

RADIO TEST REPORT

No. 1812896STO-002, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment: INTELLI light radio module
Type/Model: 19-318
Manufacturer: Tyri Sweden AB
Tested by request of: Tyri Sweden 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

47 CFR Part 15 : Subpart B: Unintentional radiators

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

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: 2018-09-28

Tested by:



Per Larsson

Approved by:



Matti Virkki

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Revision History

Edition	Date	Description	Changes
1	2018-09-28	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company Tyri Sweden AB
Aröds Industriväg 78
422 43 Hisings Backa
Sweden

Name of contact Magnus Eriksson
Phone +46 703 35 65 10

Client observer Magnus Eriksson

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: INTELLi light radio module

Type/Model: 19-318

Brand name: Tyri Sweden AB

Serial number: No visible serial number

Manufacturer: Tyri Sweden 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: 2.5 dBi

Rating RF output power: 4 dBm (measured conducted)

Type of modulation: Q-OPSK

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

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	Serial number
INTELLi light radio module	19-318	Not known	No visible

During the tests the EUT supported following software:

Software	Version	Comment
PIR-EMC-DTM	-	-

The EUT was tested with the following cables:

Port:	Type:	Length: [m]	Specifications:
DC input	5 V	1.5	Two-core

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
USB to serial	FTD1232	Not known

2.4 Test signals and operation modes

Continuous signal with BLE modulation

2.5 Modifications made to improve EMC-characteristics

No modifications were made.

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 (2018).

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,
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 #
Radio chamber 3mFAC	Radio chamber 3mFAC	2042G-4
5 m CHAMBER	Semi-anechoic 5 m	2042G-3

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 remove 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 Battery operated equipment.	NA
FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	Field strength of fundamental and antenna gain The EUT complies with the limits. Antenna gain is less than 6 dBi.	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. The margin to the limit was more than 20 dB. See clause 6.4 – 6.5.	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. The margin to the limit was more than 20 dB.See clause 6.6 – 6.7.	PASS
FCC §15.247(a)(2) RSS-GEN 6.6 RSS-247 5.2(1)	Occupied bandwidth The EUT complies with the limits. The margin to the limit is at least 0.232 MHz See clause 9.4 and 10.	PASS
FCC §15.247(b) RSS-247 5.4(4)	Conducted output power The EUT complies with the limits. The margin to the limit was more than 10 dB. See clause 8.4.	PASS
FCC §15.247(e) RSS-247 5.2(2)	Peak power spectral density The EUT complies with the limits. The margin to the limit was more than 8 dB. See clause 11.4.	PASS
FCC §15.247(e) RSS-247 5.5	Band edge The EUT complies with the limits. The margin to the limit was more than 20 dB. See clause 5.4.	PASS

5 RADIATED BAND EDGE

Date of test:	2018-09-11	Test location:	Radio hallen
EUT Serial:	TK-018	Ambient temp:	22 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	>20 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 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 and average detector was activated.

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

EUT was evaluated in three orthogonal orientations.

5.2 Test conditions

Test set-up:	1 GHz –4 GHz		
Test receiver set-up:			
Preview test:	Peak,	RBW 1 MHz	VBW 3 MHz
Final test:	Peak, Average	RBW 1 MHz Peak value + 20 x LOG (Duty cycle) / RBW 1	VBW 3 MHz
MHz. VBW 3 MHz			
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		

5.3 Requirement

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.

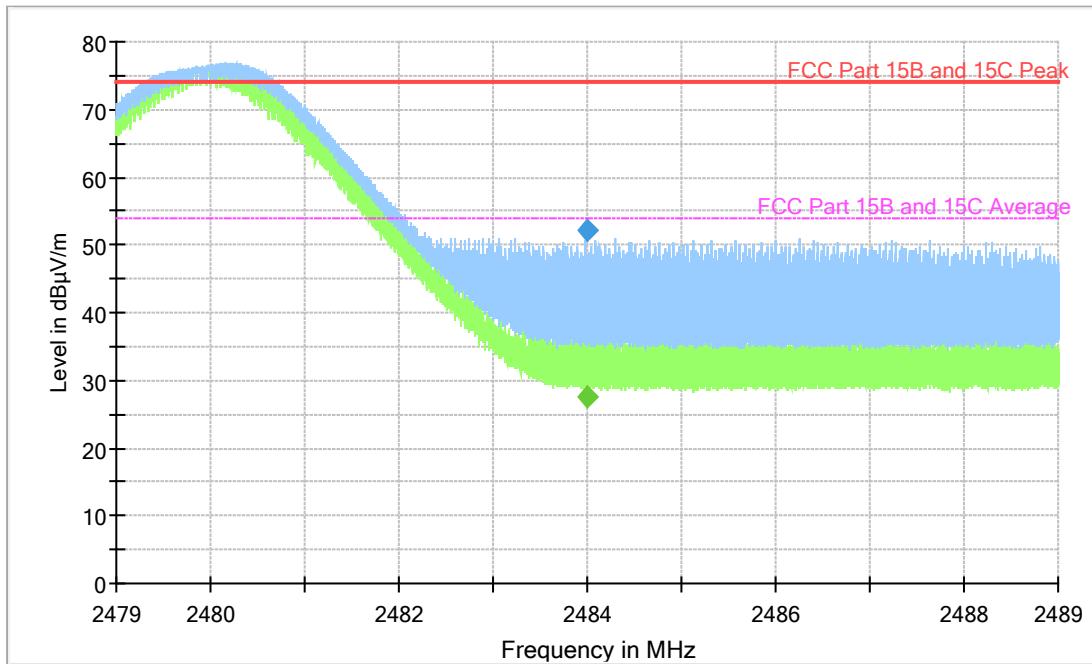
Within restricted bands:

Reference: CFR 47 §15.209, 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 (dB μ V/m)	Field strength at 10 m (dB μ V/m)	Detector (dB μ V/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

5.4 Test results



Upper band edge sweep

6 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 26.5 GHZ

Date of test:	2018-09-11	Test location:	Radio hallen
EUT Serial:	TK-018	Ambient temp:	22 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	>20 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	Peak value + 20 x LOG (Duty cycle) / 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 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 (dB μ V/m)	Field strength at 10 m (dB μ V/m)	Detector (dB μ V/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

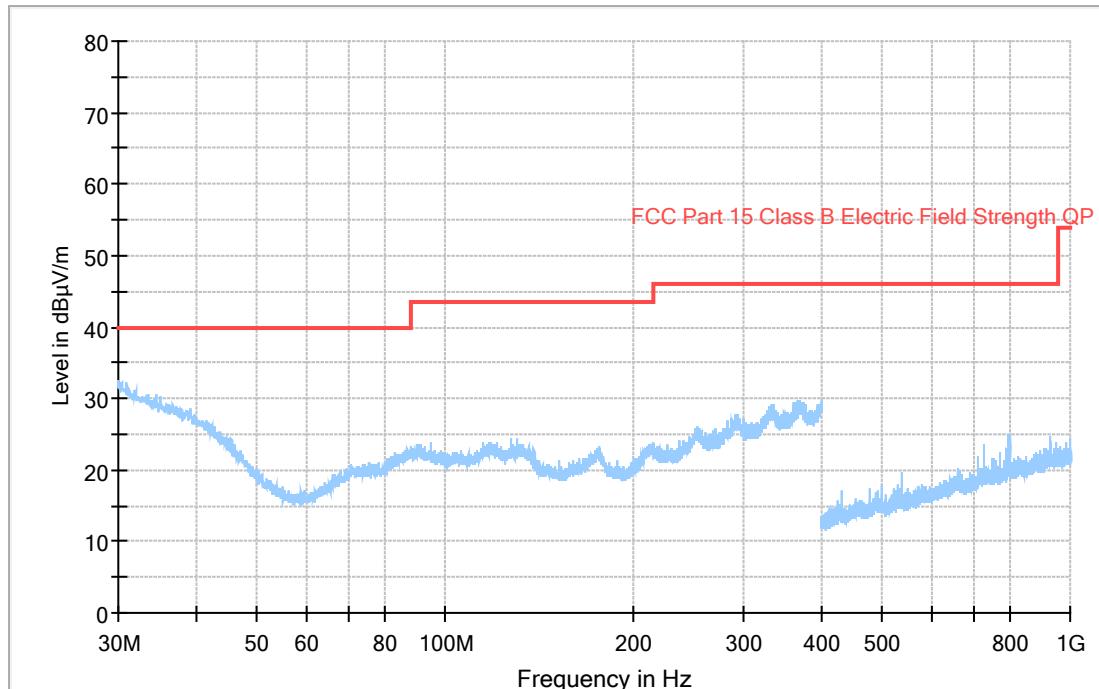
The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit.
(i.e. an extrapolation factor of 20 dB/decade according to CFR 47 §15.31(f)(1))

Outside the restricted bands:

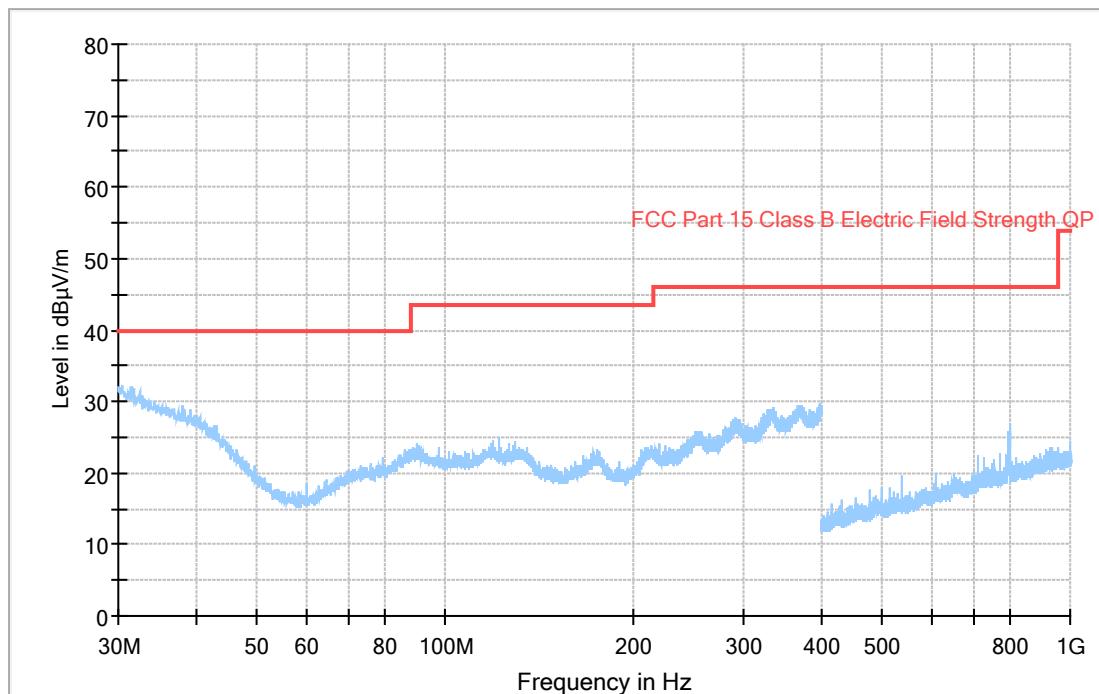
Reference: CFR 47 §15.247(d), RSS-247 5.5,

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.

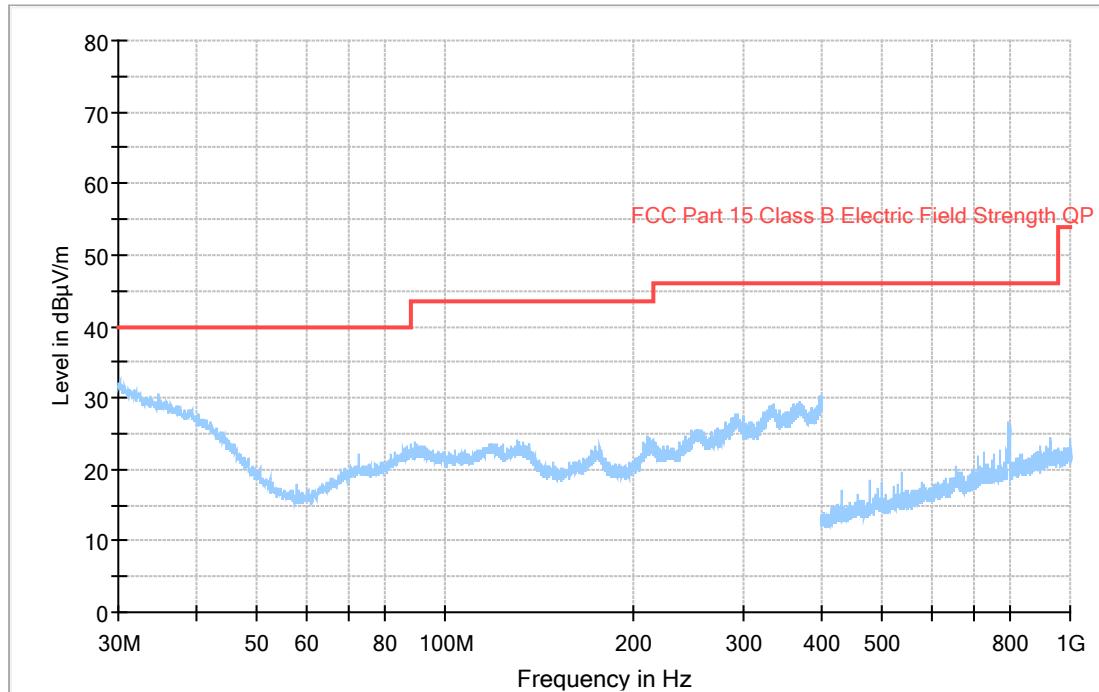
6.4 Test results 30 MHz – 1000 MHz, TX



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



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



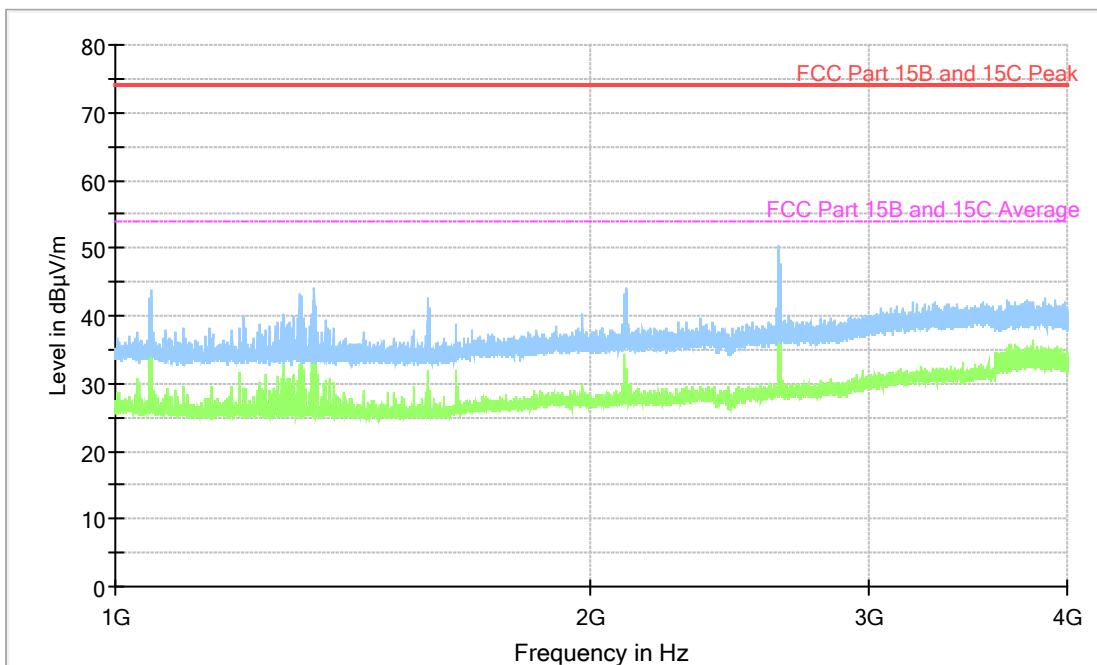
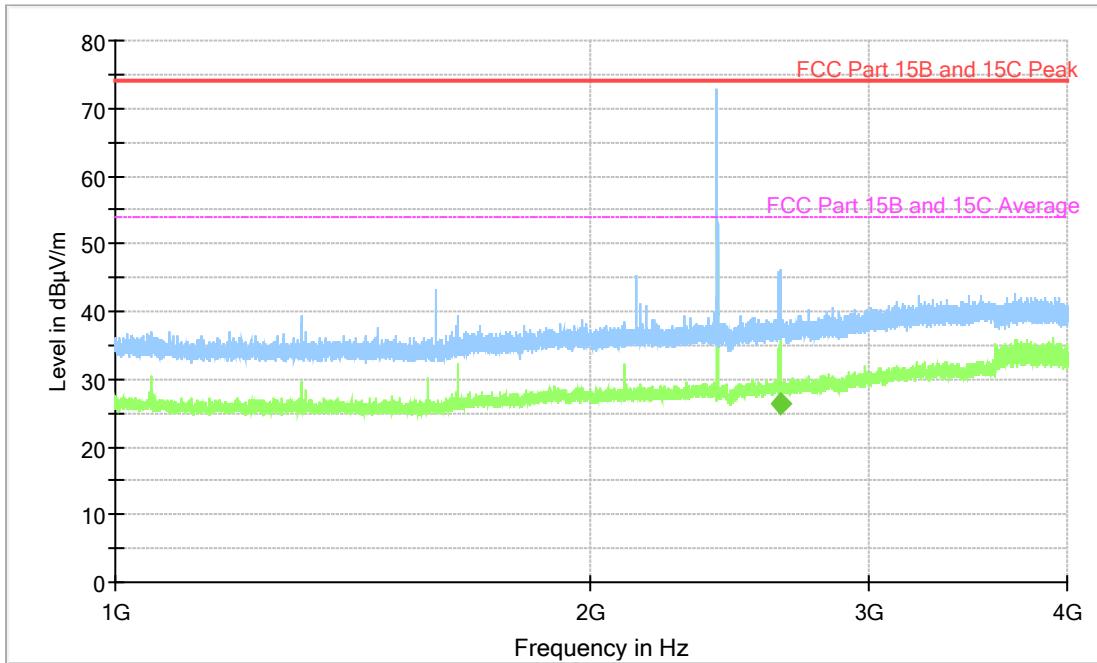
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX top channel, EUT horizontal

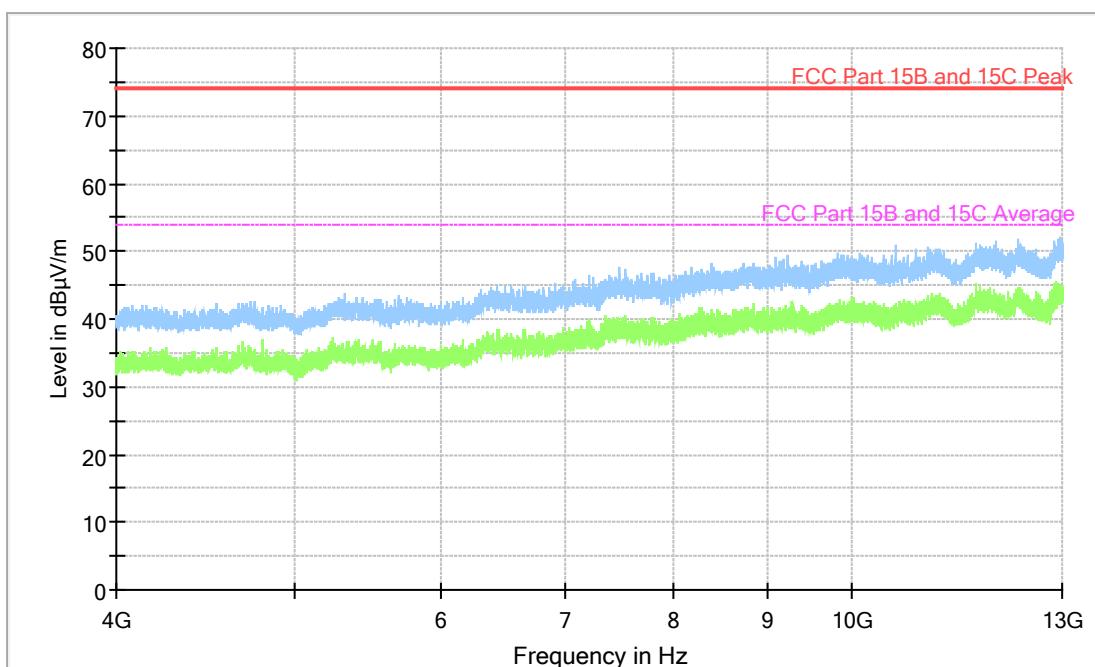
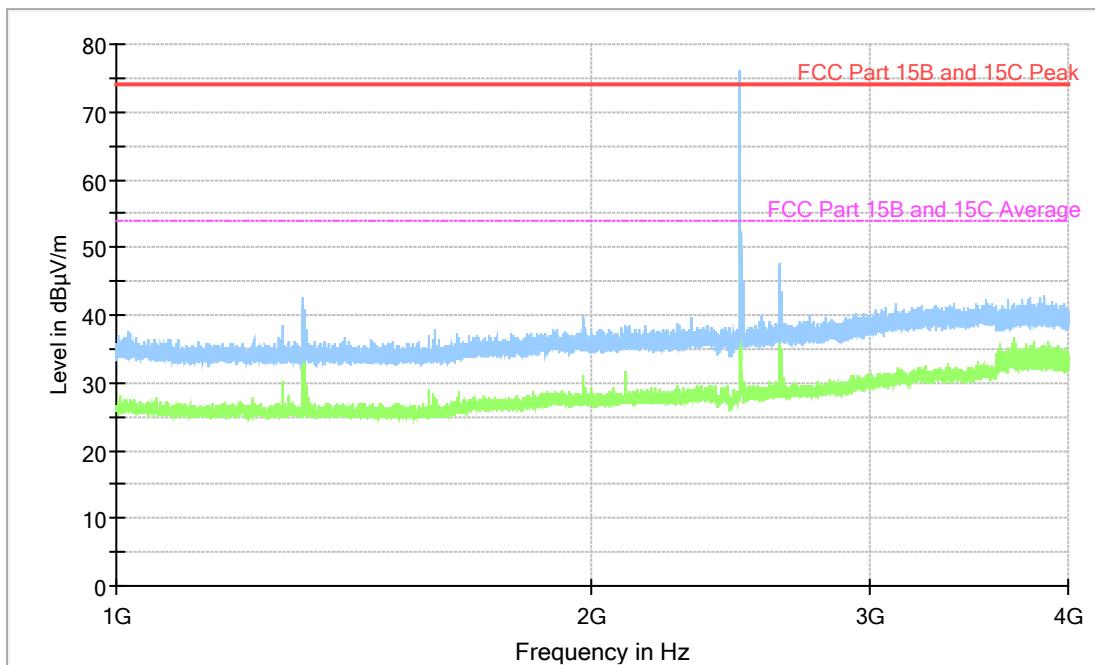
Measurement results, Quasi Peak

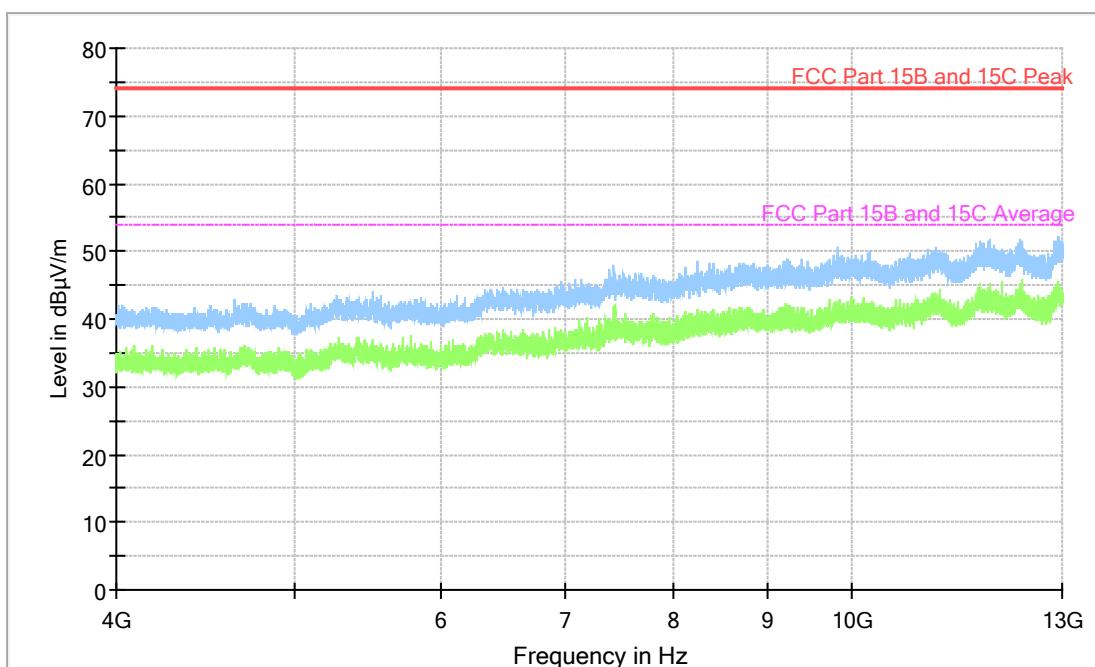
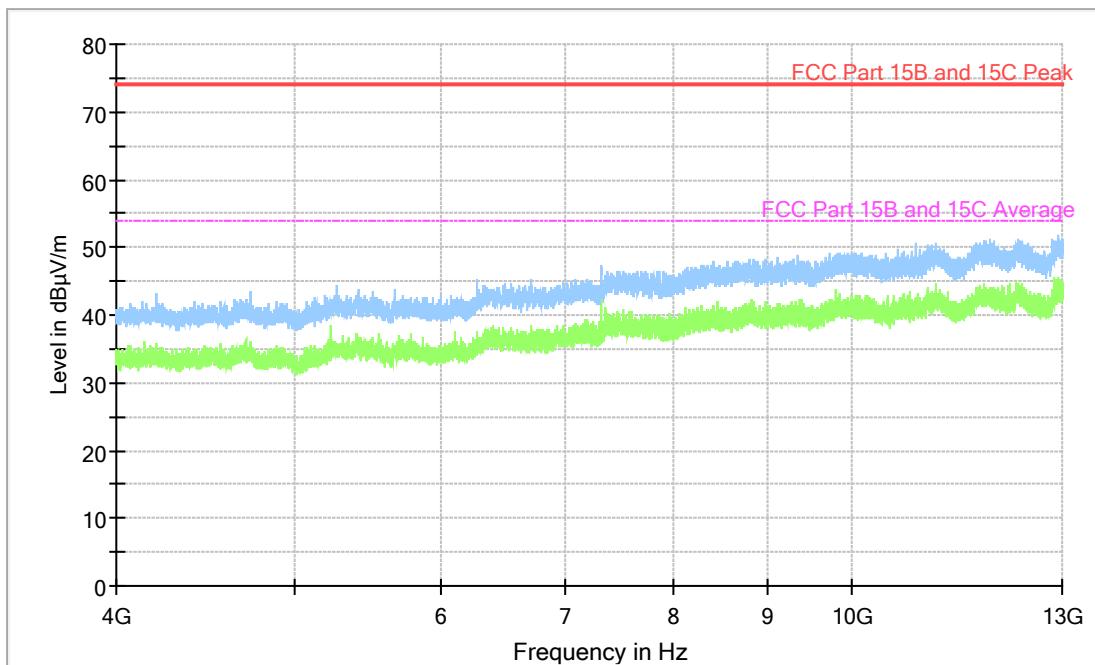
No emissions are found above noise floor or closer than 20 dB from limit.

Note, disturber att 800 MHz does not belong to the EUT

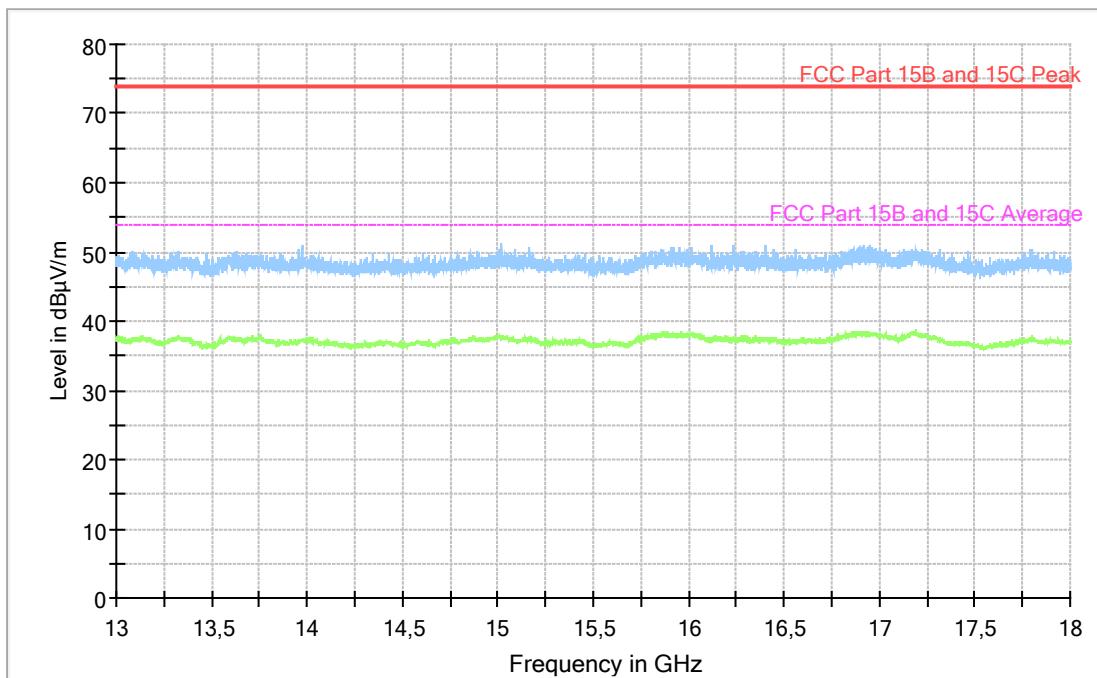
6.5 Test results 1 GHz – 26.5 GHz, TX





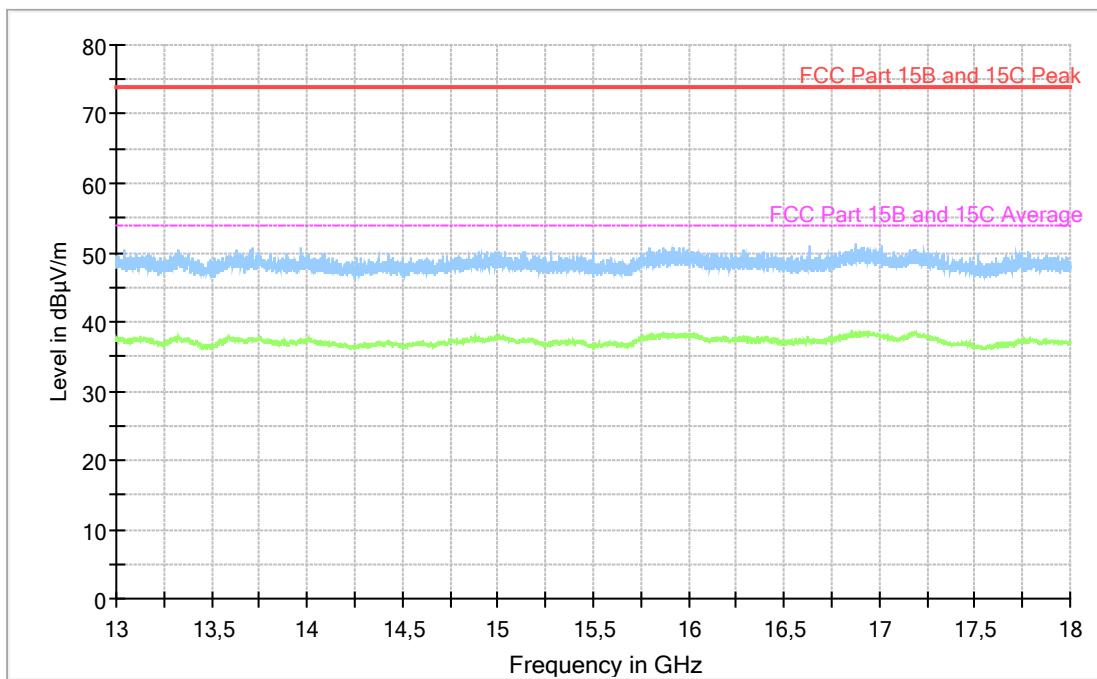


Full Spectrum



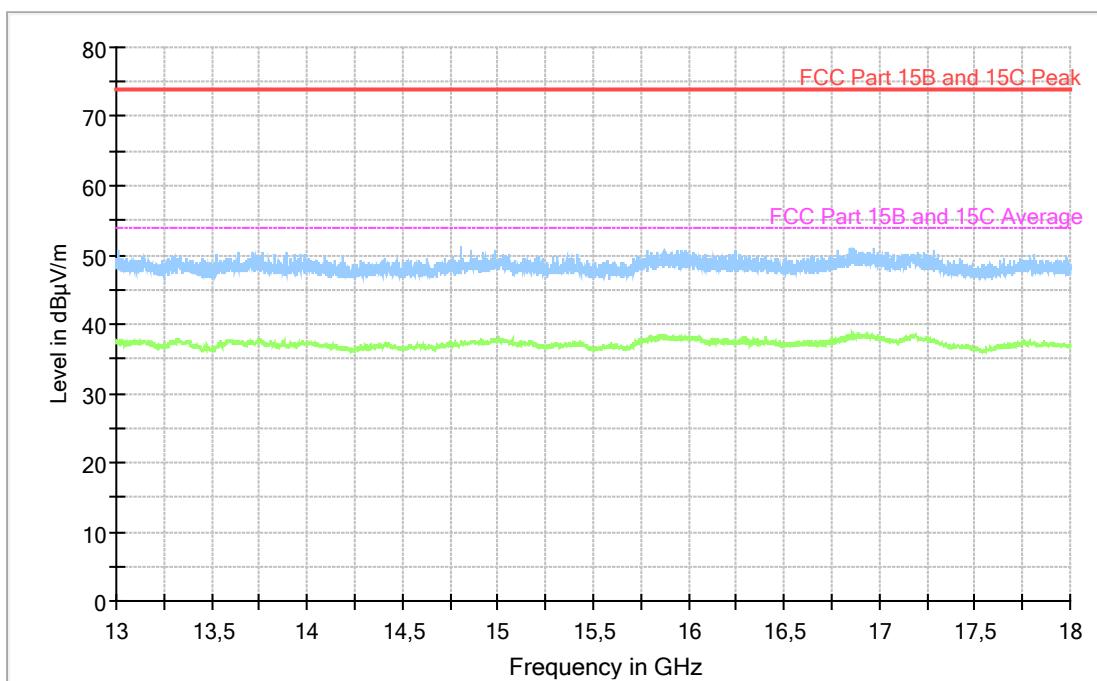
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX low channel

Full Spectrum



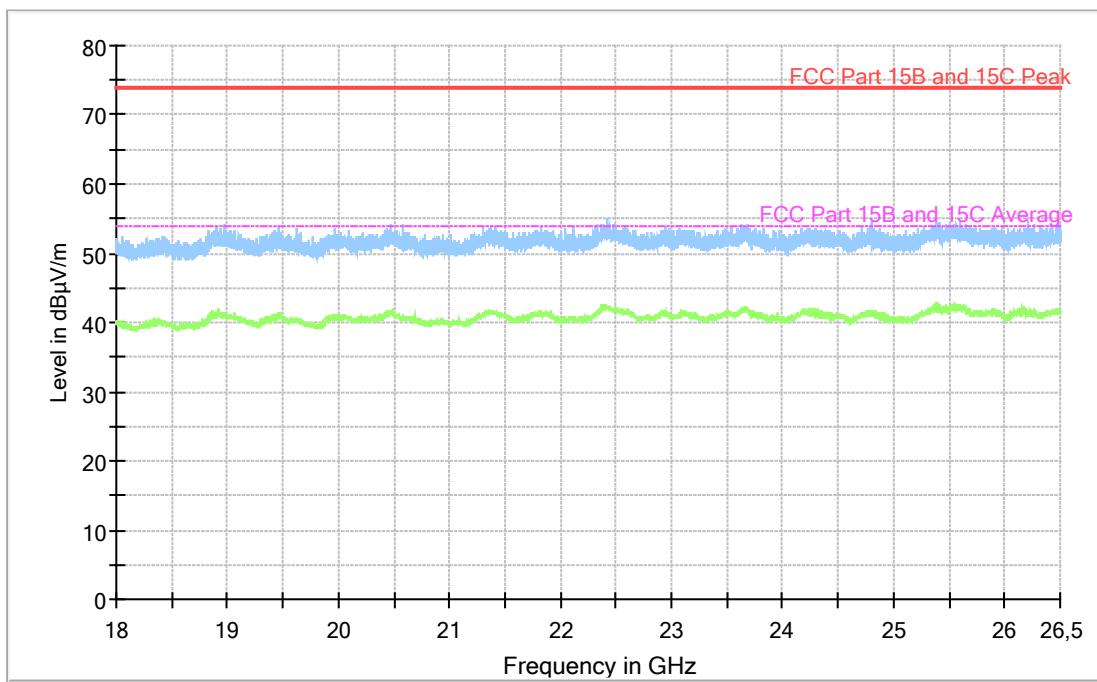
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX mid channel

Full Spectrum



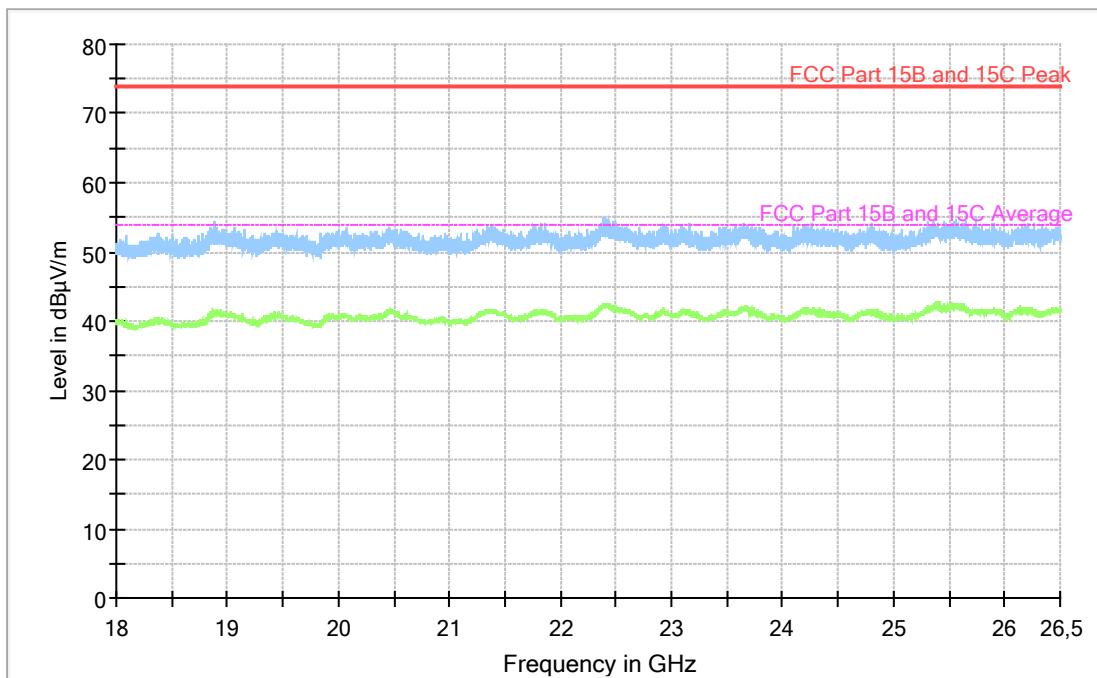
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX top channel

Full Spectrum



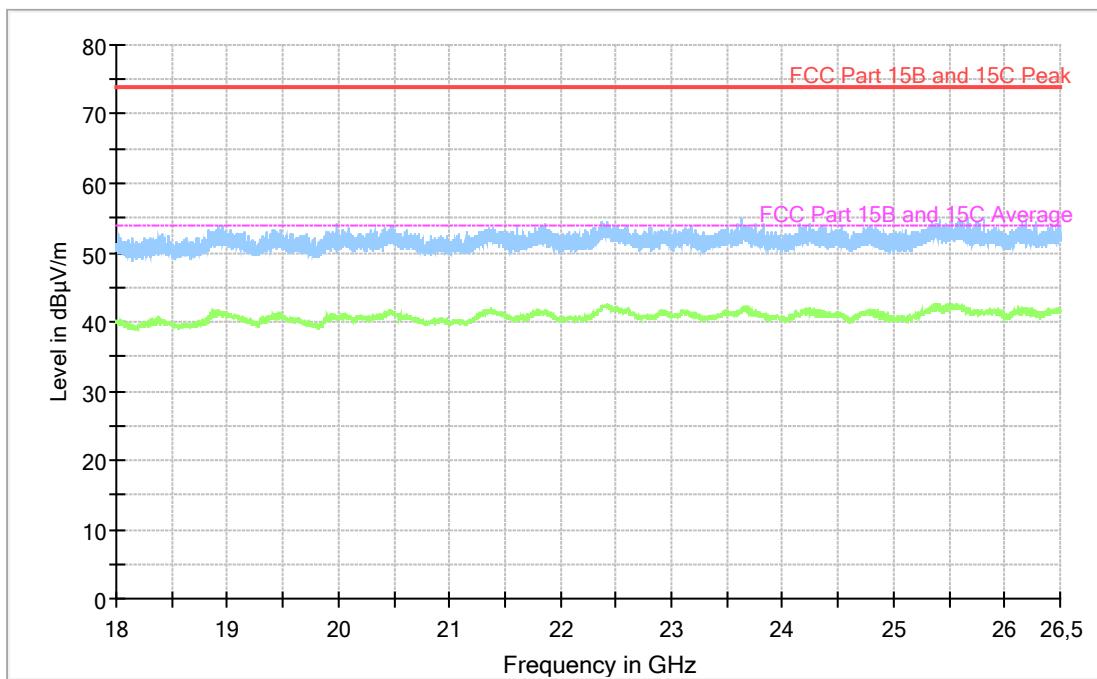
Diagram, Peak overview sweep, 18 – 26.5GHz at 3 m distance. TX low channel

Full Spectrum



Diagram, Peak overview sweep, 18 – 26.5GHz at 3 m distance. TX mid channel

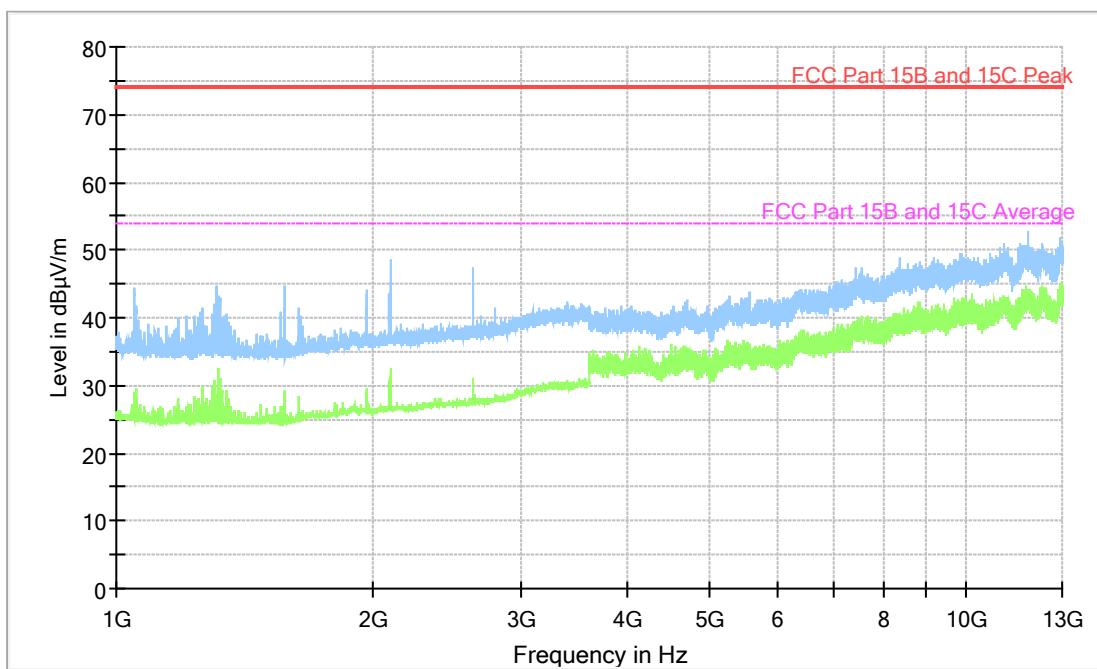
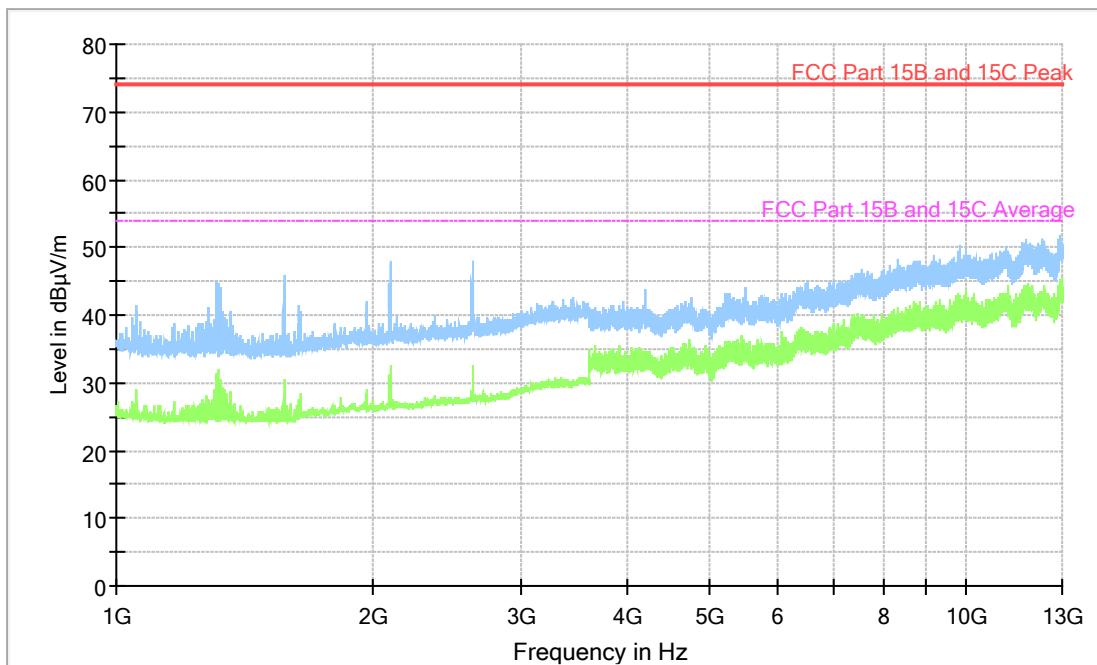
Full Spectrum

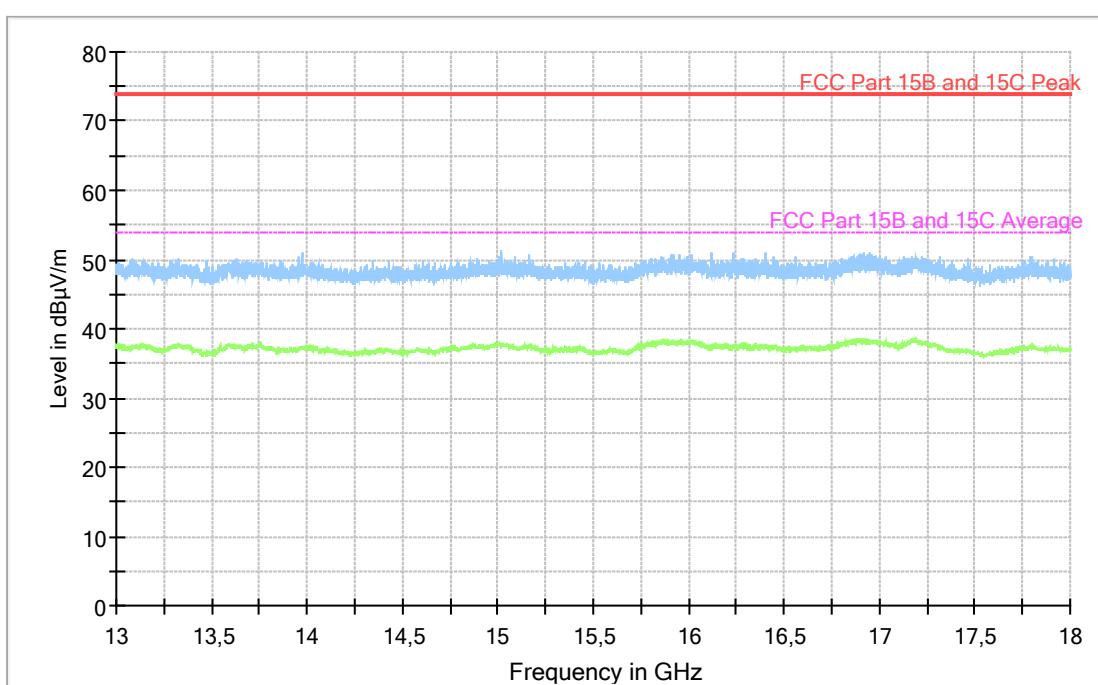
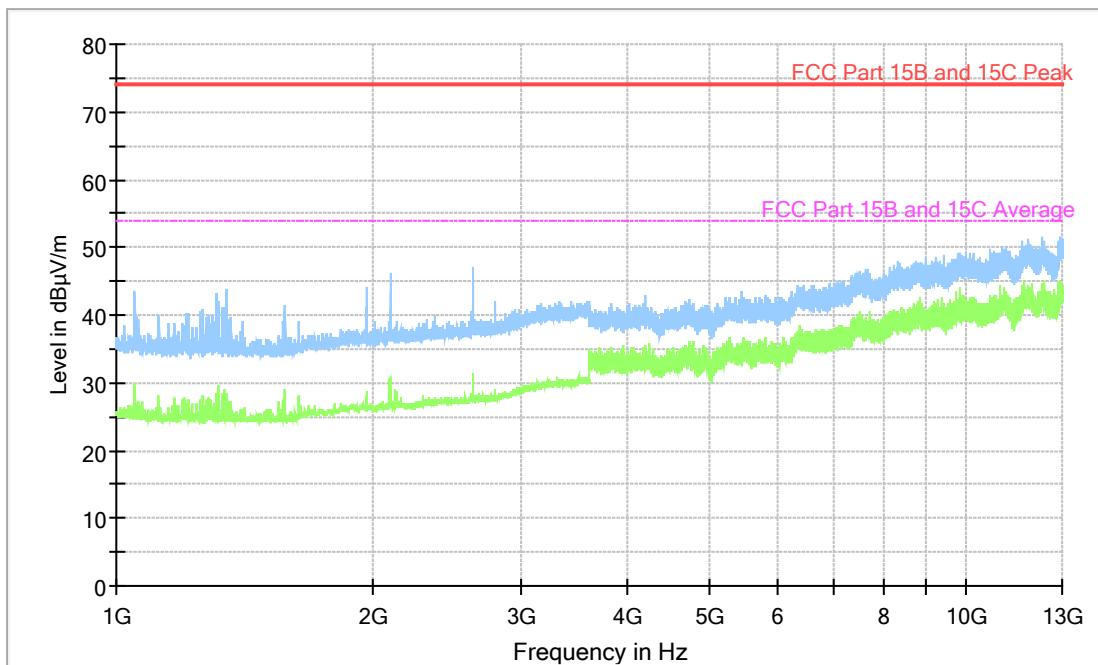


Diagram, Peak overview sweep, 18 – 26.5GHz at 3 m distance. TX top channel

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

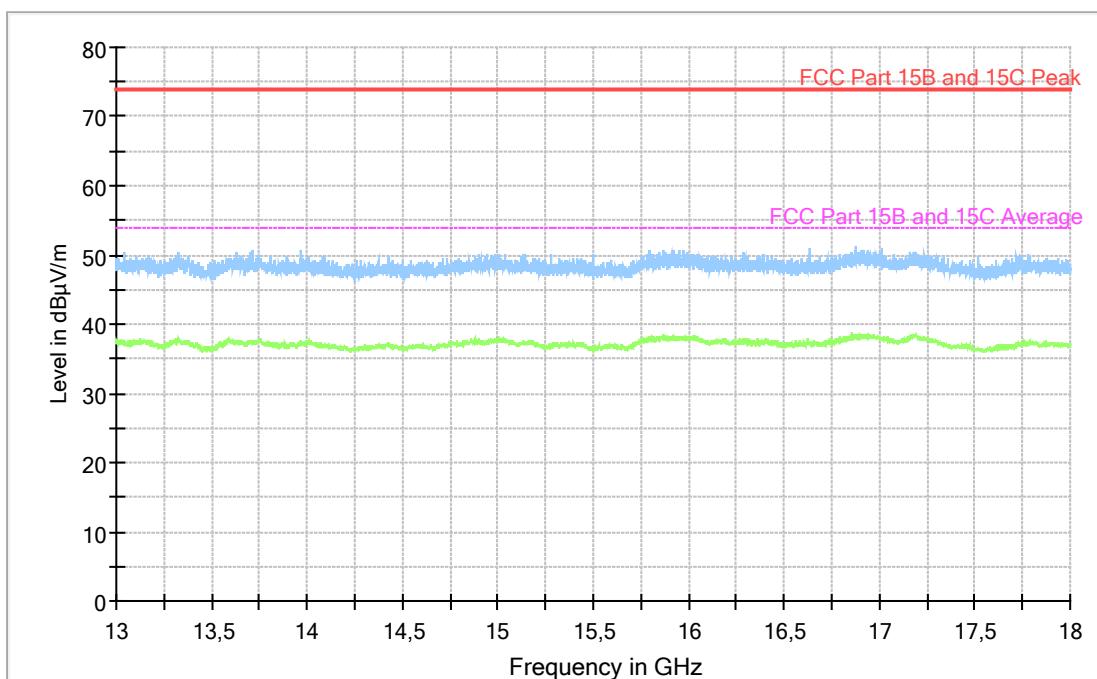
Result [dB μ V/m] = Analyser reading [dB μ V] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

6.6 Test results 1 GHz – 26,5 GHz, RX



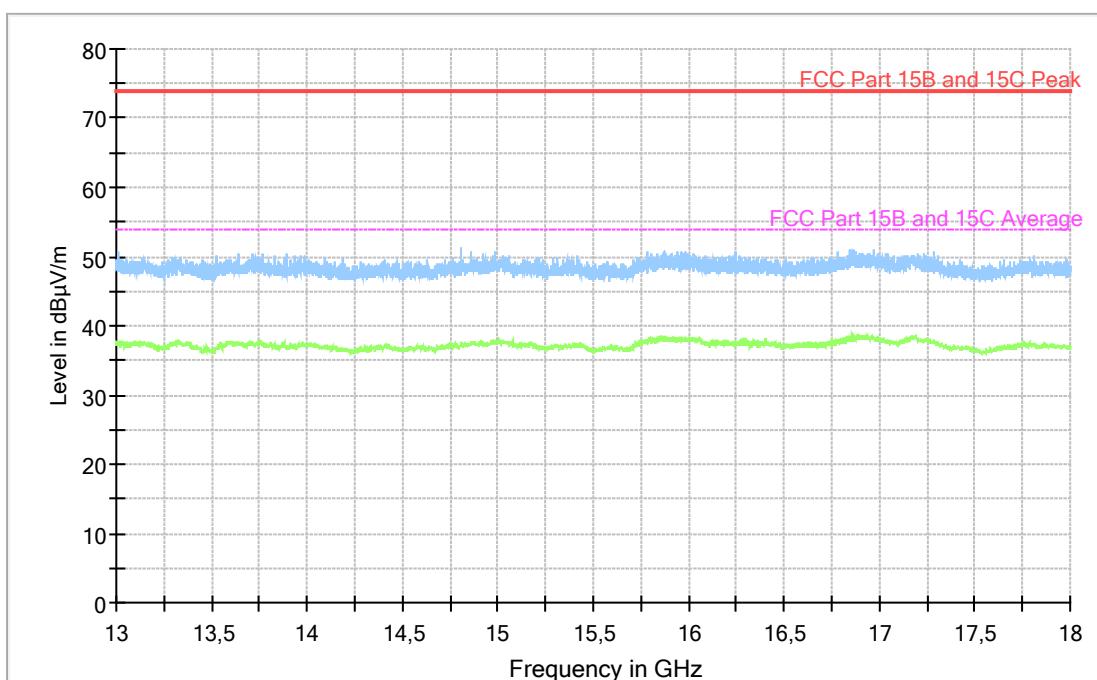
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. RX low channel

Full Spectrum



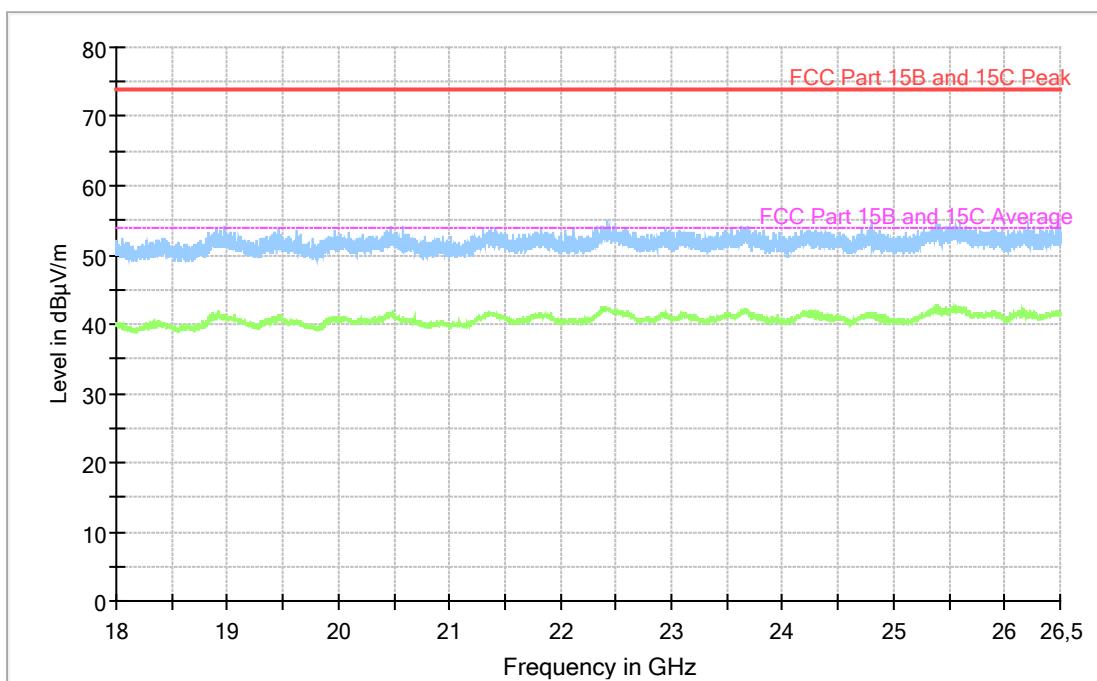
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. RX mid channel

Full Spectrum



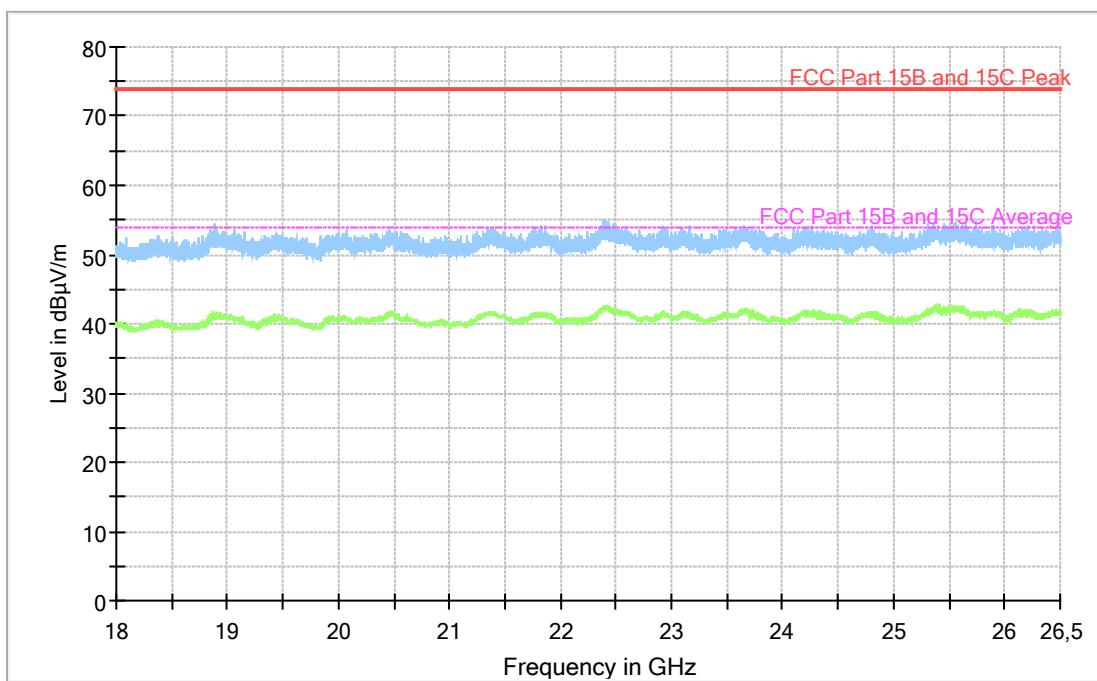
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. RX top channel

Full Spectrum

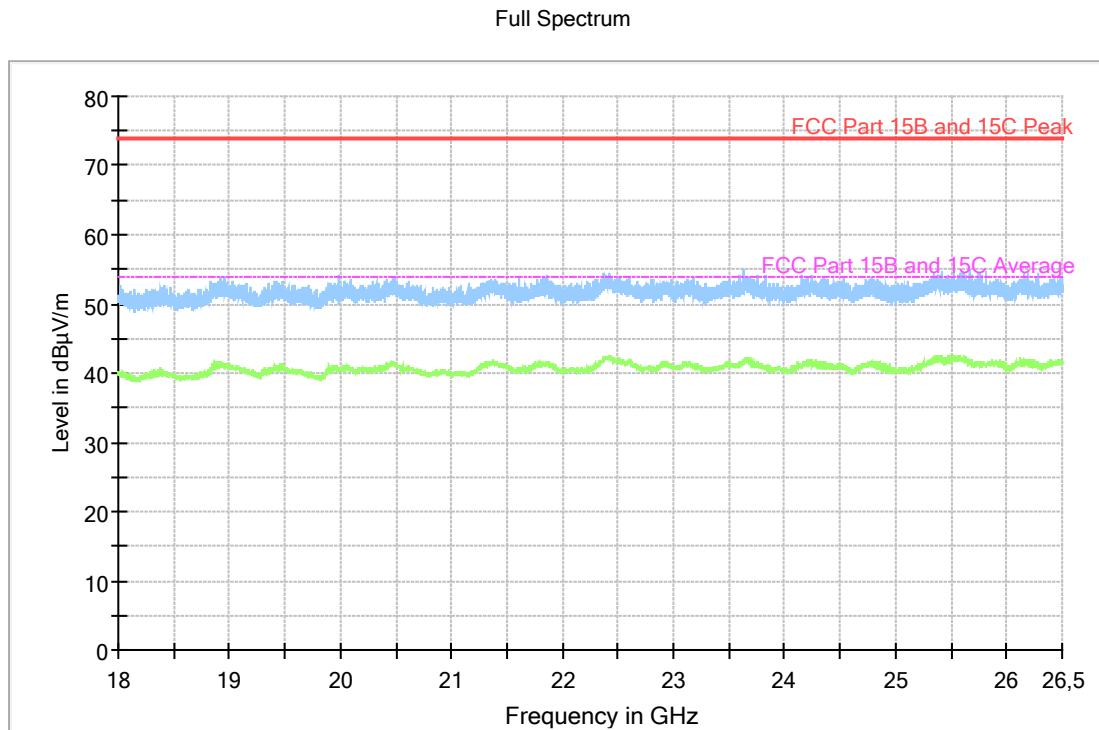


Diagram, Peak overview sweep, 18 -26.5 GHz at 3 m distance. RX low channel

Full Spectrum



Diagram, Peak overview sweep, 18 -26.5 GHz at 3 m distance. RX mid channel



Diagram, Peak overview sweep, 18 - 26.5 GHz at 3 m distance. RX top channel

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

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

7 CONDUCTED BAND EDGE MEASUREMENT

Date of test:	2018-09-19	Test location:	Radio
EUT Serial:	TK-015	Ambient temp:	21 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	>20 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

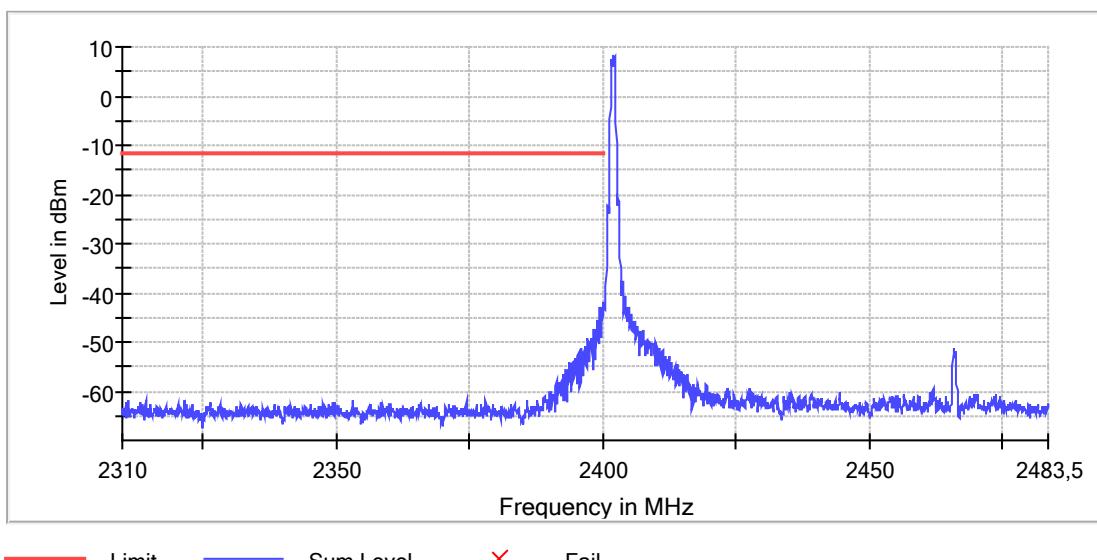
Detector: Peak,
RBW: 100 kHz
VBW: 300 kHz
Span: 83,5 MHz

7.3 Requirement

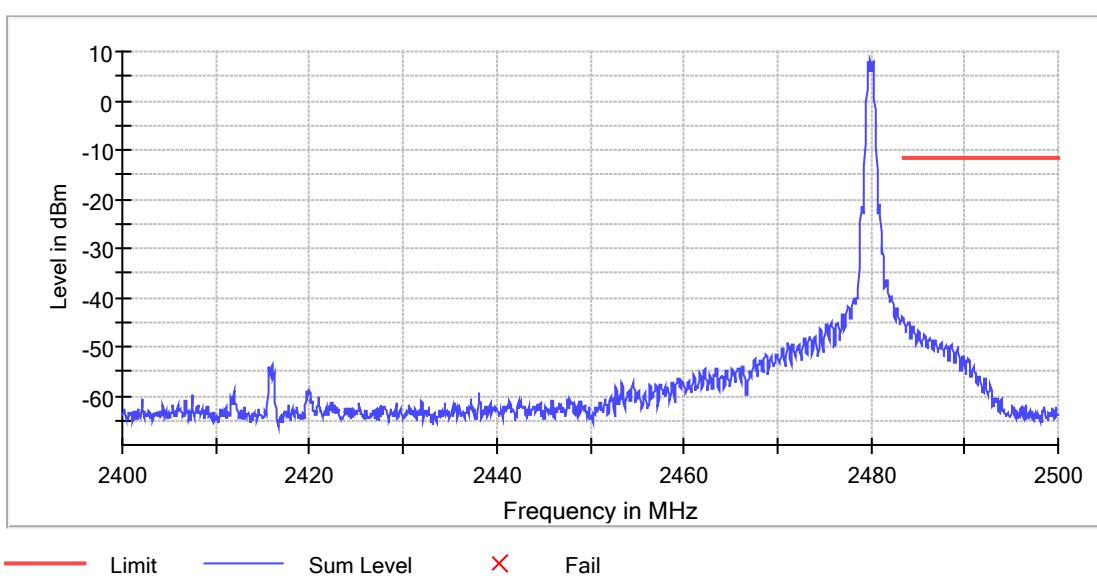
Reference: CFR 47 §15.247(d), RSS-247 5.5,

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



Screenshot: Lower band edge sweep, single channel



Screenshot: Upper band edge sweep, single channel

Test results

Band edge	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	39,6	20,0	>20,0
Upper	53,5	20,0	>20,0

8 PEAK CONDUCTED OUTPUT POWER

Date of test:	2018-09-19	Test location:	Radio
EUT Serial:	TK-015	Ambient temp:	21 °C
Tested by:	PLA	Relative humidity:	55 %
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 11.10.2.

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

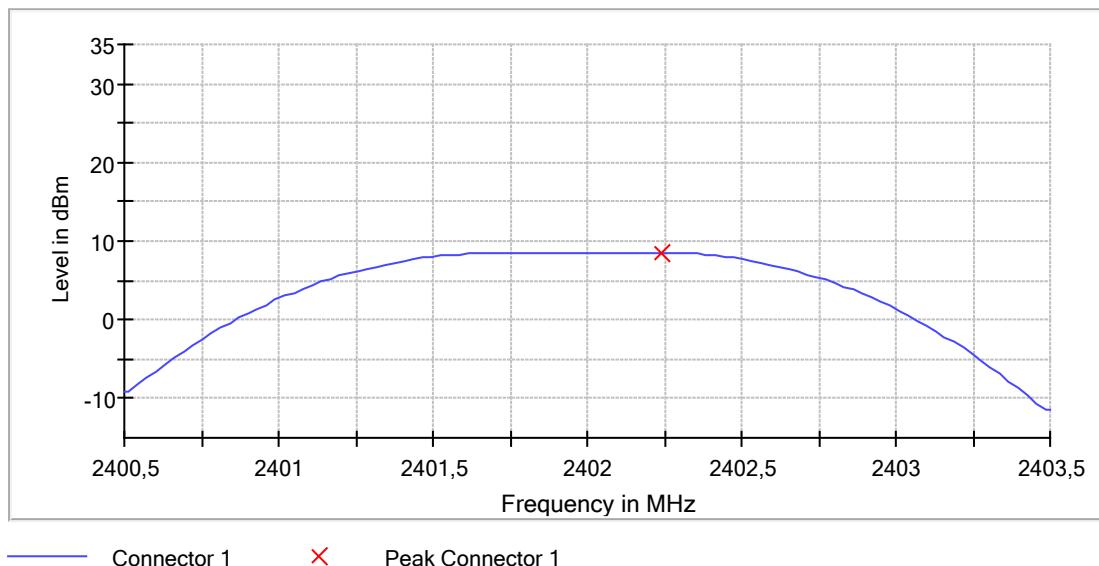
The EUT was set up in order to emit maximum disturbances.

8.3 Requirements

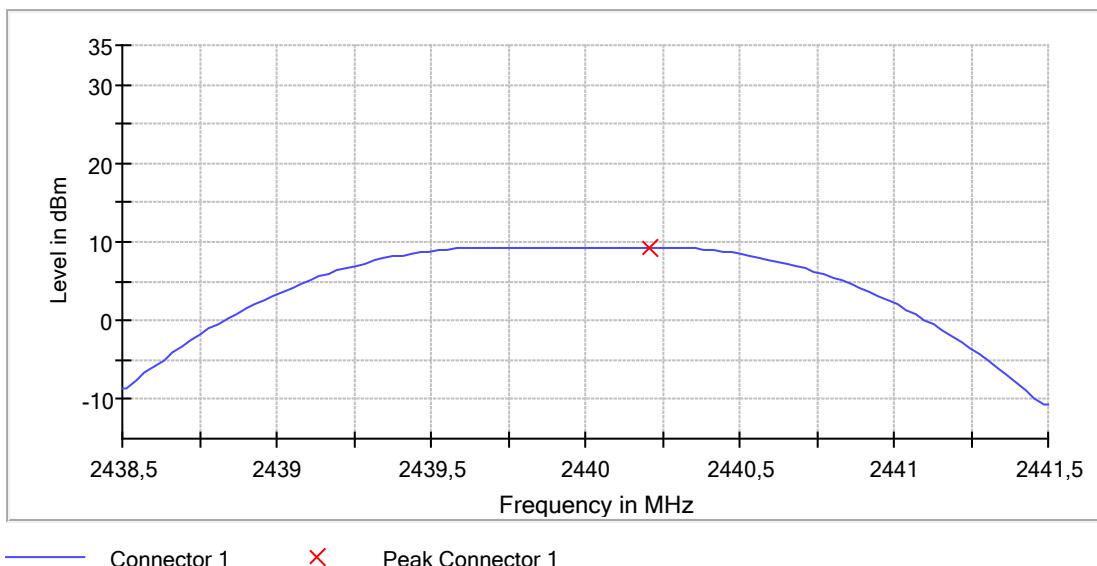
Reference: CFR 47§15.247(b)(3), RSS-247 5.4

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.

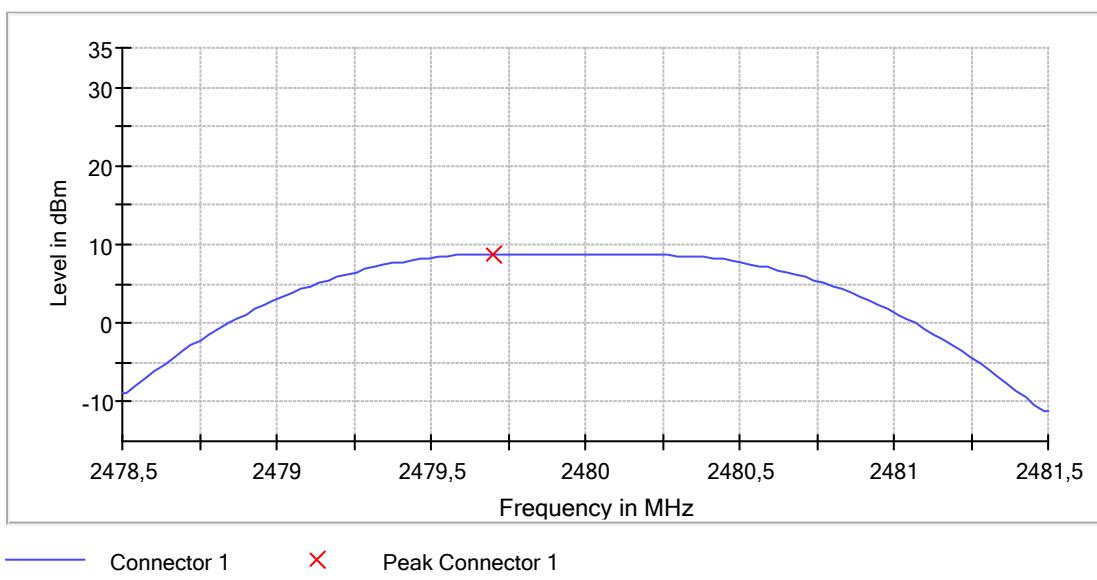
8.4 Test results



Screenshot: Output power, low channel



Screenshot: Output power, middle channel



Screenshot: Output power, high channel

Test result

Channel [MHz]	Output power [dBm]
2402	8.6
2440	9.3
2480	8.7

9 OCCUPIED 6 DB BANDWIDTH

Date of test:	2018-09-19	Test location:	Radio
EUT Serial:	TK-015	Ambient temp:	21 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	0.232 MHz

9.1 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.

9.2 Test conditions

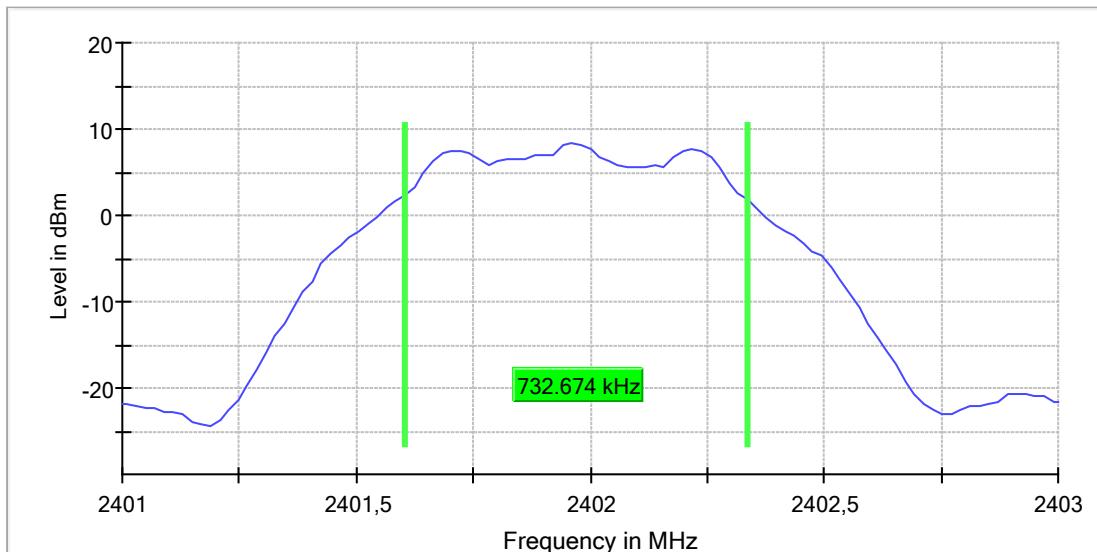
Detector: Peak,
RBW: 100 kHz
VBW: 3 x RBW
Span: >1,5 x OBW

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

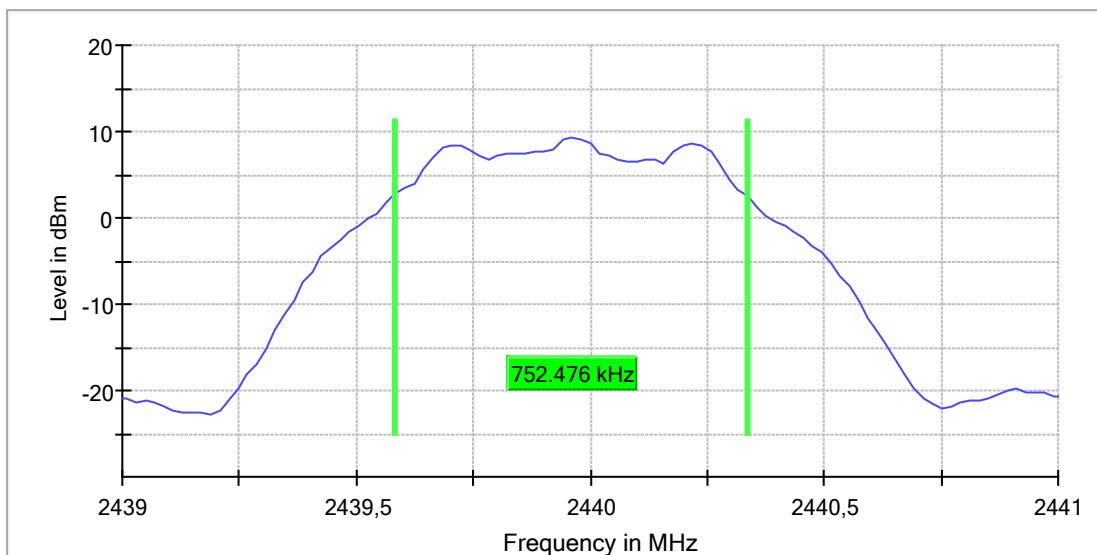
9.3 Requirements

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

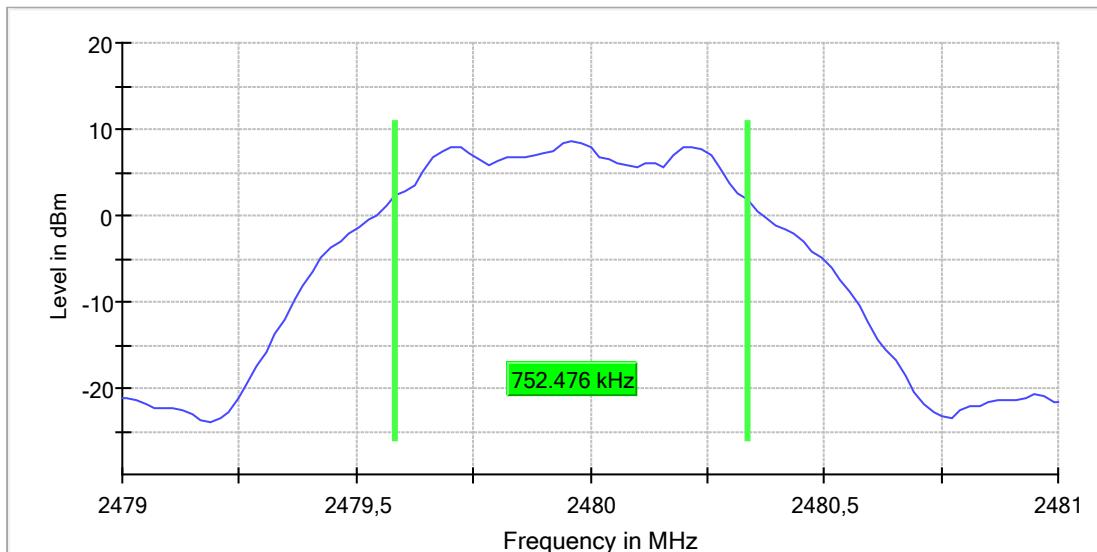
9.4 Test results



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]
2402	0.732
2440	0.752
2480	0.752

10 99 % BANDWIDTH

Date of test:	2018-09-19	Test location:	Radio
EUT Serial:	TK-015	Ambient temp:	21 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	-

10.1 Test set-up and test procedure.

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

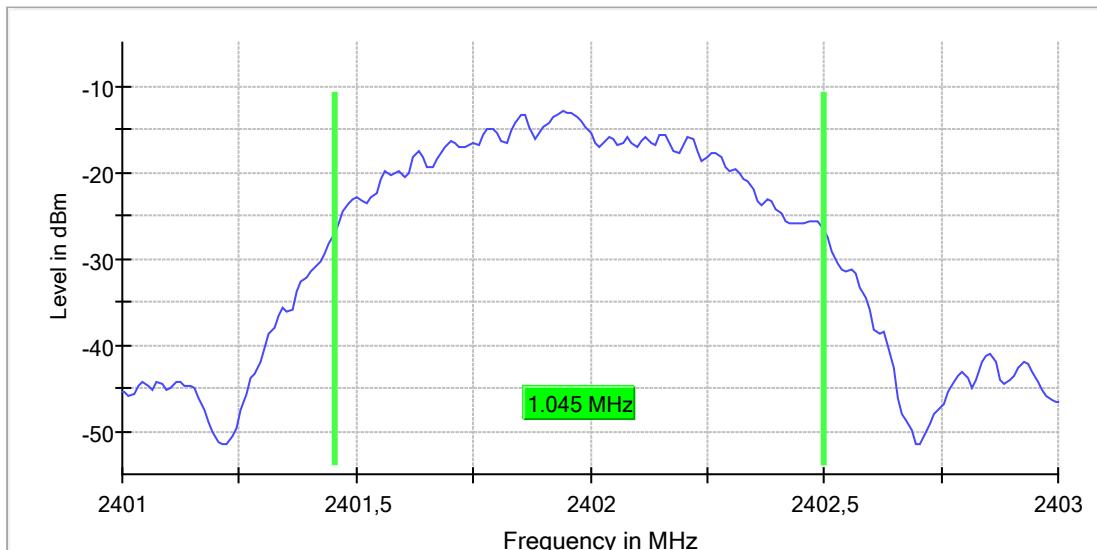
The EUT was connected to spectrum analyser via rf-cable and attenuator. Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

10.2 Test conditions

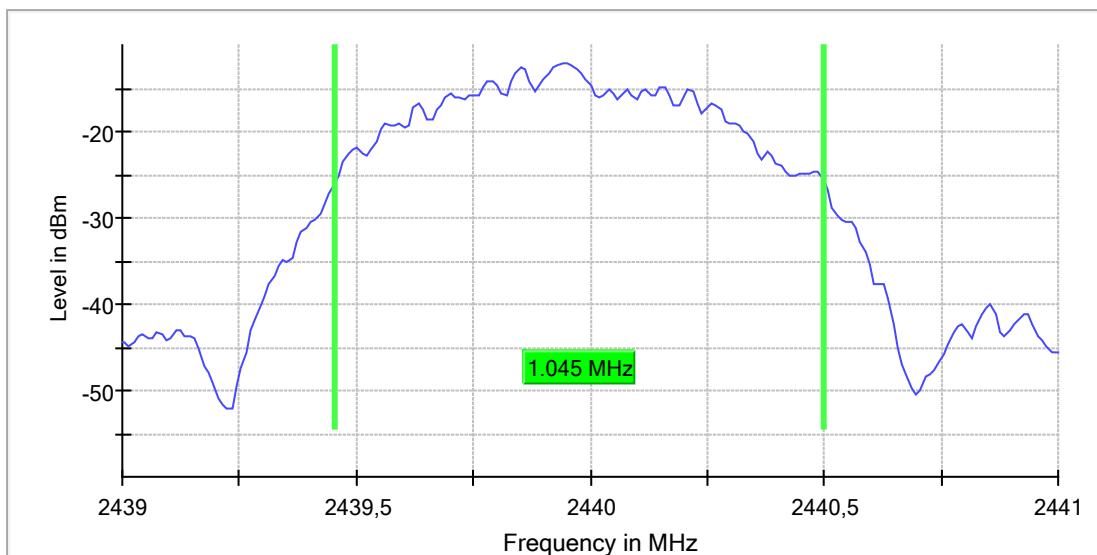
Detector: Peak,
RBW: 1 – 5 % of OBW
VBW: 3 x RBW

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

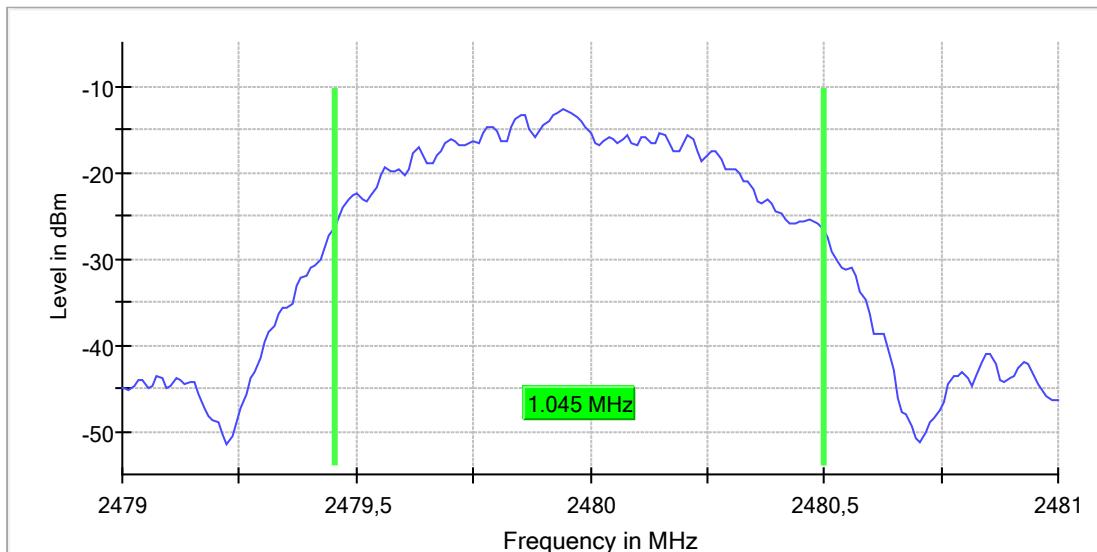
10.3 Test results



Screenshot: 99 % bandwidth Measurement, low channel



Screenshot: 99 % bandwidth Measurement, middle channel



Screenshot: 99 % bandwidth Measurement, high channel

Test result

Channel [MHz]	99 % BW [MHz]
2402	1.045
2440	1.045
2480	1.045

11 PEAK POWER SPECTRAL DENSITY

Date of test:	2018-09-19	Test location:	Radio
EUT number:	TK-015	Ambient temp:	21 °C
Tested by:	PLA	Relative humidity:	55 %
Test result:	Pass	Margin:	>8 dB

11.1 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.

11.2 Test conditions

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

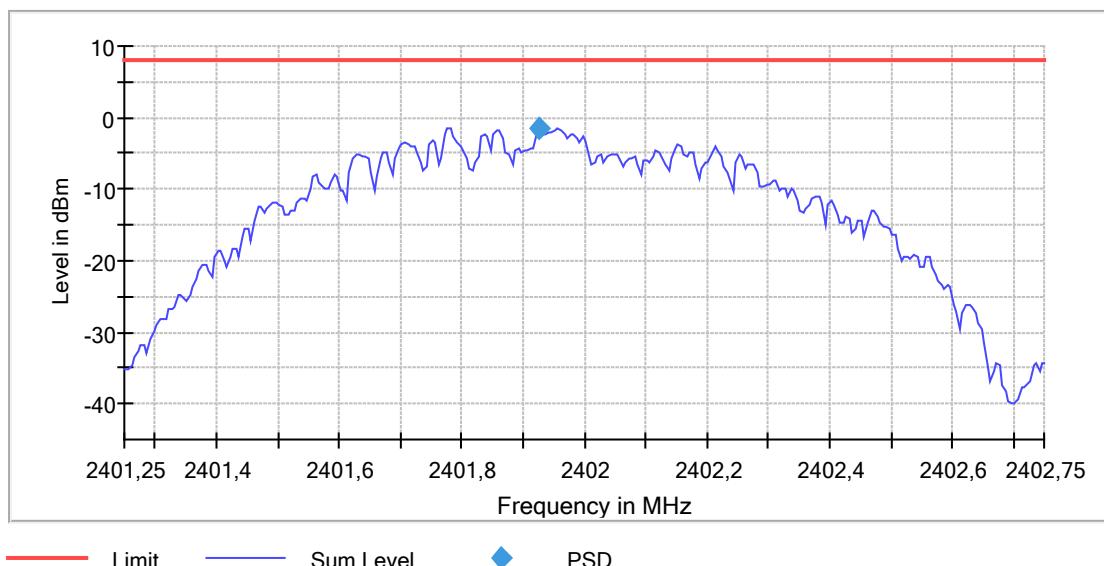
The EUT was set up in order to emit maximum disturbances.

11.3 Requirements

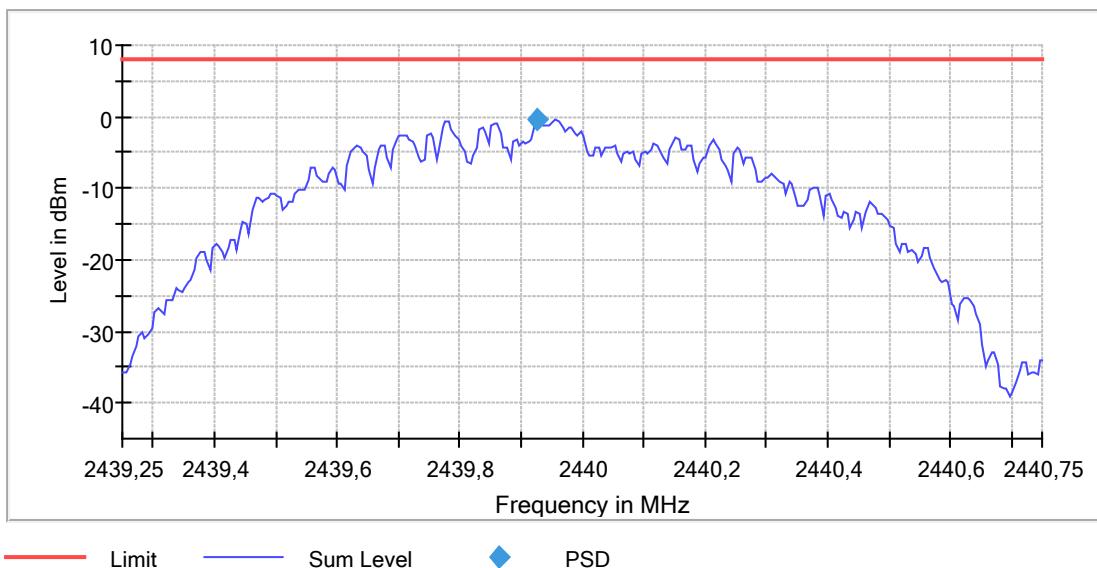
Reference: CFR 47§15.247(3), RSS-247 5.2(A)

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.

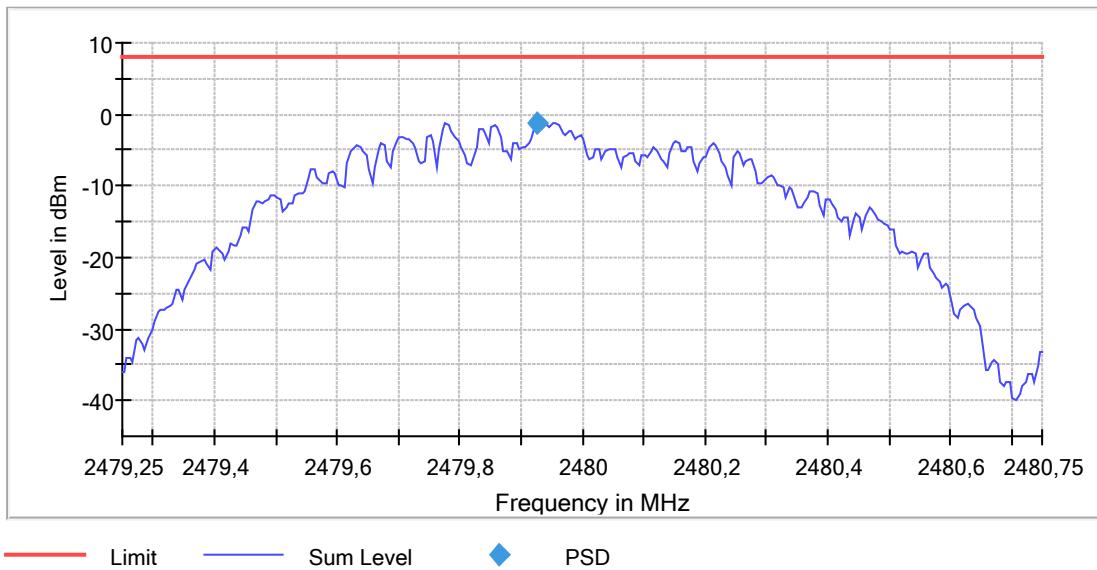
11.4 Test results



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	-1.4
2445	-0.5
2480	-1.1

12 TEST EQUIPMENT

5m SAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 10	--	--	--
Receiver	Rohde & Schwarz	ESW44	33950	Aug-2018	1 year
Antenna	Rohde & Schwarz	HL562	32310	April-2018	3 years
Coaxial cable	Rosenberger	FP1	39053	Mars-2018	1 year

Wireless Center and 3m FAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - Version 10	--	--	--
Signal analyzer	Rohde & Schwarz	ESU 40	13178	July-2018	1 year
Measurement cable	Huber + Suhner	Sucoflex 104 PE	39138	July-2018	1 year
Measurement cable	Huber + Suhner	Sucoflex 104	5191	July-2018	1 year
Measurement cable	Huber + Suhner	Sucoflex 104	39119	July-2018	1 year
Horn antenna	EMCO	3115	4628	Nov-2015	3 years
Pre amplifier	Sangus	00101400-23-10P-6-S ; AFS44-12002400-32-10P-44	12335	July-2018	1 year
Horn antenna	EMCO	3160-08	30099	Oct-2016	3 years
Horn antenna	EMCO	3160-09	30101	Oct-2016	3 years
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	Mars-2018	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	July-2018	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 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 %.

14 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1812896STO-003 Annex 1.
Test set up photos are in separate document 1812896STO-004 Annex 2.