
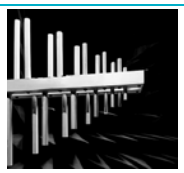
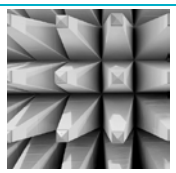

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5965_23-02-02

DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

Testing laboratory

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

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

Baumer Electric AG
Hummelstr. 17
8501 Frauenfeld - SWITZERLAND / SWITZERLAND
Phone: +41 52 728 1404
Contact: Rainerl Mauchl
e-mail: rmauch@baumer.com

Manufacturer

Baumer Electric AG
Hummelstr. 17
8501 Frauenfeld - SWITZERLAND / SWITZERLAND

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:	**122-123 GHz FMCW Radar**
Model name:	**R600V**
FCC ID:	**PGP-R600V-01**
Frequency:	122 – 123 GHz
Antenna:	Integrated antenna
Power supply:	9.0 V to 16.0 V DC by battery
Temperature range:	-40°C to +70°C

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

Test report authorized:

Thomas Vogler
on behalf of

cn=Thomas Vogler, o=cetecom advanced GmbH, ou=VOG-230609, email=thomas.vogler@cetecomadvanced.com, c=DE
2025.07.08 09:34:28 +02'00'

Meheza Walla
Lab Manager
Radio Labs

Test performed:

cn=Stephan Thiel, o=cetecom advanced GmbH, ou=THL-230601, email=Stephan.Thiel@cetecomadvanced.com, c=DE
2025.07.08 09:03:17 +02'00'

Stephan Thiel
Testing Manager
Radio Labs

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom 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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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2023-06-06
Date of receipt of test item:	2023-09-18
Start of test:*	2023-11-14
End of test:*	2024-03-19
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

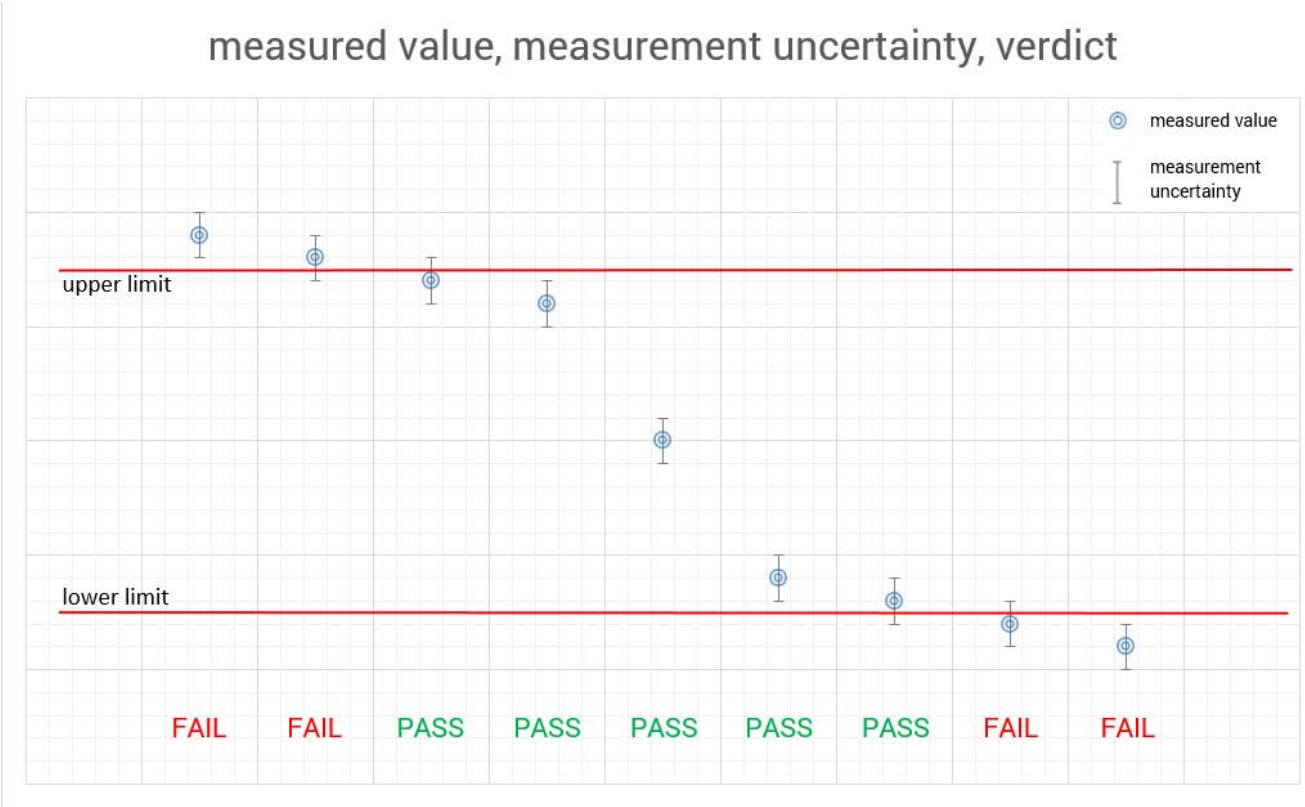
3 Test standard/s, references and accreditations

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 C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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_{nom} T_{max} T_{min}	+22 °C during room temperature tests +50°C during high temperature tests -20°C during low temperature tests
Relative humidity content	:		49 %
Barometric pressure	:		990 hPa to 1010 hPa
Power supply	:	V_{nom} V_{max} V_{min}	12.0 V DC by battery 16.0 V 9.0 V

6 Test item

6.1 General description

Kind of test item	:	122-123 GHz FMCW Radar
Model name	:	R600V
S/N serial number	:	EUT 1: S/N 700009971046 EUT 2: S/N 700009971044 EUT 3.2: S/N 700010092299 EUT 4.2: S/N 700010092308
Hardware status	:	RE00050D / RE.00061 / RE.00009 / PCBA_R714028_OSD-1 (TRX_120_067)
Software status	:	N/A
Firmware status	:	R600VMOF_S_01-20-00
Frequency band	:	122 – 123 GHz
Type of modulation	:	FMCW
Antenna	:	Integrated antenna
Power supply	:	9.0 V to 16.0 V DC by battery
Temperature range	:	-40°C to +70°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report: 1-5965/23-02-01_Annex A
1-5965/23-02-01_Annex B
1-5965/23-02-01_Annex D

Test Device:

- EUT 1: Normal operation mode

In addition to the normal operation mode, a test mode is used in accordance with CFR 47 Part §15.31 (c) & (m), in which the frequency sweep is stopped at the following positions in the range of operation:

- EUT 2: Stop mode, low frequency: 122.03 GHz
- EUT 3.2: Stop mode, middle frequency: 122.5 GHz
- EUT 4.2: Stop mode, high frequency: 122.97 GHz

Note:

- The referenced photos show EUT delivered by the customer in this project, not necessarily the exact one used for the specific tests. EUT identification shown in the photos may differ.

7 Description of the test setup

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

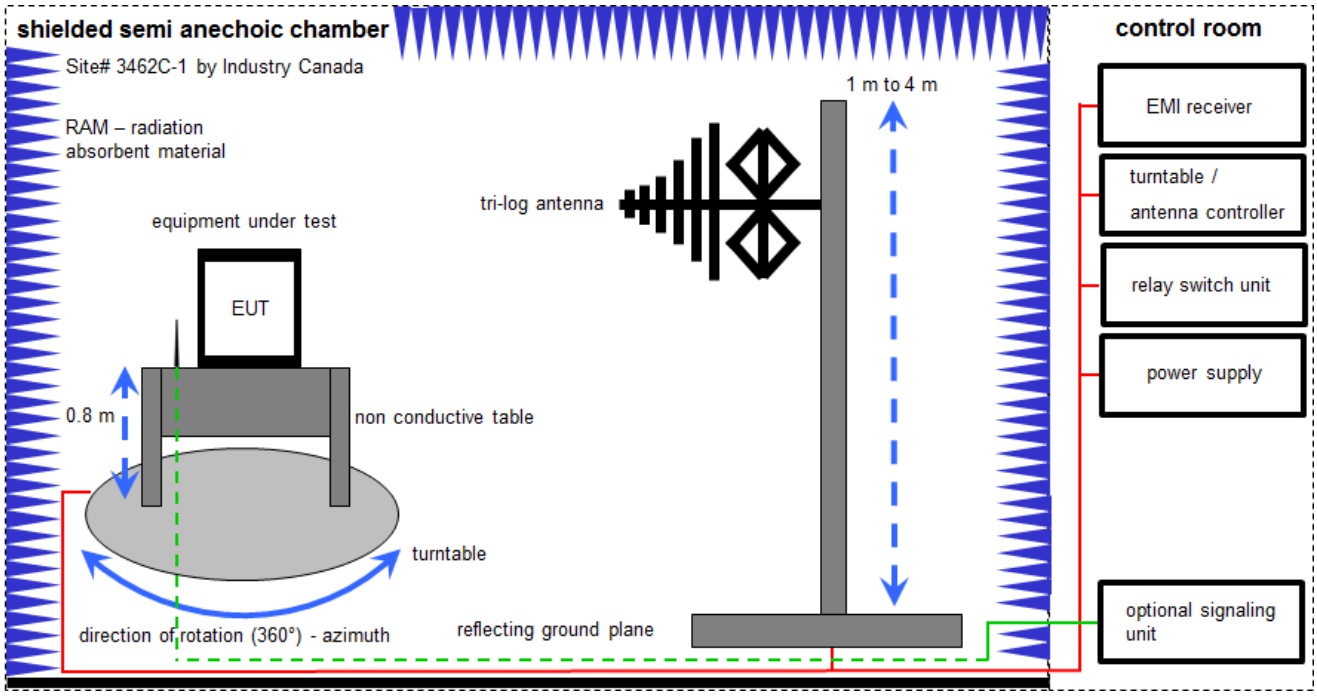
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

7.1 Shielded semi anechoic chamber

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



Measurement distance: tri-log antenna 10 meter

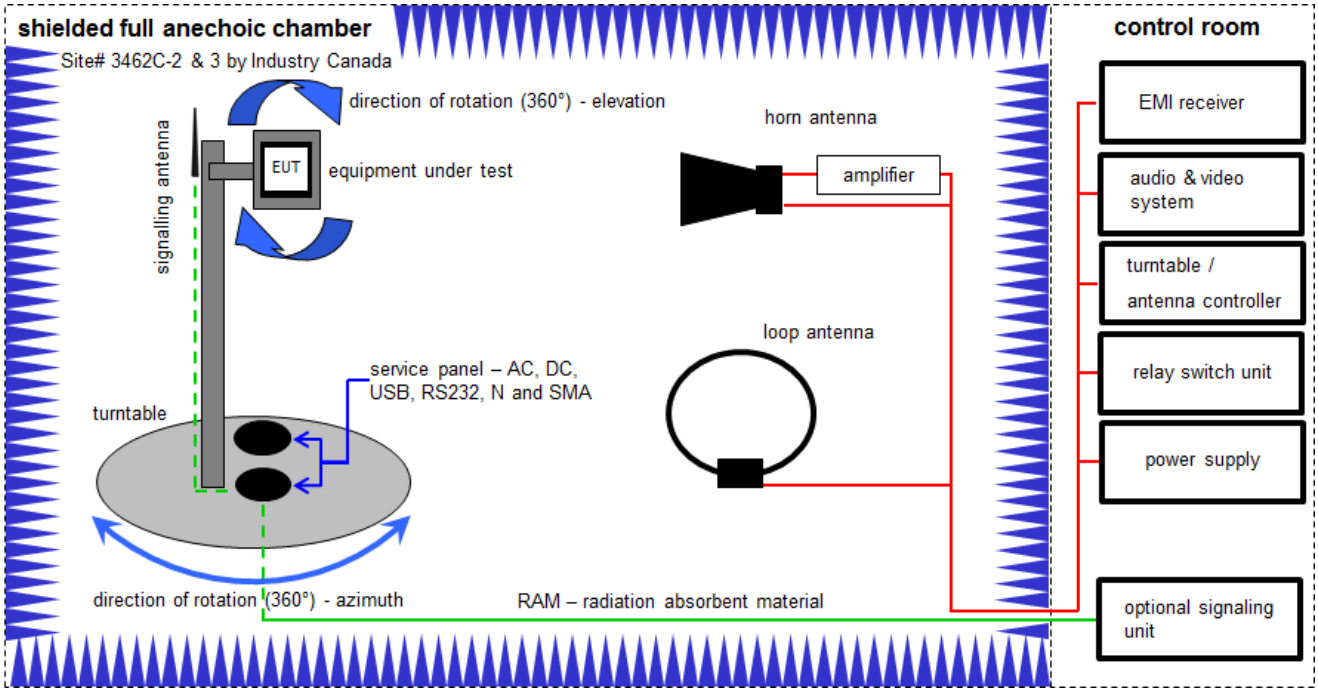
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Turntable	2089-4.0	EMCO		300004394	ne	-/-	-/-
2	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	216	300003288	vlKl!	31.08.2023	31.08.2025
3	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
4	93	Semi anechoic chamber	3000023	MWB AG		300000551	ne	-/-	-/-
5	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
6	n. a.	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	09.12.2022	31.12.2023
6.1	n. a.	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	09.12.2023	31.12.2024
7	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
8	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-

7.2 Shielded fully anechoic chamber



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

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

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

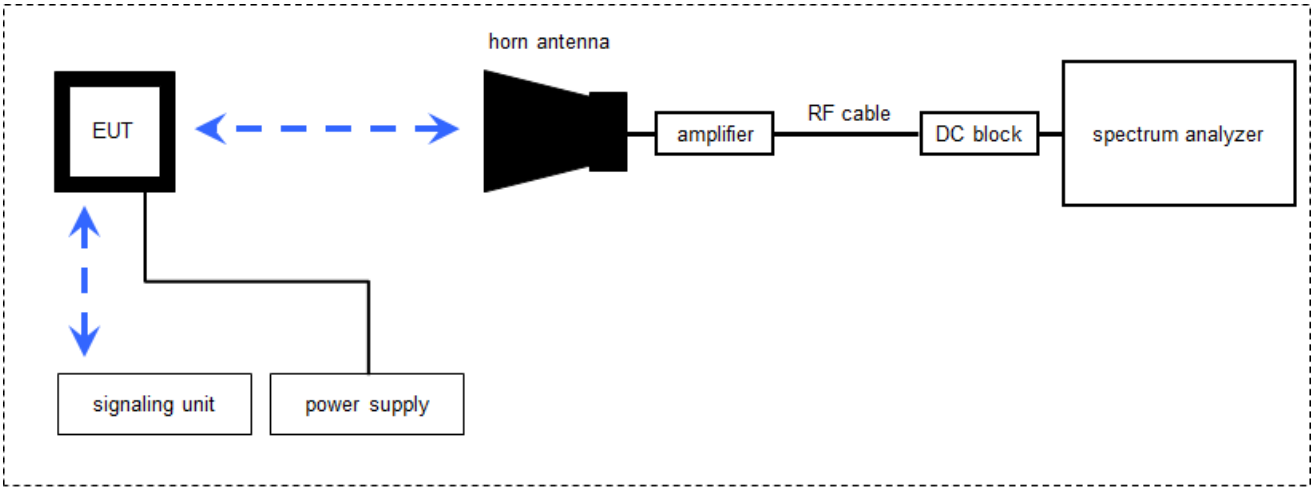
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

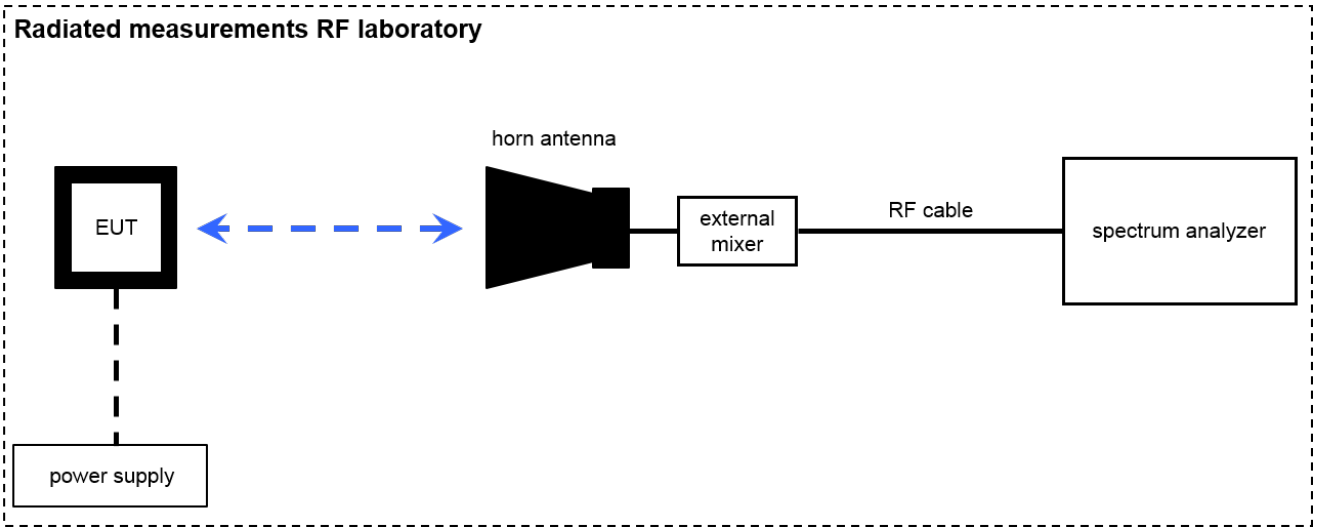
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	9	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne	-/-	-/-
2	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
3	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-
4	n. a.	NEXIO EMV-Software	BAT EMC V2022.0.32.0	Nexio		300004682	ne	-/-	-/-
5	n. a.	MXG Microwave Analog Signal Generator	N5183A	Agilent Technologies	MY47420220	300003813	vlKl!	07.12.2022	31.12.2025
6	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
7	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	07.12.2022	31.12.2023
7.1	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2023	31.12.2024
8	A037	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3089	300000307	vlKl!	11.02.2022	29.02.2024
9	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vlKl!	09.12.2020	08.12.2023
9.1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vlKl!	05.12.2023	31.12.2026
10	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
11	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
12	90	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO/2	8905-2342	300000256	vlKl!	19.07.2023	31.07.2025
13	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-

7.3 Radiated measurements > 18 GHz



7.4 Radiated measurements > 50/85 GHz



Measurement distance: horn antenna e.g. 75 cm

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

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

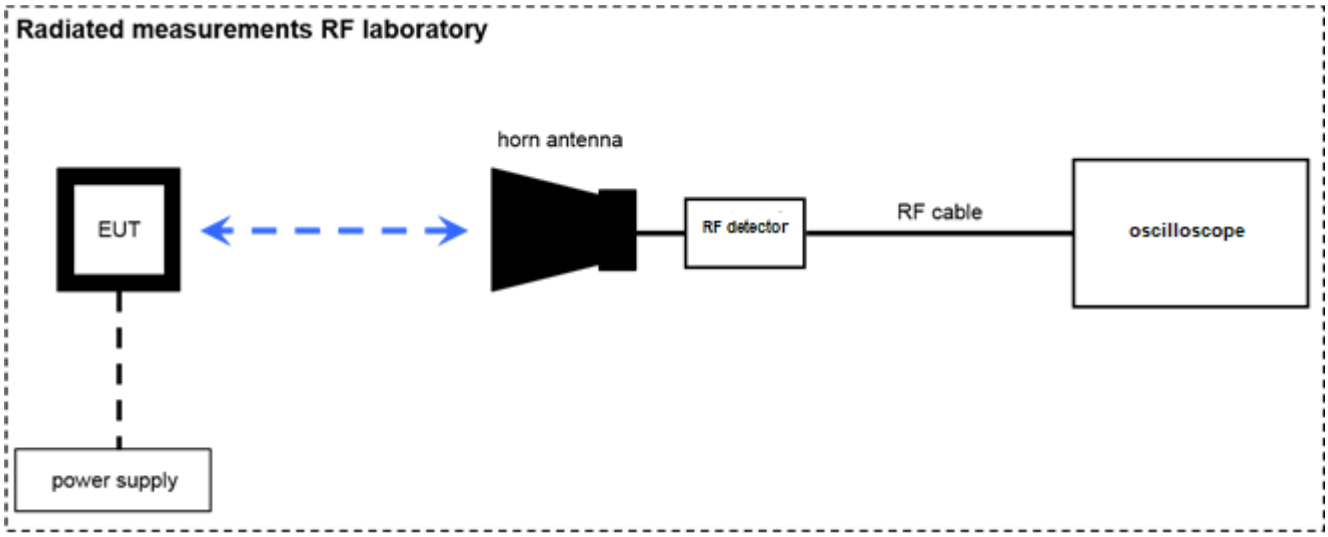
Note: conversion loss of mixer is already included in analyzer value.

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Temperature Test Chamber	T-40/50	CTS GmbH	064023	300003540	ev	09.05.2022	31.05.2024
2	A029	Std. Gain Horn Antenna 92.3-140 GHz	2824-20	Flann	*	300001993	ne	-/-	-/-
3	A027	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-
4	A036	Std. Gain Horn Antenna 60-90 GHz	COR 60_90	Thomson CSF		300000814	ev	-/-	-/-
5	A025	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne	-/-	-/-
6	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
7	CR 79	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ne	-/-	-/-
8	A031	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vlKl!	17.01.2022	31.01.2024
9	n. a.	Std. Gain Horn Antenna 217-330 GHz	32240-20	Flann	233278	300004960	ne	-/-	-/-
10	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	01096	300000486	vlKl!	17.01.2022	31.01.2024
11	A029	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	8205	300002442	k	17.01.2022	31.01.2024
12	A033	Std. Gain Horn Antenna 145-220 GHz	3024-20	Flann	*	300002000	ne	-/-	-/-
13	A032	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
14	n. a.	Standard Gain Horn 325-500 GHz	570240-20 1785-2a	Flann Microwave	273569	300006097	ev	-/-	-/-
15	n. a.	Signal Generator 100 kHz - 40 GHz	SMB100A	Rohde & Schwarz	183320	300006330	k	21.06.2022	20.06.2025
16	n. a.	Signal- and Spectrum Analyzer 3 Hz - 50 GHz	PXA N9030A	Agilent Technologies	US51350267	300004338	k	13.04.2023	30.04.2024
17	n. a.	Signal- and Spectrum Analyzer 2 Hz - 85 GHz	FSW85	Rohde&Schwarz	101333	300005568	k	02.08.2023	31.08.2024
18	n. a.	Signal- and Spectrum Analyzer 2 Hz - 50 GHz	FSW50	Rohde&Schwarz	101332	300005935	k	23.03.2023	31.03.2024
19	n. a.	Signal- and Spectrum Analyzer 2 Hz - 50 GHz	FSW50	Rohde&Schwarz	101560	300006179	k	04.04.2023	30.04.2024
20	n. a.	Power supply	N5767A	Agilent Technologies	US14J1569P	300004851	vlKl!	08.12.2020	31.12.2023
20.1	n. a.	Power supply	N5767A	Agilent Technologies	US14J1569P	300004851	vlKl!	06.12.2023	31.12.2026
21	n. a.	Oscilloscope	DPO5054	Tektronix	C010174	300004169	k	07.12.2021	31.12.2023
21.1	n. a.	Oscilloscope	DPO5054	Tektronix	C010174	300004169	k	05.12.2023	31.12.2025
22	17a	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-021	300001747	vlKl!	17.01.2022	31.01.2024
22.1	17a	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-021	300001747	vlKl!	24.01.2024	23.01.2026
23	17b	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-022	300001748	NK!	-/-	-/-

24	n. a.	Harmonic Mixer 3-port, 90-140 GHz	FS-Z140	Rohde & Schwarz	101119	300005581	k	03.08.2023	31.08.2024
25	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	Rohde & Schwarz	101411	300004959	k	21.07.2023	31.07.2024
26	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	25.08.2023	31.08.2024
27	n. a.	Harmonic Mixer 3-Port, 50-75 GHz	FS-Z75	Rohde & Schwarz	101578	300005788	k	19.07.2023	31.07.2024
28	n. a.	Harmonic Mixer 3-Port, 325-500GHz	FS-Z500	Rohde & Schwarz	101016	300006096	k	11.08.2023	31.08.2024
29	n. a.	Harmonic Mixer 3-Port, 220-325 GHz	SAM-325	Radiometer Physics GmbH	100002	300004158	k	02.08.2023	31.08.2024
30	n. a.	Harmonic Mixer 3-Port, 140-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	02.08.2023	31.08.2024
31	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	FS-Z170	Radiometer Physics GmbH	100014	300004156	k	21.07.2023	31.07.2024
32	n. a.	DC Power Supply 0 – 32V	1108-32	Heiden Elektronik	003202	300001187	vlKI!	14.12.2021	31.12.2024
33	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	09.03.2022	08.03.2024

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



Note: EUT is replaced by reference source for substitution measurement

Measurement distance: horn antenna e.g. 50 cm

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Waveguide Amplifier 90-140 GHz	VDI-WR8.0AMP	VDI	1-13	300006234	ev	-/-	-/-
2	A038	Std. Gain Horn Antenna 90-140 GHz	COR 90_140	Thomson CSF		300000799	ev	-/-	-/-
3	A032	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
4	n. a.	Signal Generator 100 kHz - 40 GHz	SMB100A	Rohde & Schwarz	183320	300006330	k	21.06.2022	20.06.2025
5	n. a.	SG Extension Module 110 - 170 GHz	E8257DV06	VDI	US53250018	300005540	ev	-/-	-/-
6	n. a.	Oscilloscope	DPO5054	Tektronix	C010174	300004169	k	07.12.2021	31.12.2023
6.1	n. a.	Oscilloscope	DPO5054	Tektronix	C010174	300004169	k	05.12.2023	31.12.2025
7	n. a.	F-Band Positive Amplitude Detector	SFD-903144-08SF-P1	Sage Millimeter Inc.	07354-1	300006119	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 ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

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 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 ± 1 dB Radiated value ± 3 dB
Permitted range of operating frequencies	± 100 kHz
Conducted unwanted emissions in the spurious domain (up to 18 GHz)	± 1 dB
Radiated unwanted emissions in the spurious domain (up to 18 GHz)	± 3 dB
Conducted unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Radiated unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Conducted unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Radiated unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Conducted unwanted emissions in the spurious domain (above 50 GHz)	± 5 dB
Radiated unwanted emissions in the spurious domain (above 50 GHz)	± 5 dB
DC and low frequency voltages	± 3 %
Temperature	± 1 °C
Humidity	± 3 %

10 Summary of measurement results

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC identifier	Description	verdict	date	Remark
RF-Testing	FCC 47 CFR Part 15	see below	2024-05-07	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Remark
§15.258 (d)	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258 (b)	Maximum E.I.R.P.	Nominal	Nominal	☒	☐	☐	☐	complies
-/-	Duty cycle	Nominal	Nominal	☐	☐	☒	☐	-/-
§15.258 (c)	Spurious Emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258 (d)	Frequency stability	Extreme Nominal	Extreme Nominal	☒	☐	☐	☐	complies
§15.207	Conducted emissions < 30 MHz (AC power line)	Nominal	Nominal	☐	☐	☒	☐	-/-

Note: NA = Not applicable; NP = Not performed

11 Additional comments

Reference documents:

- None

Special test descriptions:

- None

Configuration descriptions:

- Eache sanple is configured for a special purpose and works directly after connecting the power.
- No additional software is needed.

Test devices (EUT):

- EUT1: The normal operation mode (intended use) is used.
- EUT2: The below described Stop-Modes are used.
- EUT3.2: The below described Stop-Modes are used.
- EUT4.2: The below described Stop-Modes are used.

Additional test modes:

☐ No test modes available

☐ Special test modes/special software (see description below)

☒ Stop-Modes (see description below)

Stop-Modes:

In addition to the normal operation mode, Stop-Modes are used in accordance with CFR 47 Part §15.31 (c) & (m), in which the frequency sweep is stopped at the following positions in the range of operation:

- EUT 2: Stop mode, low frequency: 122.03 GHz
- EUT 3.2: Stop mode, middle frequency: 122.5 GHz
- EUT 4.2: Stop mode, high frequency: 122.97 GHz

12 Measurement results

12.1 Occupied bandwidth (6 dB Bandwidth)

Description:

Measurement of the bandwidth of the wanted signal.

Limits:

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

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

Note: please also see chapter 12.4.

Measurement:

Measurement parameter	
Detector:	Pos-Peak
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Trace-Mode:	Max Hold

Measurement results:

6 dB bandwidth:

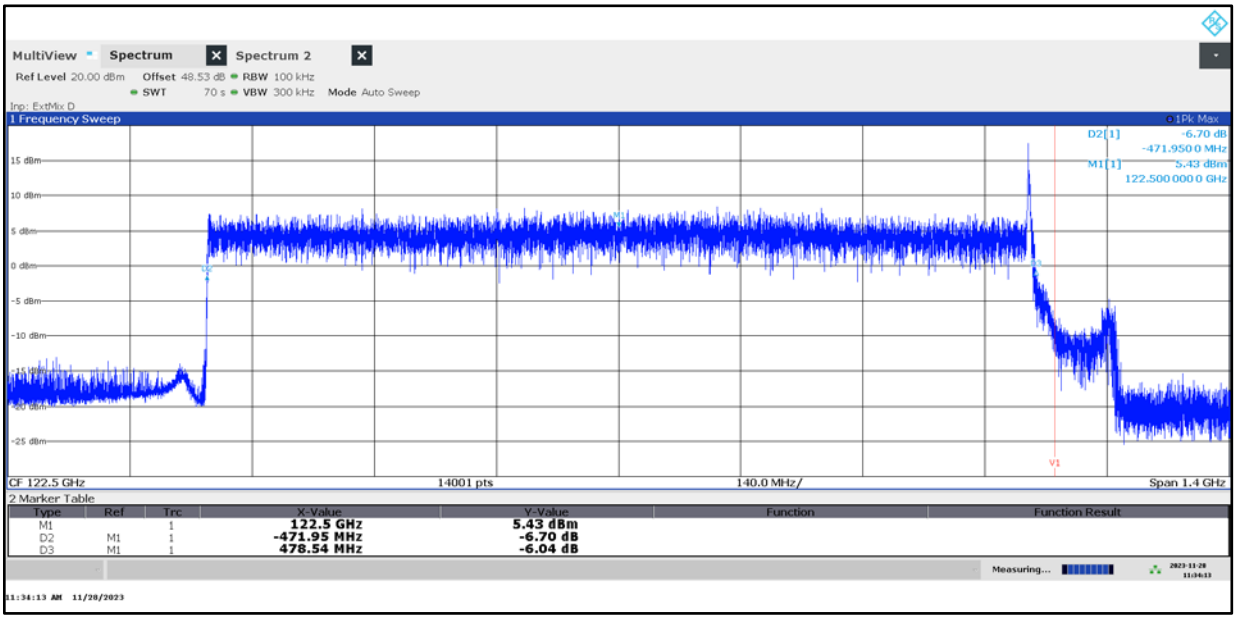
EUT	Mode	Test condition	f_L [GHz]	f_H [GHz]	Bandwidth [GHz]
EUT 1	Normal	T_{nom} / V_{nom}	122.028	122.978	0.95

Note:

- The customer specified the mid-band frequency as 122.5 GHz.

Verdict: **Complies**

Plot 1: Normal mode, 6 dB bandwidth (RBW = 100 kHz)



12.2 Maximum E.I.R.P.

Description:

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

Limits:

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

(1) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

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

Measurement:

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

Measurement results:

EUT	Mode	Test condition	Peak E.I.R.P.	Limit Peak E.I.R.P	Average E.I.R.P.	Limit Average E.I.R.P
1	Normal Mode	T_{nom} / V_{nom}	21.54 dBm	43 dBm	19.65 dBm	40 dBm

EUT	Mode	Test condition	Duty cycle
1	Normal Mode	T_{nom} / V_{nom}	39.65%

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

1) EUT emission measured with RF-detector:
   - Measurement distance: d_{EUT}
   - Maximum readout value on oscilloscope: V_{max}
   - Average readout value on oscilloscope: $V_{average}$
   - Duty cycle: D_{EUT}

2) Substitution of EUT by a cw reference source with a frequency of f_{REF} and a fixed output power of P_{REF}
   - Readout value on oscilloscope adjusted to V_{max} and $V_{average}$ by far field attenuation

3) Calculation of the Max E.I.R.P. of the EUT:
   - Free space loss: $FSL(d) = 20 \times \log(4 \times \pi \times d \times f / c)$, c: speed of light
   - Max E.I.R.P. = $P_{REF} - FSL(d_{REF,max}) + FSL(d_{EUT})$
   - Average E.I.R.P. = $P_{REF} - FSL(d_{REF,average}) + FSL(d_{EUT})$

Measurement step	Measurement parameter	EUT
		1
1)	Measurement distance d_{EUT}	0.606 m
	Maximum readout value V_{max}	12.7 mV
	Duty cycle D_{EUT}	39.65 %
2)	Output power P_{REF}	28.4 dBm
	Frequency f_{REF}	122.5 GHz
	Measurement distance $d_{REF,max}$	1.335 m
	Measurement distance $d_{REF,average}$	1.66 m
3)	Max E.I.R.P.	21.54 dBm
	Average E.I.R.P.	19.65 dBm

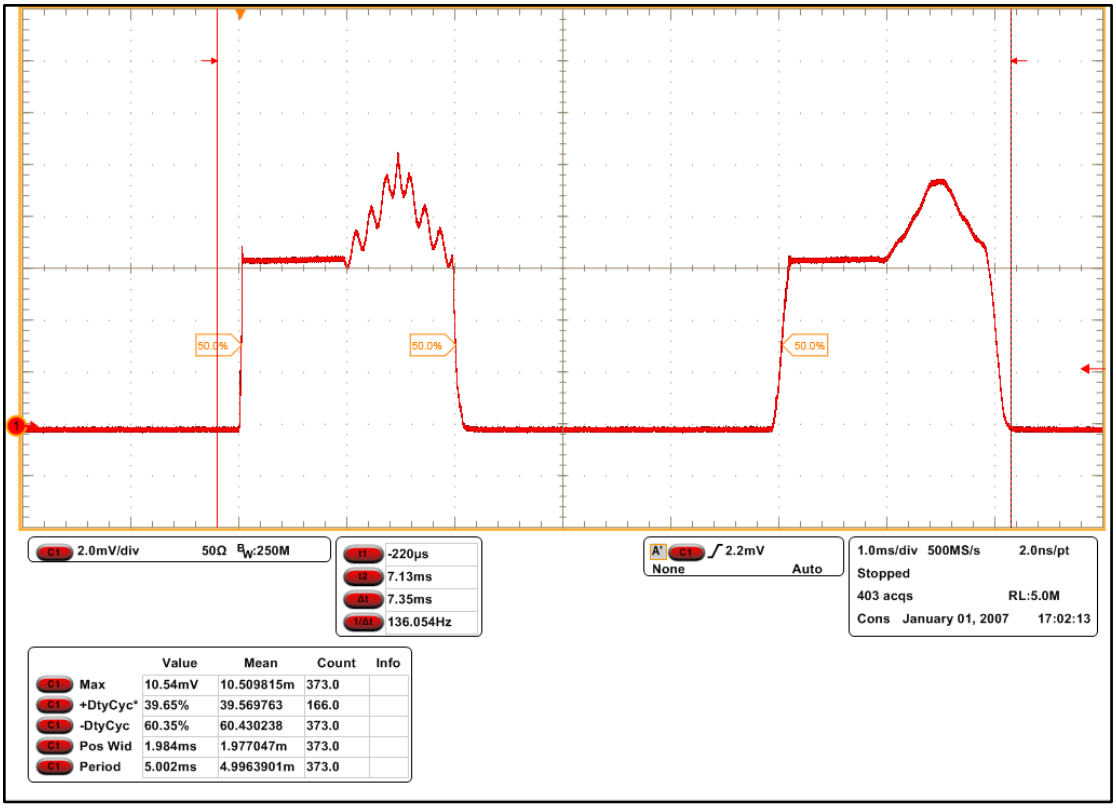
Setup of the substitution:

Note:

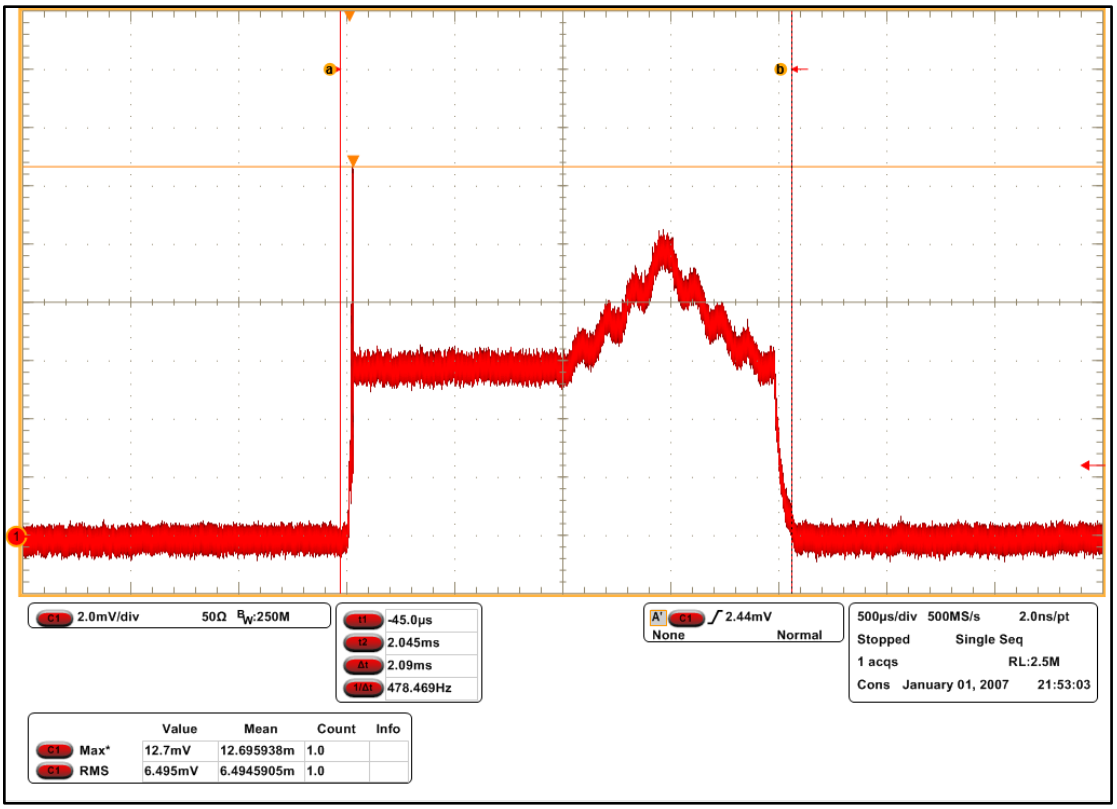
- Top of picture: SG Extension Module 110 - 170 GHz & Std. Gain Horn Antenna 114-173 GHz

- Bottom of picture: F-Band Positive Amplitude Detector & Waveguide Amplifier & Std. Gain Horn Antenna 90-140 GHz

Plot 2: Normal mode, EUT 1 emission, duty cycle



Plot 3: Normal mode, EUT 1 emission, V_max V_average



12.3 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions.

Limits:

FCC Part 15.258 (c)
Spurious emissions shall be limited as follows:

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

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

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

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

FCC / IC		
CFR Part 15.209(a) / RSS-Gen 8.9		
Radiated emission limits		
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

FCC Part 15.33 (a)
For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:

(4) If the intentional radiator operates at or above 95 GHz: To the third harmonic of the highest fundamental frequency or to 750 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.

Limit conversion (ANSI C63.10-2013 9.6):

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

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

According to this formula, an emission limit of PD = 90 pW/cm² at a distance of d = 3 m corresponds to an equivalent isotropically radiated power of EIRP = -10 dBm.

Measurement:

Measurement parameter	
Detector:	Quasi Peak / Pos-Peak / RMS
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	F < 1 GHz: 300 kHz F > 1 GHz: 3 MHz
Frequency range:	30 MHz to 380 GHz
Trace-Mode:	Max Hold

Measurement results:

Stop mode, low frequency:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
-/-	-/-	1	-/-	-/-	-/-
Please refer to the following plots for more information on the level of spurious emissions					

Stop mode, middle frequency:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
-/-	-/-	1	-/-	-/-	-/-
Please refer to the following plots for more information on the level of spurious emissions					

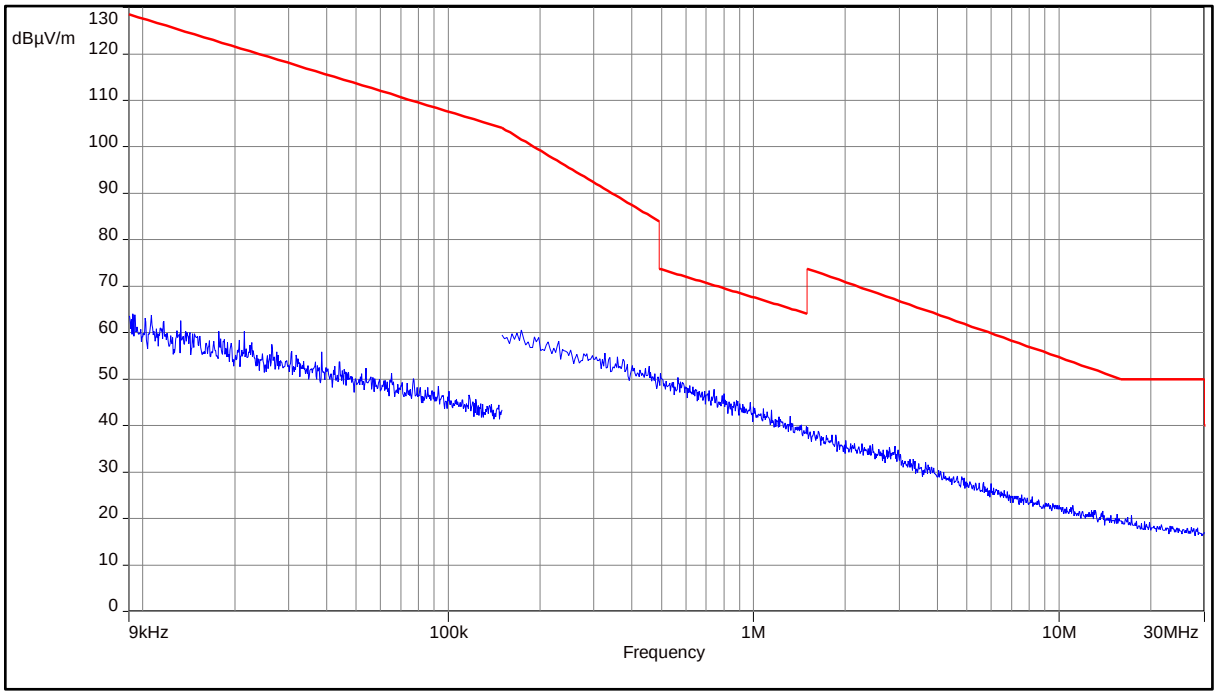
Stop mode, high frequency:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
-/-	-/-	1	-/-	-/-	-/-
Please refer to the following plots for more information on the level of spurious emissions					

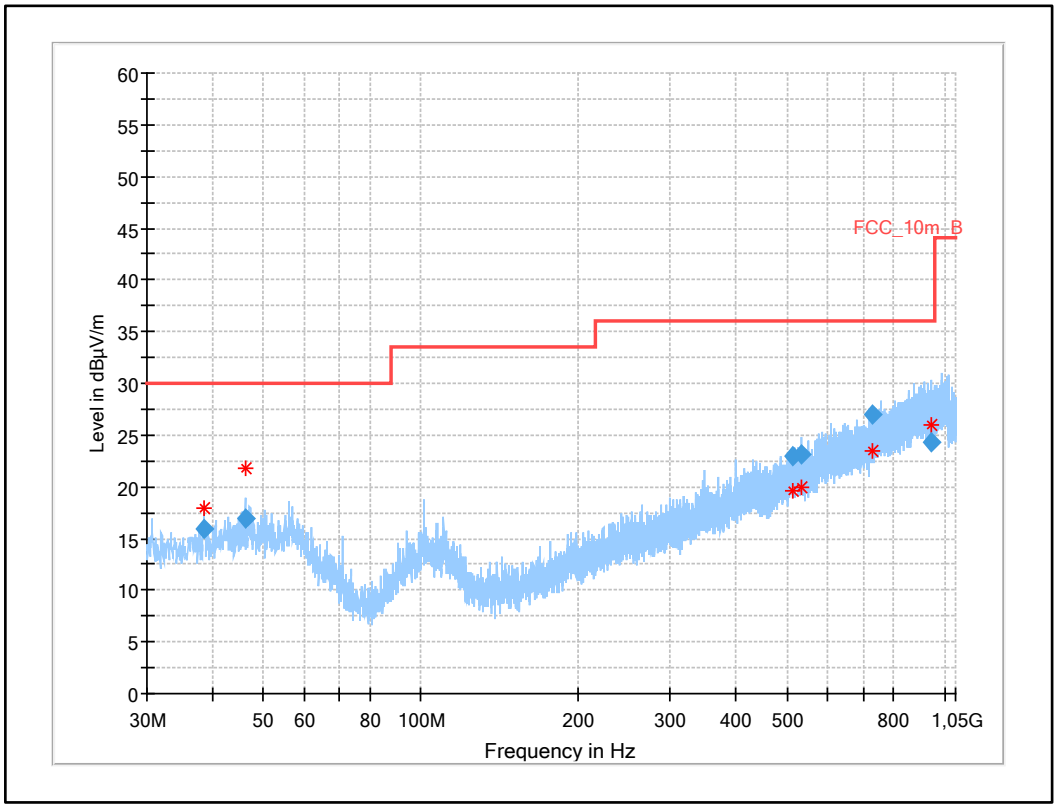
Verdict: Complies

12.3.1 Spurious emissions radiated for normal mode

Plot 4: 9 kHz – 30 MHz, normal mode

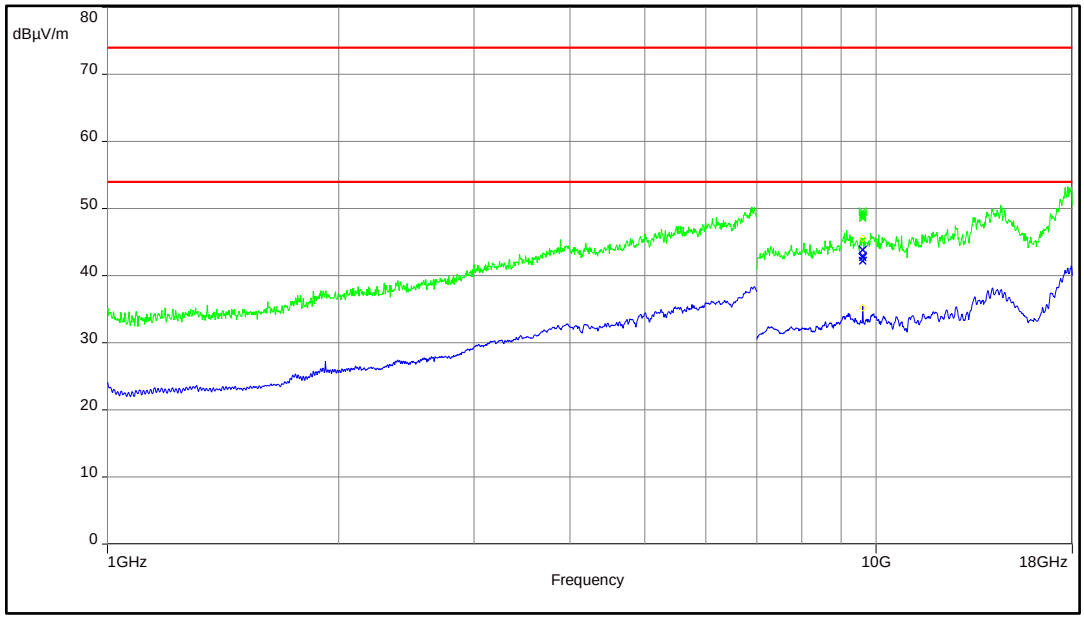


Plot 5: 30 MHz – 1GHz, normal mode

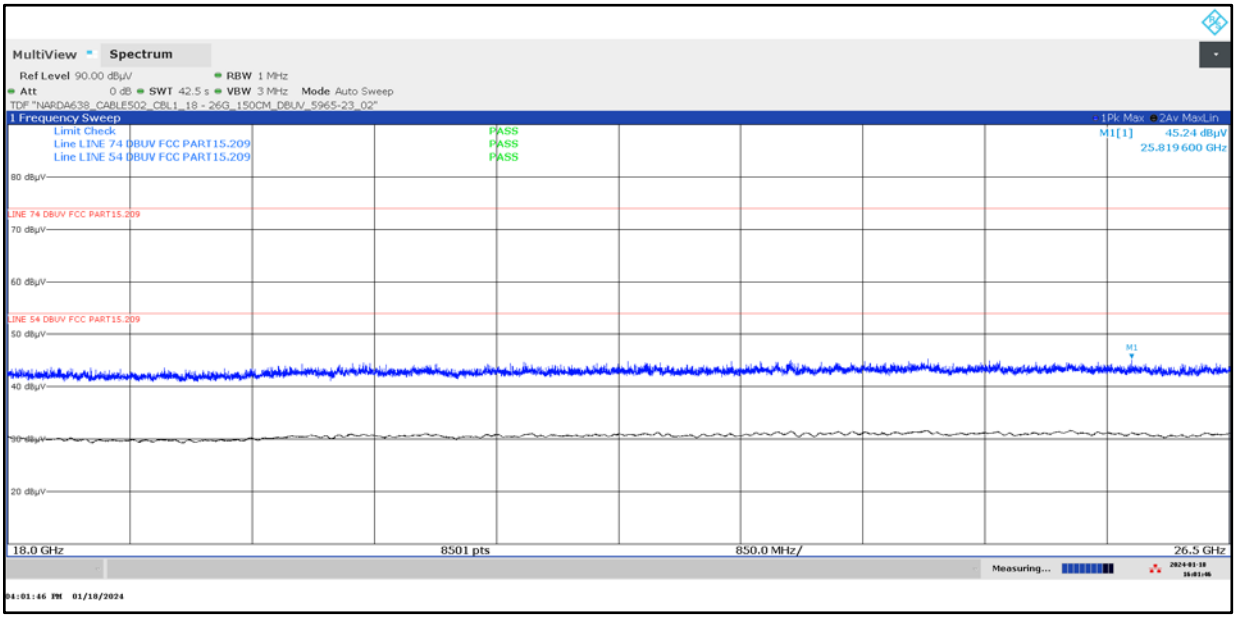


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
38.508	15.98	30.0	14.0	1000	120.0	141.0	H	-37	14
46.185	16.88	30.0	13.1	1000	120.0	145.0	V	15	15
515.189	23.02	36.0	13.0	1000	120.0	168.0	H	52	20
535.135	23.16	36.0	12.8	1000	120.0	189.0	V	142	20
729.990	27.04	36.0	9.0	1000	120.0	195.0	H	232	23
946.127	24.35	36.0	11.7	1000	120.0	195.0	H	142	25

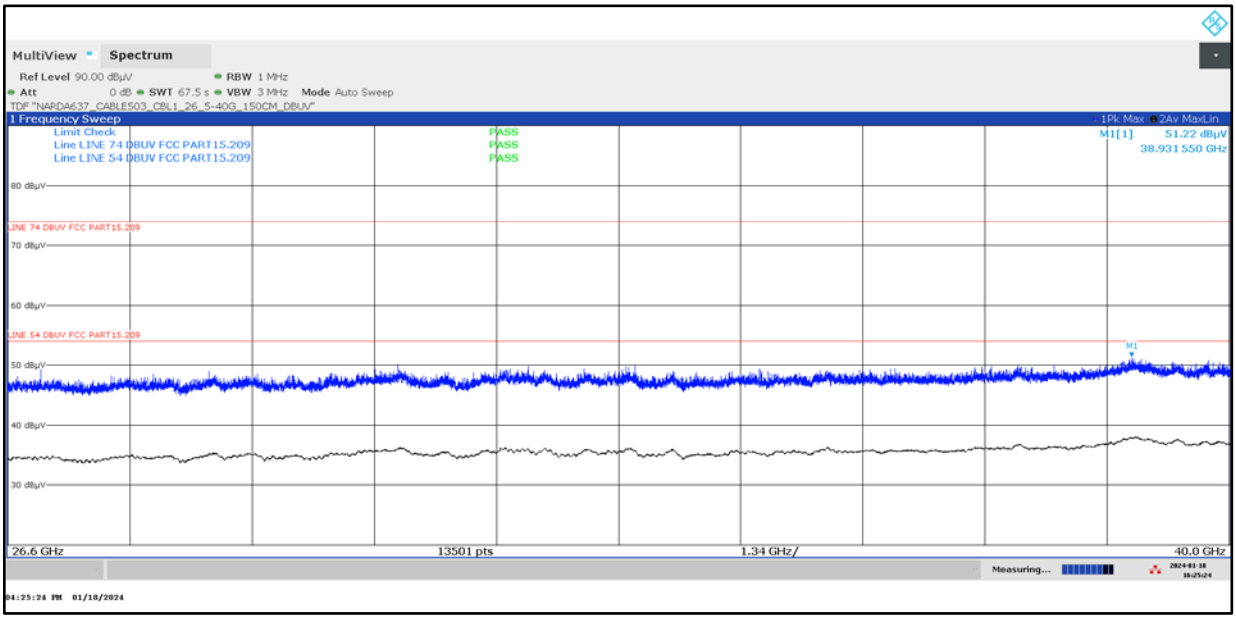
Plot 6: 1GHz – 18 GHz, normal mode



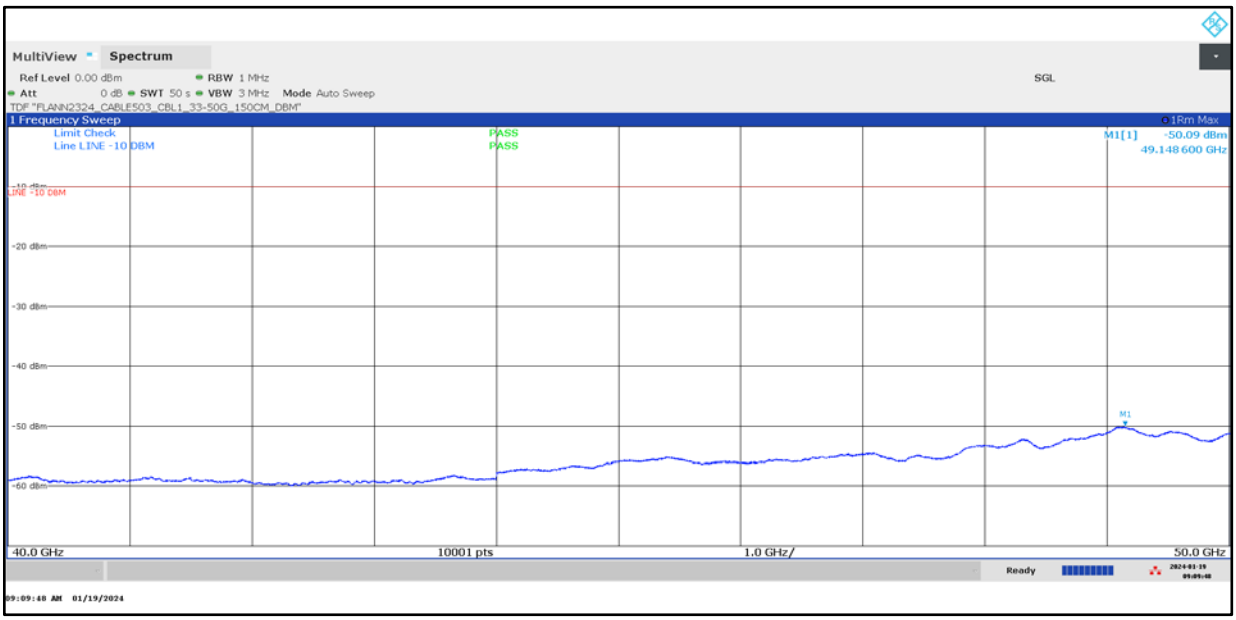
Plot 7: 18 GHz – 26.5 GHz, normal mode



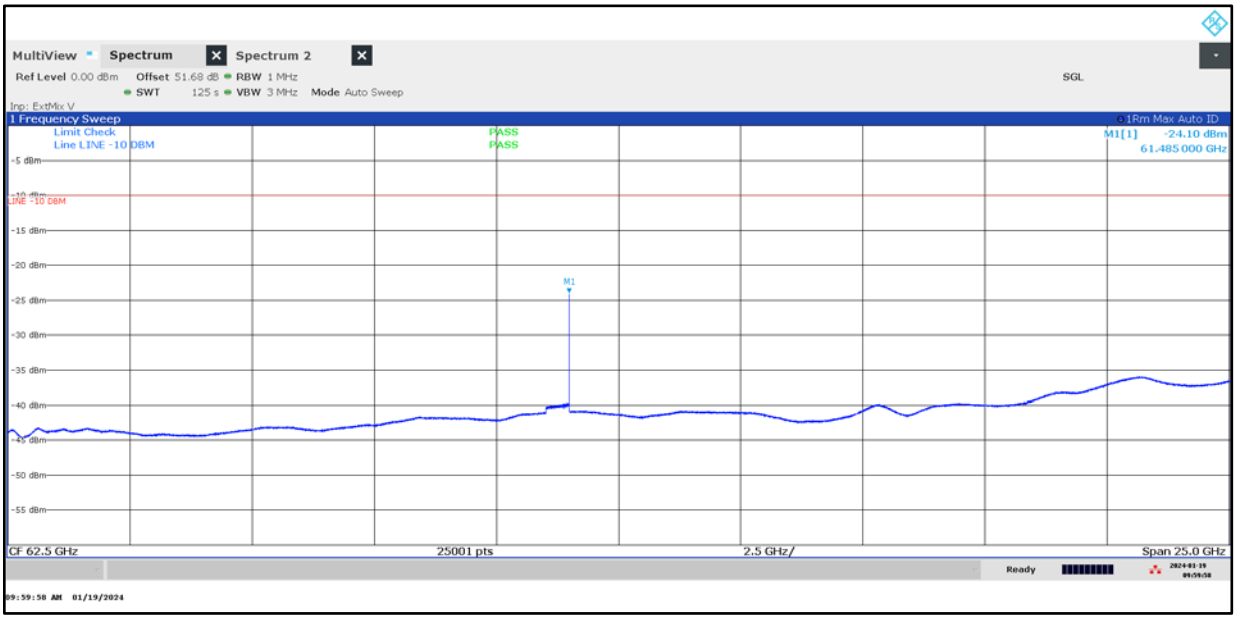
Plot 8: 26.5 GHz – 40 GHz, normal mode



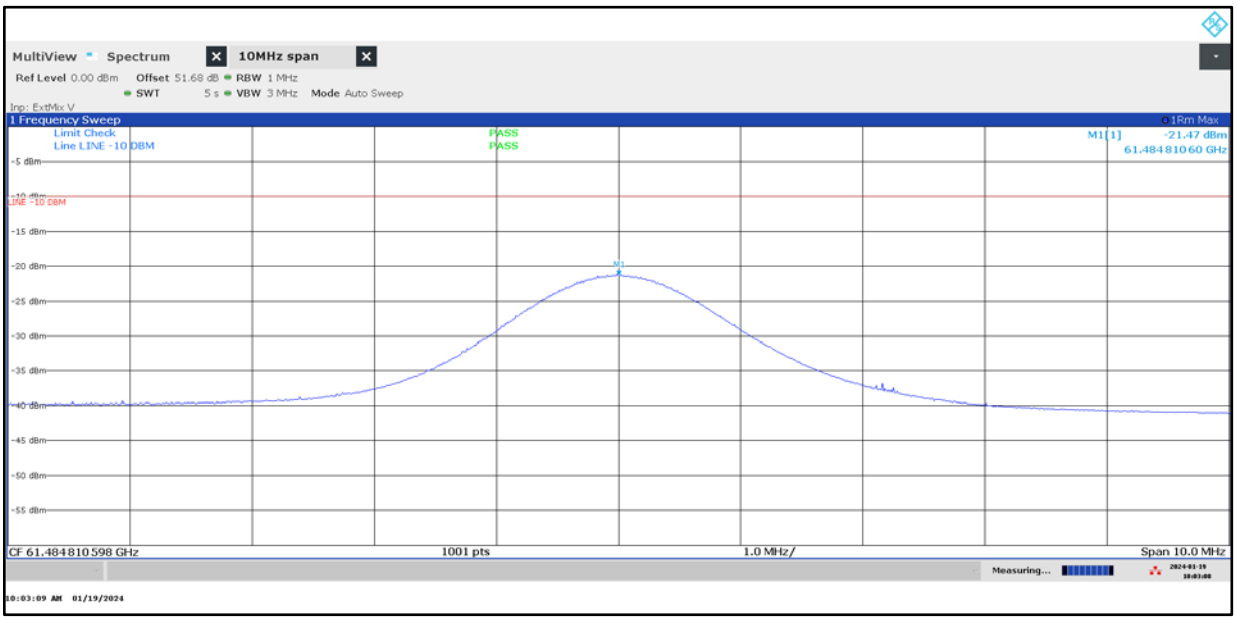
Plot 9: 40 GHz – 50 GHz, normal mode



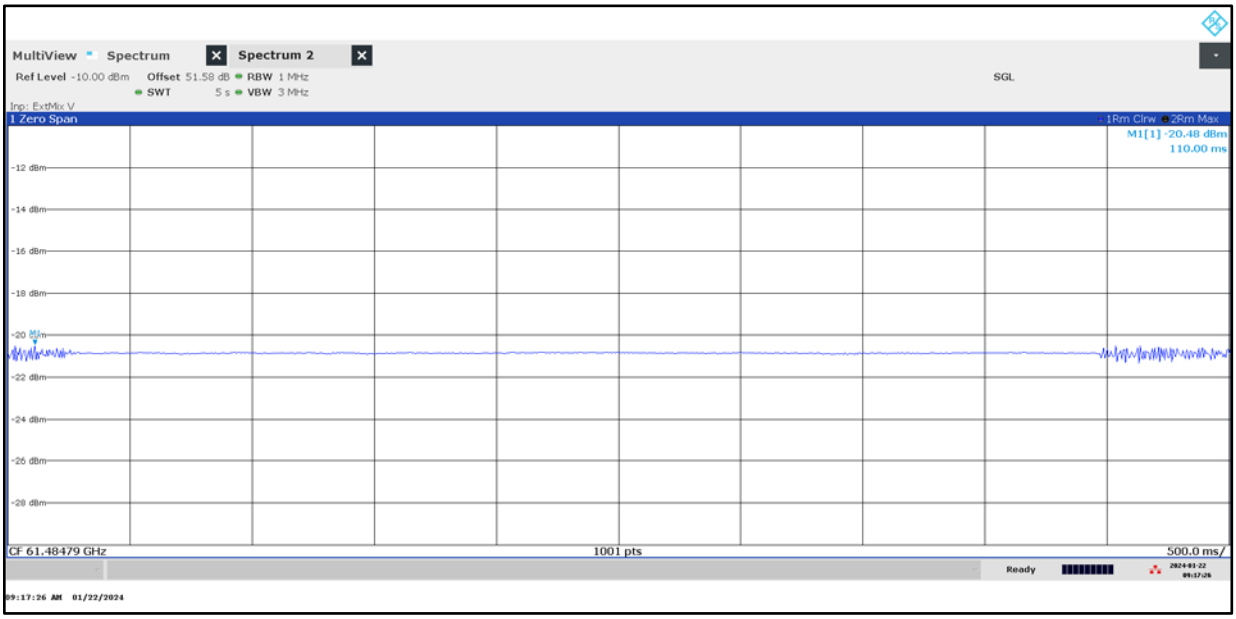
Plot 10: 50 GHz – 75 GHz, normal mode



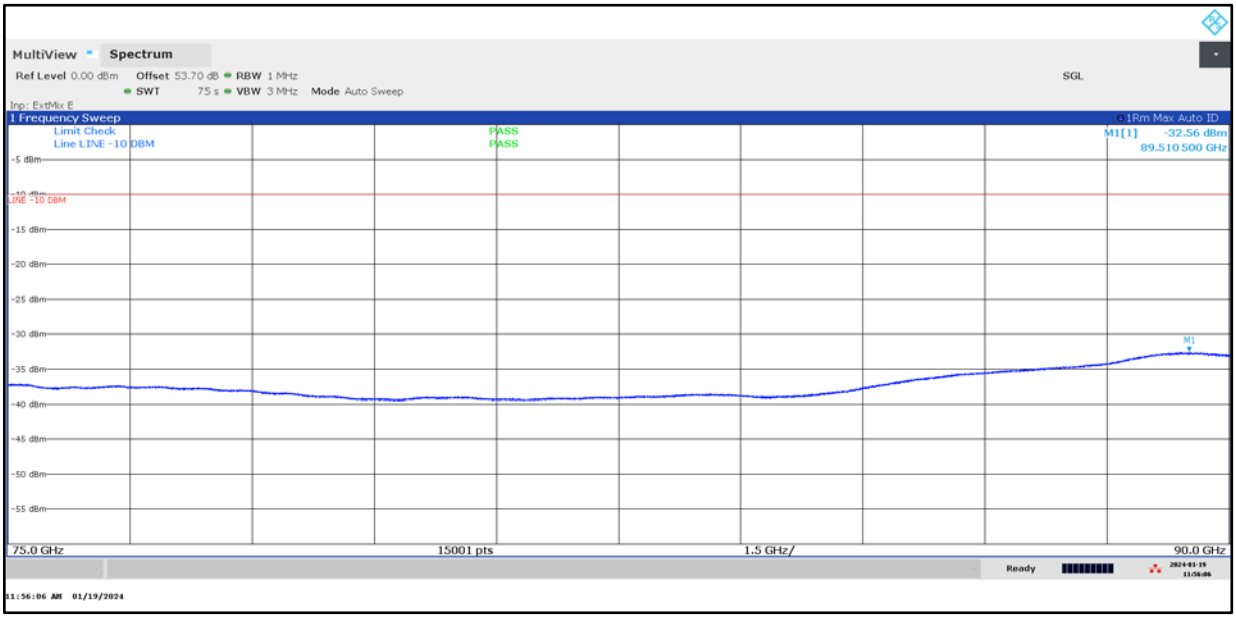
Plot 11: 61 GHz, normal mode, spurious emission with 10 MHz span



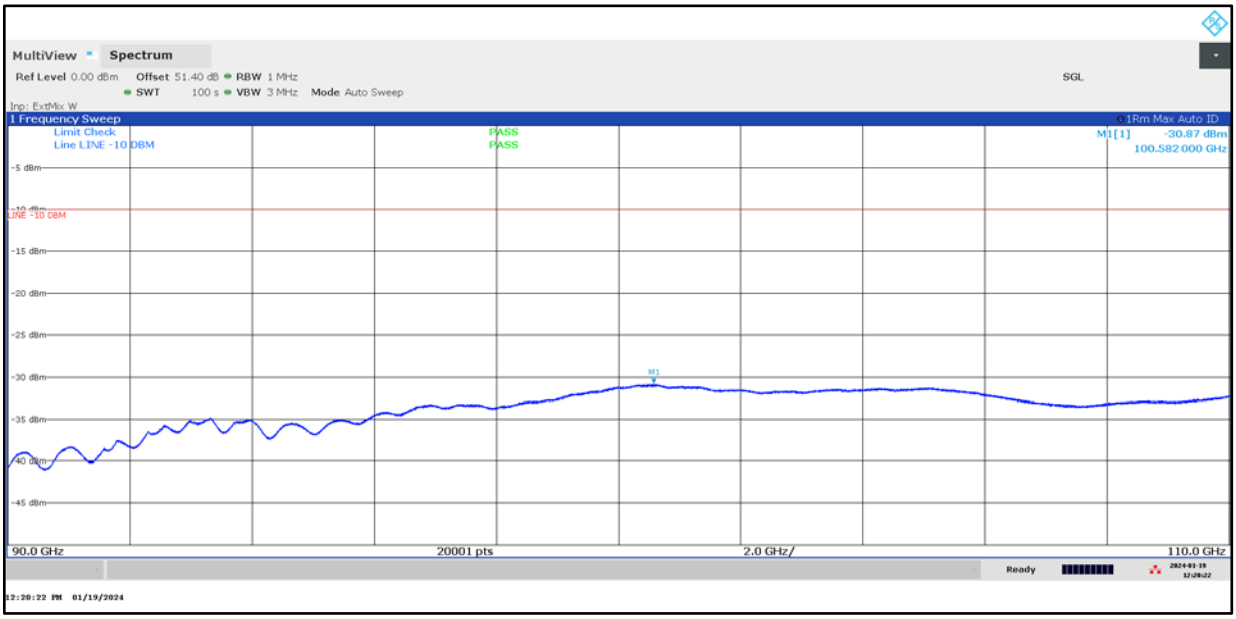
Plot 12: 61 GHz, normal mode, spurious emission with zero span



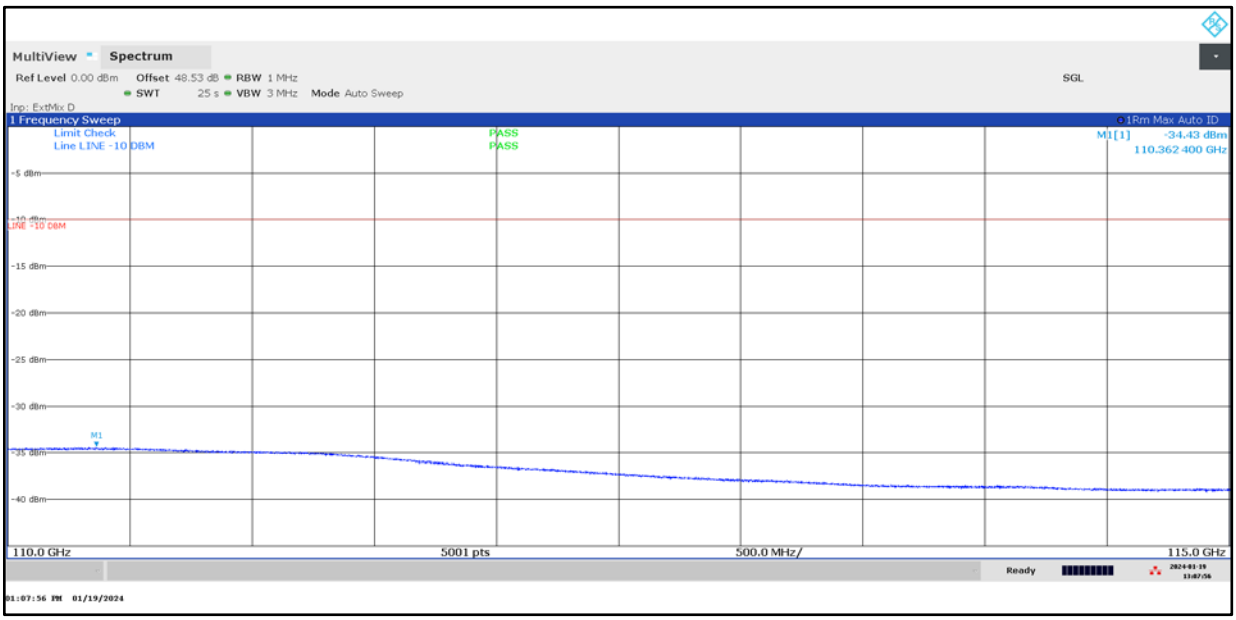
Plot 13: 75 GHz – 90 GHz, normal mode



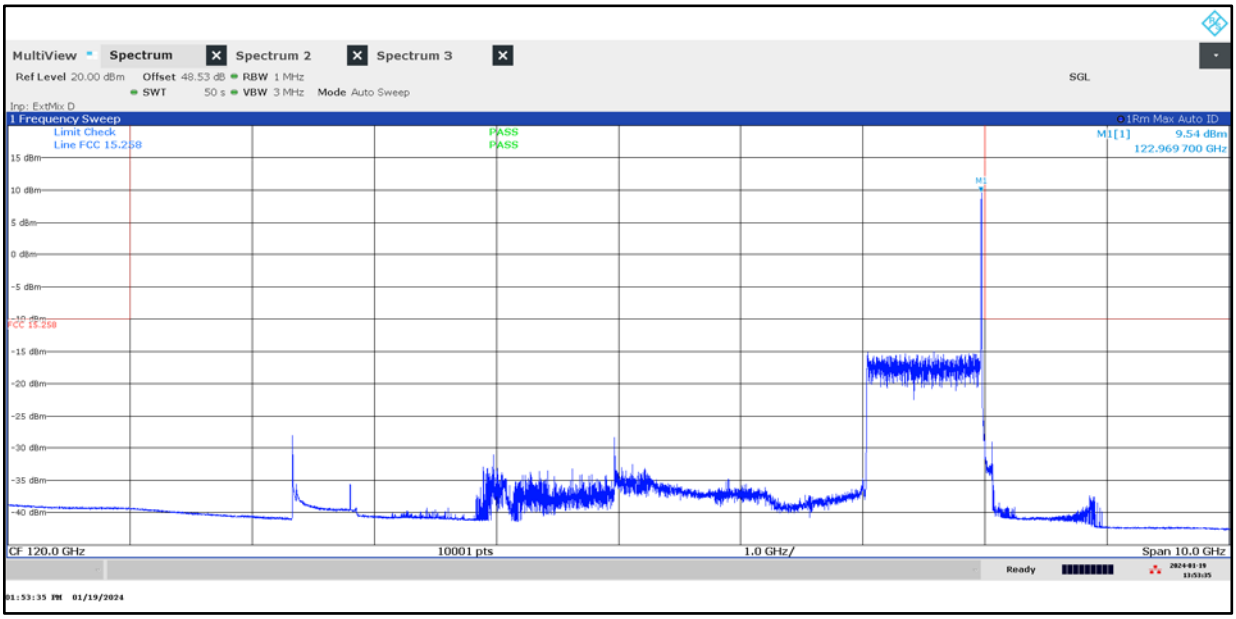
Plot 14: 90 GHz – 110 GHz, normal mode



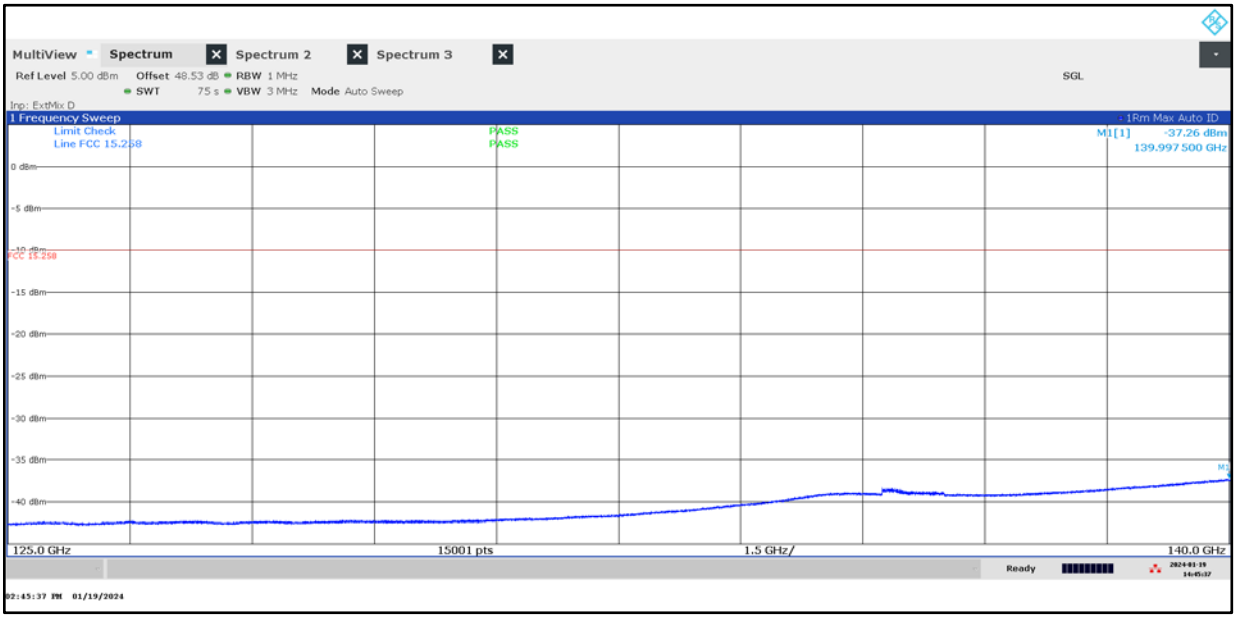
Plot 15: 110 GHz – 115 GHz, normal mode, low frequency



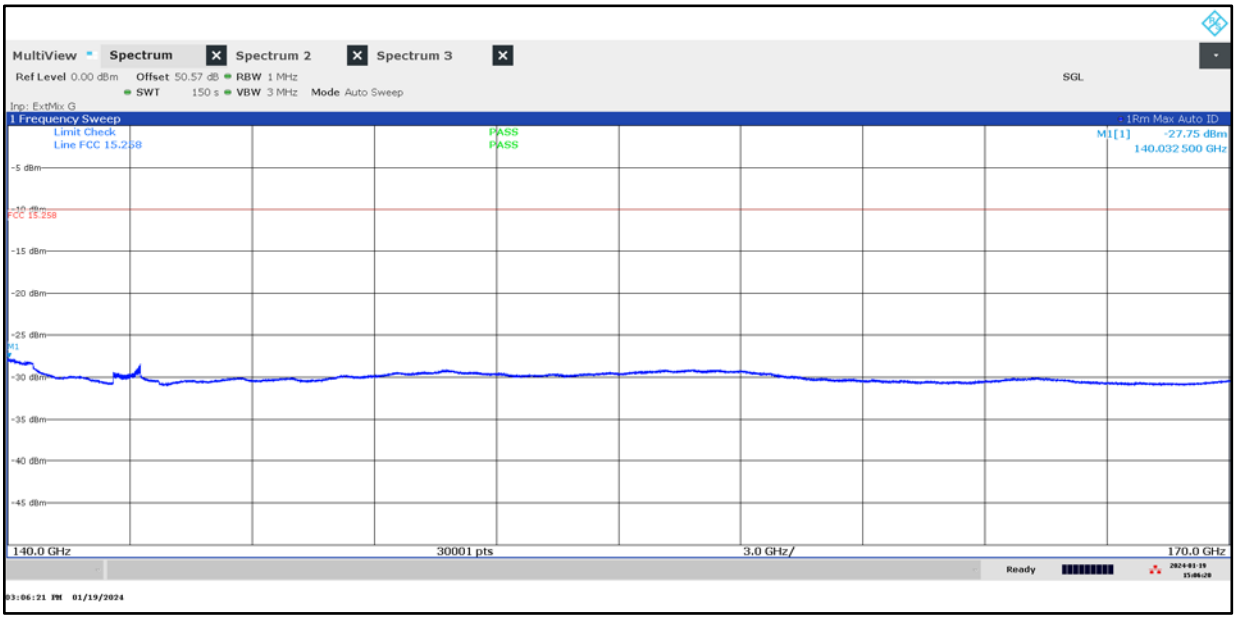
Plot 16: 115 GHz – 125 GHz, normal mode



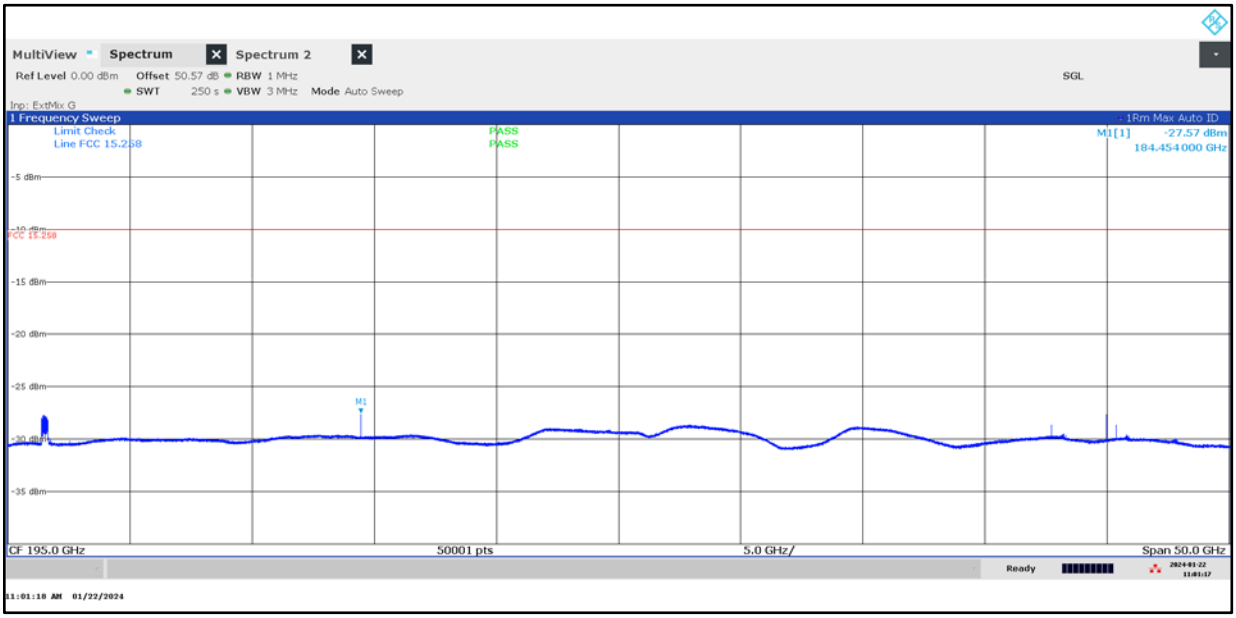
Plot 17: 125 GHz – 140 GHz, normal mode, low frequency



Plot 18: 140 GHz – 170 GHz, normal mode, low frequency



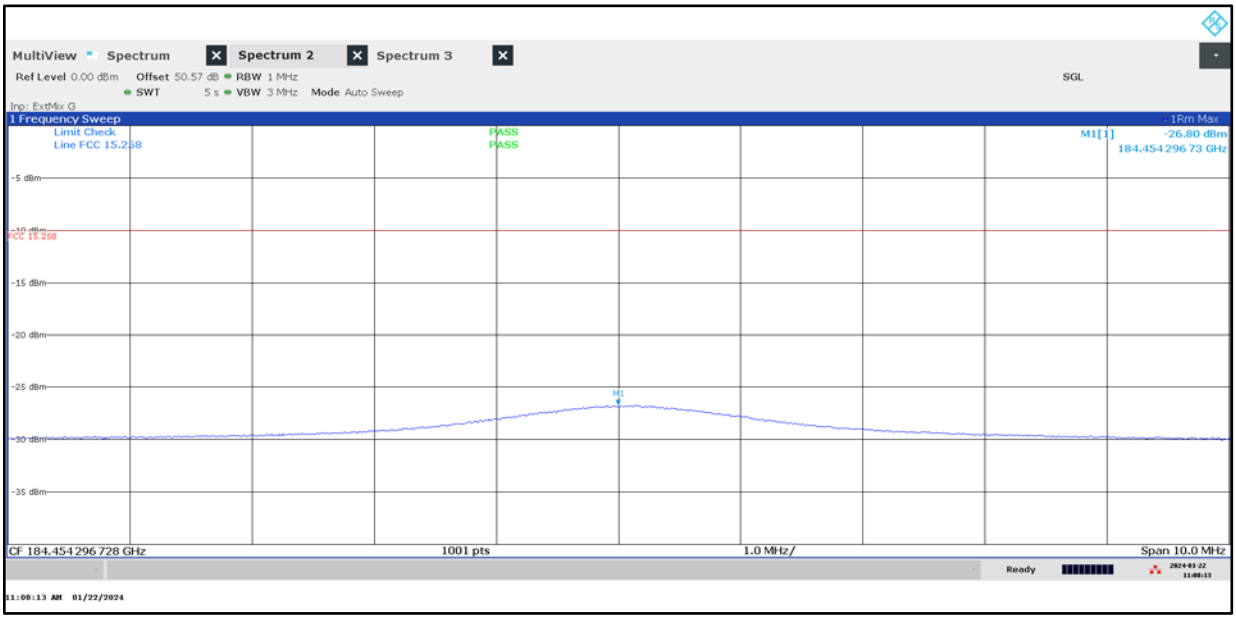
Plot 19: 170 GHz – 220 GHz, normal mode



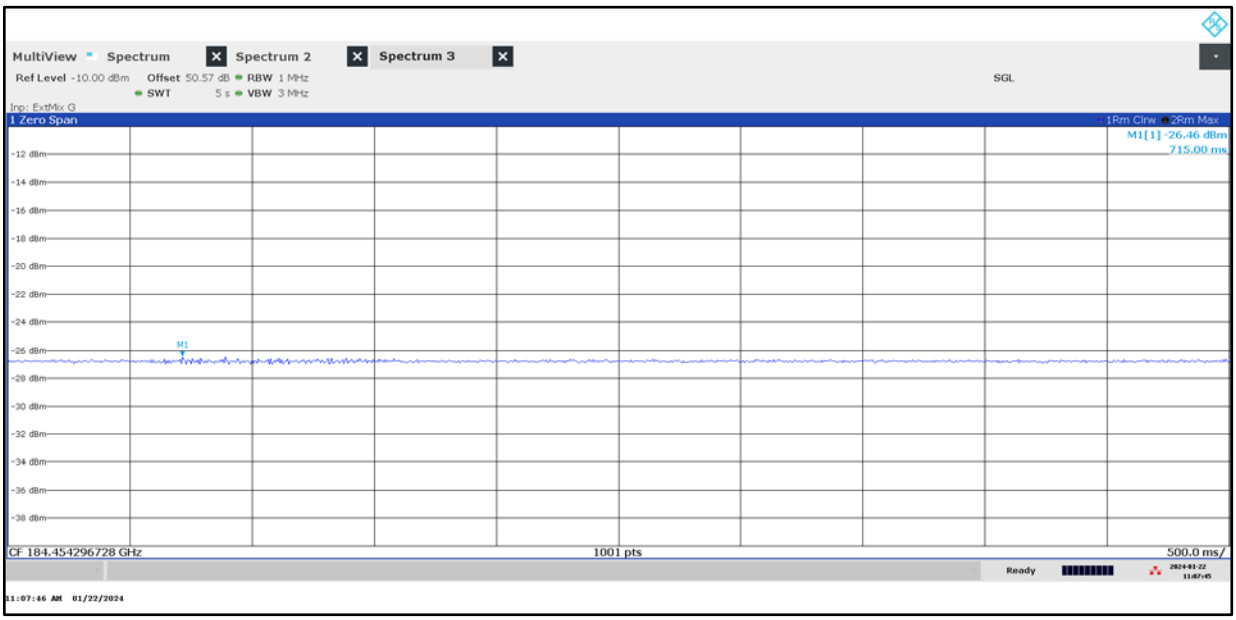
Note:

- Only the signal at 184.45GHz is a real Signal. The rest are signals from the mixer.

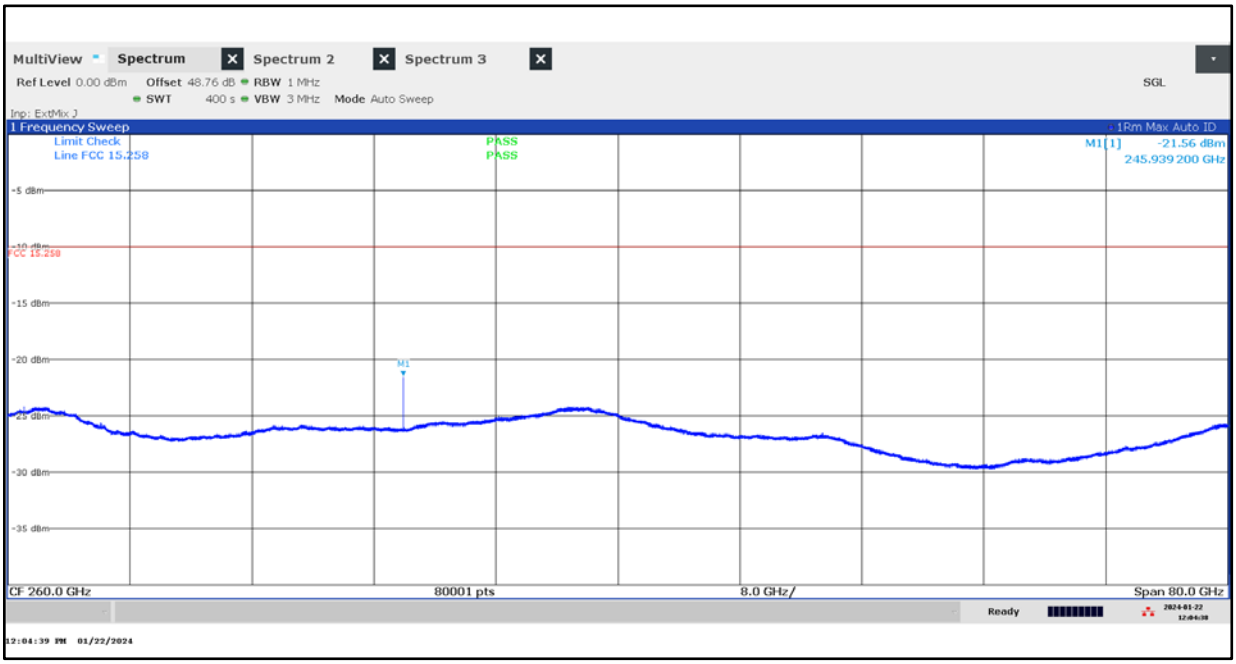
Plot 20: 184 GHz normal mode, spurious emission with 10 MHz span



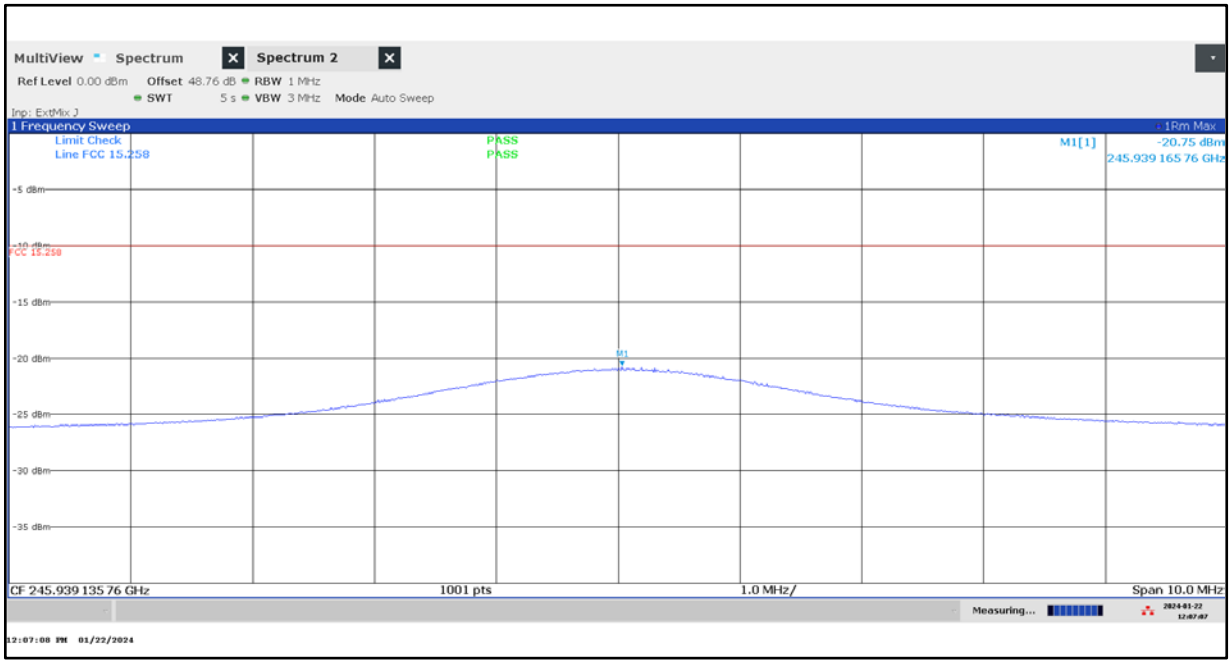
Plot 21: 184 GHz, normal mode, spurious emission with zero span



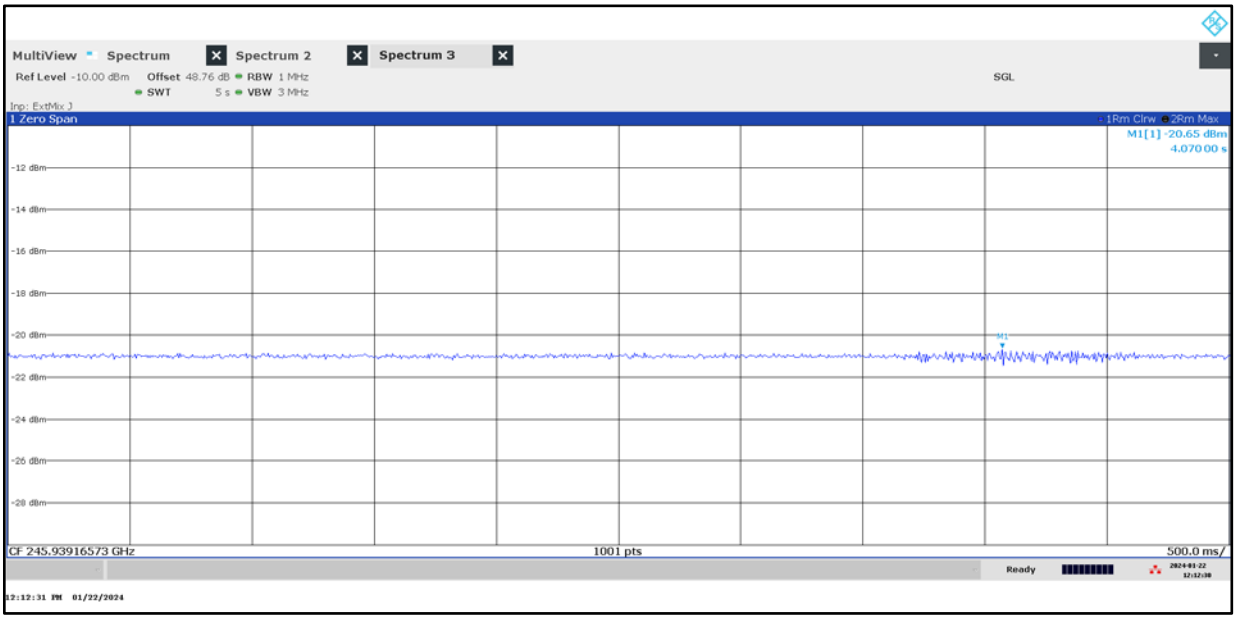
Plot 22: 220 GHz – 300 GHz, normal mode



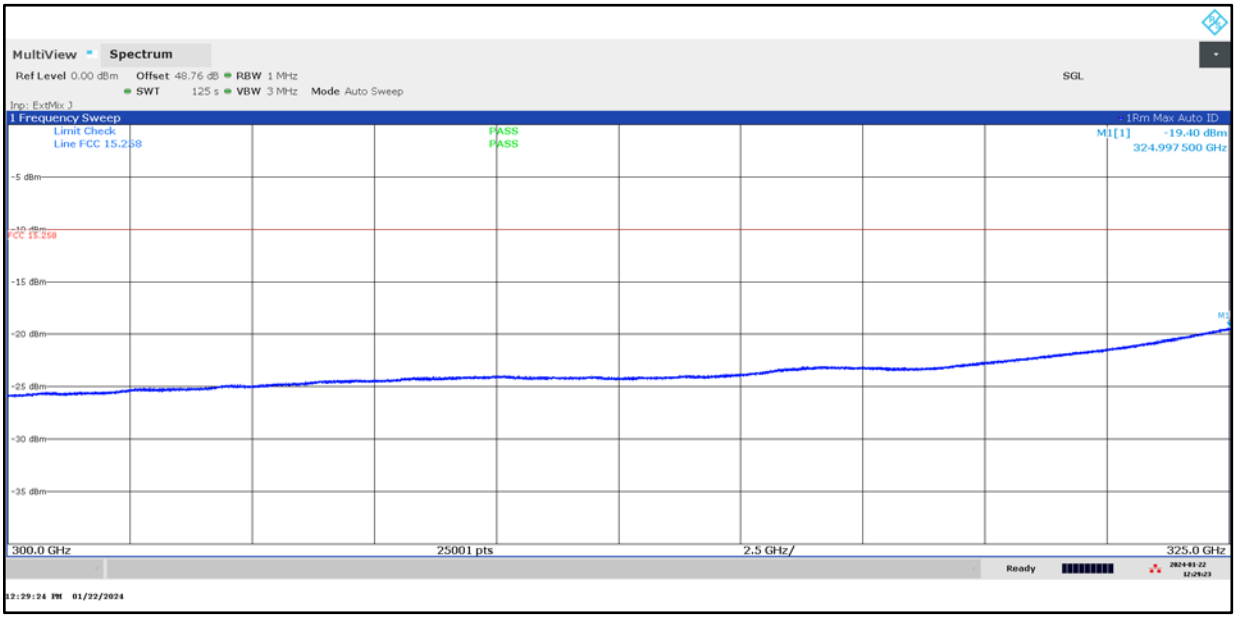
Plot 23: 245 GHz normal mode, spurious emission with 10 MHz span



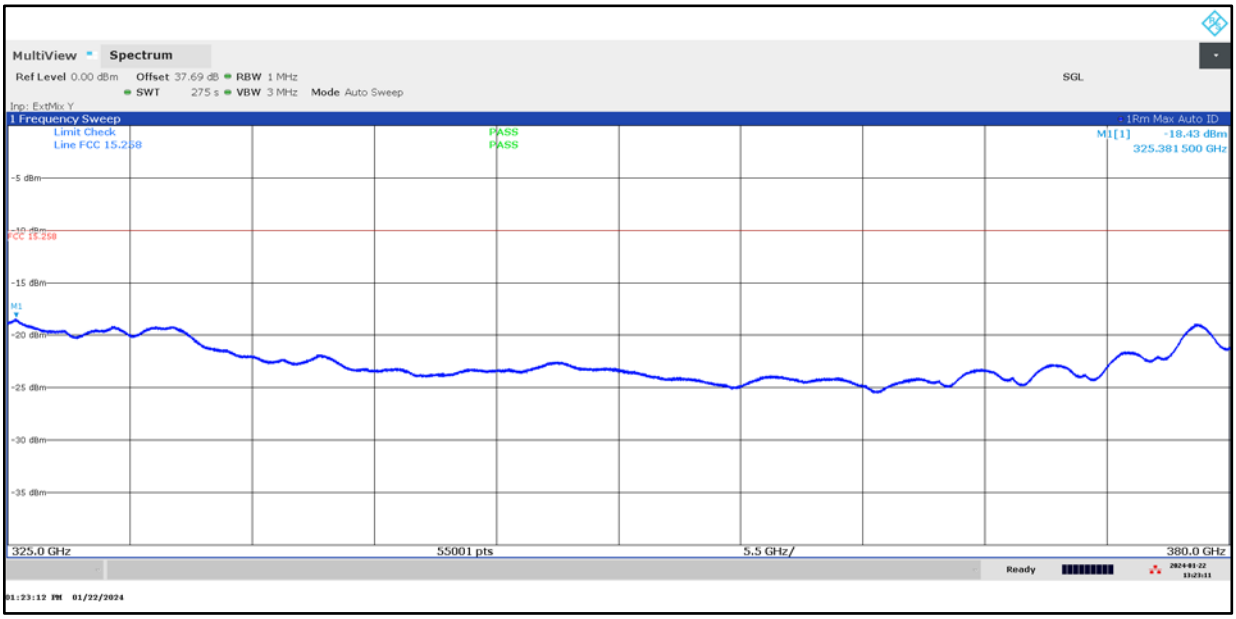
Plot 24: 245 GHz, normal mode, spurious emission with zero span



Plot 25: 300 GHz – 325 GHz, normal mode

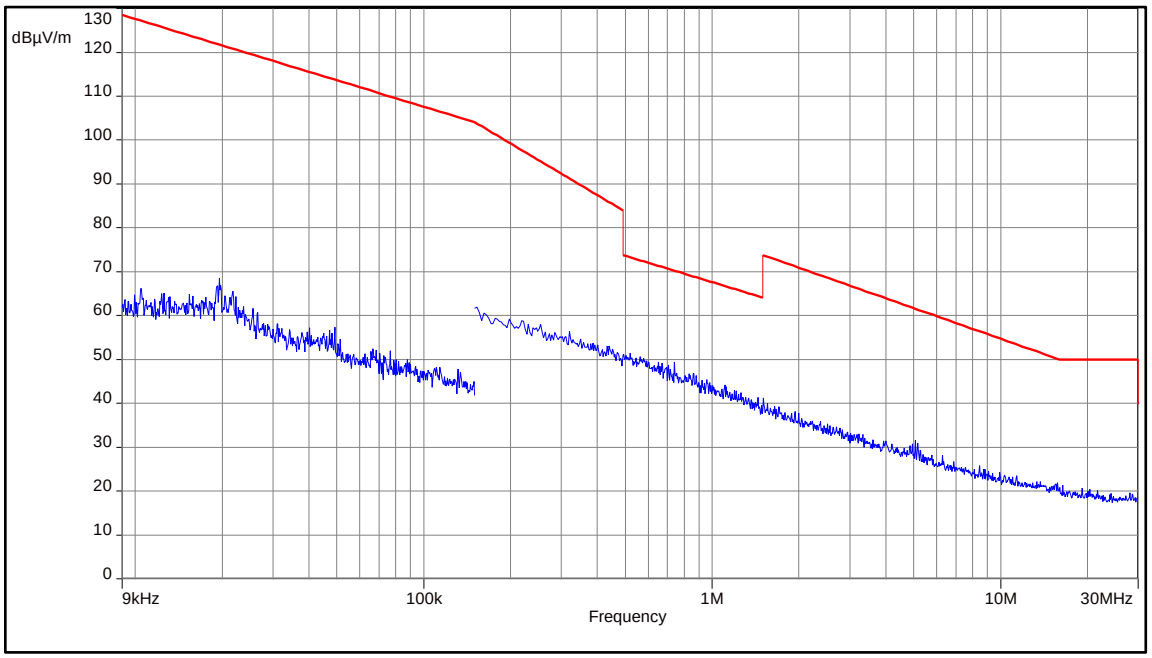


Plot 26: 325 GHz – 380 GHz, normal mode

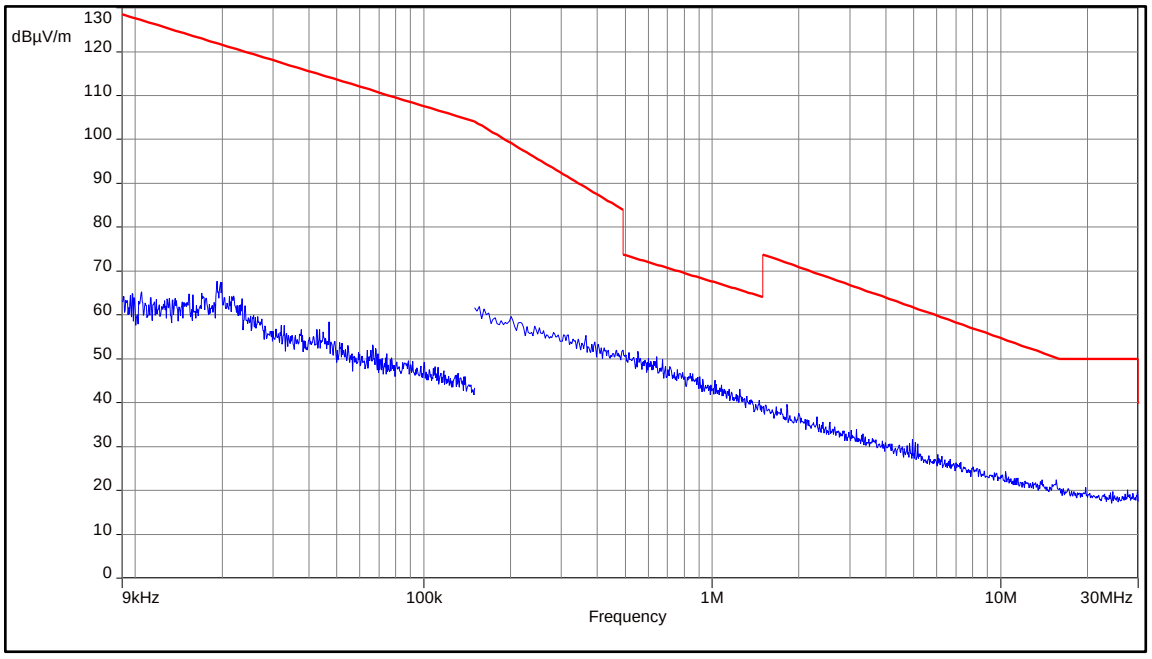


12.3.2 Spurious emissions radiated for stop mode

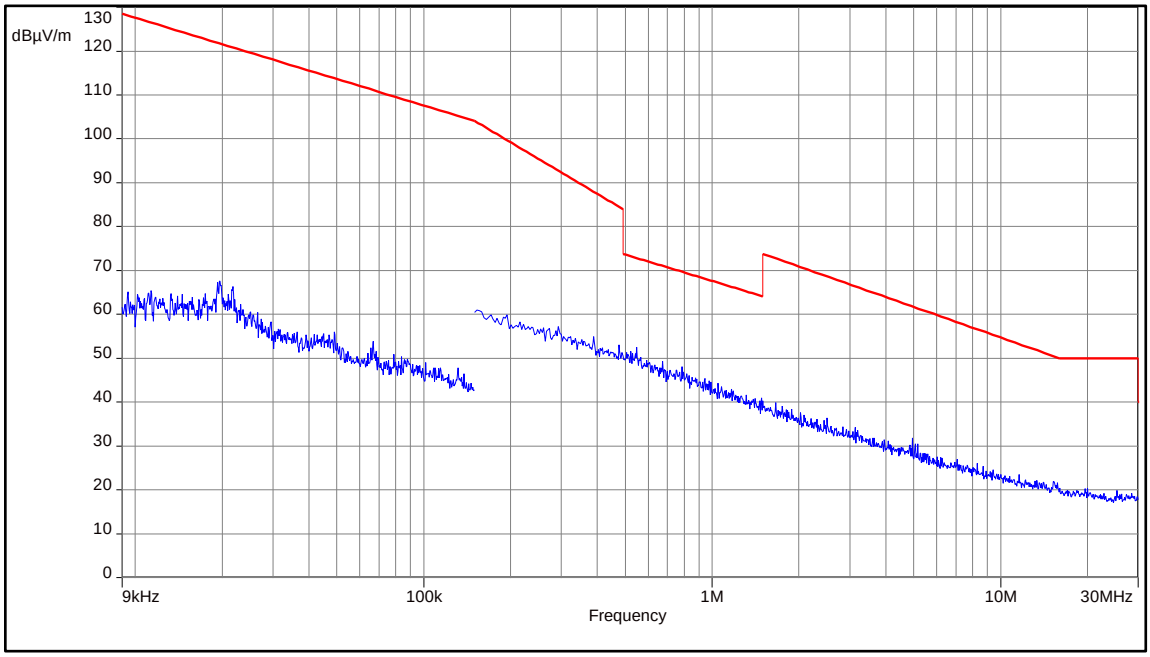
Plot 27: 9 kHz – 30 MHz, stop mode, low frequency



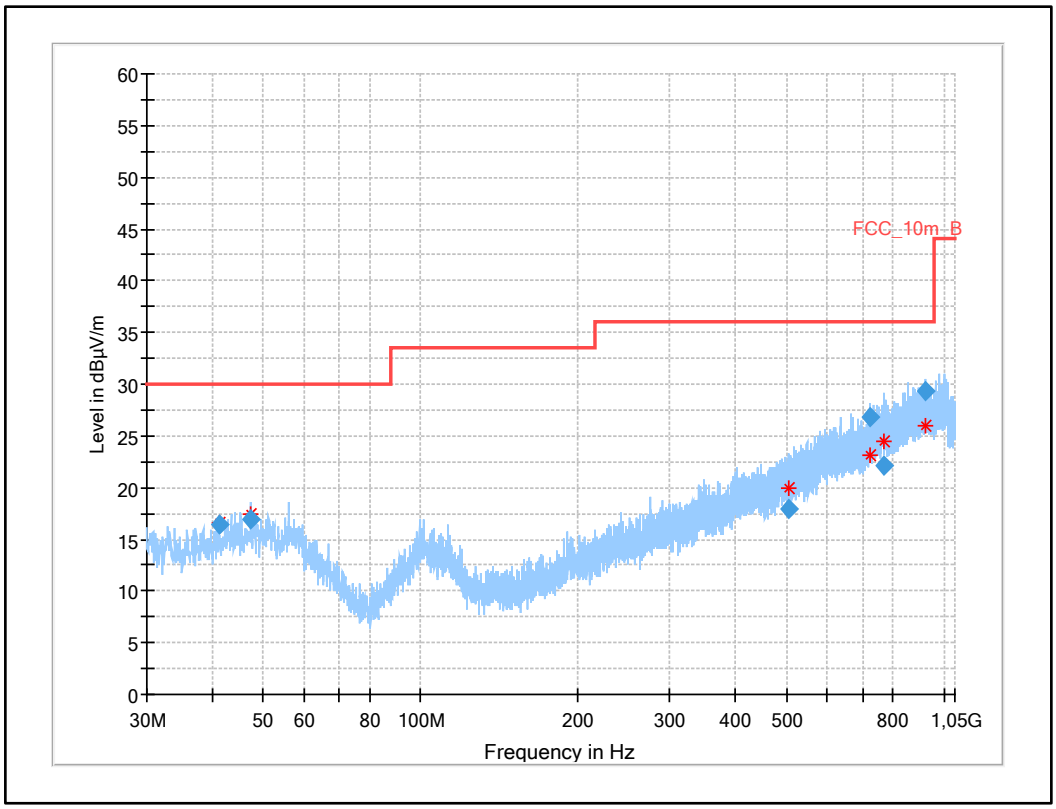
Plot 28: 9 kHz – 30 MHz, stop mode, middle frequency



Plot 29: 9 kHz – 30 MHz, stop mode, high frequency

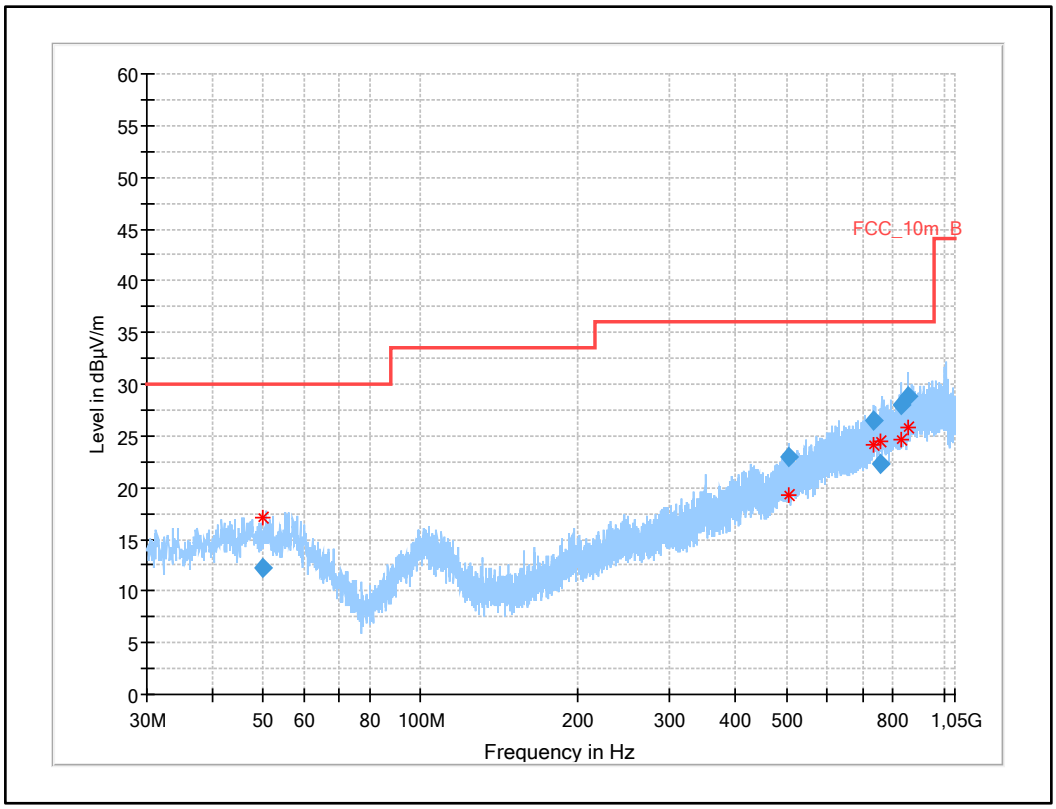


Plot 30: 30 MHz – 1GHz, stop mode, low frequency



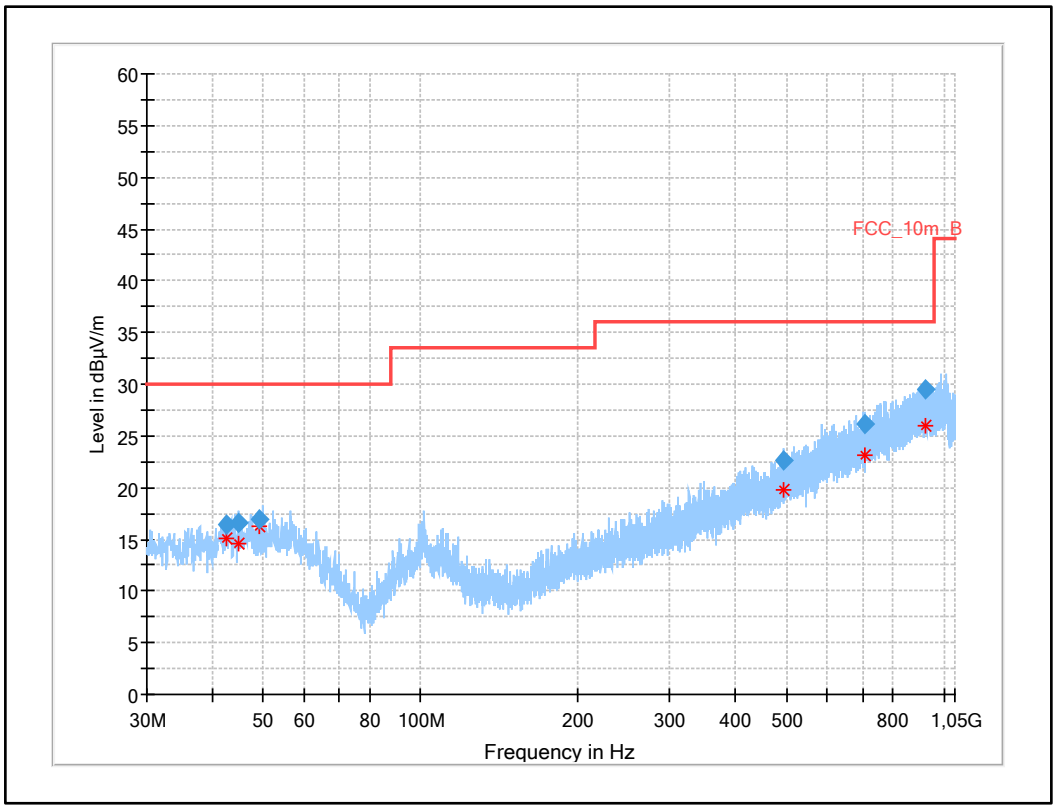
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
41.438	16.39	30.0	13.6	1000	120.0	174.0	H	-3	15
47.544	16.92	30.0	13.1	1000	120.0	139.0	V	246	15
506.679	18.00	36.0	18.0	1000	120.0	195.0	H	142	20
721.844	26.79	36.0	9.2	1000	120.0	147.0	V	-37	23
770.661	22.18	36.0	13.8	1000	120.0	195.0	V	232	24
922.631	29.41	36.0	6.6	1000	120.0	195.0	H	232	26

Plot 31: 30 MHz – 1GHz, stop mode, middle frequency



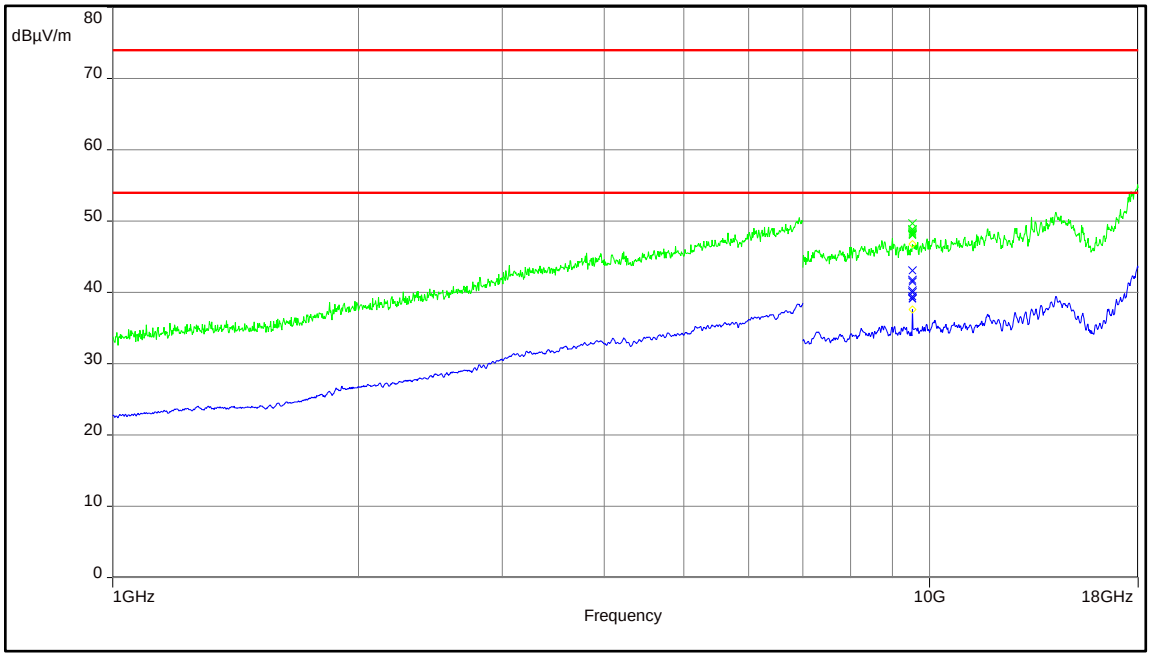
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
50.113	12.19	30.0	17.8	1000	120.0	101.0	V	199	15
504.099	22.89	36.0	13.1	1000	120.0	195.0	V	142	20
734.905	26.41	36.0	9.6	1000	120.0	195.0	H	52	23
759.720	22.21	36.0	13.8	1000	120.0	195.0	H	-3	24
829.113	27.96	36.0	8.0	1000	120.0	101.0	V	142	24
856.758	28.82	36.0	7.2	1000	120.0	177.0	H	142	25

Plot 32: 30 MHz – 1GHz, stop mode, high frequency

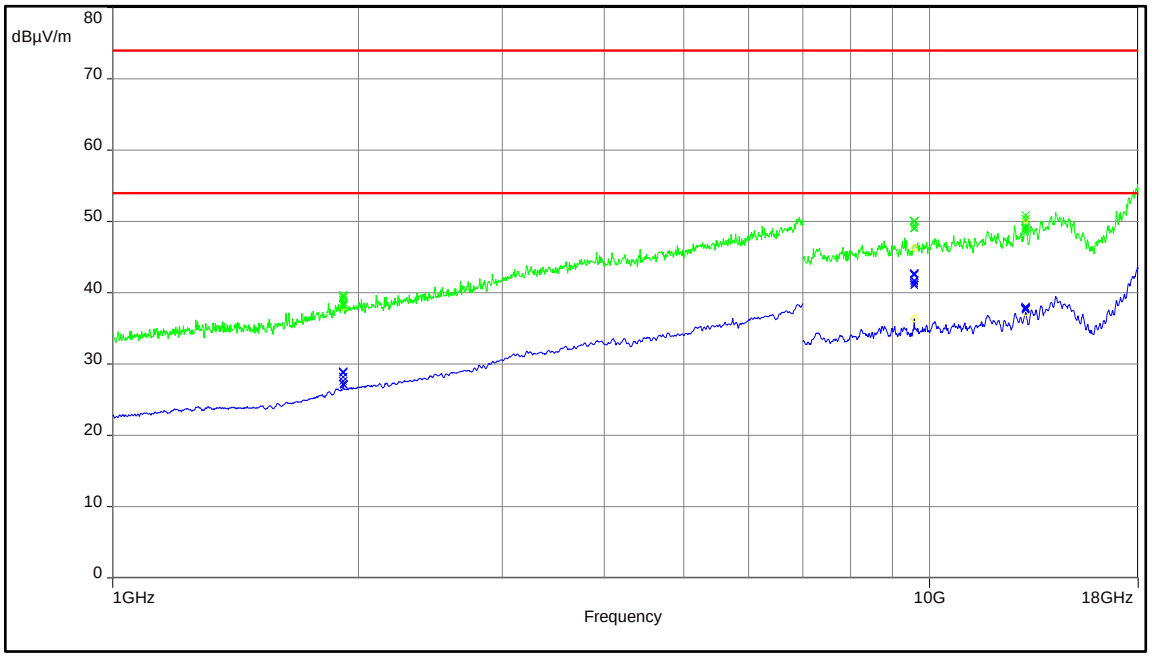


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
42.549	16.47	30.0	13.5	1000	120.0	113.0	H	174	15
45.055	16.67	30.0	13.3	1000	120.0	126.0	V	106	15
49.353	16.92	30.0	13.1	1000	120.0	190.0	V	108	15
493.055	22.70	36.0	13.3	1000	120.0	195.0	V	52	20
707.235	26.07	36.0	9.9	1000	120.0	160.0	H	90	22
924.434	29.46	36.0	6.5	1000	120.0	195.0	V	-37	26

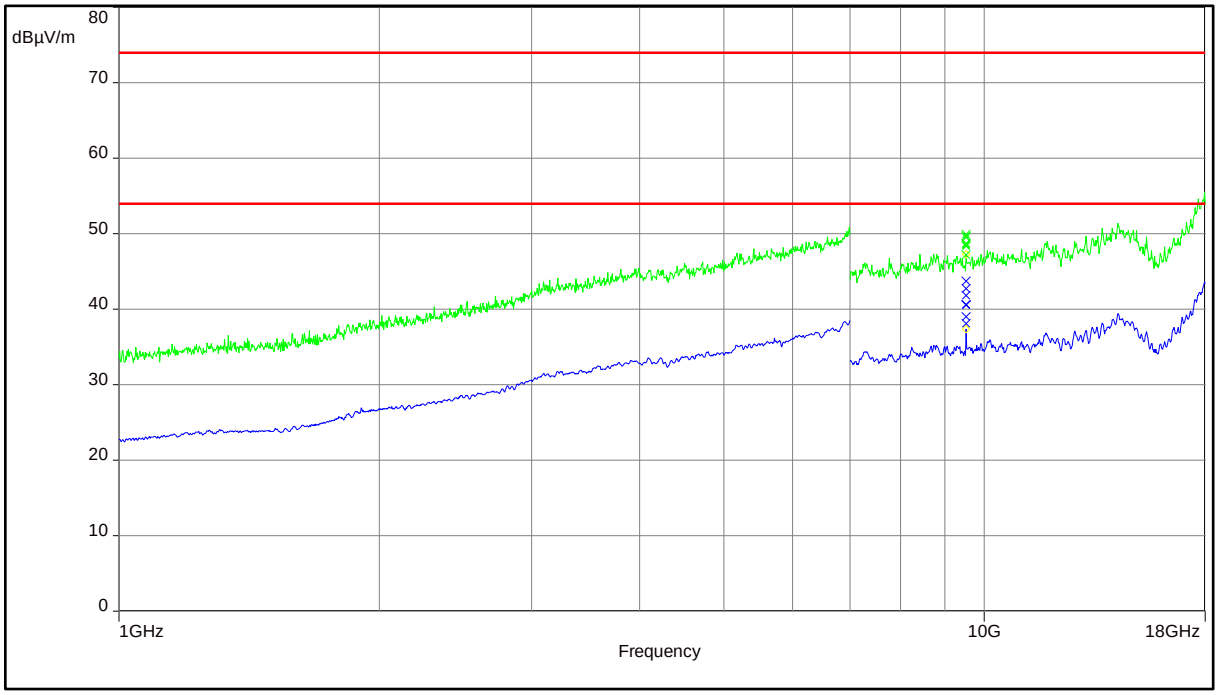
Plot 33: 1GHz – 18 GHz, stop mode, low frequency



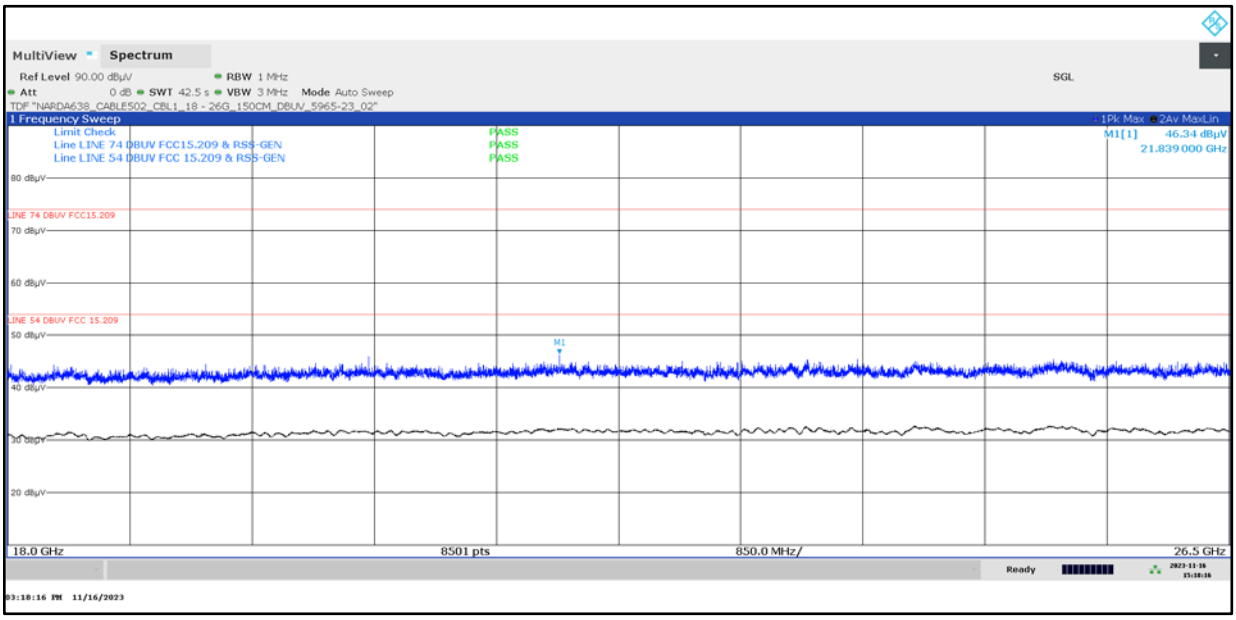
Plot 34: 1GHz – 18 GHz, stop mode, middle frequency



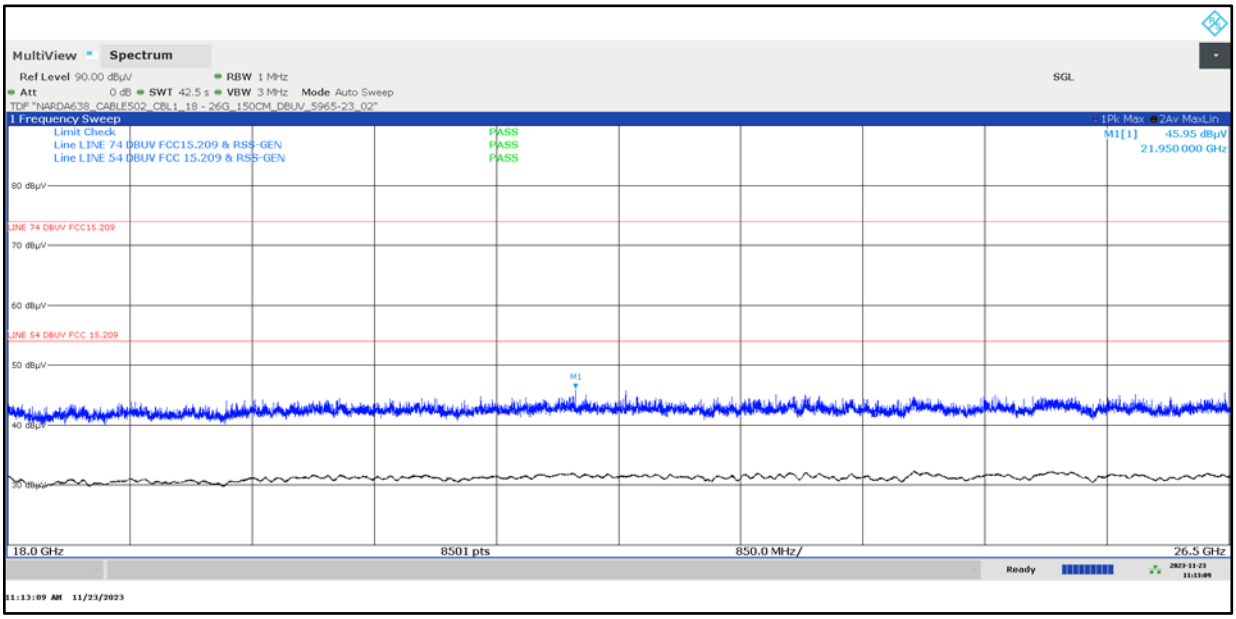
Plot 35: 1GHz – 18 GHz, stop mode, high frequency



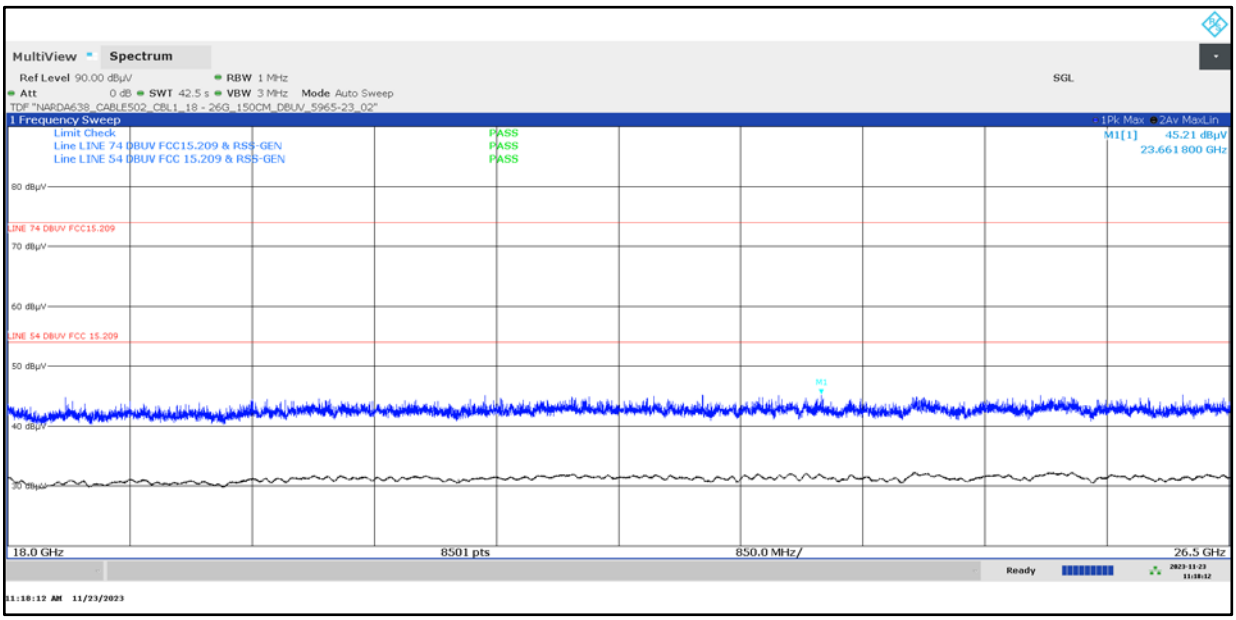
Plot 36: 18 GHz – 26.5 GHz, stop mode, low frequency



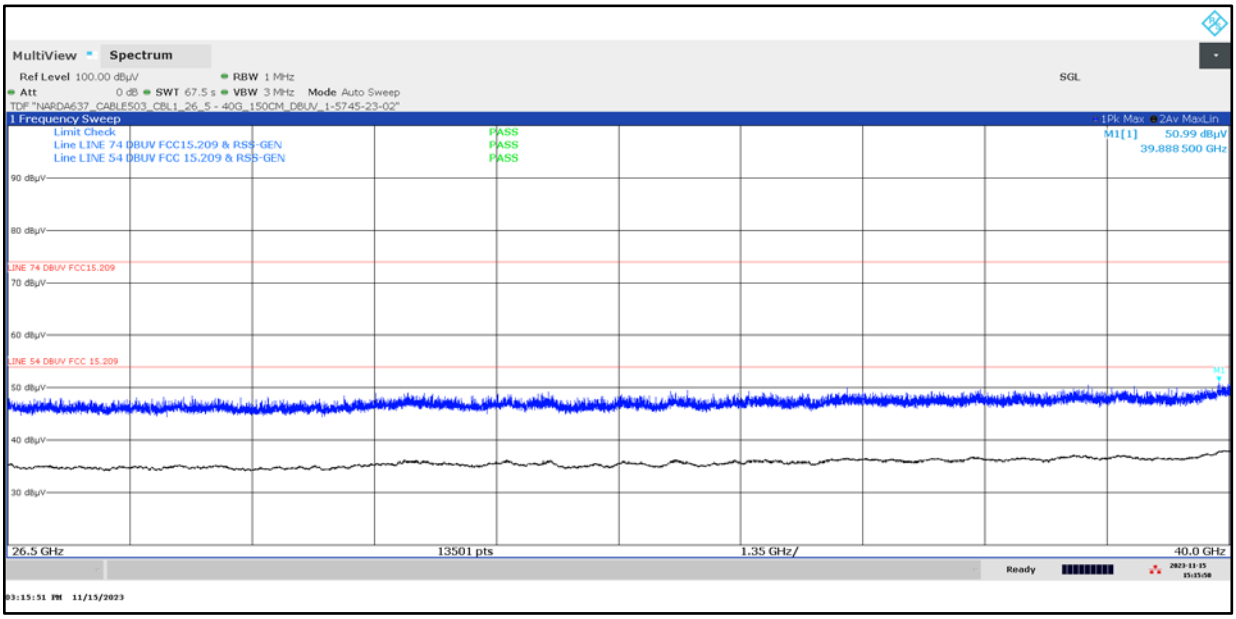
Plot 37: 18 GHz – 26.5 GHz, stop mode, middle frequency



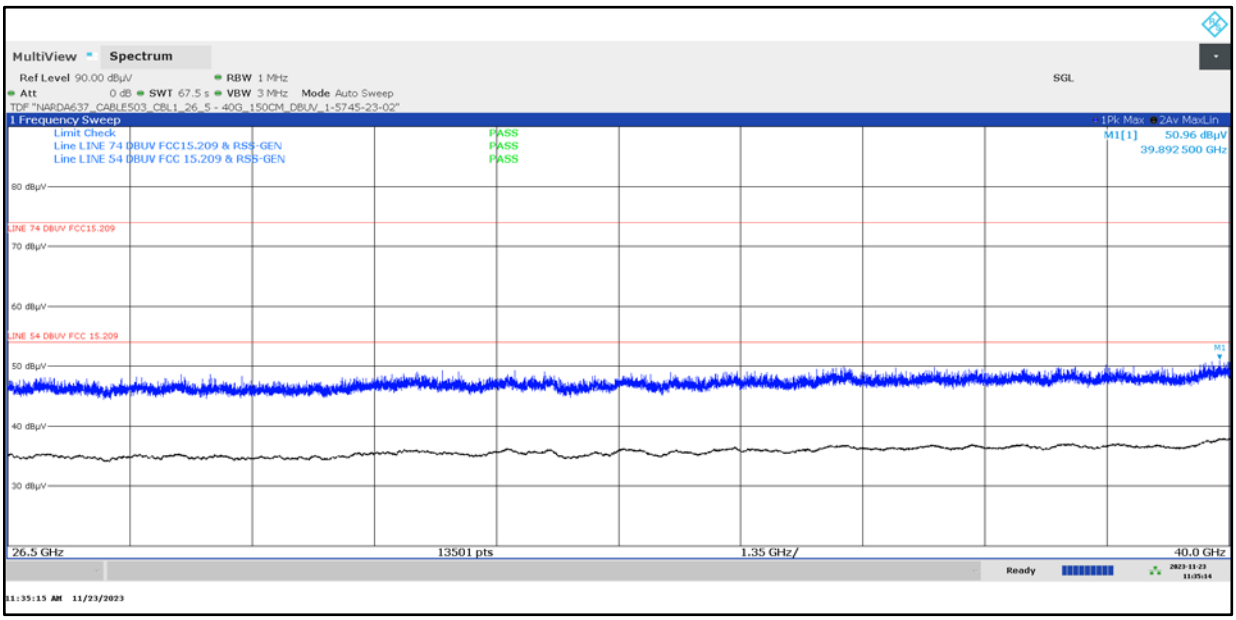
Plot 38: 18 GHz – 26.5 GHz, stop mode, high frequency



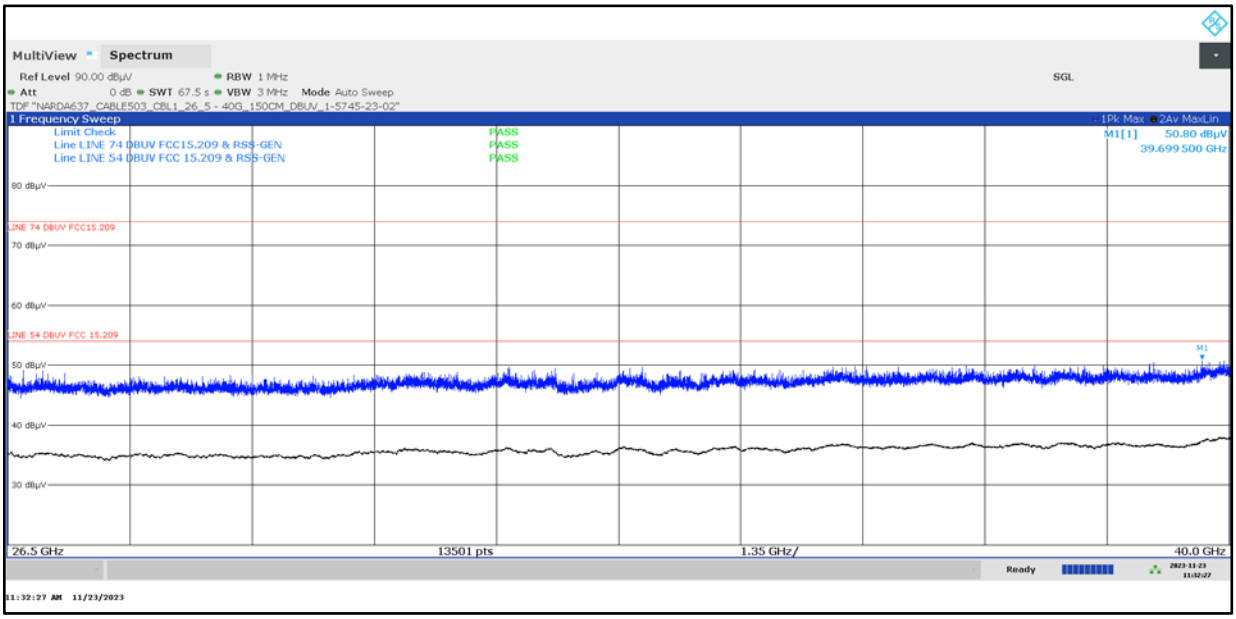
Plot 39: 26.5 GHz – 40 GHz, stop mode, low frequency



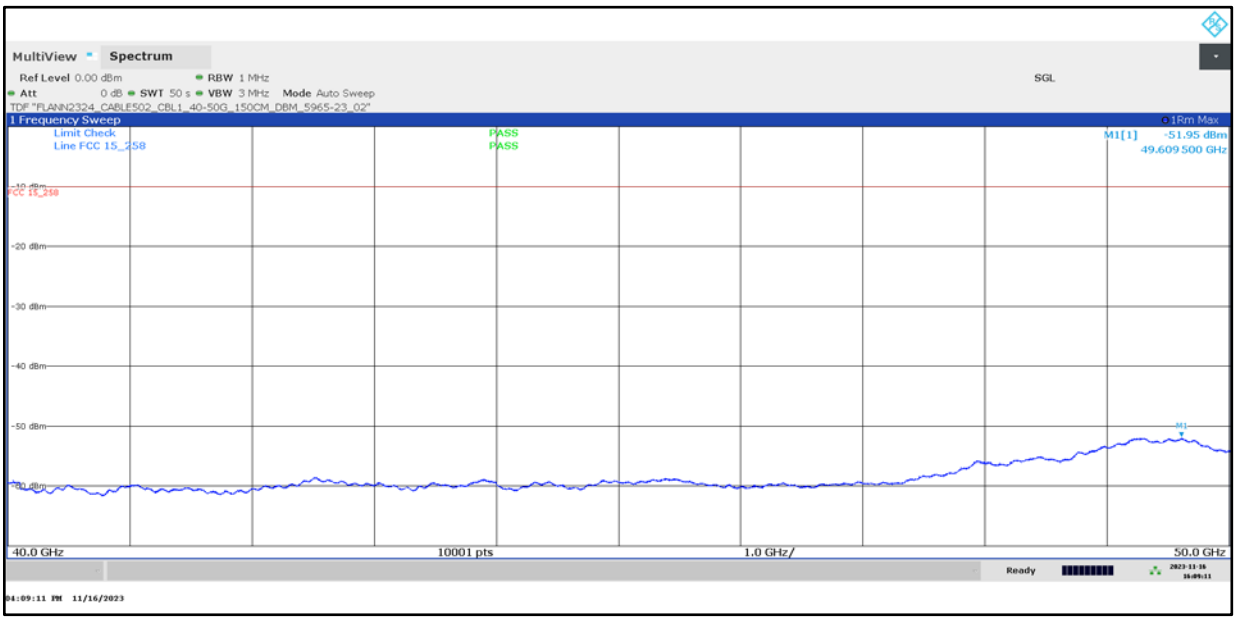
Plot 40: 26.5 GHz – 40 GHz, stop mode, middle frequency



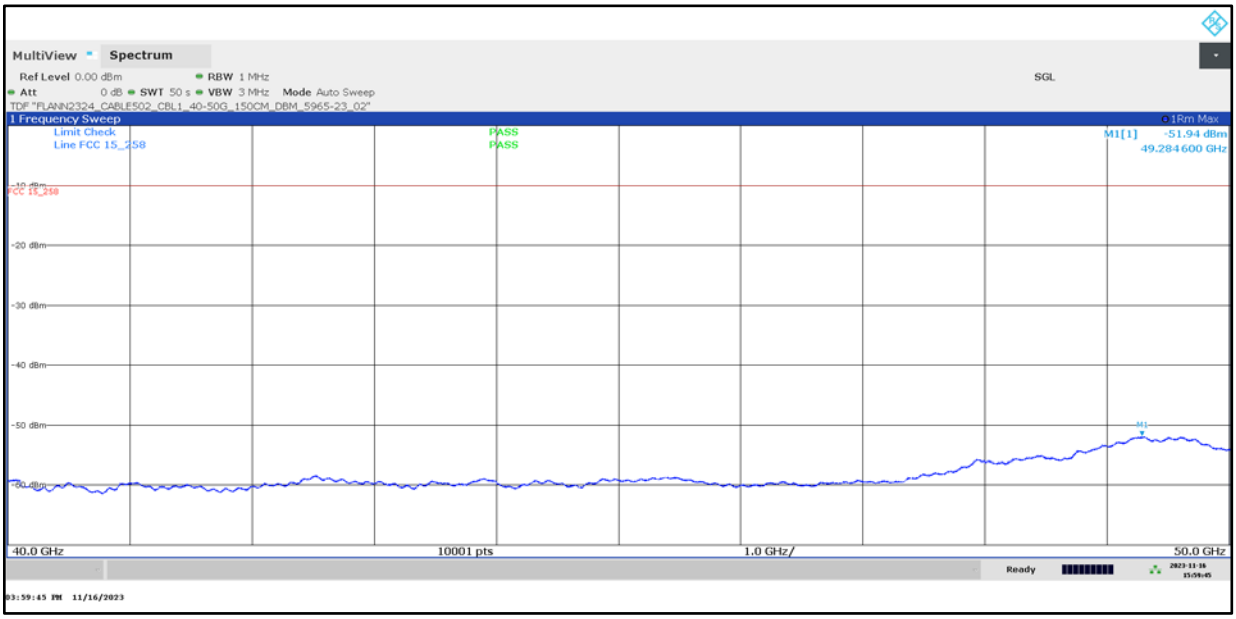
Plot 41: 26.5 GHz – 40 GHz, stop mode, high frequency



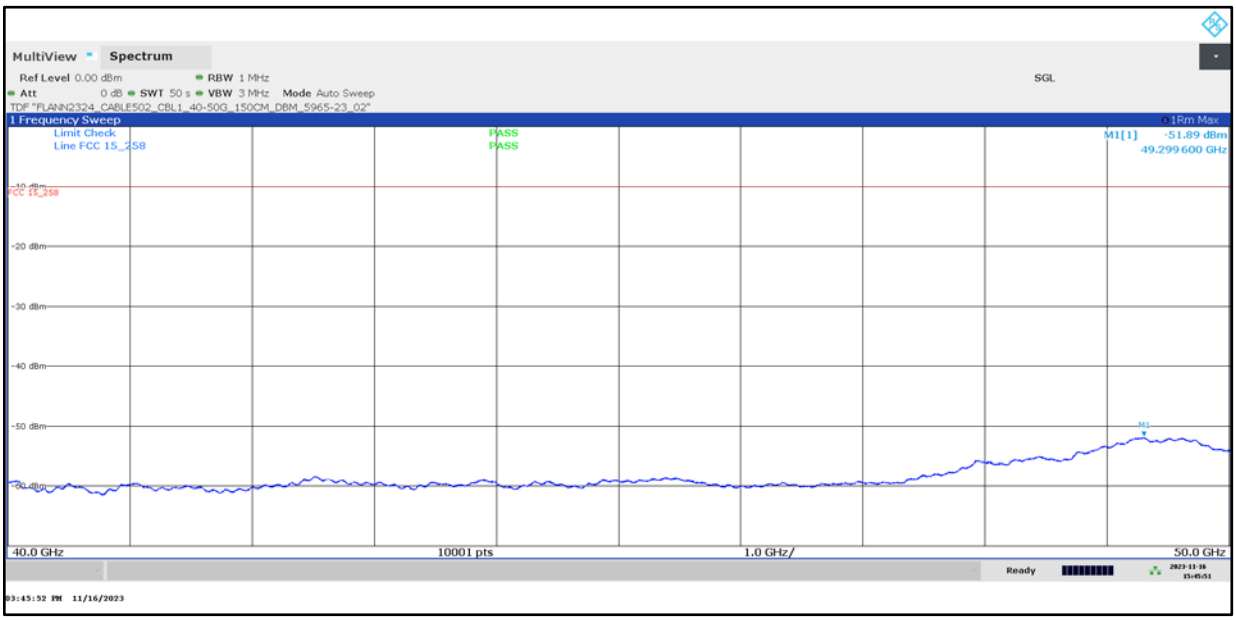
Plot 42: 40 GHz – 50 GHz, stop mode, low frequency



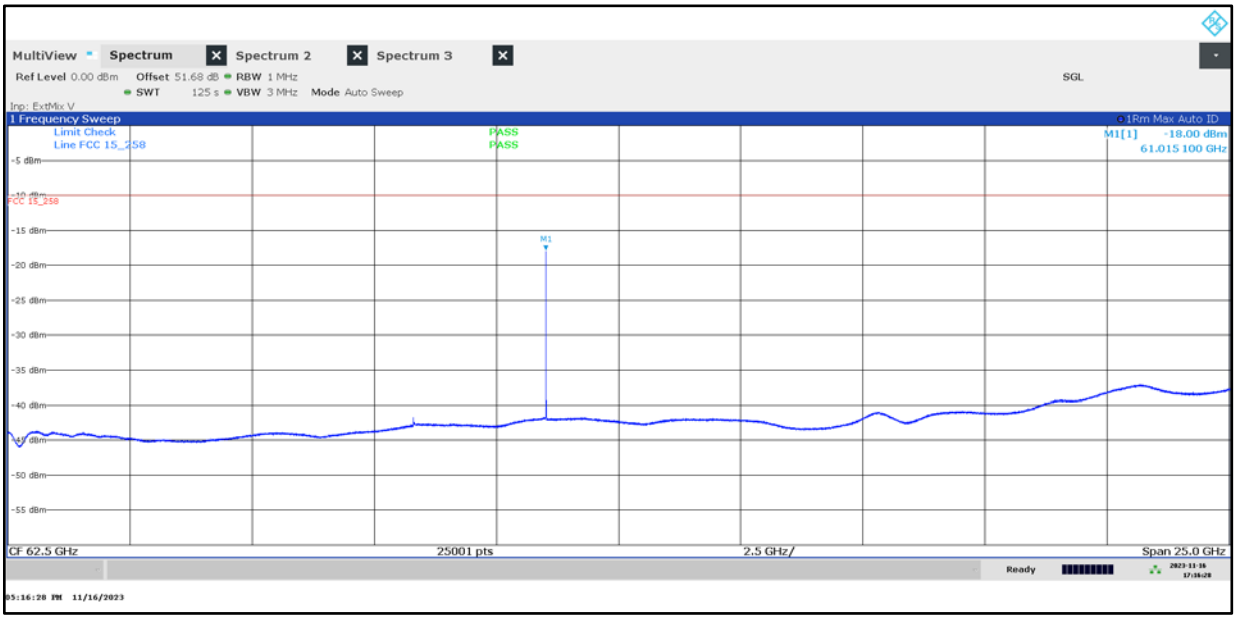
Plot 43: 40 GHz – 50 GHz, stop mode, middle frequency



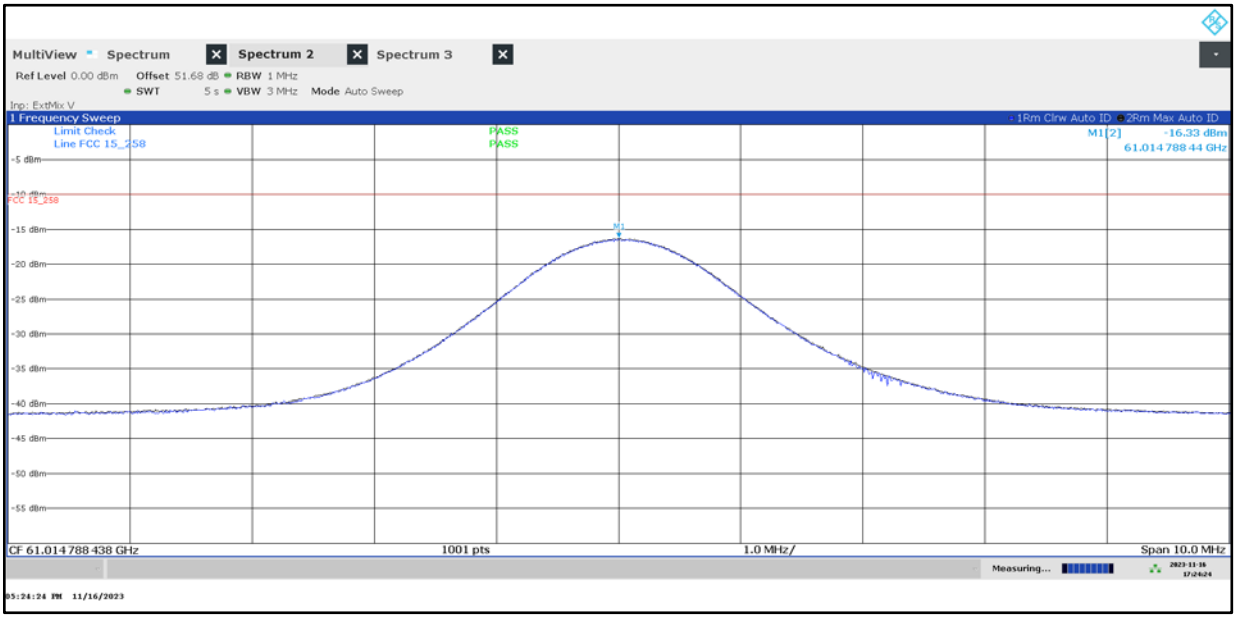
Plot 44: 40 GHz – 50 GHz, stop mode, high frequency



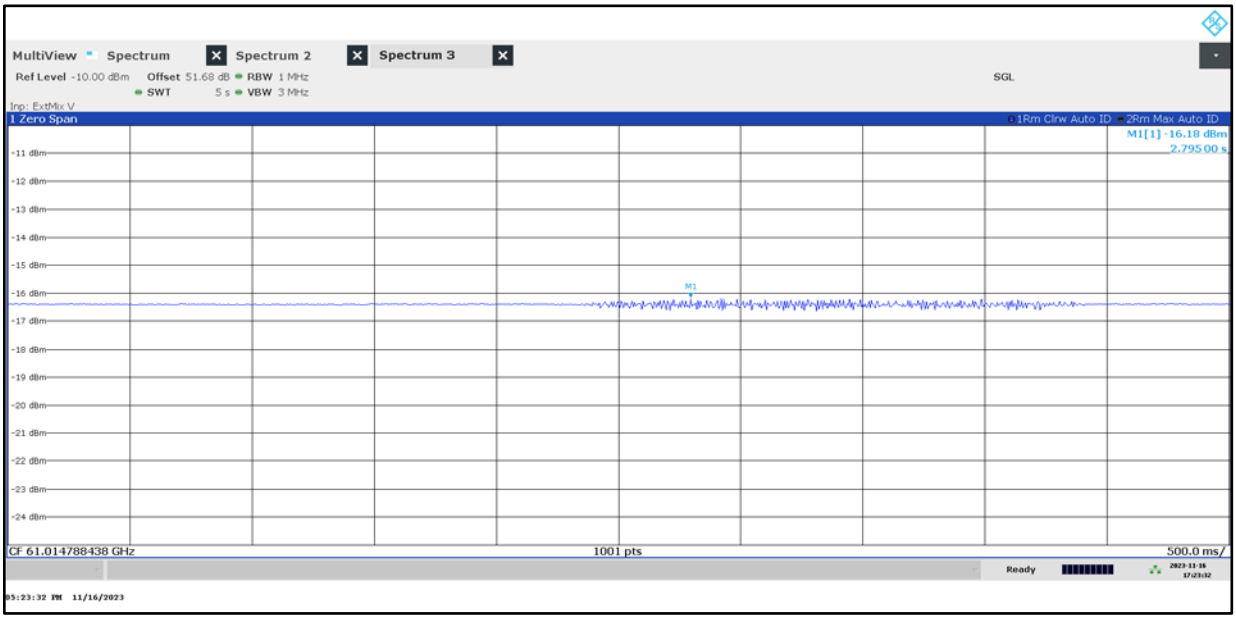
Plot 45: 50 GHz – 75 GHz, stop mode, low frequency



Plot 46: 61 GHz, stop mode, low frequency spurious emission with 10 MHz span



Plot 47: 61 GHz, stop mode, low frequency spurious emission with zero span



Plot 48: 50 GHz – 75 GHz, stop mode, middle frequency