
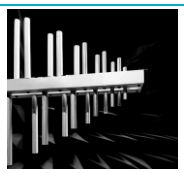
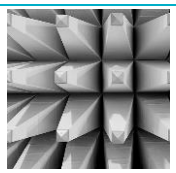

CTC advanced
member of RWTÜV group

Bundesnetzagentur

TEST REPORT

Test report no.: 1-5225/17-01-05-C

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

BNetzA-CAB-02/21-102

Testing laboratory

CTC advanced GmbH
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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 with the registration number: D-PL-12076-01-03

Applicant

Acconeer AB
Ideon Gateway, Scheelevägen 27
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

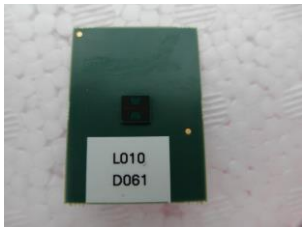
Test standard/s

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

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

Test Item

Kind of test item:	**Module**
Model name:	**Module for SRD Radar 60 GHz**
FCC ID:	**2AQ6KA1**
Frequency:	57 GHz – 64 GHz
Antenna:	Integrated antenna
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:

M. Walla

cn=Walla Meheza, o=ctcadvanced GmbH, ou=WAL-161220, email=meheza.walla@ctcadvanced.com, c=DE
2019.03.21 12:34:15 +01'00'

Meheza Walla
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Radio Communications & EMC

Test performed:

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2019.03.21 11:42:18 +01'00'

Benedikt Gerber
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.

This test report replaces the test report with the number 1-5225/17-01-05-B and dated 2018-10-17.

2.2 Application details

Date of receipt of order:	2017-11-09
Date of receipt of test item:	2018-01-24
Start of test:	2018-01-29
End of test:	2018-08-06
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

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +50 °C during high temperature tests -30 °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	:	Module
Type identification	:	Module for SRD Radar 60 GHz
S/N serial number	:	A111
HW hardware status	:	A111
SW software status	:	N/A
Frequency band	:	57 GHz – 64 GHz
Type of radio transmission Use of frequency spectrum	: :	Pulse Radar
Type of modulation	:	No modulation
Number of channels	:	1
Antenna	:	Integrated antenna
Power supply	:	1.71 V to 1.89 V DC
Temperature range	:	-40°C to +85°C

5.2 Additional information

The A111 seonsor can be configured to emit with two different profiles:

Mode 1	MAXIMIZE_SNR
Mode 2	MAXIMIZE_DEPTH_RESOLUTION

For the tests conducted in this report, special test modes are used to generate a continuous pulse pattern for these two profiles

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: 1-5225/17-01-05_AnnexA
1-5225/17-01-05_AnnexB
1-5225/17-01-05_AnnexC

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).

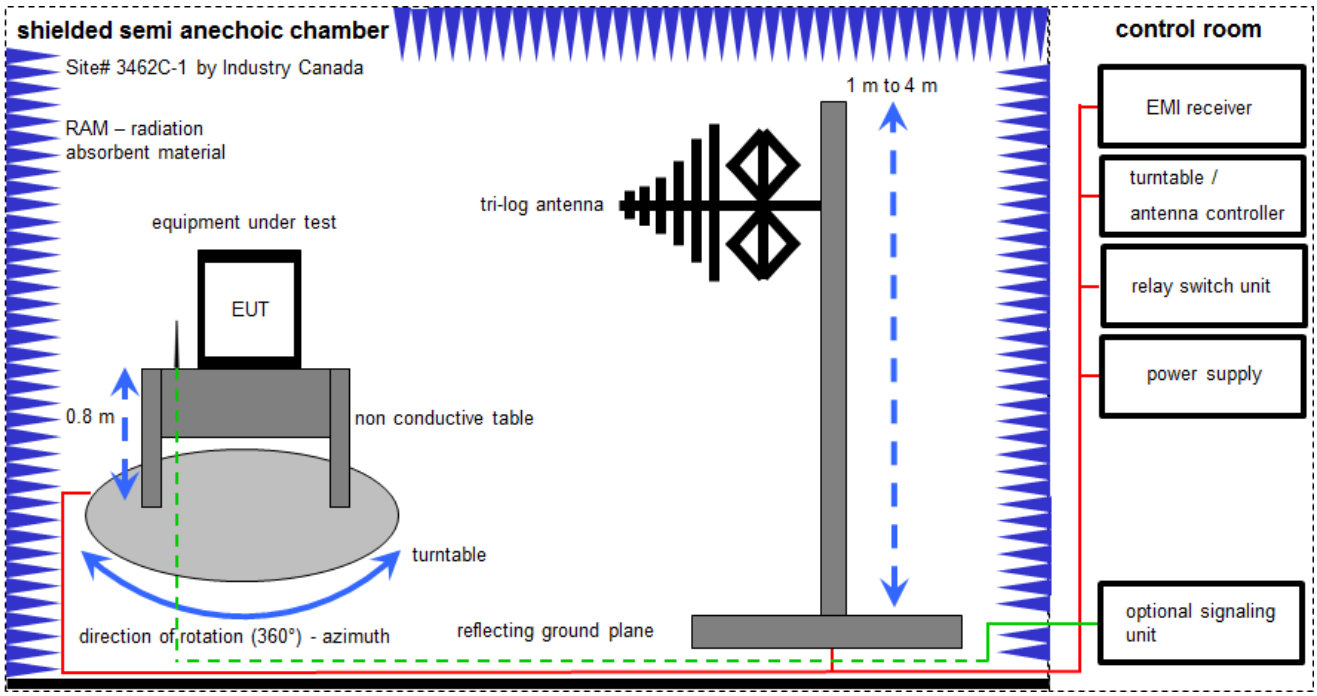
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

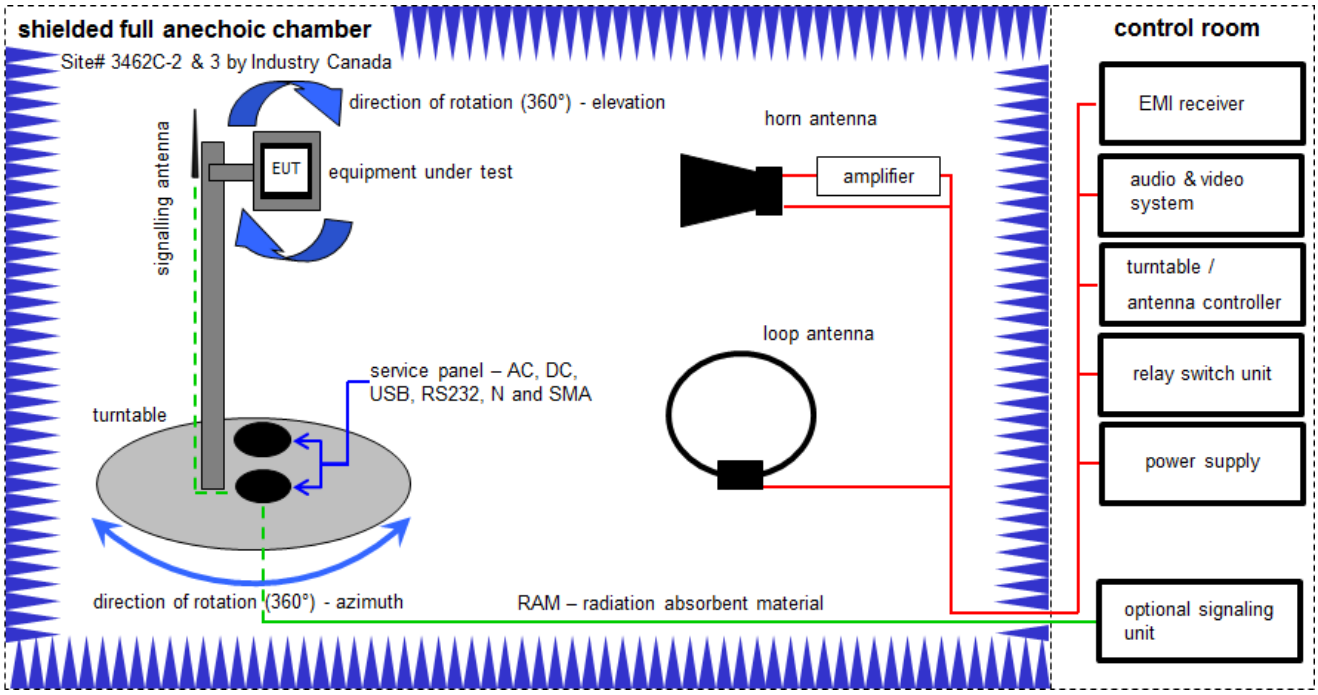
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	93	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	15.12.2017	14.12.2018
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	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	295	300003787	k	25.04.2016	25.04.2018
10	n. a.	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	20.12.2017	19.12.2018

6.2 Shielded fully anechoic chamber



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

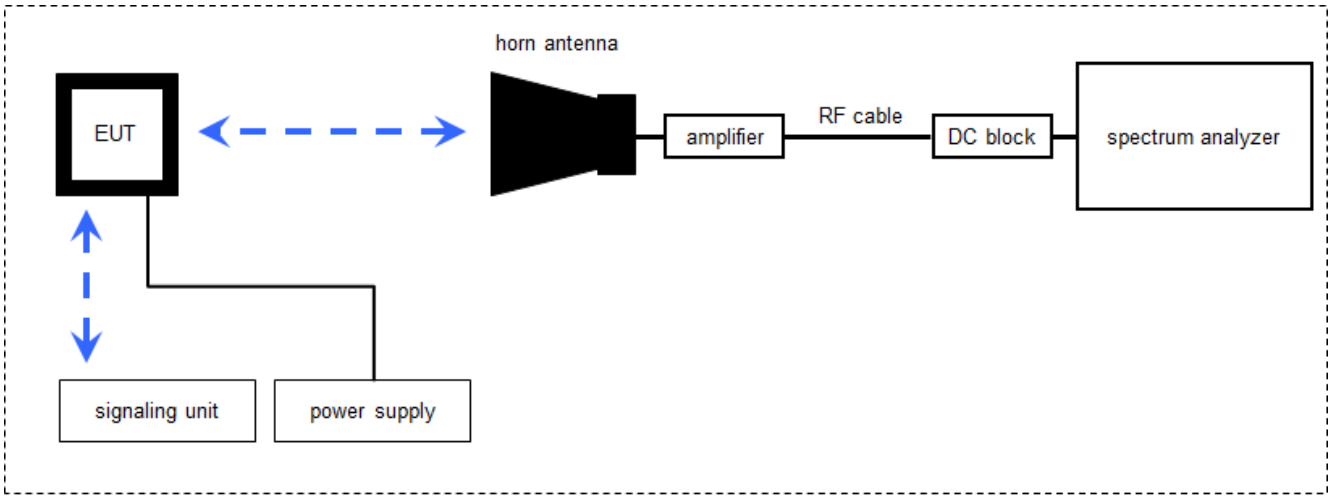
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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

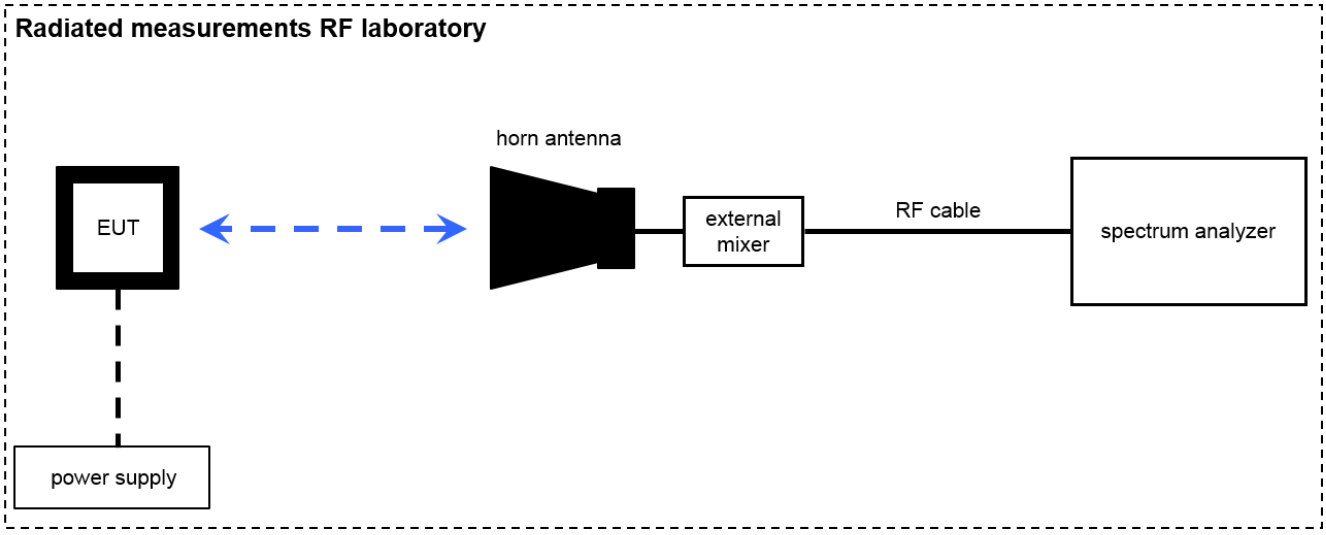
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	12.12.2017	11.12.2020
2	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	k	07.07.2017	06.07.2019
3	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	19	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	14.02.2017	13.02.2019
5	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
6	9	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne	-/-	-/-
7	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	20.12.2017	19.12.2018
8	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
9	n. a.	Broadband Amplifier 5-13 GHz	CBLU5135235	CERNEX	22010	300004491	ev	-/-	-/-
10	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
12	n. a.	PC	ExOne	F+W		300004703	ne	-/-	-/-
13	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	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)

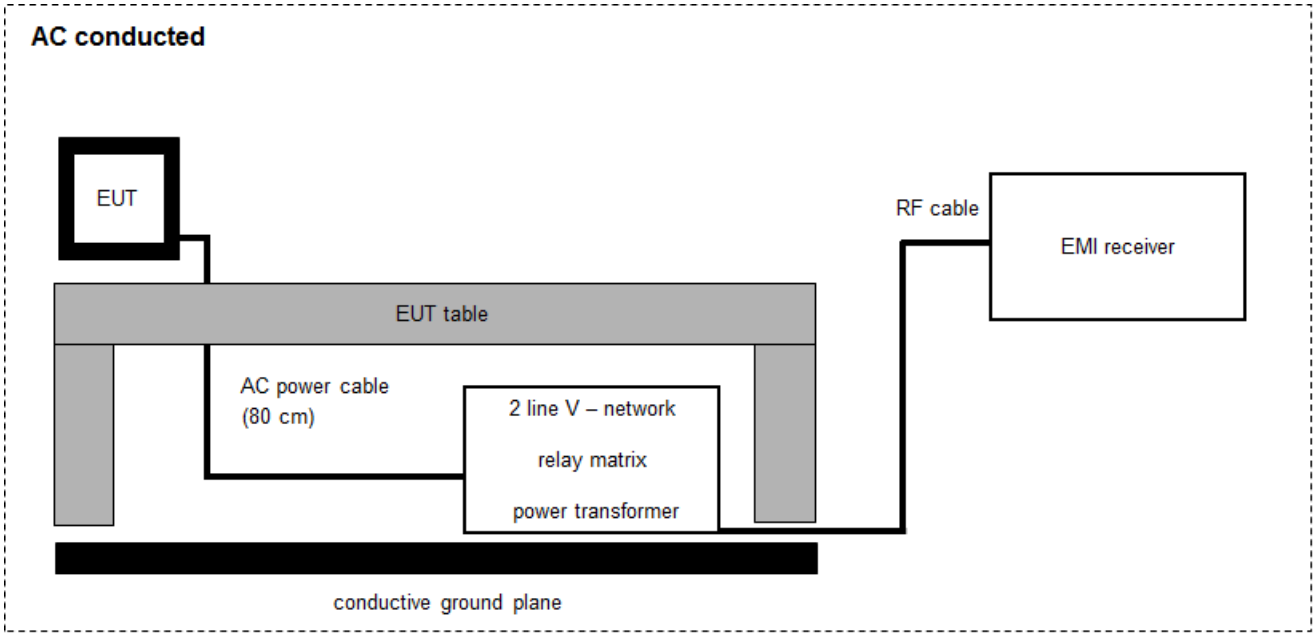
Example calculation:
OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 µW)

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	CR 79	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ne	-/-	-/-
2	A025	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne	-/-	-/-
3	A027	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-
4	A032	Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
5	A033	Std. Gain Horn Antenna 145-220 GHz	3024-20	Flann	*	300002000	ne	-/-	-/-
6	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	k	13.12.2017	12.12.2019
7	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	k	28.10.2016	27.10.2018
8	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	100099	300003949	k	30.06.2017	29.06.2018
9	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	SAM-170	Radiometer Physics GmbH	100014	300004156	k	05.07.2017	04.07.2018
10	n. a.	Harmonic Mixer 3-Port, 170-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	05.07.2017	04.07.2018
11	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
12	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
30	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	k	13.12.2017	12.12.2019
31	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	k	28.10.2016	27.10.2018
32	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	100099	300003949	k	30.06.2017	29.06.2018
33	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	SAM-170	Radiometer Physics GmbH	100014	300004156	k	05.07.2017	04.07.2018
34	n. a.	Harmonic Mixer 3-Port, 170-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	05.07.2017	04.07.2018
35	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
36	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
37	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	03.07.2017	02.07.2018
38	n.a.	Spectrum Analyzer FSW 85	FSW85	R&S	1312.8000K85-101333-gi	tbd	k	June 2018	June 2019
39	n.a.	Amplifier 50 to 67 GHz	HLNAV-389	HXI, LLC	2K280222+	Property of Acconeer AB	ev	-/-	-/-
40	n. a.	Std. Gain Horn Antenna 50.0-75.0 GHz	25240-20	Flann	254847	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	n. a.	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	k	13.12.2017	12.12.2019
2	67	RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
3	n. a.	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	08.04.2008	-/-
4	n. a.	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	18.12.2017	17.12.2018

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	D in cm	λ in cm	D_{ff} 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	Passed	2019-03-21	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Results (max.)
§15.215	Occupied bandwidth (20dB bandwidth)	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(b)	Maximum E.I.R.P.	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(c)	Spurious Emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.255(e)	Frequency stability	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

11 Measurement results

11.1 Occupied bandwidth (20 dB bandwidth)

Description:

Measurement of the 20dB 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:

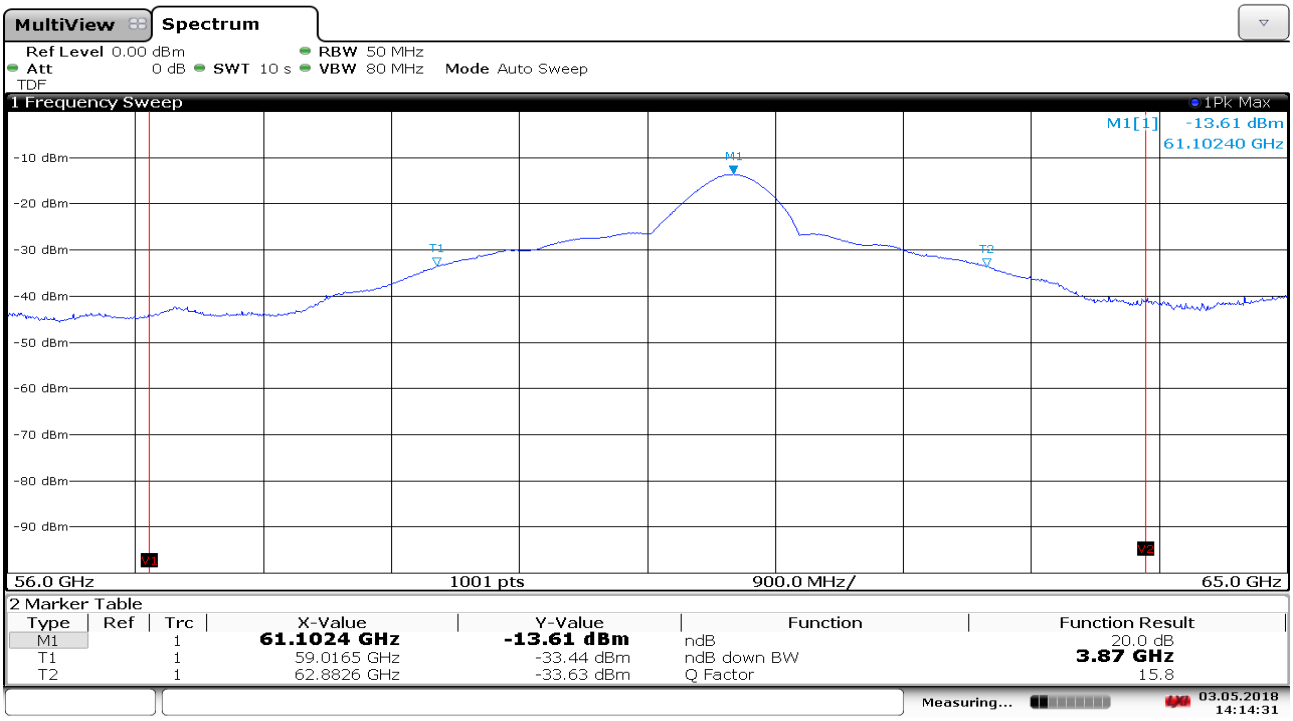
FCC
CFR Part 15.255
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:
Frequency range
57 GHz – 71 GHz

Measurement results:

Test condition t = 22 °C	F_L in GHz	F_H in GHz	Occupied bandwidth in MHz
Operating mode 1	59.0165	62.8826	3 870
Operating mode 2	59.7178	62.2982	2 580
Measurement uncertainty	± span/1000		

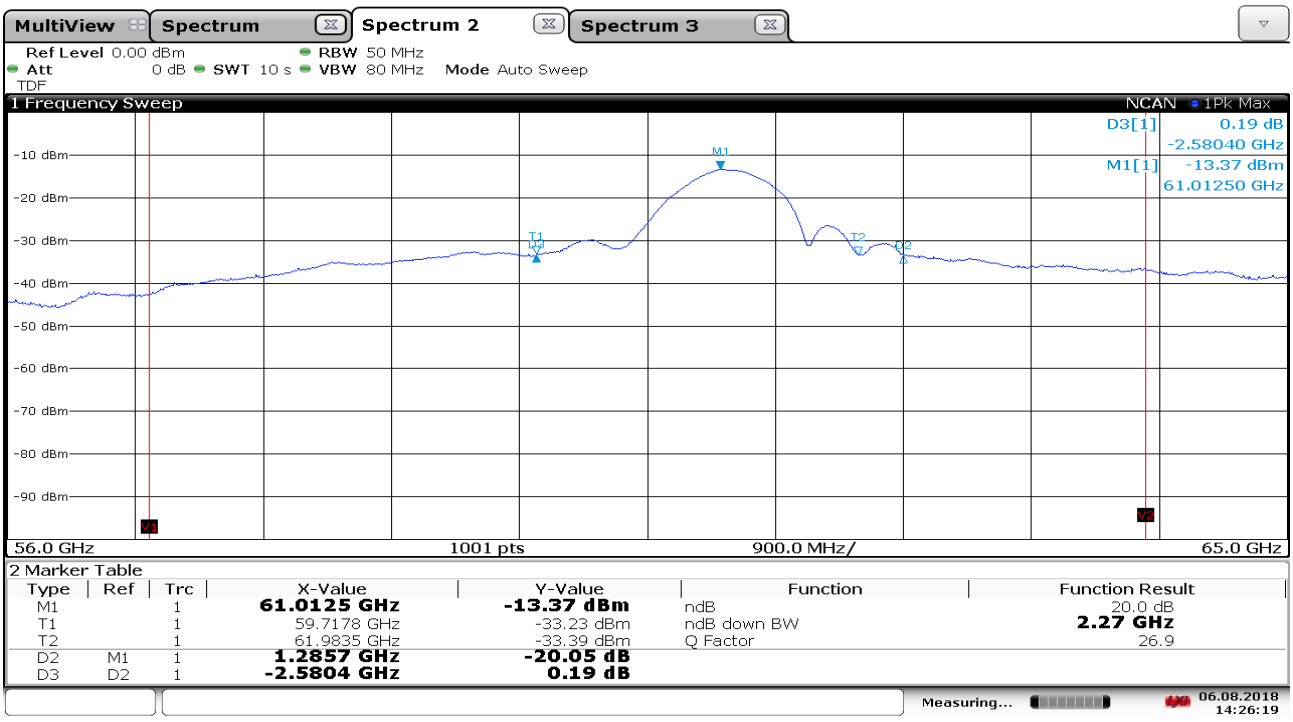
Result: **The measurement is passed.**

Plot No. 1:



14:14:31 03.05.2018

Plot No. 2:



14:26:19 06.08.2018

11.2 Maximum E.I.R.P.

Description:

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

Limits:

(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.

Measurement:

Measurement parameter	
Detector:	Pos-Peak / RMS
Sweep time:	10 s
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	9 GHz
Trace-Mode:	Max Hold
Measurement distance	16 cm

Measurement results:

Peak-Measurement:

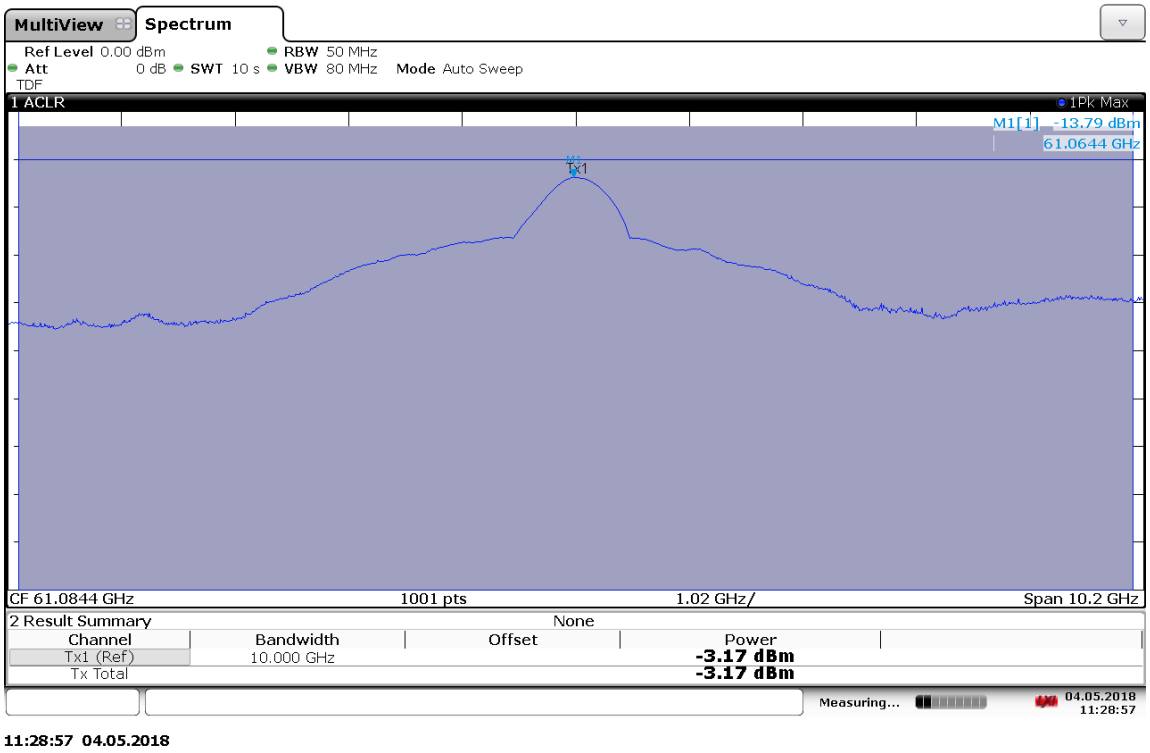
Test condition t = 22 °C	Center frequency in GHz	Maximum E.I.R.P. in dBm
Operating mode 1	61.0844	-3.17
Operating mode 2	60.0000	-2.87
Measurement uncertainty	± 3 dB	

Average-Measurement:

Test condition t = 22 °C	Center frequency in GHz	Maximum E.I.R.P. in dBm
Operating mode 1	61.1290	-20.03
Operating mode 2	60.0000	-24.03
Measurement uncertainty	± 3 dB	

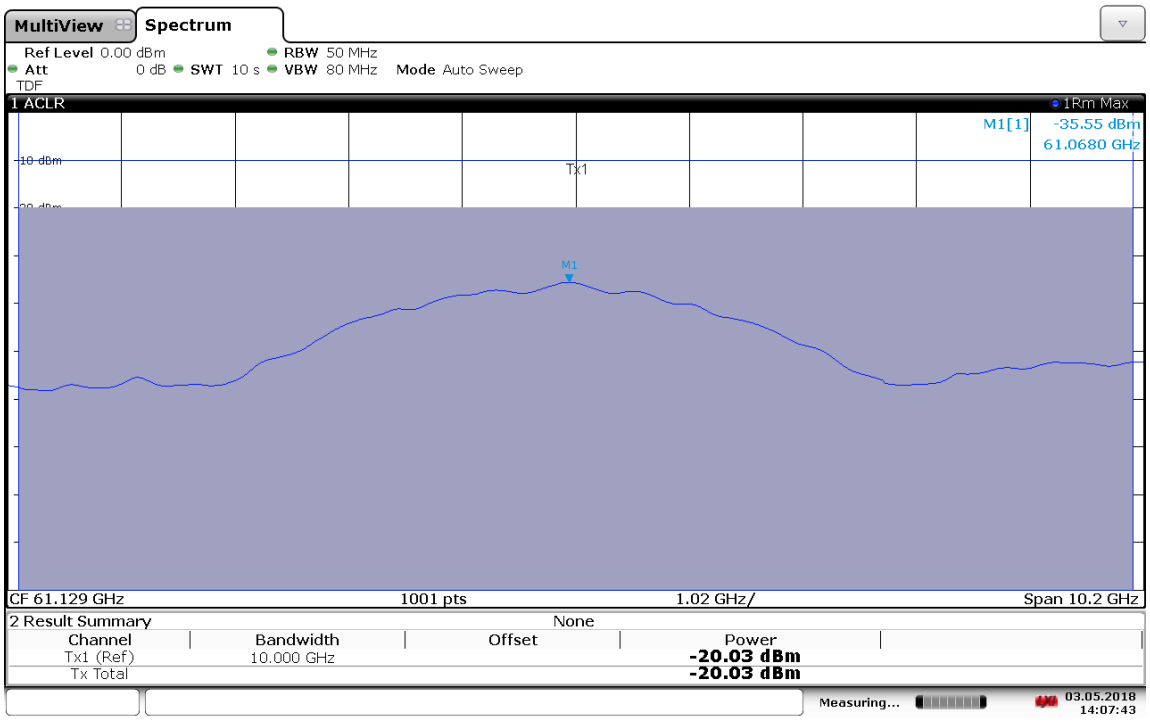
Result: The measurement is passed.

Plot No. 3: Peak Power, mode 1



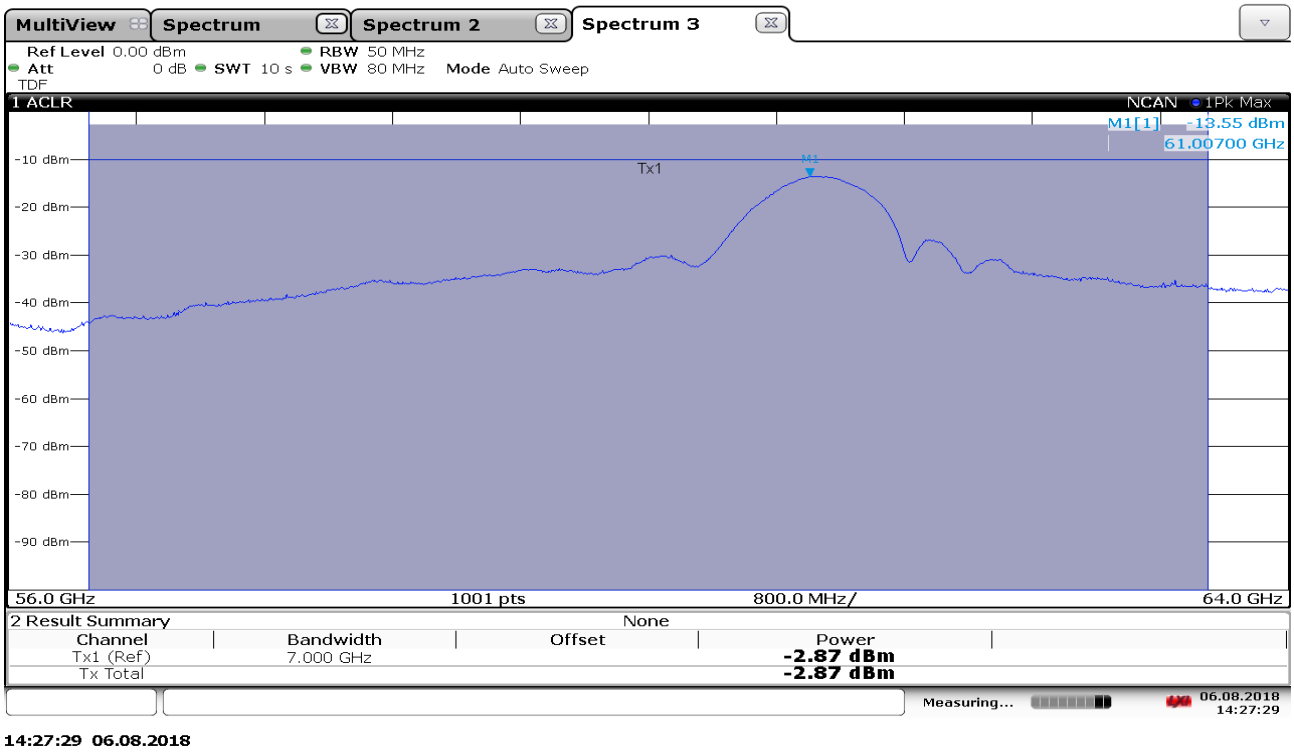
11:28:57 04.05.2018

Plot No. 4: RMS Power, mode 1

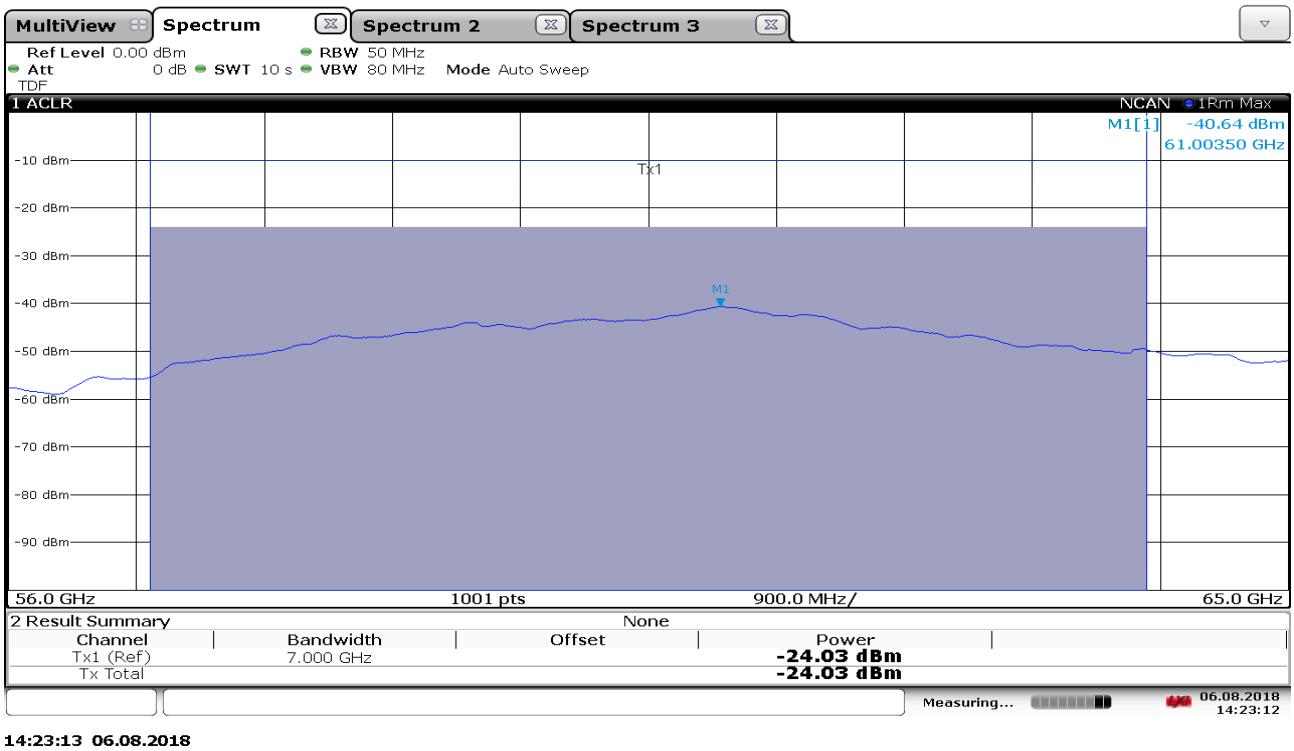


14:07:43 03.05.2018

Plot No. 5: Peak Power, mode 2



Plot No. 6: RMS Power, mode 2



11.3 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions in transmit mode.

Limits:

(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)		
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:

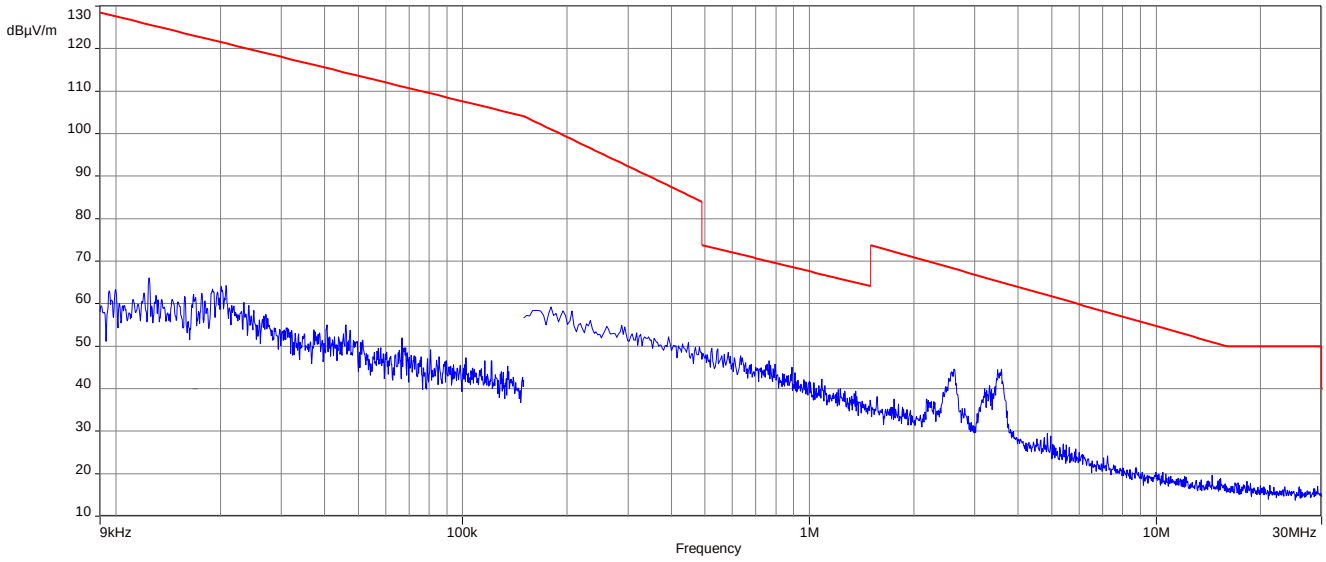
Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	Auto
Frequency range:	30 MHz to 100 GHz
Trace-Mode:	Max Hold

Measurement distance for measurements above 18 GHz	
Frequency rance in GHz	**Distance in m**
18-26.5	0.3
26.5-40	0.3
40-50	0.3
50-75	0.2
75-110	0.2
110-170	0.2
170-220	0.1
Regarding far field considerations please refer to chapter 9.	

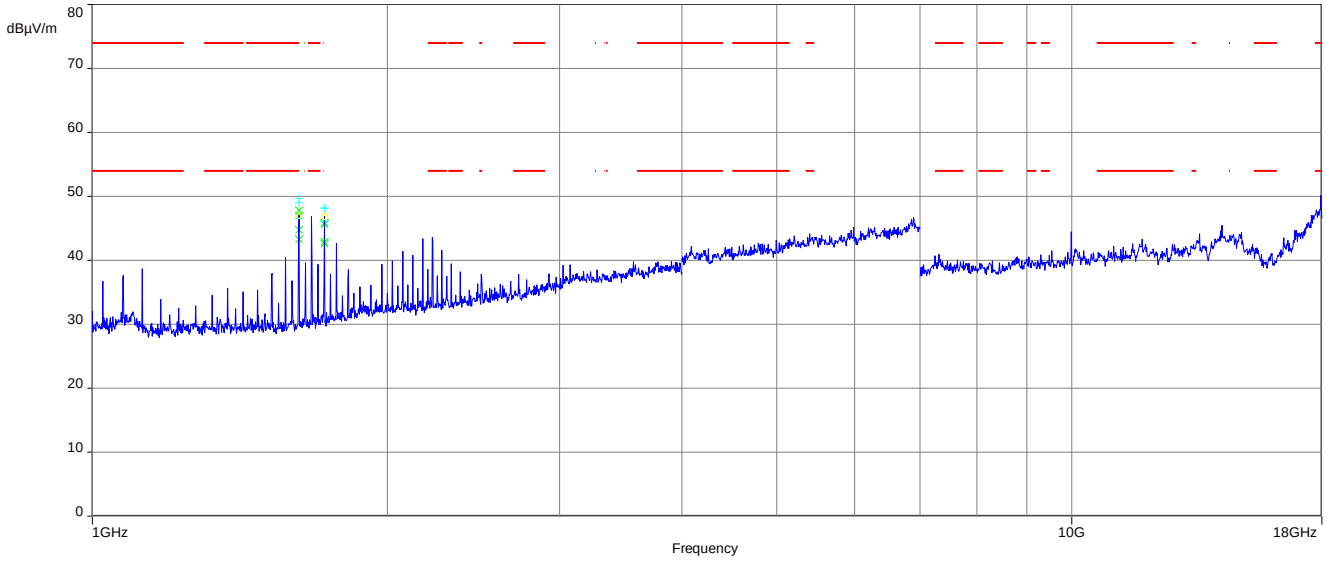
Note:
Spurious emissions test are performed on mode 1. If critical emissions are detected, they are investigated for both modes.

Result: The measurement is passed.

Plot No. 7: Tx magnetic, 9 kHz – 30 MHz

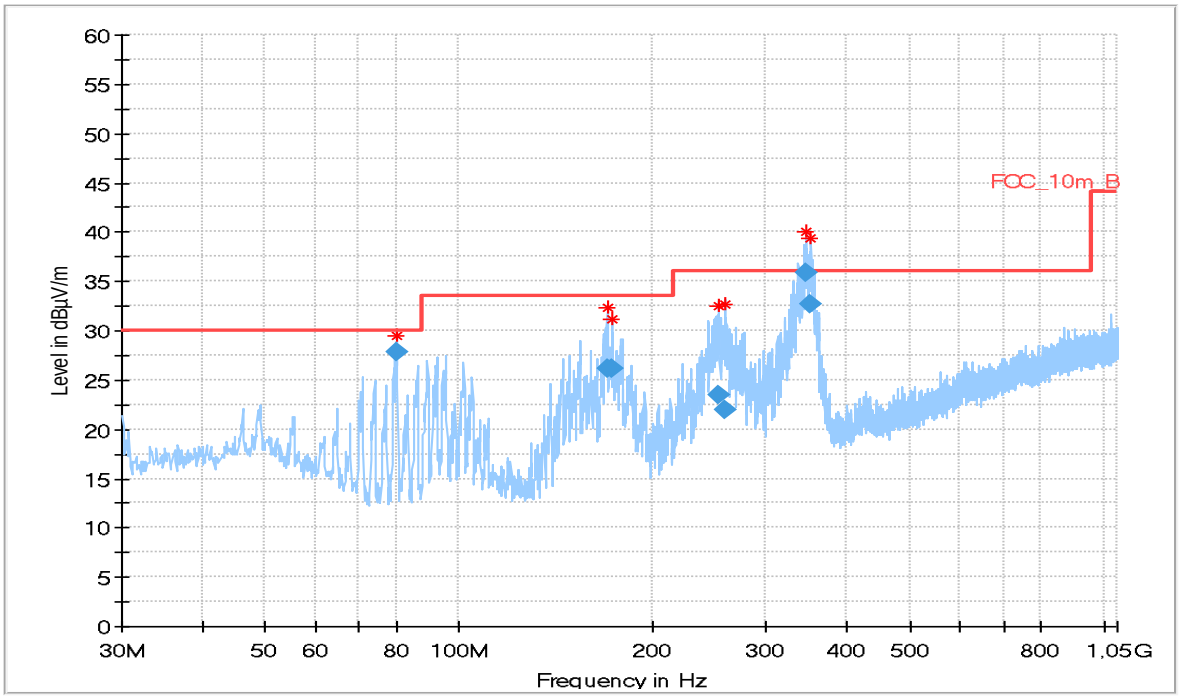


Plot No. 8: 1 GHz to 18 GHz



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Bandwidth (kHz)
1624.9	47.8	54	6.2	RMS	1000
1624.9	49.7	74	24.3	PEAK	1000
1724.8	45.9	54	8.1	RMS	1000
1724.8	48.2	74	25.8	PEAK	1000

Plot No. 9: 30 MHz to 1 GHz

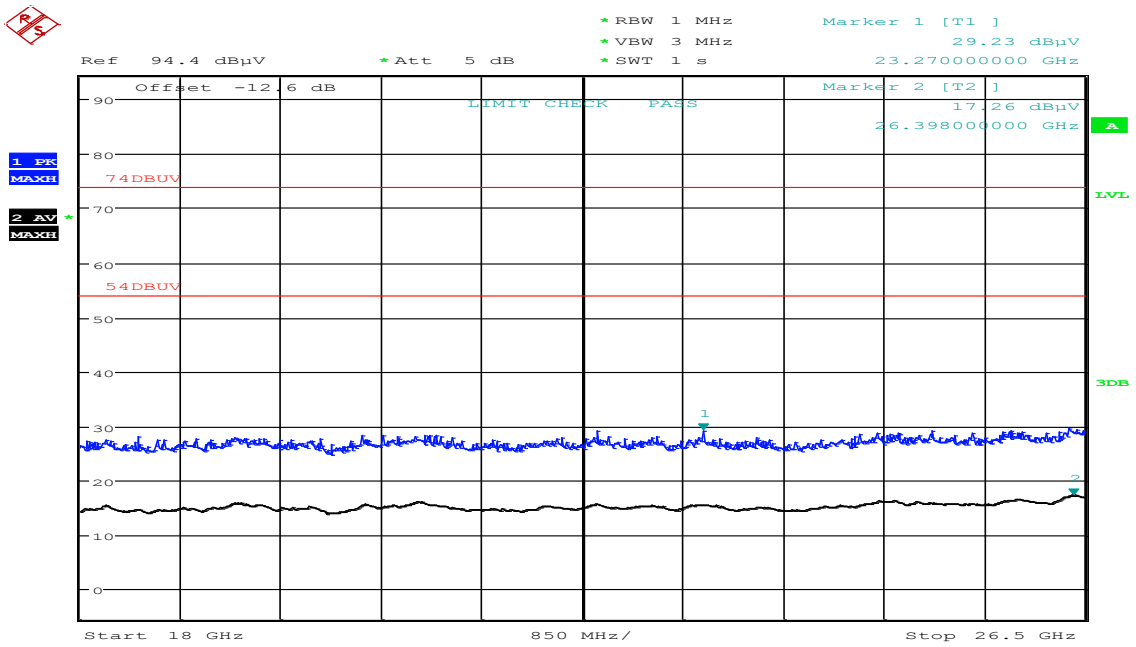


Note: The trace on this plot is a premeasurement that is performed using a peak detector (worst case). The relevant result is the final measurement of the 6 highest emissions with Quasipeak detector (table below). ” In the report.

Final_Result

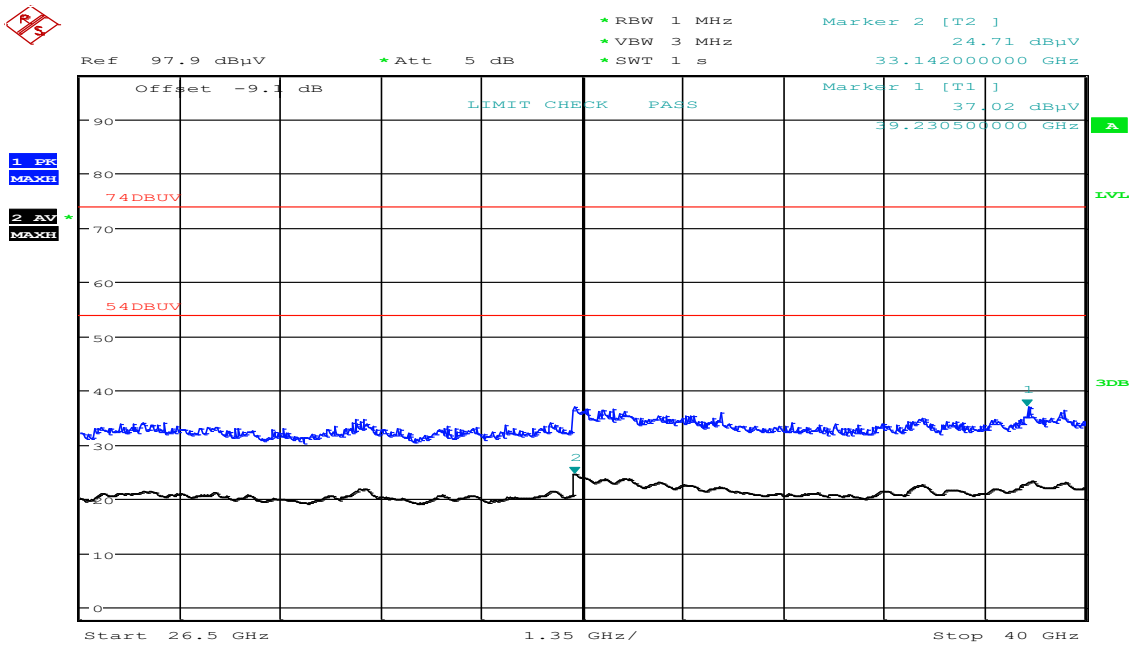
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
80.196	27.81	30.0	2.19	1000	120	203.0	V	60.0	8.1
169.717	26.17	33.5	7.33	1000	120	100.0	V	-15.0	10.3
172.855	26.07	33.5	7.43	1000	120	100.0	V	15.0	10.5
253.144	23.40	36.0	12.60	1000	120	100.0	V	60.0	13.5
259.244	22.01	36.0	13.99	1000	120	100.0	V	15.0	13.6
345.705	35.82	36.0	0.18	1000	120	273.0	H	15.0	15.9
352.080	32.68	36.0	3.32	1000	120	200.0	H	15.0	16.0

Plot No. 10: 18 GHz to 26.5 GHz



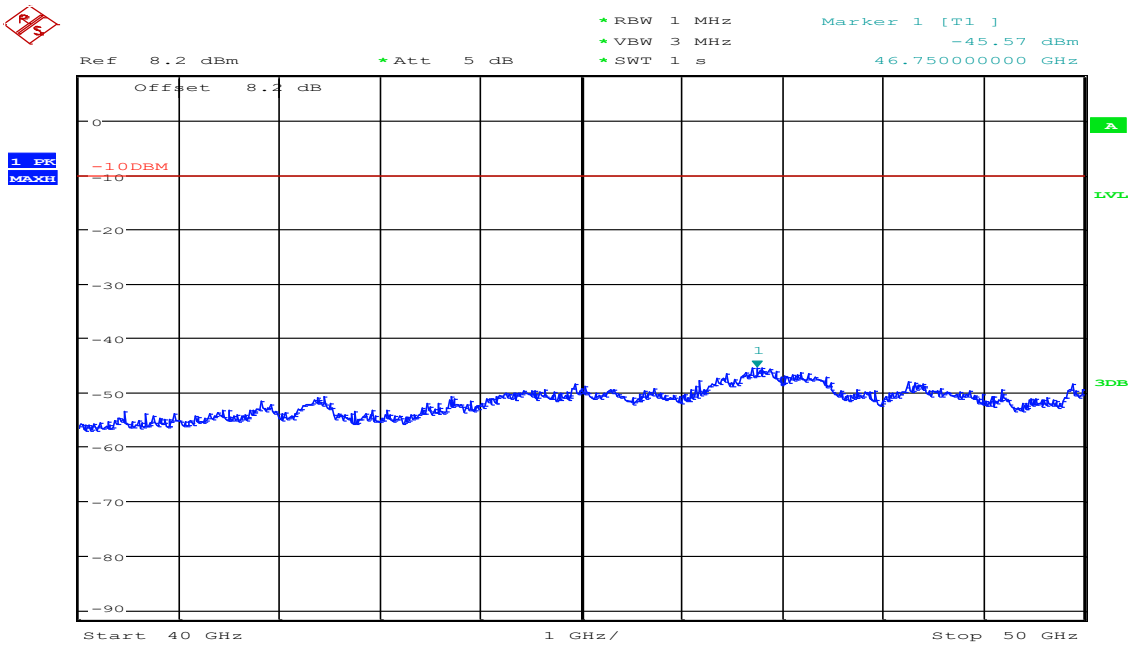
Date: 12.JUL.2018 10:29:45

Plot No. 11: 26.5 GHz to 40 GHz



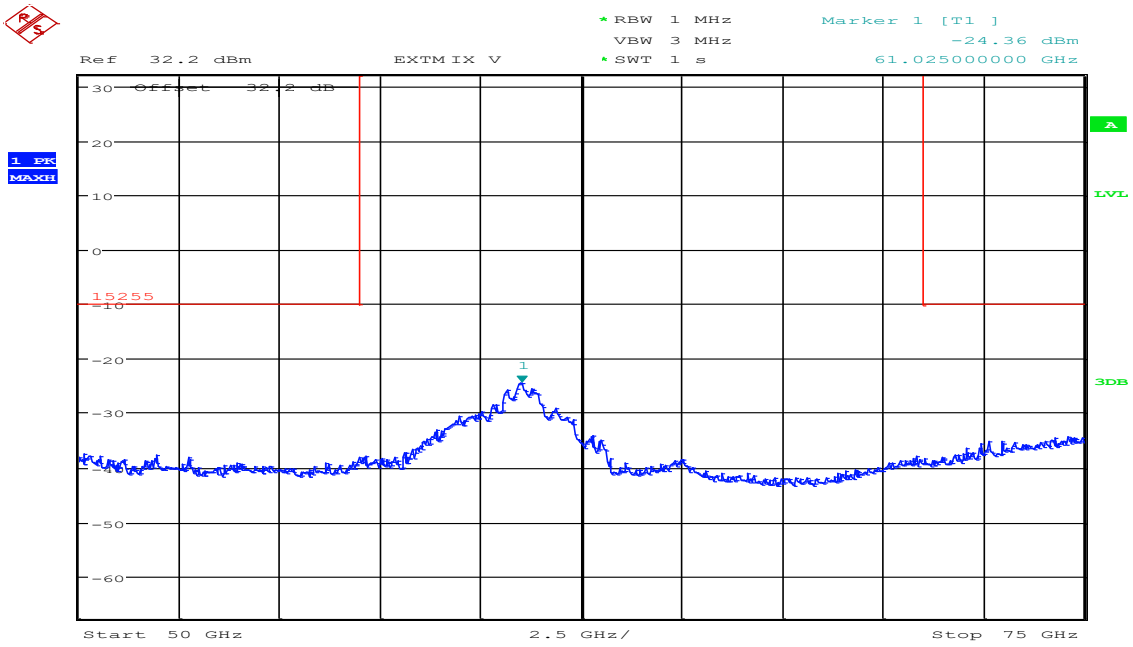
Date: 12.JUL.2018 10:28:17

Plot No. 12: 40 GHz to 50 GHz



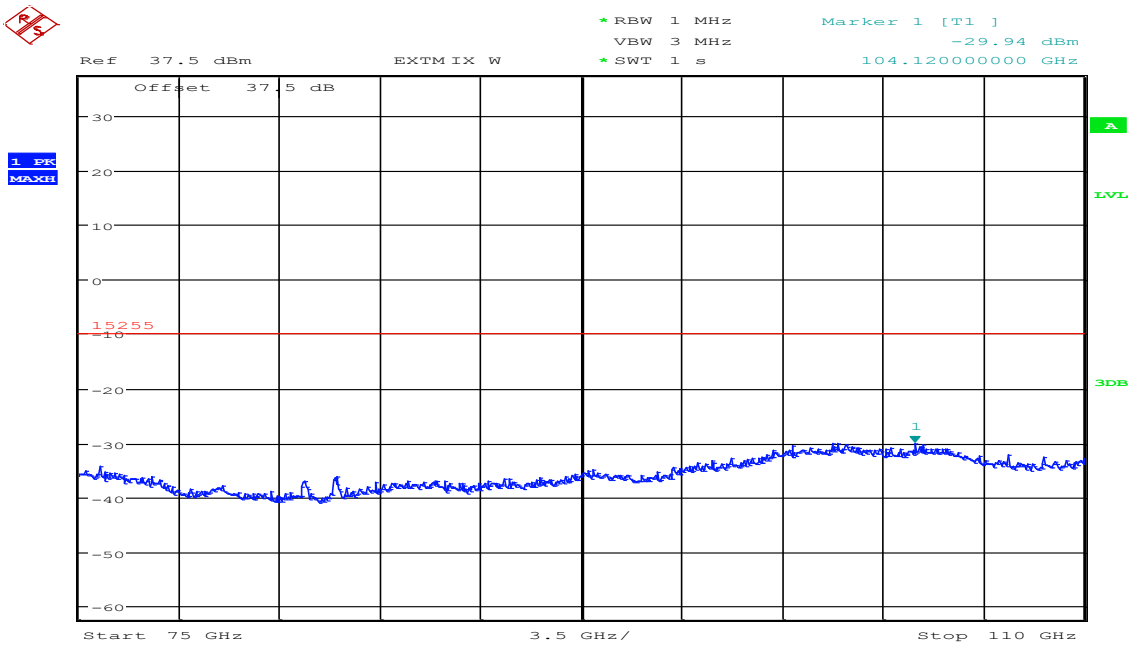
Date: 12.JUL.2018 10:25:59

Plot No. 13: 50 GHz to 75 GHz



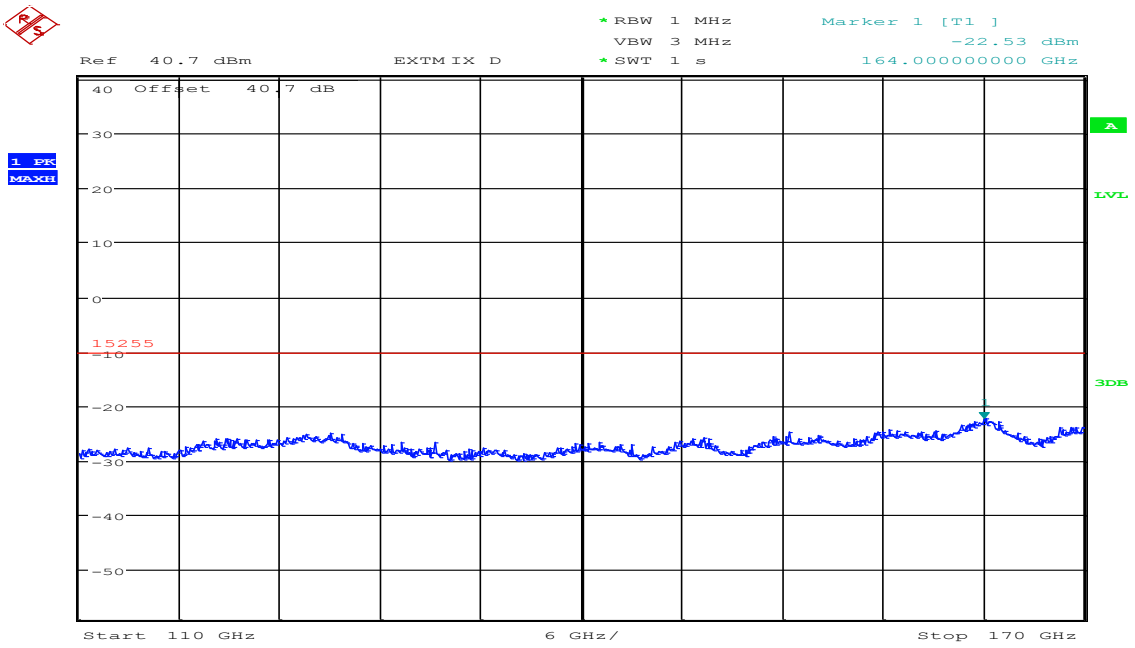
Date: 12.JUL.2018 10:10:09

Plot No. 14: 75 Ghz to 110 GHz



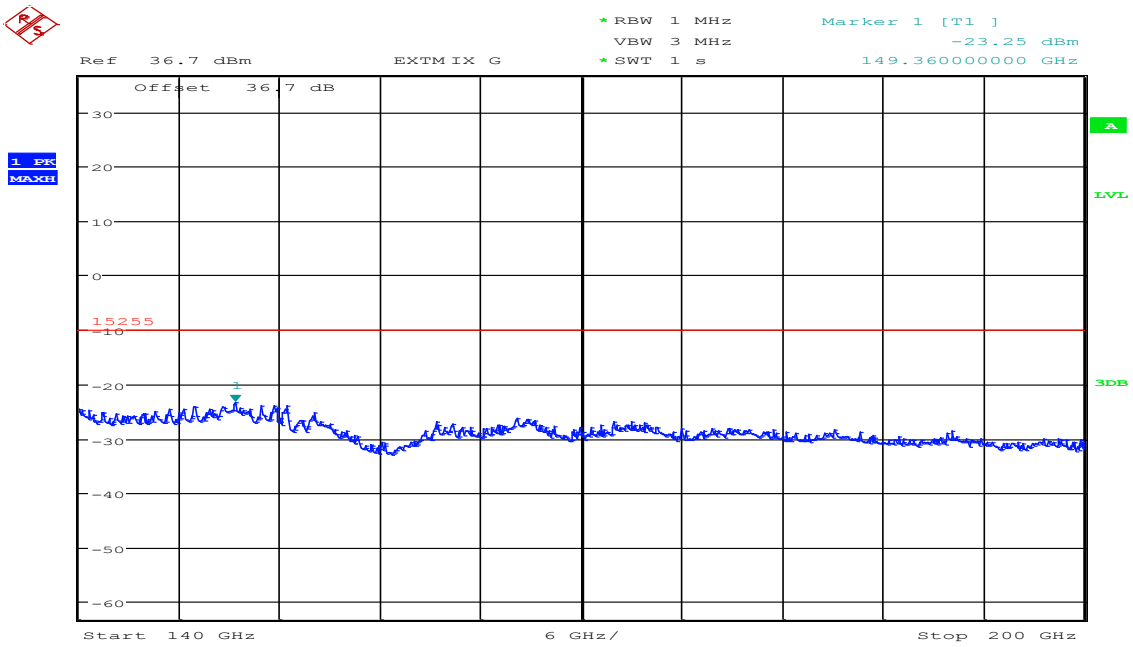
Date: 12.JUL.2018 10:14:30

Plot No. 15: 110 GHz to 170 GHz



Date: 12.JUL.2018 10:16:30

Plot No. 16: 170 GHz to 220 GHz



Date: 12.JUL.2018 10:18:56

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

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to middle channel and Idle mode. If critical peaks are found the lowest and highest channel will be measured too. Both power lines, phase and neutral line, are measured. Found peaks are remeasured 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		
TX Spurious Emissions Conducted < 30 MHz		
Frequency (MHz)	Quasi-Peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

*Decreases with the logarithm of the frequency

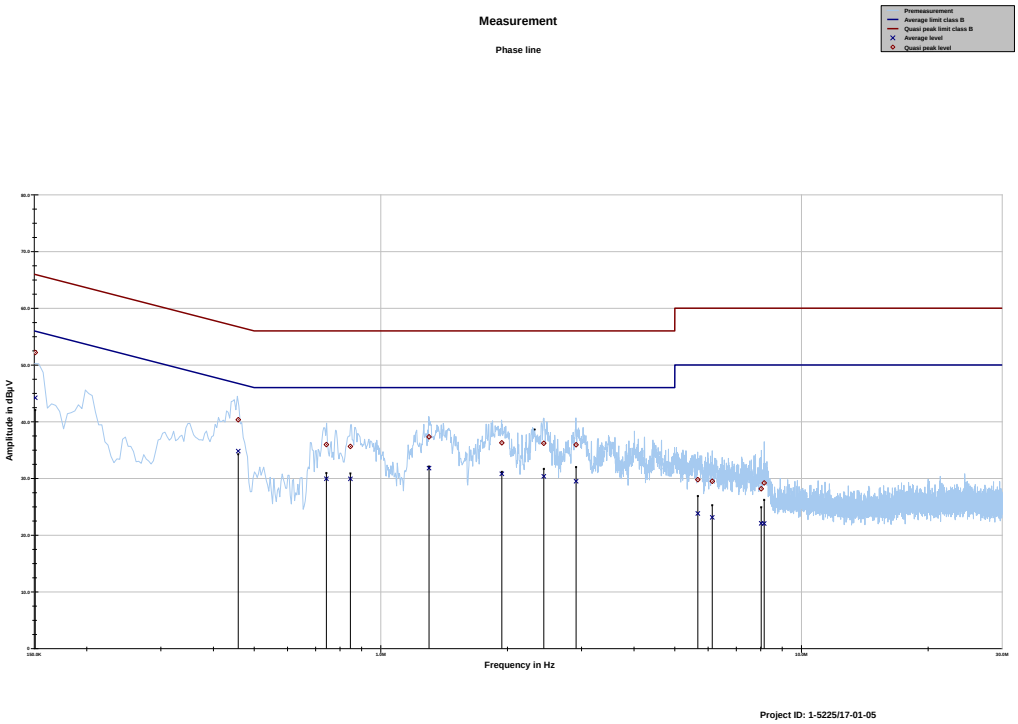
Results:

TX Spurious Emissions Conducted < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
No peaks detected.		
Measurement uncertainty	± 3 dB	

Result: The measurement is passed.

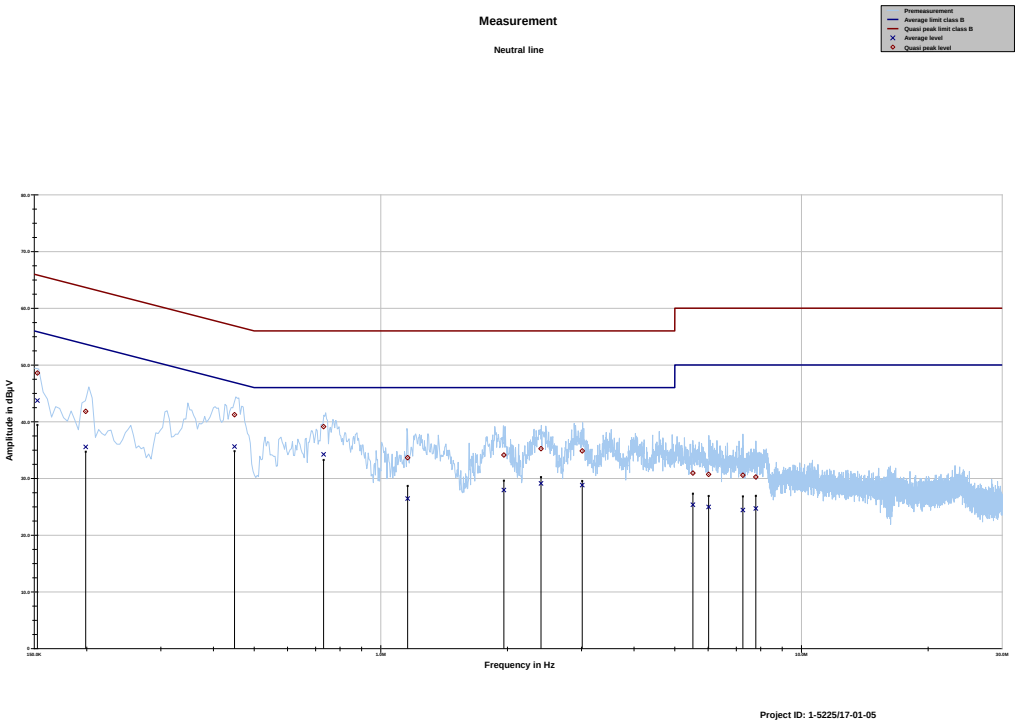
Plots:

Plot 1: TX mode, 150 kHz to 30 MHz, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150861	52.19	13.77	65.952	44.21	11.76	55.975
0.458439	40.35	16.37	56.721	34.82	12.37	47.187
0.742567	35.97	20.03	56.000	29.95	16.05	46.000
0.846964	35.64	20.36	56.000	29.92	16.08	46.000
1.302127	37.33	18.67	56.000	31.81	14.19	46.000
1.940141	36.28	19.72	56.000	30.81	15.19	46.000
2.441150	36.20	19.80	56.000	30.36	15.64	46.000
2.912548	35.93	20.07	56.000	29.49	16.51	46.000
5.671229	29.77	30.23	60.000	23.82	26.18	50.000
6.137970	29.49	30.51	60.000	23.13	26.87	50.000
8.023611	28.17	31.83	60.000	22.08	27.92	50.000
8.157341	29.21	30.79	60.000	22.05	27.95	50.000

Plot 2: TX mode, 150 kHz to 30 MHz, neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.152666	48.57	17.28	65.854	43.72	12.20	55.924
0.198883	41.83	21.83	63.657	35.56	19.05	54.603
0.449112	41.24	15.66	56.892	35.61	11.84	47.454
0.731243	39.13	16.87	56.000	34.25	11.75	46.000
1.158712	33.65	22.35	56.000	26.45	19.55	46.000
1.962148	34.13	21.87	56.000	27.96	18.04	46.000
2.404030	35.23	20.77	56.000	29.13	16.87	46.000
3.013191	34.84	21.16	56.000	28.82	17.18	46.000
5.519972	30.94	29.06	60.000	25.37	24.63	50.000
6.015875	30.72	29.28	60.000	24.96	25.04	50.000
7.256359	30.57	29.43	60.000	24.43	25.57	50.000
7.792183	30.25	29.75	60.000	24.71	25.29	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
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 – 71 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:	-30 °C / +50 °C

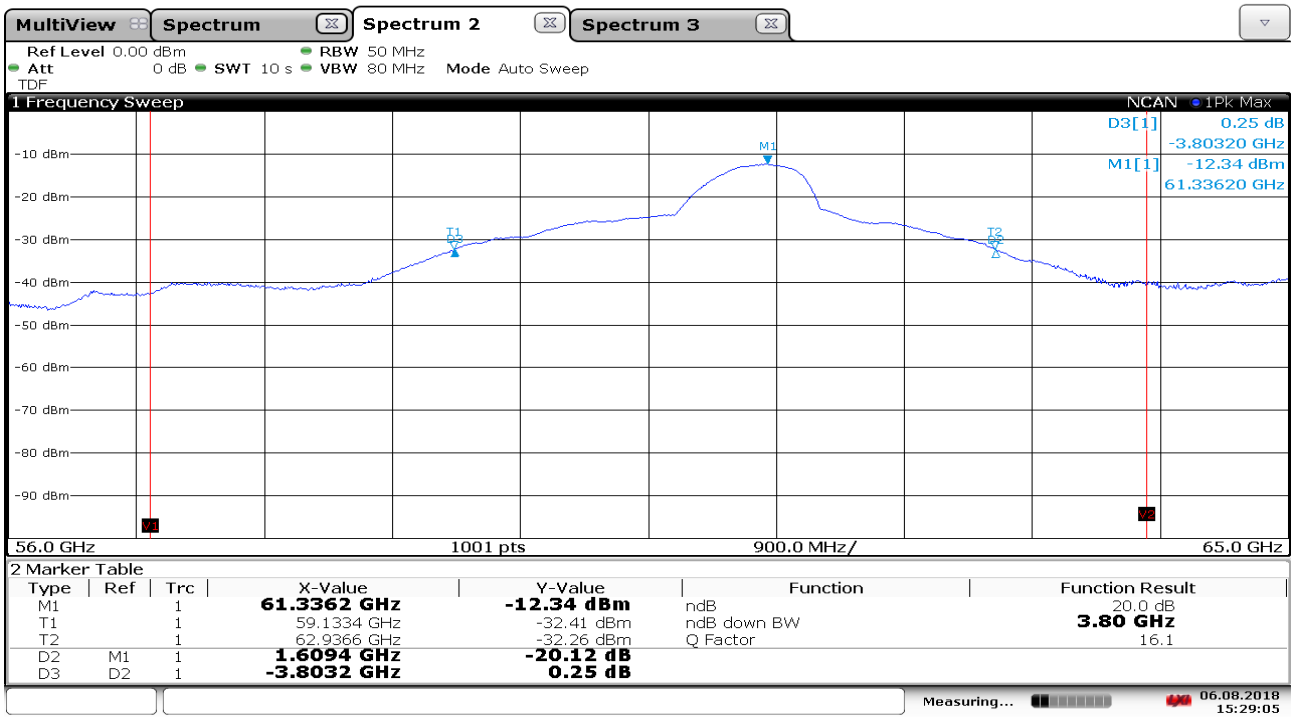
Measurement Results:

Test condition	F_L in GHz	F_H in GHz
T_{min}	59.1334	62.9366
T_{max}	58.8636	62.8017
V_{min}	59.7178	62.5769
V_{max}	59.8437	62.2082

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.

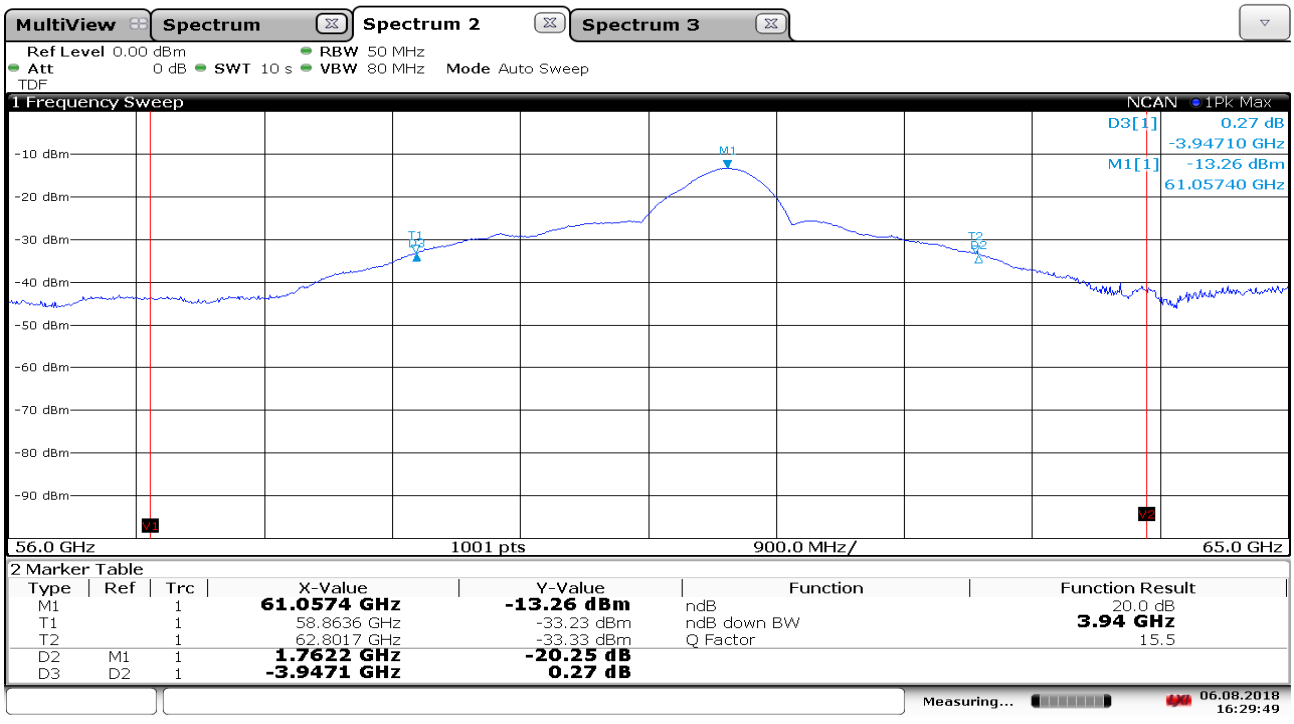
Result: The measurement is passed.

Plot No. 17: 20 dB-Bandwidth at T_{min}, mode 1



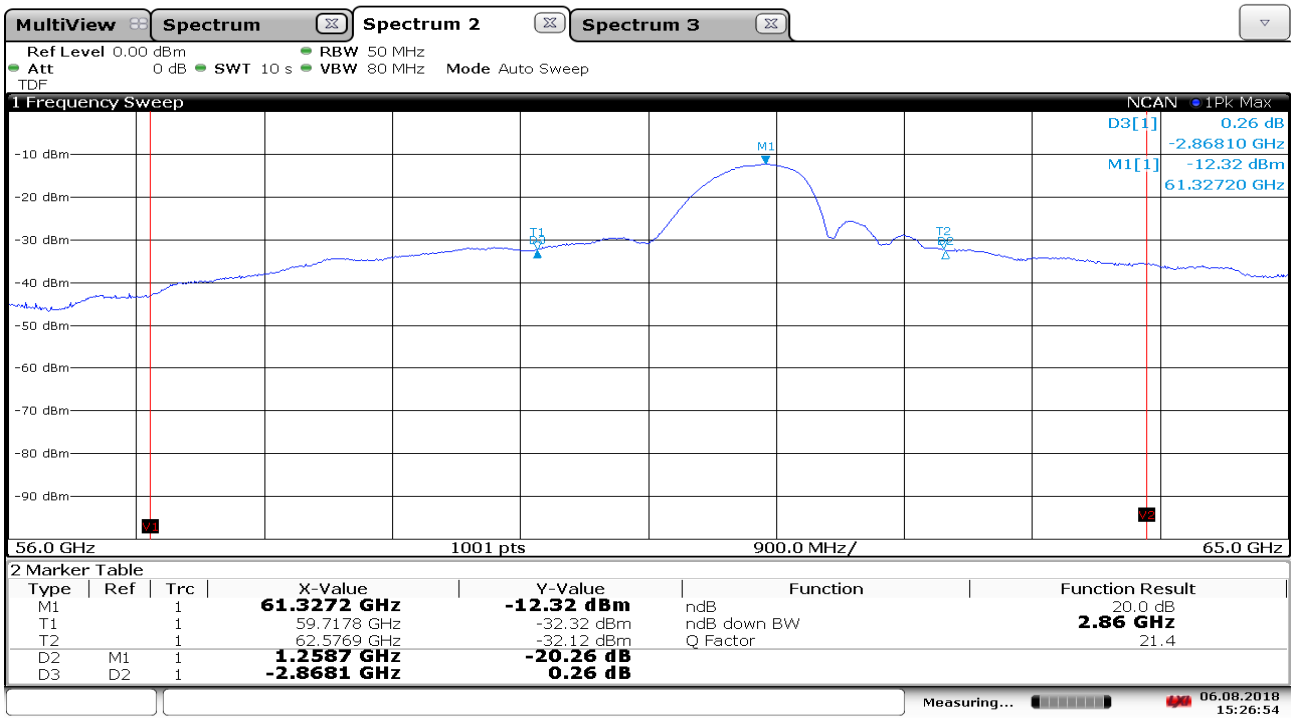
15:29:06 06.08.2018

Plot No. 18: 20 dB Bandwidth at T_{max}, mode 1



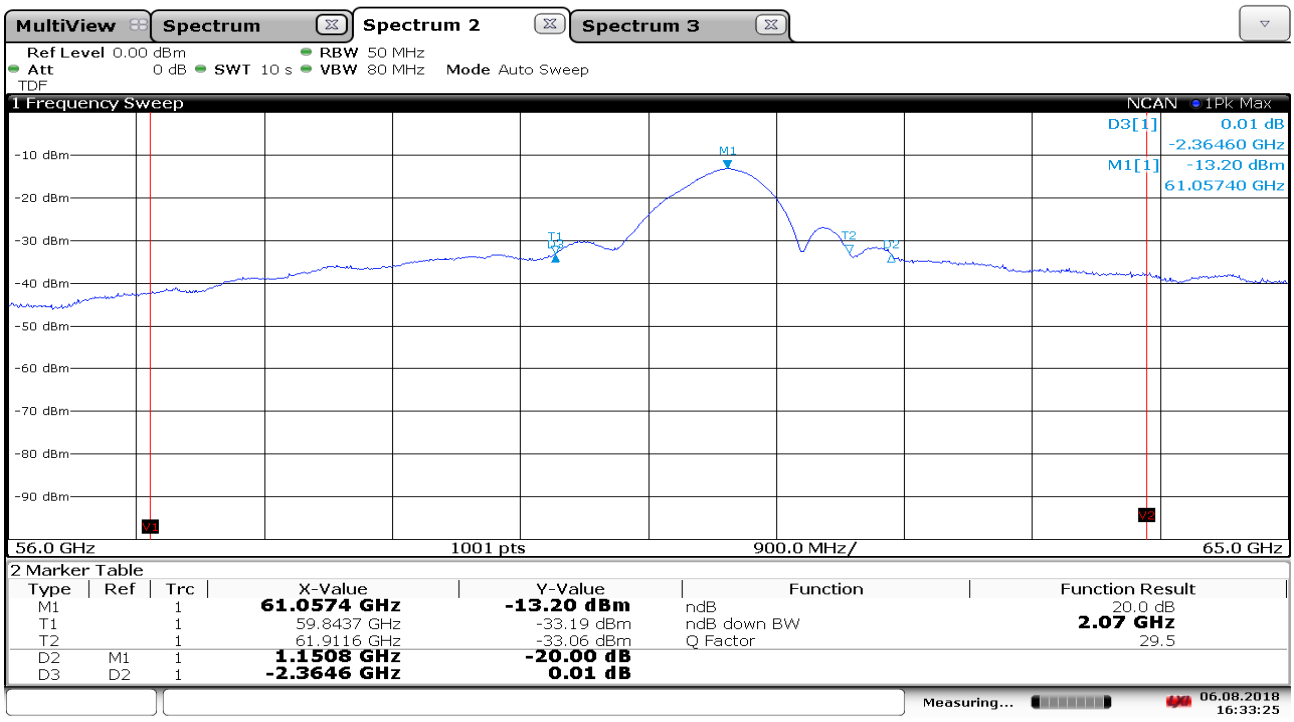
16:29:50 06.08.2018

Plot No. 19: 20 dB-Bandwidth at V_{min}, mode 2



15:26:54 06.08.2018

Plot No. 20: 20 dB Bandwidth at V_{max}, mode 2



16:33:25 06.08.2018

Annex A 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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2018-08-06
-A	Note added on page 28	2018-08-28
-B	FCC ID and ISED IDs added	2018-10-17
-C	Chapter 8 added (Measurement uncertainty) Chapter 9 added (Far field considerations) Editorial changes	2019-03-21

Annex C Accreditation Certificate – D-PL-12076-01-05

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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-12076-01-05.pdf

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