
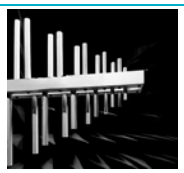
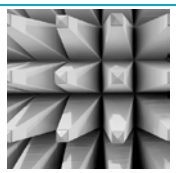

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-1054/20-01-02

Testing laboratory

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

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

Baumer Electric AG
Hummelstr. 17
8501 Frauenfeld / SWITZERLAND
Phone: +41 (0)52 728 14 85
Contact: Matthias Sutter
e-mail: msutter@baumer.com
Phone: +41 (0)52 728 1594

Manufacturer

Baumer Electric AG
Hummelstr. 17
8501 Frauenfeld / 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
RSS - 210 Issue 10	Radio Standards Specification - Licence-Exempt Radio Apparatus: Category II Equipment
RSS-GEN	General Requirements for Compliance of Radio Apparatus

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**
IC-ID	**24812-R600V**
Frequency:	122 GHz – 123 GHz
Technology tested:	FMCW Radar
Antenna:	Integrated patch antenna
Power supply:	9 V to 32 V DC by external power supply
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

cn=Thomas Vogler, o=CTC advanced GmbH, ou=VOG-161125, email=thomas.vogler@ctcadvanced.com, c=DE
2021.02.11 10:58:52 +01'00'

Thomas Vogler
Lab Manager
Radio Communications

Test performed:

cn=Sebastian Janoschka, o=CTC advanced GmbH, ou=JKA-190527, email=sebastian.janoschka@ctcadvanced.com, c=DE
2021.02.11 10:50:39 +01'00'

Sebastian Janoschka
Lab Manager
Radio Communications

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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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:	2020-11-16
Date of receipt of test item:	2020-10-22
Start of test:*	2020-11-10
End of test:*	2021-02-02
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
RSS - 210 Issue 10	12-2019	Radio Standards Specification - Licence-Exempt Radio Apparatus: Category II Equipment
RSS-GEN	03-2019	General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
ANSI C63.4-2017	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

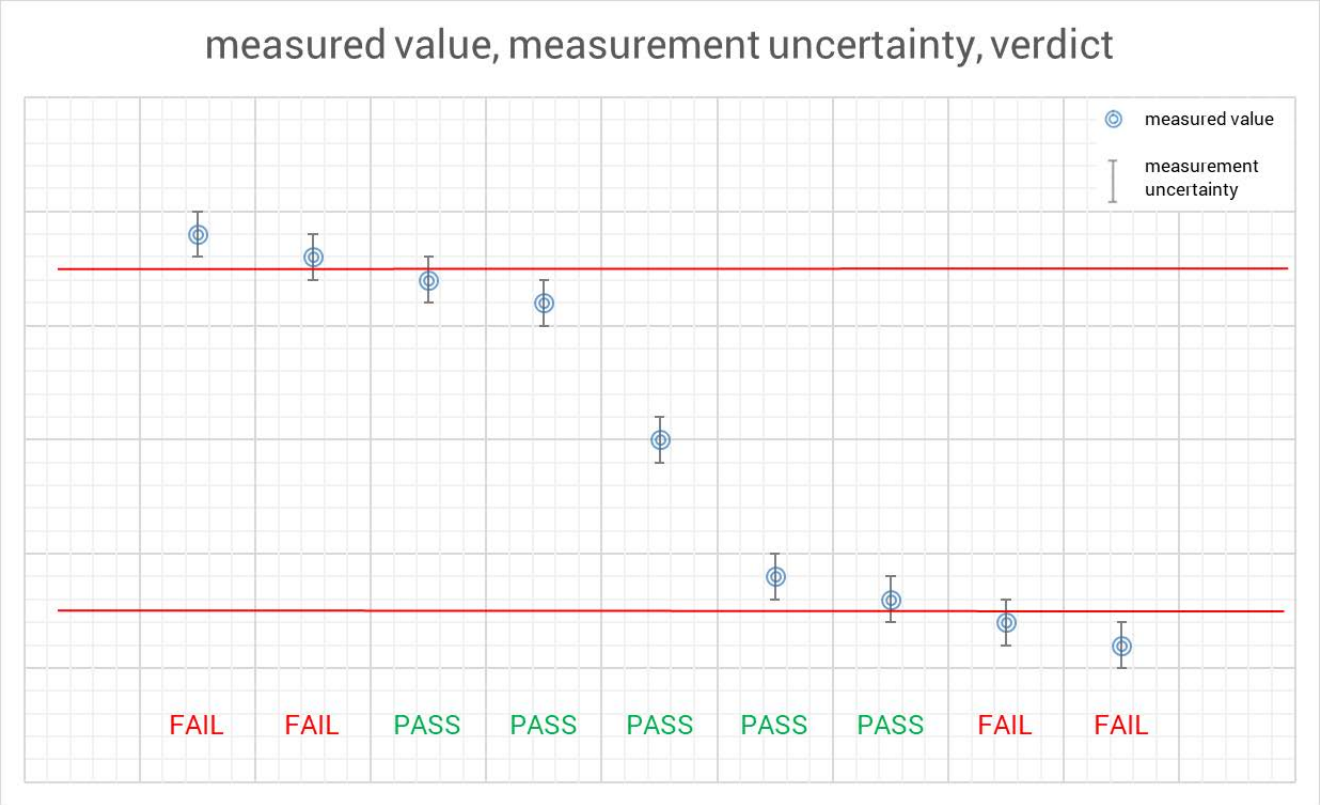
Accreditation	Description	
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf	ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-05

4 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	:		1010 hPa
Power supply	:	V_{nom} V_{max} V_{min}	12 V DC 32 V DC 9 V DC

5 Reporting statements of conformity – decision rule

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



6 Test item

6.1 General description

Kind of test item	:	122-123 GHz FMCW Radar
Model name:	:	R600V
HMN	:	n/a
PMN	:	R600V.DAE0-11188367 R600V.DAE0-11209335 R600V.DAE0-11228779 R600V.DAH5-11205779 R600V.DAH5-11221283 R600V.RAH5-11225384
HVIN	:	11188367 11209335 11228779 11205779 11221283 11225384
FVIN	:	R600VMOF_S R600VMSF_S R600VMSF_S R600VSOF_S R600VM8F_S R600VRTF_S
S/N serial number	:	M111.10.X-0543-2359 0009640 (RF-Chirp stopped, low frequency) 0010371 (RF-Chirp stopped, middle frequency) 0010019 (RF-Chirp stopped, high frequency)
Hardware status	:	RE00050D / RE.00061 / RE.00009 / PCBA_R714028_SOE-1
Software status	:	N/A
Firmware status	:	R600VSOF_S01-03-00
Frequency band	:	122 GHz – 123 GHz
Type of modulation	:	FMCW
Number of channels	:	1
Antenna	:	Integrated patch antenna
Power supply	:	9 V to 32 V DC by external power supply
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: 1-1054/20-01-01_AnnexA
1-1054/20-01-01_AnnexB
1-1054/20-01-01_AnnexD

7 Sequence of testing

7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

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

Premeasurement*

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

Final measurement

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

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

7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

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

Setup

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

Premeasurement

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

Final measurement

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

8 Description of the test setup

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

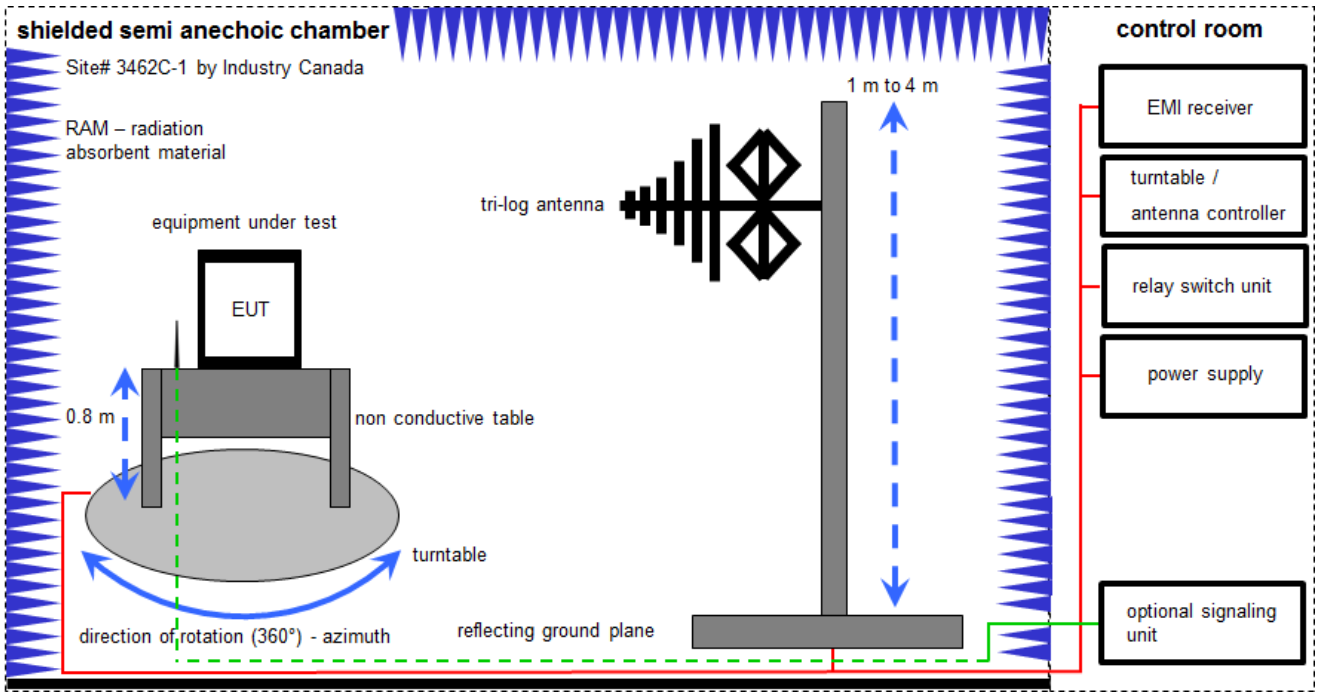
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

8.1 Shielded semi anechoic chamber

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

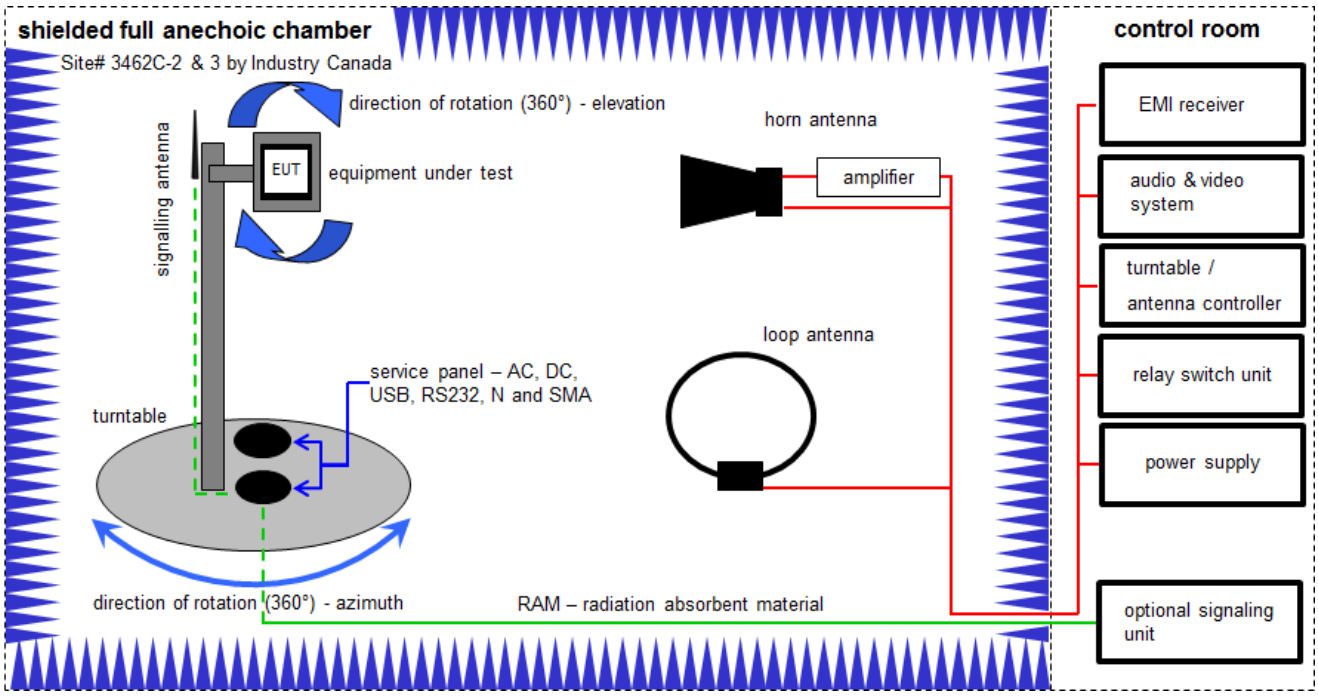


Measurement distance: tri-log antenna 10 meter

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	n. a.	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	10.12.2019 09.12.2020	08.12.2021
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	295	300003787	vlKl!	19.02.2019	18.02.2021
10	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
11	n. a.	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	10.12.2020	09.06.2022

8.2 Radiated measurements 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 [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] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

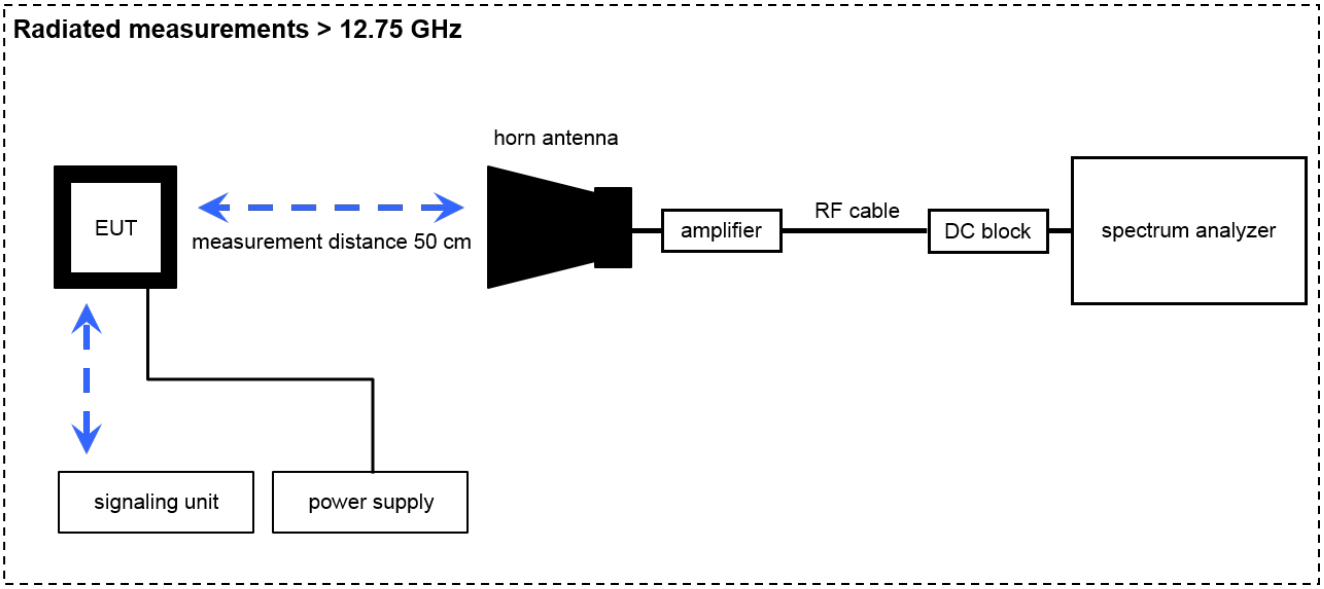
Equipment table (Chamber A):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vIKI!	27.02.2019	26.02.2021
3	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-
4	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22050	300004482	ev	-/-	-/-
5	n. a.	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
6	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
7	n. a.	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	09.12.2020	08.12.2021
8	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
9	n. a.	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
10	n. a.	NEXIO EMV-Software	BAT EMC V3.20.0.13	EMCO		300004682	ne	-/-	-/-
11	n. a.	Anechoic chamber		TDK		300003726	ne	-/-	-/-
12	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04590	300001041	vIKI!	09.12.2020	08.12.2023

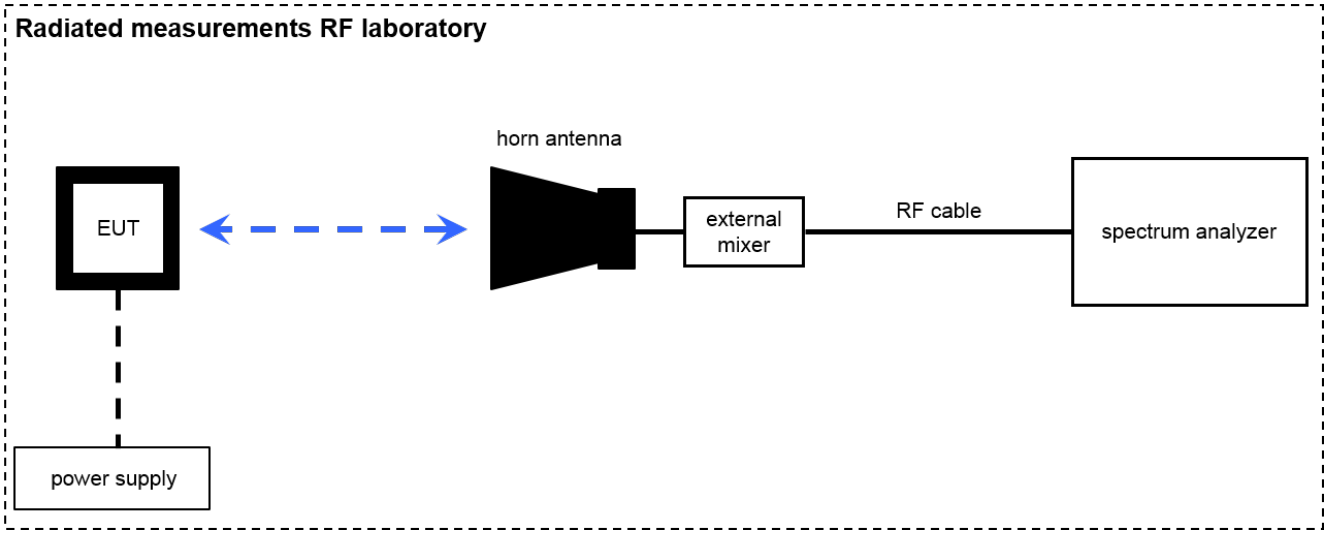
Equipment table (Chamber C):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	12.12.2017 09.12.2020	11.12.2020 08.12.2023
2	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
3	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.12.2019	26.02.2021
5	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
6	n. a.	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne	-/-	-/-
7	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2019 11.12.2020	10.12.2020 10.12.2021
8	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	n. a.	Broadband Amplifier 5-13 GHz	CBLU5135235	CERNEX	22010	300004491	ev	-/-	-/-
11	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
12	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
13	n. a.	PC	ExOne	F+W		300004703	ne	-/-	-/-
14	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-

8.3 Radiated measurements 18 GHz to 50 GHz in test lab

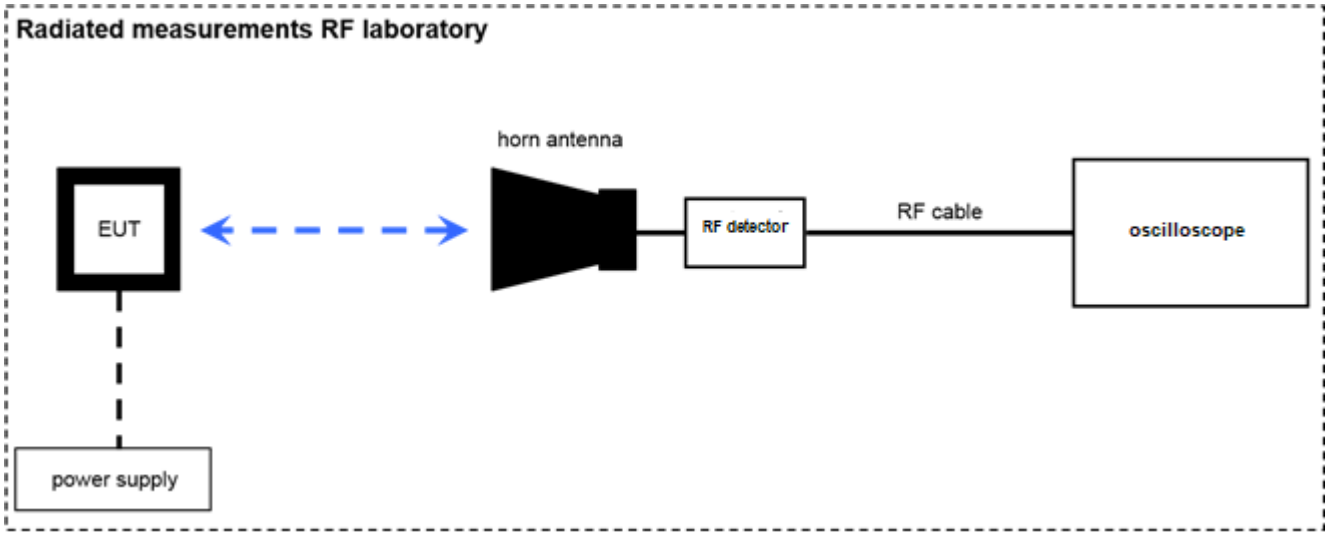


8.4 Radiated measurements > 50 GHz in test lab



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

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



Note: EUT is replaced by reference source for substitution measurement

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n.a.	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-021	300001747	vIKl!	18.02.2019	17.02.2022
2	n. a.	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	vIKl!	21.01.2020	20.01.2022
3	n. a.	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vIKl!	23.01.2020	22.01.2022
4	n.a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	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 60-90 GHz	COR 60_90	Thomson CSF		300000814	ev	-/-	-/-
7	n. a.	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-
8	n.a.	Std. Gain Horn Antenna 92.3-140 GHz	2824-20	Flann		300001993	ne	-/-	-/-
9	n. a.	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
10	n. a.	Std. Gain Horn Antenna 145-220 GHz	3024-20	Flann	*	300002000	ne	-/-	-/-
11	n. a.	Std. Gain Horn Antenna 217-330 GHz	32240-20	Flann	233278	300004960	ne	-/-	-/-
12	n. a.	Standard Gain Horn 325-500 GHz	570240-20 1785-2a	Flann	273569	300006097	ev	25.05.2020	24.05.2022
13	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	09.03.2020	08.03.2022
14	n. a.	Harmonic Mixer 3-Port, 50-75 GHz	FS-Z75	Rohde & Schwarz	101578	300005788	k	17.06.2020	16.06.2021
15	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	08.07.2020	07.07.2021
16	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	19.06.2020	18.06.2021
17	n.a.	Harmonic Mixer 3-port, 90-140 GHz	FS-Z140	Rohde & Schwarz	101119	300005581	k	09.07.2020	08.07.2021
18	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	FS-Z170	Radiometer Physics GmbH	100014	300004156	k	28.05.2020	27.05.2021
19	n. a.	Harmonic Mixer 3-Port, 140-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	14.07.2020	13.07.2021
20	n. a.	Harmonic Mixer 3-Port, 220-325 GHz	SAM-325	Radiometer Physics GmbH	100002	300004158	k	23.07.2020	22.07.2021
21	n.a.	Harmonic Mixer 325-500GHz	FS-Z500	Radiometer Physics GmbH	101016	300006096	k	25.05.2020	24.05.2021
22	n. a.	Spectrum Analyzer 2 Hz - 85 GHz	FSW85	R&S	101333	300005568	k	17.06.2020	16.06.2021
23	n. a.	Spectrum Analyzer	FSW50	Rohde & Schwarz	101332	300005935	k	26.02.2020	25.02.2021
24	n.a.	Std. Gain Horn Antenna 90-140 GHz	COR 90_140	Thomson CSF		300000799	ev	-/-	-/-
25	n.a.	F-Band Positive Amplitude Detector	SFD-903144-08SF-P1	Sage Millimeter Inc.	07354-1	300006119	ev	-/-	-/-
26	n.a.	SG Extension Module 110 - 170 GHz	E8257DV06	VDI	US53250018	300005540	ev	-/-	-/-
27	n.a.	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
28	n.a.	Synthesized Sweeper 10 MHz - 40 GHz	83640A	HP	3119A00458	300002266	vIKl!	13.12.2019	12.12.2021
29	n.a.	2.5 GHz Digital Phosphor Oscilloscope	DPO7254	Tektronix	B022702	300003573	vIKl!	07.12.2020	06.12.2022

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 Far field consideration for measurements above 18 GHz

Far field distance calculation:

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

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

Spurious emission measurements:

Antenna frequency range in GHz	Highest measured frequency in GHz	D in cm	λ in cm	D_{ff} in cm
18-26	26	3.4	1.15	20.04
26-40	40	2.2	0.75	12.91
40-50	50	2.77	0.60	25.58
50-75	75	1.85	0.40	17.11
75-110	110	1.24	0.27	11.28
90-140	140	1.02	0.22	9.72
110-170	170	0.85	0.18	8.19
140-220	220	0.68	0.14	6.78
220-325	325	0.43	0.09	4.01
325-500	500	0.26	0.06	2.22

In band measurement (OBW):

Antenna frequency range in GHz	Highest measured frequency in GHz	Antenna dimension in cm	Wavelength in cm	far field distance in cm
90 - 140	123.5	1	0.24	8.24

11 Measurement results

11.1 Summary

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

TC identifier	Description	verdict	date	Remark
RF-Testing	FCC 47 CFR Part 15 IC RSS-210 Issue 10 IC RSS-Gen Issue 5	see below	2021-02-11	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Results (max.)
§15.258 (d) RSS-Gen Issue 5 RSS-210 Issue 10	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258(b) (1) / (3) RSS-Gen Issue 5 RSS-210 Issue 10	Maximum E.I.R.P.	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258(c) RSS-Gen Issue 5 RSS-210 Issue 10	Spurious Emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258(d) RSS-Gen Issue 5 RSS-210 Issue 10	Frequency stability	Extreme Nominal	Extreme Nominal	☒	☐	☐	☐	complies
RSS-Gen Issue 5 RSS-210 Issue 10	Duty cycle	Nominal	Nominal	☒	☐	☐	☐	complies

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

According to the document “DRS Authorization Letter - Baumer (2020).pdf”, ISED is allowing a special authorization for the R600V radar family according to RSS-Gen Issue 5 and RSS-210 Issue 10 requirements.

12 Measurement results

12.1 Occupied bandwidth (6 dB Bandwidth)

Description:

Measurement of the bandwidth of the wanted signal.

Measurement:

Measurement parameter	
Detector:	Pos-Peak
Sweep time:	10 s
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Trace-Mode:	Max Hold

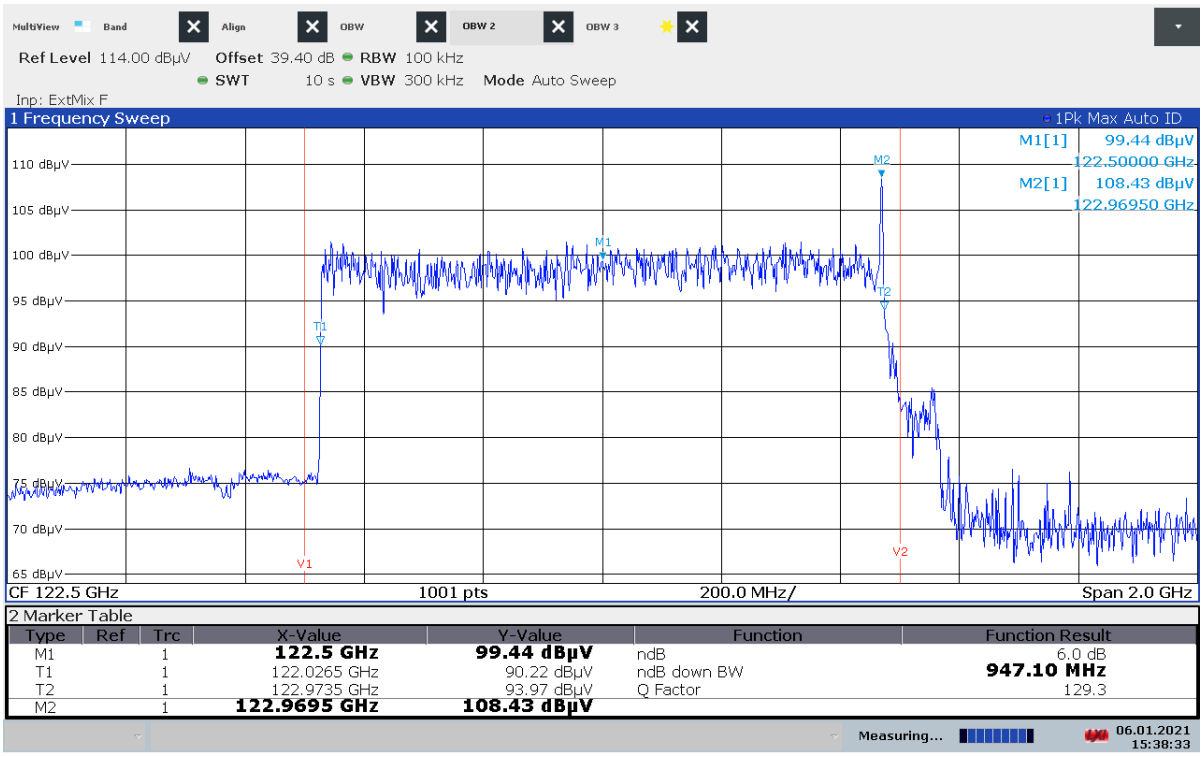
Limits:

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

Measurement results:

Test condition	F_L in GHz	F_H in GHz	Occupied bandwidth in MHz
T_{nom} / V_{nom}	122.0256	122.9735	947.1
Measurement uncertainty	± span/1000		

Plot 1: 6 dB OBW, operating frequency band



12.2 Maximum E.I.R.P.

Description:

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

Measurement:

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

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

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

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

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

Measurement results:

Test condition	Max E.I.R.P. 10 MHz VBW	Average E.I.R.P. 10 MHz VBW
T_{nom} / V_{nom}	17.1 dBm	13.0 dBm
Measurement uncertainty	± 3 dB	

Test condition	Duty cycle
T_{nom} / V_{nom}	39.2 %

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

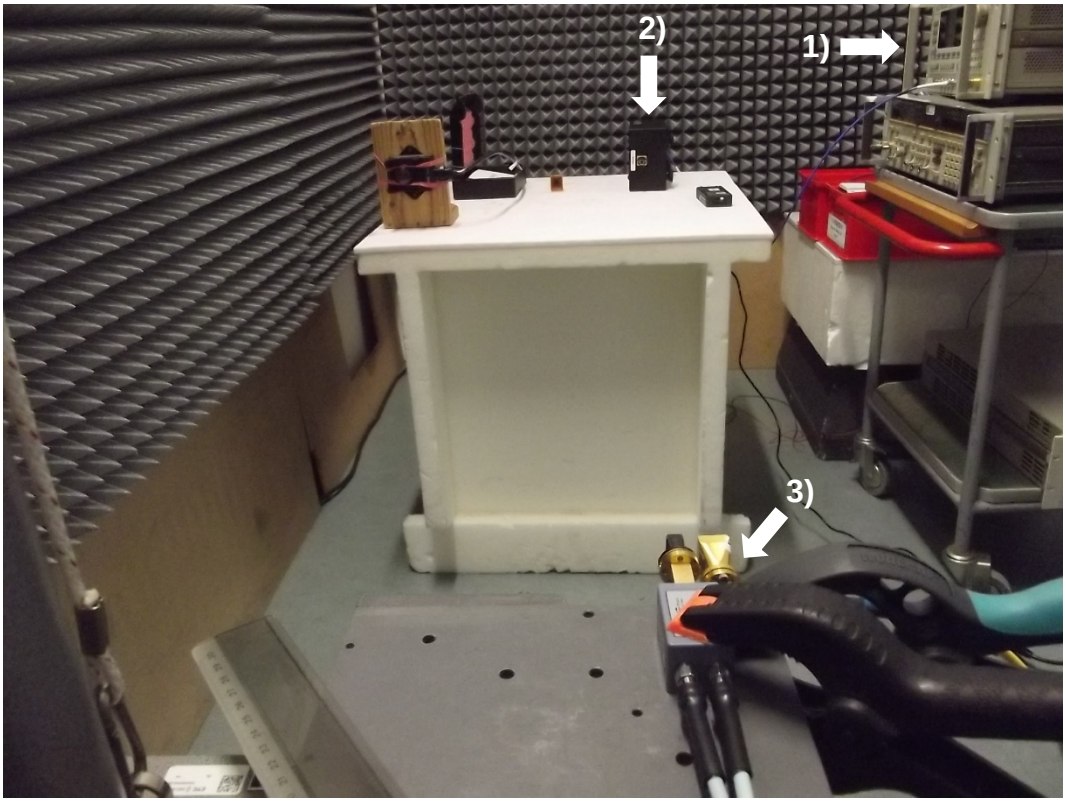
1) EUT emission measured with RF-detector:
   - Measurement distance: d = 0.26 m
   - Maximum readout value on oscilloscope: V = 2.57 mV

2) Substitution of EUT by a cw reference source with a frequency of f = 122.5 GHz and a fixed output power of P_{ref} = 28.4 dBm
   - Readout value on oscilloscope adjusted by far field attenuation

3) Calculation of the Max E.I.R.P. of the EUT:
   - Free space loss: FSL(d) = 20 × log(4×π×d×f/c), c: speed of light
   - Max E.I.R.P. = P_{ref} – FSL(0.95 m) + FSL (0.26 m) = 17.1 dBm

4) Calculation of the Average E.I.R.P. of the EUT:
   - Measured duty cycle of the EUT: 39.2 %
   - Average E.I.R.P. = Max E.I.R.P. + 10 × log(0.392) = 13.0 dBm

Setup of the substitution:

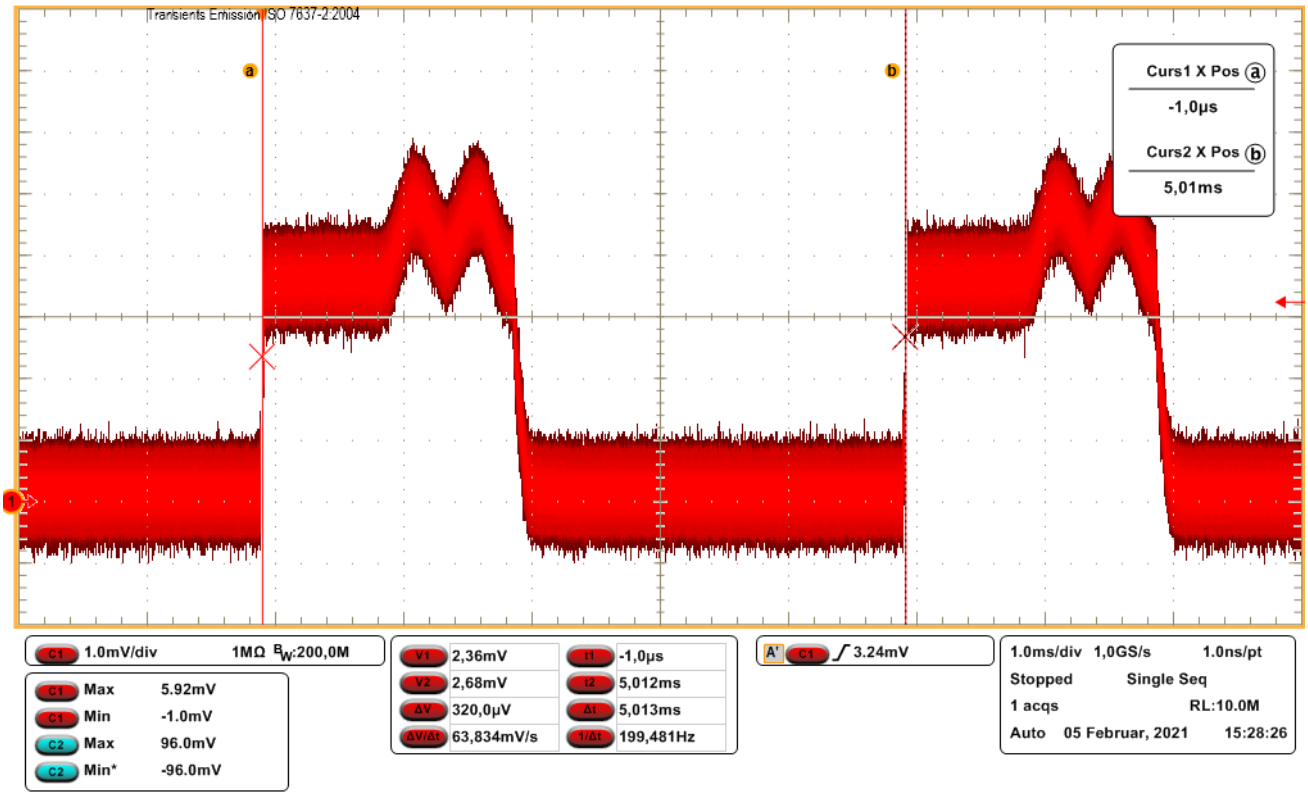


1) Synthesized Sweeper 10 MHz - 40 GHz

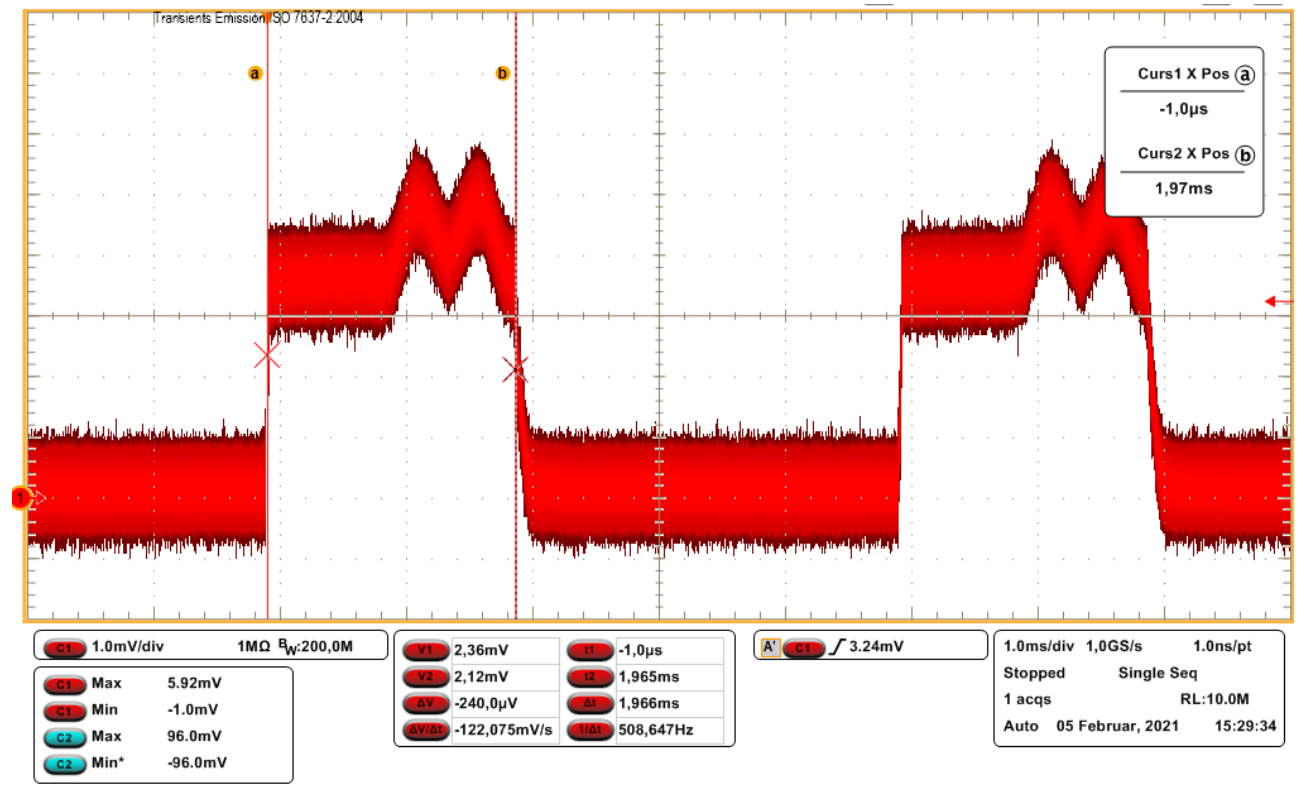
2) SG Extension Module 110 - 170 GHz & Std. Gain Horn Antenna 114-173 GHz

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

Plot 2: Duty cycle



Plot 3: Duty cycle



12.3 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions.

Measurement:

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

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

(c) Spurious emissions shall be limited as follows:

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

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

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

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

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

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

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

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

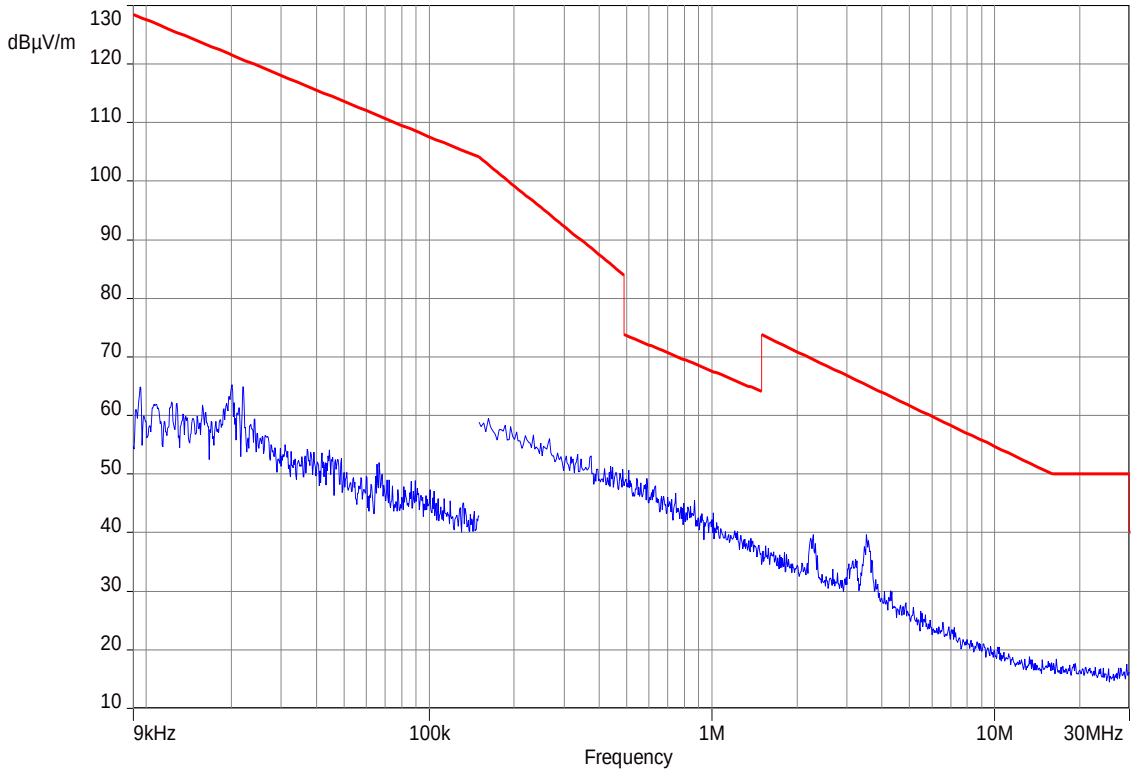
According to this formula, an emission limit of PD = 90 pW/cm² at a distance of 3 meters corresponds to EIRP = -10 dBm.

Measurement results:

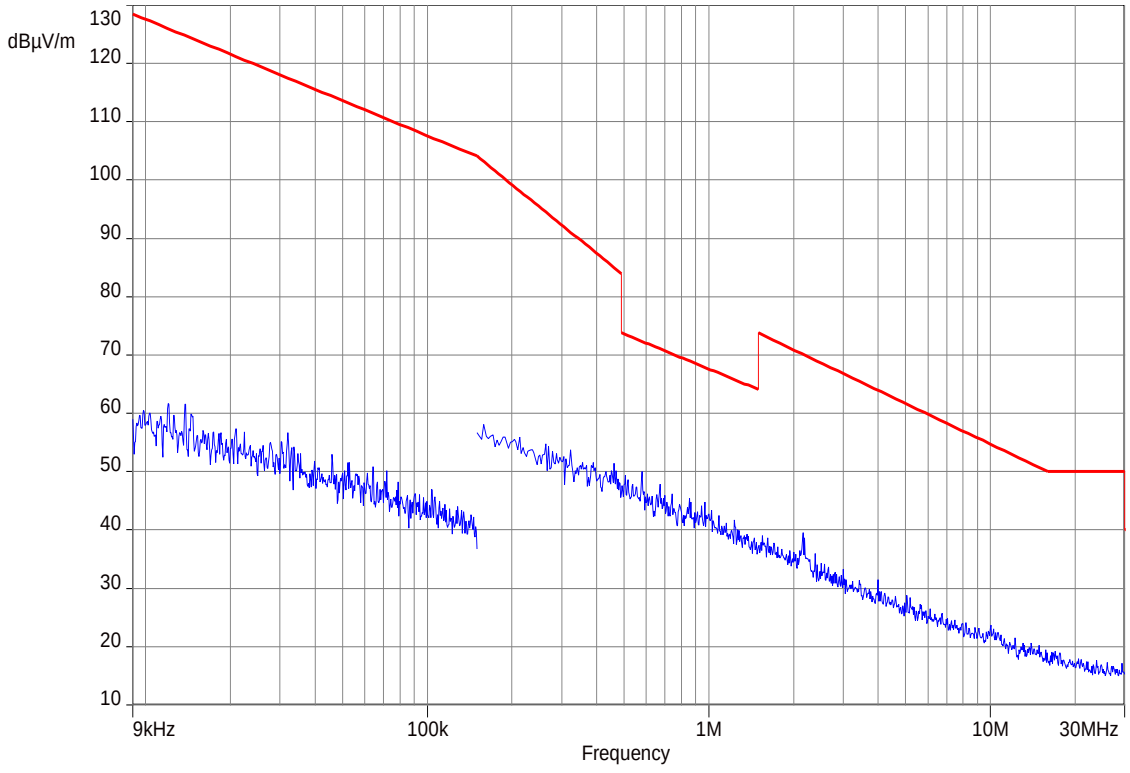
Note:
Measurements were performed in normal operation mode (frequency sweep) and in stopped mode (frequency sweep stopped at three positions within the range of operation: near top, near middle, near bottom) in accordance with §15.31(c), (m).

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

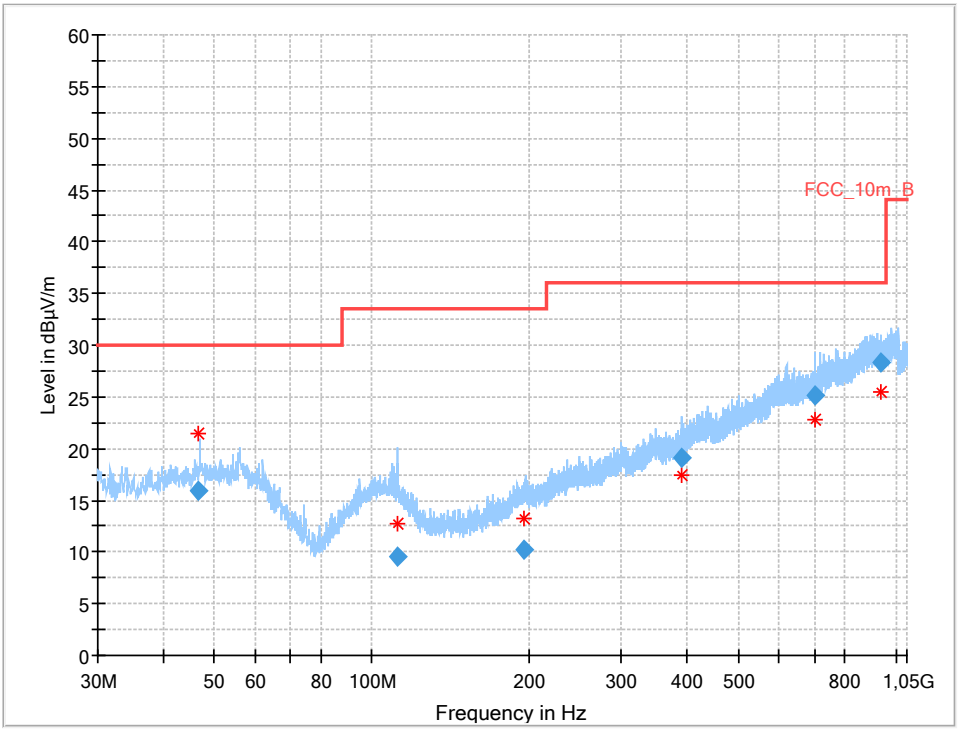
Plot 4: 9 kHz – 30 MHz, normal mode



Plot 5: 9 kHz – 30 MHz, stopped mode (sweep stopped in the middle of the range of operation)



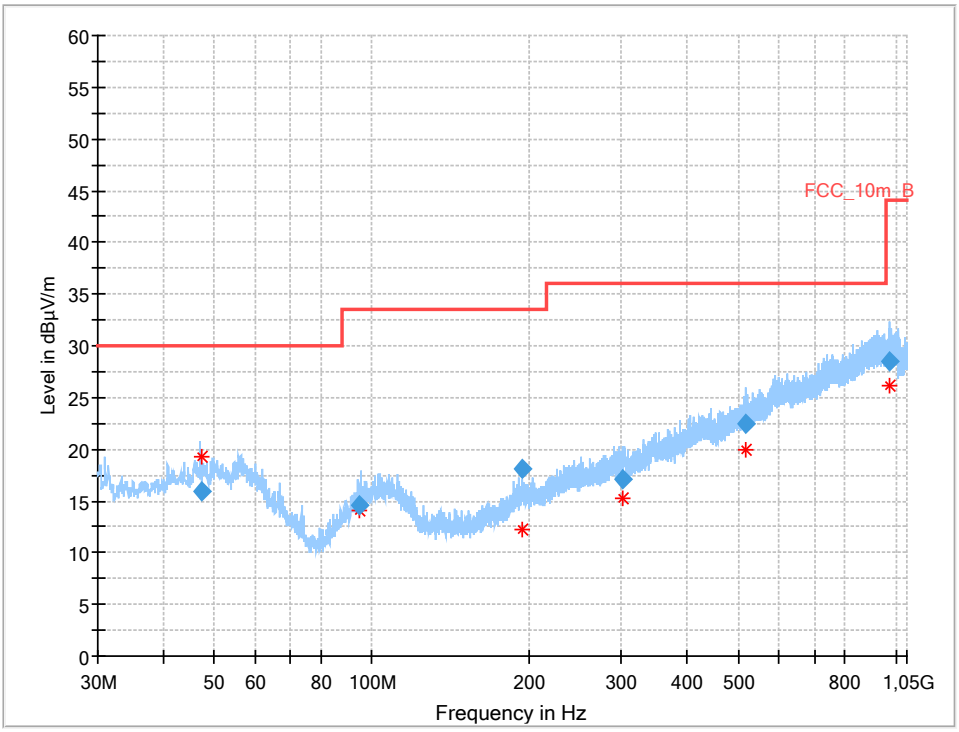
Plot 6: 30 MHz – 1 GHz, normal mode



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
46.831	15.91	30.0	14.1	1000	120.0	98.0	V	77	14
111.691	9.55	33.5	24.0	1000	120.0	160.0	H	279	12
195.743	10.19	33.5	23.3	1000	120.0	110.0	V	157	12
389.114	19.15	36.0	16.9	1000	120.0	170.0	H	-22	16
703.558	25.22	36.0	10.8	1000	120.0	170.0	H	247	21
936.988	28.39	36.0	7.6	1000	120.0	170.0	H	157	24

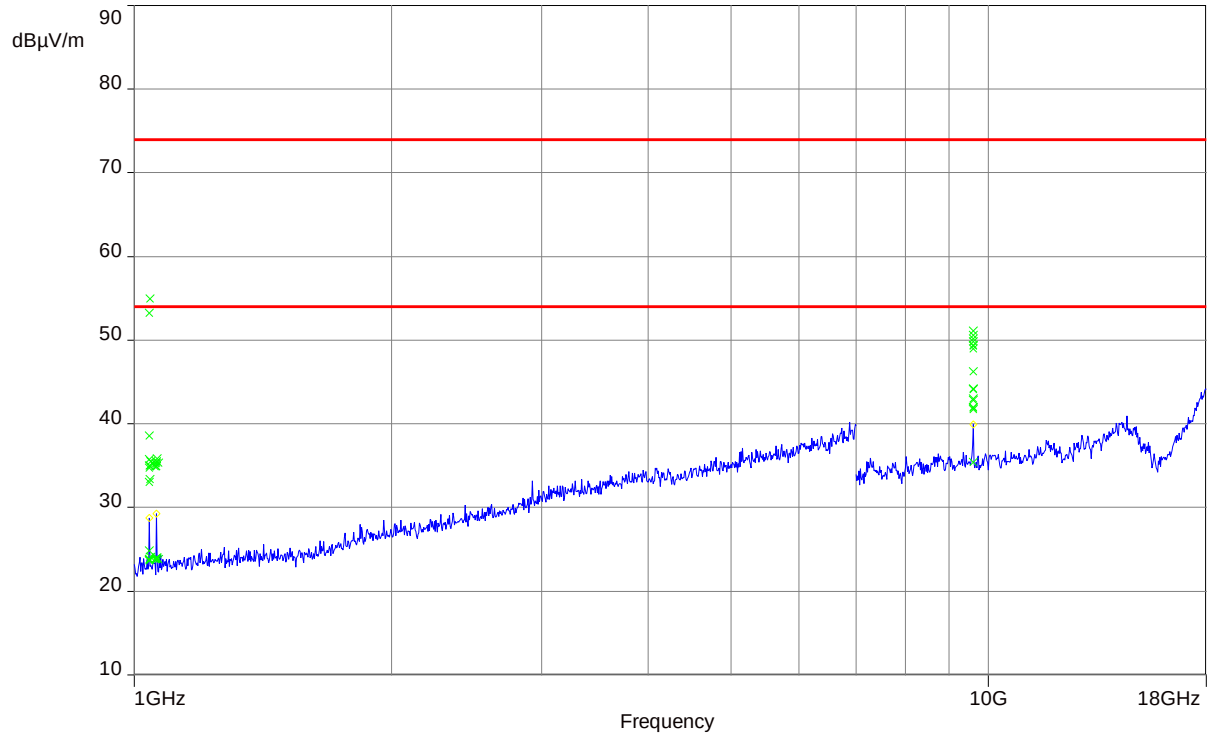
Plot 7: 30 MHz – 1 GHz, stopped mode (sweep stopped in the middle of the range of operation)



Final_Result

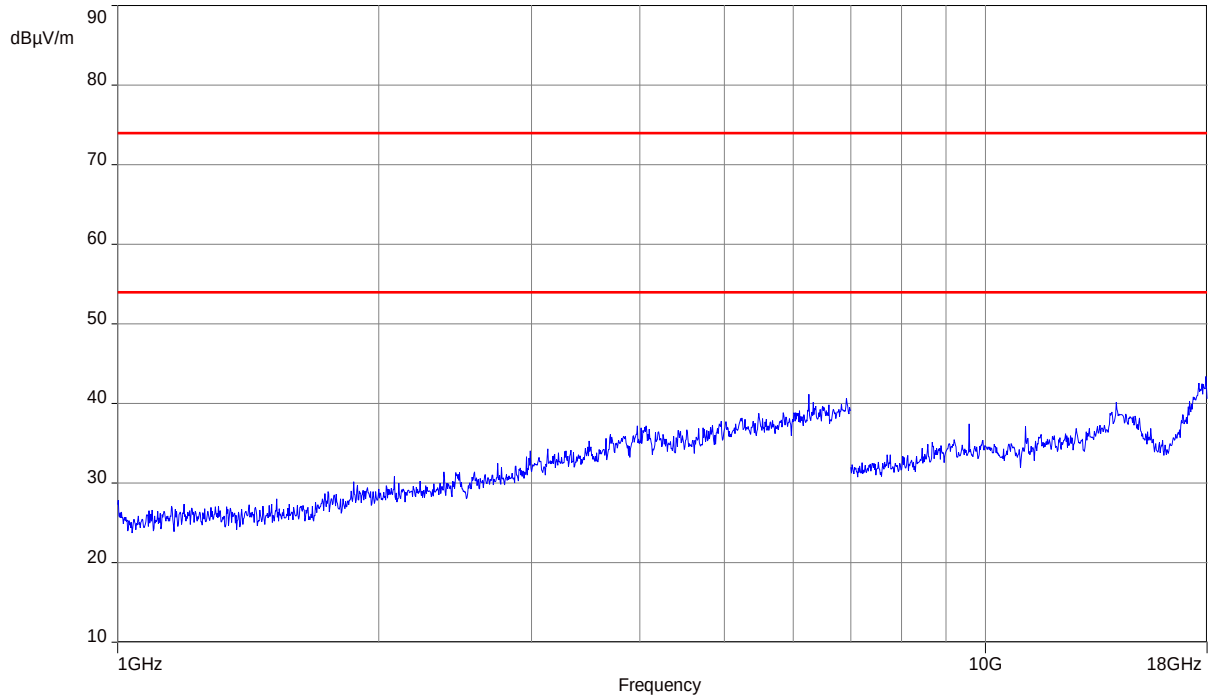
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
47.529	15.91	30.0	14.1	1000	120.0	170.0	V	282	14
94.997	14.65	33.5	18.9	1000	120.0	142.0	V	112	12
193.652	18.06	33.5	15.4	1000	120.0	121.0	V	112	12
301.403	17.06	36.0	18.9	1000	120.0	131.0	H	202	14
515.771	22.49	36.0	13.5	1000	120.0	170.0	H	157	19
970.380	28.50	44.0	15.5	1000	120.0	159.0	V	93	24

Plot 8: 1 GHz – 18 GHz, normal mode

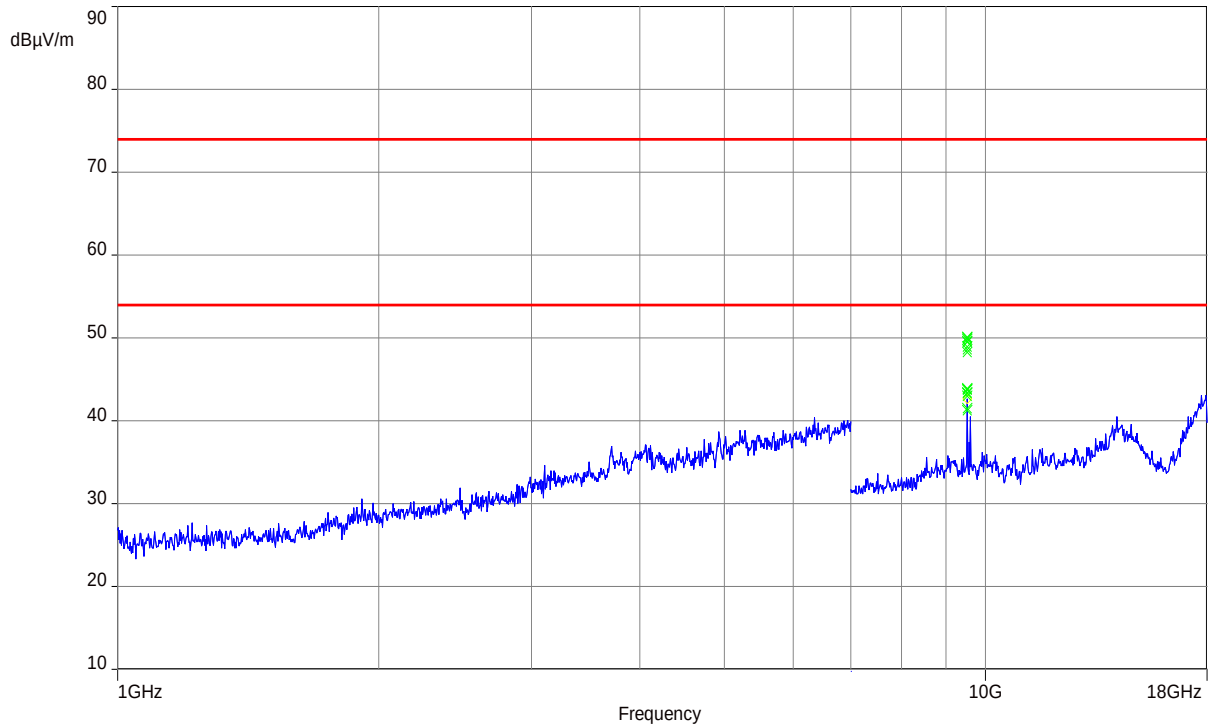


Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Average (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
1042.361	54.95	74	19.05	33.39	54	20.61
1064.420	35.84	74	38.16	23.96	54	30.04
9607.000	51.13	74	22.87	44.24	54	9.76

Plot 9: 1 GHz – 18 GHz, stopped mode (sweep stopped in the middle of the range of operation)

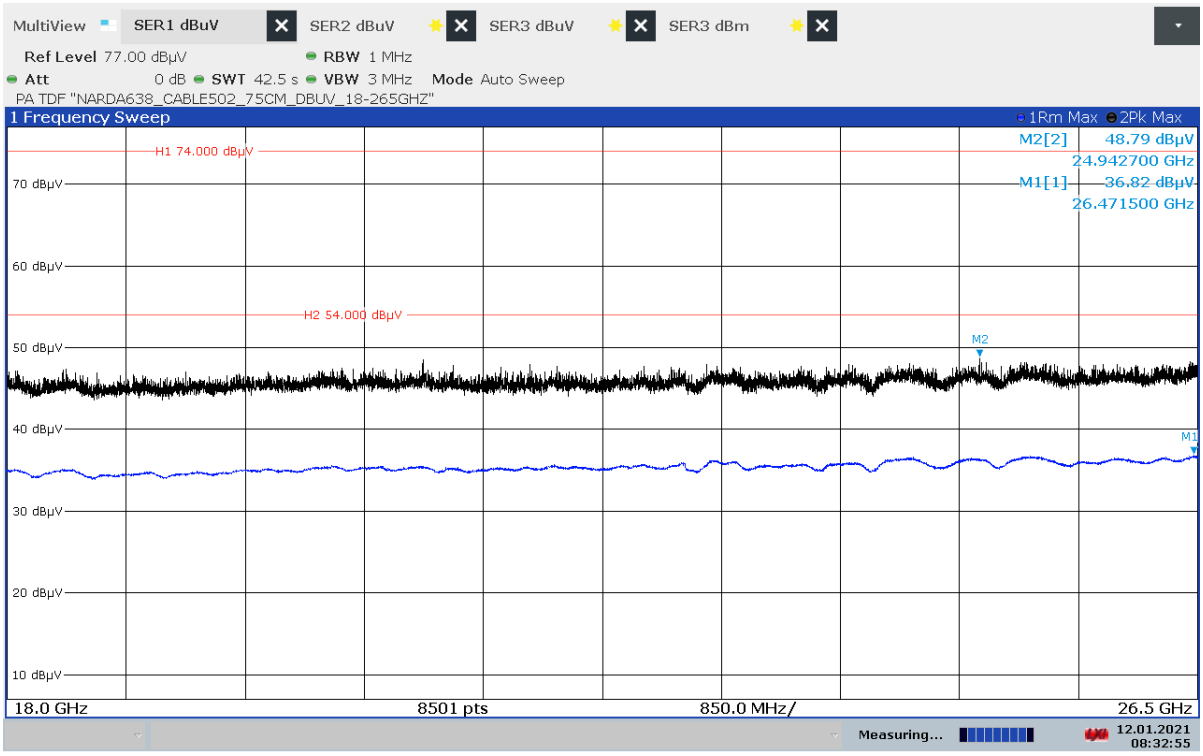


Plot 10: 1 GHz – 18 GHz, stopped mode (sweep stopped near the bottom and near the top of the range of operation)



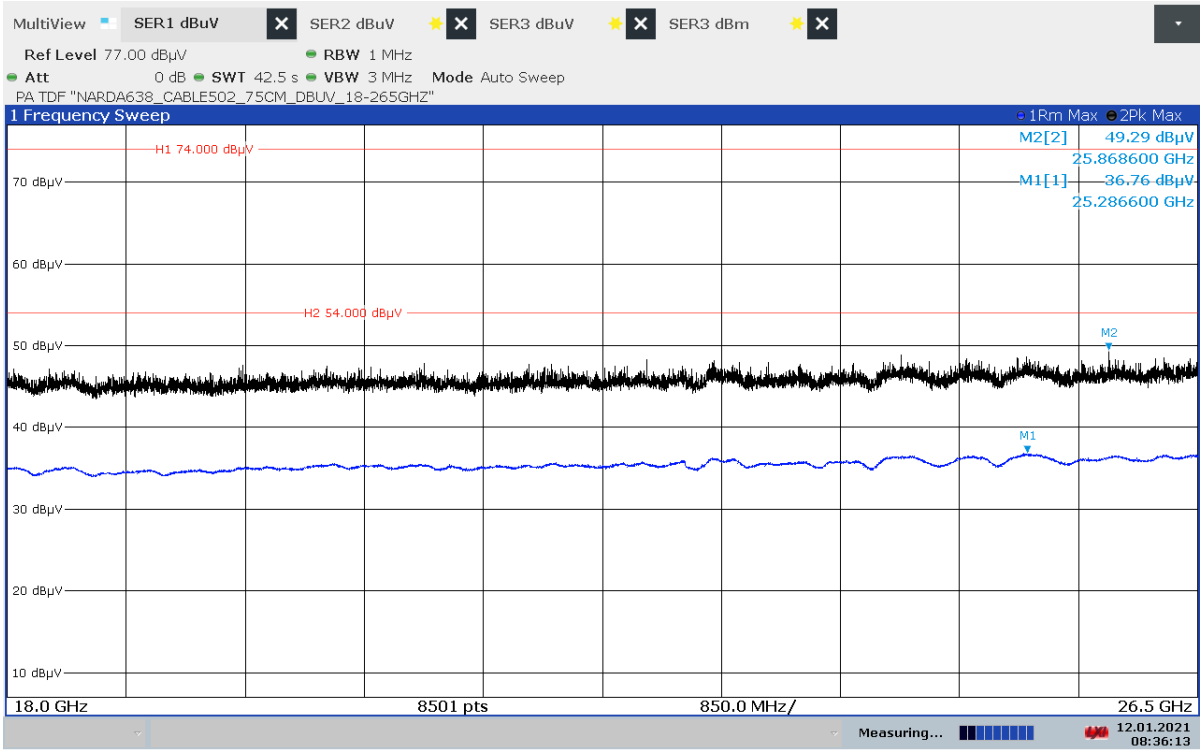
Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Average (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
9533.300	50.00	74	24.00	43.93	54	10.07
9533.472	50.07	74	23.93	43.73	54	10.27

Plot 11: 18 GHz – 26.5 GHz, normal mode



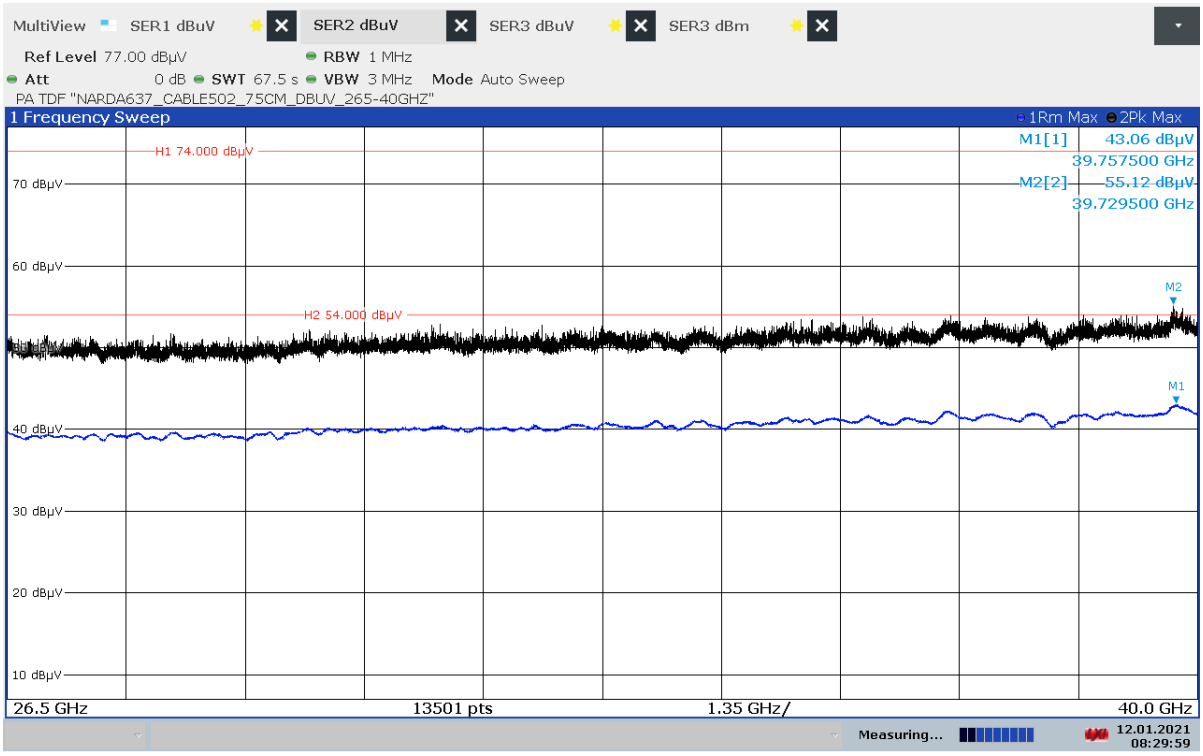
08:32:56 12.01.2021

Plot 12: 18 GHz – 26.5 GHz, stopped mode (sweep stopped in the middle of the range of operation)



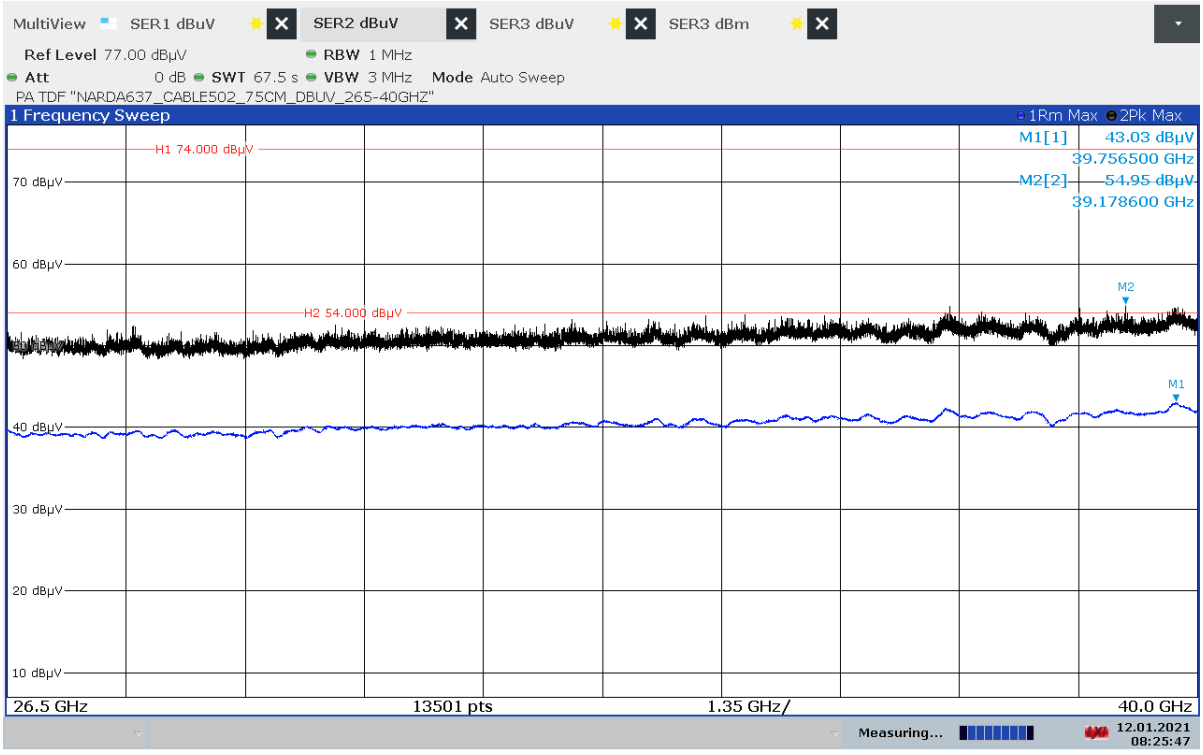
08:36:14 12.01.2021

Plot 13: 26.5 GHz – 40 GHz, normal mode



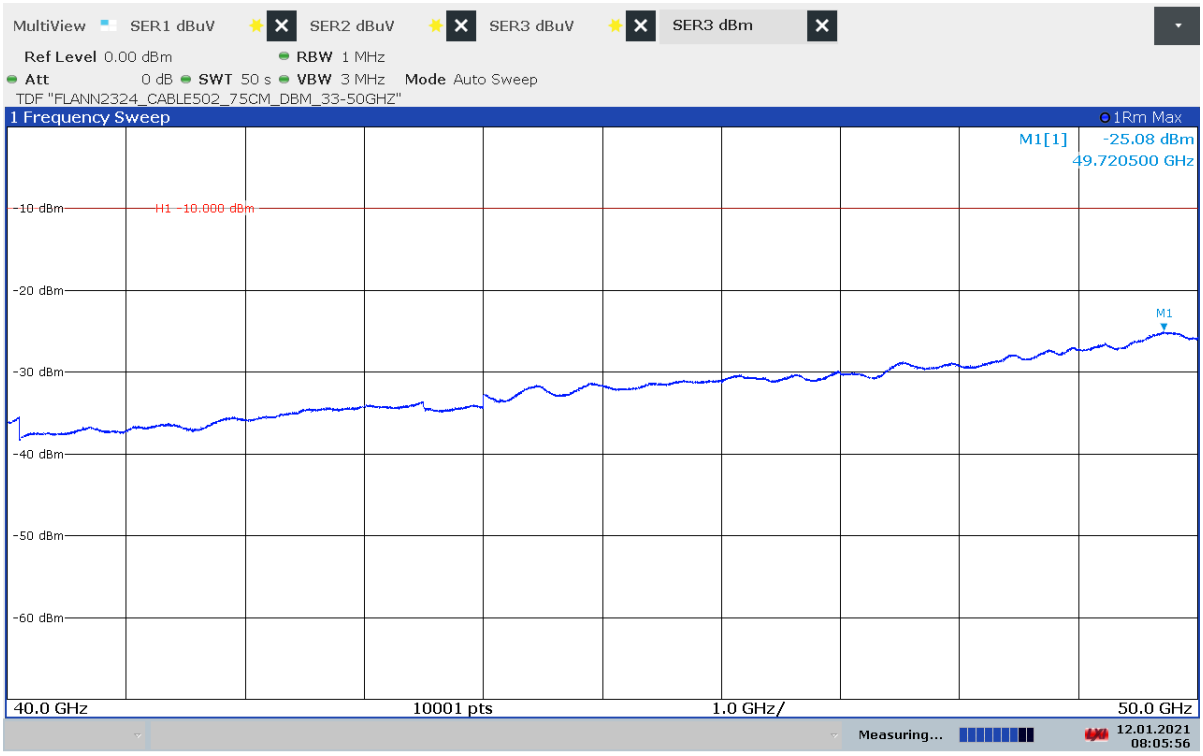
08:30:00 12.01.2021

Plot 14: 26.5 GHz – 40 GHz, stopped mode (sweep stopped in the middle of the range of operation)



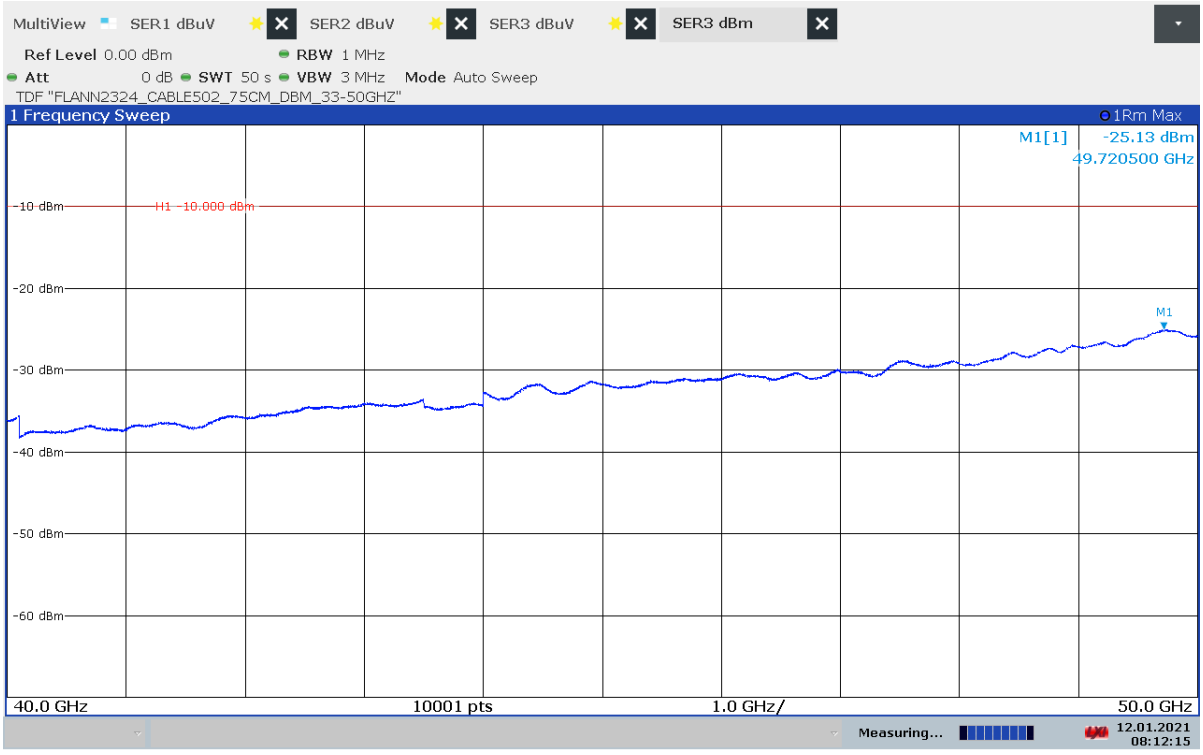
08:25:48 12.01.2021

Plot 15: 40 GHz – 50 GHz, normal mode



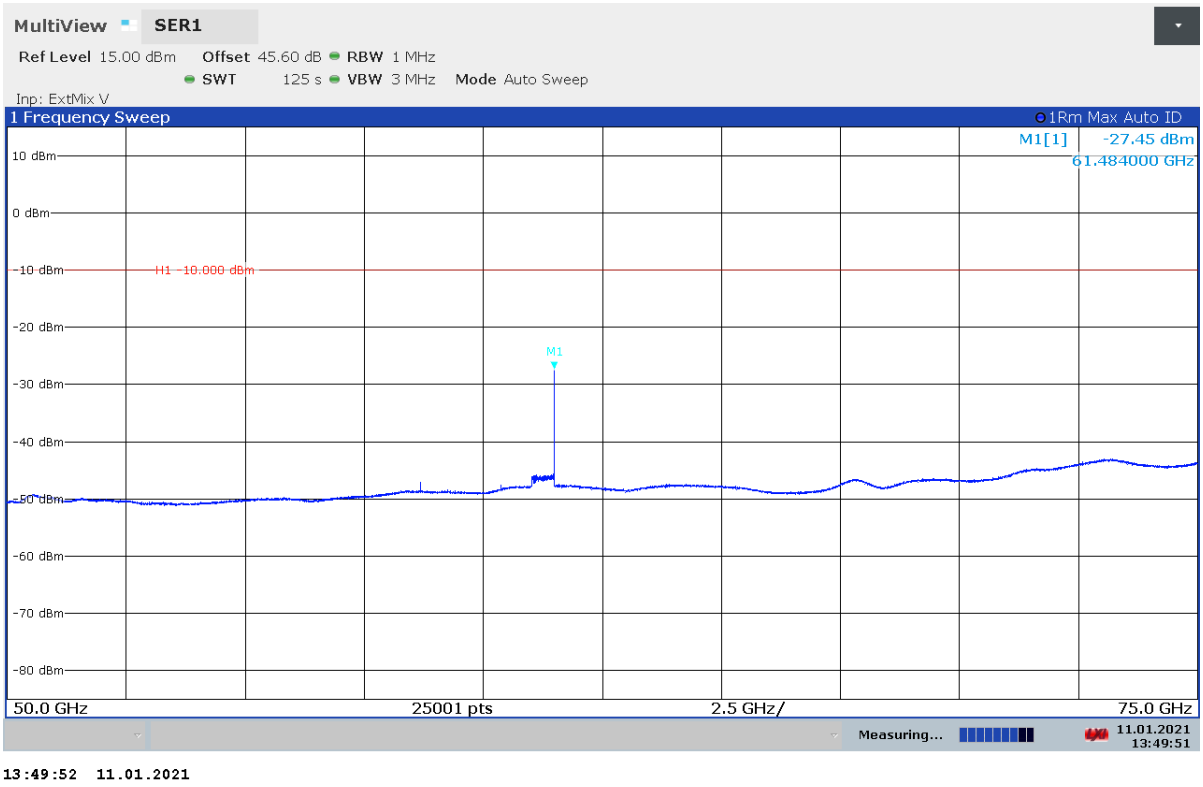
08:05:56 12.01.2021

Plot 16: 40 GHz – 50 GHz, stopped mode (sweep stopped in the middle of the range of operation)

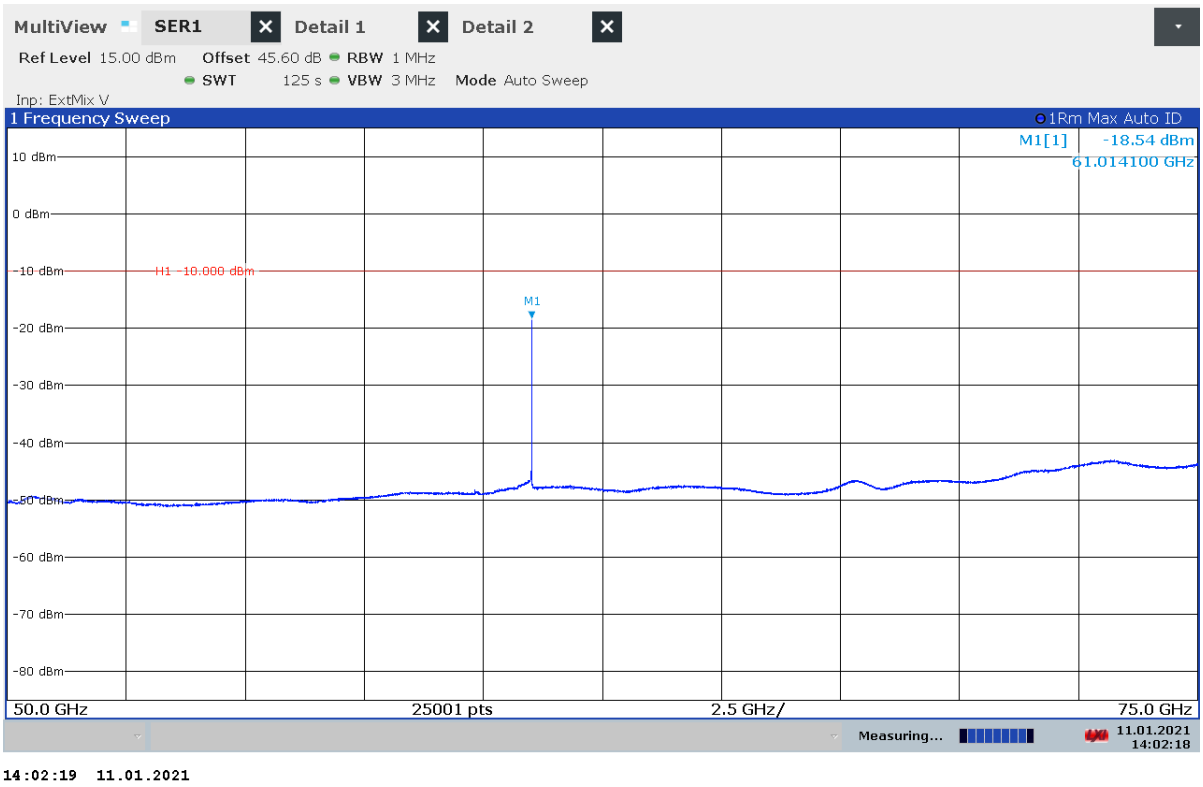


08:12:15 12.01.2021

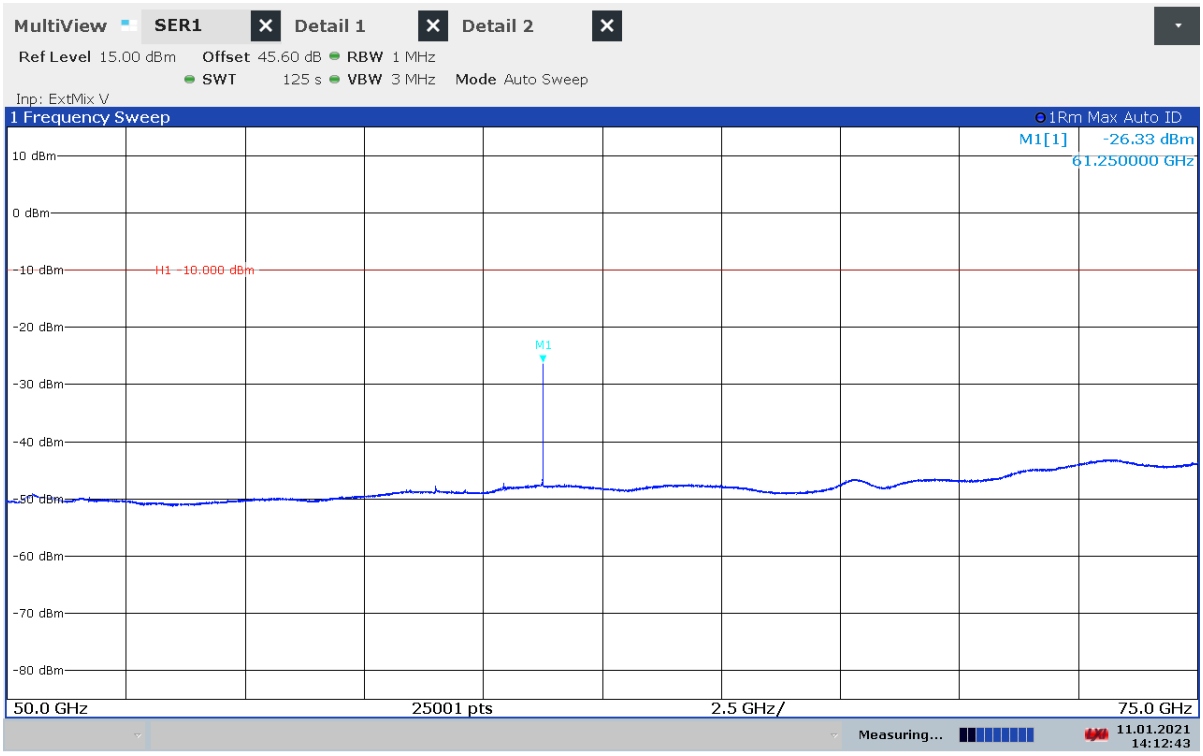
Plot 17: 50 GHz – 75 GHz, normal mode



Plot 18: 50 GHz – 75 GHz, stopped mode (sweep stopped near the bottom of the range of operation)

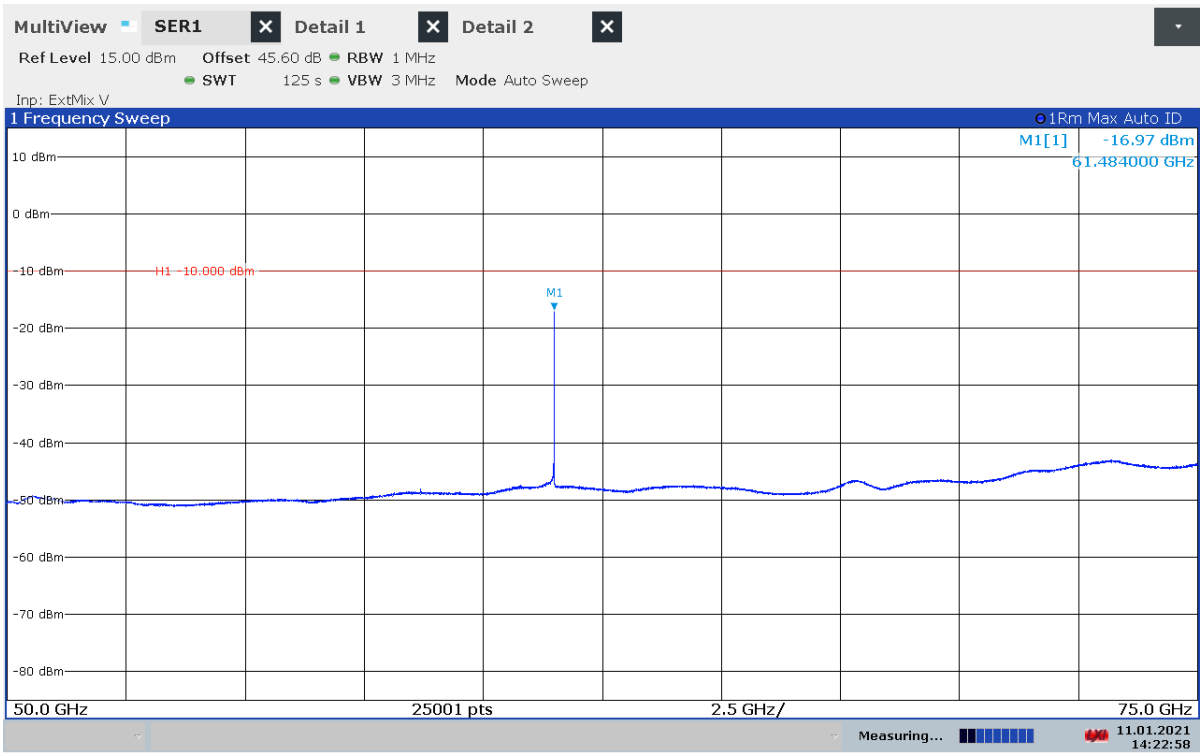


Plot 19: 50 GHz – 75 GHz, stopped mode (sweep stopped in the middle of the range of operation)



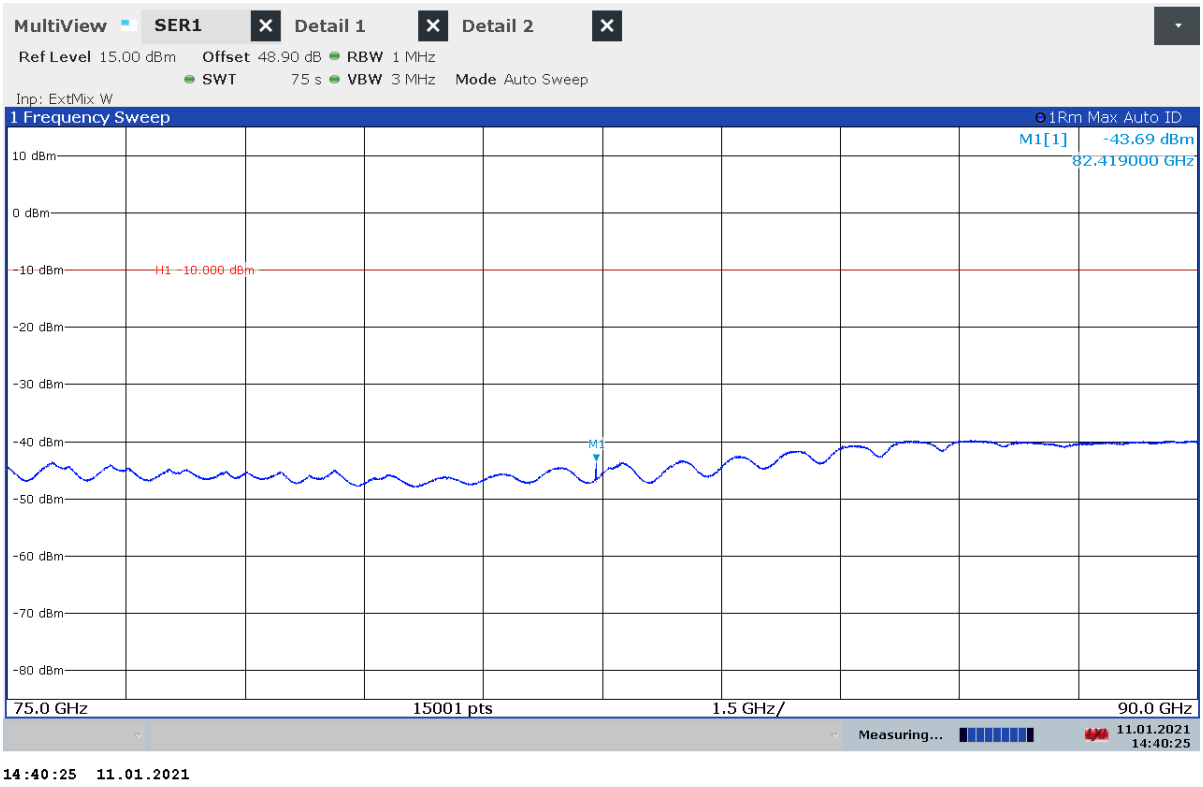
14:12:43 11.01.2021

Plot 20: 50 GHz – 75 GHz, stopped mode (sweep stopped near the top of the range of operation)



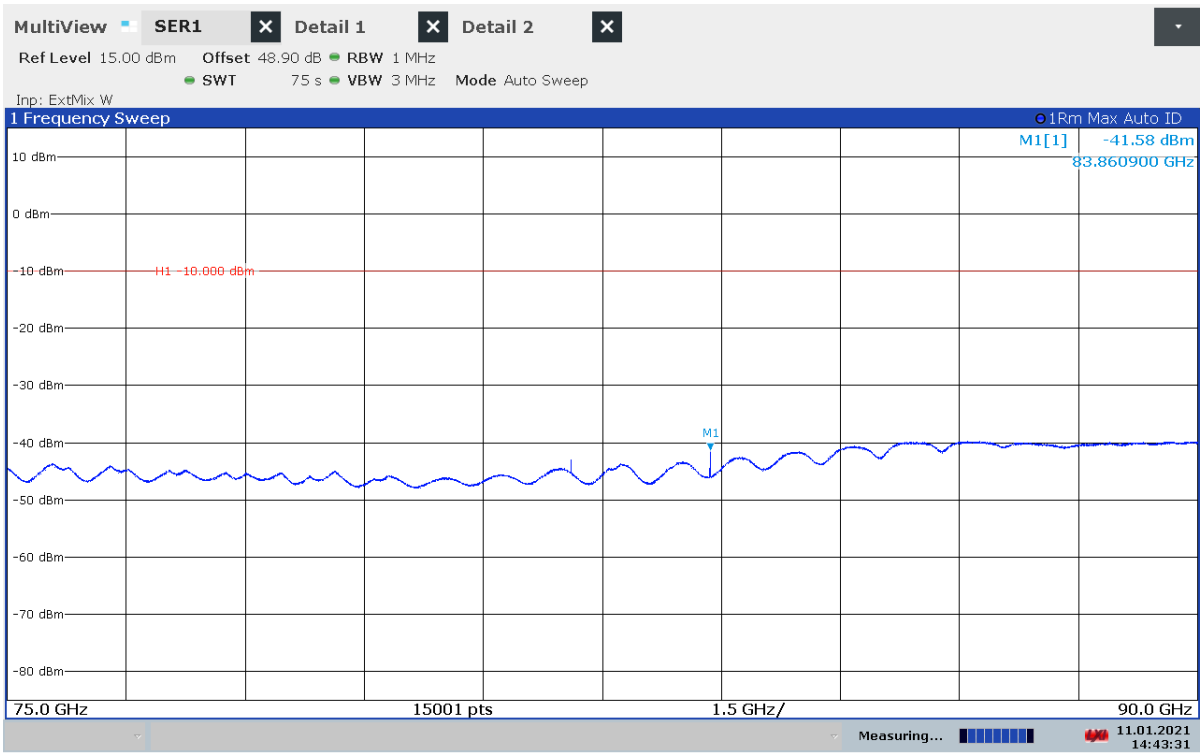
14:22:59 11.01.2021

Plot 21: 75 GHz – 90 GHz, normal mode



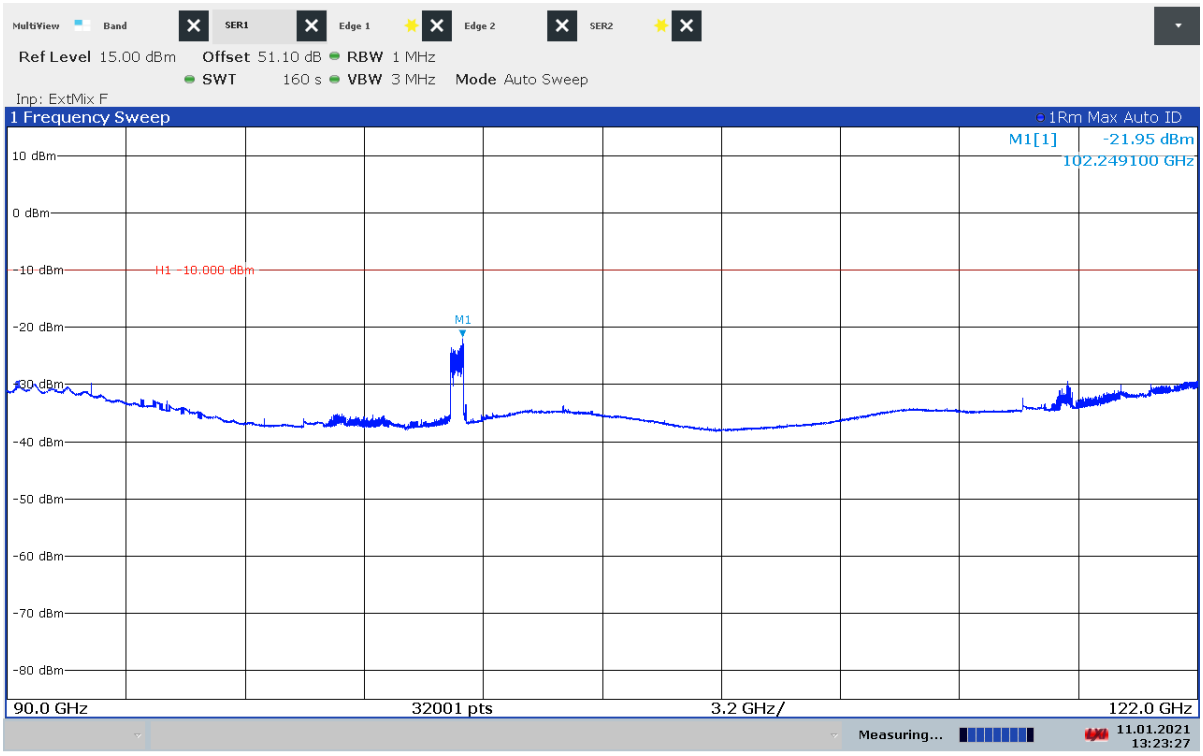
14:40:25 11.01.2021

Plot 22: 75 GHz – 90 GHz, stopped mode (sweep stopped in the middle of the range of operation)



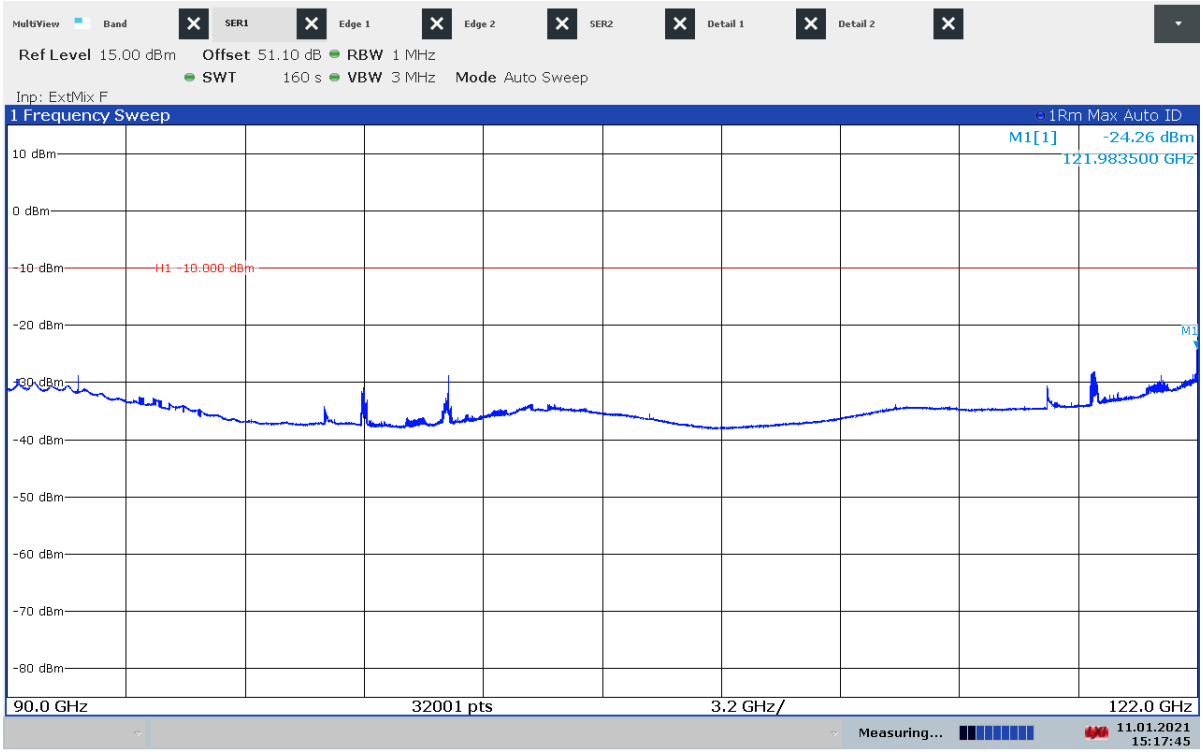
14:43:31 11.01.2021

Plot 23: 90 GHz – 122 GHz, normal mode



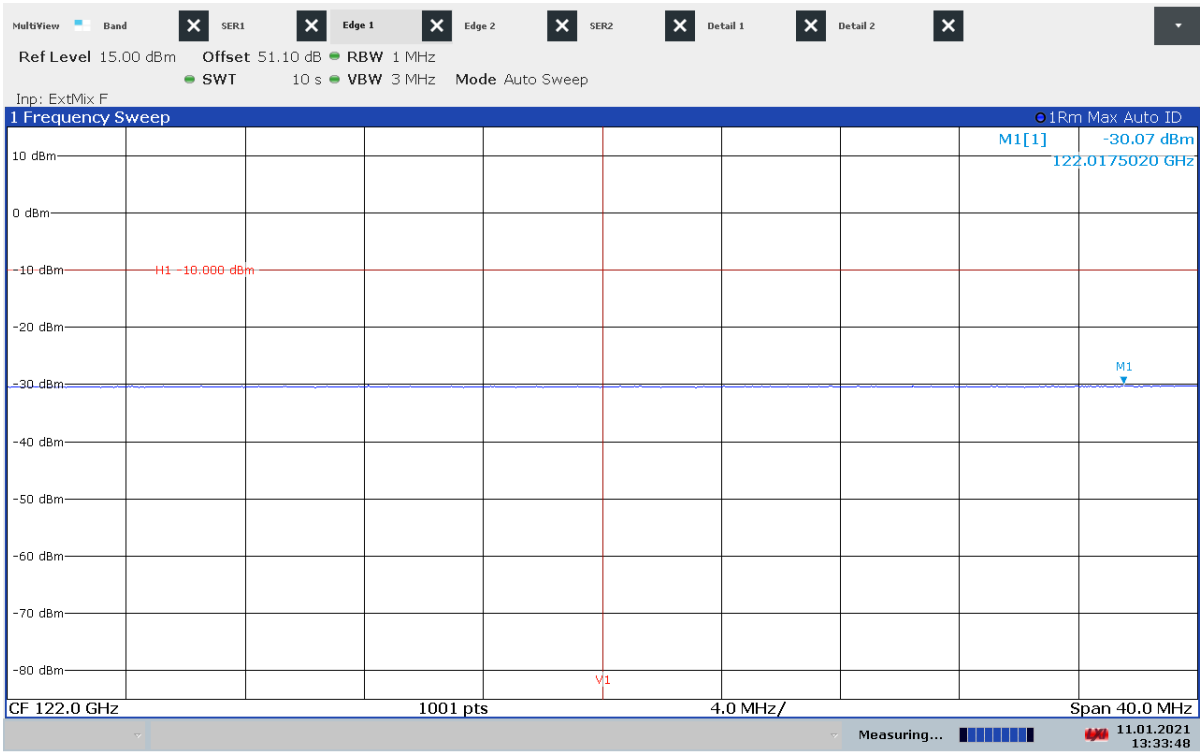
13:23:28 11.01.2021

Plot 24: 90 GHz – 122 GHz, stopped mode (sweep stopped in the middle of the range of operation)



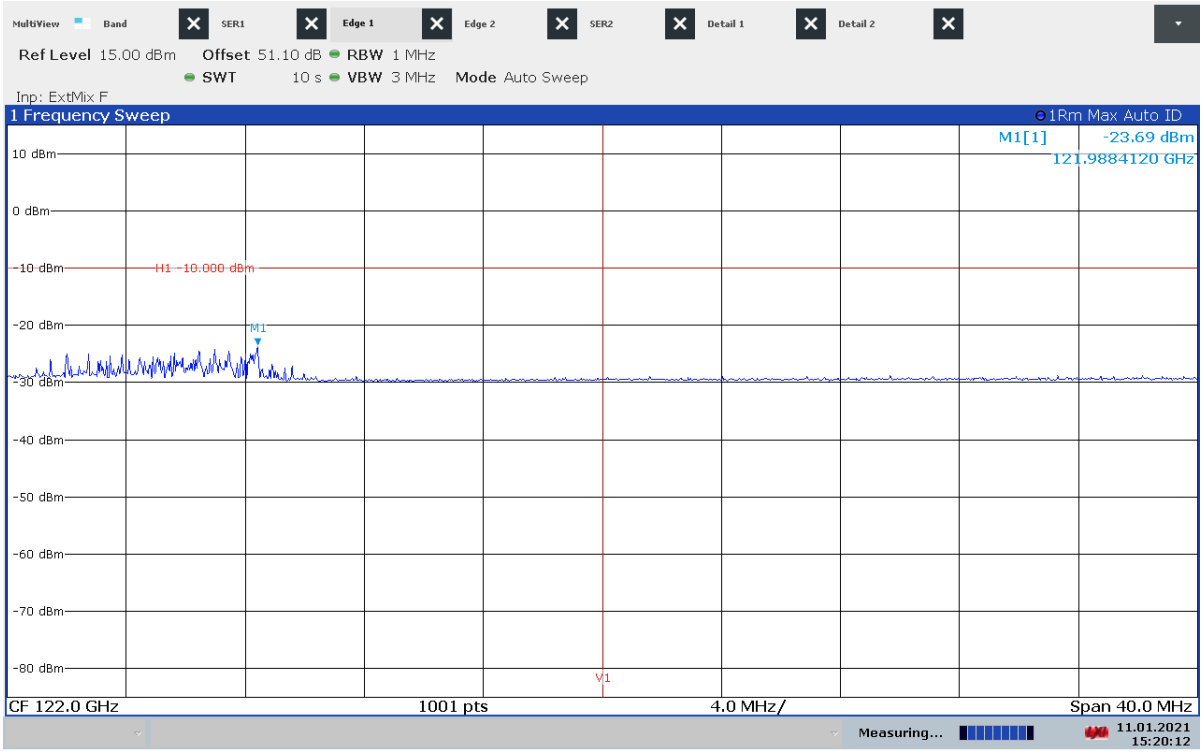
15:17:45 11.01.2021

Plot 25: lower band edge compliance, normal mode



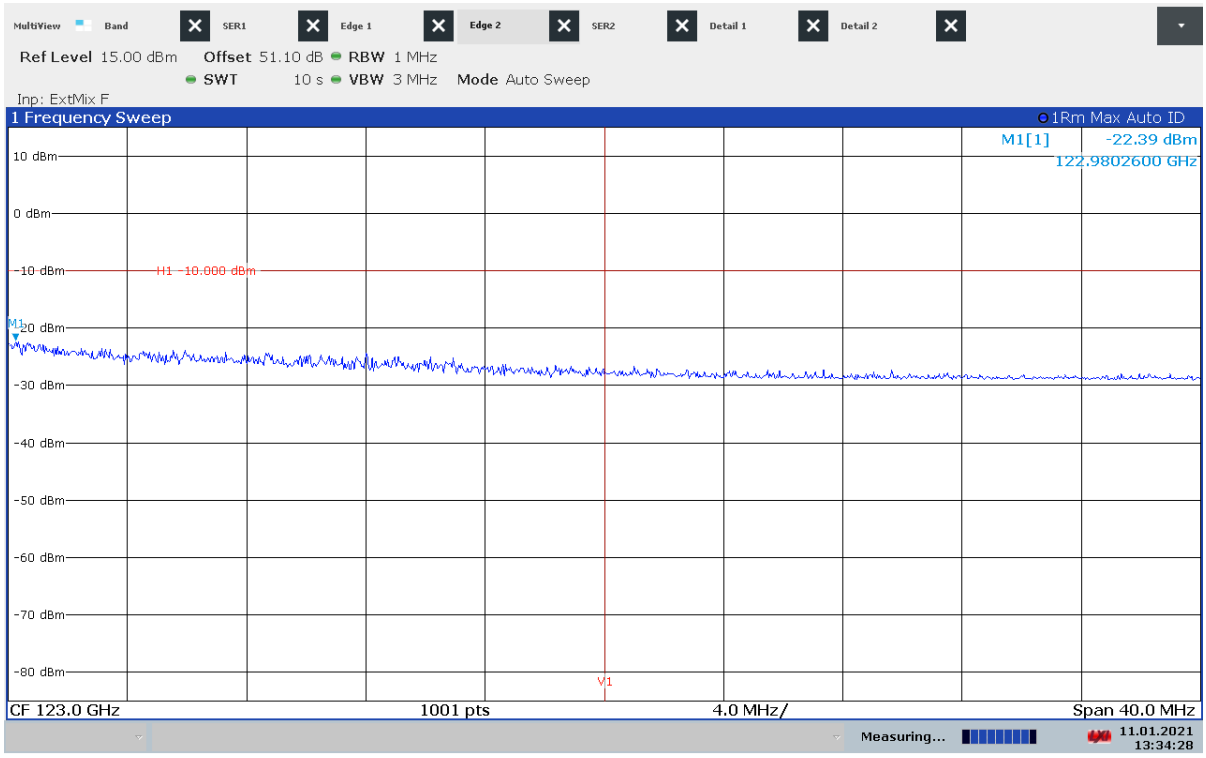
13:33:49 11.01.2021

Plot 26: lower band edge compliance, stopped mode (sweep stopped in the middle of the range of operation)



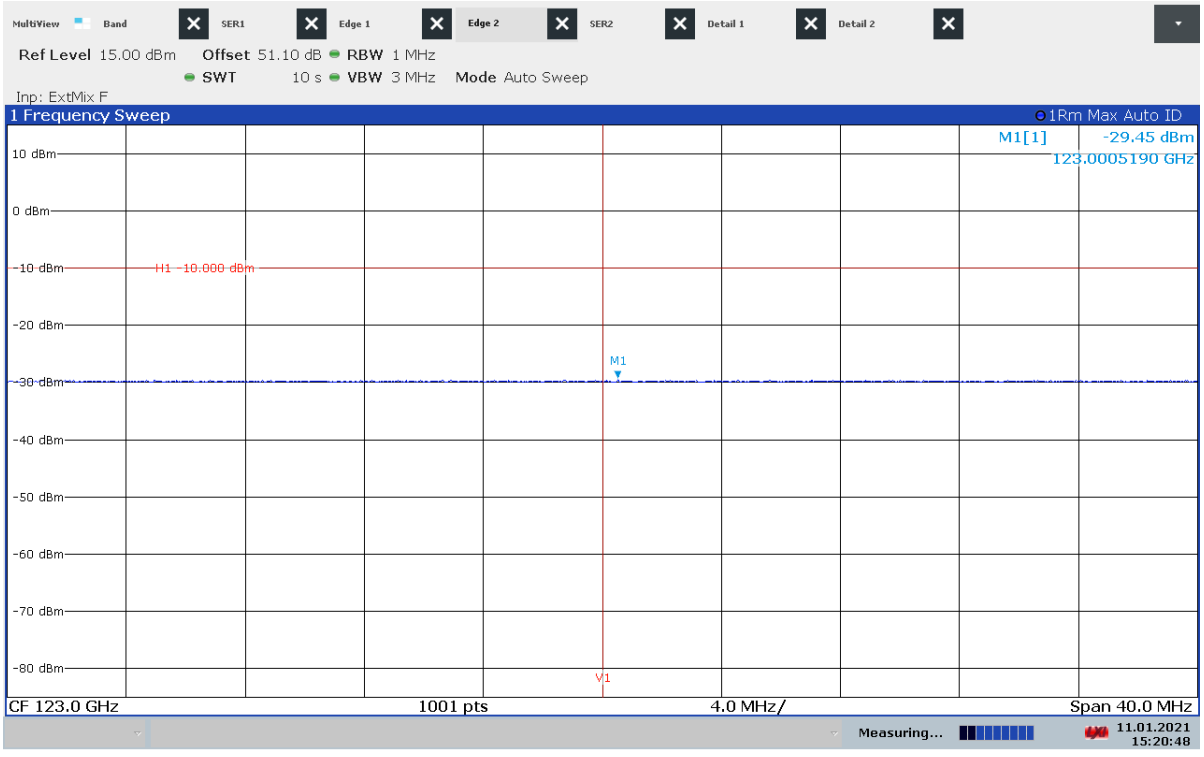
15:20:12 11.01.2021

Plot 27: upper band edge compliance, normal mode



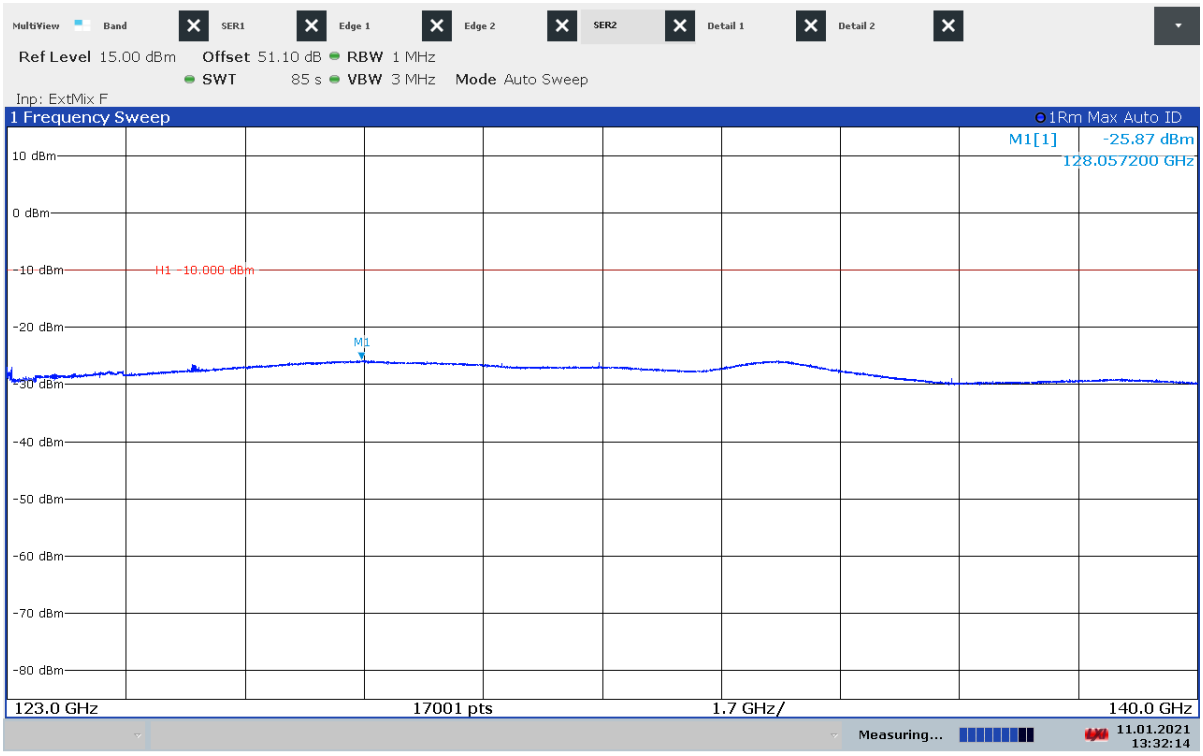
13:34:29 11.01.2021

Plot 28: upper band edge compliance, stopped mode (sweep stopped in the middle of the range of operation)



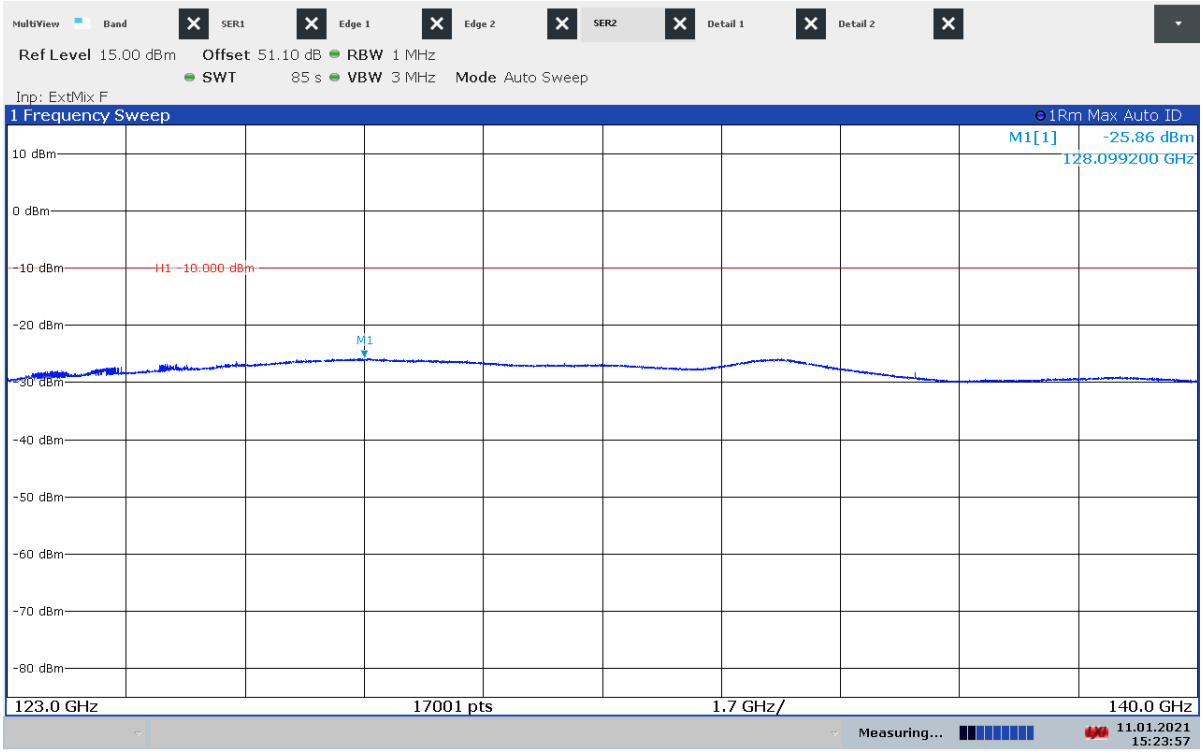
15:20:49 11.01.2021

Plot 29: 123 GHz – 140 GHz, normal mode



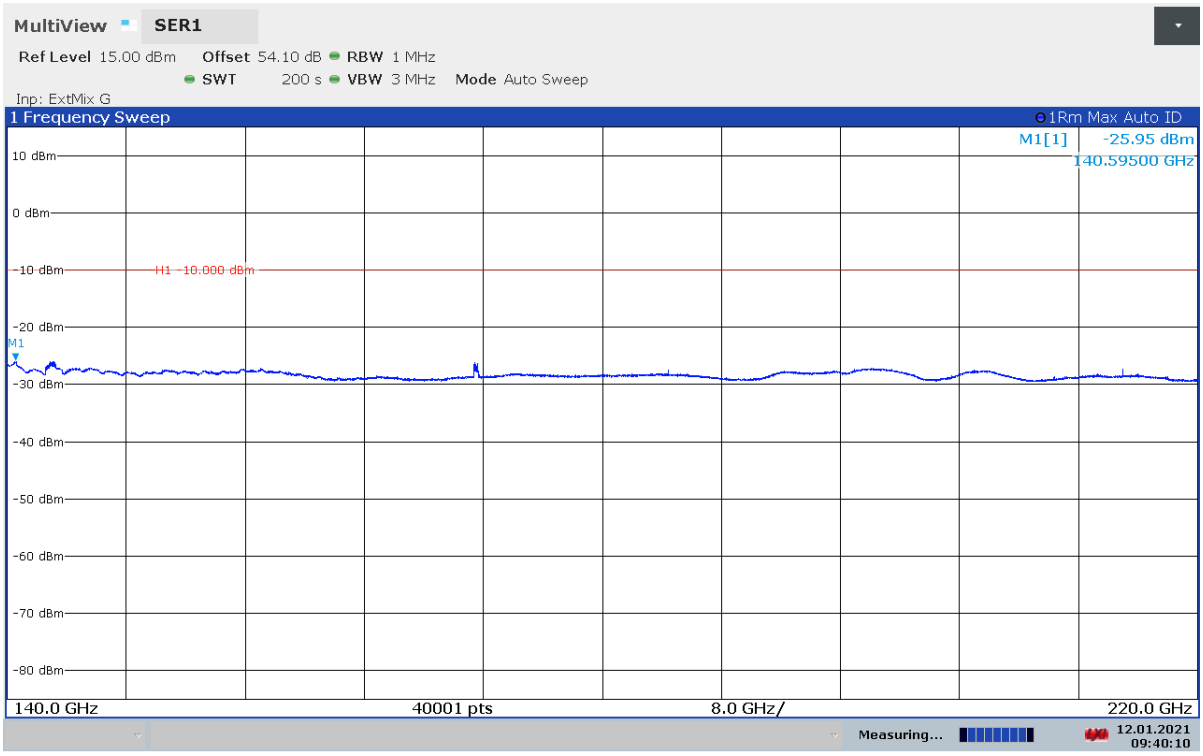
13:32:15 11.01.2021

Plot 30: 123 GHz – 140 GHz, stopped mode (sweep stopped in the middle of the range of operation)



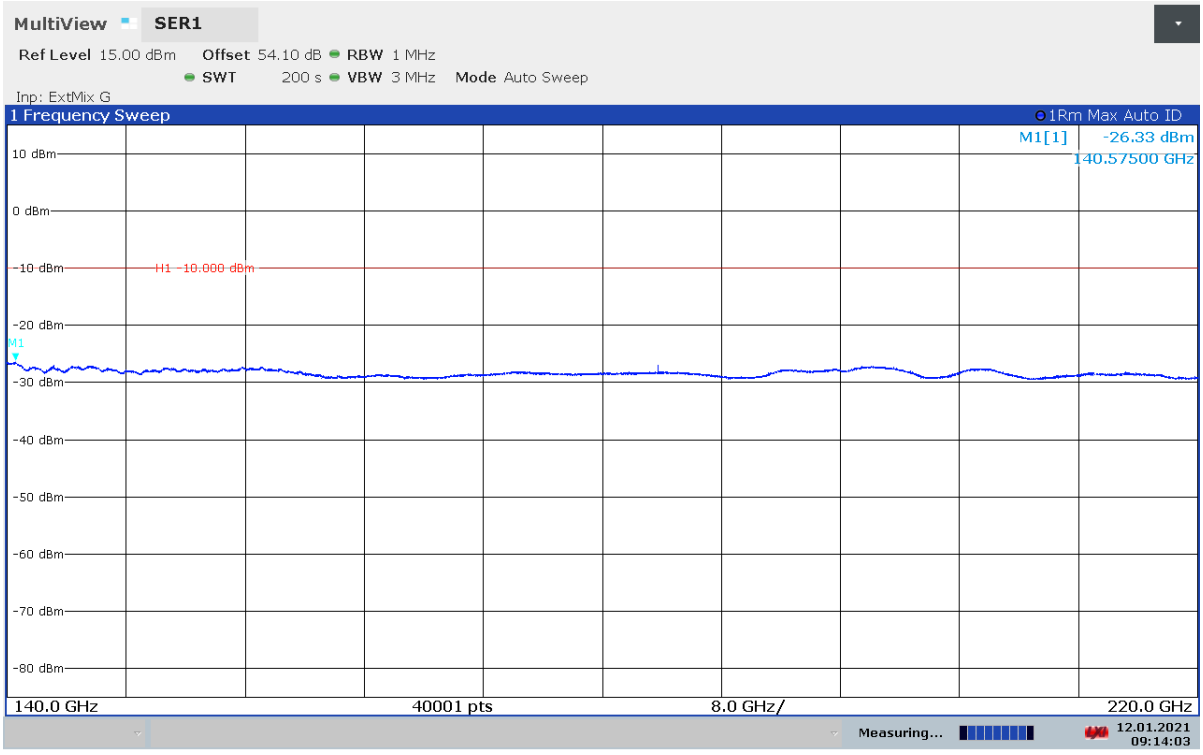
15:23:57 11.01.2021

Plot 31: 140 GHz – 220 GHz, normal mode



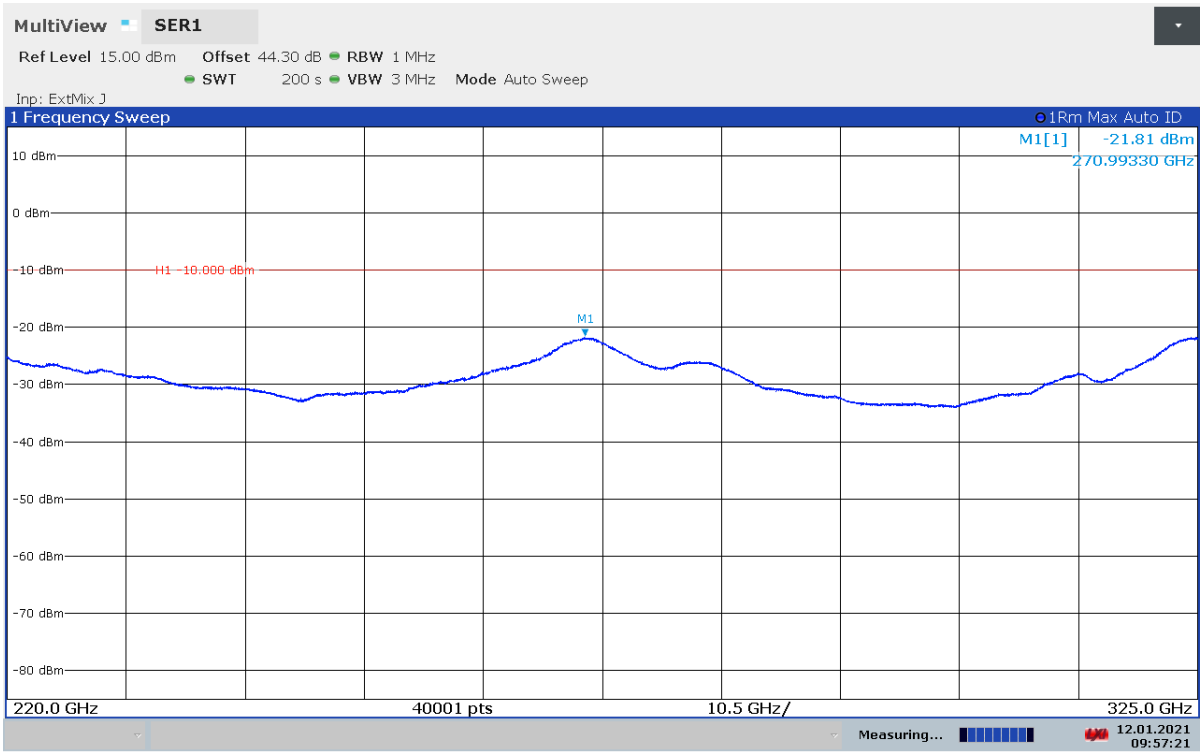
09:40:10 12.01.2021

Plot 32: 140 GHz – 220 GHz, stopped mode (sweep stopped in the middle of the range of operation)



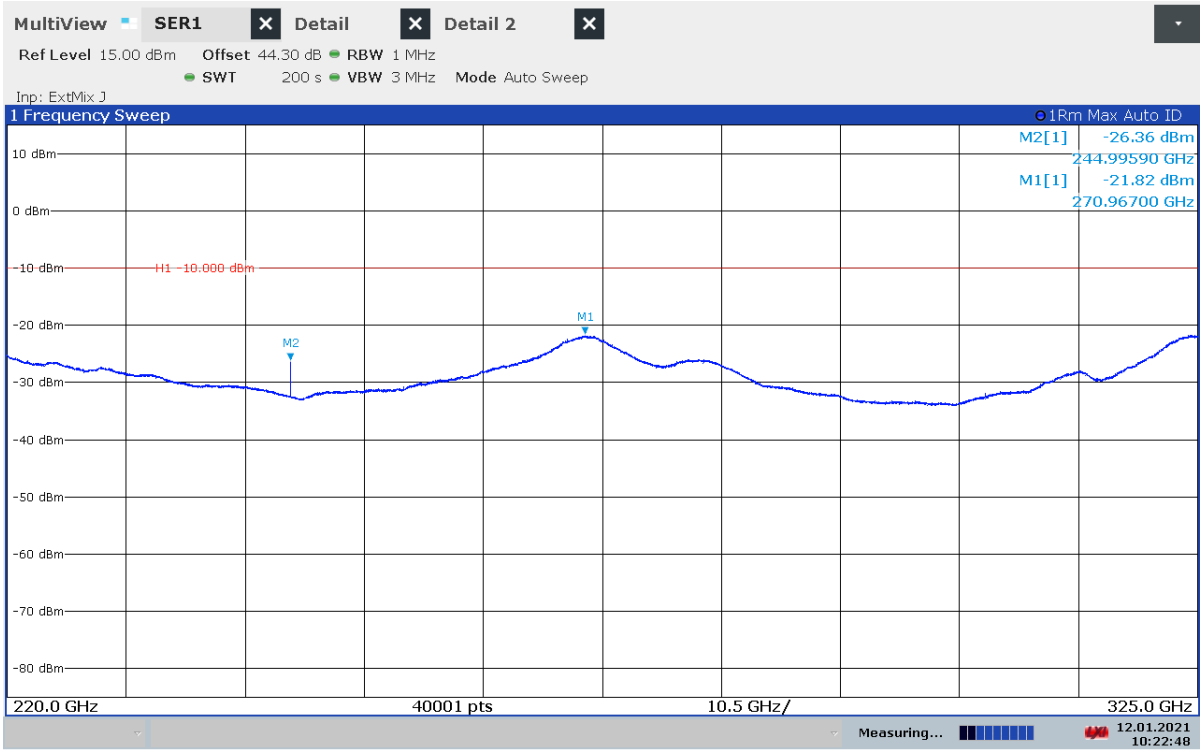
09:14:03 12.01.2021

Plot 33: 220 GHz – 325 GHz, normal mode



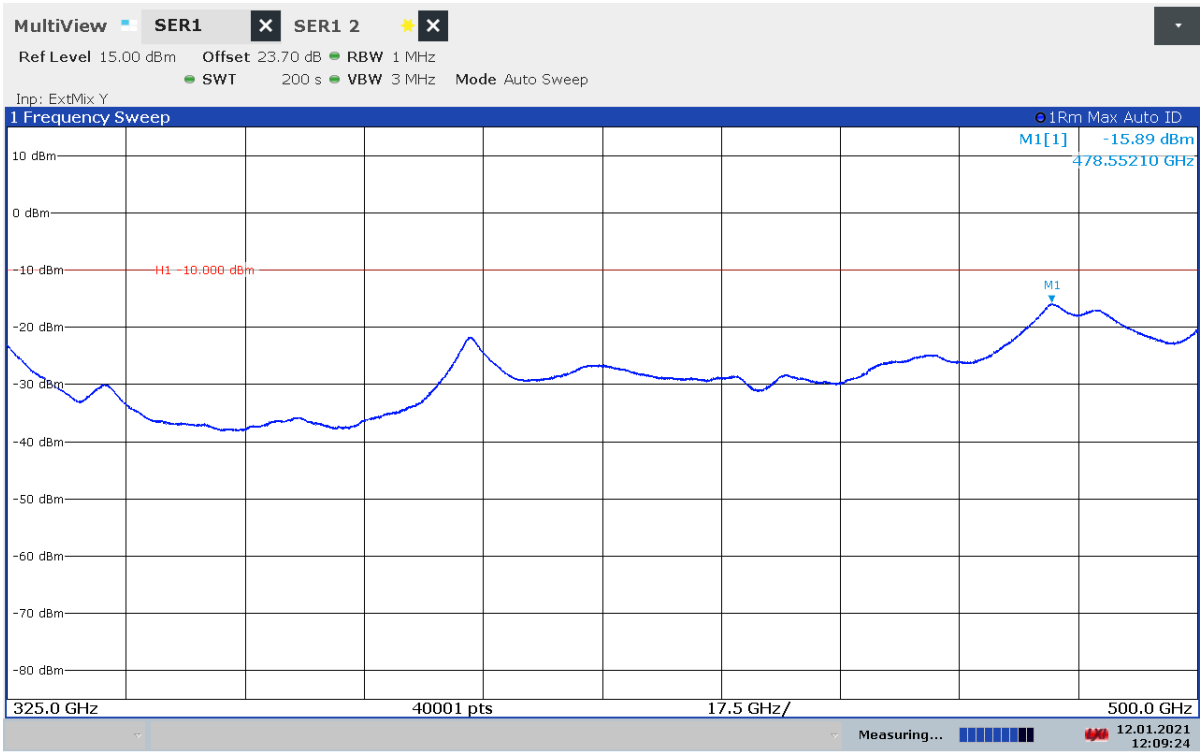
09:57:21 12.01.2021

Plot 34: 220 GHz – 325 GHz, stopped mode (sweep stopped in the middle of the range of operation)



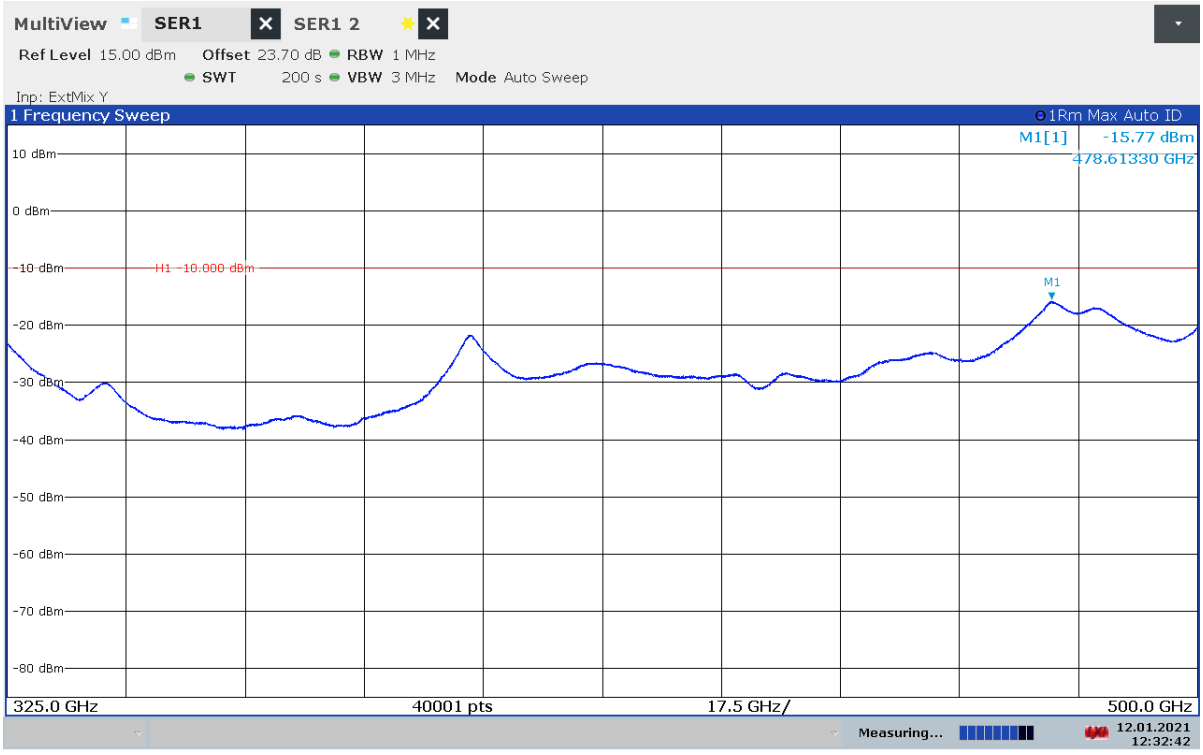
10:22:48 12.01.2021

Plot 35: 325 GHz – 500 GHz, normal mode



12:09:24 12.01.2021

Plot 36: 325 GHz – 500 GHz, stopped mode (sweep stopped in the middle of the range of operation)



12:32:43 12.01.2021

12.4 Frequency Stability

Description:

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

§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.

Measurement:

Measurement parameter	
Detector:	Pos-Peak
Sweep time:	10 s
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	1.4 GHz
Trace-Mode:	Max Hold

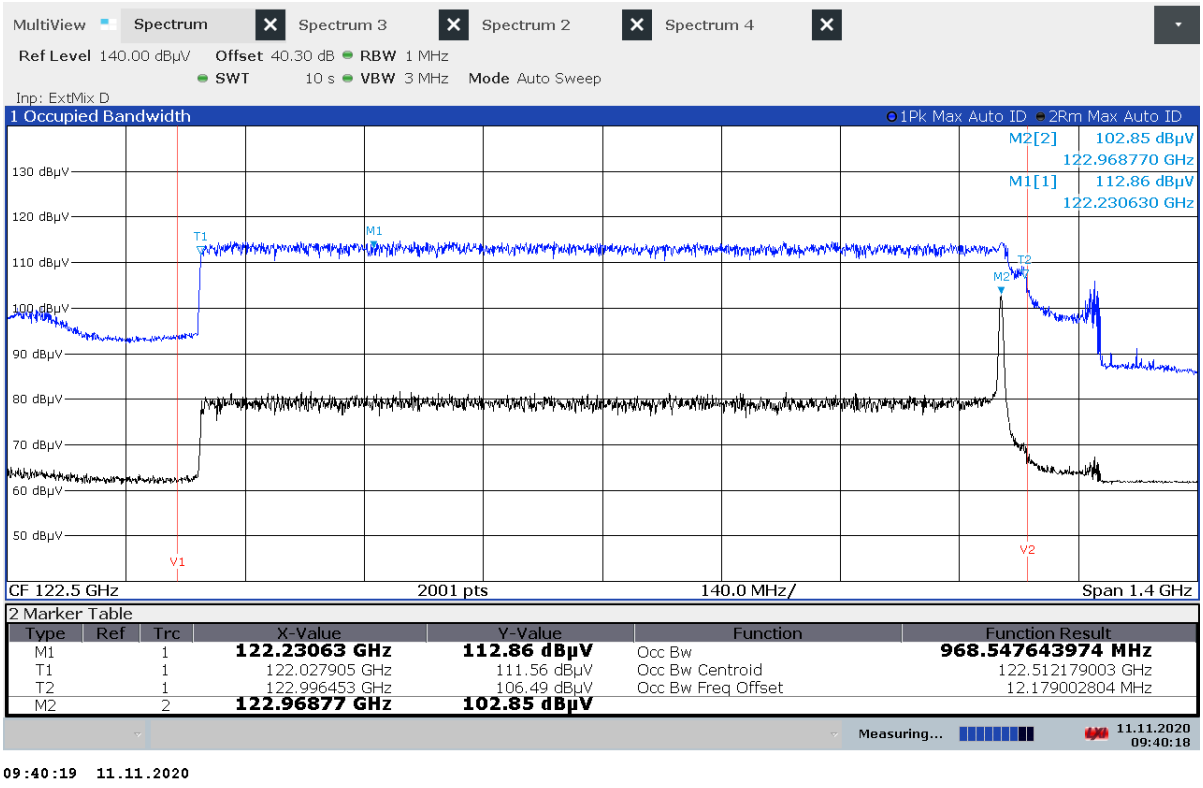
Limits:

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

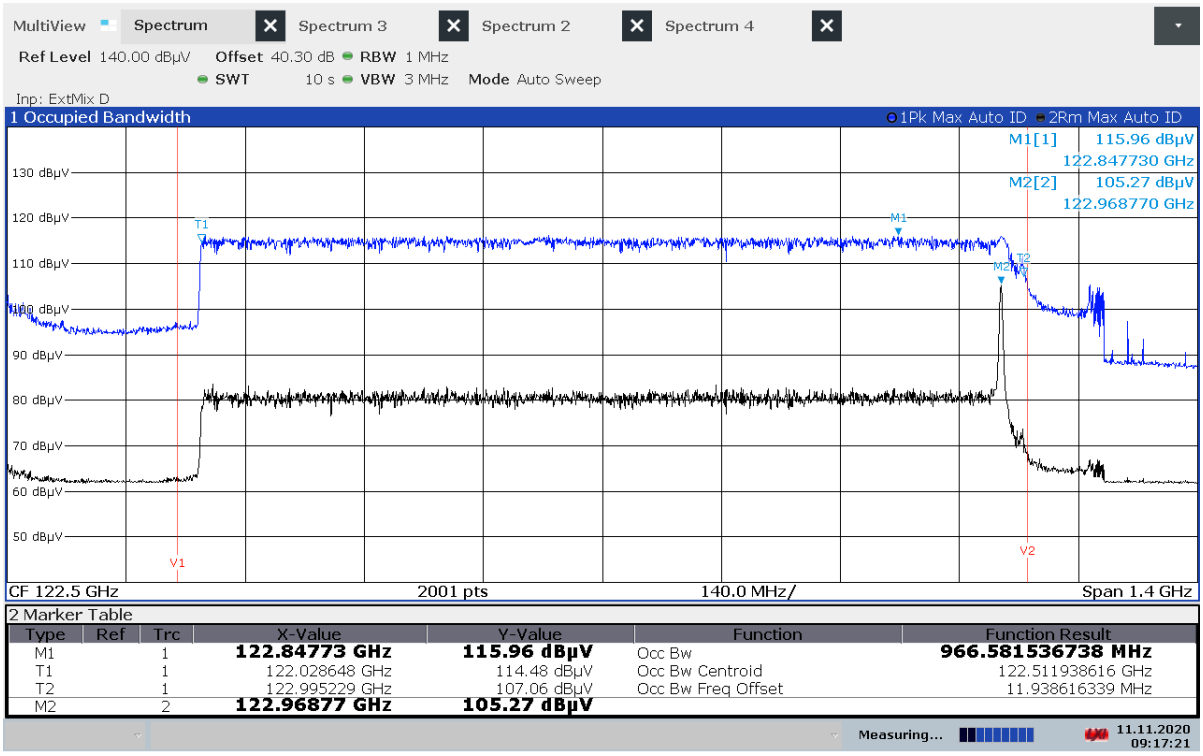
Measurement Results:

Test Conditions	Transmitter Frequency Range [GHz]		Occupied Bandwidth [MHz]
	F_L	F_H	
T_{nom} / V_{nom}	122.027905	122.996453	968.548
T_{min} / V_{nom}	122.028648	122.995229	966.581
T_{max} / V_{nom}	122.029493	122.990759	961.266
T_{nom} / V_{min}	122.028757	122.991494	962.737
T_{nom} / V_{max}	122.029375	122.990685	961.311

Plot 37: T_{nom} / V_{nom}

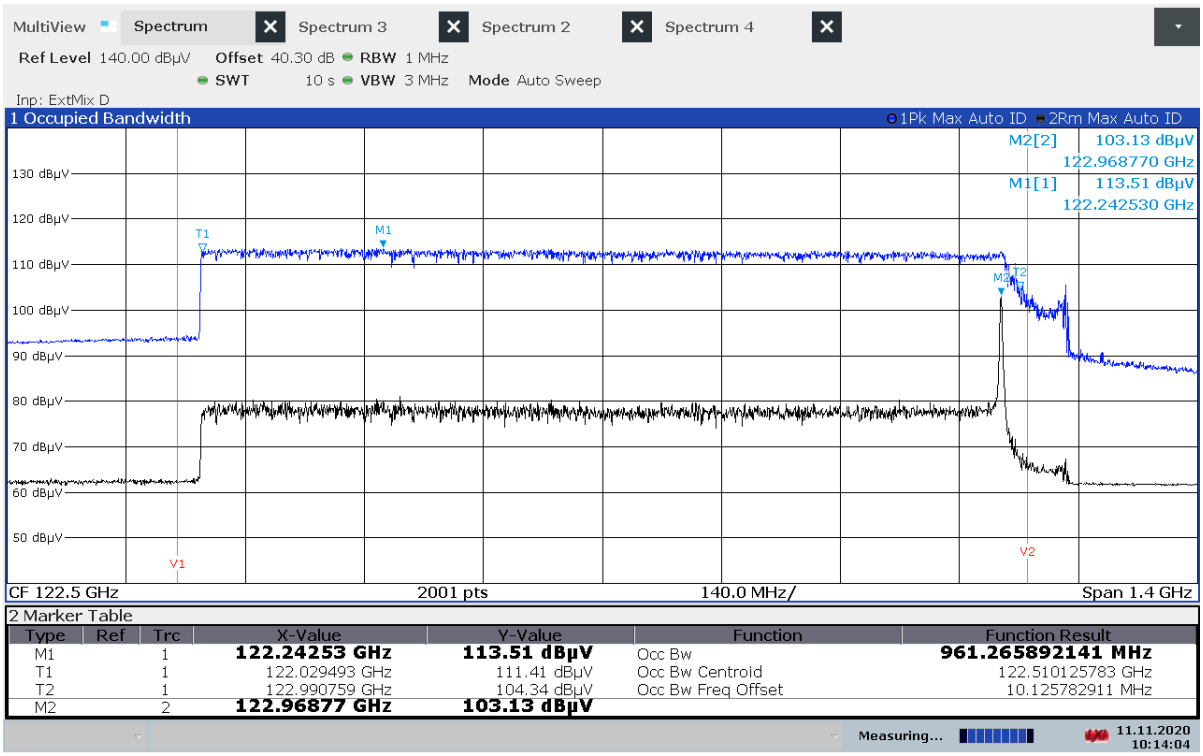


Plot 38: T_{min} / V_{nom}



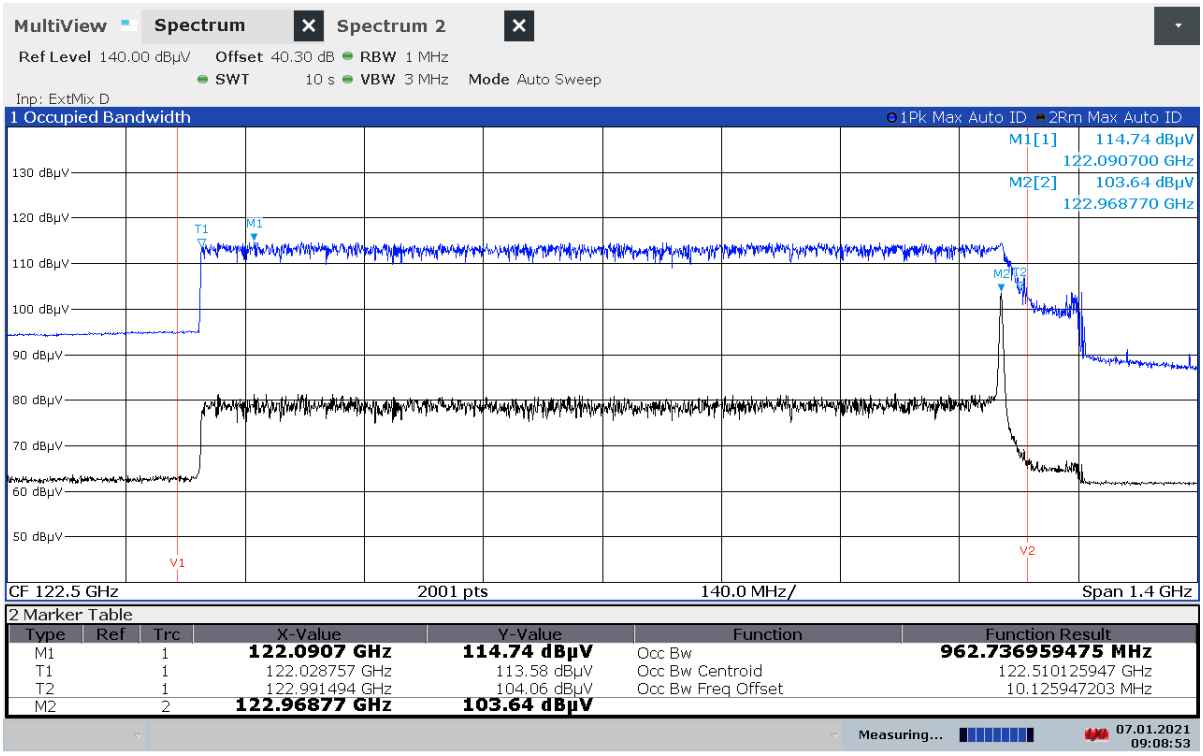
09:17:21 11.11.2020

Plot 39: T_{max} / V_{nom}



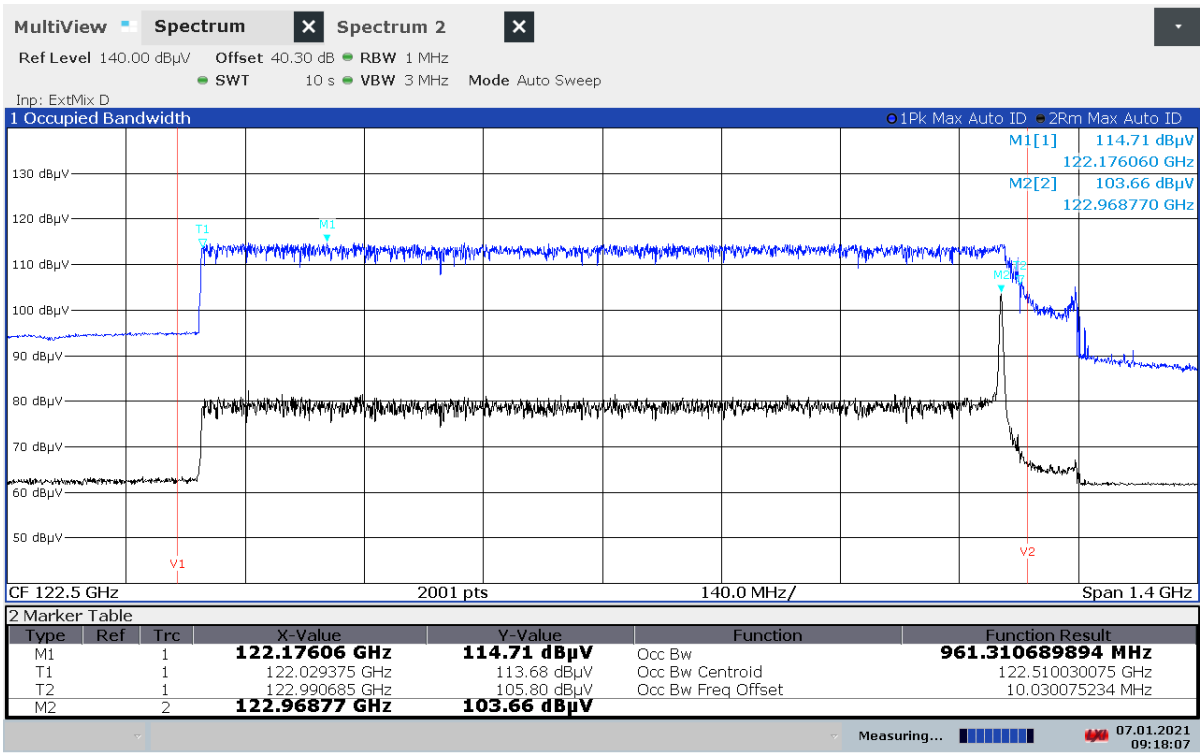
10:14:04 11.11.2020

Plot 40: T_{nom} / V_{min}



09:08:53 07.01.2021

Plot 41: T_{nom} / V_{max}



09:18:07 07.01.2021

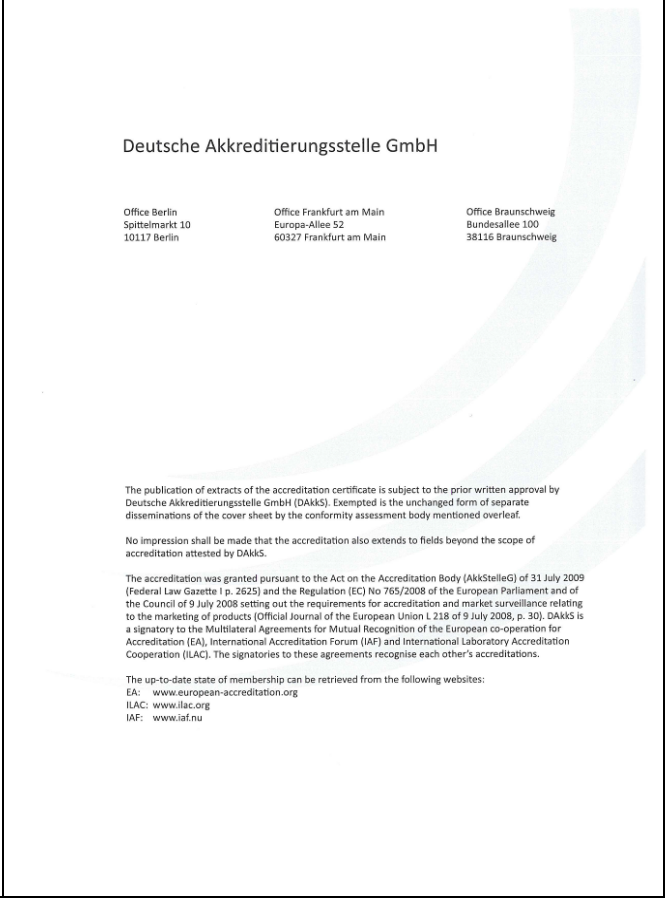
13 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

14 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-02-11

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

first page	last page
	

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

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