
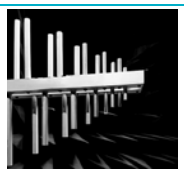
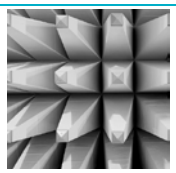

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-6141/18-01-03

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

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
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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

SIGFOX
425, rue Jean Rostand
31670 Labège / FRANCE
Phone: -/-
Contact: Susana Barreiro
e-mail: susana.barreiro@sigfox.com
Phone: +33 5 82 08 07 46

Manufacturer

SIGFOX
425, rue Jean Rostand
31670 Labège / FRANCE

Test standard/s

FCC - Title 47 CFR Part 15	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

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

Test Item

Kind of test item:	**Acces Station**
Model name:	**SMBS-T4**
FCC ID:	**2ACK7-SMBST4**
IC:	**12204A-SMBST4**
Frequencies:	Table 1: 902.2 MHz - 918.1 MHz Table 2: 911.8 MHz - 927.7 MHz
Technology tested:	Sigfox
Antenna:	Integrated antenna
Power supply:	11.0 V to 26.0 V DC by external power supply
Temperature range:	-20°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:

cn=Christoph Schneider, o=CTC advanced GmbH, ou=SND-161128, email=Christoph.Schneider@ctcadvanced.com, c=DE
2018.09.12 13:56:30 +02'00'

Christoph Schneider
Lab Manager
Radio Communications & EMC

Test performed:

cn=Tobias Wittenmeier, o=CTC advanced GmbH, ou=WIT-170519, email=tobias.wittenmeier@ctcadvanced.com, c=DE
2018.09.12 14:39:49 +02'00'

Tobias Wittenmeier
Testing Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

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

Date of receipt of order:	2018-04-05
Date of receipt of test item:	2018-09-03
Start of test:	2018-09-10
End of test:	2018-09-05
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5	April 2018	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
DTS: KDB 558074 D01	v05	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests* -20 °C during low temperature tests*
Relative humidity content	:		45 %
Barometric pressure	:		1009 hpa
Power supply	:	V_{nom} V_{max} V_{min}	24.0 V DC by external power supply 26.0 V* 11.0 V*

*No tests under extreme conditions required

5 Test item

5.1 General description

Kind of test item	:	Acces Station
Type identification	:	SMBS-T4
HMN	:	-/-
PMN	:	Micro Access Station
HVIN	:	SMBS-T4
FVIN	:	-/-
S/N serial number	:	Prototype
Hardware status	:	V1.0.0
Software status	:	TAPOS 5.0
Firmware status	:	No information available
Frequency band	:	ISM band 902 MHz – 928 MHz
Type of radio transmission Use of frequency spectrum	: :	FHSS
Type of modulation	:	GFSK
Number of channels	:	50 in each frequency table
Antenna	:	Integrated antenna
Power supply	:	11.0 V to 26.0 V DC by external power supply
Temperature range	:	-20°C to +55°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: 1-6141/18-01-03_AnnexA
1-6141/18-01-03_AnnexB
1-6141/18-01-03_AnnexD

6 Description of the test setup

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

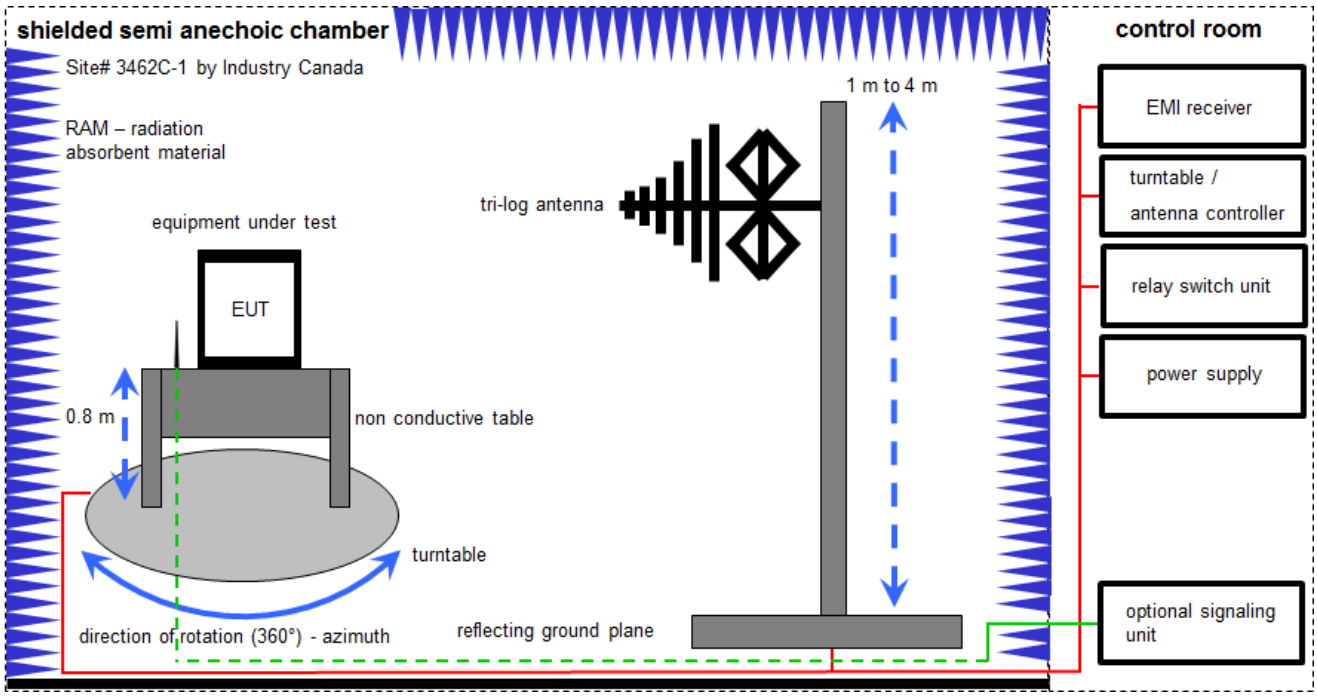
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

6.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.30.0

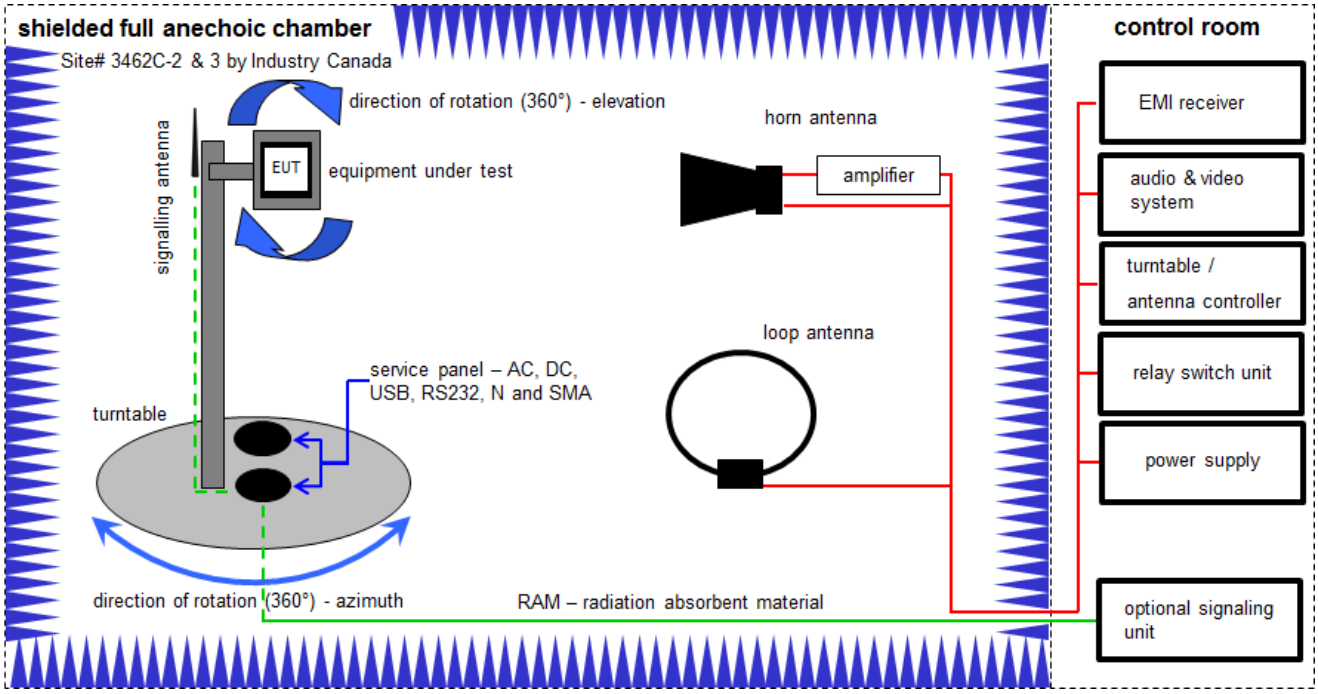
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	15.12.2017	14.12.2018
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	15.01.2018	14.01.2020
5	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	371	300003854	vlKl!	24.11.2017	23.11.2020

6.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter
BAT-EMC software version: 3.16.0.49

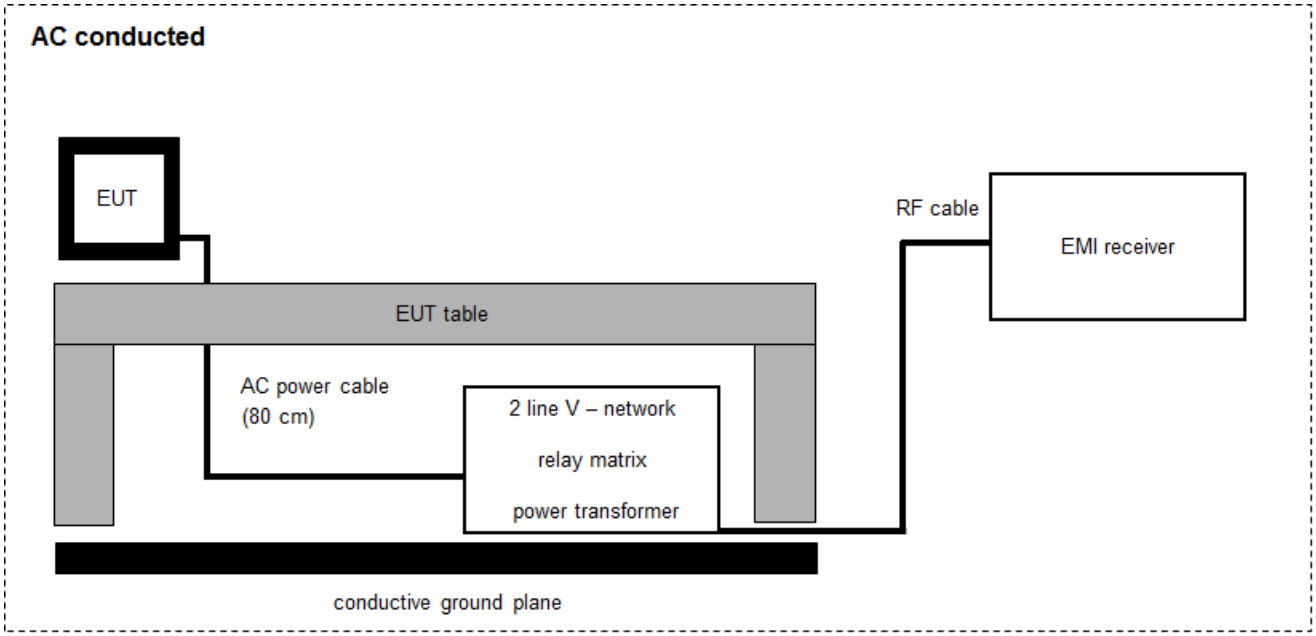
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vlKl!	07.07.2017	06.07.2019
2	A,B,C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	C	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vlKl!	14.02.2017	13.02.2019
4	A,B,C	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	C	Highpass Filter	WHKX2.9/18G-12SS	Wainwright	1	300003492	ev	-/-	-/-
6	A,B,C	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	20.12.2017	19.12.2018
7	C	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	C	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
9	A,B,C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
10	A,B,C	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
11	A,B,C	PC	ExOne	F+W		300004703	ne	-/-	-/-
12	B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	01029	300005379	vlKl!	07.04.2017	06.04.2020

6.3 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)

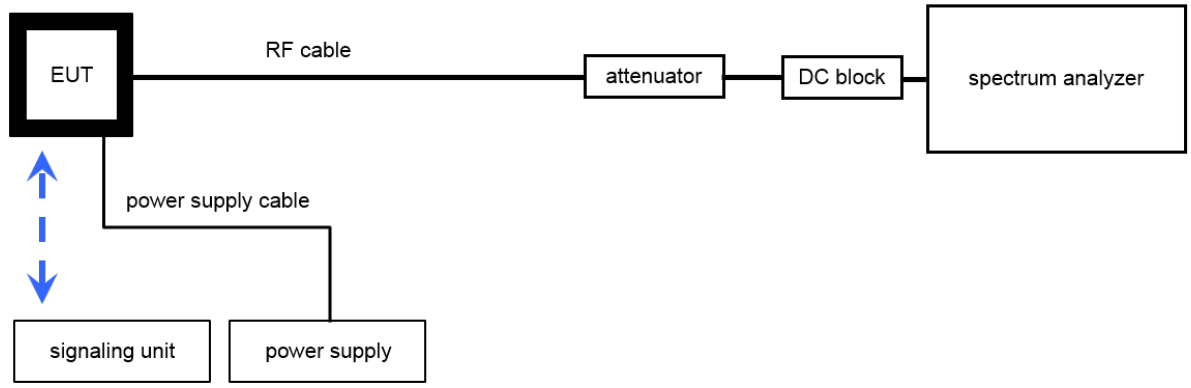
Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	893045/004	300000584	k	13.12.2017	12.12.2018
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	vlKl!	18.12.2017	17.12.2019
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	15.01.2018	14.01.2020
5	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
6	A	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	18.12.2017	17.12.2018

6.4 Conducted measurements

Conducted measurements normal 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	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	20.12.2017	19.12.2018
2	A	RF-Cable SRD021 No. 1	Enviroflex 316 D	Huber & Suhner		400001311	ev	-/-	-/-

7 Sequence of testing

7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

7.3 Sequence of testing radiated spurious 1 GHz to 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.

8 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 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	CFR Part 15 RSS - 247, Issue 2	Passed	2018-09-12	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (b)	Antenna gain	Nominal	Nominal	modulated	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (b)	Carrier frequency separation	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (d)	Number of hopping channels	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) (iii) RSS - 247 / 5.1 (d)	Time of occupancy (dwell time)	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (a)	Spectrum bandwidth of a FHSS system bandwidth	Nominal	Nominal	modulated	☒	☐	☐	☐	-/-
§15.247(b)(1) RSS - 247 / 5.4 (b)	Maximum output power	Nominal	Nominal	modulated	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	-/-	☐	☐	☒	☐	No restricted band nearby
§15.247(d) RSS - 247 / 5.5	Spurious emissions conducted	Nominal	Nominal	modulated	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	Nominal	Nominal	modulated	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	Nominal	Nominal	modulated / RX mode	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	Nominal	Nominal	modulated / RX mode	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-

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

10 RF measurements

10.1 Additional comments

Reference documents: None

Special test descriptions: The EUT uses two different hopping frequency blocks:
Frequency table1: 902.2 MHz – 918.1 MHz
Frequency table2: 911.8 MHz – 927.7 MHz
Both blocks were tested and stated in this test report.
For single channel tests we used the following nominal frequencies:
Table 1: 902.2 MHz lowest channel; 909.4 MHz middle channel; 918.1 MHz highest channel
Table 2: 911.8 MHz lowest channel; 920.2 MHz middle channel; 927.7 MHz highest channel

Hopping table 1:

Channel #	Frequency (MHz)	Channel #	Frequency (MHz)
1	902.8	26	917.8
2	905.2	27	918.1
3	913.9	28	911.8
4	902.5	29	906.7
5	903.7	30	906.1
6	903.1	31	909.4
7	917.5	32	913.6
8	906.4	33	914.5
9	907.0	34	915.7
10	904.3	35	908.8
11	904.0	36	907.9
12	908.5	37	914.8
13	910.0	38	907.6
14	904.6	39	917.2
15	913.0	40	914.2
16	911.2	41	908.2
17	905.5	42	909.7
18	902.2	43	910.3
19	904.9	44	915.4
20	903.4	45	909.1
21	905.8	46	910.9
22	907.3	47	913.3
23	912.4	48	915.1
24	911.5	49	912.1
25	912.7	50	910.6

hopping table 2:

Channel #	Frequency (MHz)	Channel #	Frequency (MHz)
1	912.4	26	927.4
2	914.8	27	927.7
3	924.7	28	922.6
4	912.1	29	917.5
5	913.3	30	915.7
6	912.7	31	920.2
7	927.1	32	924.4
8	917.2	33	925.3
9	917.8	34	926.5
10	913.9	35	919.6
11	913.6	36	918.7
12	919.3	37	925.6
13	920.8	38	918.4
14	914.2	39	926.8
15	923.8	40	925.0
16	922.0	41	919.0
17	915.1	42	920.5
18	911.8	43	921.1
19	914.5	44	926.2
20	913.0	45	919.9
21	915.4	46	921.7
22	918.1	47	924.1
23	923.2	48	925.9
24	922.3	49	922.9
25	923.5	50	921.4

Configuration descriptions: None

Test mode: ☒ Special software is used.
EUT is transmitting pseudo random data by itself

11 Measurement results

11.1 Antenna gain

The antenna gain of the complete system is calculated by the difference of radiated power in ERP and the conducted power of the module.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 6.2 B (radiated) See sub clause 6.4 A (conducted)
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
Antenna gain	
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	

Results:

Table 1	Low channel	Middle channel	High channel
Conducted power [dBm]	20.5	20.6	21.4
Radiated power [dBm]	20.9	20.2	22.8
Gain [dBi] Calculated	+0.4	-0.4	+1.4

Table 2	Low channel	Middle channel	High channel
Conducted power [dBm]	19.9	22.3	18.3
Radiated power [dBm]	21.9	22.1	20.1
Gain [dBi] Calculated	+2.0	-0.2	+1.8

11.2 Carrier Frequency Separation

Description:

Measurement of the carrier frequency separation of a hopping system. The carrier frequency separation is constant for all modulation-modes. We use GFSK-modulation to show compliance. EUT in hopping mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater. The two-thirds of the 20 dB bandwidth for IC is only valid for the ISM band 2400 – 2483.5 MHz.	

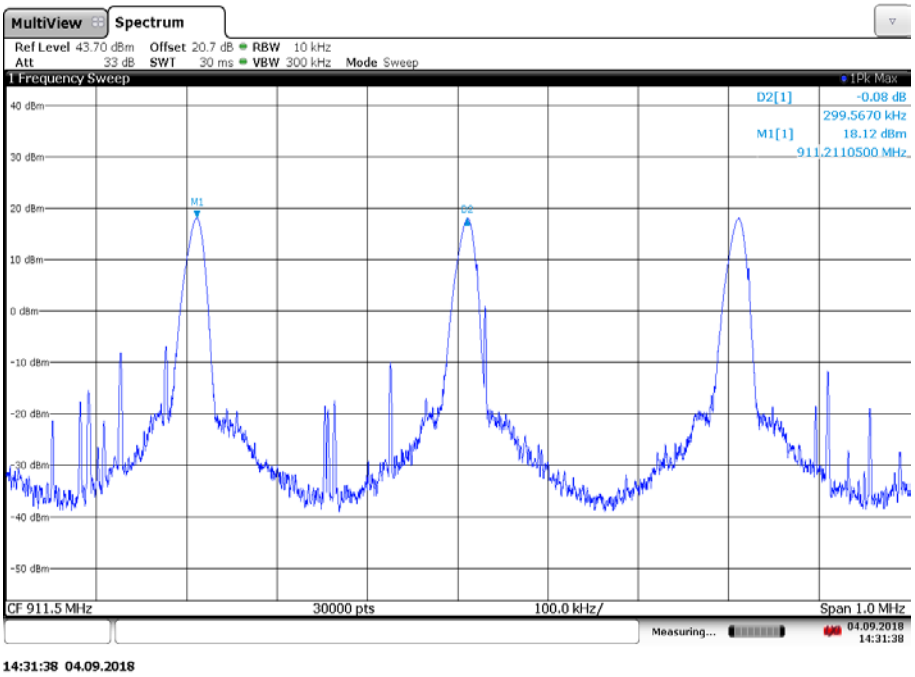
Result:

Table 1: The channel separation is 299.6 kHz.

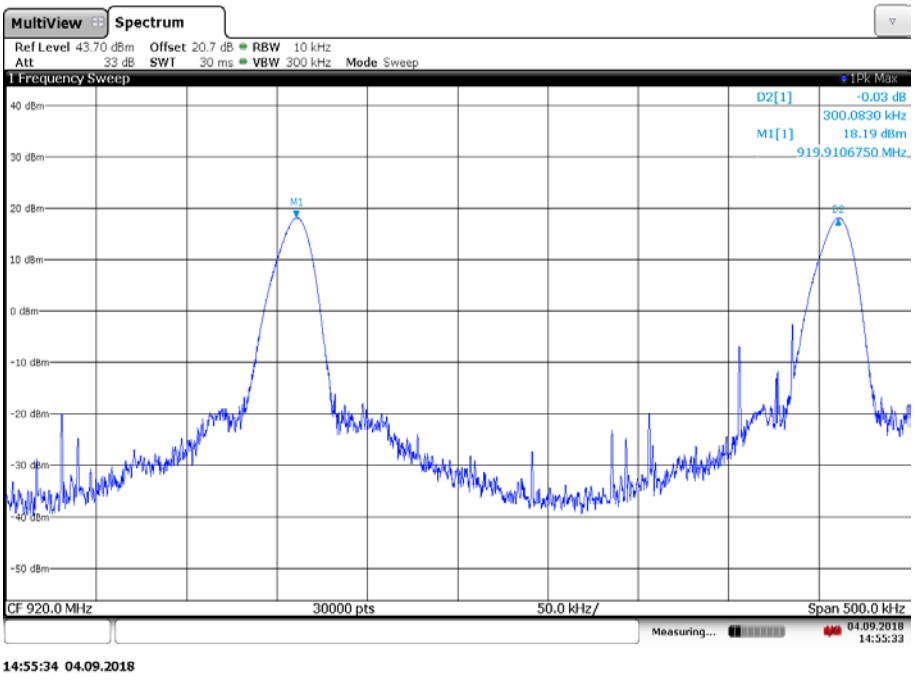
Table 2: The channel separation is 300.1 kHz.

Plots:

Plot 1: Frequency separation Table 1



Plot 2: Frequency separation Table 2



11.3 Number of Hopping Channels

Description:

Measurement of the total number of used hopping channels.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 6.3 A
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
Number of hopping channels	
At least 15 non overlapping hopping channels. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels.	

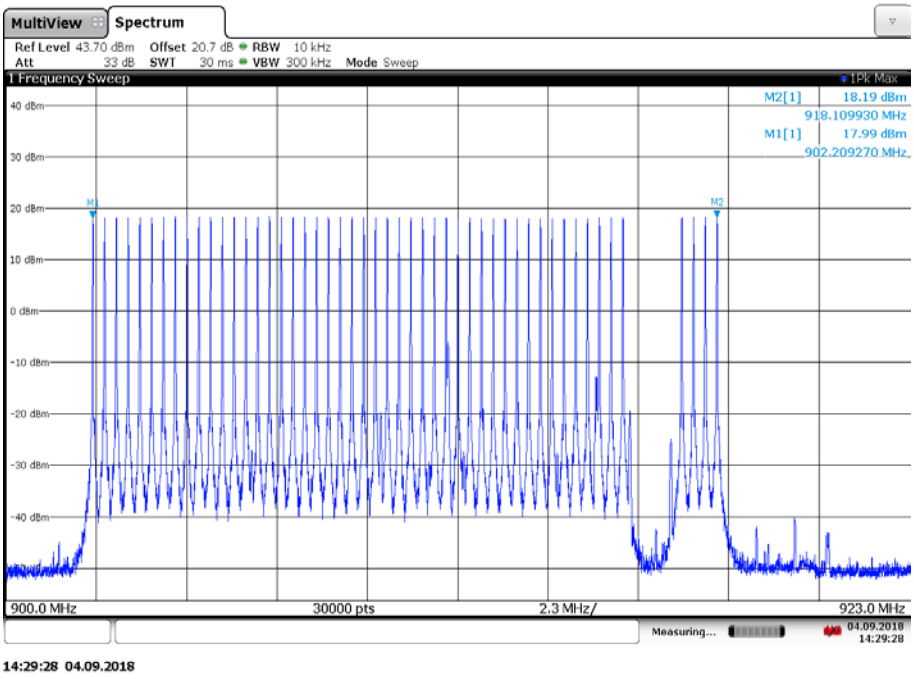
Result:

Table 1: The EUT uses 50 channels.

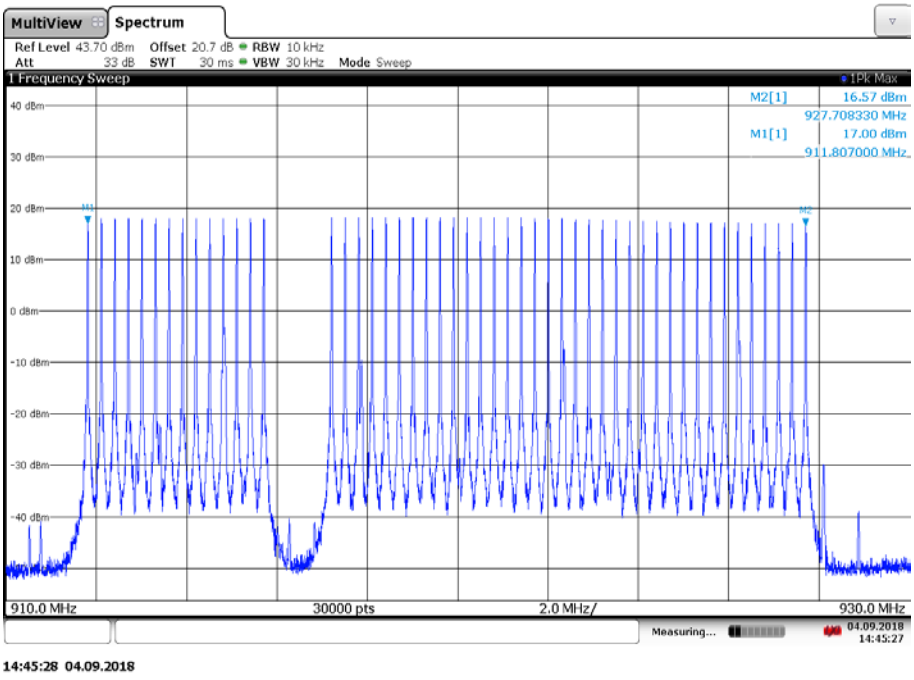
Table 2: The EUT uses 50 channels.

Plots:

Plot 1: Number channels Table 1



Plot 2: Number channels Table 2



11.4 Average Time of Occupancy (dwell time)

Measurement:

The measurement is performed in zero span mode to show that none of the 50 used channels per freqwuency block is allocated more than 0.4 seconds within a 20 seconds interval.

Limits:

FCC	IC
Average time of occupancy	
For frequency hopping systems operating in the 902-928 MHz band: If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 10 second period.	

Result table 1:

The time slot length is = 380.4 ms
Number of hops / channel @ 20s = 1

→ The average time of occupancy = 380.4 ms

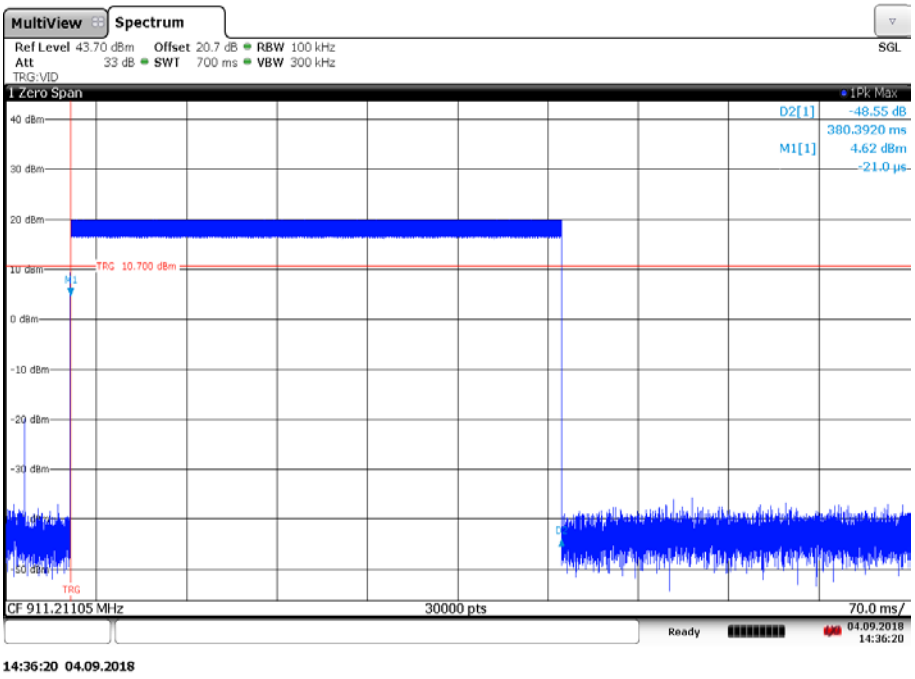
Result table 2:

The time slot length is = 380.4 ms
Number of hops / channel @ 20s = 1

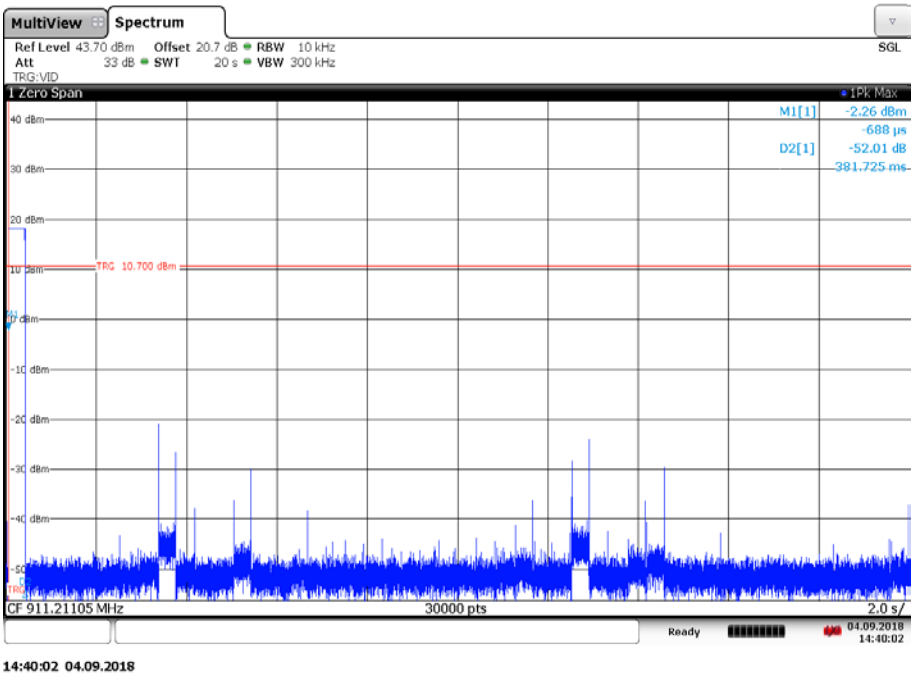
→ The average time of occupancy = 380.4 ms

Plots Table 1:

Plot 1: Time slot length = 380.4 ms

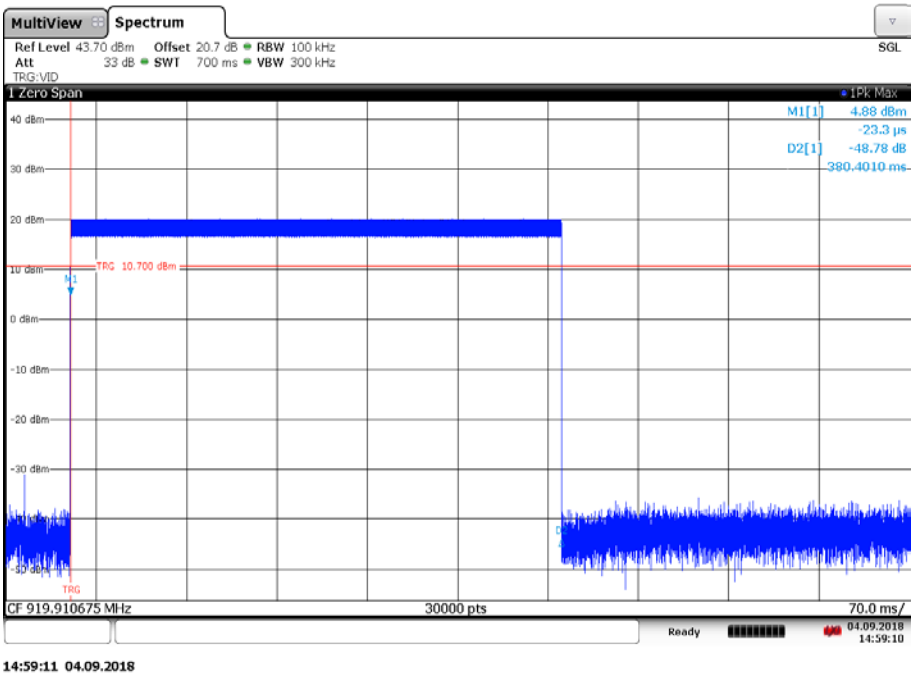


Plot 2: hops / channel @ 20s = 1

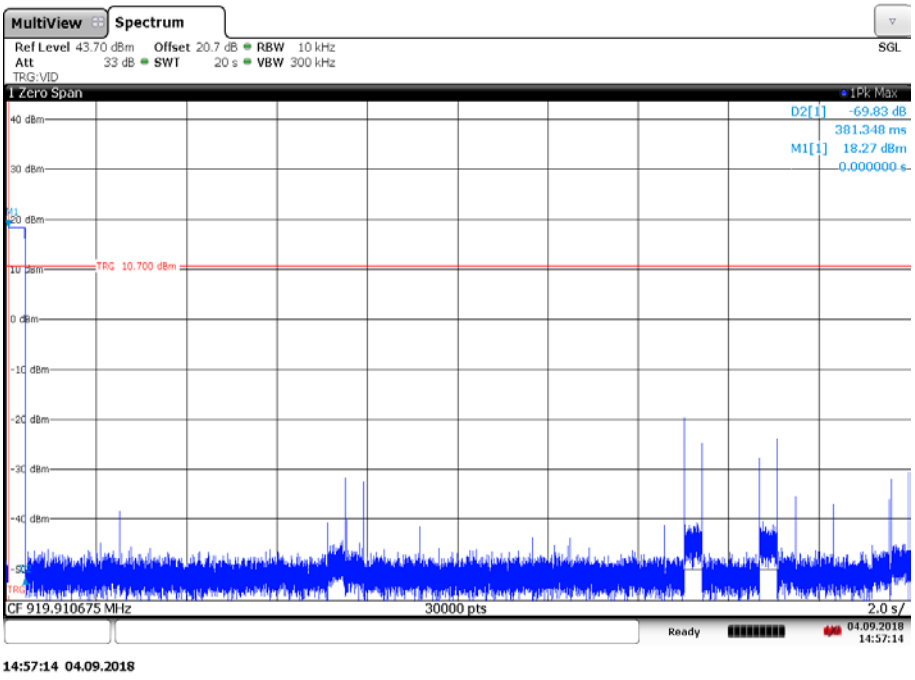


Plots Table 2:

Plot 1: Time slot length = 380.4 ms



Plot 2: hops / channel @ 20s = 1



11.5 Spectrum bandwidth of a FHSS system

Description:

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the “Measurement Guidelines” (DA 00-705, March 30, 2000). EUT in single channel mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
Spectrum bandwidth of a FHSS system	
GFSK < 1500 kHz	

Result table 1:

Test Conditions		20dB BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	161.84	162.34	162.84

Test Conditions		99% BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	157.97	157.95	158.21

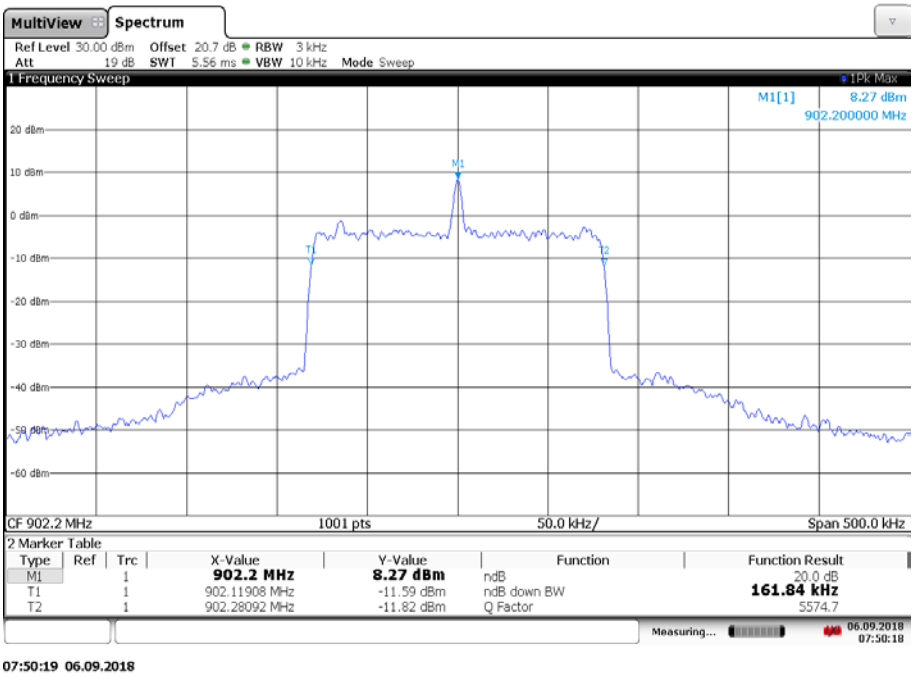
Result table 2:

Test Conditions		20dB BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	161.84	163.34	162.34

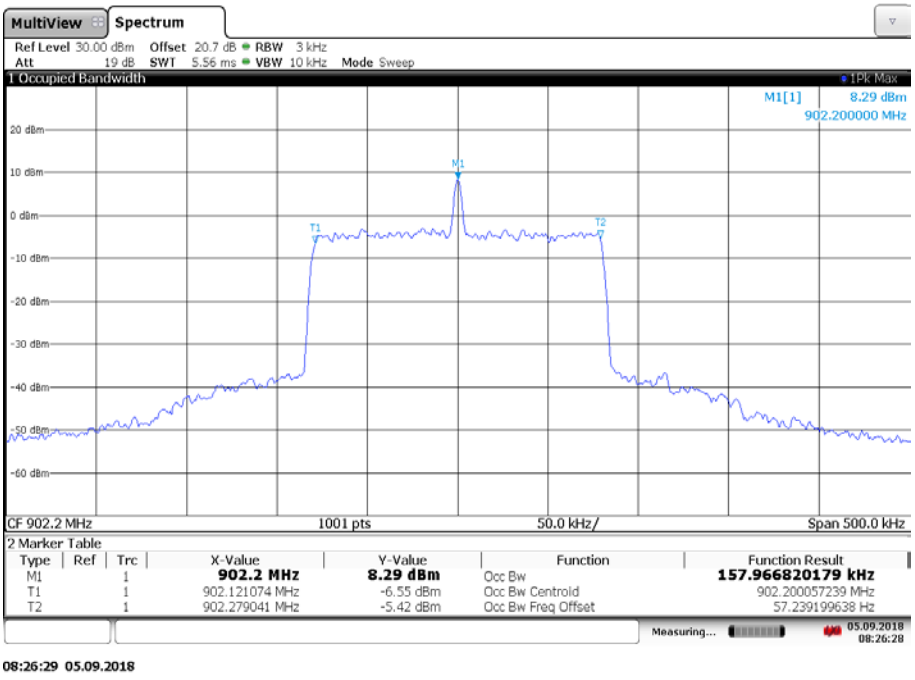
Test Conditions		99% BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	157.93	157.64	158.53

Plots table 1:

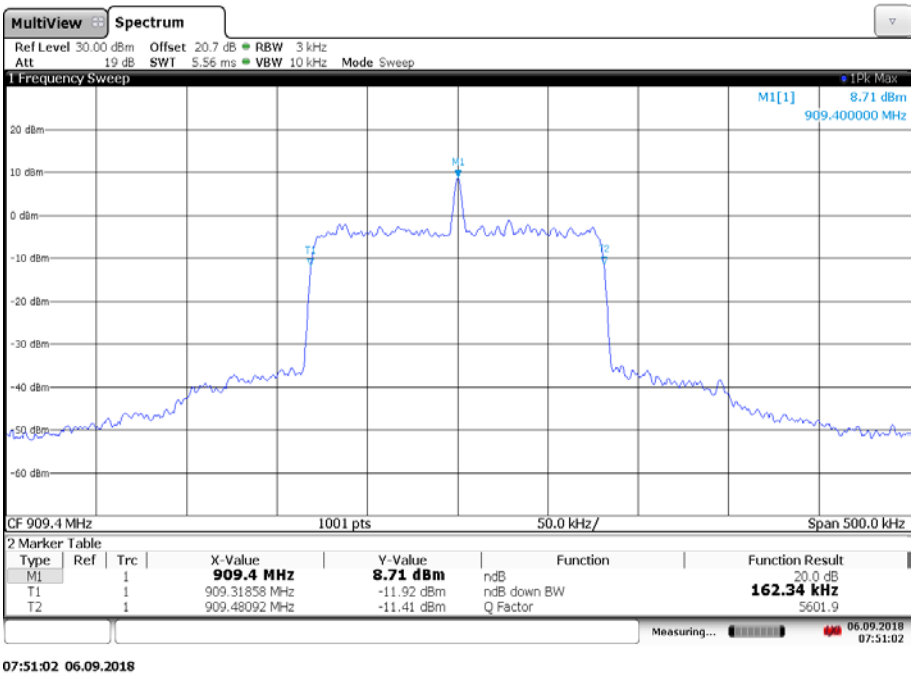
Plot 1: Low Channel; 20 dB-bandwidth



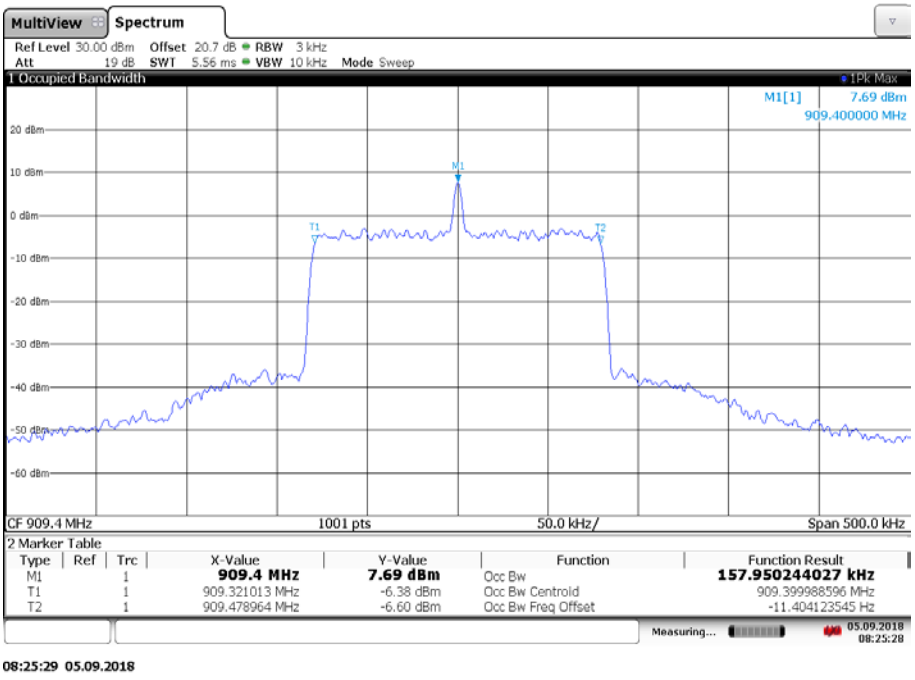
Plot 2: Low Channel; OBW99



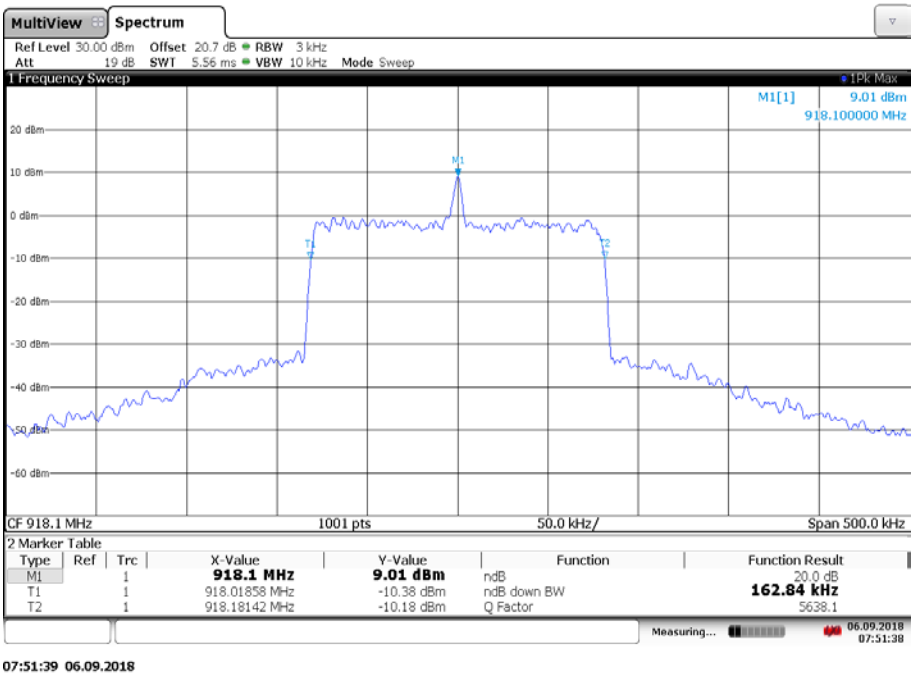
Plot 3: Middle Channel; 20 dB-bandwidth



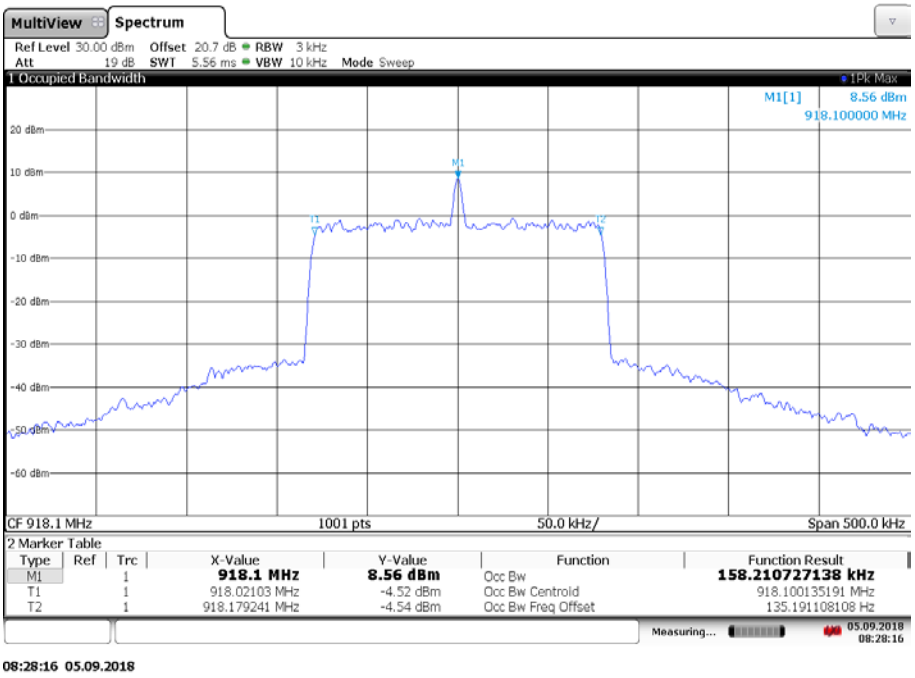
Plot 4: Middle Channel; OBW99



Plot 5: High Channel; 20 dB-bandwidth

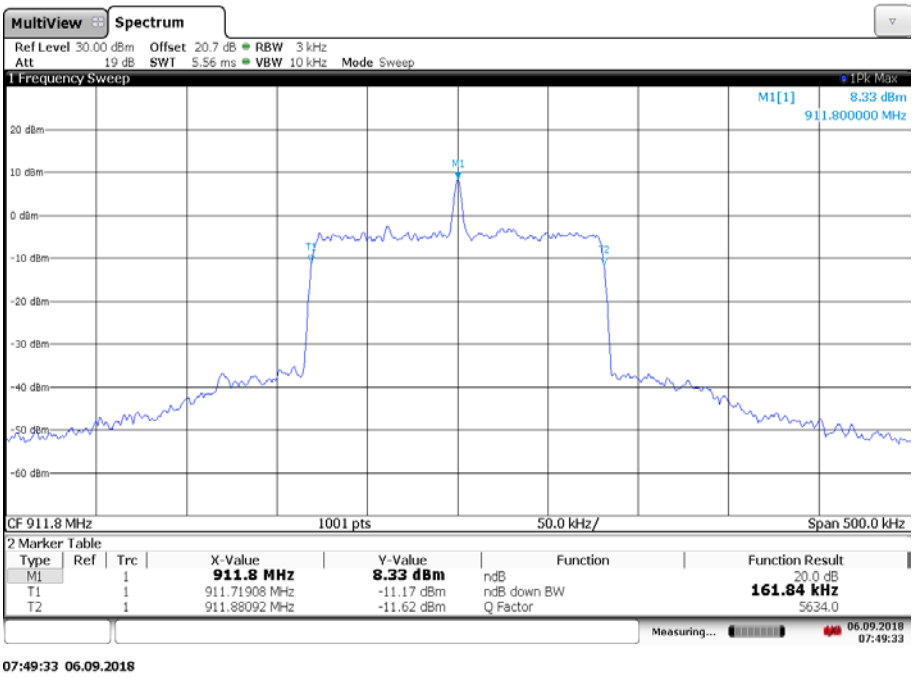


Plot 6: High Channel; OBW99

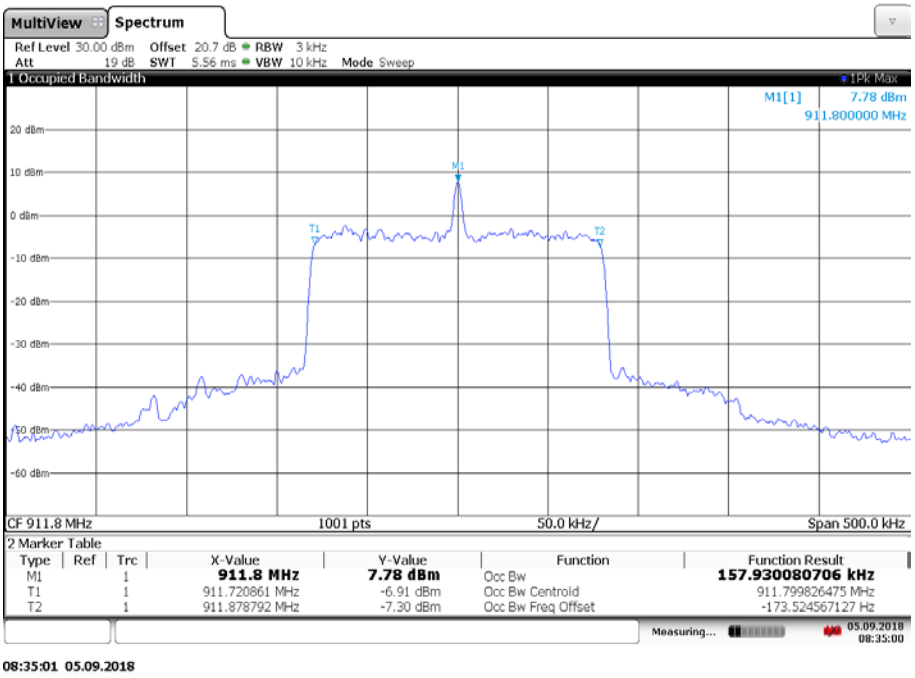


Plots table 2:

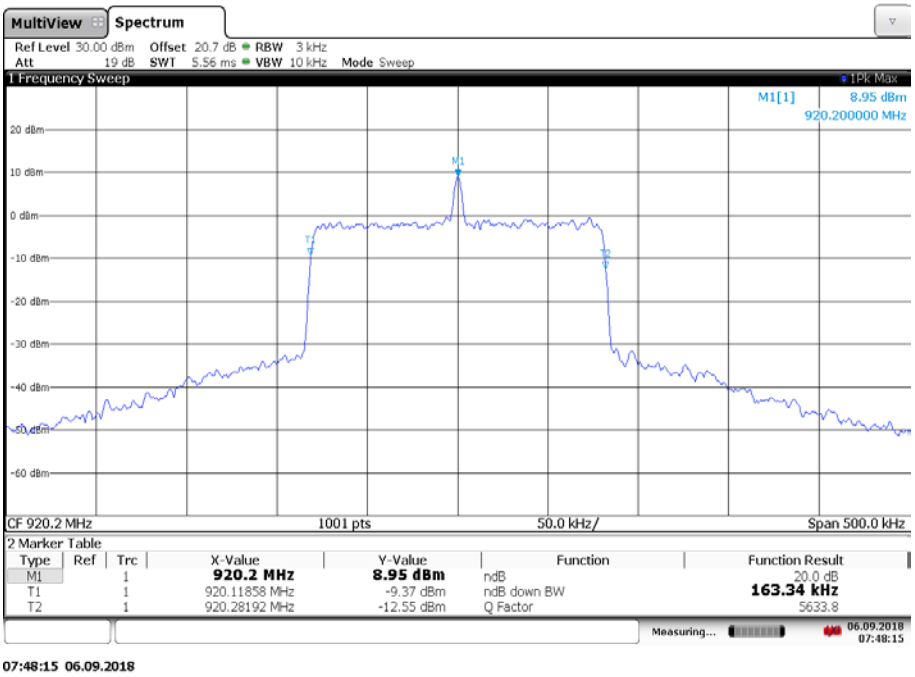
Plot 1: Low Channel; 20 dB-bandwidth



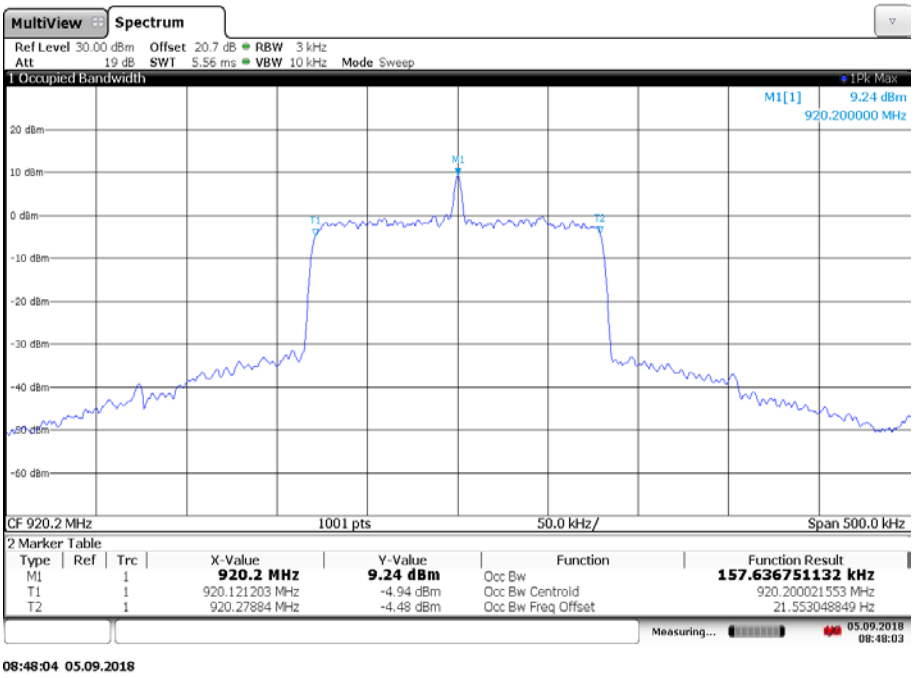
Plot 2: Low Channel; OBW99



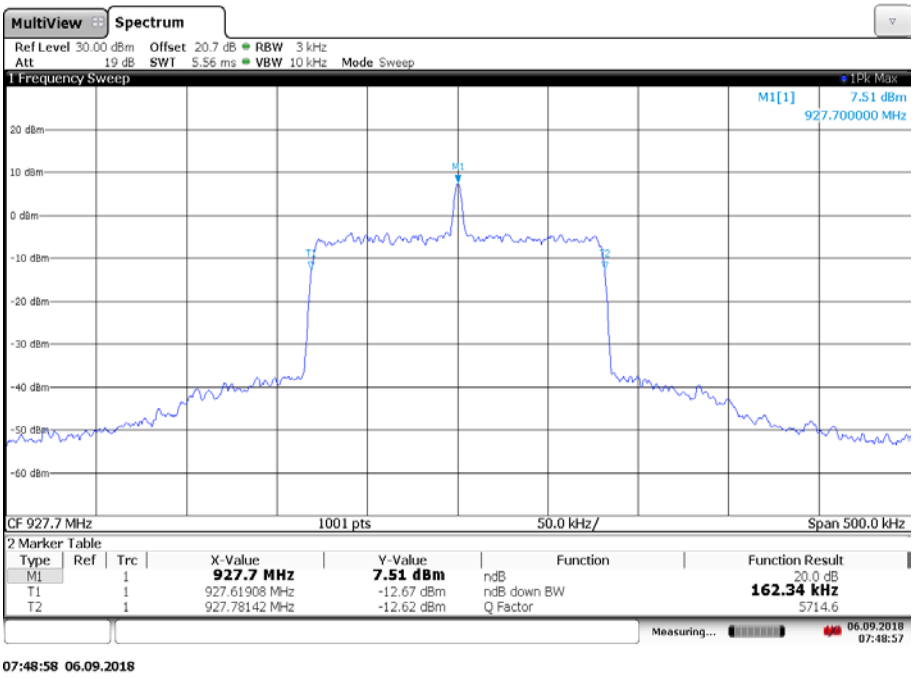
Plot 3: Middle Channel; 20 dB-bandwidth



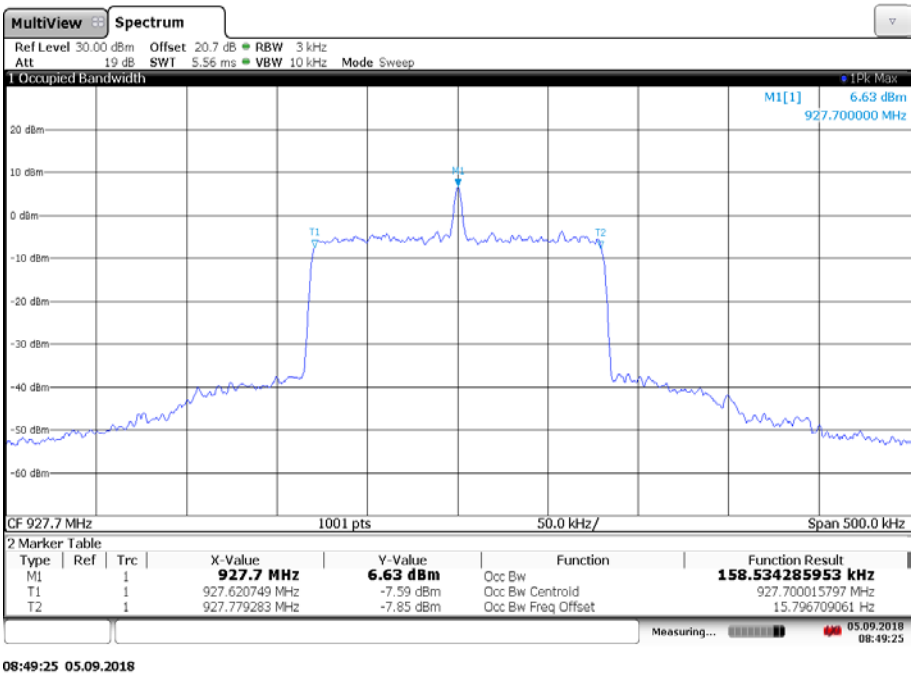
Plot 4: Middle Channel; OBW99



Plot 5: High Channel; 20 dB-bandwidth



Plot 6: High Channel; OBW99



11.6 Maximum Output Power

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	5 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.4 A
Measurement uncertainty:	See chapter 8

Limits:

FCC	IC
Maximum Output Power Conducted	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	

Result table 1:

Test Conditions		Maximum Output Power Conducted [dBm]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	20.5	20.6	21.4

Test Conditions		ERP [dBm]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	20.9	20.2	22.8

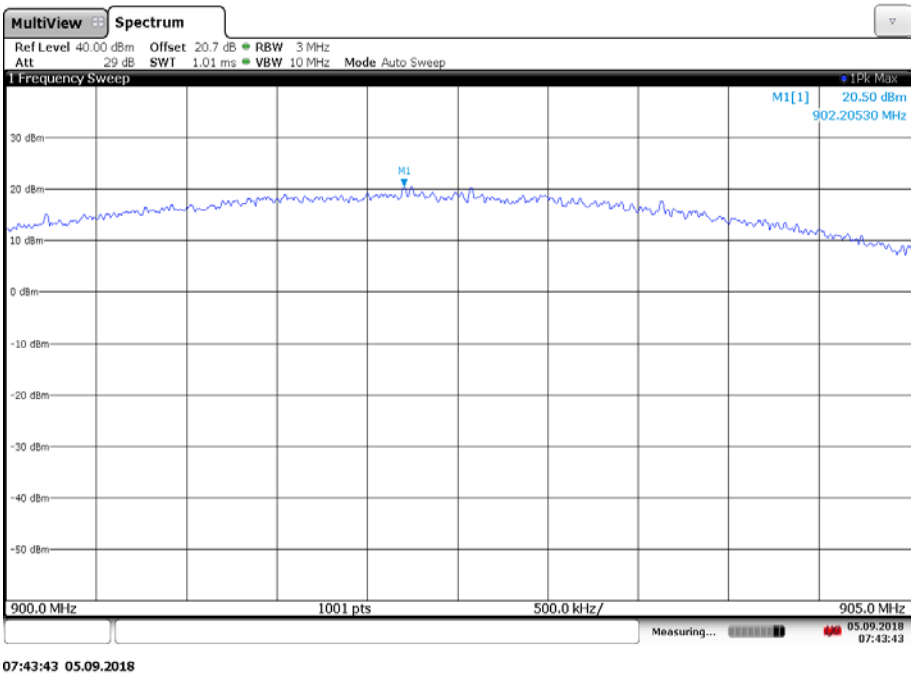
Result table 2:

Test Conditions		Maximum Output Power Conducted [dBm]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	19.9	22.3	18.3

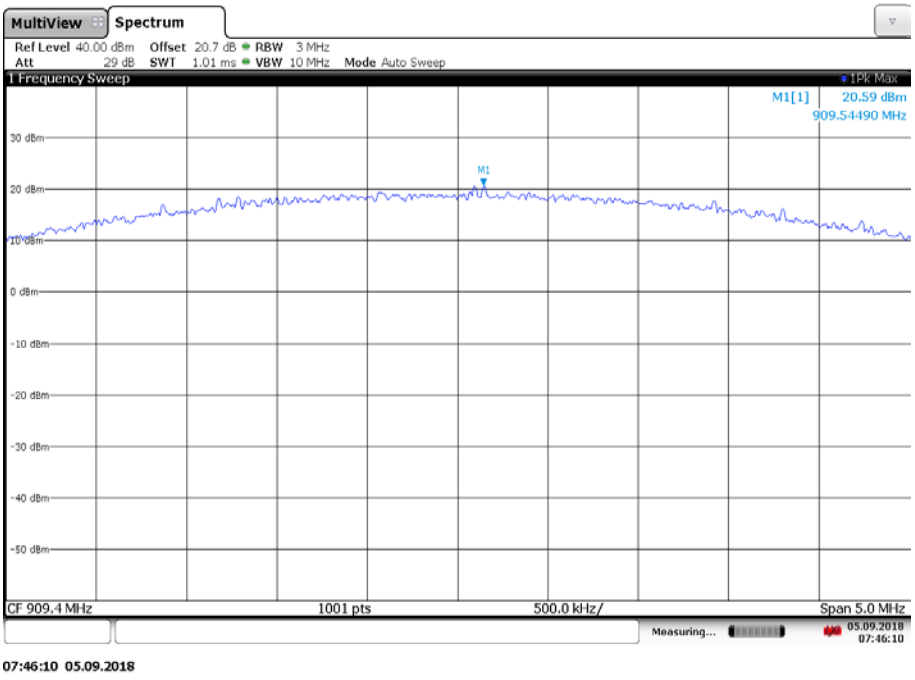
Test Conditions		ERP [dBm]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	21.9	22.1	20.1

Plots conducted Table 1:

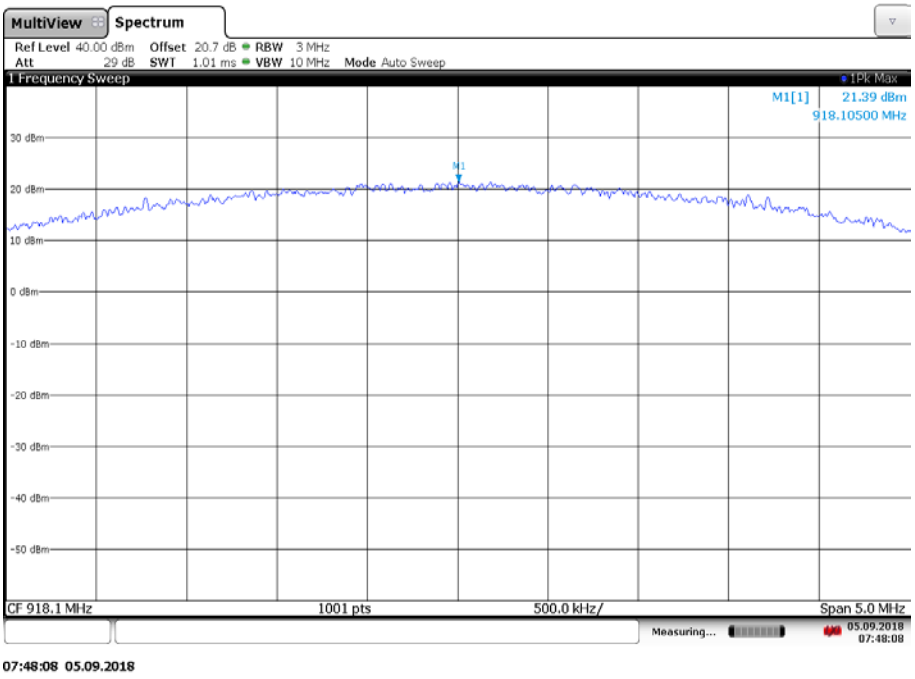
Plot 1: Low Channel



Plot 2: Middle Channel

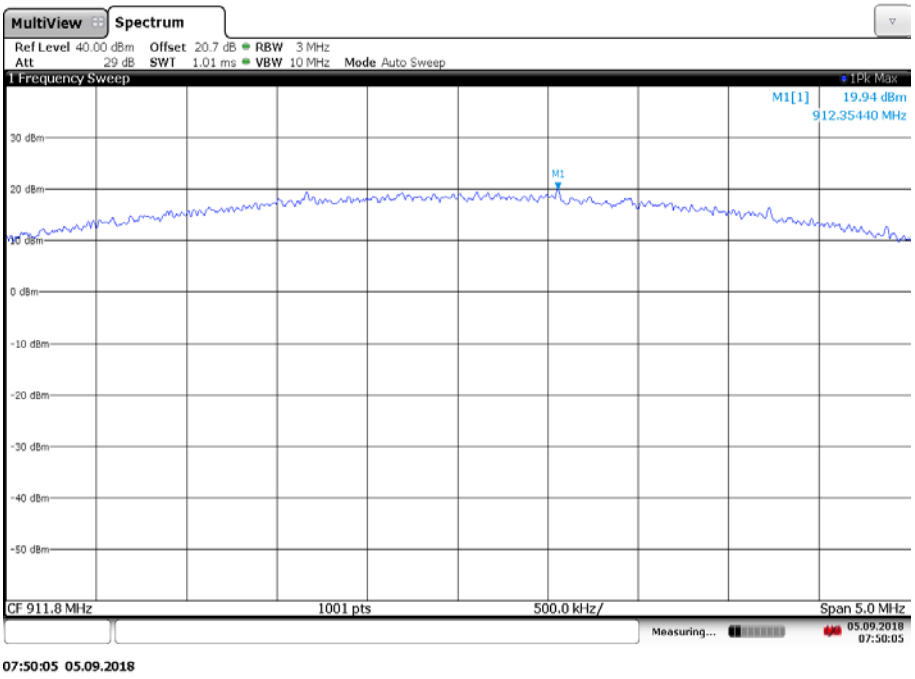


Plot 3: High Channel

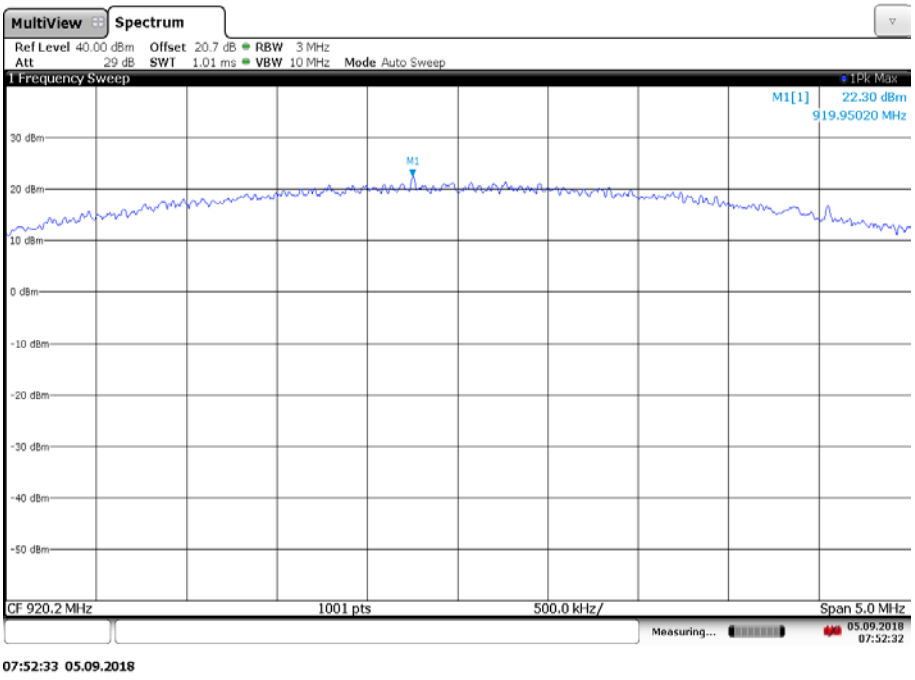


Plots conducted Table 2:

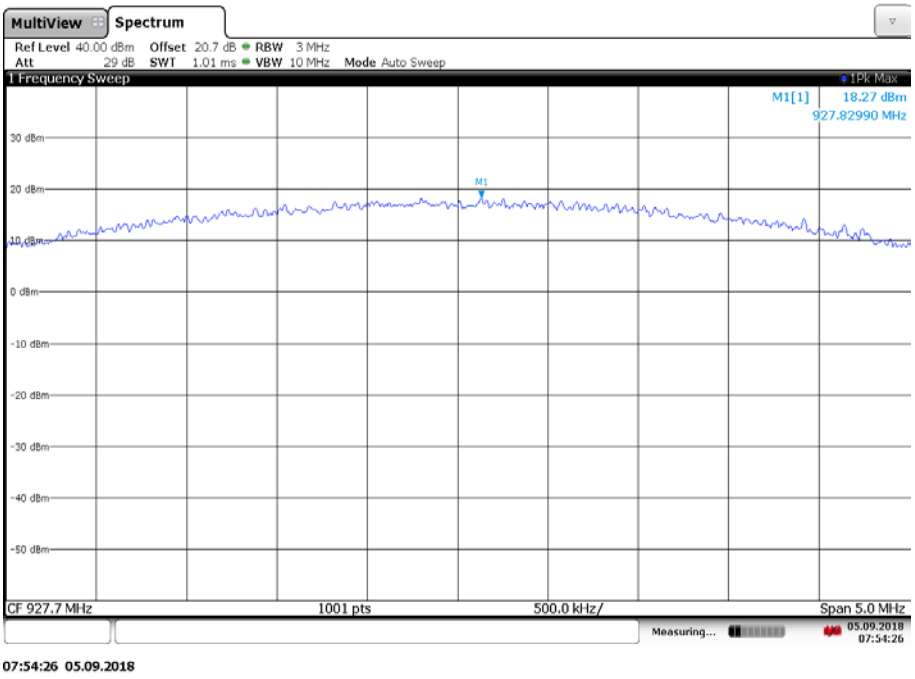
Plot 1: Low Channel



Plot 2: Middle Channel



Plot 3: High Channel



11.7 Detailed spurious emissions @ the band edge – conducted and radiated

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel and hopping mode. The measurement is repeated for all modulations.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

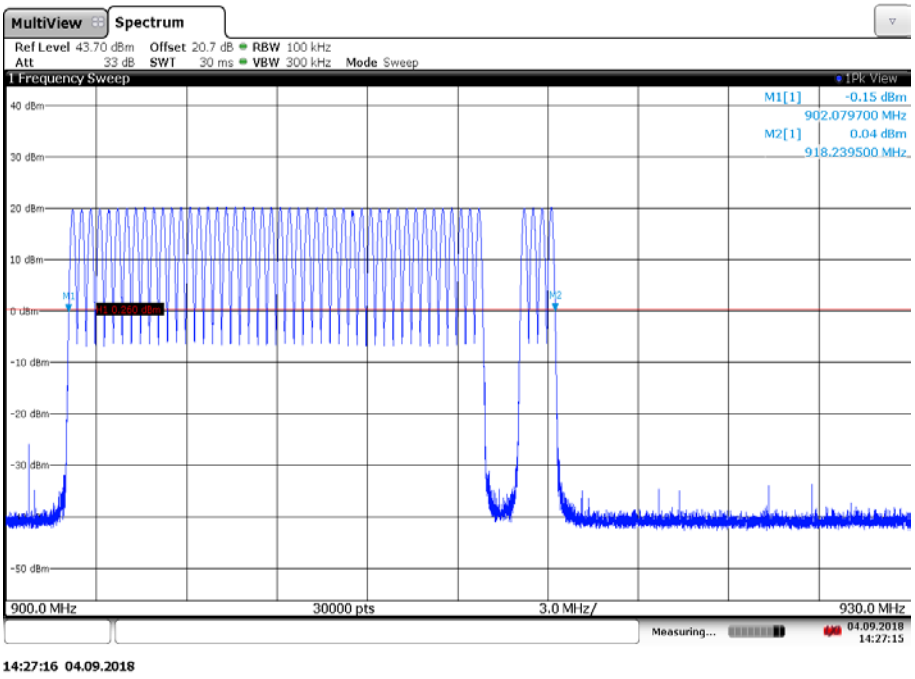
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.	

Results conducted Table 1 and Table 2:

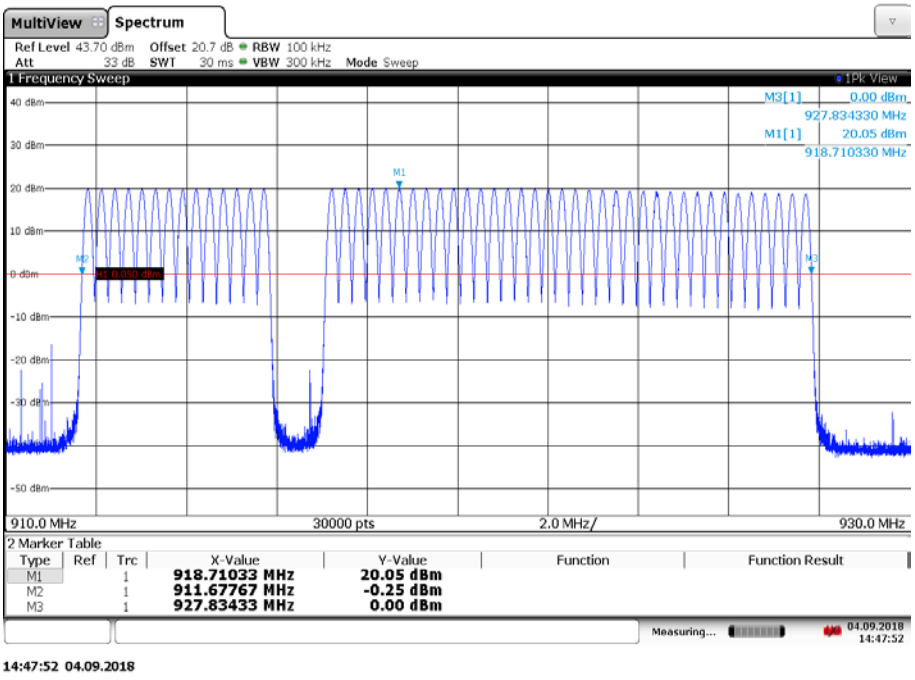
Scenario	Spurious band edge conducted [dB]		
Modulation	lowest channel	middle channel	highest channel
Lower band edge – hopping on	> 20 dB	> 20 dB	> 20 dB
Upper band edge – hopping on	> 20 dB	> 20 dB	> 20 dB

Plots:

Plot 1: 20 dB – hopping on Table 1



Plot 2: 20 dB – hopping on Table 2



Results radiated:

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

11.8 Spurious Emissions Conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 6.4A
Measurement uncertainty:	See chapter 8

Limits:

FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Result Table 1:

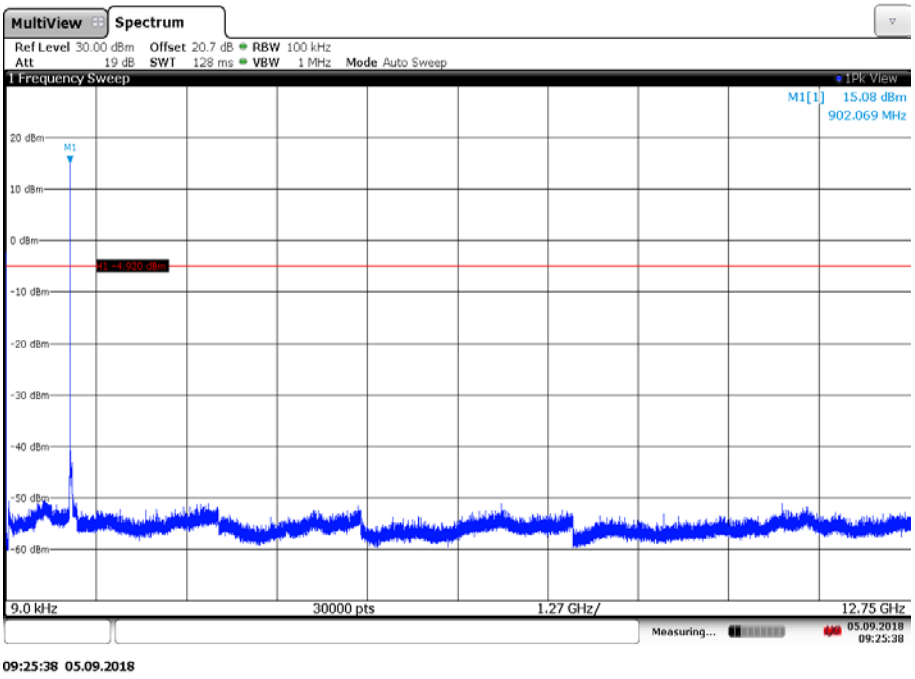
Emission Limitation					
Channel		Amplitude of emission [dBm]	Limit max. allowed emission power	actual attenuation below frequency of operation [dB]	Results
Lowest		15.08	24 dBm	No emissions detected	Operating frequency
See plot			-20 dBc		
Middle		14.14	24 dBm		Operating frequency
See plot			-20 dBc		
Highest		14.58	24 dBm		Operating frequency
See plot			-20 dBc		

Result Table 2:

Emission Limitation					
Channel		Amplitude of emission [dBm]	Limit max. allowed emission power	actual attenuation below frequency of operation [dB]	Results
Lowest		13.28	24 dBm	No emissions detected	Operating frequency
See plot			-20 dBc		
Middle		14.91	24 dBm		Operating frequency
See plot			-20 dBc		
Highest		12.69	24 dBm		Operating frequency
See plot			-20 dBc		

Plots Table 1:

Plot 1: Low channel, 9 kHz – 12.75 GHz



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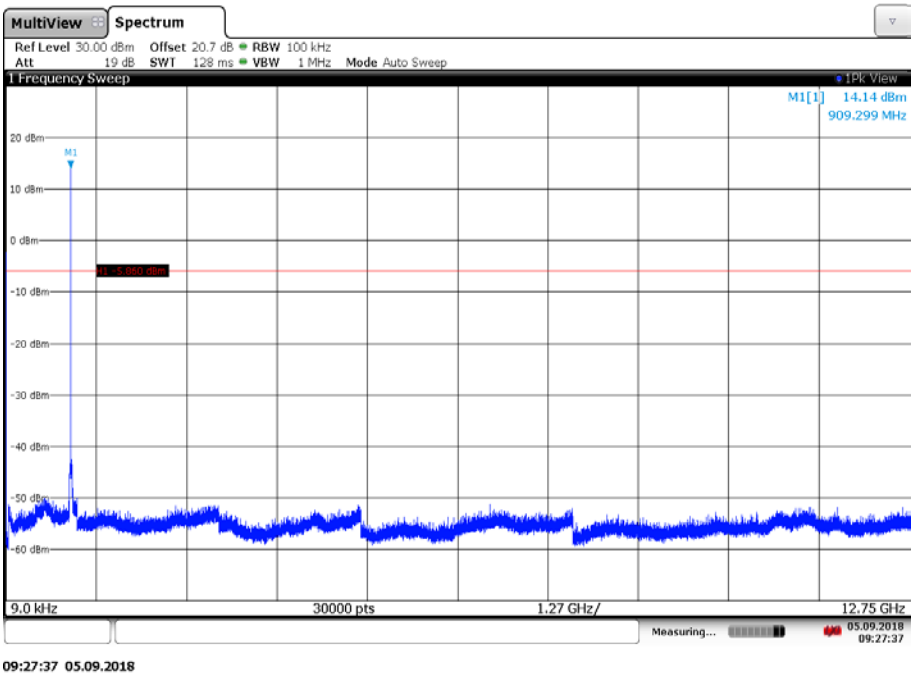
Plot 2: Middle channel, 9 kHz – 12.75 GHz



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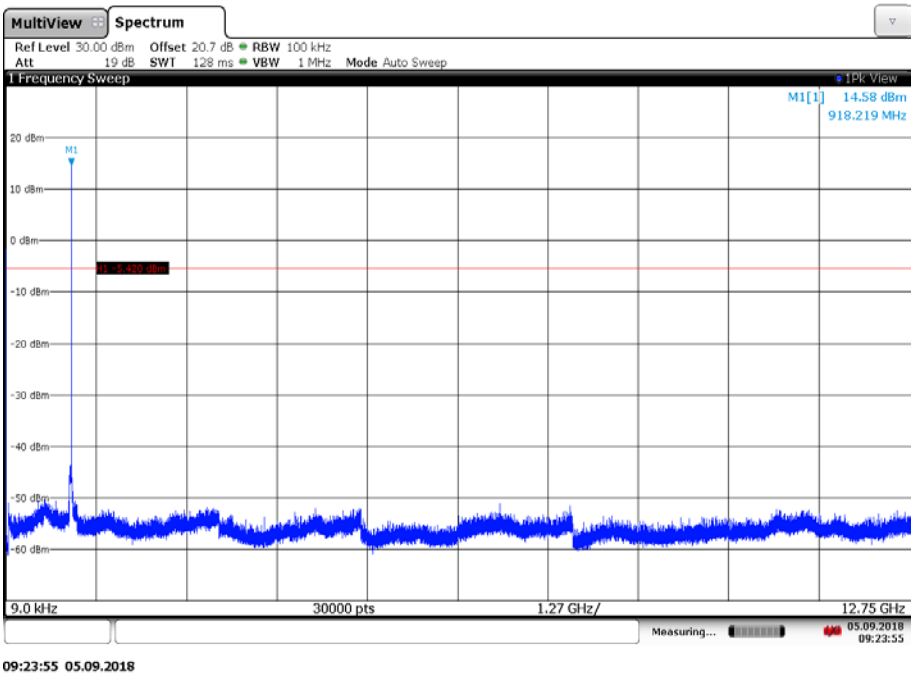
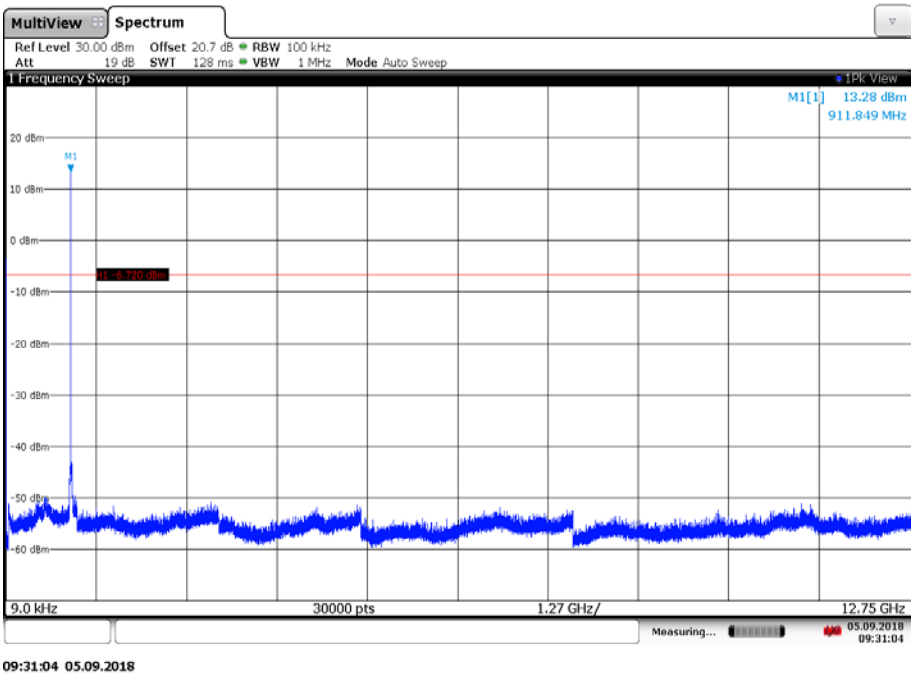
Plot 3: High channel, 9 kHz – 12.75 GHz

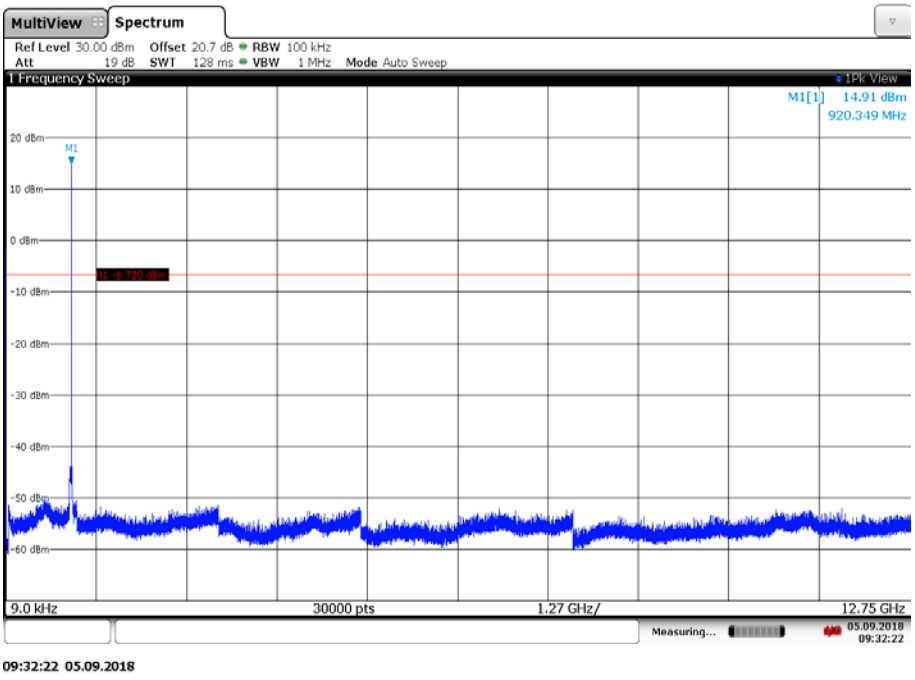


Plots Table 2:

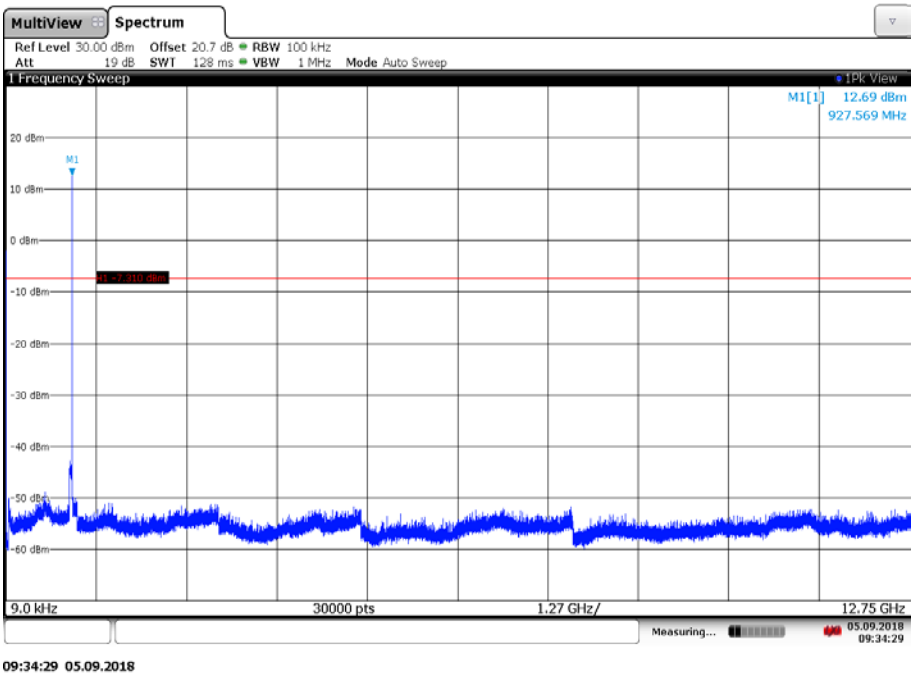
Plot 1: Low channel, 9 kHz – 12.75 GHz



Plot 2: Middle channel, 9 kHz – 12.75 GHz



Plot 3: High channel, 9 kHz – 12.75 GHz



11.9 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit channels are 00; 39 and 78. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 6.2 A
Measurement uncertainty:	See chapter 8

Limits:

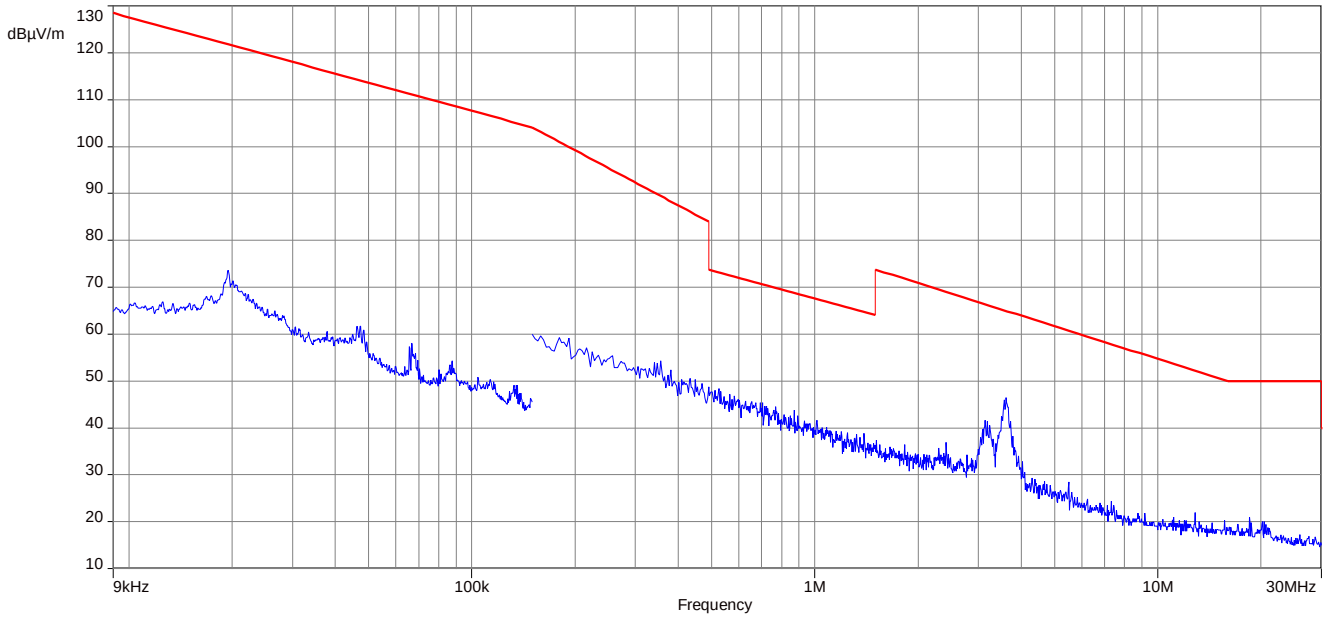
FCC		IC
TX spurious emissions radiated < 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Result Table 1 and Table 2:

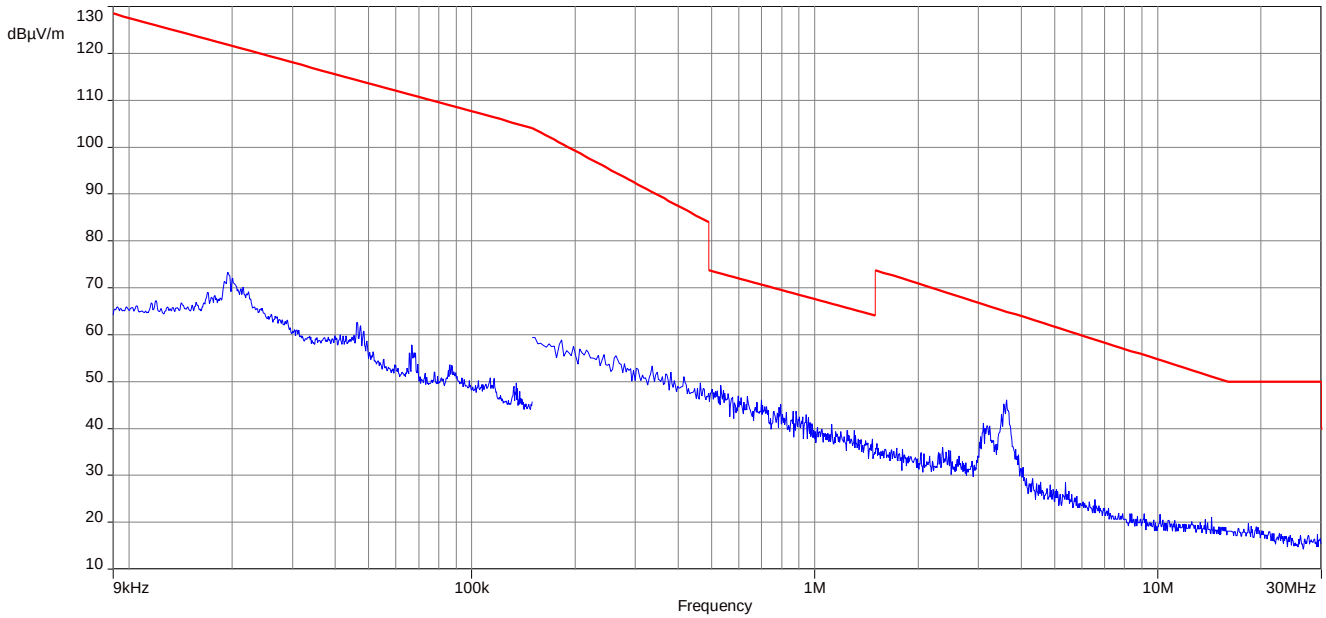
SPURIOUS EMISSIONS LEVEL [dBµV/m]								
Lowest channel			Middle channel			Highest channel		
Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]
All emissions were more than 10 dB below the limit.								

Plots Table 1:

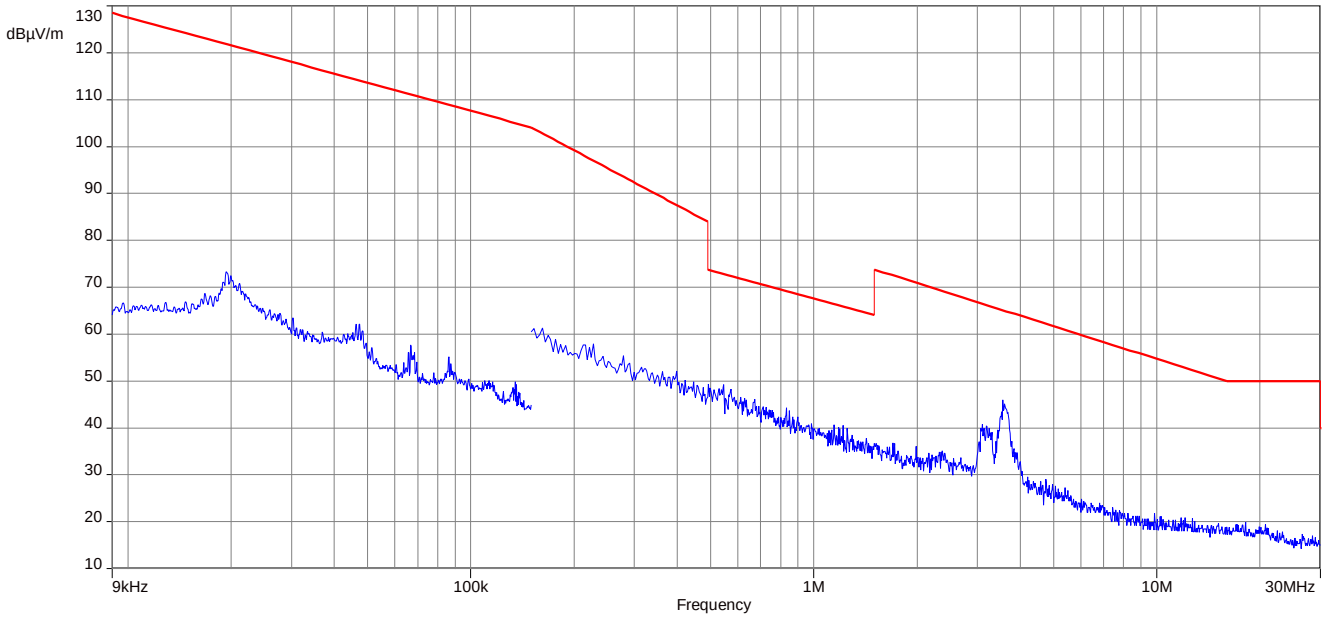
Plot 1: TX-Mode low channel



Plot 2: TX-Mode mid channel

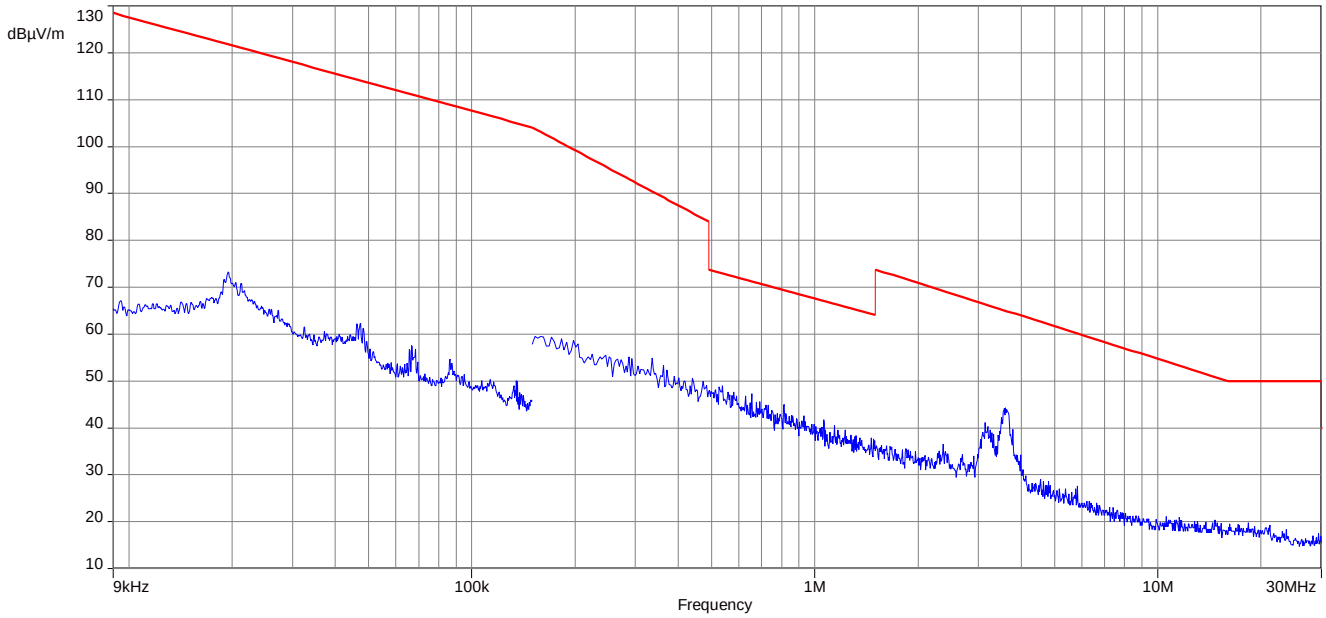


Plot 3: TX-Mode high channel

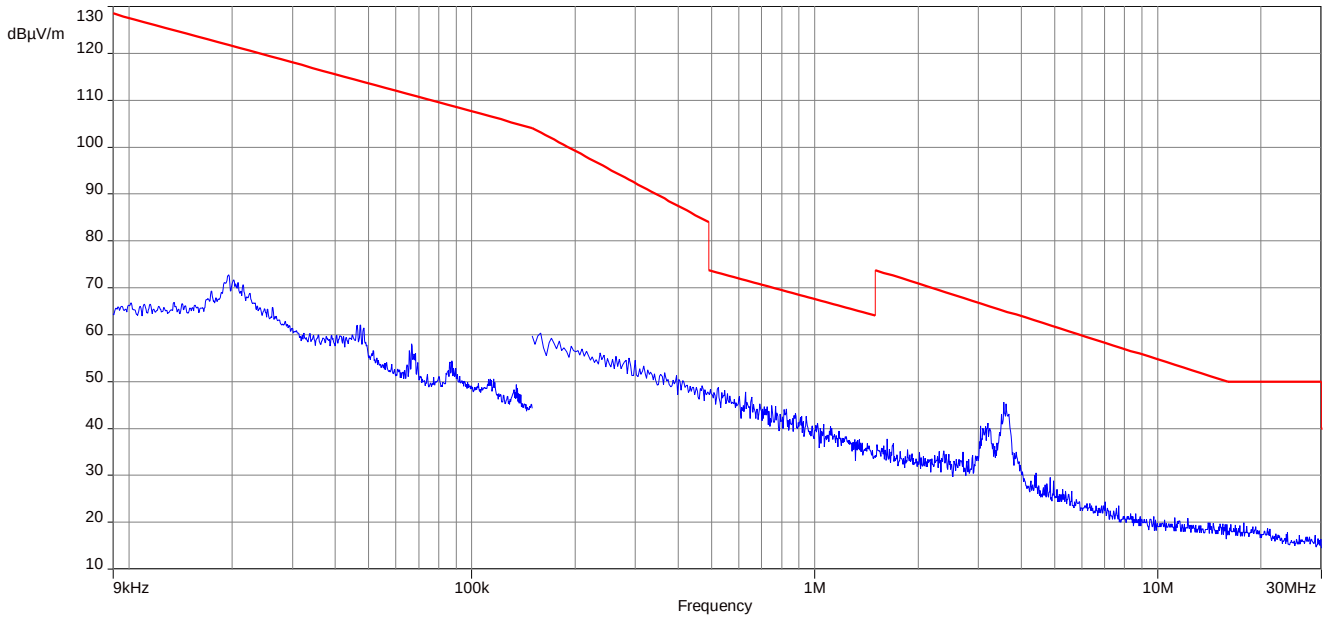


Plots Table 2:

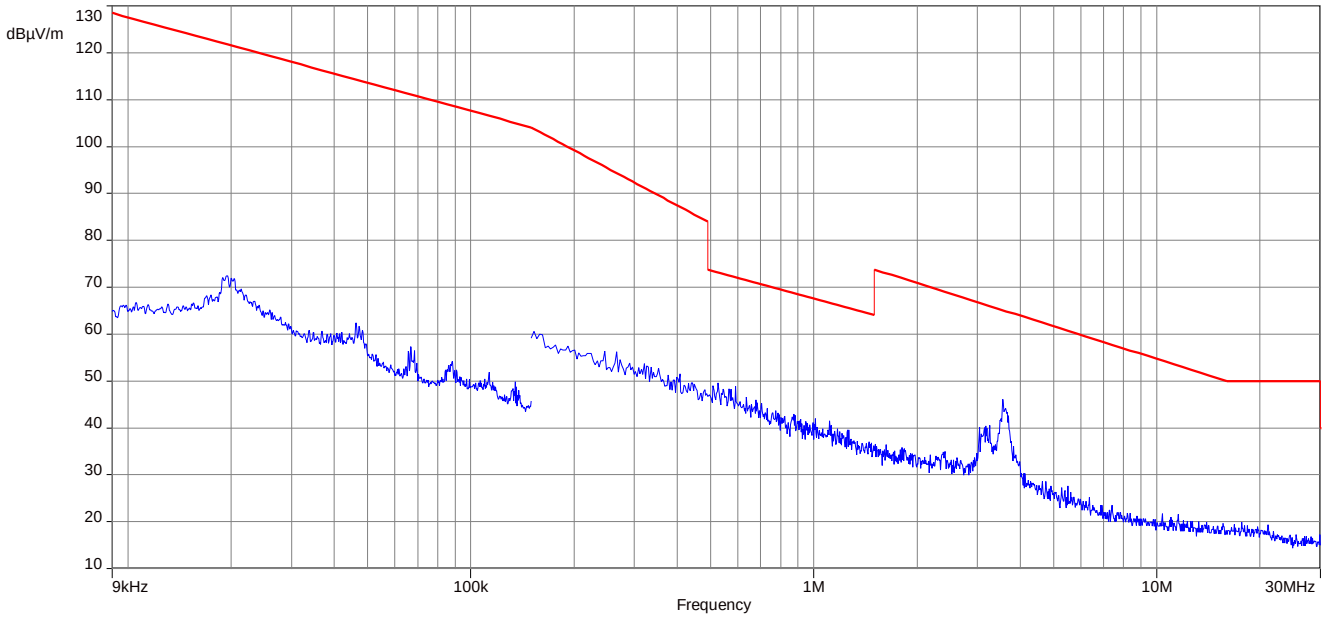
Plot 1: TX-Mode low channel



Plot 2: TX-Mode mid channel



Plot 3: TX-Mode high channel



11.10 Spurious Emissions Radiated > 30 MHz

11.10.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

Measurement:

Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Test setup	See sub clause 6.1 A
Measurement uncertainty	See sub clause 8

Limits:

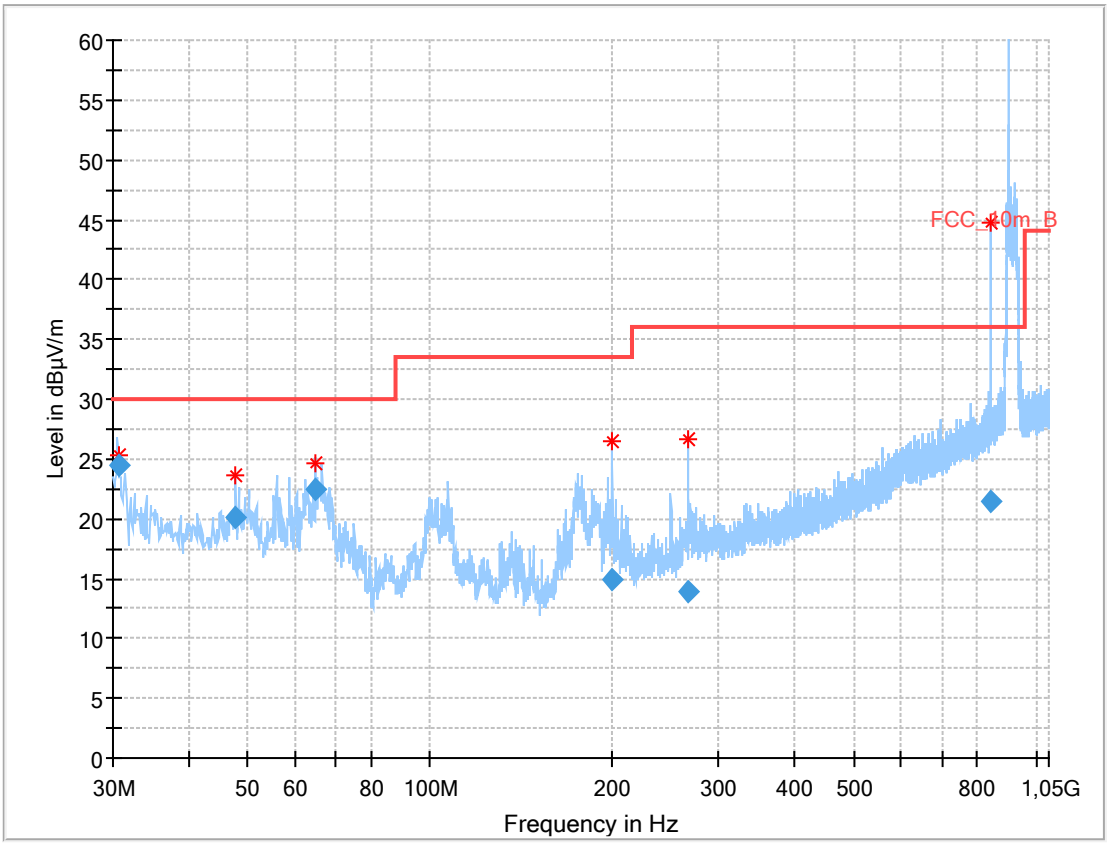
FCC	IC	
Band-edge Compliance of conducted and radiated emissions		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

Result:

See result table below the plots.

Plots Table 1:

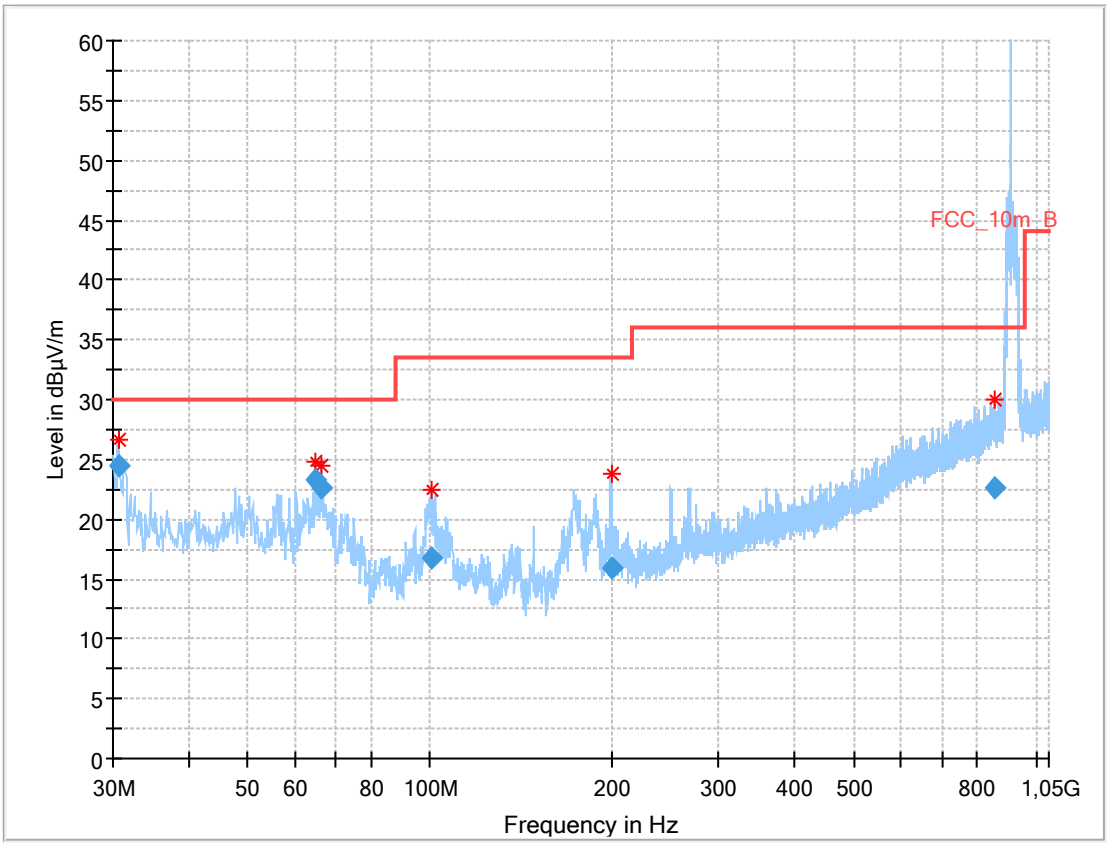
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.629	24.51	30.0	5.49	1000	120	103.0	V	129.0	12.2
47.766	20.13	30.0	9.87	1000	120	98.0	V	240.0	14.0
64.748	22.44	30.0	7.56	1000	120	272.0	V	60.0	11.1
199.041	14.96	33.5	18.54	1000	120	100.0	V	60.0	12.0
266.333	13.95	36.0	22.05	1000	120	100.0	V	60.0	13.9
841.446	21.43	36.0	14.57	1000	120	349.0	V	165.0	23.7

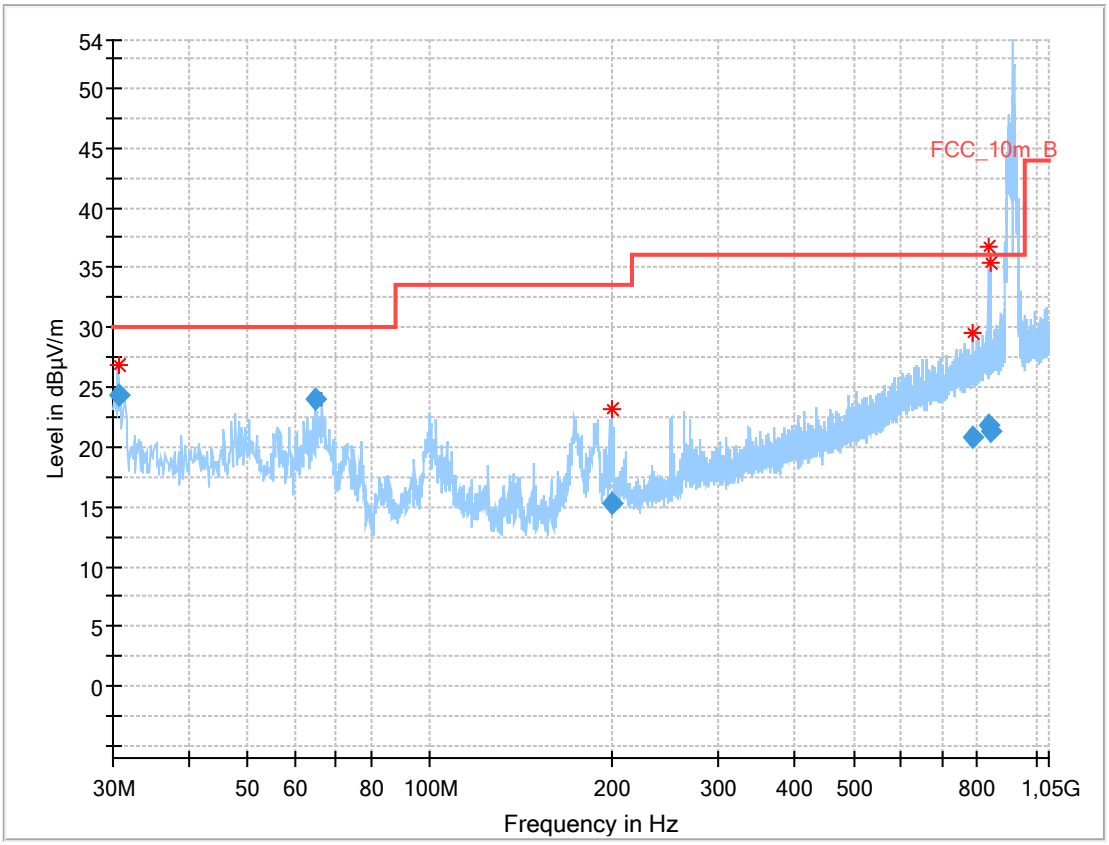
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.604	24.42	30.0	5.58	1000	120	103.0	V	150.0	12.2
64.772	23.26	30.0	6.74	1000	120	200.0	V	105.0	11.1
66.311	22.66	30.0	7.34	1000	120	271.0	V	31.0	10.8
100.979	16.68	33.5	16.82	1000	120	103.0	V	-14.0	12.2
199.112	15.94	33.5	17.56	1000	120	98.0	V	195.0	12.0
854.451	22.60	36.0	13.40	1000	120	274.0	H	120.0	23.9

Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)

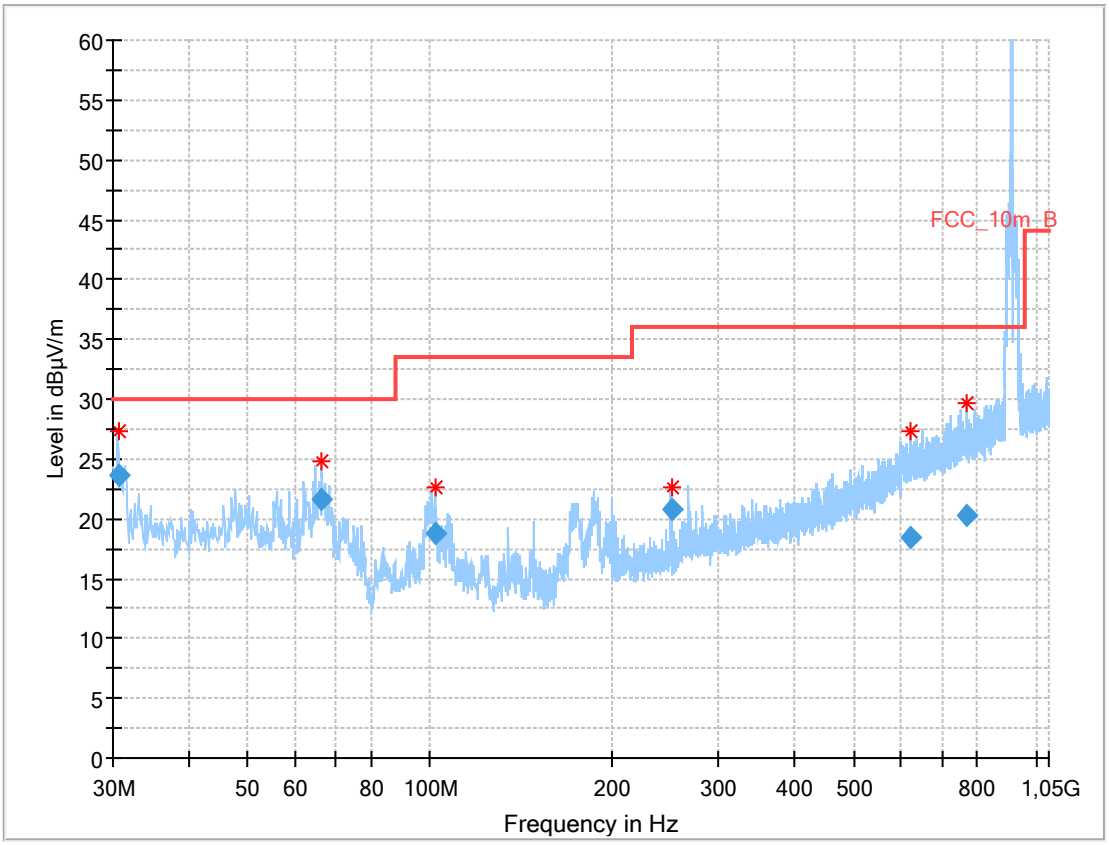


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.604	24.36	30.0	5.64	1000	120	103.0	V	60.0	12.2
64.785	24.02	30.0	5.98	1000	120	272.0	V	322.0	11.1
199.833	15.35	33.5	18.15	1000	120	100.0	V	285.0	12.0
788.003	20.83	36.0	15.17	1000	120	272.0	H	240.0	23.0
832.649	21.87	36.0	14.13	1000	120	200.0	V	31.0	23.6
841.724	21.25	36.0	14.75	1000	120	203.0	H	150.0	23.7

Plots Table 2:

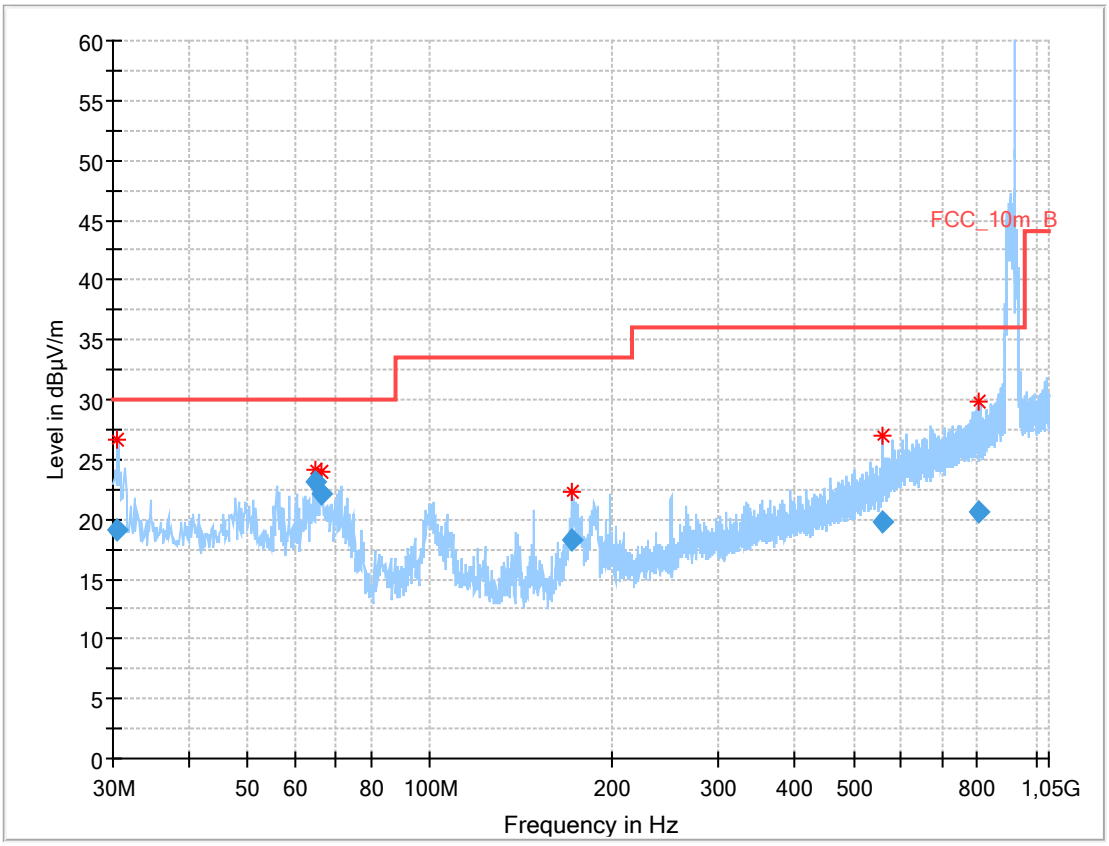
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.595	23.64	30.0	6.36	1000	120	103.0	V	270.0	12.2
66.308	21.54	30.0	8.46	1000	120	271.0	V	45.0	10.8
101.890	18.71	33.5	14.79	1000	120	103.0	V	45.0	12.1
250.014	20.75	36.0	15.25	1000	120	98.0	V	90.0	13.6
620.540	18.46	36.0	17.54	1000	120	171.0	H	0.0	21.1
768.805	20.27	36.0	15.73	1000	120	400.0	H	90.0	23.0

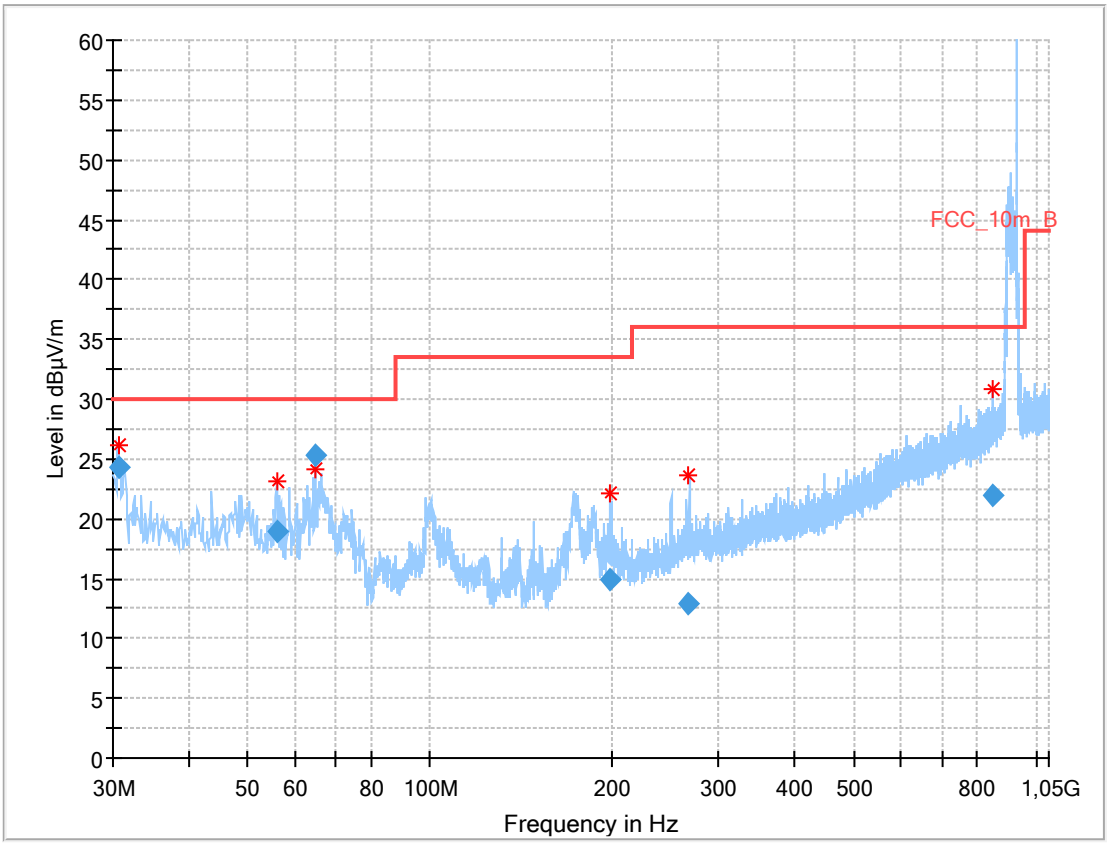
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.444	19.11	30.0	10.89	1000	120	103.0	V	90.0	12.2
64.778	23.21	30.0	6.79	1000	120	200.0	V	0.0	11.1
66.285	22.15	30.0	7.85	1000	120	273.0	V	90.0	10.8
172.112	18.33	33.5	15.17	1000	120	100.0	V	315.0	10.5
560.023	19.77	36.0	16.23	1000	120	98.0	H	135.0	19.7
802.795	20.56	36.0	15.44	1000	120	400.0	V	315.0	23.1

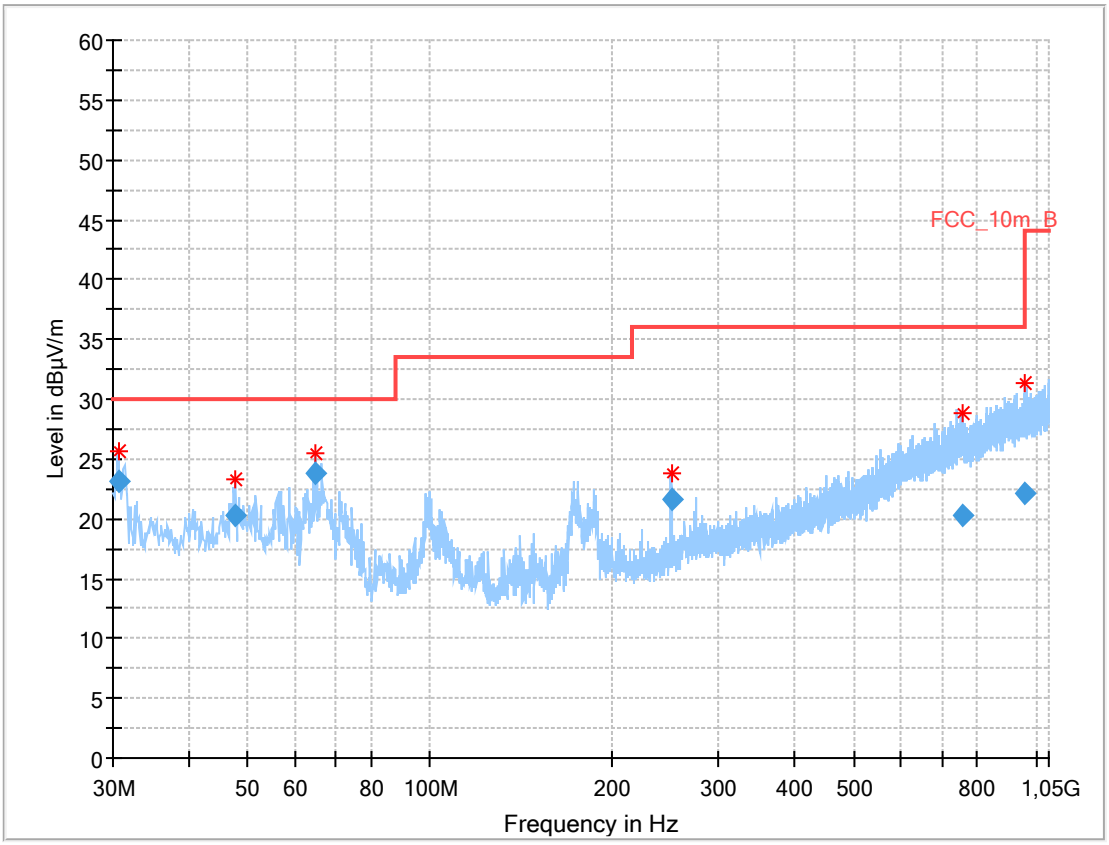
Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.599	24.28	30.0	5.72	1000	120	102.0	V	135.0	12.2
55.990	18.88	30.0	11.12	1000	120	170.0	V	90.0	13.1
64.793	25.29	30.0	4.71	1000	120	200.0	V	270.0	11.1
198.339	14.89	33.5	18.61	1000	120	98.0	V	180.0	11.9
267.312	12.87	36.0	23.13	1000	120	200.0	V	0.0	14.0
848.652	21.90	36.0	14.10	1000	120	101.0	H	225.0	23.9

Plot 4: 30 MHz – 1 GHz, horizontal & vertical polarisation (RX-Mode, valid for all channels)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.637	23.18	30.0	6.82	1000	120	200.0	V	315.0	12.2
47.817	20.34	30.0	9.66	1000	120	100.0	V	0.0	14.0
64.795	23.78	30.0	6.22	1000	120	200.0	V	270.0	11.1
250.005	21.68	36.0	14.32	1000	120	100.0	V	45.0	13.6
755.016	20.26	36.0	15.74	1000	120	103.0	H	135.0	23.0
955.249	22.08	36.0	13.92	1000	120	348.0	V	45.0	24.9

11.10.2 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 26 GHz
Trace mode	Max hold
Test setup	See sub clause 6.2 C (1 GHz – 12.75 GHz)
Measurement uncertainty	See sub clause 8

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

ANSI C63.10
The average emission shall be determined by using RMS detector. If the dwell time of the hopping signal is less than 100 ms (per channel), the RMS reading may be adjusted by a factor: F = 20log (dwell time/100 ms)

FCC		IC
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
Above 960	54.0 (average) 74.0 (peak)	3

Result:

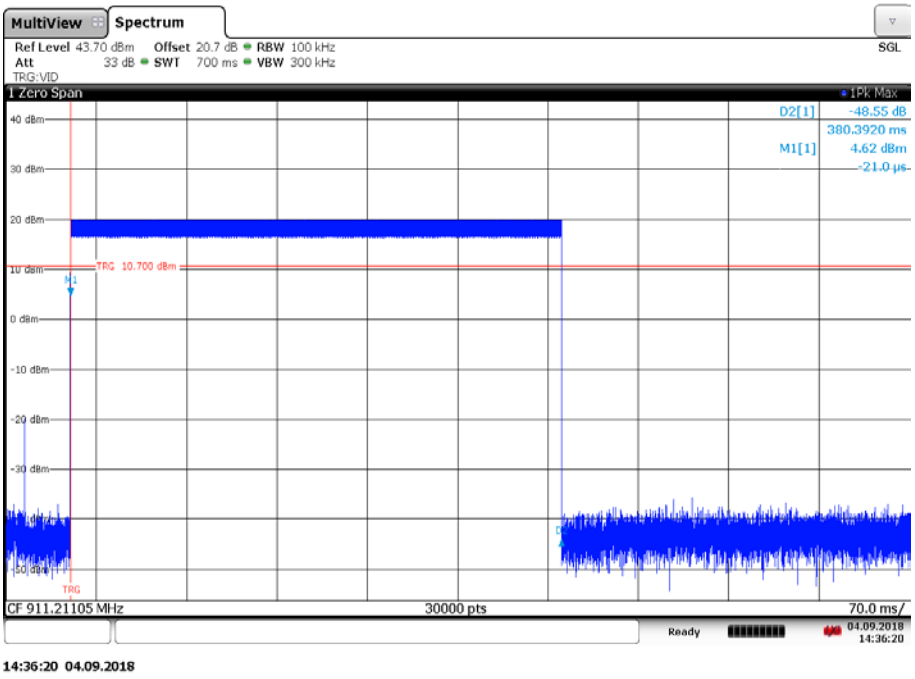
For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205. According to ANSI C63.10 the average emission shall be determined by using RMS detector. If the dwell time of the hopping signal is less than 100 ms (per channel), the RMS reading may be adjusted by a factor:

F = 20*log (dwell time/100 ms)

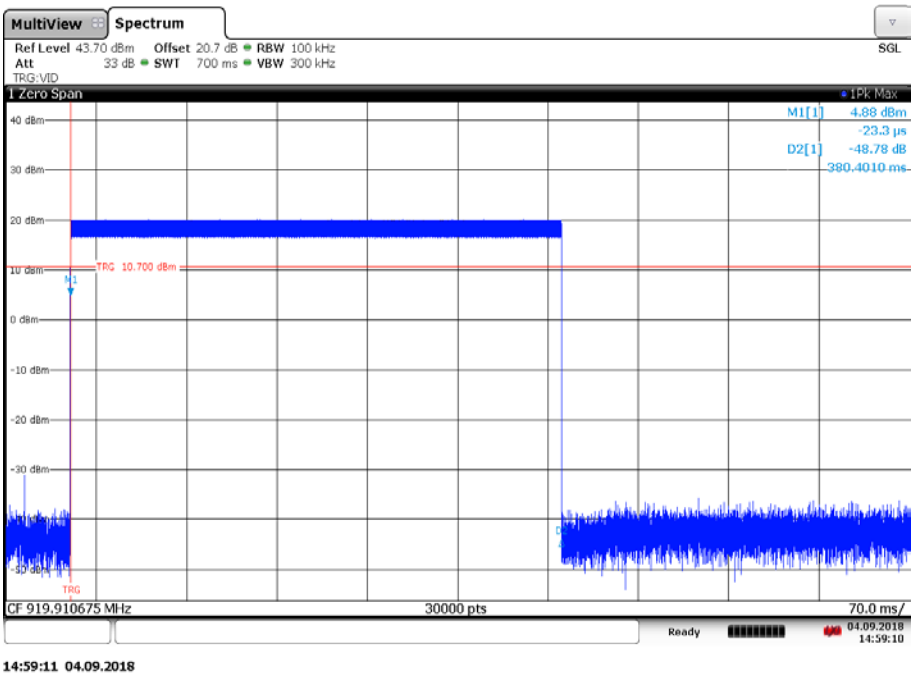
The dwell time is greater than 100 ms so the duty cycle correction factor is 0 dB according following formula:

F = 20*log (100 ms / 100 ms) = 0 dB

Plot 1: Time slot length >100 ms Table1



Plot 2: Time slot length >100 ms Table2



Results table 1:

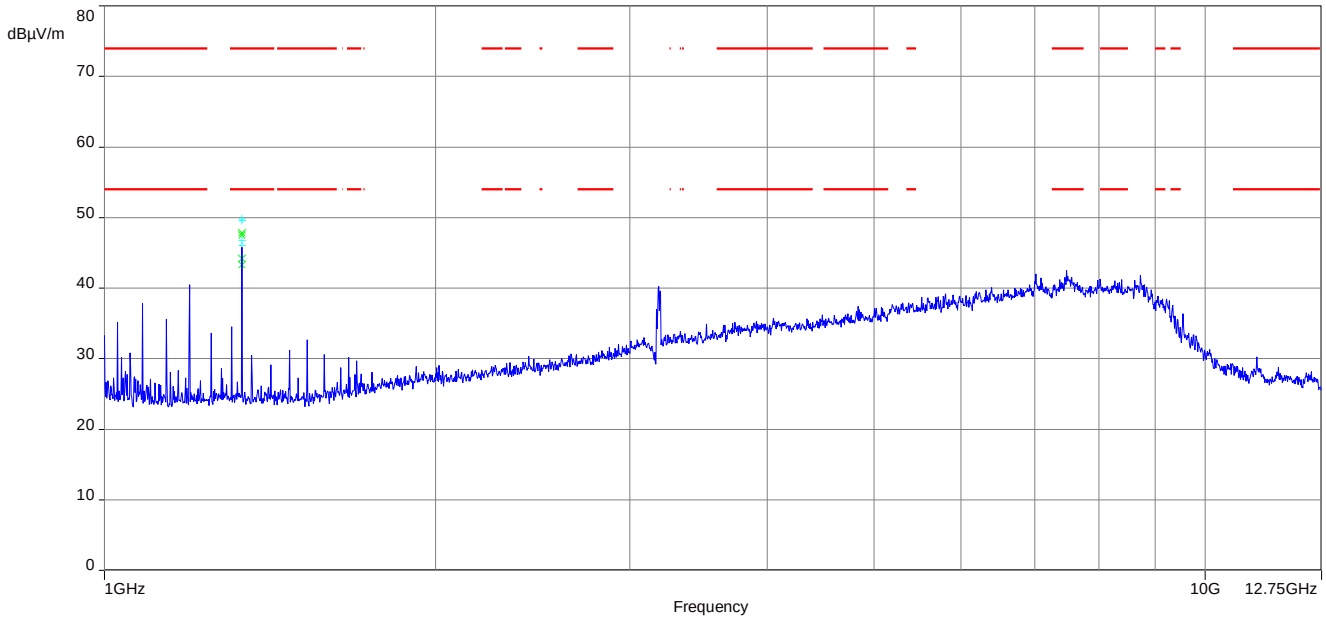
TX spurious emissions radiated [dBµV/m]								
Lowest channel			Middle channel			Highest channel		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
1333	Peak	49.8	1333	Peak	48.4	1333	Peak	51.1
	AVG	47.8		AVG	46.1		AVG	48.8

Results table 2:

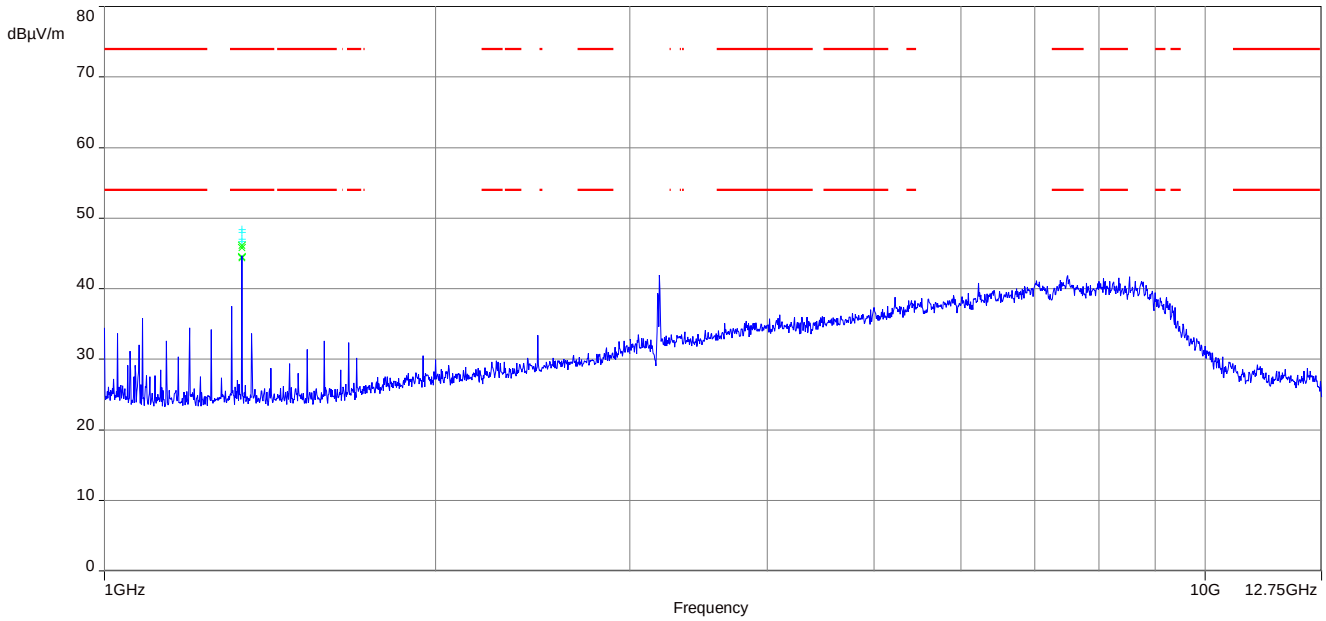
TX spurious emissions radiated [dBµV/m]								
Lowest channel			Middle channel			Highest channel		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
1333	Peak	45.4	1333	Peak	53.9	1333	Peak	46.6
	AVG	36.2		AVG	52.6		AVG	44.2

Plots table 1:

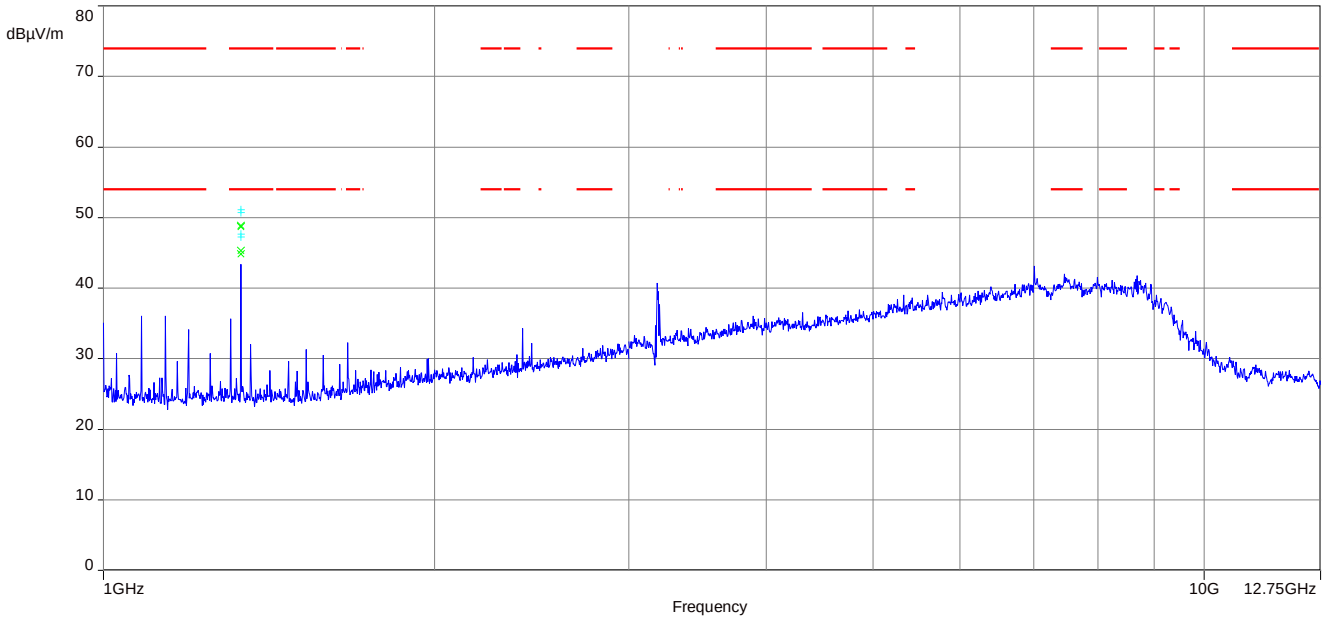
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)

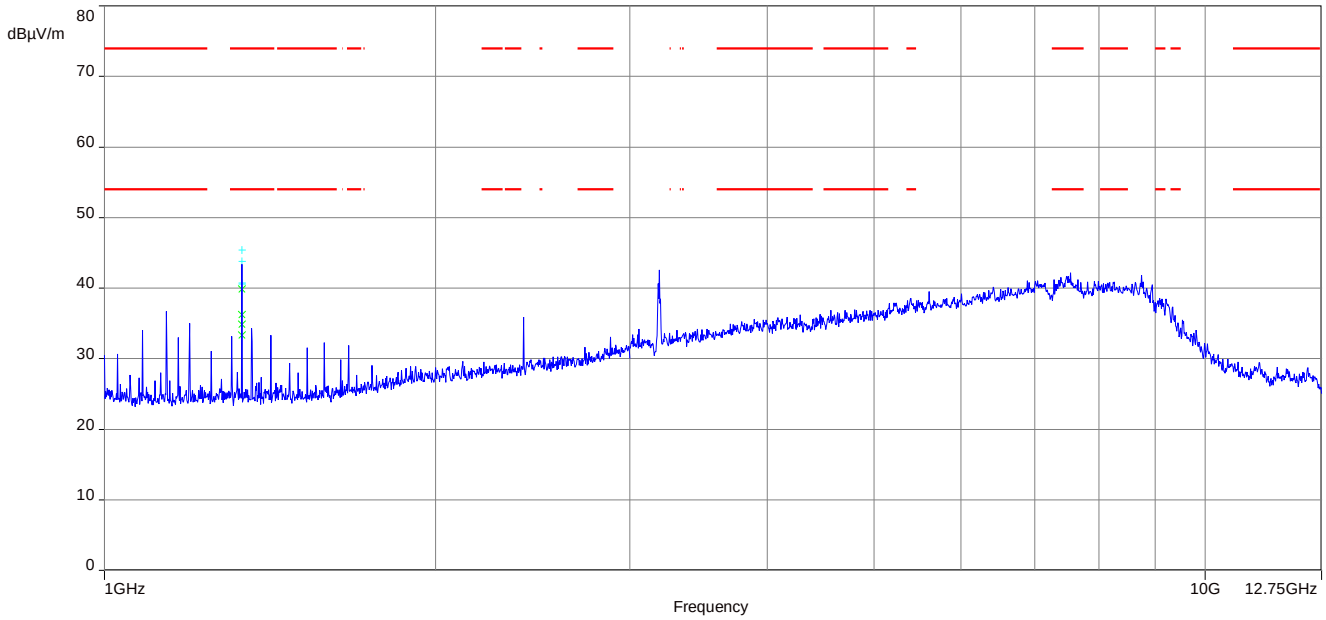


Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)

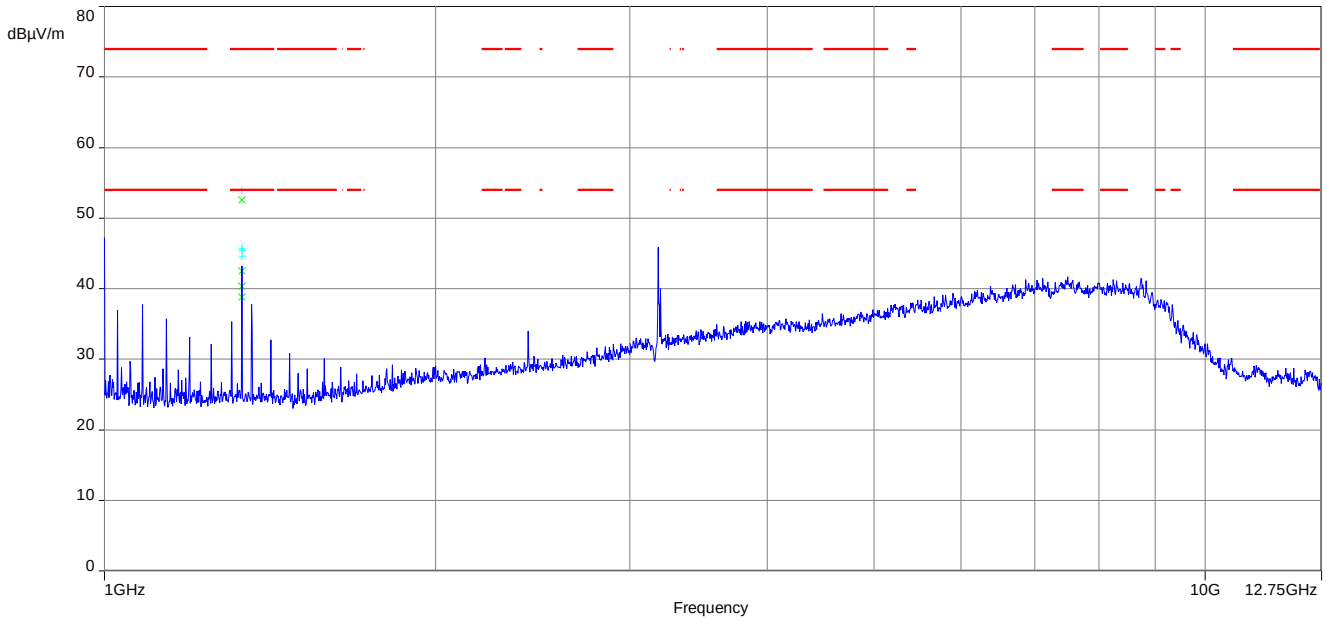


Plots table 2:

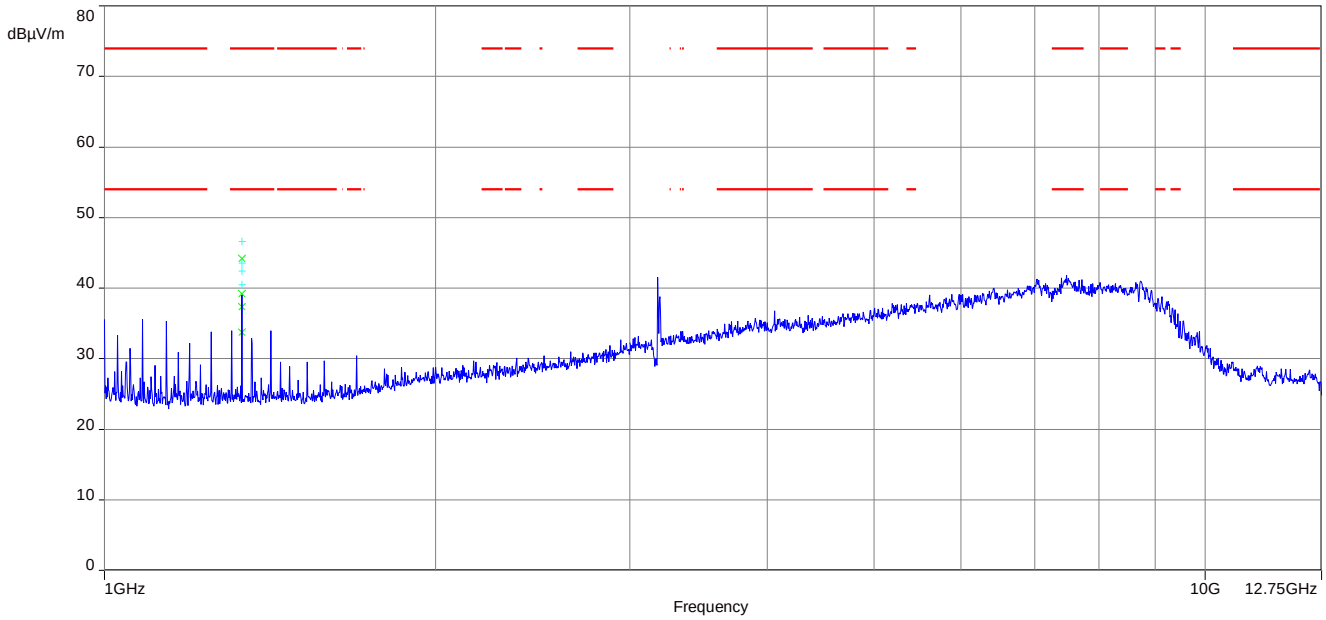
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



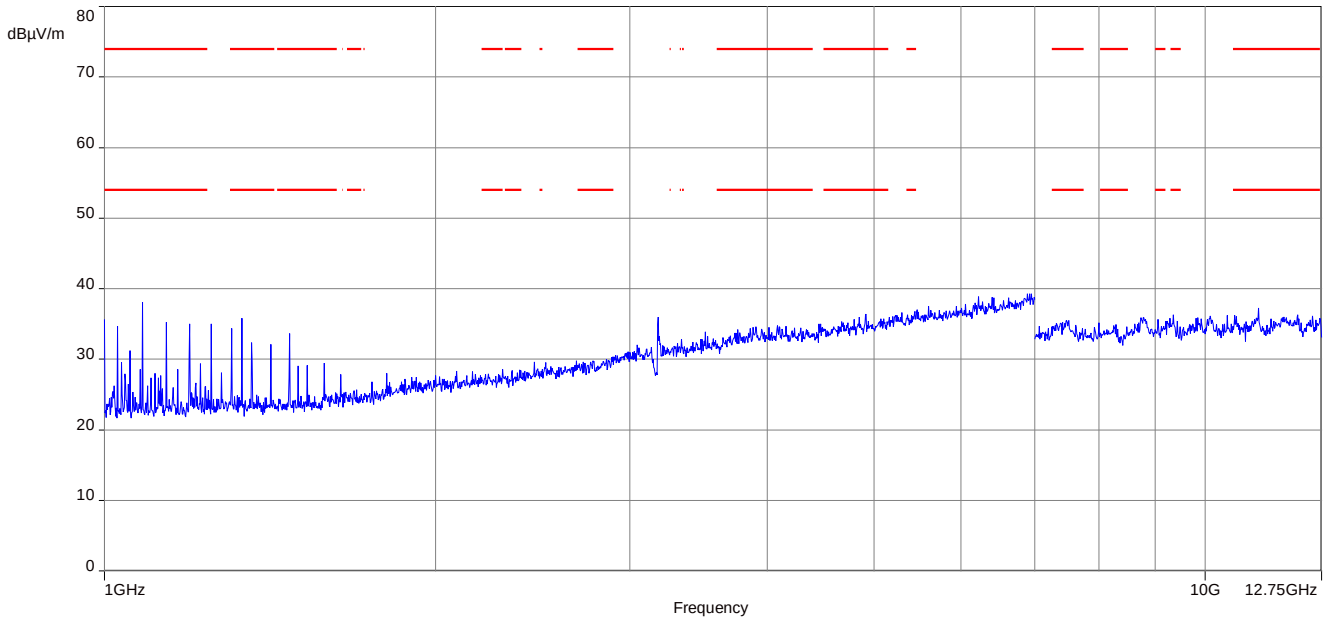
Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)



Plot 4: 1GHz – 12.75 GHz, RX-Mode, horizontal & vertical polarisation (valid for all channels)



11.11 Spurious emissions conducted below 30 MHz (AC conducted)

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequency is 2440 MHz. This measurement is representative for all channels and modes. If critical peaks are found frequency 2402 MHz and 2480 MHz will be measured too. The measurement is performed in the mode with the highest output power. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

Measurement parameters	
Detector	Peak - Quasi peak / average
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace mode:	Max hold
Test setup	See sub clause 6.3 A
Measurement uncertainty	See sub clause 8

Limits:

FCC		IC
TX spurious emissions conducted < 30 MHz		
Frequency (MHz)	Quasi-peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

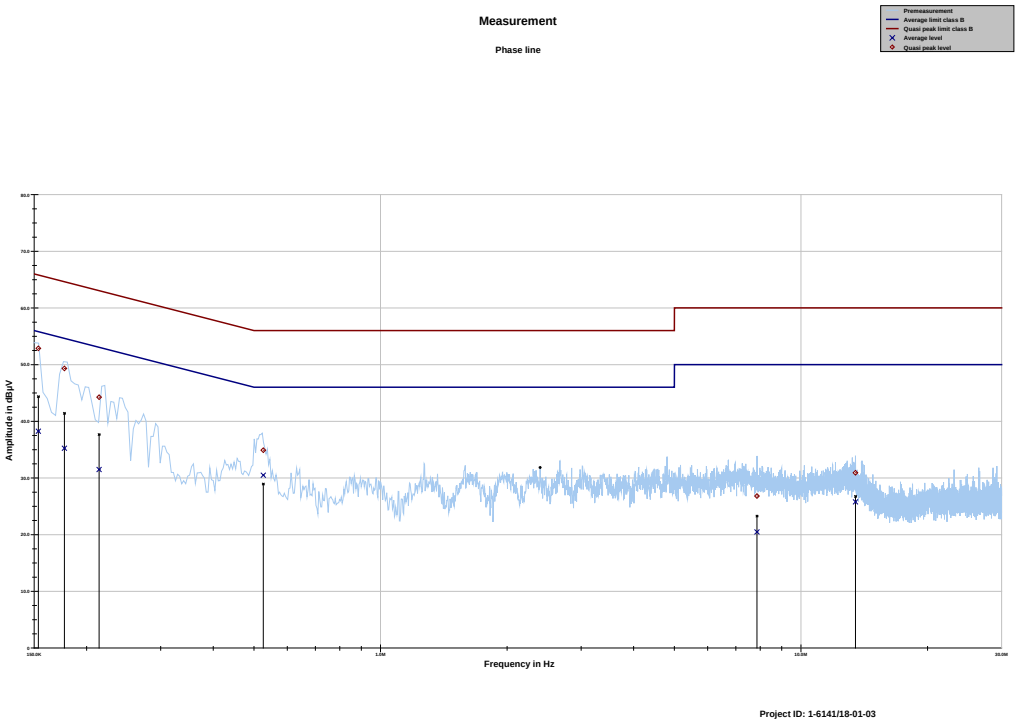
*Decreases with the logarithm of the frequency

Results:

See result table below the plots.

Plots Table 1:

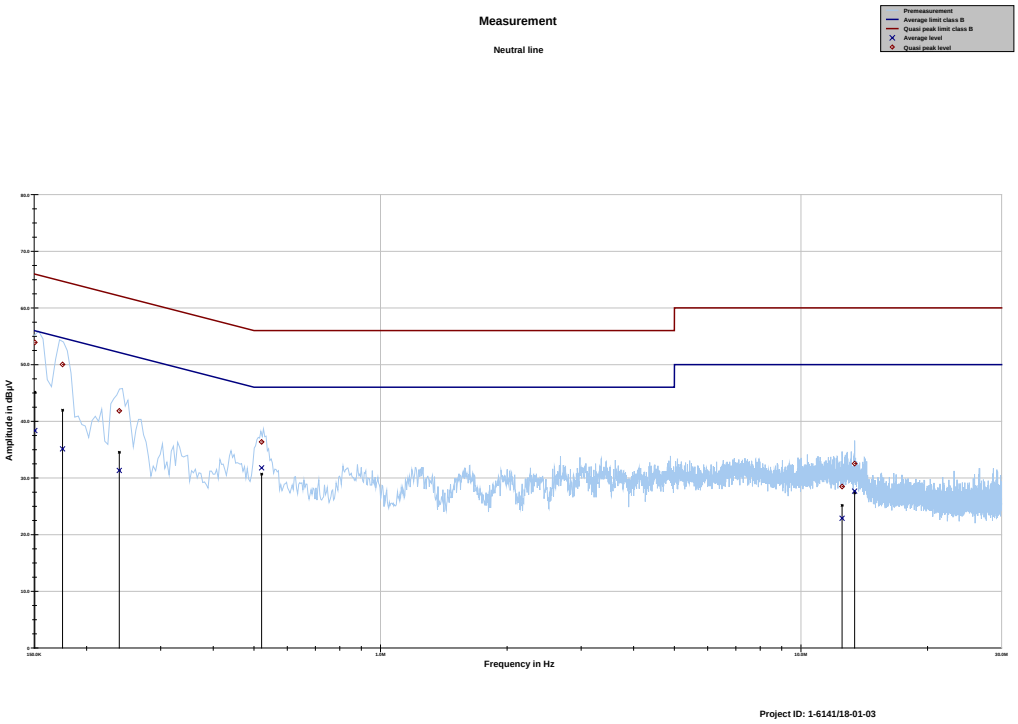
Plot 1: 150 kHz to 30 MHz, phase line



Final_Result

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.153502	52.86	12.95	65.808	38.24	17.66	55.900
0.177049	49.33	15.30	64.623	35.24	19.99	55.227
0.214120	44.25	18.79	63.044	31.49	22.68	54.168
0.526112	34.90	21.10	56.000	30.48	15.52	46.000
7.857901	26.81	33.19	60.000	20.47	29.53	50.000
13.479326	30.91	29.09	60.000	25.77	24.23	50.000

Plot 2: 150 kHz to 30 MHz, neutral line

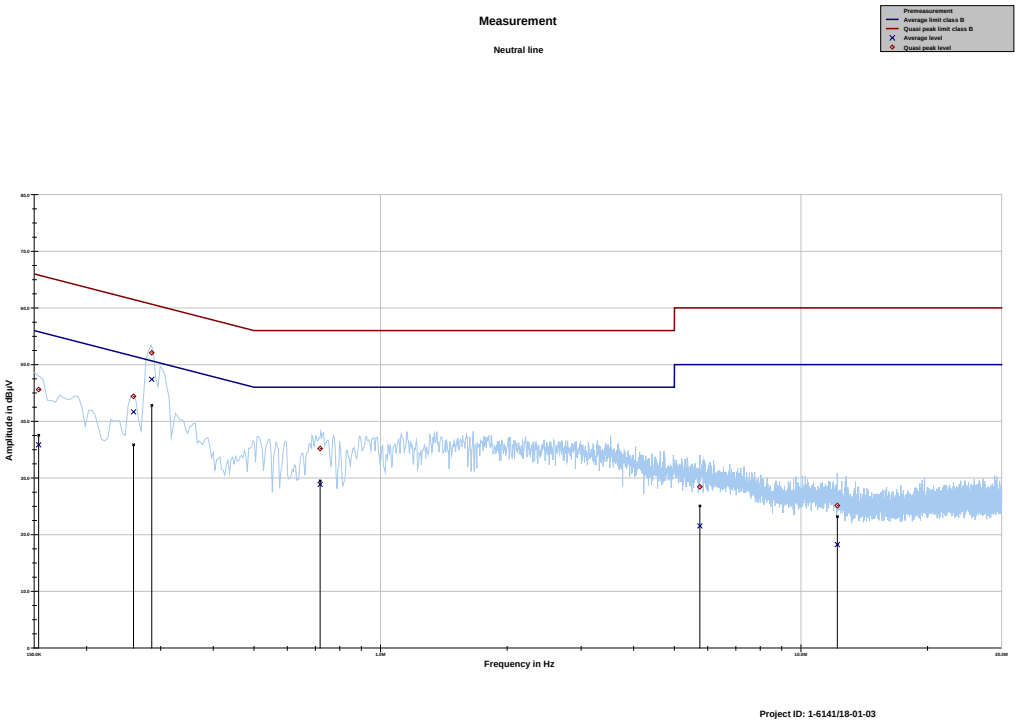


Final_Result

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150551	53.91	12.06	65.970	38.36	17.62	55.984
0.175220	50.03	14.68	64.709	35.12	20.16	55.279
0.239102	41.84	20.29	62.127	31.31	22.14	53.454
0.521314	36.36	19.64	56.000	31.79	14.21	46.000
12.525566	28.48	31.52	60.000	22.89	27.11	50.000
13.418938	32.54	27.46	60.000	27.67	22.33	50.000

Plots Table 2:

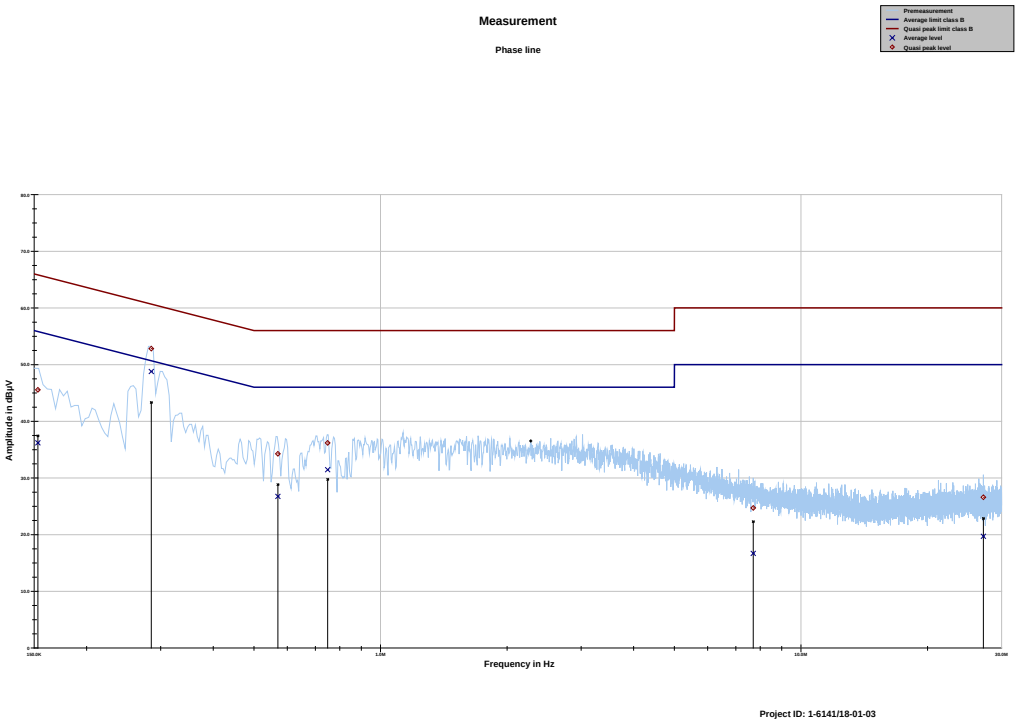
Plot 1: 150 kHz to 30 MHz, phase line



Final_Result

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.153762	45.60	20.19	65.794	35.85	20.04	55.893
0.258460	44.40	17.08	61.481	41.65	11.25	52.901
0.285625	52.08	8.57	60.651	47.40	4.73	52.125
0.718487	35.20	20.80	56.000	28.86	17.14	46.000
5.746390	28.44	31.56	60.000	21.54	28.46	50.000
12.200917	25.12	34.88	60.000	18.24	31.76	50.000

Plot 2: 150 kHz to 30 MHz, neutral line



Final_Result

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.153117	45.55	20.28	65.829	36.20	19.71	55.911
0.284911	52.82	7.85	60.671	48.79	3.36	52.145
0.570004	34.25	21.75	56.000	26.74	19.26	46.000
0.748723	36.18	19.82	56.000	31.45	14.55	46.000
7.699572	24.70	35.30	60.000	16.67	33.33	50.000
27.159500	26.59	33.41	60.000	19.71	30.29	50.000

12 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/N_0	Carrier to noise-density ratio, expressed in dB-Hz

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2018-09-12

Annex C Accreditation Certificate

first page	last page
	

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

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

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