

RADIO TEST REPORT

No. 2300614STO-101

RF Performance

EQUIPMENT UNDER TEST

Equipment: Survey equipment
Type/Model: SX12-200
Manufacturer: Trimble AB
Tested by request of: Trimble AB

SUMMARY

All selected test cases specified in this report comply with the requirements according to the following standard:

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 1 GHz – 26.5 GHz and band edge has been tested by request of the client.

Date of issue: March 15, 2023

Tested by: 
Tsegereda Gebrehiwet

Approved by: 
Björn Utermöhl

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Revision History

Test report number	Date	Description Pass/Fail	Changes
2203630STO-101	July 11, 2022	First release	
2300614STO-101	February 6, 2023	Second release	Section 4 is updated with antenna description information to be consistent with the antenna information given in section 2.1. The EUT radio module information has been updated in section 2.2.
2300614STO-101	March 15, 2023	Third release	Section 5.4 tables of measurement results are updated with correction factors.

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company Trimble AB
Box 64
Rinkebyvägen 17
182 11 Danderyd Sweden

Name of contact Mikael Ohlsson
Phone: +46 76335 54 70

Client observer Mikael Ohlsson

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: Survey equipment
Type/Model: SX12-200
Brand name: Trimble
Serial number: 55302134
Manufacturer: Trimble AB
Transmitter frequency range: 2412 – 2462 MHz (2422 – 2452 MHz for HT 40/MCS0 modulation)
Receiver frequency range: 2412 – 2462 MHz (2422 – 2452 MHz for HT 40/MCS0 modulation)
Number of channels: 11 (7 for HT 40/MCS0 modulation)
Antenna: ☐ Internal antenna ☒ External antenna
Antenna connector: ☐ None, internal antenna ☒ Yes, reversed TNC connector
Peak antenna gain:¹ +1.7 dBi
Declared RF output power:¹ +18 dBm (EIRP)
Types of modulation: No HT/9MBps/802.11G/OFDM, (disabled HT mode)
CCK/1MBps/802.11b/DSSS
HT 20/MCS0
HT 40/MCS0
Transmitter stand by mode supported: ☐ Yes ☒ No

¹Declared by Trimble AB

2.2 Additional information about the EUT

The EUT is a Land Surveying Equipment that supports WLAN 2.4 GHz.

During the tests the EUT supported following software:

Software	Version	Comment
DUT SW	S2.3.11	For radiated testing

The EUT radio module information is given in the table below:

Wi-Fi module	
Manufacturer:	Trimble AB
Model:	PMACS
Company Name:	Trimble Europe BV
FCC ID:	NZI-PMACS
IC certificate:	9288A-PMACS

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 PC	Dell Precision 5520	Dell	--
DC Battery	Li-ion 10.8 V	Trimble	99511-30

2.4 Test signals and operation modes

All tests are made with EUT in continuous transmission mode on four different modulation types.

The tests were performed on the following channels and modulation types:

No HT/9MBps/802.11G/OFDM:

Low Channel = 2412 MHz

Middle Channel = 2437 MHz

High Channel = 2462 MHz

CCK/1MBps/802.11b/DSSS:

Low Channel = 2412 MHz

High Channel = 2462 MHz

HT 20/MCS0:

Low Channel = 2412 MHz

High Channel = 2462 MHz

HT 40/MCS0:

Low Channel = 2422 MHz

Middle Channel = 2437 MHz

High Channel = 2452 MHz

The following tables show the tests that were performed on the different modulation types and measured duty cycle:

Note: The two modulations selected for spurious emission measurements were considered to be the worst case, as in the original radio module test report.

Test	Modulation type	Frequency range	Channels
Transmitter spurious emission	No HT/9MBps/802.11G/OFDM	1-13 GHz	Low Channel
		1-13 GHz	Middle Channel
		1-26 GHz	High Channel
	HT 40/MCS0	1-13 GHz	Low Channel
		1-13 GHz	Middle Channel
		1-26 GHz	High Channel

Test	Modulation type	Channels	Max duty cycle
Band edge	No HT/9MBps/802.11G/OFDM	Low Channel	92 %
		High Channel	
	CCK/1MBps/802.11b/DSSS	Low Channel	99 %
		High Channel	
	HT 20/MCS0	Low Channel	95 %
		High Channel	
	HT 40/MCS0	Low Channel	90 %
		High Channel	

2.5 Modifications made to improve EMC-characteristics

No modifications have been made during the tests

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 spurious emission transmit mode 1 GHz – 26.5 GHz has been tested by request of the client.

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

3.3 Decision rule

The statements of conformity are reported as:

Passed – When the measured values are within the specified limits.

Failed – When one or more measures values are outside the specified limits

3.4 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

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 FCC §15.247 (b)(4) RSS-247 5.4(4), 5.4(5)	Antenna	PASS
	The EUT has an external antenna which can be removed without breaking the EUT. The antenna gain is less than 6 dBi	
FCC Part 15.205 RSS-GEN 8.10	Restricted bands of operations	PASS
	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 2412 – 2462 MHz and 2422 – 2452 MHz frequency bands.	
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
	Not tested by request of the client.	
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
	Not tested by request of the client.	
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	PASS
	The EUT complies with the limits. The margin to the limit was at least 14.2 dB at 2500.5 MHz. See clause 5.4.	
FCC §15.247(a)(2) RSS-GEN 6.6 RSS-247 5.2(1)	Occupied bandwidth	NT
	Not tested by request of the client.	
FCC §15.247(b) RSS-247 5.4(4)	Conducted output power	NT
	Not tested by request of the client.	
FCC §15.247(e) RSS-247 5.2(2)	Peak power spectral density	NT
	Not tested by request of the client.	
FCC §15.247(e) RSS-247 5.5	Conducted Band edge	NT
	Not tested by request of the client.	

5 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 1 GHZ TO 26.5 GHZ

Date of test:	May 5/16/19, 2022	Test location:	Radiohallen
EUT Serial:	55302134	Ambient temp:	22 °C
Tested by:	Tsegereda Gebrehiwet, Ala El-Haery	Relative humidity:	37 %
Test result:	Pass	Margin:	> 14.2 dB

5.1 Test set-up and test procedure.

The test method is in accordance with KDB 558074 D01 v05r02 and ANSI C63.10-2013.

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

Transmit mode, 1 – 26.5 GHz: The EUT was placed 1.5 m above the floor in a stand-up position.

Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 1 – 26.5 GHz. Additionally the average detector was 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

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, §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

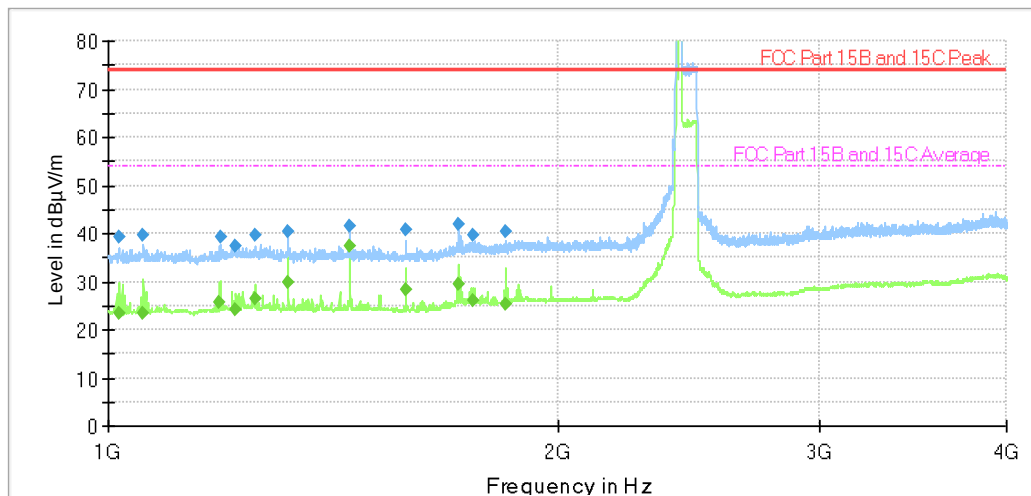
The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit.
(i.e. an extrapolation factor of 20 dB/decade according to CFR 47 §15.31(f)(1))

Outside the restricted bands:

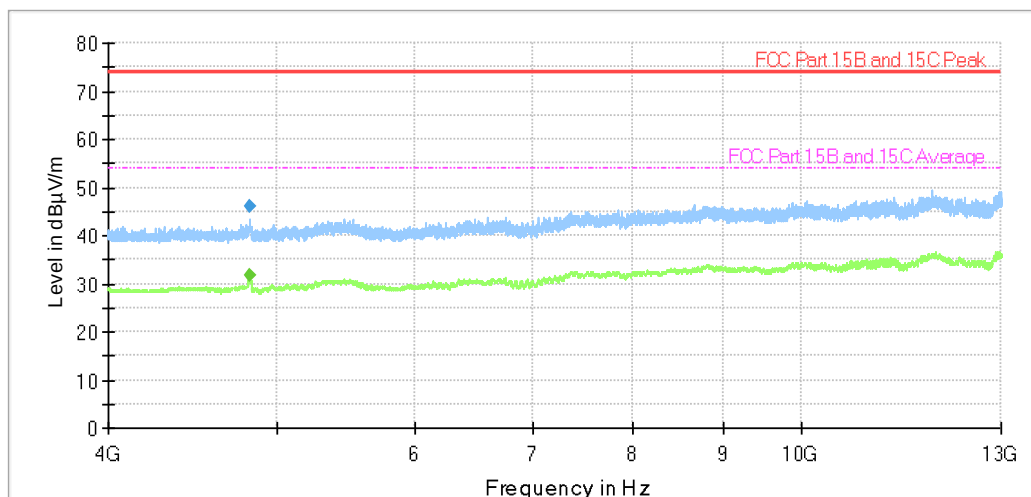
Reference: CFR 47 §15.247(d), RSS-247 5.5,

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.

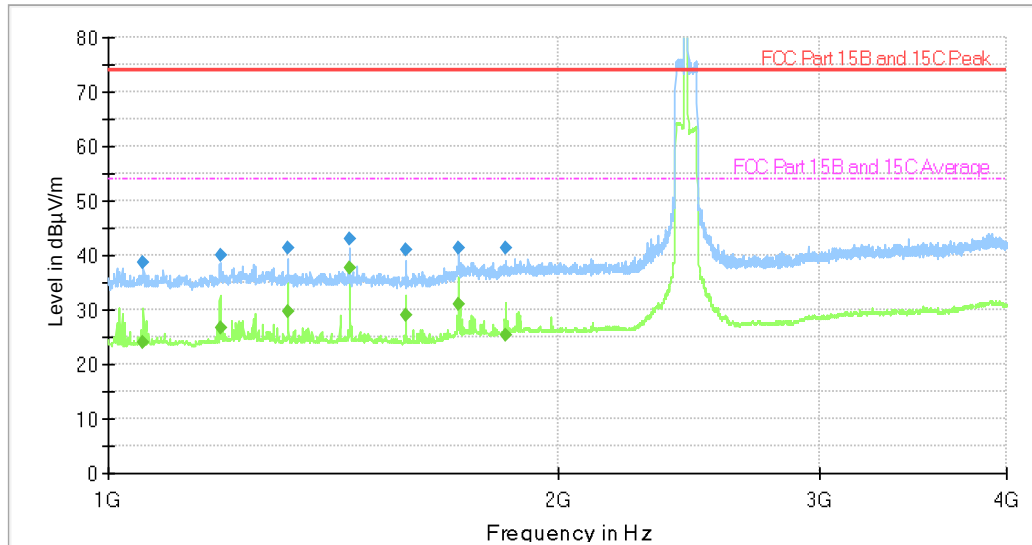
5.4 Test results 1 GHz – 26.5 GHz, TX



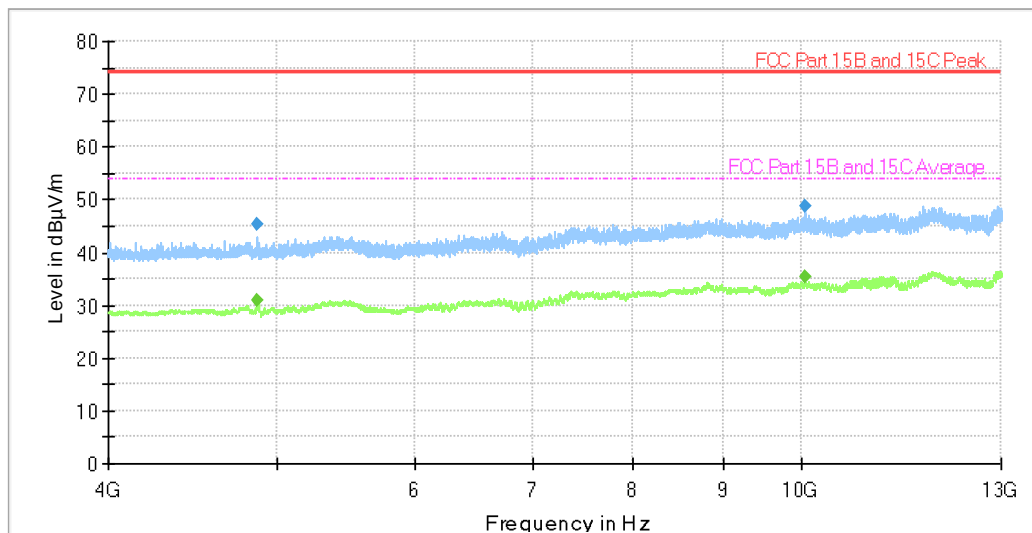
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel, No HT/9MBps/802.11G/OFDM. Carrier is attenuated by band rejection filter.



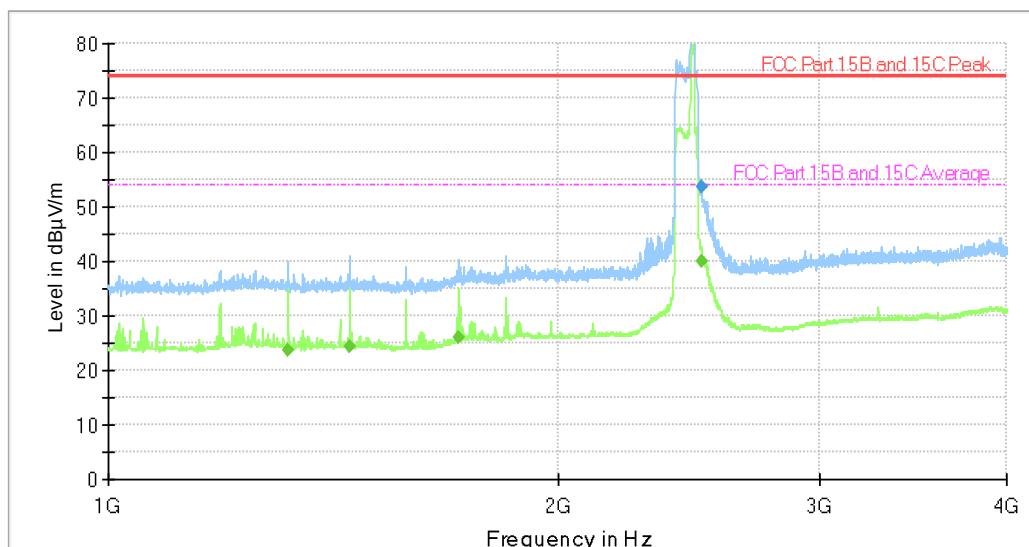
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel, No HT/9MBps/802.11G/OFDM. Emissions below 4000 MHz are attenuated by high-pass filter.



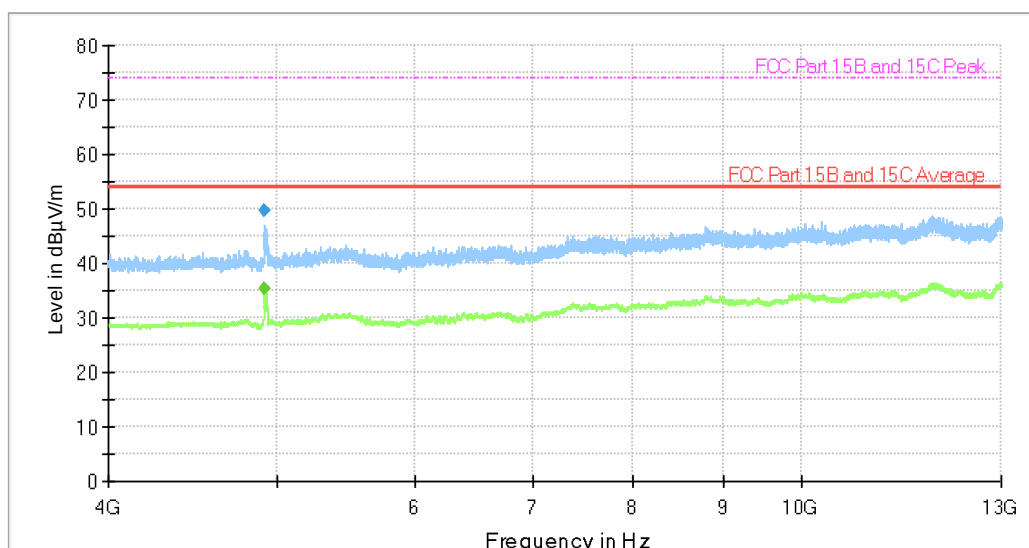
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX middle channel, No HT/9MBps/802.11G/OFDM. Carrier is attenuated by band rejection filter.



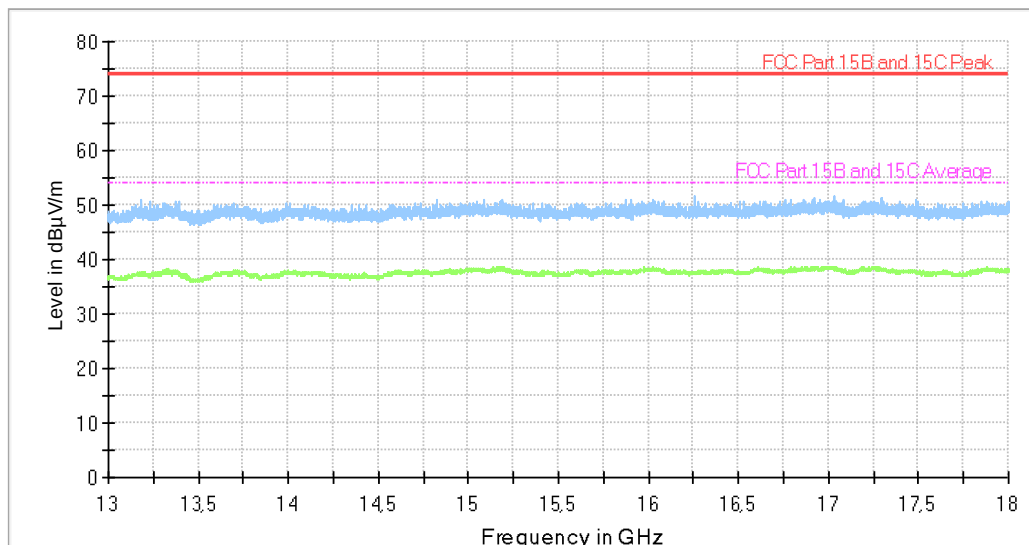
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX middle channel, No HT/9MBps/802.11G/OFDM. Emissions below 4000 MHz are attenuated by high-pass filter.



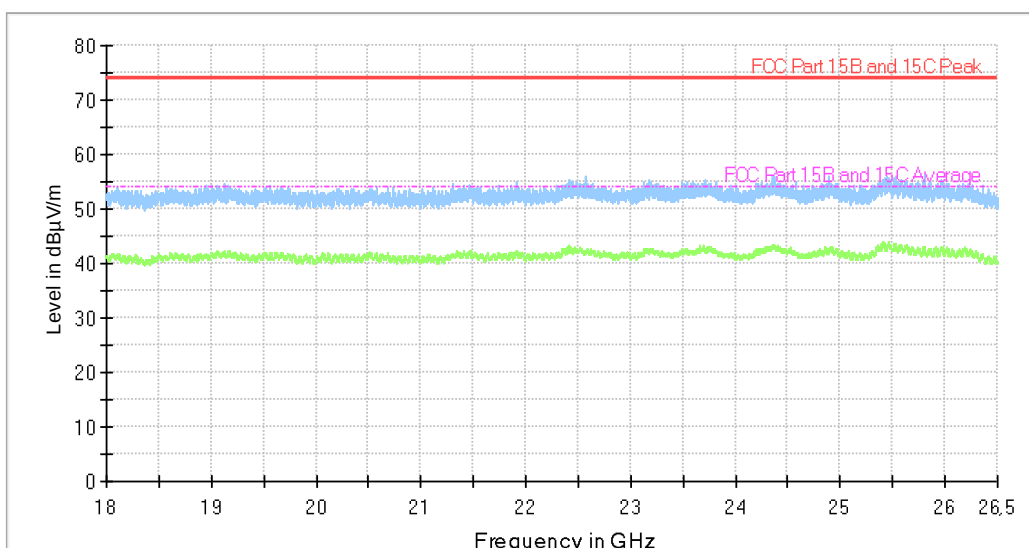
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel, No HT/9MBps/802.11G/OFDM. Carrier is attenuated by band rejection filter.



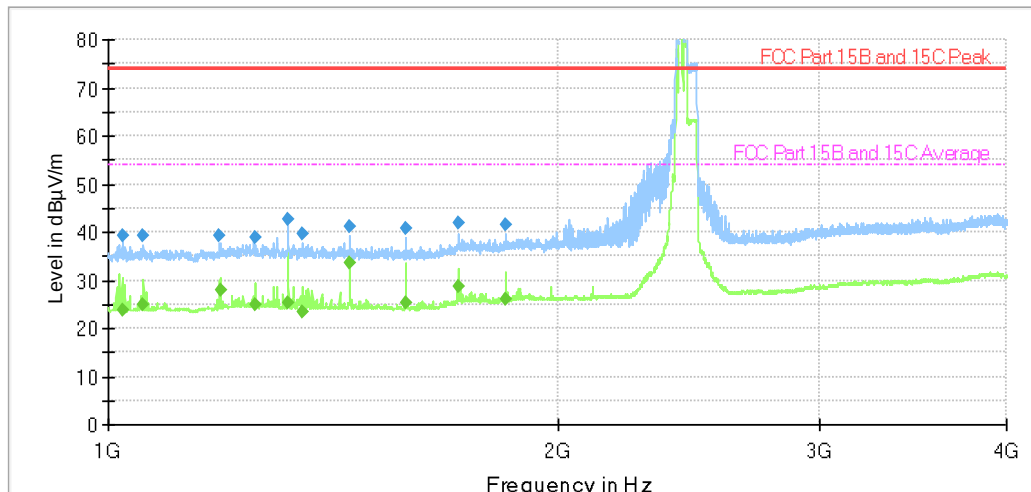
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel, No HT/9MBps/802.11G/OFDM. Emissions below 4000 MHz are attenuated by high-pass filter.



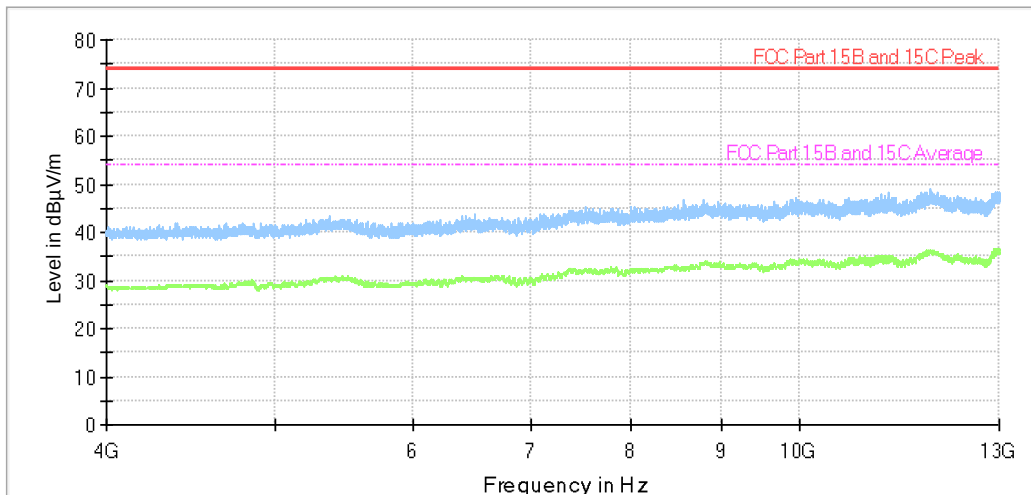
Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX high channel, No HT/9Mbps/802.11G/OFDM.



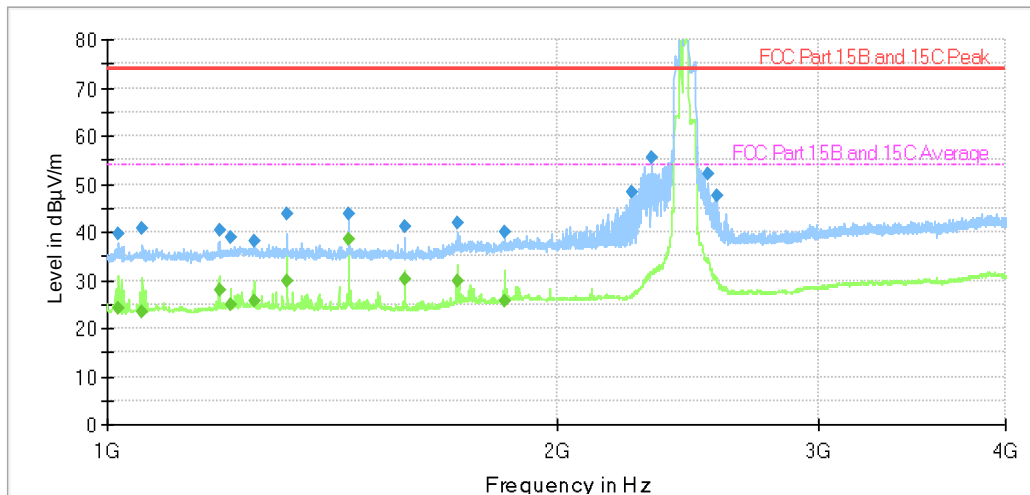
Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. TX high channel, No HT/9Mbps/802.11G/OFDM.



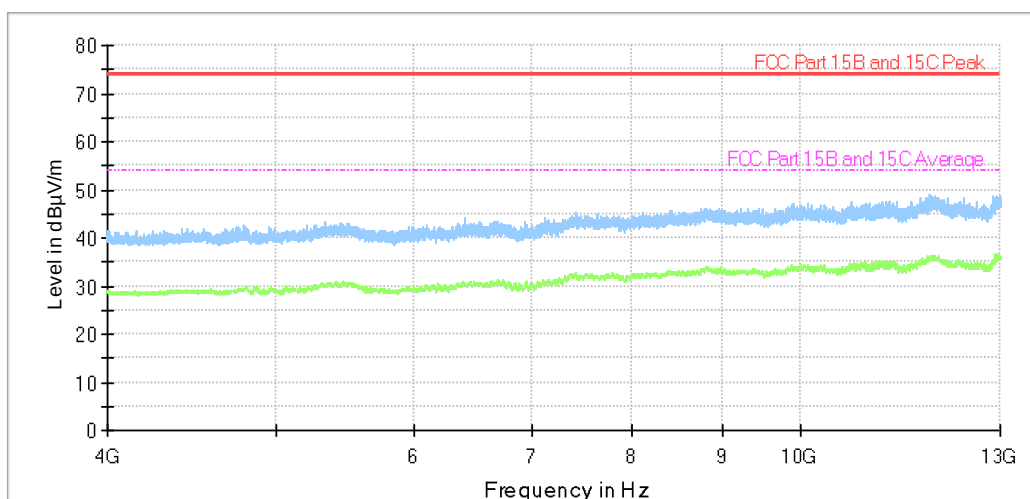
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX low channel, HT 40/MCS0. Carrier is attenuated by band rejection filter.



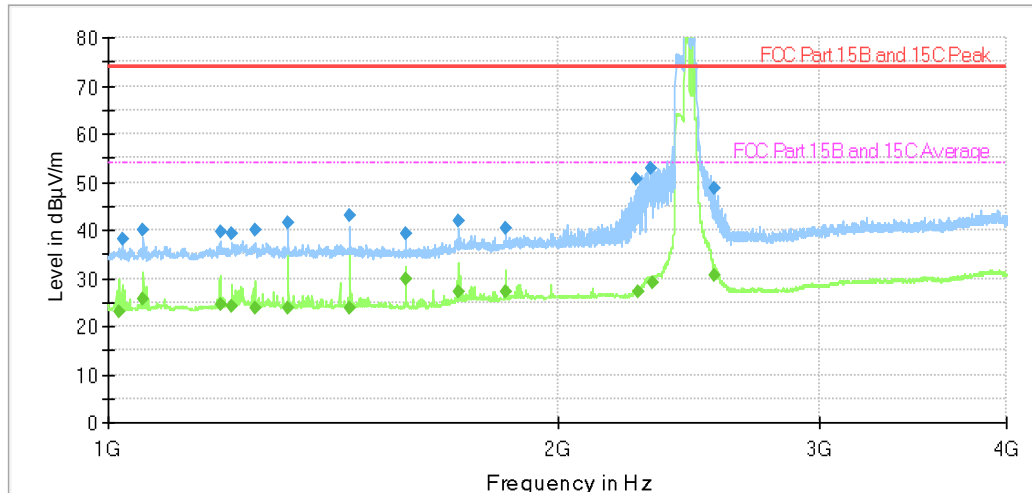
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX low channel, HT 40/MCS0. Emissions below 4000 MHz are attenuated by high-pass filter.



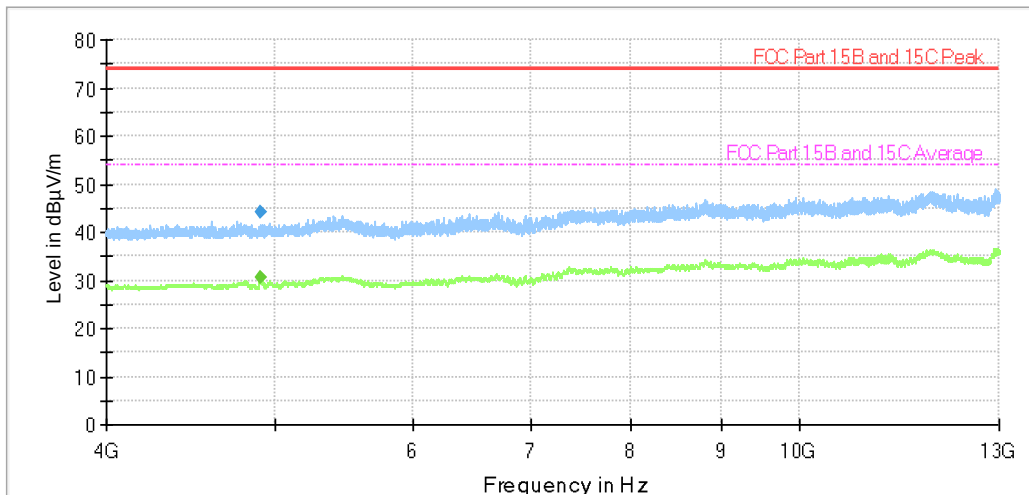
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX middle channel, HT 40/MCS0. Carrier is attenuated by band rejection filter.



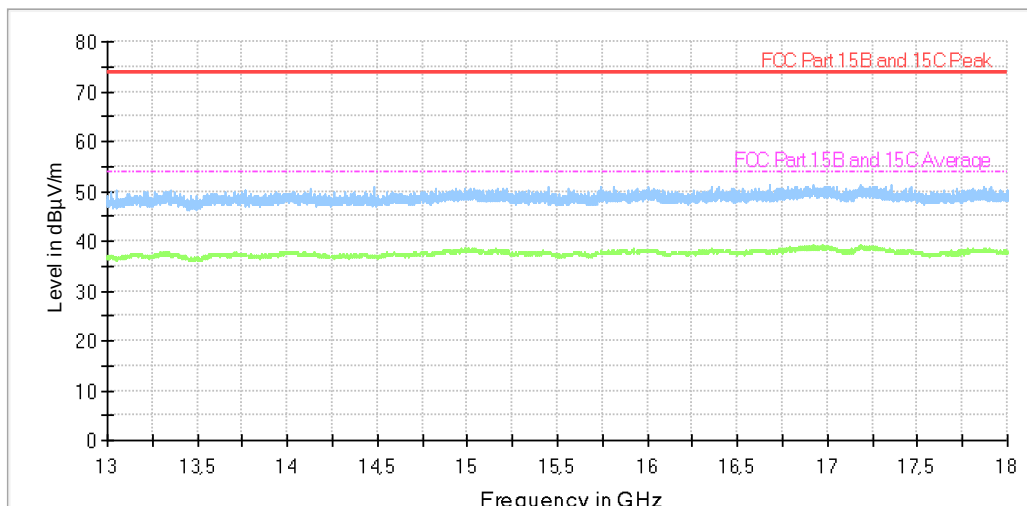
Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX middle channel, HT 40/MCS0. Emissions below 4000 MHz are attenuated by high-pass filter.



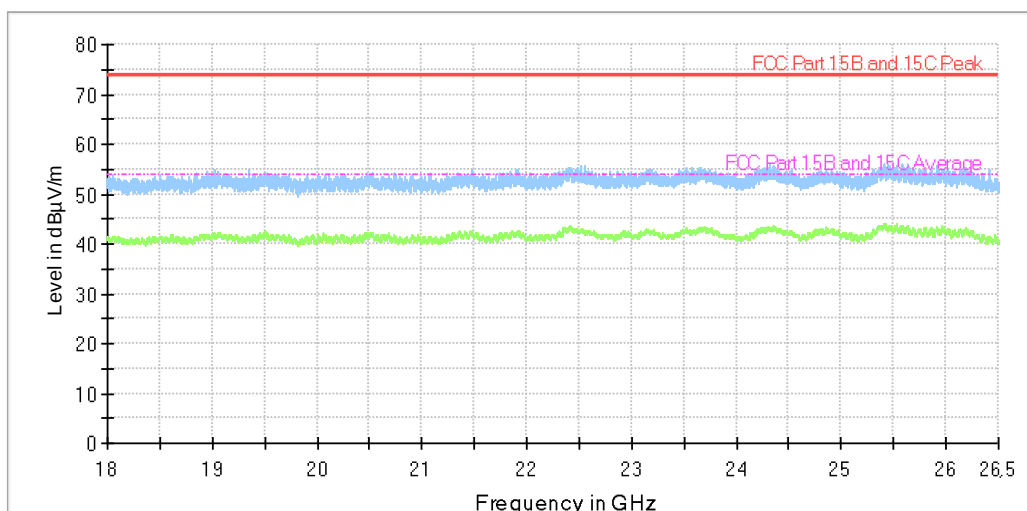
Diagram, Peak overview sweep, 1– 4 GHz at 3 m distance. TX high channel, HT 40/MCS0. Carrier is attenuated by band rejection filter.



Diagram, Peak overview sweep, 4– 13 GHz at 3 m distance. TX high channel, HT 40/MCS0. Emissions below 4000 MHz are attenuated by high-pass filter.



Diagram, Peak overview sweep, 13 – 18 GHz at 3 m distance. TX high channel, HT 40/MCS0.



Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. TX high channel, HT 40/MCS0.

Measurement results, Average, TX low channel, No HT/9MBps/802.11G/OFDM

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Corr. (dB/m)
1452.0	37.3	54	V	16.7	-10

Measurement results, Average, TX middle channel, No HT/9MBps/802.11G/OFDM

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Corr. (dB/m)
1452.0	37.7	54	V	16.3	-10
10030.5	35.5	54	V	18.5	5

Measurement results, Average, TX high channel, No HT/9MBps/802.11G/OFDM

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2500.5	39.8	54	V	14.2	-6
4921.0	35.2	54	V	18.8	-4

Measurement results, Peak, TX middle channel, HT 40/MCS0

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2317.5	55.6	74	V	18.4	-7

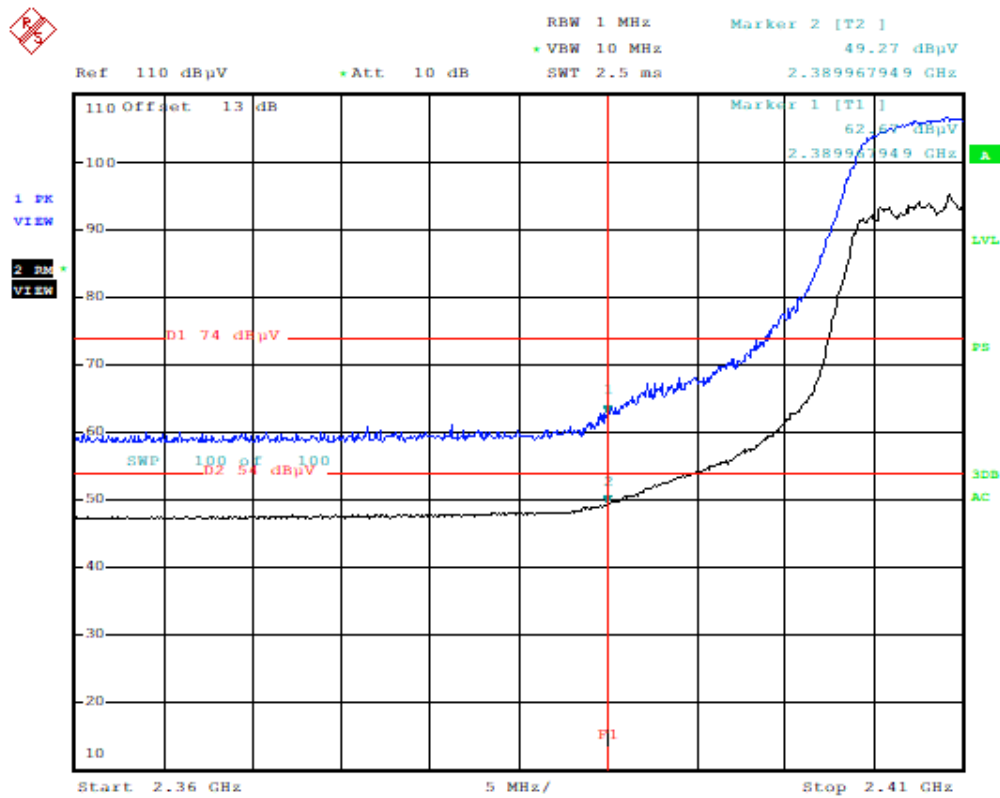
Measurement results, Average, TX middle channel, HT 40/MCS0

Frequency [MHz]	Level [dBμV/m]	Limit [dBμV/m]	Polarization H/V	Margin [dB]	Corr. (dB/m)
1452.0	38.7	54	V	15.3	-10

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]

Measurement results of Band Edge, TX low channel, No HT/9MBps/802.11G/OFDM



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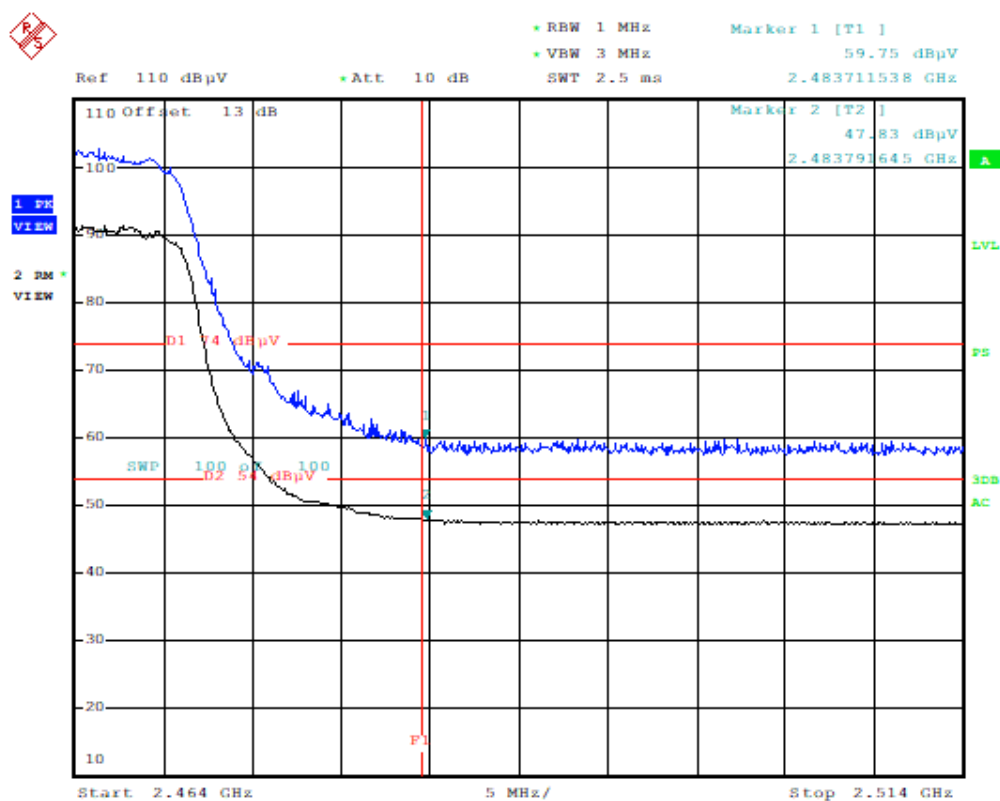
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.96	62.67	74.0	V	11.33	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.96	49.27	54.0	V	4.73	13

Measurement results of Band Edge, TX high channel, No HT/9MBps/802.11G/OFDM



Date: 22.JUN.2022 17:50:01

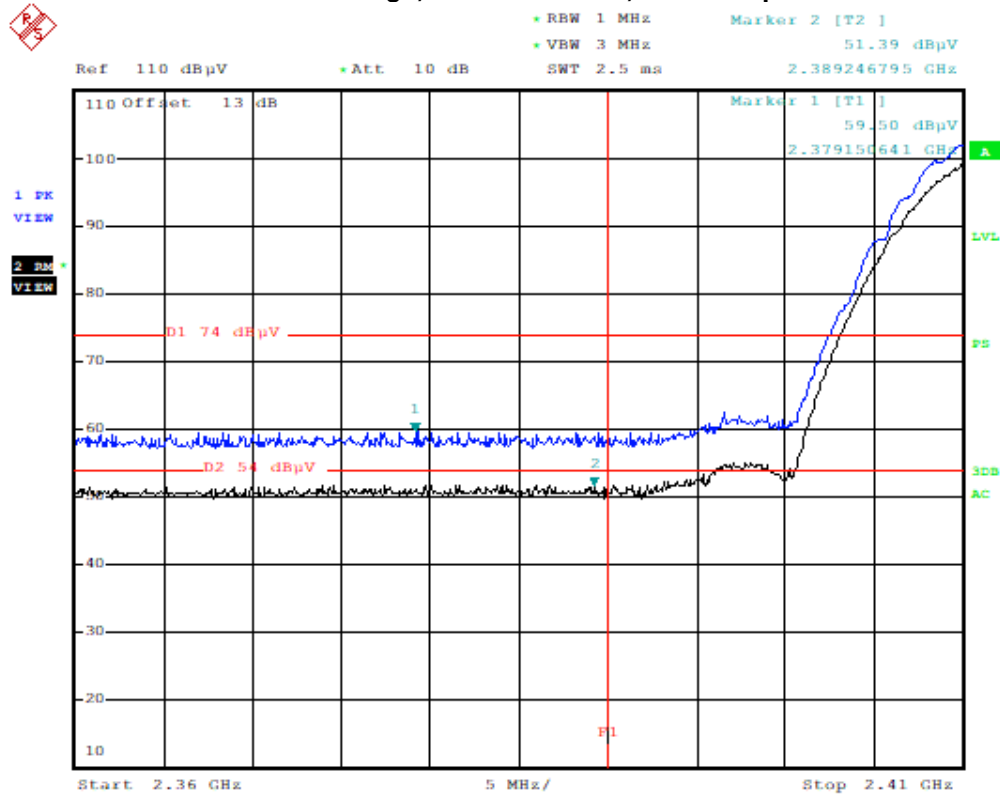
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2483.71	59.75	74.0	V	14.25	13

Measurement results, Average (trace average)

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2483.79	47.83	54.0	V	6.17	13

Measurement results of Band Edge, TX low channel, CCK/1MBps/802.11b/DSSS



Date: 22 JUN 2022 16:29:59

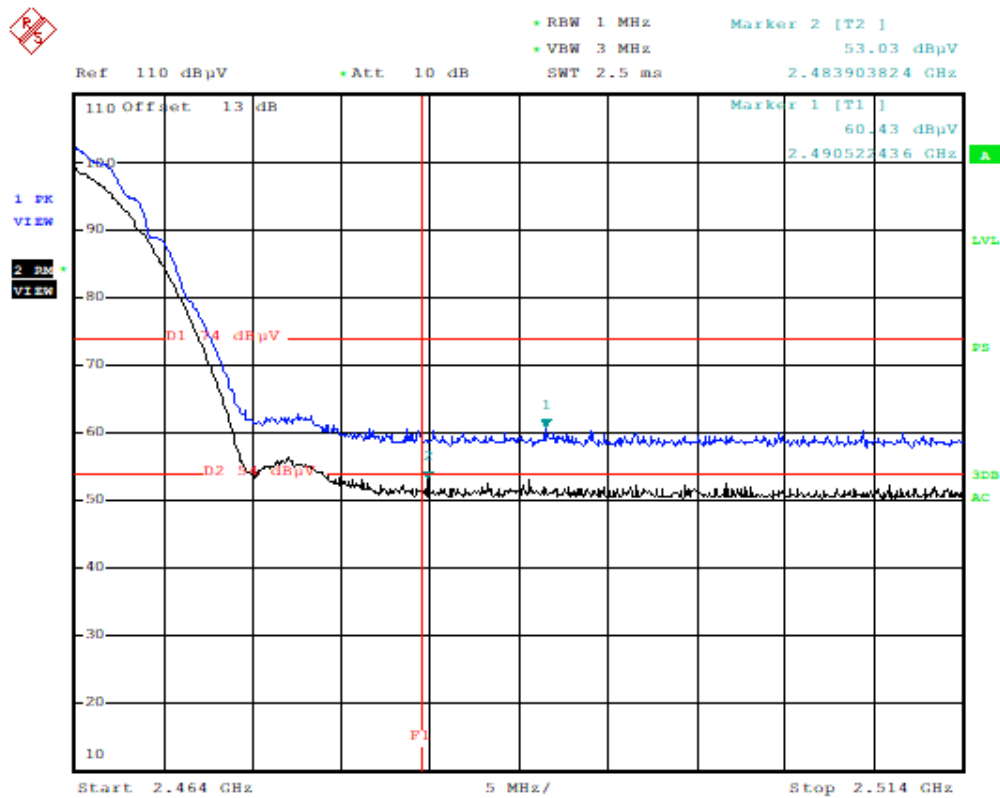
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2379.15	59.50	74.0	V	14.50	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.25	51.39	54.0	V	2.61	13

Measurement results of Band Edge, TX high channel, CCK/1MBps/802.11b/DSSS



Date: 22 JUN 2022 18:07:58

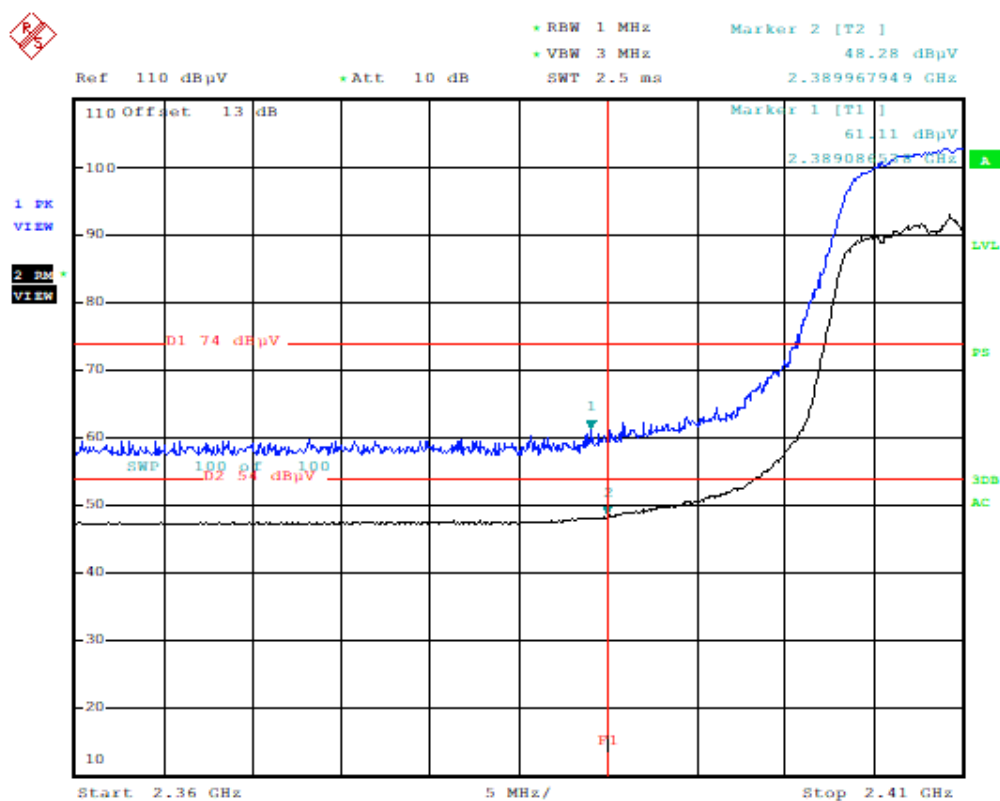
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2490.52	60.43	74.0	V	13.57	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2483.90	53.03	54.0	V	0.97	13

Measurement results of Band Edge, TX low channel, HT 20/MCS0



Date: 22 JUN 2022 15:50:22

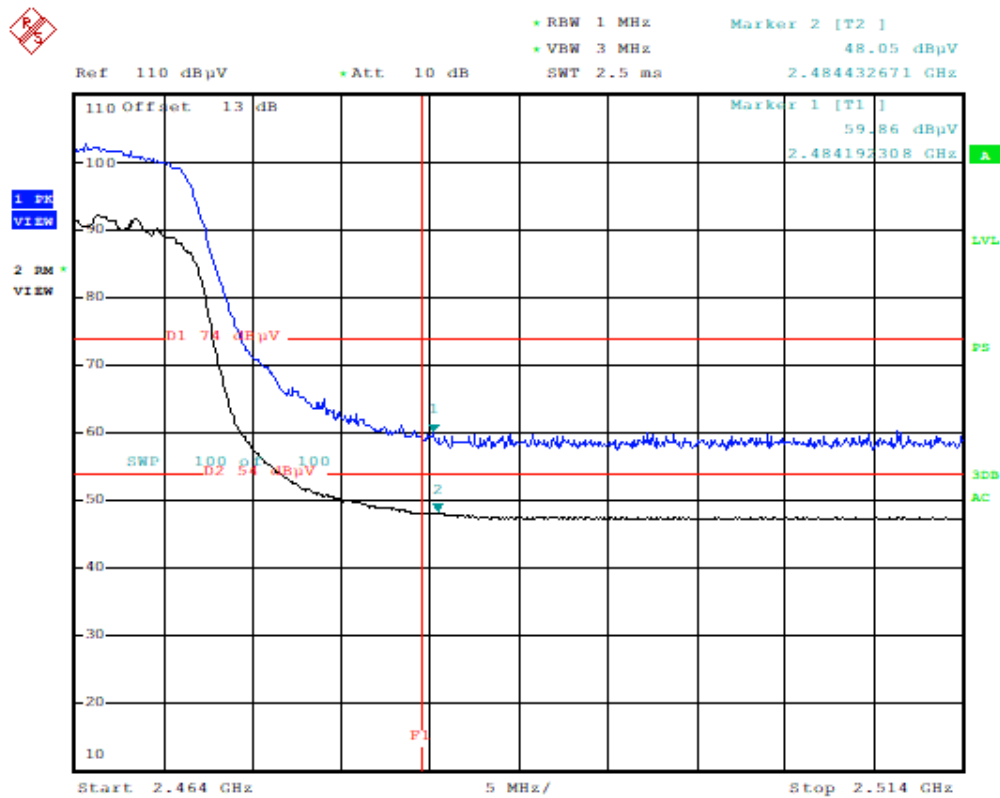
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.10	61.11	74.0	V	12.89	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.98	48.28	54.0	V	5.72	13

Measurement results of Band Edge, TX high channel, HT 20/MCS0



Date: 22. JUN. 2022 17:58:31

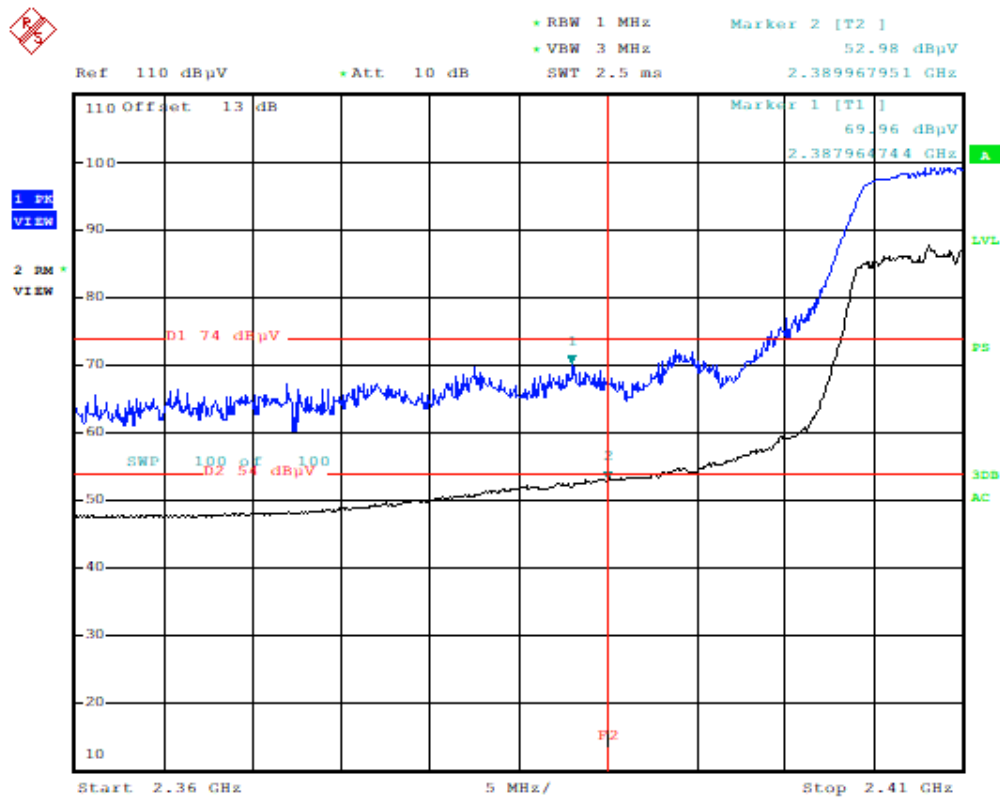
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2484.19	59.86	74.0	V	14.14	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2484.43	48.05	54.0	V	5.95	13

Measurement results of Band Edge, TX low channel, HT 40/MCS0



Date: 22 JUN 2022 17:11:31

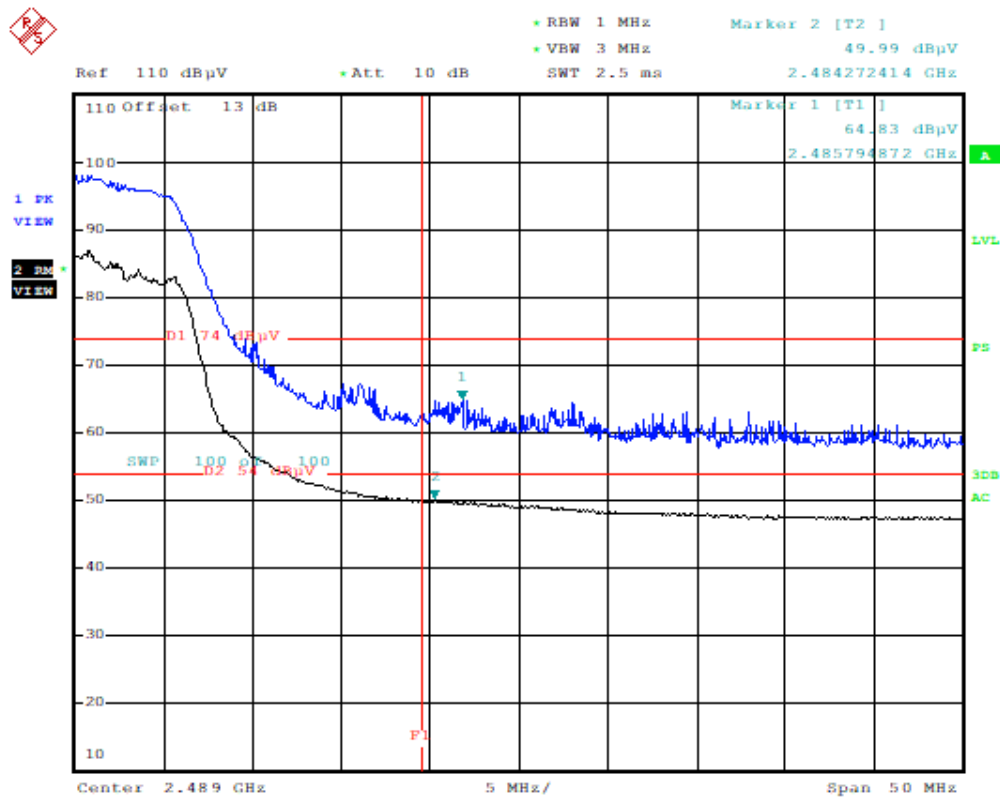
Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2387.96	69.96	74.0	V	4.0	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2389.96	52.98	54.0	V	1.02	13

Measurement results of Band Edge, TX high channel, HT 40/MCS0



Date: 22 JUN 2022 17:39:13

Measurement results, Peak

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2485.79	64.83	74.0	V	9.17	13

Measurement results, Average

Frequency [MHz]	Level [dBμV]	Limit [dBμV]	Polarization H/V	Margin [dB]	Corr. (dB/m)
2484.27	49.99	54.0	V	4.01	13

6 TEST EQUIPMENT

Radiohallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - Version 11.30.00	--	--	--
Measurement Receiver	Rohde & Schwarz	ESU 40	13178	July-2021	1 year
Preamplifier	Sangus	00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	July-2021	1 year
Horn antenna	EMCO	3160-08	30099	August-2020	3 years
Horn antenna	EMCO	3160-09	30101	August-2020	3 years
Horn antenna	EMCO	3115	4936	September-2020	3 years
10 dB Attenuator:	Huber+Suhner	5910_N-50-010	32696	April-2022	1 year
20 dB Attenuator:	Telegärtner GMBH	J01026A0021	32695	April-2022	1 year
Coaxial cable	Huber+Suhner	SUCOFLEX 104	39119	July-2021	1 year
Coaxial cable	Huber+Suhner	SUCOFLEX 102	39136	July-2021	1 year
Coaxial cable	Huber+Suhner	SUCOFLEX 102	39138	July-2021	1 year
Coaxial cable	Rosenberger	LU7-S074-500 (UFA210A)	39169	July-2021	1 year
Coaxial cable	Huber+Suhner	SUCOFLEX 104	5179	September-2021	1 year
4 GHz high pass filter	Wainwright Instr. GmbH	WHKX12-3085.5-3300-18000-40SS	33939	September-2021	1 year
2,4 GHz band reject filter	Wainwright Instr. GmbH	WRCGV10-2381-2401-2479-2499-40SS	33938	September-2021	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 2203630STO-102.

Test set up photos are in separate document 2203630STO-103.