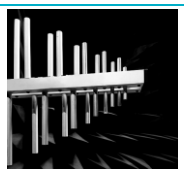
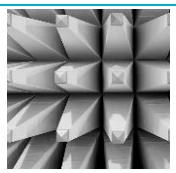




CTC advanced
member of RWTÜV group

TEST REPORT

Test report no.: 1-4132/17-01-03

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

Testing laboratory

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

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-01

Applicant

ZF – Autocruise SAS
Avenue du Technopôle - Secteur de la Pointe du Diable
29280 Plouzané / FRANCE
Phone: +33 02 98 454368
Fax:
Contact: Sylvain Germaine
e-mail: Sylvain.Germaine@TRW.COM
Phone: +33 298 489 828

Manufacturer

ZF – Autocruise SAS
Avenue du Technopôle - Secteur de la Pointe du Diable
29280 Plouzané / FRANCE

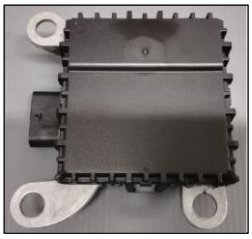
Test standard/s

47 CFR Part 95	Subpart M: 76-81 GHz Band Radar Service
RSS - Gen Issue 4	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus
RSS-251 Issue 1	Field Disturbance Sensors in the Bands 46.7-46.9 GHz (Vehicular Radar) and 76-77 GHz (Vehicular and Airport Fixed Radar)

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

Test Item

Kind of test item:	**76 GHz Automotive Radar**
Model name:	**AC1000**
FCC ID	S9I-AC1000
IC	5860A-AC1000
Frequency:	76.0 – 77.0 GHz
Antenna:	Integrated patch antenna
Power supply:	10.5 – 16.0 V DC from power supply
Temperature range:	-40°C to +85°C



This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

B. Gerber
cn=benedikt.gerber@ctcadvanced.com
2018.02.08 11:21:56 +01'00'

Benedikt Gerber
Lab Manager
Radio Communications & EMC

Test performed:

M. Walla
cn=Walla Meheza, o=ctcadvanced GmbH, ou=WAL-161220, email=meheza.walla@ctcadvanced.com, c=DE
2018.02.07 11:11:46 +01'00'

Meheza Walla
Lab Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

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

2.2 Application details

Date of receipt of order:	2017-06-16
Date of receipt of test item:	2017-09-11
Start of test:	2017-09-15
End of test:	2017-10-19
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s

Test standard	Date	Test standard description
47 CFR Part 95		Subpart M: 76-81 GHz Band Radar Service
RSS - Gen Issue 4	November 2014	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus
RSS-251 Issue 1	November 2014	Field Disturbance Sensors in the Bands 46.7-46.9 GHz (Vehicular Radar) and 76-77 GHz (Vehicular and Airport Fixed Radar)

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 +85 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	12.75 V DC from power supply 16.00 V 10.50 V

5 Test item

5.1 General description

Kind of test item	**:**	**76 GHz Automotive Radar**
Type identification	**:**	**AC1000**
S/N serial number	:	-/-
HMN	:	NA
PMN	:	AC1000
HVIN	:	C1
FVIN	:	NA
HW hardware status	:	C1
SW software status	:	Rel07
Frequency band	:	76.0 – 77.0 GHz
Type of modulation	:	FMCW
Number of channels	:	1
Antenna	:	Integrated patch antenna
Power supply	:	10.5 – 16.0 V DC from power supply
Temperature range	:	-40°C to +85°C

NA: Not Applicable

5.2 Additional information

Test mode: ☒ Normal operation mode

☒ Special test software was used to change from normal operation mode to test mode (low / middle / high) as required by CFR 47 Part 15.31(c).

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: 1-4132/17-01-01_AnnexA
1-4132/17-01-01_AnnexB
1-4132/17-01-01_AnnexD

6 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	47 CFR Part 95 Subpart M RSS – 251 Issue 1	see below	2018-02-07	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Pass	Fail	NA	NP	Results (max.)
§2.1046 §95.3367 (a) / (b) RSS-251 (5.2.2)	Power density (RF power output)	Nominal and Extreme	Nominal and Extreme	☒	☐	☐	☐	25.4 dBm PK 7.4 dBm AVG
§2.1047	Modulation characteristics	Nominal	Nominal	☒	☐	☐	☐	FMCW
§2.1049 RSS-Gen	Occupied bandwidth (99% bandwidth)	Nominal and Extreme	Nominal and Extreme	☒	☐	☐	☐	406.8 MHz
§2.1051	Spurious emissions at antenna terminals	Nominal	Nominal	☐	☐	☒	☐	see note
§2.1053 §95.3379 (a)(1) §95.3379 (a)(2) §95.3379 (a)(3) RSS-251 (5.3)	Field strength of emissions (radiated spurious)	Nominal	Nominal	☒	☐	☐	☐	complies
§2.1055 §95.3379 (b) RSS-251 (5.4)	Frequency stability	Nominal and Extreme	Nominal and Extreme	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

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

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).

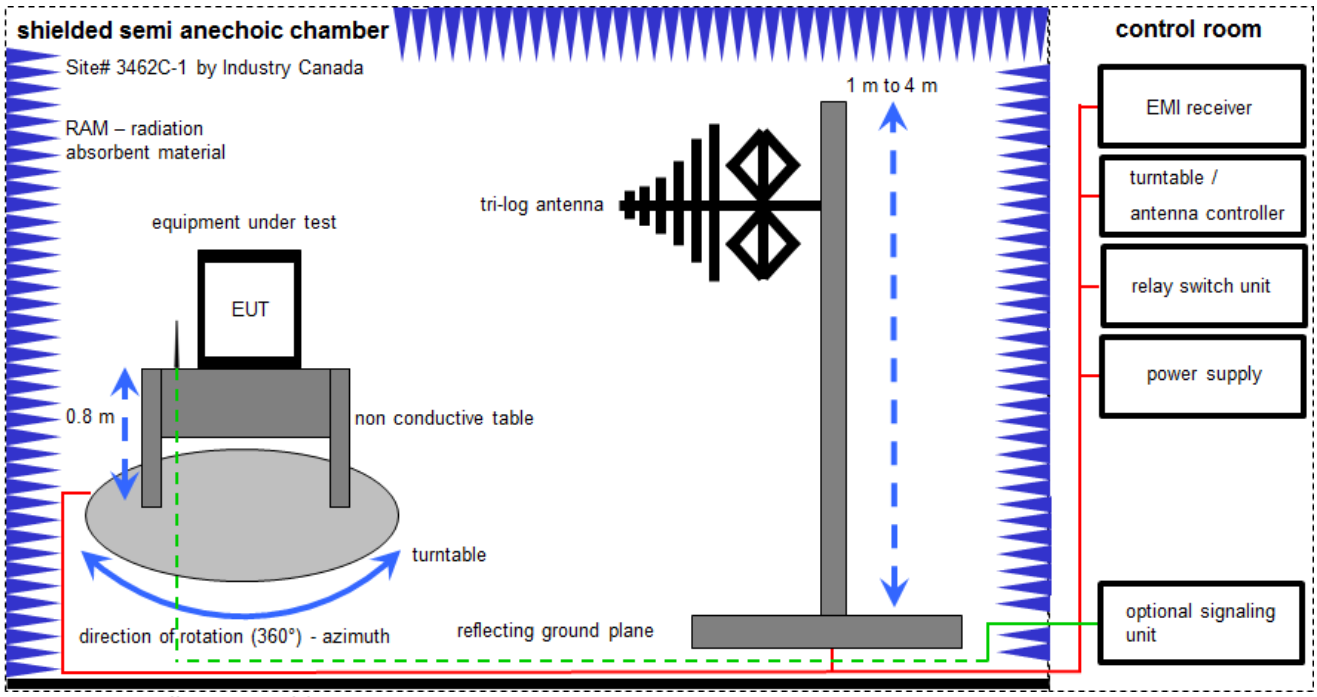
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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



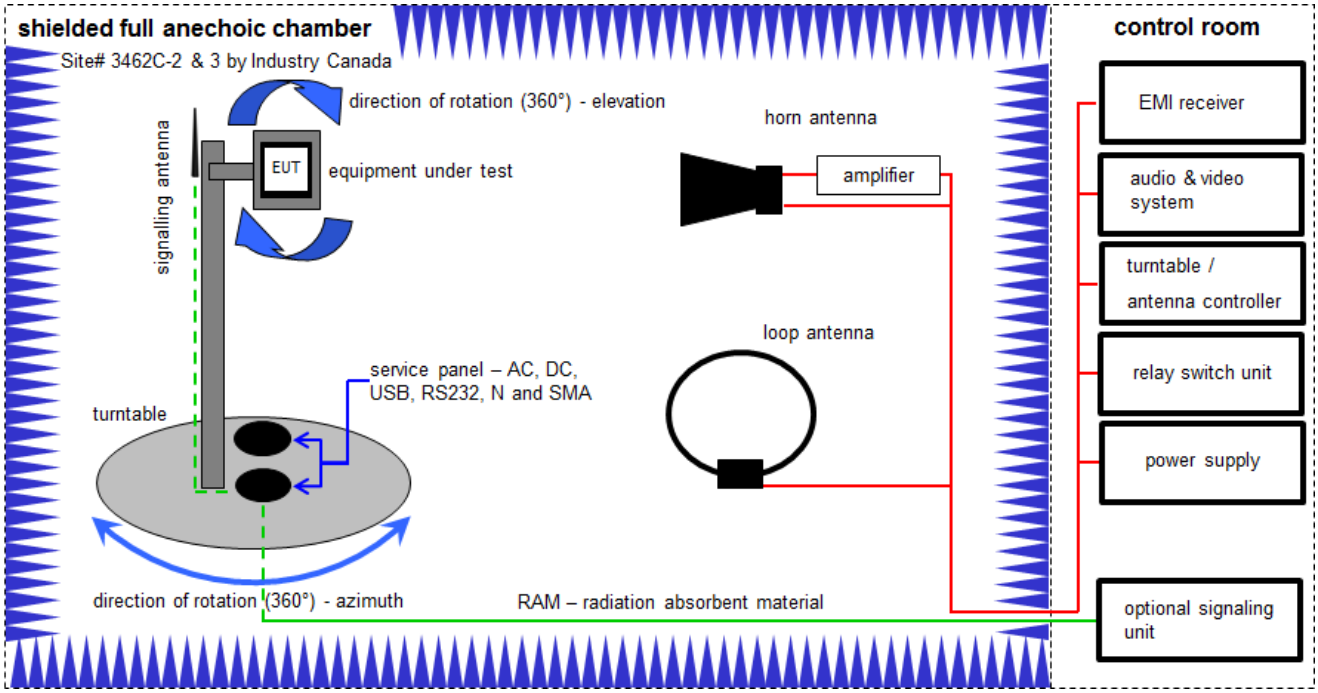
Measurement distance: tri-log antenna 10 meter

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	01.02.2017	31.01.2018
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	02.02.2016	01.02.2018
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	31.01.2017	30.01.2018

7.2 Shielded fully anechoic chamber



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

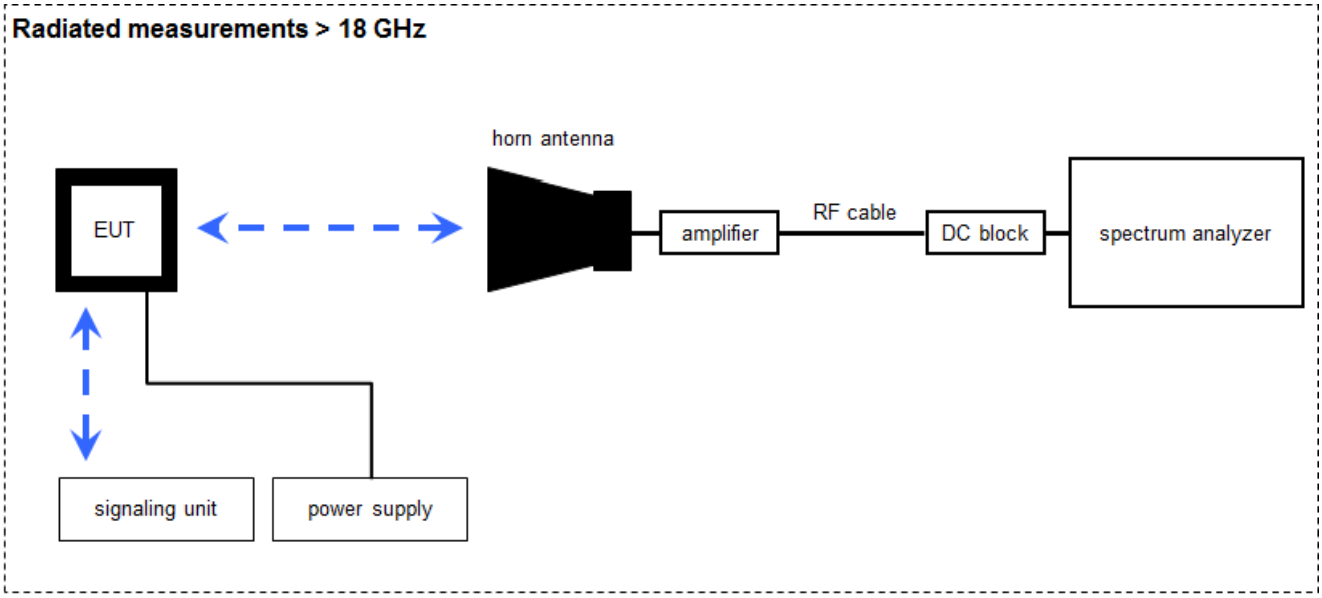
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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	Ve	20.01.2015	20.01.2018
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vlKl!	14.02.2017	13.02.2019
3	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	n. a.	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne	-/-	-/-
6	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	31.01.2017	30.01.2018
7	n. a.	MXG Microwave Analog Signal Generator	N5183A	Agilent Technologies	MY47420220	300003813	k	27.01.2017	26.01.2020
8	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vlKl!	29.10.2014	29.10.2017
9	n. a.	High Pass Filter	VHF-3500+	Mini Circuits	-/-	400000193	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.	Active Loop Antenna 10 kHz to 30 MHz	6502	EMCO/2	8905-2342	300000256	k	24.06.2015	24.06.2018

7.3 Radiated measurements > 18 GHz



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

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

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

Example calculation:
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
2	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	100099	300003949	k	30.06.2017	29.06.2018
3	n. a.	Harmonic Mixer 3-Port, 110-170 GHz	SAM-170	Radiometer Physics GmbH	100014	300004156	k	05.07.2017	04.07.2018
4	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	30.06.2017	29.06.2018
5	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	03.07.2017	02.07.2018
		Harmonic Mixer 3-Port, 110-170 GHz	SAM-170	Radiometer Physics GmbH	100014	300004156	k	05.07.2017	04.07.2018
		Harmonic Mixer 3-Port, 170-220 GHz	SAM-220	Radiometer Physics GmbH	200001	300004157	k	05.07.2017	04.07.2018
		Harmonic Mixer 3-Port, 220-325 GHz	SAM-325	Radiometer Physics GmbH	100002	300004158	k	30.06.2017	29.06.2018
6	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	Ve	28.10.2016	27.10.2018
7	n. a.	Std. Gain Horn Antenna 110-170 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
8	n. a.	Std. Gain Horn Antenna 12.4-18.0 GHz	639	Narda	8402	300000787	ne	-/-	-/-
9	n. a.	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	ne	-/-	-/-
10	n. a.	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	ne	-/-	-/-
11	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
12	n. a.	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne	-/-	-/-
13	n. a.	Std. Gain Horn Antenna 60-90 GHz	COR 60_90	Thomson CSF		300000814	ne	-/-	-/-
14	n. a.	Std. Gain Horn Antenna 75-110 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-
		Std. Gain Horn Antenna 114-173 GHz	2924-20	Flann	*	300001999	ne	-/-	-/-
		Std. Gain Horn Antenna 145-220 GHz	3024-20	Flann	*	300002000	ne	-/-	-/-

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, 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 height is 1.5 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 premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- 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.

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 results

9.1 Power density

Description:

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

Limits: **FCC §95.3367 (a) (b)**

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

Limits: **RSS-251 (5.2.2)**

Frequency	Measurement distance	Power Density ➔ EIRP
76.0 - 77.0 GHz	3.0 m	88 µW/cm² → 50 dBm (Average) 279 µW/cm² → 55 dBm (PEAK)

9.2 Occupied bandwidth

Description:

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

Limits: **FCC §95.3379 (b)**

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

Limits: **RSS-251 (5.2.2) / (5.4)**

Frequency range	f(lowest) > 76.0 GHz	f(highest) < 77.0 GHz

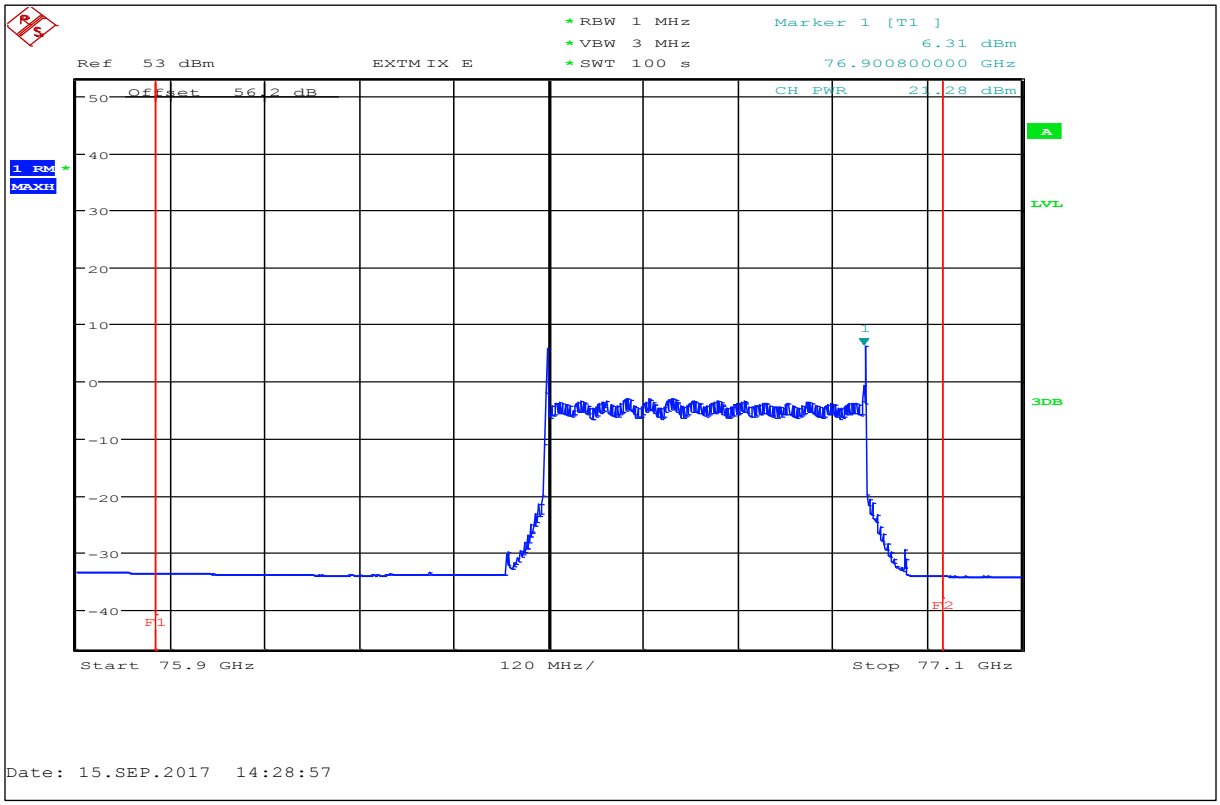
Test results:

Operating condition	Test conditions	Occupied Bandwidth	Peak EIRP	RMS EIRP
Normal mode	T_{nom} / V_{nom}	**406.8 MHz**	24.72	6.31
	T_{min} / V_{min} - V_{max}	405.6 MHz	**25.37**	**7.38**
	T_{max} / V_{min} - V_{max}	**406.8 MHz**	22.85	6.47

Operating condition	Test conditions	Occupied Bandwidth	Peak EIRP	RMS EIRP
Low Channel	T_{nom} / V_{nom}	-/-	22.34	20.00
	T_{min} / V_{min} - V_{max}	-/-	22.40	19.98
	T_{max} / V_{min} - V_{max}	-/-	22.10	20.07
Middle Channel	T_{nom} / V_{nom}	-/-	21.65	19.28
	T_{min} / V_{min} - V_{max}	-/-	21.58	19.07
	T_{max} / V_{min} - V_{max}	-/-	21.52	19.24
High Channel	T_{nom} / V_{nom}	-/-	21.48	18.30
	T_{min} / V_{min} - V_{max}	-/-	21.64	18.28
	T_{max} / V_{min} - V_{max}	-/-	21.28	18.12

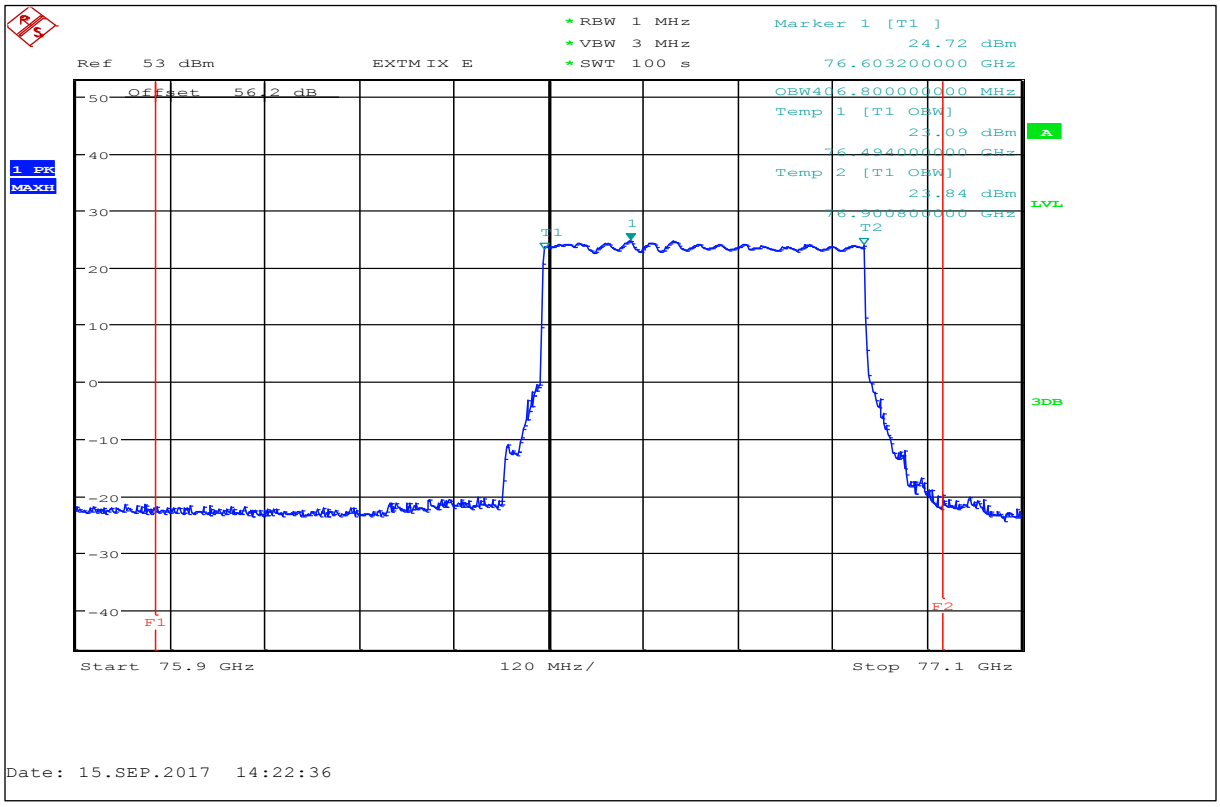
Verdict: **Complies**

Plot 1: RMS detector, T_{nom} / V_{nom}



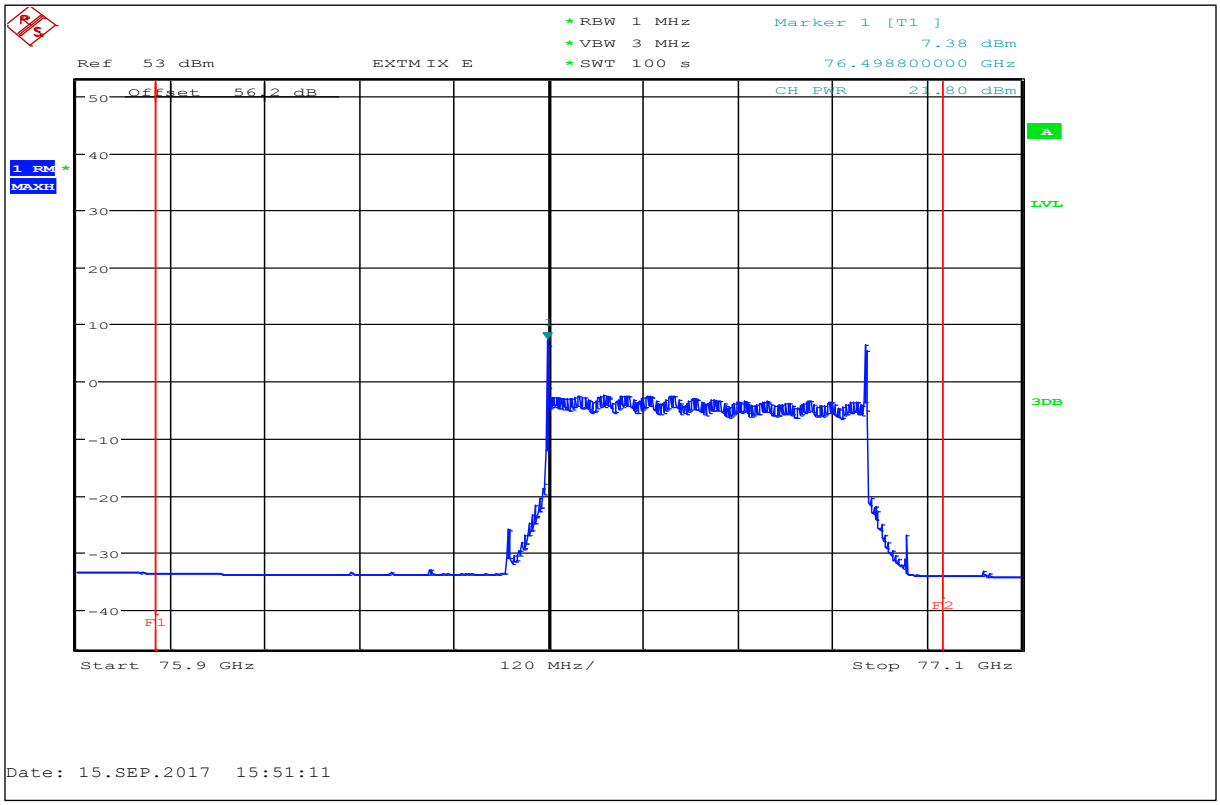
F1=76 GHz / F2=77 GHz

Plot 2: Peak detector, T_{nom} / V_{nom}



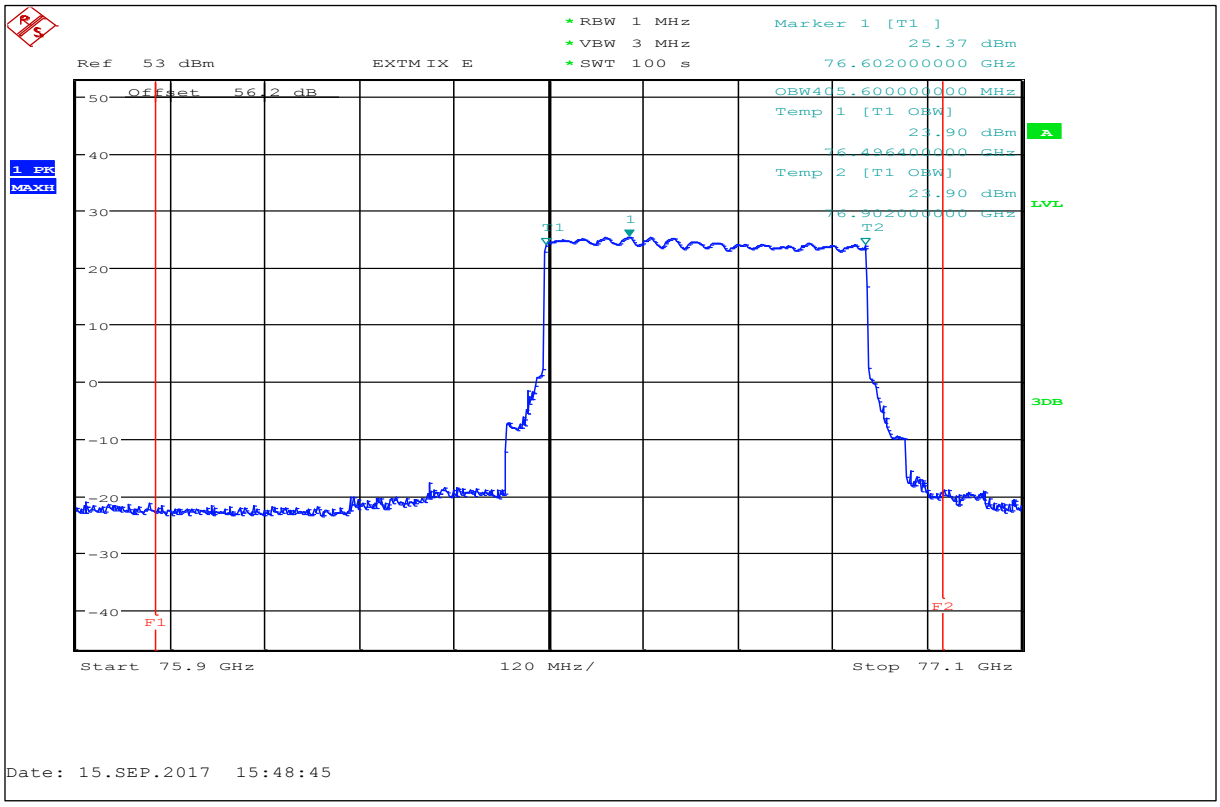
F1=76 GHz / F2=77 GHz

Plot 3: RMS detector, T_{min} / V_{min} - V_{max}



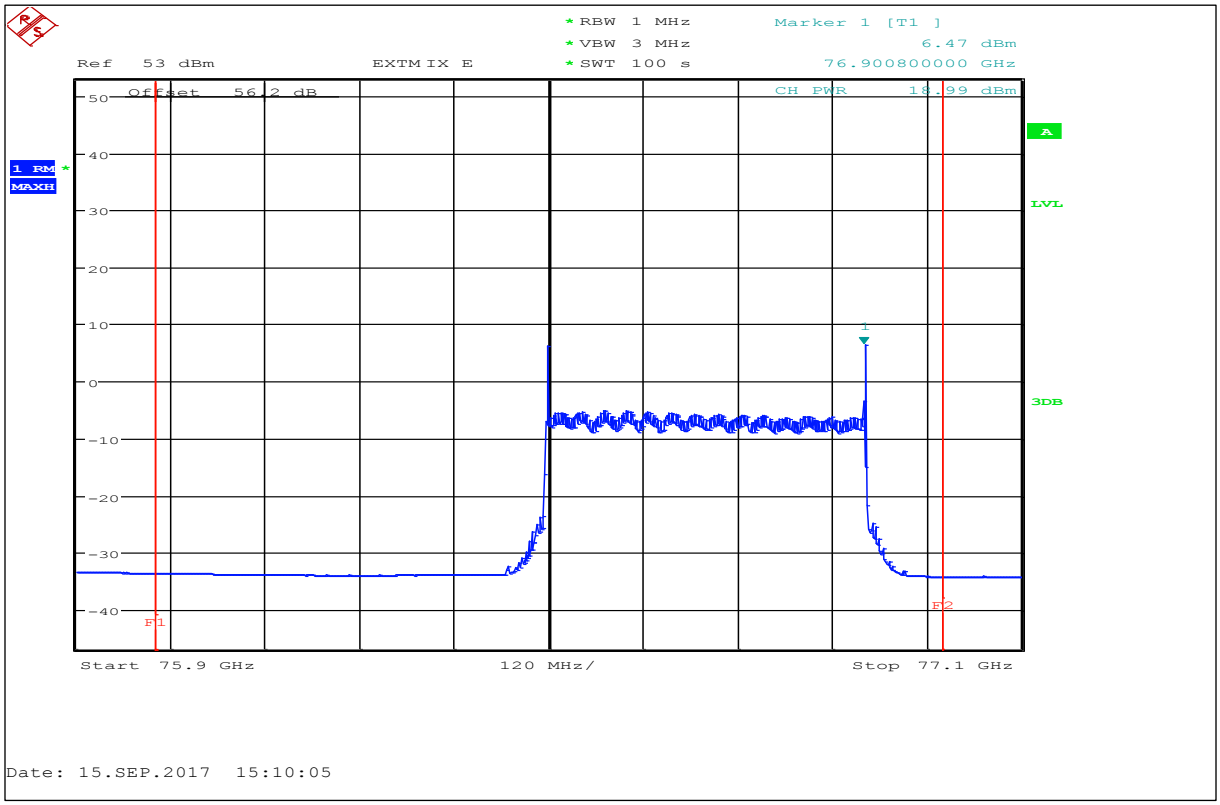
F1=76 GHz / F2=77 GHz

Plot 4: Peak detector, T_{min} / V_{min} - V_{max}



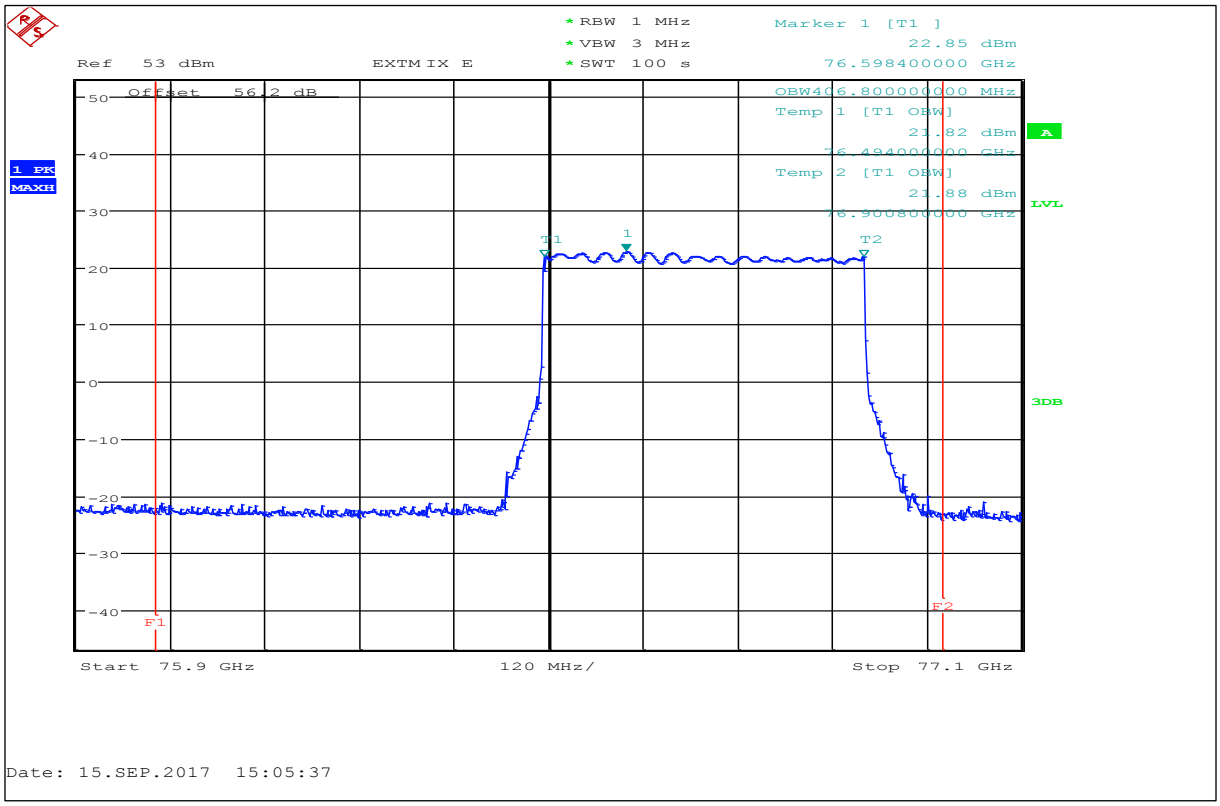
F1=76 GHz / F2=77 GHz

Plot 5: RMS detector, T_{max} / V_{min} - V_{max}



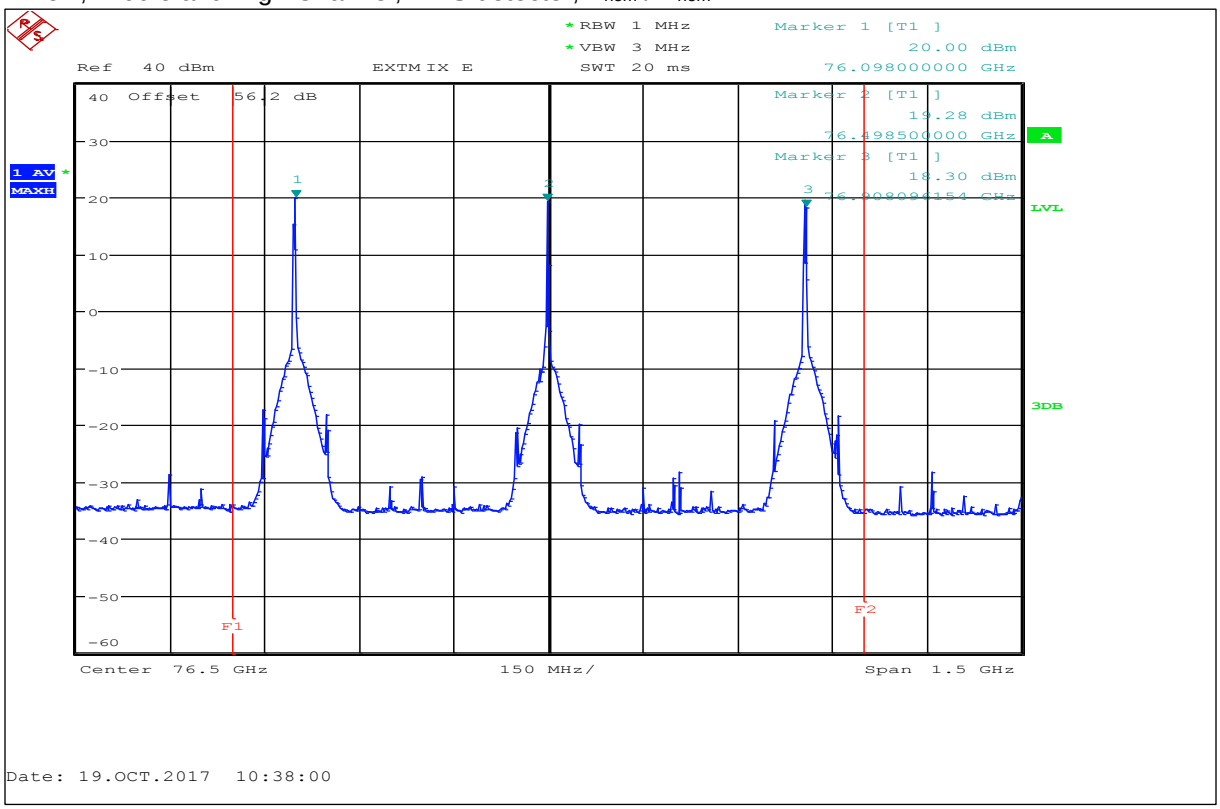
F1=76 GHz / F2=77 GHz

Plot 6: Peak detector, T_{max} / V_{min} - V_{max}



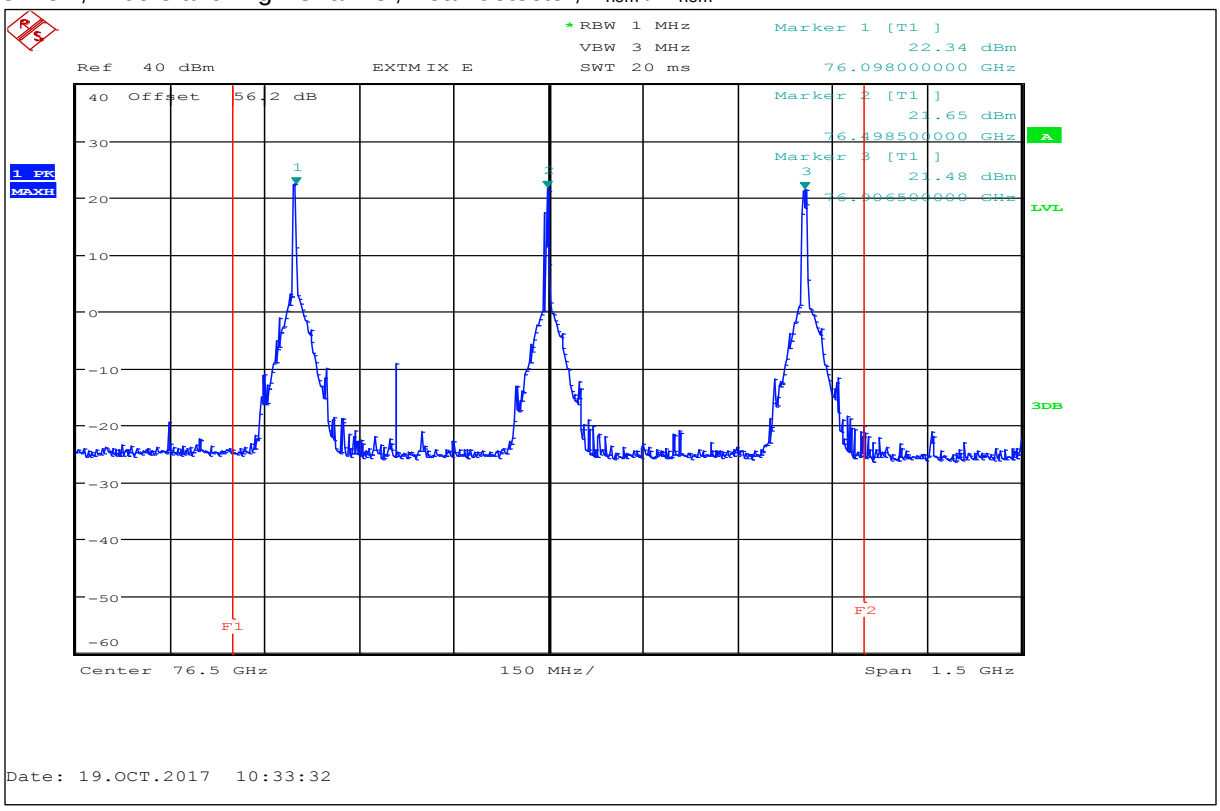
F1=76 GHz / F2=77 GHz

Plot 7: Low, Middle and High Channel, RMS detector, T_{nom} / V_{nom}



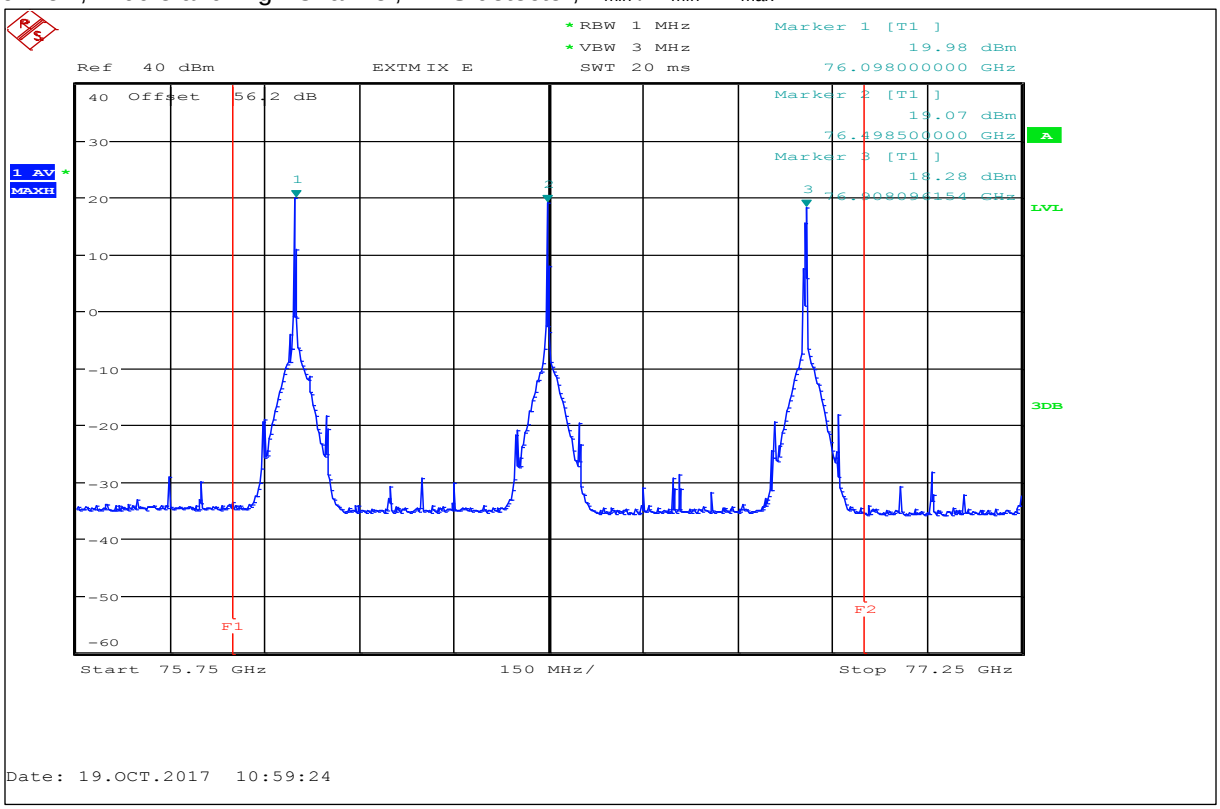
F1=76 GHz / F2=77 GHz

Plot 8: Low, Middle and High Channel, Peak detector, T_{nom} / V_{nom}



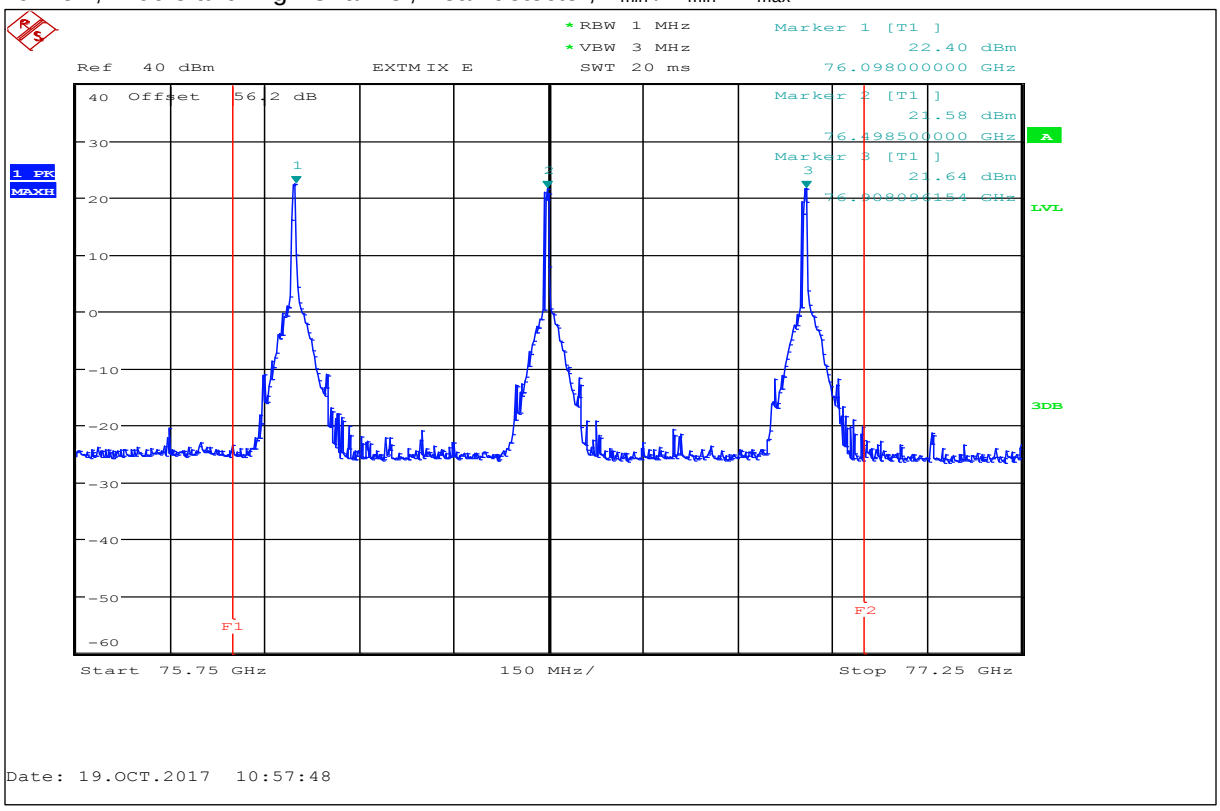
F1=76 GHz / F2=77 GHz

Plot 9: Low, Middle and High Channel, RMS detector, T_{min} / V_{min} - V_{max}



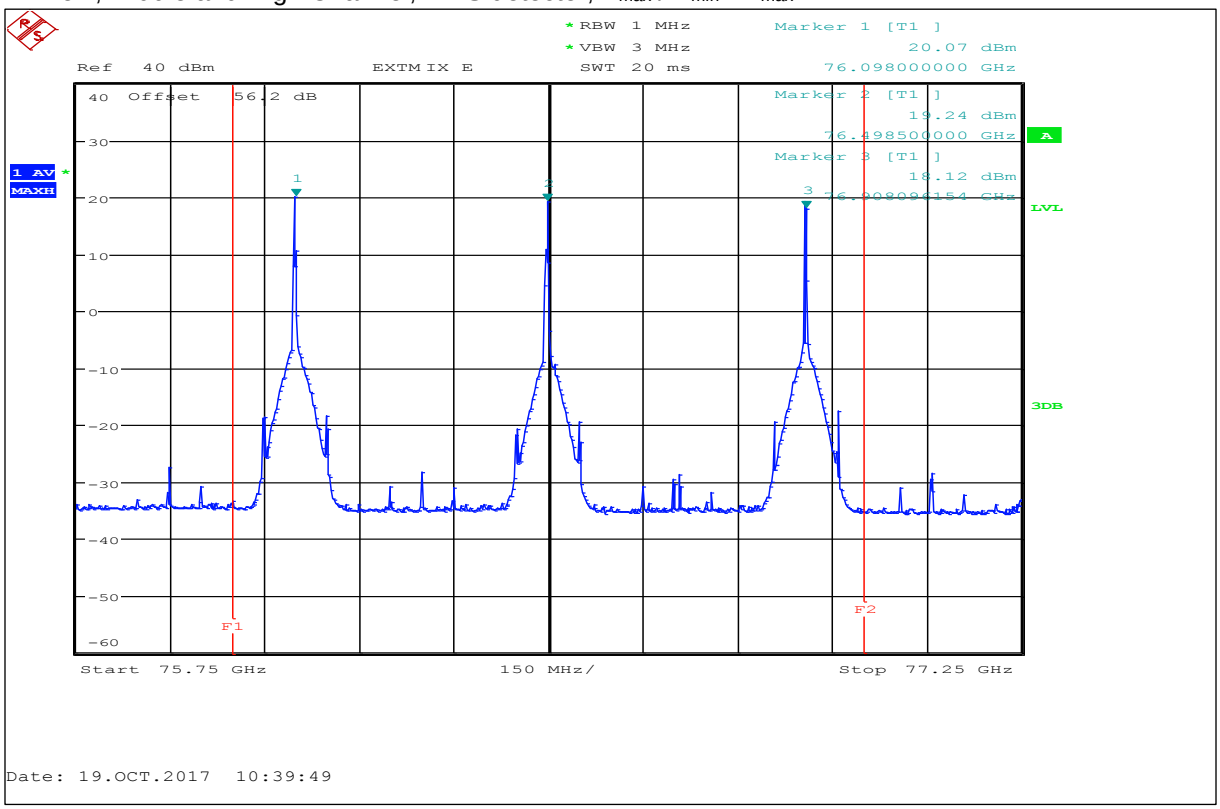
F1=76 GHz / F2=77 GHz

Plot 10: Low, Middle and High Channel, Peak detector, T_{min} / V_{min} - V_{max}



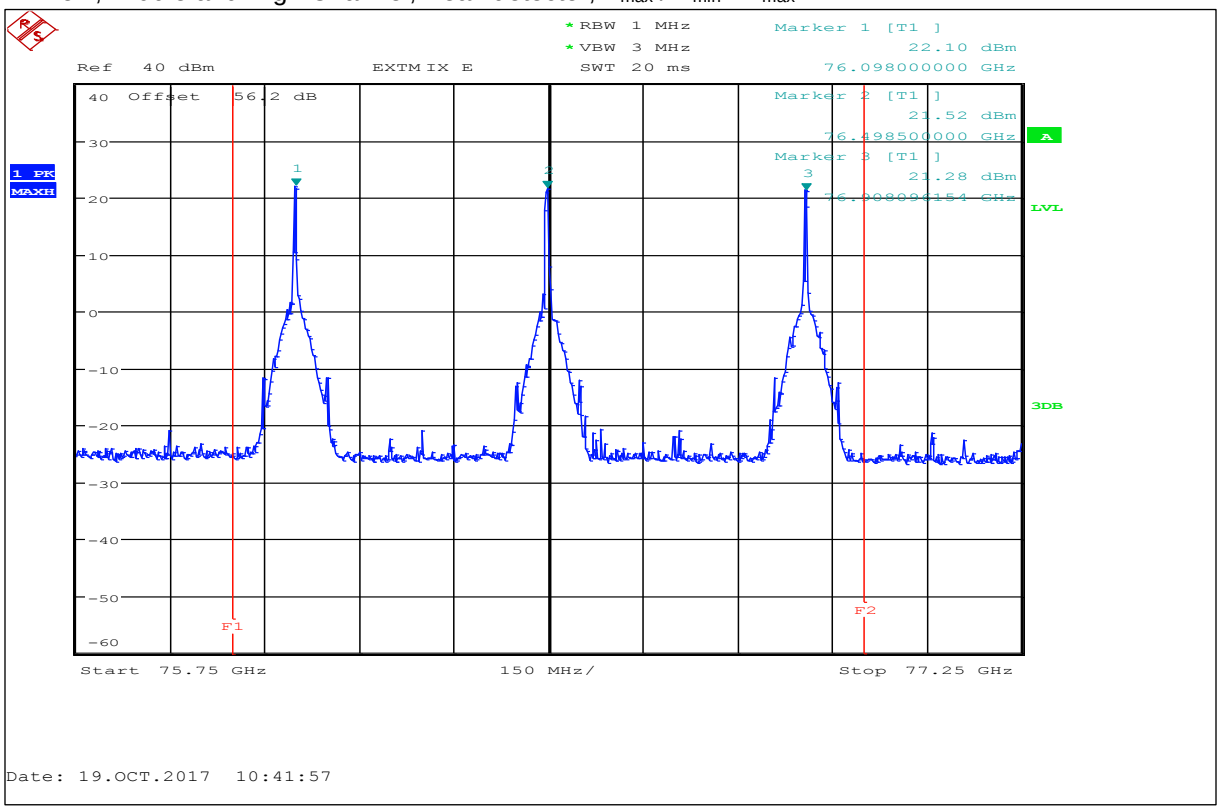
F1=76 GHz / F2=77 GHz

Plot 11: Low, Middle and High Channel, RMS detector, T_{max} / V_{min} - V_{max}



F1=76 GHz / F2=77 GHz

Plot 12: Low, Middle and High Channel, Peak detector, T_{max} / V_{min} - V_{max}



F1=76 GHz / F2=77 GHz

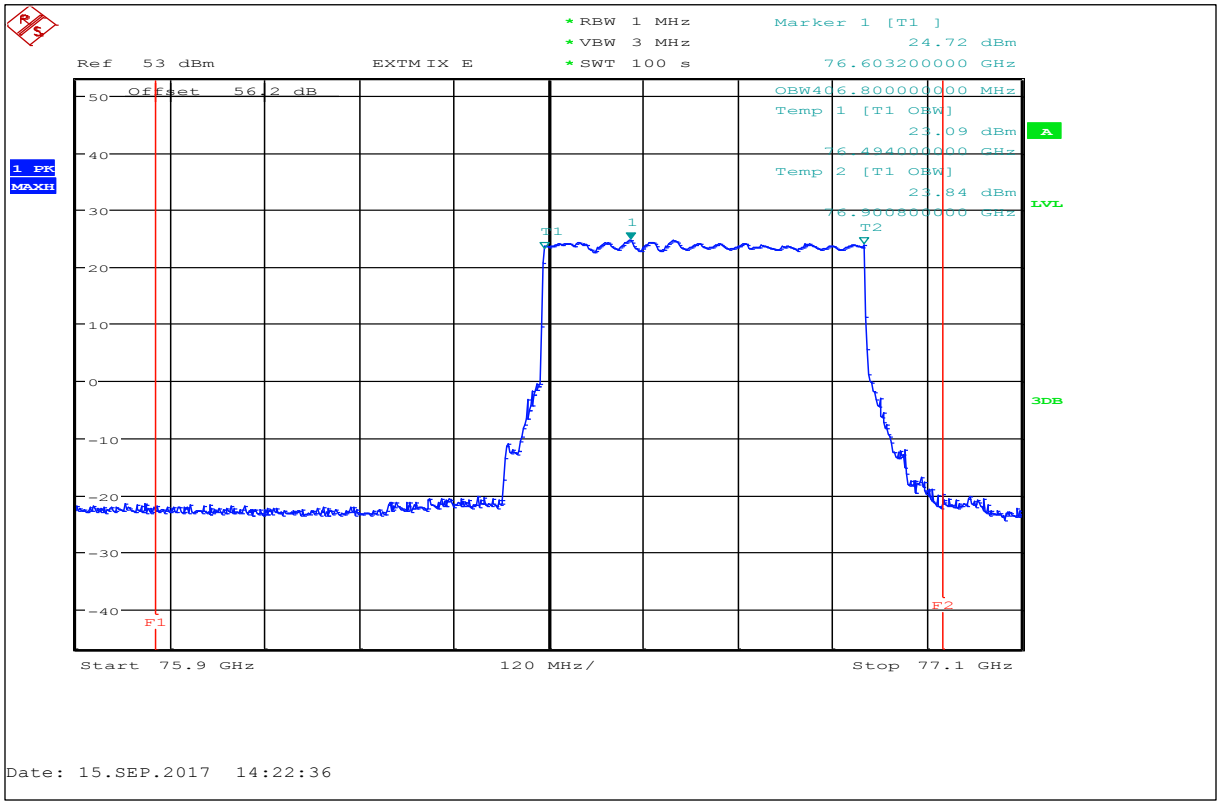
9.3 Modulation characteristics

Description:

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

Measurement results:

FMCW is mainly characterized by start and stop frequency resp. the occupied bandwidth.



9.4 Field strength of emissions (Band Edge)

Limits: **FCC §95.3379 (a) (2) (i) + (ii) / ANSI C63.10-2013 / 6.10**

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

Limits: **FCC §95.3379 (b)**

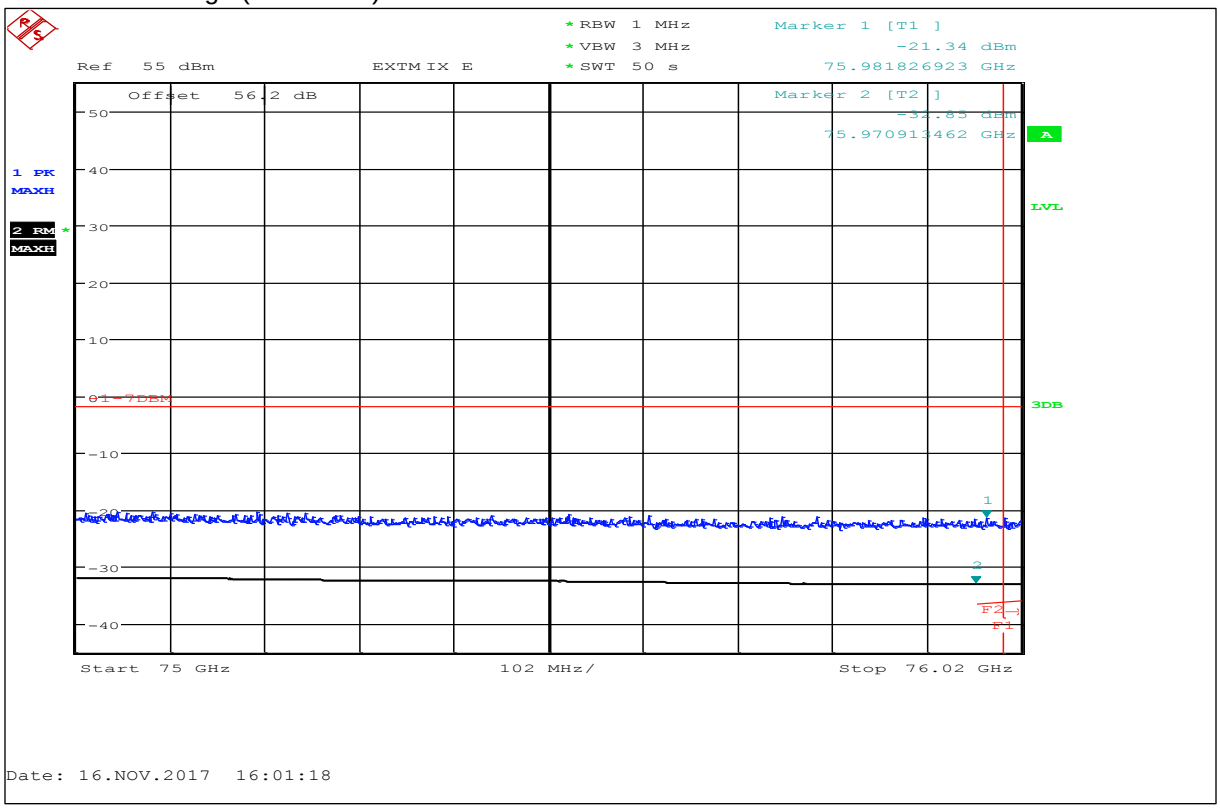
Frequency range	f(lowest) > 76.0 GHz	f(highest) < 81.0 GHz

Limits: **RSS-251 (5.2.2)**

Frequency range	f(lowest) > 76.0 GHz	f(highest) < 77.0 GHz

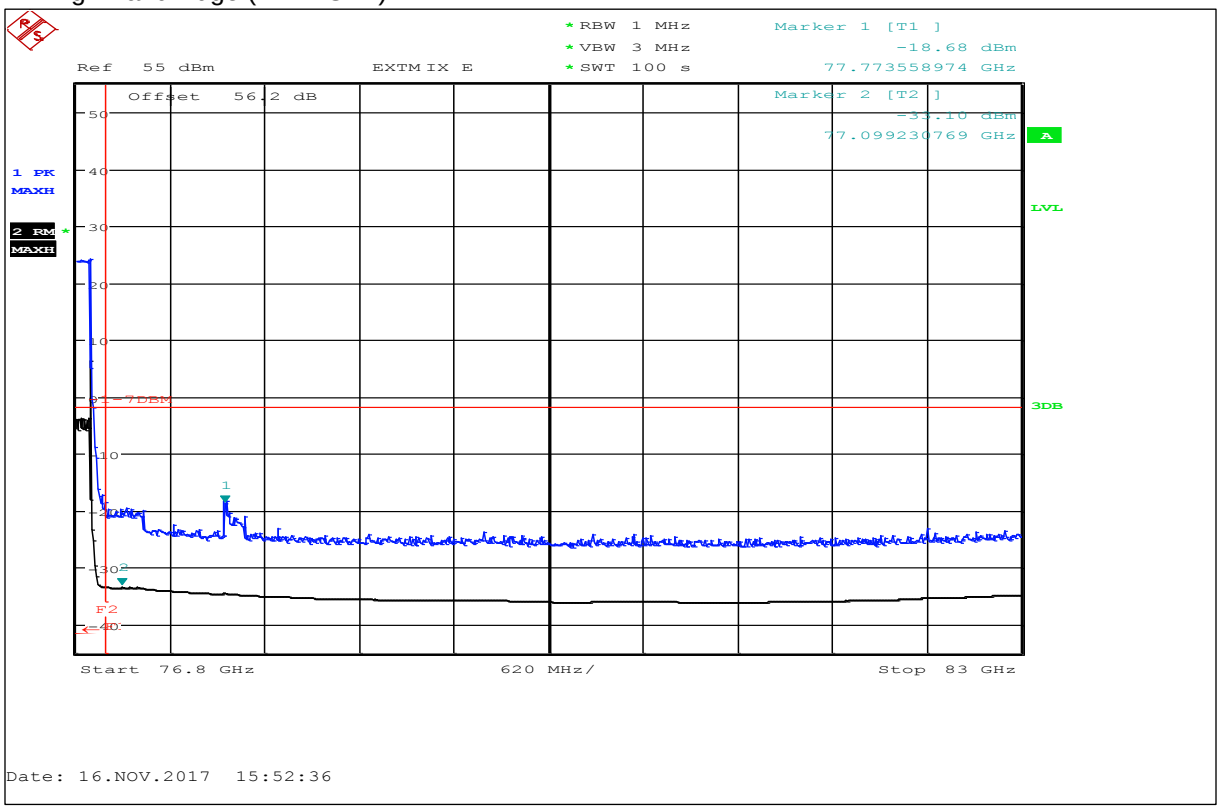
Verdict: **Complies**

Plot 13: Low Band Edge (F<76 GHz)



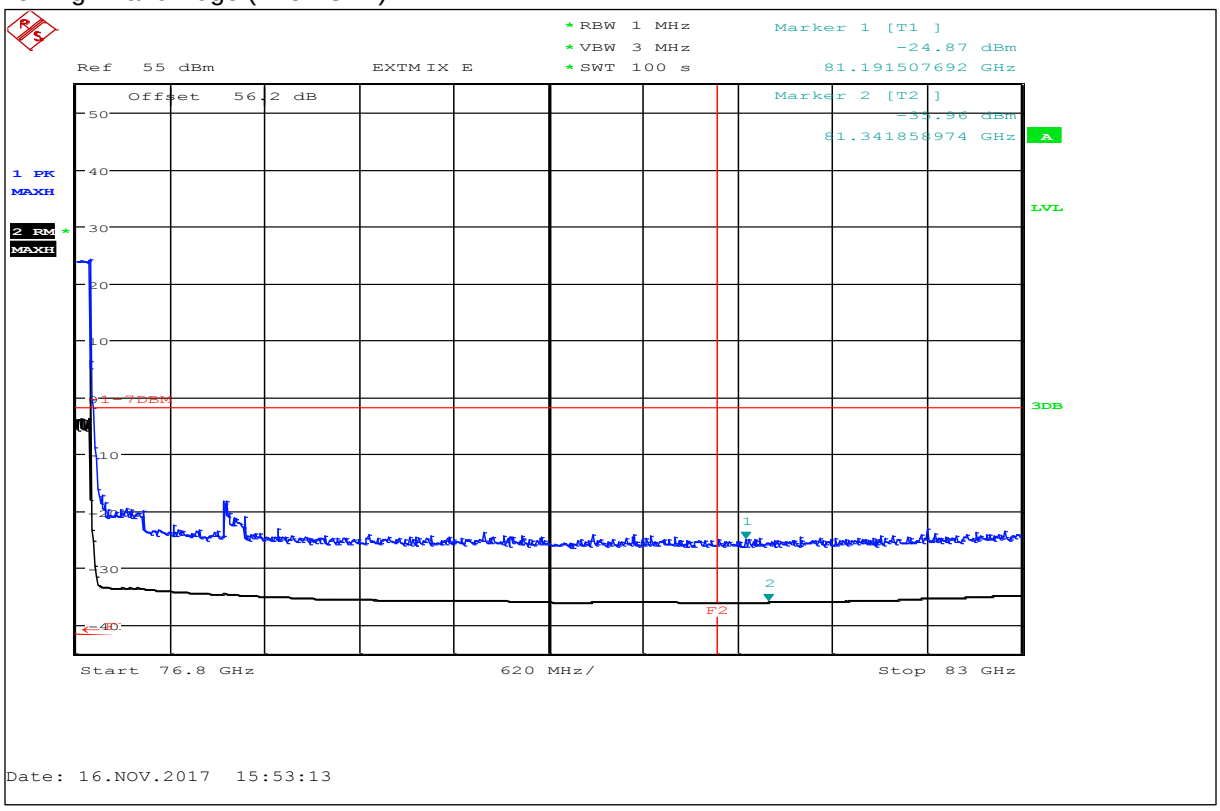
F1=76 GHz

Plot 14: High Band Edge (F>77 GHz)



F2=77 GHz

Plot 15: High Band Edge (F>81 GHz)



F2=81 GHz

9.5 Field strength of emissions (Radiated Spurious)

Description:

Measurement of the radiated spurious emissions in transmit mode.

Limits: **FCC §95.3379**

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

Limits: **FCC §95.3379 (a) (2) (i) + (ii) / RSS-251 (5.3)**

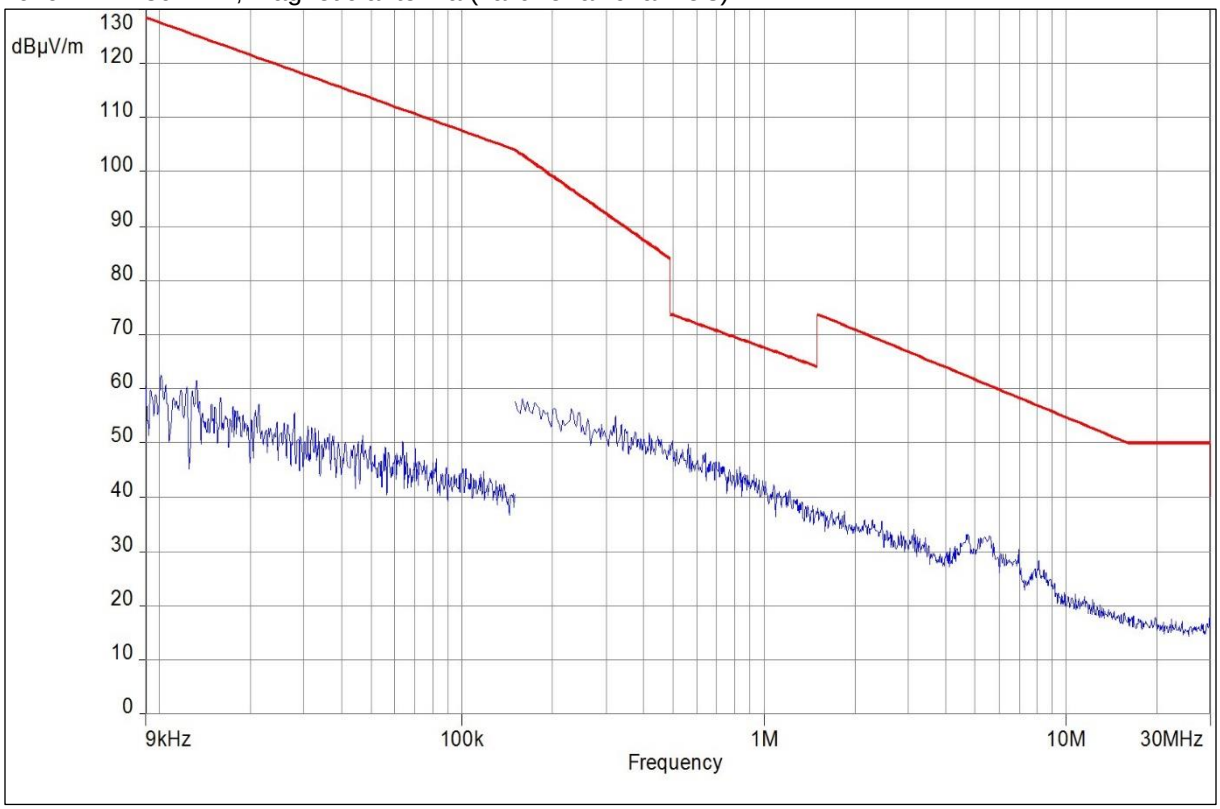
Frequency Range [GHz]	Measurement distance	Power Density
40 – 200	3.0 m	600 pW/cm² → -1.7 dBm
200 – 231	3.0 m	1000 pW/cm² → +0.5 dBm

Results:

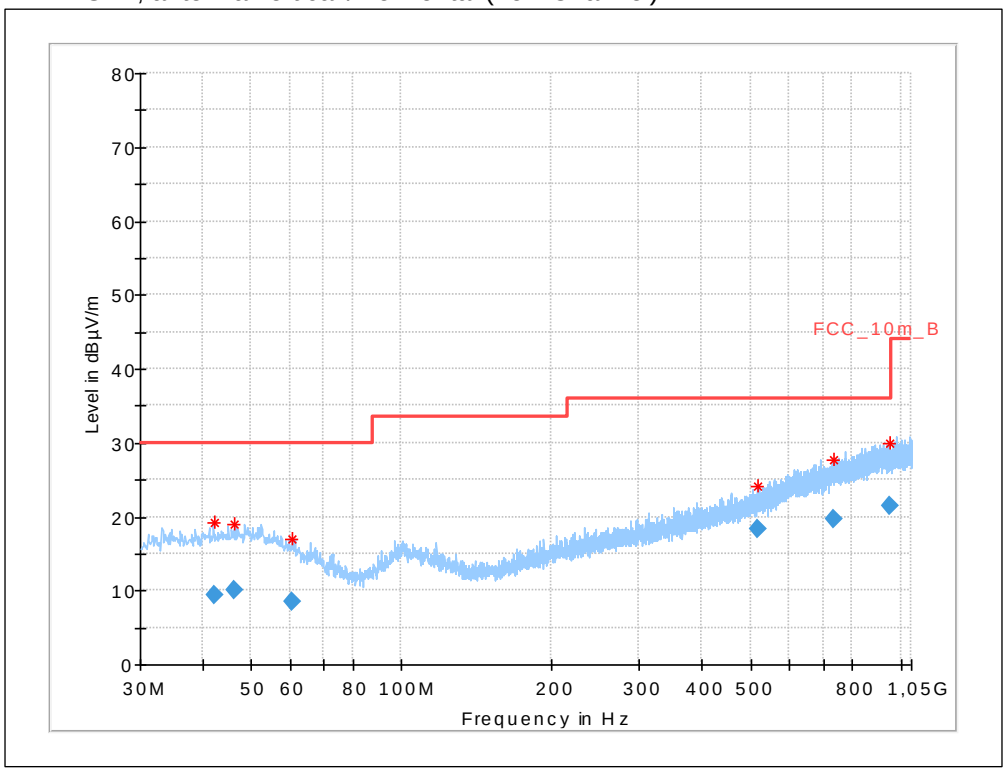
TX Spurious Emissions Radiated [dBµV/m]								
Low Channel			Middle Channel			High Channel		
F [GHz]	Detector	Level [dBµV/m]	F [GHz]	Detector	Level [dBµV/m]	F [GHz]	Detector	Level [dBµV/m]
See plots			See plots			See plots		
Measurement uncertainty			± 3 dB					

Verdict: **Complies**

Plot 16: 9 kHz – 30 MHz, Magnetic antenna (valid for all channels)

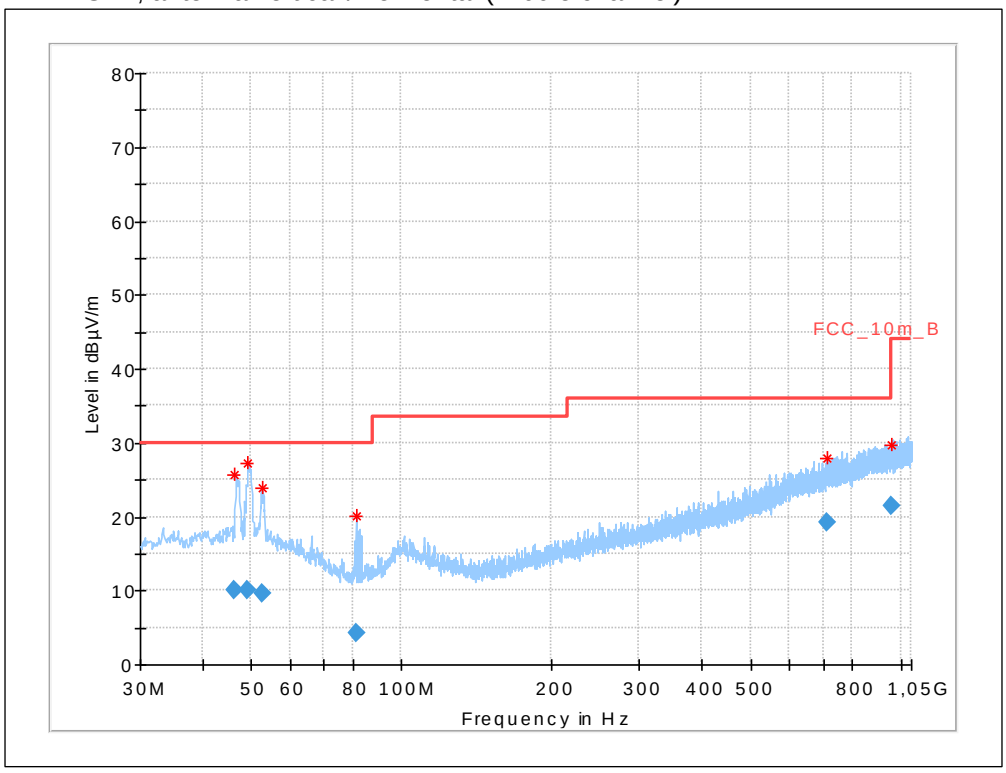


Plot 17: 30 MHz – 1 GHz, antenna vertical / horizontal (Low Channel)



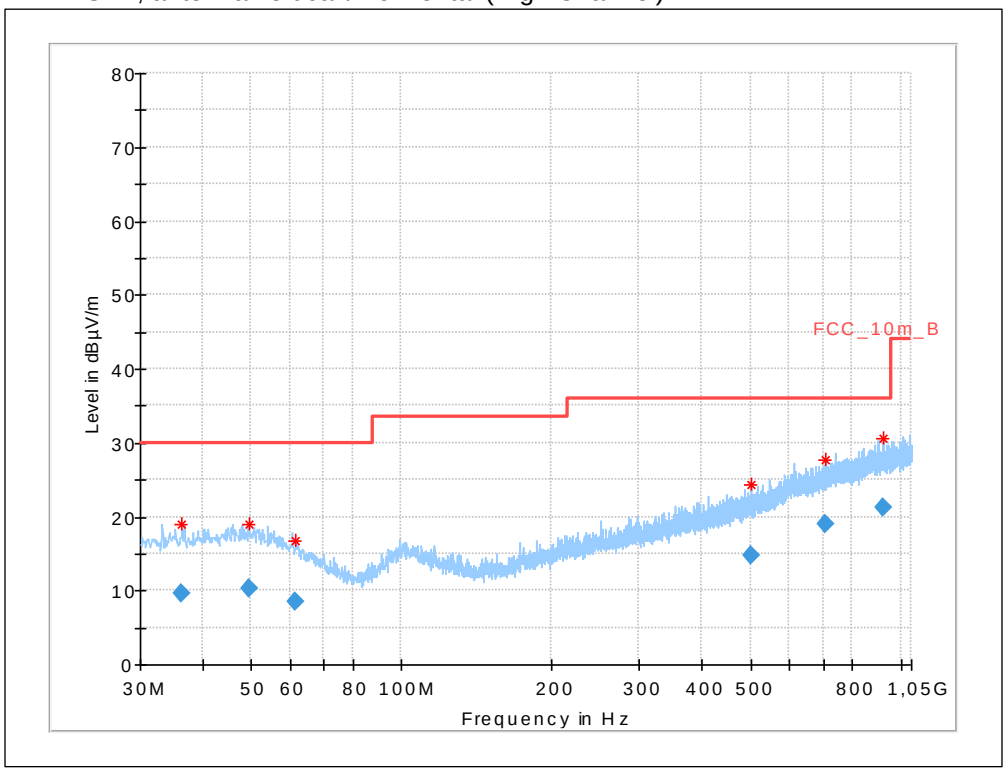
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
42.273	9.29	30.0	20.71	1000	120	101.0	H	123.0	13.4
46.301	10.09	30.0	19.91	1000	120	101.0	V	10.0	13.7
60.599	8.45	30.0	21.55	1000	120	101.0	H	56.0	11.7
515.433	18.41	36.0	17.59	1000	120	98.0	H	10.0	18.9
734.937	19.64	36.0	16.36	1000	120	101.0	H	127.0	22.4
948.713	21.51	36.0	14.49	1000	120	170.0	V	10.0	24.3

Plot 18: 30 MHz – 1 GHz, antenna vertical / horizontal (Middle channel)



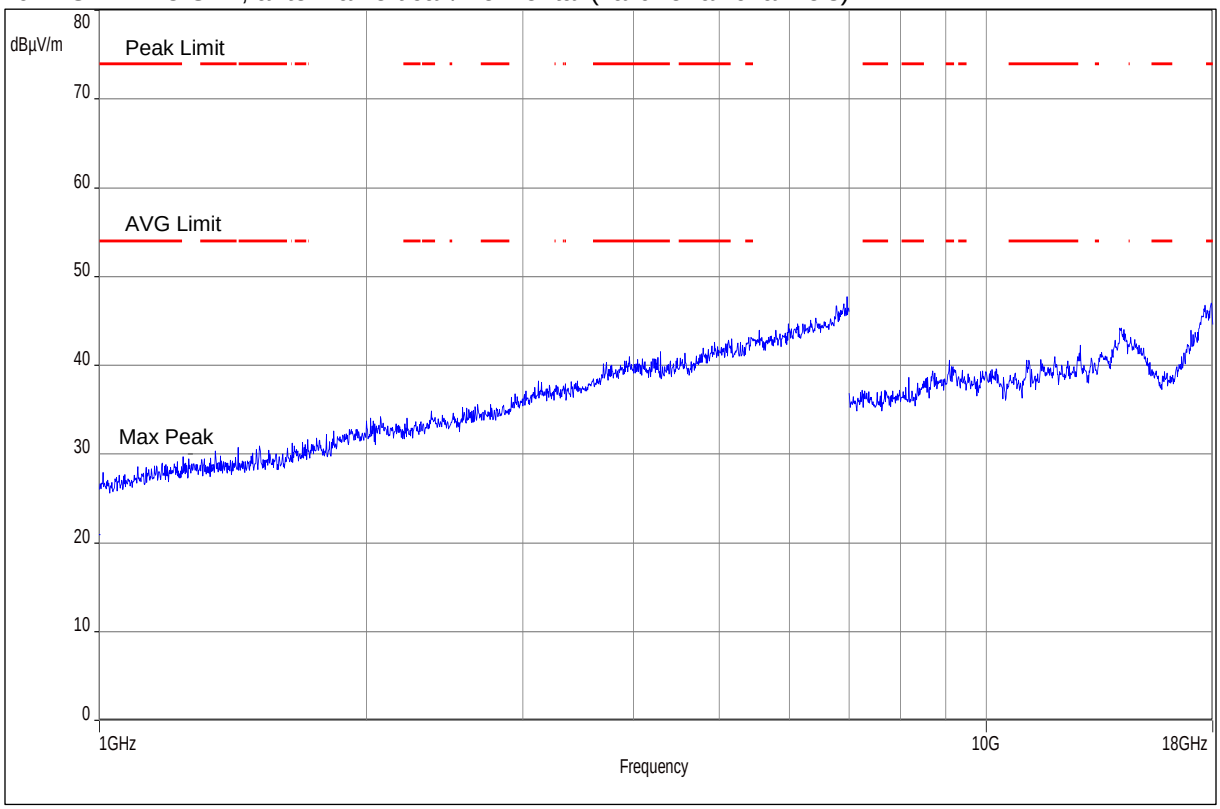
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
46.457	10.11	30.0	19.89	1000	120	101.0	V	228.0	13.7
49.091	10.10	30.0	19.90	1000	120	170.0	V	81.0	13.7
52.624	9.72	30.0	20.28	1000	120	101.0	V	320.0	13.4
81.230	4.30	30.0	25.70	1000	120	101.0	V	180.0	8.2
710.954	19.13	36.0	16.87	1000	120	101.0	H	194.0	21.8
956.421	21.44	36.0	14.56	1000	120	170.0	H	255.0	24.4

Plot 19: 30 MHz – 1 GHz, antenna vertical / horizontal (High Channel)

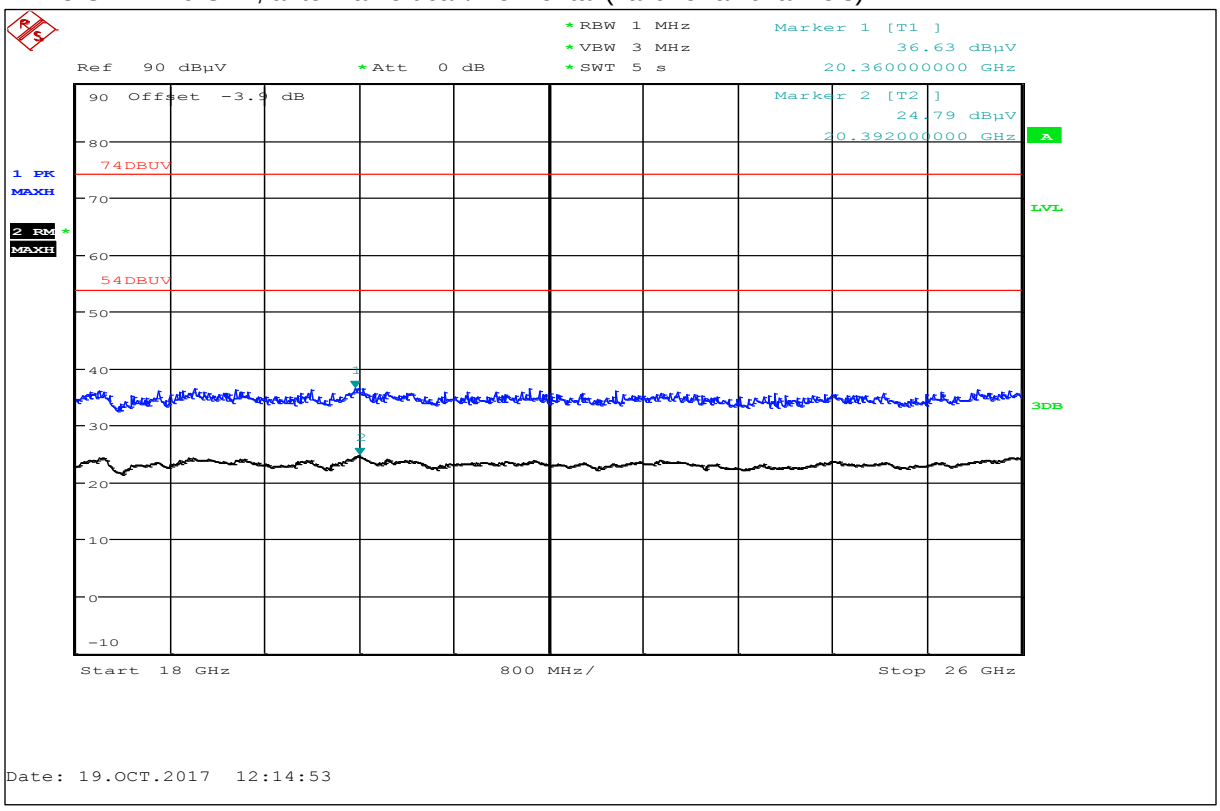


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.221	9.53	30.0	20.47	1000	120	170.0	V	283.0	12.8
49.638	10.17	30.0	19.83	1000	120	100.0	H	-10.0	13.7
61.175	8.57	30.0	21.43	1000	120	170.0	H	244.0	11.6
502.827	14.76	36.0	21.24	1000	120	170.0	H	141.0	18.7
704.265	18.92	36.0	17.08	1000	120	170.0	V	339.0	21.7
925.147	21.31	36.0	14.69	1000	120	170.0	V	341.0	24.3

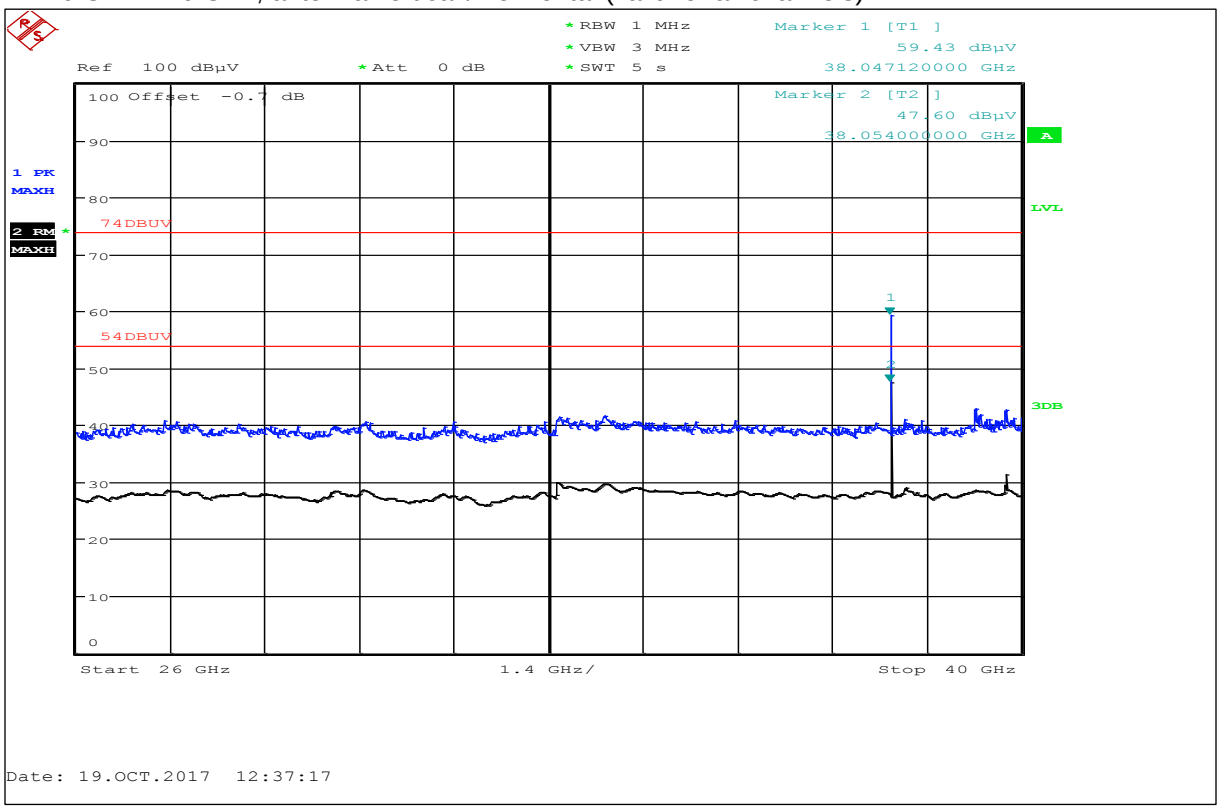
Plot 20: 1 GHz – 18 GHz, antenna vertical / horizontal (valid for all channels)



Plot 21: 18 GHz – 26 GHz, antenna vertical / horizontal (valid for all channels)

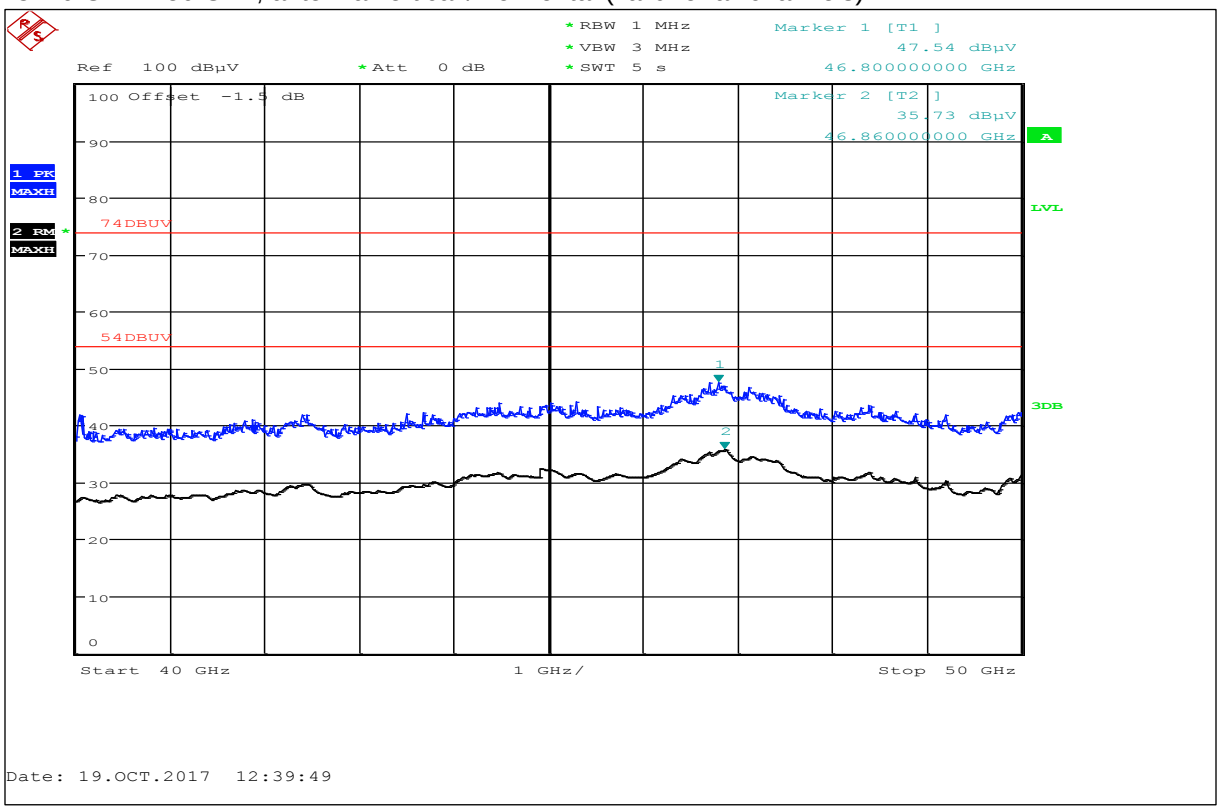


Plot 22: 26 GHz – 40 GHz, antenna vertical / horizontal (valid for all channels)

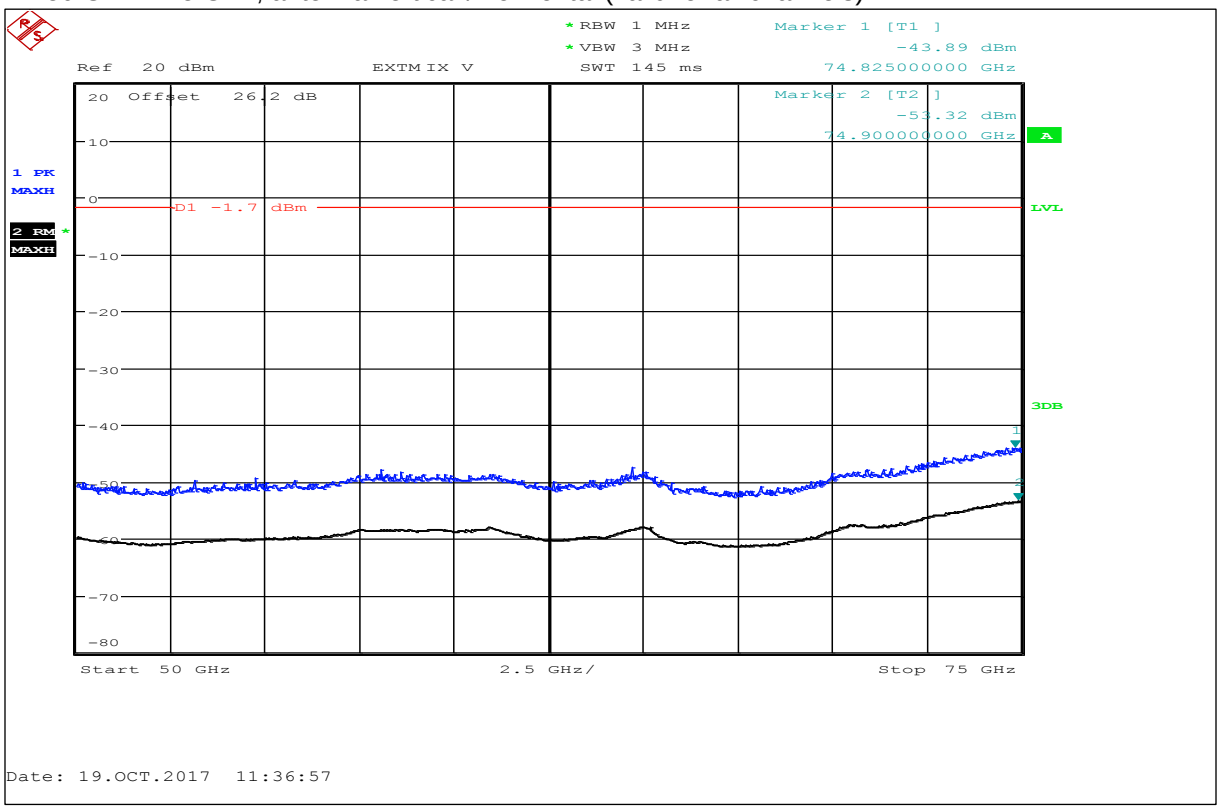


Marker 1 shows the peak value (Limit @ 74 dBuV) and Marker 2 the RMS value (Limit @ 54 dBuV)

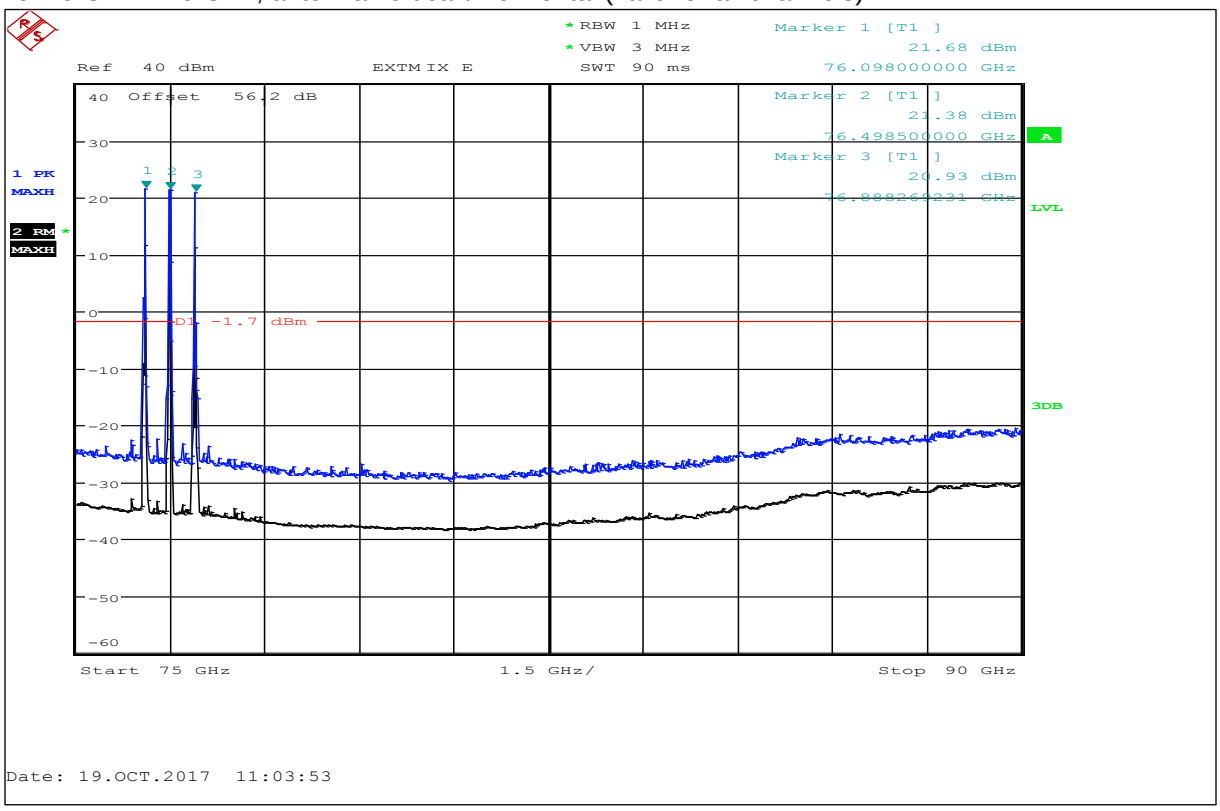
Plot 23: 40 GHz – 50 GHz, antenna vertical / horizontal (valid for all channels)



Plot 24: 50 GHz – 75 GHz, antenna vertical / horizontal (valid for all channels)

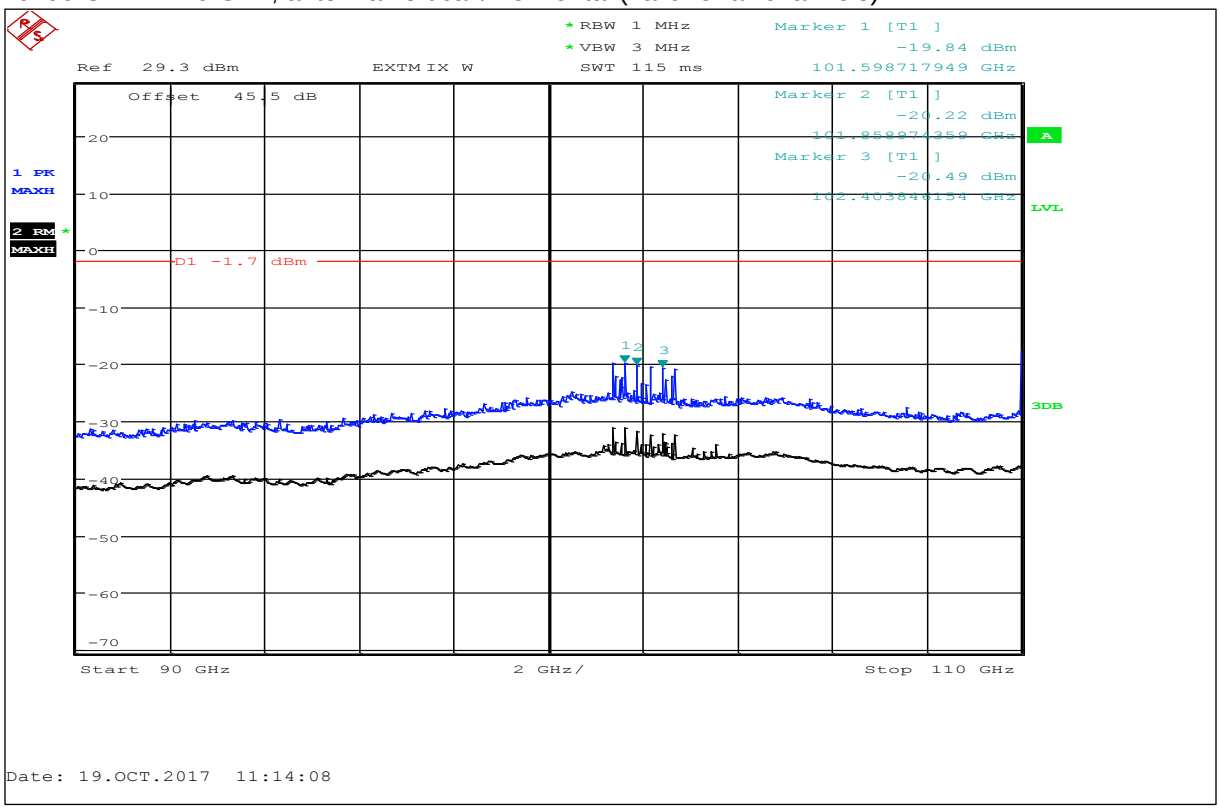


Plot 25: 75 GHz – 79 GHz, antenna vertical / horizontal (valid for all channels)



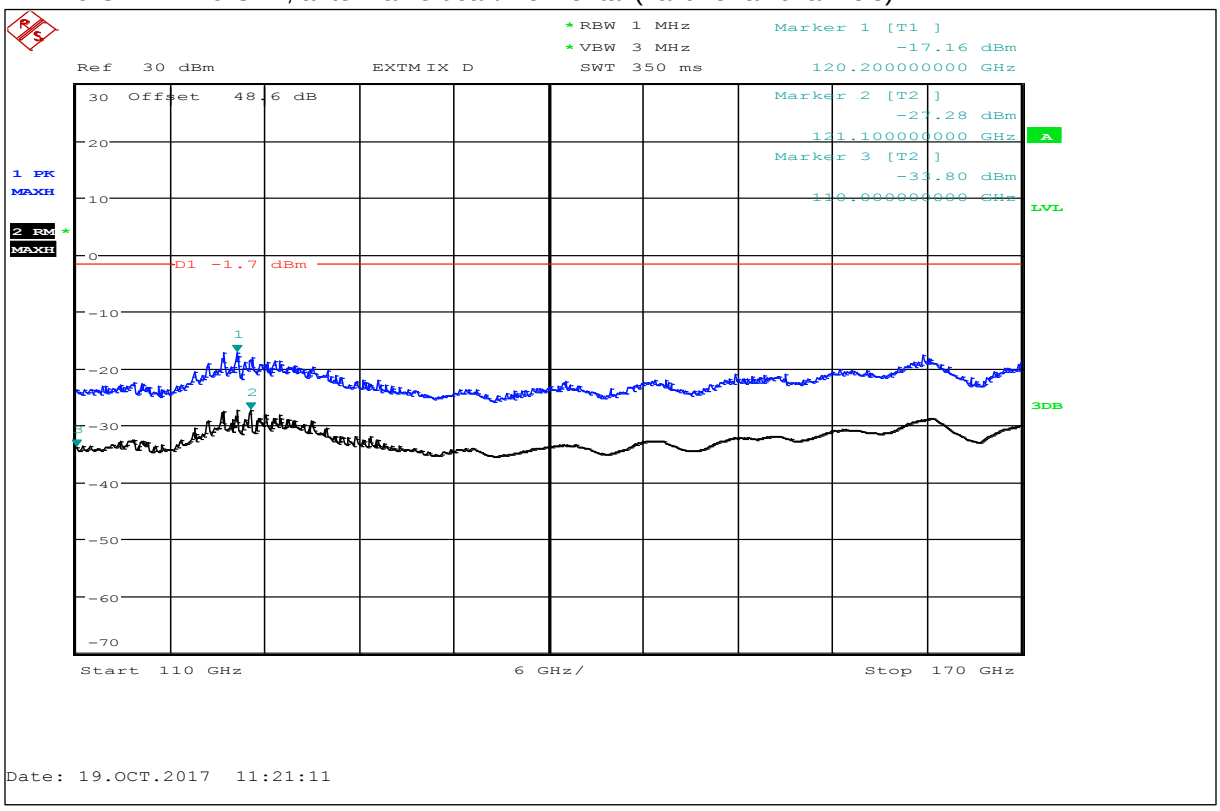
Note: Plot shows wanted signal at low, middle and high channel.

Plot 26: 90 GHz – 110 GHz, antenna vertical / horizontal (valid for all channels)

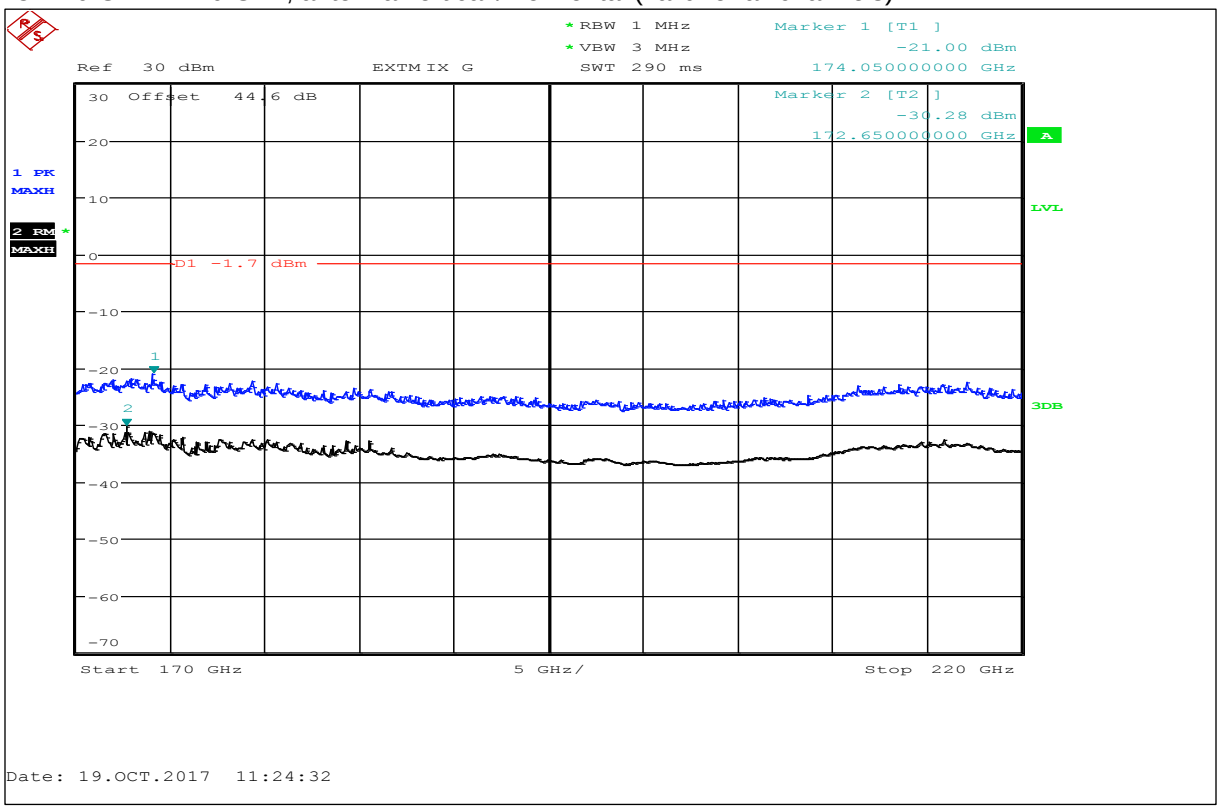


Note: Plot shows mixing products of external harmonic mixer.

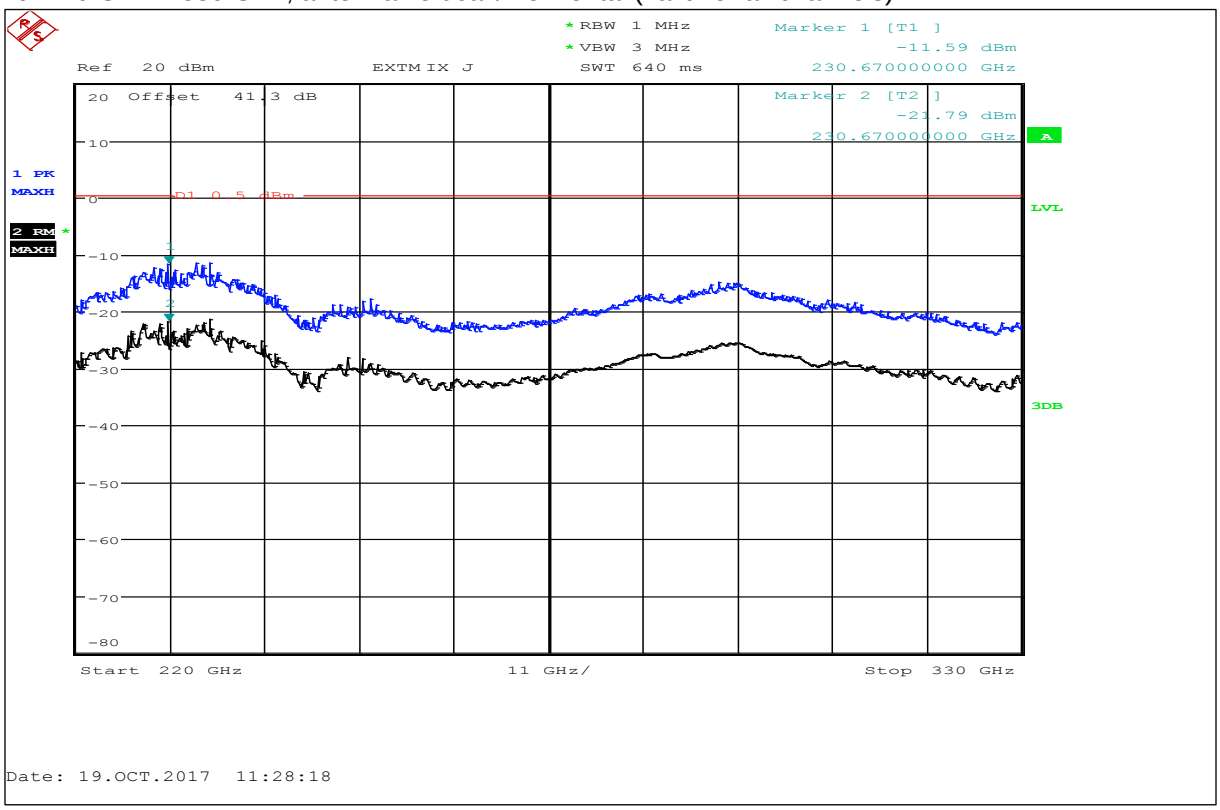
Plot 27: 110 GHz – 170 GHz, antenna vertical / horizontal (valid for all channels)



Plot 28: 170 GHz – 220 GHz, antenna vertical / horizontal (valid for all channels)



Plot 29: 220 GHz – 330 GHz, antenna vertical / horizontal (valid for all channels)



9.6 Frequency stability

Low Channel:

TEST CONDITIONS	Frequency stability [GHz]
T_{nom} / V_{nom}	76.098 000
T_{min} / V_{min}-V_{max}	76.098 000
T_{max} / V_{min}-V_{max}	76.098 000

Middle Channel:

TEST CONDITIONS	Frequency stability [GHz]
T_{nom} / V_{nom}	76.498 500
T_{min} / V_{min}-V_{max}	76.498 500
T_{max} / V_{min}-V_{max}	76.498 500

High Channel:

TEST CONDITIONS	Frequency stability [GHz]
T_{nom} / V_{nom}	76.906 500
T_{min} / V_{min}-V_{max}	76.908 096
T_{max} / V_{min}-V_{max}	76.908 096

Refer to Plots 8, 10 and 12

Limits: **FCC §95.3379 (b)**

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

Limits: **RSS-251 (5.2.2) / (5.4)**

Frequency range	f(lowest) > 76.0 GHz	f(highest) < 77.0 GHz

Verdict: **Complies**

Annex A Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
ETSI	European Telecommunications Standard Institute
EN	European Standard
FCC	Federal Communication 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

Annex B Document history

Version	Applied changes	Date of release
-/-	DRAFT	2017-11-23
-/-	Minor editorial changes	2018-02-07

Annex C Accreditation Certificate

first page	last page
	

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

http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf