
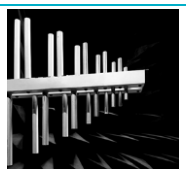
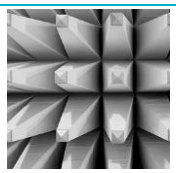

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5794/23-01-03

Testing laboratory

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

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

Applicant

Acconeer AB
Västra Varvsgatan 19
211 77 Malmö / SWEDEN
Phone: +46 72 5838428
Fax:
Contact: Mikael Egard
e-mail: Mikael.egard@acconeer.com
Phone: +46 70 760 80 48

Manufacturer

Acconeer AB
Västra Varvsgatan 19
211 77 Malmö / SWEDEN

Test standard/s

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

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

Test Item

Kind of test item:	**Module for SRD radar 60 GHz**
Model name:	**A121 Pulsed Coherent Radar module – XS121 – LH113**
FCC ID:	**2AQ6KA1201**
Frequency:	57 GHz – 71 GHz
Antenna:	2 embedded Dipole Antennas dielectric Lens LH113
Power supply:	1.71 V to 1.89 V DC
Temperature range:	-40°C to +105°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:

M. Walla

cn=Meheza Walla, o=cetecom advanced GmbH, ou=WAL-230706, email=Meheza.Walla@cetecomadvanced.com, c=DE
2023.08.02 10:03:08 +02'00'

Meheza Walla
Lab Manager
Radio Labs

Test performed:

Thomas Vogler

cn=Thomas Vogler, o=cetecom advanced GmbH, ou=VOG-230609, email=thomas.vogler@cetecomadvanced.com, c=DE
2023.08.02 09:40:06 +02'00'

Thomas Vogler
Lab Manager
Radio Labs

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2023-05-30
Date of receipt of test item:	2023-06-21
Start of test:	2023-06-30
End of test:	2023-07-25
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

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

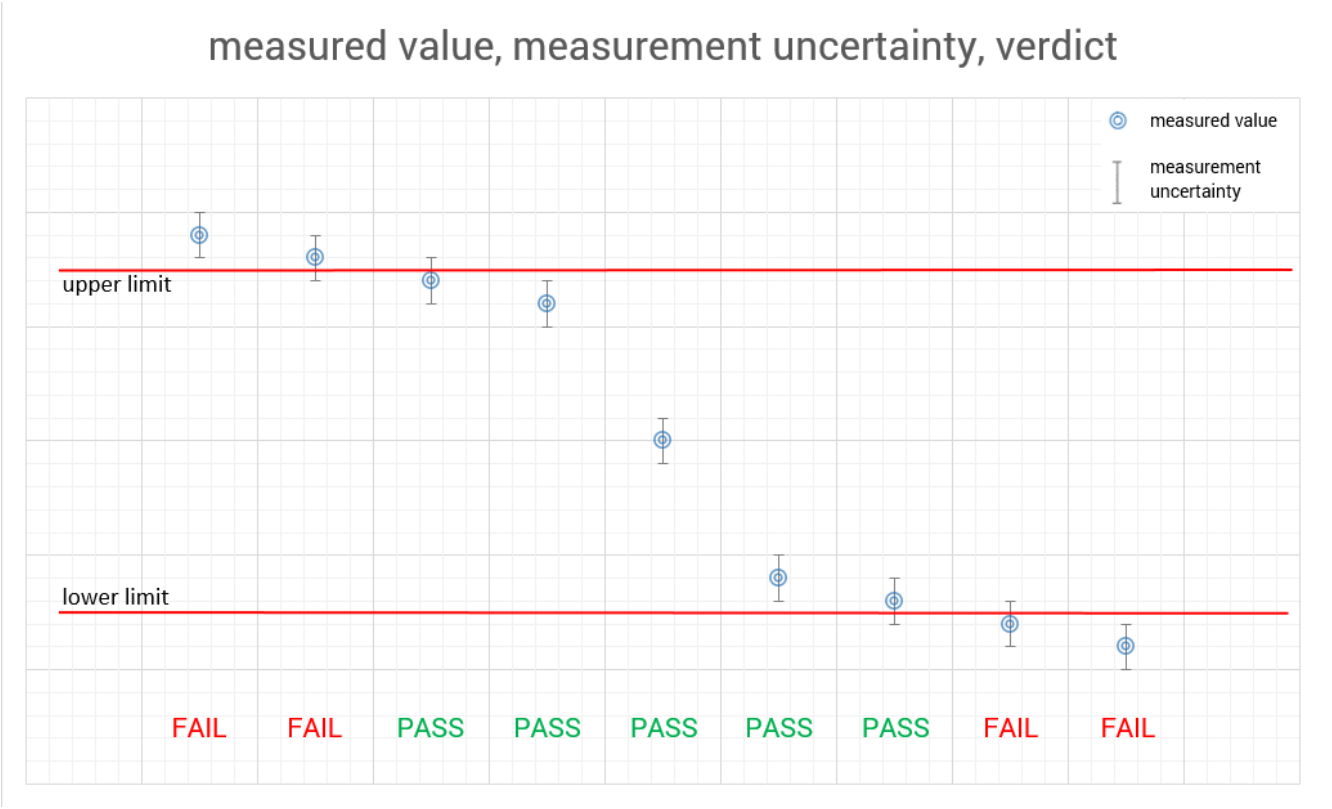
Guidance	Version	Description
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices
KDB guidance 996369	D01	Module Certification Guide v02

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

FCC designation number: DE0002

4 Reporting statements of conformity – decision rule

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



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +85 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1016 hpa
Power supply	:	V_{nom} V_{max} V_{min}	1.8 V DC by external power supply 1.89 V 1.71 V

6 Test item

6.1 General description

Kind of test item	:	Module for SRD radar 60 GHz
Type identification	:	A121 Pulsed Coherent Radar module – XS121 – LH113
S/N serial number	:	n.a.
hardware version	:	A121
software version	:	1.0.0
firmware version	:	1.0.0
Frequency band	:	57 GHz – 71 GHz
Type of modulation	:	Pulse Modulation
Number of channels	:	1
Antenna	:	2 embedded Dipole Antennas dielectric lens LH113
Power supply	:	1.71 V to 1.89 V DC
Auxiliary equipment	:	Raspberry Pi with connector board
Temperature range	:	-40°C to +105°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: 1-5794/23-01-01_AnnexD
1-5794/23-01-01_AnnexE
1-5794/23-01-01_AnnexF

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).

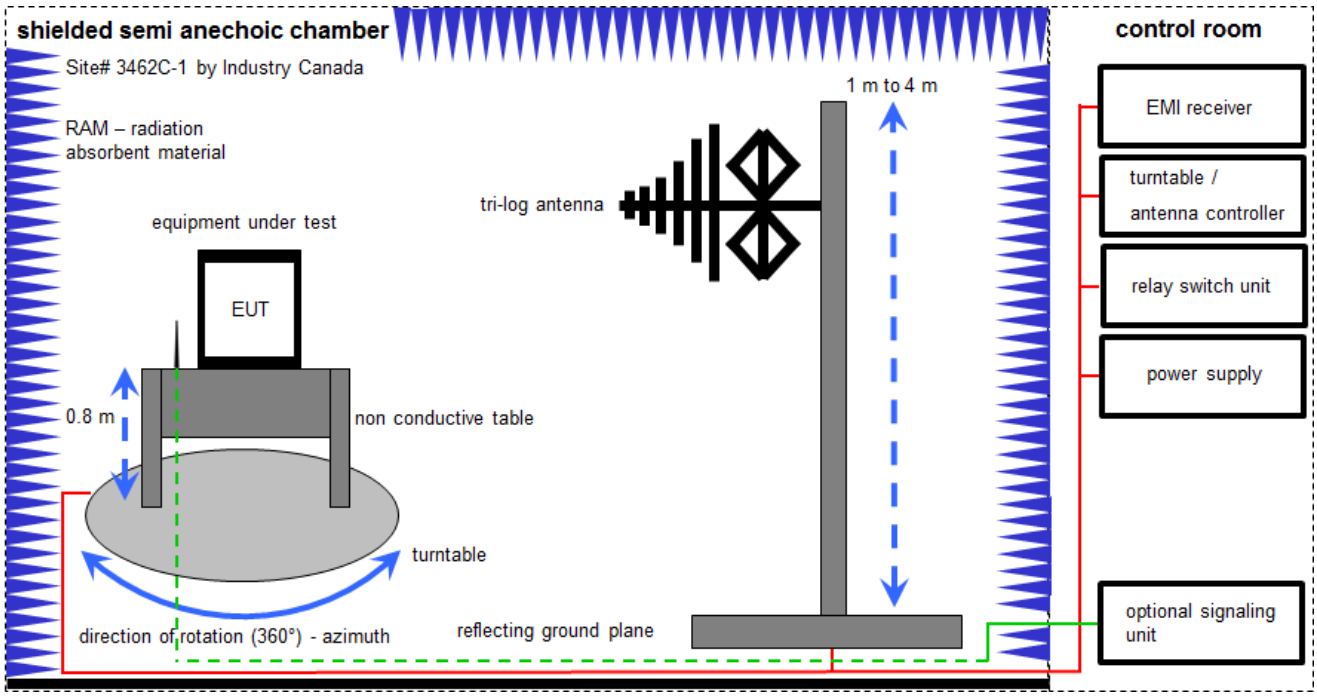
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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
EMC32 software version: 10.30.0

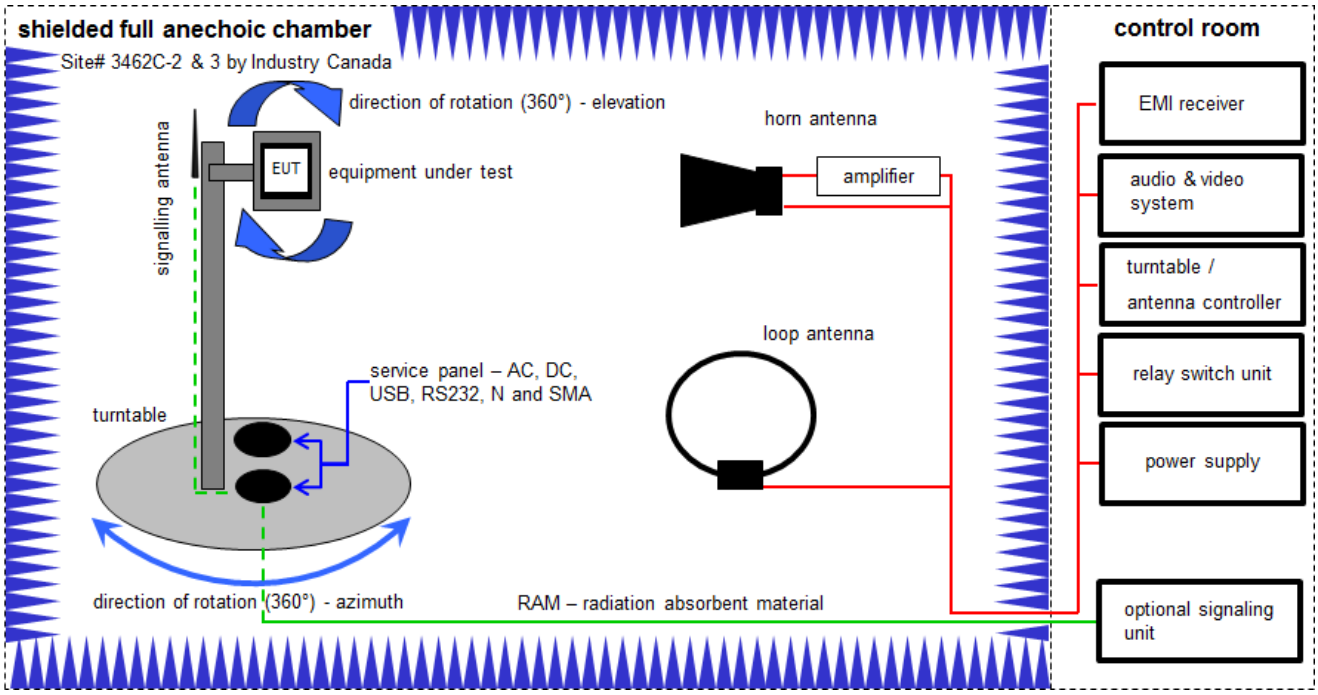
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	ESR3	Rohde & Schwarz	102587	300005771	k	09.12.2022	31.12.2023
5	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	01029	300005379	vIKI!	18.08.2021	31.08.2023
9	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-

7.2 Shielded fully anechoic chamber



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

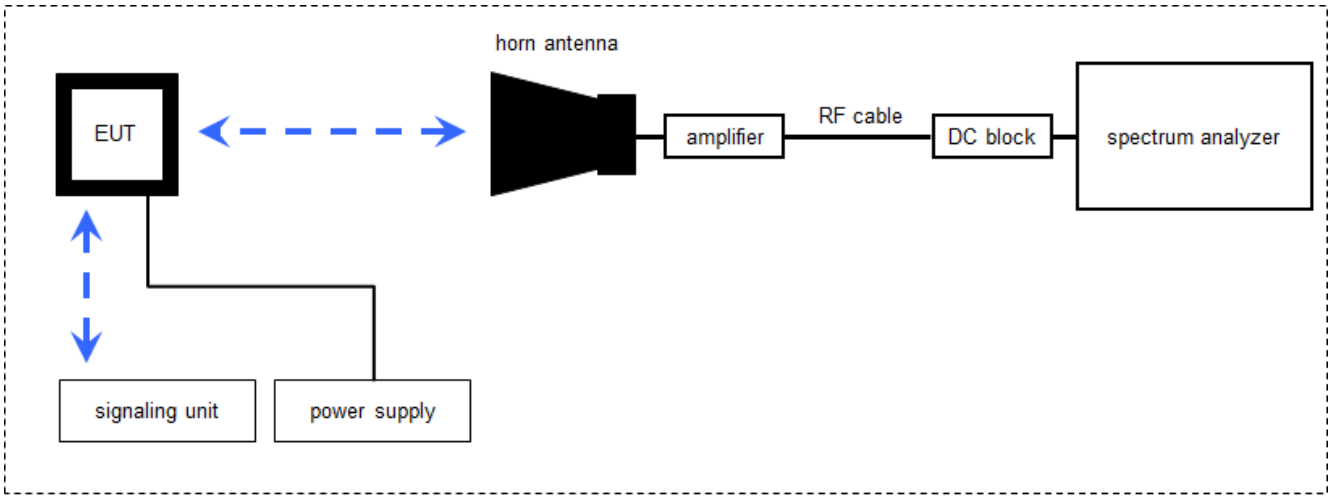
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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

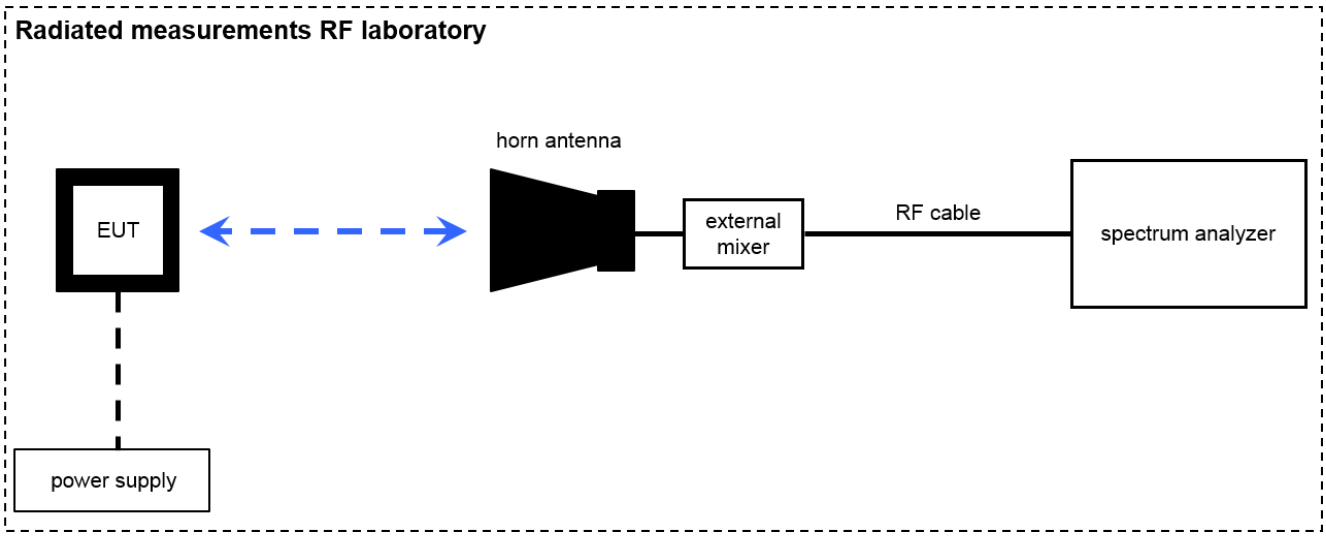
Equipment table:

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

7.3 Radiated measurements, 18 GHz – 50 GHz



7.4 Radiated measurements > 50 GHz

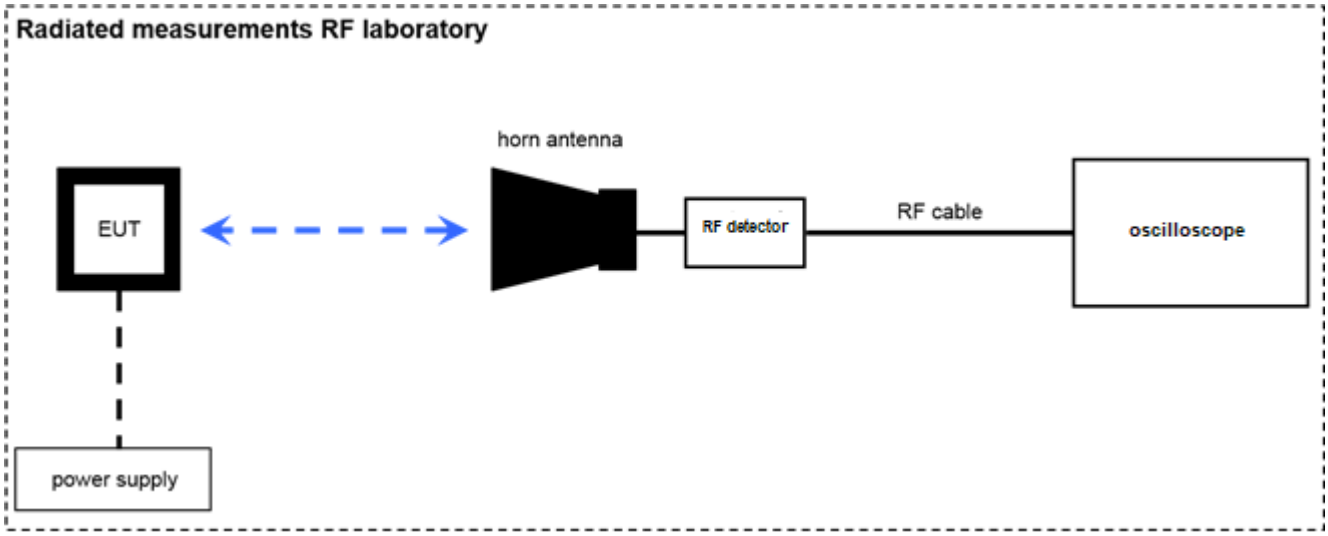


OP = AV + D - G
(OP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

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.

7.5 Radiated measurements > 50 GHz



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	vIKI!	17.01.2022	31.01.2024
2	n. a.	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	vIKI!	17.01.2022	31.01.2024
3	n. a.	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vIKI!	17.01.2022	31.01.2024
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.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	09.03.2022	08.03.2024
12	n. a.	Harmonic Mixer 3-Port, 50-75 GHz	FS-Z75	Rohde & Schwarz	101578	300005788	k	07.07.2022	31.07.2023
13	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	Rohde & Schwarz	102152	300006202	k	21.07.2022	31.07.2023
14	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	Rohde & Schwarz	101411	300004959	k	07.07.2022	31.07.2023
15	n.a.	Harmonic Mixer 3-port, 90-140 GHz	FS-Z140	Rohde & Schwarz	101119	300005581	k	20.07.2022	31.07.2023
16	n.a.	Harmonic Mixer 3-port, 110-170 GHz	FS-Z170	Rohde & Schwarz	100014	300004156	k	20.07.2022	31.07.2023
17	n. a.	Harmonic Mixer 3-Port, 140-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	01.07.2022	31.07.2023
18	n.a.	Spectrum Analyzer 2 Hz - 85 GHz	FSW85	R&S	101333	300005568	k	21.07.2022	31.07.2023
19	n. a.	Temperature Test Chamber	VT4002	Heraeus Voetsch	521/83761	300002326	ev	12.05.2022	31.05.2024
20	n.a.	Waveguide amplifier 50 to 75 GHz 30 dB Gain	AFB-V30LN-02	Ducommun	2K1701116	300005899	ev	-/-	-/-
21	n.a.	Thermal Power Sensor, DC-110GHz, 300nW-100mW	NRP-Z58	Rohde & Schwarz	100913	300004808	k	04.01.2022	31.01.2024
22	n.a.	SG Extension Module 50 – 75 GHz	E8257DV15	VDI	US54250124	300005541	ev	-/-	-/-
23	n.a.	Std. Gain Horn Antenna 50-75 GHz	COR 50_75	Thomson CSF		300000813	ev	-/-	-/-
24	n.a.	Std. Gain Horn Antenna 50-75 GHz	COR 50_75	Thomson CSF		300000813 -0001	ev	-/-	-/-
25	n.a.	RF Detector	SFD-503753-15SF-P1	Eravant	07353-1	300006118	ev	-/-	-/-
26	n.a.	Oscilloscope	DPO5054	Tektronix	C010174	300004169	k	07.12.2021	31.12.2023
27	n.a.	Signal Generator	83640A	HP	3119A00458	300002266	vIKI!	10.12.2021	31.12.2023

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

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

Premeasurement*

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

Final measurement

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

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

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

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

Setup

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

Premeasurement

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

Final measurement

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

9 Measurement uncertainty

Test case	Uncertainty
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 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
110-170	170	0.85	0.18	8.19
170-220	220	0.68	0.14	6.78

In band measurement (EIRP, OBW):

Antenna frequency range in GHz	Highest measured frequency in GHz	Antenna dimension in cm	Wavelength in cm	far field distance in cm
50-75	64	1.85	0.47	14.6

11 Summary of measurement results

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	FCC 47 CFR Part 15	Passed	2023-08-02	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Results (max.)
§15.215(c)	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(c)(3)	Maximum E.I.R.P.	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(d)	Spurious Emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(f)	Frequency stability	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

12 Measurement results

12.1 Occupied bandwidth

Description:
Measurement of the Bandwidth of the wanted signal.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	10 s
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	8 GHz
Trace-Mode:	Max Hold

Limits:

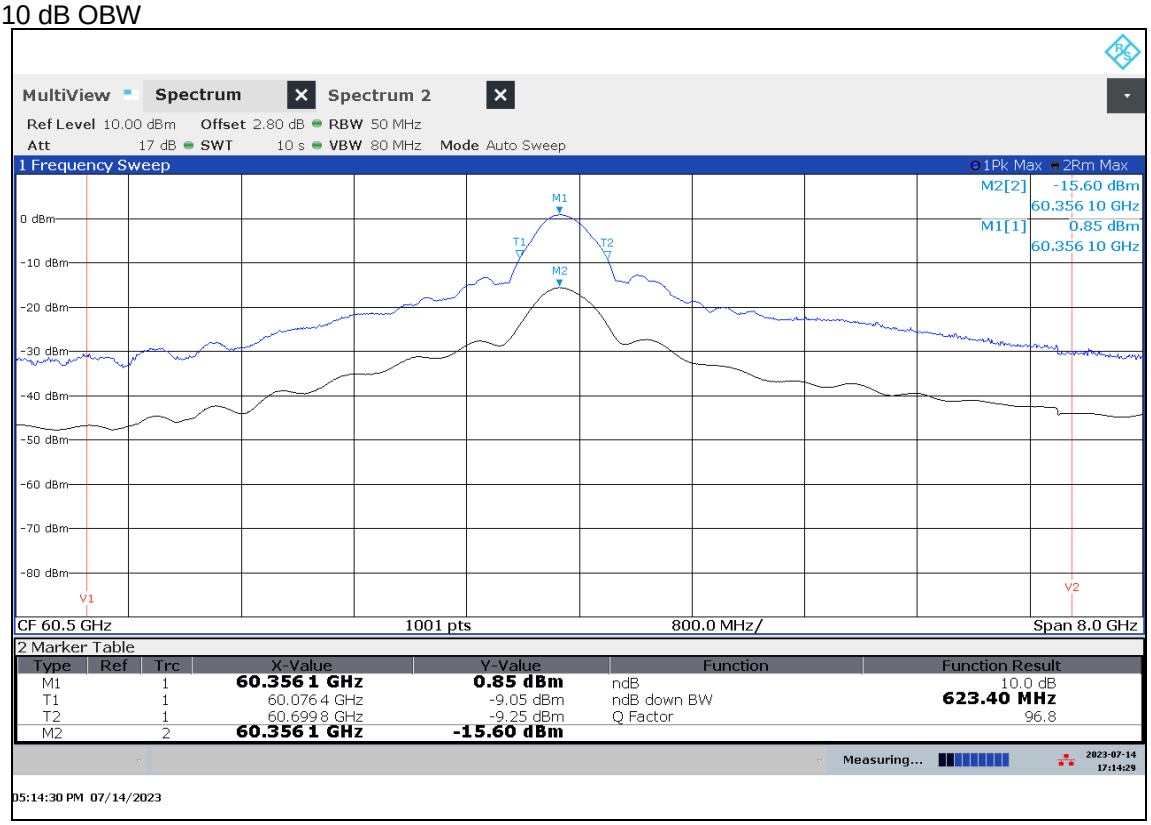
FCC
CFR Part 15.255 (c) (3)
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:
Frequency range
57 GHz – 64 GHz

Measurement results:

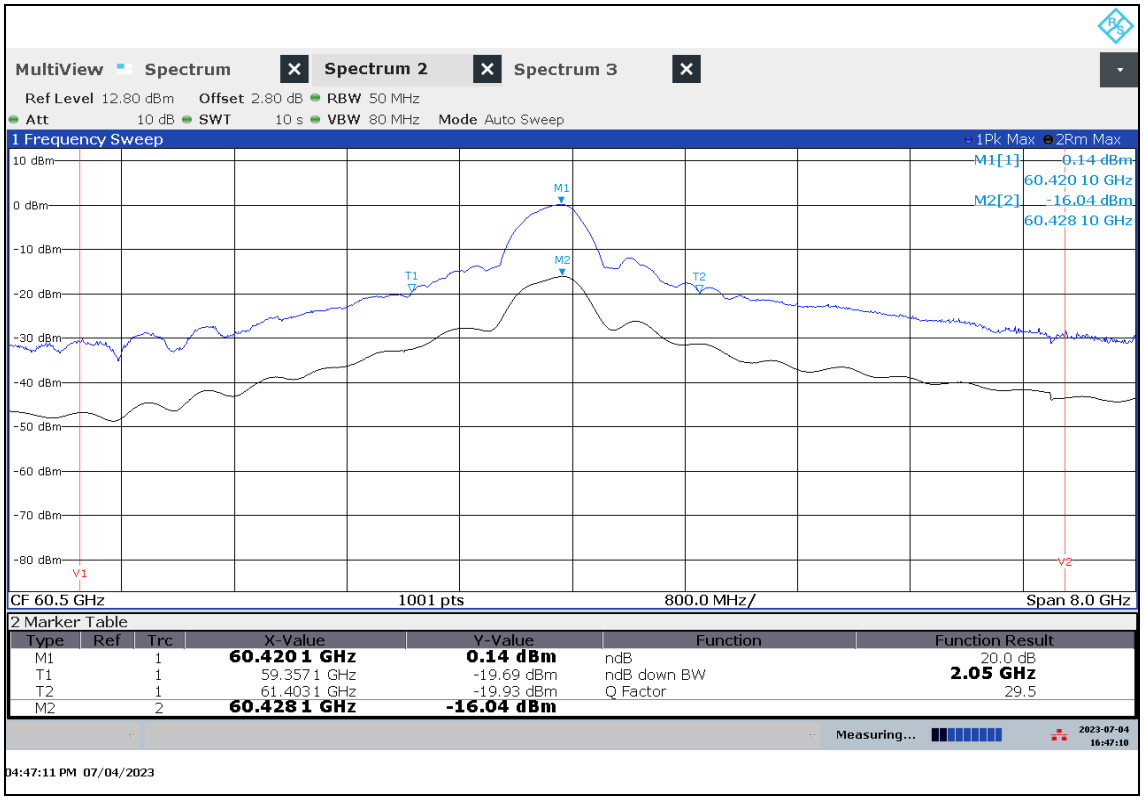
Test condition T_{nom} / V_{nom}	F_L in GHz	F_H in GHz	Occupied bandwidth in GHz
10 dB OBW	60.076 4	60.699 8	0.623
20 dB OBW	59.357 1	61.403 1	2.050
Measurement uncertainty	± span/1000		

Result: The measurement is passed.

Plot 1: 10 dB OBW



Plot 2: 20 dB OBW



12.2 Maximum E.I.R.P. / Transmitter Output Power

Description:

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

Limits: **FCC Part 15.255**

The requirements of Part 15.255 (c) (3) for pulsed field disturbance sensors are as follows:

- Pulse duration not to exceed 6 ns
- Duty factor ≤ 10% within any 0.3 µs time window
- Averaged EIRP ≤ 13 dBm
- Peak EIRP ≤ 33 dBm
- Averaged integrated EIRP <= 5 dBm in any 0.3 µs time window within 61.5 and 64 GHz

Measurement:

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

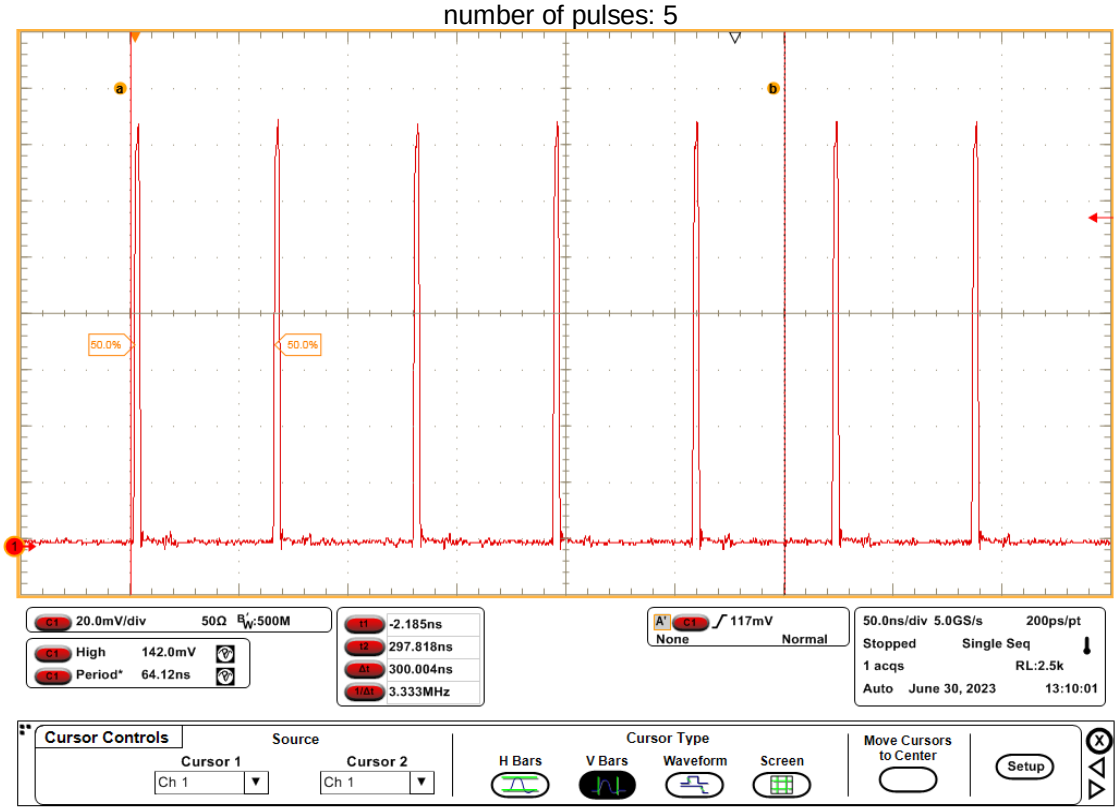
Measurement results:

	with Lens	without Lens	limit
Average E.I.R.P. 10 MHz VBW	11.6 dBm	-3.7 dBm	13 dBm
Peak E.I.R.P. 10 MHz VBW	25.5 dBm	10.2 dBm	33 dBm
Maximum Pulse duration	2.48 ns	2.48 ns	6 ns
Duty factor within 0.3µs time window	4.1%	4.1%	10%
Averaged integrated E.I.R.P. within 61.5 – 64 GHz within 0.3µs	-4.02 dBm	-18.94 dBm	5 dBm
Measurement uncertainty	± 3 dB		

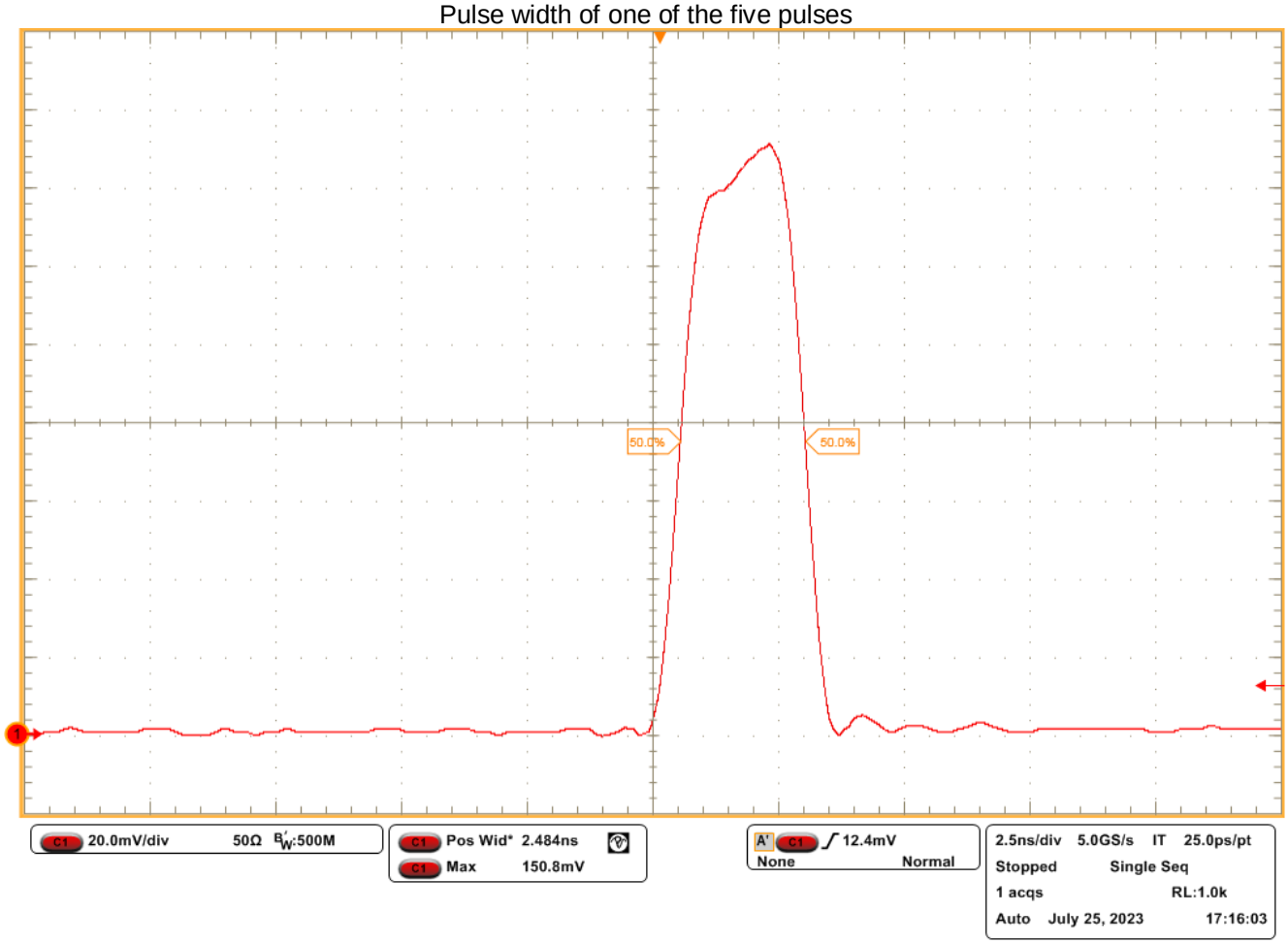
Result: **The measurement is passed.**

Determination of maximum number of pulses within 0.3µs:

number of pulses: 5



Pulse width of one of the five pulses



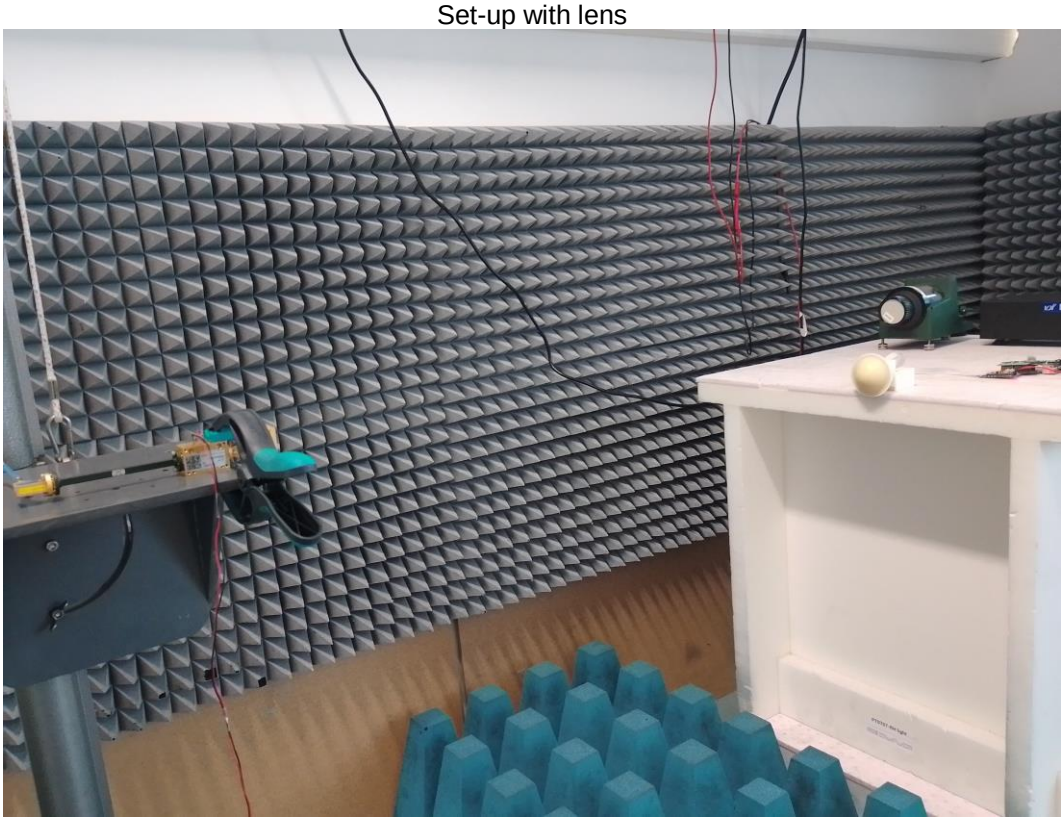
Result:

pulse duration: 2.48 ns (limit: < 6 ns)

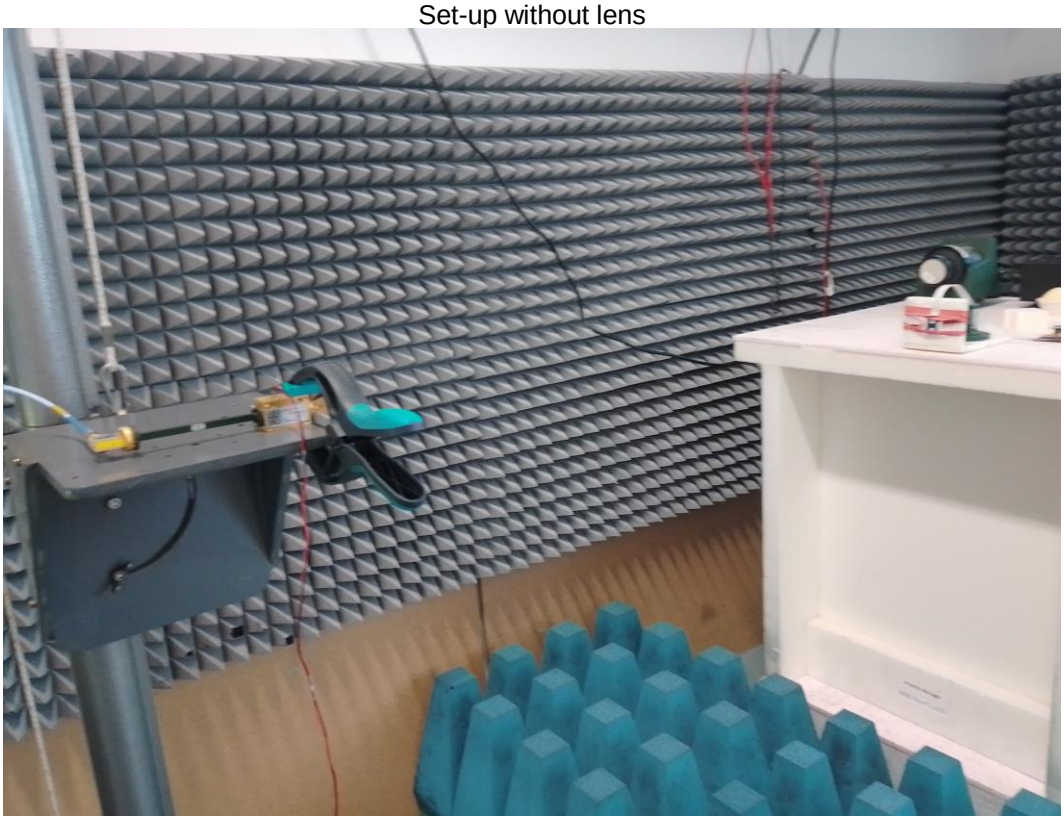
duty factor within 300 ns(0.3 µs): 5x 2.48 ns/300 ns = 4.1% (limit: 10%)

12.2.1 Radiated RF-detector and power measurement

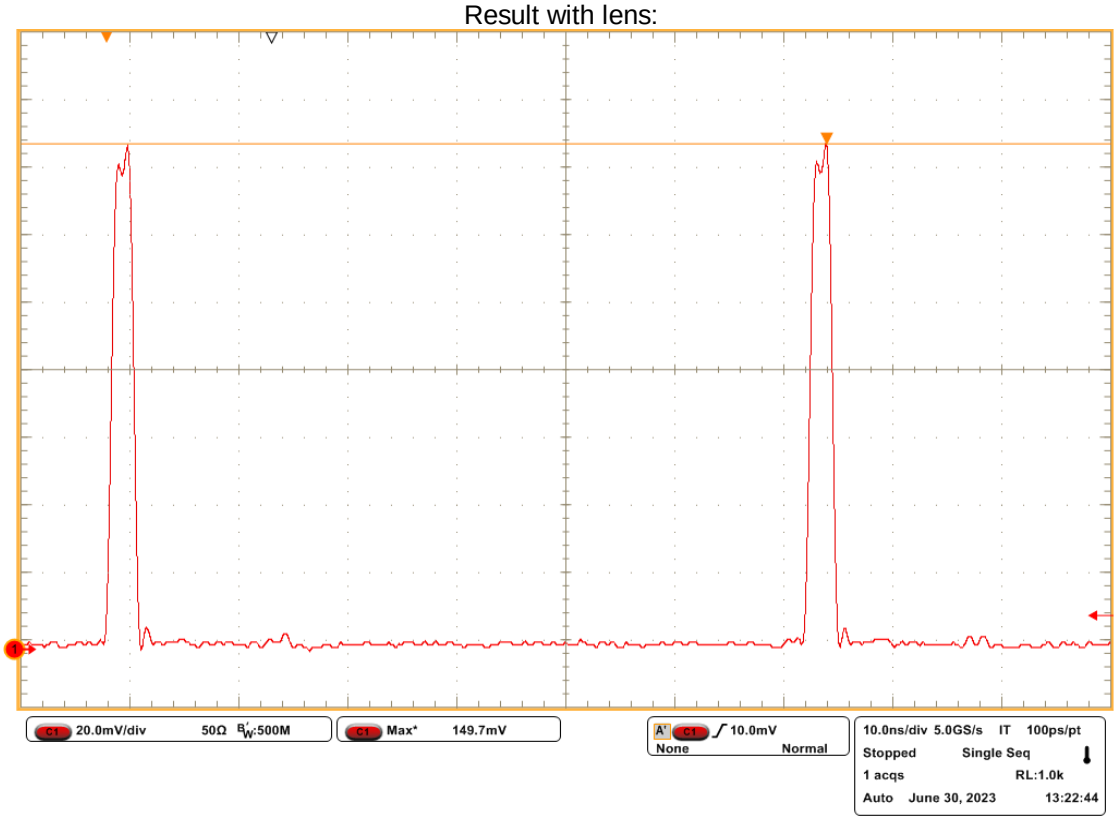
Set-up with lens



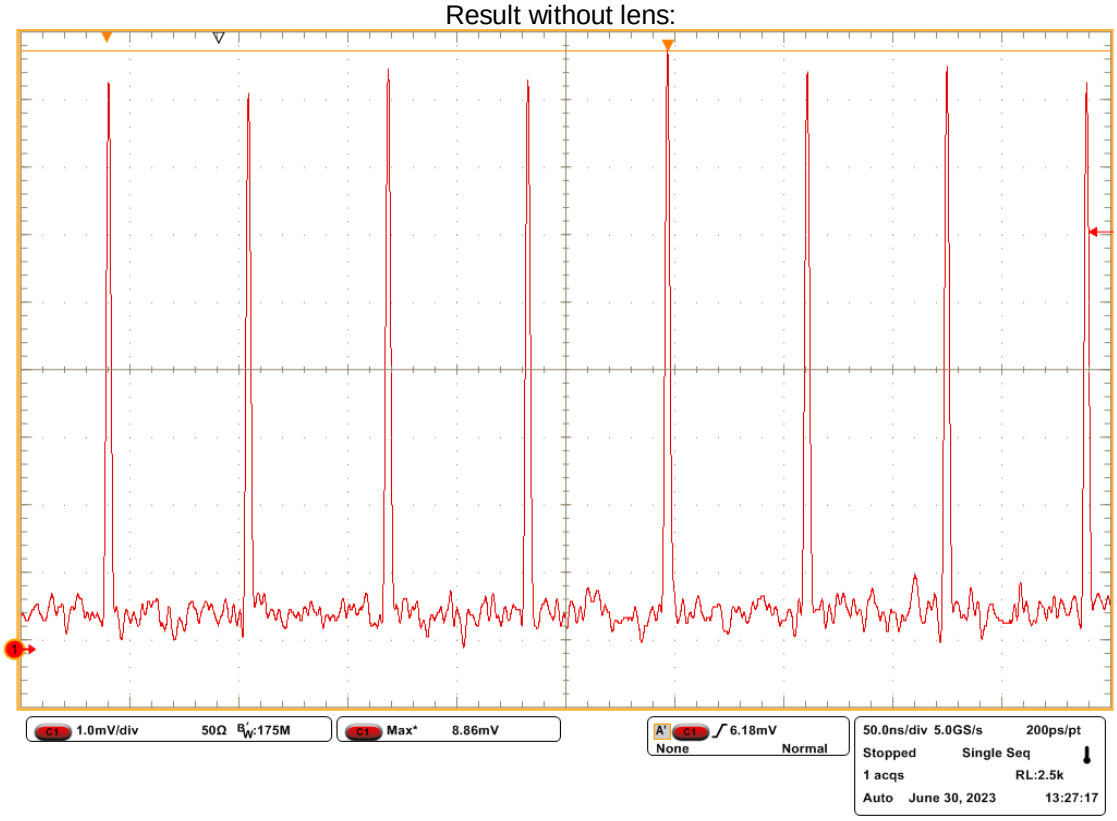
Set-up without lens



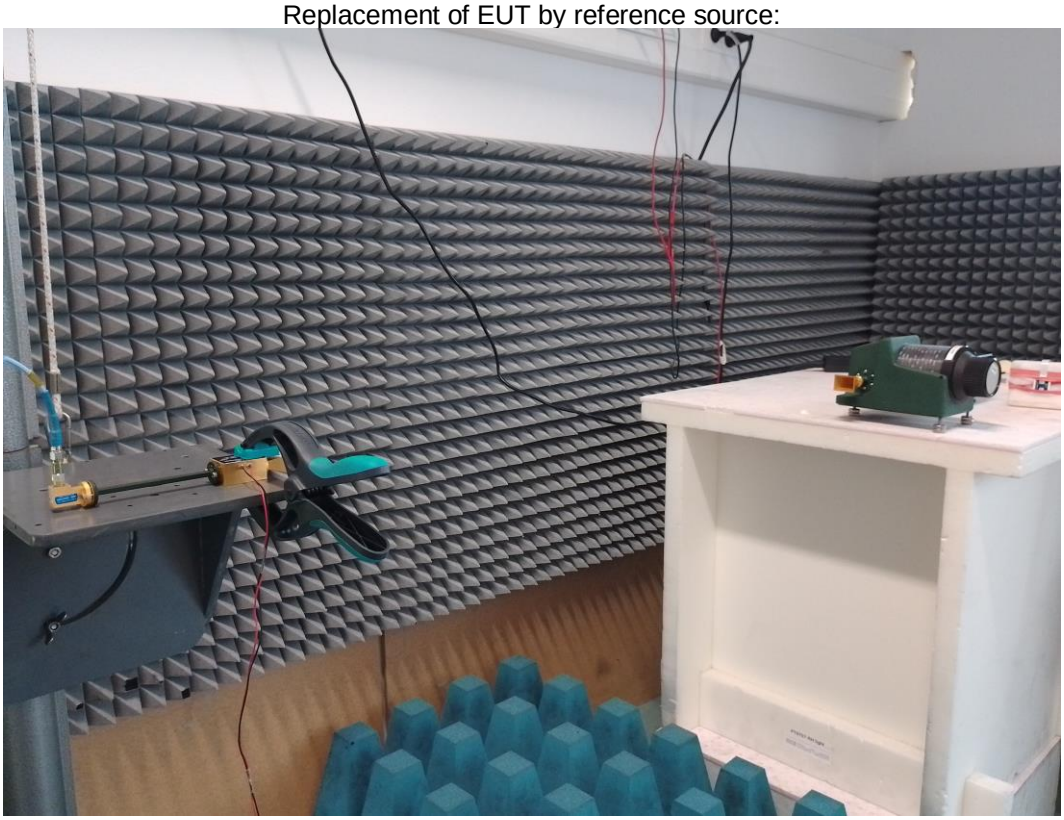
Result with lens:



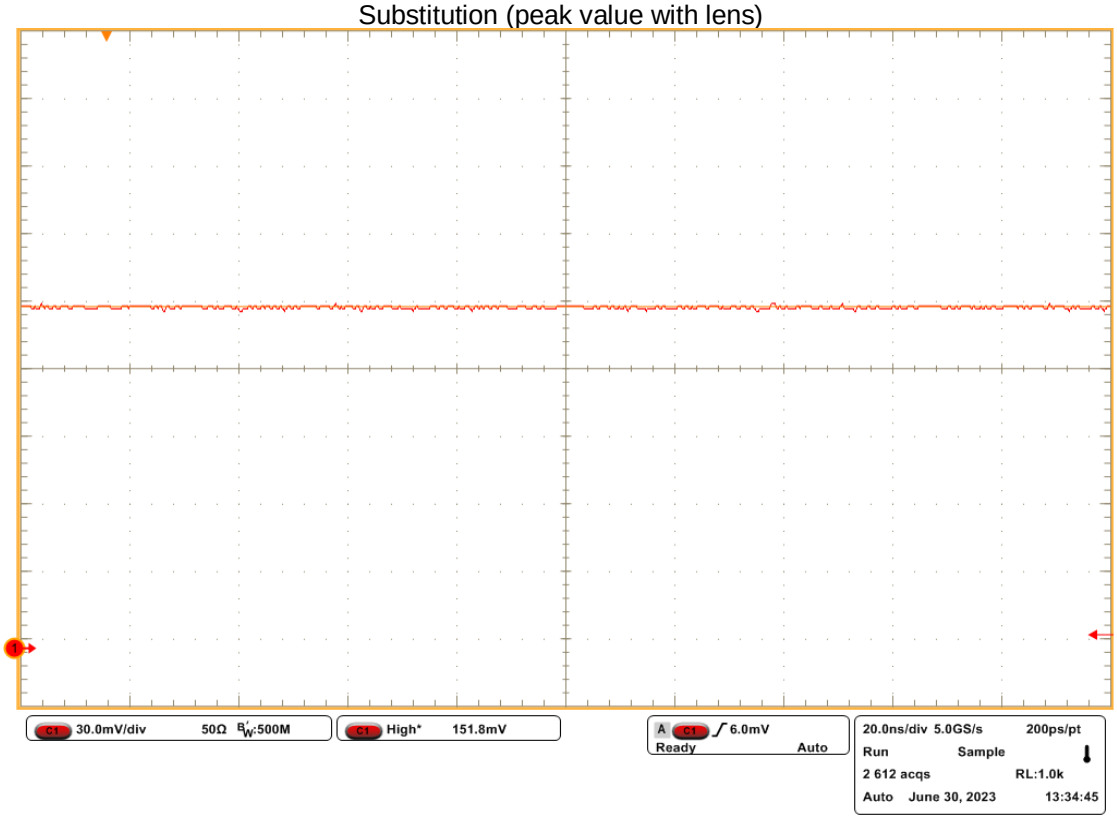
Result without lens:



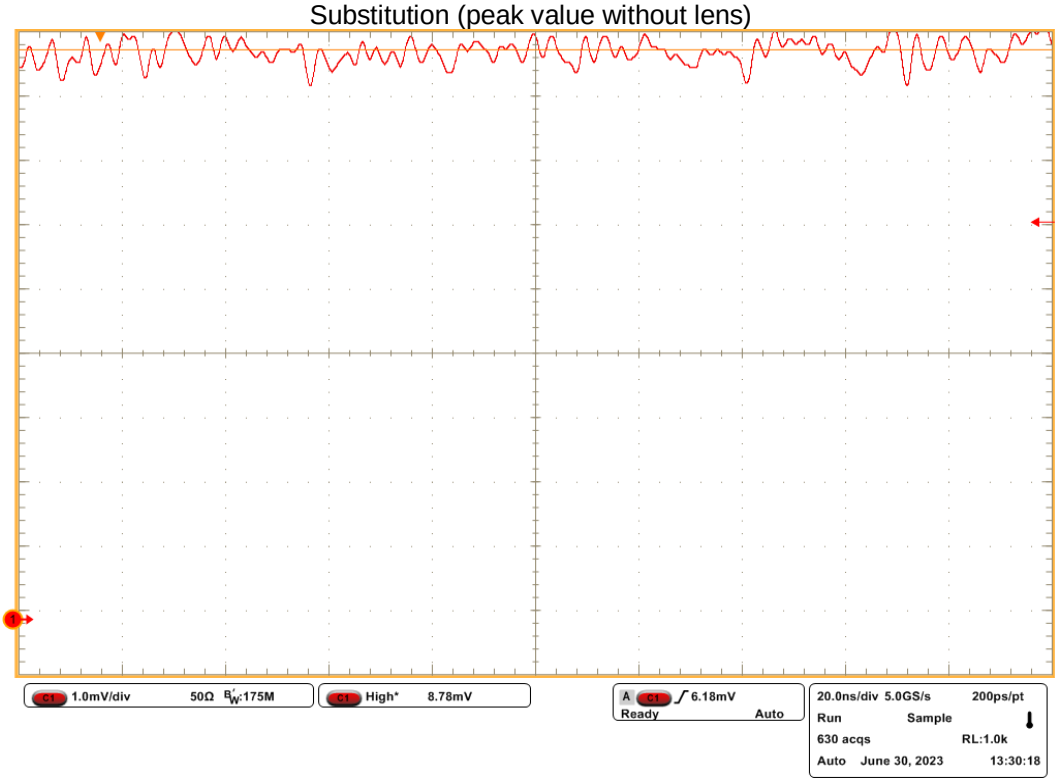
Replacement of EUT by reference source:



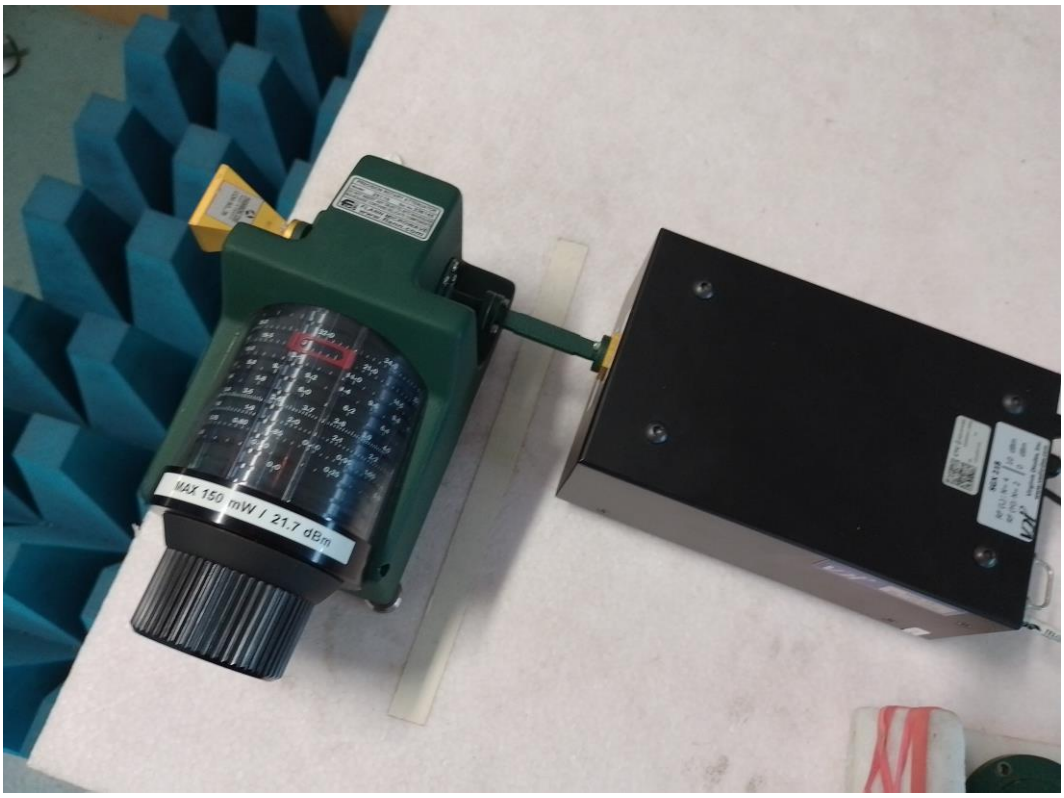
Substitution (peak value with lens)

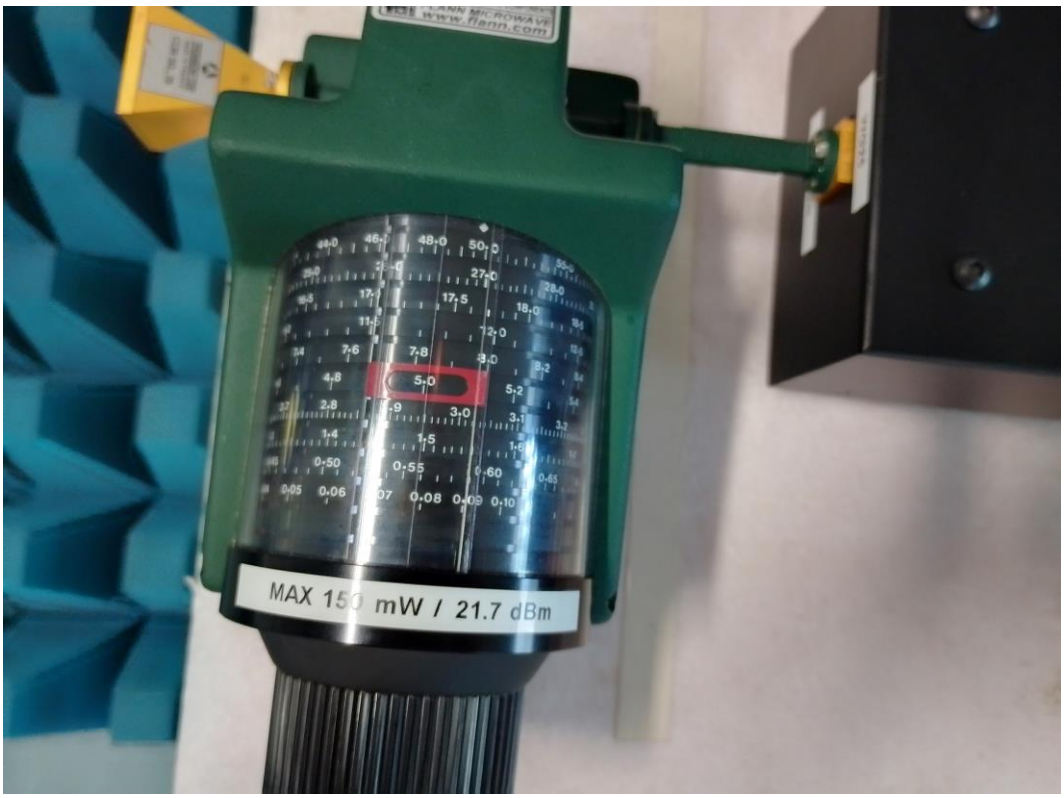


Substitution (peak value without lens)



Attenuation of rotary attenuator to align voltage levels at oscilloscope:





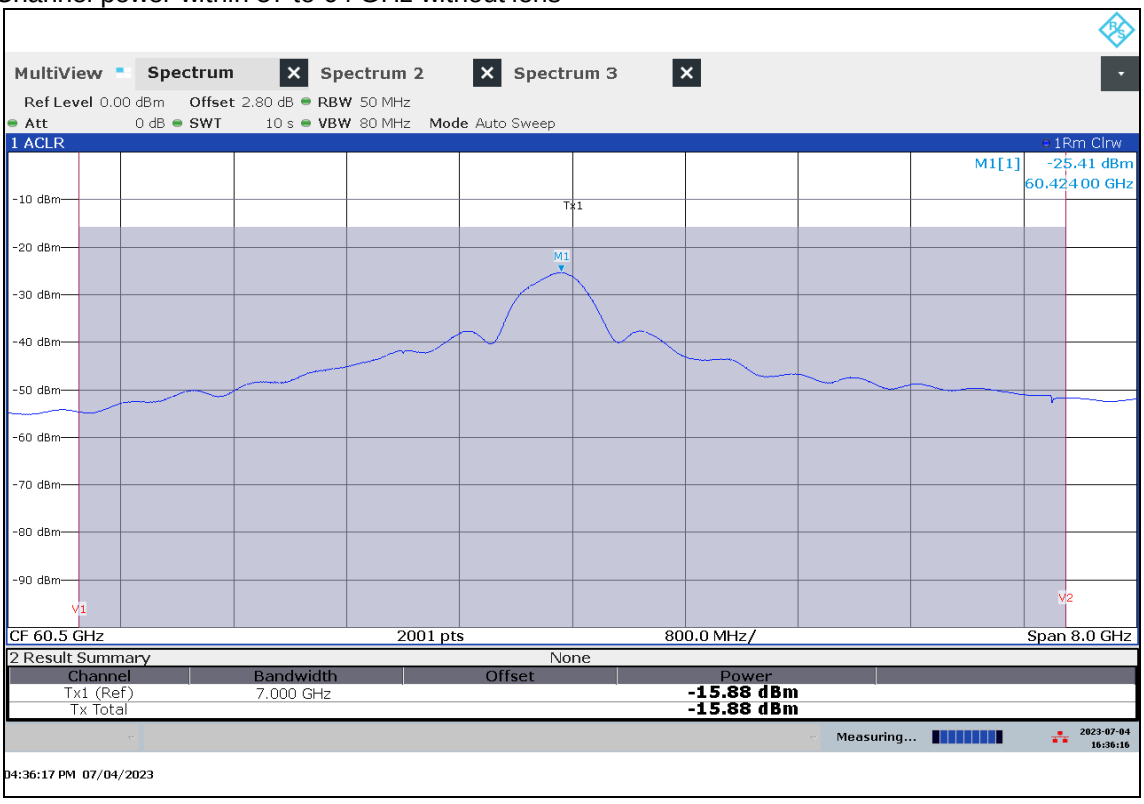
EIRP substitution measurement for determining average EIRP:

Measurement:	with Lens	Note:
Readout average (mean) value of oscilloscope at 1 m with EUT	152 mV	
EIRP of reference source at 1 m	40.5 dBm	Multiplier: ~20 dB; Horn 20.4 dBi Readout value of power sensor adjusted by far field attenuation
fix attenuation added	-10 dB	
rotary attenuator setting to reach peak voltage value of EUT with detector	-5.0 dB	adjusted to oscilloscope readout value of EUT
Peak EIRP of EUT	**25.5 dBm**	
Average EIRP of EUT within 0.3µs	**11.6 dBm**	4.1 % duty cycle within 0.3µs

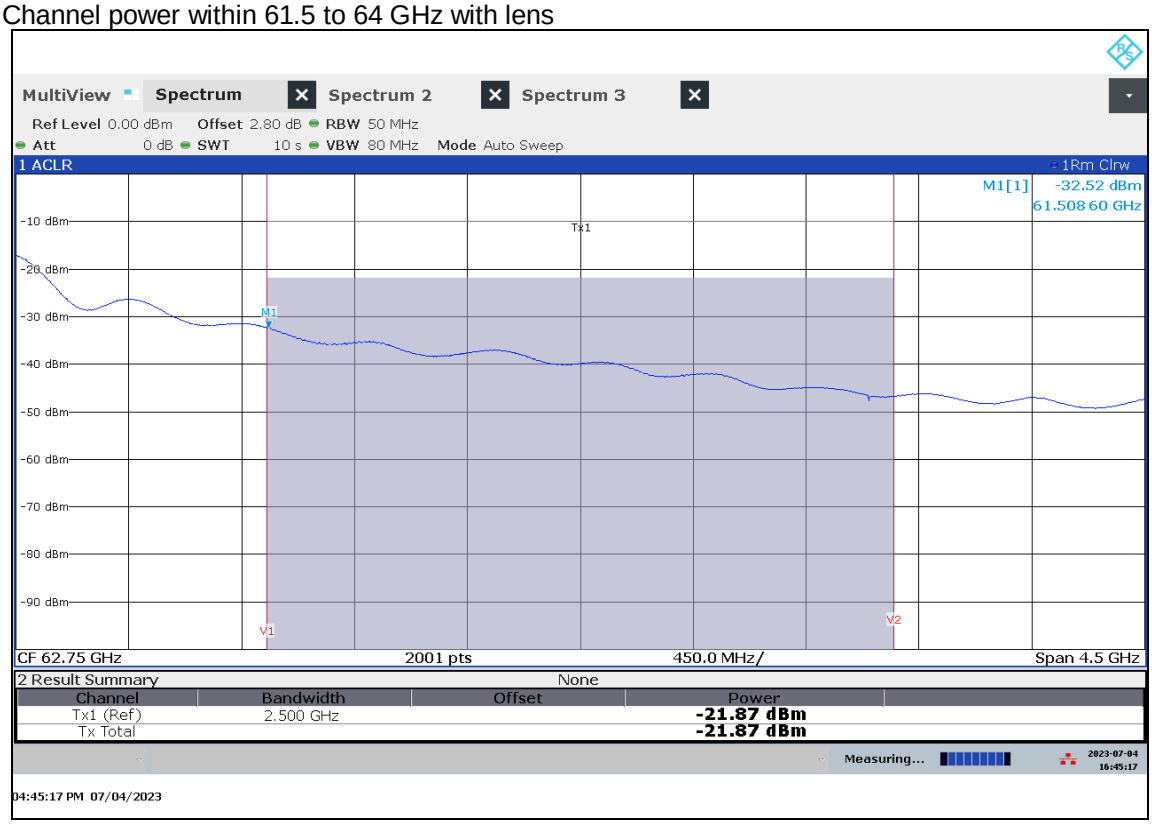
	without Lens	Note:
Readout average (mean) value of oscilloscope at 1 m with EUT	8.8 mV	
EIRP of reference source at 1 m	40.5 dBm	Multiplier: ~20 dB; Horn 20.4 dBi Readout value of power sensor adjusted by far field attenuation
fix attenuation added	-10 dB	
rotary attenuator setting to reach peak voltage value of EUT with detector	-20.3 dB	adjusted to oscilloscope readout value of EUT
Peak EIRP of EUT	**10.2 dBm**	
Average EIRP of EUT within 0.3µs	**-3.7 dBm**	4.1 % duty cycle within 0.3µs

Plot 3: Channel power within 57 to 64 GHz with lens

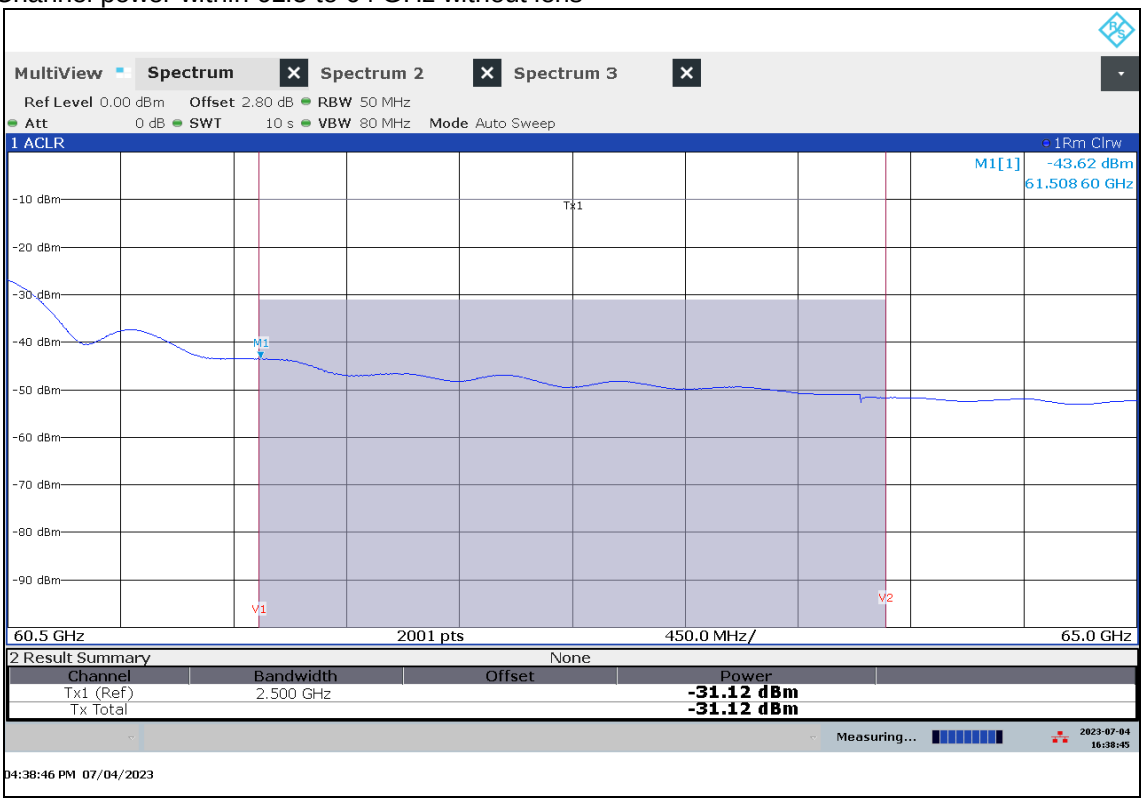
Plot 4: Channel power within 57 to 64 GHz without lens



Plot 5: Channel power within 61.5 to 64 GHz with lens



Plot 6: Channel power within 61.5 to 64 GHz without lens



Calculation of Averaged integrated EIRP within 61.5 – 64 GHz and within 0.3µs:

Measurement:	with Lens	Note:
Channel power full band	-6.25 dBm	
Channel power 61.5 – 64 GHz	-21.87 dBm	
Difference	15.62 dBm	
Average EIRP of EUT within 0.3µs	11.6 dBm	from detector measurement
Average EIRP of EUT within 0.3µs and within 61.5 – 64 GHz	**-4.02 dBm**	Limit: 5 dBm

Measurement:	without Lens	Note:
Channel power full band	-15.88 dBm	
Channel power 61.5 – 64 GHz	-31.12 dBm	
Difference	15.24 dBm	
Average EIRP of EUT within 0.3µs	-3.7 dBm	from detector measurement
Average EIRP of EUT within 0.3µs and within 61.5 – 64 GHz	**-18.94 dBm**	Limit: 5 dBm

12.3 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions in transmit mode.

Limits: **FCC Part 15.255**

(c) Limits on spurious emissions:

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

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

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 (-10dBm) at a distance of 3 meters.

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

FCC		
CFR Part 15.209(a)		
Radiated Spurious Emissions		
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
Above 960	54.0	3

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

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

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

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

Measurement:

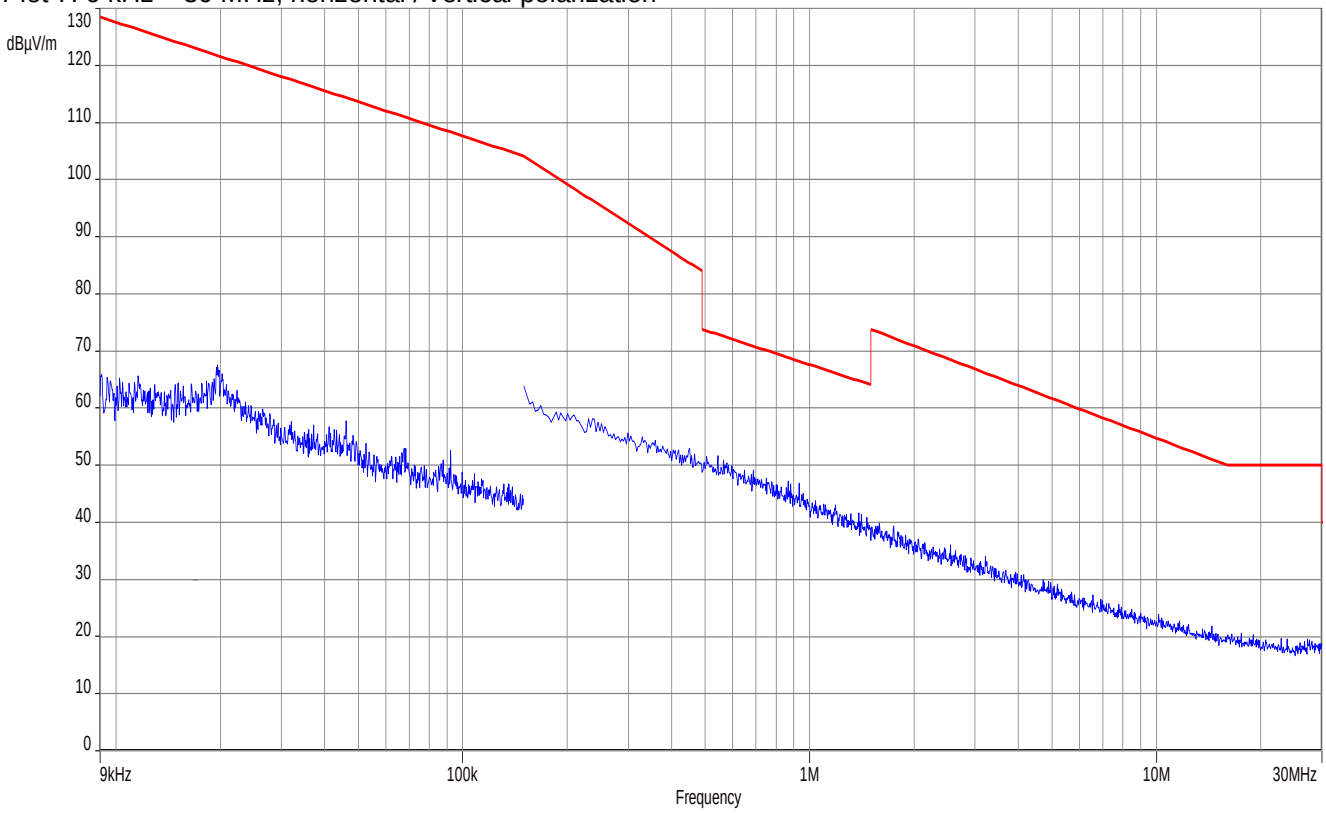
Measurement parameter	
Detector:	Quasi Peak / Pos-Peak / RMS
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	F < 1 GHz: 300 kHz F > 1 GHz: 3 MHz
Trace-Mode:	Max Hold

Measurement results:

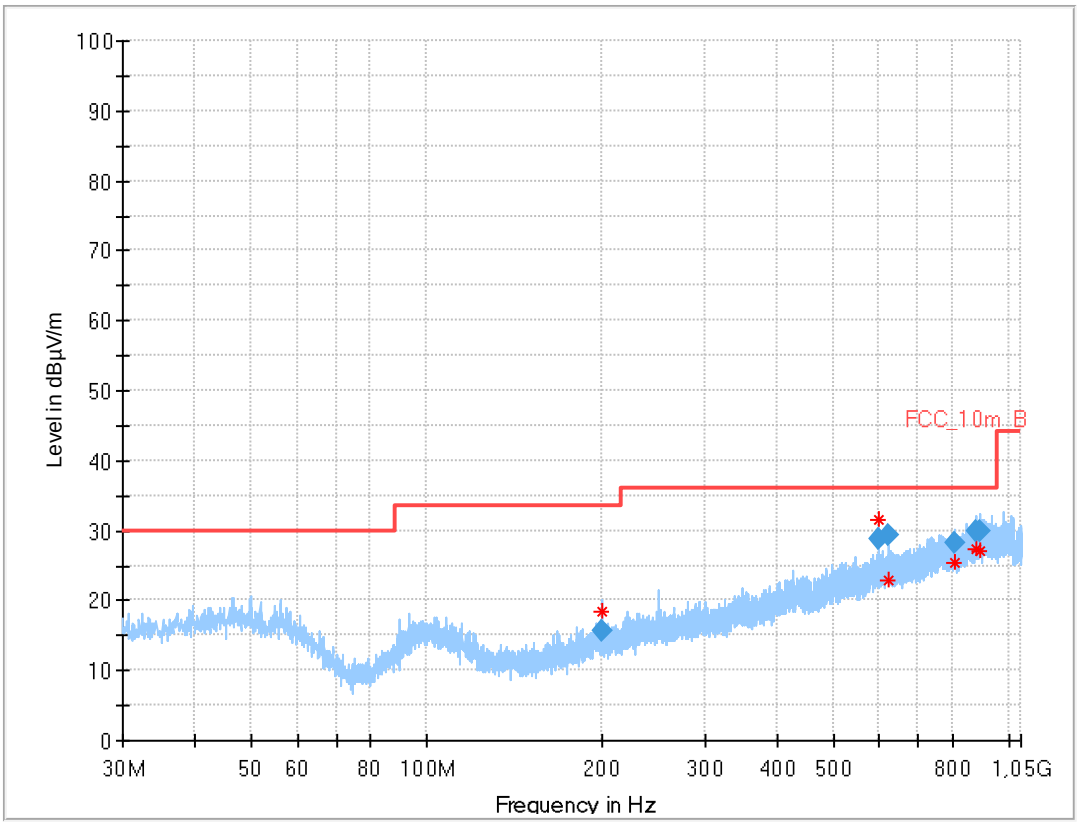
Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
No peaks detected!					
Please refer to the following plots for more information on the level of spurious emissions					

Result: **The measurement is passed.**

Plot 7: 9 kHz – 30 MHz, horizontal / vertical polarization



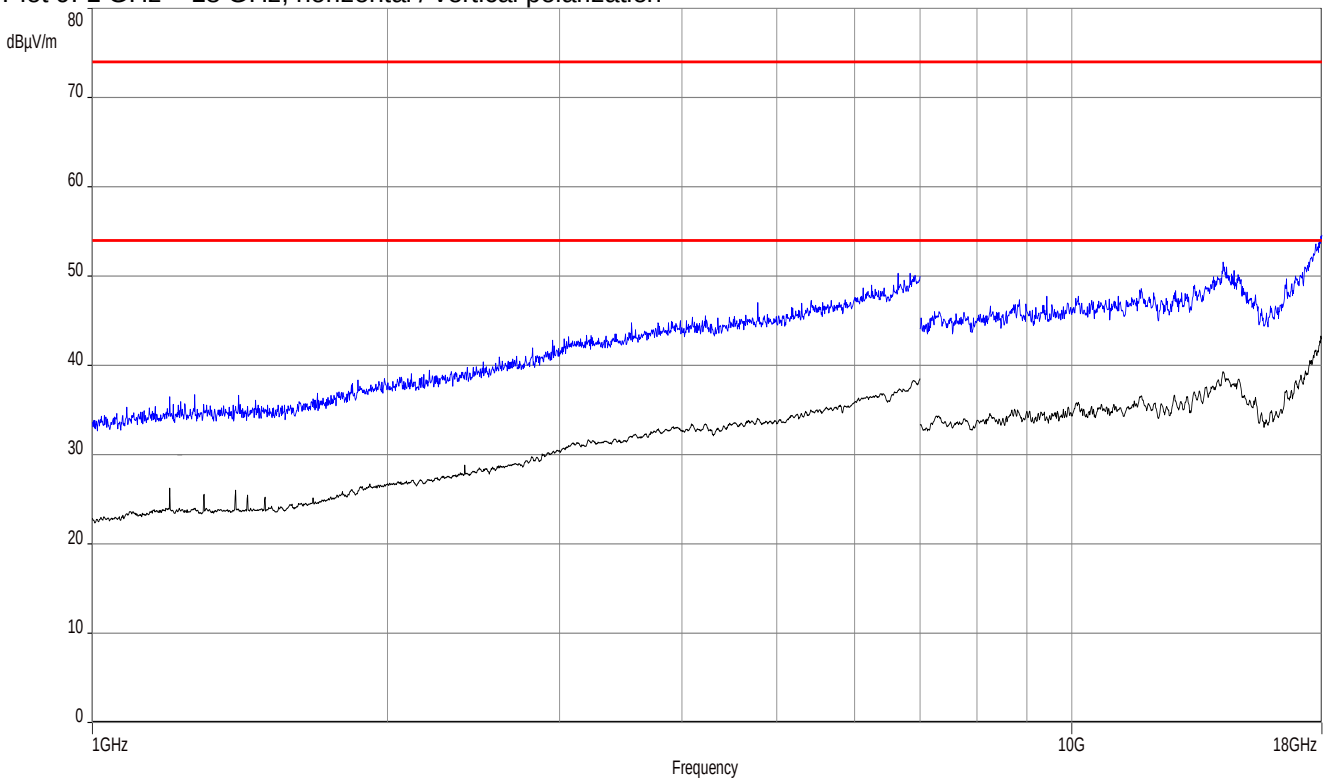
Plot 8: 30 MHz – 1 GHz, horizontal / vertical polarization



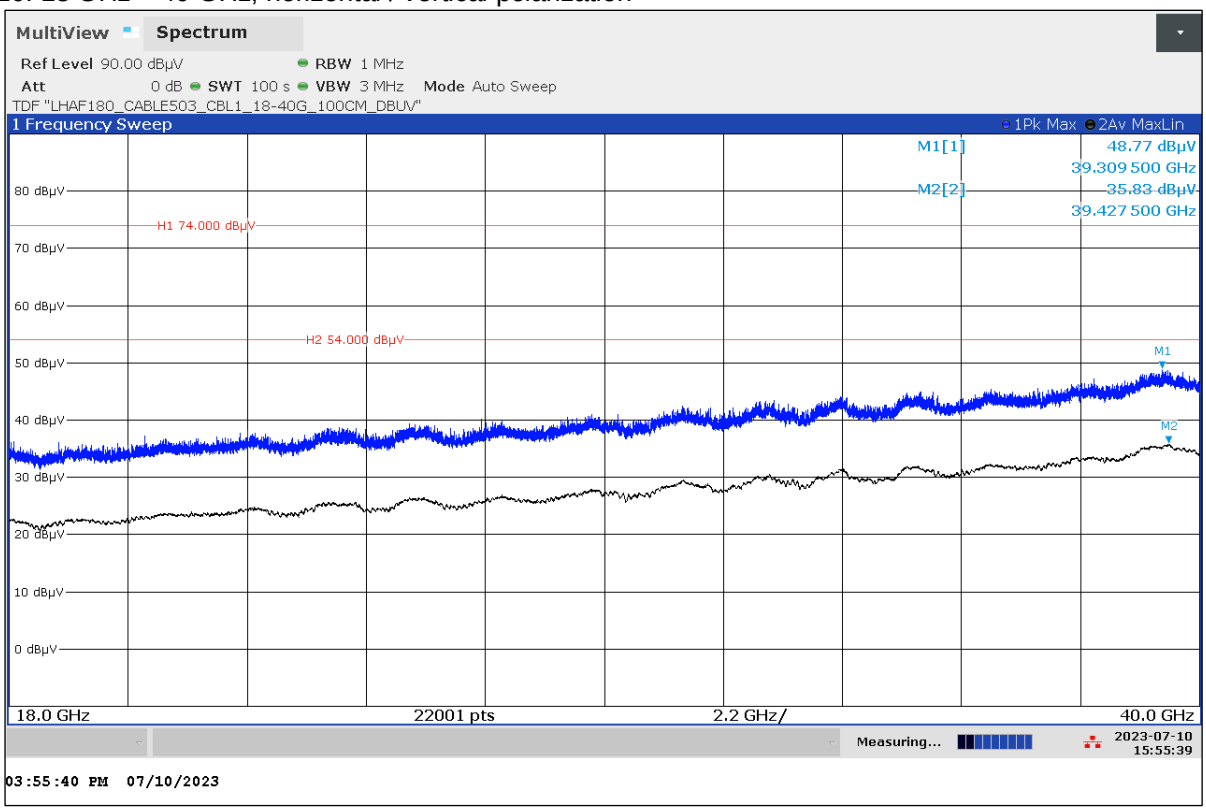
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
199.998	15.69	33.5	17.8	1000	120.0	195.0	V	284	12
599.988	28.91	36.0	7.1	1000	120.0	195.0	H	54	22
621.247	29.30	36.0	6.7	1000	120.0	186.0	H	232	22
808.879	28.17	36.0	7.8	1000	120.0	109.0	H	142	24
880.728	29.76	36.0	6.2	1000	120.0	195.0	H	-4	25
892.434	29.92	36.0	6.1	1000	120.0	195.0	H	142	25

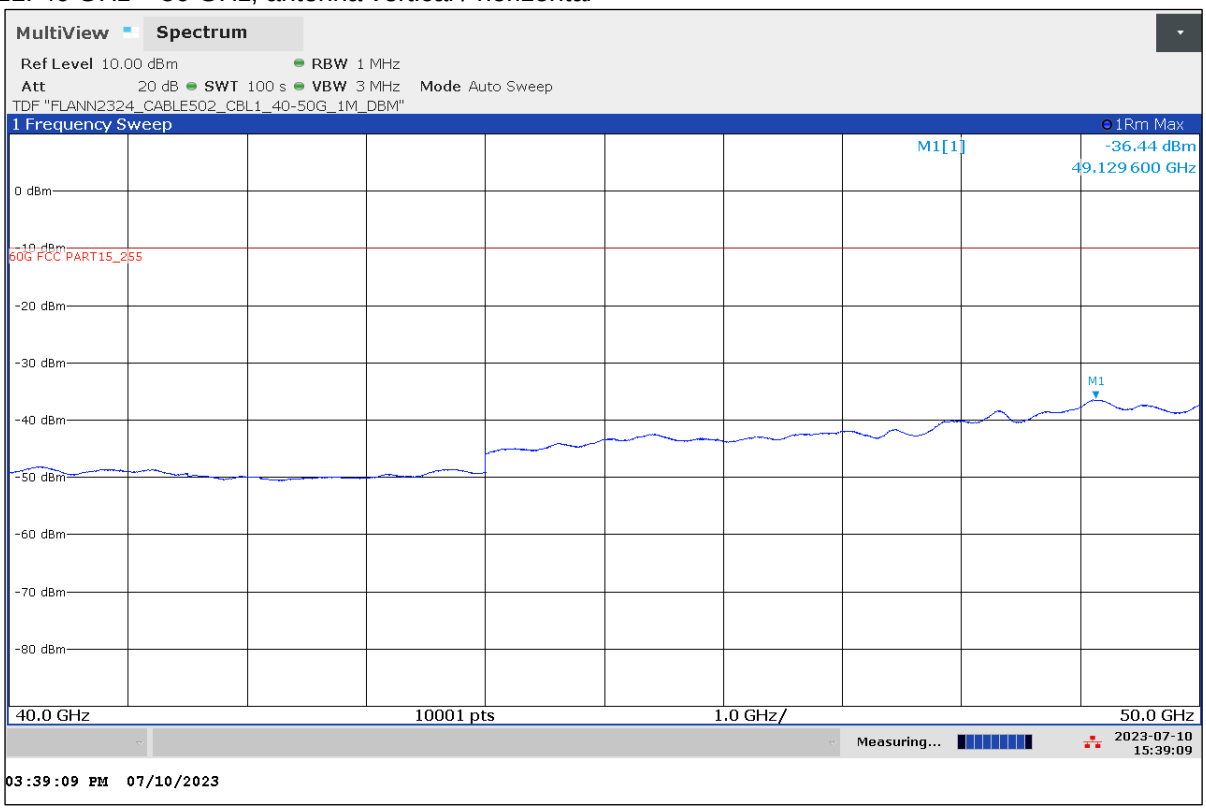
Plot 9: 1 GHz – 18 GHz, horizontal / vertical polarization



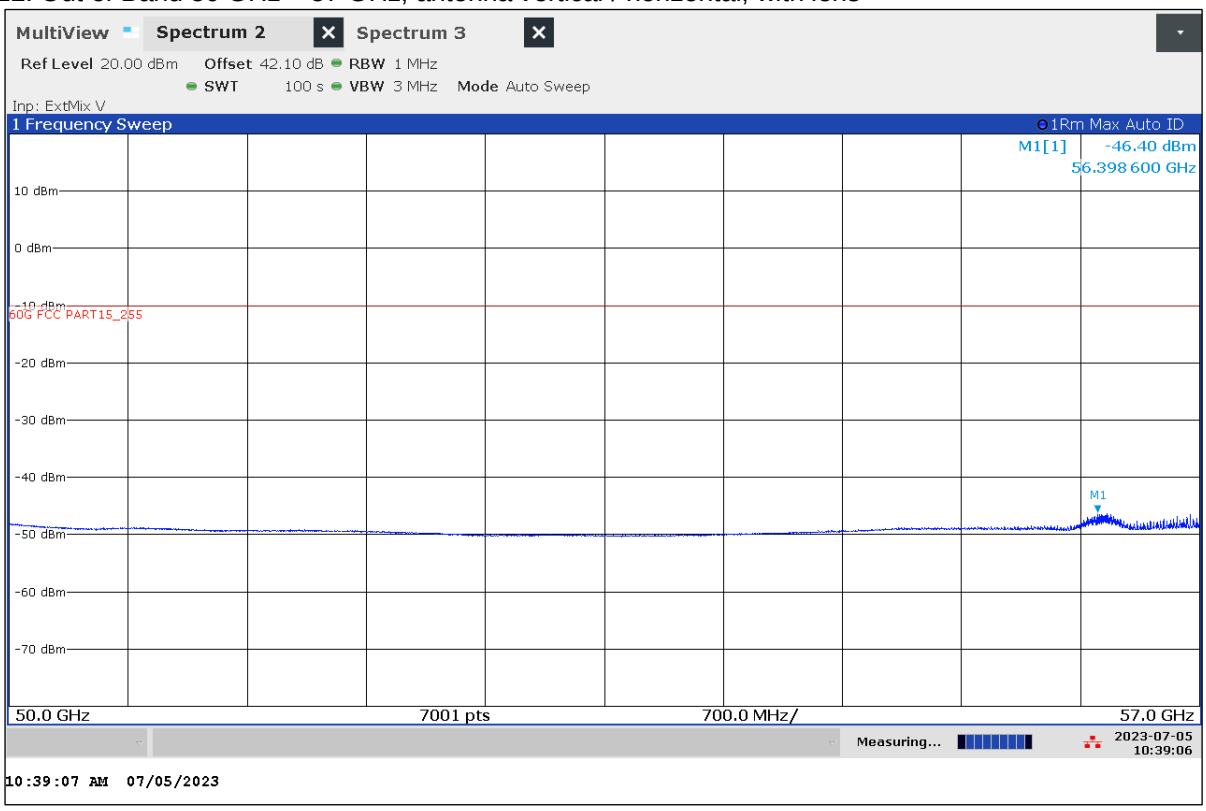
Plot 10: 18 GHz – 40 GHz, horizontal / vertical polarization



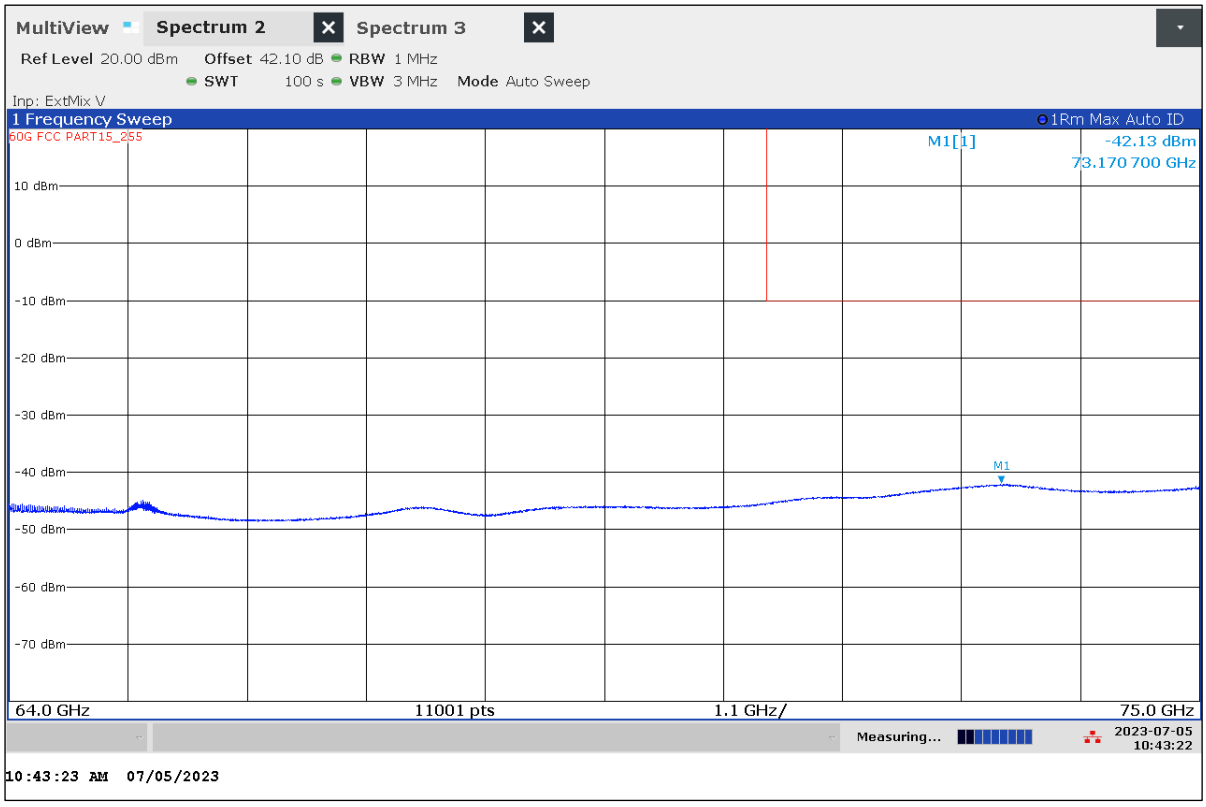
Plot 11: 40 GHz – 50 GHz, antenna vertical / horizontal



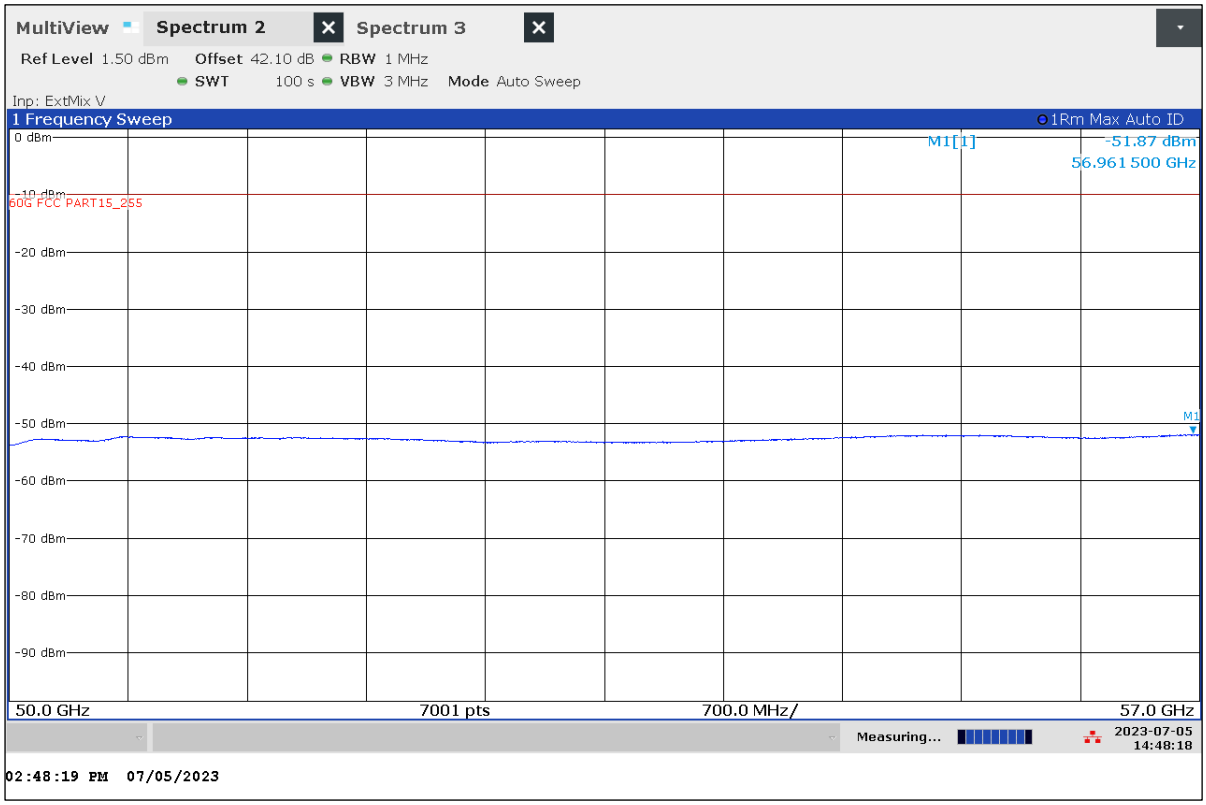
Plot 12: Out of Band 50 GHz – 57 GHz, antenna vertical / horizontal, with lens



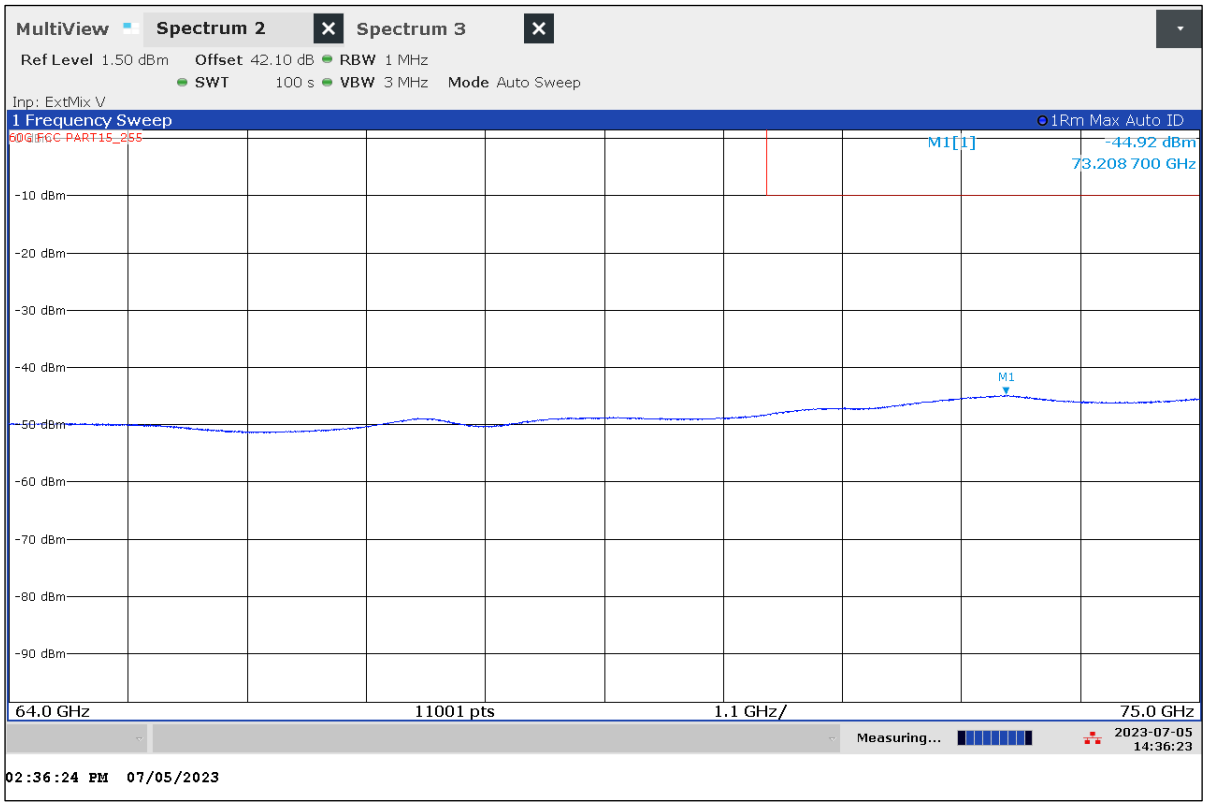
Plot 13: Out of Band 64 GHz – 75 GHz, antenna vertical / horizontal, with lens



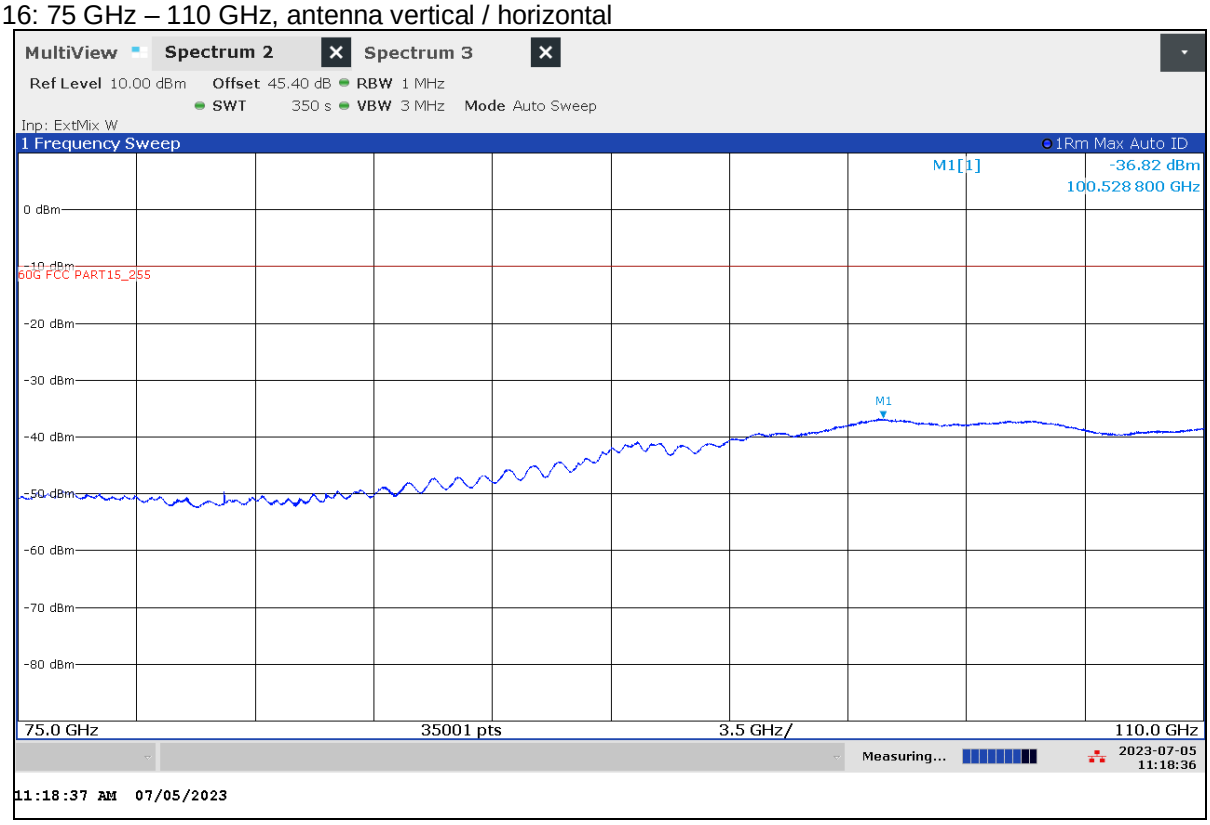
Plot 14: Out of Band 50 GHz – 57 GHz, antenna vertical / horizontal, without lens



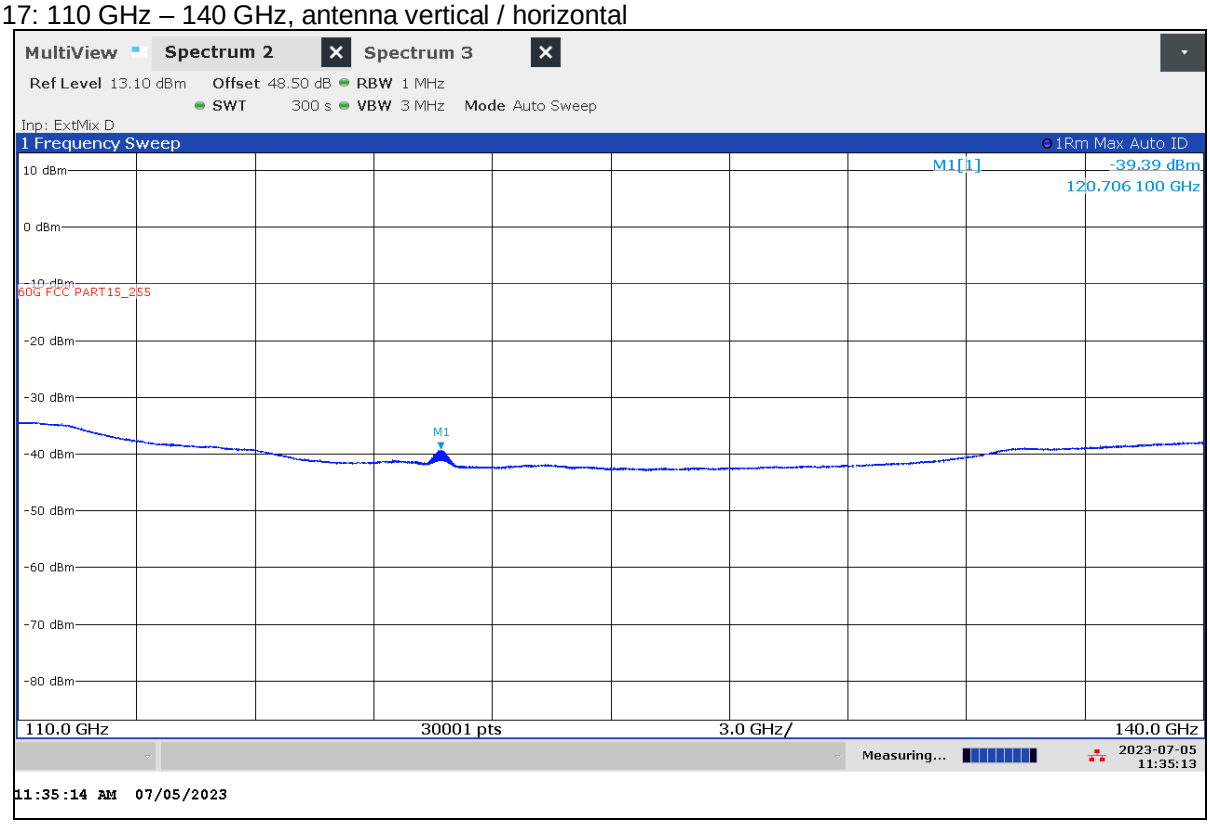
Plot 15: Out of Band 64 GHz – 75 GHz, antenna vertical / horizontal, without lens



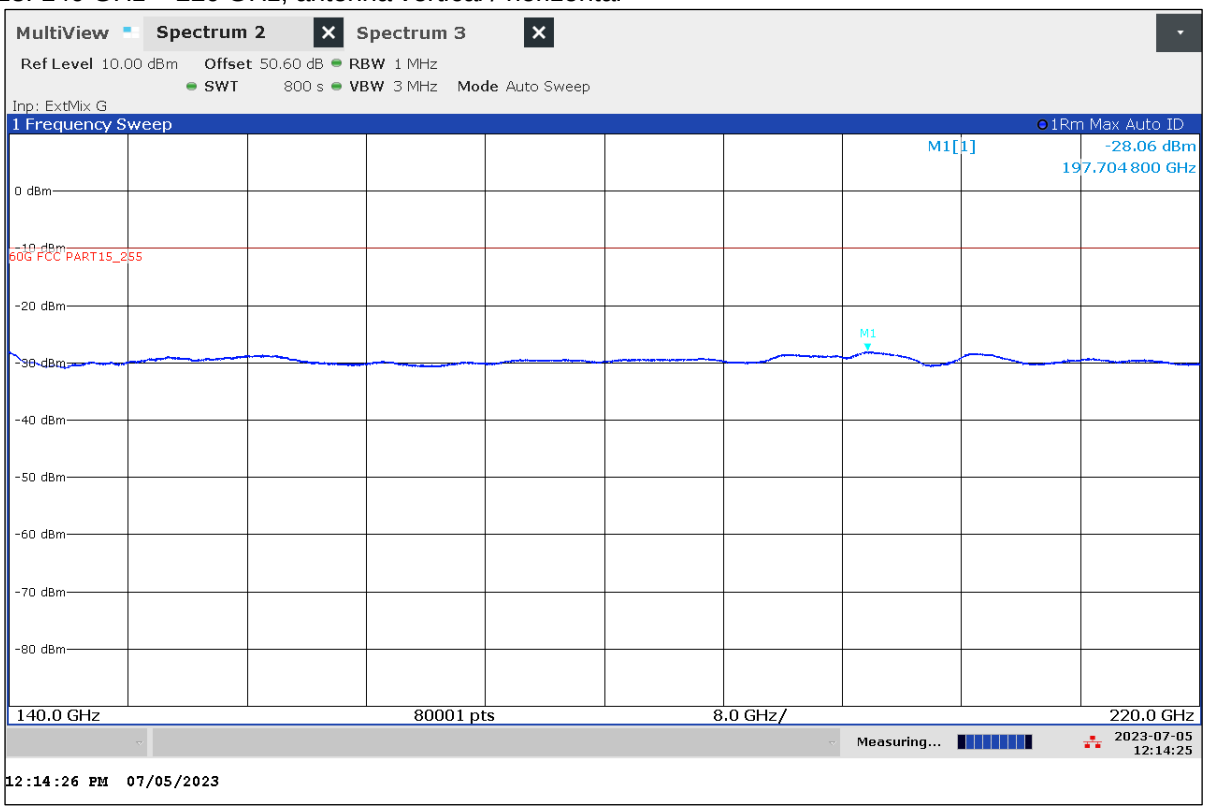
Plot 16: 75 GHz – 110 GHz, antenna vertical / horizontal



Plot 17: 110 GHz – 140 GHz, antenna vertical / horizontal



Plot 18: 140 GHz – 220 GHz, antenna vertical / horizontal



12.4 Frequency Stability

Description:

Measurement of the radiated spurious emissions in transmit mode.

Limits:

(e) *Frequency stability.* 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.

FCC
CFR Part 15.255
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:
Frequency range
57 GHz – 64 GHz

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	10 s
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	8 GHz
Trace-Mode:	Max Hold
Temperature:	-40 °C / +85 °C

Measurement Results:

Temperature in °C	Voltage	f_L in GHz	f_H in GHz
-40	V_{nom}	59.588 9	61.554 9
-20	V_{nom}	59.628 9	61.483 0
-10	V_{nom}	59.620 9	61.491 0
0	V_{nom}	59.453 0	61.459 0
10	V_{nom}	59.572 9	61.443 1
20	V_{nom}	59.549 0	61.435 1
30	V_{nom}	59.509 0	61.179 3
40	V_{nom}	59.485 0	61.123 4
50	V_{nom}	59.461 0	61.107 4
85	V_{nom}	59.437 1	61.107 4

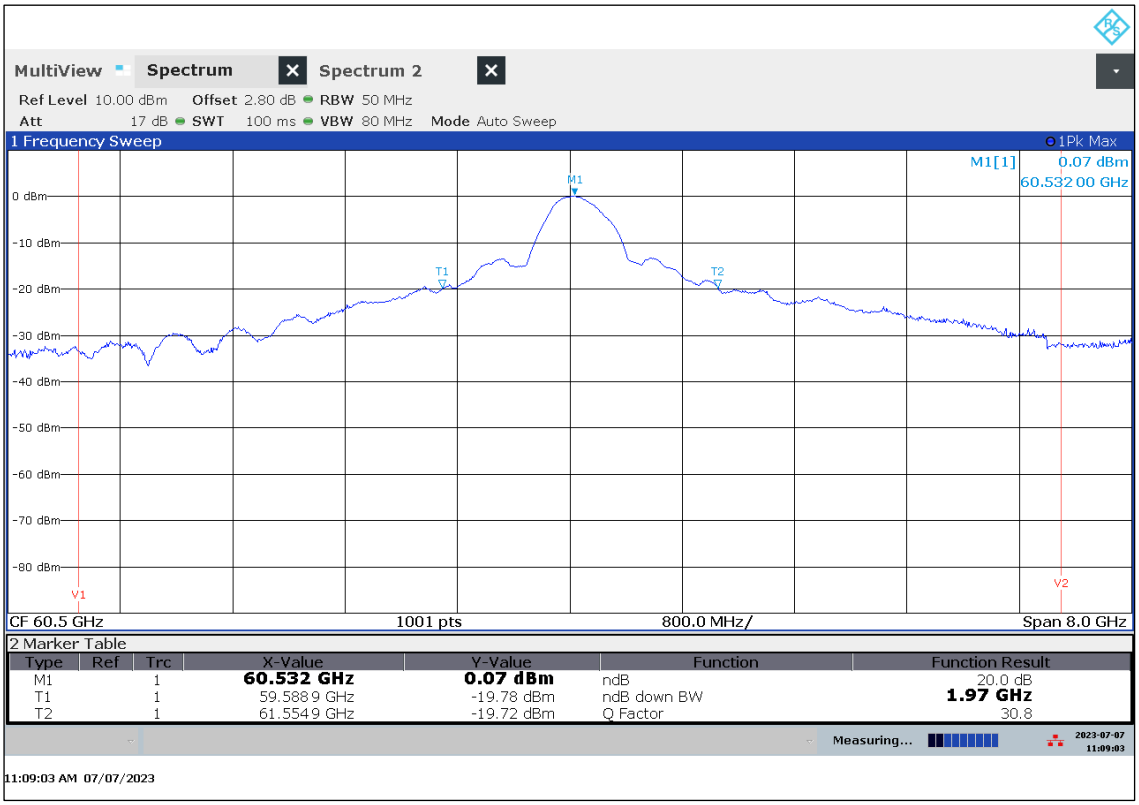
Voltage variation

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		

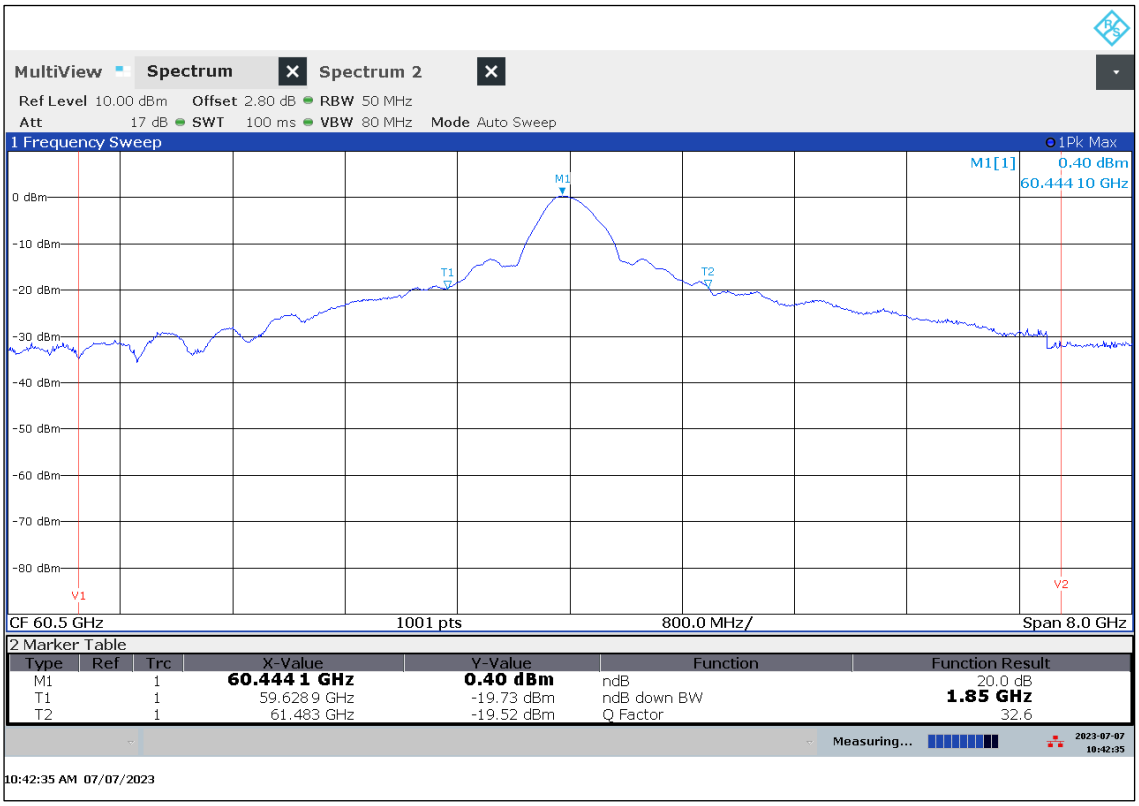
Note: The control board only allows a voltage variation of +/-5 %

Result: The measurement is passed.

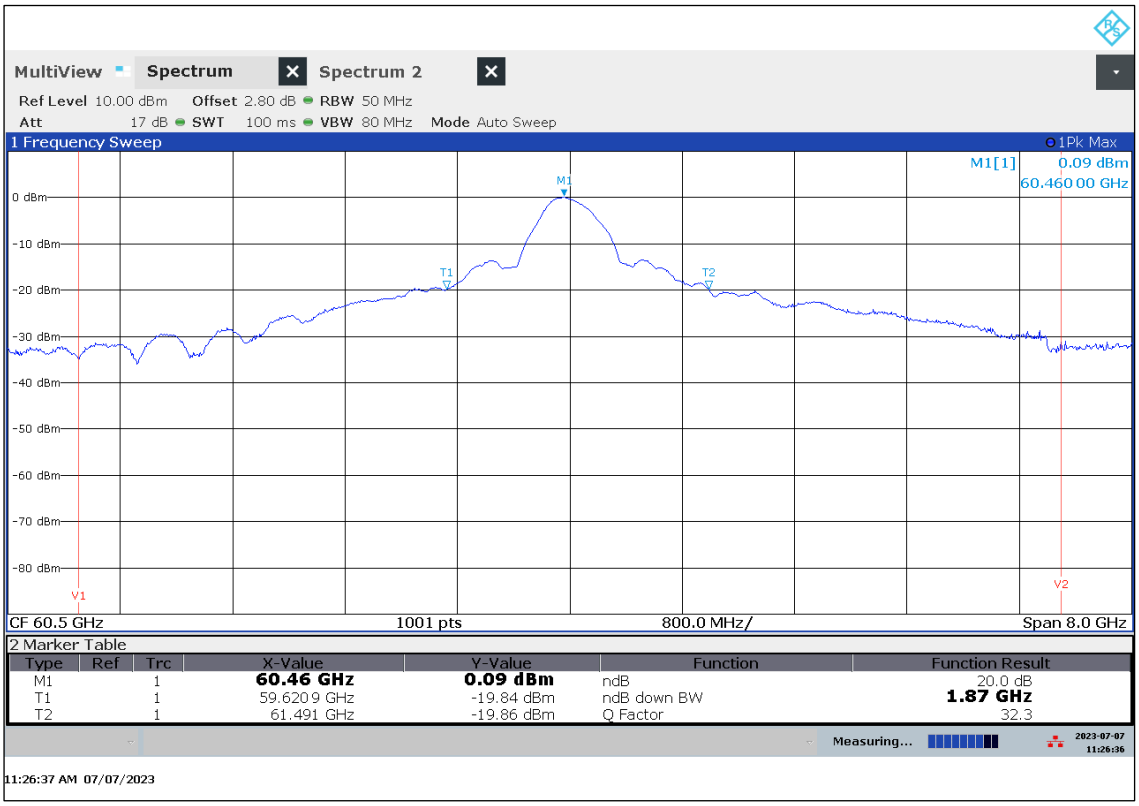
Plot 19: 20 dB-Bandwidth at T= -40 °C / $V_{min-max}$



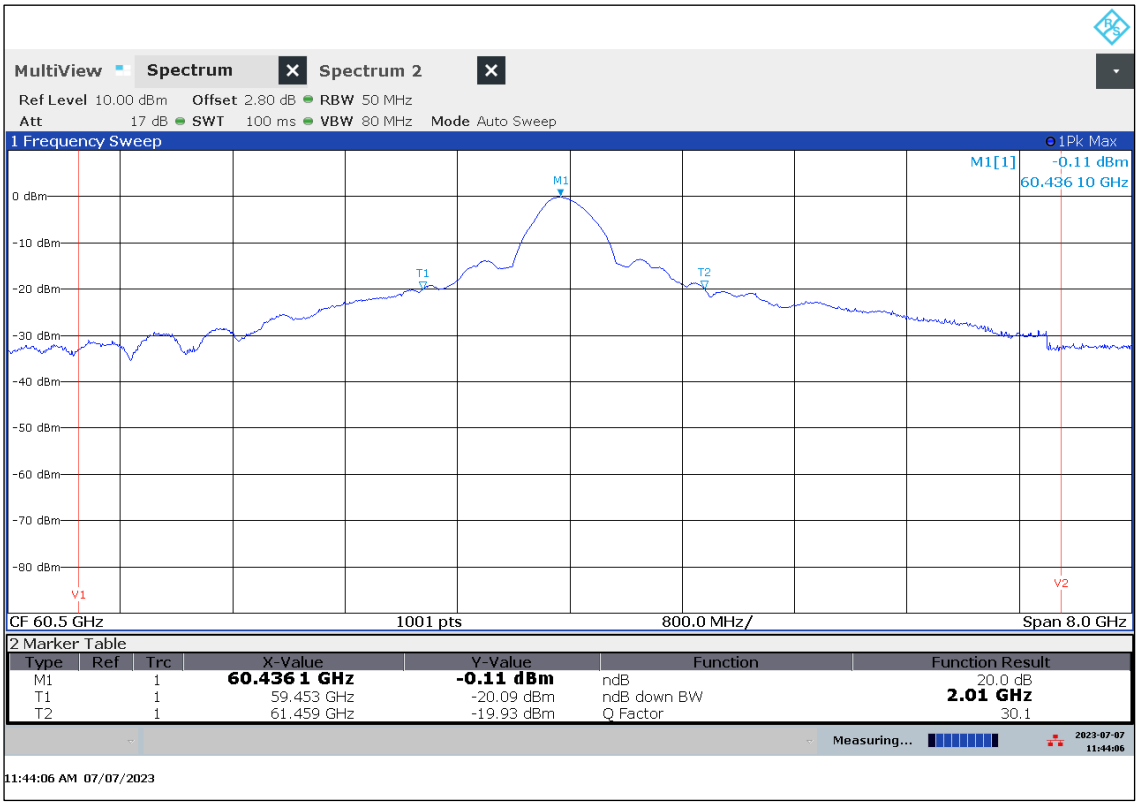
Plot 20: 20 dB-Bandwidth at T= -20 °C / $V_{min-max}$



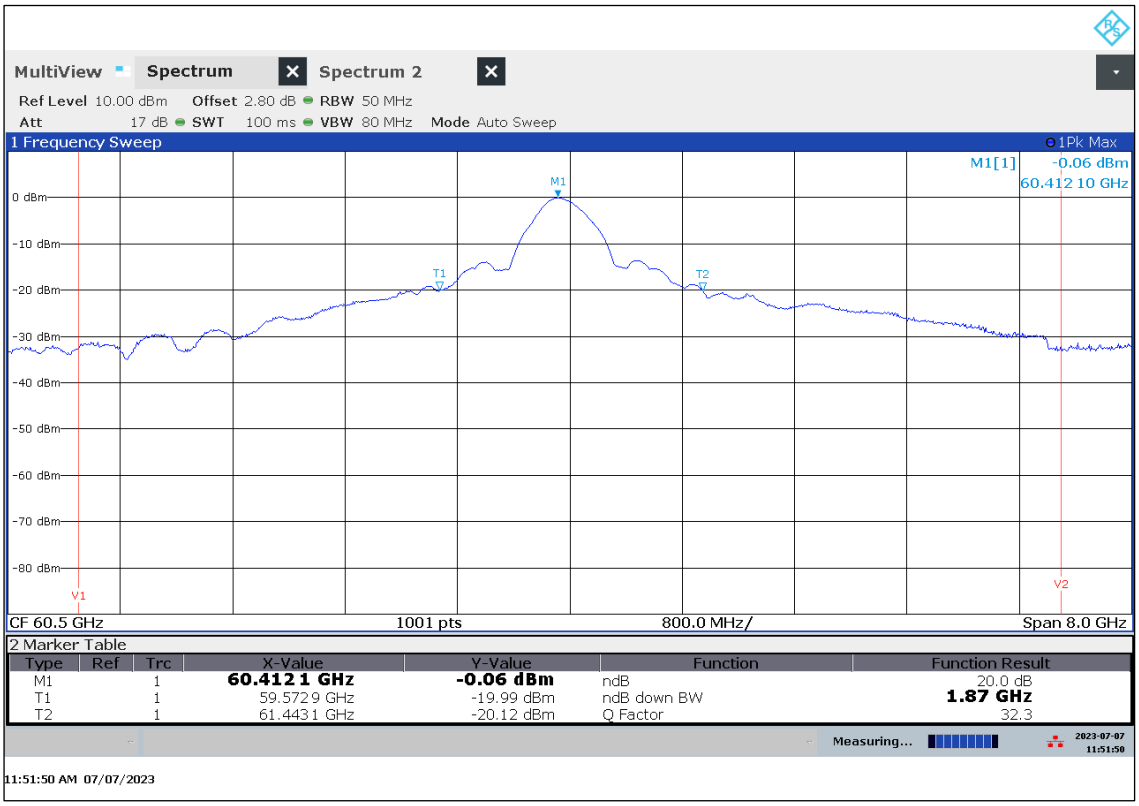
Plot 21: 20 dB-Bandwidth at T= -10 °C / $V_{min-max}$



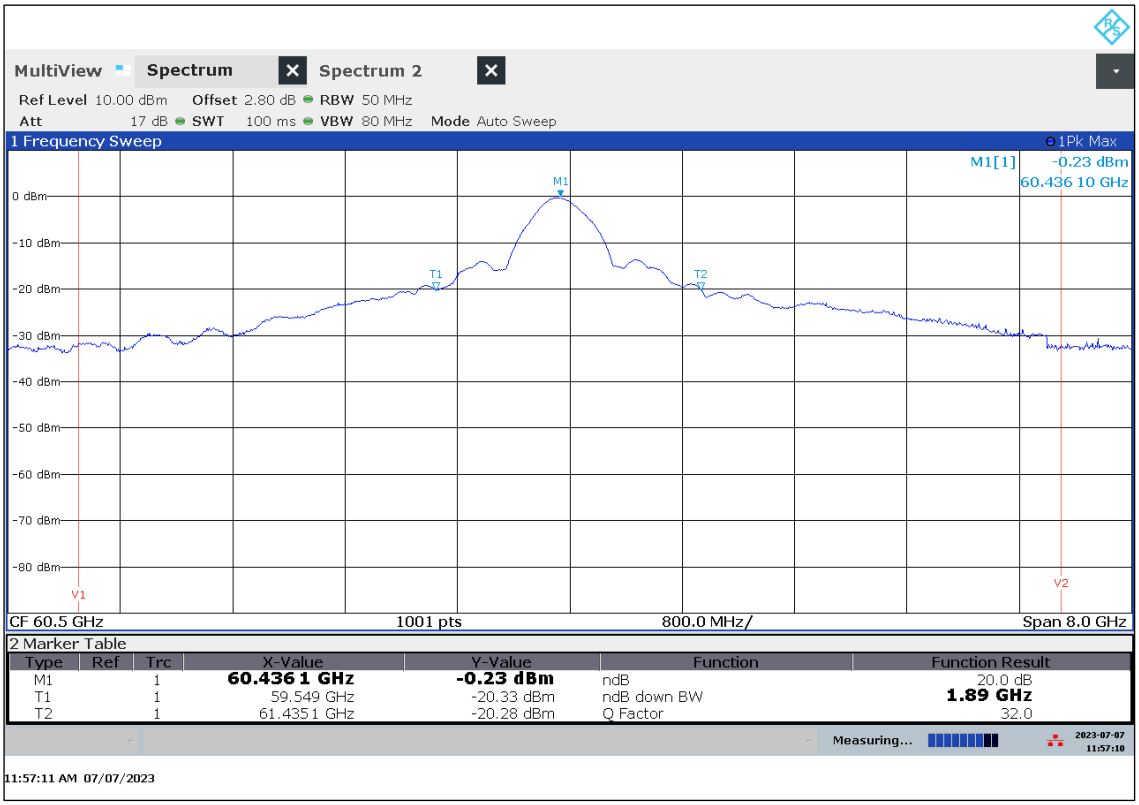
Plot 22: 20 dB-Bandwidth at T= 0 °C / $V_{min-max}$



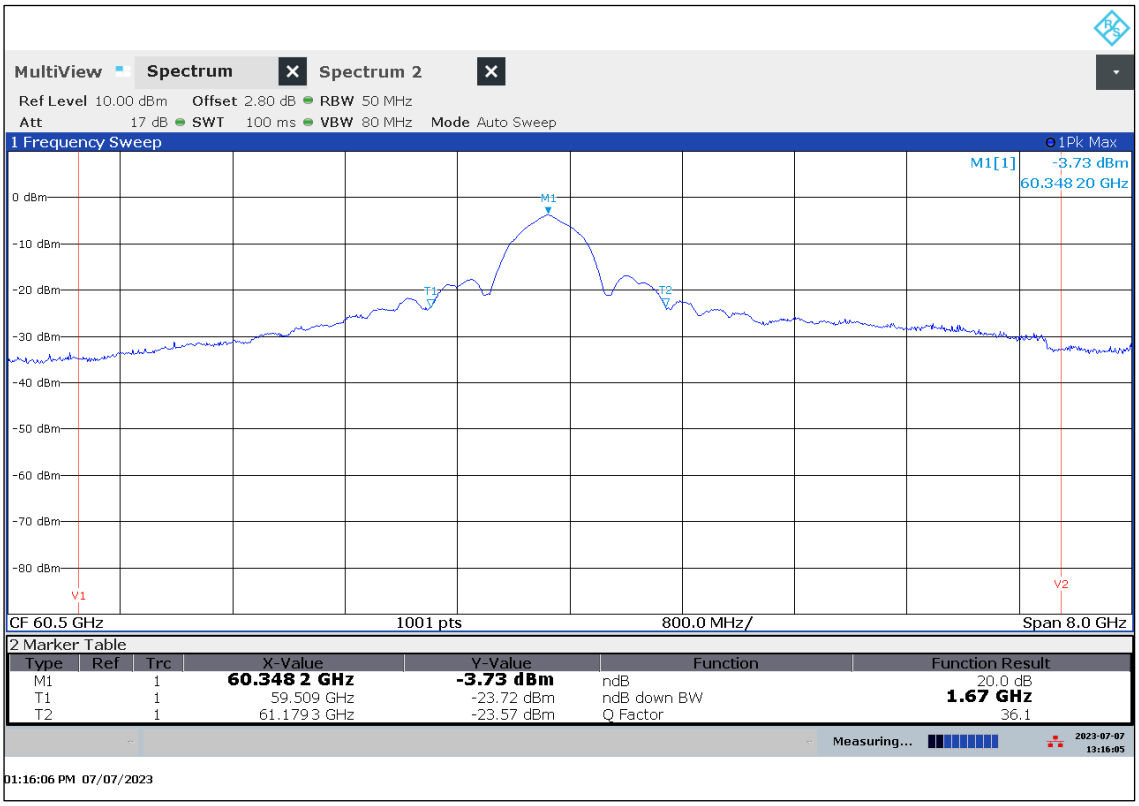
Plot 23: 20 dB-Bandwidth at T= 10 °C / $V_{min-max}$



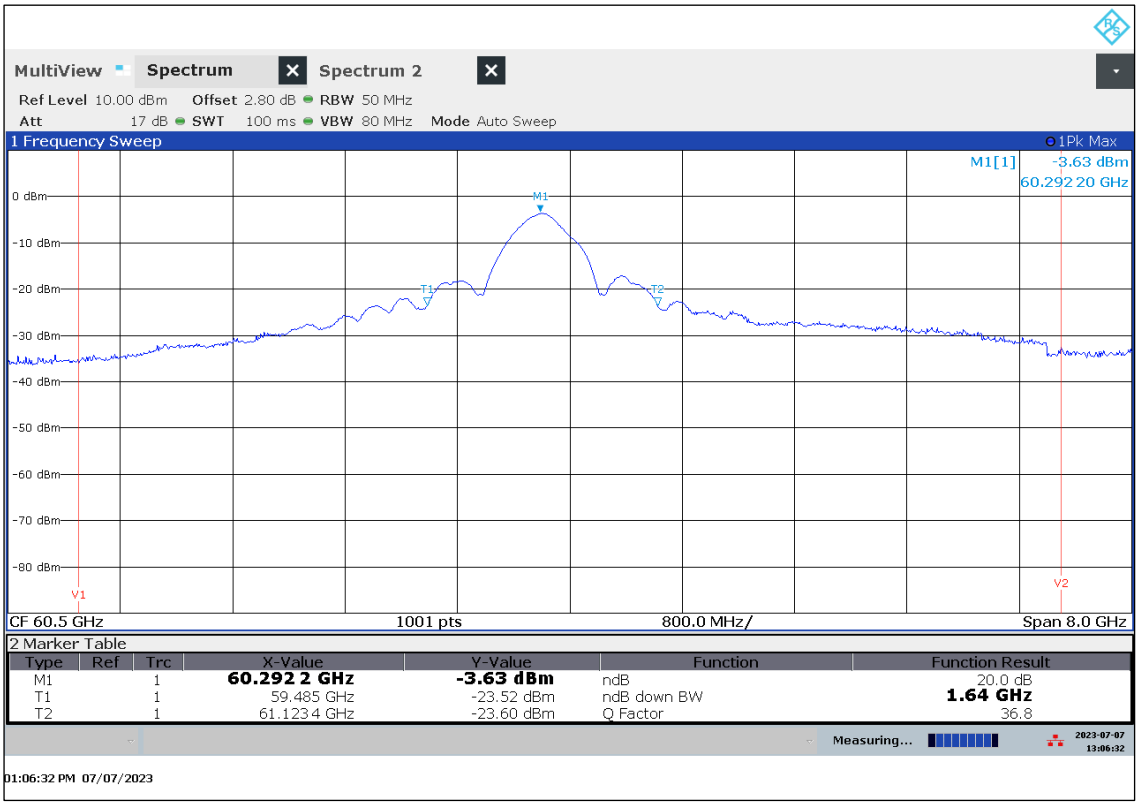
Plot 24: 20 dB-Bandwidth at T= 20 °C / $V_{min-max}$



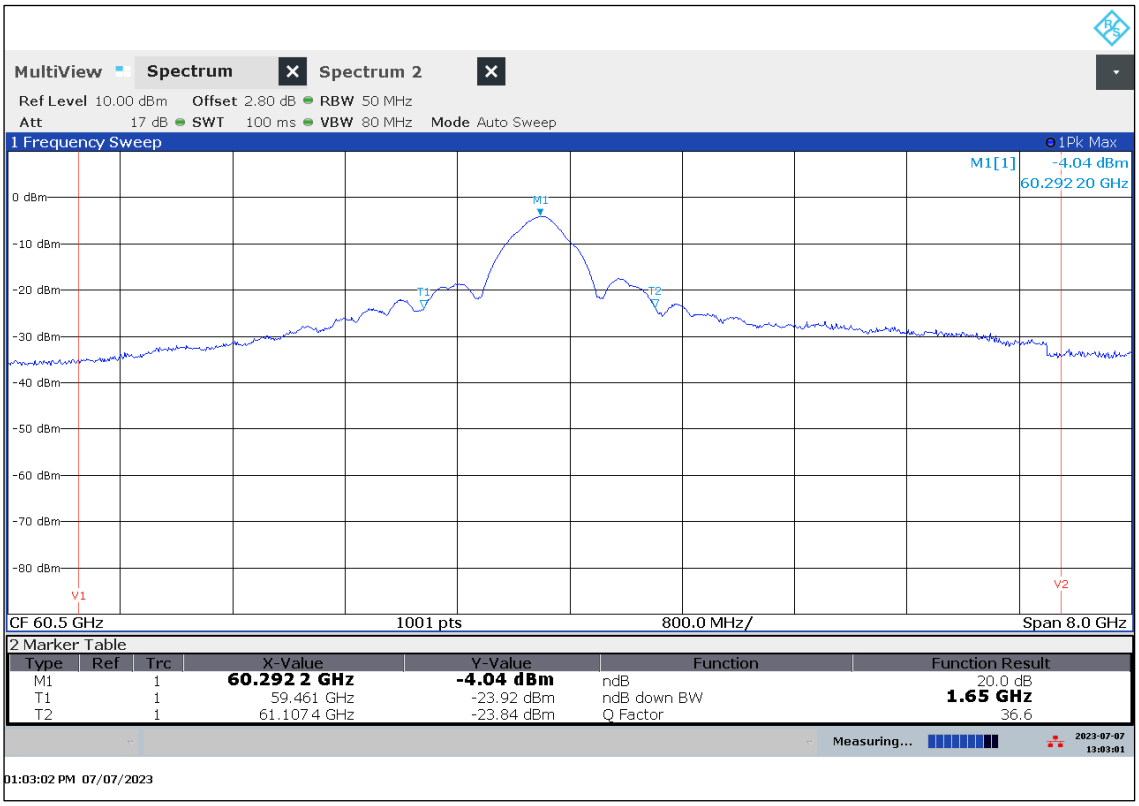
Plot 25: 20 dB-Bandwidth at T= 30 °C / $V_{min-max}$



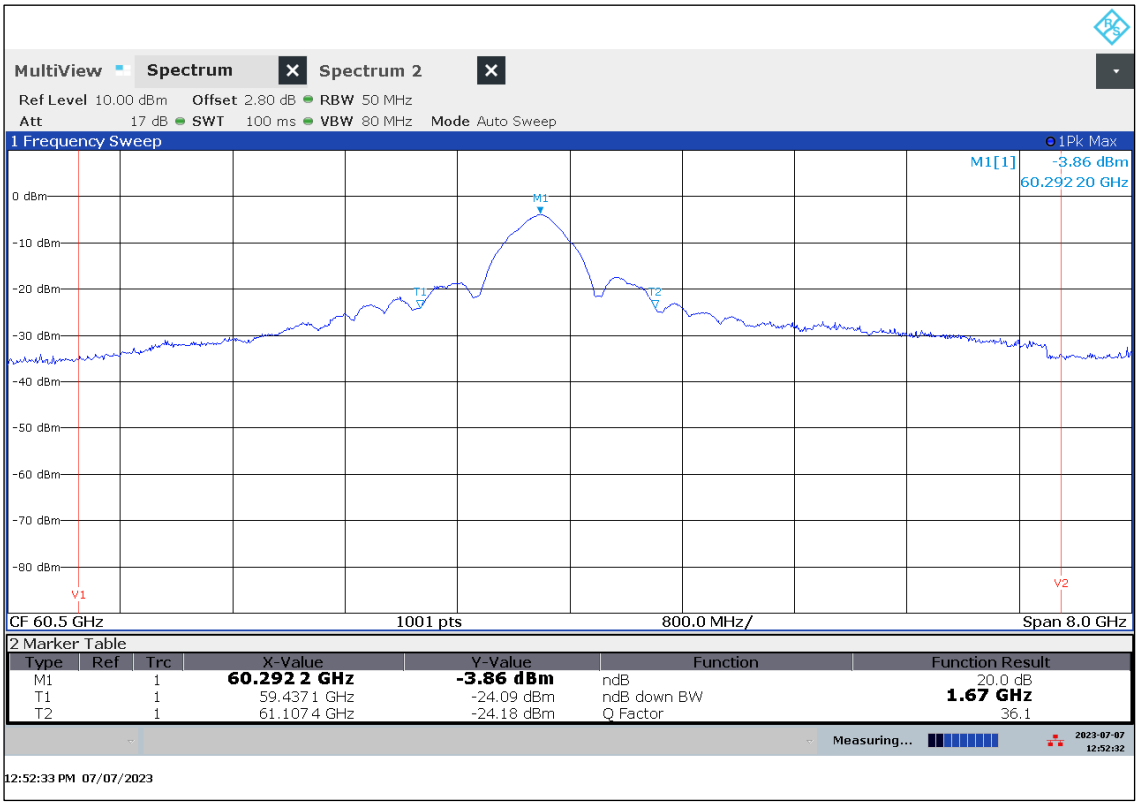
Plot 26: 20 dB-Bandwidth at T= 40 °C / $V_{min-max}$



Plot 27: 20 dB-Bandwidth at T= 50 °C / $V_{min-max}$



Plot 28: 20 dB-Bandwidth at T= 85 °C / $V_{min-max}$



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 – DRAFT	2023-07-25
	Initial release	2023-07-31

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

first page	last page
	

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

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

or

https://cetecomadvanced.com/files/pdfs/d-pl-12076-01-05_tcb_usa.pdf

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