

RADIO TEST REPORT

No. 1712544STO-003, Ed. 3

RF Performance

EQUIPMENT UNDER TEST

Equipment: Wireless Communication Hub
Type/Model: AH20
Additional type/model*: AH30
Manufacturer: ASSA ABLOY AB
Tested by request of: ASSA ABLOY AB

*See opinions and interpretations clause 2.4

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 (2016): Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 (2016): Subpart B: Unintentional radiators

RSS-GEN Issue 4 (2014): General requirements of compliance of radio apparatus (2014)

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

For details, see clause 2 – 4.

Date of issue: 2018-01-19

Tested by: *Per Larsson*

Per Larsson

Matti Virkki

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Approved by:

Stefan Andersson

Stefan Andersson

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Revision History

Edition	Date	Description	Changes
1	2017-09-29	First release	
	2018-01-12	Second release	Added radiated measurements for external antenna.
	2018-01-19	Third release	Added information about AH30. Updated measurement of duty cycle.

Version 1.00

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 Test signals and operation modes	6
2.4 Opinions and interpretations	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 Radiated rf Emission 30 MHz to 26 GHz, Internal antenna	10
5.1 Test set-up and test procedure.	10
5.2 Test conditions	10
5.3 Requirements.....	11
5.4 Test results 30 MHz – 1000 MHz, TX	11
5.5 Test results 30 MHz – 1000 MHz, RX.....	12
5.6 Test results 1 GHz – 26 GHz, TX	14
5.7 Test results 1 GHz – 13 GHz, RX	21
6 Radiated rf Emission 30 MHz to 26.5 GHz, External Antenna.....	23
6.1 Test set-up and test procedure.	23
6.2 Test conditions	23
6.3 Requirements.....	24
6.4 Test results 30 MHz – 1000 MHz, TX, External antenna.....	25
6.5 Test results 30 – 1000 MHz, RX, External antenna.....	28
6.6 Test results 1 – 18 GHz, TX, External antenna	29
6.7 Measurement result 1 – 18 GHz, RX, External antenna.....	32
6.8 Test result 18 – 26.5 GHz, TX, External antenna	33
6.9 Measurement result 18-26,5 GHz RX, External antenna	36
7 radiated Band Edge, External antenna	37
7.1 Test set-up and test procedure.	37
7.2 Test conditions	37
7.3 Requirement.....	38
7.4 Test results.....	38
8 Conducted band edge measurement.....	40
8.1 Test set-up and test procedure.	40
8.2 Test conditions	40
8.3 Requirement.....	40
8.4 Test results.....	41
9 Peak conducted output power.....	43
9.1 Test set-up and test procedure.	43
9.2 Test conditions	43
9.3 Requirements.....	43
9.4 Test results.....	44
10 Occupied 6 dB bandwidth	47
10.1 Test set-up and test procedure.	47
10.2 Test conditions	47
10.3 Requirements.....	47
10.4 Test results.....	48
11 Peak power spectral density	51

11.1	Test set-up and test procedure.....	51
11.2	Test conditions	51
11.3	Requirements	51
11.4	Test results.....	52
12	Test equipment.....	55
13	Measurement uncertainty	57
14	Test set up and EUT photos.....	57

1 CLIENT INFORMATION

The EUT has been tested by request of

Company ASSA ABLOY AB
Förmansvägen 11
SE-117 43 Stockholm
Sweden

Name of contact Magnus Axelsson

Client observer John Ljungberg

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: Wireless Communication Hub
Type/Model: AH20
Brand name: Aperio Hub
Serial number: 00.17.7A.01.02.04.97.48
Manufacturer: ASSA ABLOY AB
Transmitter frequency range: 2405 – 2480 MHz
Receiver frequency range: 2405 – 2480 MHz
Frequency agile or hopping: ☐ Yes ☒ No
Antenna: ☒ Internal antenna ☒ External antenna
Antenna connector: ☐ None, internal antenna ☒ Yes
Antenna gain internal 4 dBi
Antenna gain external 2.15 dBi
Rating RF output power: 5.4 dBm (measured conducted)
Type of modulation: O-QPSK
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: +5°C to +35°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
Aperio Hub	AH20	00.17.7A.01.02.04.97.48
2.4 GHz dipole antenna	AH-ANTENNA-1	No visible

During the tests the EUT supported following software:

Software	Version	Comment
Aperio Lock Simulator	0.0.9432	Enabling continuous signal

2.3 Test signals and operation modes

During the tests the EUT was transmitting a continuous modulated signal.

2.4 Opinions and interpretations

The following type is also included as additional type in this report:
AH30

The difference as compared to the tested type is (according to the manufacturer):

AH30 uses the same type of PCB and radio but have less assembled components, one connector and four relays.

The difference is considered not to imply different Radio-characteristics when compared to the tested type. Therefore, this type is not tested, but considered to have the same Radio-characteristics as the tested type.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

47 CFR Part 15 (2016): Subpart C: Intentional radiators. Section 15.247

47 CFR Part 15 (2016): Subpart B: Unintentional radiators

RSS-GEN Issue 4 (2014): General requirements of compliance of radio apparatus (2014).

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

RSS-247 Issue 2 (2017) is not within Intertek's scope of accreditation.

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 #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2

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. Or when External Antenna is used it is required that installation is made by a professional only.	
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
	DC operated equipment.	
FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	Field strength of fundamental and antenna gain	NA
	Antenna gain is less than 6 dBi.	
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, Internal Antenna	PASS
	The EUT complies with the limits. See clause 5.4 – 5.5.	
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, Internal Antenna	PASS
	The EUT complies with the limits. See clause 5.6 – 5.7.	
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, External Antenna	PASS
	The EUT complies with the limits. See clause 6.4 – 6.5.	
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, External Antenna	PASS
	The EUT complies with the limits. See clause 6.6 – 6.9.	
FCC §15.247(e) RSS-247 5.5	Band edge, radiated, External Antenna	PASS
	The EUT complies with the limits. See clause 7.4.	
FCC §15.247(a)(2) RSS-GEN 6.6 RSS-247 5.2(1)	Occupied bandwidth	PASS
	The EUT complies with the limits. See clause 8.4.	

Requirement	Description	Result
FCC §15.247(b) RSS-247 5.4(4)	Conducted output power	PASS
	The EUT complies with the limits. See clause 9.4.	
FCC §15.247(e) RSS-247 5.2(2)	Peak power spectral density	PASS
	The EUT complies with the limits. See clause 11.4.	
FCC §15.247(e) RSS-247 5.5	Band edge, conducted	PASS
	The EUT complies with the limits. See clause 8.4.	

5 RADIATED RF EMISSION 30 MHZ TO 26 GHZ, INTERNAL ANTENNA

Date of test:	2017-09-18	Test location:	Stora Hallen
EUT Serial:	00.17.7A.01.02.04.97.48	Ambient temp:	20 °C
Tested by:	Robert Hietala	Relative humidity:	42 %
Test result:	Pass	Margin:	0.8 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.

EUT is intended to be wall mounted and is therefore measured in one orientation.

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 VBW 1 MHz

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 VBW 3 MHz

Average RBW 1 MHz VBW 3 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 (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))

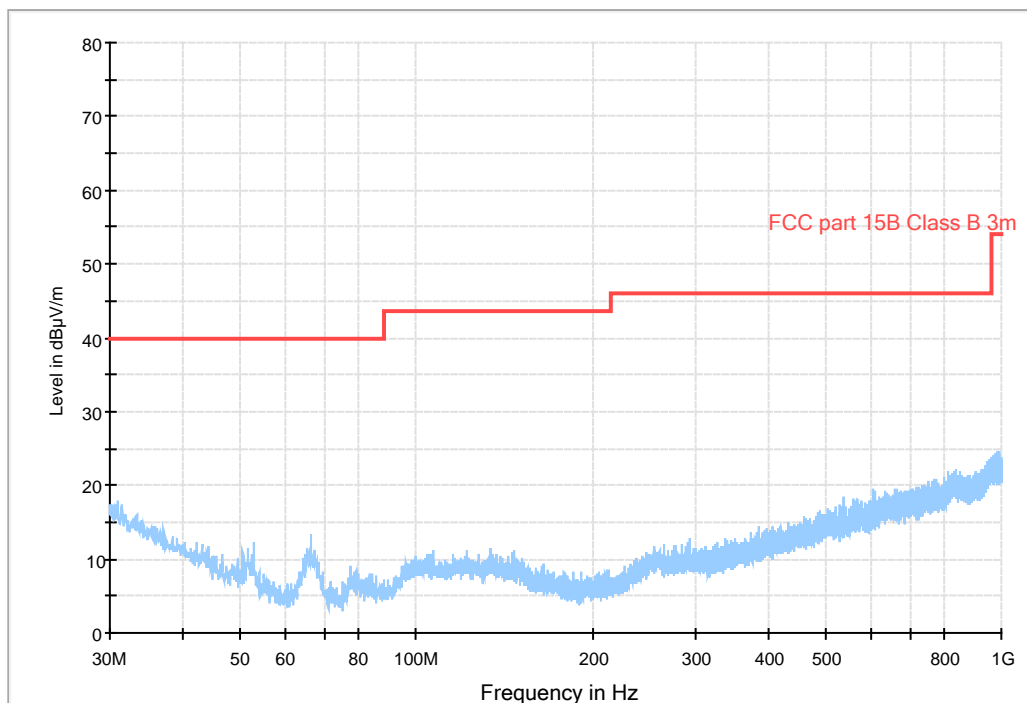
Outside the restricted bands:

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.

5.4 Test results 30 MHz – 1000 MHz, TX

Radio FCC 30 - 1000 MHz FCC class B 10m continuous TT rotation



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

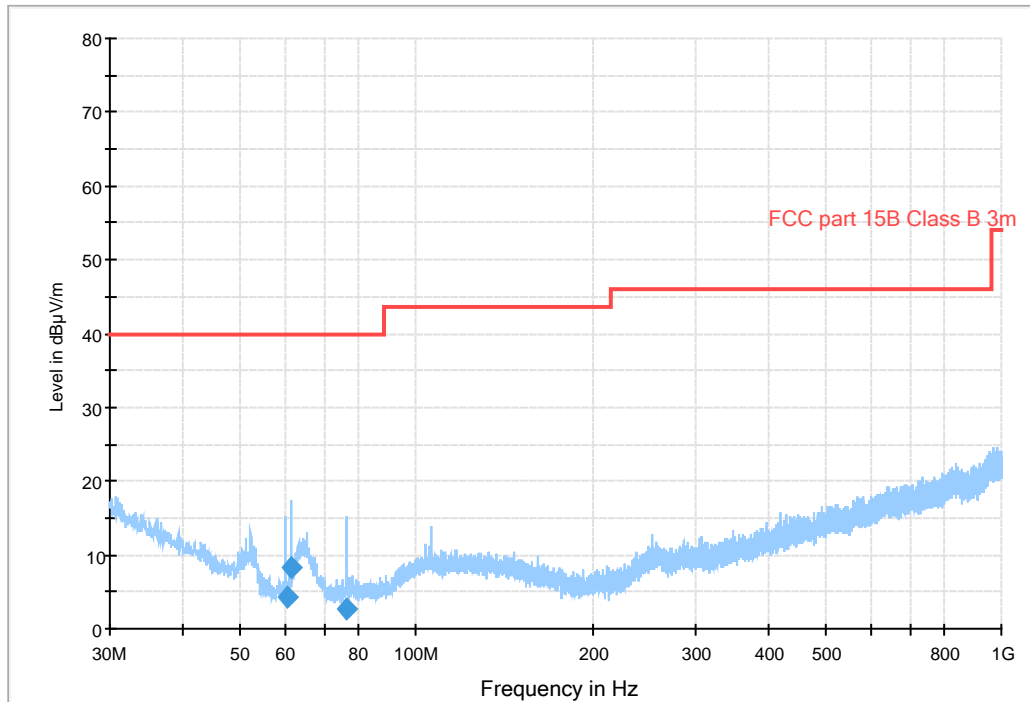
Measurement results, Quasi Peak

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]

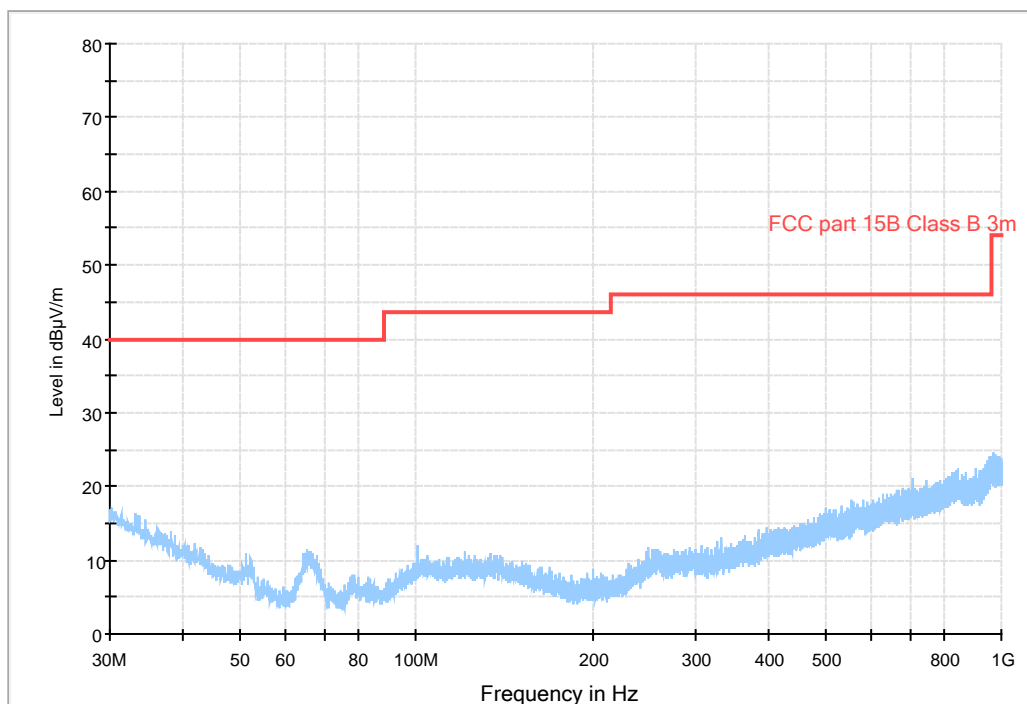
5.5 Test results 30 MHz – 1000 MHz, RX

Radio FCC 30 - 1000 MHz FCC class B 10m continuous TT rotation



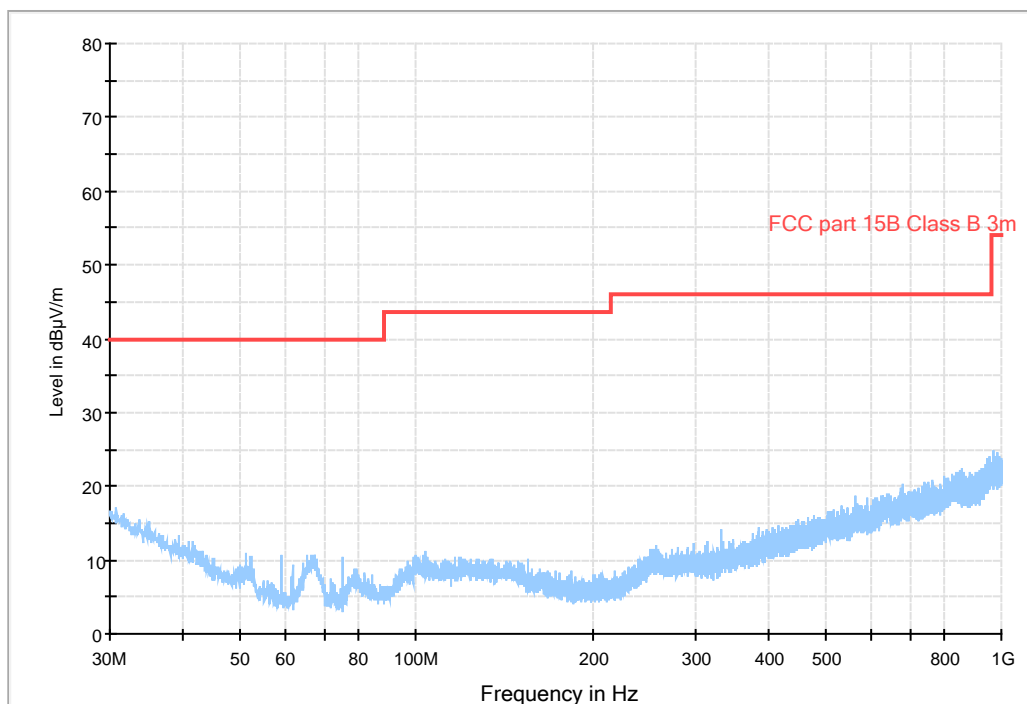
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX low channel.

Radio FCC 30 - 1000 MHz FCC class B 10m continuous TT rotation



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

Radio FCC 30 - 1000 MHz FCC class B 10m continuous TT rotation



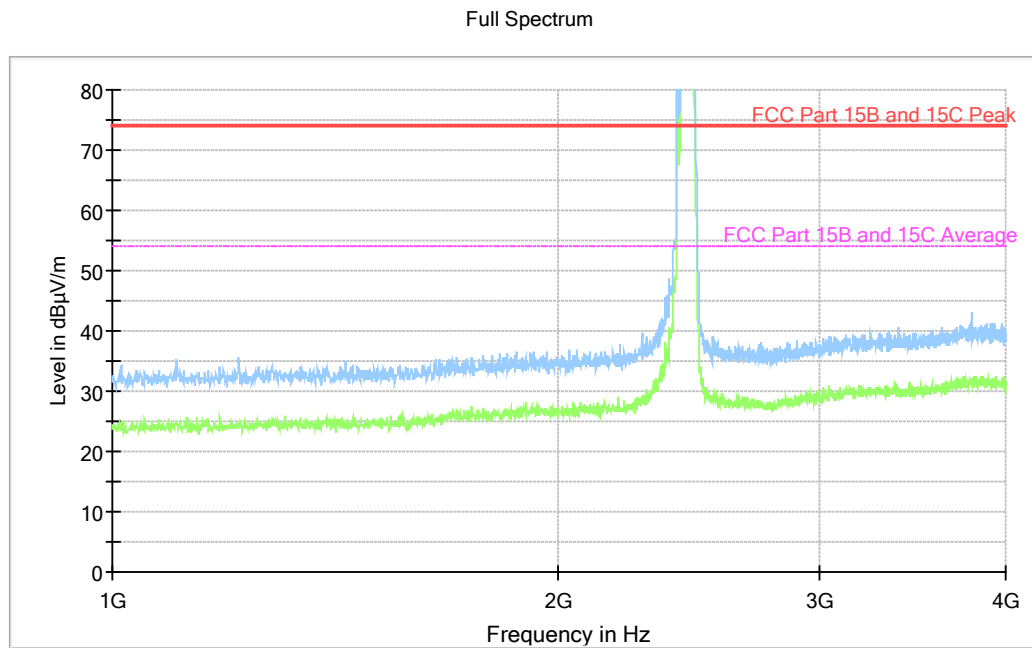
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. RX high channel.

Measurement results, Quasi Peak

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
60.342	4.4	40.0	V	35.6
61.417	8.4	40.0	H	31.6
75.955	2.7	40.0	V	37.3

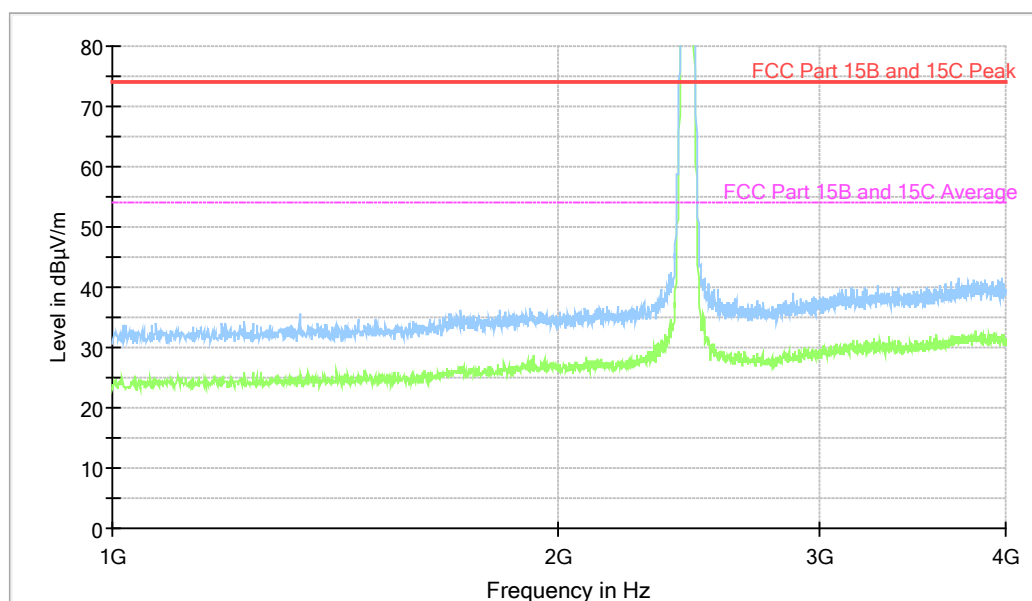
Result [dBμV/m] = Analyser reading [dBμV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

5.6 Test results 1 GHz – 26 GHz, TX



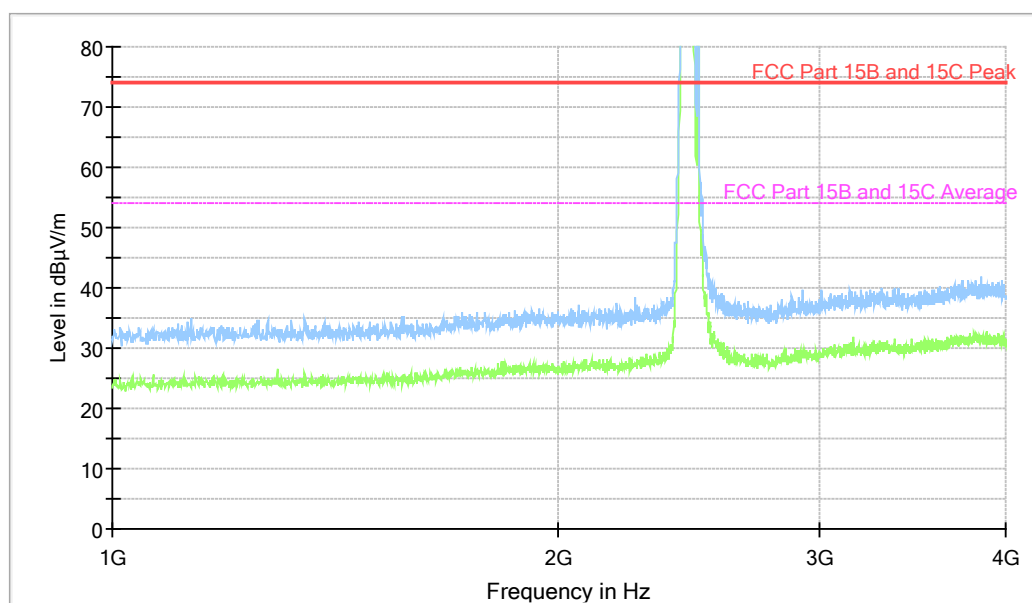
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

Full Spectrum



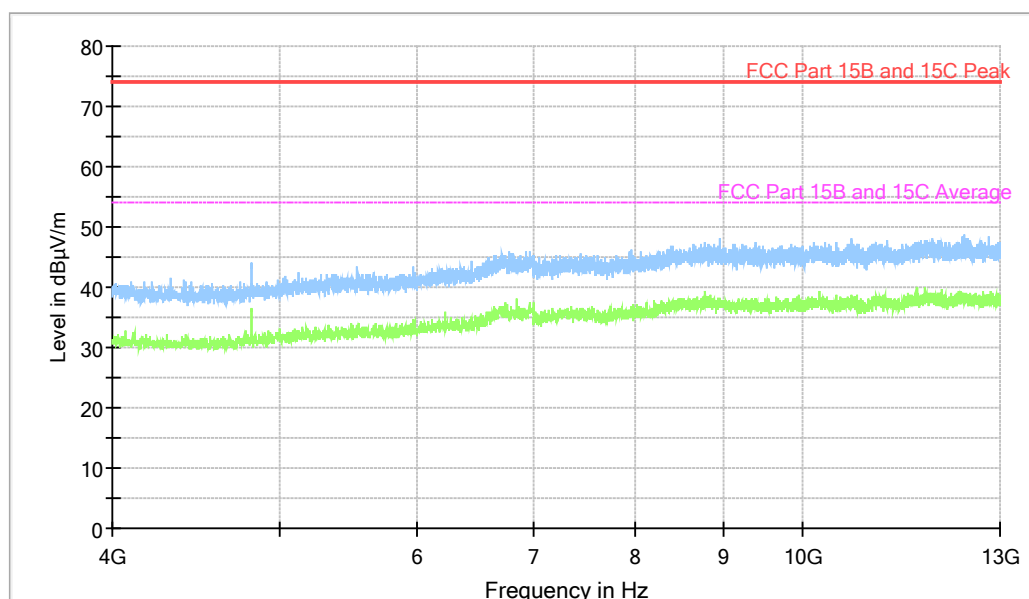
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX mid channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

Full Spectrum



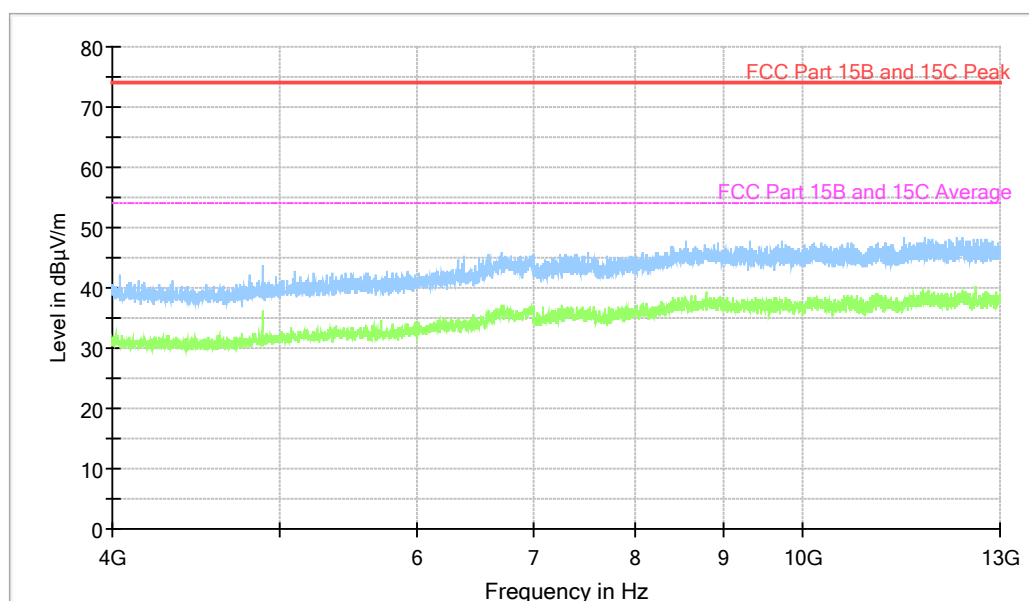
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel. Carrier is attenuated by band rejection filter K&L 6N45-2450/T 100-0/0.

Full Spectrum



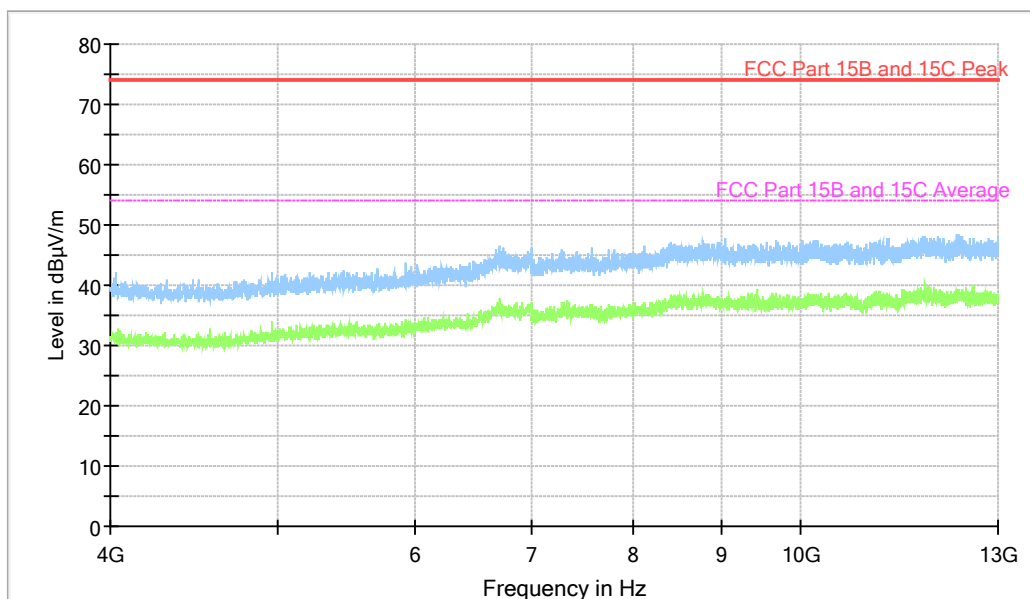
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



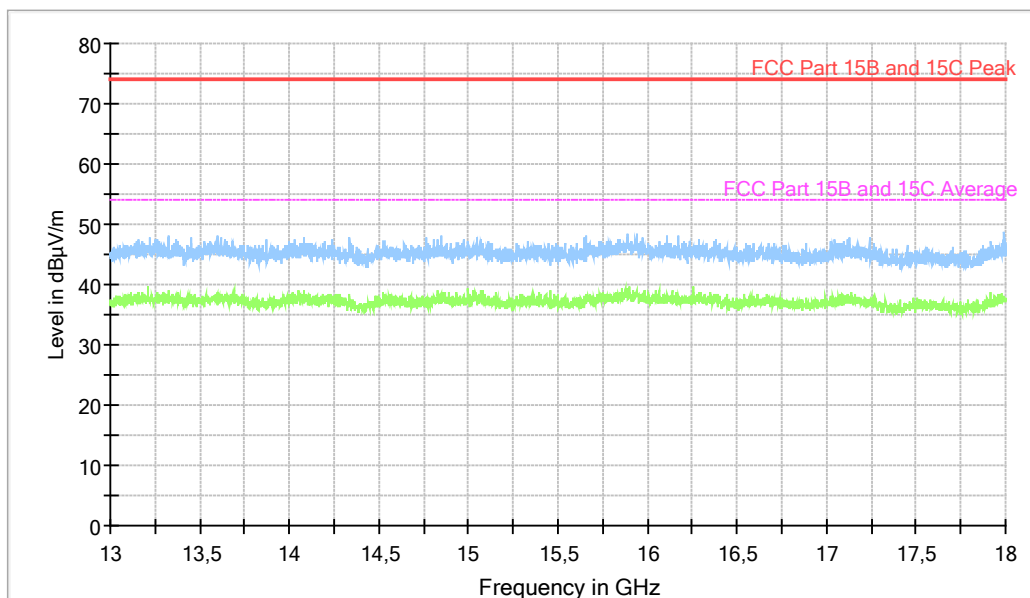
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX mid channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



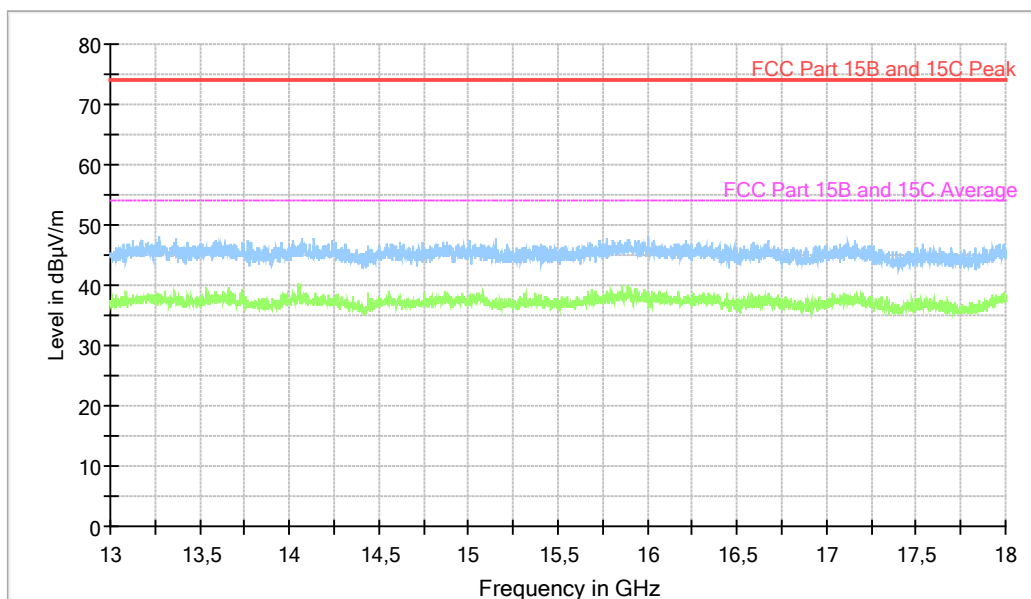
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel. Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.

Full Spectrum



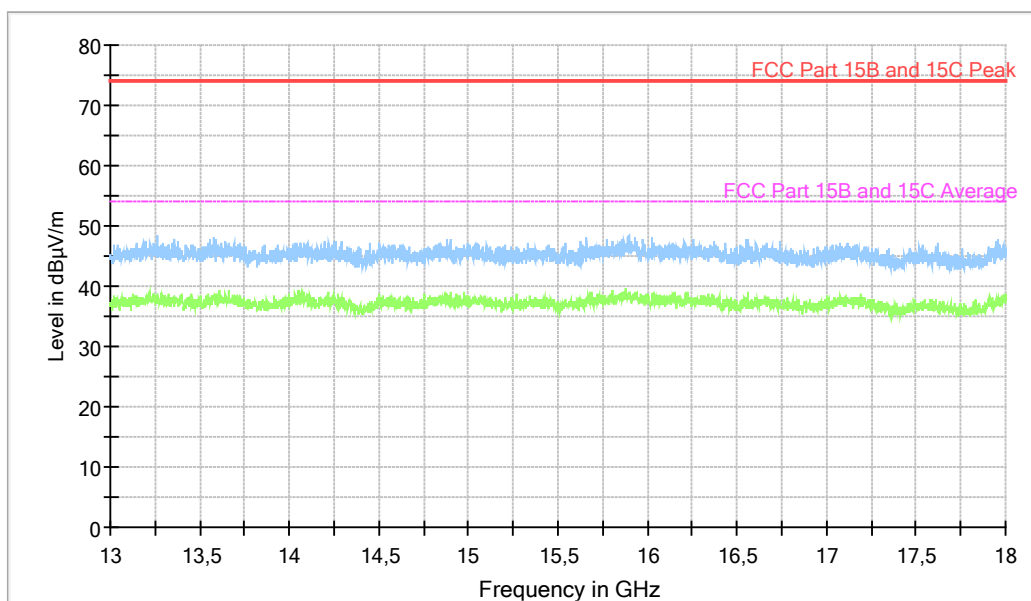
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX low channel.

Full Spectrum



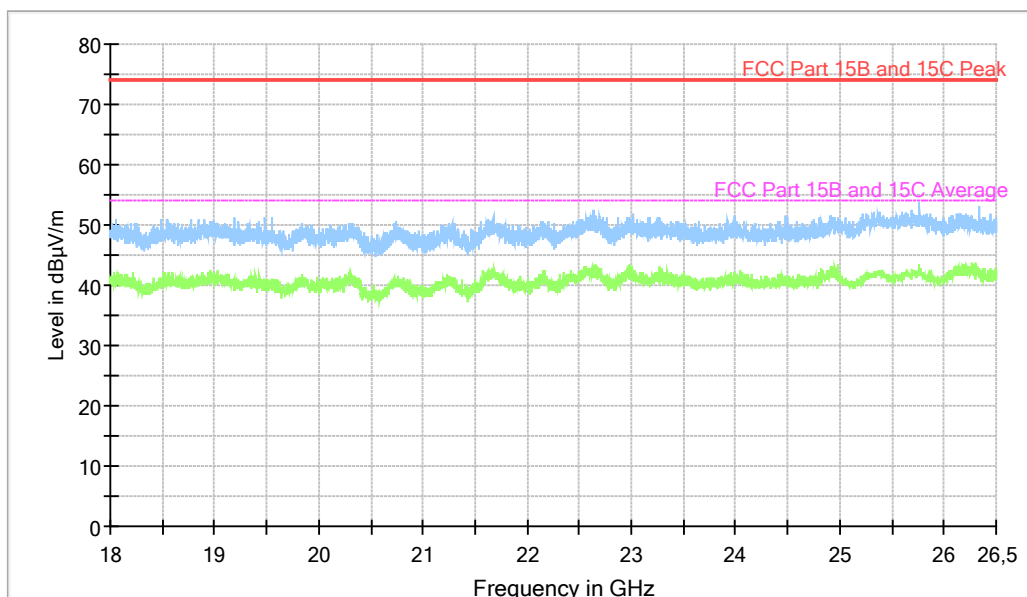
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX mid channel.

Full Spectrum



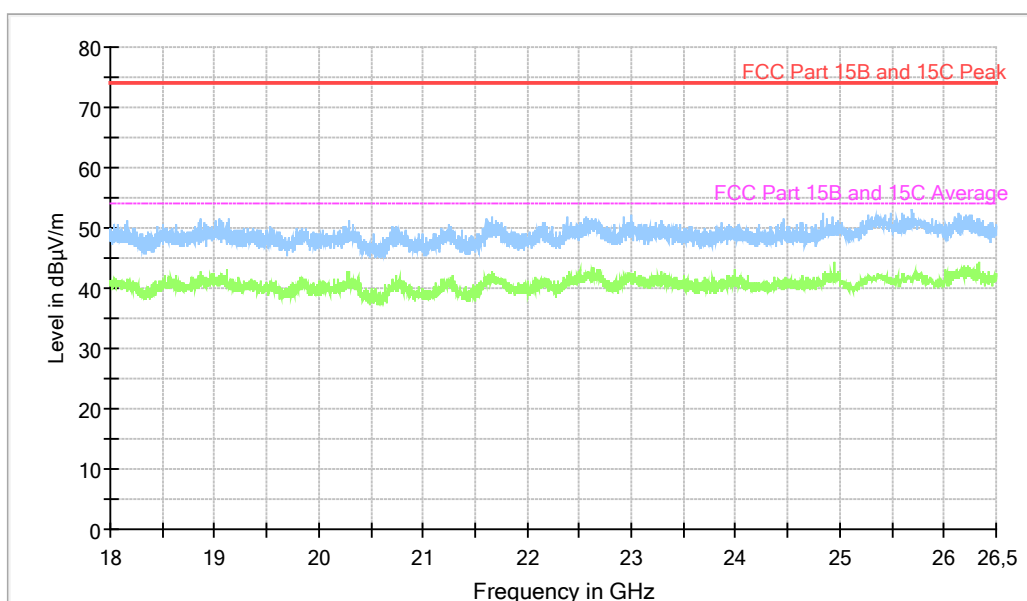
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX high channel.

Full Spectrum



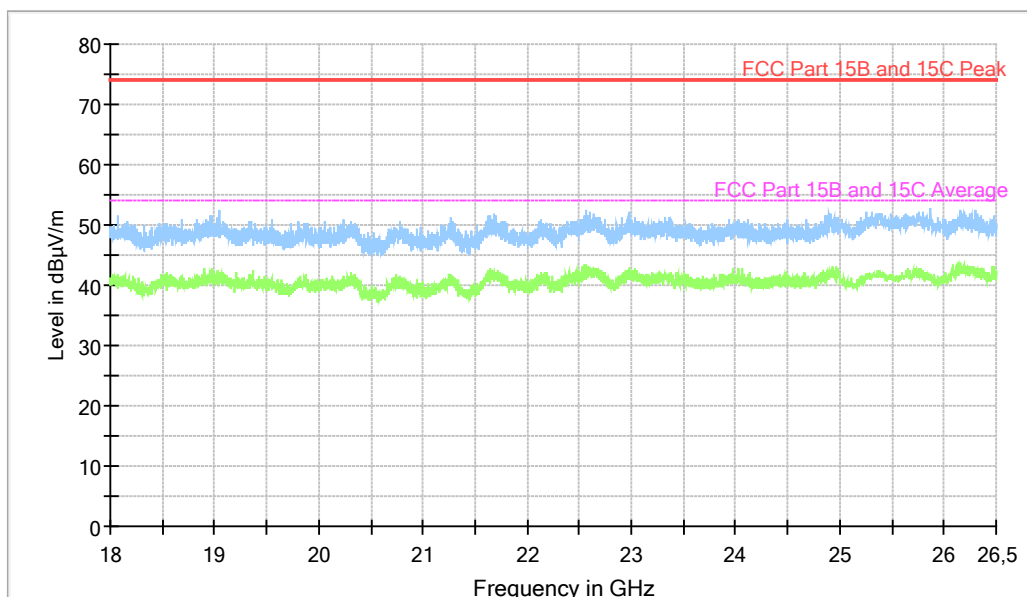
Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. TX low channel.

Full Spectrum



Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. TX mid 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]	EUT orientation	Polarization H/V	Margin [dB]
2400.0	66.2	74.0	--	V	7.8

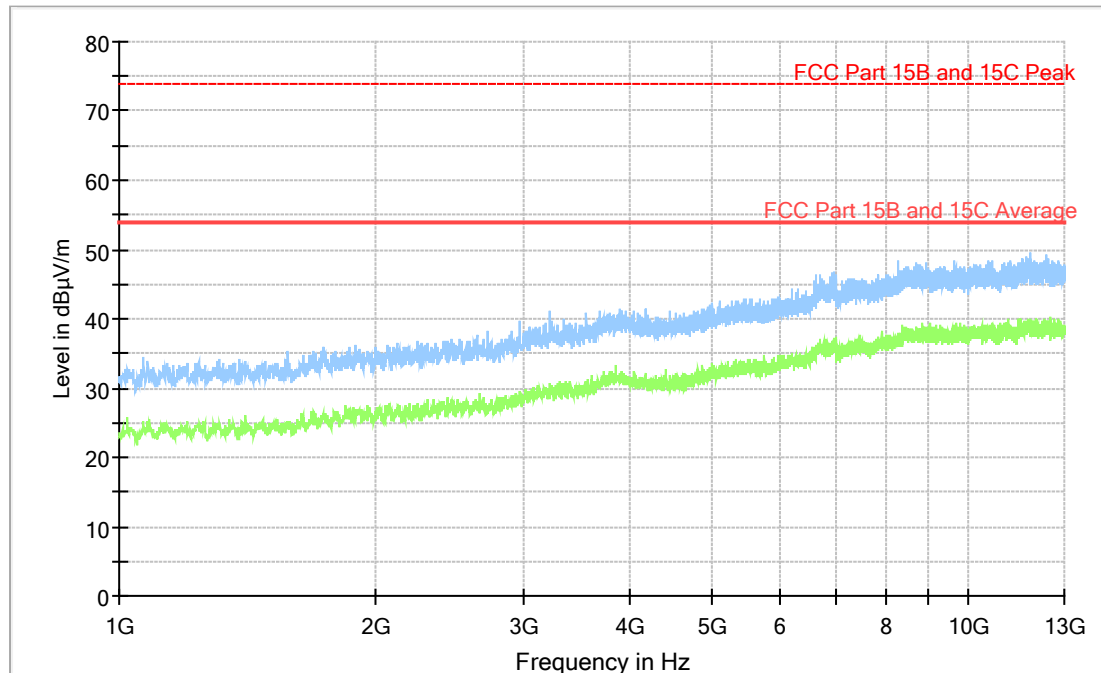
Measurement results, Average, TX low channel

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	EUT orientation	Polarization H/V	Margin [dB]
2400.0	53.2	54.0	--	V	0.8

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

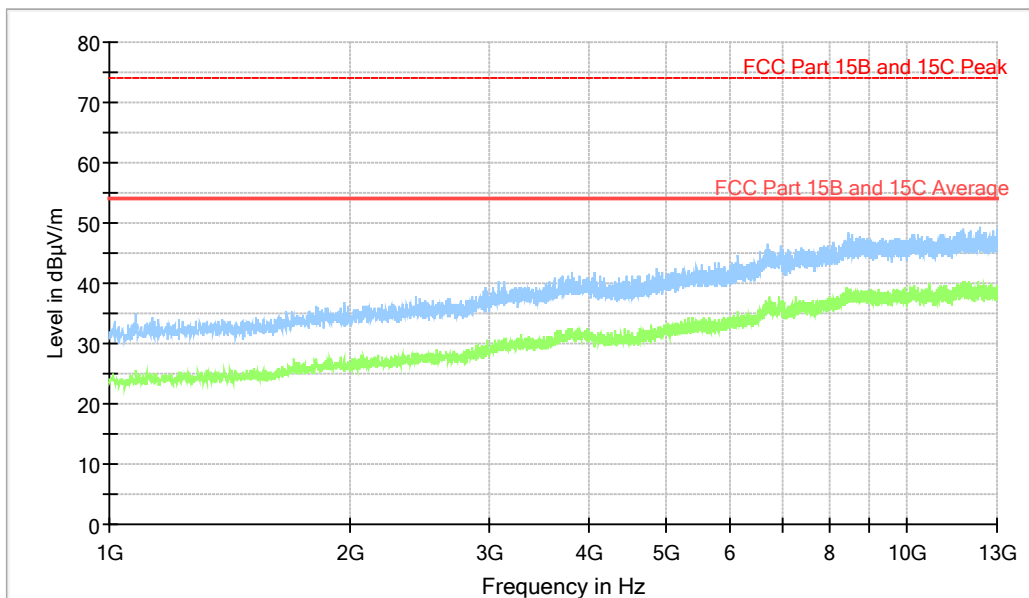
5.7 Test results 1 GHz – 13 GHz, RX

Full Spectrum



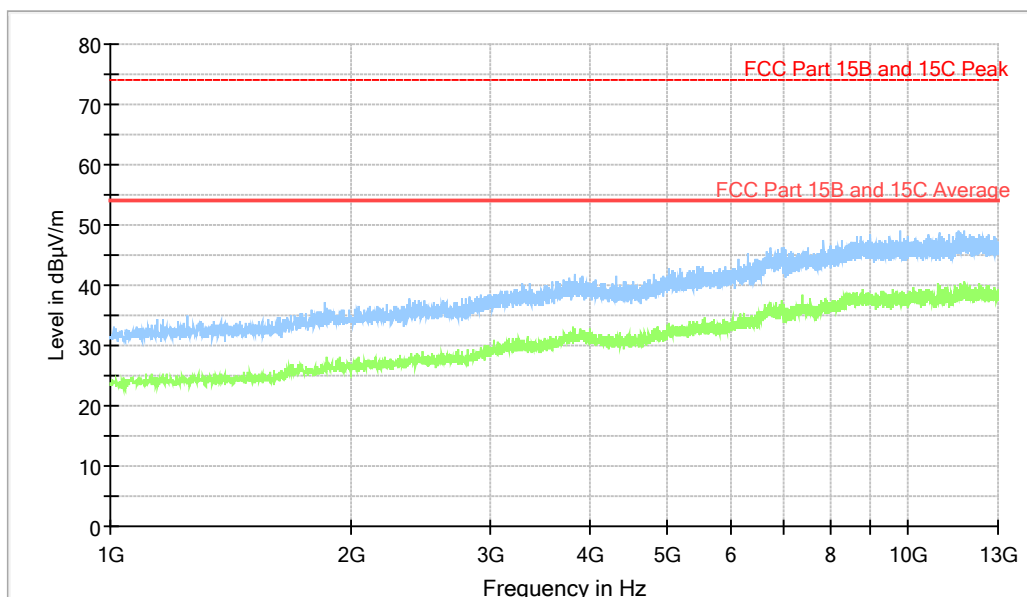
Diagram, Peak overview sweep, 1 – 13 GHz at 3 m distance. RX low channel.

Full Spectrum



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

Full Spectrum



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

Measurement results, Peak, RX low channel

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

6 RADIATED RF EMISSION 30 MHZ TO 26.5 GHZ, EXTERNAL ANTENNA

Date of test:	2017-12-28	Test location:	3m SAC
EUT Serial:	00.17.7A.01.02.04.97.48	Ambient temp:	22 °C
Tested by:	PLA	Relative humidity:	45 %
Test result:	Pass	Margin:	7.9 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.

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

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Bilog

Test set-up:

Test receiver set-up:

Preview test:

Final test:

MHz VBW 3 MHz

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 Peak value + 20 x LOG (Duty cycle) / RBW 1

1.5 m

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Horn

Activated

6.3 Requirements

Within restricted bands:

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

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

Frequency range [MHz]	Field strength at 3 m (dB μ V/m)	Field strength at 10 m (dB μ V/m)	Detector (dB μ V/m)
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

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

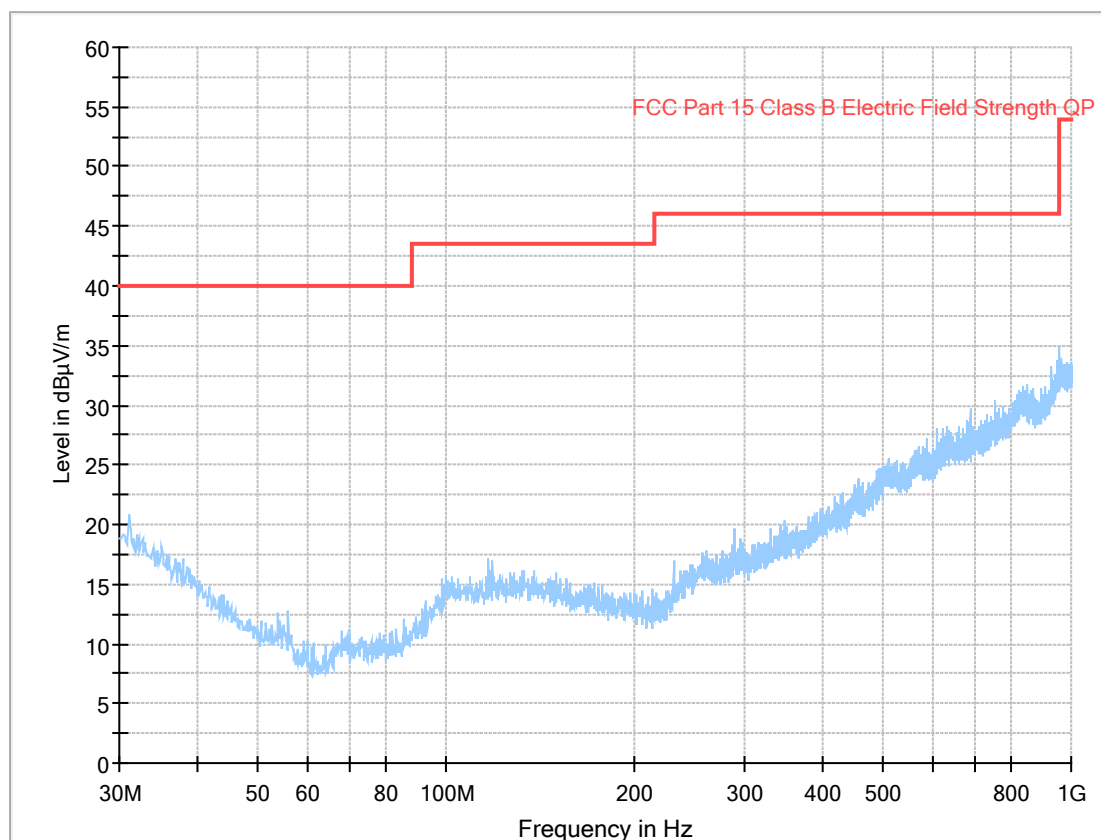
Outside the restricted bands:

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

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

6.4 Test results 30 MHz – 1000 MHz, TX, External antenna

Full Spectrum



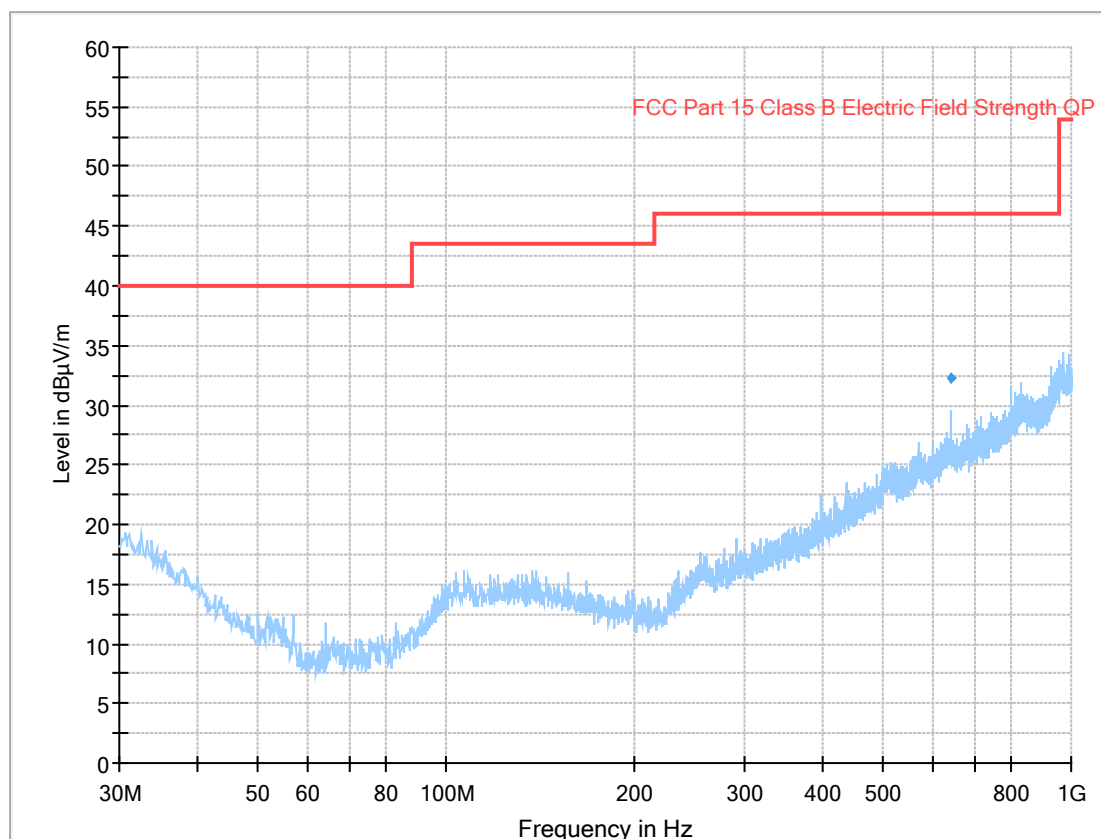
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX low channel.

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]

Full Spectrum



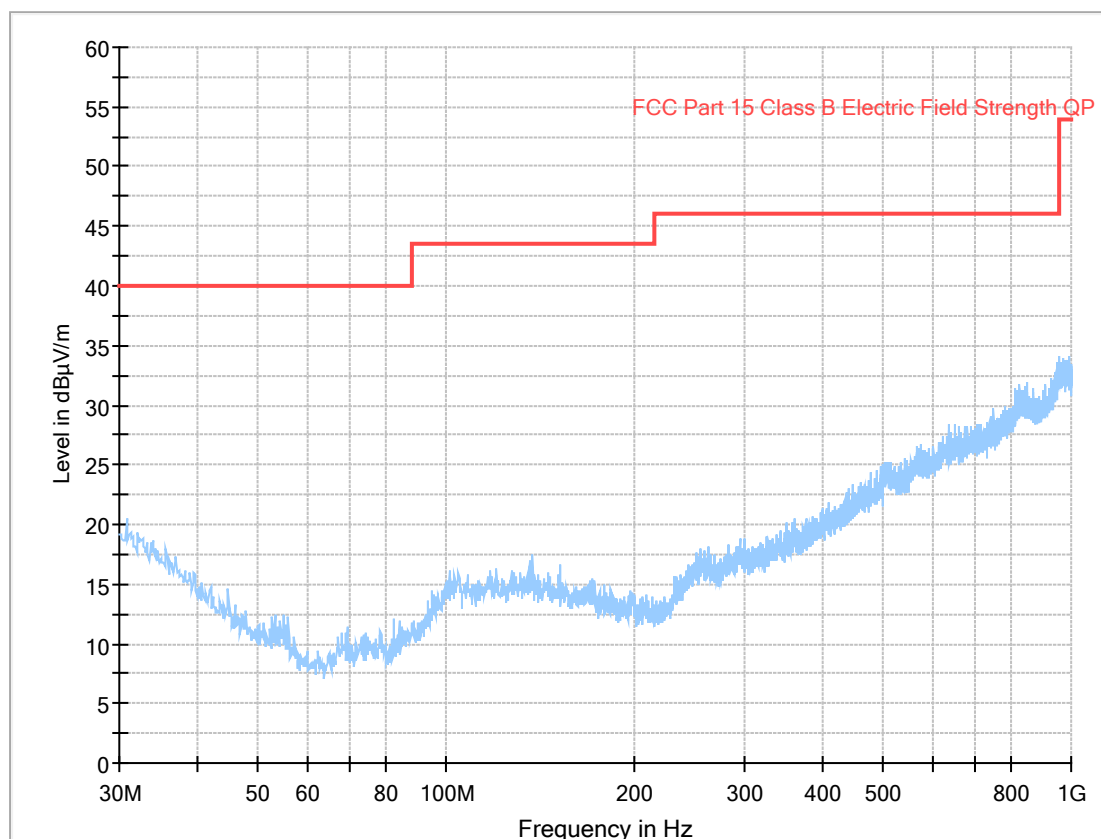
Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. TX mid channel.

Measurement results, Quasi Peak

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
642.126	32.2	46.0	V	13.8

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

Full Spectrum



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

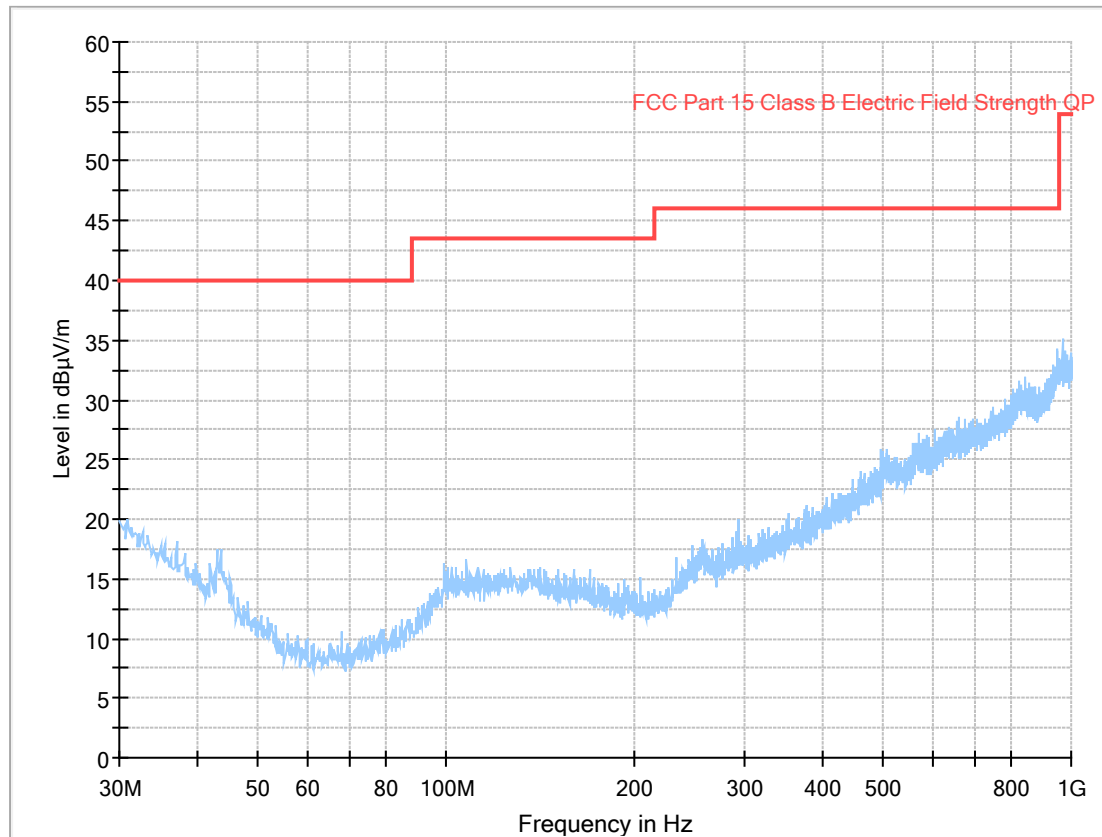
Measurement results, Quasi Peak

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]

6.5 Test results 30 – 1000 MHz, RX, External antenna

Full Spectrum



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

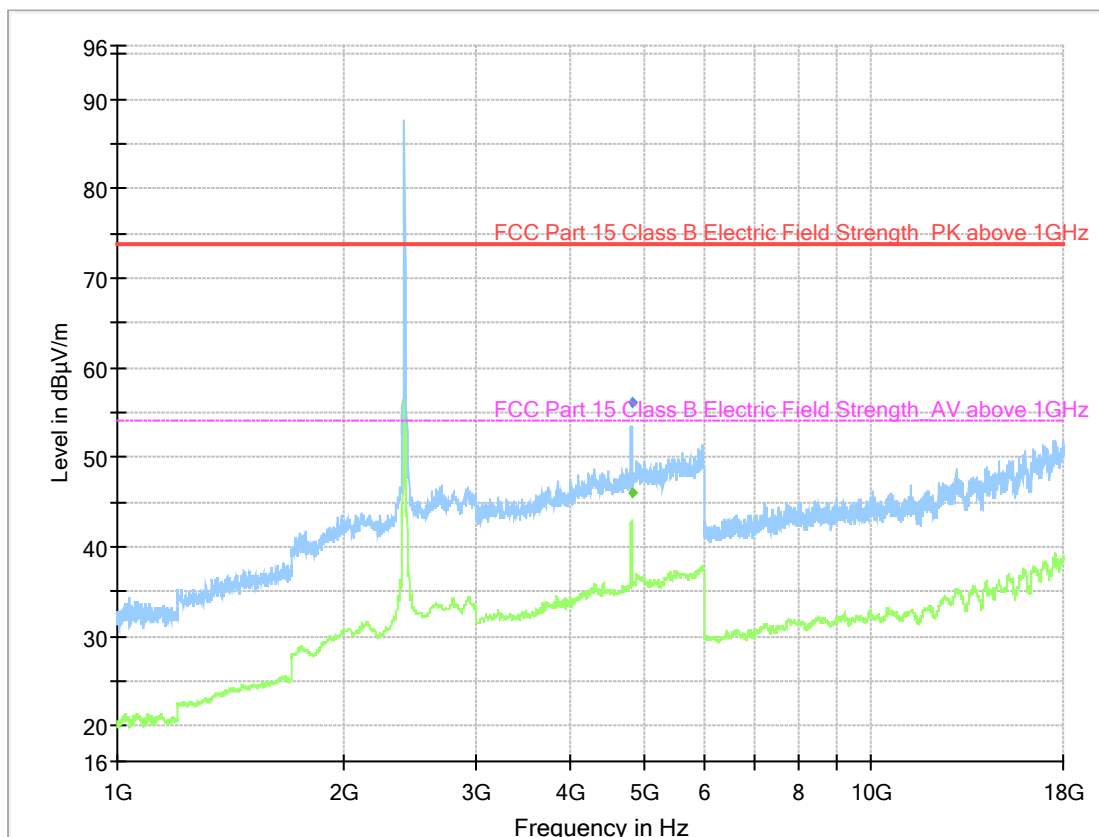
Measurement results, Quasi Peak

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]

6.6 Test results 1 – 18 GHz, TX, External antenna

Full Spectrum



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

Measurement results, Peak

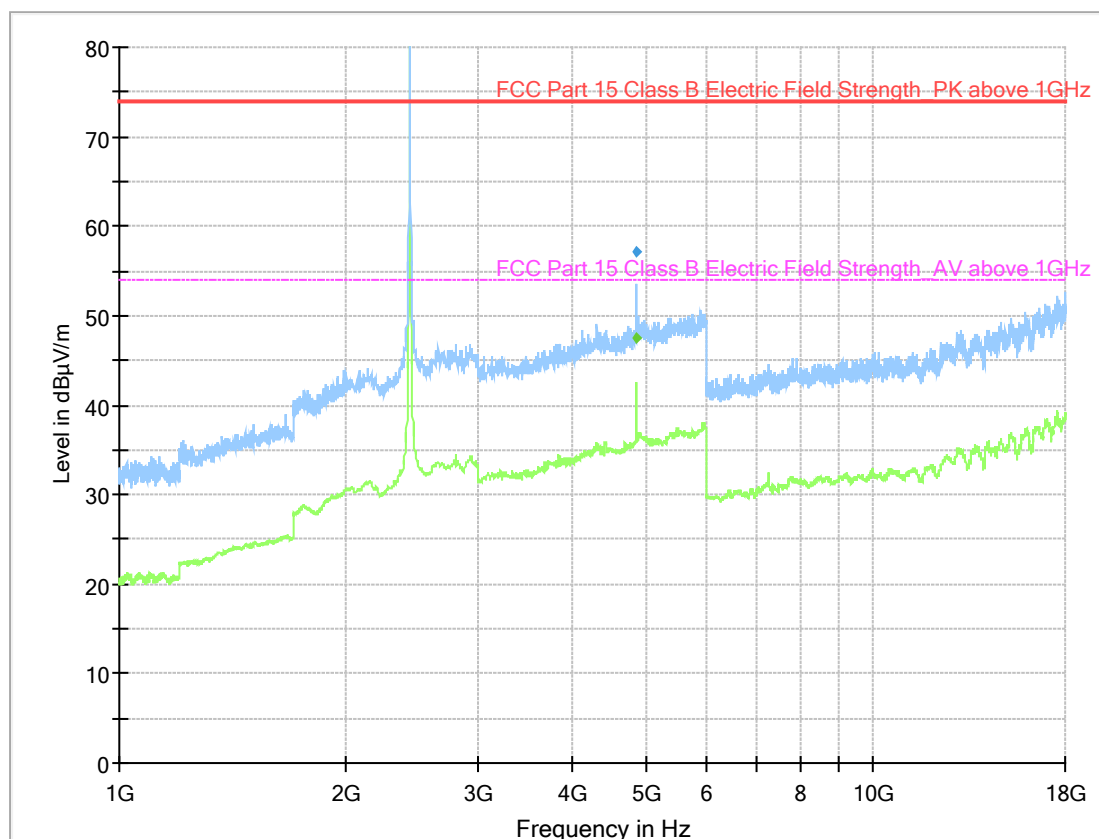
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
4810.8	56.1	73.9	V	17.9

Measurement results, Average

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
4810.8	46.1	54.0	V	7.9

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

Full Spectrum



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

Measurement results, Peak

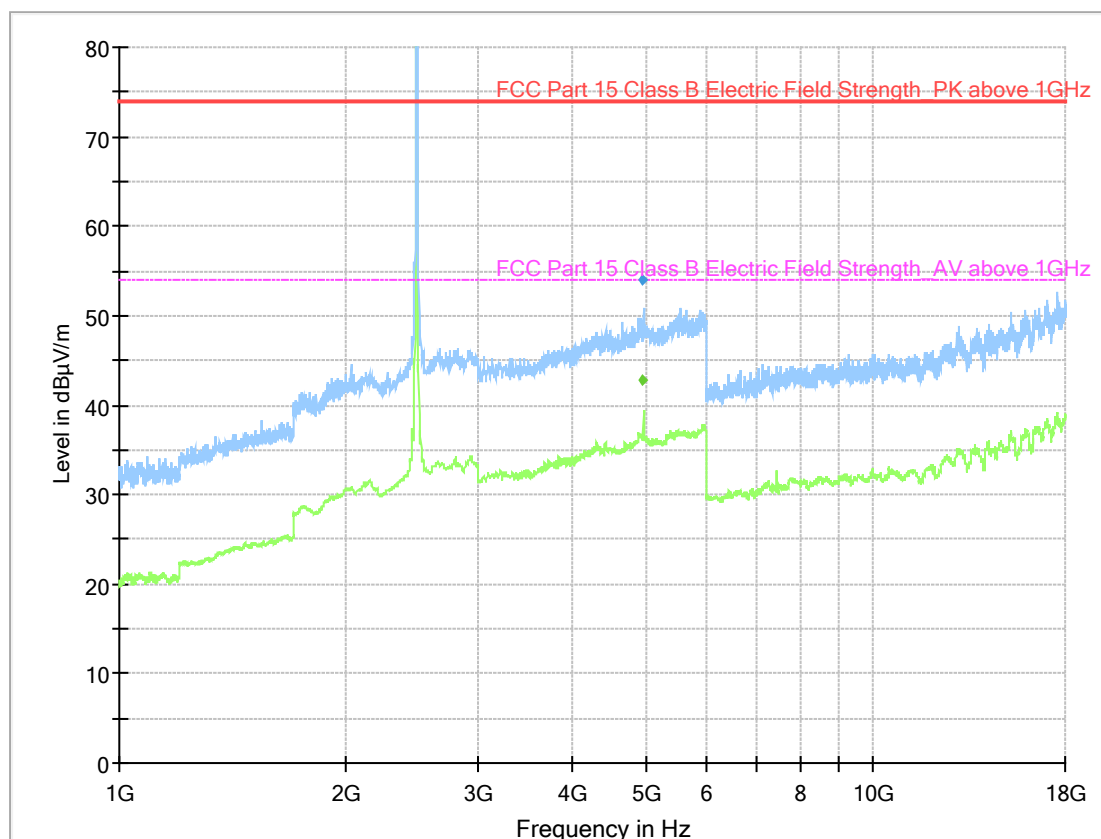
Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
4858.9	57.1	73.9	V	16.8

Measurement results, Average

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
4858.9	47.5	54.0	V	6.5

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

Full Spectrum



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

Measurement results, Peak

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
4958.9	54.0	73.9	V	19.9

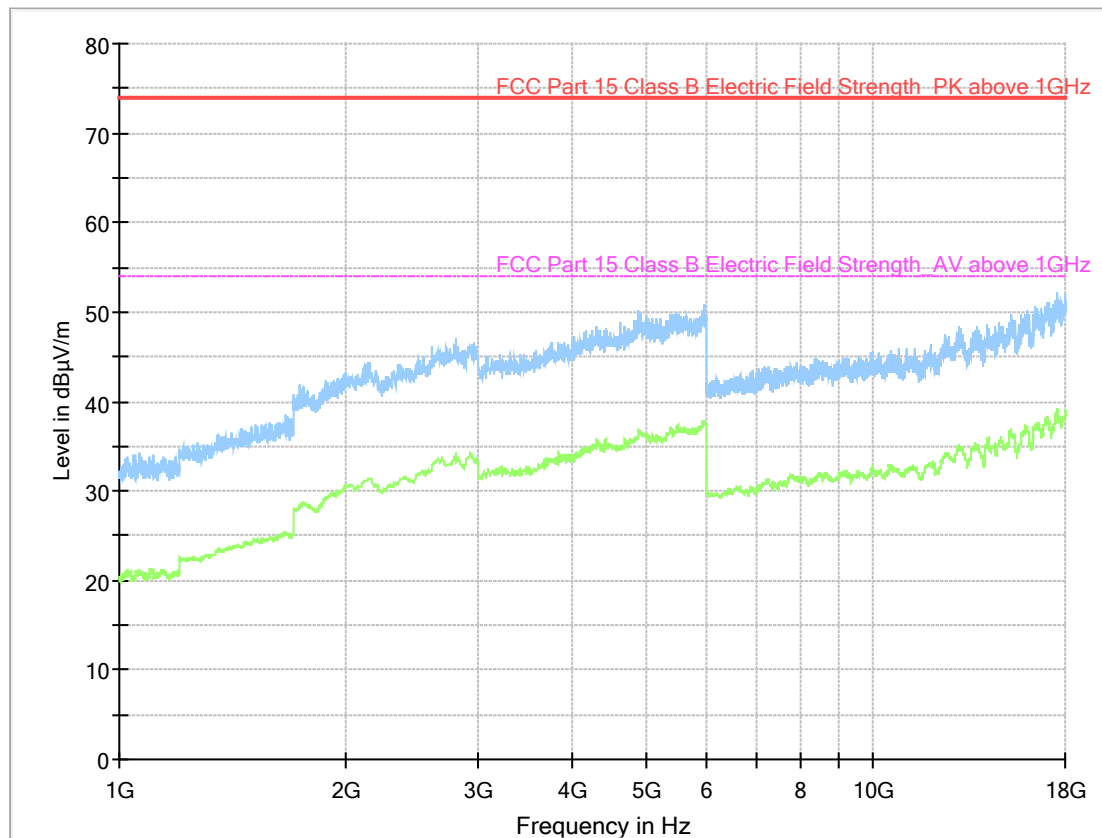
Measurement results, Average

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]
4958.9	42.8	54.0	V	11.2

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

6.7 Measurement result 1 – 18 GHz, RX, External antenna

Full Spectrum



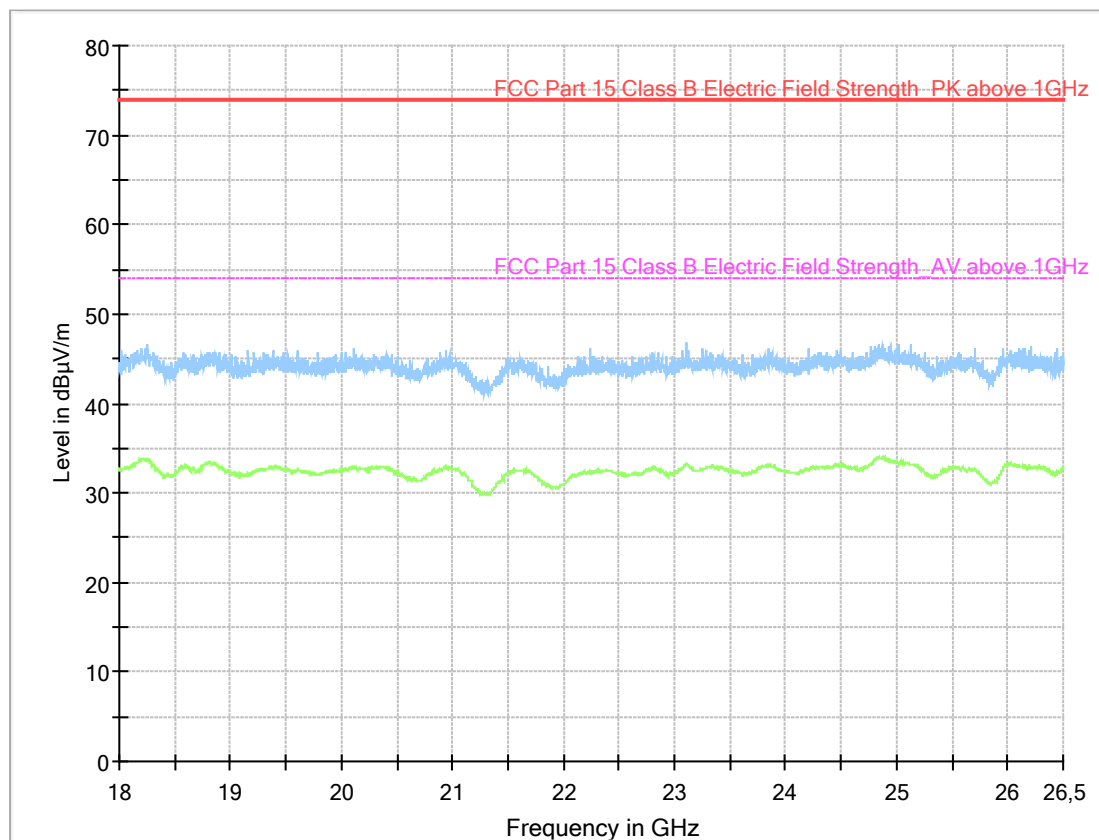
Diagram, Peak overview sweep, 1 – 18 GHz at 3 m distance. RX low channel.

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]

6.8 Test result 18 – 26.5 GHz, TX, External antenna

Full Spectrum

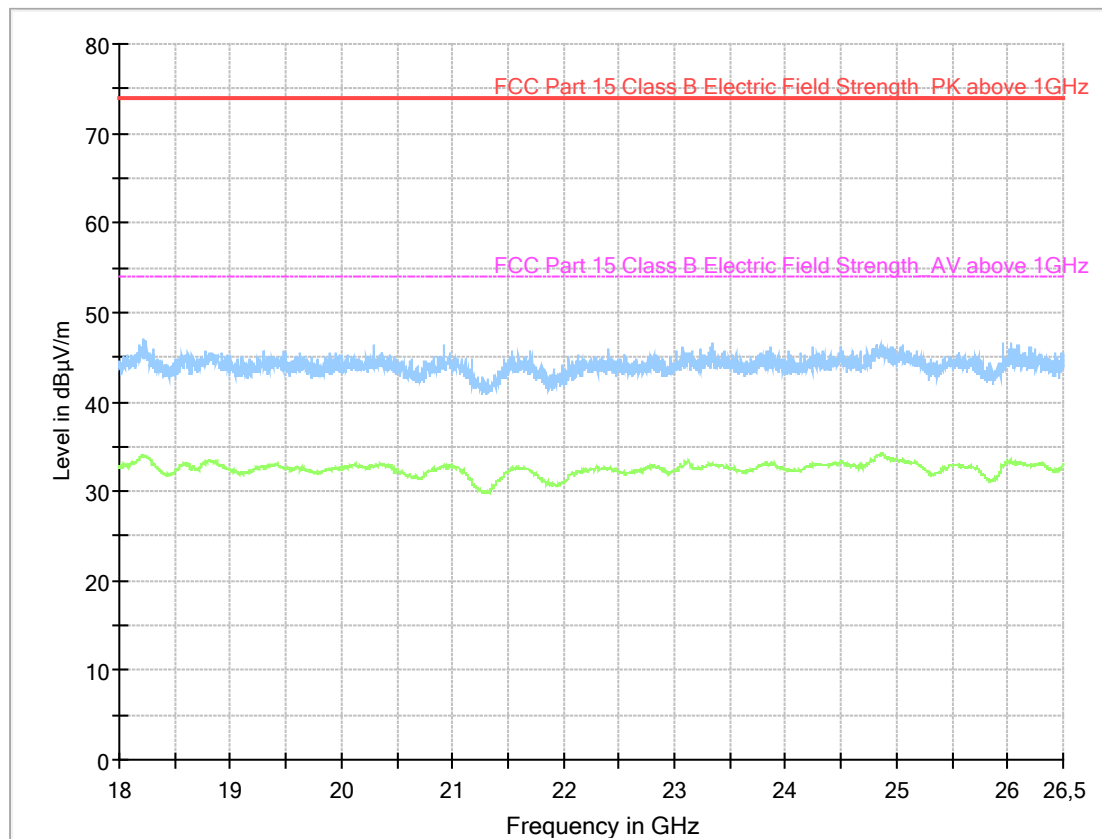


Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance. TX low channel.

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]

Full Spectrum

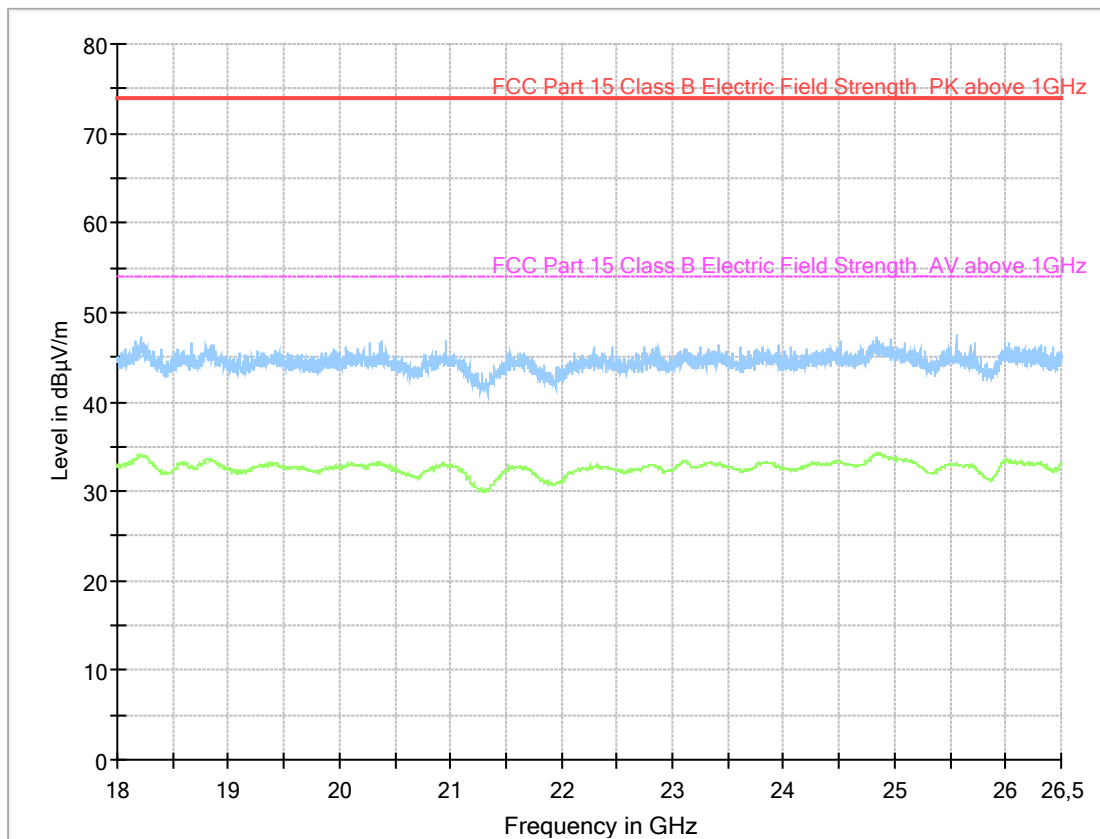


Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance. TX mid channel.

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]

Full Spectrum



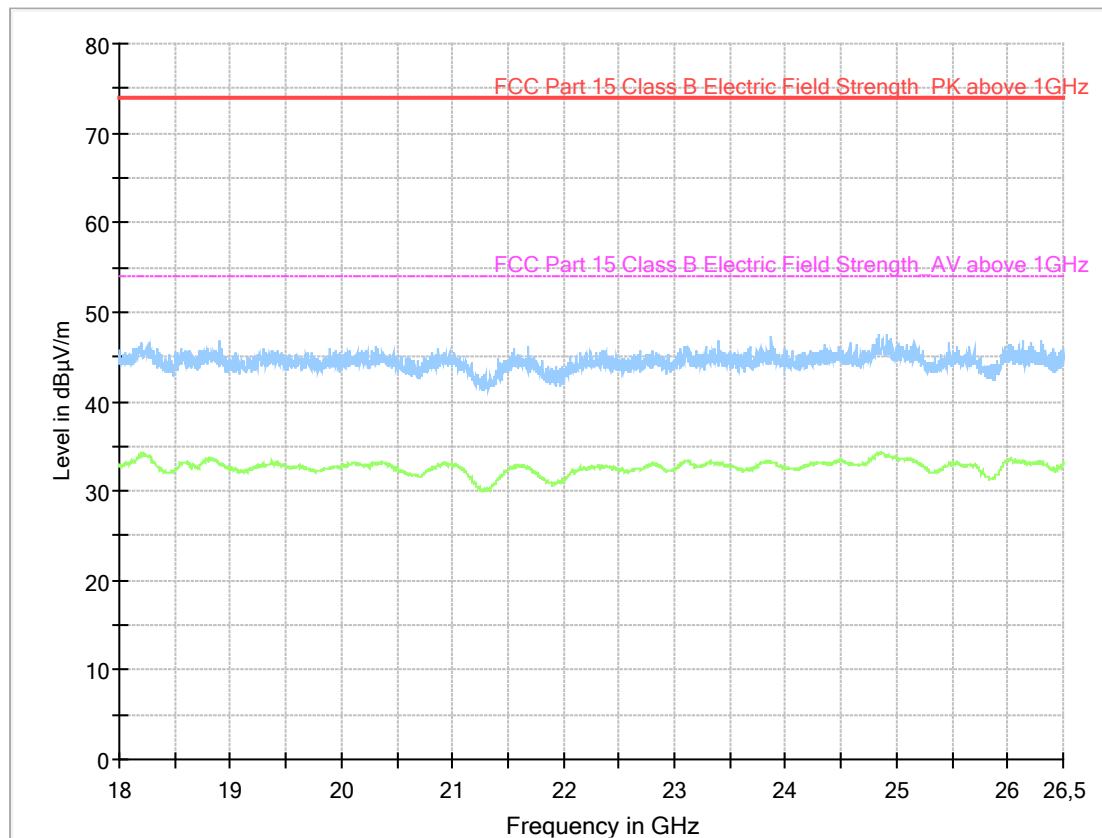
Diagram, Peak overview sweep, 18 – 26,5 GHz at 3 m distance. TX high channel.

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]

6.9 Measurement result 18-26,5 GHz RX, External antenna

Full Spectrum



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

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]

7 RADIATED BAND EDGE, EXTERNAL ANTENNA

Date of test:	2017-10-02	Test location:	3m SAC
EUT Serial:	Sample#1	Ambient temp:	22 °C
Tested by:	PLA	Relative humidity:	45 %
Test result:	Pass	Margin:	5.8 dB

7.1 Test set-up and test procedure.

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

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

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

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

EUT was evaluated in three orthogonal orientations.

7.2 Test conditions

Test set-up:

Test receiver set-up:

Preview test:

Final test:

1 GHz – 18 GHz

Peak,

RBW 1 MHz

VBW 3 MHz

Peak,

RBW 1 MHz

VBW 3 MHz

Average

Peak value + 20 x LOG (Duty cycle) / RBW 1

MHz. VBW 3 MHz

Measuring distance:

3 m

Measuring angle:

0 – 359°

Antenna

Height above ground plane:

1 – 4 m

Polarisation:

Vertical and Horizontal

Type:

Horn

Antenna tilt:

Activated

7.3 Requirement

Outside the restricted bands:

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

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

Within restricted bands:

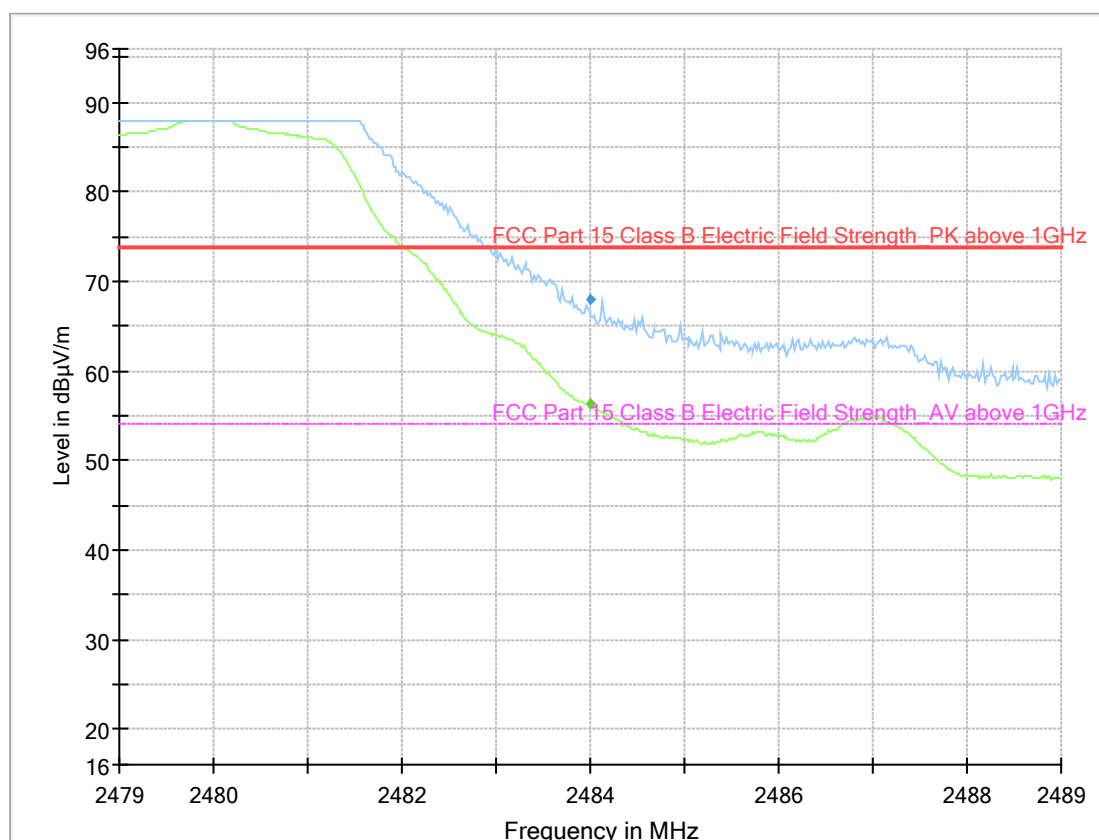
Reference: CFR 47 §15.209, RSS-Gen section 8.9

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

Frequency range [MHz]	Field strength at 3 m (dB μ V/m)	Field strength at 10 m (dB μ V/m)	Detector (dB μ V/m)
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

7.4 Test results

Full Spectrum



Upper band edge sweep, EUT in horizontal position, 3 m.

Field strength band edge, high channel, EUT in vertical position.

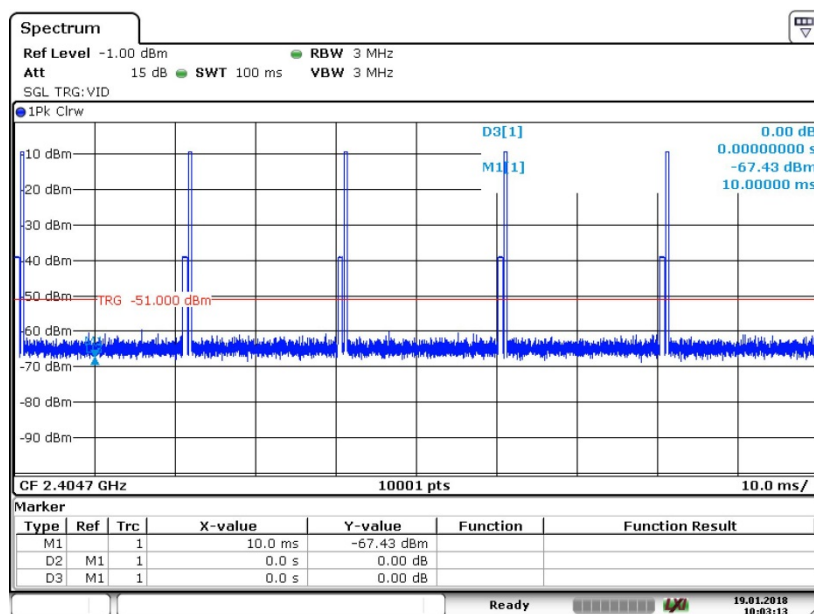
Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Detector	Polarization H/V	Margin [dB]
2484.0	68.1	73.9	Peak	V	5.8
2484.0	28.1*	54.0	Avg	V	25.9

*Value compensated for 1 % duty cycle.

Measured value for peak 68.1 dBuV/m

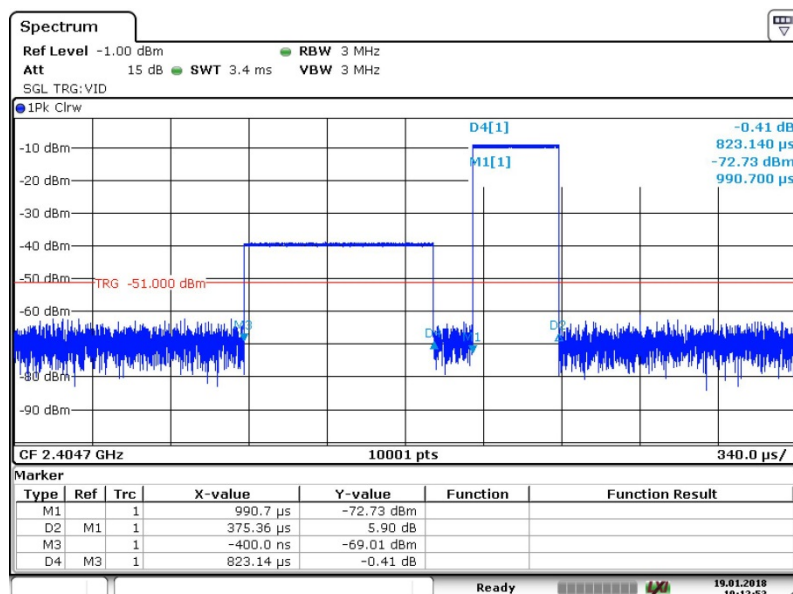
Calculation for duty cycle compensation : $68.1 \text{ dBuV/m} + 20 \log 0.01 = 28.1 \text{ dBuV/m}$

Calculation of duty cycle: $5 \times 0.375 / (100) = 0.01$



Date: 19.JAN.2018 10:03:13

Measured bursts over 100ms



Date: 19.JAN.2018 10:12:54

Measured duty cycle, on time

Note: High amplitude pulse relates to EUT, low from companion device.

8 CONDUCTED BAND EDGE MEASUREMENT

Date of test:	2017-09-25	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.48	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	48 %
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 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.

8.2 Test conditions

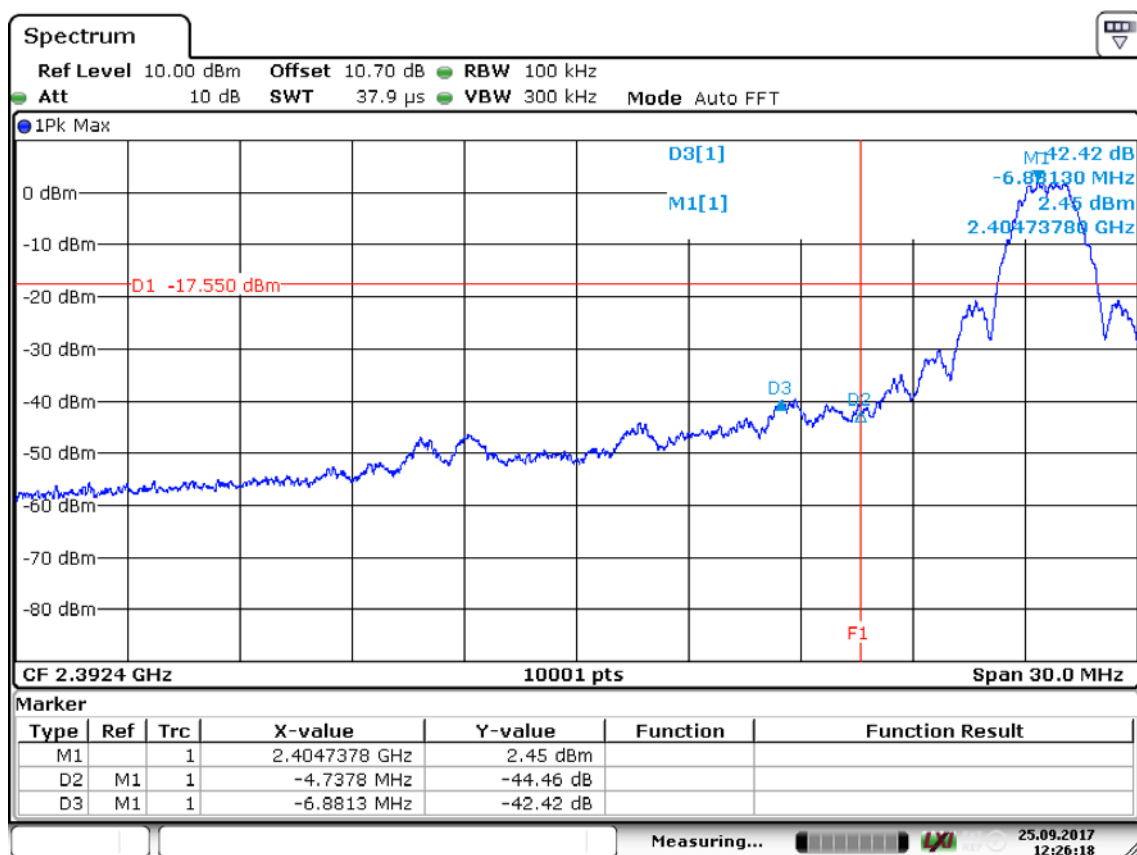
Detector: Peak
RBW: 100 kHz
VBW: 300 kHz
Span: 30 MHz

8.3 Requirement

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

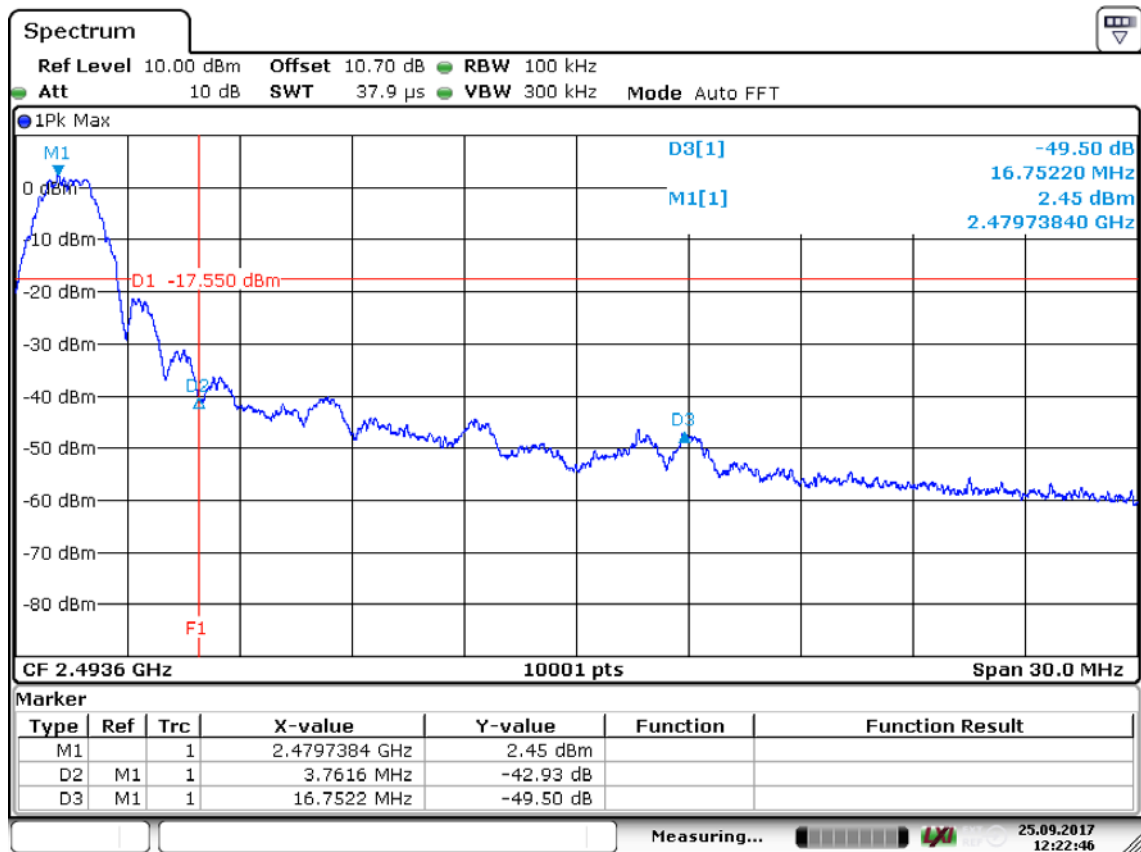
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

8.4 Test results



Date: 25.SEP.2017 12:26:18

Screenshot: Lower band edge sweep, single channel



Date: 25.SEP.2017 12:22:46

Screenshot: Upper band edge sweep, single channel

Test results

Band edge	Delta [dBc]	Limit [dBc]	Margin [dB]
Lower	44.5	20.0	24.5
Upper	42.9	20.0	22.9

9 PEAK CONDUCTED OUTPUT POWER

Date of test:	2017-09-25	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.48	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	48 %
Test result:	Pass	Margin:	> 10 dB

9.1 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.

9.2 Test conditions

Detector: Peak
RBW: >OBW
VBW: 3 x RBW
Span: >3 x OBW

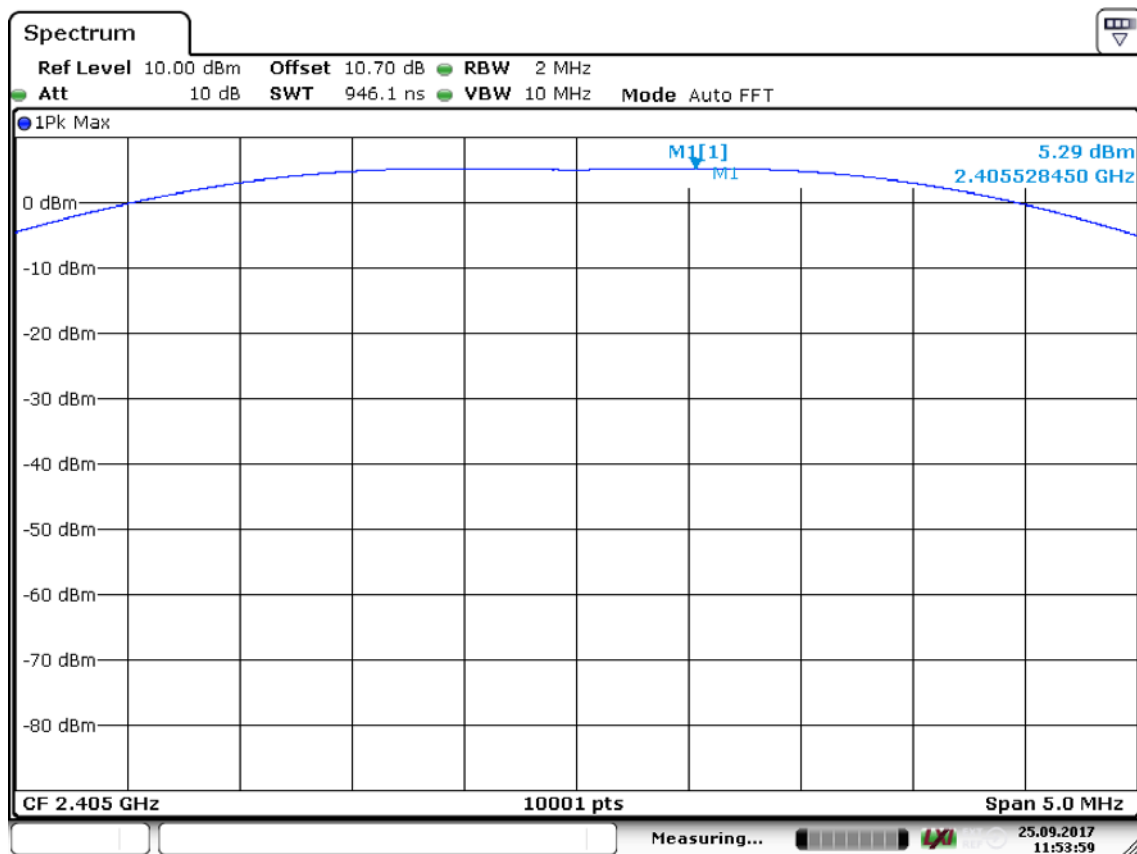
The EUT was set up in order to emit maximum disturbances.

9.3 Requirements

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

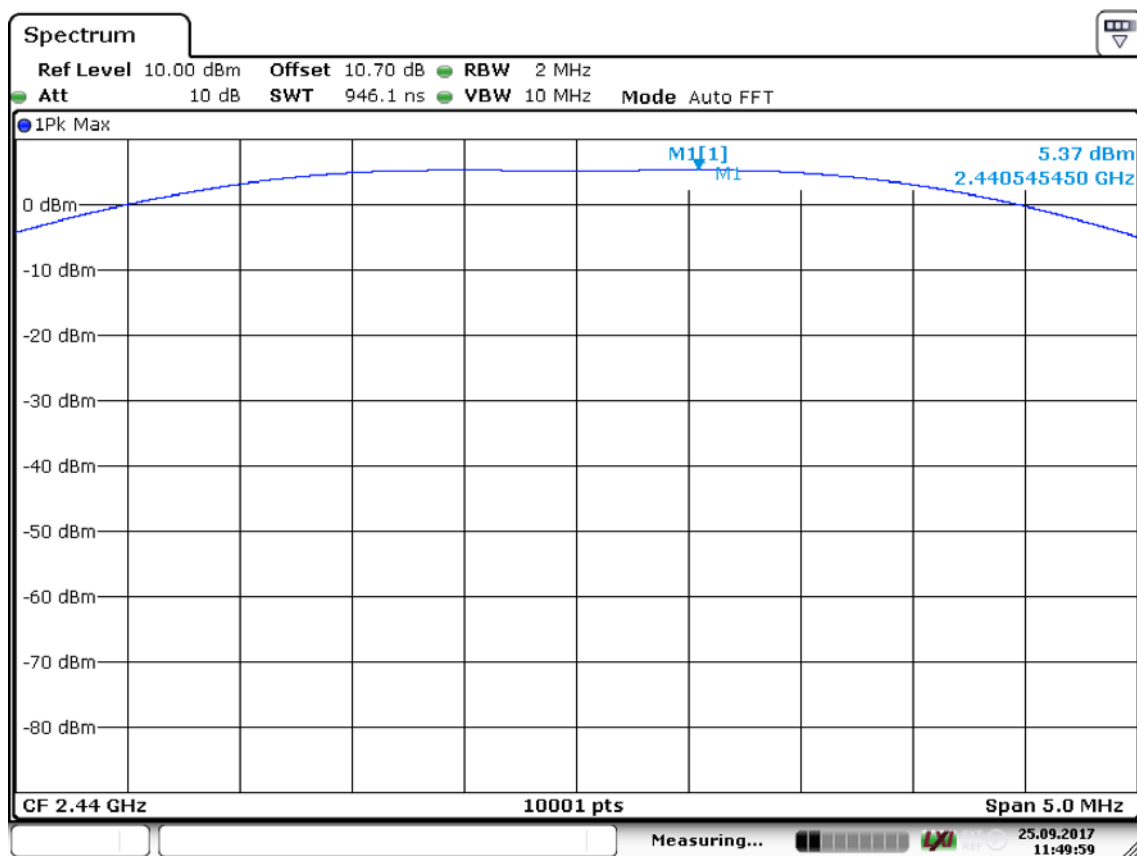
For DTSSs employing digital modulation techniques operating in the bands 902 – 128 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz, the maximum peak conducted output power shall not exceed 1W.

9.4 Test results



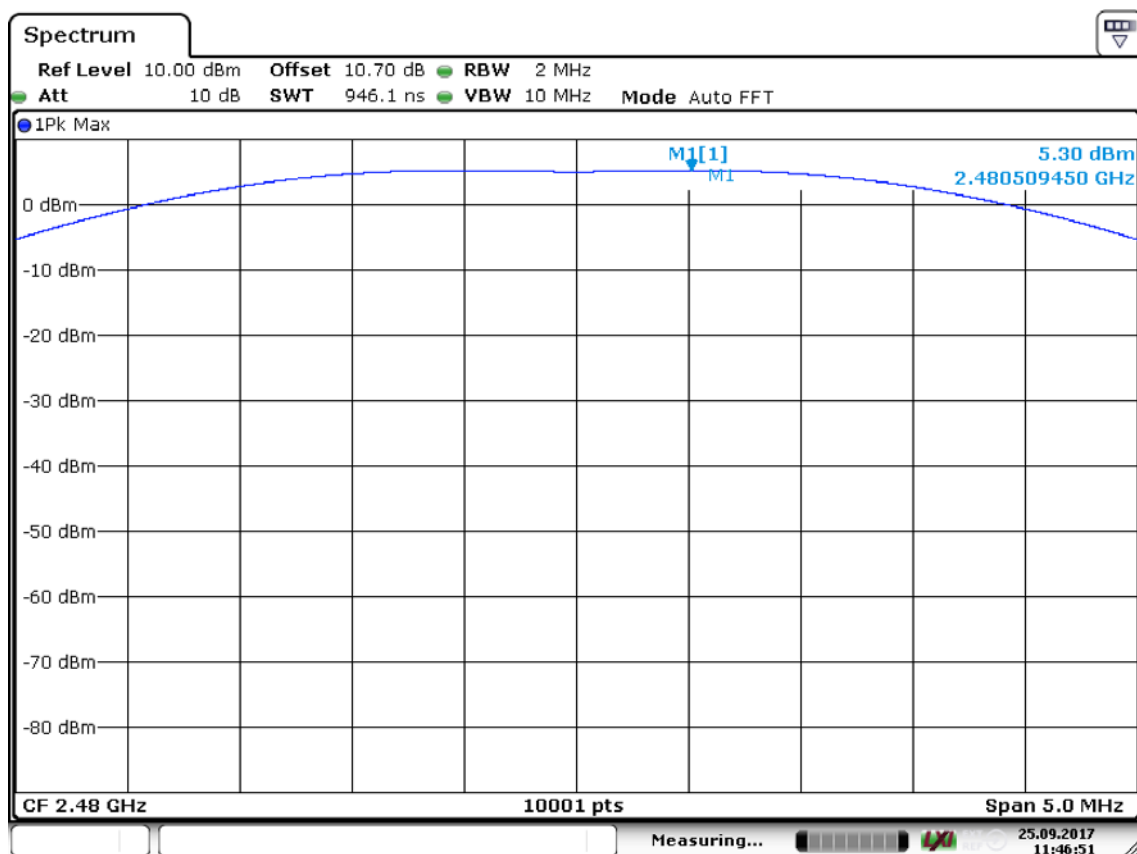
Date: 25.SEP.2017 11:54:00

Screenshot: Output power, low channel



Date: 25.SEP.2017 11:50:00

Screenshot: Output power, middle channel



Date: 25.SEP.2017 11:46:52

Screenshot: Output power, high channel

Test result

Channel [MHz]	Output power [dBm]
2405	5.3
2440	5.4
2480	5.3

10 OCCUPIED 6 DB BANDWIDTH

Date of test:	2017-09-25	Test location:	Wireless Center
EUT Serial:	00.17.7A.01.02.04.97.48	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	48 %
Test result:	Pass	Margin:	1.1 MHz

10.1 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.

10.2 Test conditions

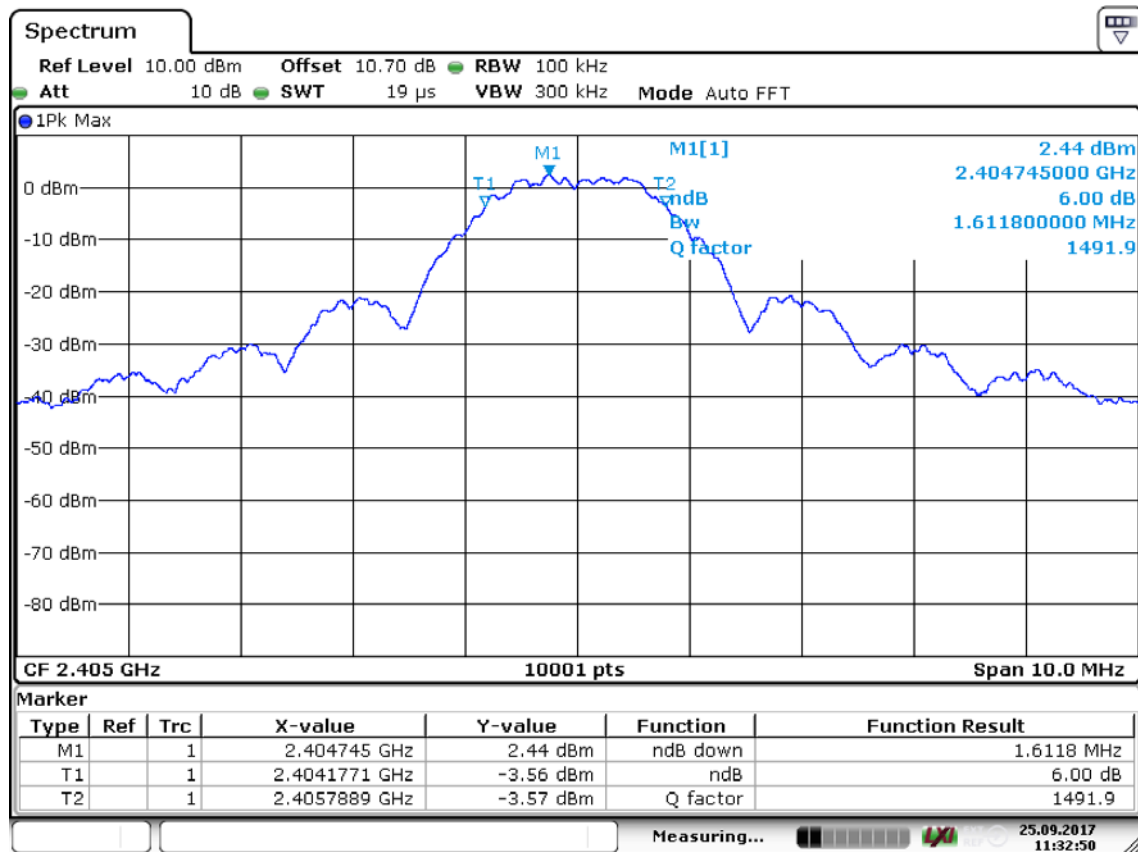
Detector: Peak
 RBW: 100 kHz
 VBW: 3 x RBW
 Span: >1,5 x OBW

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

10.3 Requirements

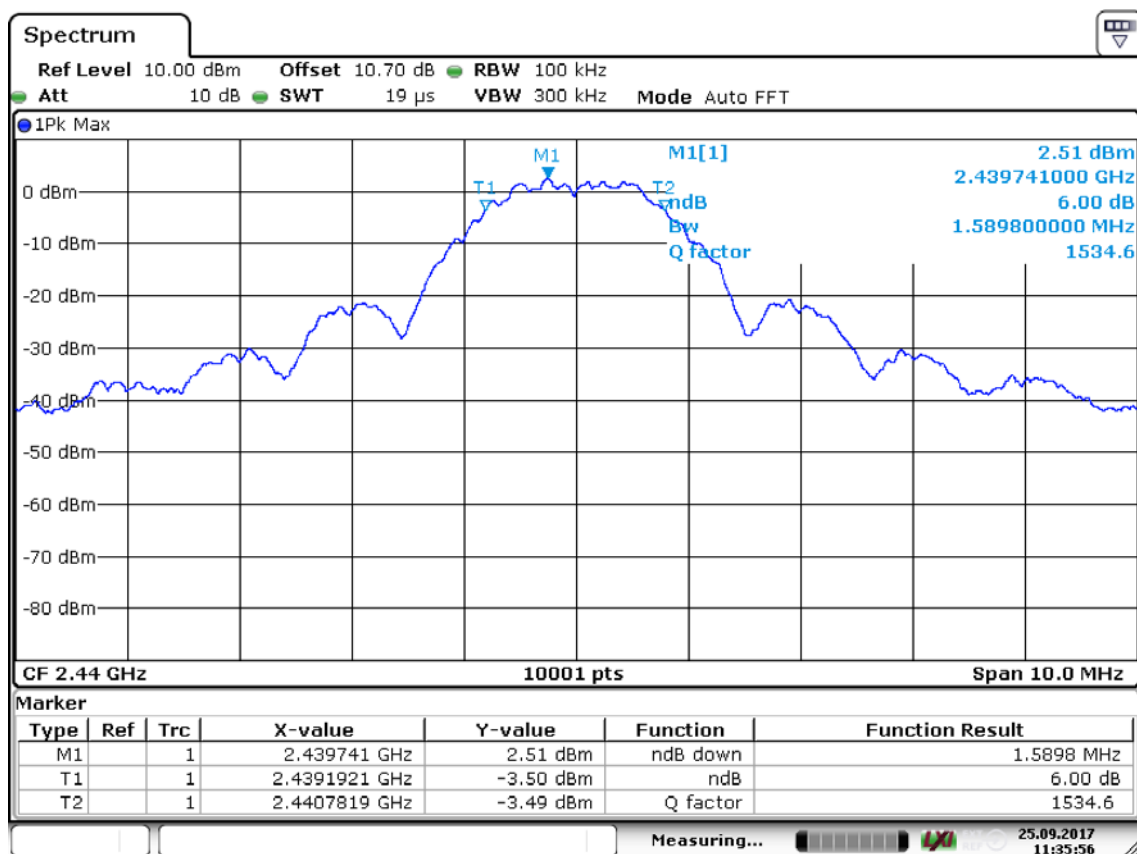
Reference: CFR 47§15.247(a)(2), RSS-247 5.2(1)
 The minimum 6 dB bandwidth shall be 500 kHz.

10.4 Test results



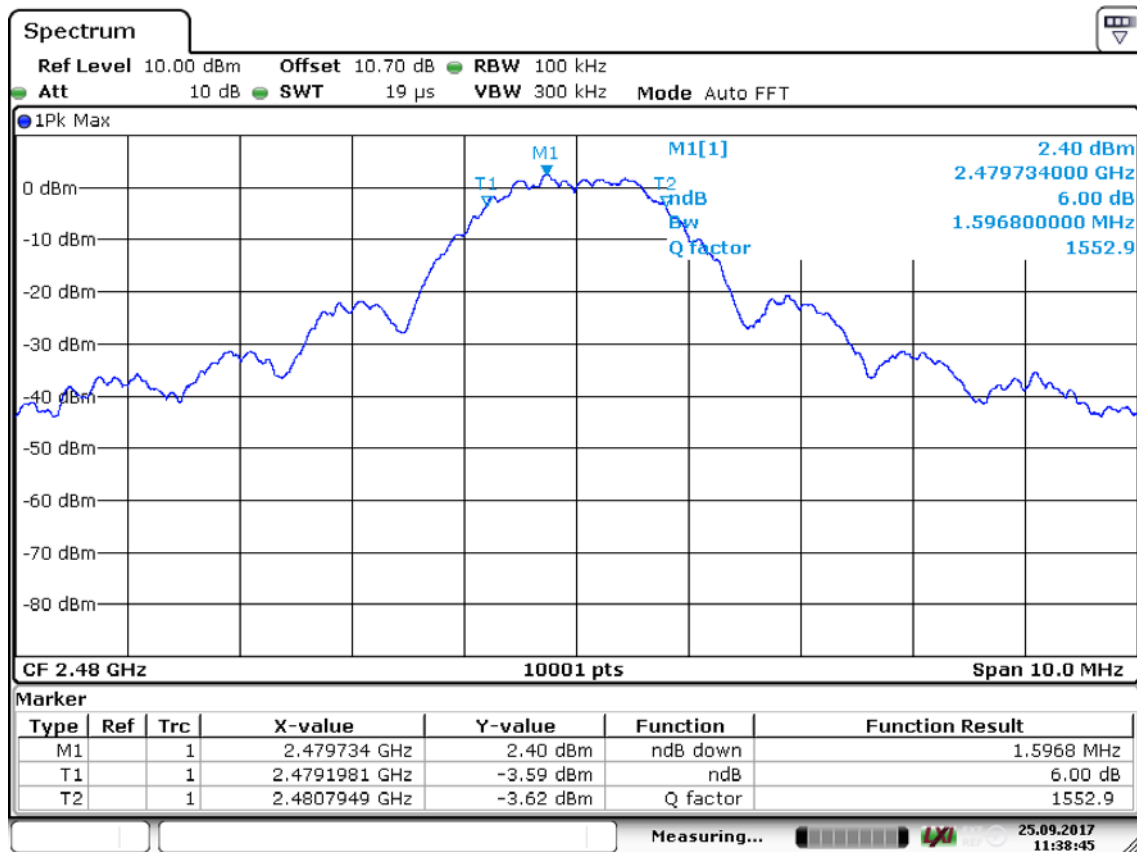
Date: 25.SEP.2017 11:32:50

Screenshot: Occupied 6 dB bandwidth Measurement, low channel



Date: 25.SEP.2017 11:35:57

Screenshot: Occupied 6 dB bandwidth Measurement, middle channel



Date: 25.SEP.2017 11:38:45

Screenshot: Occupied 6 dB bandwidth Measurement, high channel

Test result

Channel [MHz]	6 dB BW [MHz]
2405	1.6
2440	1.6
2480	1.6

11 PEAK POWER SPECTRAL DENSITY

Date of test:	2017-09-25	Test location:	Wireless Center
EUT number:	00.17.7A.01.02.04.97.48	Ambient temp:	23 °C
Tested by:	Robert Hietala	Relative humidity:	48 %
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

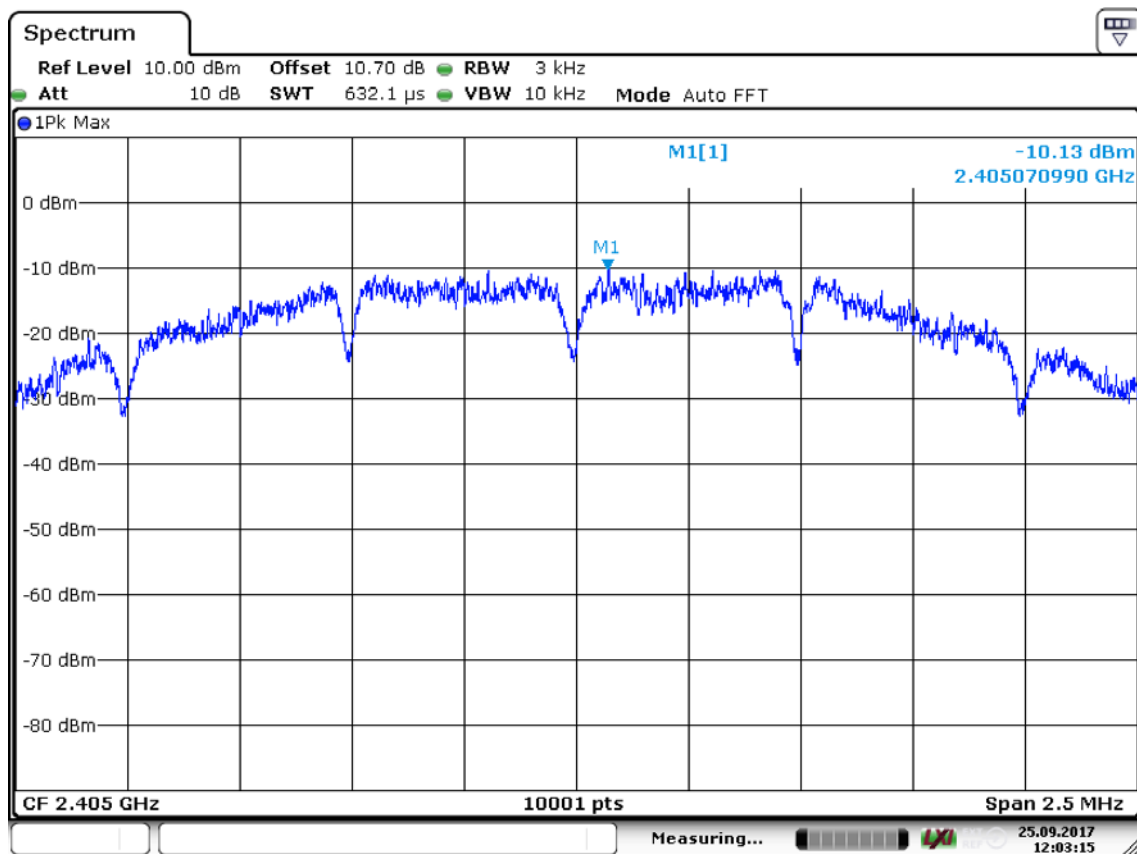
The EUT was set up in order to emit maximum disturbances.

11.3 Requirements

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

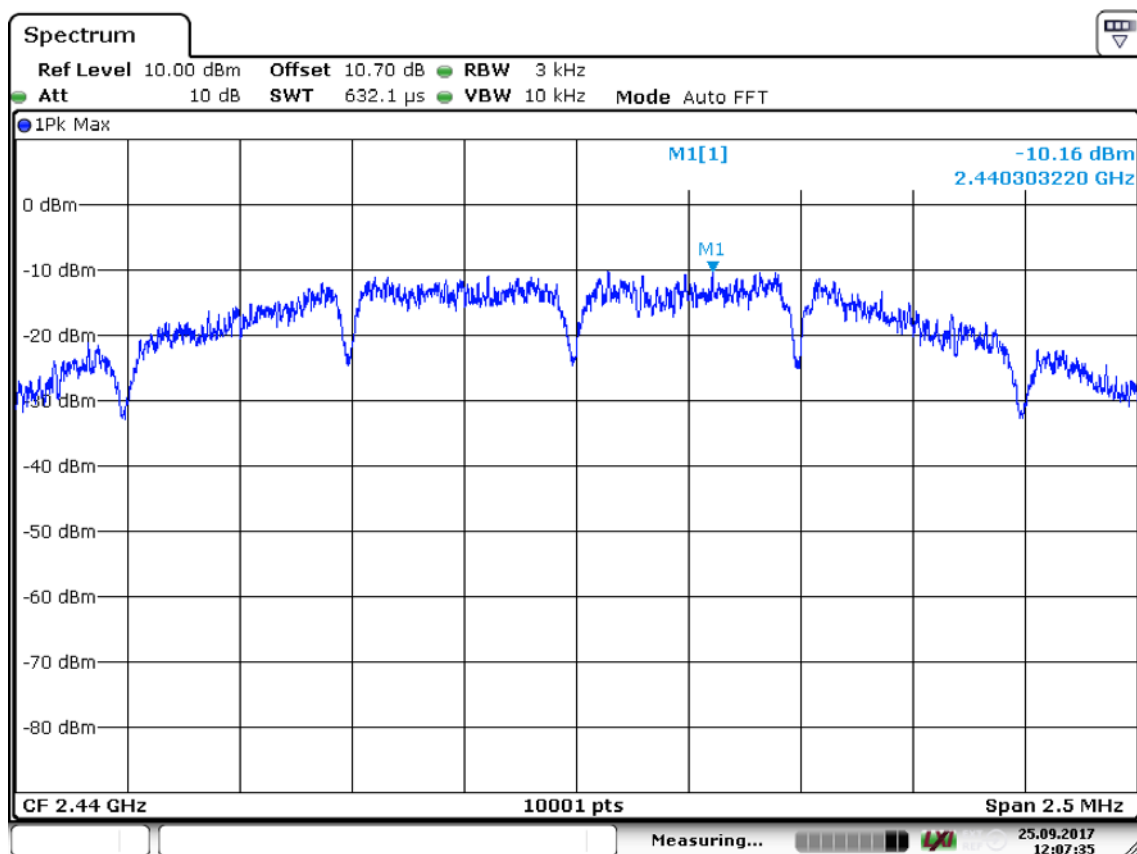
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

11.4 Test results



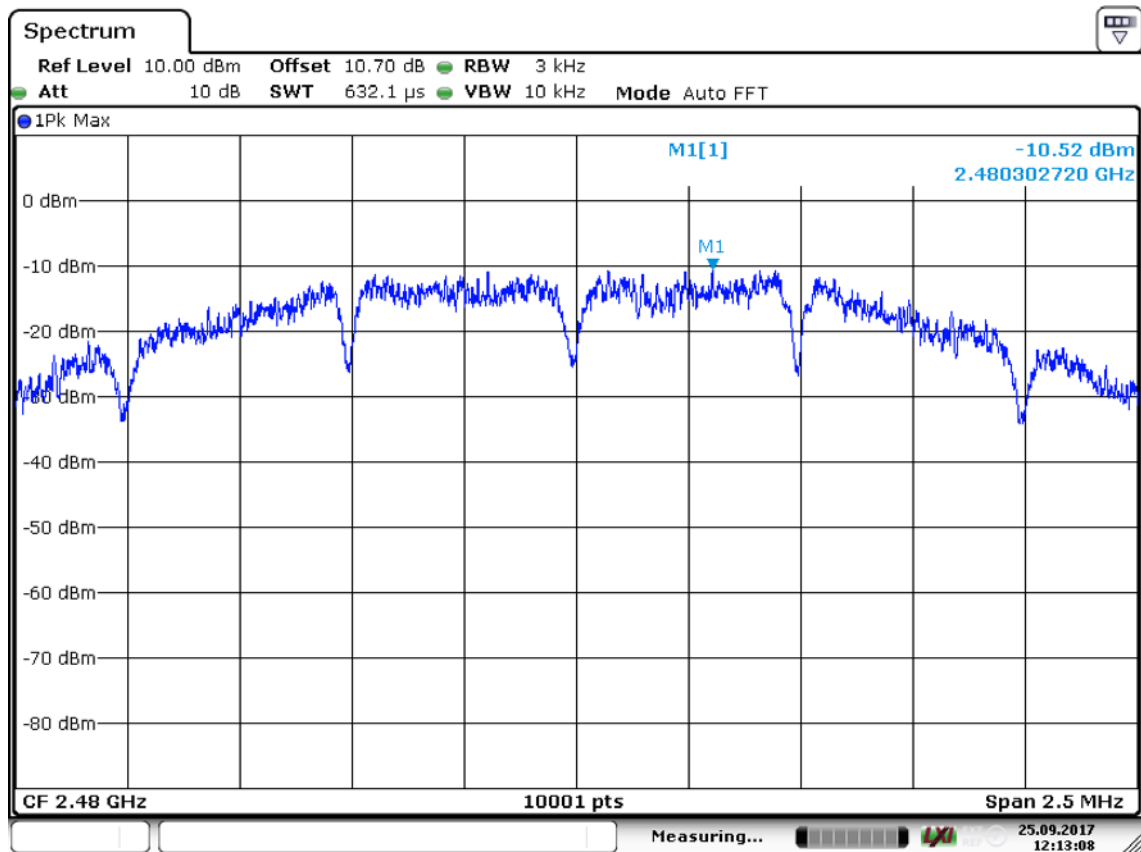
Date: 25.SEP.2017 12:03:16

Screenshot: Peak power spectral density, low channel



Date: 25.SEP.2017 12:07:35

Screenshot: Peak power spectral density, middle channel



Date: 25.SEP.2017 12:13:08

Screenshot: Peak power spectral density, high channel

Test result

Channel [MHz]	PSD [dBm/3kHz]
2405	-10.1
2440	-10.2
2480	-10.5

12 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 8	12866	07-2017	1 year
BiLog antenna	Chase	CBL 6111	8578	06-2016	3 years
Preamplifier	Semko	AM1331	30366	06-2017	1 year
Horn antenna	Rohde & Schwarz	HF907	31245	12-2016	3 years
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	07-2017	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	07-2017	1 year
10 dB attenuator	AEROFLEX / WEINSCHEL	46-10-34	9444	06-2016	2 years
Multimeter	Fluke	179	33105	10-2016	1 year

Wireless Center and 3m FAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - V9.21.0	--	--	--
Signal analyzer	Rohde & Schwarz	FSIQ 40	12793	07-2017	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	07-2017	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	07-2017	1 year
Signal generator:	Rohde & Schwarz	SMB100A	32592	07-2017	1 year
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	03-2017	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	08-2017	1 year
Multimeter	Fluke	179	33105	10-2016	1 year

3m SAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 9	--	--	--
Receiver	Rohde & Schwarz	ESU40	13178	July-2017	1 year
Receiver	Rohde & Schwarz	ESIB26	32288	July-2017	1 year
Horn antenna with preamplifier	Bonn	31247	4936	Jan-2017	3 years
Antenna	Rohde & Schwarz	HL562	30711	Dec-2014	3 years
Coaxial cable	Huber + Suhner	Sucoflex 104	39138	July-2017	1 year
Coaxial cable	Huber + Suhner	Sucoflex 104	39131	July-2017	1 year
Preamplifier	Rohde & Schwarz	TS-PRE1	32306	July-2017	1 year
Horn antenna	Bonn	BLMA	31247	Jan-2017	3 years
Coaxial cable	Huber+Suhner	Sucoflex	39057	April-2017	1 year
Coaxial cable	Huber+Suhner	Sucoflex	39054	April-2017	1 year
Coaxial cable	Huber+Suhner	Sucoflex	39057	April-2017	1 year
Horn antenna	Rohde & Schwarz	HF907	32307	July-2017	3 years
Preamplifier	Rohde & Schwarz	TS-Pre1	32306	July-2017	3 years

13 MEASUREMENT UNCERTAINTY

Continuous conducted disturbances with AMN in the frequency range 9 kHz to 30 MHz ± 3.7 dB

Measurement uncertainty for radiated disturbance

Uncertainty for the frequency range 30 to 1000 MHz at 3 m	± 5.1 dB
Uncertainty for the frequency range 30 to 1000 MHz at 10 m	± 5.0 dB
Uncertainty for the frequency range 1.0 to 18 GHz at 3 m	± 4.7 dB
Uncertainty for the frequency range 18 to 26 GHz at 3 m	± 4.8 dB
Uncertainty for the frequency range 26 to 40 GHz at 3 m	± 5.7 dB

Measurement uncertainty is calculated in accordance with CISPR 16-4-2:2011.

The measurement uncertainty is given with a confidence of 95 %.

14 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1712544STO-003 Annex 1.

Test set up photos are in separate document 1712544STO-003 Annex 2.