

RADIO TEST REPORT

No. 1912340STO-002, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment: Radio-module with Bluetooth Low Energy
Type/Model: BLEM
Manufacturer: Husqvarna AB
Tested by request of: Husqvarna 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: Subpart C: Intentional radiators. Section 15.247

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.

Note: Only transmitter spurious emission in the frequency range 1 – 26 GHz have been tested by request of the client.

Date of issue: 2019-10-16

Tested by:


Robert Hietala

Approved by:


Matti Virkki

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Revision History

Edition	Date	Description	Changes
1	2019-10-16	First release	--

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company Husqvarna AB
Jons väg 19
433 75 Jonsered
Sweden

Name of contact Tero Borg
Phone +46 31 94 91 65

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: Radio-module with Bluetooth Low Energy
Type/Model: BLEM
Brand name: Husqvarna
Serial number: No visible serial number
Manufacturer: Husqvarna
Transmitter frequency range: 2402 – 2480 MHz
Receiver frequency range: 2402 – 2480 MHz
Number of channels: 40
Antenna: ☐ Internal antenna ☒ External antenna
Antenna connector: ☐ None, internal antenna ☒ Yes, type U.FL
Antenna gain: 2.1 dBi
Rating RF output power: 2.4 dBm (measured conducted)*
Type of modulation: GFSK
Temperature range: ☐ Category I (General): -20°C to +55°C
☐ Category II (Portable equipment): -10°C to +55°C
☐ Category III (Equipment for normal indoor use): +5°C to +35°C
☒ Other: -30°C to +85°C
Transmitter standby mode supported: ☒ Yes ☐ No

*Reference report: Intertek Test Report No. 1713337STO-002, Ed. 1

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
Unit 1	Radio-module	--

During the tests the EUT supported following software:

Software	Version	Comment
Nordic Semiconductor ASA – nRFgo Studio	1.21.2.10	Used to program the EUT

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	T440s	Lenovo	--

2.4 Test signals and operation modes

During the TX tests the EUT was transmitting a modulated carrier with a PRBS9 payload model and 37 bytes payload length which gives a duty cycle of approximately 70 %.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

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

RSS-GEN Issue 5 (2018): 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

Only transmitter spurious emission in the frequency range 1 – 26 GHz have been performed by request of the client. The EUT have previously been tested for full compliance with an integral antenna, see reference report Intertek Test Report No. 1713337STO-002, Ed. 1.

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
Intertek Semko AB is an ISED recognized wireless testing laboratory with CAB identifier SE0003.

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
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	Antenna	PASS
FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	The EUT connects to its antenna using an U.FL connector which is considered to be a unique non-standard connector. 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 EUT operates in unrestricted 2400 – 2483.5 MHz frequency band.	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 --	NT
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 --	NT
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 4.5 dB at 2484.0 MHz. See clause 5.4.	PASS
FCC §15.247(a)(2) RSS-GEN 6.6 RSS-247 5.2(1)	Occupied bandwidth --	NT
FCC §15.247(b) RSS-247 5.4(4)	Conducted output power --	NT
FCC §15.247(e) RSS-247 5.2(2)	Peak power spectral density --	NT
FCC §15.247(e) RSS-247 5.5	Conducted Band edge --	NT

NT = Not Tested

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

Date of test:	2019-09-10	Test location:	Radiohallen
EUT Serial:	No visible serial number	Ambient temp:	20 °C
Tested by:	Robert Hietala	Relative humidity:	74 %
Test result:	Pass	Margin:	4.5 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 1.5 meter above the floor on a positioner which allows the EUT to rotate freely around its X and Y axis.

Overview sweeps were performed with the measurement receiver in max-hold mode with peak detector and average detector activated.

5.2 Test conditions

Test set-up:

1 GHz – 26.5 GHz

Test receiver set-up:

Preview test:

Peak, RBW 1 MHz VBW 3 MHz

Average, RBW 1 MHz VBW 3 MHz

Final test:

Peak, RBW 1 MHz VBW 3 MHz

Average, RBW 1 MHz VBW 3 MHz

EUT height above ground plane:

1.5 m

Measuring distance:

3 m

Measuring angle:

0 – 359°

Antenna

Height above ground plane:

1 – 4 m

Polarisation:

Vertical and Horizontal

Type:

Horn

Antenna tilt:

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

5.3 Requirements

Within restricted bands:

Reference: CFR 47 §15.209 and 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

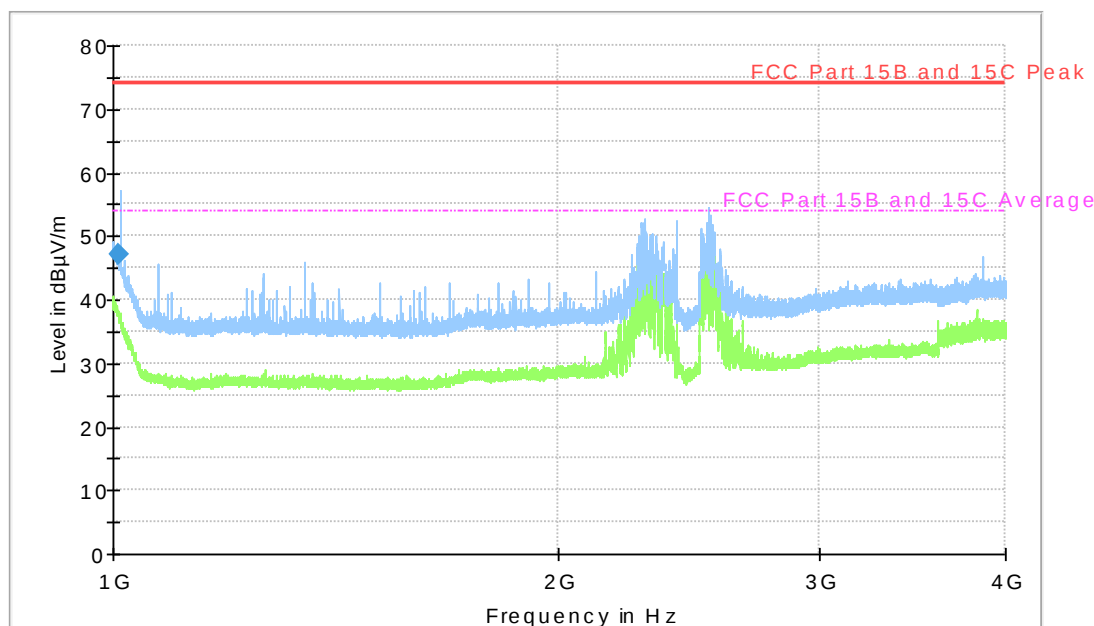
The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit. (i.e. an extrapolation factor of 20 dB/decade according to CFR 47 §15.31(f)(1))

Outside the restricted bands:

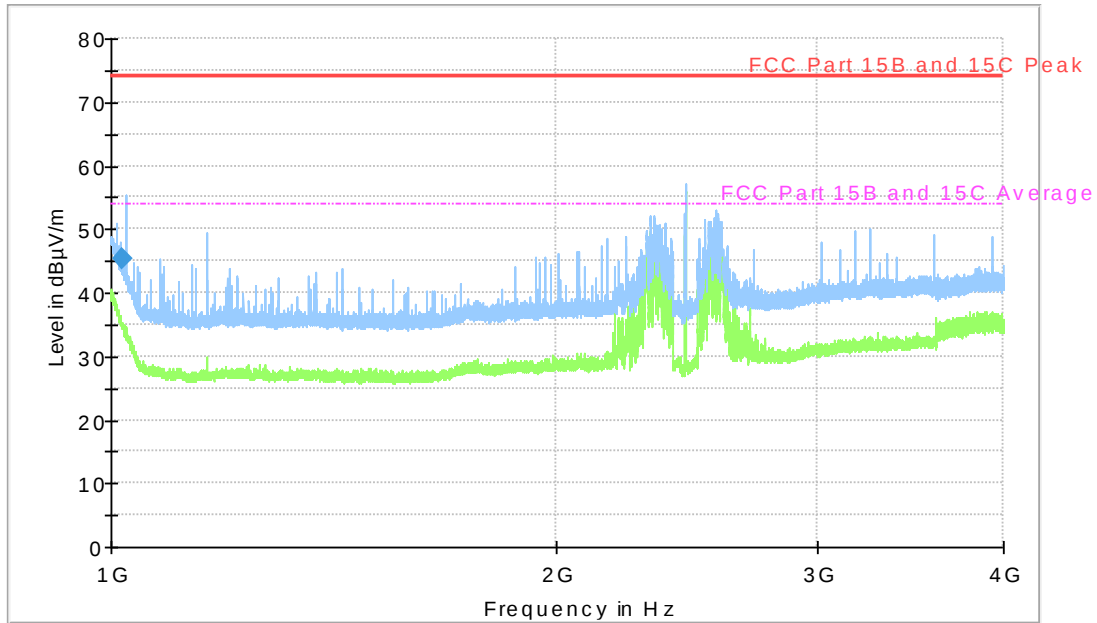
Reference: CFR 47 §15.247(d) and RSS-247 5.5.

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.

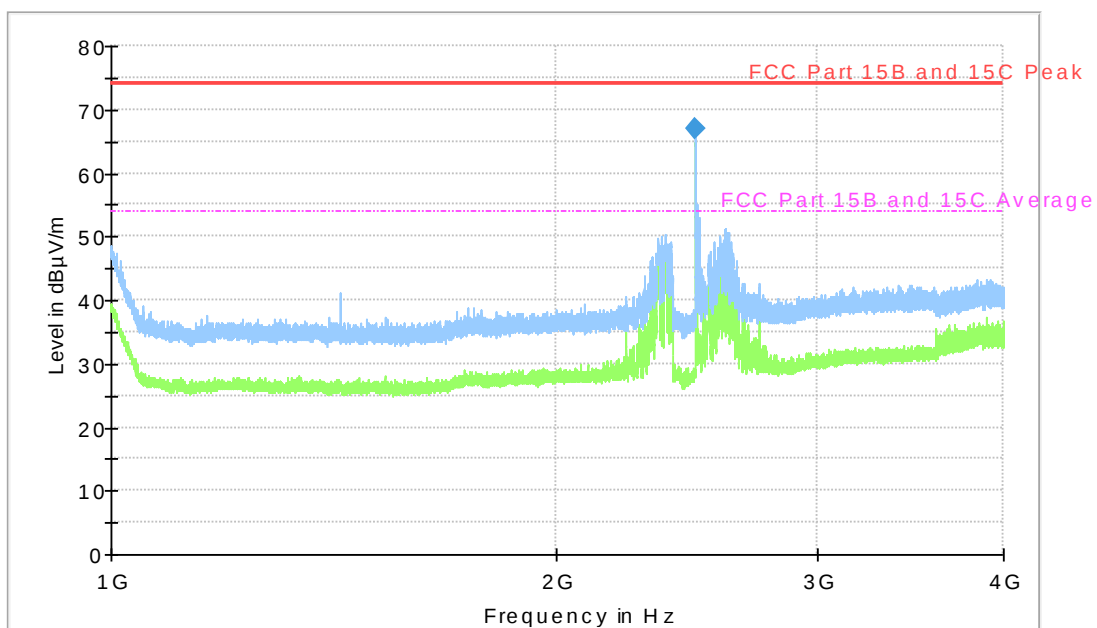
5.4 Test results 1 GHz – 26 GHz, TX



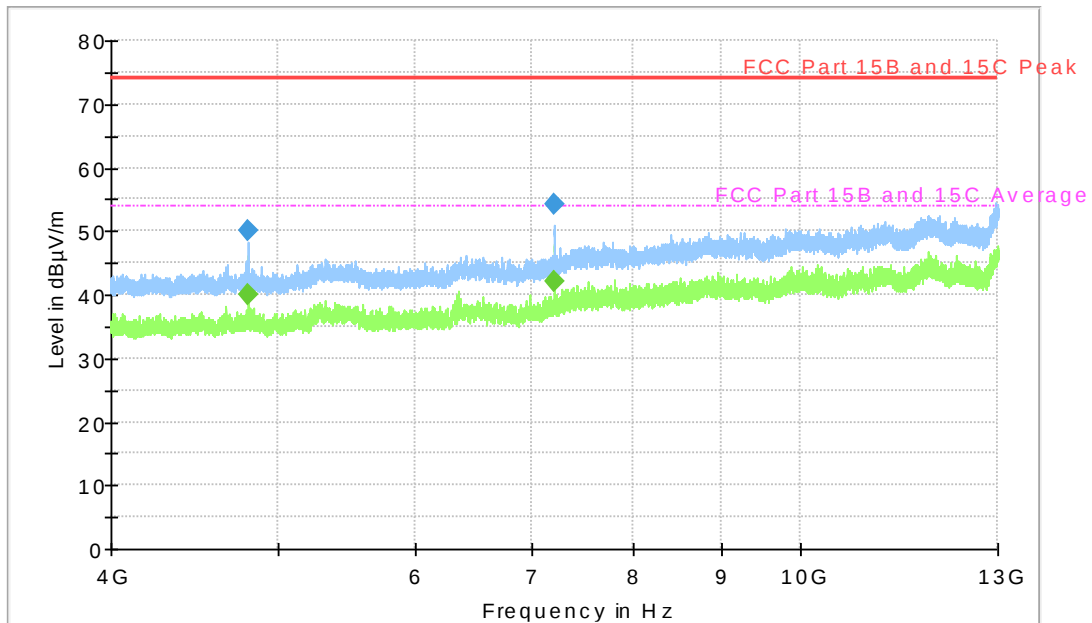
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by a band rejection filter.



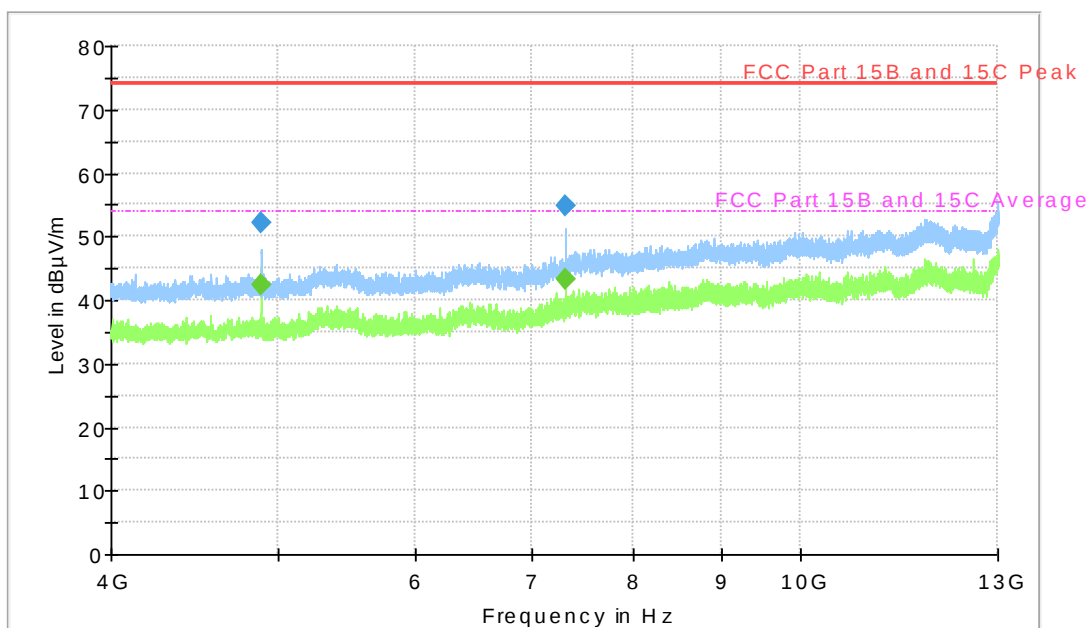
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by a band rejection filter.



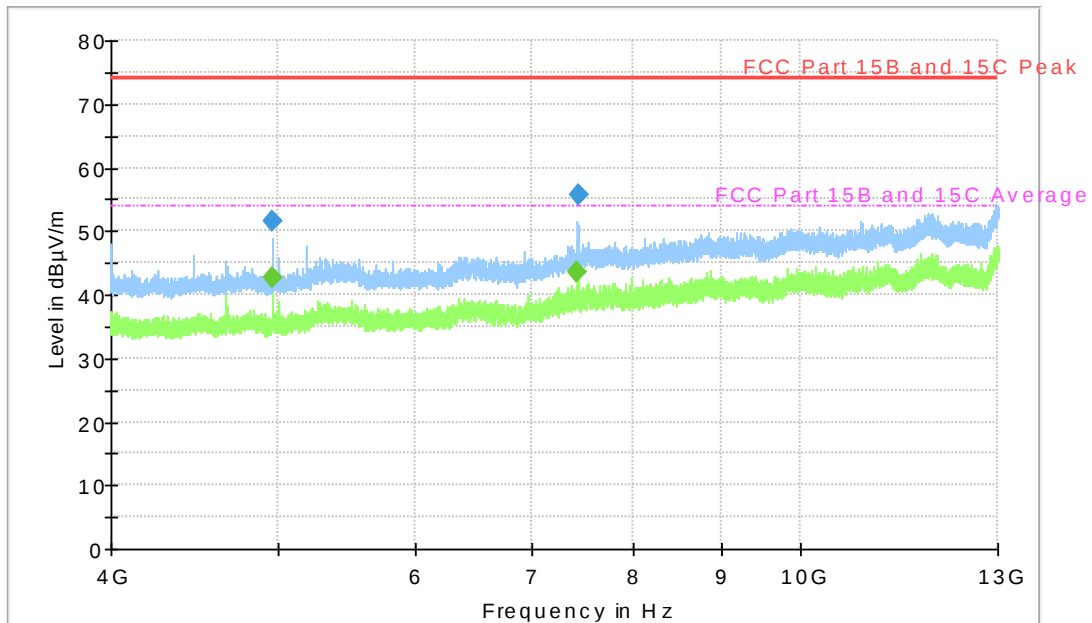
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by a band rejection filter.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by a high-pass filter.

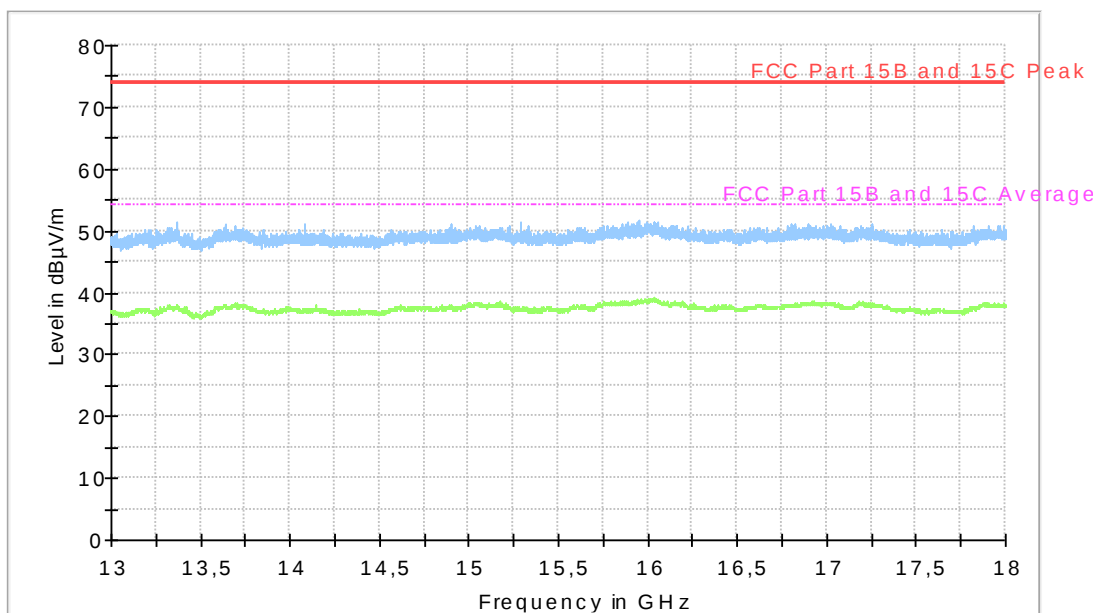


Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by a high-pass filter.



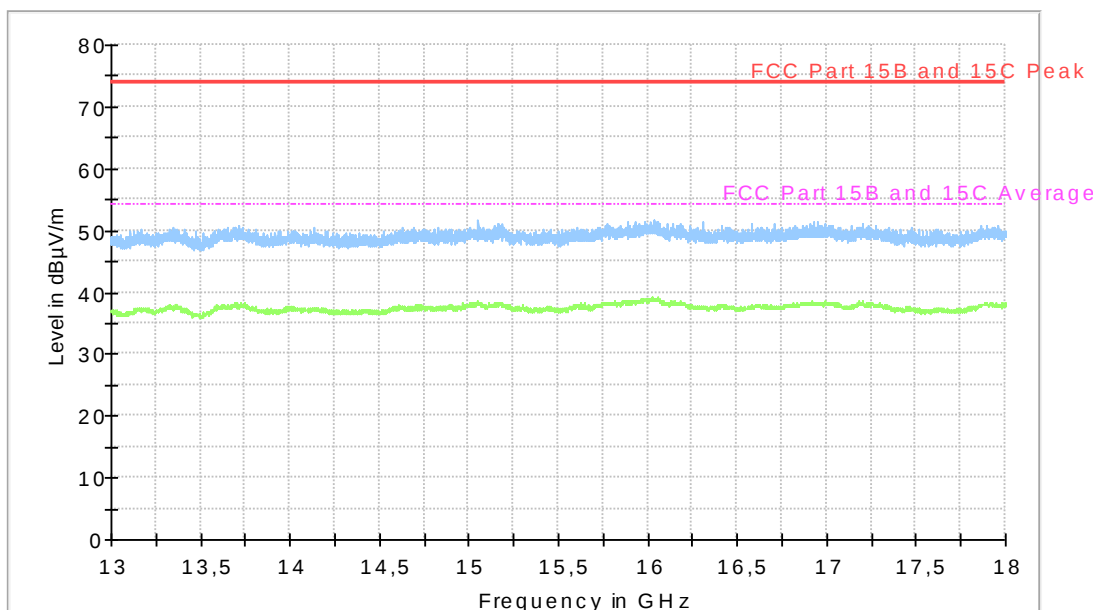
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by a high-pass filter.

Full Spectrum



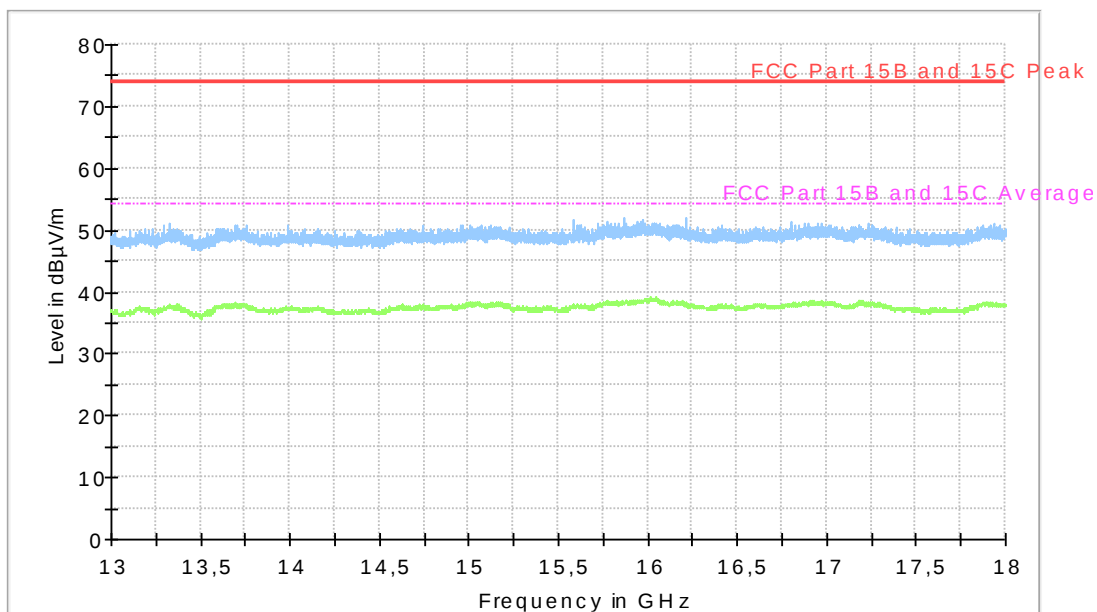
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX low channel.

Full Spectrum



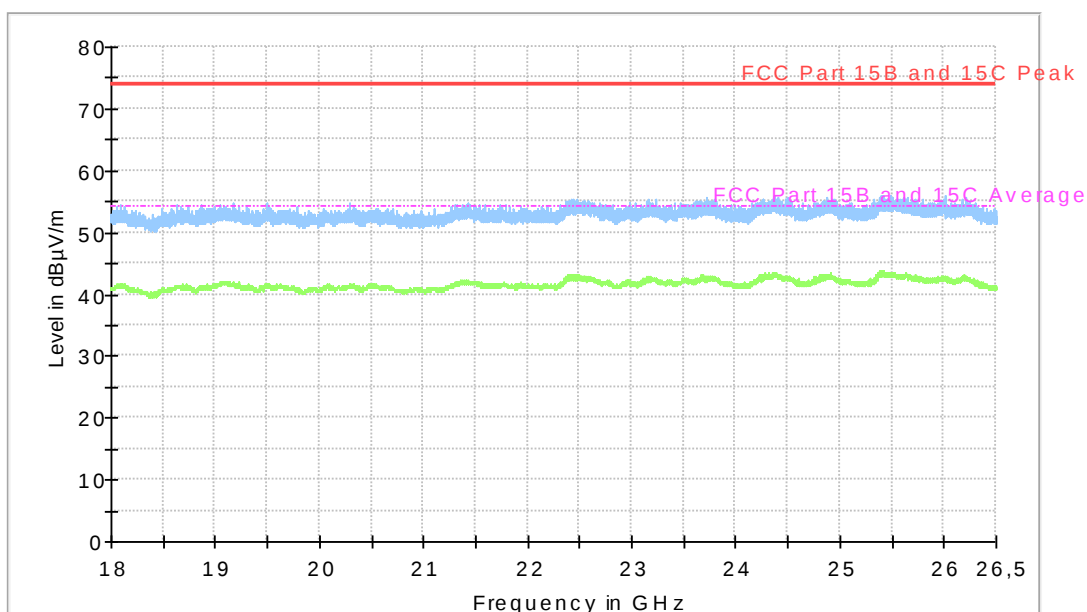
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX mid channel.

Full Spectrum



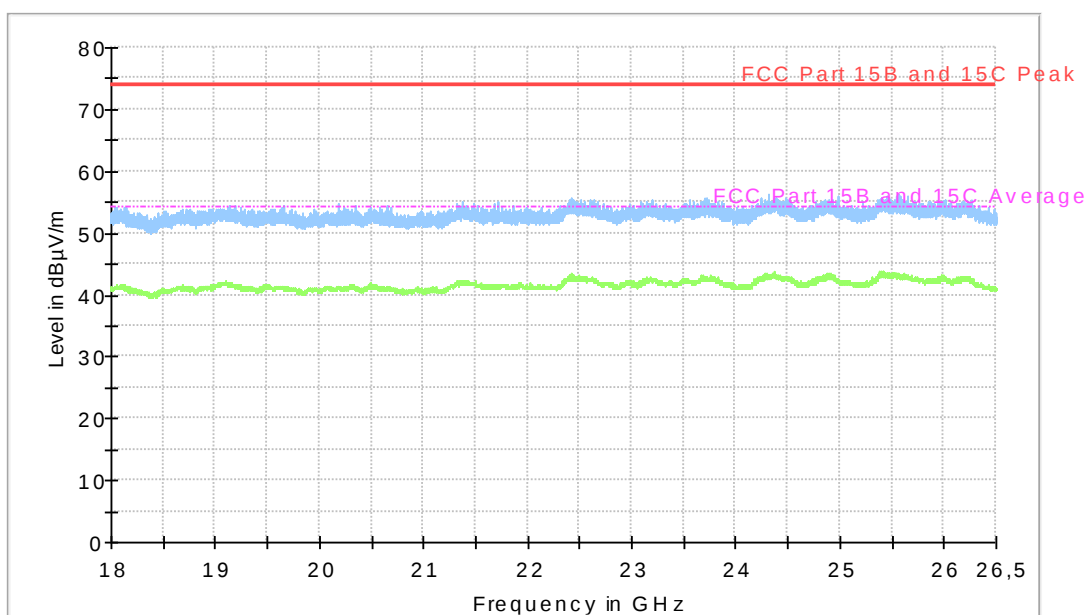
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX high channel.

Full Spectrum



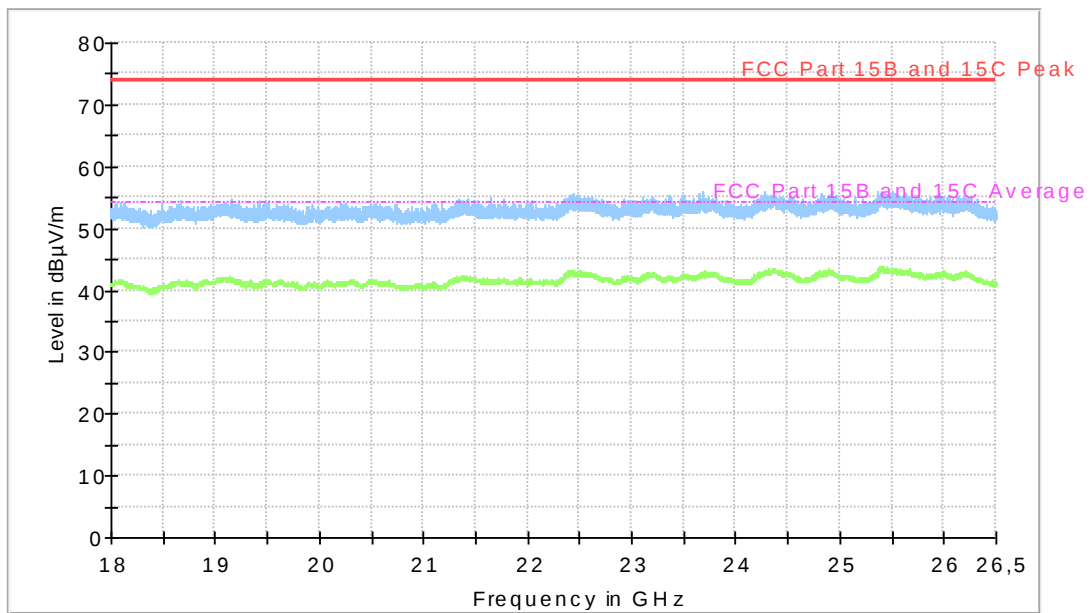
Diagram, Peak overview sweep, 18 – 26 GHz at 3 m distance. TX low channel.

Full Spectrum



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

Full Spectrum



Diagram, Peak overview sweep, 18 – 26 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]	Result
1008.7	47.0	74.0	V	27.0	PASS
4804.1	50.0	74.0	V	24.0	PASS
7206.8	54.2	74.0	V	19.8	PASS

Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
4803.4	40.0	54.0	V	14.0	PASS
7206.7	42.1	54.0	V	11.9	PASS

Measurement results, Peak, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
1018.4	45.5	74.0	H	28.5	PASS
4879.5	52.1	74.0	V	21.9	PASS
7319.2	54.8	74.0	V	19.2	PASS

Measurement results, Average, TX middle channel

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]	Result
4879.9	42.2	54.0	V	11.8	PASS
7320.4	43.3	54.0	V	10.7	PASS

Measurement results, Peak, TX high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Result
2480.2*	--	--	--	--	--
2484.0	69.5	74.0	V	4.5	PASS
4960.5	51.4	74.0	V	22.6	PASS
7440.7	55.8	74.0	V	18.2	PASS

*Carrier, in-band

Measurement results, Average, TX high channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Result
2484.0	41.1	54.0	V	12.9	PASS
4960.3	42.8	54.0	V	11.2	PASS
7439.5	43.5	54.0	V	10.5	PASS

No other disturbances found above noise floor.

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

6 TEST EQUIPMENT

Radiohallen (3m FAC)

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - V10.50.10	--	--	--
Measurement receiver	Rohde & Schwarz	ESU 40	13178	June-2019	1 year
Measurement cable	Huber+Suhner	Sucoflex 102	39138	July-2019	1 year
Measurement cable	Megaphase	G916-K1K1-79	9462	July-2018	2 years
Measurement cable	Midwest Microwave	MCN-KMKM-46-150-CS	9664	July-2019	1 year
Horn antenna	EMCO	3115	4936	July-2017	3 years
Horn antenna	EMCO	3160-08	30099	Aug-2016	3 years
Horn antenna	EMCO	3160-09	30101	Aug-2016	3 years
Pre-amplifier	Sangus	00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	June-2019	1 year
2,4 GHz band reject filter:	Wainwright Instr. GmbH	WRCGV10-2381-2401-2479-2499-40SS	33938	month-year	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	Aug-2019	1 year
Temperature reader	Vaisala	HM 40	32873	Aug-2019	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 1912340STO-002 Annex 1.

Test set up photos are in separate document 1912340STO-002 Annex 2.