



TEST REPORT

BNetzA-CAB-02/21-102

Test report no.: 1-6002_23-01-09

Testing laboratory

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

Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12047-01-00.

ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

Sennheiser electronic GmbH & Co. KG
Am Labor 1
30900 Wedemark / GERMANY
Phone: +49 5130 600-0
Contact: Ouajdi Ochi
e-mail: Ouajdi.Ochi@sennheiser.com

Manufacturer

Sennheiser electronic GmbH & Co. KG
Am Labor 1
30900 Wedemark / GERMANY

Test standard/s

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

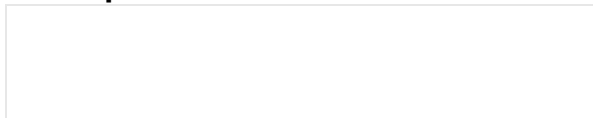
For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item: Tablestand Transmitter
Model name: EW-DX TS
FCC ID: DMOTSEWDX
ISED certification number: 2099A-TSEWDX
Frequency range: 470 MHz to 608 MHz
Technology tested: proprietary
Antenna: Integrated monopole antenna
Power supply: 2.00 V to 4.35 V DC by Li Ion battery
Temperature range: -10°C to +50°C

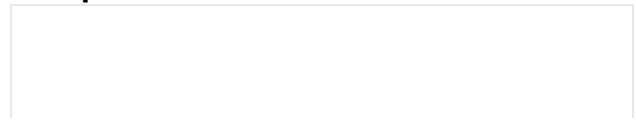
This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:



Christoph Schneider
Lab Manager
Radio Labs

Test performed:



Tobias Wittenmeier
Testing Manager
Radio Labs

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.....	8
7.1	Shielded fully anechoic chamber.....	9
7.2	Conducted measurements normal and extreme conditions	10
7.3	AC conducted.....	11
8	Sequence of testing.....	12
8.1	Sequence of testing radiated spurious 30 MHz to 12.75 GHz.....	12
9	Measurement uncertainty.....	13
10	Summary of measurement results	14
11	Additional comments	15
12	Measurement results	16
12.1	Transmitter output power	16
12.2	Occupied bandwidth	24
12.3	Transmitter frequency stability.....	31
12.4	Transmitter unwanted emissions (radiated).....	35
12.5	Necessary bandwidth (BN) for digital systems	42
12.6	Conducted limits	47
13	Observations.....	49
14	Glossary.....	50
15	Document history.....	51

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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 cetecom advanced GmbH.

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

cetecom 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 cetecom 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 cetecom advanced GmbH test report include or imply any product or service warranties from cetecom advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced GmbH.

All rights and remedies regarding vendor's products and services for which cetecom advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by cetecom 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.

2.2 Application details

Date of receipt of order:	2023-11-06
Date of receipt of test item:	2023-11-13
Start of test:*	2023-11-15
End of test:*	2023-12-15
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

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 C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

4 Reporting statements of conformity – decision rule

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

measured value, measurement uncertainty, verdict



5 Test environment

Temperature	:	T_{nom} +22 °C during room temperature tests T_{max} +50 °C during high temperature tests T_{min} -30 °C during low temperature tests
Relative humidity content	:	55 %
Barometric pressure	:	1021 hpa
Power supply	:	V_{nom} 3.80 V DC by Li Ion battery V_{max} 4.35 V V_{min} 2.00 V

6 Test item

6.1 General description

Kind of test item	:	Tablestand Transmitter
Model name	:	EW-DX TS
Series	:	Evolution Wireless Digital
HMN	:	-/-
PMN	:	EW-DX TS
HVIN	:	EW-DX TS
FVIN	:	1v3
S/N serial number	:	Rad. 470 MHz – 550 MHz: 1433000053 520 MHz – 608 MHz: 1433000035 Cond. 470 MHz – 550 MHz: 1433000053 520 MHz – 608 MHz: 1433000035
Hardware status	:	593619
Software status	:	1v3
Firmware status	:	-/-
Frequency band	:	470 MHz to 608 MHz
Type of radio transmission	:	Modulated carrier
Use of frequency spectrum	:	
Type of modulation	:	Pi/4 DQPSK
Number of channels	:	Tuning step size: 25 kHz
Antenna	:	Integrated monopole antenna
Power supply	:	2.00 V to 4.35 V DC by Li Ion battery
Temperature range	:	-10°C to +50°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:

- 1-6002_23-01-01_AnnexA
- 1-6002_23-01-01_AnnexB
- 1-6002_23-01-01_AnnexD

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).

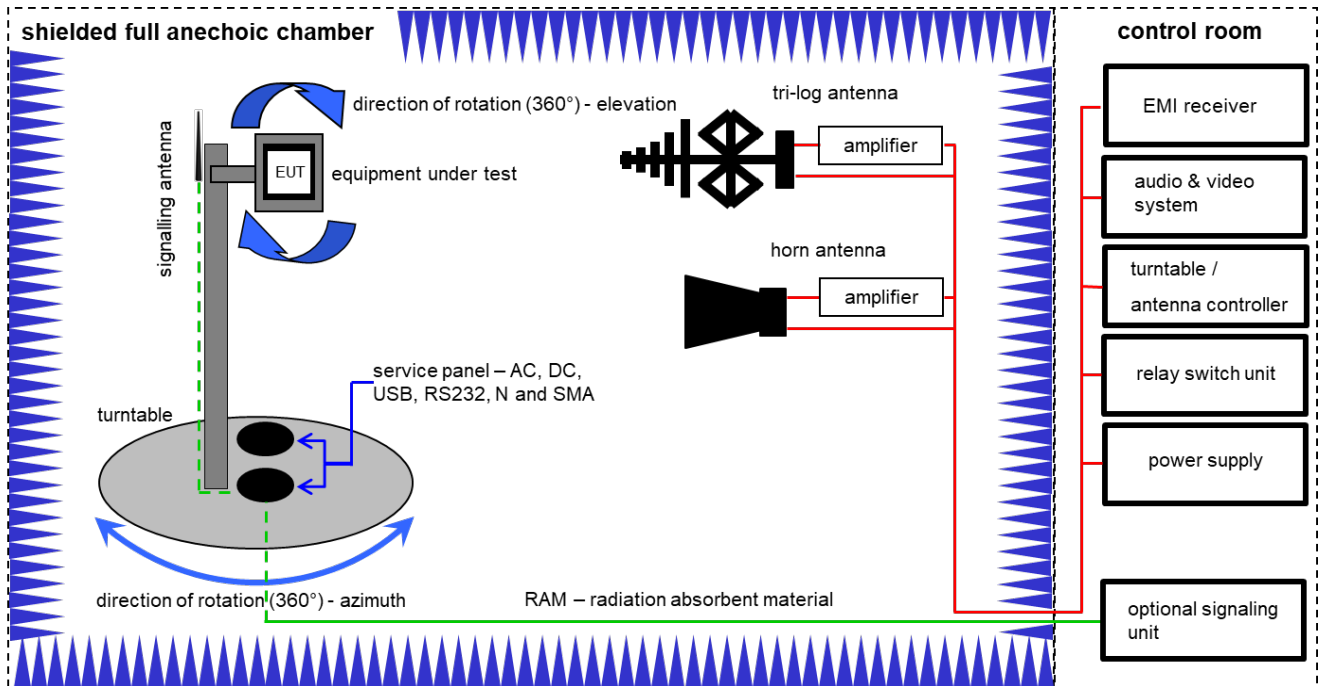
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

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)

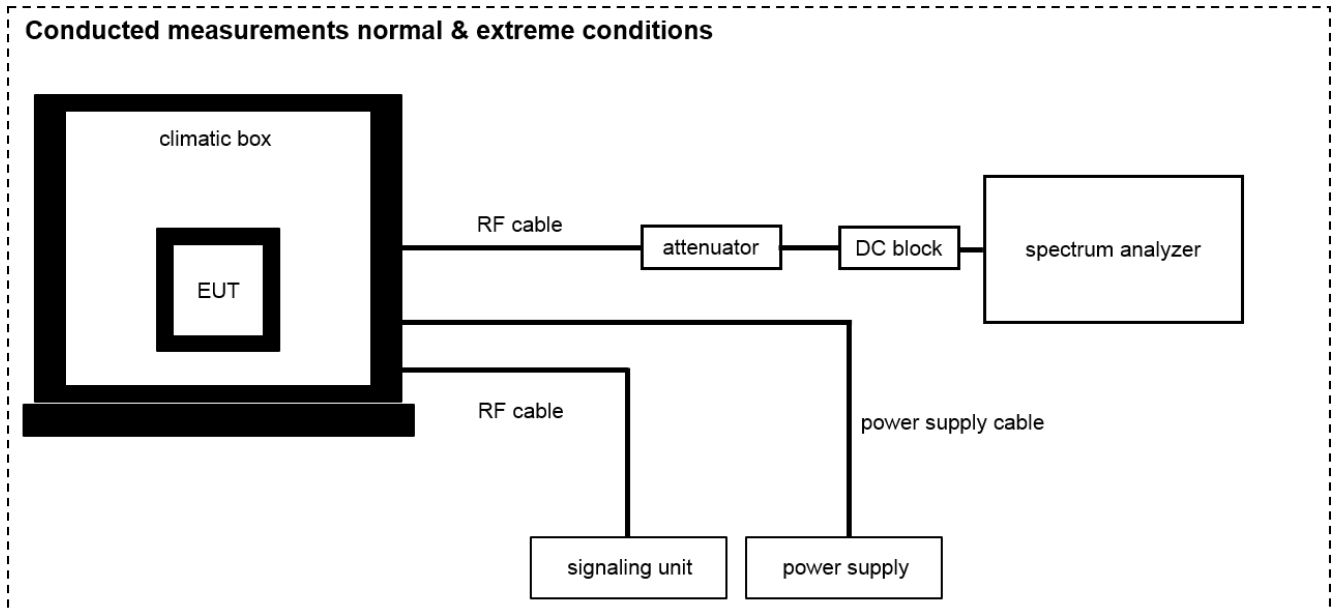
Example calculation:

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

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
2	A,B	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
3	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3089	300000307	vKI!	11.02.2022	29.02.2024
4	B	Highpass Filter	WHKX2.9/18G-12SS	Wainwright	1	300003492	ev	-/-	-/-
5	A,B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	07.12.2022	31.12.2023
6	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
7	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
8	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vKI!	30.09.2023	29.09.2025
9	A,B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A,B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	A,B	NEXIO EMV-Software	BAT EMC V2022.0.32.0	Nexio		300004682	ne	-/-	-/-

7.2 Conducted measurements normal and extreme conditions



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

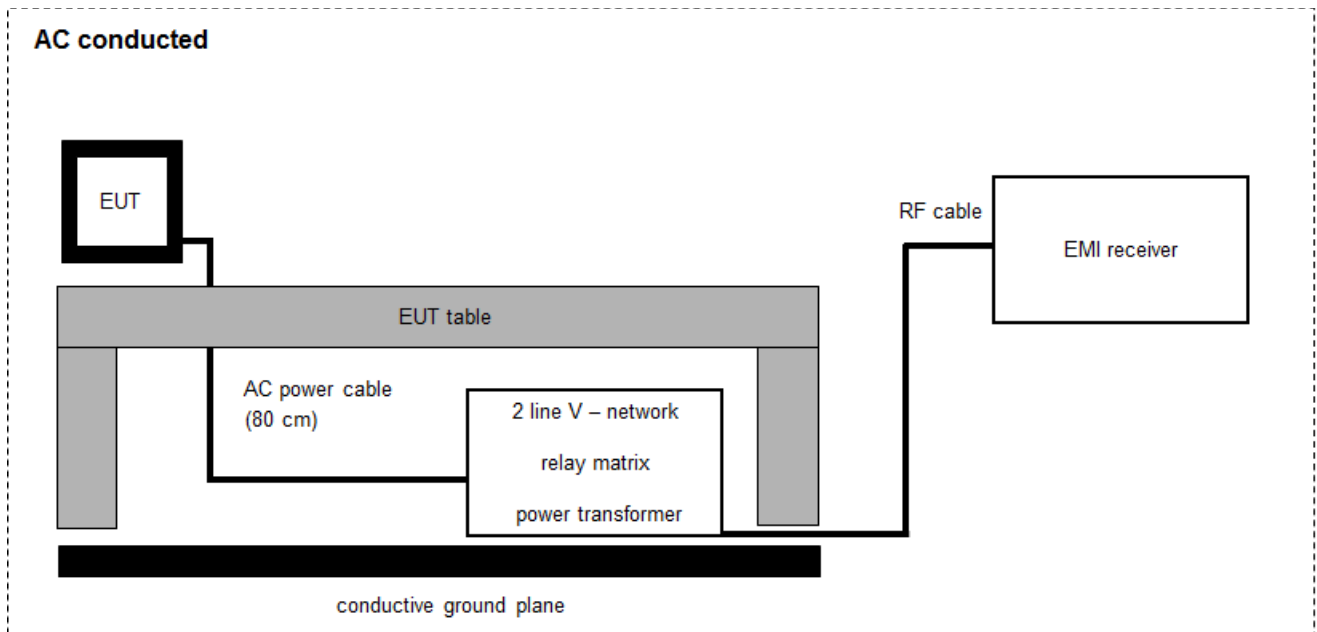
Example calculation:

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

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B	Signal analyzer	FSW26	Rohde&Schwarz	101455	300004528	k	07.12.2022	31.12.2023
2	A,B	RF-Cable SRD021 No. 1	Enviroflex 316 D	Huber & Suhner		400001311	ev	-/-	-/-
3	B	Temperature Test Chamber	VT 4011	Voetsch Industrietechnik	58566230600010	300005363	ev	09.05.2022	31.05.2024
4	B	Power Supply	HMP2020	Rohde & Schwarz	102219	300006192	k	15.12.2022	31.12.2024

7.3 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:

$$FS [dB\mu V/m] = 37.62 [dB\mu V/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dB\mu V/m] (244.06 \mu V/m)$$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	Rohde & Schwarz	892475/017	300002209	vIK!	14.12.2021	31.12.2023
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIK!	29.12.2021	31.12.2023
4	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
5	A	PC	TecLine	F+W		300003532	ne	-/-	-/-
6	A	EMI Test Receiver 3.6 GHz	ESR3	Rohde & Schwarz	102981	300006318	k	09.12.2022	31.12.2023

8 Sequence of testing

8.1 Sequence of testing radiated spurious 30 MHz to 12.75 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.

9 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

10 Summary of measurement results

<input checked="" type="checkbox"/>	No deviations from the technical specifications were ascertained
<input type="checkbox"/>	There were deviations from the technical specifications ascertained
<input type="checkbox"/>	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 9 RSS-Gen Issue 4	See table!	2024-01-03	-/-

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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
FCC Part 74.861 (e)(5) FCC Part 2.1049 RSS-210 – G.3.2 RSS-Gen – 6.6	Occupied bandwidth	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
FCC Part 74.861 (e)(4) FCC Part 2.1055 RSS-210 – G.3.3 RSS-Gen – 6.11	Transmitter frequency stability	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
		Extreme	Extreme	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
FCC Part 2.1047	Modulation characteristics	Nominal	Nominal	-/-				Digital modulation
FCC Part 74.861 (e)(7) ETSI EN 300 422-1 v1.4.2 (2011-08)	Necessary bandwidth (BN) for analogue systems	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
FCC Part 74.861 (e)(3) RSS-210 – G.3.5.2	Frequency modulation	Nominal	Nominal	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Digital modulation
FCC Part 74.861 (e)(7) RSS-210 – G.3.4	Receiver spurious emissions	Nominal	Nominal	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	No receiver integrated!
FCC Part 15.107(a) FCC Part 15.207	Conducted emissions < 30 MHz	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-

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

11 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: Frequency stability tests have been carried out in the temperature range from -30° to + 50° according the standard

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.*

12 Measurement results

12.1 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 normal mode:

Transmitter output power conducted						
Channels	Q1-9			R1-9		
Frequencies / MHz	470.2	510.0	550.0	520.0	564.0	607.8
Peak	13.81 dBm	14.12 dBm	13.87 dBm	14.13 dBm	14.34 dBm	14.08 dBm
Average	10.17 dBm	10.39 dBm	10.20 dBm	10.18 dBm	10.47 dBm	10.27 dBm

Transmitter output power e.i.r.p. / dBm						
Channels	Q1-9			R1-9		
Frequencies / MHz	470.2	510.0	550.0	520.0	564.0	607.8
Peak	9.38 dBm	13.12 dBm	13.48 dBm	13.14 dBm	15.65 dBm	13.27 dBm
Average	5.74 dBm	9.39 dBm	9.81 dBm	9.19 dBm	11.78 dBm	9.46 dBm

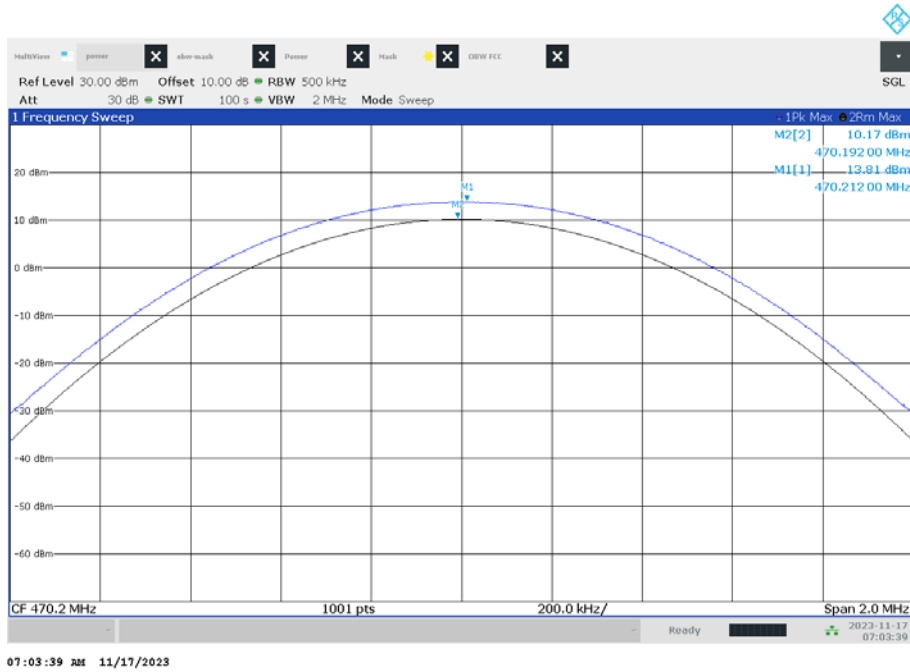
Result LD mode:

Transmitter output power conducted / dBm						
Channels	Q1-9			R1-9		
Frequencies / MHz	470.2	510.0	550.0	520.0	564.0	607.8
Peak	13.87 dBm	14.17 dBm	13.94 dBm	14.08 dBm	14.27 dBm	14.08 dBm
Average	10.20 dBm	10.45 dBm	10.28 dBm	10.14 dBm	10.44 dBm	10.27 dBm

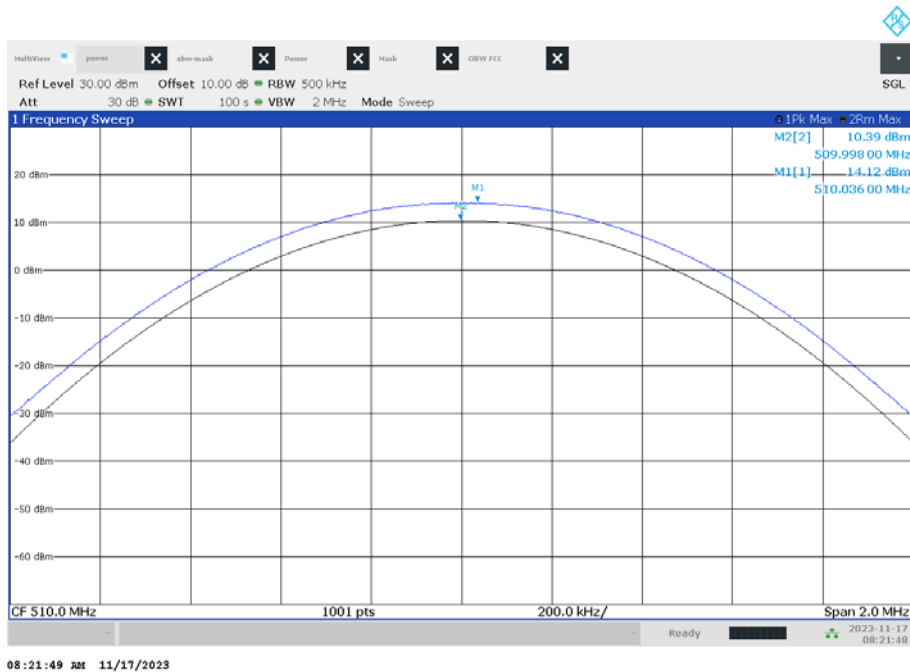
Transmitter output power e.i.r.p. / dBm						
Channels	Q1-9			R1-9		
Frequencies / MHz	470.2	510.0	550.0	520.0	564.0	607.8
Peak	9.78 dBm	12.83 dBm	13.37 dBm	13.24 dBm	16.40 dBm	13.82 dBm
Average	6.11 dBm	9.11 dBm	9.71 dBm	9.30 dBm	12.57 dBm	10.01 dBm

Plots output power conducted, normal mode:

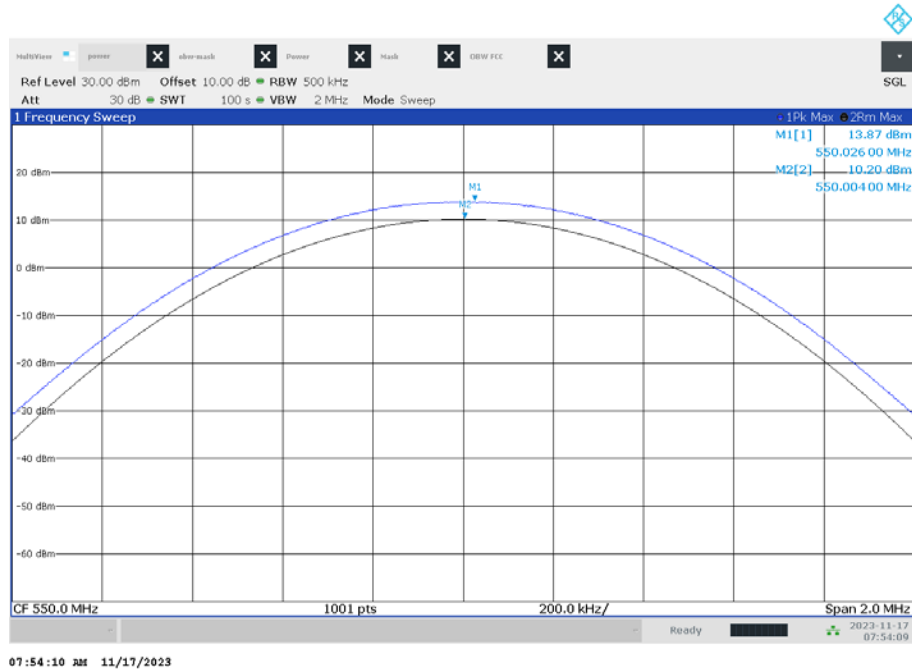
Plot 1: 470.200 MHz



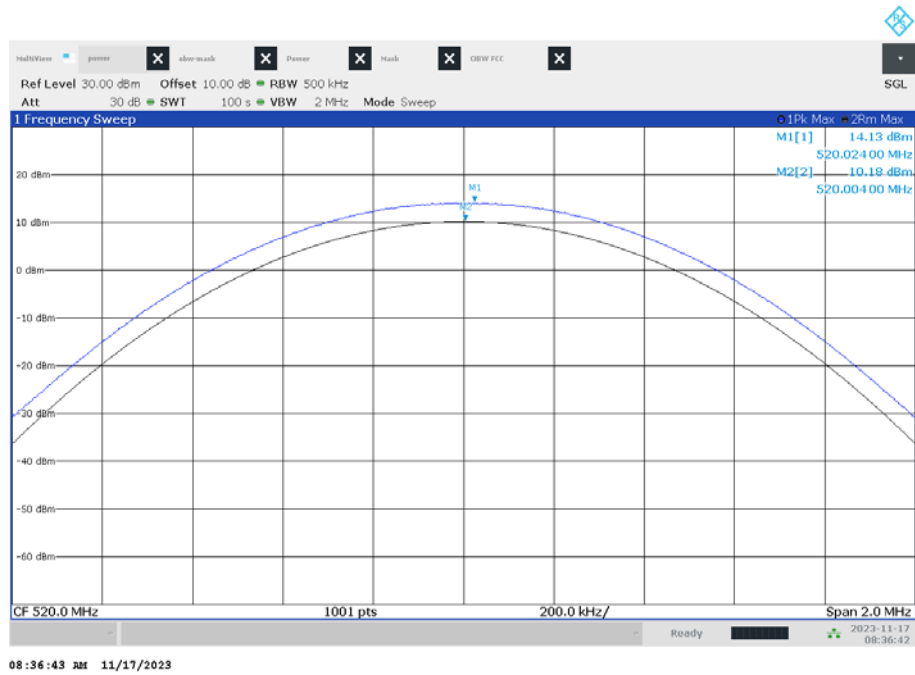
Plot 2: 510.000 MHz



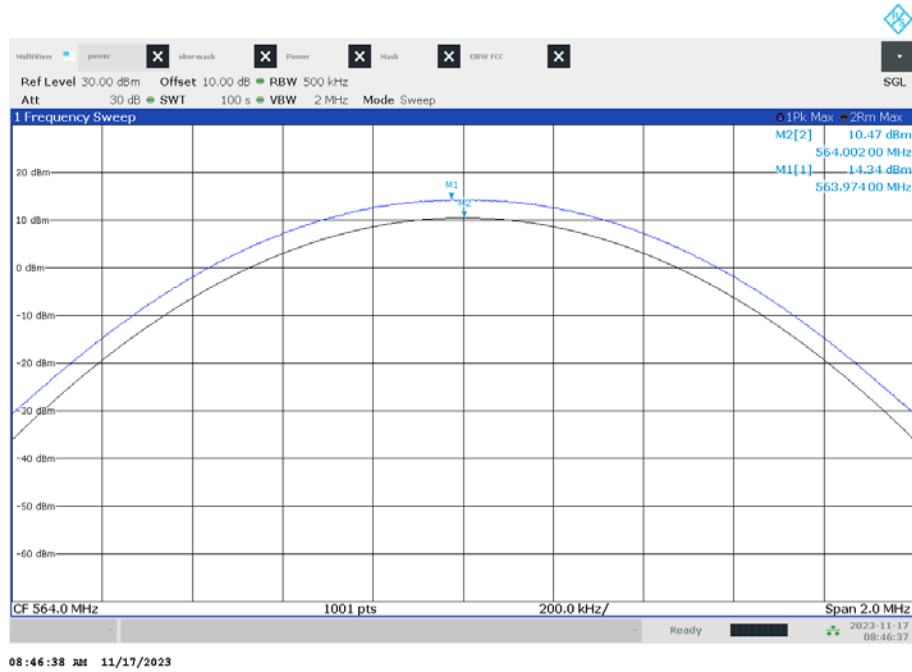
Plot 3: 550.0 MHz



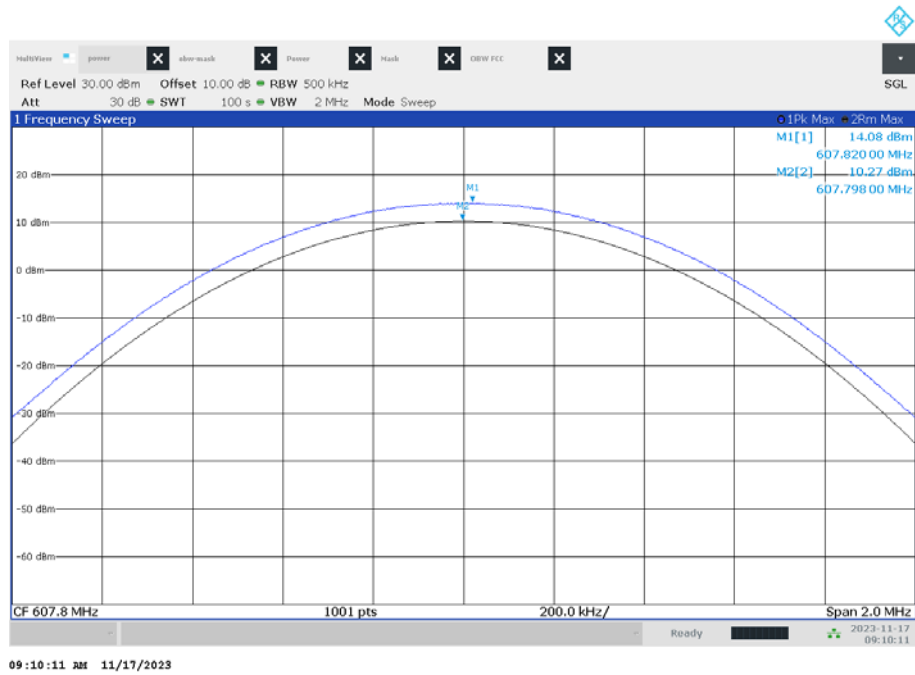
Plot 4: 520.000 MHz



Plot 5: 564.000 MHz

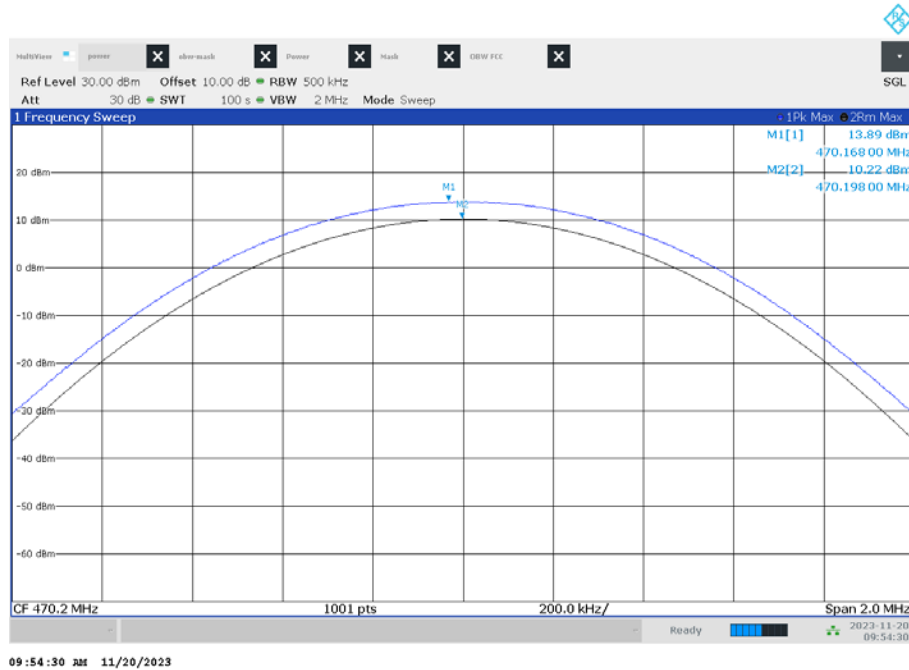


Plot 6: 607.8 MHz

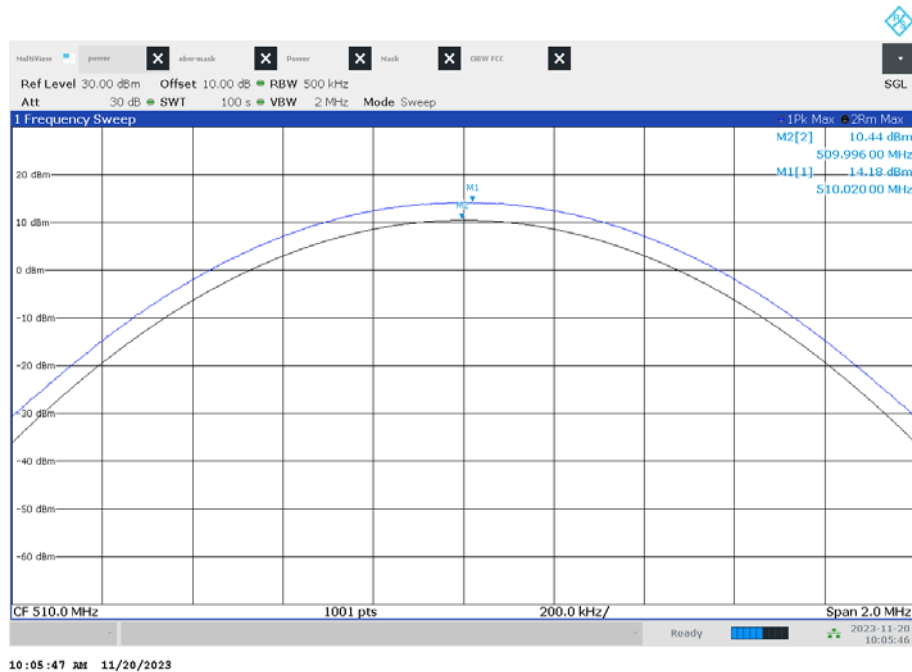


Plots output power conducted, LD mode:

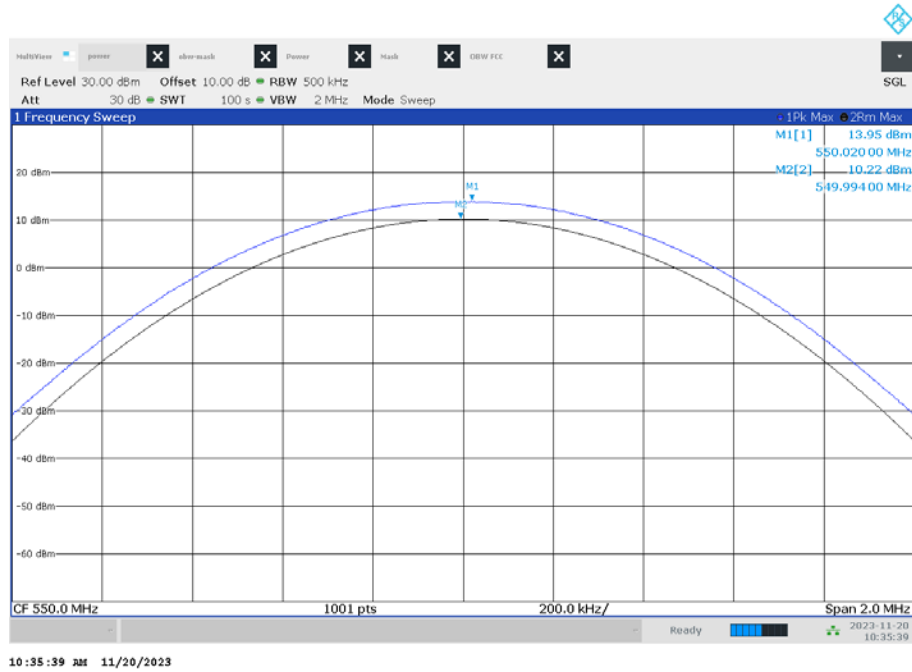
Plot 1: 470.200 MHz



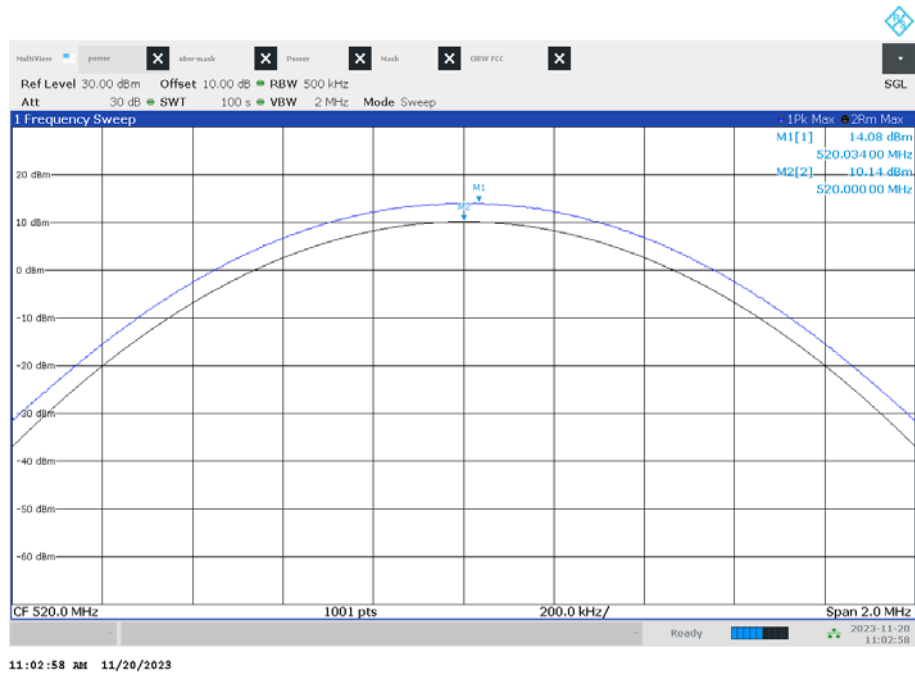
Plot 2: 510.000 MHz



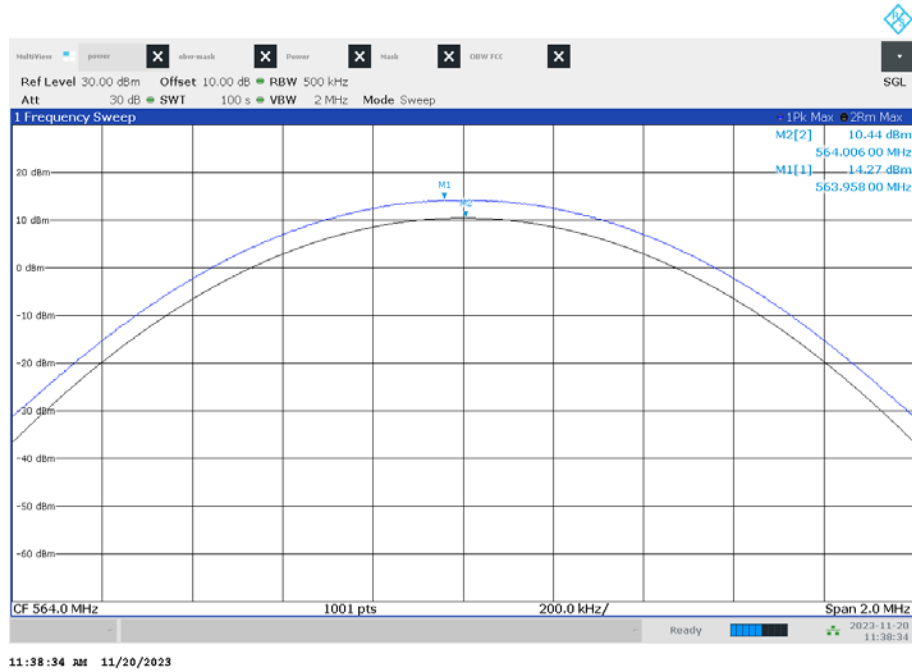
Plot 3: 550.0 MHz



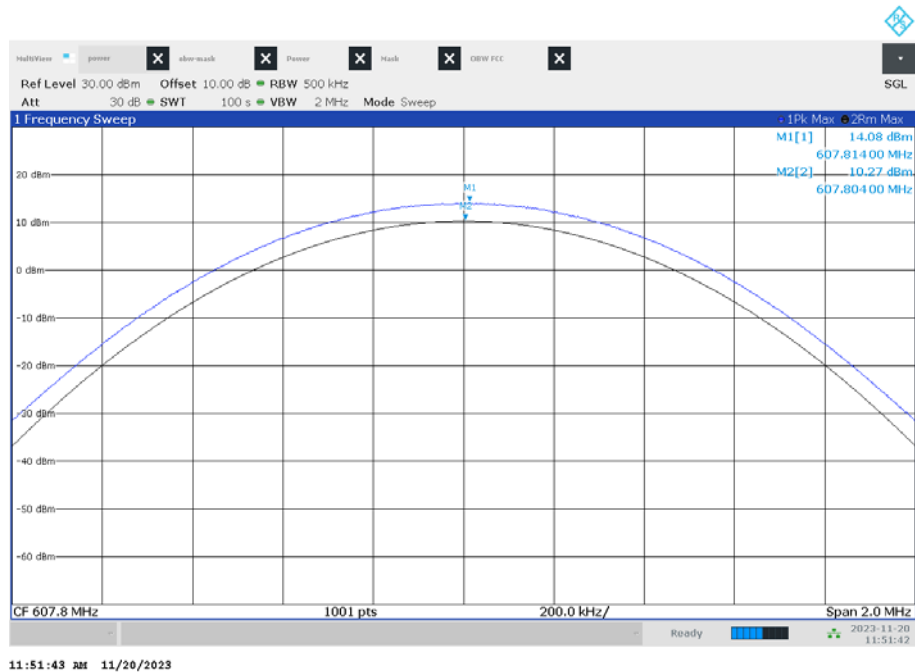
Plot 4: 520.000 MHz



Plot 5: 564.000 MHz



Plot 6: 607.8 MHz



12.2 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.

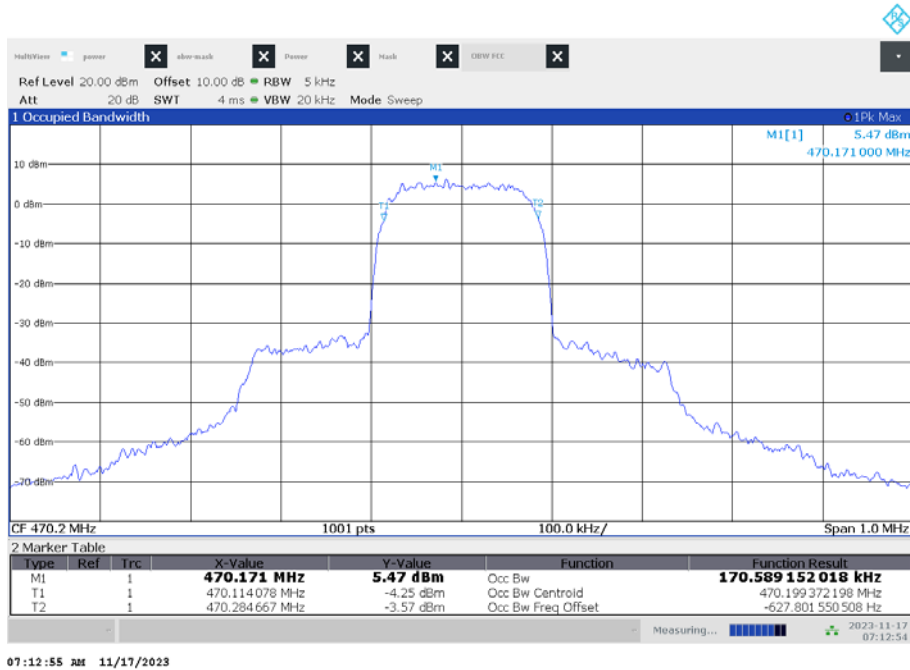
Result:

Normal mode	
Centre frequency (fc)	OBW
470.200 MHz	170.589 kHz
510.000 MHz	171.768 kHz
550.000 MHz	170.933 kHz
520.000 MHz	170.798 kHz
564.000 MHz	170.044 kHz
607.800 MHz	170.985 kHz

LD-mode	
Centre frequency (fc)	OBW
470.200 MHz	142.837 kHz
510.000 MHz	143.806 kHz
550.000 MHz	143.846 kHz
520.000 MHz	142.924 kHz
564.000 MHz	143.419 kHz
607.800 MHz	143.270 kHz

Plots normal mode:

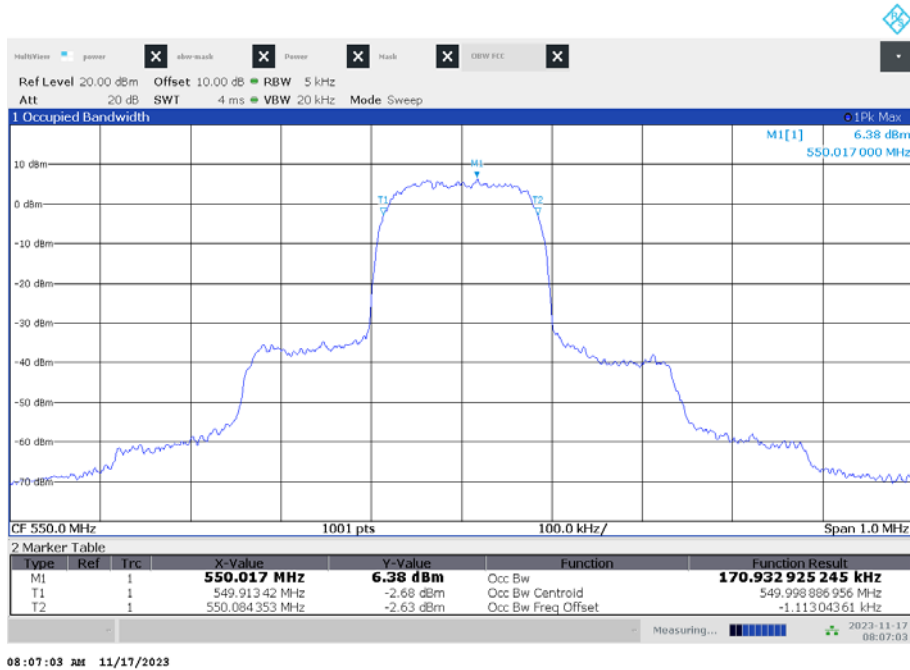
Plot 1: 470.200 MHz, OBW



Plot 2: 510.000 MHz, OBW



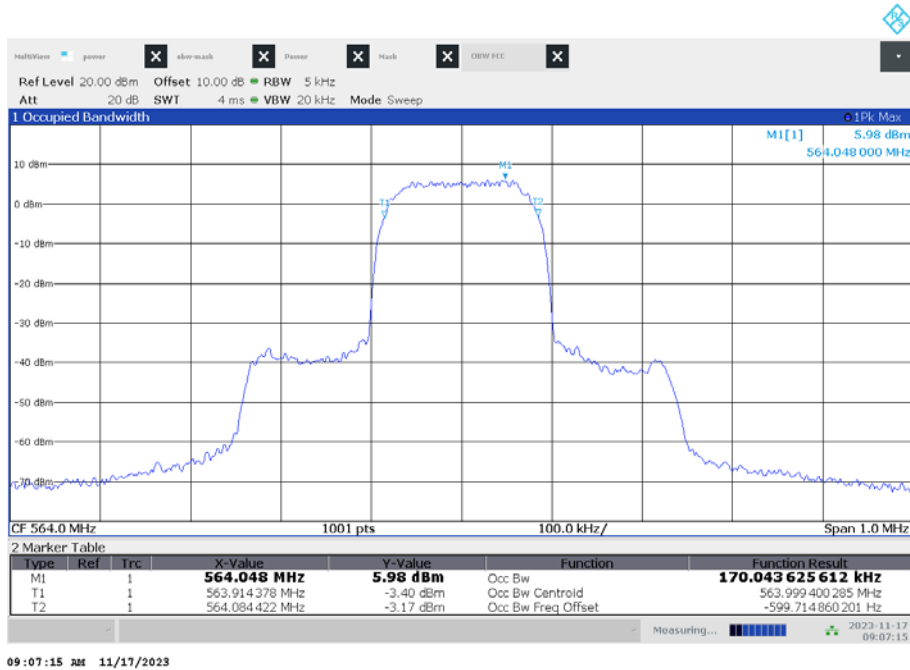
Plot 3: 550.000 MHz, OBW



Plot 4: 520.000 MHz, OBW



Plot 5: 564.000 MHz, OBW

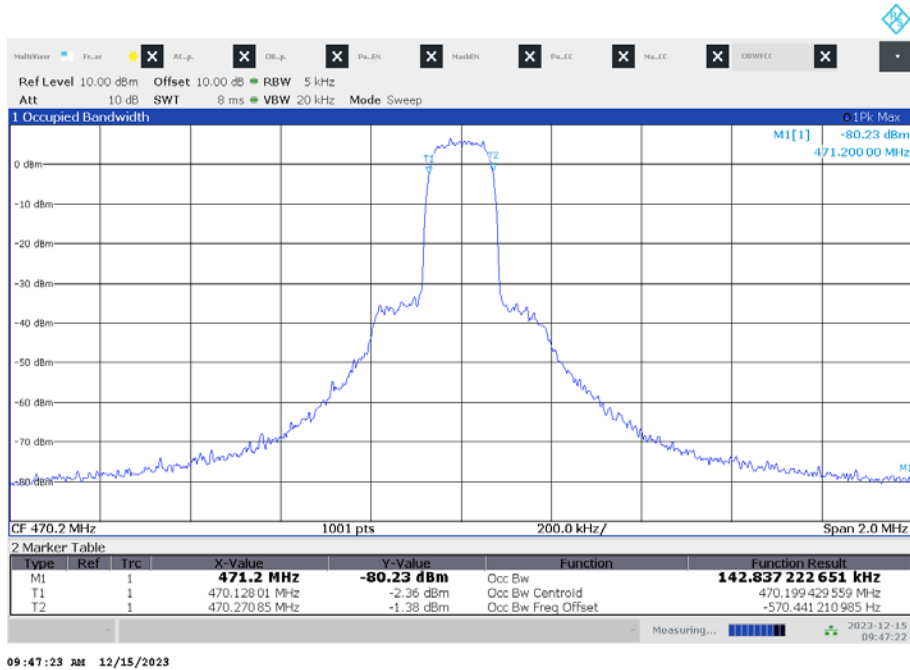


Plot 6: 607.800 MHz, OBW



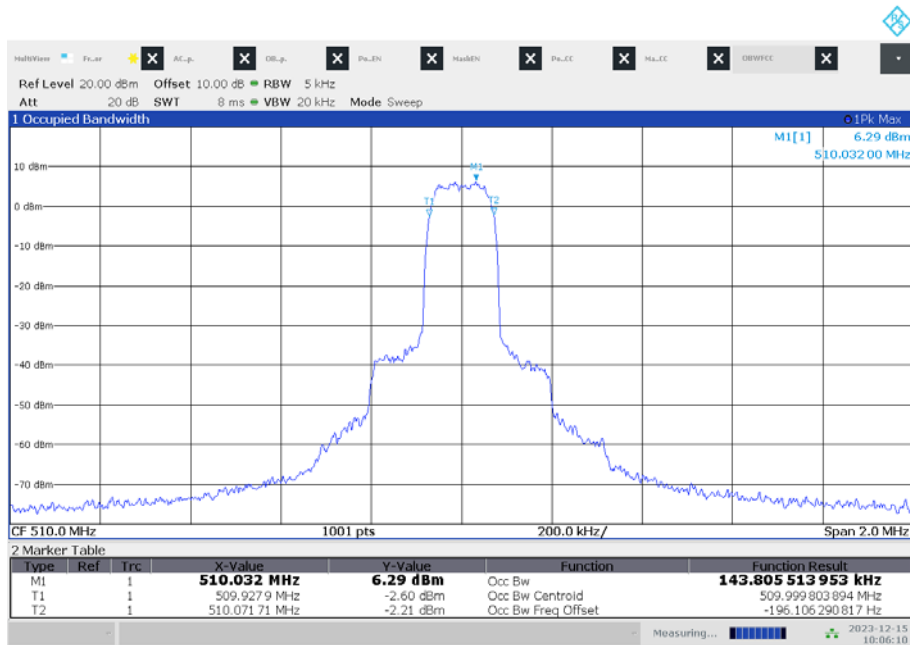
Plots LD mode:

Plot 1: 470.200 MHz, OBW



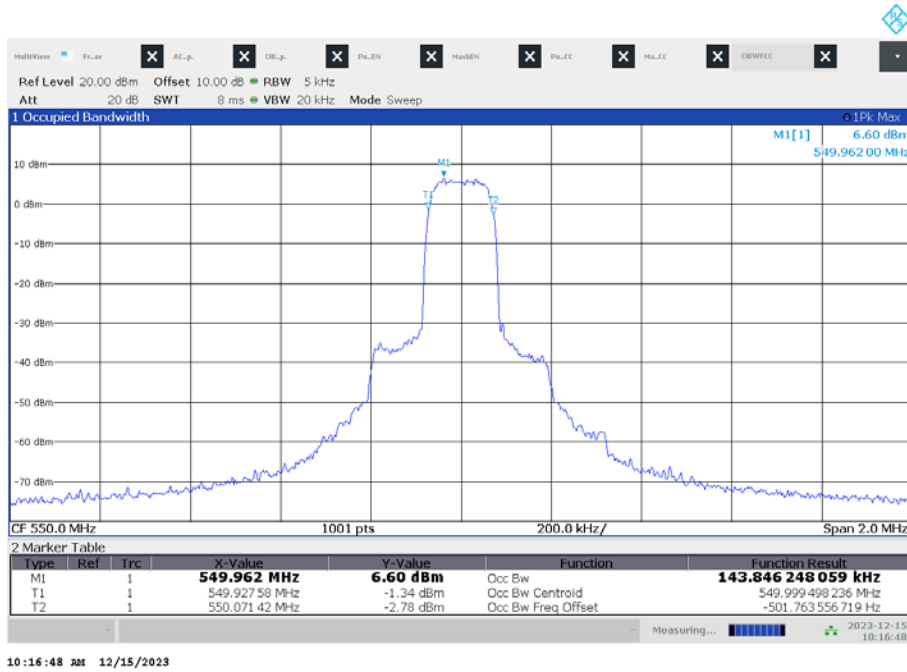
09:47:23 AM 12/15/2023

Plot 2: 510.000 MHz, OBW

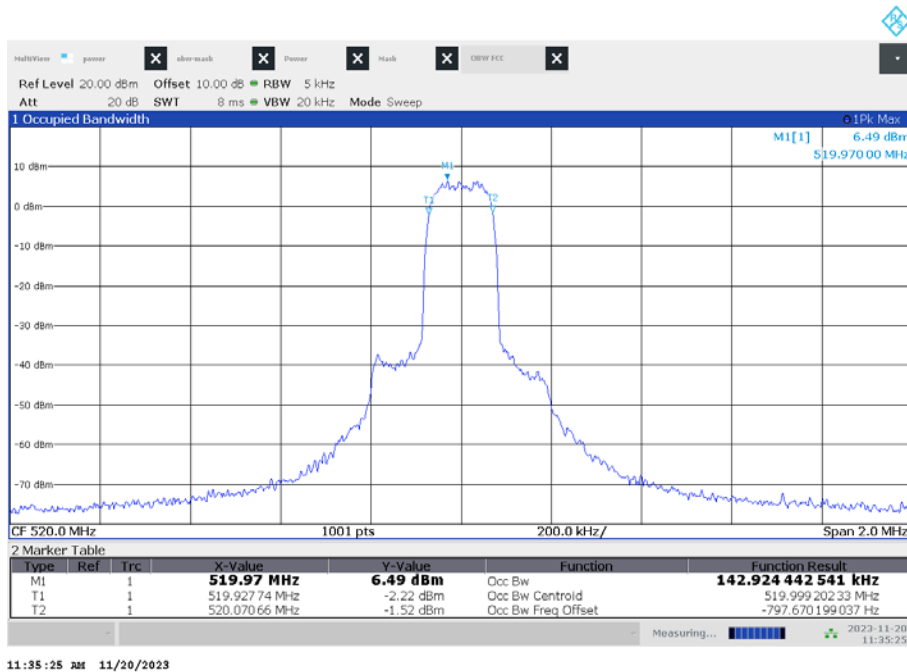


10:06:10 AM 12/15/2023

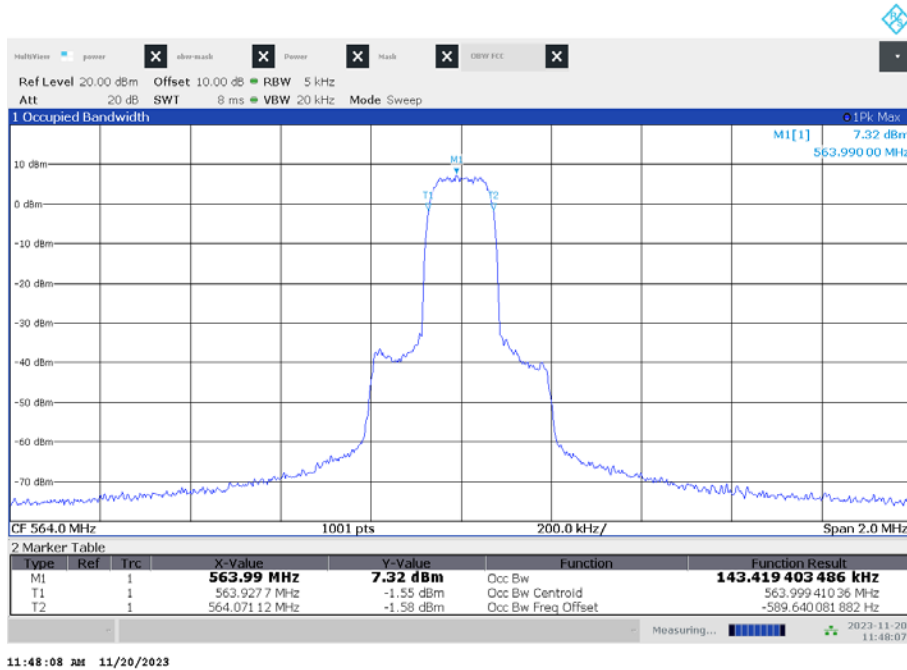
Plot 3: 550.000 MHz, OBW



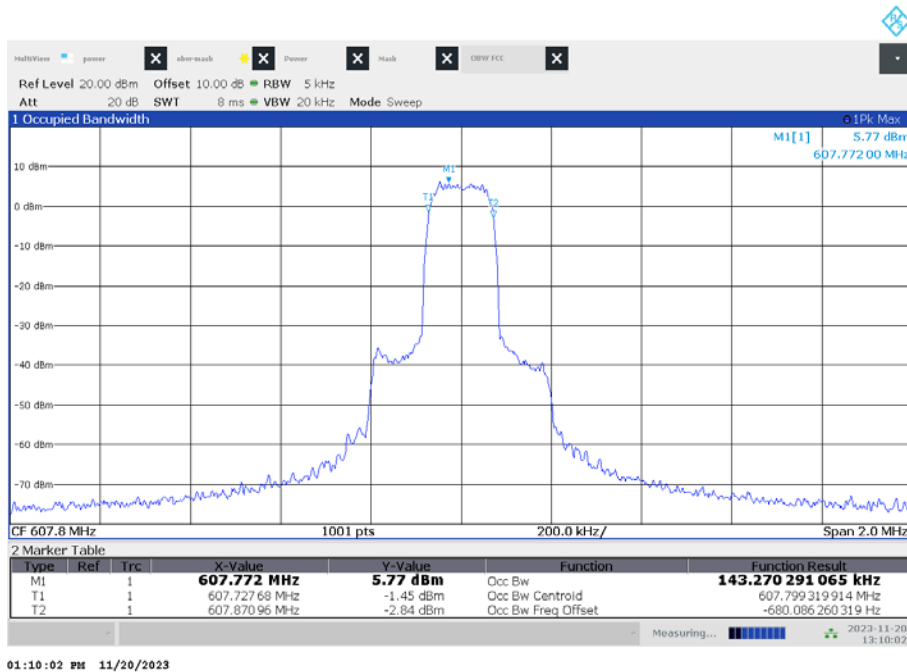
Plot 4: 520.000 MHz, OBW



Plot 5: 564.000 MHz, OBW



Plot 6: 607.800 MHz, OBW



12.3 Transmitter frequency stability

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 Hz / 10 Hz / 100 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: 470.200 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	470.199900	-0.100 / -0.21
-20 °C / V _{nom}	470.199328	-0.672 / 1.43
-10 °C / V _{nom}	470.199050	-0.950 / 2.02
0 °C / V _{nom}	470.200009	0.009 / 0.02
+10 °C / V _{nom}	470.200014	0.014 / 0.03
+20 °C / V _{nom}	470.200249	0.249 / 0.53
+30 °C / V _{nom}	470.199723	-0.277 / 0.59
+40 °C / V _{nom}	470.200306	0.306 / 0.65
+50 °C / V _{nom}	470.199610	-0.390 / 0.83
+20 °C / V _{nom} - 15%	470.199760	-0.239 / 0.51
+20 °C / V _{nom}	470.199807	-0.192 / 0.41
+20 °C / V _{nom} + 15%	470.199473	-0.524 / 1.12

Results: 510.000 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	509.999752	-0.248 / 0.49
-20 °C / V _{nom}	509.999459	-0.541 / 1.06
-10 °C / V _{nom}	509.999827	-0.173 / 0.34
0 °C / V _{nom}	509.999954	-0.046 / 0.09
+10 °C / V _{nom}	509.999567	-0.434 / 0.85
+20 °C / V _{nom}	509.999516	-0.485 / 0.95
+30 °C / V _{nom}	510.000051	0.051 / 0.10
+40 °C / V _{nom}	510.000556	0.556 / 1.09
+50 °C / V _{nom}	510.000342	0.342 / 0.67
+20 °C / V _{nom} - 15%	509.999903	-0.097 / 0.19
+20 °C / V _{nom}	510.000092	0.092 / 0.18
+20 °C / V _{nom} + 15%	509.999755	-0.245 / 0.48

Results: 550.000 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	549.999956	-0.044 / 0.08
-20 °C / V _{nom}	549.999588	-0.413 / 0.75
-10 °C / V _{nom}	549.999489	-0.512 / 0.93
0 °C / V _{nom}	549.999967	-0.033 / 0.06
+10 °C / V _{nom}	550.000209	0.209 / 0.38
+20 °C / V _{nom}	550.000319	0.319 / 0.58
+30 °C / V _{nom}	550.000495	0.495 / 0.90
+40 °C / V _{nom}	550.000154	0.154 / 0.28
+50 °C / V _{nom}	550.000215	0.215 / 0.39
+20 °C / V _{nom} - 15%	549.999769	-0.231 / 0.42
+20 °C / V _{nom}	549.999544	-0.457 / 0.83
+20 °C / V _{nom} + 15%	550.000319	0.319 / 0.58

Results: 520.000 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	519.999644	-0.356 / 0.68
-20 °C / V _{nom}	519.999792	-0.208 / 0.40
-10 °C / V _{nom}	519.999724	-0.276 / 0.53
0 °C / V _{nom}	519.999220	-0.780 / 1.50
+10 °C / V _{nom}	519.999542	-0.458 / 0.88
+20 °C / V _{nom}	519.999740	-0.260 / 0.50
+30 °C / V _{nom}	519.999589	-0.411 / 0.79
+40 °C / V _{nom}	519.999797	-0.203 / 0.39
+50 °C / V _{nom}	519.999808	-0.192 / 0.37
+20 °C / V _{nom} - 15%	519.999350	-0.650 / 1.25
+20 °C / V _{nom}	519.999984	-0.016 / 0.03
+20 °C / V _{nom} + 15%	519.999782	-0.218 / 0.42

Results: 564.000 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	564.000220	0.220 / 0.39
-20 °C / V _{nom}	563.999673	-0.327 / 0.58
-10 °C / V _{nom}	563.999515	-0.485 / 0.86
0 °C / V _{nom}	563.999594	-0.406 / 0.72
+10 °C / V _{nom}	563.999752	-0.248 / 0.44
+20 °C / V _{nom}	564.000259	0.259 / 0.46
+30 °C / V _{nom}	563.999650	-0.350 / 0.62
+40 °C / V _{nom}	564.000017	0.017 / 0.03
+50 °C / V _{nom}	564.000045	0.045 / 0.08
+20 °C / V _{nom} - 15%	564.000130	0.130 / 0.23
+20 °C / V _{nom}	564.000034	0.034 / 0.06
+20 °C / V _{nom} + 15%	563.999831	-0.169 / 0.30

Results: 607.8 MHz

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	607.799617	-0.383 / 0.63
-20 °C / V _{nom}	607.799125	-0.875 / 1.44
-10 °C / V _{nom}	607.799161	-0.839 / 1.38
0 °C / V _{nom}	607.799708	-0.292 / 0.48
+10 °C / V _{nom}	607.799301	-0.699 / 1.15
+20 °C / V _{nom}	607.799550	-0.450 / 0.74
+30 °C / V _{nom}	607.800024	0.024 / 0.04
+40 °C / V _{nom}	607.799611	-0.389 / 0.64
+50 °C / V _{nom}	607.799617	-0.383 / 0.63
+20 °C / V _{nom} - 15%	607.799672	-0.328 / 0.54
+20 °C / V _{nom}	607.799927	-0.073 / 0.12
+20 °C / V _{nom} + 15%	607.799848	-0.152 / 0.25

12.4 Transmitter unwanted emissions (radiated)

Measurement:

Measurement parameter							
Detector:	Peak (prescan) / RMS						
Sweep time:	Auto						
Resolution bandwidth:	<table border="0"> <tr> <td>25 MHz to 30 MHz</td> <td>9 kHz to 10 kHz</td> </tr> <tr> <td>30 MHz to 1 000 MHz</td> <td>100 kHz</td> </tr> <tr> <td>> 1 000 MHz</td> <td>1 MHz</td> </tr> </table>	25 MHz to 30 MHz	9 kHz to 10 kHz	30 MHz to 1 000 MHz	100 kHz	> 1 000 MHz	1 MHz
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 + 10log ₁₀ (mean output power in watts) dB

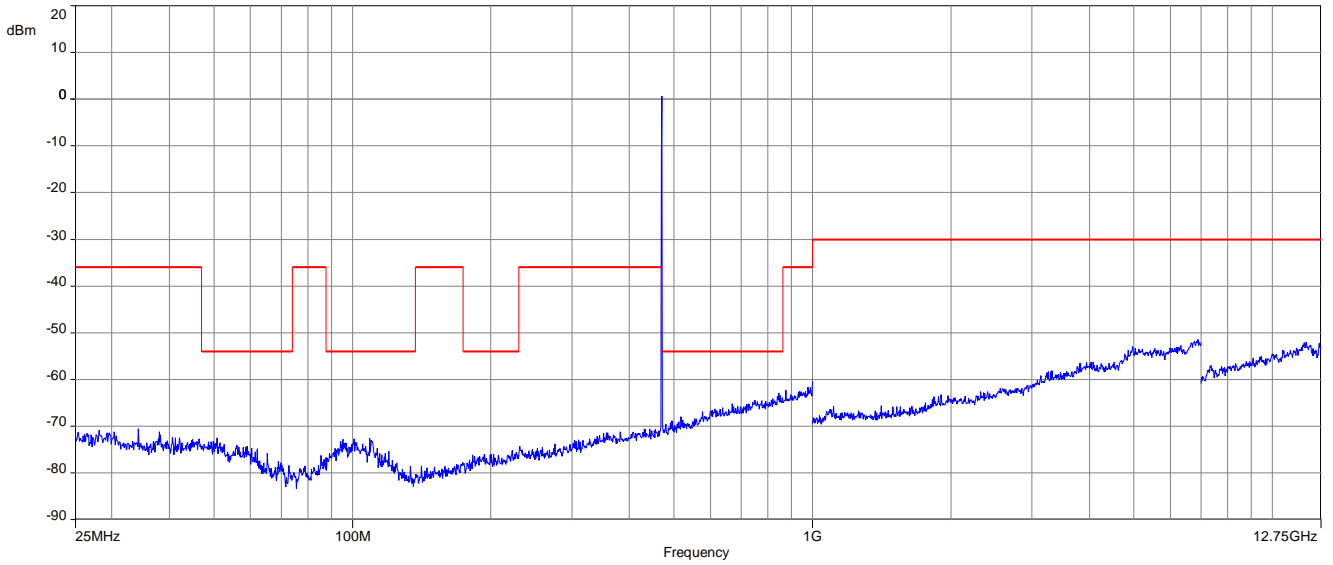
Results:

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

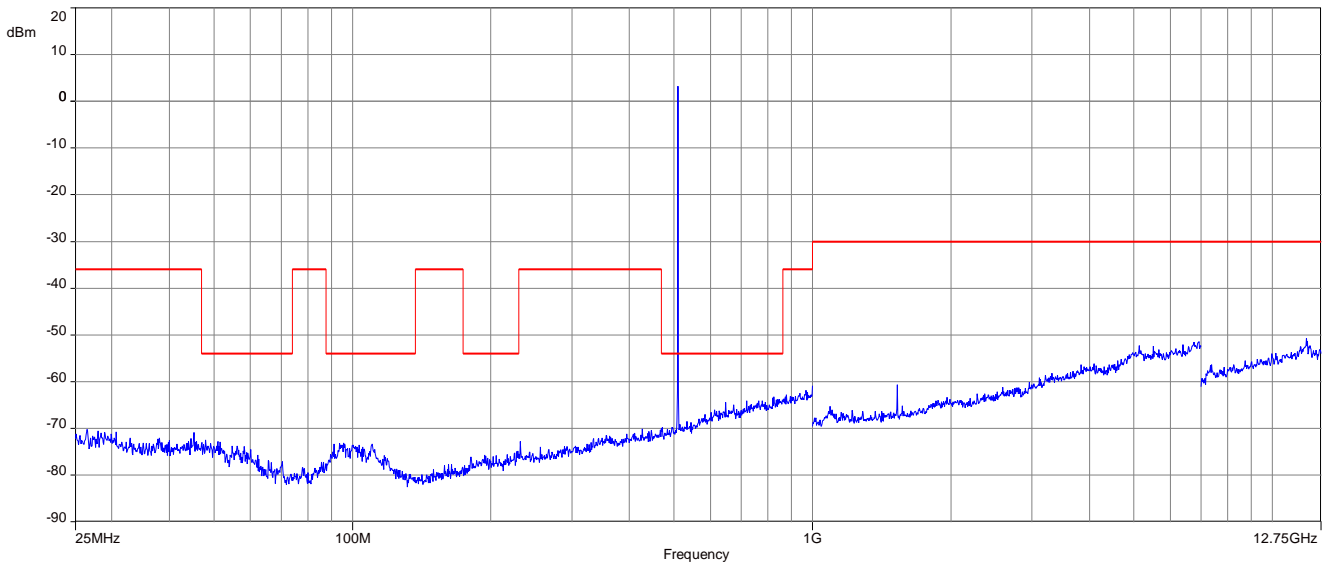
Plots: radiated

normal mode:

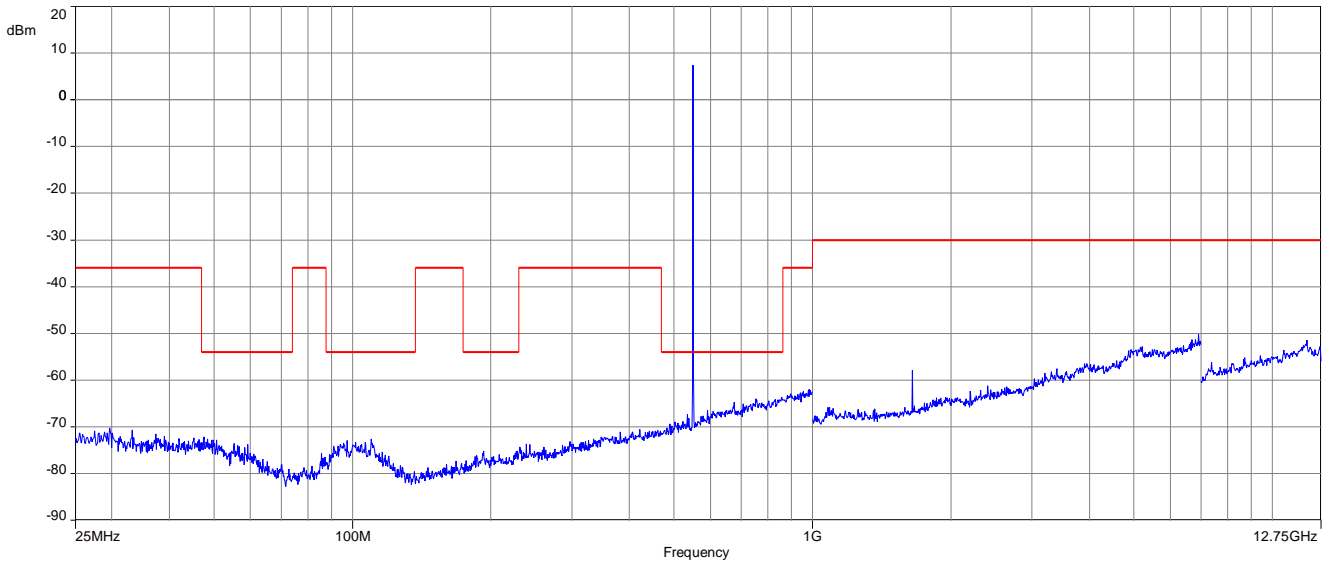
Plot 1: 470.200 MHz, 25 MHz – 12.75 GHz



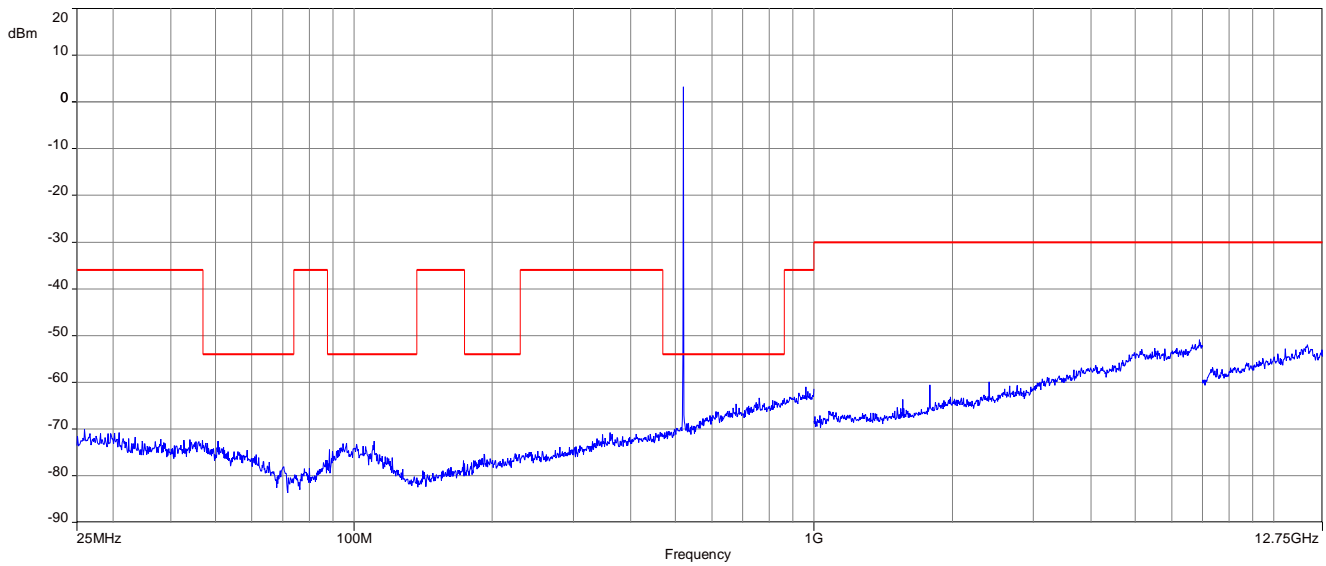
Plot 2: 510.000 MHz, 25 MHz – 12.75 GHz



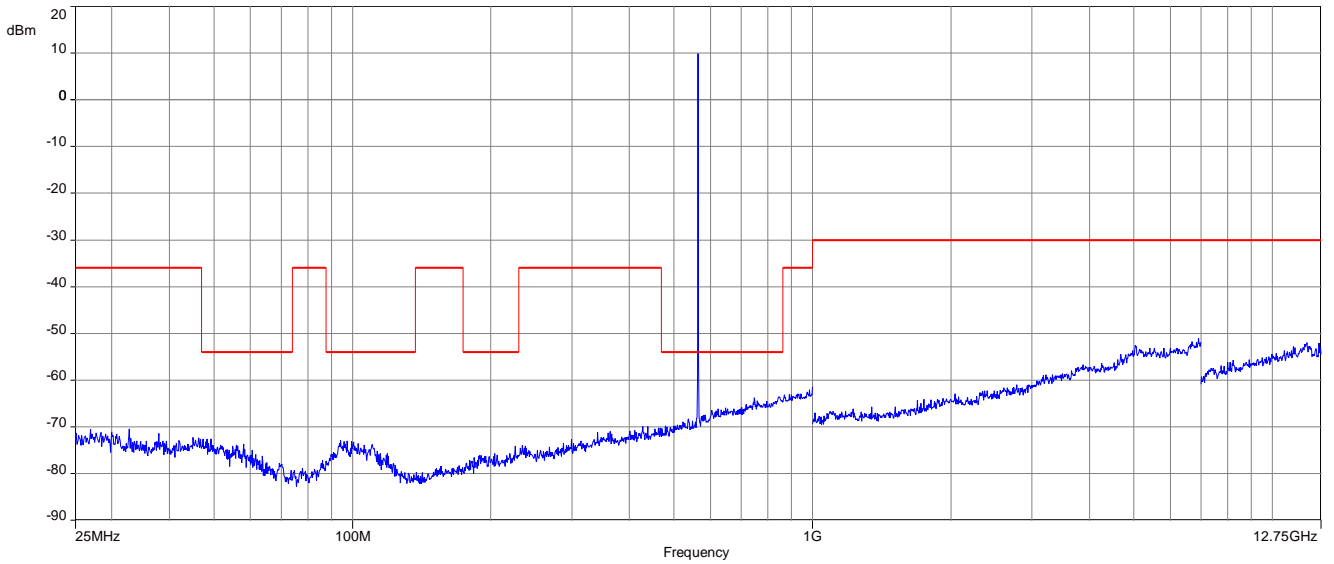
Plot 3: 550.000 MHz, 25 MHz – 12.75 GHz



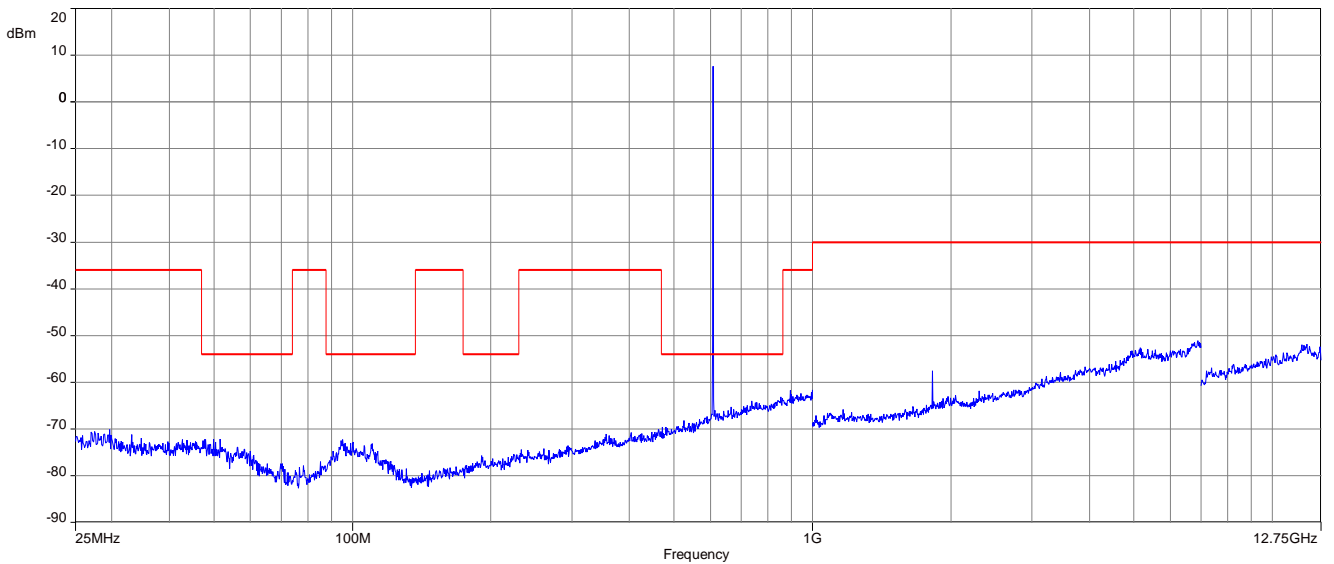
Plot 4: 520.000 MHz, 25 MHz – 12.75 GHz



Plot 5: 564.000 MHz, 25 MHz – 12.75 GHz

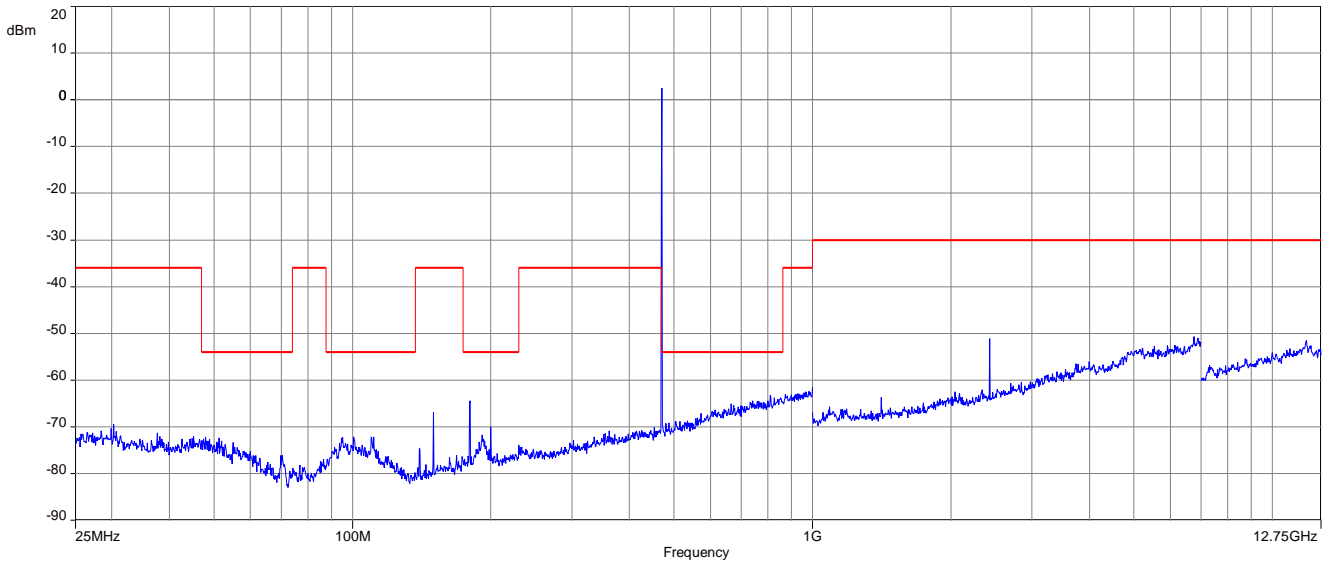


Plot 6: 607.800 MHz, 25 MHz – 12.75 GHz

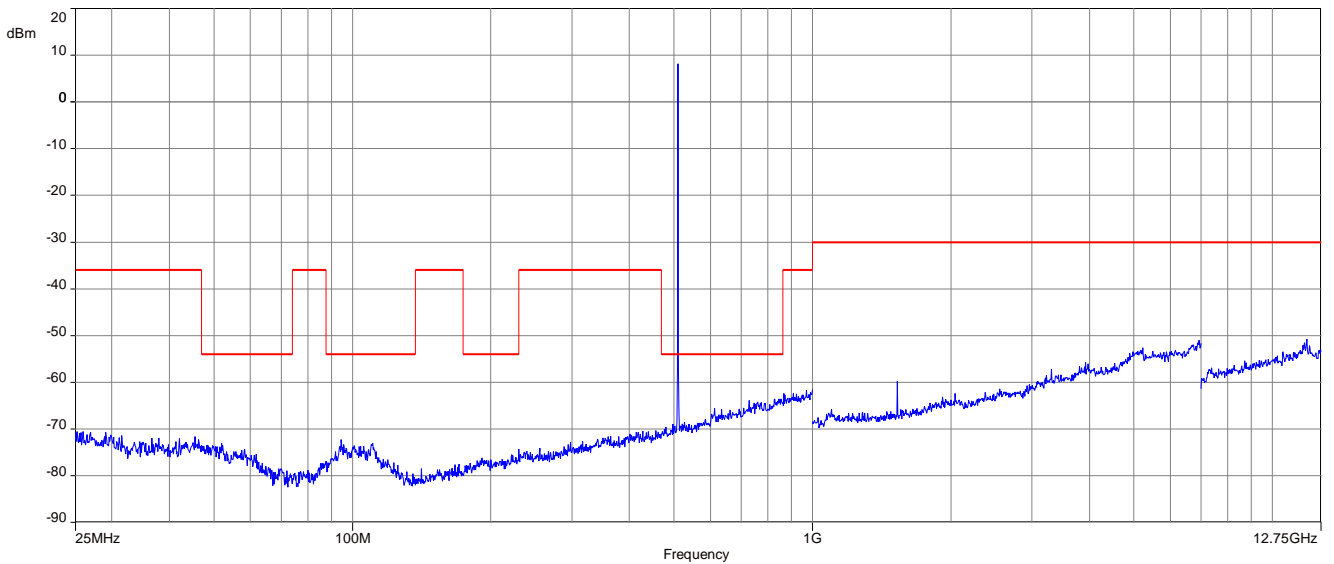


LD mode:

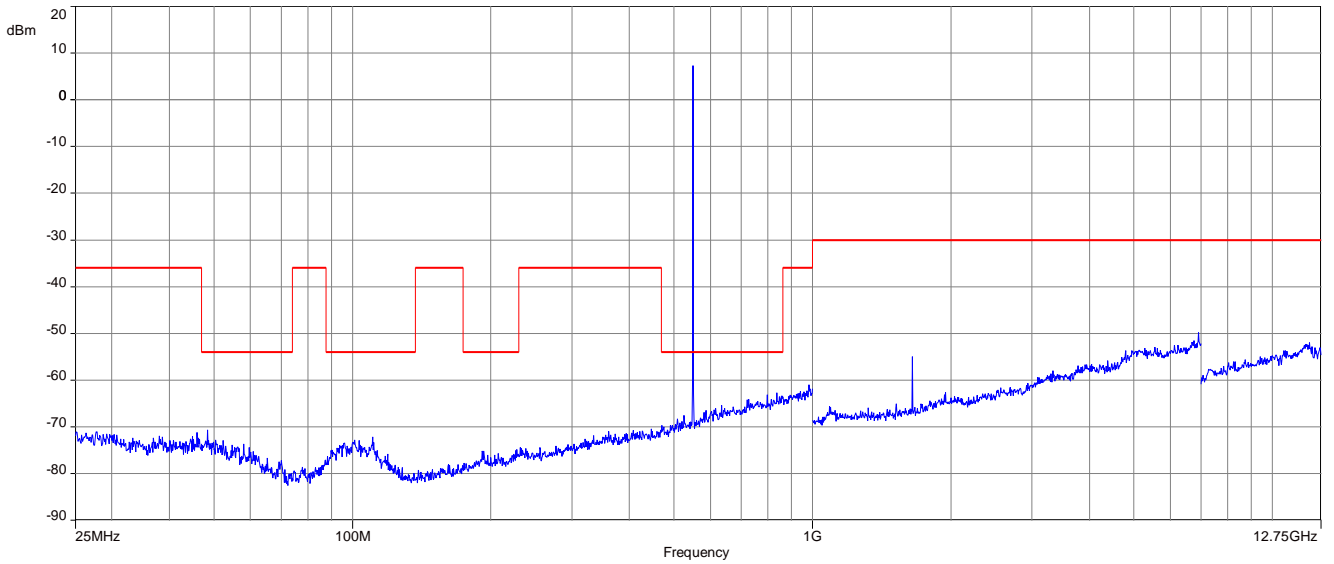
Plot 1: 470.200 MHz, 25 MHz – 12.75 GHz



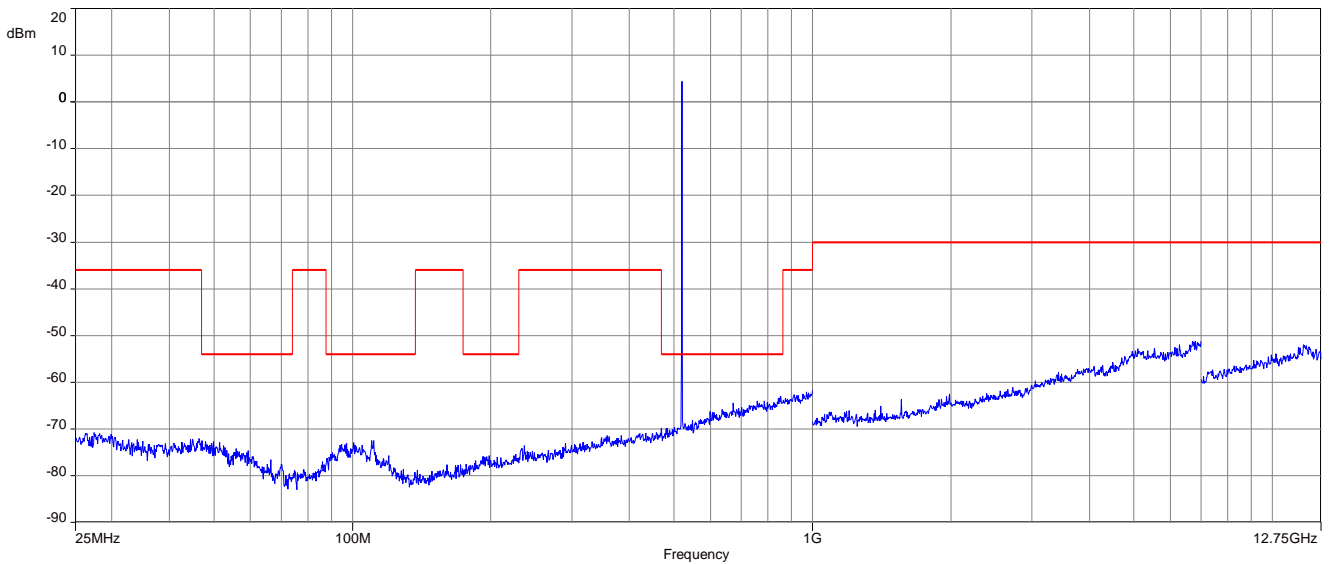
Plot 2: 510.000 MHz, 25 MHz – 12.75 GHz



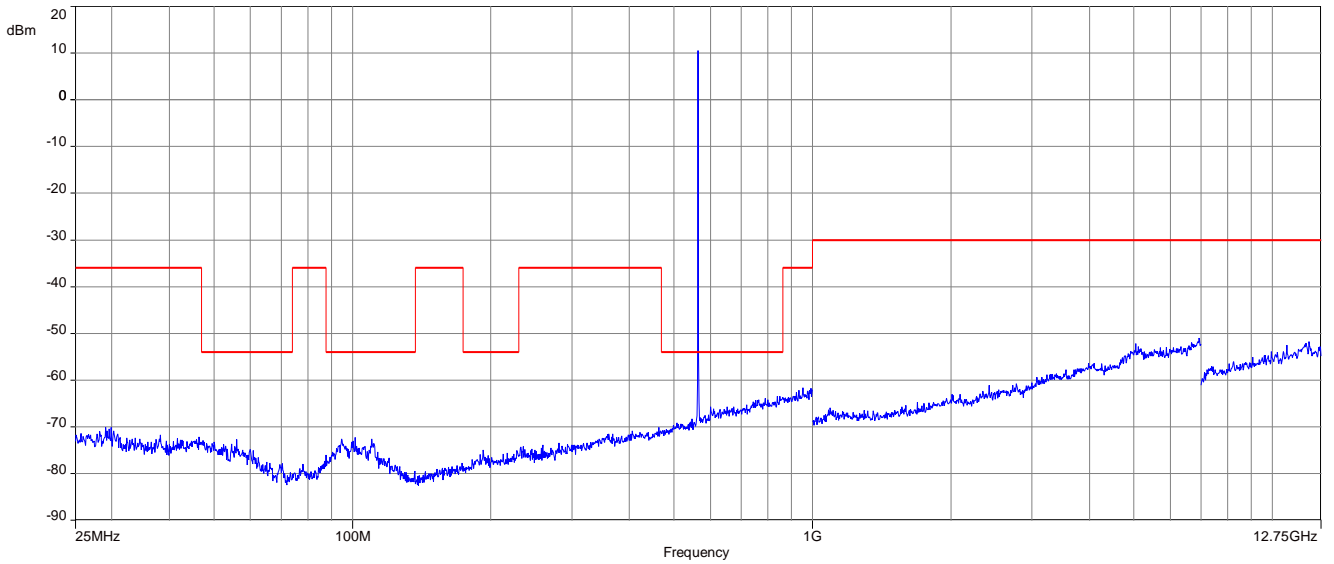
Plot 3: 550.000 MHz, 25 MHz – 12.75 GHz



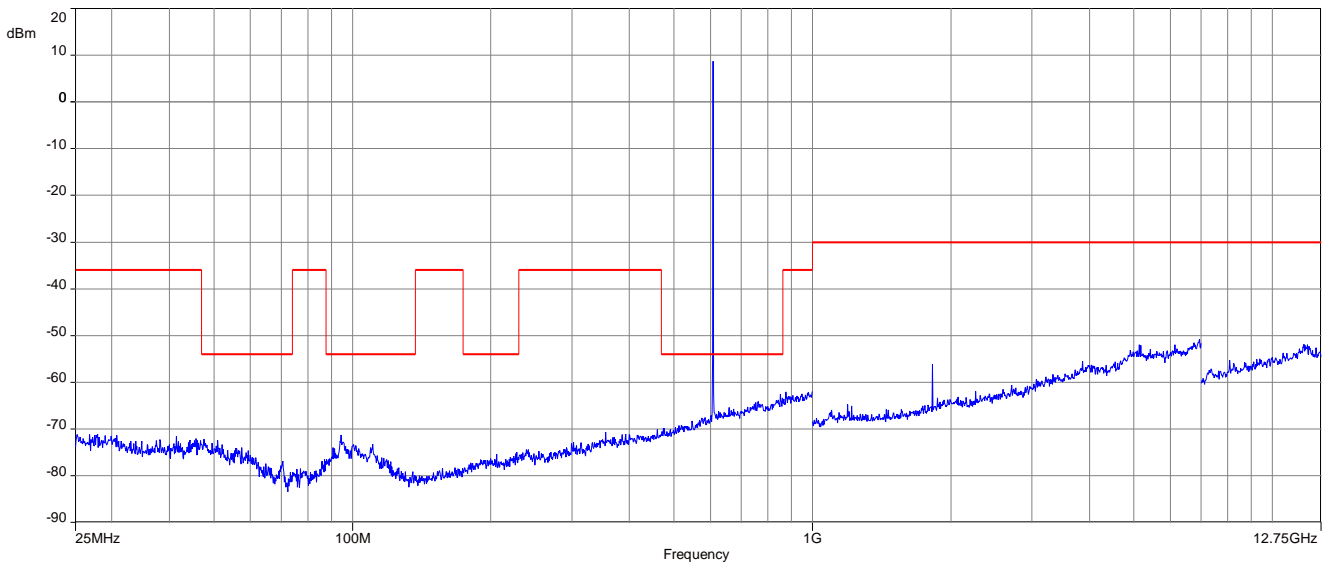
Plot 4: 520.000 MHz, 25 MHz – 12.75 GHz



Plot 5: 564.000 MHz, 25 MHz – 12.75 GHz



Plot 6: 607.800 MHz, 25 MHz – 12.75 GHz

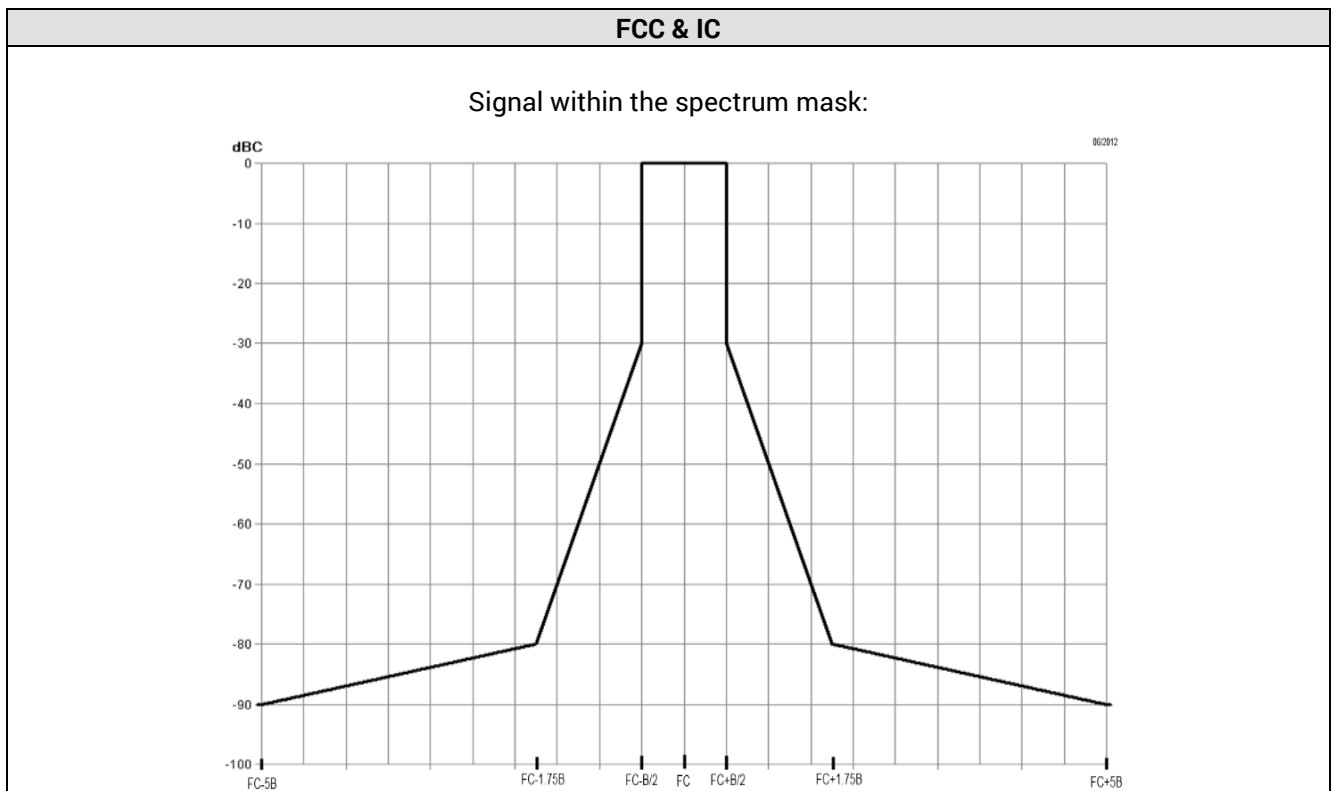


12.5 Necessary bandwidth (BN) for digital systems

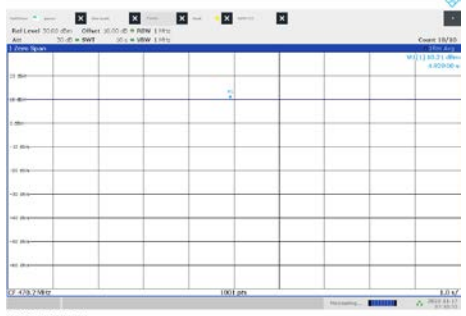
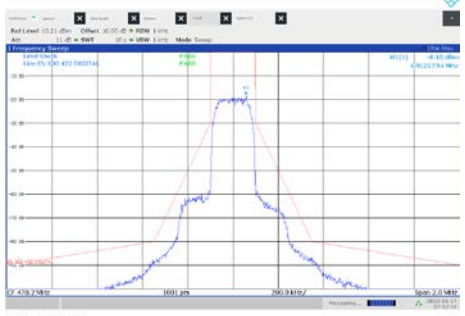
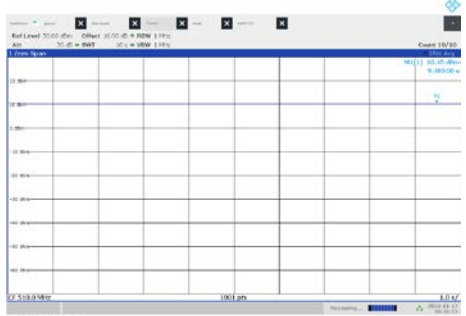
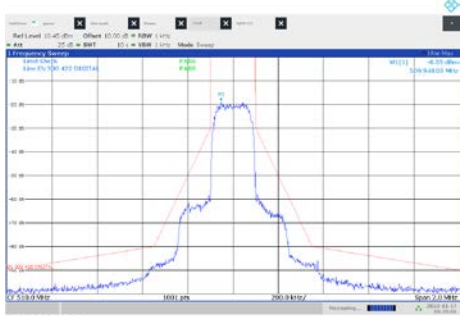
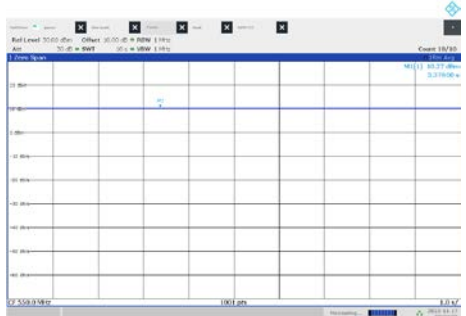
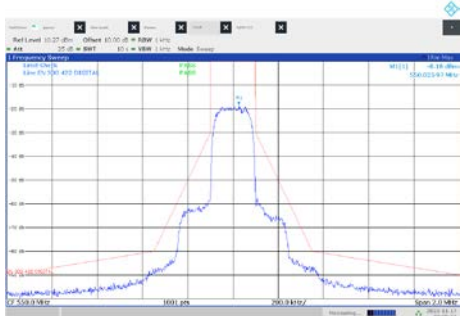
Measurement:

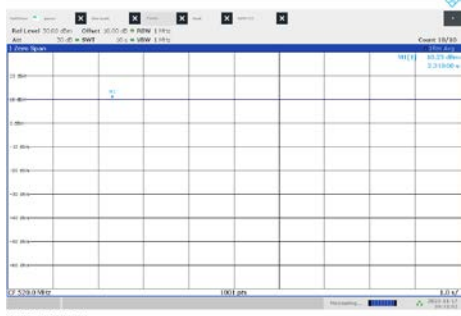
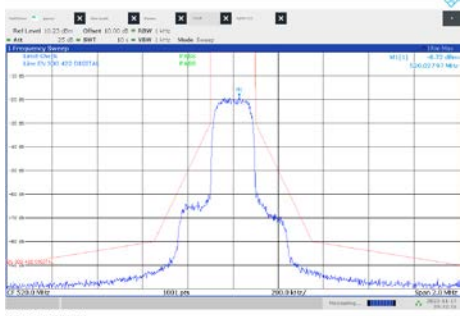
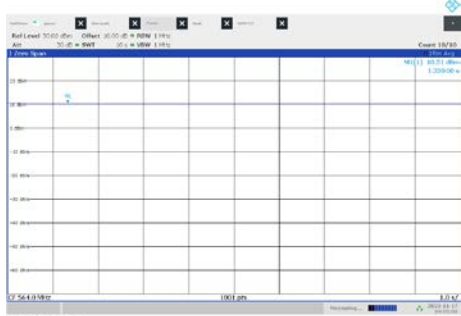
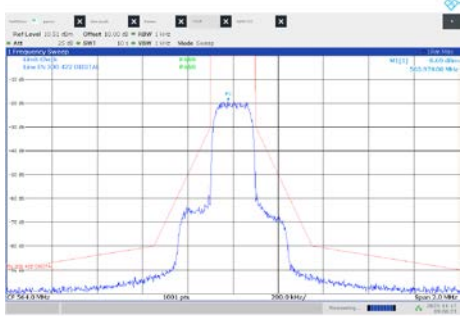
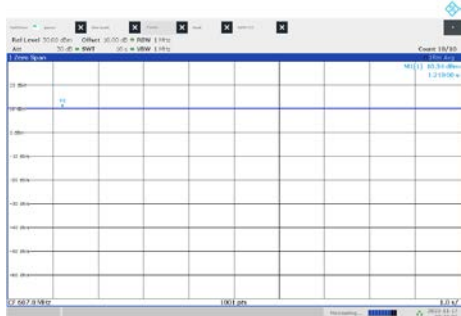
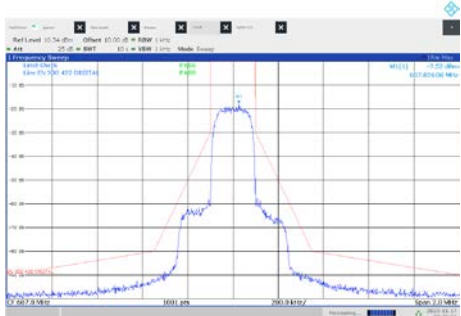
Measurement parameter	
Detector:	Peak / Average (-90 dBc point only)
Sweep time:	Auto
Resolution bandwidth:	1 kHz
Video bandwidth:	1 kHz
Span:	$f_c - 1 \text{ MHz}$ to $f_c + 1 \text{ MHz}$ (2 MHz)
Trace mode:	Max hold/view
EUT:	CW and MC
Test setup:	See sub clause 7.2 - D
Measurement uncertainty:	See sub clause 9

Limits: according to ETSI EN 300 422-1 v1.4.2

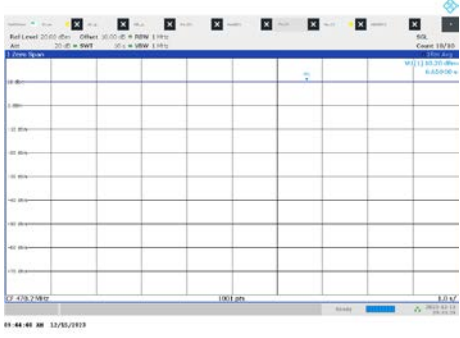
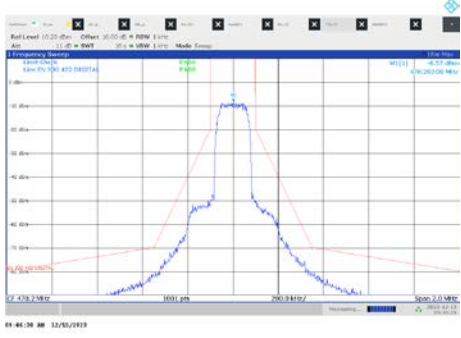
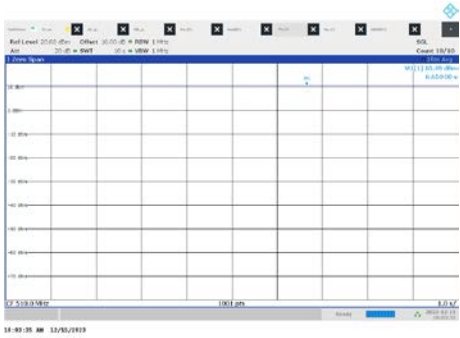
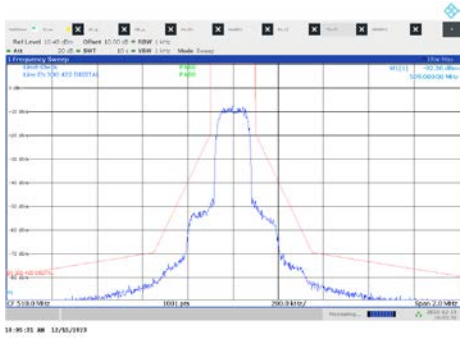
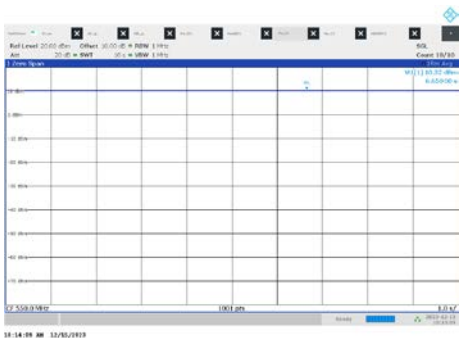
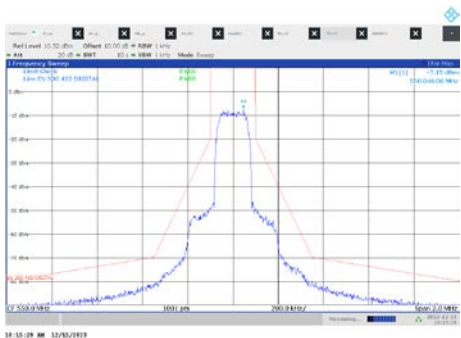


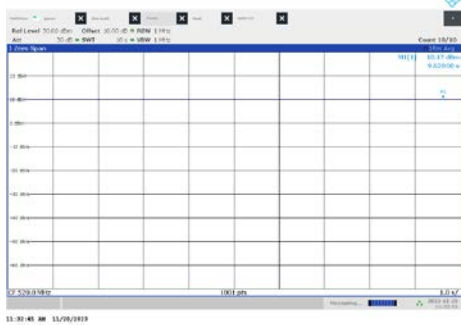
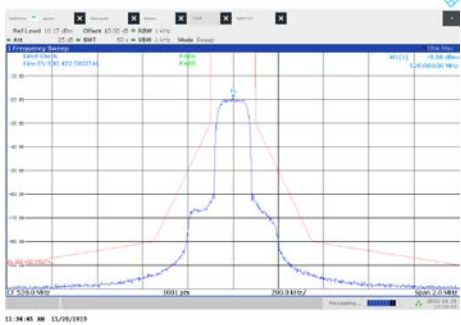
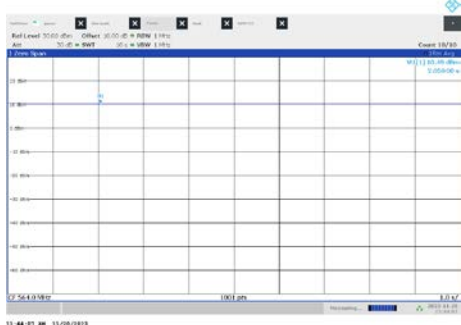
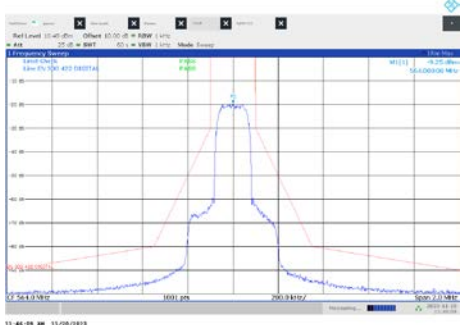
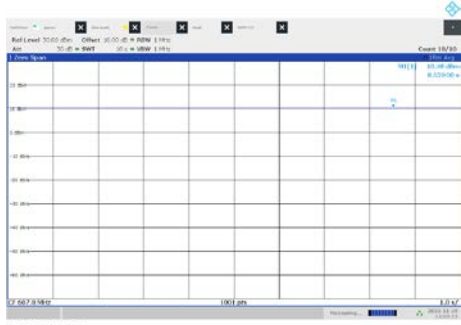
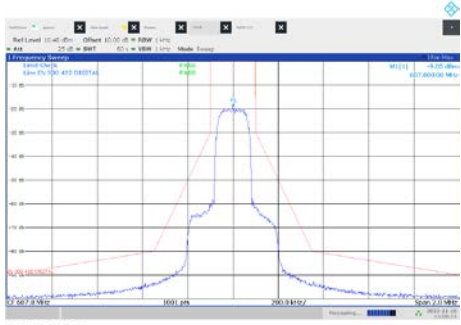
Plots normal mode:

Frequency	Carrier power	Modulated carrier with modulated carrier
470.2 MHz		
510.0 MHz		
550.0 MHz		

Frequency	Carrier power	Modulated carrier with modulated carrier
520.0 MHz	 <p>Carrier power spectrum plot at 520.0 MHz. The plot shows a flat line at approximately -100 dBm across the 100 kHz span, indicating no significant signal.</p>	 <p>Modulated carrier spectrum plot at 520.0 MHz. The plot shows a clear signal peak at 520.0 MHz with a power level of approximately -48.75 dBm. The signal is modulated, showing a characteristic shape with sidebands.</p>
564.0 MHz	 <p>Carrier power spectrum plot at 564.0 MHz. The plot shows a flat line at approximately -100 dBm across the 100 kHz span, indicating no significant signal.</p>	 <p>Modulated carrier spectrum plot at 564.0 MHz. The plot shows a clear signal peak at 564.0 MHz with a power level of approximately -48.75 dBm. The signal is modulated, showing a characteristic shape with sidebands.</p>
607.8 MHz	 <p>Carrier power spectrum plot at 607.8 MHz. The plot shows a flat line at approximately -100 dBm across the 100 kHz span, indicating no significant signal.</p>	 <p>Modulated carrier spectrum plot at 607.8 MHz. The plot shows a clear signal peak at 607.8 MHz with a power level of approximately -48.75 dBm. The signal is modulated, showing a characteristic shape with sidebands.</p>

Plots LD mode:

Frequency	Carrier power	Modulated carrier with modulated carrier
470.0 MHz	 <p>Carrier power plot for 470.0 MHz. The plot shows a flat line at approximately -100 dBm across the frequency range from 469.7 MHz to 470.3 MHz. The y-axis represents power in dBm, ranging from -120 to 20. The x-axis represents frequency in MHz.</p>	 <p>Modulated carrier with modulated carrier plot for 470.0 MHz. The plot shows a signal with a peak power of approximately -10 dBm at 470.0 MHz. The signal is modulated, showing a clear carrier wave with sidebands. The y-axis represents power in dBm, ranging from -20 to -120. The x-axis represents frequency in MHz, ranging from 469.7 to 470.3.</p>
510.0 MHz	 <p>Carrier power plot for 510.0 MHz. The plot shows a flat line at approximately -100 dBm across the frequency range from 509.7 MHz to 510.3 MHz. The y-axis represents power in dBm, ranging from -120 to 20. The x-axis represents frequency in MHz.</p>	 <p>Modulated carrier with modulated carrier plot for 510.0 MHz. The plot shows a signal with a peak power of approximately -10 dBm at 510.0 MHz. The signal is modulated, showing a clear carrier wave with sidebands. The y-axis represents power in dBm, ranging from -20 to -120. The x-axis represents frequency in MHz, ranging from 509.7 to 510.3.</p>
550.0 MHz	 <p>Carrier power plot for 550.0 MHz. The plot shows a flat line at approximately -100 dBm across the frequency range from 549.7 MHz to 550.3 MHz. The y-axis represents power in dBm, ranging from -120 to 20. The x-axis represents frequency in MHz.</p>	 <p>Modulated carrier with modulated carrier plot for 550.0 MHz. The plot shows a signal with a peak power of approximately -10 dBm at 550.0 MHz. The signal is modulated, showing a clear carrier wave with sidebands. The y-axis represents power in dBm, ranging from -20 to -120. The x-axis represents frequency in MHz, ranging from 549.7 to 550.3.</p>

Frequency	Carrier power	Modulated carrier with modulated carrier
520.0 MHz	 <p>Carrier power spectrum plot at 520.0 MHz. The plot shows a flat baseline with a noise floor around -100 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Carrier power' and shows a count of 18753.</p>	 <p>Modulated carrier spectrum plot at 520.0 MHz. The plot shows a clear signal peak at 520.0 MHz with a power level of approximately -10 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Modulated carrier with modulated carrier' and shows a count of 18753.</p>
564.0 MHz	 <p>Carrier power spectrum plot at 564.0 MHz. The plot shows a flat baseline with a noise floor around -100 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Carrier power' and shows a count of 18753.</p>	 <p>Modulated carrier spectrum plot at 564.0 MHz. The plot shows a clear signal peak at 564.0 MHz with a power level of approximately -10 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Modulated carrier with modulated carrier' and shows a count of 18753.</p>
607.8 MHz	 <p>Carrier power spectrum plot at 607.8 MHz. The plot shows a flat baseline with a noise floor around -100 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Carrier power' and shows a count of 18753.</p>	 <p>Modulated carrier spectrum plot at 607.8 MHz. The plot shows a clear signal peak at 607.8 MHz with a power level of approximately -10 dBm. The x-axis is frequency in MHz, and the y-axis is power in dBm. The plot is titled 'Modulated carrier with modulated carrier' and shows a count of 18753.</p>

12.6 Conducted limits

Measurement:

Measurement of the conducted spurious emissions for an intentional radiator that is designed to be connected to the public utility (AC) power line. Measurement performed according to ANSI C63.10, chapter 6.2

Measurement parameters	
Detector:	Quasi peak / average or peak (worst case – pre-scan)
Resolution bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Trace mode:	Max hold
Used equipment:	See chapter 7.4A
Measurement uncertainty:	See chapter 9

Limit:

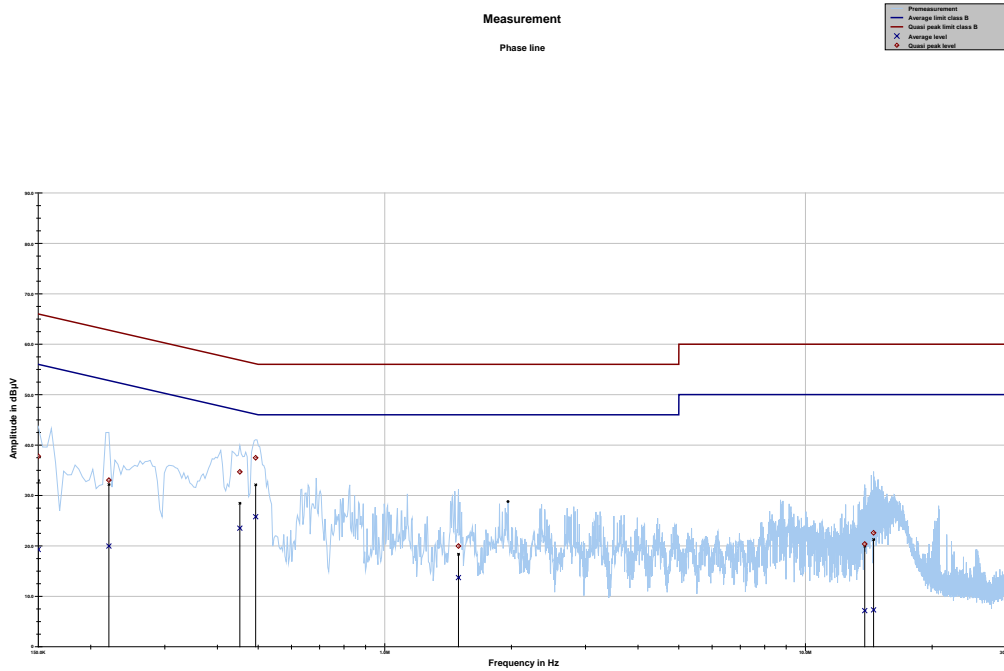
FCC & IC		
Frequency / MHz	Quasi-peak / (dB μ V/m)	Average / (dB μ V/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

Result:

see table below plots

Plots:

Plot 1: 150 kHz to 30 MHz, phase line



Project ID: 6002_01_09

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150000	37.77	28.23	66.000	19.29	36.71	56.000
0.220894	33.04	29.74	62.785	19.97	34.01	53.974
0.452231	34.68	22.15	56.834	23.51	23.85	47.365
0.493275	37.48	18.64	56.112	25.79	20.40	46.192
1.496981	19.97	36.03	56.000	13.70	32.30	46.000
13.832494	20.38	39.62	60.000	7.15	42.85	50.000
14.519044	22.59	37.41	60.000	7.31	42.69	50.000

Plot 2: 150 kHz to 30 MHz, neutral line

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dB μ V	dB	dB μ V	dB μ V	dB	dB μ V
0.183581	37.90	26.42	64.322	19.63	35.41	55.041
0.191044	35.83	28.16	63.991	19.14	35.68	54.827
0.418650	34.37	23.11	57.475	21.16	27.17	48.324
0.500737	36.44	19.56	56.000	25.36	20.64	46.000
1.444744	19.74	36.26	56.000	13.86	32.14	46.000
14.858588	23.61	36.39	60.000	7.88	42.12	50.000
16.157062	22.18	37.82	60.000	12.93	37.07	50.000

13 Observations

No observations except those reported with the single test cases have been made.

14 Glossary

AVG	Average
C	Compliant
C/N₀	Carrier to noise-density ratio, expressed in dB-Hz
CAC	Channel availability check
CW	Clean wave
DC	Duty cycle
DFS	Dynamic frequency selection
DSSS	Dynamic sequence spread spectrum
DUT	Device under test
EN	European Standard
ETSI	European Telecommunications Standards Institute
EMC	Electromagnetic Compatibility
EUT	Equipment under test
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
FHSS	Frequency hopping spread spectrum
FVIN	Firmware version identification number
GNSS	Global Navigation Satellite System
GUE	GNSS User Equipment
HMN	Host marketing name
HVIN	Hardware version identification number
HW	Hardware
IC	Industry Canada
Inv. No.	Inventory number
MC	Modulated carrier
NA	Not applicable
NC	Not compliant
NOP	Non occupancy period
NP	Not performed
OBW	Occupied bandwidth
OC	Operating channel
OCW	Operating channel bandwidth
OFDM	Orthogonal frequency division multiplexing
OOB	Out of band
OP	Occupancy period
PER	Packet error rate
PMN	Product marketing name
PP	Positive peak
QP	Quasi peak
RLAN	Radio local area network
S/N or SN	Serial number
SW	Software
UUT	Unit under test
WLAN	Wireless local area network

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2024-01-03

END OF TEST REPORT