

TEST REPORT

Test report no.: 1-8392/19-02-09-B

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 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

Sennheiser electronic GmbH & Co. KG

Am Labor 1

30900 Wedemark / GERMANY

Phone: +49 5130 600-0

Contact: Nils Knauer

e-mail: Nils.Knauer@sennheiser.com

Phone: +49 5130/600-9524

Manufacturer

Sennheiser electronic GmbH & Co. KG

Am Labor 1

30900 Wedemark / GERMANY

Test standard/s

FCC - Title 47 CFR
Part 74

FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 74 - Experimental radio, auxiliary, special broadcast and other program distributional services

RSS - 210 Issue 10

Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment

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

Test Item

Test item description:

Handheld Transmitter

Model No.:

EW-D SKM-S

FCC ID:

DMOSKMSEWD

IC number:

2099A-SKMSEWD

Operating Frequency:

470.2 MHz – 607.8 MHz

Technology:

Digital Audio Transmission

Antenna:

internal monopole antenna

Power ratings:

2.00 V to 4.35 V DC by battery Li-Ion BA 70 or 2 x AA type 1.50 V DC

Operating temperature range:

-10°C to +55°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.

Christoph Schneider
Lab Manager
Radio Communications

Test performed:

p.o.

Hans-Joachim Wolsdorfer
Lab Manager
Radio Communications

1 Table of contents

1	Table of contents	2
2	General information	3
2.1	Notes and disclaimer	3
2.2	Application details	3
2.3	Test laboratories sub-contracted	3
3	Test standard/s, references and accreditations	4
4	Reporting statements of conformity – decision rule	5
5	Test environment	6
6	Test item.....	6
6.1	General description	6
6.2	Additional information	7
7	Description of the test setup.....	7
7.1	Shielded fully anechoic chamber.....	8
7.2	Conducted measurements normal and extreme conditions.....	9
8	Measurement uncertainty	10
9	Summary of measurement results	11
10	Additional comments	12
11	Measurement results.....	13
11.1	Transmitter output power	13
11.2	Occupied bandwidth.....	19
11.3	Transmitter frequency stability	25
11.4	Transmitter unwanted emissions.....	30
11.5	Necessary bandwidth (BN) for analogue systems.....	36
11.6	Modulation characteristics.....	40
11.7	Frequency modulation.....	40
12	Glossary	41
13	Document history	42
14	Accreditation Certificate – D-PL-12076-01-04	42
15	Accreditation Certificate – D-PL-12076-01-05	43

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.

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.

The testing service provided by CTC advanced GmbH has been rendered under the current "General Terms and Conditions for CTC advanced GmbH".

CTC advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.

Under no circumstances does the CTC advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.

Under no circumstances does the CTC advanced GmbH test report include or imply any product or service warranties from CTC advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CTC advanced GmbH.

All rights and remedies regarding vendor's products and services for which CTC advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by CTC advanced GmbH. In no case this test report can be considered as a Letter of Approval.

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 1-8392/19-02-09-A and dated 2020-07-28

2.2 Application details

Date of receipt of order:	2020-04-16
Date of receipt of test item:	2020-06-15
Start of test:	2020-06-15
End of test:	2020-07-13
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 74		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 74 - Experimental radio, auxiliary, special broadcast and other program distributional services
RSS - 210 Issue 10	December 2019	Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment
ETSI EN 300 422-1 V1.4.2	2011-08	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement

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

Accreditation	Description
D-PL-12076-01-04	Telecommunication and EMC Canada https://www.dakks.de/as/ast/d/D-PL-12076-01-04.pdf
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf

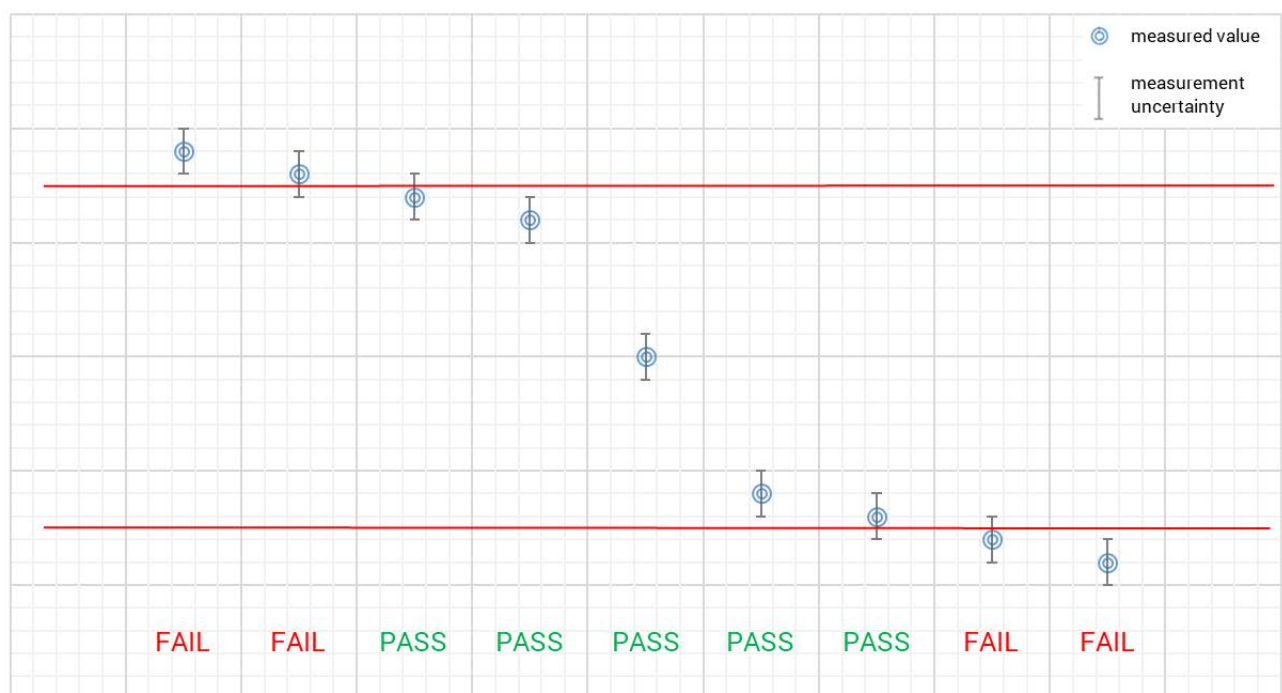


4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.

The measurement uncertainty is mentioned in this test report, see chapter 8 but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."

measured value, measurement uncertainty, verdict



5 Test environment

Temperature :	T _{nom} T _{max} T _{min}	+20 °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 ratings :	V _{nom} V _{max} V _{min}	3.80 V DC by battery Li-Ion BA 70 or 2 x AA type 1.50 V DC 4.35 V 2.00 V

6 Test item

6.1 General description

Test item description :	Handheld Transmitter
Model No. :	EW-D SKM-S
Brand name :	SENNHEISER
Product name :	Evolution Wireless Digital
HMN :	-/-
PMN :	EW-D SKM-S
HVIN :	EW-D SKM-S
FVIN :	1.0.0
S/N serial number :	Radiated: Q1-6 1220000405 R1-6 1220000433 R4-9 1220000401 Conducted Q1-6 1220000408 R1-6 1220000436 R4-9 1220000405
Hardware version :	583750_07
Software version :	-/-
Firmware version :	1.0.0
Operating frequency :	470.2 MHz – 607.8 MHz
Type of radio transmission :	modulated carrier
Use of frequency spectrum :	
Modulation type :	PI/4 DQPSK
Number of channels :	tuning step size 25 kHz
Antenna :	internal monopole antenna
Maximum transmit power :	12.53 dBm e.i.r.p.
Power ratings :	2.00 V to 4.35 V DC by battery Li-Ion BA 70 or 2 x AA type 1.50 V DC
Operating temperature range :	-10°C to +55°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report:

- 1-8392/19-02-09_AnnexA
- 1-8392/19-02-01_AnnexB
- 1-8392/19-02-01_AnnexC

7 Description of the test setup

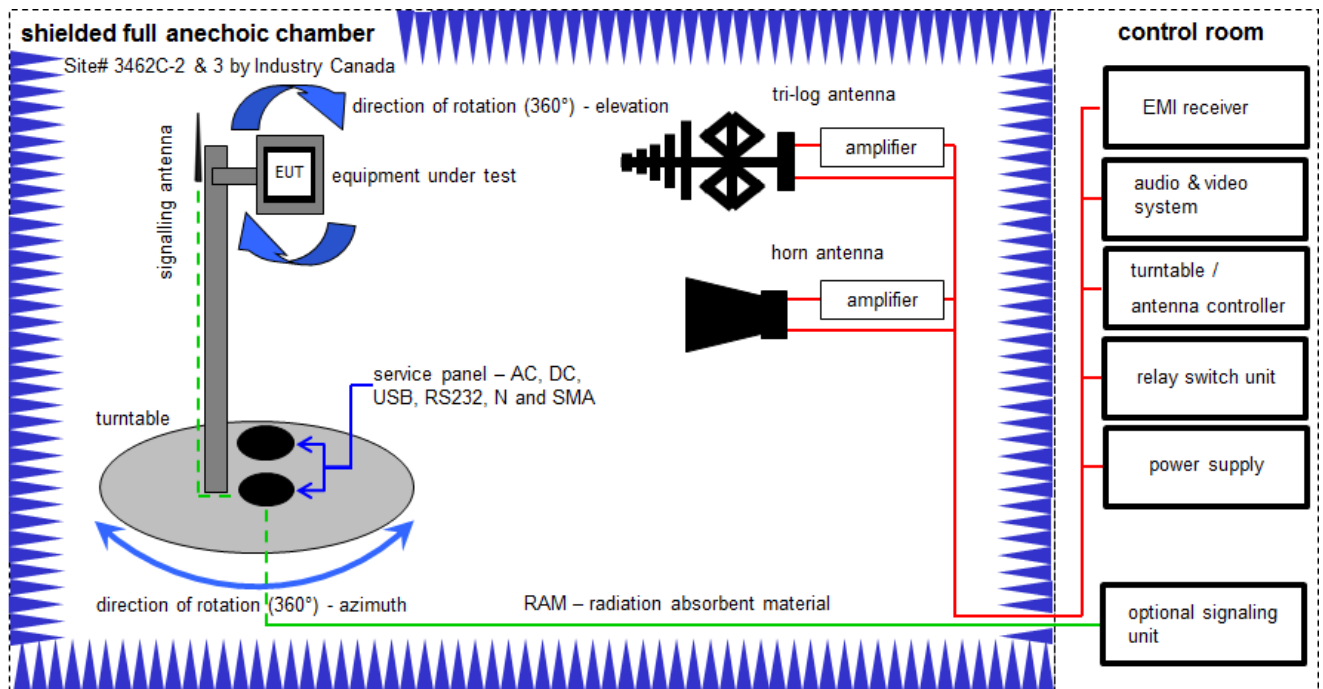
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements 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
vlk!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter

$$OP = AV + D - G + CA$$

(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:

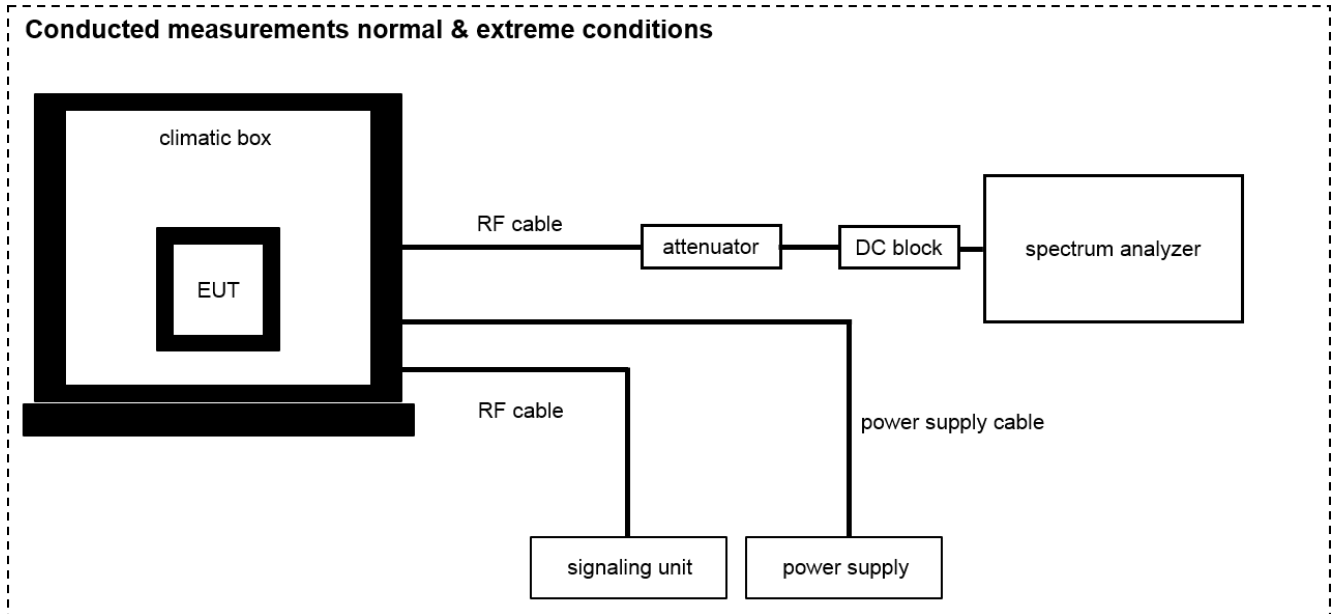
$$OP \text{ [dBm]} = -65.0 \text{ [dBm]} + 50 \text{ [dB]} - 20 \text{ [dBi]} + 5 \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vIKI!	27.02.2019	26.02.2021
2	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
3	A, B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
4	A, B	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A54 21	300004591	ne	-/-	-/-
5	A, B	NEXIO EMV-Software	BAT EMC V3.19.1.21	EMCO		300004682	ne	-/-	-/-
6	A, B	Anechoic chamber		TDK		300003726	ne	-/-	-/-
7	A, B	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	10.12.2019	09.12.2020
8	B	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-
9	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess-Elektronik	01029	300005379	vIKI!	02.07.2019	01.07.2021

7.2 Conducted measurements normal and extreme conditions

Conducted measurements normal & extreme conditions



OP = AV + CA
 (OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:

OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	B	DC Power Supply 0 – 32V	1108-32	Heiden Elektronik	001802	300001383	NK!	-/-	-/-
2	B	Temperature Test Chamber	VT 4011	Voetsch Industrietechnik	58566230600010	300005363	ev	08.05.2020	07.05.2022
3	B	Signal- and Spectrum Analyzer 2 Hz - 26 GHz	FSW26	R&S	101455	300004528	k	12.12.2019	11.12.2020
4	A	Spectrum Analyzer	FSV30	Rohde & Schwarz	104365	300005923	k	17.10.2019	16.01.2021
5	A, B	Arbitrary Function Generator	33220A	Agilent Technologies	MY44051717	300004164	vKI!	09.12.2019	08.12.2021

8 Measurement uncertainty

Measurement uncertainty	
Test case	Uncertainty
Transmitter output power	± 3 dB
Occupied bandwidth	± 3 kHz to 10 kHz (depends on the used RBW)
Transmitter frequency stability	± 1 Hz to 1 kHz (depends on the used RBW)
Transmitter unwanted emissions (radiated or conducted)	Radiated: ± 3 dB Conducted: ± 0.5 dB
Modulation characteristics	-/-
Necessary bandwidth (BN) for analogue systems	± 1 kHz (depends on the used RBW)
Frequency modulation	± 3 kHz (depends on the used RBW)
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

9 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	FCC Part 74 RSS - 210, Issue 10 RSS-Gen Issue 4 ETSI EN 300 422-1 v1.4.2	See table!	2020-08-31	-/-

Test specification clause	Test case	Temperature conditions	Voltage conditions	C	NC	NA	NP	Remark
FCC Part 74.861 (e)(1)(ii) FCC Part 2.1046 RSS-210 – G.3.1 RSS-Gen – 6.12	Transmitter output power	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 74.861 (e)(5) FCC Part 2.1049 RSS-210 – G.3.2 RSS-Gen – 6.6	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 74.861 (e)(4) FCC Part 2.1055 RSS-210 – G.3.3 RSS-Gen – 6.11	Transmitter frequency stability	Nominal	Nominal	☒	☐	☐	☐	-/-
		Extreme	Extreme	☒	☐	☐	☐	
FCC Part 74.861 (e)(6) FCC Part 74.861 (e)(7) RSS-210 – G.3.4 ETSI EN 300 422-1 v1.4.2 (2011-08)	Transmitter unwanted emissions (radiated or conducted)	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 2.1047	Modulation characteristics	Nominal	Nominal	-/-				-/-
FCC Part 74.861 (e)(7) ETSI EN 300 422-1 v1.4.2 (2011-08)	Necessary bandwidth (BN)	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 74.861 (e)(3) RSS-210 – G.3.5.2	Frequency modulation	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 74.861 (e)(7) RSS-210 – G.3.4	Receiver spurious emissions	Nominal	Nominal	☐	☐	☒	☐	No receiver integrated!
FCC Part 15.107(a) FCC Part 15.207	Conducted emissions < 30 MHz	Nominal	Nominal	☐	☐	☒	☐	-/-

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

10 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: EUT tested with a sensitivity setting of -30 dB – pre-setting from manufacturer.

Test mode:

☒ No test mode available.
Test signal is applied to the transmitter.

☐ Special software is used.
EUT is transmitting pseudo random data by itself

Antennas and transmit operating modes:

☒ **Operating mode 1 (single antenna)**

- *Equipment with 1 antenna,*
- *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,*
- *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*

☐ **Operating mode 2 (multiple antennas, no beamforming)**

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*

☐ **Operating mode 3 (multiple antennas, with beamforming)**

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.
In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.*

11 Measurement results

11.1 Transmitter output power

Measurement:

Measurement parameter	
Detector:	Peak (worst case) / Average (RMS)
Sweep time:	Auto / 20s
Resolution bandwidth:	> emission bandwidth
Video bandwidth:	> resolution bandwidth
Span:	> 2 times emissions bandwidth
Trace mode:	Max. hold
EUT configuration:	Peak: Unmodulated carrier RMS: Modulate the transmitter with a 2.5 kHz tone at a level 16 dB higher than that required to produce a frequency deviation of ± 75 kHz, or to produce 50% of the manufacturer's rated deviation, whichever is less.
Test setup:	See sub clause 7.2 – A
Measurement uncertainty:	See sub clause 9

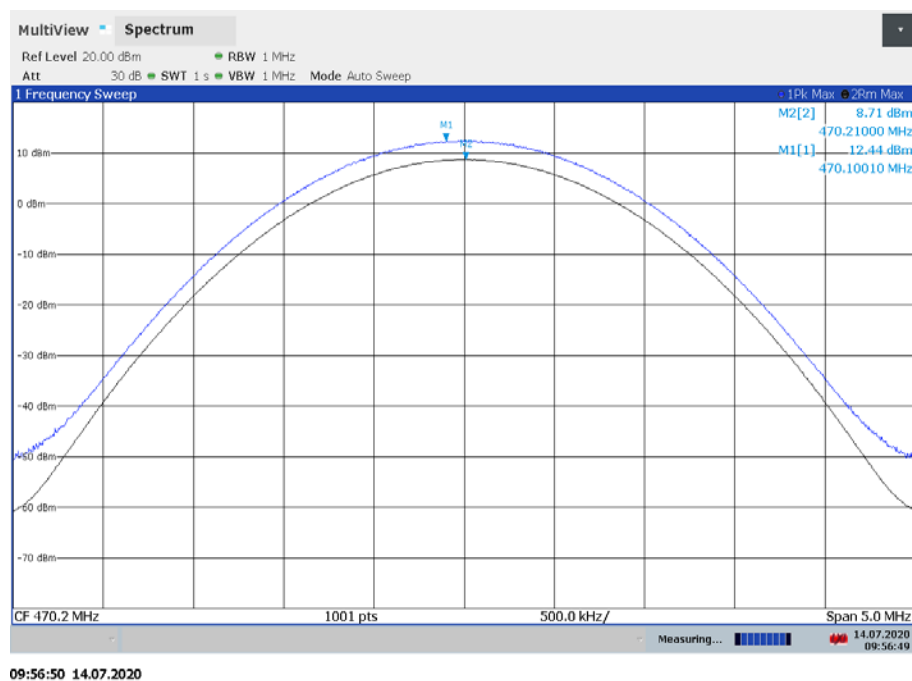
Limits:

FCC (conducted)	
470 MHz to 608 MHz	250 mW (average) / 24 dBm (average)
IC (e.i.r.p.)	
470 MHz to 608 MHz	250 mW (average) / 24 dBm (average)

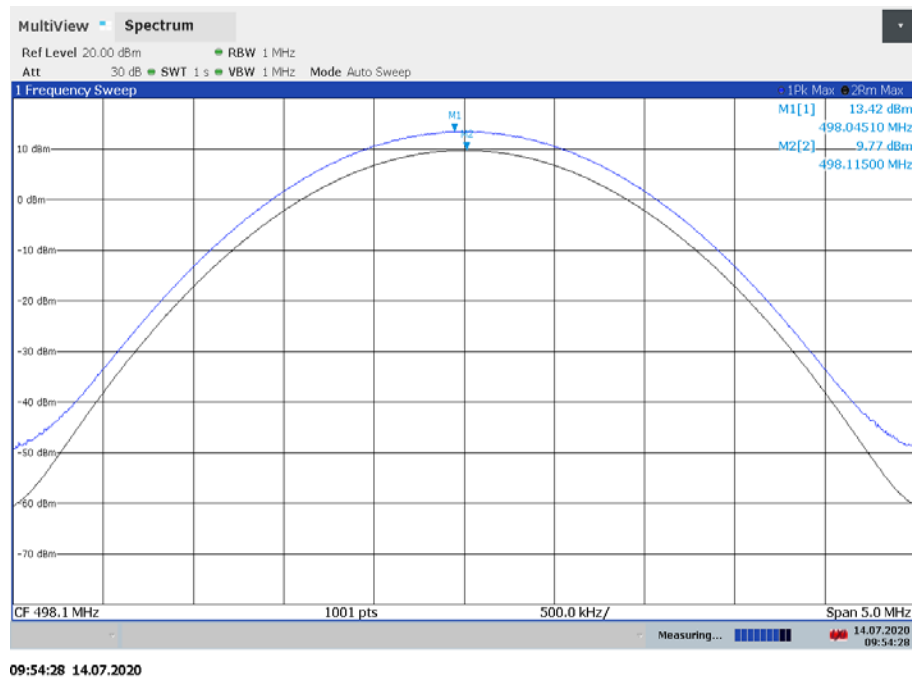
Result:

Transmitter output power conducted						
Channels	Q1-6			R1-6		
	470.2 MHz	498.1 MHz	526.0 MHz	520.0 MHz	548.0 MHz	576.0 MHz
Peak	12.44 dBm	13.42 dBm	13.03 dBm	13.43 dBm	13.45 dBm	13.35 dBm
Average	8.71 dBm	9.77 dBm	9.44 dBm	9.63 dBm	9.74 dBm	9.83 dBm
Channels	R4-9					
	552.0 MHz	579.9 MHz	607.8 MHz			
Peak	13.67 dBm	13.59 dBm	13.2 dBm			
Average	10.2 dBm	10.16 dBm	9.69 dBm			

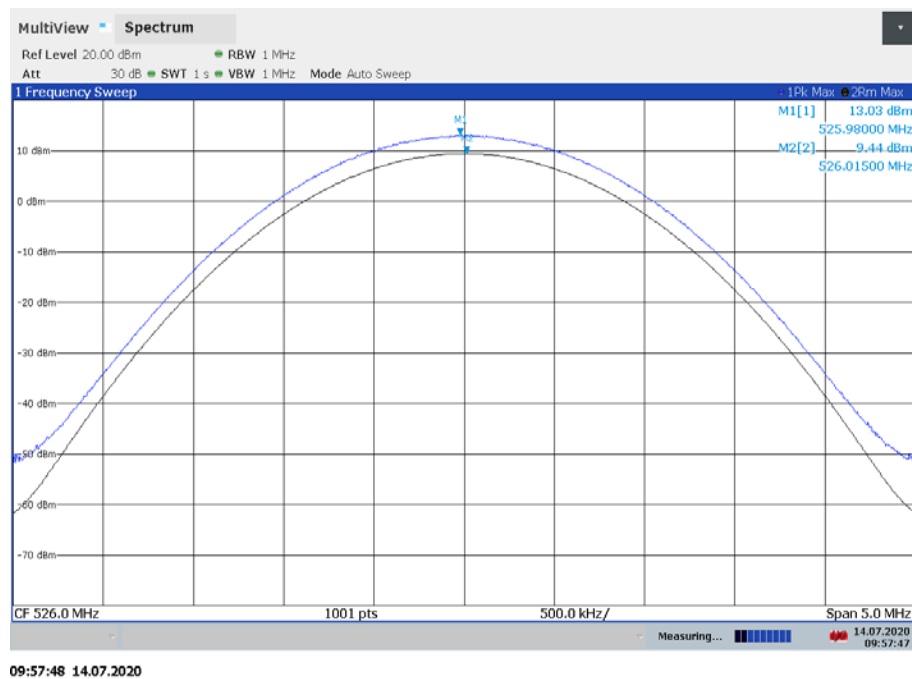
Transmitter output power e.i.r.p.						
Channels	Q1-6			R1-6		
	470.2 MHz	498.1 MHz	526.0 MHz	520.0 MHz	548.0 MHz	576.0 MHz
Peak	14.95 dBm	15.32 dBm	16.01 dBm	14.59 dBm	14.27 dBm	15.18 dBm
Average	11.41 dBm	11.76 dBm	12.53 dBm	11.07 dBm	10.85 dBm	11.64 dBm
Channels	R4-9					
	552.0 MHz	579.9 MHz	607.8 MHz			
Peak	15.06 dBm	15.58 dBm	15.65 dBm			
Average	11.86 dBm	12.19 dBm	12.26 dBm			

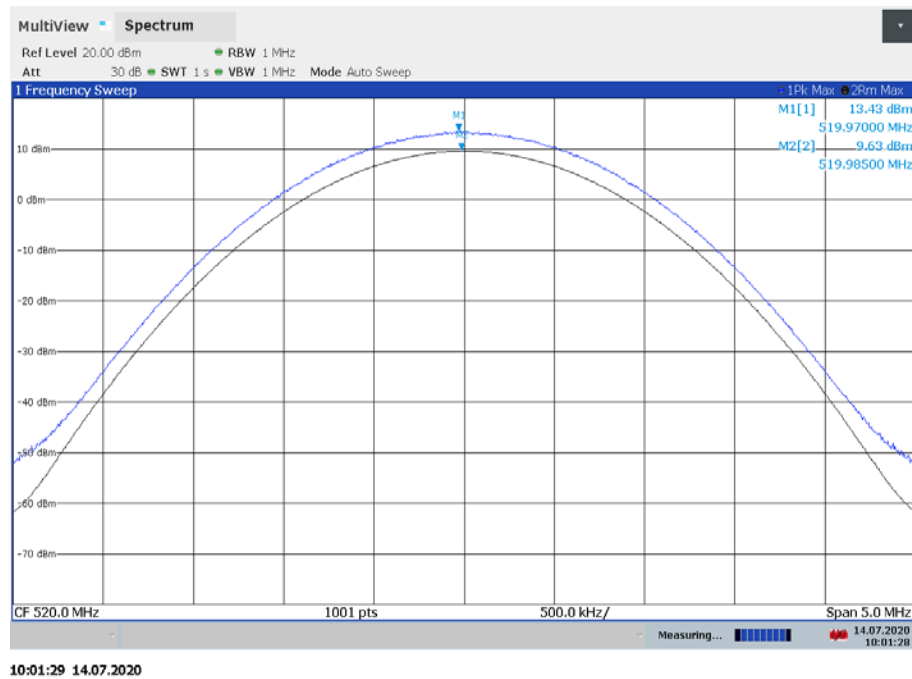
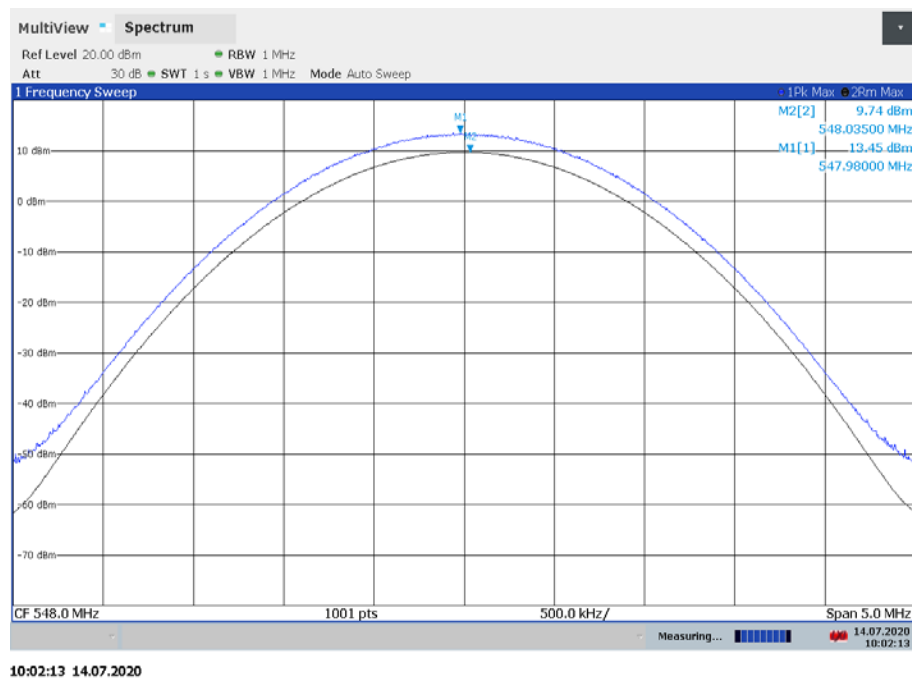
Plots: Q1-6**Plot 1:** 470.2 MHz

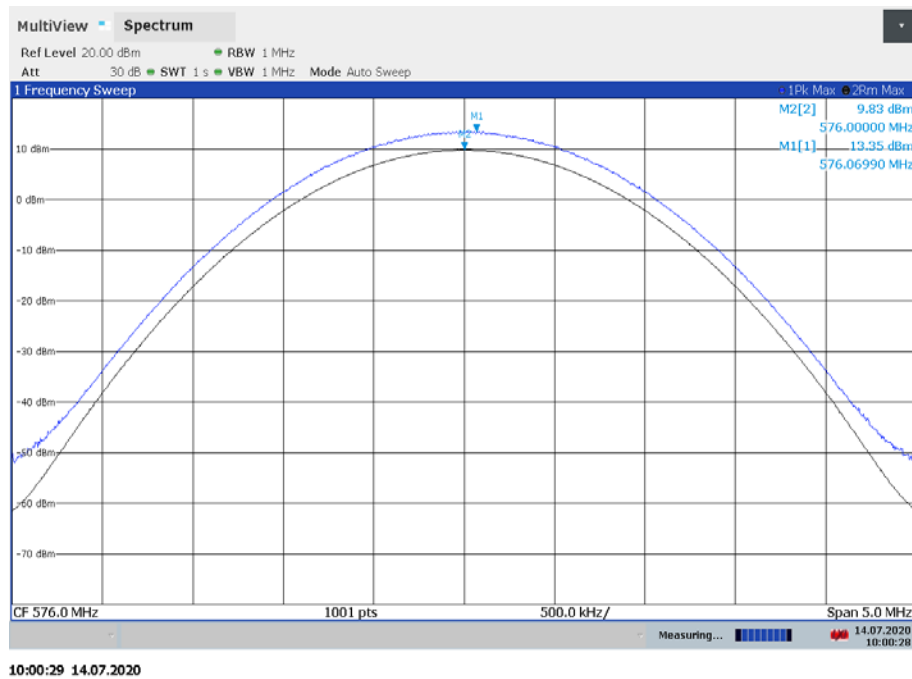
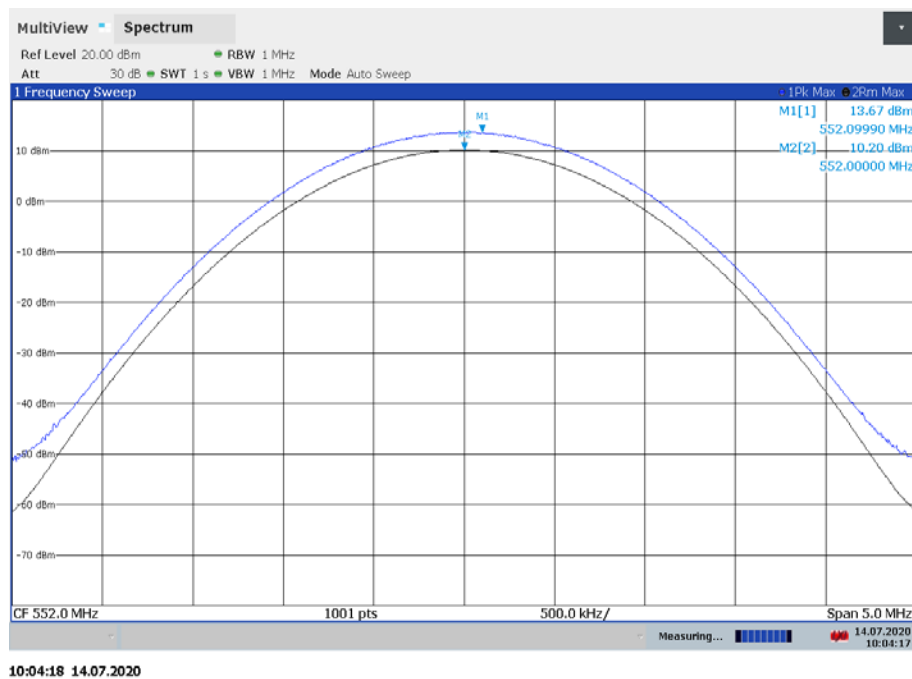
Plot 2: 498.1 MHz

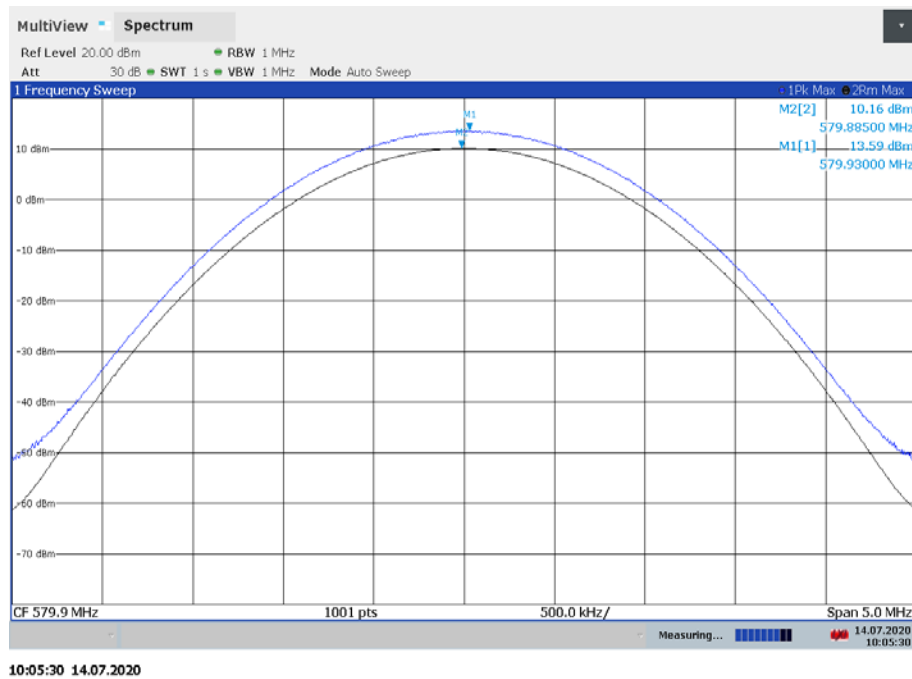
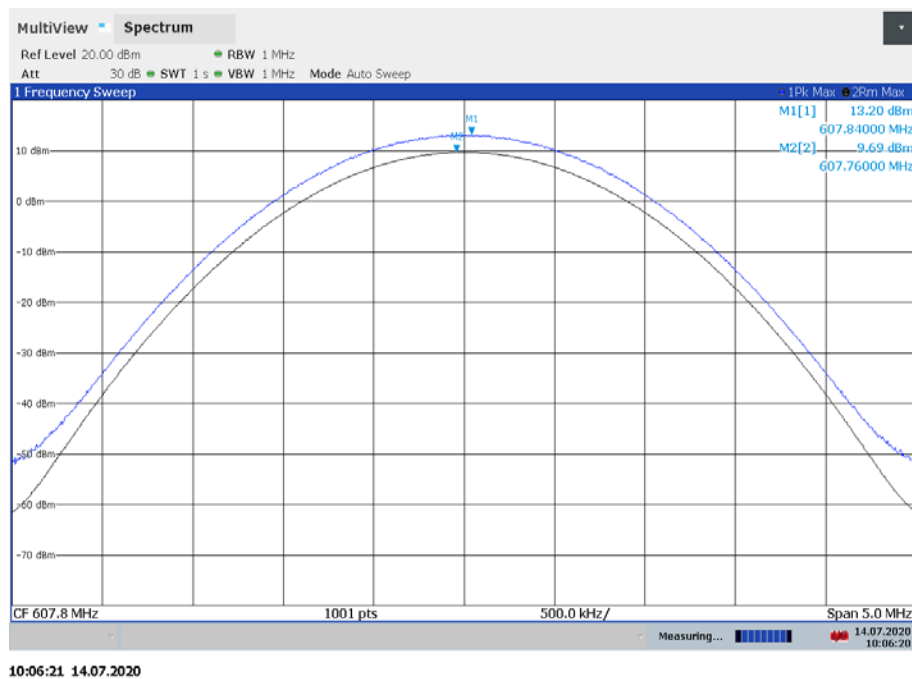


Plot 3: 526.0 MHz



Plots: R1-6**Plot 1: 520.0 MHz****Plot 2: 548.0 MHz**

Plot 3: 576.0 MHz**Plots: R4-9****Plot 1: 552.0 MHz**

Plot 2: 579.9 MHz**Plot 3: 607.8 MHz**

11.2 Occupied bandwidth

Measurement:

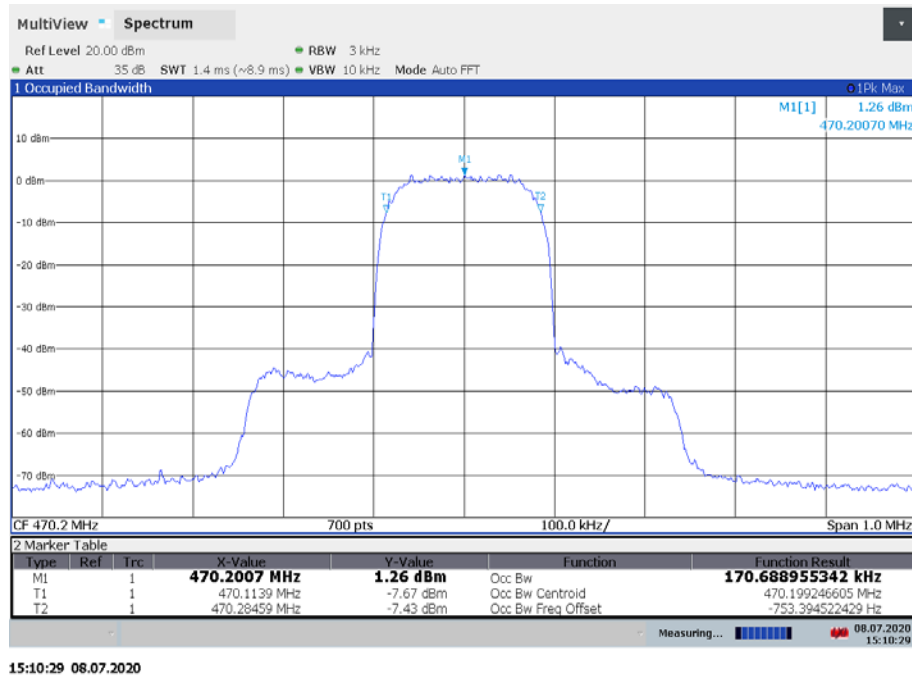
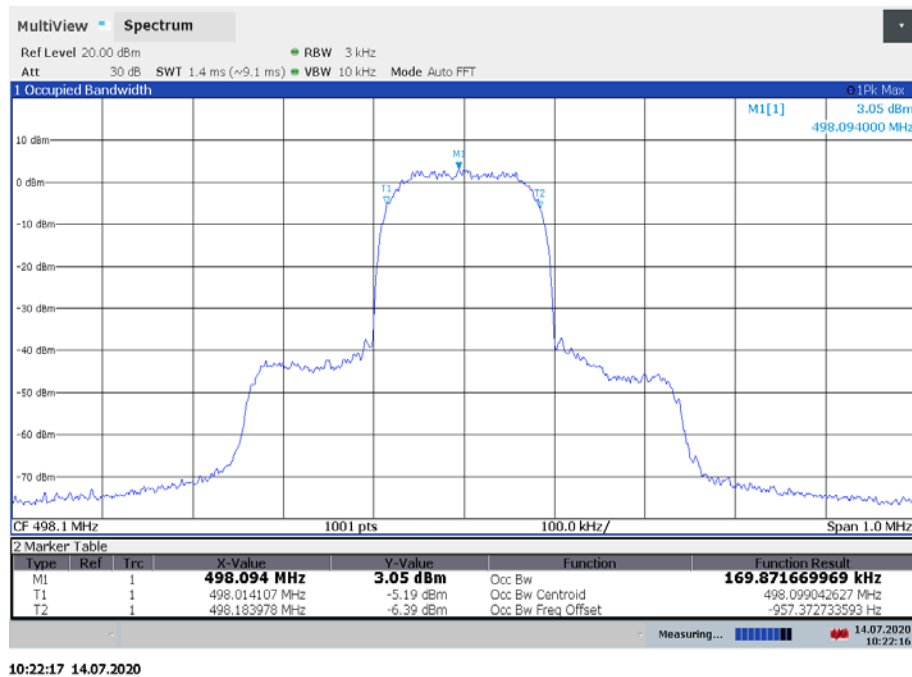
Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 % to 5 % of the occupied bandwidth
Video bandwidth:	3 x resolution bandwidth
Span:	2 x emission bandwidth
Trace mode:	Max. hold
Analyzer function:	99% power occupied bandwidth function
EUT:	Modulated signal with max. frequency deviation
Test setup:	See sub clause 7.2 - A
Measurement uncertainty:	See sub clause 9

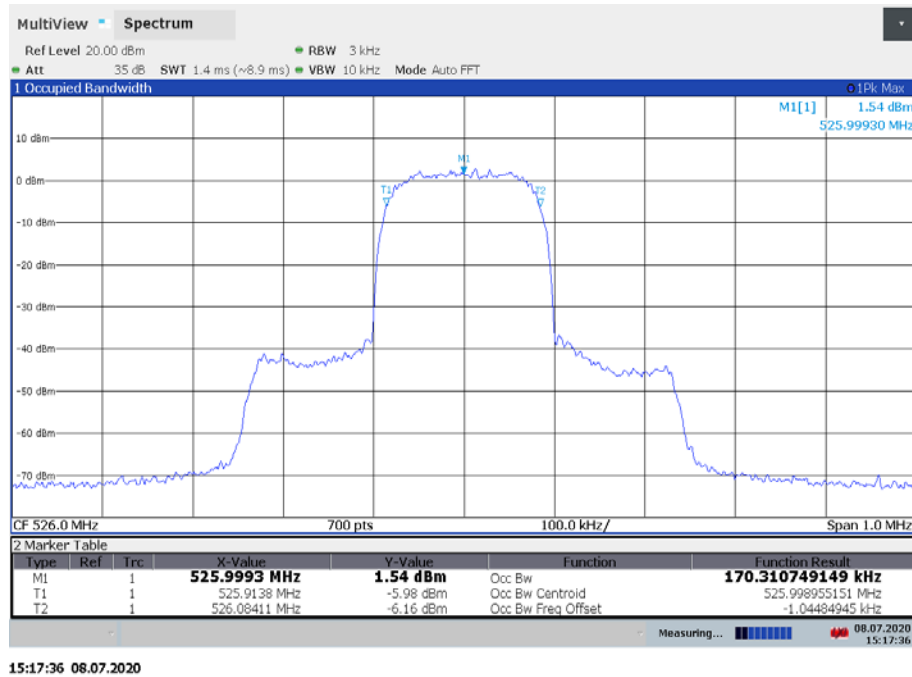
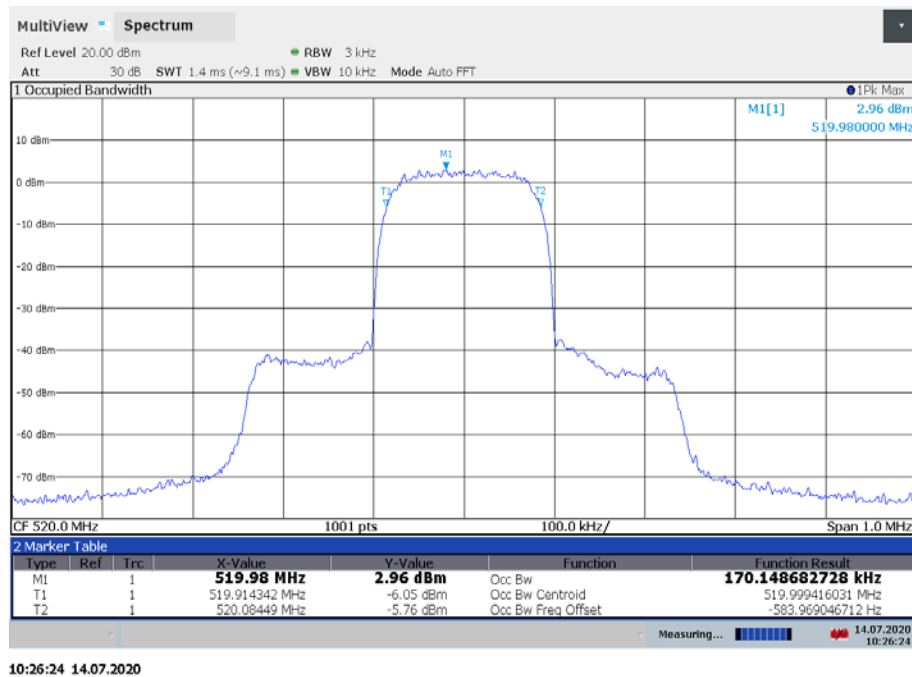
Limits:

FCC & IC
470 MHz to 608 MHz 200 kHz
Occupied bandwidth 99%. Other than single sideband or independent sideband transmitters - when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.

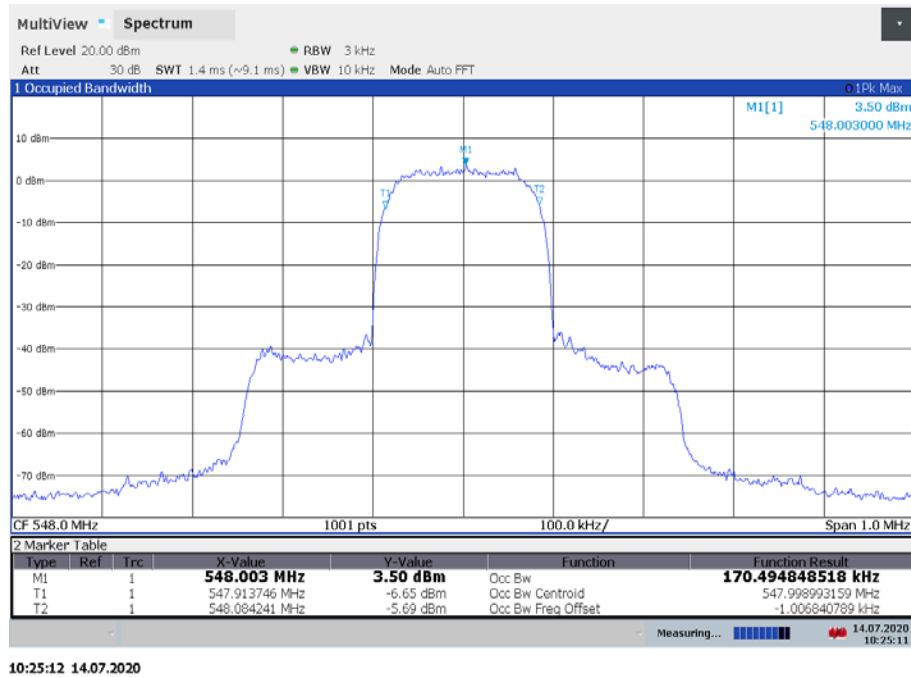
Result:

Occupied bandwidth						
Channels	Q1-6			R1-6		
	470.2 MHz	498.1 MHz	526.0 MHz	520.0 MHz	548.0 MHz	576.0 MHz
	170.68 kHz	167.87 kHz	170.31 kHz	170.14 kHz	170.49 kHz	170.82 kHz
Channels	R4-9					
	552.0 MHz		579.9 MHz		607.8 MHz	
	171.48 kHz		170.52 kHz		171.14 kHz	

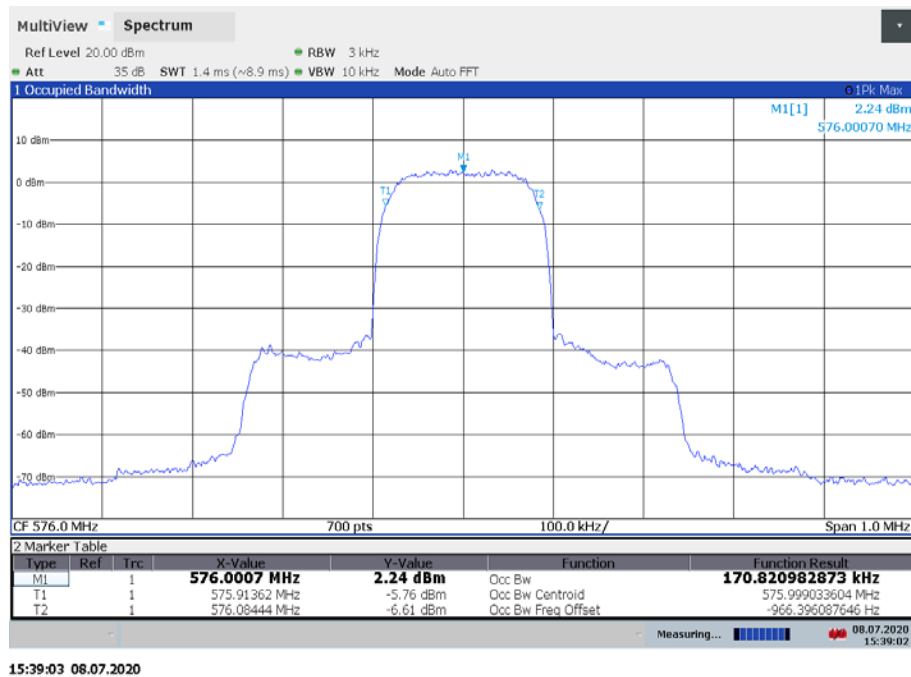
Plots: Q1-6**Plot 1:** 470.2 MHz**Plot 2:** 498.1 MHz

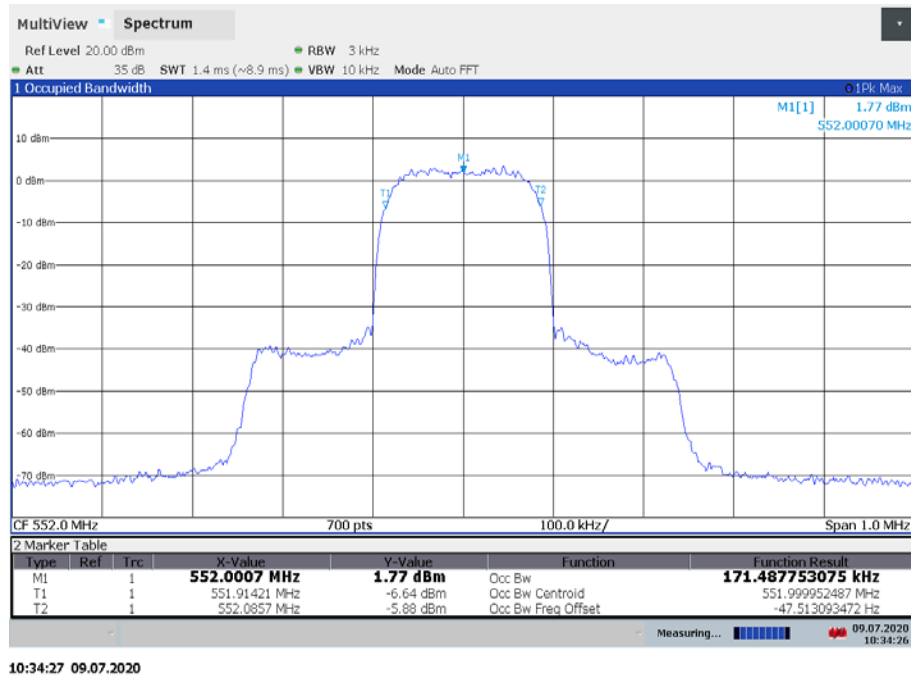
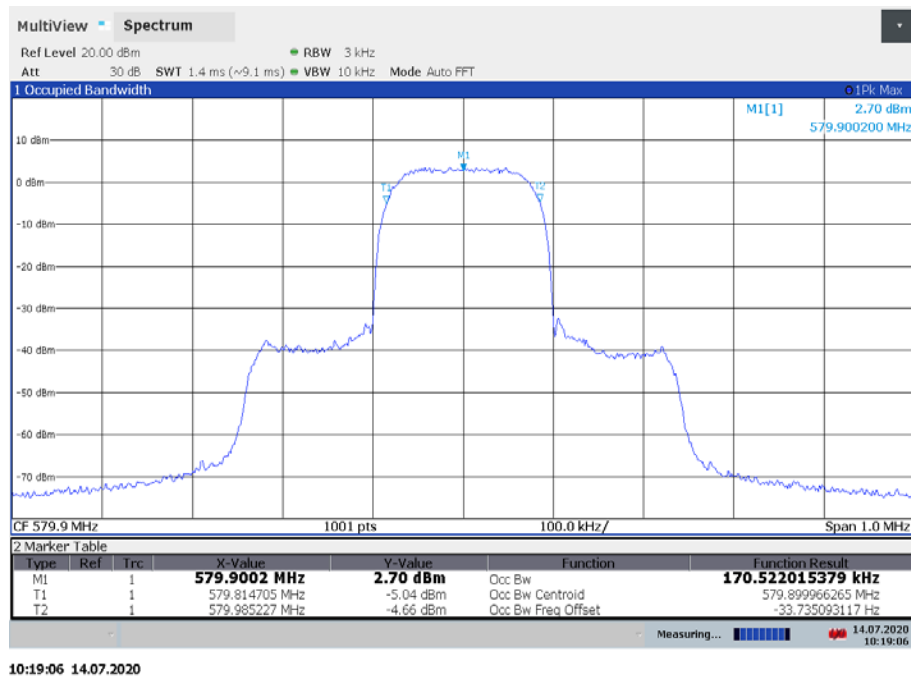
Plot 3: 526.0 MHz**Plots: R1-6****Plot 1: 520.0 MHz**

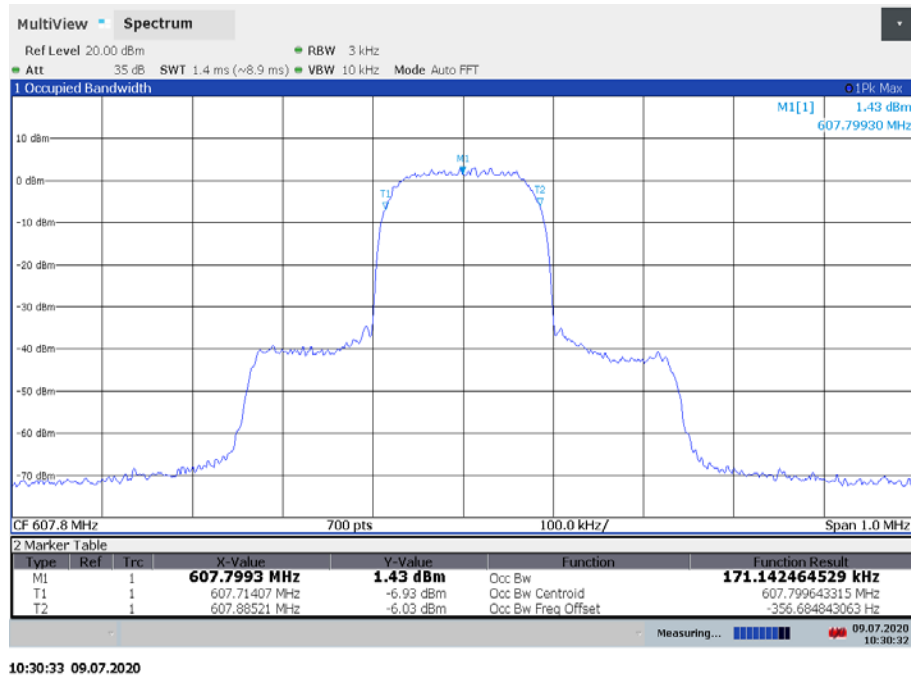
Plot 2: 548.0 MHz



Plot 3: 576.0 MHz



Plots: R4-9**Plot 1:** 552.0 MHz**Plot 2:** 579.9 MHz

Plot 3: 607.8 MHz

11.3 Transmitter frequency stability

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	10 Hz
Video bandwidth:	3 x resolution bandwidth
Span:	wide enough to follow the frequency drift
Trace mode:	clear/write/view
EUT:	CW signal or MC with measurement method description
Test setup:	See sub clause 7.2 - B
Measurement uncertainty:	See sub clause 9

Limits:

FCC & IC
470 MHz to 608 MHz ± 50 ppm

Results:

Q1-6 - 470.2 MHz			
Temperature / Voltage	Frequency	Deviation (kHz)	Deviation (ppm)
-30 °C / V _{nom}	470.199487	-0.513	-1.09
-20 °C / V _{nom}	470.199522	-0.478	-1.02
-10 °C / V _{nom}	470.199387	-0.613	-1.30
0 °C / V _{nom}	470.199390	-0.610	-1.30
+10 °C / V _{nom}	470.199350	-0.650	-1.38
+20 °C / V _{nom}	470.199339	-0.661	-1.41
+30 °C / V _{nom}	470.199404	-0.596	-1.27
+40 °C / V _{nom}	470.199272	-0.728	-1.55
+50 °C / V _{nom}	470.199391	-0.609	-1.30
+20 °C / V _{nom} - 15%	470.199413	-0.587	-1.25
+20 °C / V _{nom}	470.199339	-0.661	-1.41
+20 °C / V _{nom} + 15%	470.199386	-0.614	-1.31

Q1-6 - 498.1 MHz			
Temperature / Voltage	Frequency	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	498.099608	-0.392	-0.79
-20 °C / V_{nom}	498.099304	-0.696	-1.40
-10 °C / V_{nom}	498.099224	-0.776	-1.56
0 °C / V_{nom}	498.099353	-0.647	-1.30
+10 °C / V_{nom}	498.099351	-0.649	-1.30
+20 °C / V_{nom}	498.099257	-0.743	-1.49
+30 °C / V_{nom}	498.099316	-0.684	-1.37
+40 °C / V_{nom}	498.099286	-0.714	-1.43
+50 °C / V_{nom}	498.099238	-0.762	-1.53
+20 °C / $V_{nom} - 15\%$	498.099382	-0.618	-1.24
+20 °C / V_{nom}	498.099257	-0.743	-1.49
+20 °C / $V_{nom} + 15\%$	498.099182	-0.818	-1.64

Q1-6 - 526.0 MHz			
Temperature / Voltage	Frequency	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	525.999630	-0.370	-0.70
-20 °C / V_{nom}	525.999292	-0.708	-1.35
-10 °C / V_{nom}	525.999307	-0.693	-1.32
0 °C / V_{nom}	525.999222	-0.778	-1.48
+10 °C / V_{nom}	525.999337	-0.663	-1.26
+20 °C / V_{nom}	525.999198	-0.802	-1.52
+30 °C / V_{nom}	525.999155	-0.845	-1.61
+40 °C / V_{nom}	525.999163	-0.837	-1.59
+50 °C / V_{nom}	525.999253	-0.747	-1.42
+20 °C / $V_{nom} - 15\%$	525.999104	-0.896	-1.70
+20 °C / V_{nom}	525.999198	-0.802	-1.52
+20 °C / $V_{nom} + 15\%$	525.999463	-0.537	-1.02

R1-6 - 520.0 MHz			
Temperature / Voltage	Frequency	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	519.999377	-0.623	-1.20
-20 °C / V_{nom}	519.999412	-0.588	-1.13
-10 °C / V_{nom}	519.999440	-0.560	-1.08
0 °C / V_{nom}	519.999531	-0.469	-0.90
+10 °C / V_{nom}	519.999526	-0.474	-0.91
+20 °C / V_{nom}	519.999405	-0.595	-1.14
+30 °C / V_{nom}	519.999281	-0.719	-1.38
+40 °C / V_{nom}	519.999225	-0.775	-1.49
+50 °C / V_{nom}	519.999241	-0.759	-1.46
+20 °C / $V_{nom} - 15\%$	519.999255	-0.745	-1.43
+20 °C / V_{nom}	519.999405	-0.595	-1.14
+20 °C / $V_{nom} + 15\%$	519.999289	-0.711	-1.37

R1-6 - 548.0 MHz			
Temperature / Voltage	Frequency (MHz)	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	547.999503	-0.497	-0.91
-20 °C / V_{nom}	547.999298	-0.702	-1.28
-10 °C / V_{nom}	547.999472	-0.528	-0.96
0 °C / V_{nom}	547.999452	-0.548	-1.00
+10 °C / V_{nom}	547.999426	-0.574	-1.05
+20 °C / V_{nom}	547.999249	-0.751	-1.37
+30 °C / V_{nom}	547.999180	-0.820	-1.50
+40 °C / V_{nom}	547.999100	-0.900	-1.64
+50 °C / V_{nom}	547.999016	-0.984	-1.80
+20 °C / $V_{nom} - 15\%$	547.999288	-0.712	-1.30
+20 °C / V_{nom}	547.999249	-0.751	-1.37
+20 °C / $V_{nom} + 15\%$	547.999370	-0.630	-1.15

R1-6 - 576.0 MHz			
Temperature / Voltage	Frequency (MHz)	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	575.999483	-0.517	-0.90
-20 °C / V_{nom}	575.999366	-0.634	-1.10
-10 °C / V_{nom}	575.999480	-0.520	-0.90
0 °C / V_{nom}	575.999526	-0.474	-0.82
+10 °C / V_{nom}	575.999400	-0.600	-1.04
+20 °C / V_{nom}	575.999319	-0.681	-1.18
+30 °C / V_{nom}	575.999232	-0.768	-1.33
+40 °C / V_{nom}	575.999011	-0.989	-1.72
+50 °C / V_{nom}	575.999044	-0.956	-1.66
+20 °C / $V_{nom} - 15\%$	575.999034	-0.966	-1.68
+20 °C / V_{nom}	575.999319	-0.681	-1.18
+20 °C / $V_{nom} + 15\%$	575.999598	-0.402	-0.70

R4-9 - 552.0 MHz			
Temperature / Voltage	Frequency (MHz)	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	551.999867	-0.133	-0.24
-20 °C / V_{nom}	551.999986	-0.014	-0.03
-10 °C / V_{nom}	551.999971	-0.029	-0.05
0 °C / V_{nom}	551.999973	-0.027	-0.05
+10 °C / V_{nom}	551.999942	-0.058	-0.11
+20 °C / V_{nom}	551.999823	-0.177	-0.32
+30 °C / V_{nom}	551.999789	-0.211	-0.38
+40 °C / V_{nom}	551.999767	-0.233	-0.42
+50 °C / V_{nom}	551.999826	-0.174	-0.32
+20 °C / $V_{nom} - 15\%$	551.999777	-0.223	-0.40
+20 °C / V_{nom}	551.999823	-0.177	-0.32
+20 °C / $V_{nom} + 15\%$	551.999828	-0.172	-0.31

R4-9 - 579.9 MHz			
Temperature / Voltage	Frequency (MHz)	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	579.899745	-0.255	-0.44
-20 °C / V_{nom}	579.899817	-0.183	-0.32
-10 °C / V_{nom}	579.899825	-0.175	-0.30
0 °C / V_{nom}	579.899902	-0.098	-0.17
+10 °C / V_{nom}	579.899909	-0.091	-0.16
+20 °C / V_{nom}	579.899827	-0.173	-0.30
+30 °C / V_{nom}	579.899814	-0.186	-0.32
+40 °C / V_{nom}	579.899669	-0.331	-0.57
+50 °C / V_{nom}	579.899785	-0.215	-0.37
+20 °C / $V_{nom} - 15\%$	579.89987	-0.130	-0.22
+20 °C / V_{nom}	579.899827	-0.173	-0.30
+20 °C / $V_{nom} + 15\%$	579.899949	-0.051	-0.09

R4-9 - 607.8 MHz			
Temperature / Voltage	Frequency (MHz)	Deviation (kHz)	Deviation (ppm)
-30 °C / V_{nom}	607.799775	-0.225	-0.37
-20 °C / V_{nom}	607.799784	-0.216	-0.36
-10 °C / V_{nom}	607.79992	-0.080	-0.13
0 °C / V_{nom}	607.800032	0.032	0.05
+10 °C / V_{nom}	607.799952	-0.048	-0.08
+20 °C / V_{nom}	607.799843	-0.157	-0.26
+30 °C / V_{nom}	607.799738	-0.262	-0.43
+40 °C / V_{nom}	607.799752	-0.248	-0.41
+50 °C / V_{nom}	607.799804	-0.196	-0.32
+20 °C / $V_{nom} - 15\%$	607.799838	-0.162	-0.27
+20 °C / V_{nom}	607.799843	-0.157	-0.26
+20 °C / $V_{nom} + 15\%$	607.799812	-0.188	-0.31

11.4 Transmitter unwanted emissions

Measurement:

Measurement parameter	
Detector:	Peak (prescan) / RMS
Sweep time:	Auto
Resolution bandwidth:	25 MHz to 30 MHz 9 kHz to 10 kHz 30 MHz to 1 000 MHz 100 kHz > 1 000 MHz 1 MHz
Video bandwidth:	3 * RBW
Span:	100 MHz steps!
Trace-Mode:	Max. hold
EUT:	MC with max frequency deviation
Used equipment:	See chapter 7.1- A / B
Measurement uncertainty:	See chapter 8

Limits:

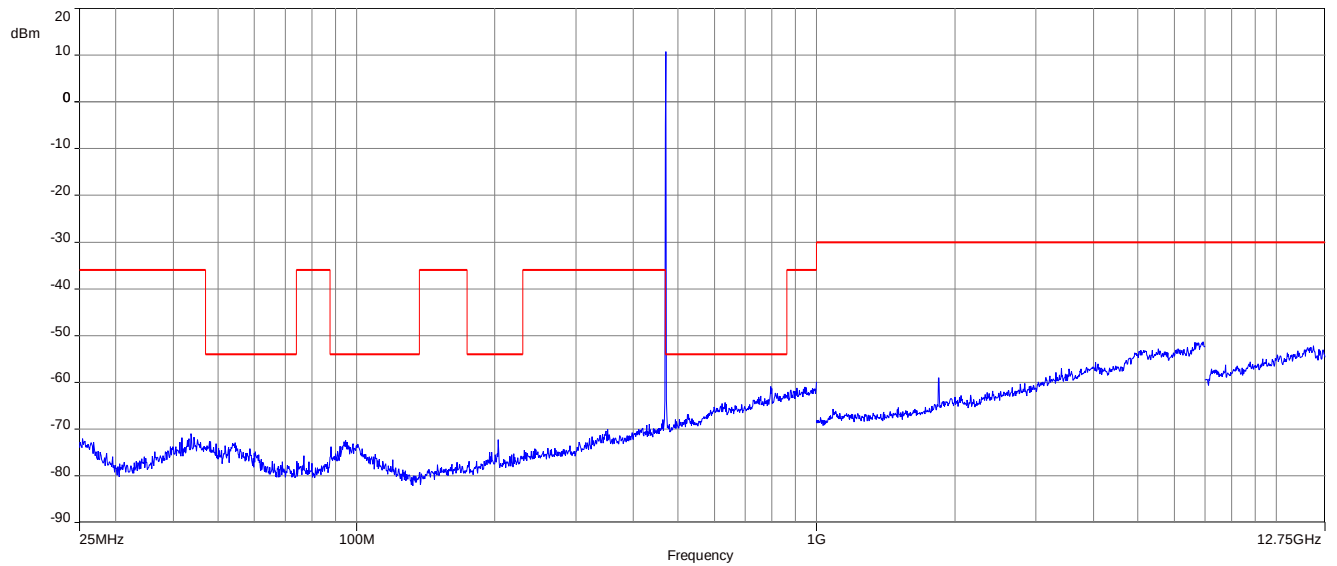
Max. spurious level FCC & IC (according to ETSI EN 300 422-1 v1.4.2 (2011-08))			
State	47 MHz to 74 MHz 87.5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies ≤ 1000 MHz	All frequencies > 1000 MHz
Operating	4.0 nW	250 nW	1.00 µW
Standby	2.0 nW	2.0 nW	20.0 nW
FCC & IC			
The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:			
On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least			25 dB
On any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth			35 dB
On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least			43 + 10log10 (mean output power in watts) dB

Results:

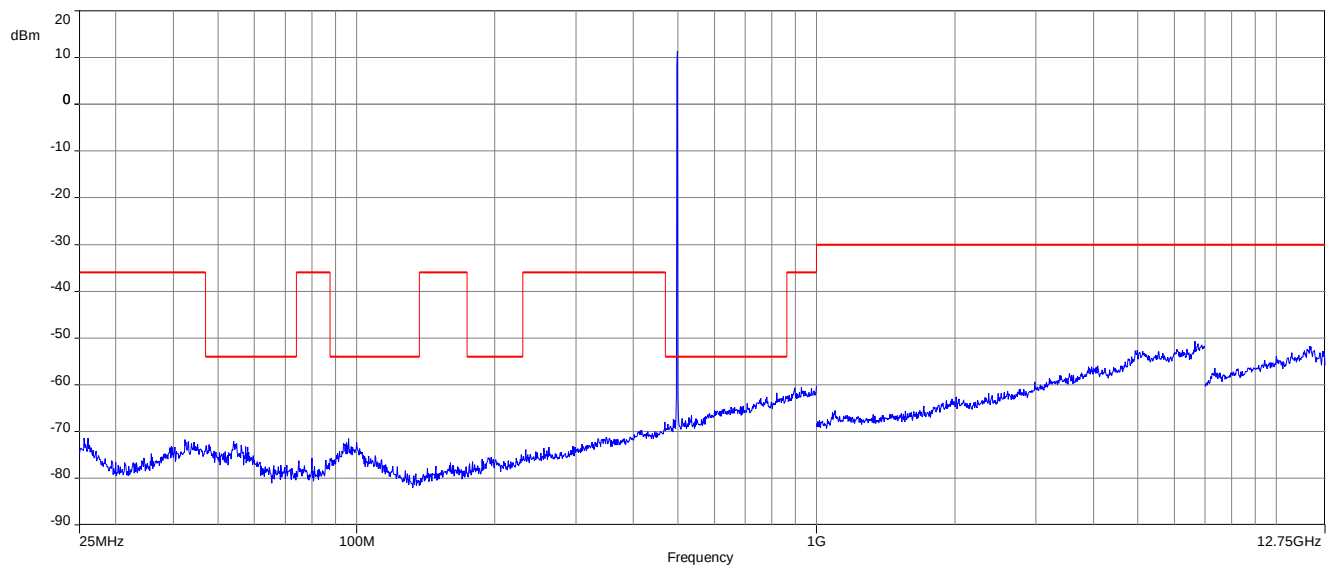
carrier frequency (MHz)	unwanted emission frequency (MHz)	Limit	level (dB) / (dBm) or remark
All detected emissions are more than 10 dB below the limit.			

Plots: Q1-6

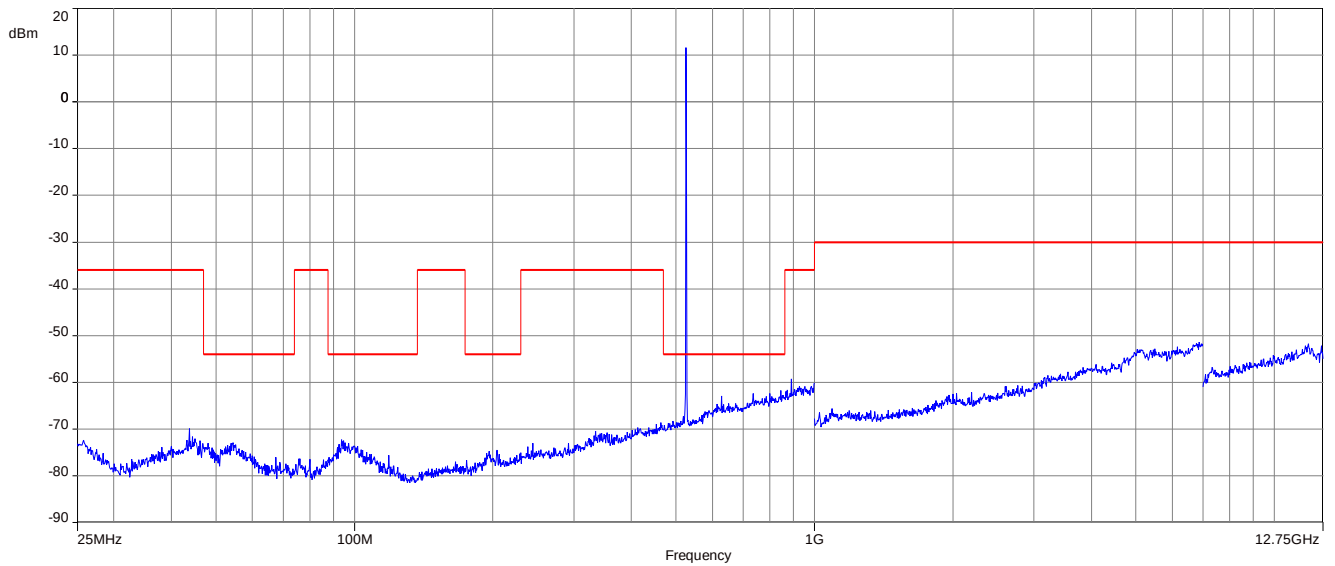
Plot 1: 470.2 MHz, 25 MHz – 12.75 GHz



Plot 2: 498.1 MHz, 25 MHz – 12.75 GHz

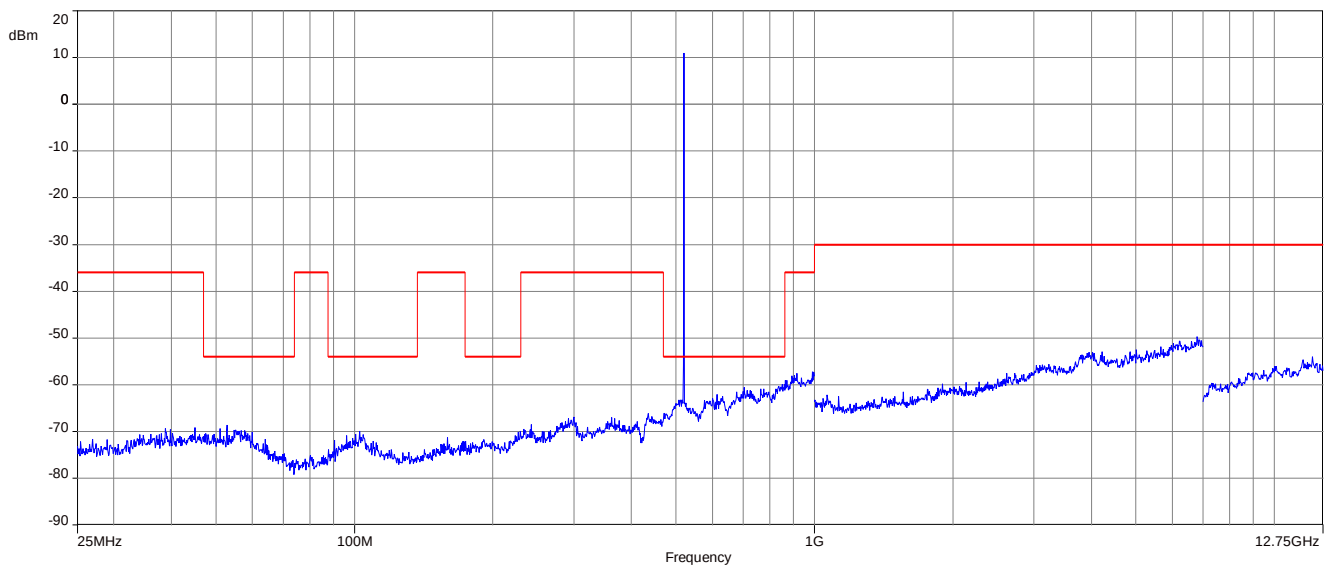


Plot 3: 526.0 MHz, 25 MHz – 12.75 GHz

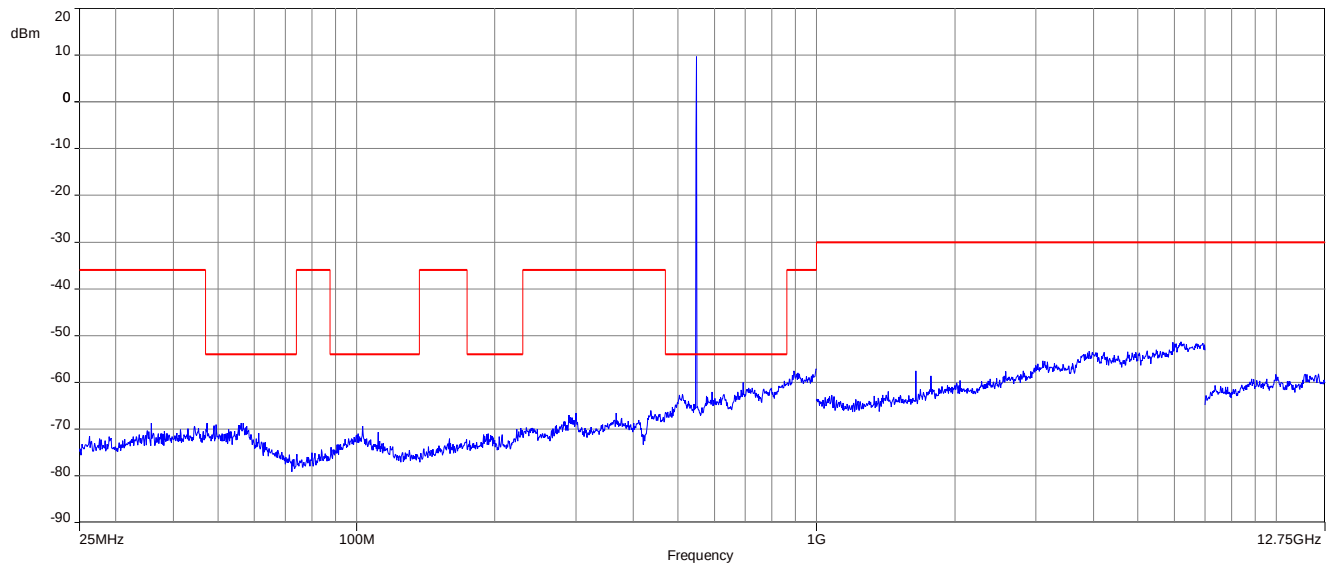


Plots: R1-6

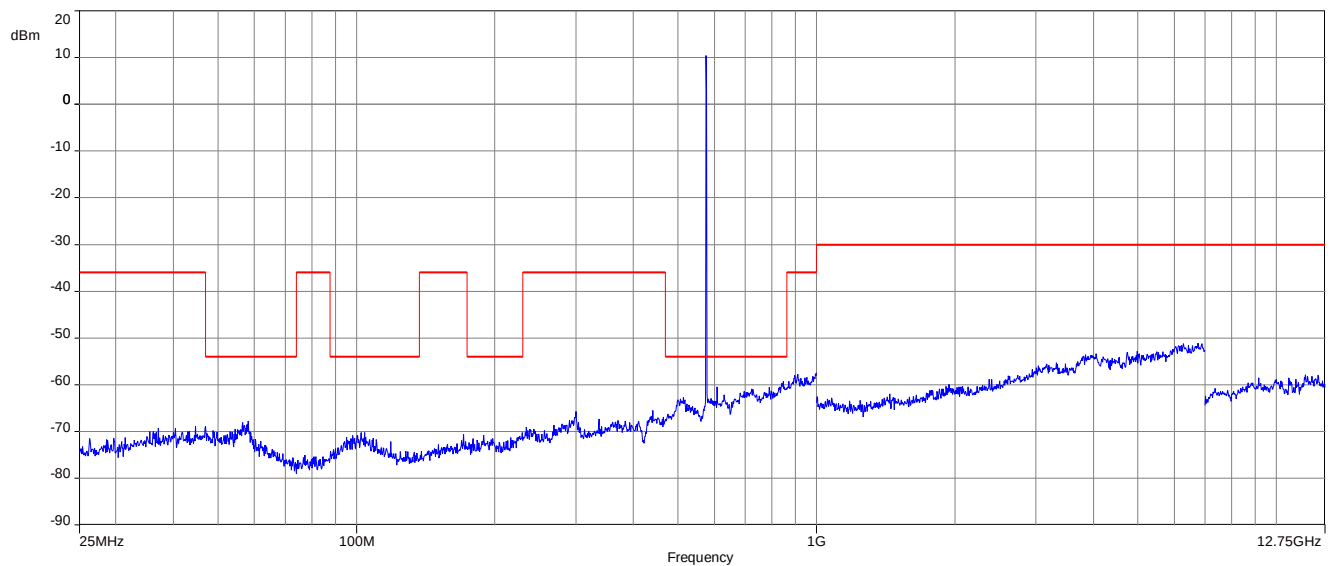
Plot 1: 520.0 MHz, 25 MHz – 12.75 GHz



Plot 2: 548.0 MHz, 25 MHz – 12.75 GHz

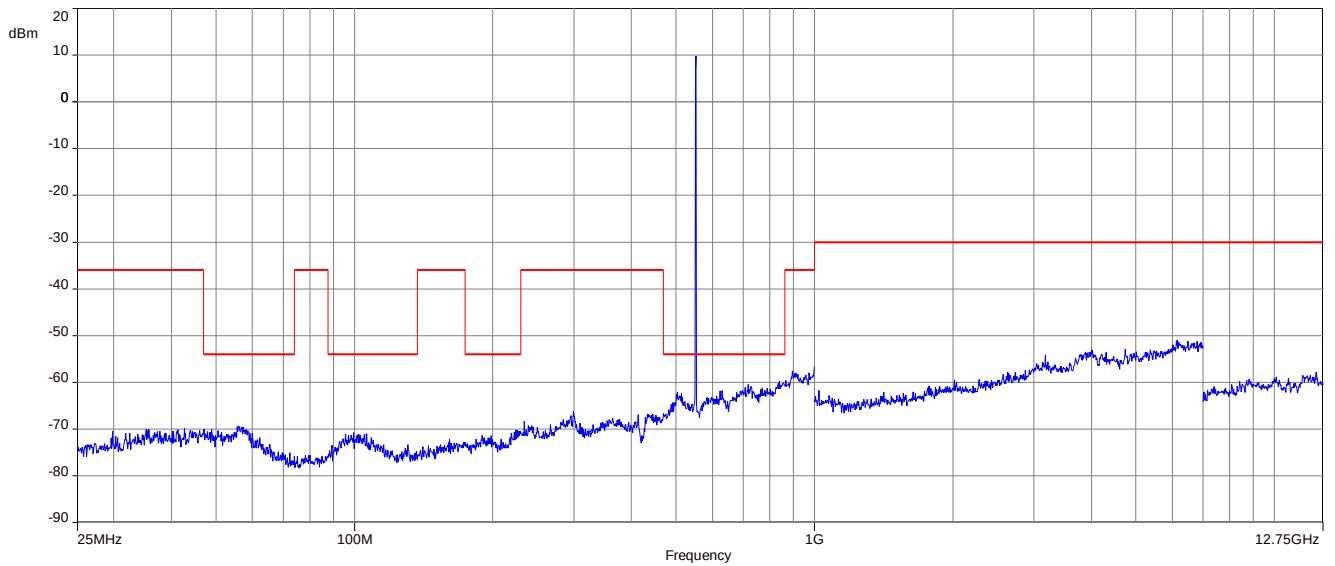


Plot 3: 576.0 MHz, 25 MHz – 12.75 GHz

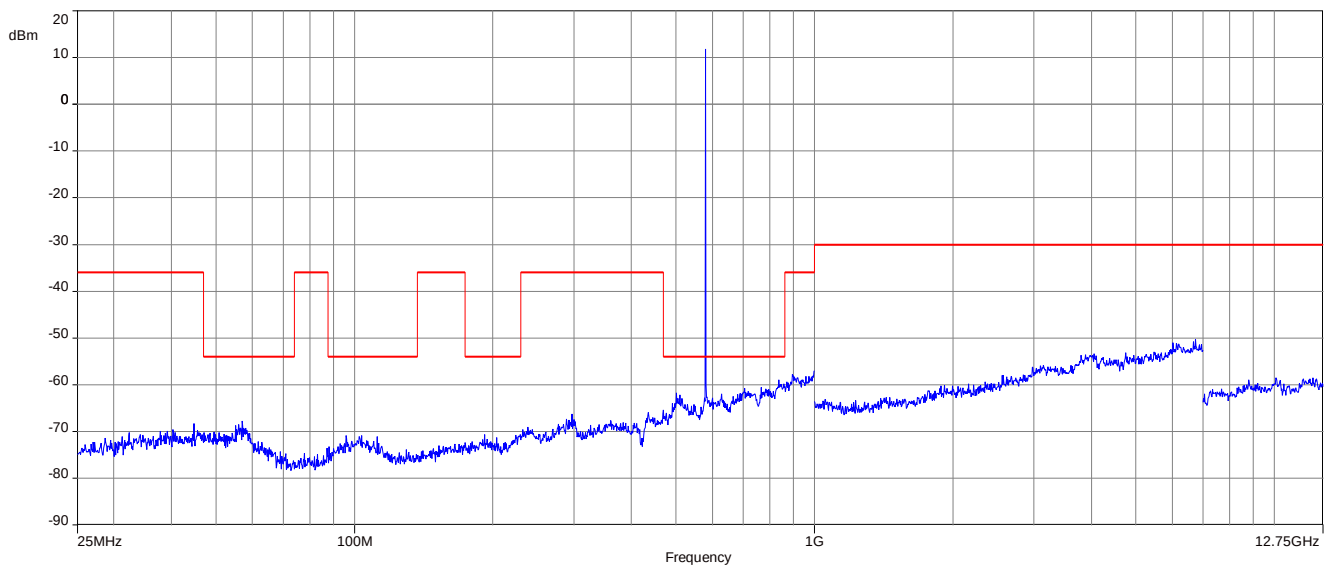


Plots: R4-9

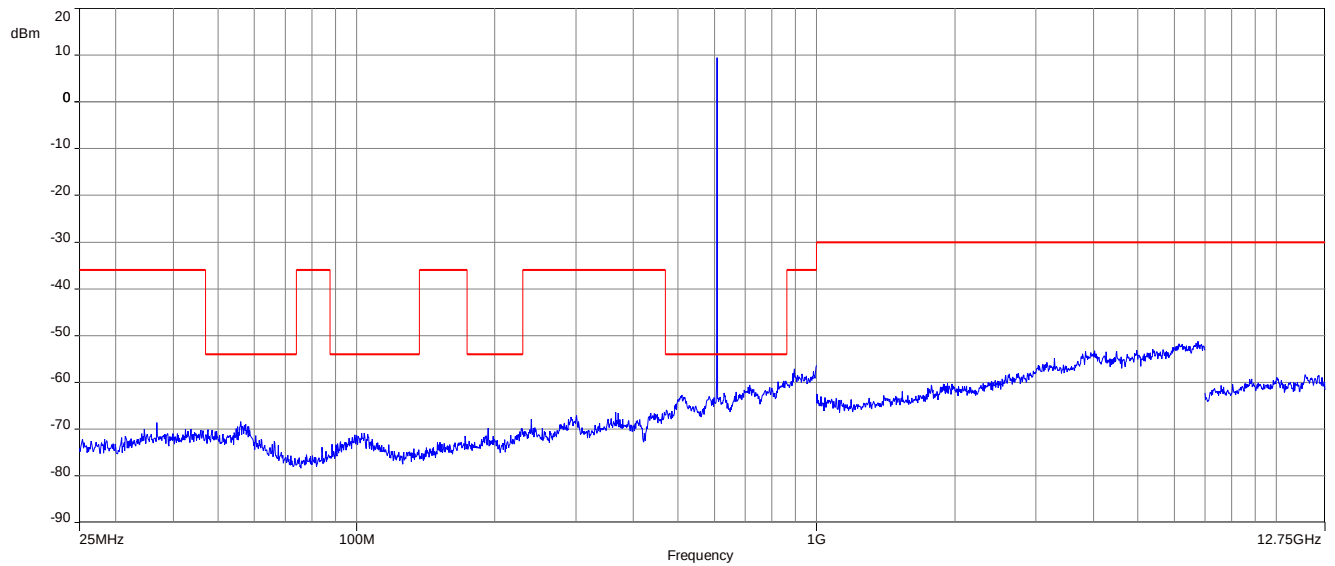
Plot 1: 552.0 MHz, 25 MHz – 12.75 GHz



Plot 2: 579.9 MHz, 25 MHz – 12.75 GHz



Plot 3: 607.8 MHz, 25 MHz – 12.75 GHz



11.5 Necessary bandwidth (BN)

Measurement:

Measurement parameters	Carrier Power	Maximum relative level (dBc) / Transmitter wide band noise floor
Detector:	RMS	RMS
Centre frequency:	f_c	f_c
Sweep time:	$\geq 2s$	$\geq 2s$
Video bandwidth:	1 MHz	1 kHz
Resolution bandwidth:	1 MHz	1 kHz
Span:	Zero span	$\geq 5 \times B$ (2 MHz)
Trace-Mode:	Average	Peak Hold

Limits:

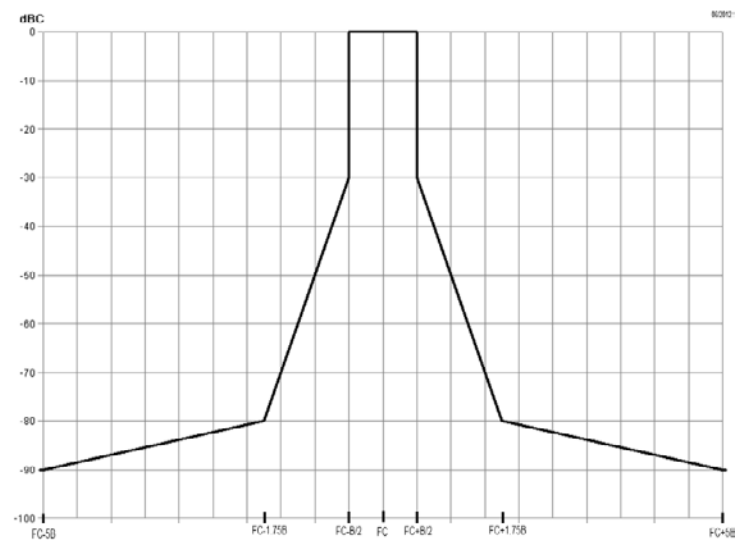
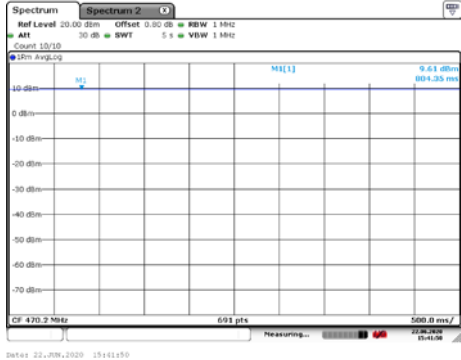
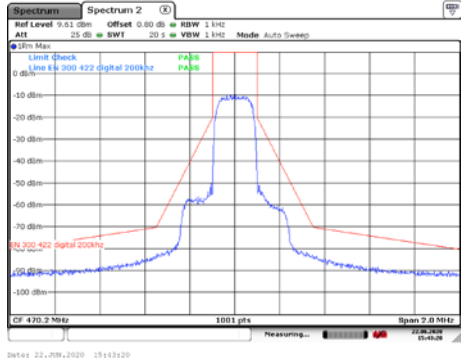
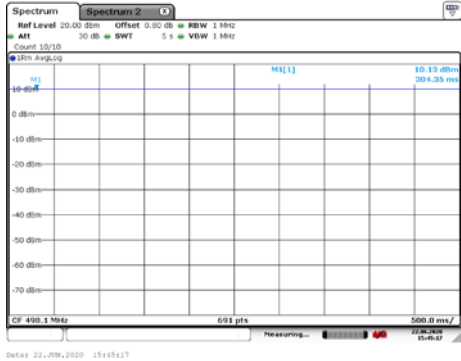
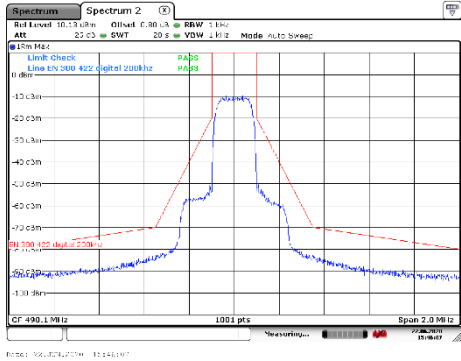
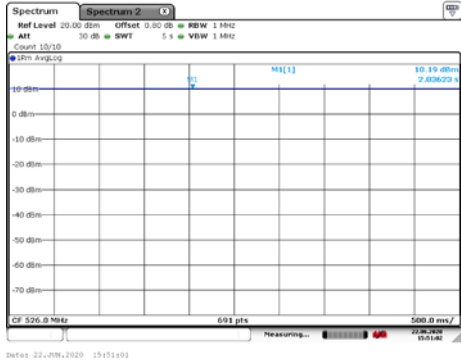
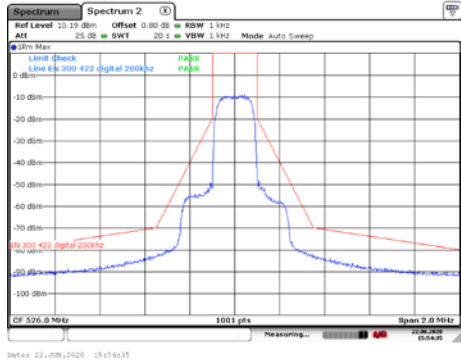


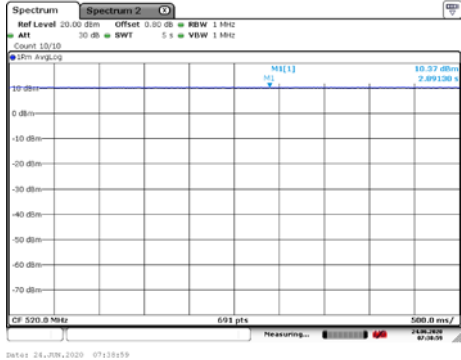
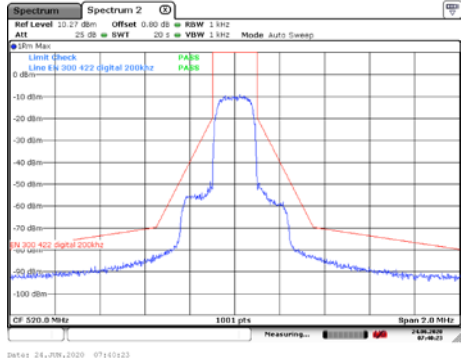
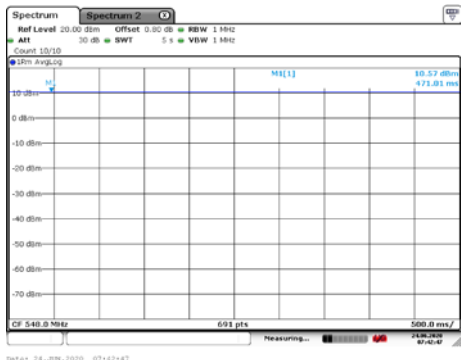
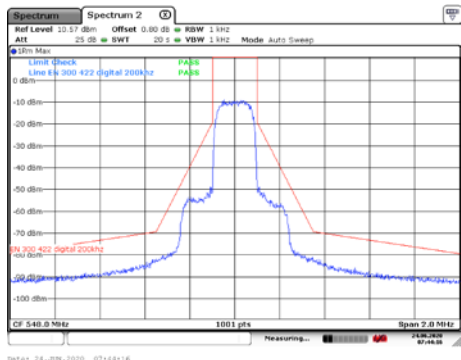
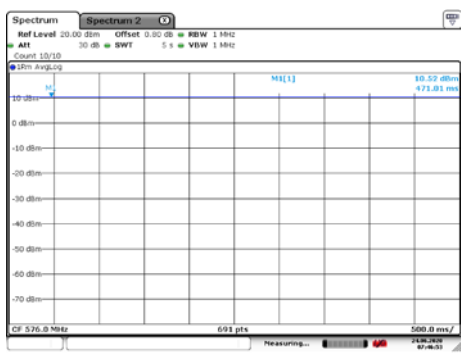
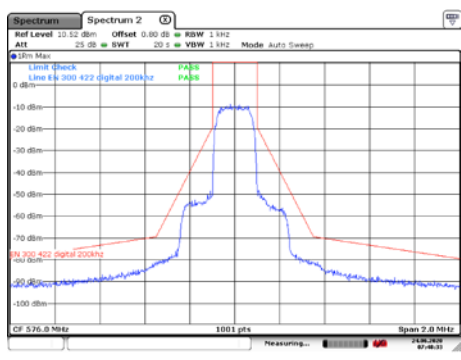
Figure 1: Spectrum mask for digital systems below 2 GHz

Results: See plots!

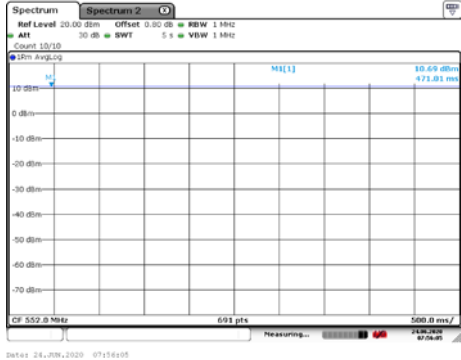
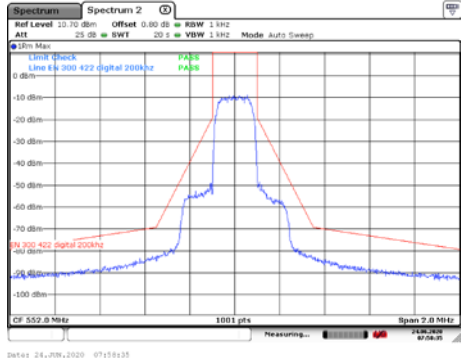
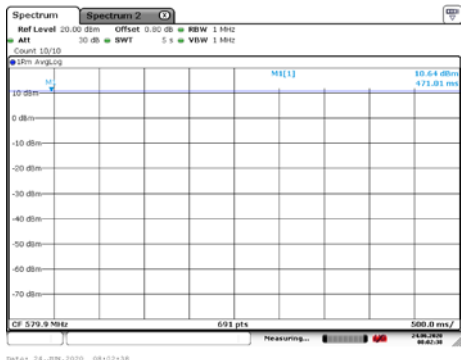
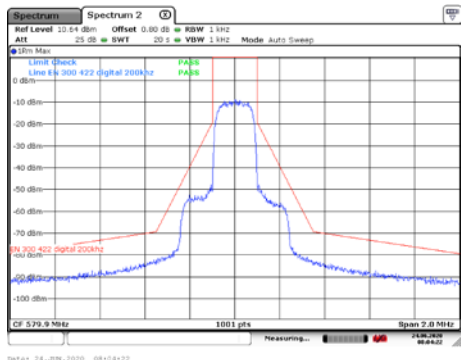
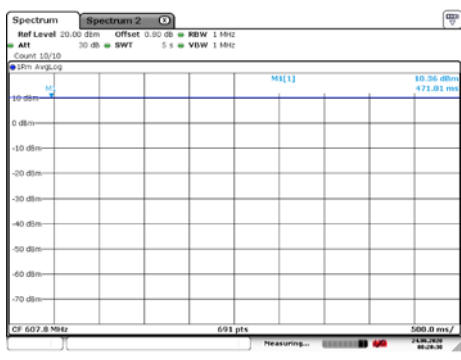
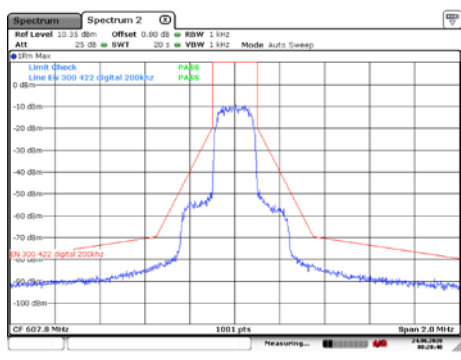
Plots: Frequency Range Q1-6

Frequency	Carrier power	Modulated carrier with the weighted noise source
470.2 MHz		
498.1 MHz		
526.0 MHz		

Plots: Frequency Range R1-6

Frequency	Carrier power	Modulated carrier with the weighted noise source
520.0 MHz		
548.0 MHz		
576.0 MHz		

Plots: Frequency Range R4-9

Frequency	Carrier power	Modulated carrier with the weighted noise source
552.0 MHz		
579.9 MHz		
607.8 MHz		

11.6 Modulation characteristics

Method of measurement:

The audio frequency response was measured in accordance with EIA/TIA 603. The plots shows 10 curves with different modulation levels, the test frequency is varied from 15 Hz to 20 kHz.

This test item is not tested, because the EUT uses digital modulation

11.7 Frequency modulation

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 % to 5 % of the occupied bandwidth
Video bandwidth:	3 x resolution bandwidth
Span:	2 x emission bandwidth
Trace mode:	Max. hold
Analyzer function:	99% power occupied bandwidth function
EUT:	Modulated signal with frequency varied between 50 Hz and 15 kHz
Test setup:	See sub clause 7.2 - D
Measurement uncertainty:	See sub clause 9

Limits:

FCC & IC
Frequency deviation up to a maximum of ± 75 kHz

This test item is not tested, because the EUT uses digital modulation

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/N₀	Carrier to noise-density ratio, expressed in dB-Hz

13 Document history

Version	Applied changes	Date of release
-/-	Initial release	2020-07-21
A	reference to external documents changed	2020-07-28
B	Editorial changes	2020-08-27

14 Accreditation Certificate – D-PL-12076-01-04

first page	last page
 Deutsche Akkreditierungsstelle GmbH Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition Accreditation  The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields: Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 7 pages. Registration number of the certificate: D-PL-12076-01-04 Frankfurt am Main, 13.01.2019  Dr. med. Uwe Zimmermann Head of Division	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.eu

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-12076-01-04.pdf>

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

first page	last page
 Deutsche Akkreditierungsstelle GmbH Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition Accreditation  The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields: Telecommunication (FCC Requirements) The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 5 pages. Registration number of the certificate: D-PL-12076-01-05 Frankfurt am Main, 11.01.2019  Dr. Peter Uwe Zimmermann Head of Division	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkks). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkks. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkks is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.eu

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