

ISED CABid: ES1909

Test Report No:
NIE: 67442RRF.001

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

(*) Identification of item tested	Communications device
(*) Trademark	Ring LLC
(*) Model and /or type reference	5AT3T3
Other identification of the product	FCC ID: 2AEUPBHAXN001 IC: 20271-BHAXN001
(*) Features	--
Applicant	Ring LLC 1523 26th Street, Santa Monica, 90404, California, United States
Test method requested, standard	USA FCC Part 15.247 (10-1-20 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-20 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 amendment 1 (March 2019). Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Manuel Gómez Industrial & Automotive EMC Lab. Manager 
Date of issue	2021-08-26
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

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DEKRA Testing and Certification S.A.U. is an FCC-recognized accredited testing laboratory with the appropriate scope of accreditation that covers the performed tests in this report.

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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the model number 5AT3T3 is a communications device.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of result.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Reception
67442/033	Communications Device	5AT3T3	GBC1ES0012150057	2021/05/28
67442/034	AC/DC Power Adapter	DSA-36PDB FUS	GB51PR0110770007	2021/05/28

Sample S/01 has undergone the test(s): The tests indicated in the Appendixes A, B, C.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient		
	AC power port	>3m	Yes	No			
	USB power port	<3m	Yes	Yes			
	Ethernet ports	>3m	Yes	No			
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	X	AC: 110V (60Hz).	X			X	
	X	DC: 12V, 3A					
Rated Power	Not provided.						
Clock frequencies.....	Not provided.						
Other parameters	Not provided.						
Software version	Not provided.						
Hardware version	Not provided.						
Dimensions in cm (W x H x D)	Not provided.						
Mounting position	X	Table top equipment					
		Wall/Ceiling mounted equipment					
		Floor standing equipment					
		Hand-held equipment					
		Other:					
Modules/parts..... :	Module/parts of test item		Type	Manufacturer			
Accessories (not part of the test item)	Description		Type	Manufacturer			
Documents as provided by the applicant	Description		File name	Issue date			

⁽³⁾ Only applicable to medical equipments.

Identification of the client

Ring LLC

1523 26th Street, Santa Monica, 90404, California, United States

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-05-12
Date (finish)	2021-06-02

Document history

Report number	Date	Description
67442RRF.001	2021-08-26	First release.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Antonio Manuel Sánchez, Victoria Olmedo, Daniel Mejías, Jaime Barranquero.

Used instrumentation:

Conducted Measurements:

	Last Calibration	Due Calibration
1. Spectrum Analyzer 9kHz-6GHz ROHDE AND SCHWARZ FSL6	2021/04	2023/04
2. Vector Signal Generator 100 KHz-6GHz ROHDE AND SCHWARZ SMU200A	2021/04	2023/04
3. Signal Generator 9 KHz-6 GHz, ROHDE AND SCHWARZ SMB100A	2019/10	2021/10
4. Open Switch and Control Platform ROHDE & SCHWARZ OSP-B157W8	2021/03	2023/03

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ALBATROSS P29419	2020/01	2023/01
2. Ultralog Antenna 30MHz-6GHz, ROHDE AND SCHWARZ HL562E_UPG	2019/10	2022/10
3. EMI Test Receiver 2Hz-44GHz, ROHDE AND SCHWARZ ESW44	2019/10	2021/10
4. Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
5. Horn Antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2021/03	2024/03
6. Preamplifier 30 dB 500MHz-18GHz, SCHWARZBECK BBV 9718 C	2021/02	2022/02
7. Preamplifier G>30 dB 18-40GHz BONN ELEKTRONIK BLMA 1840-3G	2019/11	2021/11

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

A. Bluetooth Low Energy 5.0 (2M, 1M): Bluetooth LE (1).

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
FCC 15.247 (a)(2) / RSS-247 5.2. (a)	6 dB Bandwidth	P	
FCC 15.247 (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain	P	
FCC 15.247 (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
FCC 15.247 (e) / RSS-247 5.2. (b)	Power spectral density	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
<u>Supplementary information and remarks:</u>			
None.			

B. Bluetooth Low Energy 5.0 (2M, 1M): Bluetooth LE (2).

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
FCC 15.247 (a)(2) / RSS-247 5.2. (a)	6 dB Bandwidth	P	
FCC 15.247 (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain	P	
FCC 15.247 (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
FCC 15.247 (e) / RSS-247 5.2. (b)	Power spectral density	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
<u>Supplementary information and remarks:</u>			
None.			

C. ZigBee 2.4 GHz

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
FCC 15.247 (a)(2) / RSS-247 5.2. (a)	6 dB Bandwidth	P	
FCC 15.247 (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain	P	
FCC 15.247 (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
FCC 15.247 (e) / RSS-247 5.2. (b)	Power spectral density	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
<u>Supplementary information and remarks:</u>			
None.			

Appendix A: Test results. Bluetooth Low Energy 5.0 (2M, 1M): Bluetooth LE (1)

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FCC 15.247 (d) / RSS-247 5.5. Band-Edge Emissions Compliance (Transmitter)	27
FCC 15.247 (e) / RSS-247 5.2. (b) Power Spectral Density.....	30
FCC 15.247 (d) / RSS-247 5.5. Emission Limitations Radiated (Transmitter)	34

TEST CONDITIONS

(*) Declared by the Client.

POWER SUPPLY (*):

Vnominal: 110 Vac
Type of Power Supply: AC/DC Adapter.

ANTENNA (*):

Type of Antenna: Integral.
Maximum Declared Antenna Gain: +3.7 dBi

TEST FREQUENCIES (*):

Low Channel: 2402 MHz
Middle Channel: 2440 MHz
High Channel: 2480 MHz

POWER SETTINGS (*):

Bluetooth (1) setting is 7

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (antenna and 18 GHz-40 GHz horn antenna).

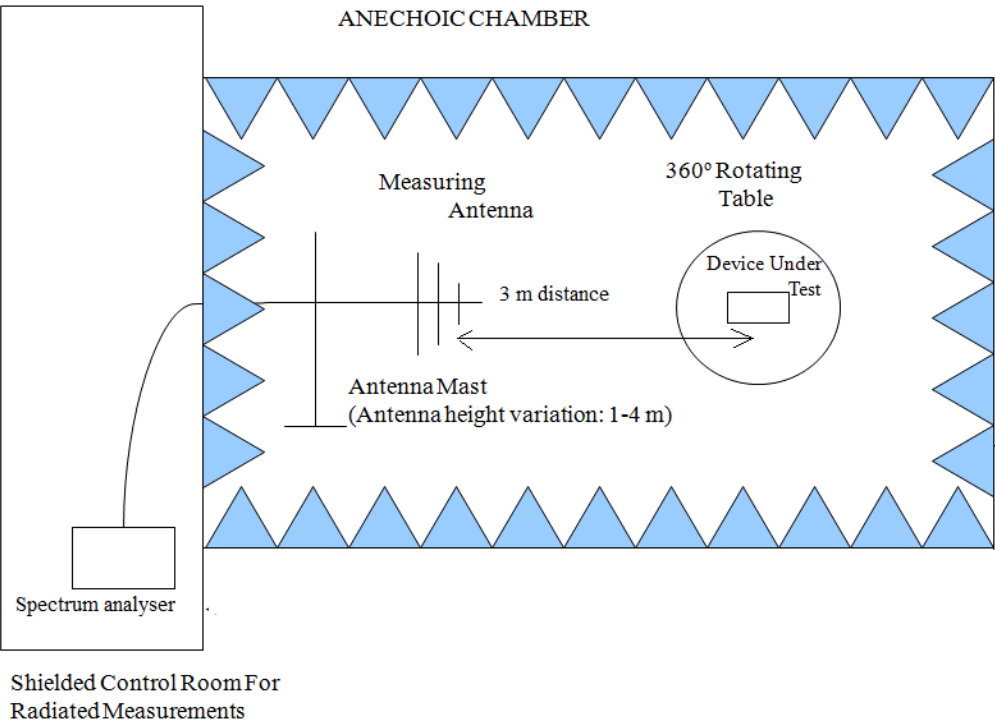
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

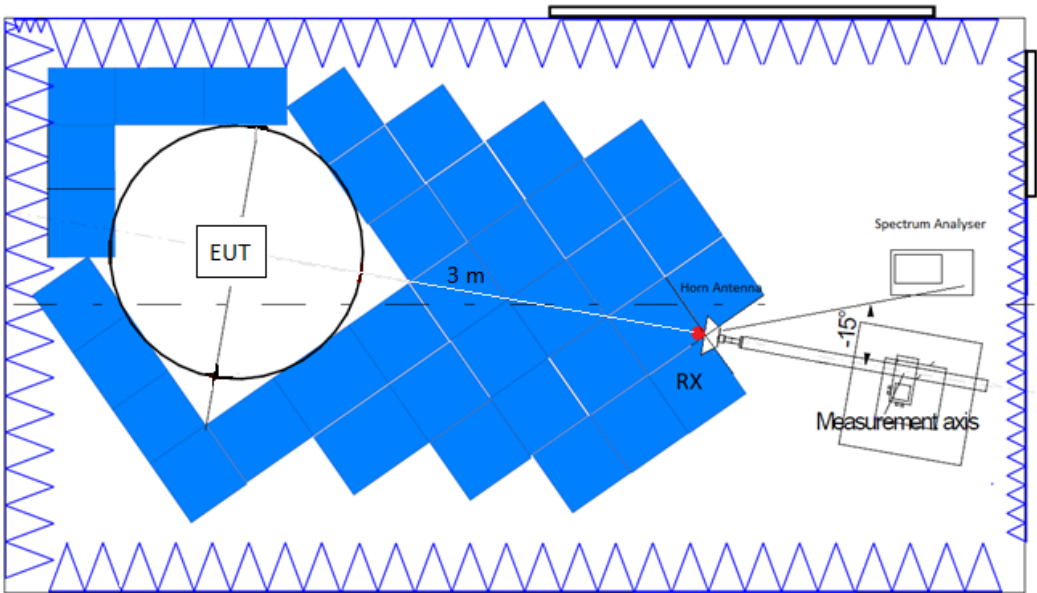
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

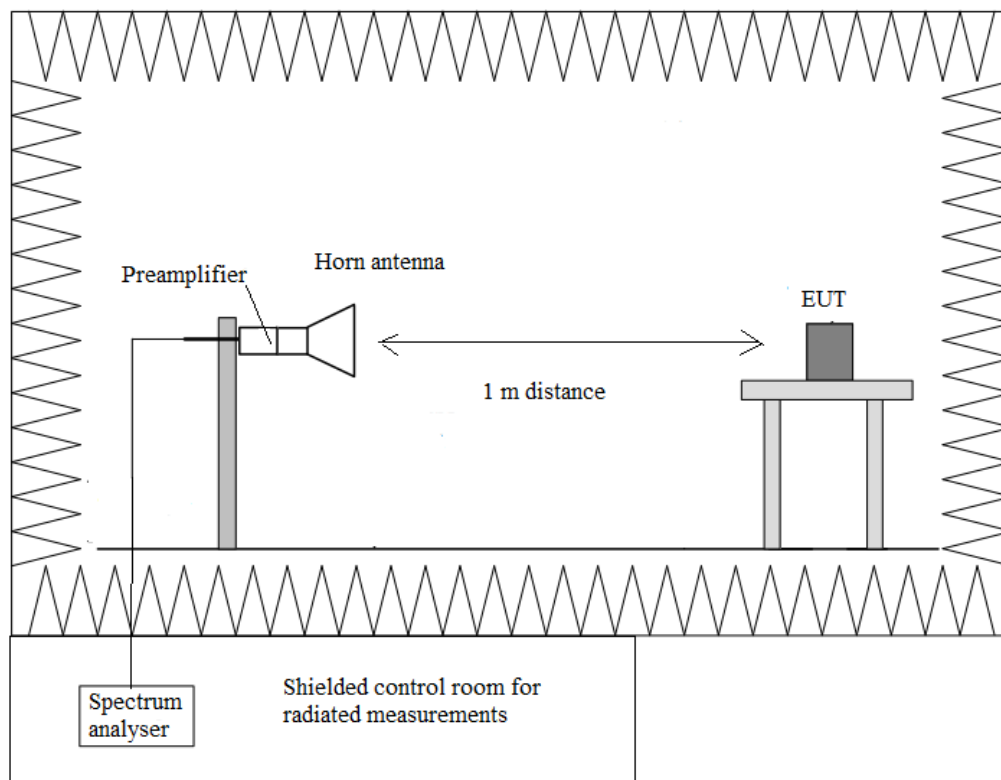
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



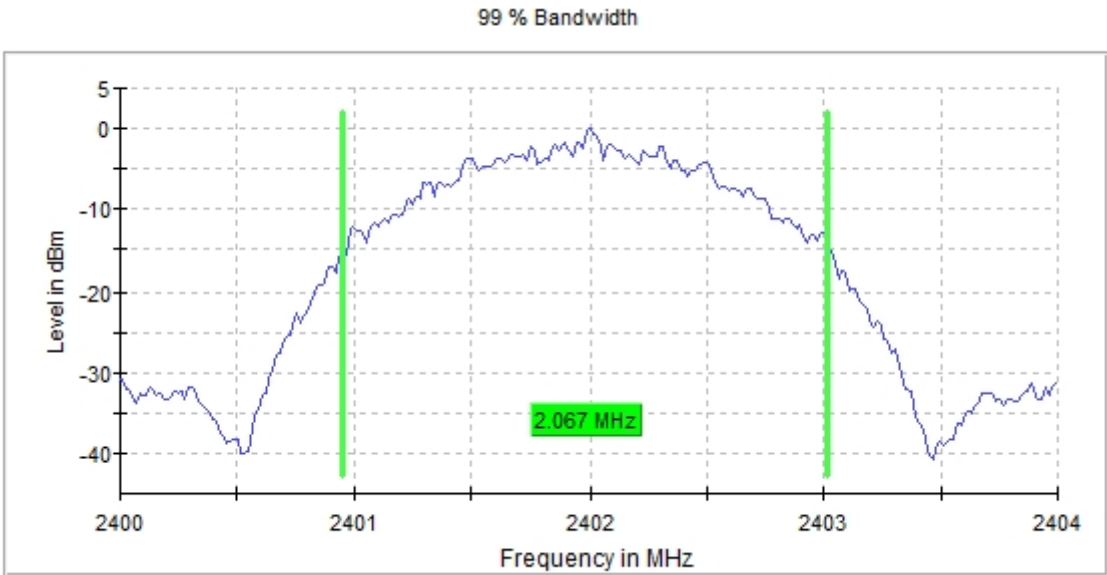
Occupied Bandwidth

RESULTS:

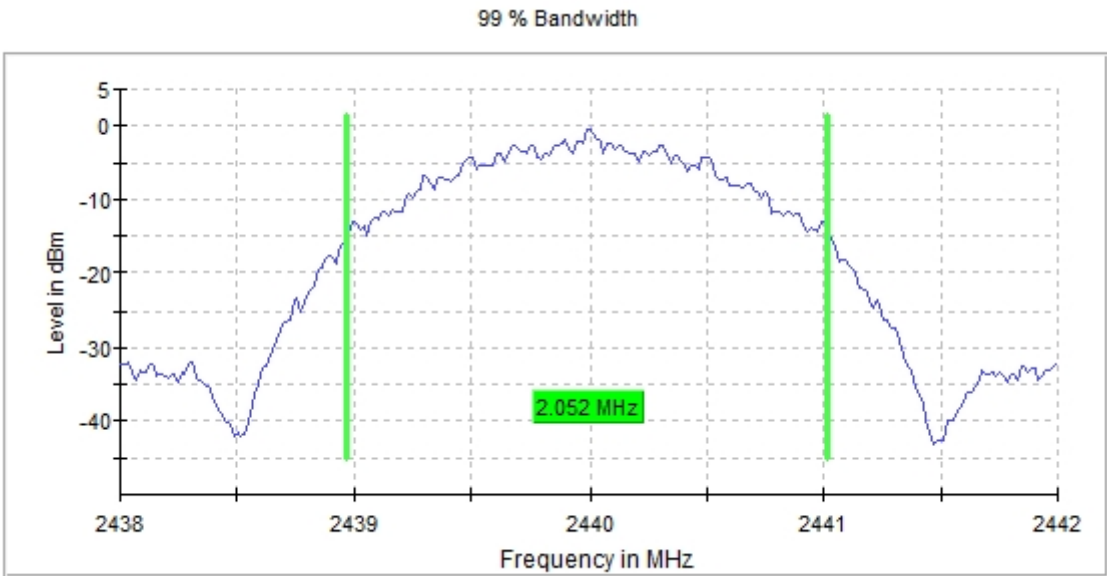
• 2M modulation:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	2.067416	2.052435	2.052435
Measurement uncertainty (%)	<± 1.17		

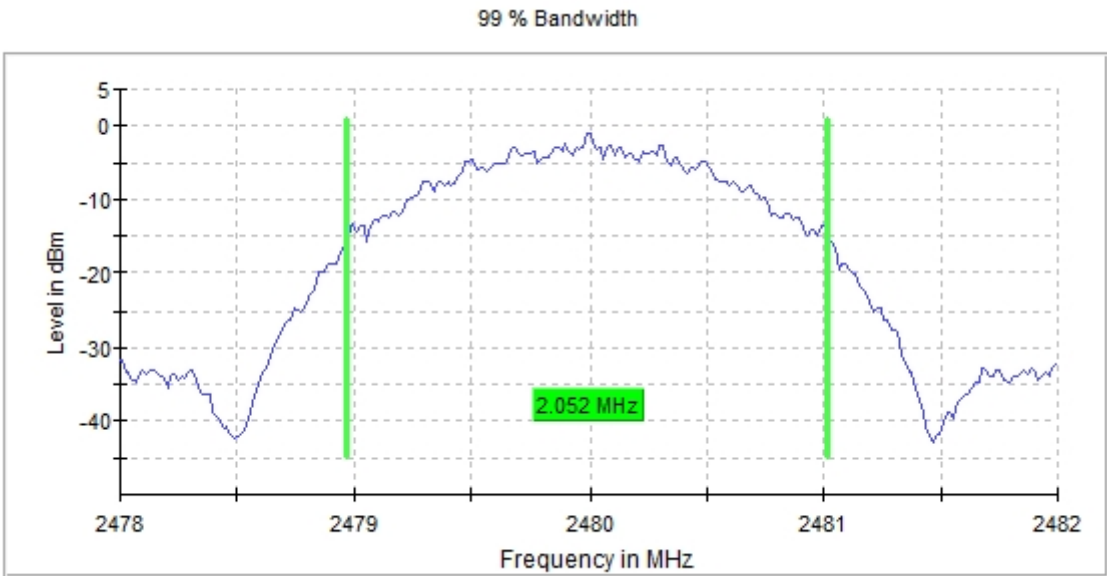
- Low Channel:



- Middle Channel:



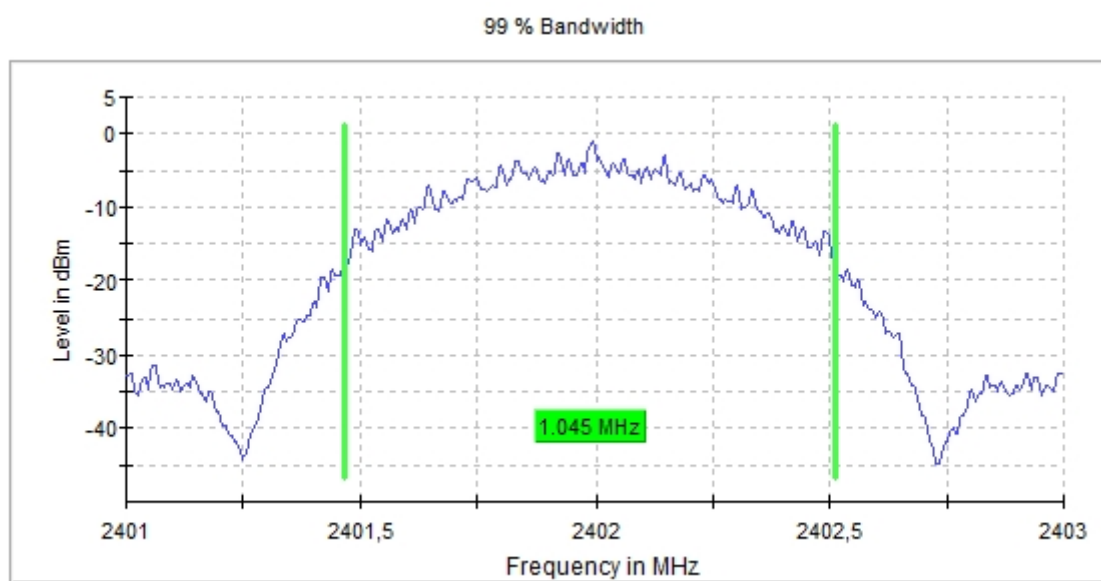
- High Channel:



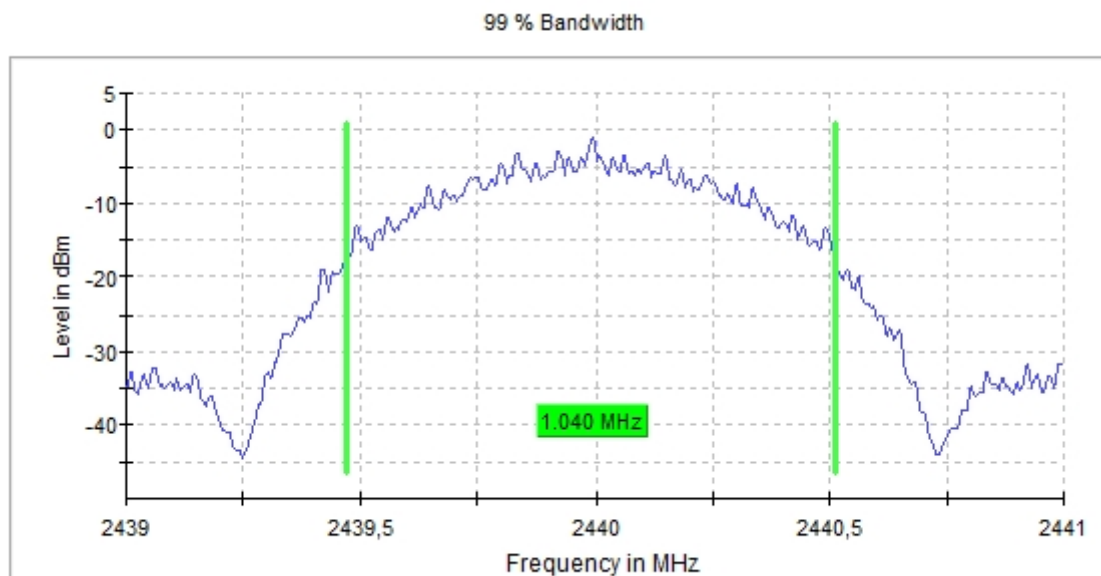
• **1M modulation:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	1.045000	1.040000	1.035000
Measurement uncertainty (%)	<± 1.17		

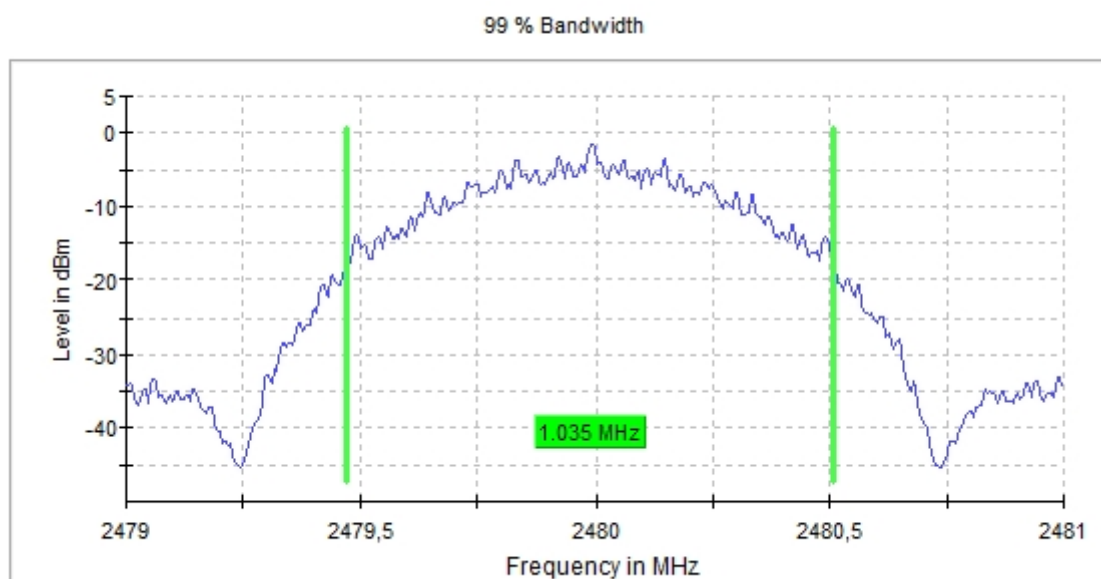
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (a)(2) / RSS-247 5.2. (a) 6 dB Bandwidth

SPECIFICATION:

The minimum 6 dB bandwidth shall be at least 500 kHz.

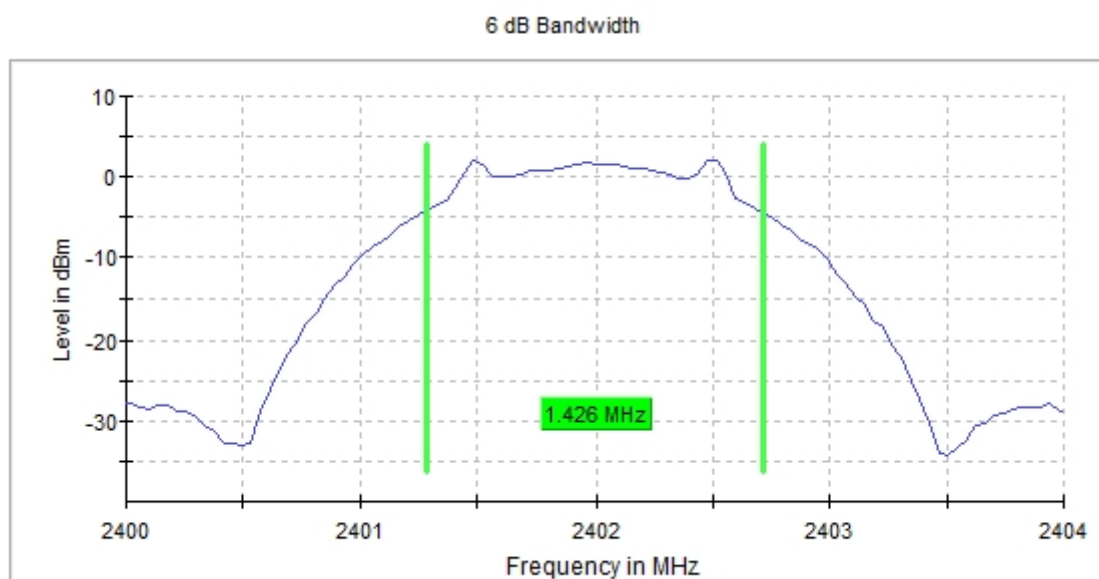
RESULTS:

• 2M modulation:

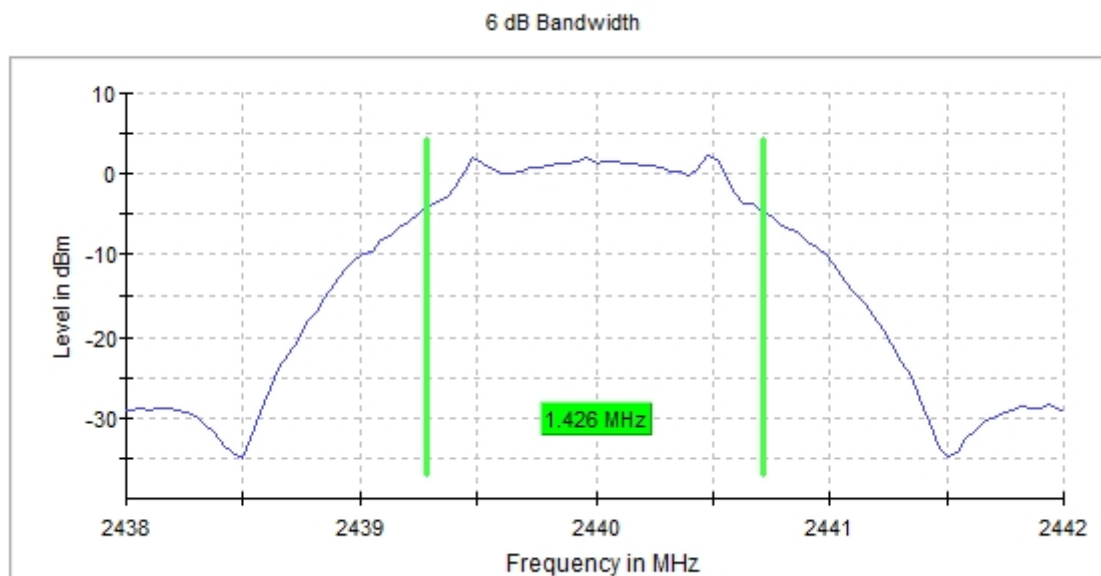
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
6 dB Spectrum bandwidth (MHz)	1.425742	1.425742	1.386138
Measurement uncertainty (%)	<±2.84		

Verdict: PASS

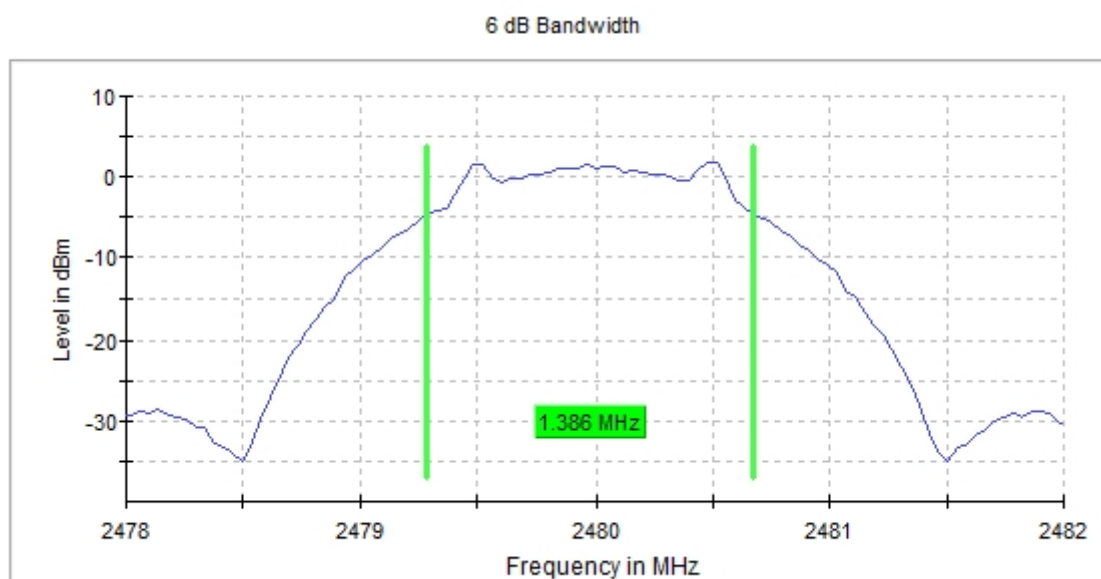
- Low Channel:



- Middle Channel:



- High Channel:

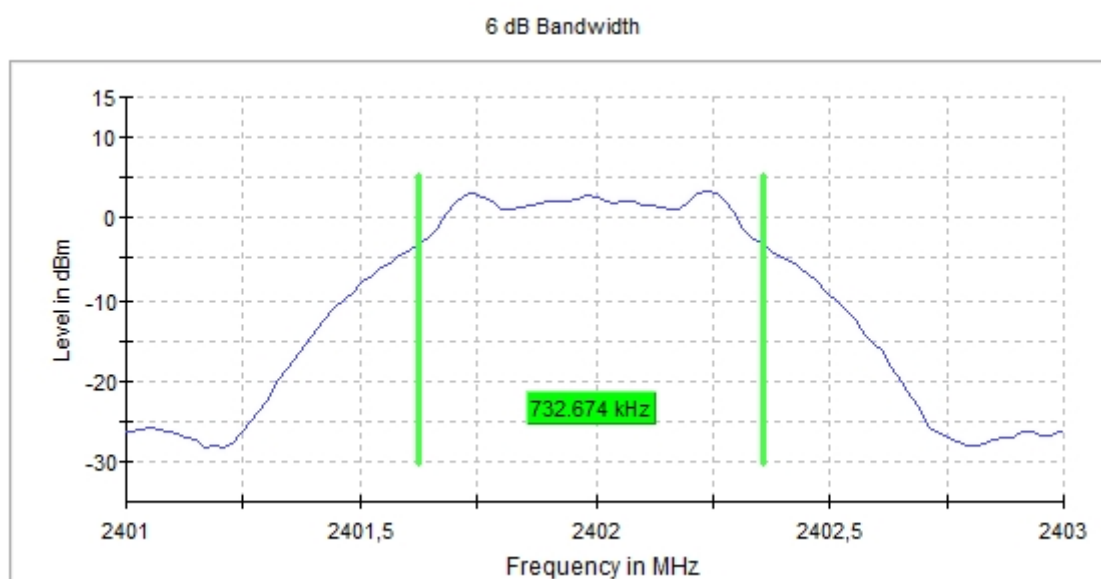


• **1M modulation:**

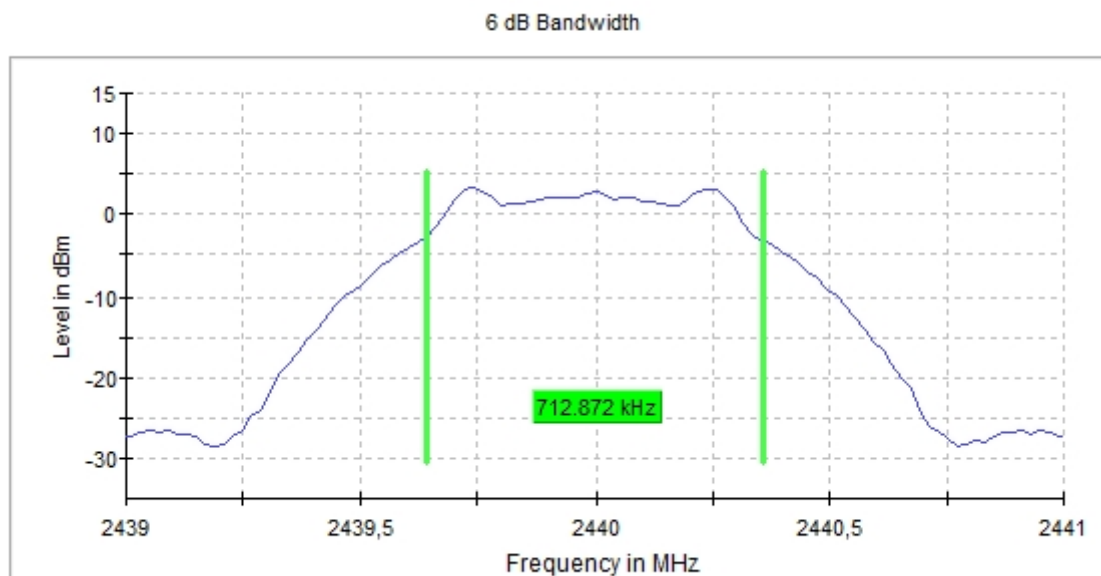
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
6 dB Spectrum bandwidth (MHz)	0.732674	0.712872	0.732674
Measurement uncertainty (%)	<±2.84		

Verdict: PASS

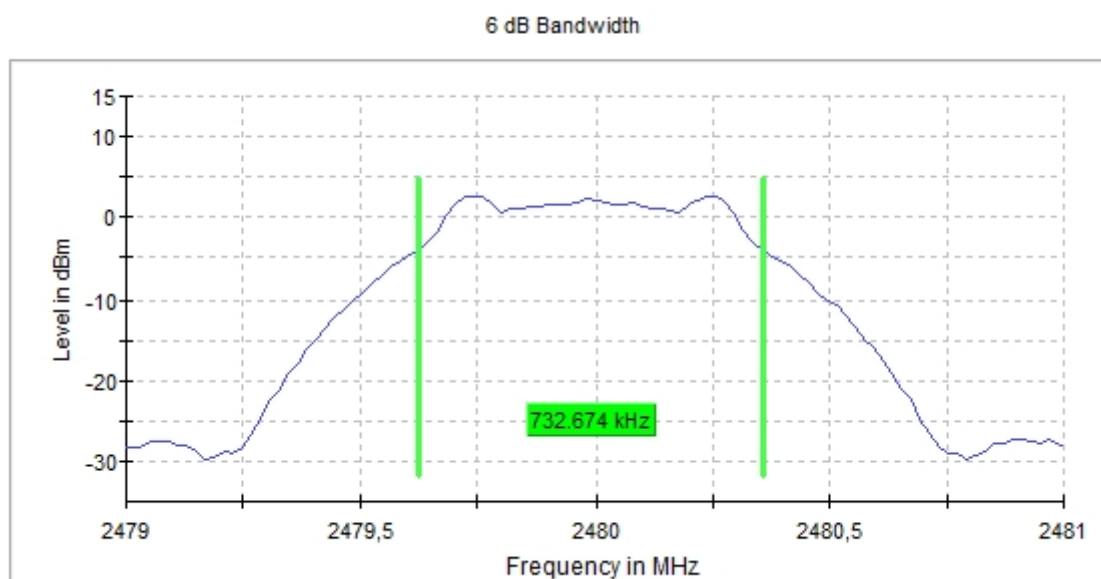
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (b) / RSS-247 5.4. (d) Maximum Output Power and Antenna Gain

SPECIFICATION:

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS:

The maximum peak conducted output power level in the fundamental emission was measured using the method according to point 11.9.1.1 "RBW ≥ DTS bandwidth" of ANSI C.63.10-2013.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: +3.7 dBi

• 2M modulation:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	3.988	3.989	3.609
Maximum EIRP Power (dBm)	7.688	7.689	7.309
Measurement uncertainty (dB)	<±0.80		

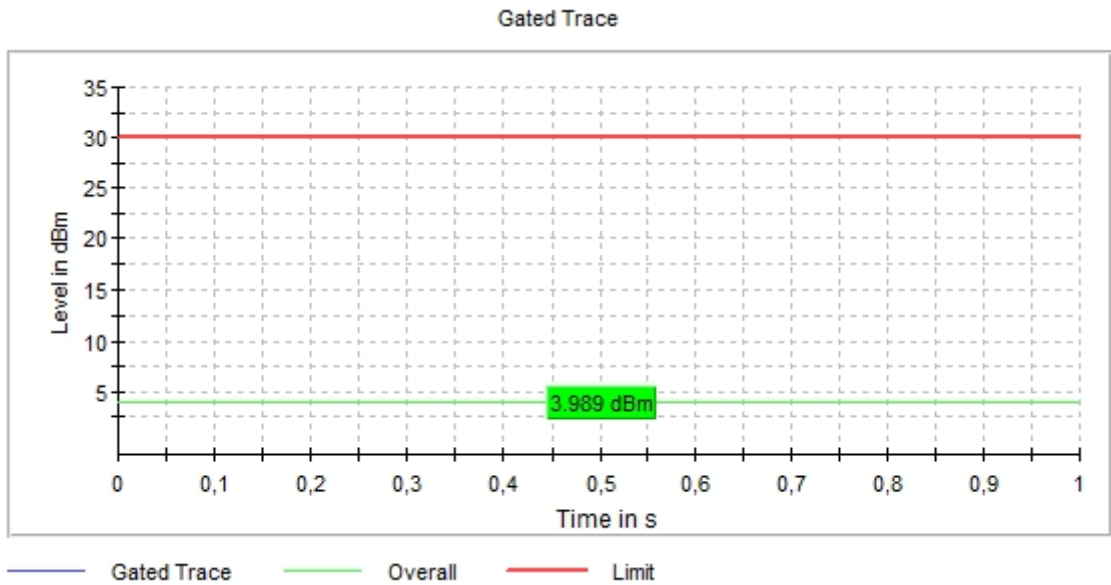
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

- Low Channel:



- Middle Channel:



- High Channel:



• **1M modulation:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	3.985	3.990	3.617
Maximum EIRP Power (dBm)	7.685	7.690	7.317
Measurement uncertainty (dB)	<±0.80		

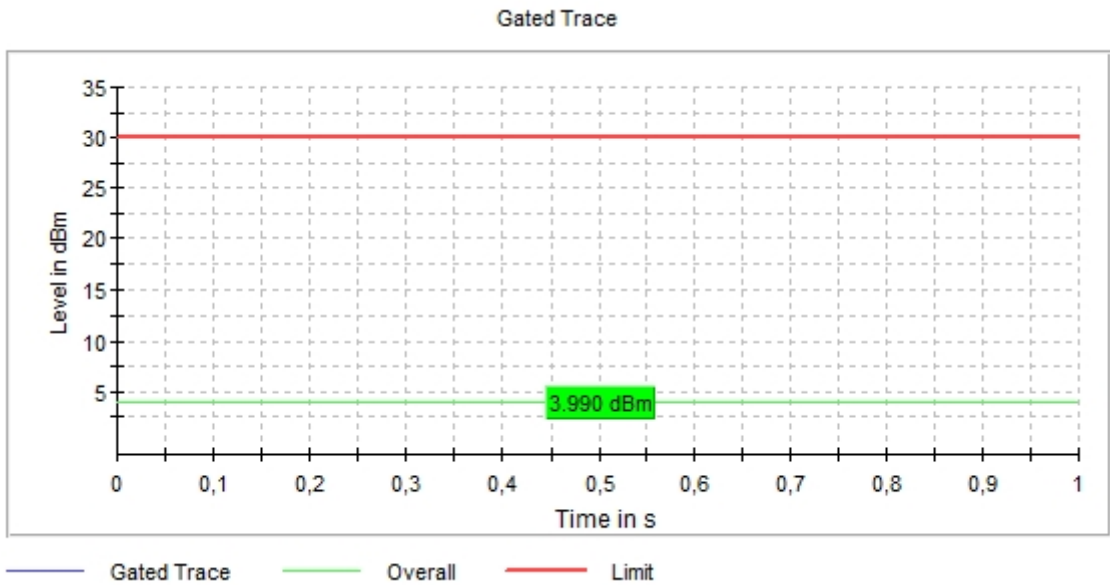
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

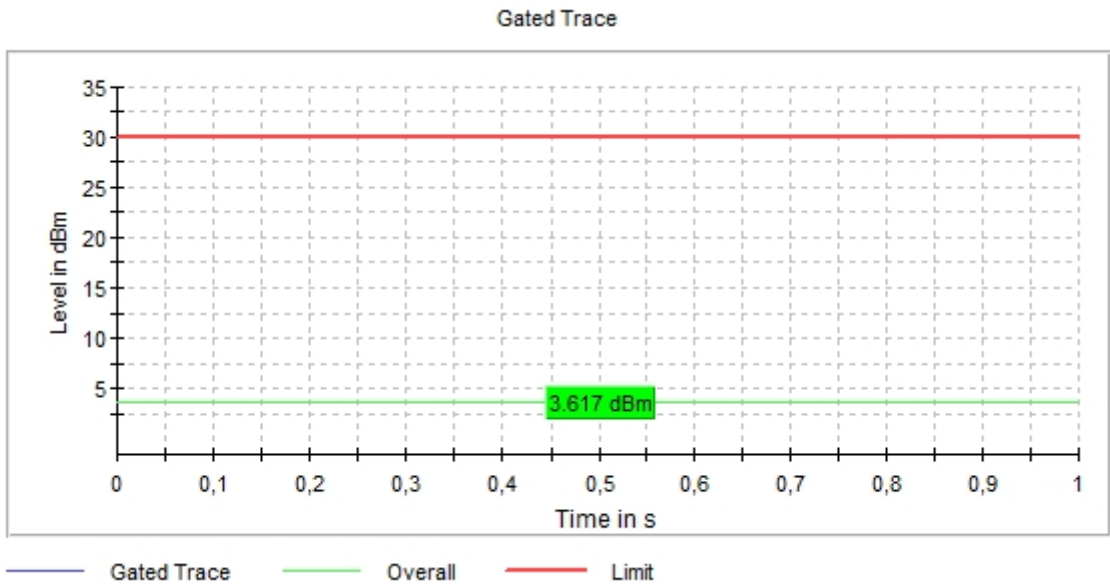
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Band-Edge Emissions Compliance (Transmitter)

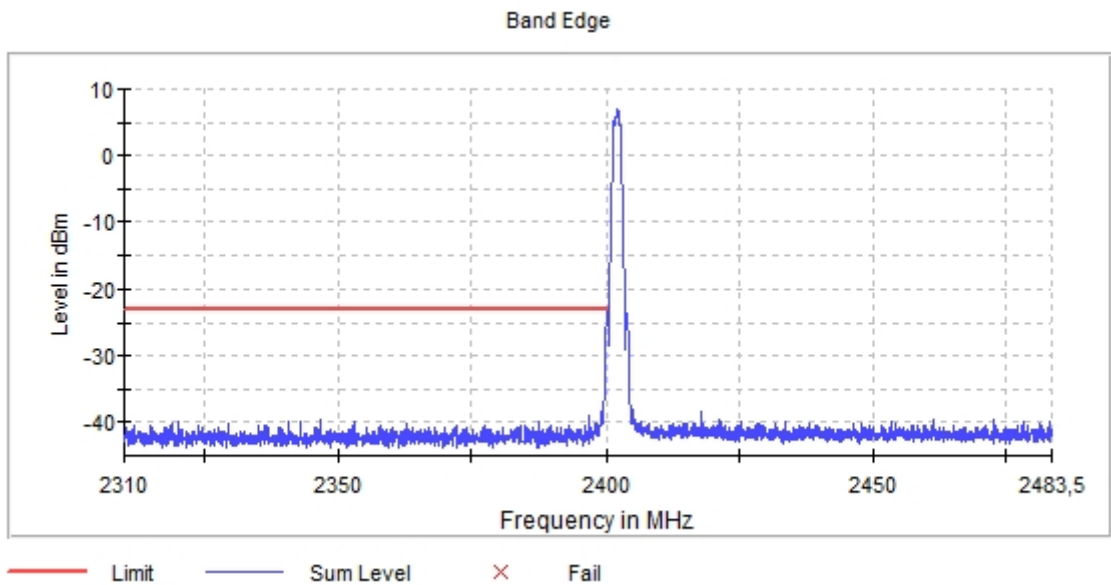
SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

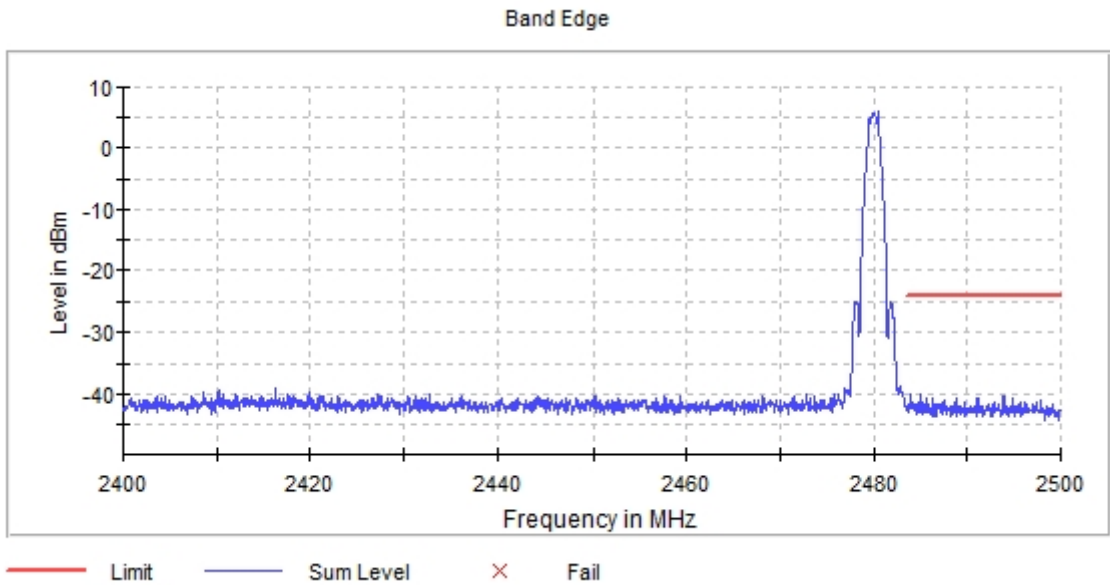
• 2M modulation:

- Low Channel:



Measurement uncertainty (dB)	<±1.53
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- High Channel:

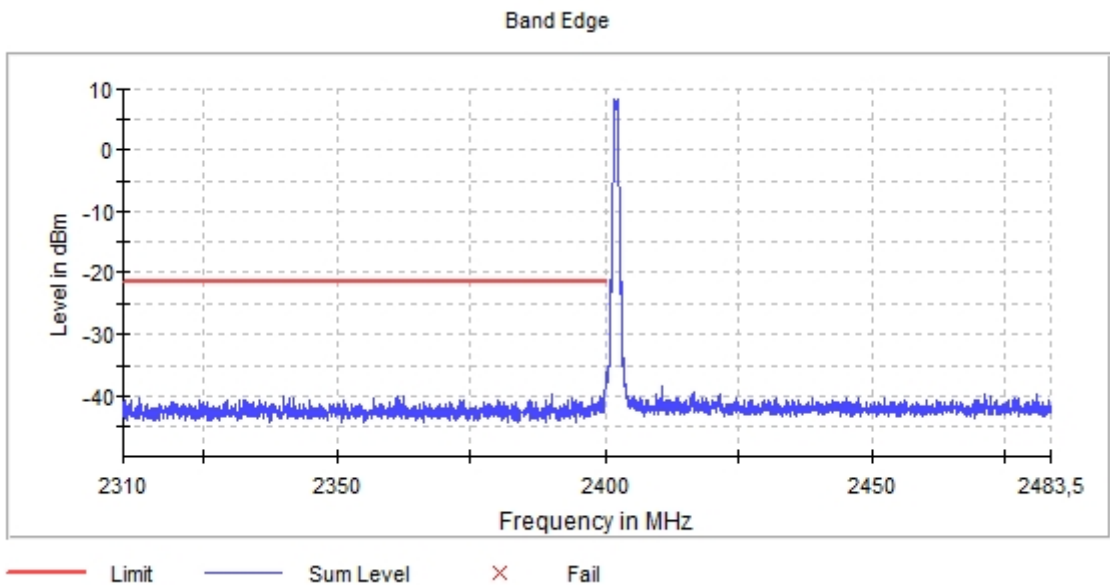


Measurement uncertainty (dB)	<±1.53
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Verdict: PASS

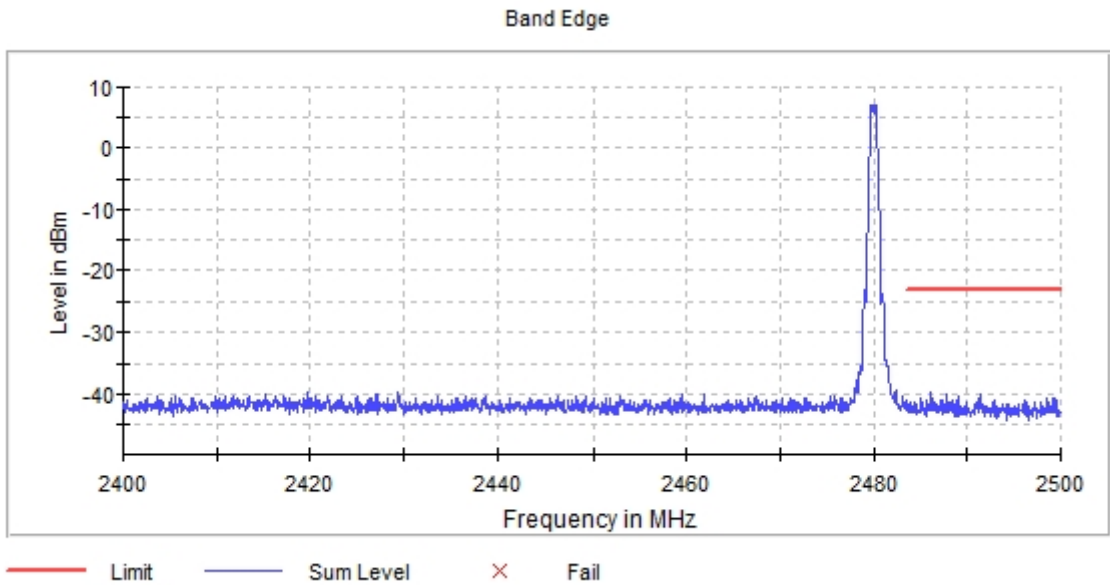
• 1M modulation:

- Low Channel:



Measurement uncertainty (dB)	<±1.53
------------------------------	--------

- High Channel:



Measurement uncertainty (dB)	<±1.53
------------------------------	--------

Verdict: PASS

FCC 15.247 (e) / RSS-247 5.2. (b) Power Spectral Density

SPECIFICATION:

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.

RESULTS:

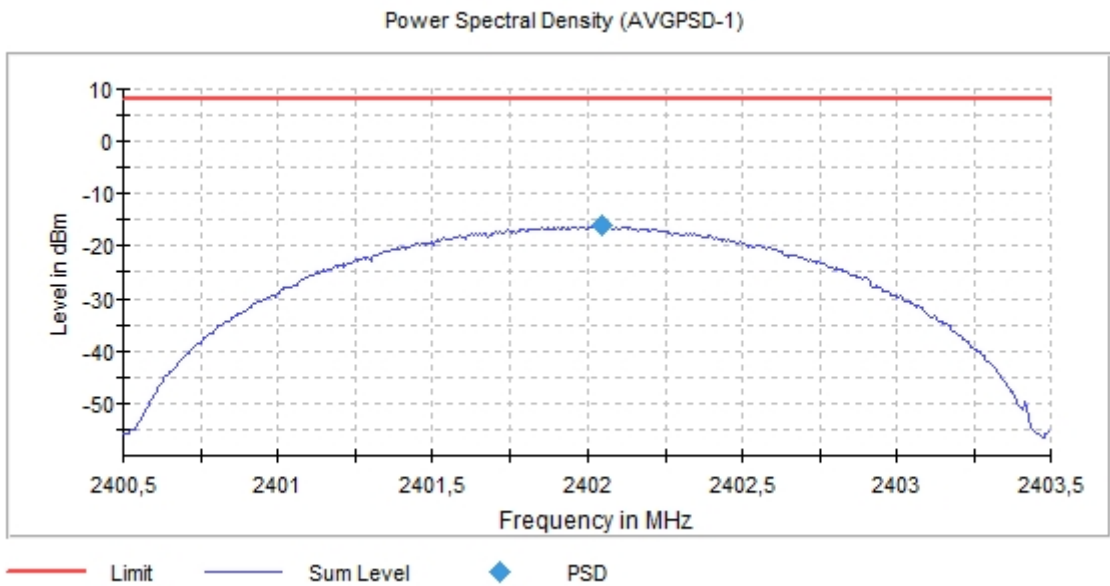
The maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2.” Method PKPSD (peak PSD)” of ANSI C.63.10-2013.

• 2M modulation:

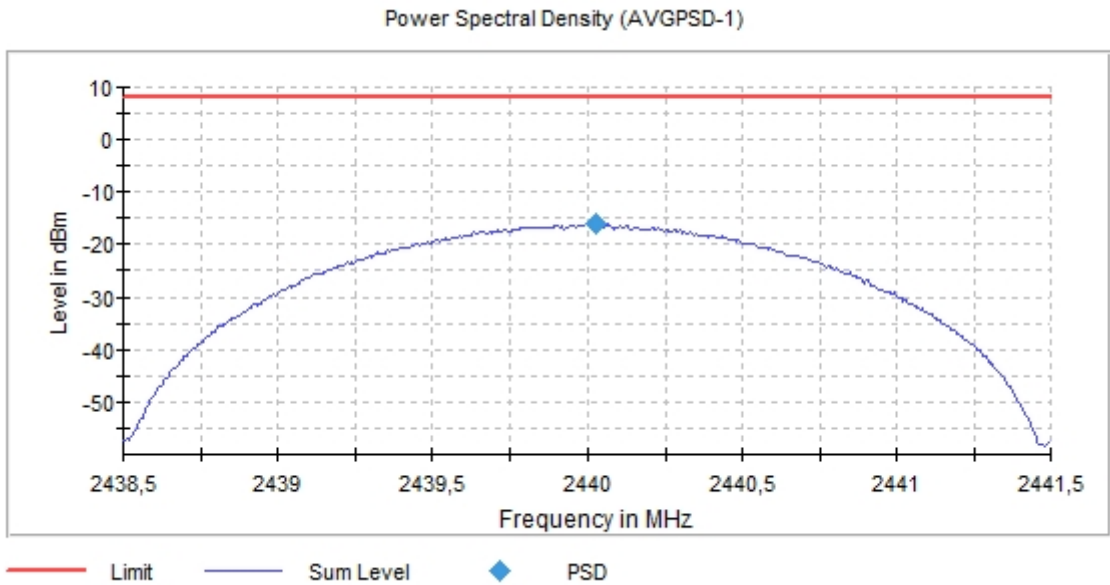
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	-16.114	-16.112	-16.697
Measurement uncertainty (dB)	<±0.99		

Verdict: PASS

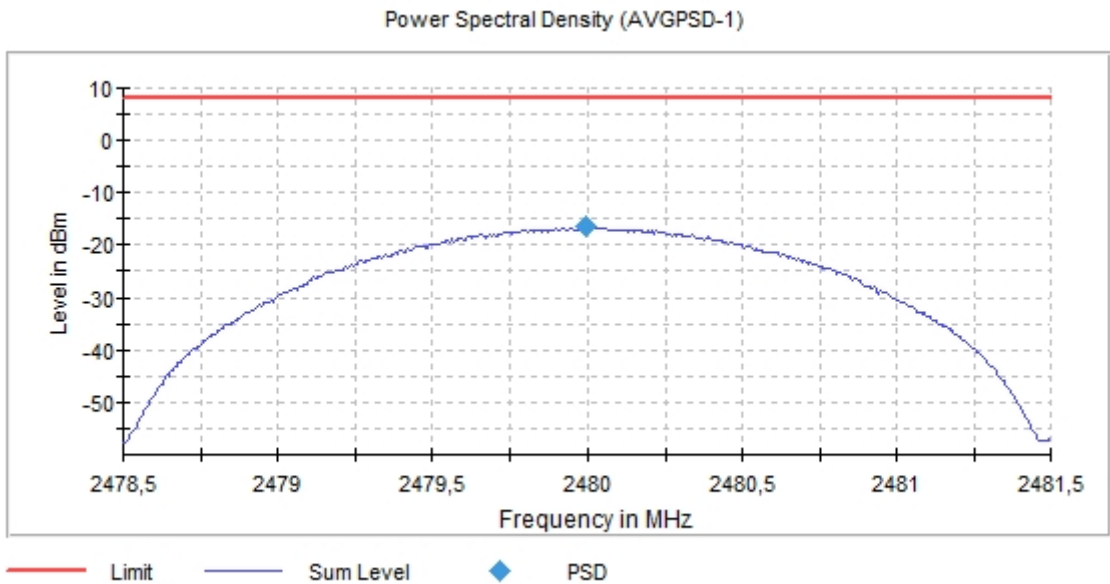
- Low Channel:



- Middle Channel:



- High Channel:

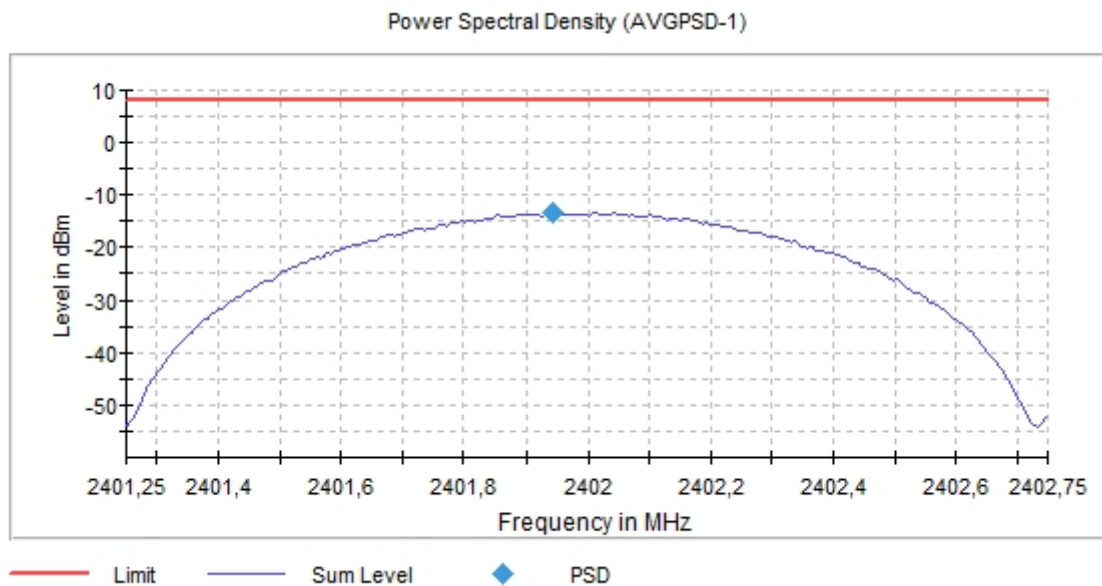


• **1M modulation:**

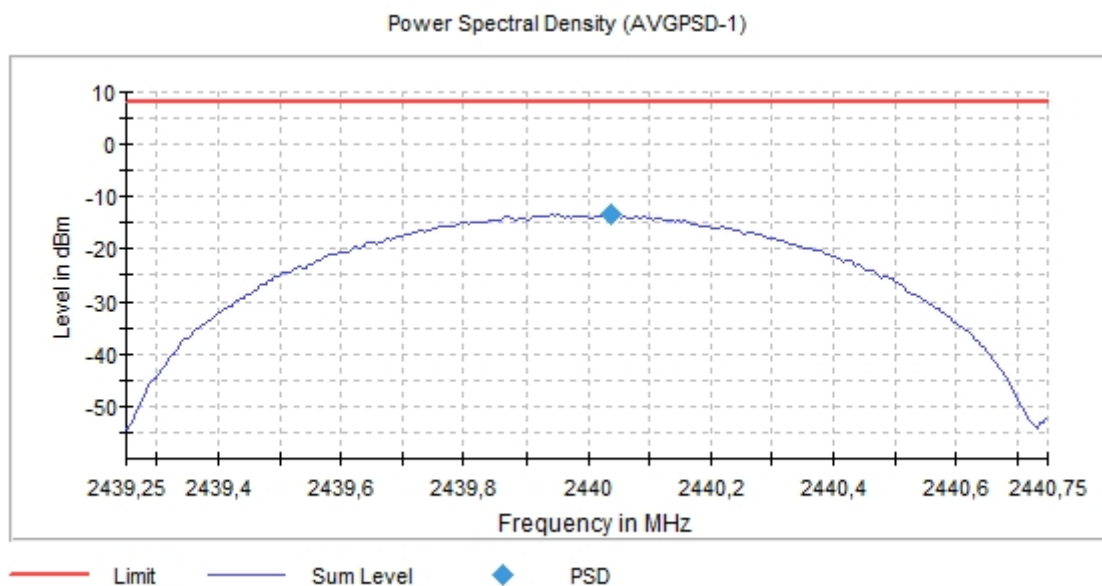
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	-13.347	-13.543	-13.984
Measurement uncertainty (dB)	<±0.99		

Verdict: PASS

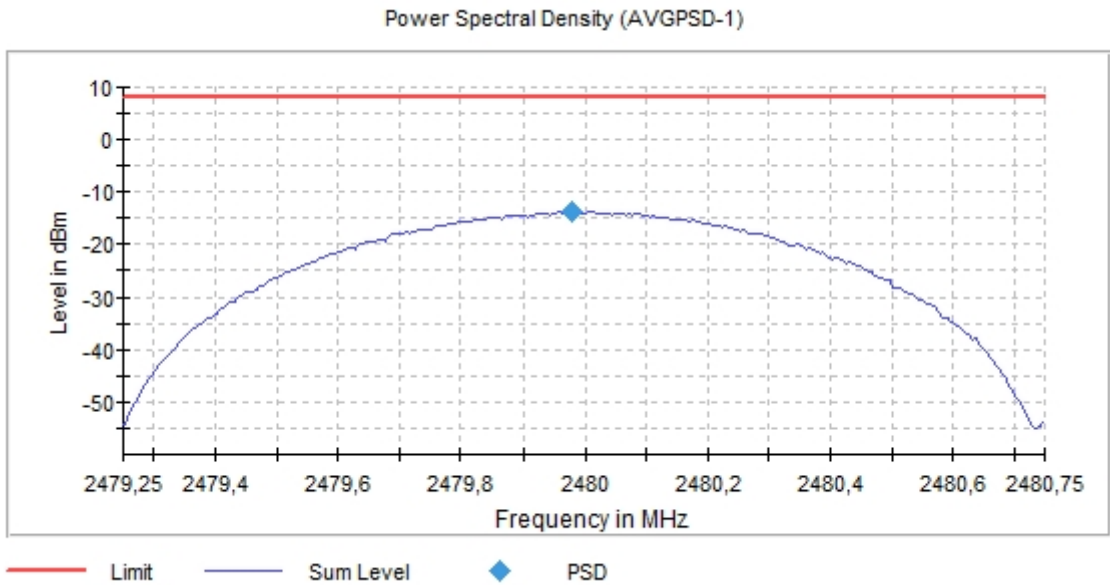
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Emission Limitations Radiated (Transmitter)

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 10000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

Spurious frequencies detected at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Level ($\text{dB}\mu\text{V/m}$)	Polarization	Detector
49.206000	29.85	V	Quasi-Peak
93.098500	26.38	V	Quasi-Peak
124.963000	34.18	V	Quasi-Peak
375.029000	31.64	V	Quasi-Peak

Measurement Uncertainty (dB) $\leq \pm 5.1$

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequencies with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with average detector for checking compliance with the average limit.

- 2M modulation:**

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2365.666667	53.00	V	Peak	$\leq \pm 4.6$
2496.533333	53.59	V	Peak	$\leq \pm 4.6$
3687.500000	41.43	H	Peak	$\leq \pm 4.6$
3749.500000	42.52	V	Peak	$\leq \pm 4.6$
3812.500000	42.46	H	Peak	$\leq \pm 4.6$
4805.000000	50.21	H	Peak	$\leq \pm 4.6$
6000.500000	44.83	V	Peak	$\leq \pm 4.6$
10337.000000	51.96	V	Peak	$\leq \pm 4.6$

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2335.466667	53.15	V	Peak	$\leq \pm 4.6$
2488.800000	53.62	V	Peak	$\leq \pm 4.6$
3750.000000	44.20	H	Peak	$\leq \pm 4.6$
3812.500000	42.75	V	Peak	$\leq \pm 4.6$
4880.500000	47.42	H	Peak	$\leq \pm 4.6$
6250.000000	45.76	H	Peak	$\leq \pm 4.6$
10439.500000	52.46	V	Peak	$\leq \pm 4.6$
14472.500000	52.88	V	Peak	$\leq \pm 4.6$
22245.000000	40.30	V	Peak	$\leq \pm 4.6$

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2370.400000	53.73	V	Peak	$\leq \pm 4.6$
2486.600000	53.57	H	Peak	$\leq \pm 4.6$
3750.000000	44.06	V	Peak	$\leq \pm 4.6$
3812.500000	42.51	V	Peak	$\leq \pm 4.6$
4960.500000	46.87	H	Peak	$\leq \pm 4.6$
6250.500000	44.80	V	Peak	$\leq \pm 4.6$
9648.000000	52.05	V	Peak	$\leq \pm 4.6$
10440.000000	52.69	V	Peak	$\leq \pm 4.6$
14472.000000	52.74	V	Peak	$\leq \pm 4.6$

Measurement Uncertainty (dB): $\leq \pm 4.6$ for $1 < f \leq 17$ GHz
 $\leq \pm 4.89$ for $17 < f \leq 26$ GHz

Verdict: PASS

- **1M modulation:**

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2384.800000	53.68	V	Peak	<± 4.6
2493.266667	53.38	V	Peak	<± 4.6
3750.000000	43.85	V	Peak	<± 4.6
4804.500000	49.75	H	Peak	<± 4.6
11658.500000	51.95	H	Peak	<± 4.6
19136.000000	40.99	H	Peak	<± 4.6

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2314.333333	53.44	V	Peak	<± 4.6
2495.333333	53.33	V	Peak	<± 4.6
3750.000000	44.11	V	Peak	<± 4.6
4880.000000	47.94	H	Peak	<± 4.6
6250.000000	45.41	V	Peak	<± 4.6
10440.000000	52.73	V	Peak	<± 4.6

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

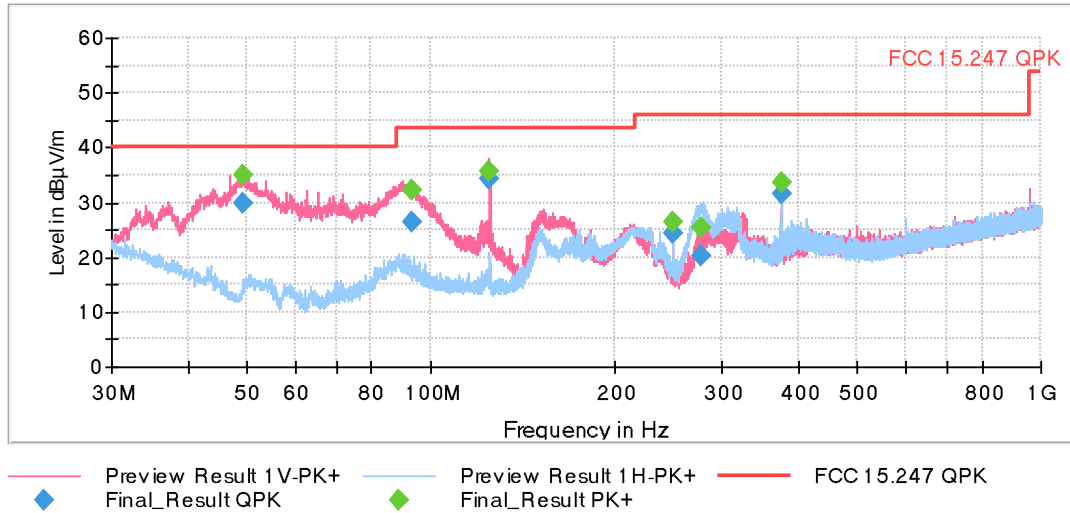
Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2363.533333	53.92	H	Peak	<± 4.6
2492.733333	53.24	V	Peak	<± 4.6
3749.500000	42.51	V	Peak	<± 4.6
4959.500000	47.46	H	Peak	<± 4.6
6250.000000	45.45	H	Peak	<± 4.6
10636.500000	52.30	H	Peak	<± 4.6

Measurement Uncertainty (dB): <± 4.6 for $1 < f \leq 17$ GHz
<± 4.89 for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

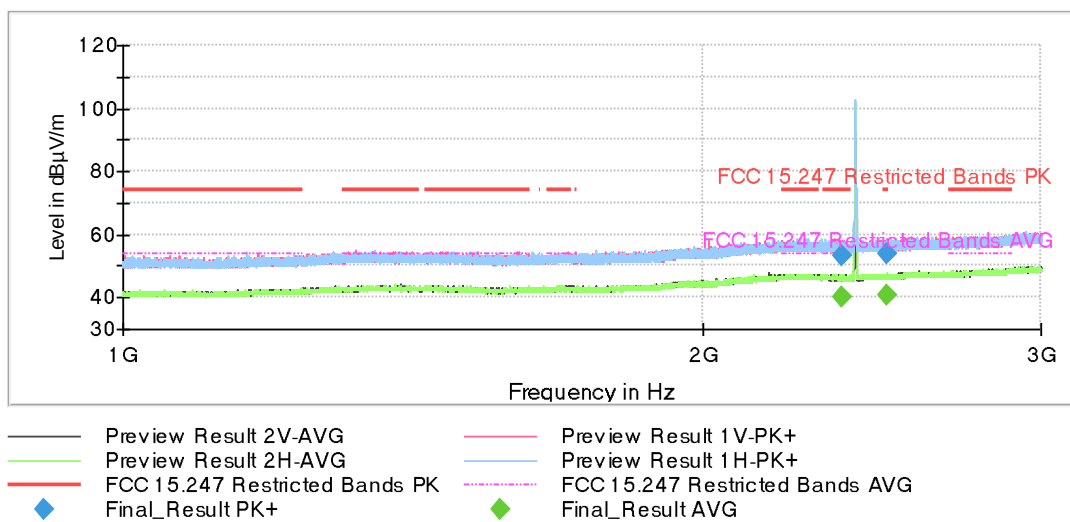


This plot is valid for the Low, Middle and High Channels.

- 2M modulation:

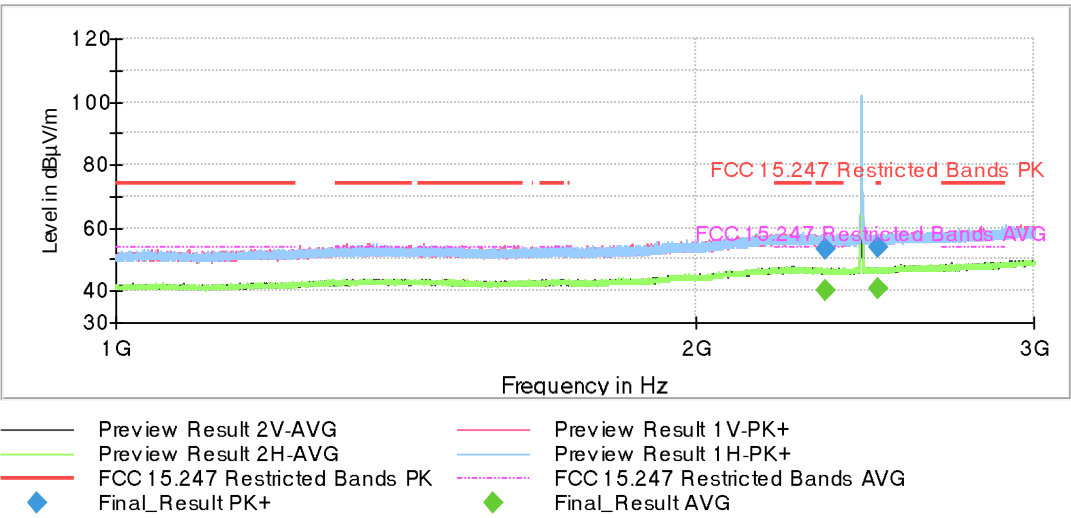
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



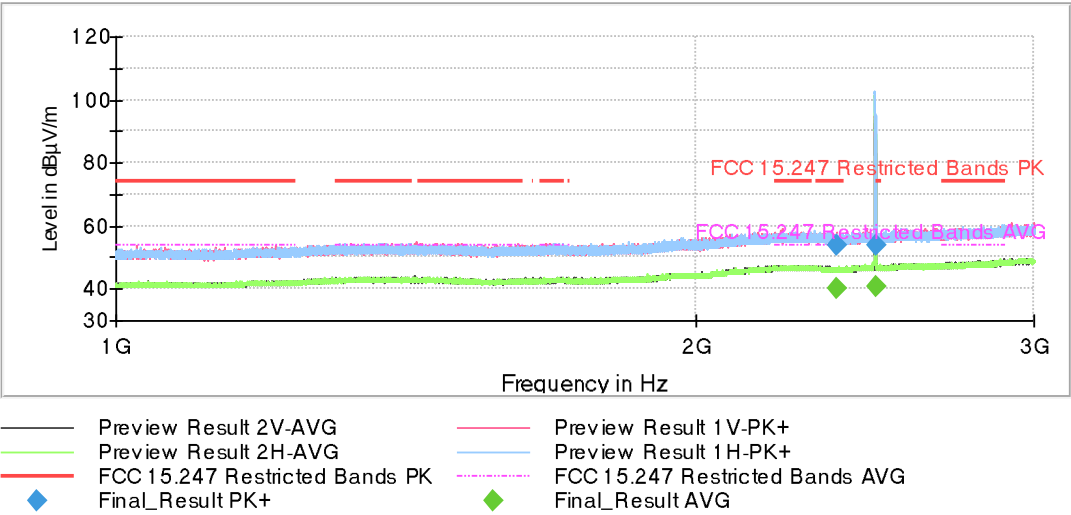
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

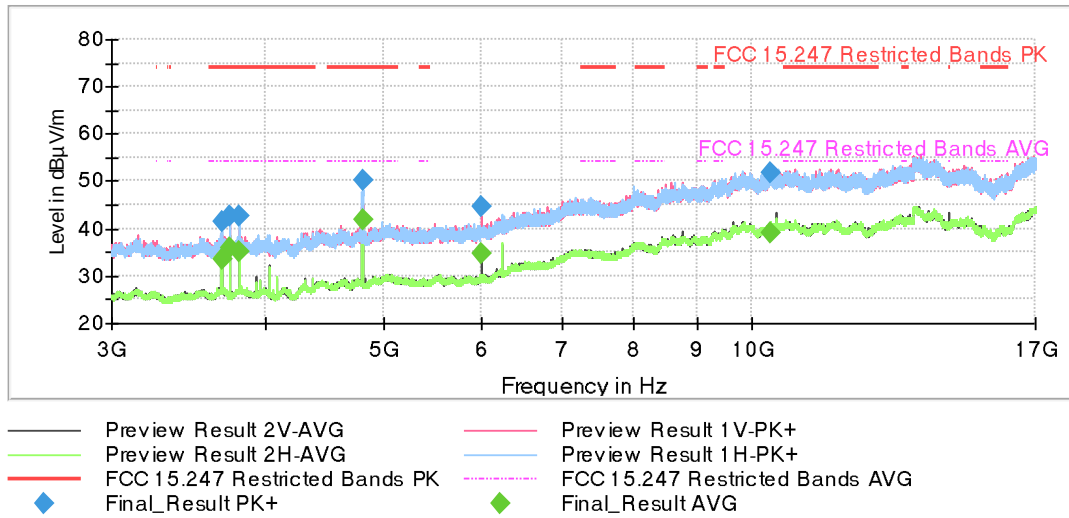
- High Channel:



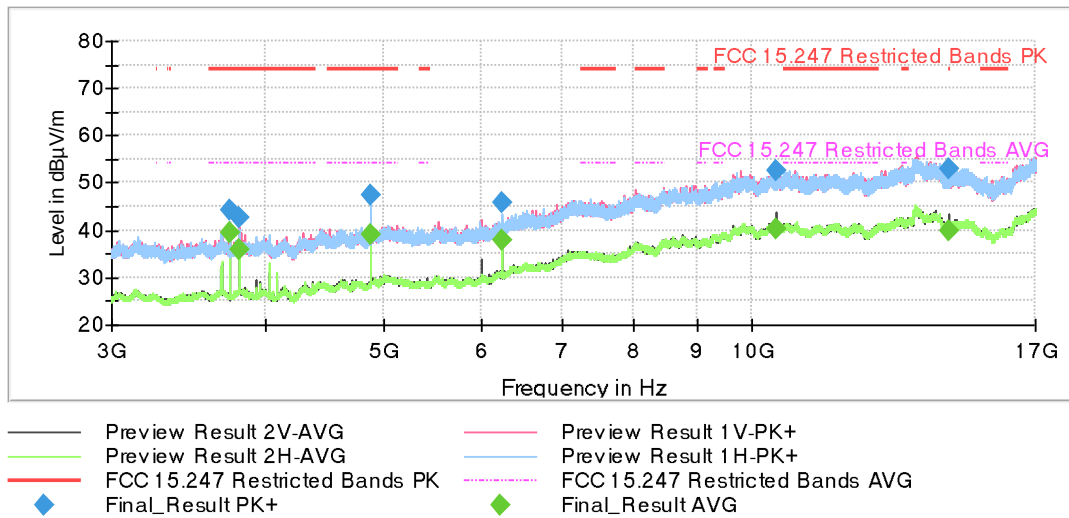
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

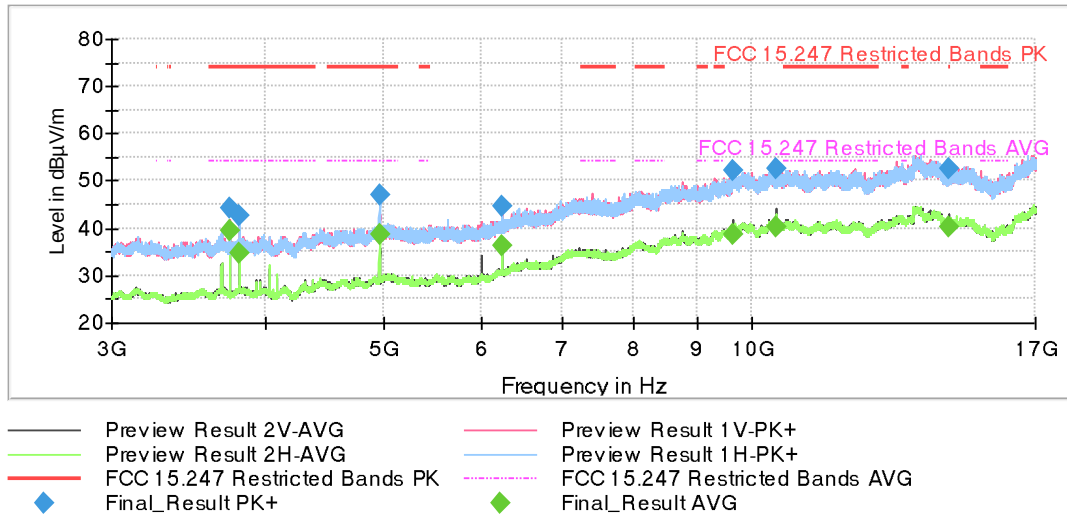
- Low Channel:



- Middle Channel:

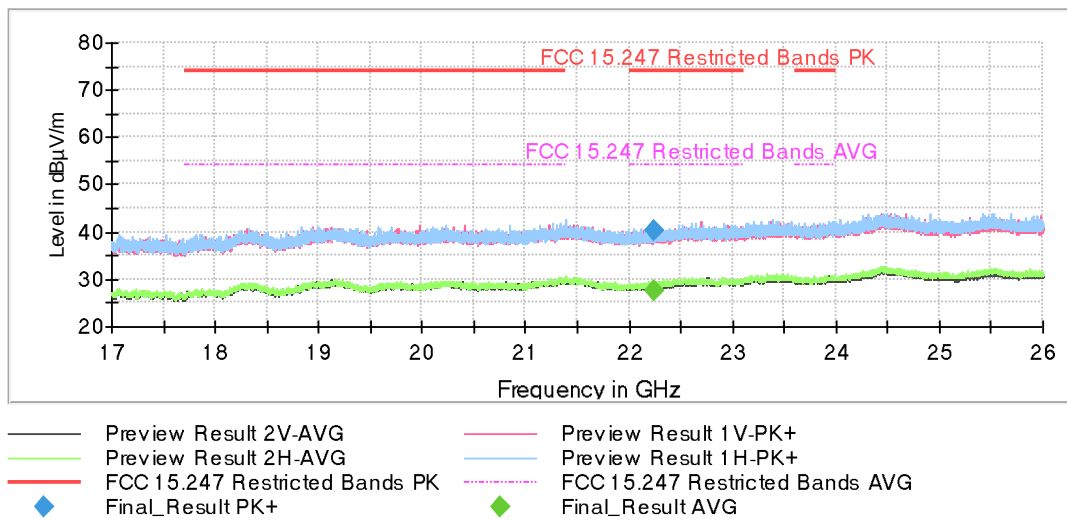


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

The spurious frequencies detected do not depend on the operating channel.

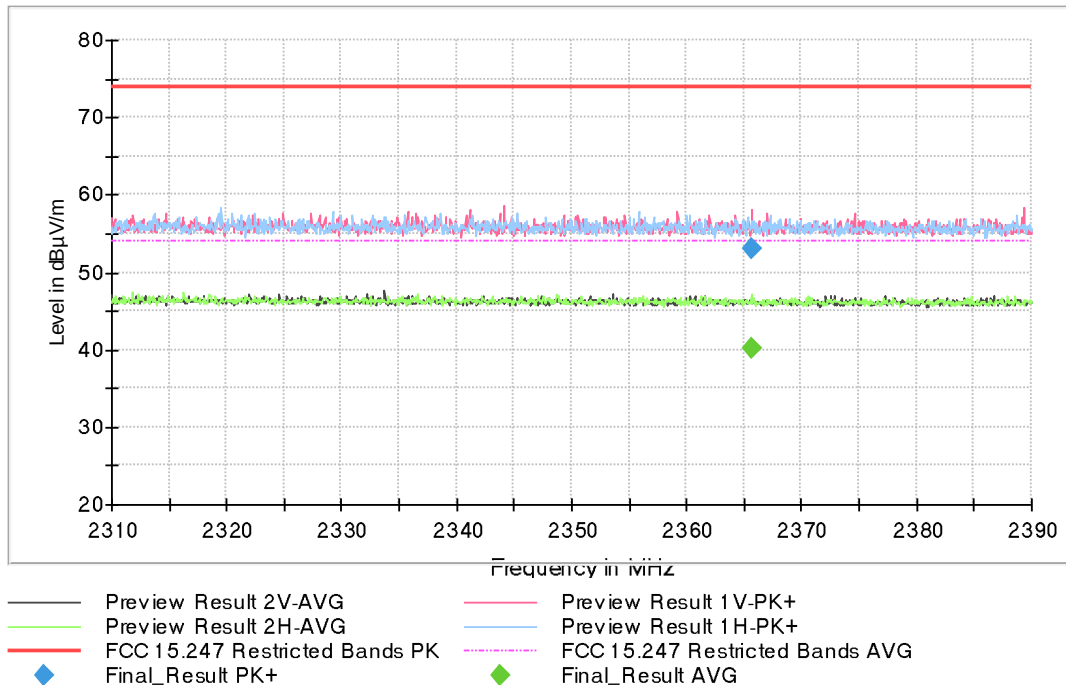


This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

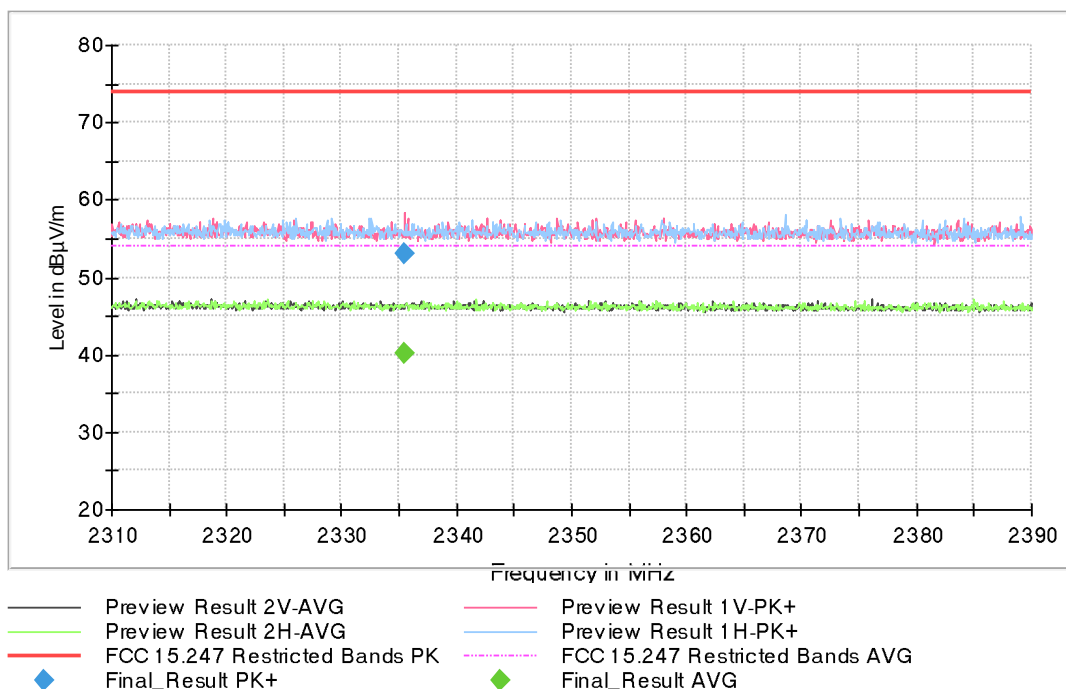
- Low Channel:

Full Spectrum

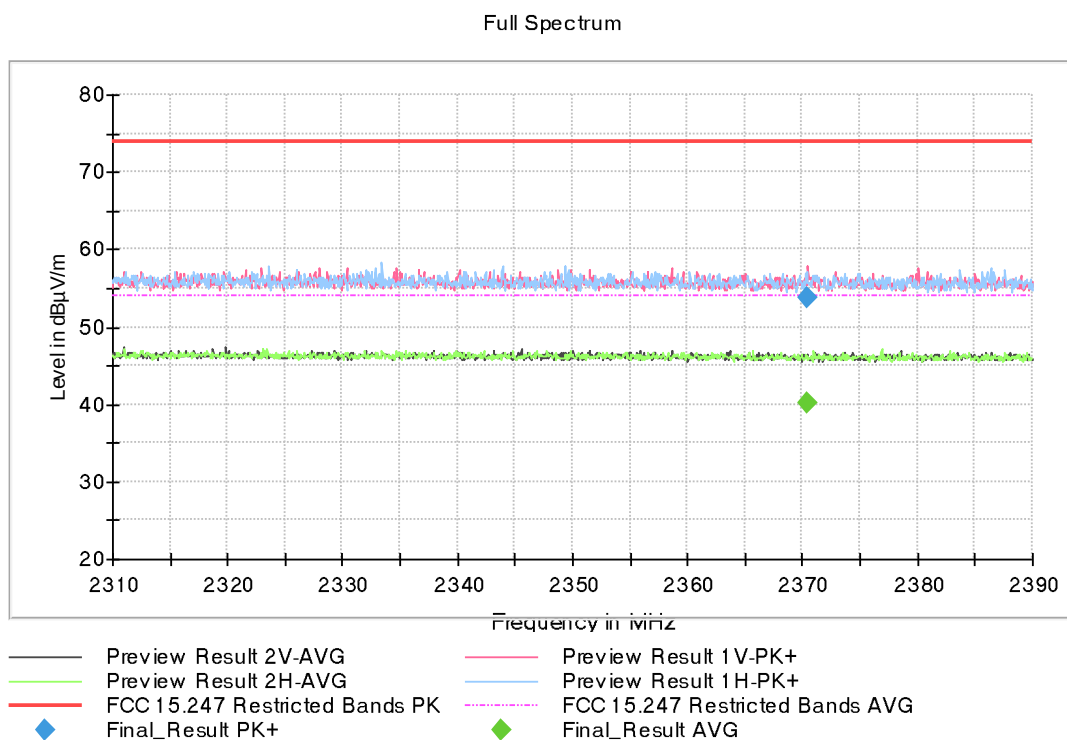


- Middle Channel:

Full Spectrum

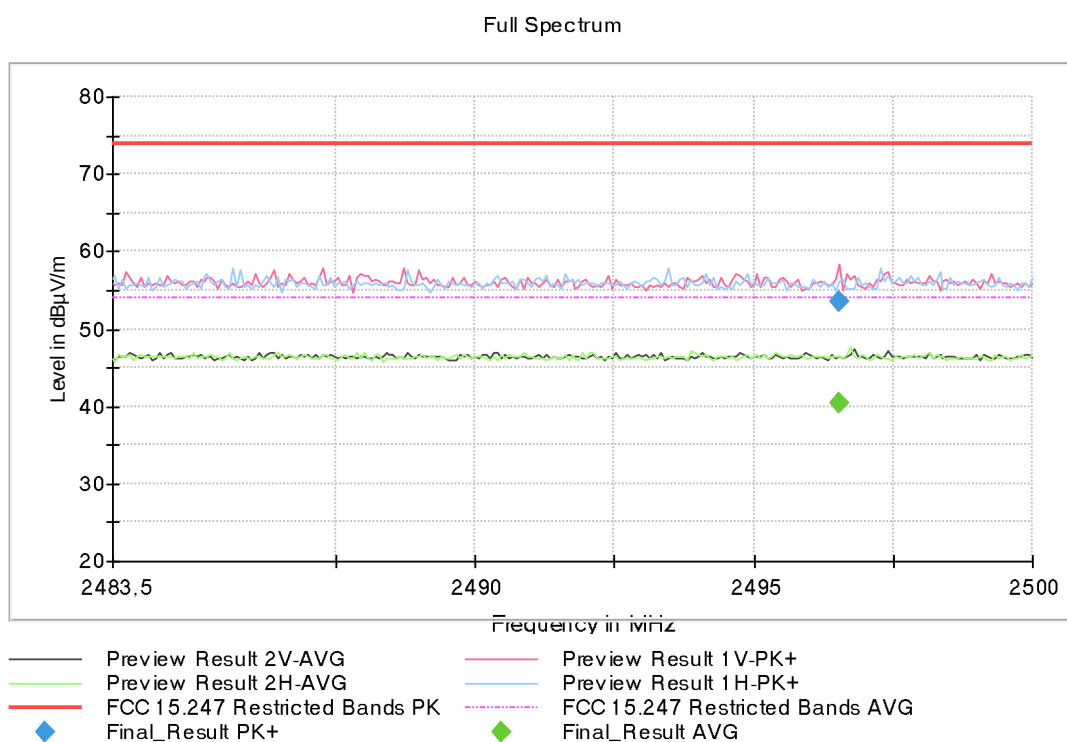


- High Channel:

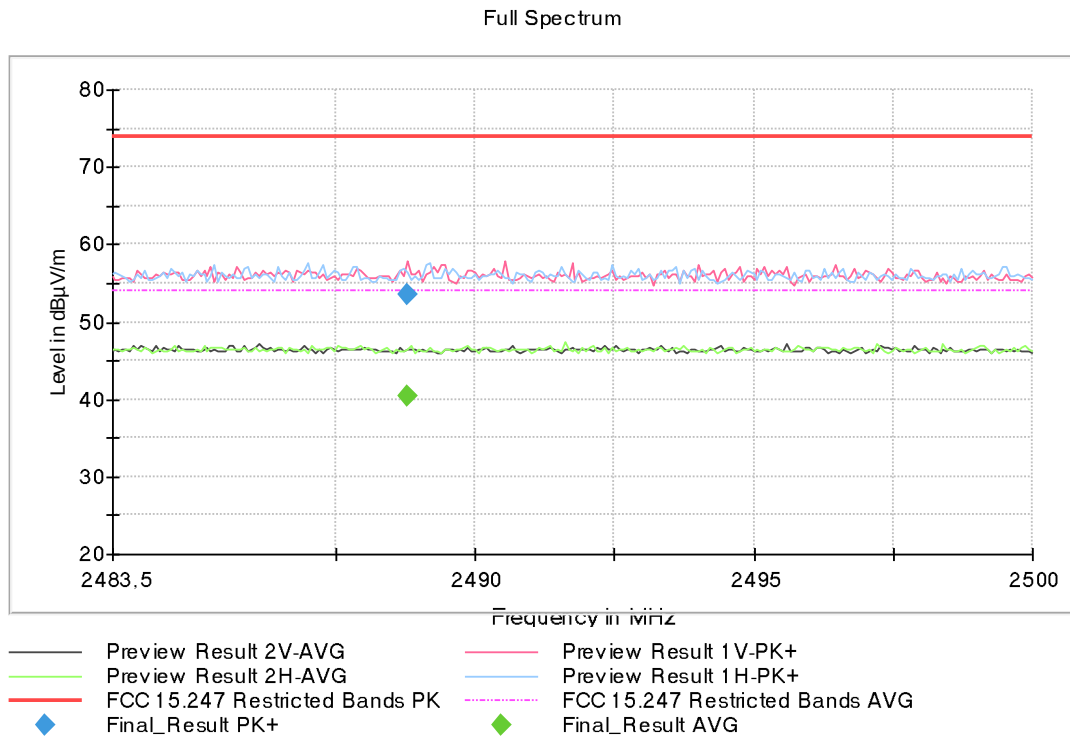


FREQUENCY RANGE 2.4835-2.5 GHz:

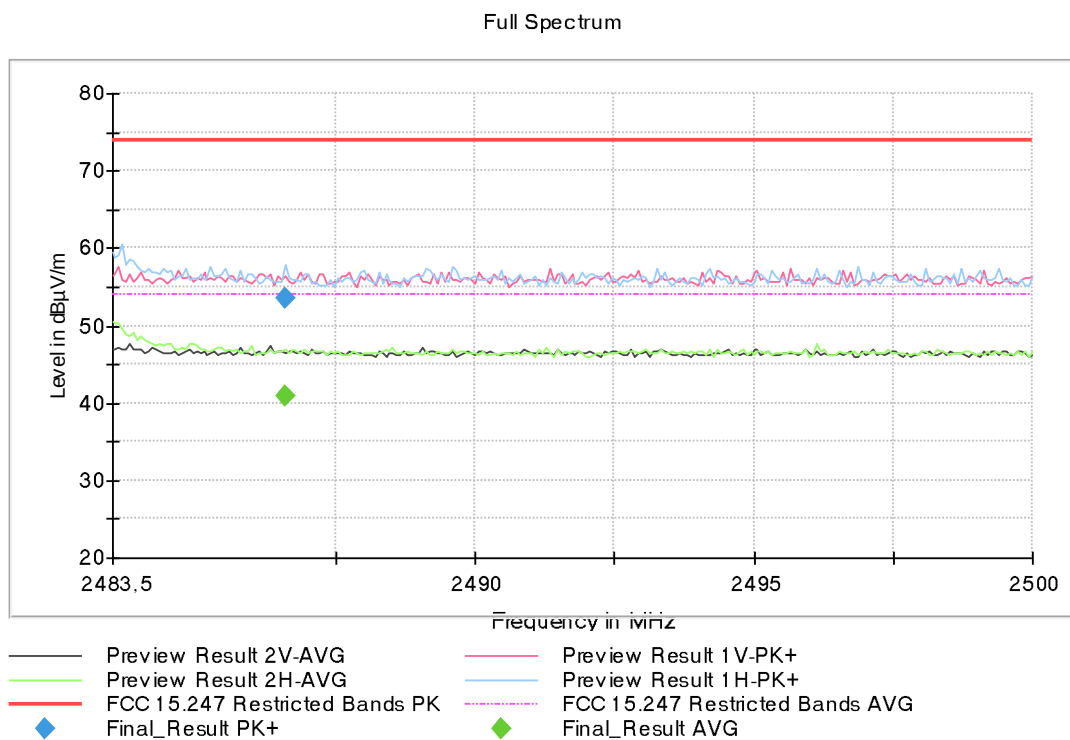
- Low Channel:



- Middle Channel:



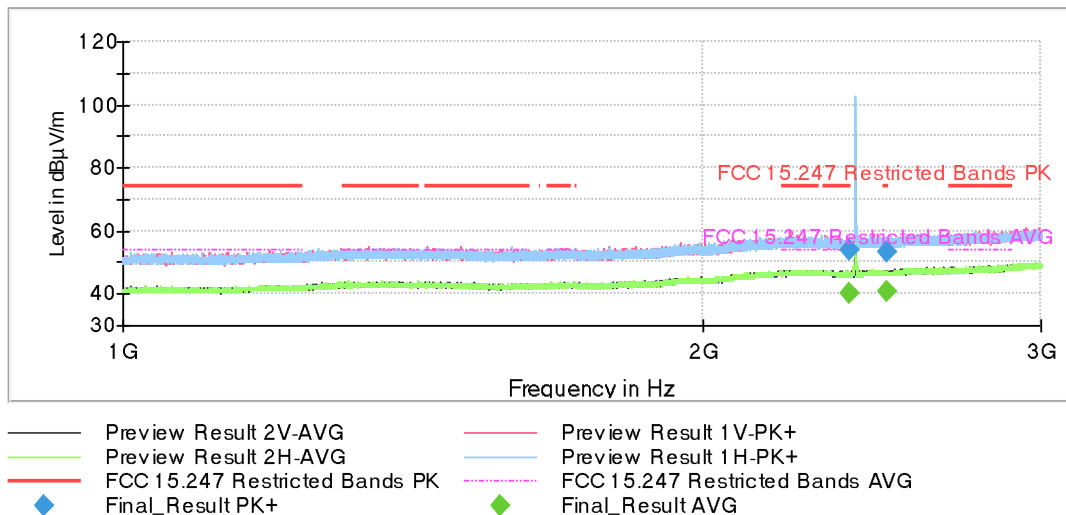
- High Channel:



- **1M modulation:**

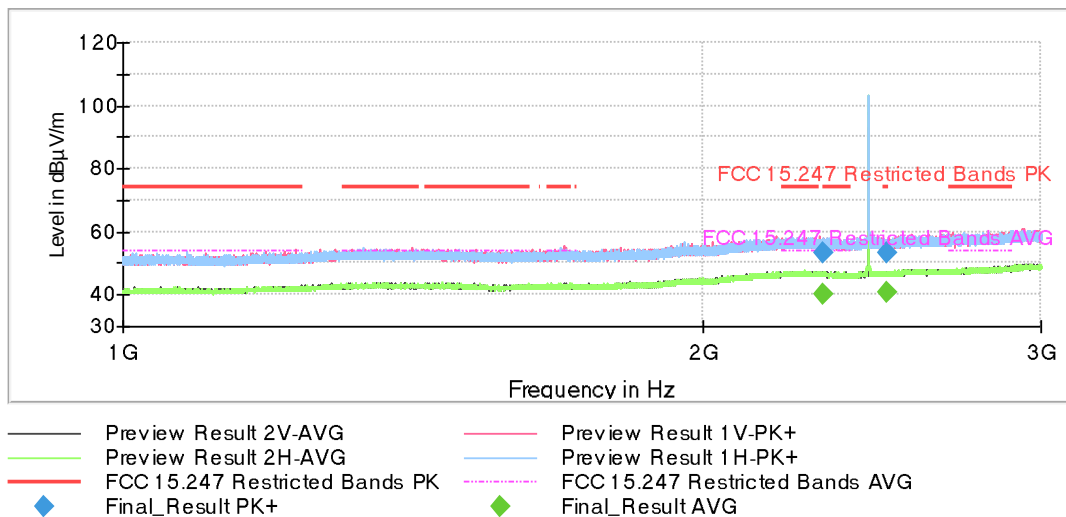
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



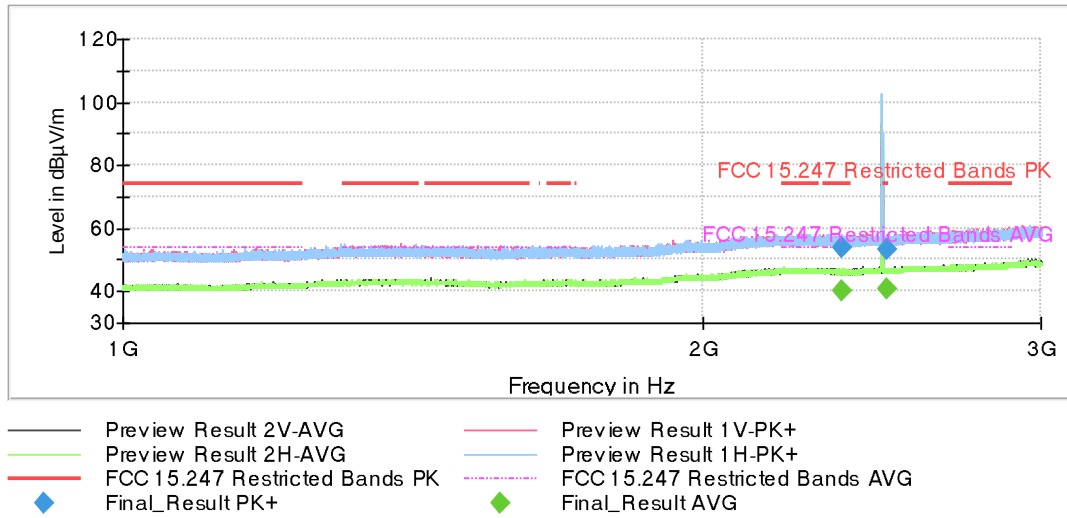
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

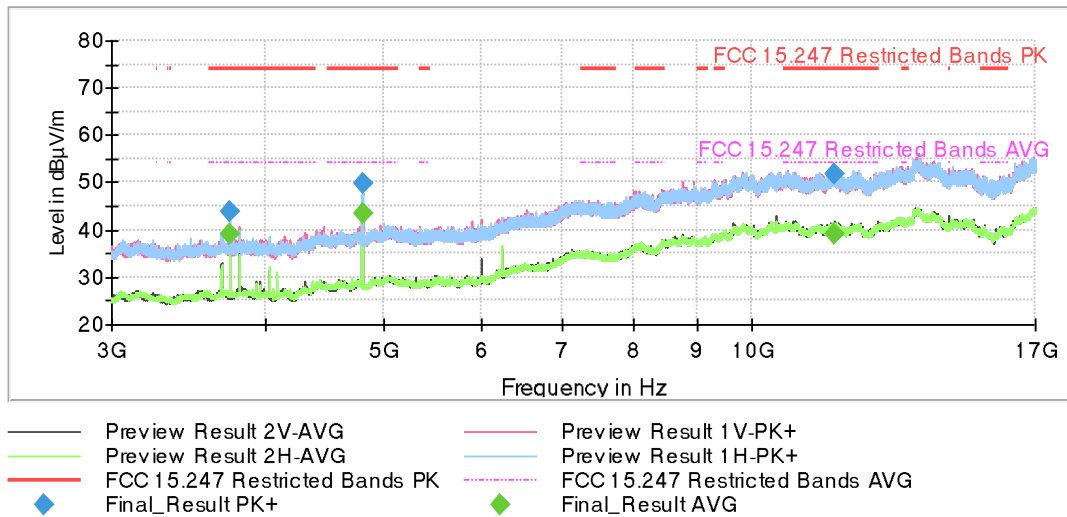
- High Channel:



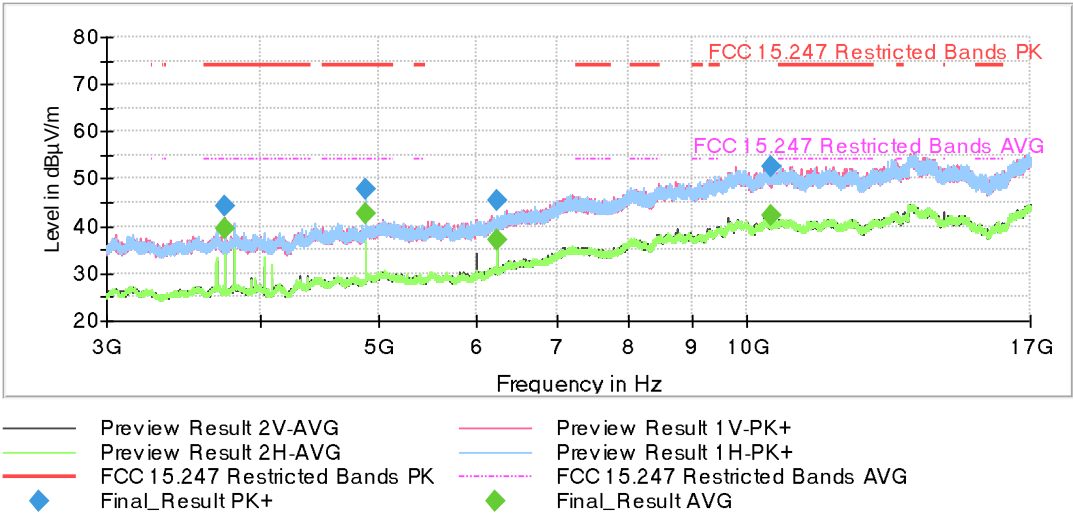
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

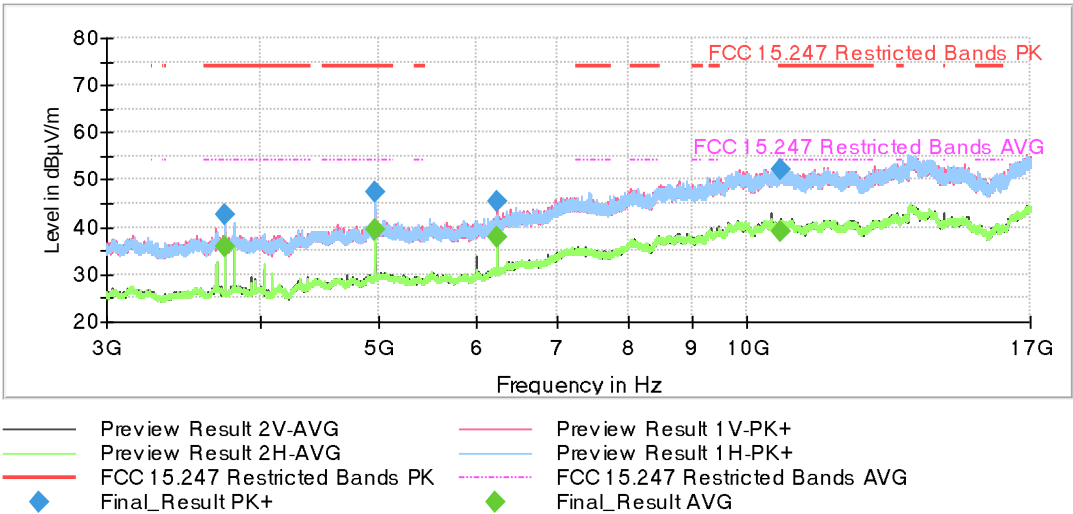
- Low Channel:



- Middle Channel:

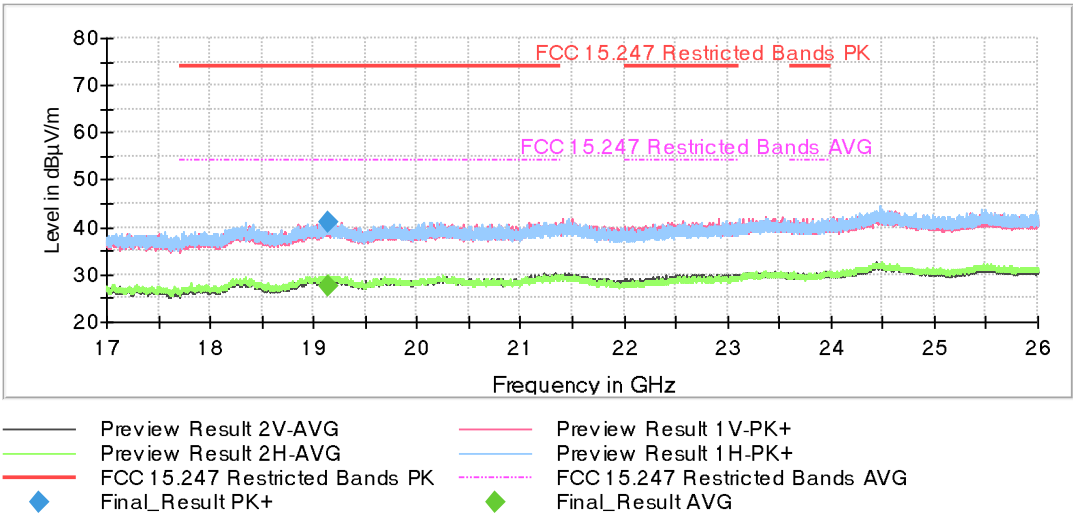


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

The spurious frequencies detected do not depend on the operating channel.

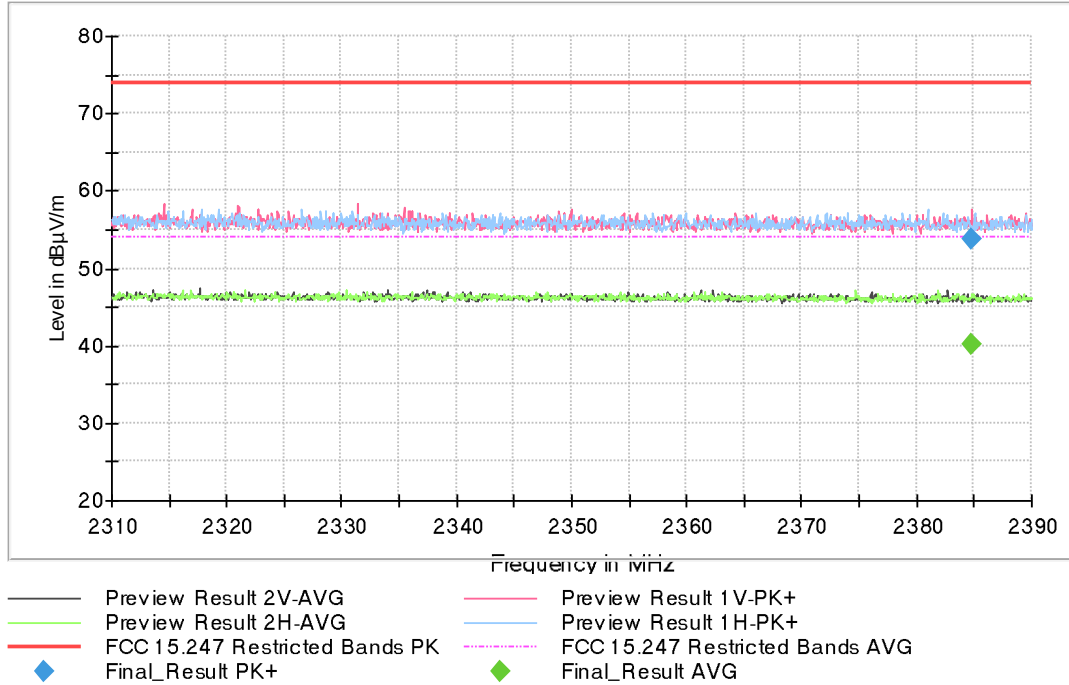


This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

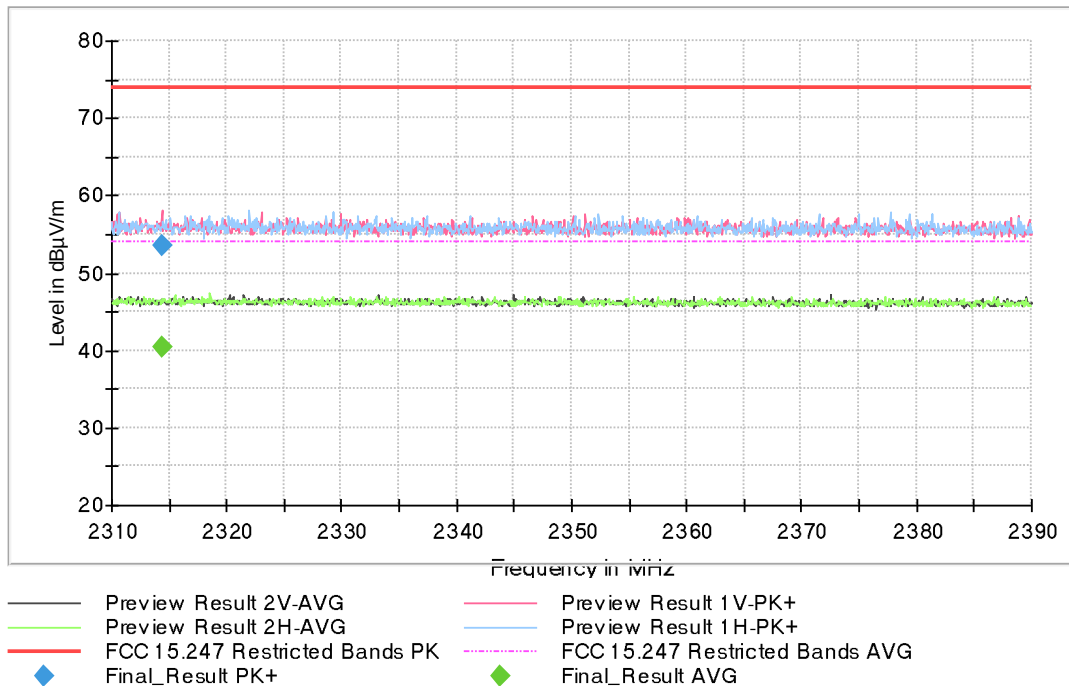
- Low Channel:

Full Spectrum



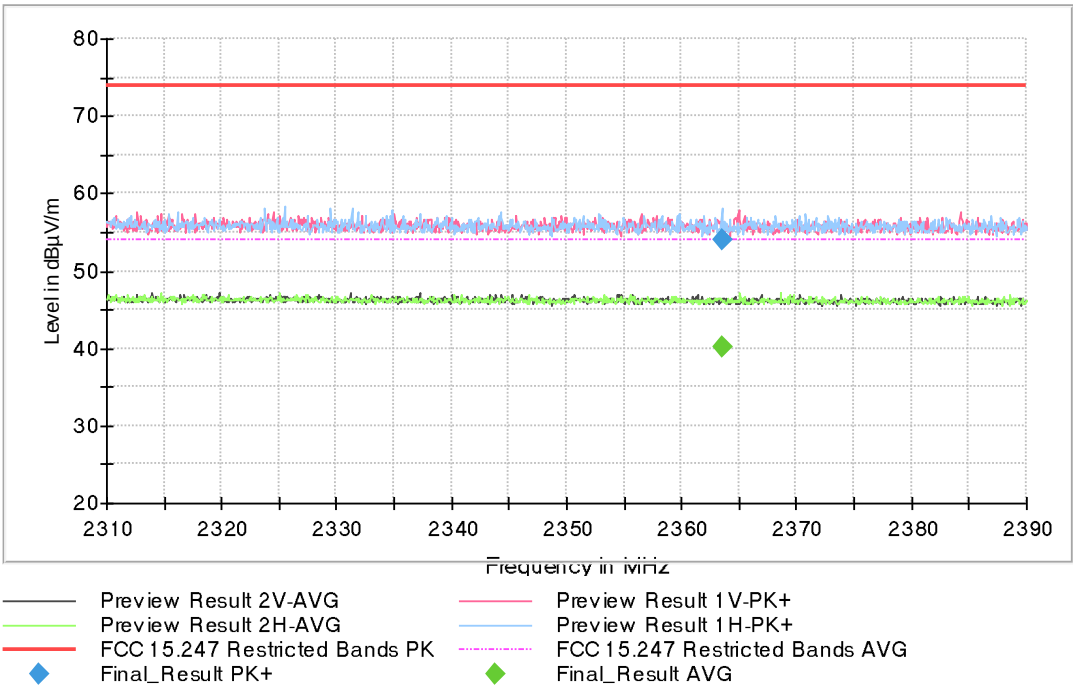
- Middle Channel:

Full Spectrum



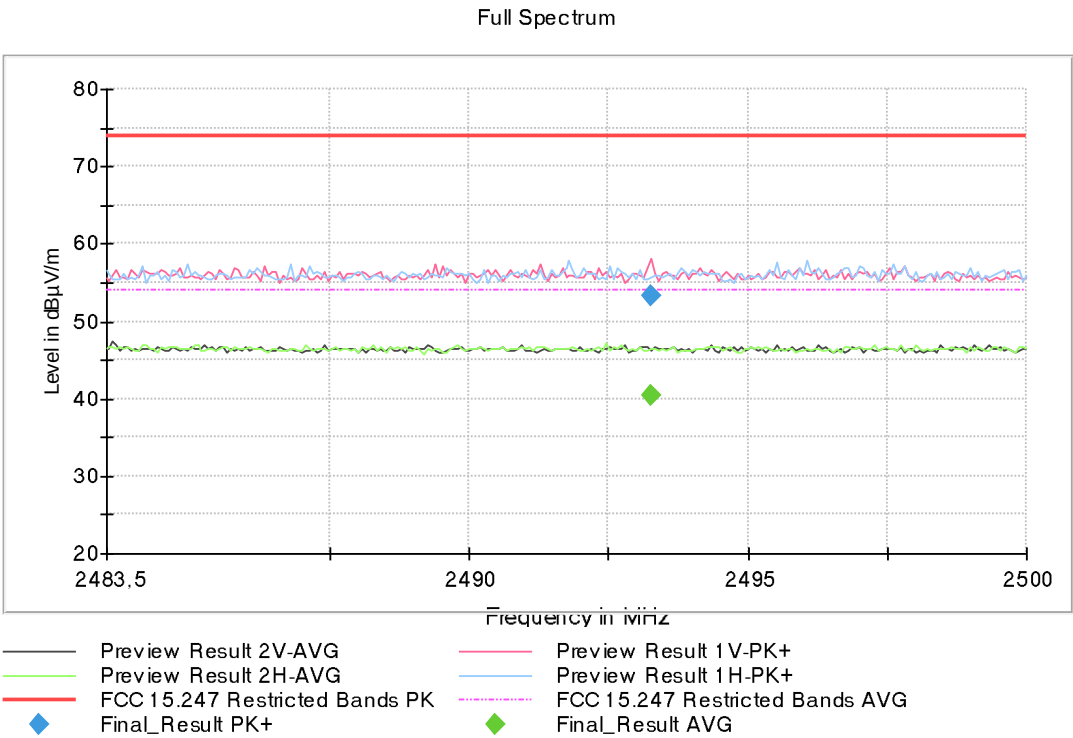
- High Channel:

Full Spectrum

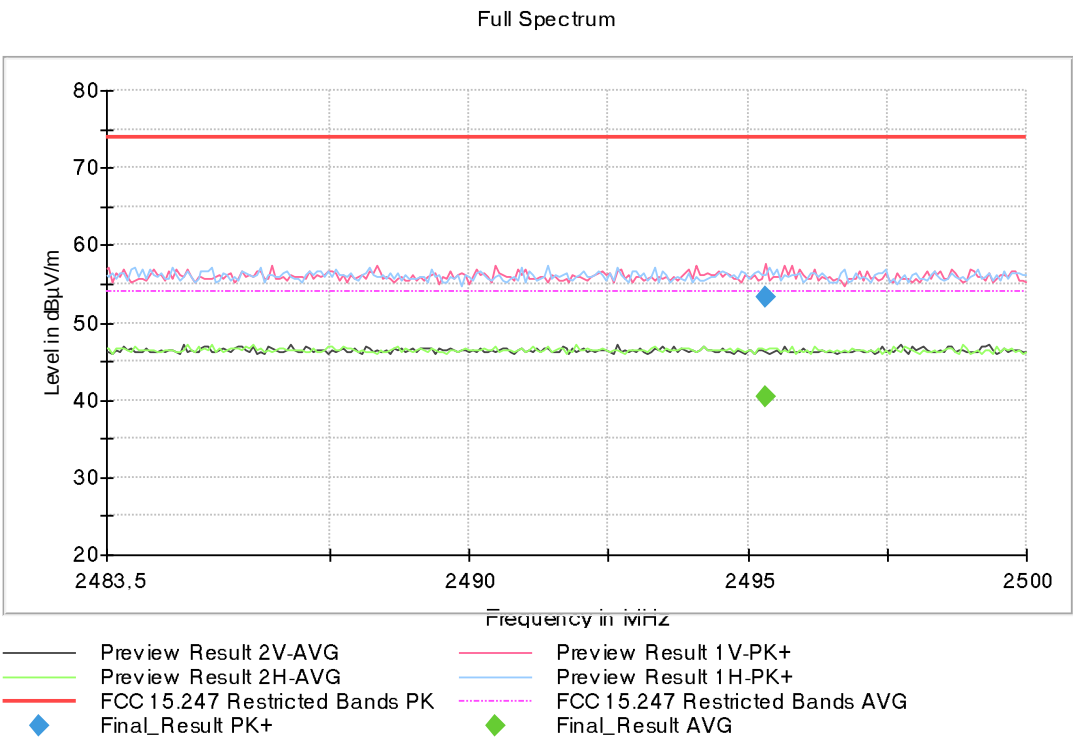


FREQUENCY RANGE 2.4835-2.5 GHz:

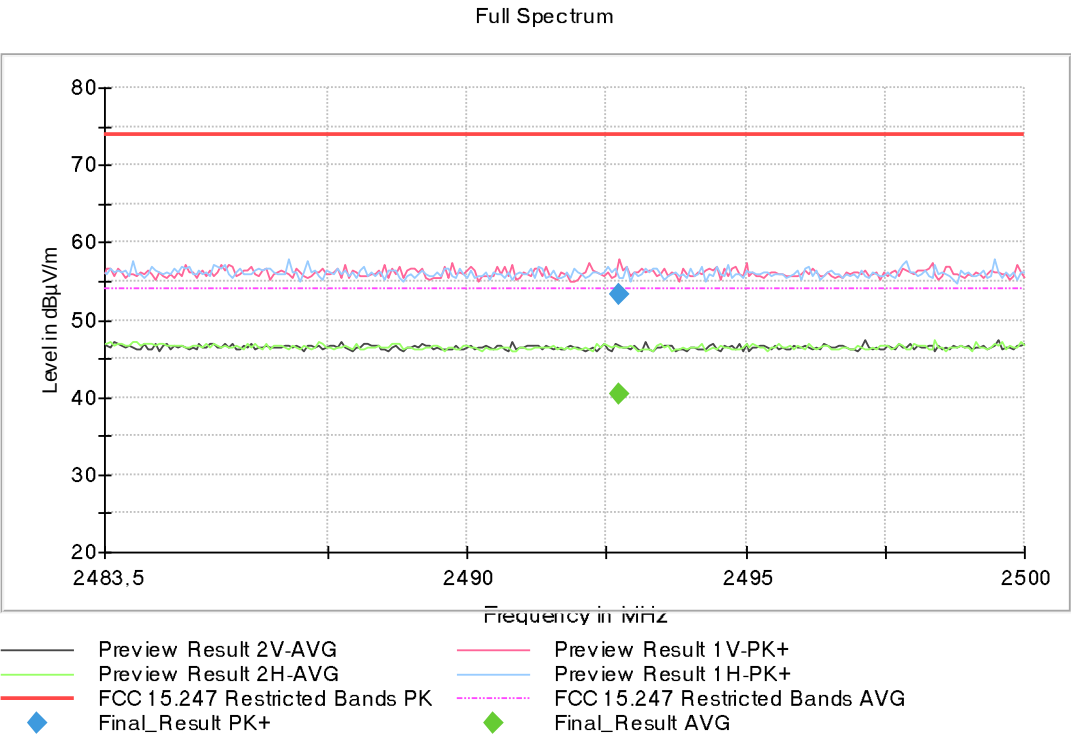
- Low Channel:



- Middle Channel:



- High Channel:



Appendix B: Test results. Bluetooth Low Energy 5.0 (2M, 1M): Bluetooth LE (2)

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TEST CONDITIONS

(*) Declared by the Client.

POWER SUPPLY (*):

Vnominal: 110 Vac
Type of Power Supply: AC/DC Adapter.

ANTENNA (*):

Type of Antenna: Integral.
Maximum Declared Antenna Gain: +3.7 dBi

TEST FREQUENCIES (*):

Low Channel: 2402 MHz
Middle Channel: 2440 MHz
High Channel: 2480 MHz

POWER SETTINGS (*):

Bluetooth (2) setting is 200

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (antenna and 18 GHz-40 GHz horn antenna).

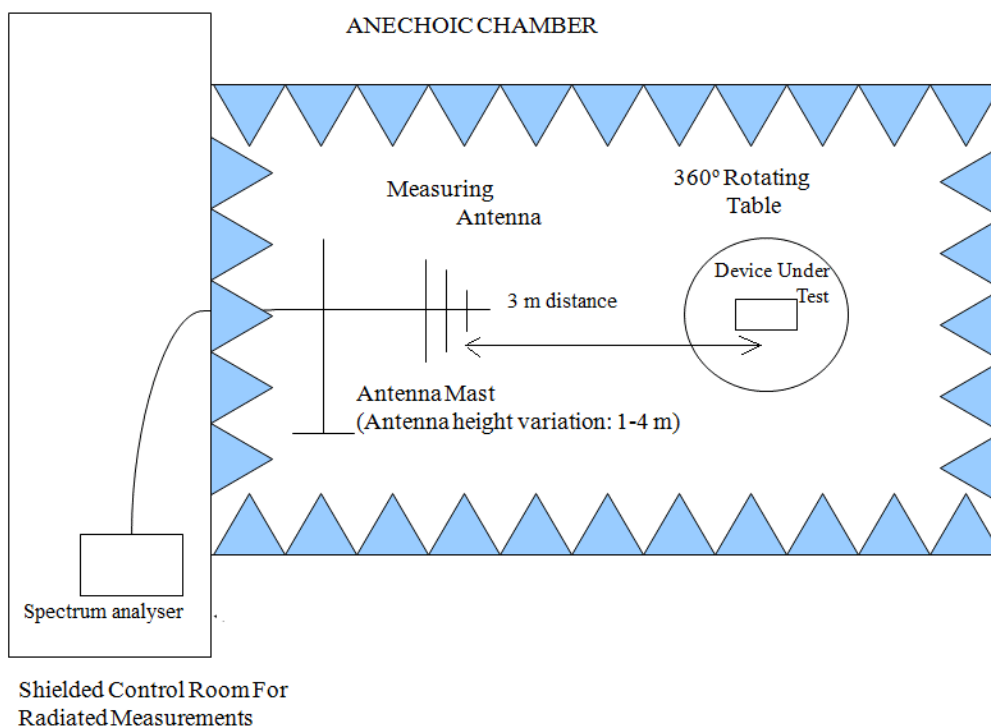
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

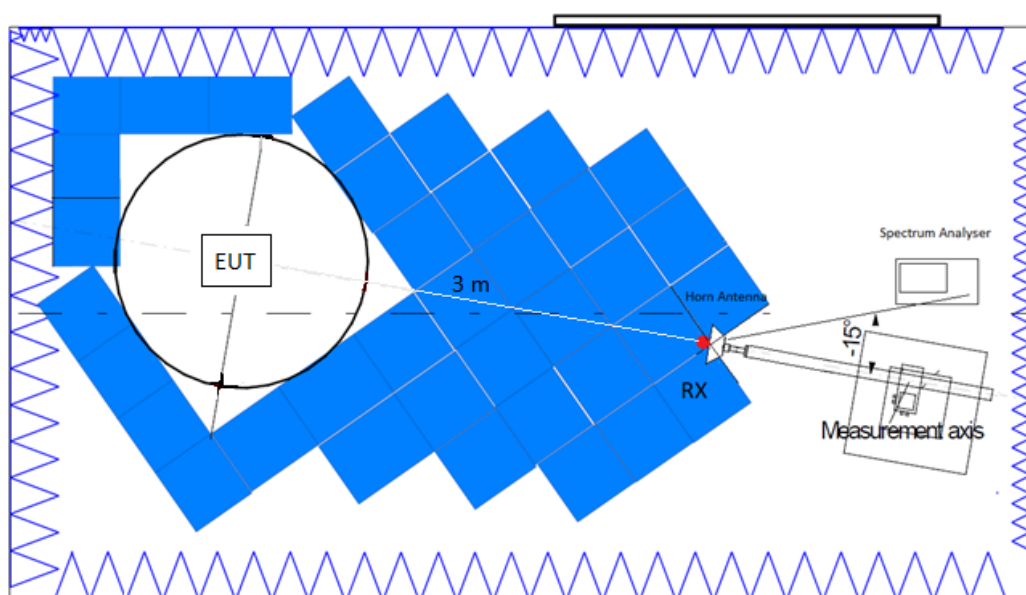
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

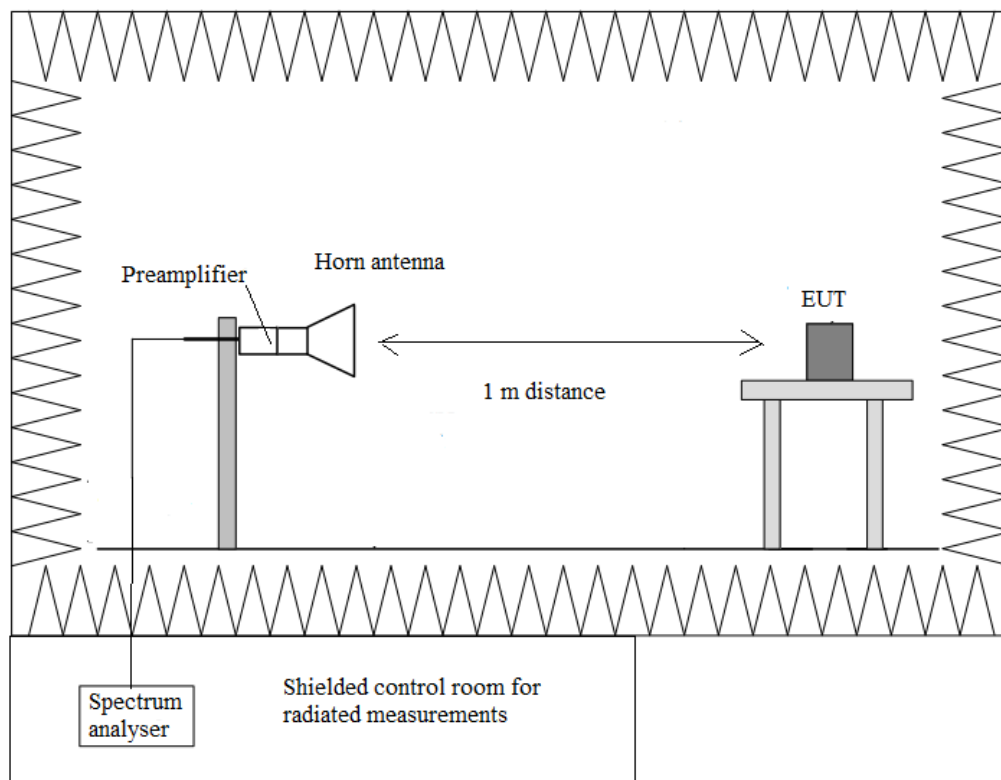
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



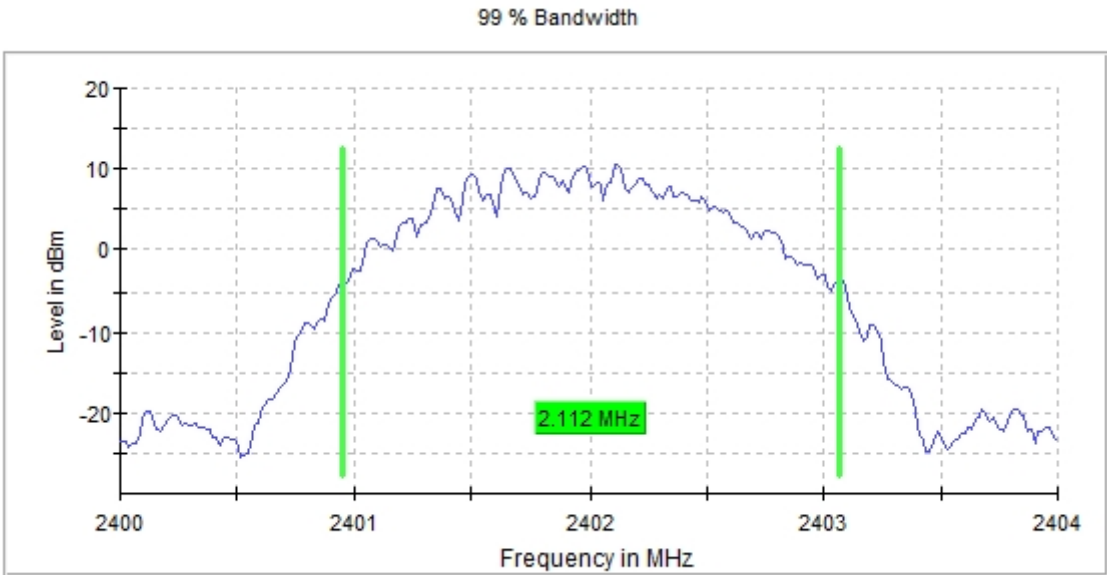
Occupied Bandwidth

RESULTS:

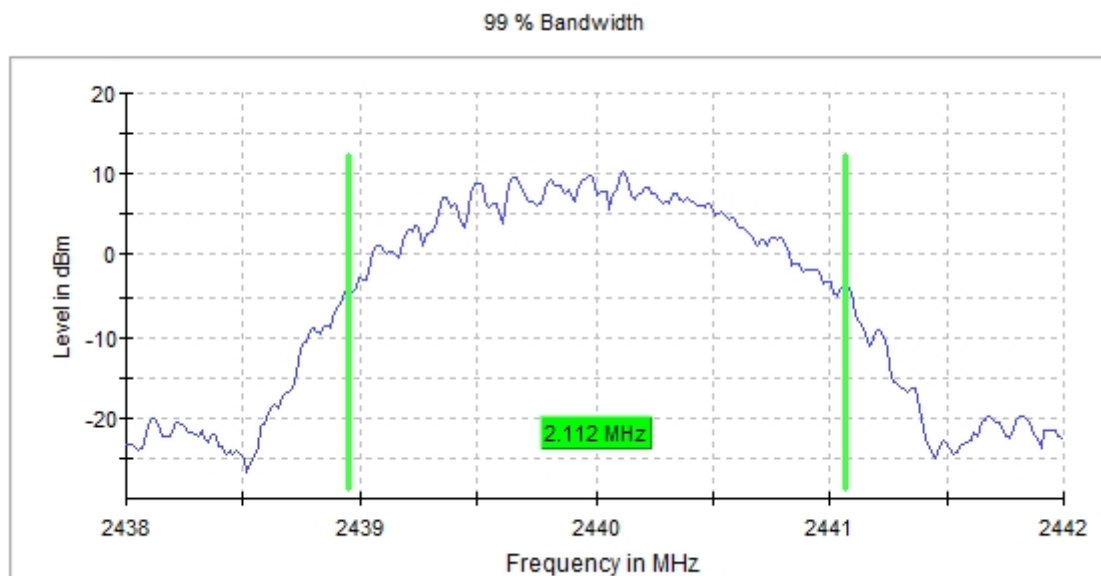
• 2M modulation:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	2.112359	2.112359	2.127340
Measurement uncertainty (%)	<± 1.17		

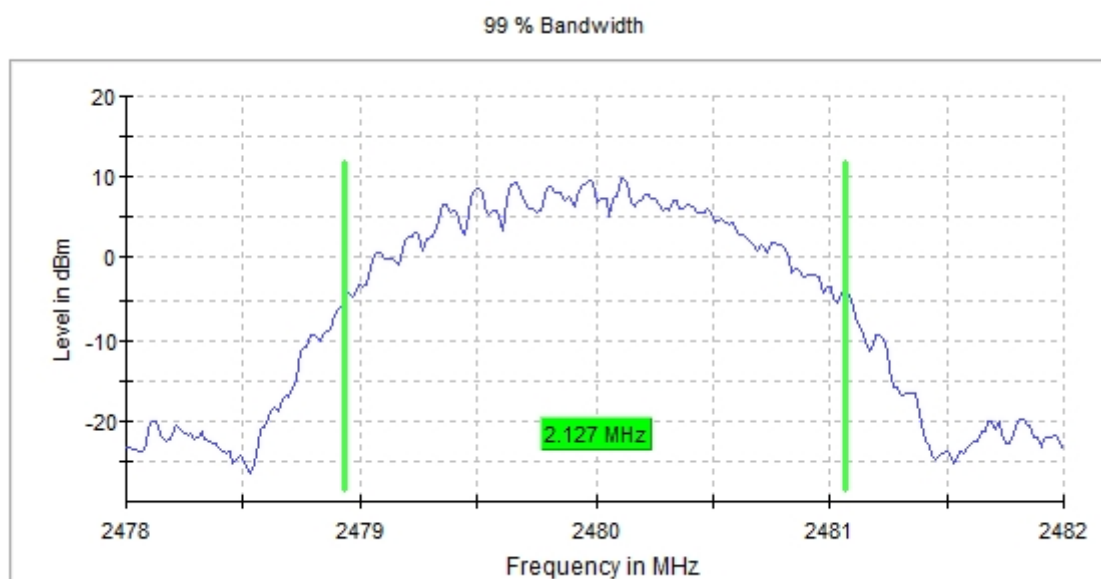
- Low Channel:



- Middle Channel:



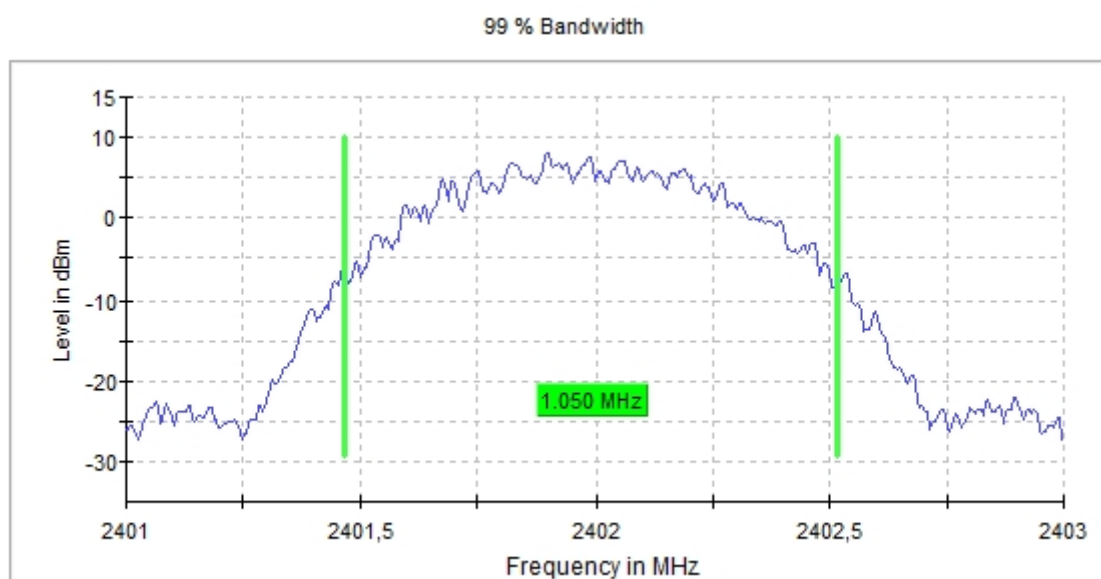
- High Channel:



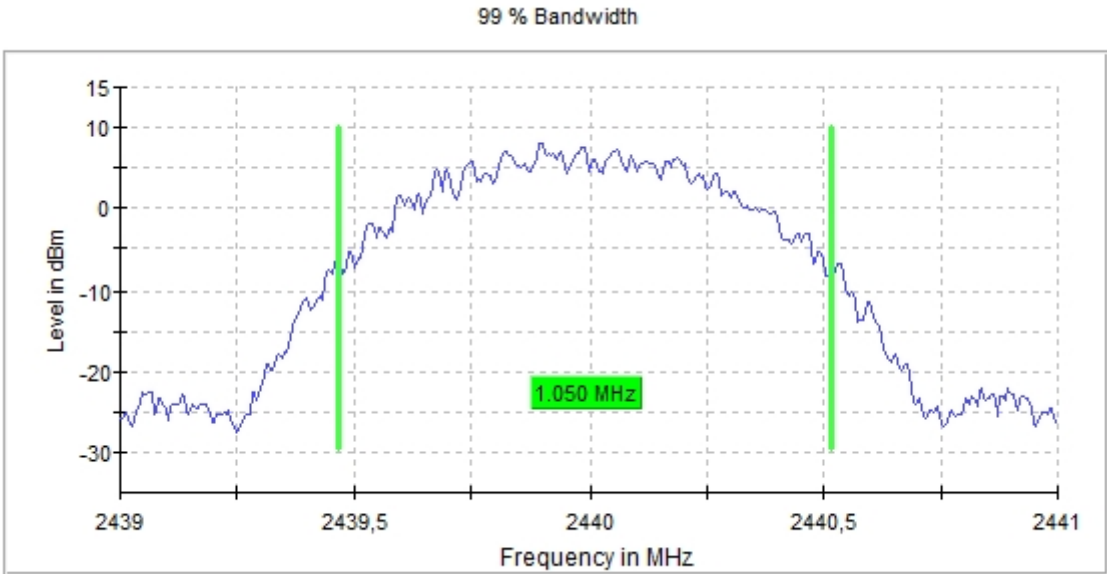
• **1M modulation:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	1.050000	1.050000	1.050000
Measurement uncertainty (%)	<± 1.17		

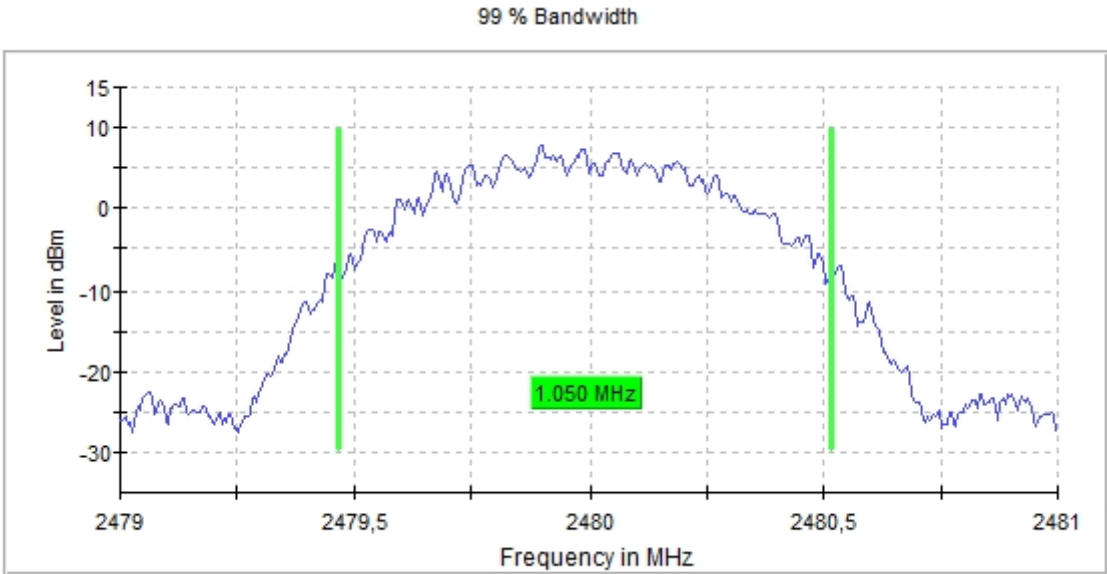
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (a)(2) / RSS-247 5.2. (a) 6 dB Bandwidth

SPECIFICATION:

The minimum 6 dB bandwidth shall be at least 500 kHz.

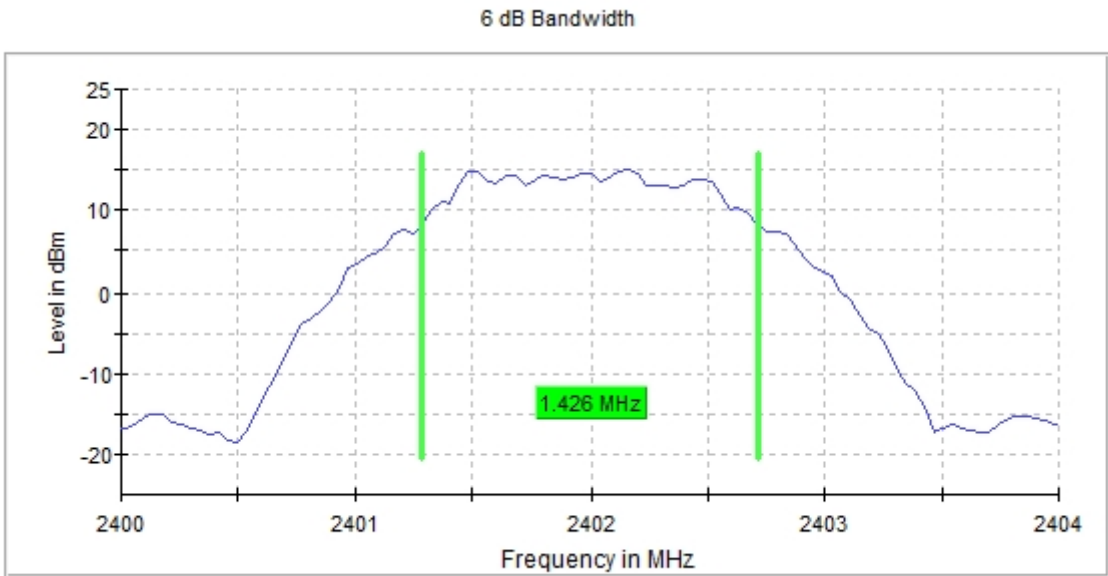
RESULTS:

• 2M modulation:

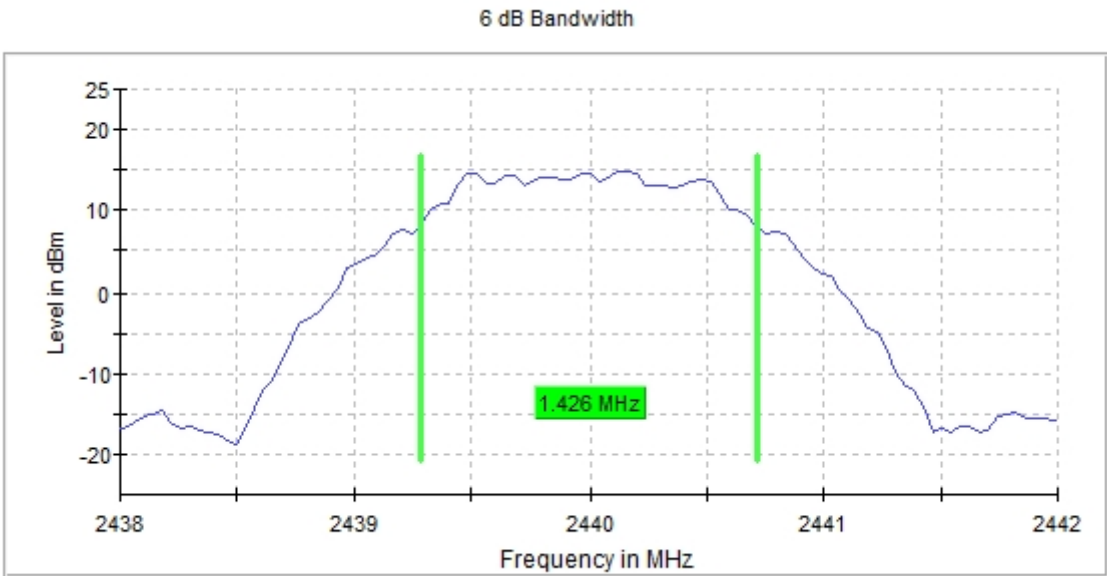
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
6 dB Spectrum bandwidth (MHz)	1.425742	1.425742	1.425742
Measurement uncertainty (%)	<±2.84		

Verdict: PASS

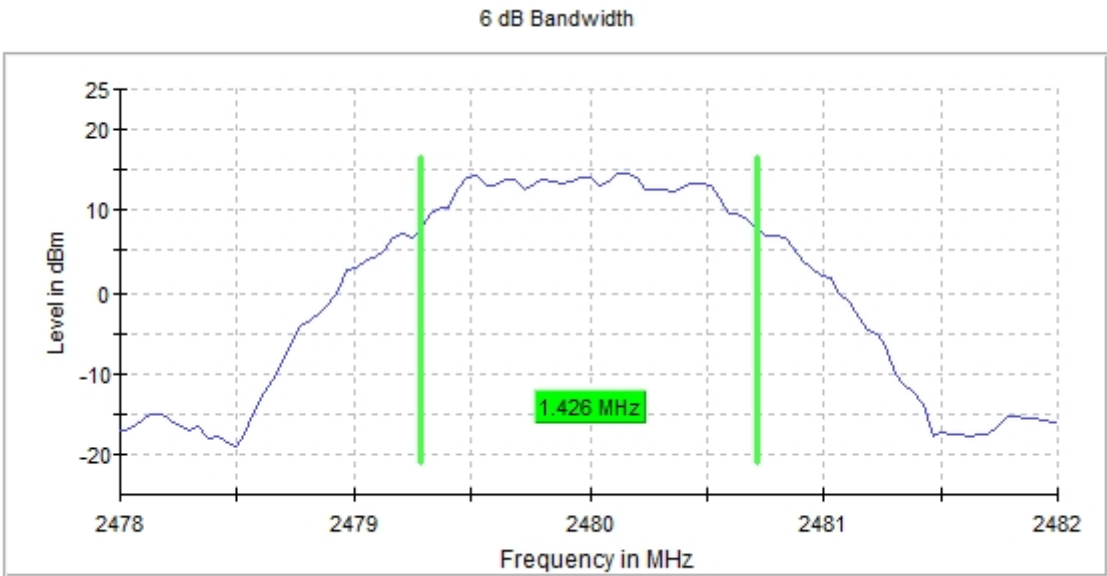
- Low Channel:



- Middle Channel:



- High Channel:

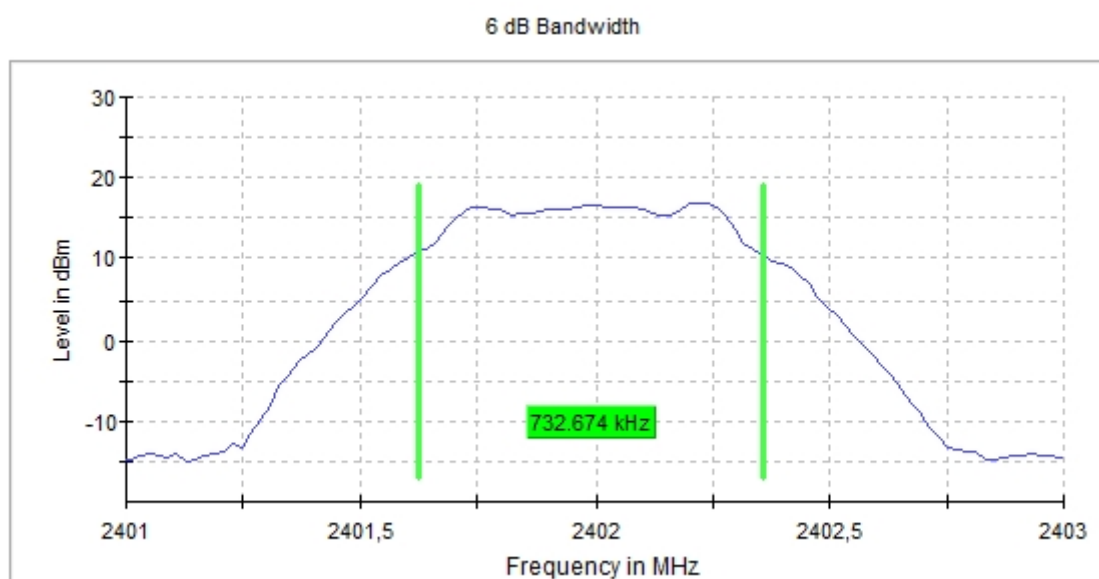


• **1M modulation:**

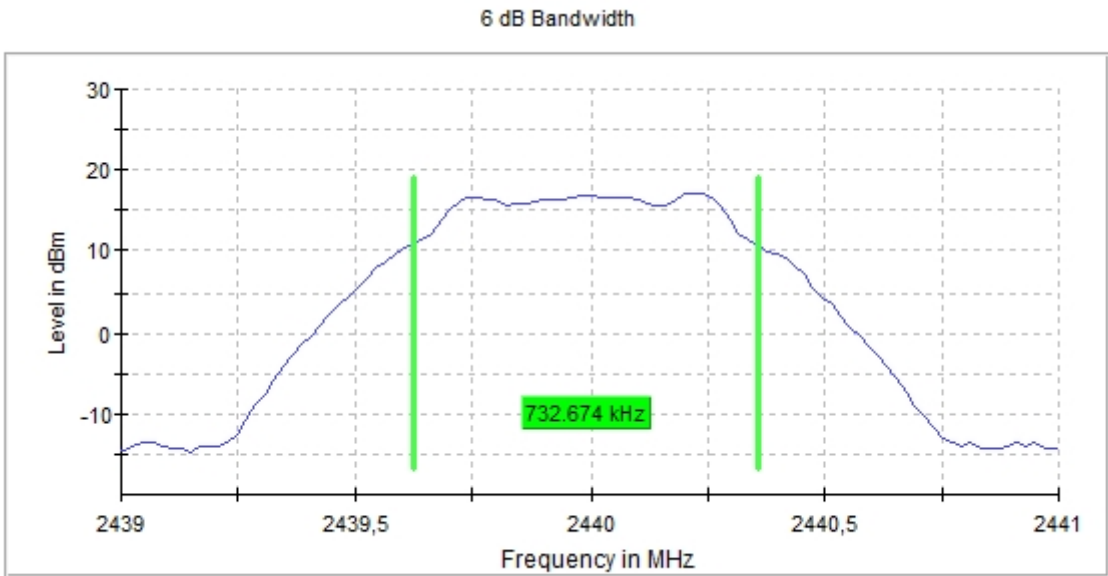
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
6 dB Spectrum bandwidth (MHz)	0.732674	0.732674	0.732674
Measurement uncertainty (%)	<±2.84		

Verdict: PASS

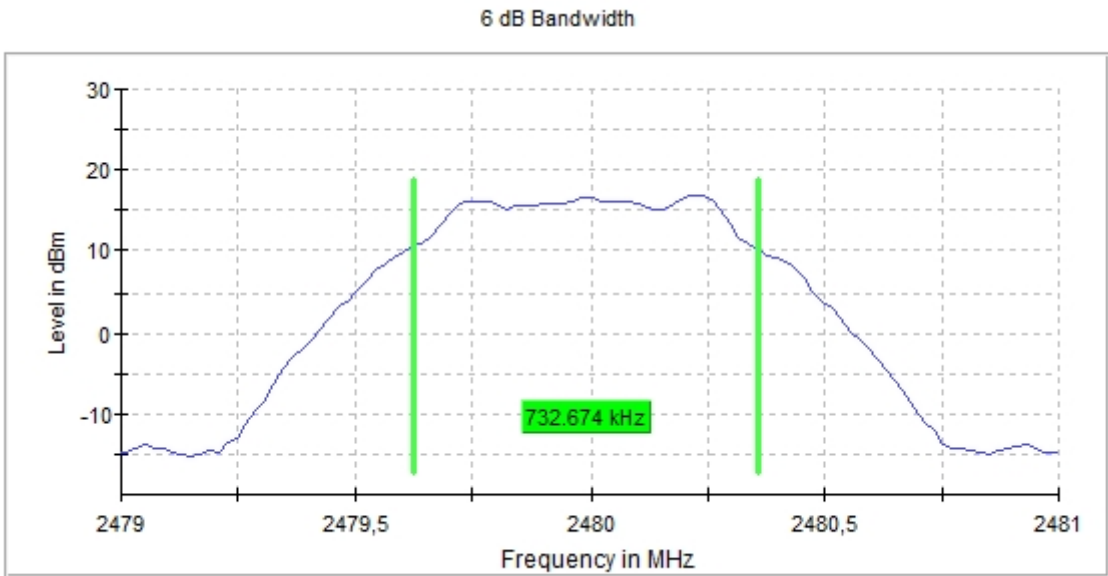
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (b) / RSS-247 5.4. (d) Maximum Output Power and Antenna Gain

SPECIFICATION:

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS:

The maximum peak conducted output power level in the fundamental emission was measured using the method according to point 11.9.1.1 "RBW $\geq$ DTS bandwidth" of ANSI C.63.10-2013.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: +3.7 dBi

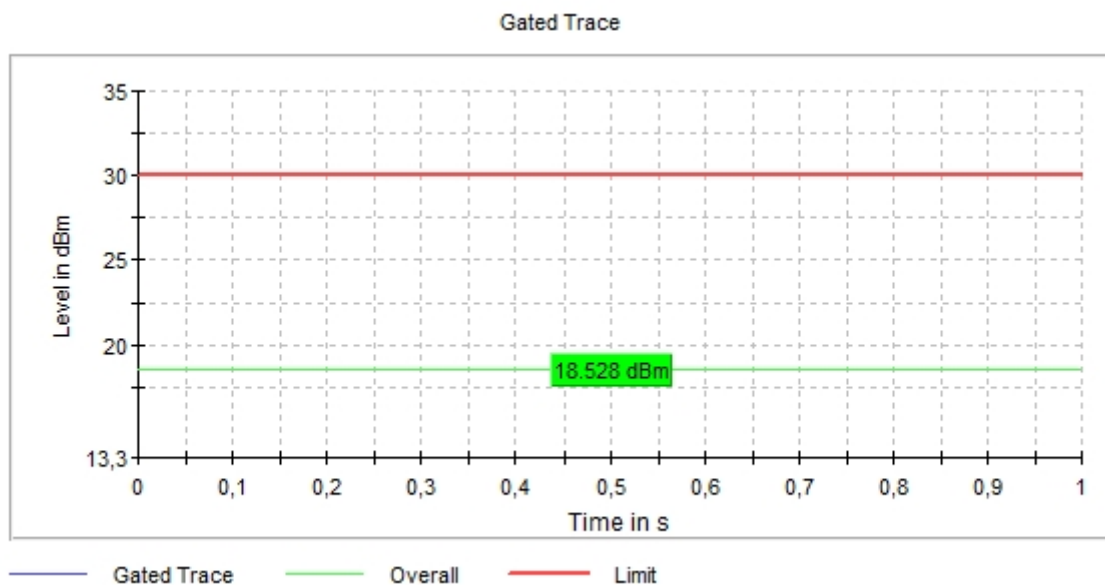
• 2M modulation:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	18.528	18.505	18.142
Maximum EIRP Power (dBm)	22.228	22.205	21.842
Measurement uncertainty (dB)	< $\pm$ 0.80		

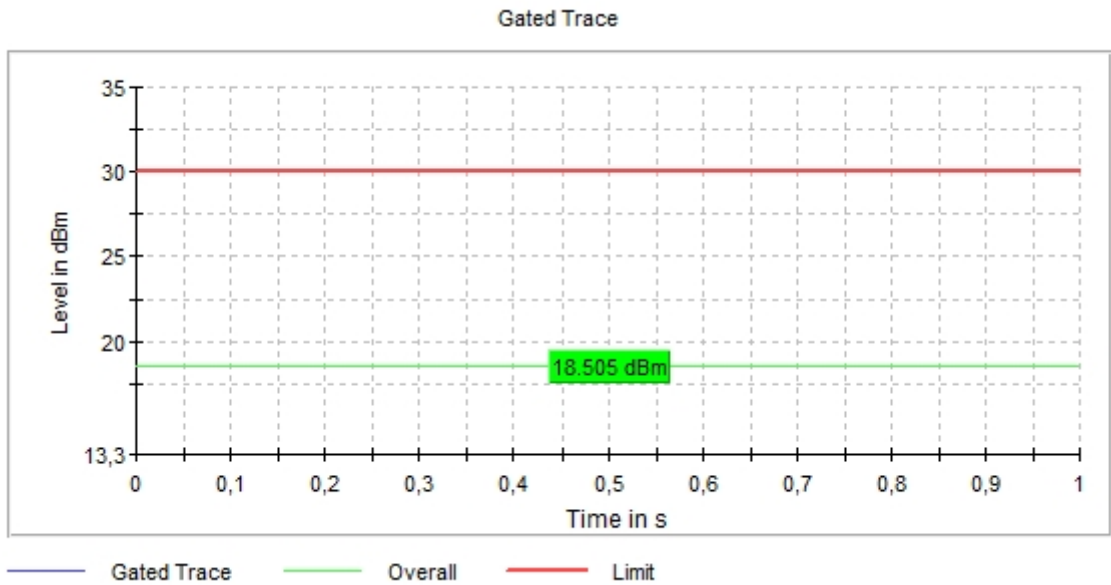
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

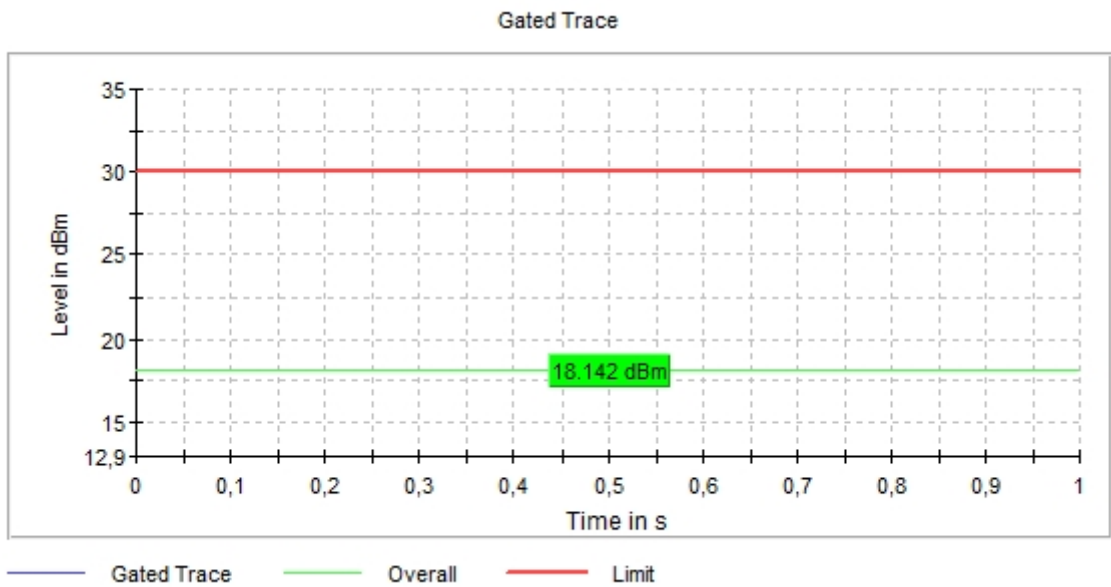
- Low Channel:



- Middle Channel:



- High Channel:



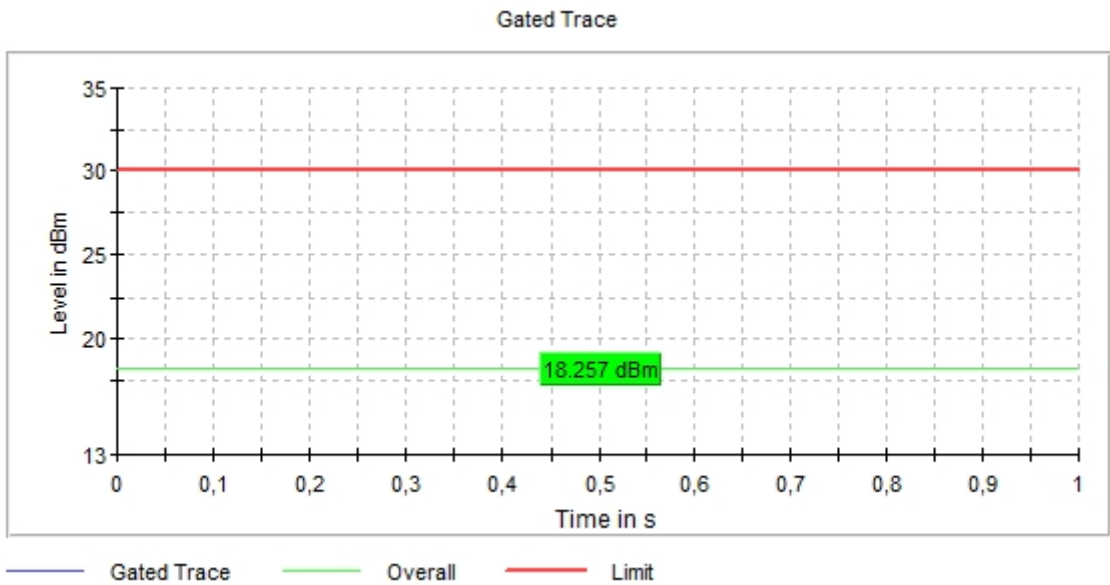
• 1M modulation:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	18.257	18.520	18.159
Maximum EIRP Power (dBm)	21.957	22.220	21.859
Measurement uncertainty (dB)	<±0.80		

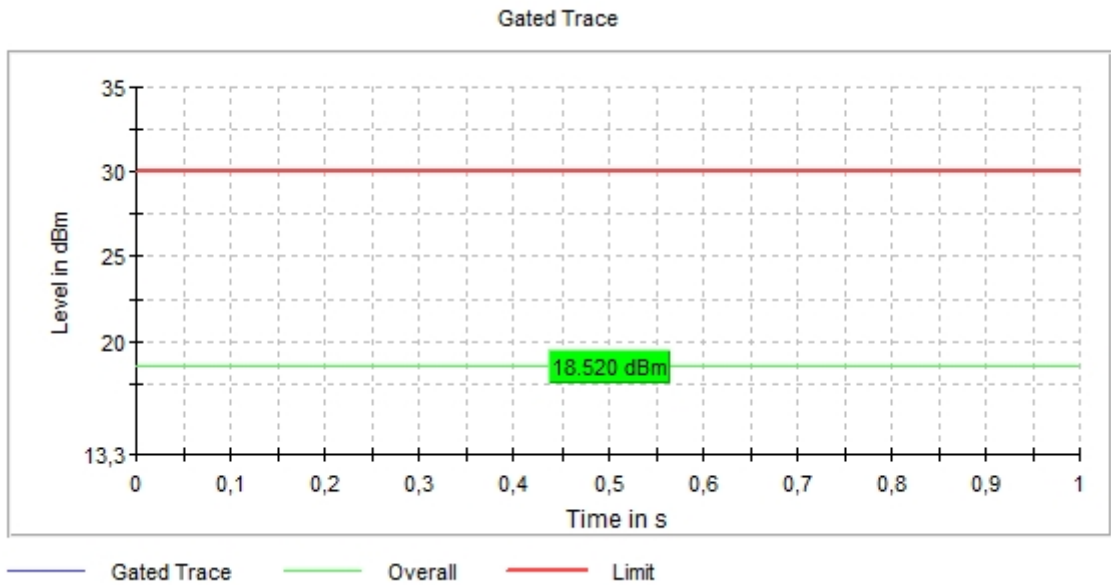
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

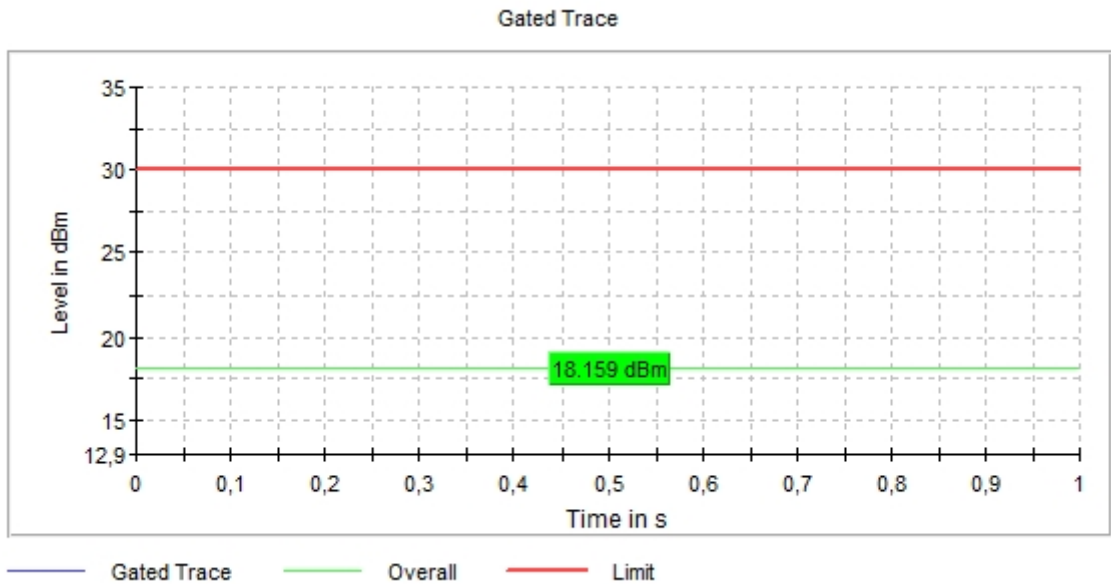
- Low Channel:



- Middle Channel:



- High Channel:



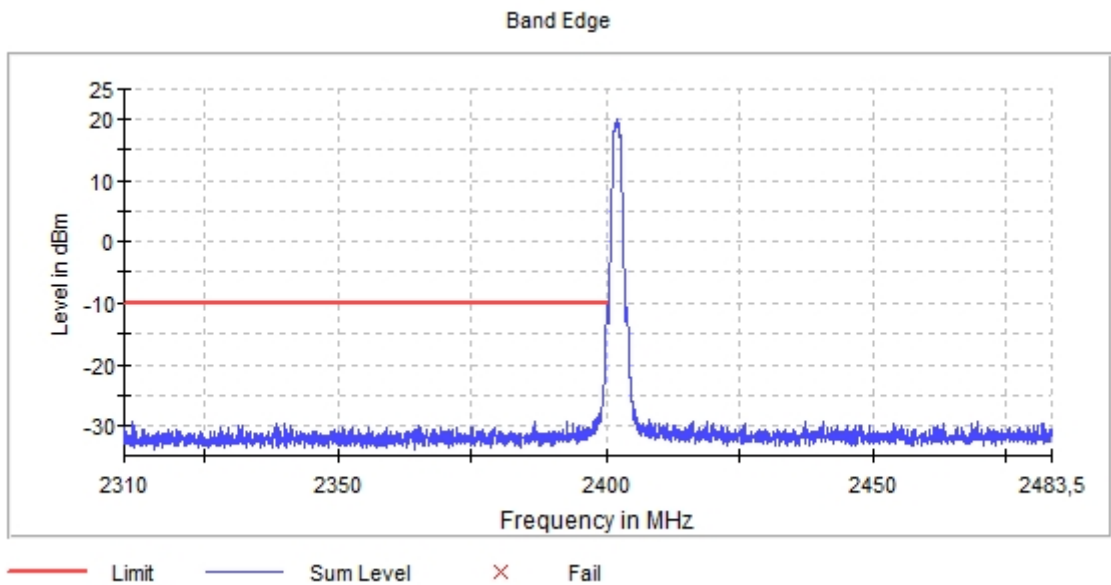
FCC 15.247 (d) / RSS-247 5.5. Band-Edge Emissions Compliance (Transmitter)

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

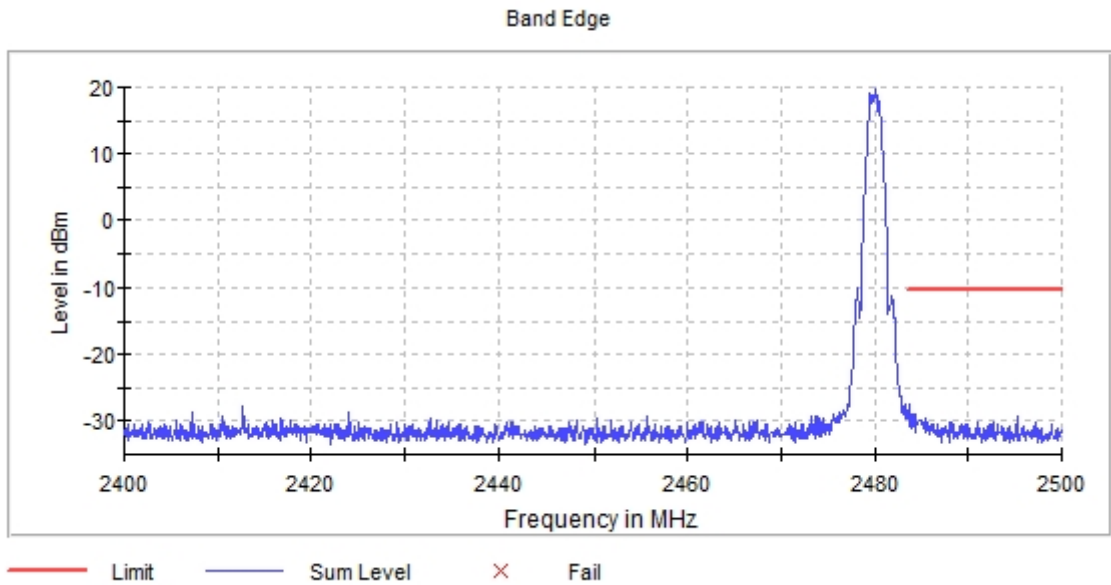
RESULTS:

- 2M modulation:
- Low Channel:



Measurement uncertainty (dB)	<±1.53
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- High Channel:

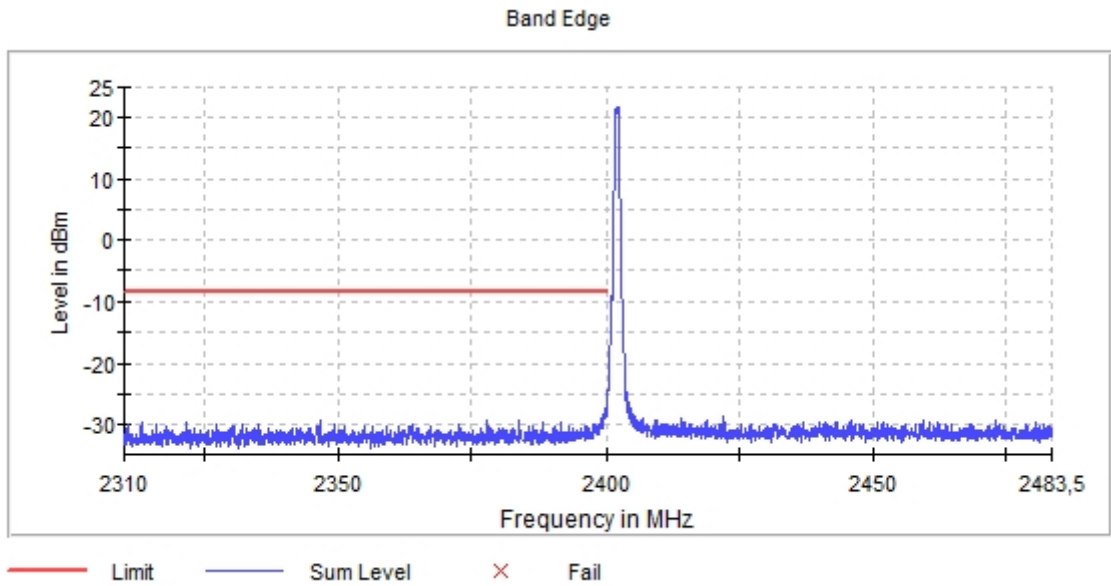


Measurement uncertainty (dB)	<±1.53
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Verdict: PASS

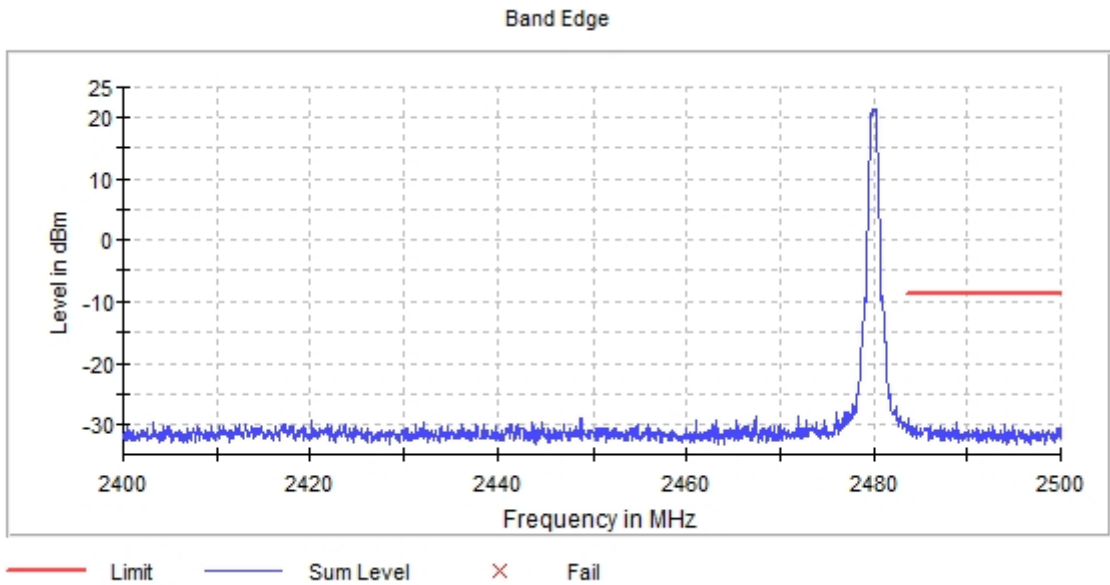
• 1M modulation:

- Low Channel:



Measurement uncertainty (dB)	<±1.53
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- High Channel:



Measurement uncertainty (dB)	<±1.53
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Verdict: PASS

FCC 15.247 (e) / RSS-247 5.2. (b) Power Spectral Density

SPECIFICATION:

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.

RESULTS:

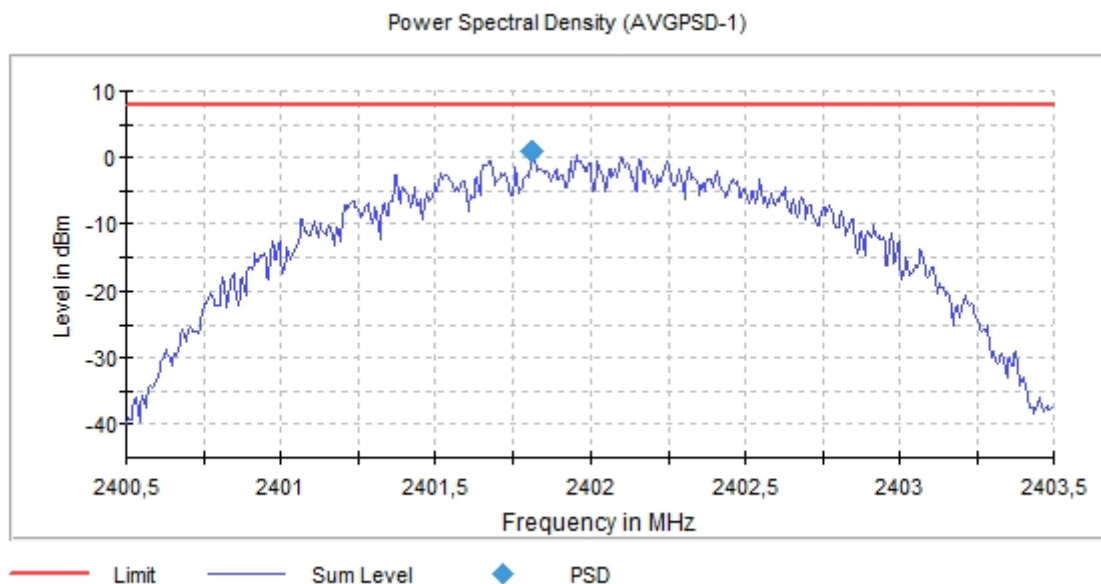
The maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2." Method PKPSD (peak PSD)" of ANSI C.63.10-2013.

• 2M modulation:

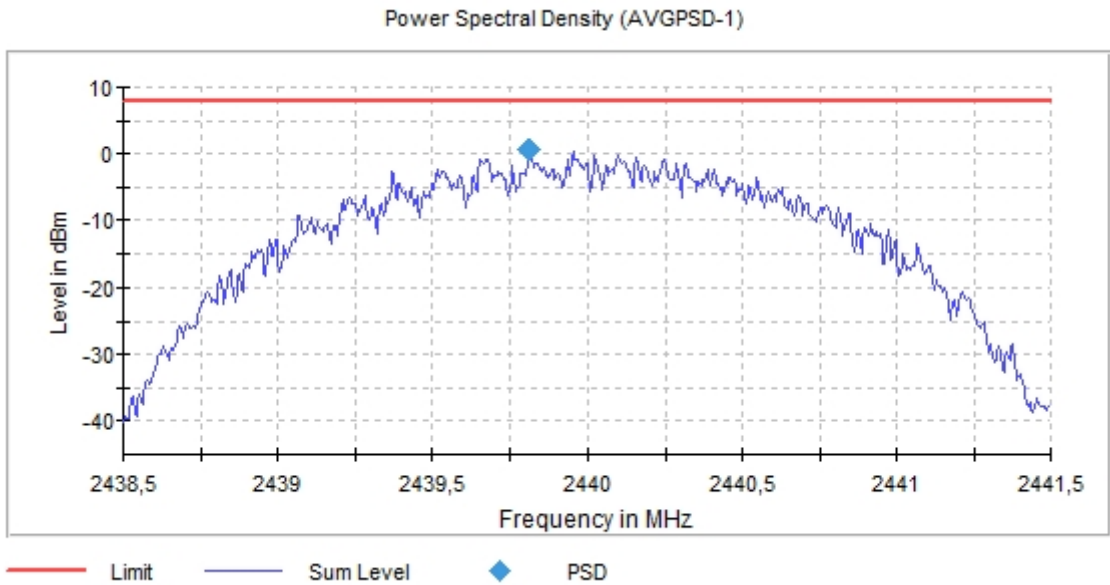
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	0.842	0.707	0.432
Measurement uncertainty (dB)	<±0.99		

Verdict: PASS

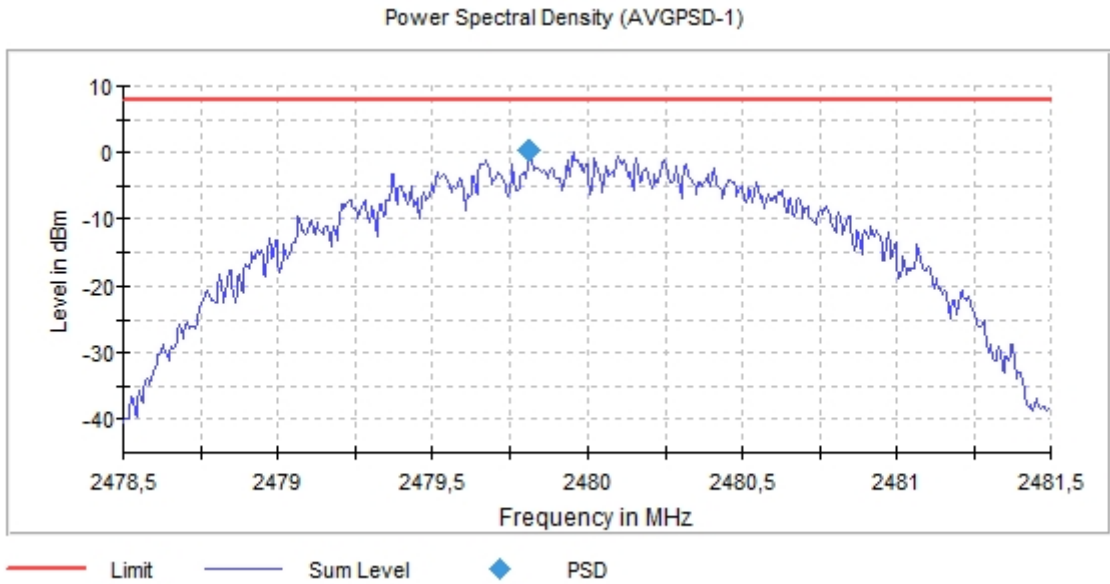
- Low Channel:



- Middle Channel:



- High Channel:

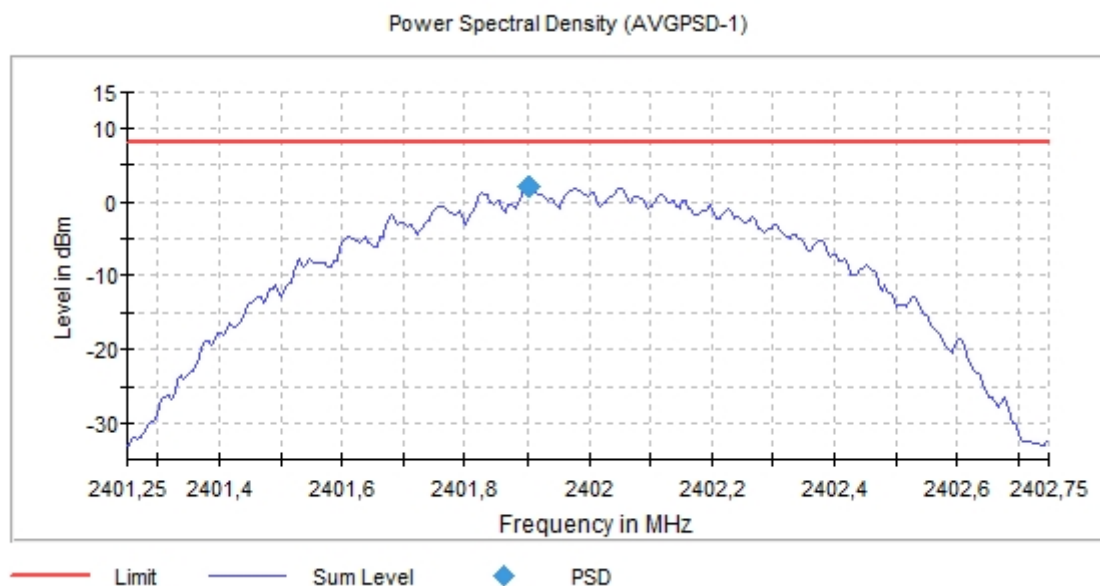


• **1M modulation:**

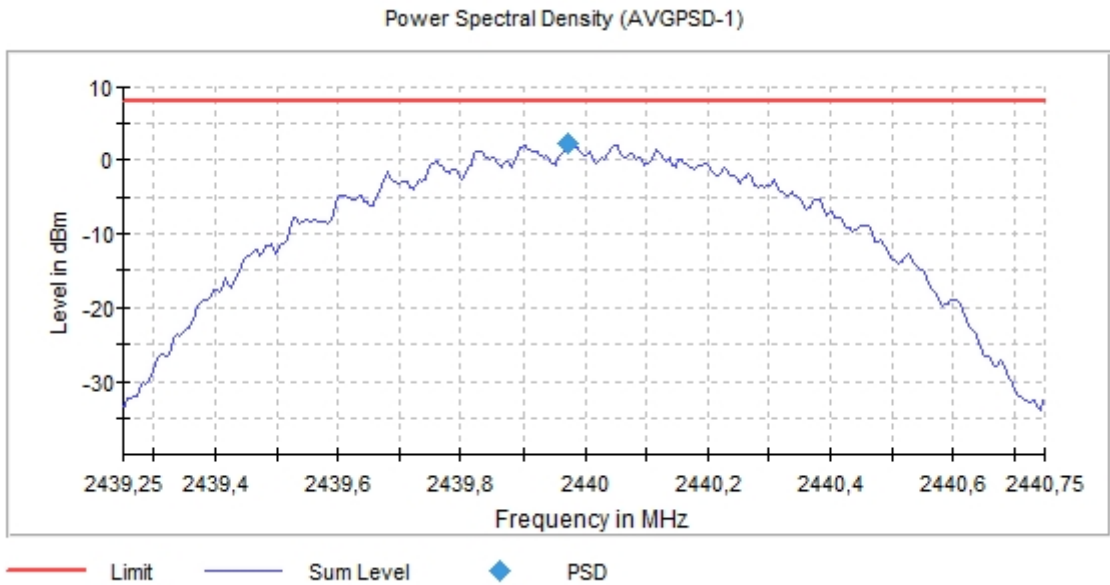
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	2.219	2.356	1.807
Measurement uncertainty (dB)	<±0.99		

Verdict: PASS

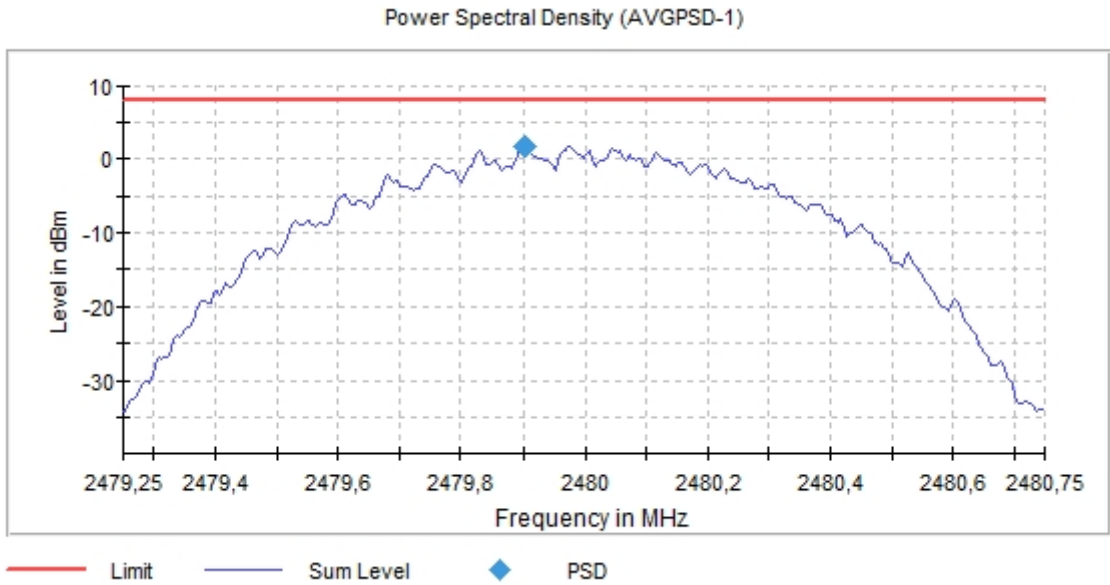
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Emission Limitations Radiated (Transmitter)

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 10000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

Spurious frequencies detected at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Level ($\text{dB}\mu\text{V/m}$)	Polarization	Detector
49.109000	29.01	V	Quasi-Peak
124.963000	25.02	V	Quasi-Peak
375.029000	35.73	V	Quasi-Peak

Measurement Uncertainty (dB) $< \pm 5.1$

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequencies with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with average detector for checking compliance with the average limit.

- 2M modulation:**

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2389.933333	55.23	H	Peak	< $\pm$ 4.6
	42.41		Peak	< $\pm$ 4.6
2440.200000	57.95	H	Peak	< $\pm$ 4.6
	51.21		Peak	< $\pm$ 4.6
2483.933333	53.08	V	Peak	< $\pm$ 4.6
3687.500000	41.81	H	Peak	< $\pm$ 4.6
3749.500000	42.07	H	Peak	< $\pm$ 4.6
3937.500000	39.36	V	Peak	< $\pm$ 4.6
4031.000000	41.68	H	Peak	< $\pm$ 4.6
4094.000000	40.74	H	Peak	< $\pm$ 4.6
4375.000000	41.15	H	Peak	< $\pm$ 4.6
5999.500000	44.10	V	Peak	< $\pm$ 4.6
6250.000000	45.37	H	Peak	< $\pm$ 4.6
7204.500000	52.67	V	Peak	< $\pm$ 4.6

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2387.733333	53.17	H	Peak	< $\pm$ 4.6
2401.666667	55.86	H	Peak	< $\pm$ 4.6
	46.68		Peak	< $\pm$ 4.6
2478.200000	56.29	H	Peak	< $\pm$ 4.6
	47.09		Peak	< $\pm$ 4.6
2485.466667	53.36	H	Peak	< $\pm$ 4.6
3687.500000	40.71	H	Peak	< $\pm$ 4.6
3750.500000	43.98	H	Peak	< $\pm$ 4.6
3812.500000	42.59	H	Peak	< $\pm$ 4.6
3937.500000	39.28	V	Peak	< $\pm$ 4.6
4031.000000	39.56	H	Peak	< $\pm$ 4.6
4093.500000	39.73	H	Peak	< $\pm$ 4.6
4375.000000	41.16	H	Peak	< $\pm$ 4.6
6000.000000	44.22	V	Peak	< $\pm$ 4.6
6250.000000	45.74	H	Peak	< $\pm$ 4.6
7318.500000	51.58	V	Peak	< $\pm$ 4.6

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2387.400000	53.15	V	Peak	<± 4.6
2441.466667	56.69	H	Peak	<± 4.6
	48.53		Peak	<± 4.6
2483.533333	66.52	H	Peak	<± 4.6
	52.82		Peak	<± 4.6
3687.500000	39.35	V	Peak	<± 4.6
3750.000000	44.76	H	Peak	<± 4.6
3812.500000	43.51	V	Peak	<± 4.6
3937.500000	38.66	V	Peak	<± 4.6
4031.000000	41.13	H	Peak	<± 4.6
4093.500000	39.91	H	Peak	<± 4.6
4312.500000	40.10	V	Peak	<± 4.6
4375.000000	40.99	H	Peak	<± 4.6
4959.000000	45.08	H	Peak	<± 4.6
6000.000000	45.32	V	Peak	<± 4.6
6250.000000	46.02	H	Peak	<± 4.6
7438.500000	50.55	V	Peak	<± 4.6

Measurement Uncertainty (dB): <± 4.6 for $1 < f \leq 17$ GHz
<± 4.89 for $17 < f \leq 26$ GHz

Verdict: PASS

- **1M modulation:**

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2389.800000	55.76	H	Peak	<± 4.6
2440.266667	56.69	H	Peak	<± 4.6
	47.63		Peak	<± 4.6
2485.600000	53.69	V	Peak	<± 4.6
3750.000000	44.32	H	Peak	<± 4.6
3812.500000	42.91	V	Peak	<± 4.6
4804.000000	42.77	H	Peak	<± 4.6
6250.000000	43.92	V	Peak	<± 4.6
7213.500000	46.06	V	Peak	<± 4.6
9608.000000	51.76	V	Peak	<± 4.6
10440.000000	53.34	V	Peak	<± 4.6
14472.000000	52.77	V	Peak	<± 4.6
21251.500000	40.22	H	Peak	<± 4.6

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2388.800000	53.16	H	Peak	<± 4.6
2401.466667	57.32	H	Peak	<± 4.6
	49.74		Peak	<± 4.6
2478.600000	56.24	H	Peak	<± 4.6
	47.46		Peak	<± 4.6
2484.600000	53.80	H	Peak	<± 4.6
3687.500000	41.66	V	Peak	<± 4.6
3750.000000	45.19	H	Peak	<± 4.6
3812.500000	41.96	H	Peak	<± 4.6
4031.000000	40.18	V	Peak	<± 4.6
4093.500000	39.67	H	Peak	<± 4.6
6000.000000	44.48	V	Peak	<± 4.6
6250.000000	44.02	H	Peak	<± 4.6
7320.500000	52.56	V	Peak	<± 4.6

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

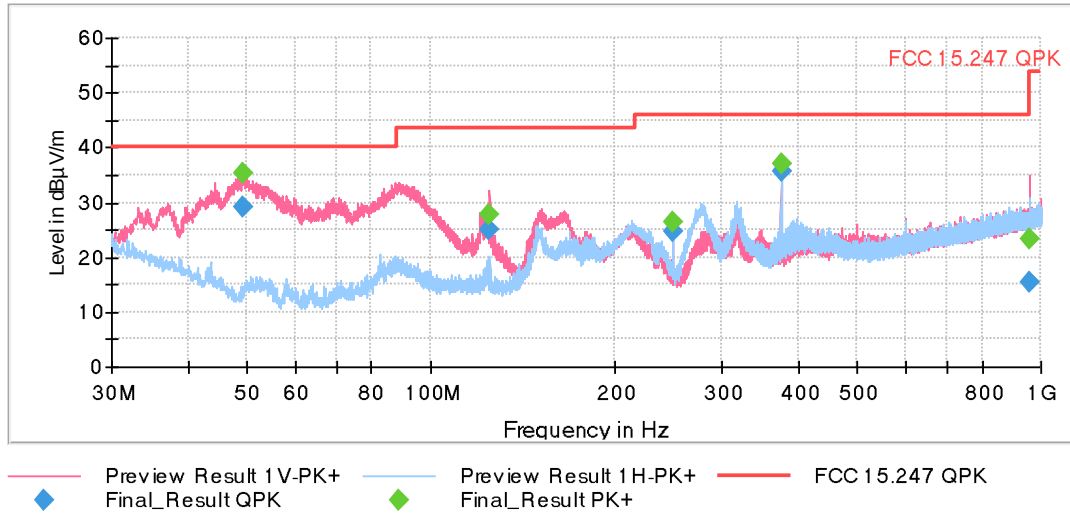
Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2388.866667	53.15	V	Peak	$<\pm 4.6$
2441.666667	56.83	H	Peak	$<\pm 4.6$
	48.88		Peak	$<\pm 4.6$
2483.533333	62.26	H	Peak	$<\pm 4.6$
	49.07		Peak	$<\pm 4.6$
3687.500000	41.12	V	Peak	$<\pm 4.6$
3750.000000	44.73	H	Peak	$<\pm 4.6$
3812.500000	43.12	V	Peak	$<\pm 4.6$
4031.000000	41.61	H	Peak	$<\pm 4.6$
4093.500000	39.05	V	Peak	$<\pm 4.6$
4959.500000	44.81	H	Peak	$<\pm 4.6$
6000.000000	44.13	V	Peak	$<\pm 4.6$
6250.000000	45.93	H	Peak	$<\pm 4.6$
7439.500000	50.31	V	Peak	$<\pm 4.6$

Measurement Uncertainty (dB): $<\pm 4.6$ for $1 < f < \leq 17$ GHz
 $<\pm 4.89$ for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

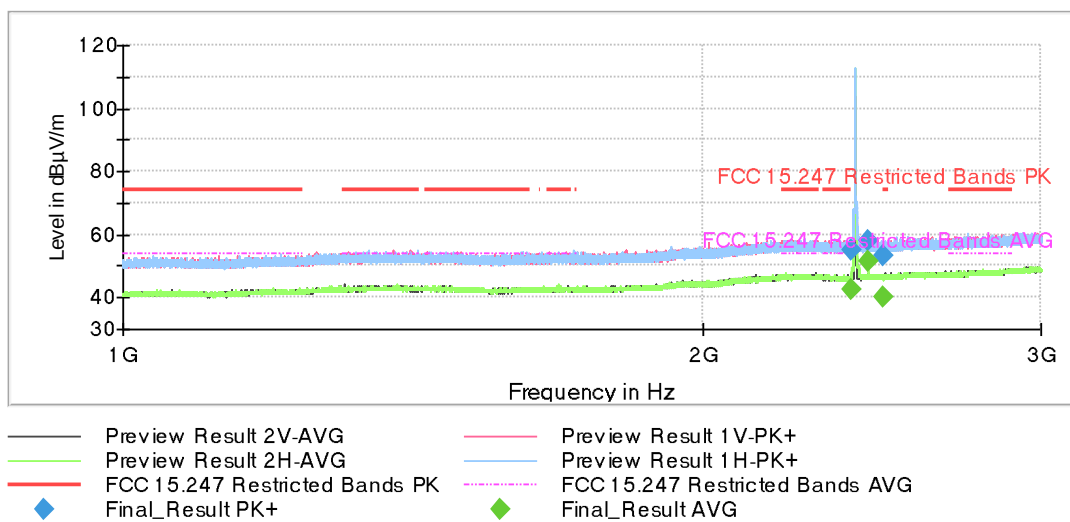


This plot is valid for the Low, Middle and High Channels.

• 2M modulation:

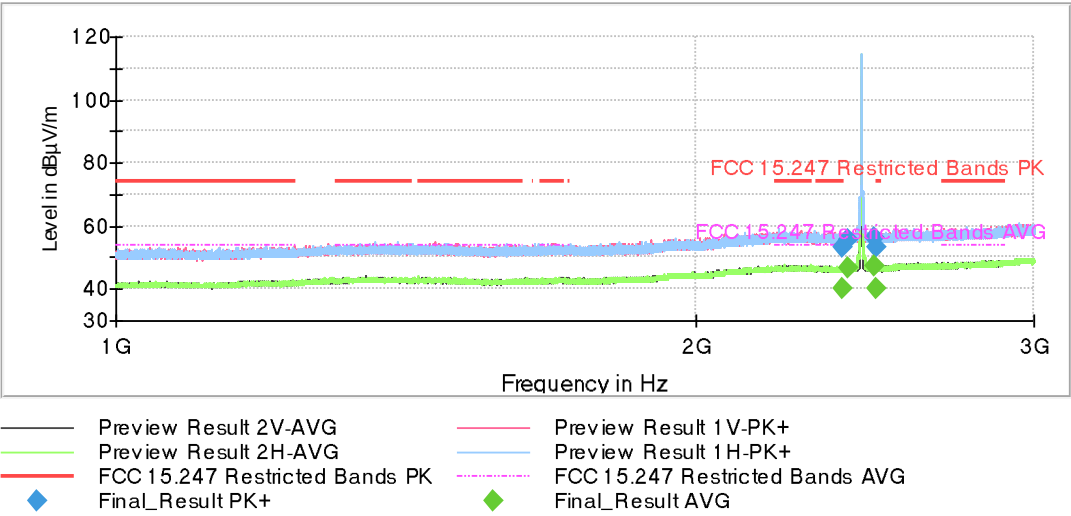
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



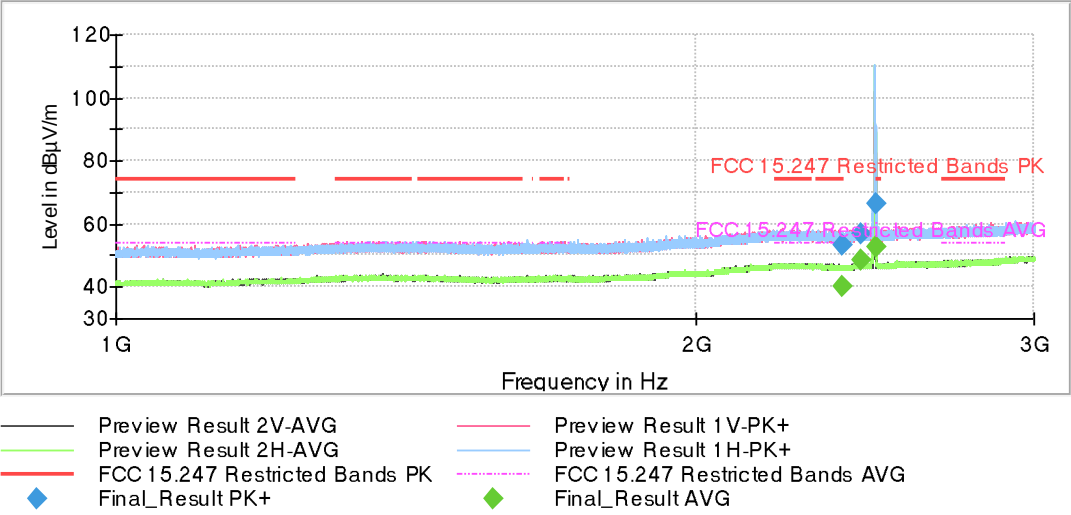
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

- High Channel:



The peak above the limit is the carrier frequency.