

Appendix B: Test results. 802.11 bgn20 2x2

TEST CONDITIONS	40
FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter).....	42

TEST CONDITIONS

POWER SUPPLY (V):

V nominal:	12 Vdc
Type of Power Supply:	DC voltage from external power supply (car battery).

ANTENNAS:

Type of Antenna: External.

Maximum Declared Antennas Gain:

- SISO – WLAN0_CORE1_Port4 Antenna: +2.4 dBi
- SISO – WLAN0_CORE0_Port2 Antenna: -0.3 dBi

TEST FREQUENCIES:

WLAN 802.11bgn20 SISO and MIMO 2x2:

Low Channel (1):	2412 MHz
Middle Channel (6):	2437 MHz
High Channel (11):	2462 MHz

The sample was used to configure the EUT to continuously transmit at a specified output power in all channels with different modes and modulation schemes.

The field strength at the band edges was evaluated for each mode for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The EUT has four separate antennas which correspond to one port of the equipment.

The data rates of 1Mb/s for 802.11b, 6.5Mb/s for 802.11g, MSC0 for 802.11n20 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

RADIATED MEASUREMENTS:

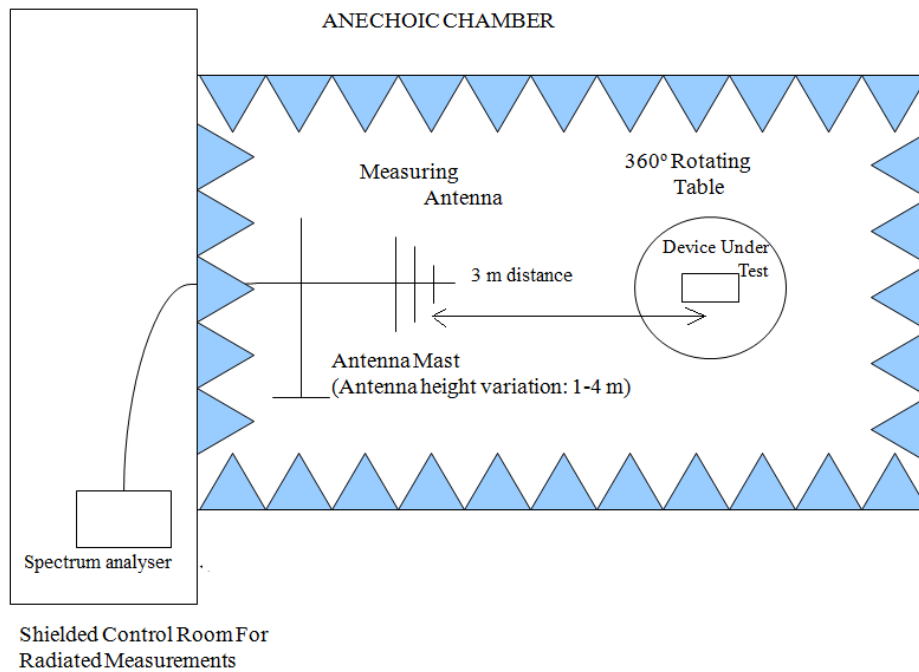
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 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.

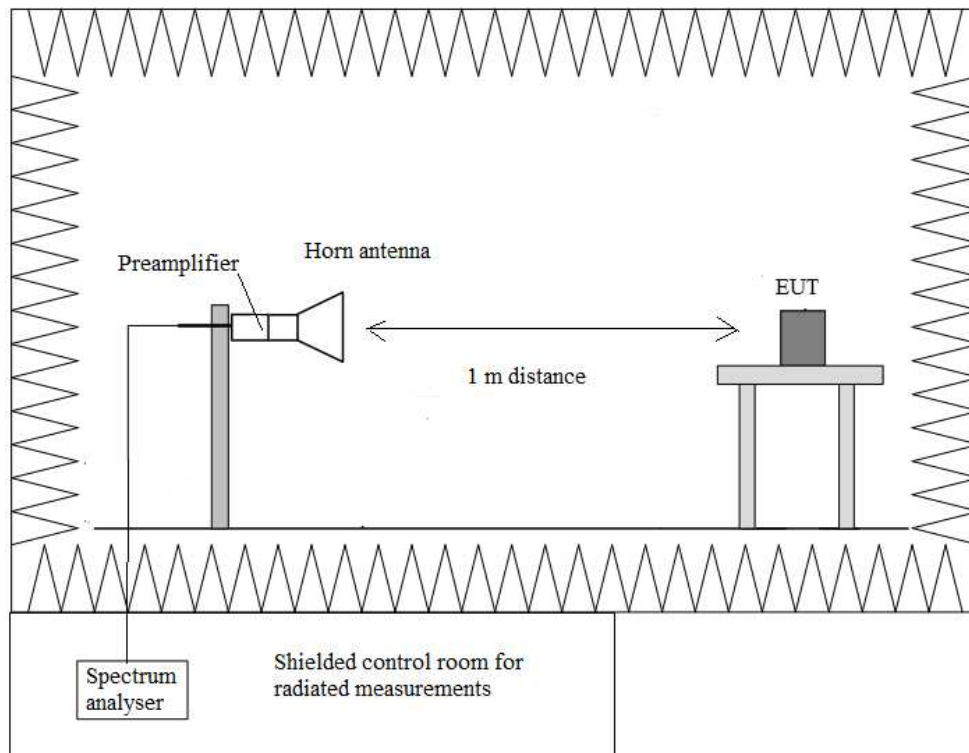
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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



FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)

SPECIFICATION:

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

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength (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 - 25000	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.

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-1000 MHz and at distance of 1m for the frequency range 1 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.

SISO – WLAN0_CORE1_Port4 Antenna (Worst case in Antenna Gain):

Frequency range 30 MHz - 1 GHz:

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

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
45.763	35.3	40	V	Quasi peak	<± 5.08
86.373	30.5	40	V	Quasi peak	<± 5.08
125.012	29.3	43.5	H	Quasi peak	<± 5.08
250.012	30.3	46	H	Quasi peak	<± 5.08
525.007	28.8	46	V	Quasi peak	<± 5.08
875.016	31.3	46	H	Quasi peak	<± 5.08

- **Mode 802.11 b**

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 signals 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)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.82397	36.22	74	H	Peak	<±5.13
6.99957	38.72	74	V	Peak	<±5.13
23.34695	42.99	74	V	Peak	<±4.82

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
1.963239	46.6	74	V	Peak	<±4.11
4.8739	35.76	74	H	Peak	<±5.13
7.00003	38.55	74	V	Peak	<±5.13
23.34755	42.63	74	V	Peak	<±4.82

- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
1.716646	44.6	74	H	Peak	<±4.11
1.963678	45.99	74	V	Peak	<±4.11
6.99957	38.69	74	V	Peak	<±5.13
13.0807	43.79	74	H	Peak	<±5.13
23.34695	43.95	74	V	Peak	<±4.82

- RESTRICTED BANDS. Spurious frequencies closest to the limit:

Restricted Band: Channel	Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
RB1: CH1	2.3875133	37.57	74	V	Peak	<±4.11
RB2: CH11	2.48393588	49.66	74	V	Peak	<±4.11

Verdict: PASS

OFDM modes:

For spurious emissions in the range 30 MHz - 26 GHz (except field strength at the band edges that was performed for all modes) a preliminary scan was performed to determine the worst case mode.

Herein the results for the worst case mode: 802.11 n20.

Spurious emissions in the Restricted Bands 2.31-2.39 GHz and 2.4835-2.5 GHz are measured for all modes.

- Mode 802.11 n20 (OFDM worst case for spurious emissions)**

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 signals 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)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
1.225767	44.19	74	H	Peak	<±4.11
7.00003	39.47	74	V	Peak	<±5.13

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
1.225567	44.34	74	V	Peak	<±4.11
5.57157	36.84	74	H	Peak	<±5.13
7.00003	39.31	74	V	Peak	<±5.13
23.34725	42.4	74	V	Peak	<±4.82

- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
1.470473	43.65	74	H	Peak	<±4.11
5.57203	35.38	74	H	Peak	<±5.13
7.00003	39.81	74	V	Peak	<±5.13
23.34695	41.45	74	V	Peak	<±4.82

- RESTRICTED BANDS. Spurious frequencies closest to the limit:

Restricted Band: Channel	Spurious frequency (GHz)	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
RB1: CH1	2.3893293	56.63	74	V	Peak	< $\pm$ 4.11
		43.06	54		Average	
RB2: CH11	2.48470588	61.18	74	V	Peak	< $\pm$ 4.11
		43.42	54		Average	

Verdict: PASS

- **Mode 802.11 g**

The results in the next tables show the maximum measured levels in 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.

- RESTRICTED BANDS. Spurious frequencies closest to the limit:

Restricted Band: Channel	Spurious frequency (GHz)	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
RB1: CH1	2.389508	50.98	74	V	Peak	< $\pm$ 4.11
RB2: CH11	2.48386713	56.1	74	V	Peak	< $\pm$ 4.11
		41.89	54		Average	

Verdict: PASS

MIMO – WLAN0_CORE1_Port4 & CORE0_Port2 Antennas:

Frequency range 30 MHz - 1 GHz:

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

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
43.887	33.1	40	V	Quasi peak	<± 5.08
73.828	28.8	40	V	Quasi peak	<± 5.08
125.012	36.2	43.5	V	Quasi peak	<± 5.08
250.012	37.8	46	V	Quasi peak	<± 5.08
375.013	30.9	46	H	Quasi peak	<± 5.08
875.016	29.6	46	H	Quasi peak	<± 5.08

- **Mode 802.11 b**

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 signals 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)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.82397	35.08	74	H	Peak	<±5.13
5.57157	36.44	74	V	Peak	<±5.13
5.99997	37.3	74	V	Peak	<±5.13

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.8739	34.81	74	H	Peak	<±5.13
5.57157	36.22	74	V	Peak	<±5.13
5.99997	38.18	74	V	Peak	<±5.13

- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
4.9439	35.29	74	H	Peak	<±5.13
5.57157	37.05	74	V	Peak	<±5.13
5.99997	37.77	74	V	Peak	<±5.13

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

Verdict: PASS

OFDM modes:

For spurious emissions in the range 30 MHz - 26 GHz (except field strength at the band edges that was performed for all modes) a preliminary scan was performed to determine the worst case mode.

Herein the results for the worst case mode: 802.11 n20.

Spurious emissions in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz are measured for all modes.

- Mode 802.11 n20 (OFDM worst case for spurious emissions)**

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 closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.57203	35.68	74	H	Peak	< $\pm$ 5.13
5.99997	37.77	74	V	Peak	< $\pm$ 5.13

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.57157	41.09	74	H	Peak	< $\pm$ 5.13
5.99997	37.88	74	V	Peak	< $\pm$ 5.13

- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.57157	37.8	74	V	Peak	< $\pm$ 5.13
5.99997	37.52	74	V	Peak	< $\pm$ 5.13

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

Verdict: PASS

- **Mode 802.11 g**

The results in the next tables show the maximum measured levels in 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.

- RESTRICTED BANDS. Spurious frequencies detected at less than 20 dB below the limit:

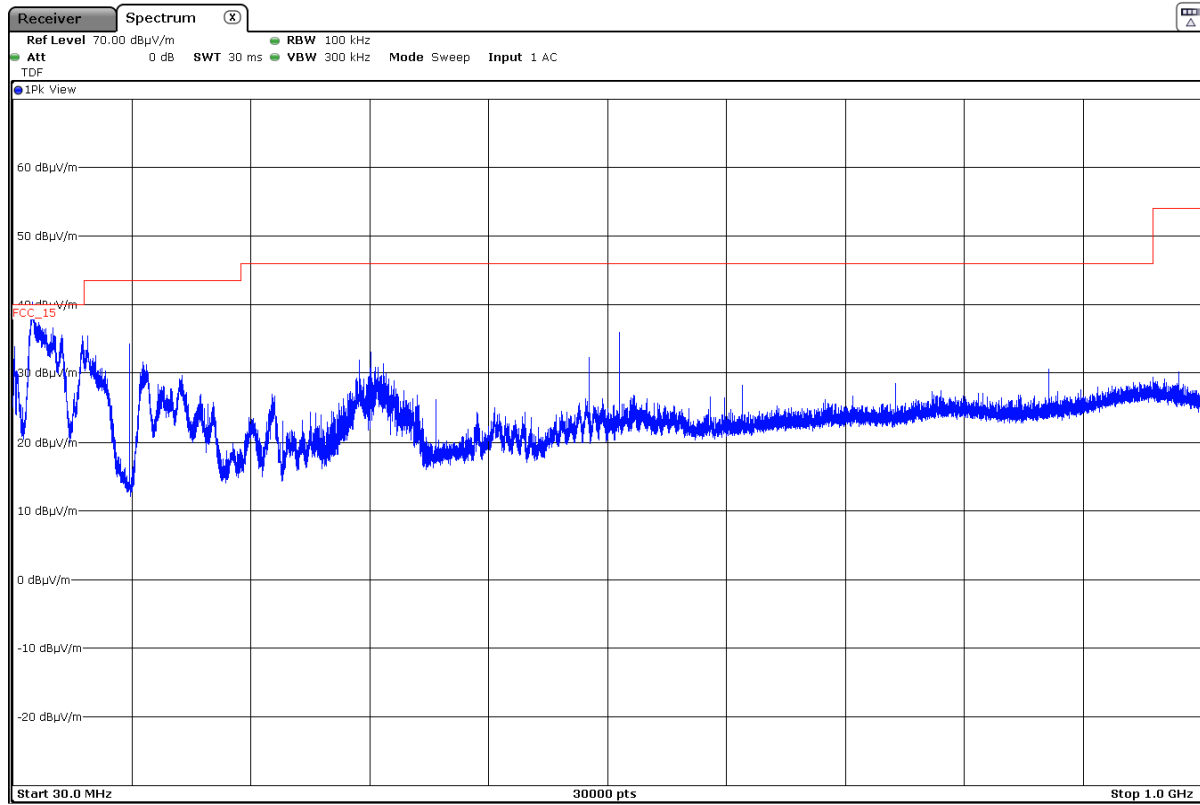
Restricted Band: Channel	Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
RB1: CH1	2.38922	55.51	74	V	Peak	<±4.11
		42.71	54		Average	
RB2: None.						

Verdict: PASS

SISO – WLAN0_CORE1_Port4 Antenna:

FREQUENCY RANGE 30 MHz - 1 GHz:

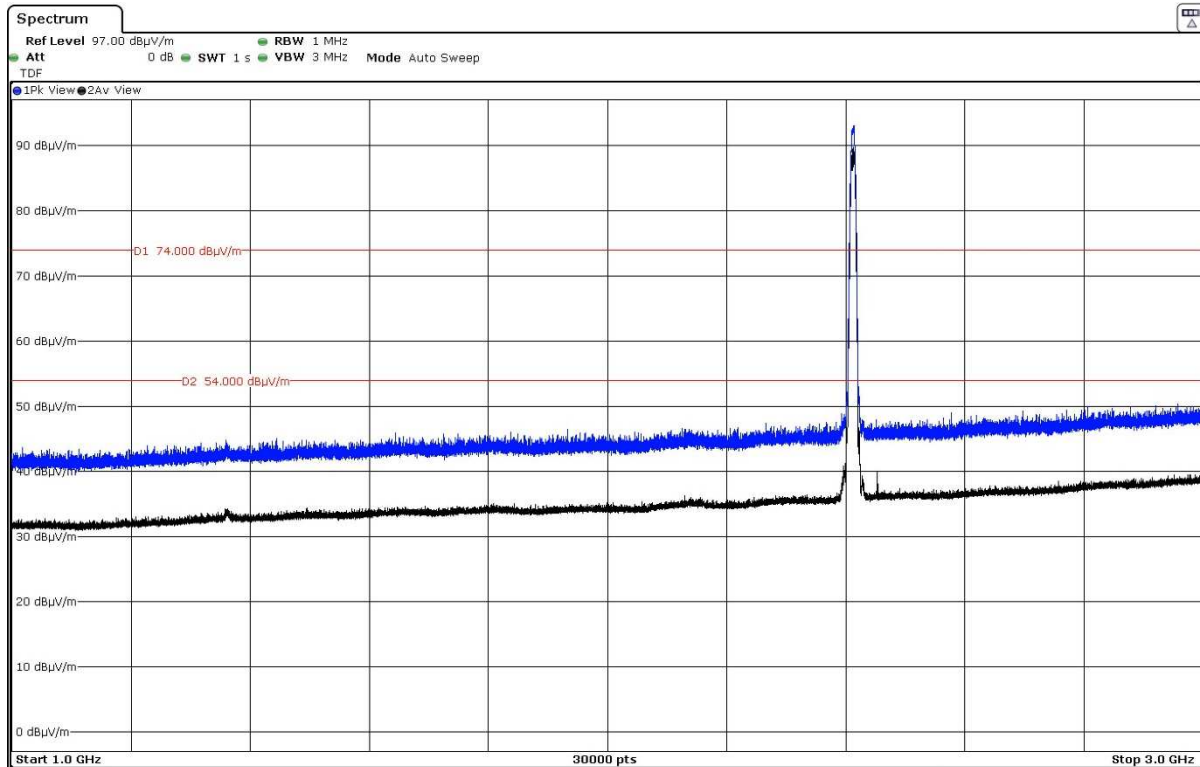
The spurious signals detected do not depend neither on the operating channel nor the modulation mode.



- **Mode 802.11 b**

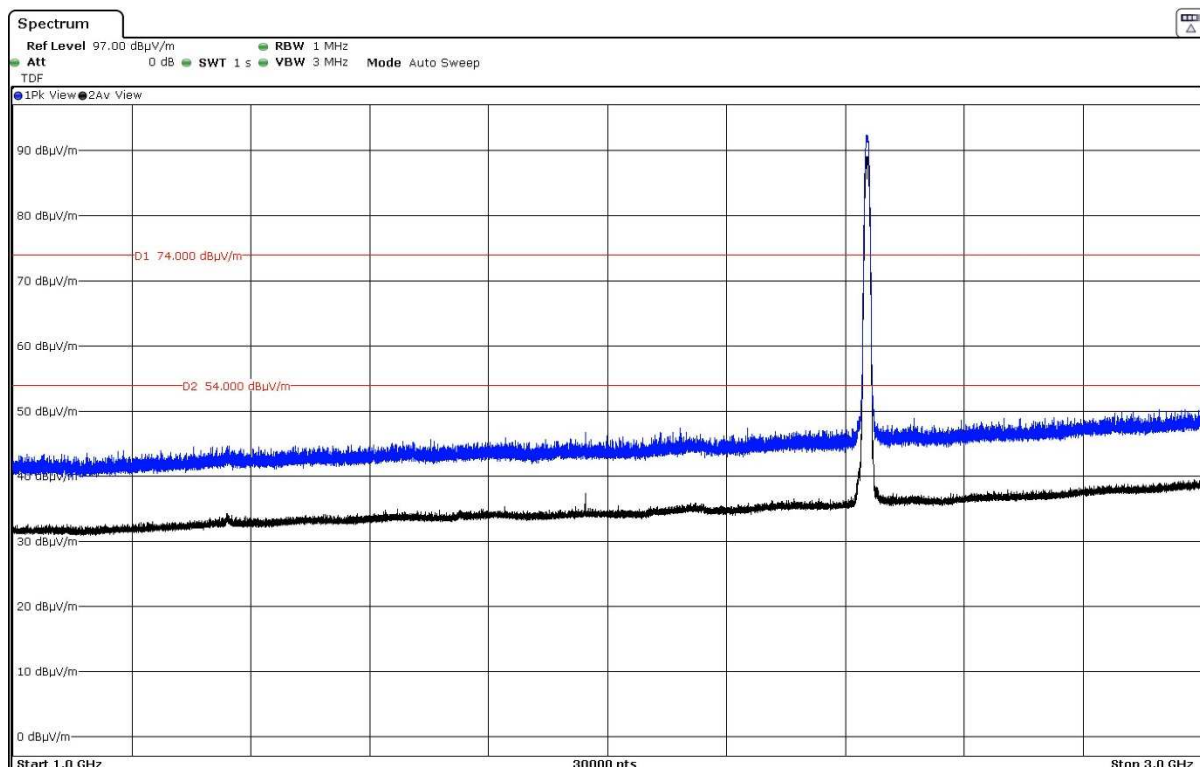
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



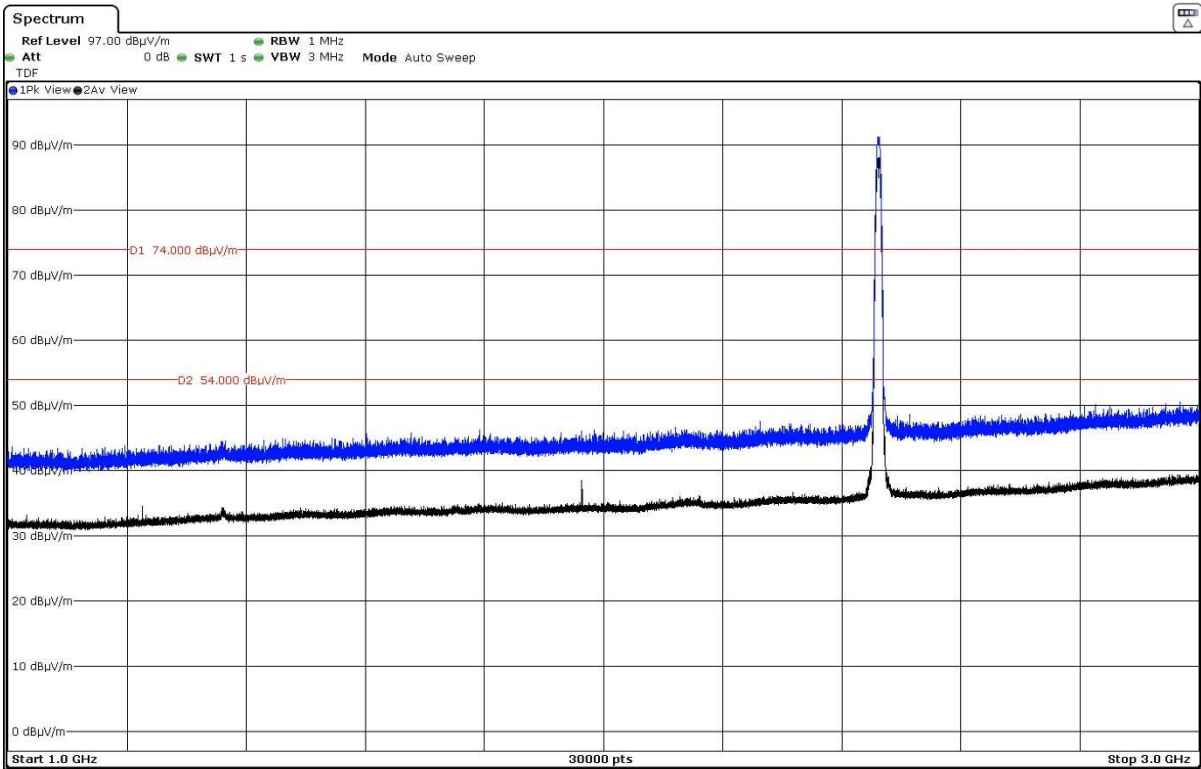
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

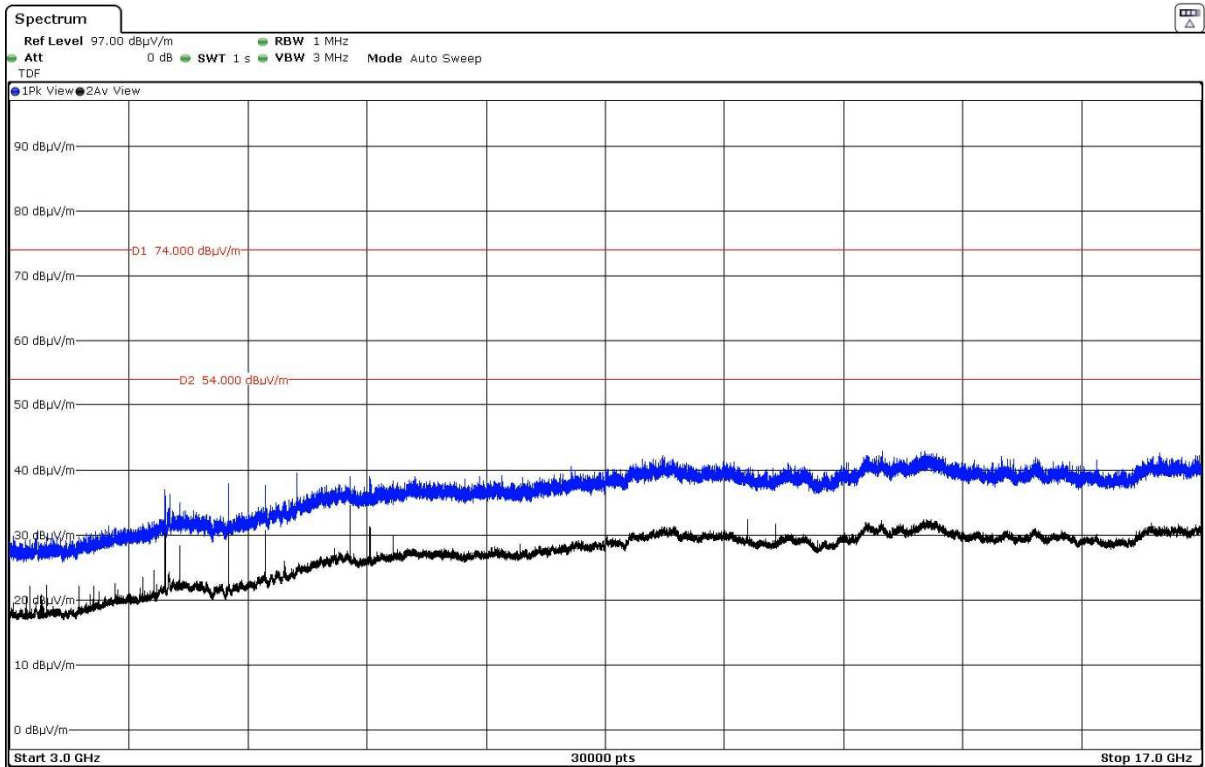
- High Channel:



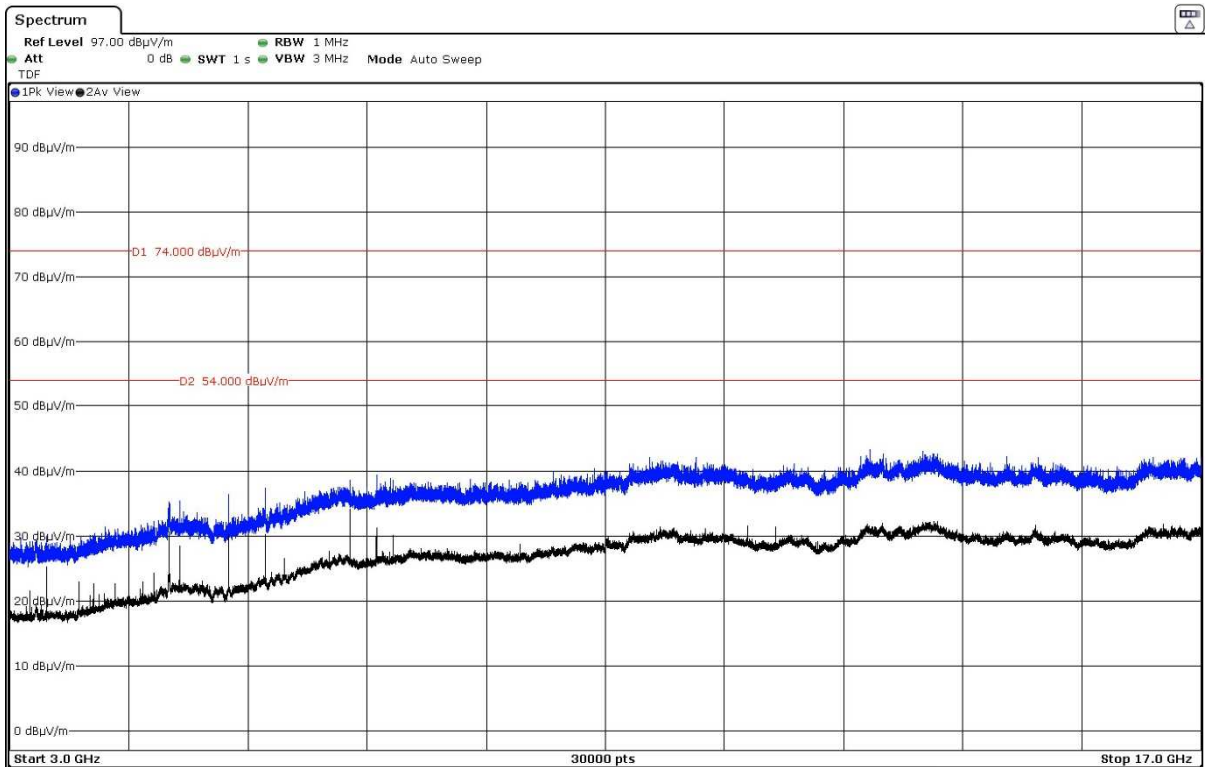
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

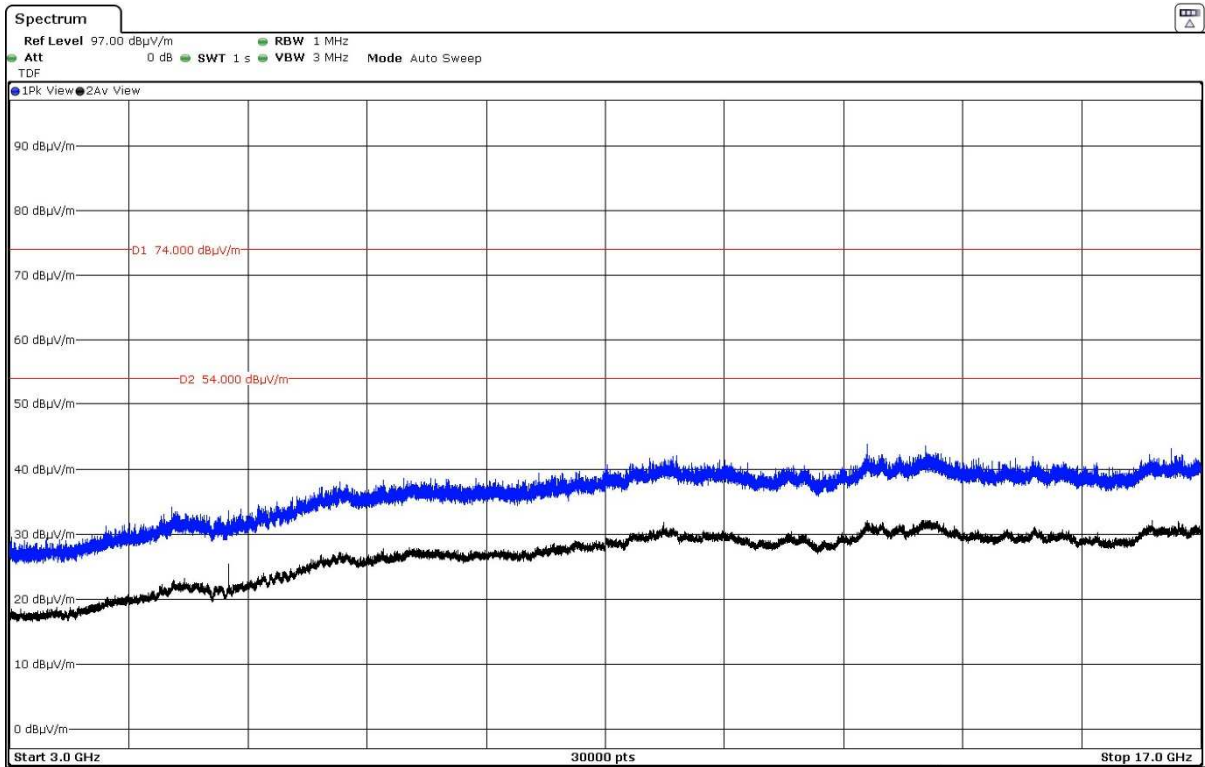
- Low Channel:



- Middle Channel:

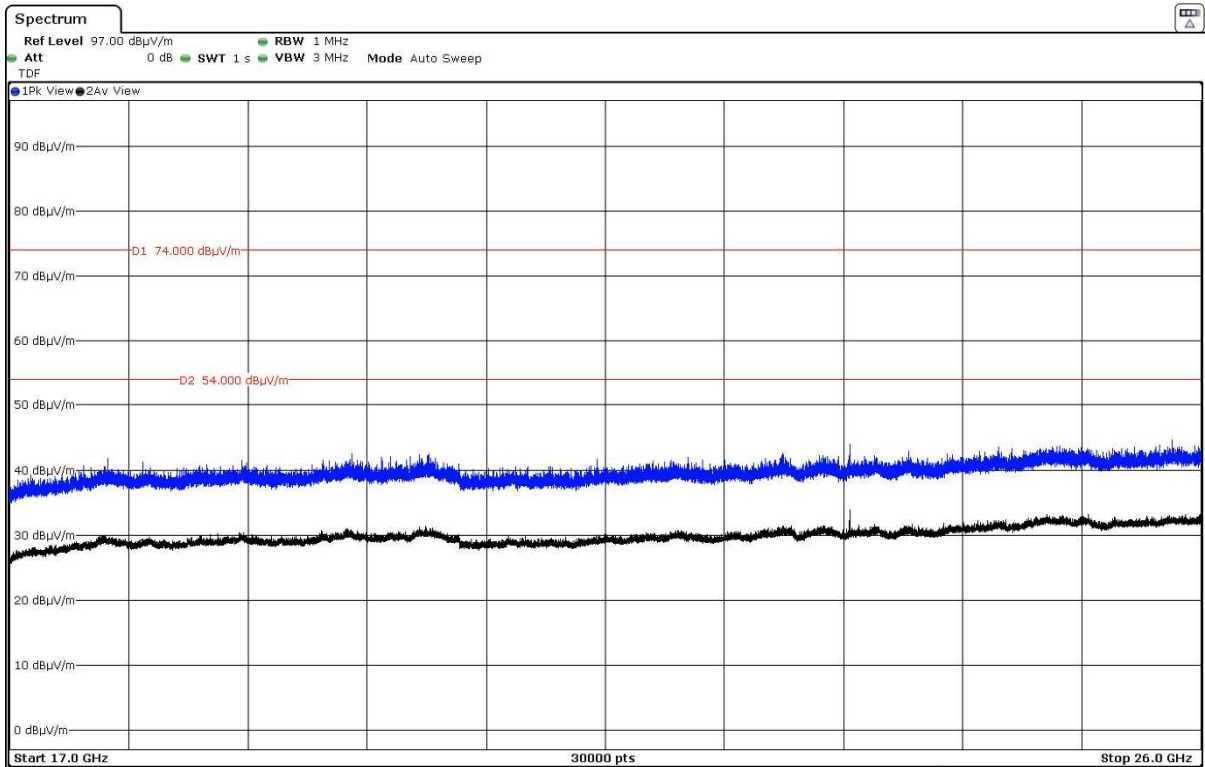


- High Channel:



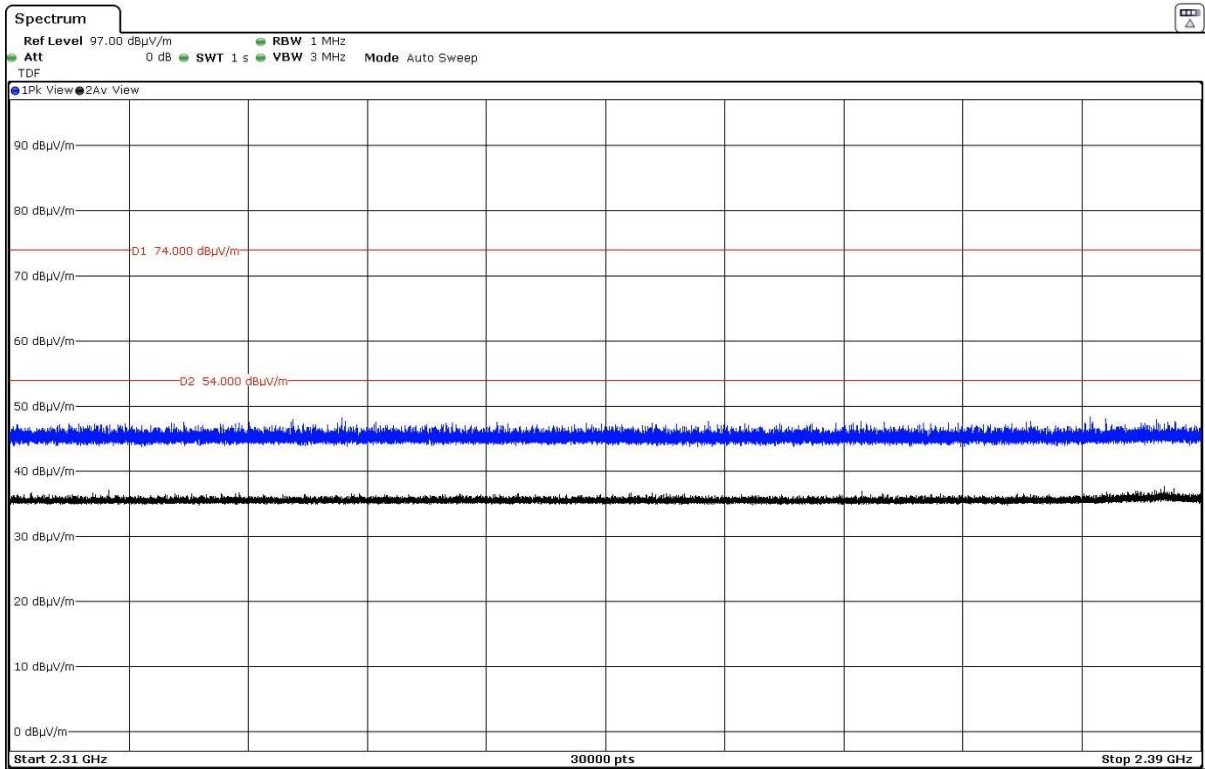
FREQUENCY RANGE 17 - 26 GHz:

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



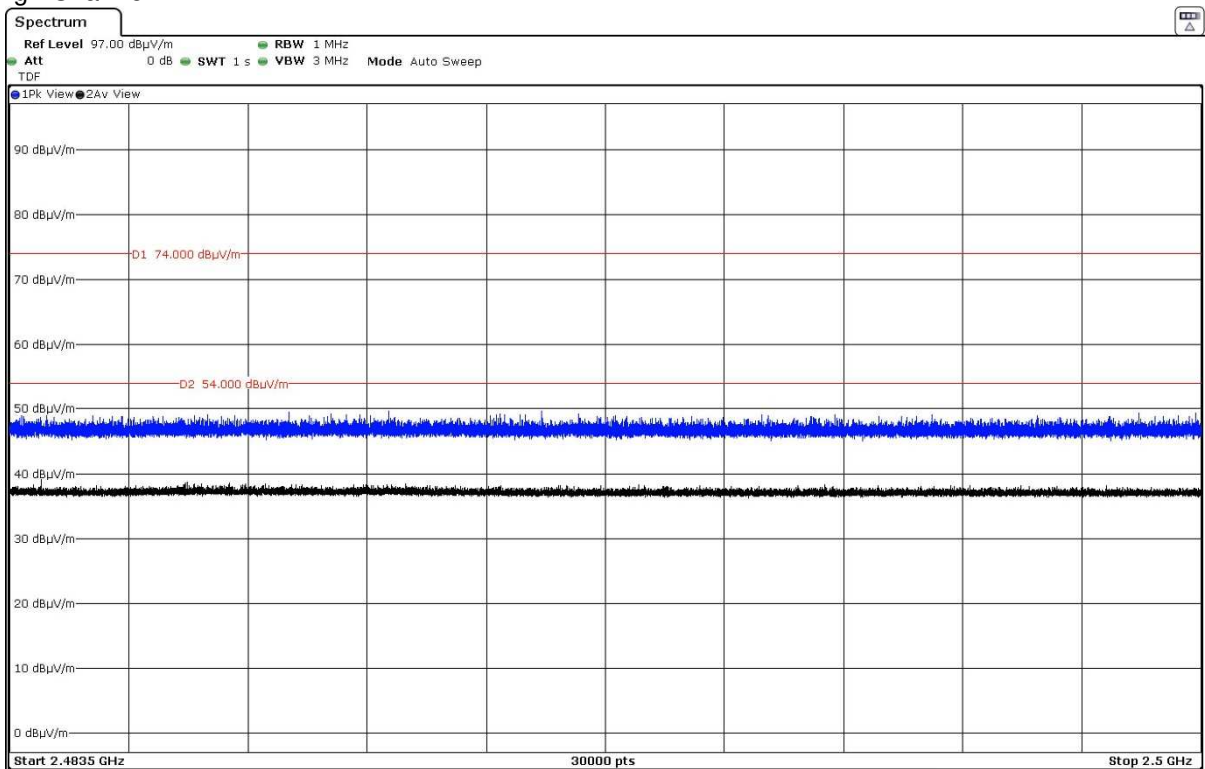
RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

- High Channel:

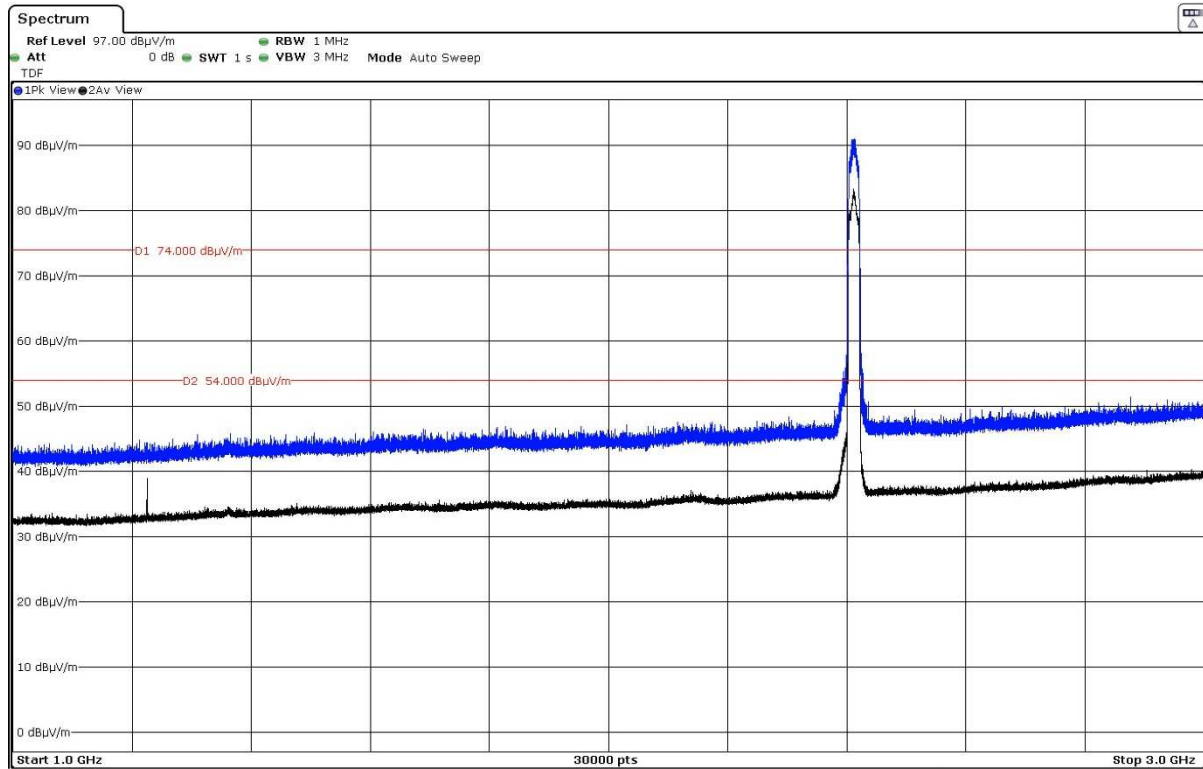


SISO – WLAN0_CORE1_Port4 Antenna:

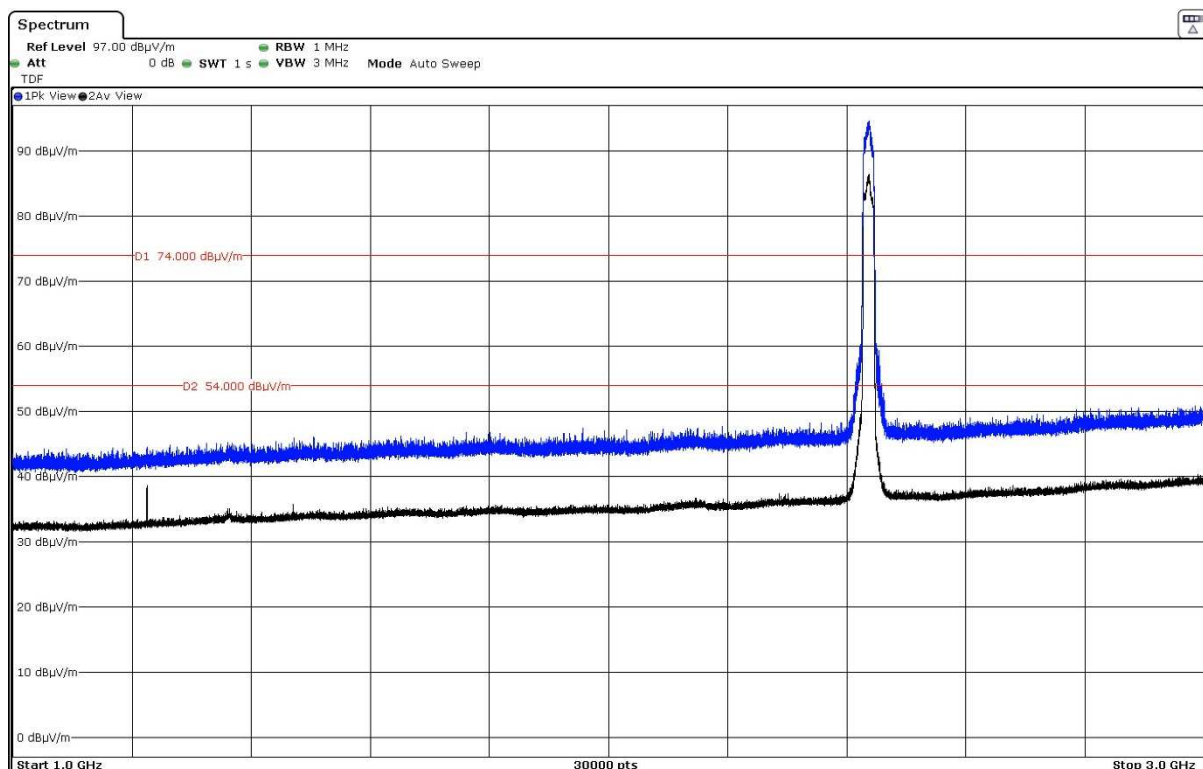
- Mode 802.11 n20 (OFDM worst case for spurious emissions)

FREQUENCY RANGE 1 - 3 GHz:

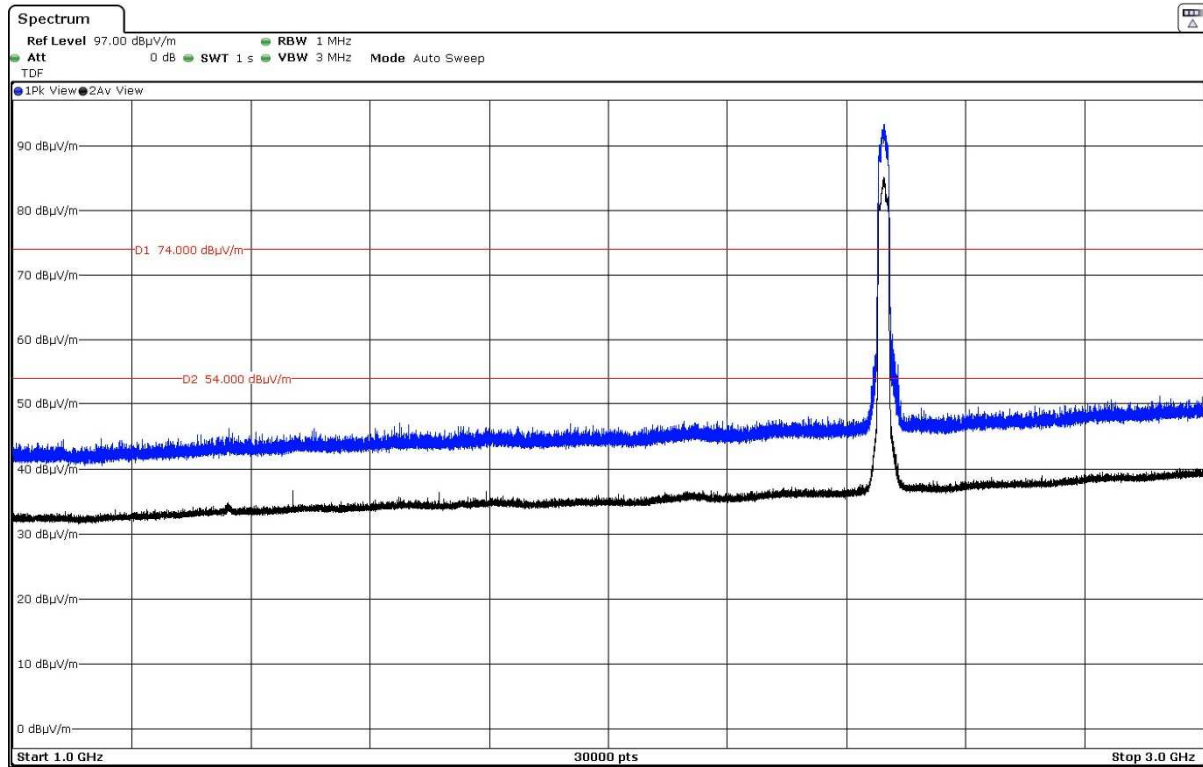
- Low Channel:



- Middle Channel:



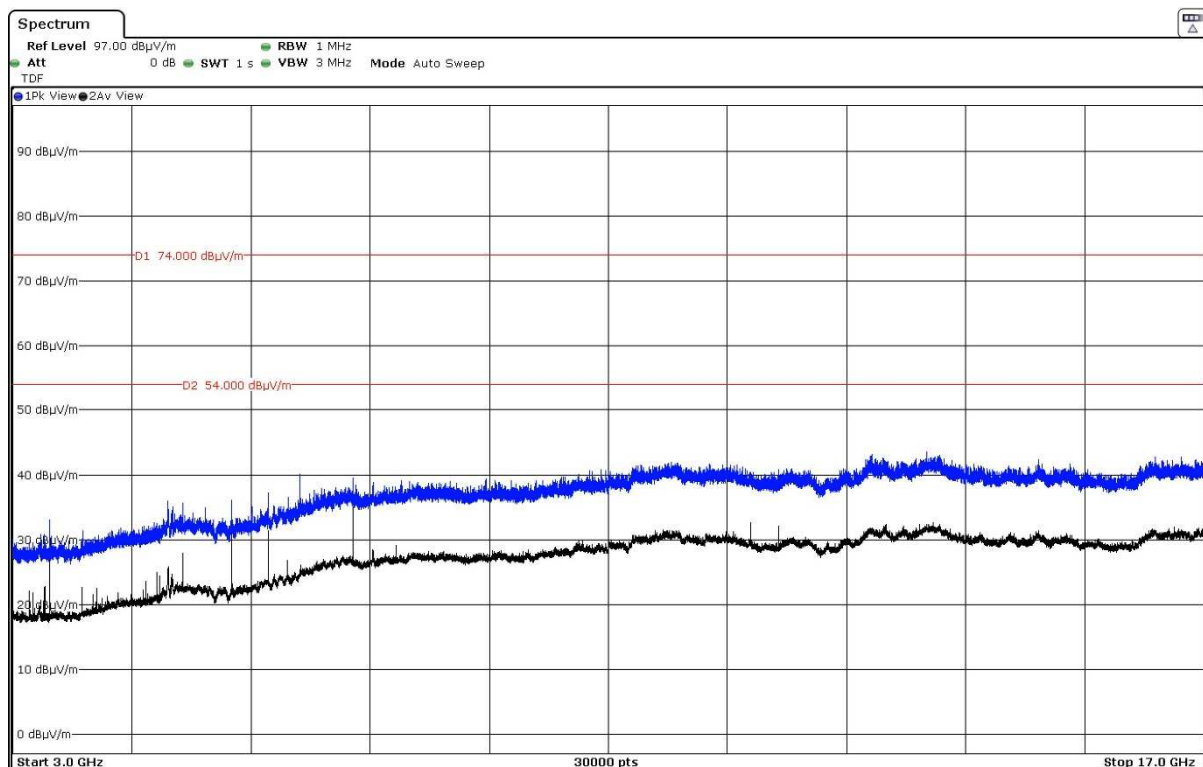
- High Channel:



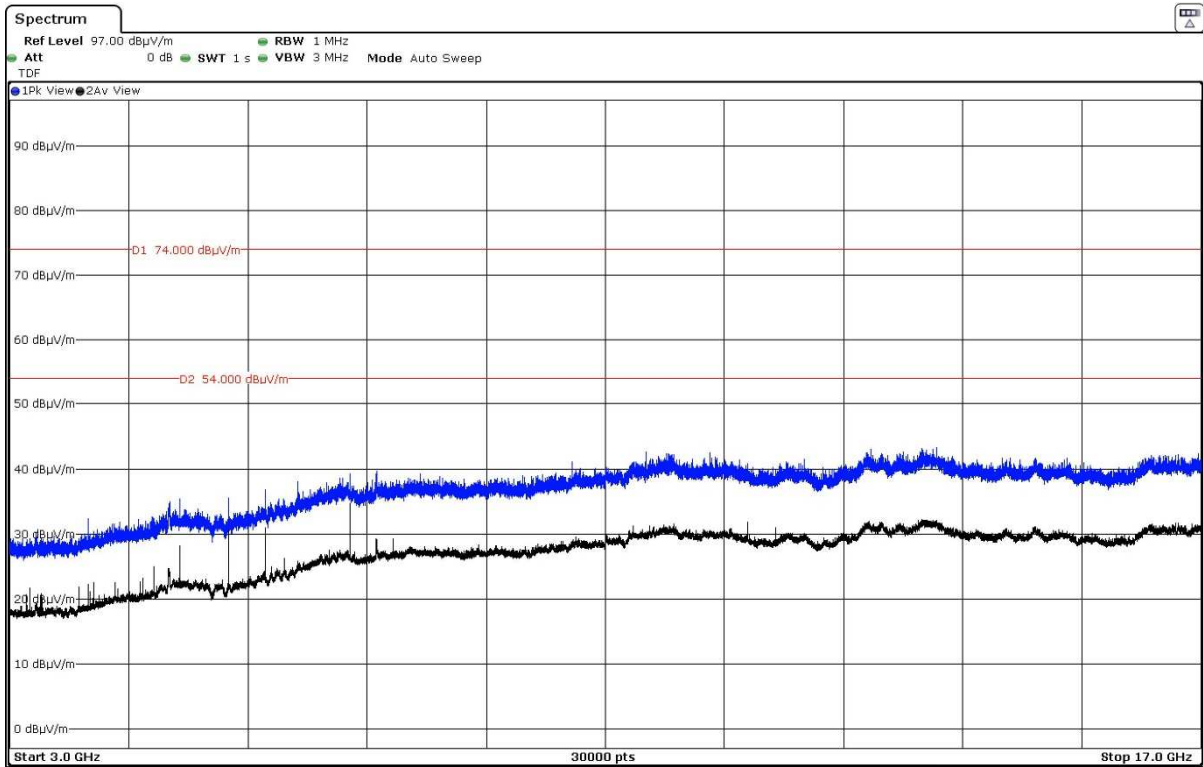
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

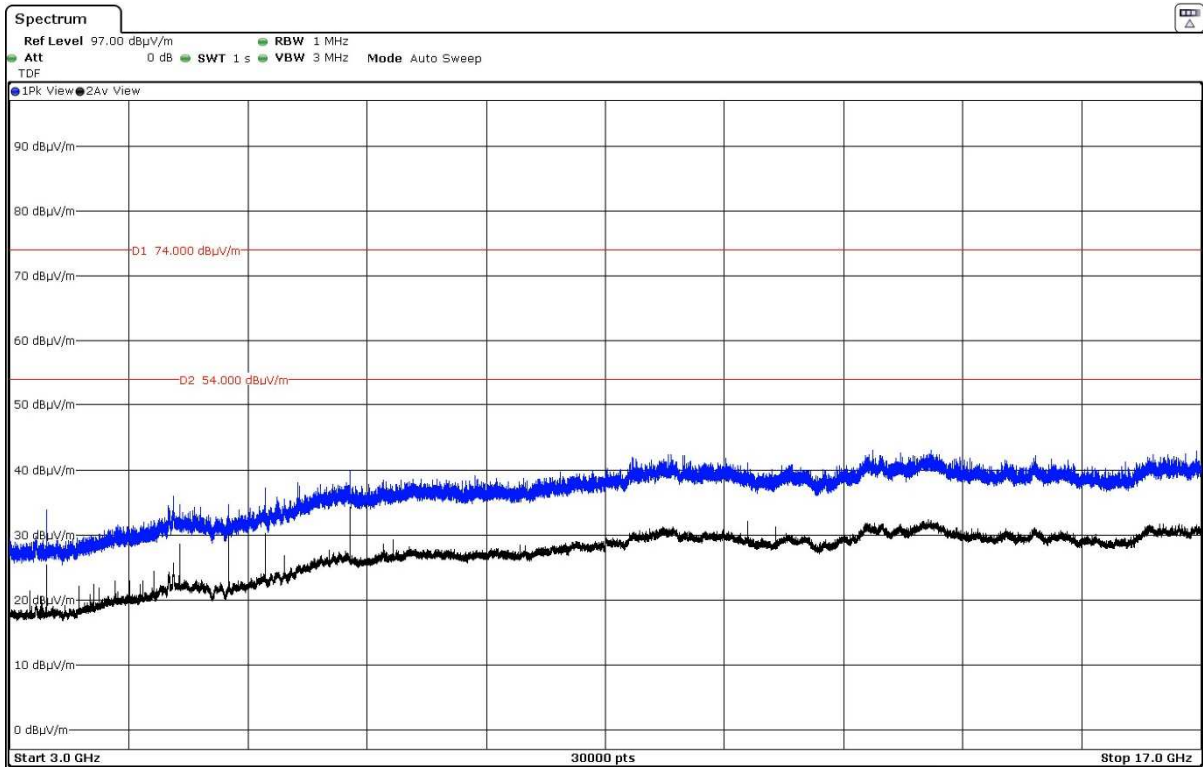
- Low Channel:



- Middle Channel:

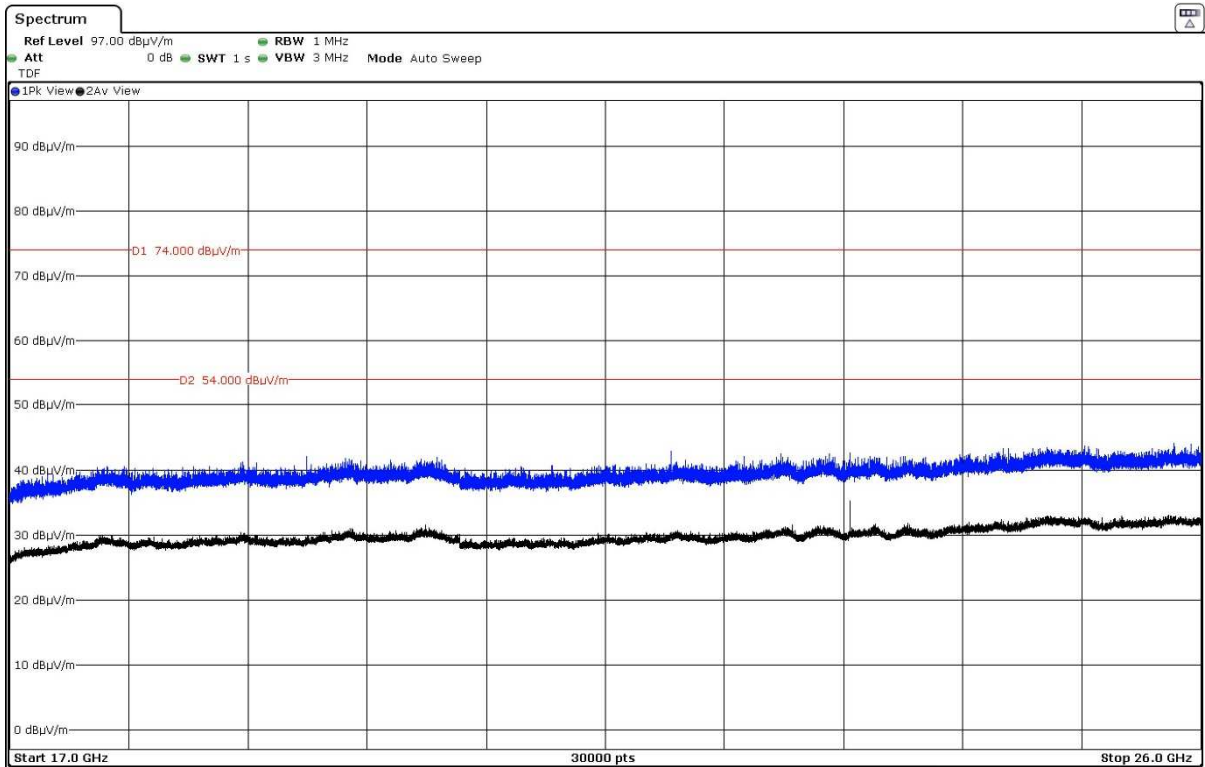


- High Channel:



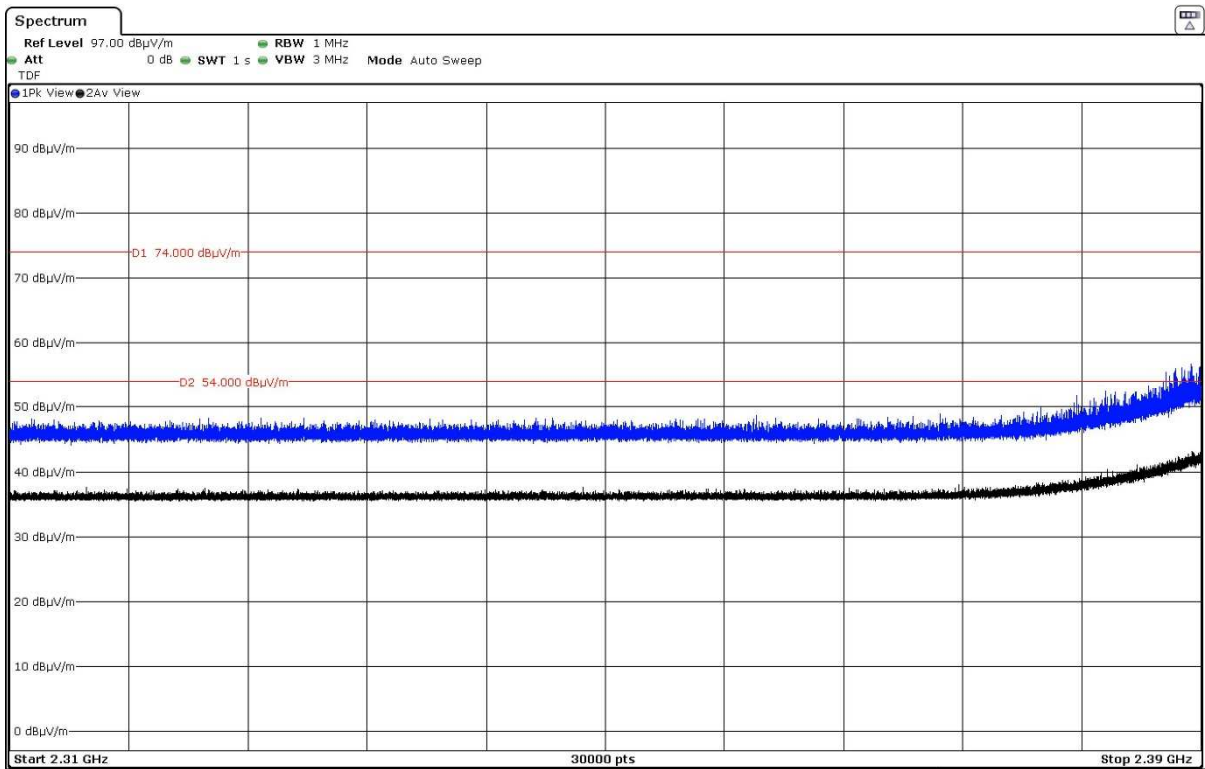
FREQUENCY RANGE 17 - 26 GHz:

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



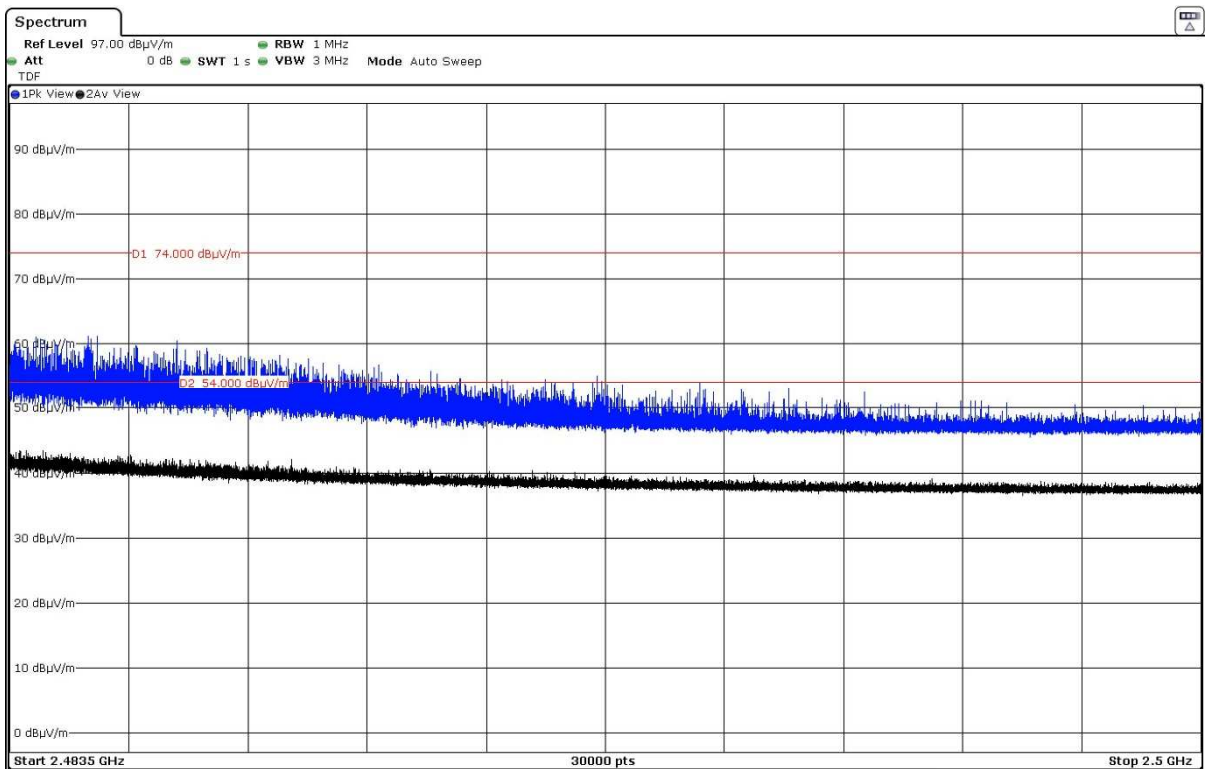
RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

- High Channel:

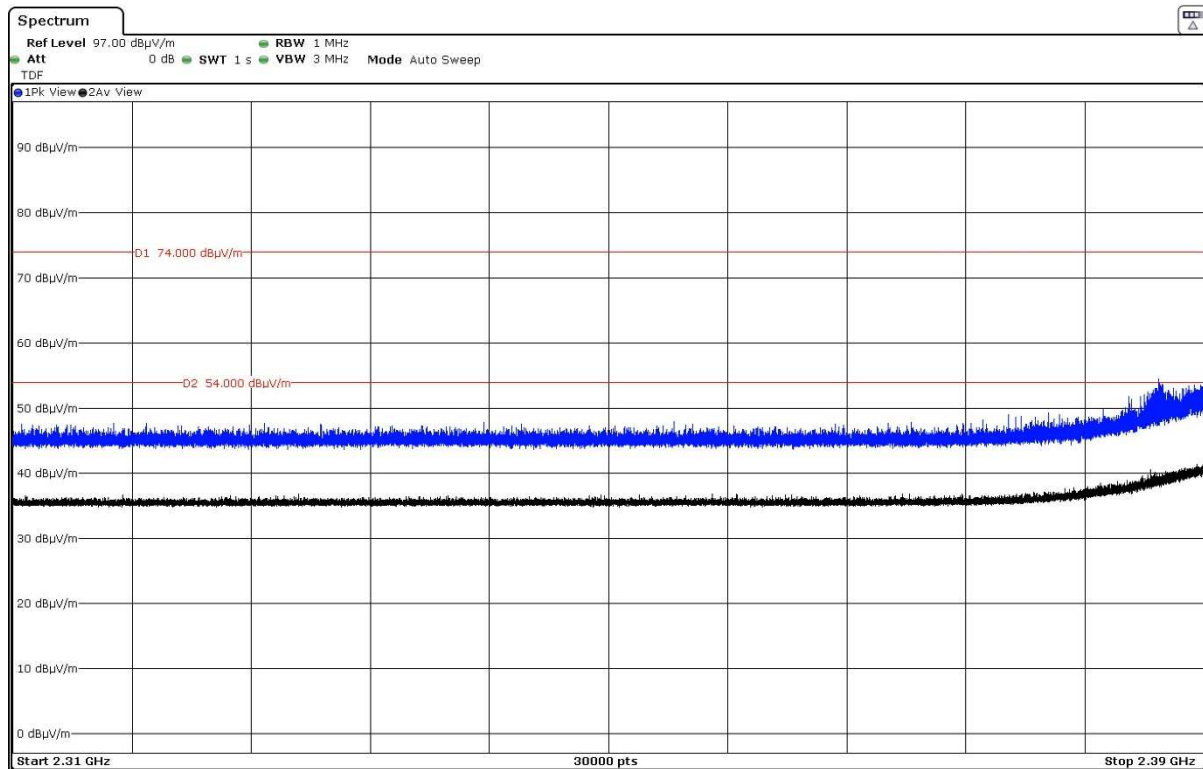


SISO – WLAN0_CORE1_Port4 Antenna:

- **Mode 802.11 g**

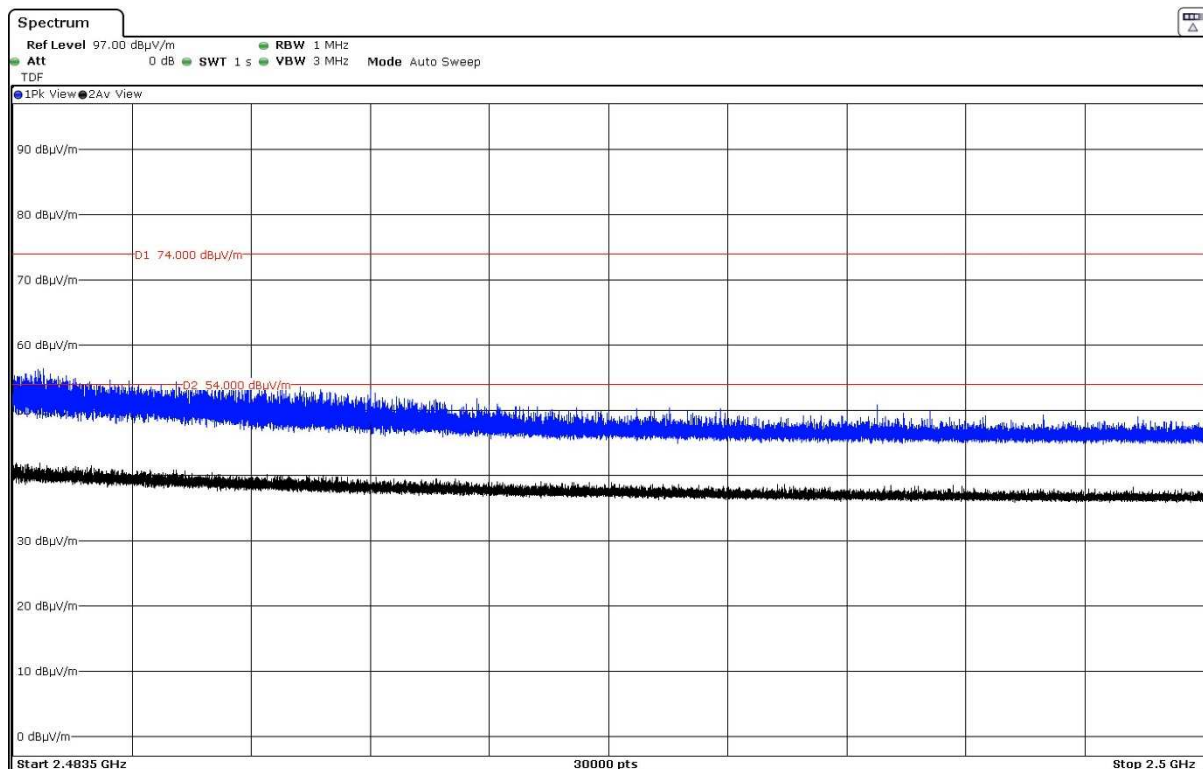
RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

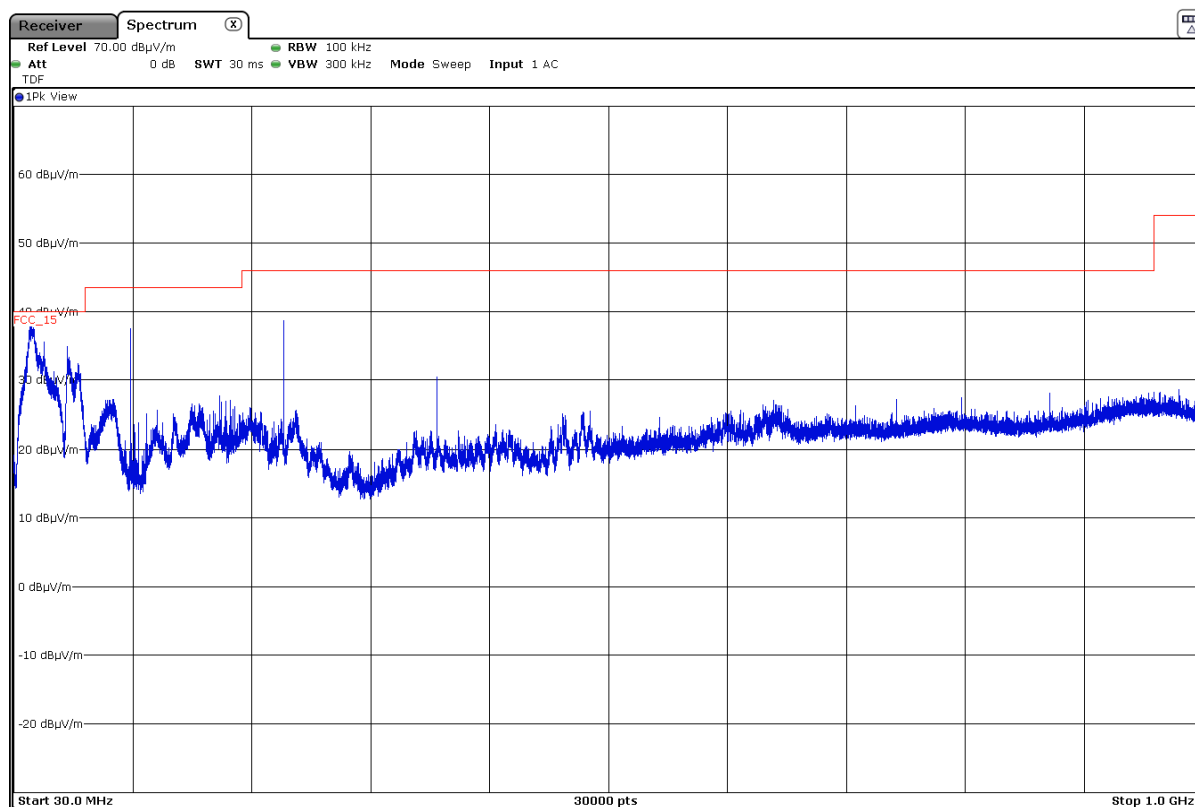
- High Channel:



MIMO – WLAN0_CORE1_Port4 & CORE0_Port2 Antennas:

FREQUENCY RANGE 30 MHz - 1 GHz:

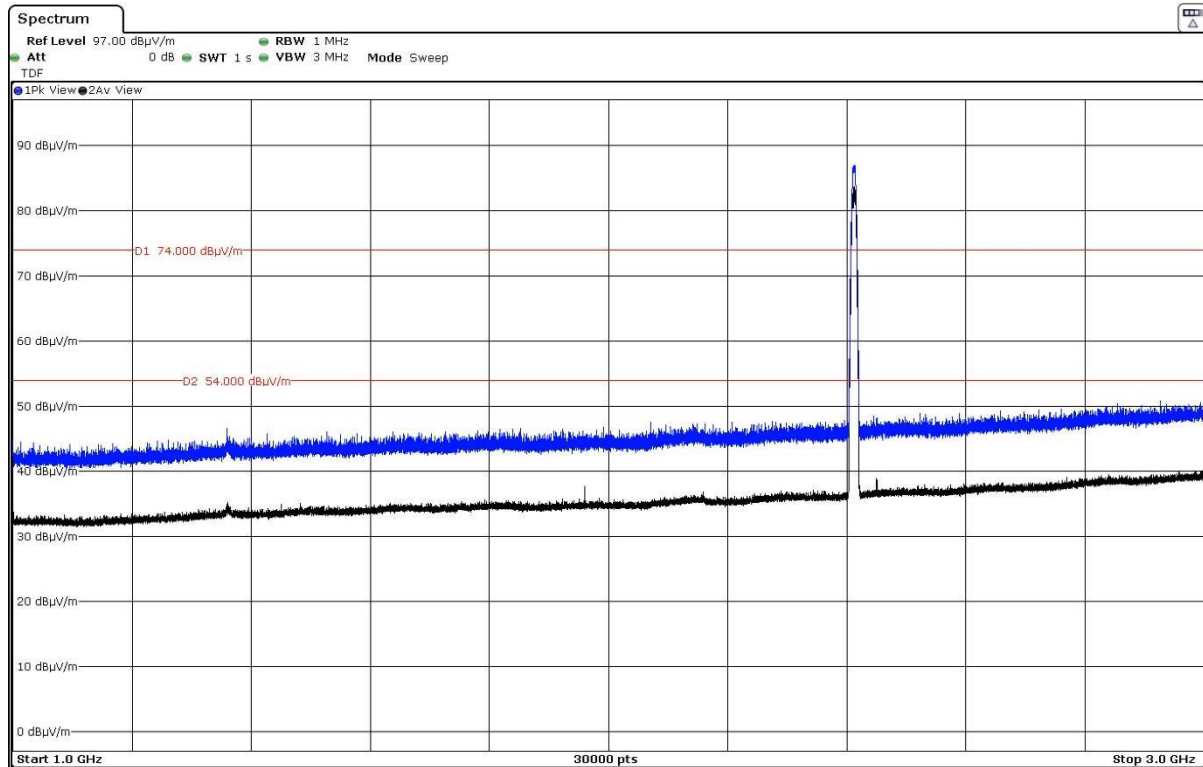
The spurious signals detected do not depend neither on the operating channel nor the modulation mode.



- **Mode 802.11 b**

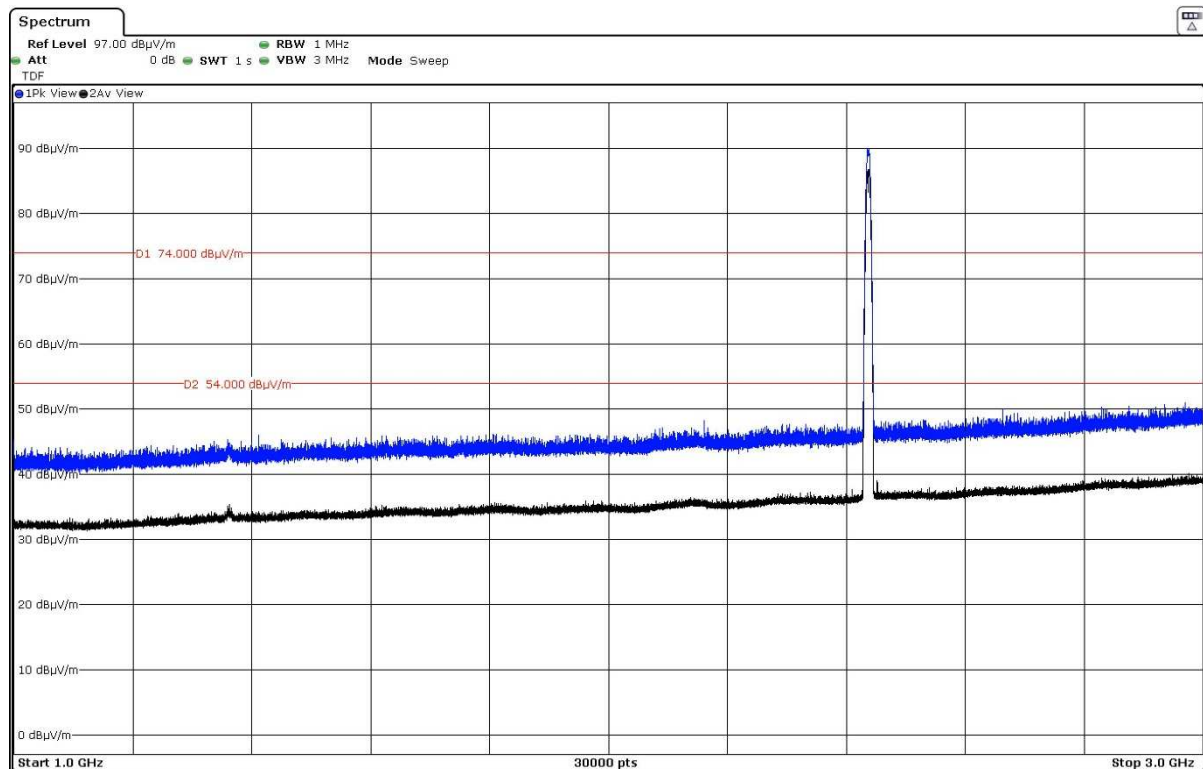
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



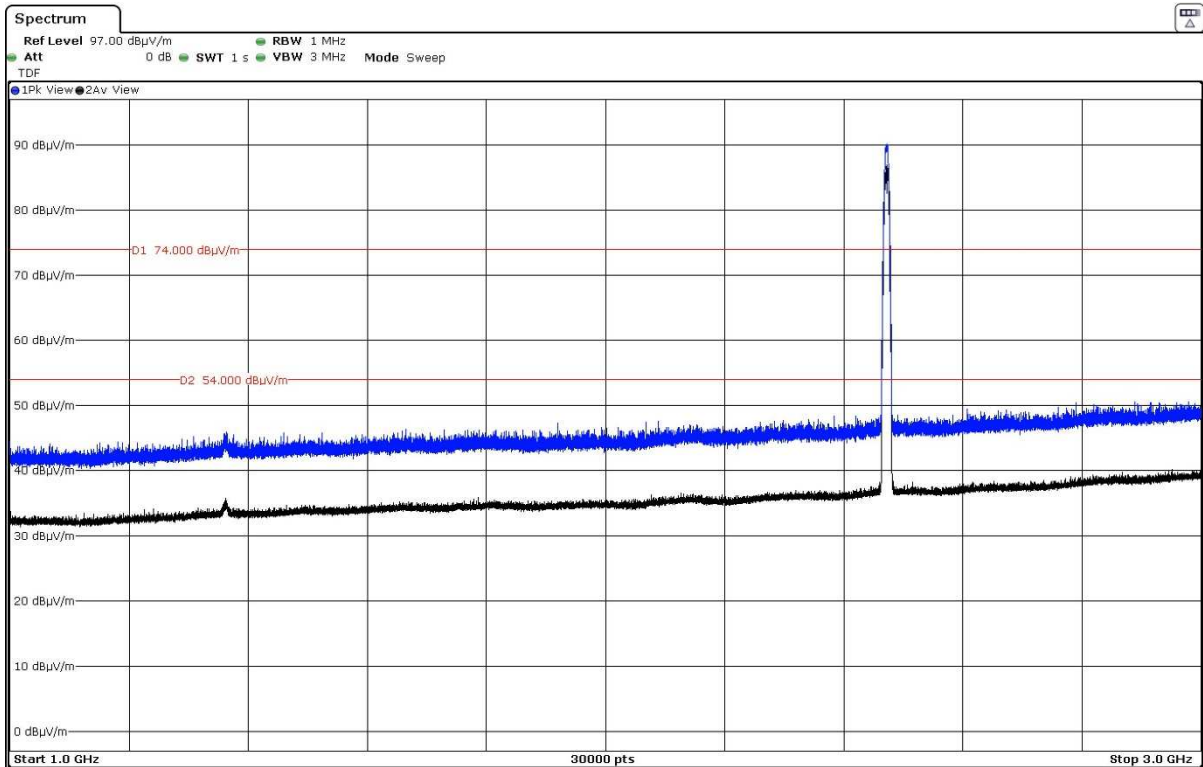
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

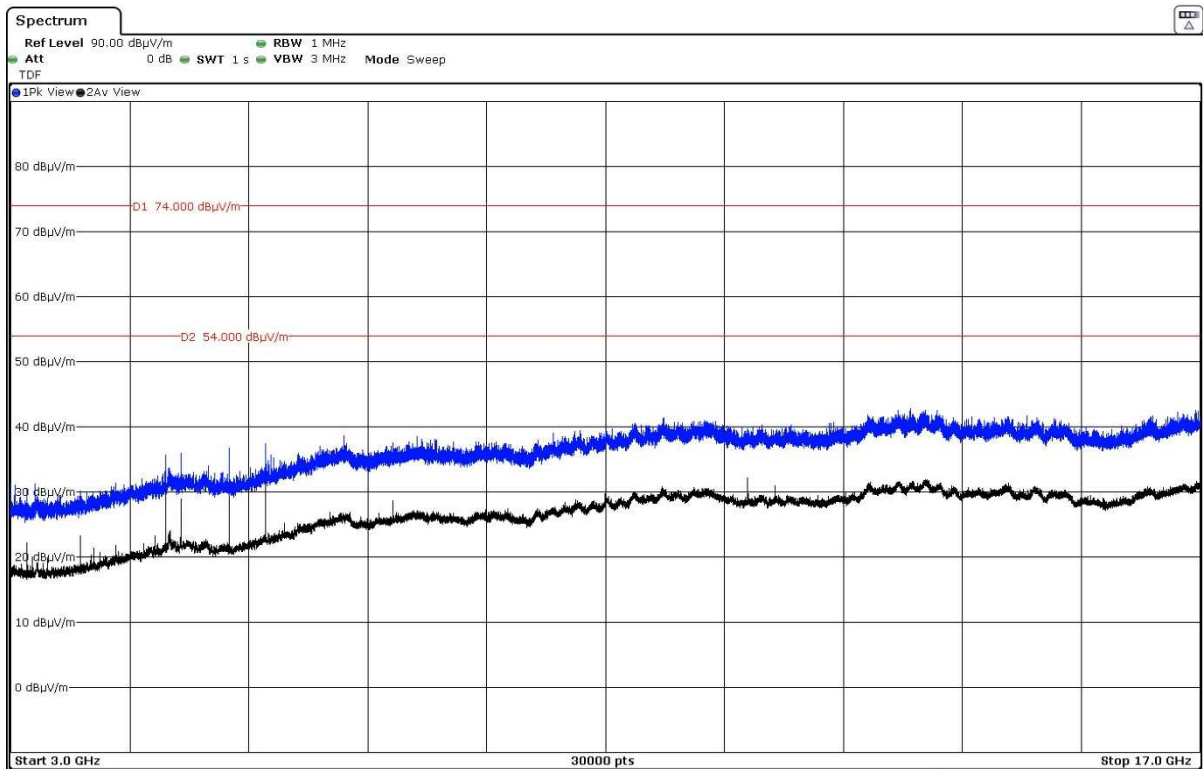
- High Channel:



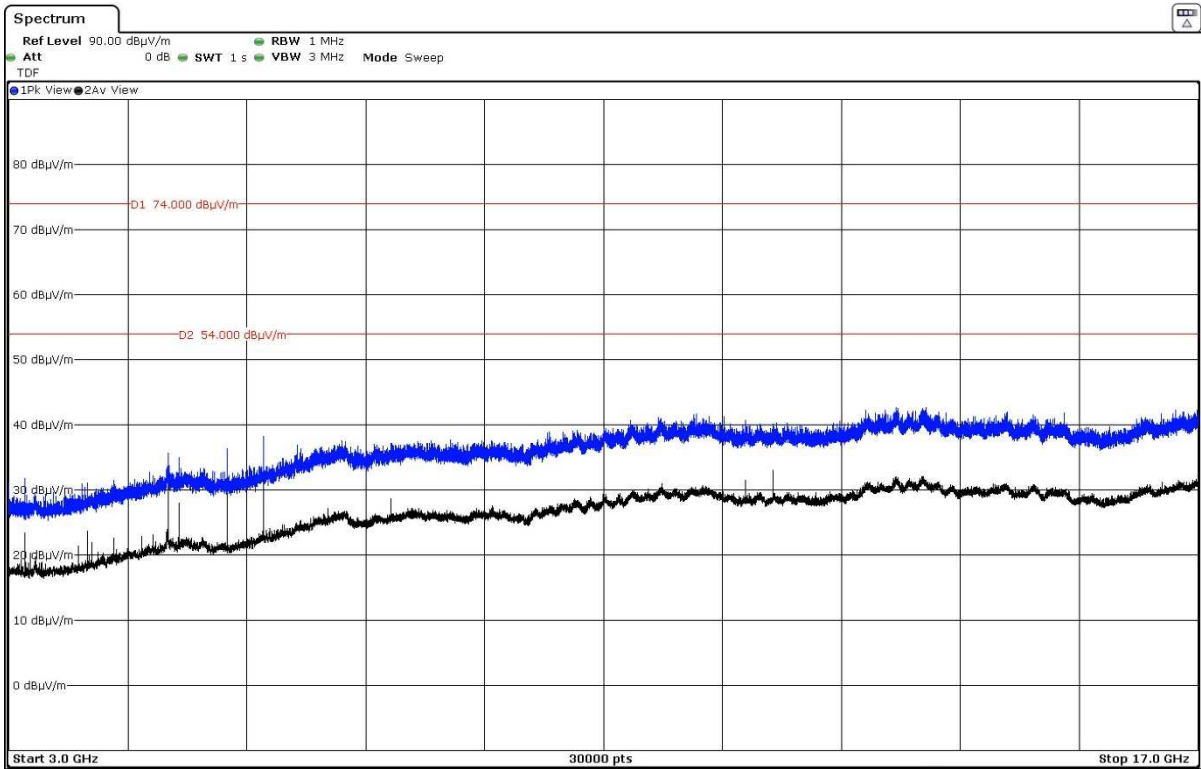
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

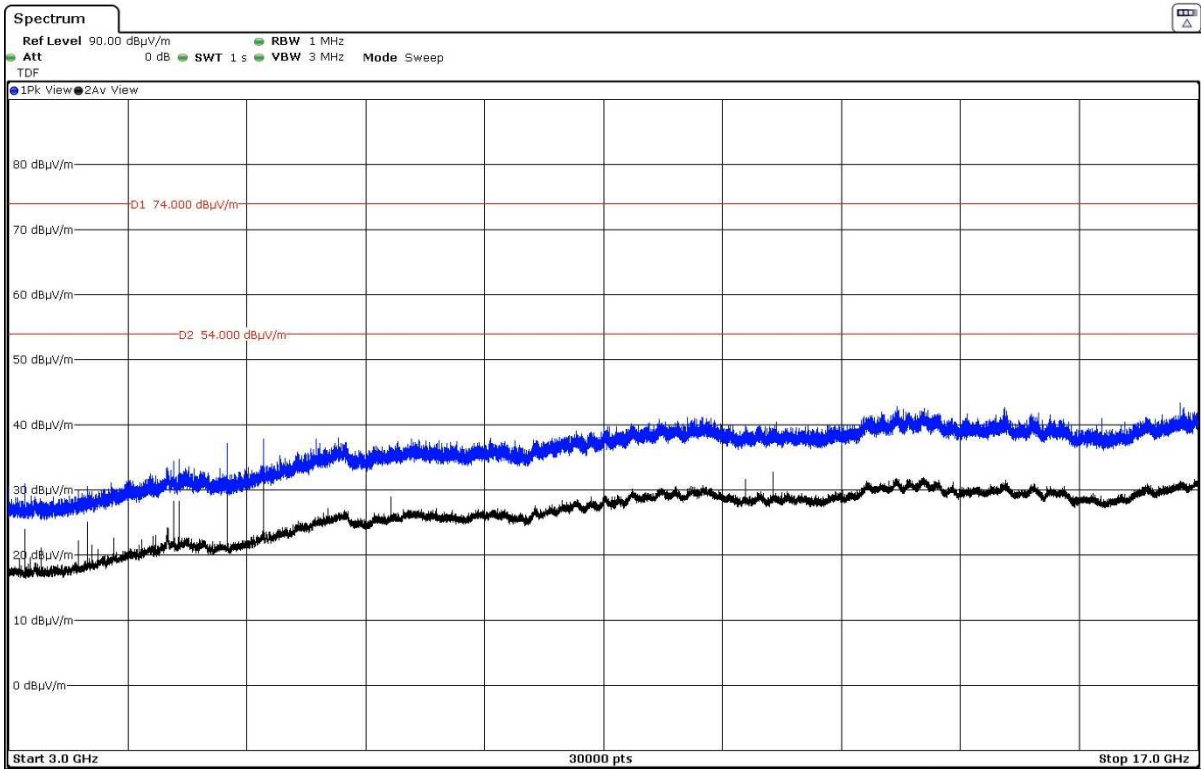
- Low Channel:



- Middle Channel:

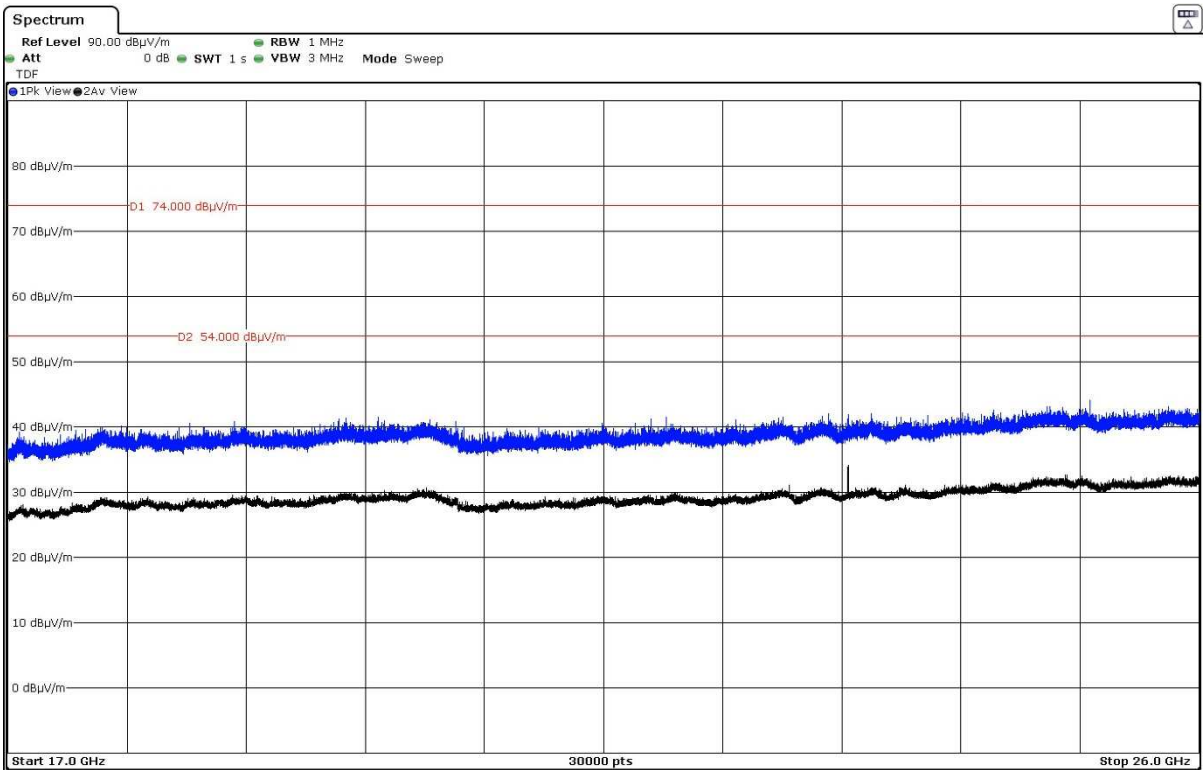


- High Channel:



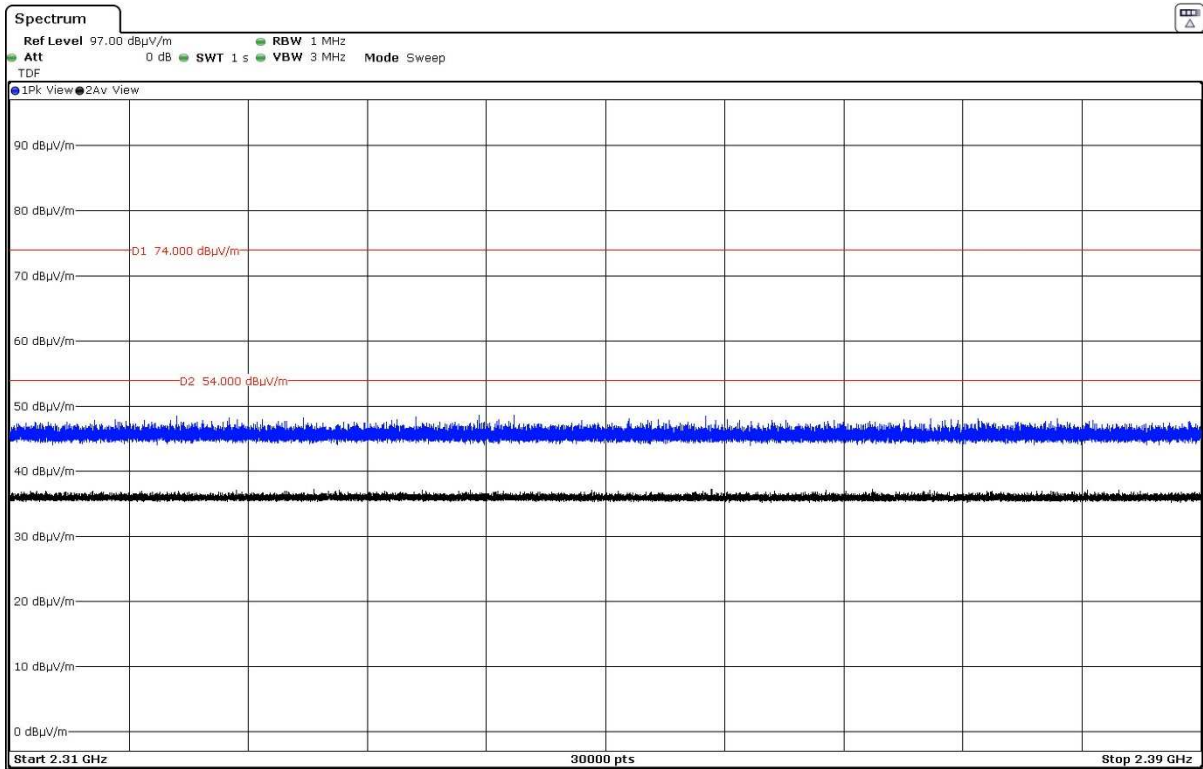
FREQUENCY RANGE 17 - 26 GHz:

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



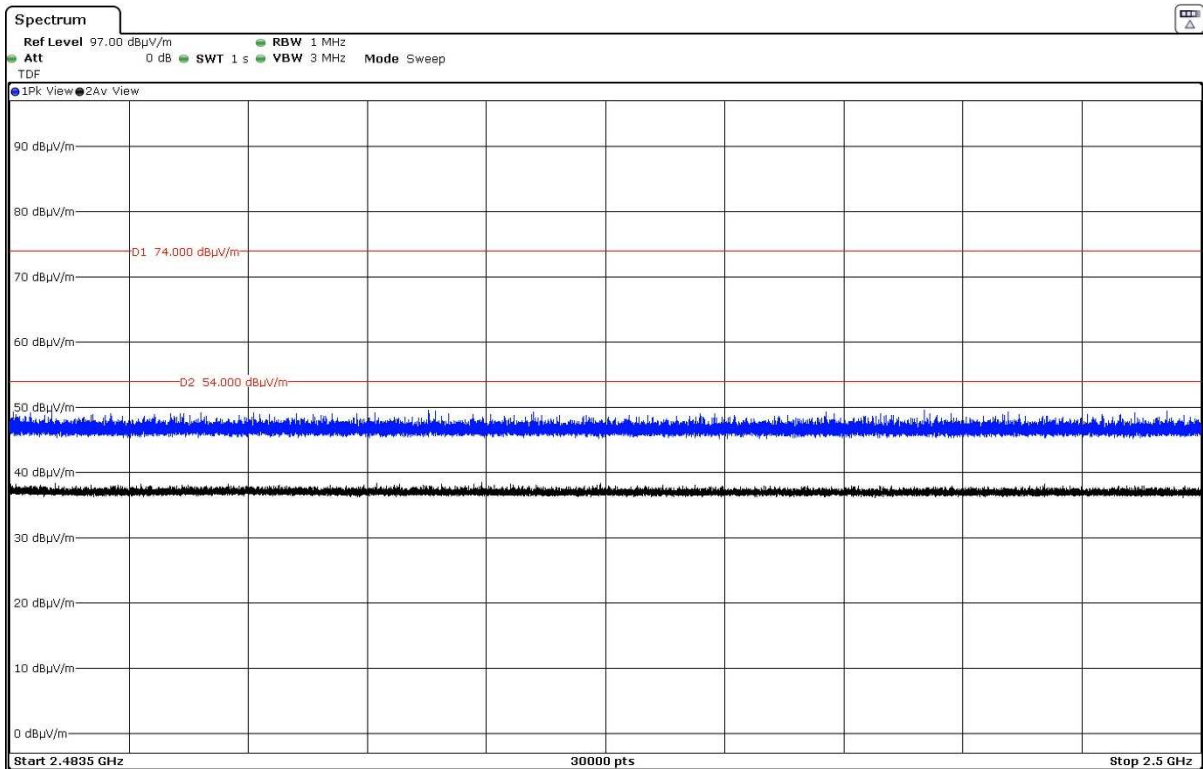
RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

- High Channel:

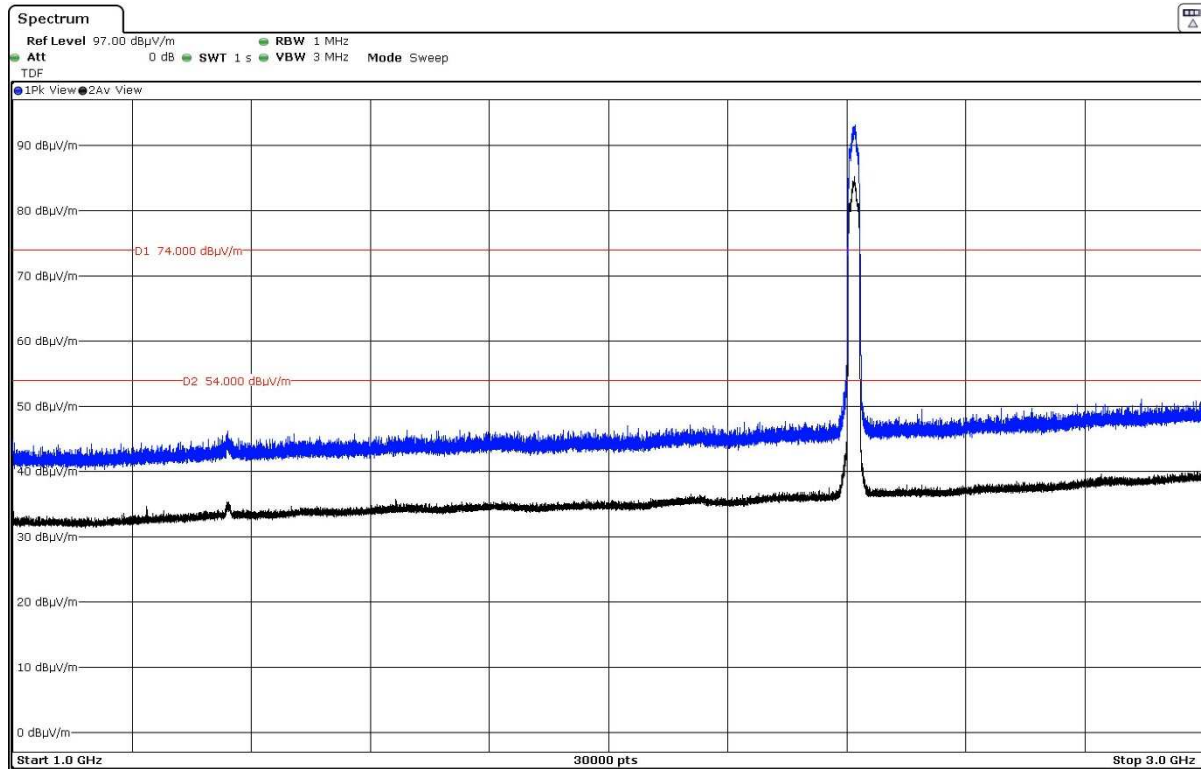


MIMO – WLAN0_CORE1_Port4 & CORE0_Port2 Antennas:

- Mode 802.11 n20 (OFDM worst case for spurious emissions)

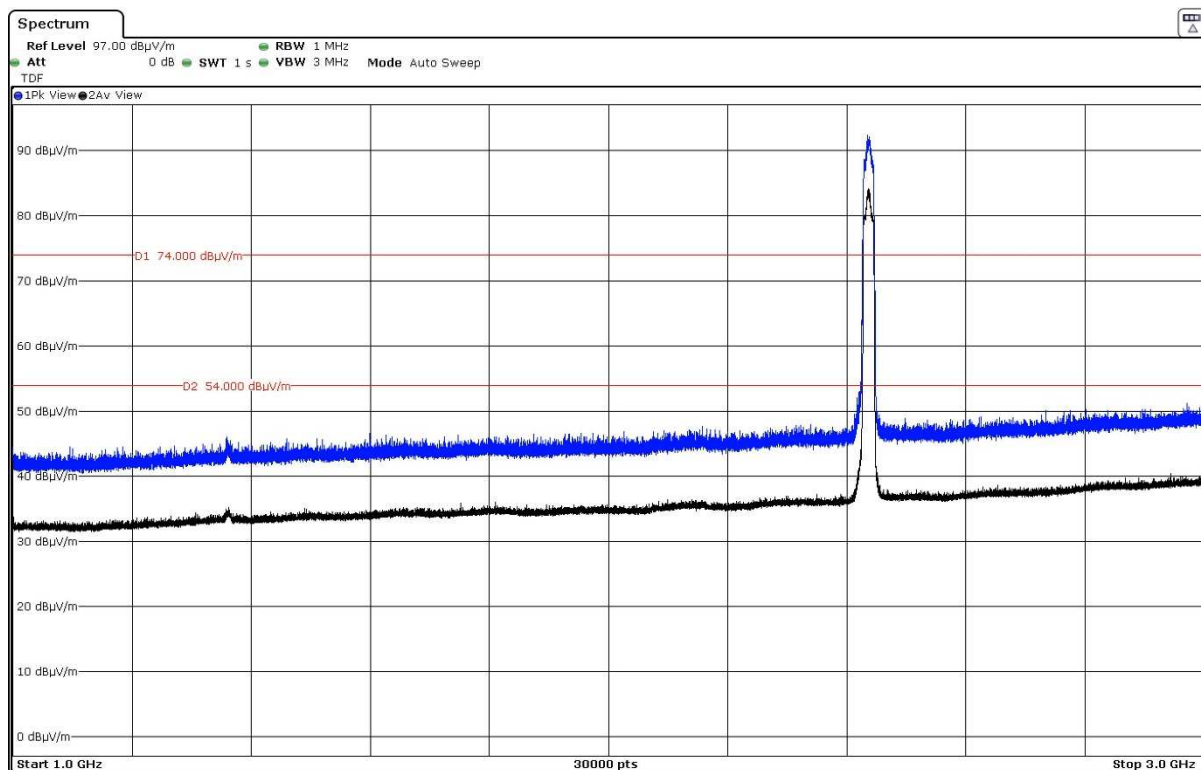
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



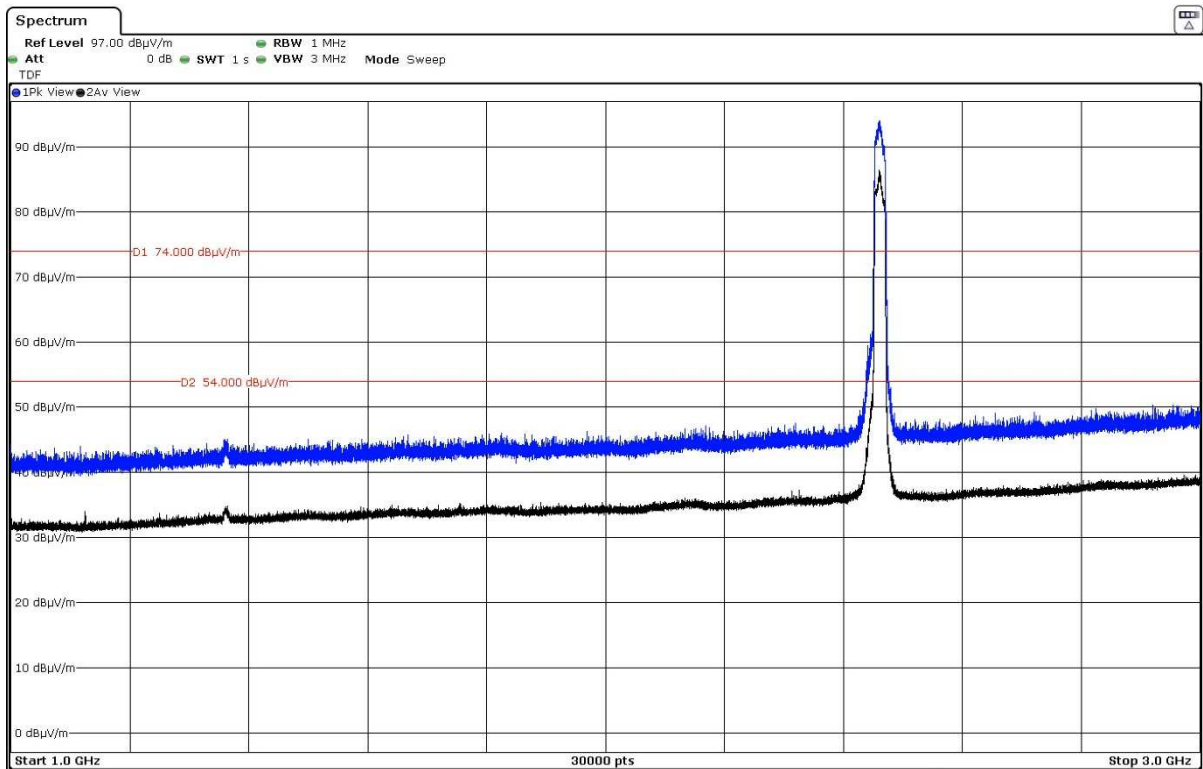
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

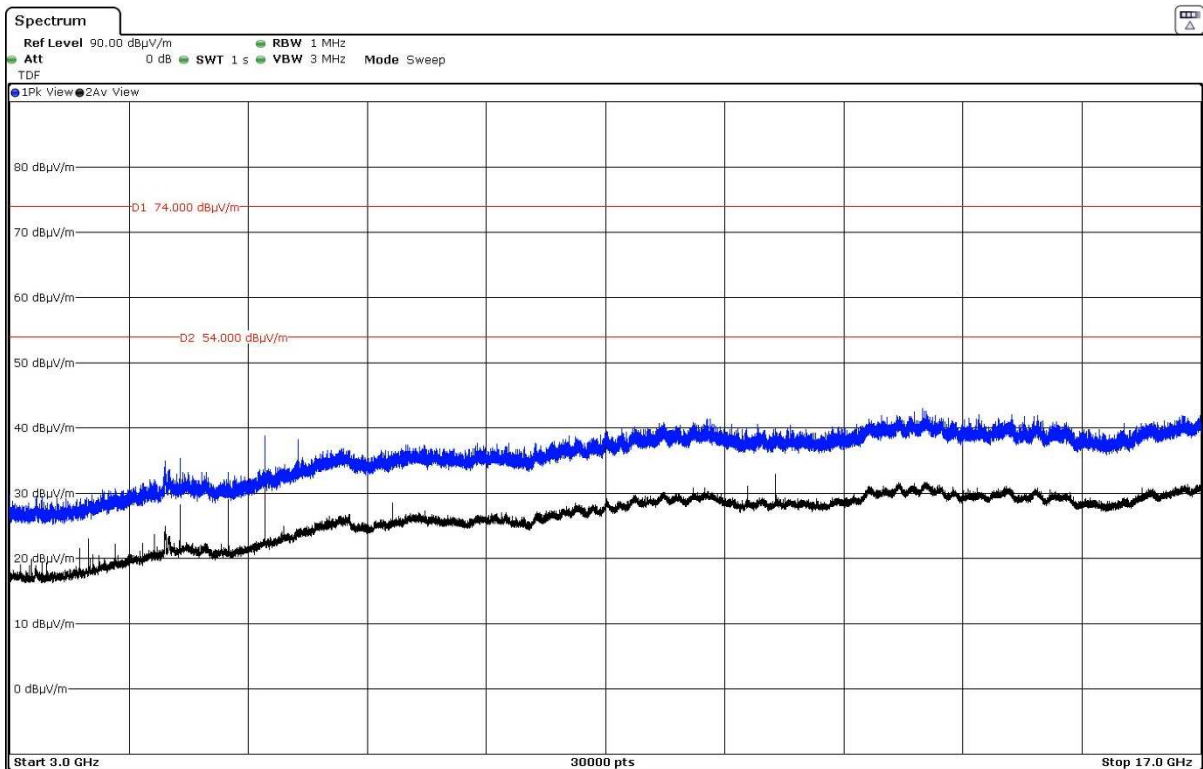
- High Channel:



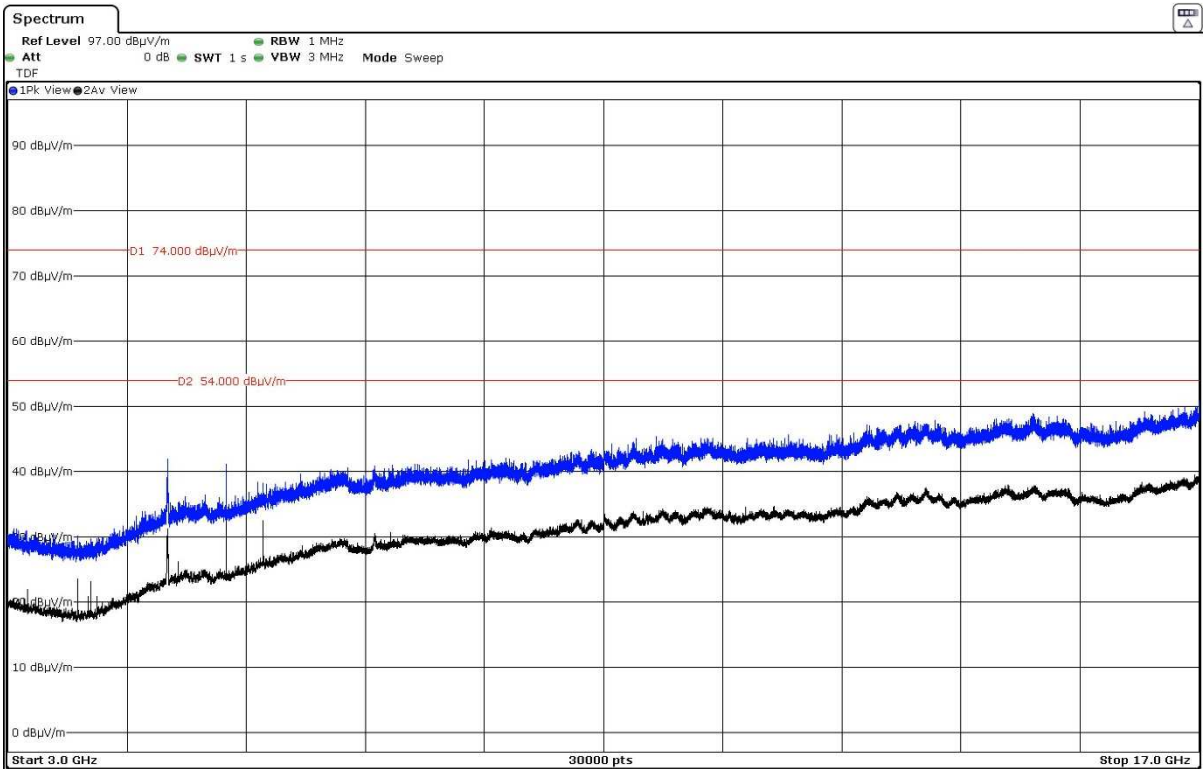
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

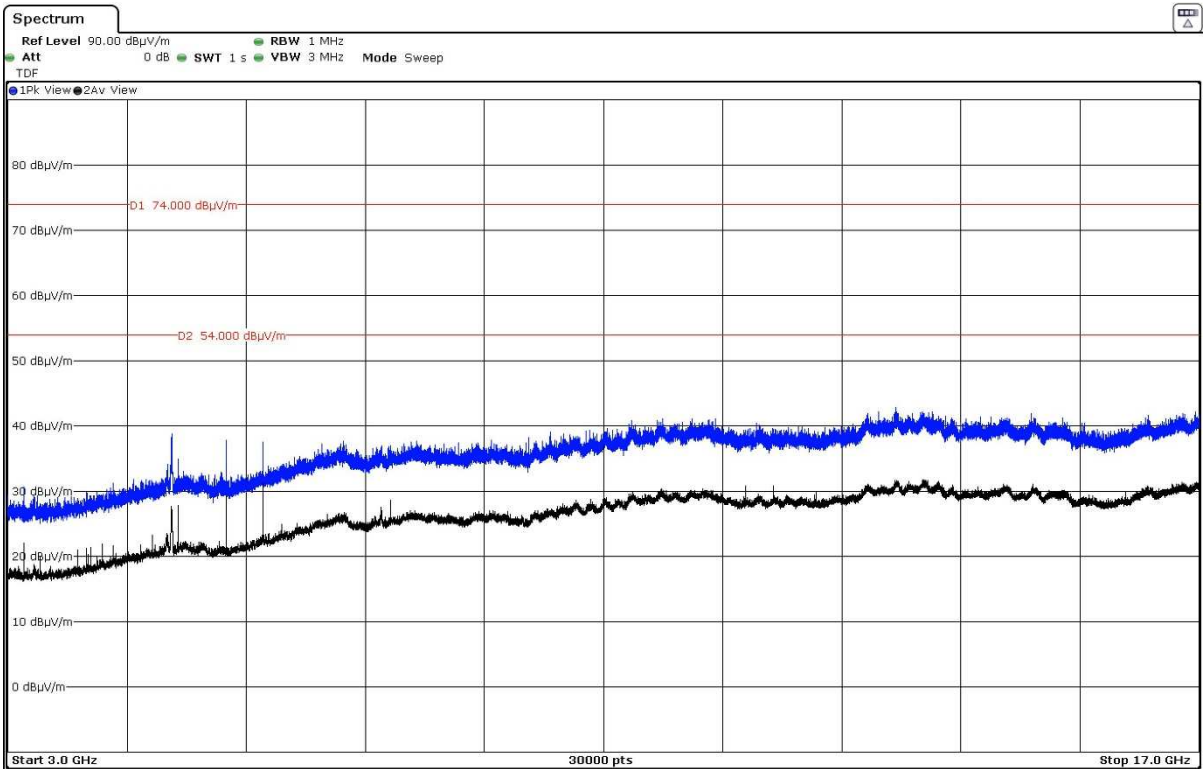
- Low Channel:



- Middle Channel:

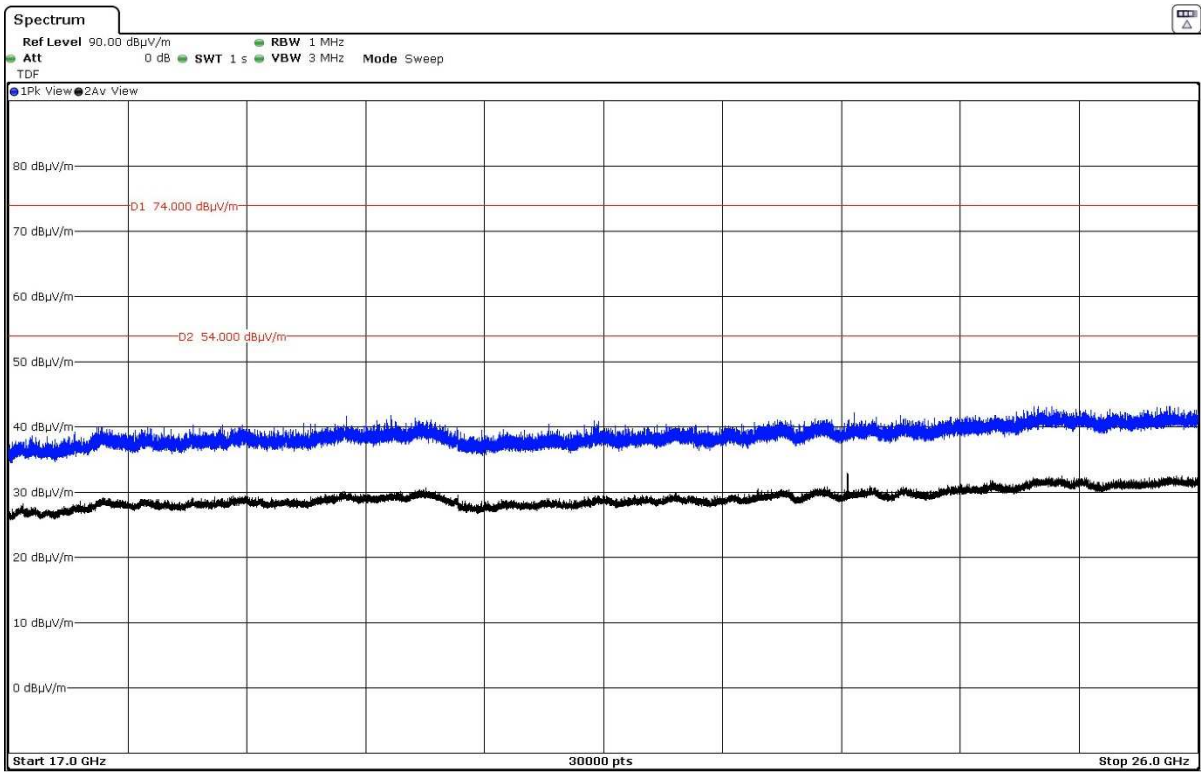


- High Channel:



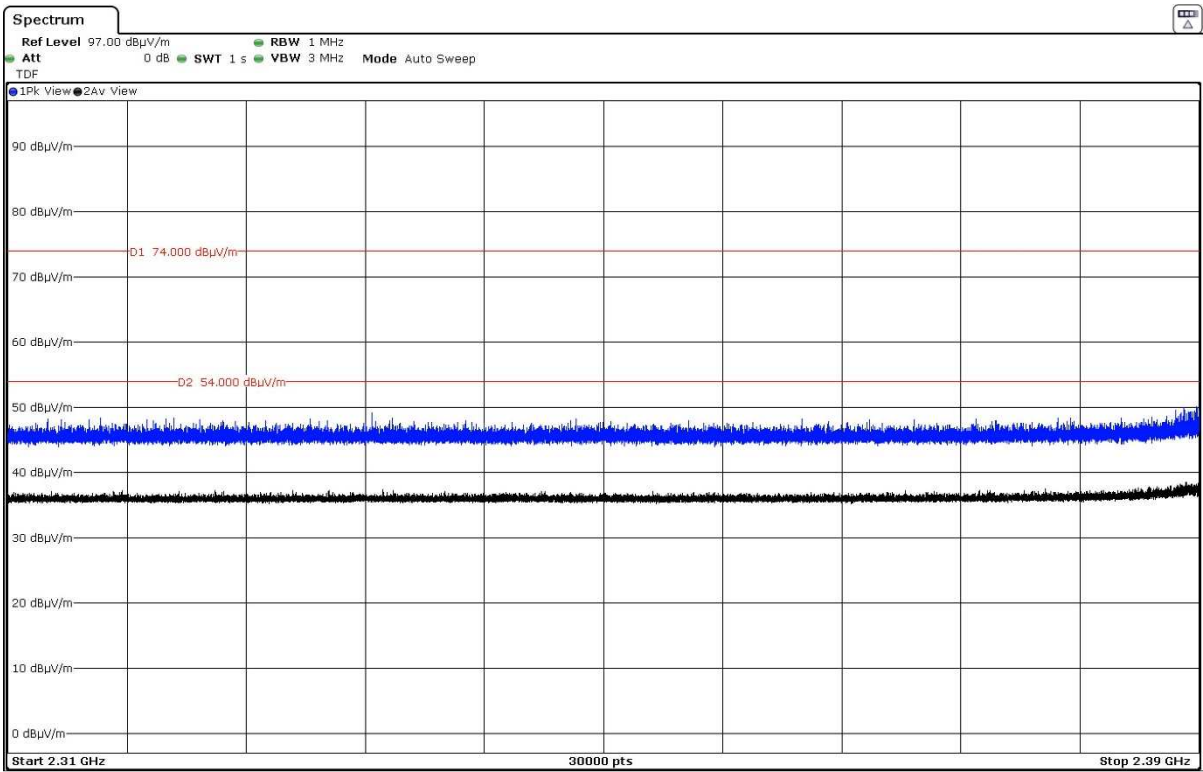
FREQUENCY RANGE 17 - 26 GHz:

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



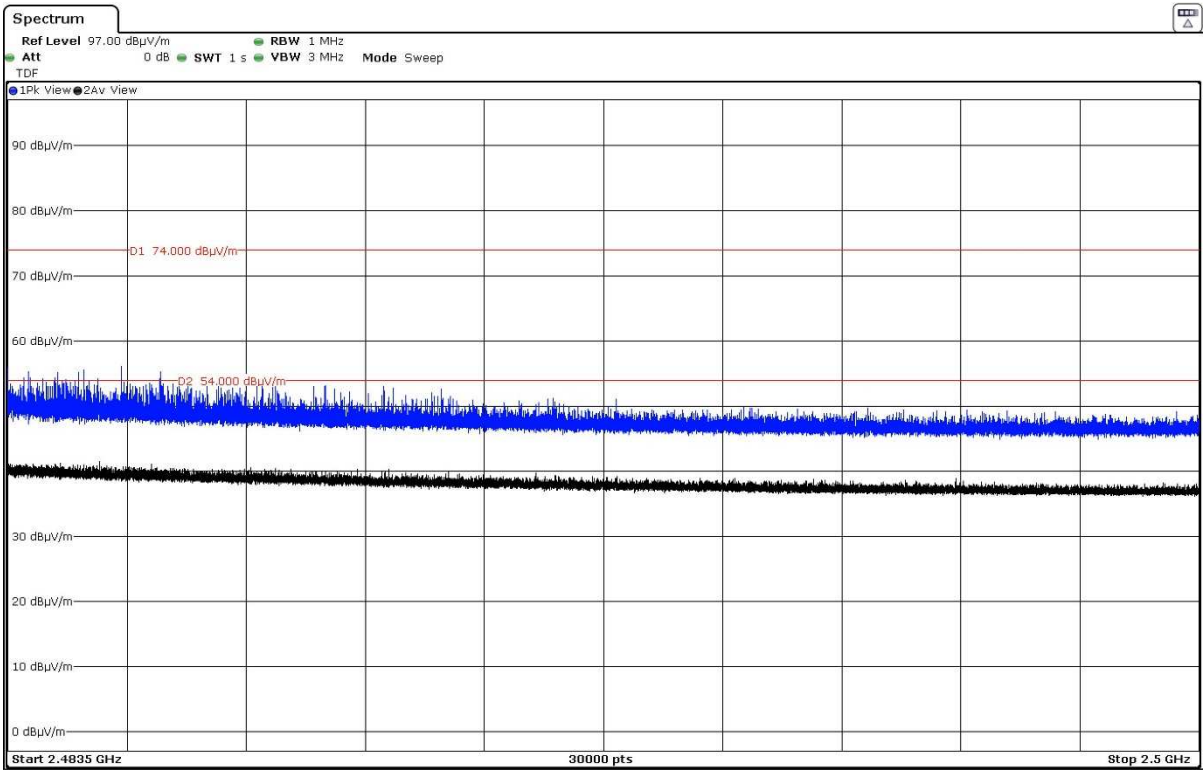
RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

- High Channel:

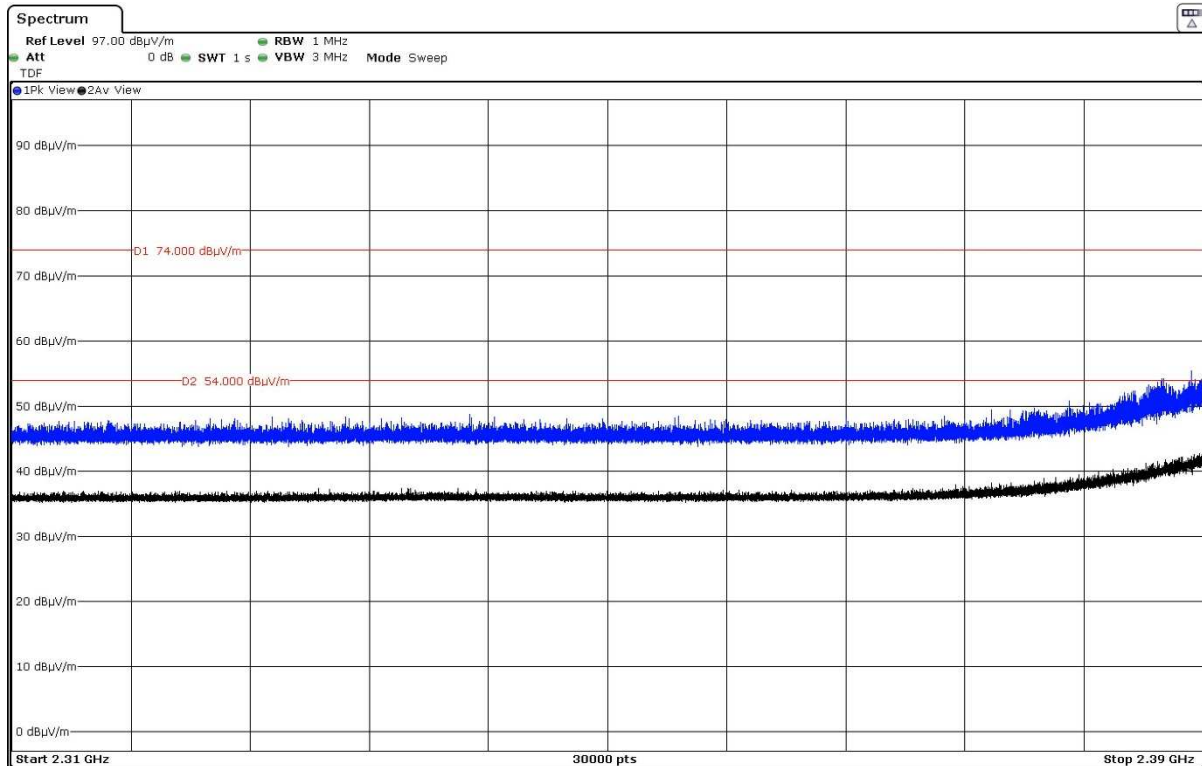


MIMO – WLAN0_CORE1_Port4 & CORE0_Port2 Antennas:

- Mode 802.11 g

RESTRICTED BAND 2.31-2.39 GHz:

- Low Channel:



RESTRICTED BAND 2.4835-2.5 GHz:

- High Channel:

