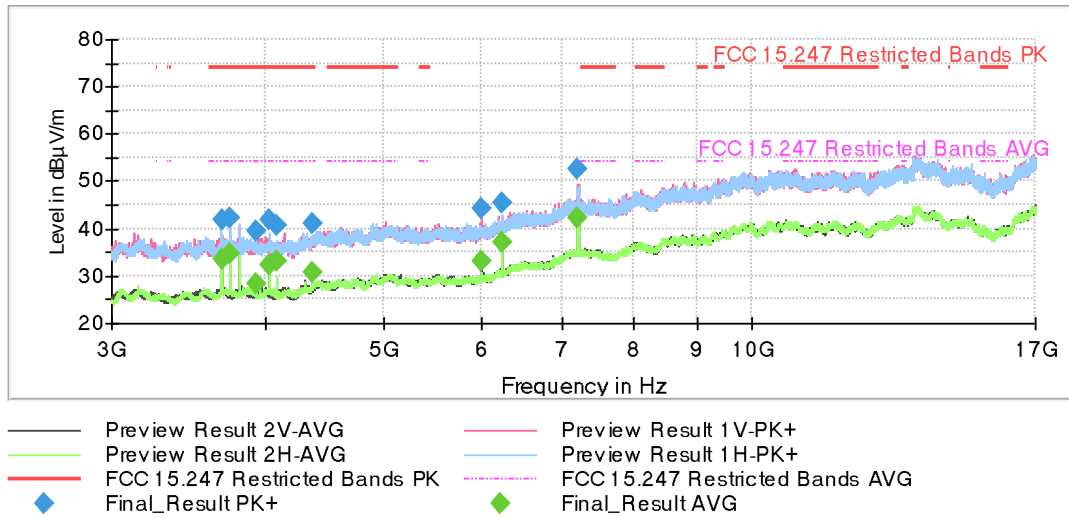
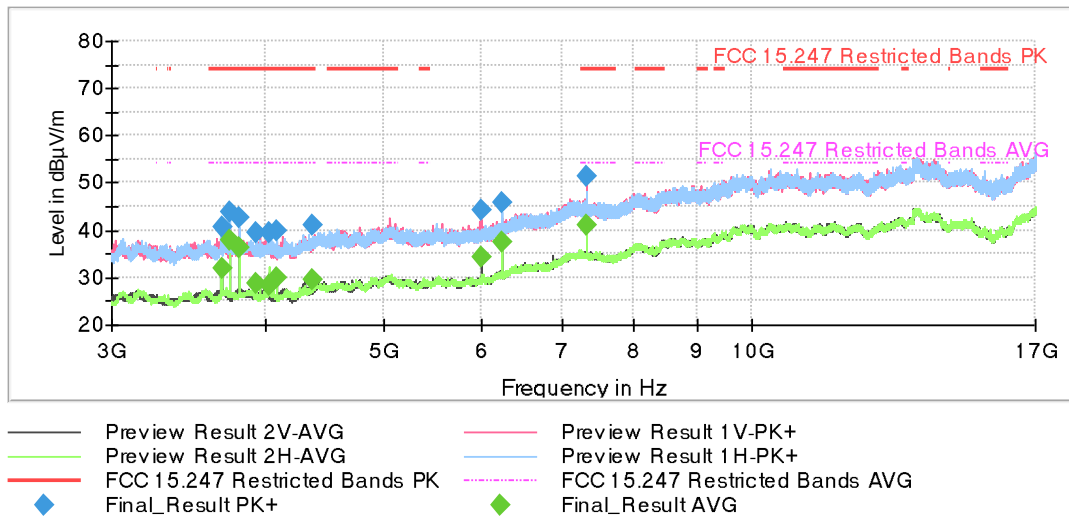


FREQUENCY RANGE 3 - 17 GHz:

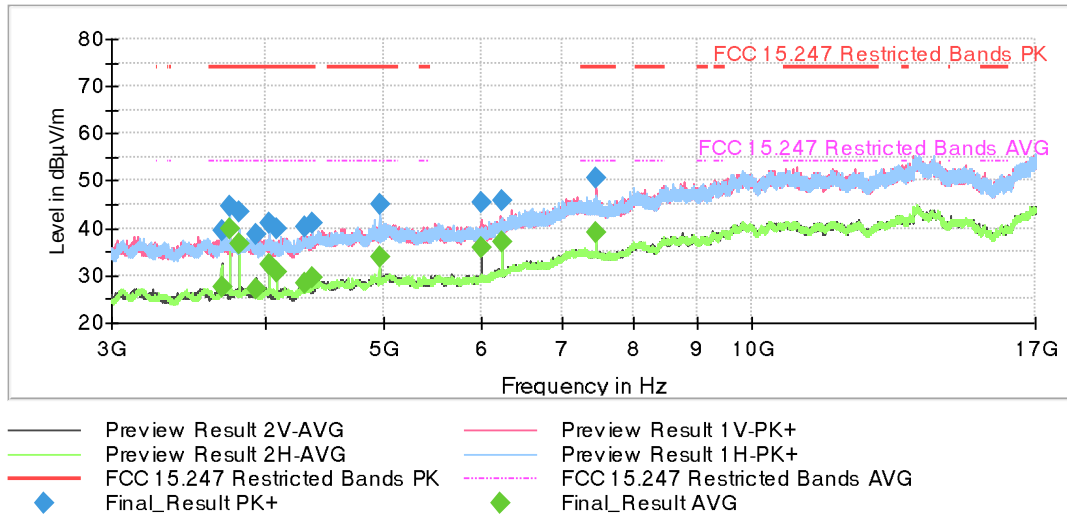
- Low Channel:



- Middle Channel:

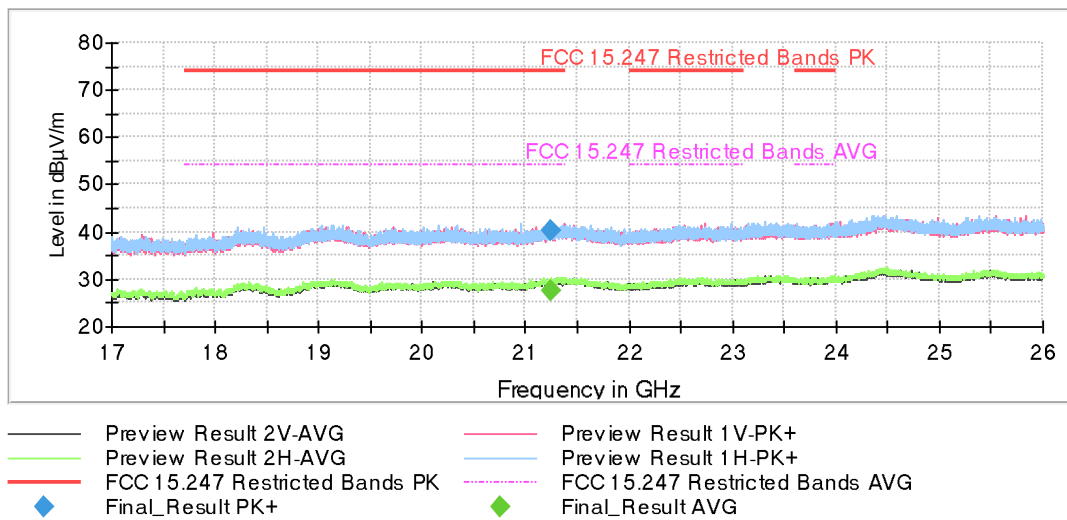


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

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

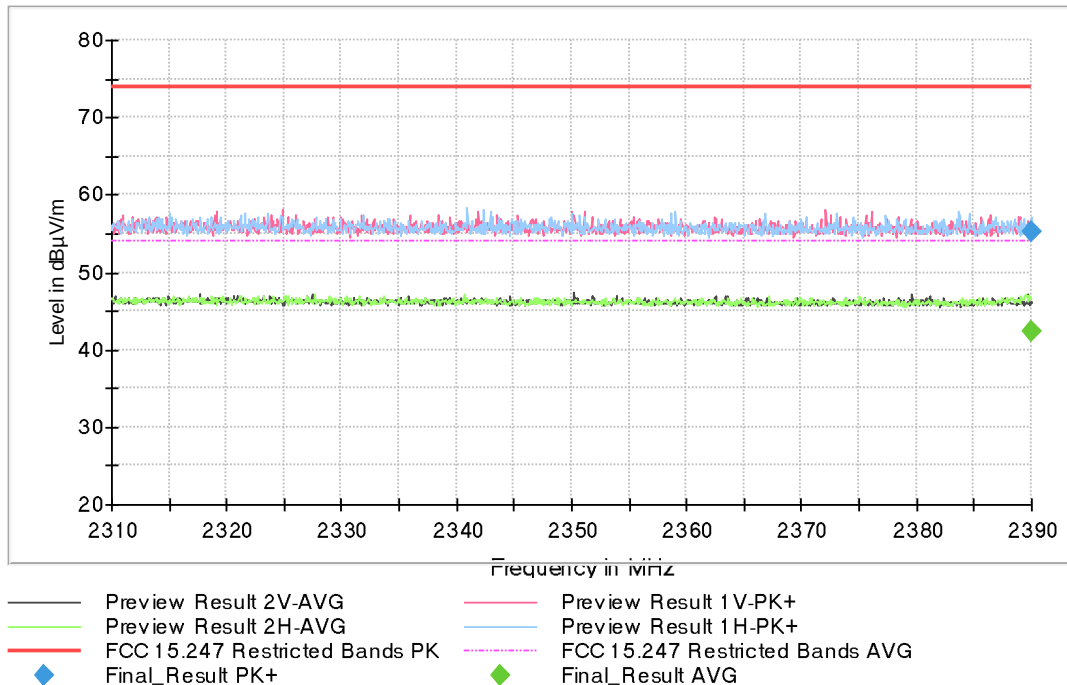


This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

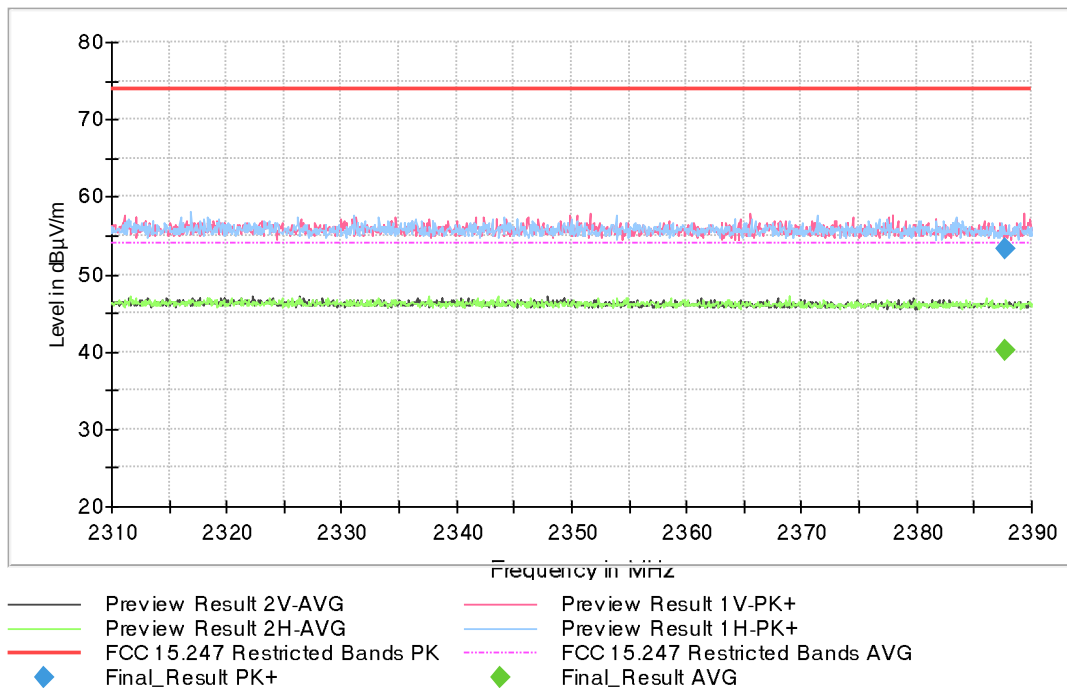
- Low Channel:

Full Spectrum

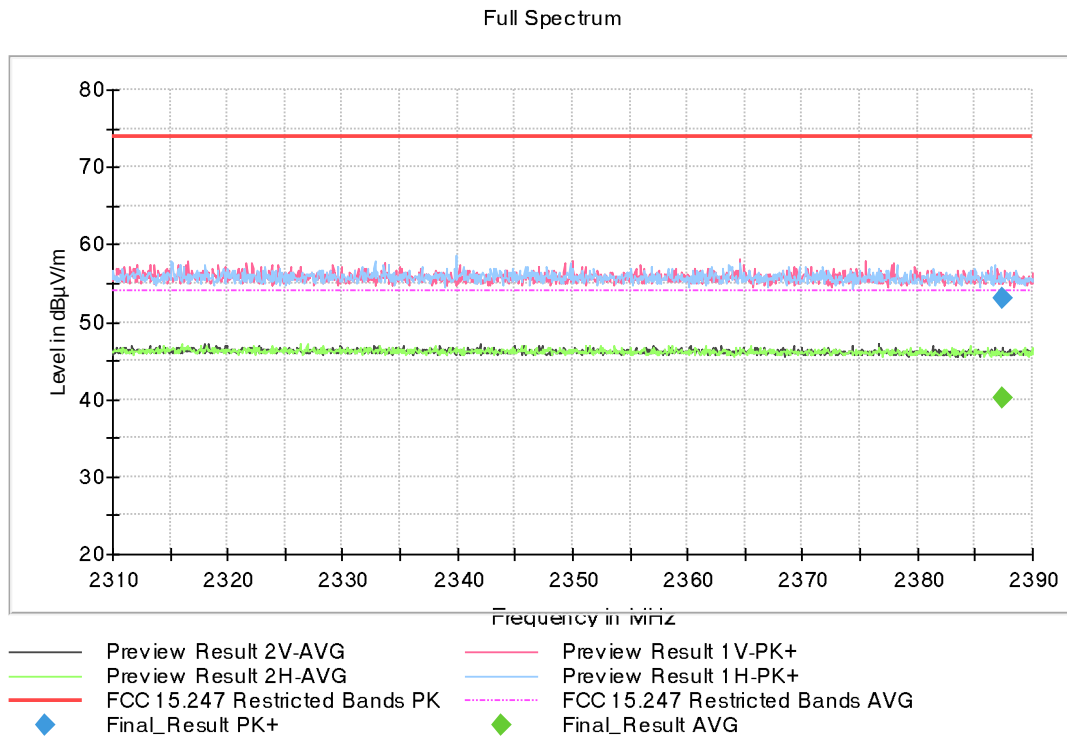


- Middle Channel:

Full Spectrum

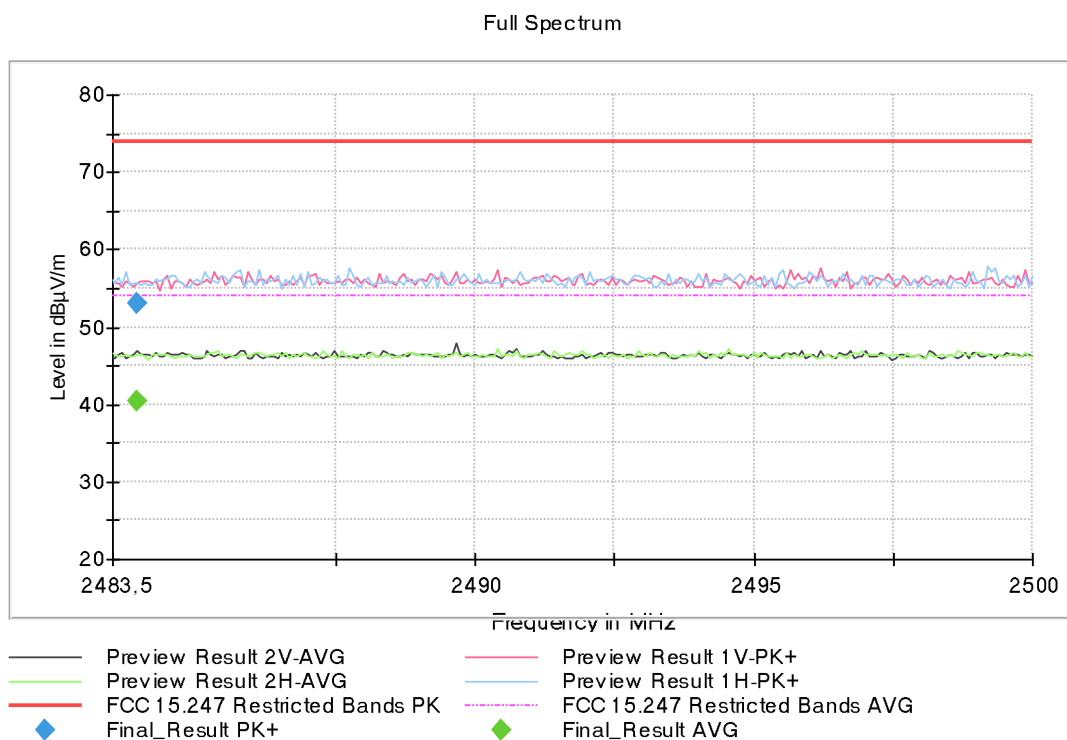


- High Channel:

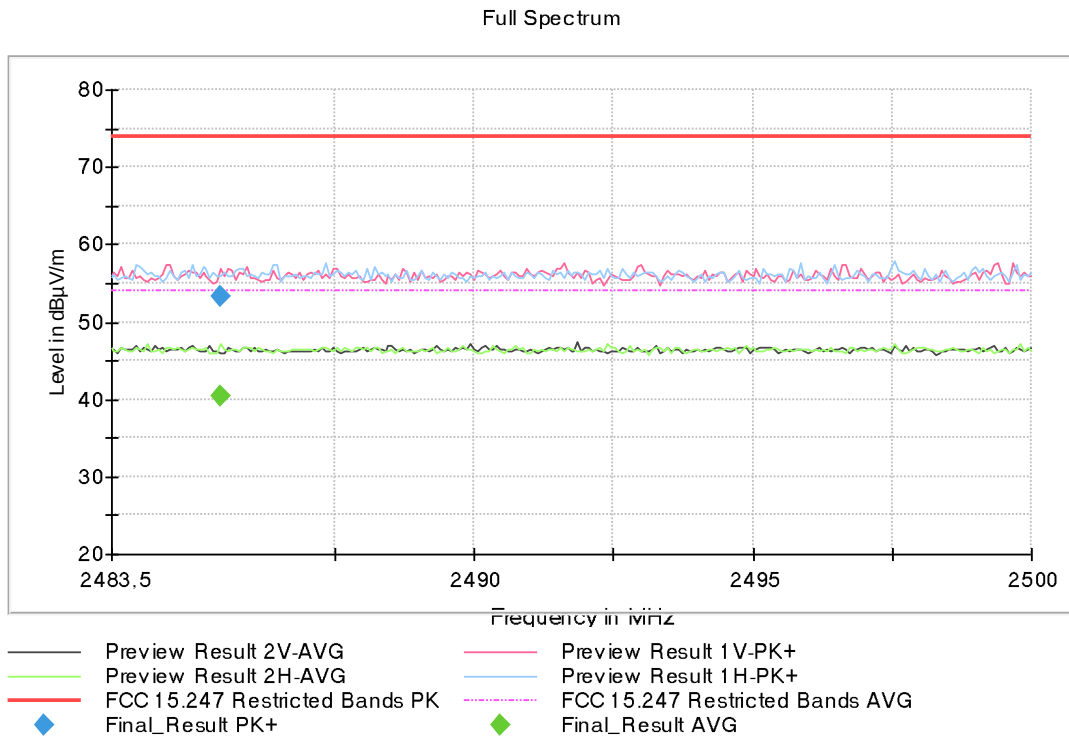


FREQUENCY RANGE 2.4835-2.5 GHz:

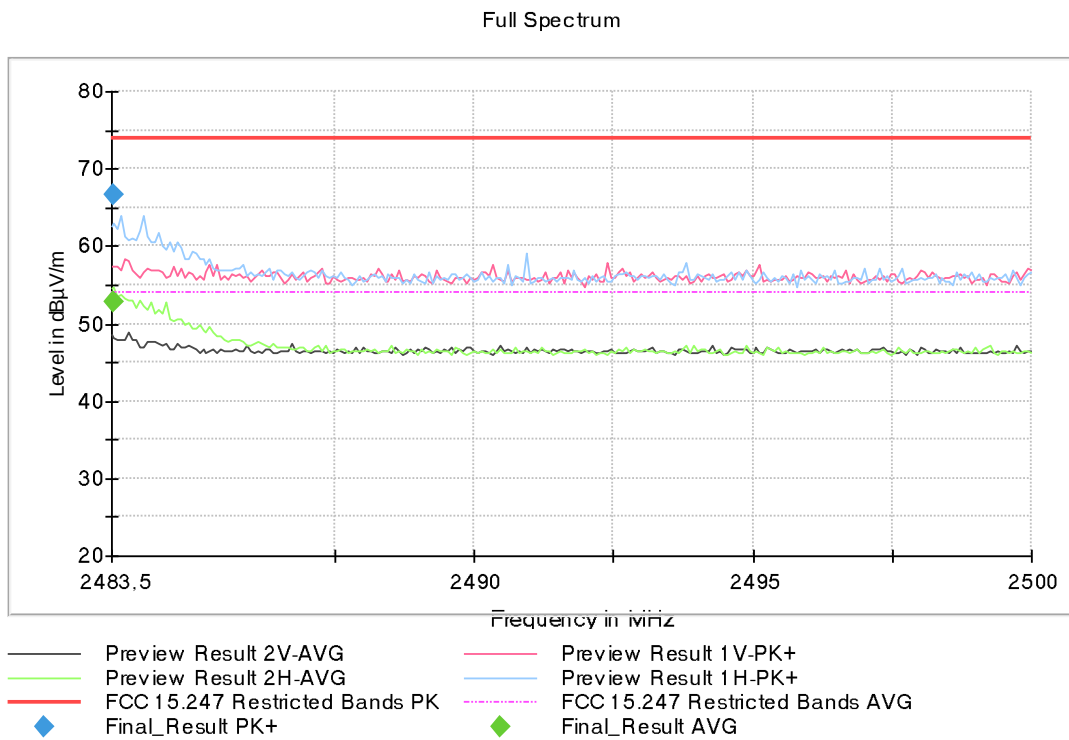
- Low Channel:



- Middle Channel:



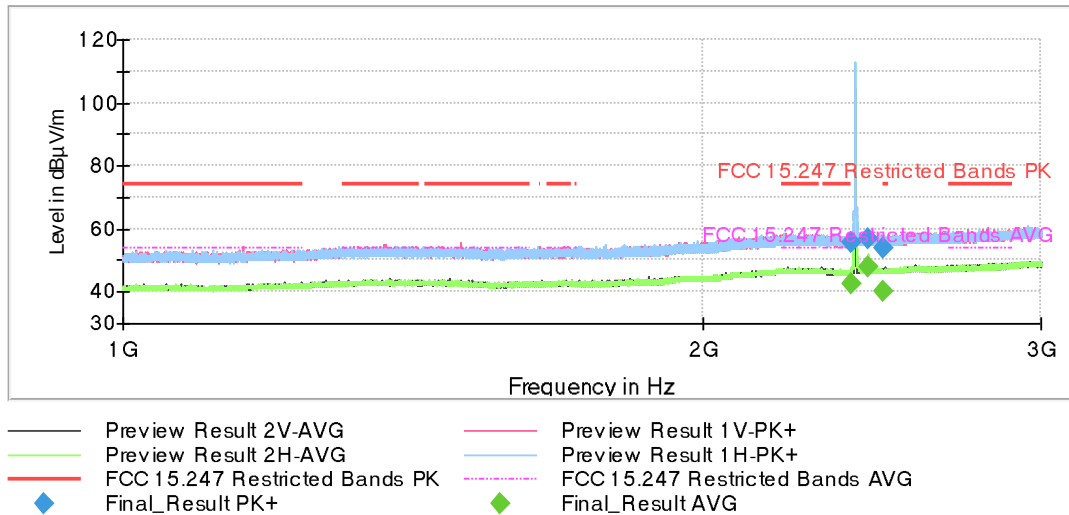
- High Channel:



- **1M modulation:**

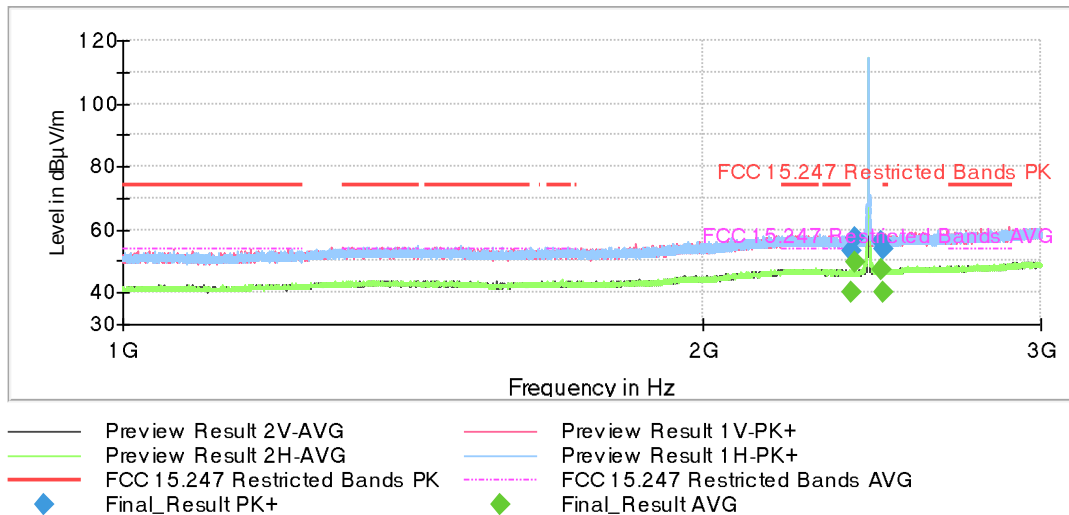
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



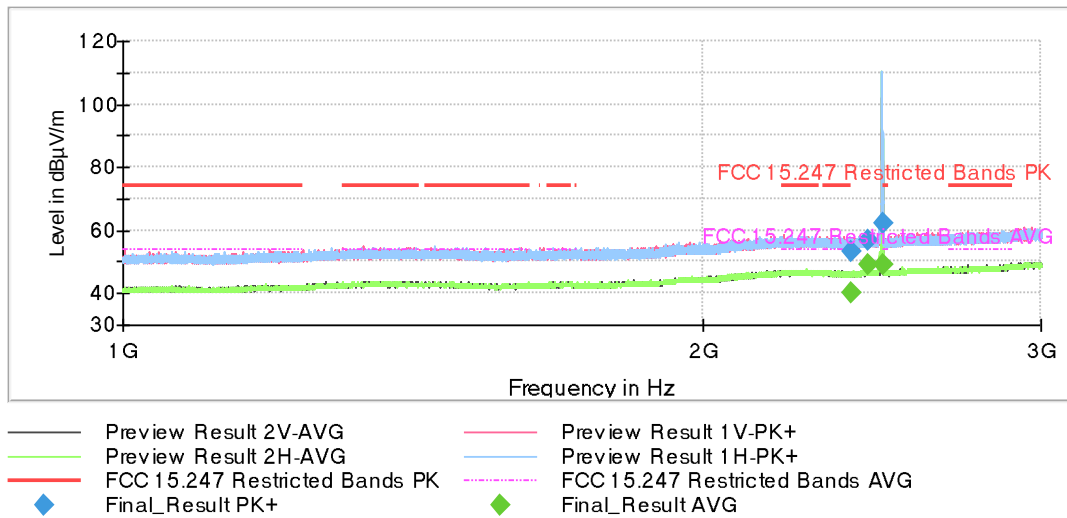
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

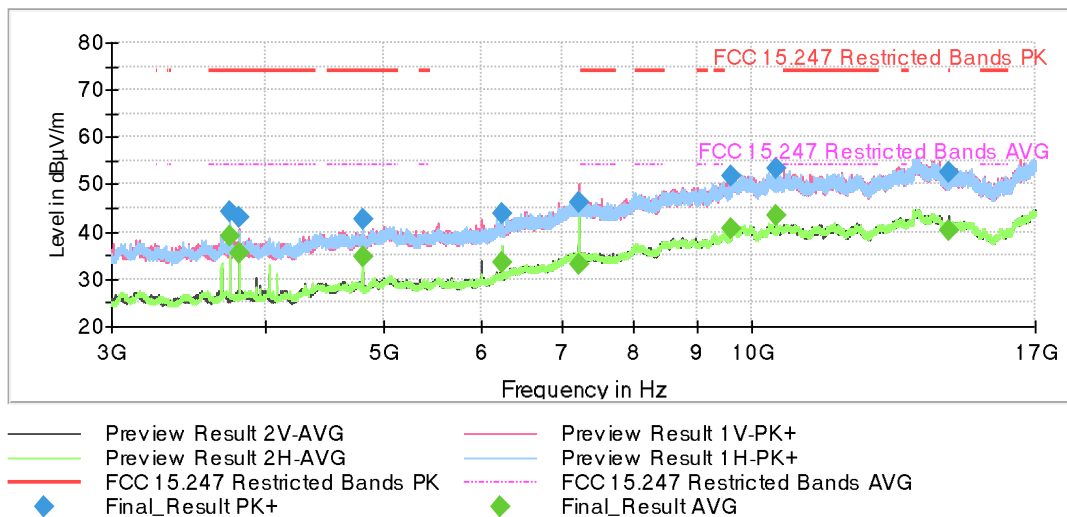
- High Channel:



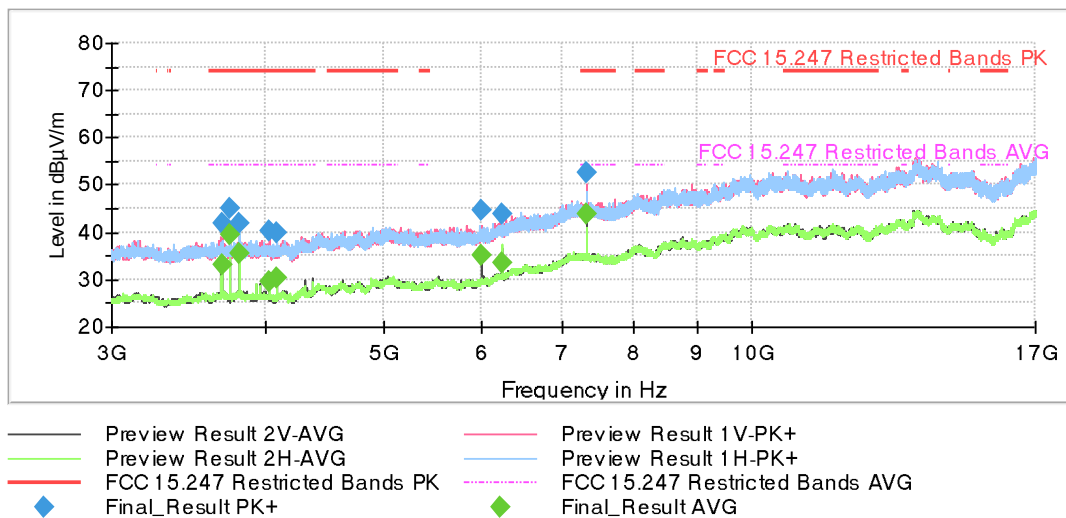
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

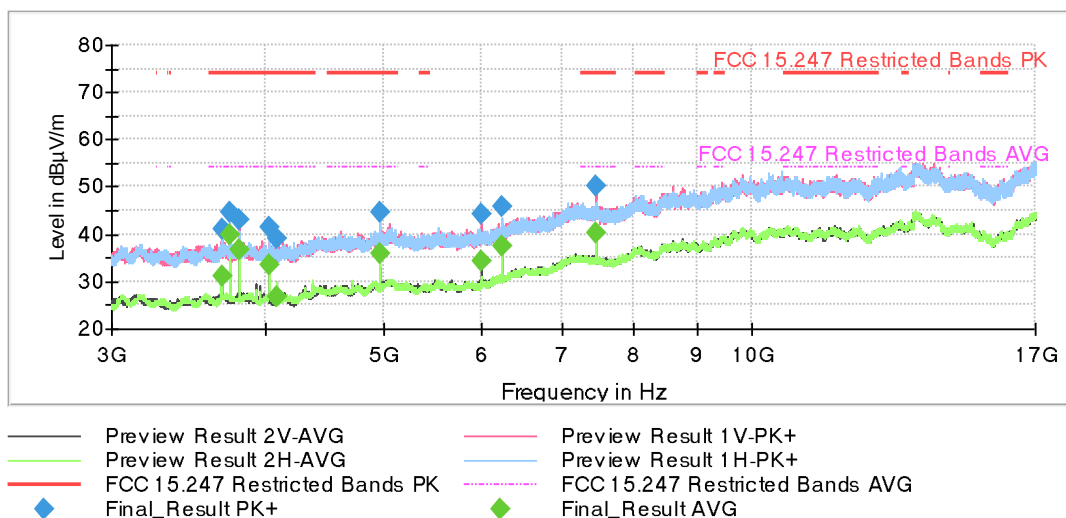
- Low Channel:



- Middle Channel:

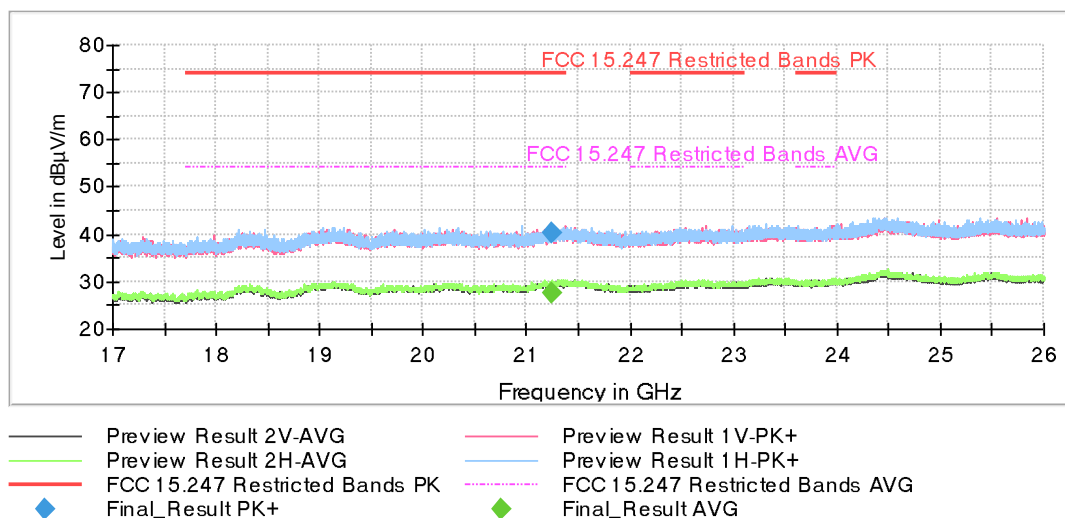


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

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

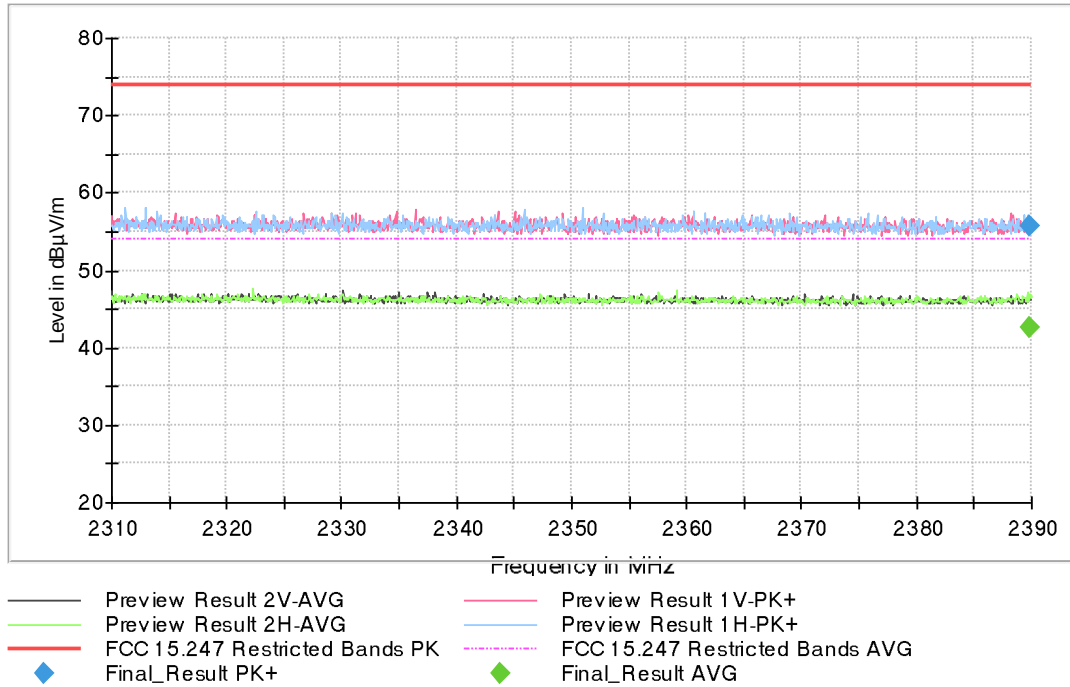


This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

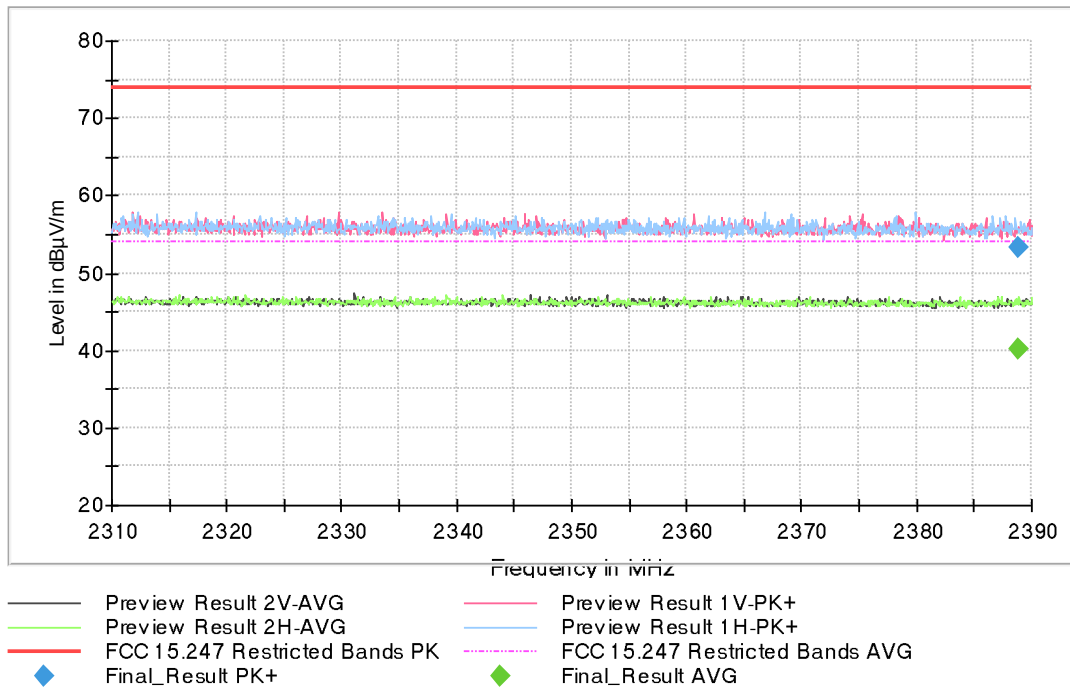
- Low Channel:

Full Spectrum



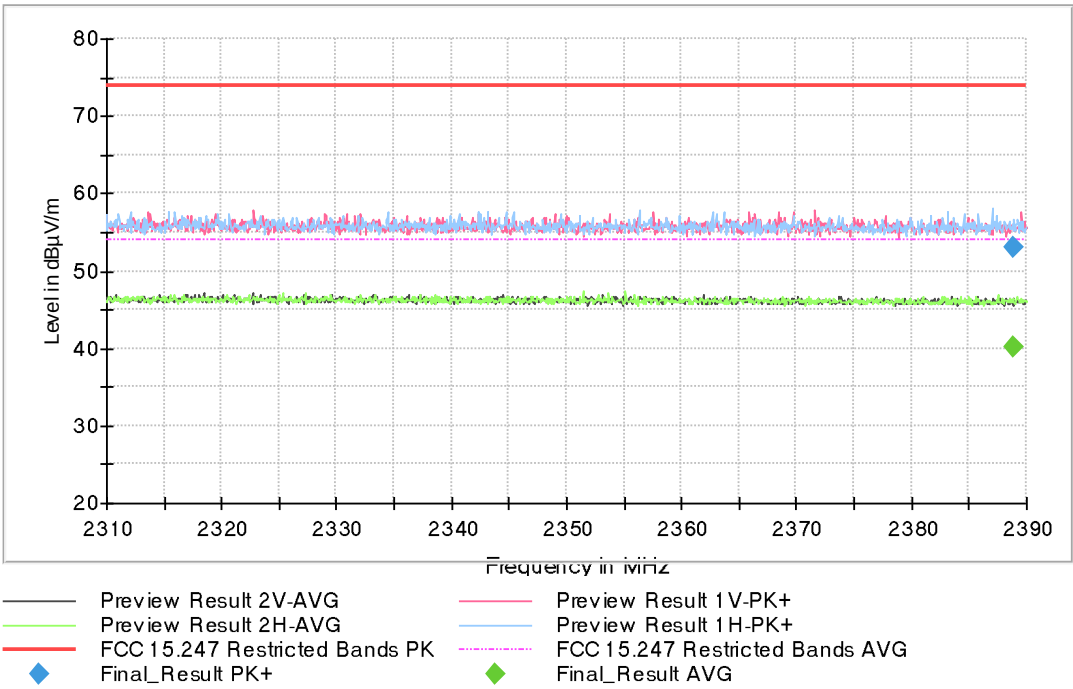
- Middle Channel:

Full Spectrum



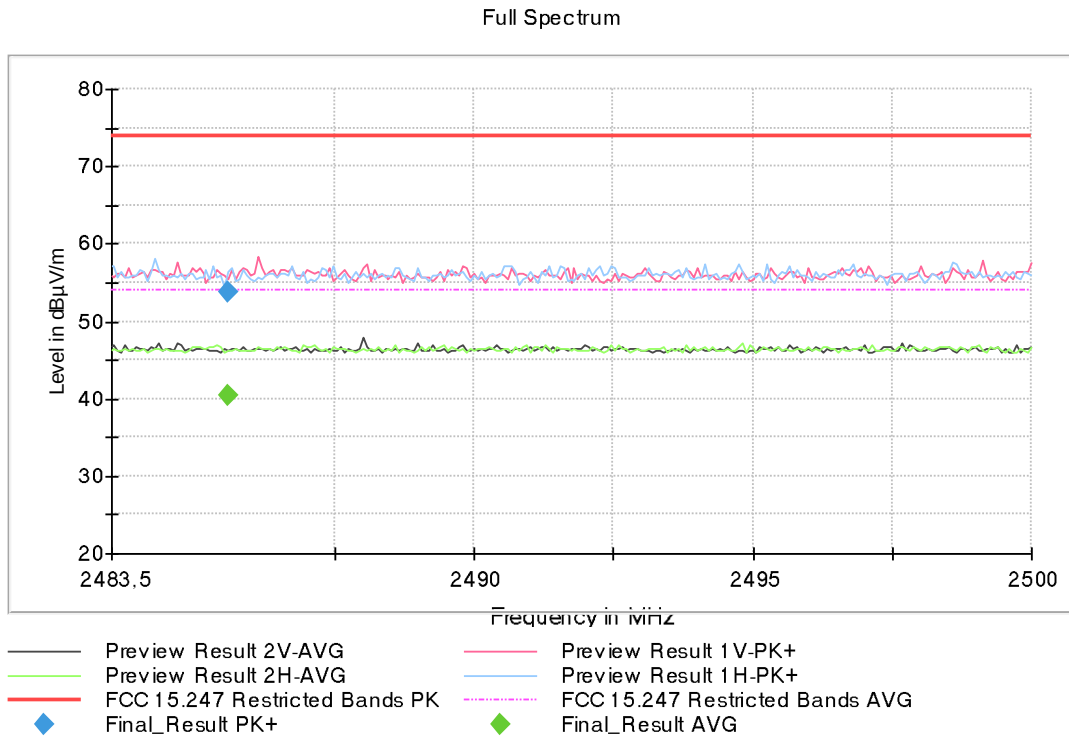
- High Channel:

Full Spectrum

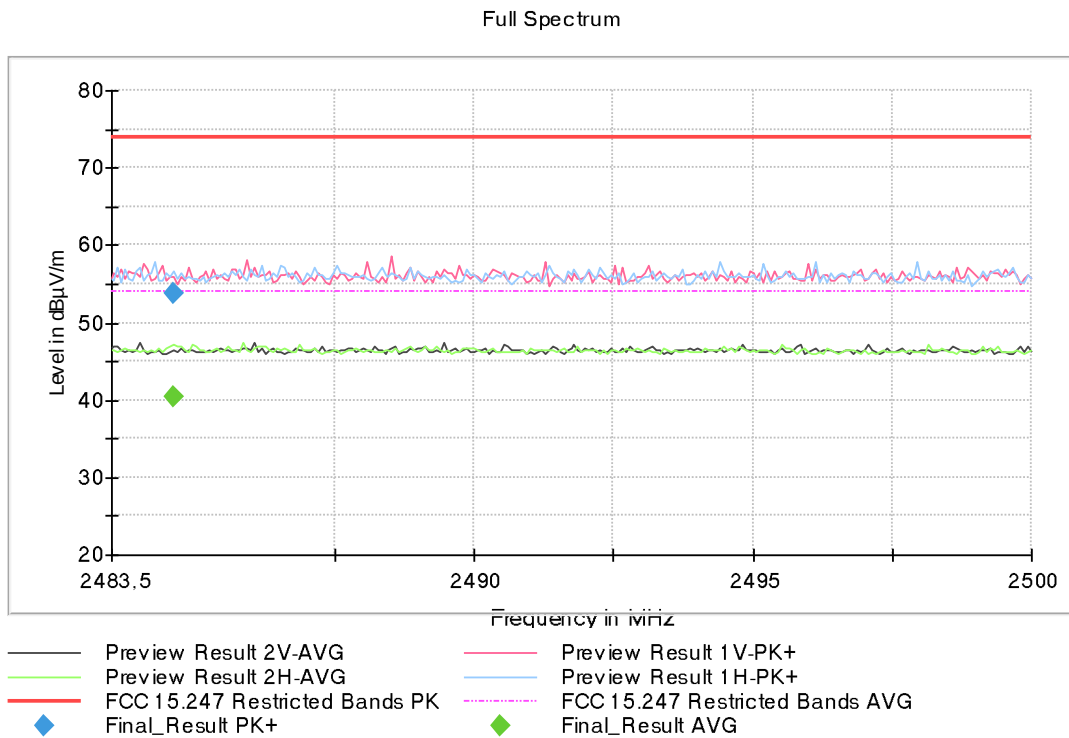


FREQUENCY RANGE 2.4835-2.5 GHz:

- Low Channel:

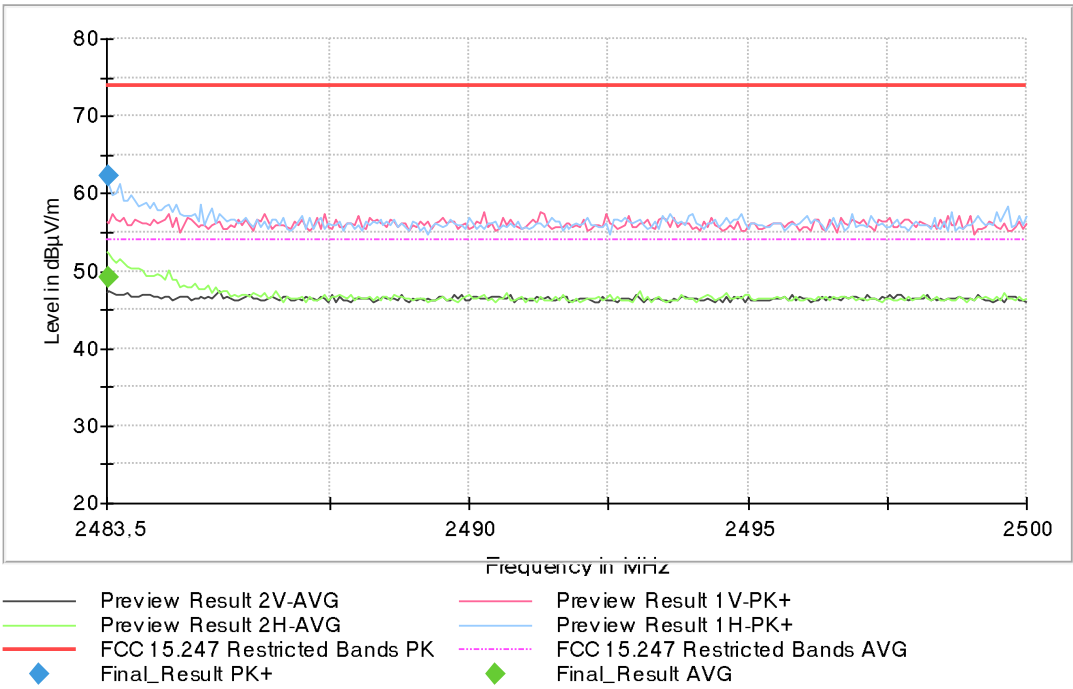


- Middle Channel:



- High Channel:

Full Spectrum



Appendix C: Test results. ZigBee 2.4 GHz.

TEST CONDITIONS.....	98
Occupied Bandwidth	101
FCC 15.247 (a)(2) / RSS-247 5.2. (a) 6 dB Bandwidth	103
FCC 15.247 (b) / RSS-247 5.4. (d) Maximum output power and antenna gain	105
FCC 15.247 (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter).....	107
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FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter).....	111

TEST CONDITIONS

(*) Data provided by the Applicant.

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: 2405 MHz
Middle Channel: 2445 MHz
High Channel: 2480 MHz

POWER SETTINGS (*):

ZigBee setting is 200

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 using an external calibrated power supply with a multimeter.

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-18 GHz Double ridge horn antenna is situated at a distance of 3 m and a distance of 1 m for the frequency range 17 GHz-26 GHz (18 GHz-40 GHz horn antenna).

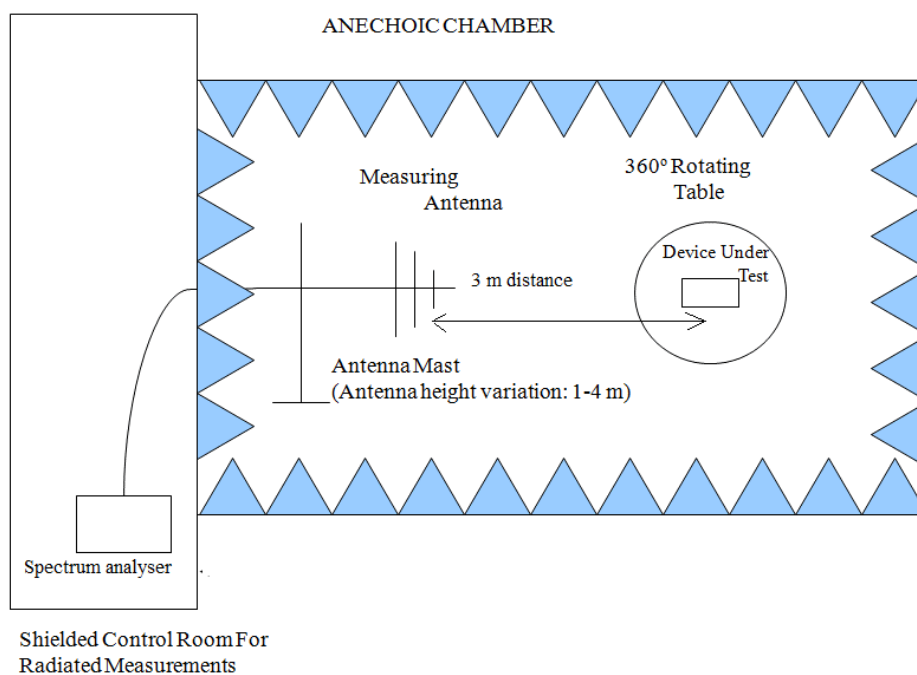
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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.

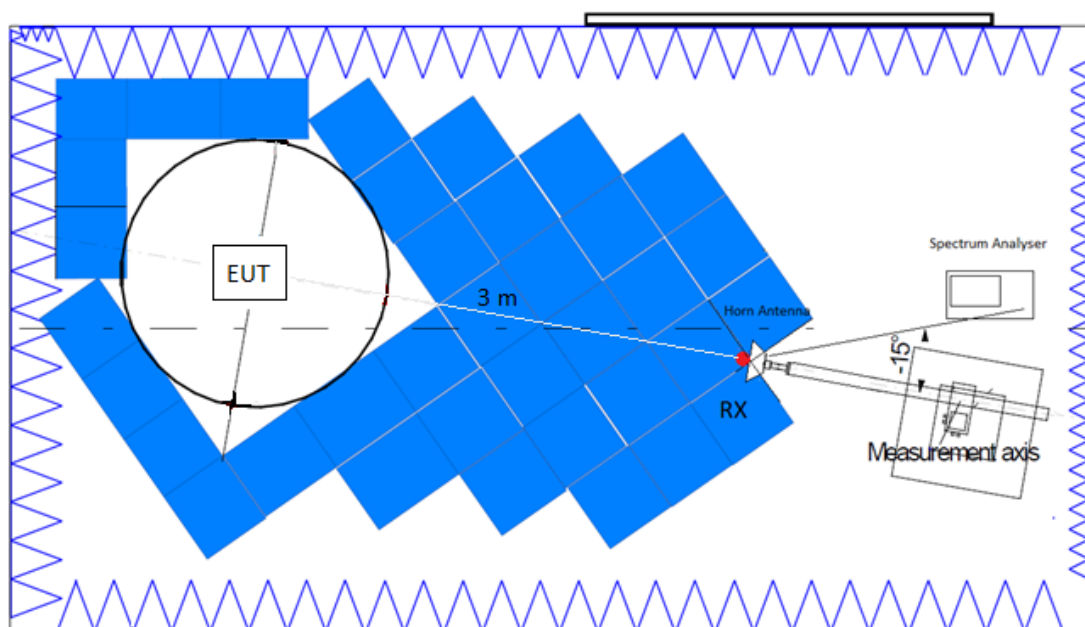
Measurements were made in both horizontal and vertical planes of polarization.

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.

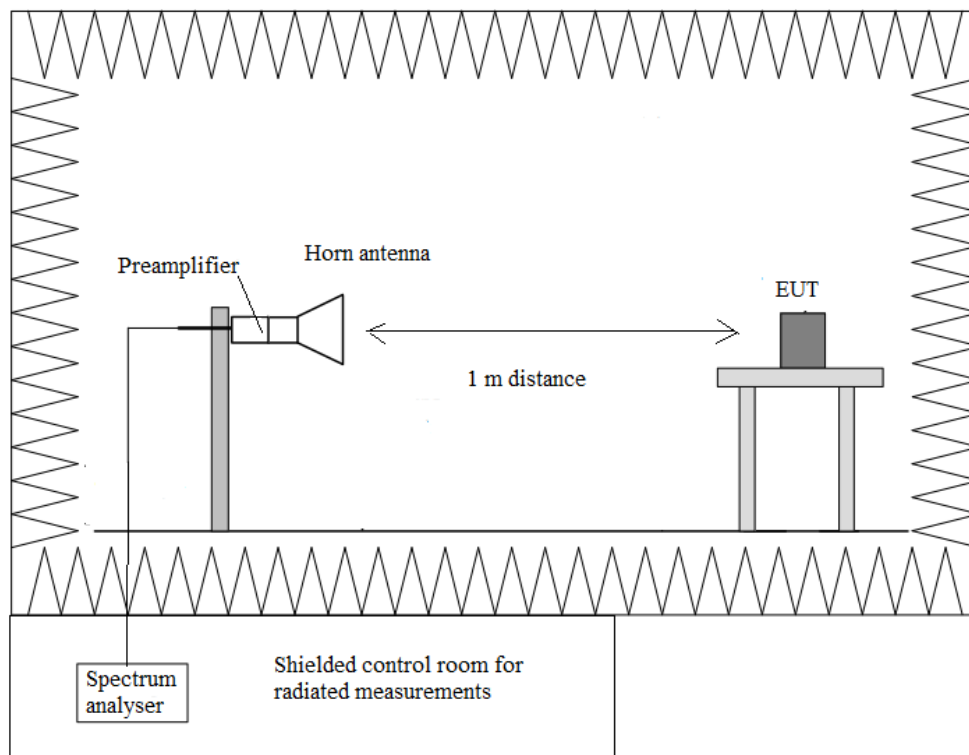
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



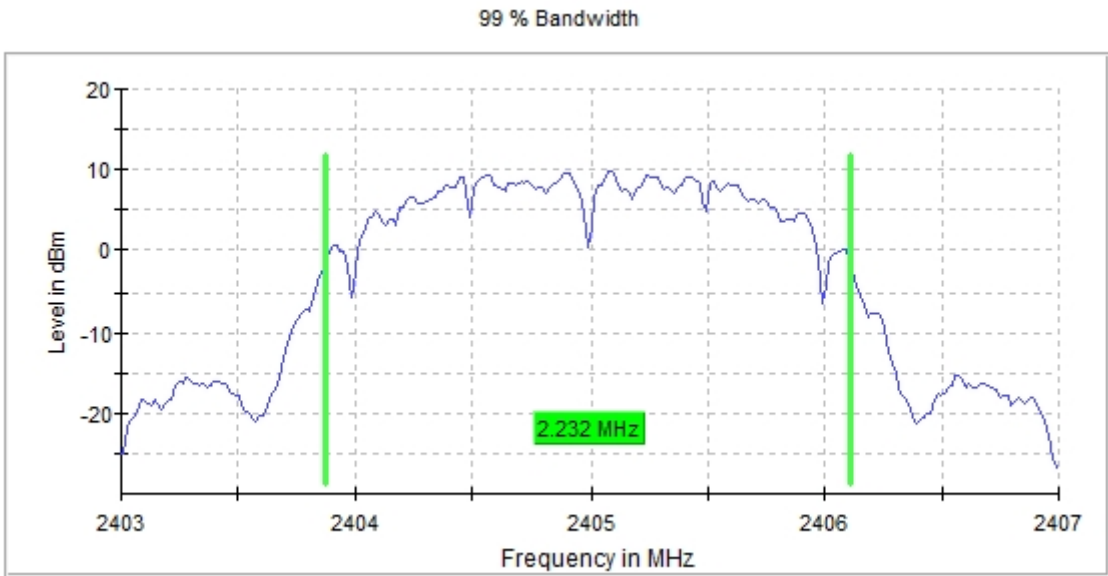
Occupied Bandwidth

RESULTS:

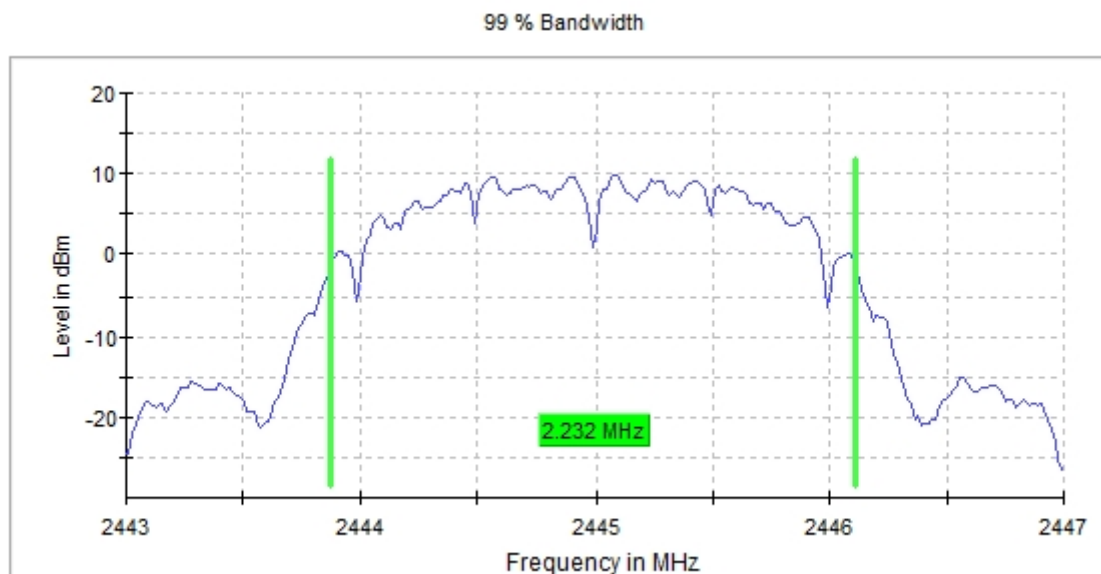
	Low Channel 2405 MHz	Middle Channel 2445 MHz	High Channel 2480 MHz
99% bandwidth (MHz)	2.232210	2.232210	2.247191
Measurement uncertainty (kHz)	<± 5.00		

Verdict: PASS

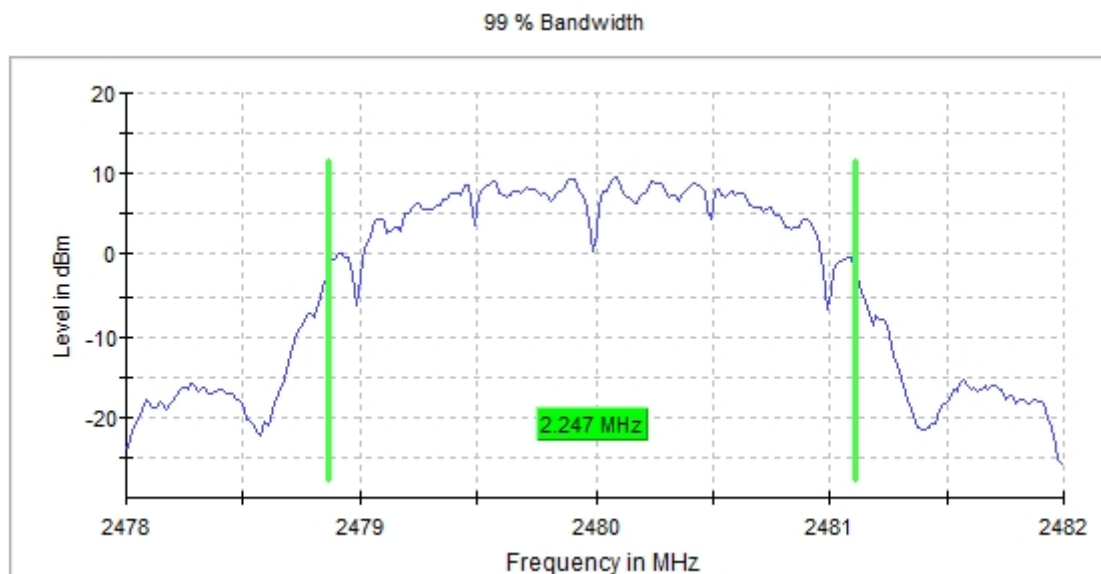
- Low Channel:



- Middle Channel:



- High Channel:



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

SPECIFICATION:

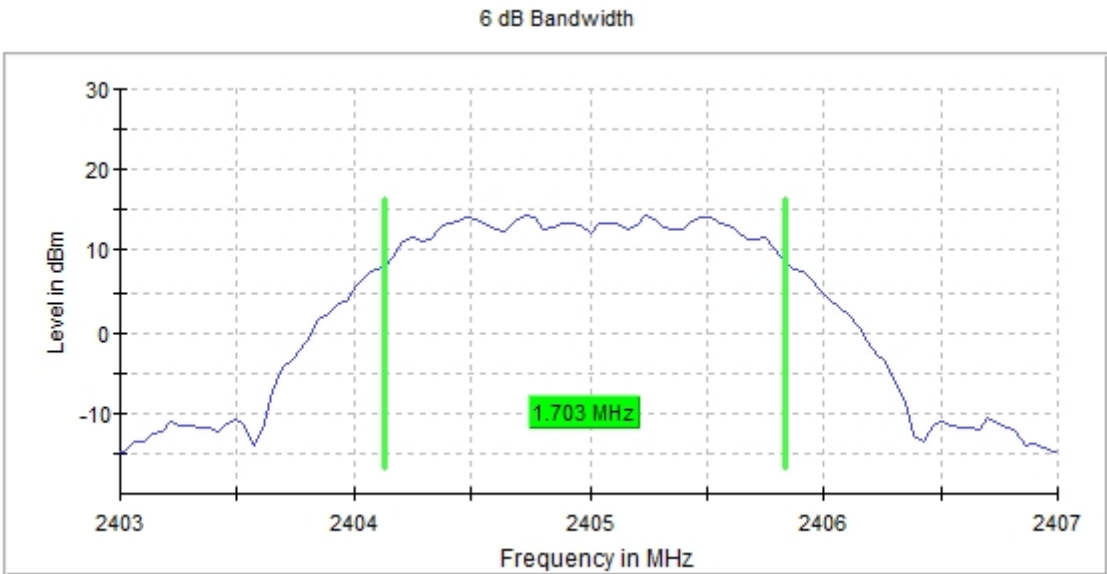
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

	Low Channel 2405 MHz	Middle Channel 2445 MHz	High Channel 2480 MHz
6 dB Bandwidth (kHz)	1.702970	1.702970	1.702970
Measurement uncertainty (kHz)	<±17.0		

Verdict: PASS

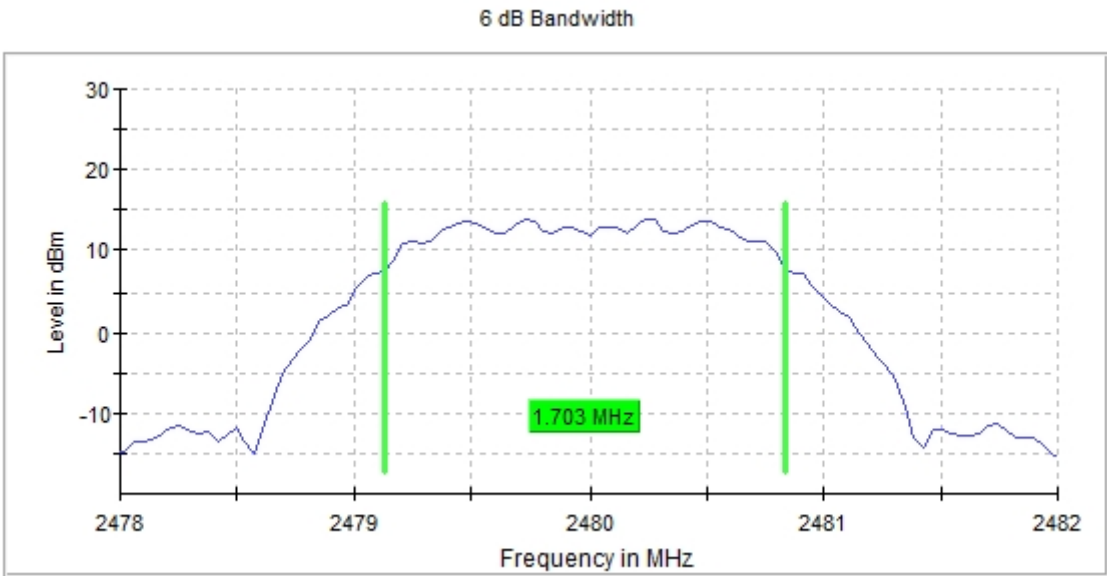
- Low Channel:



- 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

	Low Channel 2405 MHz	Middle Channel 2445 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	18.484	18.516	18.142
Maximum EIRP Power (dBm)	22.184	22.216	21.842
Measurement uncertainty (dB)	< $\pm$ 0.78		

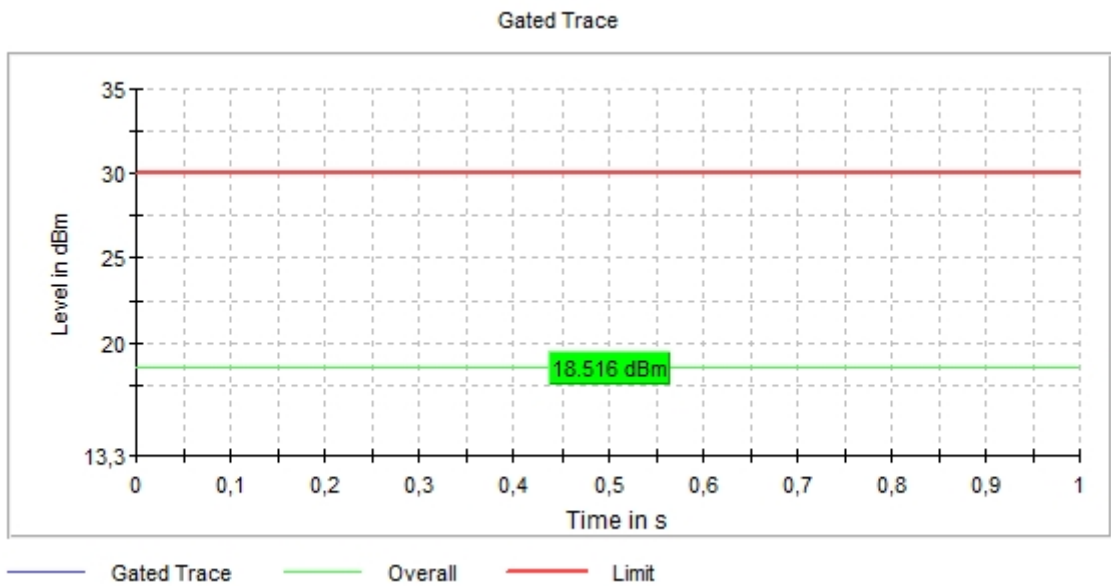
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

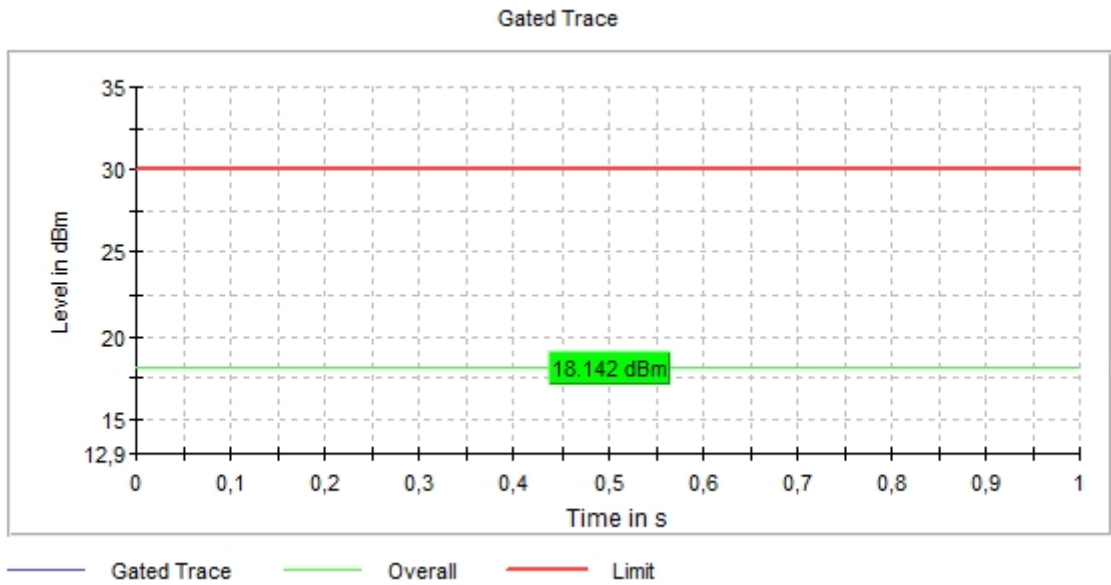
- Low Channel:



- Middle Channel:



- High Channel:



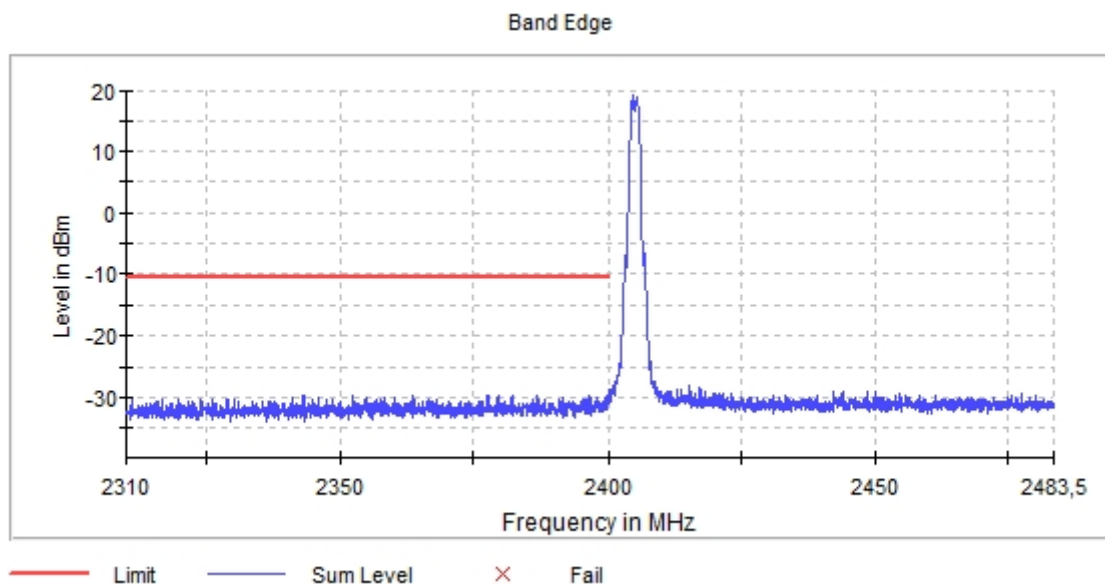
FCC 15.247 (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)

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.

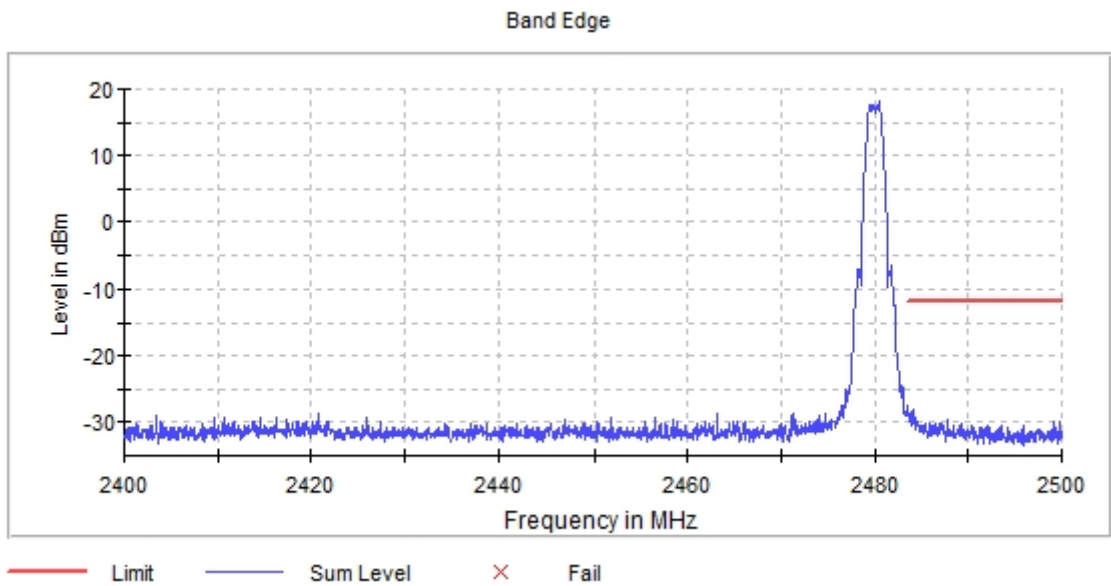
RESULTS:

- Low Channel:



Verdict: PASS

- High Channel:



Verdict: PASS

Measurement uncertainty (dB)	<±2.03
------------------------------	--------

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.

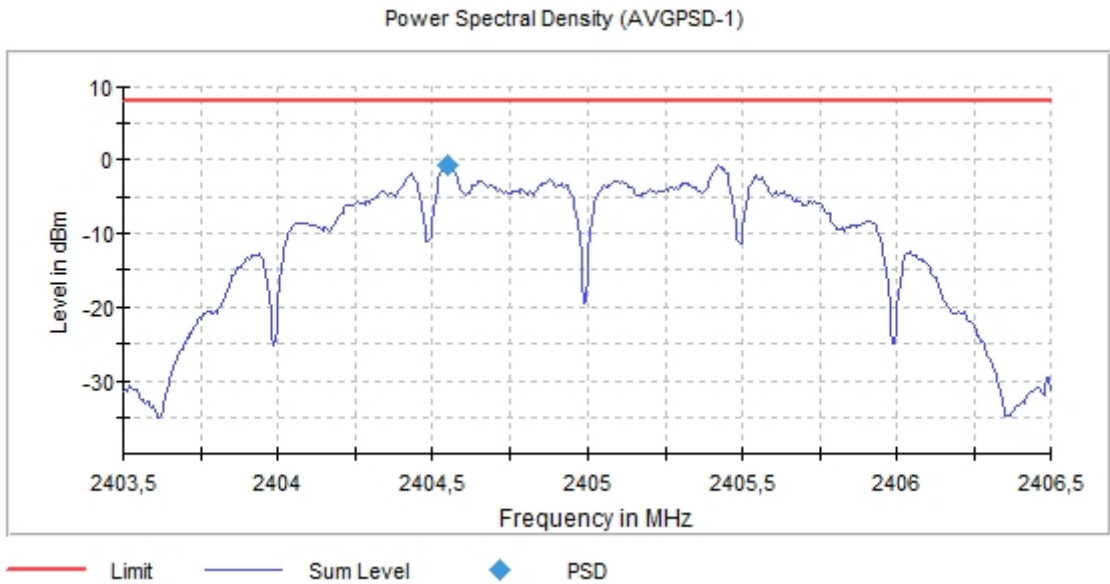
RESULTS:

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.

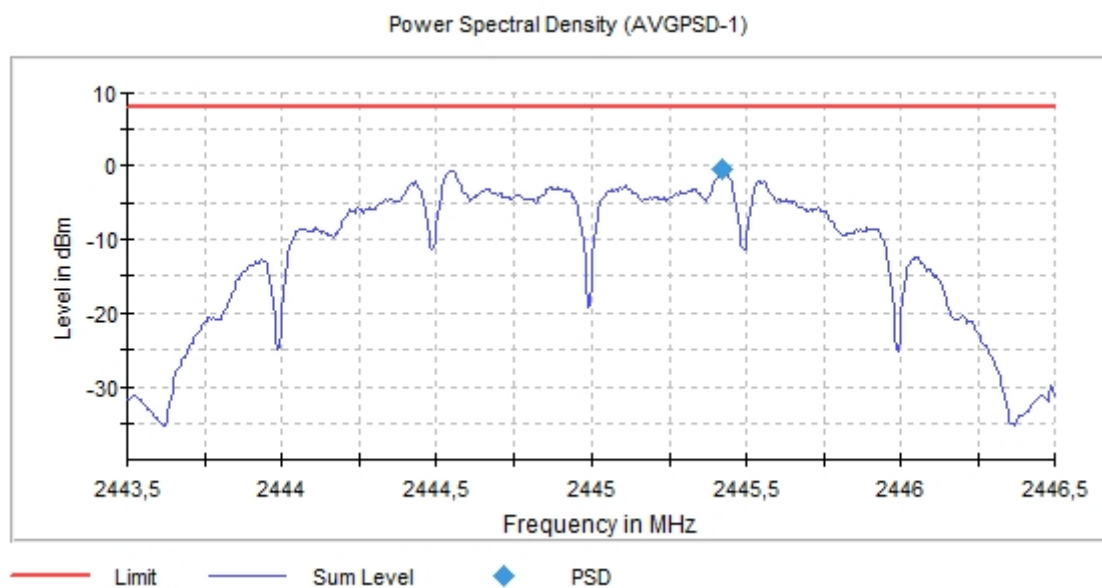
	Low Channel 2405 MHz	Middle Channel 2445 MHz	High Channel 2480 MHz
Power Spectral Density (dBm)	-0.653	-0.502	-0.754
Measurement uncertainty (dB)	<±0.78		

Verdict: PASS

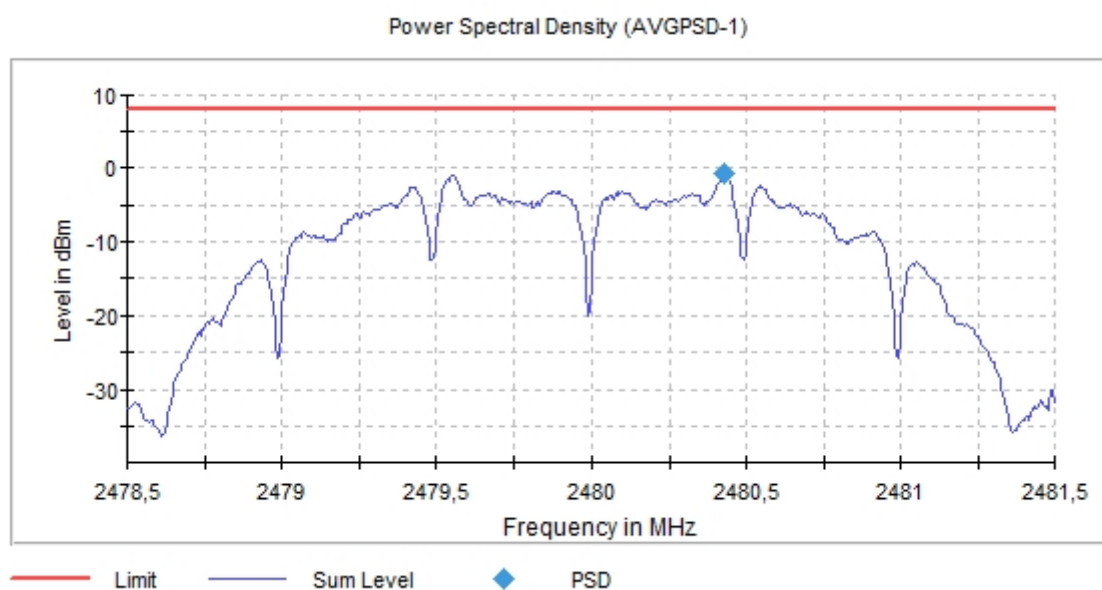
- Low Channel:



- 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-25 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
36.838500	23.71	V	Quasi-Peak
46.393000	26.79	V	Quasi-Peak
50.564000	29.78	V	Quasi-Peak
54.347000	27.97	V	Quasi-Peak
82.962000	26.63	V	Quasi-Peak
86.696500	28.86	V	Quasi-Peak
125.011500	29.58	V	Quasi-Peak
374.980500	31.66	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.

- LOW CHANNEL. Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2377.666667	53.39	H	Peak	< $\pm$ 4.6
2443.000000	58.40	H	Peak	< $\pm$ 4.6
	49.42		Peak	< $\pm$ 4.6
2487.266667	53.84	V	Peak	< $\pm$ 4.6
3750.000000	44.25	H	Peak	< $\pm$ 4.6
3812.500000	42.21	V	Peak	< $\pm$ 4.6
6000.000000	44.57	V	Peak	< $\pm$ 4.6
6250.000000	44.59	V	Peak	< $\pm$ 4.6
7216.500000	52.40	V	Peak	< $\pm$ 4.6
8750.500000	50.81	V	Peak	< $\pm$ 4.6
19143.500000	40.79	V	Peak	< $\pm$ 4.6

- MIDDLE CHANNEL. Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2367.266667	53.90	V	Peak	< $\pm$ 4.6
2406.666667	57.45	H	Peak	< $\pm$ 4.6
	49.02		Peak	< $\pm$ 4.6
2483.533333	55.06	H	Peak	< $\pm$ 4.6
	43.58		Peak	< $\pm$ 4.6
3750.000000	44.86	H	Peak	< $\pm$ 4.6
3812.500000	42.93	V	Peak	< $\pm$ 4.6
5999.500000	44.44	V	Peak	< $\pm$ 4.6
6250.000000	45.21	H	Peak	< $\pm$ 4.6
7333.000000	49.78	V	Peak	< $\pm$ 4.6
8750.500000	51.08	V	Peak	< $\pm$ 4.6
20230.500000	41.21	H	Peak	< $\pm$ 4.6

- HIGH CHANNEL. Spurious frequencies detected at less than 20 dB below the limit:

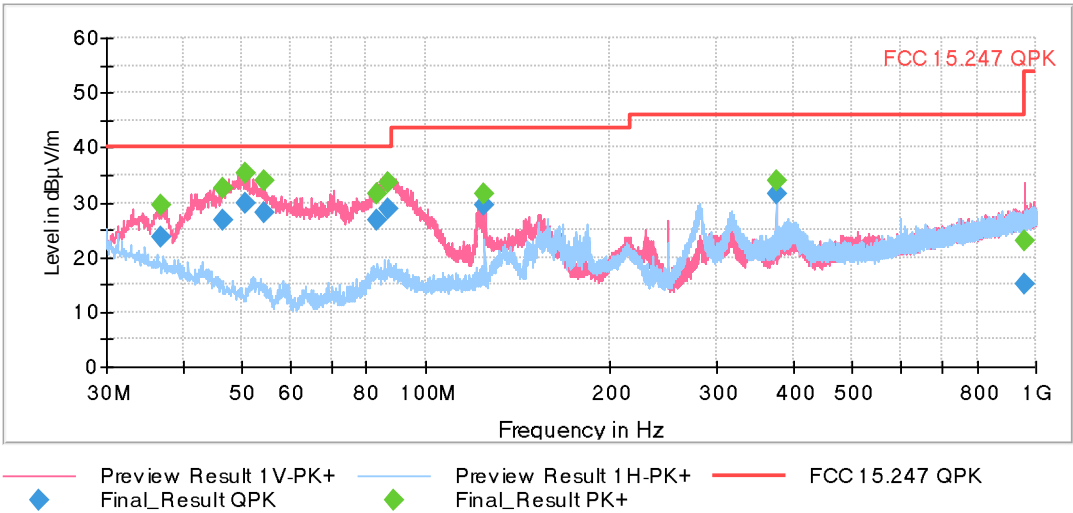
Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
2386.866667	53.39	V	Peak	$<\pm 4.6$
2442.000000	56.32	H	Peak	$<\pm 4.6$
	46.24		Peak	$<\pm 4.6$
2483.600000	68.81	H	Peak	$<\pm 4.6$
	54.85		Peak	$<\pm 4.6$
3750.000000	44.67	V	Peak	$<\pm 4.6$
3812.500000	42.49	V	Peak	$<\pm 4.6$
4959.000000	44.96	H	Peak	$<\pm 4.6$
5999.500000	45.20	V	Peak	$<\pm 4.6$
6250.000000	44.49	H	Peak	$<\pm 4.6$
7438.500000	50.11	V	Peak	$<\pm 4.6$
21366.000000	40.75	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:

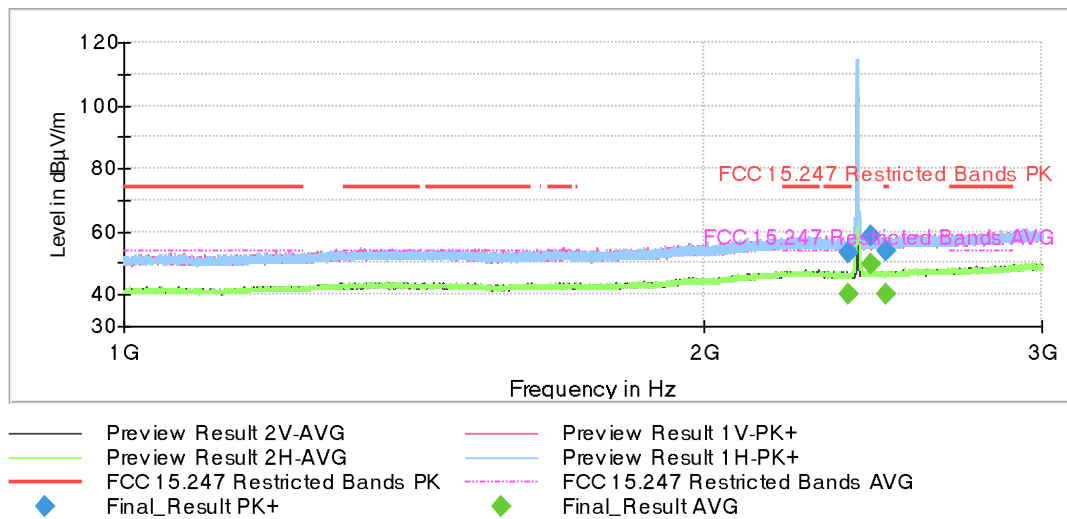
The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.
This plot is valid for the Low, Middle and High Channels.



The above plot shows the results of the scan using peak detector.

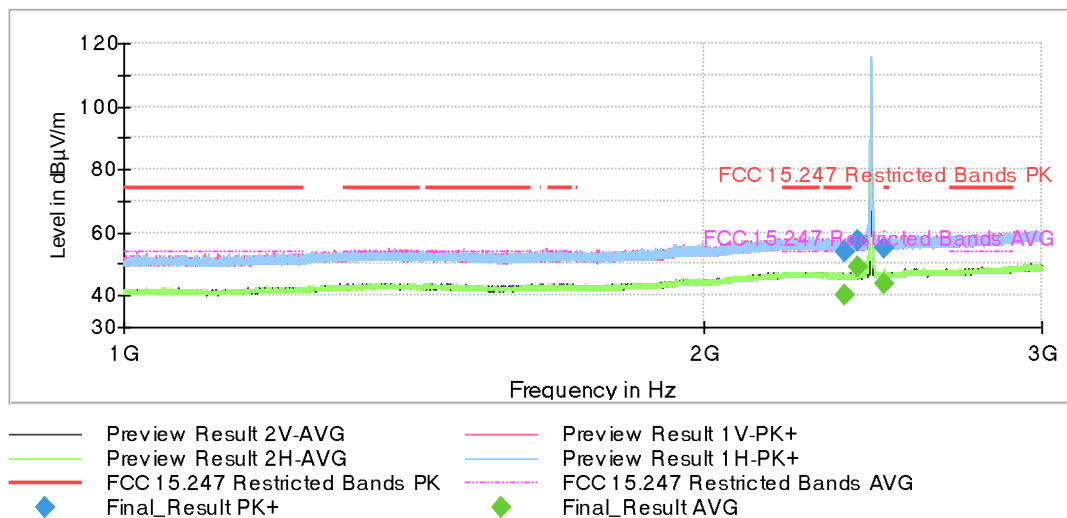
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



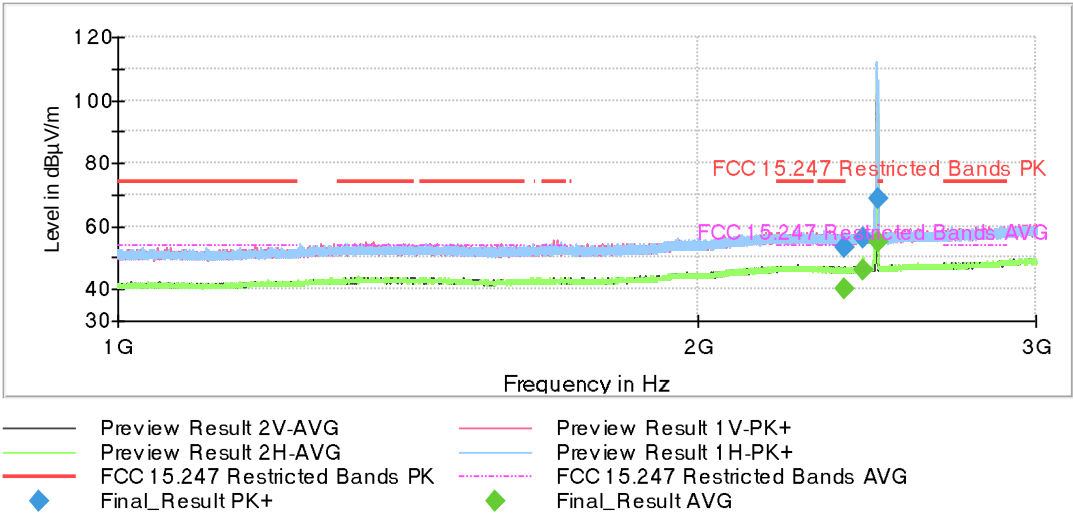
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

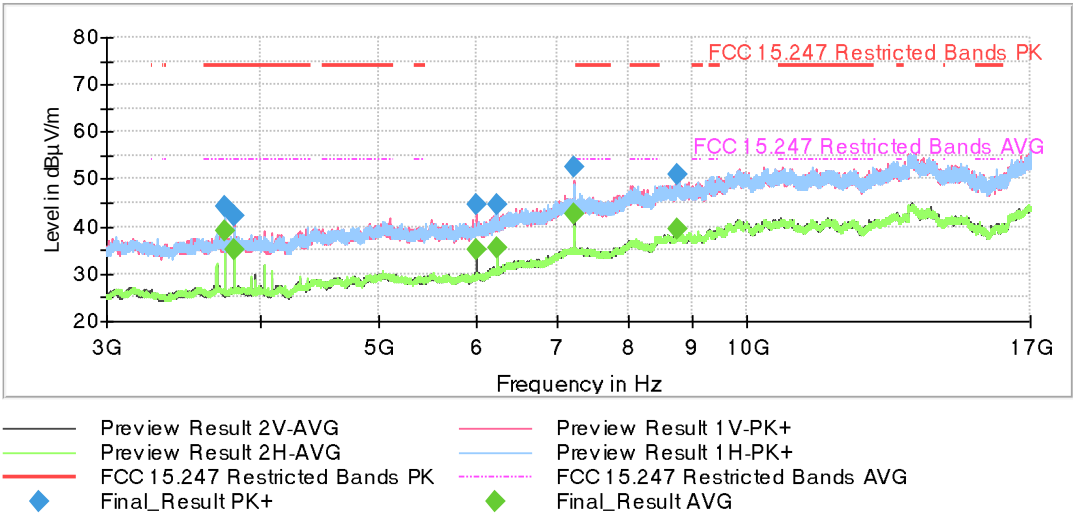
- High Channel:



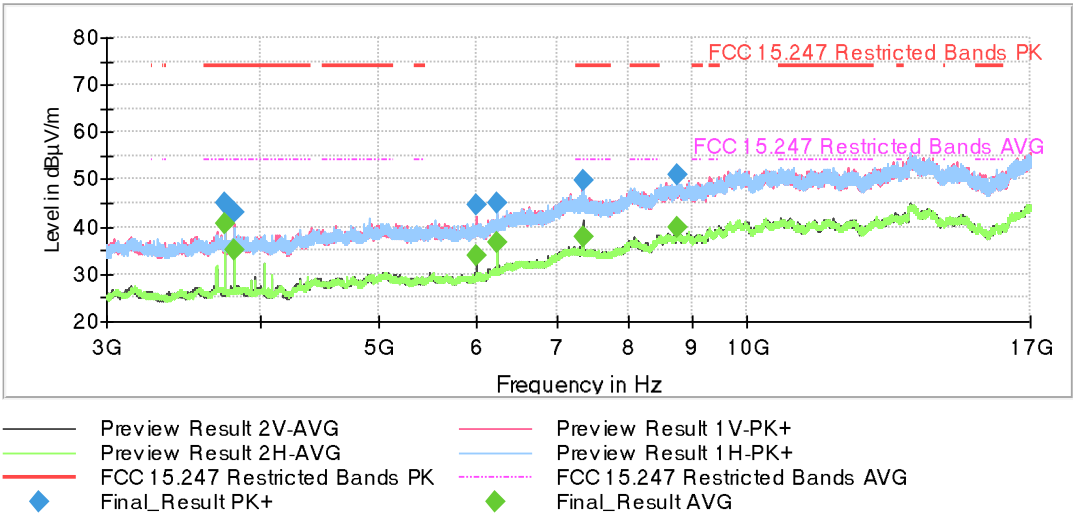
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

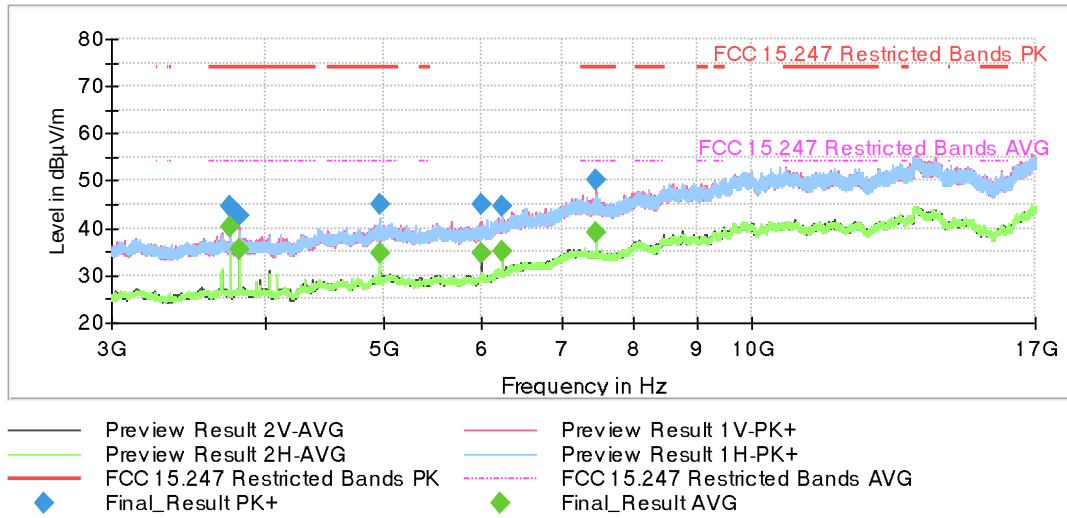
- Low Channel:



- Middle Channel:

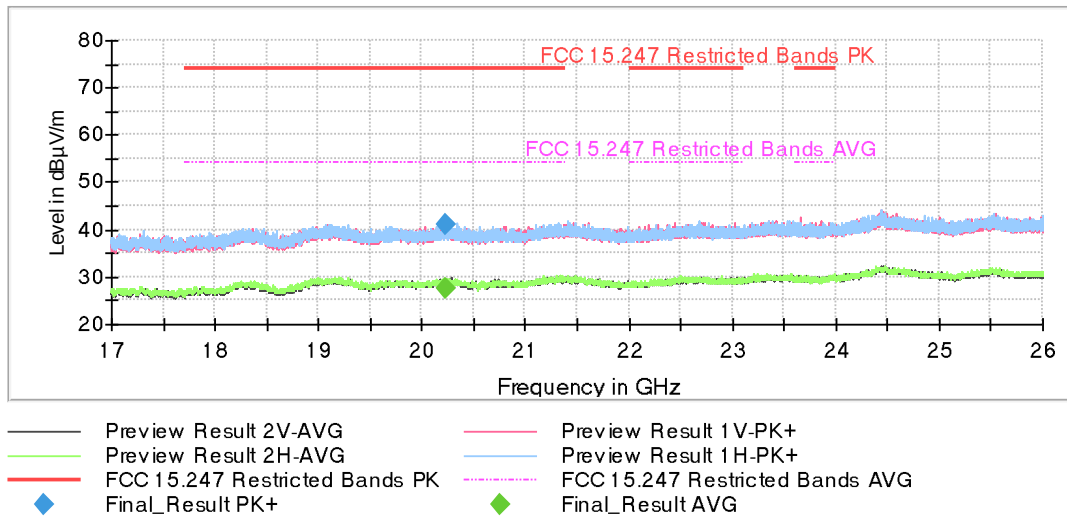


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

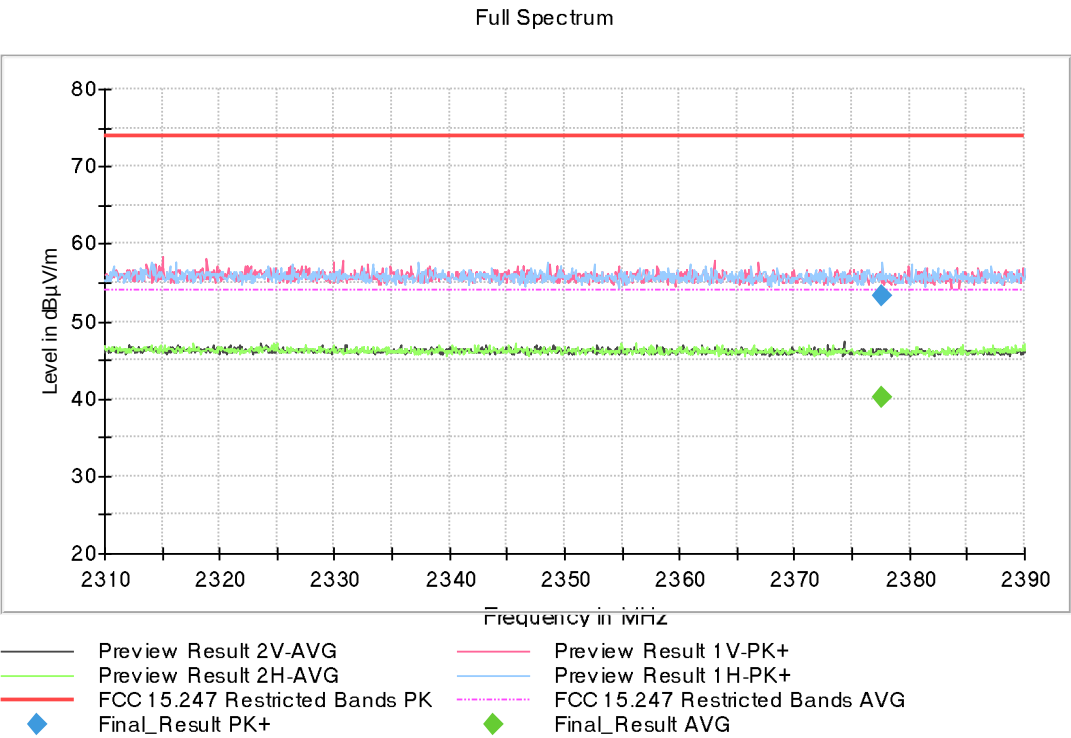
The spurious frequencies detected do not depend on the operating channel.



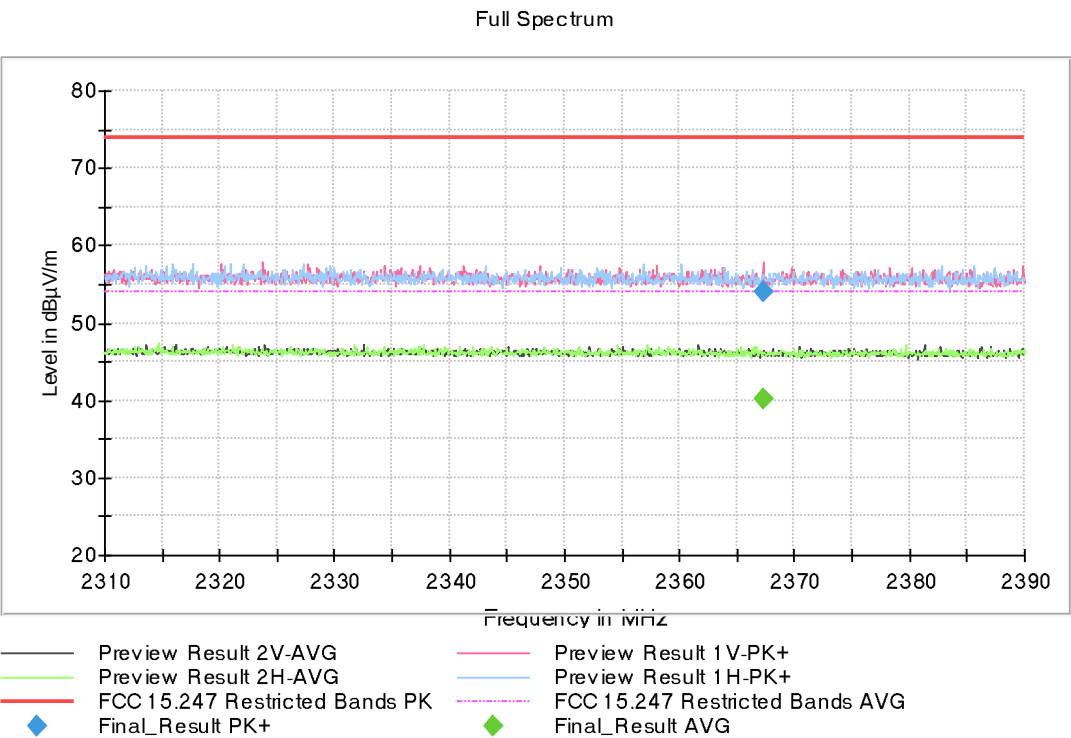
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

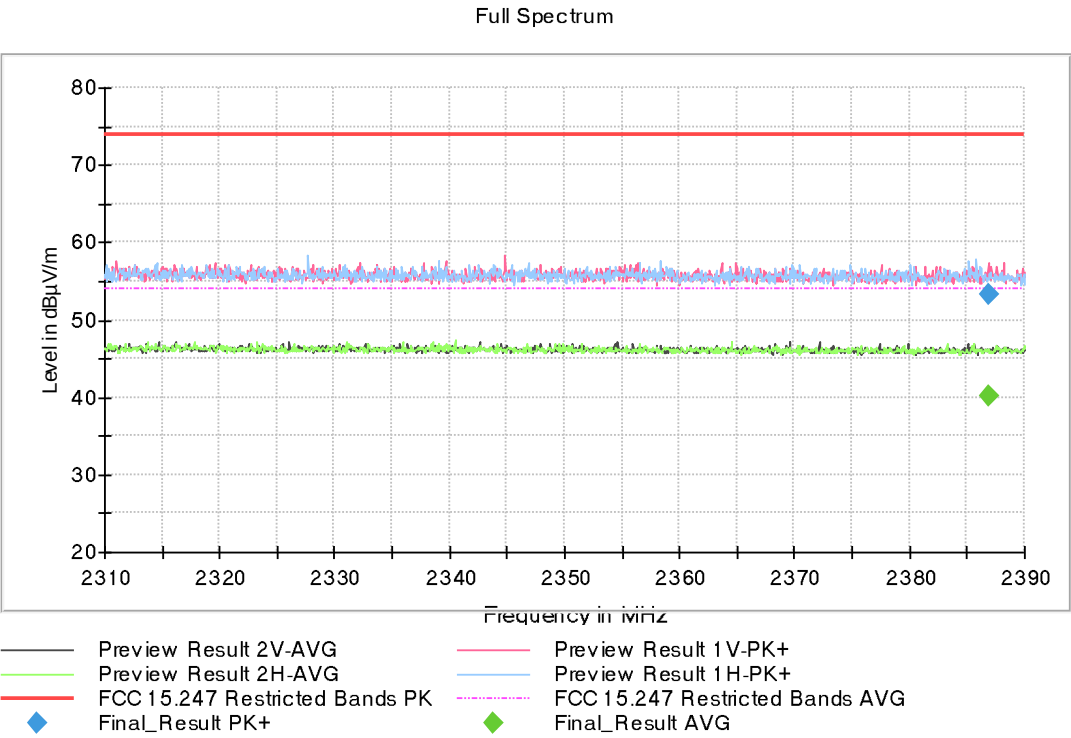
- Low Channel:



- Middle Channel:

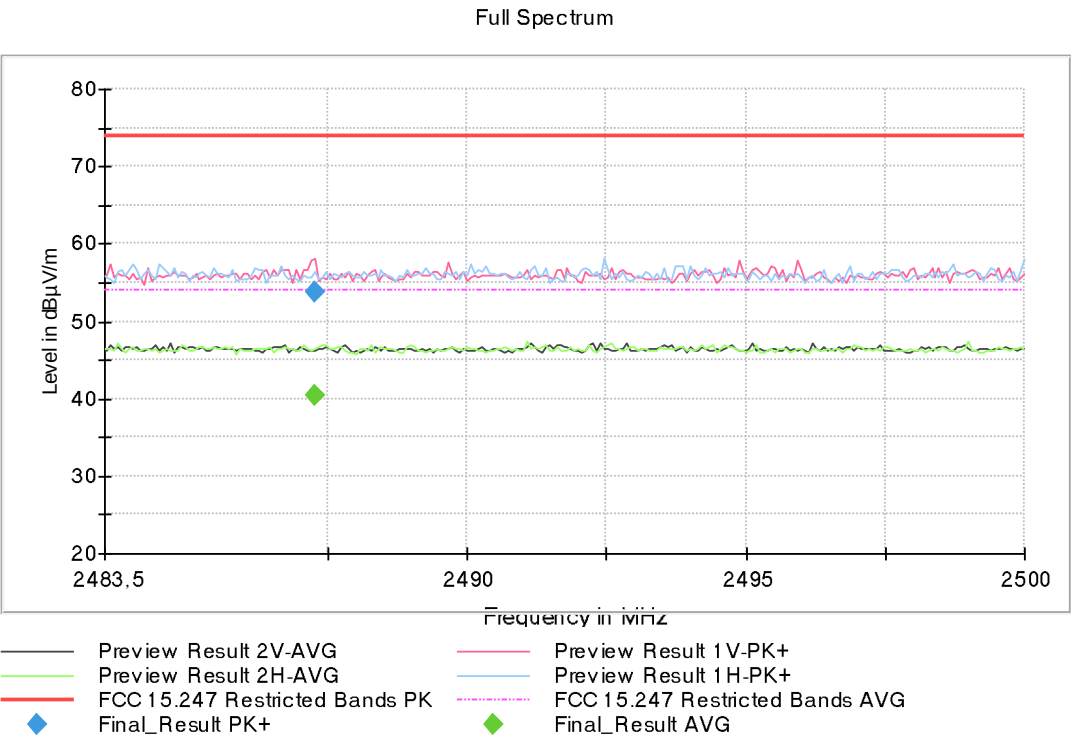


- High Channel:

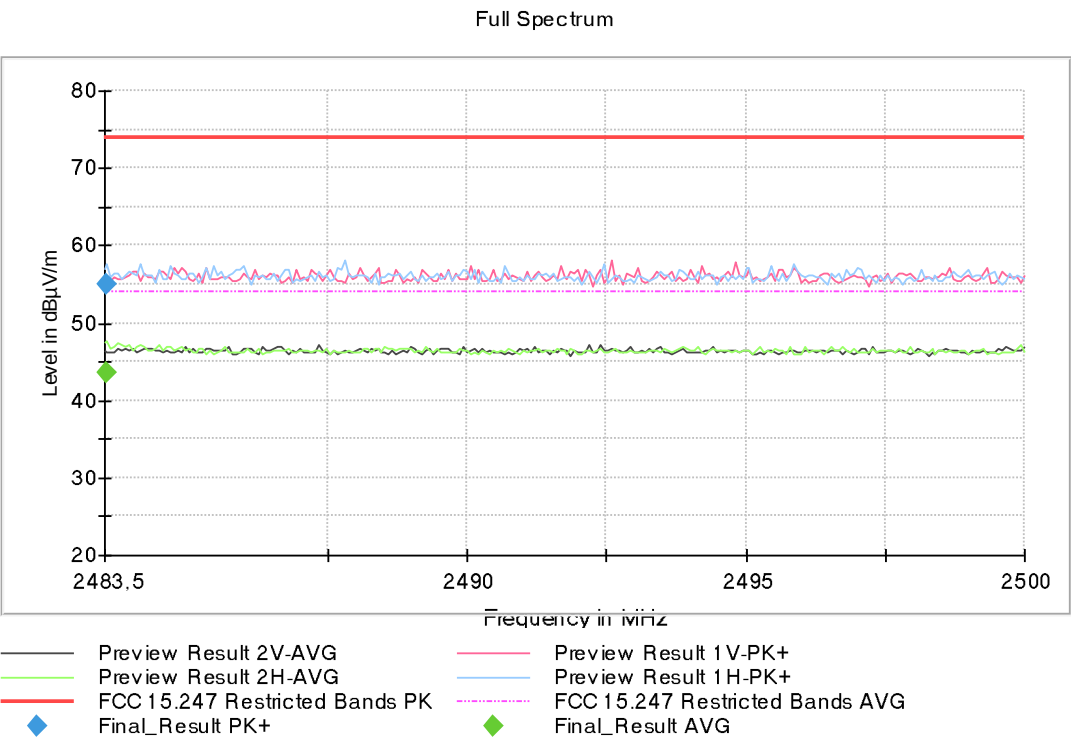


FREQUENCY RANGE 2.4835-2.5 GHz:

- Low Channel:



- Middle Channel:



- High Channel:

