RADIO TEST REPORT

No. 1906290STO-001, Ed. 2

RF Performance

EQUIPMENT UNDER TEST

Equipment:	Radio module
Type/Model:	HE1074-915
Manufacturer:	Hartvik Engineering AB
Tested by request of:	Hartvik Engineering AB

SUMMARY

Referring to the emission limits, and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards:

47 CFR Part 15 Subpart B: Unintentional radiators

47 CFR Part 15 Subpart C: Intentional radiators. Section 15.247

RSS-GEN Issue 5 (2018): General requirements of compliance of radio apparatus

RSS-247 Issue 2 (2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

For details, see clause 2 – 4.

Date of issue: 2019-09-16

Tested by: Robert Hietala

Approved by: Matti Virkki

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Revision History

Edition	Date	Description	Changes
1	2019-03-28	First release	--
2	2019-09-16	Second release	Added duty cycle measurement

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company	Hartvik Engineering AB Fridhemsvägen 4 755 97 Uppsala Sweden
Name of contact	Johan Hartvik
Client observer	Johan Hartvik

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	Radio module	
Type/Model:	HE1074-915	
Brand name:	Hartvik Engineering	
Serial number:	915-639, 915-640, 915-642 and 915-643	
Manufacturer:	Hartvik Engineering	
Transmitter frequency range:	902 – 928 MHz	
Receiver frequency range:	902 – 928 MHz	
Frequency agile or hopping:	☒ Yes	☐ No
Antenna:	☐ Internal antenna	☒ External antenna, see section 2.2
Antenna connector:	☐ None, internal antenna	☒ Yes, see section 2.2
Antenna gain:	+1.2 dBi, see section 2.2	
Rating RF output power:	+19.0 dBm (measured conducted)	
Type of modulation:	2GFSK	
Temperature range:	☐ Category I (General): -20°C to +55°C ☐ Category II (Portable equipment): -10°C to +55°C ☐ Category III (Equipment for normal indoor use): +5°C to +35°C ☒ Other: <-40°C to +70°C	
Transmitter standby mode supported:	☒ Yes	☐ No

2.2 Antenna information

Radiated spurious emissions were tested with the following antenna:

Antenna	Manufacturer	Type/model	Gain [dBi]	Connector
--	Linx	ANT-916-CW-HW-SMA	+1.2*	SMA

*Peak gain

2.3 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
Unit 1	Single channel; low channel	915-639
Unit 2	Single channel; middle channel	915-640
Unit 3	Single channel; high channel	915-642
Unit 4	Hopping mode	915-643

2.4 Test signals and operation modes

The tests were performed with a continuous modulated signal as described in tables below:

Test case	EUT mode of operation
Radiated spurious emission	Single channel
Conducted band edge	Single channel
Peak conducted output power	Single channel
Occupied bandwidth, 6 dB	Single channel
Occupied bandwidth, 99 %	Single channel
Number of hopping frequencies	Hopping
Carrier frequency separation	Hopping
Transmitter time of occupancy	Hopping

Channel	Frequency [MHz]
Low	902.200
Middle	913.601
High	925.002

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

47 CFR Part 15 Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 Subpart B: Unintentional radiators

RSS-GEN Issue 5 (2018): General requirements of compliance of radio apparatus.

RSS-247 Issue 2 (2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test methods:
ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

3.2 Additions, deviations and exclusions from standards and accreditation

No additions, deviations or exclusions have been made from standards and accreditation.

3.3 Test site

Measurements were performed at:

Intertek Semko AB
Torshamnsgatan 43
Box 1103
SE-164 22 Kista

Intertek Semko AB is a FCC listed test site with site registration number 90913
Intertek Semko AB is a FCC accredited conformity assessment body with designation number SE0002
Intertek Semko AB is an Industry Canada listed test facility with IC assigned code 2042G

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2
Radiohallen	Fully anechoic 3m	2042G-4

4 TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.203 **RSS-GEN 8.3** **FCC §15.247 (b)(4)** **RSS-247 5.4(4), 5.4(5)**	**Antenna** The EUT has integrated non detachable antenna which can't be remove without breaking the EUT. The antenna gain is less than 6 dBi.	**PASS**
FCC Part 15.205 **RSS-GEN 8.10**	**Restricted bands of operations** The transmit frequency, including fundamental components of modulation, of license-exempt radio apparatus shall not fall within the restricted frequency bands listed in CFR 47 §15.205 and in RSS-GEN section 8.10 EUT operates in unrestricted 902 – 928 MHz frequency band.	**PASS**
FCC §15.207, 15.107 **RSS-GEN 8.8 table 3**	**Conducted continuous emission in the frequency range 150 kHz to 30 MHz, AC Power input port** Battery operated equipment.	**NA**
FCC §15.247 (d), 15.209(a), 15.109 **RSS-GEN 8.9** **RSS-247 5.5**	**Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz** The EUT complies with the limits. The margin to the limit was at least 2.6 dB at 934.200 MHz. See clause 5.4 – 5.5.	**PASS**
FCC §15.247(d), 15.209(a)a **RSS-GEN 8.9** **RSS-247 5.5**	**Radiated emission of electromagnetic fields in the frequency range above 1 GHz** The EUT complies with the limits. The margin to the limit was at least 8.5 dB at 7308.8 MHz. See clause 5.6 – 5.7.	**PASS**
FCC §15.247(a)(1) **RSS-GEN 6.6** **RSS-247 5.1.a**	**Occupied bandwidth** The EUT complies with the limits. The margin to the limit is at least 473.7 kHz See clause 8.4.	**PASS**
FCC §15.247(b) **RSS-247 5.4**	**Conducted output power** The EUT complies with the limits. The margin to the limit was at least 10 dB at any frequency. See clause 7.4.	**PASS**
FCC §15.247(a)(1) **RSS-247 5.1(b)**	**Carrier frequency separation** The EUT complies with the limits. The margin to the limit was at least 402.1 kHz. See clause 11.4.	**PASS**
FCC §15.247(a)(1) **RSS-247 5.1(c)**	**Number of hopping frequencies** The EUT complies with the limits. See clause 10.4.	**PASS**

Requirement	Description	Result
FCC §15.247(a)(1) **RSS-247 5.1(c)**	**Time of occupancy** The EUT complies with the limits. The margin to the limit was at least 314.6 ms. See clause 12.4.	**PASS**
FCC §15.247(d) **RSS-247 5.5**	**Band edge** The EUT complies with the limits. The margin to the limit was at least 10 dB at any frequency. See clause 6.4.	**PASS**

5 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 13 GHZ

Date of test:	2019-02-19	**Test location:**	Stora Hallen, Radiohallen
EUT Serial:	915-639, 915-640 and 915-642	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	30 %
Test result:	Pass	**Margin:**	2.6 dB

5.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013.
The EUT was set up in order to emit maximum disturbances.

30 – 1000 MHz: The EUT was placed on an insulating support 0.8 and 1.5 m above the turntable which is part of the reference ground plane.

1 – 13 GHz: The EUT was placed 1.5 m above the floor on a positioner which allows the EUT to rotate freely around its X and Y axis.

5.2 Test conditions

Test set-up:	**30 MHz to 1000 MHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 120 kHz. VBW 1 MHz
Final test:	Quasi-Peak,	RBW 120 kHz
EUT height above ground plane:	0.8 m	
Measuring distance:	10 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Bilog	

Test set-up:	**1 GHz – 13 GHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 1 MHz. VBW 3 MHz
	Average,	RBW 1 MHz. VBW 3 MHz
Final test:	Peak,	RBW 1 MHz
	Average	RBW 1 MHz
EUT height above ground plane:	1.5 m	
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Horn	
Antenna tilt:	The EUT is rotated around its axis as described in ANSI C63.10 (2013) clause 6.6.5.	

5.3 Requirements

Within restricted bands and receive mode:
Reference: CFR 47 §15.209, §15.109, RSS-Gen section 8.9

Field strength of emissions must comply with limits shown in table below

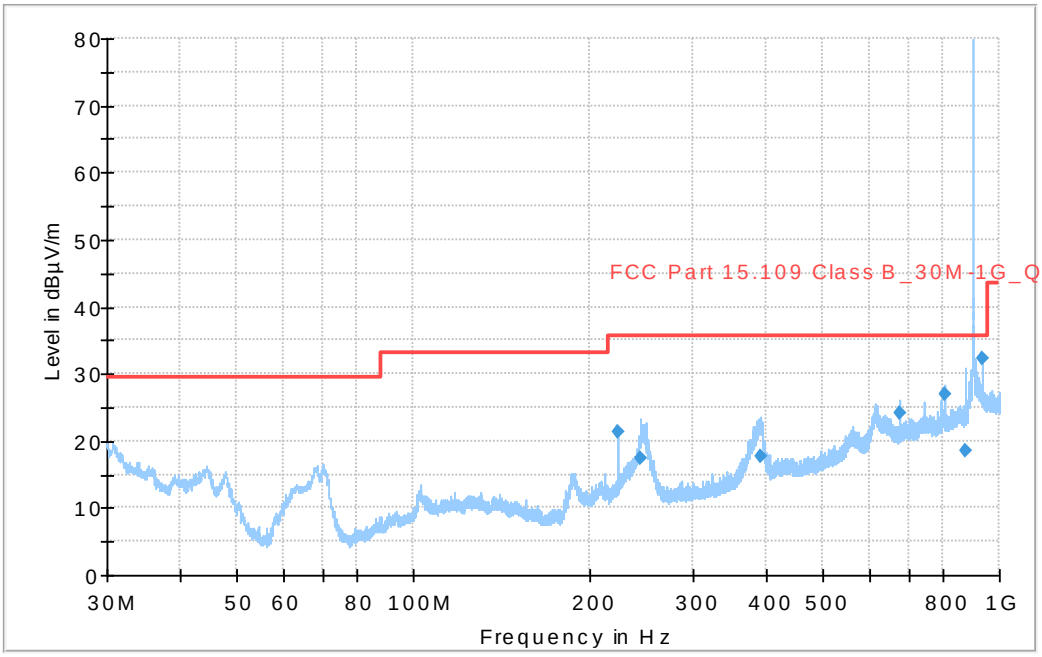
Frequency range [MHz]	Field strength at 3 m (dBµV/m)	Field strength at 10 m (dBµV/m)	Detector
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit.
(i.e. an extrapolation factor of 20 dB/decade according to CFR 47 §15.31(f)(1))

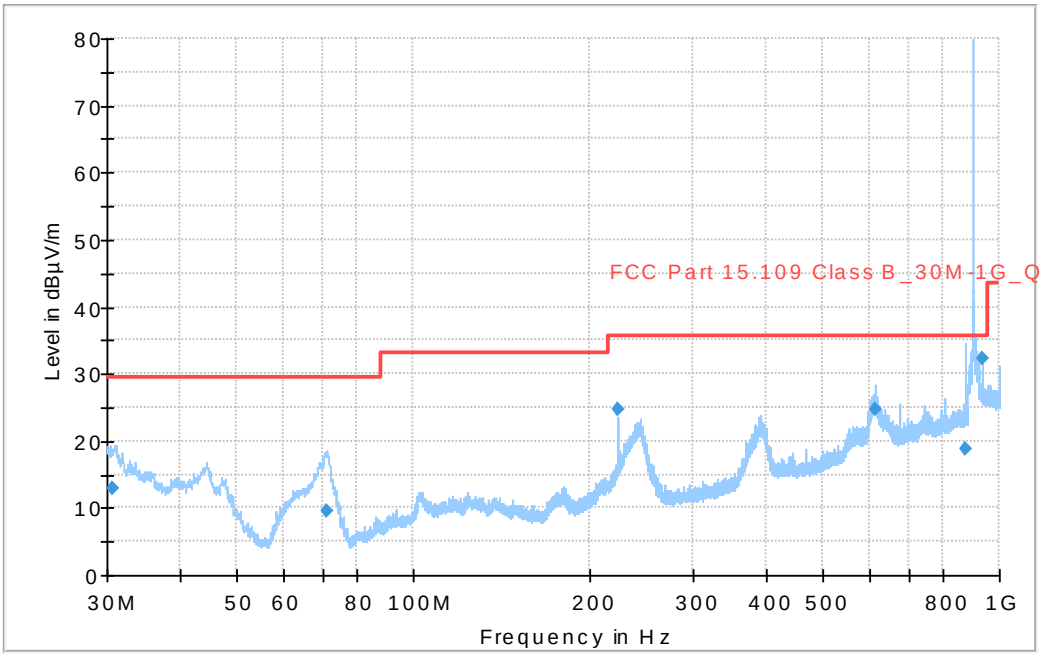
Outside the restricted bands:
Reference: CFR 47 §15.247(d), RSS-247 5.5,

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits.

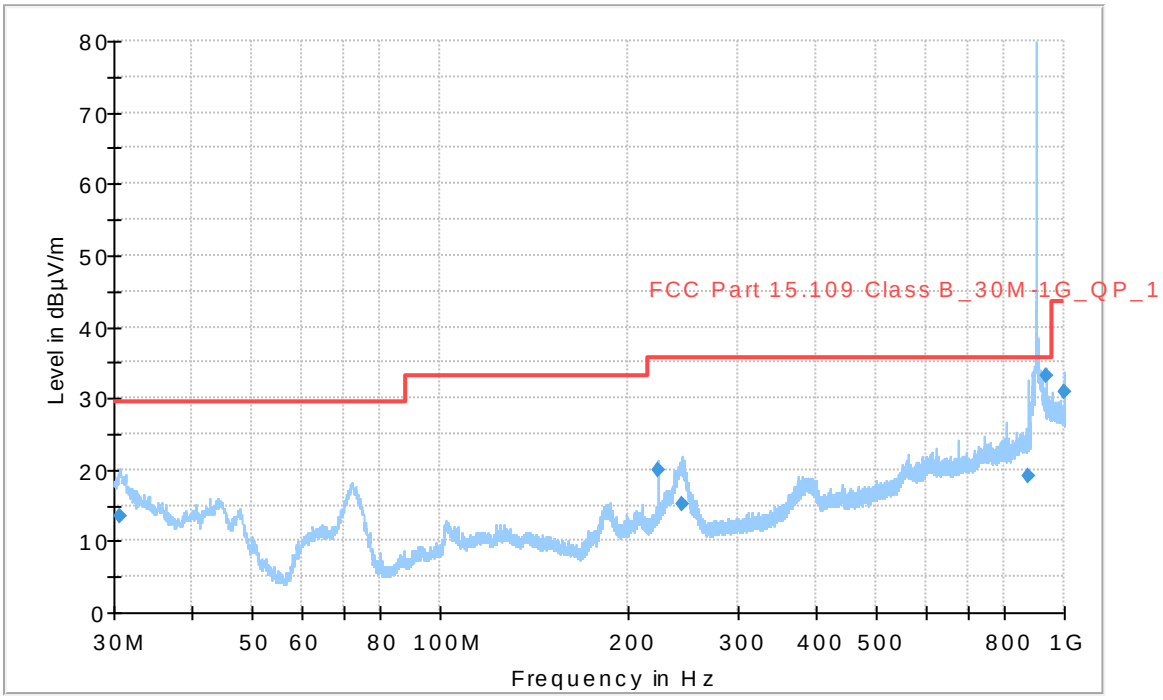
5.4 Test results 30 MHz – 1000 MHz, TX



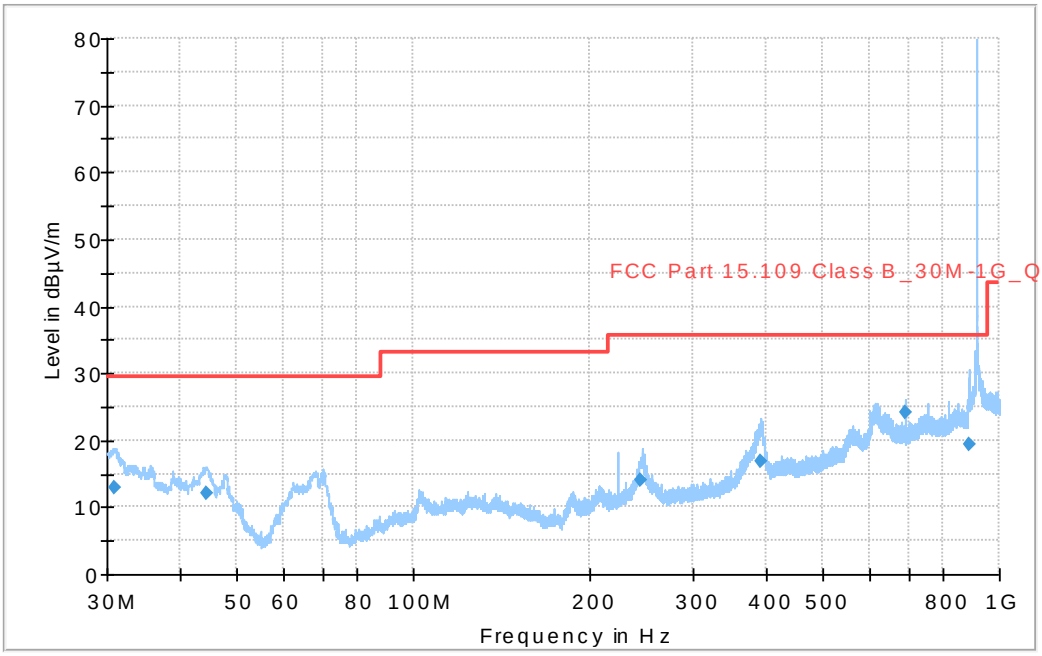
Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX low channel, EUT orientation X.



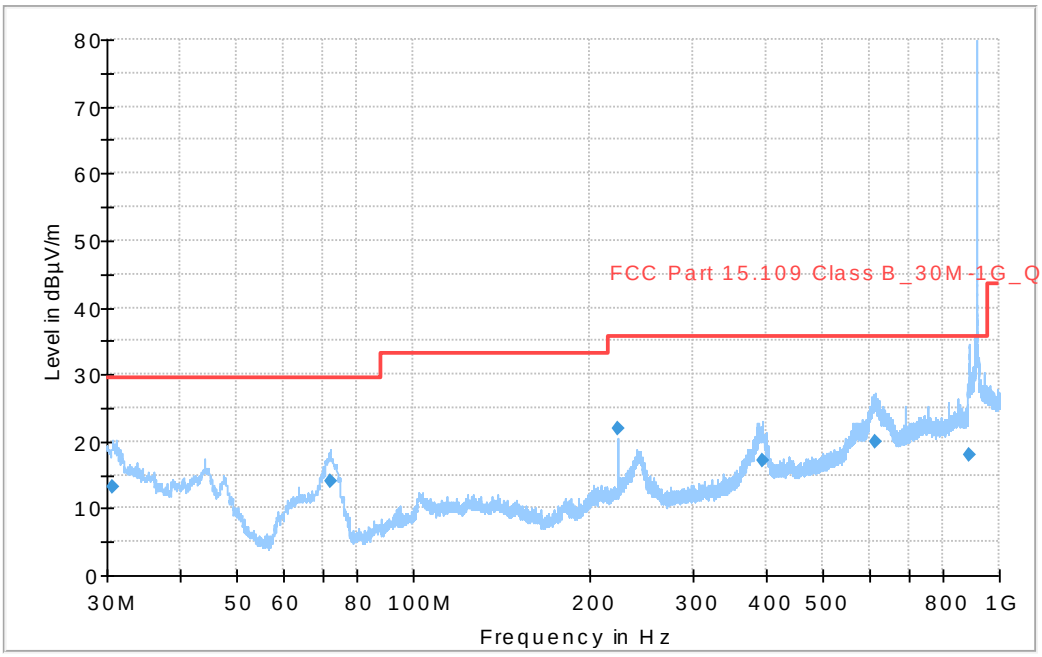
Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX low channel, EUT orientation Y.



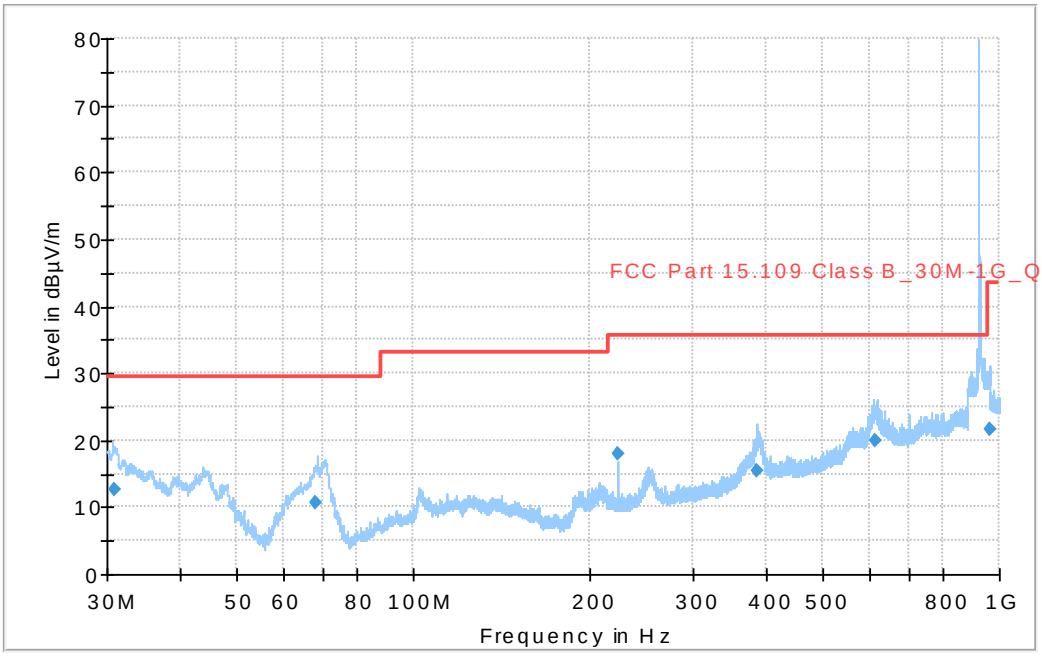
Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX low channel, EUT orientation Z.



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX mid channel, EUT orientation X.



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX mid channel, EUT orientation Y.



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. TX high channel, EUT orientation X.

Measurement results, Quasi Peak, low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
224.010	21.2	35.6	H	X	14.3
244.590	17.5	35.6	H	X	18.1
392.280	17.7	35.6	H	X	17.8
678.210	24.3	35.6	H	X	11.3
806.190	27.1	35.6	H	X	8.5
876.300	18.5	35.6	H	X	17.1
934.200	32.4	35.6	H	X	3.2
30.690	12.9	29.5	V	Y	16.6
71.100	9.6	29.5	V	Y	19.9
224.010	24.6	35.6	H	Y	11.0
614.190	24.6	35.6	H	Y	11.0
876.060	18.8	35.6	H	Y	16.8
934.200	32.3	35.6	H	Y	3.3
30.660	13.4	29.5	V	Z	16.1
224.010	20.0	35.6	V	Z	15.6
224.170	15.2	35.6	V	Z	20.4
875.460	19.1	35.6	V	Z	16.5
934.200	33.0	35.6	V	Z	2.6
998.190	30.9	43.5	V	Z	12.6

Measurement results, Quasi Peak, mid channel

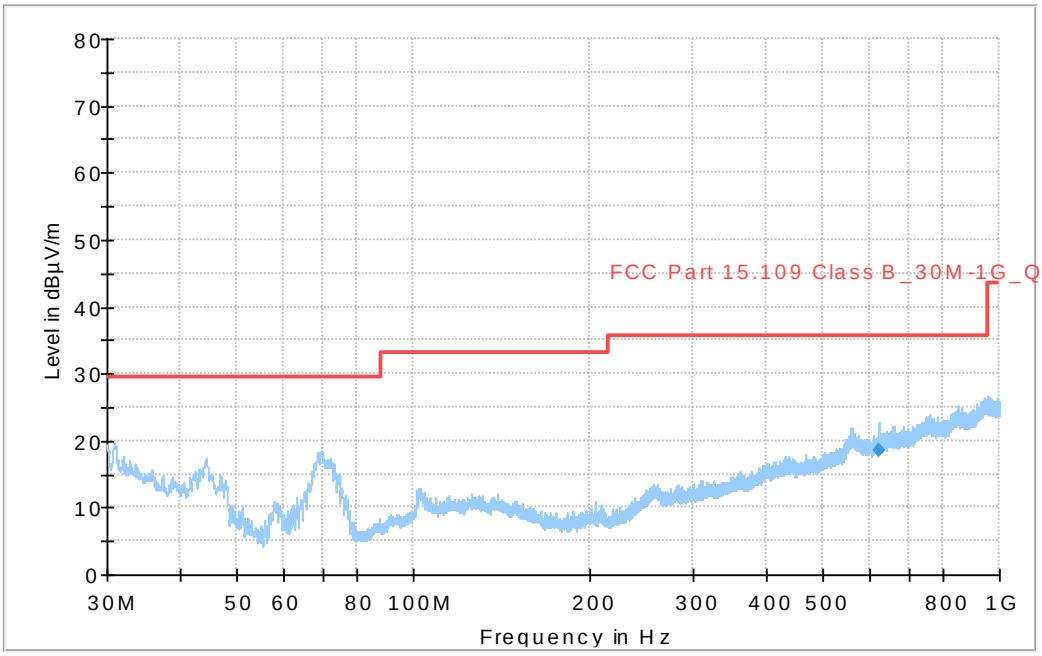
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
30.810	13.0	29.5	V	X	16.5
44.520	12.1	29.5	V	X	17.4
244.920	13.9	35.6	H	X	21.7
392.580	16.9	35.6	H	X	18.7
689.610	24.1	35.6	H	X	11.5
889.950	19.4	35.6	H	X	16.2
30.780	13.3	29.5	V	Y	16.2
72.060	14.0	29.5	V	Y	15.5
224.010	21.9	35.6	H	Y	13.6
393.870	17.2	35.6	H	Y	18.4
616.260	19.9	35.6	H	Y	15.7
890.040	18.0	35.6	H	Y	17.6

Measurement results, Quasi Peak, high channel

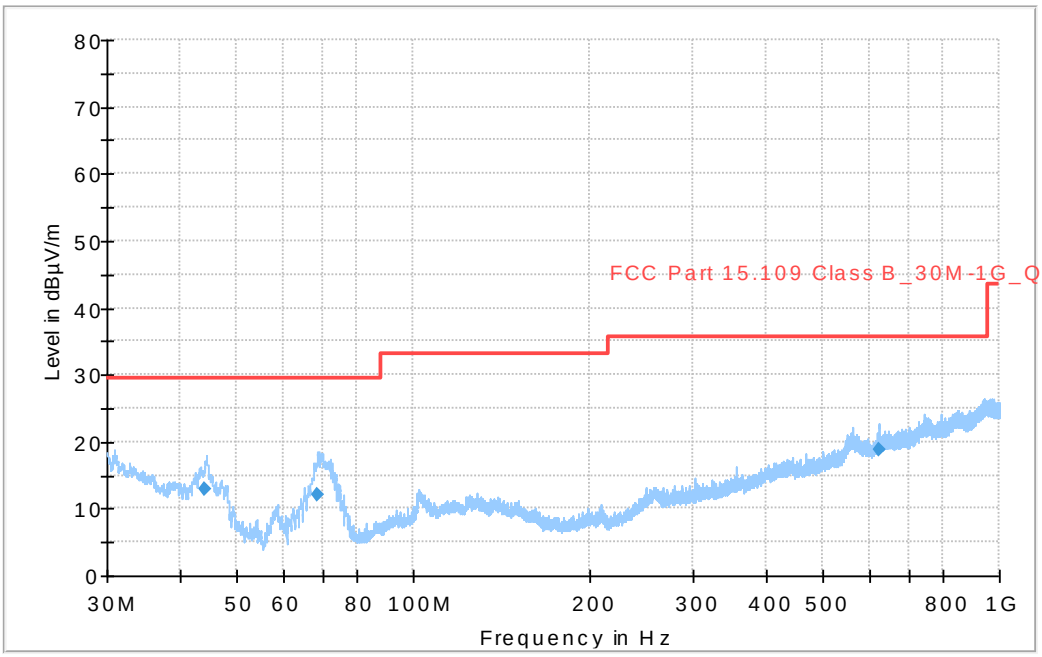
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
30.840	12.8	29.5	V	X	16.7
67.950	10.7	29.5	V	X	18.8
224.010	17.9	35.6	H	X	17.7
386.220	15.4	35.6	H	X	20.2
612.450	20.0	35.6	H	X	15.6
960.330	21.7	35.6	H	X	21.9

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

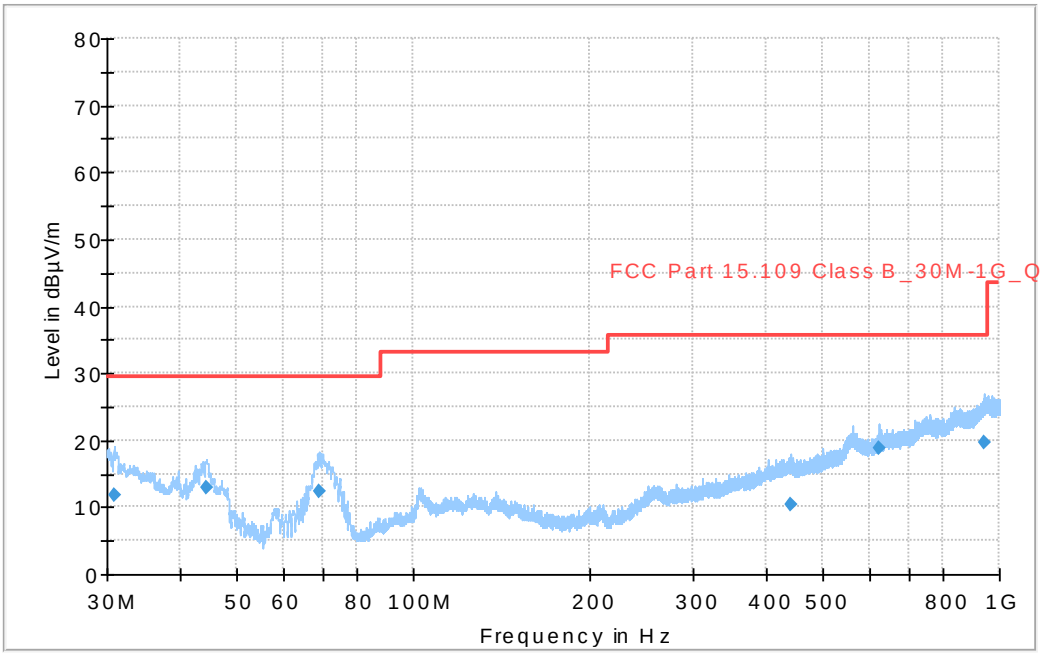
5.5 Test results 30 MHz – 1000 MHz, RX



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. RX low channel, EUT orientation X.



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. RX low channel, EUT orientation Y.



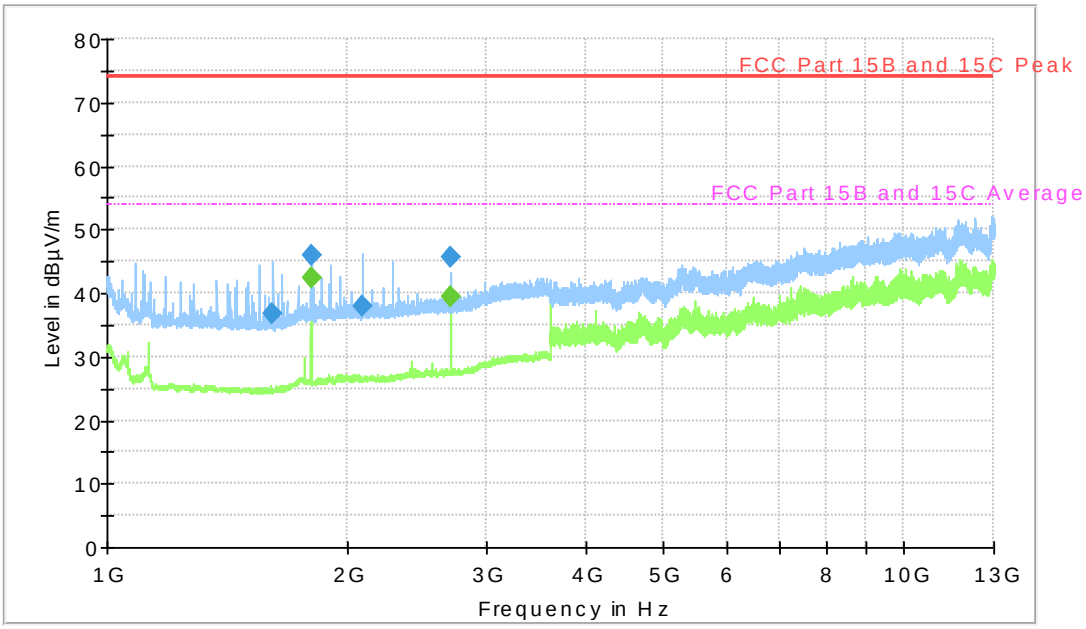
Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance. RX low channel, EUT orientation Z.

Measurement results, Quasi Peak, low channel

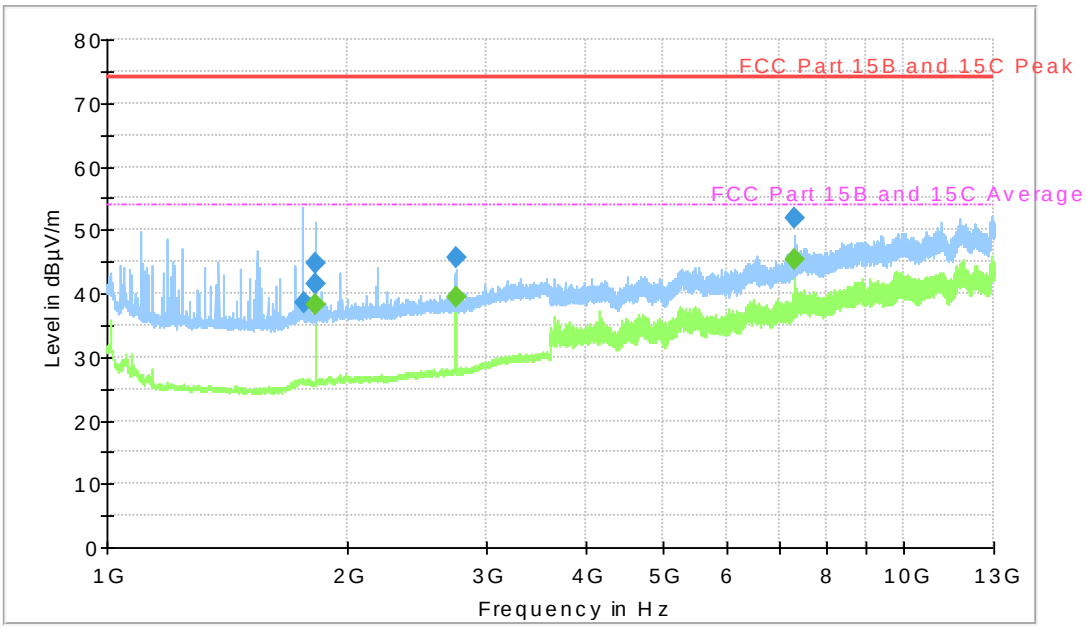
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
626.050	18.6	35.6	V	X	17.0
44.040	12.9	29.5	V	Y	16.6
68.760	12.0	29.5	V	Y	17.5
625.050	18.9	35.6	V	Y	16.6
30.930	11.8	29.5	V	Z	17.7
44.280	13.1	29.5	V	Z	16.4
69.330	12.2	29.5	V	Z	17.3
439.095	10.3	35.6	V	Z	25.3
625.050	18.8	35.6	V	Z	16.8
944.220	19.6	35.6	V	Z	16.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

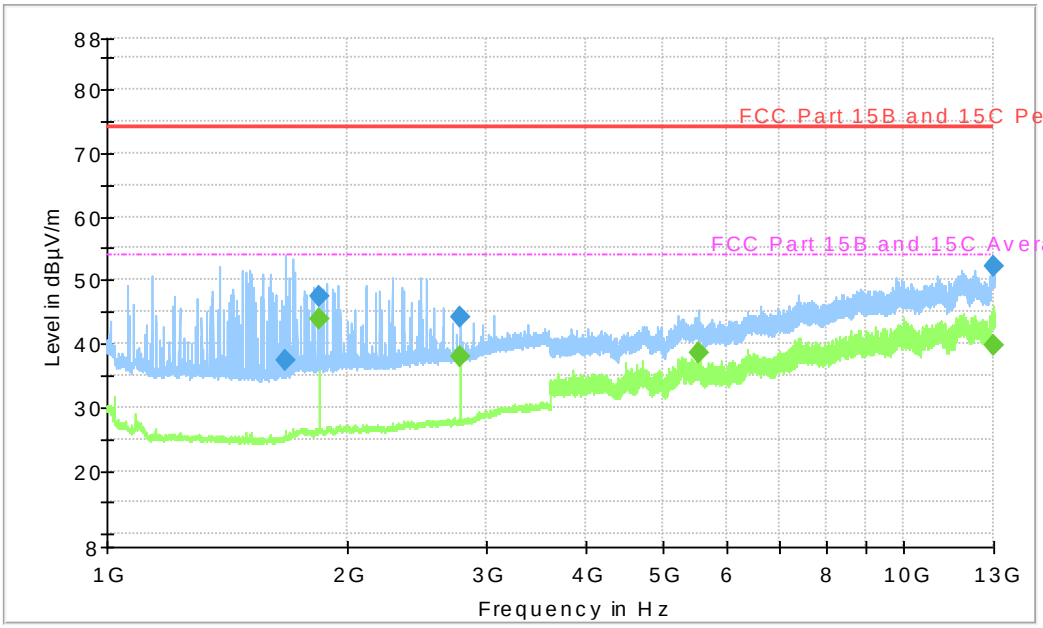
5.6 Test results 1 GHz – 13 GHz, TX



Diagram, Peak overview sweep, 1 – 13 GHz at 3 m distance. TX low channel.



Diagram, Peak overview sweep, 1 – 13 GHz at 3 m distance. TX middle channel.



Diagram, Peak overview sweep, 1 – 13 GHz at 3 m distance. TX high channel.

Measurement results, Peak, TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1613.9	36.6	74.0	H	37.4	PASS
1804.5	45.9	74.0	V	28.1	PASS
2091.8	37.9	74.0	V	36.1	PASS
2706.7	45.7	74.0	V	28.3	PASS

Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1804.4	42.3	54.0	V	11.7	PASS
2706.4	39.4	54.0	V	14.6	PASS

Measurement results, Peak, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1765.1	38.4	74.0	H	35.6	PASS
1827.0	41.4	74.0	H	32.6	PASS
1827.1	44.7	74.0	V	29.3	PASS
2741.0	45.7	74.0	V	28.3	PASS
7308.4	51.8	74.0	H	22.2	PASS

Measurement results, Average, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1826.8	38.3	54.0	V	15.7	PASS
2740.8	39.5	54.0	V	14.5	PASS
7308.8	45.5	54.0	H	8.5	PASS

Measurement results, Peak, TX high channel

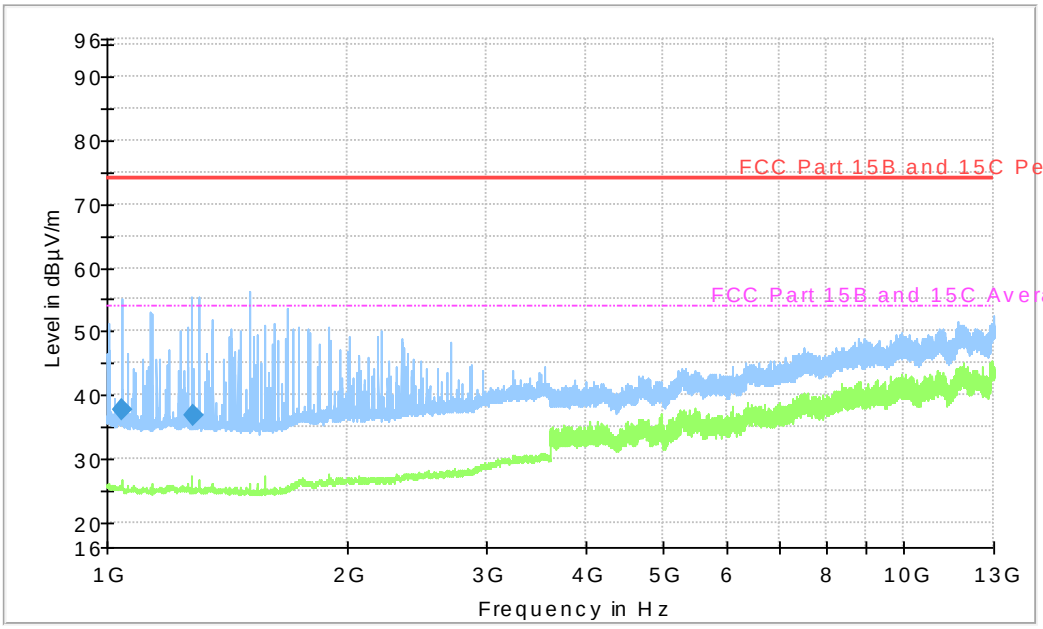
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1676.4	37.3	74.0	H	36.7	PASS
1850.0	47.5	74.0	V	26.5	PASS
2775.0	44.2	74.0	V	29.8	PASS
12965.9	52.2	74.0	V	21.8	PASS

Measurement results, Average, TX high channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1850.0	44.0	54.0	V	10.0	PASS
2774.8	38.1	54.0	V	15.9	PASS
5550.0	38.5	54.0	H	15.5	PASS
12968.0	39.7	54.0	V	14.3	PASS

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

5.7 Test results 1 GHz – 13 GHz, RX



Diagram, Peak overview sweep, 1– 13 GHz at 3 m distance. RX low channel.

Measurement results, Peak, RX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1043.5	37.7	74.0	H	36.3	PASS
1281.7	36.7	74.0	H	37.3	PASS

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

6 CONDUCTED BAND EDGE MEASUREMENT

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT Serial:	915-639, 915-642 and 915-643	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	> 10 dB

6.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 6.10.4.

The EUT was connected to spectrum analyser via rf-cable and attenuator

The EUT was set up in order to emit maximum disturbances. Measurements are made with EUT on single channel and with EUT in hopping mode.

6.2 Test conditions

Detector: Peak
RBW: 100 kHz
VBW: 300 kHz
Span: 15 MHz

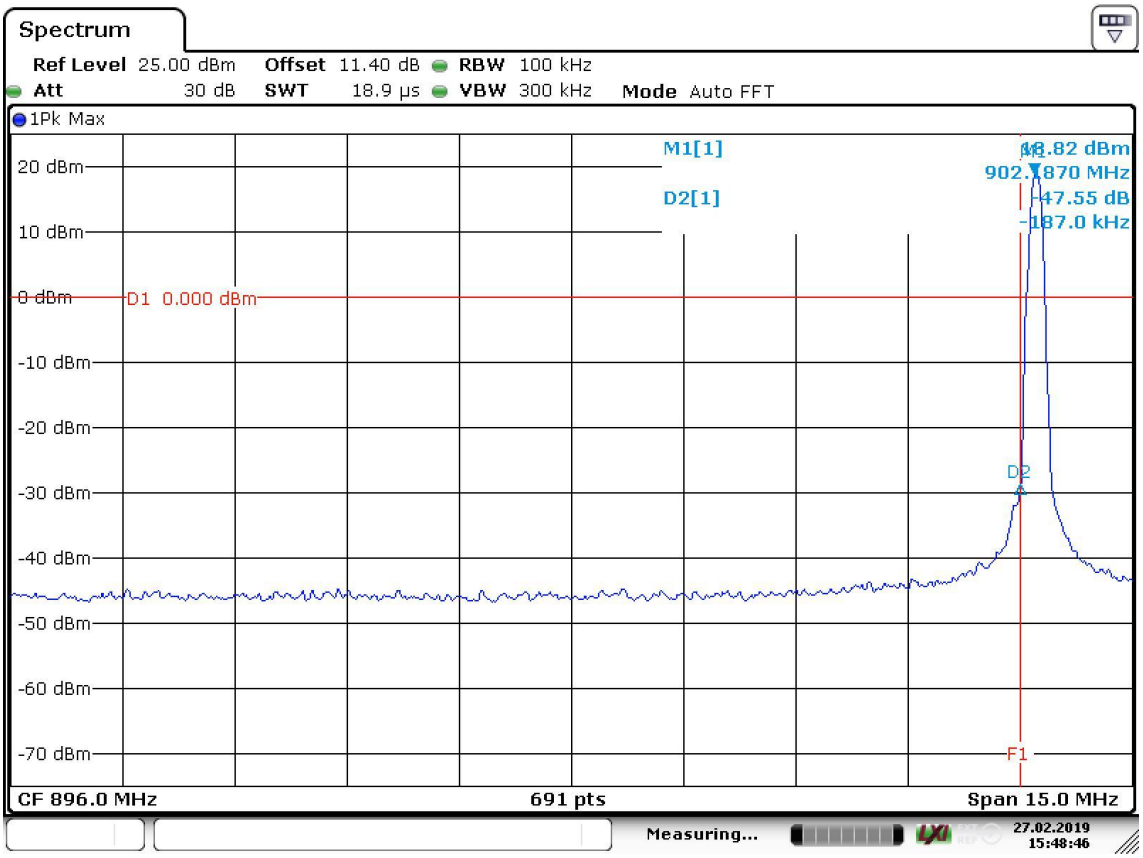
6.3 Requirement

Reference: CFR 47 §15.247(d), RSS-247 5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits.

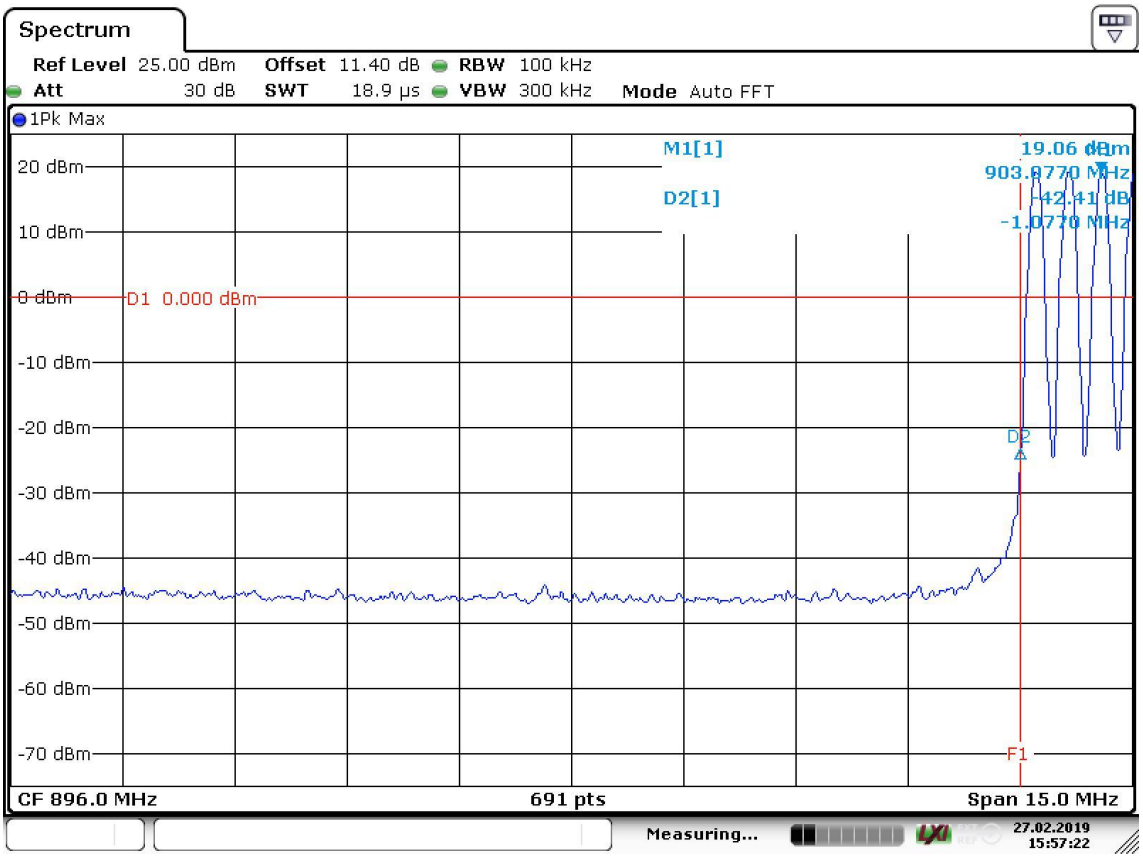
6.4 Test results

Band edge	EUT mode of operation	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	Single channel	47.6	20.0	27.6
Lower	Hopping	42.4	20.0	22.4
Upper	Single channel	64.4	20.0	44.4
Upper	Hopping	66.5	20.0	46.5



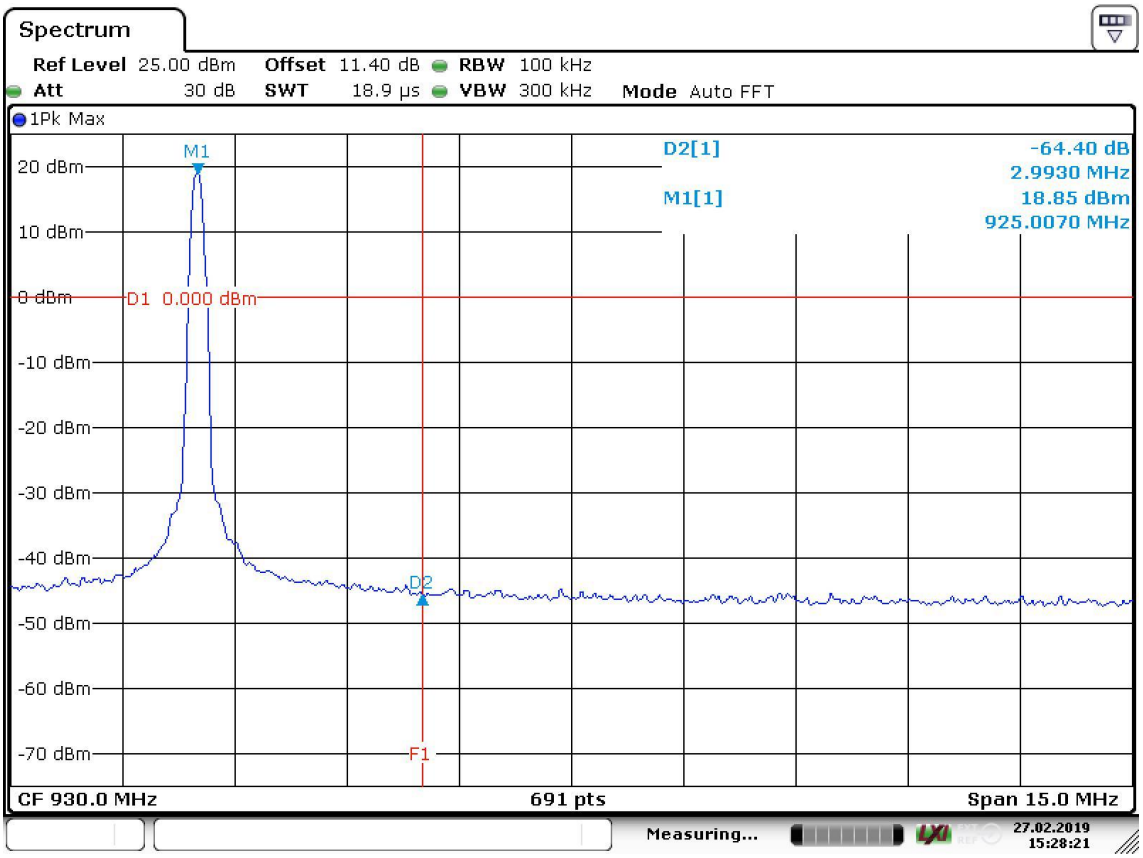
Date: 27.FEB.2019 15:48:46

Screenshot: Lower band edge sweep, single channel



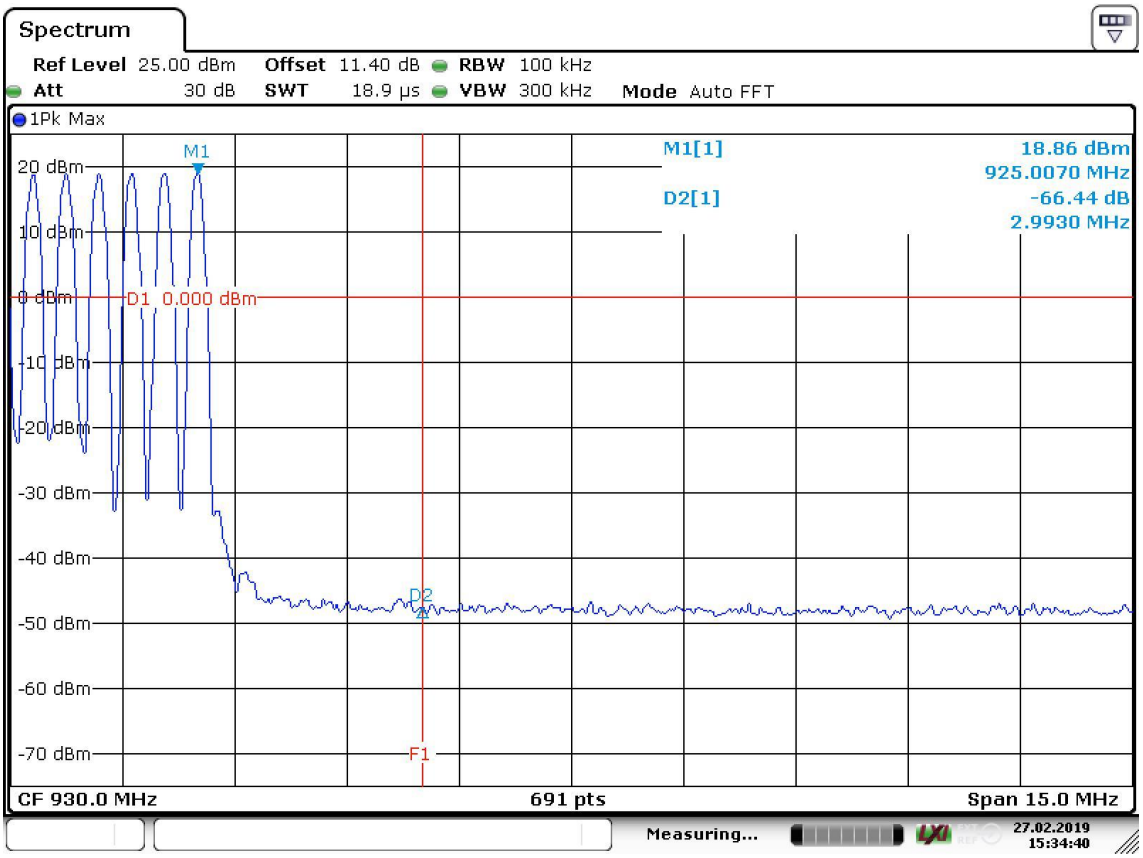
Date: 27.FEB.2019 15:57:22

Screenshot: Lower band edge sweep, hopping mode



Date: 27.FEB.2019 15:28:22

Screenshot: Upper band edge sweep, single channel



Date: 27.FEB.2019 15:34:41

Screenshot: Upper band edge sweep, hopping mode

7 PEAK CONDUCTED OUTPUT POWER

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT Serial:	915-639, 915-640 and 915-642	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	> 10 dB

7.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 7.8.5.

The EUT was connected to spectrum analyser via rf-cable and attenuator.

7.2 Test conditions

Detector: Peak,
RBW: >20 dB BW
VBW: 3 x RBW
Span: 5 x 20 dB BW

The EUT was set up in order to emit maximum disturbances.

7.3 Requirement

Reference: CFR 47 §15.247(b)(2), RSS-247 5.4(a).

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels.

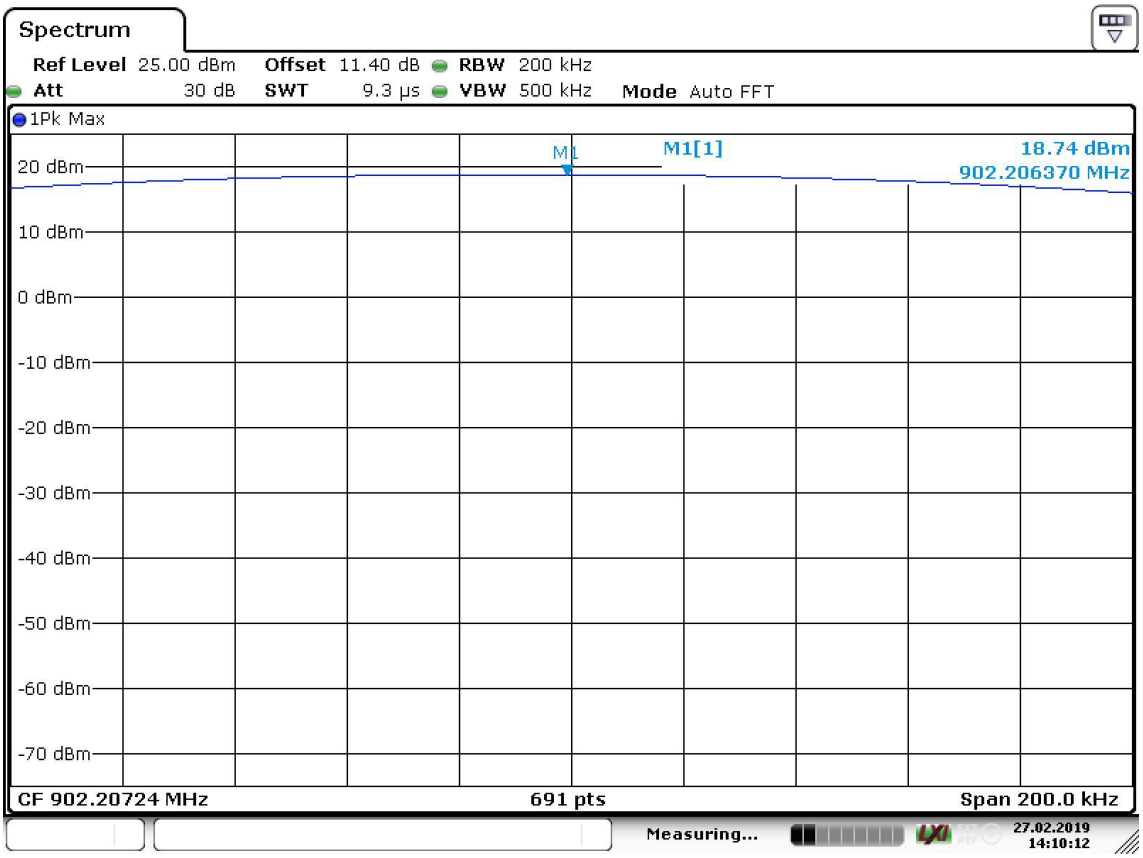
The e.i.r.p. shall not exceed 4 W.

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 by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.4 Test results

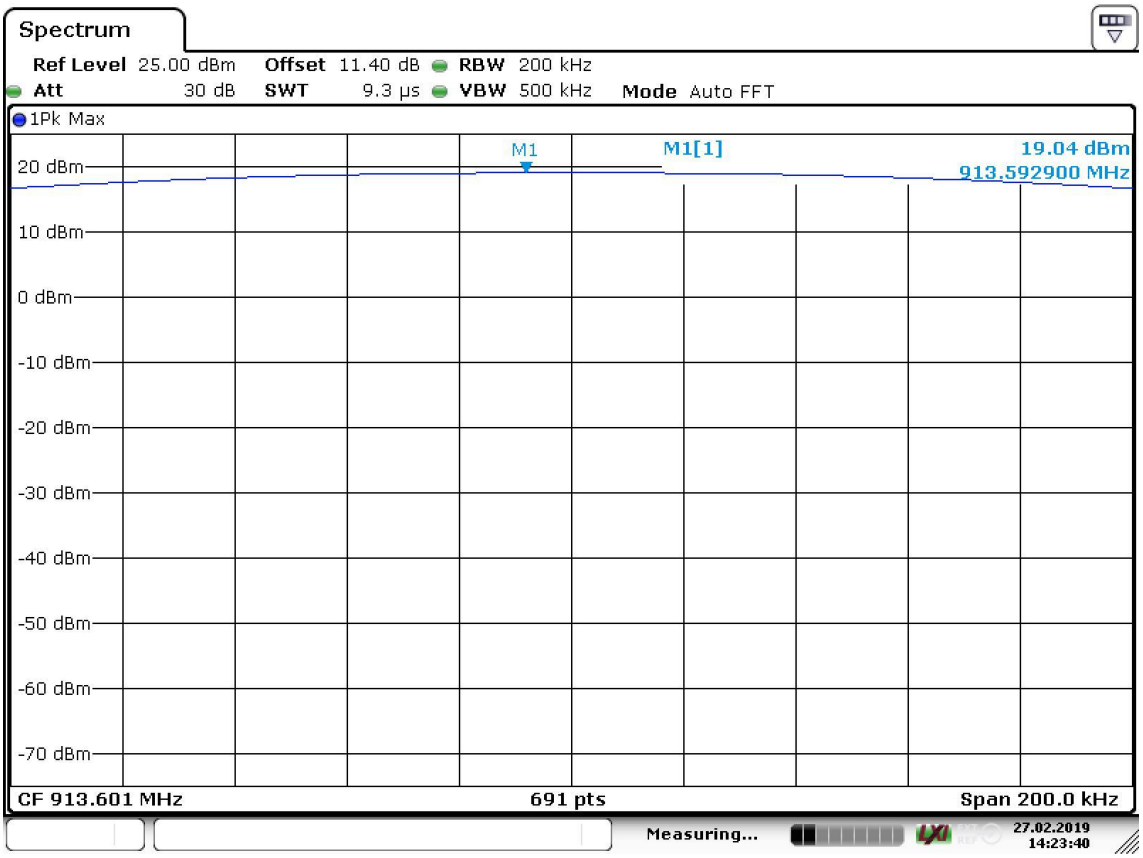
Test result

Channel [MHz]	Output power [dBm]	Limit [dBm]	Margin [dB]
902.2	18.7	30.0	11.3
913.6	19.0	30.0	11.0
925.0	18.8	30.0	11.2



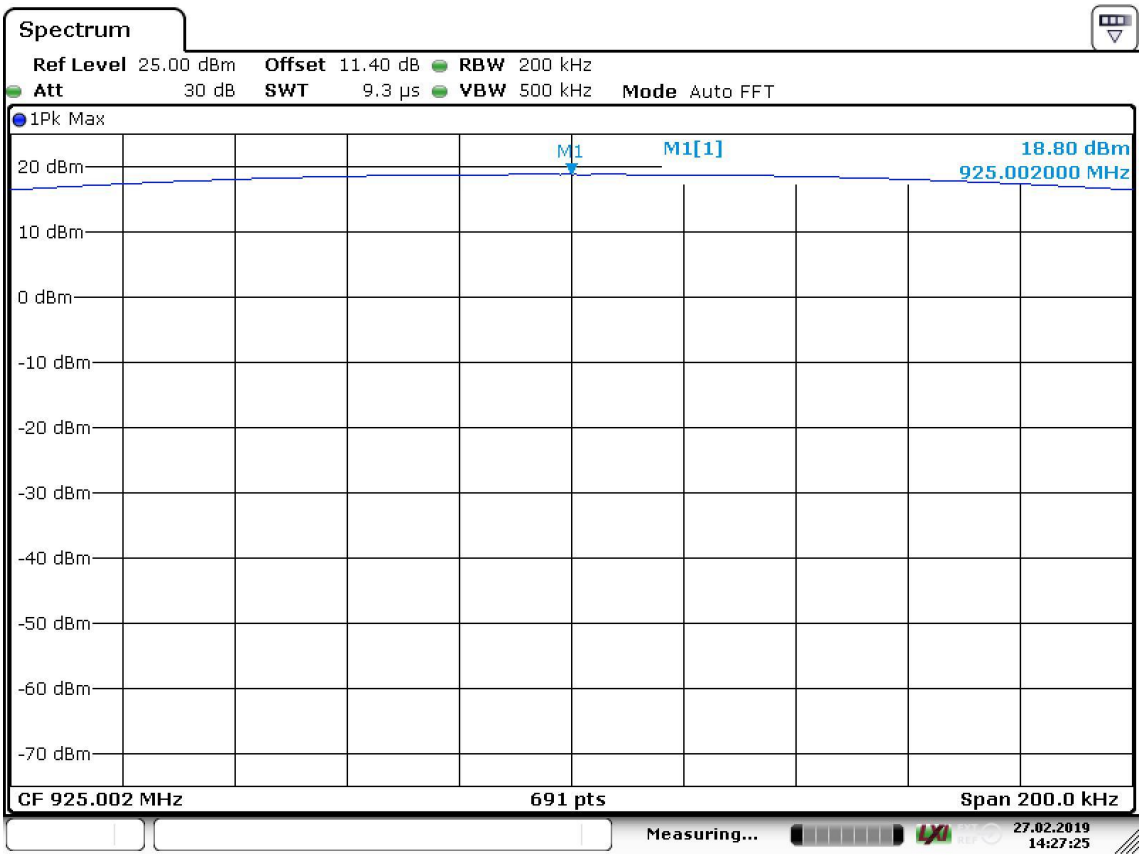
Date: 27.FEB.2019 14:10:13

Screenshot: Output power, low channel



Date: 27.FEB.2019 14:23:39

Screenshot: Output power, middle channel



Date: 27.FEB.2019 14:27:25

Screenshot: Output power, high channel

8 OCCUPIED 20 DB BANDWIDTH

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT Serial:	915-639, 915-640 and 915-642	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	473.7 kHz

8.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 6.9.2.

The EUT was connected to spectrum analyser via rf-cable and attenuator.

8.2 Test conditions

Detector: Peak,
RBW: 1 – 5 % of span
VBW: 3 x RBW
Span: >1,5 x OBW

The EUT was set up in order to emit maximum disturbances.

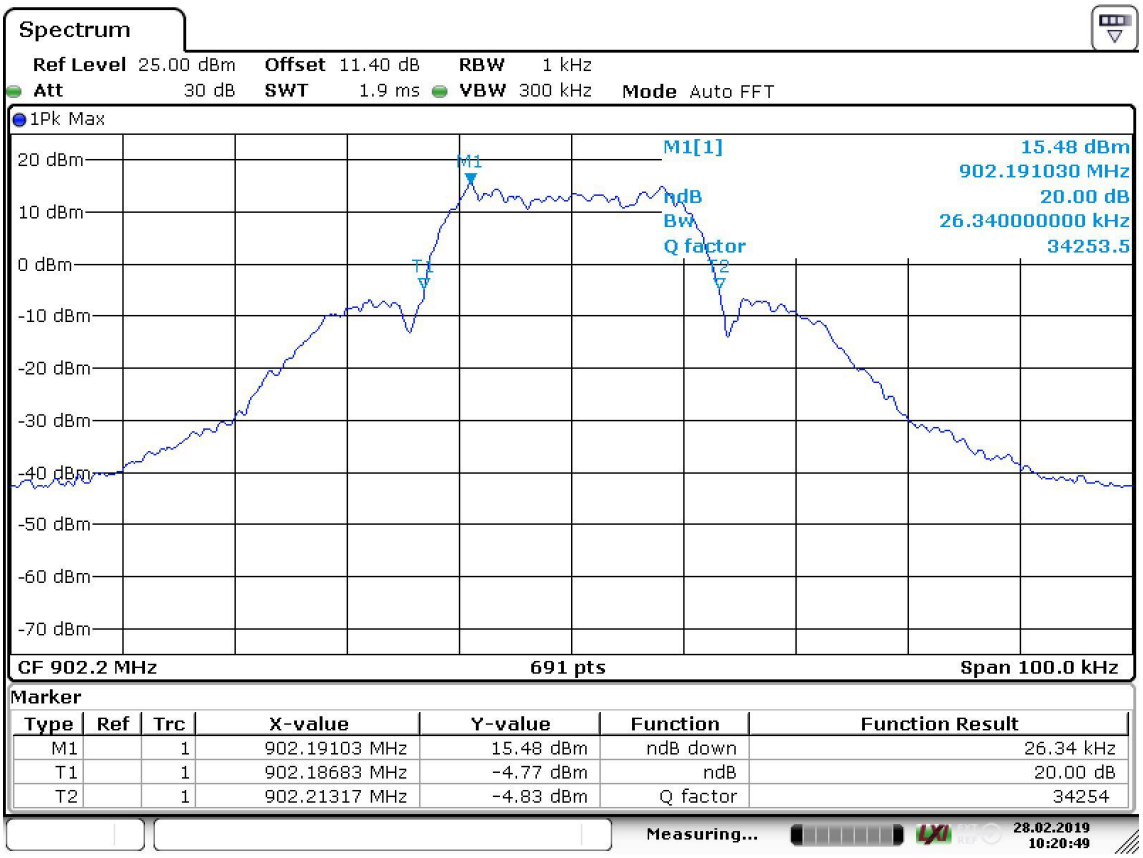
8.3 Requirements

Reference: CFR 47 §15.247(a)(1), RSS-247 5.1(c).

For frequency hopping systems operating in the 902-928 MHz band the maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

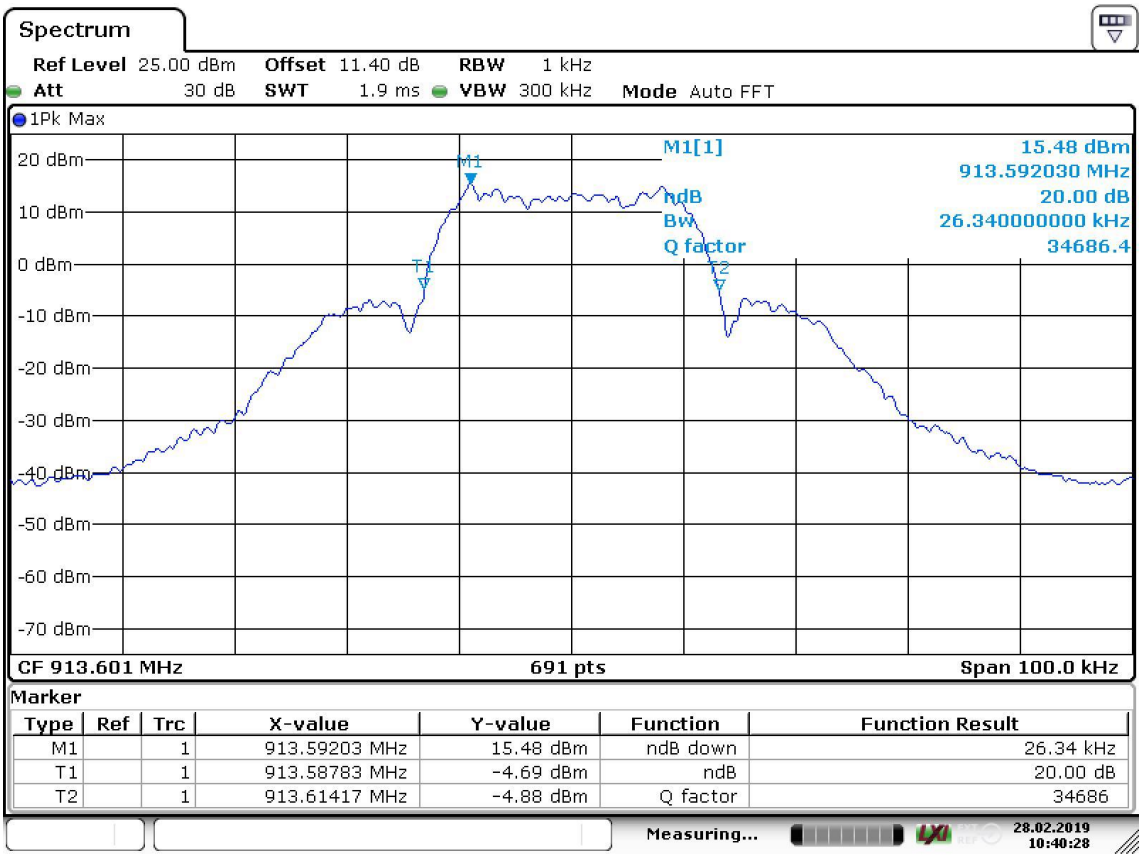
8.4 Test results

Channel [MHz]	20 dB BW [kHz]
902.2	26.3
913.6	26.3
925.0	26.2



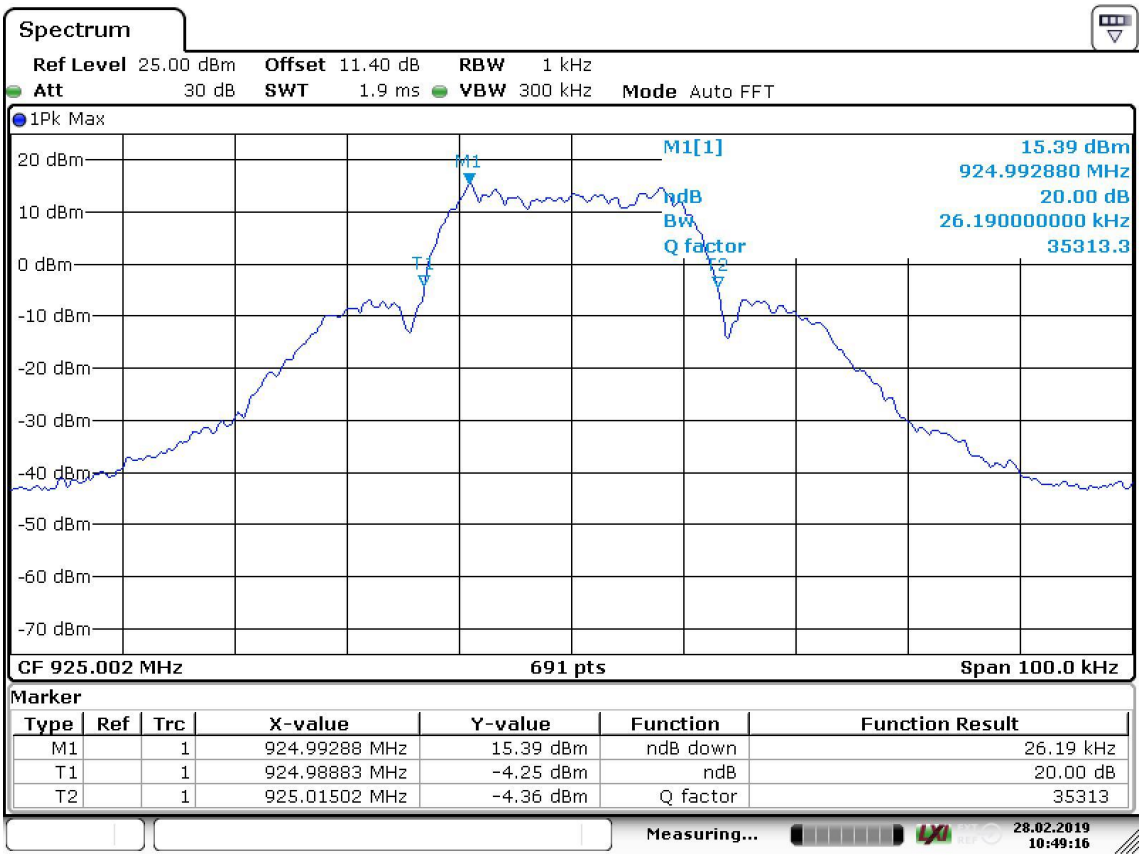
Date: 28.FEB.2019 10:20:49

Screenshot: Occupied bandwidth Measurement, low channel



Date: 28.FEB.2019 10:40:28

Screenshot: Occupied bandwidth Measurement, middle channel



Date: 28.FEB.2019 10:49:16

Screenshot: Occupied bandwidth Measurement, high channel

9 99 % BANDWIDTH

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT Serial:	915-639, 915-640 and 915-642	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	--

9.1 Test set-up and test procedure.

The test method is in accordance with RSS-GEN section 6.7.

Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth. The EUT was connected to spectrum analyser via rf-cable and attenuator.

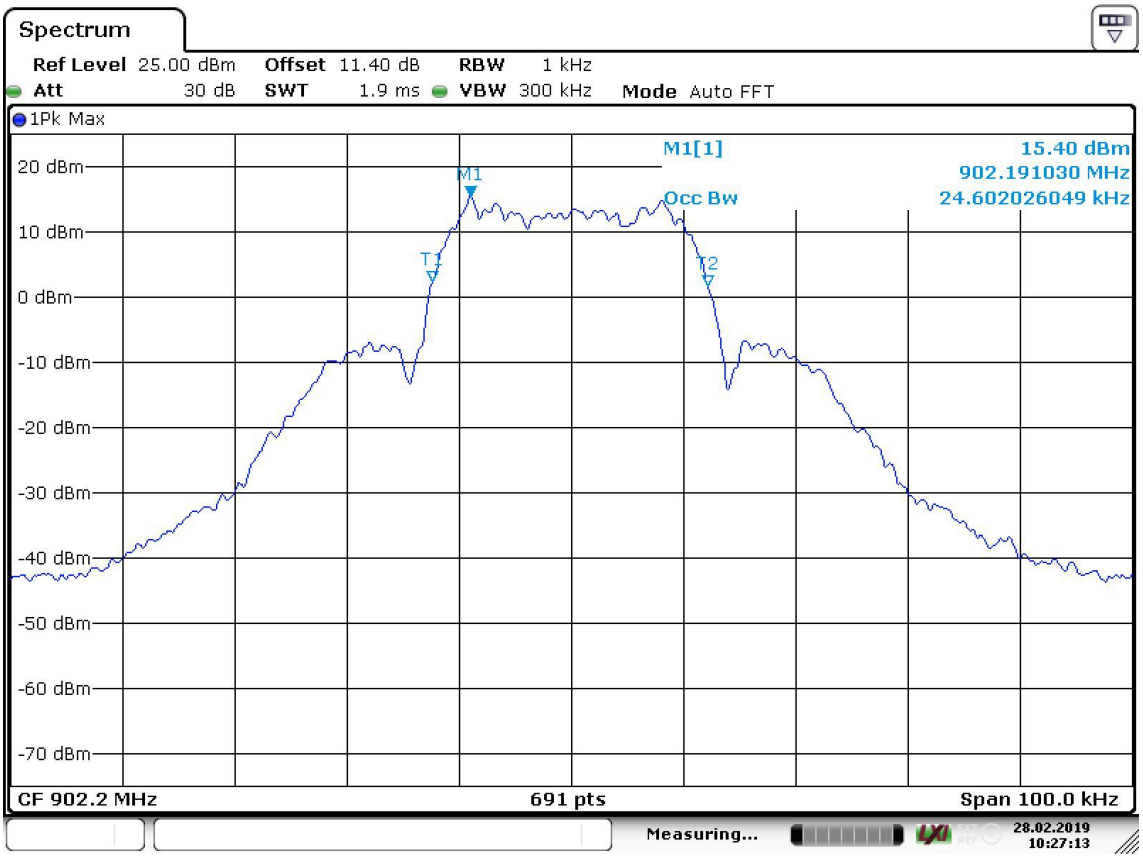
9.2 Test conditions

Detector: Peak,
RBW: 1 – 5 % of OBW
VBW: 3 x RBW

The EUT was set up in order to emit maximum disturbances.

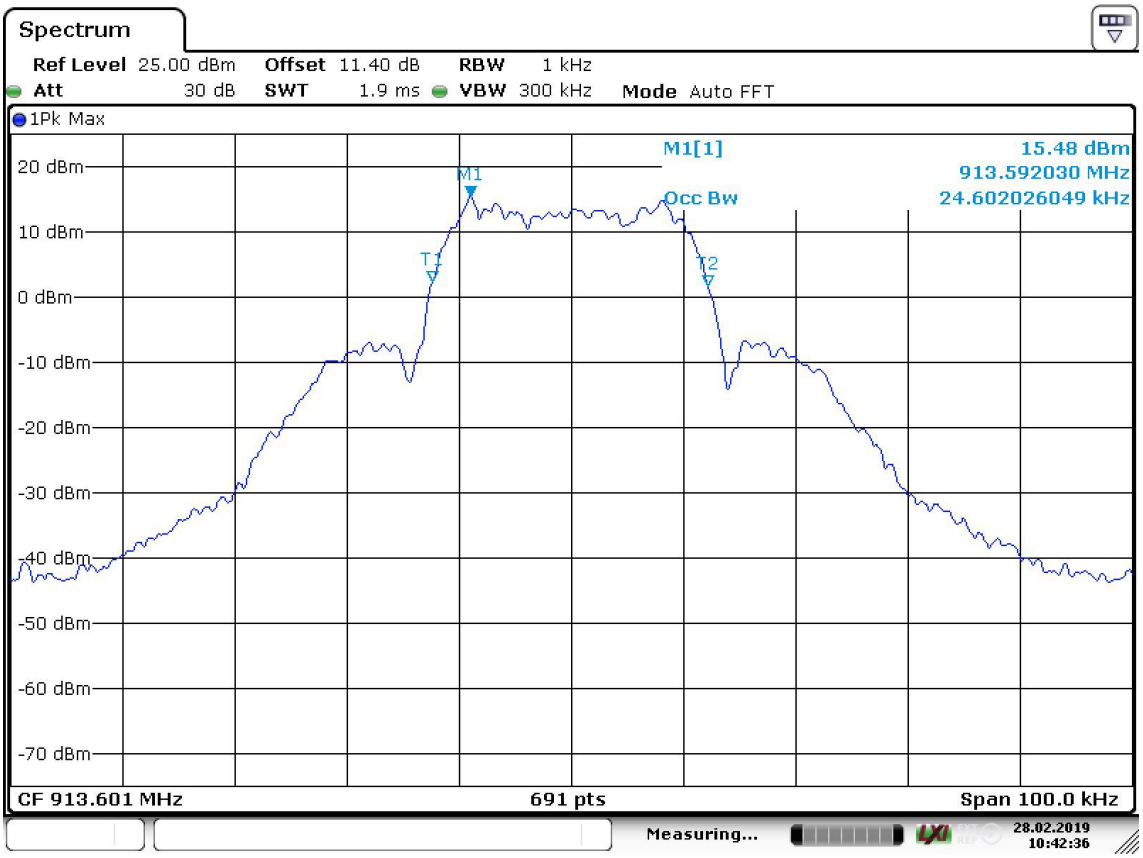
9.3 Test results

Channel [MHz]	99 % BW [MHz]
902.2	24.6
913.6	24.6
925.0	24.6



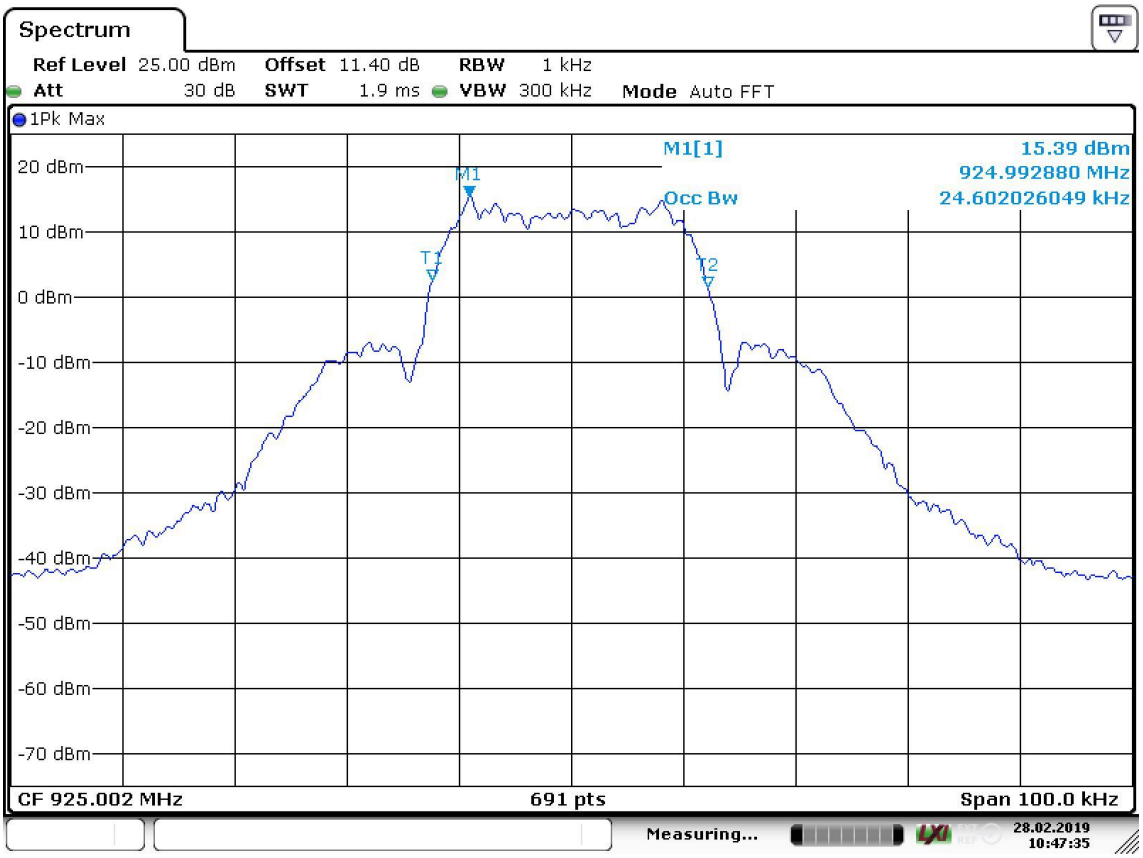
Date: 28.FEB.2019 10:27:13

Screenshot: Occupied bandwidth Measurement, low channel



Date: 28.FEB.2019 10:42:36

Screenshot: Occupied bandwidth Measurement, middle channel



Date: 28.FEB.2019 10:47:36

Screenshot: Occupied bandwidth Measurement, high channel

10 NUMBER OF HOPPING FREQUENCIES

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT number:	915-643	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	3 channels

10.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 7.8.3.

The EUT was connected to spectrum analyser via rf-cable and attenuator

10.2 Test conditions

Detector: Peak
Trace Max hold
RBW 100 kHz
VBW 3 x RBW
Span 900 – 930 MHz
Sweep Auto

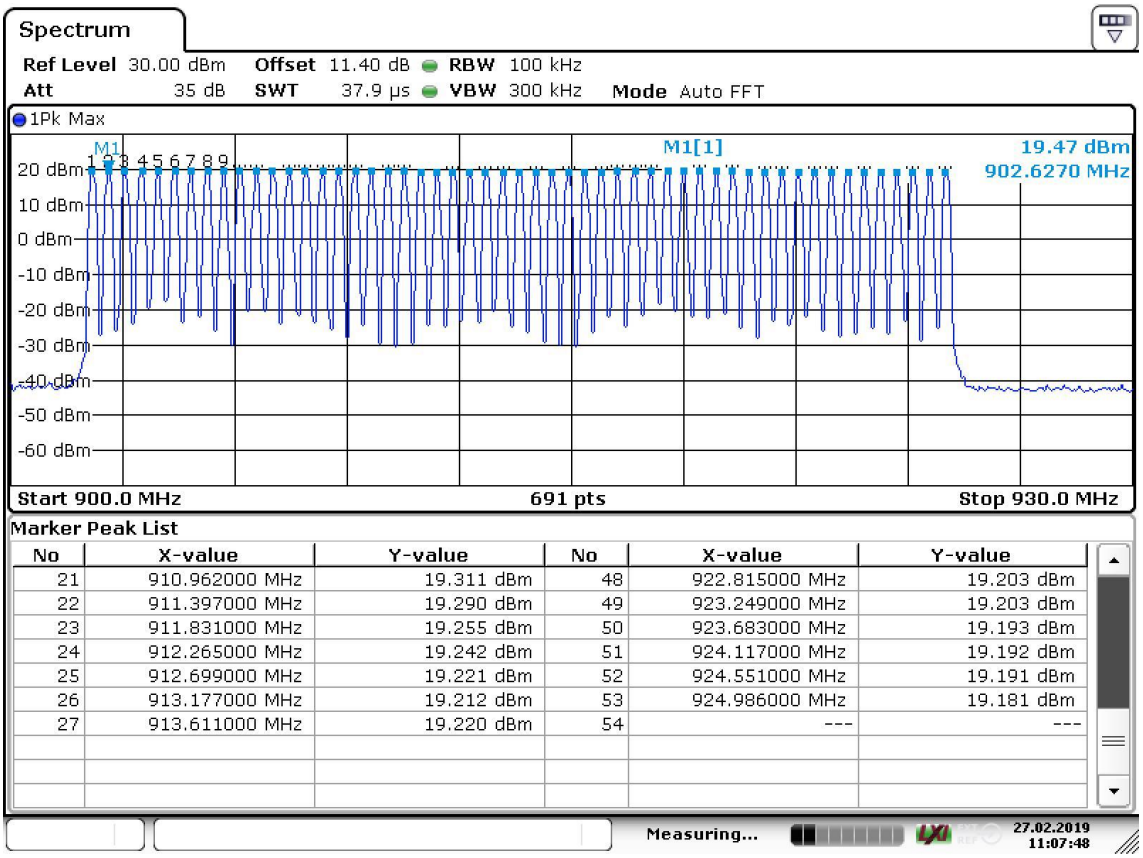
10.3 Requirements

Reference: CFR 47§15.247(a)(1)(i), RSS-247 5.1(c).

For frequency hopping systems in the band 902–928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels.

10.4 Test results

Number of hopping frequencies	Limit	Margin
53	50	3



No	X-value	Y-value	No	X-value	Y-value
21	910.962000 MHz	19.311 dBm	48	922.815000 MHz	19.203 dBm
22	911.397000 MHz	19.290 dBm	49	923.249000 MHz	19.203 dBm
23	911.831000 MHz	19.255 dBm	50	923.683000 MHz	19.193 dBm
24	912.265000 MHz	19.242 dBm	51	924.117000 MHz	19.192 dBm
25	912.699000 MHz	19.221 dBm	52	924.551000 MHz	19.191 dBm
26	913.177000 MHz	19.212 dBm	53	924.986000 MHz	19.181 dBm
27	913.611000 MHz	19.220 dBm	54	---	---

Date: 27.FEB.2019 11:07:49

Screenshot: Number of hopping frequencies

11 CARRIER FREQUENCY SEPARATION

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT number:	915-643	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	402.1

11.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 7.8.2.

The EUT was connected to spectrum analyser via rf-cable and attenuator.

11.2 Test conditions

Detector:	Peak
Trace	Max hold
RBW	100 kHz
VBW	3 x RBW
Span	2 MHz
Sweep	Auto

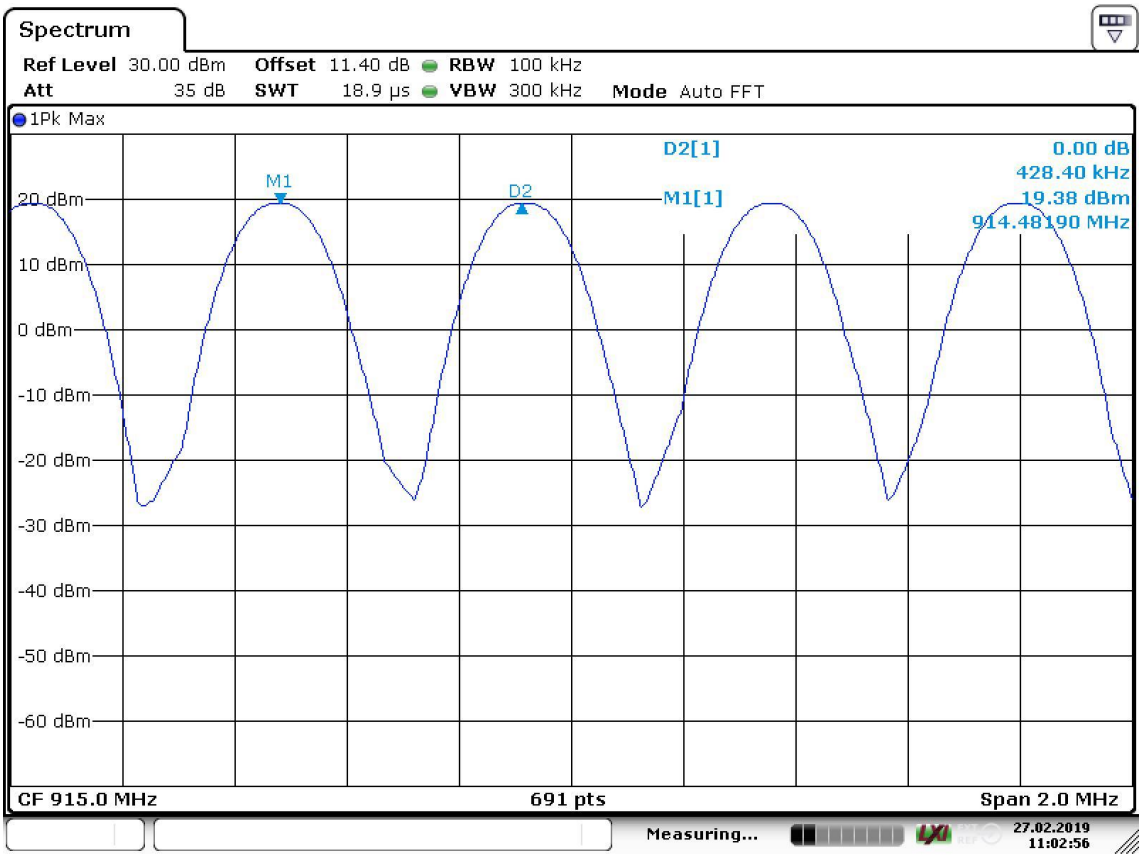
11.3 Requirements

Reference: CFR 47§15.247(a)(1), RSS-247 5.1(b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

11.4 Test results

Carrier frequency separation [kHz]	Limit [kHz]	Margin [kHz]
428.4	26.3	402.1



Date: 27.FEB.2019 11:02:57

Screenshot: Carrier frequency separation

12 TRANSMITTER TIME OF OCCUPANCY

Date of test:	2019-02-27	**Test location:**	Radiolabbet
EUT number:	915-640	**Ambient temp:**	21 °C
Tested by:	Magnus Thorildsson Robert Hietala	**Relative humidity:**	33 %
Test result:	Pass	**Margin:**	314.6 ms

12.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 7.8.4.

The EUT was connected to spectrum analyser via rf-cable and attenuator.

12.2 Test conditions

Detector: Peak
RBW 100 kHz
VBW 3 x RBW
Span 0 Hz
Sweep time 20 s

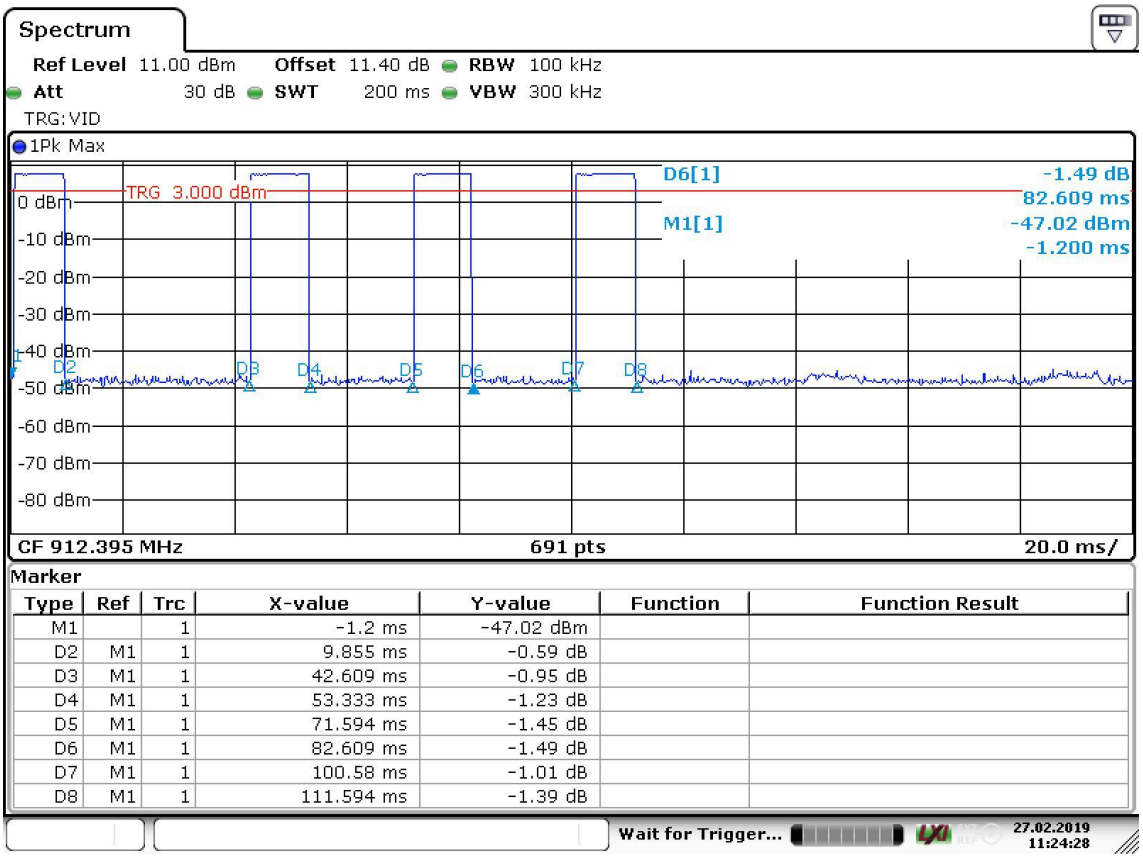
12.3 Requirement

Reference: CFR 47 §15.247(a)(1)(i), RSS-247 5.1(c).

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period.

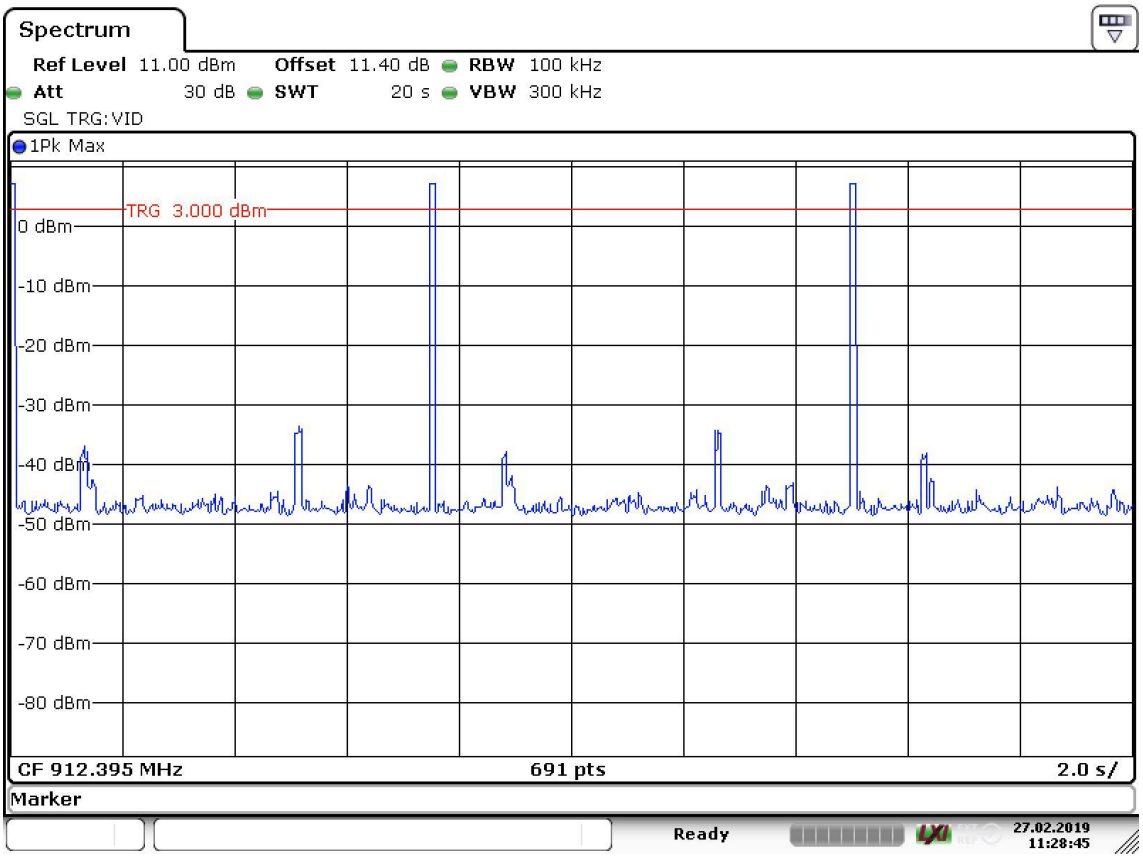
12.4 Test results

Number of transmissions	Transmission time [ms]	Time of occupancy / 20 s [ms]	Limit [ms]	Margin [ms]
2	42.6	85.4	400	314.6



Date: 27.FEB.2019 11:24:28

Screenshot: time of one transmission



Date: 27.FEB.2019 11:28:45

Screenshot: time of occupancy / 20 s

13 TRANSMITTER DUTY CYCLE FOR PULSED TRANSMISSIONS

Date of test:	2019-09-16	**Test location:**	Radiolabbet
EUT Serial:	--	**Ambient temp:**	21 °C
Tested by:	Robert Hietala	**Relative humidity:**	64 %
Test result:	Pass	**Margin:**	--

13.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10 section 7.5.

The EUT was connected to spectrum analyser via rf-cable and attenuator. EUT was in hopping mode on a single channel.

13.2 Test conditions

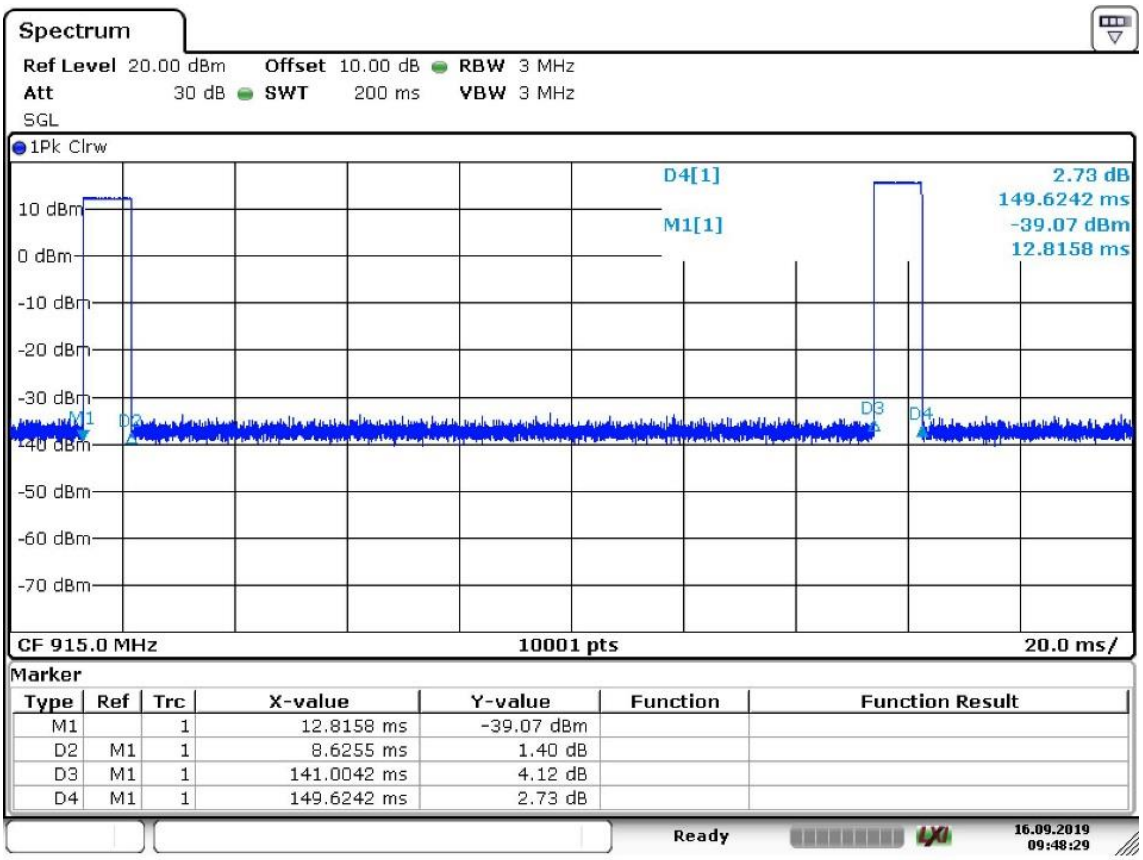
Detector: Peak
RBW 3 MHz
VBW 3 MHz
Span 0 Hz
Sweep time 200 ms

13.3 Requirement

CFR 47 15.35(c) and RSS-GEN section 8.2.

13.4 Test results

T_{on} = 8.6 ms
Pulse period = 141.0 ms
Duty cycle is calculated T_{on} / pulse period; which gives 8.6 / 141.0 = 6.1
Duty cycle = 6.1 %



Date: 16.SEP.2019 09:48:29

Screenshot: 200 ms sweep time measurement

14 TEST EQUIPMENT

Stora Hallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 – 10.35.02	--	--	--
Measurement receiver	Rohde & Schwarz	ESW44	33890	2018-02	1.5 years
BiLog antenna	Chase	CBL6110A	971	2017-09	3 years

Radiohallen 3m FAC and Radiolabbet

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 10.35.1	--	--	--
Measurement receiver	Rohde & Schwarz	ESU 40	13178	2018-07	1 year
Measurement cable	Huber + Suhner	Sucoflex 104 PE	39077	2018-05	1 year
Measurement cable	Huber + Suhner	Sucoflex 104	39119	2018-07	1 year
Measurement cable	Huber + Suhner	Sucoflex 104	5179	2018-07	1 year
Measurement cable	Huber + Suhner	Suxoflex 102	39137	2018-07	1 year
Horn antenna	EMCO	3115	4936	2017-07	3 years
Pre amplifier	Sangus	00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	2018-07	1 year
Signal analyzer:	Rohde & Schwarz	FSV30	32594	2018-07	1 year
Signal generator:	Rohde & Schwarz	SMB100A	32592	2018-06	1 year
2,4 GHz band reject filter:	Wainwright Instr. GmbH	WRCGV10-2381-2401-2479-2499-40SS	33938	2018-10	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	2018-08	1 year
Multimeter	Fluke	287	33454	2018-12	1 year

15 MEASUREMENT UNCERTAINTY

Continuous conducted disturbances with AMN in the frequency range 9 kHz to 30 MHz ± 3.7 dB

Measurement uncertainty for radiated disturbance

Uncertainty for the frequency range 30 to 1000 MHz at 3 m	± 5.1 dB
Uncertainty for the frequency range 30 to 1000 MHz at 10 m	± 5.0 dB
Uncertainty for the frequency range 1.0 to 18 GHz at 3 m	± 4.7 dB
Uncertainty for the frequency range 18 to 26 GHz at 3 m	± 4.8 dB
Uncertainty for the frequency range 26 to 40 GHz at 3 m	± 5.7 dB

Measurement uncertainty is calculated in accordance with CISPR 16-4-2:2011.
The measurement uncertainty is given with a confidence of 95 %.

16 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1906290STO-001 Annex 1.
Test set up photos are in separate document 1906290STO-001 Annex 2.