



Test report No:
NIE: 65127RRF.001

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Sensor device with Wirepas mesh network connectivity
(*) Trademark	Thingsee Beam
(*) Model and /or type reference	TSD2
Other identification of the product	HW Version: TSD2_02 SW Version: 2020.04.17.2_ts_tof2 FCC ID: 2AEU3TSBEAM IC: 20236-TSBEAM
(*) Features	Measurement of distance and acceleration. Wirepas protocol stack using BT LE radio.
Applicant	HALTIAN PRODUCTS OY Yrttipellontie 1 D, 90230 Oulu, Finland
Test method requested, standard	USA FCC Part 15.247 (10-1-19 Edition): Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-19 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (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)	Jose Carlos Luque RF Lab. Supervisor
Date of issue	2020-08-07
Report template No	FDT08_22 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

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DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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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 TSD2 is used for distance measurements and resulting data is sent wirelessly to a Wirepas protocol mesh network. The device has also an accelerometer. Typically TSD2 is used together with MTXH Thingsee Gateway in use cases where distance measurements are performed in several locations and this data is wirelessly collected and sent via 2G cellular connection to a data server / cloud.

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°	Date of reception
65127/004	Sensor device with Wirepas mesh network connectivity	TSD2	EV701700013	2020/06/10

Auxiliary elements used with the sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
65127/005	Nordic Module	nRF52832	--	2020/06/10

Sample S/01 has undergone the test(s): All conducted tests indicated in the Appendix A.

- Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
65127/001	Sensor device with Wirepas mesh network connectivity	TSD2	EV701700038	2020/06/10

Auxiliary elements used with the sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
65127/005	Nordic Module	nRF52832	--	2020/06/10

Sample S/02 has undergone the test(s): All radiated tests indicated in the Appendix A.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾		
			☐	☐	☐		
			☐	☐	☐		
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐ AC:		☐	☐	☐	☐	☐
	☒ DC: 3.0V, 2 x AAA 1.5V alkaline primary batteries						
Rated Power	Peak 24mW (3V x 8mA), average 120uW (3V x 40uA)						
Clock frequencies.....	BT IC clocks 32.768kHz, 32MHz						
Other parameters	Not provided data						

Software version	2020.04.17.2_ts_tof2		
Hardware version	TSD2_02		
Dimensions in cm (W x H x D)	34mm x 17mm x 54mm		
Mounting position	☐	Table top equipment	
	☒	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☐	Other:	
Modules/parts.....	Module/parts of test item	Type	Manufacturer
	nRF52832	BT IC	Nordic Semiconductor
Accessories (not part of the test item)	Description	Type	Manufacturer
	N/A		
Documents as provided by the applicant	Description	File name	Issue date
	N/A		

Identification of the client

HALTIAN PRODUCTS OY
Yrtyipellontie 1 D, 90230 Oulu, Finland.

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-07-07
Date (finish)	2020-07-20

Document history

Report number	Date	Description
65127RRF.001	2020-08-07	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 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Pablo Redondo, José Gabriel Pendón, Cristina Calle and Nicolás Salguero.

Used instrumentation:

Conducted Measurements:

	Last Calibration	Due Calibration
1. Shielded Room ETS LINDGREN S101	N.A.	N.A.
2. DC POWER SUPPLY 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
3. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09
4. EMI TEST RECEIVER 9kHz-7GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
4. Digital Multimeter FLUKE 179	2019/10	2020/10

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2. Shielded Room ETS LINDGREN S101	N.A.	N.A.
3. Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
4. Pre-Amplifier G>40dB 10MHz-6GHz, BONN ELEKTRONIK, BLNA 0160-01N	2020/02	2021/02
5. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
6. Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
7. Broadband Horn antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
8. RF Pre-amplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
9. Low Noise Amplifier G>30dB, 18 - 40 GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02
10. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09

Testing verdicts

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

Summary

1. Bluetooth Low Energy.

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

TEST CONDITIONS.....	11
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TEST CONDITIONS

POWER SUPPLY (V):

Vnominal:	3 Vdc
Type of Power Supply:	2 x AAA 1.5V alkaline primary batteries
Type of Antenna:	
Maximum Declared Antenna Gain:	+2.5 dBi

TEST FREQUENCIES:

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

CONDUCTED MEASUREMENTS

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



The DC supply voltage is applied from USB cable.

RADIATED MEASUREMENTS

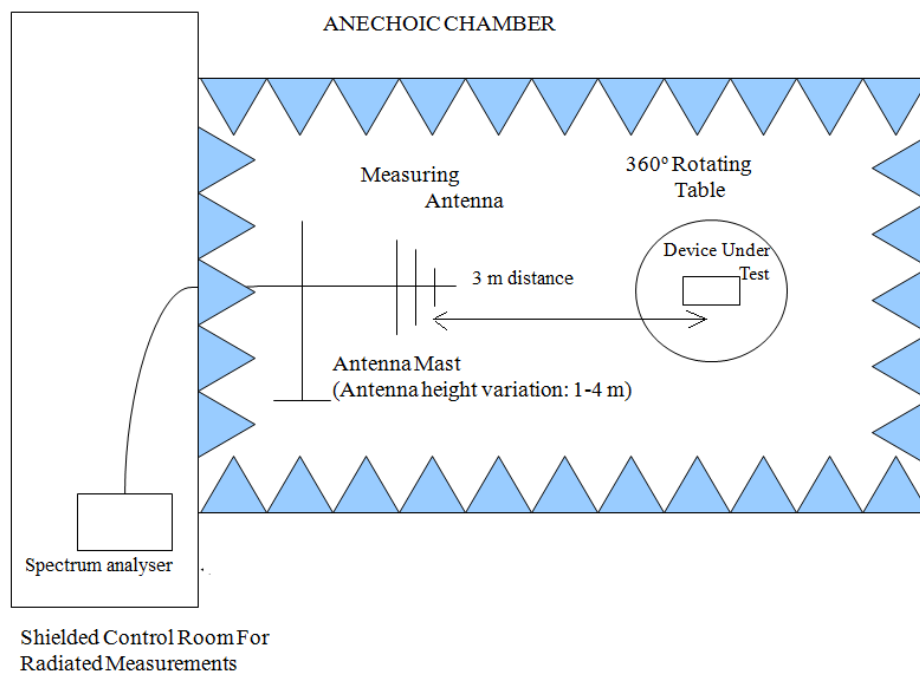
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1m for the frequency range 17 GHz-26 GHz (antenna and 18 GHz-40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

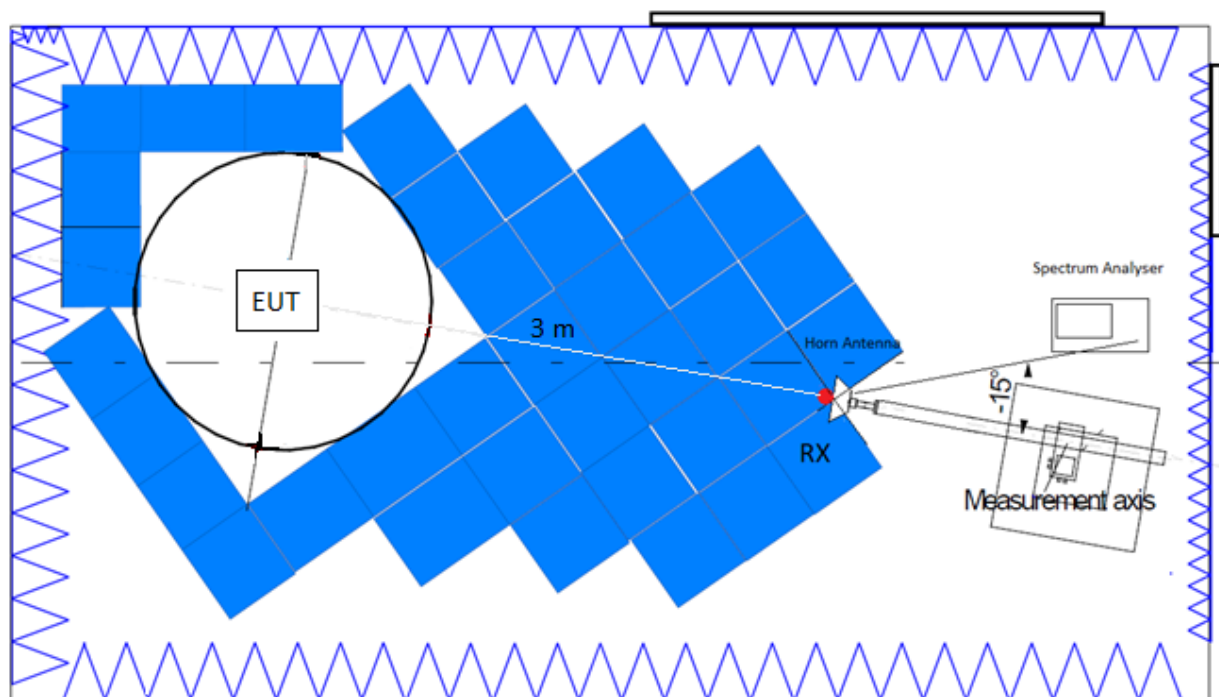
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

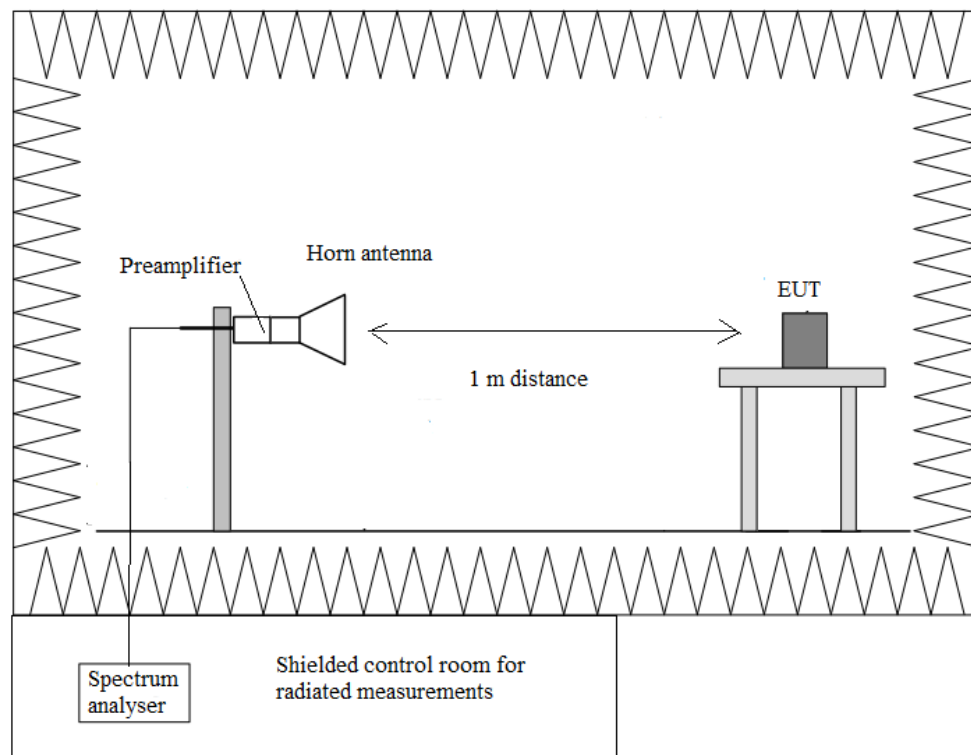
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



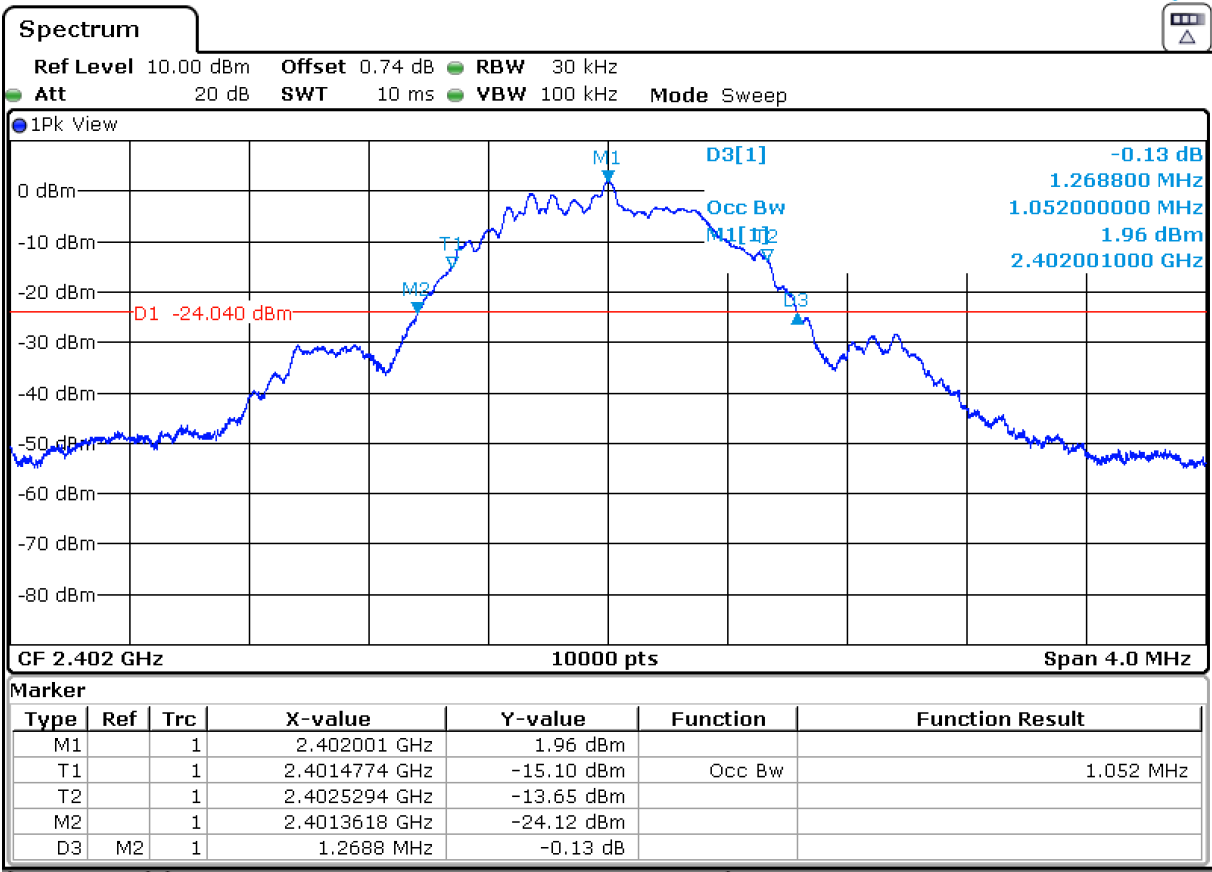
Occupied Bandwidth

RESULTS:

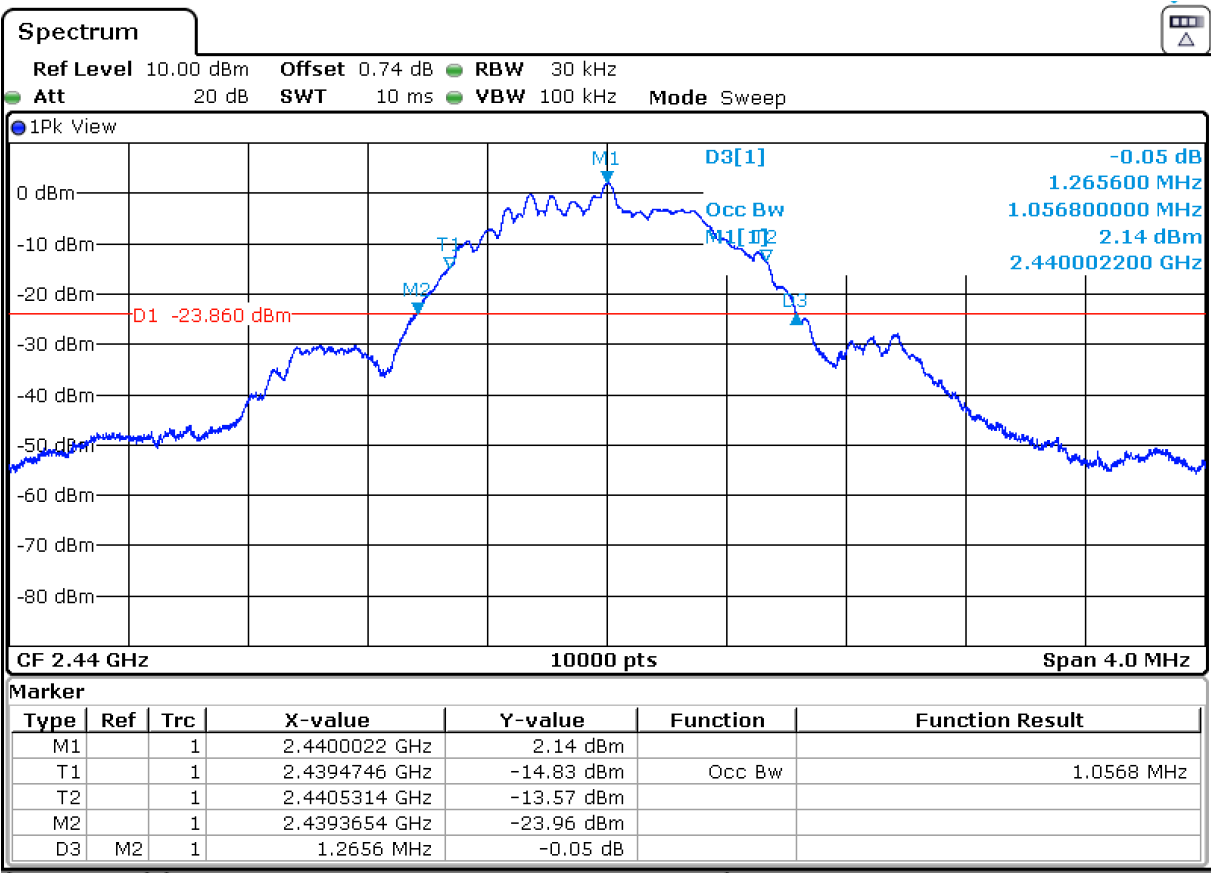
BLE:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	1.052	1.0568	1.0536
Measurement uncertainty (kHz)	<± 3.82		

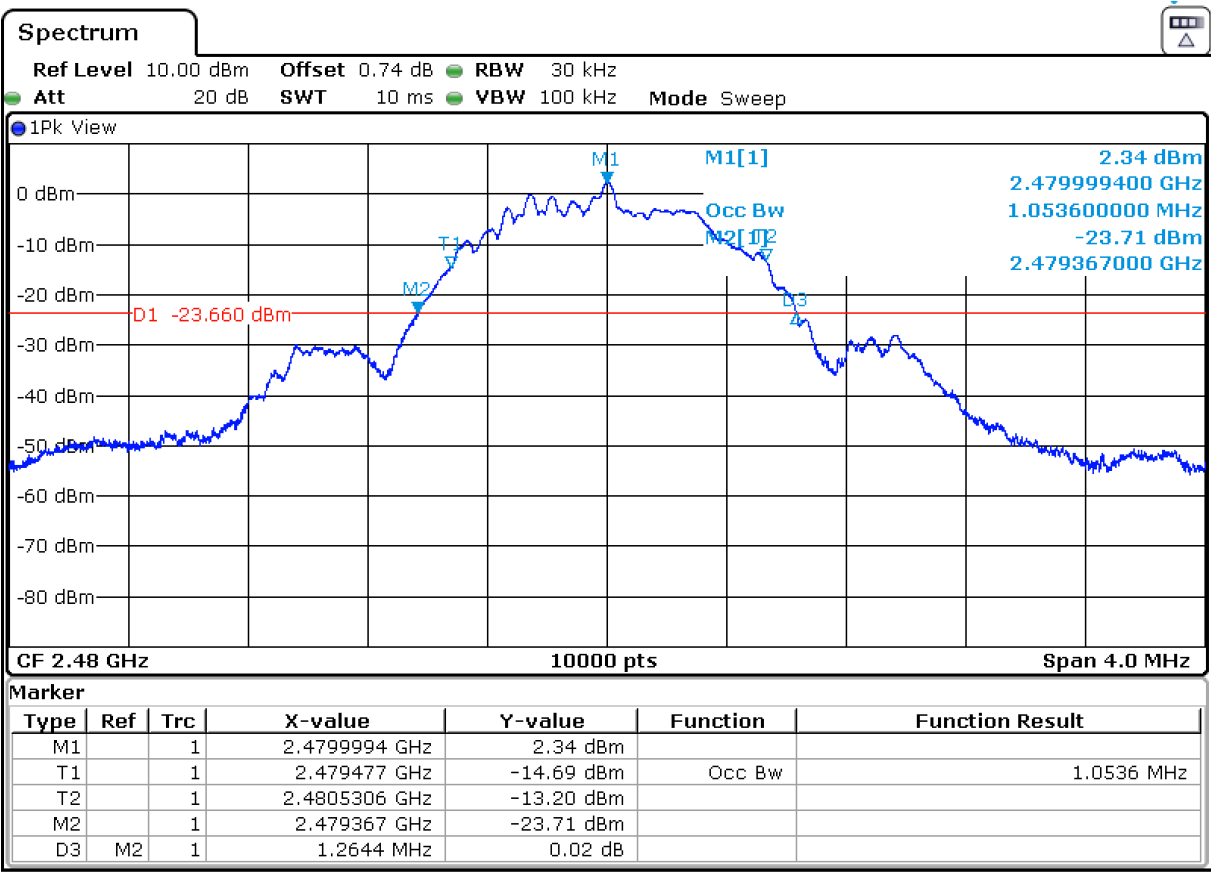
- Low Channel:



- 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.

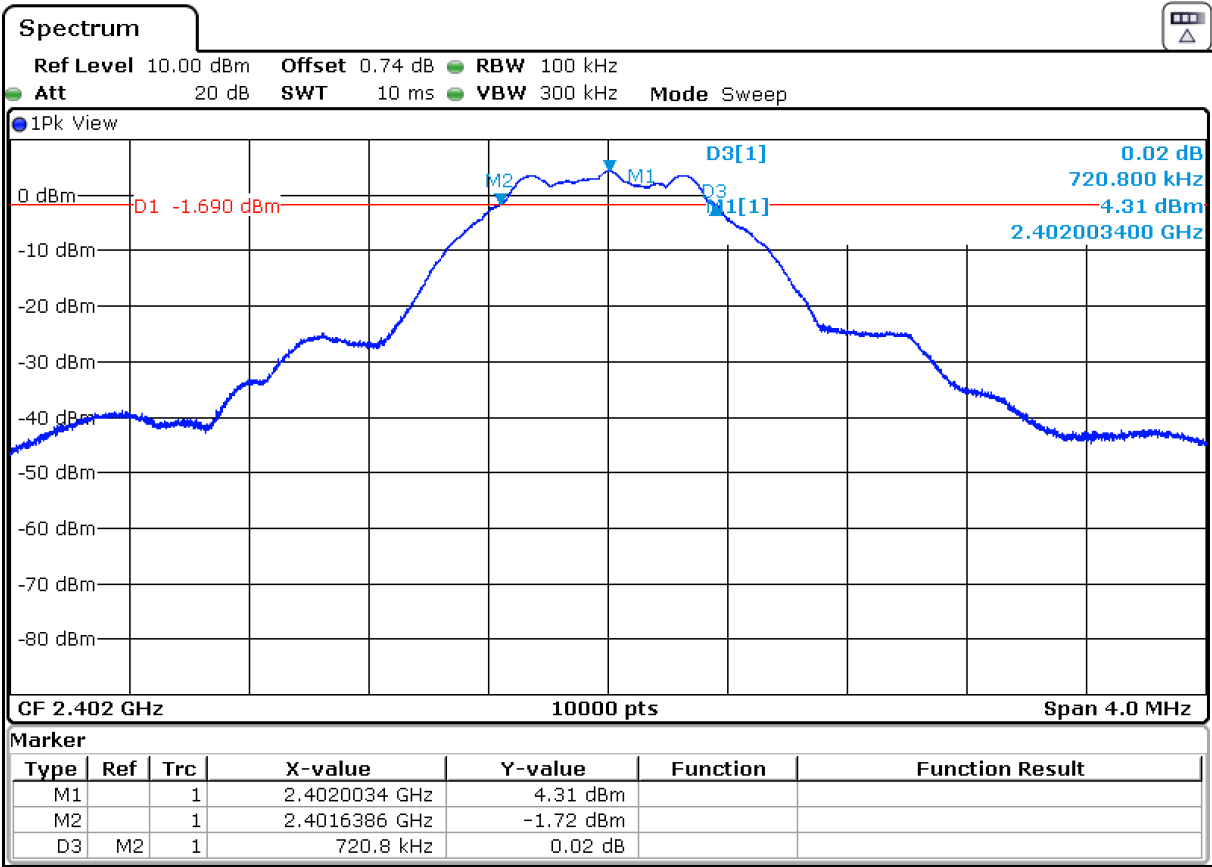
RESULTS:

BLE:

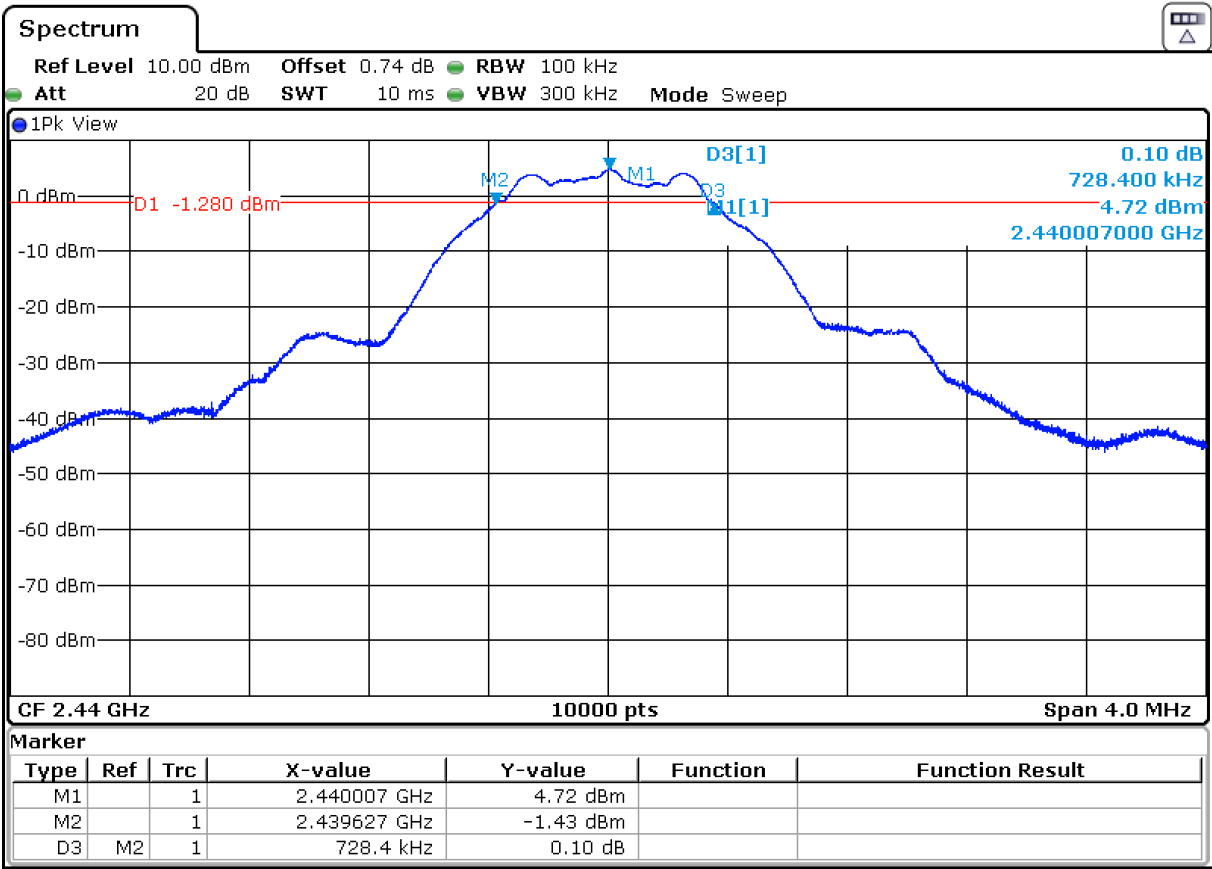
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
6 dB Spectrum bandwidth (kHz)	720.8	728.4	713.6
Measurement uncertainty (kHz)	<±11.82		

Verdict: PASS

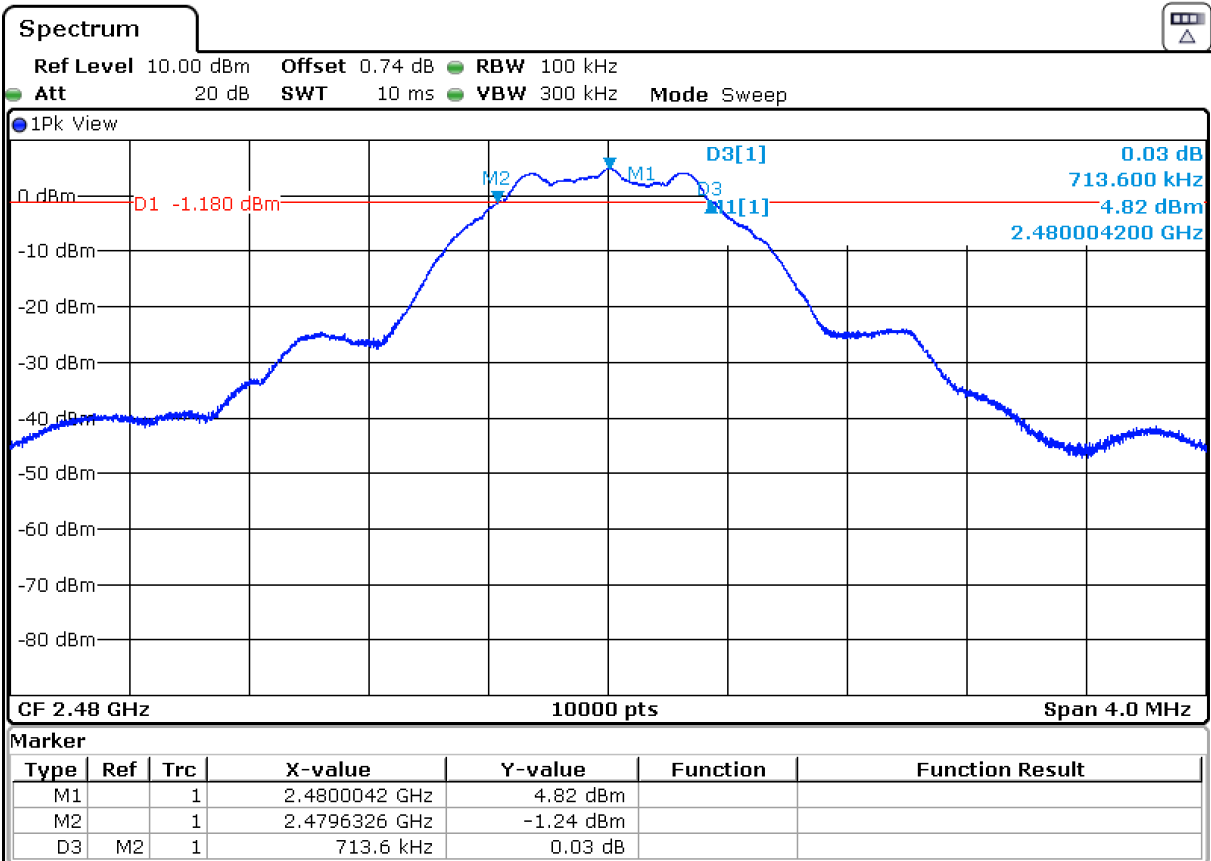
- Low Channel:



- 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: +2.5 dBi

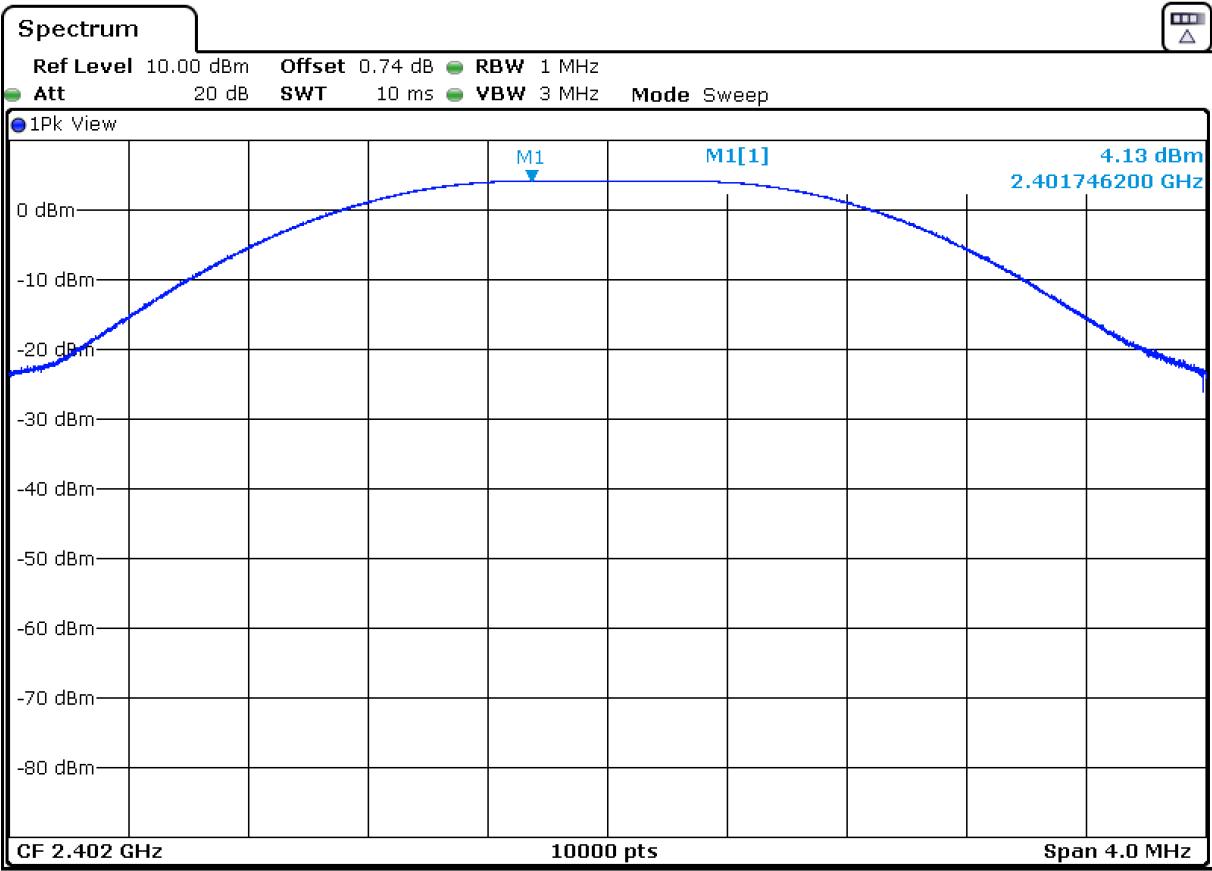
• BLE:

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.13	1.31	4.36
Maximum EIRP Power (dBm)	6.63	6.81	6.86
Measurement uncertainty (dB)	< $\pm$ 2.57		

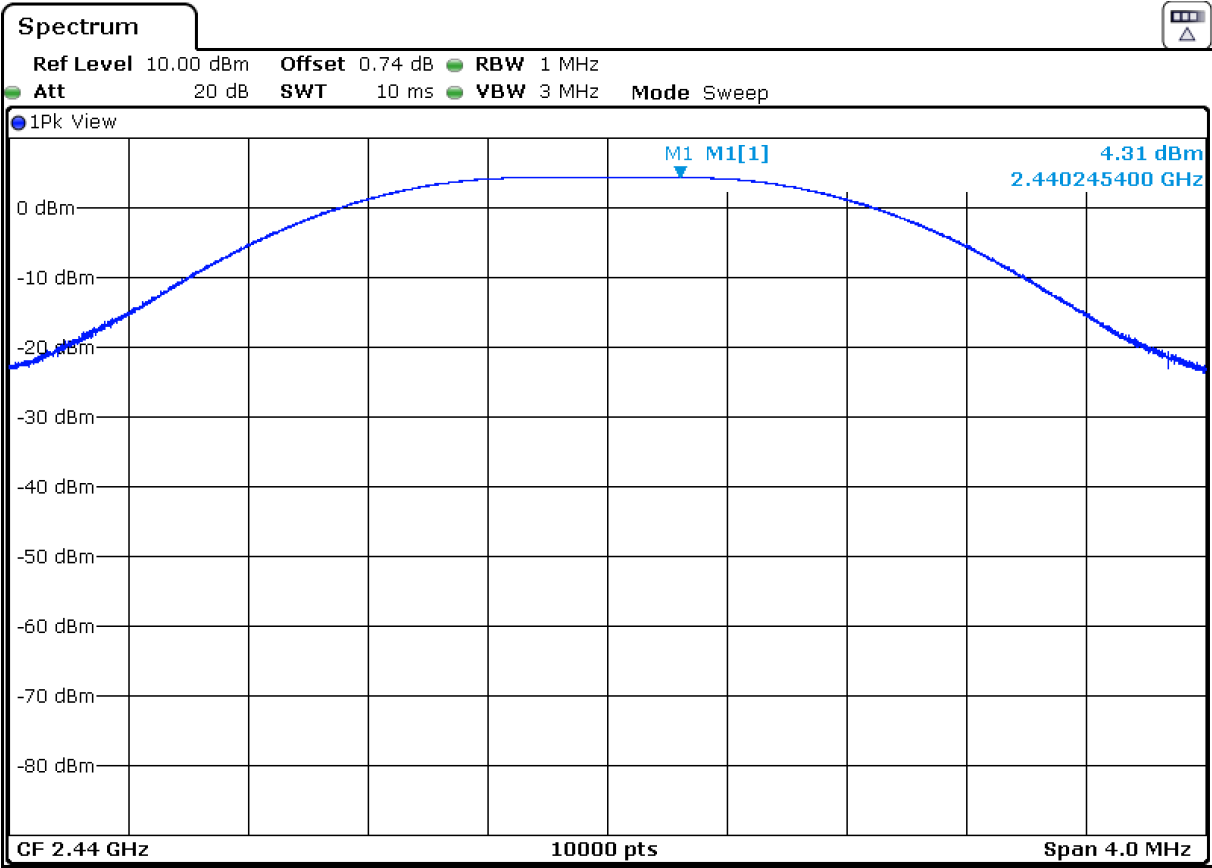
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

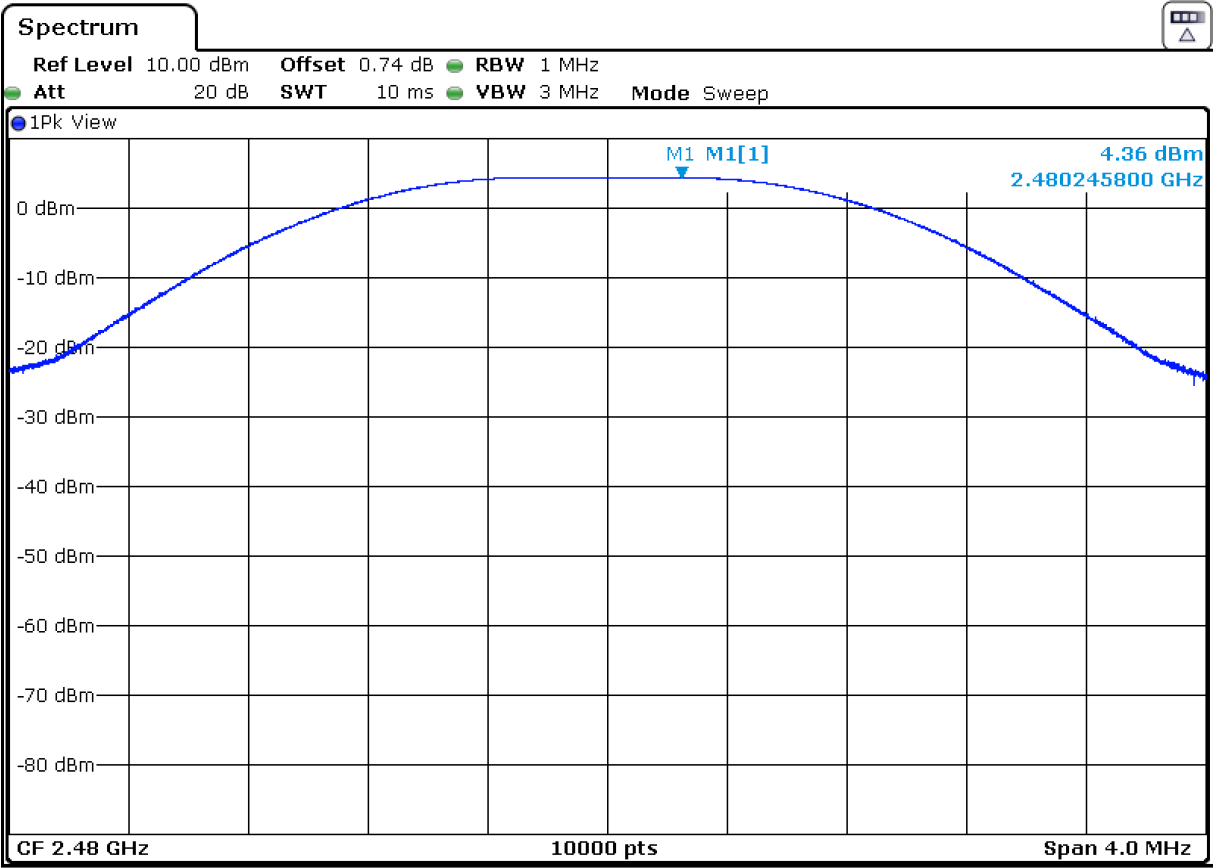
- Low Channel:



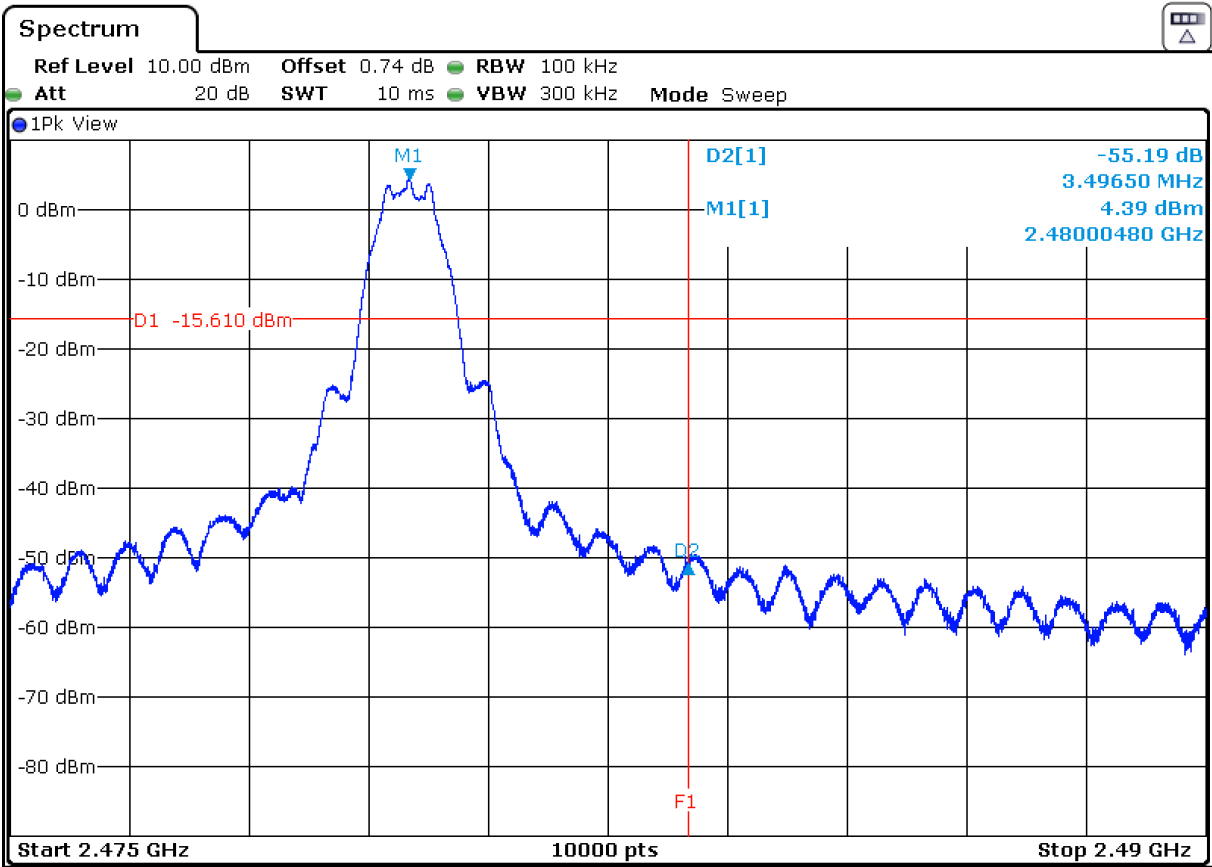
- Middle Channel:



- High Channel:



- High Channel:



Verdict: PASS

Measurement uncertainty (dB)	<±2.57
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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:

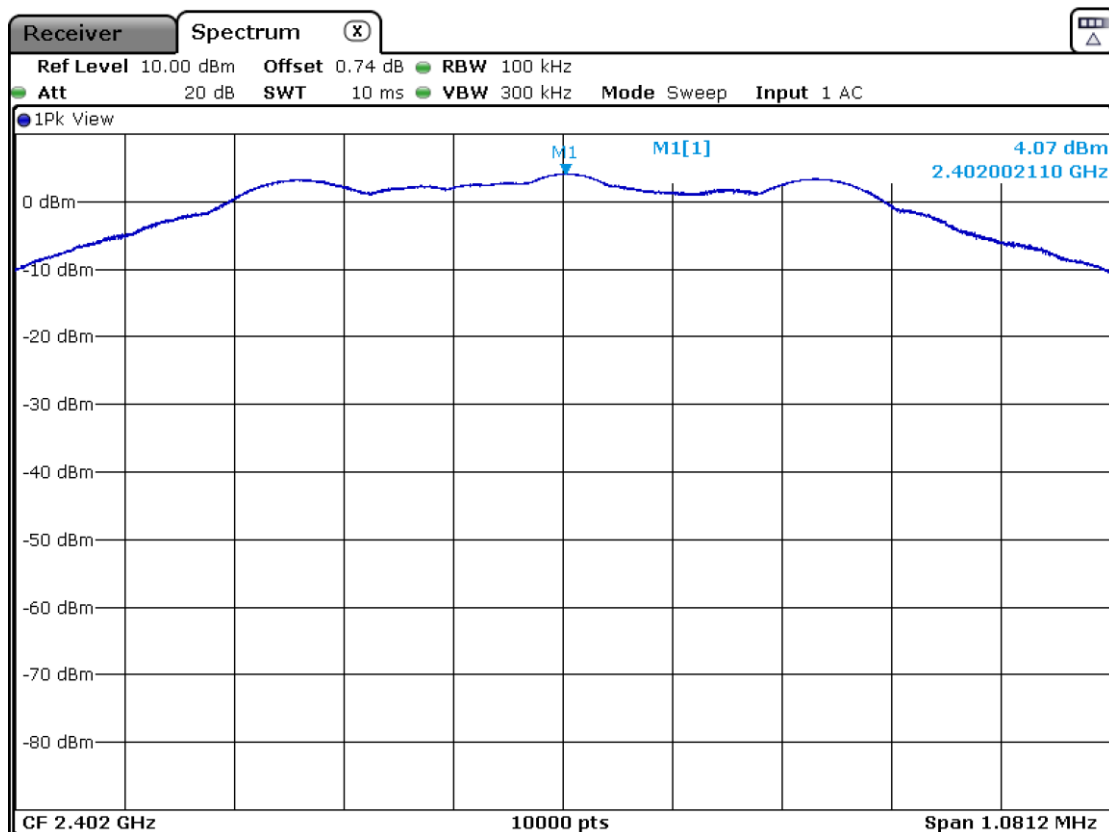
The maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2." Method PKPSD (peak PSD)" of ANSI C.63.10-2013.

• BLE:

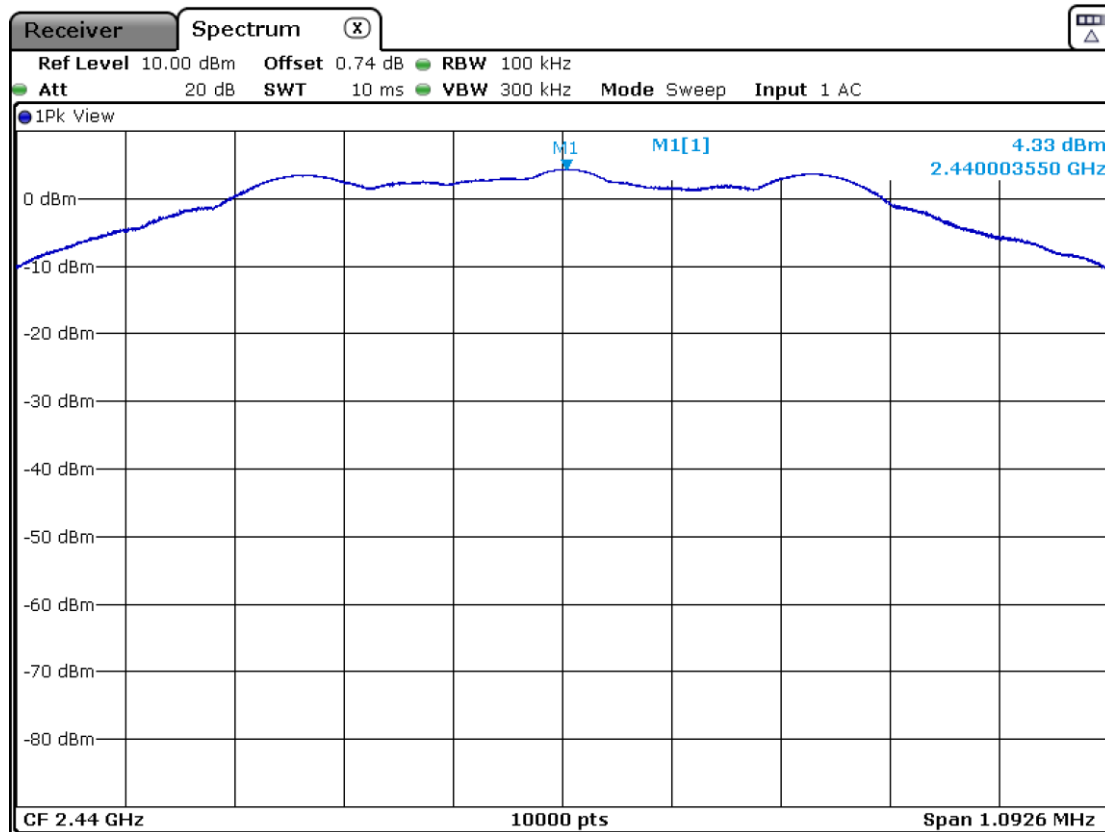
	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	4.07	4.33	4.47
Measurement uncertainty (dB)	<±2.57		

Verdict: PASS

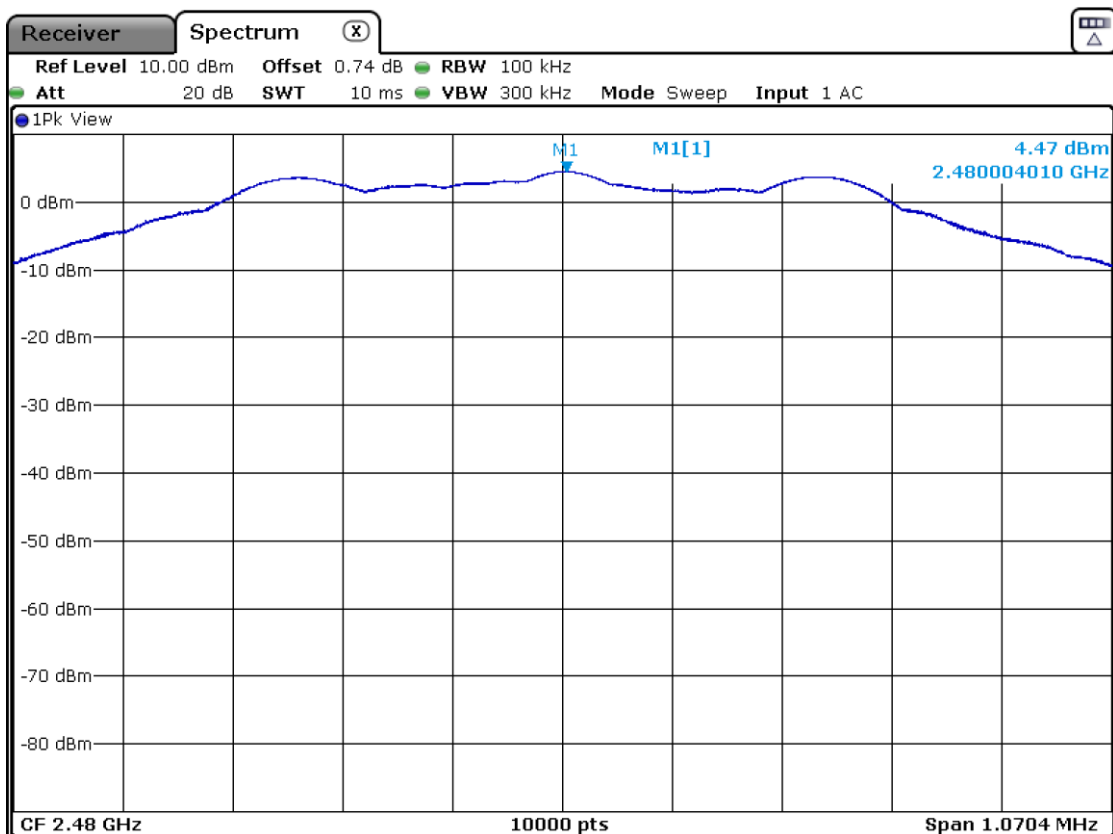
- Low Channel:



- 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 1m 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 on the operating channel.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level ($\text{dB}\mu\text{V/m}$)	Limit ($\text{dB}\mu\text{V/m}$)	Polarization	Detector	Measurement Uncertainty (dB)
932.003	26.32	46	V	Quasi-peak	$<\pm 4.99$

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 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Limit (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.8080	55.58	--	55.58	74	H	Peak	<± 4.98
	44.76	2.12	46.88	54		Average	<± 4.98
12.557	49.47	--	49.47	74	V	Peak	<± 4.98
14.494	52.3	--	52.3	74	V	Peak	<± 4.98

RESTRICTED BANDS: No spurious frequencies at less than 20 dB below the limit.

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Limit (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.8800	55.22	--	--	74	H	Peak	<± 4.98
	44.93	2.12	47.05	54		Average	<± 4.98
12.159	49.05	--	49.05	74	V	Peak	<± 4.98
14.499	53.45	--	53.45	74	H	Peak	<± 4.98

RESTRICTED BANDS: No spurious frequencies at less than 20 dB below the limit.

- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Limit (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.96	53	--	53	74	H	Peak	<± 4.98
7.4395	48.65	--		74	H	Peak	<± 4.98
14.433	52.49	--	52.49	74	V	Peak	<± 4.98

RESTRICTED BANDS: Spurious frequencies closest to the limit:

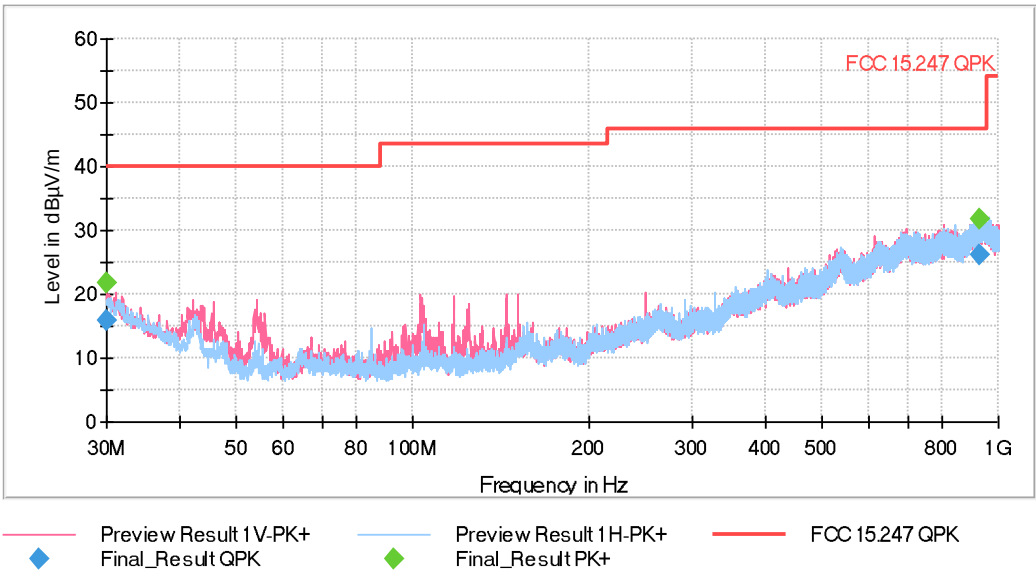
Restricted Band	Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
RB: 2.31 - 2.39 GHz	--	--	--	--	74	--	Peak	<± 4.98
RB: 2.4835 - 2.5 GHz	2.4835333	65.56	--	65.56	74	H	Peak	<± 4.98
		46.23	2.12	48.35	54		Average	<± 4.98

Measurement uncertainty (dB)	f < 1 GHz, <± 4.99 f ≥ 1 GHz up to 17 GHz, <± 4.98 f ≥ 17 GHz up to 26 GHz, <± 5.08
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Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

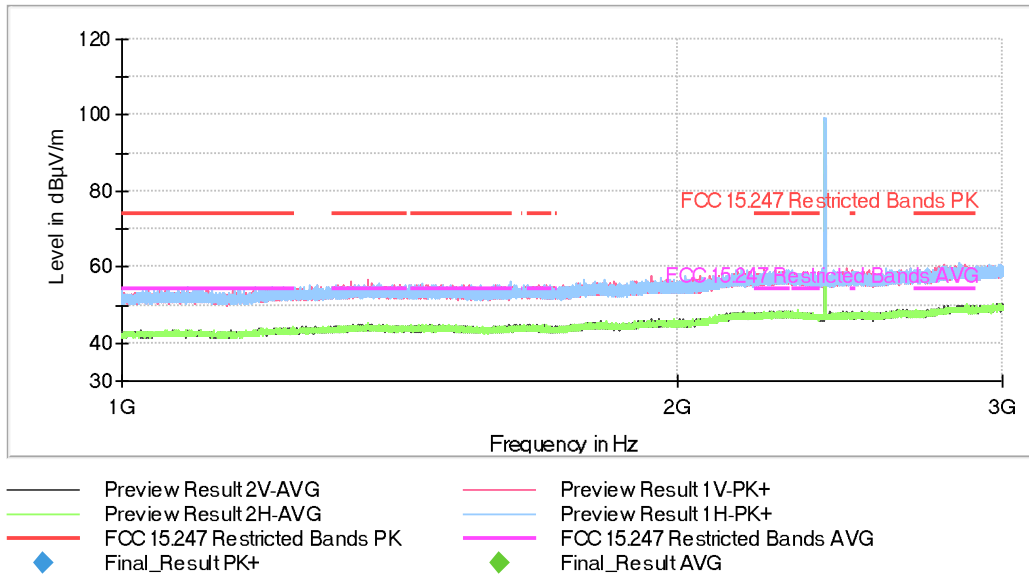
The spurious frequencies detected do not depend on the operating channel.



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

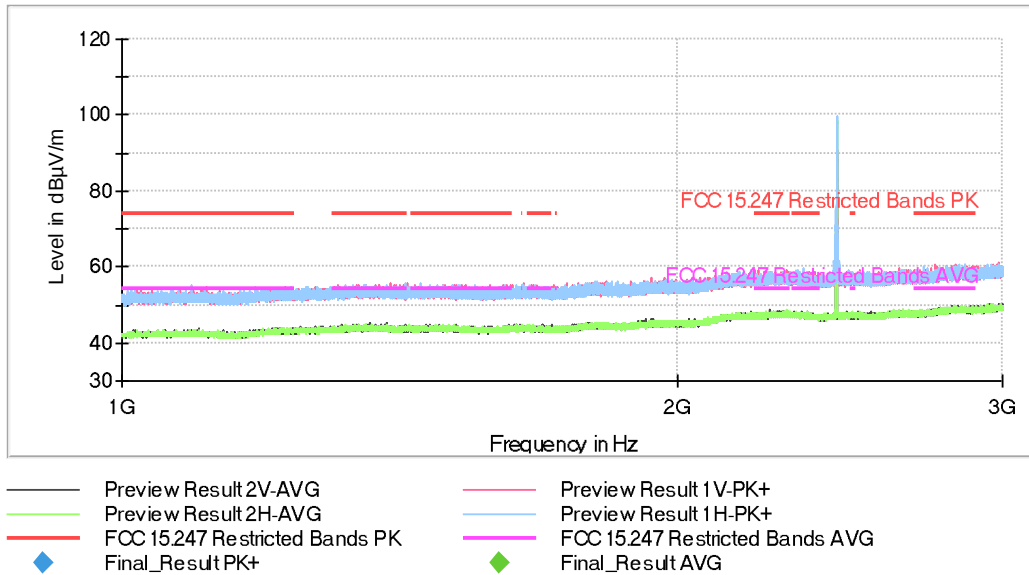
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



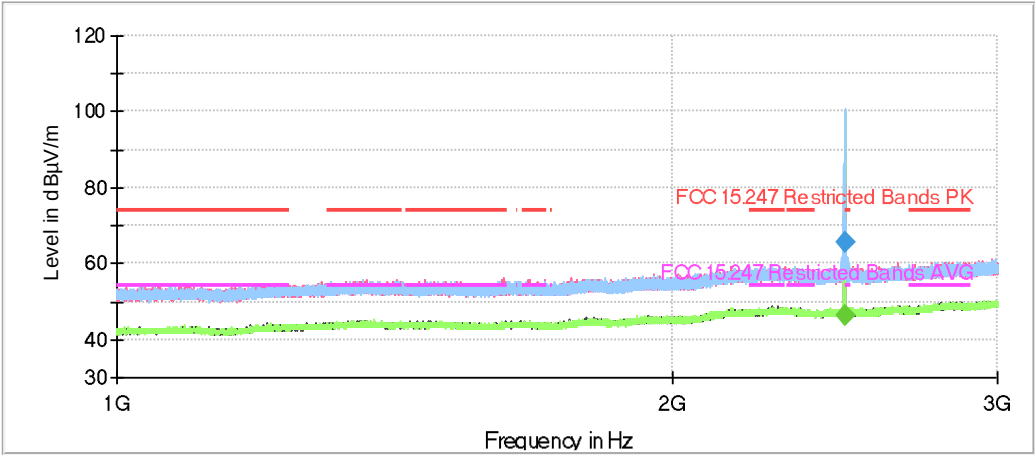
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

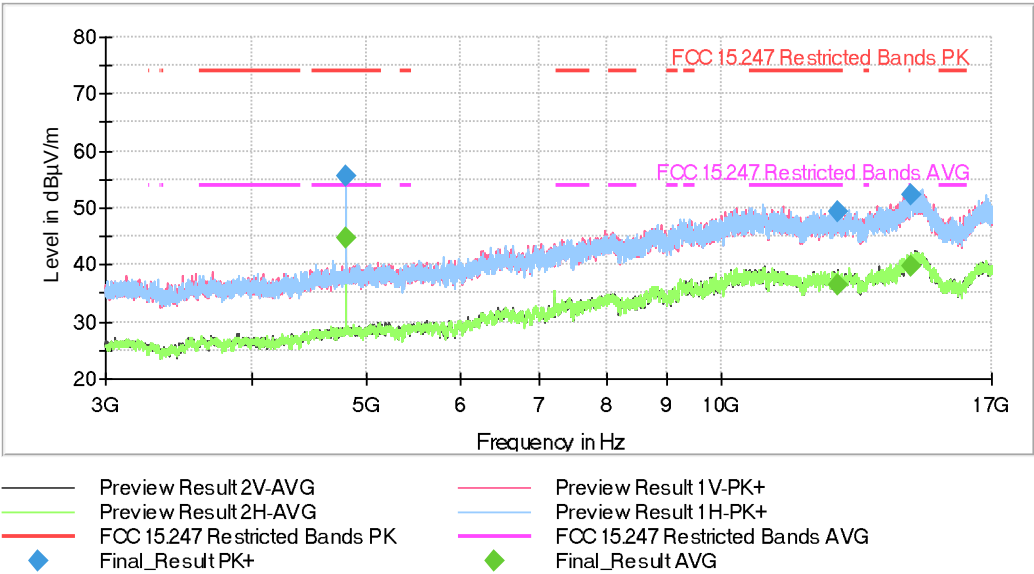
- High Channel:



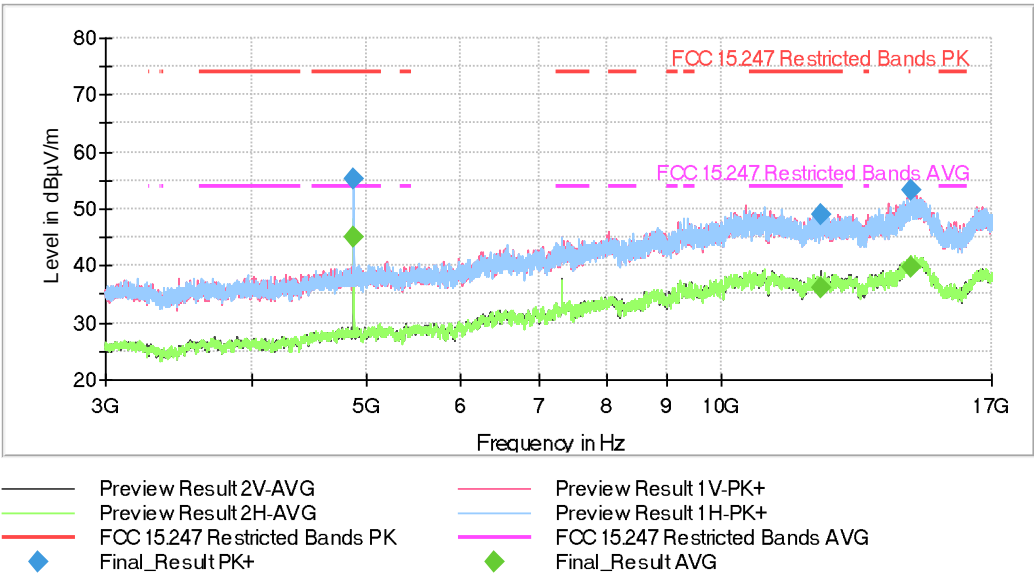
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

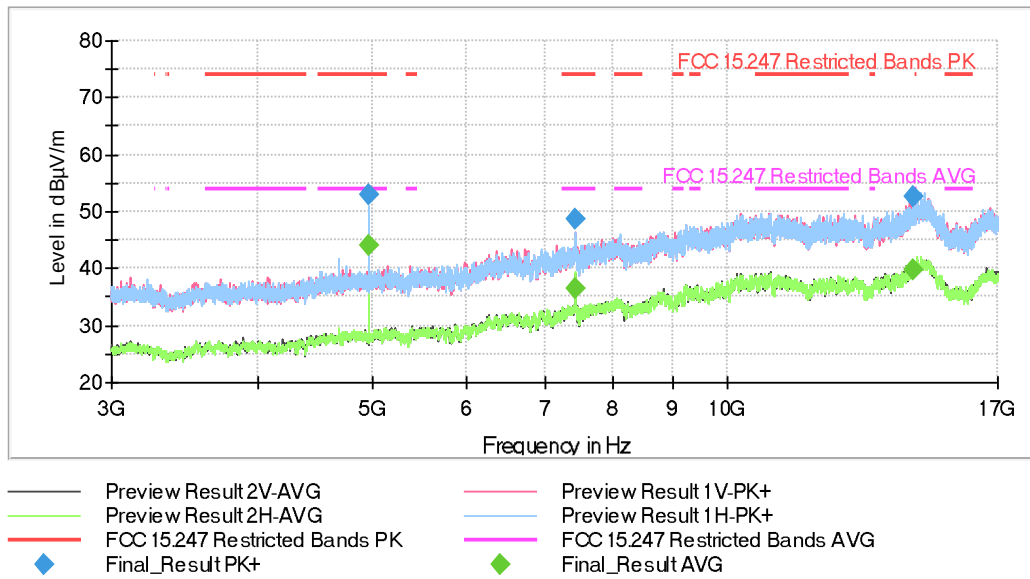
- Low Channel:



- Middle Channel:

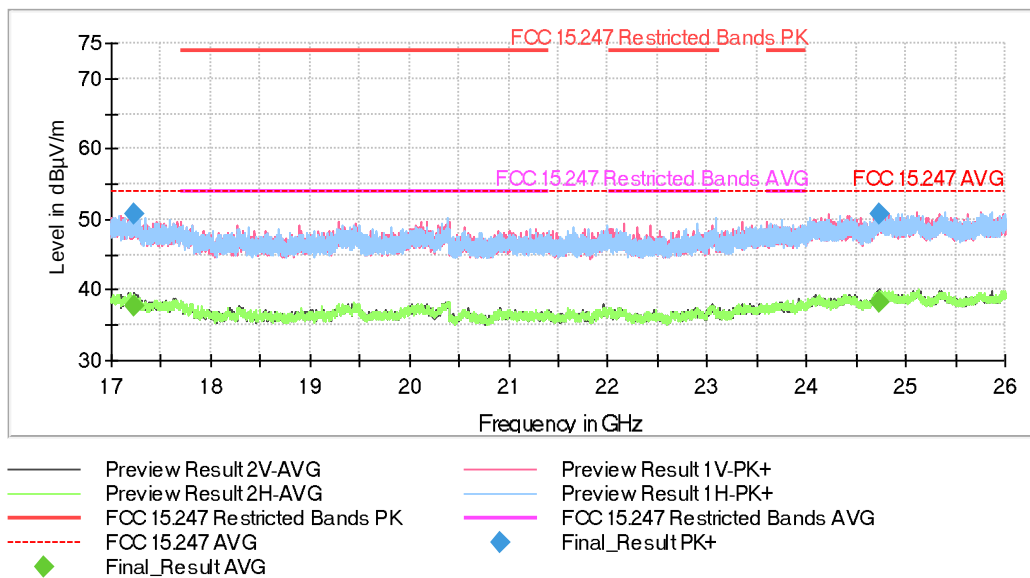


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

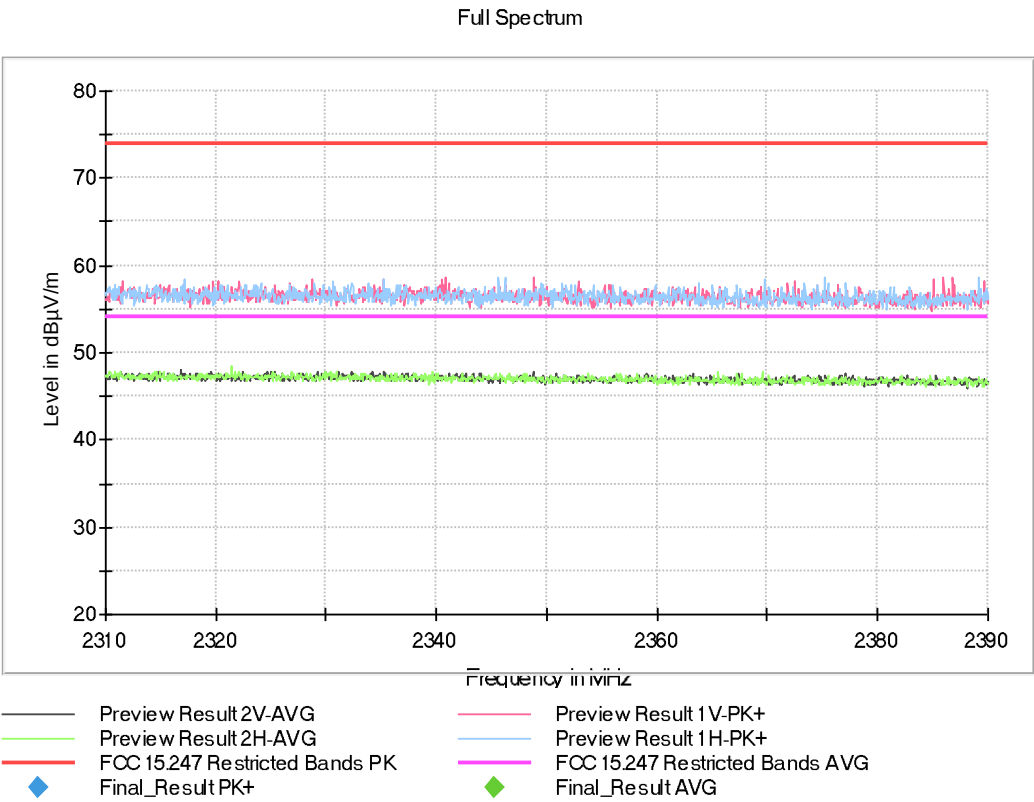
The spurious frequencies detected do not depend on the operating channel.



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

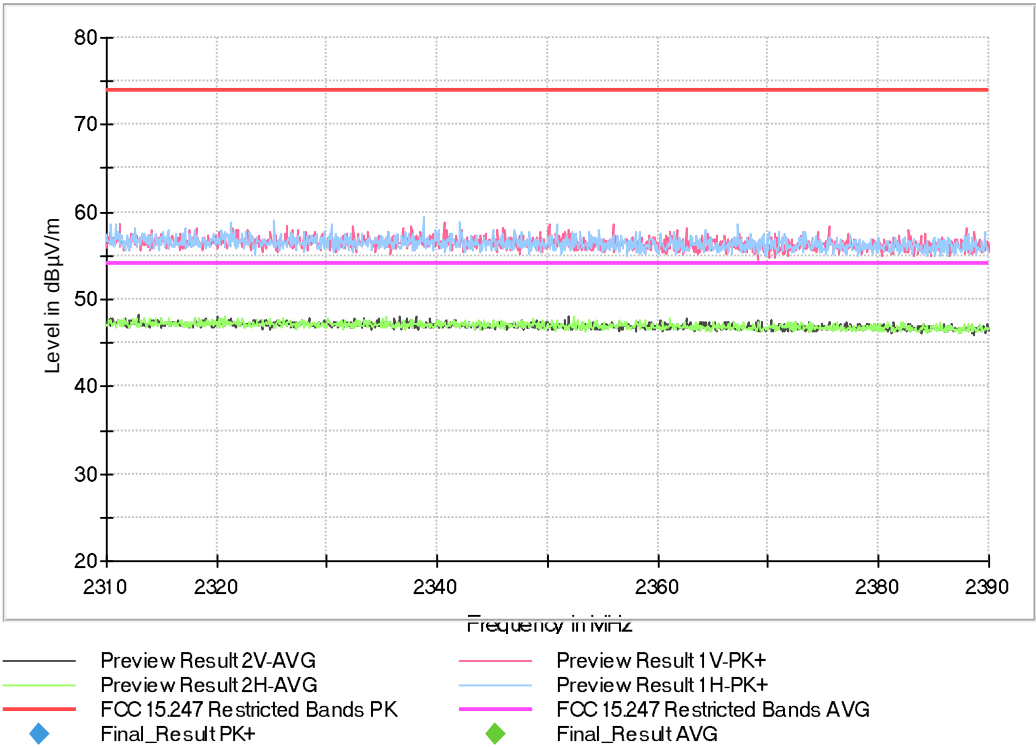
FREQUENCY RANGE 2.31-2.39 GHz (RESTRICTED BAND):

- Low Channel:



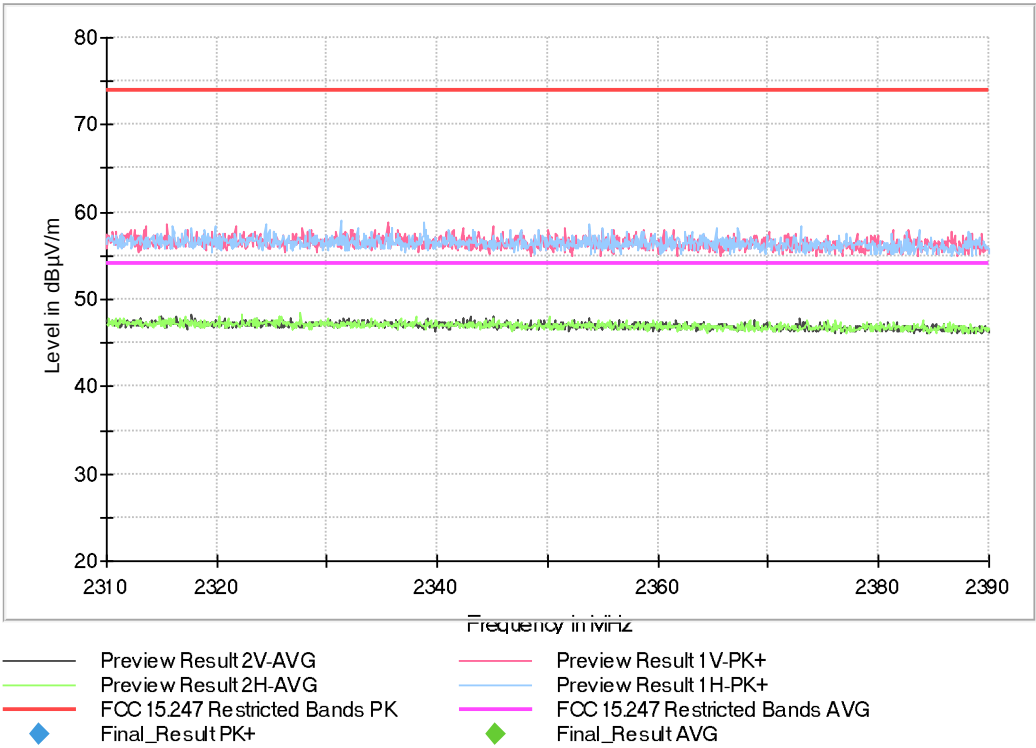
- Middle Channel:

Full Spectrum



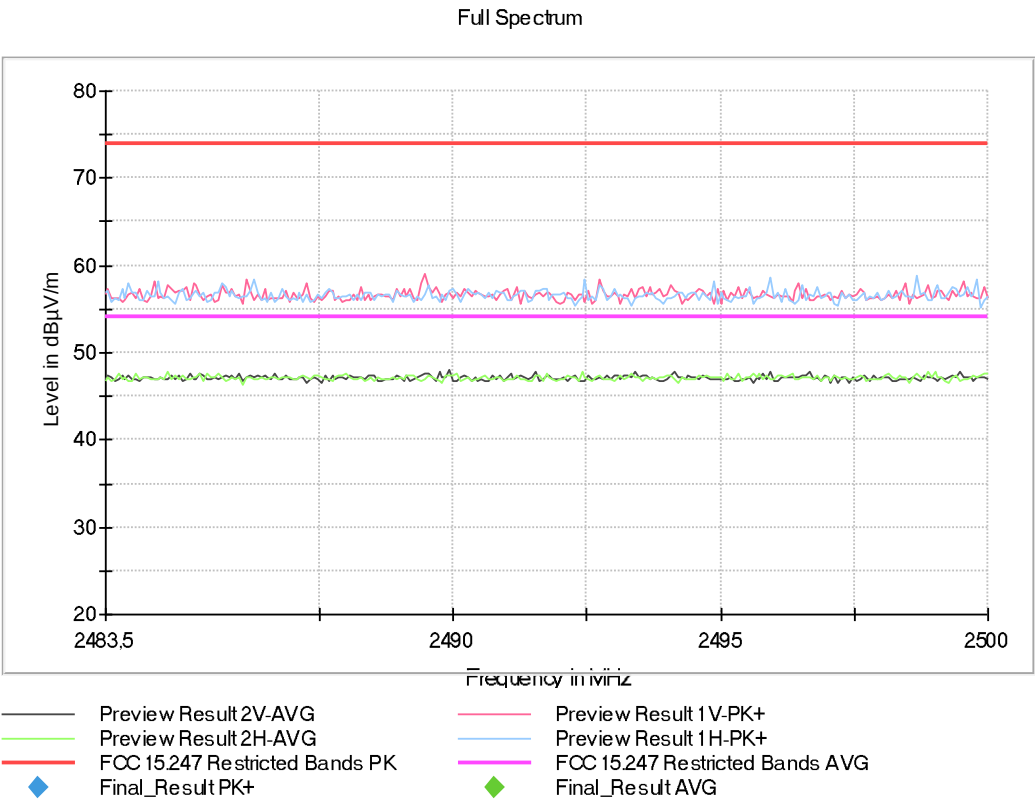
- High Channel:

Full Spectrum



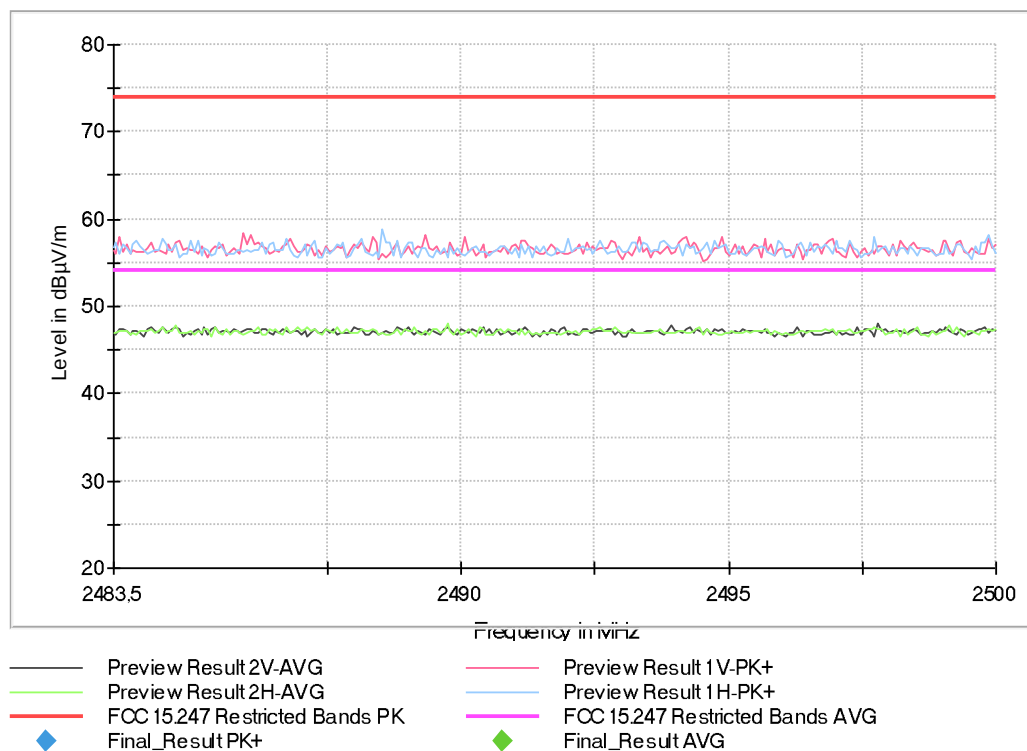
FREQUENCY RANGE 2.4835-2.5 GHz (RESTRICTED BAND):

- Low Channel:



- Middle Channel:

Full Spectrum



- High Channel:

