

RADIO TEST REPORT

No. 1810944STO-001, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment: Wireless Communication Hub
Type/Model: AH40
Manufacturer: ASSA ABLOY AB
Tested by request of: ASSA ABLOY 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 (2017): Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 (2017): Subpart B: Unintentional radiators

RSS-Gen Issue 5 (2018): General Requirements for 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: 2018-06-25

Tested by:


Robert Hietala

Approved by:


Matti Virkki

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Revision History

Edition	Date	Description	Changes
1	2018-06-25	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company ASSA ABLOY AB
Förmansvägen 11
SE-117 43 Stockholm
Sweden

Name of contact Magnus Axelsson

Client observer Magnus Axelsson

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: Wireless Communication Hub
Type/Model: AH40
Brand name: Aperio Hub
Serial number: 00.17.7A.01.02.04.97.CC
Manufacturer: ASSA ABLOY AB
Transmitter frequency range: 2405 – 2480 MHz
Receiver frequency range: 2405 – 2480 MHz
Frequency agile or hopping: ☐ Yes ☒ No
Antenna: ☒ Internal antenna ☒ External antenna
Antenna connector: ☐ None, internal antenna ☒ Yes, type RP-SMA
Antenna gain internal: 4 dBi
Antenna gain external: 2.15 dBi
Rating RF output power: 5.3 dBm (measured conducted)
Type of modulation: O-QPSK
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: +5°C to +35°C
Transmitter standby mode supported: ☒ Yes ☐ No

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
Aperio Hub	AH40	00.17.7A.01.02.04.97.CC
2.4 GHz dipole antenna	AH-ANTENNA-1	No visible serial number

During the tests the EUT supported following software:

Software	Version	Comment
Aperio Lock Simulator	0.0.9432	Software for enabling test modes

2.3 Test signals and operation modes

During the tests the EUT was transmitting a continuous modulated signal with a duty cycle of 100 %.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

47 CFR Part 15 (2017): Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 (2017): Subpart B: Unintentional radiators

RSS-Gen Issue 5 (2018): General requirements of compliance of radio apparatus (2014).

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

RSS-Gen Issue 5 (2018) and RSS-247 Issue 2 (2017) are not within Intertek's scope of accreditation.

No other 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 #
BJÖRKHALLEN	Semi-anechoic 3 m	2042G-1
RADIOHALLEN	Fully-anechoic 3 m	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	Antenna requirement	PASS
	The EUT has integrated non detachable antenna which can't be remove without breaking the EUT. When external antenna is used it is required that installation is made by a professional only.	
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	NA
	DC operated equipment.	
FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	Field strength of fundamental and antenna gain	PASS
	Antenna gain is less than 6 dBi.	
FCC §15.247 (d), 15.209(a) RSS-GEN 8.9 RSS-247 5.5	Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz	PASS
	The EUT complies with the limits. The margin to the limit was at least 10 dB. See clause 5.4 – 5.5 and 6.4.	
FCC §15.247(d), 15.209(a) RSS-GEN 8.9 RSS-247 5.5	Radiated emission of electromagnetic fields in the frequency range above 1 GHz	PASS
	The EUT complies with the limits. The margin to the limit was at least 2.7 dB at 4810.6 MHz. See clause 5.6 – 5.7 and 6.5.	
FCC §15.247(a)(2) RSS-GEN 6.7 RSS-247 5.2(1)	Occupied bandwidth	PASS
	The EUT complies with the limits. The margin to the limit is at least 1.1 MHz See clause 9.4.	
FCC §15.247(b) RSS-247 5.4(4)	Conducted output power	PASS
	The EUT complies with the limits. The margin to the limit was at least 10 dB. See clause 8.4.	
FCC §15.247(e) RSS-247 5.2(2)	Peak power spectral density	PASS
	The EUT complies with the limits. The margin to the limit was at least 10 dB. See clause 11.4.	
FCC §15.247(e) RSS-247 5.5	Band edge	PASS
	The EUT complies with the limits. The margin to the limit was at least 1.6 dB at 2484.0 MHz. See clause 5.6.	

5 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHz TO 26 GHz, INTERNAL ANTENNA

Date of test:	2018-06-07	Test location:	Radiohallen, Björkhallen
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	38 %
Test result:	Pass	Margin:	1.6 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.

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.

Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 30 – 1000 MHz. Above 1 GHz additionally the average detector was activated.

Mobile device: Pre scan was made in two orthogonal EUT orientations.

5.2 Test conditions

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

30 MHz to 1000 MHz

Peak,

RBW 120 kHz

VBW 1 MHz

Quasi-Peak,

RBW 120 kHz

VBW 1 MHz

0.8 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Bilog

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

Antenna tilt:

1 GHz – 26.5 GHz

Peak,

RBW 1 MHz

VBW 3 MHz

Average,

RBW 1 MHz

VBW 3 MHz

Peak,

RBW 1 MHz

VBW 3 MHz

Average

RBW 1 MHz

VBW 3 MHz

1.5 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Horn

Activated

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 (dBμV/m)
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))

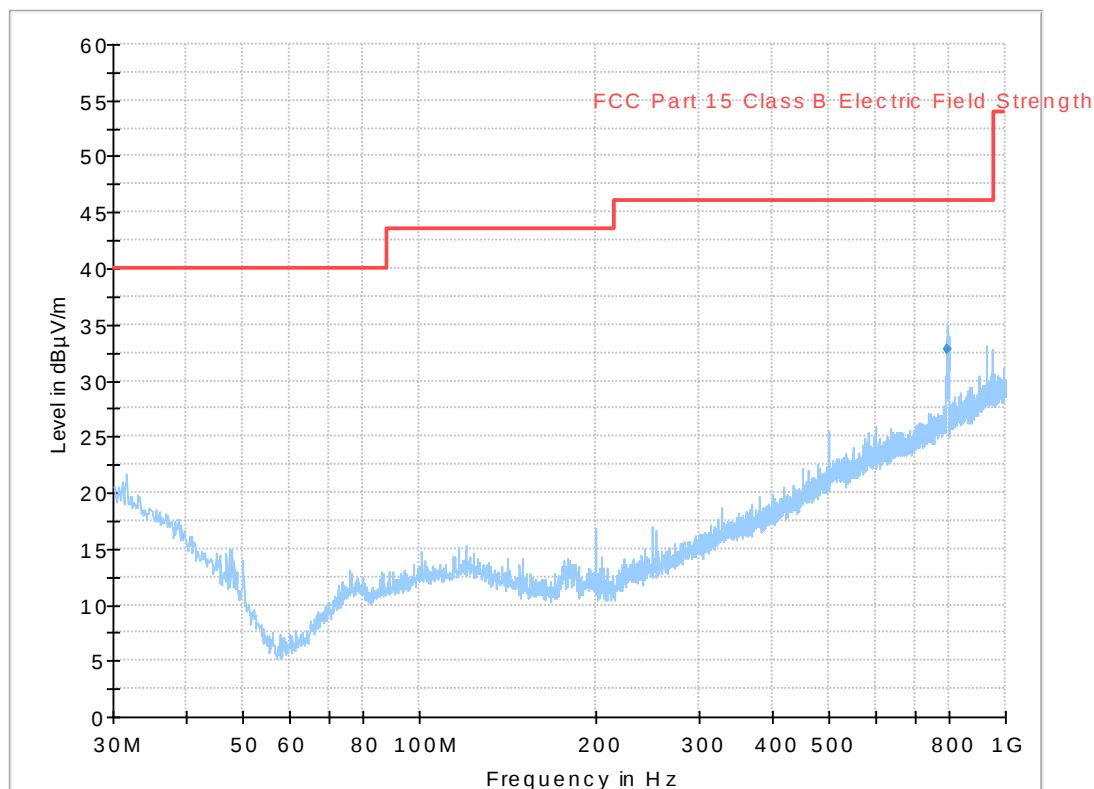
Outside the restricted bands:

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.

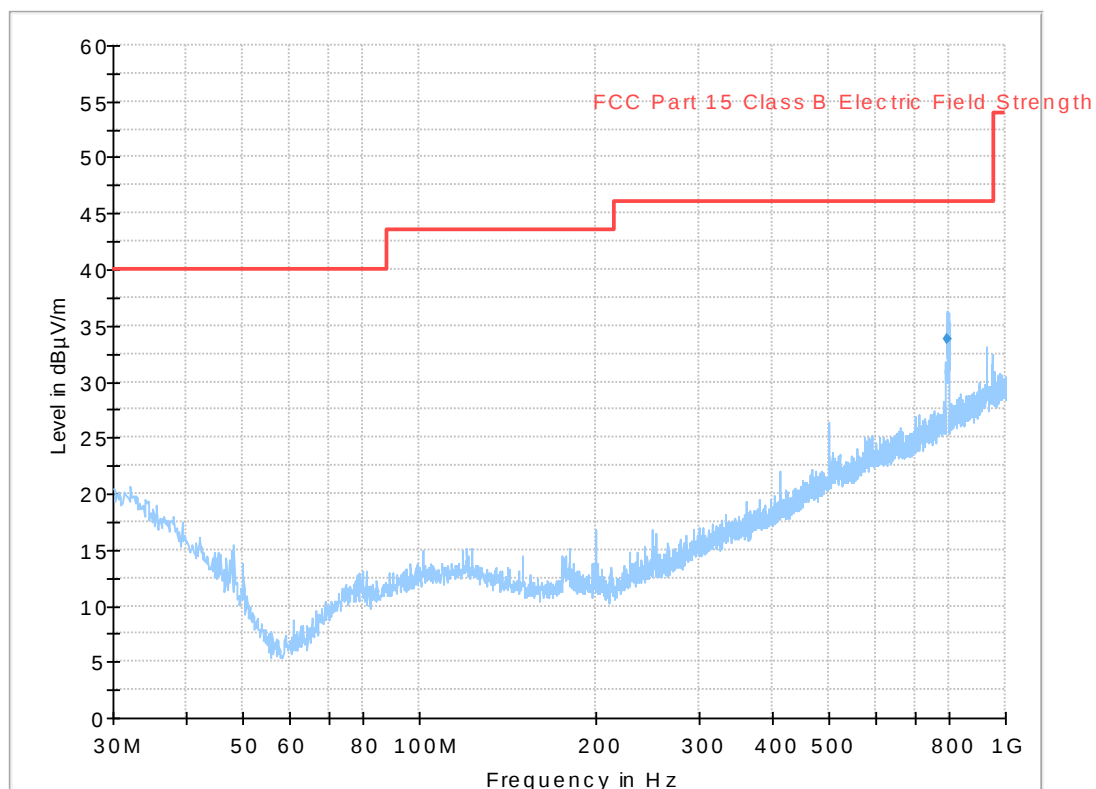
5.4 Test results 30 MHz – 1000 MHz, TX

Full Spectrum



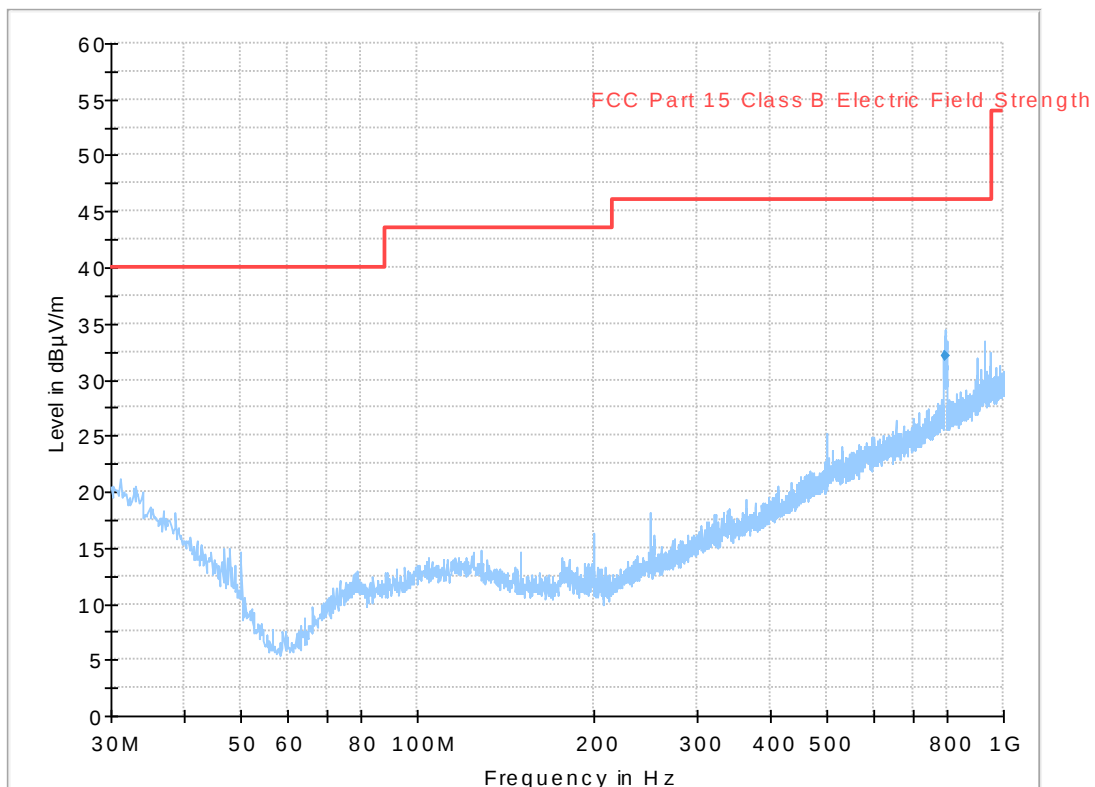
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel.

Full Spectrum



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX mid channel.

Full Spectrum



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX high channel.

Measurement results, Quasi Peak, low channel.

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
797.435	32.8	46.0	V	13.2

Measurement results, Quasi Peak, mid channel.

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
797.576	33.8	46.0	H	12.2

Measurement results, Quasi Peak, high channel.

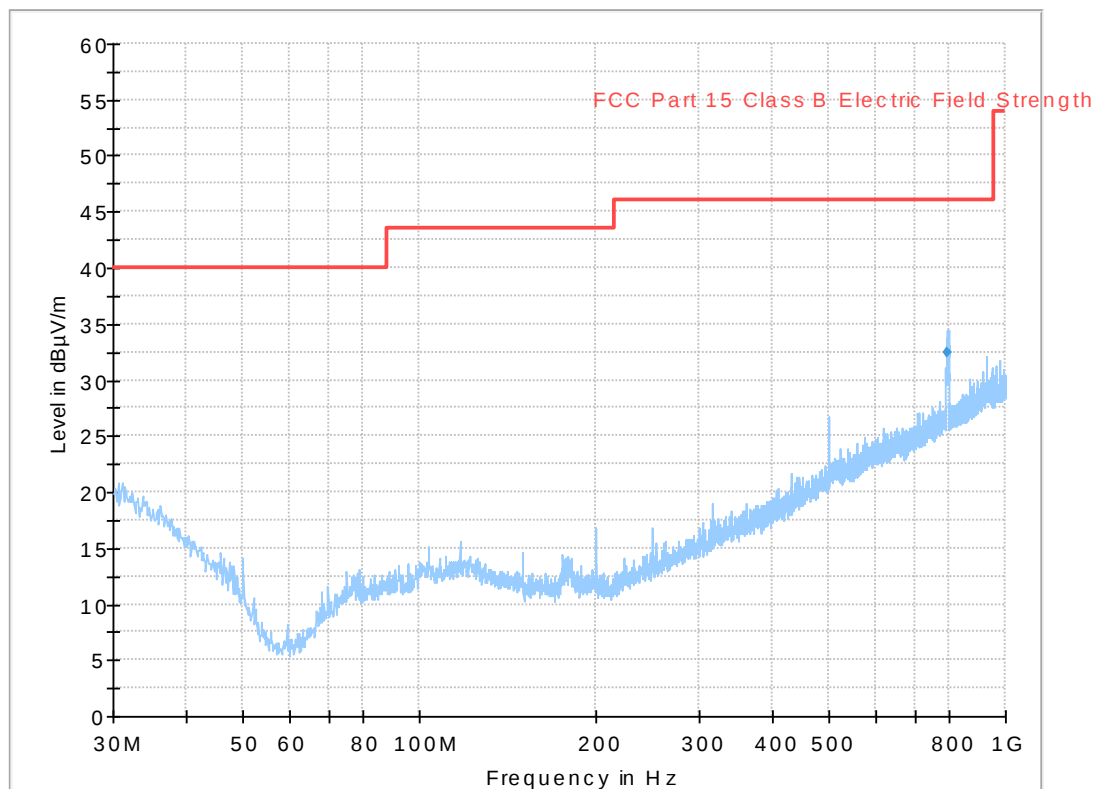
Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
795.109	32.0	46.0	V	14.0

All other measured disturbances have a margin of more than 20 dB to the limits.

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

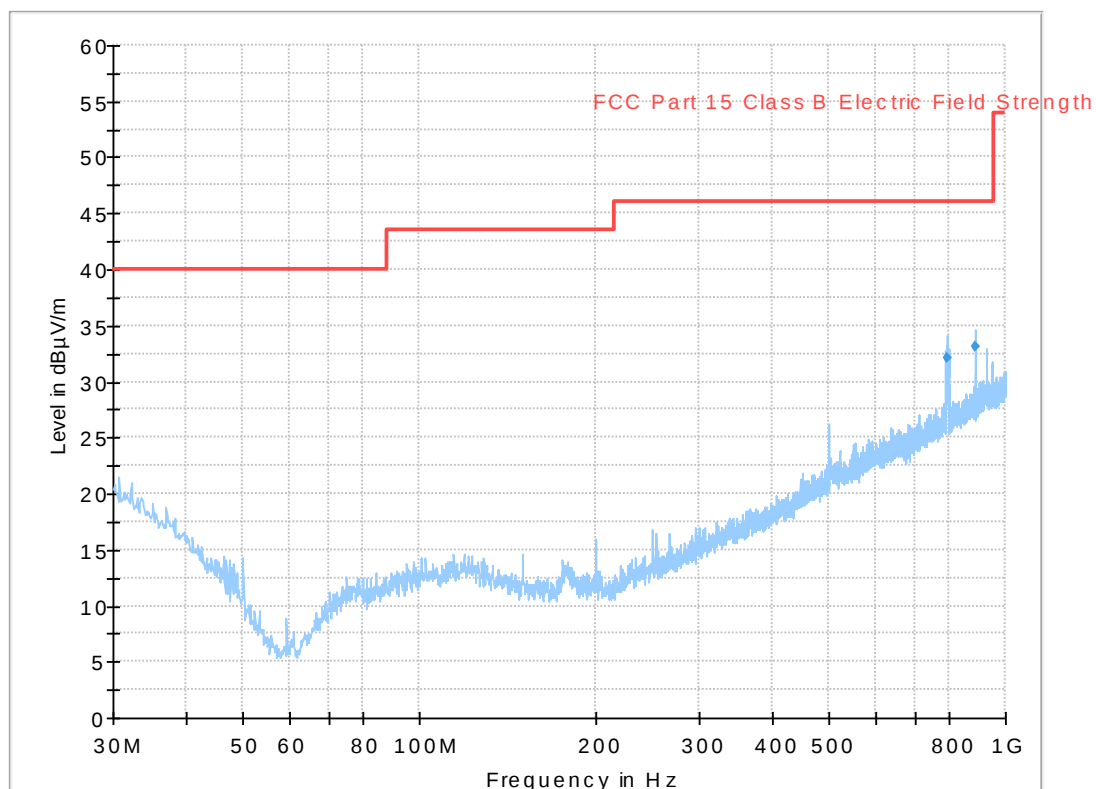
5.5 Test results 30 MHz – 1000 MHz, RX

Full Spectrum



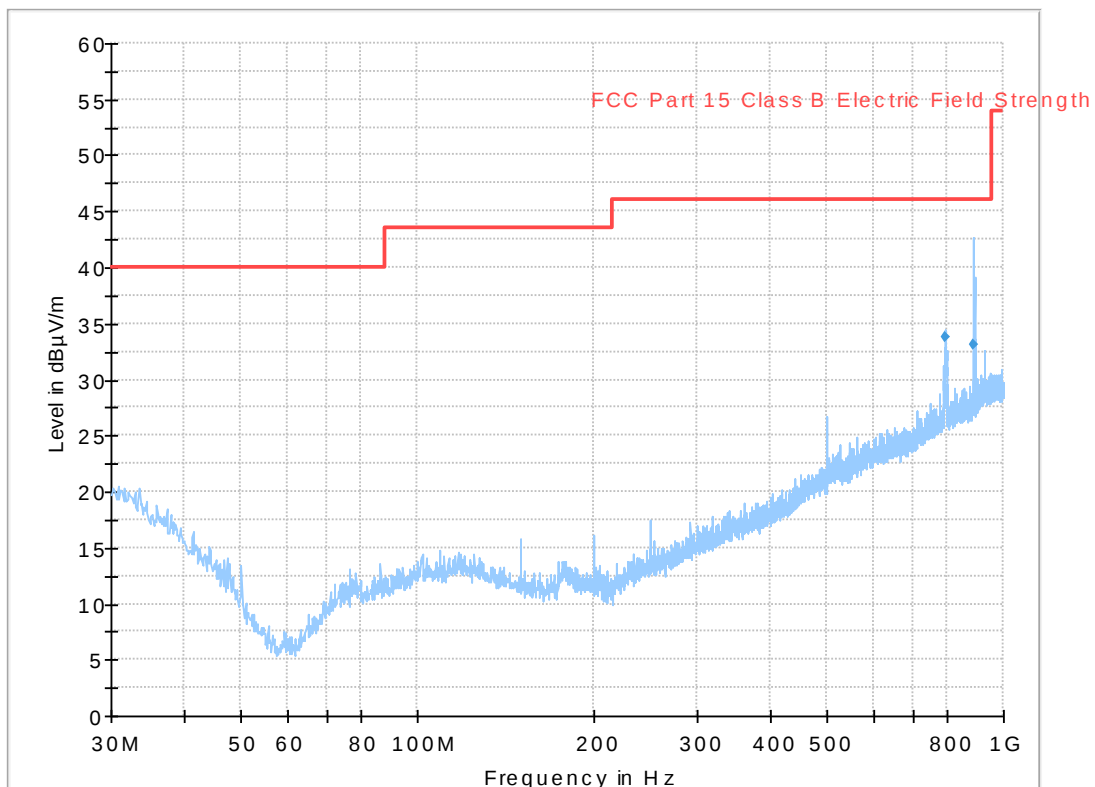
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX low channel.

Full Spectrum



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX mid channel.

Full Spectrum



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX high channel.

Measurement results, Quasi Peak, low channel.

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
797.717	32.4	46.0	V	13.6

Measurement results, Quasi Peak, mid channel.

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
798.114	32.2	46.0	H	13.8
887.854	33.2	46.0	V	12.9

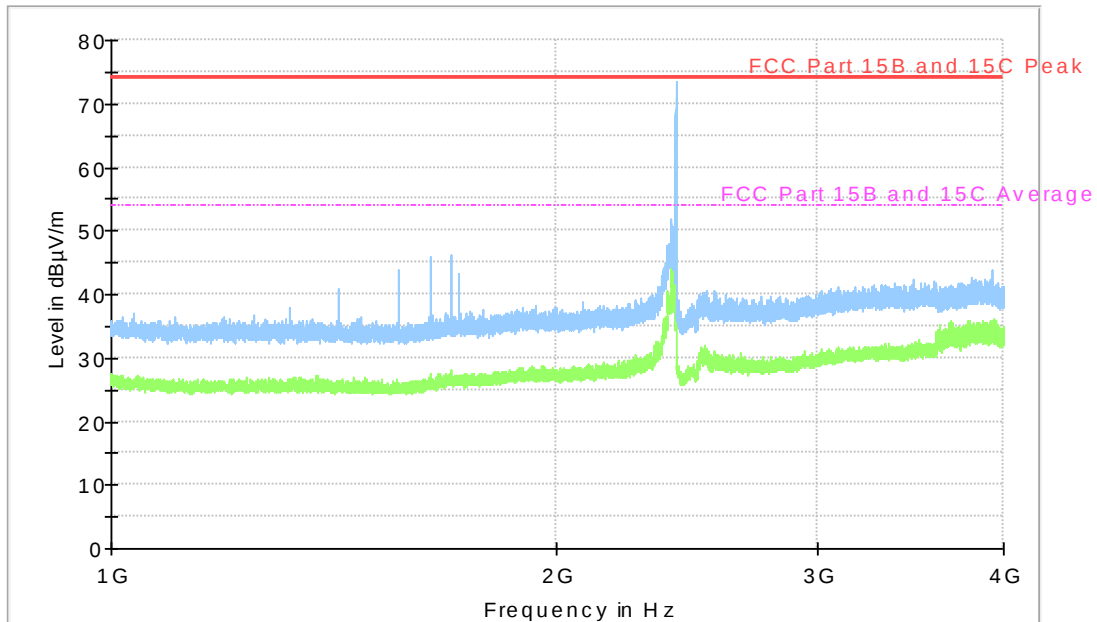
Measurement results, Quasi Peak, high channel.

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
798.115	33.9	46.0	H	12.1
889.230	33.2	46.0	H	12.8

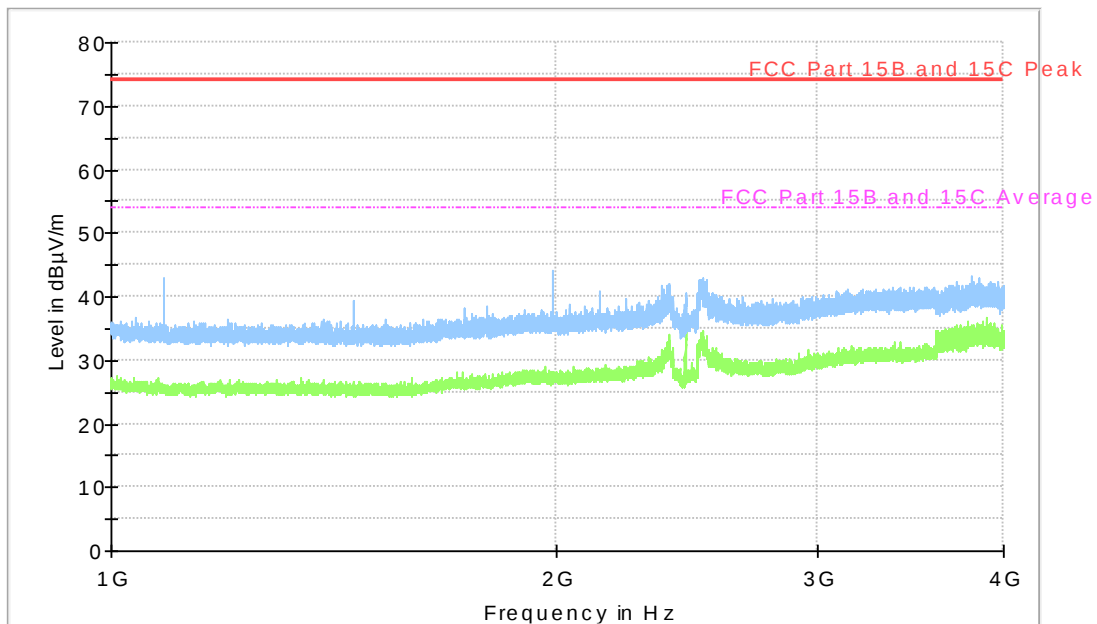
All other measured disturbances have a margin of more than 20 dB to the limits.

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

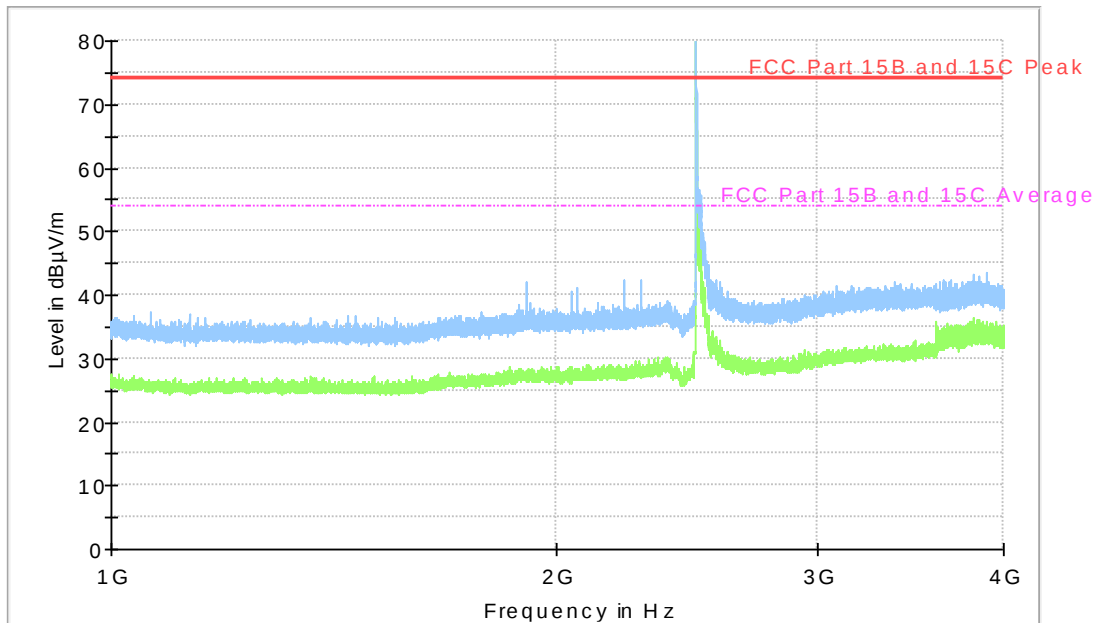
5.6 Test results 1 GHz – 26 GHz, TX



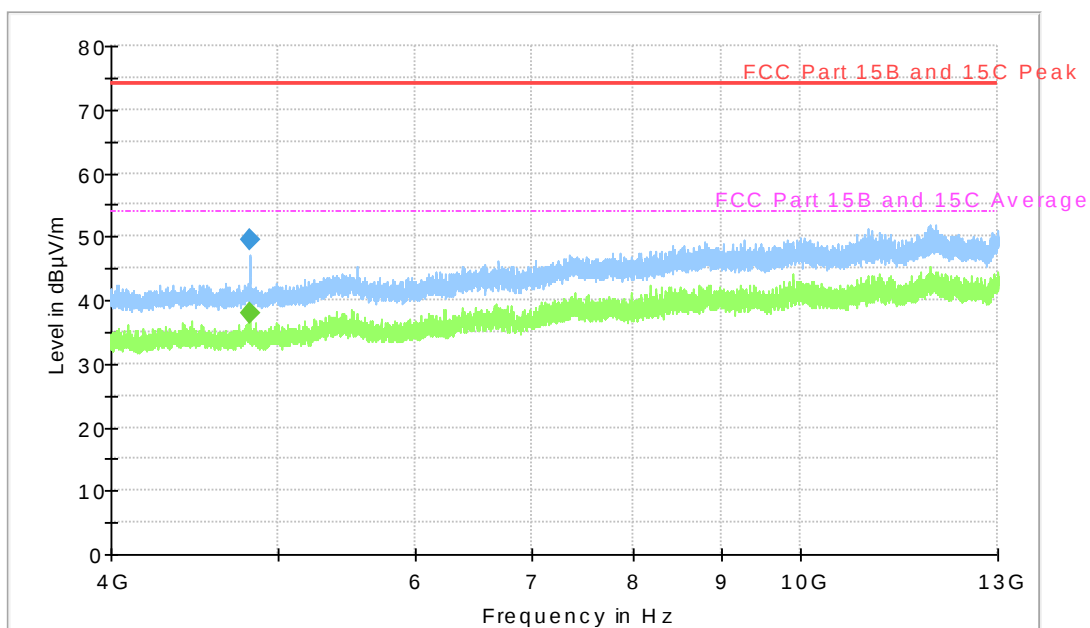
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



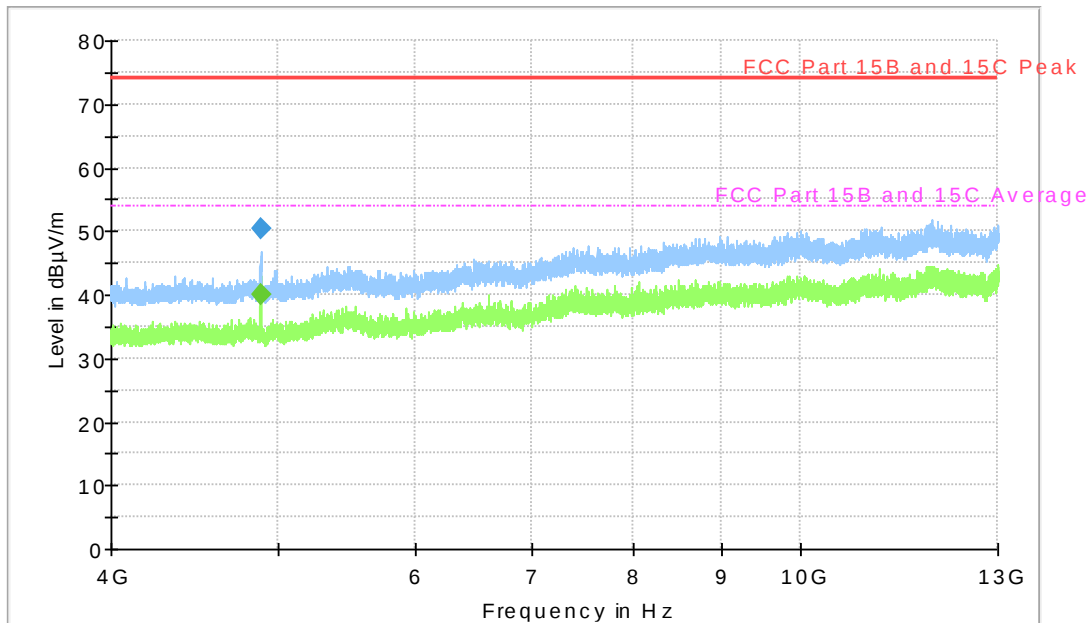
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



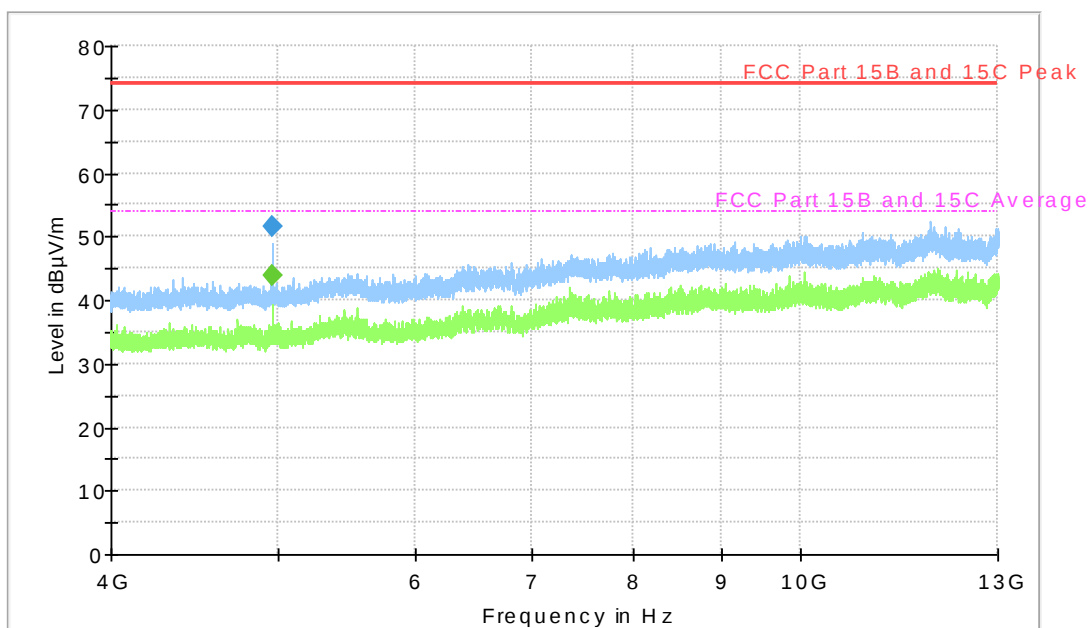
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

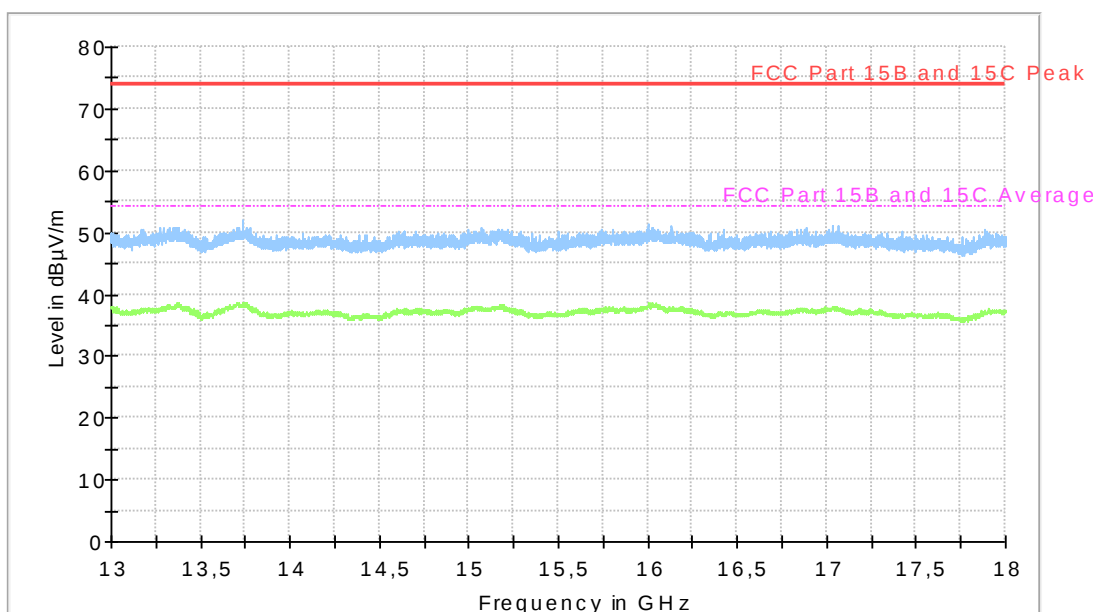


Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



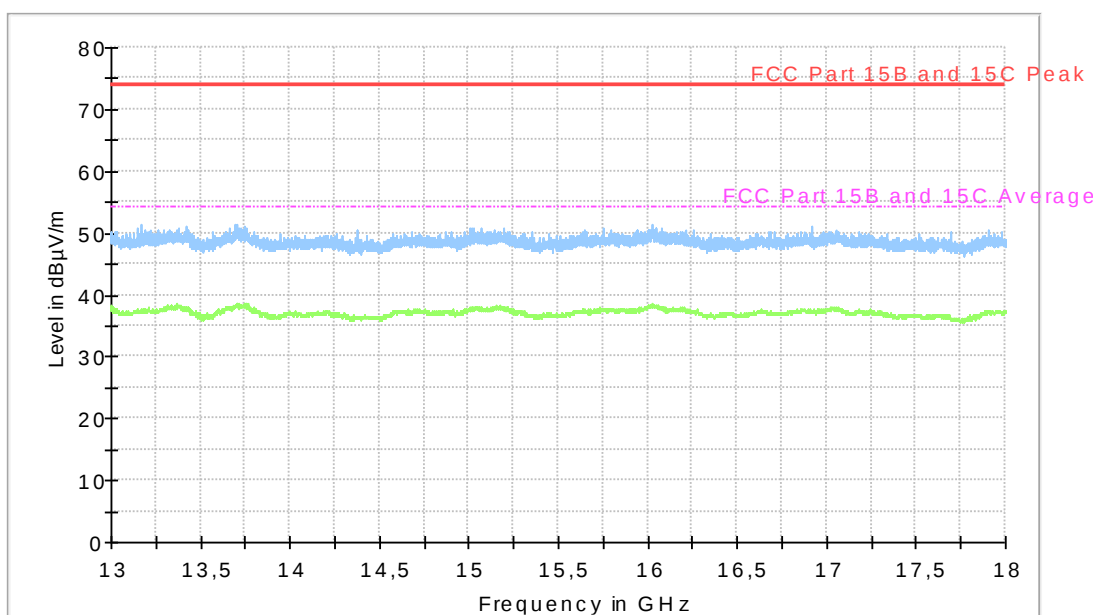
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



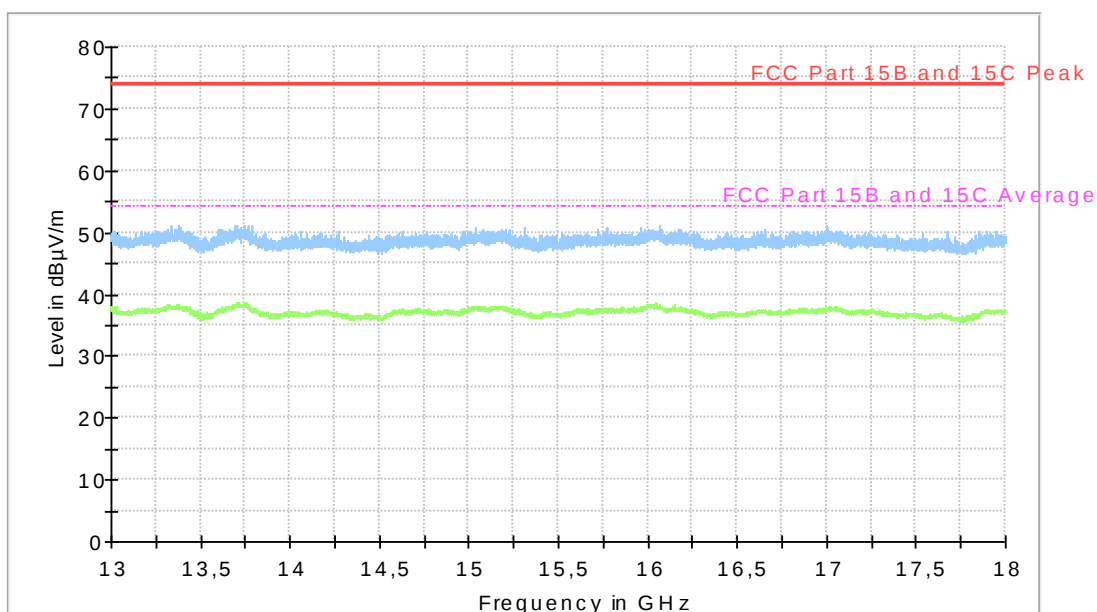
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX low channel.

Full Spectrum



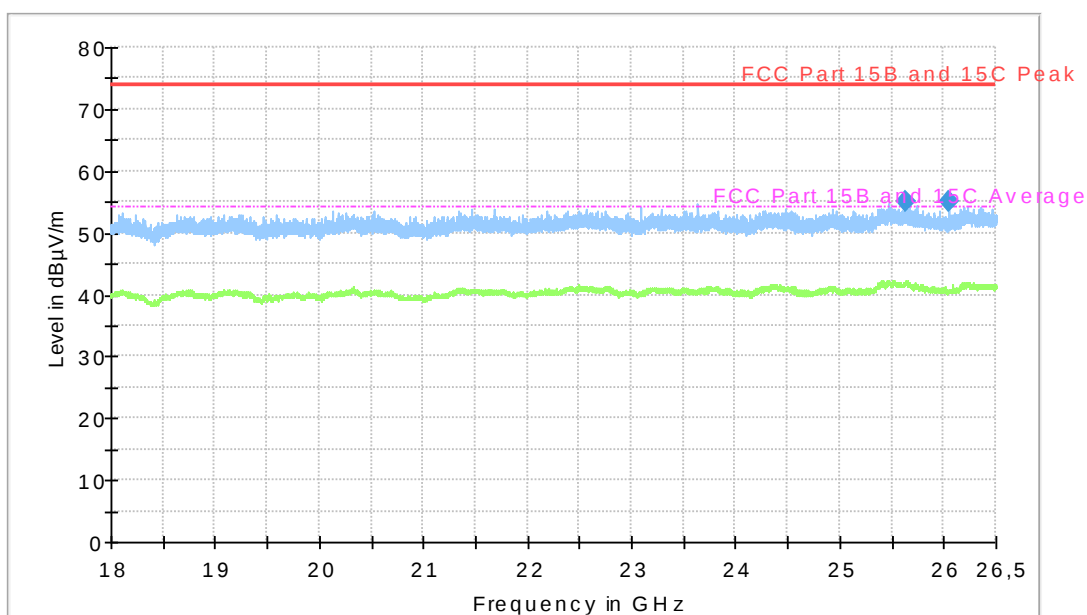
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX mid channel.

Full Spectrum



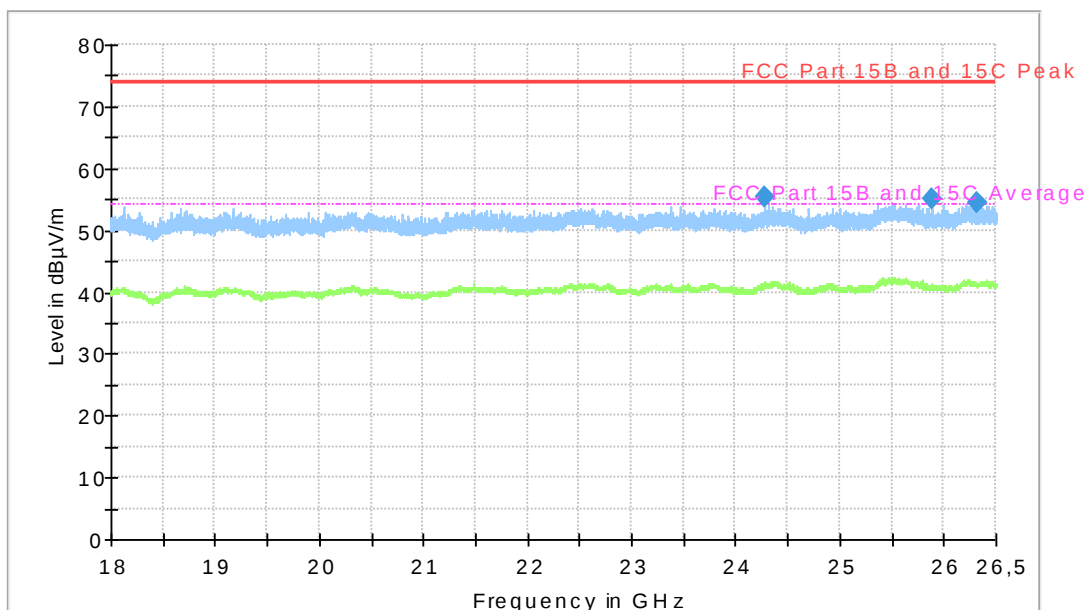
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX high channel.

Full Spectrum



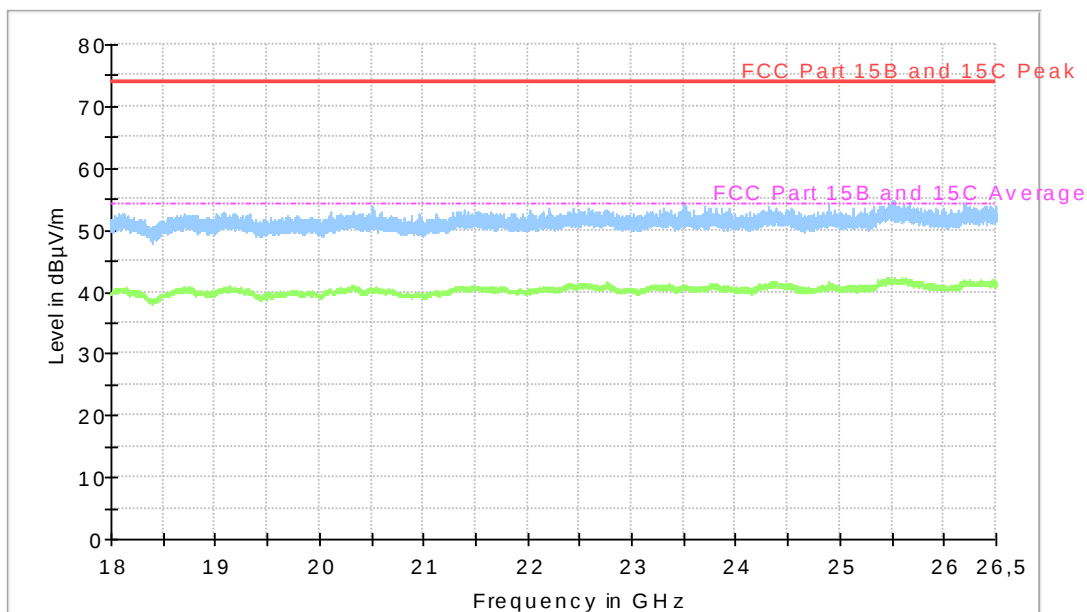
Diagram, Peak overview sweep, 18 – 26 GHz at 3 m distance. TX low channel.

Full Spectrum



Diagram, Peak overview sweep, 18 – 26 GHz at 3 m distance. TX mid channel.

Full Spectrum



Diagram, Peak overview sweep, 18 – 26 GHz at 3 m distance. TX high channel.

Measurement results, Peak, TX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4811.0	49.4	74.0	25.0	V	24.6
25625.9	55.0	74.0	19.0	V	19.0
26048.6	55.1	74.0	-1.0	V	18.9

Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4808.8	37.9	54.0	30.0	V	16.1

Measurement results, Peak, TX middle channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4878.9	50.4	74.0	-13.0	V	23.6
24272.1	55.3	74.0	-5.0	H	18.7
25886.6	55.1	74.0	5.0	V	18.9
26316.3	54.3	74.0	6.0	H	19.7

Measurement results, Average, TX middle channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4880.8	39.9	54.0	-30.0	V	14.1

Measurement results, Peak, TX high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
2484.0	72.4	74.0	0.0	V	1.6
4959.0	51.5	74.0	-17.0	V	22.5

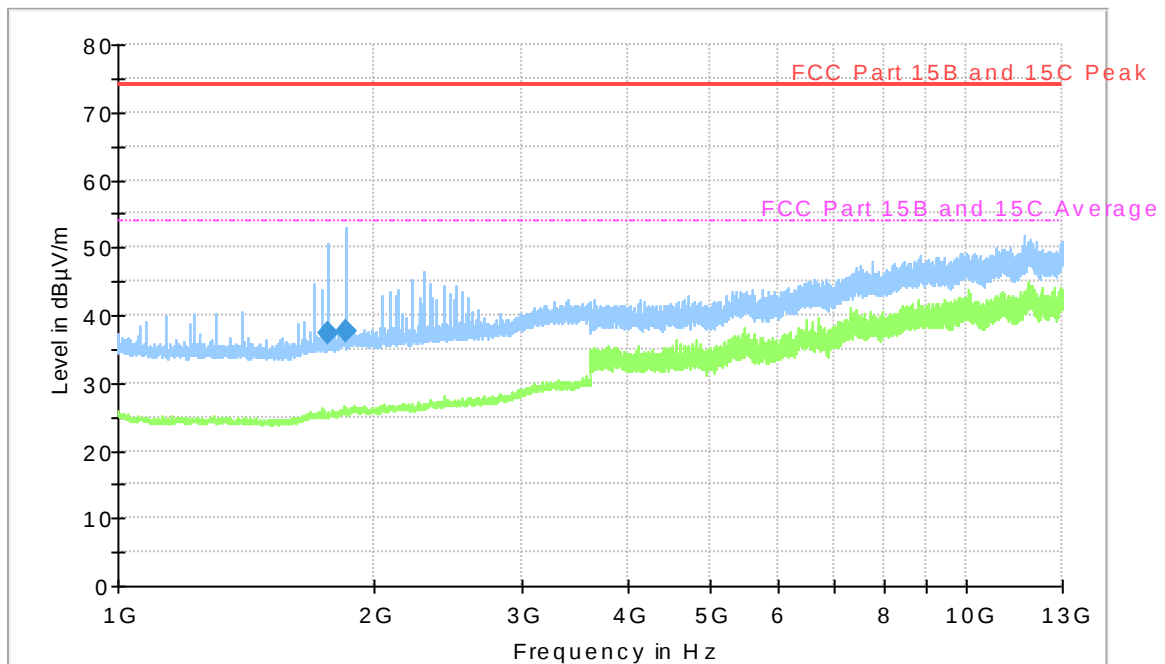
Measurement results, Average, TX high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
2484.0	27.6*	54.0	0.0	V	26.4
4960.6	43.7	54.0	-30.0	V	10.3

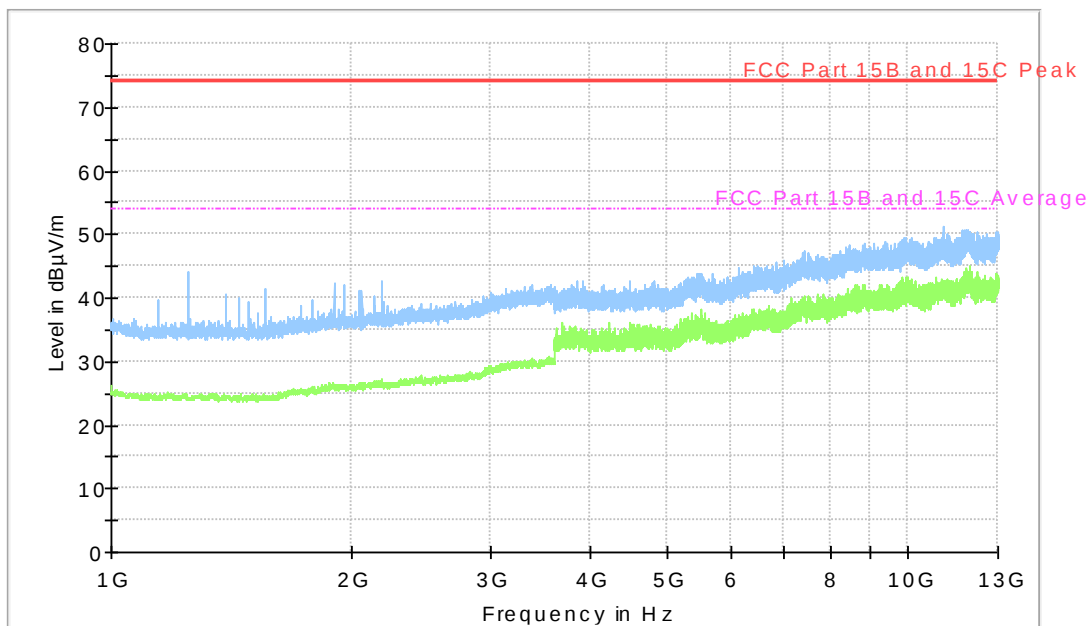
*Level have been compensated for by using duty cycle correction factor from section 12.4.

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

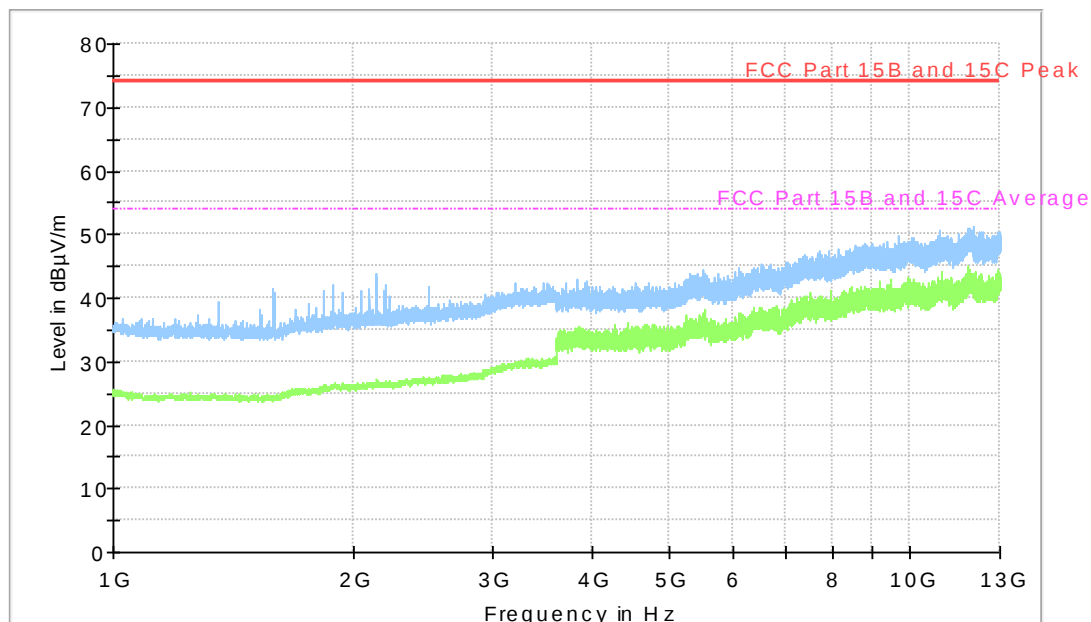
5.7 Test results 1 GHz – 13 GHz, RX



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



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



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

Measurement results, Peak, RX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
1769.9	37.3	74.0	0.0	H	36.7
1860.4	37.6	74.0	-7.0	H	36.4

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

6 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHz TO 26 GHz, EXTERNAL ANTENNA

Date of test:	2018-06-07	Test location:	Radiohallen, Björkhallen
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	38 %
Test result:	Pass	Margin:	2.7 dB

6.1 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.

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.

Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 30 – 1000 MHz. Above 1 GHz additionally the average detector was activated.

Mobile device: Pre scan was made in two orthogonal EUT orientations.

6.2 Test conditions

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

30 MHz to 1000 MHz

Peak,

RBW 120 kHz

VBW 1 MHz

Quasi-Peak,

RBW 120 kHz

VBW 1 MHz

0.8 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Bilog

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

Antenna tilt:

1 GHz – 26.5 GHz

Peak,

RBW 1 MHz

VBW 3 MHz

Average,

RBW 1 MHz

VBW 3 MHz

Peak,

RBW 1 MHz

VBW 3 MHz

Average

RBW 1 MHz

VBW 3 MHz

1.5 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Horn

Activated

6.3 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 (dBμV/m)
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))

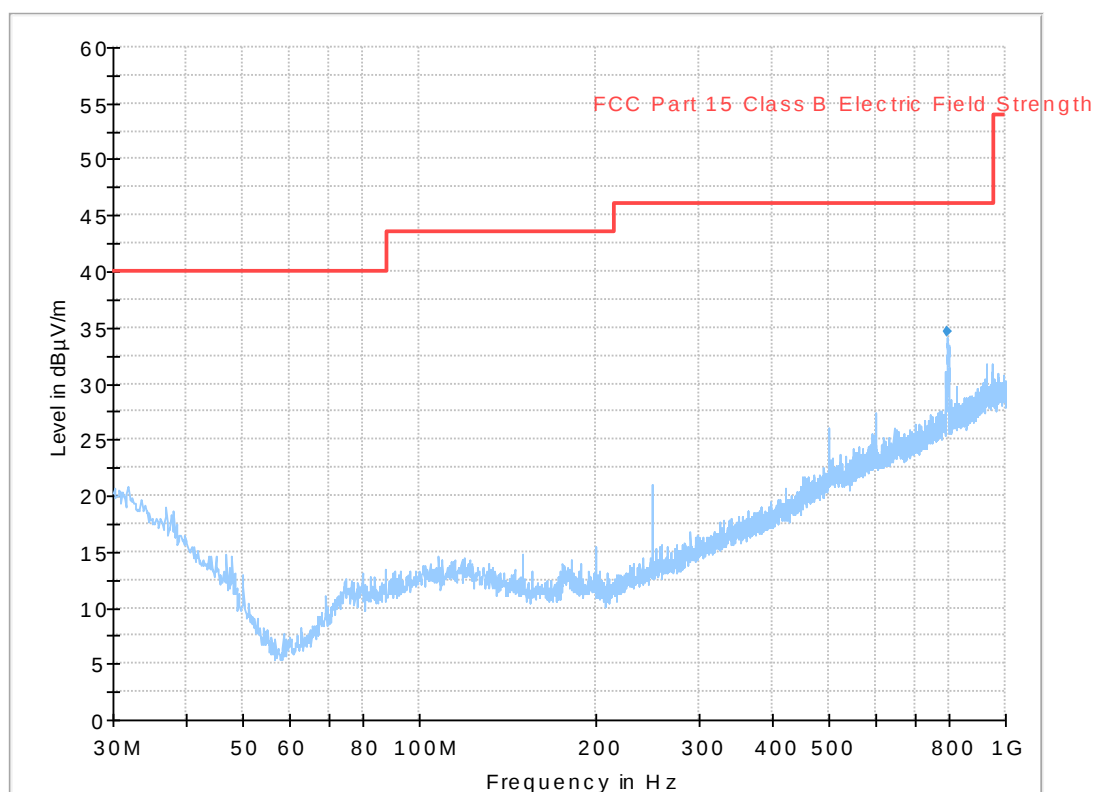
Outside the restricted bands:

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.

6.4 Test results 30 MHz – 1000 MHz, TX, external antenna

Full Spectrum



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, external antenna.

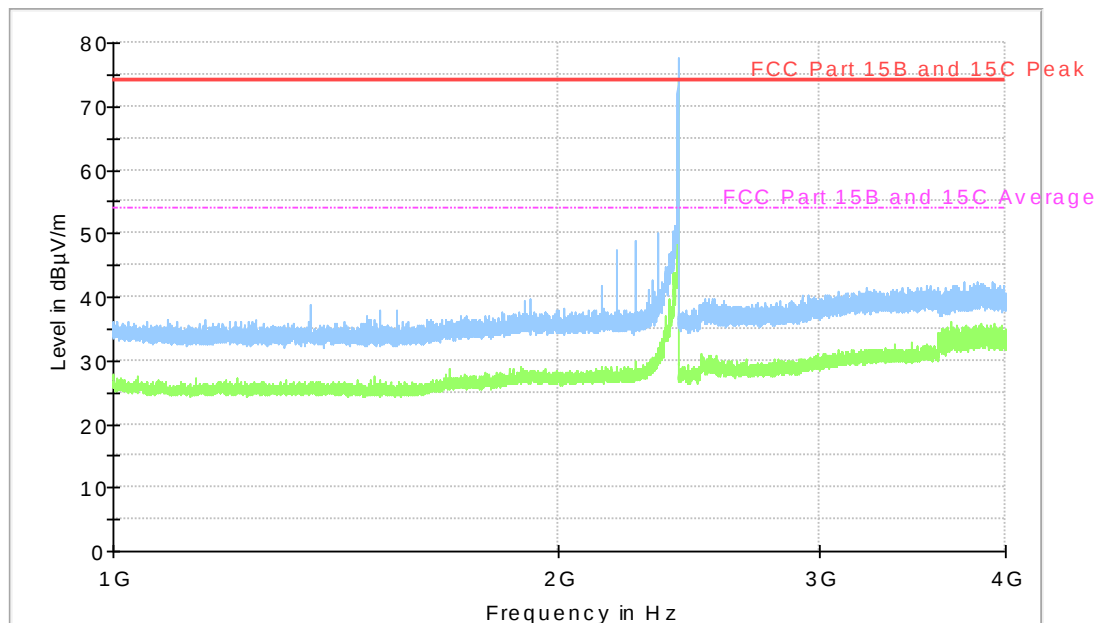
Measurement results, Quasi Peak

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
797.296	34.6	46.0	H	11.4

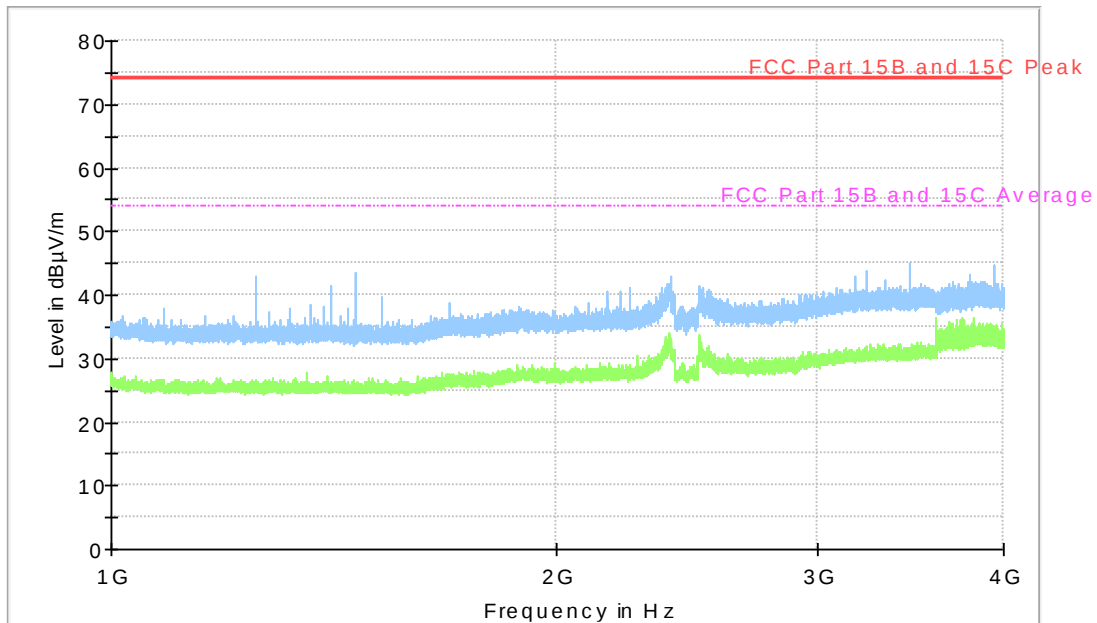
All other measured disturbances have a margin of more than 20 dB to the limits.

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

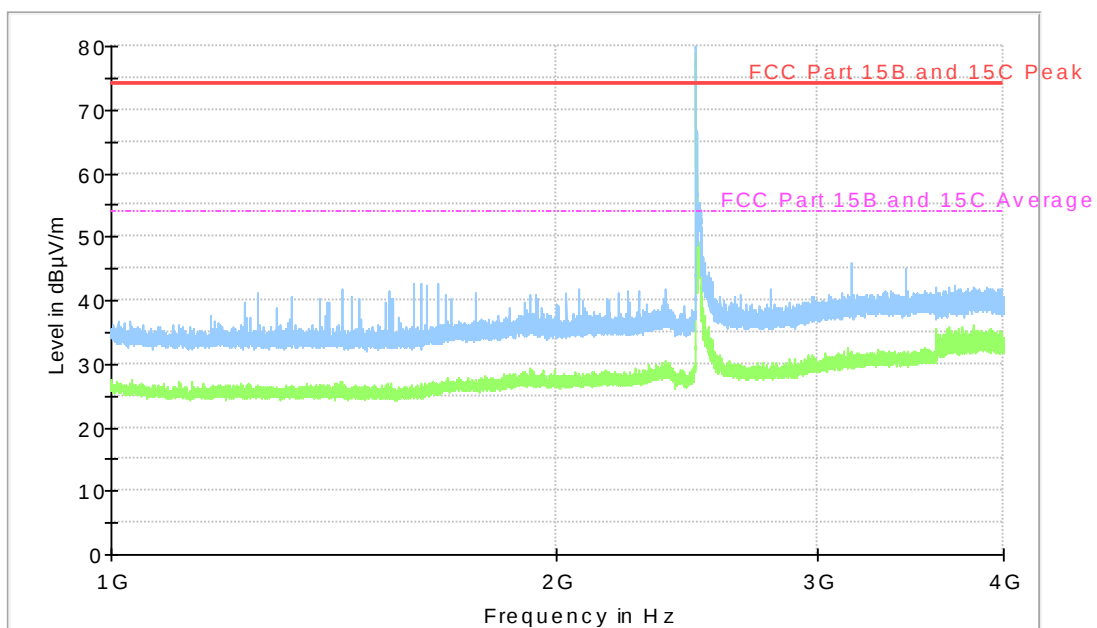
6.5 Test results 1 GHz – 26 GHz, TX, external antenna



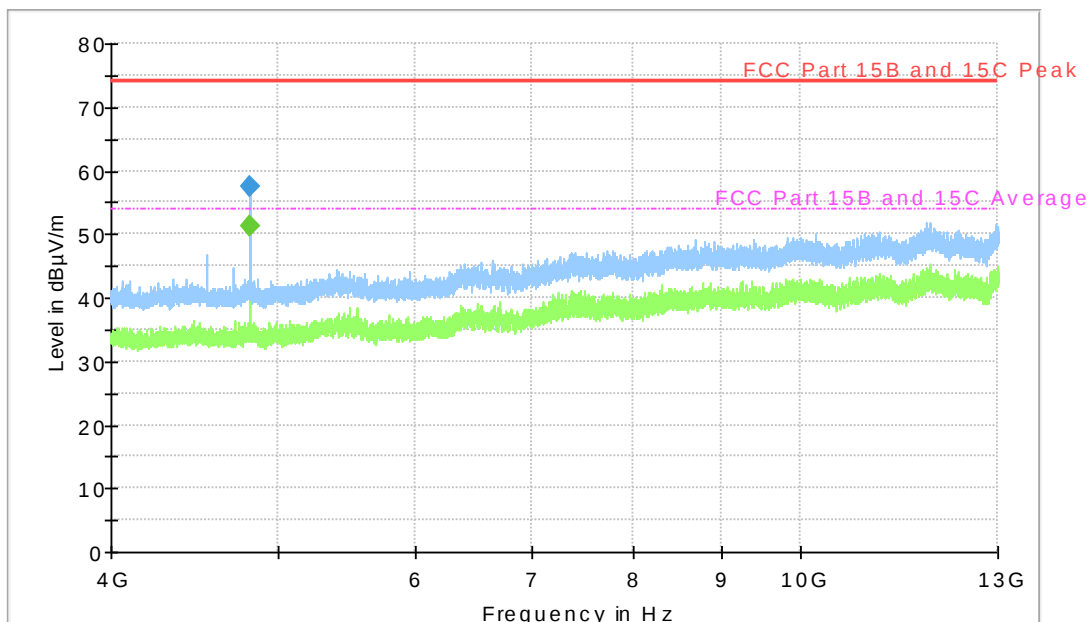
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



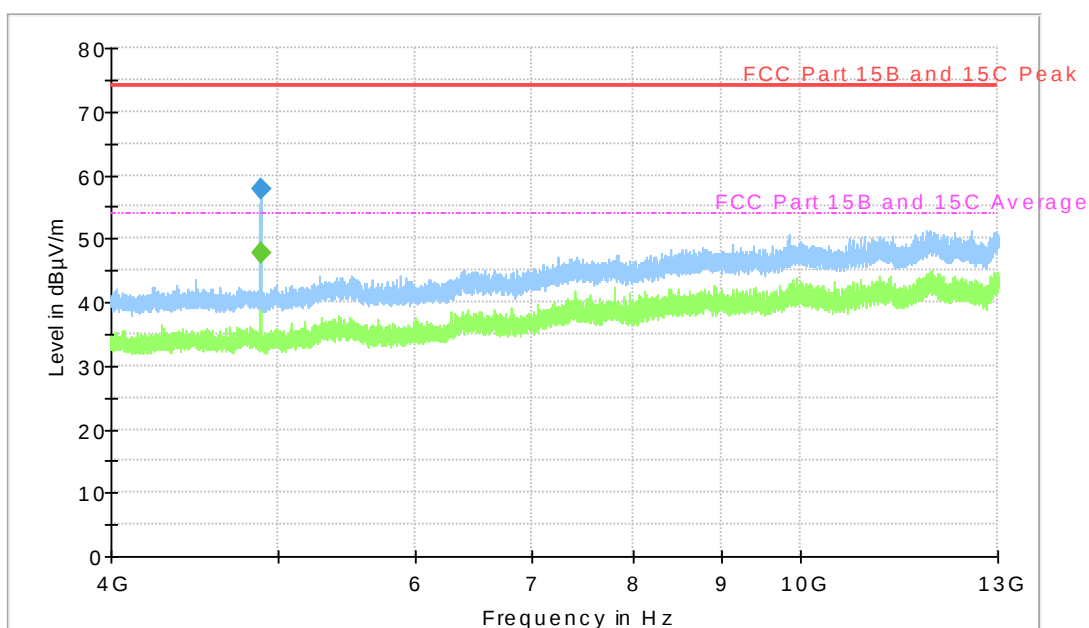
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



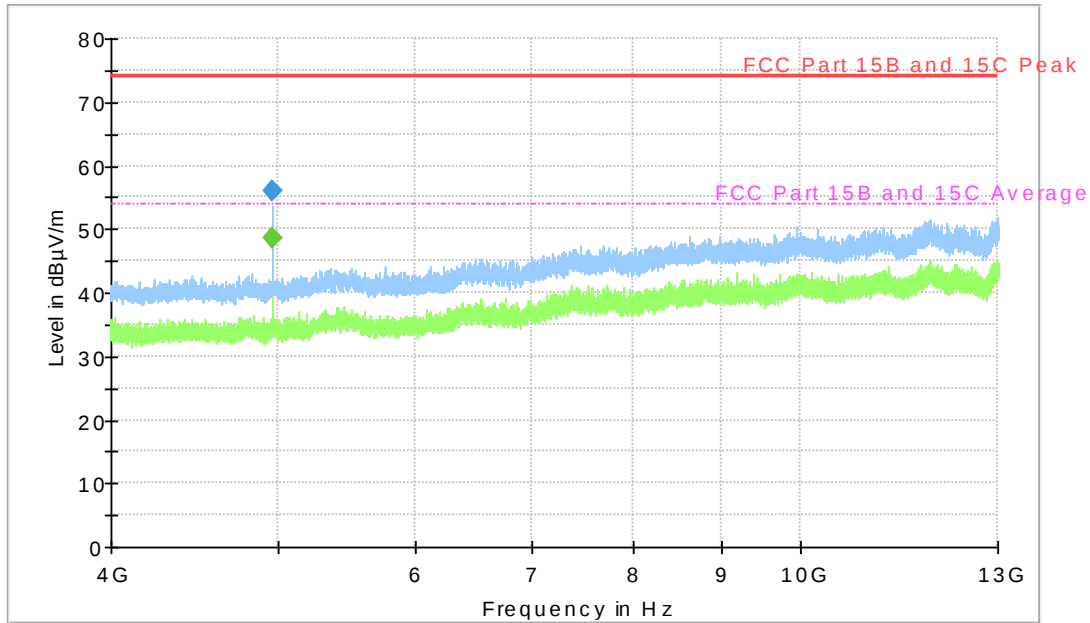
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Measurement results, Peak, TX low channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4808.8	57.5	74.0	35.0	V	16.5

Measurement results, Average, TX low channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4810.6	51.3	54.0	30.0	V	2.7

Measurement results, Peak, TX middle channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4880.9	57.7	74.0	0.0	V	16.3

Measurement results, Average, TX middle channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4878.7	47.8	54.0	30.0	V	6.2

Measurement results, Peak, TX high channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4961.0	56.1	74.0	32.0	V	17.9

Measurement results, Average, TX high channel, external antenna

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Elevation [degree]	Polarization H/V	Margin [dB]
4959.1	48.5	54.0	0.0	V	5.6

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

7 CONDUCTED BAND EDGE MEASUREMENT

Date of test:	2018-06-04	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala, Oskar Eliasson	Relative humidity:	30 %
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 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.

7.2 Test conditions

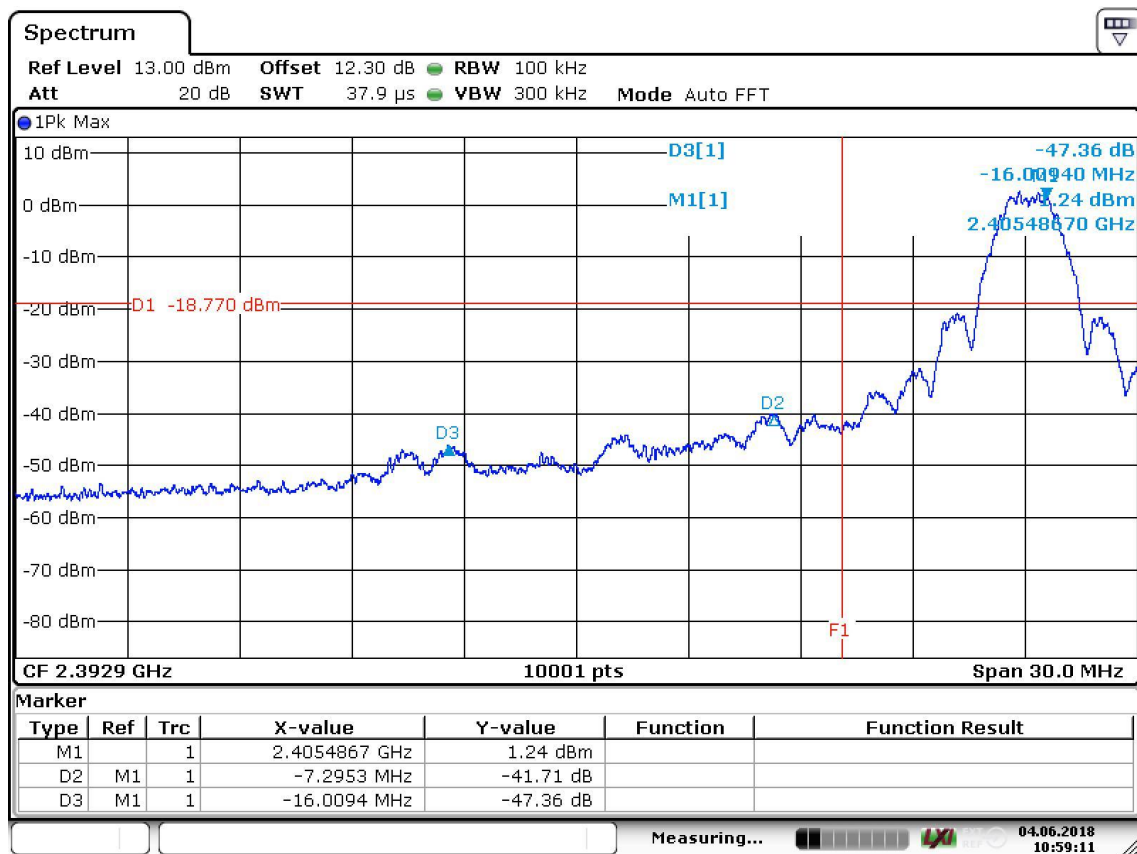
Detector: Peak,
RBW: 100 kHz
VBW: 300 kHz
Span: 30 MHz

7.3 Requirement

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

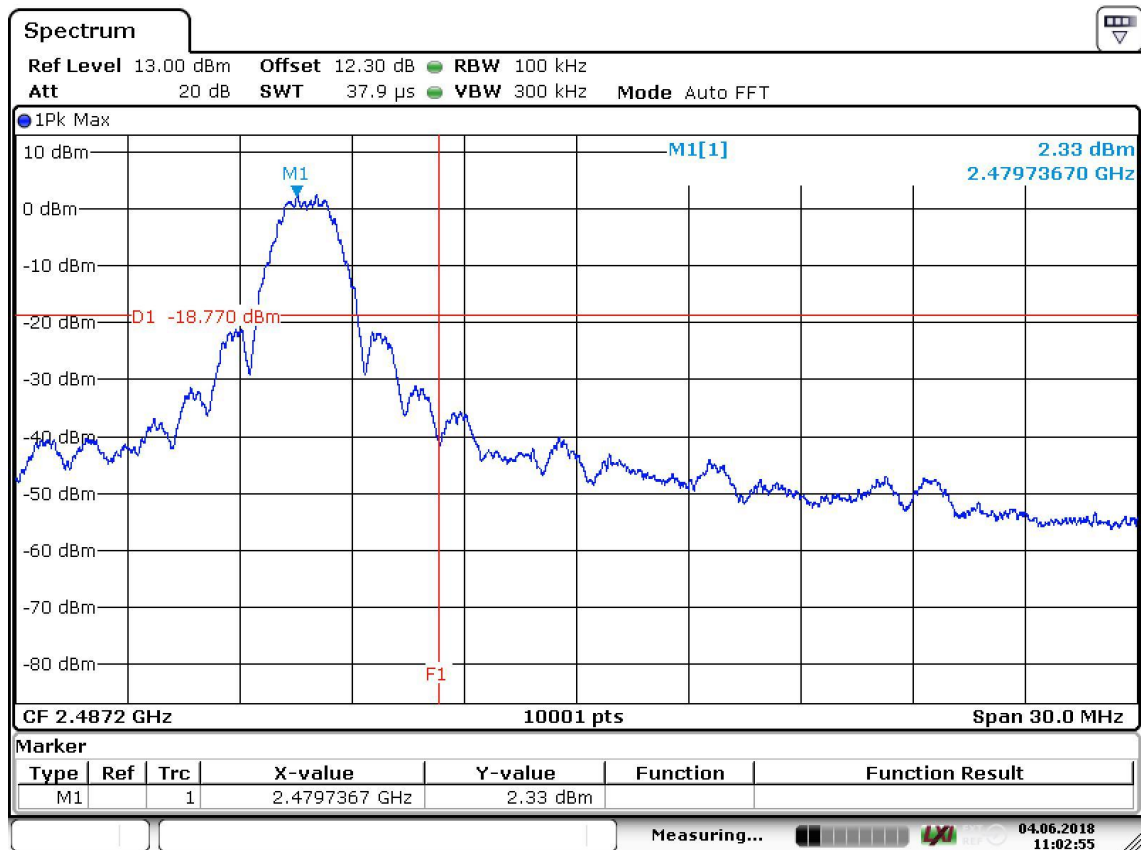
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

7.4 Test results



Date: 4.JUN.2018 10:59:11

Screenshot: Lower band edge sweep, single channel



Date: 4.JUN.2018 11:02:55

Screenshot: Upper band edge sweep, single channel

Test results

Band edge	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	41.7	20.0	21.7
Upper	> 30	20.0	> 10

8 PEAK CONDUCTED OUTPUT POWER

Date of test:	2018-06-04	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala, Oskar Eliasson	Relative humidity:	30 %
Test result:	Pass	Margin:	> 10 dB

8.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 11.9.1.1.

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

8.2 Test conditions

Detector: Peak
 RBW: >OBW
 VBW: 3 x RBW
 Span: >3 x OBW

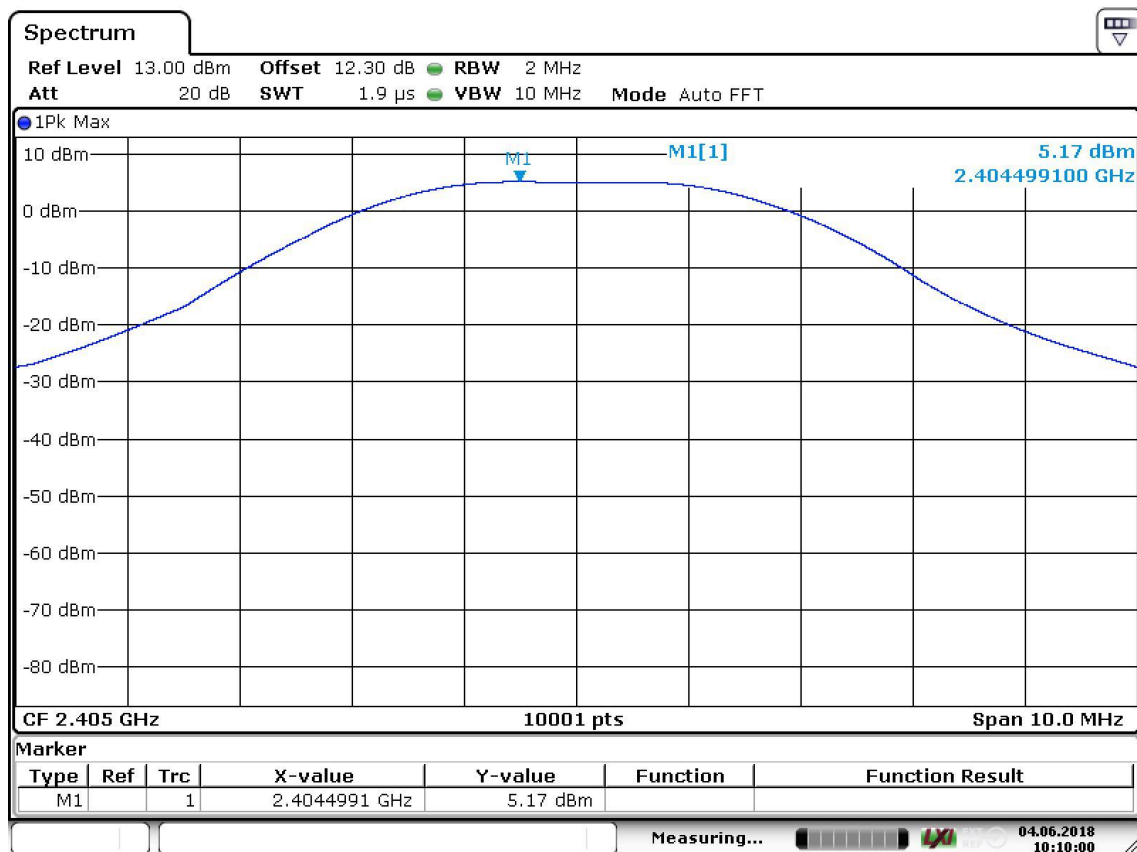
The EUT was set up in order to emit maximum disturbances.

8.3 Requirements

Reference: CFR 47§15.247(b)(3), RSS-247 5.4

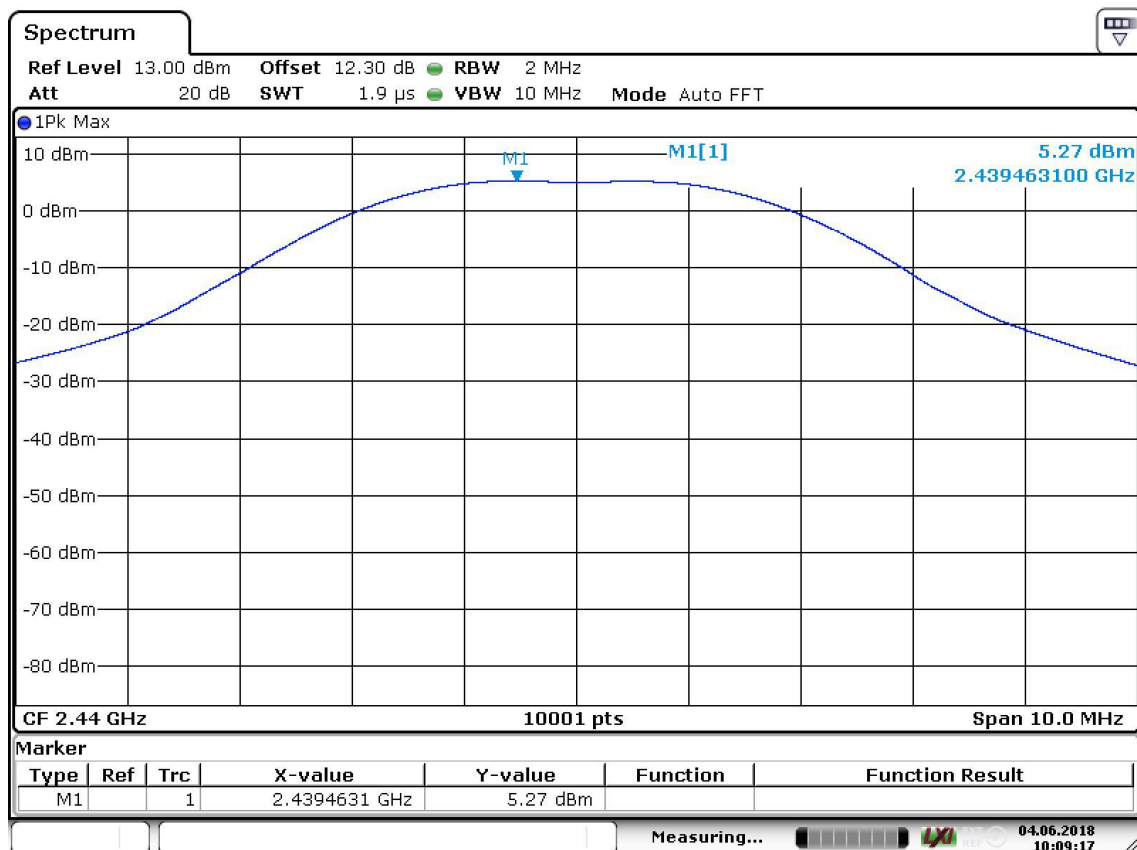
For DTSs employing digital modulation techniques operating in the bands 902 – 128 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz, the maximum peak conducted output power shall not exceed 1W.

8.4 Test results



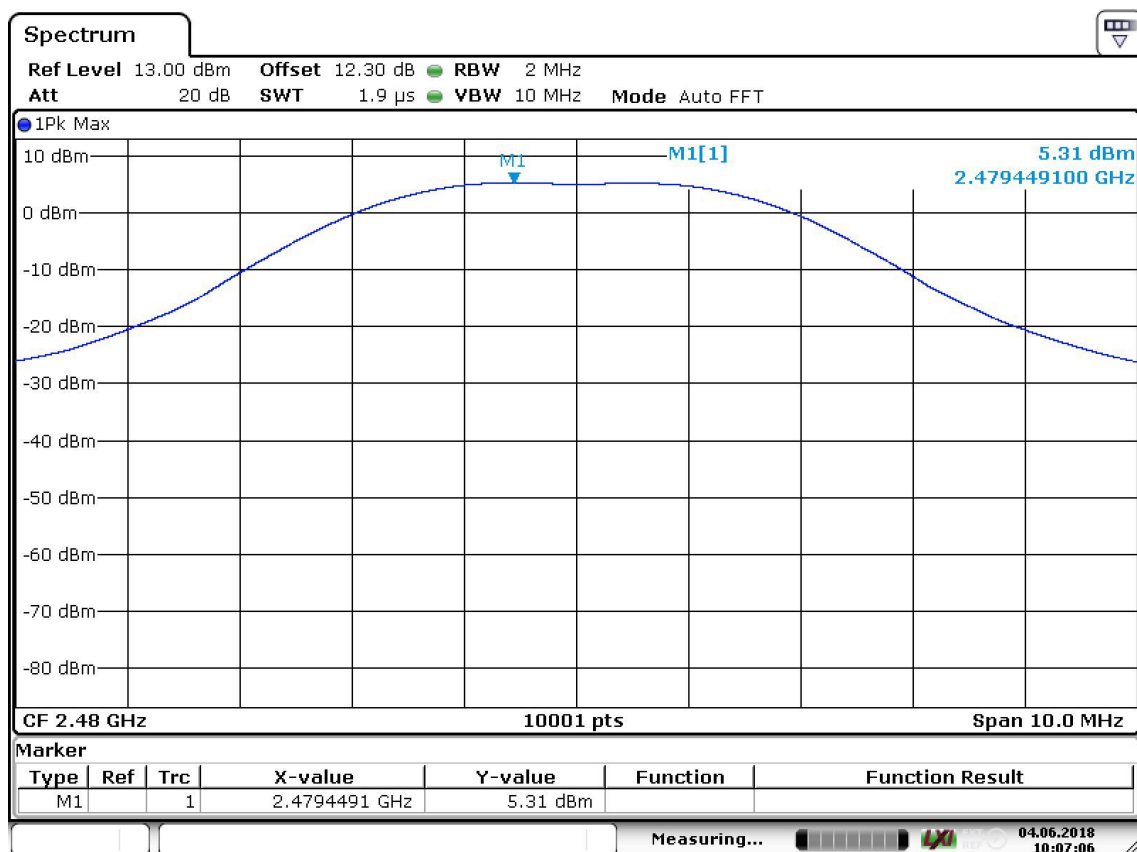
Date: 4.JUN.2018 10:10:00

Screenshot: Output power, low channel



Date: 4.JUN.2018 10:09:17

Screenshot: Output power, middle channel



Date: 4.JUN.2018 10:07:06

Screenshot: Output power, high channel

Test result

Channel [MHz]	Output power [dBm]
2405	5.2
2440	5.3
2480	5.3

9 OCCUPIED 6 DB BANDWIDTH

Date of test:	2018-06-04	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala, Oskar Eliasson	Relative humidity:	30 %
Test result:	Pass	Margin:	1.1 MHz

9.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 11.8.1.

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

9.2 Test conditions

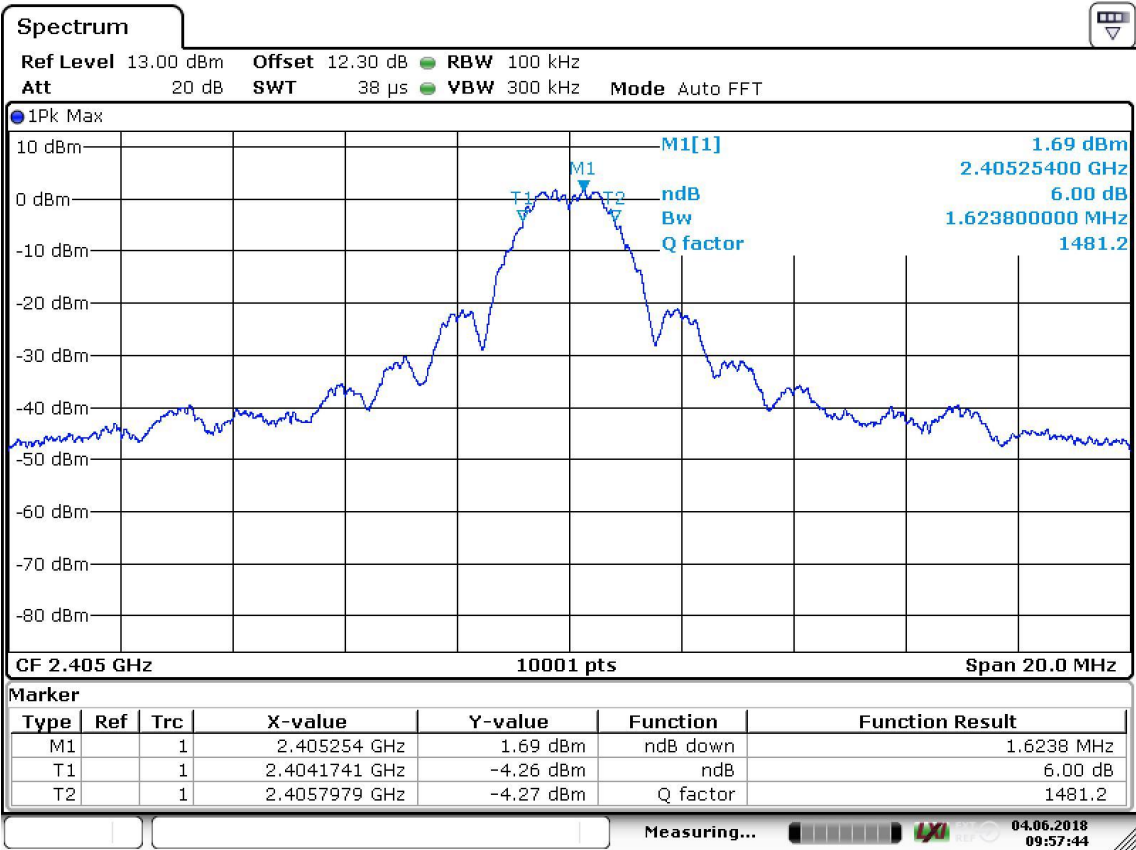
Detector: Peak,
RBW: 100 kHz
VBW: 3 x RBW
Span: >1,5 x OBW

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

9.3 Requirements

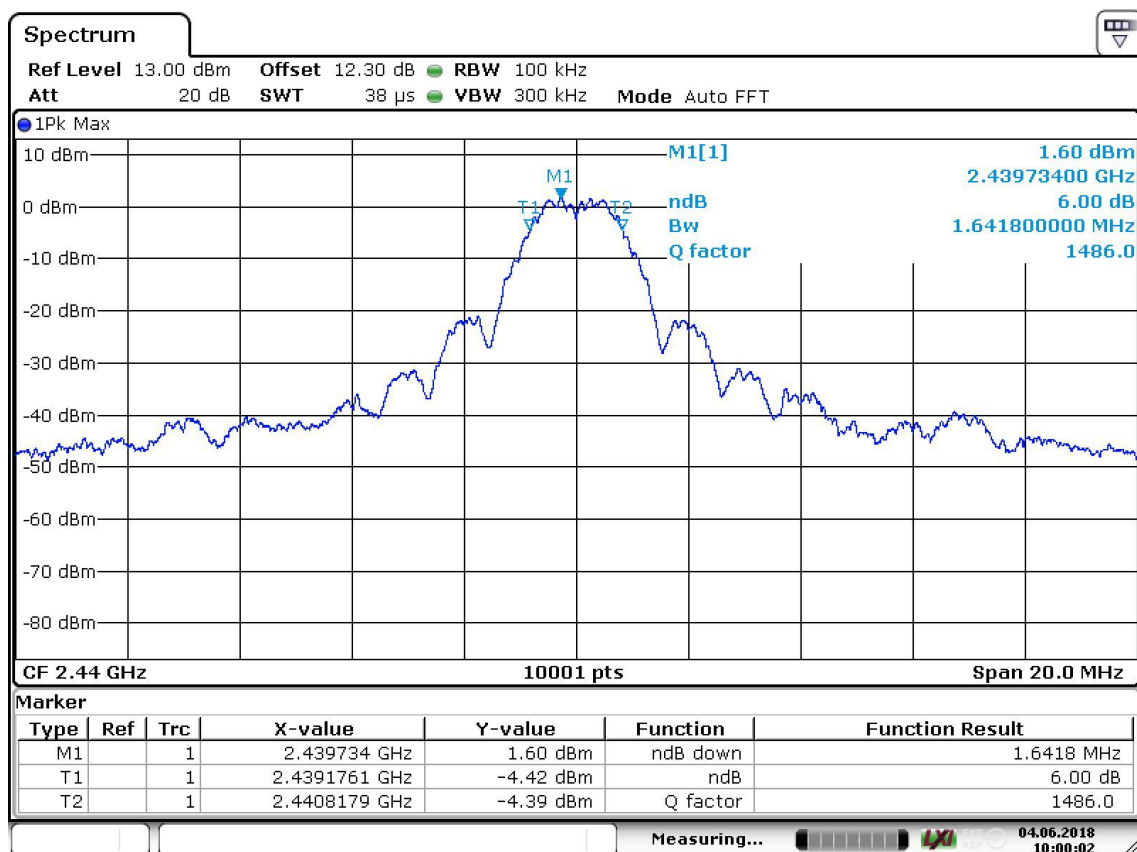
Reference: CFR 47§15.247(a)(2), RSS-247 5.2(1)
The minimum 6 dB bandwidth shall be 500 kHz.

9.4 Test results



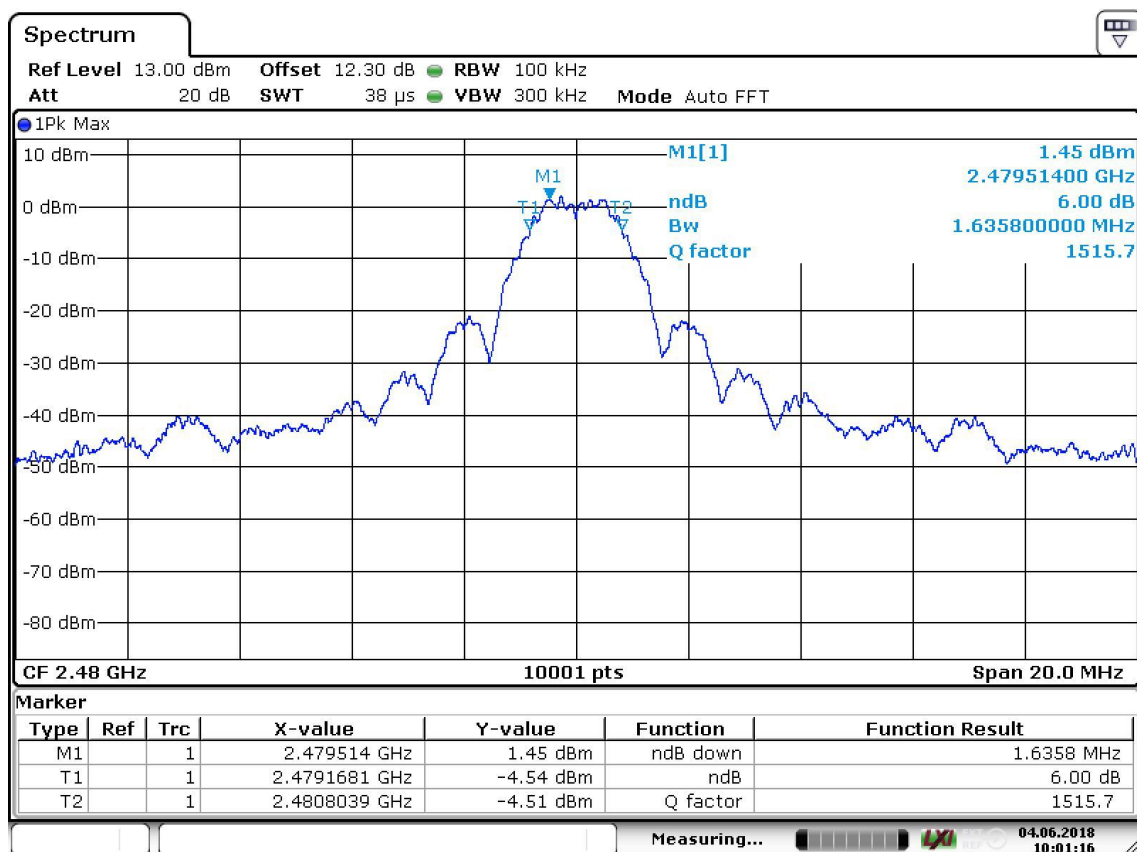
Date: 4.JUN.2018 09:57:45

Screenshot: Occupied 6 dB bandwidth Measurement, low channel



Date: 4.JUN.2018 10:00:02

Screenshot: Occupied 6 dB bandwidth Measurement, middle channel



Date: 4.JUN.2018 10:01:16

Screenshot: Occupied 6 dB bandwidth Measurement, high channel

Test result

Channel [MHz]	6 dB BW [MHz]
2405	1.6
2440	1.6
2480	1.6

10 99 % BANDWIDTH

Date of test:	2018-06-04	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala, Oskar Eliasson	Relative humidity:	30 %
Test result:	Pass	Margin:	--

10.1 Test set-up and test procedure.

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

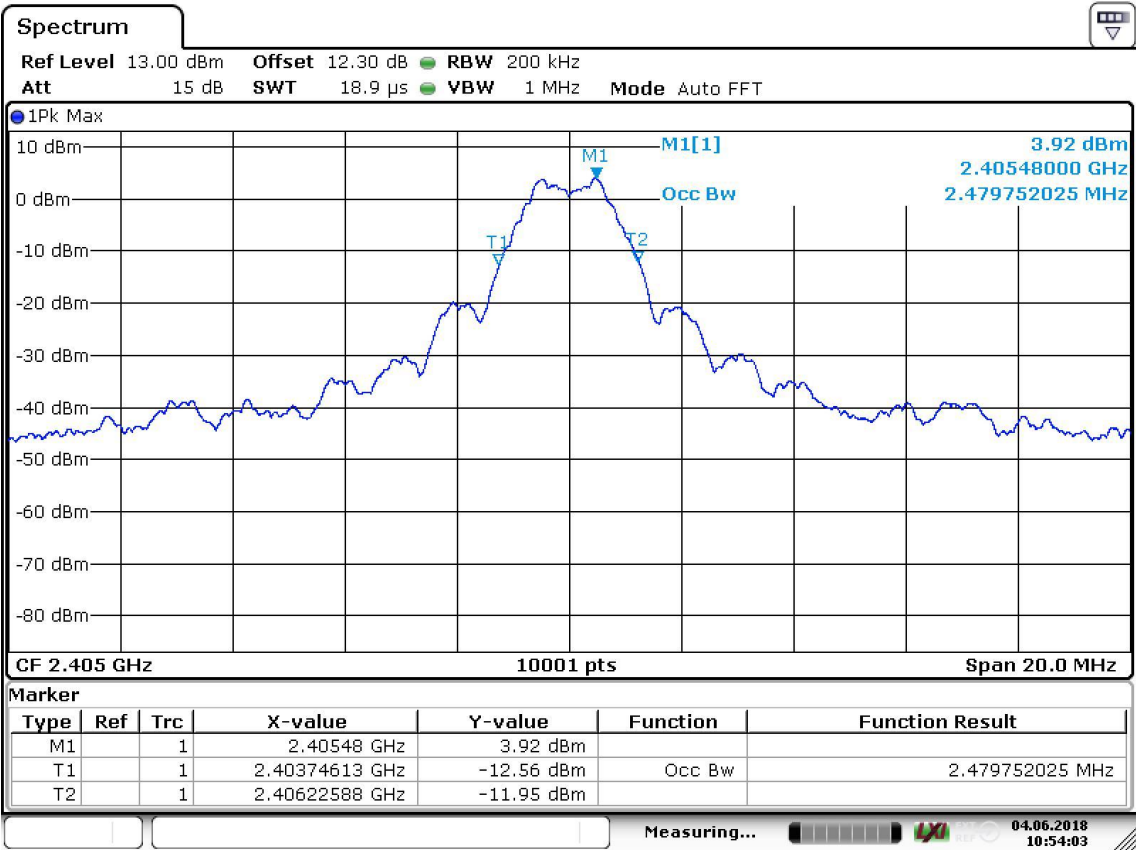
The EUT was connected to spectrum analyser via rf-cable and attenuator. Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

10.2 Test conditions

Detector: Peak,
RBW: 1 – 5 % of OBW
VBW: $\geq 3 \times$ RBW

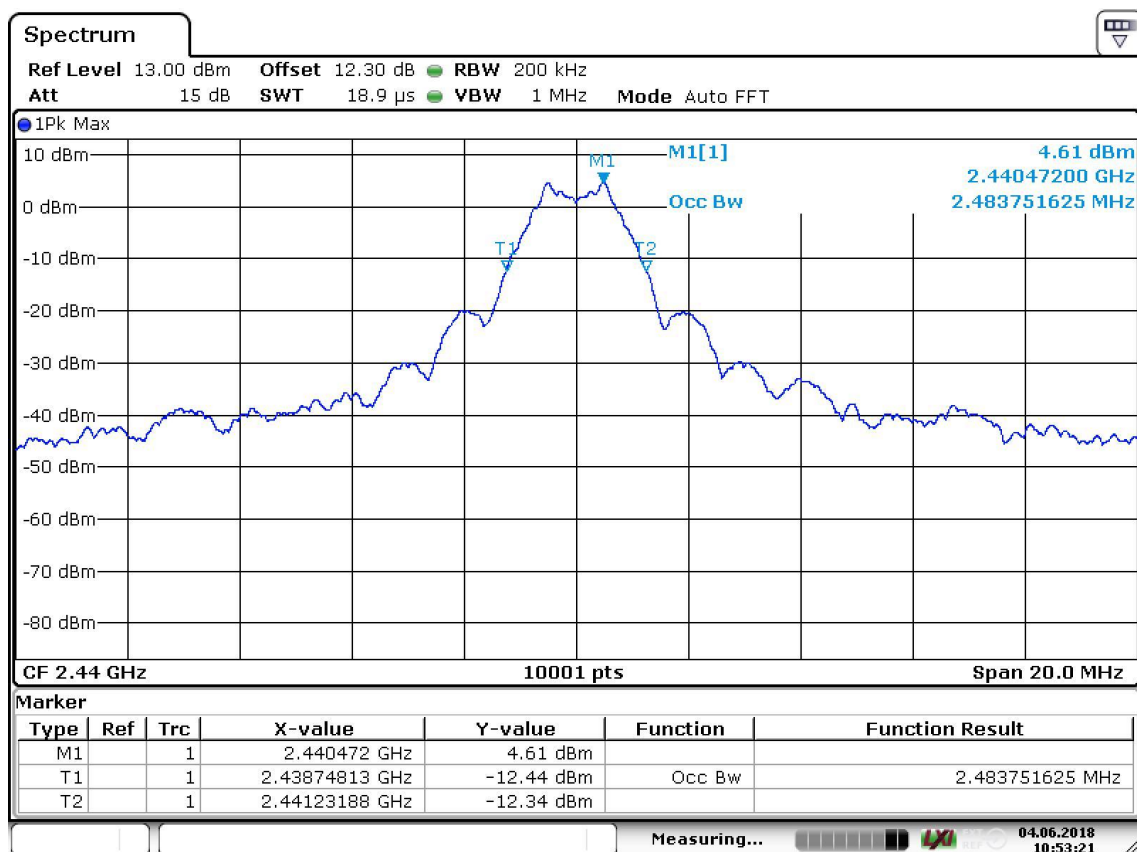
The EUT was set up in order to emit maximum disturbances.

10.3 Test results



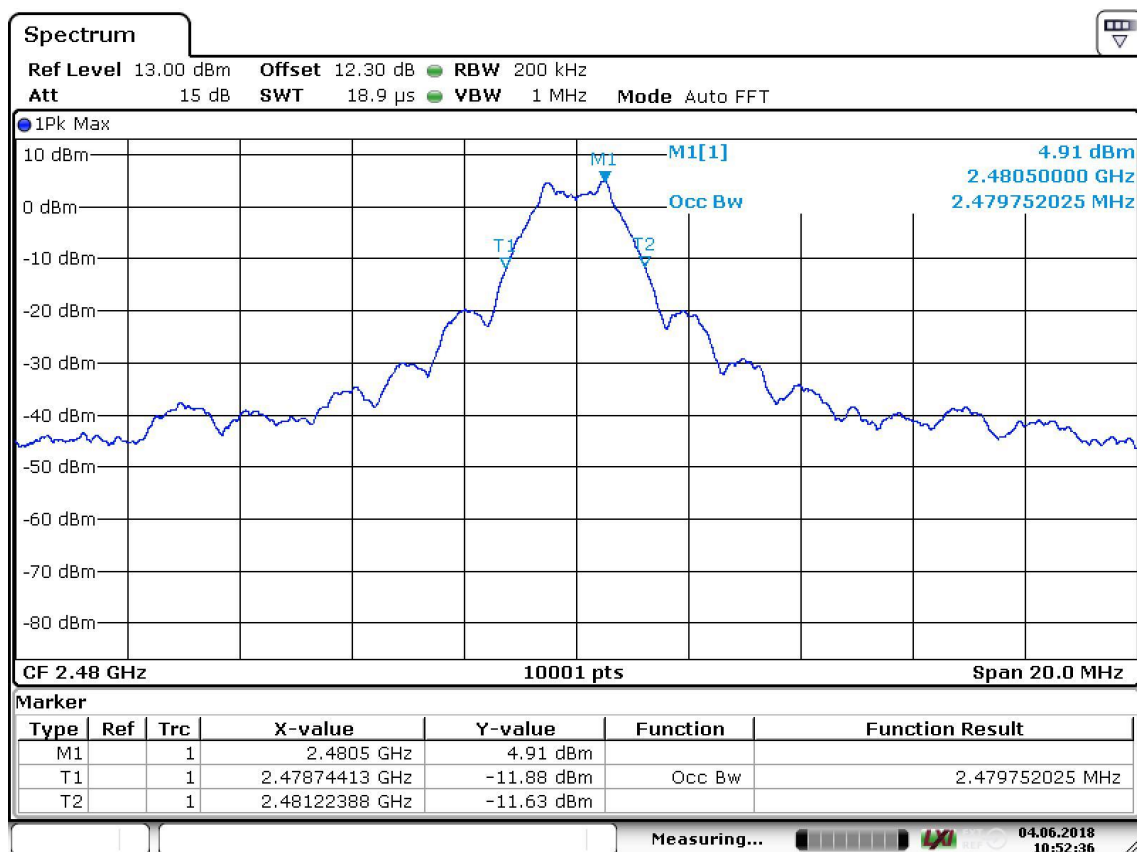
Date: 4.JUN.2018 10:54:03

Screenshot: 99 % bandwidth Measurement, low channel



Date: 4.JUN.2018 10:53:21

Screenshot: 99 % bandwidth Measurement, middle channel



Date: 4.JUN.2018 10:52:36

Screenshot: 99 % bandwidth Measurement, high channel

Test result

Channel [MHz]	99 % BW [MHz]
2405	2.5
2440	2.5
2480	2.5

11 PEAK POWER SPECTRAL DENSITY

Date of test:	2018-06-04	Test location:	Wireless Center
EUT number:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala, Oskar Eliasson	Relative humidity:	30 %
Test result:	Pass	Margin:	> 10 dB

11.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10-2013 section 11.10.2.

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

11.2 Test conditions

Detector: Peak
 RBW: 3 kHz
 VBW: >3 x RBW
 Span: 1.5 x 6 dB bandwidth

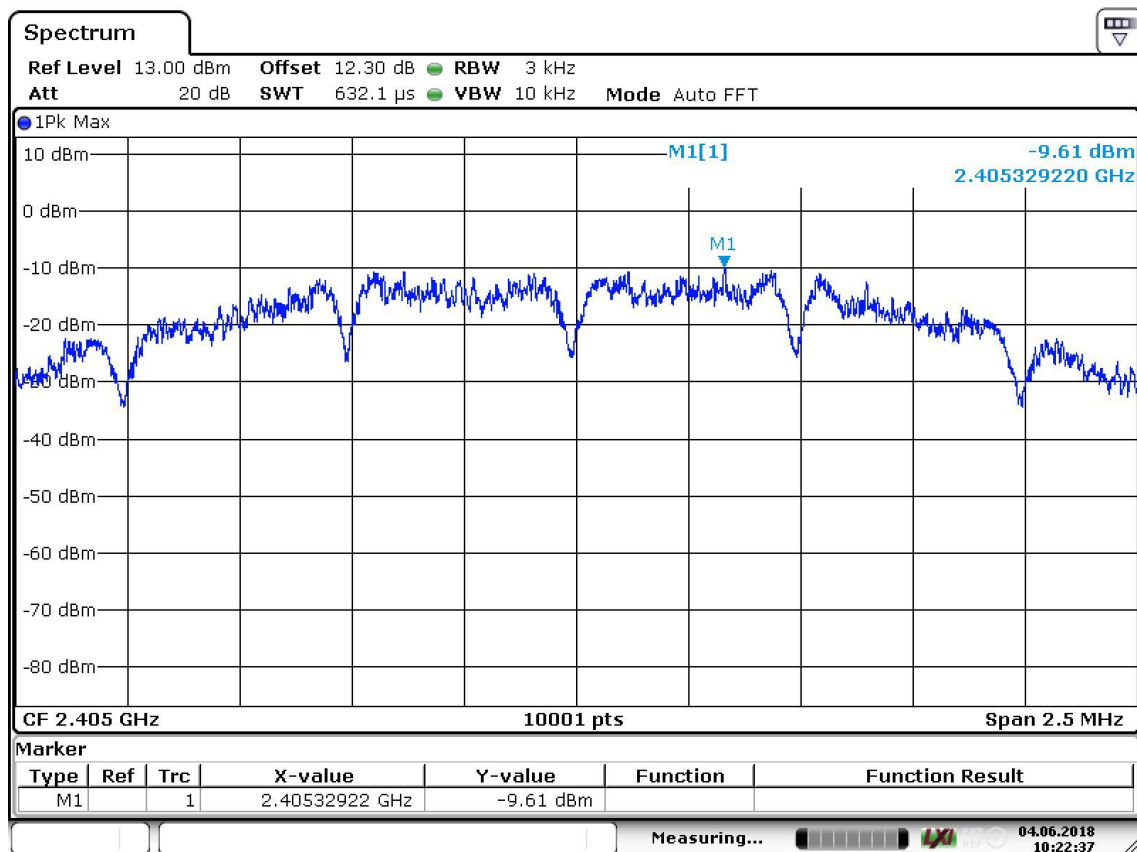
The EUT was set up in order to emit maximum disturbances.

11.3 Requirements

Reference: CFR 47§15.247(3), RSS-247 5.2(2)

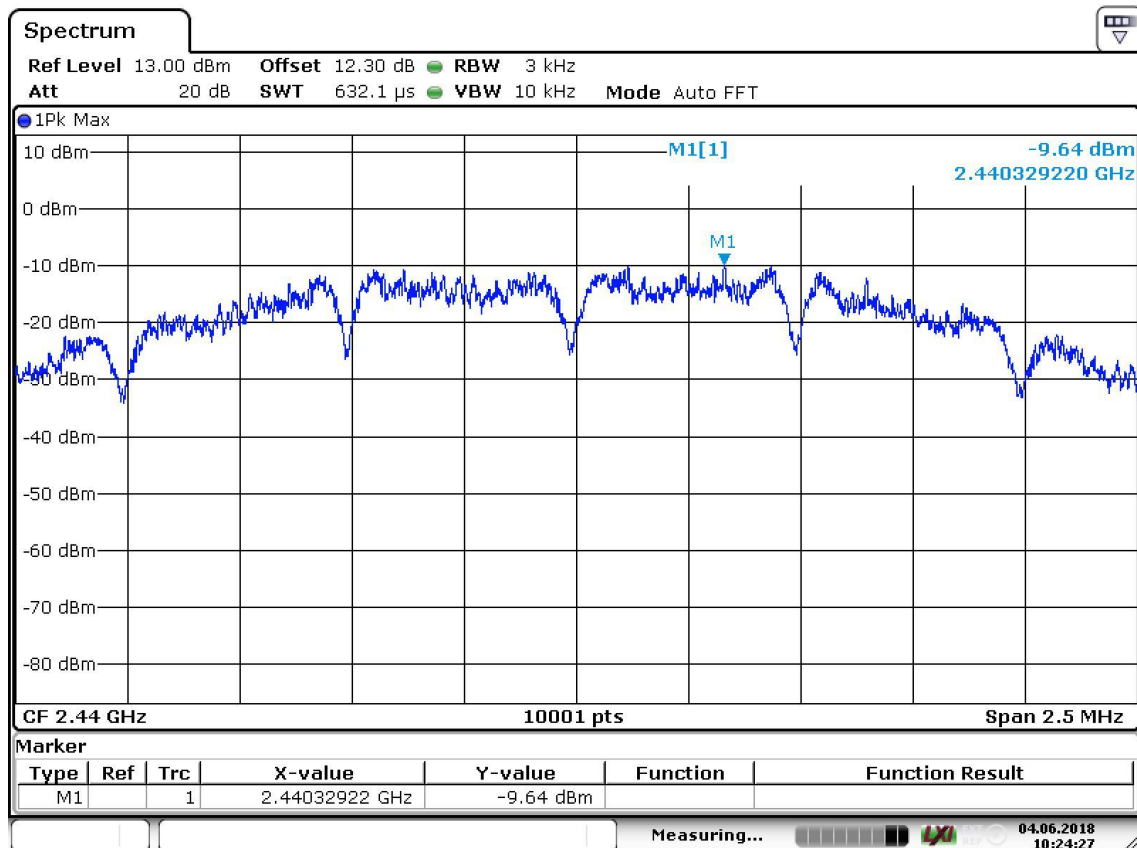
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

11.4 Test results



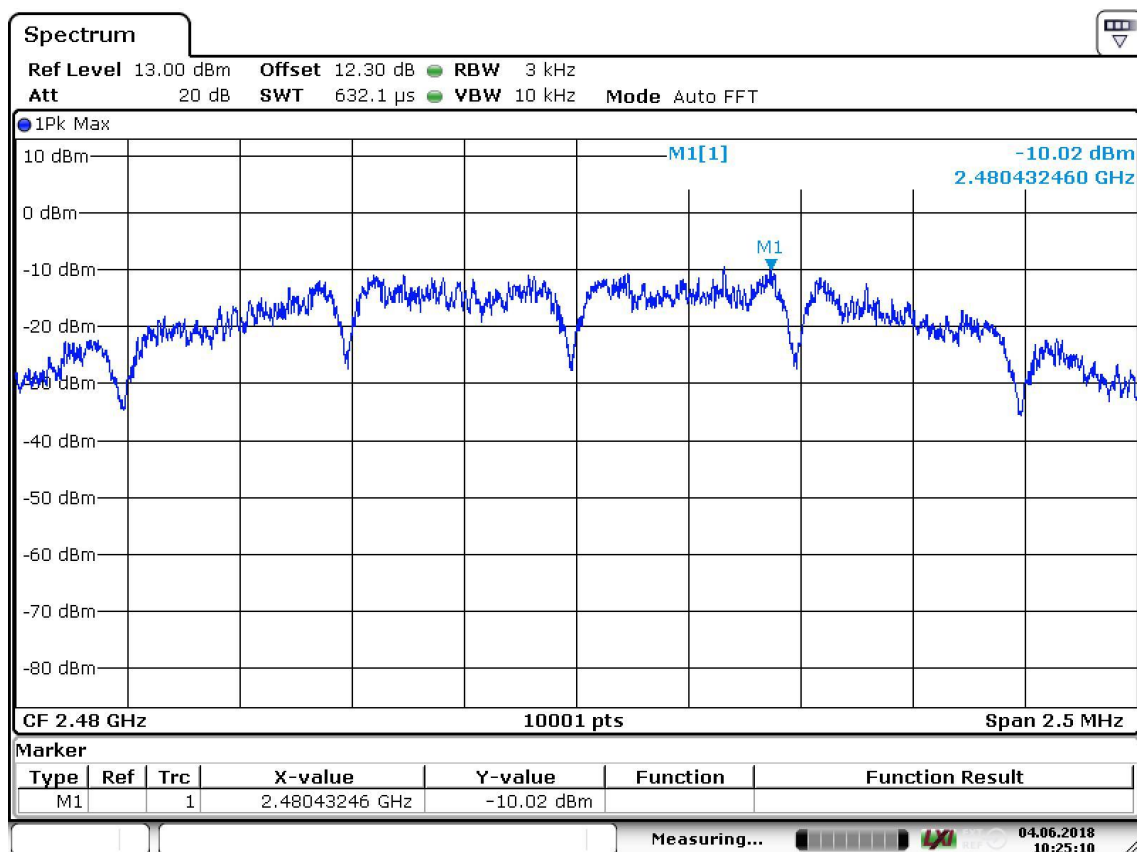
Date: 4.JUN.2018 10:22:37

Screenshot: Peak power spectral density, low channel



Date: 4.JUN.2018 10:24:28

Screenshot: Peak power spectral density, middle channel



Date: 4.JUN.2018 10:25:10

Screenshot: Peak power spectral density, high channel

Test result

Channel [MHz]	PSD [dBm/3kHz]
2405	-9.6
2440	-9.6
2480	-10.0

12 TRANSMITTER DUTY CYCLE FOR PULSED TRANSMISSIONS

Date of test:	2018-06-19	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.CC	Ambient temp:	22 °C
Tested by:	Robert Hietala	Relative humidity:	32 %
Test result:	Pass	Margin:	N/A

12.1 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.

12.2 Test conditions

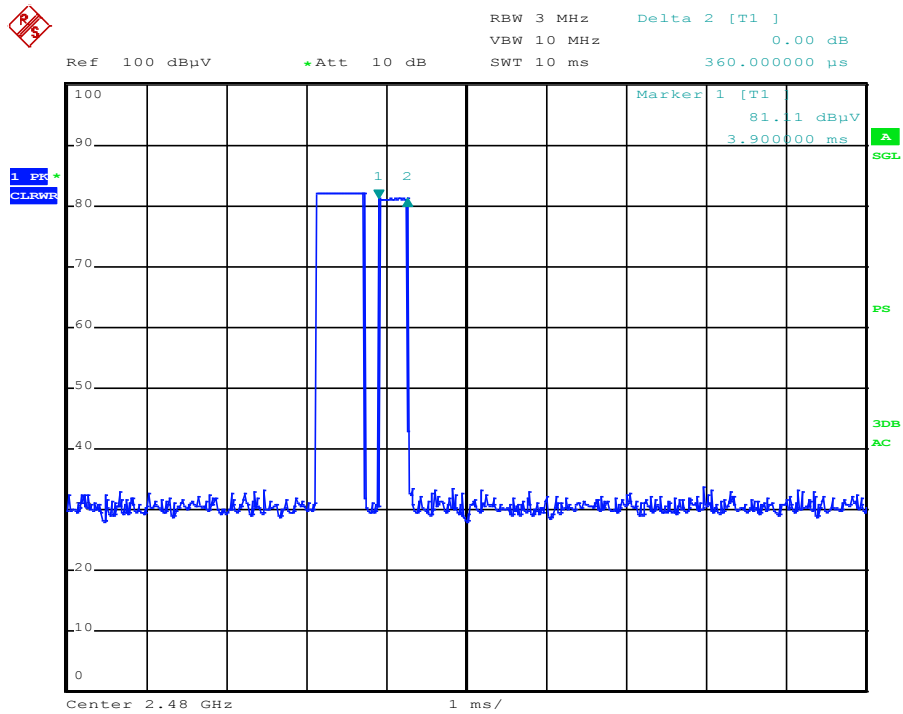
Detector: Peak
 RBW 3 MHz
 VBW 3 x RBW
 Span 0 Hz
 Sweep time 100 ms

12.3 Requirement

CFR 47 15.35(c) and RSS-GEN section 6.10

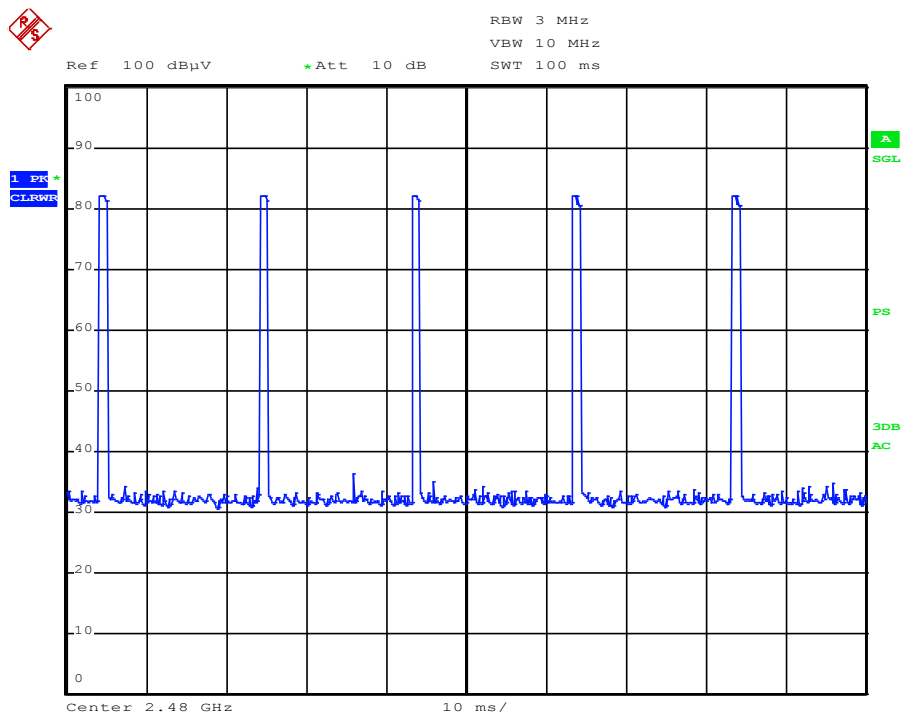
12.4 Test results

$T_{on} = 5 \times 360.0 \mu s$
 Duty cycle is calculated $T_{on} / 100 \text{ ms} = 0.02$
 Peak to average correction factor = $20 \text{ LOG } (0.02) = -34.0$



Date: 19.JUN.2018 13:39:38

Screenshot: Time of one pulse, transmitter signal attenuated compared to companion device



Date: 19.JUN.2018 13:38:58

Screen shot: 100 ms measurement

13 TEST EQUIPMENT

Björkhallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 – V10.35.1	--	--	--
Receiver	Rohde & Schwarz	ESIB 26	32288	July – 2018	1 year
UltraLog antenna	Rohde & Schwarz	HL562	30711	Jan – 2018	3 years

Radiohallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 9.12.10	--	--	--
Receiver	Rohde & Schwarz	ESU 40	13178	Nov – 2018	1 year
Horn antenna	EMCO	3115	4936	July – 2017	3 years
Pre amplifier	Sangus	00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	July – 2017	1 year
Horn antenna	EMCO	3160-08	30099	Sep – 2017	3 years
Horn antenna	EMCO	3160-09	30101	Sep – 2017	3 years
Signal analyzer:	Rohde & Schwarz	FSV 30	32594	July – 2018	1 year
Signal generator:	Rohde & Schwarz	SMB100A	32592	July – 2017	1 year
Receiver:	Rohde & Schwarz	ESCI 3	12741	July – 2017	1 year
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	March – 2018	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	Aug – 2017	1 year

14 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 %.

15 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1810944STO-001 Annex 1.

Test set up photos are in separate document 1810944STO-001 Annex 2.