
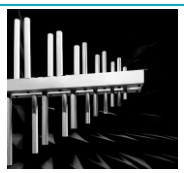
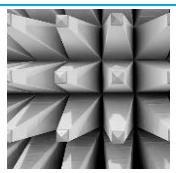

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-8617/17-01-03

Testing laboratory

CTC advanced GmbH
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Applicant

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223 70 Lund / SWEDEN
Phone: +46 722212179
Fax:
Contact: Mikael Rosenhed
e-mail: mikael.rosenhed@acconeer.com
Phone: +46 722212179

Manufacturer

Acconeer AB
Ideon Gateway, Scheelevägen 27
223 70 Lund / SWEDEN

Test standard/s

47 CFR Part 15	Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS-210, Issue 9	License-Exempt Radio Apparatus
RSS-Gen	General Requirements for Compliance of Radio Apparatus

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

Test Item

Kind of test item:	**60 GHz Module for SRD Radar**
Model name:	**A111**
FCC ID:	**2AQ6KA1001**
IC:	**24388-A111**
Frequency:	57 GHz – 64 GHz (RSS) 57 GHz – 71 GHz (FCC)
Antenna:	2 embedded Dipole Antennas
Power supply:	1.71 V to 1.89 V DC
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:

p.o.

cn=Bernd Rebmann, o=CTC advanced GmbH, ou=REB-161202, email=bernd.rebmann@ctcadvanced.com, c=DE
2019.10.10 16:16:49 +02'00'

Geraldy Karsten
Lab Manager
Radio Communications & EMC

Test performed:

cn=Walla Meheza, o=ctcadvanced GmbH, ou=WAL-161220, email=meheza.walla@ctcadvanced.com, c=DE
2019.10.10 16:08:29 +02'00'

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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2.2 Application details

Date of receipt of order:	2017-11-09
Date of receipt of test item:	2019-09-30
Start of test:	2019-09-30
End of test:	2019-10-09
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
RSS-210, Issue 9	August 2016	License-Exempt Radio Apparatus
Referenced Standards		
RSS-Gen	Nov 2014	General Requirements for Compliance of Radio Apparatus

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

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +50 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	1.8 V DC by external power supply 1.89 V 1.71 V

5 Test item

5.1 General description

Kind of test item	:	60 GHz Module for SRD Radar
Type identification	:	A111
HMN	:	-/-
PMN	:	A111
HVIN	:	A111
FVIN	:	2.0.0
S/N serial number	:	-/-
HW hardware status	:	A111
SW software status	:	2.0.0
Frequency band	:	57 GHz – 64 GHz (RSS) 57 GHz – 71 GHz (FCC)
Type of modulation	:	Pulse and Frequency Modulation
Number of channels	:	1
Antenna	:	2 embedded Dipole Antennas
Power supply	:	1.71 V to 1.89 V DC
Temperature range	:	-40°C to +85°C

5.2 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: 1-8617/19-01-01_AnnexA
1-8617/19-01-01_AnnexB

6 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).

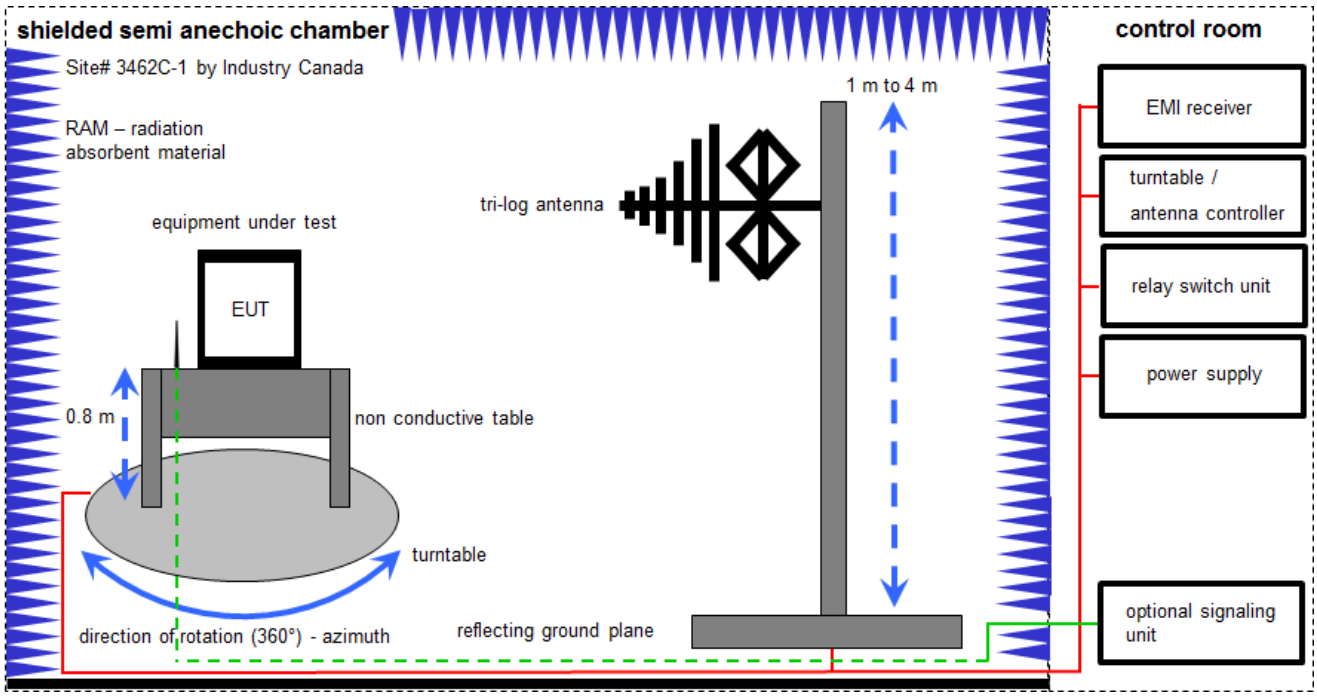
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

6.1 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

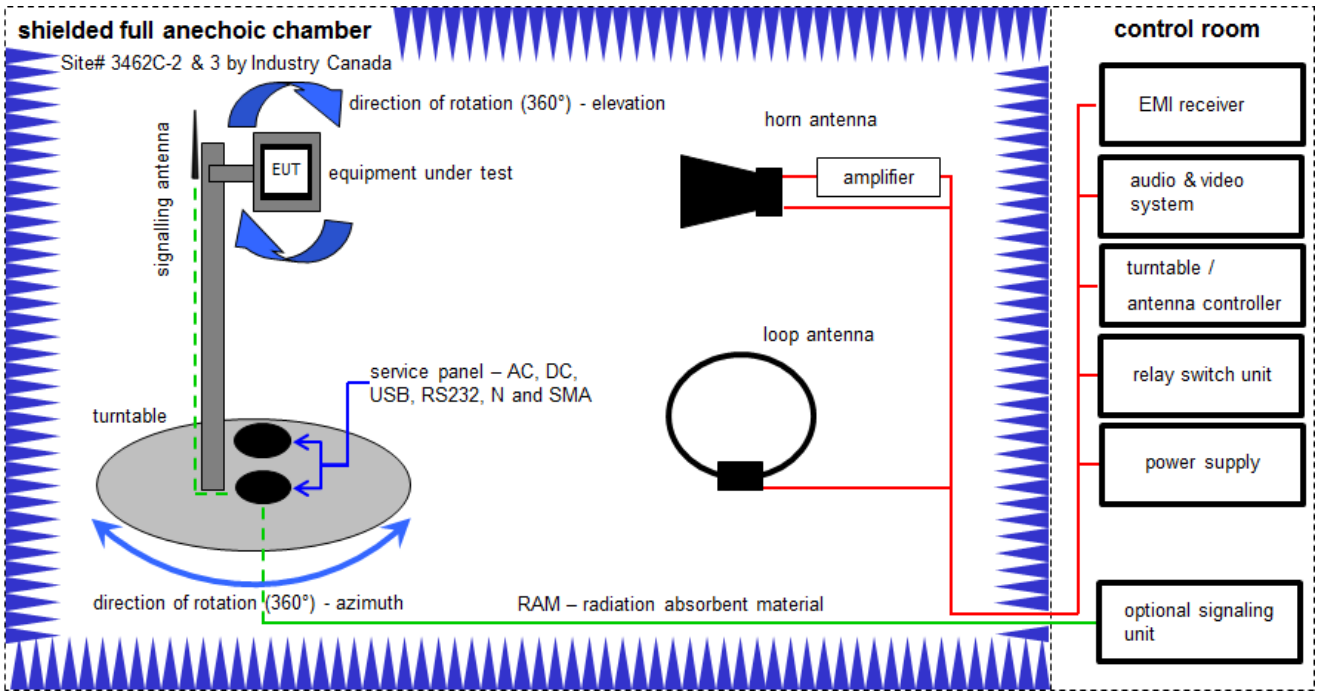
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	ESCI 3	R&S	100083	300003312	k	12.12.2018	11.12.2019
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	15.01.2018	14.01.2020
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	17.12.2018	16.12.2019

6.2 Shielded fully anechoic chamber



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

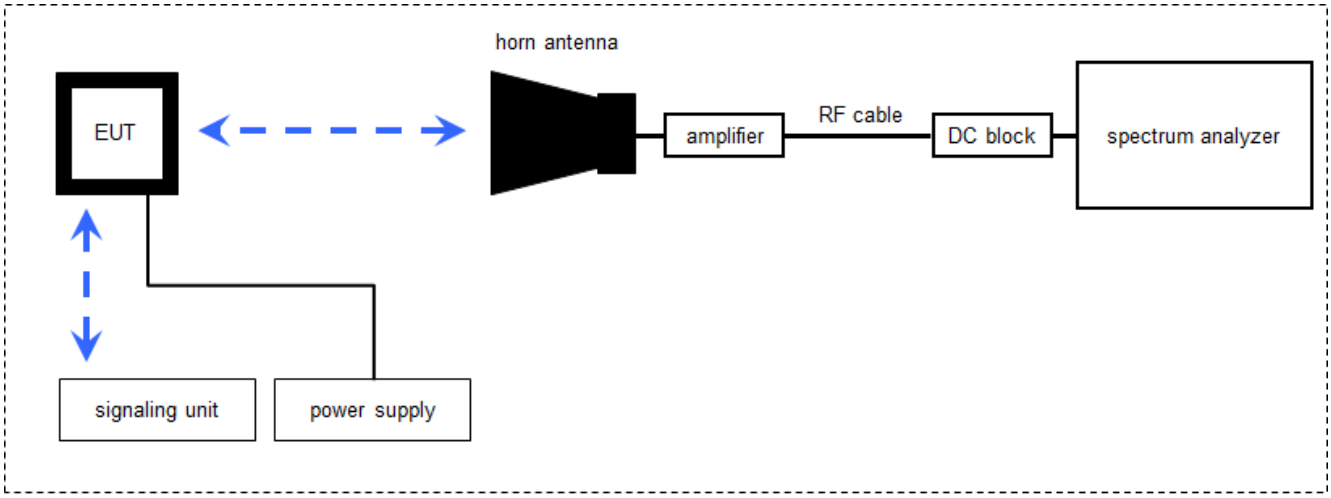
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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

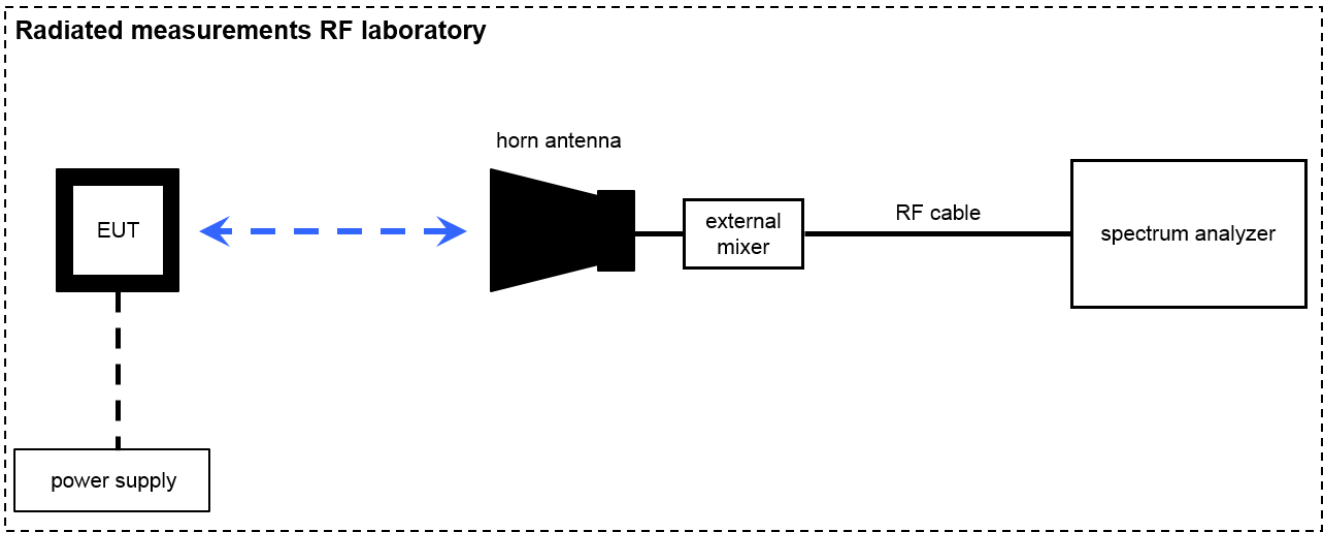
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.02.2019	26.02.2021
1	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	19.12.2018	18.12.2019
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	-/-	-/-

6.3 Radiated measurements, 18 GHz – 50 GHz



6.4 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)

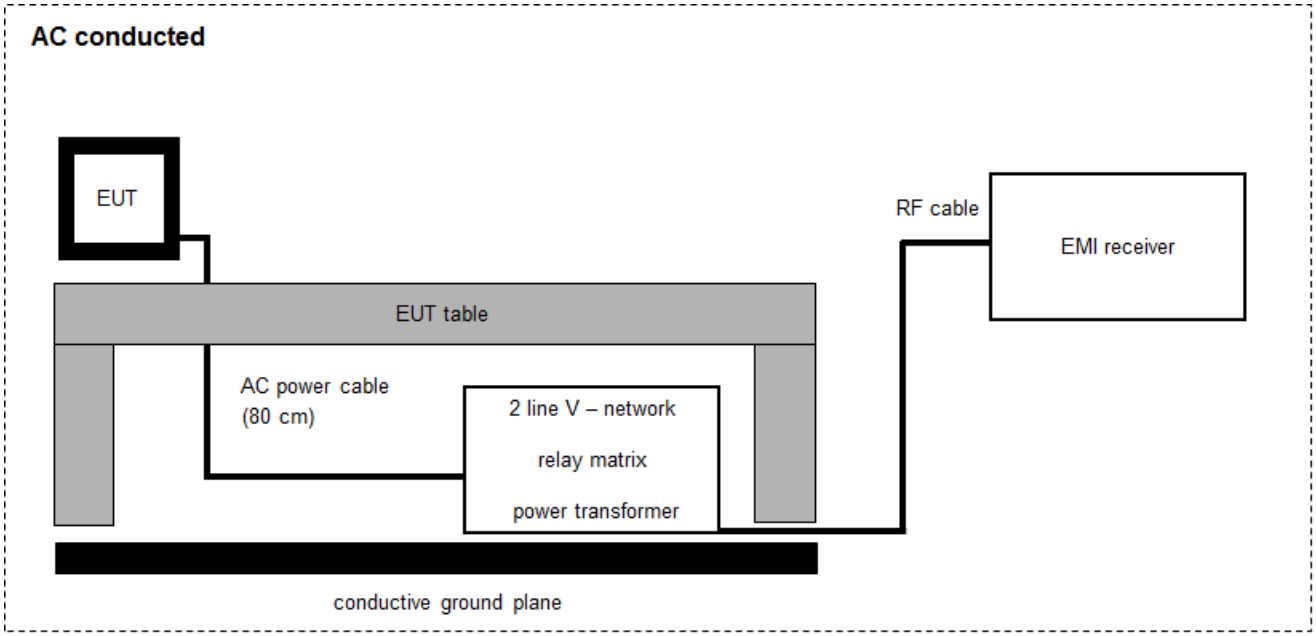
Example calculation:
OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 µW)

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

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	vIKI!	13.12.2017	12.12.2019
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	29.05.2019	28.05.2020
12	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	08.05.2019	07.05.2020
13	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	FS-Z170	Radiometer Physics GmbH	100014	300004156	k	09.05.2019	08.05.2020
14	n. a.	Harmonic Mixer 3-Port, 140-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	10.07.2019	09.07.2020
15	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	09.07.2019	08.07.2020
16	n. a.	Spectrum Analyzer 2 Hz - 85 GHz	FSW85	R&S	101333	300005568	k	29.05.2019	28.05.2021
17	n.a.	Waveguide amplifier 50 to 67 GHz 30 dB Gain	HLNAV-389	HXI, LLC	2K1701116	Property of Acconeer AB	ev	-/-	-/-

6.5 AC conducted



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

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	101	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	vIKI!	13.12.2017	12.12.2019
2	67	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	27	EM-Injection Clamp	FCC-203i	emv	232	300000626	ev	-/-	-/-
4	n. a.	Magnetfeldantenne	MS 100	EM-Test	-----	300002659	ev	-/-	-/-
5	n. a.	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	vIKI!	18.12.2017	17.12.2019
6	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	15.01.2018	14.01.2020
7	n. a.	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
8	n. a.	Power Supply DC	NGSM 32/10	Rohde & Schwarz	3939	400000192	vIKI!	31.01.2017	30.01.2020
9	n. a.	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	12.12.2018	11.12.2019

7 Sequence of testing

7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

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

Premeasurement*

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

Final measurement

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

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

7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

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

Setup

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

Premeasurement

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

Final measurement

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

8 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 %

9 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

10 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 / IC RSS-210	Passed	2019-10-10	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Results (max.)
§15.215 RSS-Gen, Clause 6.6	Occupied bandwidth (20dB bandwidth)	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(b) RSS-210, Annex J.2	Maximum E.I.R.P.	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(c) RSS-210, Annex J.3	Spurious Emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(e) RSS-210, Annex J.6	Frequency stability	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

11 Measurement results

11.1 Occupied bandwidth (99%, 20 dB, 23 dB 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:	9 GHz
Trace-Mode:	Max Hold

Limits:

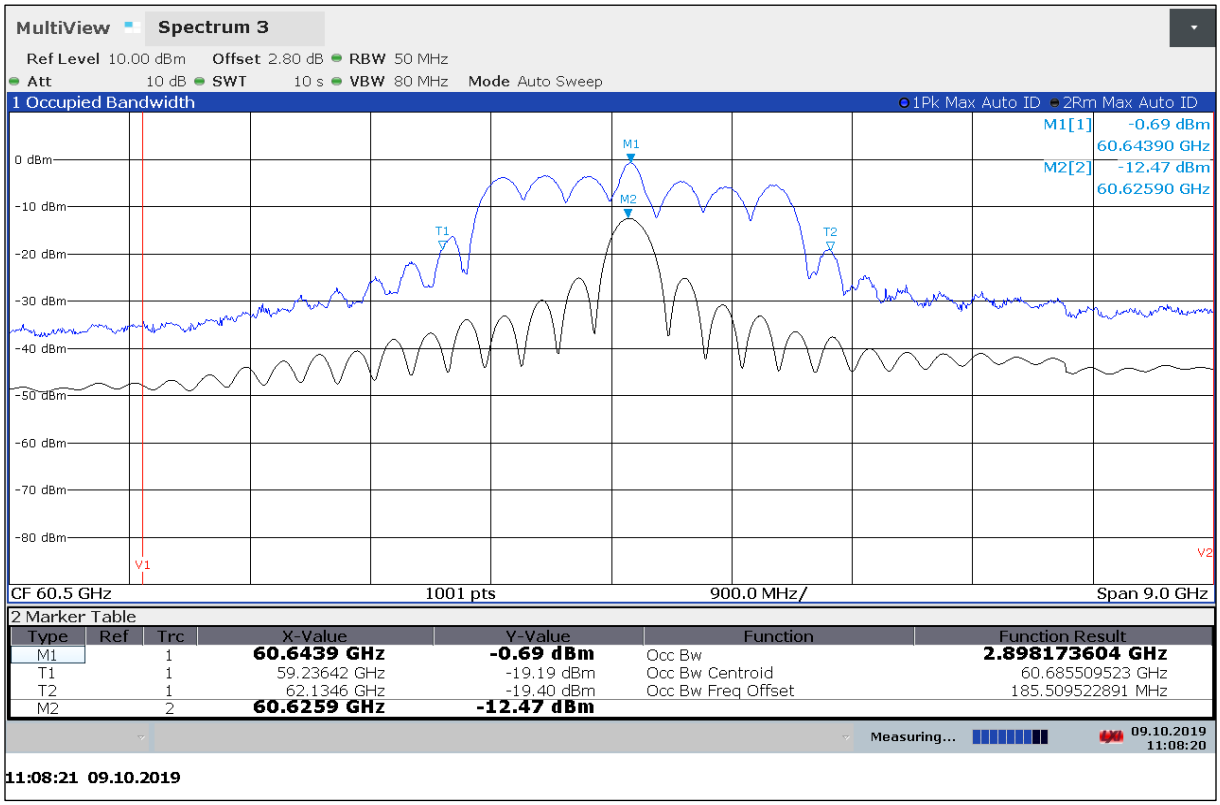
FCC	IC
CFR Part 15.255	RSS-210 J.1
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:	
Frequency range	
57 GHz – 71 GHz	57 GHz – 64 GHz

Measurement results:

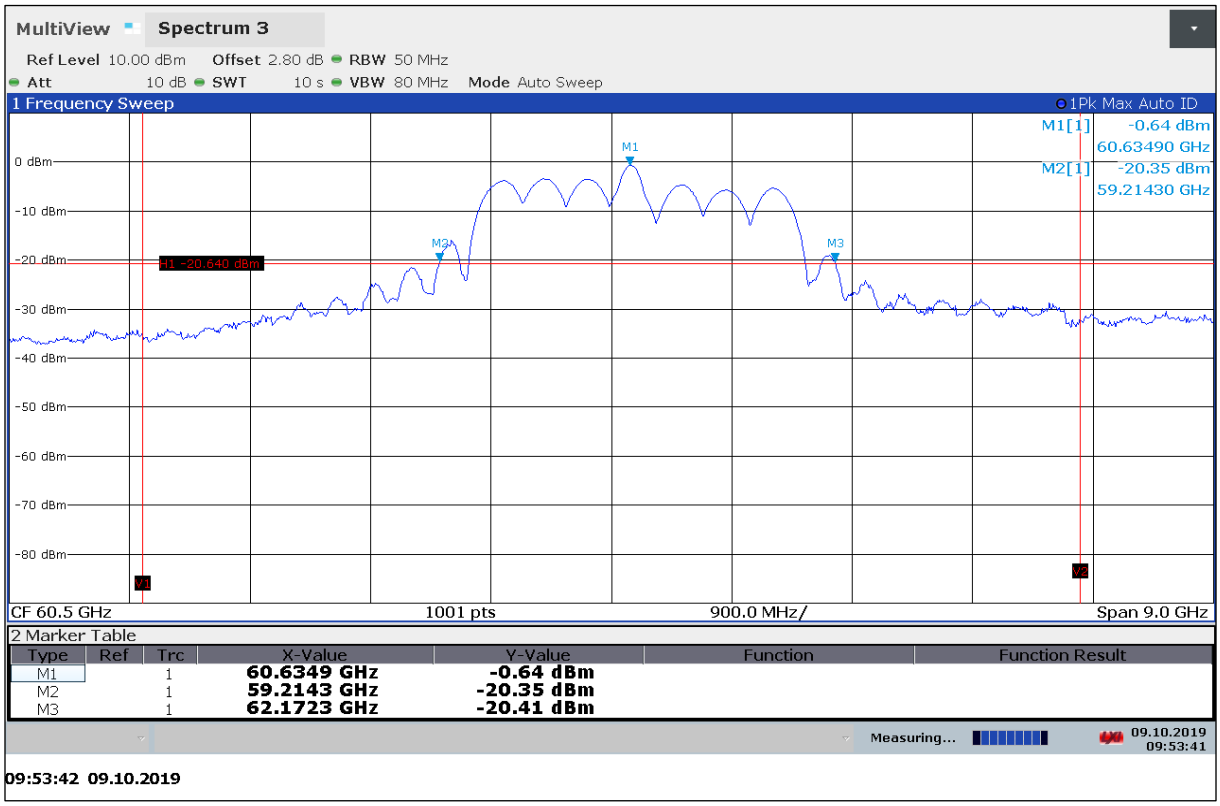
Test condition T_{nom} / V_{nom}	F_L in GHz	F_H in GHz	Occupied bandwidth in GHz
99% OBW	59.236 420	62.134 600	2.898
20 dB OBW	59.214 300	62.172 300	2.958
23 dB OBW	58.944 600	62.208 300	3.264
Measurement uncertainty	± span/1000		

Result: **The measurement is passed.**

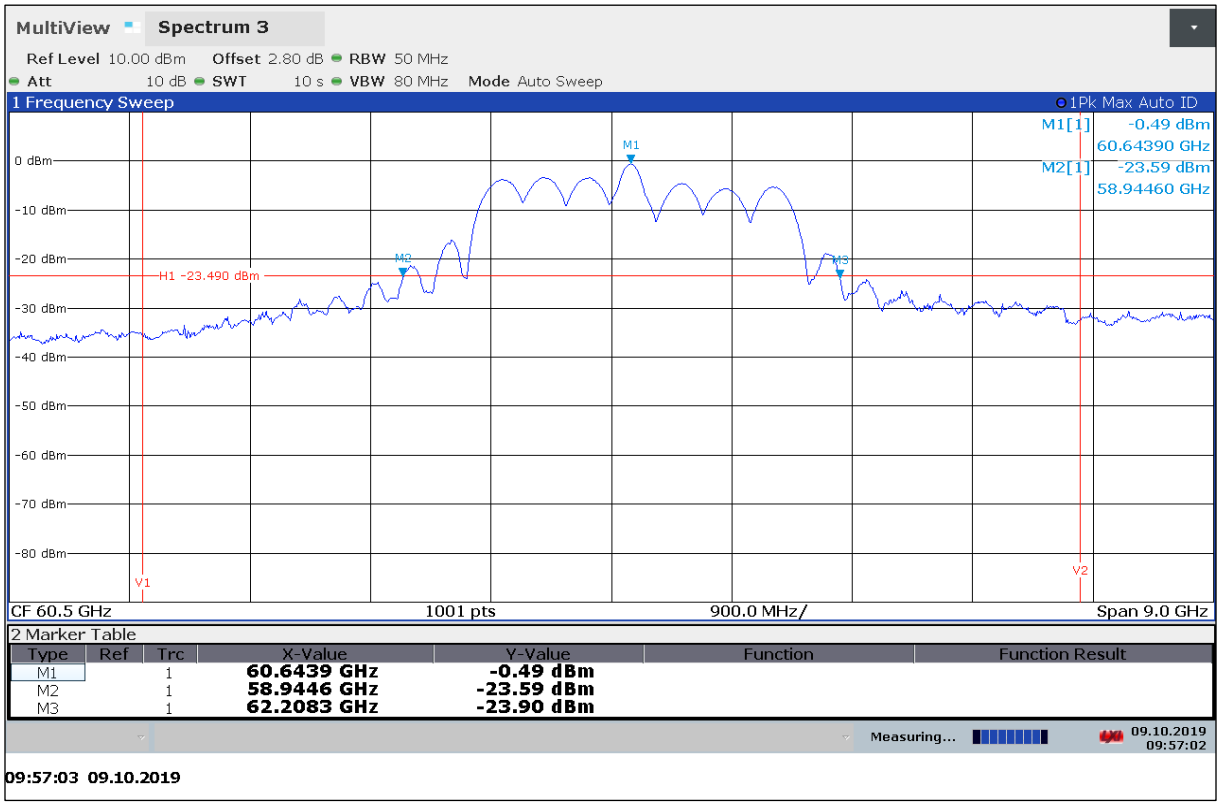
Plot 1: 99% OBW



Plot 2: 20 dB OBW



Plot 3: 23 dB OBW



11.2 Maximum E.I.R.P. Peak / Transmitter Output Power

Description:

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

Limits: **FCC Part 15.255 / RSS-210 J2**

(b) Within the 57-71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(1) Products other than fixed field disturbance sensors and short-range devices for interactive motion sensing shall comply with one of the following emission limits, as measured during the transmit interval:

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

(ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.

(A) The provisions in this paragraph for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (b)(1)(i) of this section.

(B) The provisions of §15.204(c)(2) and (4) that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in §2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.

(2) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

(3) For fixed field disturbance sensors other than those operating under the provisions of paragraph (b)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm.

(4) The peak power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be measured over the actual time period during which transmission occurs.

Limits: **RSS-210 J2**

Within the band 57-64 GHz, the power of any emissions, measured during in the transmit interval, shall comply with the e.i.r.p. limits in this section.

For the purpose of this standard, the terms" average e.i.r.p." and "peak e.i.r.p." refer to e.i.r.p. with transmitter output power measured in terms of average value or peak value respectively.

Limits: **RSS-210 J4**

Following are the conditions for peak transmitter output power:

(a) For devices with an emission bandwidth greater than or equal to 100 MHz, the peak transmitter output power shall not exceed 500 mW. For devices with an emission bandwidth less than 100 MHz, the peak transmitter output power shall be less than the product of 500 mW times their emission bandwidth divided by 100 MHz.

(b) For the purposes of demonstrating compliance with this RSS, corrections to the transmitter output power may be made to compensate for antenna and circuit loss.

(c) For the purpose of this standard, emission bandwidth is defined as the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density shall be 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth. The center frequency must be stationary during the measurement interval, even if not stationary normally.

Measurement:

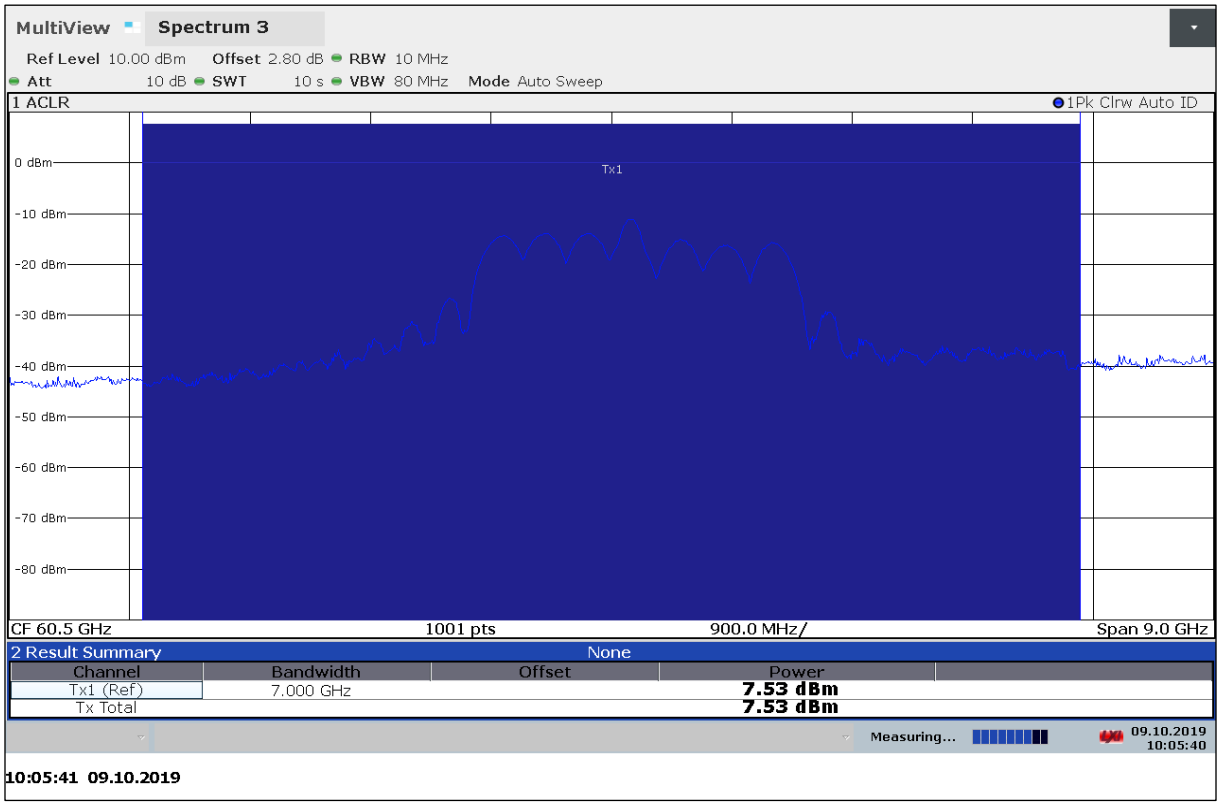
Measurement parameter	
Detector:	Pos-Peak / RMS
Sweep time:	10 s
Resolution bandwidth:	See plots
Video bandwidth:	80 MHz
Span:	See plots
Trace-Mode:	Max Hold
Measurement distance	25 cm

Measurement results:

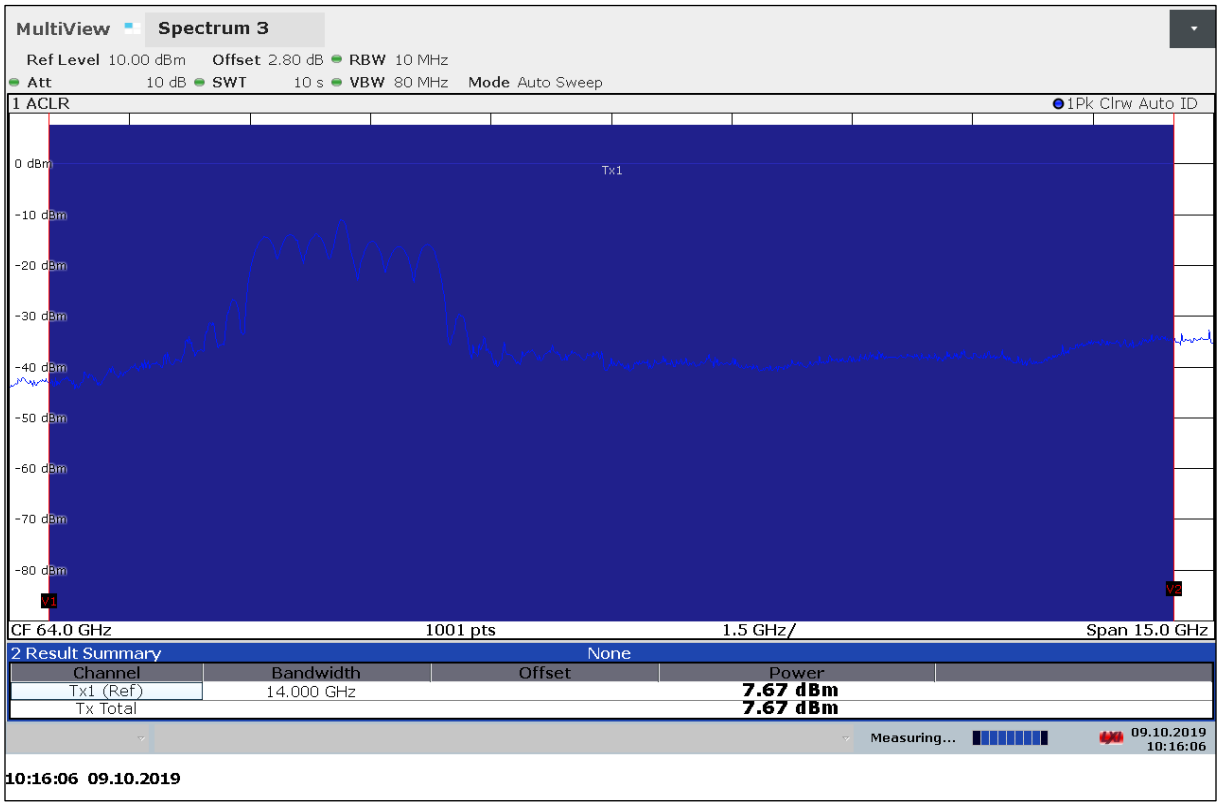
Test condition T_{nom} / V_{nom}	**Max E.I.R.P.** **10 MHz RBW**
Peak-Measurement RSS-210 / 57 GHz – 64 GHz	7.53
Peak-Measurement FCC 15.255 / 57 GHz – 71 GHz	7.67
Average-Measurement RSS-210 / 57 GHz – 64 GHz	-4.13
Average-Measurement FCC 15.255 / 57 GHz – 71 GHz	-4.10
Peak Transmitter Output Power	-10.91
Measurement uncertainty	± 3 dB

Result: **The measurement is passed.**

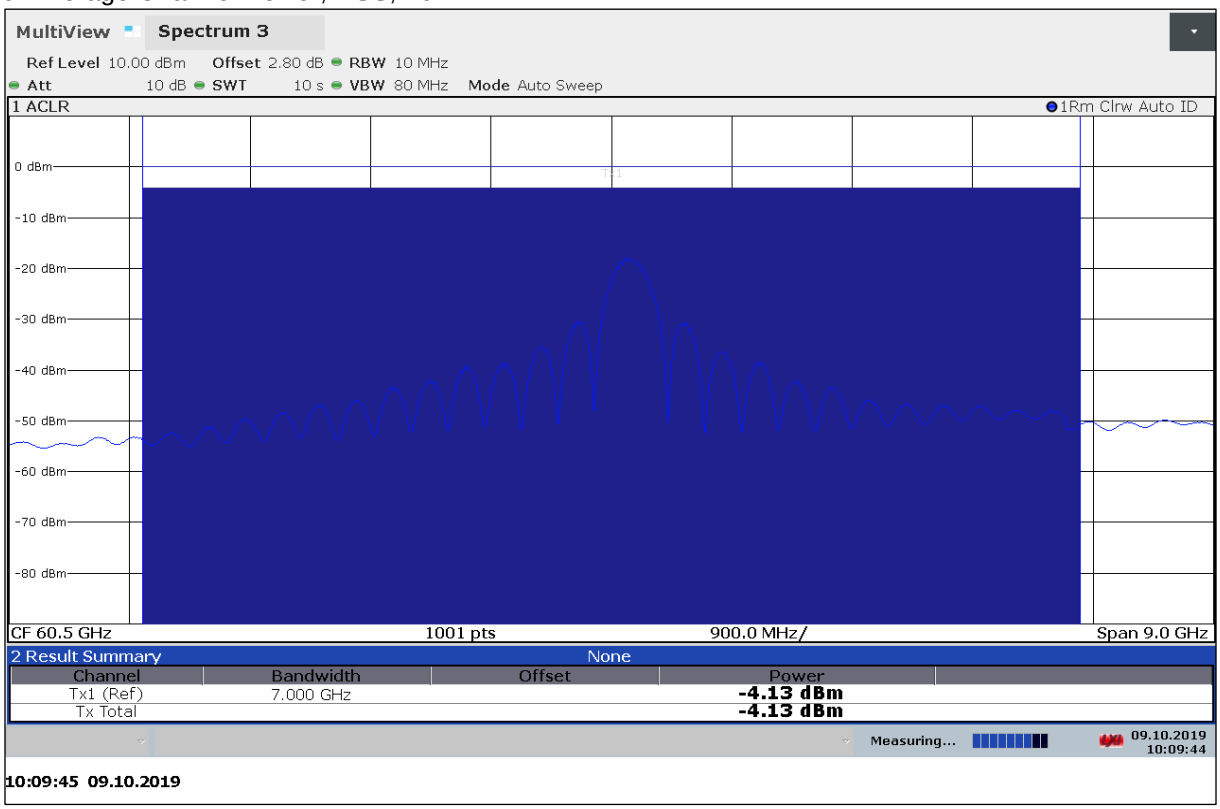
Plot 4: Peak Channel Power, RSS, 10 MHz RBW



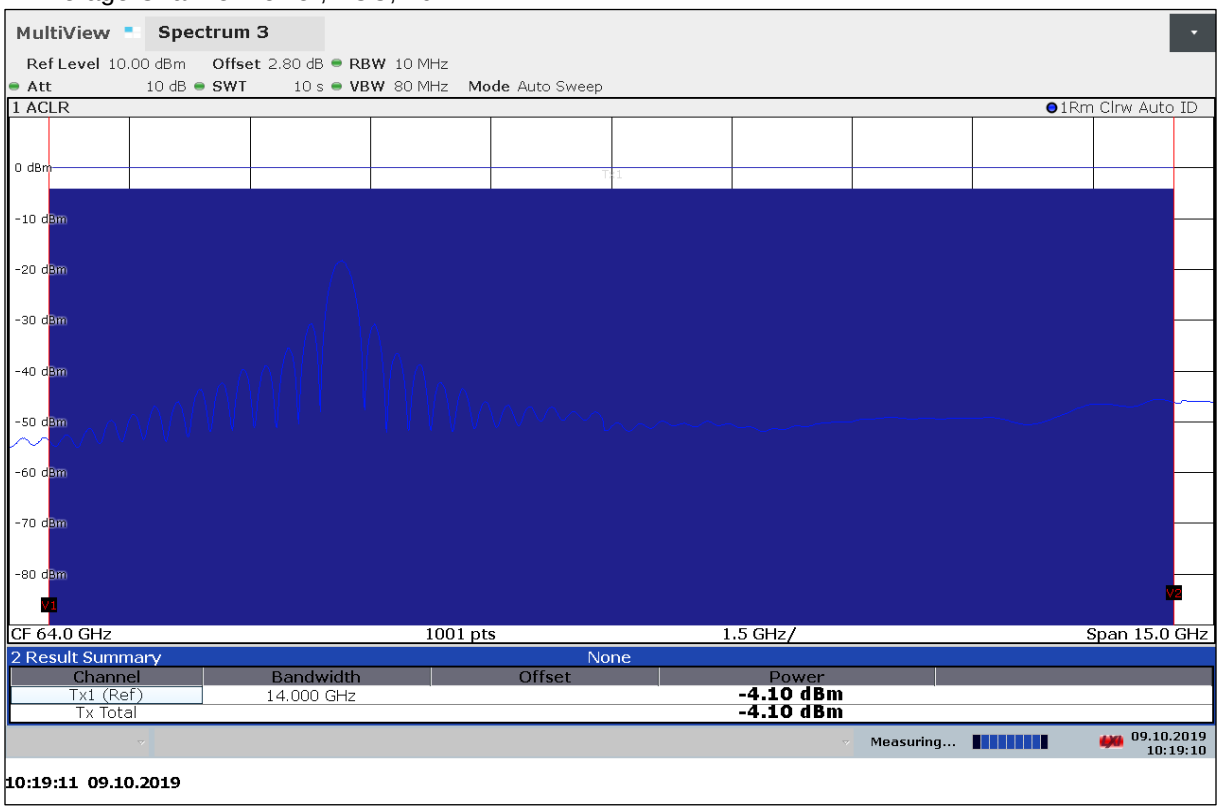
Plot 5: Peak Channel Power, FCC, 10 MHz RBW



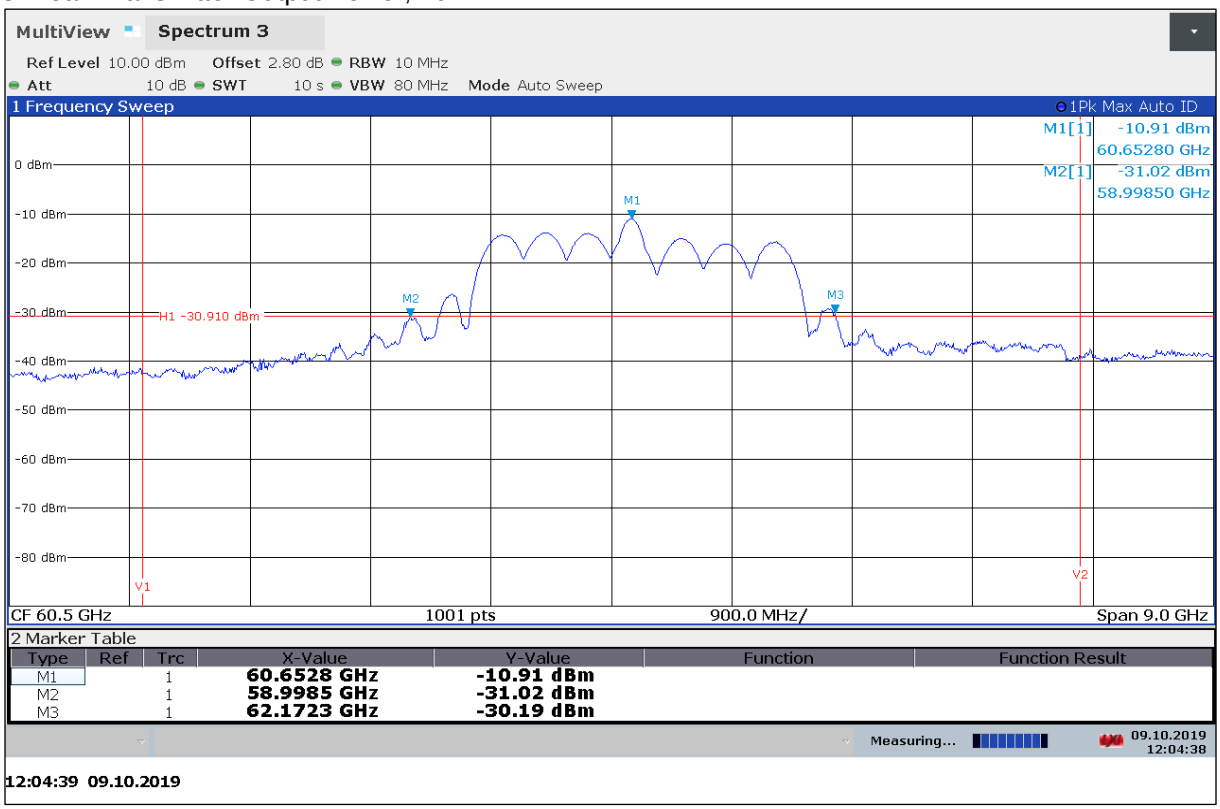
Plot 6: Average Channel Power, RSS, 10 MHz RBW



Plot 7: Average Channel Power, FCC, 10 MHz RBW



Plot 8: Peak Transmitter Output Power, 10 MHz RBW



11.3 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions in transmit mode.

Limits: **FCC Part 15.255 / RSS-210 J3**

(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 / IC		
CFR Part 15.209(a) / RSS-210 J.3/ RSS-Gen		
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
Above 960	54.0	3

Limit conversion:

P[dBm] = 10×log(4×π×d²×P[W/m²])

d = distance of the limit defined in W/m²

With this calculation an emission limit of 90 pW/cm² corresponds to -10 dBm.

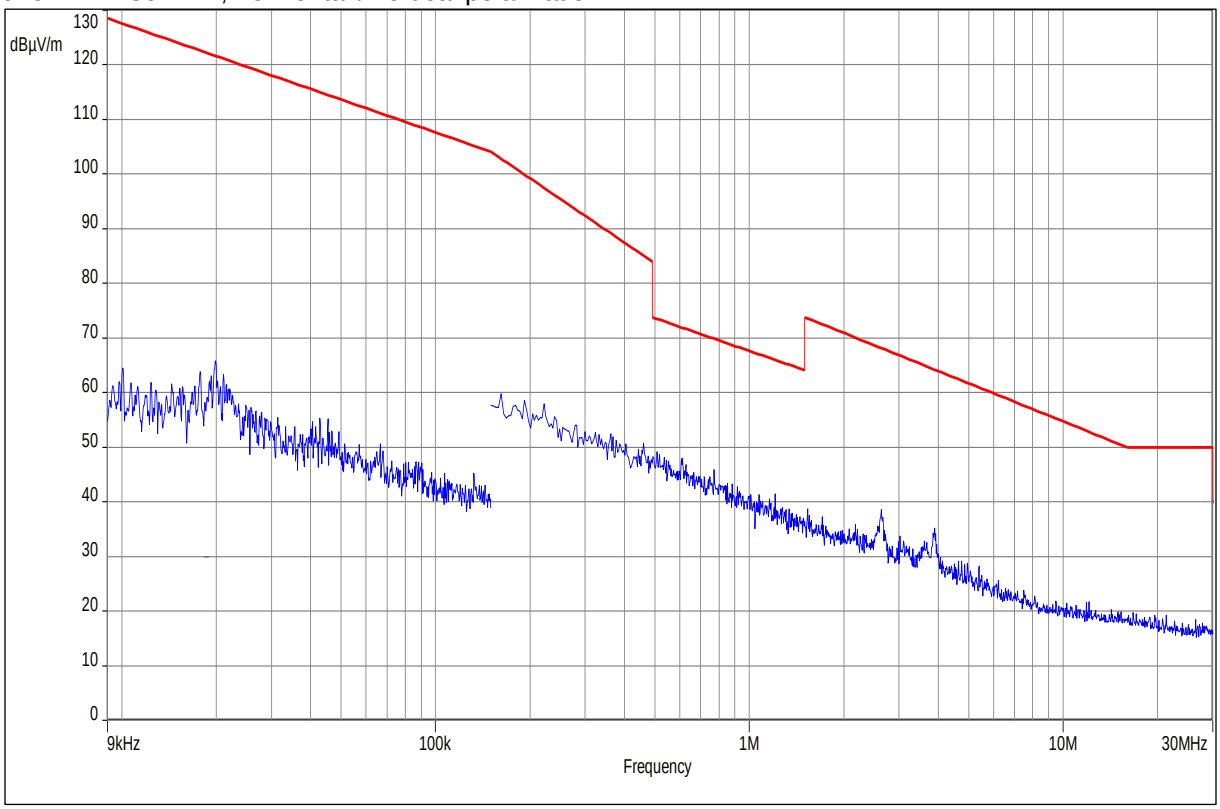
Measurement:

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

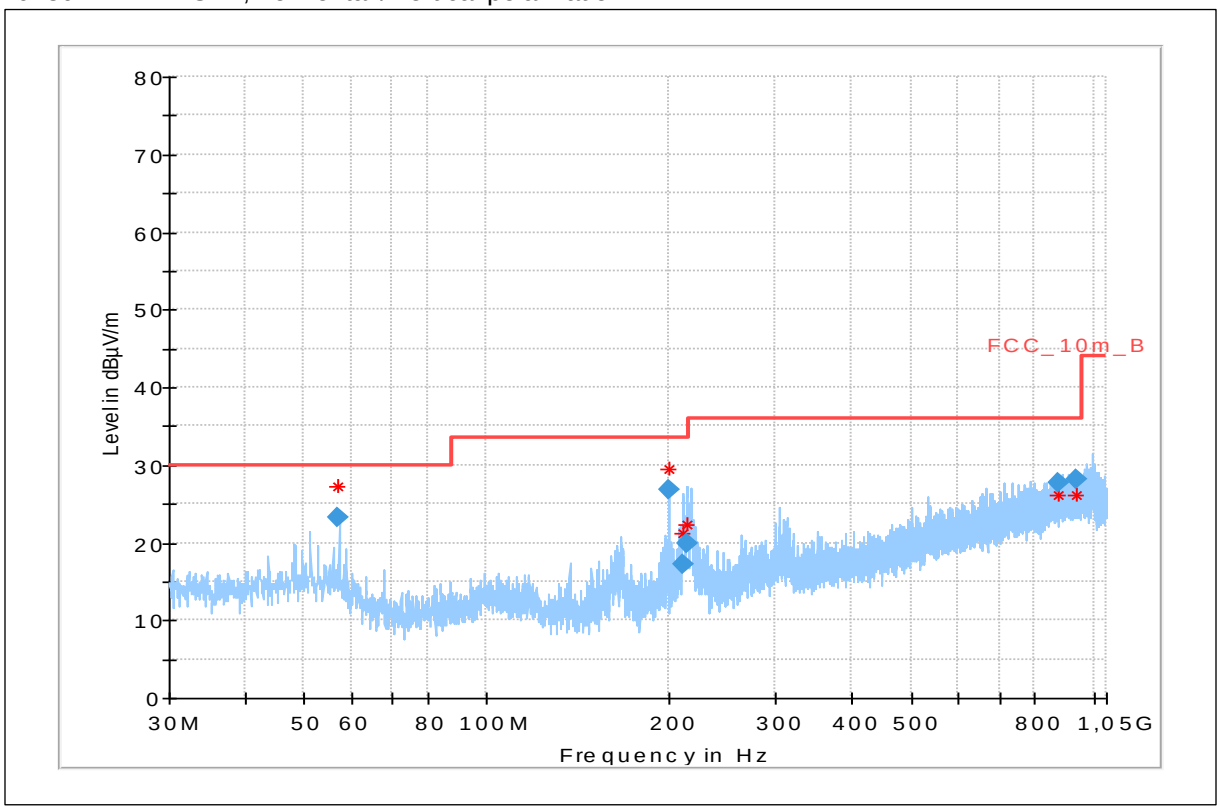
Measurement distance for measurements above 18 GHz	
Frequency rance in GHz	**Distance in m**
18-26.5	0.2
26.5-40	0.2
40-50	0.2
50-75	0.2
75-110	0.1
110-170	0.1
170-220	0.1

Result: The measurement is passed.

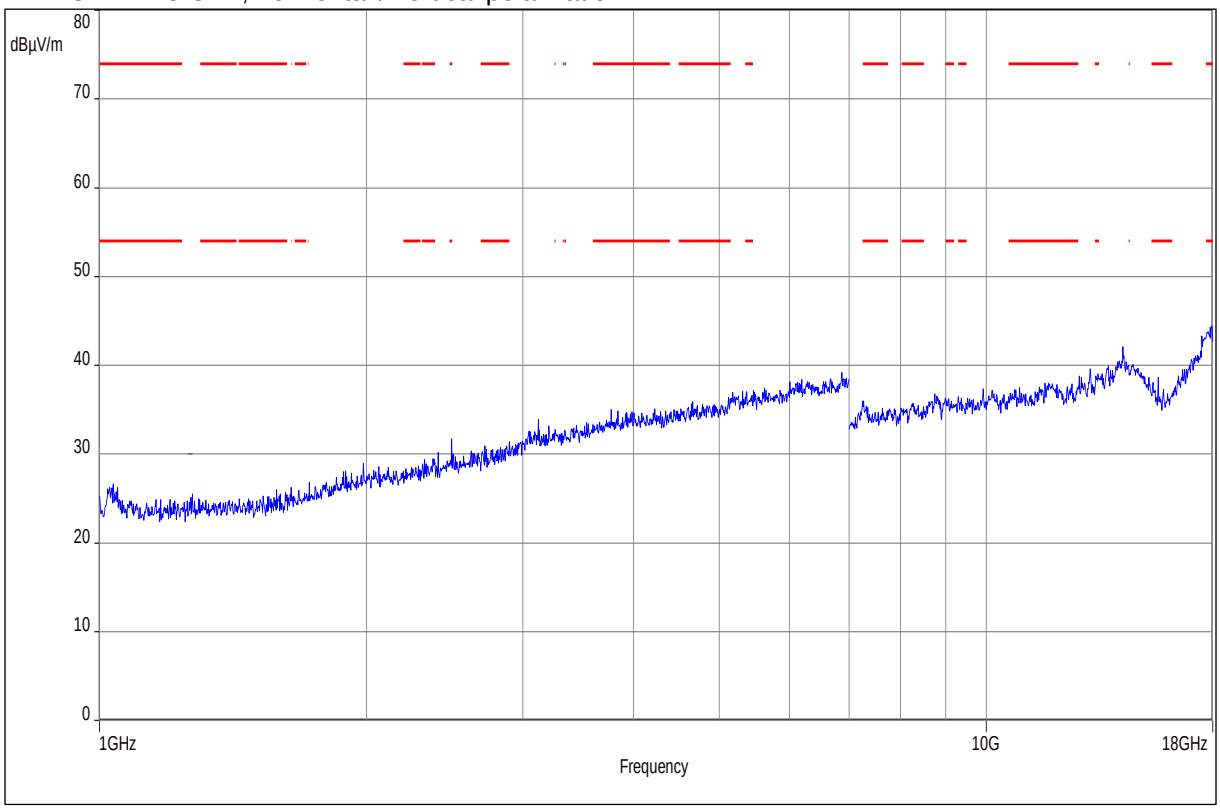
Plot 9: 9 kHz – 30 MHz, horizontal / vertical polarization



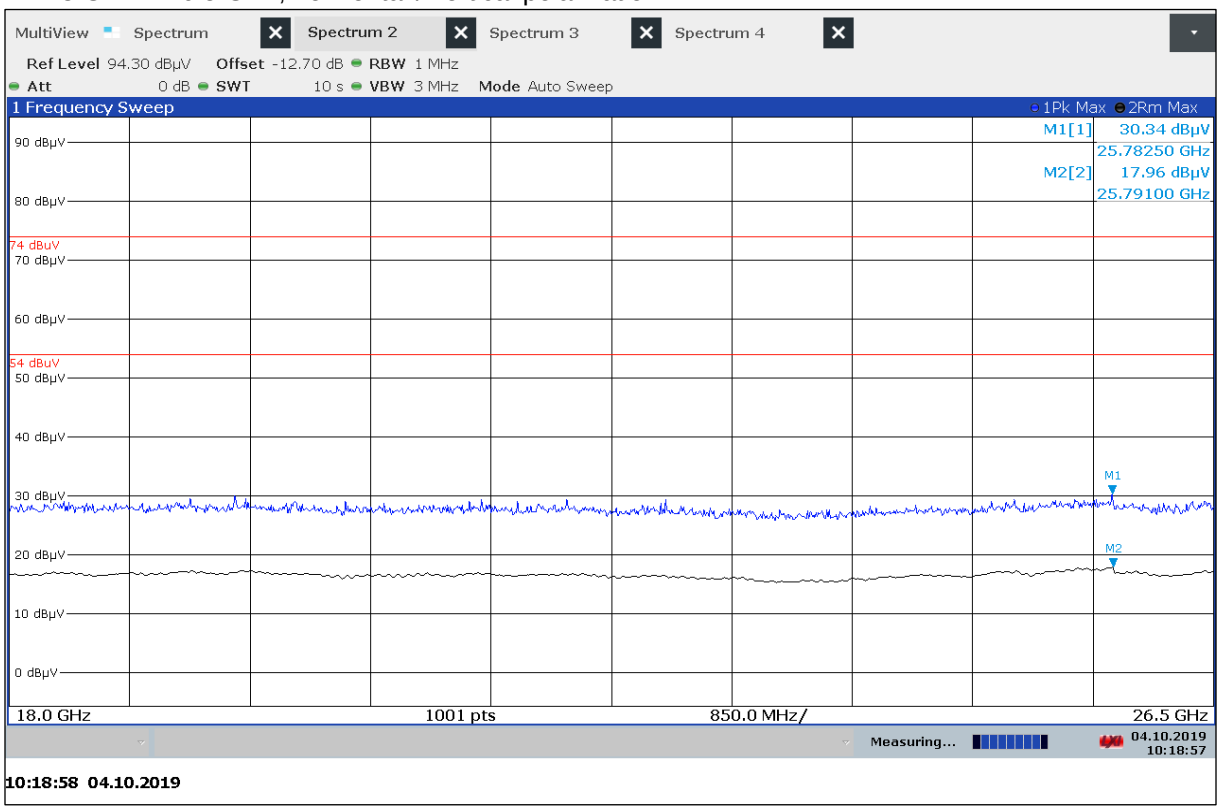
Plot 10: 30 MHz – 1 GHz, horizontal / vertical polarization



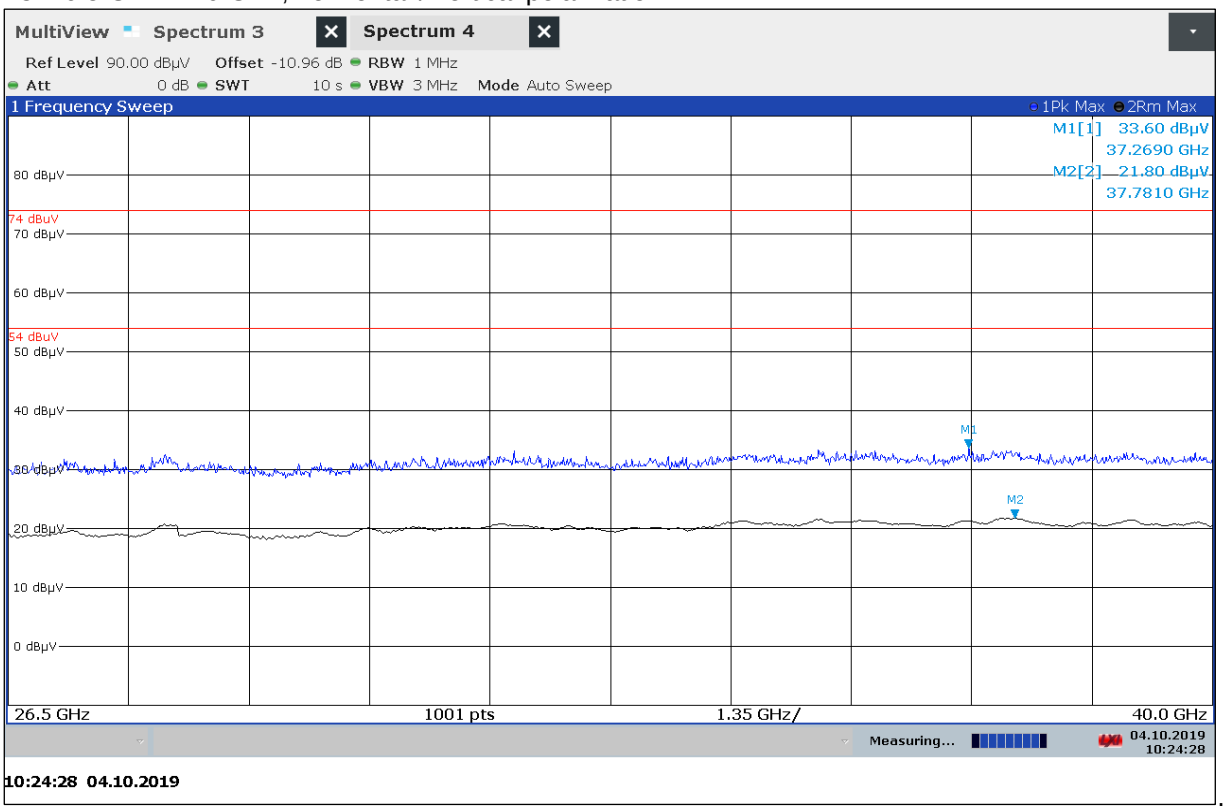
Plot 11: 1 GHz – 18 GHz, horizontal / vertical polarization



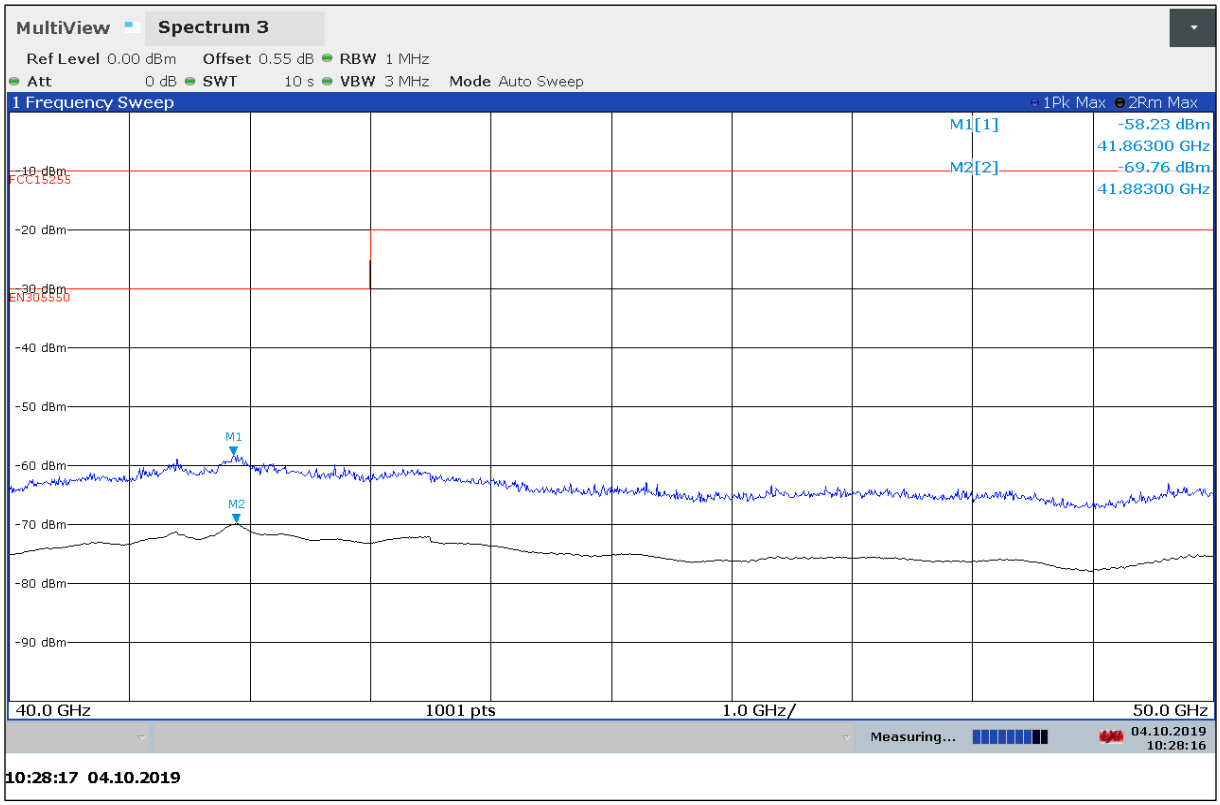
Plot 12: 18 GHz – 26.5 GHz, horizontal / vertical polarization



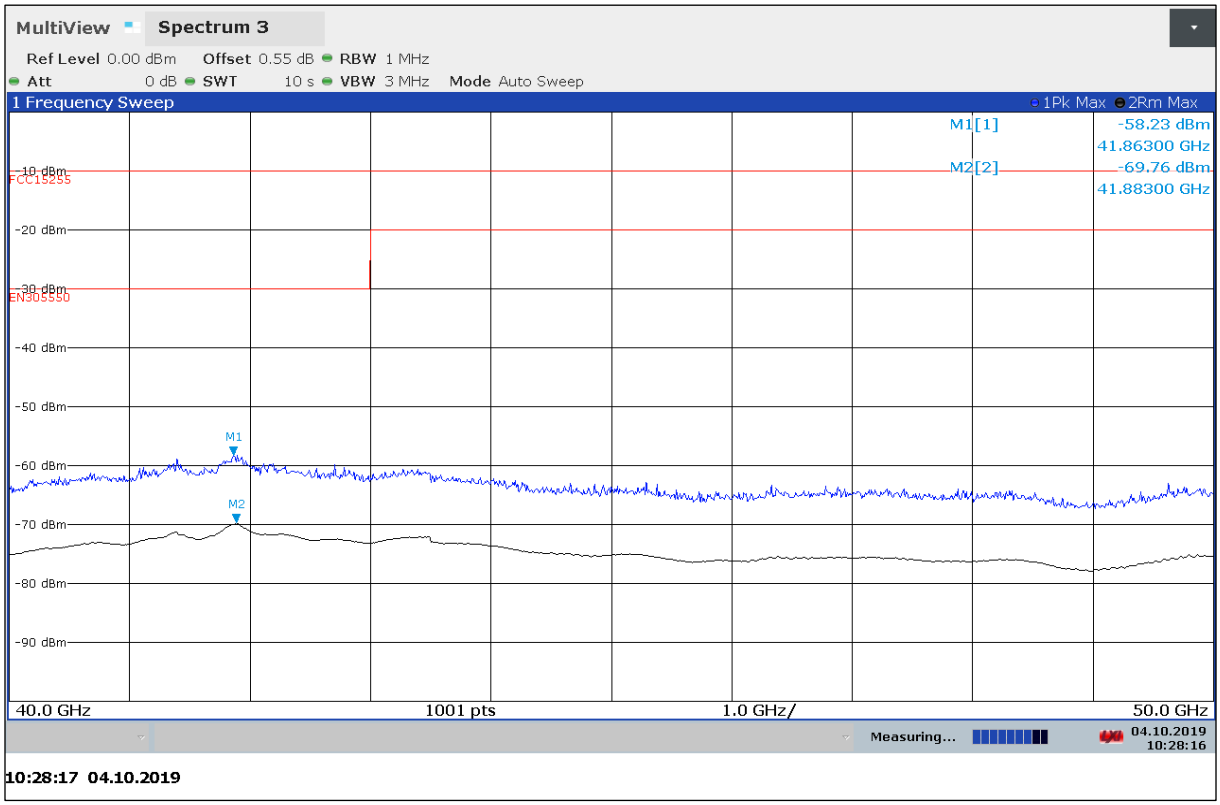
Plot 13: 26.5 GHz – 40 GHz, horizontal / vertical polarization



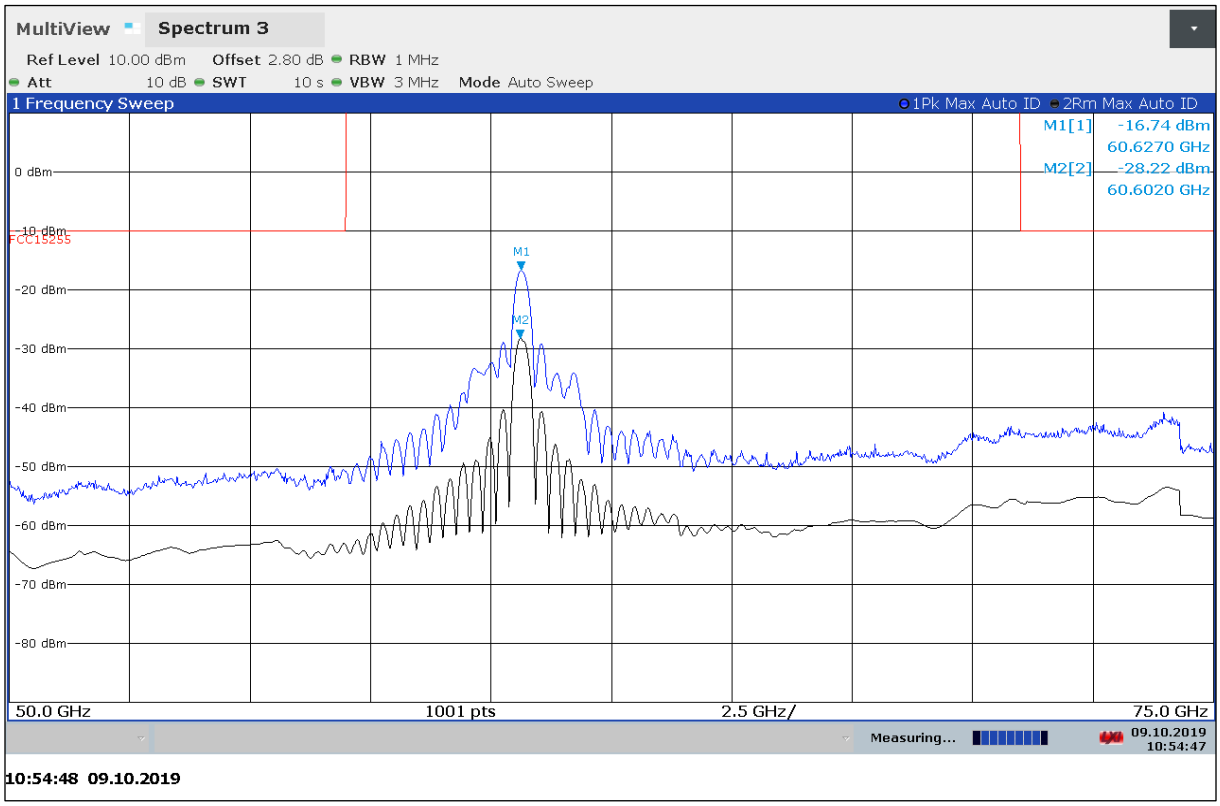
Plot 14: 40 GHz – 50 GHz, antenna vertical / horizontal



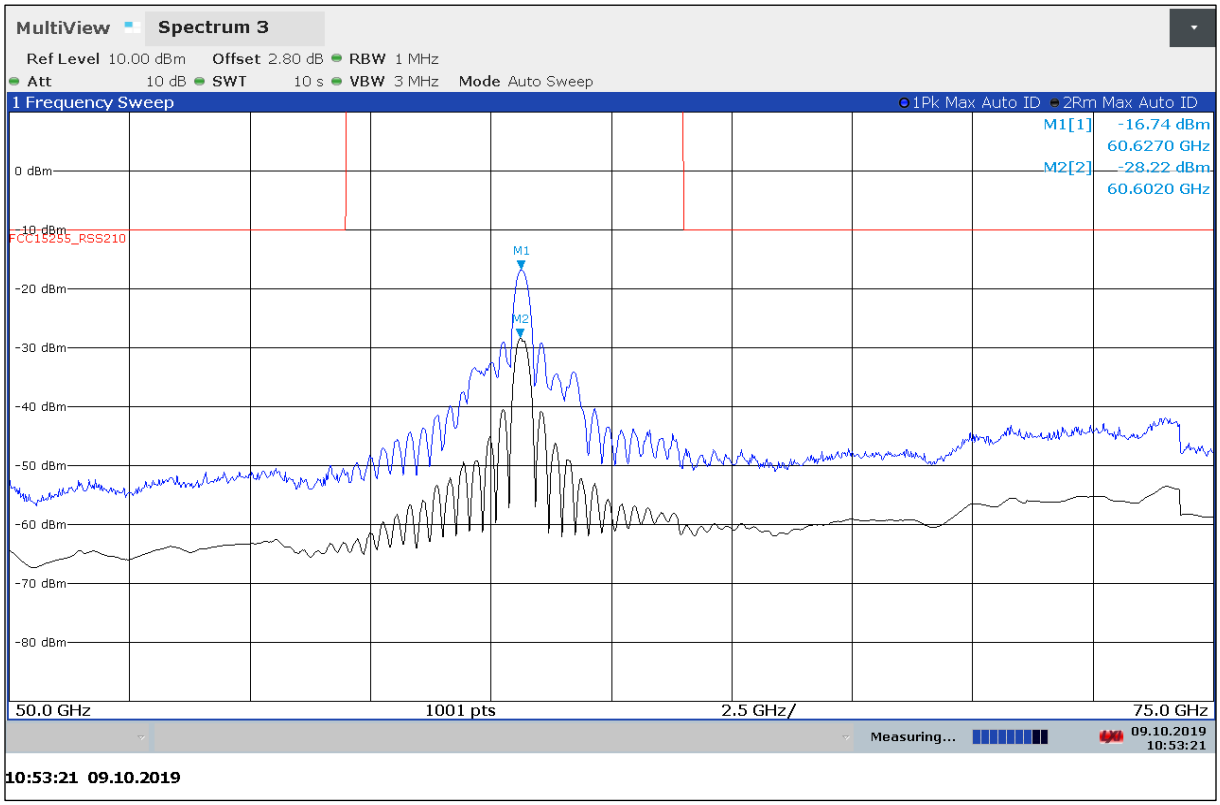
Plot 15: 40 GHz – 50 GHz, antenna vertical / horizontal



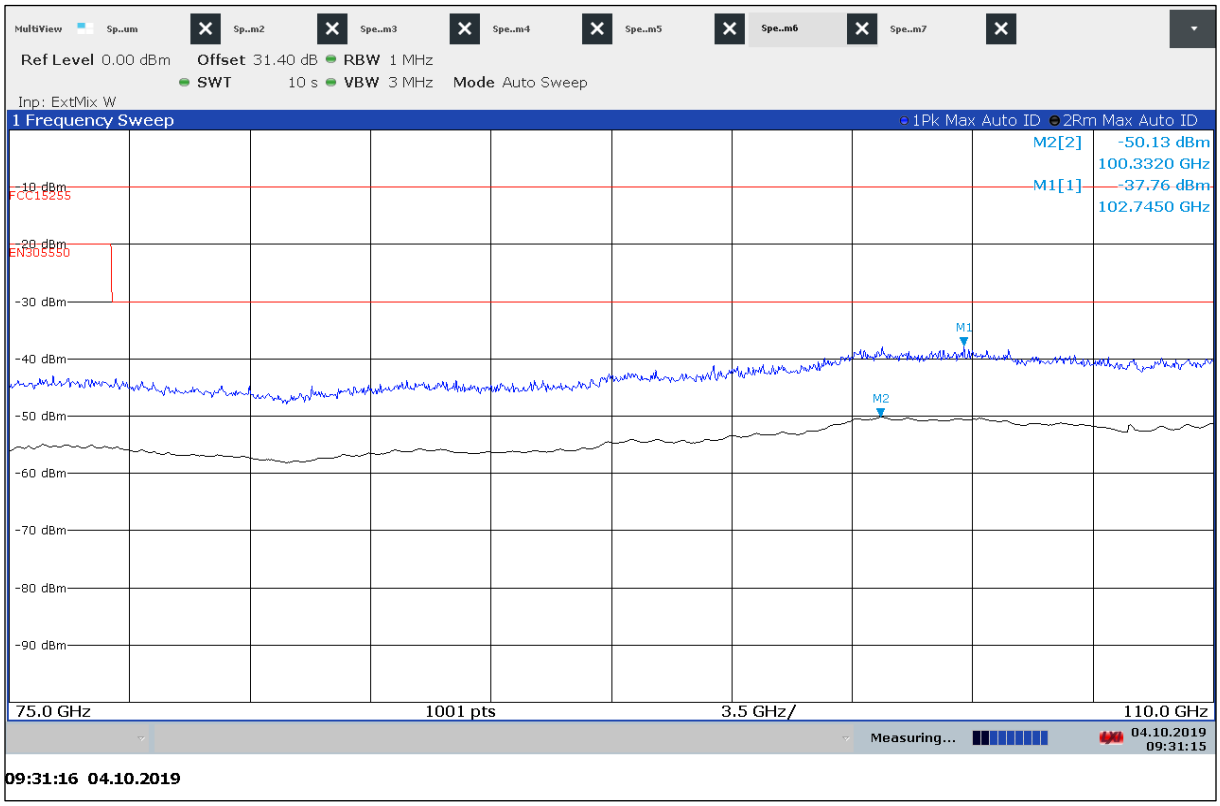
Plot 16: Out of Band FCC 15.255, 50 GHz – 75 GHz, antenna vertical / horizontal.



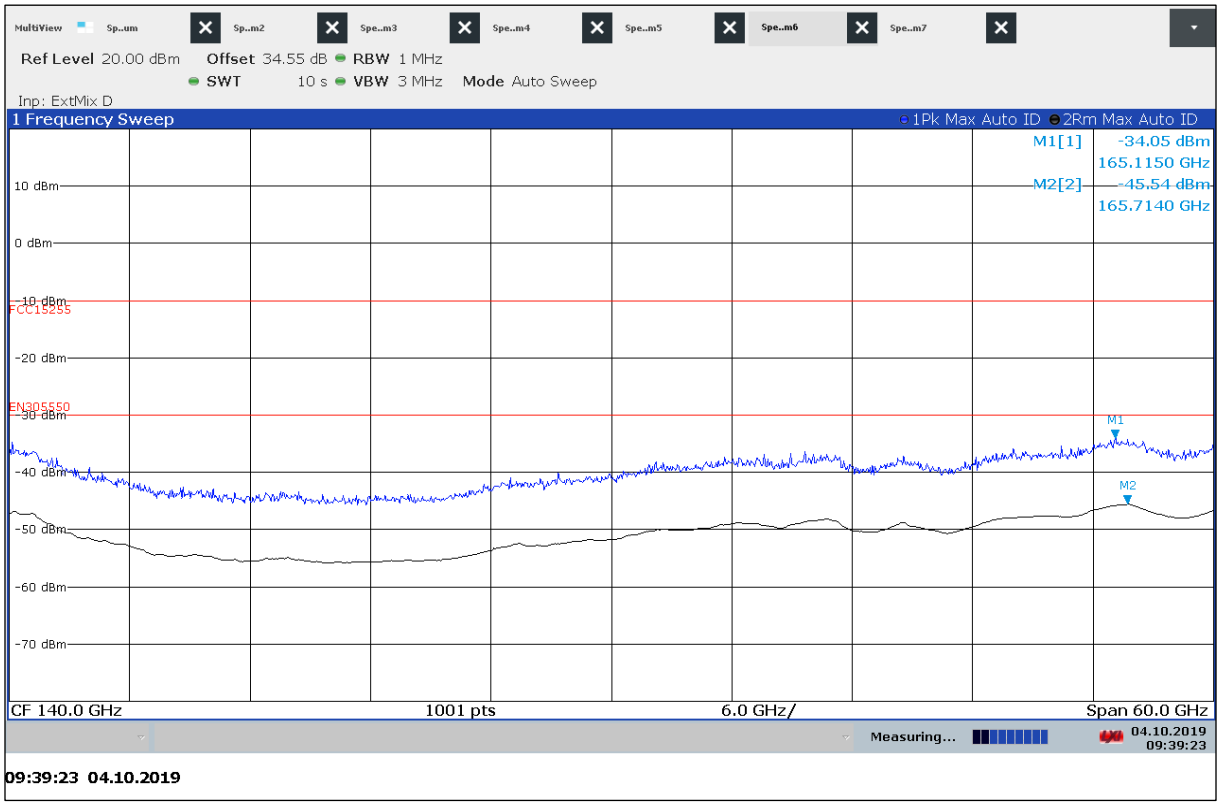
Plot 17: Out of Band RSS-210, 50 GHz – 75 GHz, antenna vertical / horizontal.



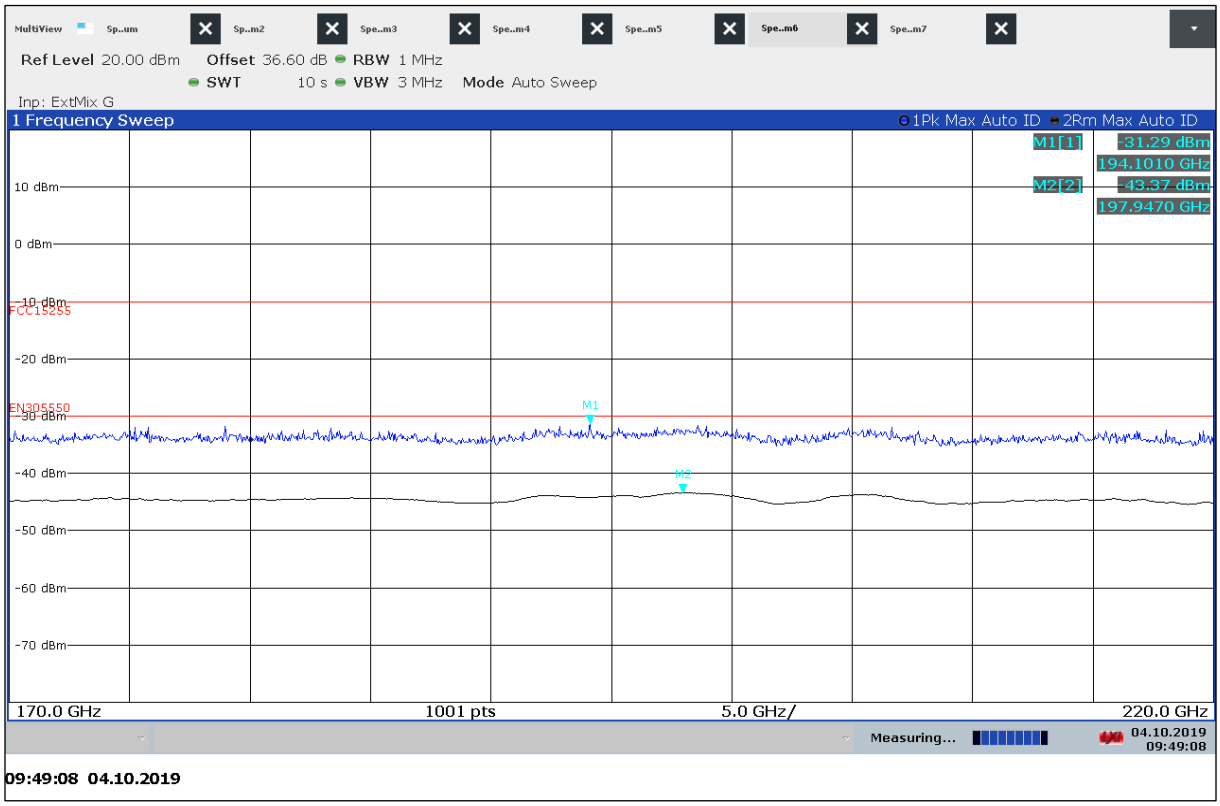
Plot 18: 75 GHz – 110 GHz, antenna vertical / horizontal



Plot 19: 110 GHz – 170 GHz, antenna vertical / horizontal



Plot 20: 170 GHz – 220 GHz, antenna vertical / horizontal



11.4 Spurious emissions conducted < 30 MHz (AC power line)

Description:

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

Measurement:

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

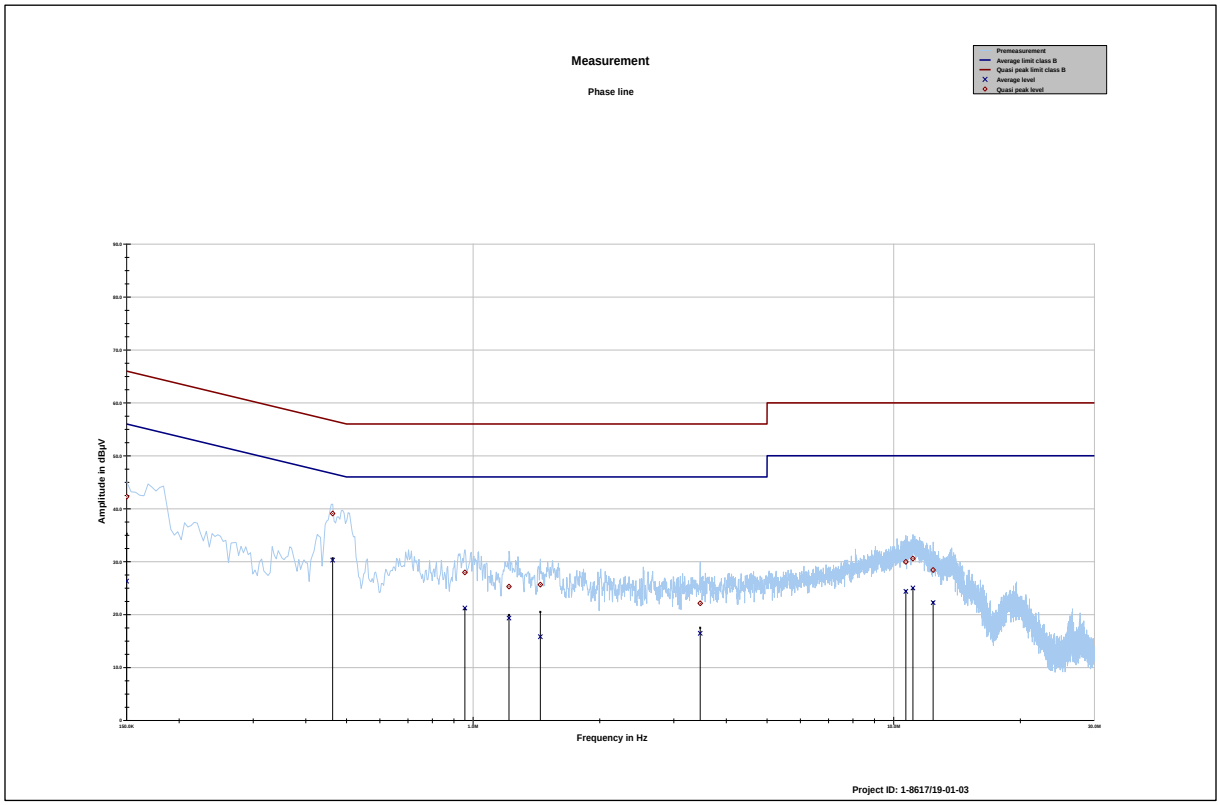
Limits:

FCC		IC
CFR Part 15.207(a)		RSS-Gen 8.8
Conducted Spurious Emissions < 30 MHz		
Frequency (MHz)	Quasi-Peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	79 to 69* (Class A) 66 to 56* (Class B)	79 to 69* (Class A) 56 to 46* (Class B)
0.5 – 5	73 (Class A) 56 (Class B)	63 (Class A) 46 (Class B)
5 – 30.0	73 (Class A) 60 (Class B)	63 (Class A) 50 (Class B)

*Decreases with the logarithm of the frequency

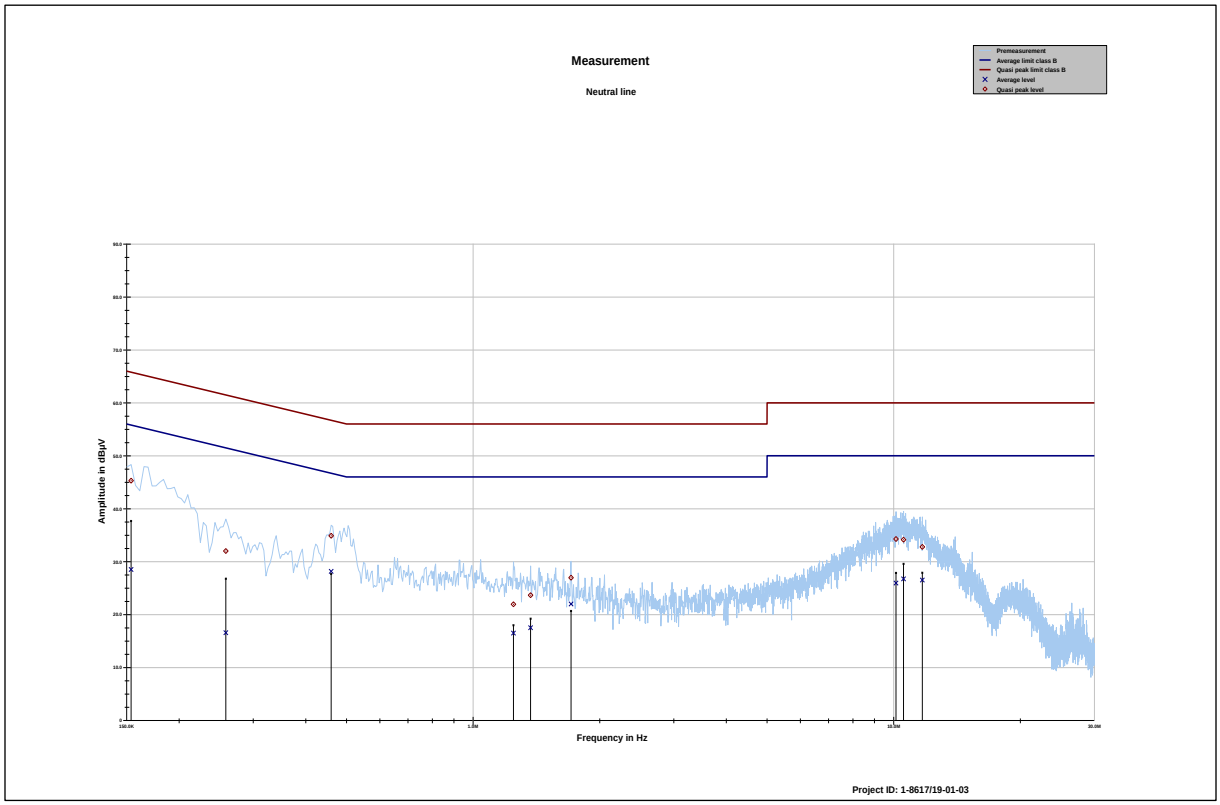
Result: **The measurement is passed.**

Plot No. 21: Phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150000	42.26	23.74	66.000	26.31	29.69	56.000
0.463425	39.09	17.54	56.631	30.29	16.76	47.045
0.955950	27.97	28.03	56.000	21.23	24.77	46.000
1.217137	25.28	30.72	56.000	19.34	26.66	46.000
1.444744	25.65	30.35	56.000	15.81	30.19	46.000
3.467081	22.13	33.87	56.000	16.45	29.55	46.000
10.690781	29.95	30.05	60.000	24.37	25.63	50.000
11.112412	30.59	29.41	60.000	25.02	24.98	50.000
12.410887	28.43	31.57	60.000	22.26	27.74	50.000

Plot No. 22: Neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.153731	45.30	20.49	65.796	28.52	27.37	55.893
0.258206	32.01	29.48	61.489	16.58	36.33	52.908
0.459694	34.88	21.81	56.698	28.16	18.99	47.152
1.246987	21.94	34.06	56.000	16.50	29.50	46.000
1.370119	23.67	32.33	56.000	17.52	28.48	46.000
1.709663	26.96	29.04	56.000	22.00	24.00	46.000
10.127363	34.27	25.73	60.000	25.95	24.05	50.000
10.556456	34.14	25.86	60.000	26.74	23.26	50.000
11.698219	32.78	27.22	60.000	26.52	23.48	50.000

11.5 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	IC
CFR Part 15.255	RSS-210 J.1
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:	
Frequency range	
57 GHz – 71 GHz	57 GHz – 64 GHz

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	10 s
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	9 GHz
Trace-Mode:	Max Hold
Temperature:	-40 °C / +85 °C

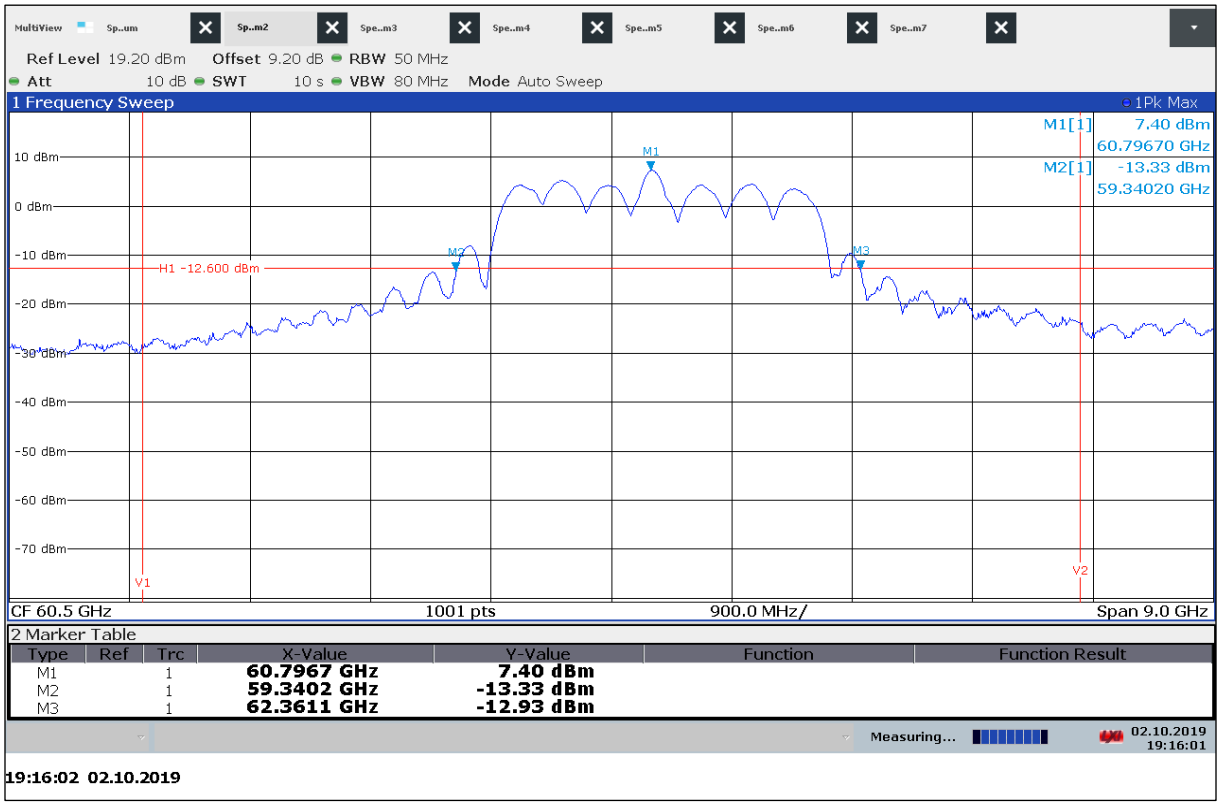
Measurement Results:

Test condition	F_L in GHz	F_H in GHz
T_{min}	59.340 200	62.361 100
T_{max}	59.106 400	62.010 500
V_{min}	59.196 300	62.181 300
V_{max}	59.187 300	62.163 300

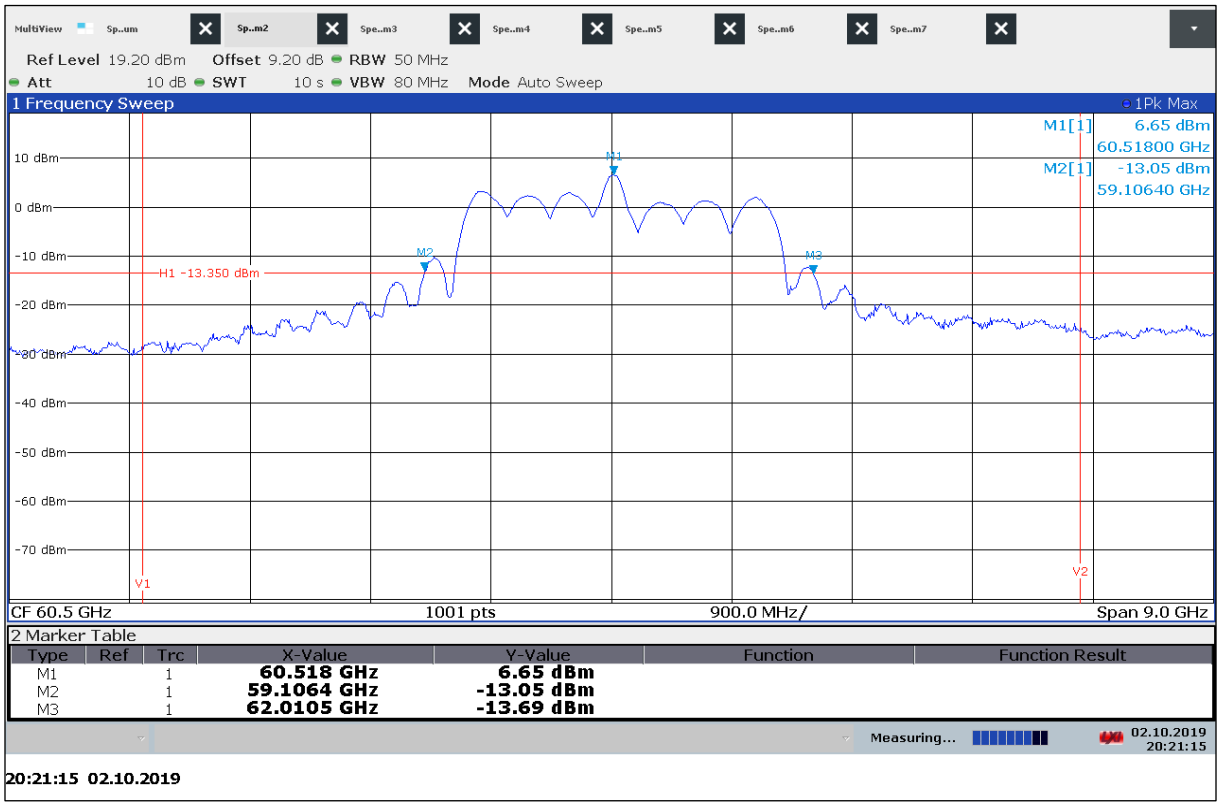
Note: The corresponding plots show a Max-Hold trace over 10 minutes after the EUT is powered on at the corresponding Temperature/Voltage. Therefore the plots show the worst case results of the frequency stability after 2, 5 and 10 minutes.

Result: The measurement is passed.

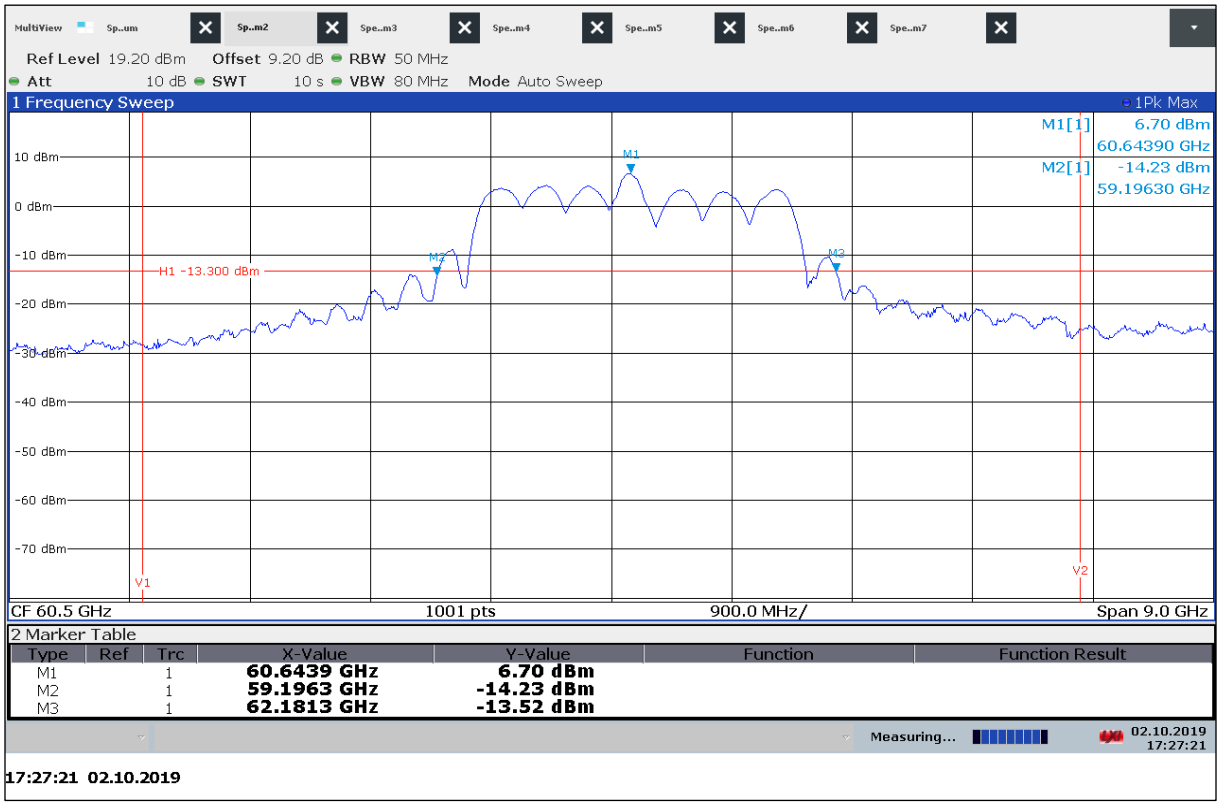
Plot 23: 20 dB-Bandwidth at T_{min}



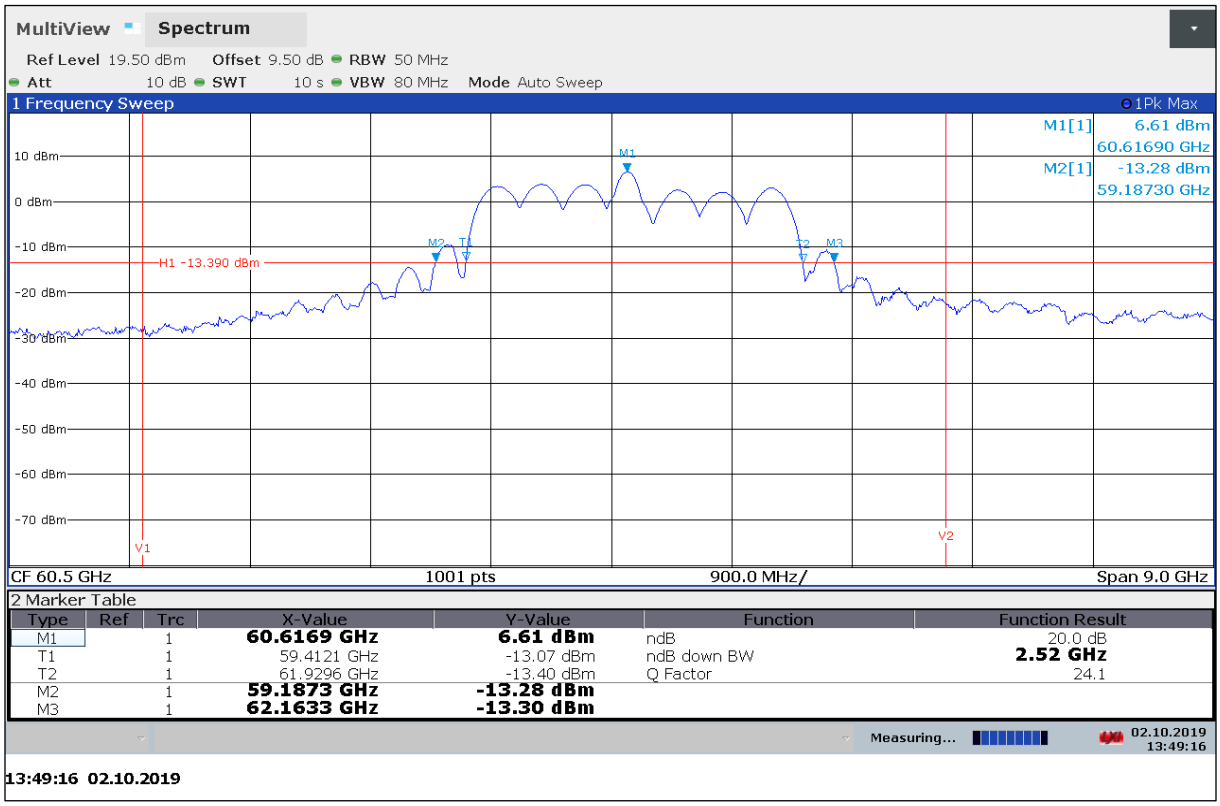
Plot 24: 20 dB Bandwidth at T_{max}



Plot 25: 20 dB-Bandwidth at V_{min}



Plot 26: 20 dB Bandwidth at V_{max}



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	2019-10-07
-/-	DRAFT2 (In-band Offset updated)	2019-10-09
-/-	Minor changes	2019-10-10