

## TEST REPORT

BNetzA-CAB-02/21-102

Test report no.: 1-5034\_22-01-02

### Testing laboratory

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**Accredited Testing Laboratory:**

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAKKS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

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### Manufacturer

**InnoSenT GmbH**

Am Rödertor 30

97499 Donnersdorf / GERMANY

### Test standard/s

FCC - Title 47 CFR Part 15    FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

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

### Test Item

**Kind of test item:**                      **Stationary Traffic Monitoring**  
**Model name:**                         **ITR-3800**  
**FCC ID:**                                 **UXS-ITR-3800**  
**Frequency:**                            24.00 GHz – 24.25 GHz  
**Antenna:**                                Integrated patch antenna  
**Power supply:**                        24 V – 48 V DC (0.76 A)  
**Temperature range:**                -40°C to +80°C

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

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## 2 General information

### 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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### 2.2 Application details

|                                    |            |
|------------------------------------|------------|
| Date of receipt of order:          | 2022-11-03 |
| Date of receipt of test item:      | 2022-12-01 |
| Start of test:*                    | 2022-12-12 |
| End of test:*                      | 2022-12-23 |
| Person(s) present during the test: | -/-        |

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

### 2.3 Test laboratories sub-contracted

None

### 3 Test standard/s, references and accreditations

| Test standard              | Date | Description                                                                                     |
|----------------------------|------|-------------------------------------------------------------------------------------------------|
| FCC - Title 47 CFR Part 15 |      | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices |

| Guidance         | Version | Description                                                                                                                                                         |
|------------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANSI C63.4-2014  | -/-     | 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                                                                      |
| ANSI C63.26-2015 | -/-     | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services                                                                   |

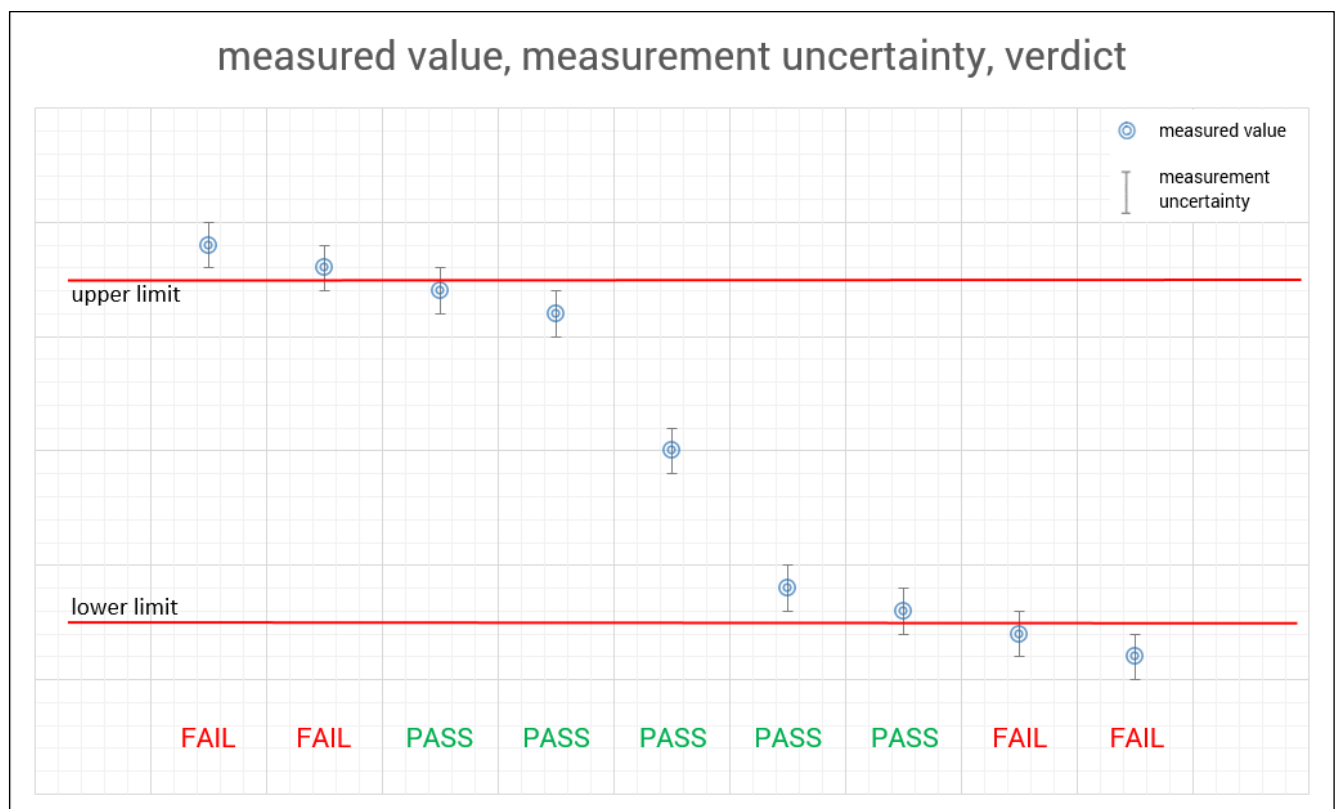
| Accreditation    | Description                                                                                                                                                 |                                                                                                                                                                                                                                      |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D-PL-12076-01-05 | Telecommunication FCC requirements<br><a href="https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf">https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf</a> |  <br>Deutsche<br>Akkreditierungsstelle<br>D-PL-12076-01-05 |

FCC designation number: DE0002

#### 4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.

The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



## 5 Test environment

|                             |                                                          |                                                                                                                     |
|-----------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Temperature :               | T <sub>nom</sub><br>T <sub>max</sub><br>T <sub>min</sub> | +22 °C during room temperature tests<br>+80 °C during high temperature tests<br>-40 °C during low temperature tests |
| Relative humidity content : |                                                          | 55 %                                                                                                                |
| Barometric pressure :       |                                                          | 1021 hpa                                                                                                            |
| Power supply :              | V <sub>nom</sub><br>V <sub>max</sub><br>V <sub>min</sub> | 36.0 V DC by power supply<br>48.0 V DC by power supply<br>24.0 V DC by power supply                                 |

## 6 Test item

### 6.1 General description

|                      |                                                                                                                          |
|----------------------|--------------------------------------------------------------------------------------------------------------------------|
| Kind of test item :  | Stationary Traffic Monitoring                                                                                            |
| Model name :         | ITR-3800                                                                                                                 |
| S/N serial number :  | 00000136                                                                                                                 |
| Hardware status :    | -/-                                                                                                                      |
| Software status :    | -/-                                                                                                                      |
| Firmware status :    | v1.421                                                                                                                   |
| Frequency band :     | 24.00 GHz – 24.25 GHz                                                                                                    |
| Type of modulation : | FMCW                                                                                                                     |
| Number of channels : | Stopped Mode - Low Channel 24.07 GHz<br>Stopped Mode - Middle Channel 24.15 GHz<br>Stopped Mode - High Channel 24.24 GHz |
| Antenna :            | Integrated patch antenna                                                                                                 |
| Power supply :       | 24 V – 48 V DC (0.76 A)                                                                                                  |
| Temperature range :  | -40°C to +80°C                                                                                                           |

### 6.2 Additional information

Special test software was used to change from normal operation mode to stopped mode (low / middle / high) as required by CFR 47 Part 15.31(m):

|                                |           |
|--------------------------------|-----------|
| Stopped Mode - Low Channel:    | 24.07 GHz |
| Stopped Mode - Middle Channel: | 24.15 GHz |
| Stopped Mode - High Channel:   | 24.24 GHz |

Test setup and EUT photos are included in test report:

1-5034\_22-01-01\_AnnexA  
1-5034\_22-01-01\_AnnexB  
1-5034\_22-01-01\_AnnexD

## 7 Description of the test setup

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

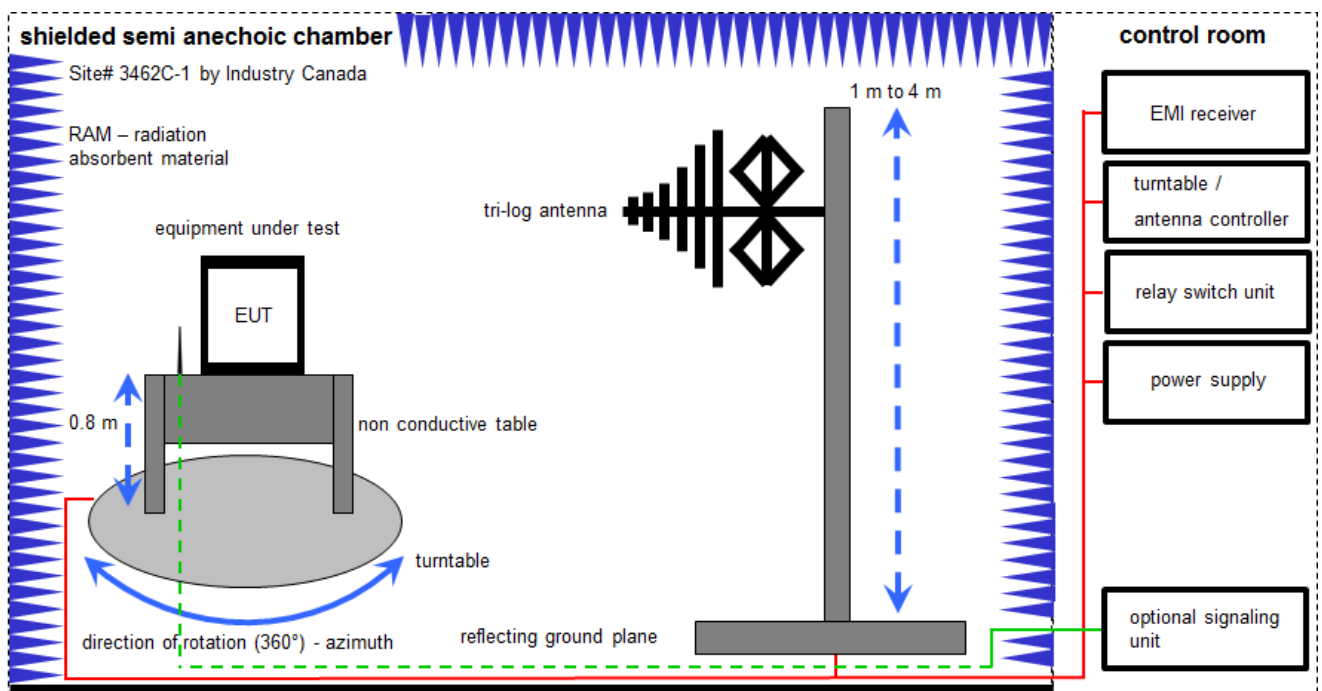
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

**Agenda:** Kind of Calibration

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

## 7.1 Shielded semi anechoic chamber

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



Measurement distance: tri-log antenna 10 meter

$$FS = UR + CL + AF$$

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

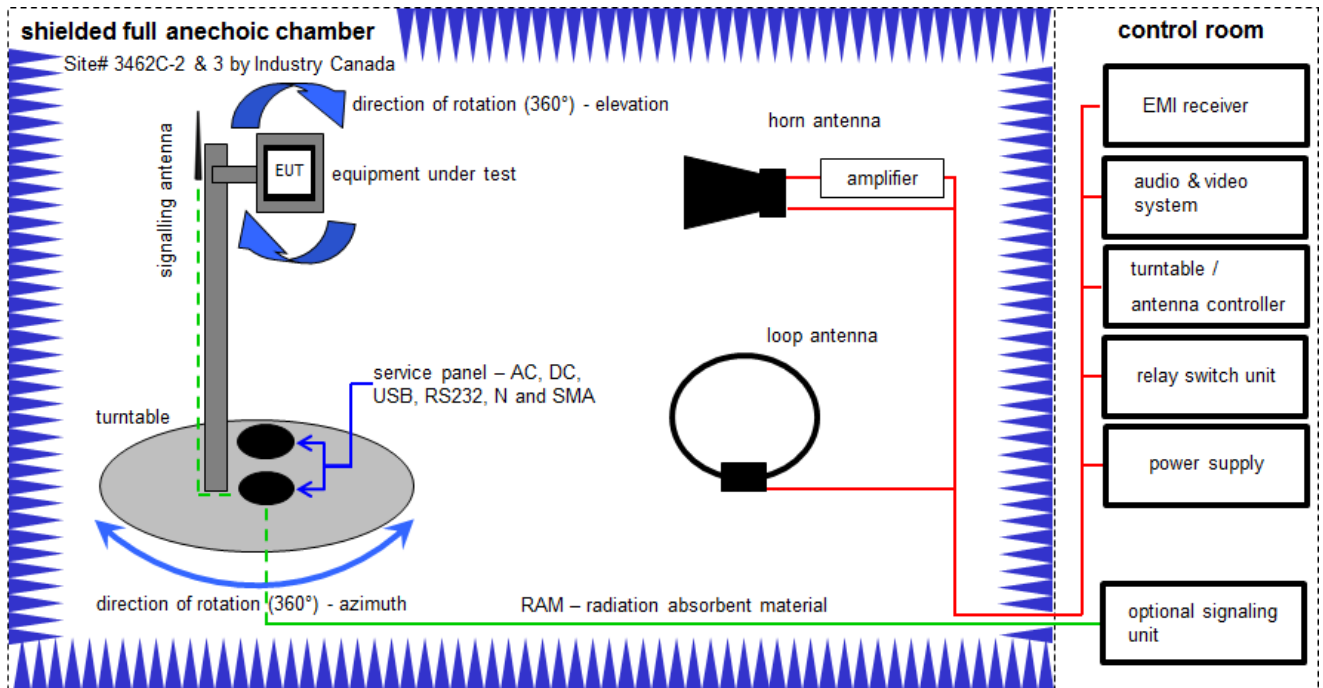
Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 12.35 \text{ [dB}\mu\text{V/m]} + 1.90 \text{ [dB]} + 16.80 \text{ [dB/m]} = 31.05 \text{ [dB}\mu\text{V/m]} \text{ (35.69 } \mu\text{V/m)}$$

**Equipment table:**

| No. | Lab / Item | Equipment                                    | Type             | Manufacturer                  | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|----------------------------------------------|------------------|-------------------------------|------------|-----------|---------------------|------------------|------------------|
| 1   | n. a.      | Switch-Unit                                  | 3488A            | HP                            | 2719A14505 | 300000368 | ev                  | -/-              | -/-              |
| 2   | n. a.      | DC power supply, 60Vdc, 50A, 1200 W          | 6032A            | HP                            | 2920A04466 | 300000580 | ne                  | -/-              | -/-              |
| 3   | n. a.      | Meßkabine 1                                  | HF-Absorberhalle | MWB AG 300023                 |            | 300000551 | ne                  | -/-              | -/-              |
| 4   | n. a.      | EMI Test Receiver                            | ESCI 3           | R&S                           | 101240     | 300004427 | k                   | 14.12.2022       | 31.12.2023       |
| 5   | n. a.      | Antenna Tower                                | Model 2175       | ETS-Lindgren                  | 64762      | 300003745 | izw                 | -/-              | -/-              |
| 6   | n. a.      | Positioning Controller                       | Model 2090       | ETS-Lindgren                  | 64672      | 300003746 | izw                 | -/-              | -/-              |
| 7   | n. a.      | Turntable Interface-Box                      | Model 105637     | ETS-Lindgren                  | 44583      | 300003747 | izw                 | -/-              | -/-              |
| 8   | n. a.      | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163         | Schwarzbeck Mess - Elektronik | 318        | 300003696 | vKI!                | 30.09.2019       | 29.09.2023       |
| 9   | n. a.      | Switch-Unit                                  | 3488A            | HP                            | 2719A14505 | 300000368 | ev                  | -/-              | -/-              |
| 10  | n. a.      | EMI Test Receiver                            | ESR3             | Rohde & Schwarz               | 102587     | 300005771 | k                   | 20.05.2022       | 31.05.2023       |

## 7.1 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

$$FS = UR + CA + AF$$

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

### Example calculation:

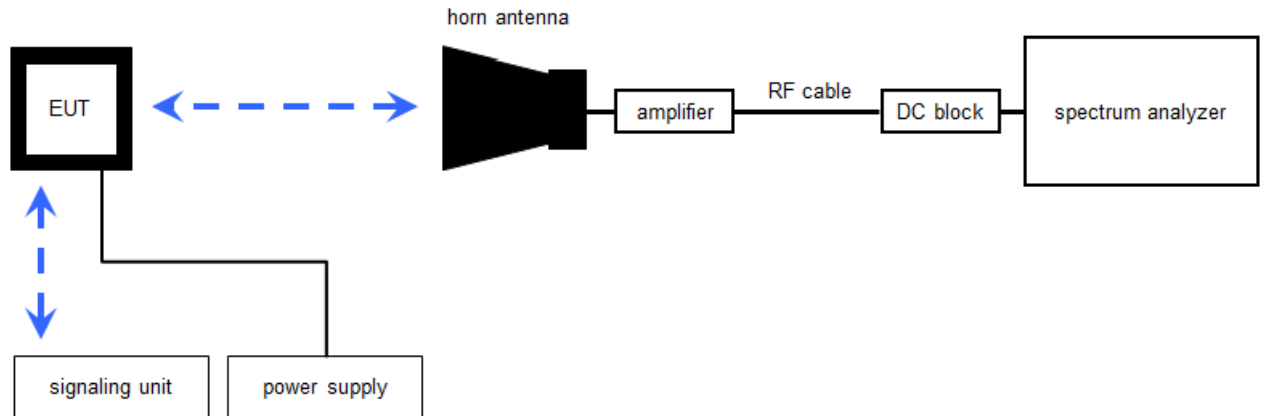
$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-35.8) \text{ [dB]} + 32.9 \text{ [dB/m]} = 37.1 \text{ [dB}\mu\text{V/m]} \text{ (71.61 } \mu\text{V/m)}$$

**Equipment table:**

| No. | Lab / Item | Equipment                                      | Type                                          | Manufacturer                  | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|------------------------------------------------|-----------------------------------------------|-------------------------------|------------|-----------|---------------------|------------------|------------------|
| 1   | n. a.      | DC power supply, 60Vdc, 50A, 1200 W            | 6032A                                         | HP                            | 2818A03450 | 300001040 | vKI!                | 09.12.2020       | 08.12.2023       |
| 2   | n. a.      | Active Loop Antenna 9 kHz to 30 MHz            | 6502                                          | EMCO                          | 2210       | 300001015 | vKI!                | 01.07.2021       | 31.07.2023       |
| 3   | n. a.      | Anechoic chamber                               | FAC 3/5m                                      | MWB / TDK                     | 87400/02   | 300000996 | ev                  | -/-              | -/-              |
| 4   | n. a.      | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz   | VULB9163                                      | Schwarzbeck Mess - Elektronik | 318        | 300003696 | vKI!                | 30.09.2021       | 29.09.2023       |
| 5   | n. a.      | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115                                          | EMCO                          | 9709-5289  | 300000213 | vKI!                | 26.07.2022       | 25.07.2024       |
| 6   | n. a.      | Switch / Control Unit                          | 3488A                                         | HP                            | *          | 300000199 | ne                  | -/-              | -/-              |
| 7   | n. a.      | Variable isolating transformer                 | MPL IEC625 Bus Variable isolating transformer | ErFi                          | 91350      | 300001155 | ne                  | -/-              | -/-              |
| 8   | n. a.      | EMI Test Receiver 20Hz- 26,5GHz                | ESU26                                         | R&S                           | 100037     | 300003555 | k                   | 07.12.2022       | 31.12.2023       |
| 9   | n. a.      | Highpass Filter                                | WHKX7.0/18G-8SS                               | Wainwright                    | 19         | 300003790 | ne                  | -/-              | -/-              |
| 10  | n. a.      | Broadband Amplifier 0.5-18 GHz                 | CBLU5184540                                   | CERNEX                        | 22049      | 300004481 | ev                  | -/-              | -/-              |
| 11  | n. a.      | Broadband Amplifier 5-13 GHz                   | CBLU5135235                                   | CERNEX                        | 22010      | 300004491 | ev                  | -/-              | -/-              |
| 12  | n. a.      | 4U RF Switch Platform                          | L4491A                                        | Agilent Technologies          | MY50000037 | 300004509 | ne                  | -/-              | -/-              |
| 13  | n. a.      | NEXIO EMV-Software                             | BAT EMC V3.16.0.49                            | EMCO                          |            | 300004682 | ne                  | -/-              | -/-              |
| 14  | n. a.      | PC                                             | ExOne                                         | F+W                           |            | 300004703 | ne                  | -/-              | -/-              |
| 15  | n. a.      | RF-Amplifier                                   | AMF-6F06001800-30-10P-R                       | NARDA-MITEQ Inc               | 2011572    | 300005241 | ev                  | -/-              | -/-              |

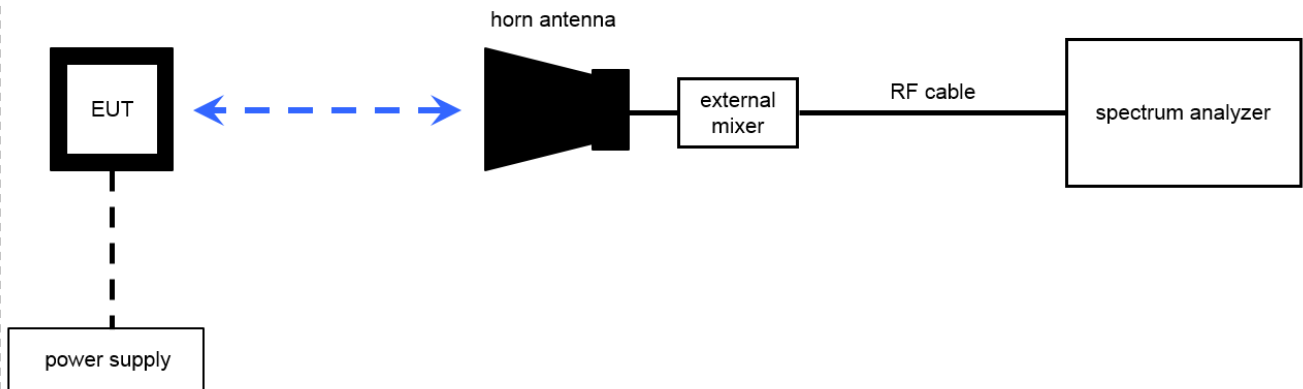
## 7.2 Radiated measurements > 18 GHz

### Radiated measurements > 18 GHz



## 7.3 Radiated measurements > 50/85 GHz

### Radiated measurements RF laboratory



$$OP = AV + D - G$$

(OP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

#### Example calculation:

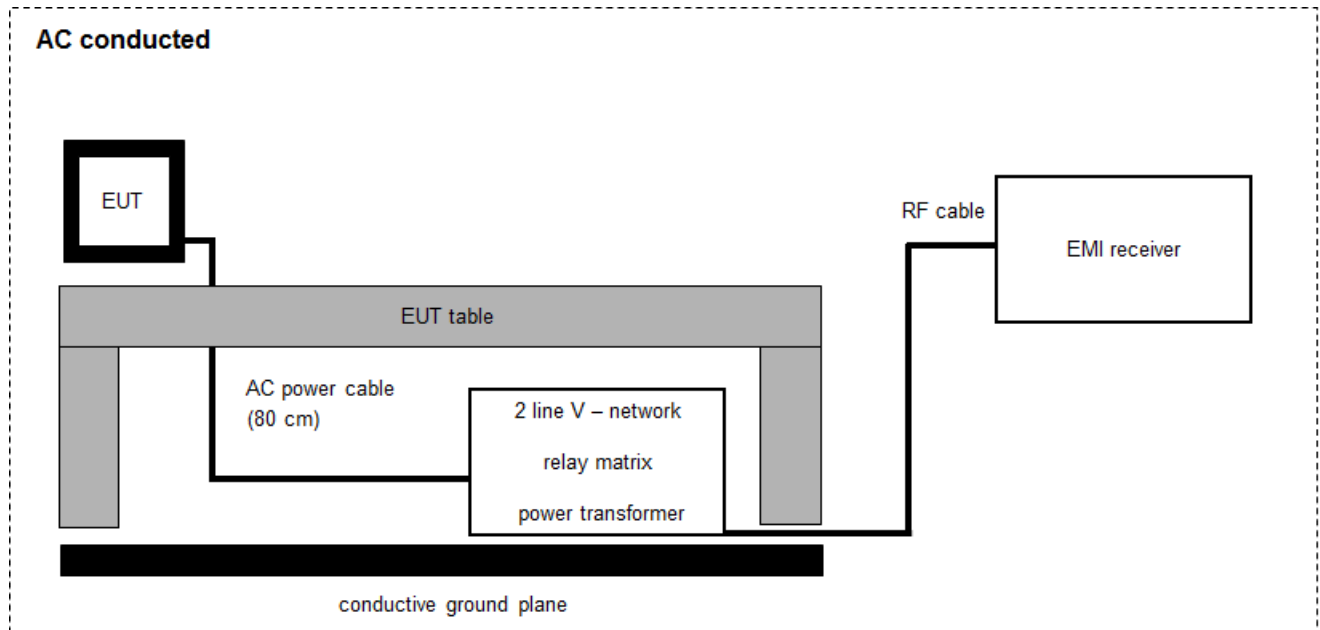
$$OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 \mu W)$$

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

**Equipment table:**

| No. | Lab / Item | Equipment                            | Type          | Manufacturer         | Serial No.    | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|--------------------------------------|---------------|----------------------|---------------|-----------|---------------------|------------------|------------------|
| 1   | n.a.       | Horn Antenna 18,0-40,0 GHz           | LHAF180       | Microw.Devel         | 39180-103-021 | 300001747 | vKI!                | 17.01.2022       | 31.01.2024       |
| 2   | n. a.      | Std. Gain Horn Antenna 18.0-26.5 GHz | 638           | Narda                |               | 300000486 | vKI!                | 17.01.2022       | 31.01.2024       |
| 3   | n. a.      | Std. Gain Horn Antenna 26.5-40.0 GHz | V637          | Narda                | 82-16         | 300000510 | vKI!                | 17.01.2022       | 31.01.2024       |
| 4   | n.a.       | Std. Gain Horn Antenna 39.3-59.7 GHz | 2424-20       | Flann                | 75            | 300001979 | ne                  | -/-              | -/-              |
| 5   | n. a.      | Std. Gain Horn Antenna 49.9-75.8 GHz | 2524-20       | Flann                | *             | 300001983 | ne                  | -/-              | -/-              |
| 6   | n. a.      | Std. Gain Horn Antenna 73.8-112 GHz  | 2724-20       | Flann                | *             | 300001988 | ne                  | -/-              | -/-              |
| 7   | n. a.      | Broadband LNA 18-50 GHz              | CBL18503070PN | CERNEX               | 25240         | 300004948 | ev                  | 09.03.2022       | 08.03.2024       |
| 8   | n. a.      | Spectrum Analyzer 2 Hz - 85 GHz      | FSW85         | R&S                  | 101333        | 300005568 | k                   | 11.07.2022       | 31.07.2023       |
| 9   | n.a.       | Power Supply                         | E3632A        | Agilent Technologies | MY40001320    | 400000396 | ev                  | -/-              | -/-              |
| 10  | n. a.      | Temperature Test Chamber             | VT4002        | Heraeus Voetsch      | 521/83761     | 300002326 | ev                  | 12.05.2022       | 31.05.2024       |
| 11  | n. a.      | Harmonic Mixer 3-Port, 50-75 GHz     | FS-Z75        | Rohde & Schwarz      | 101578        | 300005788 | k                   | 07.07.2022       | 31.07.2023       |
| 12  | n. a.      | Harmonic Mixer 3-Port, 75-110 GHz    | FS-Z110       | R&S                  | 101411        | 300004959 | k                   | 07.07.2022       | 31.07.2023       |

## 7.4 AC power-line conducted emissions



$$FS = UR + CF + VC$$

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

### Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 37.62 \text{ [dB}\mu\text{V/m]} + 9.90 \text{ [dB]} + 0.23 \text{ [dB]} = 47.75 \text{ [dB}\mu\text{V/m]} \text{ (244.06 } \mu\text{V/m)}$$

### Equipment table:

| No. | Lab / Item | Equipment                                 | Type    | Manufacturer | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|-------------------------------------------|---------|--------------|------------|-----------|---------------------|------------------|------------------|
| 1   | -/-        | Two-line V-Network (LISN) 9 kHz to 30 MHz | ESH3-Z5 | R&S          | 892475/017 | 300002209 | vKI!                | 14.12.2021       | 31.12.2023       |
| 2   | -/-        | RF-Filter-section                         | 85420E  | HP           | 3427A00162 | 300002214 | NK!                 | -/-              | -/-              |
| 3   | -/-        | EMI Test Receiver                         | ESCI 3  | R&S          | 101240     | 300004427 | k                   | 14.12.2022       | 31.12.2023       |
| 4   | -/-        | Hochpass 150 kHz                          | EZ-25   | R&S          | 100010     | 300003798 | ev                  | -/-              | -/-              |

## 8 Sequence of testing

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

#### Setup

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

#### Premeasurement\*

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

#### Final measurement

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

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

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

### Setup

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

### Premeasurement

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

### Final measurement

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

### 8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

#### Setup

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

#### Premeasurement

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

#### Final measurement

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

## 8.4 Sequence of testing radiated spurious above 18 GHz

### Setup

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

### Premeasurement

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

### Final measurement

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

## 8.5 Sequence of testing radiated spurious above 50/85 GHz with external mixers

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate for far field (e.g. 0.25 m).
- The EUT is set into operation.

### Premeasurement

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

### Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

## 9 Measurement uncertainty

| Test case                                                           | Uncertainty                                             |
|---------------------------------------------------------------------|---------------------------------------------------------|
| Equivalent isotropically radiated power (e.i.r.p.)                  | Conducted value $\pm 1$ dB<br>Radiated value $\pm 3$ dB |
| Permitted range of operating frequencies                            | $\pm 100$ kHz                                           |
| Conducted unwanted emissions in the spurious domain (up to 40 GHz)  | $\pm 1$ dB                                              |
| Radiated unwanted emissions in the spurious domain (up to 40 GHz)   | $\pm 3$ dB                                              |
| Conducted unwanted emissions in the spurious domain (40 to 50 GHz)  | $\pm 4$ dB                                              |
| Radiated unwanted emissions in the spurious domain (40 to 50 GHz)   | $\pm 4$ dB                                              |
| Conducted unwanted emissions in the spurious domain (50 to 300 GHz) | $\pm 5$ dB                                              |
| Radiated unwanted emissions in the spurious domain (50 to 300 GHz)  | $\pm 5$ dB                                              |
| DC and low frequency voltages                                       | $\pm 3$ %                                               |
| Temperature                                                         | $\pm 1$ °C                                              |
| Humidity                                                            | $\pm 3$ %                                               |

## 10 Far field consideration for measurements above 18 GHz

### Far field distance calculation:

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

with

$D_{ff}$  Far field distance  
 $D$  Antenna dimension  
 $\lambda$  wavelength

### Spurious emission measurements:

| Antenna frequency range in GHz | Highest measured frequency in GHz | D in cm | $\lambda$ in cm | $D_{ff}$ in cm |
|--------------------------------|-----------------------------------|---------|-----------------|----------------|
| 18-26                          | 26                                | 3.4     | 1.15            | 20.04          |
| 26-40                          | 40                                | 2.2     | 0.75            | 12.91          |
| 40-50                          | 50                                | 2.77    | 0.60            | 25.58          |
| 50-75                          | 75                                | 1.85    | 0.40            | 17.11          |
| 75-110                         | 110                               | 1.24    | 0.27            | 11.28          |

## 11 Summary of measurement results

|                                     |                                                                                                                          |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | <b>No deviations from the technical specifications were ascertained</b>                                                  |
| <input type="checkbox"/>            | There were deviations from the technical specifications ascertained                                                      |
| <input type="checkbox"/>            | This test report is only a partial test report.<br>The content and verdict of the performed test cases are listed below. |

| TC Identifier | Description    | Verdict | Date       | Remark |
|---------------|----------------|---------|------------|--------|
| RF-Testing    | 47 CFR Part 15 | Passed  | 2023-02-02 | -/-    |

| Test specification clause | Test case                                       | Temperature conditions | Power source voltages | C                                   | NC                       | NA                       | NP                       | Results (max.)                       |
|---------------------------|-------------------------------------------------|------------------------|-----------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------------------|
| §15.249(a)                | Field strength of emissions (wanted signal)     | Nominal                | Nominal               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 101.3 dBµV (PEAK)<br>64.2 dBµV (AVG) |
| §2.1049                   | Occupied bandwidth (99% bandwidth)              | Nominal                | Nominal               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 171.4 MHz                            |
| §15.209(a)<br>§15.249(d)  | Field strength of emissions (radiated spurious) | Nominal                | Nominal               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies                             |
| §15.207(a)                | Conducted emissions < 30 MHz                    | Nominal                | Nominal               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies                             |
| §15.215(c)                | Frequency Stability                             | Nominal<br>Extreme     | Nominal<br>Extreme    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies                             |

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

## 12 Measurement results

### 12.1 Field strength of fundamental emission

#### Description:

Measurement of the maximum radiated field strength of the wanted signal.

#### Measurement:

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

This test was performed on a shorter test distance. A correction factor of  $20 \cdot \log(x \text{ m} / 3 \text{ m})$  is already considered in the plots.

#### Limits:

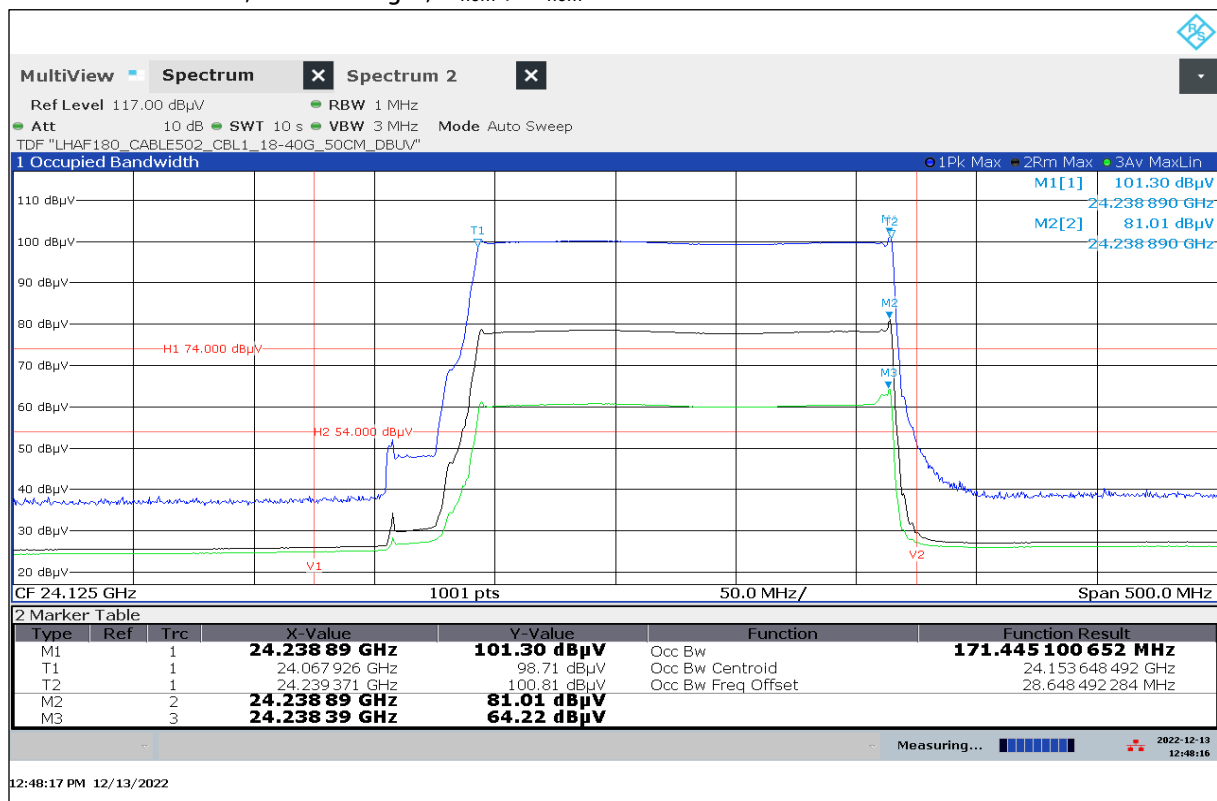
| FCC                                                                                                                               |                                           |                      |
|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------|
| CFR Part 15.249(a)                                                                                                                |                                           |                      |
| Field strength of emissions                                                                                                       |                                           |                      |
| The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following: |                                           |                      |
| Frequency                                                                                                                         | Field Strength                            | Measurement distance |
| 24.0 GHz – 24.25 GHz                                                                                                              | 108 dBµV/m (Average)<br>128 dBµV/m (PEAK) | 3 m                  |

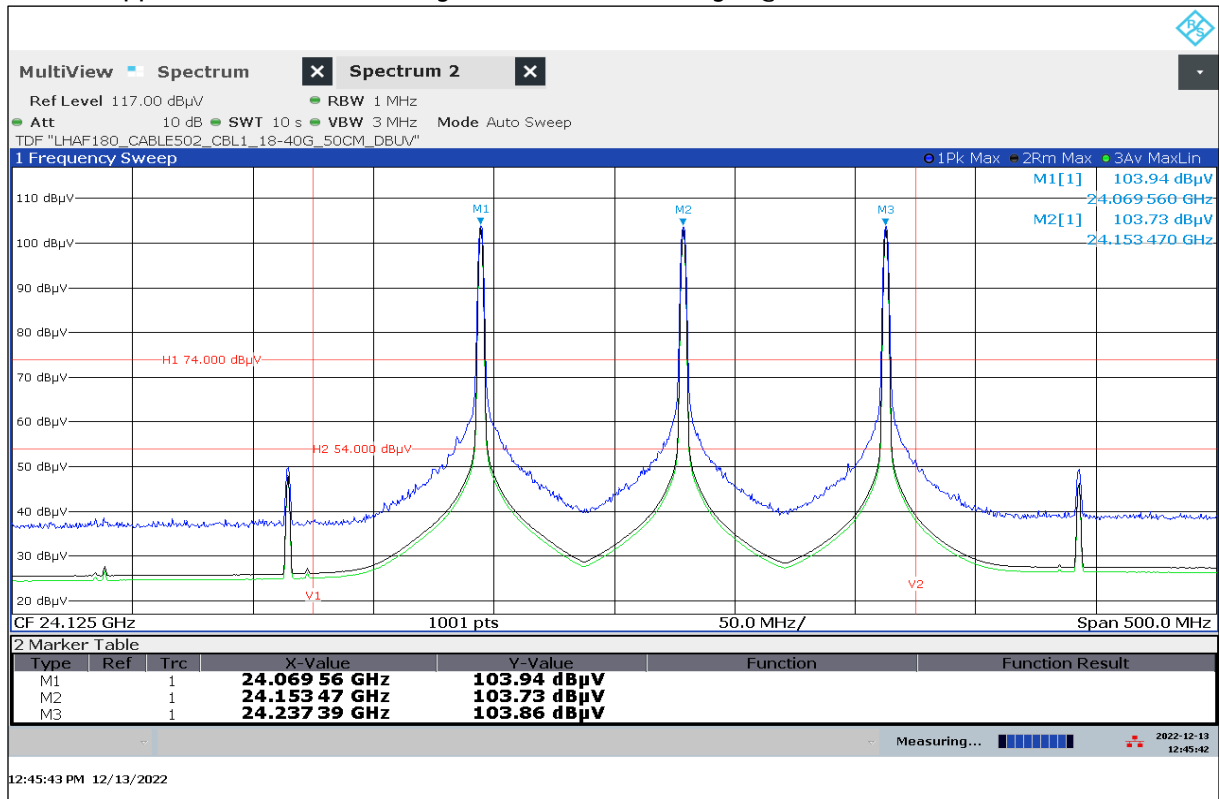
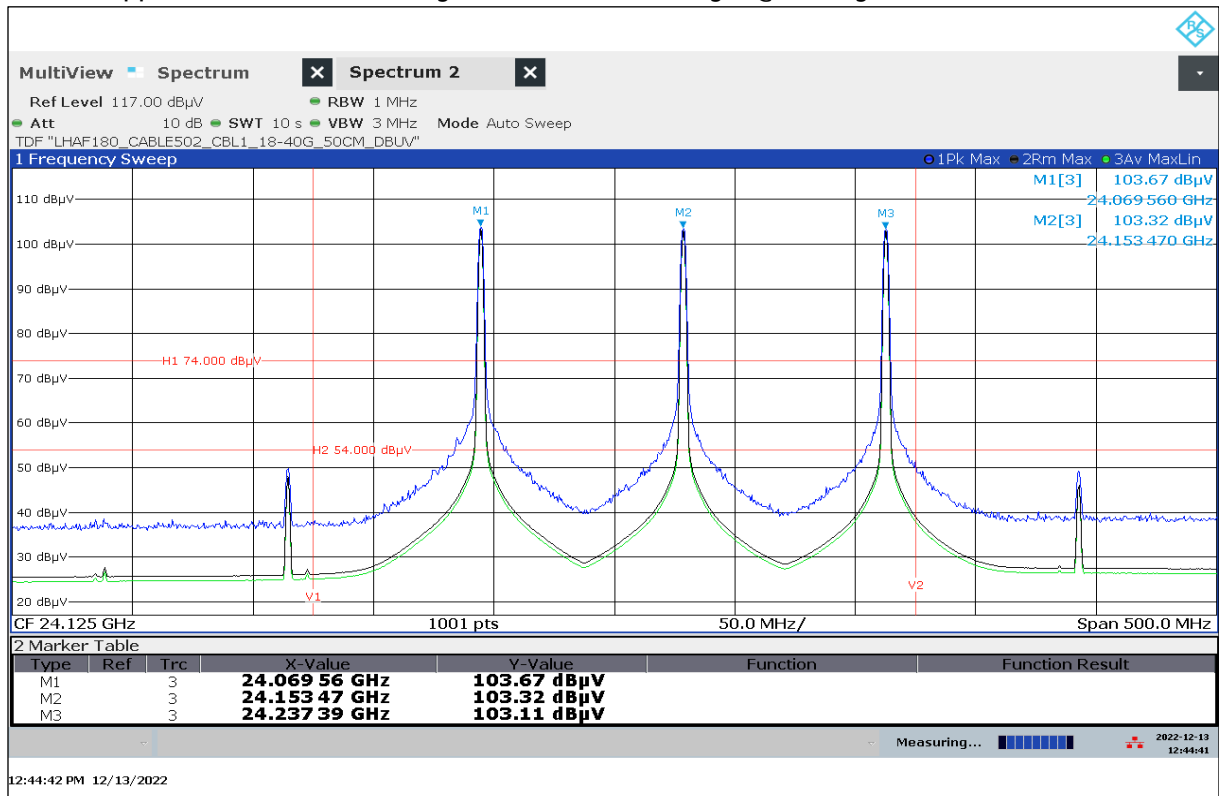
§15.249 (e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

§15.31 (c) Except as otherwise indicated in §15.256, for swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

**Measurement results:**

| Test condition<br>$T_{nom} / V_{nom}$ | Maximum field strength (Peak)<br>(dB $\mu$ V/m @3m) | Maximum field strength (Average)<br>(dB $\mu$ V/m @3m) |
|---------------------------------------|-----------------------------------------------------|--------------------------------------------------------|
| Normal Mode                           | 101.3                                               | 64.2                                                   |
| Stopped Mode Low Ch.                  | 103.9                                               | 103.7                                                  |
| Stopped Mode Middle Ch.               | 103.7                                               | 103.3                                                  |
| Stopped Mode High Ch.                 | 103.9                                               | 103.1                                                  |

Plot No. 1: Normal Mode, Field Strength,  $T_{nom} / V_{nom}$ 

Plot No. 2: Stopped Mode Low-Middle-High Channel, Field Strength @ Peak Detector,  $T_{nom}$  /  $V_{nom}$ Plot No. 3: Stopped Mode Low-Middle-High Channel, Field strength @ Average Detector,  $T_{nom}$  /  $V_{nom}$ 

## 12.2 Occupied bandwidth (99% bandwidth)

### Description:

Measurement of the 99% bandwidth of the wanted signal.

### Measurement:

| Parameter             |           |
|-----------------------|-----------|
| Detector:             | Pos-Peak  |
| Sweep time:           | See plots |
| Resolution bandwidth: | 1 MHz     |
| Video bandwidth:      | 3 MHz     |
| Span:                 | See plots |
| Trace-Mode:           | Max Hold  |

### Limits:

| FCC                                                                                                                                     |                | IC             |  |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|--|
| CFR Part 15.249(a)                                                                                                                      |                | RSS-210, B.10  |  |
| The field strength of emissions from intentional radiators operated within the specified frequency band shall comply with the following |                |                |  |
| Frequency range                                                                                                                         | f <sub>L</sub> | f <sub>H</sub> |  |
| 250 MHz                                                                                                                                 | > 24.0 GHz     | < 24.25 GHz    |  |

### Measurement results:

| Test condition<br>$T_{nom} / V_{nom}$ | $f_L$<br>[GHz] | $f_H$<br>[GHz] | Occupied bandwidth<br>[MHz] |
|---------------------------------------|----------------|----------------|-----------------------------|
| Normal Mode                           | 24.067 926     | 24.239 371     | 171.4                       |

### 12.3 Field strength of emissions (radiated spurious)

#### Description:

Measurement of the radiated spurious emissions in transmit mode.

#### Measurement:

| Parameter             |                                 |
|-----------------------|---------------------------------|
| Detector:             | Quasi-Peak / Pos-Peak / Average |
| Sweep time:           | Auto                            |
| Resolution bandwidth: | 100 kHz / 1 MHz                 |
| Video bandwidth:      | 300 kHz / 3 MHz                 |
| Trace-Mode:           | Max Hold                        |

#### Limits:

| FCC                                                                                                                                                                                                                                                      |                       |                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| CFR Part 15.209(a) / CFR Part 15.249(d)                                                                                                                                                                                                                  |                       |                          |
| Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation. |                       |                          |
| Frequency (MHz)                                                                                                                                                                                                                                          | Field Strength (µV/m) | Measurement distance (m) |
| 0.009 – 0.490                                                                                                                                                                                                                                            | 2400/F(kHz)           | 300                      |
| 0.490 – 1.705                                                                                                                                                                                                                                            | 24000/F(kHz)          | 30                       |
| 1.705 – 30.0                                                                                                                                                                                                                                             | 30                    | 30                       |
| 30 – 88                                                                                                                                                                                                                                                  | 100                   | 3                        |
| 88 – 216                                                                                                                                                                                                                                                 | 150                   | 3                        |
| 216 – 960                                                                                                                                                                                                                                                | 200                   | 3                        |
| Above 960                                                                                                                                                                                                                                                | 500                   | 3                        |

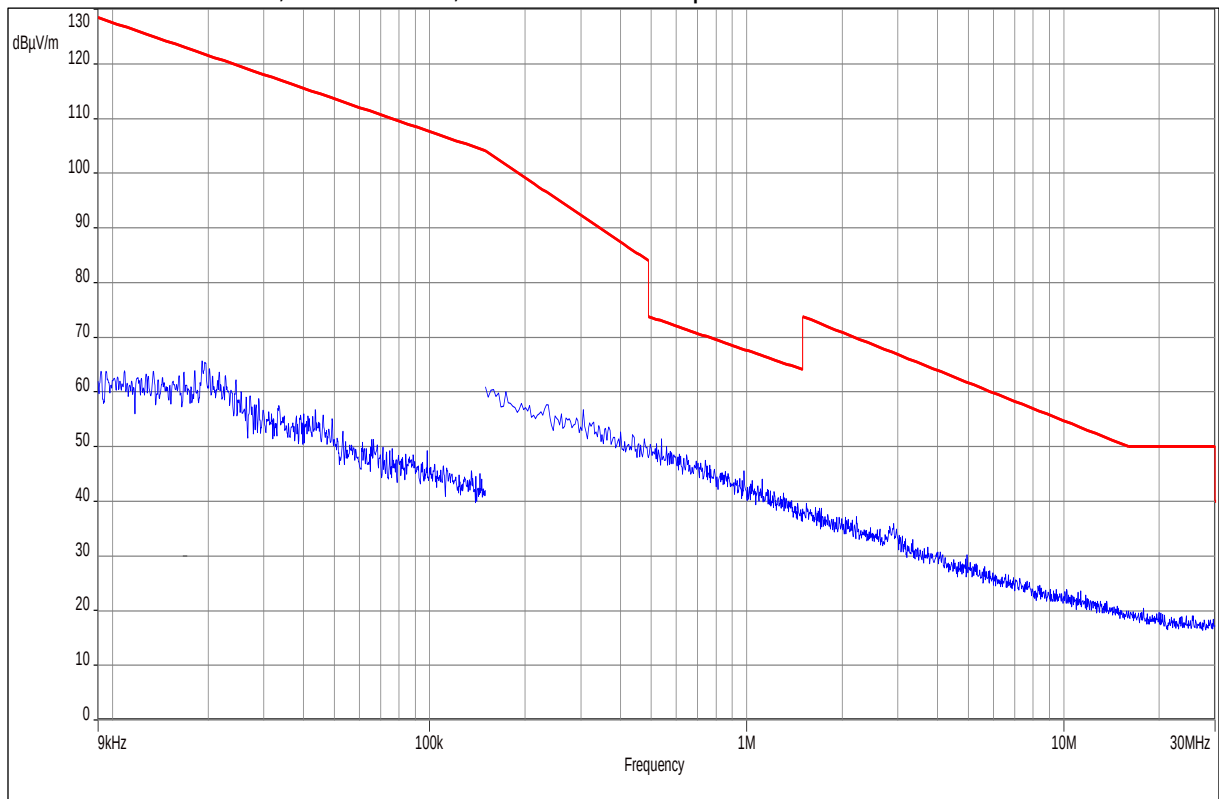
§15.249 (e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

§15.31 (c) Except as otherwise indicated in §15.256, for swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

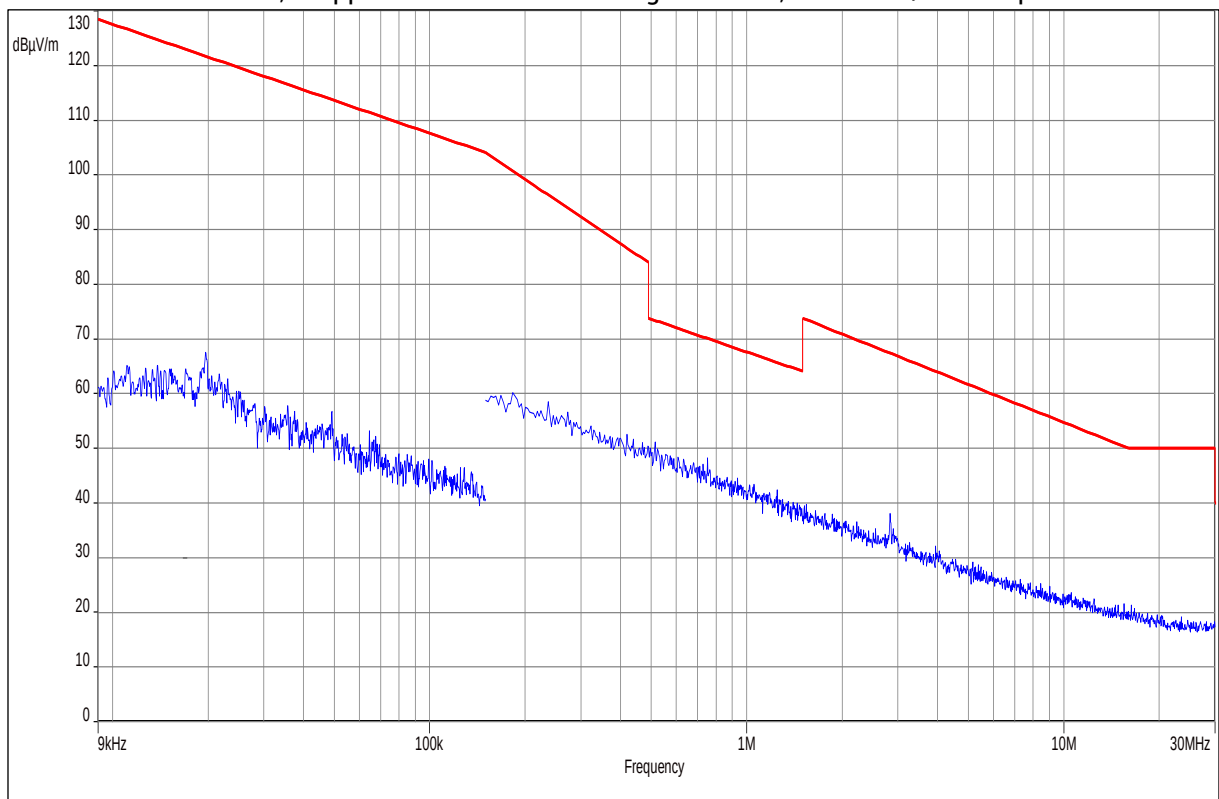
**Measurement results:**

| Frequency in [GHz]                 | Detector | Bandwidth [MHz] | Level [dBμV] | Distance [m] | Limit [dBμV] | Margin [dB] |
|------------------------------------|----------|-----------------|--------------|--------------|--------------|-------------|
| Normal Mode<br>24.25 GHz           | Peak     | 1               | 52.07        | 1            | 74           | 21.93       |
|                                    | AVG      | 1               | 26.94        | 1            | 54           | 27.06       |
| Stopped Mode Low<br>Ch. 48.1 GHz   | Peak     | 1               | 52.24        | 1            | 74           | 21.76       |
|                                    | AVG      | 1               | 48.11        | 1            | 54           | 5.89        |
| Stopped Mode<br>Middle Ch.48.3 GHz | Peak     | 1               | 51.49        | 1            | 74           | 22.51       |
|                                    | AVG      | 1               | 47.14        | 1            | 54           | 6.86        |
| Stopped Mode<br>High Ch.48.5 GHz   | Peak     | 1               | 49.33        | 1            | 74           | 24.67       |
|                                    | AVG      | 1               | 44.13        | 1            | 54           | 9.87        |

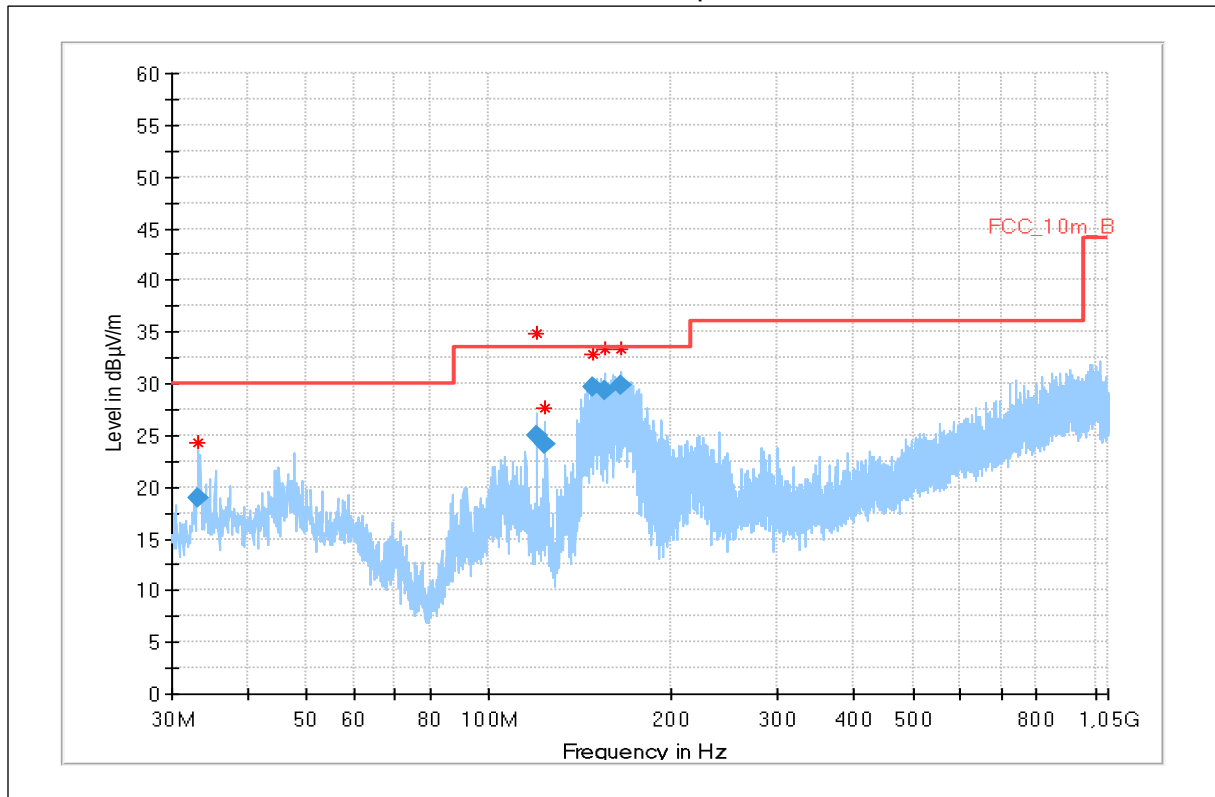
Plot No. 4: 9 kHz to 30 MHz, Normal Mode, horizontal/vertical polarization



Plot No. 5: 9 kHz to 30 MHz, Stopped Mode Low-Middle-High Channel, horizontal/vertical polarization

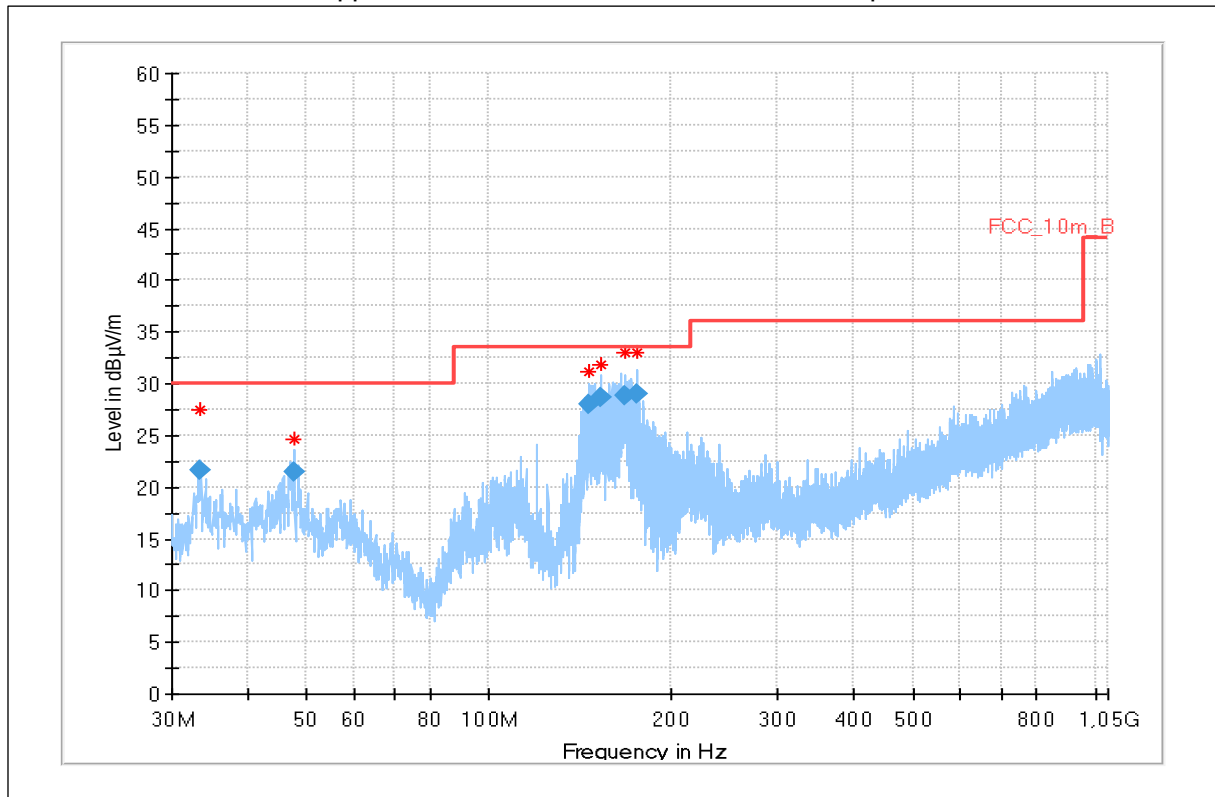


Plot No. 6: 30 MHz to 1 GHz, Normal Mode, horizontal/vertical polarization



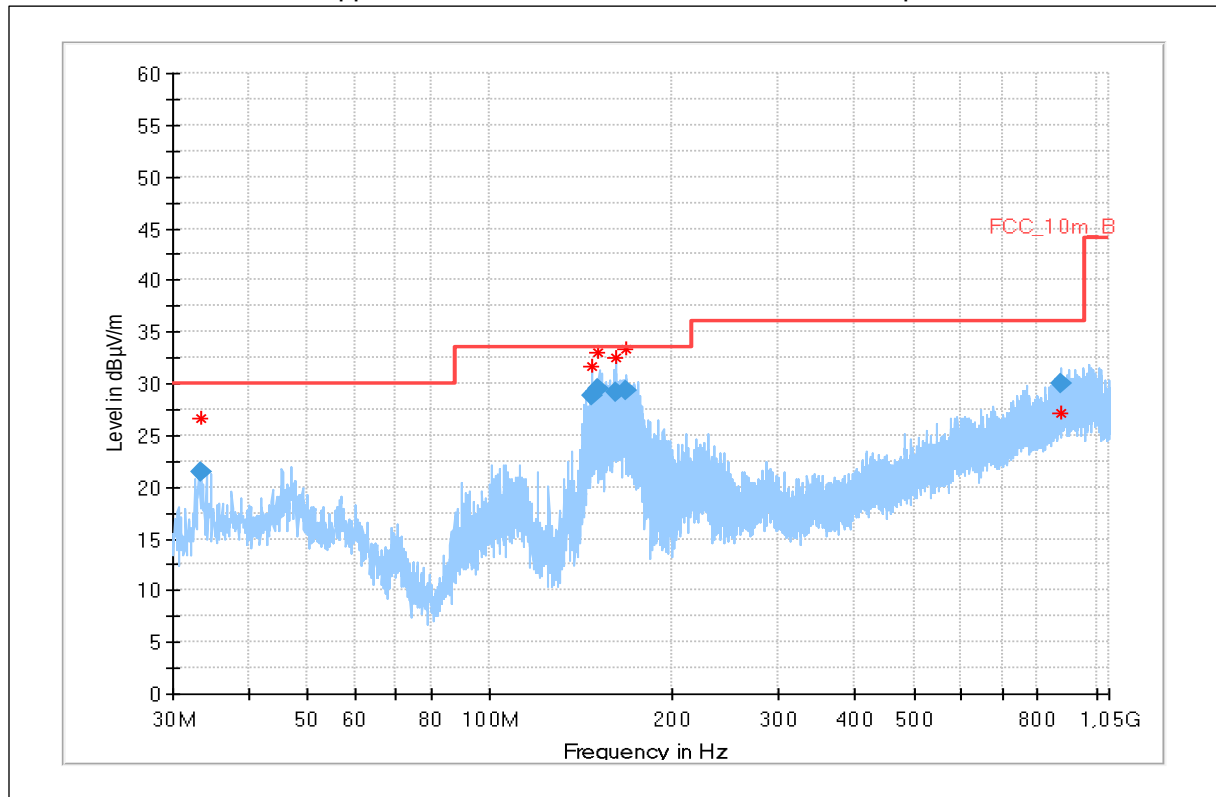
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 33.173          | 18.98              | 30.0           | 11.0        | 1000            | 120.0           | 116.0       | V   | 144           | 14           |
| 120.030         | 24.93              | 33.5           | 8.6         | 1000            | 120.0           | 195.0       | V   | 307           | 11           |
| 123.516         | 24.19              | 33.5           | 9.3         | 1000            | 120.0           | 156.0       | V   | 293           | 10           |
| 148.930         | 29.61              | 33.5           | 3.9         | 1000            | 120.0           | 104.0       | V   | 57            | 10           |
| 155.085         | 29.32              | 33.5           | 4.2         | 1000            | 120.0           | 114.0       | V   | -16           | 10           |
| 164.812         | 29.78              | 33.5           | 3.7         | 1000            | 120.0           | 102.0       | V   | -3            | 11           |

Plot No. 7: 30 MHz to 1 GHz, Stopped Mode Low Channel, horizontal/vertical polarization



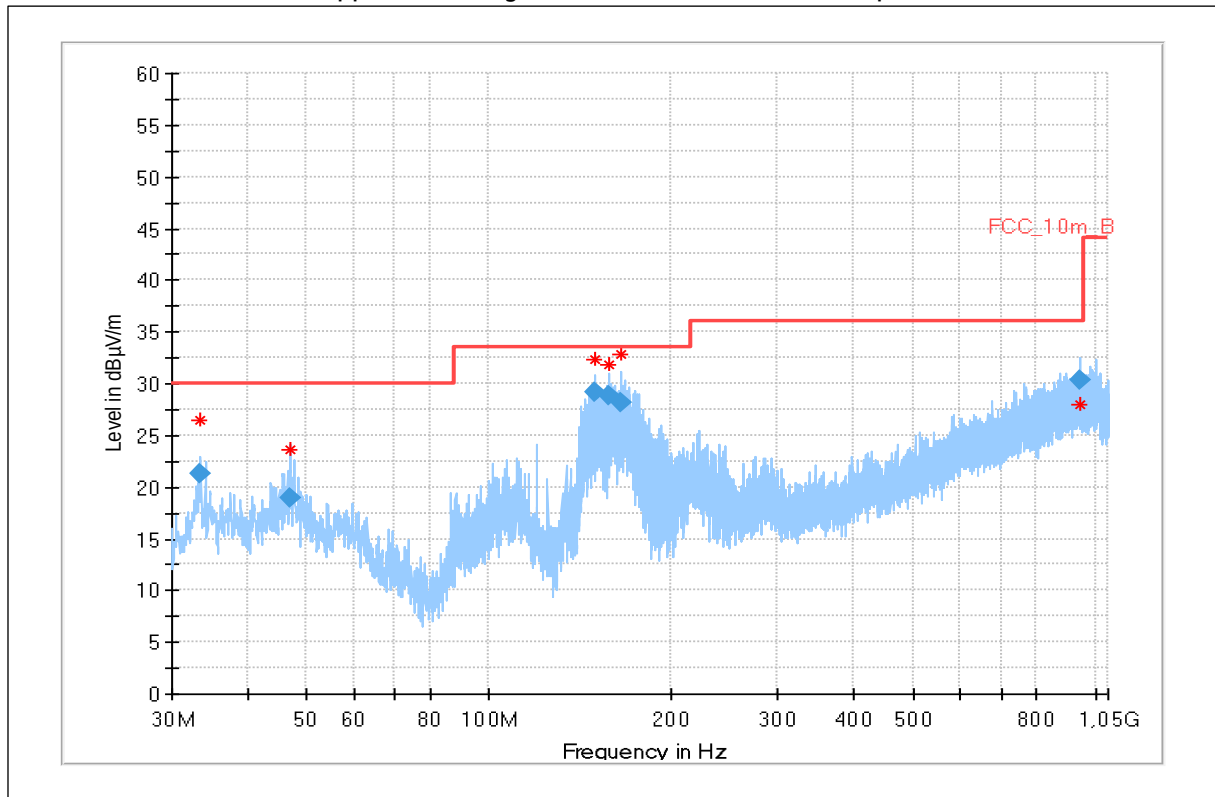
| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 33.455          | 21.59              | 30.0           | 8.4         | 1000            | 120.0           | 121.0       | V   | 121           | 14           |
| 47.802          | 21.42              | 30.0           | 8.6         | 1000            | 120.0           | 163.0       | V   | 104           | 16           |
| 145.643         | 28.03              | 33.5           | 5.5         | 1000            | 120.0           | 98.0        | V   | -10           | 10           |
| 153.263         | 28.71              | 33.5           | 4.8         | 1000            | 120.0           | 113.0       | V   | -7            | 10           |
| 168.012         | 28.89              | 33.5           | 4.6         | 1000            | 120.0           | 98.0        | V   | -34           | 11           |
| 174.954         | 28.94              | 33.5           | 4.6         | 1000            | 120.0           | 102.0       | V   | -12           | 11           |

Plot No. 8: 30 MHz to 1 GHz, Stopped Mode Middle Channel, horizontal/vertical polarization



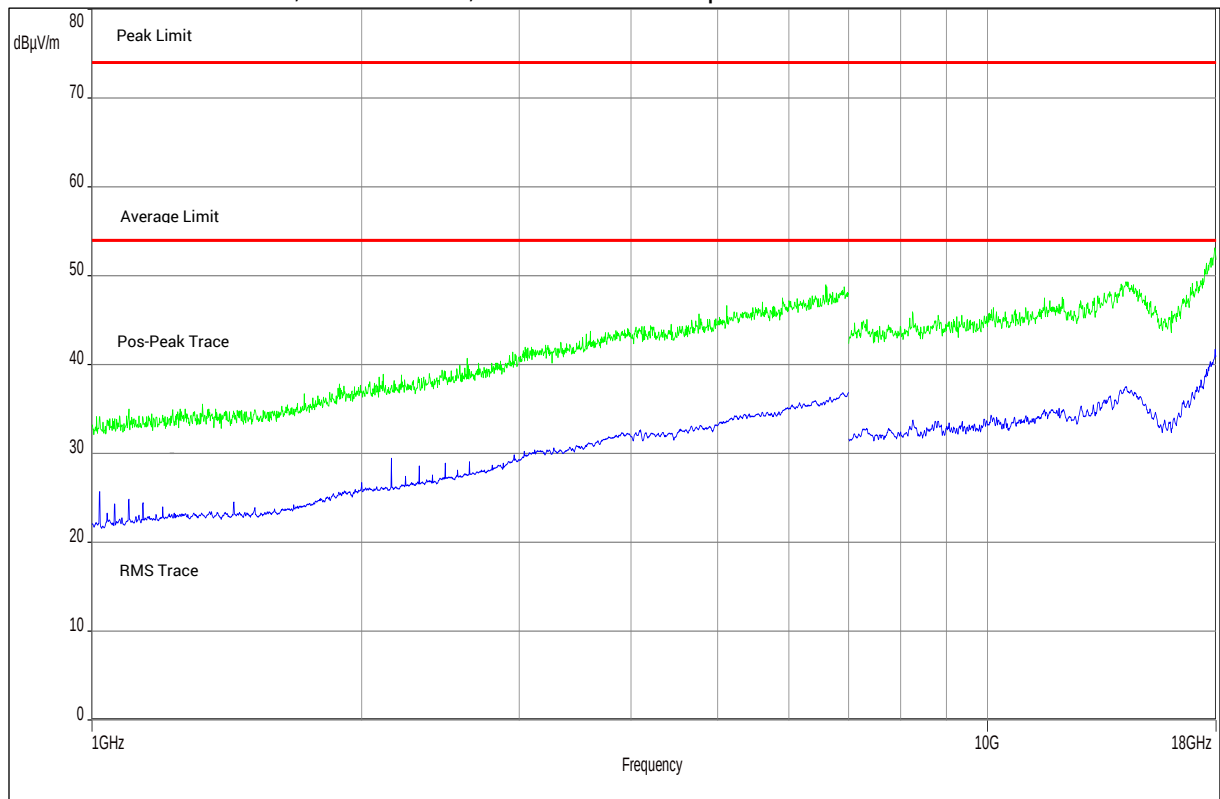
| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 33.428          | 21.53              | 30.0           | 8.5         | 1000            | 120.0           | 106.0       | V   | 127           | 14           |
| 147.144         | 28.79              | 33.5           | 4.7         | 1000            | 120.0           | 102.0       | V   | 25            | 10           |
| 151.220         | 29.46              | 33.5           | 4.0         | 1000            | 120.0           | 104.0       | V   | 16            | 10           |
| 161.540         | 29.24              | 33.5           | 4.3         | 1000            | 120.0           | 136.0       | V   | -24           | 10           |
| 167.446         | 29.25              | 33.5           | 4.3         | 1000            | 120.0           | 98.0        | V   | -9            | 11           |
| 873.967         | 30.08              | 36.0           | 5.9         | 1000            | 120.0           | 105.0       | H   | 251           | 25           |

Plot No. 9: 30 MHz to 1 GHz, Stopped Mode High Channel, horizontal/vertical polarization

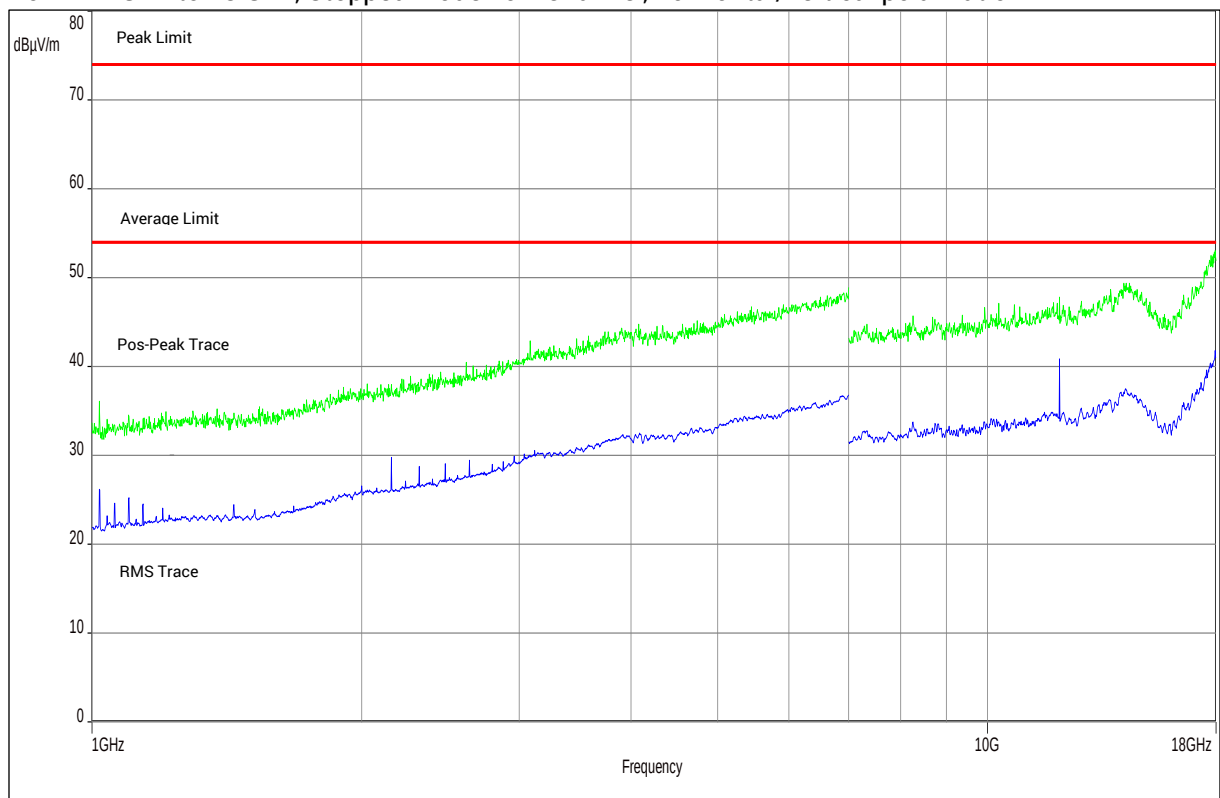


| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 33.449          | 21.28              | 30.0           | 8.7         | 1000            | 120.0           | 121.0       | V   | 14            | 14           |
| 47.147          | 18.90              | 30.0           | 11.1        | 1000            | 120.0           | 104.0       | V   | 12            | 16           |
| 149.090         | 29.10              | 33.5           | 4.4         | 1000            | 120.0           | 102.0       | V   | 18            | 10           |
| 158.014         | 28.81              | 33.5           | 4.7         | 1000            | 120.0           | 104.0       | V   | 5             | 10           |
| 164.484         | 28.24              | 33.5           | 5.3         | 1000            | 120.0           | 101.0       | V   | -13           | 11           |
| 946.304         | 30.35              | 36.0           | 5.7         | 1000            | 120.0           | 195.0       | V   | 92            | 25           |

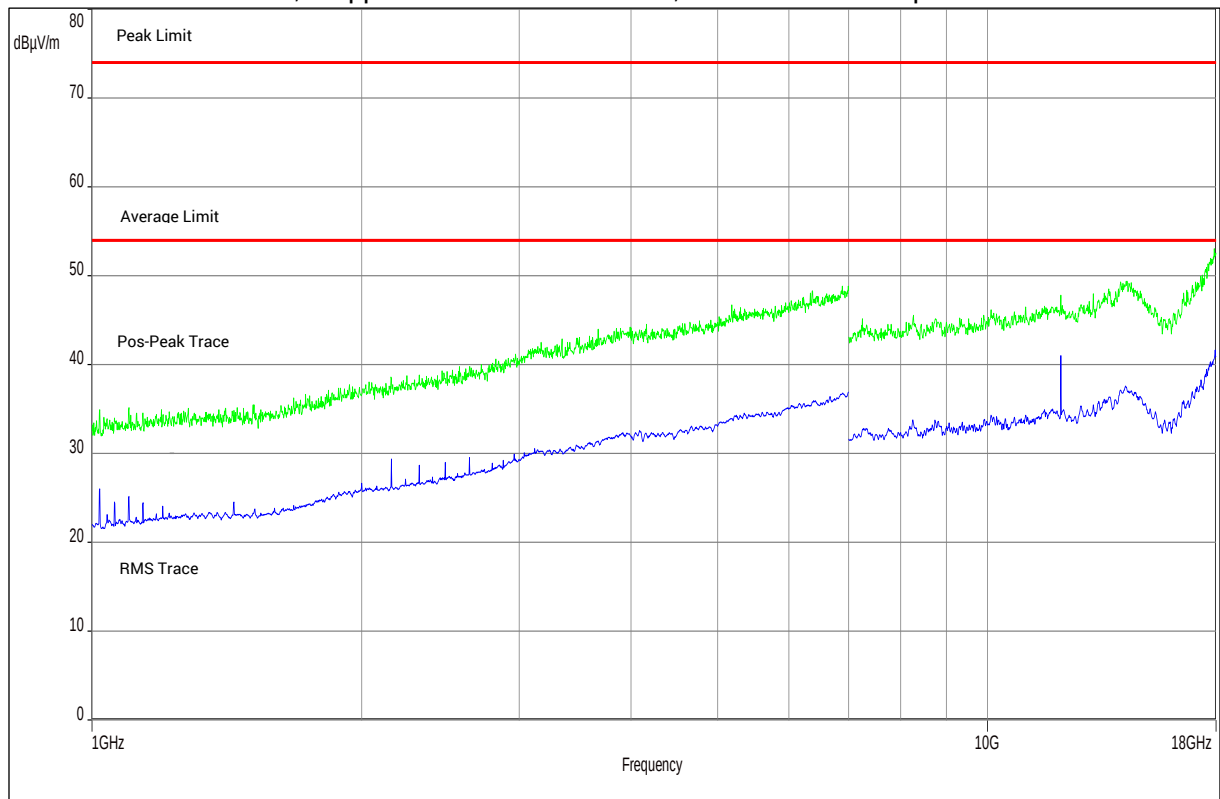
Plot No. 10: 1 GHz to 18 GHz, Normal Mode, horizontal/vertical polarization



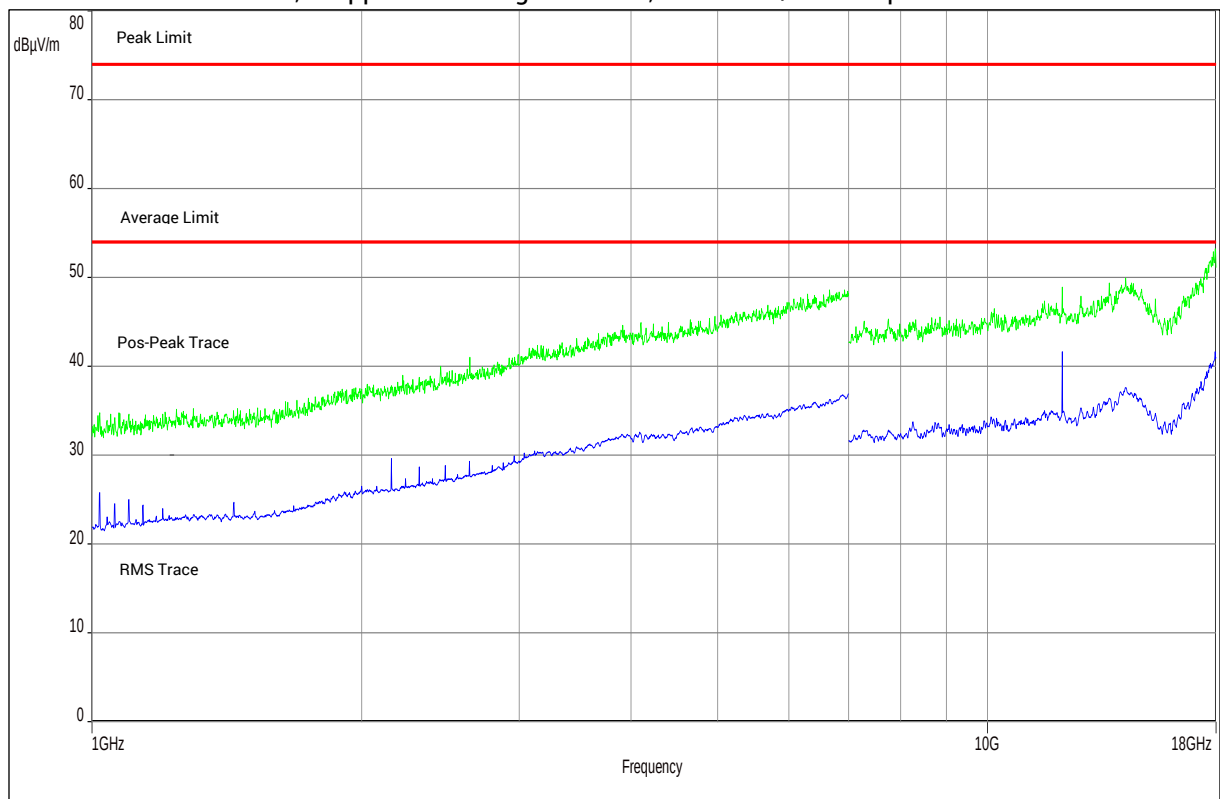
Plot No. 11: 1 GHz to 18 GHz, Stopped Mode Low Channel, horizontal/vertical polarization



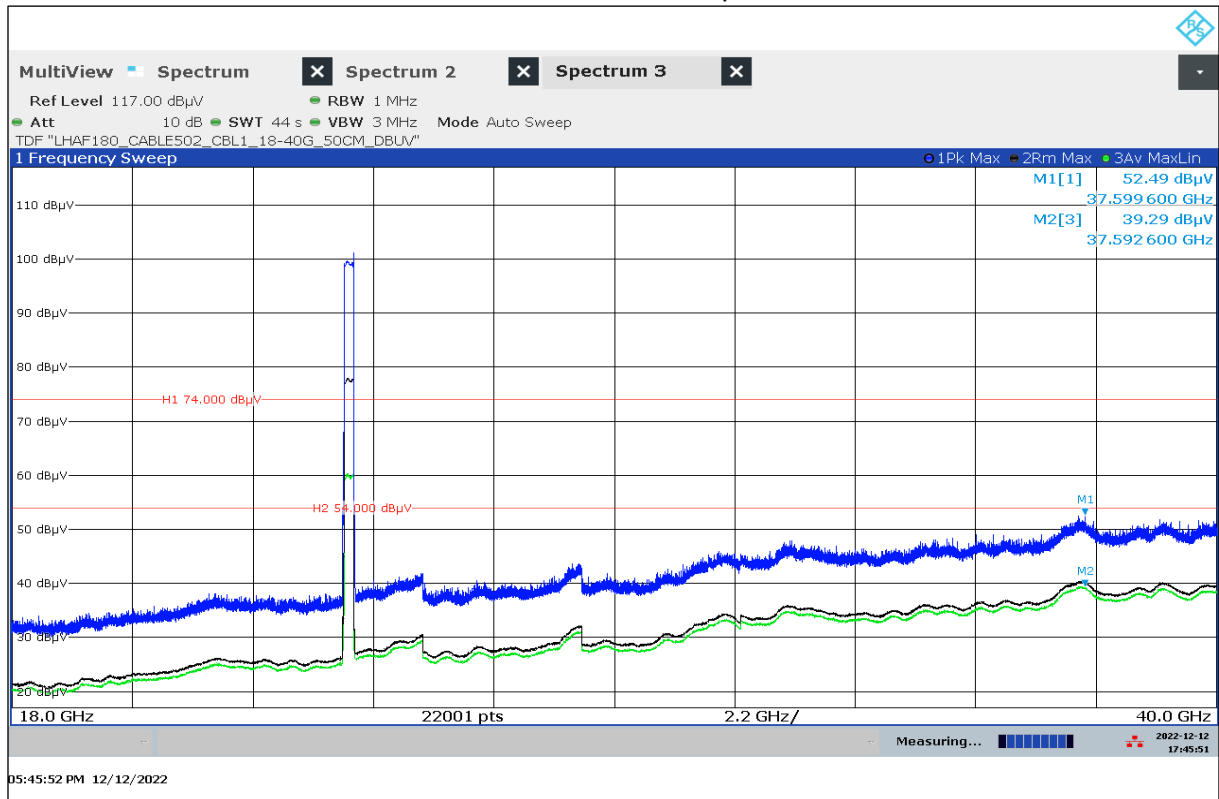
Plot No. 12: 1 GHz to 18 GHz, Stopped Mode Middle Channel, horizontal/vertical polarization



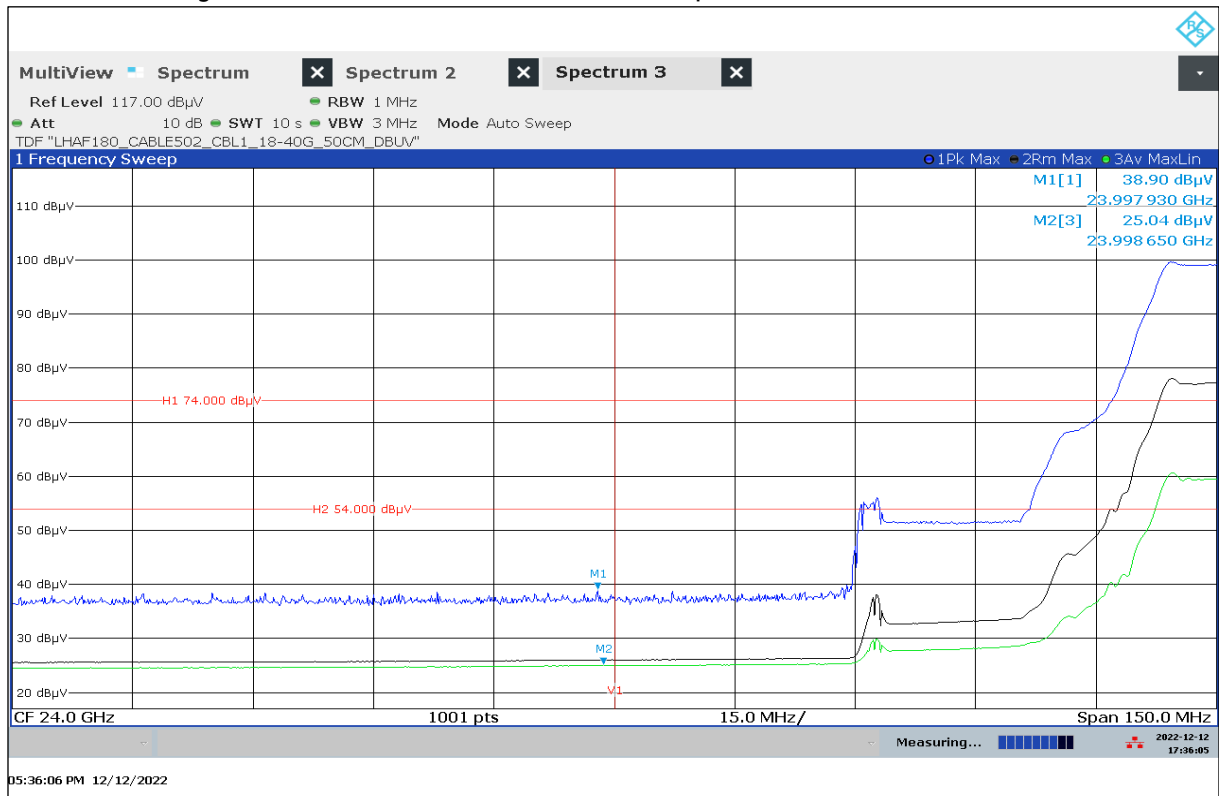
Plot No. 13: 1 GHz to 18 GHz, Stopped Mode High Channel, horizontal/vertical polarization



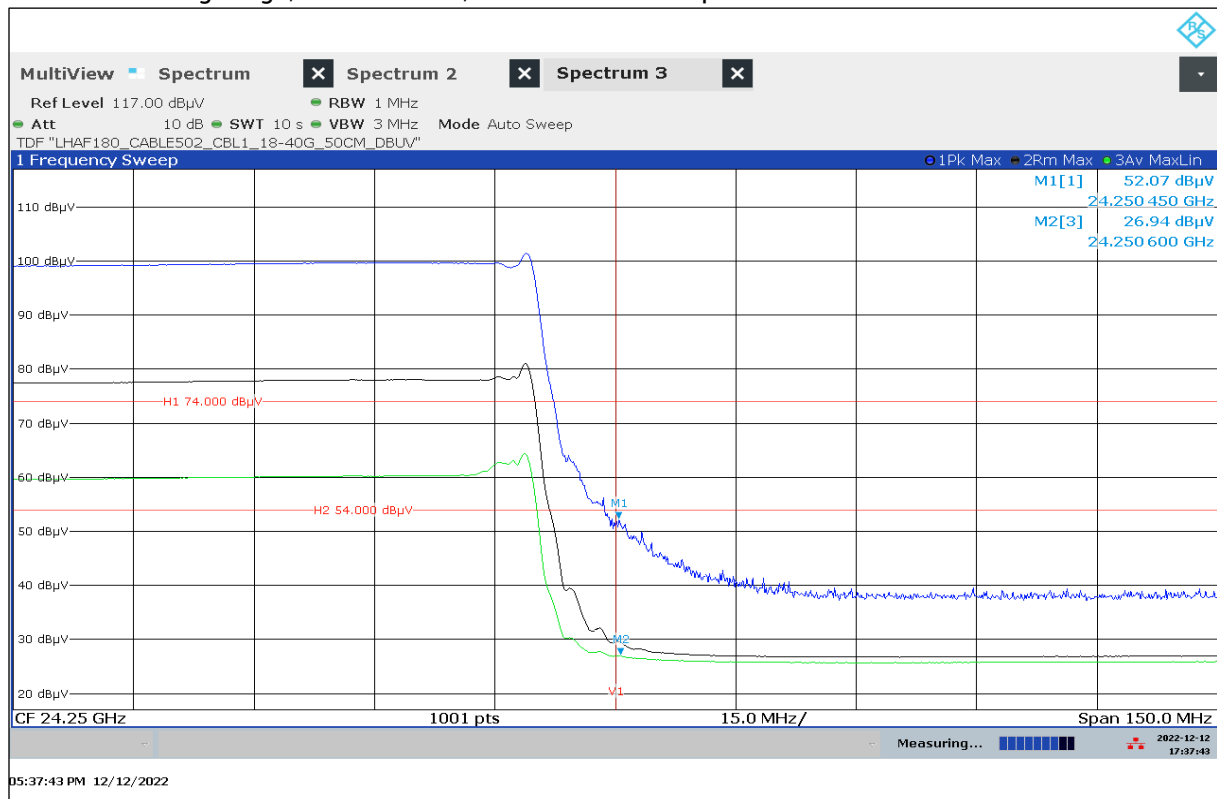
Plot No. 14: 18 GHz to 40 GHz, Normal Mode, horizontal/vertical polarization



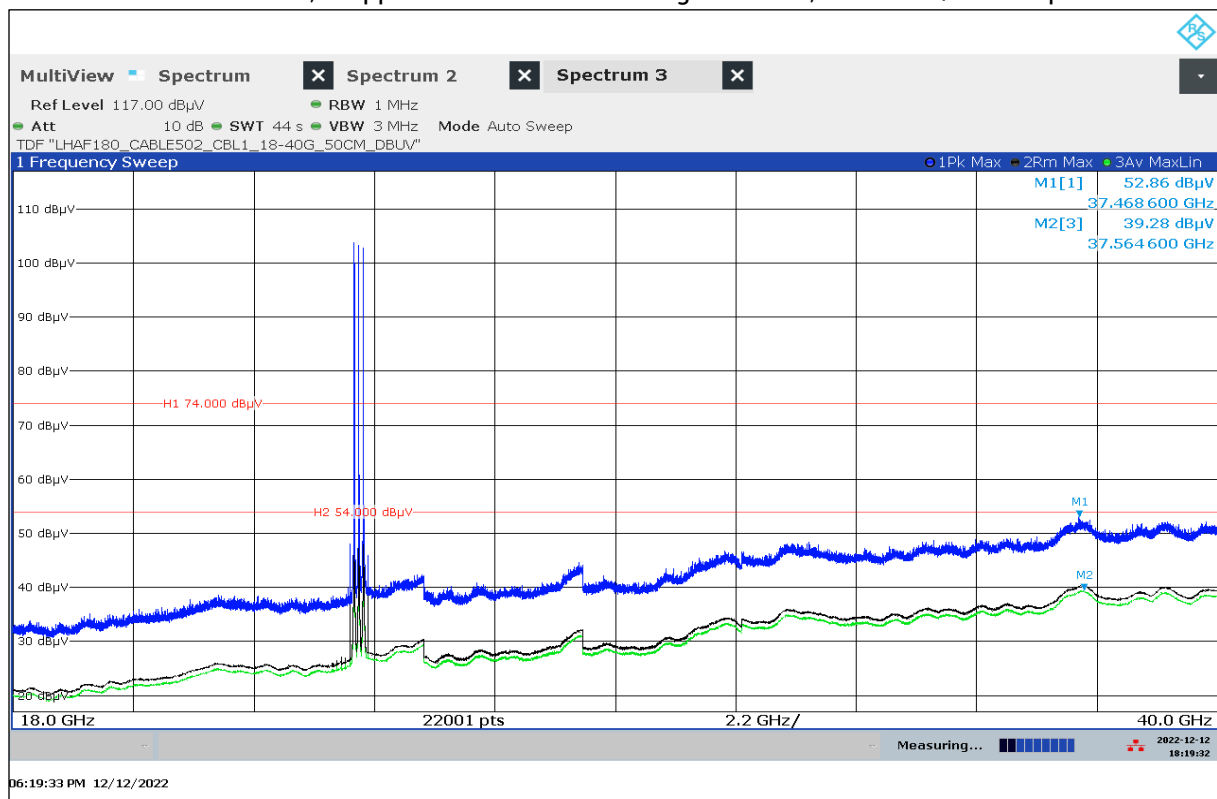
Plot No. 15: Band Edge Low, Normal Mode, horizontal/vertical polarization



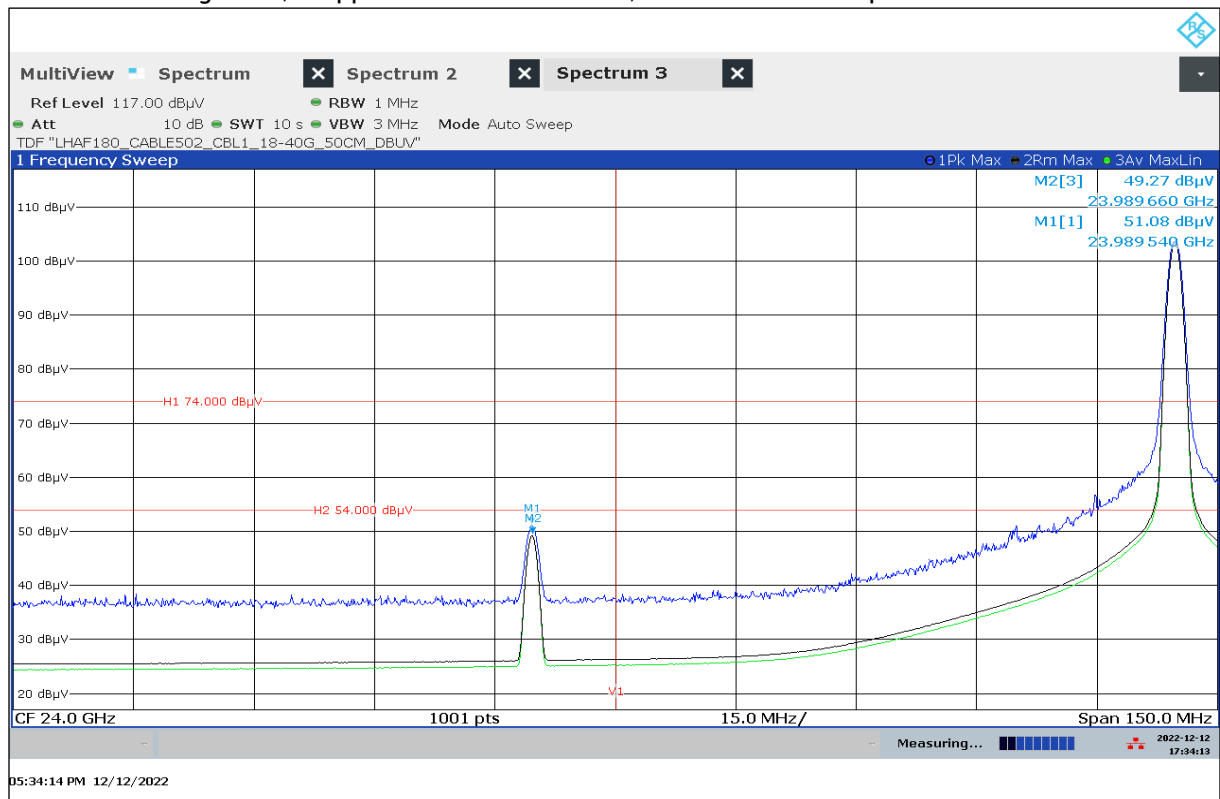
Plot No. 16: Band Edge High, Normal Mode, horizontal/vertical polarization



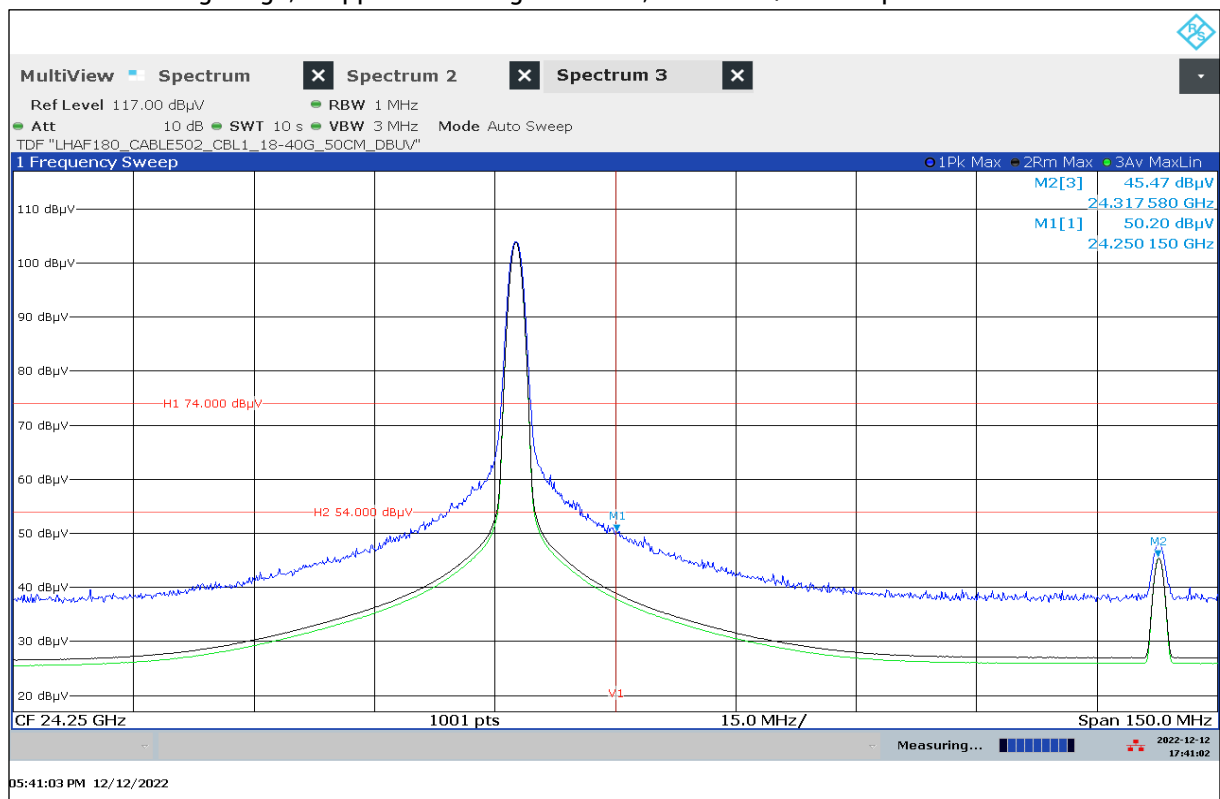
Plot No. 17: 18 GHz to 40 GHz, Stopped Mode Low-Middle-High Channel, horizontal/vertical polarization



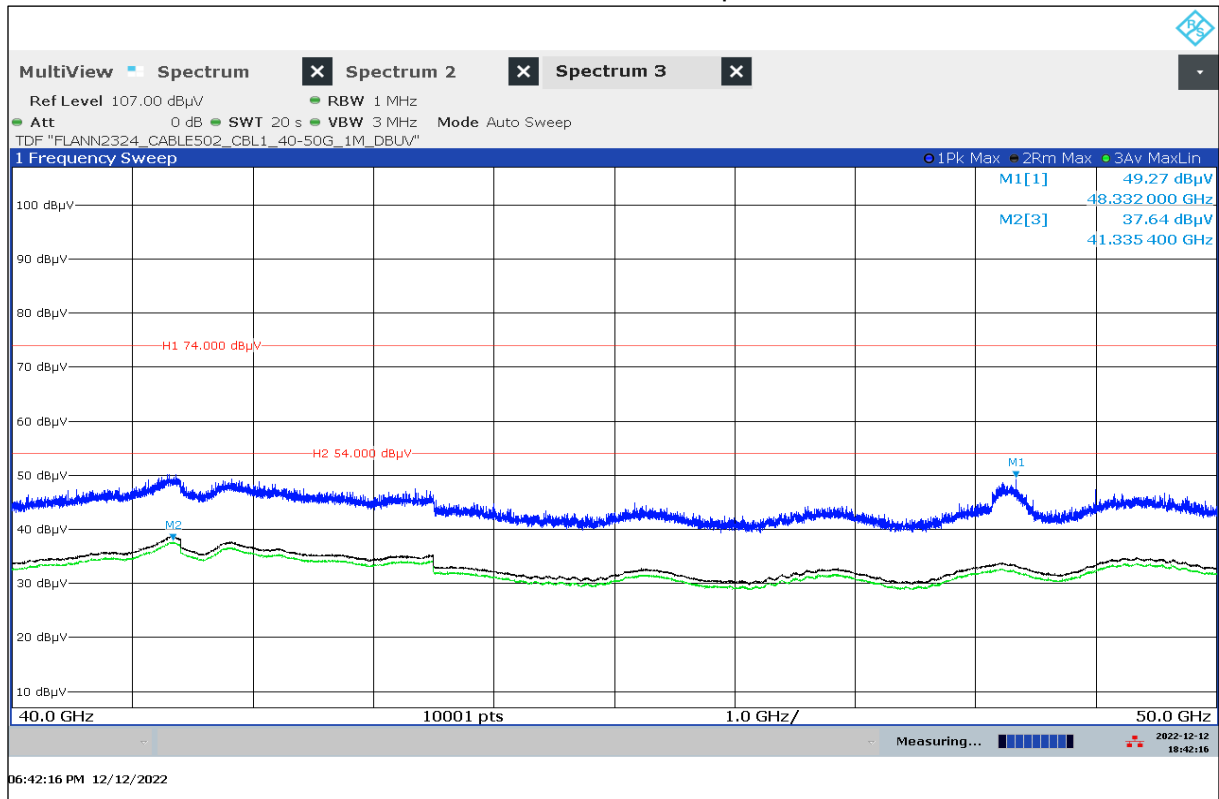
Plot No. 18: Band Edge Low, Stopped Mode Low Channel, horizontal/vertical polarization



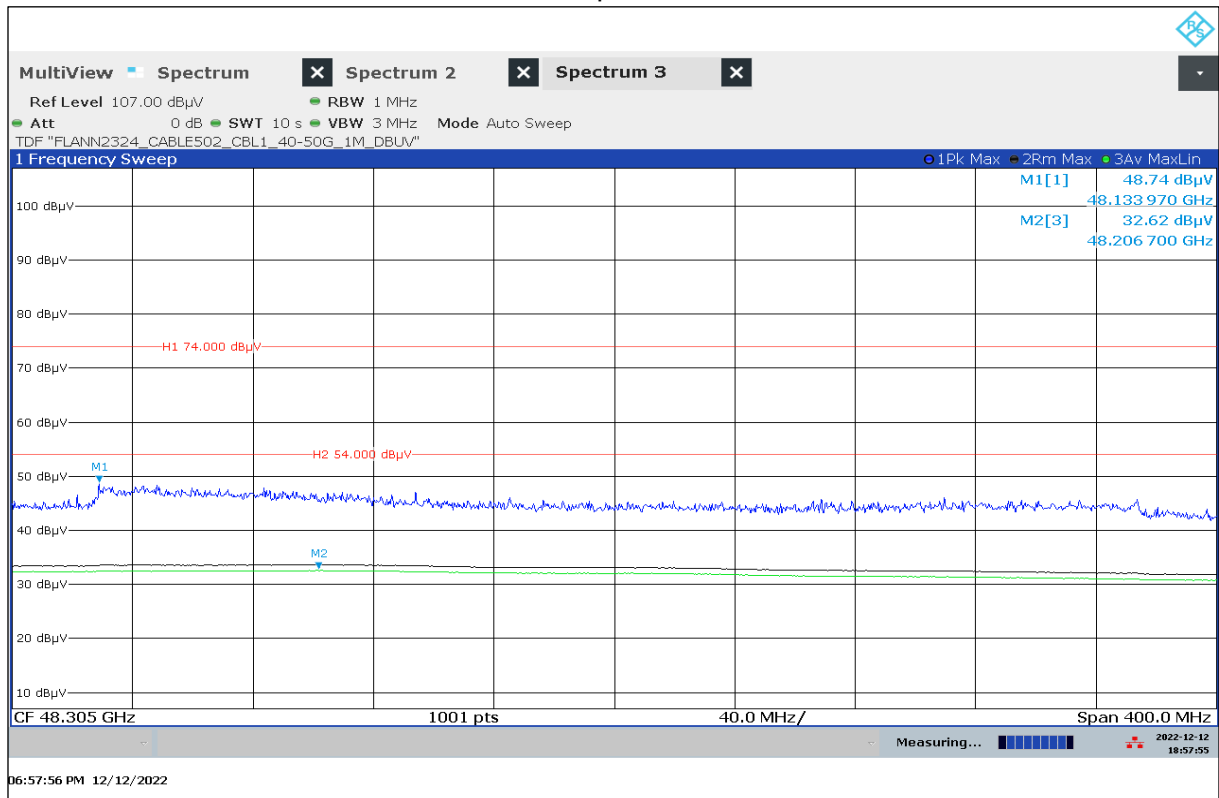
Plot No. 19: Band Edge High, Stopped Mode High Channel, horizontal/vertical polarization



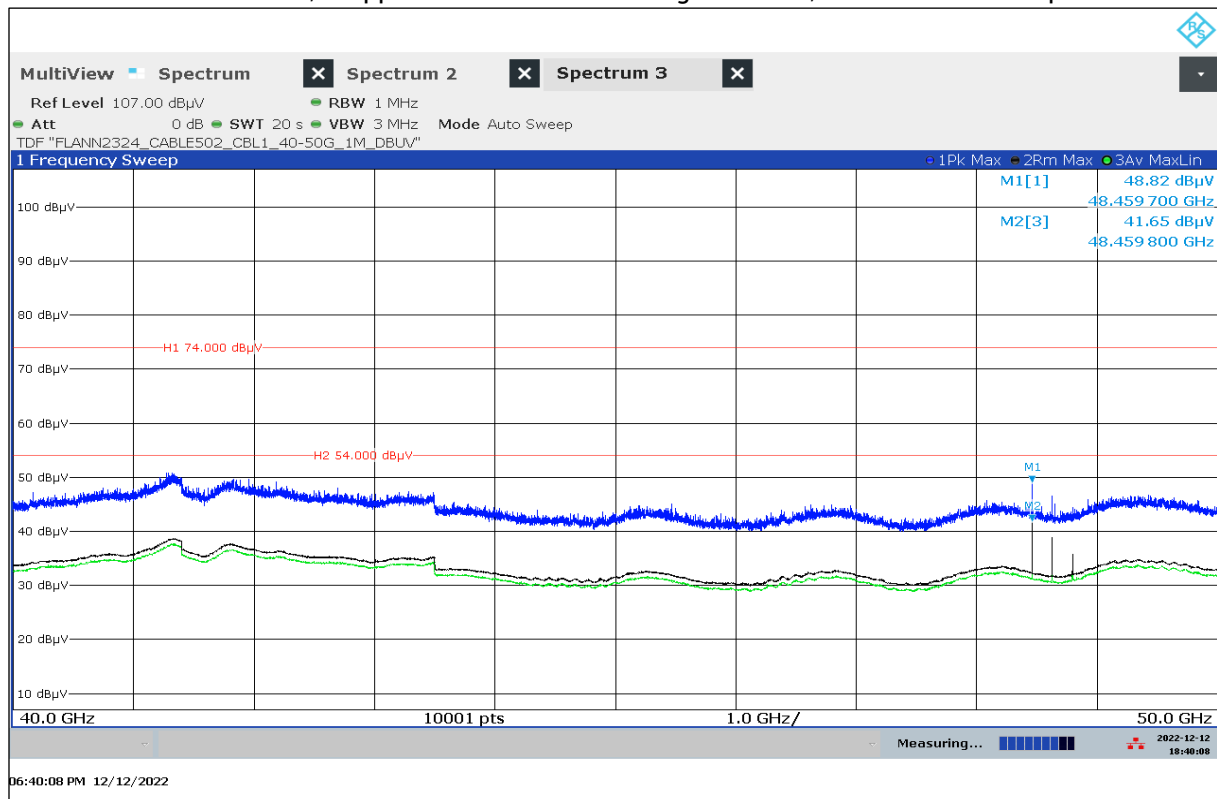
Plot No. 20: 40 GHz to 50 GHz, Normal Mode, horizontal/vertical polarization



Plot No. 21: 48 GHz, Normal Mode, horizontal/vertical polarization



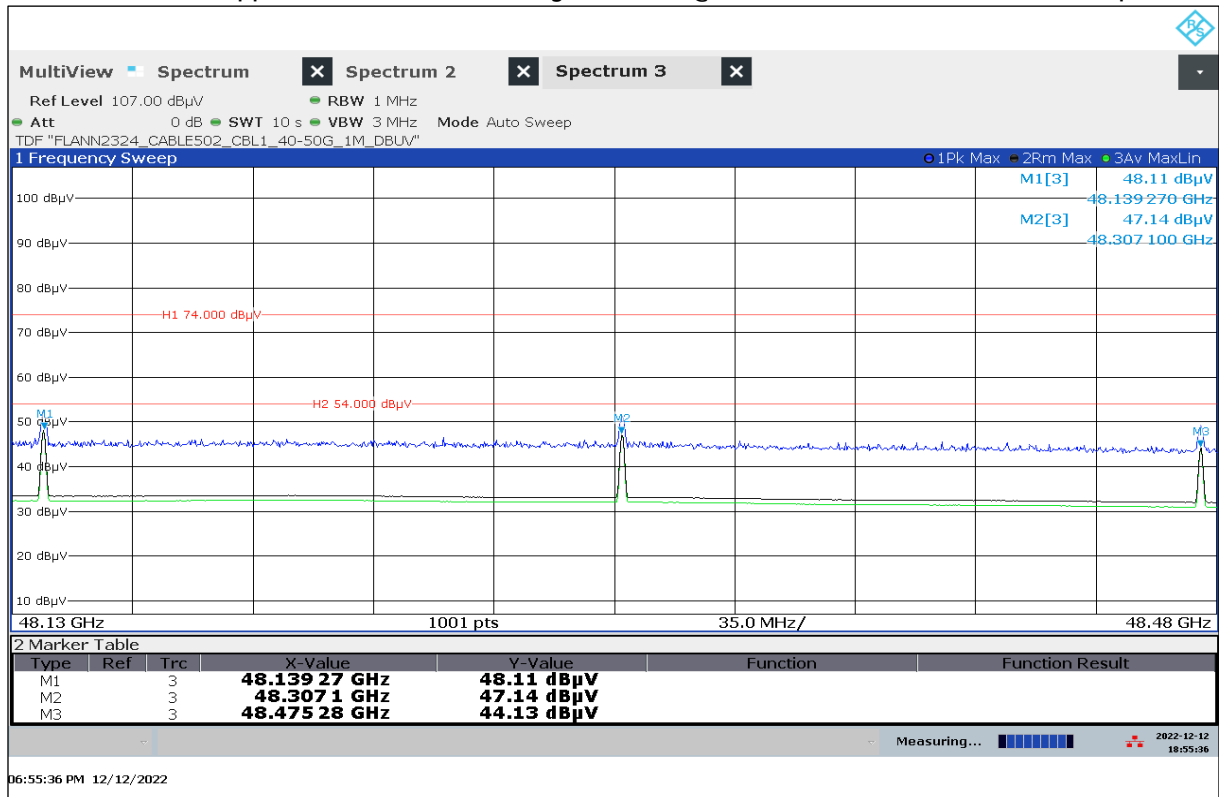
Plot No. 22: 40 GHz to 50 GHz, Stopped Mode Low-Middle-High Channel, horizontal/vertical polarization



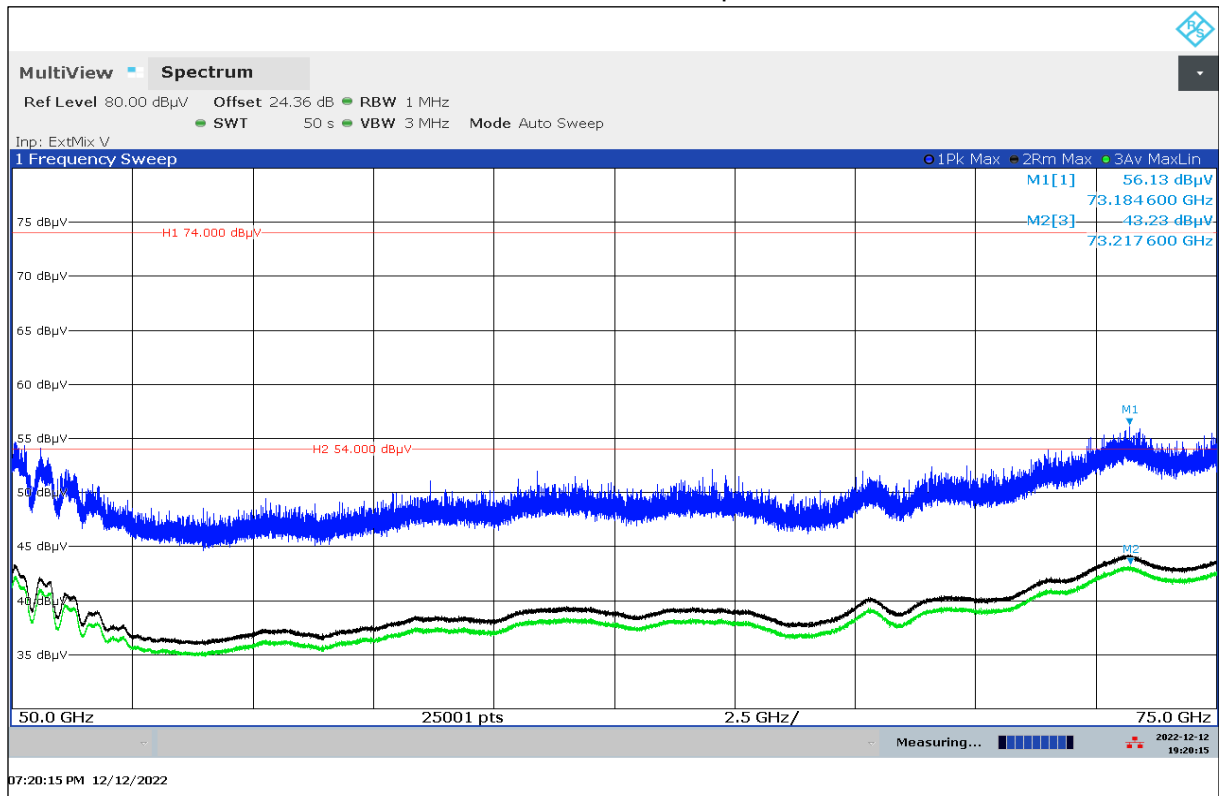
Plot No. 23: 48 GHz, Stopped Mode Low-Middle-High Channel @ Peak detector, horizontal/vertical polarization



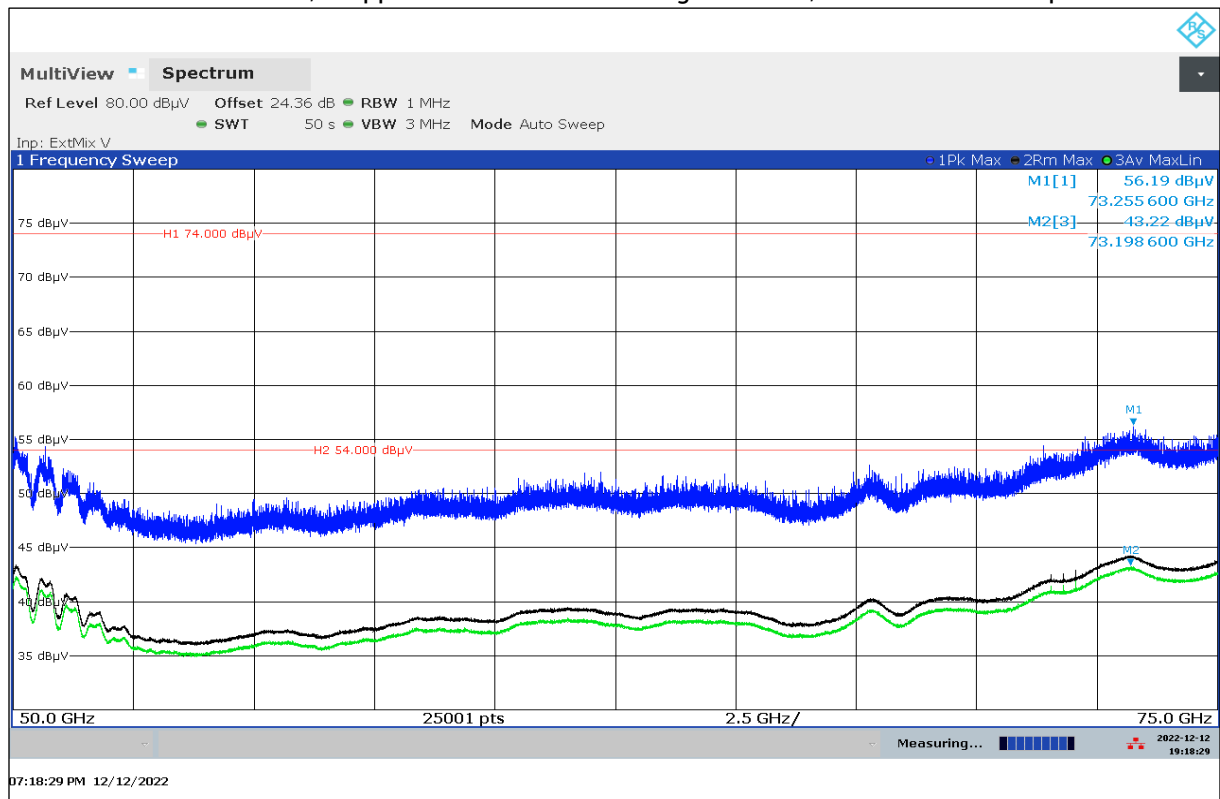
Plot No. 24: 48 GHz, Stopped Mode Low-Middle-High Channel @ AVG detector, horizontal/vertical polarization



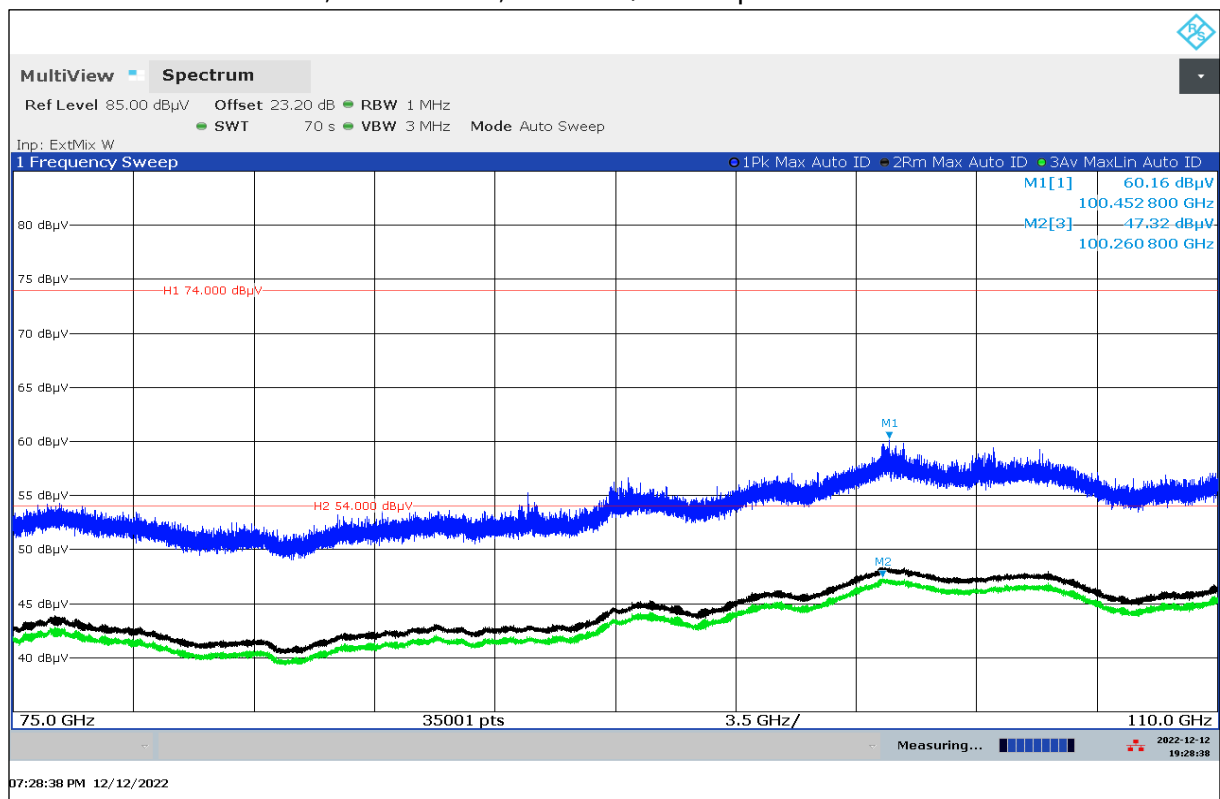
Plot No. 25: 50 GHz to 75 GHz, Normal Mode, horizontal/vertical polarization



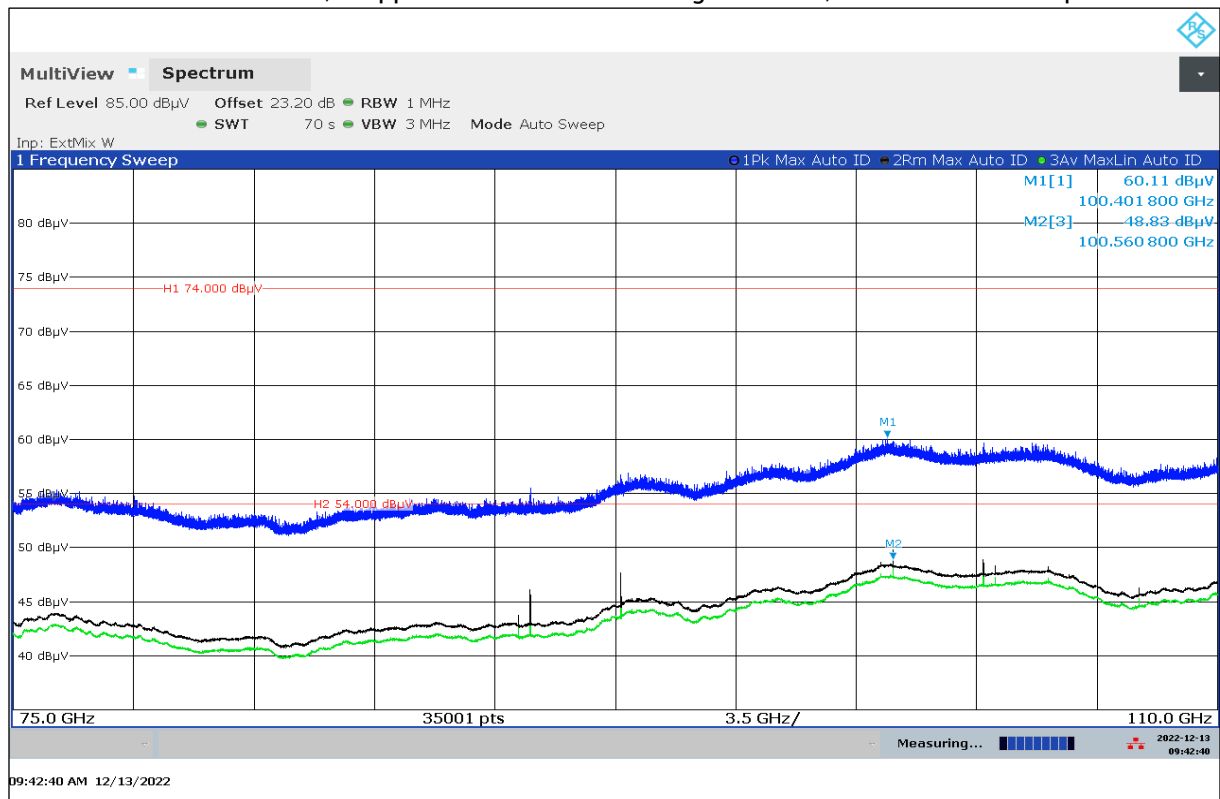
Plot No. 26: 50 GHz to 75 GHz, Stopped Mode Low-Middle-High Channel, horizontal/vertical polarization



Plot No. 27: 75 GHz to 110 GHz, Normal Mode, horizontal/vertical polarization



Plot No. 28: 75 GHz to 110 GHz, Stopped Mode Low-Middle-High Channel, horizontal/vertical polarization



## 12.4 Conducted emissions < 30 MHz

### Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. Both power lines, phase and neutral line, are measured. Found peaks are re-measured with average and quasi peak detection to show compliance to the limits.

### Measurement:

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

### Limits:

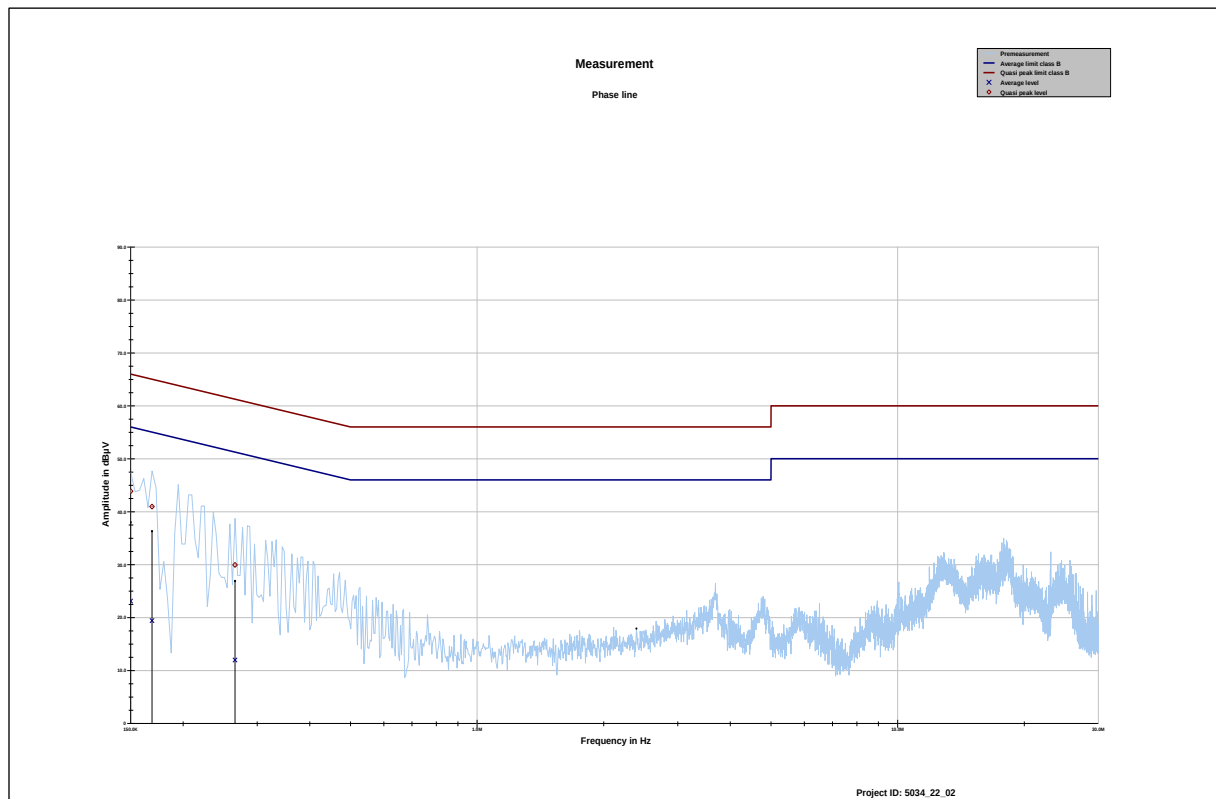
| FCC                                   |                     |                  |
|---------------------------------------|---------------------|------------------|
| CFR Part 15.207(a)                    |                     |                  |
| Conducted Spurious Emissions < 30 MHz |                     |                  |
| Frequency (MHz)                       | Quasi-Peak (dBμV/m) | Average (dBμV/m) |
| 0.15 – 0.5                            | 66 to 56*           | 56 to 46*        |
| 0.5 – 5                               | 56                  | 46               |
| 5 – 30.0                              | 60                  | 50               |

\*Decreases with the logarithm of the frequency

### Measurement results:

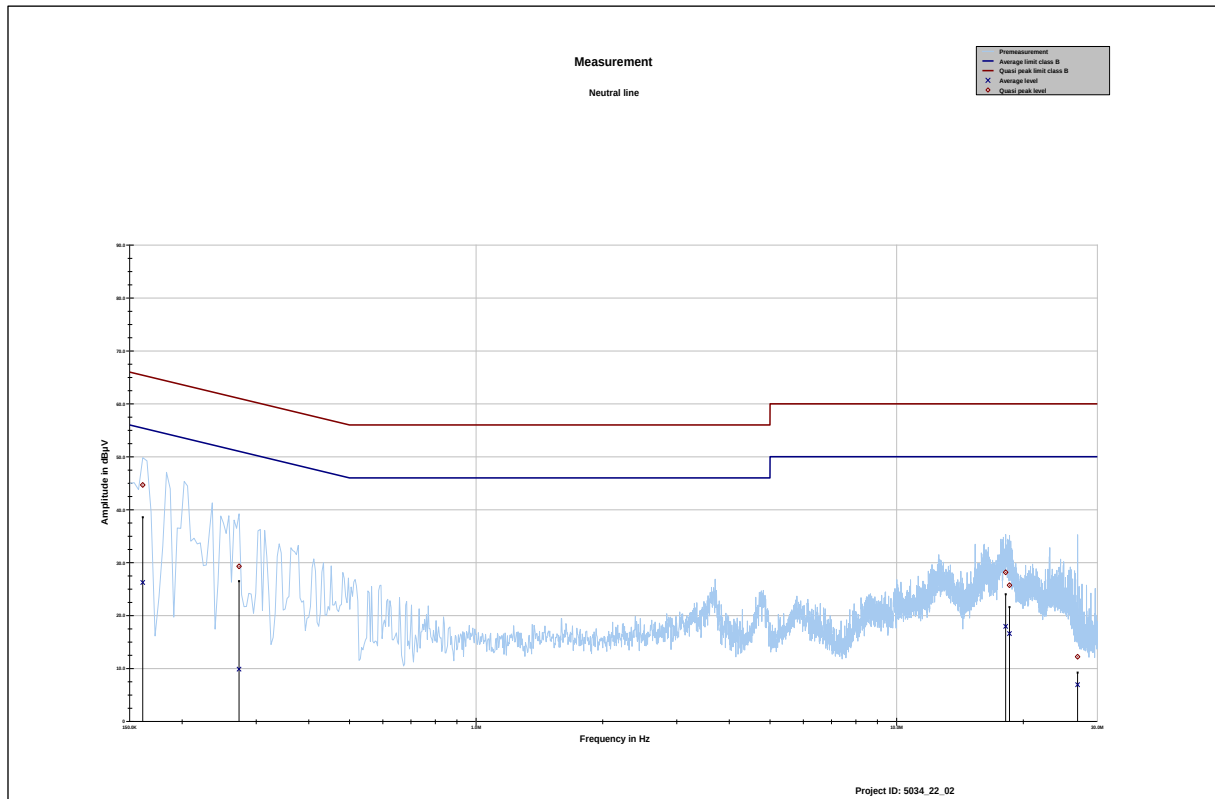
See plots below.

Plot 29: Phase line



| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AVG |
|-----------|------------------|-------------------|----------|---------------|----------------|-----------|
| MHz       | dBµV             | dB                | dBµV     | dBµV          | dB             | dBµV      |
| 0.150000  | 43.86            | 22.14             | 66.000   | 23.10         | 32.90          | 56.000    |
| 0.168656  | 40.96            | 24.07             | 65.026   | 19.42         | 36.05          | 55.467    |
| 0.265669  | 29.93            | 31.32             | 61.252   | 11.98         | 40.72          | 52.695    |

Plot 30: Neutral line



| Frequency | Quasi peak level | Margin quasi peak | Limit QP | Average level | Margin average | Limit AVG |
|-----------|------------------|-------------------|----------|---------------|----------------|-----------|
| MHz       | dBµV             | dB                | dBµV     | dBµV          | dB             | dBµV      |
| 0.161194  | 44.67            | 20.73             | 65.402   | 26.24         | 29.44          | 55.680    |
| 0.273131  | 29.29            | 31.73             | 61.022   | 9.88          | 42.61          | 52.482    |
| 18.164475 | 28.16            | 31.84             | 60.000   | 17.96         | 32.04          | 50.000    |
| 18.552525 | 25.73            | 34.27             | 60.000   | 16.58         | 33.42          | 50.000    |
| 26.940375 | 12.21            | 47.79             | 60.000   | 6.93          | 43.07          | 50.000    |

## 12.5 Frequency Stability

### Description:

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

### Measurement:

| Parameter             |           |
|-----------------------|-----------|
| Detector:             | Pos-Peak  |
| Sweep time:           | See plots |
| Resolution bandwidth: | 1 MHz     |
| Video bandwidth:      | 3 MHz     |
| Trace-Mode:           | Max Hold  |

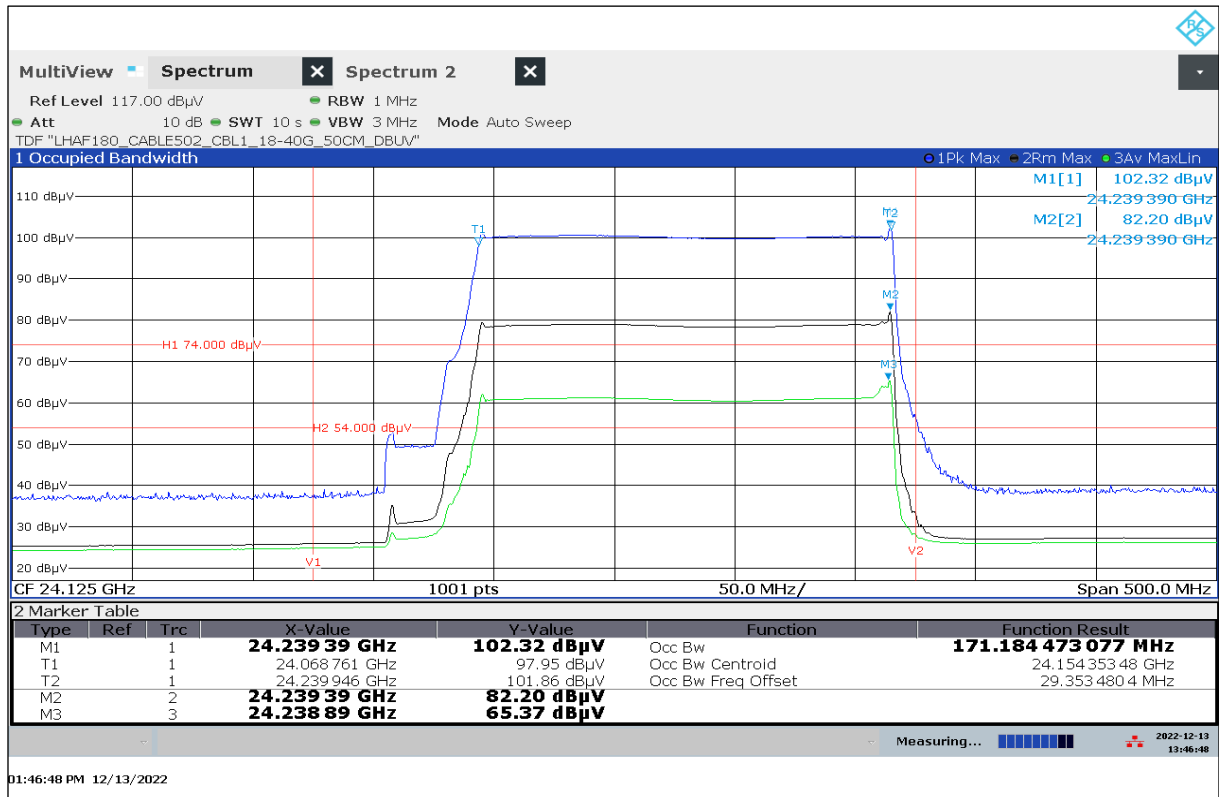
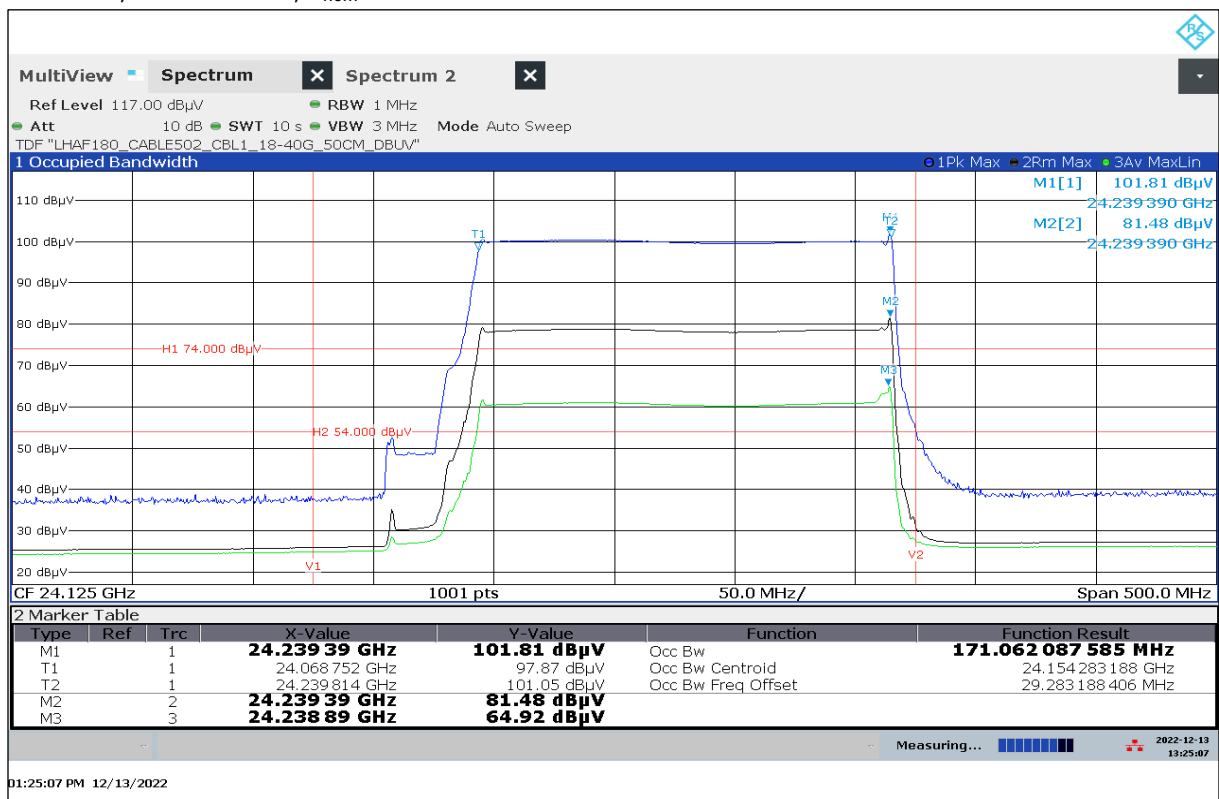
### Limits:

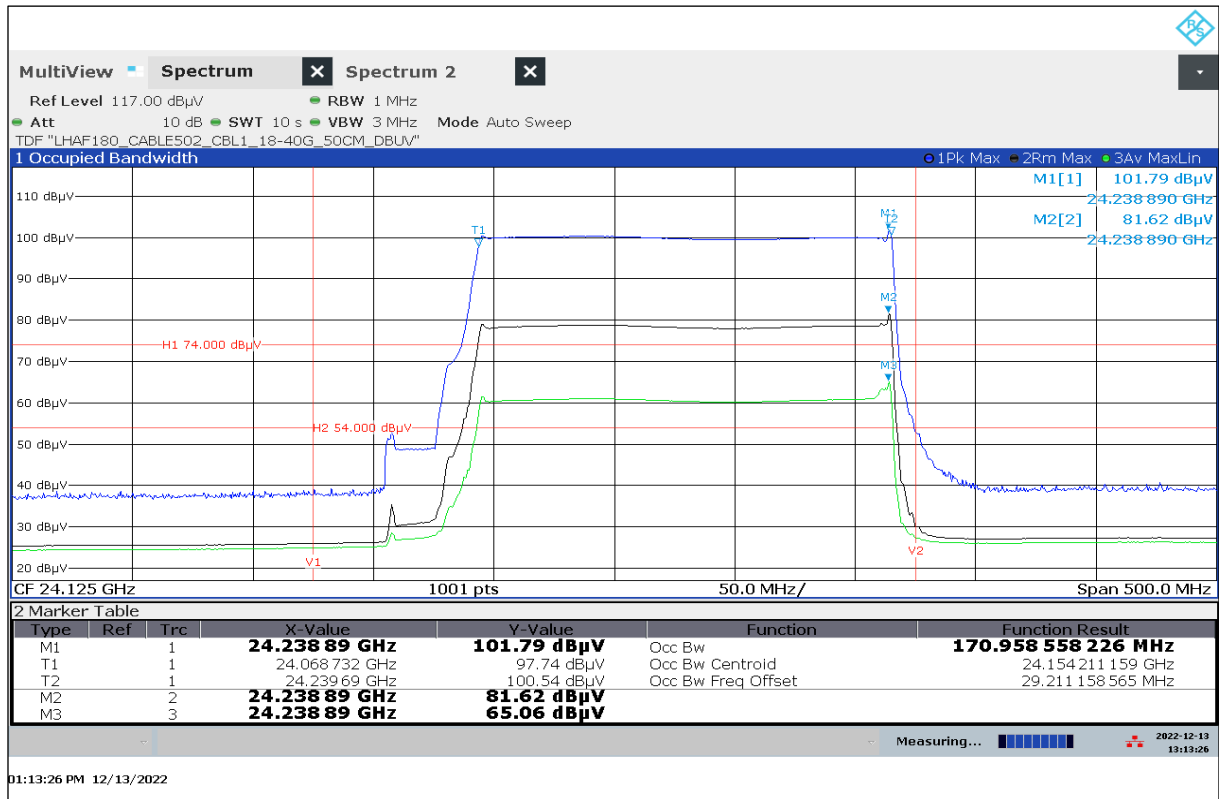
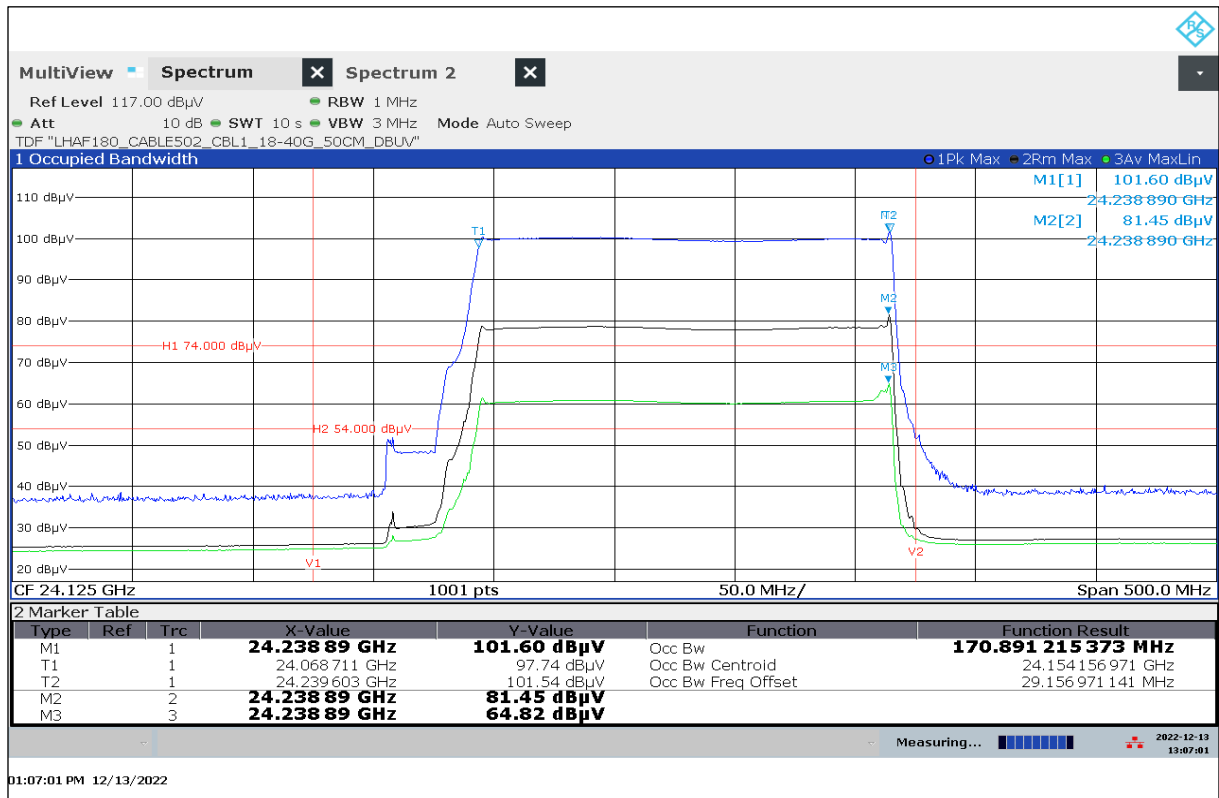
| FCC                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CFR Part 15.215(c)                                                                                                                                                                                                                                    |
| Frequency Stability                                                                                                                                                                                                                                   |
| As specified in Section 15.215(c), the bandwidth of the fundamental emission must be contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage. |

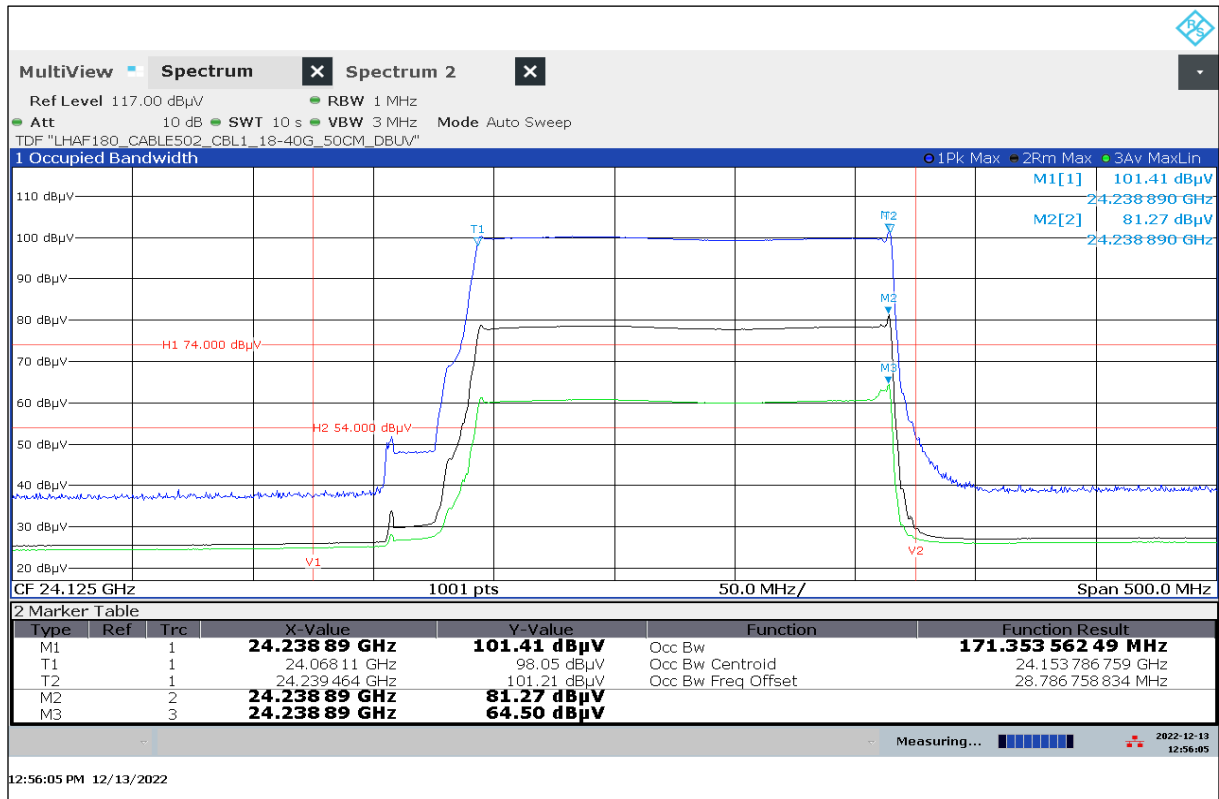
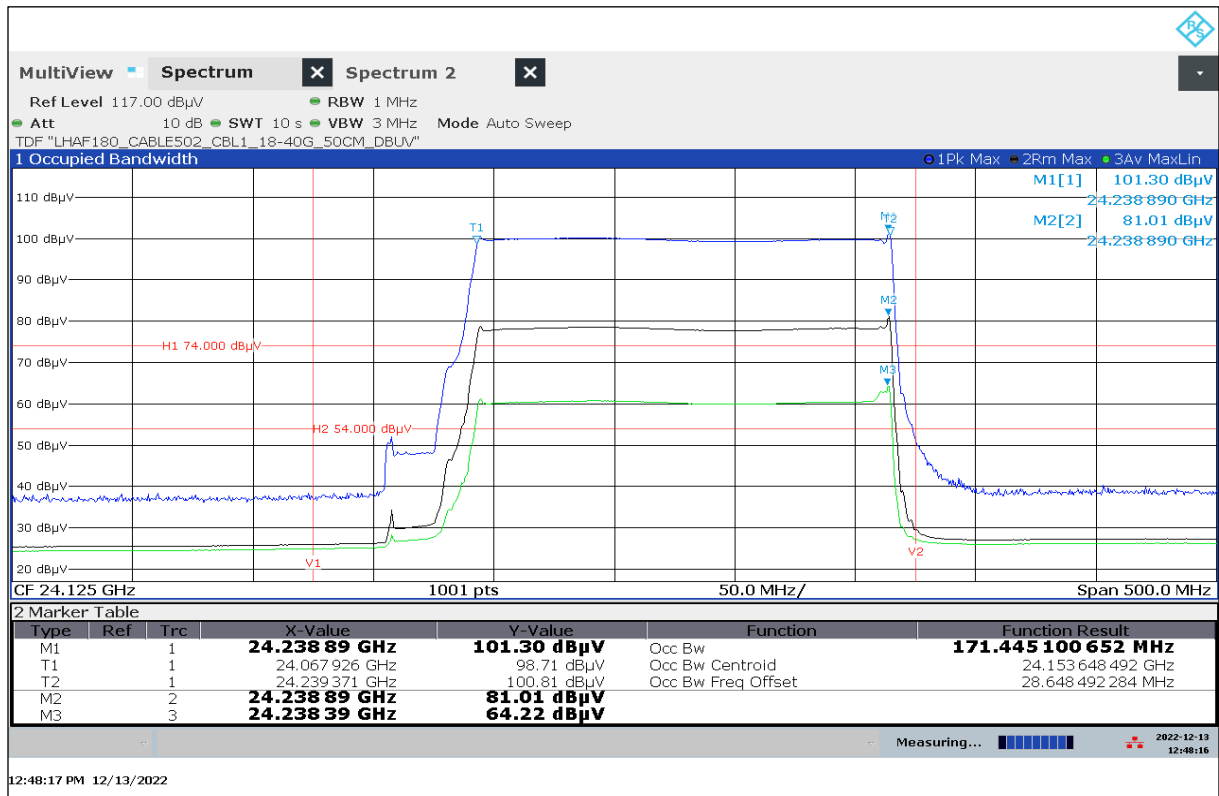
**Measurement results:**

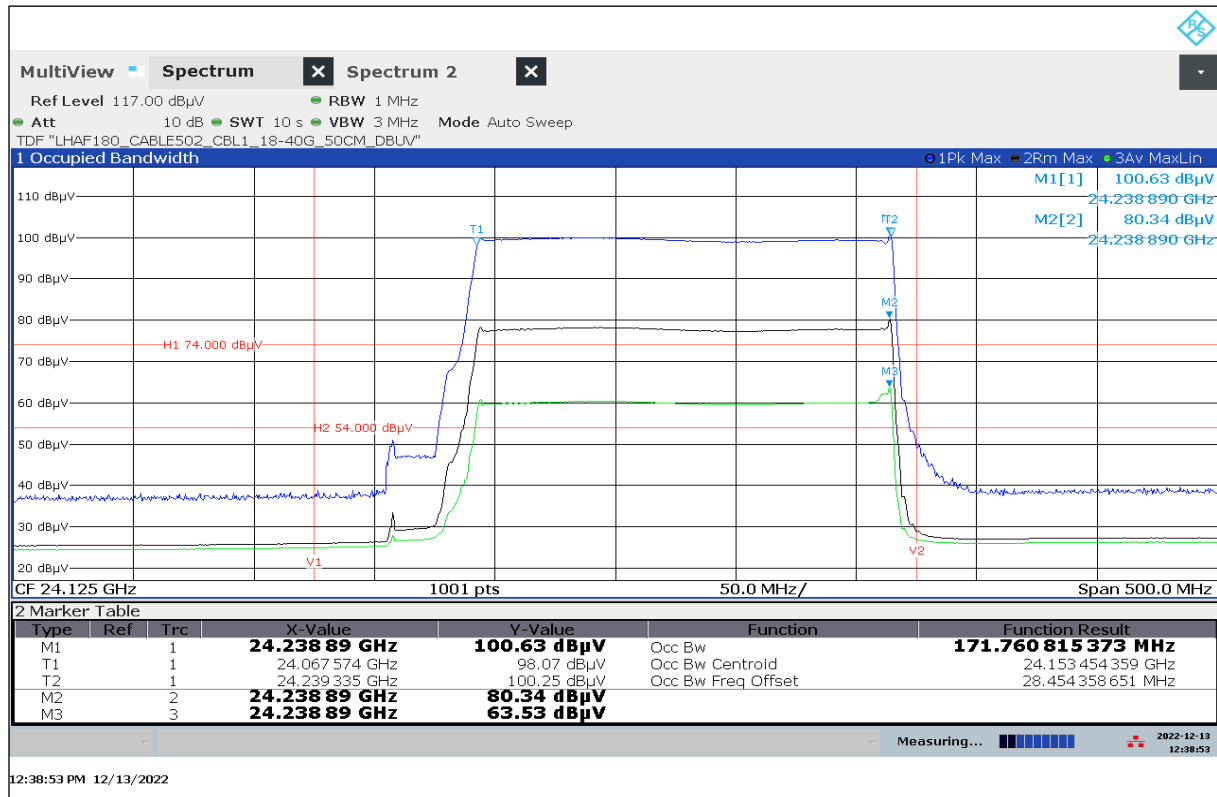
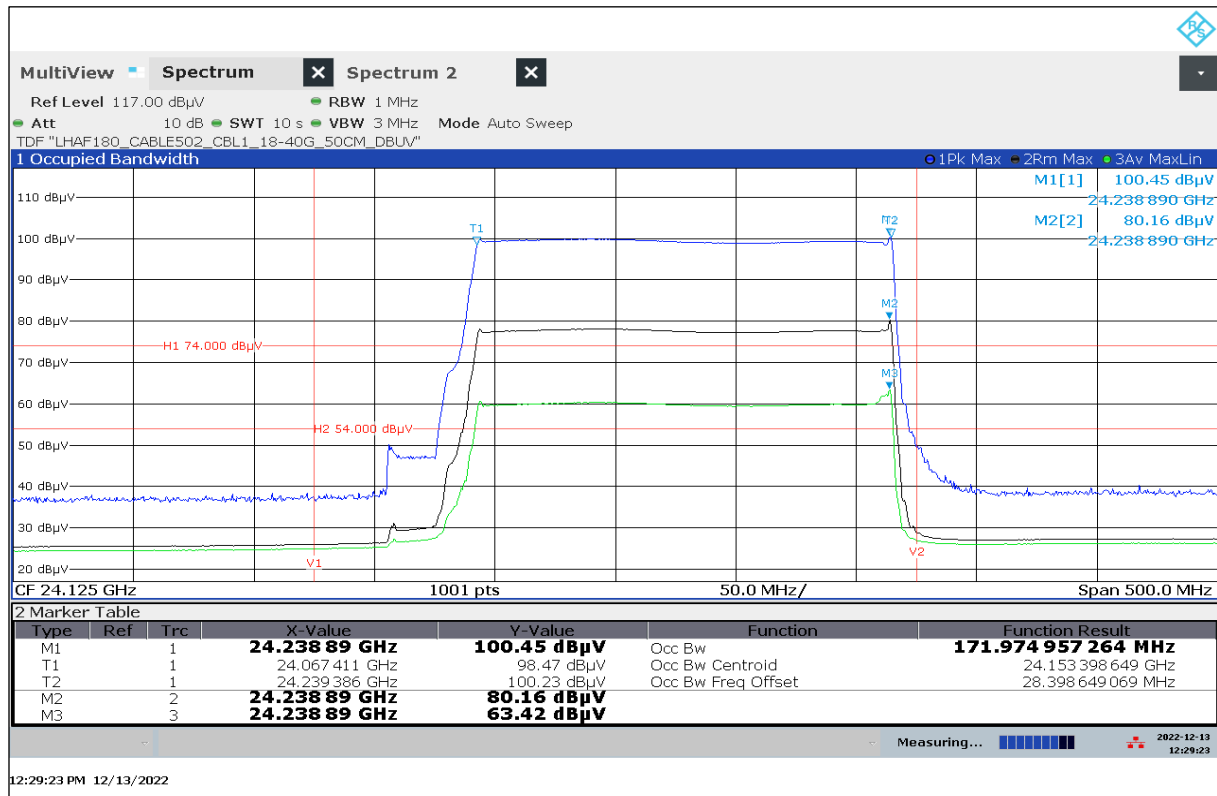
| Test Conditions<br>Channel F2 | $f_L$ in GHz | $f_H$ in GHz | Bandwidth<br>(MHz) |
|-------------------------------|--------------|--------------|--------------------|
| -40 °C / $V_{nom}$            | 24.068 761   | 24.239 946   | 171.2              |
| -20 °C / $V_{nom}$            | 24.068 752   | 24.239 814   | 171.1              |
| -10 °C / $V_{nom}$            | 24.068 732   | 24.239 690   | 171.0              |
| 0 °C / $V_{nom}$              | 24.068 711   | 24.239 603   | 170.9              |
| 10 °C / $V_{nom}$             | 24.068 110   | 24.239 464   | 171.4              |
| 20 °C / $V_{min-max}$         | 24.067 926   | 24.239 371   | 171.4              |
| 30 °C / $V_{nom}$             | 24.067 574   | 24.239 335   | 171.8              |
| 40 °C / $V_{nom}$             | 24.067 411   | 24.239 386   | 171.9              |
| 50 °C / $V_{nom}$             | 24.067 413   | 24.239 431   | 172.0              |
| 80 °C / $V_{nom}$             | 24.067 498   | 24.239 512   | 172.0              |

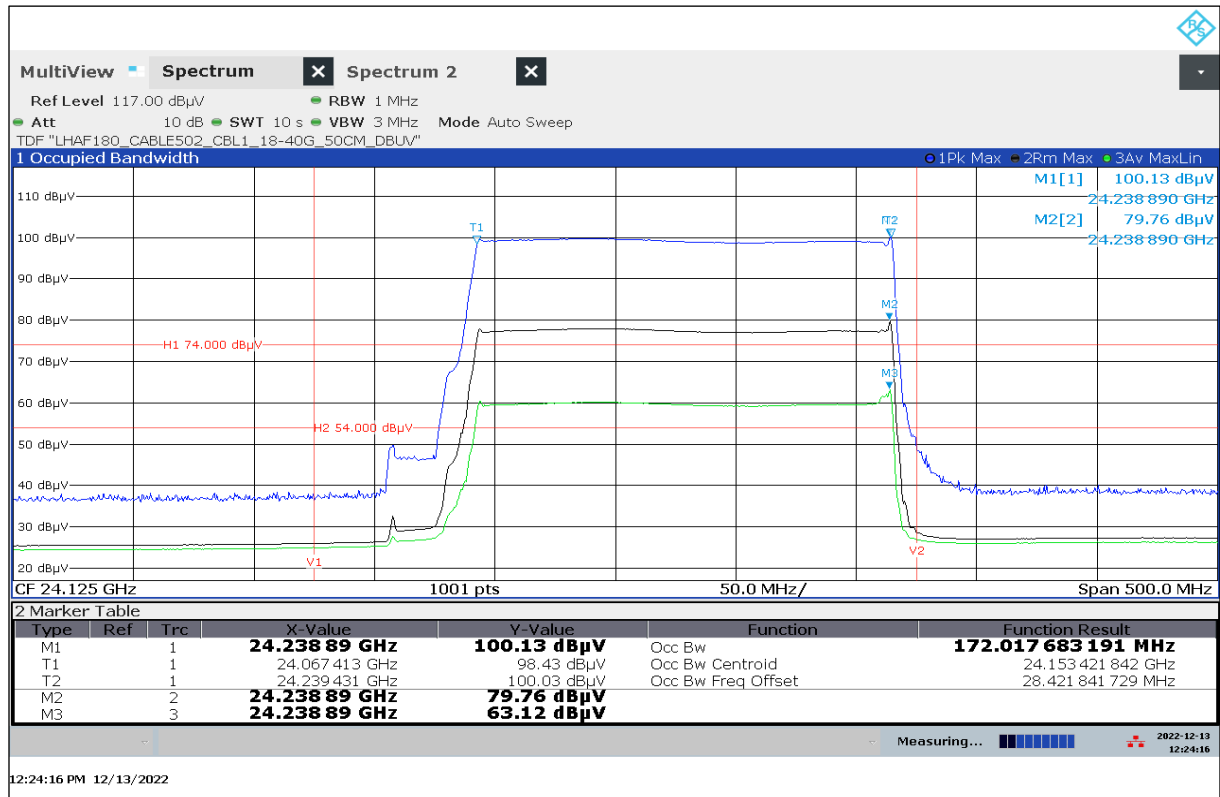
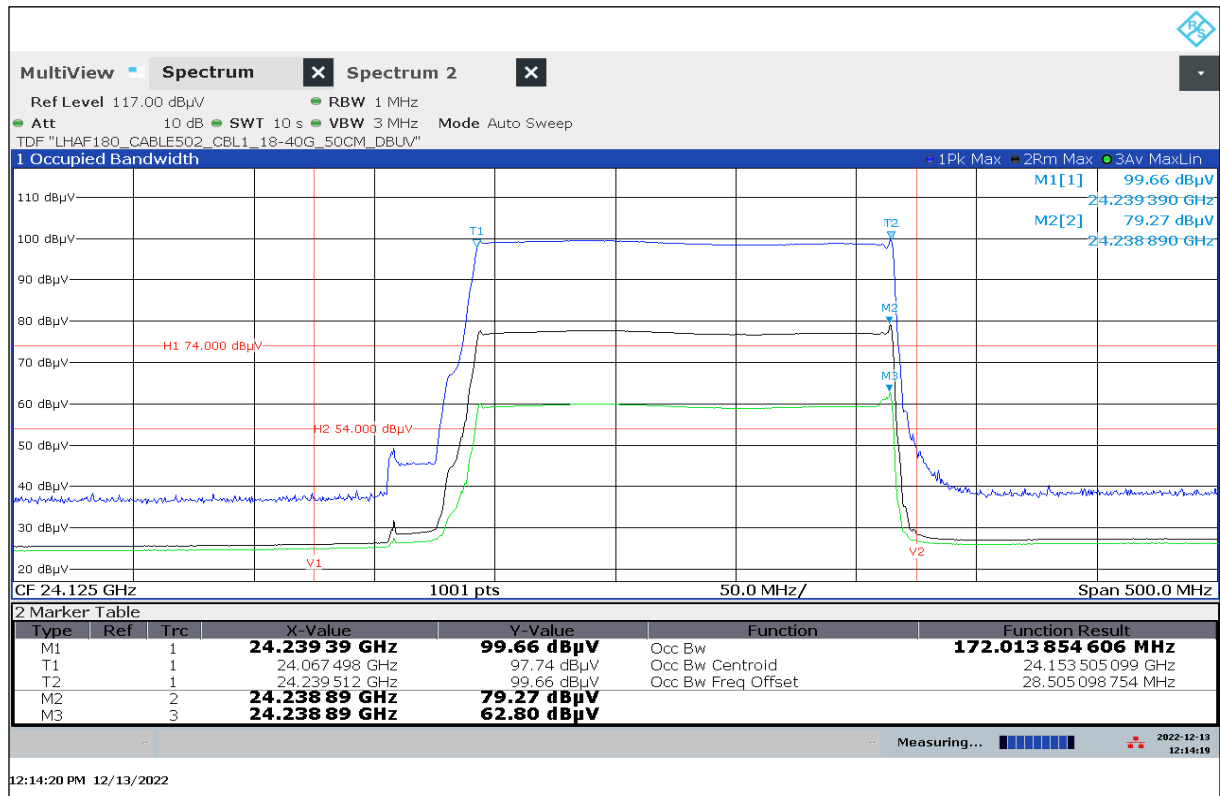
Voltage variation does not affect the radiated signal

Plot 31: - 40°C, Normal Mode,  $V_{nom}$ Plot 32: - 20°C, Normal Mode,  $V_{nom}$ 

Plot 33: - 10°C, Normal Mode,  $V_{nom}$ Plot 34: 0°C, Normal Mode,  $V_{nom}$ 

Plot 35: 10°C, Normal Mode,  $V_{nom}$ Plot 36: 20°C, Normal Mode,  $V_{min-max}$ 

Plot 37: 30°C, Normal Mode,  $V_{nom}$ Plot 38: 40°C, Normal Mode,  $V_{nom}$ 

Plot 39: 50°C, Normal Mode,  $V_{nom}$ Plot 40: 80°C, Normal Mode,  $V_{nom}$ 

## 13 Glossary

|                        |                                                    |
|------------------------|----------------------------------------------------|
| <b>EUT</b>             | Equipment under test                               |
| <b>DUT</b>             | Device under test                                  |
| <b>UUT</b>             | Unit under test                                    |
| <b>GUE</b>             | GNSS User Equipment                                |
| <b>ETSI</b>            | European Telecommunications Standards Institute    |
| <b>EN</b>              | European Standard                                  |
| <b>FCC</b>             | Federal Communications Commission                  |
| <b>FCC ID</b>          | Company Identifier at FCC                          |
| <b>IC</b>              | Industry Canada                                    |
| <b>PMN</b>             | Product marketing name                             |
| <b>HMN</b>             | Host marketing name                                |
| <b>HVIN</b>            | Hardware version identification number             |
| <b>FVIN</b>            | Firmware version identification number             |
| <b>EMC</b>             | Electromagnetic Compatibility                      |
| <b>HW</b>              | Hardware                                           |
| <b>SW</b>              | Software                                           |
| <b>Inv. No.</b>        | Inventory number                                   |
| <b>S/N or SN</b>       | Serial number                                      |
| <b>C</b>               | Compliant                                          |
| <b>NC</b>              | Not compliant                                      |
| <b>NA</b>              | Not applicable                                     |
| <b>NP</b>              | Not performed                                      |
| <b>PP</b>              | Positive peak                                      |
| <b>QP</b>              | Quasi peak                                         |
| <b>AVG</b>             | Average                                            |
| <b>OC</b>              | Operating channel                                  |
| <b>OCW</b>             | Operating channel bandwidth                        |
| <b>OBW</b>             | Occupied bandwidth                                 |
| <b>OOB</b>             | Out of band                                        |
| <b>DFS</b>             | Dynamic frequency selection                        |
| <b>CAC</b>             | Channel availability check                         |
| <b>OP</b>              | Occupancy period                                   |
| <b>NOP</b>             | Non occupancy period                               |
| <b>DC</b>              | Duty cycle                                         |
| <b>PER</b>             | Packet error rate                                  |
| <b>CW</b>              | Clean wave                                         |
| <b>MC</b>              | Modulated carrier                                  |
| <b>WLAN</b>            | Wireless local area network                        |
| <b>RLAN</b>            | Radio local area network                           |
| <b>DSSS</b>            | Dynamic sequence spread spectrum                   |
| <b>OFDM</b>            | Orthogonal frequency division multiplexing         |
| <b>FHSS</b>            | Frequency hopping spread spectrum                  |
| <b>GNSS</b>            | Global Navigation Satellite System                 |
| <b>C/N<sub>0</sub></b> | Carrier to noise-density ratio, expressed in dB-Hz |

## 14 Document history

| Version | Applied changes         | Date of release |
|---------|-------------------------|-----------------|
| -/-     | Initial release - DRAFT | 2023-01-27      |
| -/-     | Minor changes           | 2023-02-02      |

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

| first page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | last page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV<br/>Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition</p> <p><b>Accreditation</b> </p> <p>The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory<br/><b>CTC advanced GmbH</b><br/>Untertürkheimer Straße 6-10, 66117 Saarbrücken<br/>is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out tests in the following fields:<br/><b>Telecommunication (FCC Requirements)</b></p> <p>The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 05 pages.</p> <p>Registration number of the certificate: <b>D-PL-12076-01-05</b></p> <p>Frankfurt am Main, 09.06.2020</p> <p>by order: Dipl.-Ing. (FH)  Head of Division</p> <p><small>The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.<br/><a href="https://www.dakks.de/en/content/accredited-bodies-dakks">https://www.dakks.de/en/content/accredited-bodies-dakks</a><br/>Date valid until: _____</small></p> | <p>Deutsche Akkreditierungsstelle GmbH</p> <p>Office Berlin<br/>Spittelmarkt 10<br/>10117 Berlin</p> <p>Office Frankfurt am Main<br/>Europa-Allee 52<br/>60327 Frankfurt am Main</p> <p>Office Braunschweig<br/>Bundesallee 100<br/>38116 Braunschweig</p> <p>The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkKS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf.</p> <p>No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkKS.</p> <p>The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkKS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.</p> <p>The up-to-date state of membership can be retrieved from the following websites:<br/>EA: <a href="http://www.european-accreditation.org">www.european-accreditation.org</a><br/>ILAC: <a href="http://www.ilac.org">www.ilac.org</a><br/>IAF: <a href="http://www.iaf.nu">www.iaf.nu</a></p> |

**Note: The current certificate annex is published on the websites (link see below).**

<https://www.dakks.de/files/data/as/pdf/D-PL-12076-01-05e.pdf>

or

[https://ctcadvanced.com/app/uploads/2020/06/D-PL-12076-01-05\\_TCB\\_USA.pdf](https://ctcadvanced.com/app/uploads/2020/06/D-PL-12076-01-05_TCB_USA.pdf)

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