

TEST REPORT

Test report no.: 1-7205/18-01-03



Testing laboratory

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Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

Applicant

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Am Labor 1

30900 Wedemark / GERMANY

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Manufacturer

Sennheiser electronic GmbH & Co. KG

Am Labor 1

30900 Wedemark / GERMANY

Test standard/s

47 CFR Part 74

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 9

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

RSS - Gen Issue 5

General Requirements for Compliance of Radio

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

Test Item

Kind of test item: Bodypack Transmitter

Model name: SK 5212-II

FCC ID: DMOSK5212A2

IC: 2099A-SK5212A2

Frequency: 470.100 MHz – 607.900 MHz

Technology tested: Proprietary

Antenna: Integrated antenna

Power supply: 1.5 V DC by battery

Temperature range: -30°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
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Test performed:

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2 General information

2.1 Notes and disclaimer

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

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2.2 Application details

Date of receipt of order:	2018-10-30
Date of receipt of test item:	2018-10-30
Start of test:	2018-11-06
End of test:	2018-12-12
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 74	-/-	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 9	August 2016	Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment
RSS - Gen Issue 5	April 2018	General Requirements for Compliance of Radio
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

4 Test environment

Temperature	:	T _{nom} T _{max} T _{min}	+22 °C during room temperature tests +50 °C during high temperature tests -30 °C during low temperature tests
Relative humidity content	:		45 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V _{nom} V _{max} V _{min}	1.5 V DC by battery 1.6 V 1.0 V

5 Test item

5.1 General description

Kind of test item	:	Bodypack Transmitter
Type identification	:	SK 5212-II
HMN	:	-/-
PMN	:	SK 5212-II
HVIN	:	SK 5212-II
FVIN	:	3.1.0_LUS-PR
S/N serial number	:	1378000002
Hardware status	:	533438_18
Software status	:	3.1.0_LUS-PR
Firmware status	:	-/-
Frequency band	:	470.100 MHz – 607.900 MHz Lowest channel: 470.100 MHz Middle Channel: 539.000 MHz Highest Channel: 607.900 MHz
Type of radio transmission	:	Modulated carrier
Use of frequency spectrum	:	
Type of modulation	:	FM
Antenna	:	Integrated antenna
Power supply	:	1.5 V DC by battery
Temperature range	:	-30°C to +50°C

5.2 Additional information

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

Test setup and EUT photos are included in test report:

- 1-7205/18-01-01_AnnexA
- 1-7205/18-01-01_AnnexB
- 1-7205/18-01-01_AnnexC

6 Description of the test setup

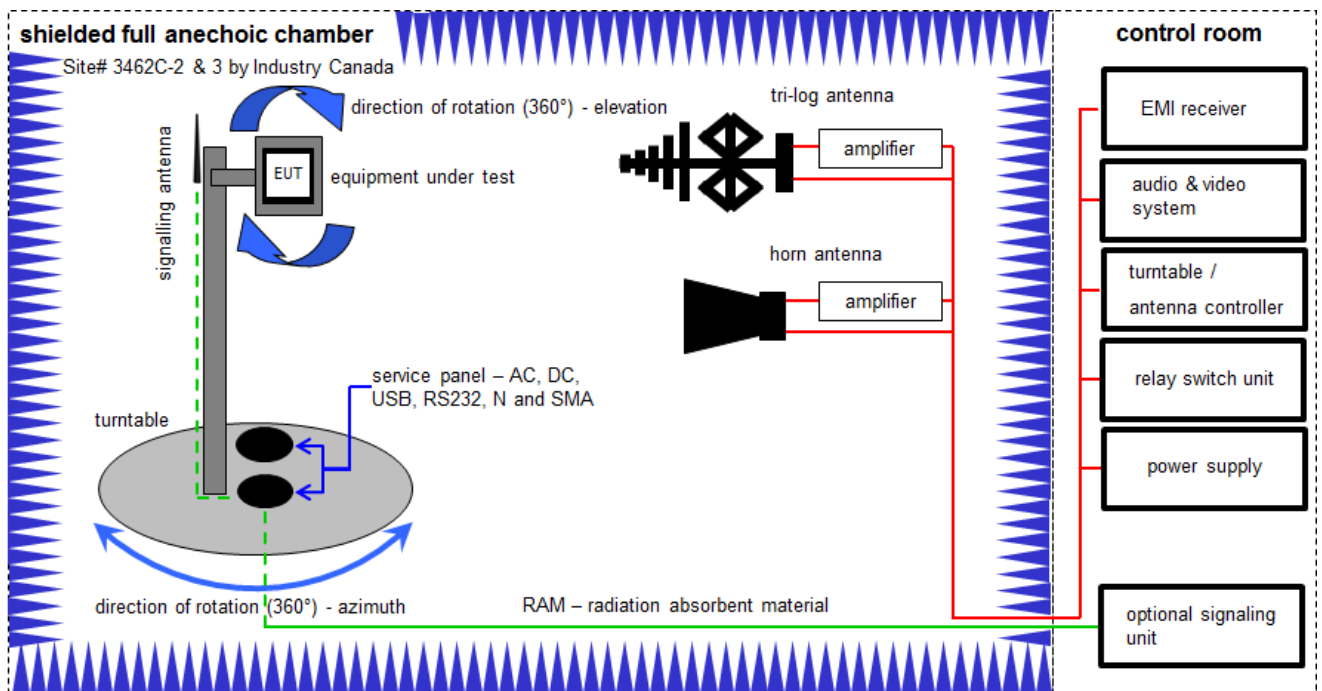
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

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

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
v/k!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

6.1 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:

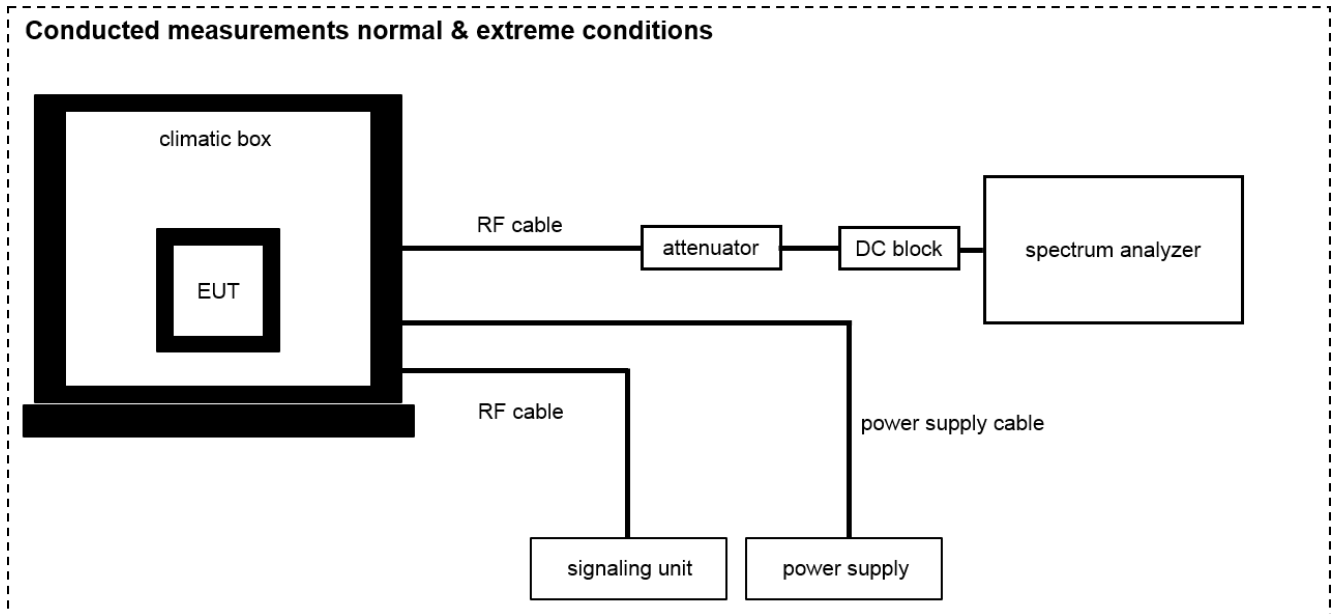
$$OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 \mu W)$$

Equipment table:

No.	Lab / Item	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	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vKI!	14.02.2017	13.02.2019
3	A, B	Switch / Control Unit	3488A	HP	-/-	300000199	ne	-/-	-/-
4	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
5	A	TRILOG Broadband Test-Antenna	VULB9163	Schwarzbeck Mess Elektronik	01029	300005379	k	07.04.2017	06.04.2020
6	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
7	A, B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
8	A, B	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO	-/-	300004682	ne	-/-	-/-
9	A, B	PC	ExOne	F+W	-/-	300004703	ne	-/-	-/-
10	A,B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	20.12.2017	19.12.2018

6.2 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	A, B	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	20.12.2017	19.12.2018
2	B	Audio Analyzer 2Hz - 300 kHz	UPD	R&S	841074/009	300001236	k	29.01.2018	28.01.2020
3	B	Climatic Box	VT 4011	Voetsch Industrietechnik	58566230600010	300005363	ev	07.05.2018	06.05.2020
4	B	Radiocom. Analyzer	CMTA 54	R&S	894043/010	300001175	NK!!		
5	B	DC Power Supply, 60V, 10A	6038A	HP	3122A11097	300001204	vIK!!	12.12.2017	11.12.2020

7 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

8 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!	2018-12-17	-/-

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"/>	Additional measurement for 539 MHz only.
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"/>	Additional measurement for 539 MHz only.
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"/>	Additional measurement for 539 MHz only.
		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	-/-				Additional measurement for 539 MHz only.
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 checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Additional measurement for 539 MHz only.
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 type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-/-

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

9 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.*

10 Measurement results

10.1 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 6.2 – A
Measurement uncertainty:	See sub clause 7

Limits:

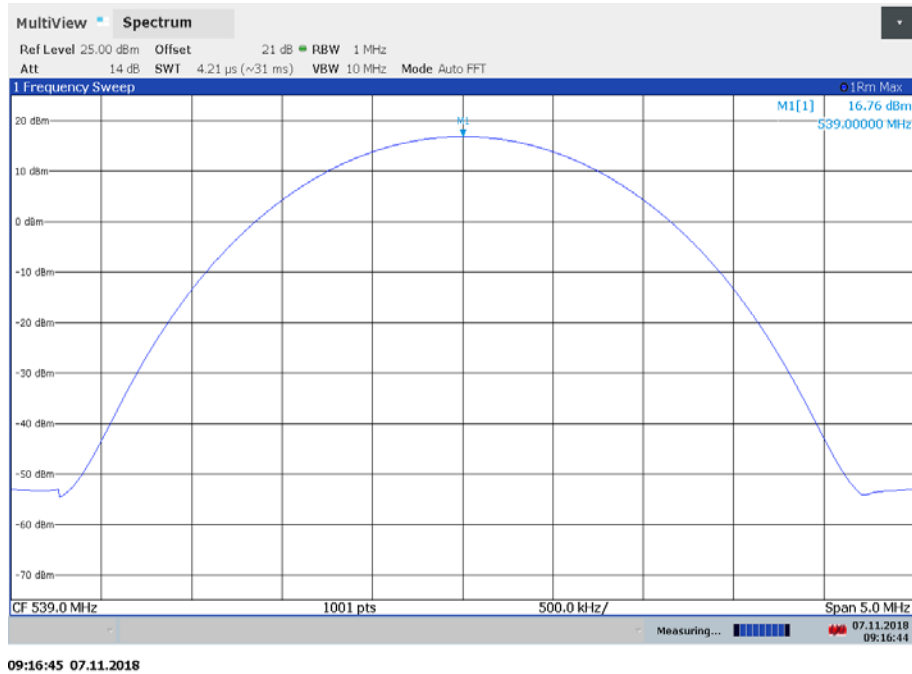
FCC & IC
470 MHz to 608 MHz 250 mW (average) / 24 dBm (average)

Result:

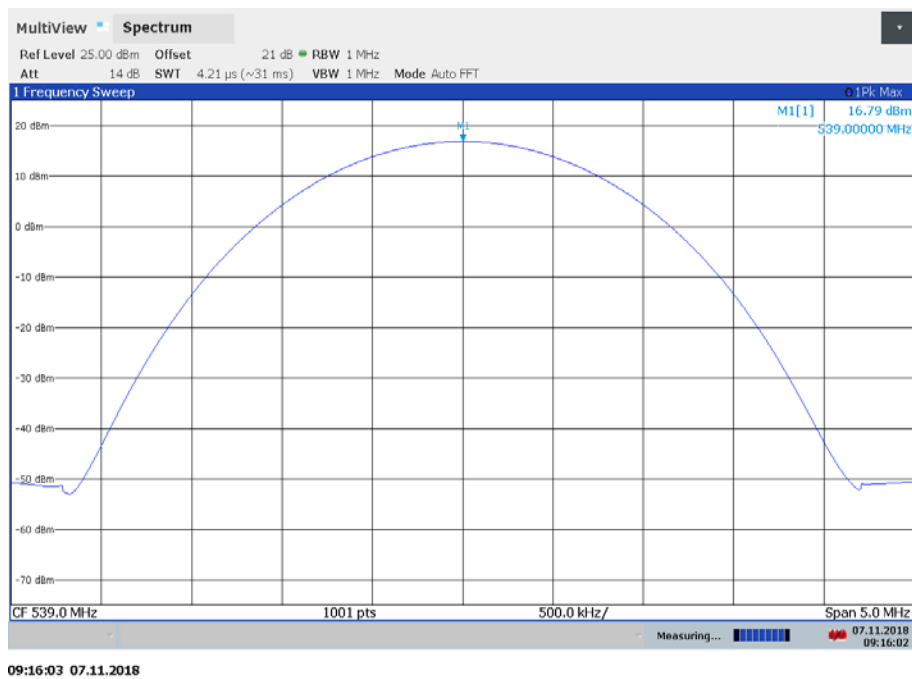
Channels	Transmitter conducted output power (dBm)					
	539.0 MHz		-/-		-/-	
	Peak	Average	Peak	Average	Peak	Average
Middle	16.79	16.76	-/-	-/-	-/-	-/-

Plots:

Plot 1: middle channel, average (modulated carrier)



Plot 2: middle channel, peak (unmodulated carrier)



10.2 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 6.2 - A
Measurement uncertainty:	See sub clause 7

Limits:

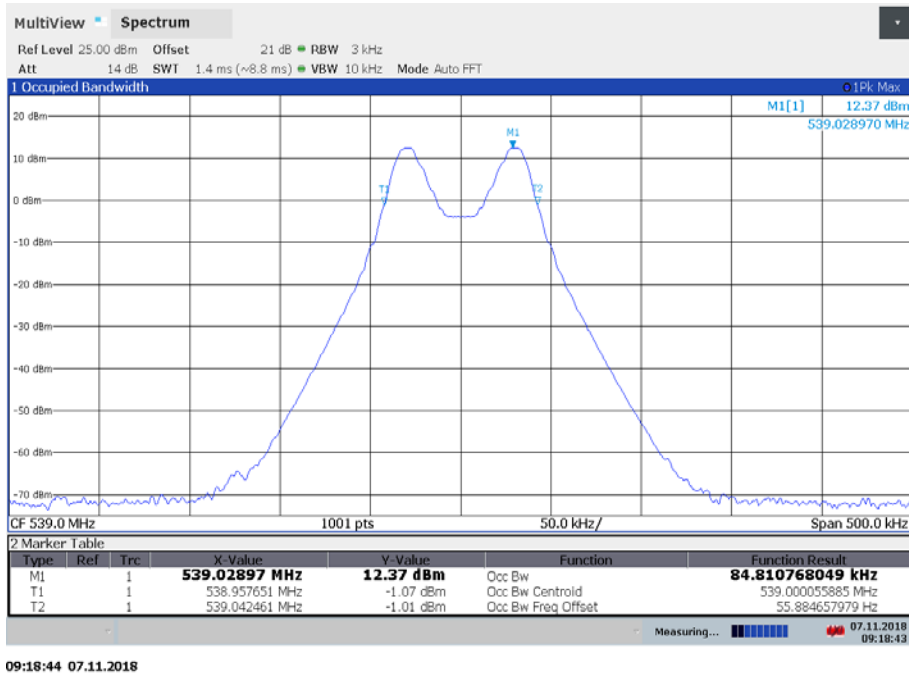
FCC & IC
470 MHz to 608 MHz 200 kHz
Occupied bandwidth 99%. Other than single sideband or independent sideband transmitters - when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of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

Result:

Occupied bandwidth (kHz)			
Channels	539.0 MHz	-/-	-/-
Middle	84.81	-/-	-/-

Plots:

Plot 1: middle channel



10.3 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 6.2 - B
Measurement uncertainty:	See sub clause 7

Limits:

FCC & IC
470 MHz to 608 MHz ± 50 ppm

Results: middle channel

Temperature / Voltage	Frequency (MHz)	Deviation (kHz / ppm)
-30 °C / V _{nom}	538.995714339	-4.28 / -7.95
-20 °C / V _{nom}	538.995264301	-4.73 / -8.78
-10 °C / V _{nom}	538.997592769	-2.40 / -4.46
0 °C / V _{nom}	538.999585007	-0.41 / -0.76
+10 °C / V _{nom}	539.000165809	0.16 / 0.30
+20 °C / V _{nom}	539.000471230	0.47 / 0.87
+30 °C / V _{nom}	539.000320123	0.32 / 0.59
+40 °C / V _{nom}	539.000214432	0.21 / 0.39
+50 °C / V _{nom}	539.00018527	0.18 / 0.34
+20 °C / V _{nom} - 15%	539.000173720	0.17 / 0.32
+20 °C / V _{nom}	539.000471230	0.47 / 0.87
+20 °C / V _{nom} + 15%	539.000159450	0.15 / 0.29

10.4 Transmitter unwanted emissions (radiated)

Measurement:

Measurement parameter	
Detector:	Peak (prescan) / RMS
Sweep time:	Auto
Resolution bandwidth:	See table below!
Video bandwidth:	See table below!
Span:	100 MHz steps!
Trace-Mode:	Max. hold
EUT:	MC with max frequency deviation
Used equipment:	See chapter 6.1- A / B
Measurement uncertainty:	See chapter 7

Frequency being measured	Measuring receiver bandwidth
25 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1 000 MHz	100 kHz
> 1 000 MHz	1 MHz

Limits:

FCC & IC (according to ETSI EN 300 422-1 v1.4.2 (2011-08))			
State	Max. spurious level		
	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

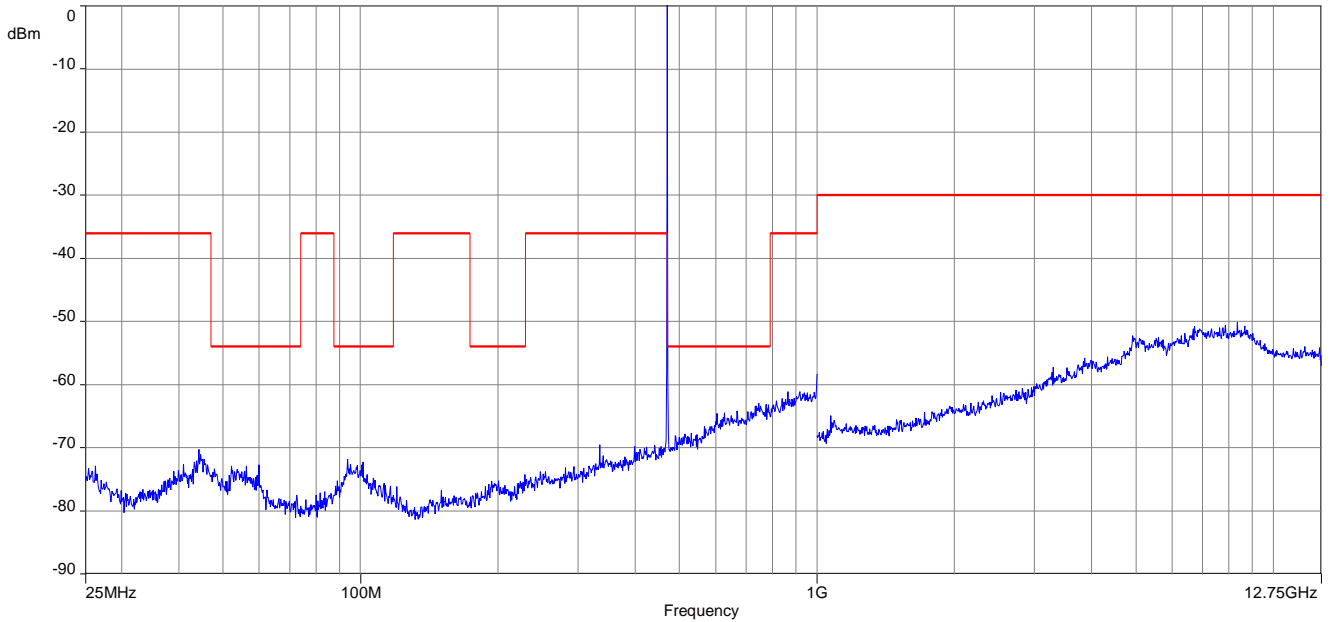
FCC & IC	
The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:	
On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least	25 dB
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:

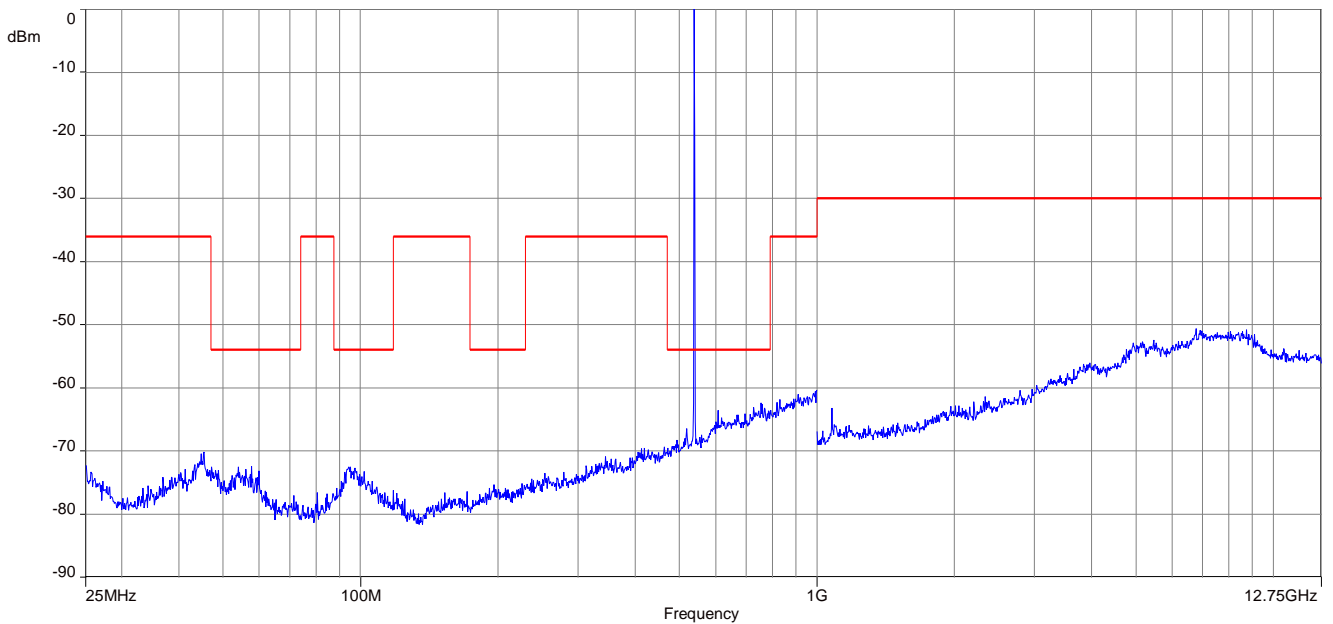
carrier frequency (MHz)	unwanted emission frequency (MHz)	Limit	level (dB) / (dBm) or remark
No Peaks detected.			

Plots: radiated

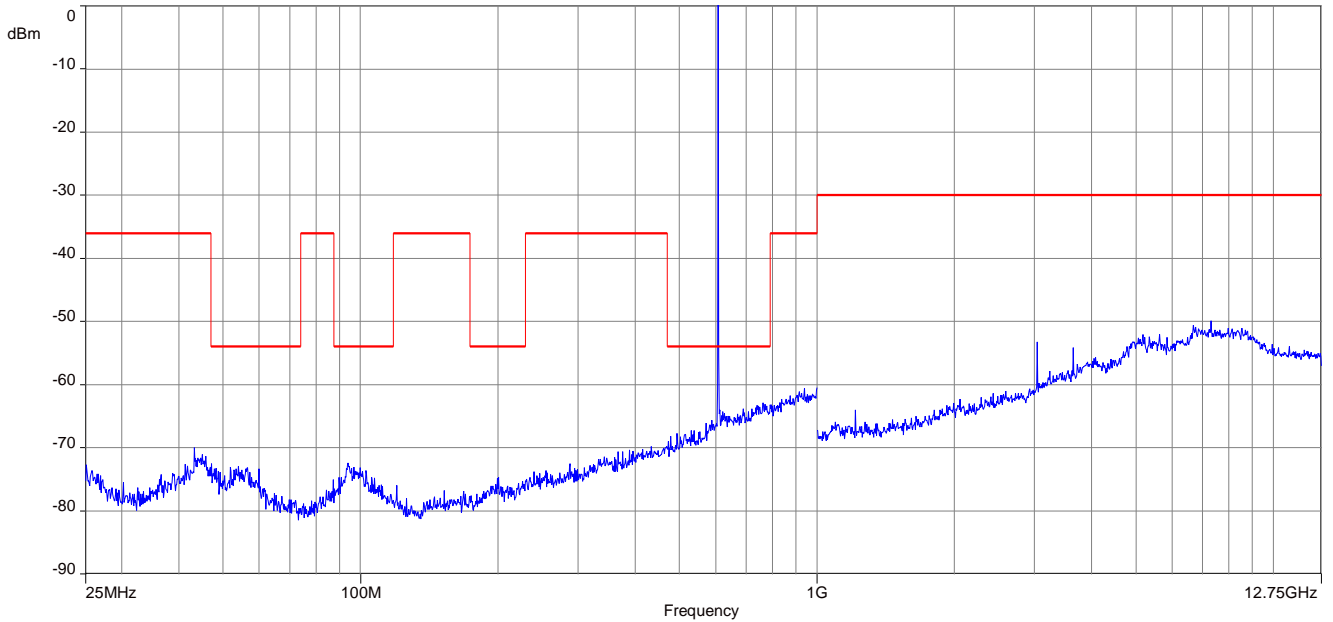
Plot 1: lowest channel, spurious emissions, 25 MHz – 12.75 GHz



Plot 2: middle channel, spurious emissions, 25 MHz – 12.75 GHz

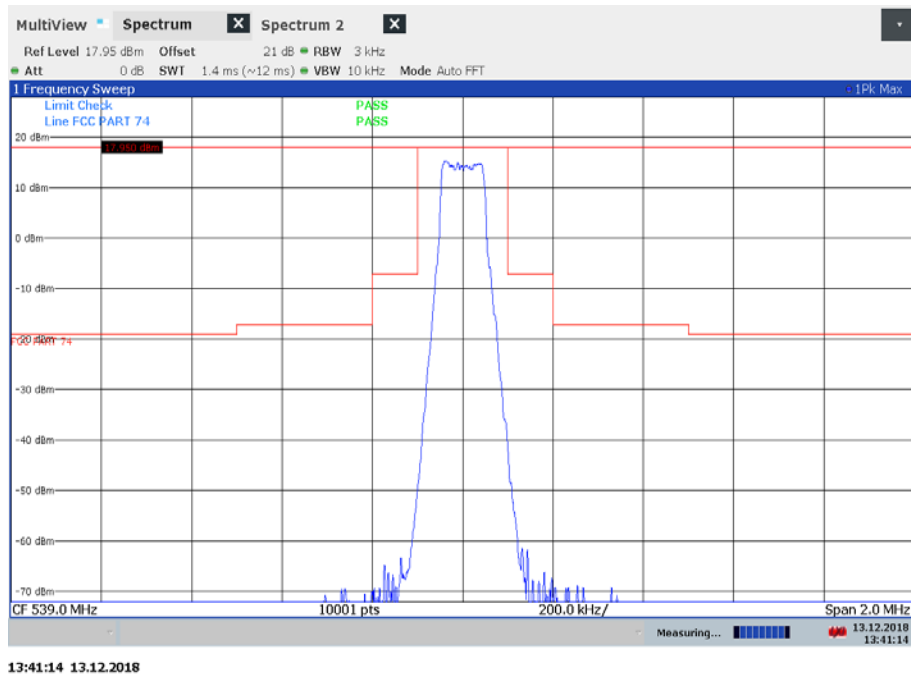


Plot 3: highest channel, spurious emissions, 25 MHz – 12.75 GHz



Plots: Conducted

Plot 1: middle channel, Spectrum Mask



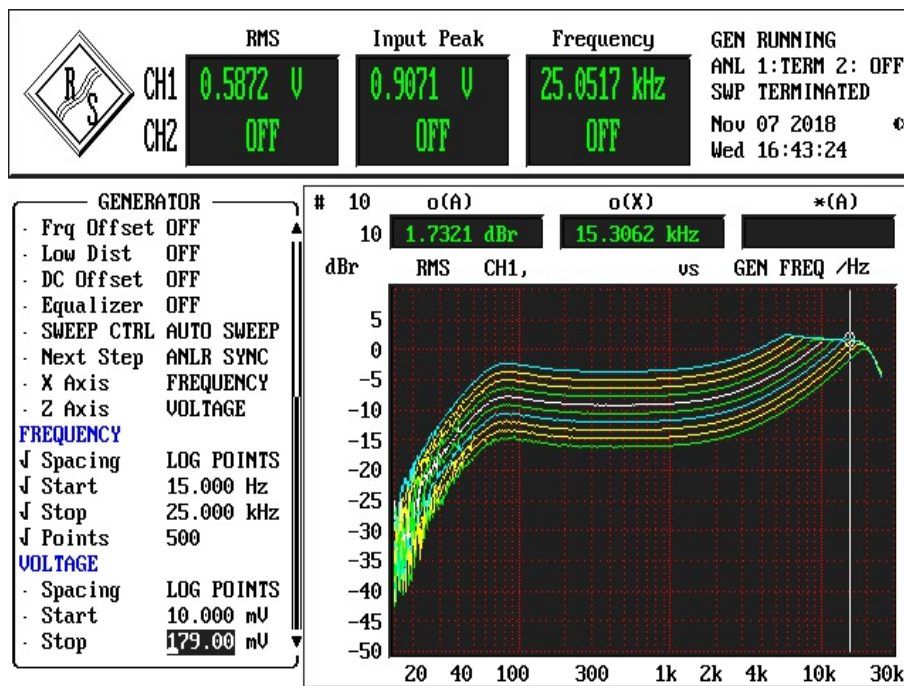
10.5 Modulation characteristics

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.

Plots:

Plot 1: 10 curves with voltage and frequency variation

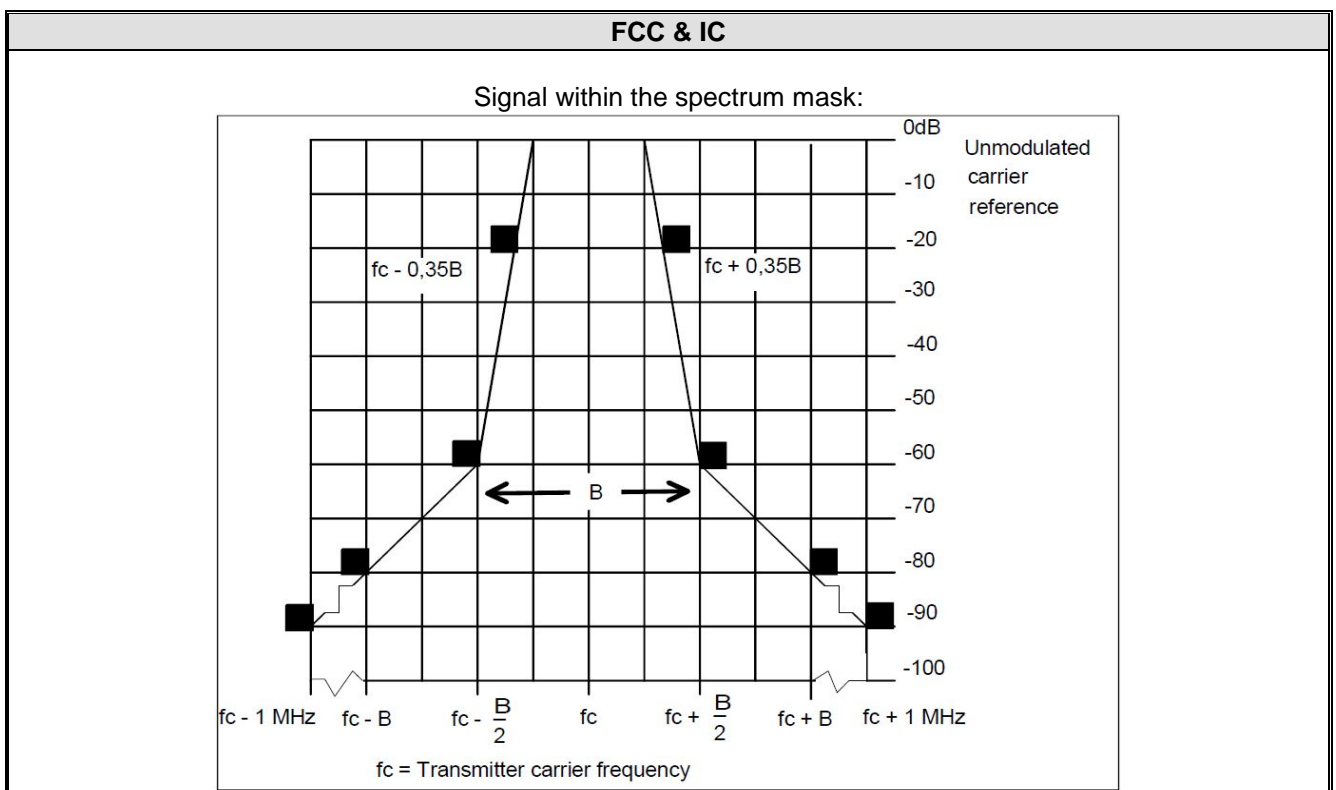


10.6 Necessary bandwidth (BN) for analogue systems

Measurement:

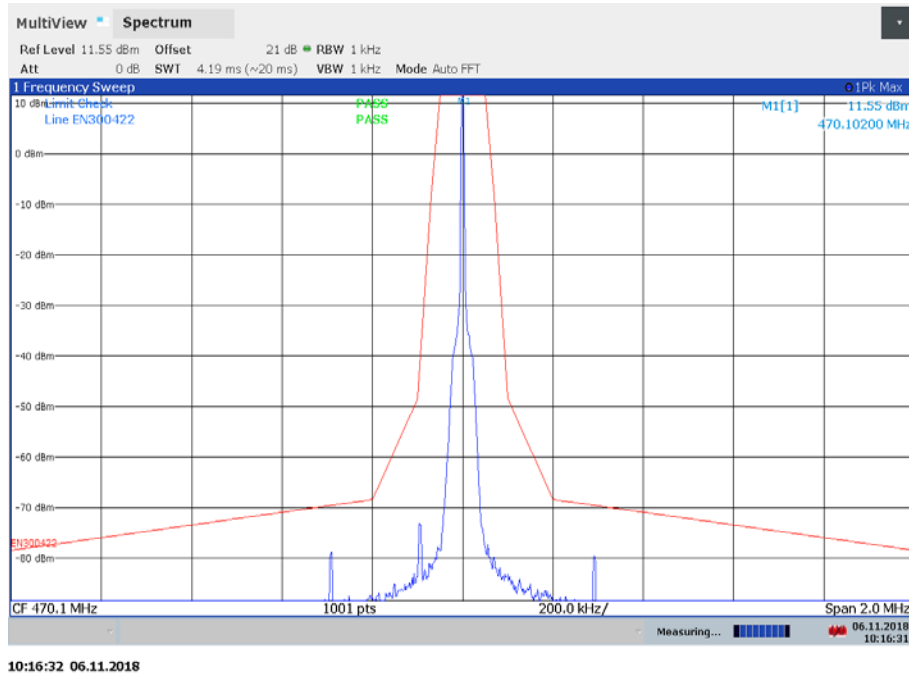
Measurement parameter	
Detector:	Peak / Average (-90 dBc point only)
Sweep time:	Auto
Resolution bandwidth:	1 kHz
Video bandwidth:	1 kHz
Span:	$f_c - 1 \text{ MHz}$ to $f_c + 1 \text{ MHz}$ (2 MHz)
Trace mode:	Max hold/view
EUT:	CW and MC
Test setup:	See sub clause 7.2 - D
Measurement uncertainty:	See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

Limits: according to ETSI EN 300 422-1 v1.4.2 (2011-08)

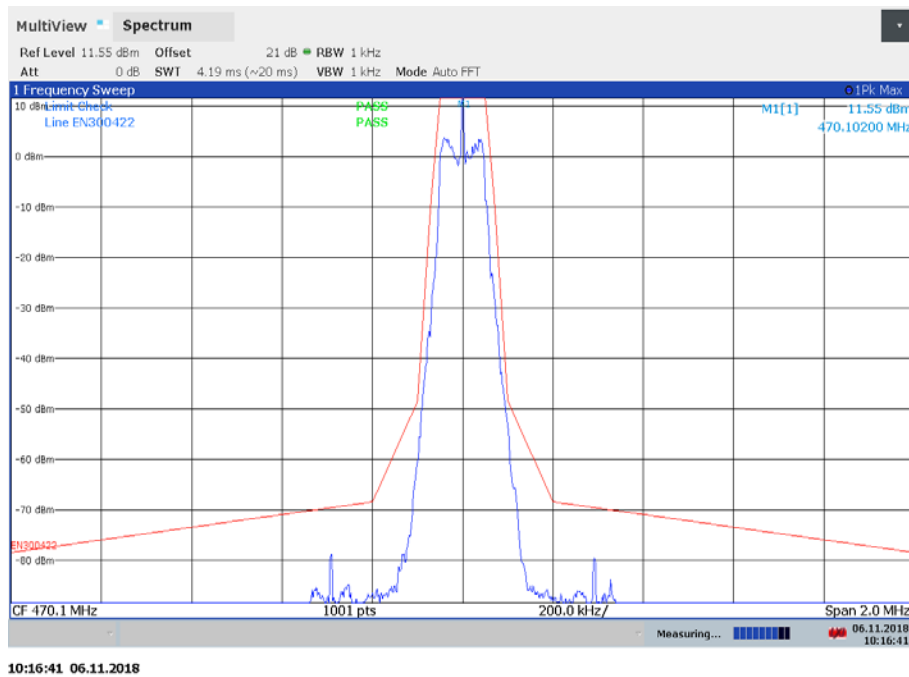


Plots: Low channel

Plot 1: Unmodulated carrier reference (with pilot-tone)

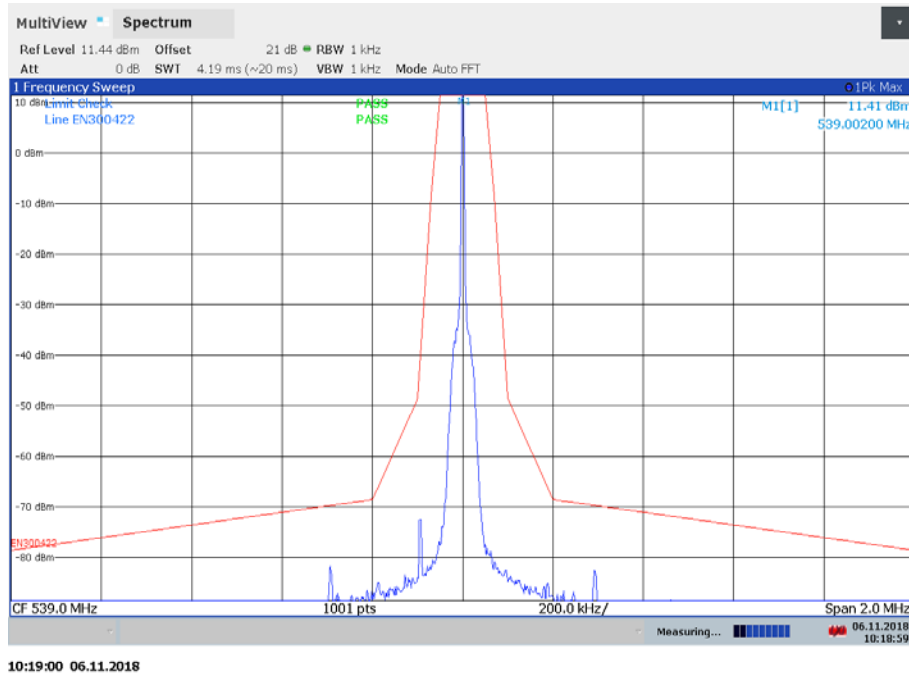


Plot 2: Modulated carrier with the weighted noise source

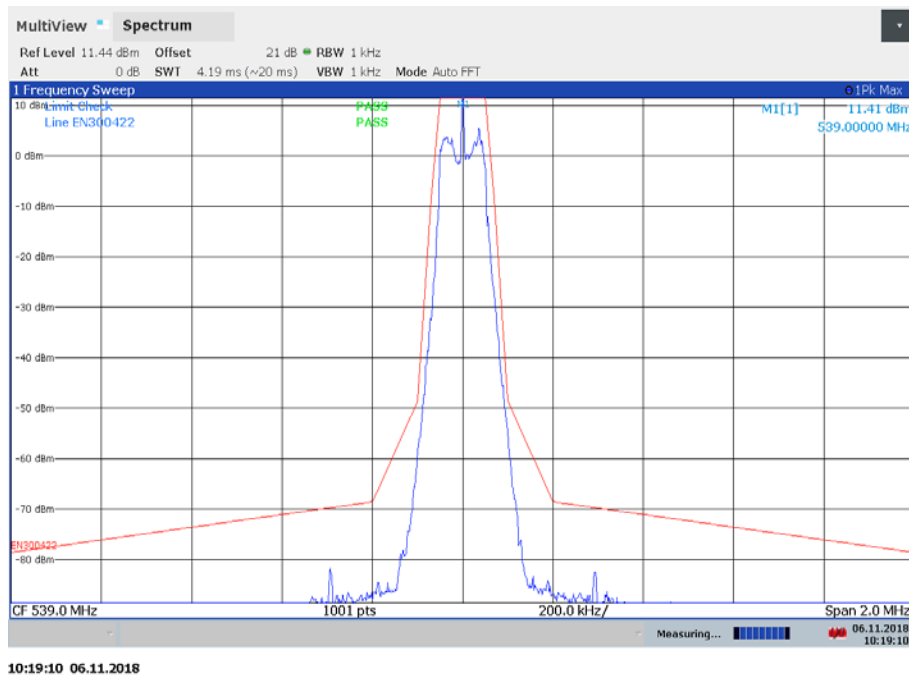


Plots: Middle channel

Plot 1: Unmodulated carrier reference (with pilot-tone)

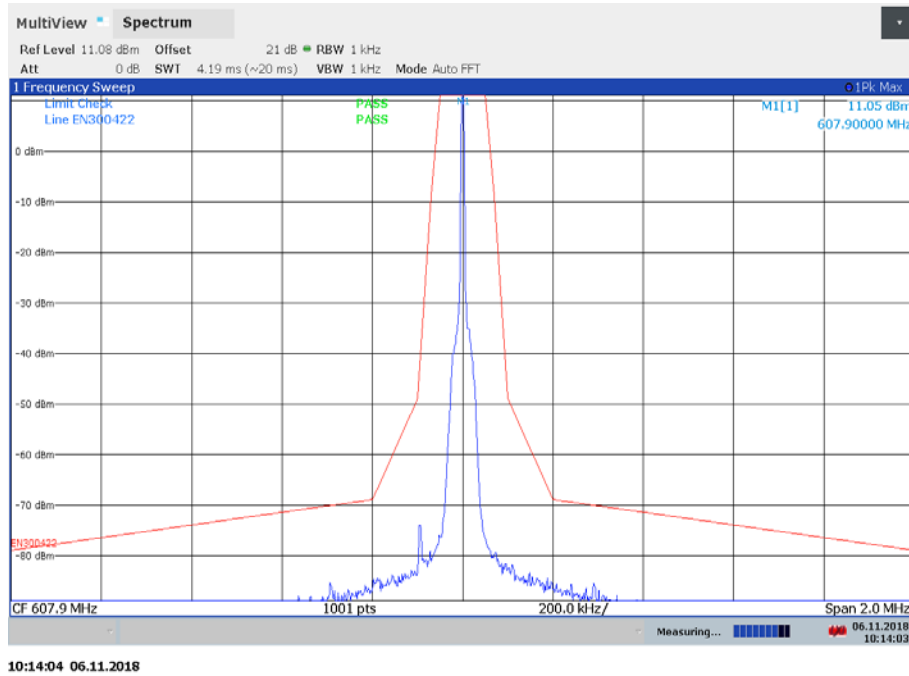


Plot 2: Modulated carrier with the weighted noise source

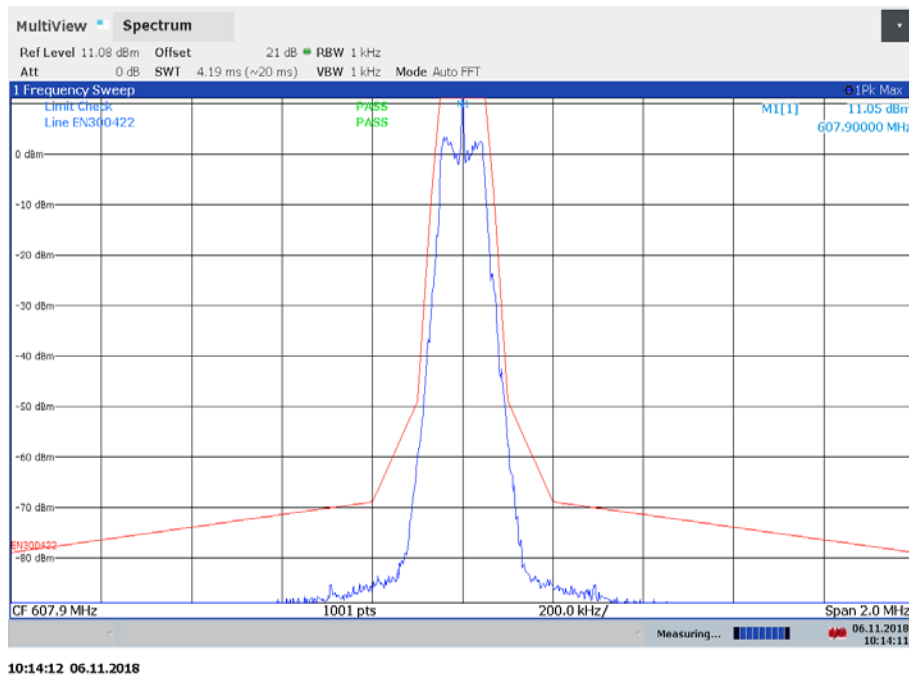


Plots: Highest channel

Plot 1: Unmodulated carrier reference (with pilot-tone)



Plot 2: Modulated carrier with the weighted noise source



10.7 Frequency modulation

Measurement:

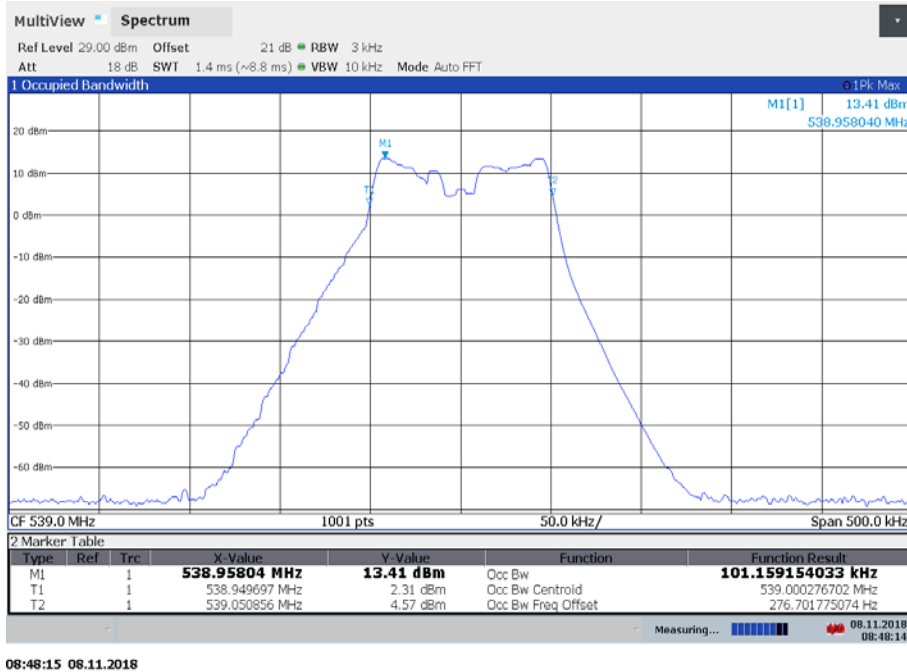
Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 % to 5 % of the occupied bandwidth
Video bandwidth:	3 x resolution bandwidth
Span:	2 x emission bandwidth
Trace mode:	Max. hold
Analyzer function:	99% power occupied bandwidth function
EUT:	Modulated signal with frequency 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

Plots:

Plot 1: lowest channel, max hold with frequency variation from 50 Hz to 15 kHz



11 Observations

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

Annex A Glossary

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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2018-12-17

Annex C Accreditation Certificate

first page	last page
<p>The first page of the accreditation certificate includes the DAkKS logo (Deutsche Akkreditierungsstelle), the company name 'Deutsche Akkreditierungsstelle GmbH', and accreditation details for CTC advanced GmbH. It states that the company is competent under DIN EN ISO/IEC 17025:2005 for telecommunication tests. The certificate is signed by Dipl.-Ing. (FH) Ralf Böker, Head of Division, dated Frankfurt, 02.06.2017.</p>	<p>The last page of the certificate lists three office locations: Berlin (Spittelmarkt 10), Frankfurt am Main (Europa-Allee 52), and Braunschweig (Bundesallee 100). It contains legal disclaimers regarding the publication of extracts and the scope of accreditation, and provides website links for DAkKS, ILAC, and IAF.</p>

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-12076-01-03e.pdf>

END OF TEST REPORT