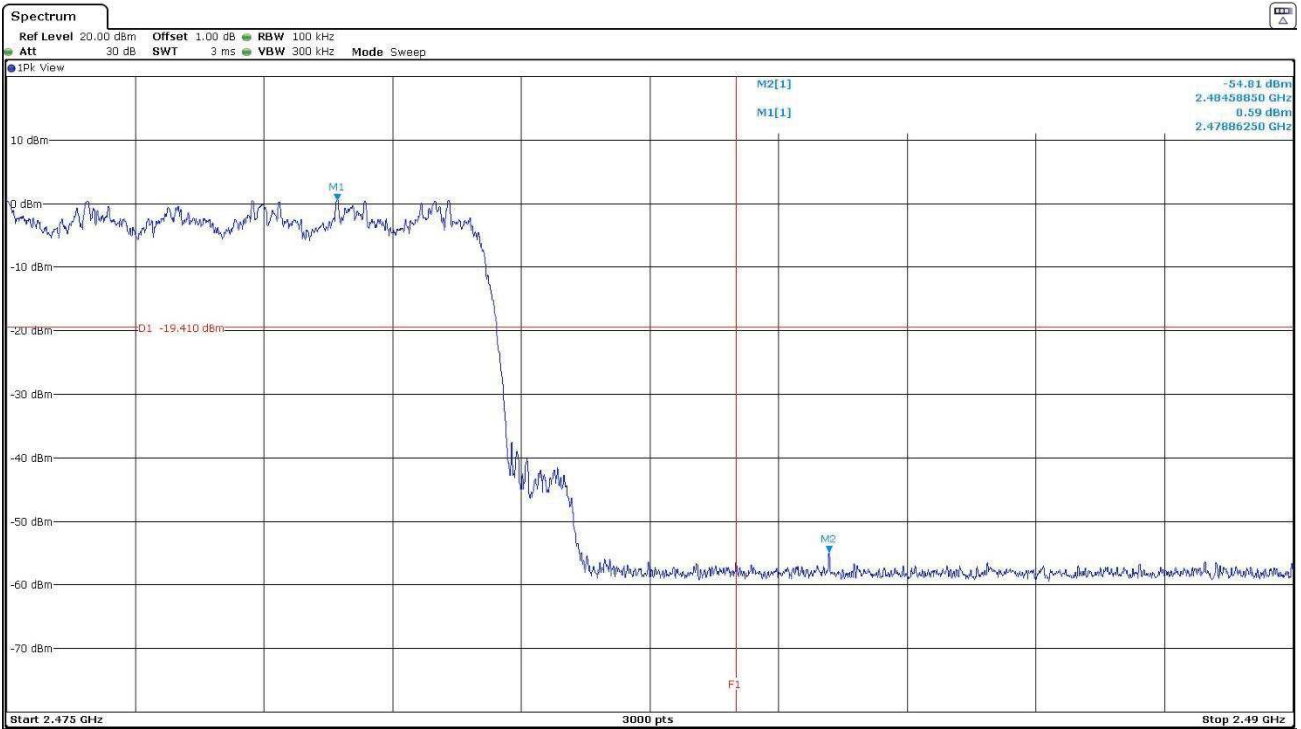


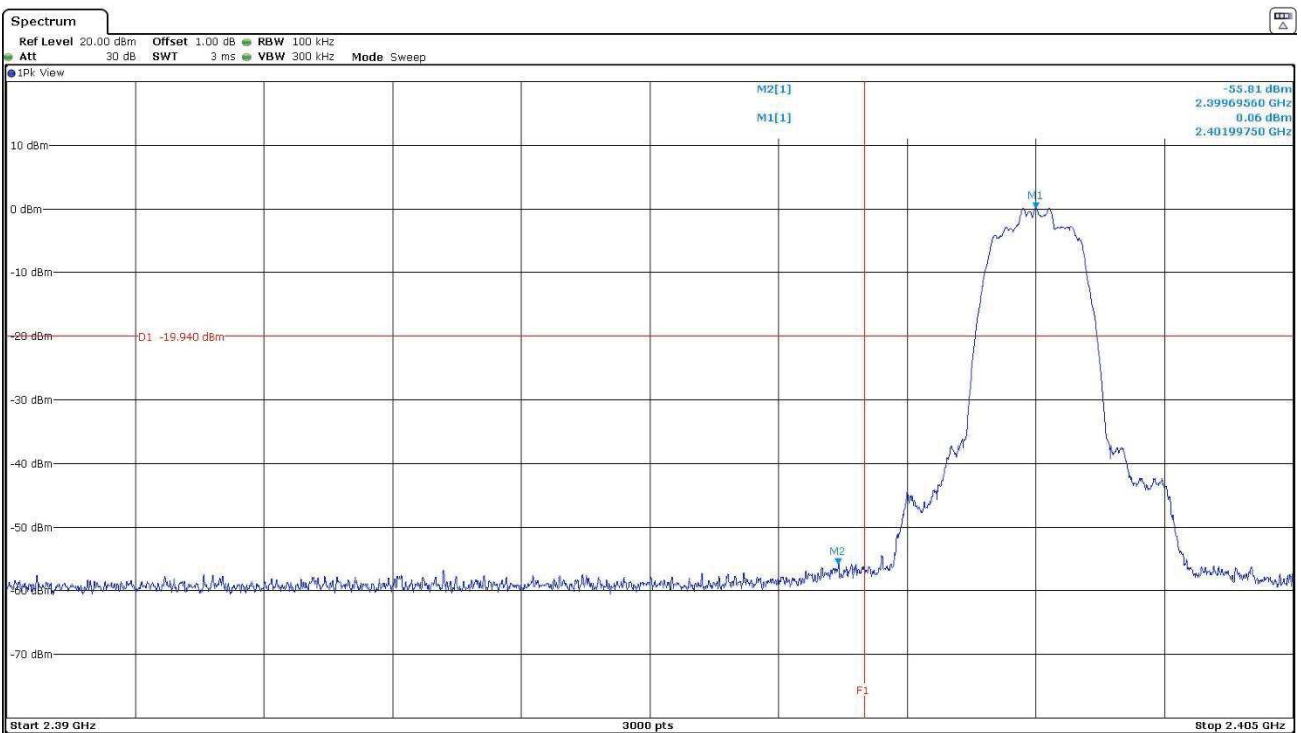
- High Frequency Section 2480 MHz:



Verdict: PASS

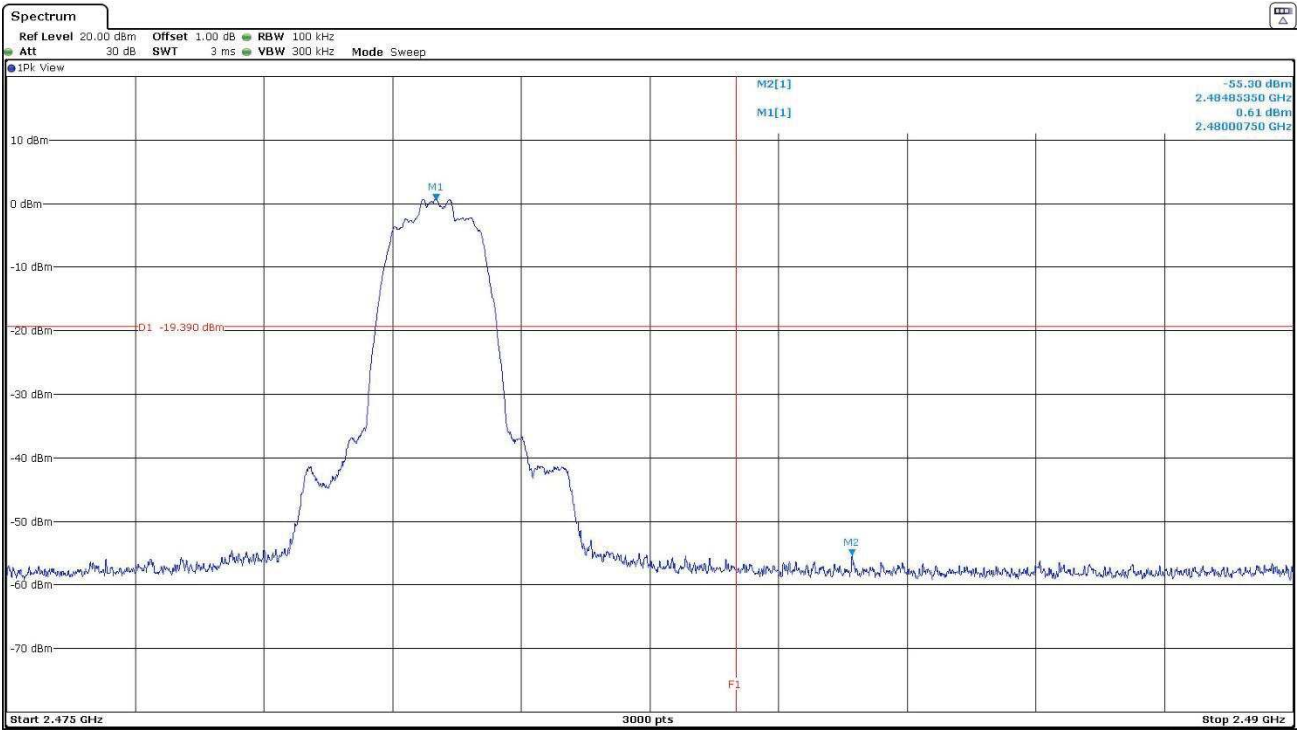
- HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

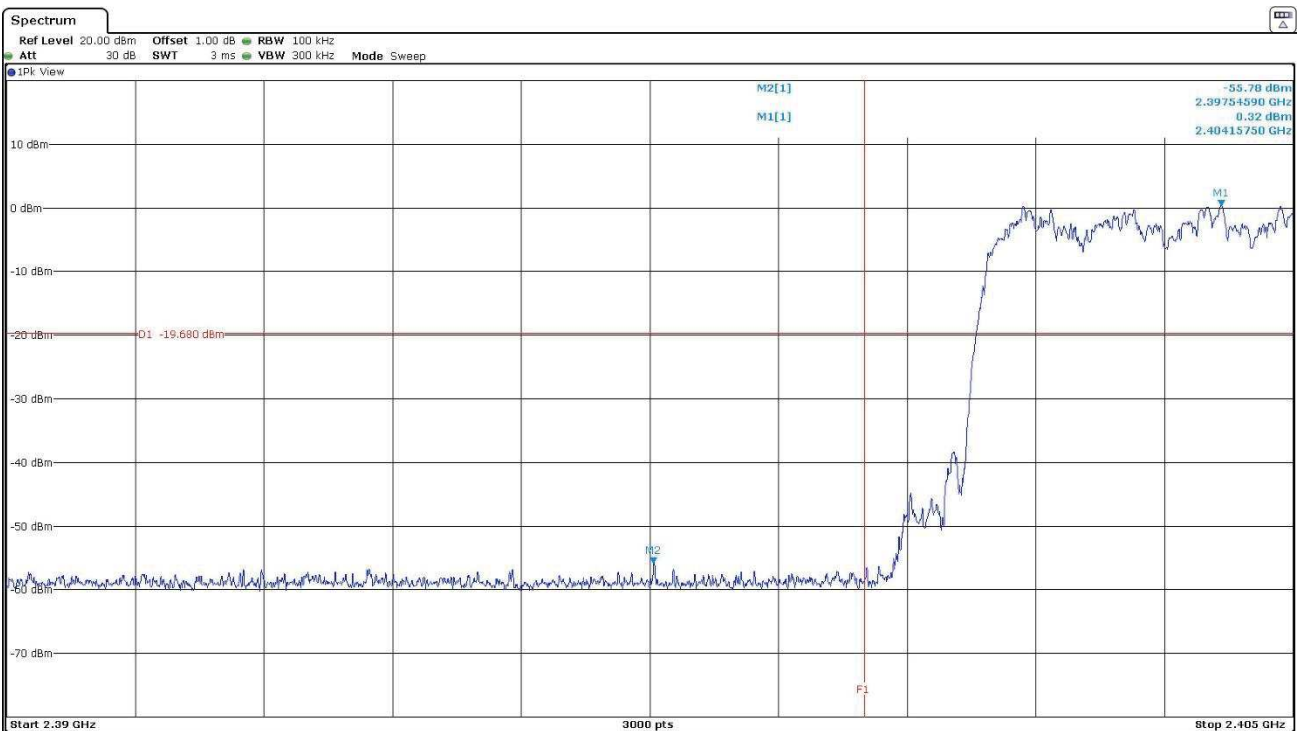


Verdict: PASS

- 8DPSK – Band-edge emissions compliance

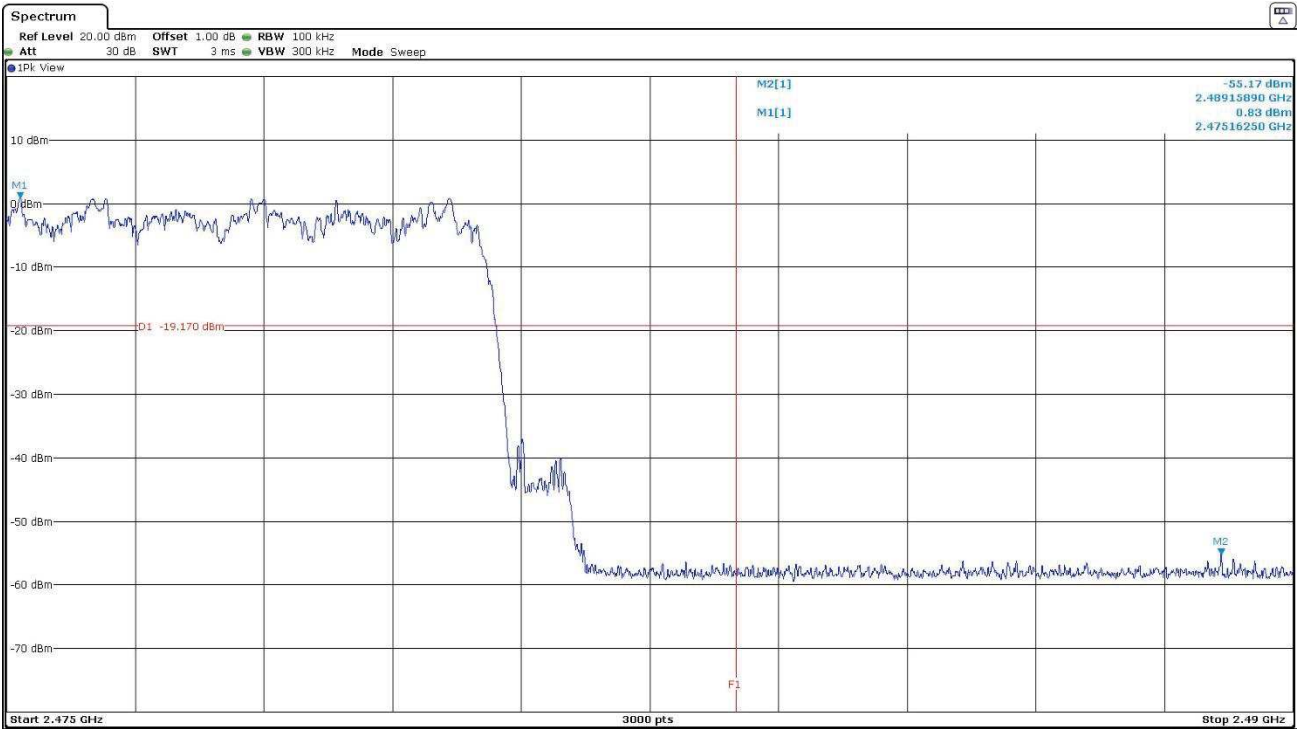
- ❖ HOPPING ON:

- Low Frequency Section 2402 MHz:



Verdict: PASS

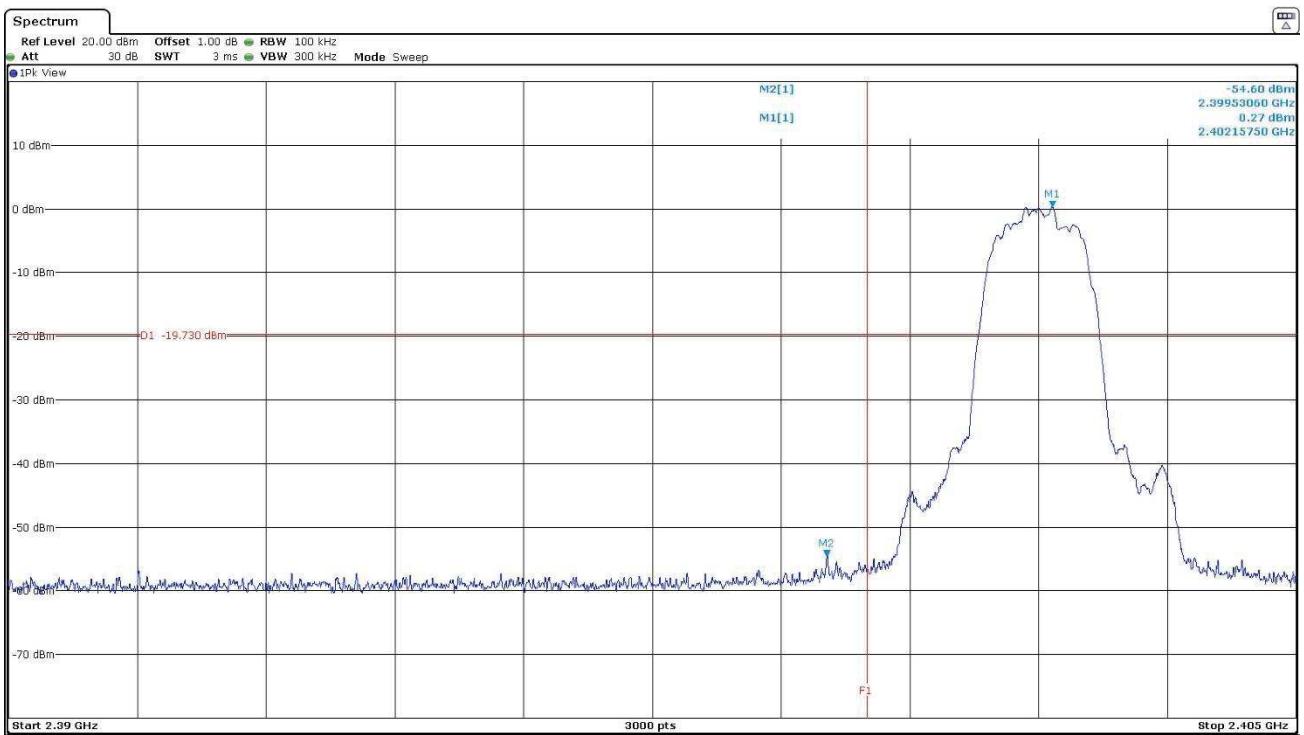
High Frequency Section 2480 MHz:



Verdict: PASS

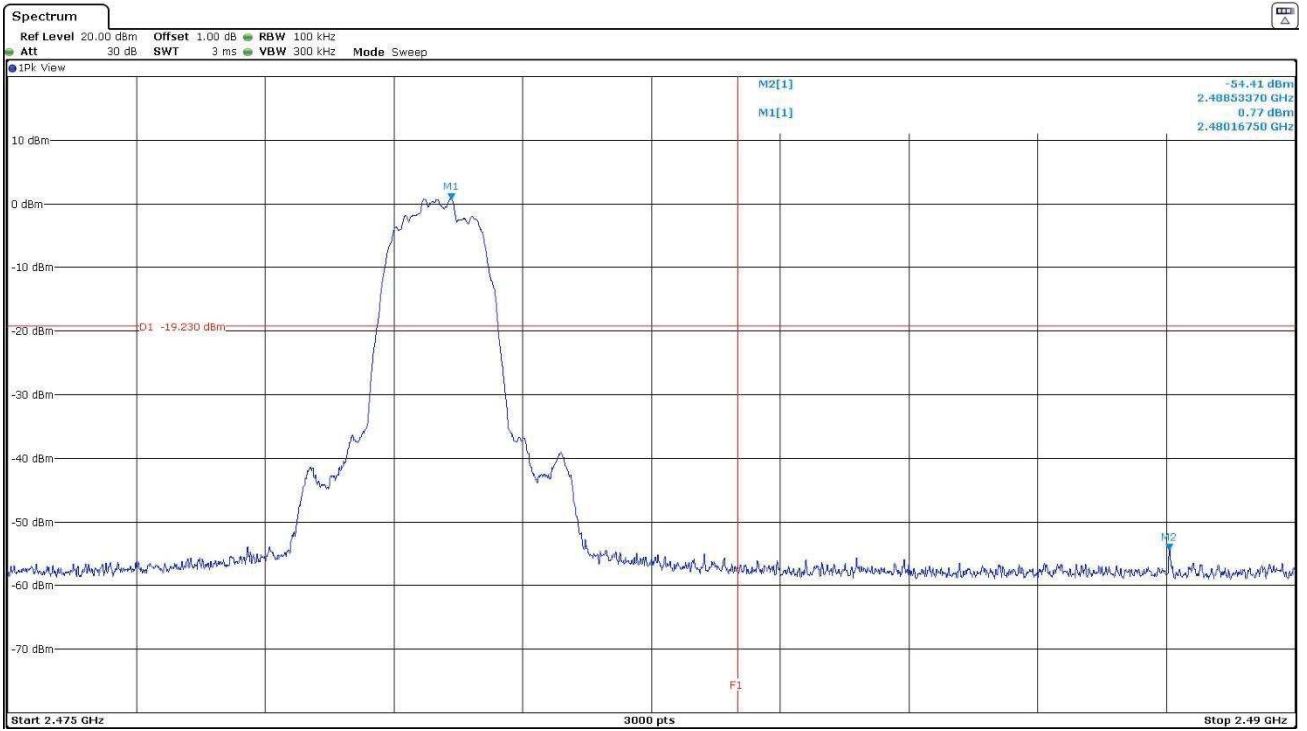
HOPPING OFF:

Low Frequency Section 2402 MHz:



Verdict: PASS

High Frequency Section 2480 MHz:



Verdict: PASS

## 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 ( $\mu\text{V}/\text{m}$ ) | Field strength ( $\text{dB}\mu\text{V}/\text{m}$ ) | 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.

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-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 below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

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

| Spurious frequency (MHz) | Emission Level (dBµV/m) | Limit (dBµV/m) | Polarization | Detector   | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|----------------|--------------|------------|------------------------------|
| 500.01                   | 37.52                   | 46             | H            | Quasi-peak | <± 5.08                      |
| 576.98                   | 25.13                   | 46             | V            | Quasi-peak | <± 5.08                      |
| 625.05                   | 19.34                   | 46             | V            | Quasi-peak | <± 5.08                      |
| 781.17                   | 19.97                   | 46             | H            | Quasi-peak | <± 5.08                      |
| 875.02                   | 29.55                   | 46             | H            | Quasi-peak | <± 5.08                      |

### 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.

- **GFSK modulation (DH5)**

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

| Spurious frequency (GHz) | Emission Level (dBµV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 5.69                     | 36.33                   | V            | Peak     | <±5.13                       |

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

| Spurious frequency (GHz) | Emission Level (dBµV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 5.6455                   | 40.21                   | H            | Peak     | <±5.13                       |

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

| Spurious frequency (GHz) | Emission Level (dBµV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 2.4835                   | 54.11                   | V            | Peak     | <±4.11                       |
|                          | 43.15                   |              | Average  | <±4.11                       |
| 5.6455                   | 42.71                   | H            | Peak     | <±5.13                       |

Verdict: PASS

• **Pi/4-DQPSK modulation (2-DH5)**

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

| Spurious frequency (GHz) | Emission Level (dBμV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 5.6455                   | 41.15                   | H            | Peak     | <±5.13                       |

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

| Spurious frequency (GHz) | Emission Level (dBμV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 5.6455                   | 43.32                   | V            | Peak     | <±5.13                       |

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

| Spurious frequency (GHz) | Emission Level (dBμV/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------|--------------|----------|------------------------------|
| 2.4835                   | 54.33                   | H            | Peak     | <±4.11                       |
|                          | 43.1                    |              | Average  | <±4.11                       |
| 5.6455                   | 42.96                   | V            | Peak     | <±5.13                       |

Verdict: PASS

• **8-DPSK modulation (3DH5)**

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

| Spurious frequency (GHz) | Emission Level (dB $\mu$ V/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------------|--------------|----------|------------------------------|
| 5.6455                   | 46.26                         | V            | Peak     | < $\pm$ 5.13                 |

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

| Spurious frequency (GHz) | Emission Level (dB $\mu$ V/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------------|--------------|----------|------------------------------|
| 5.646                    | 47.82                         | V            | Peak     | < $\pm$ 5.13                 |

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

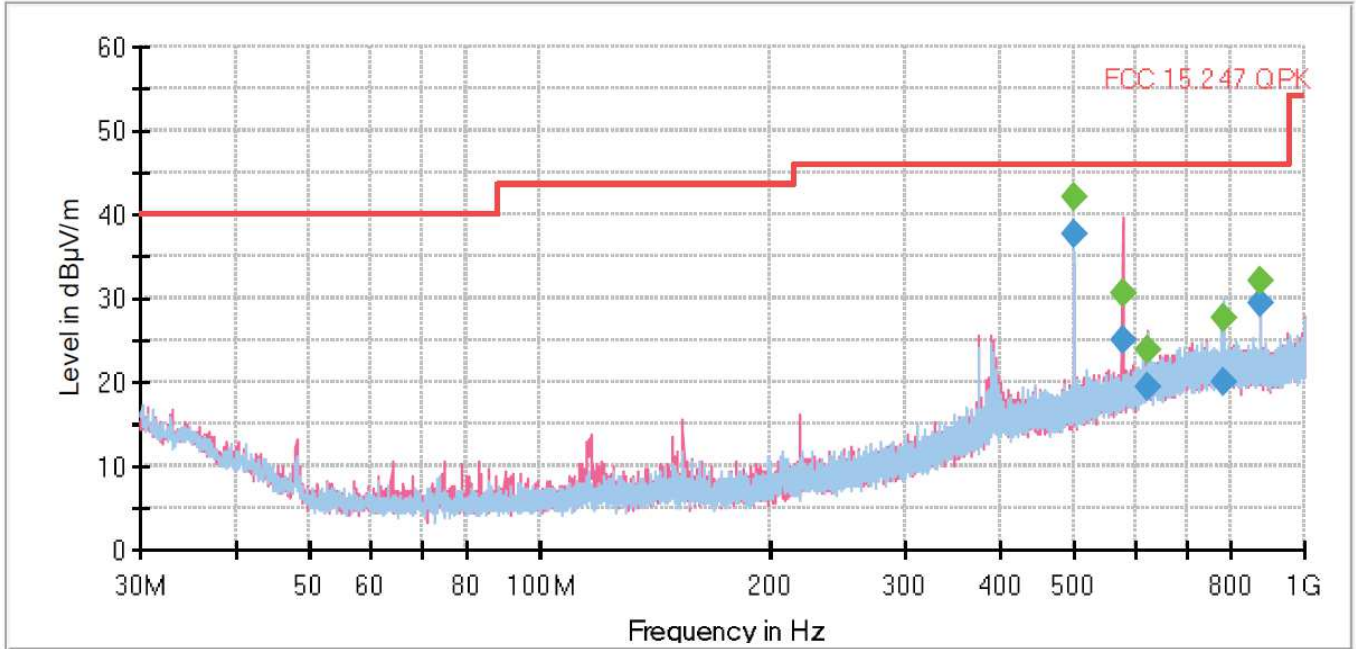
| Spurious frequency (GHz) | Emission Level (dB $\mu$ V/m) | Polarization | Detector | Measurement Uncertainty (dB) |
|--------------------------|-------------------------------|--------------|----------|------------------------------|
| 2.484                    | 55.15                         | H            | Peak     | < $\pm$ 4.11                 |
|                          | 43.22                         |              | Average  | < $\pm$ 4.11                 |
| 16.048                   | 43.36                         | V            | Peak     | < $\pm$ 5.13                 |
| 5.645                    | 41.22                         | H            | Peak     | < $\pm$ 5.13                 |

Verdict: PASS



**FREQUENCY RANGE 30 MHz - 1 GHz:**

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

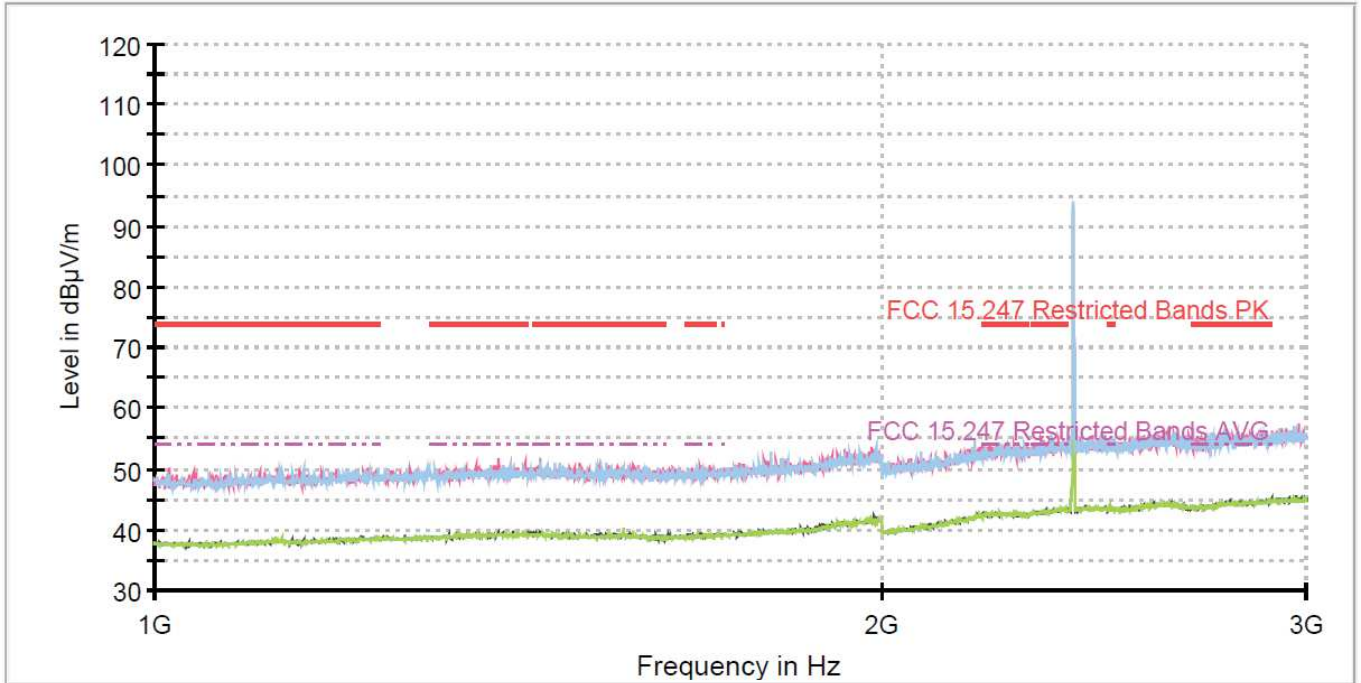


- Preview Result 1V-PK+
- Preview Result 1H-PK+
- FCC 15.247 QPK
- ◆ Final\_Result QPK
- ◆ Final\_Result PK+

**FREQUENCY RANGE 1 - 3 GHz:**

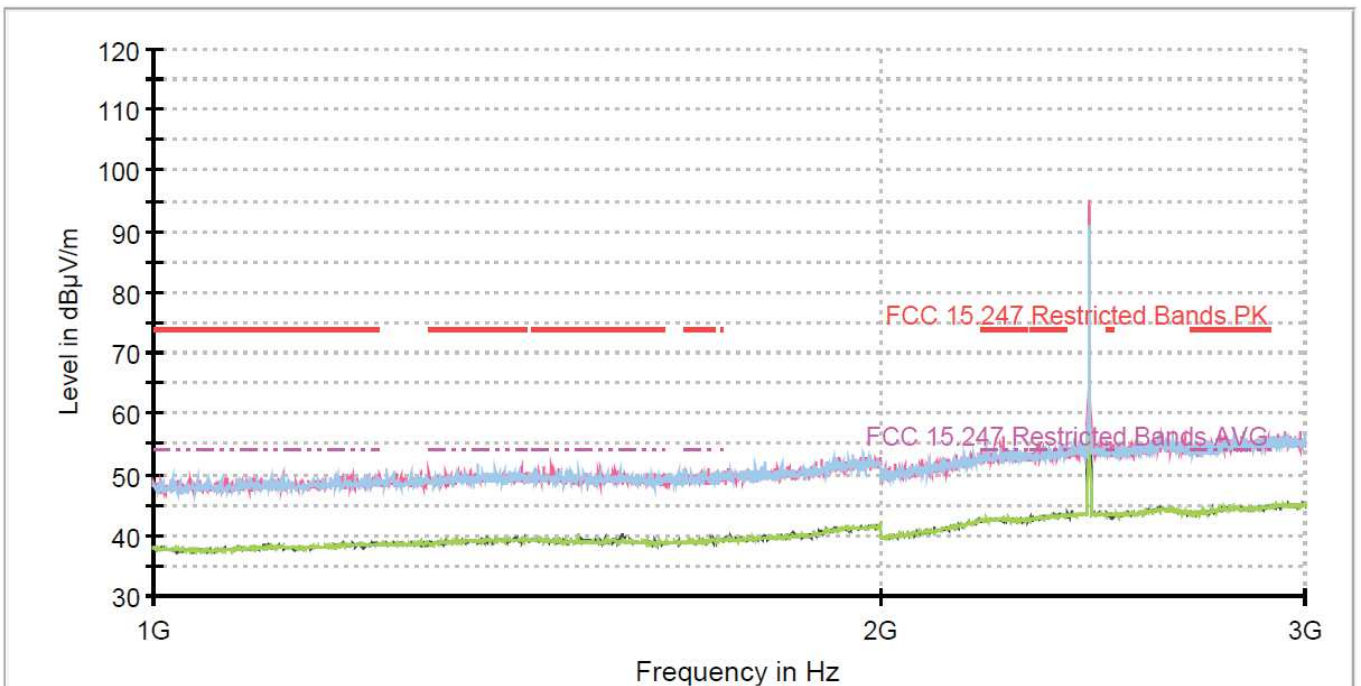
- **GFSK modulation (DH5)**

- Low Channel:



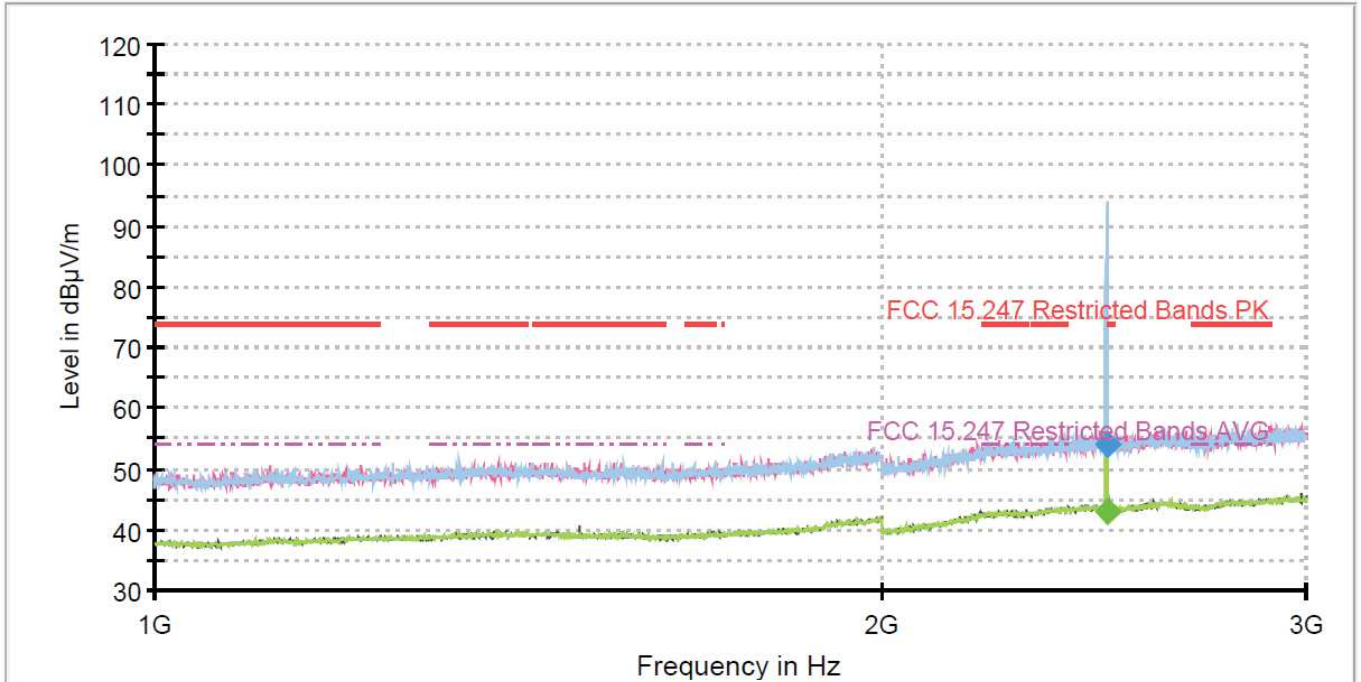
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

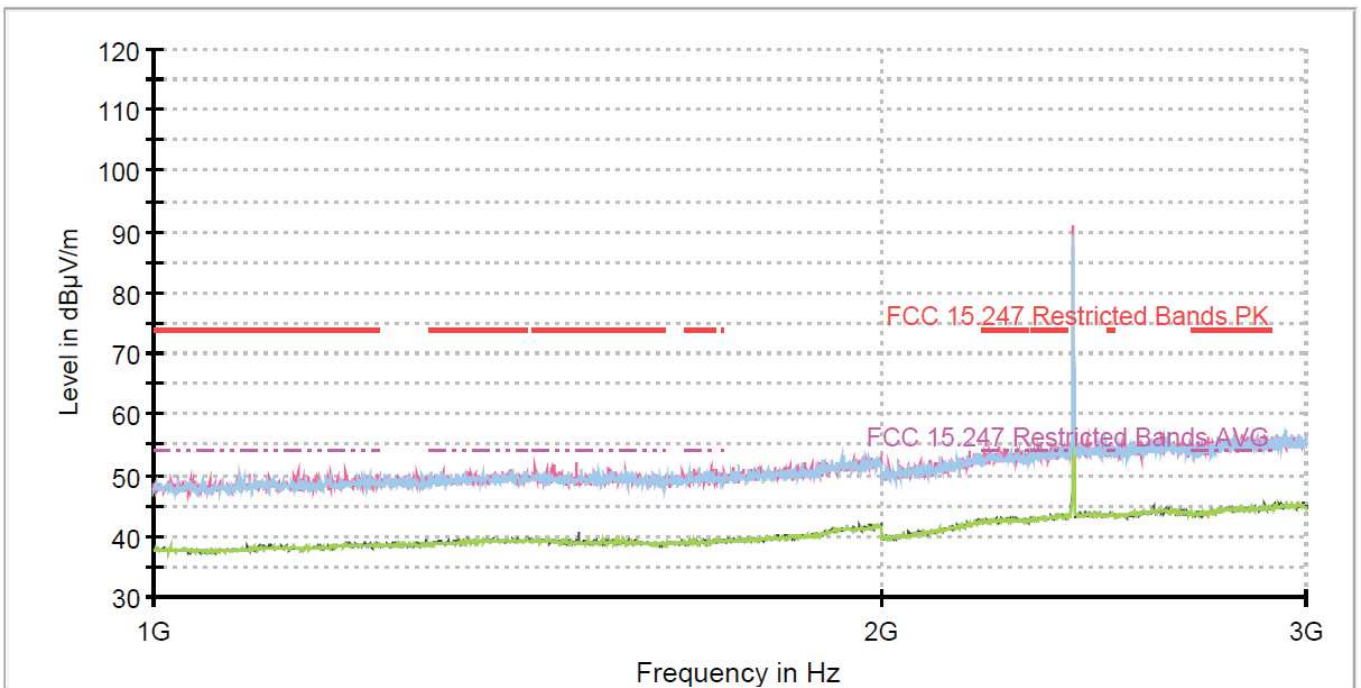
- High Channel:



The peak above the limit is the carrier frequency.

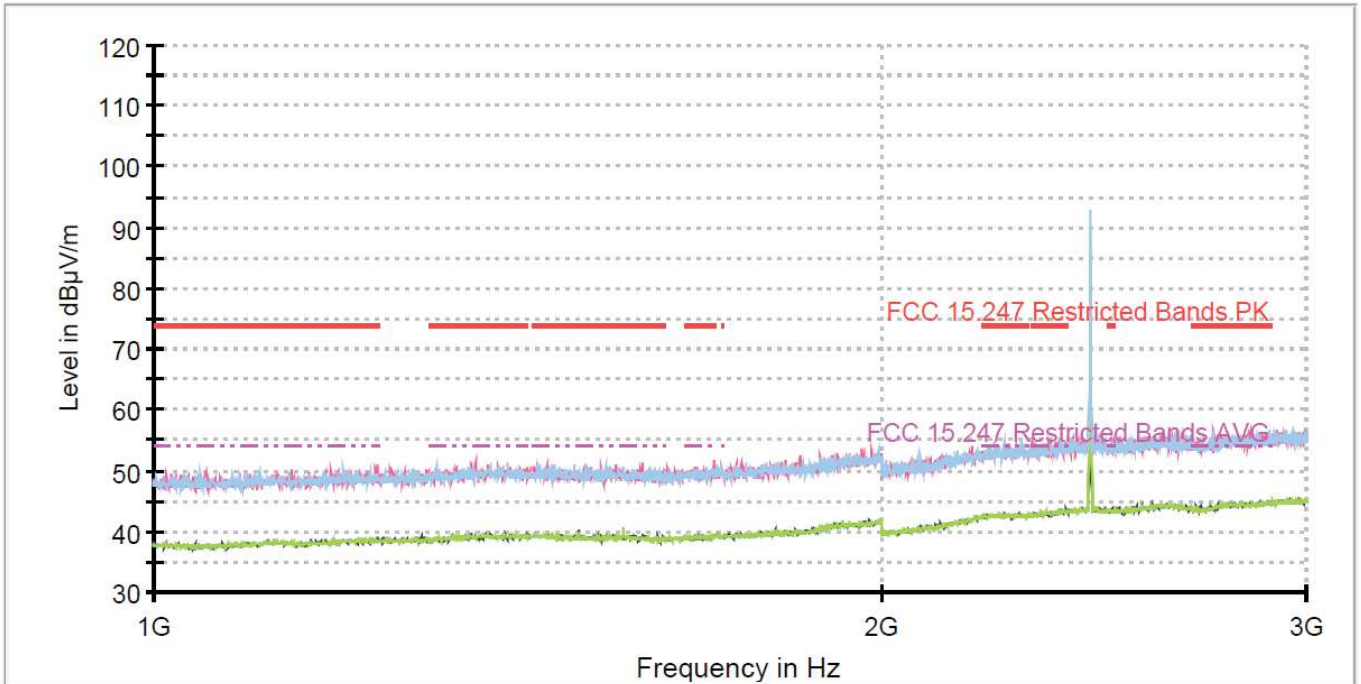
- Pi/4-DQPSK modulation (2DH5)

- Low Channel:



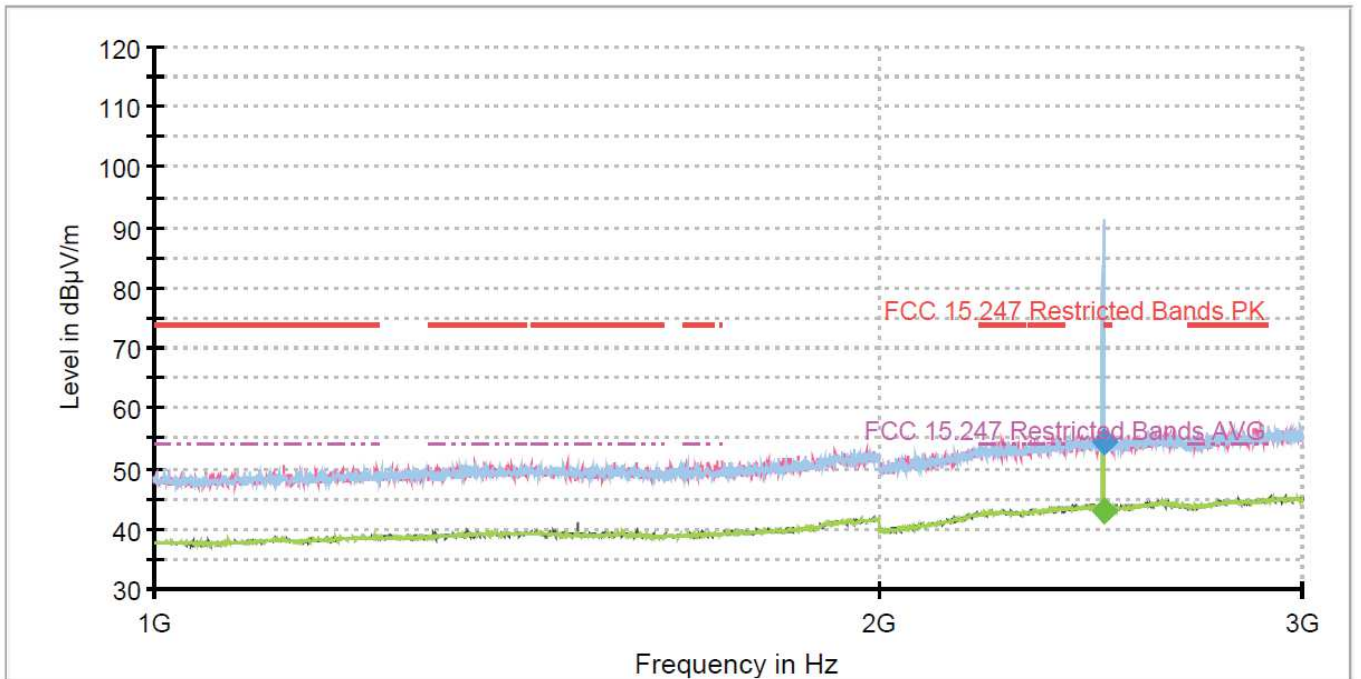
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

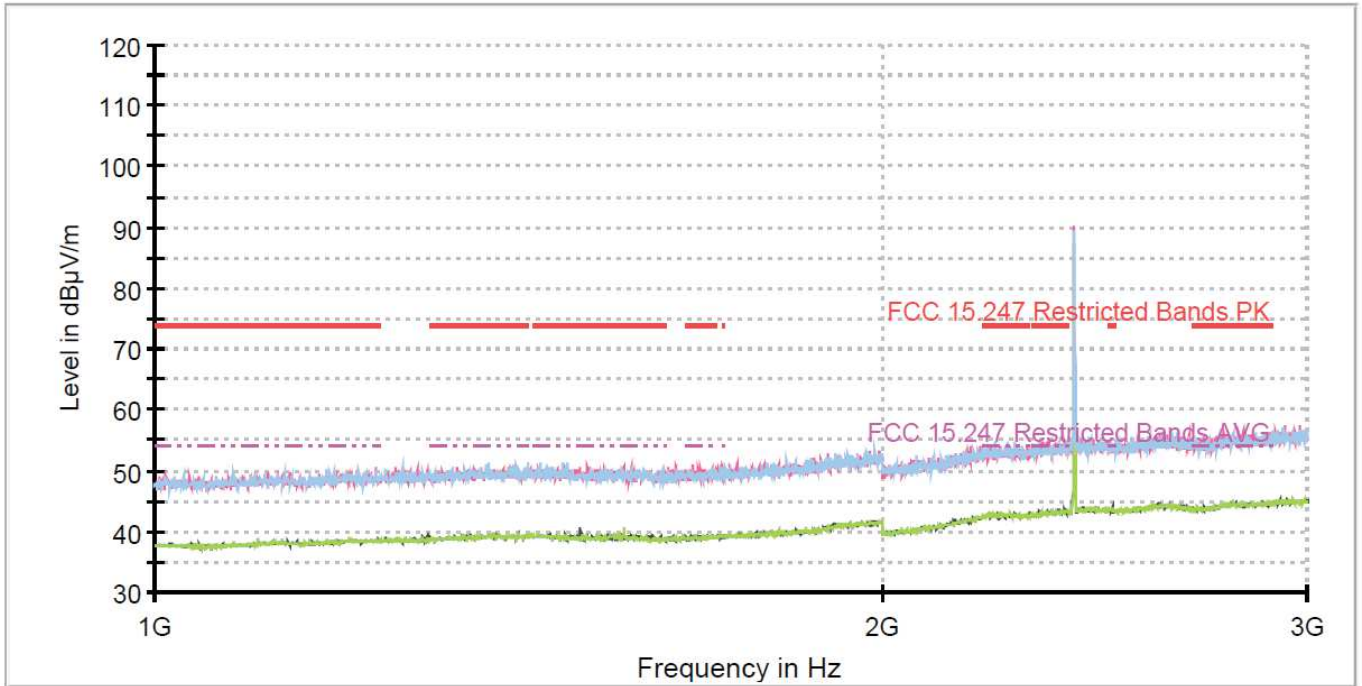
- High Channel:



The peak above the limit is the carrier frequency.

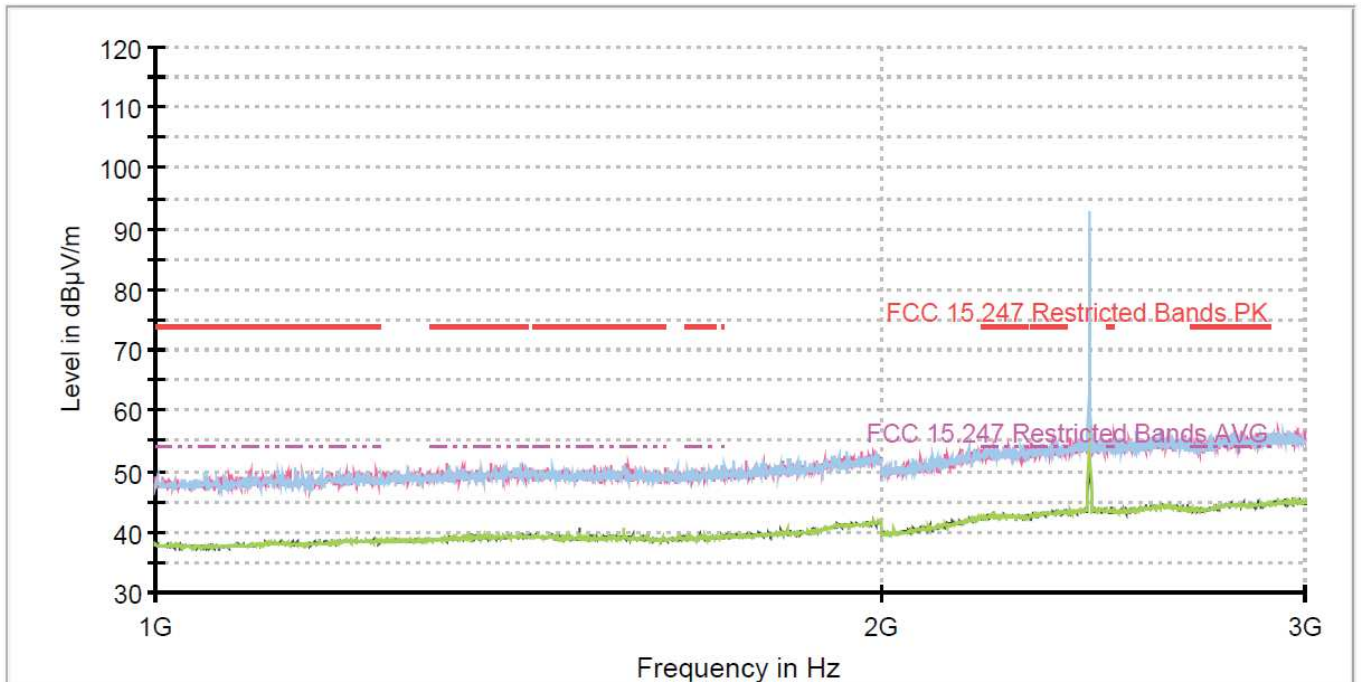
- 8-DPSK modulation (3DH5)

- Low Channel:



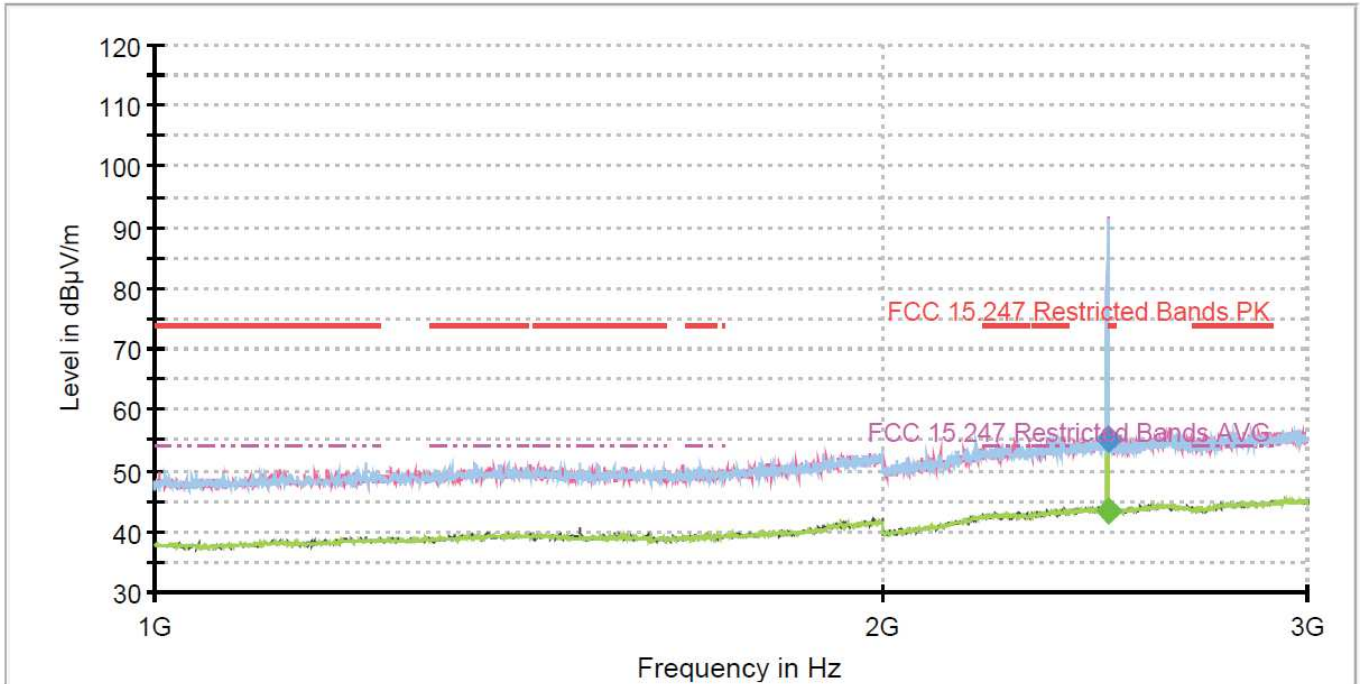
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

- High Channel:

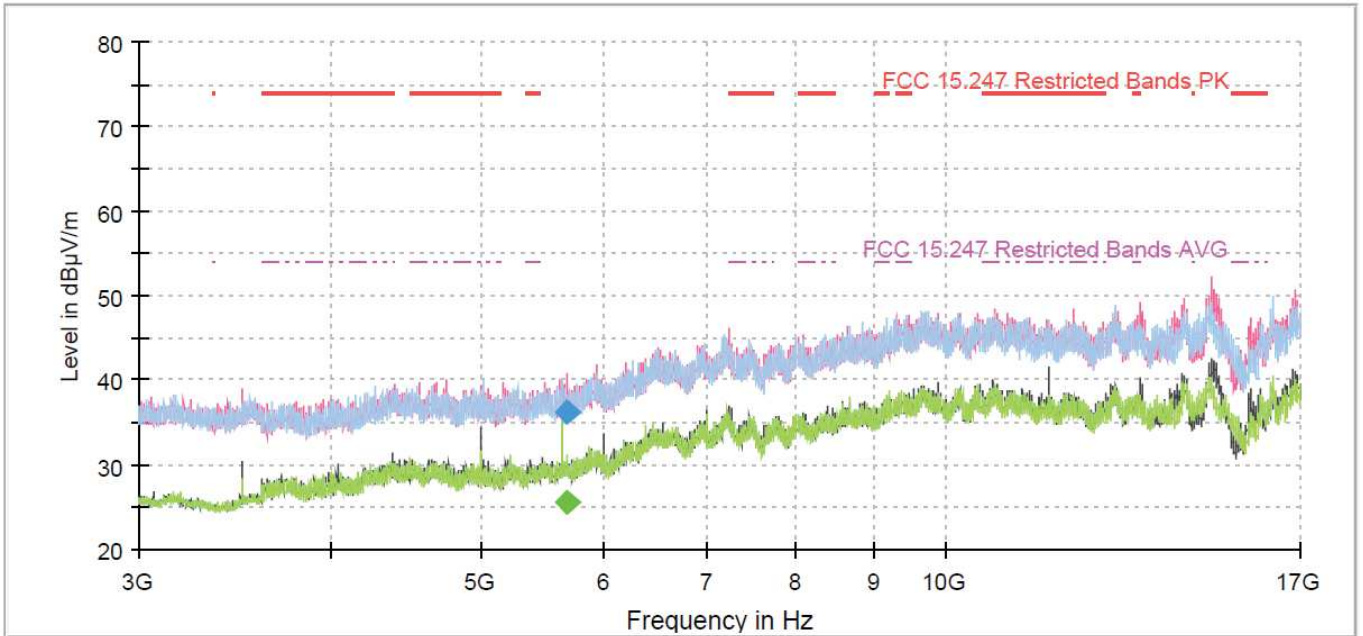


The peak above the limit is the carrier frequency.

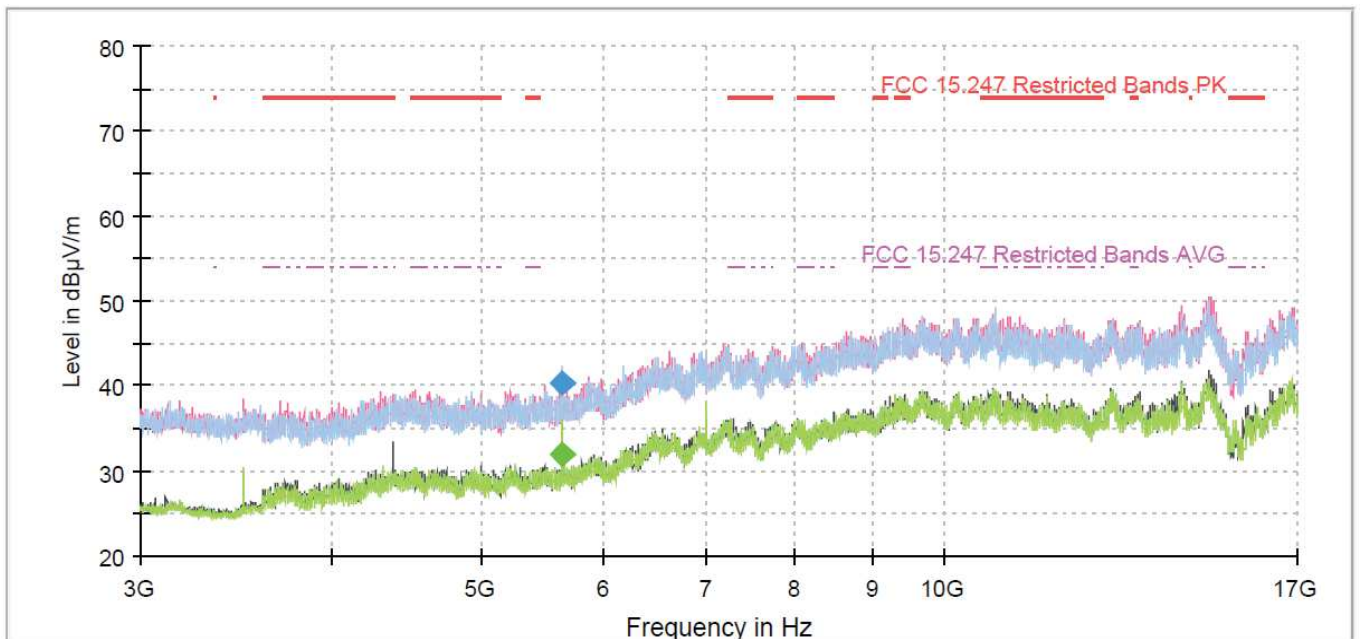
**FREQUENCY RANGE 3 - 17 GHz:**

- **GFSK modulation (DH5)**

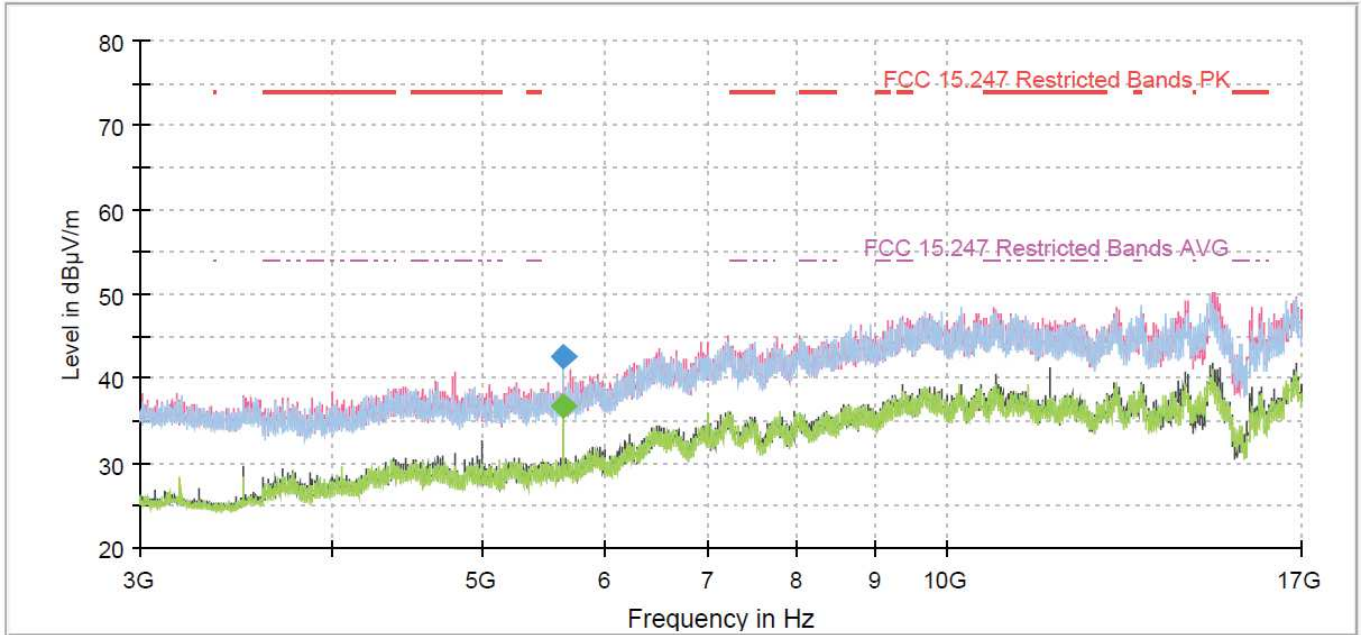
- Low Channel:



- Middle Channel:

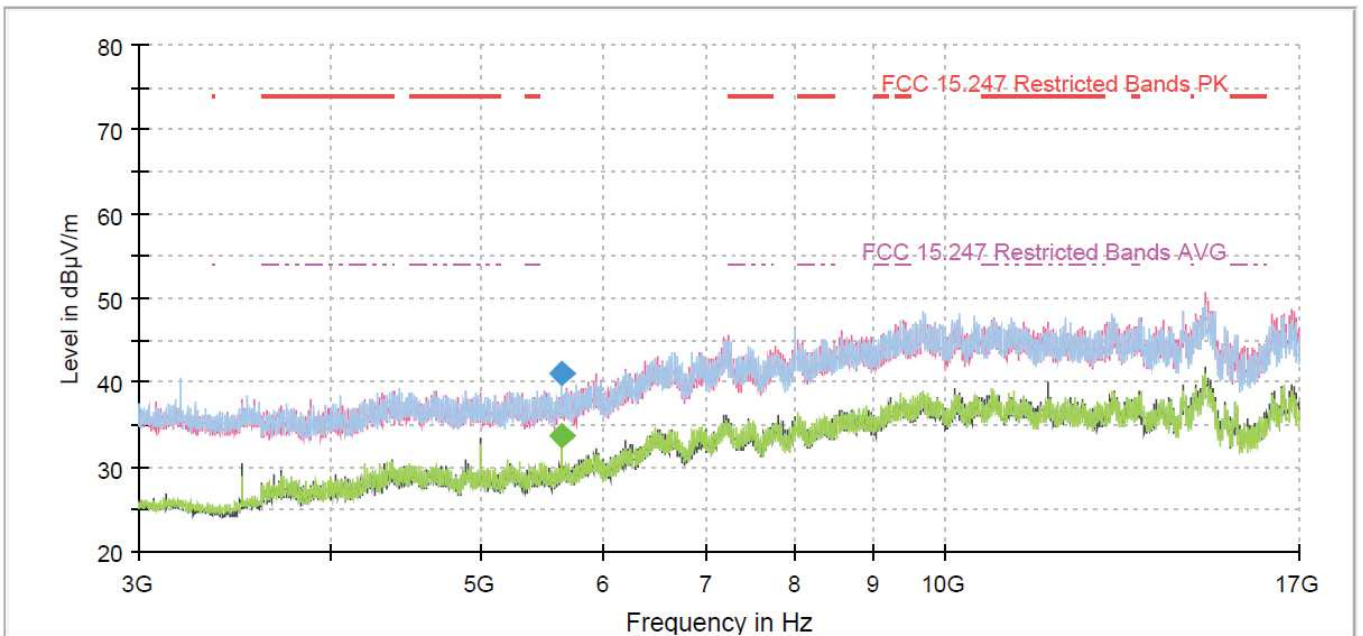


- High Channel:



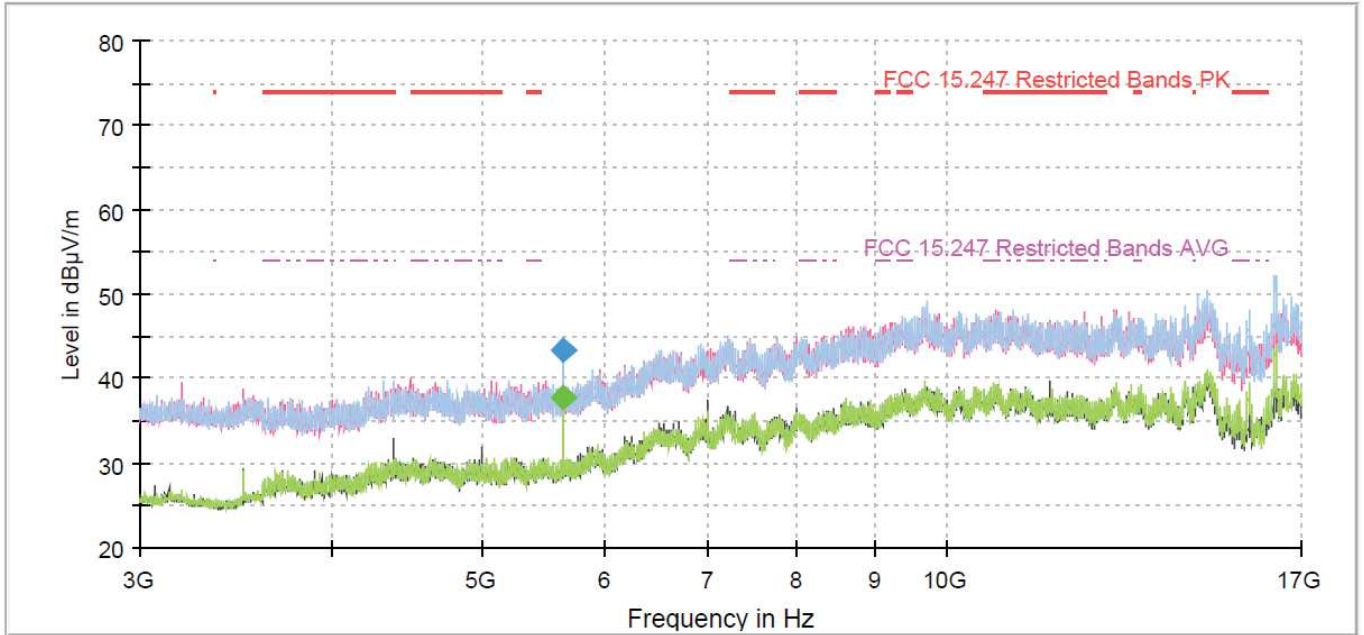
- Pi/4-DQPSK modulation (2DH5)

- Low Channel:

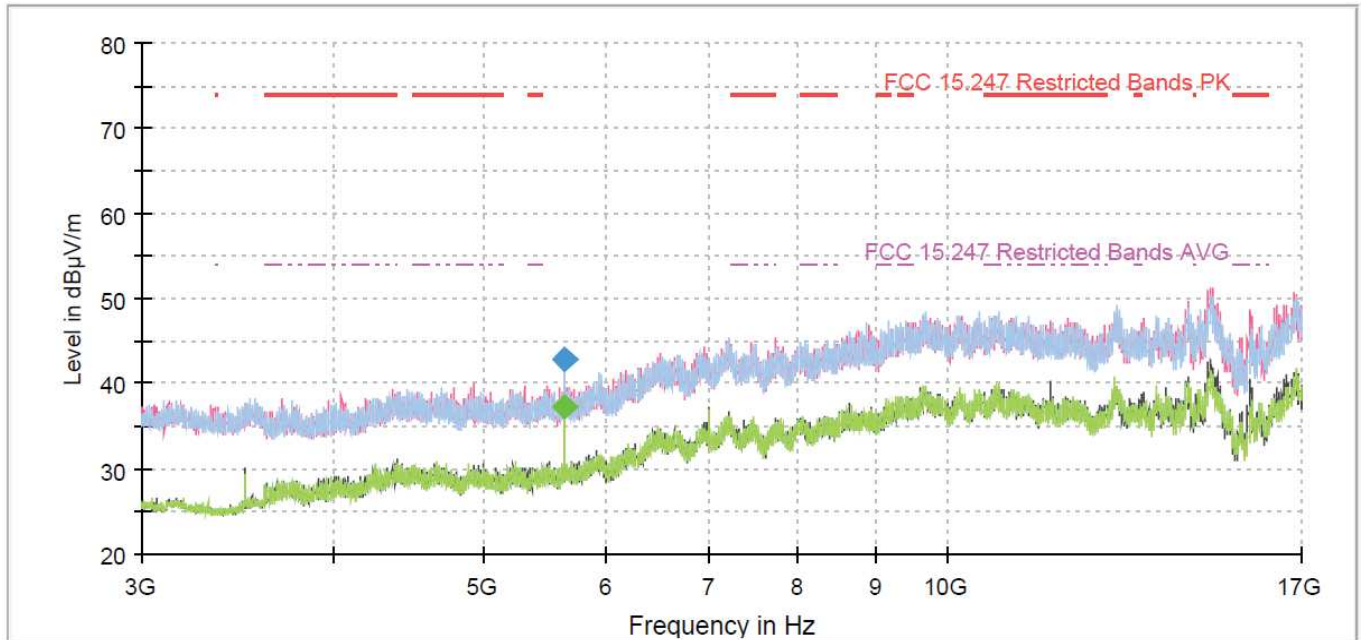




- Middle Channel:

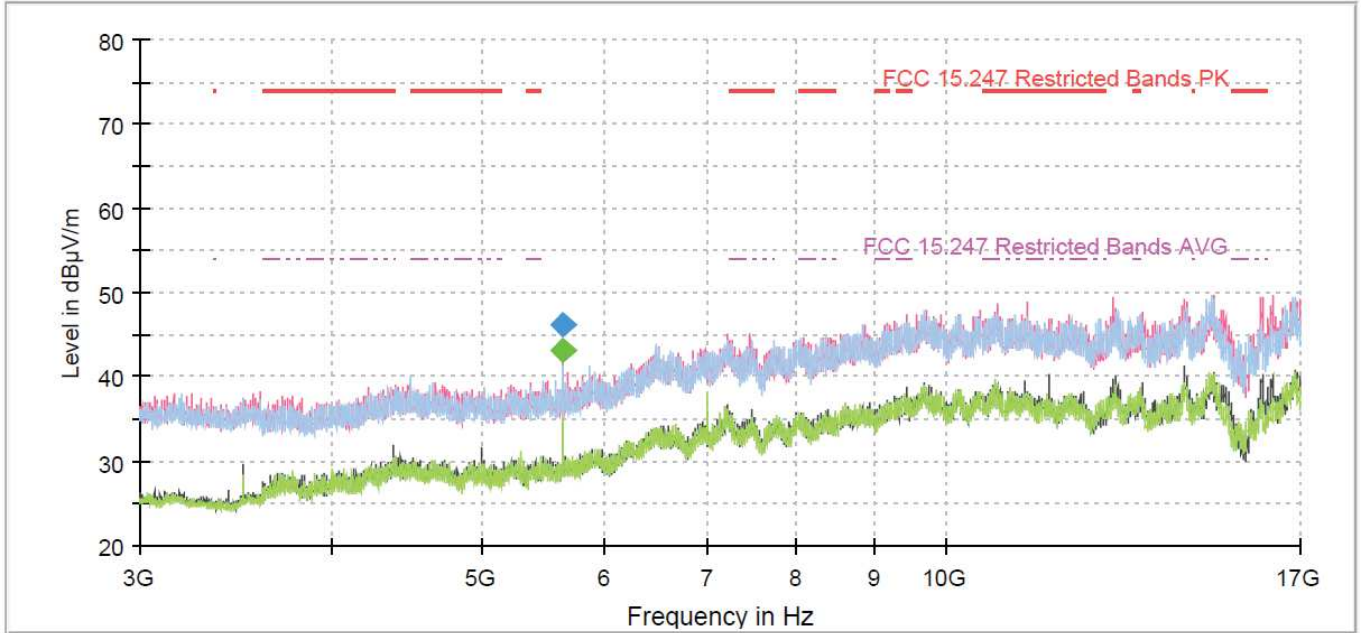


- High Channel:

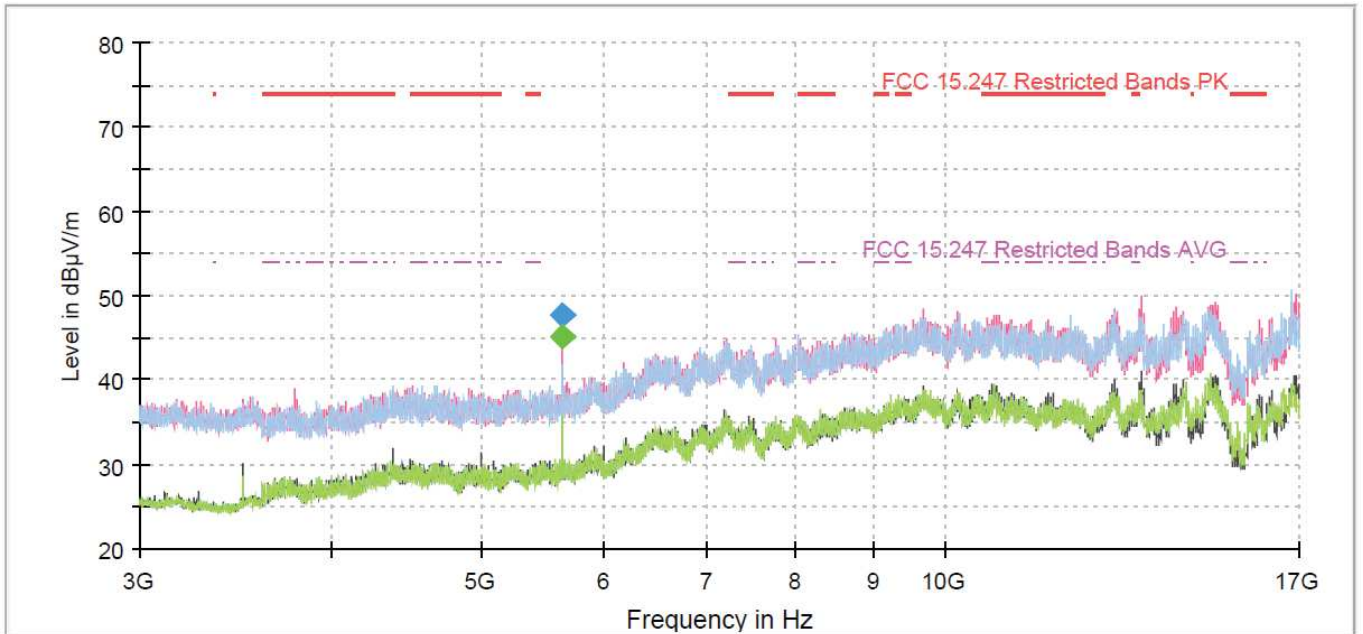


- 8-DPSK modulation (3DH5)

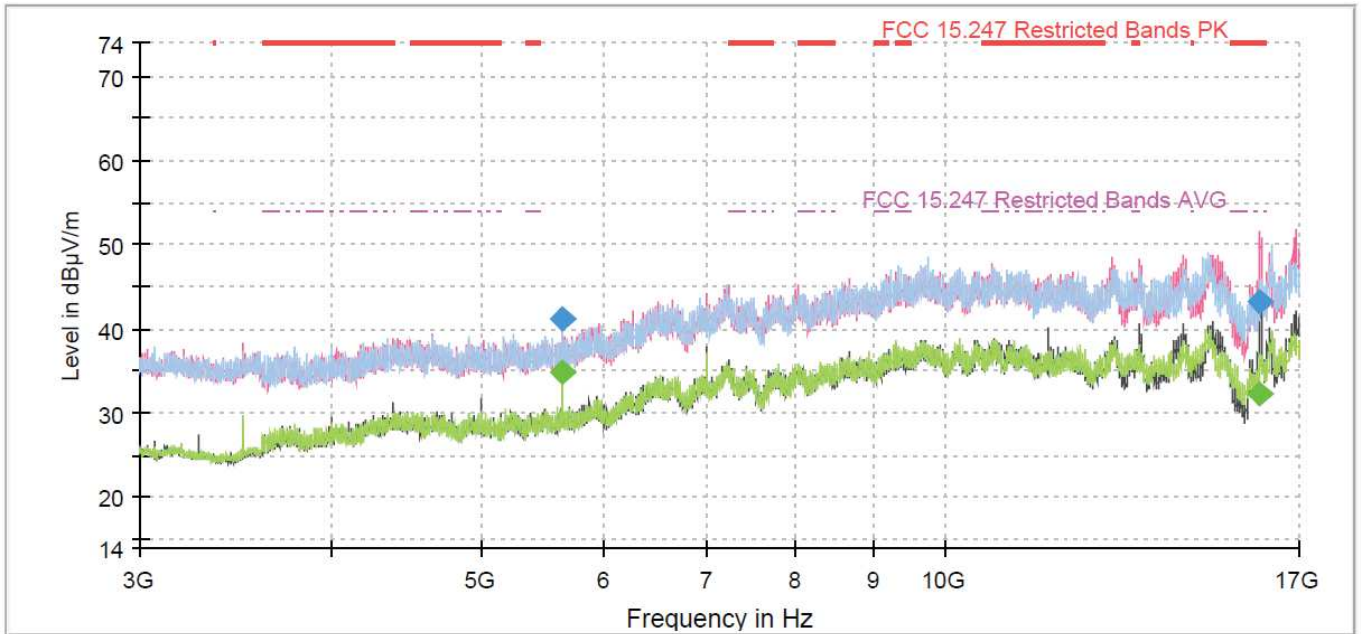
- Low Channel:



- Middle Channel:

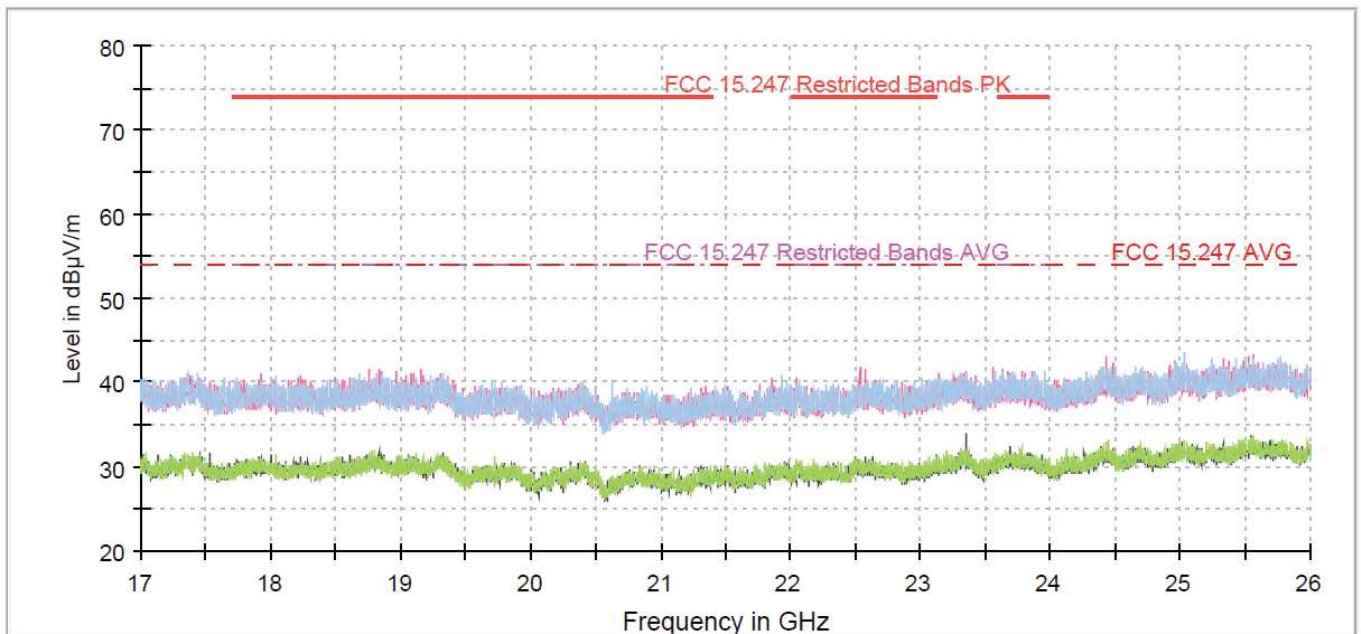


- High Channel:



**FREQUENCY RANGE 17 - 26 GHz:**

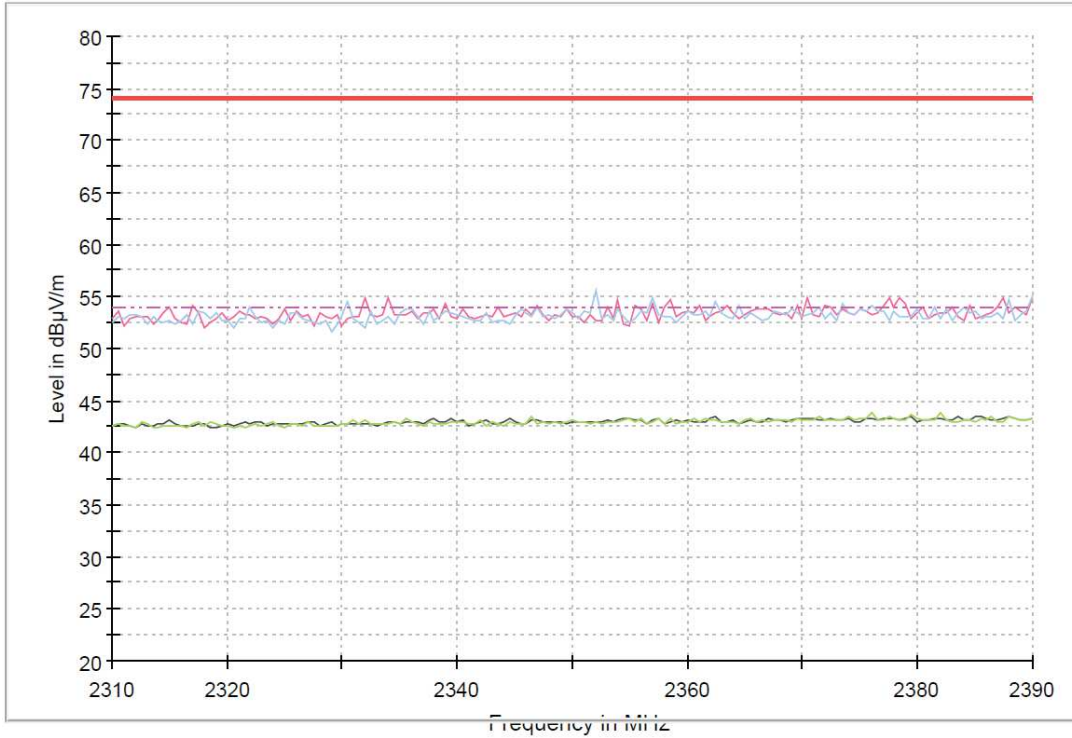
This plot is valid for the Low, Middle and High Channels and all the modulation modes.



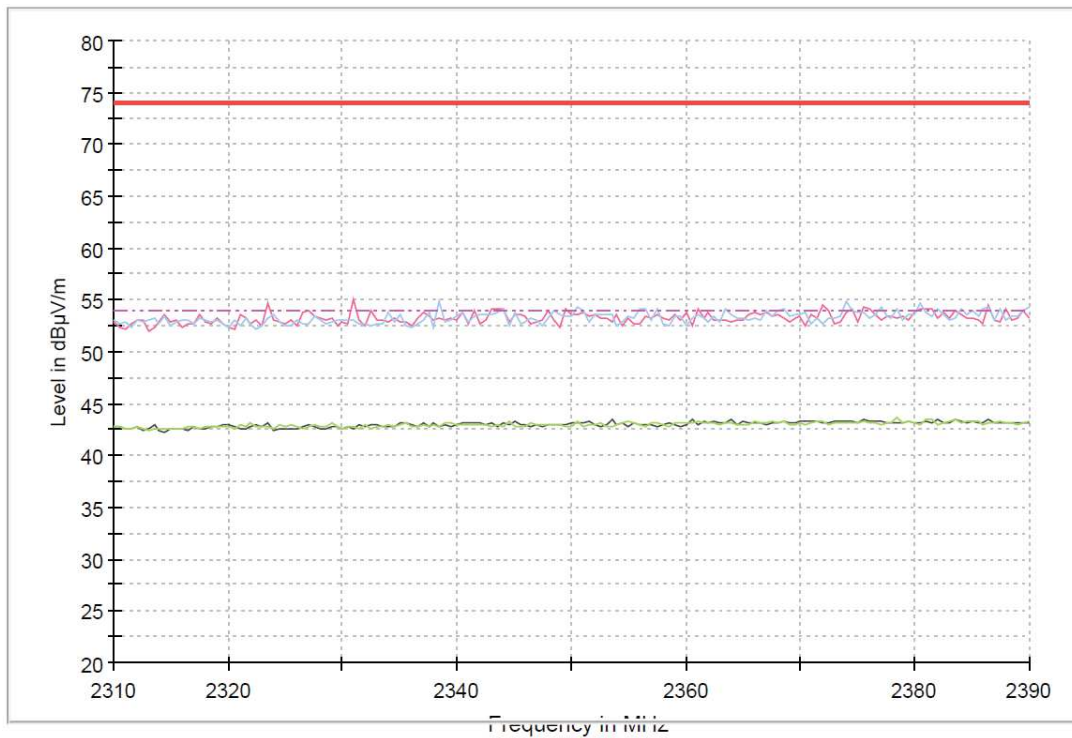
**FREQUENCY RANGE 2.31-2.39 GHz:**

- **GFSK modulation (DH5)**

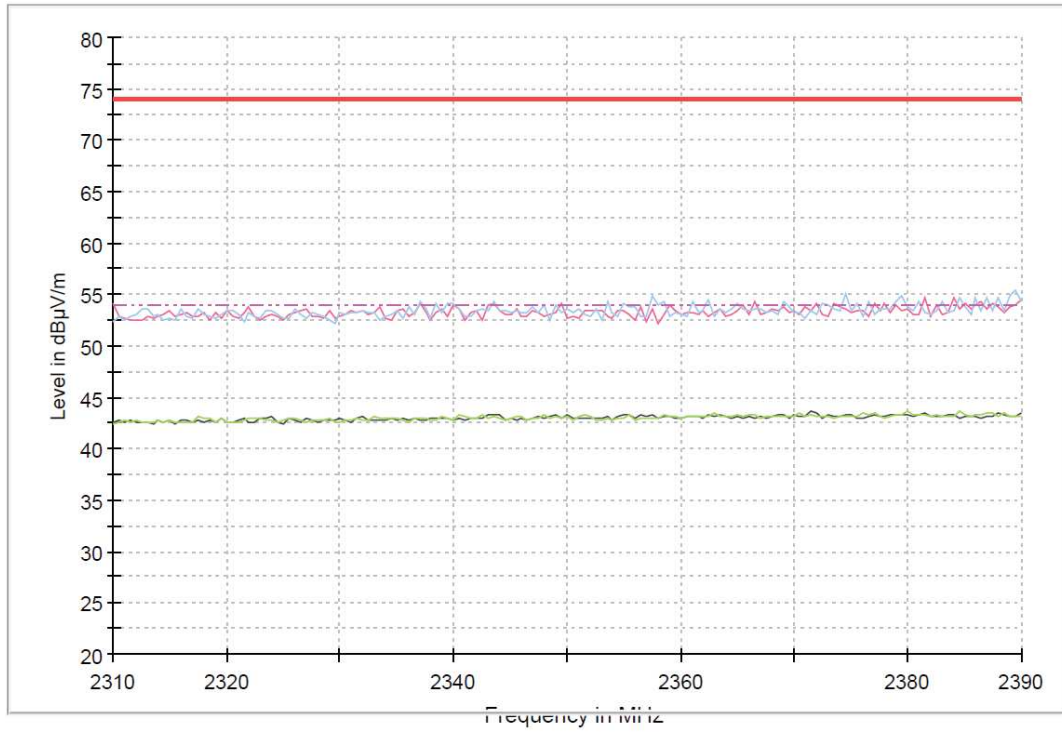
- Low Channel:



- Middle Channel:

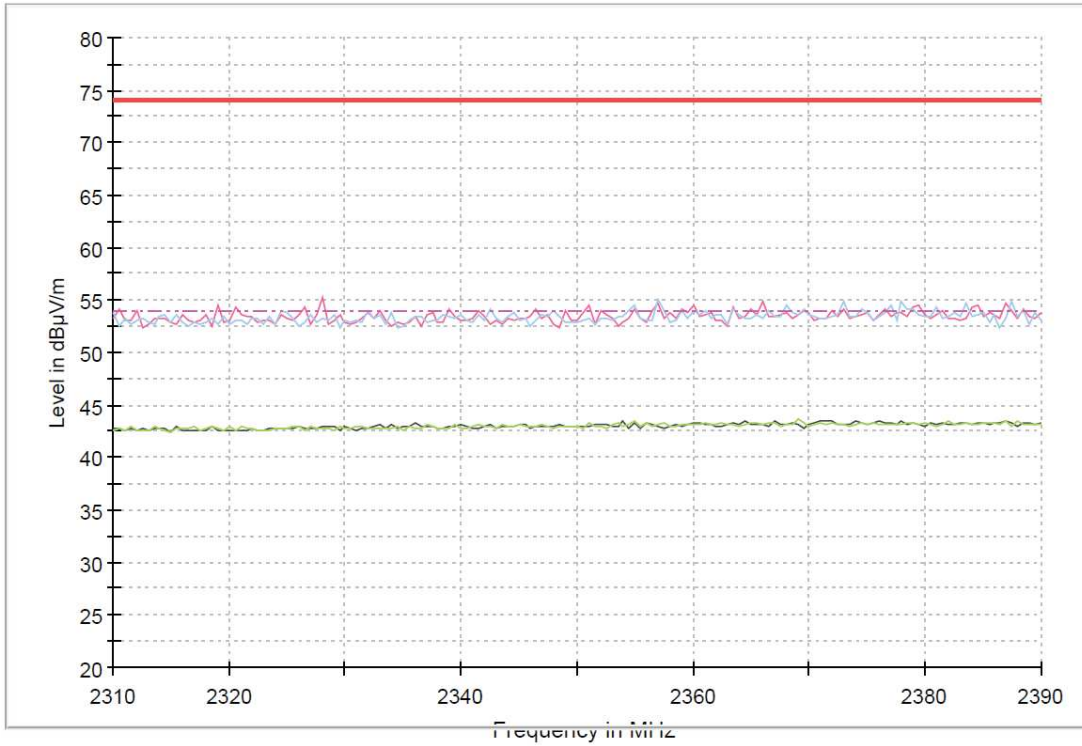


- High Channel:

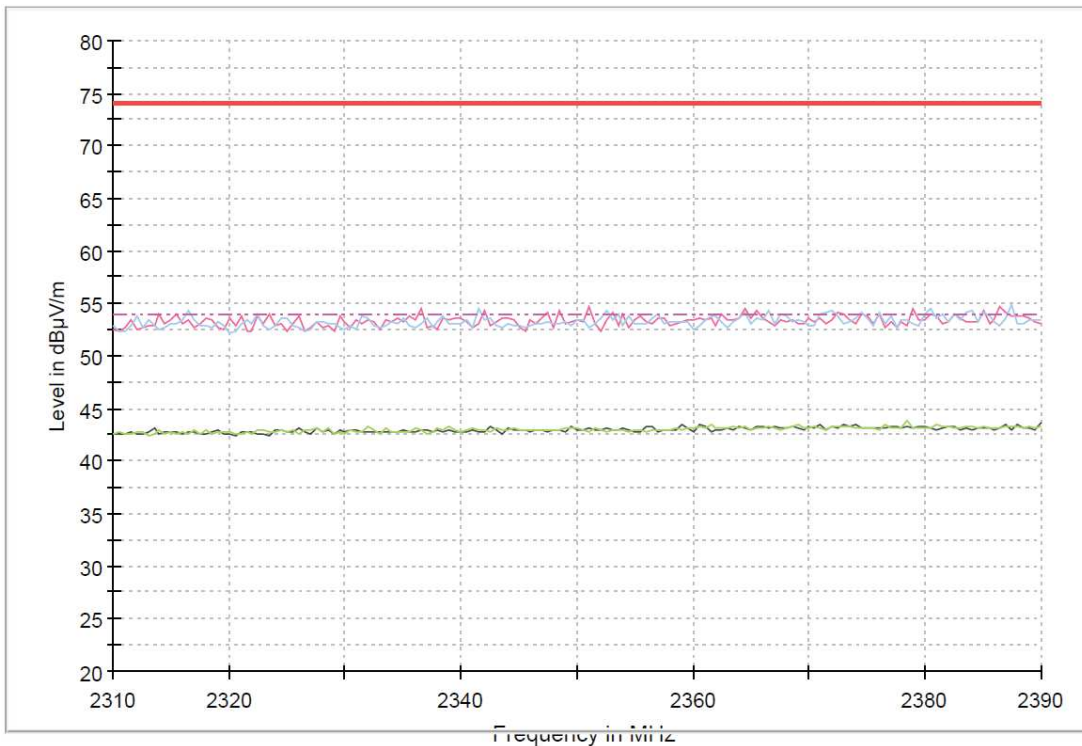


- **PI/4-DQPSK modulation (2DH5)**

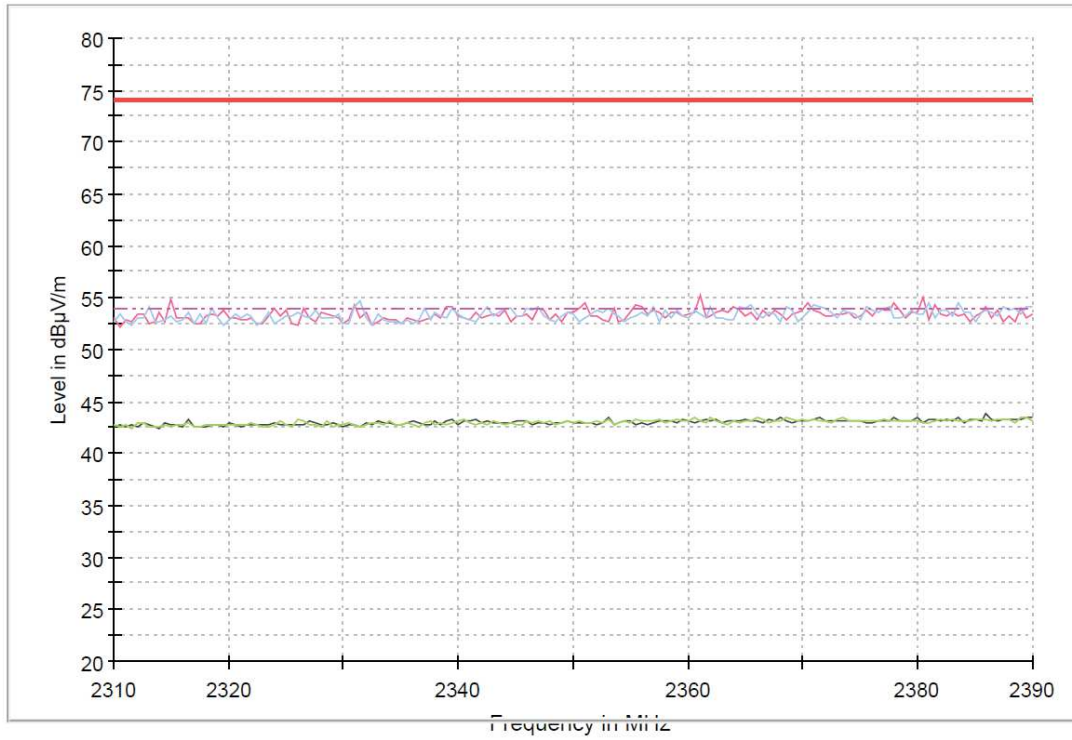
- Low Channel:



- Middle Channel:

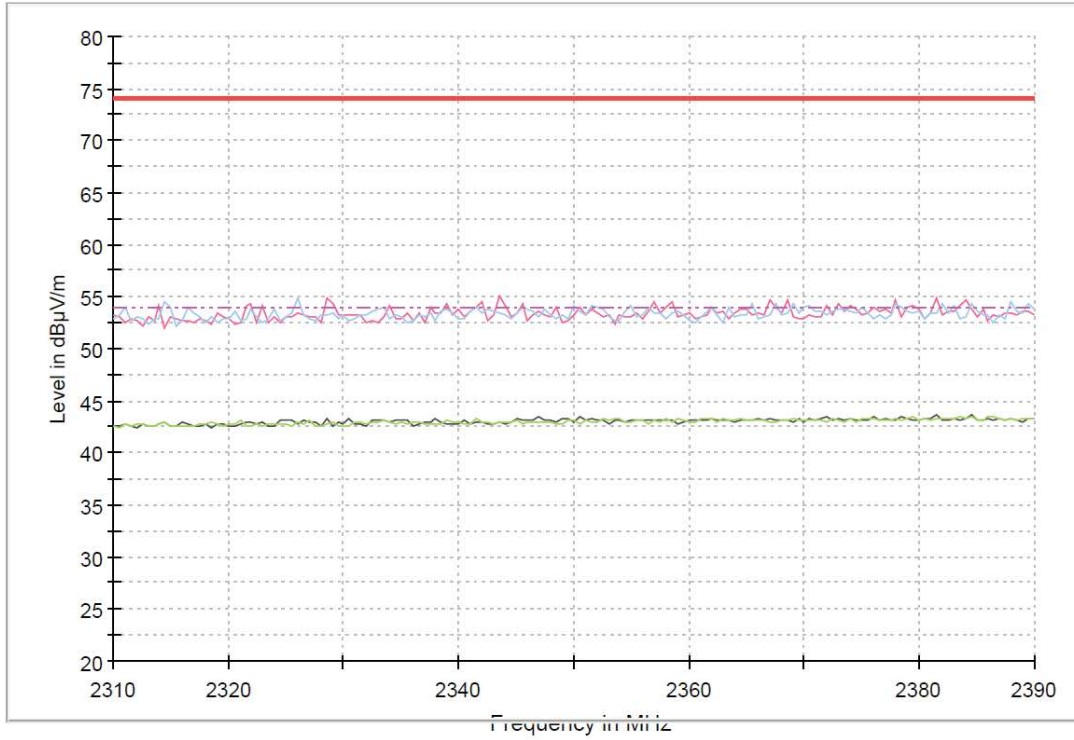


- High Channel:

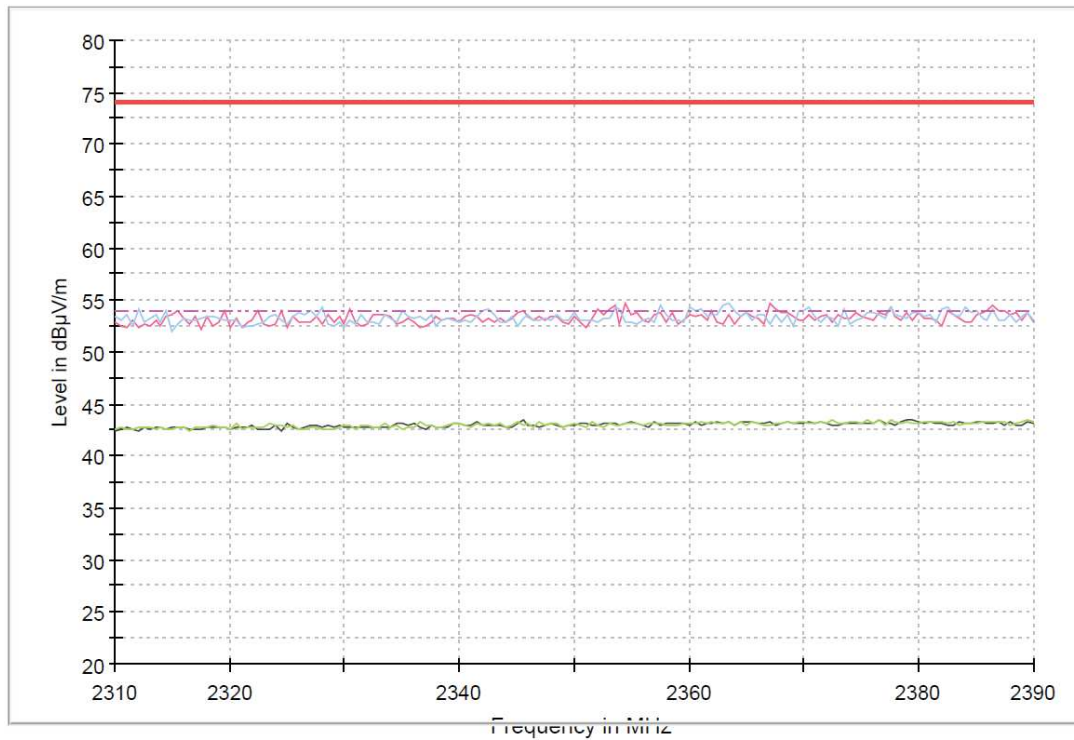


- 8-DPSK modulation (3DH5)

- Low Channel:

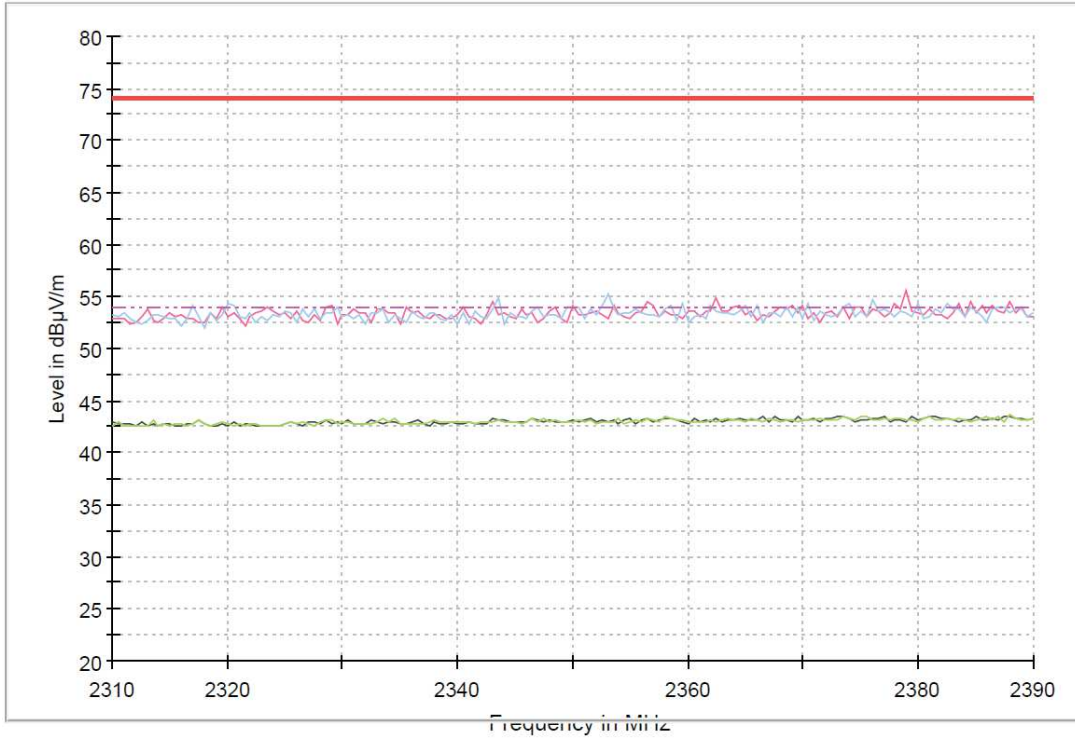


- Middle Channel:





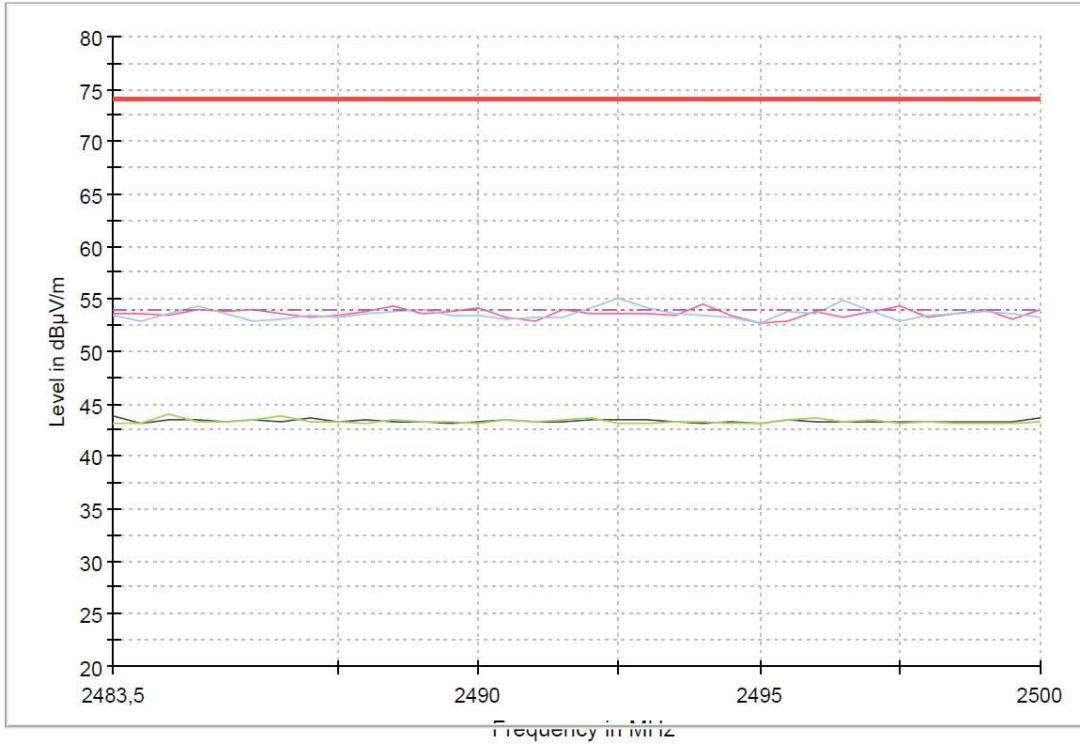
- High Channel:



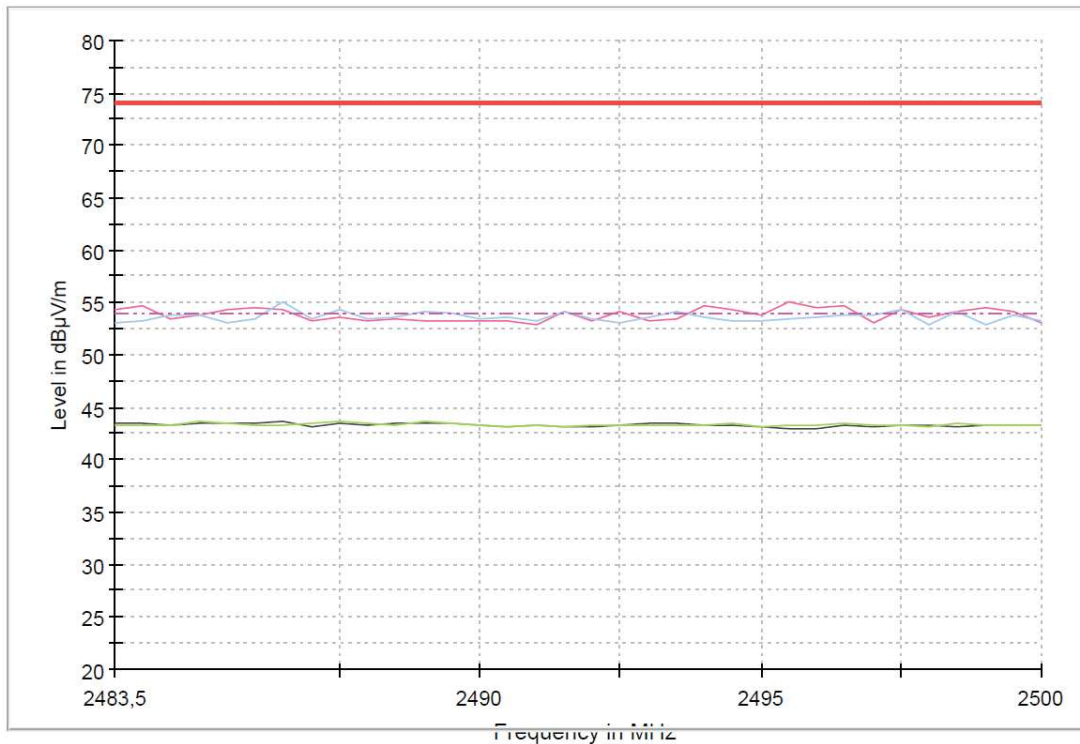
**FREQUENCY RANGE 2.4835-2.5 GHz:**

- **GFSK modulation (DH5)**

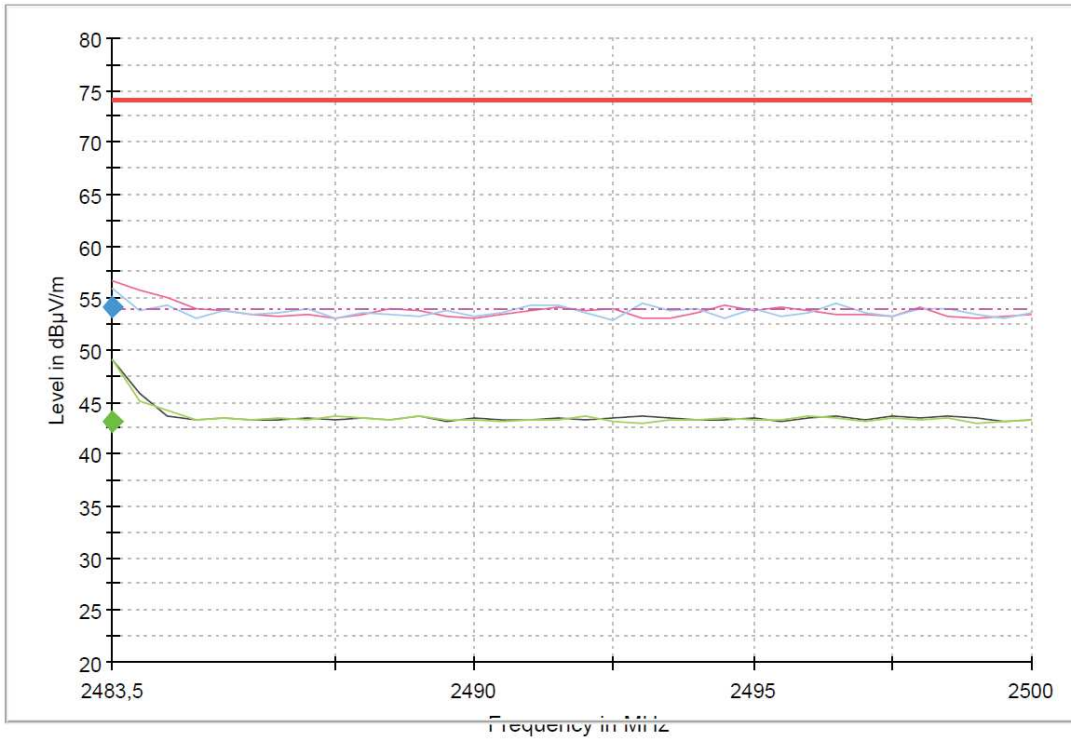
- Low Channel:



- Middle Channel:

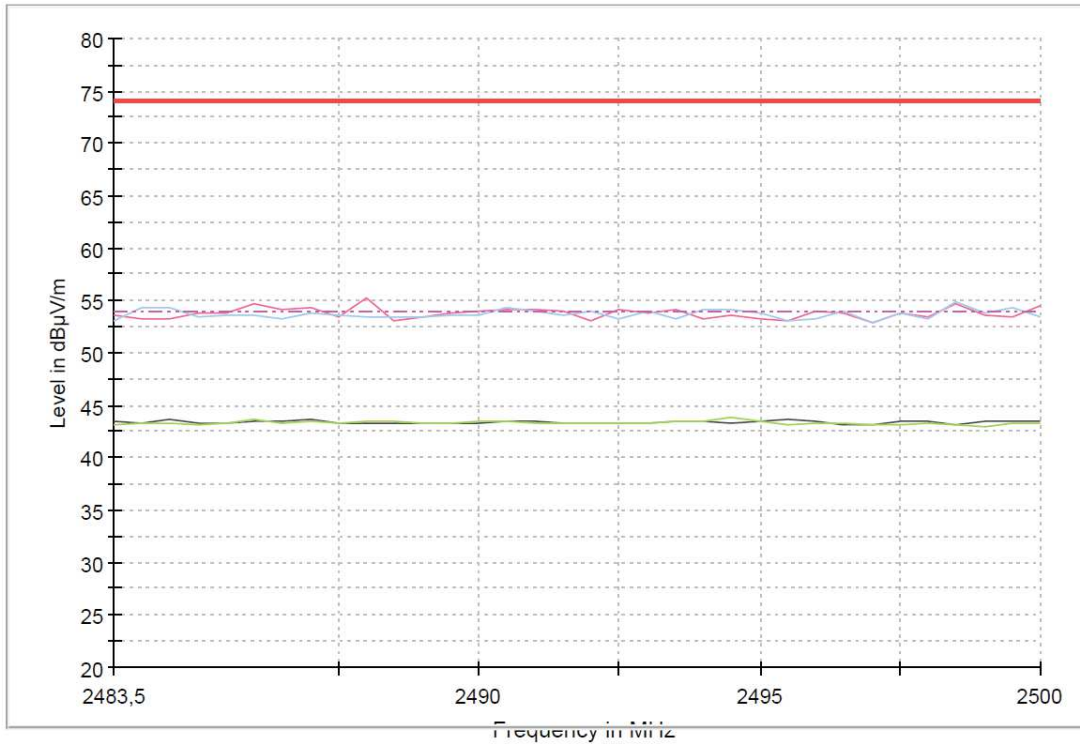


- High Channel:

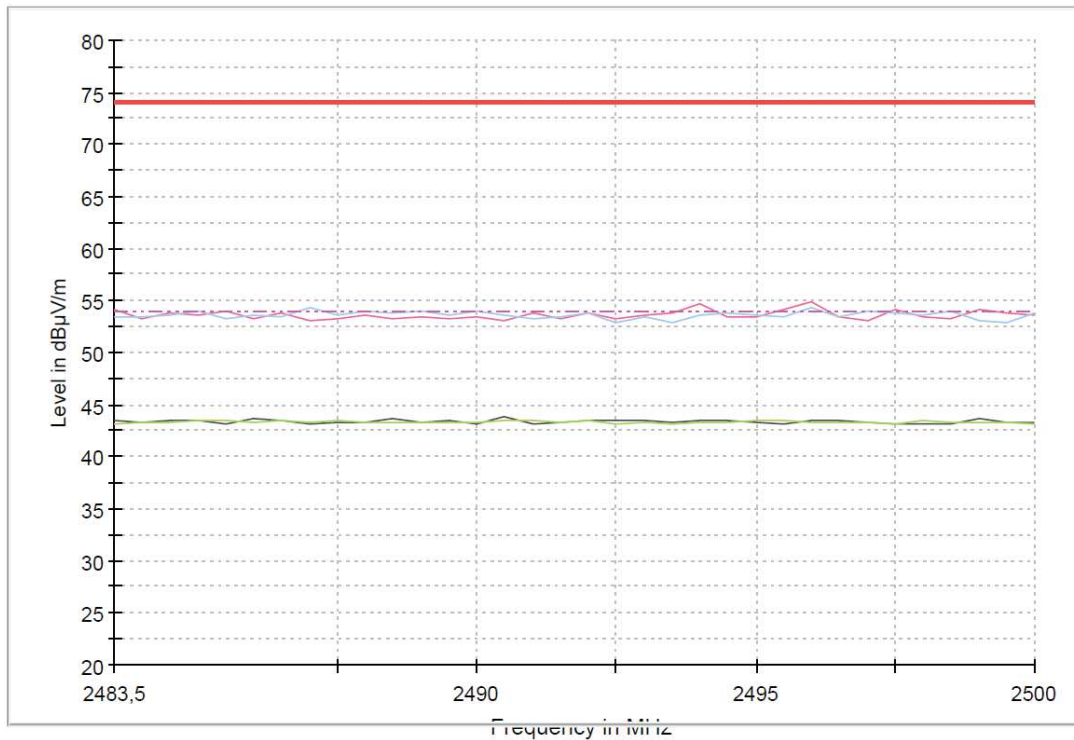


- **Pi/4-DQPSK modulation (2DH5)**

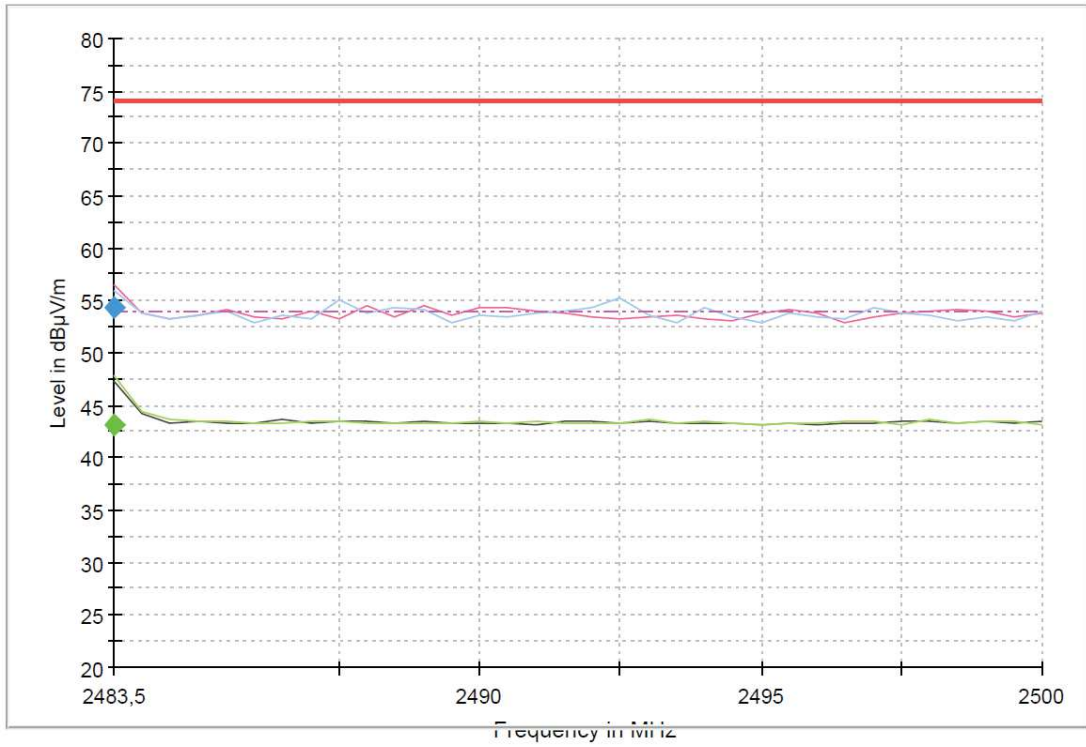
- Low Channel:



- Middle Channel:

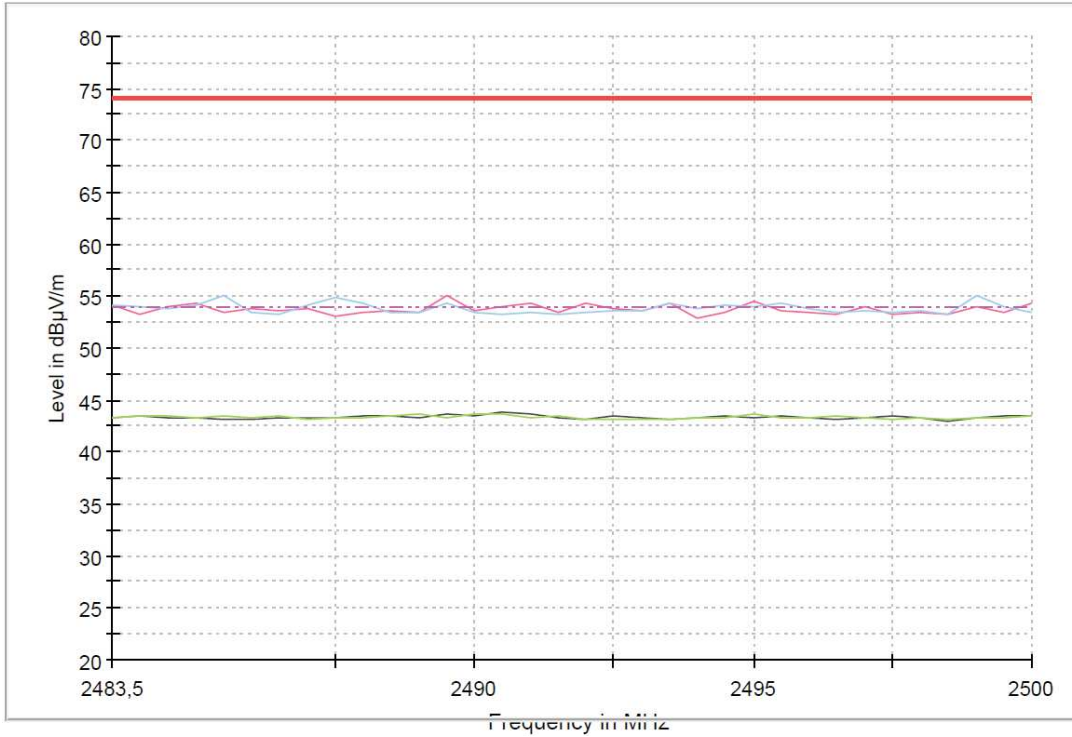


- High Channel:

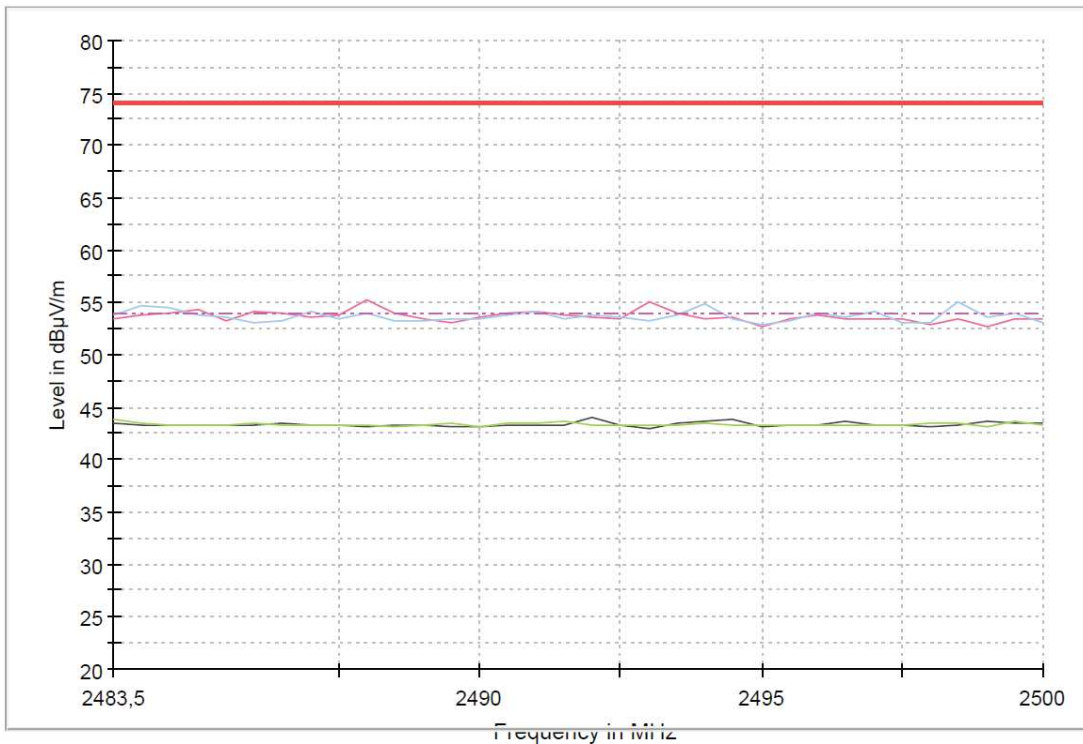


- 8-DPSK modulation (3DH5)

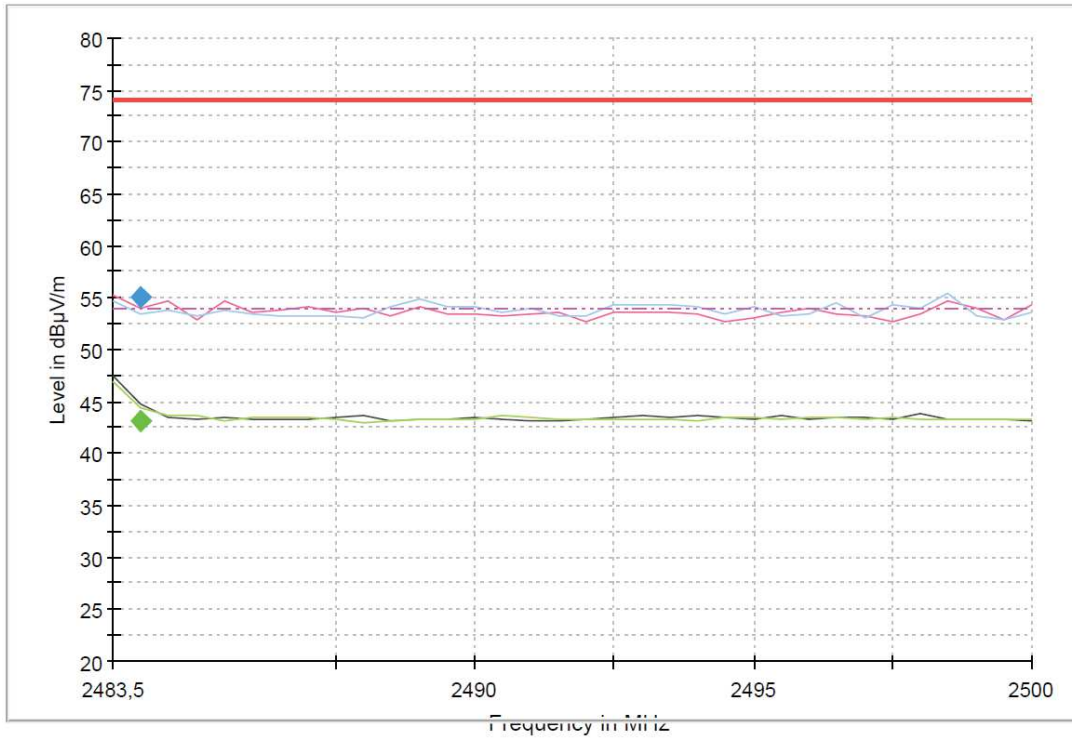
- Low Channel:



- Middle Channel:



- High Channel:



## Appendix B: Test results. 802.11 bgn20 2x2



## INDEX

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## 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 Antenna Gain: |           |
| CORE1_Port4:                   | +2.4 dBi  |
| CORE0_Port2:                   | -0.3 dBi  |

### Directional Antenna Gain Calculations for CDD MIMO:

For 2Tx CDD MIMO modes, in accordance with KDB 662911 D01 v02r01 Section F)2)f)(ii), directional gain was calculated as (worst case):

$N_{ss} = 1$ ,  $N_{ANT} = 2$ ,  $G_{CORE1} = 2.4$  dBi,  $G_{CORE0} = -0.3$  dBi

$$\begin{aligned} \text{Directional Gain} &= 10 \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left( \sum_{k=1}^{N_{ANT}} g_{j,k} \right)^2}{N_{ANT}} \right] = 10 \log \left[ \frac{\sum_{j=1}^1 \left( \sum_{k=1}^2 g_{j,k} \right)^2}{2} \right] \\ &= 10 \log \left[ \frac{(g_{1,1} + g_{1,2})^2}{2} \right] = 10 \log \left[ \frac{\left( 10^{\frac{2.4}{20}} + 10^{\frac{-0.3}{20}} \right)^2}{2} \right] = 10 \log \left[ \frac{\left( 10^{\frac{-0.3}{20}} + 10^{\frac{2.4}{20}} \right)^2}{2} \right] = +4.16 \text{ dBi} \end{aligned}$$

### TEST FREQUENCIES:

For 802.11b/g/n20:

|                     |          |
|---------------------|----------|
| 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.

For the Transmitter Minimum 6 dB Bandwidth test, only SISO modes were tested since the bandwidth does not change depending on chains used.

The data rates of 1Mb/s for 802.11b, 6.5Mb/s for 802.11g, MCS0 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.

## 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.



## RADIATED MEASUREMENTS

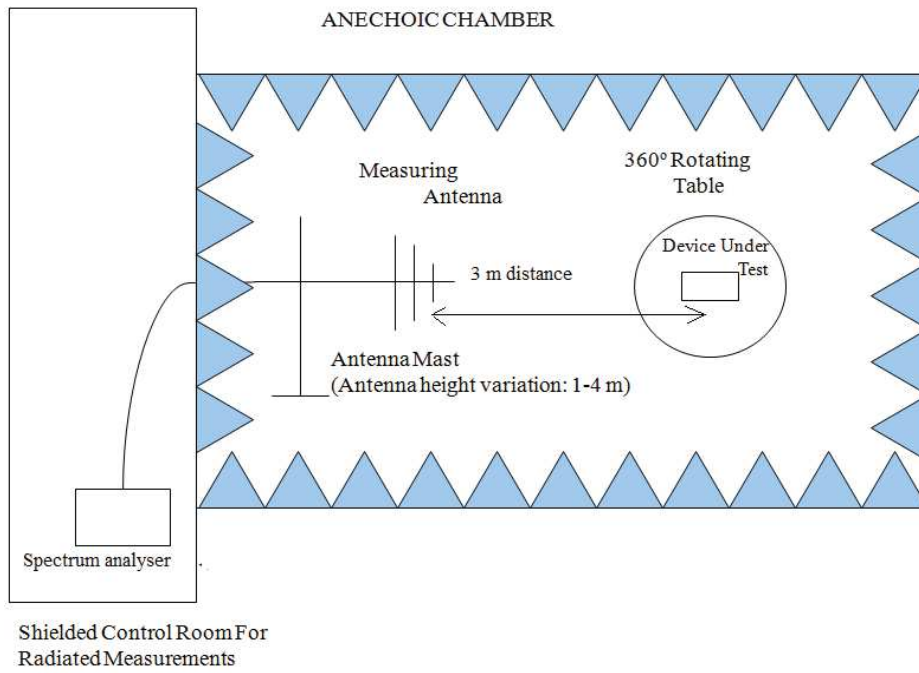
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) and 1 GHz-18 GHz Double ridge horn antenna is situated at a distance of 3 m and a distance of 1m for the frequency range 17 GHz-26 GHz (18 GHz-40 GHz horn antenna).

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.

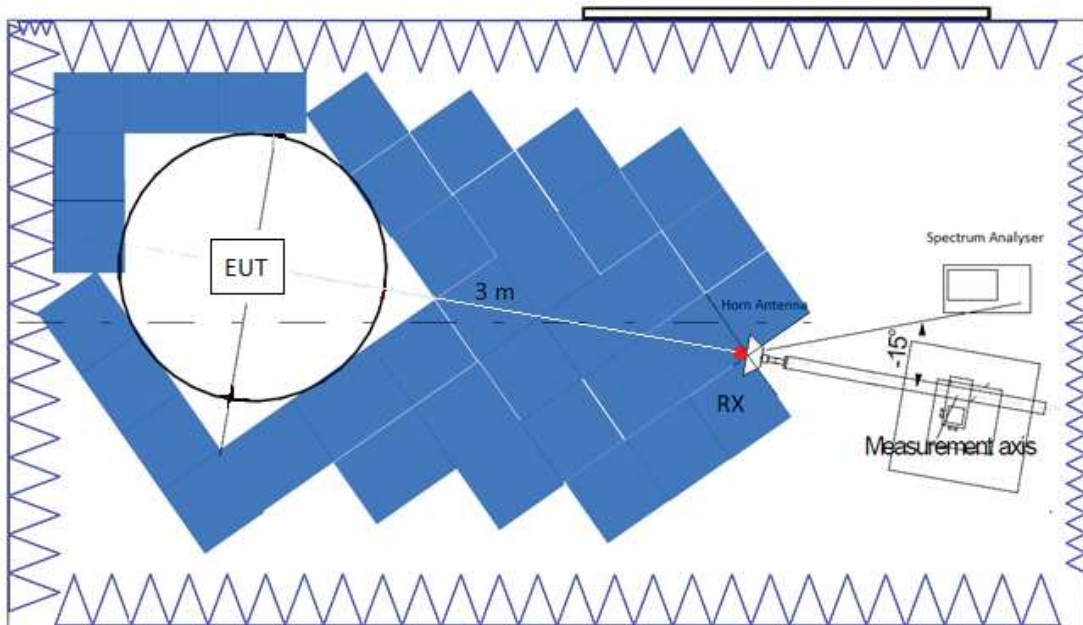
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

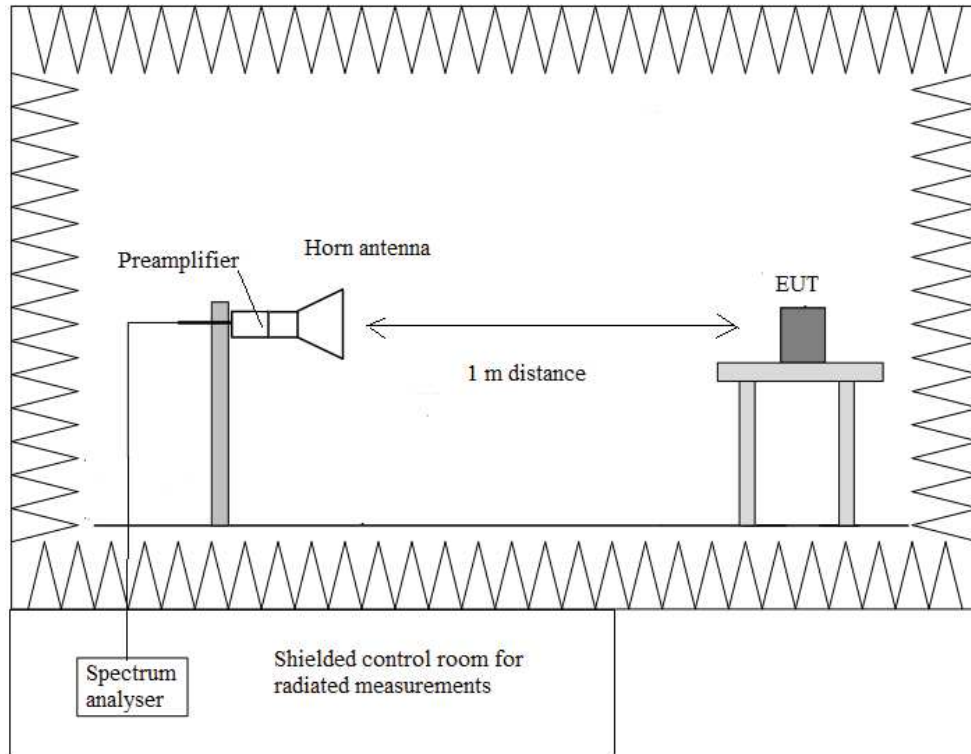
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup  $f > 17$  GHz:



## Occupied Bandwidth

### RESULTS:

SISO case CORE1\_Port4 Antenna and SISO case CORE0\_Port2 Antenna.  
 MIMO case is CORE1\_Port4 Antenna & CORE0\_Port2 Antenna.

#### SISO CORE1\_Port4 Antenna:

- **Mode 802.11 b:**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 10.1437                 | 10.2546                    | 10.2213                  |
| -26 dBc bandwidth (MHz)       | 13.345                  | 13.779                     | 13.46                    |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

- **Mode 802.11 g:**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 16.8098                 | 16.9257                    | 16.9055                  |
| -26 dBc bandwidth (MHz)       | 21.262                  | 21.445                     | 21.316                   |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

- **Mode 802.11 n20**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 18.0389                 | 17.9799                    | 18.0134                  |
| -26 dBc bandwidth (MHz)       | 21.59                   | 21.254                     | 21.528                   |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

Verdict: PASS

**SISO CORE0\_Port2 Antenna:**

- **Mode 802.11 b:**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 10.1823                 | 10.1723                    | 10.2093                  |
| -26 dBc bandwidth (MHz)       | 13.767                  | 13.759                     | 13.738                   |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

- **Mode 802.11 g:**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 16.7779                 | 16.8199                    | 16.8375                  |
| -26 dBc bandwidth (MHz)       | 21.235                  | 21.316                     | 21.374                   |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

- **Mode 802.11 n20**

|                               | Low Channel<br>2412 MHz | Middle Channel<br>2437 MHz | High Channel<br>2462 MHz |
|-------------------------------|-------------------------|----------------------------|--------------------------|
| 99% bandwidth (MHz)           | 17.9287                 | 17.9683                    | 17.9203                  |
| -26 dBc bandwidth (MHz)       | 21.532                  | 21.649                     | 21.674                   |
| Measurement uncertainty (kHz) | <± 140.5                |                            |                          |

Verdict: PASS

**MIMO – CORE1\_Port4 Antenna & CORE0\_Port2 Antenna:**

- Mode 802.11 b**

|                               | Low Channel     |                 | Middle Channel  |                 | High Channel    |                 |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 |
| 99% bandwidth (MHz)           | 10.23           | 10.21           | 10.25           | 10.24           | 10.24           | 10.21           |
| -26 dBc bandwidth (MHz)       | 13.41           | 13.4            | 14.19           | 14.23           | 14.17           | 14.16           |
| Measurement uncertainty (kHz) | <± 42.35        |                 |                 |                 |                 |                 |

- Mode 802.11 g**

|                               | Low Channel     |                 | Middle Channel  |                 | High Channel    |                 |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 |
| 99% bandwidth (MHz)           | 16.85           | 16.89           | 16.8            | 16.87           | 16.8            | 16.88           |
| -26 dBc bandwidth (MHz)       | 21.4            | 21.36           | 21.413          | 21.39           | 21.37           | 21.48           |
| Measurement uncertainty (kHz) | <± 42.35        |                 |                 |                 |                 |                 |

- Mode 802.11 n20**

|                               | Low Channel     |                 | Middle Channel  |                 | High Channel    |                 |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 | CORE1_<br>Port4 | CORE0_<br>Port2 |
| 99% bandwidth (MHz)           | 17.73           | 18.03           | 17.73           | 18.12           | 17.75           | 18.07           |
| -26 dBc bandwidth (MHz)       | 21.37           | 21.72           | 21.45           | 21.83           | 21.48           | 21.75           |
| Measurement uncertainty (kHz) | <± 42.35        |                 |                 |                 |                 |                 |

Verdict: PASS