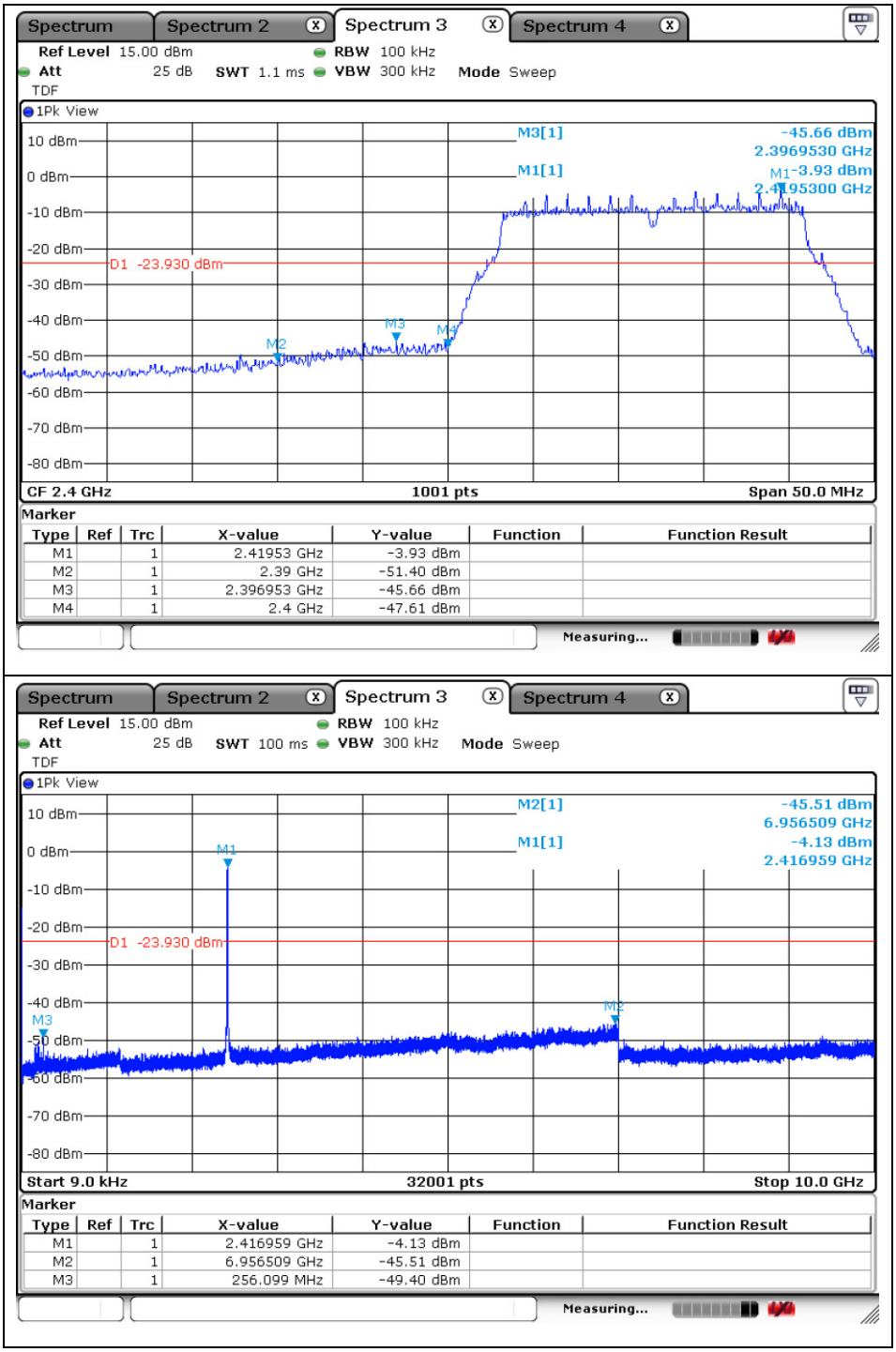
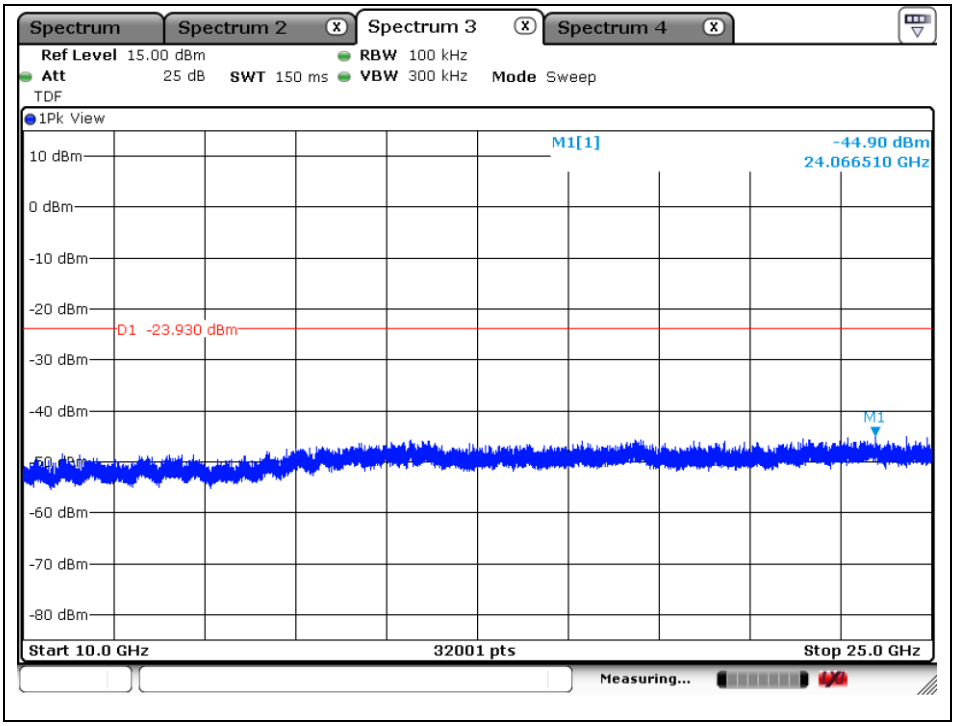
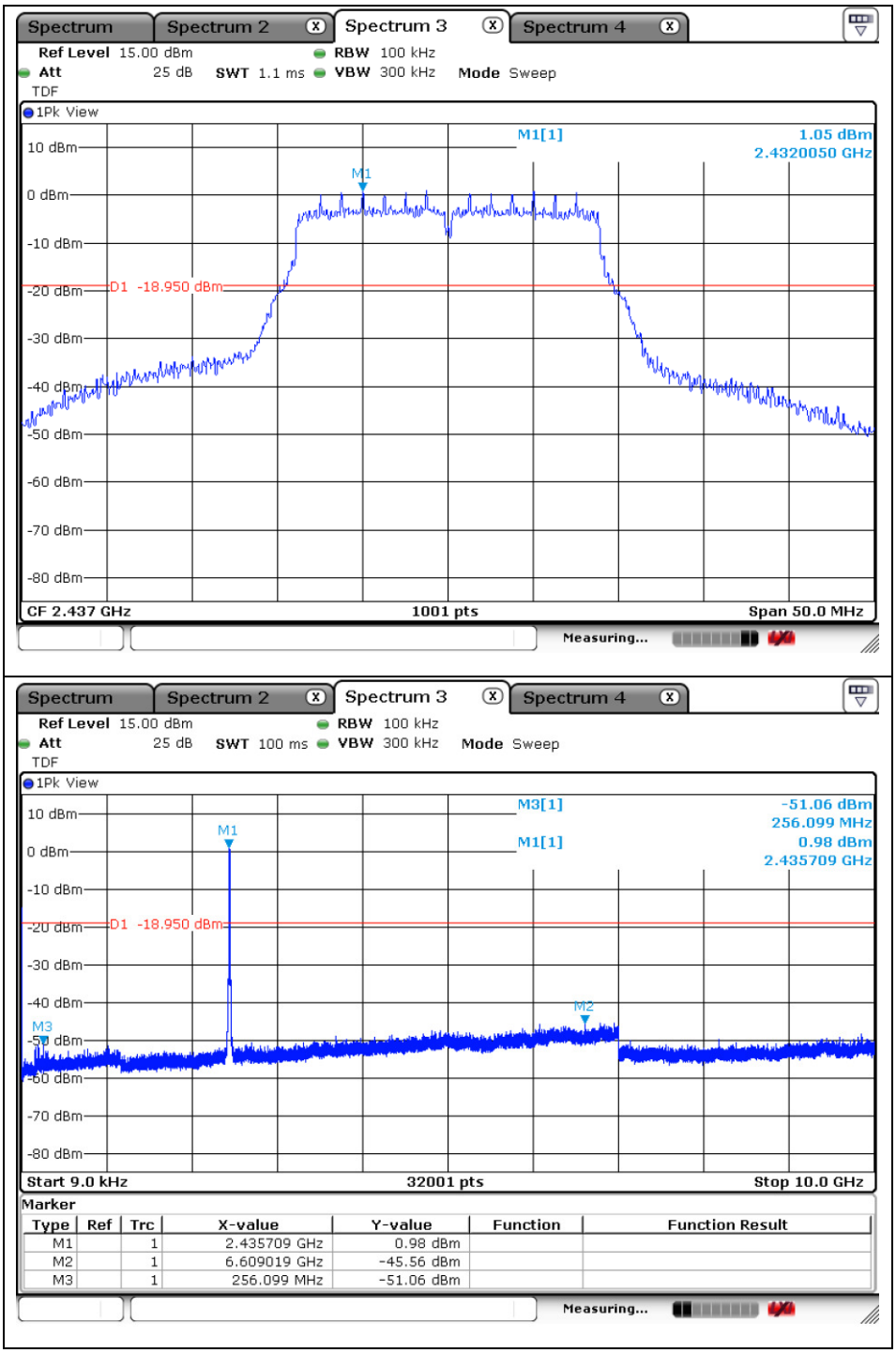
**OFDM: 802.11n_HT20(MCS8) - ANT1**

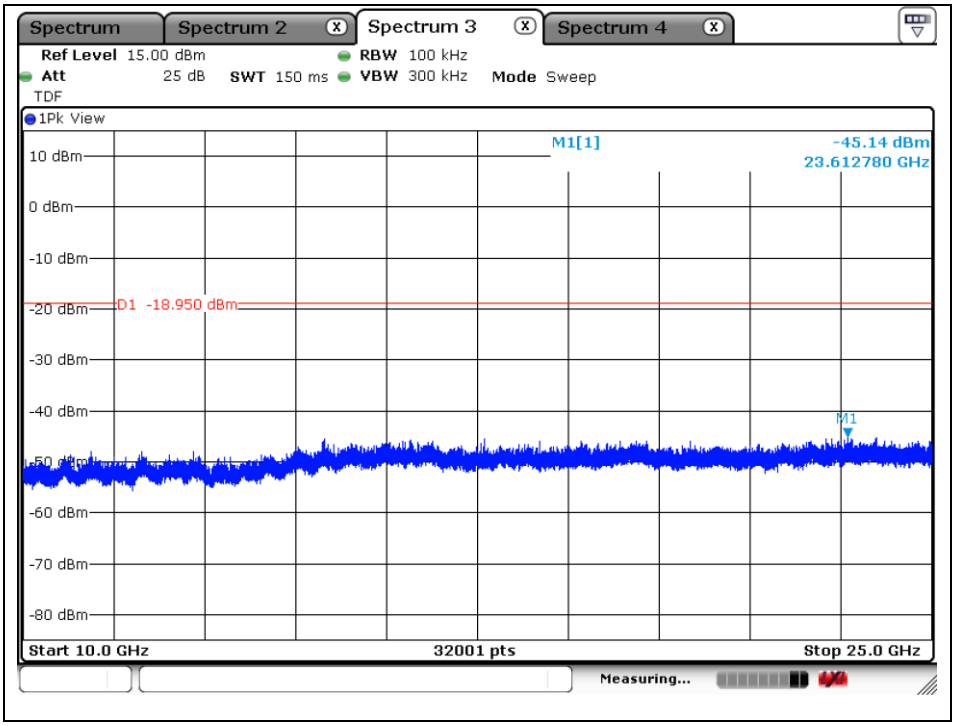
Low Channel



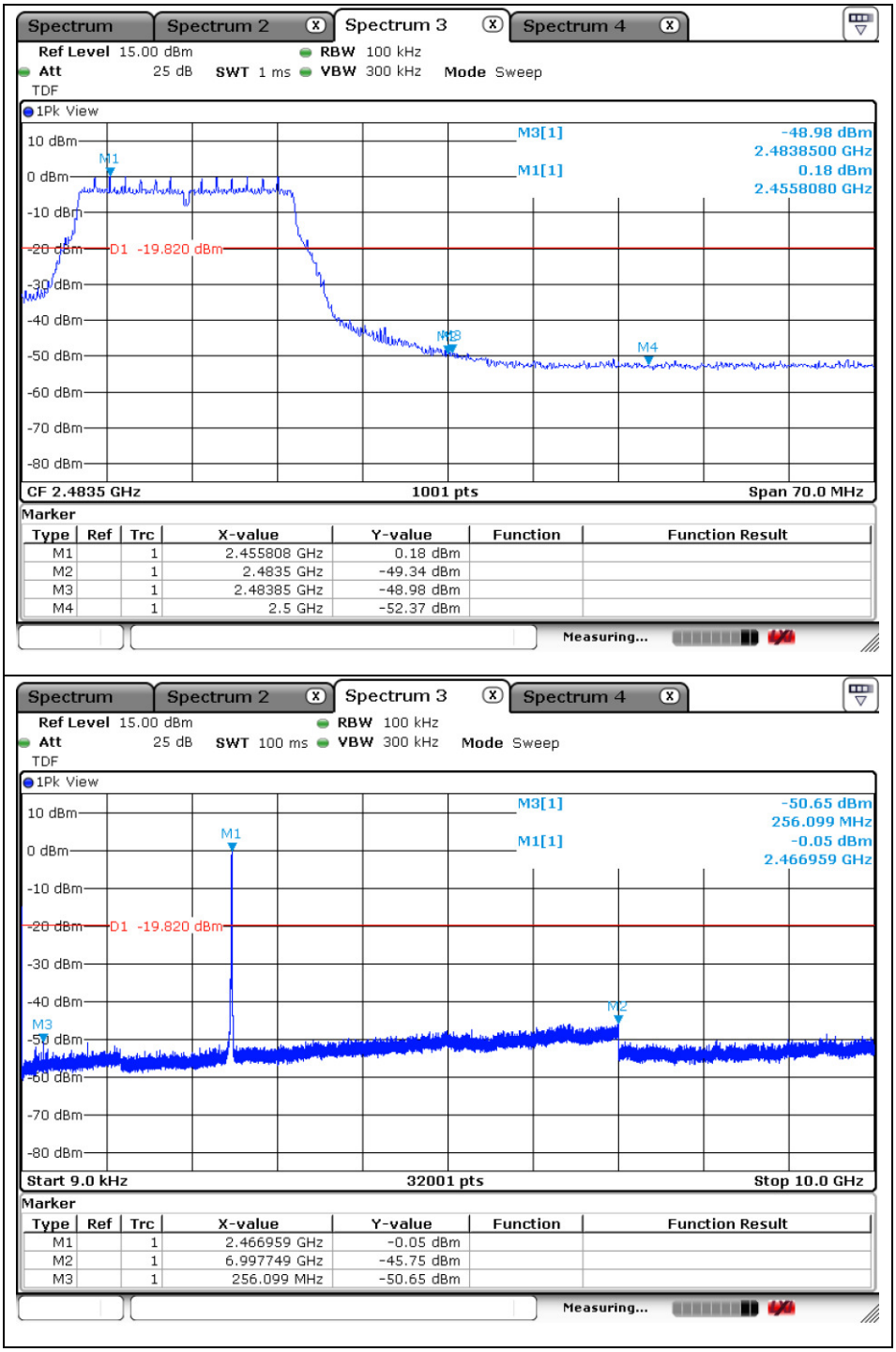


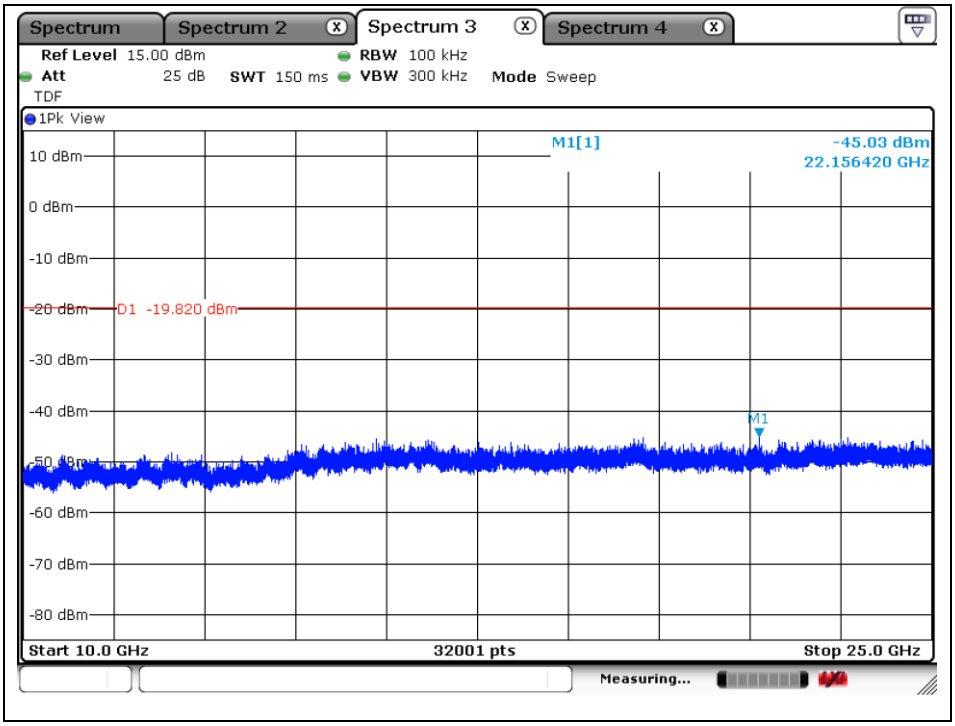
Middle Channel





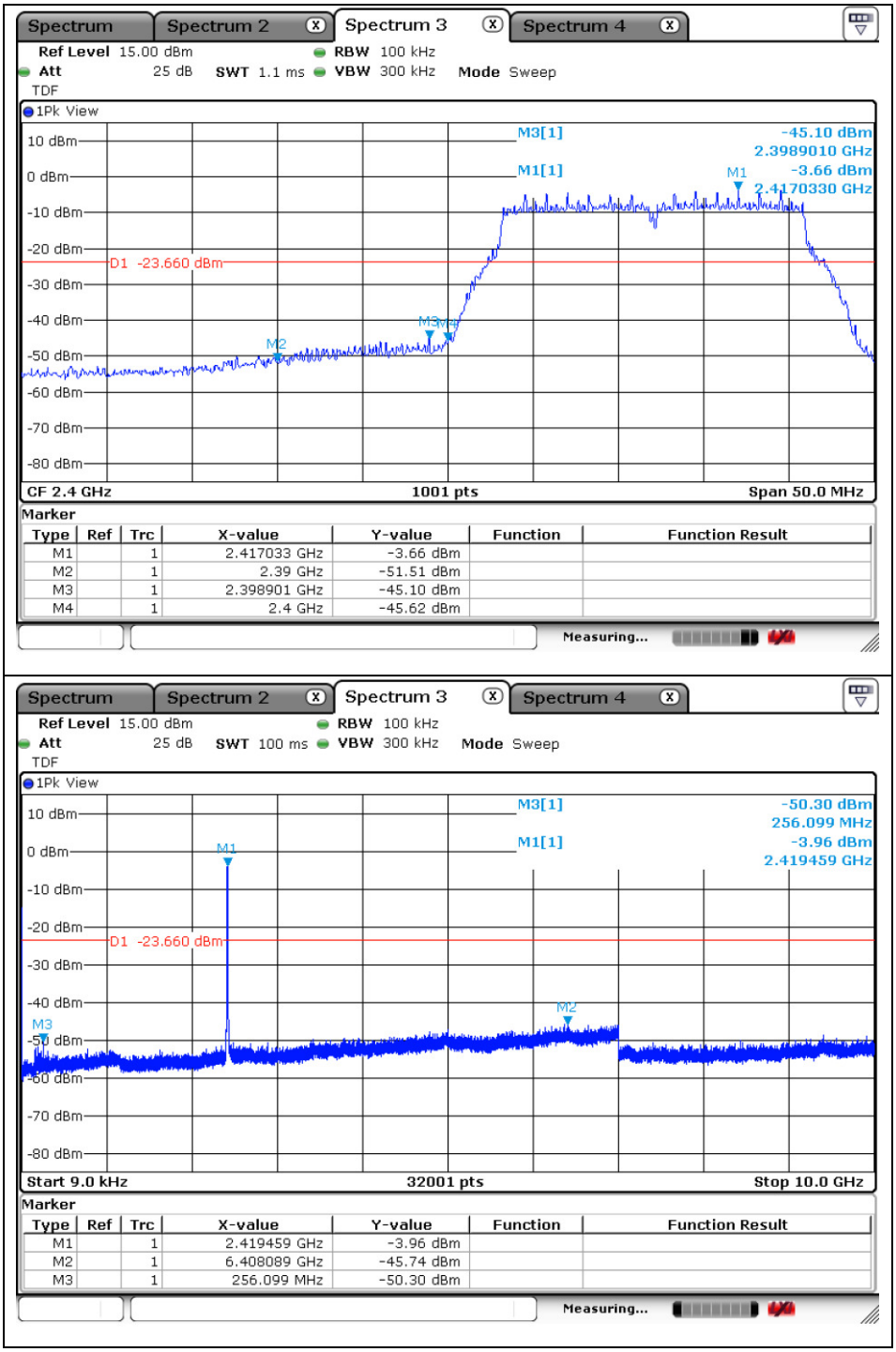
High Channel

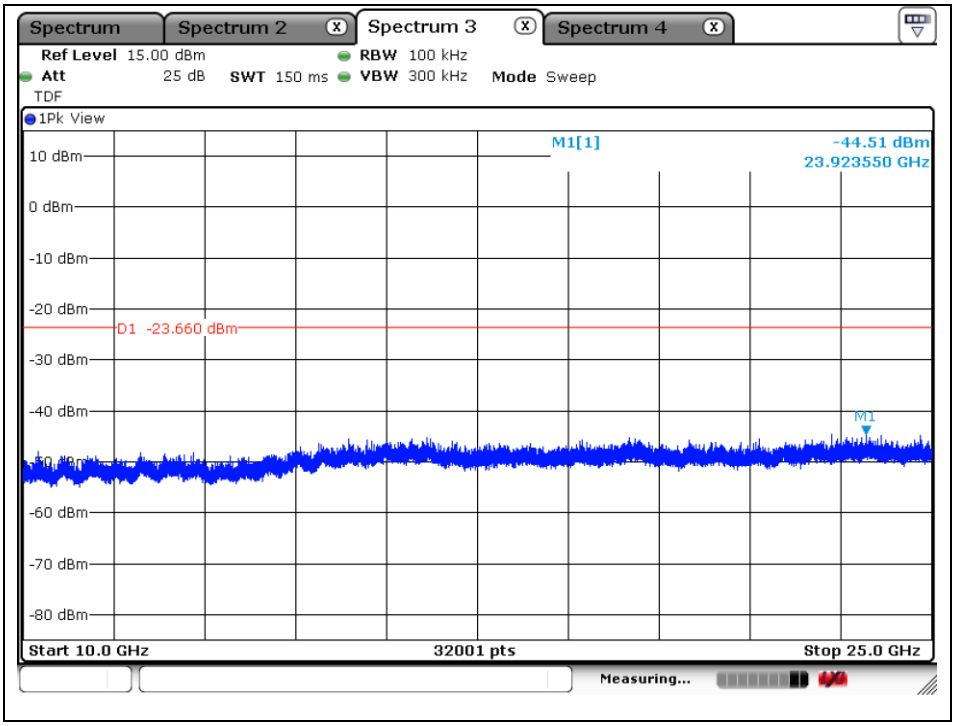




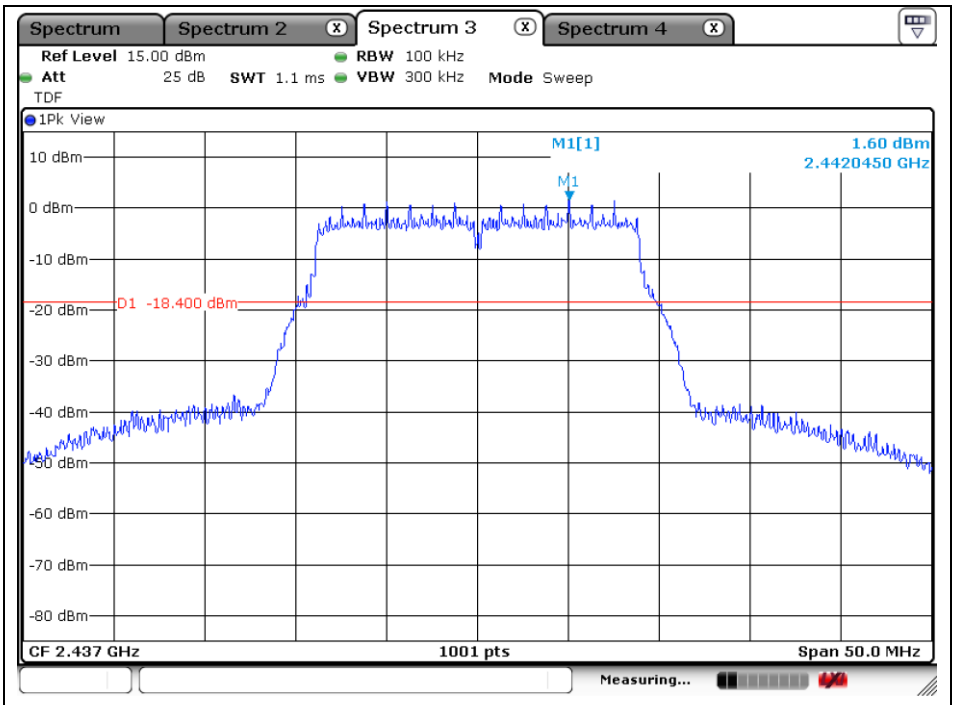
**OFDM: 802.11n_HT20(MCS8) - ANT2**

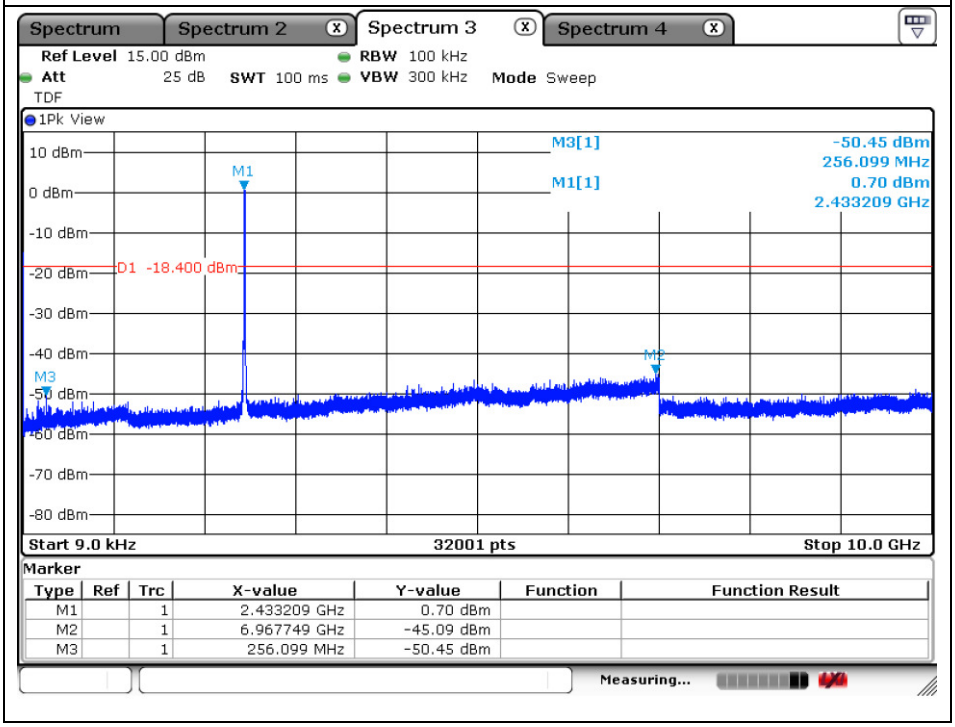
Low Channel

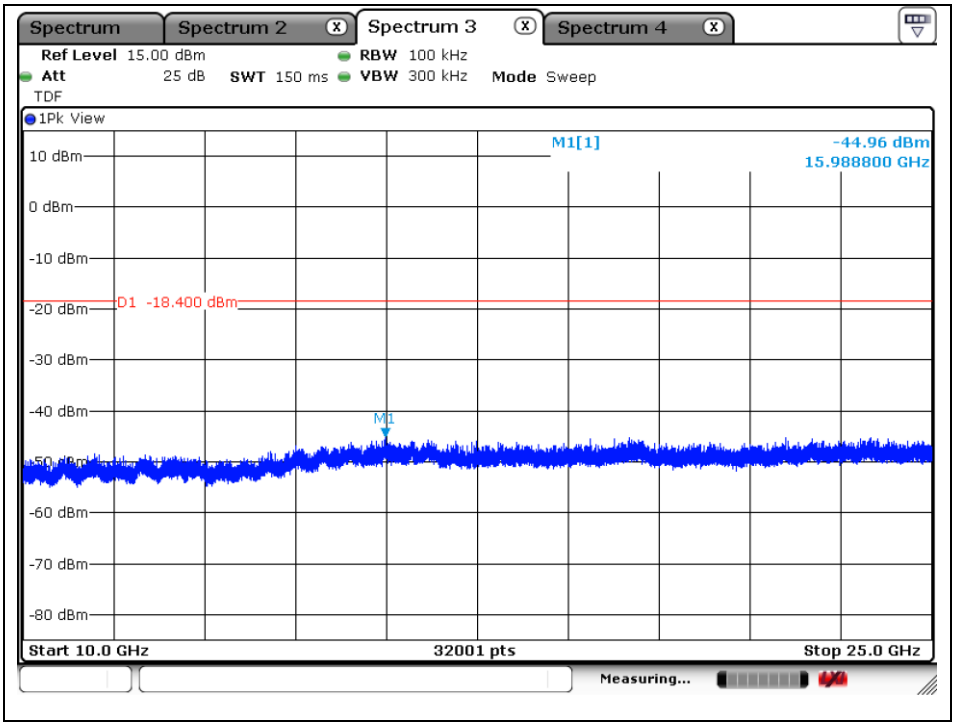




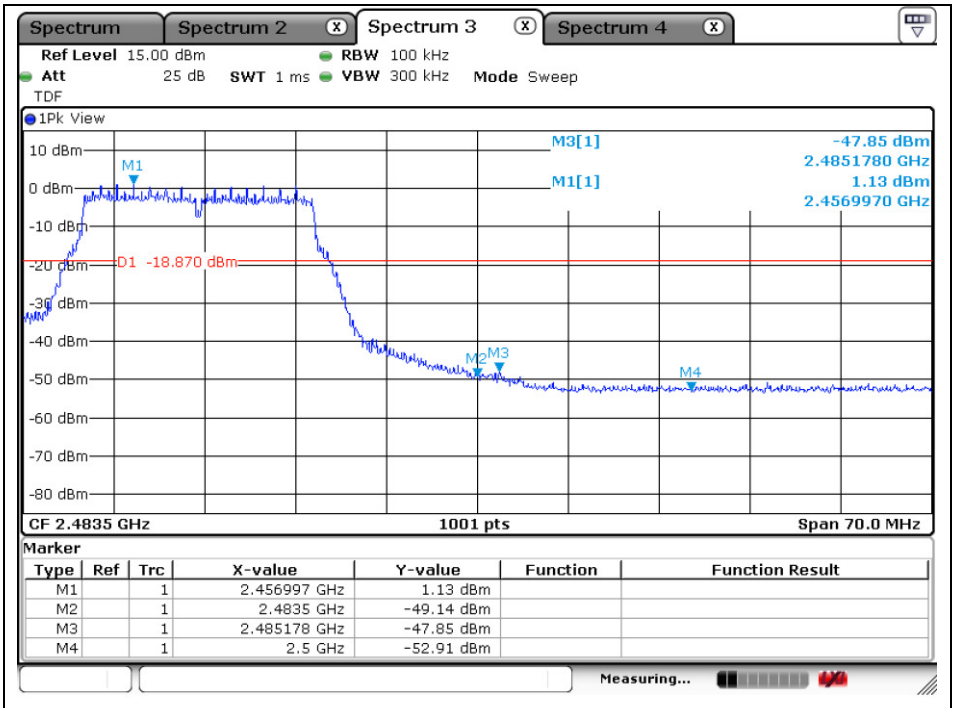
Middle Channel

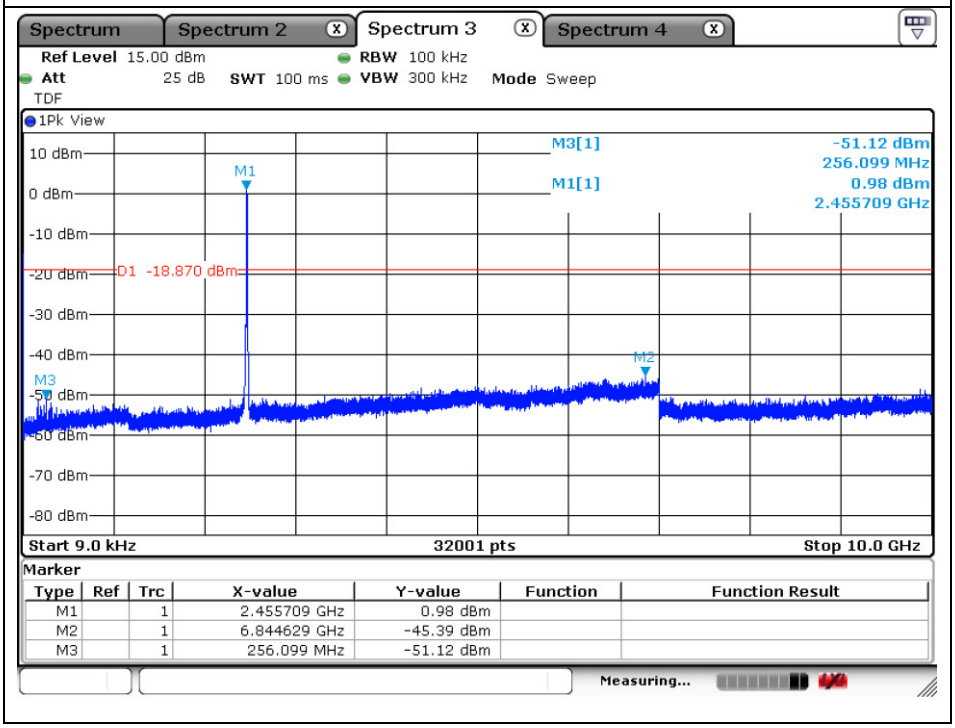


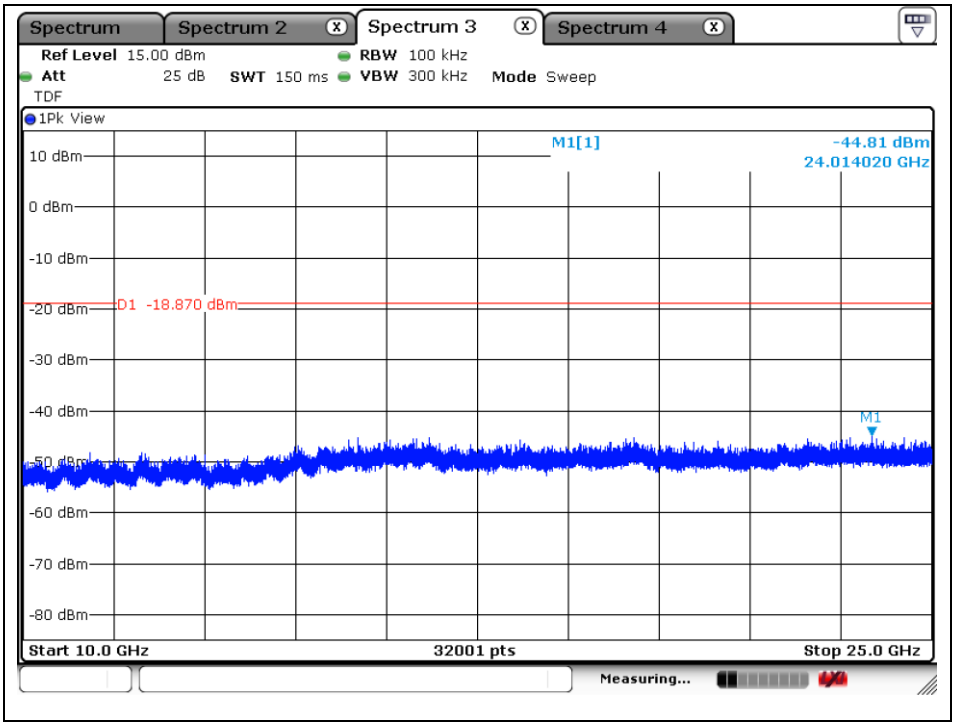




Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 15.00 dBm
RBW 100 kHz
Att 25 dB
SWT 150 ms
VBW 300 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-44.96 dBm
15.988800 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
D1 -18.400 dBm
M1
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Measuring...

High Channel





# 3. 6 dB Bandwidth

## 3.1. Test Setup


## 3.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 ~928 ㎒, 2 400 ~ 2 483.5 ㎒, and 5 725 ~ 5 825 ㎒ bands. The minimum of 6 ㏈ Bandwidth shall be at least 500 ㎑.

## 3.3. Test Procedure

### 3.3.1. 6 dB Bandwidth

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The test follows section 8.0 DTS bandwidth of FCC KDB Publication 558074_v03r04.
Tests performed using section 8.1 Option 1

- Option 1:
1. Set RBW = 100 ㎑.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 ㏈ relative to the maximum level measured in the fundamental emission.

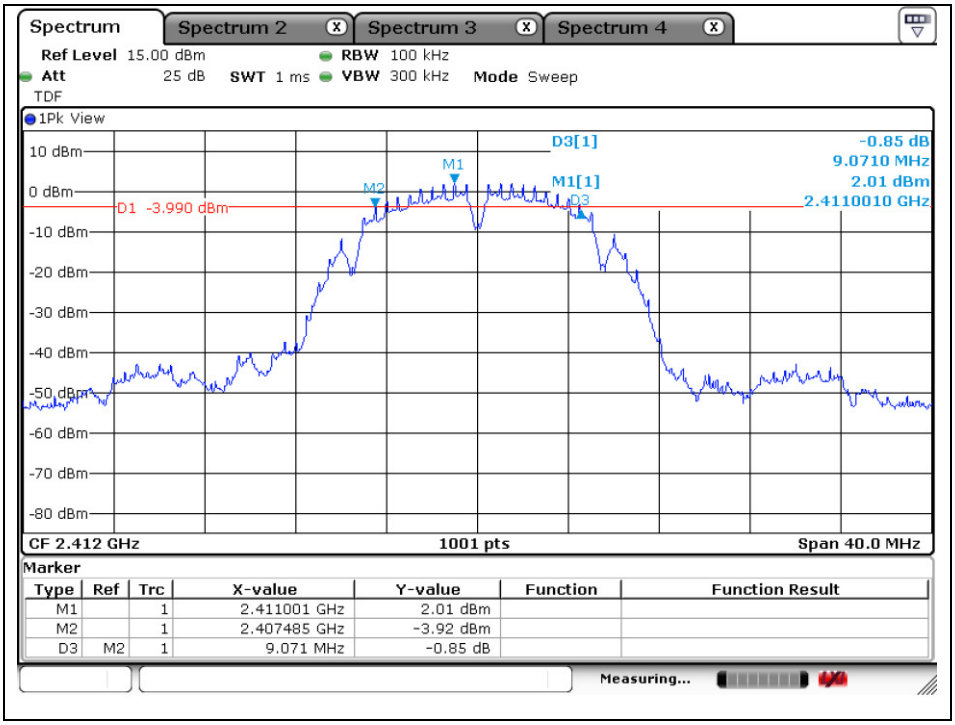
## 3.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

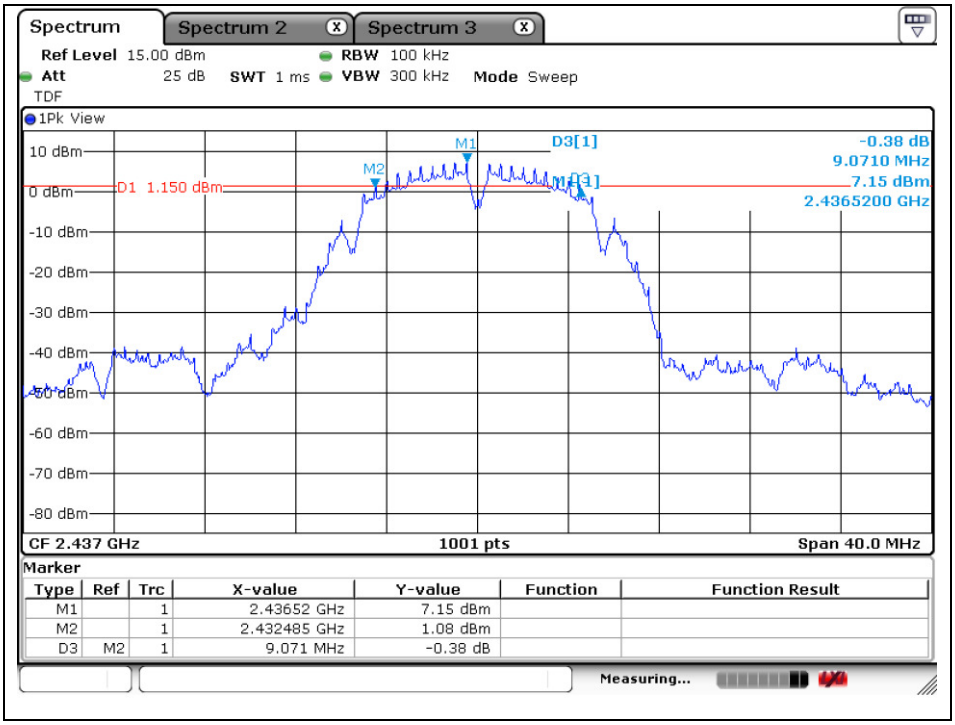
| Operation Mode | Data Rate (Mbps) | Channel | Channel Frequency (㎒) | 6 ㏈ Bandwidth (㎒) | Minimum Bandwidth (㎑) |
|---|---|---|---|---|---|
| DSSS (802.11b) | 1 | Low | 2 412 | 9.071 | 500 |
| | | Middle | 2 437 | 9.071 | 500 |
| | | High | 2 462 | 9.111 | 500 |
| OFDM (802.11g) | 6 | Low | 2 412 | 16.464 | 500 |
| | | Middle | 2 437 | 16.343 | 500 |
| | | High | 2 462 | 16.439 | 500 |
| OFDM (802.11n_HT20) | MCS8 | Low | 2 412 | 17.622 | 500 |
| | | Middle | 2 437 | 17.622 | 500 |
| | | High | 2 462 | 17.662 | 500 |

**DSSS: 802.11b**

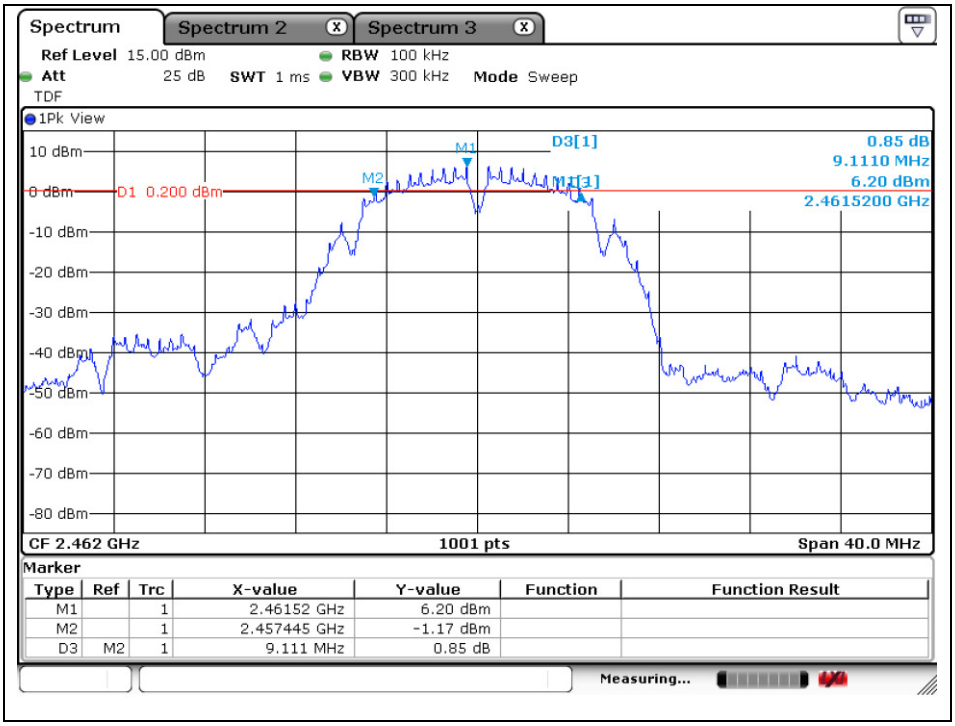
Low Channel



Middle Channel

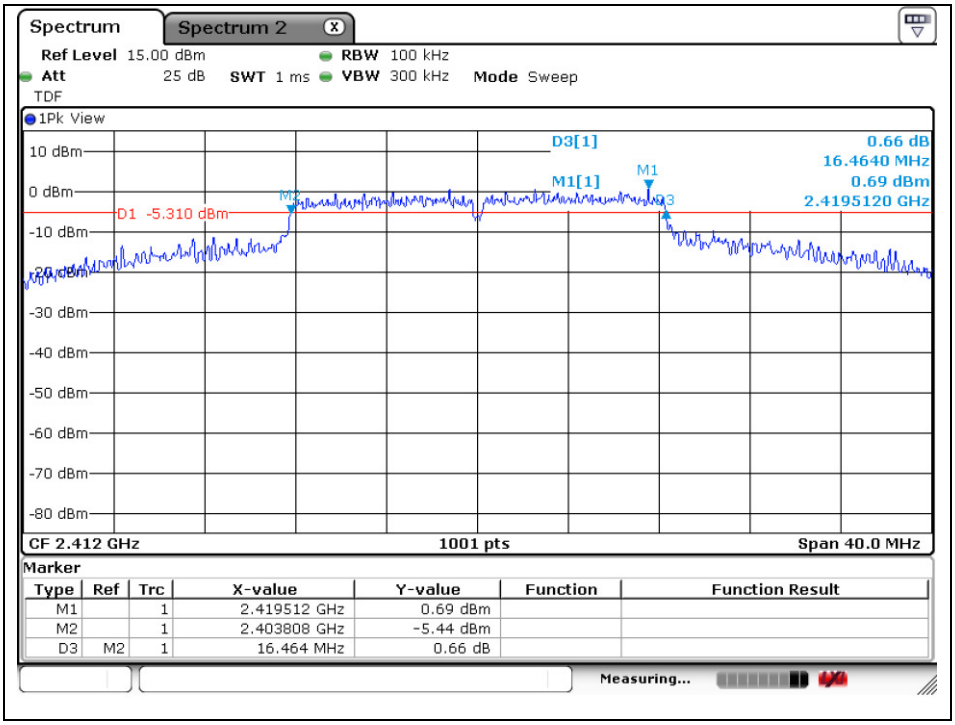



High Channel

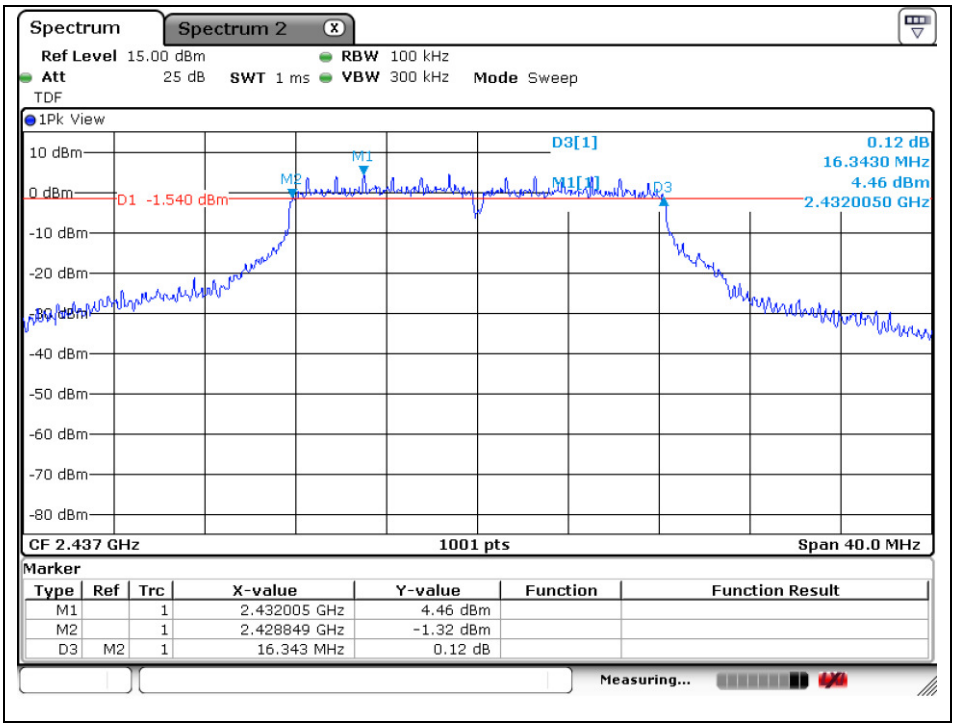


**OFDM: 802.11g**

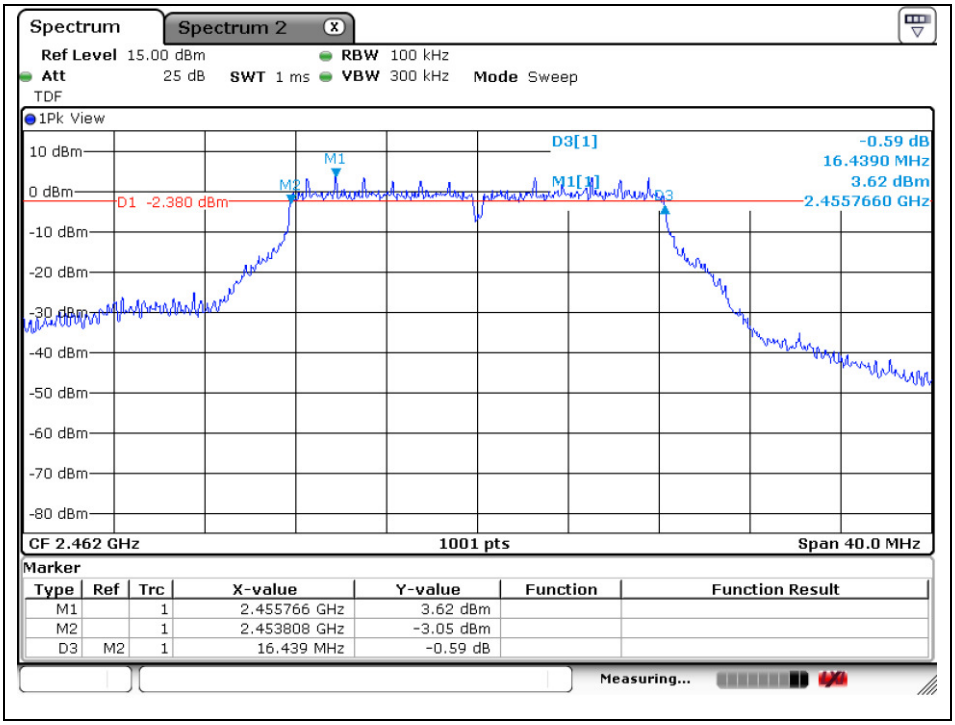
Low Channel




Middle Channel

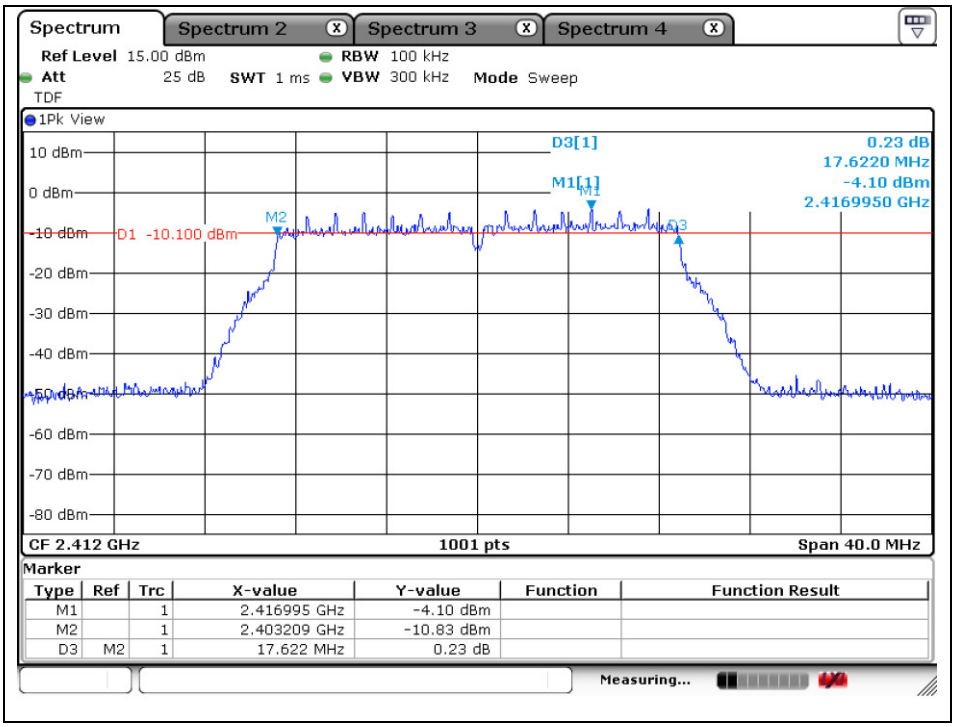


High Channel

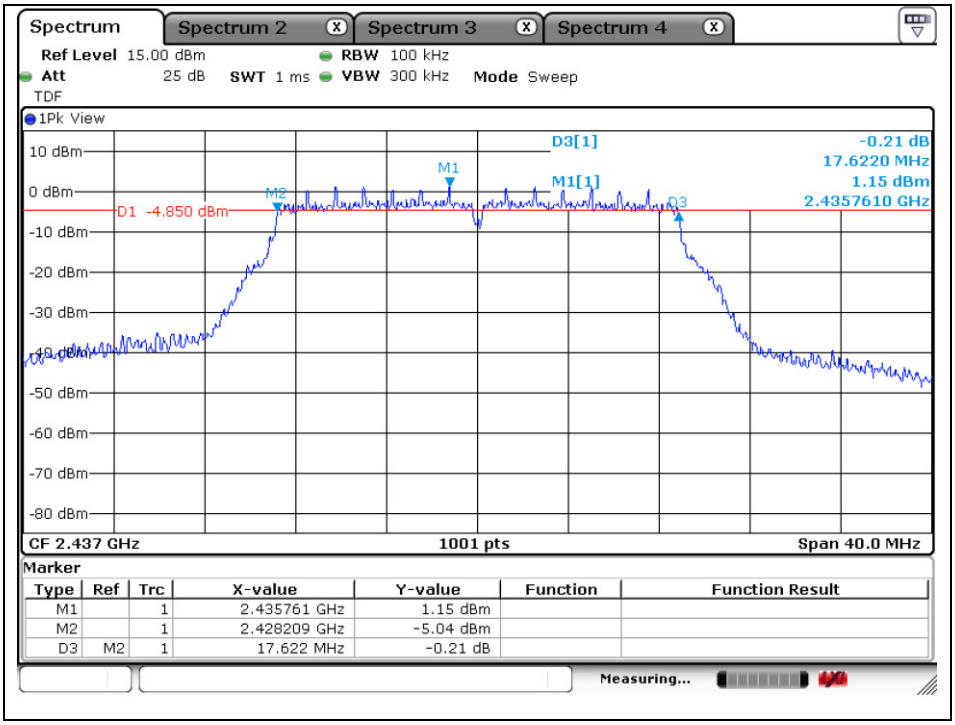



**OFDM: 802.11n_HT20**

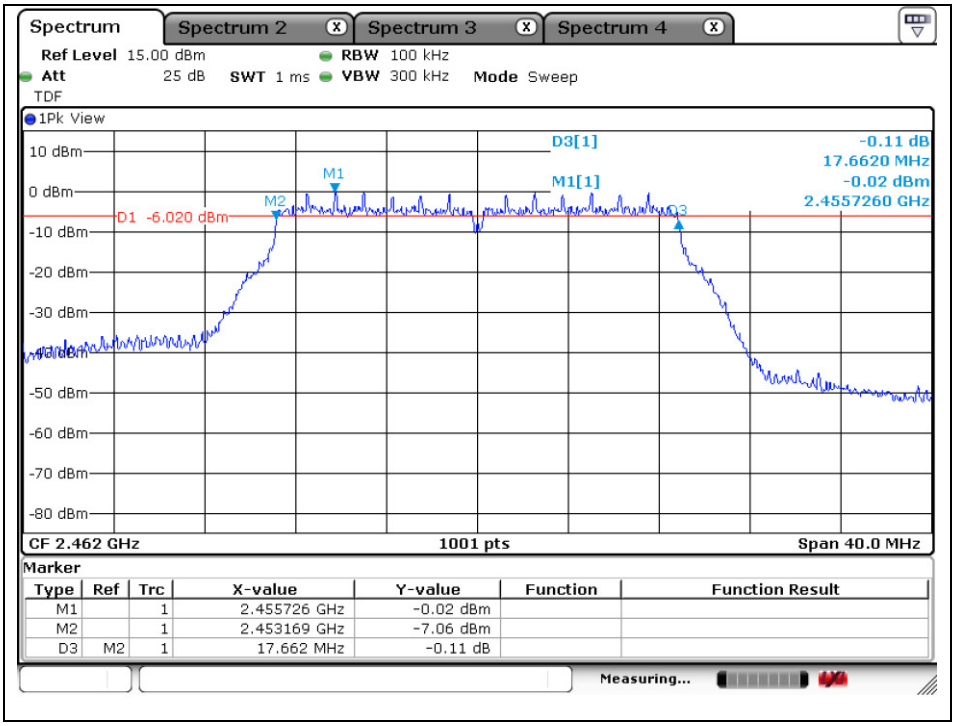
Low Channel



Middle Channel

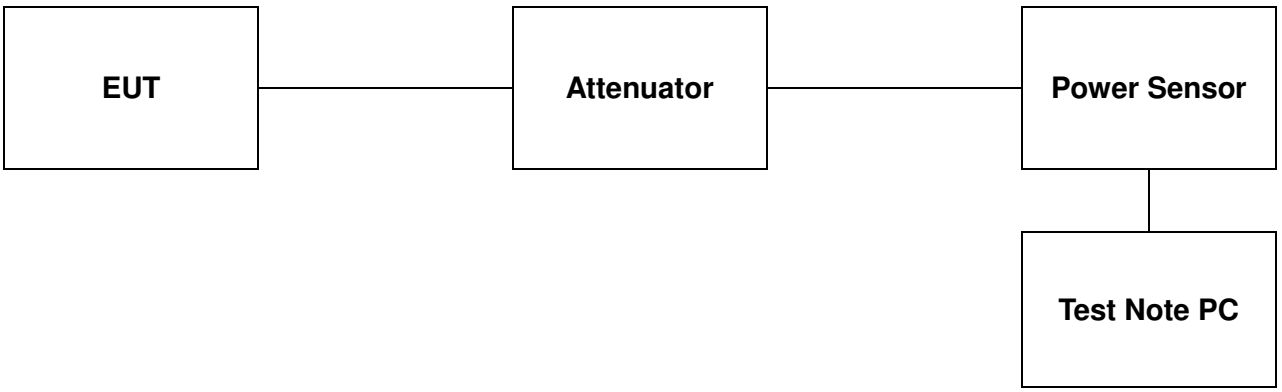



High Channel



# 4. Maximum Peak Conducted Output Power

## 4.1. Test Setup




## 4.2. Limit

According to §15.247(b)(3), for systems using digital modulation in the 902 ~ 928 ㎒, 2 400 ~ 2 483.5 ㎒, and 5 725 ~ 5 850 ㎒ band : 1 Watt. As an alternative to a peak power measurement, compliance with the one watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antenna elements. The average must not include any intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
According to §15.247(b)(4), the conducted output power limit specified in paragraph(b) of this section is based on the use of antenna with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph(c) of this section, if transmitting antenna of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

## 4.3. Test Procedure

The test follows section 9.1.2 of FCC KDB Publication 558074 v03r04.

**- Peak power meter method**

-The maximum peak conducted output power can be measured using a broad band peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

**Test program: (S/W name : R&S Power Viewer, Version : 3.2.0)**

1. Initially overall offset for attenuator and cable loss is measured per frequency.
2. Measured offset is inserted in test program in advance of measurement for output power.
3. Power for each frequency (channel) and data rate of device is investigated as final result.
4. Final result reported on this section from R&S power viewer program includes with several factors and test program shows only final result.

## 4.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Ant1

| Mode | Channel | Channel Frequency (㎒) | Data Rate (Mbps) | Attenuator + Cable offset (dB) | Peak Power Result (dB m) | Peak Power Limit (dB m) |
|---|---|---|---|---|---|---|
| DSSS (802.11b) | Low | 2 412 | 1 | 10.81 | 14.60 | 30 |
| | | | 2 | | 14.51 | |
| | | | 5.5 | | 14.54 | |
| | | | 11 | | 14.88 | |
| | Middle | 2 437 | 1 | 10.80 | 19.37 | 30 |
| | | | 2 | | 19.41 | |
| | | | 5.5 | | 19.46 | |
| | | | 11 | | 19.92 | |
| | High | 2 462 | 1 | 10.80 | 18.75 | 30 |
| | | | 2 | | 18.80 | |
| | | | 5.5 | | 18.94 | |
| | | | 11 | | 18.80 | |

Ant2

| Mode | Channel | Channel Frequency (㎒) | Data Rate (Mbps) | Attenuator + Cable offset (dB) | Peak Power Result (dB m) | Peak Power Limit (dB m) |
|---|---|---|---|---|---|---|
| DSSS (802.11b) | Low | 2 412 | 1 | 10.81 | 14.86 | 30 |
| | | | 2 | | 14.96 | |
| | | | 5.5 | | 14.82 | |
| | | | 11 | | 15.17 | |
| | Middle | 2 437 | 1 | 10.80 | 19.97 | 30 |
| | | | 2 | | 19.95 | |
| | | | 5.5 | | 19.91 | |
| | | | 11 | | 20.22 | |
| | High | 2 462 | 1 | 10.80 | 19.68 | 30 |
| | | | 2 | | 19.74 | |
| | | | 5.5 | | 19.77 | |
| | | | 11 | | 20.01 | |

Ant1 + Ant2

| Mode | Channel | Channel Frequency (㎒) | Data rate (Mbps) | Attenuator + Cable offset (dB) | Ant1 | Ant2 | Ant1+2 | Peak Power Limit (dB m) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Peak Power Result (dB m) | Peak Power Result (dB m) | Peak Power Result (dB m) | |
| OFDM (802.11g) | Low | 2 412 | 6 | 10.81 | 18.67 | 19.19 | 21.95 | 30 |
| | | | 9 | | 18.43 | 18.55 | 21.50 | |
| | | | 12 | | 18.10 | 18.77 | 21.46 | |
| | | | 18 | | 18.12 | 18.43 | 21.29 | |
| | | | 24 | | 18.76 | 19.29 | 22.04 | |
| | | | 36 | | 18.55 | 19.22 | 21.91 | |
| | | | 48 | | 18.29 | 19.33 | 21.85 | |
| | | | 54 | | 18.20 | 18.84 | 21.54 | |
| | Middle | 2 437 | 6 | 10.80 | 23.60 | 24.06 | 26.85 | 30 |
| | | | 9 | | 23.33 | 23.89 | 26.63 | |
| | | | 12 | | 23.49 | 24.31 | 26.93 | |
| | | | 18 | | 23.51 | 23.80 | 26.67 | |
| | | | 24 | | 23.60 | 23.99 | 26.81 | |
| | | | 36 | | 23.66 | 24.06 | 26.87 | |
| | | | 48 | | 23.78 | 23.77 | 26.79 | |
| | | | 54 | | 23.50 | 23.63 | 26.58 | |
| | High | 2 462 | 6 | 10.80 | 22.92 | 23.44 | 26.20 | 30 |
| | | | 9 | | 23.11 | 23.10 | 26.12 | |
| | | | 12 | | 22.55 | 22.84 | 25.71 | |
| | | | 18 | | 21.76 | 22.90 | 25.38 | |
| | | | 24 | | 22.51 | 23.31 | 25.94 | |
| | | | 36 | | 22.76 | 23.22 | 26.01 | |
| | | | 48 | | 22.39 | 23.50 | 25.99 | |
| | | | 54 | | 22.66 | 23.10 | 25.90 | |

Ant1 + Ant2

| Mode | Channel | Channel Frequency (㎒) | Data rate (Mbps) | Attenuator + Cable offset (dB) | Ant1 | Ant2 | Ant1+2 | Peak Power Limit (dB m) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Peak Power Result (dB m) | Peak Power Result (dB m) | Peak Power Result (dB m) | |
| OFDM (802.11n_HT20) | Low | 2 412 | MCS8 | 10.81 | 14.86 | 15.44 | 18.17 | 30 |
| | | | MCS9 | | 14.82 | 15.08 | 17.96 | |
| | | | MCS10 | | 14.33 | 14.82 | 17.59 | |
| | | | MCS11 | | 16.59 | 17.78 | 20.24 | |
| | | | MCS12 | | 17.04 | 17.69 | 20.39 | |
| | | | MCS13 | | 16.97 | 17.57 | 20.29 | |
| | | | MCS14 | | 17.36 | 17.51 | 20.45 | |
| | | | MCS15 | | 16.77 | 18.46 | 20.71 | |
| | Middle | 2 437 | MCS8 | 10.80 | 20.58 | 21.41 | 24.03 | 30 |
| | | | MCS9 | | 20.37 | 20.97 | 23.69 | |
| | | | MCS10 | | 20.26 | 20.56 | 23.42 | |
| | | | MCS11 | | 22.59 | 22.80 | 25.71 | |
| | | | MCS12 | | 22.34 | 22.89 | 25.63 | |
| | | | MCS13 | | 22.14 | 22.68 | 25.43 | |
| | | | MCS14 | | 21.98 | 22.74 | 25.39 | |
| | | | MCS15 | | 22.35 | 22.77 | 25.58 | |
| | High | 2 462 | MCS8 | 10.80 | 19.72 | 20.65 | 23.22 | 30 |
| | | | MCS9 | | 19.59 | 20.24 | 22.94 | |
| | | | MCS10 | | 19.44 | 20.12 | 22.80 | |
| | | | MCS11 | | 20.59 | 21.91 | 24.31 | |
| | | | MCS12 | | 20.12 | 22.09 | 24.23 | |
| | | | MCS13 | | 20.22 | 22.43 | 24.47 | |
| | | | MCS14 | | 20.51 | 22.28 | 24.49 | |
| | | | MCS15 | | 20.34 | 22.15 | 24.35 | |

**Remark:**

Attenuator and cable offset was compensated in test program (R&S Power Viewer) before measuring.

According to KDB 662911 v02r01, peak power of each port (Ant1 + Ant2) was combined by using below calculation.

Power: 10log{10^(Ant1 power/10)+10^(Ant2 power/10)}

# 5. Power Spectral Density

## 5.1. Test Setup


## 5.2. Limit

§15.247(e) For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈ m in any 3 ㎑ band any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

## 5.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The measurements are recorded using the PKPSD measurement procedure in section 10.2 of KDB 558074_v03r04.

- This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to at least 1.5 times the DTS channel bandwidth.
3. Set the RBW to : 3 ㎑ ≤ RBW ≤ 100 ㎑.
4. Set the VBW ≥ 3 x RBW.
5. Detector = Peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 ㎑) and repeat.

## 5.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

| Operation Mode | Data Rate (Mbps) | Channel | Frequency (㎒) | Measured PSD (dB m) | Maximum Limit (dB m) |
|---|---|---|---|---|---|
| DSSS (802.11b) - Ant1 | 1 | Low | 2 412 | -9.82 | 8 |
| | | Middle | 2 437 | -4.92 | 8 |
| | | High | 2 462 | -6.97 | 8 |
| DSSS (802.11b) - Ant2 | 1 | Low | 2 412 | -11.21 | 8 |
| | | Middle | 2 437 | -6.35 | 8 |
| | | High | 2 462 | -6.74 | 8 |

| Operation Mode | Data Rate (Mbps) | Channel | Frequency (㎒) | Ant1 | Ant2 | Ant1+2 | Maximum Limit (dB m) |
|---|---|---|---|---|---|---|---|
| | | | | Measured PSD (dB m) | Measured PSD (dB m) | PSD Result (dB m) | |
| OFDM (802.11g) | 6 | Low | 2 412 | -14.38 | -13.99 | -11.17 | 8 |
| | | Middle | 2 437 | -9.12 | -9.09 | -6.09 | 8 |
| | | High | 2 462 | -9.99 | -8.92 | -6.41 | 8 |

| Operation Mode | Data Rate (Mbps) | Channel | Frequency (㎒) | Ant1 | Ant2 | Ant1+2 | Maximum Limit (dB m) |
|---|---|---|---|---|---|---|---|
| | | | | Measured PSD (dB m) | Measured PSD (dB m) | PSD Result (dB m) | |
| OFDM (802.11n_HT20) | MCS8 | Low | 2 412 | -17.99 | -16.89 | -14.39 | 8 |
| | | Middle | 2 437 | -13.16 | -12.43 | -9.77 | 8 |
| | | High | 2 462 | -13.39 | -11.81 | -9.52 | 8 |

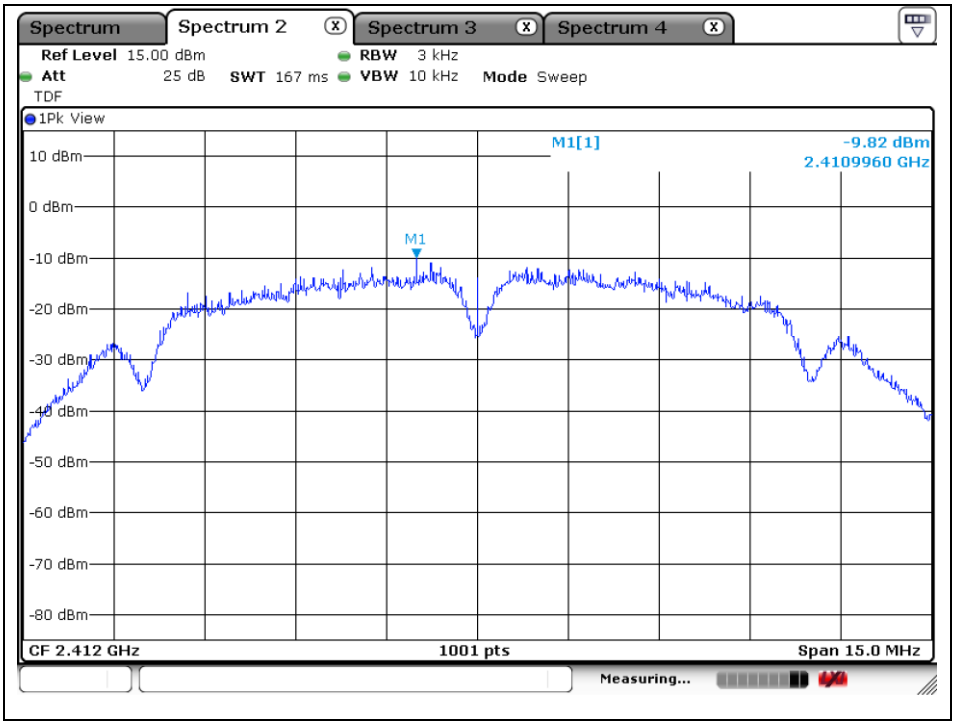
Note;

According to KDB 662911 v02r01, power spectral density of each port (Ant1 + Ant2) was combined by using below calculation.

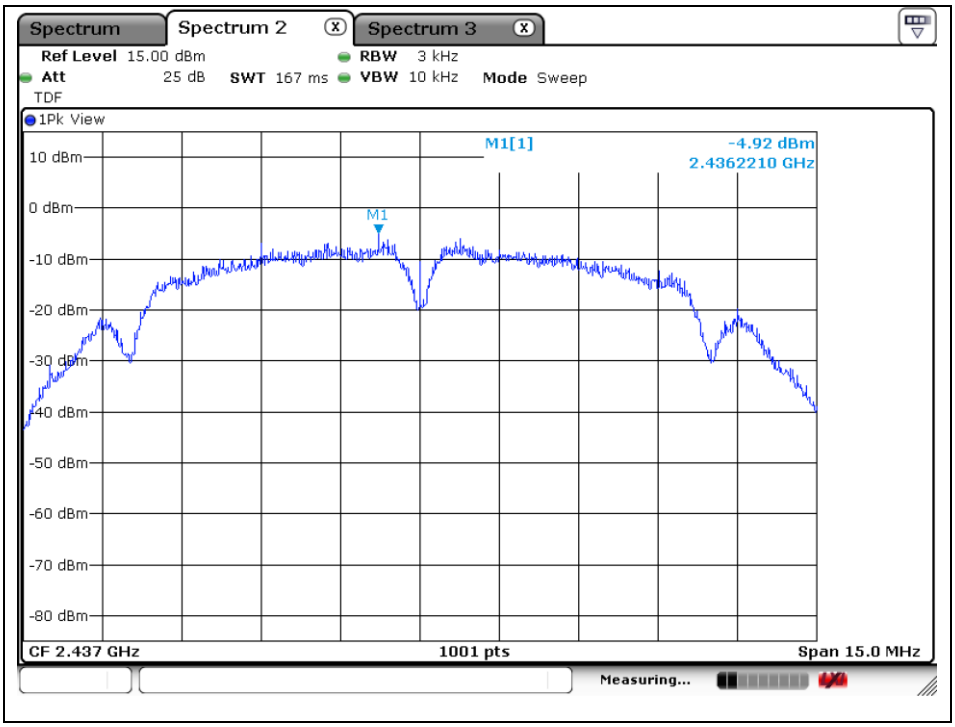
PSD: 10log{10^(Ant1 psd/10)+10^(Ant2 psd/10)}

**DSSS: 802.11b - ANT1**

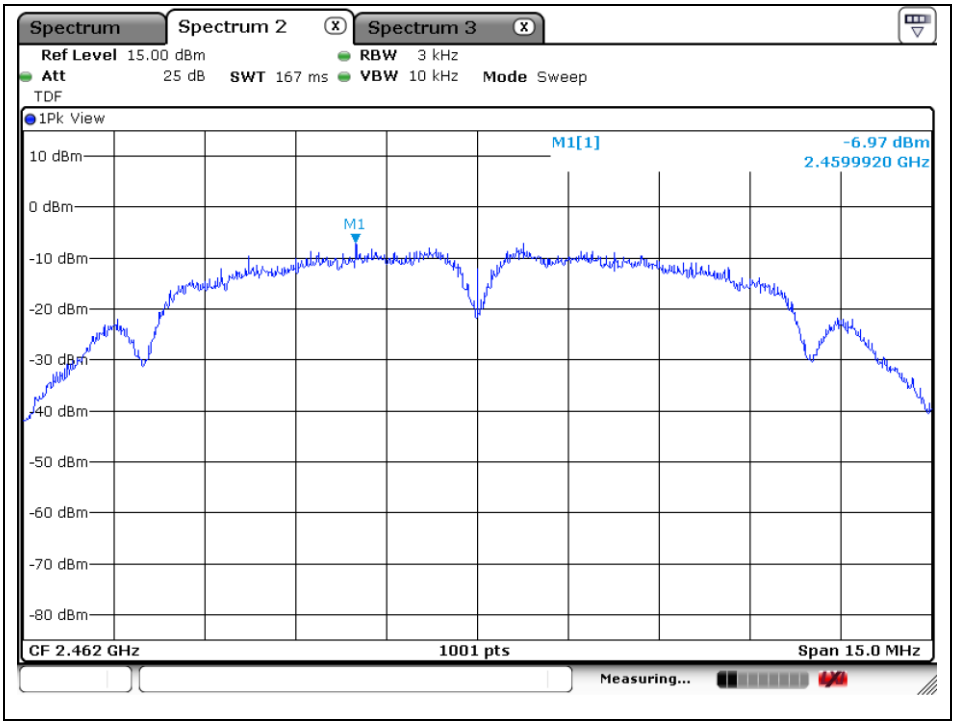
Low Channel




Middle Channel

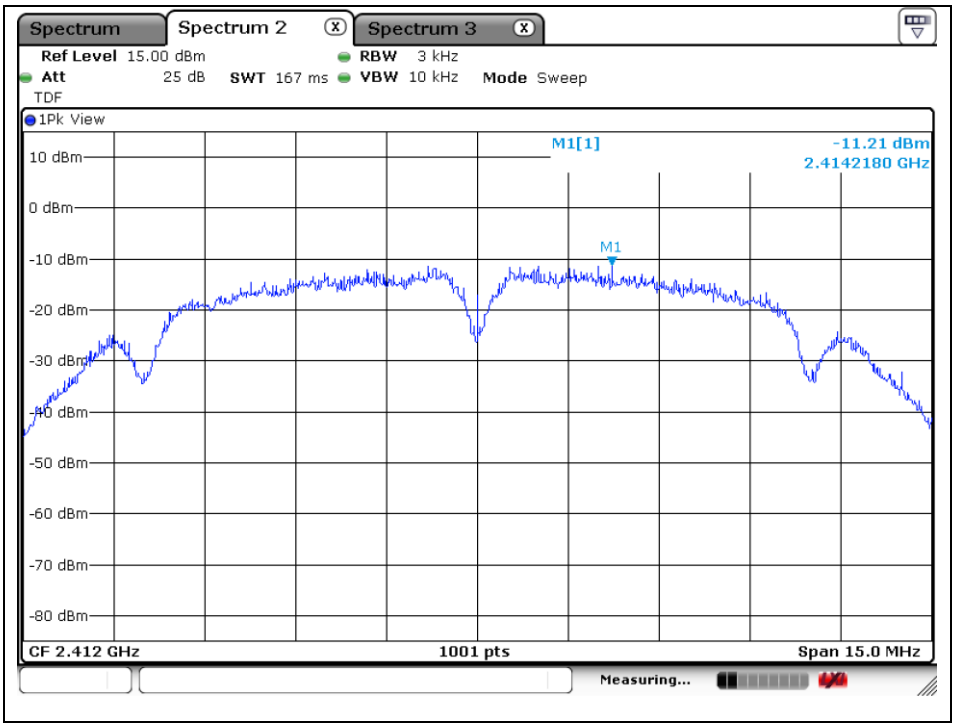


High Channel

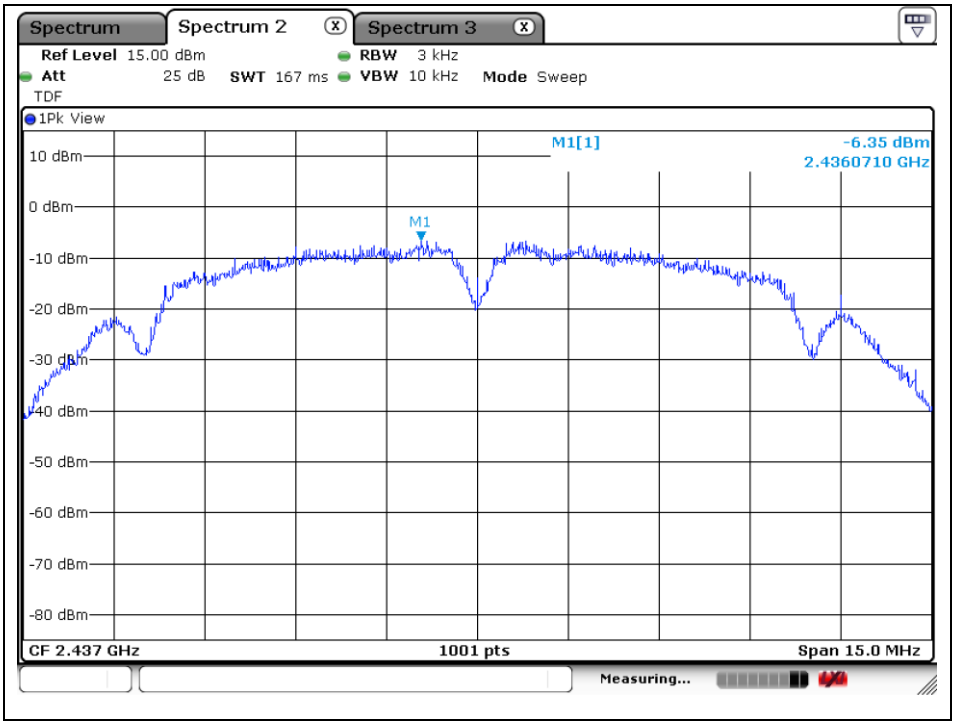



**DSSS: 802.11b - ANT2**

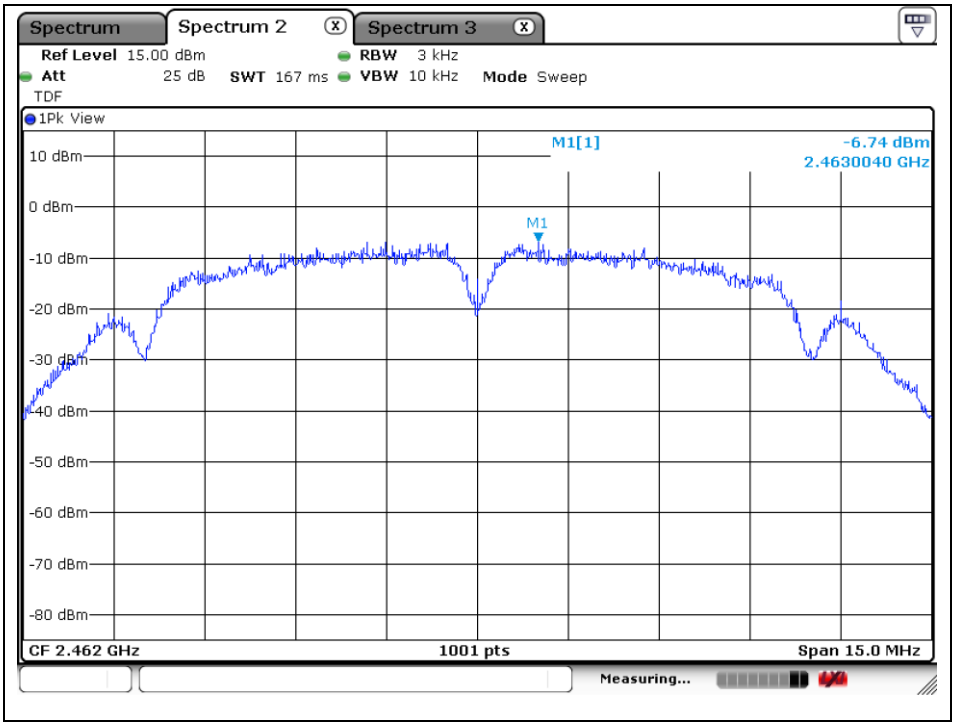
Low Channel



Middle Channel

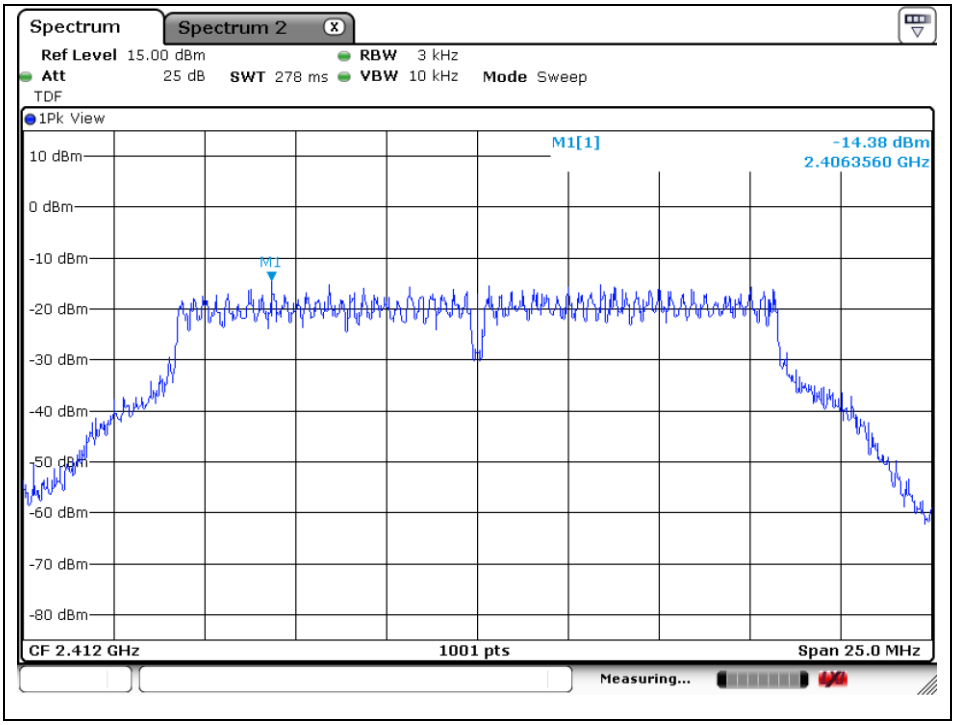



High Channel

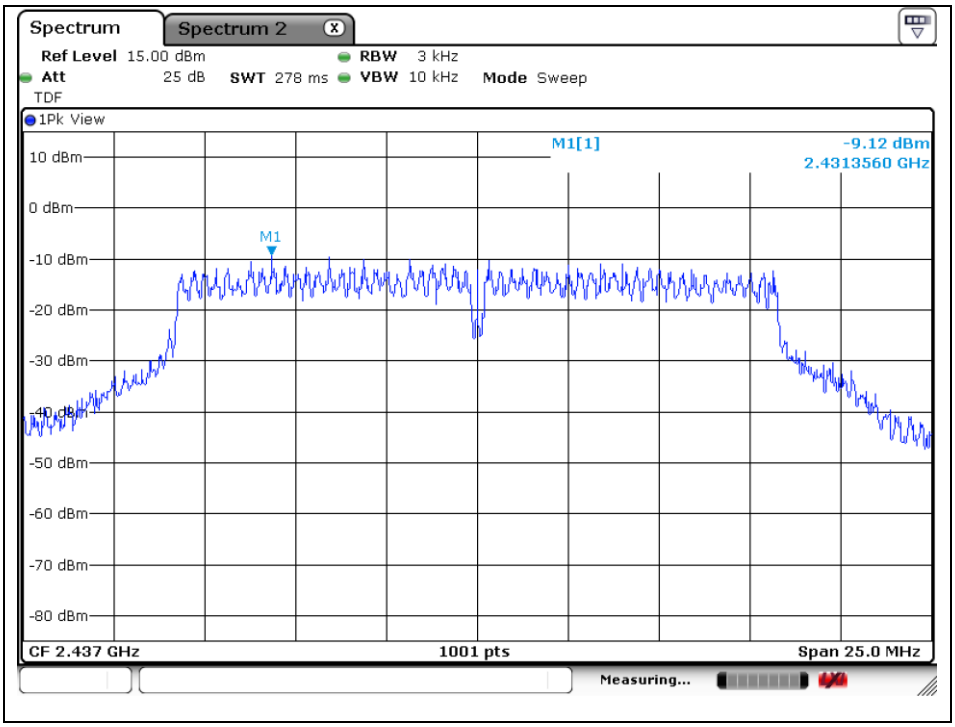


**OFDM: 802.11g - ANT1**

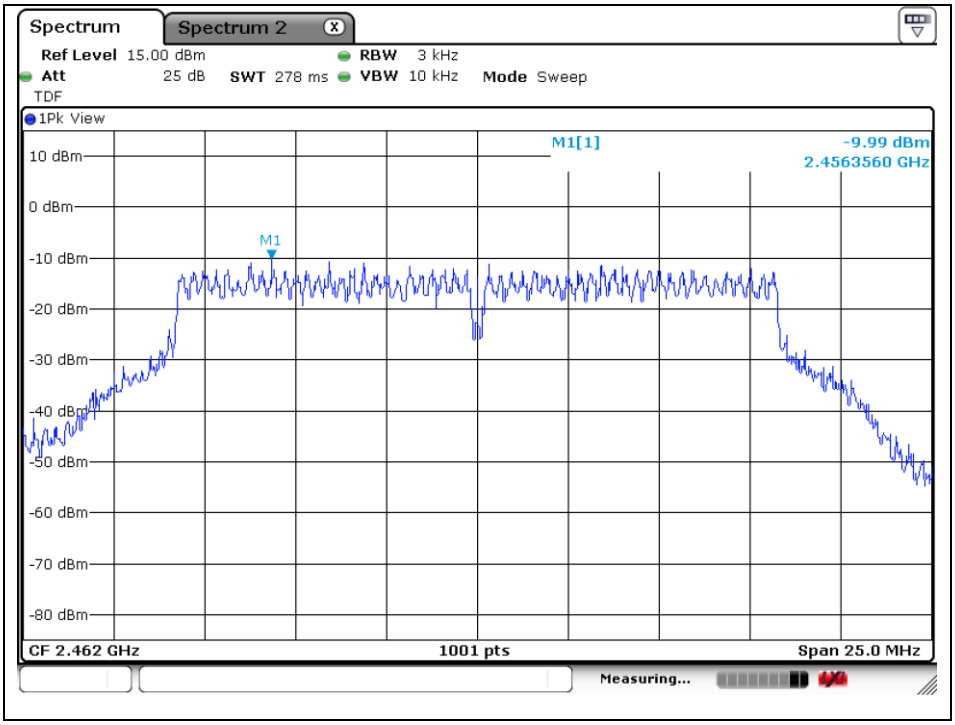
Low Channel




Middle Channel

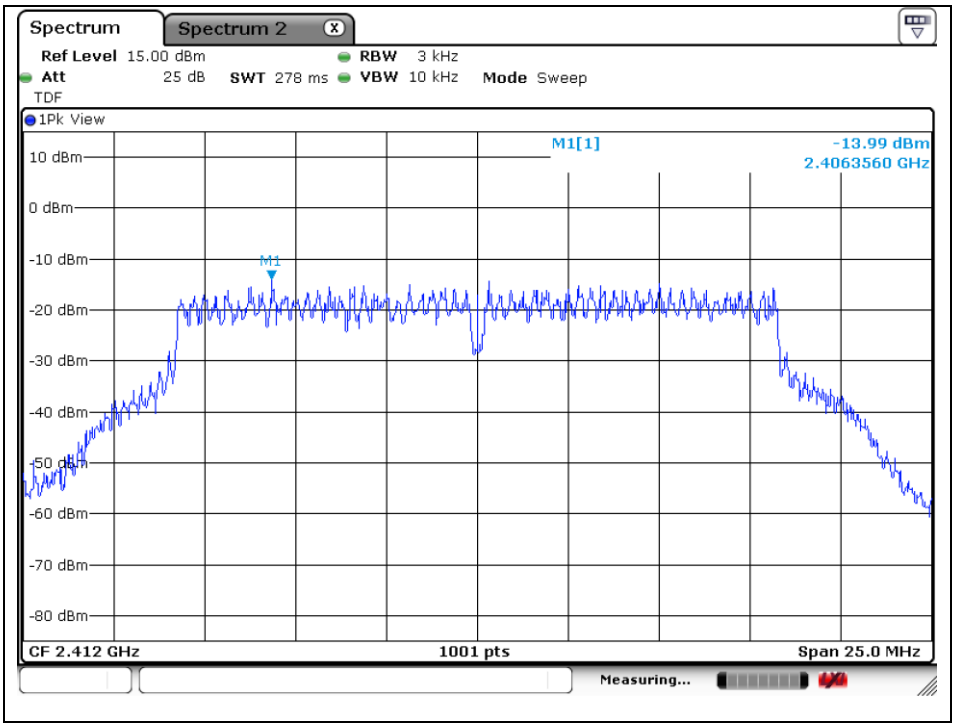


High Channel

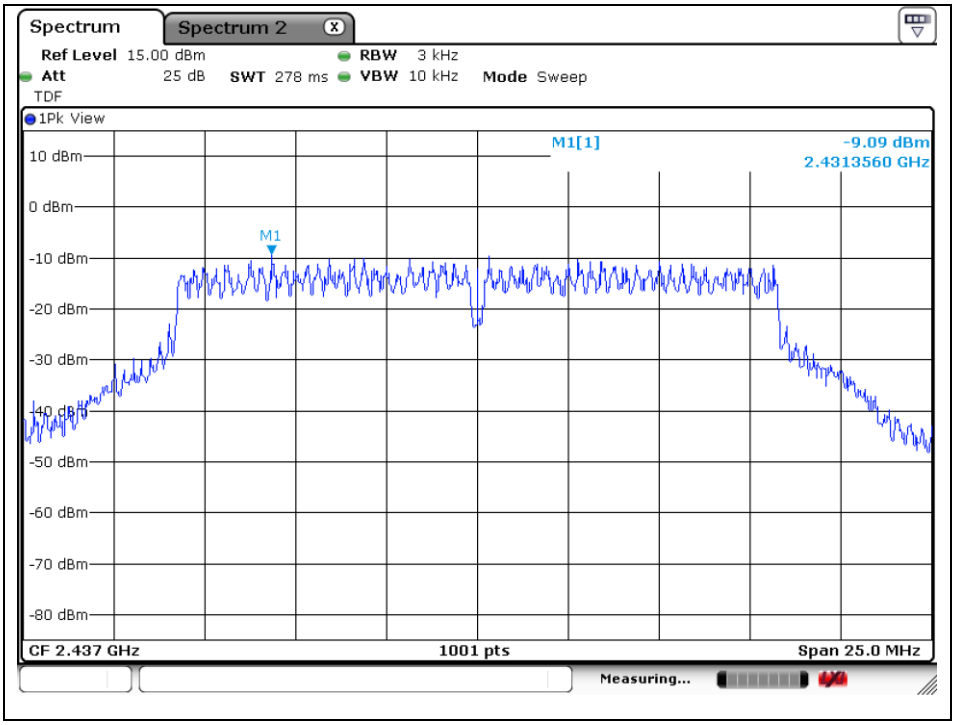



**OFDM: 802.11g - ANT2**

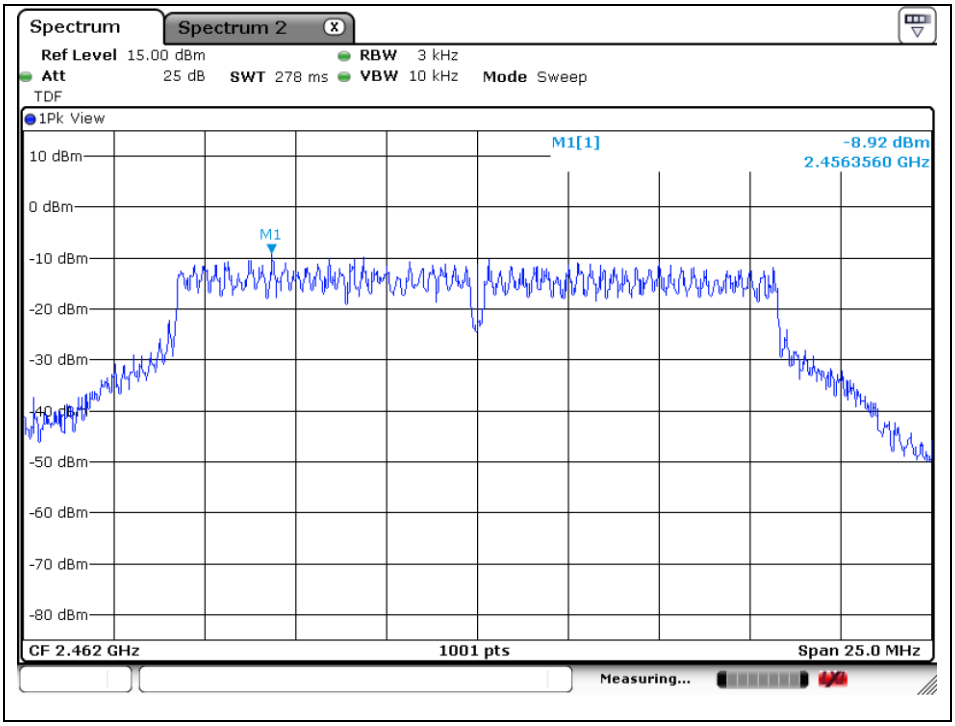
Low Channel



Middle Channel

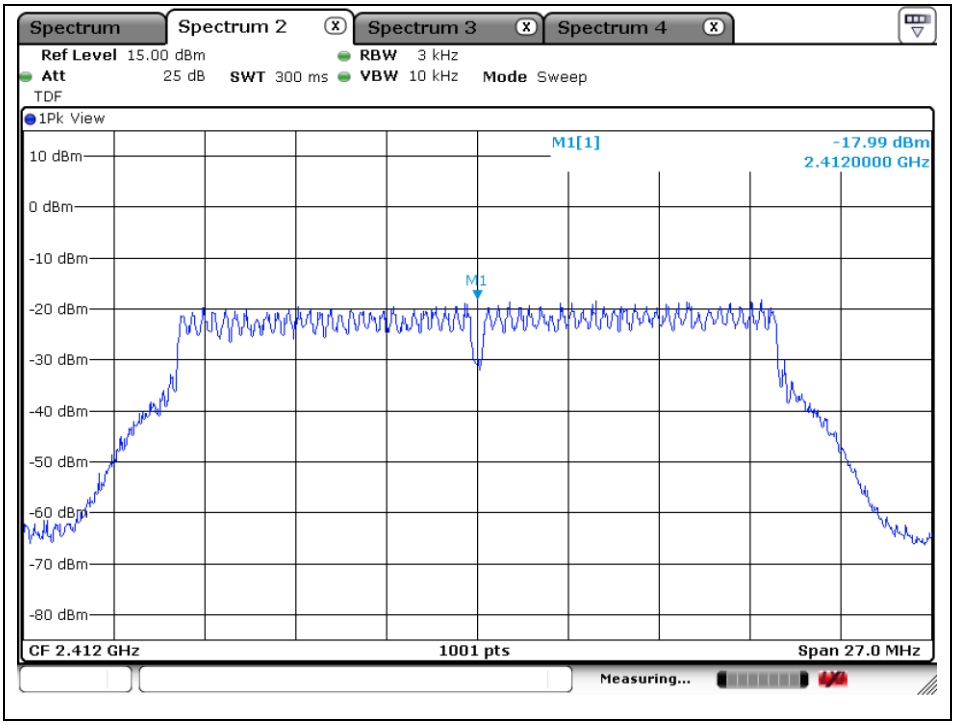



High Channel

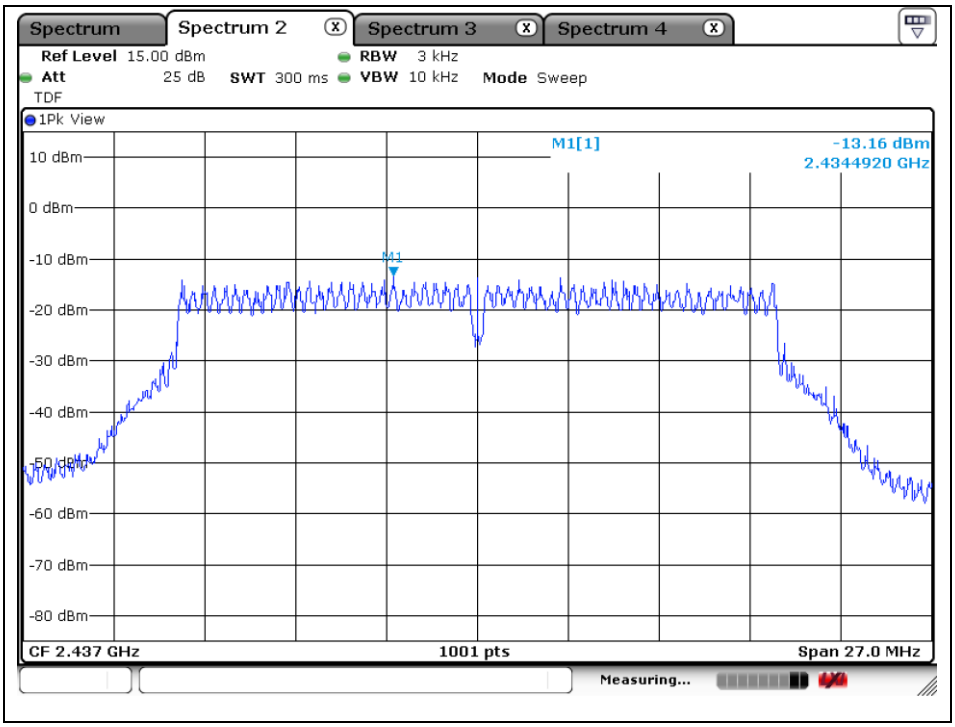


**OFDM: 802.11n_HT20 - Ant1**

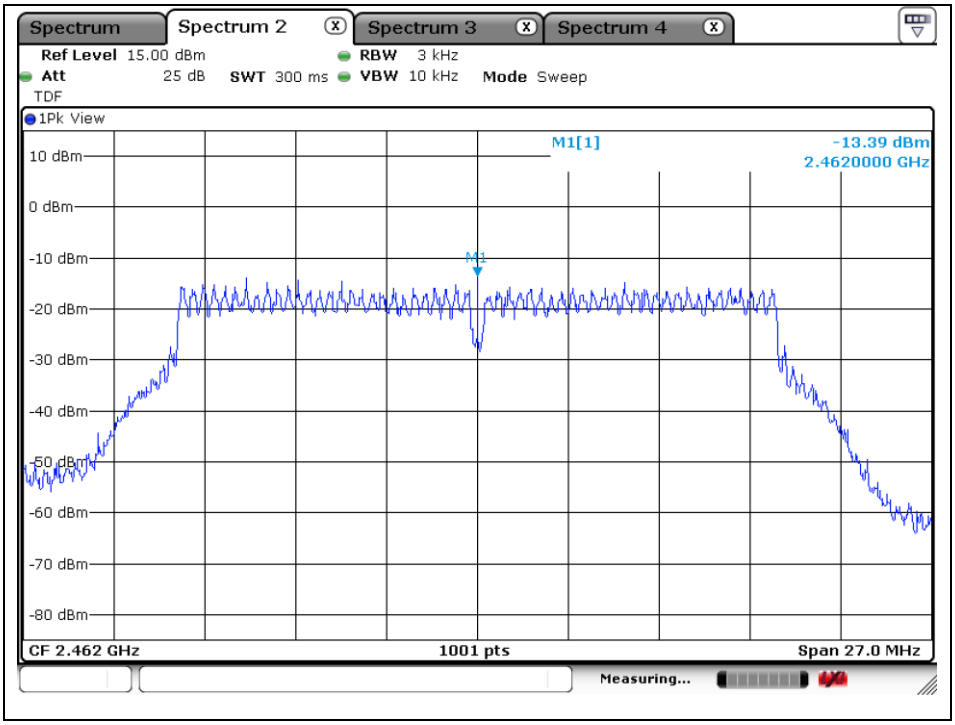
Low Channel




Middle Channel

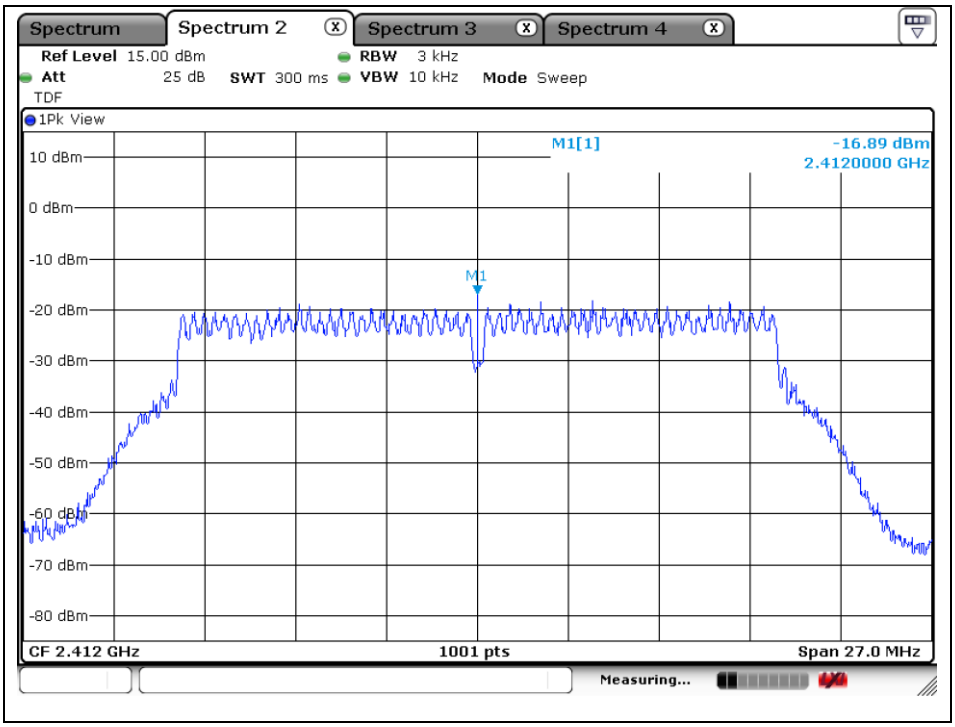


High Channel

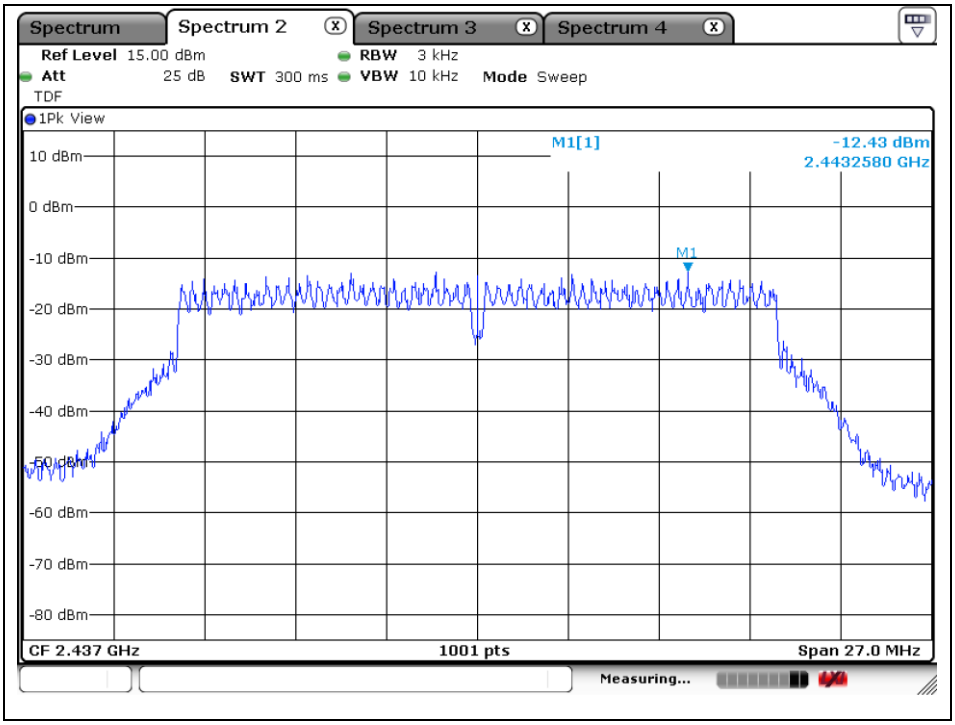



**OFDM: 802.11n_HT20 - Ant2**

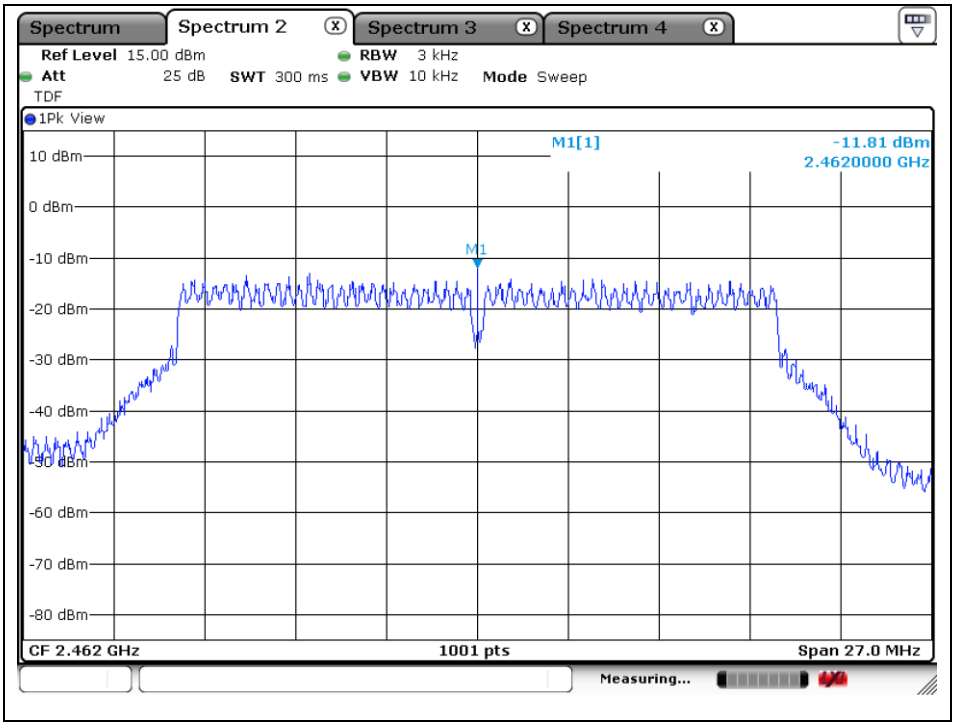
Low Channel



Middle Channel

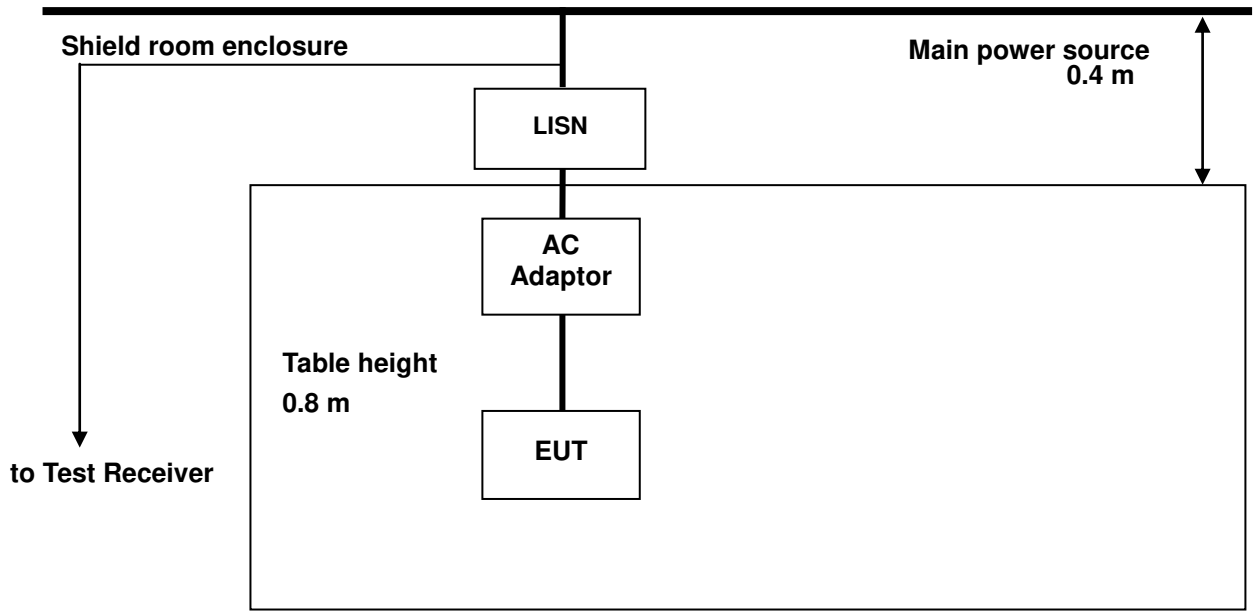



High Channel



# 6. AC Power Line Conducted Emission

## 6.1. Test Setup




## 6.2. Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 ㎛H /50 ohm line impedance stabilization network(LISN).
Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

| Frequency of Emission (㎒) | Conducted limit (dB㎶) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 – 0.50 | 66 - 56* | 56 - 46* |
| 0.50 – 5.00 | 56 | 46 |
| 5.00 – 30.0 | 60 | 50 |

* Decreases with the logarithm of the frequency.

## 6.3. Test Procedures

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

AC line conducted emissions from the EUT were measured according to the dictates of ANSI C63.10-2009

1. The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.

## 6.4. Test Results

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Frequency range : 0.15 ㎒ – 30 ㎒
Measured Bandwidth : 9 ㎑

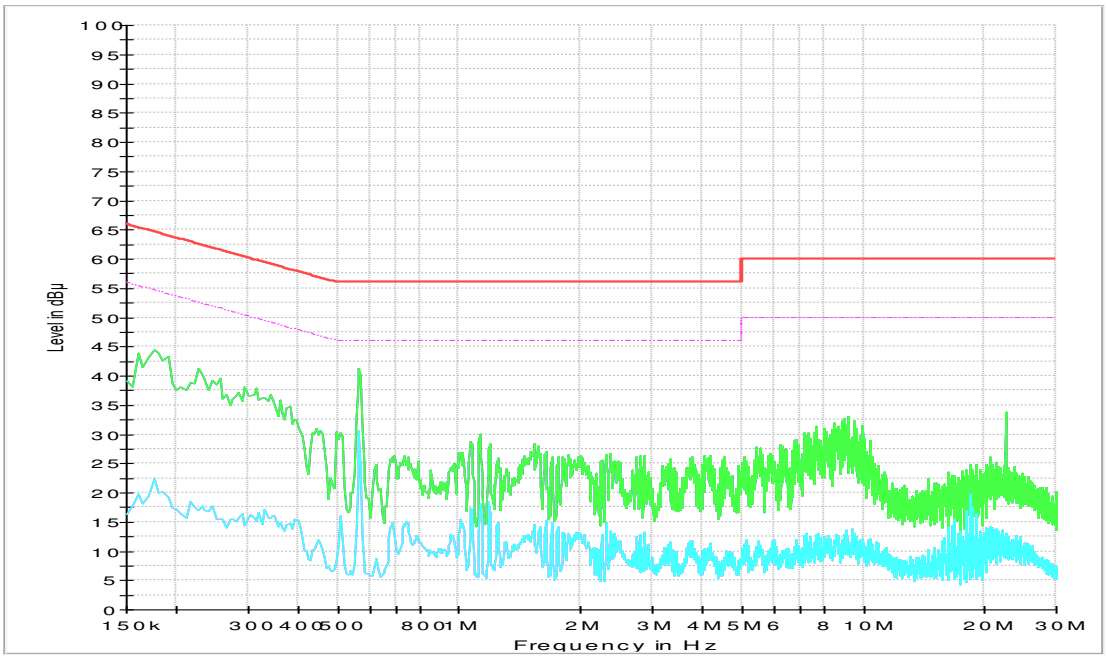
| FREQ. | LEVEL(dBμV) | | LINE | LIMIT(dBμV) | | MARGIN(dB) | |
|---|---|---|---|---|---|---|---|
| (㎒) | Q-Peak | Average | | Q-Peak | Average | Q-Peak | Average |
| 0.56 | 38.90 | 29.80 | N | 56.00 | 46.00 | 17.10 | 16.20 |
| 1.13 | 27.20 | 18.30 | N | 56.00 | 46.00 | 28.80 | 27.70 |
| 1.64 | 22.90 | 16.10 | N | 56.00 | 46.00 | 33.10 | 29.90 |
| 9.07 | 25.20 | 12.00 | N | 60.00 | 50.00 | 34.80 | 38.00 |
| 18.47 | 21.90 | 19.90 | N | 60.00 | 50.00 | 38.10 | 30.10 |
| 22.44 | 17.40 | 11.30 | N | 60.00 | 50.00 | 42.60 | 38.70 |
| 0.56 | 44.10 | 39.20 | H | 56.00 | 46.00 | 11.90 | 6.80 |
| 0.68 | 29.90 | 22.60 | H | 56.00 | 46.00 | 26.10 | 23.40 |
| 1.13 | 29.50 | 21.00 | H | 56.00 | 46.00 | 26.50 | 25.00 |
| 3.83 | 23.50 | 16.10 | H | 56.00 | 46.00 | 32.50 | 29.90 |
| 8.66 | 24.40 | 13.10 | H | 60.00 | 50.00 | 35.60 | 36.90 |
| 18.44 | 22.00 | 17.80 | H | 60.00 | 50.00 | 38.00 | 32.20 |

Remark;

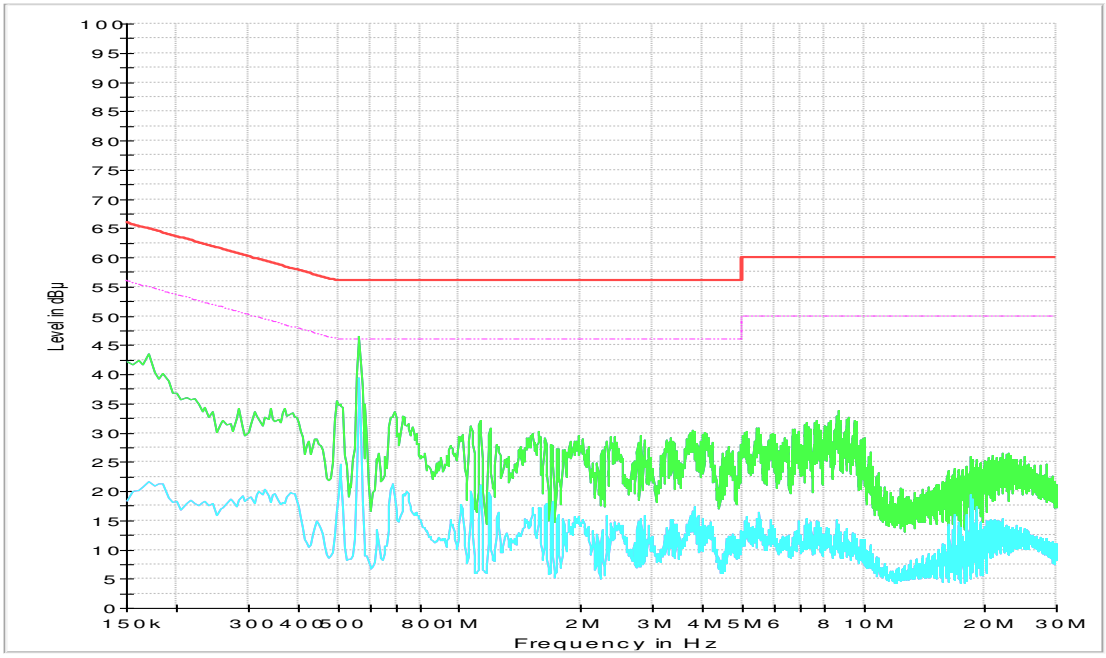
1. Line ( H ): Hot, Line ( N ): Neutral
2. All modes of operation were investigated and the worst-case emissions were reported using 11b Mode, 1Mbps, middle channel.
3. Traces shown in plot mad using a peak detector and average detector
4. The limit for Class B device(s) from 150 ㎑ to 30 ㎒ are specified in Section of the Title 47 CFR.
5. Deviations to the Specifications: None.

**Plots of Conducted Power line**

Test mode: (Neutral)




Test mode: (Hot)



# 7. Antenna Requirement

## 7.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

## 7.2. Antenna Connected Construction

Antenna used in this product is PIFA type and peak max gain of antenna as below.

| Band | 2 412 ㎒ – 2 462 ㎒ |
|---|---|
| Mode | 11b/g/n_HT20 |
| Ant1 Gain | -0.55 dBi |
| Ant2 Gain | 0.28 dBi |

$$DirectionalGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

Where

Each antenna is driven by no more than one spatial stream;

$N_{ss}$ = the number of independent spatial streams of data;

$N_{ANT}$ = the total number of antennas

$g_{j,k} = 10^{G_k / 20}$ if the kth antenna is being fed by spatial stream j, or zero if it is not;

$G_k$ is the gain in dBi of the kth antenna.

Directional Gain = 2.89 dBi