RADIO TEST REPORT

No. 1809890STO-002, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment:	Biometric Wristband
Type/Model:	BWB01
Manufacturer:	ASSA ABLOY Logistic Security Solutions AB
Tested by request of:	ASSA ABLOY Logistic Security Solutions 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 C: Intentional radiators. Section 15.247

RSS-GEN Issue 4 (2014): 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

For details, see clause 2 – 4.

Date of issue: 2018-05-30

Tested by: Matti Virkki

Approved by: Stefan Andersson

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Revision History

Edition	Date	Description	Changes
1	2018-05-30	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company	ASSA ABLOY Logistic Security Solutions AB Förmansvägen 11, 3rd floor 11743 Stockholm Sweden
Name of contact	Jennie Söderlund
Client observer	Daniel Kahlin

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	Biometric Wristband
Type/Model:	BWB01
Brand name:	ASSA ABLOY
Serial number:	1725
Manufacturer:	ASSA ABLOY Logistic Security Solutions AB
Transmitter frequency range:	2402 – 2480 MHz
Receiver frequency range:	2402 – 2480 MHz

Frequency agile or hopping:	☐ Yes	☒ No
Antenna:	☒ Internal antenna	☐ External antenna
Antenna connector:	☒ None, internal antenna	☐ Yes,
Antenna gain:	< 0 dBi	
Rating RF output power:	+1 dBm (conducted)	
Type of modulation:	GFSK	
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 +85°C	
Transmitter stand by mode supported:	☒ Yes	☐ No

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Part number	Note
1	Wristband	1725	Normal internal antenna
2	Wristband PCB	1220012500001722	Temporary SMA antenna connector
3	Wristband PCB	1290012500001729	Temporary SMA antenna connector
4	Charging clip		
5	AC DC adapter	S008ACMN0500150	

2.3 Peripheral equipment

Peripheral equipment is equipment needed for correct operation of the EUT, but not included as part of the testing and evaluation of the EUT.

Equipment	Type / Model	Manufacturer	Serial no.
Charging clip AC / DC adapter			

2.4 Test signals and operation modes

Units 1 and 2 had following test modes: Continuous transmission with GFSK modulation and 1 Mbit data rate on 2402, 2440 and 2480 MHz frequencies.

Continuous receive on 2402 and 2480 MHz.

Unit 3 had a following test mode: Continuous Test sequence consisting of BLE scan, pairing, data transmission and the release of pairing.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

47 CFR Part 15 (2015): Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 (2015): Subpart B: Unintentional radiators

RSS-GEN Issue 4 (2014): 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-247 Ed 2 is not within Intertek Semko AB's scope of 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,
P.O. 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

3.4 Test set-up

3.4.1 General description of R&S®TS8997

R&S®TS8997 was developed by Rohde and Schwartz as an all-in-one solution for testing according to the FCC §15.247, §15.407 and RSS-247. It comprises of an FSV signal analyzer, a SMB100A signal generator, a SMBV100A vector signal generator and an OSP-B157 open switch and control unit (an additionally equipped version of the OSP-120). Using a R&S®WMS32 measurement software, R&S®TS8997 is capable of measuring all required characteristics per ANSI C63.10 2013 in an automated sequence.

3.4.2 Conducted measurements

All conducted measurements, except receiver blocking, were performed using the TS8997 system and the test setup shown below.

Schematic of conducted measurements

To ensure a normal operating mode, a companion device, was paired to the equipment and the connection was monitored for the duration of the tests.

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** The EUT has integrated non detachable antenna which can't be removed without breaking the EUT.	**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** The EUT complies with the limits. See clause 5.3.	**PASS**
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** The EUT complies with the limits. See clause 6.4	**PASS**
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** The EUT complies with the limits. See clause 6.5.	**PASS**
FCC §15.247(a)(2) **RSS-GEN 6.6** **RSS-247 5.2(1)**	**Occupied bandwidth** The EUT complies with the limits. See clauses 9.4 and 10.3	**PASS**
FCC §15.247(b) **RSS-247 5.4(4)**	**Conducted output power** The EUT complies with the limits. See clause 8.4.	**PASS**
FCC §15.247(e) **RSS-247 5.2(2)**	**Peak power spectral density** The EUT complies with the limits. See clause 11.4.	**PASS**
FCC §15.247(e) **RSS-247 5.5**	**Band edge** The EUT complies with the limits. See clause 7.4.	**PASS**

5 CONDUCTED CONTINUOUS DISTURBANCES IN THE FREQUENCY-RANGE 0.15 TO 30 MHZ

Date of test:	2018-05-25	**Test location:**	Bur 3
EUT Serial:	1	**Ambient temp:**	24 °C
Tested by:	Matti Virkki	**Relative humidity:**	31 %
Test result:	Pass	**Margin:**	19.1 dB

5.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.10-2013 section 6.2.

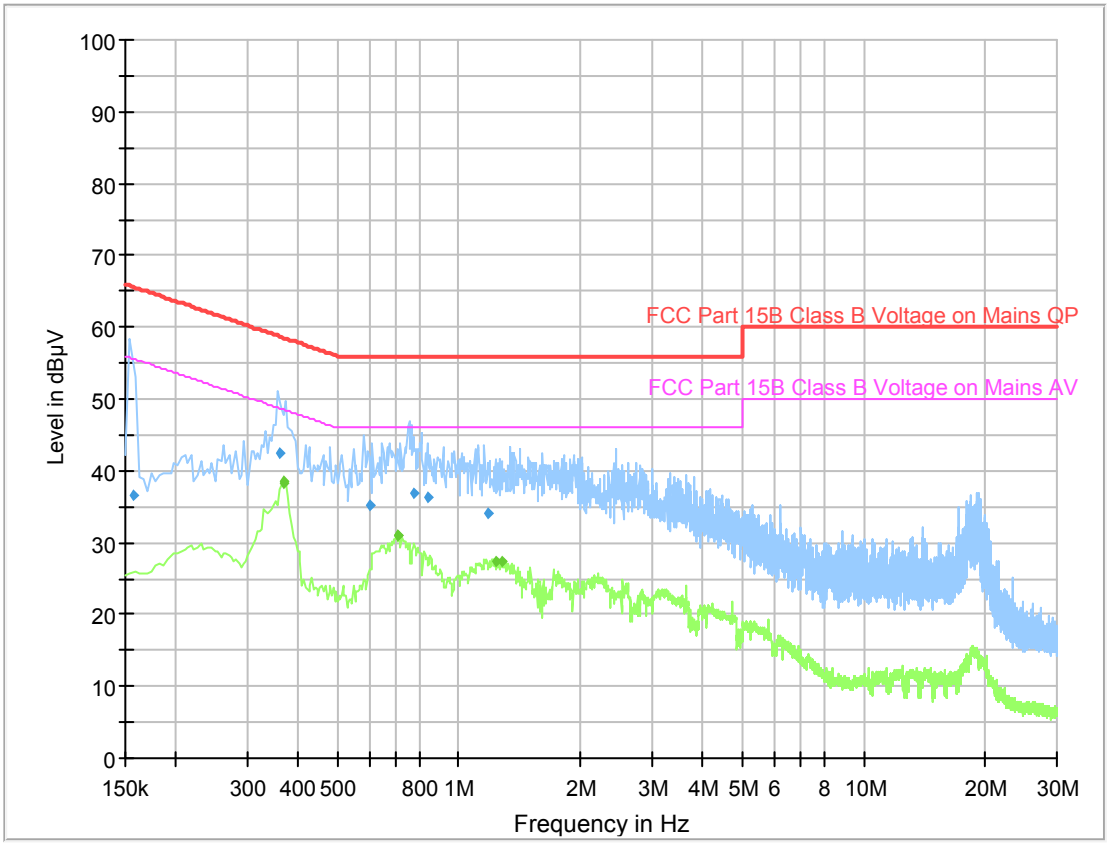
The EUT was connected to the power via Artificial Mains Networks AMN.
The EUT was placed on an insulating support 0.8 m above the floor, 0.4 m from the vertical reference ground plane (RGP) and 0.8 m from the AMN/ISN.
Overview sweeps were performed for each lead.
During the tests the EUT was operated according to the mode of operation mentioned in clause 2.4.

5.2 Requirement

Limits for conducted emission from AC mains
The EUT shall meet the limits for the standards.
Reference: 47 CFR §15.207
RSS-GEN, section 8.8 table 3

Frequency range [MHz]	Limits [dBµV]	
	Quasi-Peak	Average
0.15 – 0.50	66 – 56	56 – 46
0,50 – 5.00	56	46
5.00 – 30.0	60	50

5.3 Test results



Diagram, Peak and Average overview sweep

Measurement results, Quasi-peak

Frequency [MHz]	Level [dBµV]	Limit [dBµV]	Line L/N	Margin [dB]
0.157	36.7	65.6	N	28.9
0.360	42.5	58.7	L1	16.2
0.599	35.2	56.0	N	20.8
0.771	36.9	56.0	L1	19.1
0.839	36.4	56.0	N	19.6
1.184	34.1	56.0	L1	21.9

Measurement results, Average

All measured QP levels are below Average limit

Result [dBµV] = Analyser reading [dBµV] + cable loss [dB] + LISN insertion loss [dB]

6 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 26 GHZ

Date of test:	2018-05-15	**Test location:**	Björkhallen
EUT Serial:	1	**Ambient temp:**	25 °C
Tested by:	Matti Virkki	**Relative humidity:**	32 %
Test result:	Pass	**Margin:**	5.9 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.

Portable device: Pre scan was made in three orthogonal EUT orientations.

6.2 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	VBW 1 MHz
EUT height above ground plane:	0.8 m		
Measuring distance:	3 m		
Measuring angle:	0 – 359°		
Antenna			
Height above ground plane:	1 – 4 m		
Polarisation:	Vertical and Horizontal		
Type:	Bilog		

Test set-up: **1 GHz – 26.5 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	VBW 3 MHz
	Average	RBW 1 MHz	VBW 3 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:	Activated		

6.3 Requirement

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

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

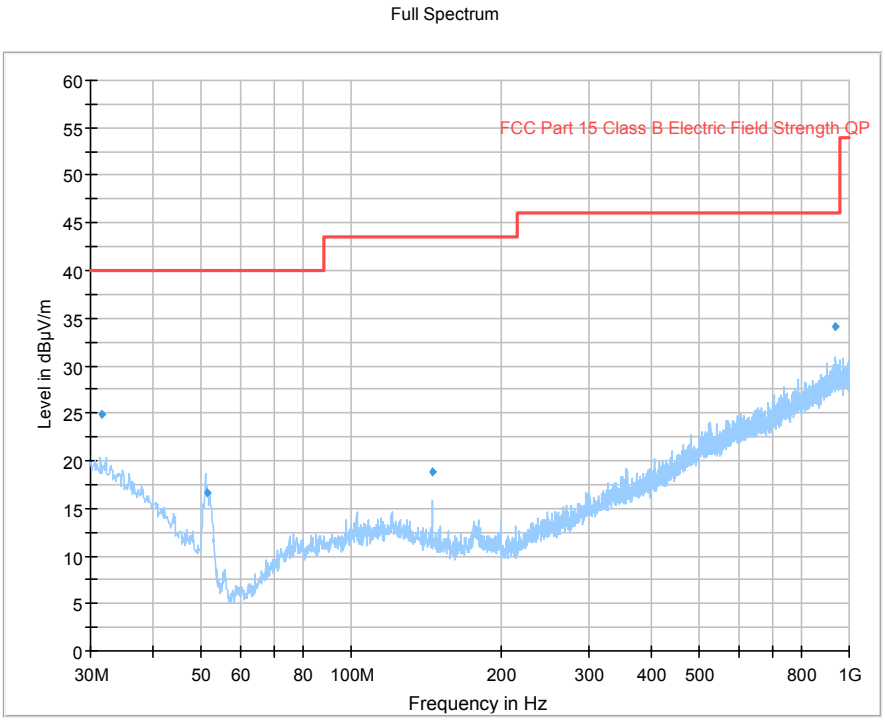
Frequency range [MHz]	Field strength at 3 m (dBµV/m)	Field strength at 10 m (dBµV/m)	Detector (dBµV/m)
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

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))

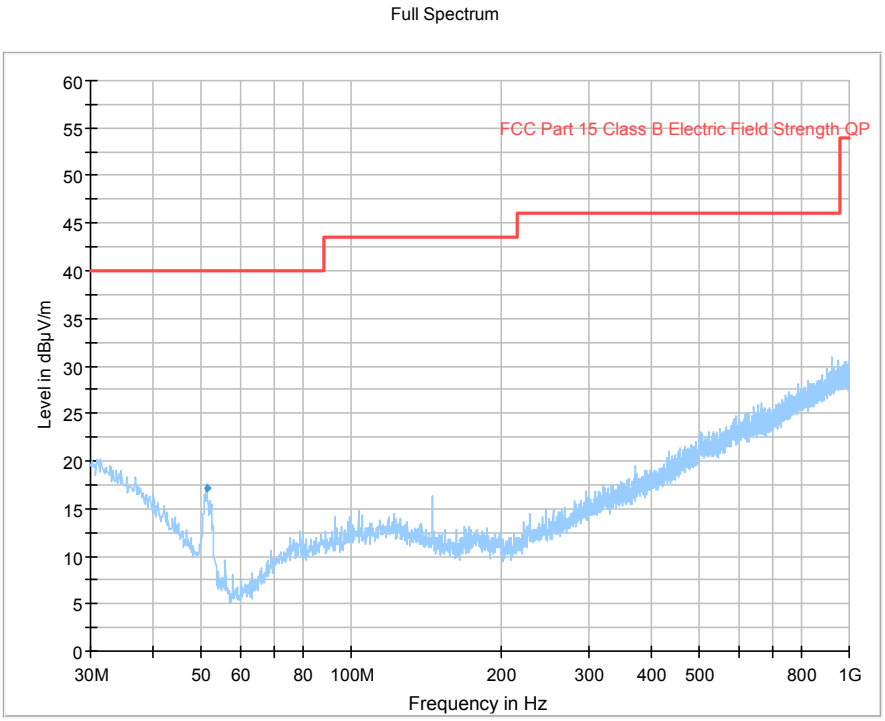
Outside the restricted bands:
Reference: CFR 47 §15.247(d), RSS-247 5.5,

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.

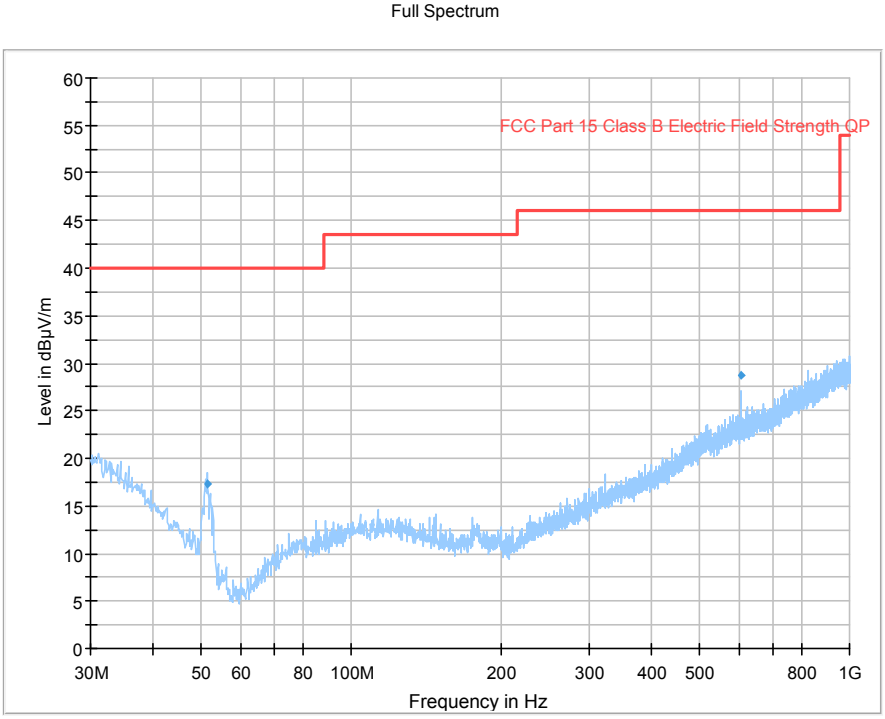
6.4 Test results 30 MHz – 1000 MHz



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation 1.



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation 2.



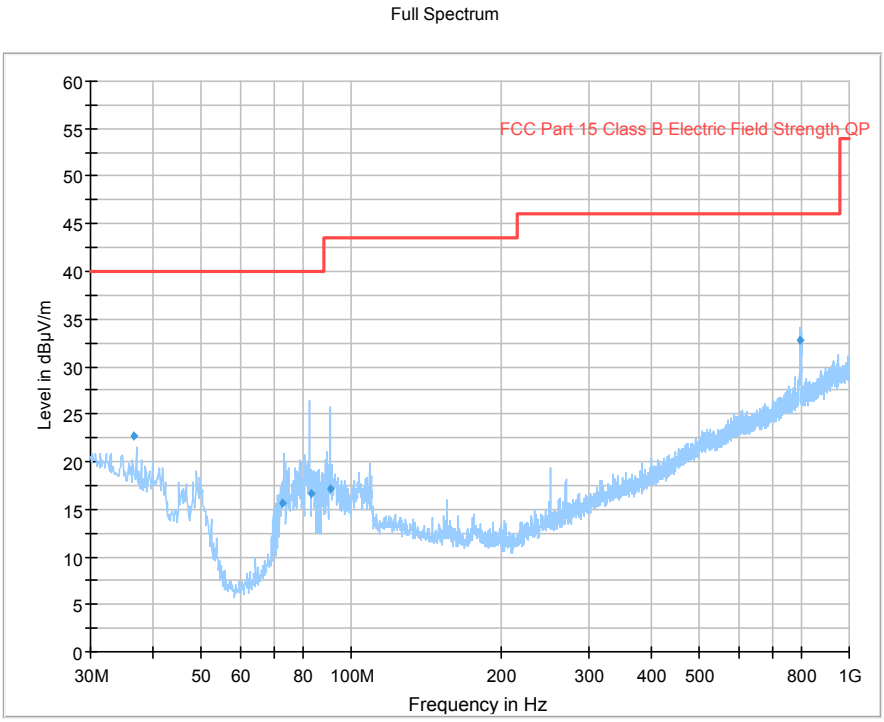
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation 3.

Measurement results, Quasi Peak

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
31.684	24.9	40.0	H	15.1
51.302	16.7	40.0	V	23.3
145.571	18.8	43.5	V	24.7
938.218	34.2	46.0	H	11.8

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]

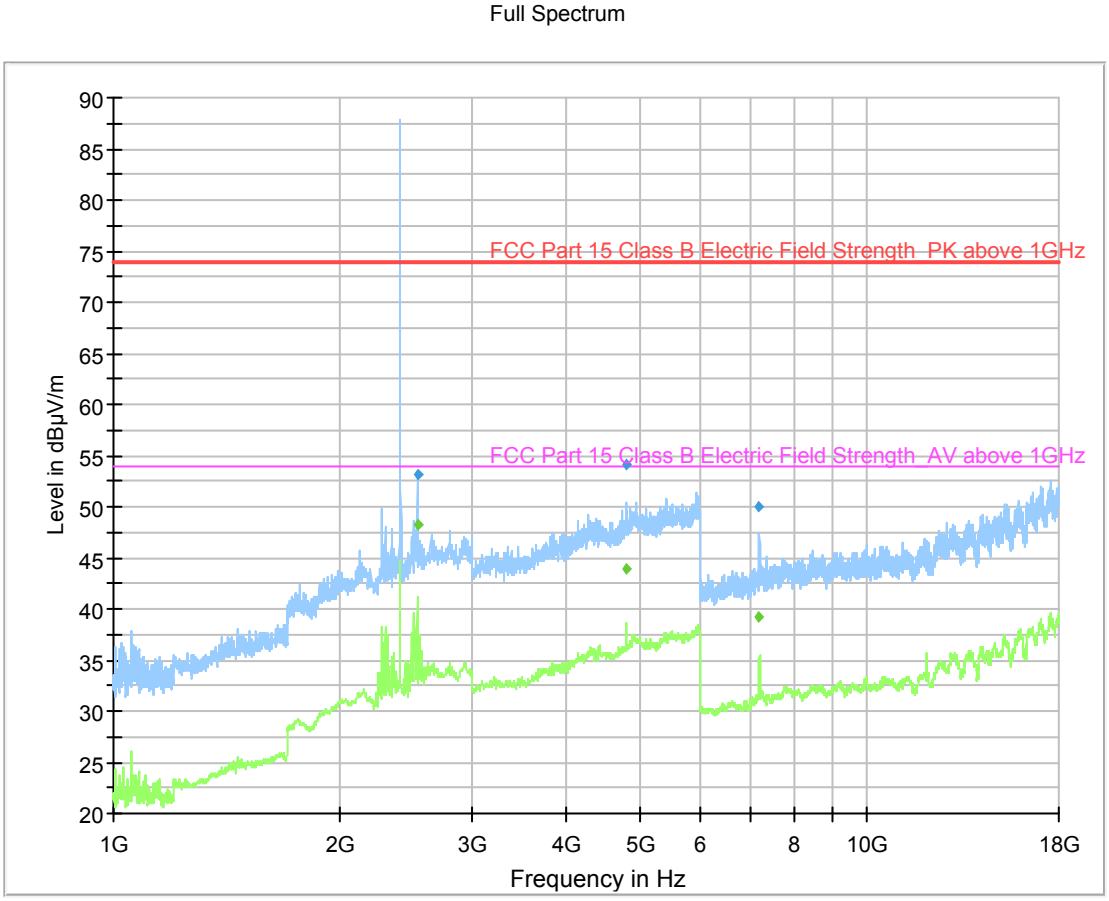


Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. EUT charging the battery

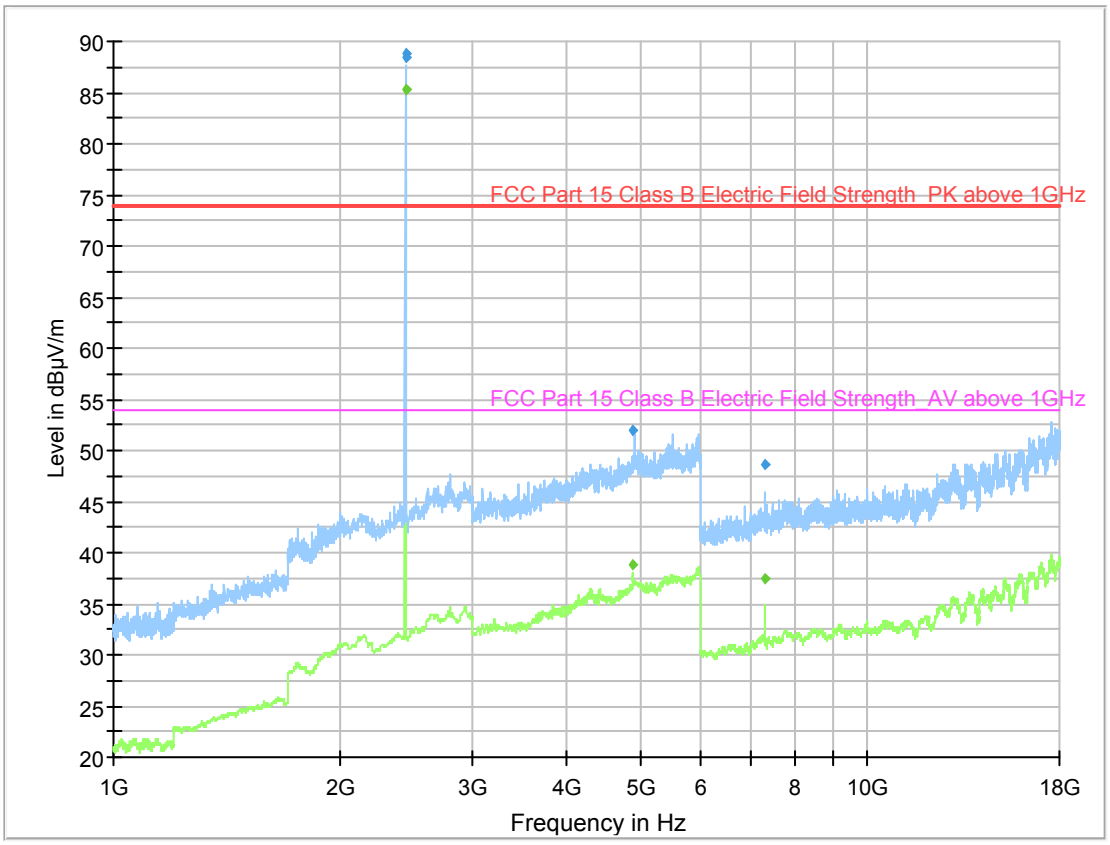
Measurement results, Quasi Peak

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
36.494	22.8	40.0	V	17.2
72.826	15.7	40.0	V	24.3
83.204	16.6	40.0	V	23.4
90.921	17.2	43.5	V	26.3
798.056	32.7	46.0	V	13.3

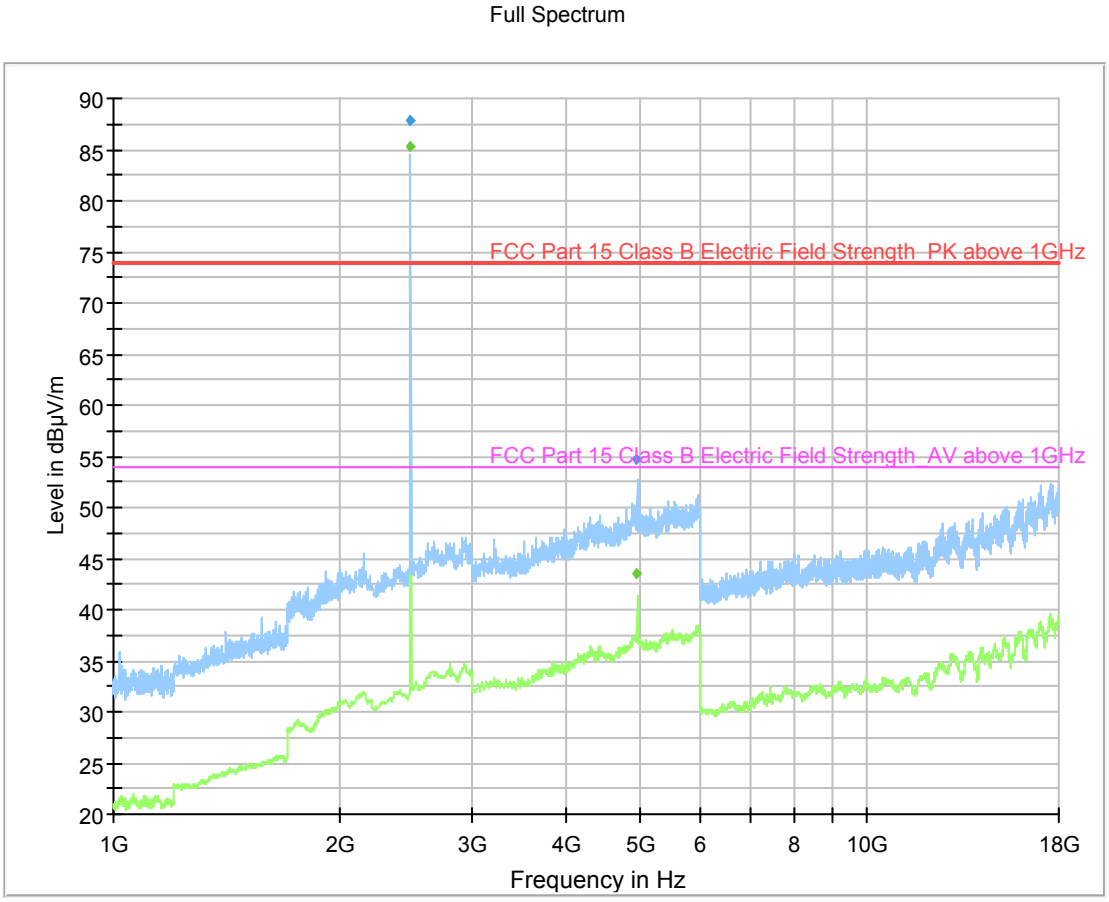
6.5 Test results 1 GHz – 26 GHz, TX



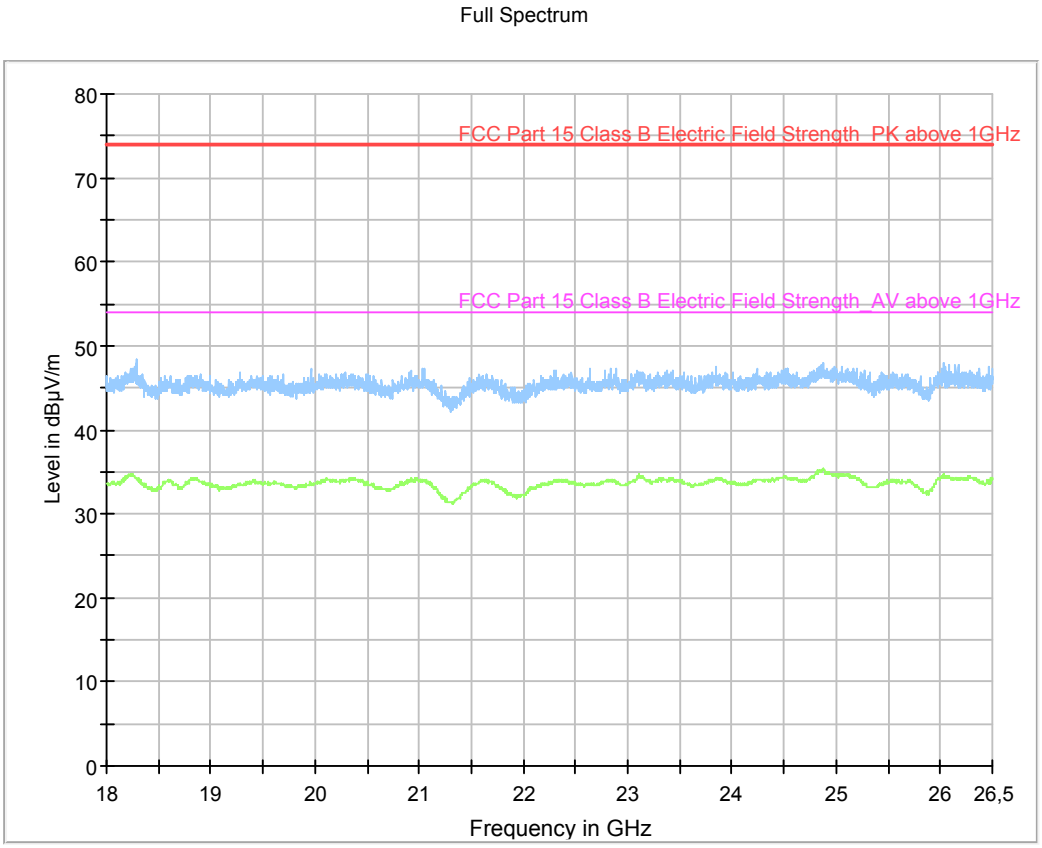
Diagram, Peak overview sweep, 1– 18 GHz at 3 m distance. TX low channel, EUT orientation 1.



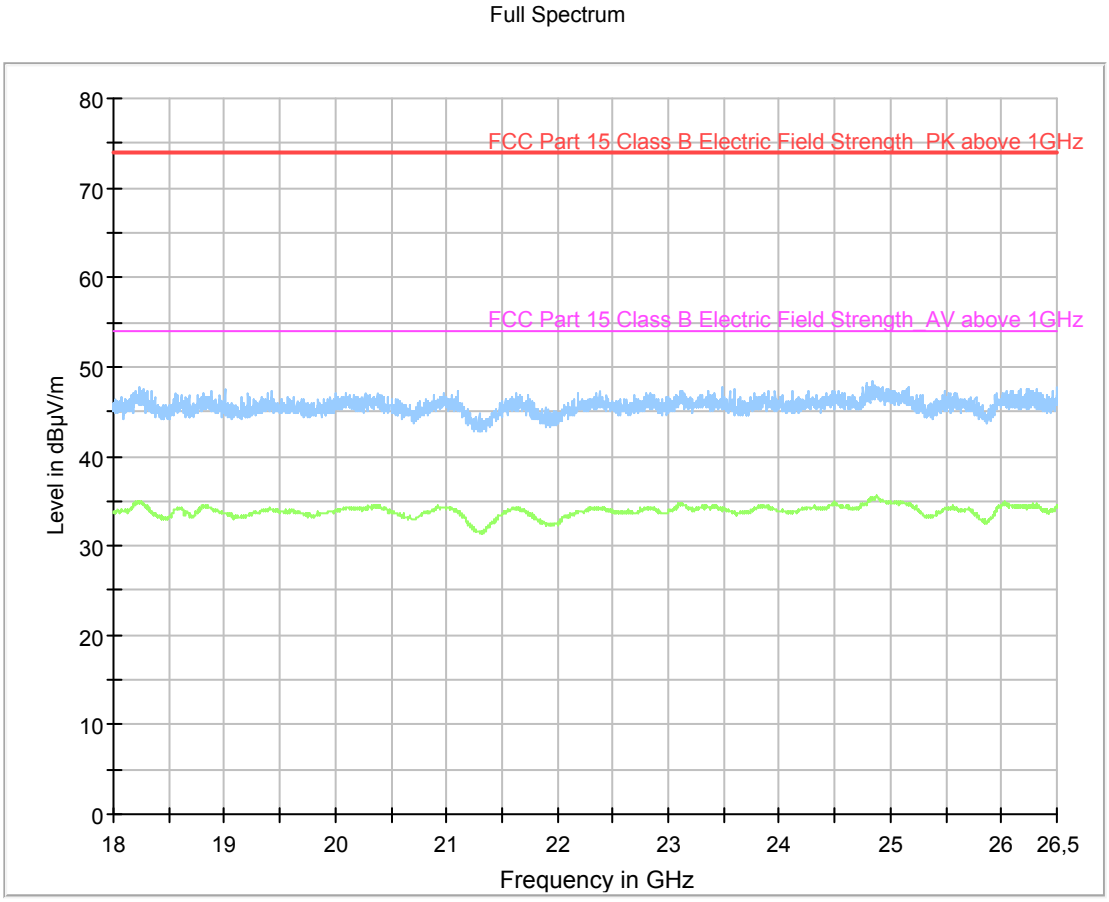
Diagram, Peak overview sweep, 1– 18 GHz at 3 m distance. TX middle channel, EUT orientation 2.



Diagram, Peak overview sweep, 1– 18 GHz at 3 m distance. TX high channel, EUT orientation 3.

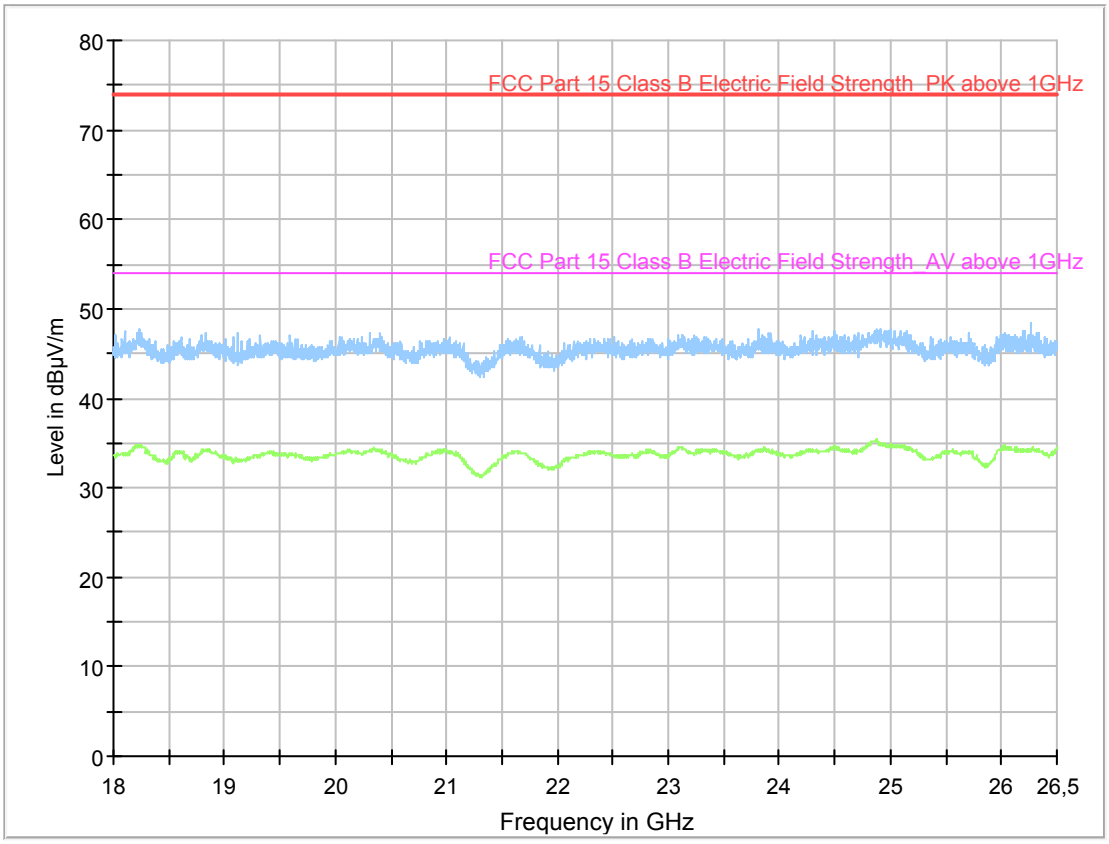


Diagram, Peak overview sweep, 18-26.5 GHz at 3 m distance. TX low channel, EUT orientation 1.



Diagram, Peak overview sweep, 18-26.5 GHz at 3 m distance. TX middle channel, EUT orientation 1.

Full Spectrum



Diagram, Peak overview sweep, 18-26.5 GHz at 3 m distance. TX middle channel, EUT orientation 1.

Measurement results, Peak, TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2274.1	52.1	74	2	H	21.9
2530.3	55.2	74	1	H	21.8
4803.8	54.2	74	1	V	19.8
7205.6	50.0	74	1	H	24.0

Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2530.3	52.1	74	2	H	5.9
4803.8	43.9	74	1	V	10.1
7205.6	39.2	74	1	H	14.8

Measurement results, Peak, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
4880.4	52.0	74	3	H	22
7320.4	48.5	74	2	V	24.5

Measurement results, Average, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
4880.5	38.8	54	3	H	15.2
7319.4	37.5	54	2	V	16.5

Measurement results, Peak, TX high channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2484.0	45.1	74	2	V	28.9
4959.5	54.8	74	3	H	19.2

Measurement results, Average, TX high channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2484.0	31.1	54	2	V	14.5
4959.5	43.6	54	3	H	10.4

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]

7 CONDUCTED BAND EDGE MEASUREMENT

Date of test:	2018-05-18	**Test location:**	Wireless Center
EUT Serial:	2	**Ambient temp:**	22 °C
Tested by:	Matti Virkki	**Relative humidity:**	31 %
Test result:	Pass	**Margin:**	29.1 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 the test system via an rf-cable and an attenuator.

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

7.2 Test conditions

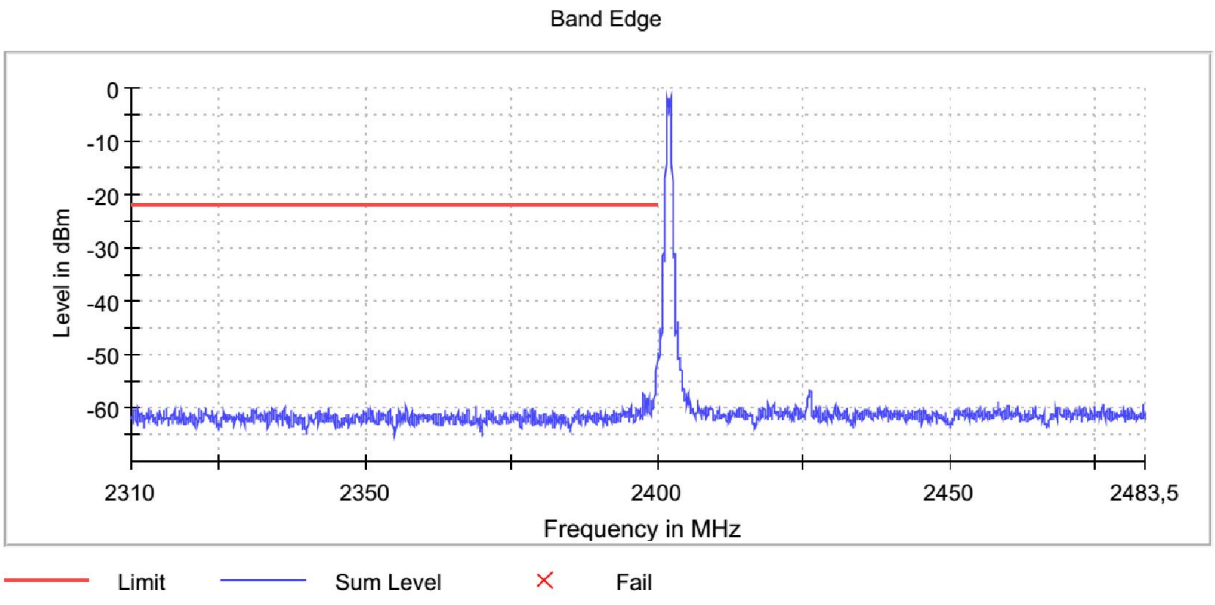
Detector: Peak,
RBW: 100 kHz
VBW: 300 kHz

7.3 Requirement

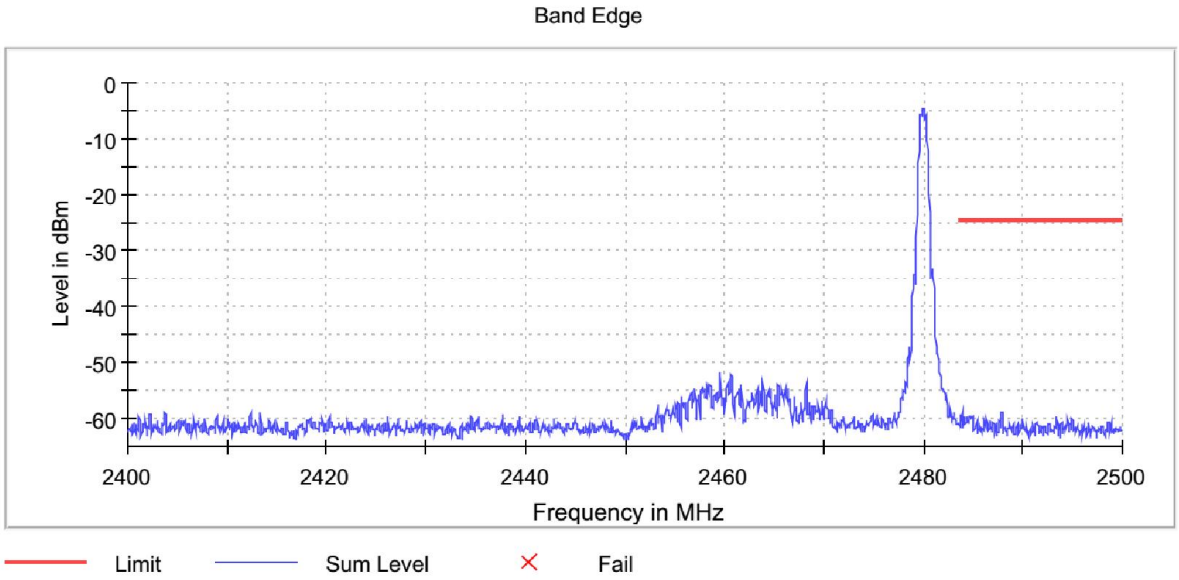
Reference: CFR 47 §15.247(d), RSS-247 5.5,

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



Screenshot: Lower band edge sweep, single channel



Screenshot: Upperband edge sweep, single channel

Test results

Band edge	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	50.9	20.0	29.1
Upper	54.4	20.0	34.4

8 PEAK CONDUCTED OUTPUT POWER

Date of test:	2018-05-18	**Test location:**	Wireless Center
EUT Serial:	2	**Ambient temp:**	24°C
Tested by:	Matti Virkki	**Relative humidity:**	20 %
Test result:	Pass	**Margin:**	29.4 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 the test system via an rf-cable and an attenuator

8.2 Test conditions

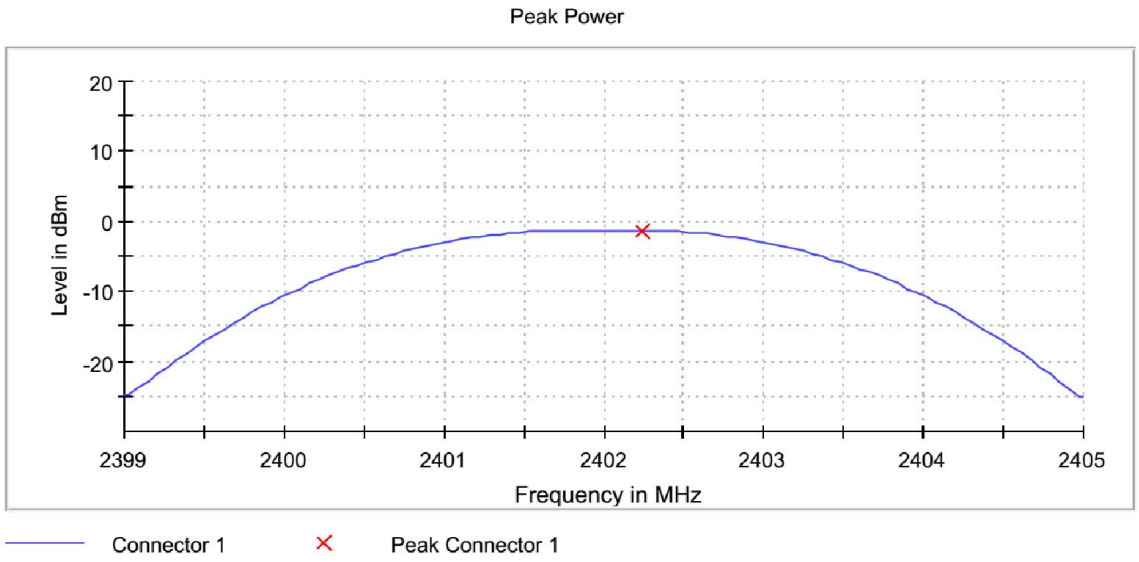
Detector: Peak,
RBW: 2 MHz
VBW: 10 MHz
Span: 6 MHz

The EUT was set up in order to transmit modu.

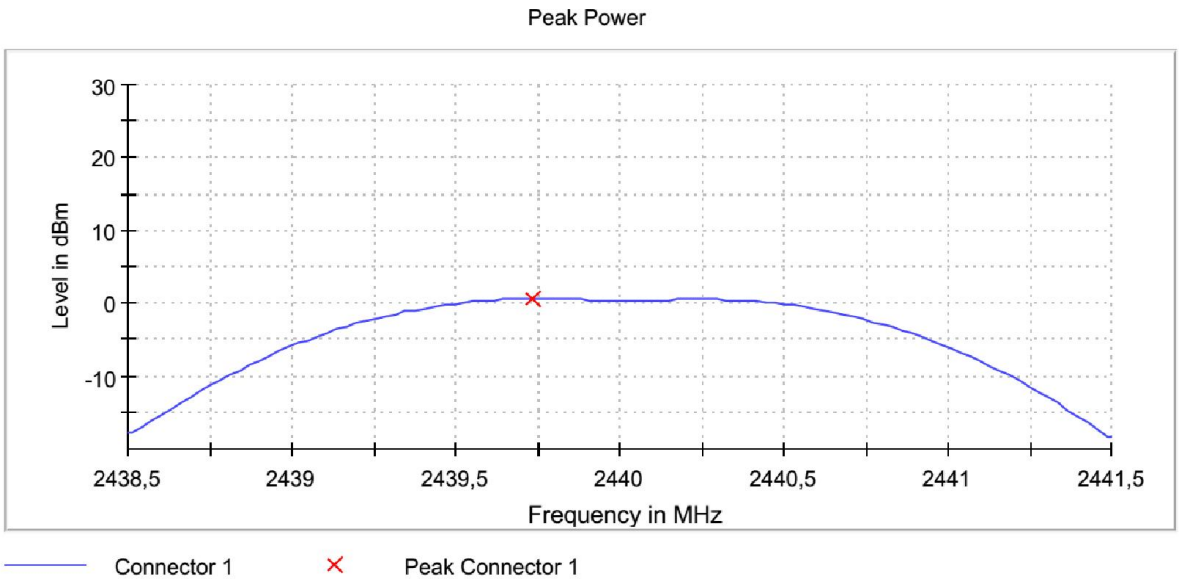
8.3 Requirements

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.

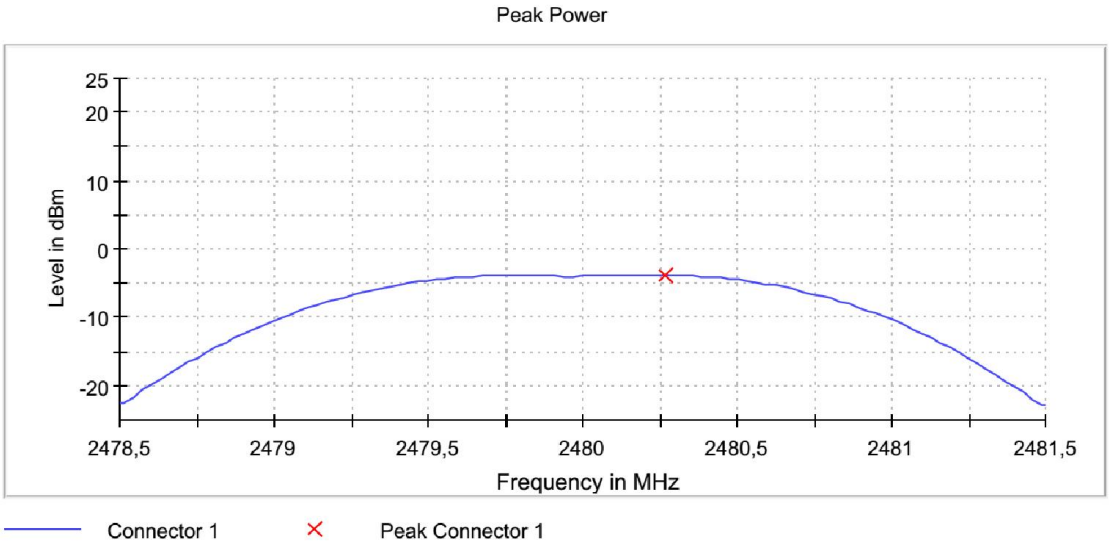
8.4 Test results



Screenshot: Output power, low channel



Screenshot: Output power, middle channel



Screenshot: Output power, high channel

Test result

Channel [MHz]	Output power [dBm]	Limit [dBm]	Margin [dB]
2402	-1.4	30	31.4
2440	0.6	30	29.4
2480	-3.8	30	32.2

9 OCCUPIED 6 DB BANDWIDTH

Date of test:	2018-05-18	**Test location:**	Wireless Center
EUT Serial:	2	**Ambient temp:**	24°C
Tested by:	Matti Virkki	**Relative humidity:**	20 %
Test result:	Pass	**Margin:**	213 kHz

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 the test system via an rf-cable and an attenuator

9.2 Test conditions

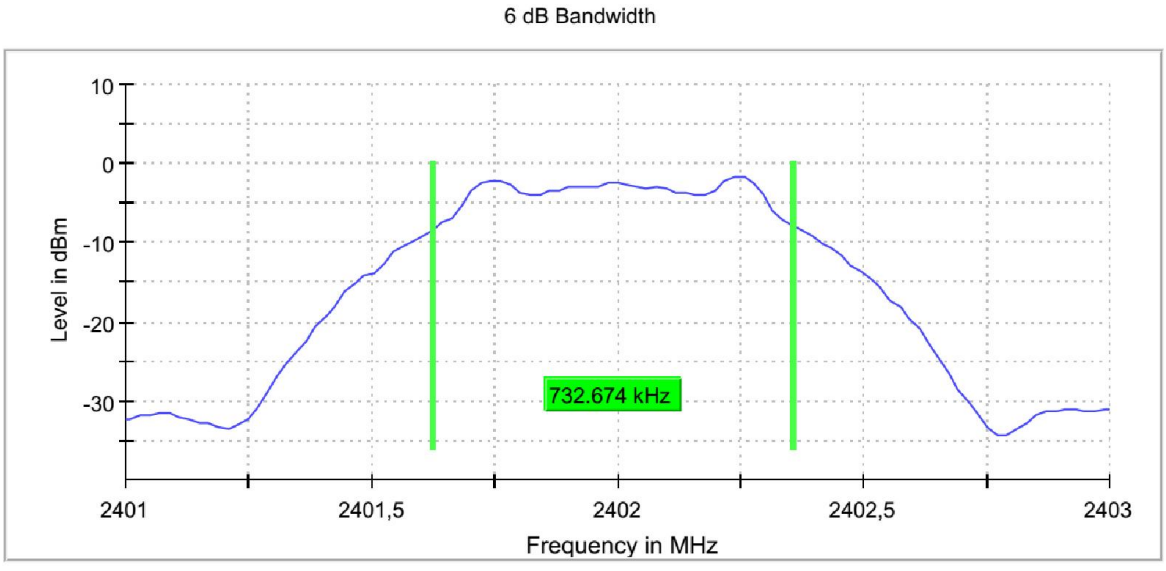
Detector: Peak,
RBW: 100 kHz
VBW: 3 x RBW
Span: 2 MHz

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

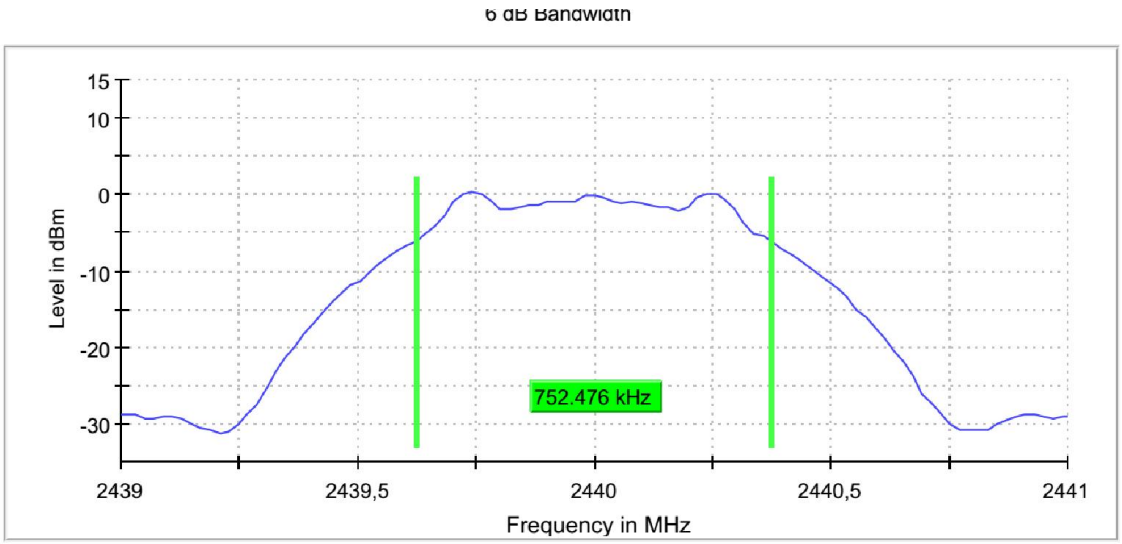
9.3 Requirements

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

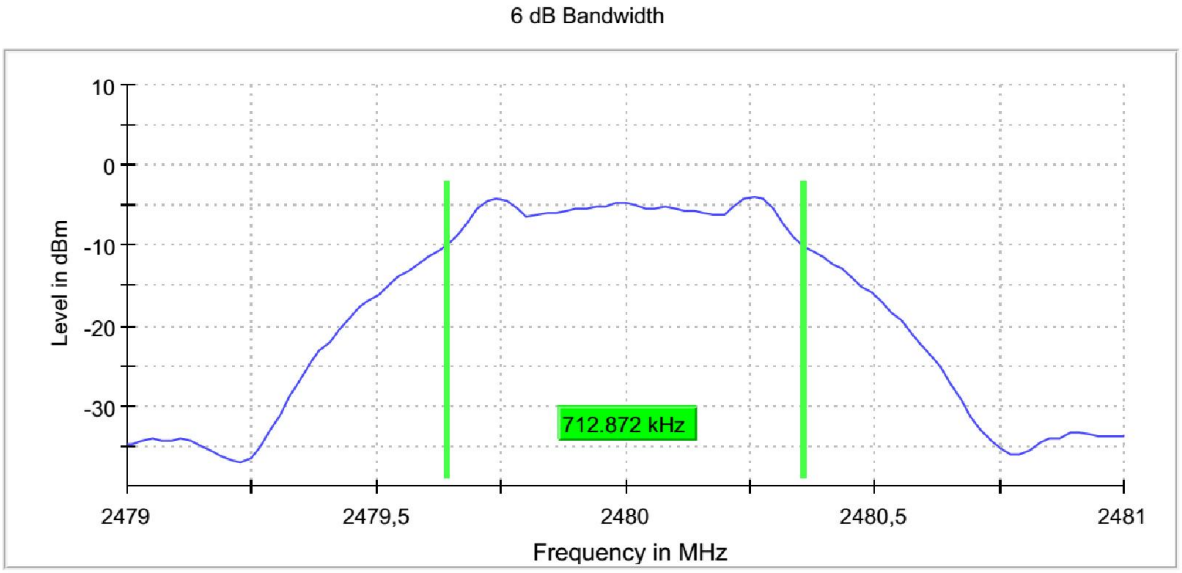
9.4 Test results



Screenshot: Occupied 6 dB bandwidth Measurement, low channel



Screenshot: Occupied 6 dB bandwidth Measurement, middle channel



Screenshot: Occupied 6 dB bandwidth Measurement, high channel

Test result

Channel [MHz]	6 dB BW [MHz]	Limit [MHz]	Margin [MHz]
2402	0.732	≥0.5	0.232
2440	0.752	≥0.5	0.252
2480	0.713	≥0.5	0.213

10 99 % BANDWIDTH

Date of test:	2018-05-18	**Test location:**	Wireless Center
EUT Serial:	2	**Ambient temp:**	24°C
Tested by:	Matti Virkki	**Relative humidity:**	20 %
Test result:	NA	**Margin:**	NA

10.1 Test set-up and test procedure.

The test method is in accordance with RSS-GEN section 6.6.

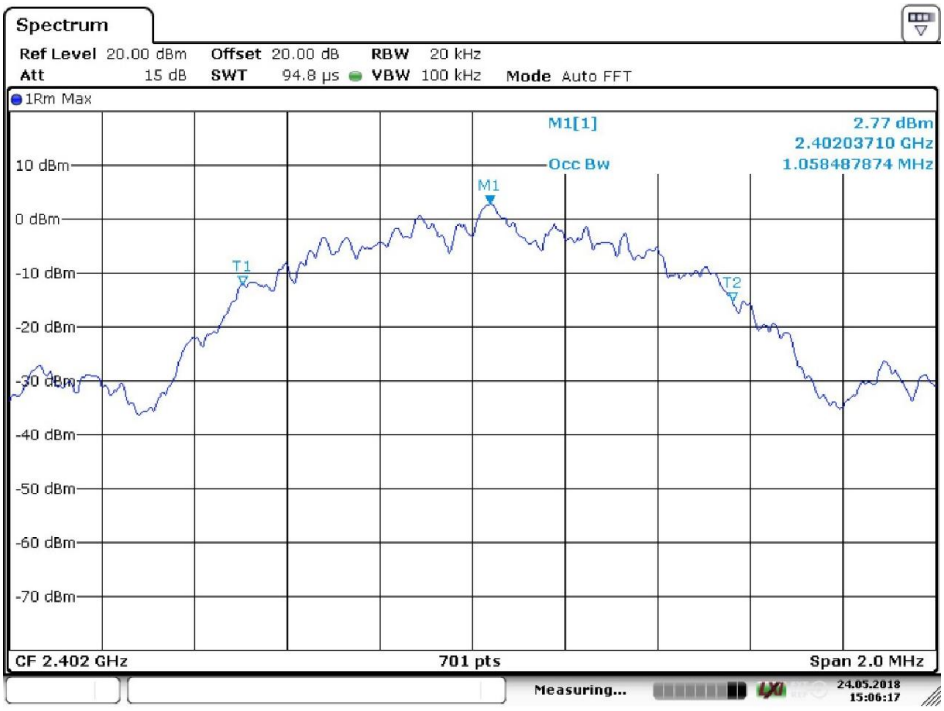
The EUT was connected to the test system via an rf-cable and an attenuator

10.2 Test conditions

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

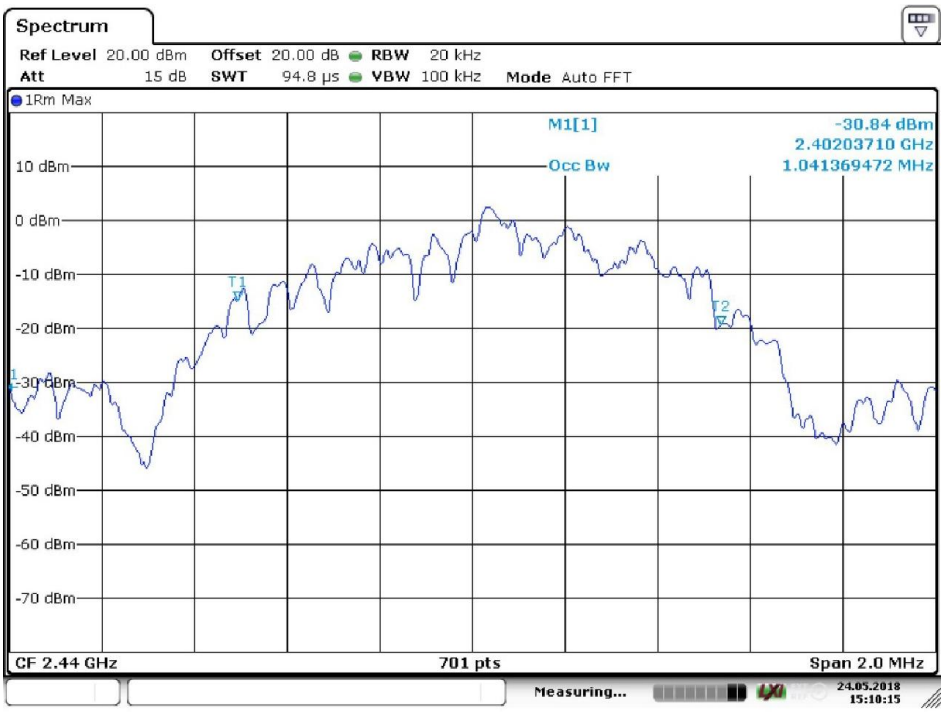
The EUT was set up in order to emit maximum disturbances.

10.3 Test results



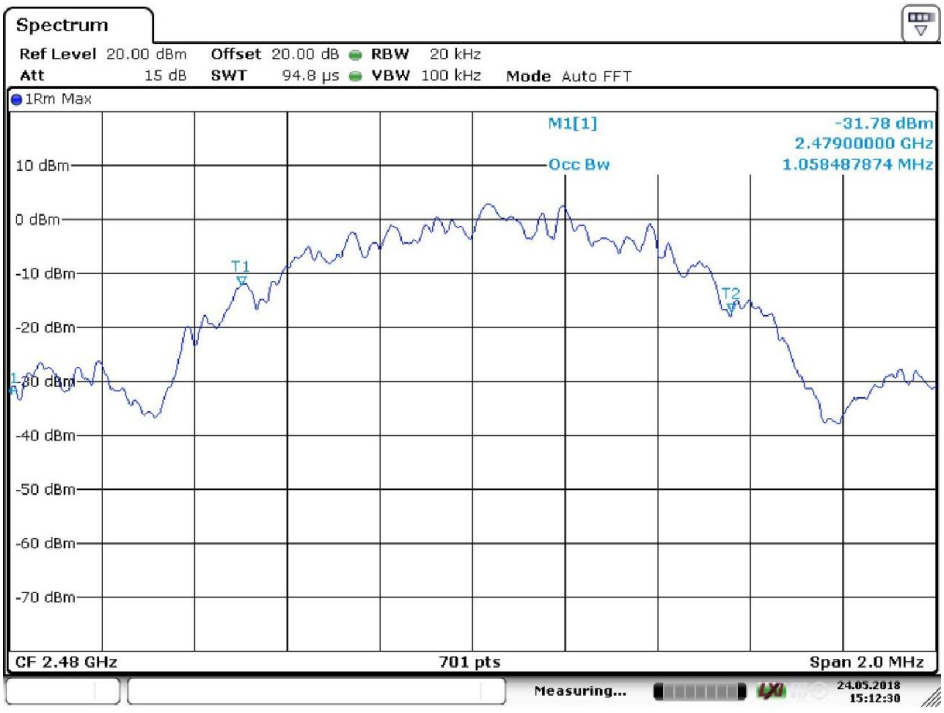
Date: 24.MAY.2018 15:06:18

Screenshot: 99 % bandwidth Measurement, low channel



Date: 24.MAY.2018 15:10:15

Screenshot: 99 % bandwidth Measurement, middle channel



Date: 24.MAY.2018 15:12:30

Screenshot: 99 % bandwidth Measurement, high channel

Test result

Channel [MHz]	99 % BW [MHz]
2402	1.058
2440	1.041
2480	1.058

11 PEAK POWER SPECTRAL DENSITY

Date of test:	2018-05-18	**Test location:**	Wireless Center
EUT Serial:	2	**Ambient temp:**	24°C
Tested by:	Matti Virkki	**Relative humidity:**	20 %
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 the test system via an rf-cable and an attenuator

11.2 Test conditions

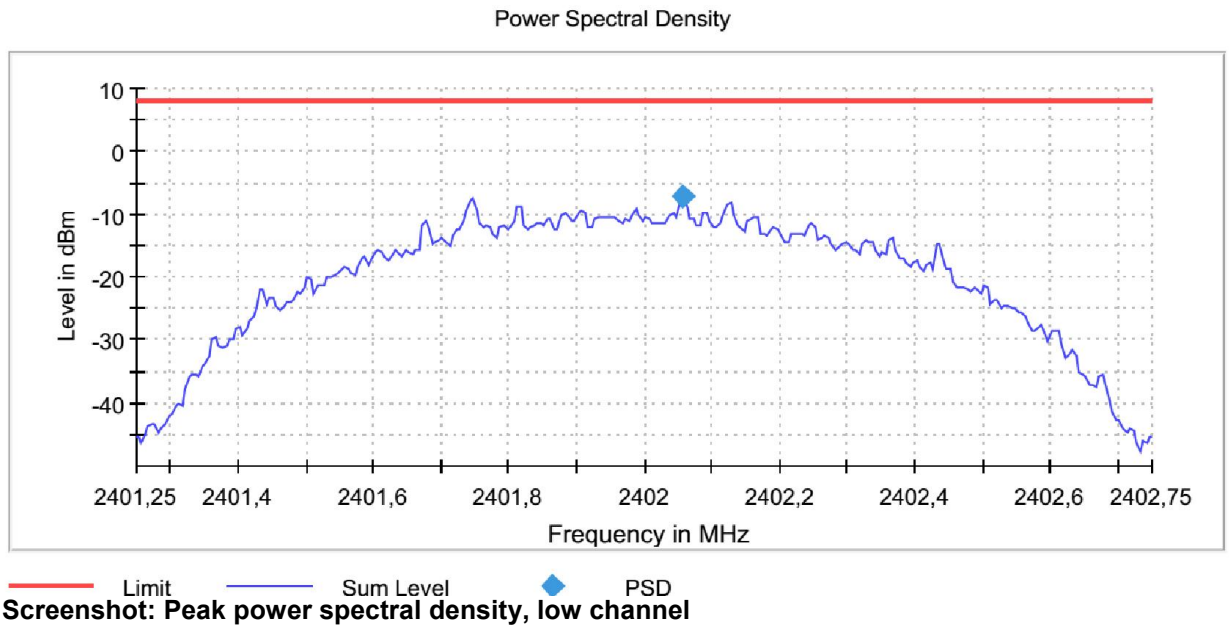
Detector: Peak,
RBW: 3 kHz
VBW: >3 x RBW
Span: 1.5 x 6 dB bandwidth

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

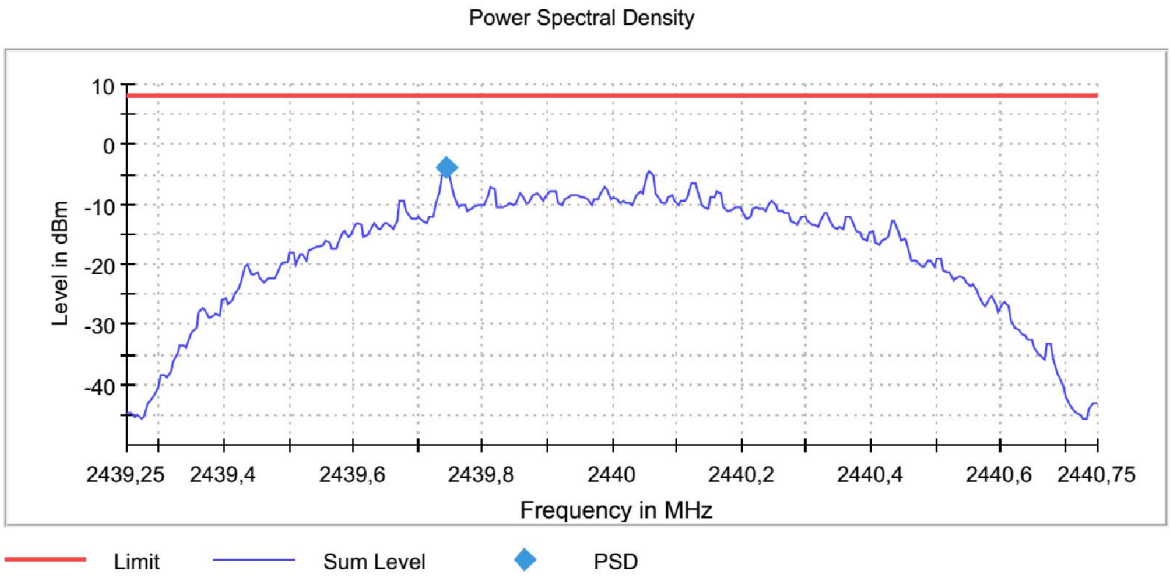
11.3 Requirements

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.

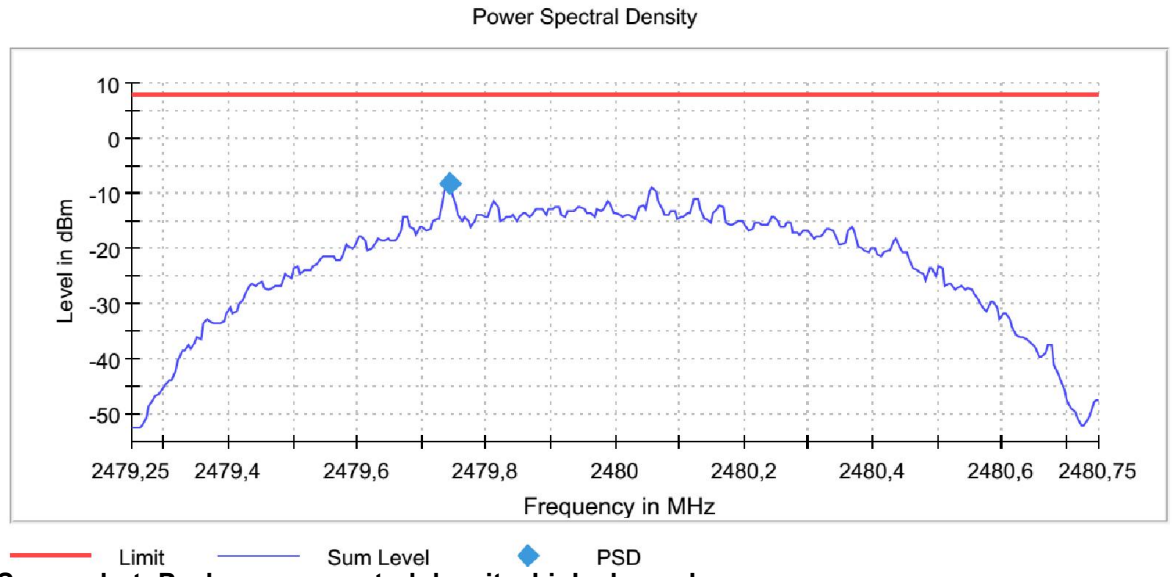
11.4 Test results



Screenshot: Peak power spectral density, low channel



Screenshot: Peak power spectral density, middle channel



Screenshot: Peak power spectral density, high channel

Test result

Channel [MHz]	PSD [dBm/3kHz]
2402	-7.139
2440	-3.745
2480	-8.336

12 TEST EQUIPMENT

Conducted emission test site BUR 3

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - Version	--	--	--
Receiver	Rohde & Schwarz	ESCI	31686	7-2017	1 year
AMN / LISN	Rohde & Schwarz	ESH2-Z5	3017	7-2017	1 year

Wireless Center and 3m FAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - Version	--	--	--
Receiver	Rohde & Schwarz	ESIB 26	32288	7-2017	1 year
Horn antenna	Rohde & Schwarz	HF907	32307	7-2015	3 years
Horn antenna	EMCO	3160-08	30099	10-2016	3 years
Horn antenna	EMCO	3160-09	30101	10-2016	3 years
UltraLog antenna	Rohde & Schwarz	HL562	32310	4-2018	3 years
Signal analyzer:	Rohde & Schwarz	FSV	32594	7-2017	1 year
Switch and control platform	Rohde & Schwarz	OSP120	32595	7-2017	1 year
Band reject filter	K&L Microwave	6N45-2450/T100/0	12389	7-2017	1 year
High pass filter	K&L Microwave	4410-x450 /18000-0/0	5133	7-2017	1 year

13 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 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

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

14 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1809890STO-002 Annex 1.
Test set up photos are in separate document 1809890STO-002 Annex 2.