
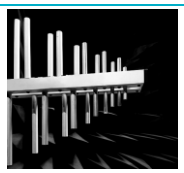
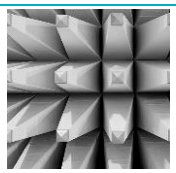

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-1154/20-01-03

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-05

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: http://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 (2005) 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

ADC Automotive Distance Control Systems GmbH
Peter-Dornier-Str. 10
88131 Lindau/Bodensee / GERMANY
Phone: +49 8382 9699 - 0
e-mail: info.automotive.approvals@continental-corporation.com

Manufacturer

ADC Automotive Distance Control Systems GmbH
Peter-Dornier-Str. 10
88131 Lindau / Germany

Test standard/s

CFR 47 Part 95, Subpart M	The 76-81 GHz Band Radar Service
CFR 47 Part 2, Subpart J	Frequency allocations and radio treaty matters; general rules and regulations

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

Test Item

Kind of test item:	**Advanced Radar Sensor**
Type:	**ARS5-A**
FCC ID:	**OAYARS5A**
Frequency:	76.0 – 77.0 GHz
Antenna:	Integrated 3D antenna (12 Tx, 16 Rx)
Power supply:	VN = 12.0 V DC (8.5 V – 17.0 V) by external power supply
Temperature range:	-40°C to +85°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
2020.12.17 11:39:34 +01'00'

Thomas Vogler
Lab Manager
Radio Communications & EMC

Test performed:

M. Walla

cn=Meheza Walla, o=CTC advanced GmbH, ou=WAL-200806, email=meheza.walla@ctcadvanced.com, c=DE
2020.12.17 09:54:58 +01'00'

Meheza Walla
Lab Manager
Radio Communications & EMC

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:	2020-09-10
Date of receipt of test item:	2020-11-12
Start of test:	2020-11-16
End of test:	2020-12-04
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

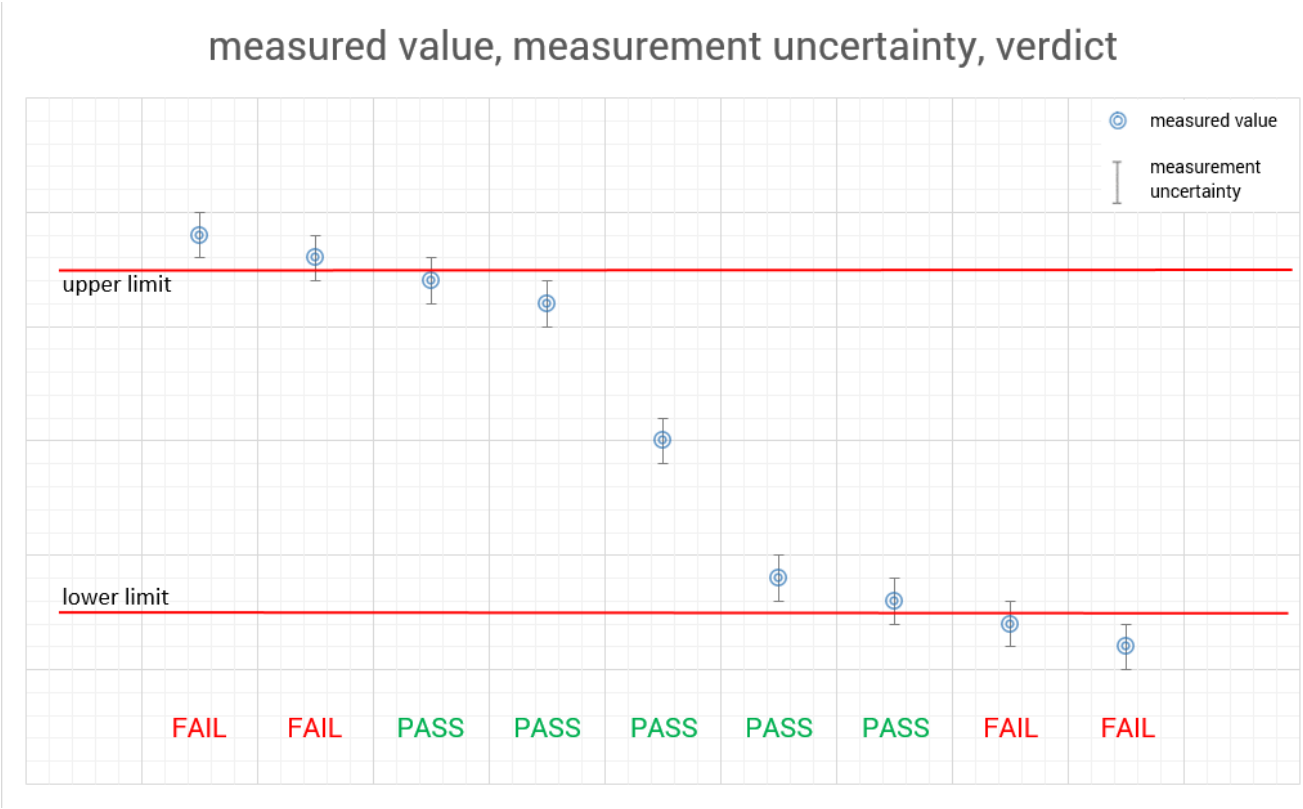
Test standard	Date	Description
CFR 47 Part 95, Subpart M	-/-	The 76-81 GHz Band Radar Service
CFR 47 Part 2, Subpart J	-/-	Frequency allocations and radio treaty matters; general rules and regulations

Guidance	Version	Description
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.26-2015	-/-	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
KDB 653005 D01	v01r01 2019-04	Equipment Authorization Guidance for 76-81 GHz Radar Devices

Accreditation	Description
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

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}	+20 °C during room temperature tests +85 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	12.0 V DC (8.5 V – 17.0) by external power supply 17.0 V 8.5 V

6 Test item

6.1 General description

Kind of test item	:	Advanced Radar Sensor
Type	:	ARS5-A
S/N serial number	:	A2C77021301000001209101347 55 (DUT_15) A2C77021301000001209101416 52 (DUT_17)
HW hardware status	:	D-Sample
SW software status	:	003.027.033
Frequency band	:	76.0 – 77.0 GHz
Type of modulation	:	FMCW
Number of modes	:	See additional information
Antenna	:	Integrated 3D antenna (12 Tx, 16 Rx)
Power supply	:	VN = 12.0 V DC (8.5 V – 17.0 V) by external power supply
Temperature range	:	-40°C to +85°C

6.2 Additional information

Operating modes as declared by manufacturer:

Mode	fcenter [GHz]	Bandwidth [MHz]	Info
3	76.48	960	Operation
9	76.23	460	Operation
21	76.48	960	Operation
27	76.23	460	Operation
107	76.45	855	EOL / Service

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: 1-1154/20-01-01_AnnexA
1-1154/20-01-01_AnnexB
1-1154/20-01-01_AnnexD

7 Description of the test setup

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

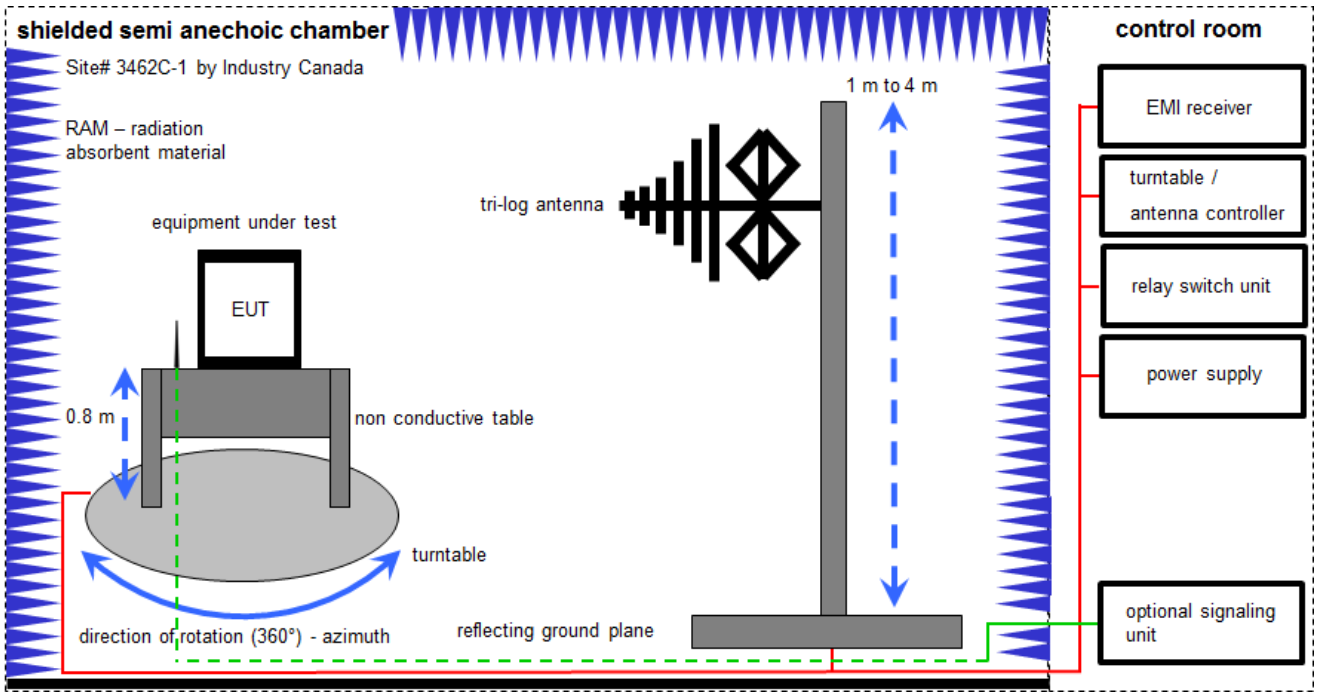
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated		EK	limited calibration
ne	not required (k, ev, izw, zw not required)		zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification		izw	internal cyclical maintenance
Ve	long-term stability recognized		g	blocked for accredited testing
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

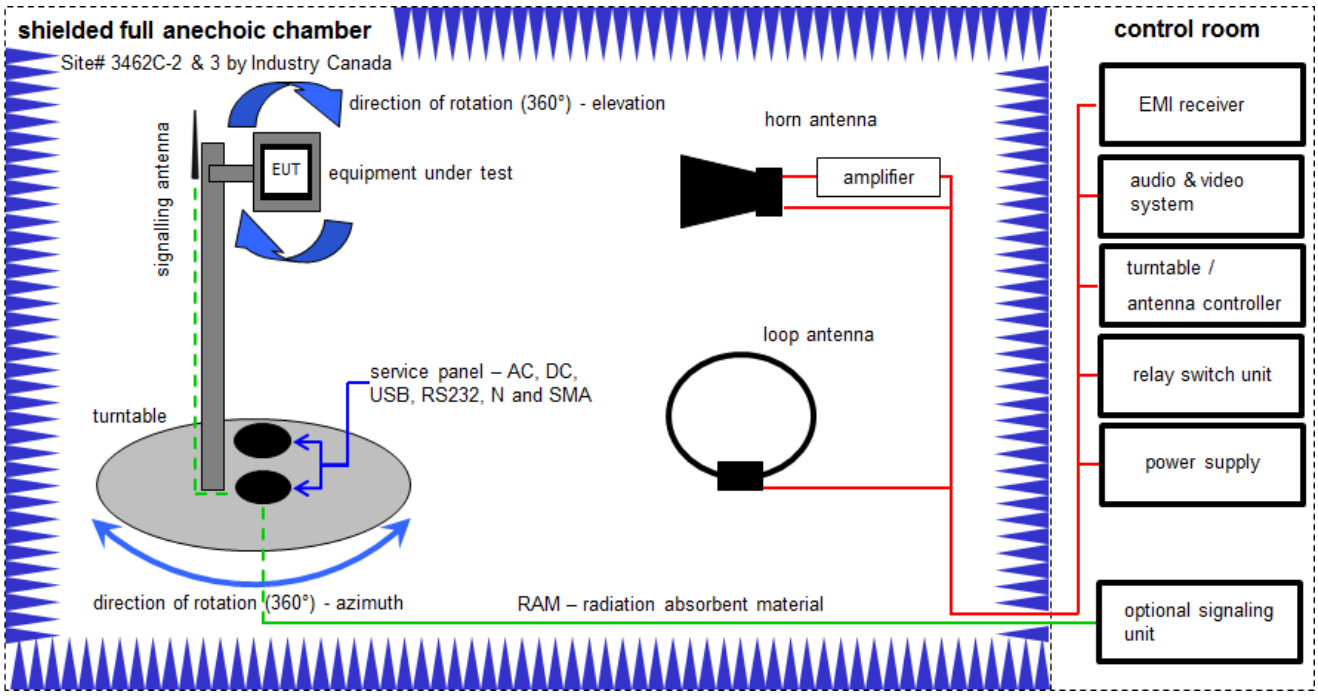
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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.	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
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	17.01.2020	16.01.2022
6	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
7	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
8	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
9	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	371	300003854	vlKl!	24.11.2017	23.11.2020
10	n. a.	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	16.12.2019	15.12.2020

7.2 Shielded fully anechoic chamber



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

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

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

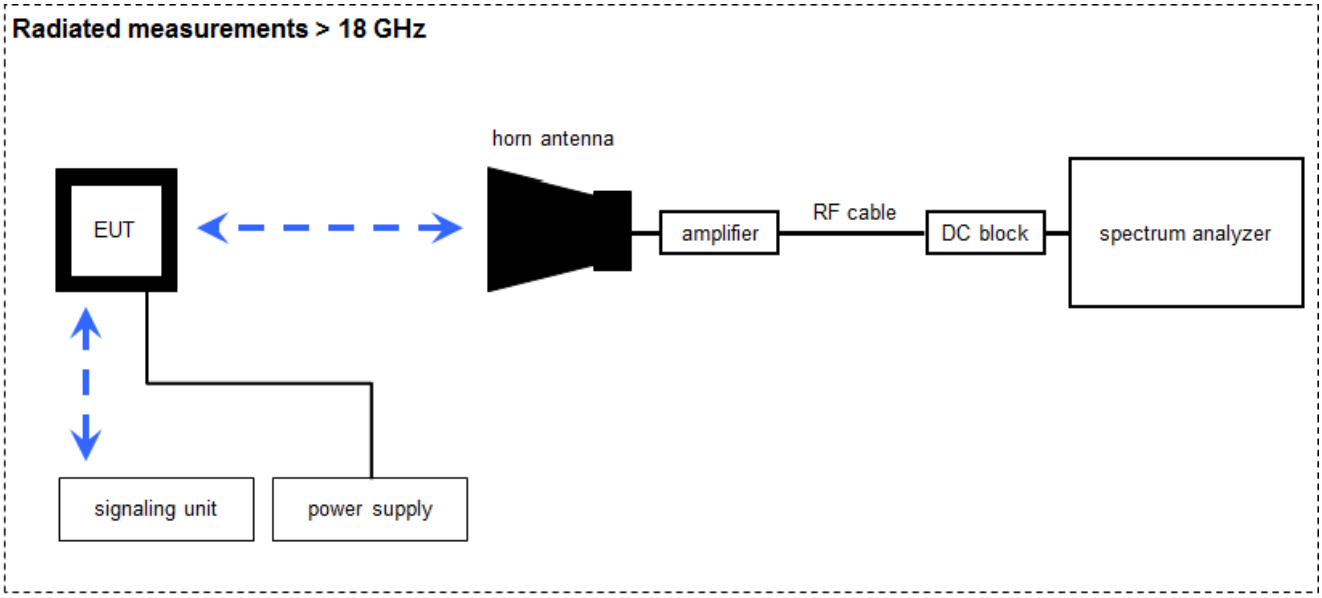
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

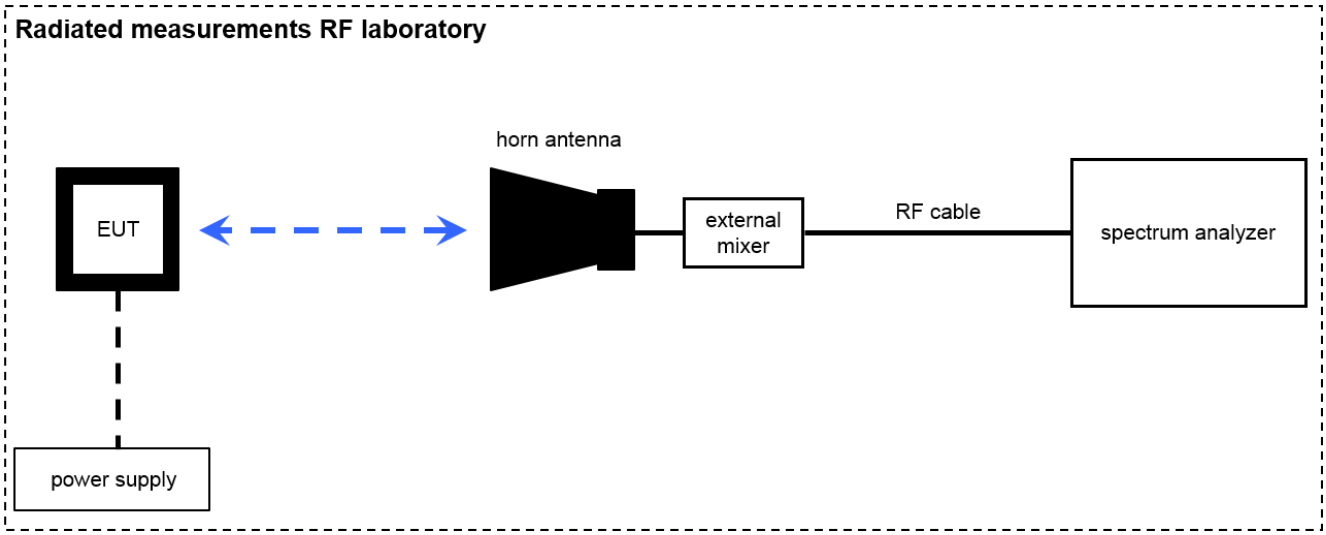
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.02.2019	26.02.2021
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.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04590	300001041	vIKI!	14.12.2017	13.12.2020
4	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
5	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
6	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
7	n. a.	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
8	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
9	n. a.	Anechoic chamber		TDK		300003726	ne	-/-	-/-
10	n. a.	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	10.12.2019	09.12.2020
11	n. a.	RF Amplifier	AFS4-00100800-28-20P-4-R	MITEQ	2008992	300005204	ne	-/-	-/-
12	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-

7.3 Radiated measurements > 18 GHz



7.4 Radiated measurements > 50/85 GHz



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

Example calculation:
OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 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.	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	k	21.01.2020	20.01.2022
2	n. a.	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ne	-/-	-/-
3	n. a.	Std. Gain Horn Antenna 39.3-59.7 GHz	2424-20	Flann	75	300001979	ne	-/-	-/-
4	n. a.	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne	-/-	-/-
5	n. a.	Std. Gain Horn Antenna 60-90 GHz	COR 60_90	Thomson CSF		300000814	ev	-/-	-/-
6	n. a.	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-
7	n. a.	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
8	n. a.	Std. Gain Horn Antenna 145-220 GHz	3024-20	Flann	*	300002000	ne	-/-	-/-
9	n. a.	Std. Gain Horn Antenna 217-330 GHz	32240-20	Flann	233278	300004960	ne	-/-	-/-
10	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
11	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	101578	tbd	k	17.06.2020	16.06.2021
12	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	19.06.2020	18.06.2021
13	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	FS-Z170	Radiometer Physics GmbH	100014	300004156	k	28.05.2020	27.05.2021
14	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	08.07.2020	07.07.2021
15	n. a.	Harmonic Mixer 3-Port, 140-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	14.07.2020	13.07.2021
16	n. a.	Harmonic Mixer 3-Port, 220-325 GHz	SAM-325	Radiometer Physics GmbH	100002	300004158	k	23.07.2020	22.07.2021
17	n. a.	Spectrum Analyzer 2 Hz - 85 GHz	FSW85	R&S	101333	300005568	k	29.05.2019	28.05.2021
18	n. a.	Spectrum Analyzer 2 Hz - 50 GHz	FSW50	R&S	101332	300005935	k	26.02.2020	25.02.2021
19	n. a.	Temperature Test Chamber	T-40/50	CTS GmbH	064023	300003540	ev	08.05.2020	07.05.2022

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 50/85 GHz with external mixers

Setup

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

Premeasurement

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

Final measurement

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

9 Measurement uncertainty

Test case	Uncertainty
Equivalent isotropically radiated power (e.i.r.p.)	Conducted value ± 1 dB Radiated value ± 3 dB
Permitted range of operating frequencies	± 100 kHz
Conducted unwanted emissions in the spurious domain (up to 40 GHz)	± 1 dB
Radiated unwanted emissions in the spurious domain (up to 40 GHz)	± 3 dB
Conducted unwanted emissions in the spurious domain (40 to 50 GHz)	± 4 dB
Radiated unwanted emissions in the spurious domain (40 to 50 GHz)	± 4 dB
Conducted unwanted emissions in the spurious domain (50 to 300 GHz)	± 5 dB
Radiated unwanted emissions in the spurious domain (50 to 300 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	47 CFR Part 95 Subpart M	see below	2020-12-17	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	C	NC	NA	NP	Results (max.)
§2.1046 §95.3367 (a) / (b)	Radiated power	Nominal	Nominal	☒	☐	☐	☐	-/-
§2.1047	Modulation characteristics	-/-	-/-	☒	☐	☐	☐	-/-
§2.1049	Occupied bandwidth (99% bandwidth)	Nominal	Nominal	☒	☐	☐	☐	-/-
§2.1051	Spurious emissions at antenna terminals	Nominal	Nominal	☐	☐	☒	☐	see note
§2.1053 §95.3379 (a)(1) §95.3379 (a)(2) §95.3379 (a)(3)	Field strength of emissions (radiated spurious)	Nominal	Nominal	☒	☐	☐	☐	-/-
§2.1055 §95.3379 (b)	Frequency stability	Nominal and Extreme	Nominal and Extreme	☒	☐	☐	☐	-/-

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

See FCC's Millimeter Wave Test Procedures:
I. A radiated method of measurements in order to demonstrate compliance with the various regulatory requirements has been chosen in consideration of test equipment availability and the limitations of many external harmonic mixers. A conducted method of measurement could be employed if EUT and mixer waveguides both are accessible and of the same type (WG number) and if waveguide sections and transitions can be found. Another potential problem is that the peak power output of devices operating under Sections 15.253 and 15.255 may exceed the +20 dBm input power limit of many commercially available mixers. For these reasons a radiated method is preferred.

11 Measurement results

11.1 Radiated power

Description:

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as shown below.

Measurement:

Parameters	
Detector:	RMS / Pos-Peak
Sweep time:	120 s
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

Limits: **FCC §95.3367 (a) (b)**

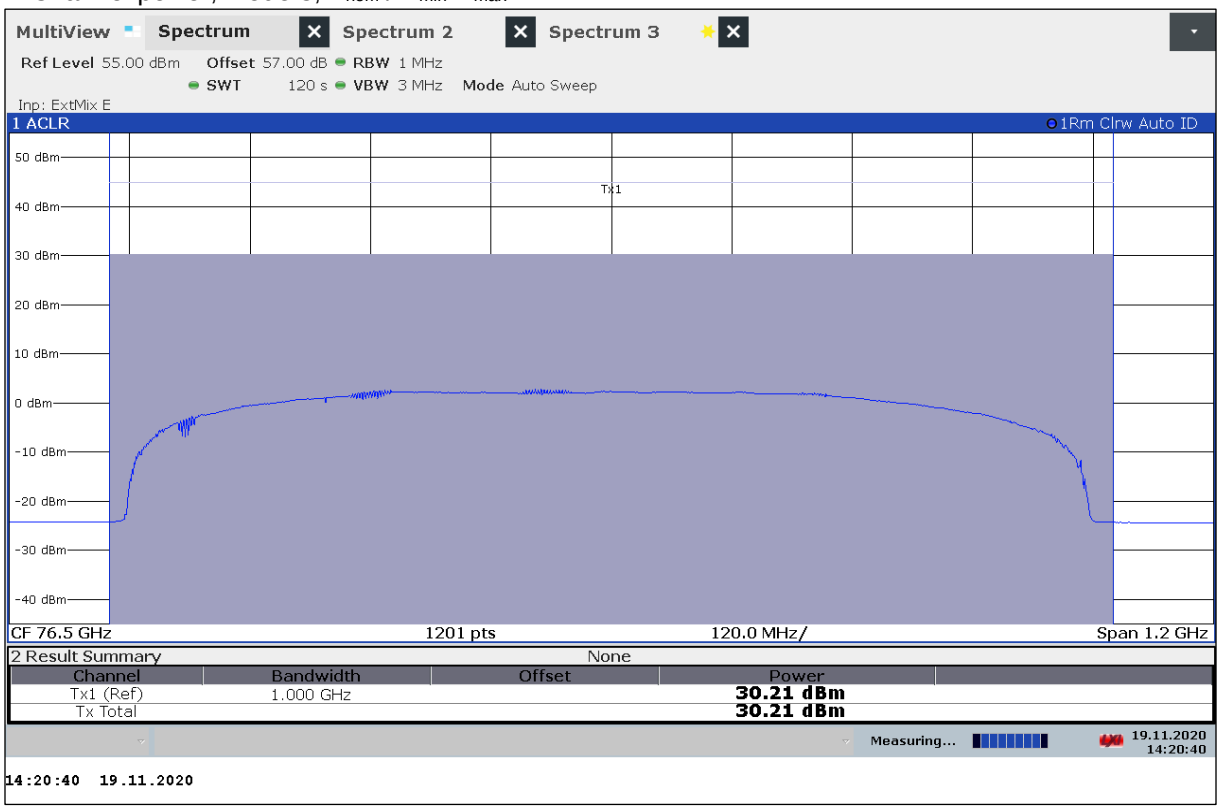
Frequency	Measurement distance	EIRP
76.0 - 81.0 GHz	3.0 m	88 µW/cm² → 50 dBm (Average) 279 µW/cm² → 55 dBm (PEAK)

Measurement results:

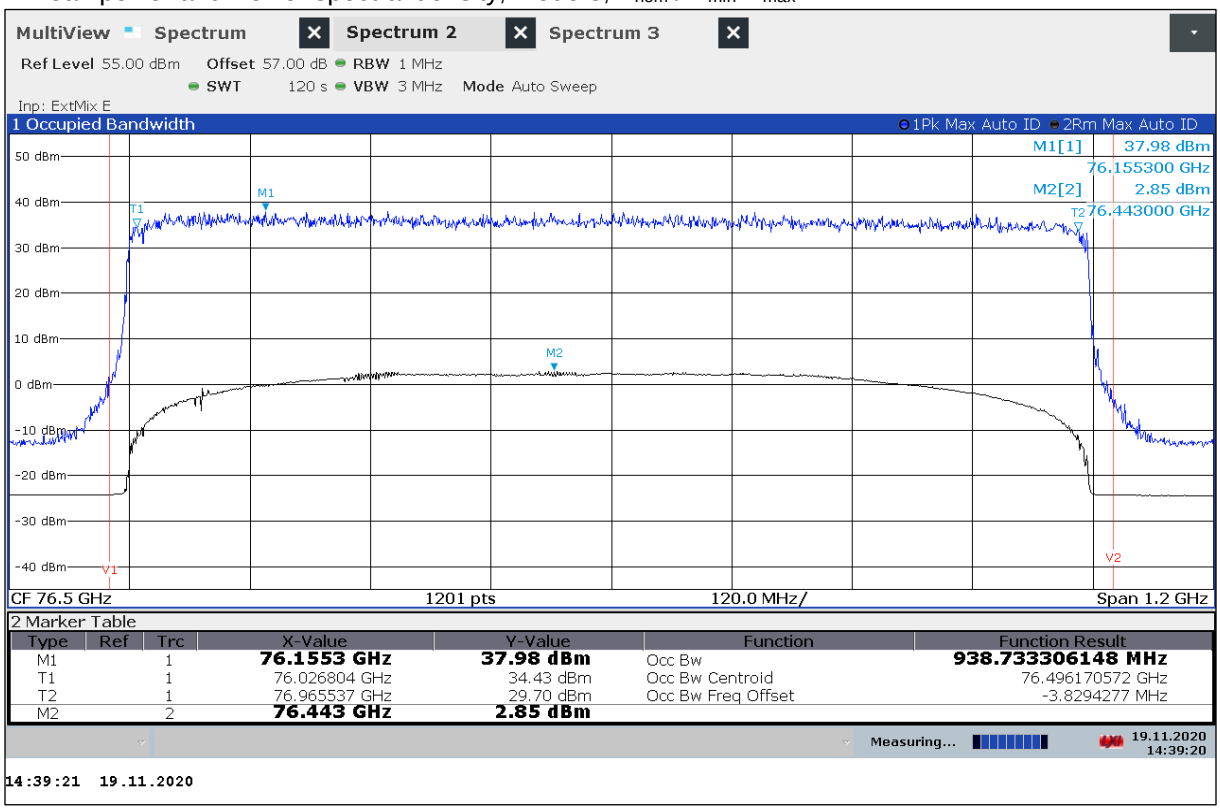
Mode	Test conditions	Channel power Radiated mean power (eirp)	Radiated peak power (eirp)	Radiated power spectral density
3	T_{nom} / $V_{min-max}$	30.21	37.98	2.85
9	T_{nom} / $V_{min-max}$	30.57	38.54	6.63
21	T_{nom} / $V_{min-max}$	20.10	27.59	-7.40
27	T_{nom} / $V_{min-max}$	20.18	27.68	-3.86
107	T_{nom} / $V_{min-max}$	20.15	24.72	-7.60

Note: Voltage variation does not affect the radiated signal

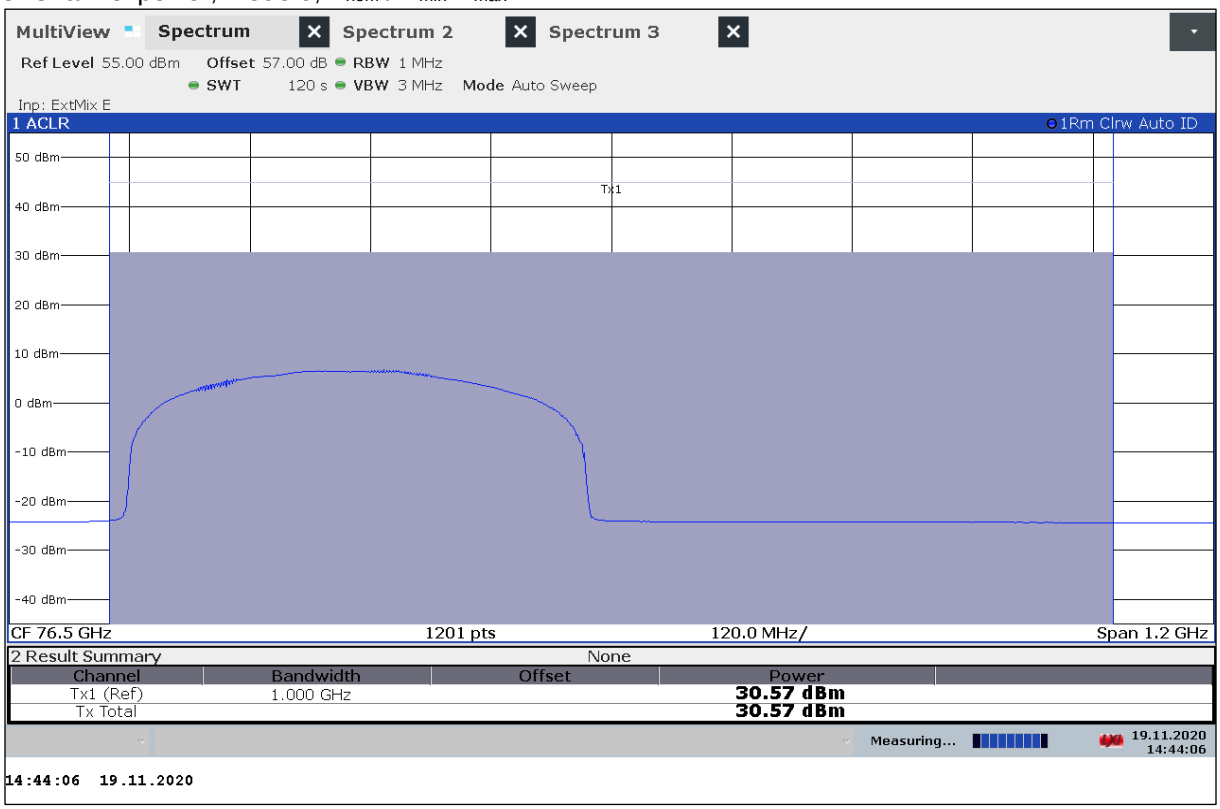
Plot 1: Channel power, Mode 3, T_{nom} / V_{min}-V_{max}



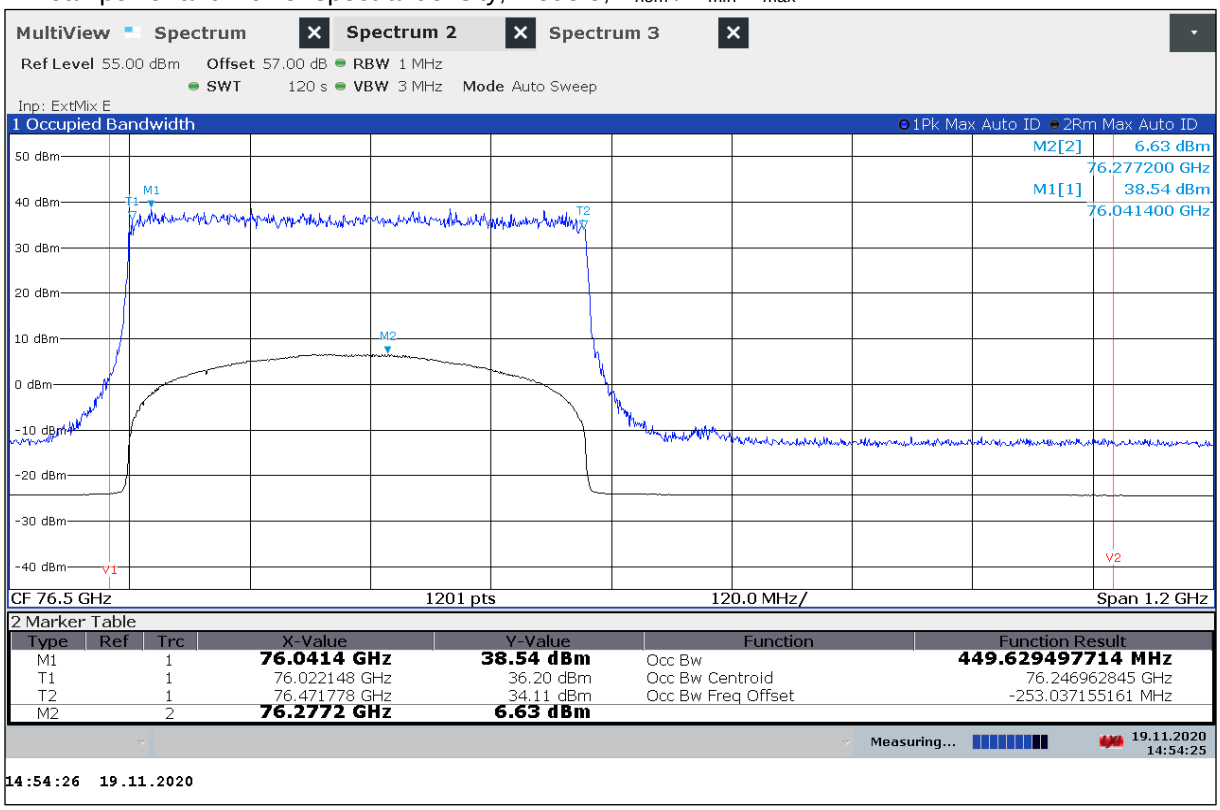
Plot 2: Peak power and Power spectral density, Mode 3, T_{nom} / V_{min}-V_{max}



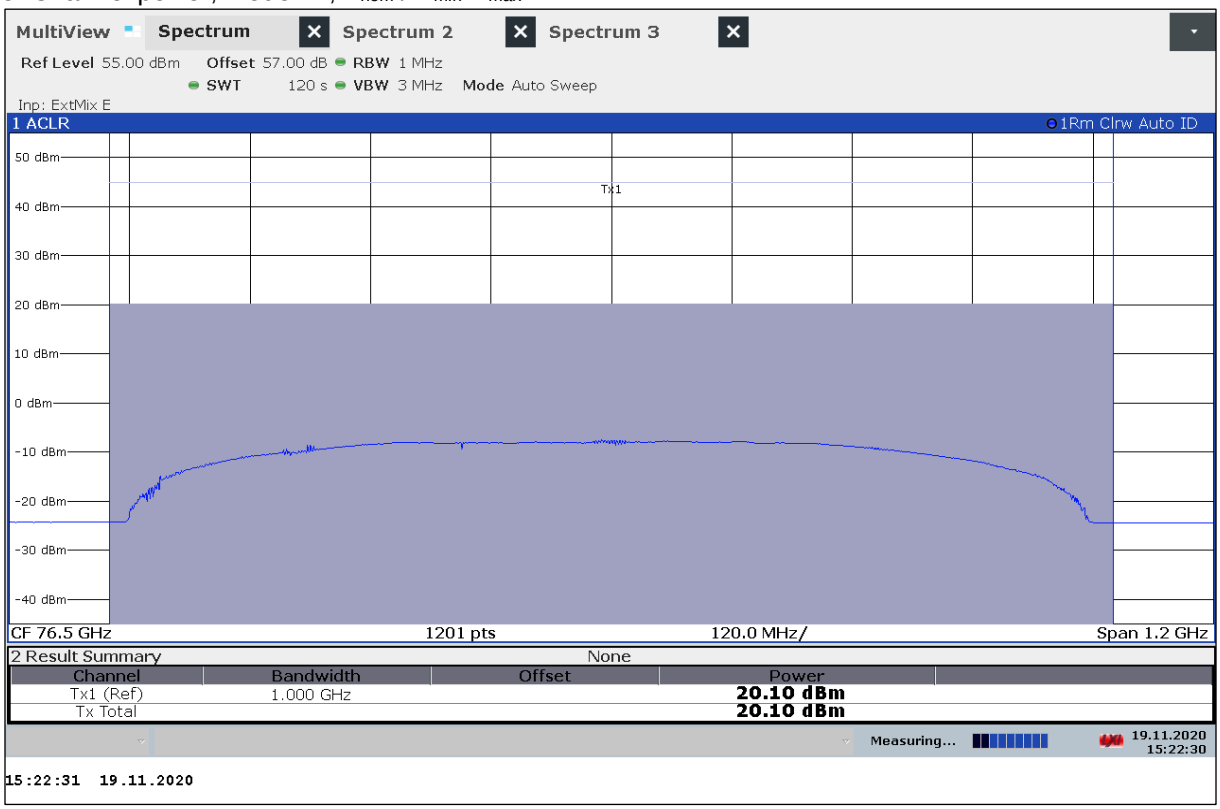
Plot 3: Channel power, Mode 9, T_{nom} / V_{min}-V_{max}



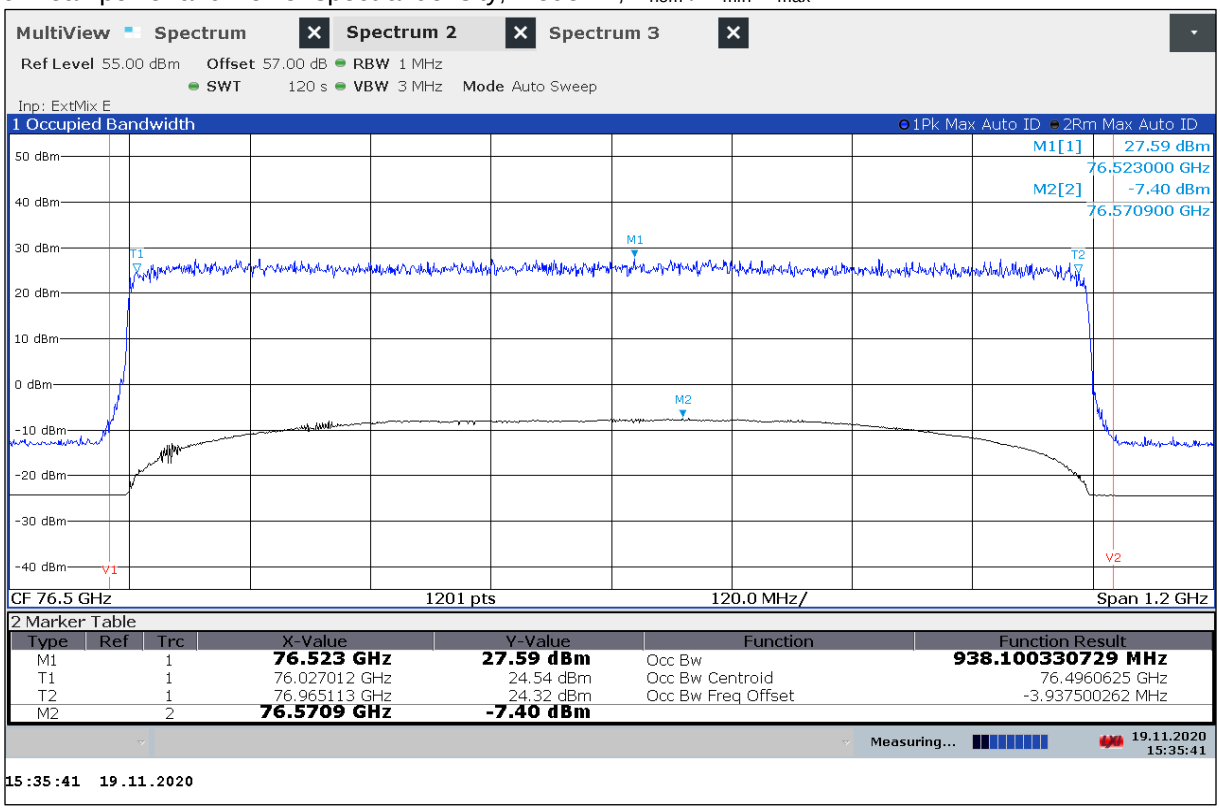
Plot 4: Peak power and Power spectral density, Mode 9, T_{nom} / V_{min}-V_{max}



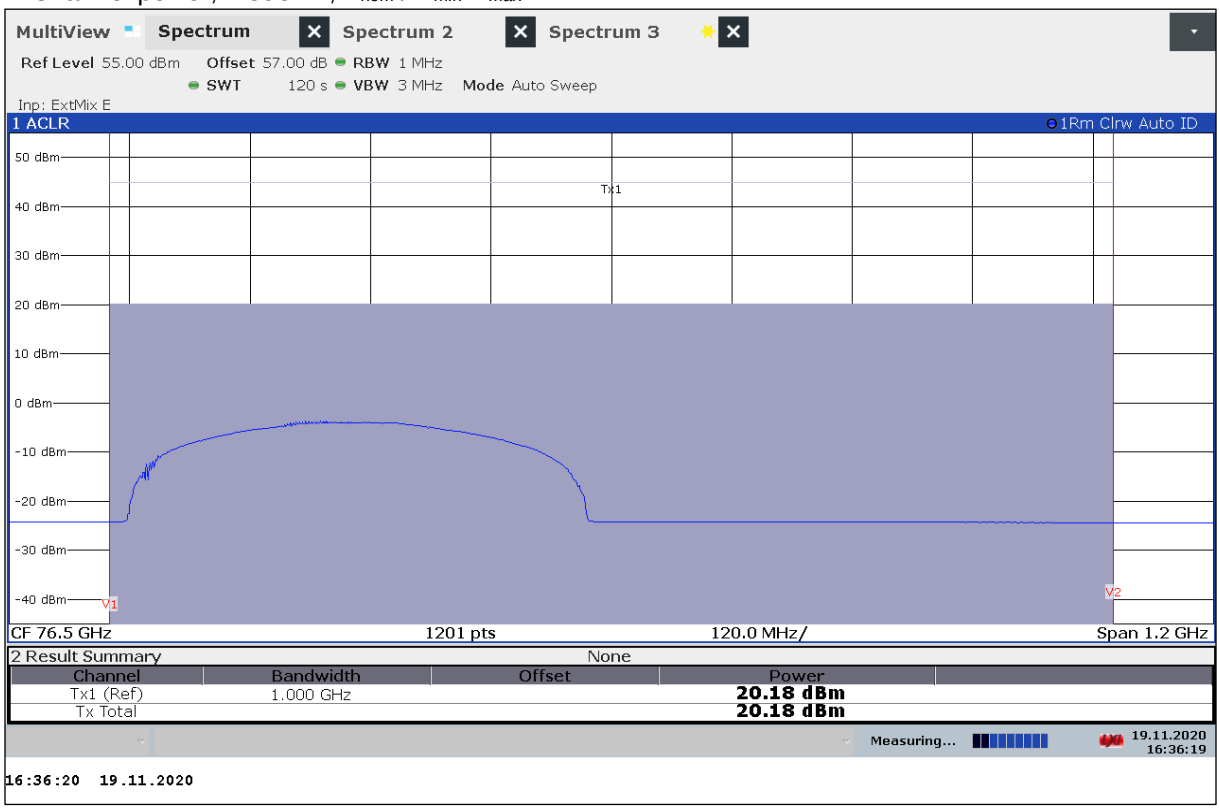
Plot 5: Channel power, Mode 21, T_{nom} / V_{min}-V_{max}



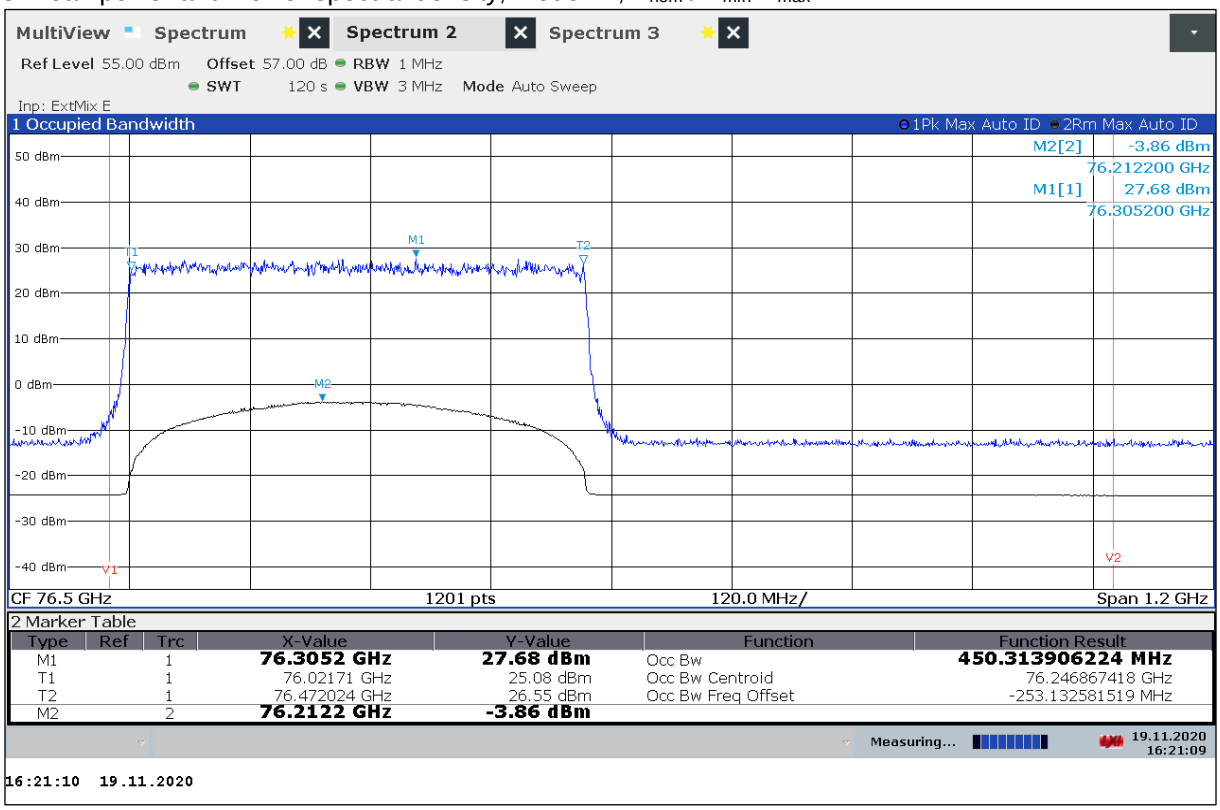
Plot 6: Peak power and Power spectral density, Mode 21, T_{nom} / V_{min}-V_{max}



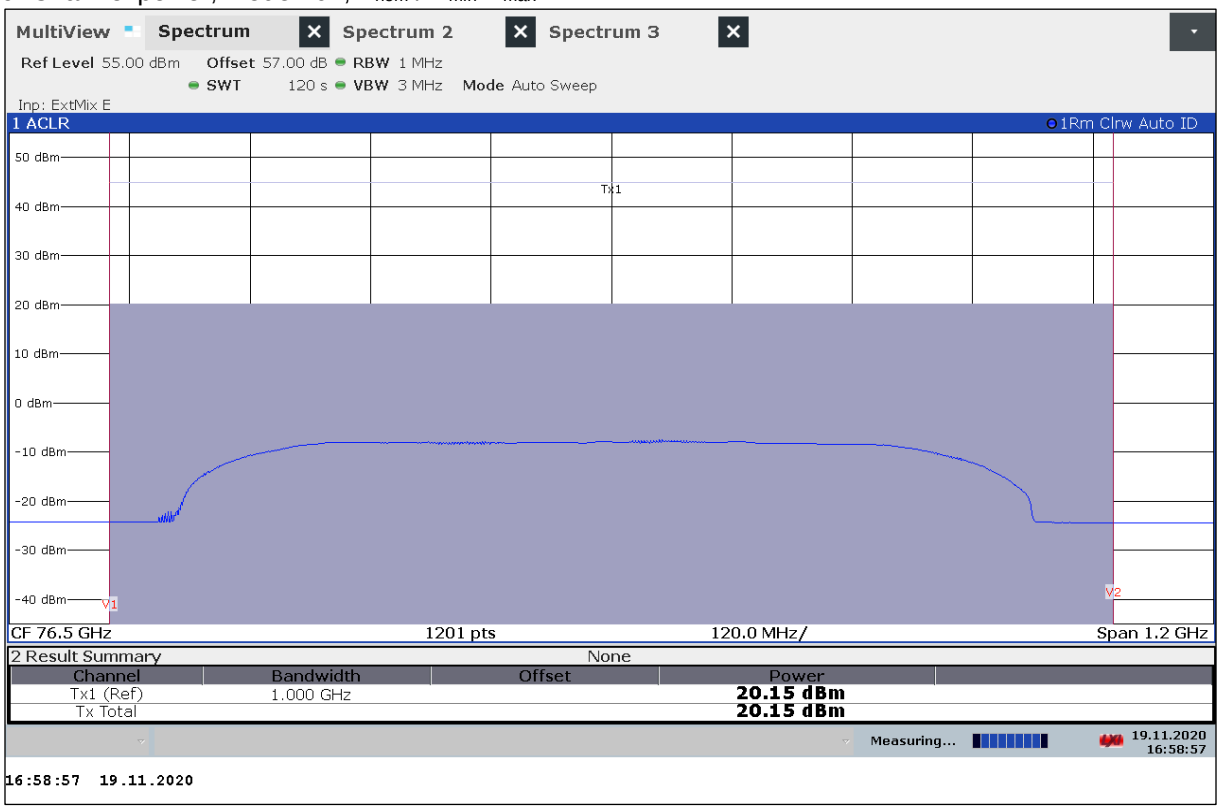
Plot 7: Channel power, Mode 27, T_{nom} / V_{min}-V_{max}



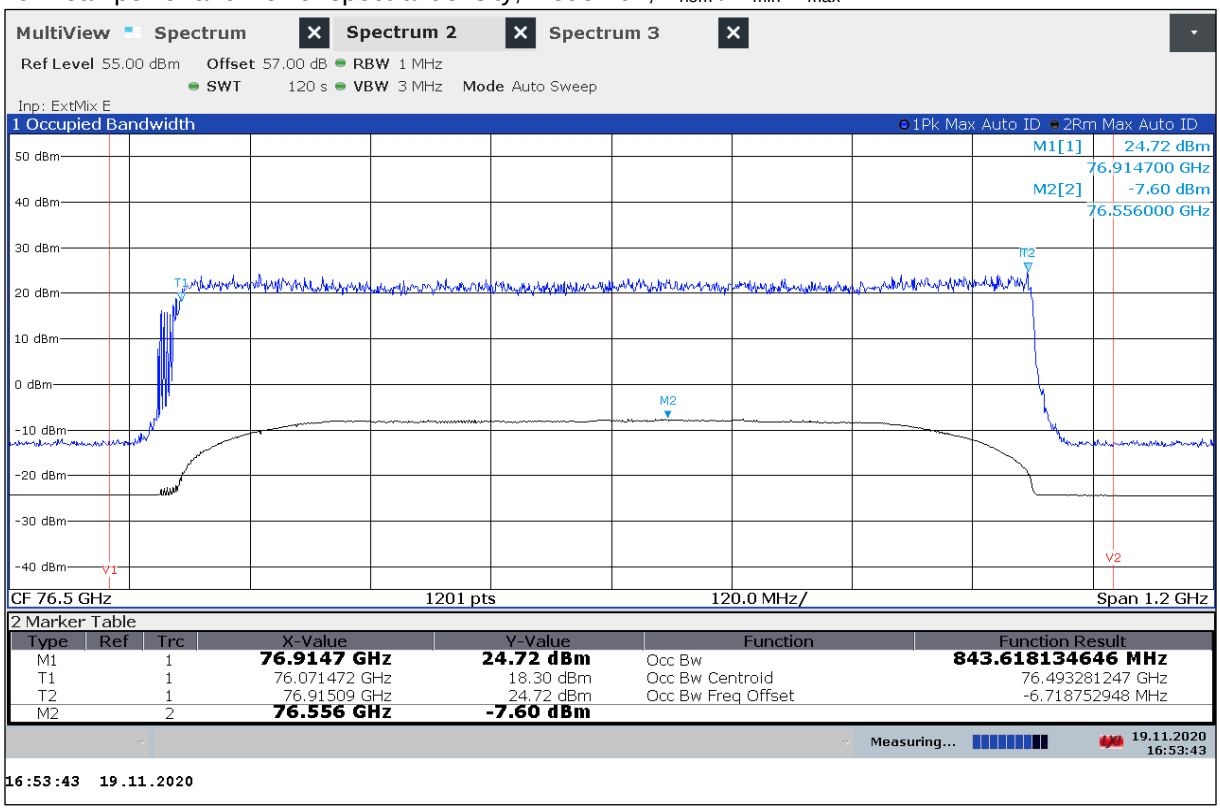
Plot 8: Peak power and Power spectral density, Mode 27, T_{nom} / V_{min}-V_{max}



Plot 9: Channel power, Mode 107, T_{nom} / V_{min}-V_{max}



Plot 10: Peak power and Power spectral density, Mode 107, T_{nom} / V_{min}-V_{max}



11.2 Modulation characteristics

Description:

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

Comments from manufacturer on modulation characteristics according to KDB:

Parameter	**ARS5-A**
Duty Cycle	40 % or less (all modes)
Timing	Typical Cycle Time: 50ms In average 20 ms RF on (512-515 Ramps).
Modulation	FM-chirps, negative Sawtooth with linear change of center frequency over sweep bandwidth
Sweep Bandwidth	Mode dependent: 460 MHz, 855 MHz, 960 MHz
Sweep rate	25600 Sweeps/second
Power	Power constant during RF on
Steepness of Ramps	Fixed steepness during given operation mode. Only varies for different bandwidth.
Calibration	No calibration routines applied
Antenna Beam Steering (Tx)	No beam steering

11.3 Occupied bandwidth

Description:

§2.1049 The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

Measurement:

Parameters	
Detector:	Pos-Peak
Sweep time:	120 s
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold
Measurement uncertainty	Span/1000

Limits: **FCC §95.3379 (b)**

Frequency range	f(lowest) > 76.0 GHz	f(highest) < 81.0 GHz

Measurement results:

Mode	Test conditions	99% Occupied Bandwidth		OBW [MHz]
		f_L [GHz]	f_H [GHz]	
3	T_{nom} / $V_{min-max}$	76.026 804	76.965 537	938.7
9	T_{nom} / $V_{min-max}$	76.022 148	76.471 778	449.6
21	T_{nom} / $V_{min-max}$	76.027 012	76.965 113	938.1
27	T_{nom} / $V_{min-max}$	76.021 710	76.472 024	450.3
107	T_{nom} / $V_{min-max}$	76.071 472	76.915 090	843.6

Note: Voltage variation does not affect the radiated signal

11.4 Field strength of spurious emissions

Description:

The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

Limits: **FCC §95.3379**

FCC		
CFR Part 95.3379 (a) (1) / CFR Part 95.3379 (a) (3)		
Radiated Spurious Emissions		
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.		
Frequency [MHz]	Field Strength [dBµV/m]	Measurement distance
0.009 – 0.490	2400/F[kHz]	300
0.490 – 1.705	24000/F[kHz]	30
1.705 – 30.0	30	30
30 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
960 – 40 000	54.0	3

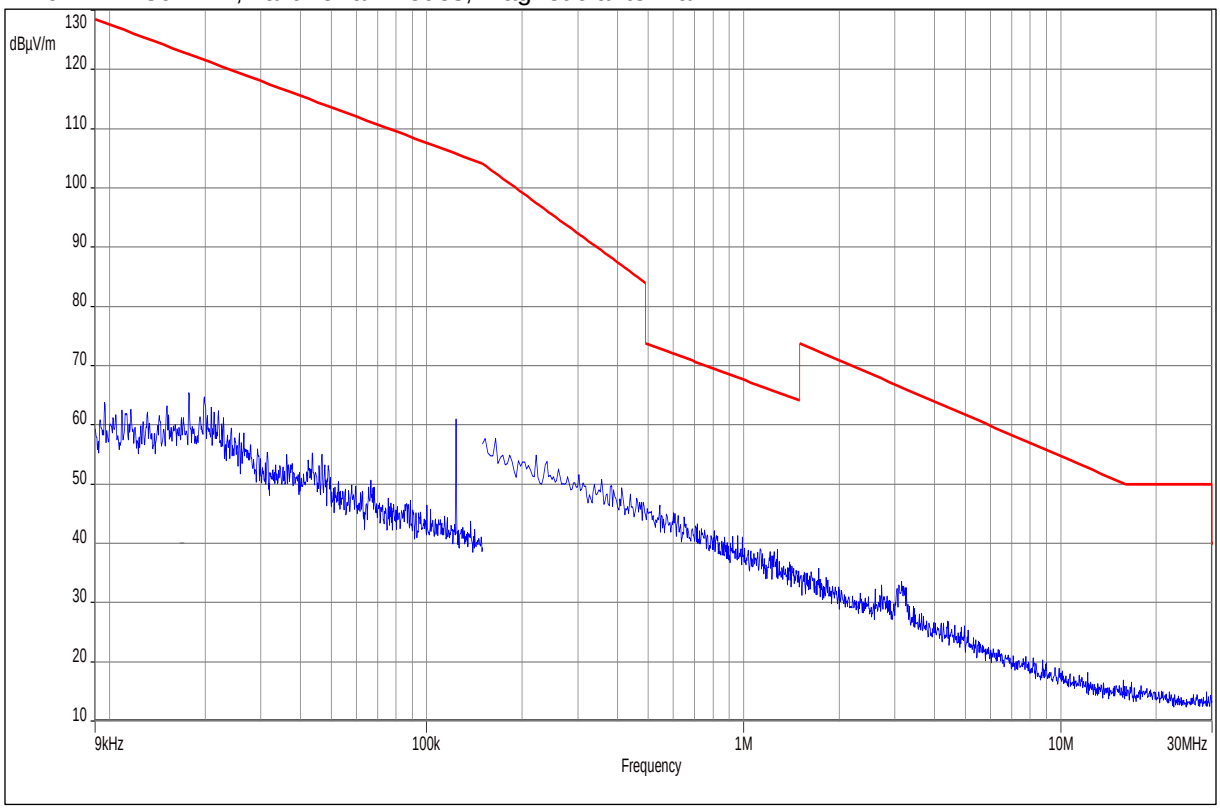
Limits: **FCC §95.3379 (a) (2) (i) + (ii)**

Frequency Range [GHz]	Measurement distance	Power Density
40 – 200	3.0 m	600 pW/cm² → -1.7 dBm
200 – 231	3.0 m	1000 pW/cm² → +0.5 dBm

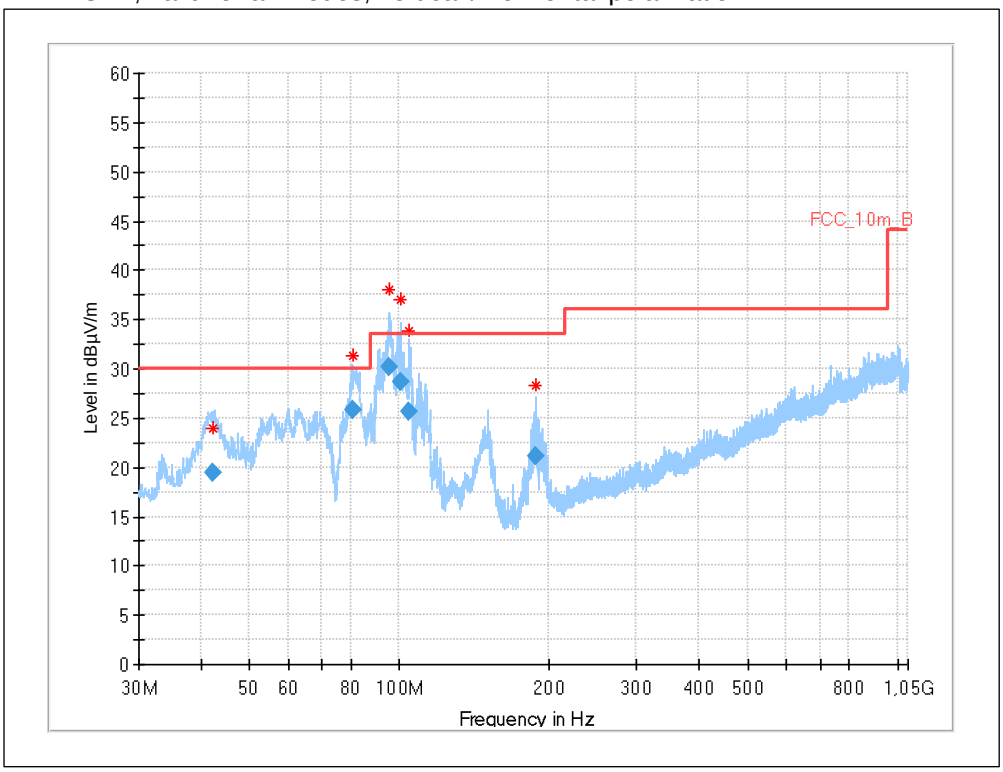
Measurement results:

Frequency in [GHz]	Detector	Bandwidth [MHz]	Level [dBµV]	Distance [m]	Limit [dBµV]	Margin [dB]
19.2 GHz (Worst case)	AVG	1	31.4	1	54	22.6
28.8 GHz (Worst case)	AVG	1	46.3	1	54	7.7

Plot 11: 9 kHz – 30 MHz, valid for all Modes, Magnetic antenna

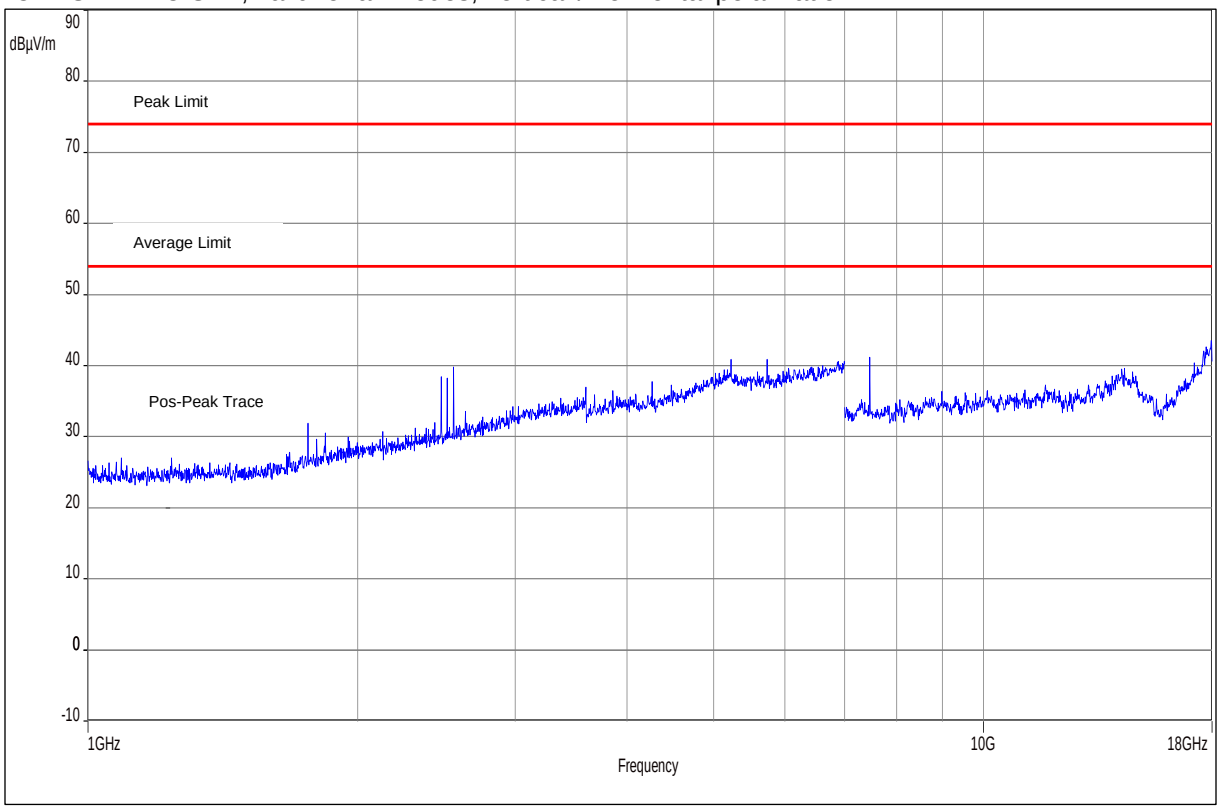


Plot 12: 30 MHz – 1 GHz, valid for all Modes, vertical / horizontal polarization

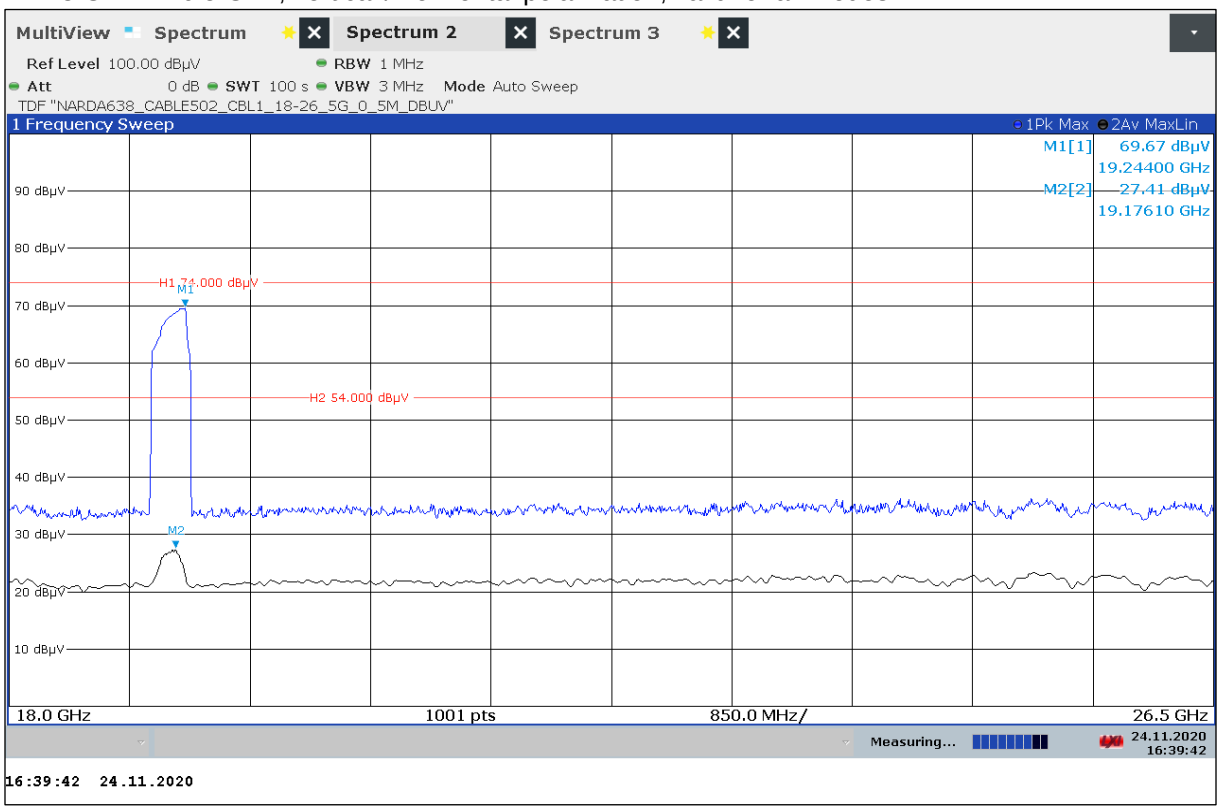


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
42.231	19.44	30.0	10.6	1000	120.0	106.0	V	9	14
80.775	25.79	30.0	4.2	1000	120.0	276.0	V	308	7
95.516	30.23	33.5	3.3	1000	120.0	138.0	V	241	12
100.540	28.68	33.5	4.8	1000	120.0	106.0	V	234	13
104.733	25.65	33.5	7.9	1000	120.0	116.0	V	223	13
187.397	21.14	33.5	12.4	1000	120.0	120.0	V	209	11

Plot 13: 1 GHz – 18 GHz, valid for all Modes, vertical / horizontal polarization

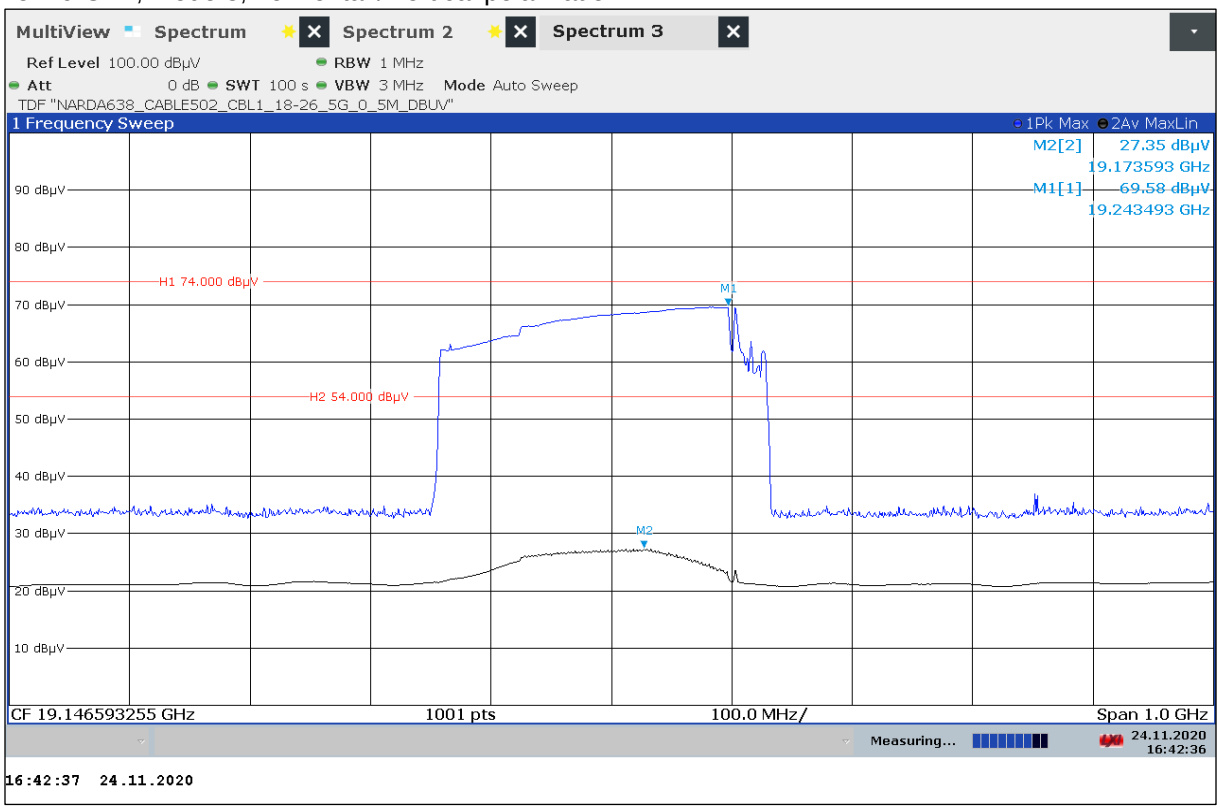


Plot 14: 18 GHz – 26.5 GHz, vertical / horizontal polarization, valid for all modes



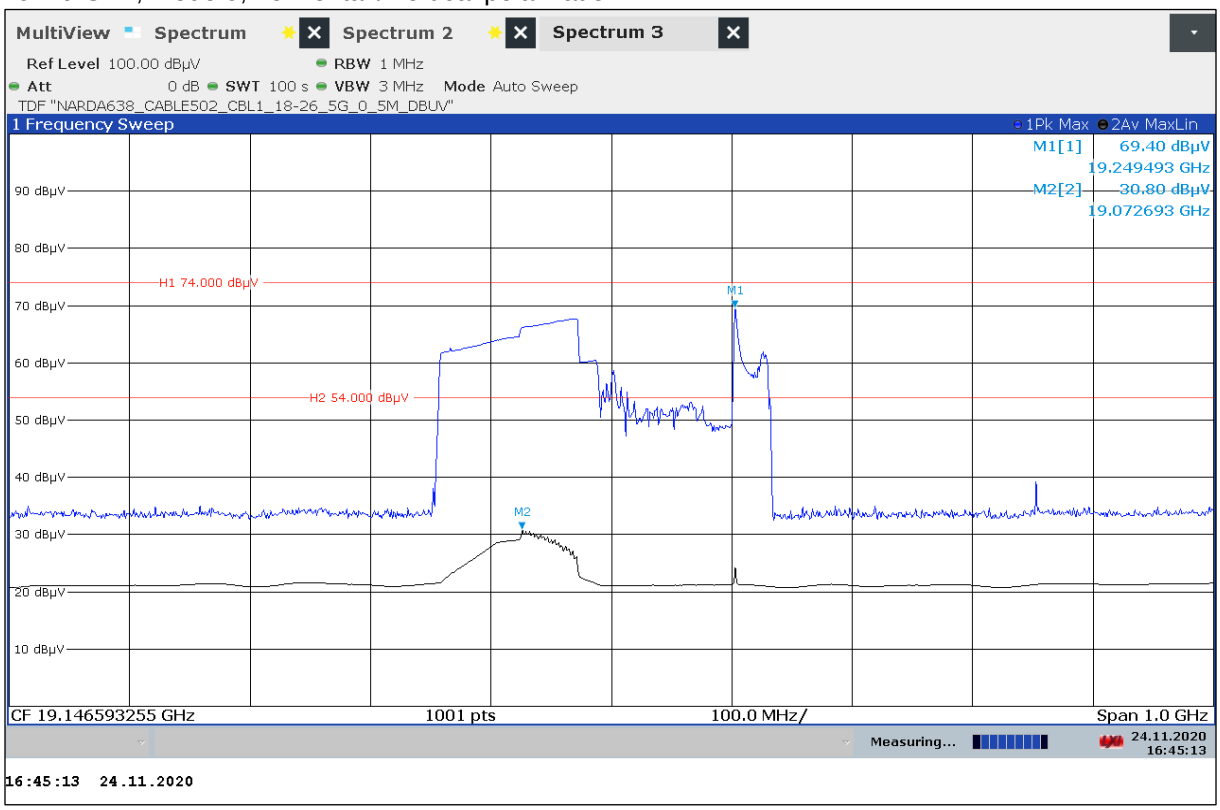
See next plots, plot 35-36-37-38-39

Plot 15: 19 GHz, Mode 3, horizontal / vertical polarization



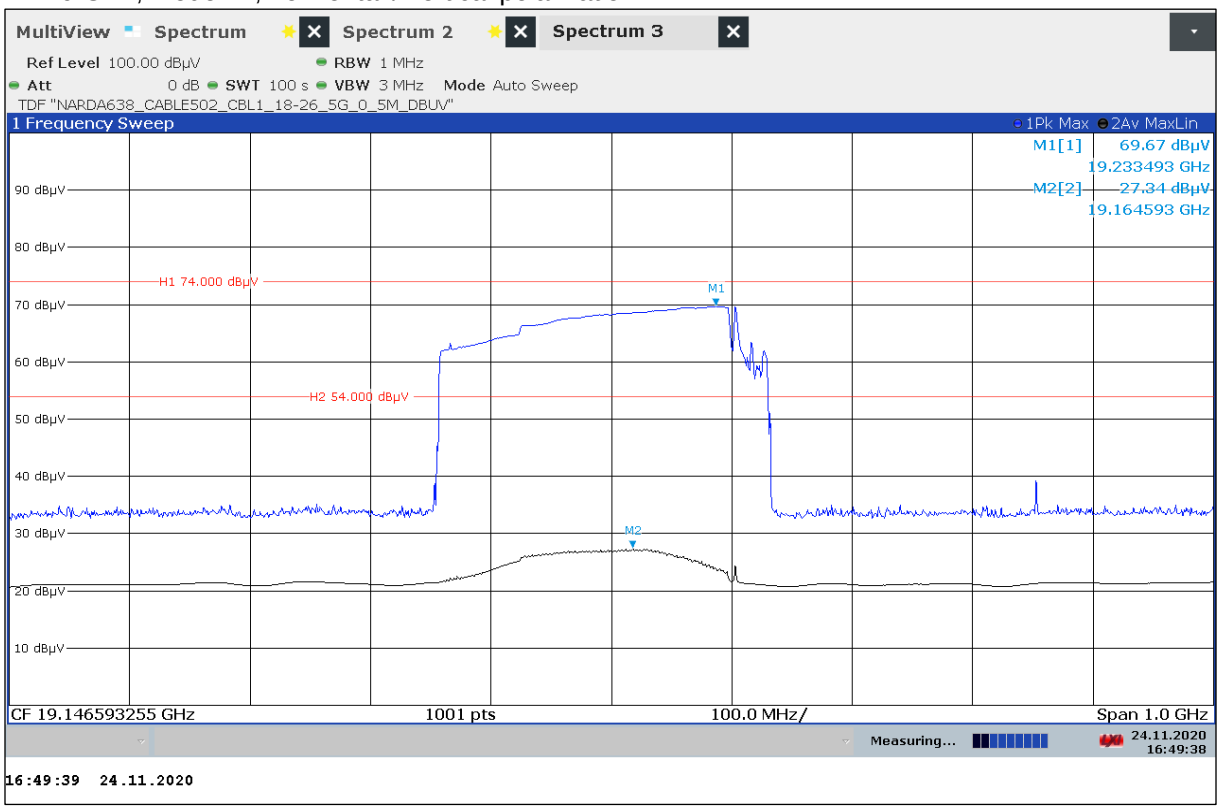
Peak Value: 69.58 dBµV/m (Informative – no limit) / Average 27.35 dBµV/m (Limit 54 dBµV/m)

Plot 16: 19 GHz, Mode 9, horizontal / vertical polarization



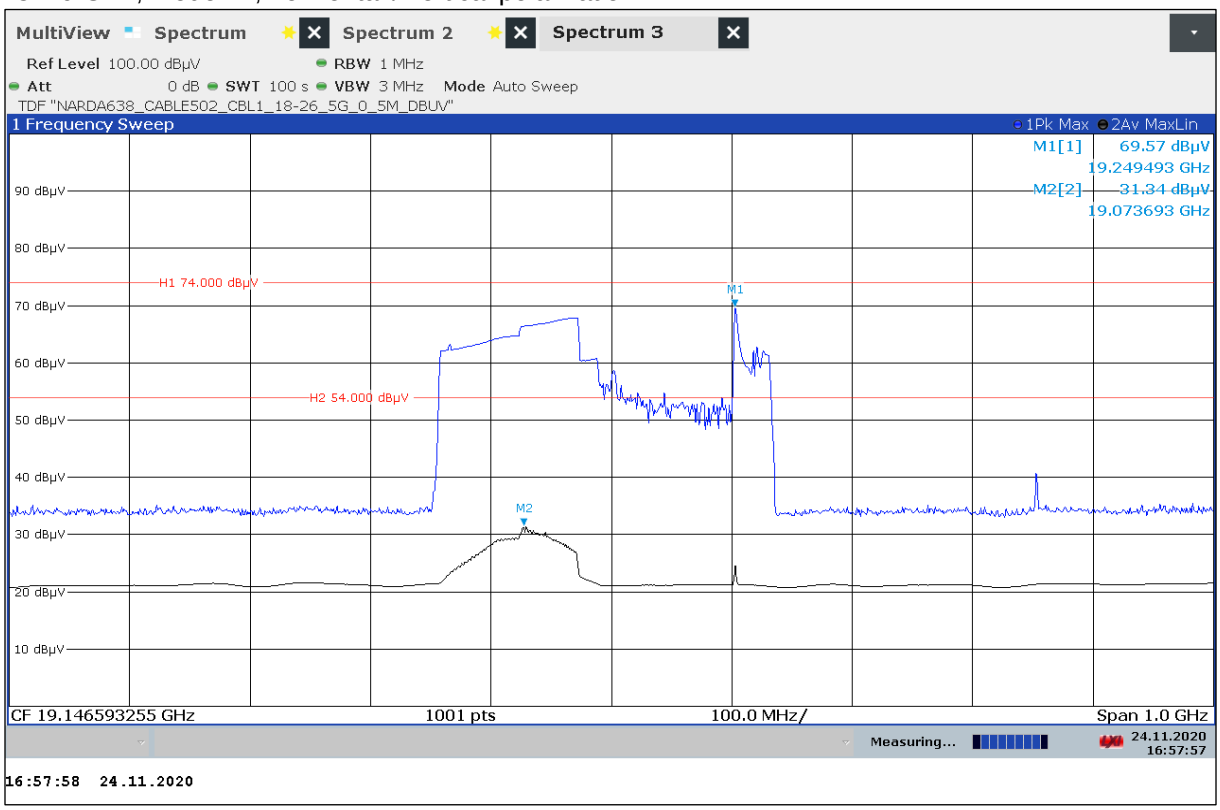
Peak Value: 69.40 dBµV/m (Informative – no limit) / Average 30.80 dBµV/m (Limit 54 dBµV/m)

Plot 17: 19 GHz, Mode 21, horizontal / vertical polarization



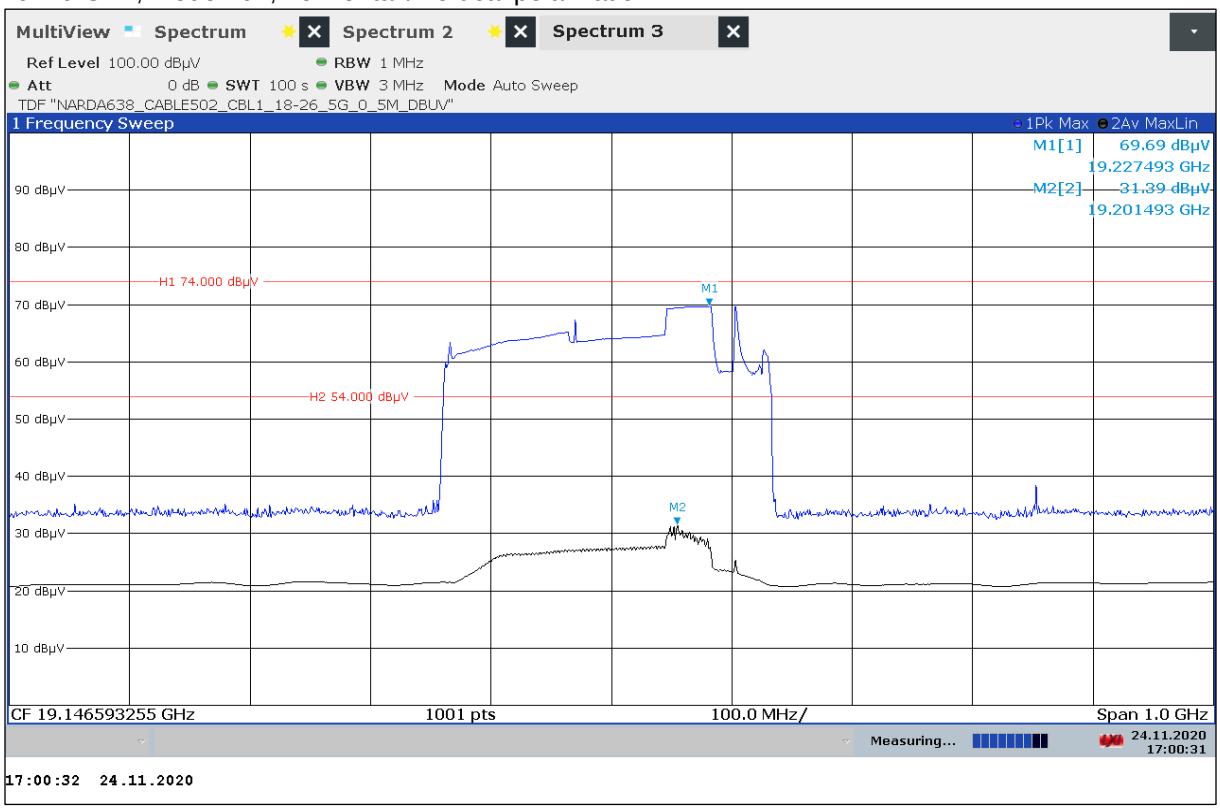
Peak Value: 69.67 dBµV/m (Informative – no limit) / Average 27.34 dBµV/m (Limit 54 dBµV/m)

Plot 18: 19 GHz, Mode 27, horizontal / vertical polarization



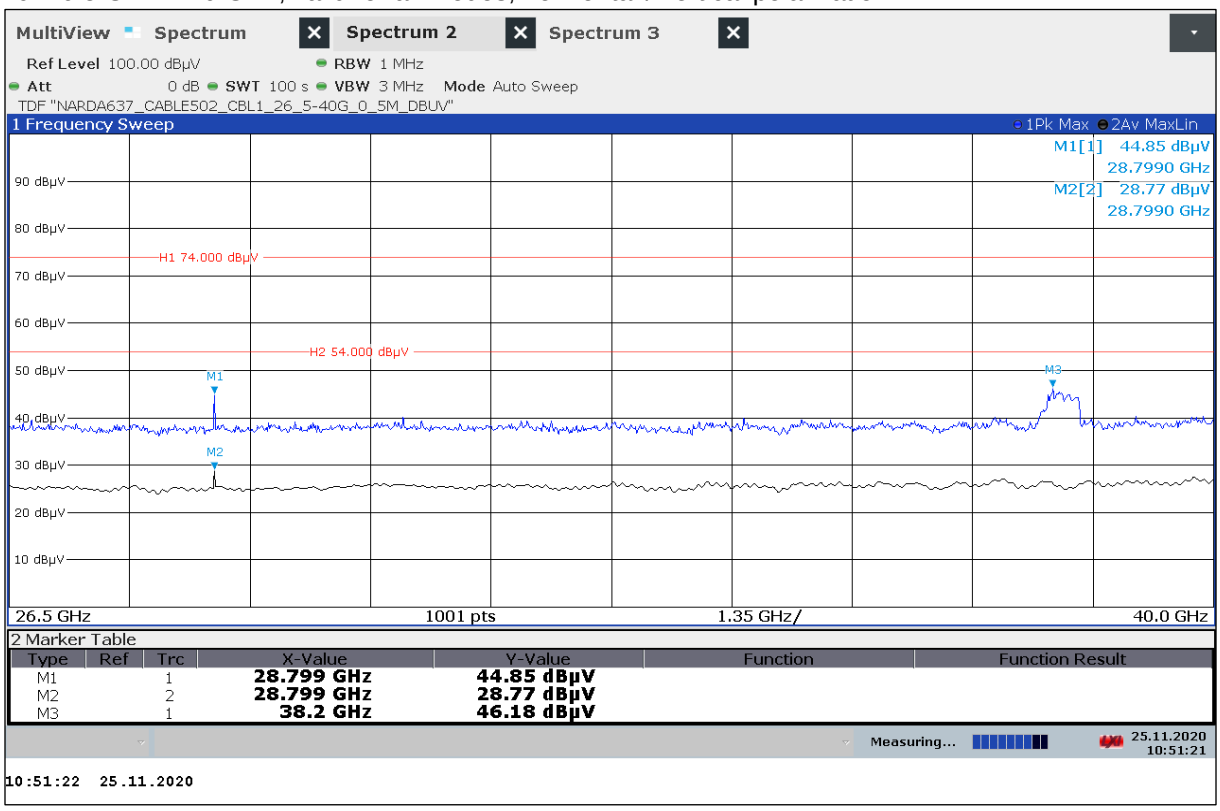
Peak Value: 69.57 dBµV/m (Informative – no limit) / Average 31.34 dBµV/m (Limit 54 dBµV/m)

Plot 19: 19 GHz, Mode 107, horizontal / vertical polarization



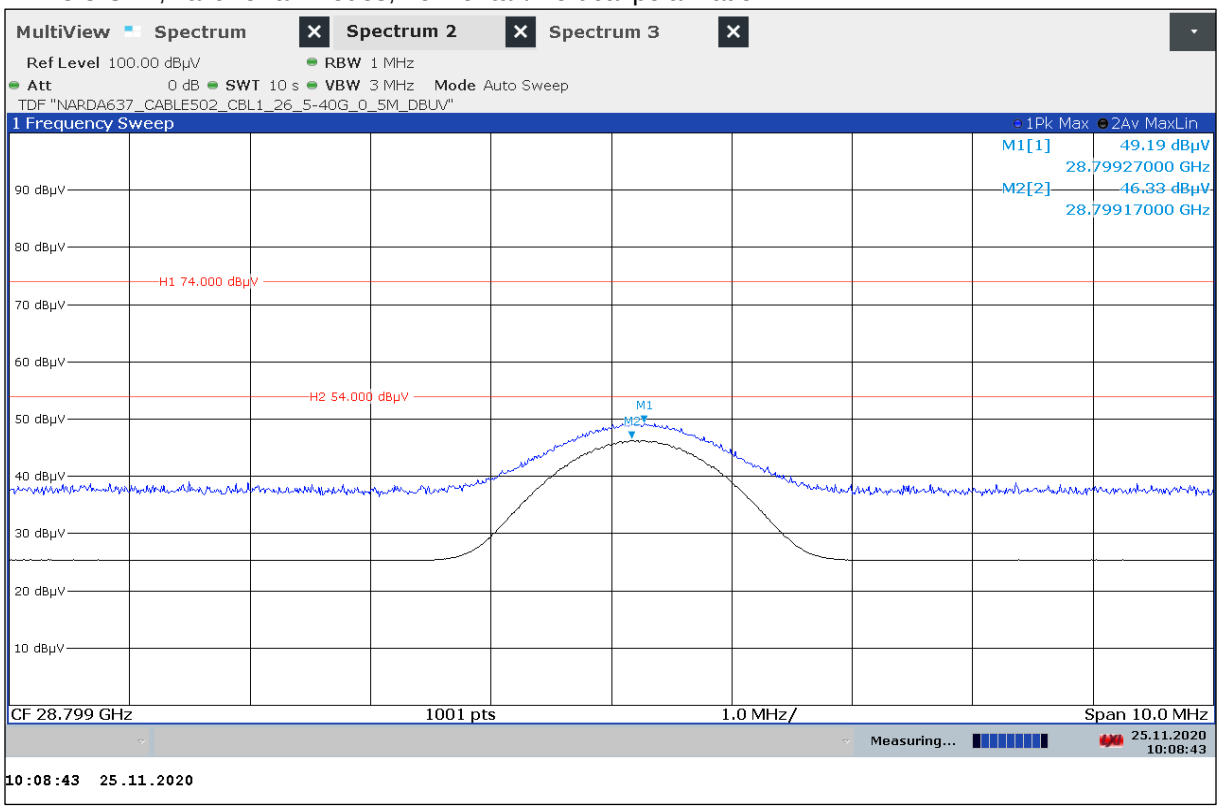
Peak Value: 69.69 dBµV/m (Informative – no limit) / Average 31.39 dBµV/m (Limit 54 dBµV/m)

Plot 20: 26.5 GHz – 40 GHz, valid for all modes, horizontal / vertical polarization



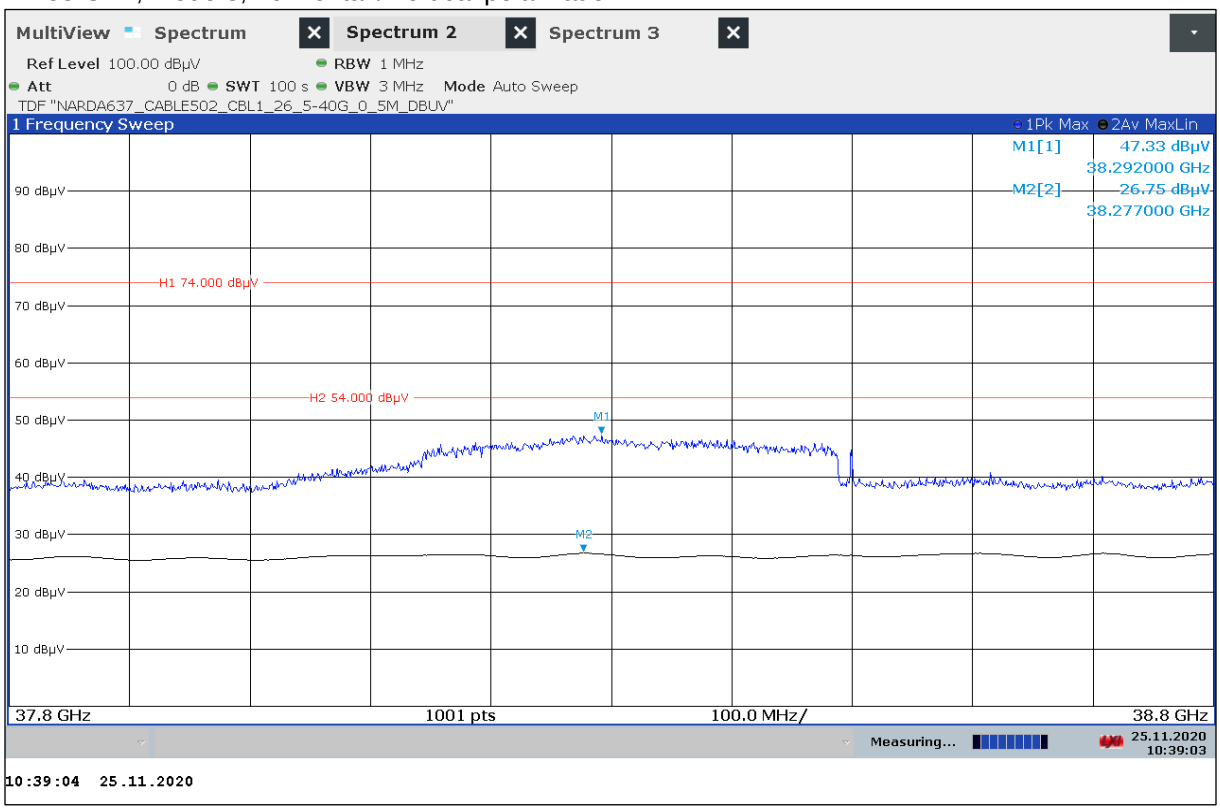
See next plots, plot 41-42-43-44-45-46

Plot 21: 28.8 GHz, valid for all modes, horizontal / vertical polarization



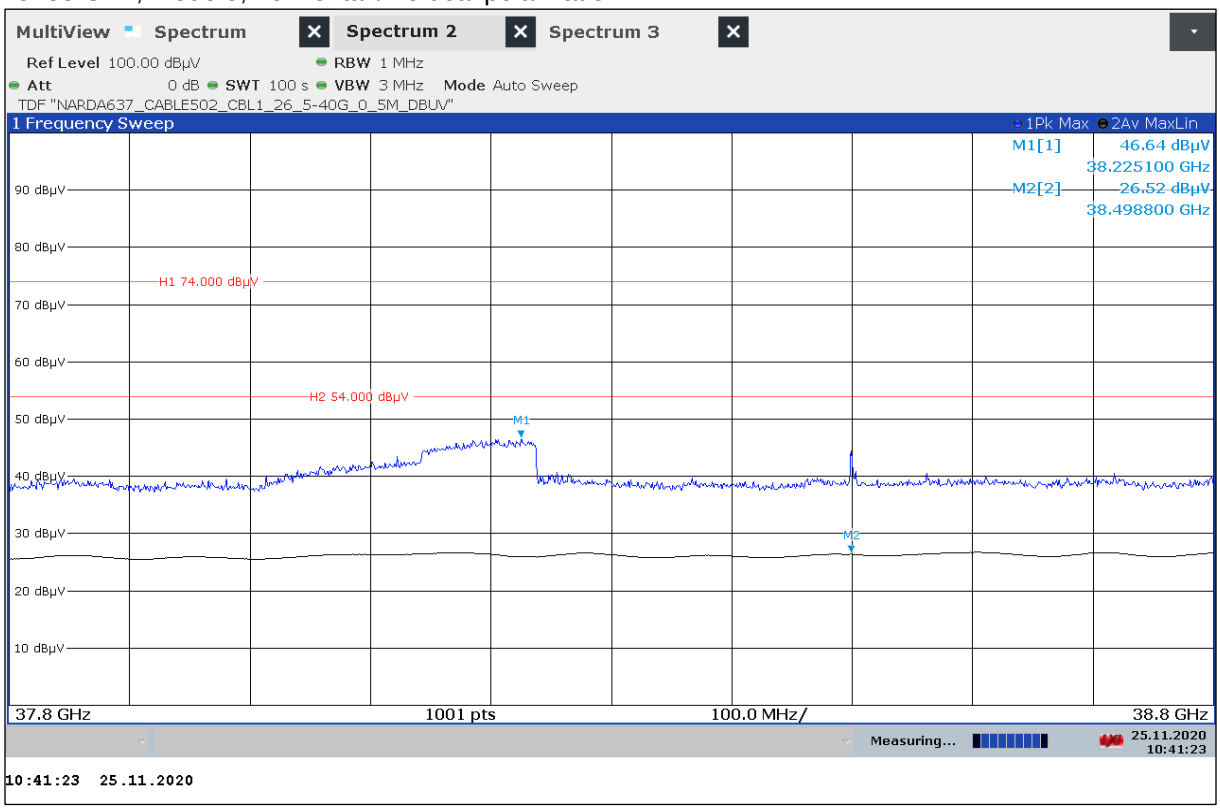
Peak Value: 49.19 dBµV/m (Informative – no limit) / Average 46.33 dBµV/m (Limit 54 dBµV/m)

Plot 22: 38 GHz, Mode 3, horizontal / vertical polarization



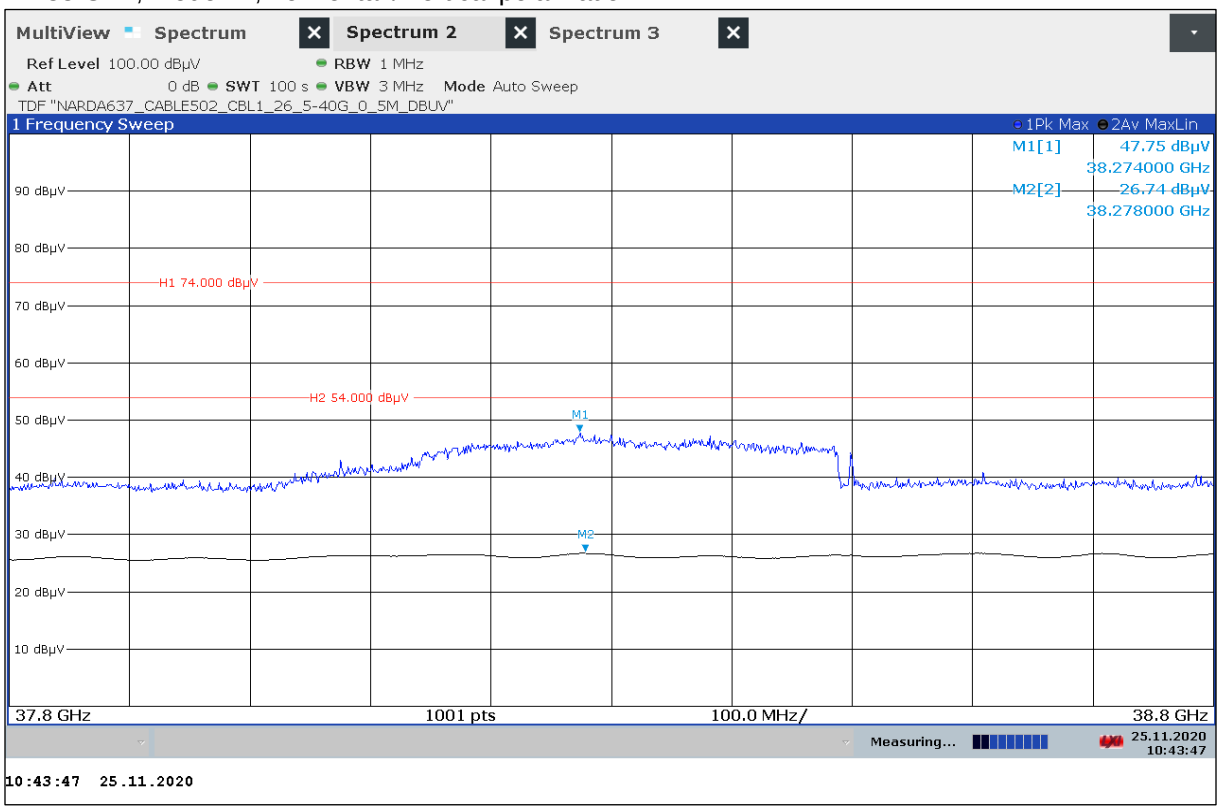
Peak Value: 47.33 dBµV/m (Informative – no limit) / Average 26.75 dBµV/m (Limit 54 dBµV/m)

Plot 23: 38 GHz, Mode 9, horizontal / vertical polarization



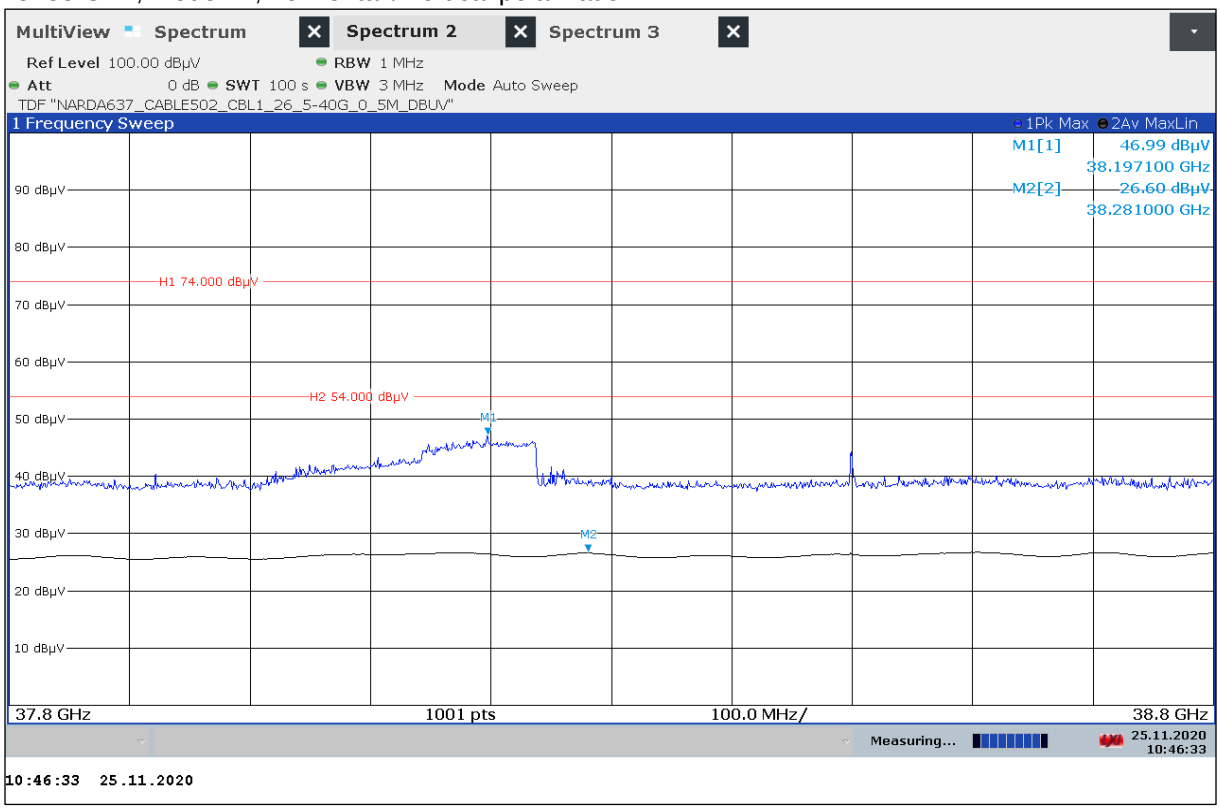
Peak Value: 46.64 dBµV/m (Informative – no limit) / Average 26.52 dBµV/m (Limit 54 dBµV/m)

Plot 24: 38 GHz, Mode 21, horizontal / vertical polarization



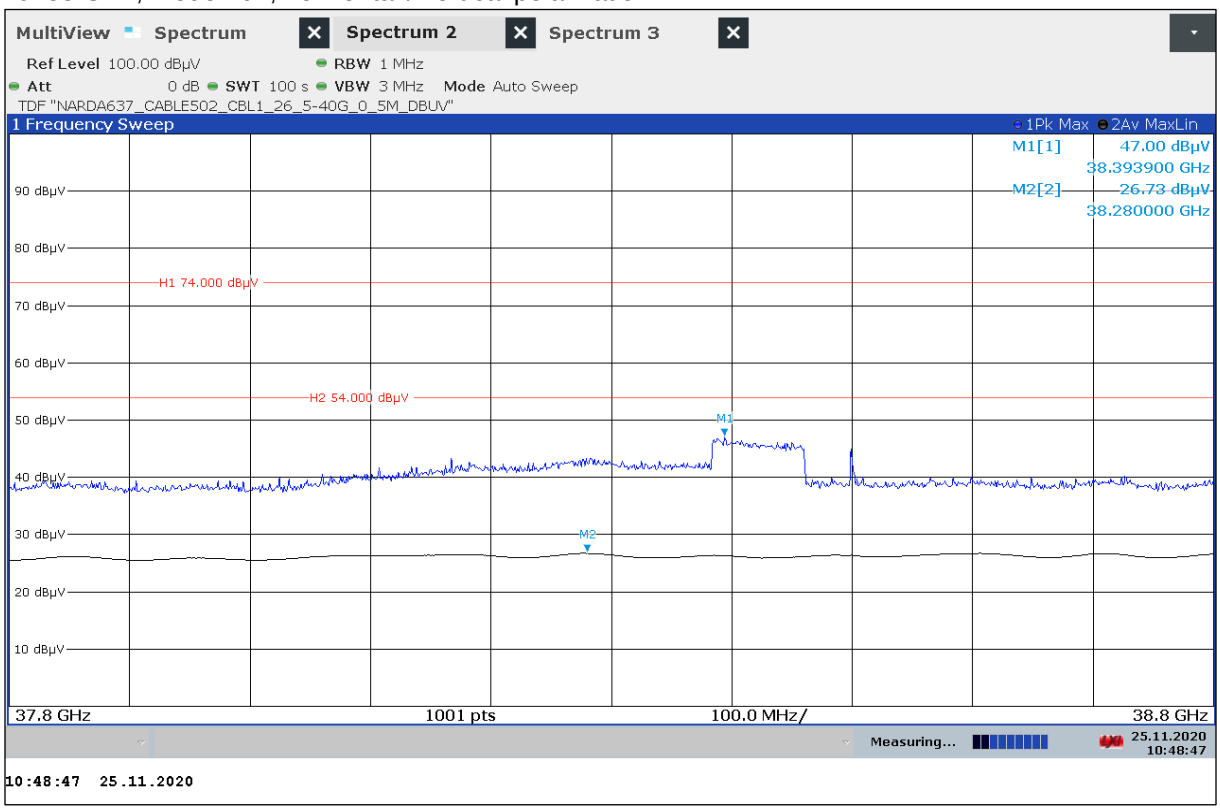
Peak Value: 47.75 dBµV/m (Informative – no limit) / Average 26.74 dBµV/m (Limit 54 dBµV/m)

Plot 25: 38 GHz, Mode 27, horizontal / vertical polarization



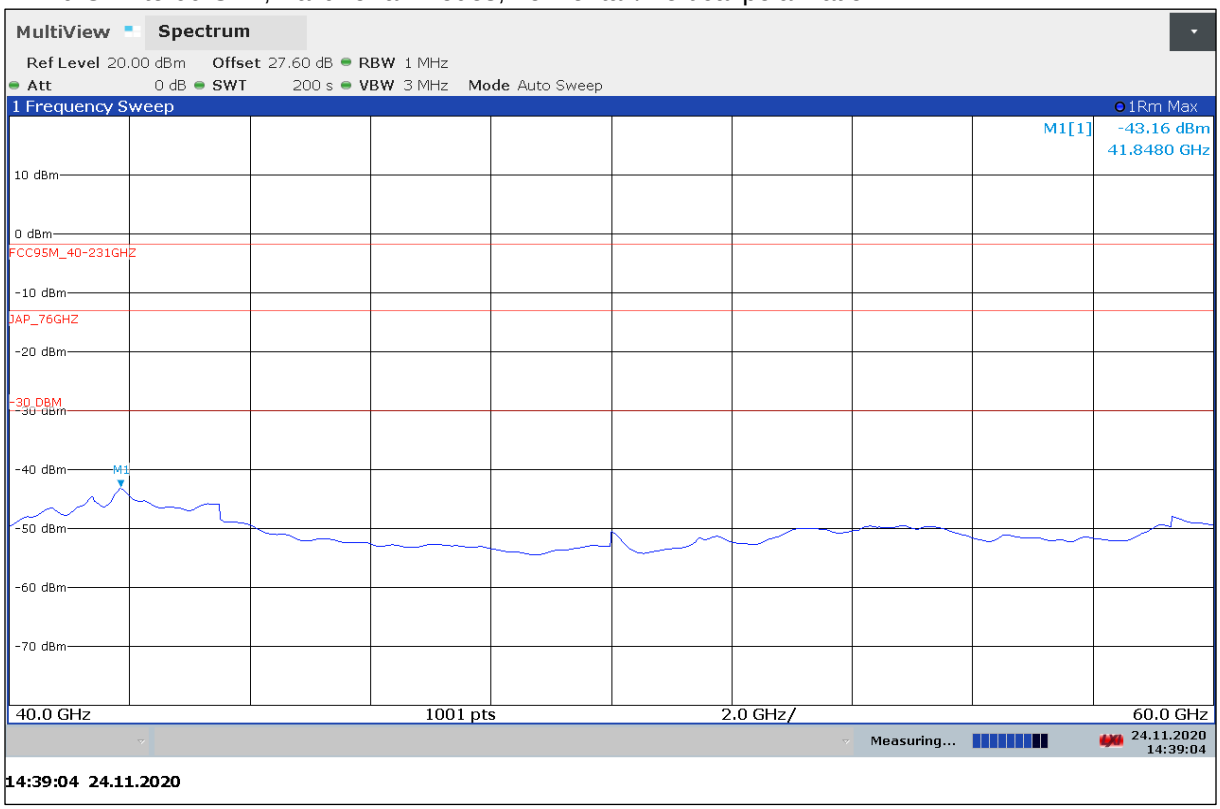
Peak Value: 46.99 dBµV/m (Informative – no limit) / Average 26.60 dBµV/m (Limit 54 dBµV/m)

Plot 26: 38 GHz, Mode 107, horizontal / vertical polarization



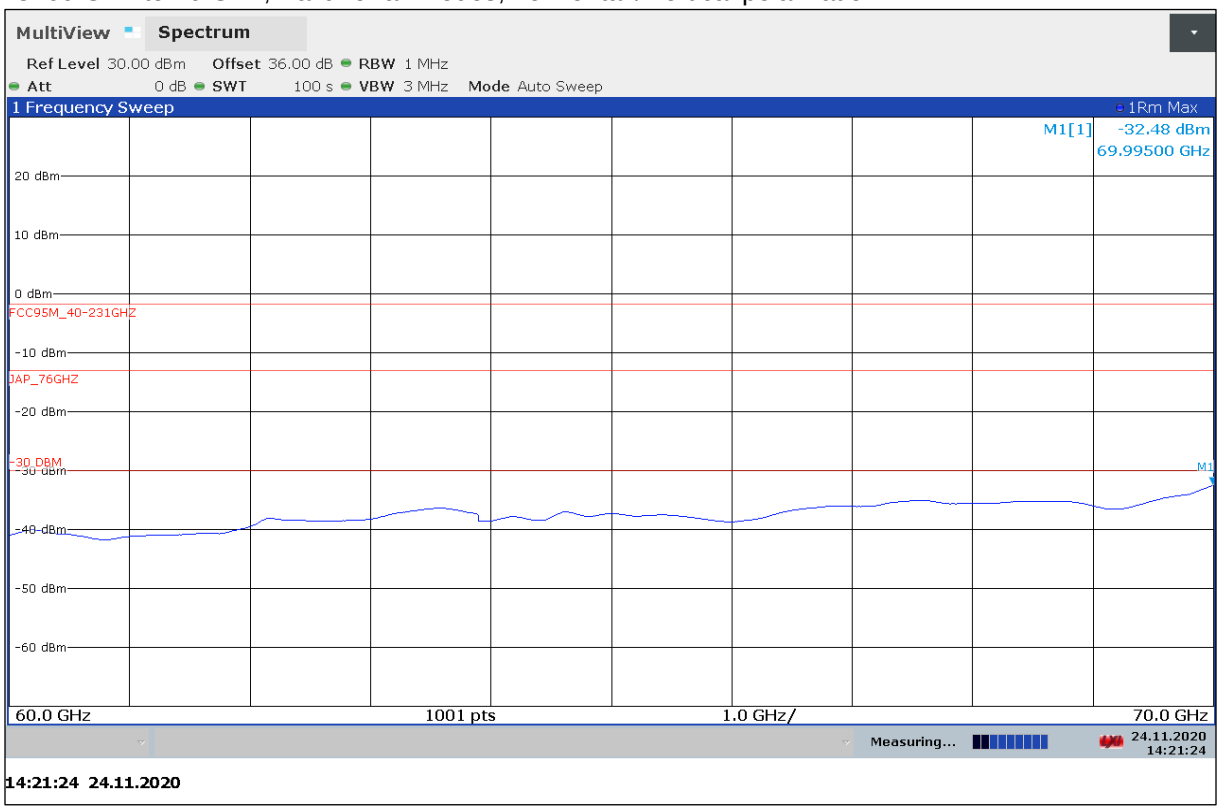
Peak Value: 47.00 dBµV/m (Informative – no limit) / Average 26.73 dBµV/m (Limit 54 dBµV/m)

Plot 27: 40 GHz to 60 GHz, Valid for all Modes, horizontal / vertical polarization



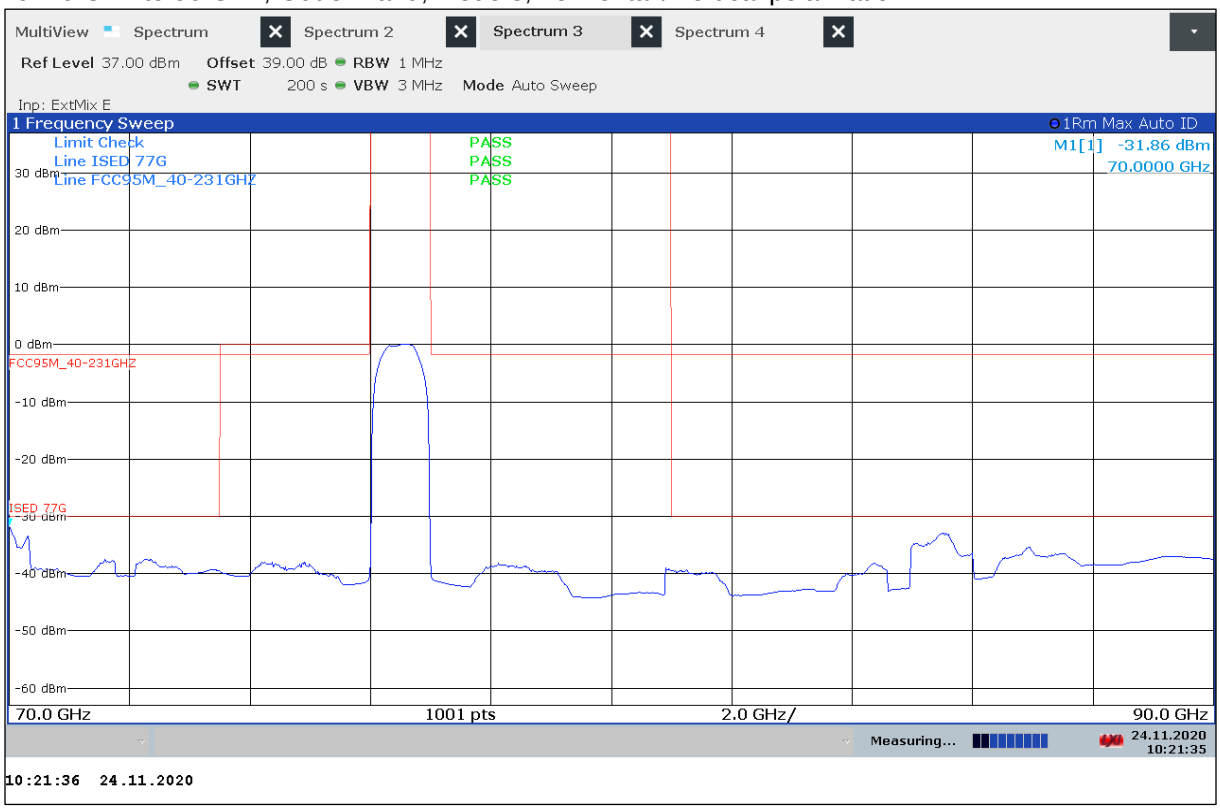
RMS Value: -43.16 dBm (Limit -1.7 dBm)

Plot 28: 60 GHz to 70 GHz, Valid for all Modes, horizontal / vertical polarization

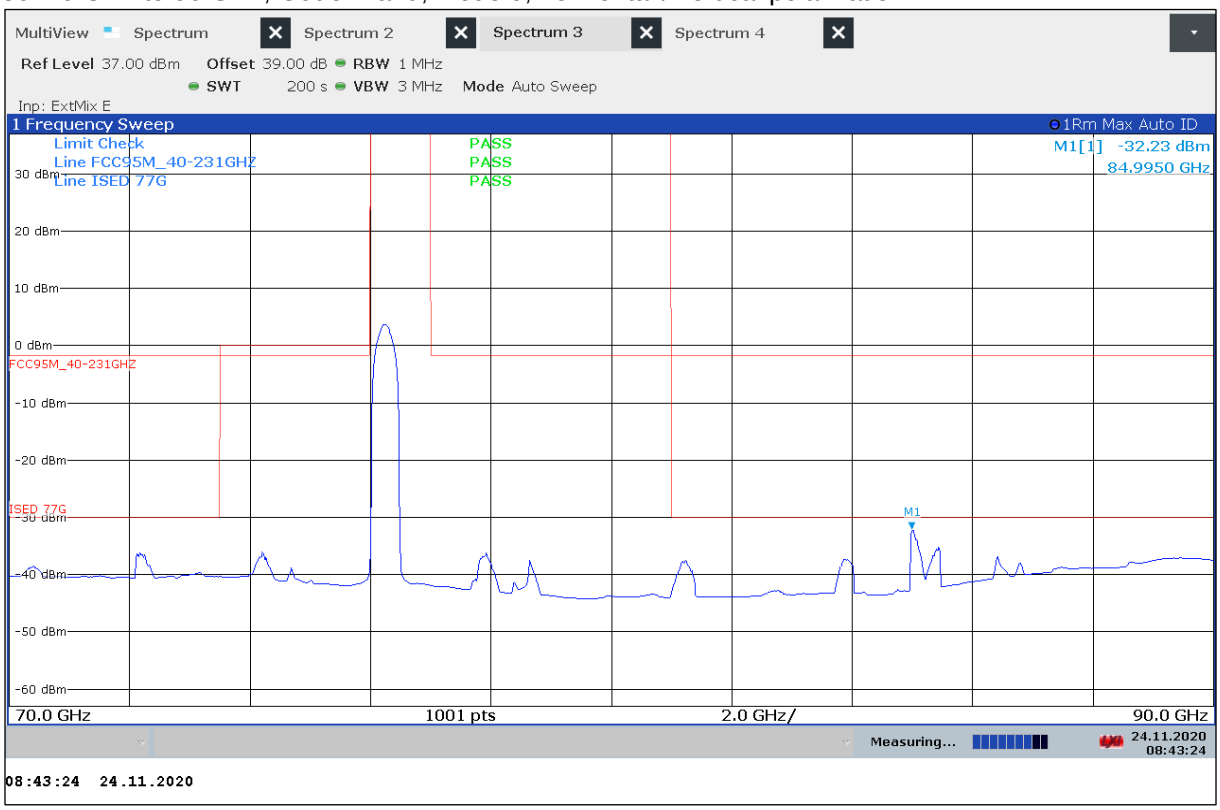


RMS Value: -32.48 dBm (Limit -1.7 dBm)

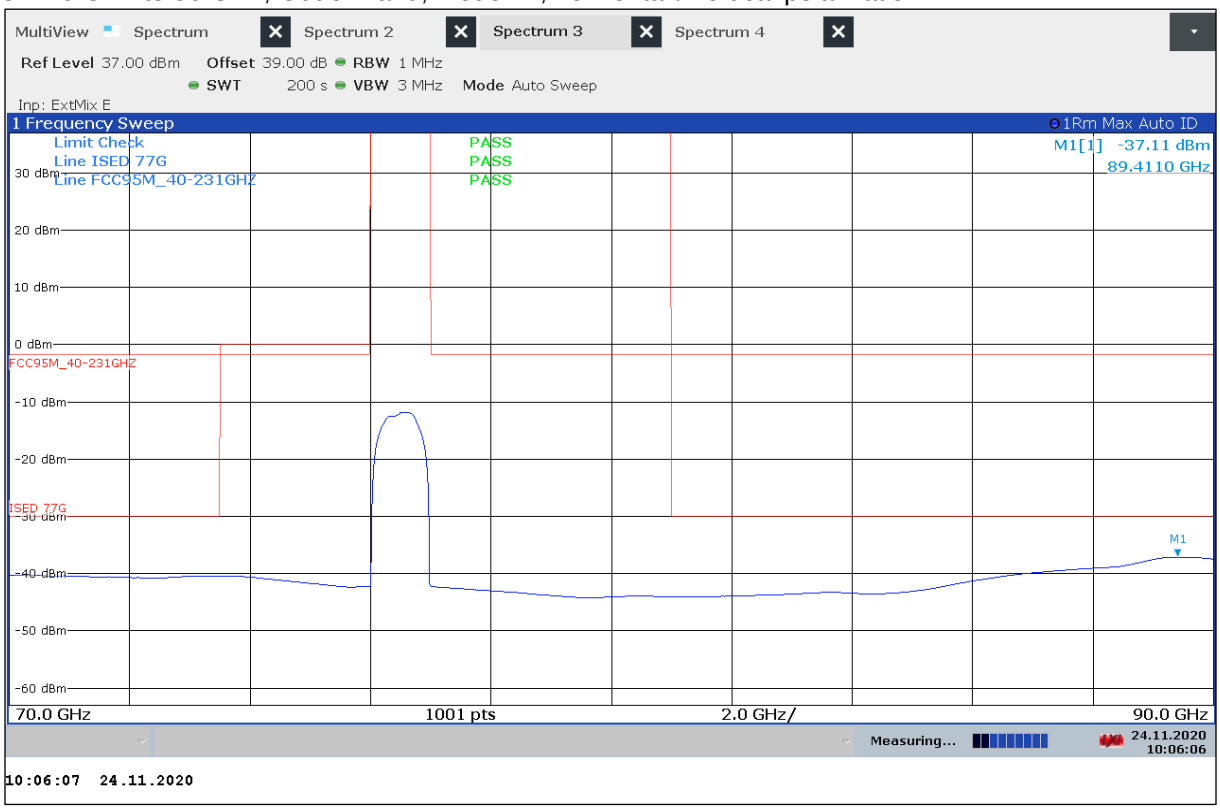
Plot 29: 70 GHz to 90 GHz, Out of Band, Mode 3, horizontal / vertical polarization



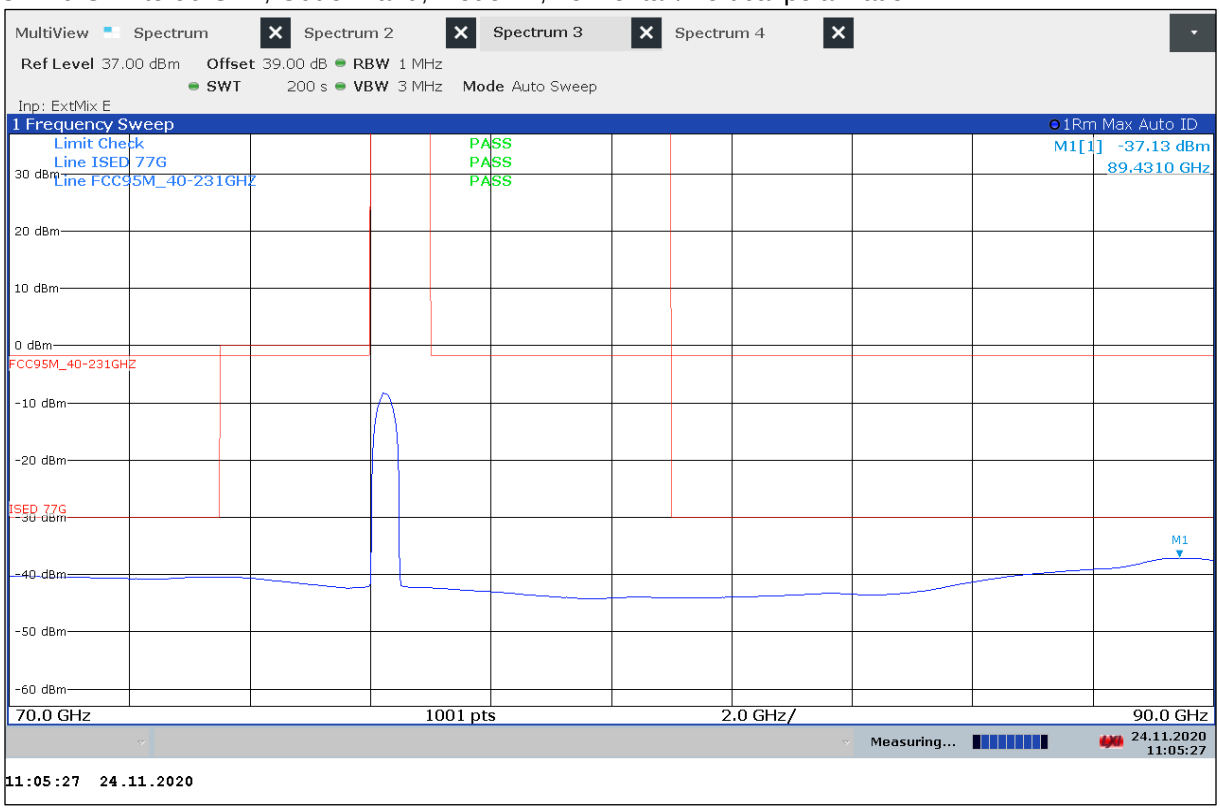
Plot 30: 70 GHz to 90 GHz, Out of Band, Mode 9, horizontal / vertical polarization



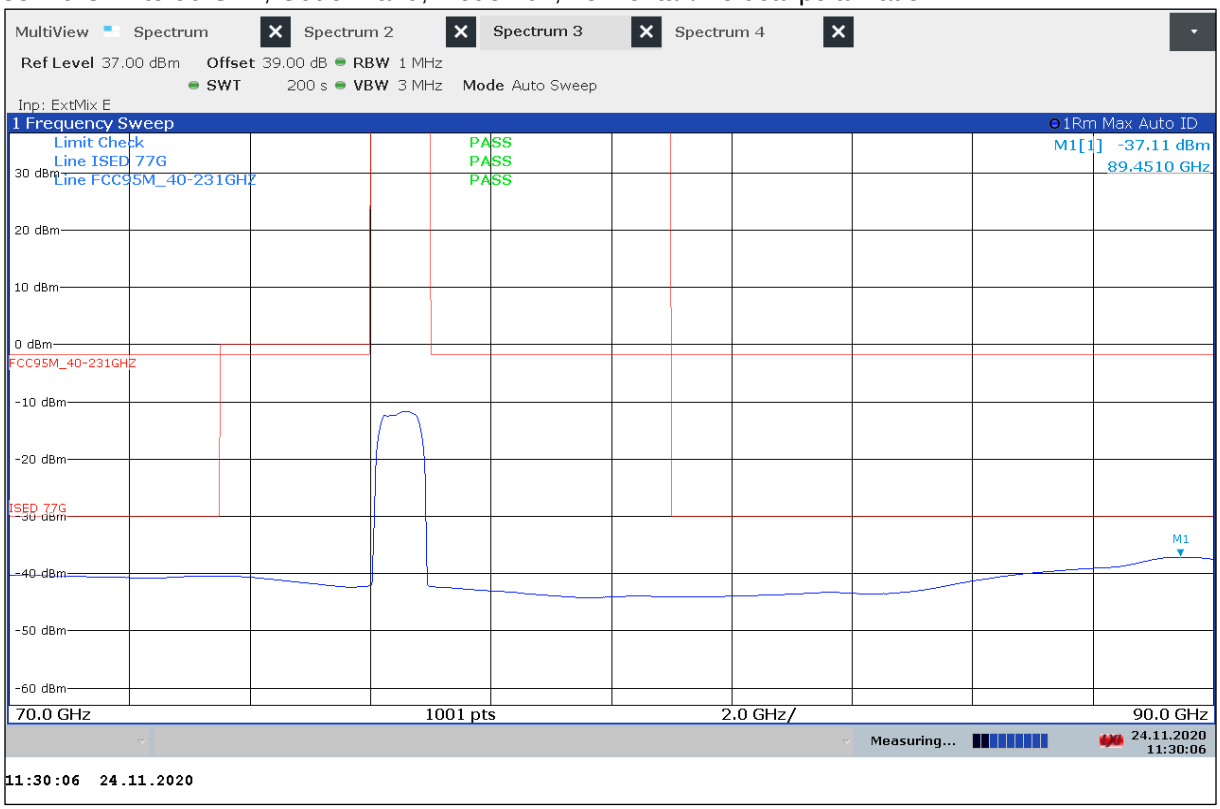
Plot 31: 70 GHz to 90 GHz, Out of Band, Mode 21, horizontal / vertical polarization



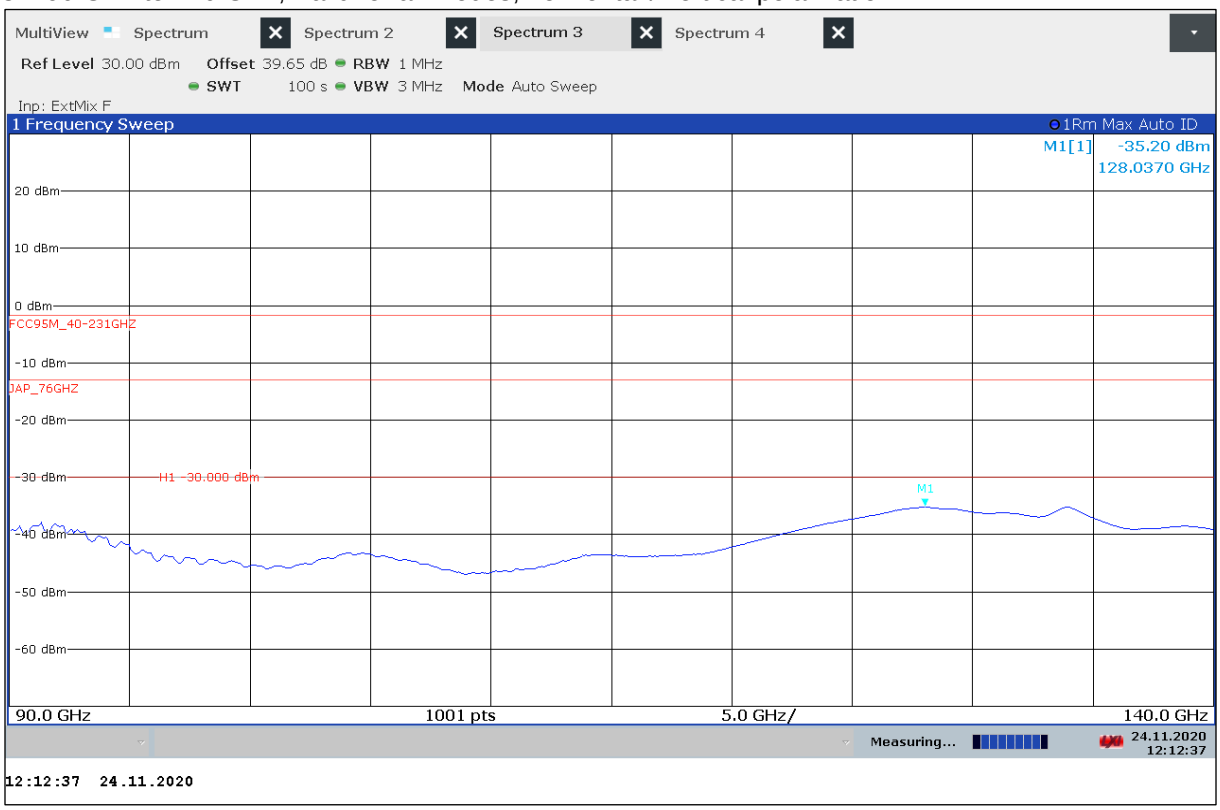
Plot 32: 70 GHz to 90 GHz, Out of Band, Mode 27, horizontal / vertical polarization



Plot 33: 70 GHz to 90 GHz, Out of Band, Mode 107, horizontal / vertical polarization

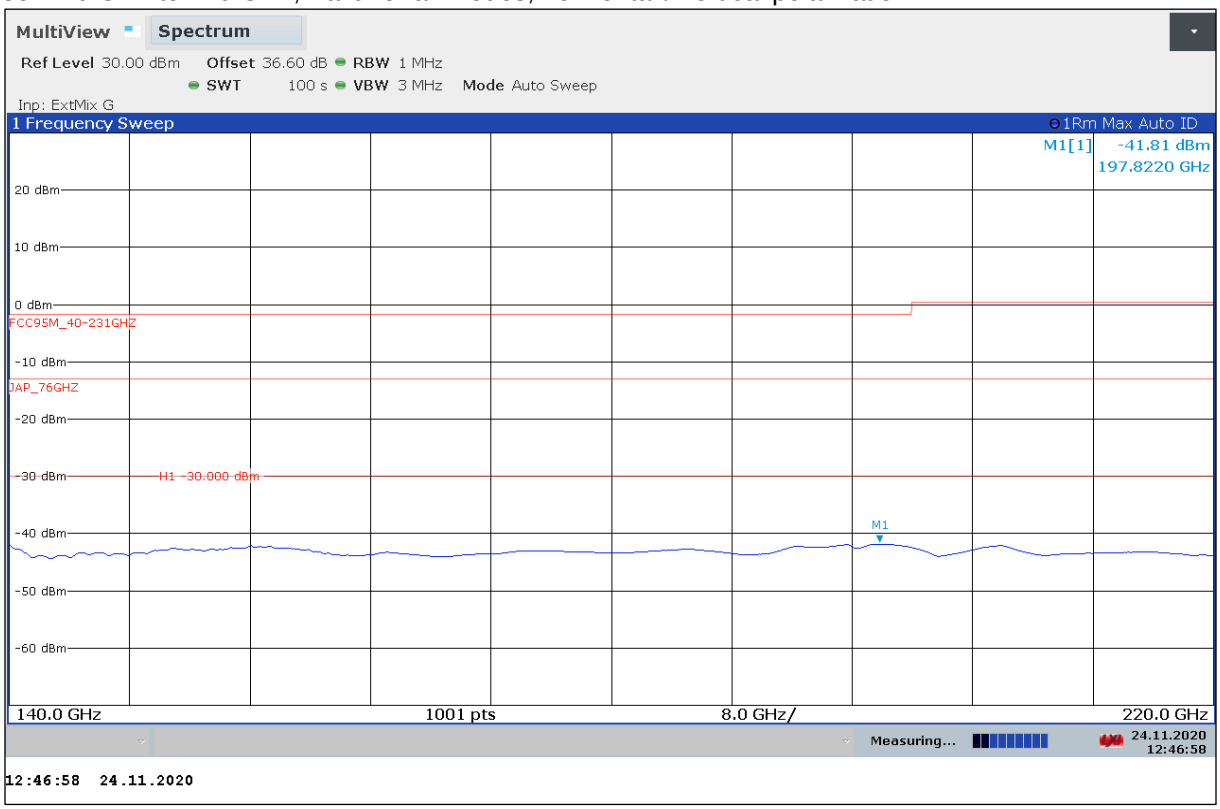


Plot 34: 90 GHz to 140 GHz, Valid for all Modes, horizontal / vertical polarization



RMS Value: -35.20 dBm (Limit -1.7 dBm)

Plot 35: 140 GHz to 220 GHz, Valid for all Modes, horizontal / vertical polarization



RMS Value: -41.81 dBm (Limit -1.7 dBm / +0.5 dBm)

11.5 Frequency stability

Description:

§95.3379 (b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

Limits: **FCC §95.3379 (b)**

Frequency range	f(lowest) > 76.0 GHz	f(highest) < 81.0 GHz

Measurement results:

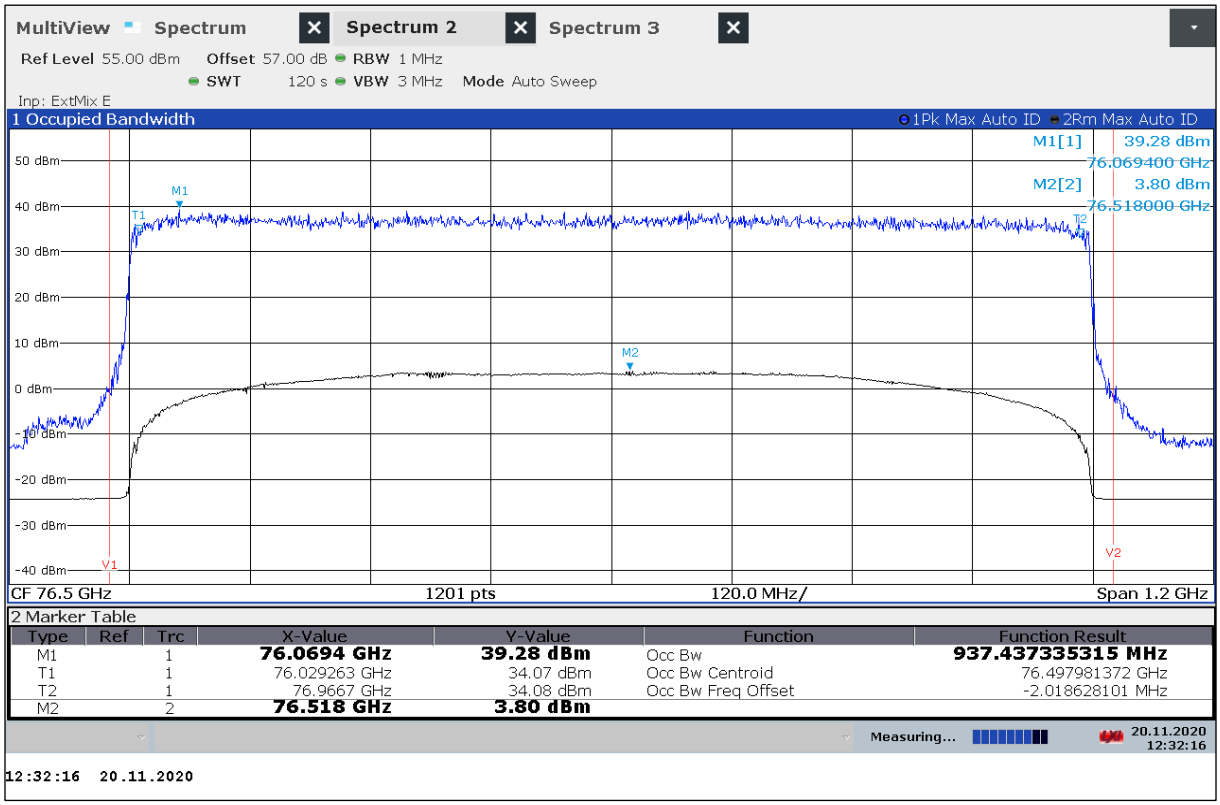
Temperature variation:

Mode	Temperature in °C	f_L in GHz	f_H in GHz
Mode 3 (Worst case)	-40	76.029 260	76.966 700
	-30	76.028 129	76.969 477
	-20	76.027 618	76.968 355
	-10	76.028 294	76.966 562
	0	76.026 417	76.966 409
	10	76.026 815	76.964 386
	20	76.026 804	76.965 537
	30	76.025 445	76.963 262
	40	76.024 587	76.964 919
	50	76.026 648	76.964 667
	85	76.026 816	76.964 140

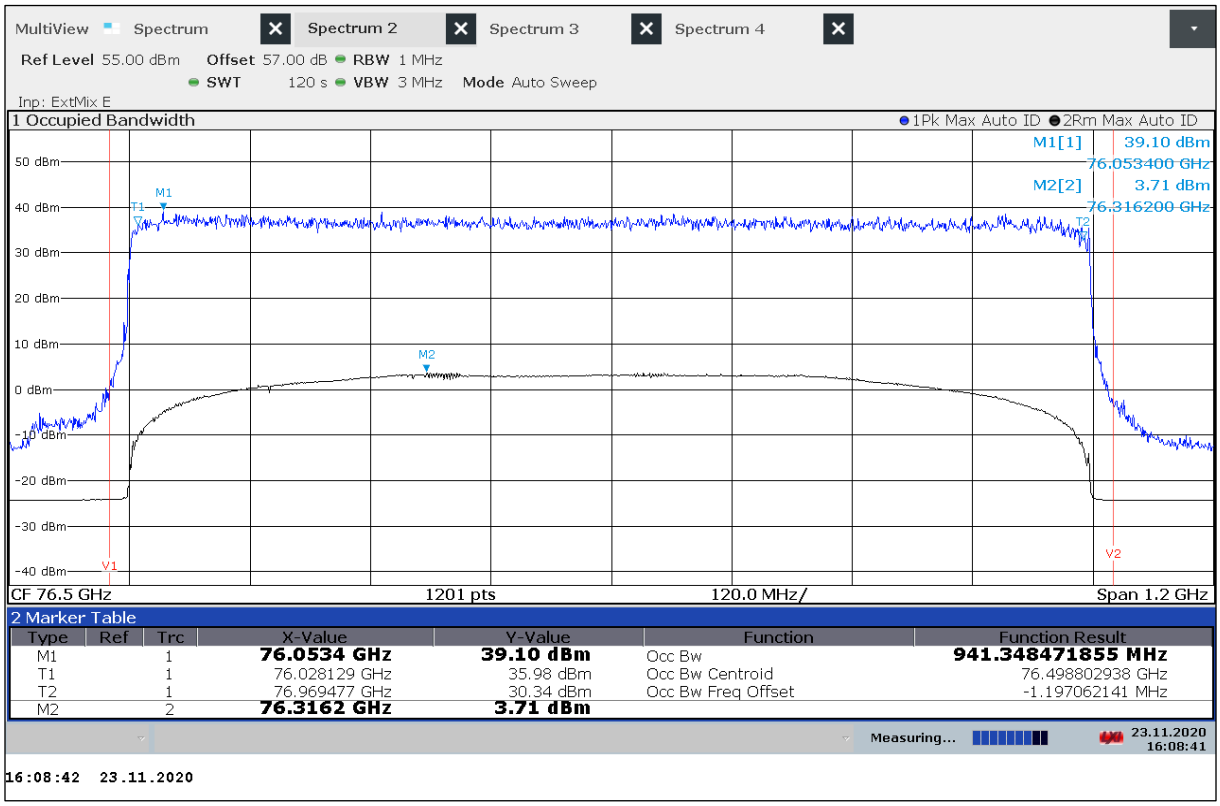
Voltage variation:

Voltage variation of rated input voltage	f_L in GHz	f_H in GHz
< 85 % of U	Voltage variation does not affect the radiated signal	
> 115 % of U		

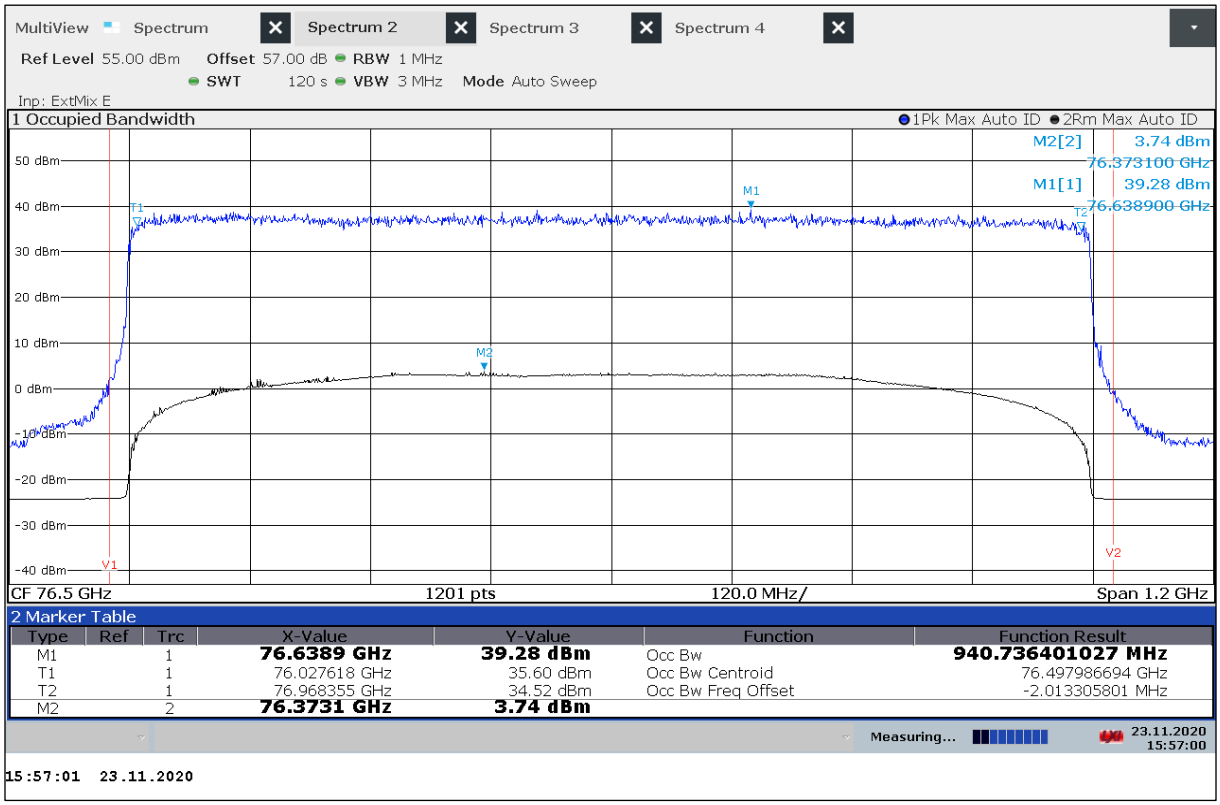
Plot 36: Mode 3, OBW, T_{min} / V_{nom}



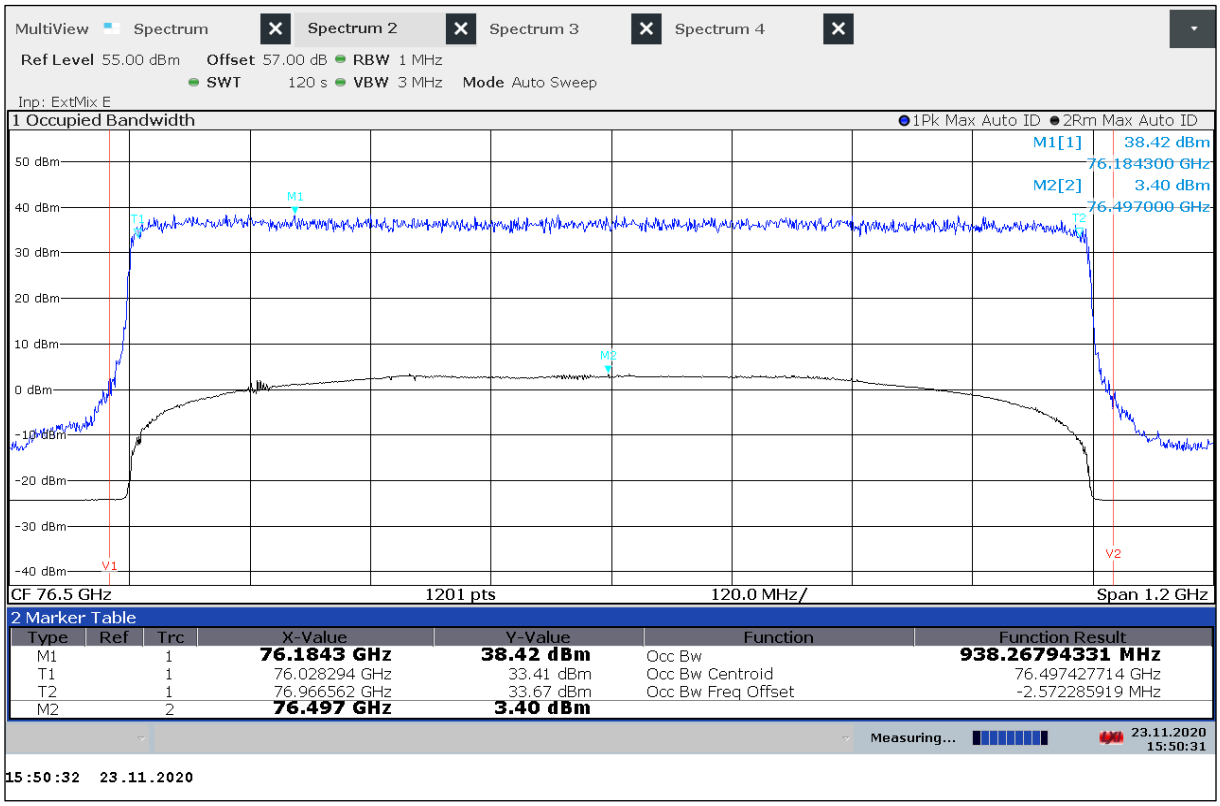
Plot 37: Mode 3, OBW, -30 °C / V_{nom}



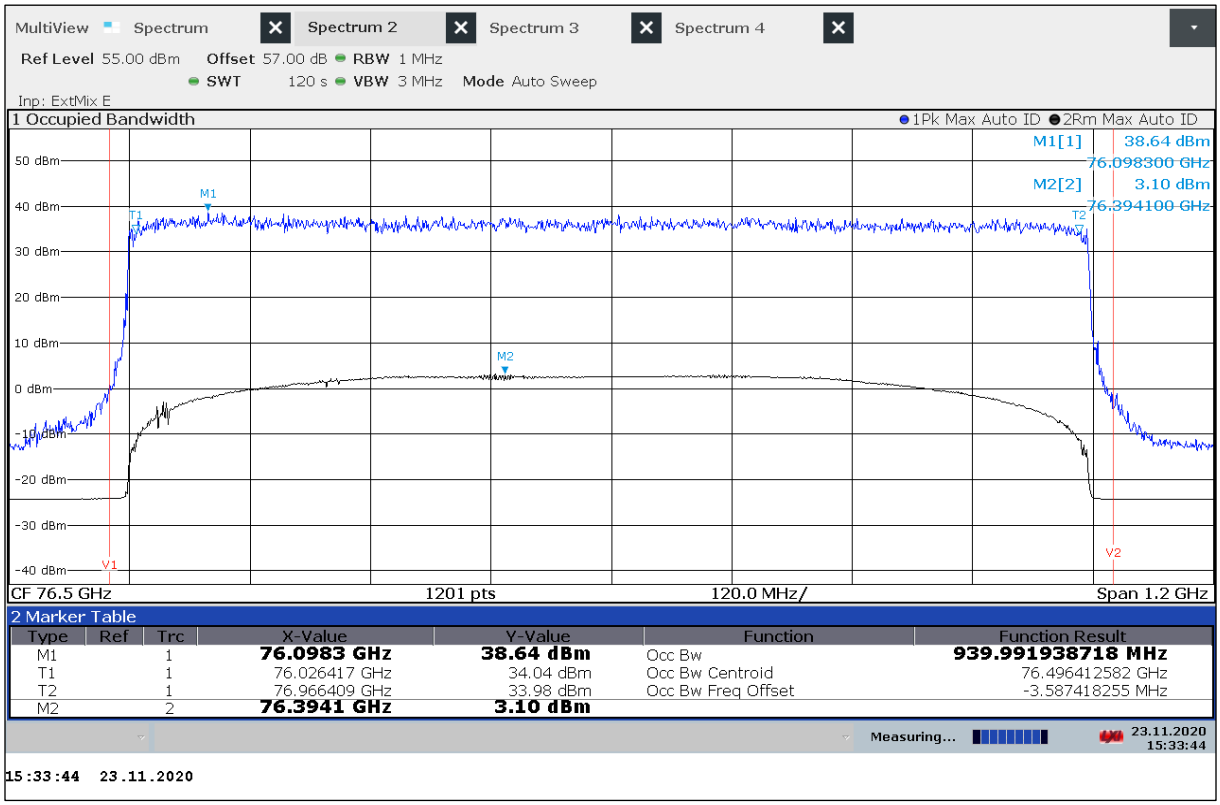
Plot 38: Mode 3, OBW, -20 °C / V_{nom}



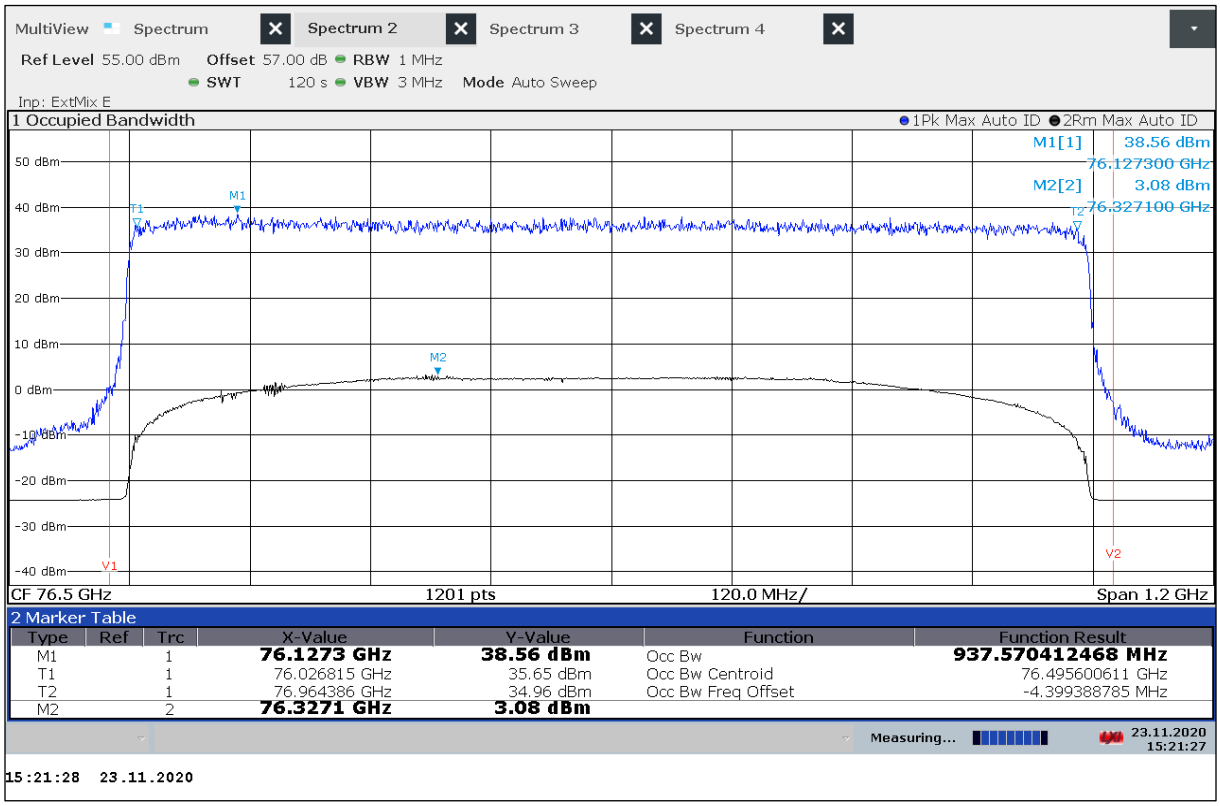
Plot 39: Mode 3, OBW, -10 °C / V_{nom}



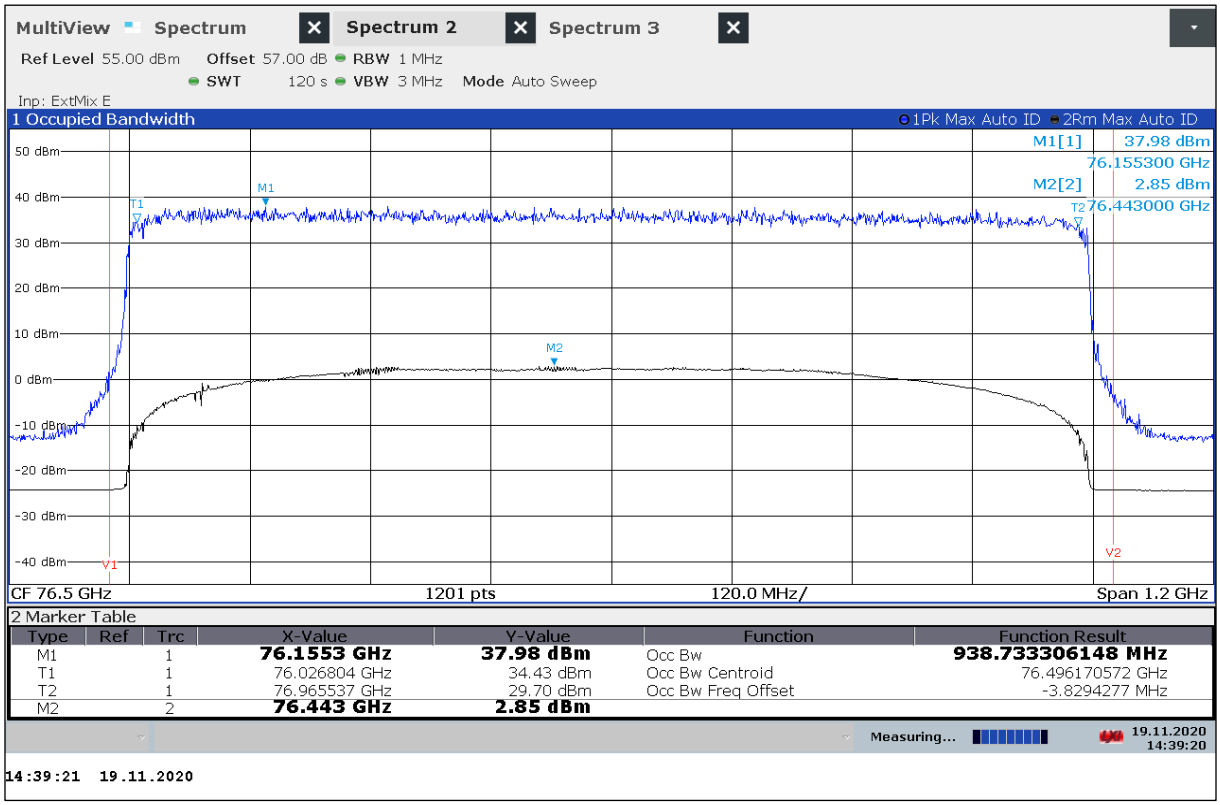
Plot 40: Mode 3, OBW, 0 °C / V_{nom}



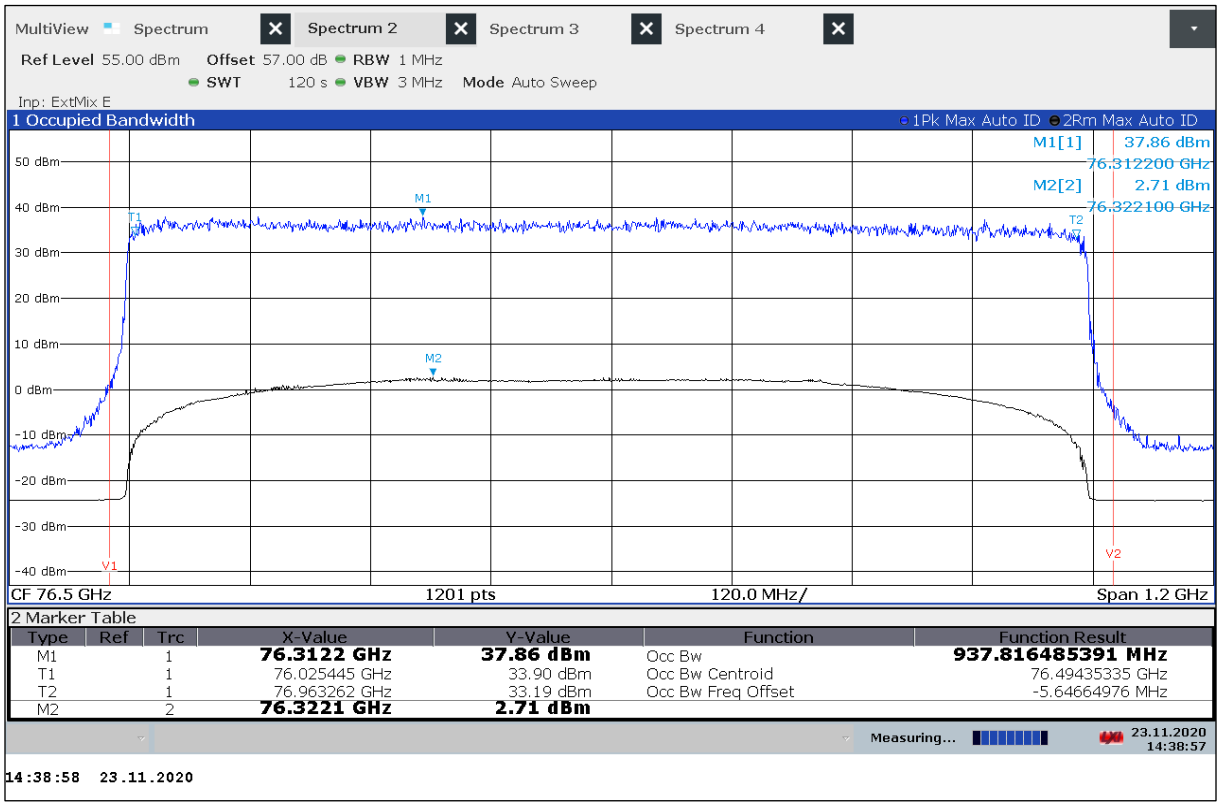
Plot 41: Mode 3, OBW, 10 °C / V_{nom}



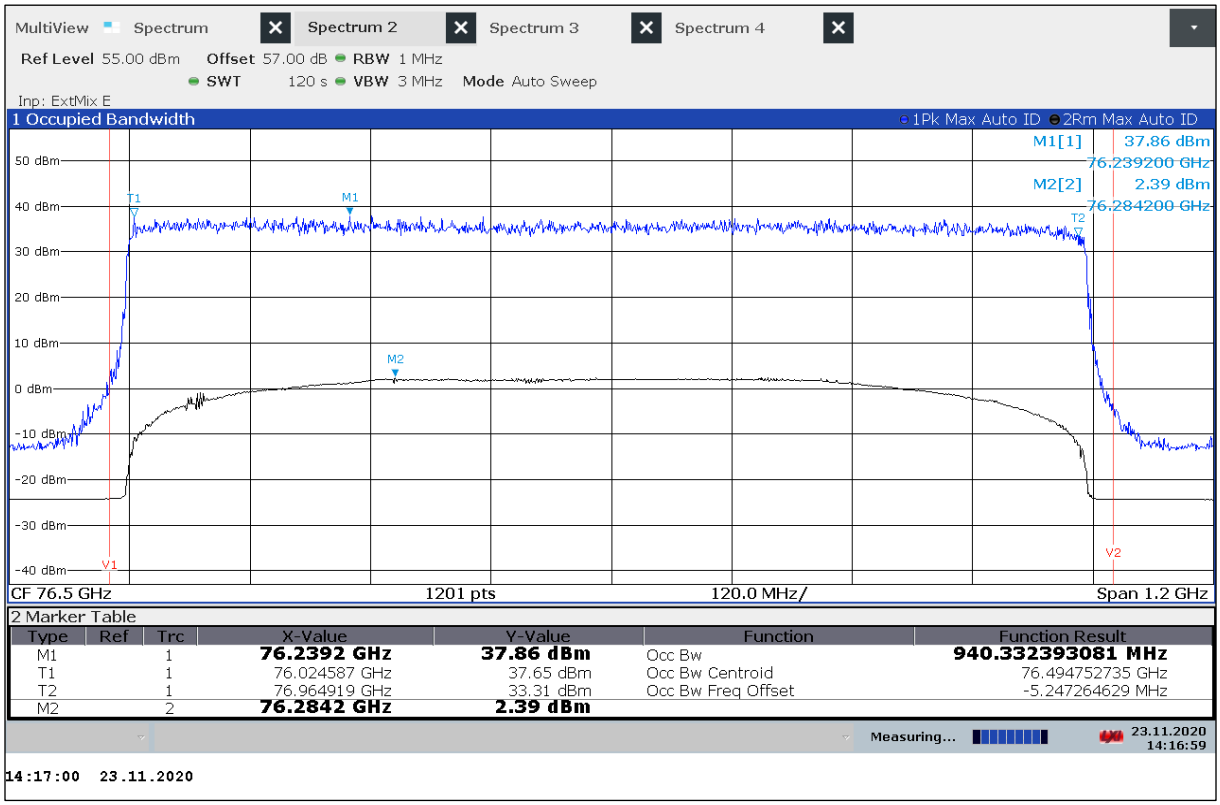
Plot 42: Mode 3, OBW, 20 °C / V_{nom}



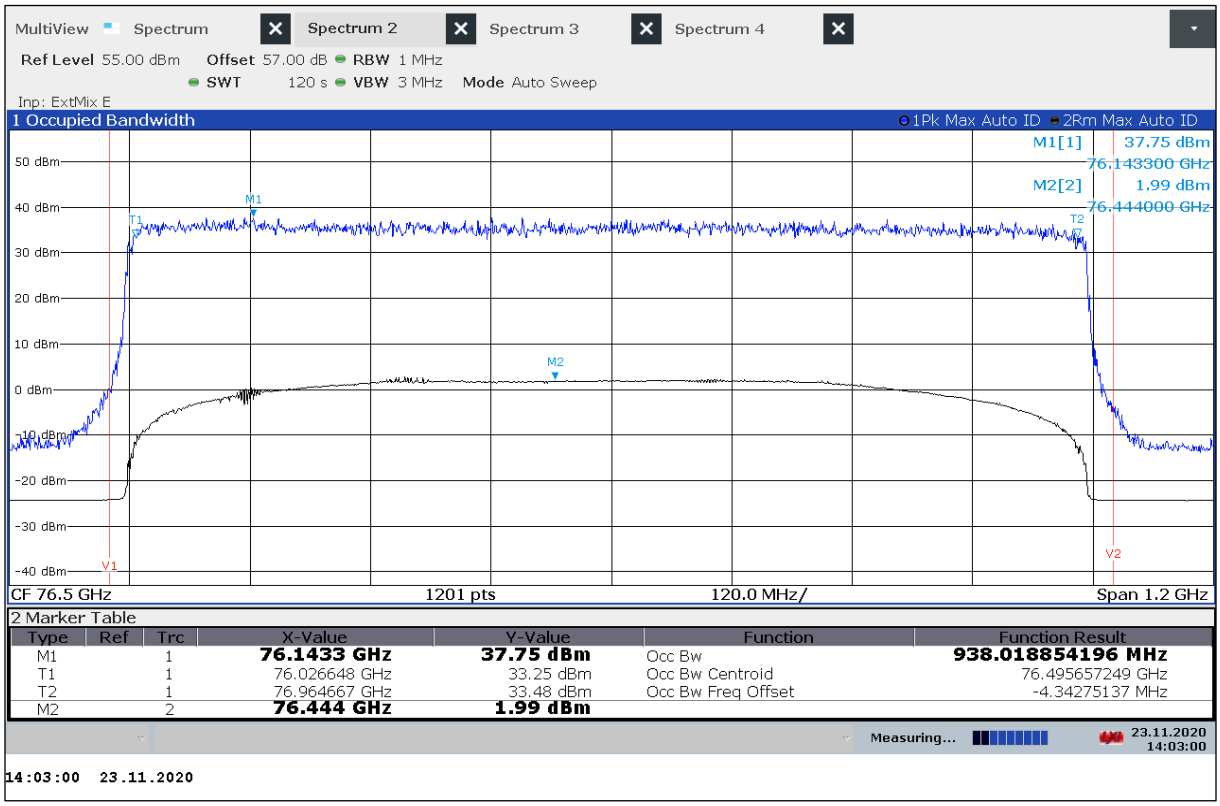
Plot 43: Mode 3, OBW, 30 °C / V_{nom}



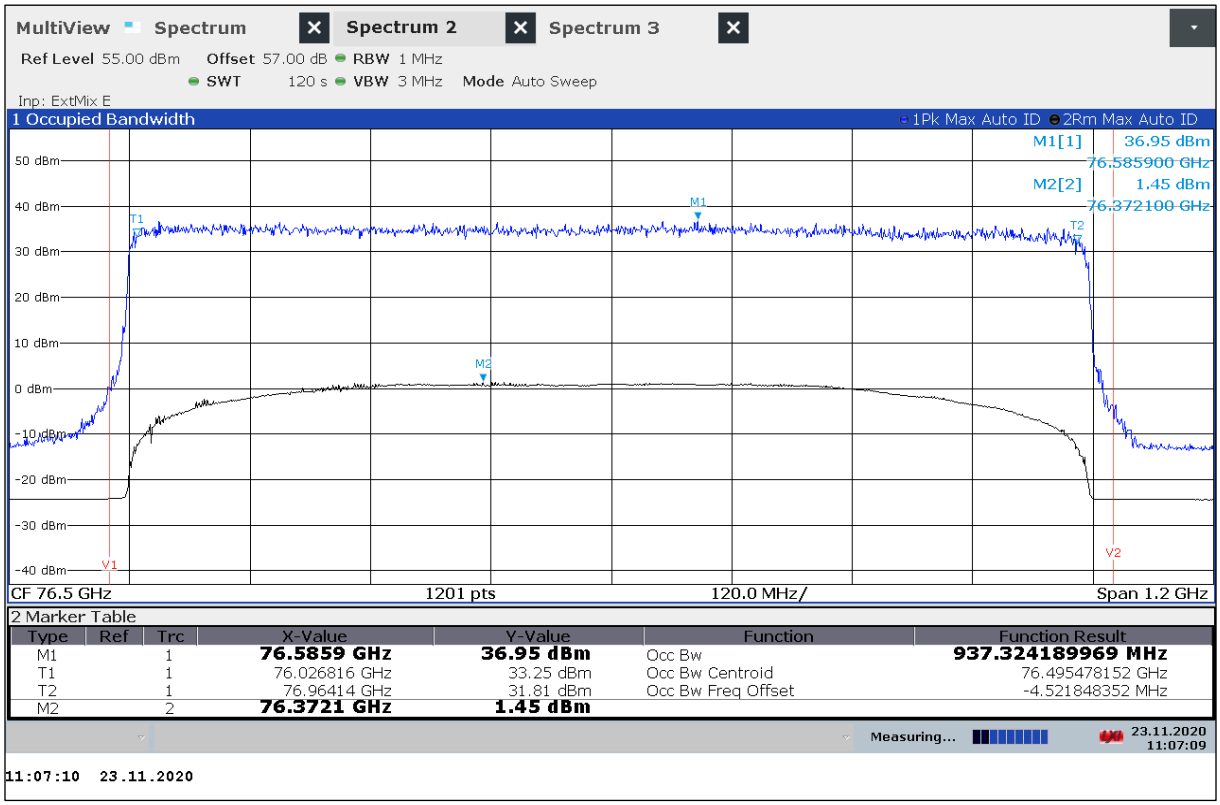
Plot 44: Mode 3, OBW, 40 °C / V_{nom}



Plot 45: Mode 3, OBW, 50 °C / V_{nom}



Plot 46: Mode 3, OBW, T_{max} / V_{nom}



12 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

13 Document history

Version	Applied changes	Date of release
-/-	Initial release – DRAFT	2020-12-16
-/-	Final release	2020-12-17

14 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