

RADIO TEST REPORT

No. 1910014STO-002, Ed. 3

RF performance

EQUIPMENT UNDER TEST

Equipment: Gateway
Type/Model: TENA SmartCare (BLE version)
Tork EasyCube (802.15.4 version)
Manufacturer: Essity AB
Tested by request of: Essity 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 5 Amendment 1 (2019): General requirements of compliance of radio apparatus (2019)

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: August 26, 2020

Tested by:



Robert Hietala

Approved by:



Björn Utermöhl

Revision History

Edition	Date	Description	Changes
1	January 15, 2020	First release	--
2	July 9, 2020	Second release	<ul style="list-style-type: none"> - Added conducted measurement results for Bluetooth Low Energy - Updated section 2 and section 4
3	August 26, 2020	Third release	<ul style="list-style-type: none"> - Updated section 4, from external antenna connector to internal antenna connector

CONTENTS

	Page
1 Client Information	5
2 Equipment under test (EUT).....	5
2.1 Identification of the EUT	5
2.2 Additional information about the EUT	6
2.3 Peripheral equipment	6
2.4 Test signals and operation modes	6
3 Test Specifications	7
3.1 Standards	7
3.2 Additions, deviations and exclusions from standards and accreditation	7
3.3 Test site	7
4 Test Summary	8
5 Conducted continuous disturbances in the frequency-range 0.15 to 30 MHz	9
5.1 Test set-up and test procedure	9
5.2 Requirement.....	9
5.3 Test results.....	10
6 Radiated rf Emission in the frequency-range 30 MHz to 26,5 GHz	11
6.1 Test set-up and test procedure.	11
6.2 Test conditions	11
6.3 Requirements	12
6.4 Test results 30 MHz – 1000 MHz. TX	12
6.5 Test results 1 GHz – 26.5 GHz. TX 802.15.4	14
6.6 Test results 1 GHz – 26.5 GHz. TX BLE.....	22
7 Conducted band edge measurement	31
7.1 Test set-up and test procedure.	31
7.2 Test conditions	31
7.3 Requirement.....	31
7.4 Test results 802.15.4.....	32
7.5 Test results BLE.....	33
8 Peak conducted output power.....	34
8.1 Test set-up and test procedure.	34
8.2 Test conditions	34
8.3 Requirements.....	34
8.4 Test results. 802.15.4.....	35
8.5 Test results. BLE.....	37
9 Occupied 6 dB bandwidth	39
9.1 Test set-up and test procedure.	39
9.2 Test conditions	39
9.3 Requirements	39
9.4 Test results. 802.15.4.....	40
9.5 Test results. BLE.....	42
10 99 % bandwidth	44
10.1 Test set-up and test procedure.	44
10.2 Test conditions	44
10.3 Test results. 802.15.4.....	44
10.4 Test results. BLE.....	46
11 Peak power spectral density	48
11.1 Test set-up and test procedure.	48
11.2 Test conditions	48
11.3 Requirements	48
11.4 Test results. 802.15.4.....	49
11.5 Test results. BLE.....	51
12 Test equipment.....	53

13 Measurement uncertainty 53
14 Test set up and EUT photos..... 53

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
Gateway	--	GW-REV-05-01

The EUT was tested with the following cables:

Port:	Type:	Length: [m]	Specifications:
AC Mains	AC Power	1 m	--

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.
Transmitter	--	Essity	--

2.4 Test signals and operation modes

EUT can transmit either BLE or 802.15.4 and EUT can transmit either GSM or LTE-m. Any combination of these is possible i.e the BLE model can operate both with GSM or LTE-m and the 802.15.4 model can also operate with GSM or LTE-m. An assessment before the tests concluded that there was no noticeable difference for spurious emissions whether LTE-m or GSM was operated at the same time as BLE or 802.15.4. Therefore, in these tests the EUT had BLE and LTE-m active together and 802.15.4 and GSM active together.

This report covers BLE and 802.15.4 techniques.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

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

RSS-GEN Issue 5 Amendment 1 (2019): General requirements of compliance of radio apparatus

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

Test methods:

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

3.2 Additions, deviations and exclusions from standards and accreditation

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

3.3 Test site

Measurements were performed at:

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

Intertek Semko AB is a FCC listed test site with site registration number 90913
 Intertek Semko AB is a FCC accredited conformity assessment body with designation number SE0002
 Intertek Semko AB is an Industry Canada listed test facility with IC assigned code 2042G
 Intertek Semko AB is an ISED recognized wireless testing laboratory with CAB identifier SE003

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2
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 FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	Antenna The EUT's antenna is within the enclosure of the transmitter, and the antenna can only be reached if the enclosure is disassembled.	PASS
	The antenna gain is less than 6 dBi.	
FCC Part 15.205 RSS-GEN 8.10	Restricted bands of operations The transmit frequency, including fundamental components of modulation, of license-exempt radio apparatus shall not fall within the restricted frequency bands listed in CFR 47 §15.205 and in RSS-GEN section 8.10	PASS
	EUT operates in unrestricted 2402 – 2480 MHz frequency band.	
FCC §15.207(a), 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 margin to the limit was at least 18.3 dB at 165 kHz. 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. The margin to the limit was at least 10 dB. See clause 7.4 – 7.5.	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 at least 13.5 dB at 1804.9 MHz. See clause 7.6 – 7.7.	PASS
FCC §15.247(a)(2) RSS-GEN 6.7 RSS-247 5.2(1)	Occupied bandwidth The EUT complies with the limits. The margin to the limit is at least 232.7 kHz. See clause 9.4.	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 at least 24.5 dB at 2440 MHz. 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 at least 13.1 dB at 2440 MHz. See clause 11.4.	PASS
FCC §15.247(d) RSS-247 5.5	Conducted Band edge The EUT complies with the limits. The margin to the limit was at least 8.3 dB at 2484 MHz. See clause 6.4.	PASS

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

Date of test:	3 July 2019	Test location:	BUR 1
EUT Serial:	GW-REV03-01 GW-REV03-06	Ambient temp:	22°C
Tested by:	Linn Lemón	Relative humidity:	41%
Test result:	Pass	Margin:	> 10 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

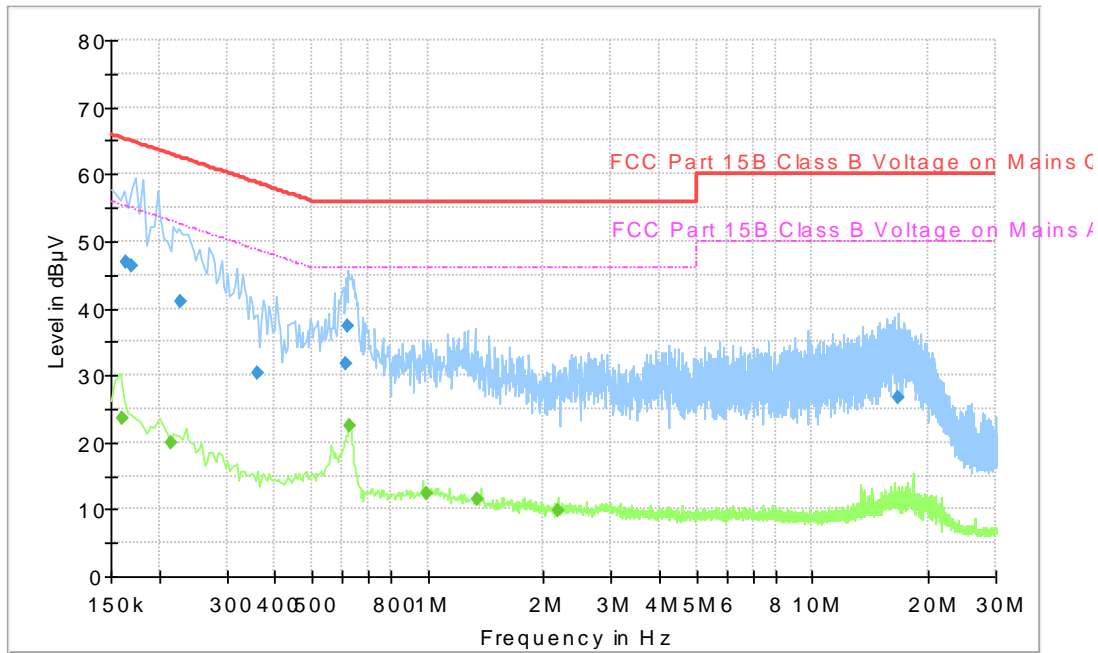
Limits for conducted emission from AC mains

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]
0.161	23.6	55.4	L1	31.8
0.216	20.0	53.0	N	33.0
0.624	22.4	46.0	N	23.6
0.992	12.3	46.0	N	33.7
1.349	11.4	46.0	N	34.6
2.189	9.9	46.0	N	36.1

Measurement results, Average

Frequency [MHz]	Level [dBµV]	Limit [dBµV]	Line L/N	Margin [dB]
0.165	46.9	65.2	N	18.3
0.170	46.4	65.0	L1	18.4
0.228	41.1	62.5	N	21.4
0.361	30.3	58.7	L1	28.4
0.609	31.9	56.0	L1	24.1
0.622	37.2	56.0	N	18.8

All other measured disturbances have a margin of more than 20 dB to the limits.
 Result [dBµV] = Analyser reading [dBµV] + cable loss [dB] + LISN insertion loss [dB]

6 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 26,5 GHZ

Date of test:	August 15, 2019	Test location:	Stora Hallen and Radiohallen
EUT Serial:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
Test result:	Pass	Margin:	7,2 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:

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

10 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°

1.5 m

Vertical and Horizontal

Horn

The EUT is rotated around its axis as described in ANSI C63.10 (2013) clause 6.6.5.

6.3 Requirements

Within restricted bands and receive mode:
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 (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

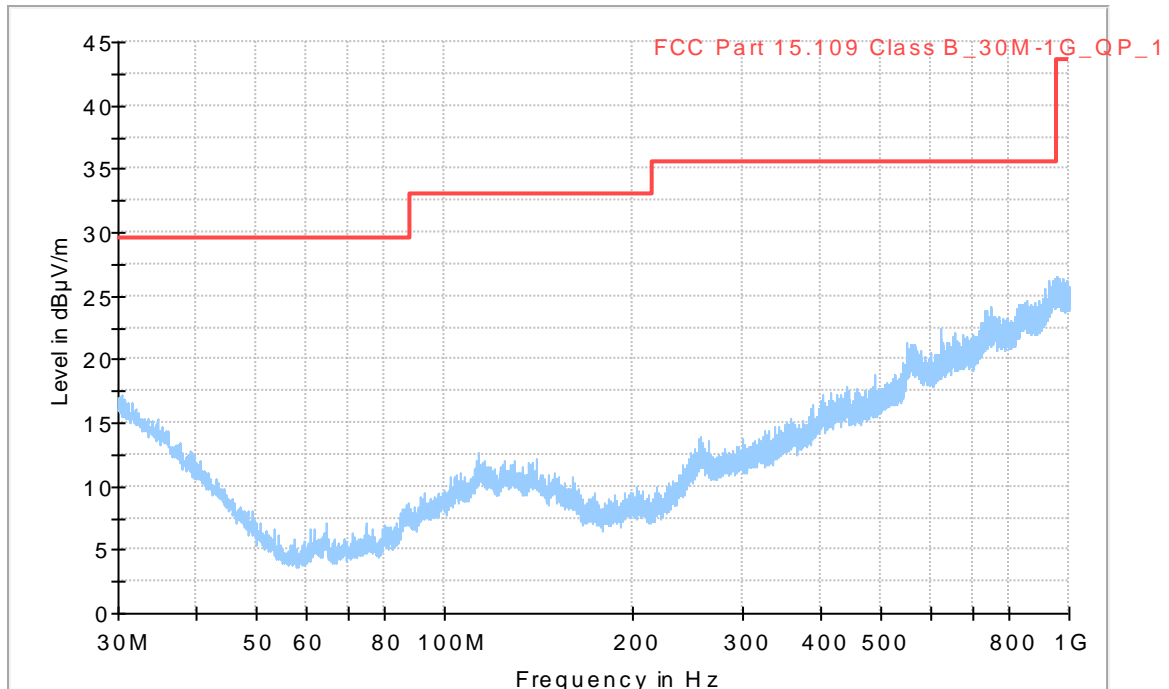


Diagram. Peak overview sweep. 30 – 1000 MHz at 10 m distance. TX high channel. EUT orientation X.

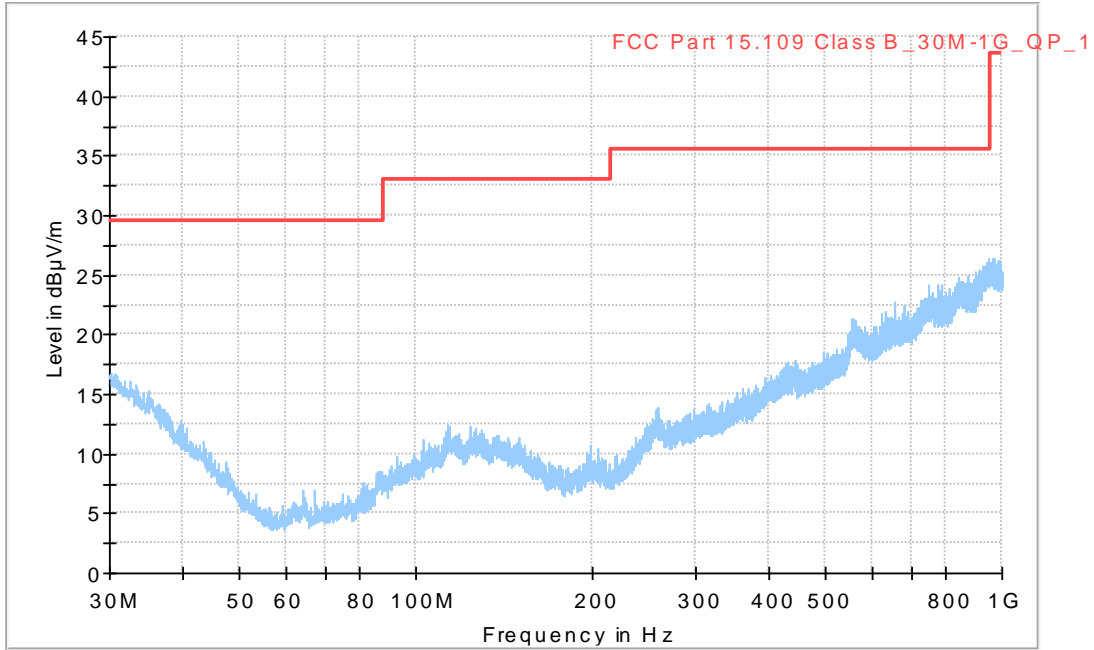


Diagram. Peak overview sweep. 30 – 1000 MHz at 10 m distance. TX mid channel. EUT orientation Y.

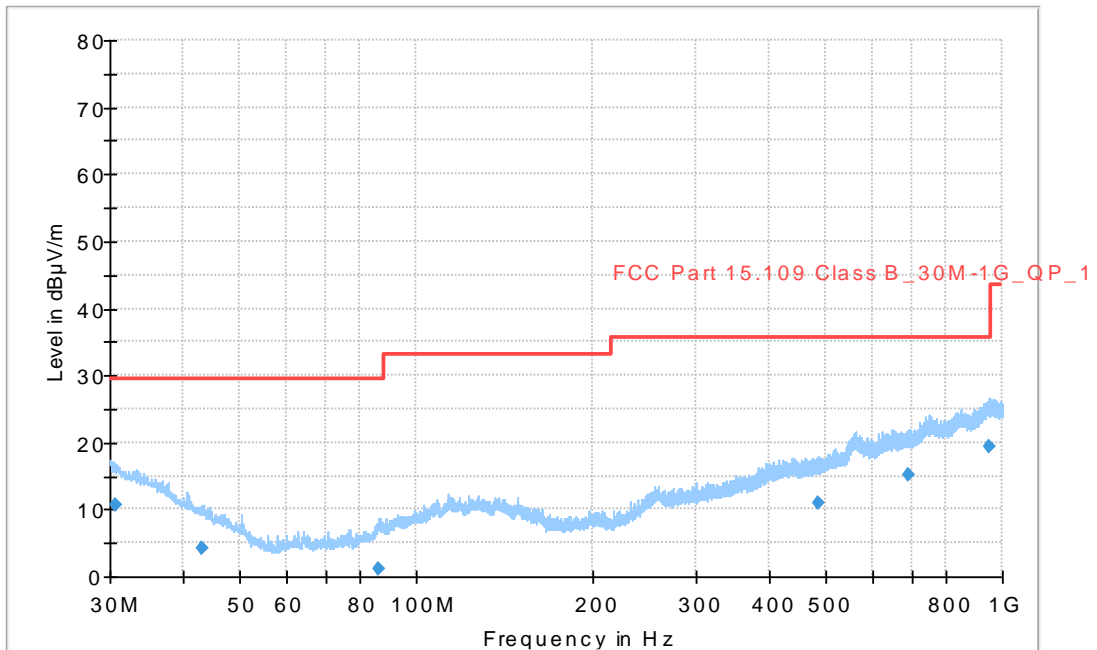


Diagram. Peak overview sweep. 30 – 1000 MHz at 10 m distance. TX low channel. EUT orientation Z.

Measurement results. Quasi Peak

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

6.5 Test results 1 GHz – 26.5 GHz. TX 802.15.4

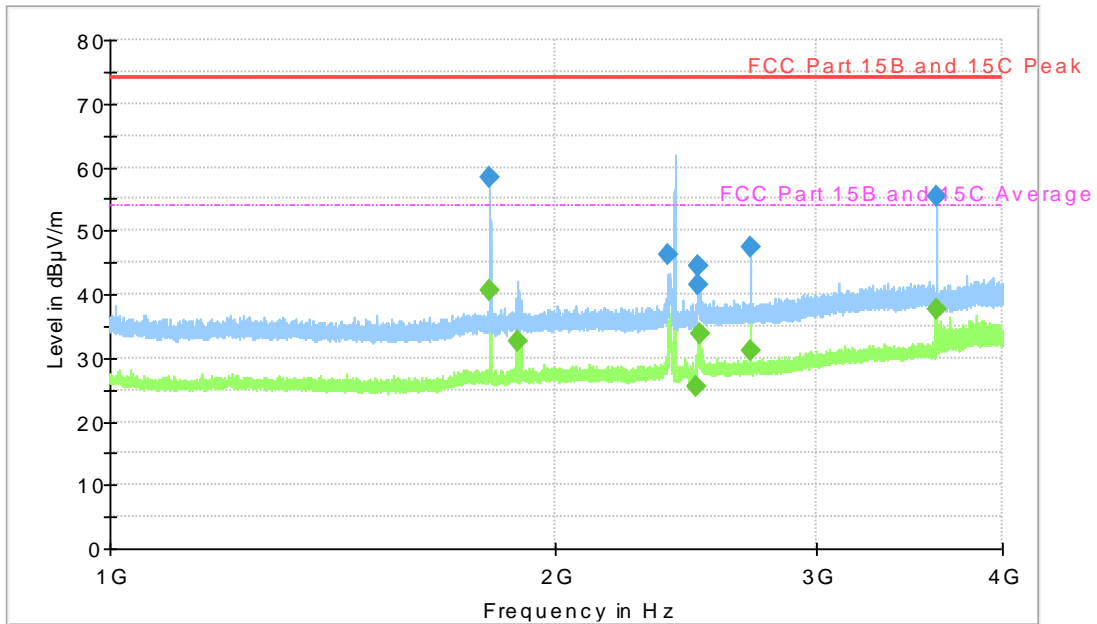


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

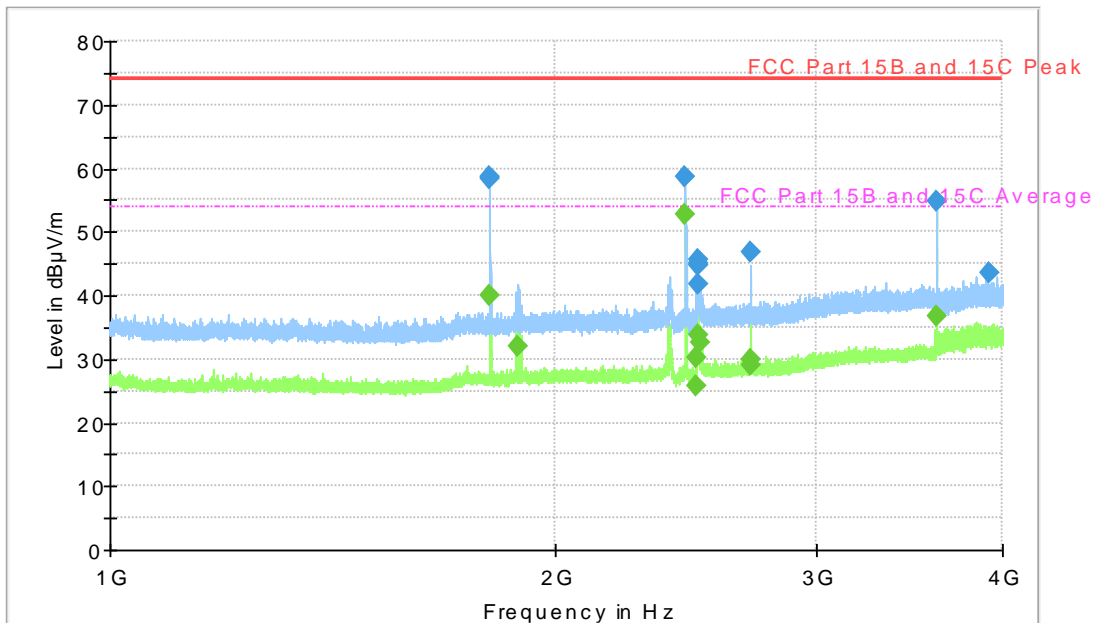


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0. Peaks close to limit are carriers that can be ignored.

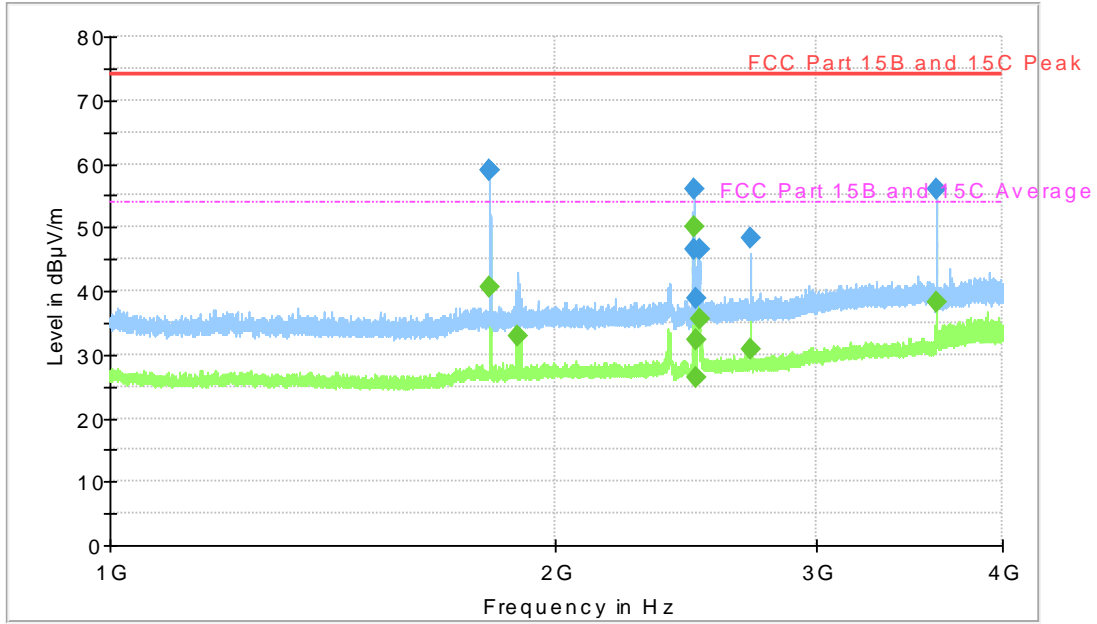


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

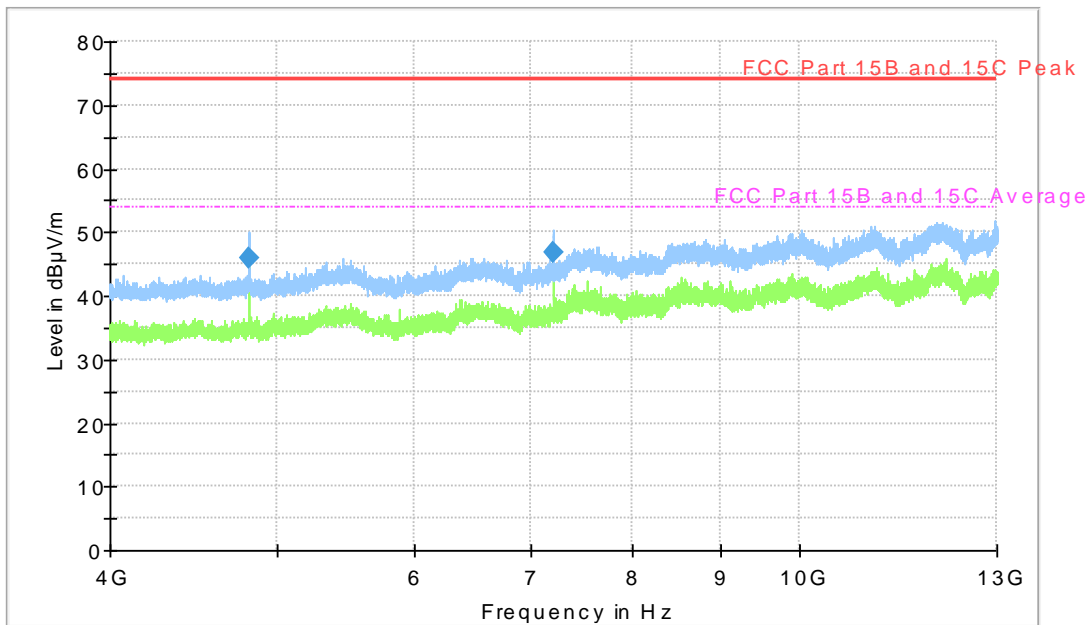


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

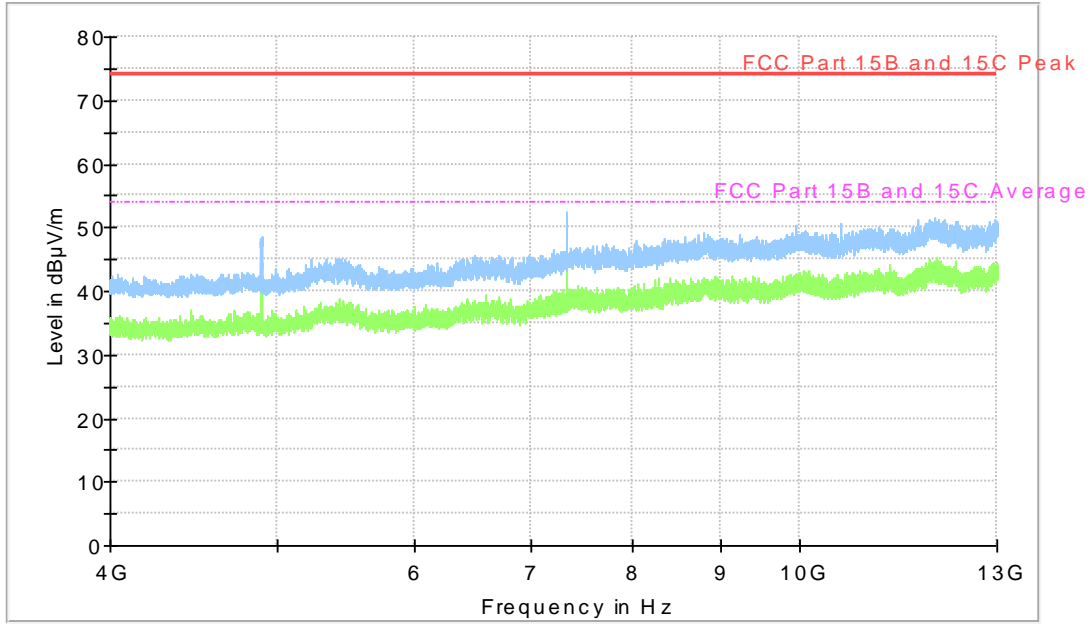


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

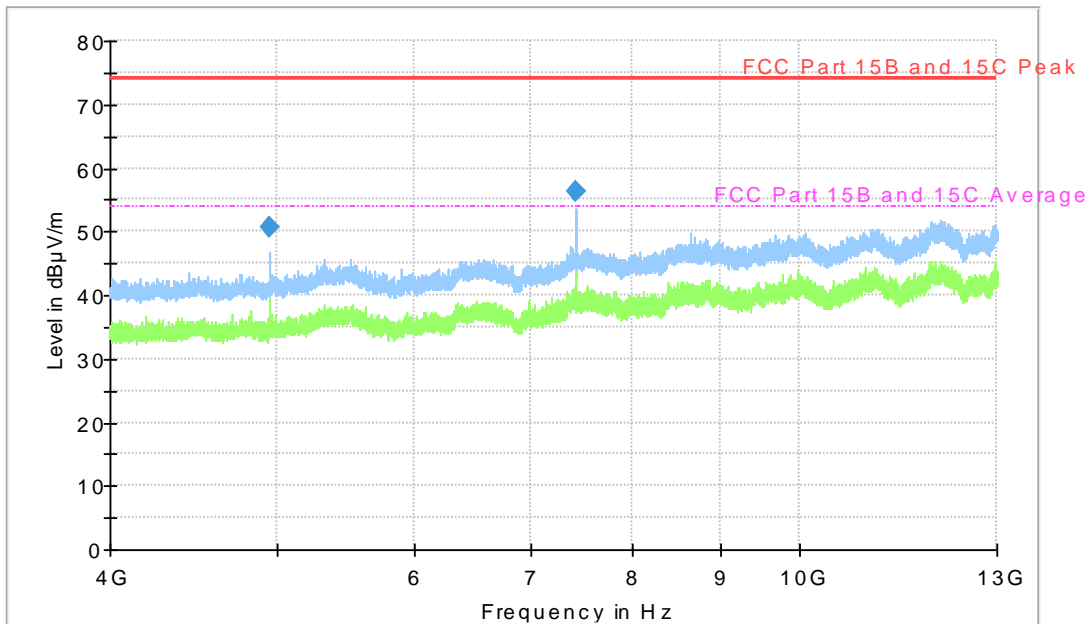


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum

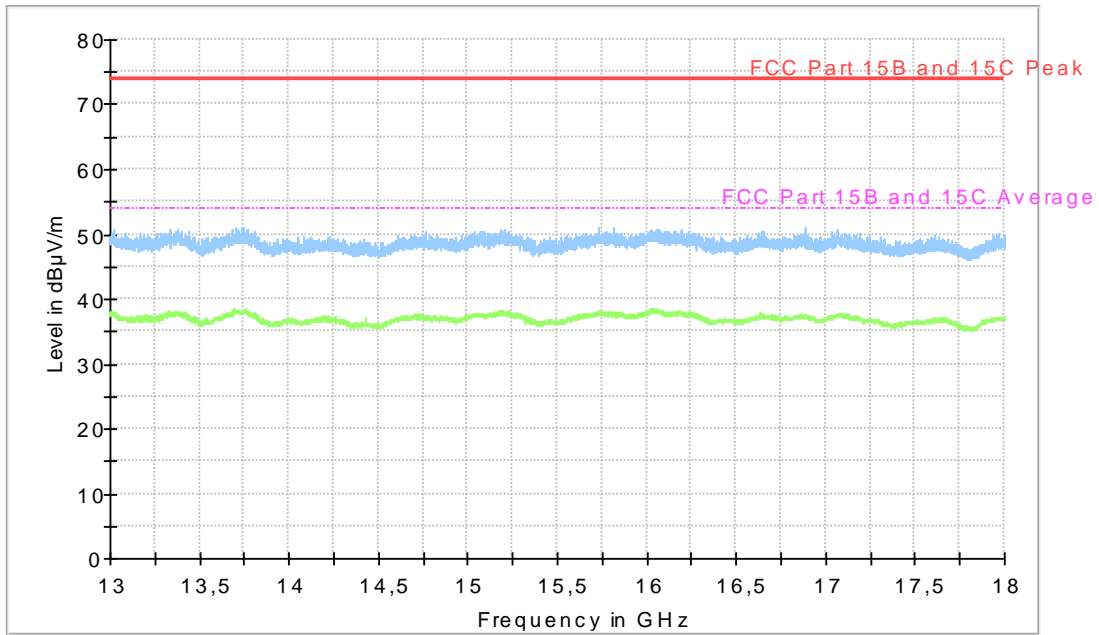


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX low channel.

Full Spectrum

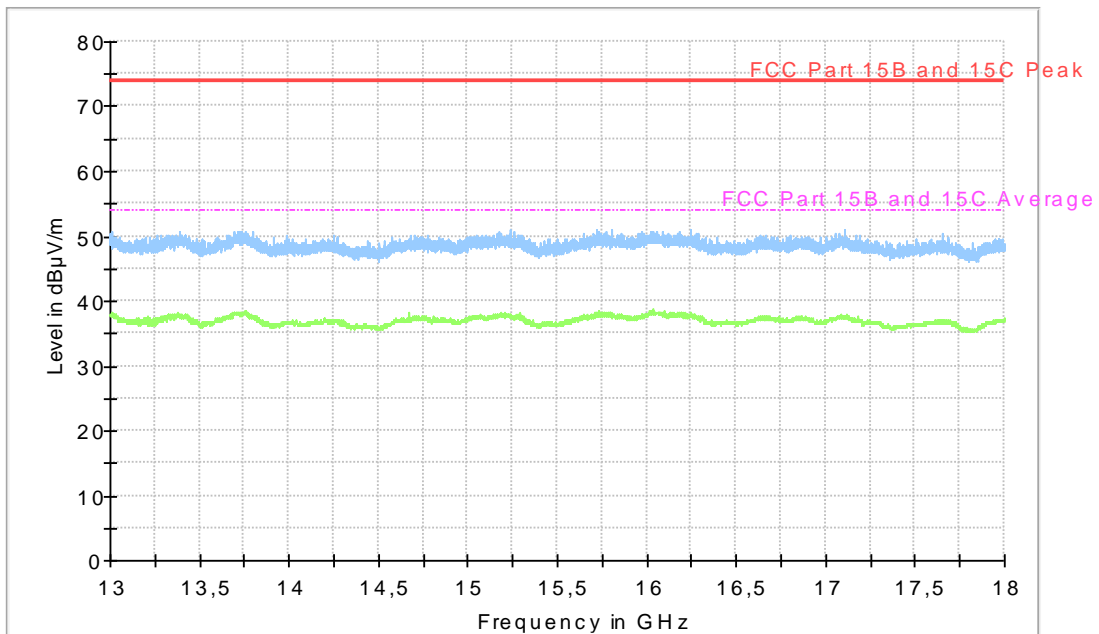


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX mid channel.

Full Spectrum

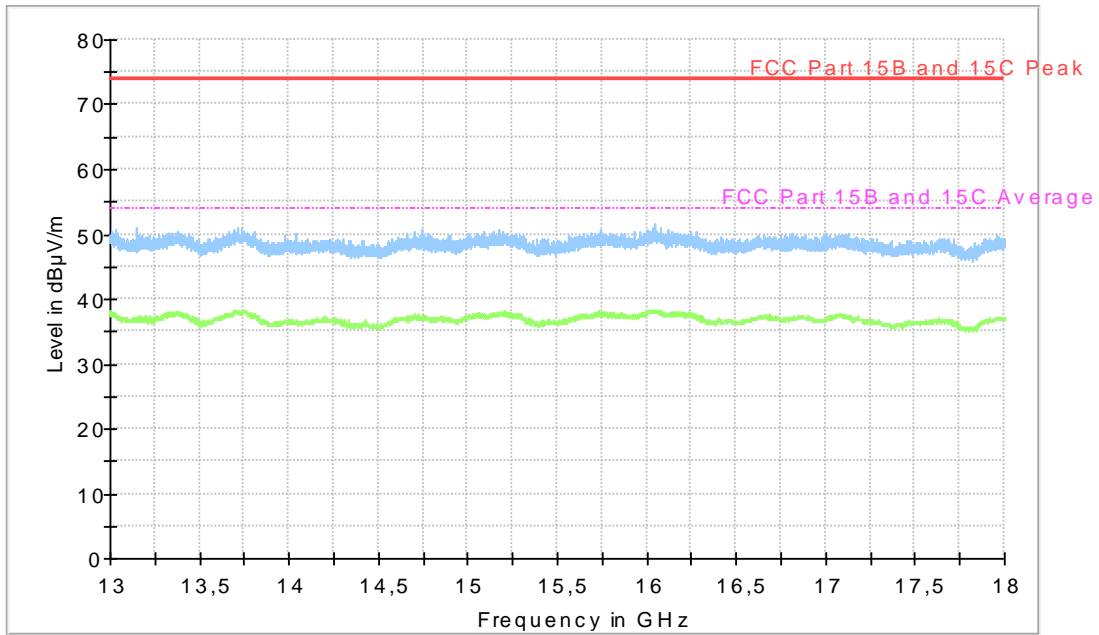


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX high channel.

Full Spectrum

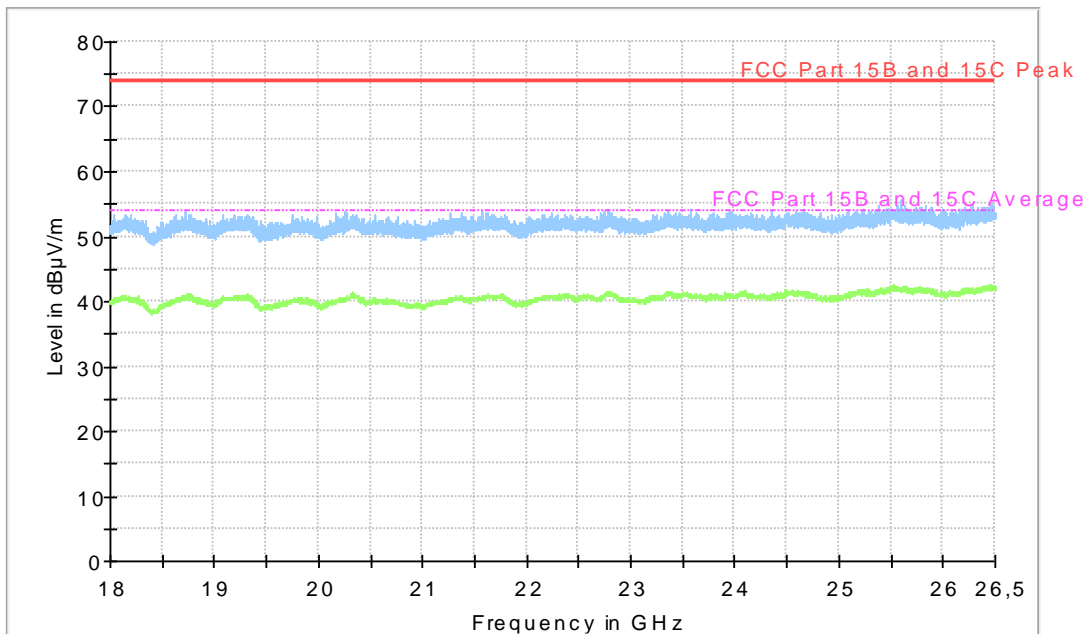


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX low channel.

Full Spectrum

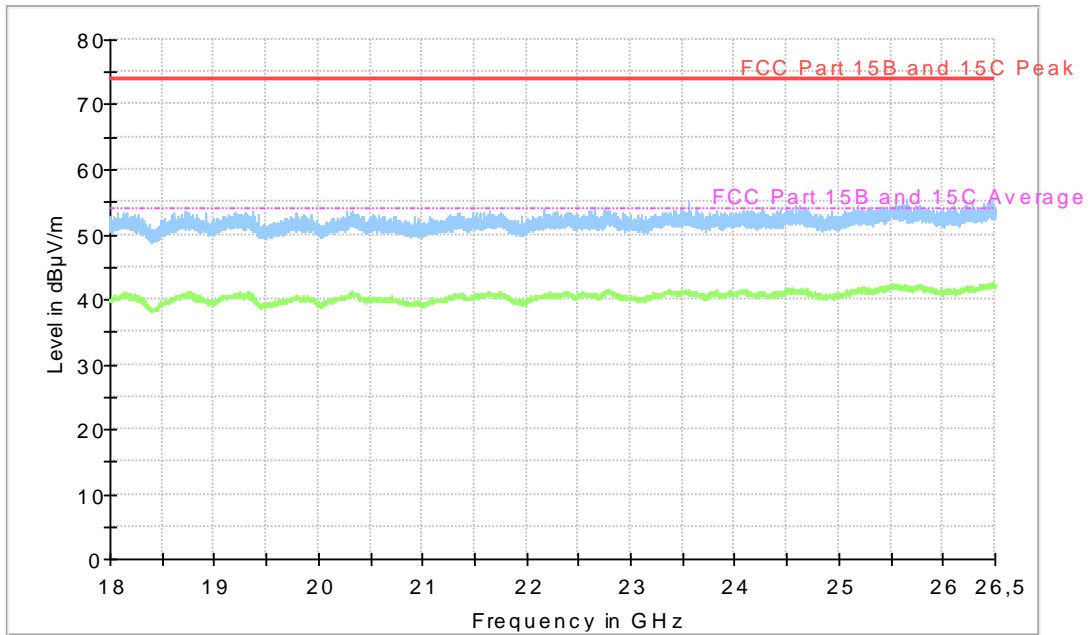


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX middle channel.

Full Spectrum

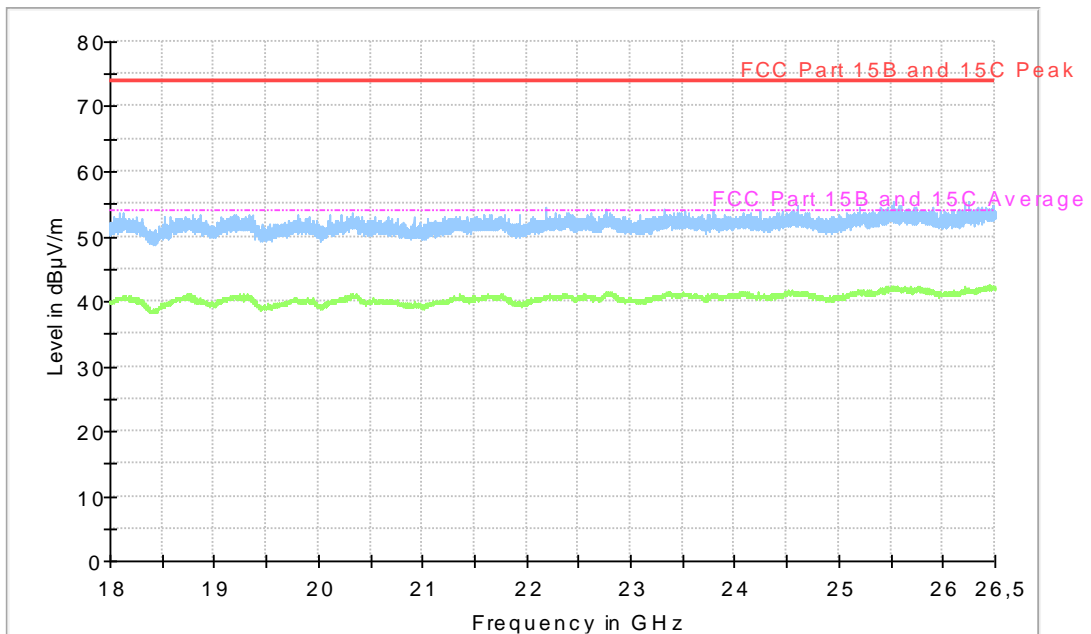


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX high channel.

Measurement results. Peak. TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
1804.4	58.3	74.0	H	15.7
2381.0	46.2	74.0	H	27.8
2492.4	44.5	74.0	H	29.6
2493.2	44.5	74.0	H	29.5
2493.3	41.5	74.0	H	32.5
2706.6	47.5	74.0	H	26.5
3609.5	55.4	74.0	H	18.6

Measurement results. Average. TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
1804.8	40.5	54.0	H	13.5
1886.5	32.6	54.0	V	21.4
2484.0	25.5	54.0	H	28.5
2501.0	33.8	54.0	H	20.2
2707.0	31.1	54.0	H	22.9
3609.5	37.6	54.0	H	16.4

Measurement results. Peak. TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
1804.6	58.2	74.0	H	15.8
1804.8	58.5	74.0	H	15.5
2444.5	58.7	74.0	H	15.3
2492.7	45.2	74.0	H	28.8
2492.9	45.6	74.0	H	28.5
2493.1	44.7	74.0	H	29.3
2493.9	41.8	74.0	H	32.2
2706.7	46.9	74.0	H	27.1
3610.0	54.9	74.0	H	19.1
3916.9	43.6	74.0	V	30.4

Measurement results. Average. TX high channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
1804.7	40.0	54.0	H	14.0
1886.5	32.0	54.0	V	22.0
2484.0	25.7	54.0	H	28.3
2486.6	30.1	54.0	H	23.9
2493.2	33.8	54.0	H	20.2
2501.3	32.7	54.0	H	21.3
2706.3	29.2	54.0	H	24.9
2707.4	30.1	54.0	H	23.9
3609.9	36.7	54.0	H	17.3

Measurement results. Peak. TX high channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1804.6	59.0	74.0	H	15.0
1805.0	59.1	74.0	H	15.0
2475.5	56.1	74.0	H	17.9
2476.7	46.7	74.0	H	27.4
2485.0	38.9	74.0	V	35.1
2498.1	46.4	74.0	H	27.6
2707.2	48.4	74.0	H	25.6
3609.7	56.0	74.0	H	18.0

Measurement results. Average. TX high channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1804.9	40.5	54.0	H	13.5
1886.4	32.9	54.0	H	21.1
2484.0	26.3	54.0	H	27.7
2489.2	32.2	54.0	H	21.8
2496.9	35.7	54.0	H	18.3
2707.4	30.7	54.0	H	23.3
3609.5	38.2	54.0	H	15.8

All other 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]

6.6 Test results 1 GHz – 26.5 GHz. TX BLE

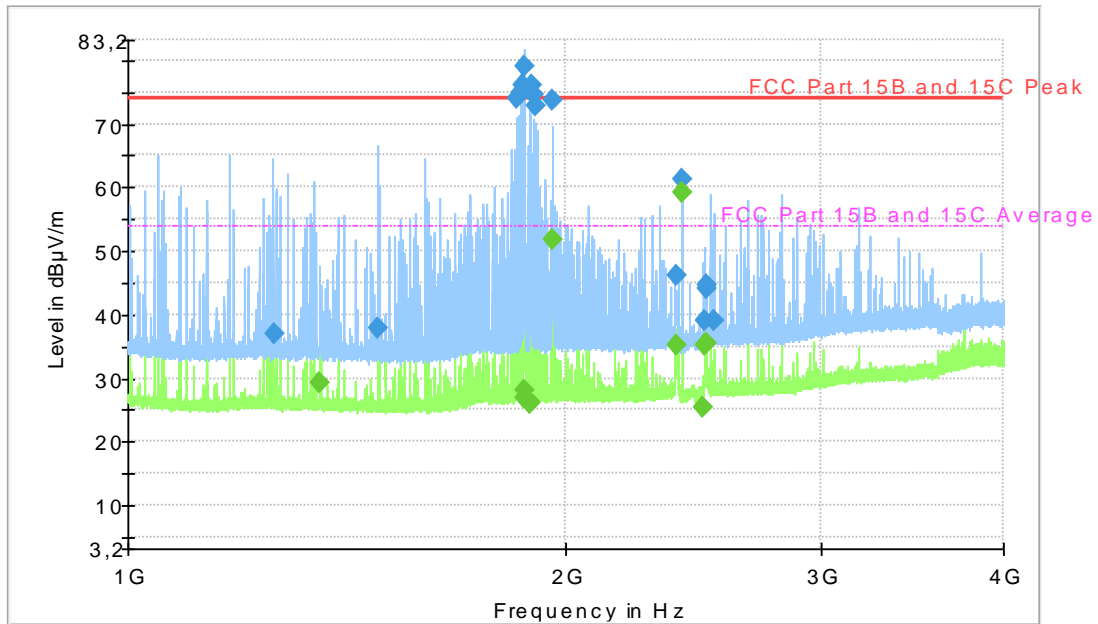


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0. Emission lines above the limit are from the LTE carriers and can be ignored.

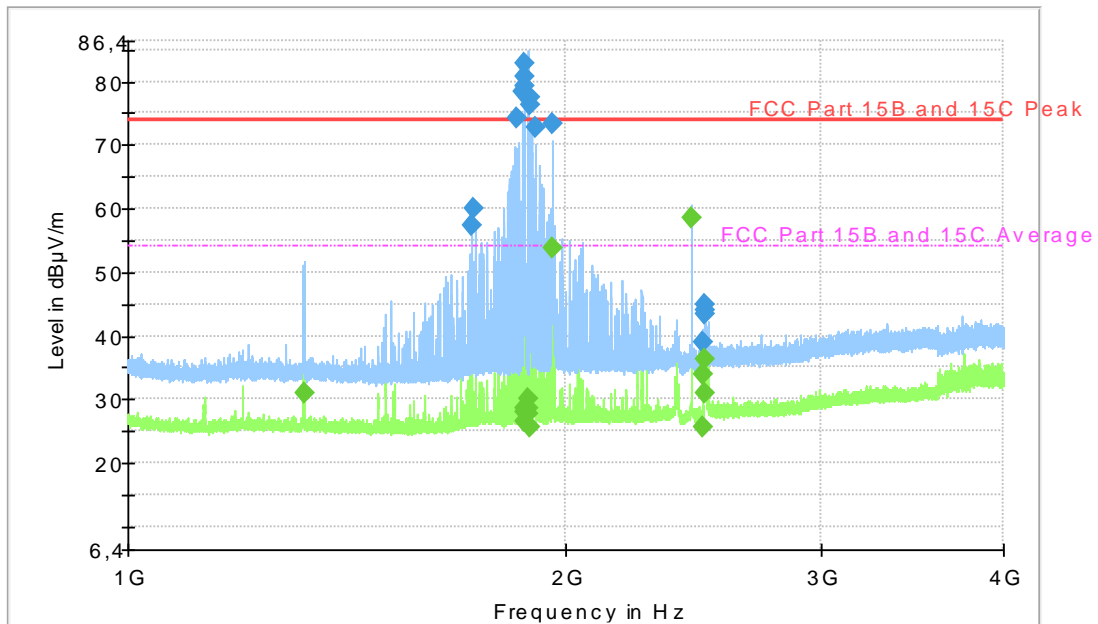


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0. Emission lines above the limit are from the LTE and BLE carriers and can be ignored.

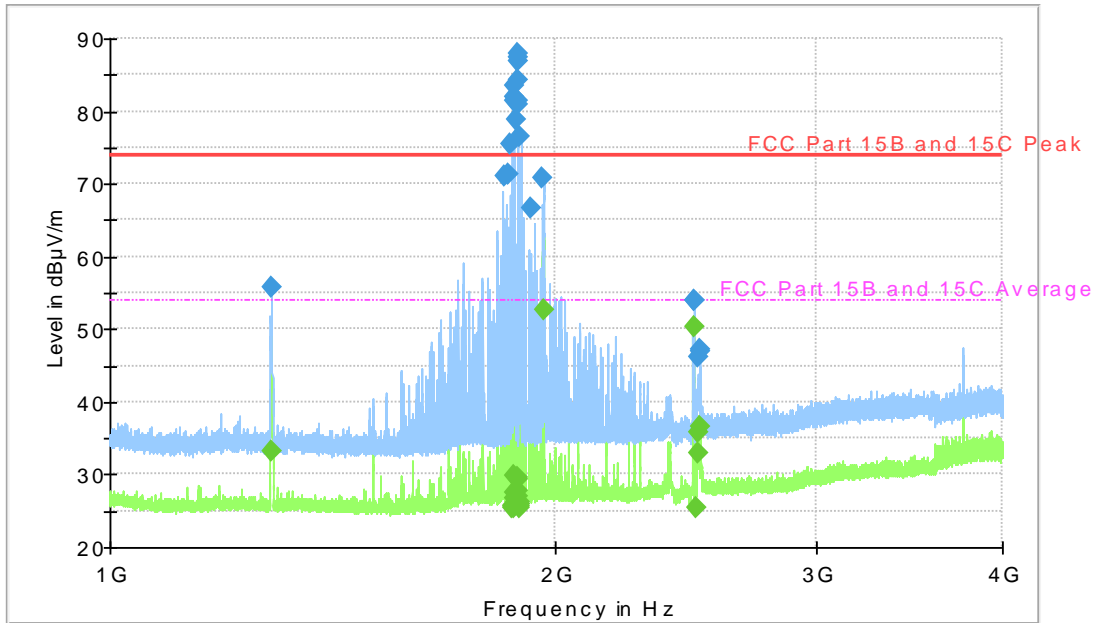


Diagram. Peak overview sweep. 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0. Emission lines above the limit are from the LTE and BLE carriers and can be ignored.

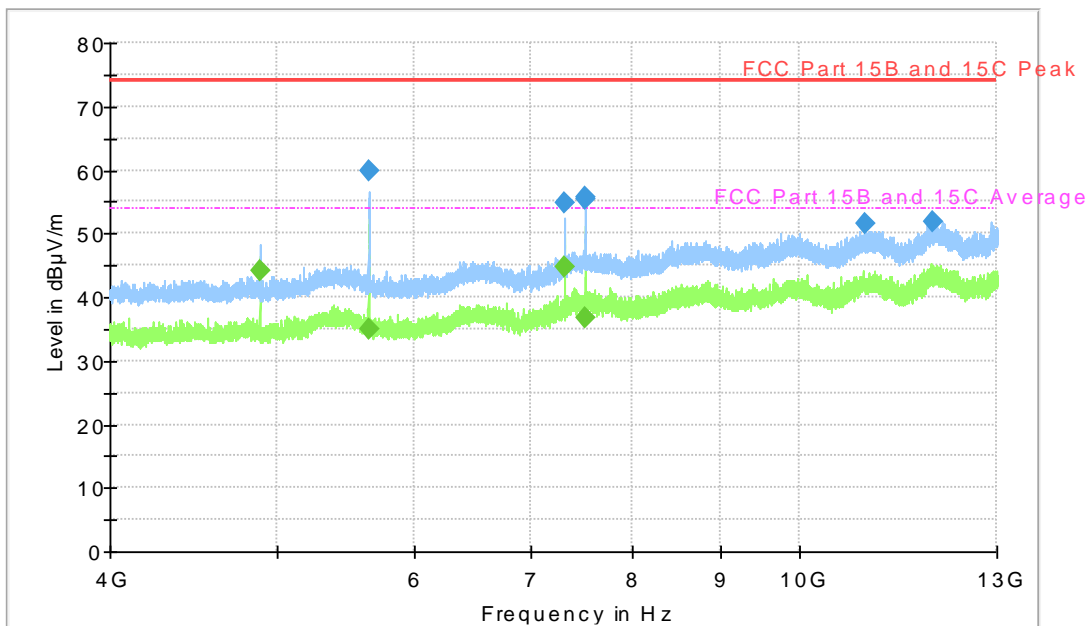


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0. Emission lines above the limit are from the LTE and BLE carriers and can be ignored.

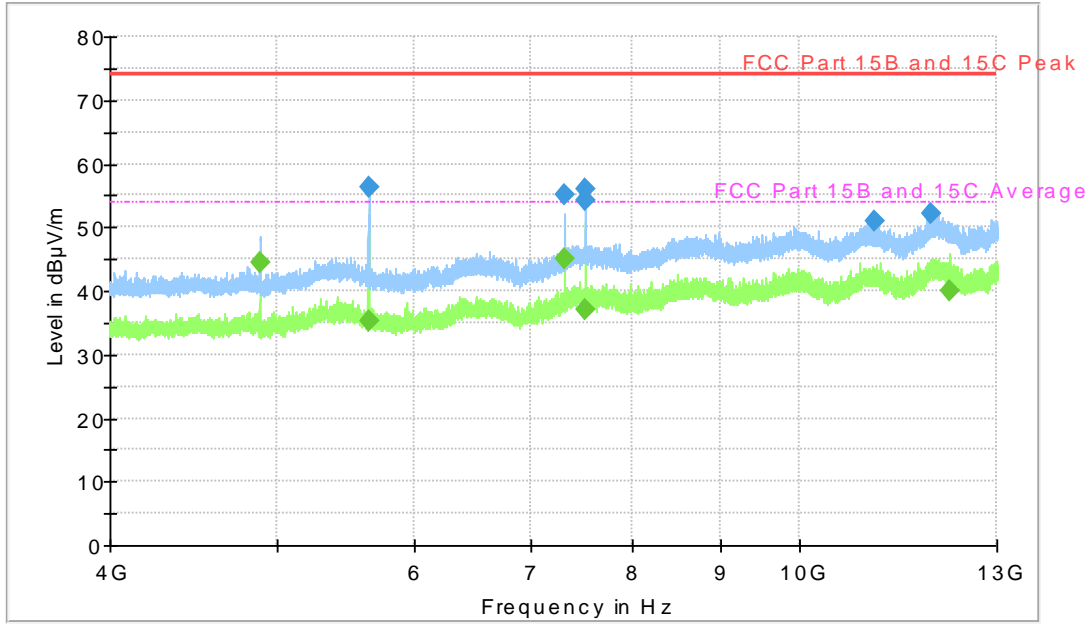


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

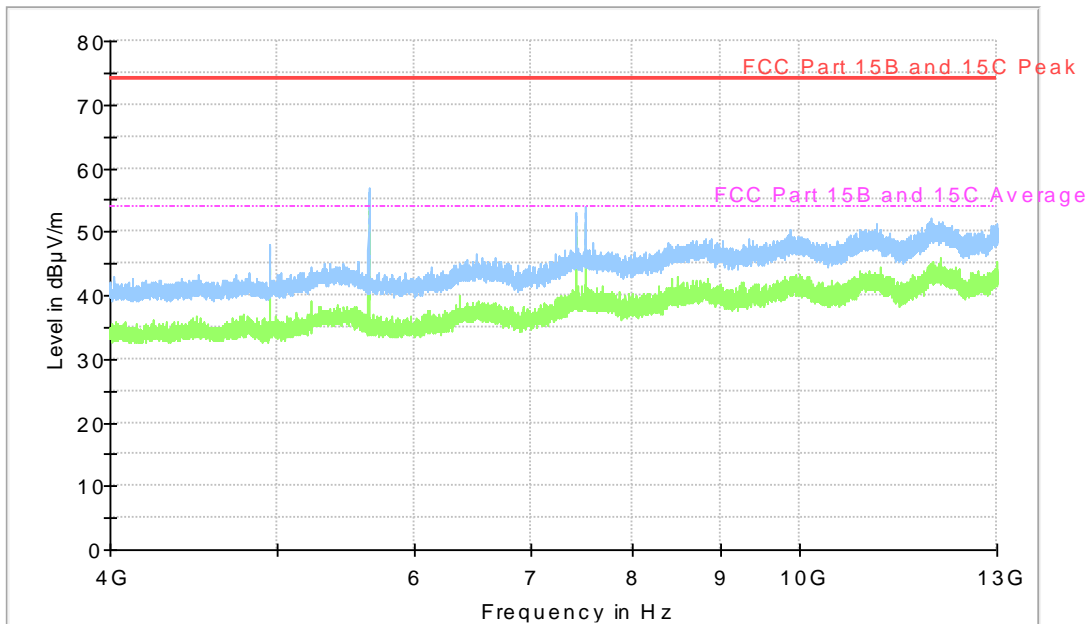


Diagram. Peak overview sweep. 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum

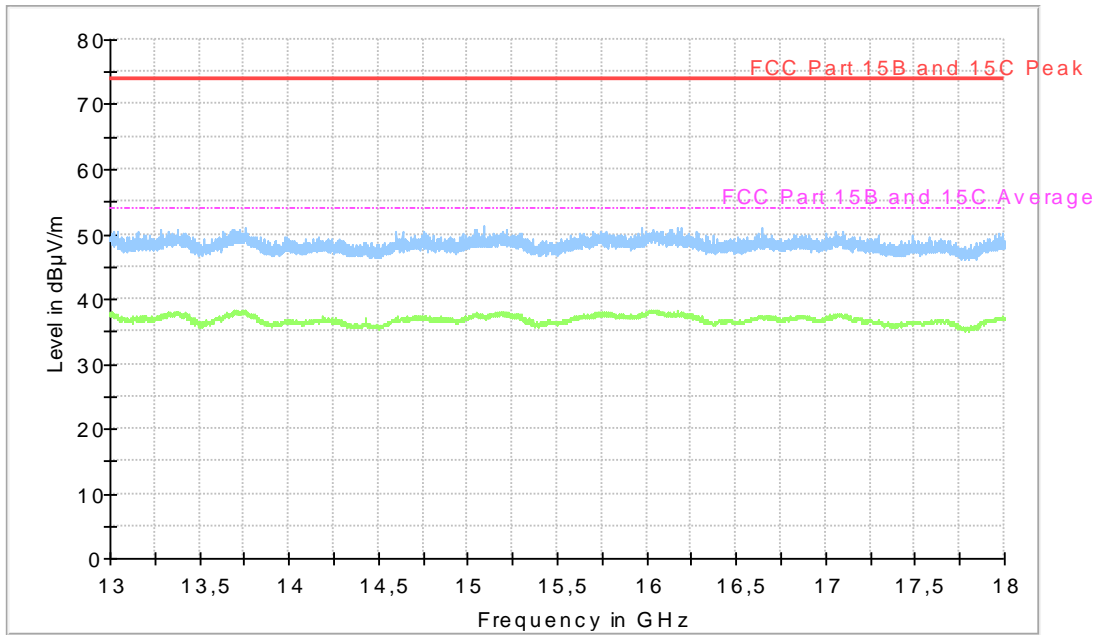


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX low channel.

Full Spectrum

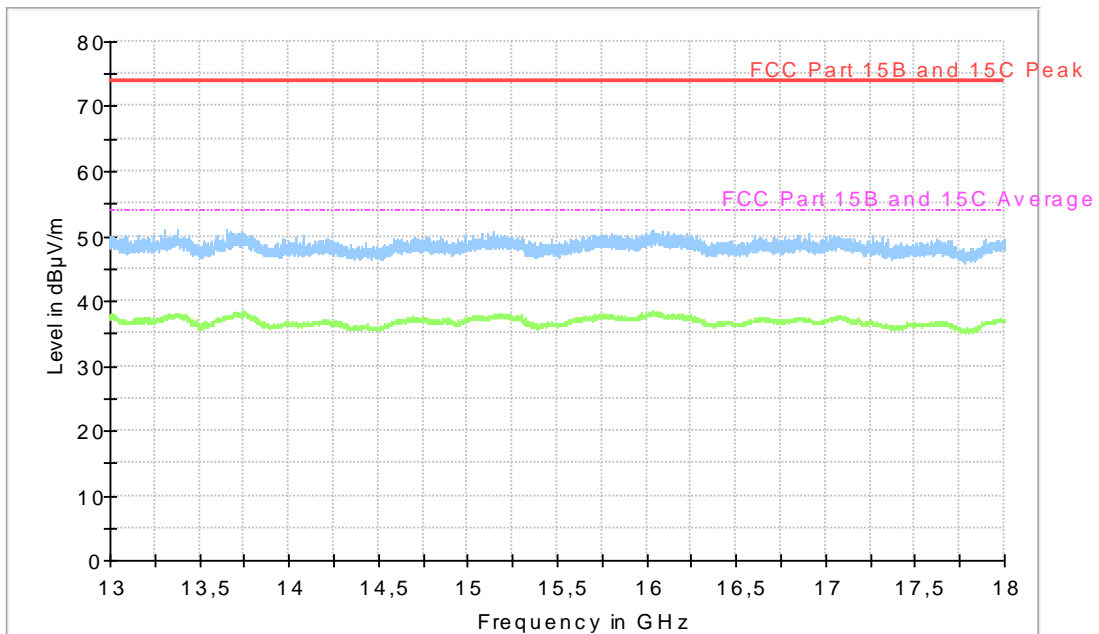


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX mid channel.

Full Spectrum

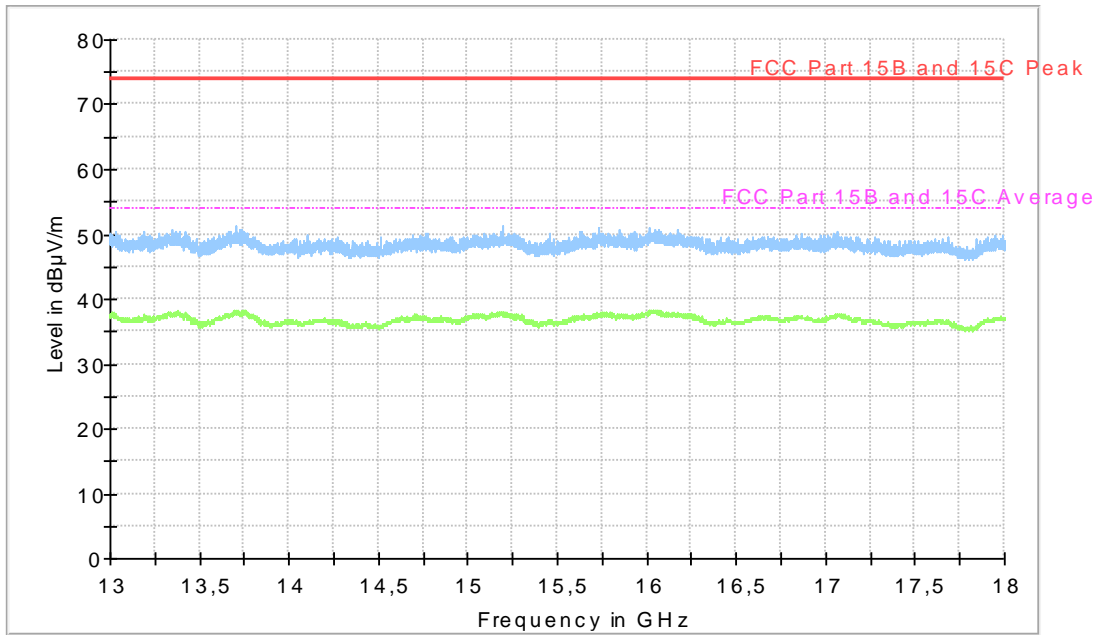


Diagram. Peak overview sweep. 13 – 18 GHz at 3 m distance. TX high channel.

Full Spectrum

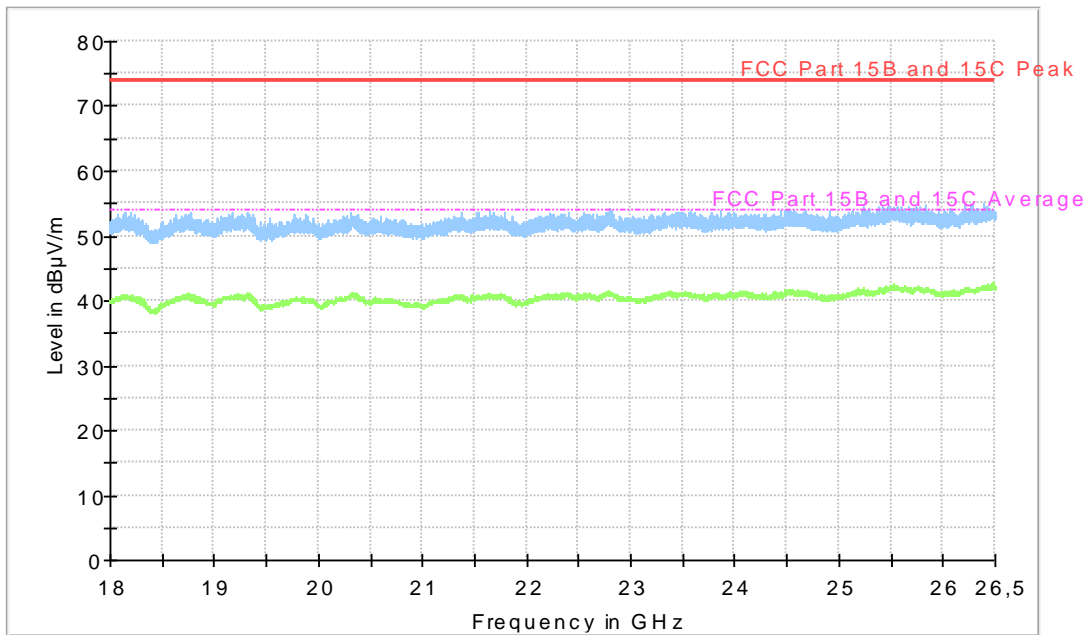


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX low channel.

Full Spectrum

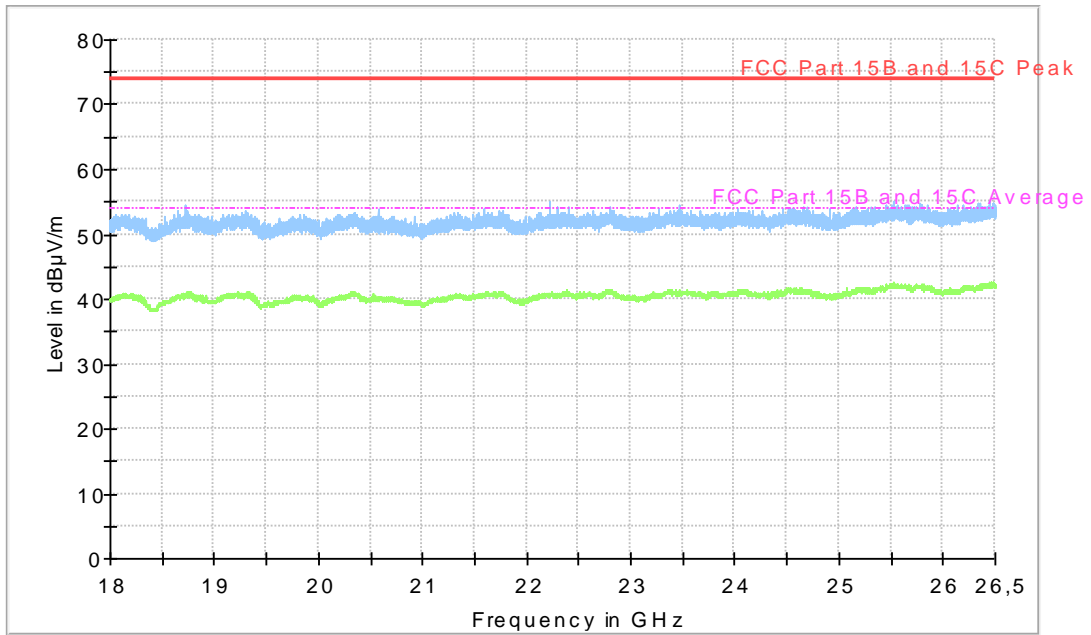


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX middle channel.

Full Spectrum

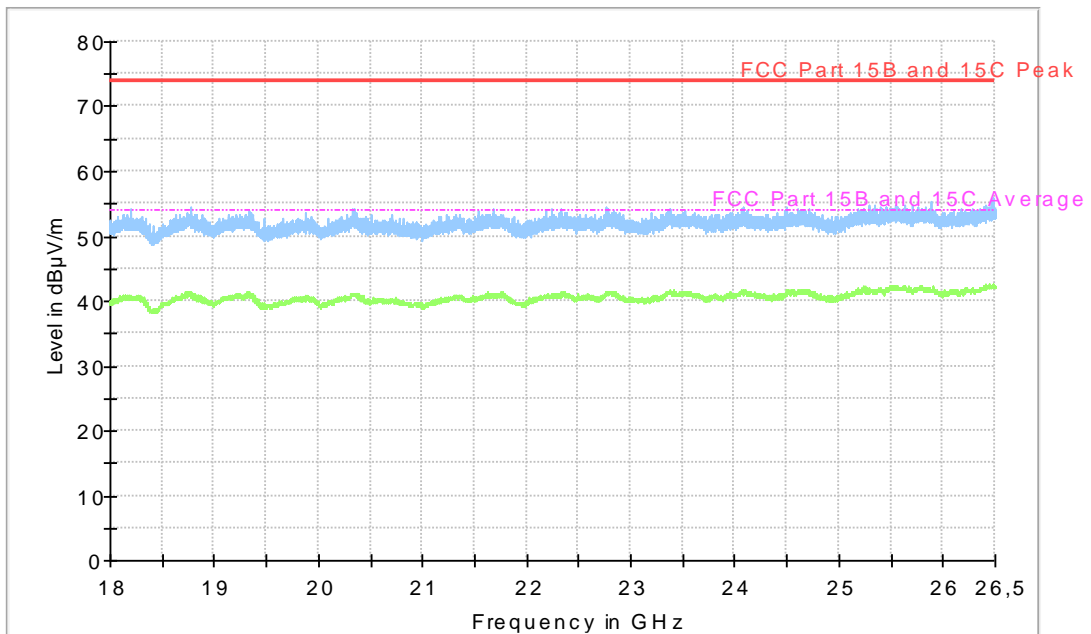


Diagram. Peak overview sweep. 18 – 26.5 GHz at 3 m distance. TX high channel.

Measurement results. Peak. TX low channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1259.7	36.9	74.0	V	37.1
1484.6	38.0	74.0	H	36.0
2381.5	46.1	74.0	H	28.0
2404.7	61.4	74.0	H	12.6
2494.7	39.0	74.0	V	35.0
2500.4	44.0	74.0	H	30.0
2501.1	44.7	74.0	H	29.3
2527.6	39.2	74.0	H	34.8
5641.7	59.8	74.0	V	14.2
7319.3	54.7	74.0	H	19.3
7521.4	55.6	74.0	V	18.4
7521.5	55.3	74.0	V	18.7
10905.6	51.6	74.0	H	22.4
11934.8	51.7	74.0	V	22.3

Measurement results. Average. TX low channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1355.8	29.3	54.0	H	24.7
1873.1	28.1	54.0	H	25.9
1875.6	26.8	54.0	H	27.2
1888.6	26.1	54.0	H	27.9
1891.0	26.2	54.0	H	27.8
2380.8	35.2	54.0	H	18.9
2484.0	25.5	54.0	V	28.5
2493.1	35.3	54.0	H	18.7
2501.2	35.6	54.0	H	18.4
4880.5	44.0	54.0	H	10.0
5641.3	35.0	54.0	V	19.0
7321.0	44.6	54.0	H	9.4
7522.0	36.8	54.0	H	17.2

Measurement results. Peak. TX middle channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1724.0	57.3	74.0	H	16.7
1728.9	60.1	74.0	H	13.9
2487.6	39.1	74.0	V	34.9
2496.0	44.8	74.0	H	29.2
2496.1	44.1	74.0	H	29.9
2496.1	43.6	74.0	H	30.4
5641.7	56.2	74.0	V	17.8
7319.4	55.1	74.0	H	18.9
7520.1	54.3	74.0	H	19.7
7521.6	56.0	74.0	H	18.0
11047.3	51.0	74.0	H	23.0
11907.0	52.2	74.0	V	21.8

Measurement results. Average. TX high channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1320.8	31.0	54.0	H	23.0
1872.7	26.6	54.0	H	27.4
1874.8	28.5	54.0	H	25.5
1875.8	27.9	54.0	H	26.1
1884.7	28.8	54.0	H	25.2
1884.9	27.8	54.0	H	26.2
1885.6	30.2	54.0	H	23.8
1889.7	25.8	54.0	H	28.2
2483.8	25.7	54.0	H	28.3
2488.1	34.0	54.0	H	20.1
2490.7	31.0	54.0	H	23.0
2496.0	36.4	54.0	H	17.7
4879.9	44.3	54.0	H	9.7
5641.3	35.4	54.0	V	18.6
7319.2	45.2	54.0	H	8.8
7521.7	36.9	54.0	H	17.1
12200.5	40.1	54.0	V	13.9

Measurement results. Peak. TX high channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1286.1	55.9	74.0	H	18.2
1922.4	66.8	74.0	H	7.2
2475.2	53.9	74.0	H	20.1
2475.3	54.0	74.0	H	20.0
2496.3	46.2	74.0	H	27.8
2498.7	47.3	74.0	H	26.7
2499.1	47.0	74.0	H	27.0

Measurement results. Average. TX high channel

Frequency [MHz]	Level [dB μ V/m]	Limit [dB μ V/m]	Polarization H/V	Margin [dB]
1285.2	33.3	54.0	H	20.7
1869.1	25.4	54.0	H	28.6
1869.8	25.8	54.0	H	28.2
1889.2	26.0	54.0	H	28.0
1890.7	25.7	54.0	H	28.3
2484.0	25.5	54.0	V	28.5
2491.0	32.9	54.0	H	21.1
2496.6	35.9	54.0	H	18.1
2499.1	36.6	54.0	H	17.4

All other 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:	2019-08-05	Test location:	TS8997
EUT Serial:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
Test result:	Pass	Margin:	8,3 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: 90 MHz

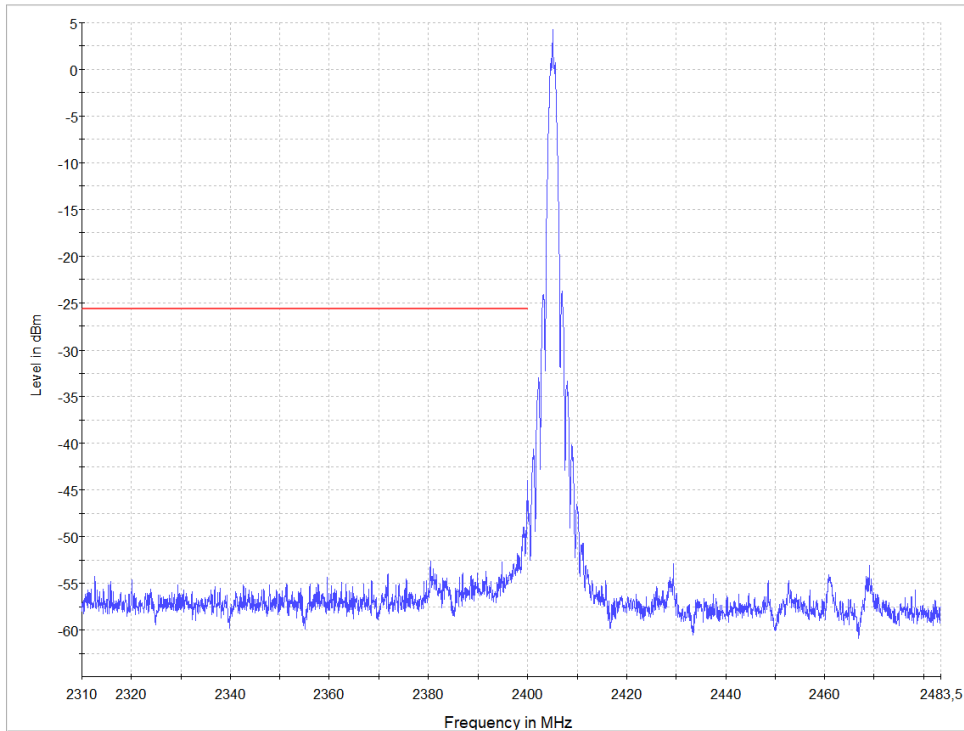
7.3 Requirement

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 802.15.4

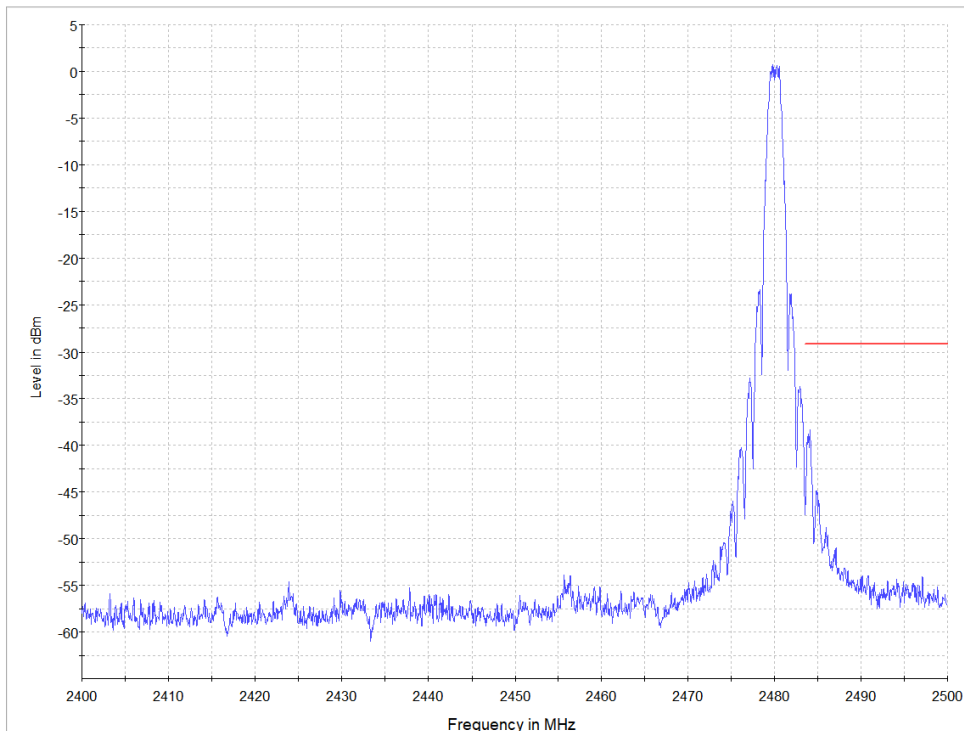
Band Edge



— Limit — Sum Level × Fail

Screenshot: Lower band edge sweep. low channel

Band Edge



— Limit — Sum Level × Fail

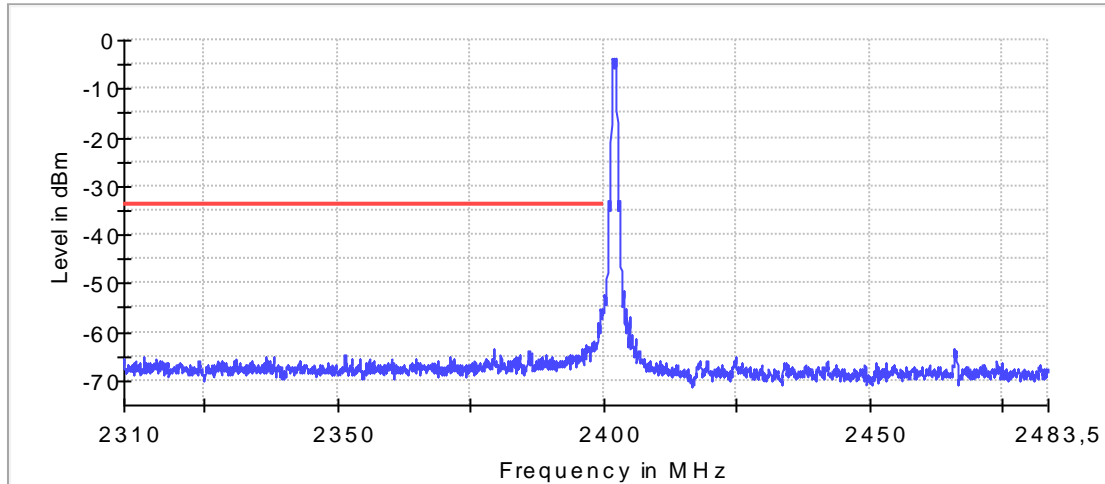
Screenshot: Upper band edge sweep. high channel

Test results. 802.15.4.

Band edge	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	44.0	20.0	24.0
Upper	38.3	20.0	18.3

7.5 Test results BLE

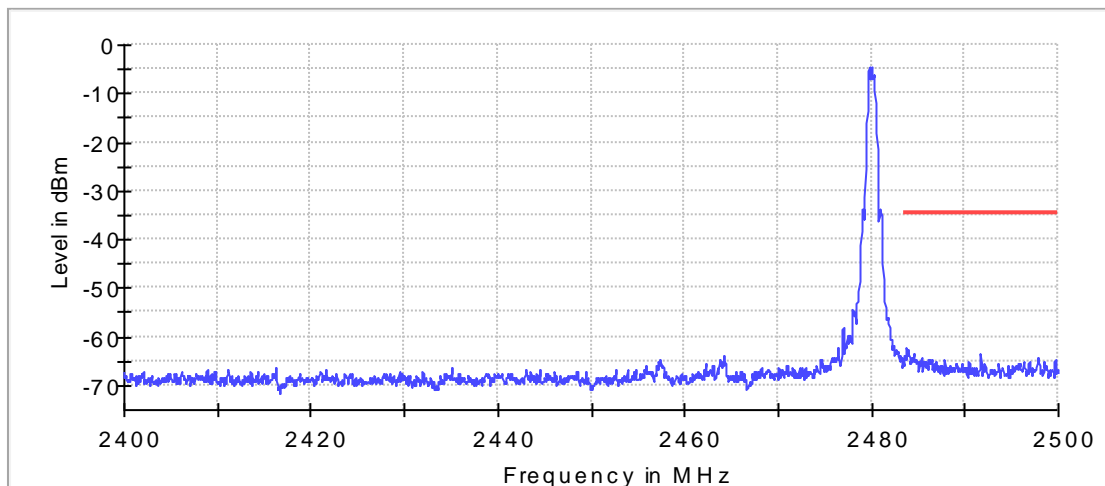
Band Edge



— Limit — Sum Level × Fail

Screenshot: Lower band edge sweep. Low channel. BLE.

Band Edge



— Limit — Sum Level × Fail

Screenshot: Upper band edge sweep. High channel. BLE.

Test results. BLE.

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

8 PEAK CONDUCTED OUTPUT POWER

Date of test:	2019-08-05	Test location:	TS8997
EUT Serial:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
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

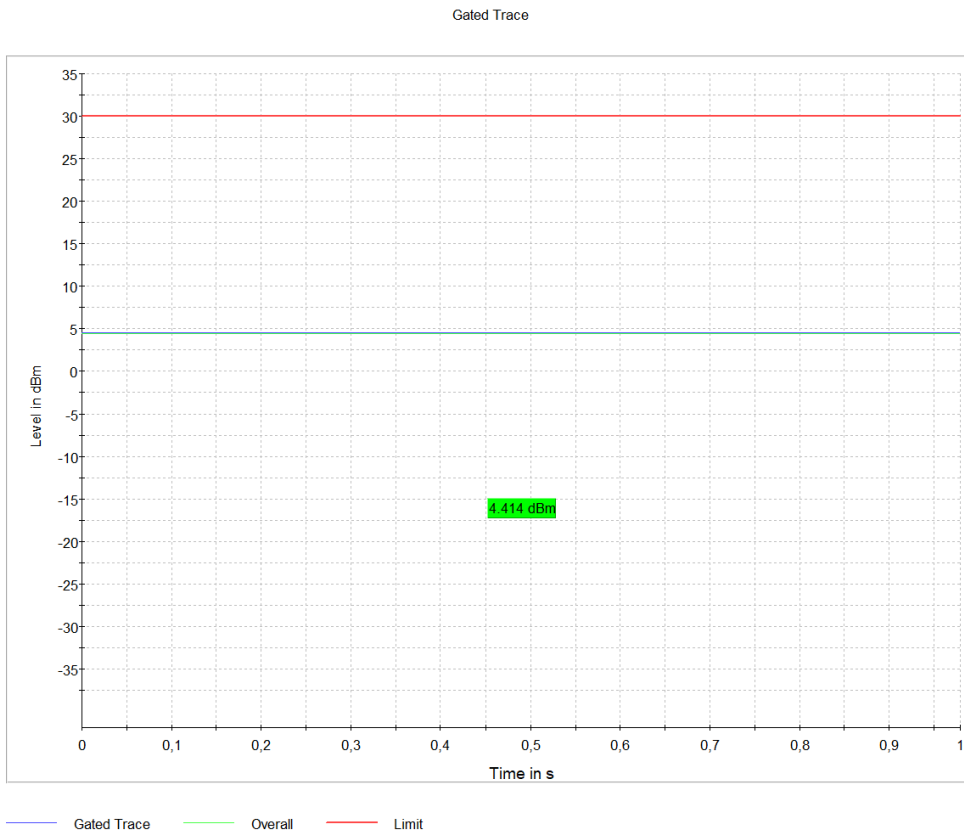
The EUT was set up in order to emit maximum disturbances.

8.3 Requirements

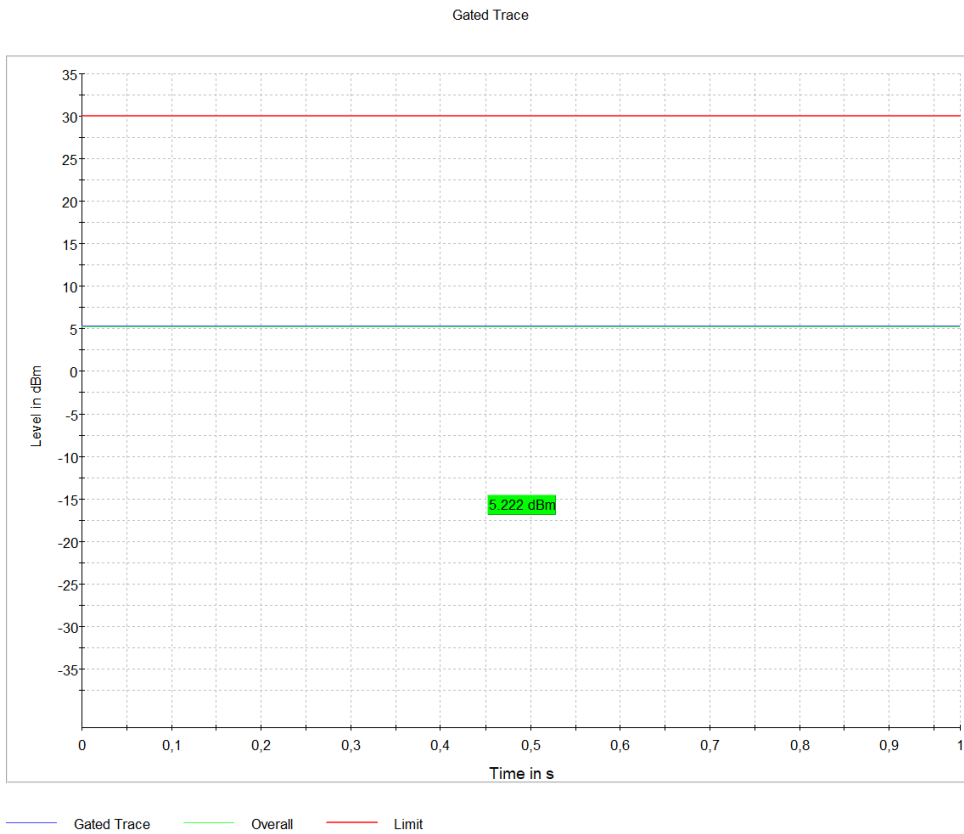
Reference: CFR 47§15.247(b)(3). RSS-247 5.4

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. 802.15.4.

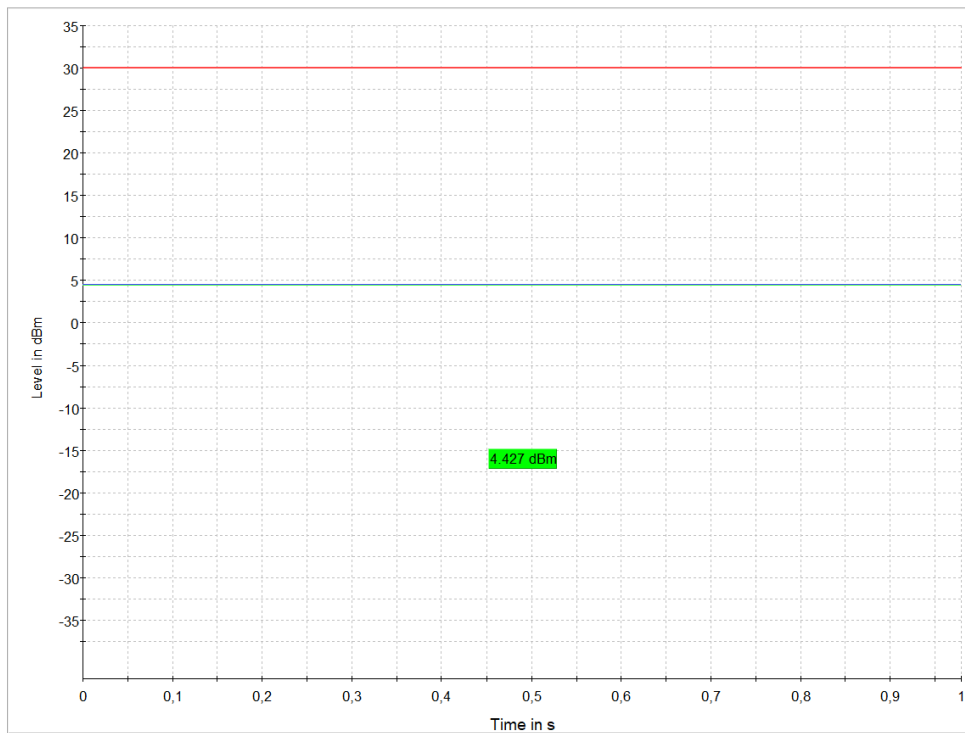


Screenshot: Output power. low channel. 802.15.4.



Screenshot: Output power. middle channel. 802.15.4.

Gated Trace

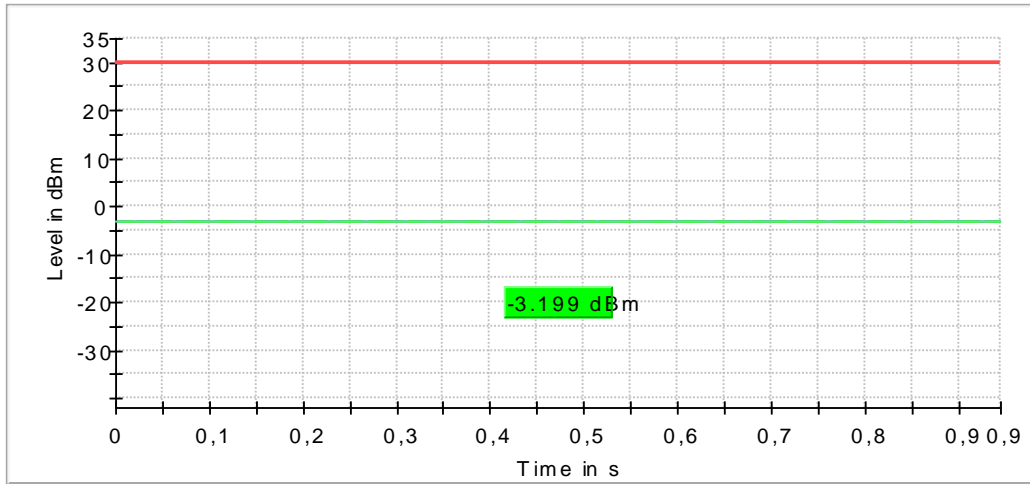


Screenshot: Output power. high channel. 802.15.4.

Test results. 802.15.4.

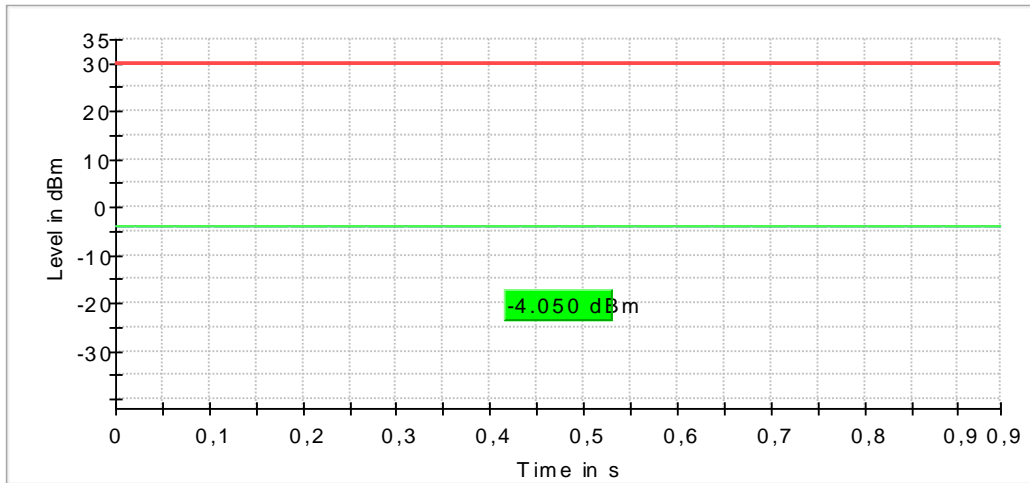
Channel [MHz]	Output power [dBm]
2405	4,4
2445	5,2
2480	4,4

8.5 Test results. BLE.



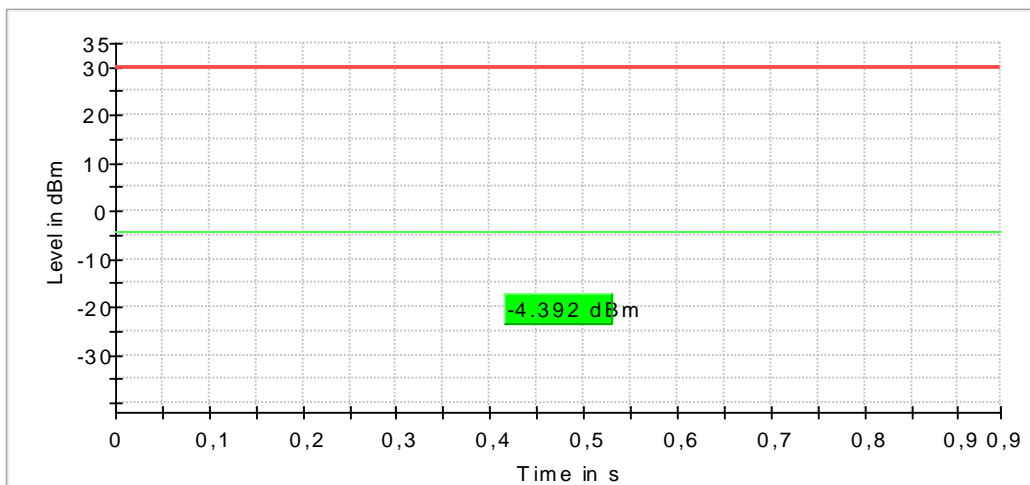
— Gated Trace — Overall — Limit

Screenshot: Output power. Low channel. BLE.



— Gated Trace — Overall — Limit

Screenshot: Output power. Middle channel. BLE.



— Gated Trace — Overall — Limit

Screenshot: Output power. High channel. BLE.

Test results. BLE.

Channel [MHz]	Output power [dBm]
2402	-3.2
2440	-4.1
2480	-4.4

9 OCCUPIED 6 DB BANDWIDTH

Date of test:	2019-08-05	Test location:	TS8997
EUT Serial:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
Test result:	Pass	Margin:	232.7 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 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.

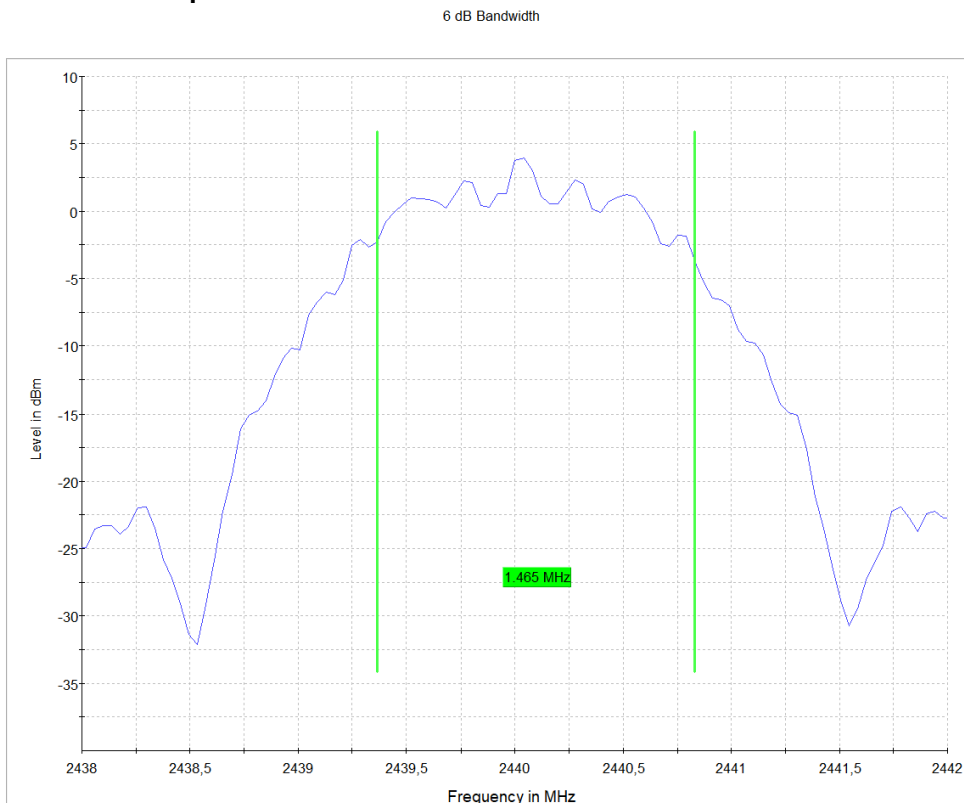
9.3 Requirements

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. 802.15.4.

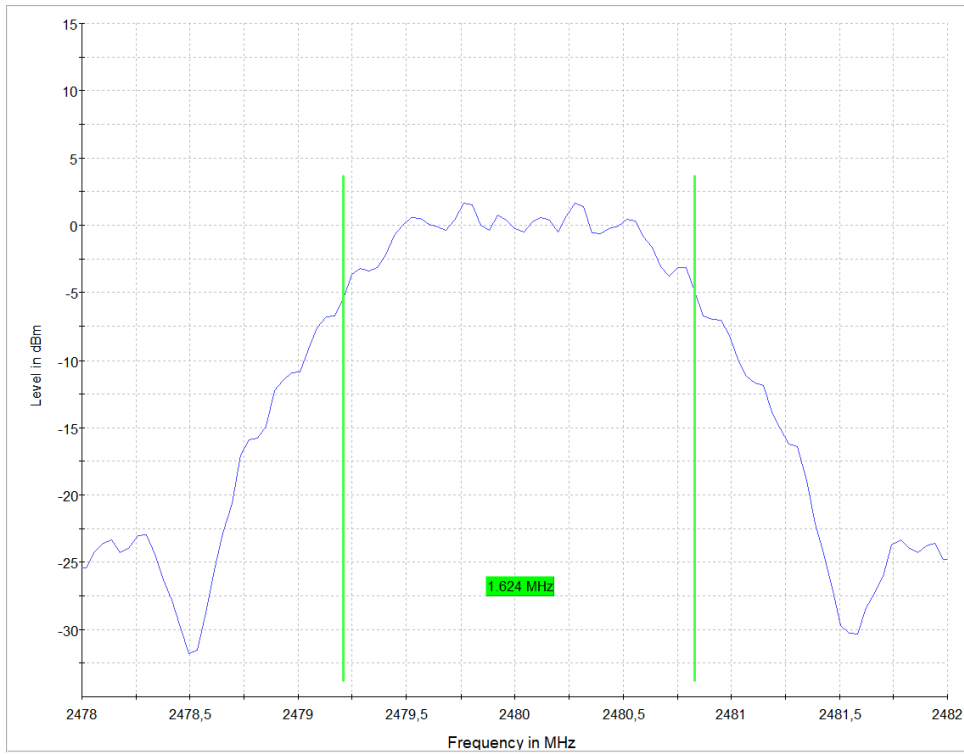


Screenshot: Occupied 6 dB bandwidth Measurement. low channel. 802.15.4.



Screenshot: Occupied 6 dB bandwidth Measurement. middle channel. 802.15.4.

6 dB Bandwidth

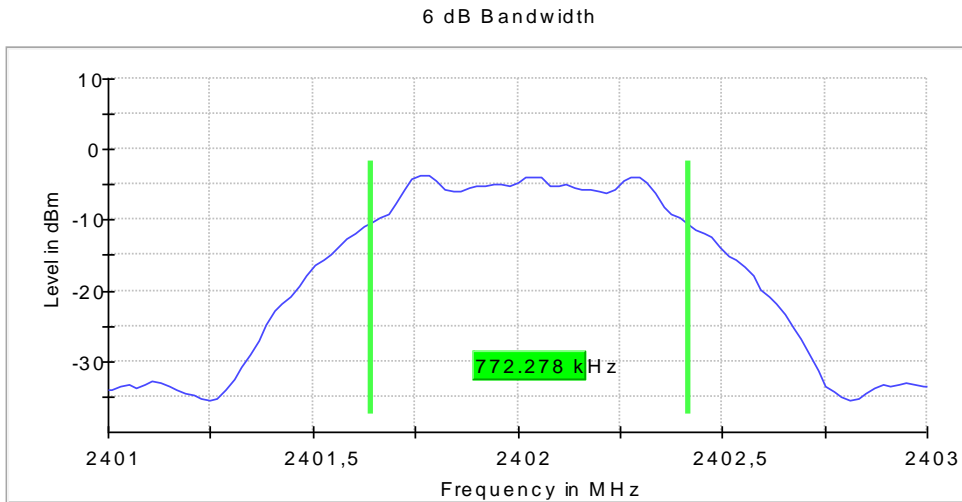


Screenshot: Occupied 6 dB bandwidth Measurement. high channel. 802.15.4.

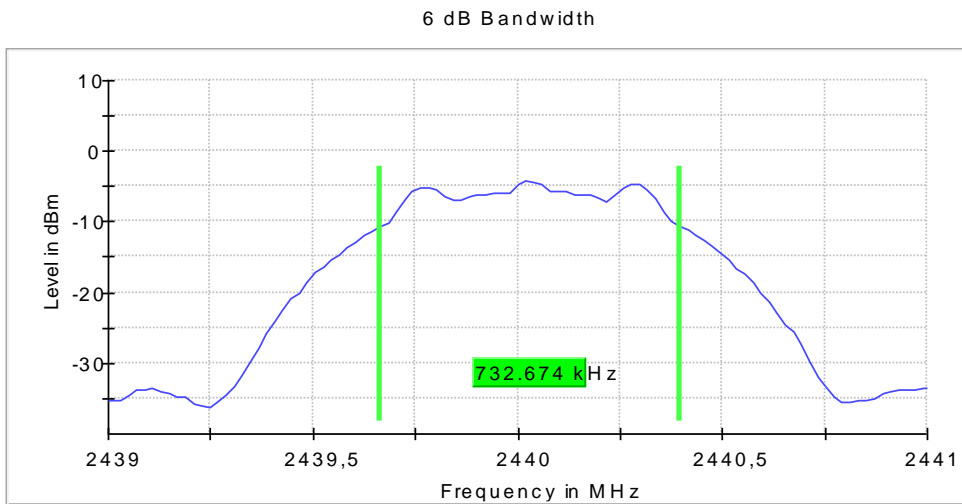
Test results. 802.15.4.

Channel [MHz]	6 dB BW [MHz]
2405	1.584
2445	1.465
2480	1.624

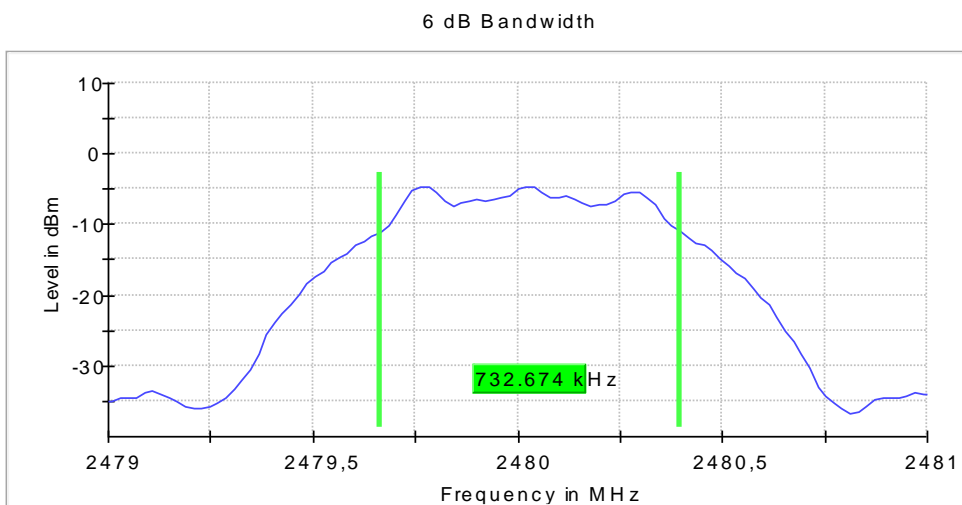
9.5 Test results. BLE.



Screenshot: Occupied 6 dB bandwidth Measurement. Low channel. BLE.



Screenshot: Occupied 6 dB bandwidth Measurement. Middle channel. BLE.



Screenshot: Occupied 6 dB bandwidth Measurement. High channel. BLE.

Test results. BLE.

Channel [MHz]	6 dB BW [kHz]
2402	772.3
2440	732.7
2480	732.7

10 99 % BANDWIDTH

Date of test:	2019-08-05	Test location:	TS8997
EUT Serial:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
Test result:	Pass	Margin:	--

10.1 Test set-up and test procedure.

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

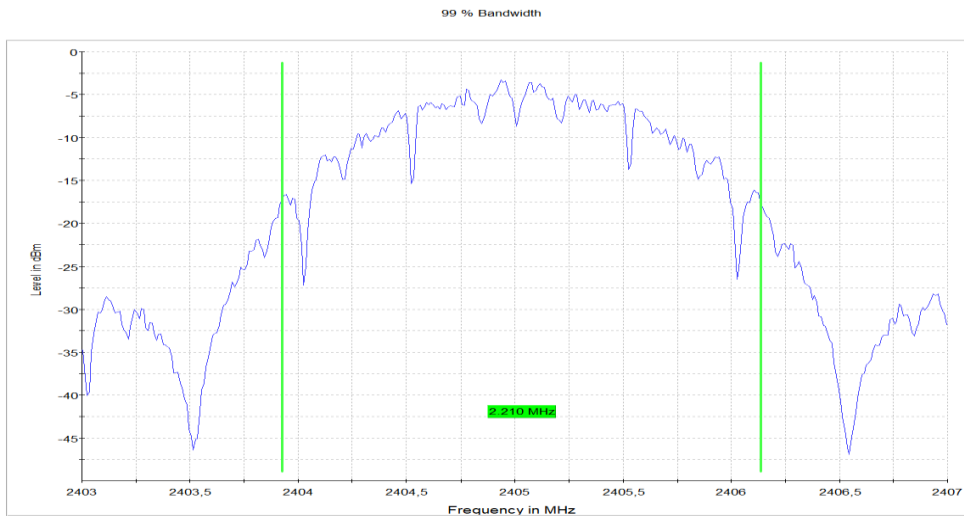
The EUT was connected to spectrum analyser via rf-cable and attenuator. Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

10.2 Test conditions

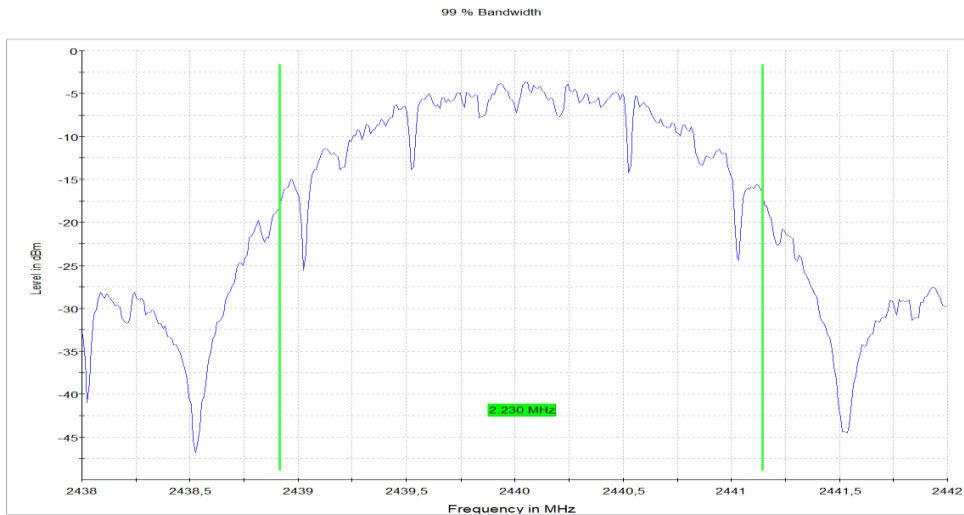
Detector: Peak.
 RBW: 1 – 5 % of OBW
 VBW: 3 x RBW

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

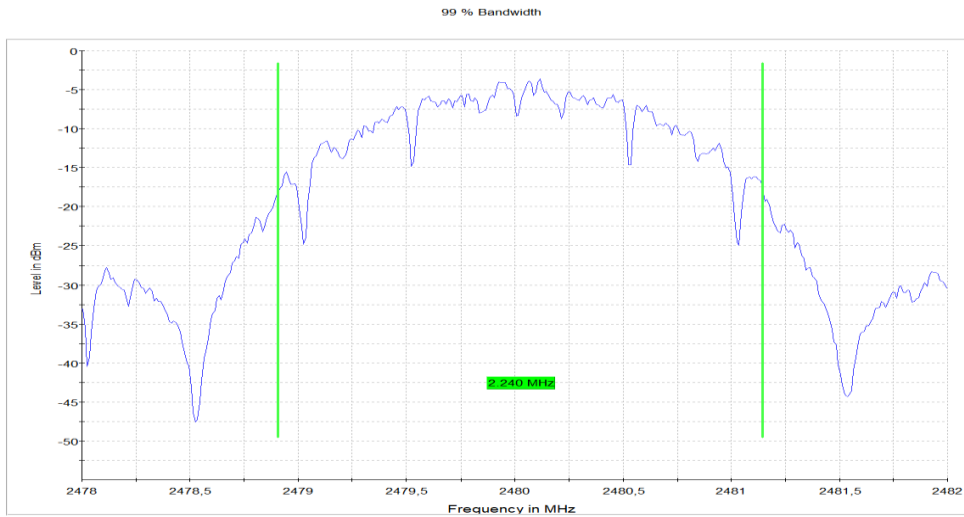
10.3 Test results. 802.15.4.



Screenshot: 99 % bandwidth Measurement. low channel. 802.15.4.



Screenshot: 99 % bandwidth Measurement. middle channel. 802.15.4.

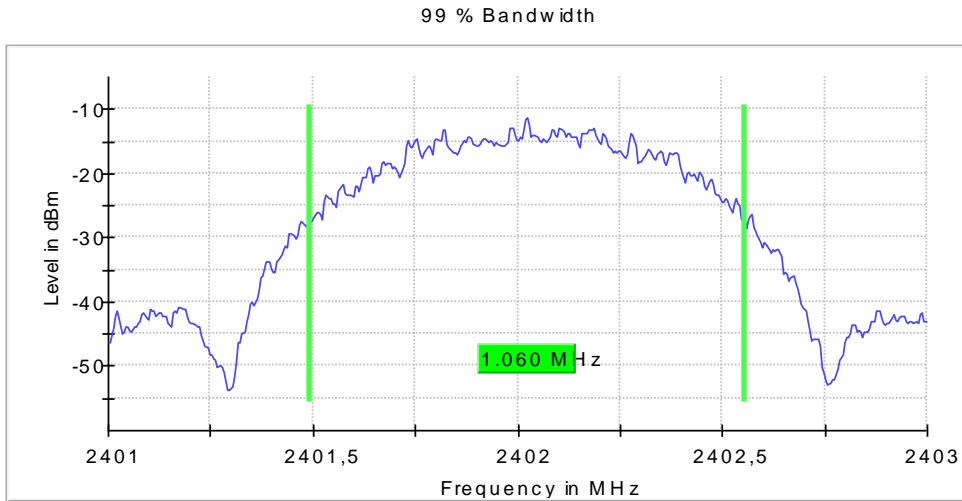


Screenshot: 99 % bandwidth Measurement. high channel. 802.15.4.

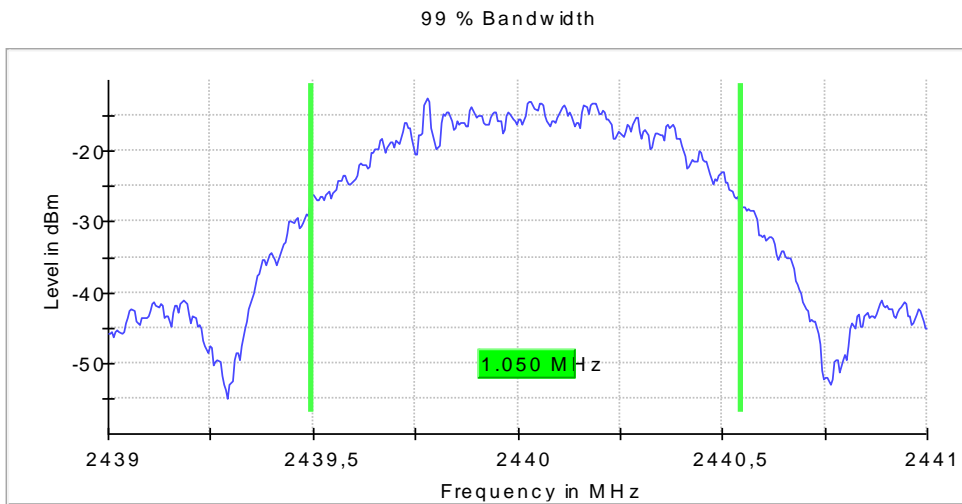
Test results. 802.15.4.

Channel [MHz]	99 % BW [MHz]
2405	2.210
2440	2.230
2480	2.240

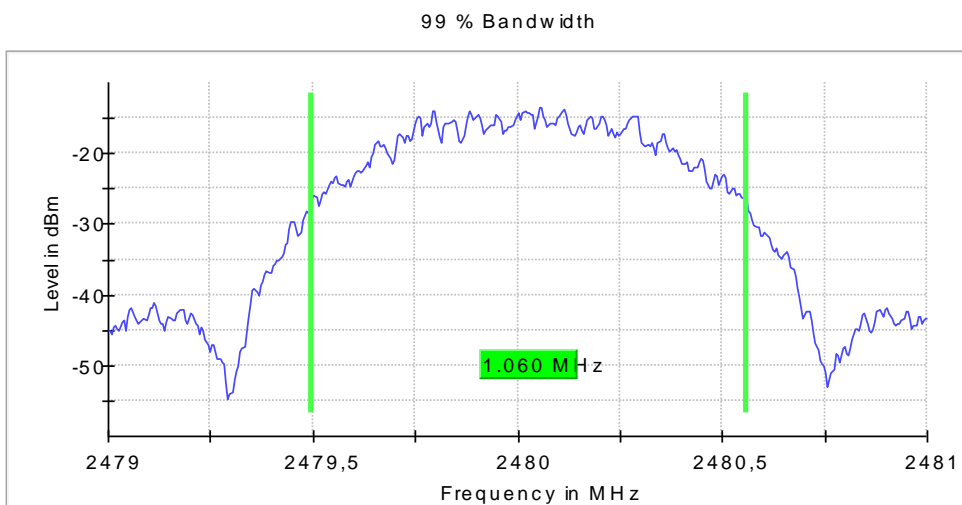
10.4 Test results. BLE.



Screenshot: 99 % bandwidth Measurement. Low channel. BLE.



Screenshot: 99 % bandwidth Measurement. Middle channel. BLE.



Screenshot: 99 % bandwidth Measurement. High channel. BLE.

Test results. BLE.

Channel [MHz]	99 % BW [MHz]
2402	1.060
2440	1.050
2480	1.060

11 PEAK POWER SPECTRAL DENSITY

Date of test:	2019-08-05	Test location:	TS8997
EUT number:	GW-REV03-02 GW-REV03-05	Ambient temp:	20 °C
Tested by:	Usman UI-Haq	Relative humidity:	40 %
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

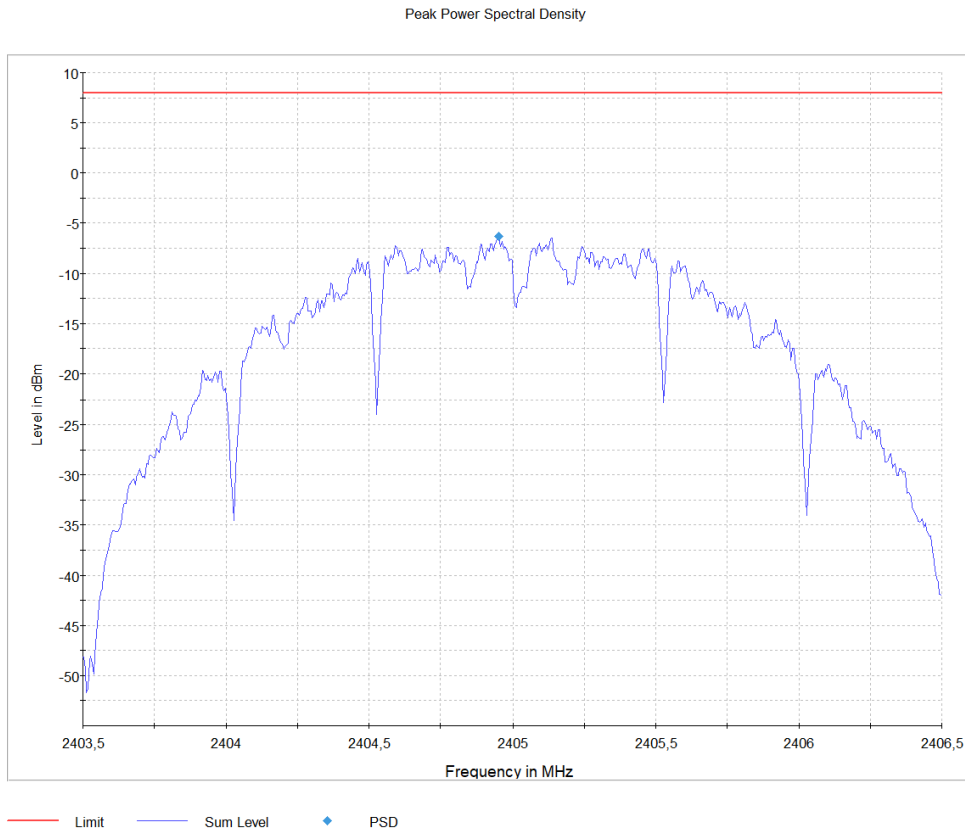
The EUT was set up in order to emit maximum disturbances.

11.3 Requirements

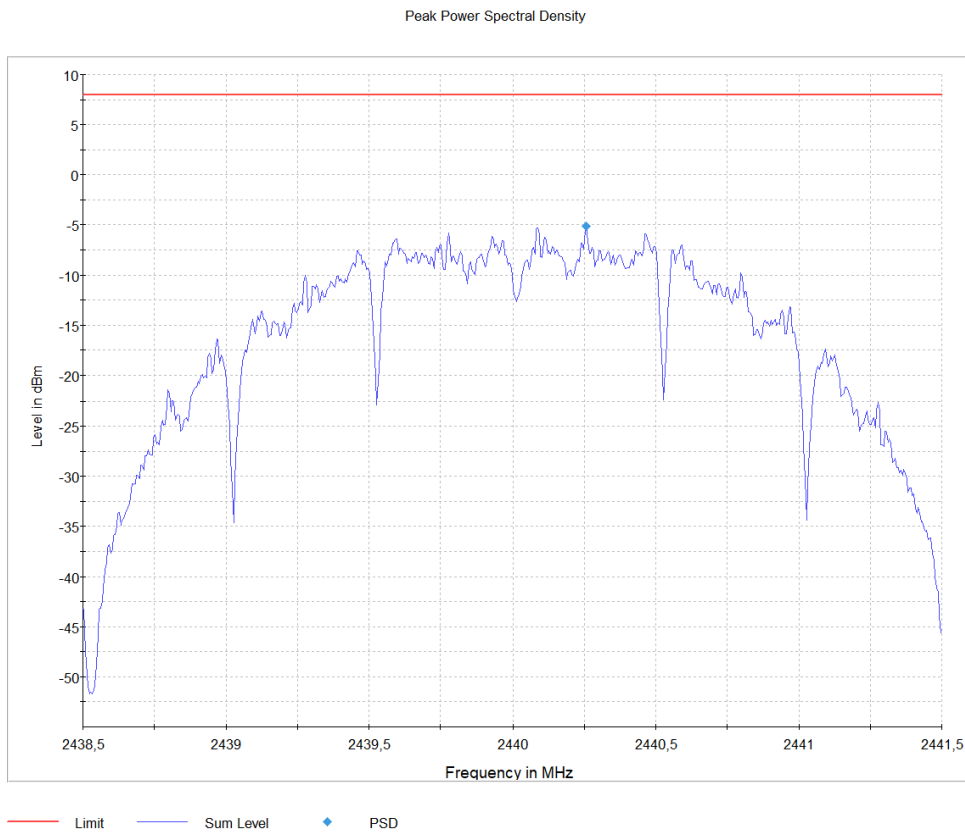
Reference: CFR 47§15.247(3). RSS-247 5.2(2)

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. 802.15.4.

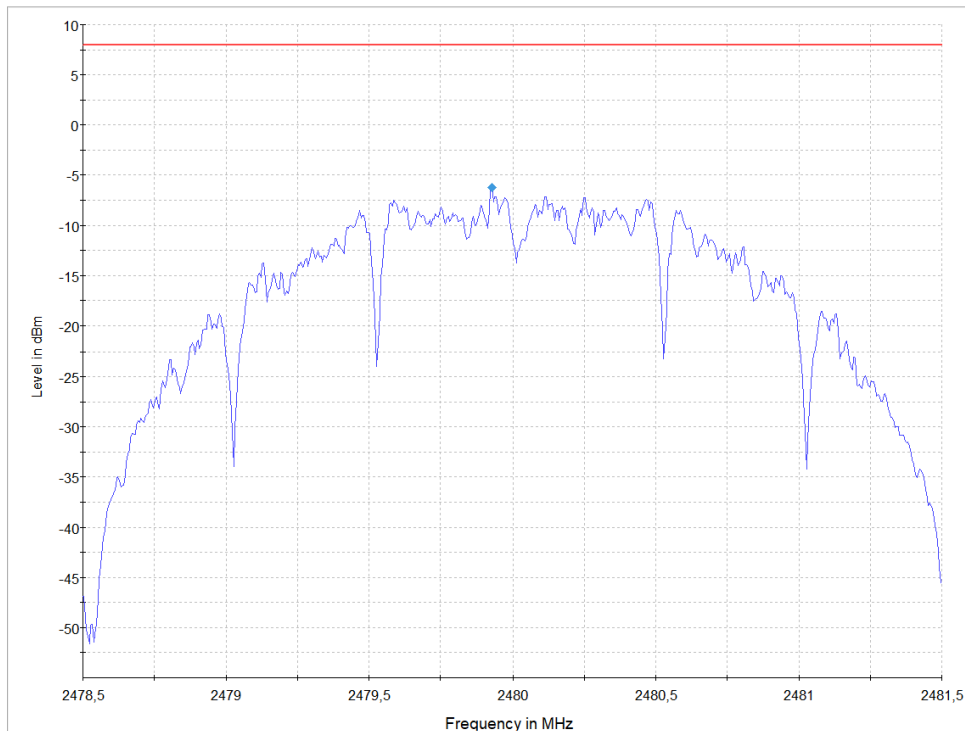


Screenshot: Peak power spectral density. low channel. 802.15.4.



Screenshot: Peak power spectral density. middle channel. 802.15.4.

Peak Power Spectral Density



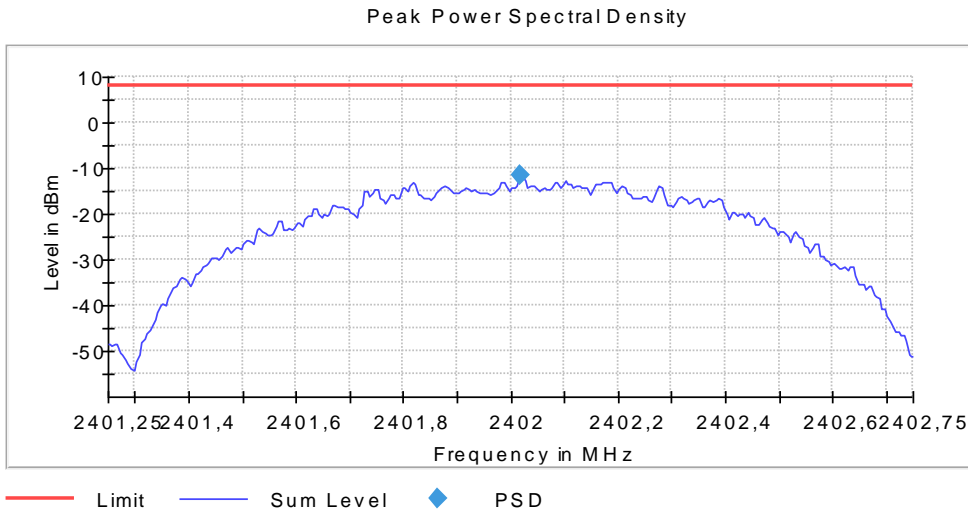
— Limit — Sum Level ◆ PSD

Screenshot: Peak power spectral density. high channel. 802.15.4.

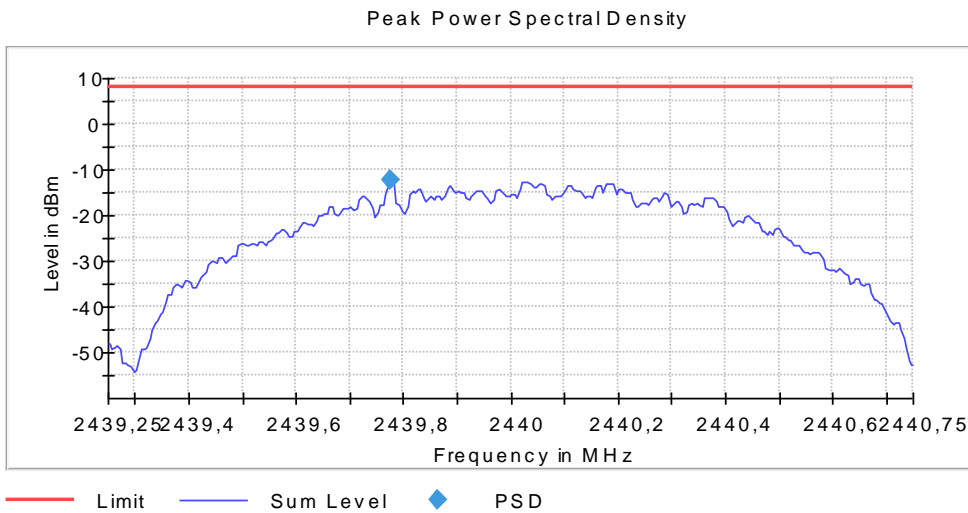
Test results. 802.15.4.

Channel [MHz]	PSD [dBm/3kHz]
2405	-6.3
2440	-5.1
2480	-6.2

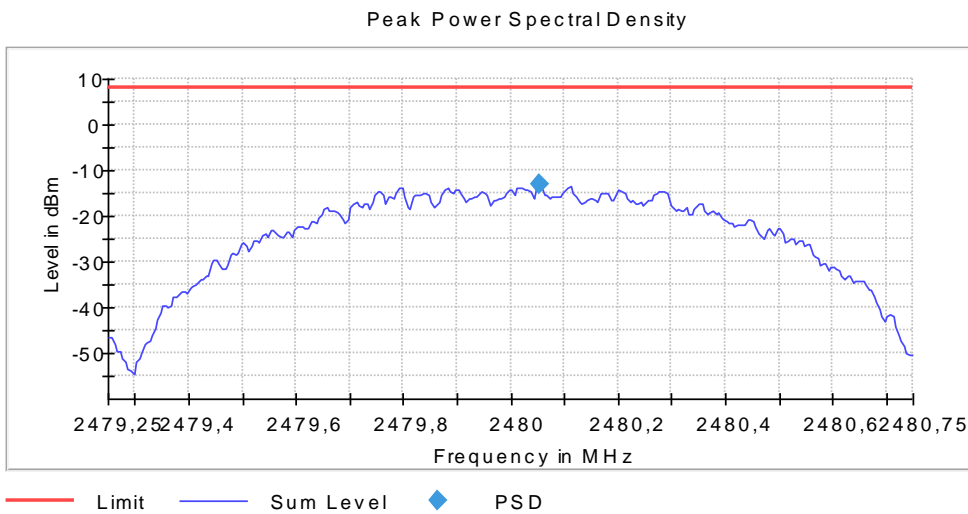
11.5 Test results. BLE.



Screenshot: Peak power spectral density. Low channel. BLE.



Screenshot: Peak power spectral density. Middle channel. BLE.



Screenshot: Peak power spectral density. High channel. BLE.

Test results. BLE.

Channel [MHz]	PSD [dBm/3kHz]
2405	-6.3
2440	-5.1
2480	-6.2

12 TEST EQUIPMENT

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32	--	--	--
Signal analyzer	Rohde & Schwarz	ESU 40	13178	06-2019	1 year
Measurement cable	Huber + Suhner	Sucoflex 104 PE	39070	07-2016	1 year
Horn antenna	EMCO	3115	4936	07-2017	3 years
Pre-amplifier	Sangus	00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	03-2019	1 year
Horn antenna	EMCO	3160-08	30099	10-2016	3 years
Horn antenna	EMCO	3160-09	30101	10-2016	3 years
Signal analyzer:	Rohde & Schwarz	FSV	32594	07-2019	1 year
Signal generator:	Rohde & Schwarz	SMB100A	32592	07-2019	1 year
2.4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	03-2019	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	08-2019	1 year
BiLog antenna	Chase	CBL6110A	971	09-2017	3 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 1910014STO-002 Annex 1.
 Test set up photos are in separate document 1910014STO-002 Annex 2.