

RADIO TEST REPORT

No. 1619091STO-001, Ed. 2

RF Performance

EQUIPMENT UNDER TEST

Equipment: Low power voice communication radio
Type/Model: Spirocom BT
Manufacturer: Interspiro AB
Tested by request of: Interspiro AB

SUMMARY

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

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 1 (2015): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

For details, see clause 2 – 4.

Note: Only spurious emission have been tested.

Date of issue: 2017-01-18

Tested by:


Robert Hietala

Approved by:


Matti Virkki

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Revision History

Edition	Date	Description	Changes
1	2016-11-29	First release	
2	2017-01-18	Second release	Correction of interpretation of peak-to-average values

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1. CLIENT INFORMATION

The EUT has been tested by request of

Company	Interspiro AB Emistvägen 21 183 79 Täby Sweden
Name of contact	Roland Tschöp Phone +46 70 123 45 67
Client observer	Jacob Norrby and Mikael Sandin

2. EQUIPMENT UNDER TEST (EUT)

2.1. Identification of the EUT

Equipment:	Low power voice communication radio		
Type/Model:	Spirocom BT		
Brand name:	Spirocom		
Serial number:	FCC 3, FCC 4		
Manufacturer:	Interspiro AB		
Transmitter frequency range:	902 – 927 MHz, 2402 – 2480 MHz		
Receiver frequency range:	902 – 927 MHz, 2402 – 2480 MHz		
FCC Identification:	SSSBC127-X (2.4 GHz) YDFSCM30605 (915 MHz)		
Frequency agile or hopping:	☒ Yes	☐ No	
Antenna:	☒ Internal antenna	☐ External antenna	
Antenna connector:	☒ None, internal antenna	☐ Yes	
Antenna gain:	915 MHz: 0 dBi 2.4 GHz: 0 dBi		
Rating RF output power:	915 MHz: 17 dBm 2.4 GHz: < 4 dBm		
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: -30°C to +70°C		
Transmitter standby mode supported:	☒ Yes	☐ No	

2.2. Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
Unit 1	Spirocom BT	FCC 3
Unit 2	Spirocom BT	FCC 4

During the tests the EUT supported following software:

Software	Version	Comment
BlueTest3	2.6.0.450	Cambridge Silicon Radio

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.
Laptop computer	--	Lenovo	--

2.4. Test signals and operation modes

Continuous signal from both 915 MHz and 2.4 GHz radio simultaneously on lowest, middle and highest channel.

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 1 (2015): 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

The EUT contains two radio modules, 915 MHz and 2.4 GHz band, which will be co-located and able to transmit simultaneously. Both radio modules have been separately FCC certified previously.

Radio module with FCC ID SSSBC127-X must not be co-located or operating in conjunction with any other antenna or transmitters within a host device according to FCC certificate.

Therefore only spurious emission, with both radio modules, 915 MHz and 2.4 GHz, transmitting simultaneously has been performed.

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

3.3. Test site

Measurements were performed at:

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

Intertek Semko AB is a FCC listed test site with site registration number 90913

Intertek Semko AB is a FCC accredited conformity assessment body with designation number SE0002

Intertek Semko AB is an Industry Canada listed test facility with IC assigned code 2042G

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
BJÖRKHALLEN	Semi-anechoic 3 m	2042G-1

4. TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.203 RSS-GEN 8.3	Antenna requirement	PASS
	The EUT has integrated non detachable antenna which can't be remove without breaking the EUT.	
FCC §15.207, 15.107 RSS-GEN 8.8 table 3	Conducted continuous emission in the frequency range 150 kHz to 30 MHz, AC Power input port	NA
	Battery operated equipment.	
FCC §15.247 (d), 15.209(a), 15.109 RSS-GEN 8.9 RSS-247 5.5	Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz	PASS
	The EUT complies with the limits. The margin to the limit was at least 3.2 dB at 746.072 MHz. See clause 5.4 – 5.5.	
FCC §15.247(d), 15.209(a), 15.109 RSS-GEN 8.9 RSS-247 5.5	Radiated emission of electromagnetic fields in the frequency range above 1 GHz	PASS
	The EUT complies with the limits. The margin to the limit was at least 5.1 dB at 2483.5 MHz. See clause 5.6 – 5.7.	
FCC §15.247(a)(1) RSS-GEN 6.6 RSS-247 5.1	Occupied bandwidth	NT
	Not tested, see clause 3.2.	
FCC §15.247(b) RSS-247 5.4	Conducted output power	NT
	Not tested, see clause 3.2.	
FCC §15.247(a)(1) RSS-247 5.1(2)	Carrier frequency separation	NT
	Not tested, see clause 3.2.	
FCC §15.247(a)(1) RSS-247 5.1	Number of hopping frequencies	NT
	Not tested, see clause 3.2.	
FCC §15.247(a)(1) RSS-247 5.1	Time of occupancy	NT
	Not tested, see clause 3.2.	
FCC §15.247(d) RSS-247 5.5	Band edge	PASS
	The EUT complies with the limits. See clause 5.4 – 5.7.	

NT = Not tested by request of the client

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

Date of test:	2016-11-09	Test location:	Björkhallen, Radiohallen
EUT Serial:	FCC 3, FCC 4	Ambient temp:	21 °C
Tested by:	Robert Hietala	Relative humidity:	24 %
Test result:	Pass	Margin:	3.2 dB

5.1. Test set-up and test procedure.

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

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

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

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

Exploratory pre scans was performed in three orthogonal EUT orientations while the EUT was transmitting. The worst-case orientation was identified and used for final scan on three channels which is presented in this report.

Worst-case channel and EUT orientation identified during TX tests was used for RX tests.

5.2. Test conditions

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

30 MHz to 1000 MHz

Peak, RBW 120 kHz. VBW 1 MHz

Quasi-Peak, RBW 120 kHz

0.8 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Bilog

Test set-up:

Test receiver set-up:

Preview test:

Final test:

EUT height above ground plane:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

Antenna tilt:

1 GHz – 26.5 GHz

Peak, RBW 1 MHz. VBW 3 MHz

Average, RBW 1 MHz. VBW 3 MHz

Peak, RBW 1 MHz

Average RBW 1 MHz

1.5 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Horn

Activated

5.3. Requirements

Within restricted bands and receive mode:

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

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

Frequency range [MHz]	Field strength at 3 m (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))

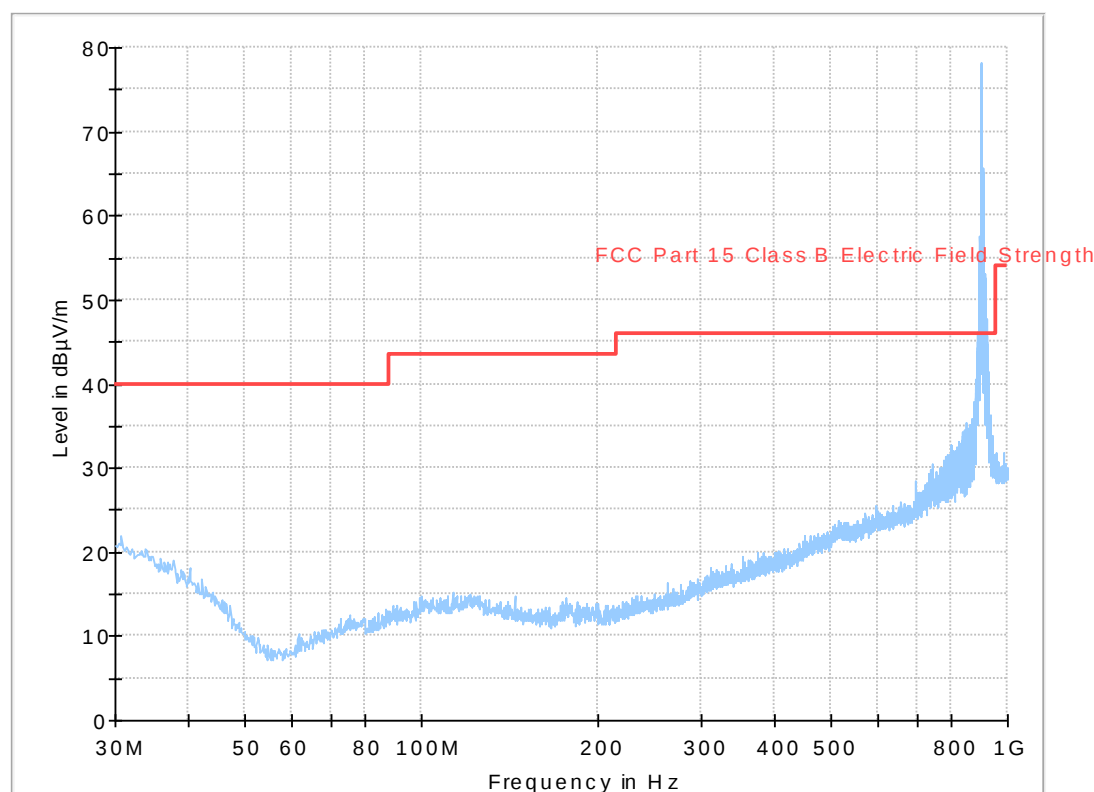
Outside the restricted bands:

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.

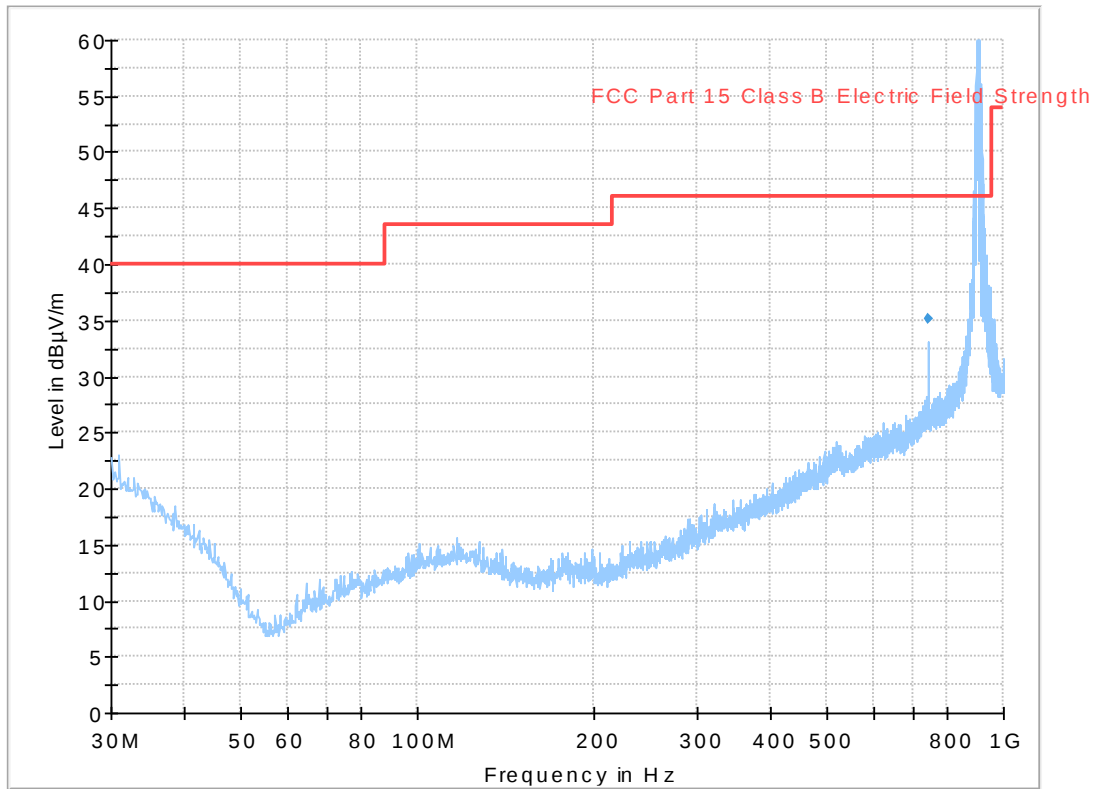
5.4. Test results 30 MHz – 1000 MHz, TX

Full Spectrum



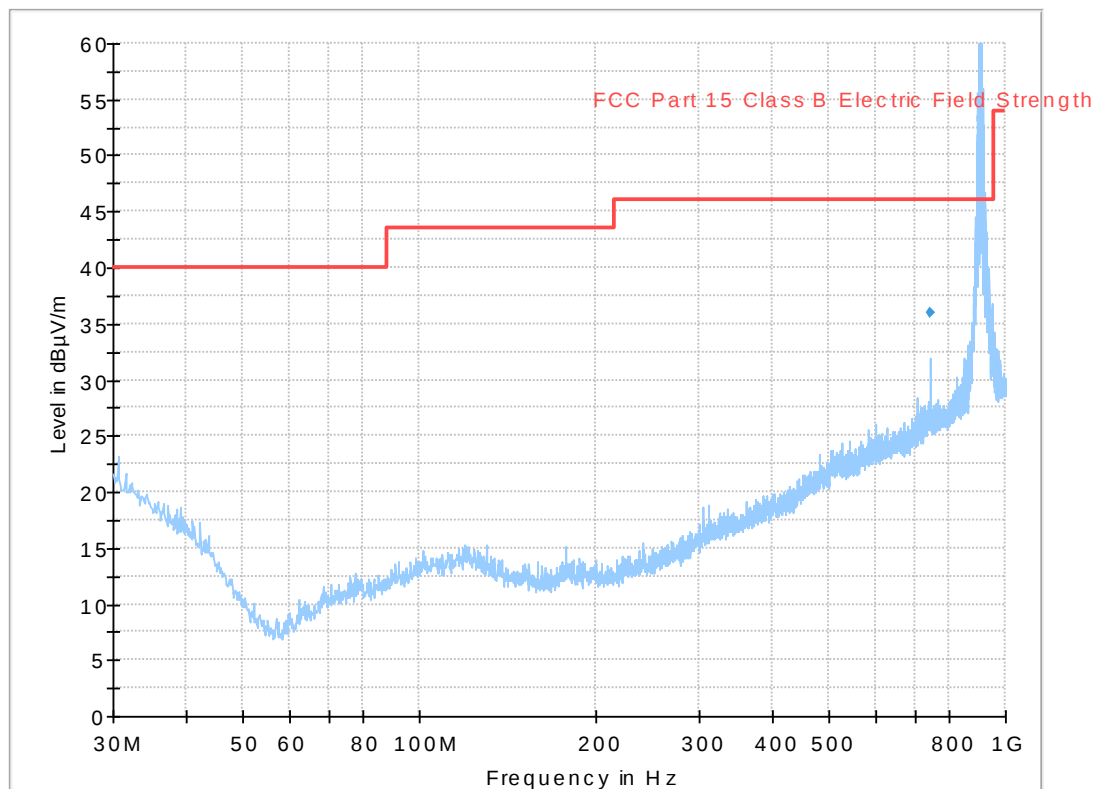
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation X.

Full Spectrum



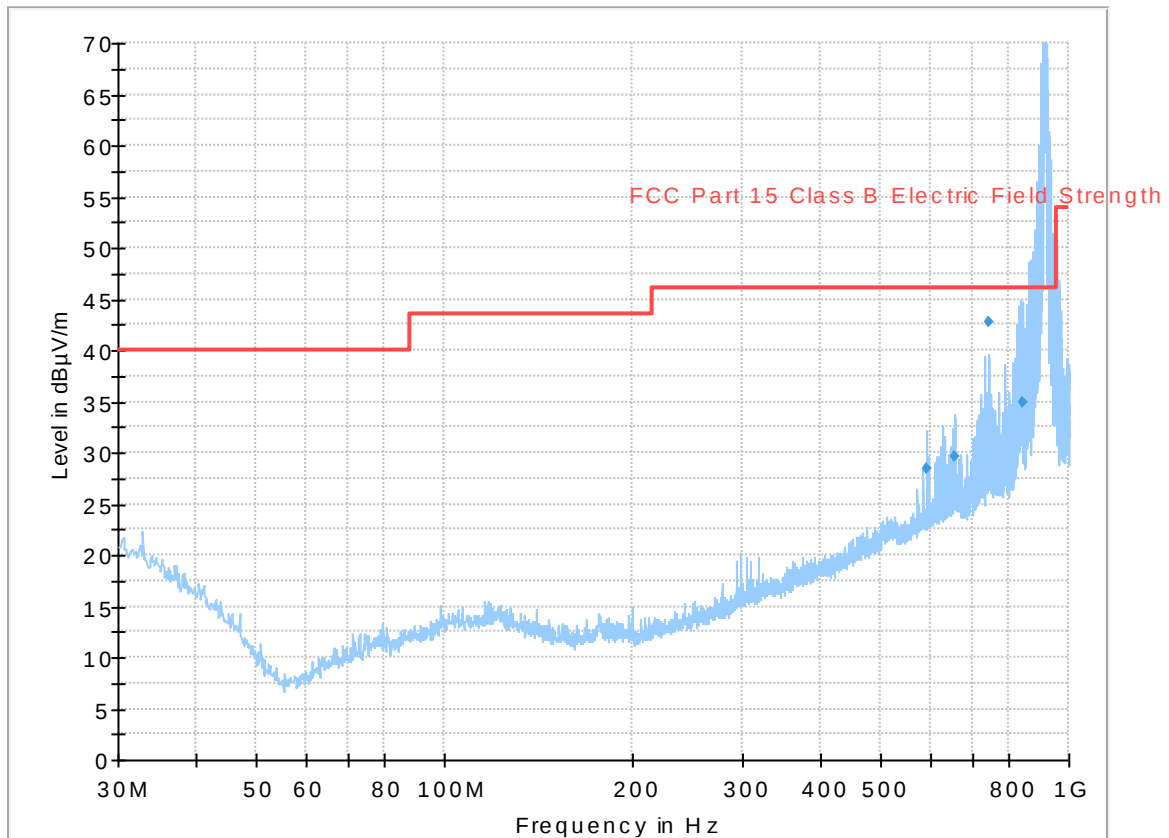
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation Y.

Full Spectrum



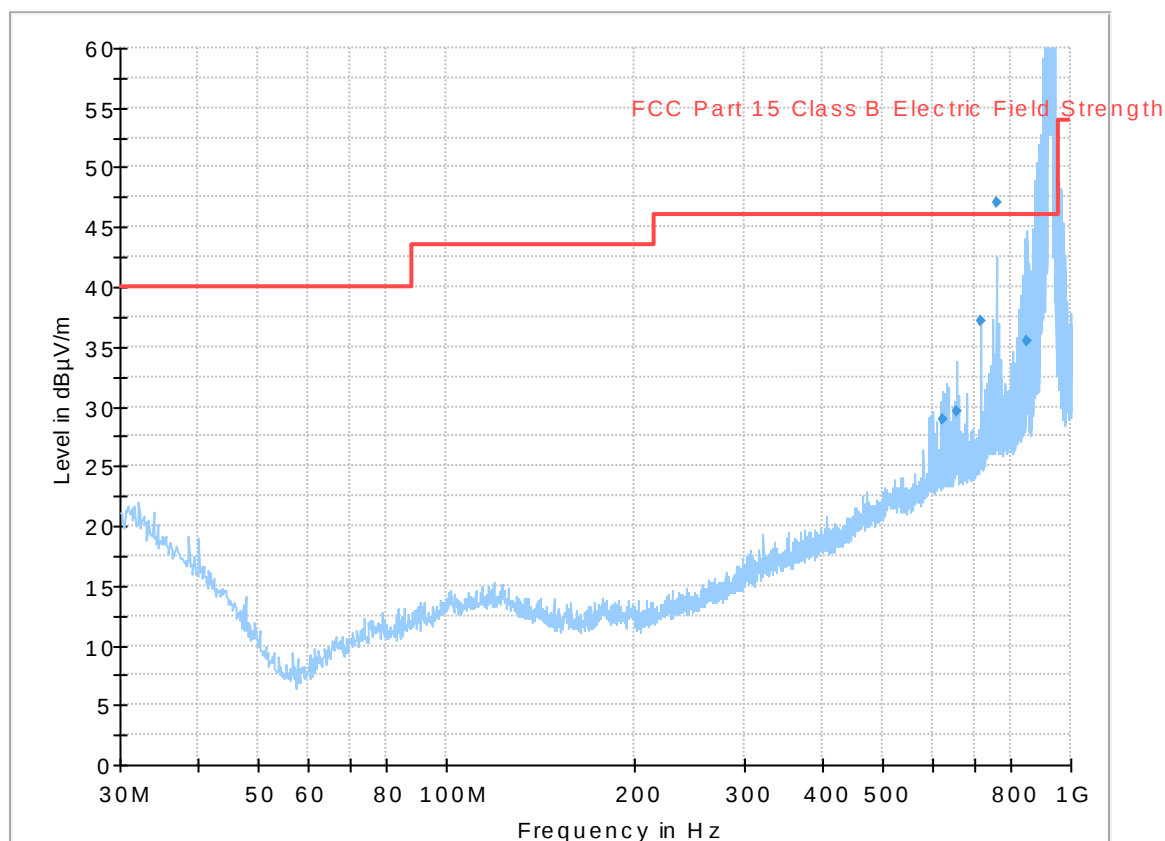
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel, EUT orientation Z.

Full Spectrum



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

Full Spectrum



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

Measurement results, Quasi Peak, low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
746.533	35.2	46.0	V	Y	10.8
746.533	36.0	46.0	H	Z	10.0

Measurement results, Quasi Peak, middle channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
593.226	28.4	46.0	H	Z	17.6
658.417	29.6	46.0	H	Z	16.4
746.072	42.8	46.0	V	Z	3.2
843.647	35.0	46.0	H	Z	11.0

Measurement results, Quasi Peak, high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	EUT orientation X/Y/Z	Margin [dB]
621.403	28.9	46.0	H	Z	17.1
657.517	29.6	46.0	H	Z	16.4
719.538	37.1	46.0	H	Z	8.9
758.537	47.0	46.0	H	Z	-1.0*
848.335	35.5	46.0	H	Z	10.5
901.950	91.0	46.0	H	Z	-45.0**
902.665	119.2	46.0	H	Z	-73.2***
927.315	112.5	46.0	H	Z	-66.5***
928.050	84.1	46.0	H	Z	-38.1**

NOTE: *Signal originates from transmitter, re-measured manually. Fulfils requirement of 20 dB lower than highest emission within band with 100 kHz measuring bandwidth and is not within a restricted band.

NOTE: **Band edge measurement, signal originates from transmitter, measured manually. Fulfils requirement of 20 dB lower than highest emission within band with 100 kHz measuring bandwidth and is not within a restricted band.

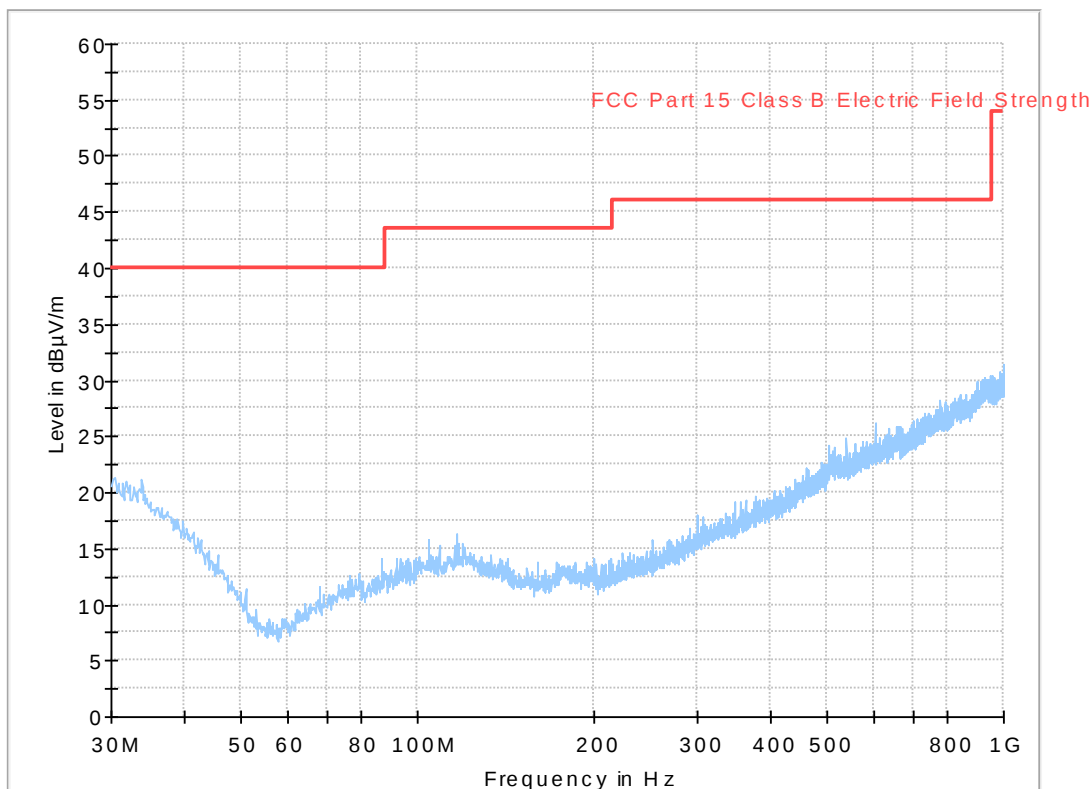
NOTE: ***Carrier for low channel (902 MHz) and high channel (927 MHz).

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

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

5.5. Test results 30 MHz – 1000 MHz, RX

Full Spectrum



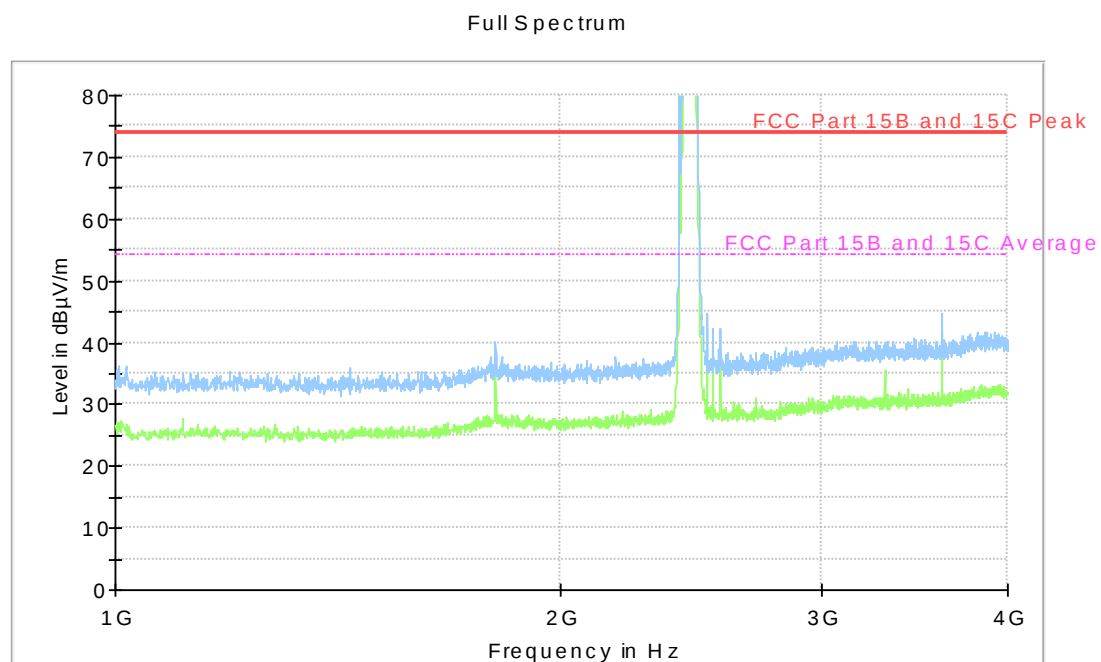
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX high channel, EUT orientation Z.

Measurement results, Quasi Peak

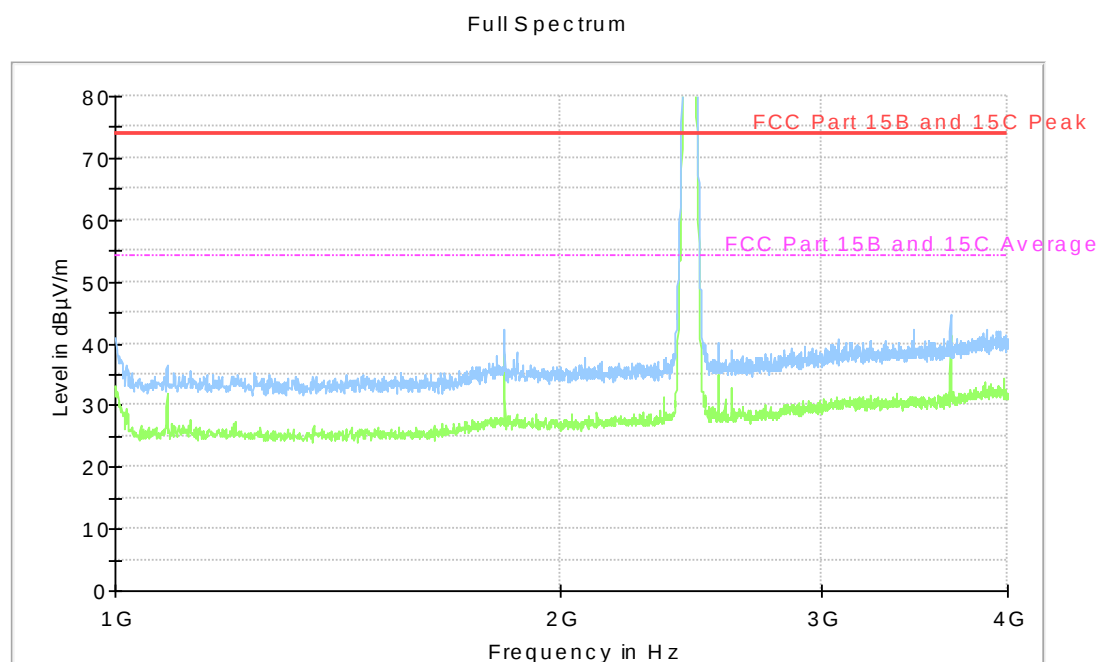
No emissions are found above noise floor or closer than 20 dB from limit.

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

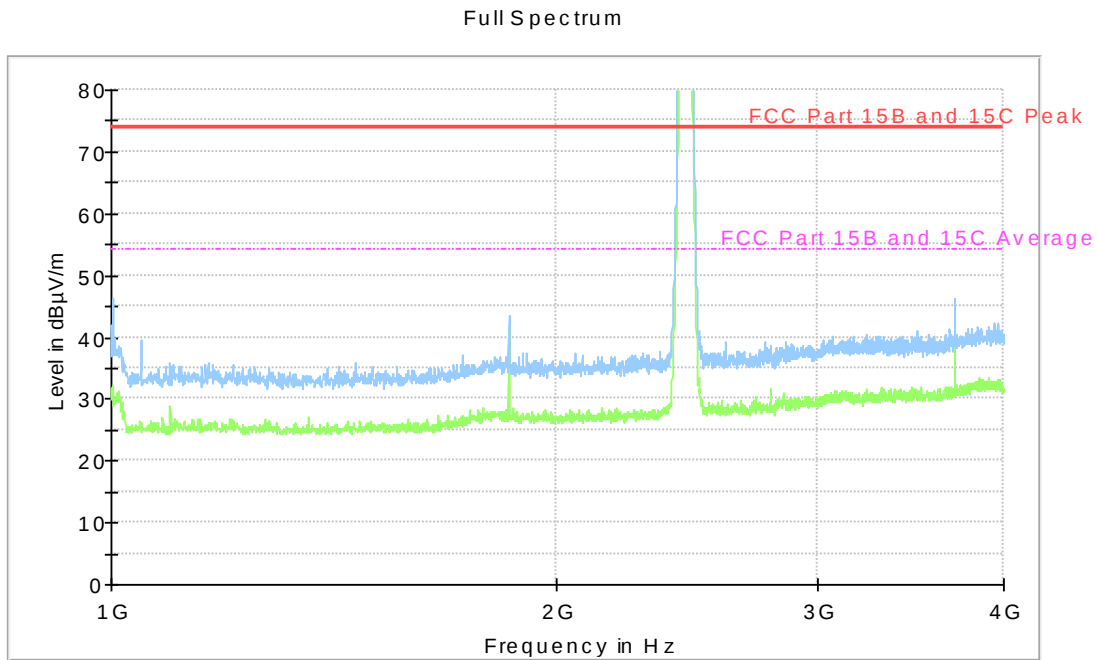
5.6. Test results 1 GHz – 26 GHz, TX



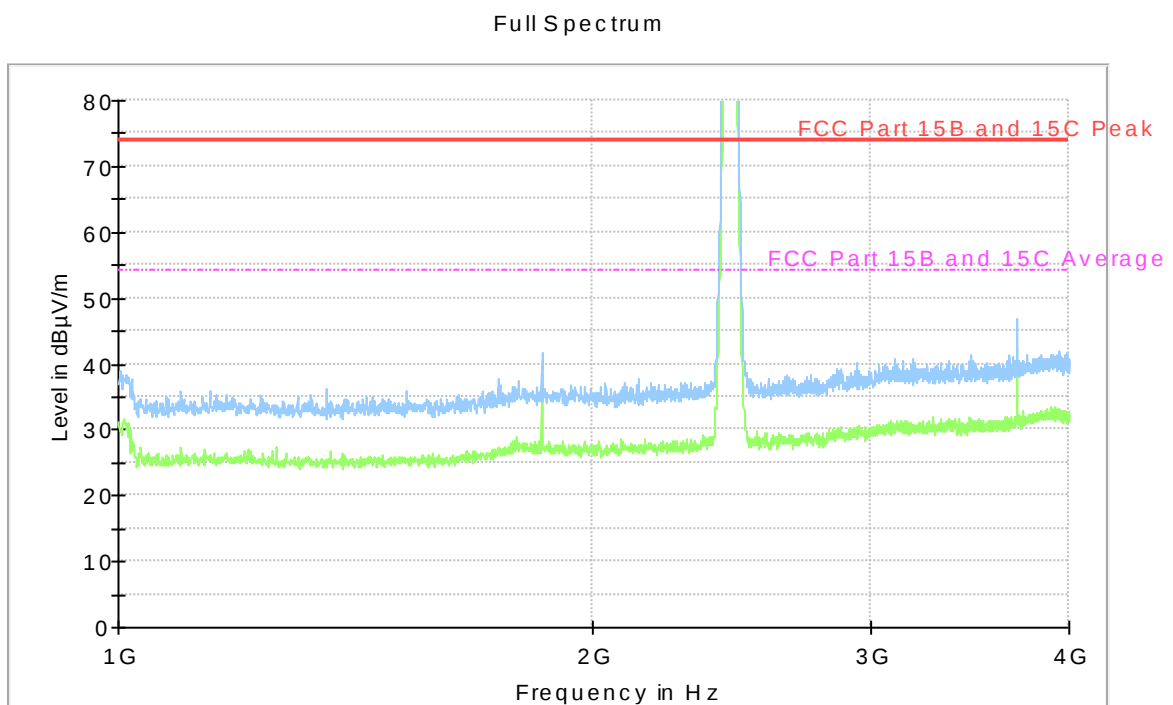
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel, EUT orientation X. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



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

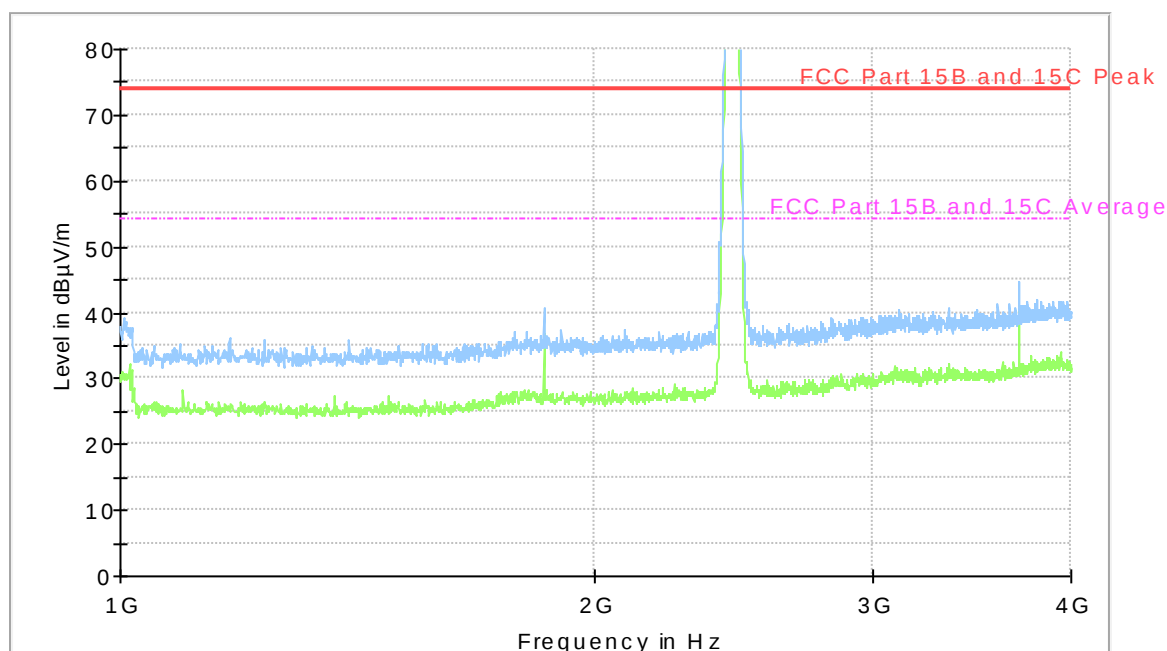


Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel, EUT orientation X. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.



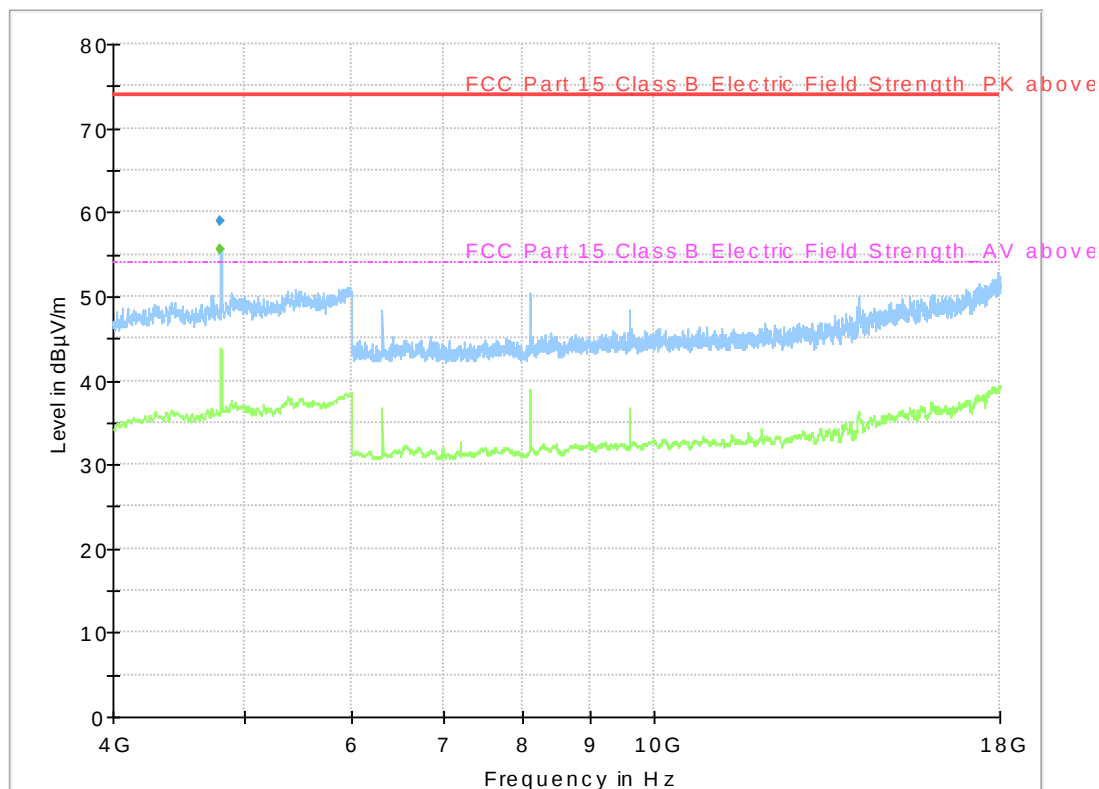
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel, EUT orientation Y. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

Full Spectrum



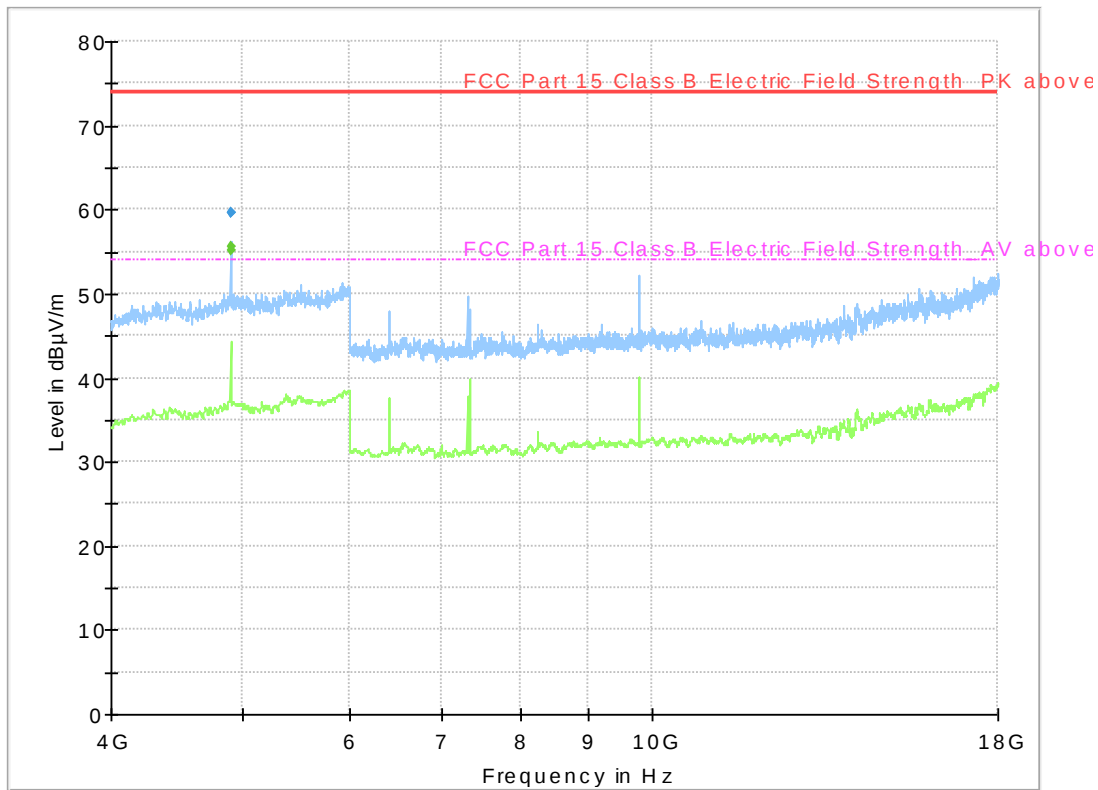
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel, EUT orientation Z. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

Full Spectrum



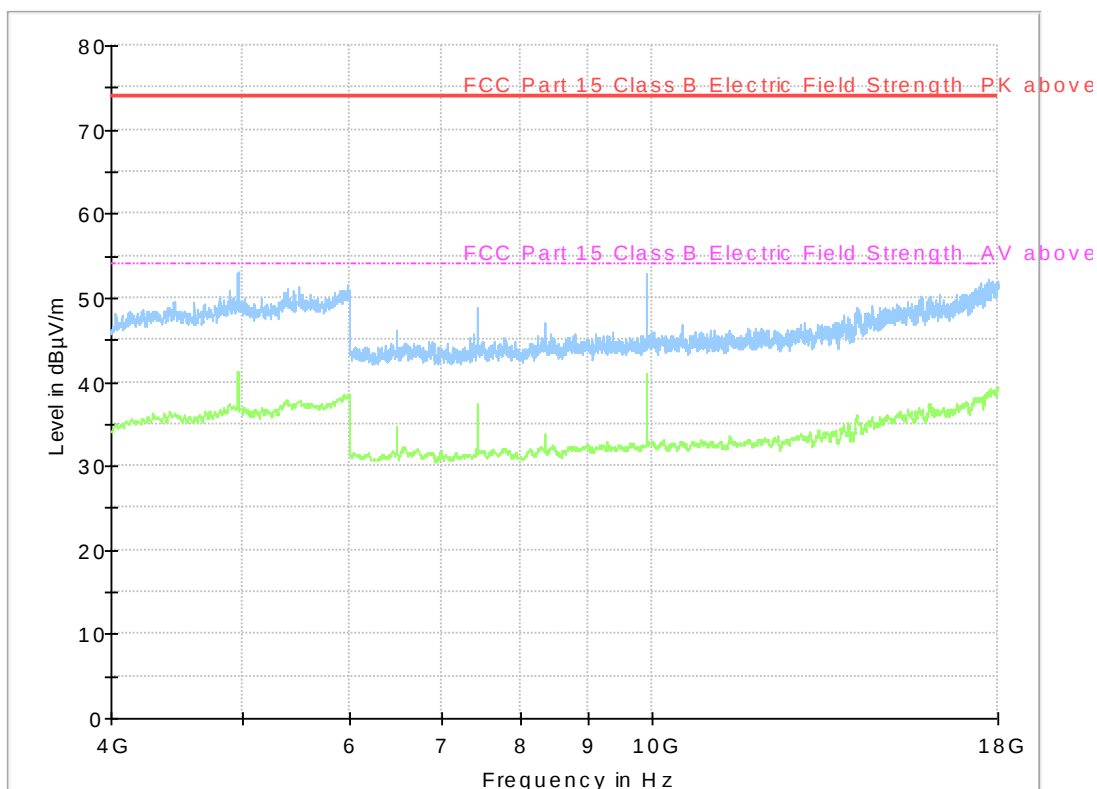
Diagram, Peak overview sweep, 4– 18 GHz at 3 m distance. TX low channel, EUT orientation X. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



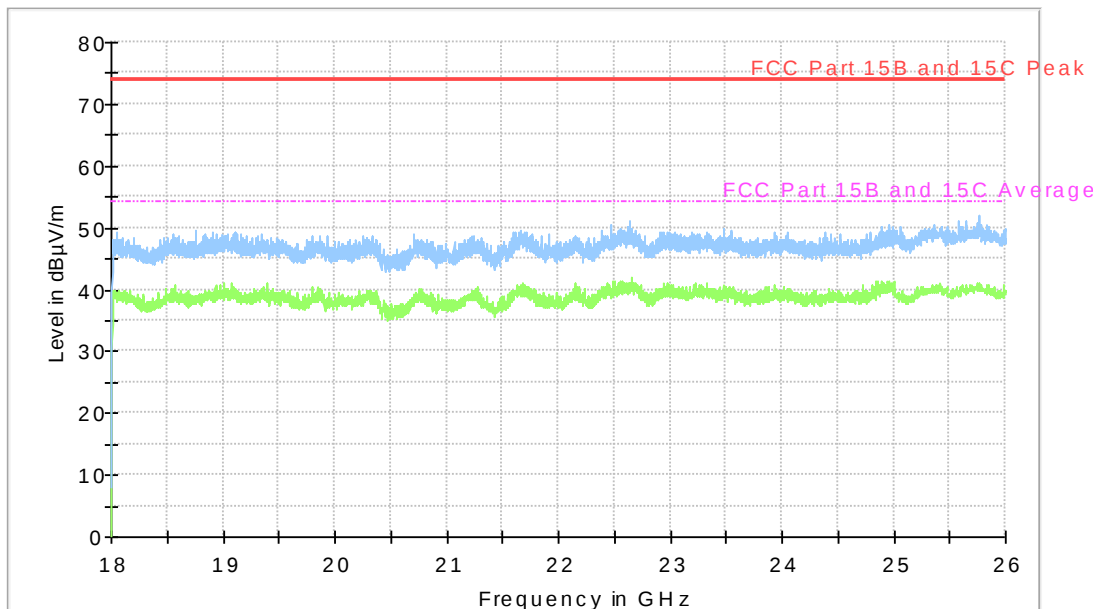
Diagram, Peak overview sweep, 4– 18 GHz at 3 m distance. TX mid channel, EUT orientation X. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



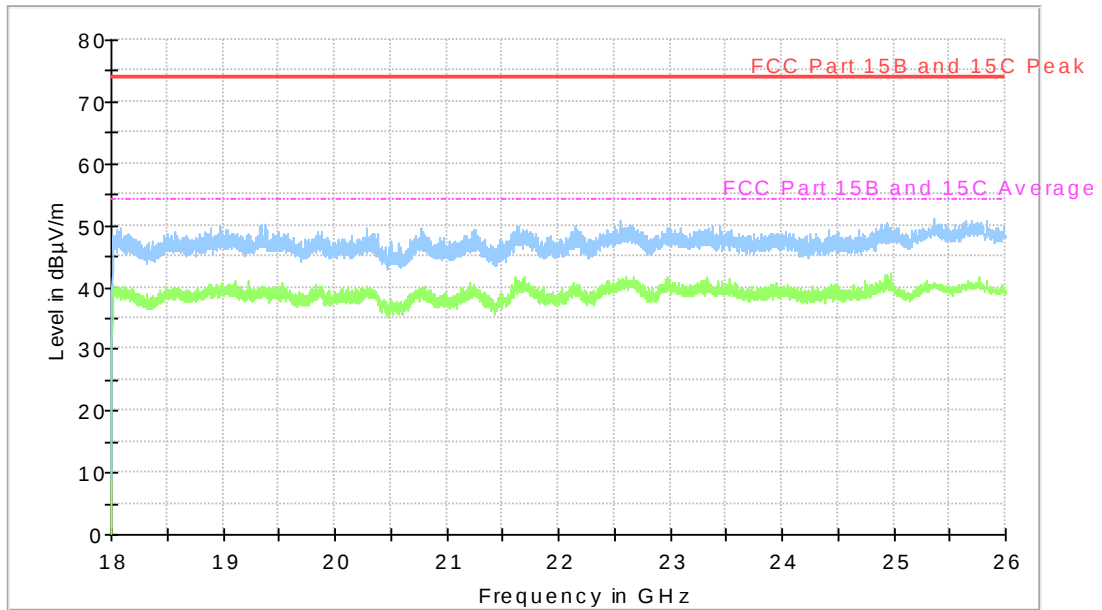
Diagram, Peak overview sweep, 4– 18 GHz at 3 m distance. TX high channel, EUT orientation X. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



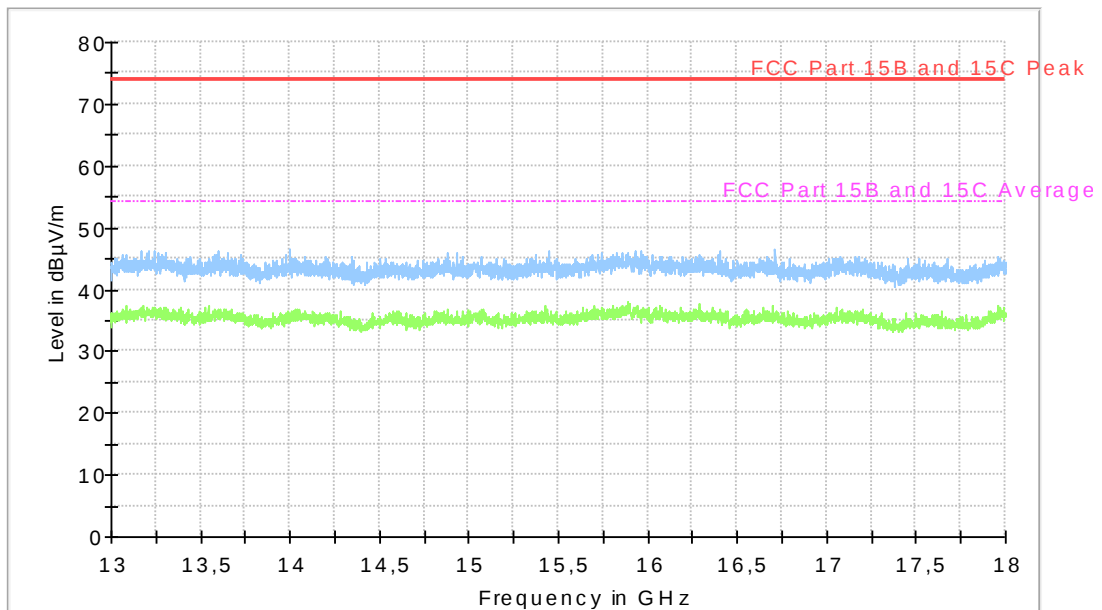
Diagram, Peak overview sweep, 18 – 26 GHz at 3 m distance. TX low channel, EUT orientation X.

Full Spectrum



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

Full Spectrum



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

Measurement results, Peak, TX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
4804.011	59.0	73.9	X	H	14.9

Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
2402.044	96.7	54.0	X	V	-42.7*
4804.011	55.5	54.0	X	H	-1.5**

NOTE:*Carrier for low channel

NOTE: ** Signal originates from transmitter. With a maximum duty cycle of 10 % in normal mode of operation (according to the manufacturer) the duty cycle correction factor for calculating peak to average is 10 dB (20xlog(duty cycle)) which gives a value of 49.0 dBμV/m, which is below the limit with a margin of 5.0 dB.

Measurement results, Peak, TX middle channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
4897.996	59.7	74.0	X	H	14.3

Measurement results, Average, TX middle channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
2448.998	97.1	54.0	X	V	-43.1*
4897.996	55.5	54.0	X	H	-1.5**

NOTE:*Carrier for middle channel

NOTE: ** Signal originates from transmitter. With a maximum duty cycle of 10 % in normal mode of operation (according to the manufacturer) the duty cycle correction factor for calculating peak to average is 10 dB (20xlog(duty cycle)) which gives a value of 49.7 dBμV/m, which is below the limit with a margin of 4.3 dB.

Measurement results, Peak, TX high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
2483.5	63.2	74.0	X	H	10.8

Measurement results, Average, TX high channel

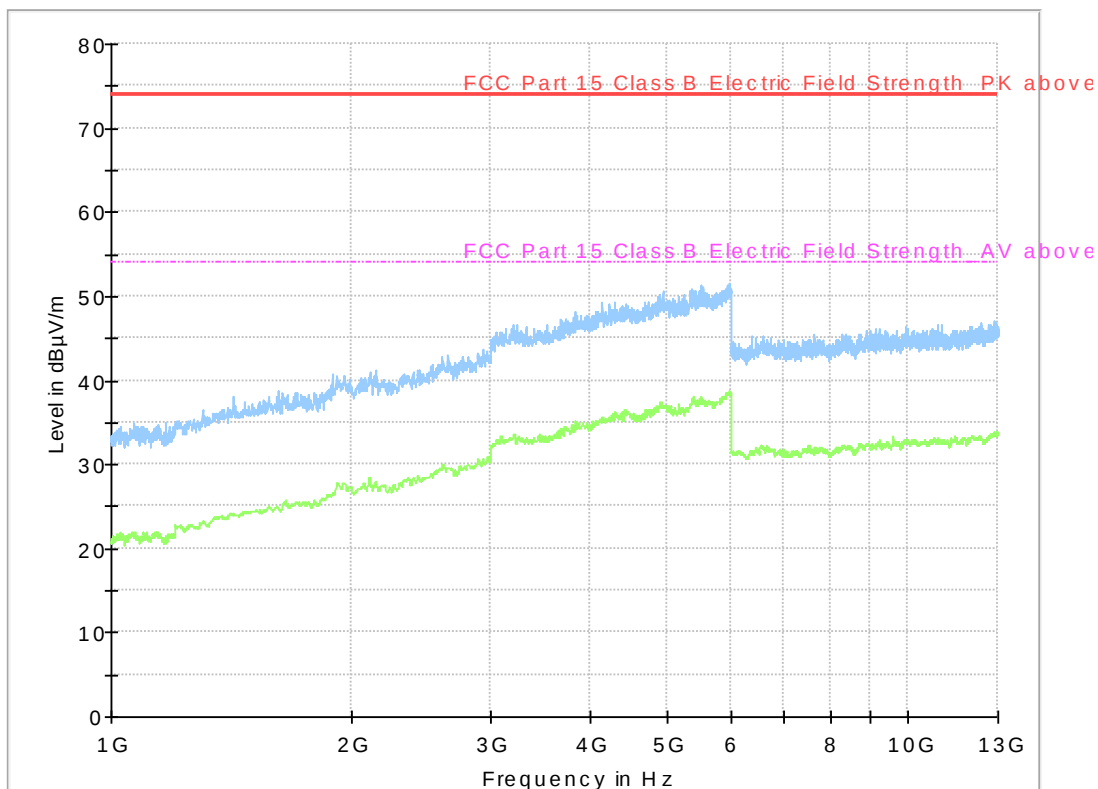
Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
2483.5	48.9	54.0	X	H	5.1

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

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

5.7. Test results 1 GHz – 13 GHz, RX

Full Spectrum



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

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

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

6. TEST EQUIPMENT

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 – v9.12.10	--	--	--
Measurement receiver	Rohde & Schwarz	ESIB26	32291	2016-07	1 year
Coaxial cable	Radiall	SHF8M	9975	2016-07	1 year
Open switch and control platform	Rohde & Schwarz	OSP130	32300	2016-07	1 year
Antenna ultralog	Rohde & Schwarz	HL562	30711	2014-12	3 years
Horn Antenna	Rohde & Schwarz	HF907	32307	2015-07	3 years
2.4 GHz band reject filter	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	2016-03	3 years
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	2016-08	1 year
1 GHz high pass filter	MICROWAVE CIRCUITS INC	H1G013G1	13142	2016-08	1 year

7. 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 %.

8. TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1619091STO-001 Annex 1.

Test set up photos are in separate document 1619091STO-001 Annex 2.