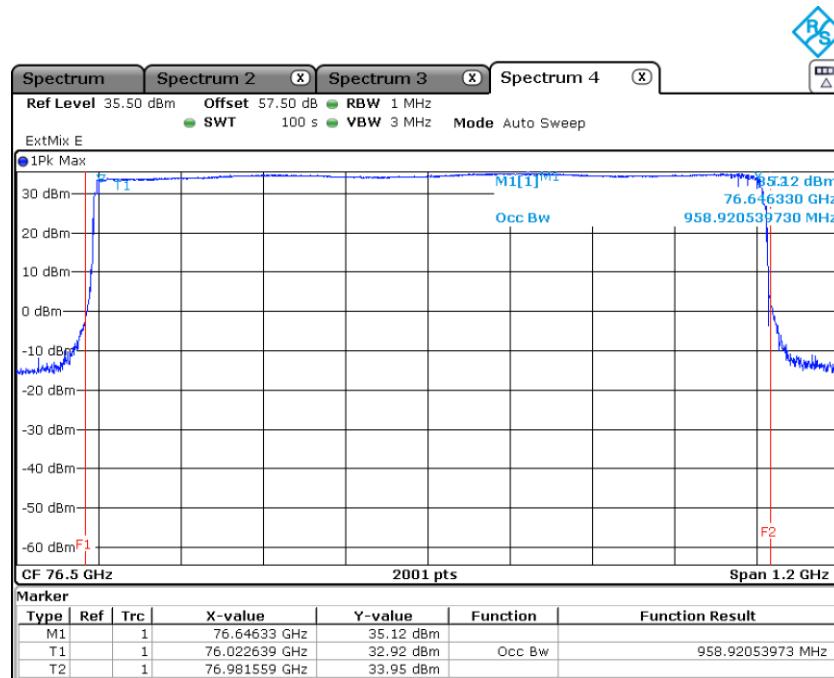
Date: 16.OCT.2024 14:48:07

0 °C, 12 V



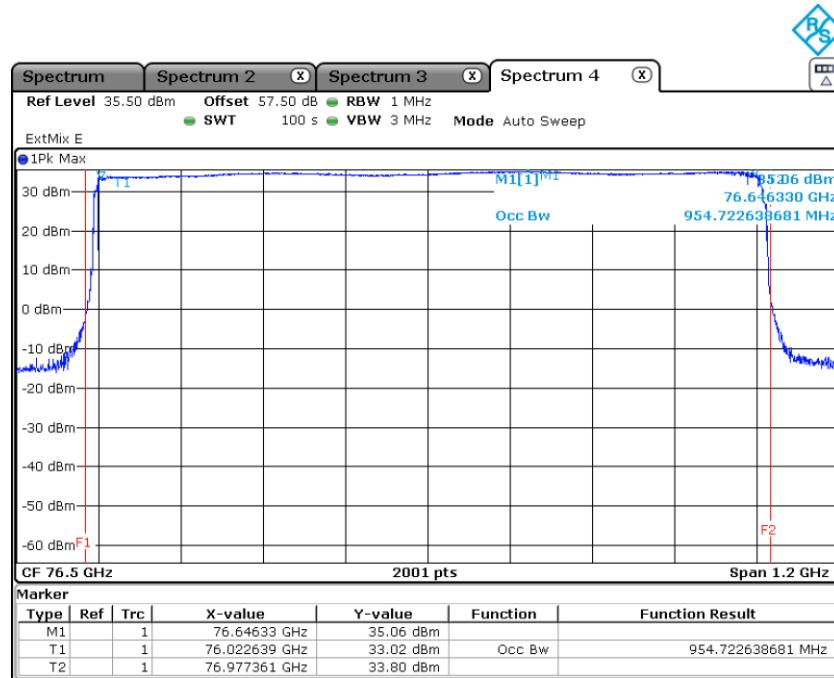
Date: 16.OCT.2024 15:11:21

10 °C, 12 V



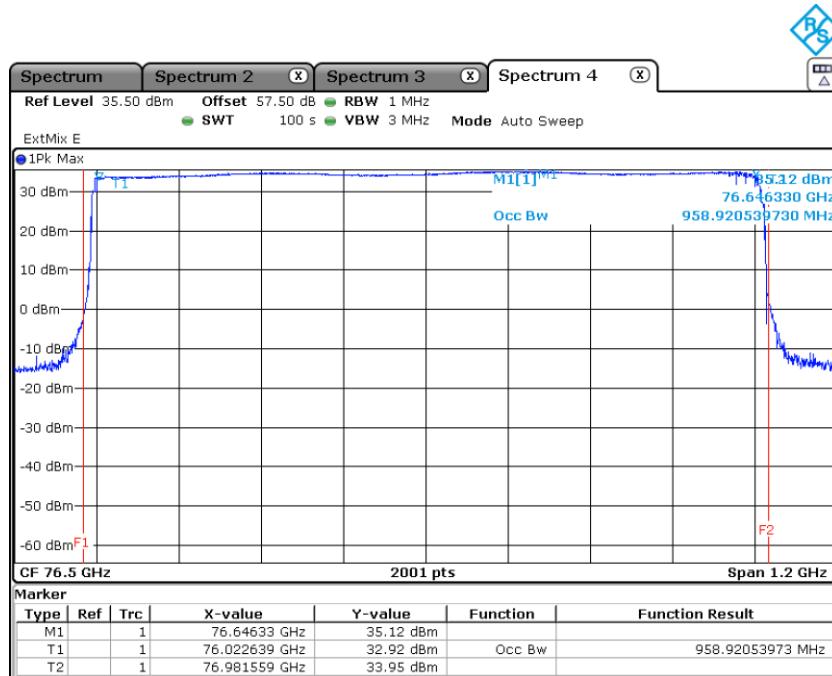
Date: 17.OCT.2024 08:51:19

20 °C, 6.5 V



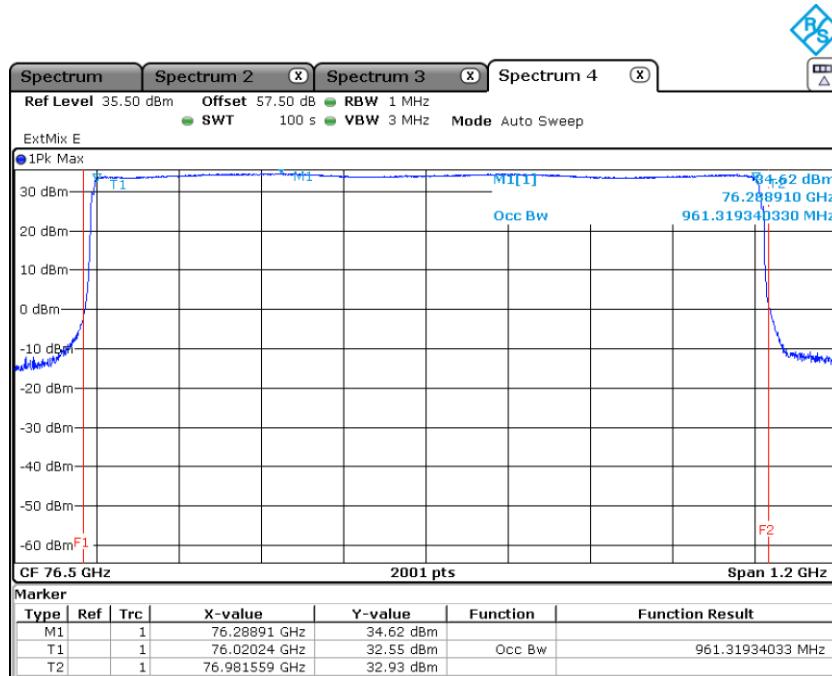
Date: 17.OCT.2024 08:47:19

20 °C, 12 V



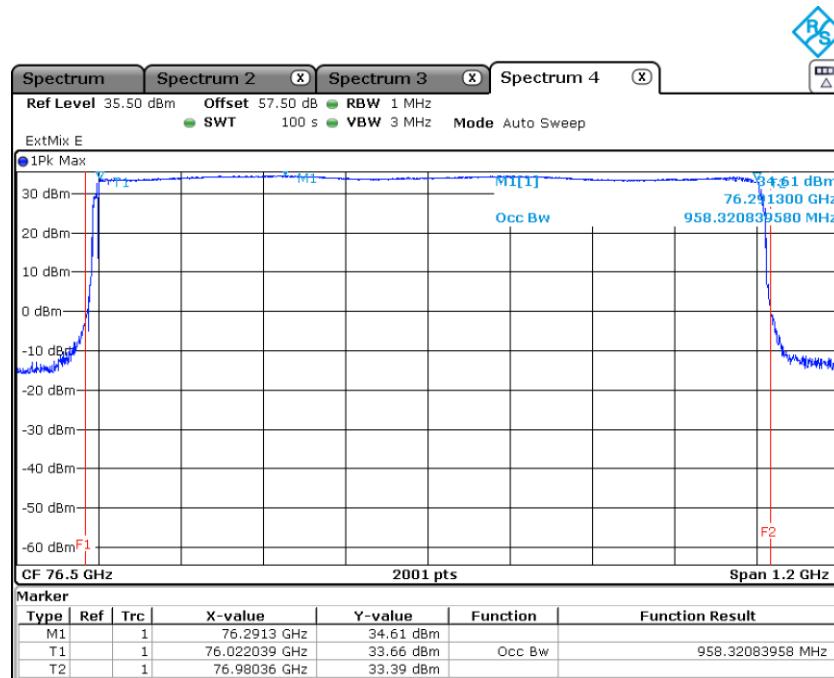
Date: 17.OCT.2024 08:51:19

20 °C, 16 V

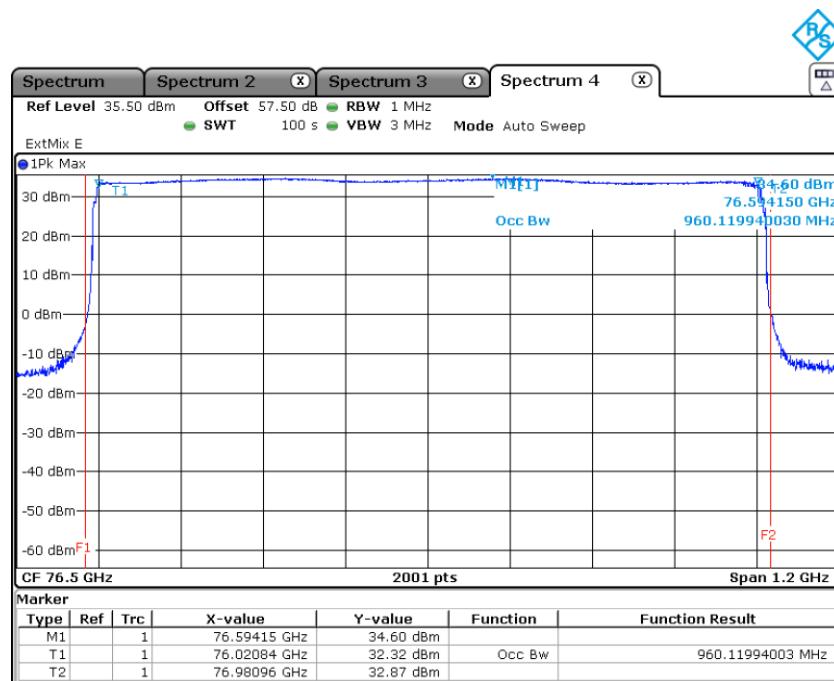


Date: 16.OCT.2024 17:35:55

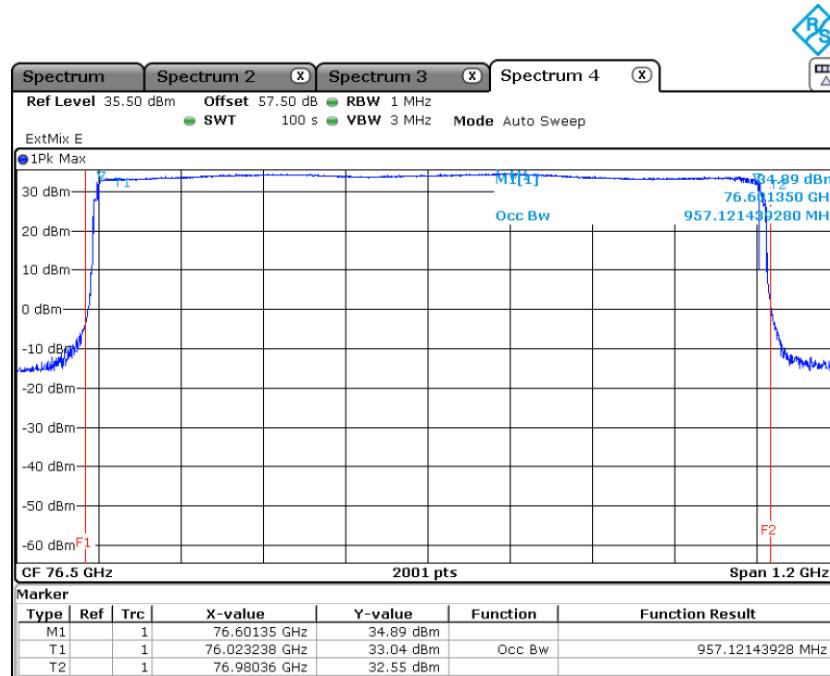
30 °C, 12 V



40 °C, 12 V

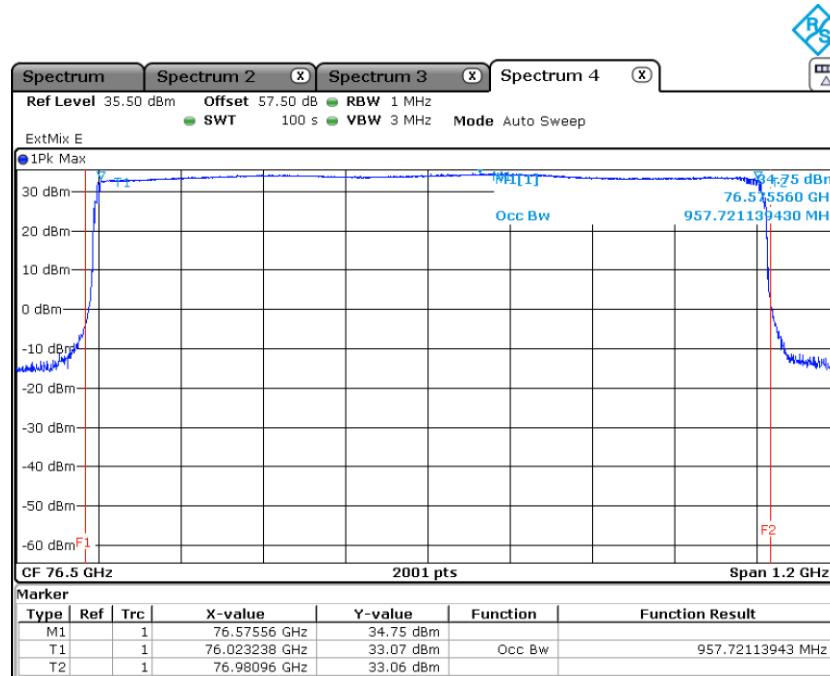


50 °C, 12 V



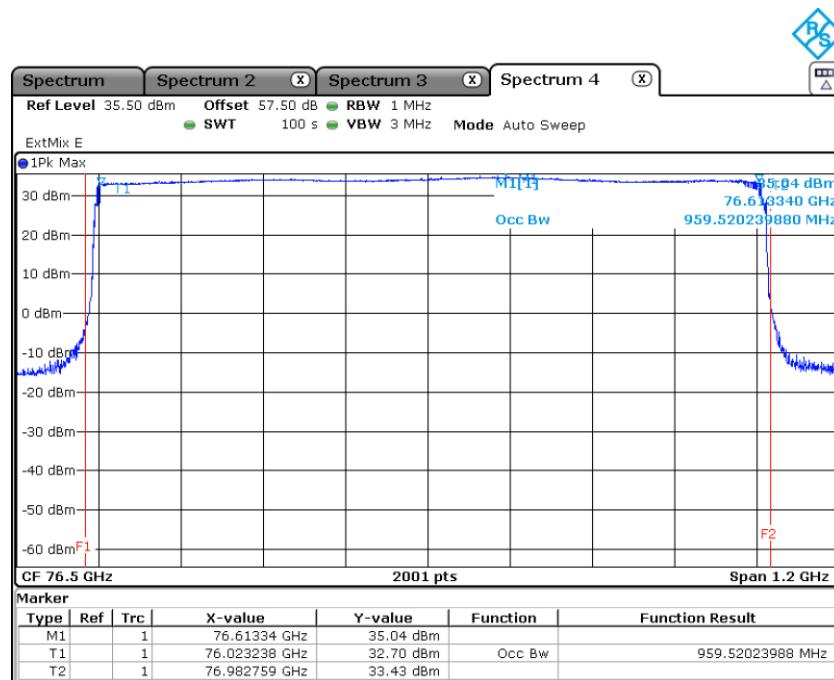
Date: 16.OCT.2024 17:02:03

60 °C, 12 V



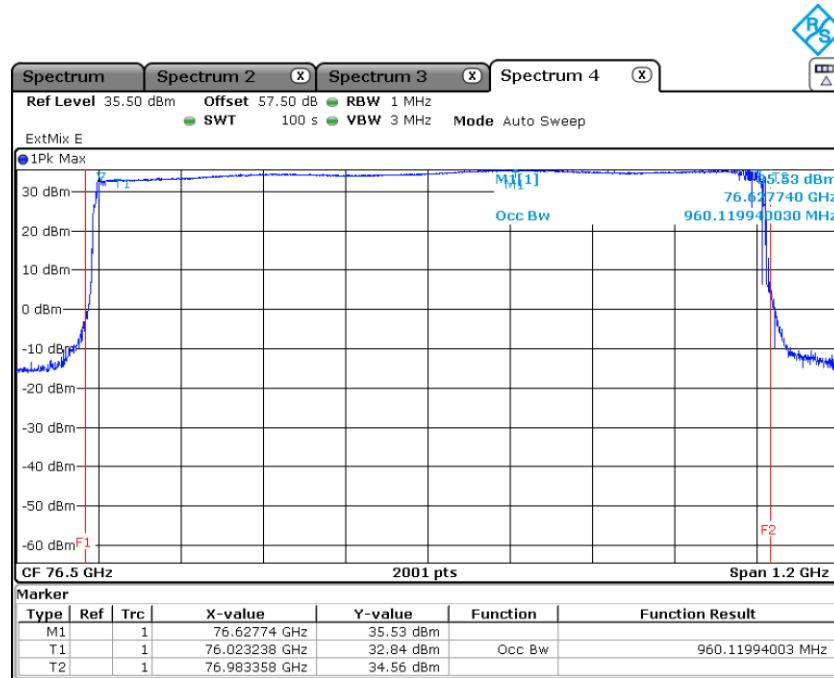
Date: 16.OCT.2024 16:48:52

70 °C, 12 V



Date: 16.OCT.2024 16:34:26

80 °C, 12 V



Date: 16.OCT.2024 15:45:13

85 °C, 12 V

10 Revision History

| Revision History | | | |
|-------------------------|-------------|------------------|---|
| <i>Edition</i> | <i>Date</i> | <i>Issued by</i> | <i>Modifications</i> |
| 0 | 2024-11-18 | Alex Fink | First Edition |
| 1 | 2025-02-05 | Alex Fink | RSS-251 limit added to Spurious Radiated Emissions Plots. |