# FCC Part 15C
# Measurement and Test Report

**For**

**HOLOGRUF INC.**

**FCC ID:2AR7E-HOLO-50**

| | |
|---|---|
| **FCC Rule(s):** | FCC Part 15C |
| **Product Description:** | HOLOGRUF |
| **Tested Model:** | HOLO-50 |
| **Report No.:** | BSL181111114301RF |
| **Tested Date:** | December 5~18, 2018 |
| **Issued Date:** | December 18,2018 |
| **Tested By:** | Steven Wen/ Engineer |
| **Reviewed By:** | Lisa. Ji / EMC Manager |
| **Approved & Authorized By:** | Mike mo / PSQ Manager |
| **Prepared By:** | |

**BSL Testing Co.,LTD.**
NO. 24, ZH Park, Nantou, Shenzhen, 518000 China
Tel: 400-882-9628 Fax: 86- 755-26508703

## TABLE OF CONTENTS

**1. GENERAL INFORMATION....3**
1.1 PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)....3
1.2 TEST STANDARDS....4
1.3 TEST METHODOLOGY....4
1.4 TEST FACILITY....4
1.5 EUT SETUP AND TEST MODE....5
1.6 MEASUREMENT UNCERTAINTY....5
1.7 TEST EQUIPMENT LIST AND DETAILS....6
**2. SUMMARY OF TEST RESULTS....7**
**3. RF EXPOSURE....8**
3.1 STANDARD APPLICABLE....8
3.2 TEST RESULT....8
**4. ANTENNA REQUIREMENT....9**
4.1 STANDARD APPLICABLE....9
4.2 EVALUATION INFORMATION....9
**5. POWER SPECTRAL DENSITY....10**
5.1 STANDARD APPLICABLE....10
5.2 TEST PROCEDURE....10
5.3 ENVIRONMENTAL CONDITIONS....10
5.4 SUMMARY OF TEST RESULTS/PLOTS....11
**6. 6DB BANDWIDTH....18**
6.1 STANDARD APPLICABLE....18
6.2 TEST PROCEDURE....18
6.3 ENVIRONMENTAL CONDITIONS....18
6.4 SUMMARY OF TEST RESULTS/PLOTS....18
**7. RF OUTPUT POWER....25**
7.1 STANDARD APPLICABLE....25
7.2 TEST PROCEDURE....25
7.3 ENVIRONMENTAL CONDITIONS....25
7.4 SUMMARY OF TEST RESULTS/PLOTS....26
**8. FIELD STRENGTH OF SPURIOUS EMISSIONS....27**
8.1 STANDARD APPLICABLE....27
8.2 TEST PROCEDURE....27
8.3 CORRECTED AMPLITUDE & MARGIN CALCULATION....29
8.4 ENVIRONMENTAL CONDITIONS....29
8.5 SUMMARY OF TEST RESULTS/PLOTS....29
**9. OUT OF BAND EMISSIONS....39**
9.1 STANDARD APPLICABLE....39
9.2 TEST PROCEDURE....39
9.3 ENVIRONMENTAL CONDITIONS....40
9.4 SUMMARY OF TEST RESULTS/PLOTS....40
**10. CONDUCTED EMISSIONS....45**
10.1 TEST PROCEDURE....45
10.2 BASIC TEST SETUP BLOCK DIAGRAM....45
10.3 ENVIRONMENTAL CONDITIONS....45
10.4 TEST RECEIVER SETUP....46
10.5 SUMMARY OF TEST RESULTS/PLOTS....46
10.6 CONDUCTED EMISSIONS TEST DATA....46

# 1. GENERAL INFORMATION

## 1.1 Product Description for Equipment Under Test (EUT)

**Client Information**

| | |
|---|---|
| Applicant: | HOLOGRUF INC. |
| Address of applicant: | 263 Towerview Court, Cary, NC, 27513, USA |
| Manufacturer: | HOLOGRUF INC. |
| Address of manufacturer: | 263 Towerview Court, Cary, NC, 27513, USA |

| **General Description of EUT** | |
|---|---|
| Product Name: | HOLOGRUF |
| Trade Name: | HOLO-50 |
| Model No.: | HOLO-50 |
| Rated Voltage: | DC 12V/3.5A By Adapter |
| Adapter information: | 100-240V 50/60Hz 1.3A |
| | |

| **Technical Characteristics of EUT** | |
|---|---|
| Support Standards: | 802.11b, 802.11g, 802.11n |
| Frequency Range: | 2412-2462MHz for 802.11b/g/n(HT20)<br>2422-2452MHz for 802.11n(HT40) |
| RF Output Power: | 13.41dBm (Conducted) |
| Type of Modulation: | CCK, OFDM, QPSK, BPSK, 16QAM, 64QAM |
| Data Rate: | 1-11Mbps, 6-54Mbps, up to 150Mbps |
| Quantity of Channels: | 11 for 802.11b/g/n(HT20); 7 for 802.11n(HT40) |
| Channel Separation: | 5MHz |
| Type of Antenna: | Internal Antenna |
| Antenna Gain: | 0dBi |
| Lowest Internal Frequency | 32.768KHz |

## 1.2 Test Standards

The following report is prepared on behalf of the MAD Gaze (Shen Zhen) Limited in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

The objective is to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

**Maintenance of compliance** is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

## 1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices, and ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz. The measurement guide KDB 558074 D01 v05 for digital transmission systems shall be performed also.

## 1.4 Test Facility

BSL Testing Co.,LTD.
NO. 24, ZH Park, Nantou, Shenzhen, 518000 China
Designation Number : CN1217
Test Firm Registration Number: 866035
Tel: 86- 755-26508703
Fax: 86- 755-26508703

## 1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, and to measure its highest possible emissions level, more detailed description as follows:

| **Test Mode List** | | |
|---|---|---|
| Test Mode | Description | Remark |
| TM1 | 802.11b | 2412MHz, 2437MHz, 2462MHz |
| TM2 | 802.11g | 2412MHz, 2437MHz, 2462MHz |
| TM3 | 802.11n-HT20 | 2412MHz, 2437MHz, 2462MHz |
| TM4 | 802.11n-HT40 | 2422MHz, 2437MHz, 2452MHz |
| Note: All test modes (different data rate and different modulation) are performed, but only the worst case is recorded in this report. | | |

| **Accessories Equipment List and Details** | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Model No.** | **Serial Number** |
| AC Adapter | Channel Well Technology | 2ABN042F | / |
| | | | |
| **Accessories Cable List and Details** | | | |
| **Cable Description** | **Length (m)** | **Shielded/Unshielded** | **With Core/Without Core** |
| | | | |
| **EUT Cable List and Details** | | | |
| **Cable Description** | **Length (m)** | **Shielded/Unshielded** | **With Core/Without Core** |
| | | | |

| **Auxiliary Equipment List and Details** | | | |
|---|---|---|---|
| Description | Manufacturer | Model | Serial Number |
| Notebook | Lenovo | Lenovo B490 | BSTSZEMC-77 |
| USB | ESR | Shielded | Without Core |

## 1.6 Measurement Uncertainty

| **Measurement uncertainty** | | |
|---|---|---|
| Parameter | Conditions | Uncertainty |
| RF Output Power | Conducted | ±0.42dB |
| Occupied Bandwidth | Conducted | ±1.5% |
| Power Spectral Density | Conducted | ±1.8dB |
| Conducted Spurious Emission | Conducted | ±2.17dB |
| Conducted Emissions | Conducted | ±2.88dB |
| Transmitter Spurious Emissions | Radiated | ±5.1dB |

## 1.7 Test Equipment List and Details

| Description | Manufacturer | Model | Serial No. | Cal Date | Due. Date |
|---|---|---|---|---|---|
| Communication Tester | Rohde & Schwarz | CMW500 | 100358 | 2018-11-08 | 2019-11-07 |
| Spectrum Analyzer | R&S | FSP40 | 100550 | 2018-10-08 | 2019-10-07 |
| Test Receiver | R&S | ESCI7 | US47140102 | 2018-10-08 | 2019-10-07 |
| Signal Generator | HP | 83630B | 3844A01028 | 2018-10-08 | 2019-10-07 |
| Test Receiver | R&S | ESPI-3 | 100180 | 2018-10-08 | 2019-10-07 |
| Amplifier | Agilent | 8449B | 4035A00116 | 2018-10-08 | 2019-10-07 |
| Amplifier | HP | 8447E | 2945A02770 | 2018-10-08 | 2019-10-07 |
| Signal Generator | IFR | 2023A | 202307/242 | 2018-10-08 | 2019-10-07 |
| Broadband Antenna | SCHAFFNER | 2774 | 2774 | 2018-10-21 | 2019-10-20 |
| Biconical and log periodic antennas | ELECTRO-METRICS | EM-6917B-1 | 171 | 2018-10-21 | 2019-10-20 |
| Horn Antenna | R&S | HF906 | 100253 | 2018-10-21 | 2019-10-20 |
| Horn Antenna | EM | EM-6961 | 6462 | 2018-10-21 | 2019-10-20 |
| LISN | R&S | ESH3-Z5 | 100196 | 2018-10-08 | 2019-10-07 |
| LISN | COM-POWER | LI-115 | 02027 | 2018-10-08 | 2019-10-07 |
| 3m Semi-Anechoic Chamber | Chengyu Electron | 9 (L)*6 (W)* 6 (H) | BSL086 | 2018-10-08 | 2019-10-07 |
| Horn Antenna | Schwarzbeck | BBHA9170 | 00814 | 2018-10-21 | 2019-10-20 |
| Loop Antenna | Schwarz beck | FMZB 1519B | 9773 | 2018-10-21 | 2019-10-20 |

# 2. SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test Item | Result |
|---|---|---|
| § 2.1093 | RF Exposure | PASS |
| § 15.203; § 15.247(b)(4)(i) | Antenna Requirement | PASS |
| §15.205 | Restricted Band of Operation | PASS |
| § 15.207(a) | Conducted Emission | PASS |
| § 15.247(e) | Power Spectral Density | PASS |
| § 15.247(a)(2) | 6 dB Bandwidth | PASS |
| § 15.247(b)(3) | RF Output Power | PASS |
| § 15.209(a) | Radiated Emission | PASS |
| § 15.247(d) | Band Edge (Out of Band Emissions) | PASS |

Note: PASS: applicable, N/A: not applicable.

# 3. RF Exposure

## 3.1 Standard Applicable

According to § 1.1307 and § 2.1093, the portable transmitter must comply the RF exposure requirements.

## 3.2 Test Result

This product complied with the requirement of the RF exposure, please see the RF Exposure Report.

# 4. Antenna Requirement

## 4.1 Standard Applicable

According to FCC Part 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

## 4.2 Evaluation Information

This product has a Internal Antenna, fulfill the requirement of this section.

# 5. Power Spectral Density

## 5.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

## 5.2 Test Procedure

According to the KDB 558074 D01 v05, such specifications require that the same method as used to determine the conducted output power shall also be used to determine the power spectral density. The test method of power spectral density as below:

a) Set instrument center frequency to DTS channel center frequency.
b) Set span to at least 1.5 times the OBW.
c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz. .
d) Set VBW ≥3 x RBW.
e) Detector = power averaging (RMS) or sample detector (when RMS not available).
f) Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
g) Sweep time = auto couple.
h) Employ trace averaging (RMS) mode over a minimum of 100 traces.
i) Use the peak marker function to determine the maximum amplitude level.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

## 5.3 Environmental Conditions

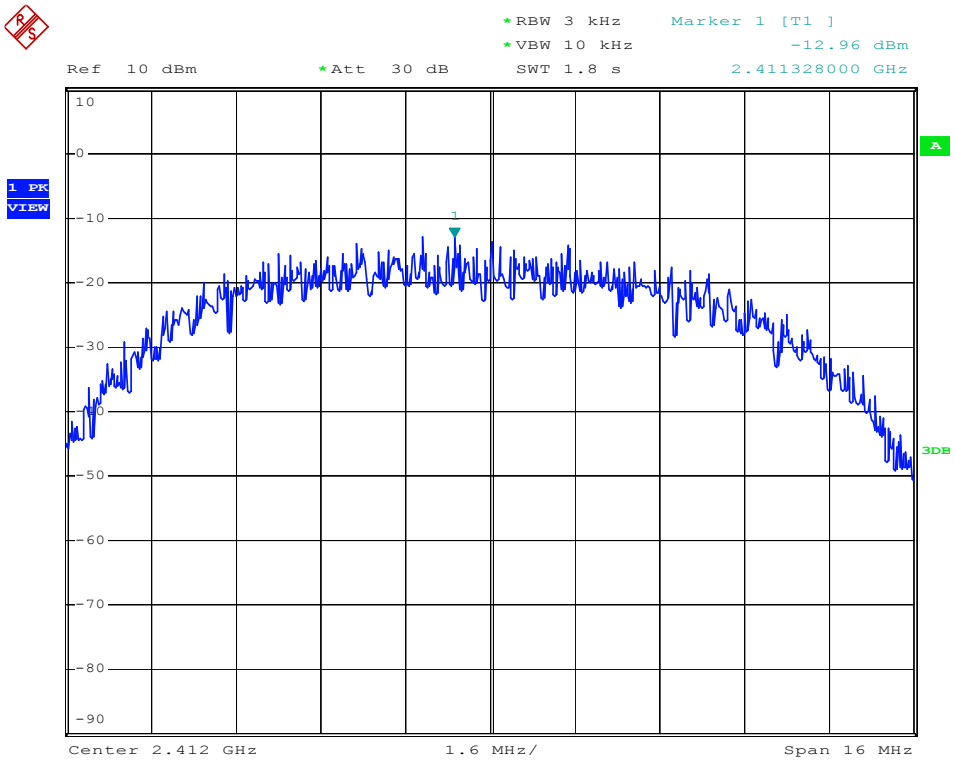
| | |
|---|---|
| Temperature: | 26° C |
| Relative Humidity: | 54% |
| ATM Pressure: | 1011 mbar |

### 5.4 Summary of Test Results/Plots

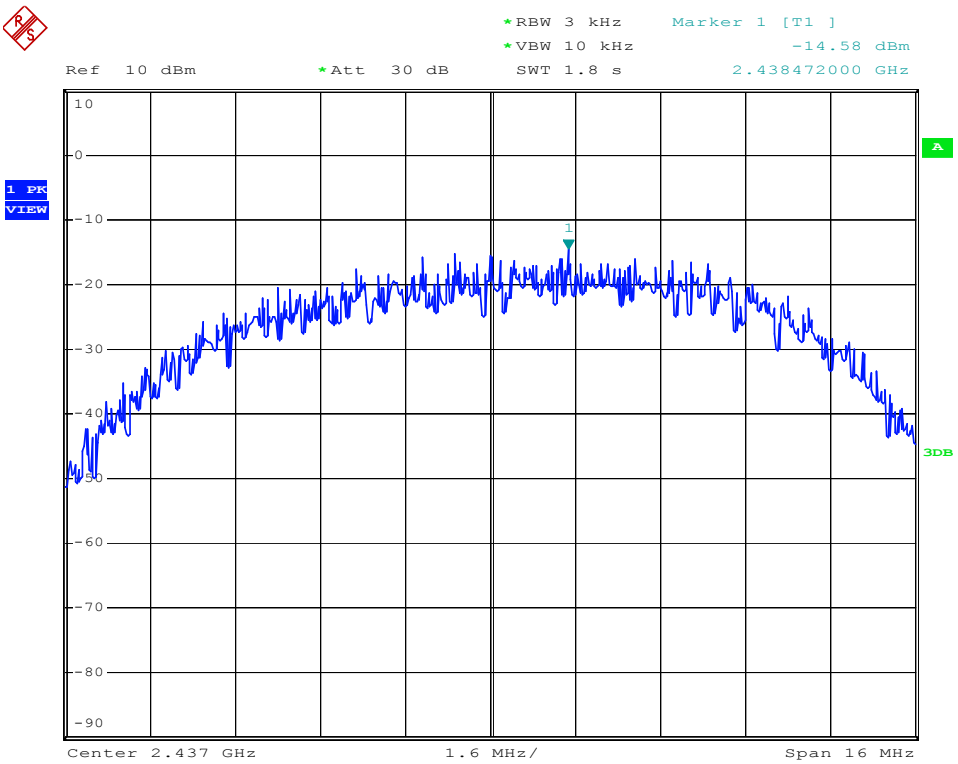
| Test Mode | Test Channel MHz | Power Spectral Density dBm/3kHz | Limit dBm/3kHz |
|---|---|---|---|
| 802.11b | 2412 | -12.96 | 8 |
| | 2437 | -14.58 | 8 |
| | 2462 | -15.34 | 8 |
| 802.11g | 2412 | -16.34 | 8 |
| | 2437 | -18.08 | 8 |
| | 2462 | -19.11 | 8 |
| 802.11n HT20 | 2412 | -21.52 | 8 |
| | 2437 | -21.84 | 8 |
| | 2462 | -21.33 | 8 |
| 802.11n HT40 | 2422 | -22.24 | 8 |
| | 2437 | -24.03 | 8 |
| | 2452 | -23.67 | 8 |

Please refer to the following test plots:

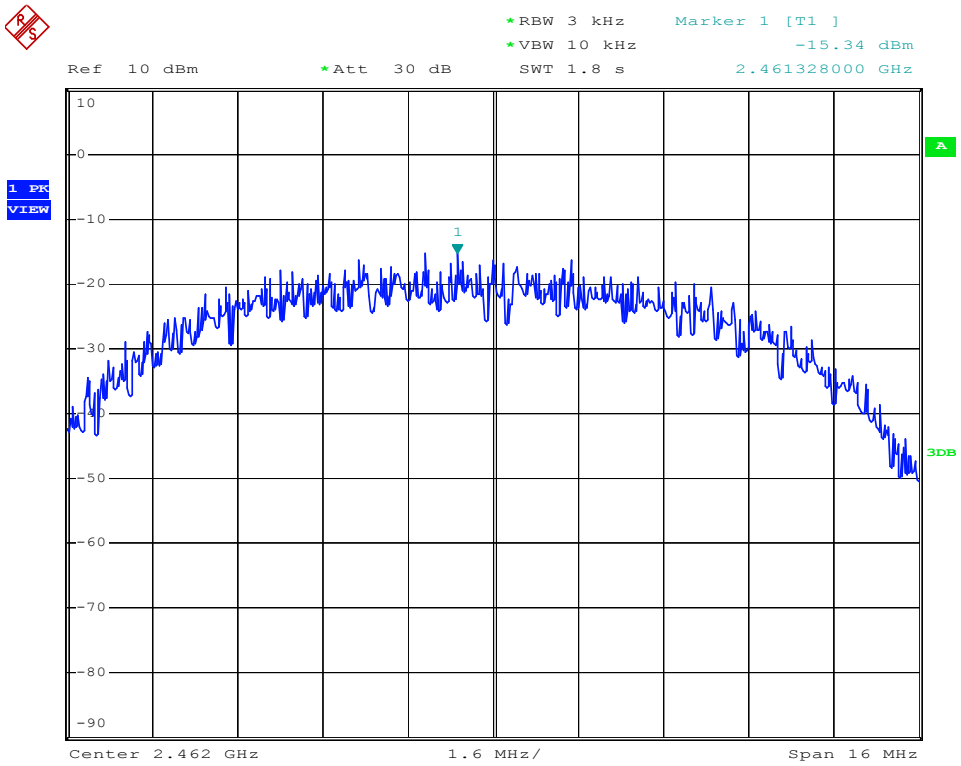
802.11b-Low Channel



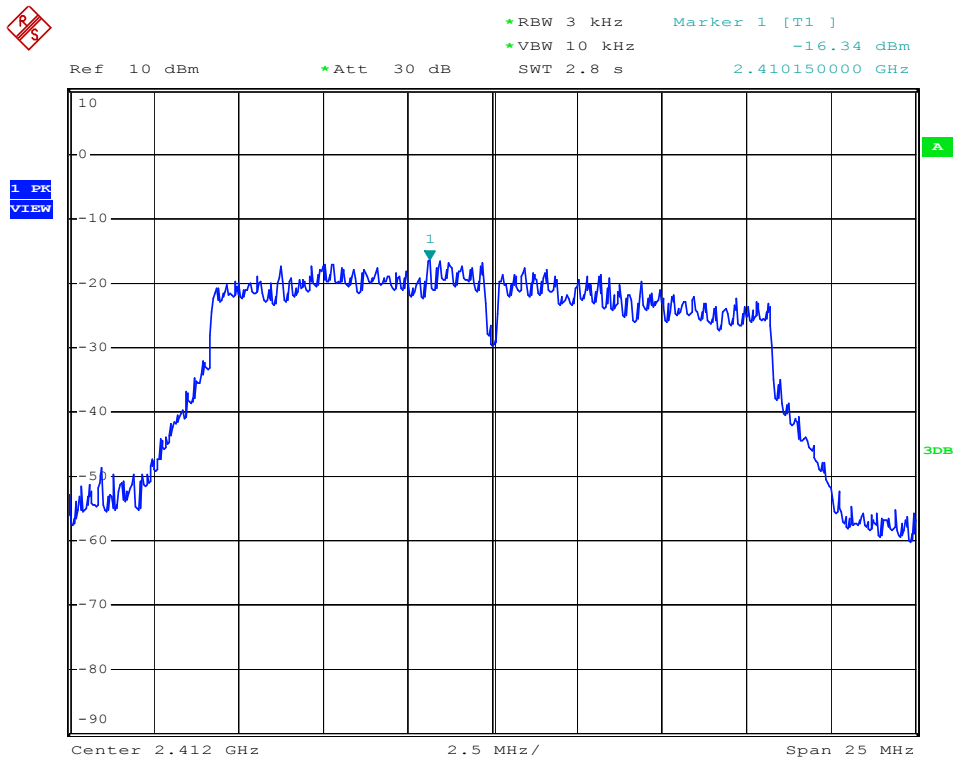

802.11b-Middle Channel



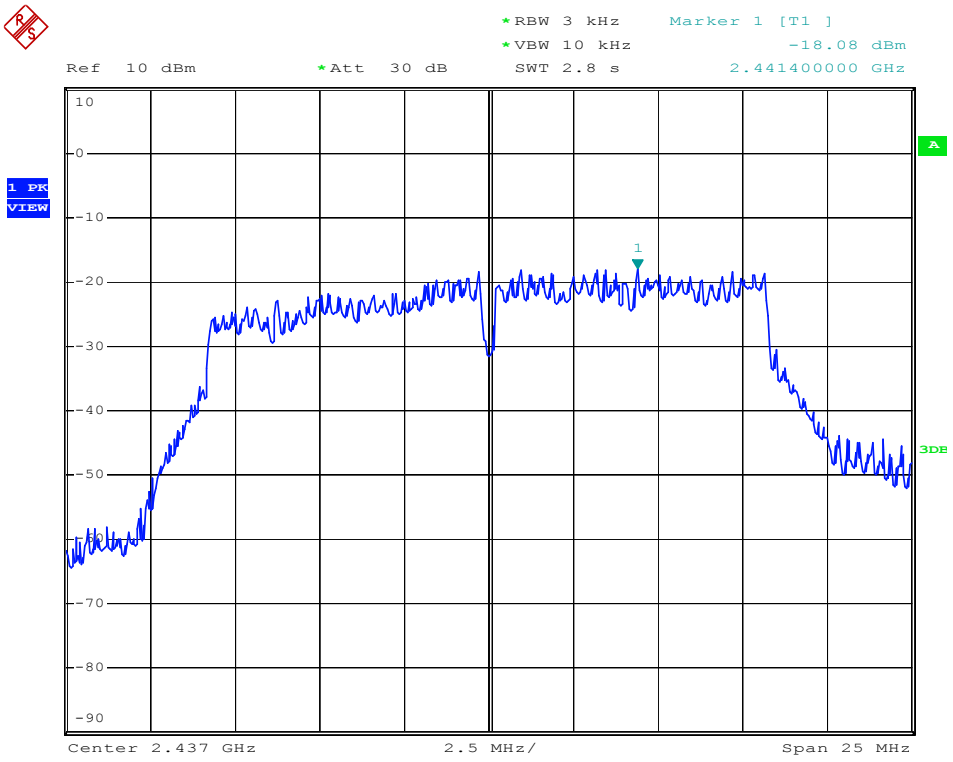
802.11b-High Channel



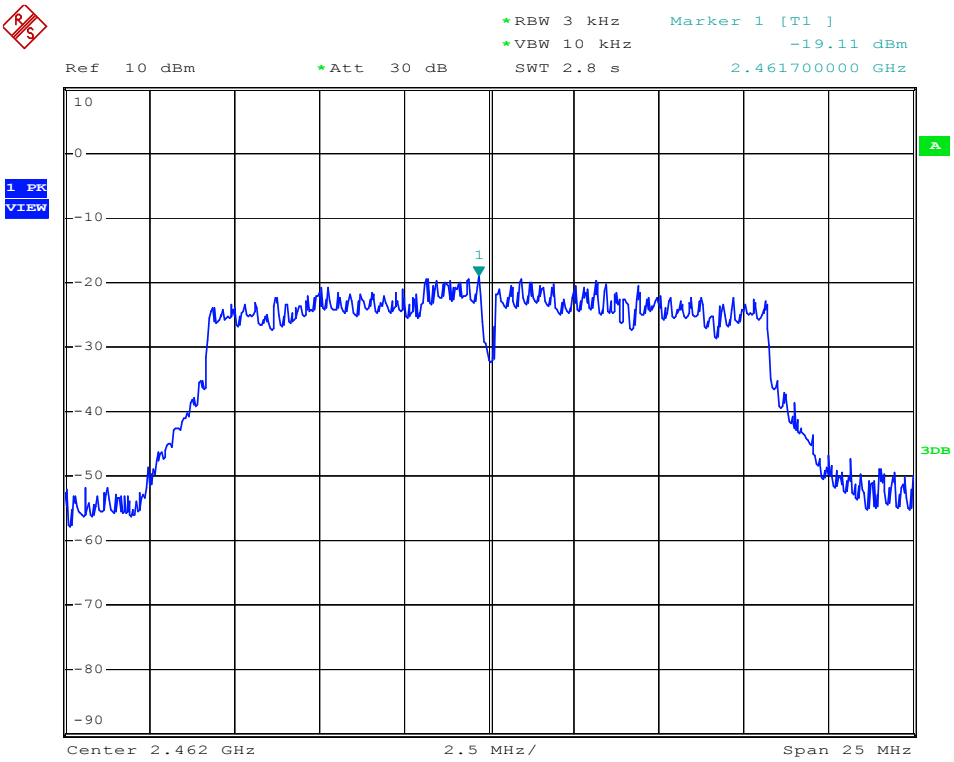

802.11g-Low Channel



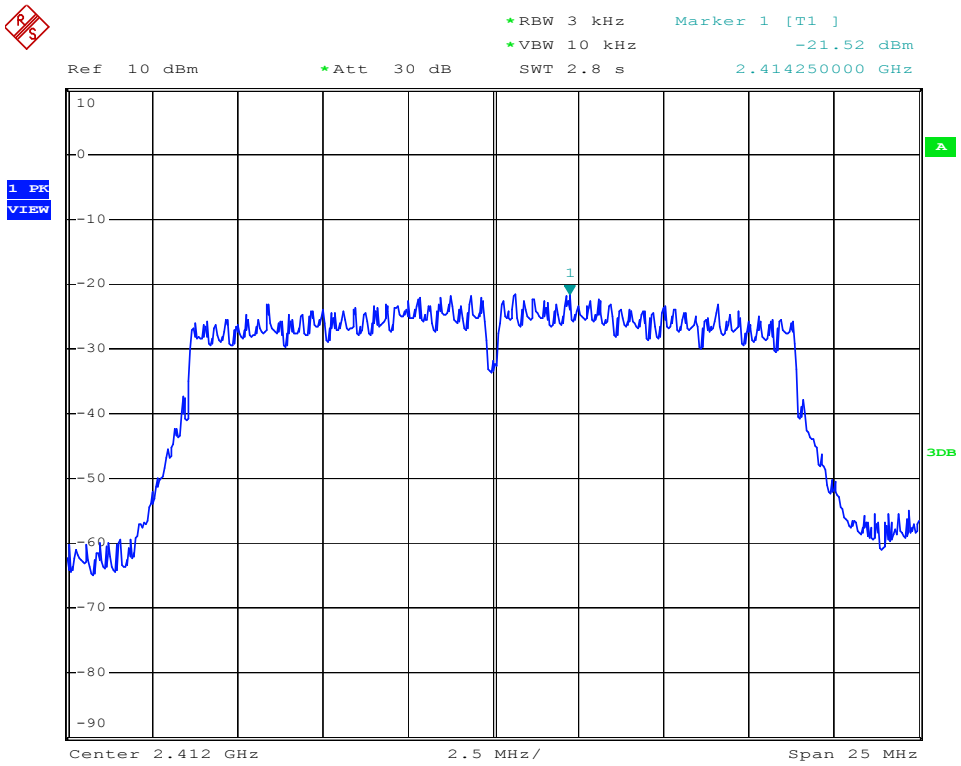
802.11g-Middle Channel



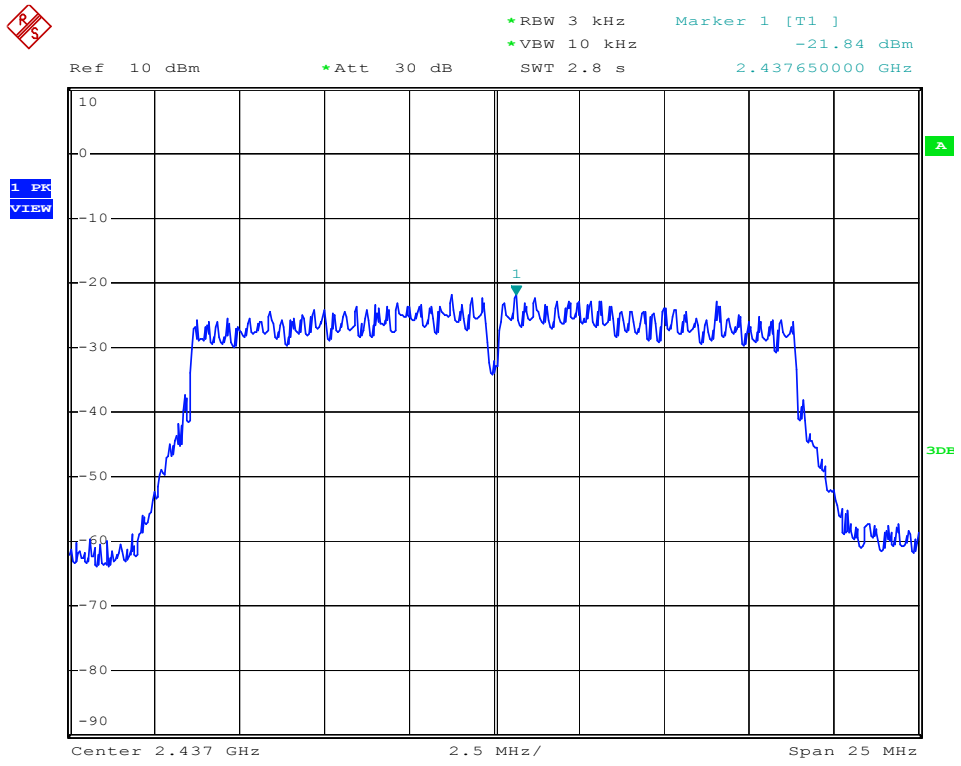

802.11g-High Channel



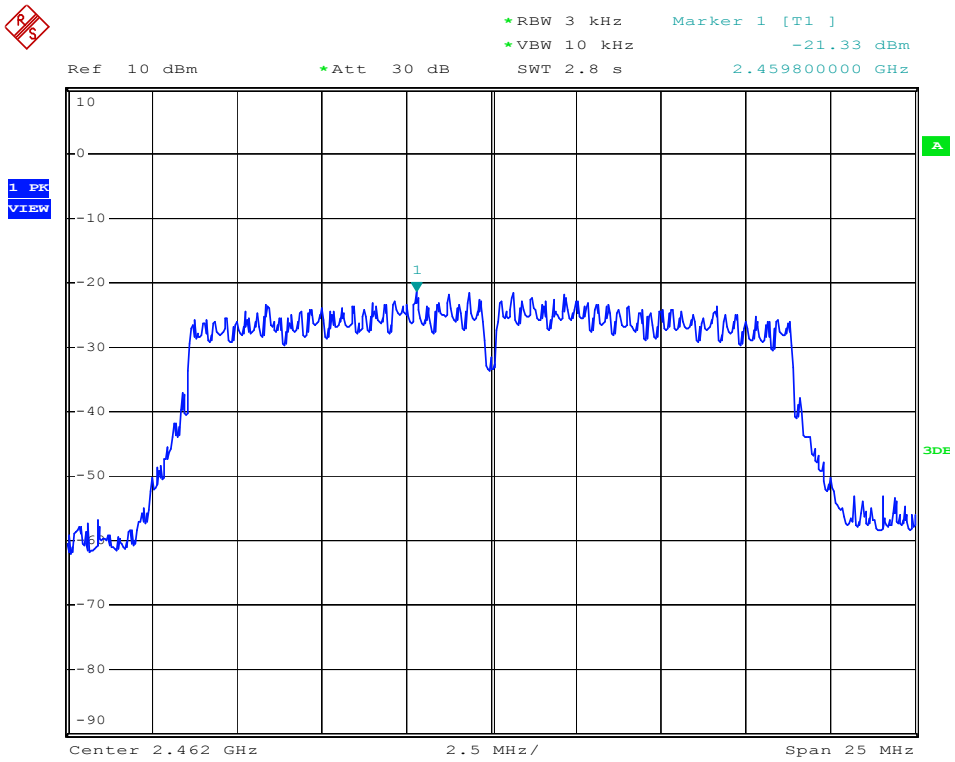
802.11n-HT20-Low Channel



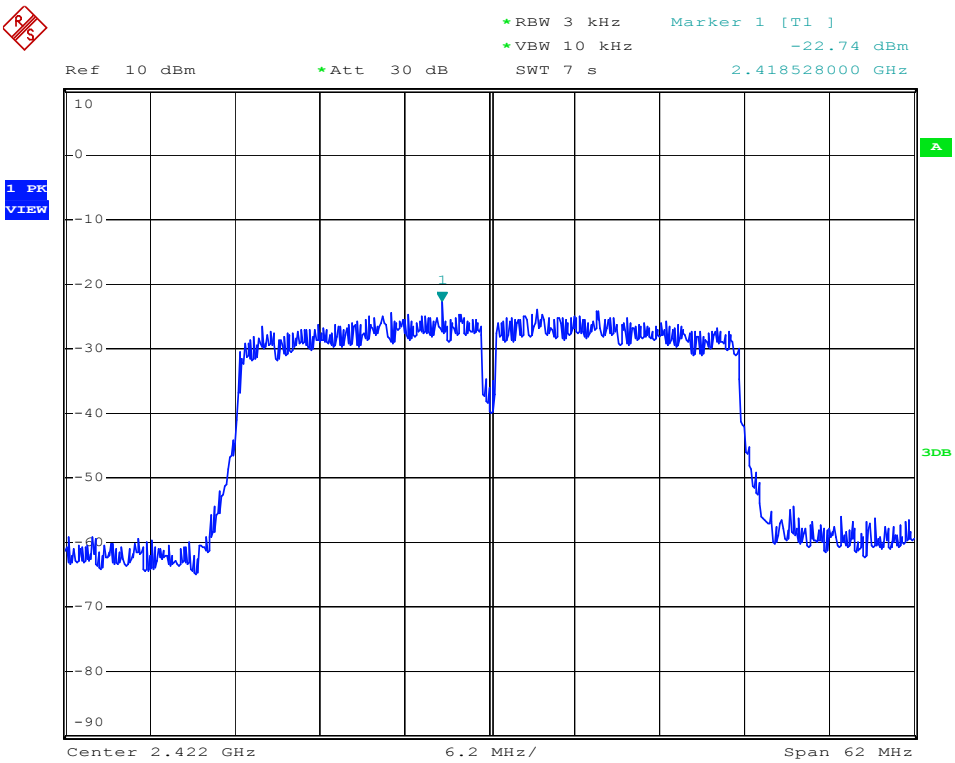

802.11n-HT20-Middle Channel



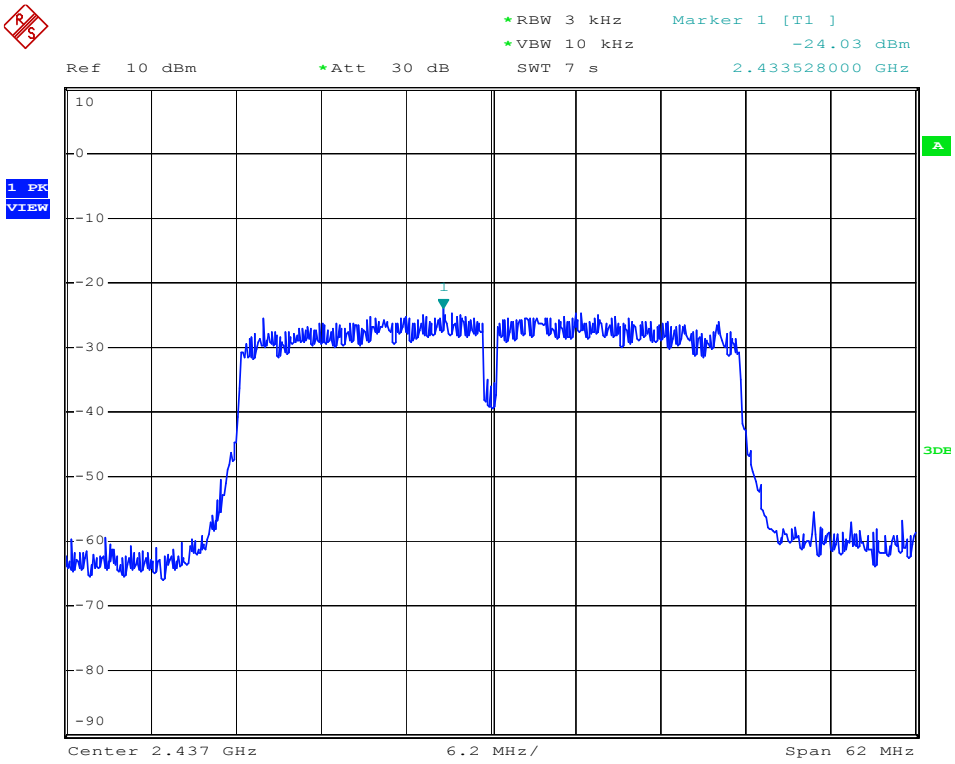
802.11n-HT20-High Channel



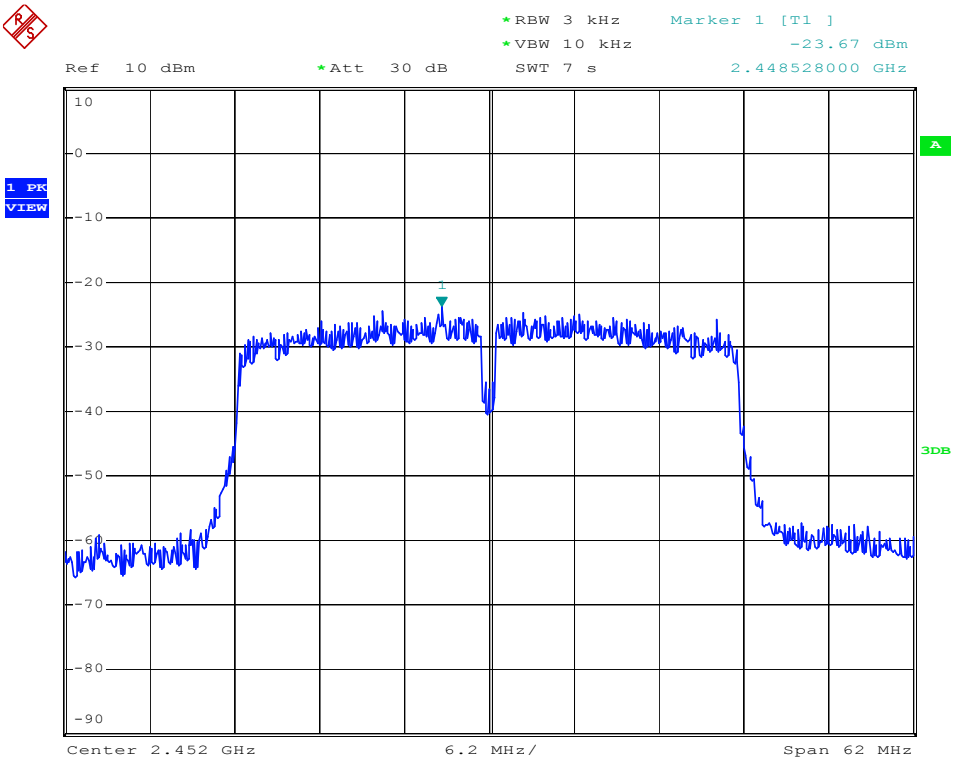

802.11n-HT40-Low Channel



802.11n-HT40-Middle Channel




802.11n-HT40-High Channel



# 6. 6dB Bandwidth

## 6.1 Standard Applicable

According to 15.247(a)(2). Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

## 6.2 Test Procedure

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

## 6.3 Environmental Conditions

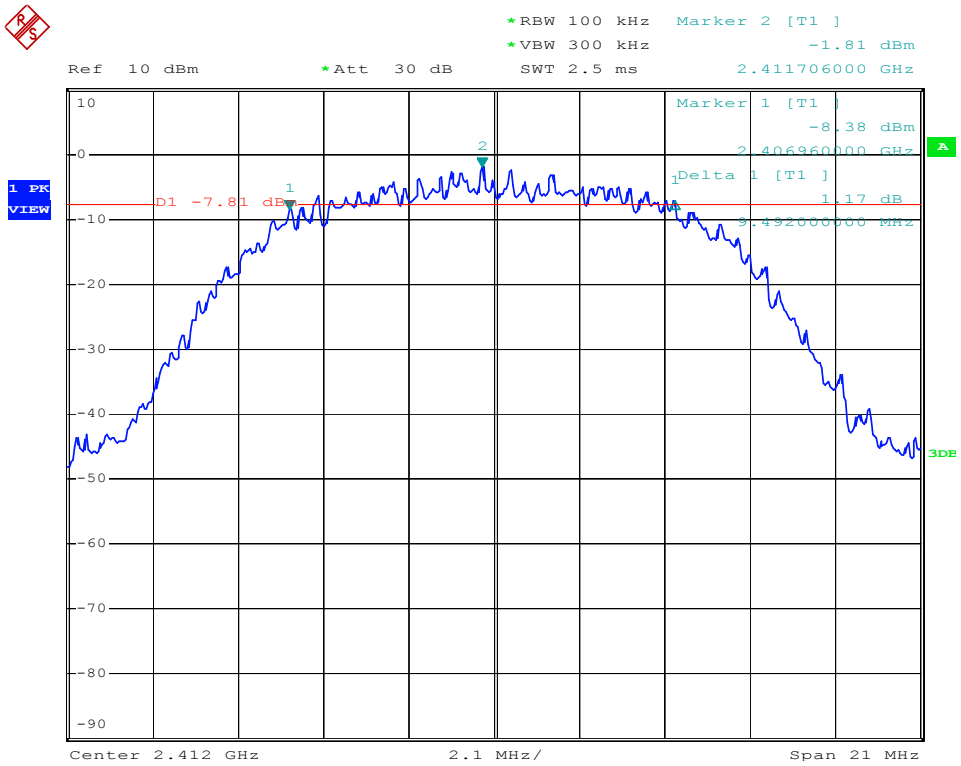
| | |
|---|---|
| Temperature: | 25° C |
| Relative Humidity: | 53% |
| ATM Pressure: | 1018 mbar |

## 6.4 Summary of Test Results/Plots

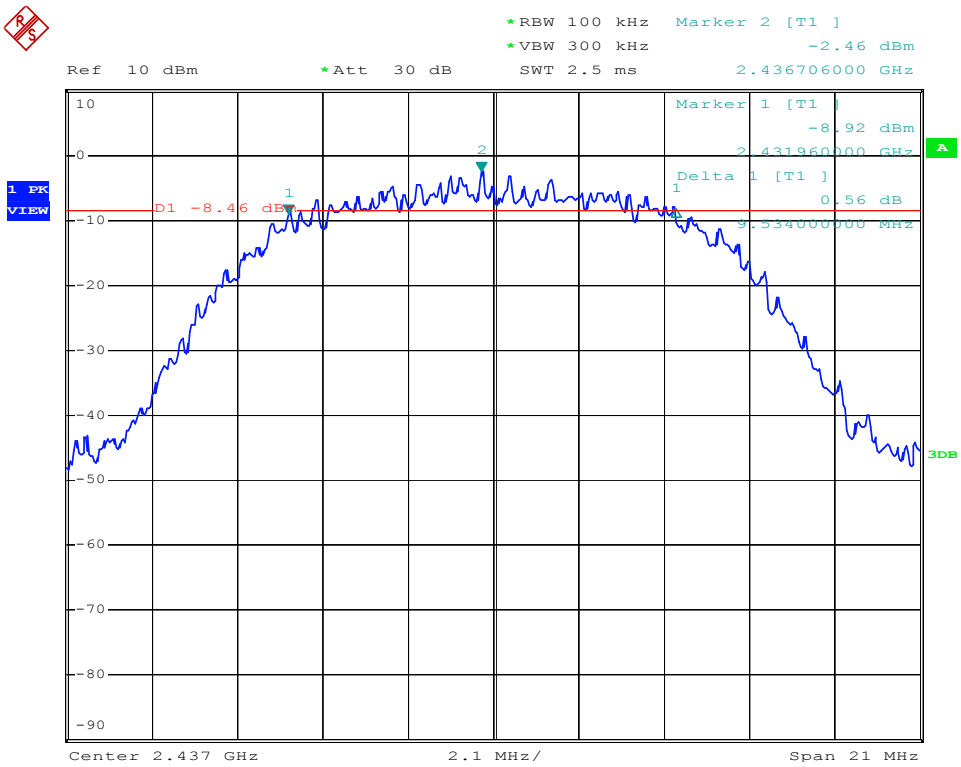
| Test Mode | Test Channel MHz | 6 dB Bandwidth MHz | Limit kHz |
|---|---|---|---|
| 802.11b | 2412 | 9.492 | ≥500 |
| | 2437 | 9.534 | ≥500 |
| | 2462 | 9.534 | ≥500 |
| 802.11g | 2412 | 16.536 | ≥500 |
| | 2437 | 16.536 | ≥500 |
| | 2462 | 16.536 | ≥500 |
| 802.11n-HT20 | 2412 | 17.680 | ≥500 |
| | 2437 | 17.680 | ≥500 |
| | 2462 | 17.680 | ≥500 |
| 802.11n-HT40 | 2422 | 36.504 | ≥500 |
| | 2437 | 36.460 | ≥500 |
| | 2452 | 36.472 | ≥500 |

Please refer to the following test plots:

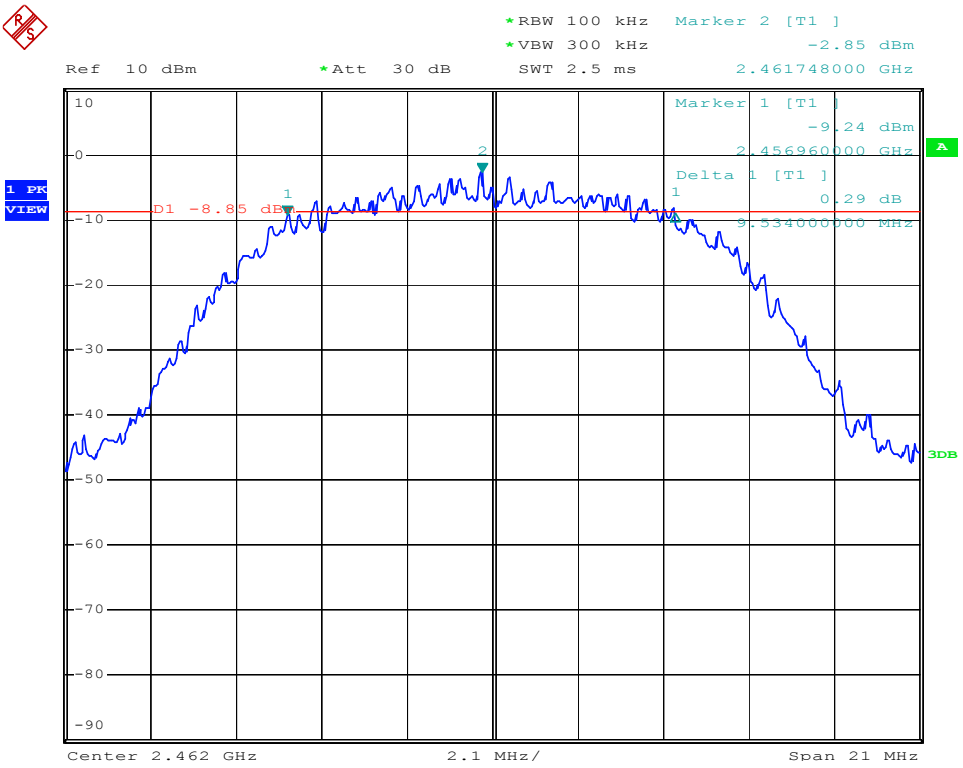
802.11b-Low Channel



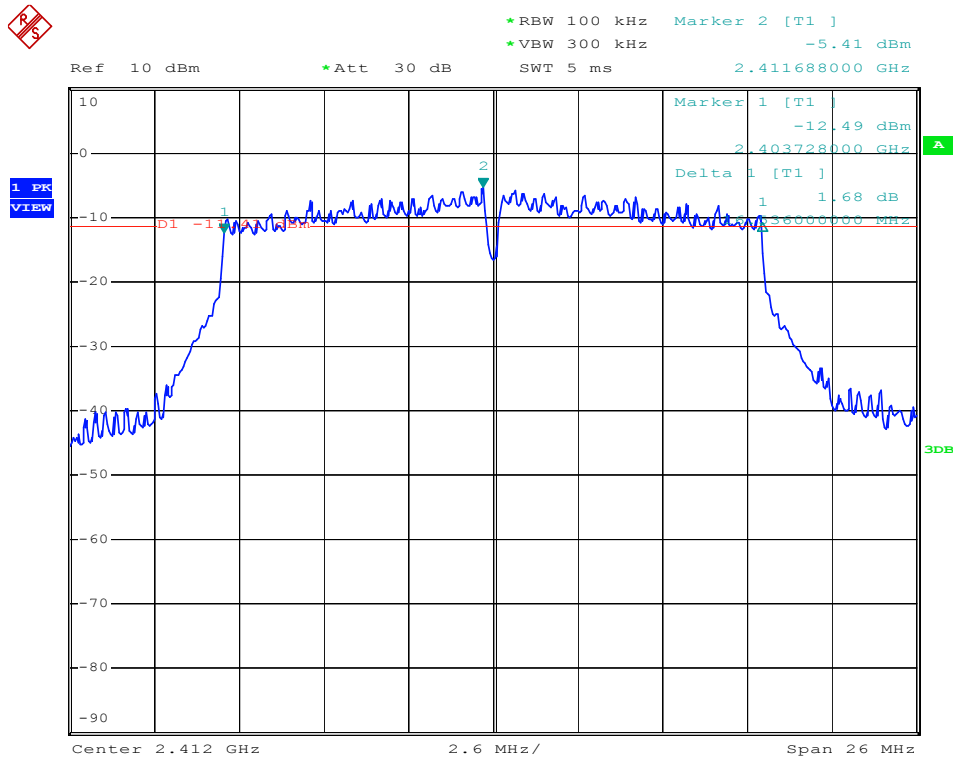

802.11b-Middle Channel



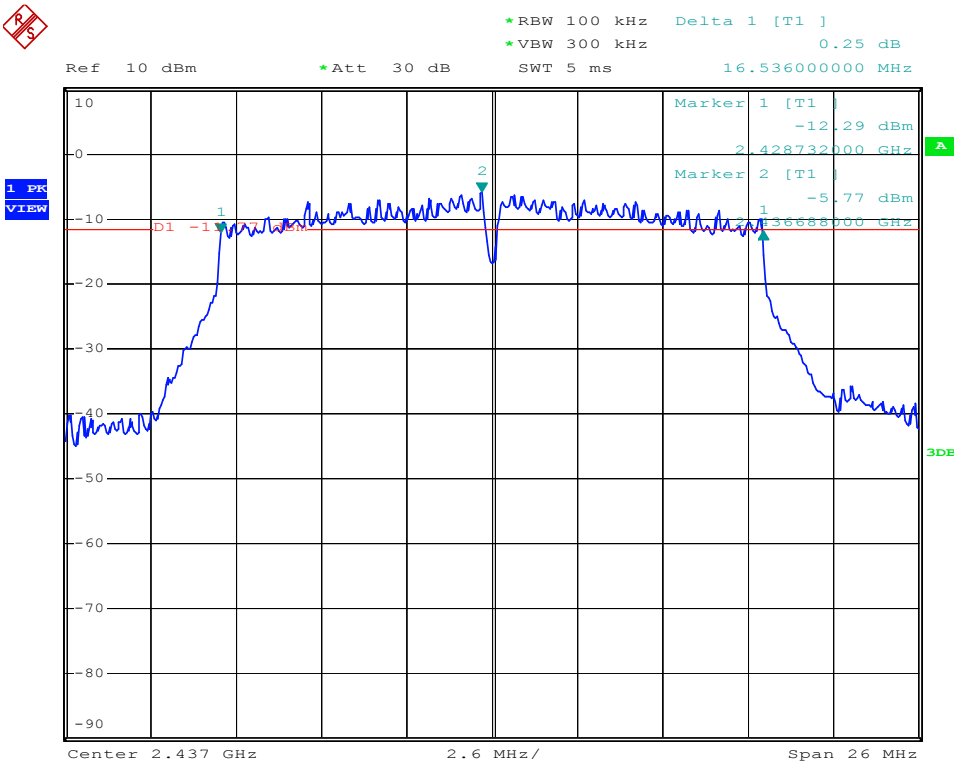
802.11b-High Channel



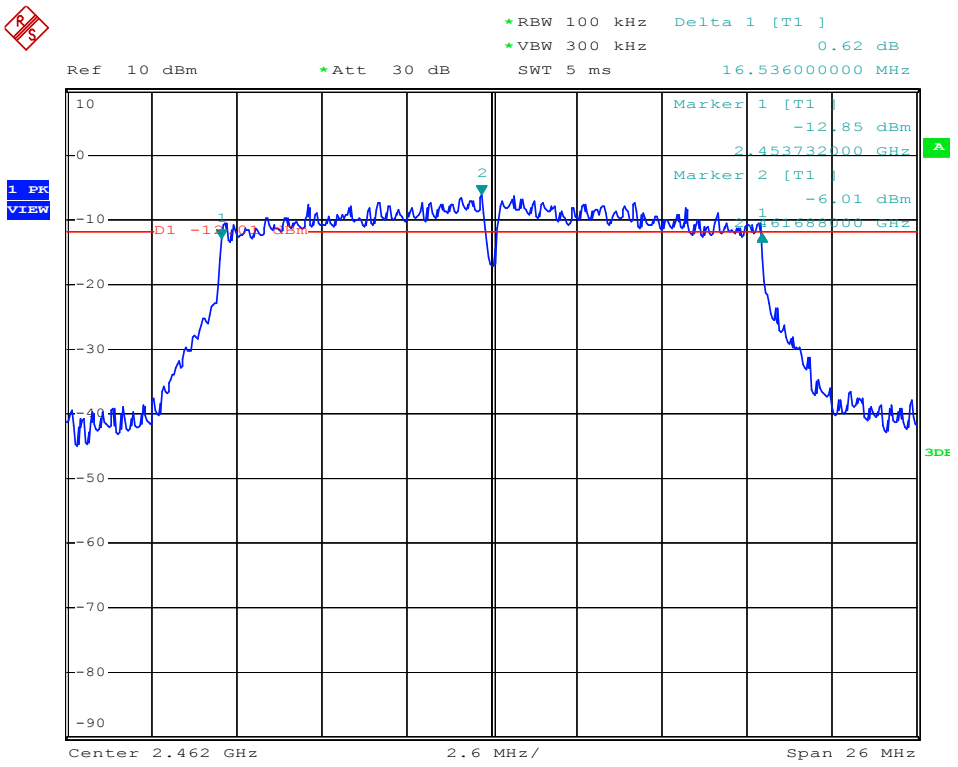

802.11g-Low Channel



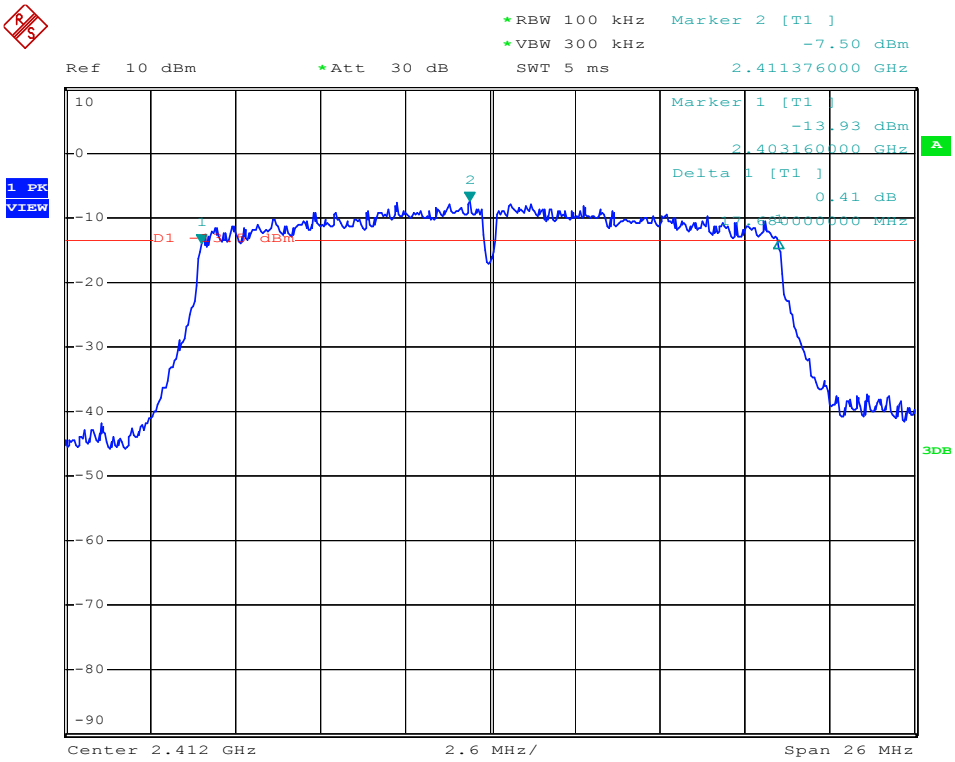
802.11g-Middle Channel



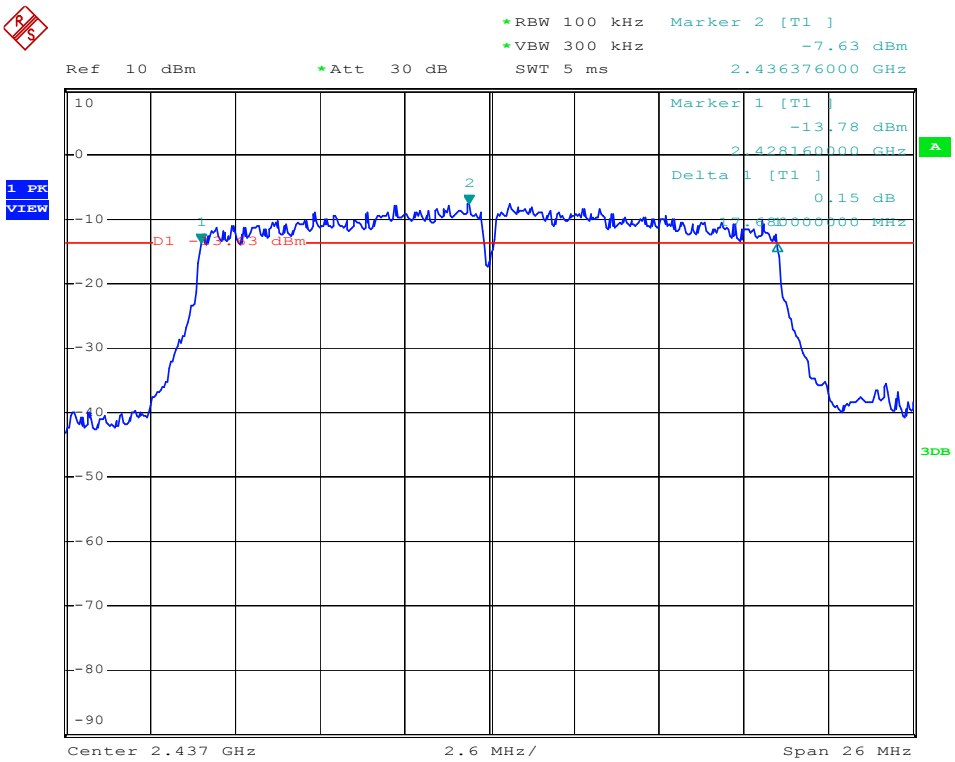

802.11g-High Channel



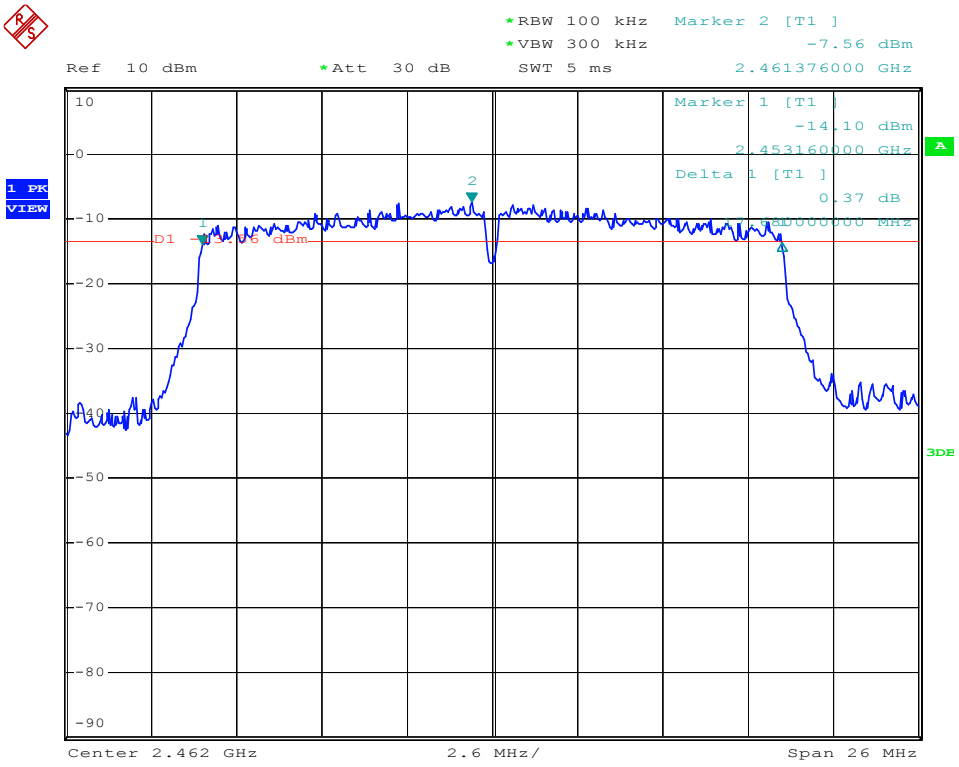
802.11n-HT20-Low Channel



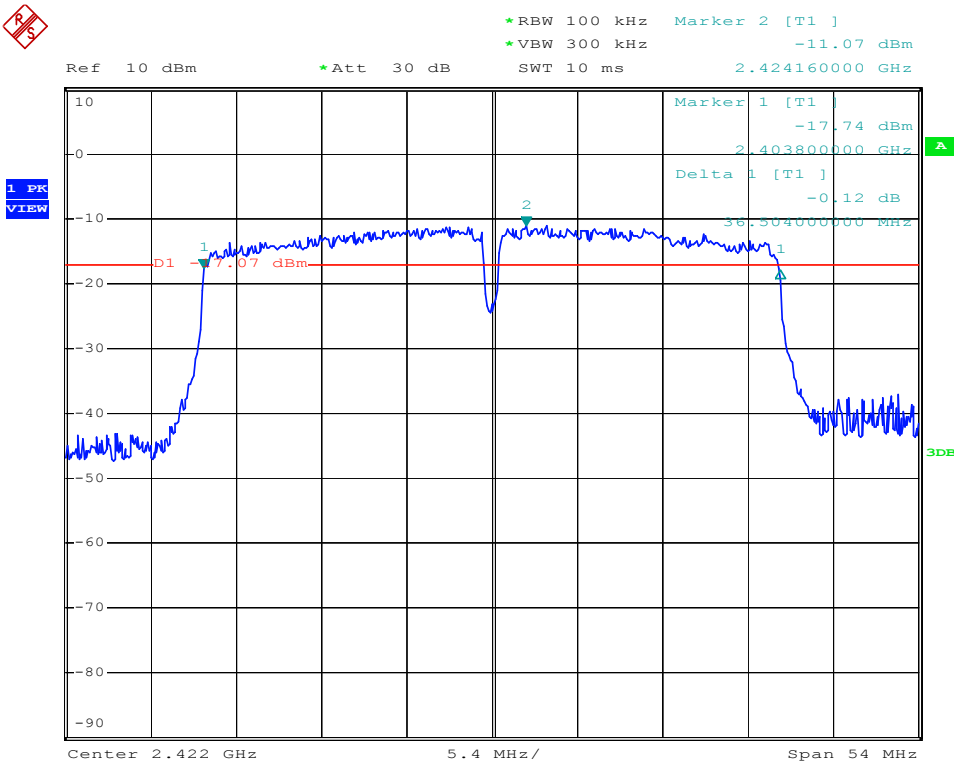

802.11n-HT20-Middle Channel



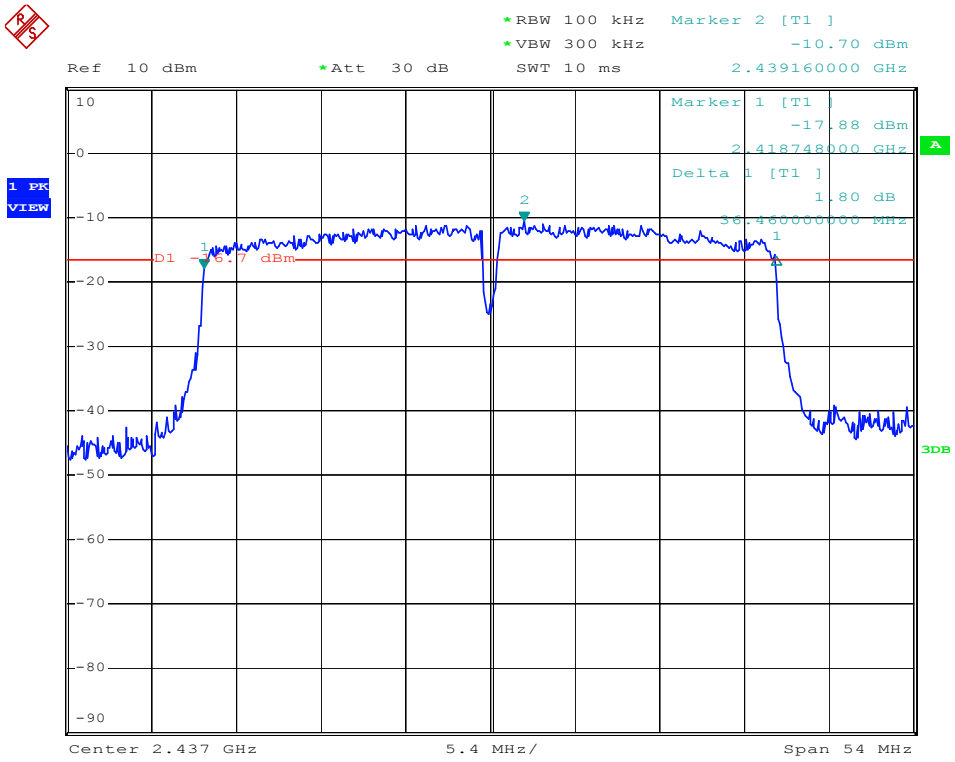
802.11n-HT20-High Channel



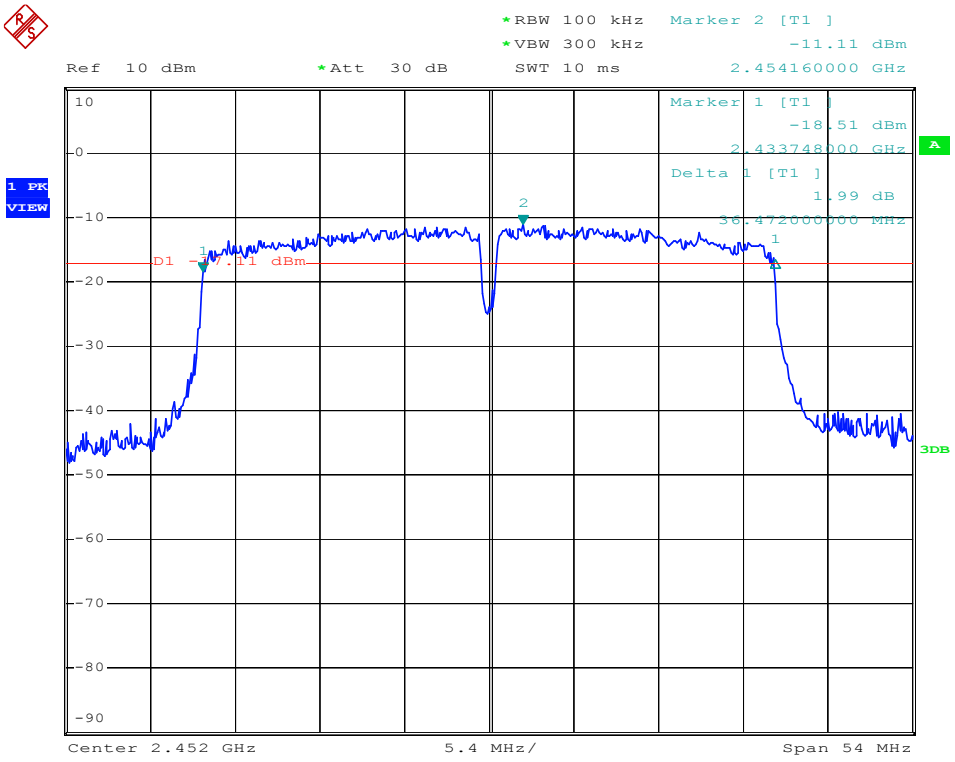

802.11n-HT40-Low Channel



802.11n-HT40-Middle Channel




802.11n-HT40-High Channel



# 7. RF Output Power

## 7.1 Standard Applicable

According to 15.247(b)(3). For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

## 7.2 Test Procedure

According to the KDB-558074 D01 v05, 9.2.2.2, when this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth

a) Set span to at least 1.5 times the OBW.
b) Set RBW = 1-5% of the OBW, not to exceed 1 MHz.
c) Set VBW ≥ 3 x RBW.
d) Number of points in sweep ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
e) Sweep time = auto.
f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
g) If transmit duty cycle < 98 %, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run".
h) Trace average at least 100 traces in power averaging (i.e., RMS) mode.
i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

## 7.3 Environmental Conditions

| | |
|---|---|
| Temperature: | 26° C |
| Relative Humidity: | 57% |
| ATM Pressure: | 1011 mbar |

## 7.4 Summary of Test Results/Plots

| Test Mode | Frequency MHz | Reading dBm | Output Power mW | Limit mW |
|---|---|---|---|---|
| 802.11b _ 11Mbps | 2412 | 13.32 | 21.47 | 1000 |
| | 2437 | 13.41 | 21.92 | 1000 |
| | 2462 | 13.25 | 21.13 | 1000 |
| 802.11g_54Mbps | 2412 | 12.53 | 17.90 | 1000 |
| | 2437 | 12.38 | 17.29 | 1000 |
| | 2462 | 12.41 | 17.41 | 1000 |
| 802.11n HT20_MCS7 | 2412 | 11.76 | 14.99 | 1000 |
| | 2437 | 11.48 | 14.06 | 1000 |
| | 2462 | 11.41 | 13.83 | 1000 |
| 802.11n HT40_MCS7 | 2422 | 11.37 | 13.70 | 1000 |
| | 2437 | 11.33 | 13.58 | 1000 |
| | 2452 | 11.29 | 13.45 | 1000 |

# 8. Field Strength of Spurious Emissions

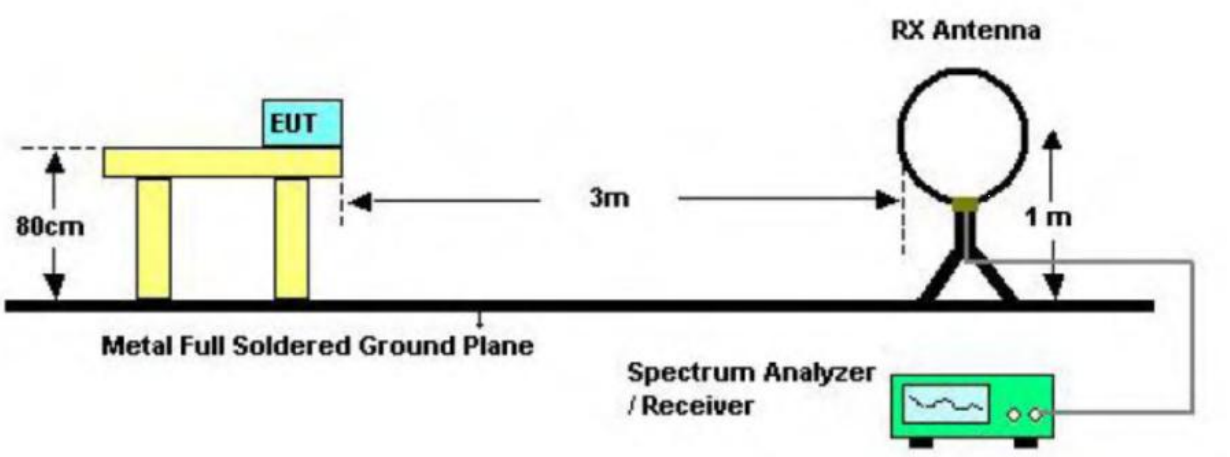
## 8.1 Standard Applicable

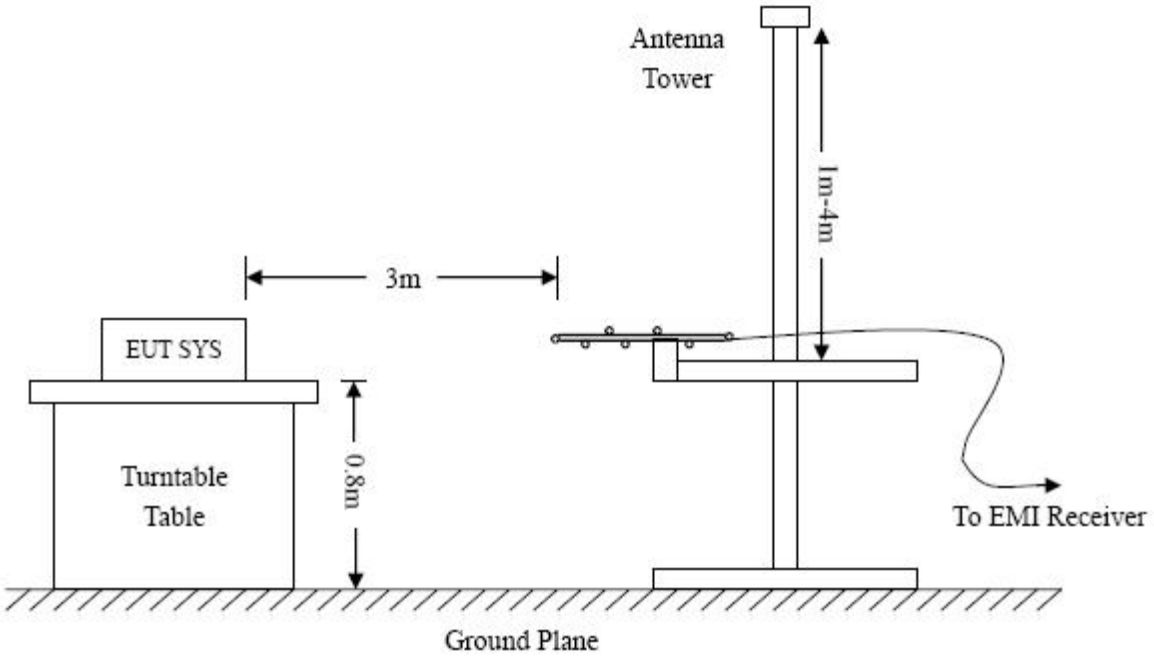
According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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).

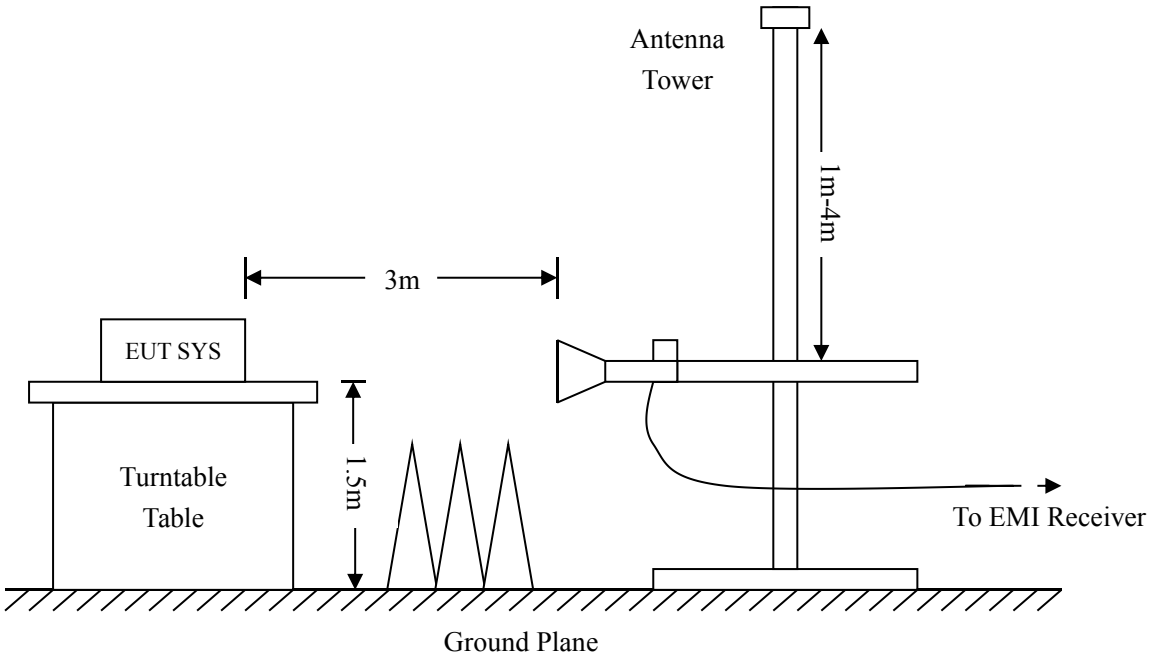
The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

## 8.2 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.






| | | |
|---|---|---|
| Frequency :9kHz-30MHz | Frequency :30MHz-1GHz | Frequency :Above 1GHz |
| RBW=10KHz, | RBW=120KHz, | RBW=1MHz, |
| VBW =30KHz | VBW=300KHz | VBW=3MHz(Peak), 10Hz(AV) |
| Sweep time= Auto | Sweep time= Auto | Sweep time= Auto |
| Trace = max hold | Trace = max hold | Trace = max hold |
| Detector function = peak | Detector function = peak, QP | Detector function = peak, AV |

## 8.3 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Ant. Factor + Cable Loss – Ampl. Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dBμV means the emission is 6dBμV below the maximum limit. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – FCC Part 15 Limit

## 8.4 Environmental Conditions

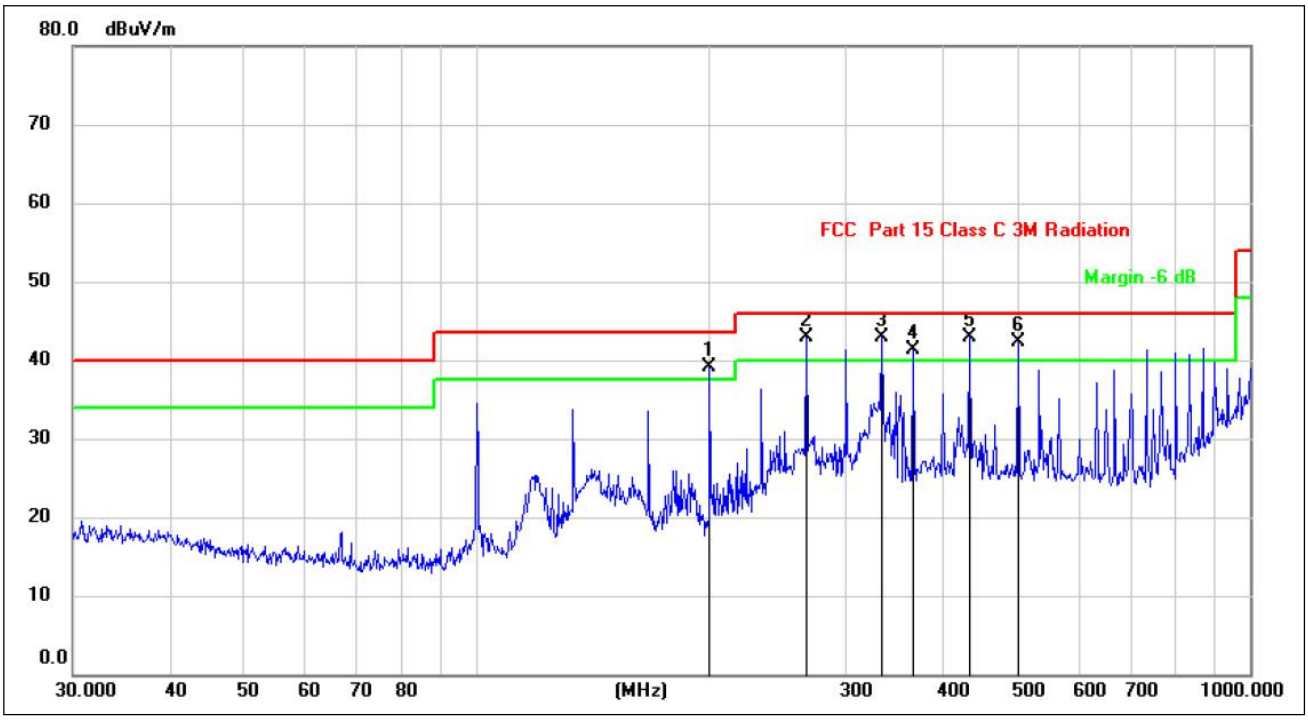
| | |
|---|---|
| Temperature: | 25 °C |
| Relative Humidity: | 52% |
| ATM Pressure: | 1012 mbar |

## 8.5 Summary of Test Results/Plots

According to the data below, the FCC Part 15.205, 15.209 and 15.247 standards, and had the worst cases:

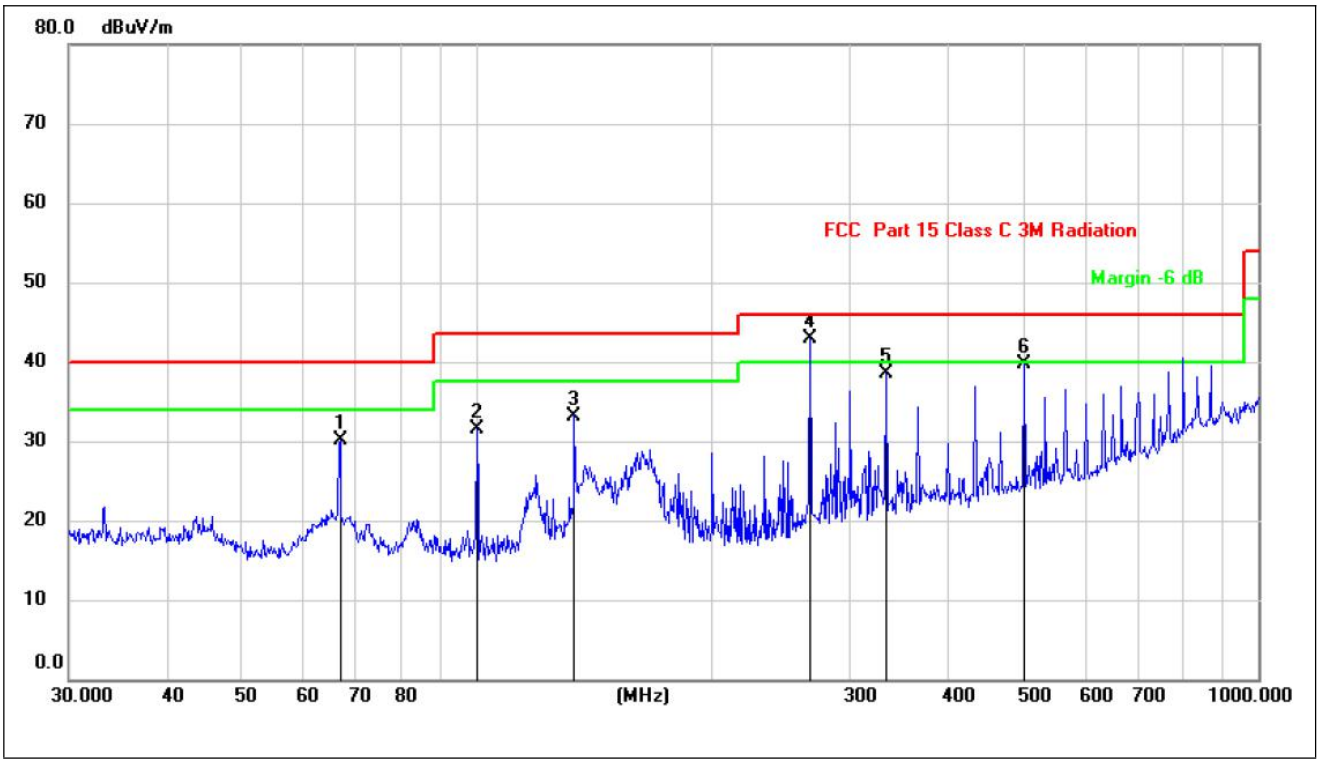
*Note:*
*1. Worst-case radiated emission below 1GHz is 802.11b (CH Low) mode.*
*2. Worst-case radiated emission above 1GHz is 802.11g (CH Low, Middle, High) mode.*

**Plot of Radiated Emissions Test Data (30MHz to 1GHz)**
*Operating Condition: 802.11b Transmitting Low Channel-2412MHz*
*Test Specification: Horizontal*




| No. | Mk. | Freq. | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | ! | 199.9856 | 39.04 | 43.50 | -4.46 | QP | | | |
| 2 | * | 266.6089 | 43.00 | 46.00 | -3.00 | QP | | | |
| 3 | ! | 333.6865 | 42.87 | 46.00 | -3.13 | QP | | | |
| 4 | ! | 366.8231 | 41.24 | 46.00 | -4.76 | QP | | | |
| 5 | ! | 434.0650 | 42.93 | 46.00 | -3.07 | QP | | | |
| 6 | ! | 501.1789 | 42.22 | 46.00 | -3.78 | QP | | | |

*Test Specification:* *Vertical*




| No. | Mk. | Freq. | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | | 66.7325 | 30.03 | 40.00 | -9.97 | QP | | | |
| 2 | | 99.8777 | 31.54 | 43.50 | -11.96 | QP | | | |
| 3 | | 133.1511 | 33.20 | 43.50 | -10.30 | QP | | | |
| 4 | * | 266.6089 | 42.89 | 46.00 | -3.11 | QP | | | |
| 5 | | 333.6867 | 38.47 | 46.00 | -7.53 | QP | | | |
| 6 | | 501.1790 | 39.63 | 46.00 | -6.37 | QP | | | |

*Spurious Emissions Above 1GHz*

*Test Mode: 802.11g*

| Frequency | Result | Limit | Margin | Polar | Detector |
|---|---|---|---|---|---|
| (MHz) | (dBuV/m) | (dBuV/m) | (dB) | H/V | |
| Low channel-2412MHz | | | | | |
| 4824.000 | 54.36 | 74 | -19.64 | H | PK |
| 4824.000 | 45.81 | 54 | -8.19 | H | AV |
| 7236.000 | 55.77 | 74 | -18.23 | H | PK |
| 7236.000 | 46.39 | 54 | -7.61 | H | AV |
| 4824.000 | 54.78 | 74 | -19.22 | V | PK |
| 4824.000 | 46.23 | 54 | -7.77 | V | AV |
| 7236.000 | 52.71 | 74 | -21.29 | V | PK |
| 7236.000 | 40.96 | 54 | -13.04 | V | AV |
| Middle channel-2437MHz | | | | | |
| 4874.000 | 52.37 | 74 | -21.63 | H | PK |
| 4874.000 | 44.58 | 54 | -9.42 | H | AV |
| 7311.000 | 51.25 | 74 | -22.75 | H | PK |
| 7311.000 | 38.76 | 54 | -15.24 | H | AV |
| 4874.000 | 54.68 | 74 | -19.32 | V | PK |
| 4874.000 | 44.29 | 54 | -9.71 | V | AV |
| 7311.000 | 53.79 | 74 | -20.21 | V | PK |
| 7311.000 | 39.86 | 54 | -14.14 | V | AV |
| High channel-2462MHz | | | | | |
| 4924.000 | 52.77 | 74 | -21.23 | H | PK |
| 4924.000 | 39.68 | 54 | -14.32 | H | AV |
| 7386.000 | 52.59 | 74 | -21.41 | H | PK |
| 7386.000 | 39.37 | 54 | -14.63 | H | AV |
| 4924.000 | 52.34 | 74 | -20.06 | V | PK |
| 4924.000 | 43.68 | 54 | -10.32 | V | AV |
| 7386.000 | 52.91 | 74 | -21.09 | V | PK |
| 7386.000 | 38.57 | 54 | -15.43 | V | AV |

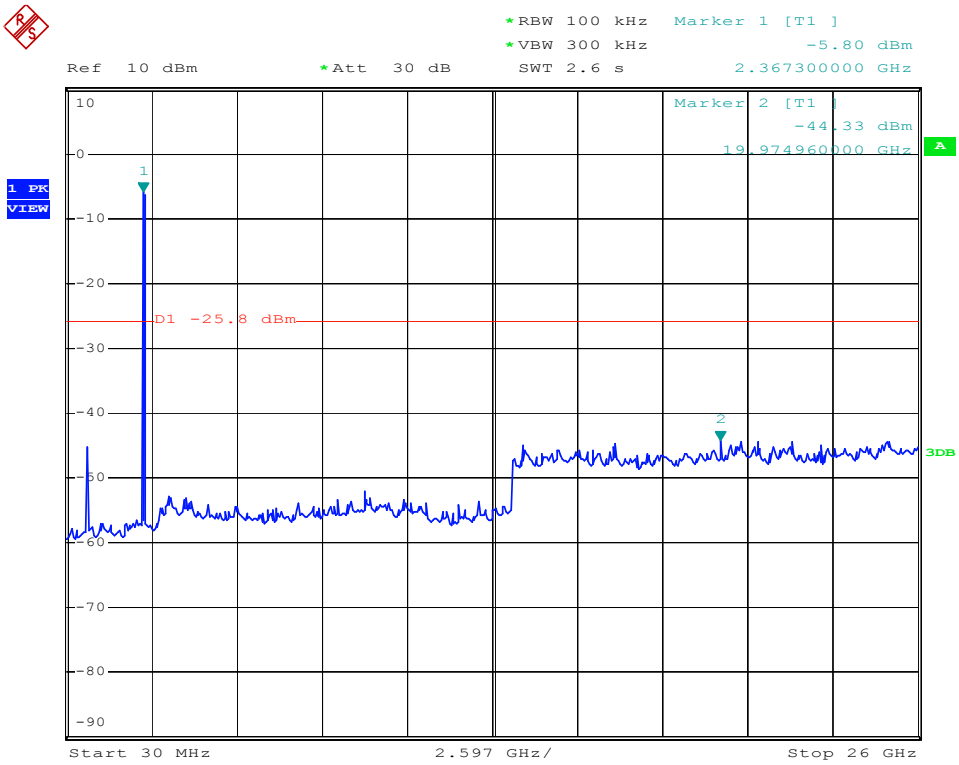
Note:

1. Calculation of result is: Result (dBm) = Reading (dBm) + Correction Factor (dB).
2. Correction Factor (dB)=Ant. Factor + Cable Loss – Ampl. Gain.
3. Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

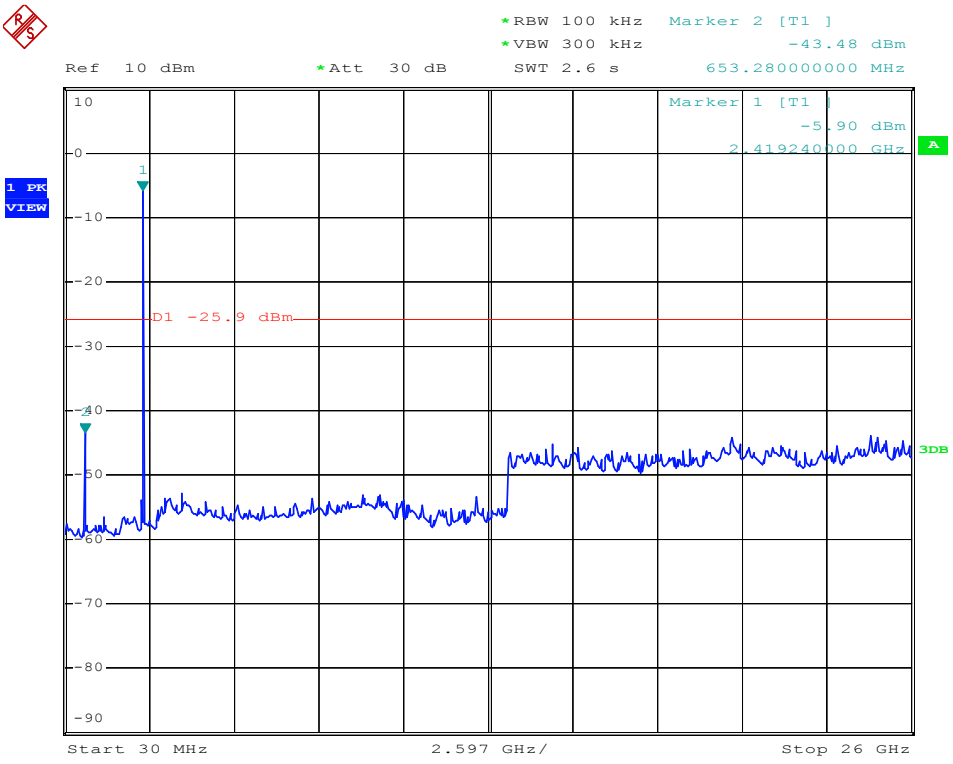
Spurious (Conducted)

802.11b-Lowest

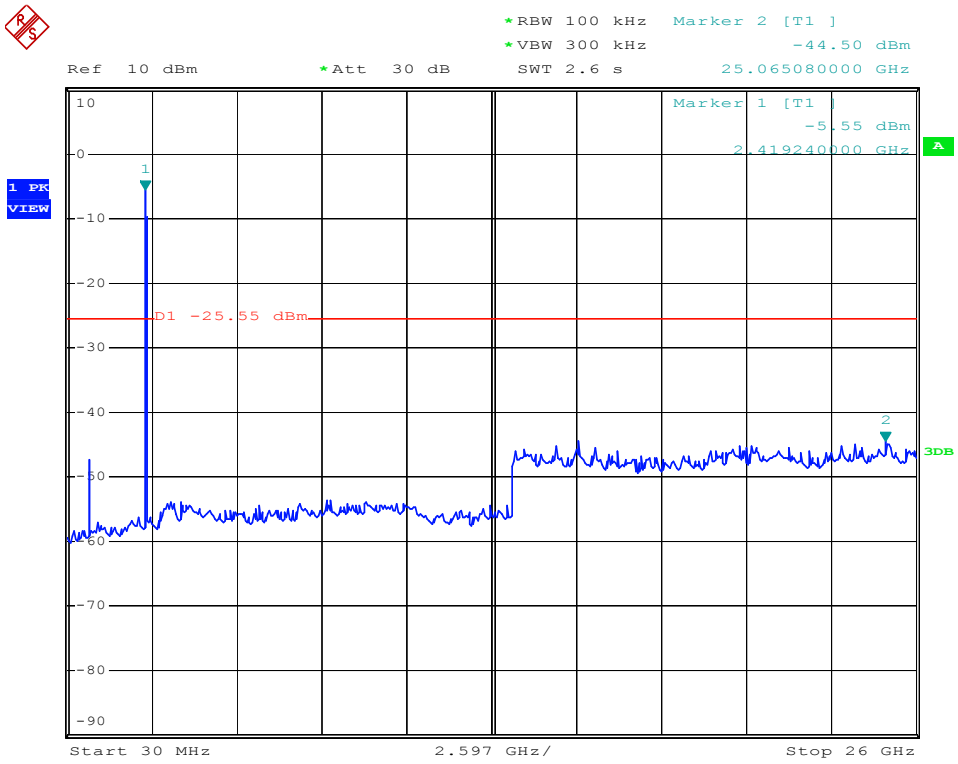
Lowest




Middle



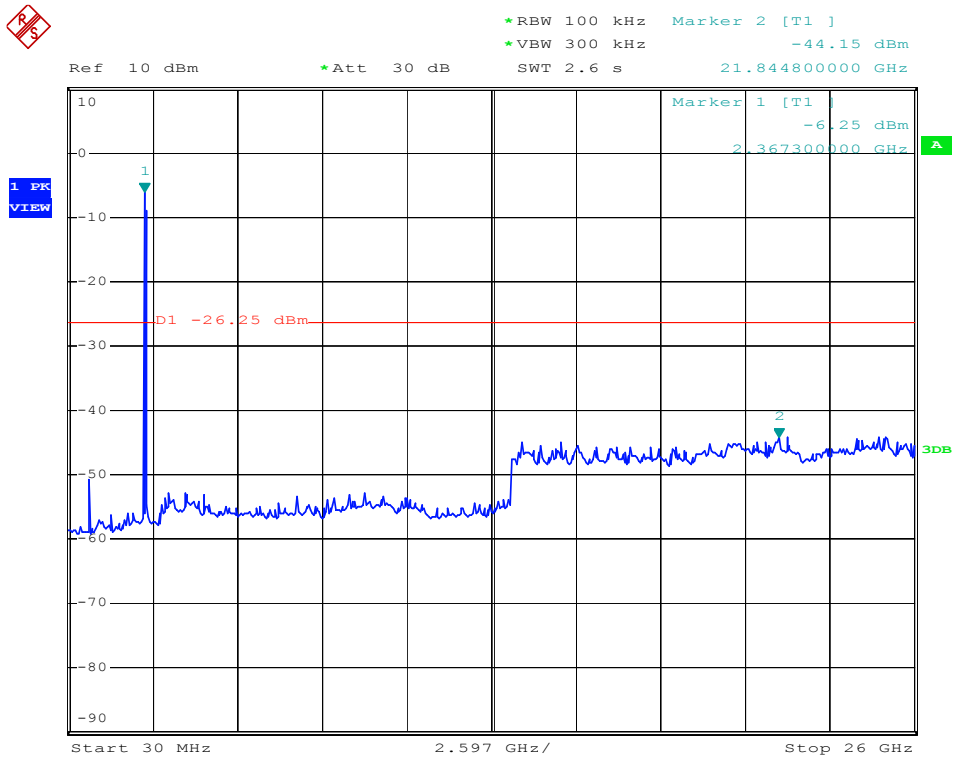
Highest



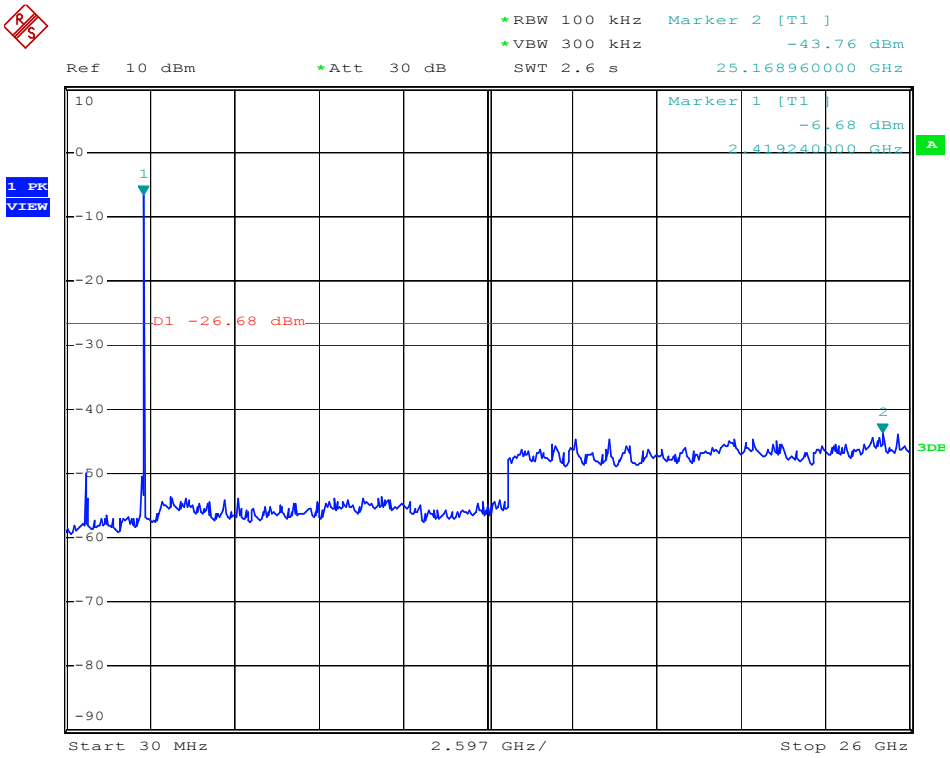

Spurious (Conducted)

802.11g-Lowest

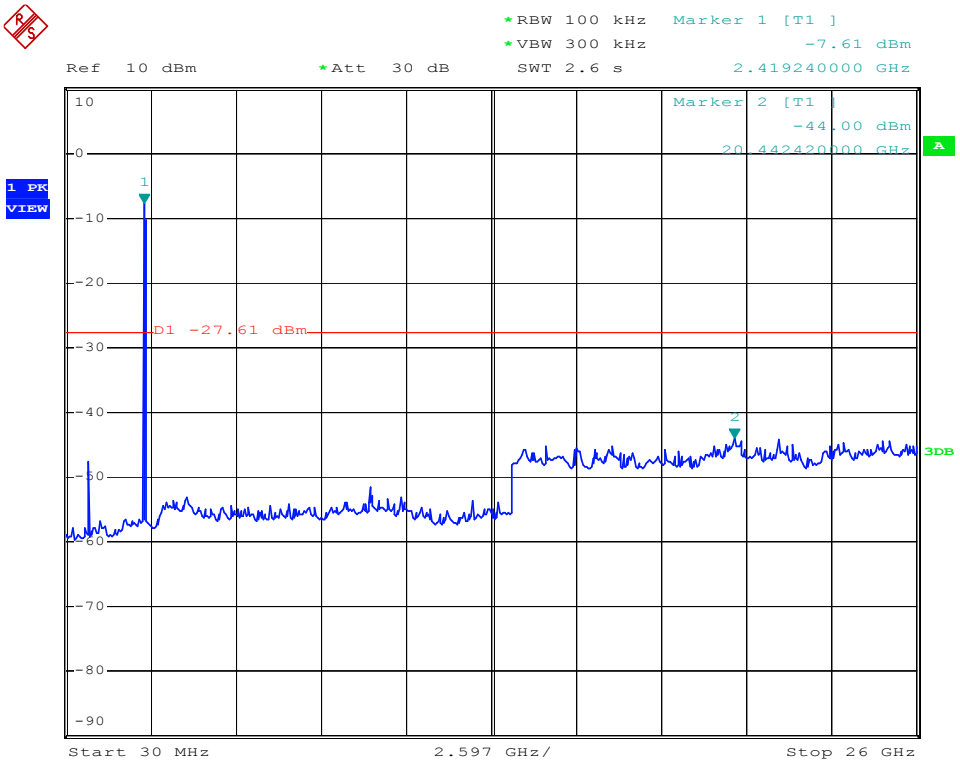
Lowest



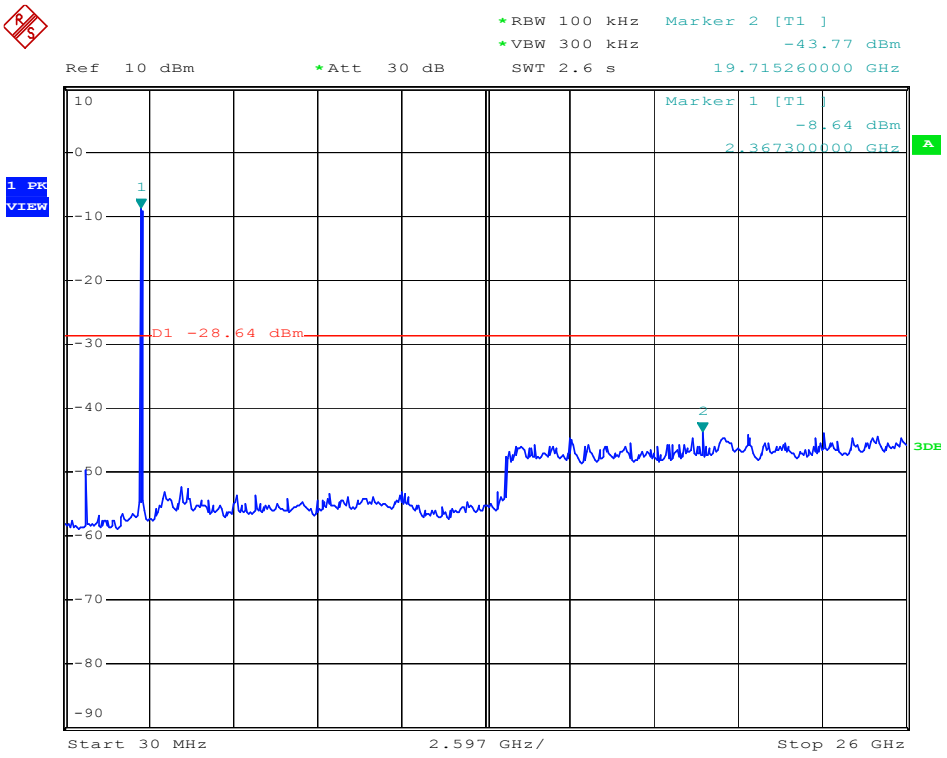
Middle



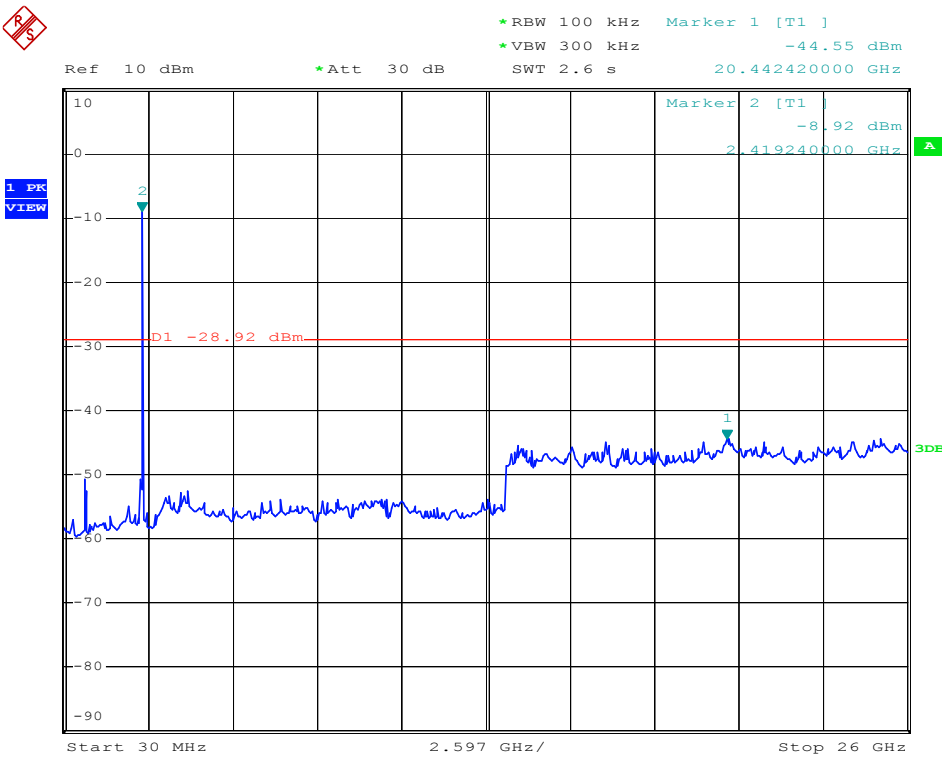

Highest



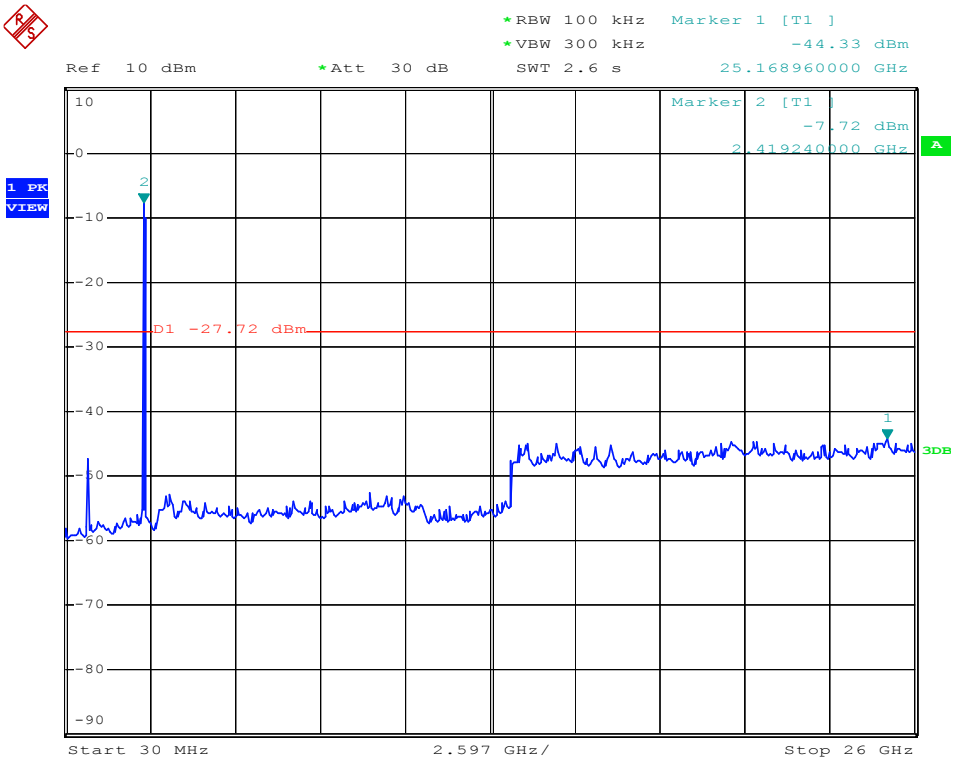
Spurious (Conducted)
802.11n-HT20-Lowest
Lowest




Middle



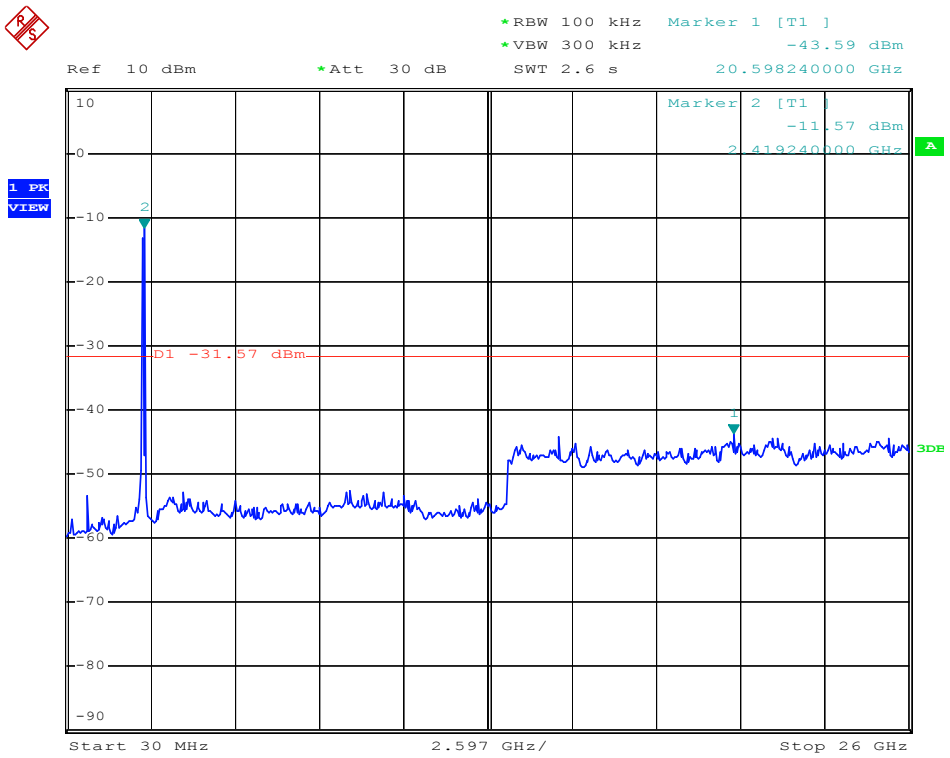
Highest



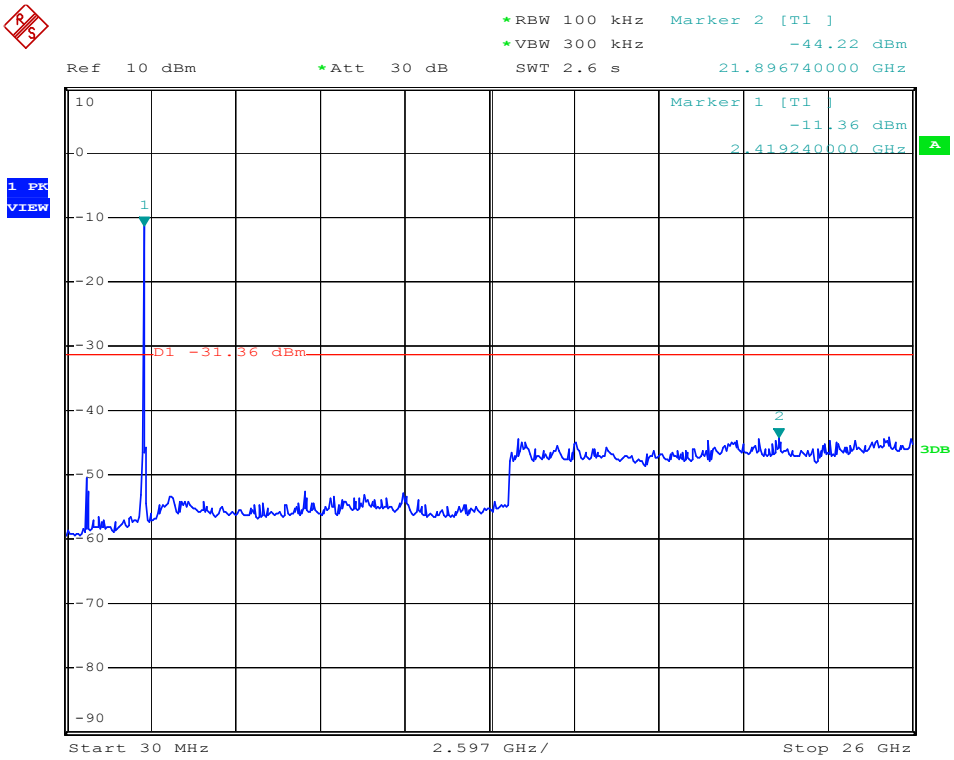

Spurious (Conducted)

802.11n-HT40-Lowest

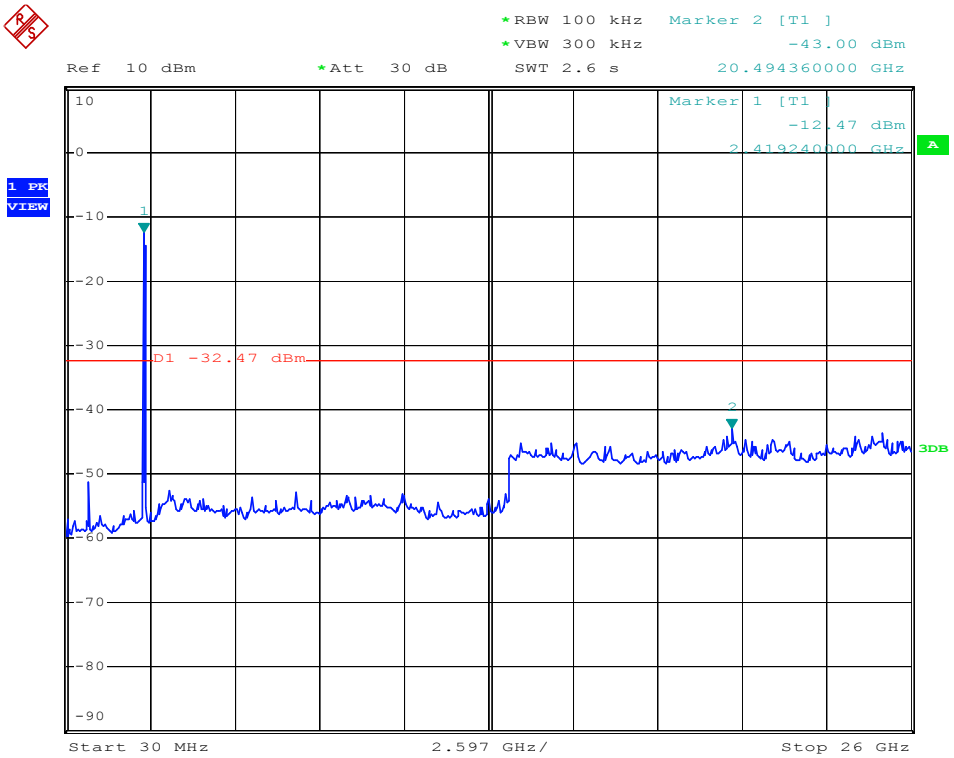
Lowest



Middle




Highest



# 9. Out of Band Emissions

## 9.1 Standard Applicable

According to §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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).

## 9.2 Test Procedure

According to the KDB 558074D01 v05, the band-edge radiated test method as follows:

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz for low bandedge, 2460MHz to 2500MHz for the high bandedge)
RBW = 1MHz, VBW = 1MHz for peak value measured
RBW = 1MHz, VBW = 10Hz for average value measured
Sweep = auto; Detector function = peak/average; Trace = max hold
All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement KDB publication number: 913591 may be used for the radiated bandedge measurements.

According to the KDB 558074 D01 v05, the conducted spurious emissions test method as follows:
1. Set start frequency to DTS channel edge frequency.
2. Set stop frequency so as to encompass the spectrum to be examined.
3. Set RBW = 100 kHz.
4. Set VBW ≥ 300 kHz.
5. Detector = peak.
6. Trace Mode = max hold.
7. Sweep = auto couple.
8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
9. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1. Report the three highest emissions relative to the limit.

## 9.3 Environmental Conditions

| | |
|---|---|
| Temperature: | 23°C |
| Relative Humidity: | 54% |
| ATM Pressure: | 1011 mbar |

## 9.4 Summary of Test Results/Plots

802.11b- Bandedge (Radiated)

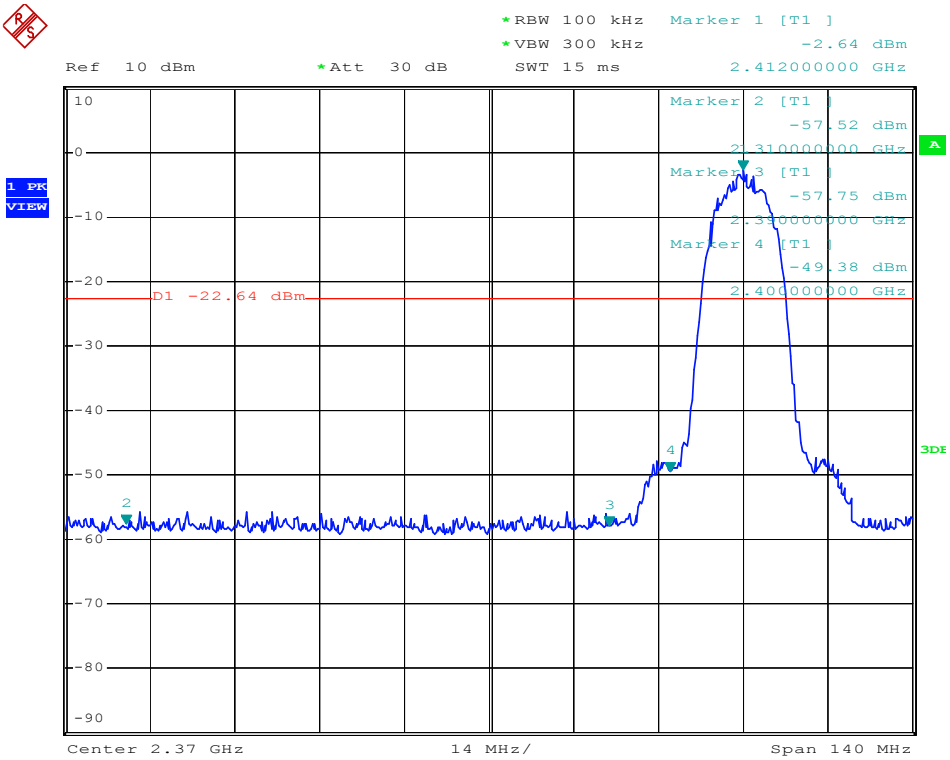
Note: we are pre-scan all modes, the worst data is 802.11g mode.

| Channel | Freq.(MHz) | Level(dBuV) | Limit(dBuV) | Margin(dB) | Detector |
|---|---|---|---|---|---|
| | 2390 | 65.85 | 74 | -8.15 | Peak |
| LOW | 2390 | 42.17 | 54 | -11.83 | Average |
| | 2483.5 | 62.23 | 74 | -11.77 | Peak |
| HIGH | 2483.5 | 40.83 | 54 | -13.17 | Average |

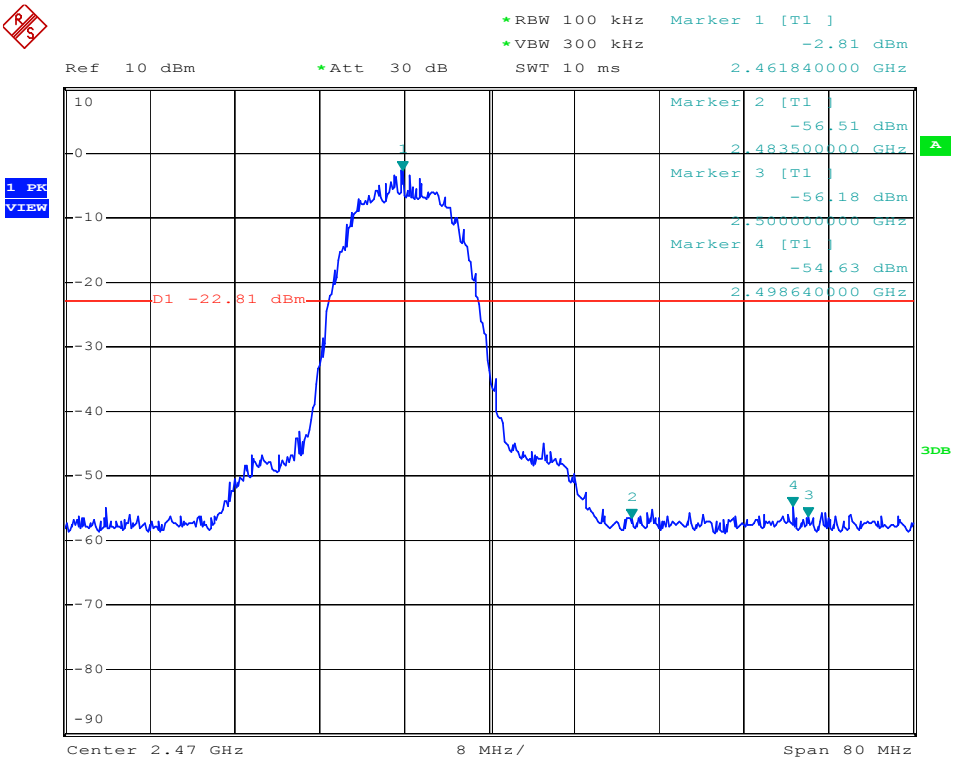
Bandedge (Conducted)

802.11b-Lowest

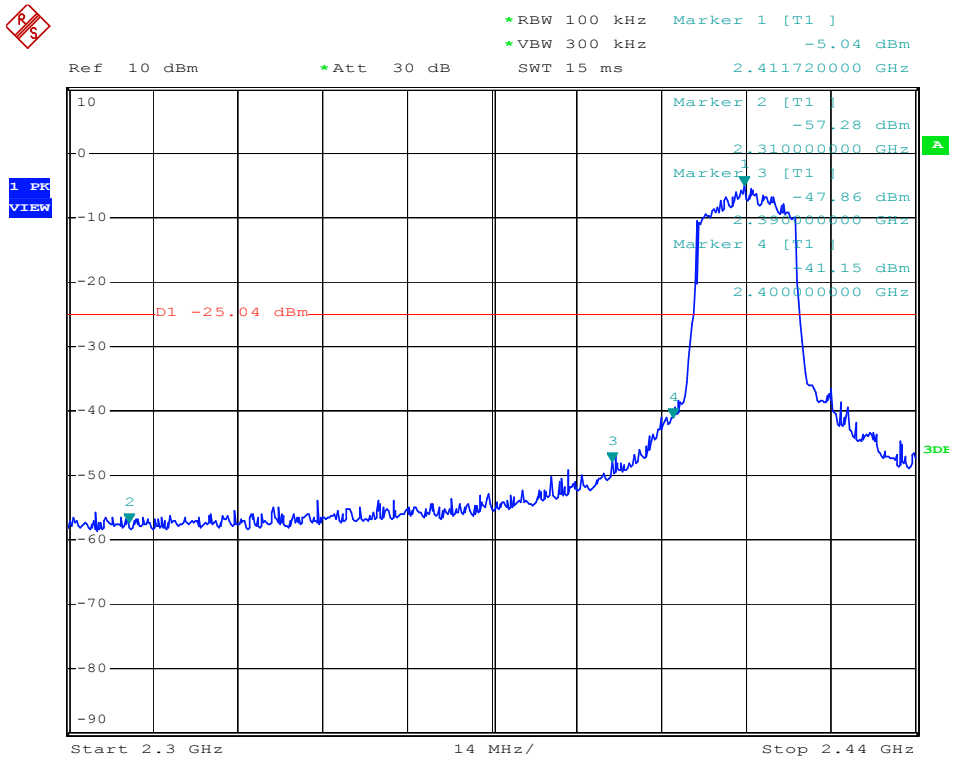
Lowest



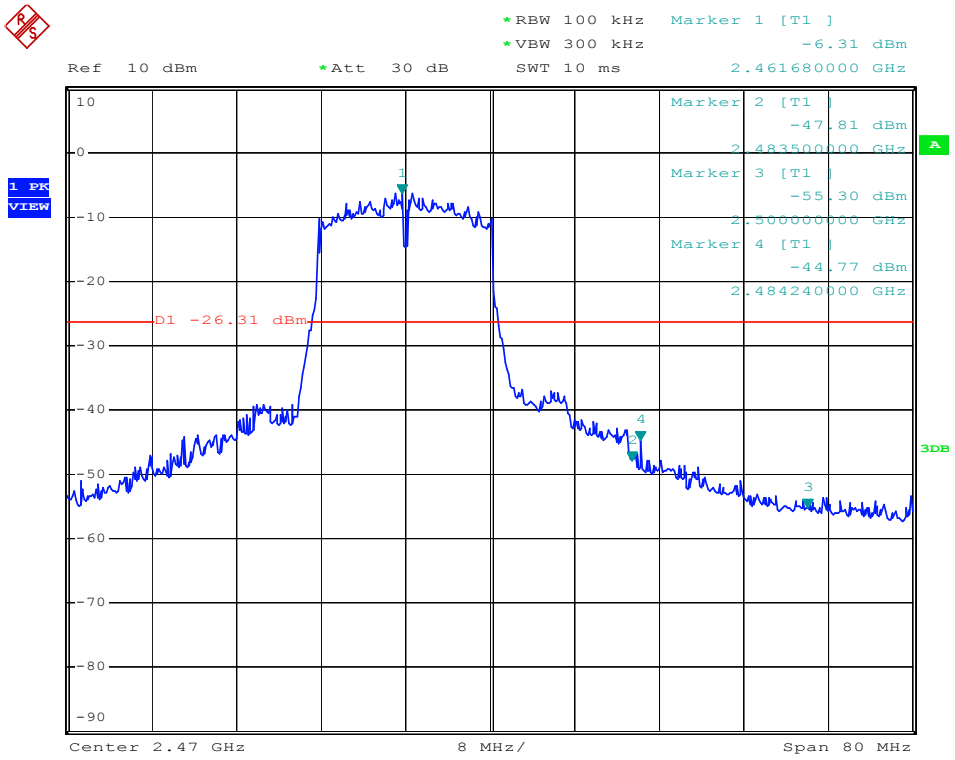
Highest




802.11g-Lowest

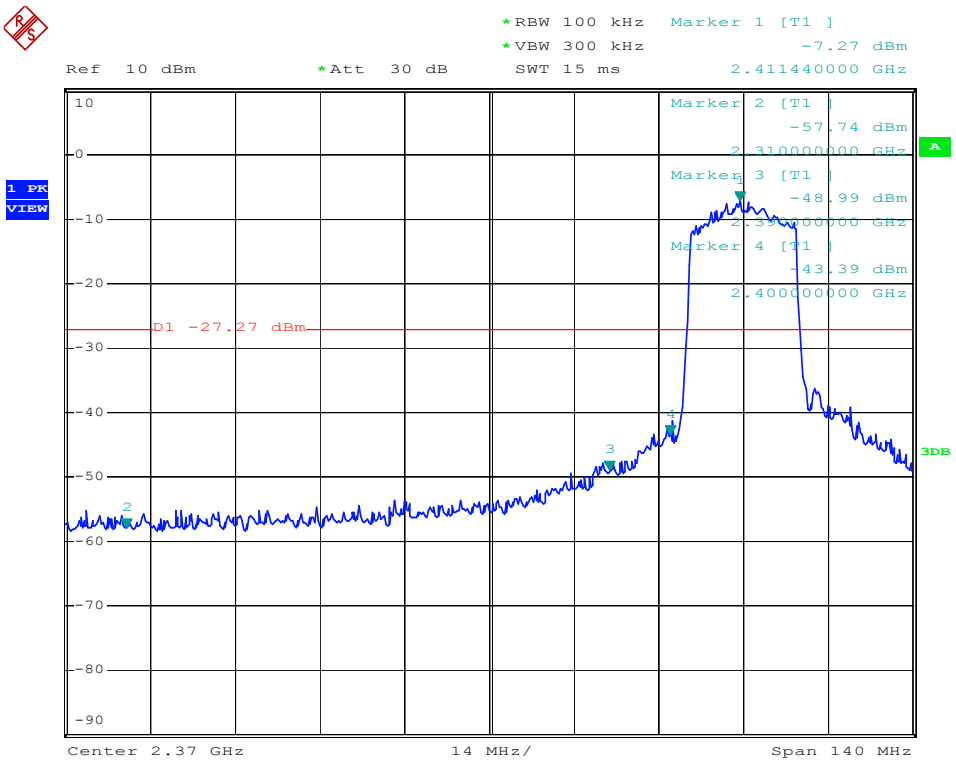


Highest

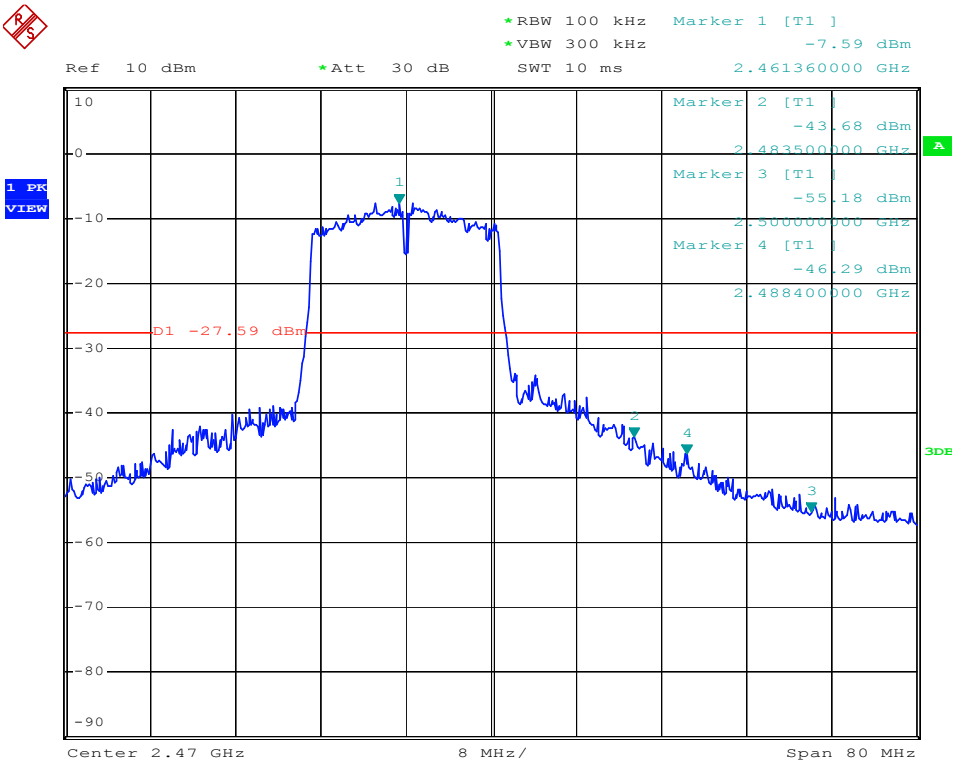



802.11n-HT20-Lowest

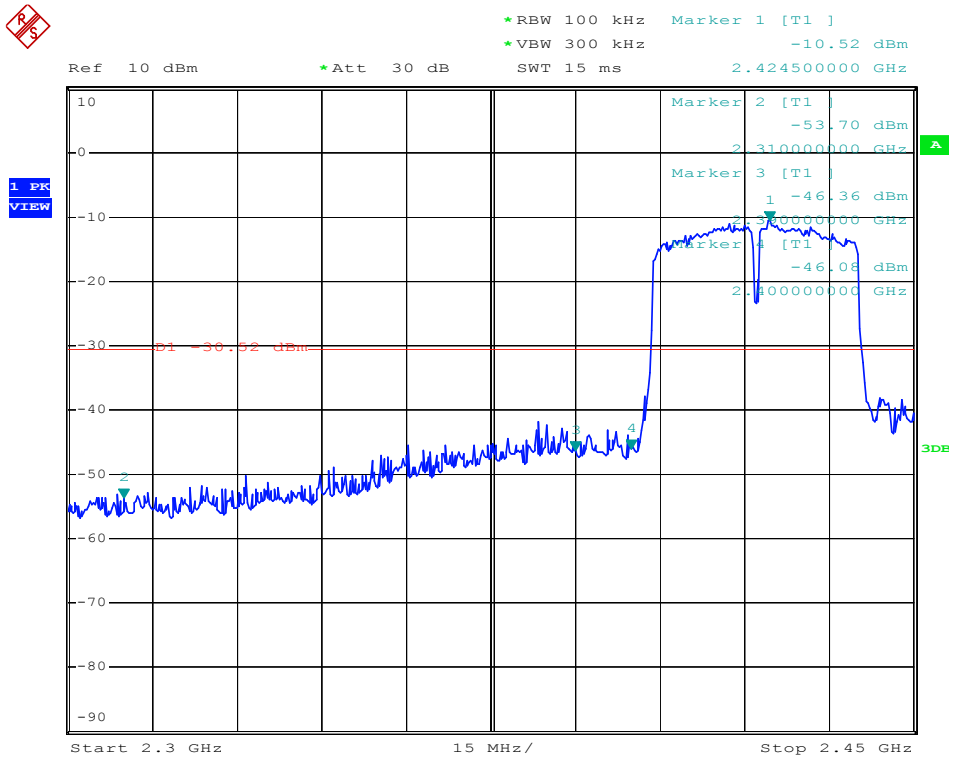
Lowest



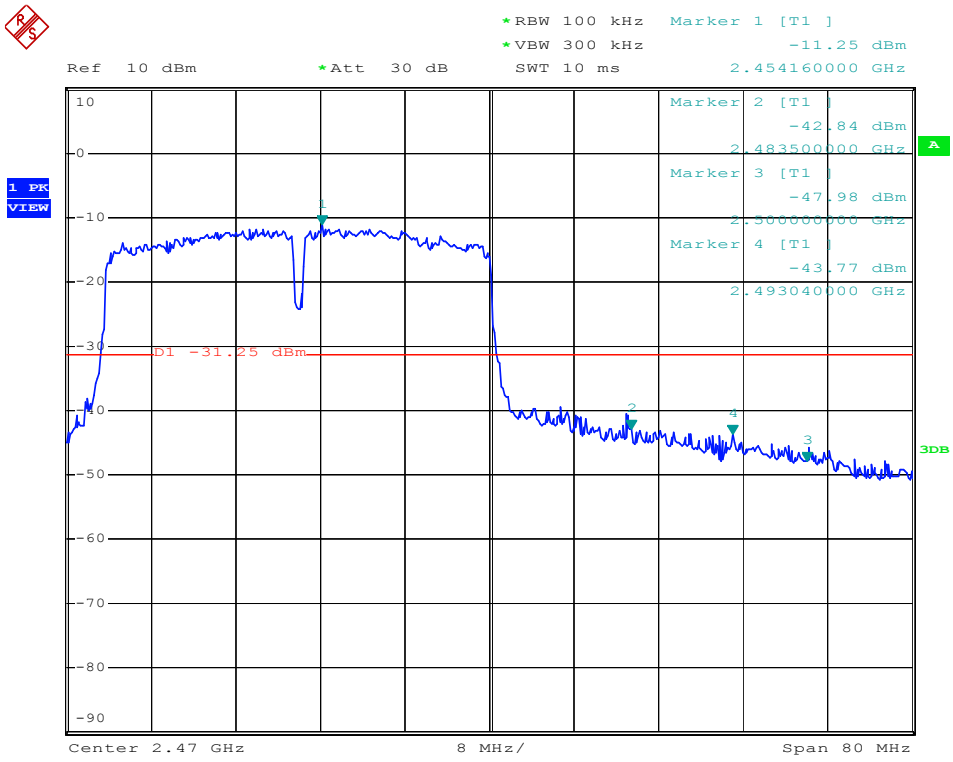
Highest




802.11n-HT40-Lowest



Highest

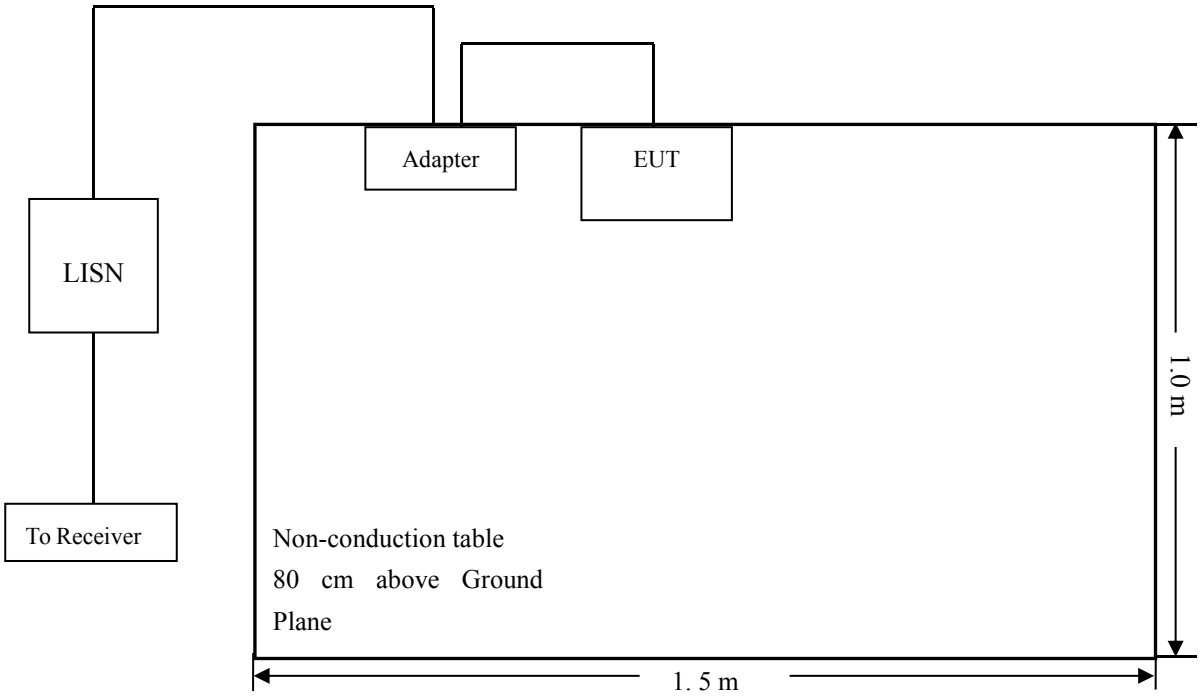

*RBW 100 kHz
*VBW 300 kHz
Ref 10 dBm
*Att 30 dB
SWT 10 ms
Marker 1 [T1 ]
-11.25 dBm
2.454160000 GHz
Marker 2 [T1 ]
-42.84 dBm
2.483500000 GHz
Marker 3 [T1 ]
-47.98 dBm
2.500000000 GHz
Marker 4 [T1 ]
-43.77 dBm
2.493040000 GHz
1 PK VIEW
A
3DB
D1 -31.25 dBm
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.47 GHz
8 MHz/
Span 80 MHz

# 10. Conducted Emissions

## 10.1 Test Procedure

The setup of EUT is according with per ANSI C63.4-2014 measurement procedure. The specification used was with the FCC Part 15.207 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

## 10.2 Basic Test Setup Block Diagram




## 10.3 Environmental Conditions

| | |
|---|---|
| Temperature: | 25 °C |
| Relative Humidity: | 52% |
| ATM Pressure: | 1012 mbar |

## 10.4 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency..... 150 kHz
Stop Frequency..... 30 MHz
Sweep Speed..... Auto
IF Bandwidth..... 10 kHz
Quasi-Peak Adapter Bandwidth..... 9 kHz
Quasi-Peak Adapter Mode.....Normal

## 10.5 Summary of Test Results/Plots

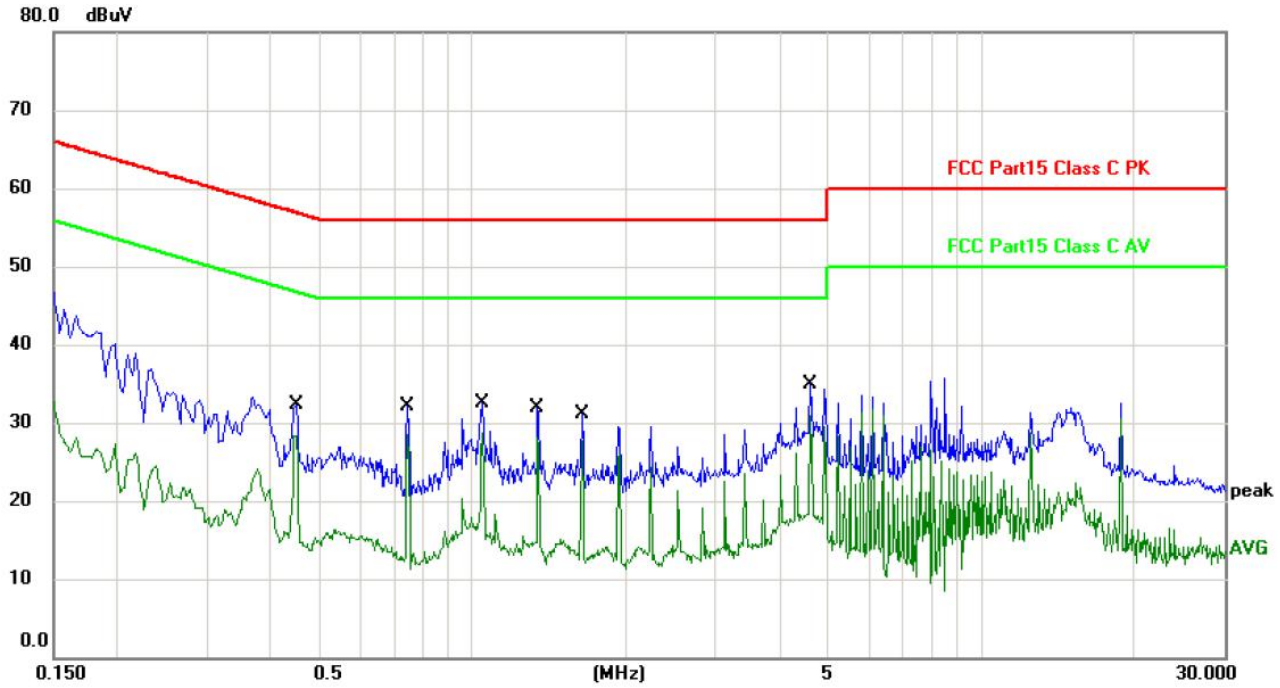
According to the data in section 10.6, the EUT complied with the FCC Part 15.207 Conducted margin for this device.

## 10.6 Conducted Emissions Test Data

Note: we are pre-scan all modes, the worst data is 802.11n HT20(Low) mode.

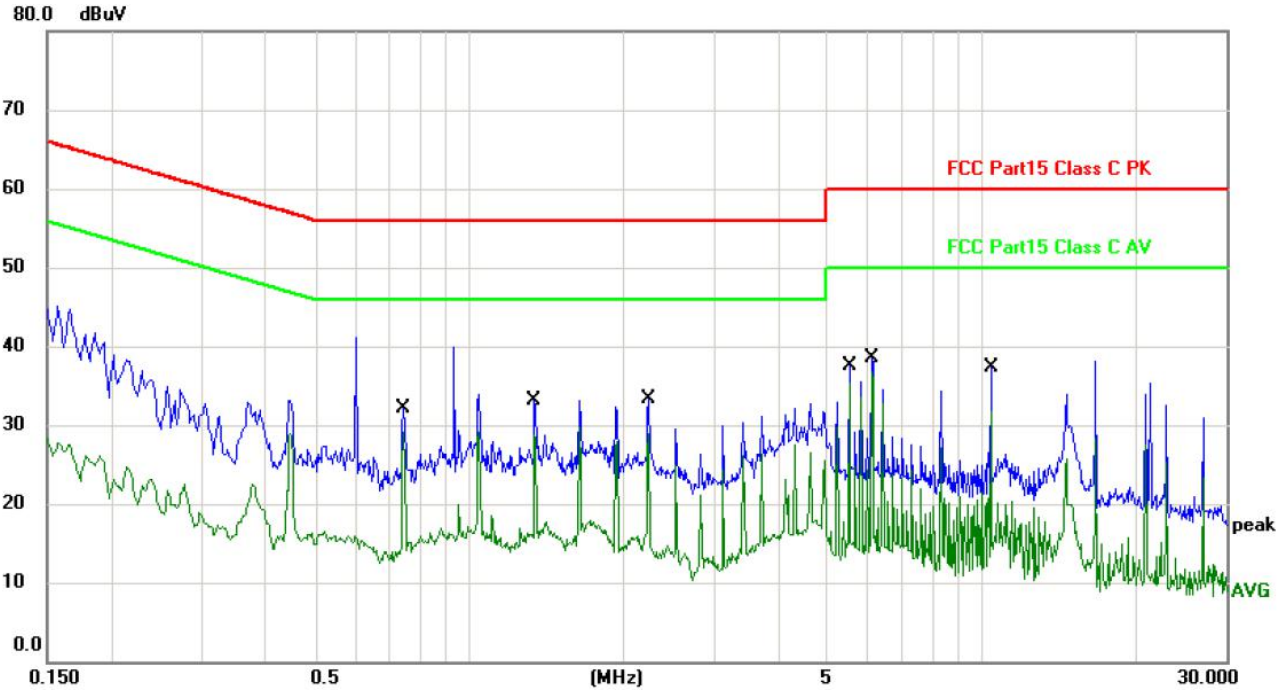
**Plot of Conducted Emissions Test Data: 802.11n HT20(Low)**

*Test Specification:* *Neutral*




| No. | Mk. | Freq. | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.4500 | 32.24 | 56.87 | -24.63 | QP | |
| 2 | | 0.4500 | 28.12 | 46.87 | -18.75 | AVG | |
| 3 | | 0.7460 | 32.13 | 56.00 | -23.87 | QP | |
| 4 | | 0.7460 | 27.37 | 46.00 | -18.63 | AVG | |
| 5 | | 1.0460 | 32.53 | 56.00 | -23.47 | QP | |
| 6 | | 1.0460 | 28.65 | 46.00 | -17.35 | AVG | |
| 7 | | 1.3420 | 31.83 | 56.00 | -24.17 | QP | |
| 8 | | 1.3420 | 27.26 | 46.00 | -18.74 | AVG | |
| 9 | | 1.6420 | 31.16 | 56.00 | -24.84 | QP | |
| 10 | * | 1.6420 | 34.37 | 46.00 | -11.63 | AVG | |
| 11 | | 4.6220 | 34.84 | 56.00 | -21.16 | QP | |
| 12 | | 4.6220 | 28.66 | 46.00 | -17.34 | AVG | |

*Test Specification:* *Live*




| No. | Mk. | Freq. | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.7460 | 32.13 | 56.00 | -23.87 | QP | |
| 2 | | 0.7460 | 28.67 | 46.00 | -17.33 | AVG | |
| 3 | | 1.3420 | 33.04 | 56.00 | -22.96 | QP | |
| 4 | | 1.3420 | 28.61 | 46.00 | -17.39 | AVG | |
| 5 | | 2.2380 | 33.23 | 56.00 | -22.77 | QP | |
| 6 | | 2.2380 | 27.58 | 46.00 | -18.42 | AVG | |
| 7 | | 5.5179 | 37.56 | 60.00 | -22.44 | QP | |
| 8 | | 5.5179 | 36.24 | 50.00 | -13.76 | AVG | |
| 9 | | 6.1179 | 38.41 | 60.00 | -21.59 | QP | |
| 10 | * | 6.1179 | 37.18 | 50.00 | -12.82 | AVG | |
| 11 | | 10.4139 | 37.38 | 60.00 | -22.62 | QP | |
| 12 | | 10.4139 | 34.69 | 50.00 | -15.31 | AVG | |

******* END OF REPORT *******