RADIO TEST REPORT

No. 1508253STO-001, Ed. 4

RF Performance

EQUIPMENT UNDER TEST

Equipment:	WIFI Module
Tested type/model:	WF111-A modified with external antenna connector
Additional type/model*:	WF111-E
Manufacturer:	BlueGiga Technologies Oy
Tested by request of:	Silicon Laboratories Finland Oy

*See opinions and interpretations clause 2.6

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 standard:

47 CFR Part 15 (2014): Subpart C: Intentional radiators. Section 15.247.

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

Note: Only radiated emissions measurements for new antenna have been performed.

For details, see clause 2 – 4.

Date of issue: 2015-09-30

Tested by: Åke Carlson

Approved by: Matti Virkki

Revision History

Edition	Date	Description	Changes
1	2015-05-11	First release	
2	2015-08-31	Second release	Additional EUT type was added. Section 2.6 is added.
3	2015-09-04	Third release	Additional EUT type name is corrected.
4	2015-09-30	Fourth release	FCC ID typo corrected. Client company name updated. IC standard revised to RSS-247

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company	Silicon Laboratories Finland Oy Sinikalliontie 5A, 5th Floor FI-02630 Espoo FINLAND
Name of contact	Sami Kaislasuo

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	WLAN Module	
Tested type/model:	WF111-A modified with external antenna connector	
Additional type/model	WF111-E	
Brand name:	BlueGiga	
Serial number:	-	
Manufacturer:	BlueGiga Technologies Oy PL 120 FI-02631 Espoo FINLAND	
Transmitter frequency range:	2412 – 2462 MHz	
Receiver frequency range:	2412 – 2462 MHz	
Frequency agile or hopping:	☐ Yes	☒ No
Antenna:	☐ Internal antenna	☒ External antenna
Antenna connector:	☐ None, internal antenna	☒ Yes, type U.FL
Antenna gain:	2.2 dBi (highest declared by manufacturer)	
Rating RF output power:	19.15 dBm (conducted, listed power)	
Type of modulation:	CCK/OFDM	
Transmitter stand by mode supported:	☒ Yes	☐ No

2.2 Purpose of test

The WLAN module has been tested previously and found to comply with the requirements of the listed standards. This report contains measurements of radiated emissions with a new antenna not originally included in the measurements.

2.3 Additional information about the EUT

The EUT has the following FCC ID: QOQWF111

The EUT has the following IC Number: 5123A-BGTWF111

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The EUT consists of the following units:

Units	Type	Serial number
WLAN Module	WF111 V1.1 modified with external antenna connector	-
Antenna	Inverted F-antenna with U.FL. connector	68001638A

During the tests the EUT was controlled using following software:

Software	Version	Comment
UniTest App	7.4.1.11	-

During the tests the EUT was using the following firmware:

Firmware	Comment
Ptest_unifi_603x_a10_11	-

The EUT was tested with the following cables:

Port:	Type:	Length: [m]	Specifications:
5 V	DC Power	1,8	-

2.4 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.
Power Supply	Battery eliminator/Type 8713	Mascot	-

2.5 Test signals and operation modes

The EUT was operated with specific software (see section 2.2) to enable setting of modulation, data-rate, channel and transmission times. Following a worst case investigation of all modulations and data-rates the worst was determined to be 1 Mbps with CCK modulation. All results in this report have been measured using that worst case mode.

The measurements were performed on the following channels:

Channel [#]	Center frequency [MHz]
1	2412
6	2437
11	2462

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2.6 Opinions and interpretations

The following type is also included as additional type in this report:
WF111-E

According to the manufacturer there is no difference between the tested type and the type WF111-E. Therefore, this type is not tested, but considered to have the same characteristics.

2.7 Modifications made to improve EMC-characteristics

No modifications were made to the EUT to improve EMC-characteristics.

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3 TEST SPECIFICATIONS

3.1 Standards

Requirements:
47 CFR Part 15: Radio frequency device, Subpart C: Unintentional radiators (2014).

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 C63.10-2009: American National Standard for testing Unlicensed Wireless Devices

3.2 Additions, deviations and exclusions from standards and accreditation

Only radiated emissions measurements for new antenna have 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
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 #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2

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4 TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.247 (d), 15.209(a) **RSS-247 5.5** **RSS-Gen section 8.9**	**Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz**	**PASS**
FCC §15.247(d), 15.209(a) **RSS-210 5.5** **RSS-Gen section 8.9**	**Radiated emission of electromagnetic fields in the frequency range above 1 GHz**	**PASS[1]**

1. The measured result is below the upper limit, but by a margin less than half of the uncertainty interval. It is therefore not possible to state compliance based on the 95% level of confidence. However, the result indicates that compliance is more probable than non-compliance.

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

5.1 Operating environment

Date of test:	Temperature:	Relative Humidity:
2015-03-31, 2015-04-01, 2015-04-07	19.5 – 21.1 [°C]	25 – 27.8 [%]

5.2 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10 and ANSI C63.4
The EUT was set up in order to emit maximum disturbances.
The EUT was placed on an insulating support 0.8 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.

5.3 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: Peak, RBW 120 kHz. VBW 1 MHz
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
Final test: Peak, RBW 1 MHz
Average RBW 1 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

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5.4 Radiated emission requirements

Outside restricted bands

§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. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.

Within restricted bands

§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 §15.31(f)(1)) and RSS-Gen section 6.5.

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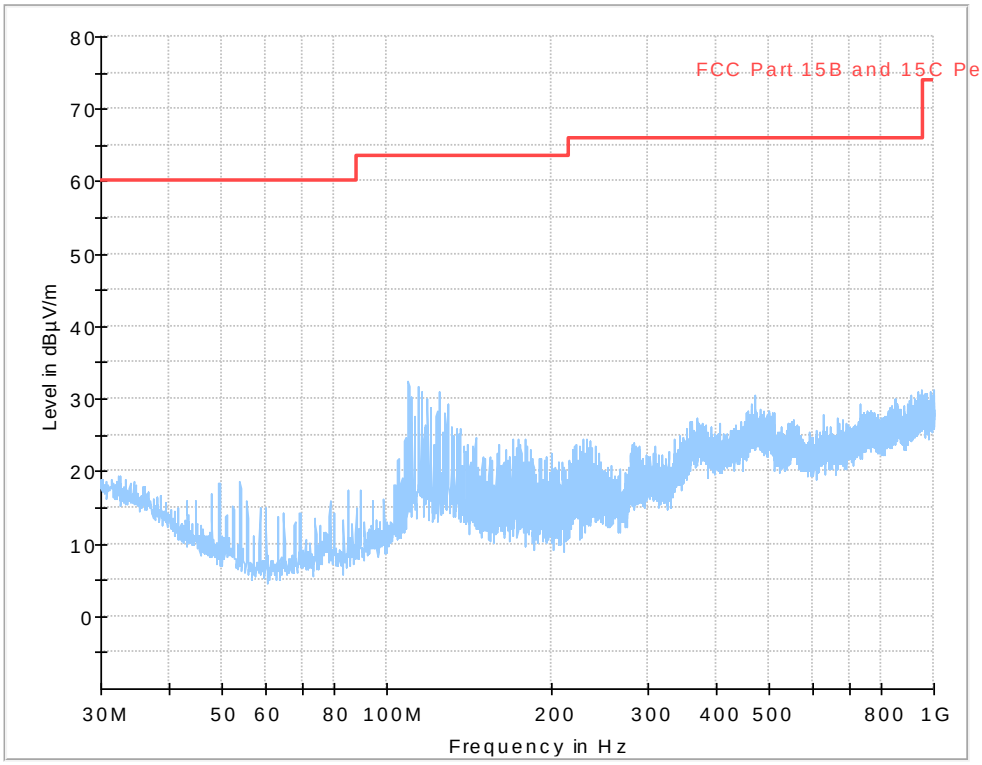
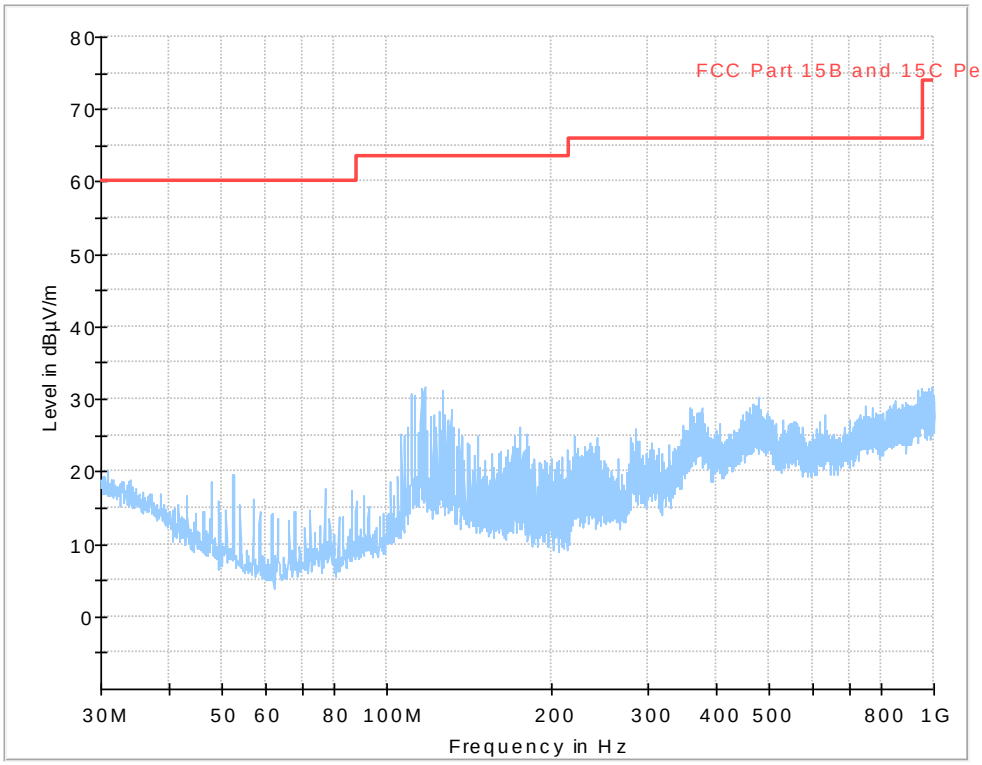
5.5 Test results 30 MHz – 1000 MHz

Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m, channel 1.



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m, channel 6.



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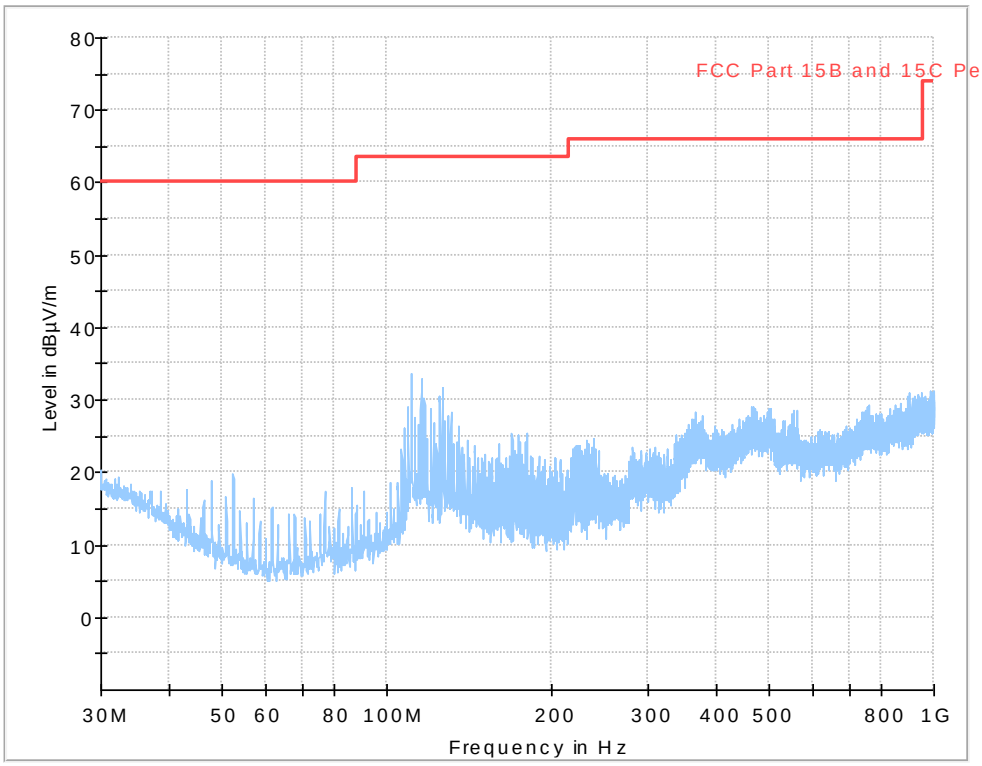
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m, channel 11.



Measurement results, 30 – 1000 MHz

No final measurements were made since peak emissions were more than 20 dB from limits.

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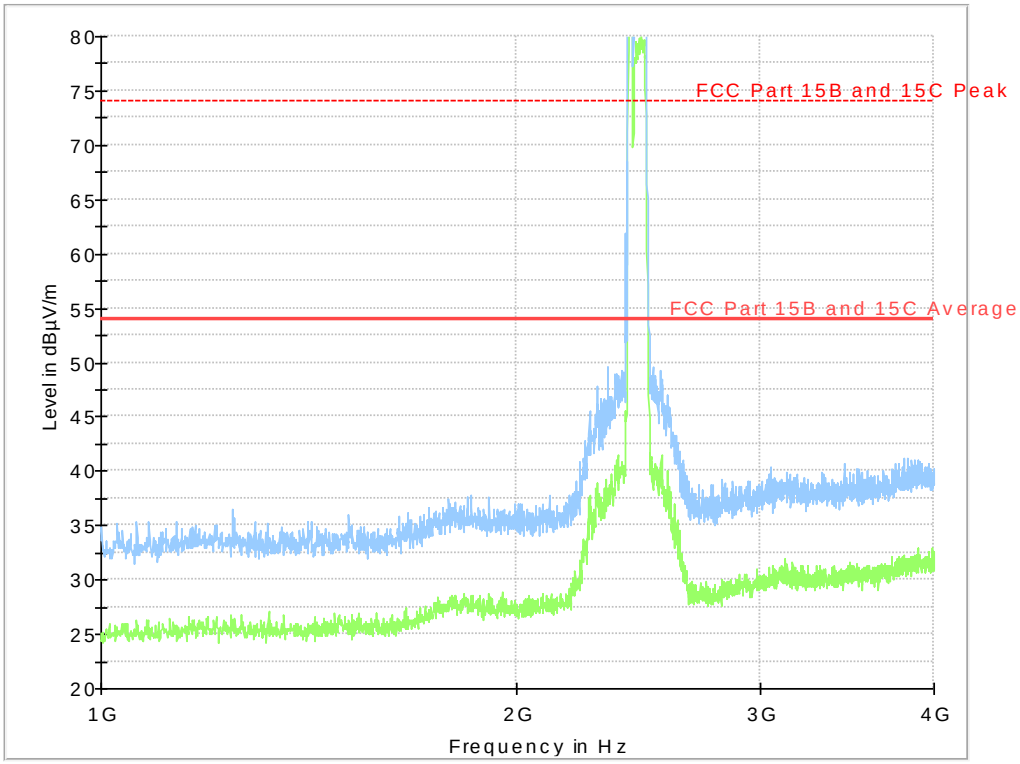
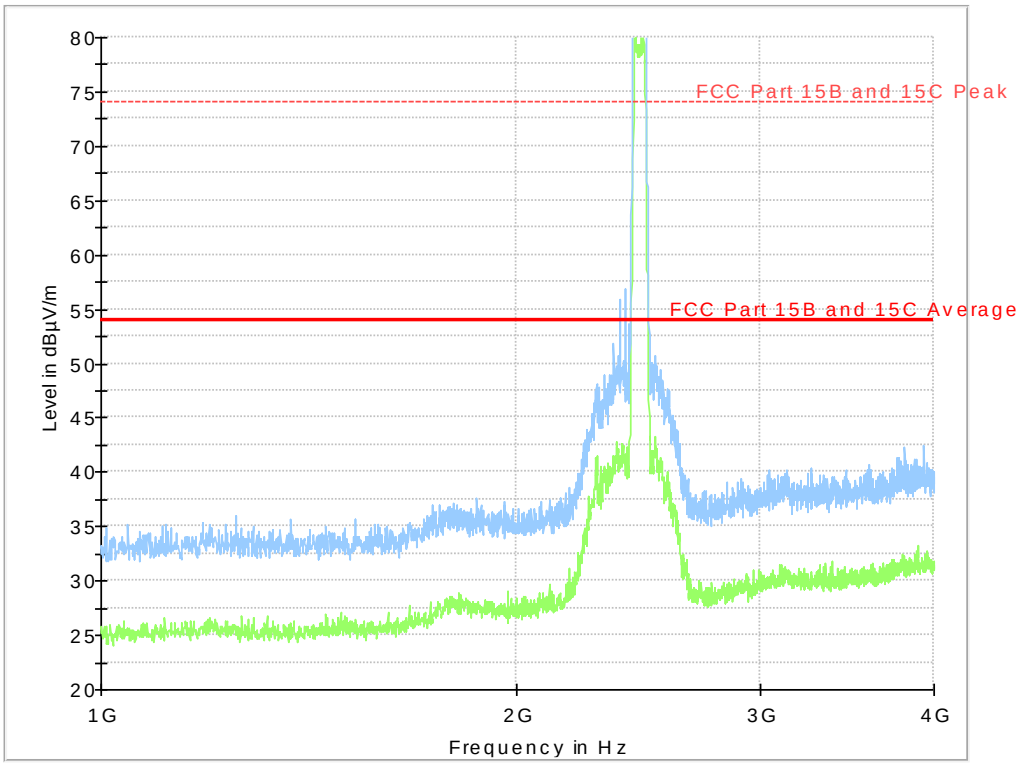
5.6 Test results 1 GHz – 26,5 GHz

Diagram, Peak overview sweep, 1 – 4 GHz at 3 m distance, channel 1.



Diagram, Peak overview sweep, 1 – 4 GHz at 3 m distance, channel 6.



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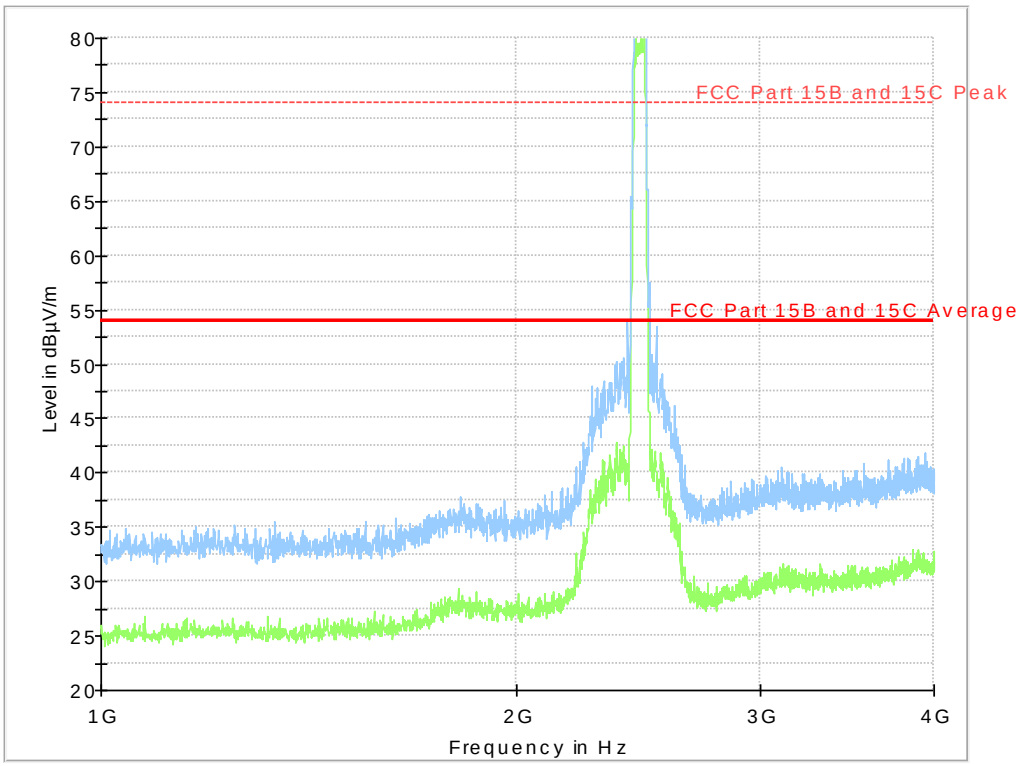
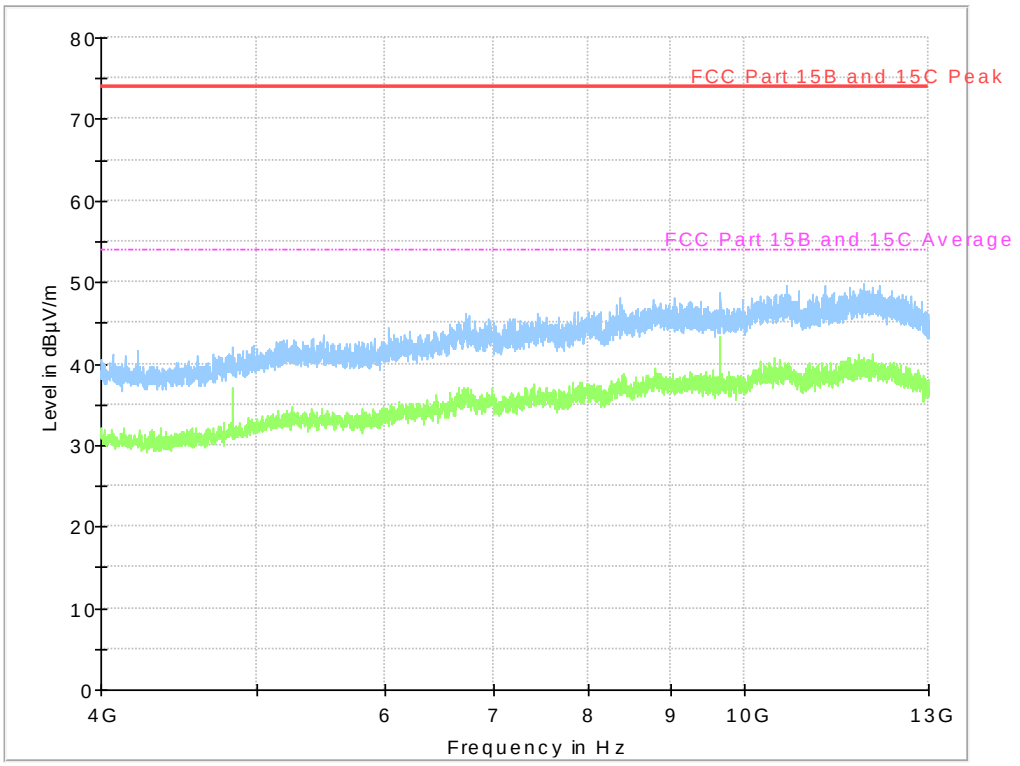
Diagram, Peak overview sweep, 1 – 4 GHz at 3 m distance, channel 11.



Diagram, Peak overview sweep, 4 – 13 GHz at 3 m distance, channel 1.



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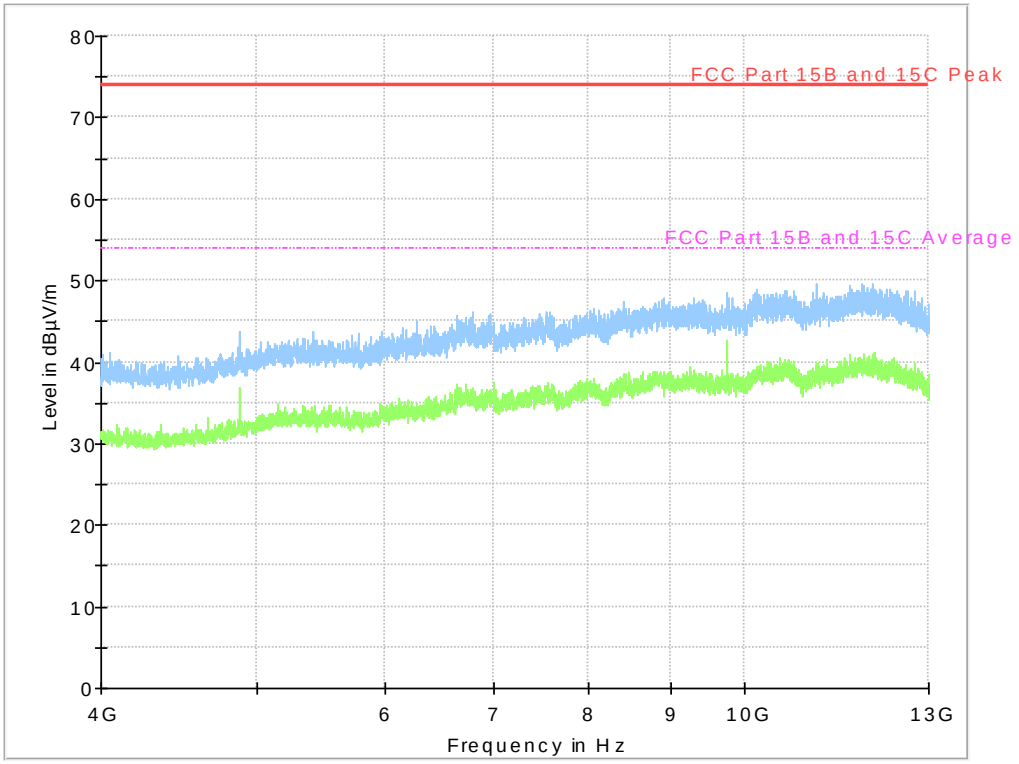
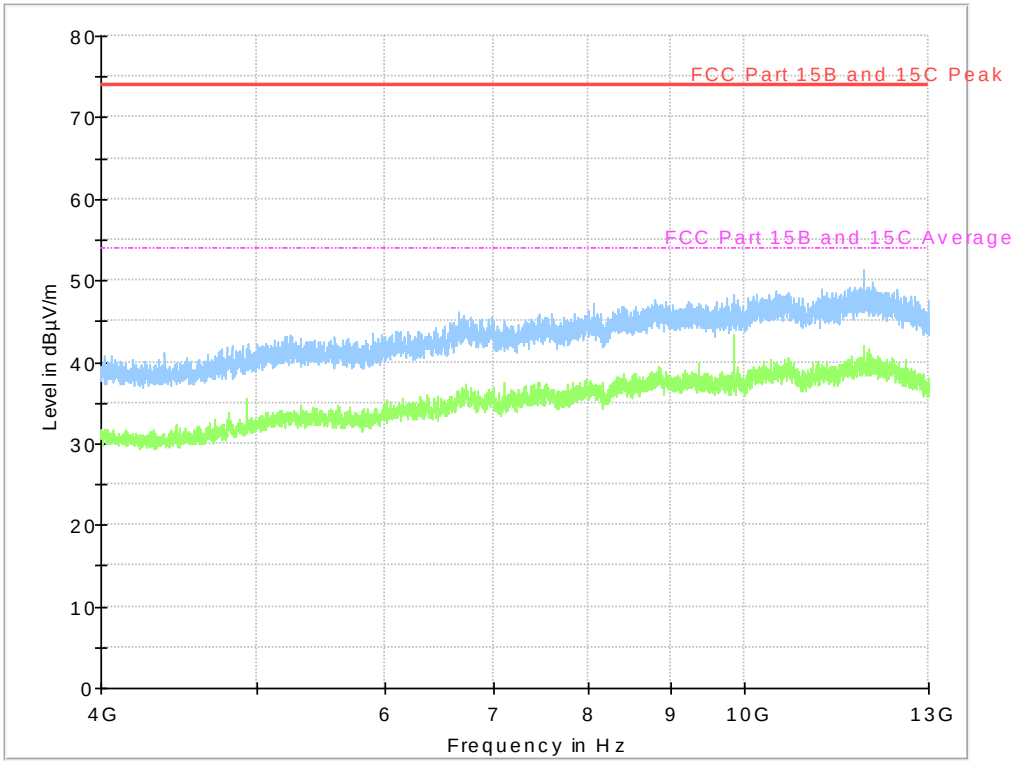
Diagram, Peak overview sweep, 4 – 13 GHz at 3 m distance, channel 6.



Diagram, Peak overview sweep, 4 – 13 GHz at 3 m distance, channel 11.



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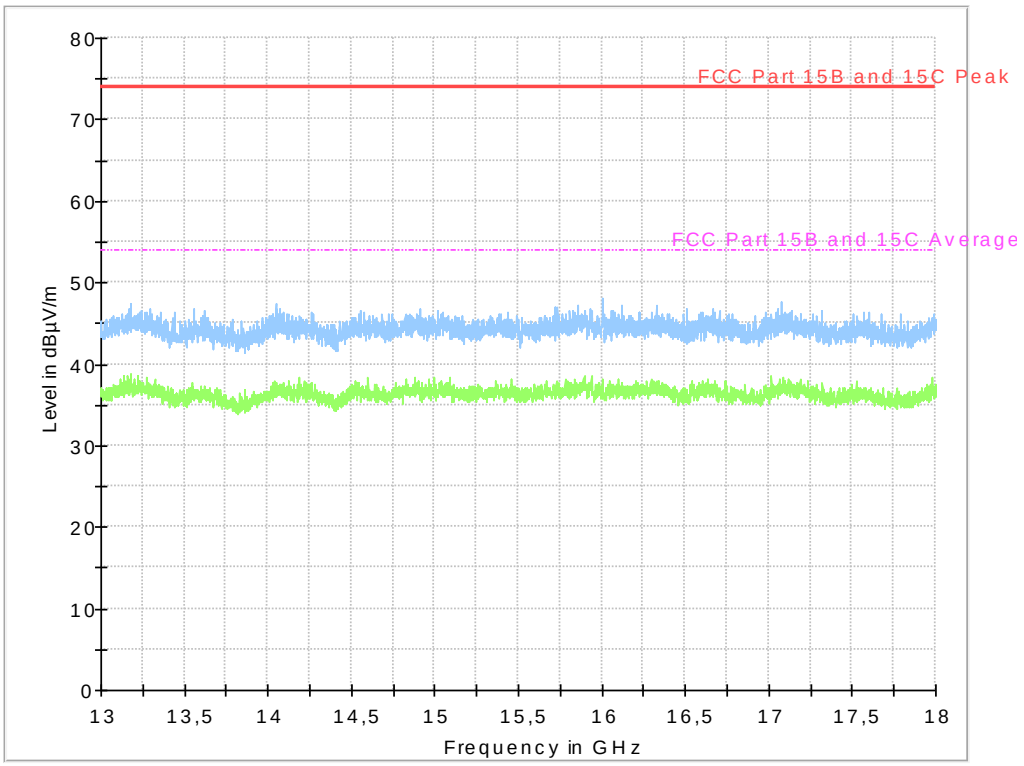
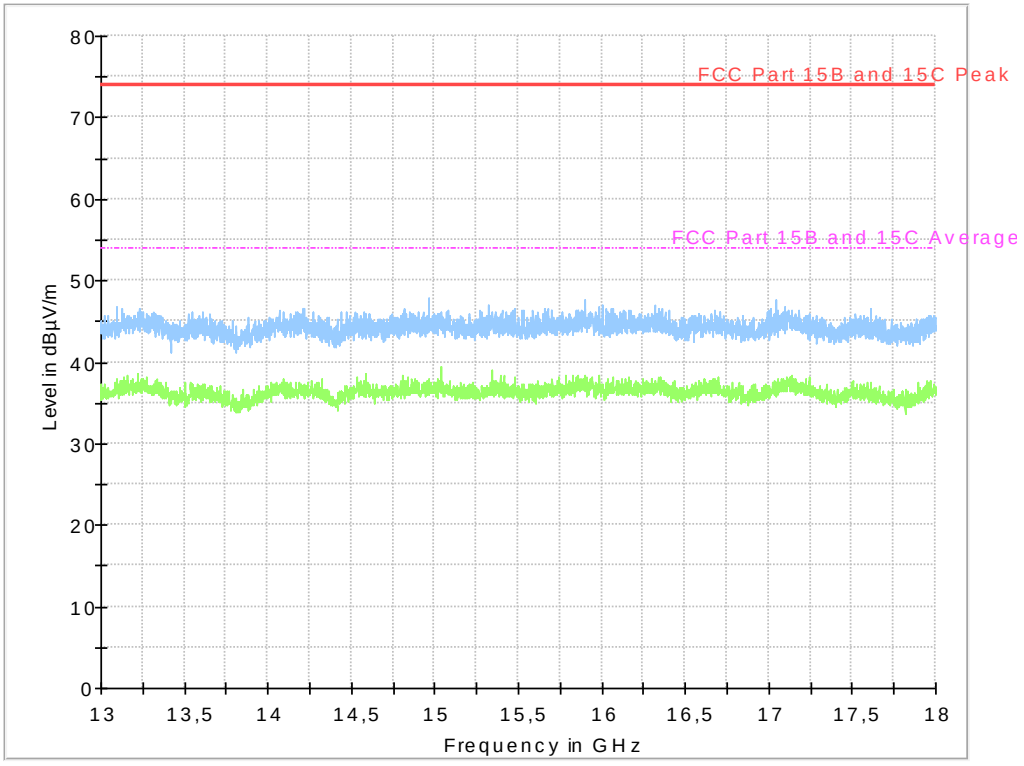
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance, channel 1.



Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance, channel 6.



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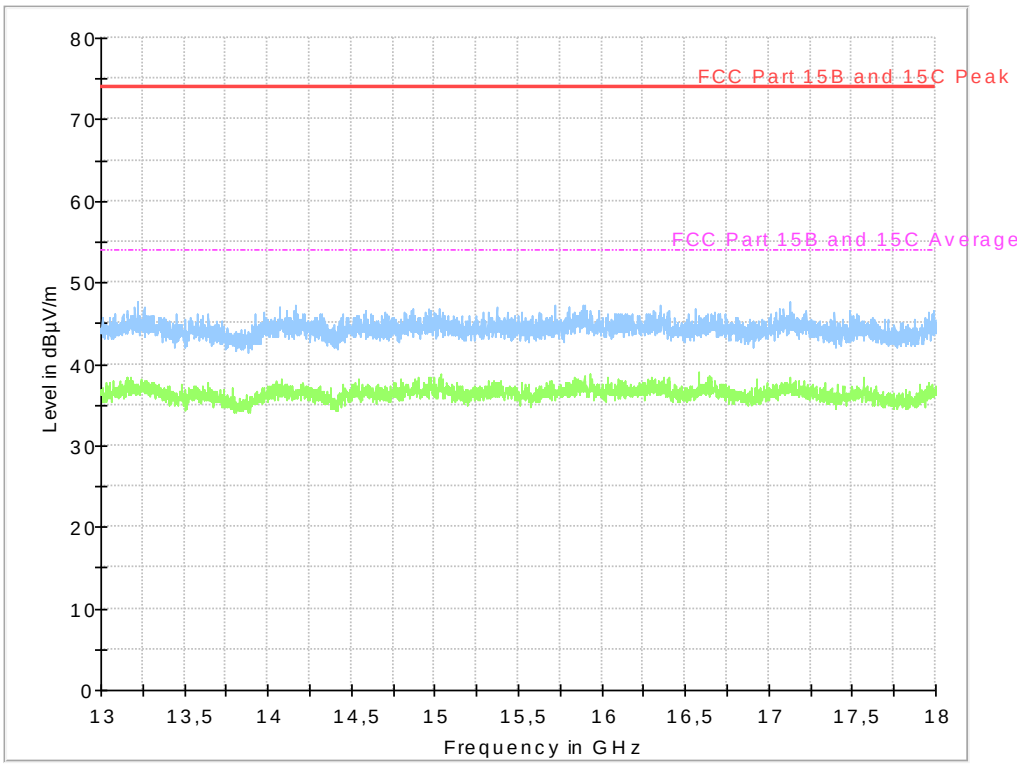
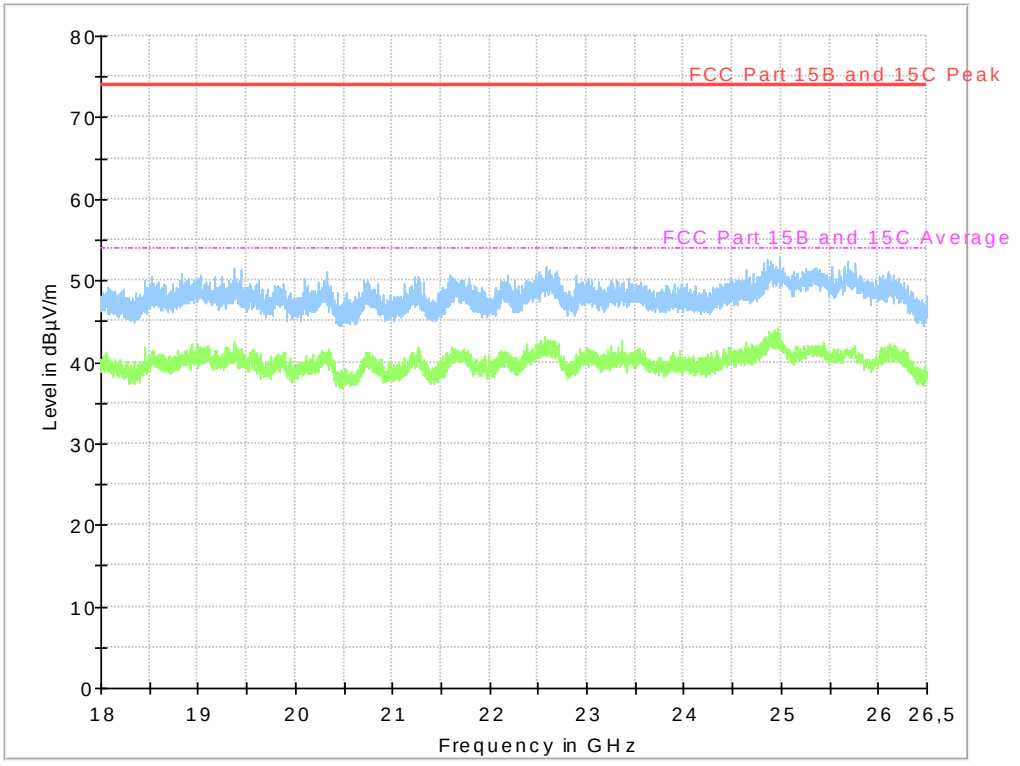
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance, channel 11.



Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance, channel 1.



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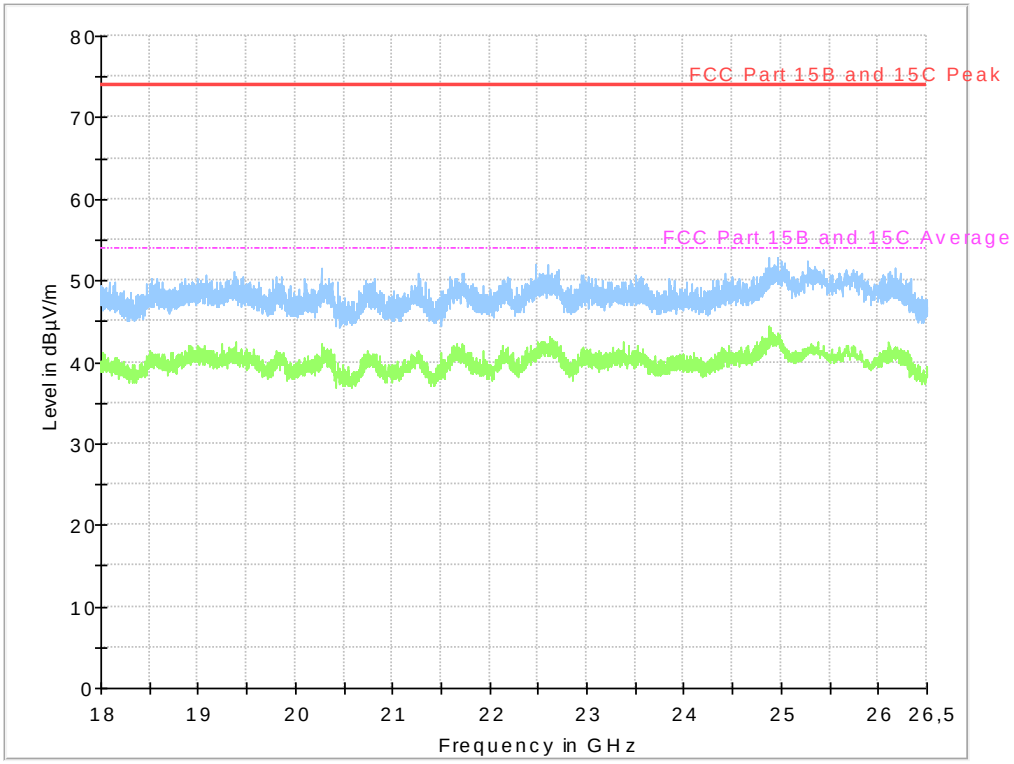
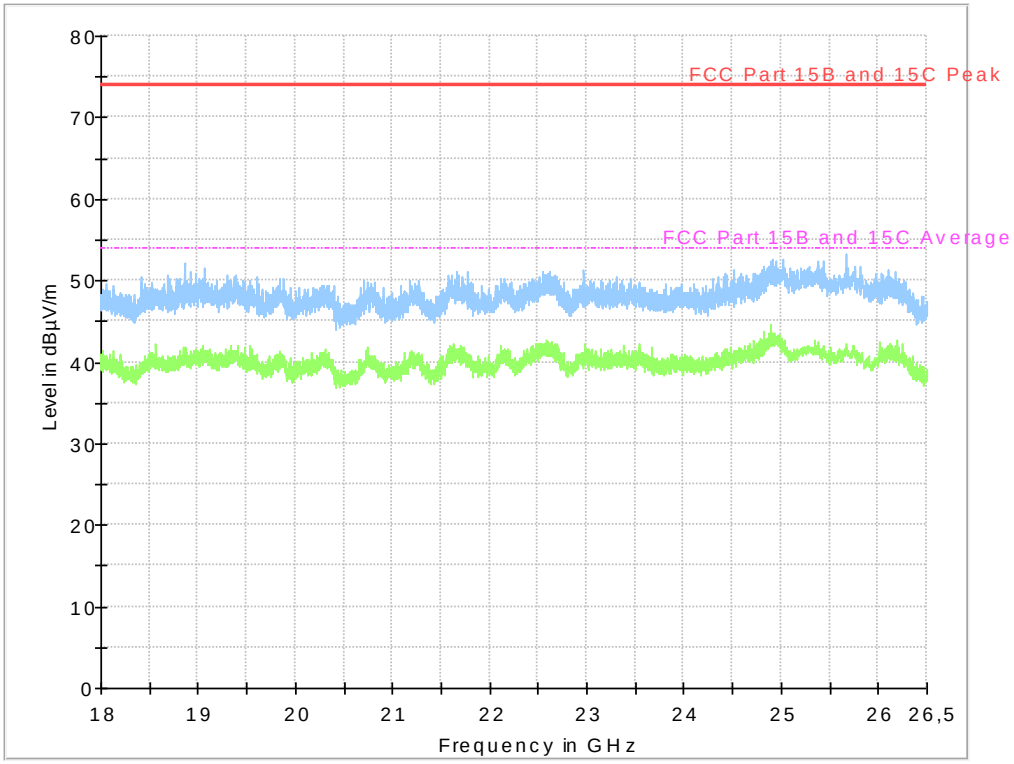
Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance, channel 6.



Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance, channel 11.



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Measurement results, Peak, channel 1

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2396.74	72.95	83*	-	H	10.05
2400.00	76.39	83*	-	H	6.61
2483.50	65.66	74	-	H	8.34
4824.03	49.62	74	-	H	24.38
7236.00	46.22	83*	-	H	36.78
9648.07	50.01	83*	-	V	32.99
12060.00	48.51	74	-	H	25.49

Measurement results, Average, channel 1

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2396.74	47.45	-	-	H	-
2400.00	53.89	-	-	H	-
2483.50	52.36	54	-	H	1.64[1]
4824.03	43.86	54	-	H	10.14
7236.00	33.12	-	-	V	-
9648.07	49.70	-	-	V	-
12060.00	35.85	54	-	V	18.15

*Carrier is measured to be 102.5 dBµV/m , with a 20 dBc limit this equals 83.0 dBµV/m.

1. The measured result is below the upper limit, but by a margin less than half of the uncertainty interval. It is therefore not possible to state compliance based on the 95% level of confidence. However, the result indicates that compliance is more probable than non-compliance.

No final measurements were made above 13 GHz because no emissions were above noise floor.

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

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Measurement results, Peak, channel 6

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2360.63	57.70	74	-	H	16.30
2377.14	61.83	74	-	H	12.17
2397.10	65.35	82.7*	-	H	17.35
2400.00	64.89	82.7*	-	H	17.81
2483.50	58.06	74	-	V	15.94
2518.32	58.01	82.7*	-	H	37.99
4873.98	48.44	74	-	H	25.56
7309.00	45.55	74	-	V	28.45
9748.06	54.09	82.7*	-	V	28.61
12060.00	48.75	74	-	V	25.25

Measurement results, Average, channel 6

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2360.63	44.30	54	-	H	9.7
2377.14	43.53	54	-	H	10.47
2397.10	44.05	-	-	H	-
2400.00	43.59	-	-	H	-
2483.50	52.76	54	-	H	1.24[1]
2518.32	40.76	-	-	H	-
4873.98	43.44	54	-	H	10.56
7309.00	32.45	54	-	V	21.55
9748.06	51.69	-	-	V	-
12060.00	35.75	54	-	V	18.25

*Carrier is measured to be 102.5 dBµV/m, with a 20 dBc limit this equals 82.7 dBµV/m.

1. The measured result is below the upper limit, but by a margin less than half of the uncertainty interval. It is therefore not possible to state compliance based on the 95% level of confidence. However, the result indicates that compliance is more probable than non-compliance.

No final measurements were made above 13 GHz because no emissions were above noise floor.

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

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Measurement results, Peak, channel 11

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2360.63	57.04	74	-	H	16.96
2381.21	57.97	74	-	H	16.03
2396.36	61.18	82.5*	-	H	21.32
2400.00	60.75	82.5*	-	H	21.75
2483.50	73.68	74	-	H	0.32[1]
2485.02	70.09	74	-	V	3.91
2490.07	70.19	74	-	H	3.81
4924.08	48.97	74	-	V	25.03
7386.00	45.13	74	-	H	28.87
9847.98	52.74	82.5*	-	V	29.76
12310.00	49.14	74	-	V	24.86

Measurement results, Average, channel 11

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	EUT orientation	Polarization H/V	Margin [dB]
2360.63	44.04	54	-	H	9.96
2381.21	44.65	54	-	H	9.35
2396.36	44.68	-	-	H	-
2400.00	43.89	-	-	H	-
2483.50	53.18	54	-	H	0.82[1]
2485.02	49.94	54	-	H	4.06
2490.07	46.60	54	-	H	7.4
4924.08	44.89	54	-	V	9.11
7386.00	32.65	54	-	V	21.35
9847.98	48.88	-	-	V	-
12310.00	36.03	54	-	V	17.97

*Carrier is measured to be 102.5 dBµV/m, with a 20 dBc limit this equals 82.5 dBµV/m.

1. The measured result is below the upper limit, but by a margin less than half of the uncertainty interval. It is therefore not possible to state compliance based on the 95% level of confidence. However, the result indicates that compliance is more probable than non-compliance.

No final measurements were made above 13 GHz because no emissions were above noise floor.

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

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6 TEST EQUIPMENT

Stora hallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - V8.51.0	--	--	--
Receiver	Rohde & Schwarz	ESU 40	13187	7 / 2014	1 year
Preamplifier	Bonn	BLMA 0118-M	31246	7 / 2014	1 year
Horn antenna	Rohde & Schwarz	HF907	31245	11 / 2013	3 year
Measurement cable	Huber+Suhner	Sucoflex 104	39049	7 / 2014	1 year
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	7 / 2014	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000 - 0/0	5133	7 / 2014	1 year

Wireless Center

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - V9.15.0	--	--	--
Measurement receiver	Rohde & Schwarz	ESIB 26	32288	7 / 2014	1 year
Signal analyzer	Rohde & Schwarz	FSIQ 40	12793	7 / 2014	1 year
BiLog antenna	Chase	CBL 6111	12474	3 / 2013	3 year
Preamplifier	Sangus	AFS6/AFS44	12335	7 / 2014	1 year
Measurement cable	Huber+Suhner	Sucoflex 104	5191	7 / 2014	1 year
Measurement cable	Huber+Suhner	Sucoflex 104	5192	7 / 2014	1 year
Measurement cable	Huber+Suhner	Sucoflex 104 PE	39070	7 / 2014	1 year
Measurement cable	Huber+Suhner	Sucoflex 104 PE	39071	7 / 2014	1 year
Measurement cable	Huber+Suhner	Sucoflex 104	39094	2 / 2015	1 year
Horn antenna	EMCO	3115	4936	4 / 2014	3 year
Horn antenna	EMCO	3160-08	30099	10 / 2013	3 year
Horn antenna	EMCO	3160-09	30101	10 / 2013	3 year
Preamplifier	µComp Nordic	MCN-AMPL-06006-35	12647	7 / 2014	1 year
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	7 / 2014	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000 - 0/0	5133	7 / 2014	1 year

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7 MEASUREMENT UNCERTAINTY

Measurement uncertainty for radiated disturbance

Uncertainty for the frequency range 30 to 1000 MHz at 3 m	± 4.9 dB
Uncertainty for the frequency range 1.0 to 18 GHz at 3 m	± 5.4 dB
Uncertainty for the frequency range 18 to 26 GHz at 3 m	± 5.5 dB
Uncertainty for the frequency range 26 to 40 GHz at 3 m	± 5.6 dB

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

8 EUT AND TEST SET UP PHOTOS

EUT photos are in a separate document 150823STO-001, Ed. 1 Annex 1

Test set up photos are in separate document 1508253STO-001, Ed. 1 Annex 2

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