REP011127

# Test Report

| | |
|---|---|
| **Product** | **Electronic Control Unit for vehicle Integration** |
| **Name and address of the applicant** | **CPAC Systems AB**<br>**Bergskroken 3**<br>**431 37 Mölndal, Sweden** |
| **Name and address of the manufacturer** | **CPAC Systems AB**<br>**Bergskroken 3**<br>**431 37 Mölndal, Sweden** |
| **Model** | **SID 2.0** |
| **Rating** | **24$V_{DC}$** |
| **Trademark** | **CPAC Systems AB** |
| **Additional information** | **WiFi, Bluetooth** |
| **Tested according to** | **FCC Part 15.247**<br>Frequency Hopping Transmitters / Digital Transmission Systems<br>**Industry Canada RSS-247, Issue 2**<br>Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| **Order number** | **PRJ0024292** |
| **Tested in period** | **2023-02-27 to 2023-06-06** |
| **Issue date** | **2023-06-28** |
| **Name and address of the testing laboratory** | Nemko Scandinavia AS<br>Instituttveien 6<br>2007 Kjeller, Norway<br>www.nemko.com<br>CAB Number:<br>FCC: NO0001<br>ISED: NO0470<br>ISED No: 2040D-1<br>**An accredited technical test executed under the Norwegian accreditation scheme** |

| | |
|---|---|
| Prepared by [Frode Sveinsen] | Approved by [G.Suhanthakumar] |

This report was originally distributed electronically with digital signatures. For more information, please contact Nemko Scandinavia AS.

Template version: C

## Revision history

| Revision | Date | Comment | Sign |
|---|---|---|---|
| A | 2023-06-28 | First edition | FS |
| | | | |

## GENERAL REMARKS

This report applies only to the sample(s) tested. It is the manufacturer's responsibility to ensure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is solely responsible for any modifications to the product that could result in non-compliance with the relevant regulations.

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Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither are opinions expressed regarding model variants covered by the testing of this report.

## CALIBRATION

All instruments used in the tests given in this test report are calibrated and traceable to national or international standards. Between calibrations all test set-ups are controlled and verified on a regular basis by periodic checks to ensure, with 95% confidence, that the instruments remain within the calibrated levels.

## MEASUREMENT UNCERTAINTY

Measurement uncertainties are calculated or considered for all instruments and instrument set-ups used during these tests. Uncertainty figures are found in a separate clause in this report.

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# 1 INFORMATION

## 1.1 Test Item

| | |
|---|---|
| **Name** | **CPAC Systems AB** |
| **Model/version** | **SID 2.0** |
| **FCC ID** | **AHV-SID2** |
| **ISED ID** | **10111-SID2** |
| **Serial number** | **HYD-3891** |
| **Hardware identity and/or version** | **P-01** |
| **Software identity and/or version** | **Hydra_WLANSW_1.0** |
| **Frequency Range** | **2412 – 2462 MHz** |
| **Number of Channels** | **11** |
| **Operating Modes** | **DSSS, OFDM** |
| **Type of Modulation** | **Digital** |
| **Conducted Output Power** | **802.11b: 69.7 mW**<br>**802.11g/n HT20: 50.9 mW**<br>**802.11n HT40: 46.8 mW** |
| **Antenna Connector** | **Fakra** |
| **Number of Antennas** | **2 External Antenna Connectors for WiFi** |
| **Diversity or Smart Antennas** | **Diversity with all modulations, MIMO with 802.11n mode** |
| **Power Supply** | **External Power Supply, 8-32 $V_{DC}$** |

### Description of Test Item

The EUT is an electronic control unit for vehicle integration. The EUT contains WiFi, Bluetooth, and LTE modules.

## 1.2 Antenna Types

| Name | P/N | Function | Number of inputs | Description |
|---|---|---|---|---|
| 2J 2× 4G/3G/2G MIMO, +2× 2.4/5.0 GHz MIMO and GNSS | 2J #2J4A50PCFa | 2.4GHz Wifi+BT | 2 | COMBI ANT |
| | | 2G+3G+4G | 2 | |
| TE ANTENNA BASE FULL FEAT | Volvo #23311779 | 2.4GHz Wifi+BT | 1 | WHIP ANT |
| | | 2G+3G+4G | 1 | |
| TE ANTENNA INTERIOR WLAN | Volvo #23311706 | 2.4GHz Wifi+BT | 1 | PATCH ANT |

## 1.3 Normal test condition

| | |
|---|---|
| **Temperature:** | **20 - 24 °C** |
| **Relative humidity:** | **20 - 50 %** |
| **Normal test voltage:** | **24 V DC** |

The values are the limit registered during the test period.

The EUT was powered from a regulated power supply during all tests.

## 1.4 Test Engineer(s)

Frode Sveinsen

## 1.5 Antenna Requirement

| | | |
|---|---|---|
| **Does the EUT have detachable antenna(s)?** | ☒ **YES** | ☐ **NO** |
| **If detachable, is the antenna connector(s) non-standard?** | ☒ **YES** | ☐ **NO** |
| **The tested equipment has FAKRA connectors.** | | |

**Requirement: FCC 15.203, 15.204**

## 1.6 EUT Operating Modes

| | |
|---|---|
| **Operating modes** | Radiated Emissions and Power Line Conducted Emissions were performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario. |
| **Additional information** | The worst case data rates were:<br>802.11b mode : 1 Mbps<br>802.11g mode : 6 Mbps<br>802.11n HT20 mode : MCS0<br>802.11n HT40 mode : MCS0 |

## 1.7 Power Settings

| Power Setting | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Channel** | **11b 1M** | **11b 11M** | **11g 6M** | **11g 54M** | **11n HT20 MCS0** | **11n HT20 MCS7** | **11n HT40 MCS0 SISO** | **11n HT40 MCS7 SISO** | **11n HT40 MCS0 MIMO** | **11n HT40 MCS7 MIMO** |
| **Ch01 Ch02** | 11 | 11 | 11 | 11 | 11 | 11 | | | | |
| **Ch03** | 15 | 15 | 17 | 17 | 17 | 16 | 11 | 11 | 8 | 7 |
| **Ch04** | | | | | | | 14 | 14 | 12 | 12 |
| **Ch05** | | | | | | | 16 | 16 | 13 | 13 |
| **Ch06** | | | | | | | 16 | 16 | 13 | 13 |
| **Ch07** | | | | | | | 14 | 14 | 13 | 13 |
| **Ch08** | | | | | | | 12 | 12 | 12 | 12 |
| **Ch09** | | | 13 | 13 | 13 | 13 | 11 | 11 | 8 | 8 |
| **Ch10 Ch11** | 11 | 11 | 11 | 11 | 11 | 11 | | | | |

## 1.8 Comments

All ports were populated during spurious emission measurements.

# 2 TEST REPORT SUMMARY

## 2.1 General

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and ISED RSS-247 Issue 2 and RSS-GEN Issue 5.

Tests were performed in accordance with ANSI C63.4-2014 and ANSI C63.10-2013.

Radiated tests were performed in a semi-anechoic chamber at measuring distances of 3m and 1m.

A description of the test facility is on file with the FCC and ISED.

| | |
|---|---|
| ☒ **New Submission** | ☒ **Production Unit** |
| ☐ **Class II Permissive Change** | ☐ **Pre-production Unit** |
| **DTS Equipment Code** | ☐ **Family Listing** |

## 2.2 Test Summary

| Name of test | FCC Part 15 reference | RSS-247 Issue 2, RSS-GEN Issue 5 reference | ANSI C63.10-2013 Reference | Result |
|---|---|---|---|---|
| Supply Voltage Variations | 15.31(e) | 6.11 (RSS-GEN) | 5.13 | Complies |
| Antenna Requirement | 15.203 | 6.8 (RSS-GEN) | 5.8 | Complies |
| Power Line Conducted Emission | 15.107(a)<br>15.207(a) | 7.2 / 8.8 (RSS-GEN) | 6.2 | N/A |
| Occupied Bandwidth (99% BW) | N/A | 6.7 (RSS-GEN) | 6.9.3 | Complies |
| DTS Bandwidth | 15.247(a)(2) | 5.2 (1) (RSS-247) | 11.8 Option 2 | Complies |
| Peak Power Output | 15.247(b) | 5.4 (RSS-247) | 11.9.1.1 | Complies |
| Power Spectral Density | 15.247(d) | 5.2 (2) (RSS-247) | 11.10.2 PKPSD (DTS) | Complies |
| Spurious Emissions (Antenna Conducted) | 15.247(c) | 5.5 (RSS-247) | 6.7<br>11.11 (DTS) | Complies |
| Spurious Emissions (Radiated) | 15.247(c)<br>15.109(a)<br>15.209(a) | 5.5 (RSS-247)<br>7.3 (RSS-GEN)<br>8.9 (RSS-GEN) | 6.3, 6.5, 6.6, 6.10<br>11.12, 11.13 (DTS) | Complies |

# 3 TEST RESULTS

## 3.1 Occupied Bandwidth (99% BW)

**ISED Canada RSS-GEN Issue 5, Clause 6.7**

**Measurement procedure: ANSI C63.10-2013 Clause 6.9.2**

**Test Results: Complies**

**Measurement Data:**

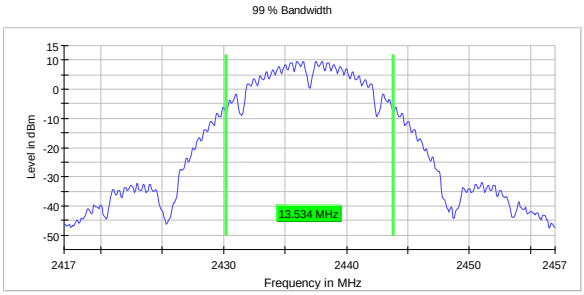
| Carrier Frequency, Modulation and Data Rate | Occupied Bandwidth (99% BW) |
|---|---|
| 2437 MHz, 802.11b | 13.5 MHz |
| 2437 MHz, 802.11g | 16.6 MHz |
| 2437 MHz, 802.11n SISO | 17.8 MHz |
| 2437 MHz, 802.11n MIMO | 17.8 MHz |
| 2437 MHz, 802.11n HT40 SISO | 36.4 MHz |
| 2437 MHz, 802.11n HT40 MIMO | 36.4 MHz |

Occupied Bandwidth is the same for all channels.

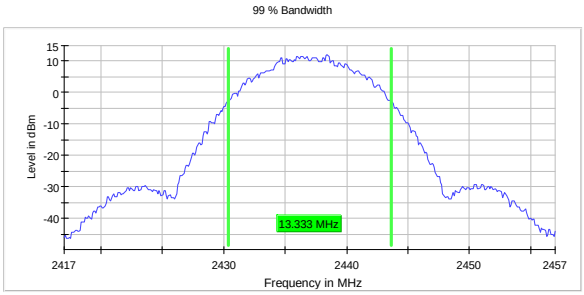
See attached plots.

### Requirements:

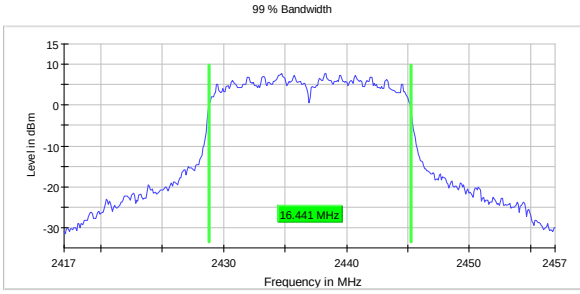
No requirement for 99% BW, reported for information only.



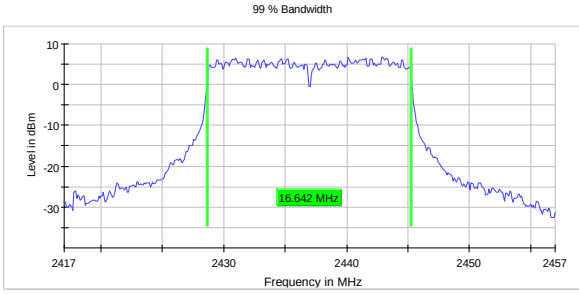

**99% Occupied BW, 802.11b 1M**



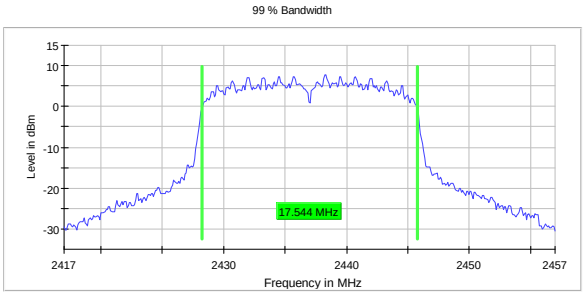

**99% Occupied BW, 802.11b 11M**



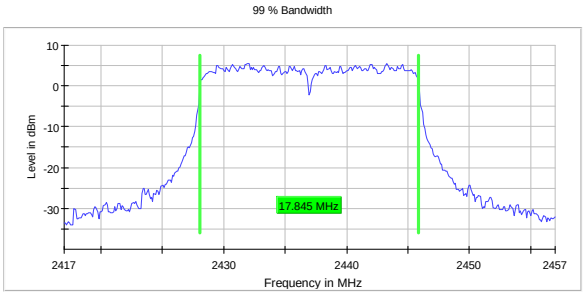

**99% Occupied BW, 802.11g 6M**



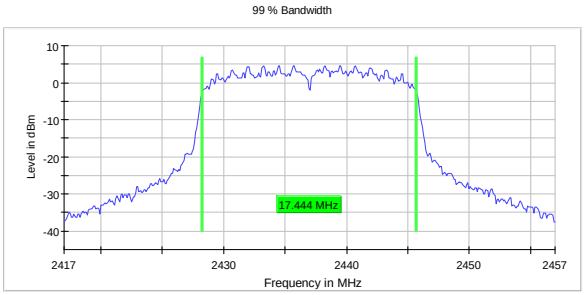

**99% Occupied BW, 802.11g 54M**



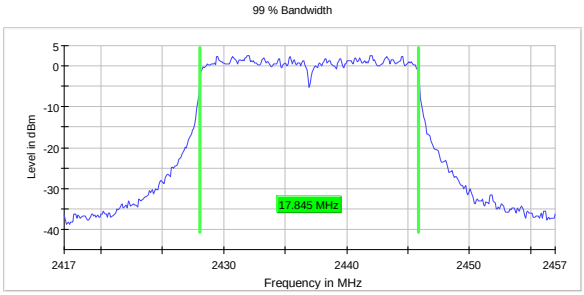

**99% Occupied BW, 802.11n SISO MCS0**



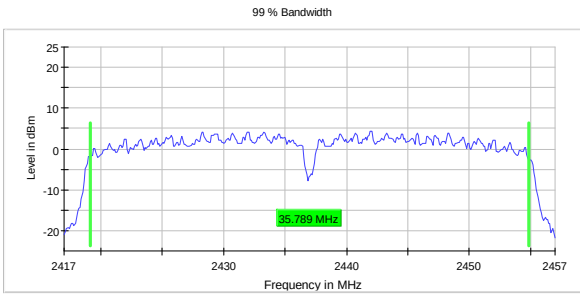

**99% Occupied BW, 802.11n SISO MCS7**

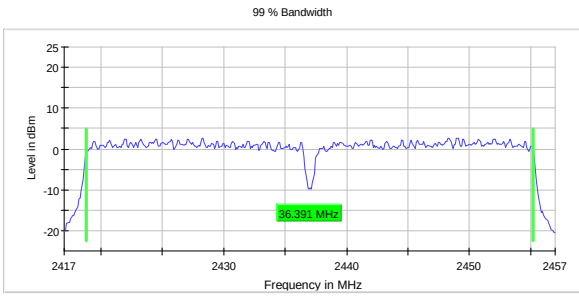


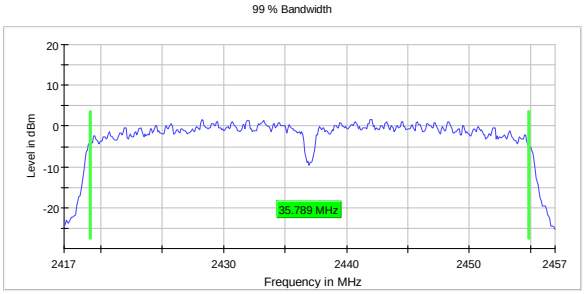
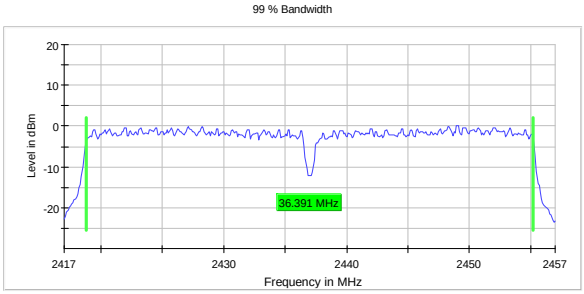

**99% Occupied BW, 802.11n MIMO MCS8**




**99% Occupied BW, 802.11n MIMO MCS15**



| 99% Occupied BW, 802.11n HT40 SISO MCS0 | 99% Occupied BW, 802.11n HT40 SISO MCS7 |
|---|---|
|   |   |
| **99% Occupied BW, 802.11n HT40 MIMO MCS8** | **99% Occupied BW, 802.11n HT40 MIMO MCS15** |

## 3.2 DTS Bandwidth

**FCC Part 15.247 (a)(2)**

**ISED Canada RSS-247 Issue 2, Clause 5.2 (a)**

**Measurement procedure:** **ANSI C63.10-2013 Clause 11.8**

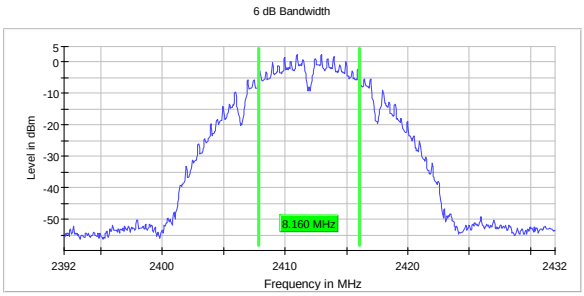
**Test Results:** **Complies**

### Measurement Data:

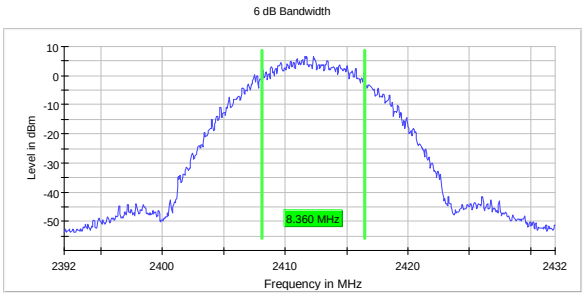
| Modulation type | Measured DTS Bandwidth (MHz) | | |
|---|---|---|---|
| | 2412 MHz | 2437 MHz | 2462 MHz |
| 802.11b | 8.36 | 9.06 | 9.06 |
| 802.11g | 16.6 | 16.6 | 16.6 |
| 802.11n HT20 SISO | 17.8 | 17.8 | 17.8 |
| 802.11n HT20 MIMO | 17.8 | 17.8 | 17.8 |
| 802.11n HT40 SISO | 36.5 | 36.6 | 36.6 |
| 802.11n HT40 MIMO | 36.6 | 36.6 | 36.6 |

Power supply variations within 85 % to 115% of nominal value has no influence on measured value.

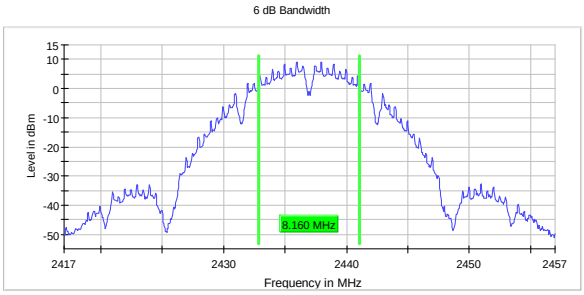
| Frequency Band | Requirement for systems using Digital Modulation |
|---|---|
| 902-928 MHz | The minimum 6 dB bandwidth shall be at least 500 kHz. |
| 2400-2483.5 MHz | |
| 5725-5850 MHz | |



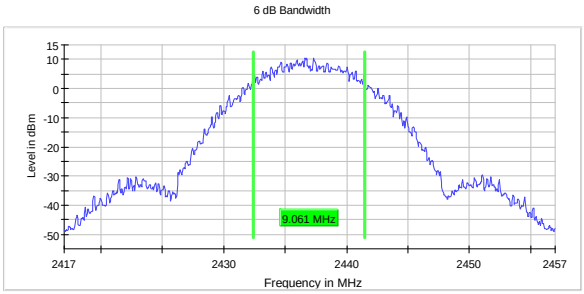

**DTS BW, 2412 MHz, 802.11b 1M**



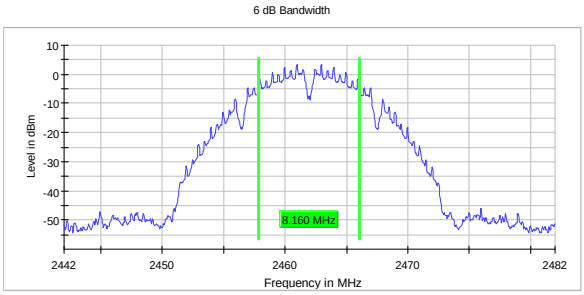

**DTS BW, 2412 MHz, 802.11b 11M**



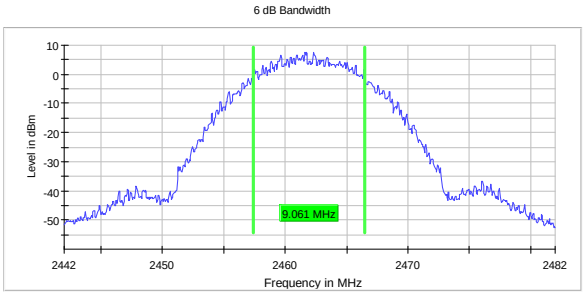

**DTS BW, 2437 MHz, 802.11b 1M**



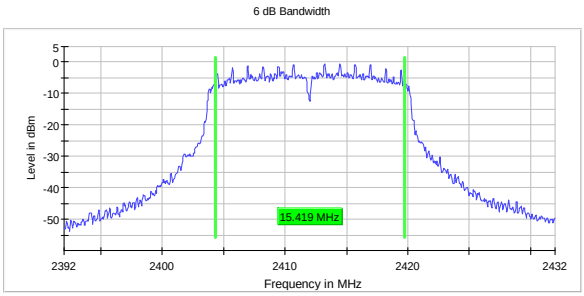

**DTS BW, 2437 MHz, 802.11b 11M**



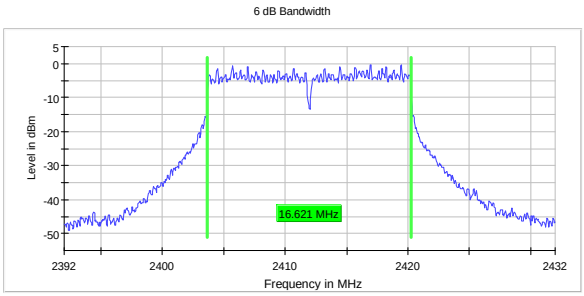

**DTS BW, 2462 MHz, 802.11b 1M**



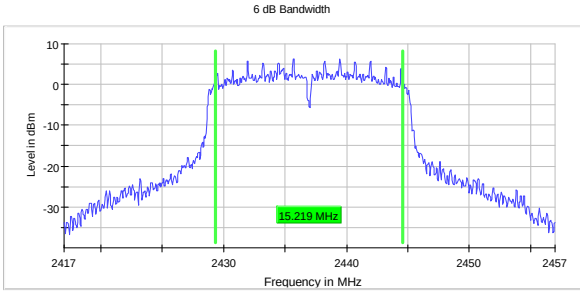

**DTS BW, 2462 MHz, 802.11b 11M**



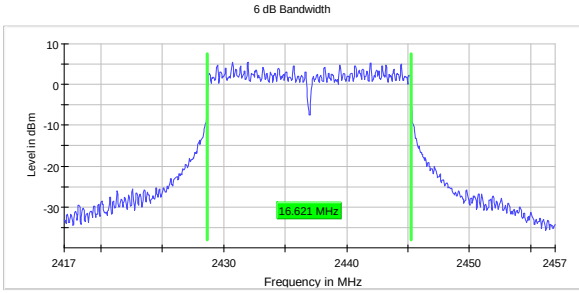

**DTS BW, 2412 MHz, 802.11g 6M**



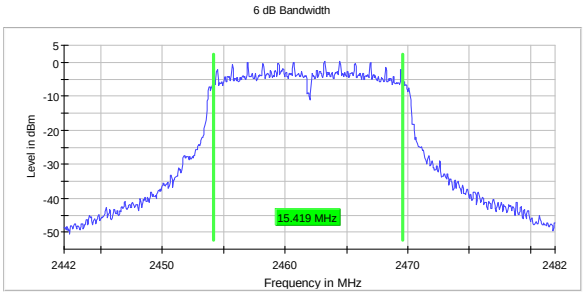

**DTS BW, 2412 MHz, 802.11g 54M**



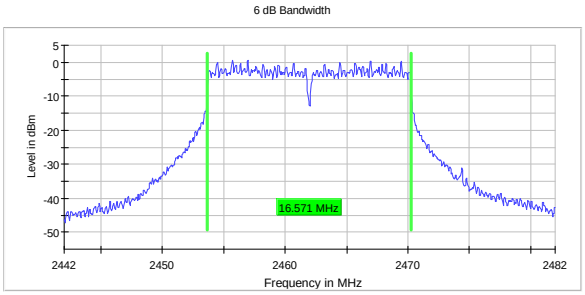

**DTS BW, 2437 MHz, 802.11g 6M**



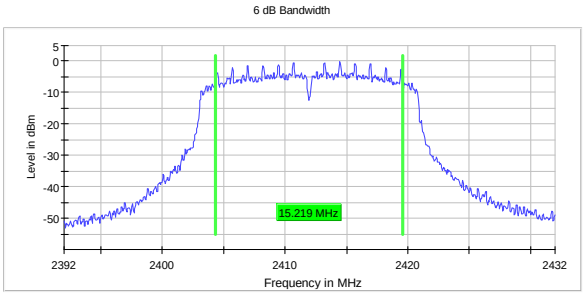

**DTS BW, 2437 MHz, 802.11g 54M**



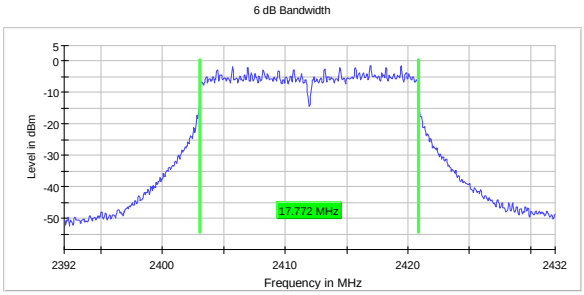

**DTS BW, 2462 MHz, 802.11g 6M**



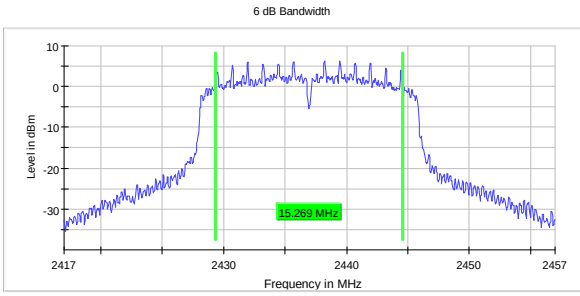

**DTS BW, 2462 MHz, 802.11g 54M**



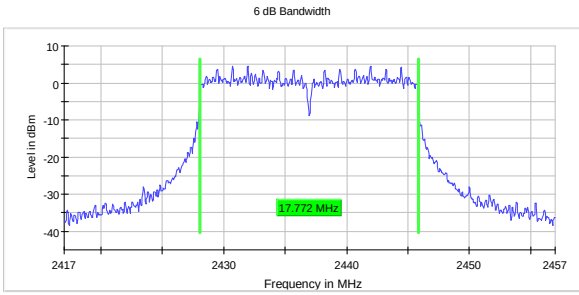

**DTS BW, 2412 MHz, 802.11n SISO MCS0**



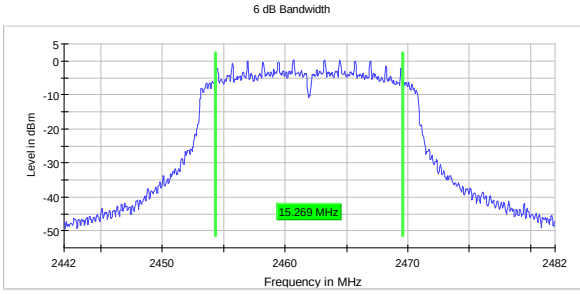

**DTS BW, 2412 MHz, 802.11n SISO MCS7**



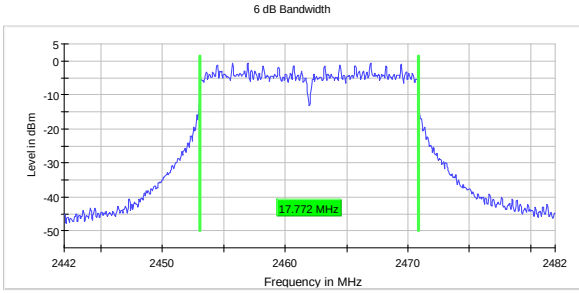

**DTS BW, 2437 MHz, 802.11n SISO MCS0**



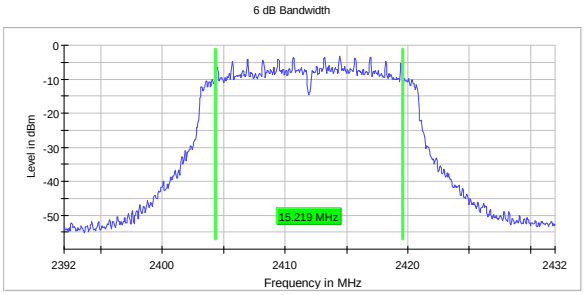

**DTS BW, 2437 MHz, 802.11n SISO MCS7**



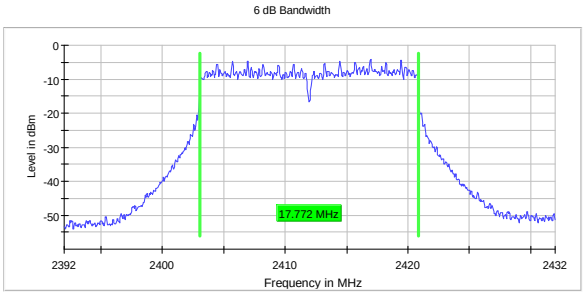

**DTS BW, 2462 MHz, 802.11n SISO MCS0**



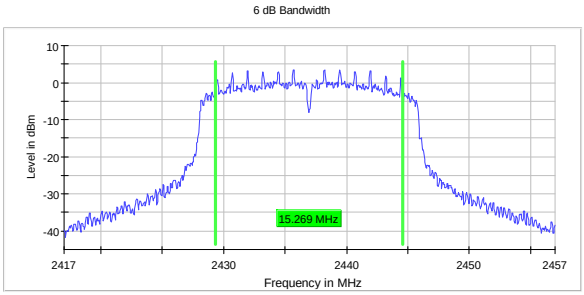

**DTS BW, 2462 MHz, 802.11n SISO MCS7**



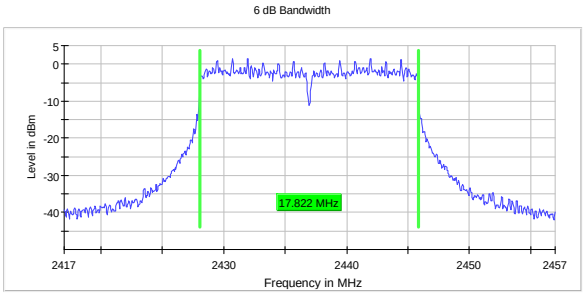

**DTS BW, 2412 MHz, 802.11n MIMO MCS8**



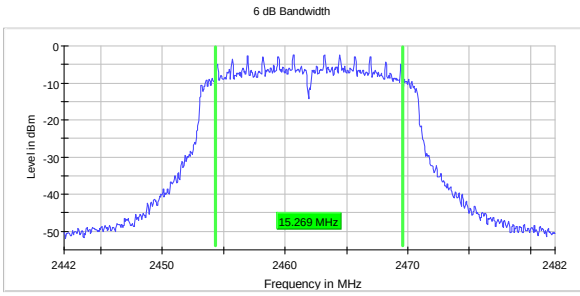

**DTS BW, 2412 MHz, 802.11n MIMO MCS15**



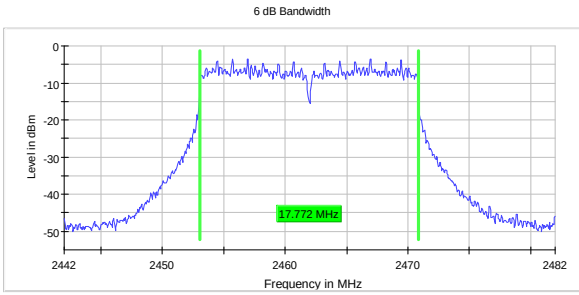

**DTS BW, 2437 MHz, 802.11n MIMO MCS8**



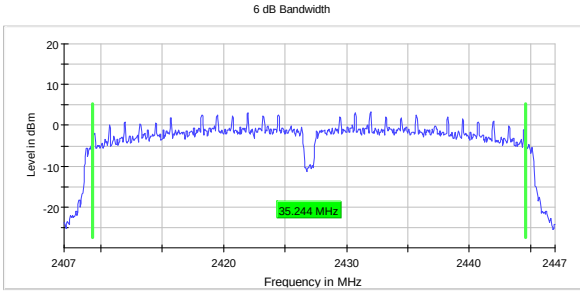

**DTS BW, 2437 MHz, 802.11n MIMO MCS15**



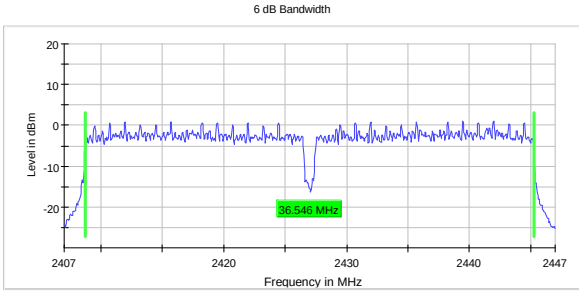

**DTS BW, 2462 MHz, 802.11n MIMO MCS8**



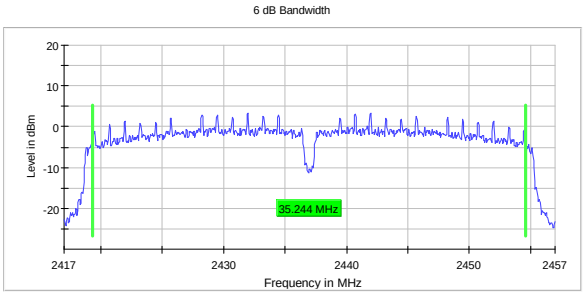

**DTS BW, 2462 MHz, 802.11n MIMO MCS15**



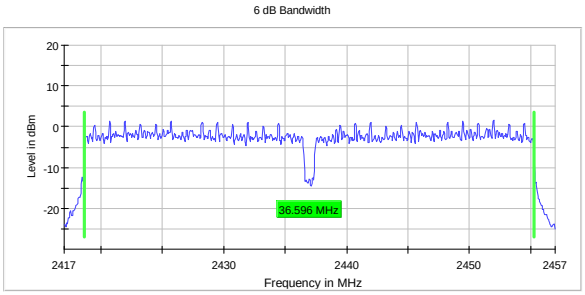

**DTS BW, 2427 MHz, 802.11n HT40 SISO MCS0**



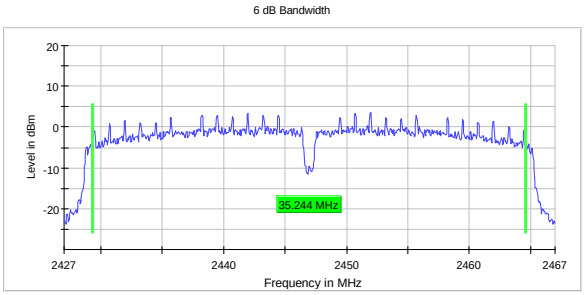

**DTS BW, 2427 MHz, 802.11n HT40 SISO MCS7**



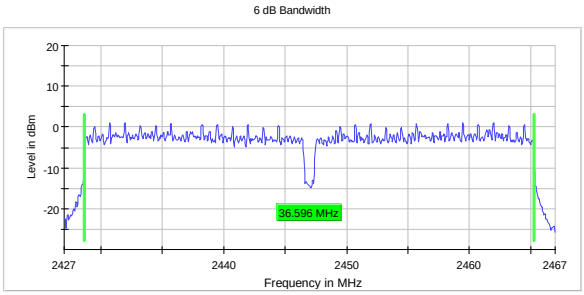

**DTS BW, 2437 MHz, 802.11n HT40 SISO MCS0**



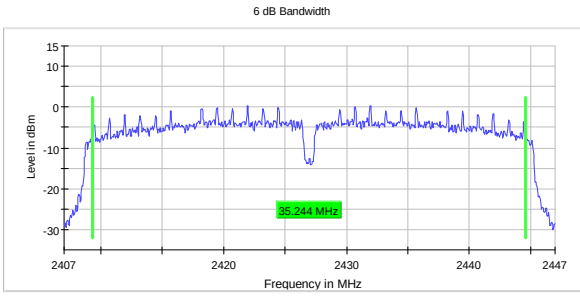

**DTS BW, 2437 MHz, 802.11n HT40 SISO MCS7**



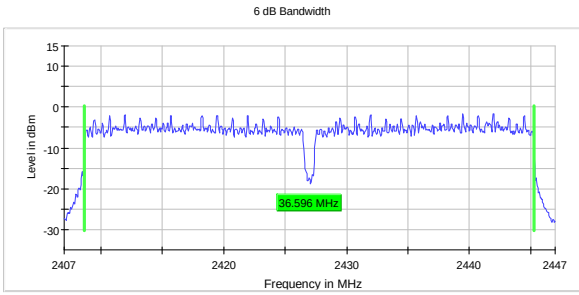

**DTS BW, 2447 MHz, 802.11n HT40 SISO MCS0**



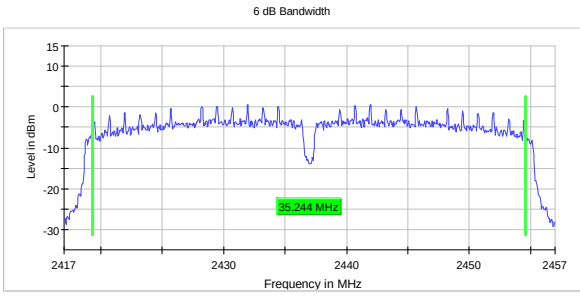

**DTS BW, 2447 MHz, 802.11n HT40 SISO MCS7**



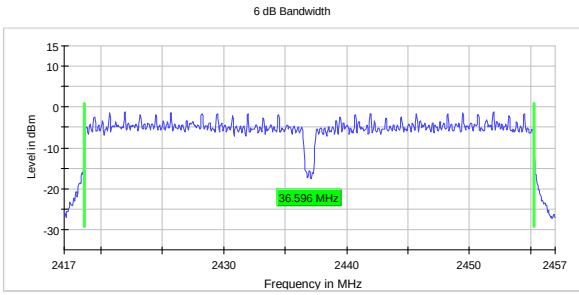

**DTS BW, 2427 MHz, 802.11n HT40 MIMO MCS8**



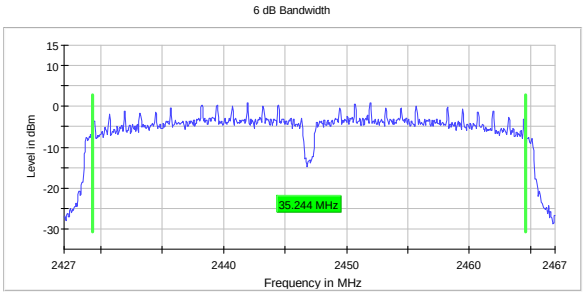

**DTS BW, 2427 MHz, 802.11n HT40 MIMO MCS15**



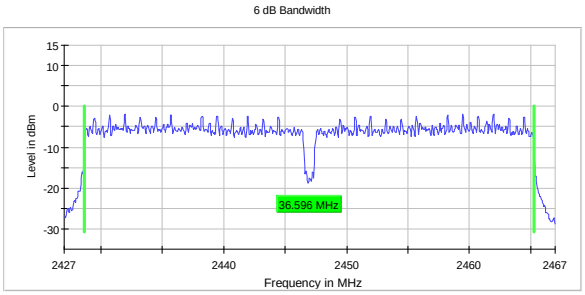

**DTS BW, 2437 MHz, 802.11n HT40 MIMO MCS8**




**DTS BW, 2437 MHz, 802.11n HT40 MIMO MCS15**




**DTS BW, 2447 MHz, 802.11n HT40 MIMO MCS8**




**DTS BW, 2447 MHz, 802.11n HT40 MIMO MCS15**

## 3.3 Output Power

**FCC Part 15.247 (b)**

**ISED Canada RSS-247 Issue 2, Clause 5.4**

**Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2**

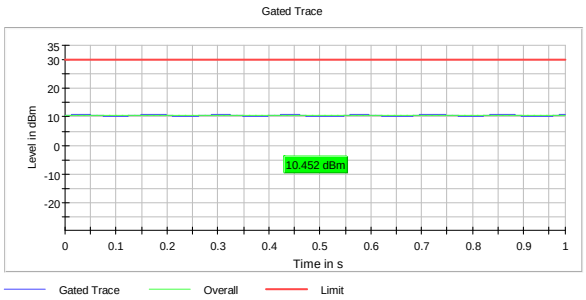
**Test Results: Complies**

**Measurement Data:**

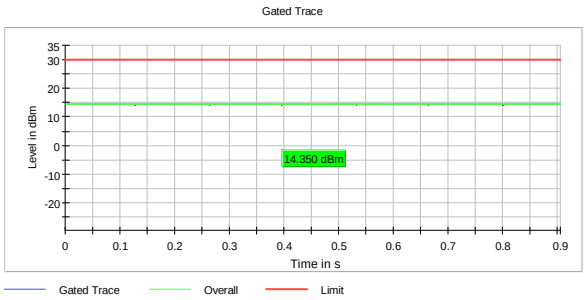
| Carrier Frequency | Conducted Output Power, dBm | | | | | |
|---|---|---|---|---|---|---|
| | 802.11b 11M | 802.11g 6M | 802.11n HT20 SISO MCS0 | 802.11n HT20 MIMO MCS0 | 802.11n HT40 SISO MCS0 | 802.11n HT40 MIMO MCS0 |
| 2412 MHz | 14.35 | 10.58 | 9.92 | 10.29 | | |
| 2417 MHz | 18.13 | 16.20 | 15.96 | 16.43 | | |
| 2422 MHz | | | | | 10.07 | 10.41 |
| 2427 MHz | | | | | 15.32 | 16.55 |
| 2432 MHz | | | | | 15.34 | |
| 2437 MHz | 18.23 | 16.76 | 16.54 | 16.66 | 16.48 | 16.61 |
| 2442 MHz | | | | | 16.54 | |
| 2447 MHz | | | | | 15.69 | 16.68 |
| 2452 MHz | | | | | 10.48 | 10.38 |
| 2457 MHz | 18.43 | 17.07 | 16.86 | 16.76 | | |
| 2462 MHz | 15.24 | 11.57 | 10.74 | 10.52 | | |

Output Power reported is RMS Power.
Power is measured with a high-speed sampling power meter and the RMS value is calculated.
MIMO value is measured on both antenna connectors simultaneously, and the sum is calculated.
Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.
According to the submitted Antenna Datasheets, Maximum Antenna Gain is 12.0 dBi in MIMO mode and 8.0 dBi in SISO mode.
Maximum allowed Output Power is reduced by 6.0 dB to 24.0 dBm in MIMO mode and by 2.0 dB to 28.0 dBm in SISO mode.
See attached plots.

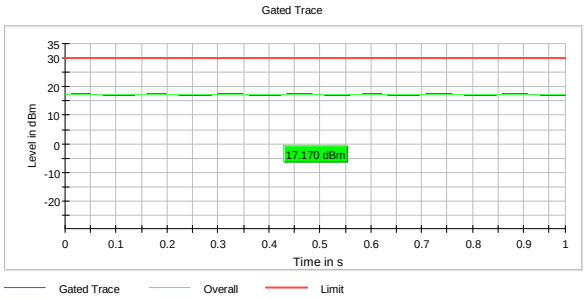
| **Requirements for Digital Modulation systems** |
|---|
| For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.<br><br>As an alternative to a peak power measurement, compliance with the 1 Watt limit can be based on a measurement of the maximum conducted 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 antennas and antenna elements. The average must not include any time 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. |
| **Maximum Antenna Gain** |
| If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi. |



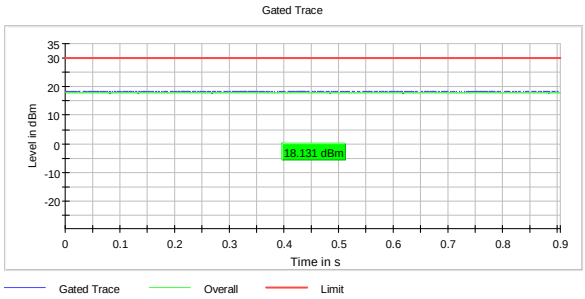

**RMS Power, 2412 MHz, 802.11b 1M**



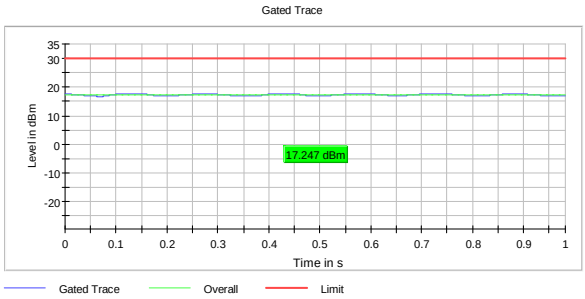

**RMS Power, 2412 MHz, 802.11b 11M**



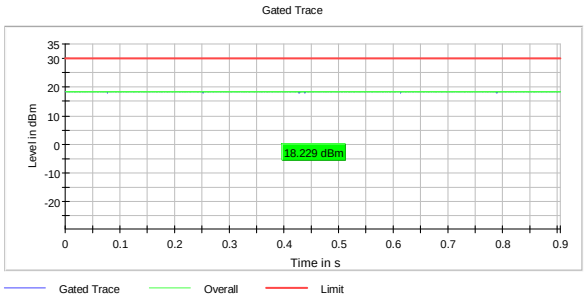

**RMS Power, 2417 MHz, 802.11b 1M**



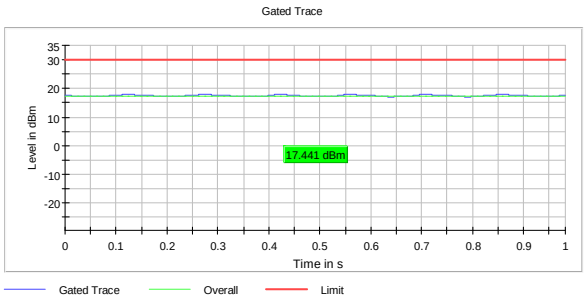

**RMS Power, 2417 MHz, 802.11b 11M**



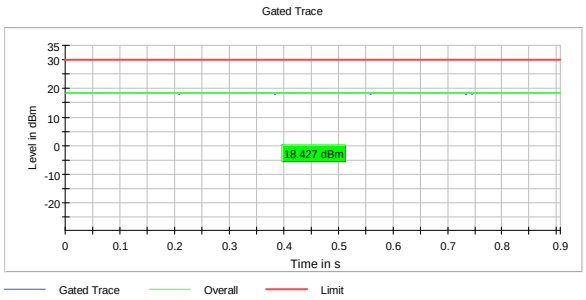

**RMS Power, 2437 MHz, 802.11b 1M**



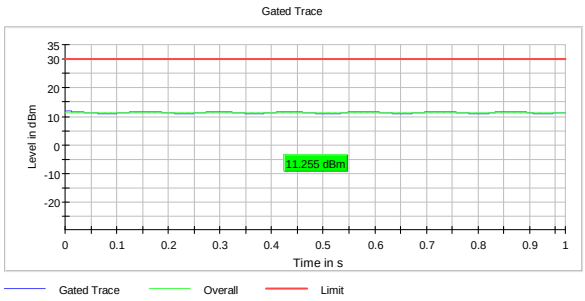

**RMS Power, 2437 MHz, 802.11b 11M**



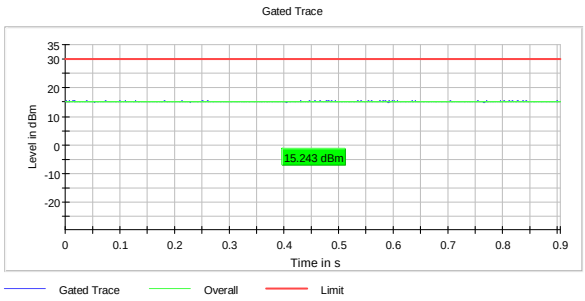

**RMS Power, 2457 MHz, 802.11b 1M**




**RMS Power, 2457 MHz, 802.11b 11M**

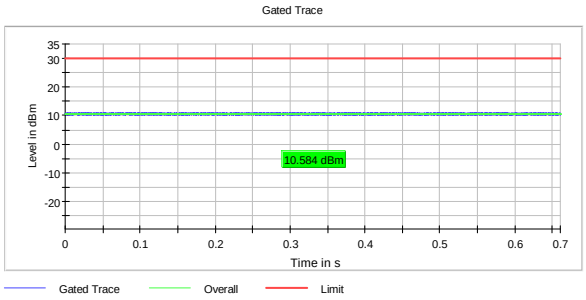



**RMS Power, 2462 MHz, 802.11b 1M**

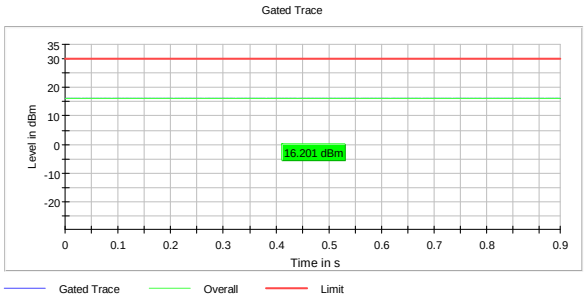



**RMS Power, 2462 MHz, 802.11b 11M**

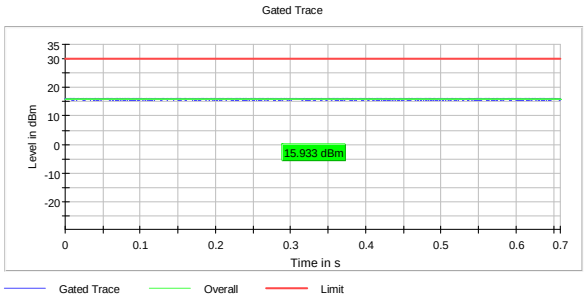
**RMS Power, 2412 MHz, 802.11g 6M**



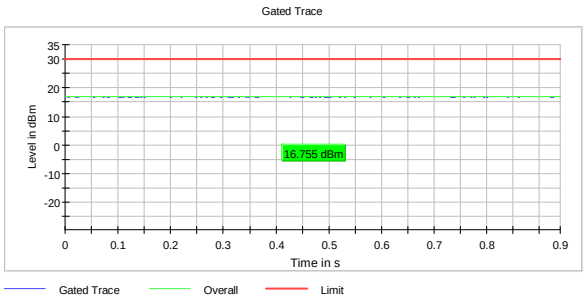

**RMS Power, 2412 MHz, 802.11g 54M**



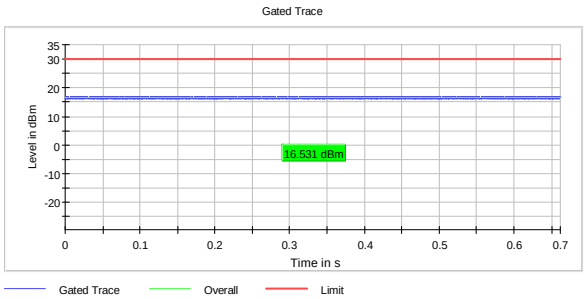

**RMS Power, 2417 MHz, 802.11g 6M**



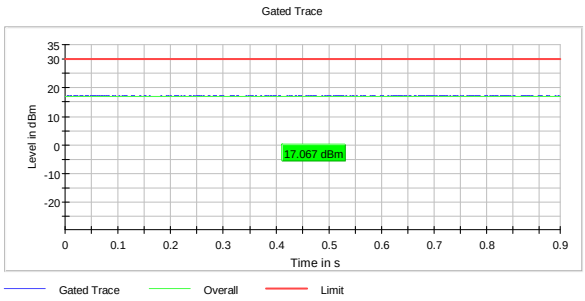

**RMS Power, 2417 MHz, 802.11g 54M**



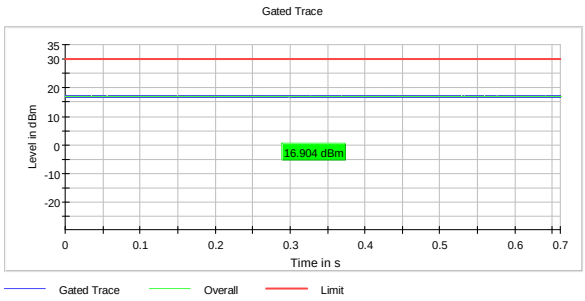

**RMS Power, 2437 MHz, 802.11g 6M**



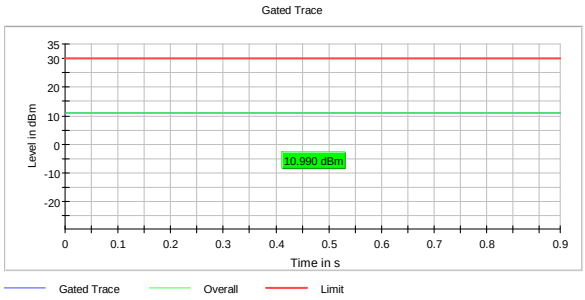

**RMS Power, 2437 MHz, 802.11g 54M**



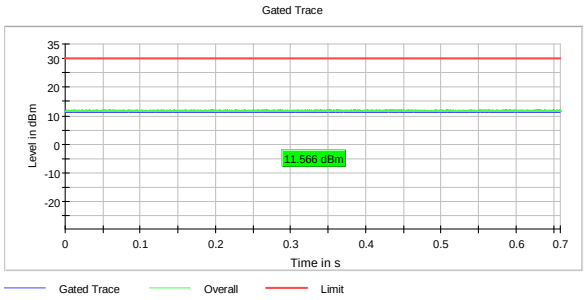

**RMS Power, 2457 MHz, 802.11g 6M**



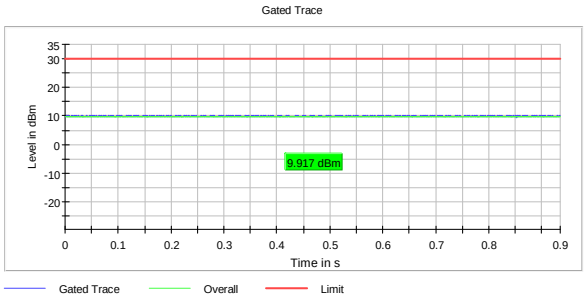

**RMS Power, 2457 MHz, 802.11g 54M**



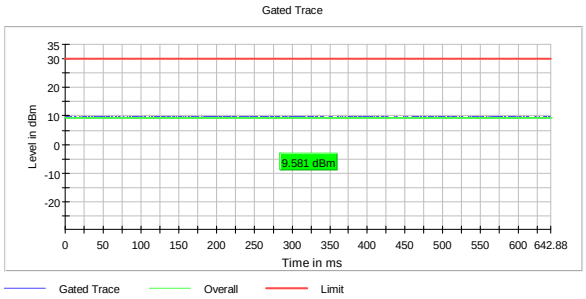

**RMS Power, 2462 MHz, 802.11g 6M**



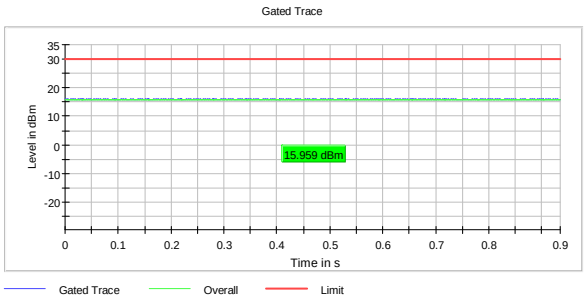

**RMS Power, 2462 MHz, 802.11g 54M**



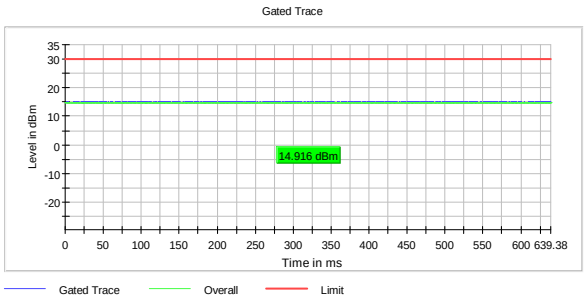

**RMS Power, 2412 MHz, 802.11n SISO MCS0**



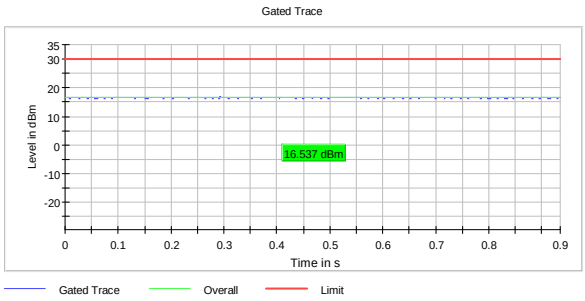

**RMS Power, 2412 MHz, 802.11n SISO MCS7**



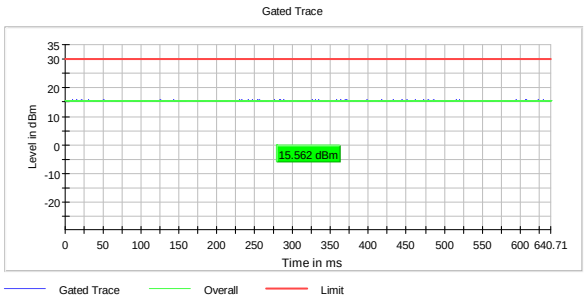

**RMS Power, 2417 MHz, 802.11n SISO MCS0**



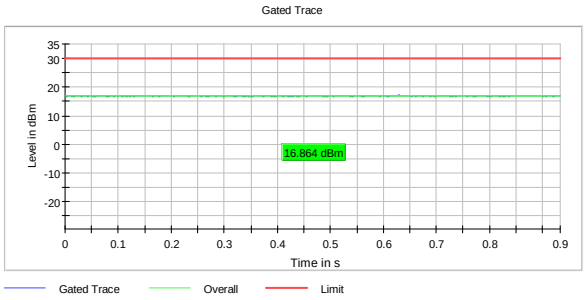

**RMS Power, 2417 MHz, 802.11n SISO MCS7**



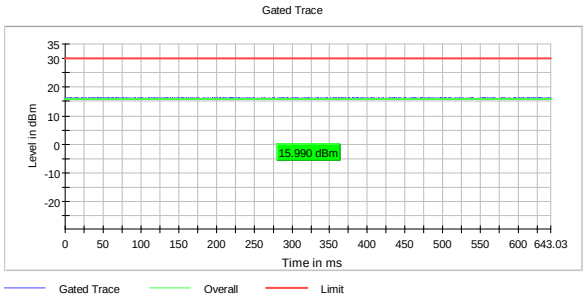

**RMS Power, 2437 MHz, 802.11n SISO MCS0**



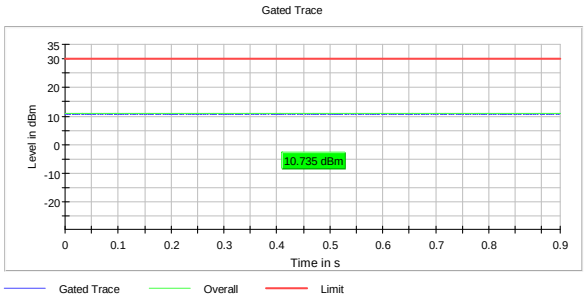

**RMS Power, 2437 MHz, 802.11n SISO MCS7**



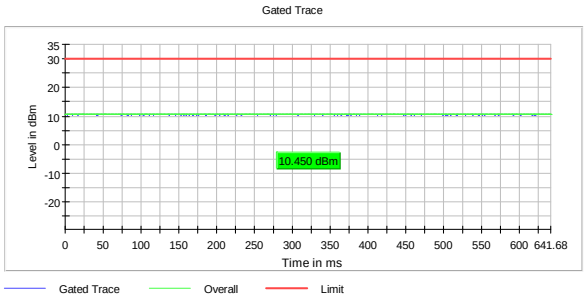

**RMS Power, 2457 MHz, 802.11n SISO MCS0**



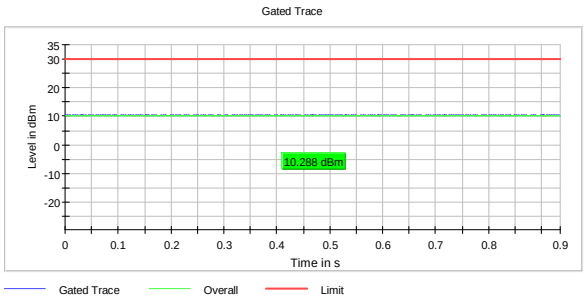

**RMS Power, 2457 MHz, 802.11n SISO MCS7**




**RMS Power, 2462 MHz, 802.11n SISO MCS0**

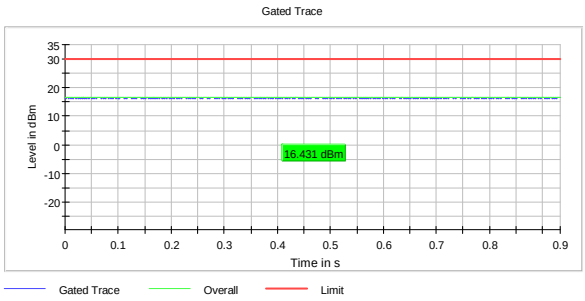



**RMS Power, 2462 MHz, 802.11n SISO MCS7**

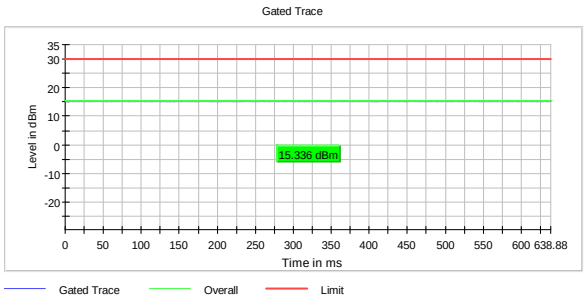



**RMS Power, 2412 MHz, 802.11n MIMO MCS8**

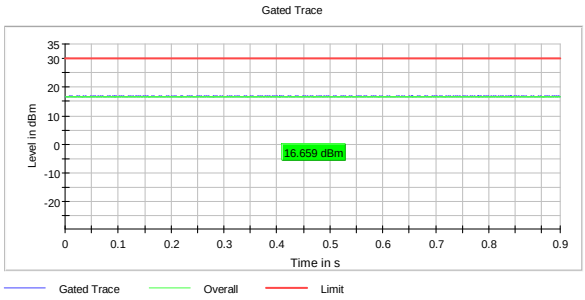
**RMS Power, 2412 MHz, 802.11n MIMO MCS15**



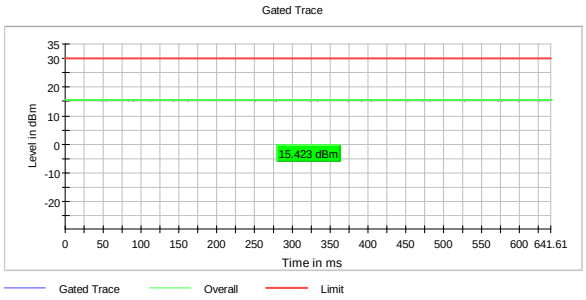

**RMS Power, 2417 MHz, 802.11n MIMO MCS8**



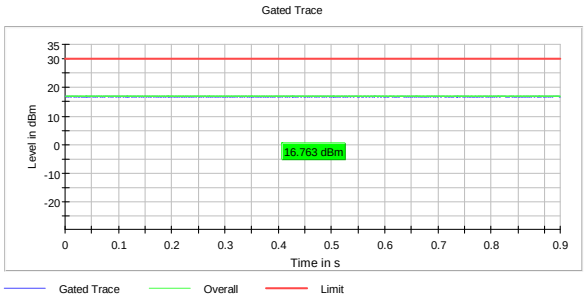

**RMS Power, 2417 MHz, 802.11n MIMO MCS15**



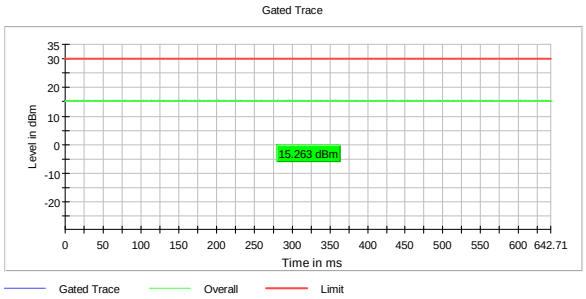

**RMS Power, 2437 MHz, 802.11n MIMO MCS8**



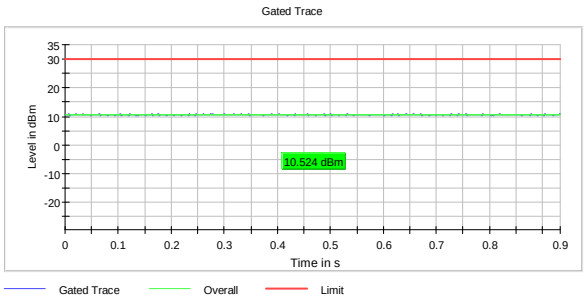

**RMS Power, 2437 MHz, 802.11n MIMO MCS15**




**RMS Power, 2457 MHz, 802.11n MIMO MCS8**

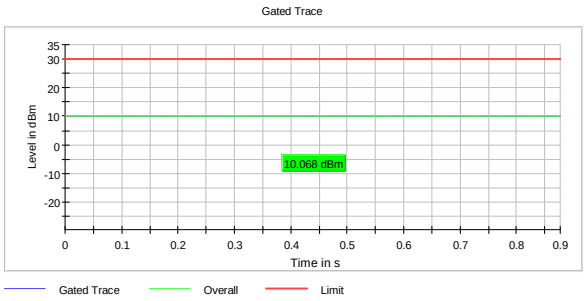



**RMS Power, 2457 MHz, 802.11n MIMO MCS15**

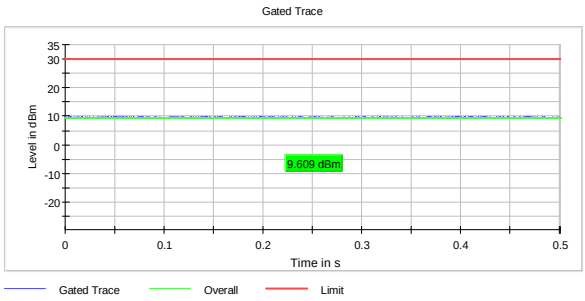



**RMS Power, 2462 MHz, 802.11n MIMO MCS8**

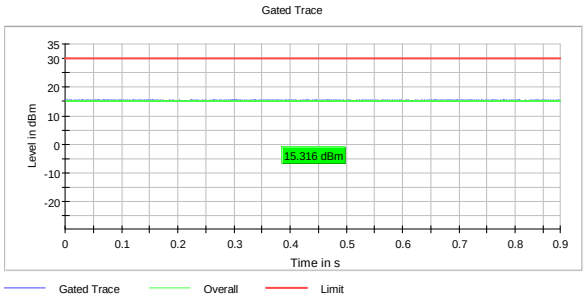
**RMS Power, 2462 MHz, 802.11n MIMO MCS15**



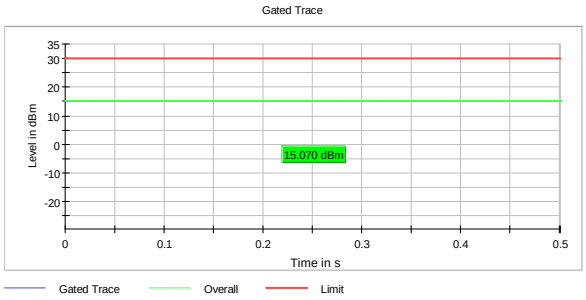

**RMS Power, 2422 MHz, 802.11n HT40 SISO MCS0**



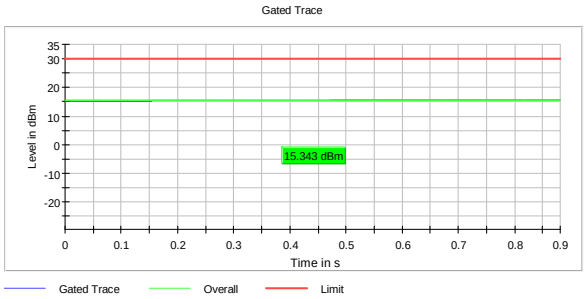

**RMS Power, 2422 MHz, 802.11n HT40 SISO MCS7**



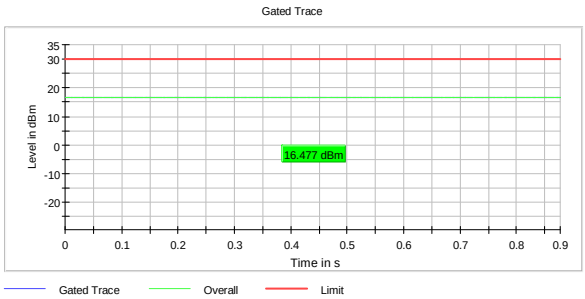

**RMS Power, 2427 MHz, 802.11n HT40 SISO MCS0 PL16**



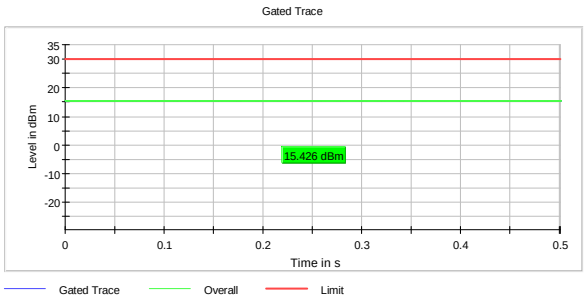

**RMS Power, 2427 MHz, 802.11n HT40 SISO MCS7**



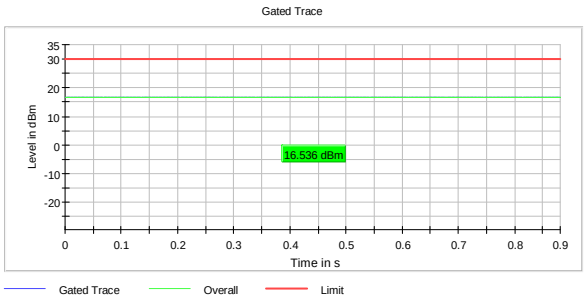

**RMS Power, 2432 MHz, 802.11n HT40 SISO MCS0 PL16**



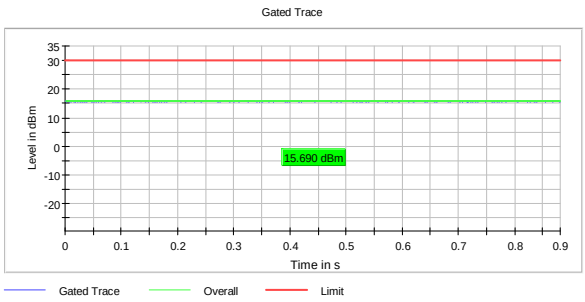

**RMS Power, 2437 MHz, 802.11n HT40 SISO MCS0**



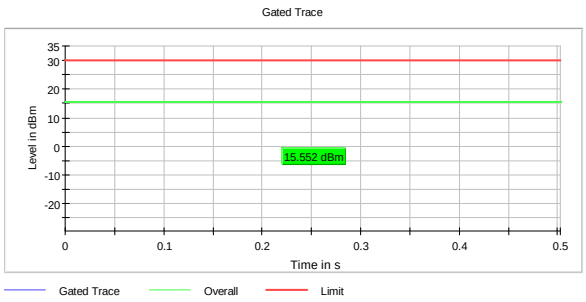

**RMS Power, 2437 MHz, 802.11n HT40 SISO MCS7**



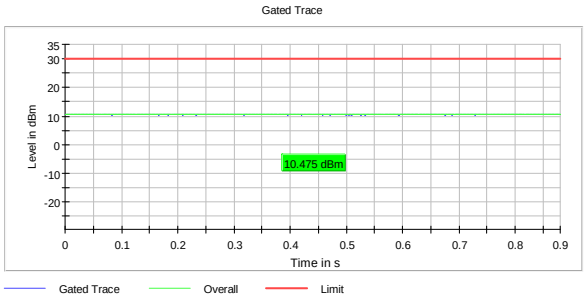

**RMS Power, 2442 MHz, 802.11n HT40 SISO MCS0**



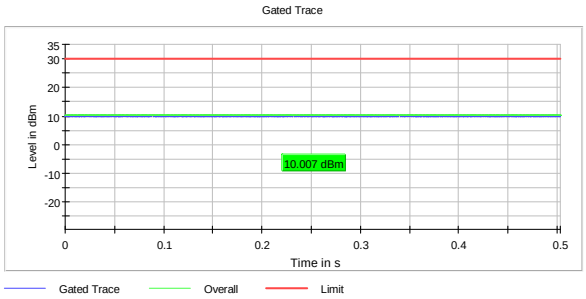

**RMS Power, 2447 MHz, 802.11n HT40 SISO MCS0 PL16**



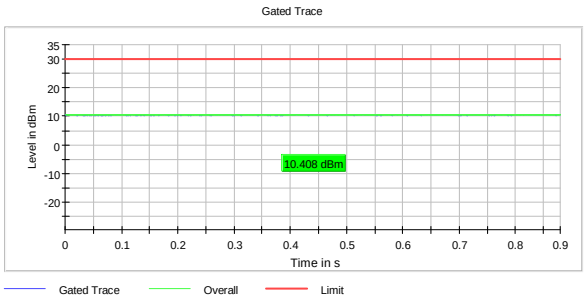

**RMS Power, 2447 MHz, 802.11n HT40 SISO MCS7**



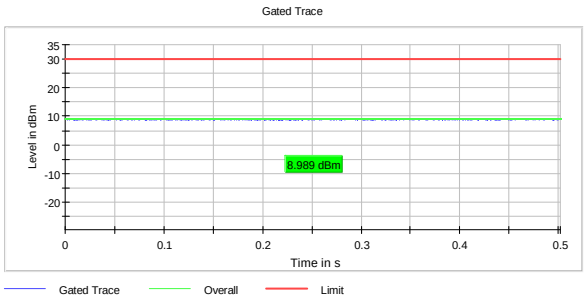

**RMS Power, 2452 MHz, 802.11n HT40 SISO MCS0**



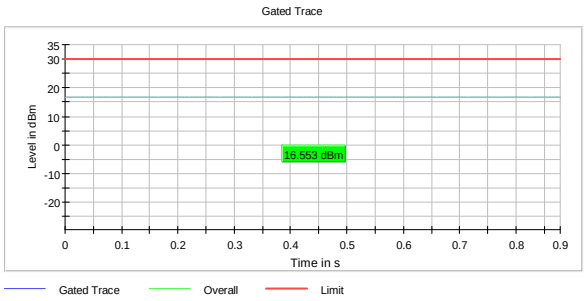

**RMS Power, 2452 MHz, 802.11n HT40 SISO MCS7**



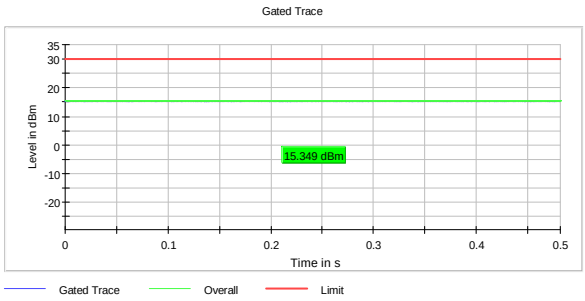

**RMS Power, 2422 MHz, 802.11n HT40 MIMO MCS8**



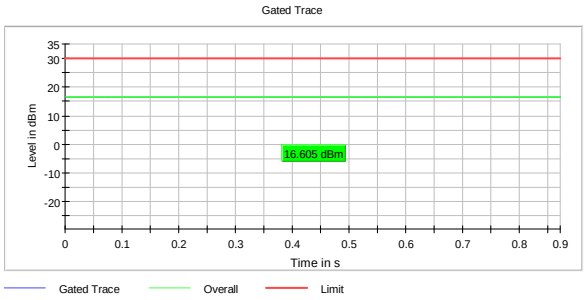

**RMS Power, 2422 MHz, 802.11n HT40 MIMO MCS15 PL7**



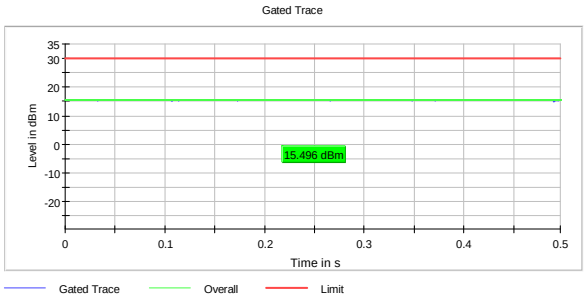

**RMS Power, 2427 MHz, 802.11n HT40 MIMO MCS8**



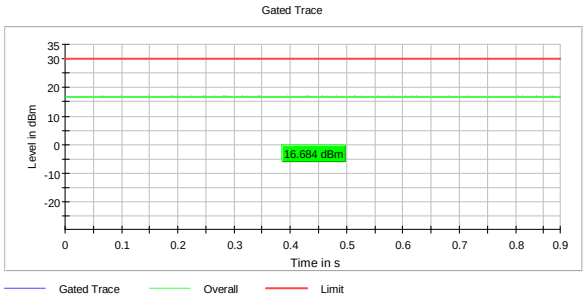

**RMS Power, 2427 MHz, 802.11n HT40 MIMO MCS15**



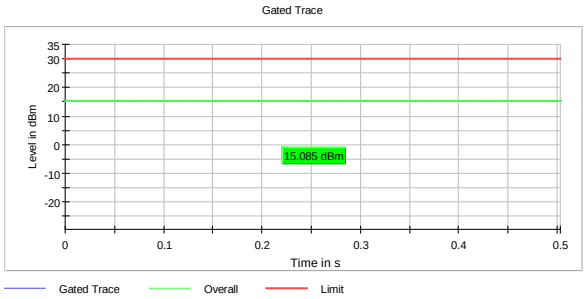

**RMS Power, 2437 MHz, 802.11n HT40 MIMO MCS8**



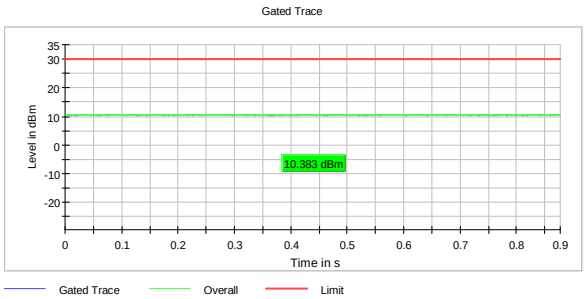

**RMS Power, 2437 MHz, 802.11n HT40 MIMO MCS15**



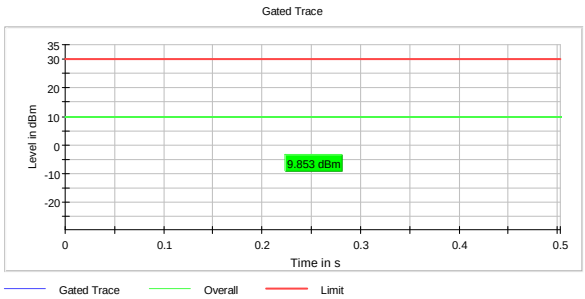

**RMS Power, 2447 MHz, 802.11n HT40 MIMO MCS8**




**RMS Power, 2447 MHz, 802.11n HT40 MIMO MCS15**




**RMS Power, 2452 MHz, 802.11n HT40 MIMO MCS8**




**RMS Power, 2452 MHz, 802.11n HT40 MIMO MCS15**

## 3.4 Conducted Emissions at Antenna Connector

**FCC Part 15.247 (d)**

**ISED Canada RSS-247 Issue 2, Clause 5.5**

**Measurement procedure: ANSI C63.10-2013 Clause 11.11**

**Test Results: Complies**

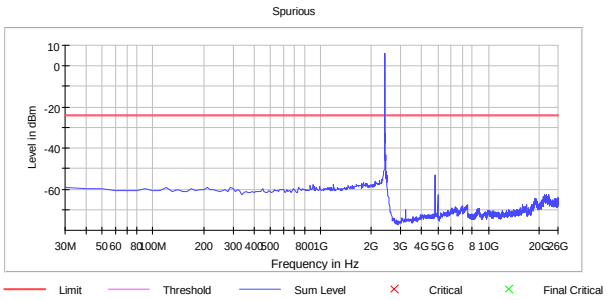
**Measurement Data:**

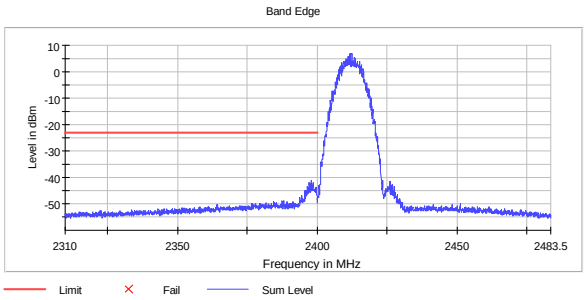
| Carrier Frequency | Highest Value (dBc) | Margin | Verdict |
|---|---|---|---|
| Any Channel and Modulation | ≥ 30 dBc | ≥ 10 dB | Pass |

Measured with Peak Detector

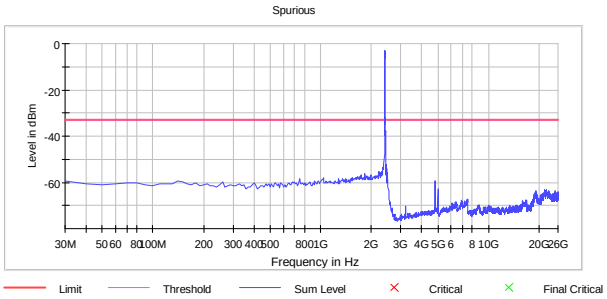
**RF conducted power** to 25 GHz: see attached plots.

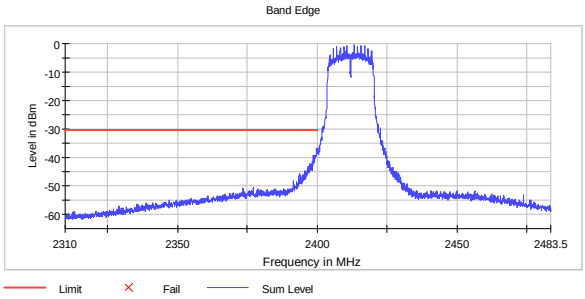
| Requirements for all systems | |
|---|---|
| **Peak measurement** | **RMS averaging (alternative measurement)** |
| 20 dB or more below carrier measured in 100 kHz bandwidth | 30 dB or more below carrier measured in 100 kHz bandwidth |
| In any 100 kHz bandwidth outside the frequency band in which 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.<br><br>Attenuation below the general limits specified in § 15.209(a) is not required. | |



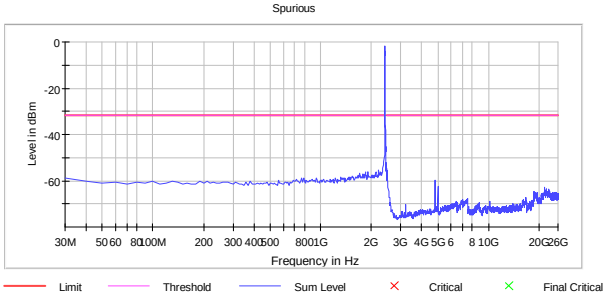



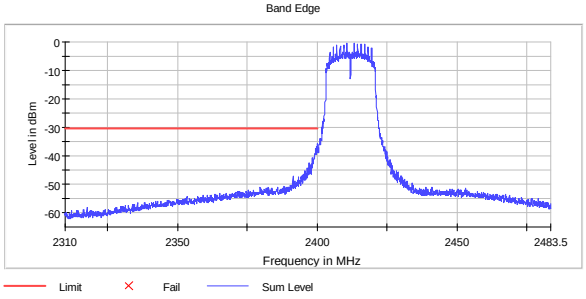

**Conducted Emissions Ch01, 802.11b 11M** **Band Edge**



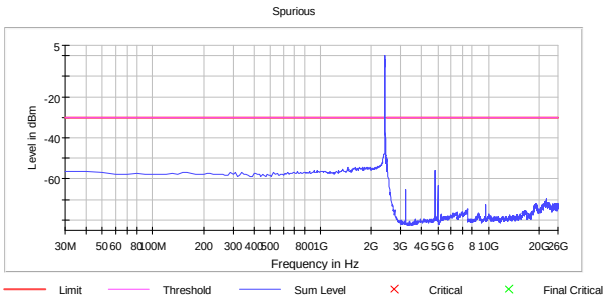



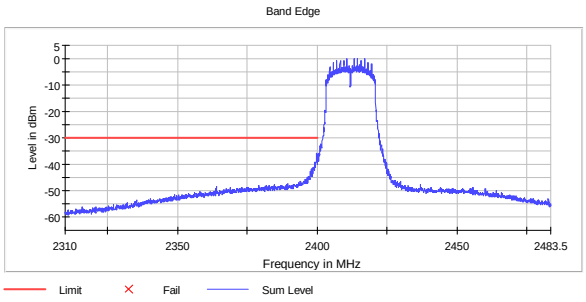

**Conducted Emissions Ch01, 802.11g 6M** **Band Edge**



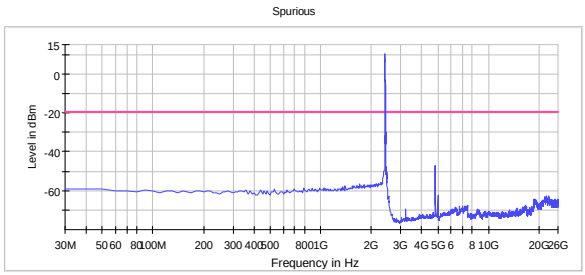



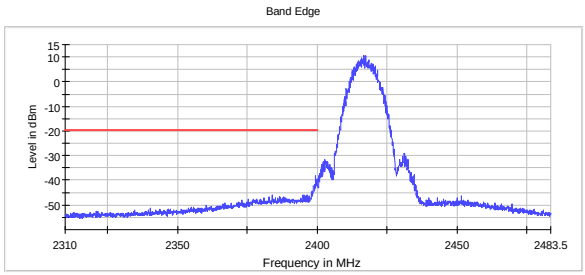

**Conducted Emissions Ch01, 802.11n MCS0 SISO** **Band Edge**



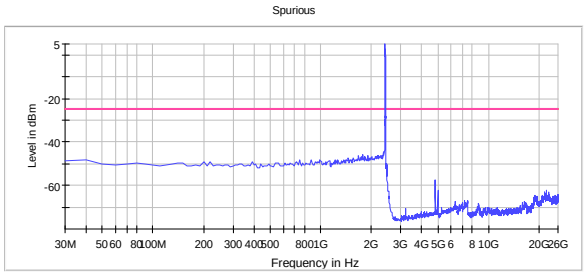



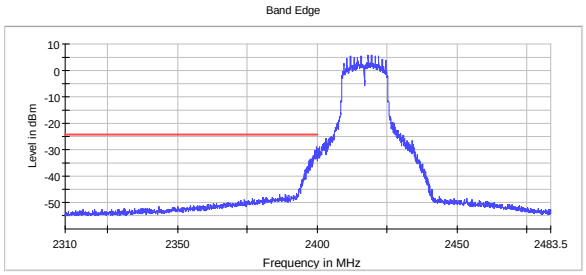

**Conducted Emissions Ch01, 802.11n MCS8 MIMO** **Band Edge**



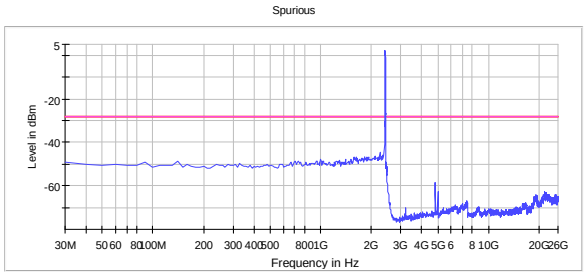



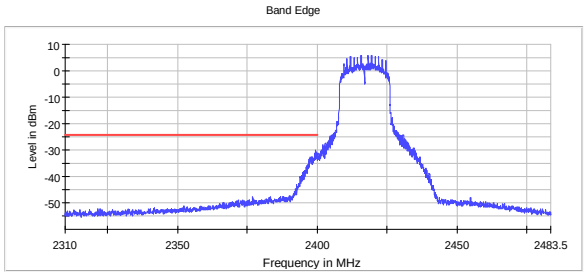

**Conducted Emissions Ch02, 802.11b 11M** **Band Edge**



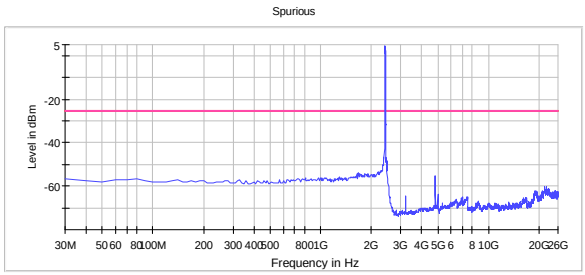



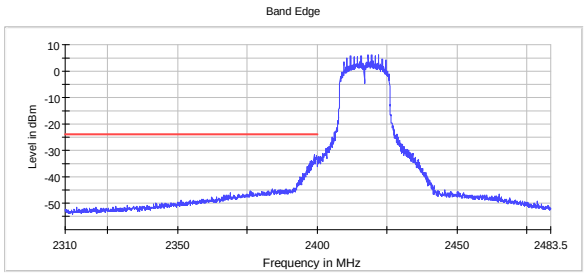

**Conducted Emissions Ch02, 802.11g 6M** **Band Edge**



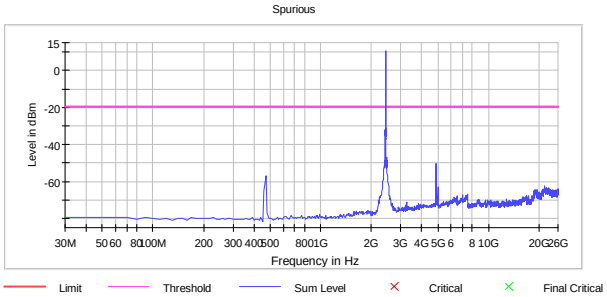




**Conducted Emissions Ch02, 802.11n MCS0 SISO** **Band Edge**

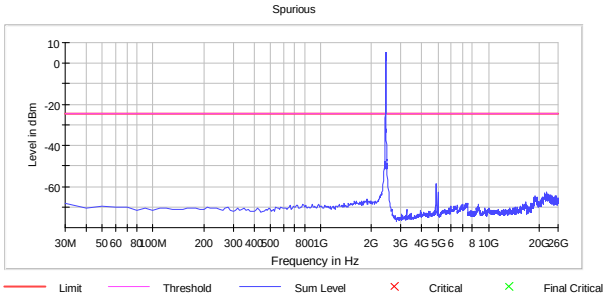


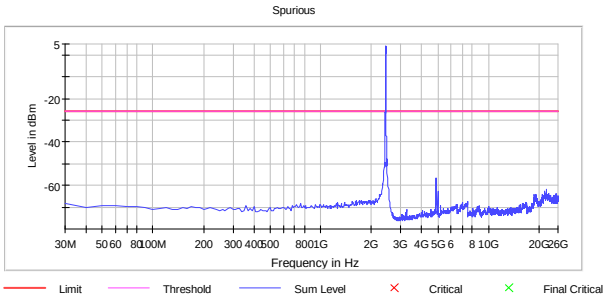

**Conducted Emissions Ch02, 802.11n MCS8 MIMO** **Band Edge**



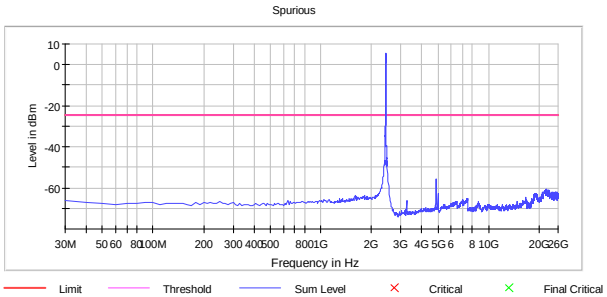

**Conducted Emissions Ch06, 802.11b 11M**



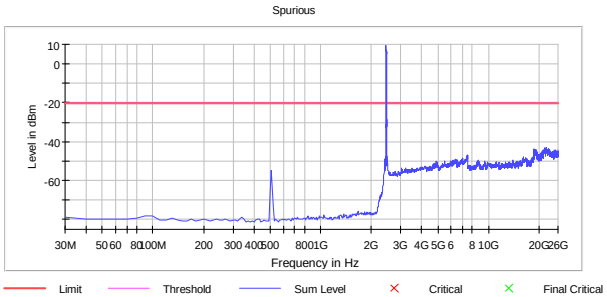

**Conducted Emissions Ch06, 802.11g 6M**



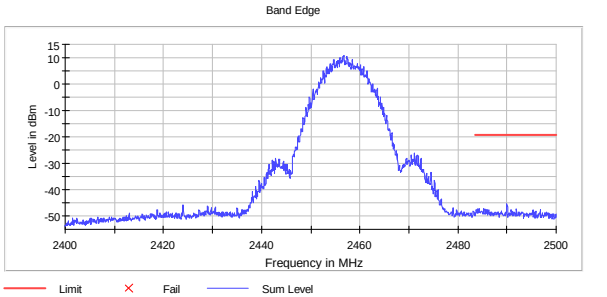

**Conducted Emissions Ch06, 802.11n MCS0 SISO**



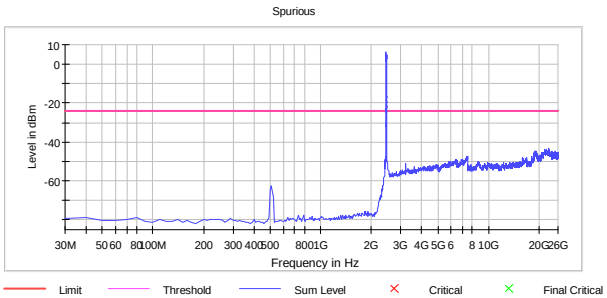

**Conducted Emissions Ch06, 802.11n MCS8 MIMO**



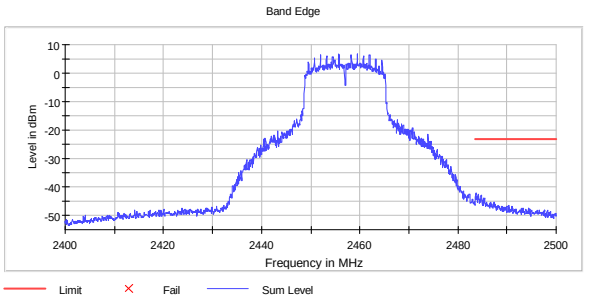

**Conducted Emissions Ch10, 802.11b 11M**



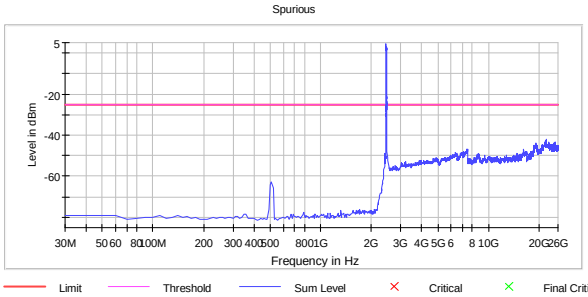

**Band Edge**

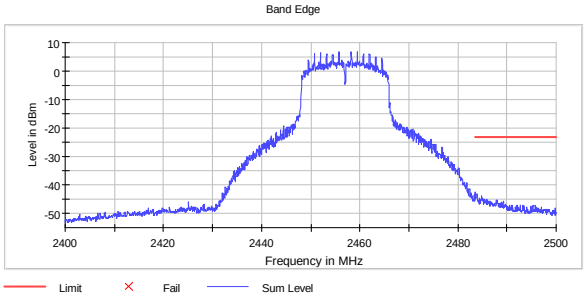



**Conducted Emissions Ch10, 802.11g 6M**

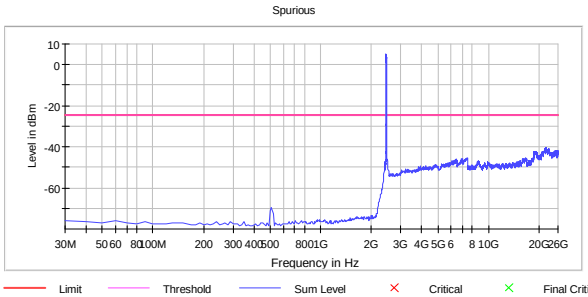


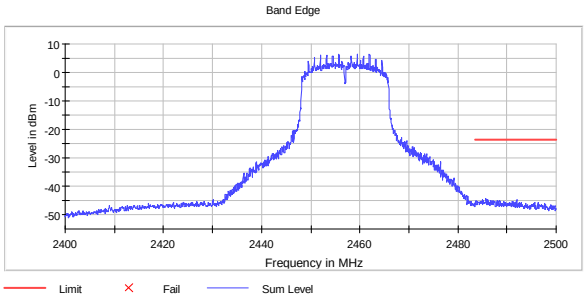

**Band Edge**



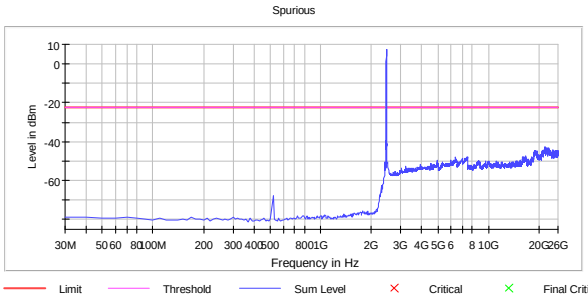



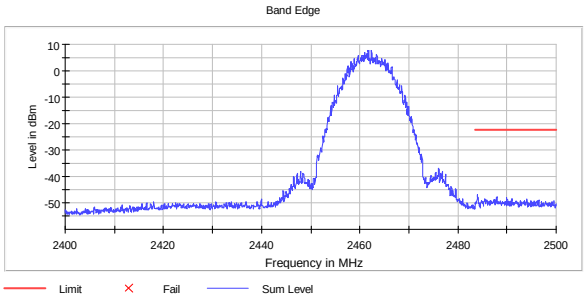

**Conducted Emissions Ch10, 802.11n MCS0 SISO** **Band Edge**



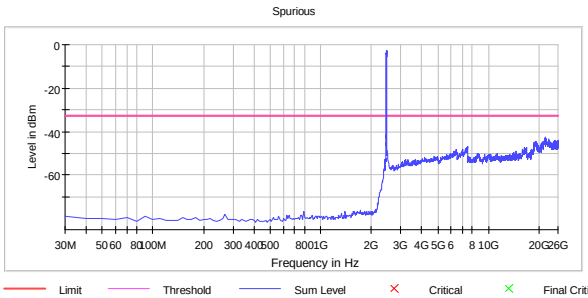



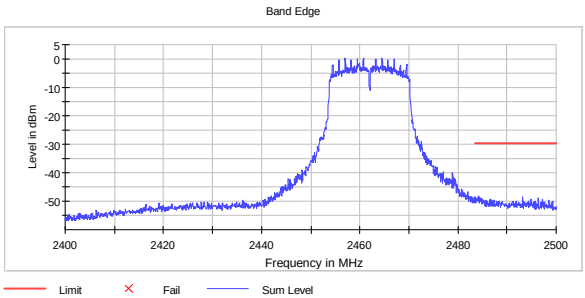

**Conducted Emissions Ch10, 802.11n MCS8 MIMO** **Band Edge**



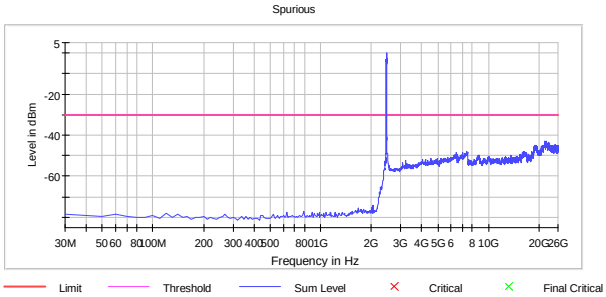




**Conducted Emissions Ch11, 802.11b 11M** **Band Edge**

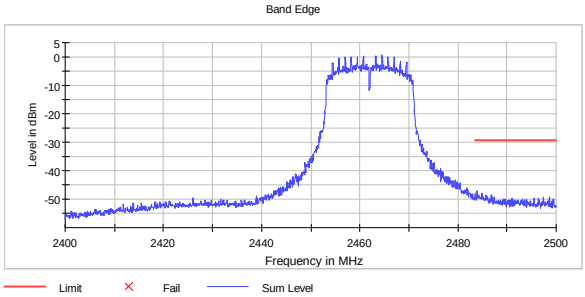


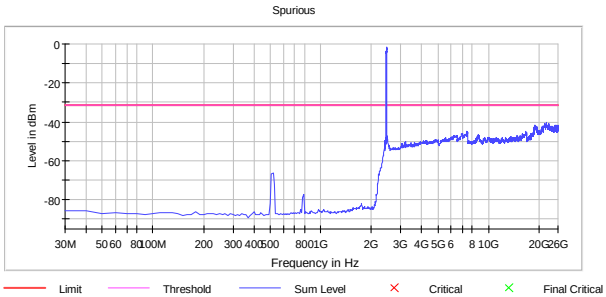

**Conducted Emissions Ch11, 802.11g 6M** **Band Edge**



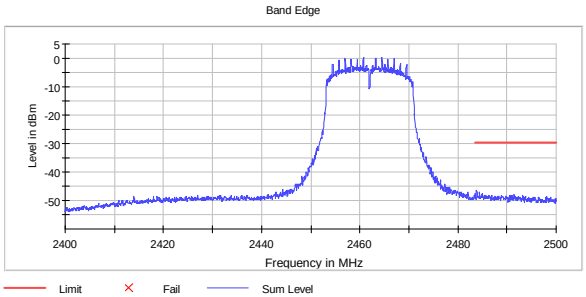

**Conducted Emissions Ch11, 802.11n MCS0 SISO**



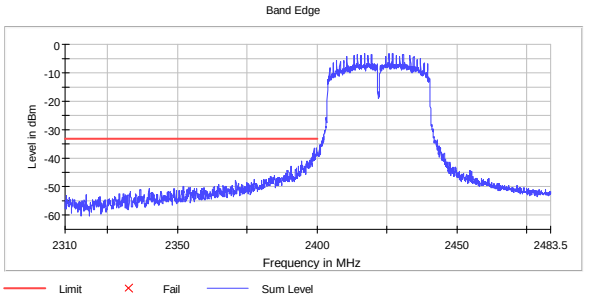

**Band Edge**



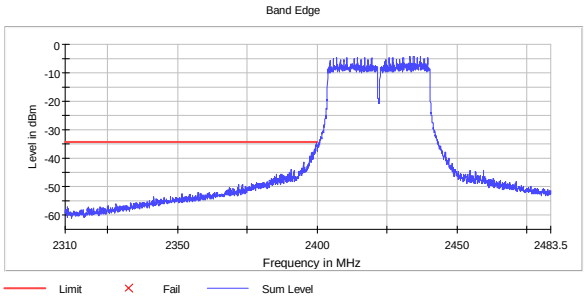

**Conducted Emissions Ch11, 802.11n MCS8 MIMO**



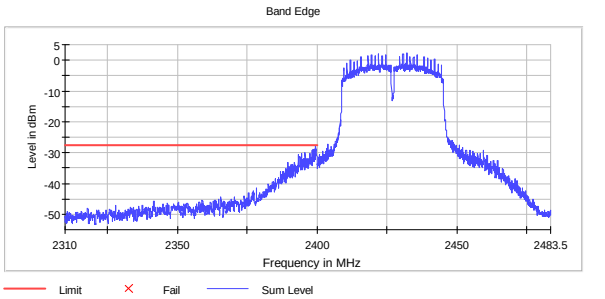

**Band Edge**



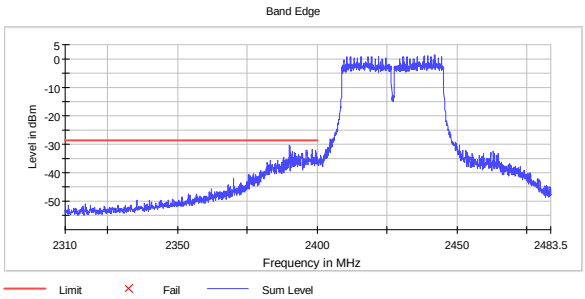

**Band Edge Ch03 802.11n HT40 MCS0 SISO**



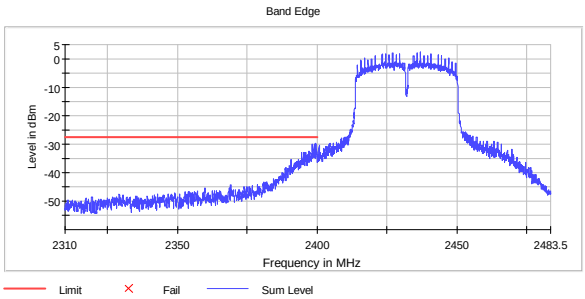

**Band Edge Ch03 802.11n HT40 MCS7 SISO**



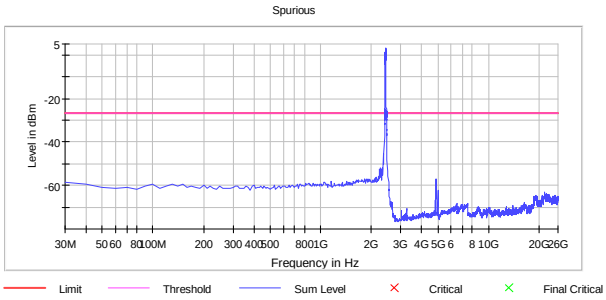

**Band Edge Ch04 802.11n HT40 MCS0 SISO PL16**



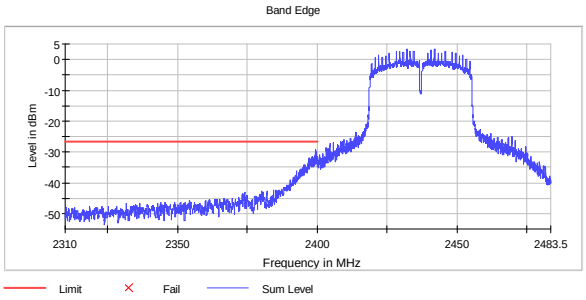

**Band Edge Ch04 802.11n HT40 MCS7 SISO**



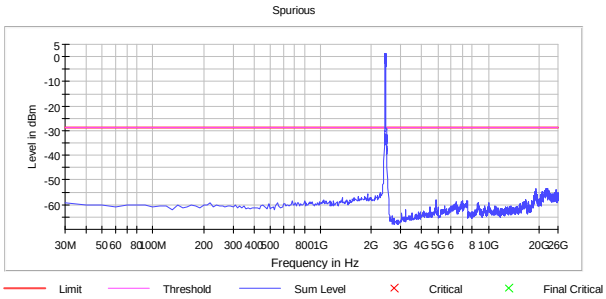

**Band Edge Ch05 802.11n HT40 MCS0 SISO PL16**



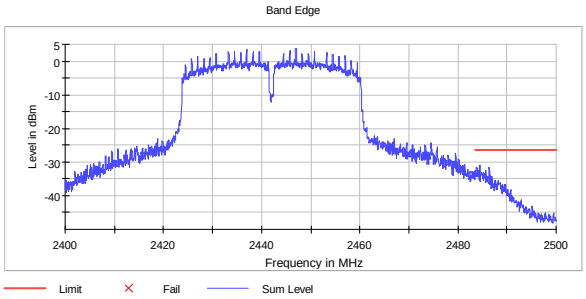

**Conducted Emissions Ch06 802.11n HT40 MCS0 SISO**



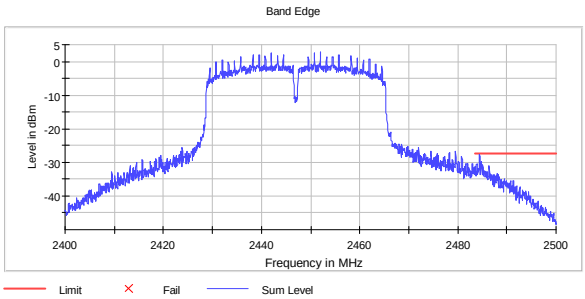

**Band Edge Ch06 802.11n HT40 MCS0 SISO**



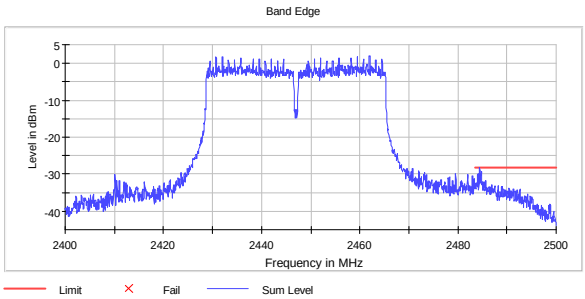

**Conducted Emissions Ch06 802.11n HT40 MCS7 SISO**



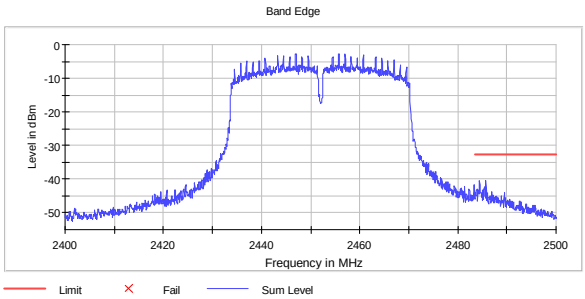

**Band Edge Ch07 802.11n HT40 MCS0 SISO**



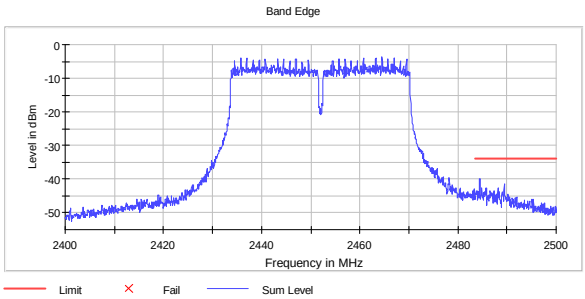

**Band Edge Ch08 802.11n HT40 MCS0 SISO PL16**



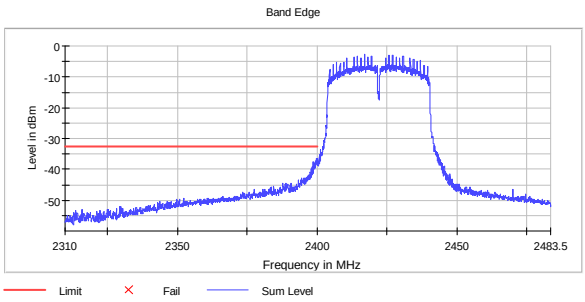

**Band Edge Ch08 802.11n HT40 MCS7 SISO**



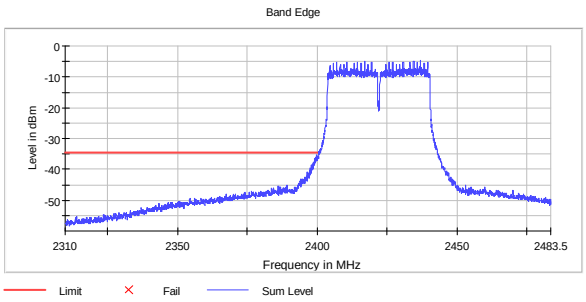

**Band Edge Ch09 802.11n HT40 MCS0 SISO**



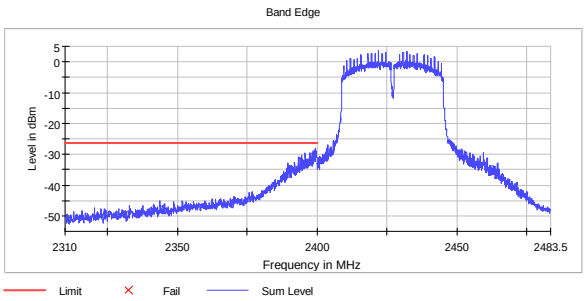

**Band Edge Ch09 802.11n HT40 MCS7 SISO**



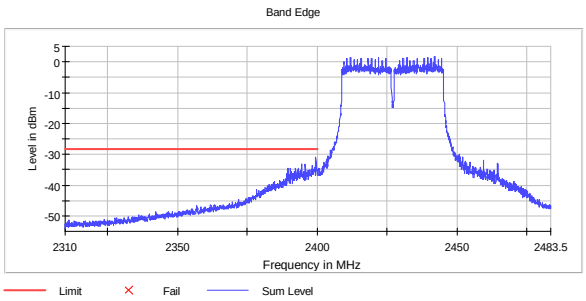

**Band Edge Ch03 802.11n HT40 MCS8 MIMO**



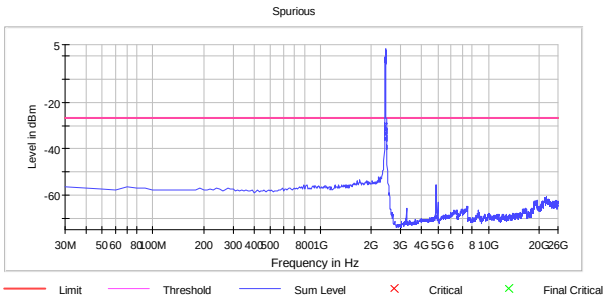

**Band Edge Ch03 802.11n HT40 MCS15 MIMO PL7**



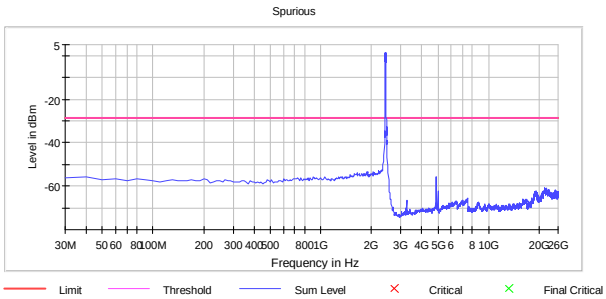

**Band Edge Ch04 802.11n HT40 MCS8 MIMO**



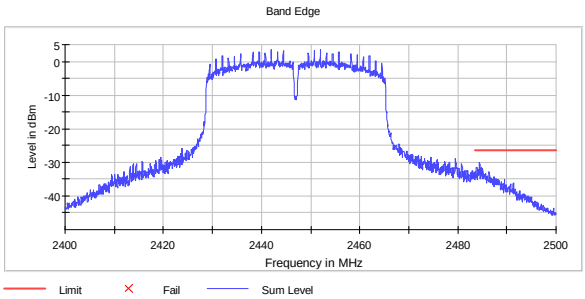

**Band Edge Ch04 802.11n HT40 MCS15 MIMO**



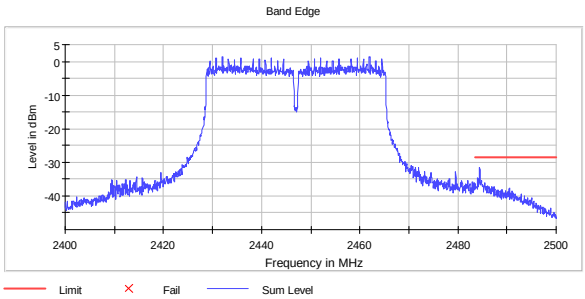

**Conducted Emissions Ch06 802.11n HT40 MCS8 MIMO**



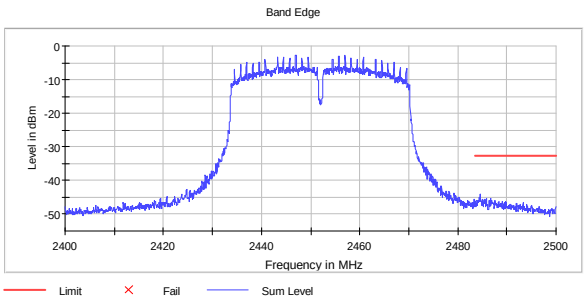

**Conducted Emissions Ch06 802.11n HT40 MCS15 MIMO**



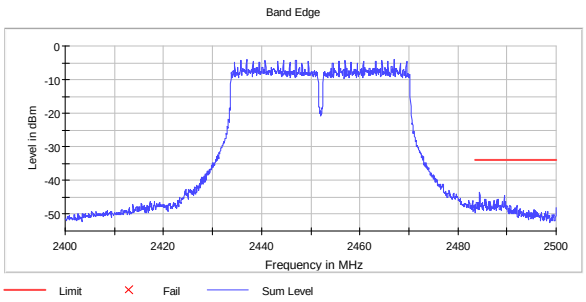

**Band Edge Ch08 802.11n HT40 MCS8 MIMO**




**Band Edge Ch08 802.11n HT40 MCS15 MIMO**




**Band Edge Ch09 802.11n HT40 MCS8 MIMO**




**Band Edge Ch09 802.11n HT40 MCS15 MIMO**

## 3.5 Restricted Bands of operation

Restricted Bands of operation for FCC and ISED are defined in FCC Part 15.205 and ISED RSS-GEN, Issue 5 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

| FCC (MHz) | ISED (MHz) | FCC (GHz) | ISED (GHz) |
|---|---|---|---|
| 0.090-0.110 | | **0.96-1.24**<br>**1.3-1.427** | **0.96-1.427** |
| 0.495-0.505 | | 1.435-1.6265 | |
| 2.1735-2.1905 | | 1.6455-1.6465 | |
| | **3.020-3.026** | 1.660-1.710 | |
| 4.125-4.128 | | 1.7188-1.7222 | |
| 4.17725-4.17775 | | 2.2-2.3 | |
| 4.20725-4.20775 | | 2.31-2.39 | |
| | **5.677-5.683** | 2.4835-2.5 | |
| 6.215-6.218 | | **2.69-2.9** | **2.655-2.9** |
| 6.26775-6.26825 | | 3.26-3.267 | |
| 6.31175-6.31225 | | 3.332-3.339 | |
| 8.291-8.294 | | 3.3458-3.358 | |
| 8.362-8.366 | | **3.6-4.4** | **3.5-4.4** |
| 8.37625-8.38675 | | 4.5-5.15 | |
| 8.41425-8.41475 | | 5.35-5.46 | |
| 12.29-12.293 | | 7.25-7.75 | |
| 12.51975-12.52025 | | 8.025-8.5 | |
| 12.57675-12.57725 | | 9.0-9.2 | |
| 13.36-13.41 | | 9.3-9.5 | |
| 16.42-16.423 | | 10.6-12.7 | |
| 16.69475-16.69525 | | 13.25-13.4 | |
| 16.80425-16.80475 | | 14.47-14.5 | |
| 25.5-25.67 | | 15.35-16.2 | |
| 37.5-38.25 | | 17.7-21.4 | |
| 73-74.6 | | 22.01-23.12 | |
| 74.8-75.2 | | 23.6-24.0 | |
| **108-121.94**<br>**123-138** | **108-138** | 31.2-31.8 | |
| 149.9-150.05 | | 36.43-36.5 | |
| 156.52475-156.52525 | | Above 38.6 | |
| 156.7-156.9 | | | |
| 162.0125-167.17 | | | |
| 167.72-173.2 | | | |
| 240-285 | | | |
| 322-335.4 | | | |
| 399.9-410 | | | |
| 608-614 | | | |

Frequencies in **Bold** text are specific for FCC or ISED, all other frequencies are common.

## 3.6 Radiated Emissions, Band Edge

**FCC Part 15.209 (a)**

**ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9**

**Measurement procedure:** **ANSI C63.10-2013 Clause 11.12**

**Test Results: Complies**

**Measurement Data:**

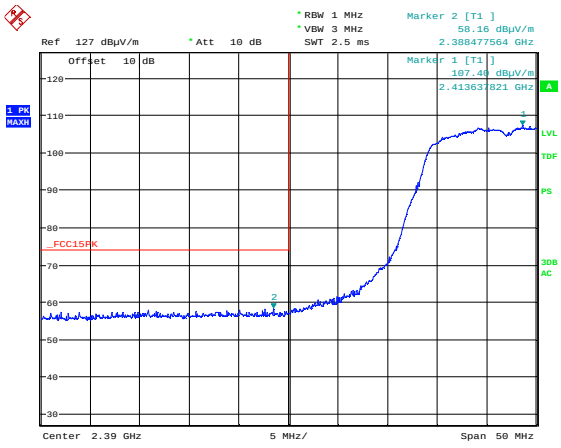
| Combi Antenna, Peak Detector | | | | | |
|---|---|---|---|---|---|
| Modulation and Bitrate | Measured field strength (dBµV/m) | | Limit | Margin | |
| | 2390 MHz | 2483.5 MHz | dB | dB | |
| 802.11g, 6 Mbps | 58.2 | 62.1 | 74 | 15.8 | 11.9 |
| 802.11n, SISO MCS0 | 59.6 | 64.2 | 74 | 14.4 | 9.8 |
| 802.11n, MIMO MCS0 | 59.2 | 66.1 | 74 | 14.8 | 7.9 |
| 802.11n, HT40 SISO MCS0 | 66.5 | 66.1 | 74 | 7.5 | 7.9 |
| 802.11n, HT40 MIMO MCS0 | 73.4 | 68.8 | 74 | 0.6 | 5.2 |
| Combi Antenna, Average Detector | | | | | |
| Modulation and Bitrate | Measured field strength (dBµV/m) | | Limit | Margin | |
| | 2390 MHz | 2483.5 MHz | dB | dB | |
| 802.11g, 6 Mbps | 46.0 | 49.8 | 54 | 8.0 | 4.2 |
| 802.11n, SISO MCS0 | 47.7 | 50.6 | 54 | 6.3 | 3.4 |
| 802.11n, MIMO MCS0 | 47.0 | 52.6 | 54 | 7.0 | 1.4 |
| 802.11n, HT40 SISO MCS0 | 52.3 | 52.1 | 54 | 1.7 | 1.9 |
| 802.11n, HT40 MIMO MCS0 | 53.6 | 53.8 | 54 | 0.4 | 0.2 |

| Whip Antenna, Peak Detector | | | | | |
|---|---|---|---|---|---|
| Modulation and Bitrate | Measured field strength (dBµV/m) | | Limit | Margin | |
| | 2390 MHz | 2483.5 MHz | dB | dB | |
| 802.11b, 11 Mbps | 57.9 | 58.2 | 74 | 16.1 | 15.8 |
| 802.11g, 6 Mbps | 57.8 | 63.4 | 74 | 16.2 | 10.6 |
| 802.11n, SISO MCS0 | 57.8 | 62.3 | 74 | 16.2 | 11.7 |
| 802.11n, MIMO MCS0 | 63.4 | 63.9 | 74 | 10.6 | 10.1 |
| Whip Antenna, Average Detector | | | | | |
| Modulation and Bitrate | Measured field strength (dBµV/m) | | Limit | Margin | |
| | 2390 MHz | 2483.5 MHz | dB | dB | |
| 802.11b, 11 Mbps | 45.6 | 45.7 | 54 | 8.4 | 8.3 |
| 802.11g, 6 Mbps | 44.9 | 48.7 | 54 | 9.1 | 5.3 |
| 802.11n, SISO MCS0 | 44.8 | 51.4 | 54 | 9.2 | 2.6 |
| 802.11n, MIMO MCS0 | 50.0 | 51.0 | 54 | 4.0 | 3.0 |

Average values were measured using trace averaging as described in ANSI C63.10-2013 clause 11.12.2.5.1 (Duty Cycle is 100%).

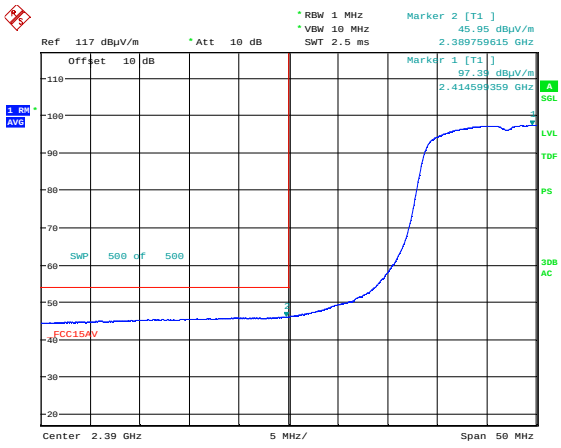
See attached plots.

## Combi Antenna



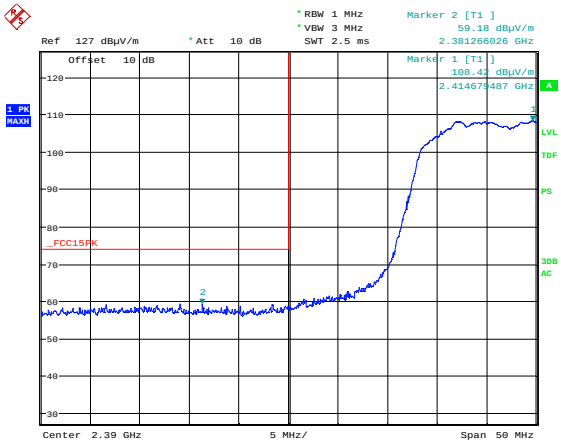

Date: 28.FEB.2023 09:26:36

**Band Edge, 2412 MHz, 802.11g 6M, Ant 0, Peak**



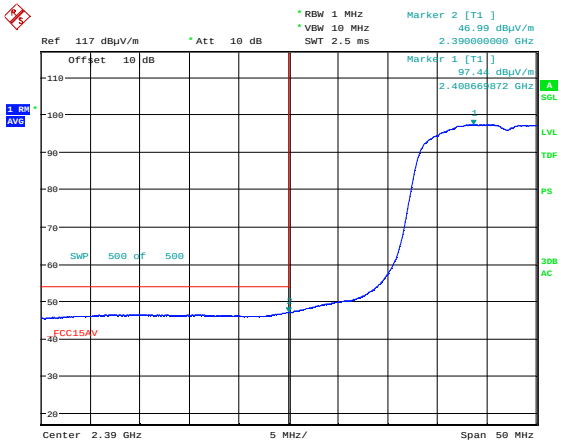

Date: 28.FEB.2023 09:27:05

**Average**



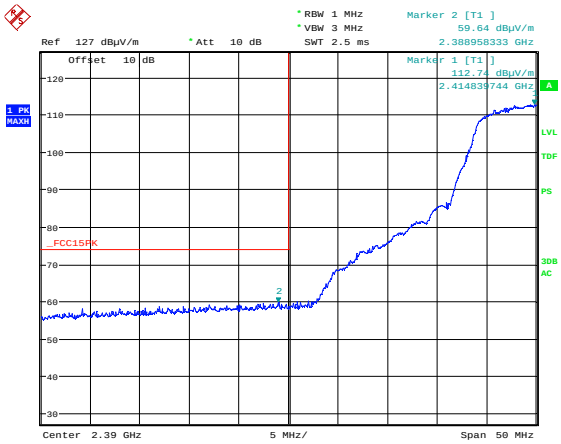

Date: 27.FEB.2023 16:26:10

**Band Edge, 2412 MHz, 802.11n MCS0, MIMO, Peak**



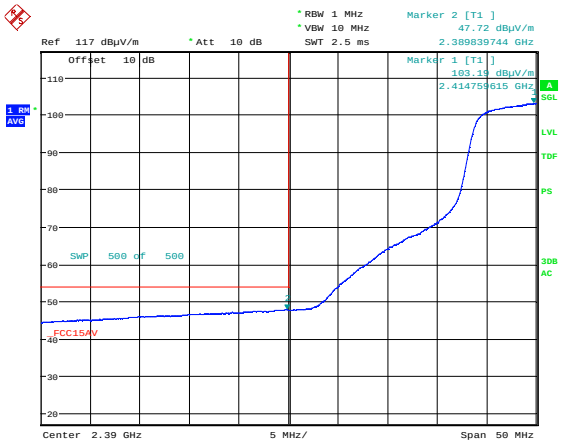

Date: 27.FEB.2023 16:23:59

**Average**



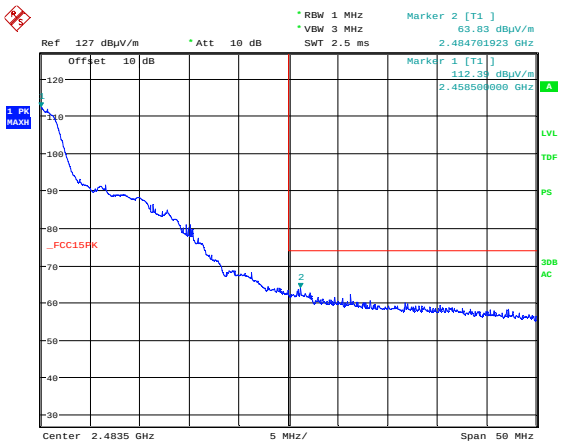

Date: 28.FEB.2023 09:33:39

**Band Edge, 2417 MHz, 802.11n MCS0, Ant 0, Peak**



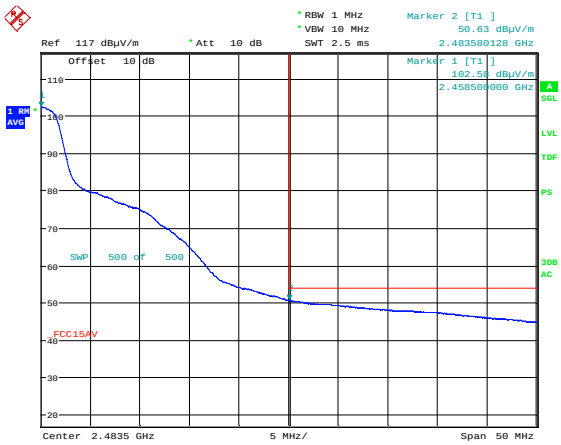

Date: 28.FEB.2023 09:34:08

**Average**



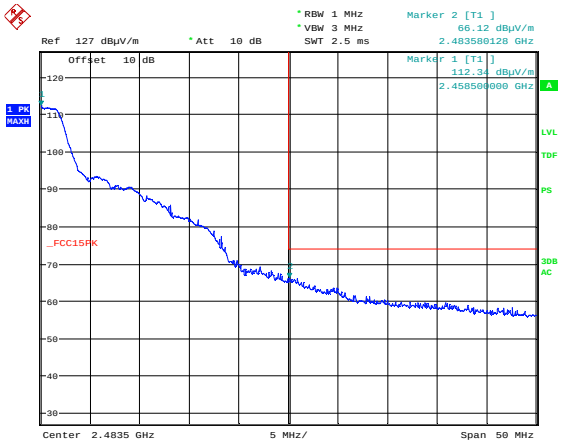

Date: 28.FEB.2023 10:15:01

**Band Edge, 2452 MHz, 802.11n MCS0, Ant 0, Peak**



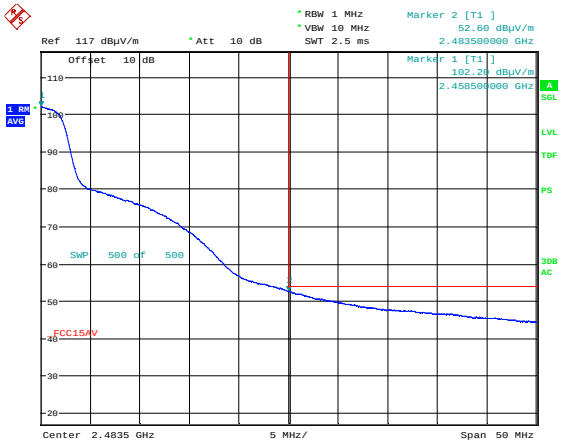

Date: 28.FEB.2023 10:14:11

**Average**



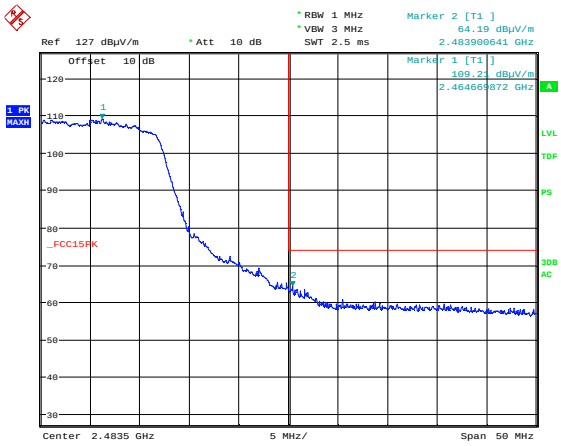

Date: 28.FEB.2023 10:30:32

**Band Edge, 2452 MHz, 802.11n MCS0, MIMO, Peak**



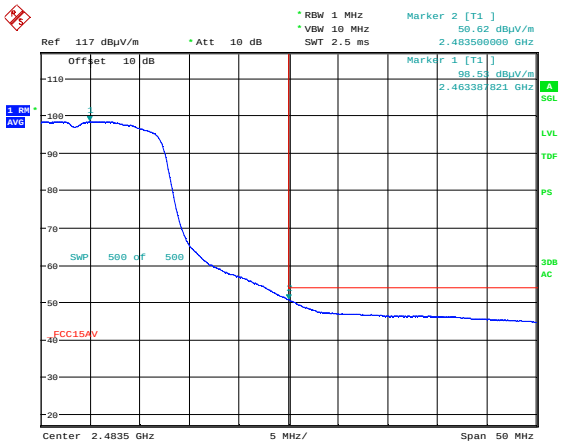

Date: 28.FEB.2023 10:31:00

**Average**



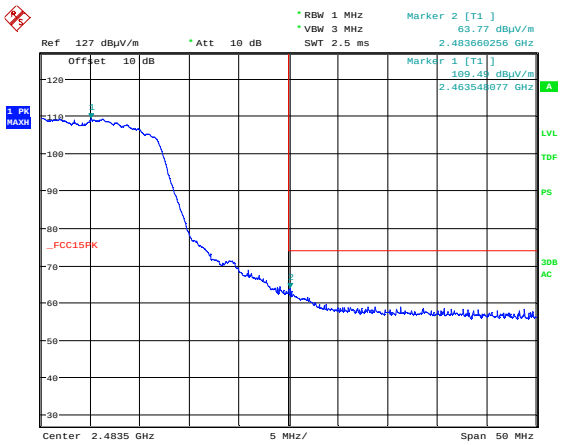

Date: 28.FEB.2023 10:33:29

**Band Edge, 2462 MHz, 802.11n MCS0, Ant 0, Peak**



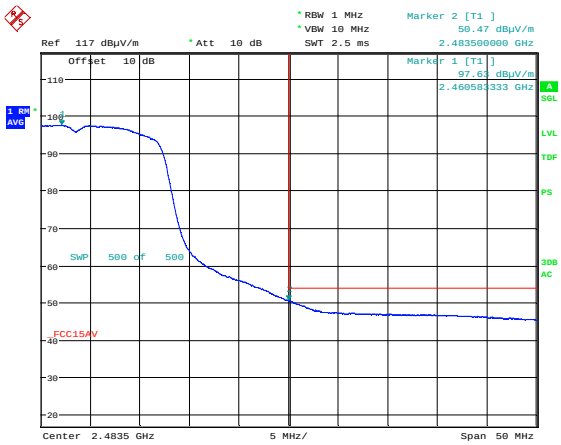

Date: 28.FEB.2023 10:33:57

**Average**



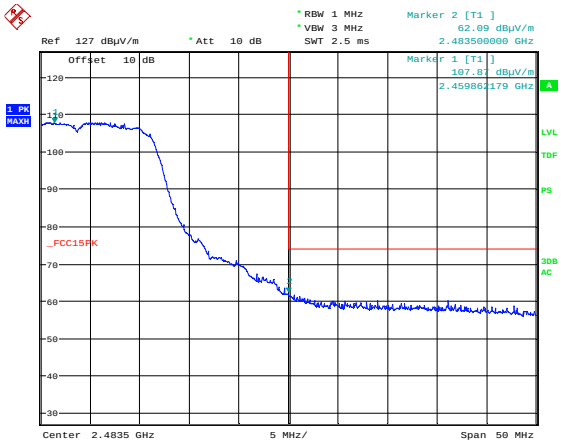

Date: 27.FEB.2023 16:30:24

**Band Edge, 2462 MHz, 802.11n MCS0, MIMO, Peak**



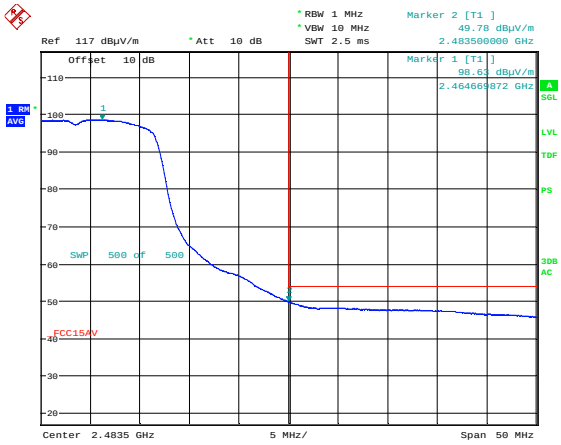

Date: 27.FEB.2023 16:30:52

**Average**




Date: 28.FEB.2023 09:42:30

**Band Edge, 2462 MHz, 802.11g 6M, Ant 0, Peak**




Date: 28.FEB.2023 09:43:12

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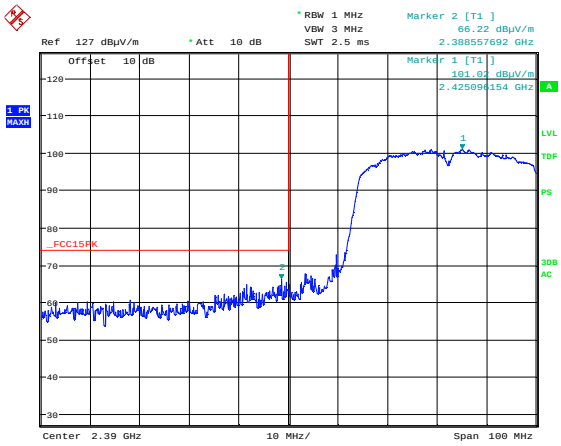
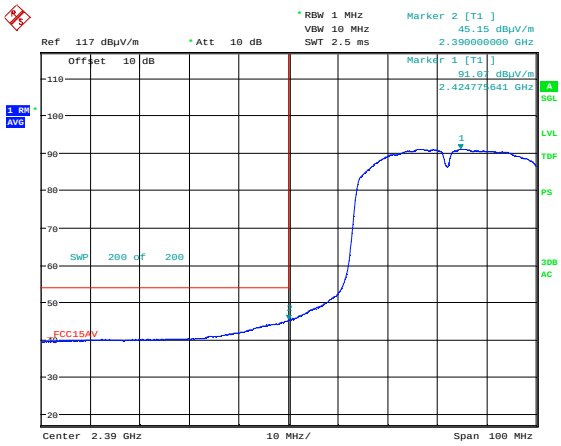


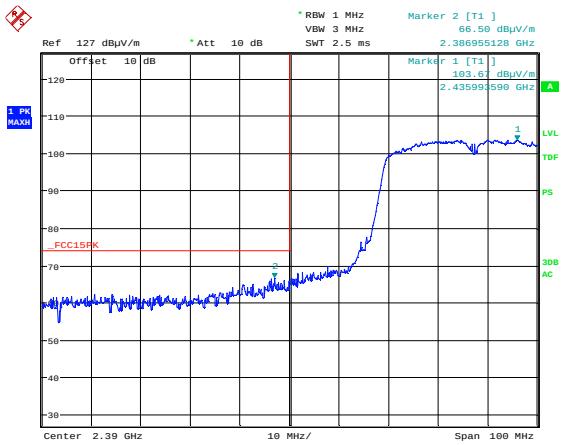

Date: 6.JUN.2023 15:50:46

**Band Edge, 2422 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak**

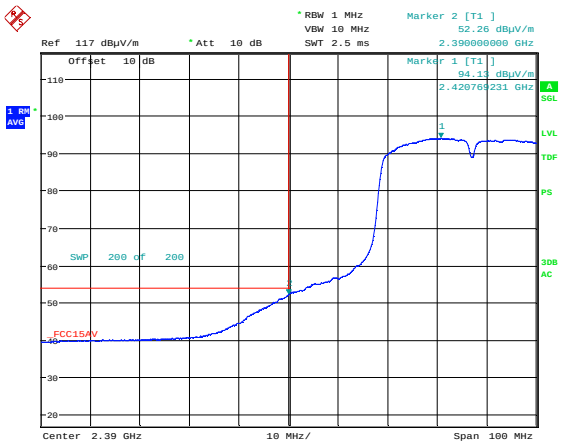



Date: 6.JUN.2023 15:51:09

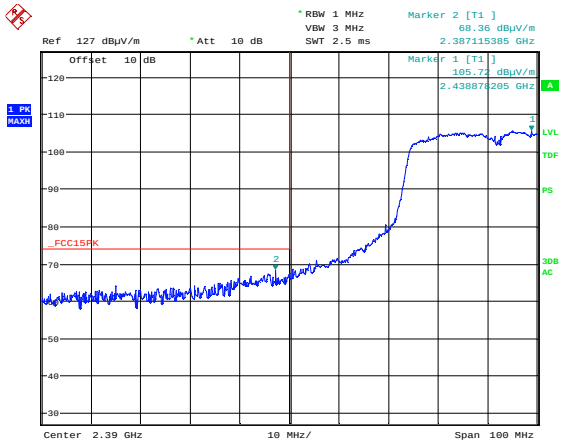
**Average**



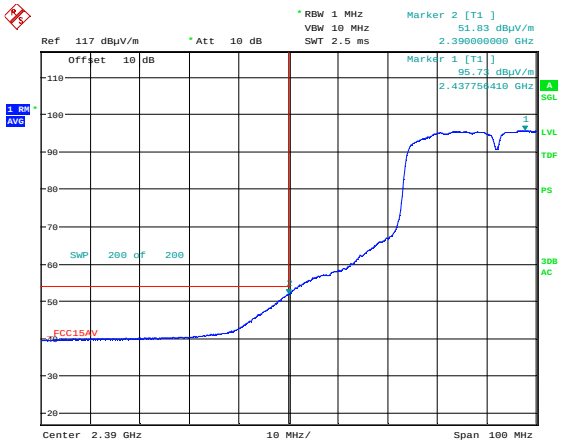

**Band Edge, 2427 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL14**



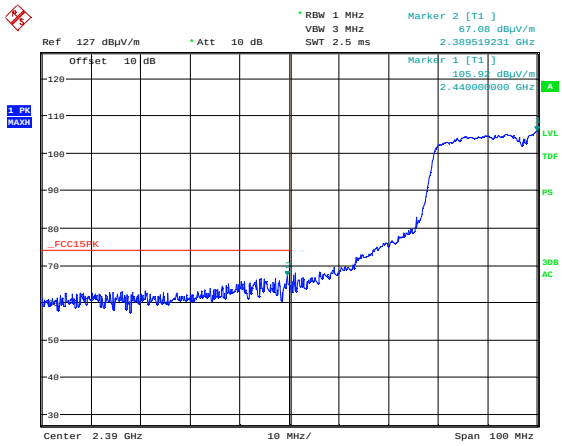

**Average**



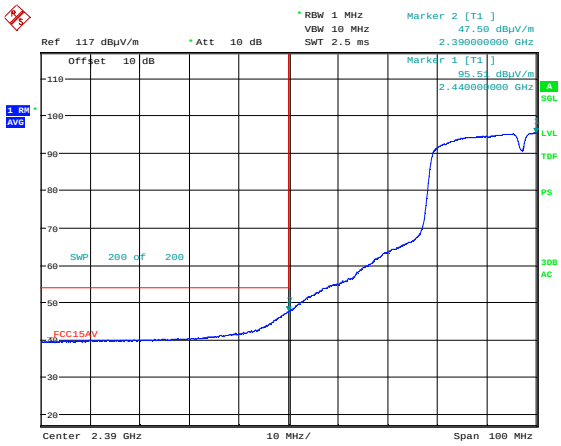

**Band Edge, 2432 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL16**



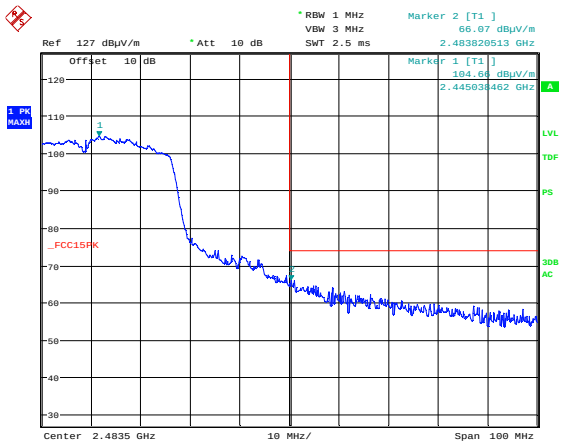

**Band Edge, 2437 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL16**



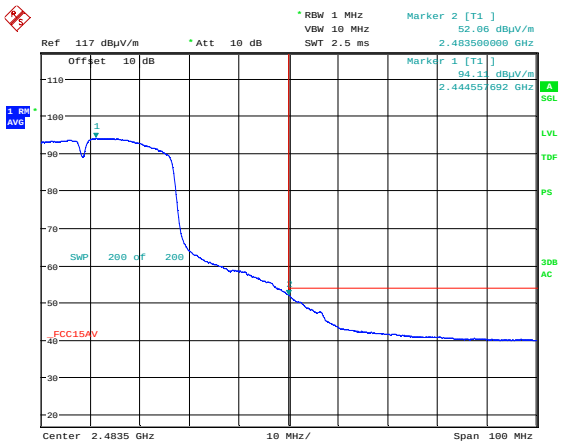

**Band Edge, 2437 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL16**



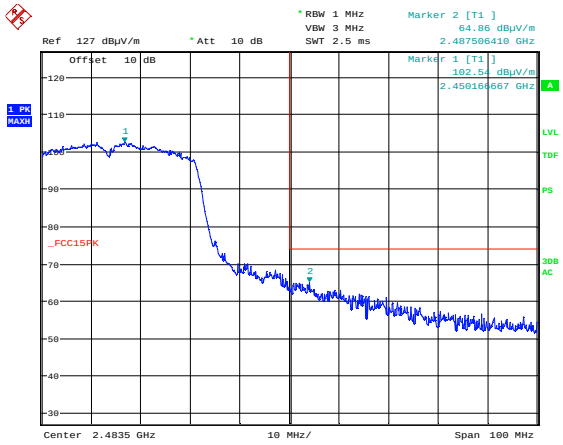

**Average**



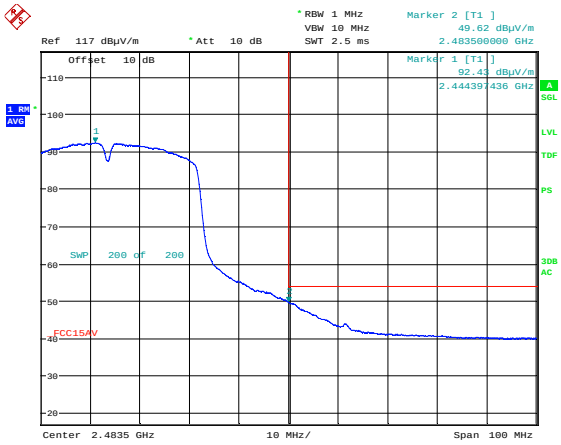

**Band Edge, 2442 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL14**



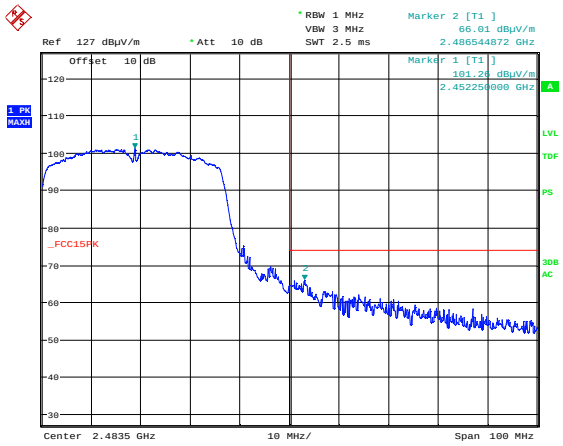

**Average**



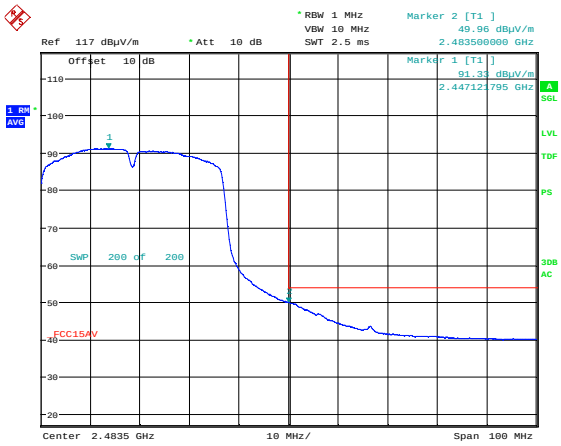

**Band Edge, 2447 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak PL12**



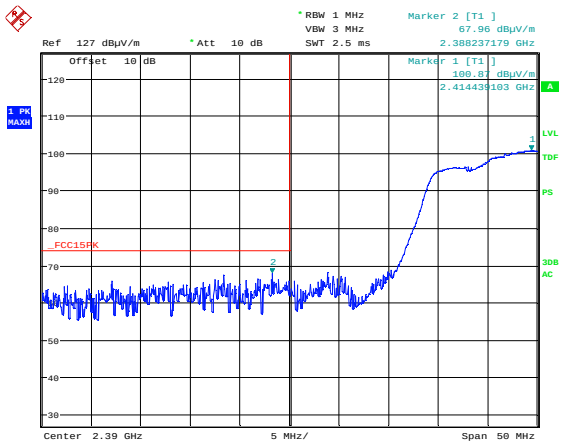

**Average**




**Band Edge, 2452 MHz, 802.11n HT40 MCS0, Max: Ant 0, Peak**

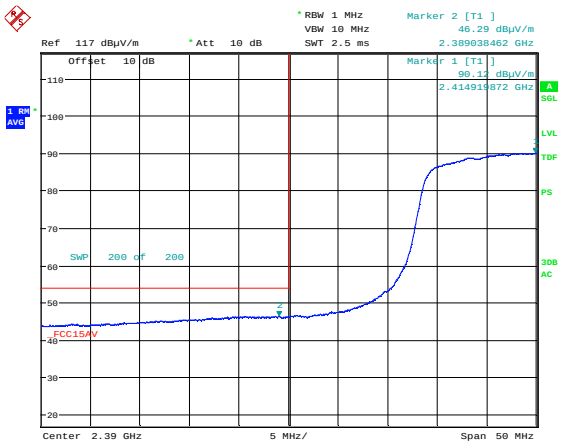



**Average**



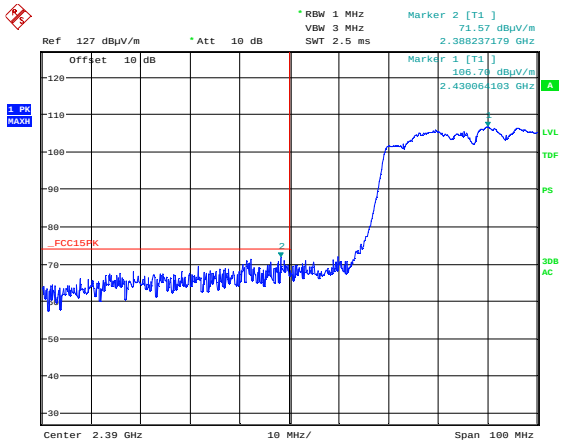

Date: 6.JUN.2023 15:01:20

**Band Edge, 2422 MHz, 802.11n HT40 MCS0, MIMO, Peak**



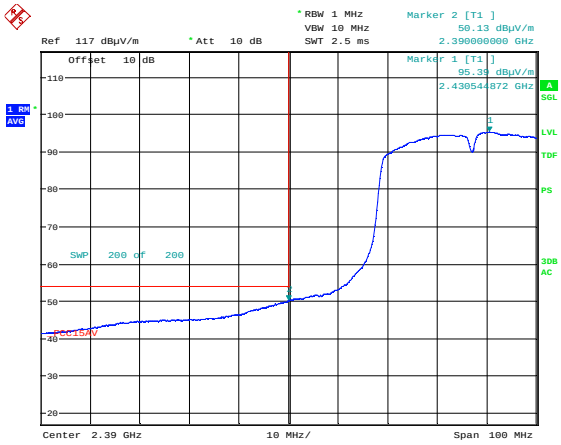

Date: 6.JUN.2023 14:57:16

**Average**



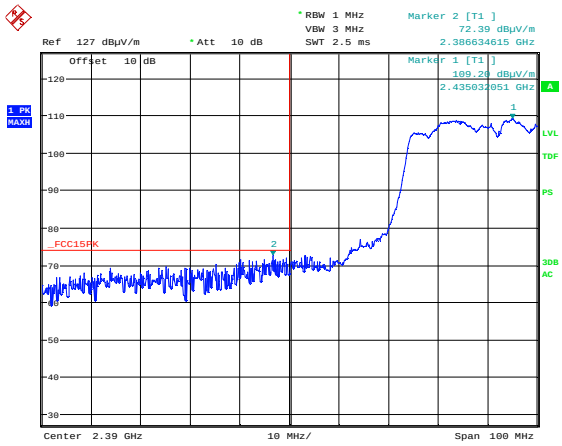

Date: 6.JUN.2023 15:03:42

**Band Edge, 2427 MHz, 802.11n HT40 MCS0, MIMO, Peak PL12**



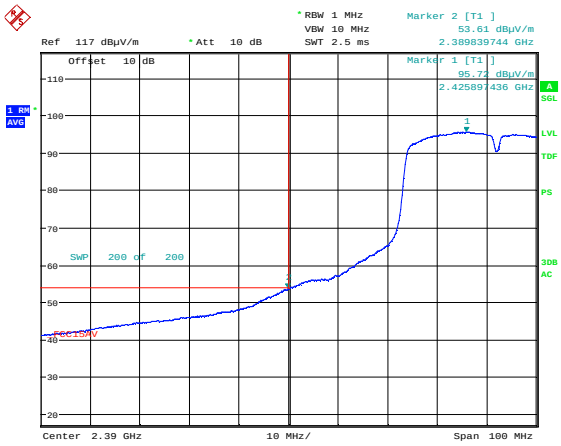

Date: 6.JUN.2023 15:02:55

**Average**



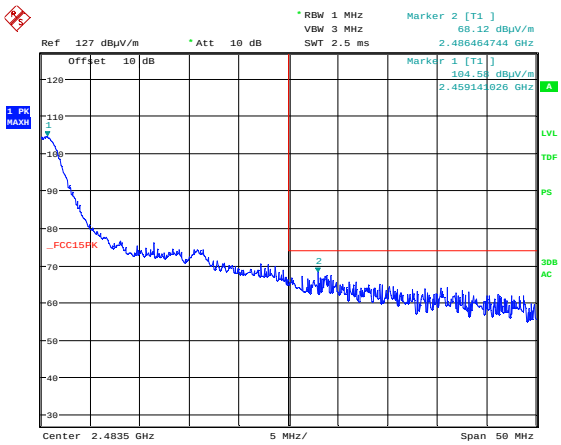

Date: 6.JUN.2023 15:06:32

**Band Edge, 2432 MHz, 802.11n HT40 MCS0, MIMO, Peak**



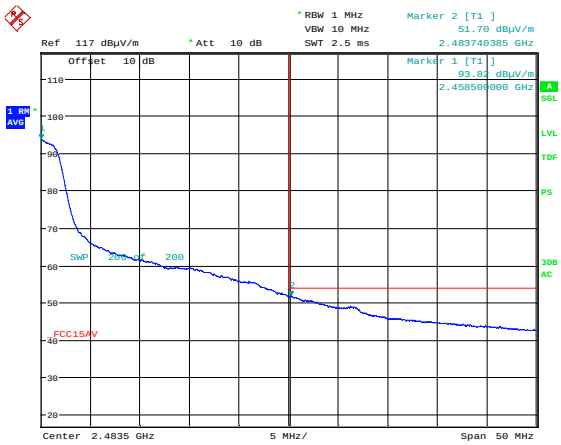

Date: 6.JUN.2023 15:05:43

**Average**



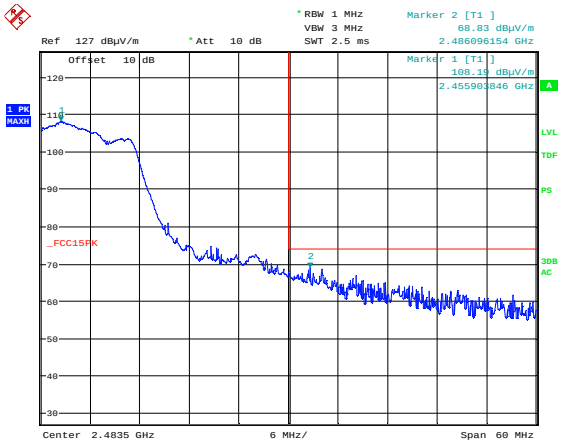

Date: 6.JUN.2023 14:53:29

**Band Edge, 2442 MHz, 802.11n HT40 MCS0, MIMO, Peak PL13**



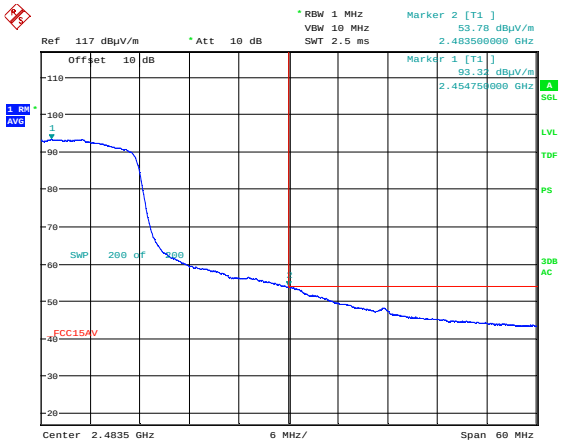

Date: 6.JUN.2023 14:50:42

**Average**



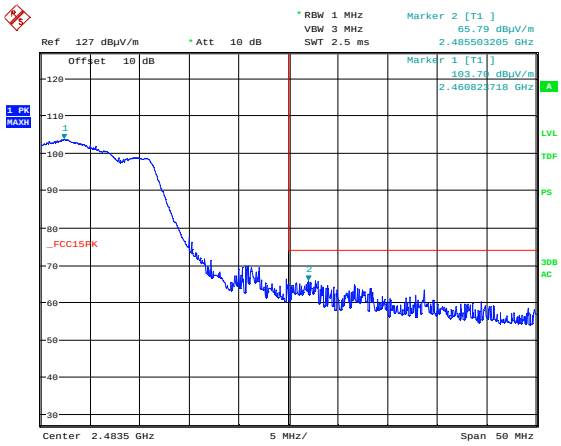

Date: 6.JUN.2023 14:46:33

**Band Edge, 2447 MHz, 802.11n HT40 MCS0, MIMO, Peak PL12**



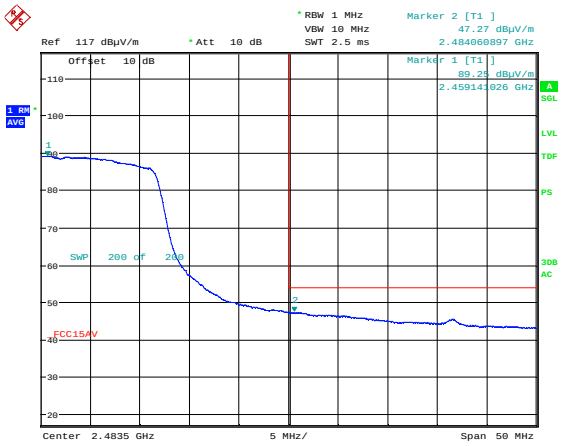

Date: 6.JUN.2023 14:44:48

**Average**




Date: 6.JUN.2023 14:56:10

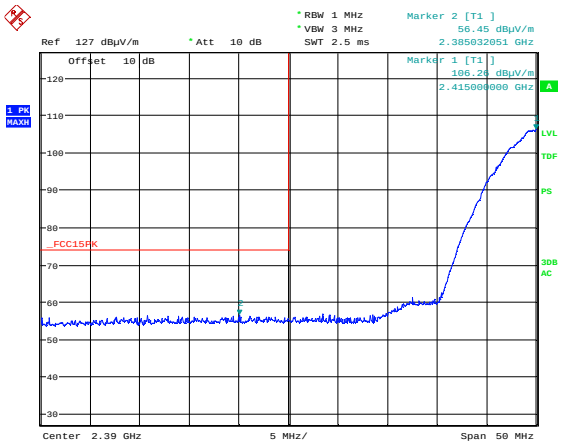
**Band Edge, 2452 MHz, 802.11n HT40 MCS0, MIMO, Peak**




Date: 6.JUN.2023 14:56:31

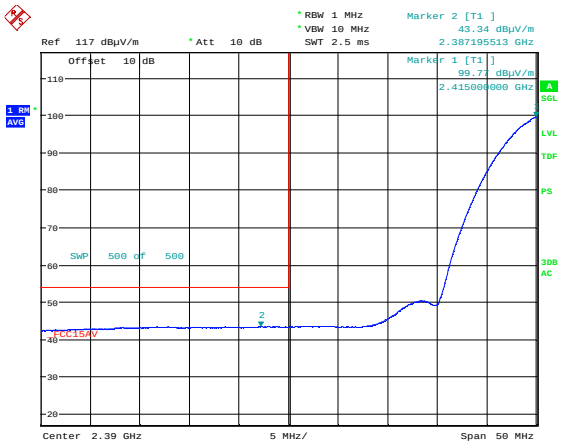
**Average**

## Whip Antenna



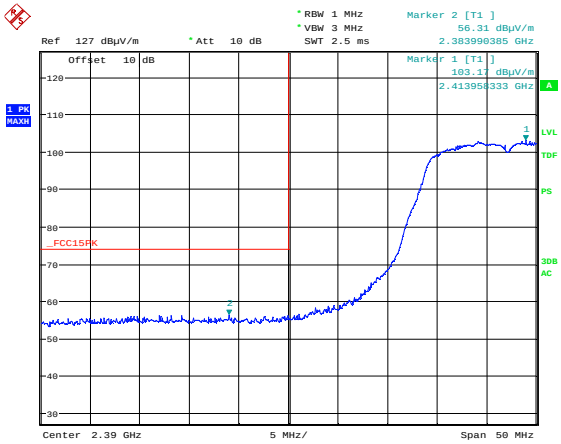

Date: 2.MAR.2023 12:23:36

**Band Edge, 2412 MHz, 802.11b 11M, Peak**



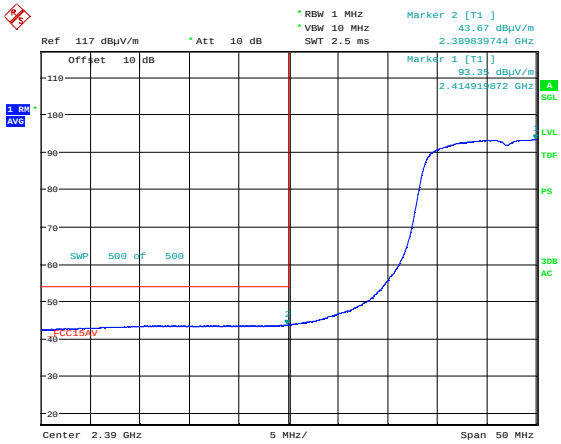

Date: 2.MAR.2023 12:24:05

**Average**



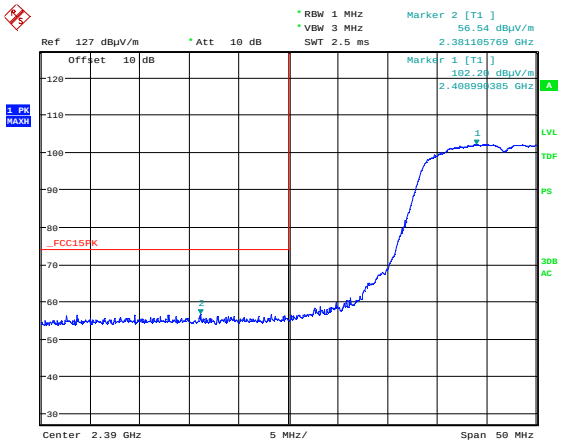

Date: 2.MAR.2023 12:27:15

**Band Edge, 2412 MHz, 802.11g 6M, Peak**



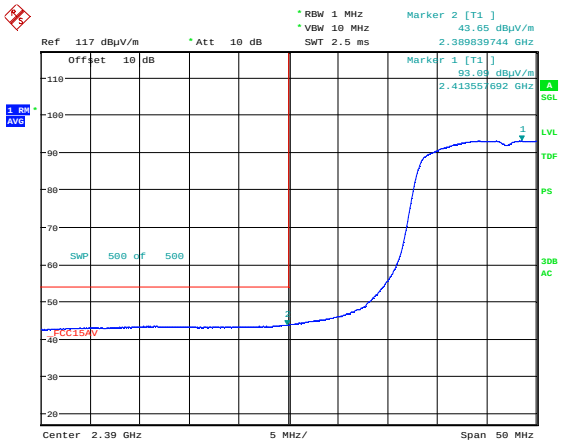

Date: 2.MAR.2023 12:27:44

**Average**



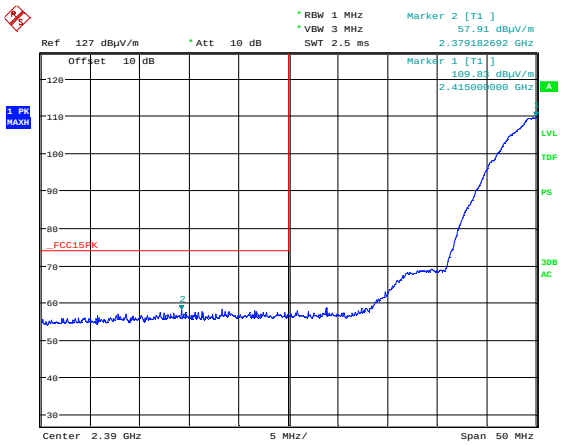

Date: 2.MAR.2023 12:30:20

**Band Edge, 2412 MHz, 802.11n MCS0, Peak**

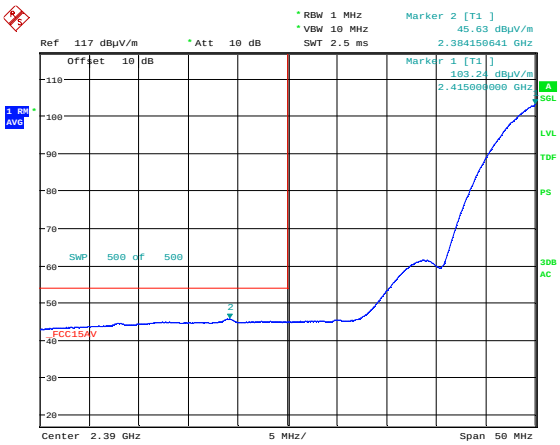



Date: 2.MAR.2023 12:30:49

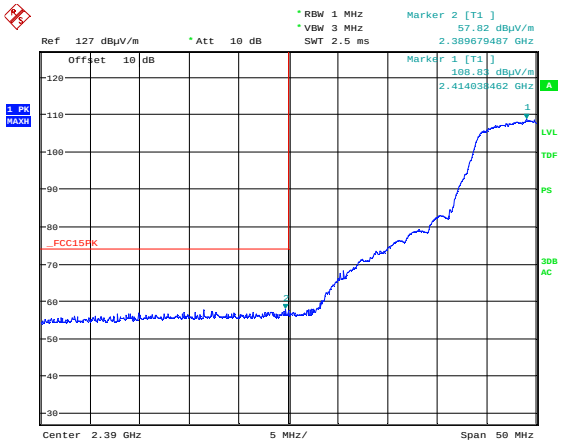
**Average**



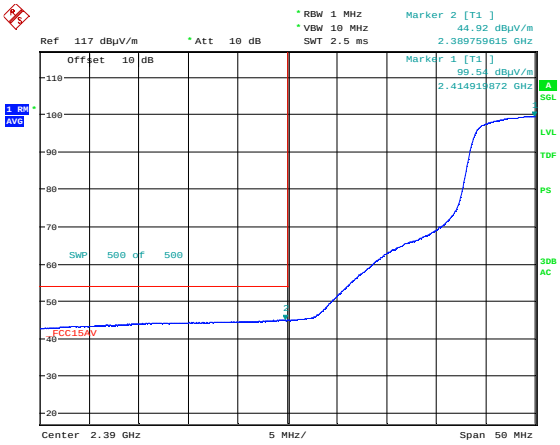

**Band Edge, 2417 MHz, 802.11b 11M, Peak**



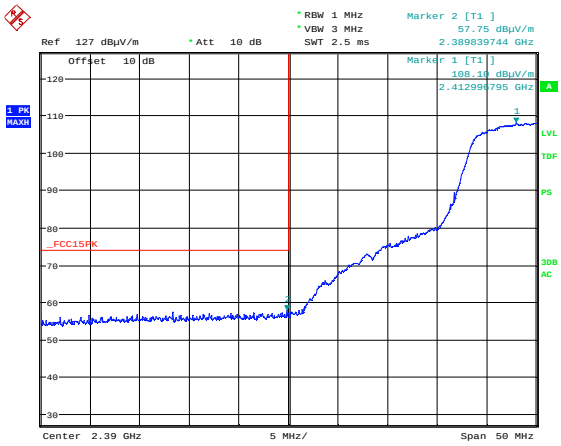

**Average**



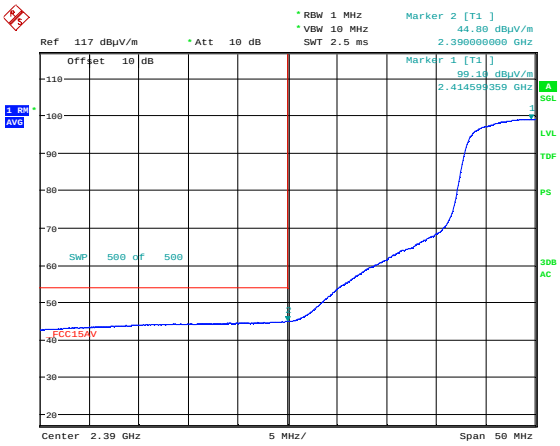

**Band Edge, 2417 MHz, 802.11g 6M, Peak**



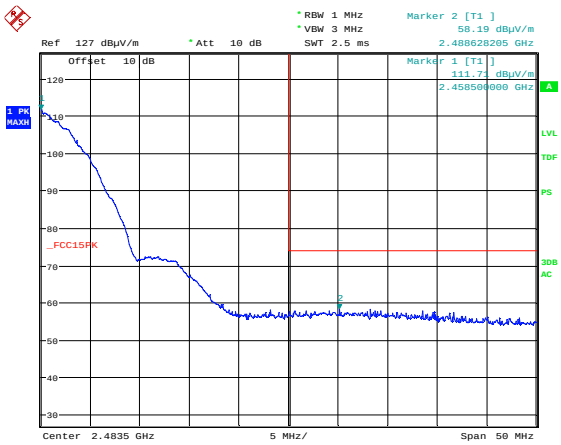

**Band Edge, 2417 MHz, 802.11g 6M, Peak**




**Band Edge, 2417 MHz, 802.11n MCS0, Peak**

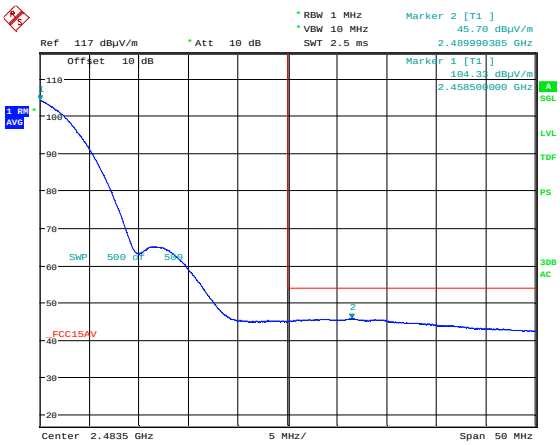



**Average**



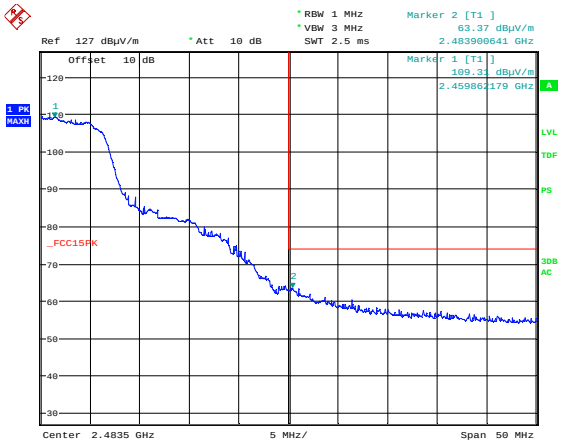

Date: 2.MAR.2023 10:48:35

**Band Edge, 2457 MHz, 802.11b 11M, Peak**



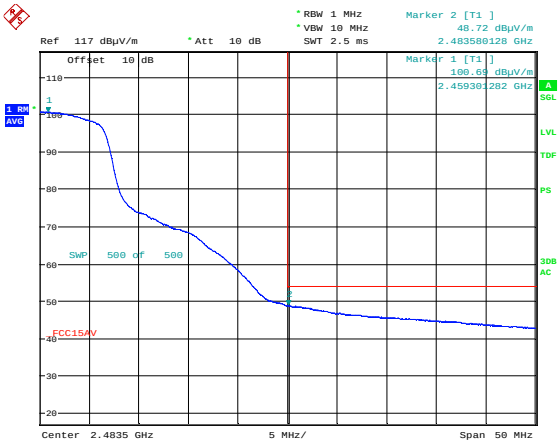

Date: 2.MAR.2023 10:49:03

**Average PL18**



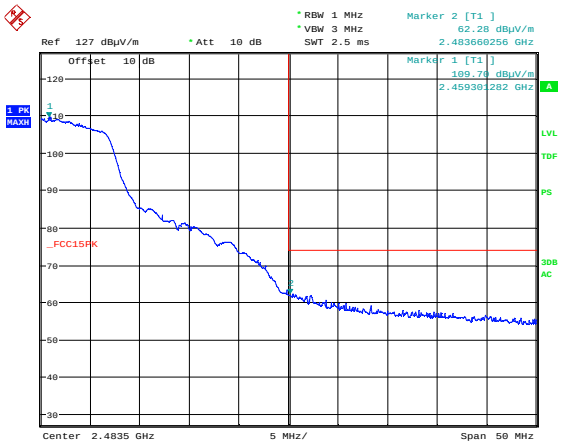

Date: 2.MAR.2023 10:44:40

**Band Edge, 2457 MHz, 802.11g 6M, Peak**



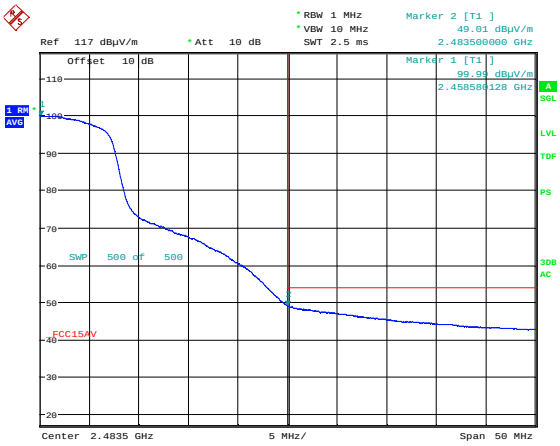

Date: 2.MAR.2023 10:45:13

**Average PL17**



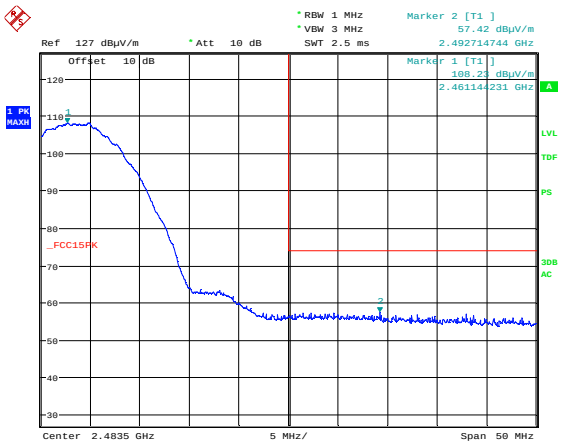

Date: 2.MAR.2023 11:01:50

**Band Edge, 2457 MHz, 802.11n MCS0, Peak**



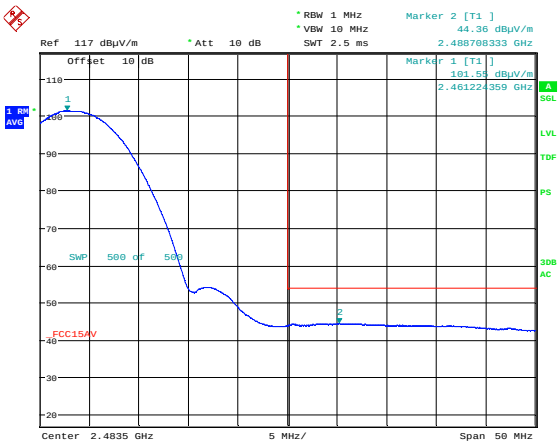

Date: 2.MAR.2023 11:02:17

**Average PL17**



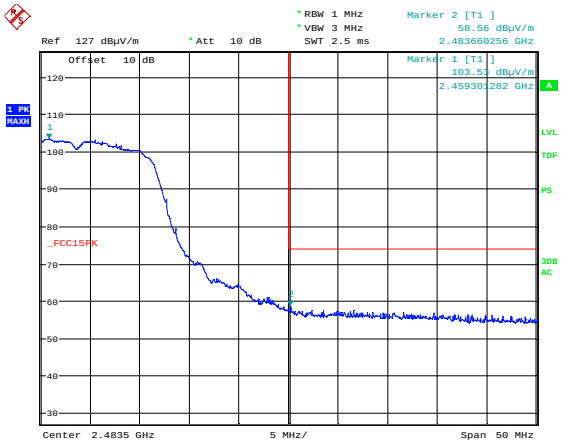

Date: 2.MAR.2023 10:52:45

**Band Edge, 2462 MHz, 802.11b 11M, Peak**



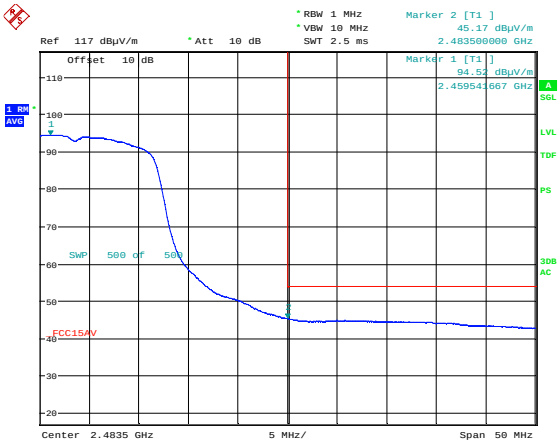

Date: 2.MAR.2023 10:53:13

**Average PL15**



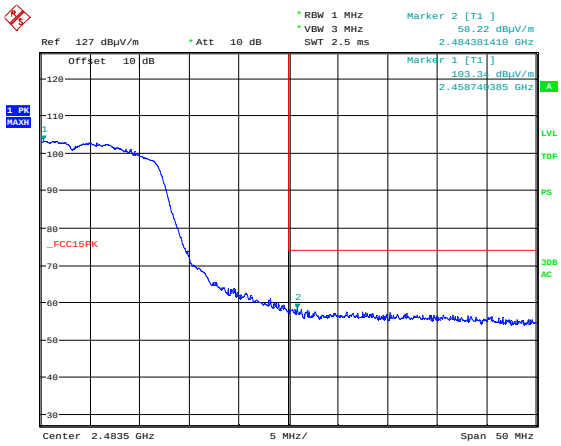

Date: 2.MAR.2023 10:42:43

**Band Edge, 2462 MHz, 802.11g 6M, Peak**



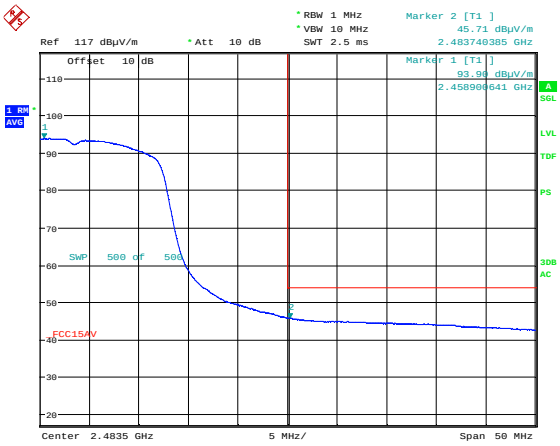

Date: 2.MAR.2023 10:43:13

**Average**




Date: 2.MAR.2023 10:58:23

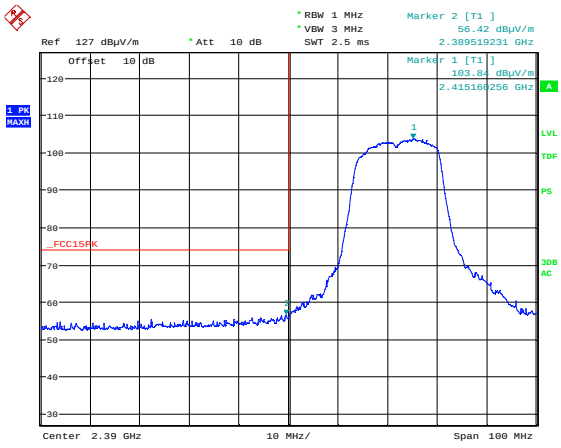
**Band Edge, 2462 MHz, 802.11n MCS0, Peak**




Date: 2.MAR.2023 10:58:51

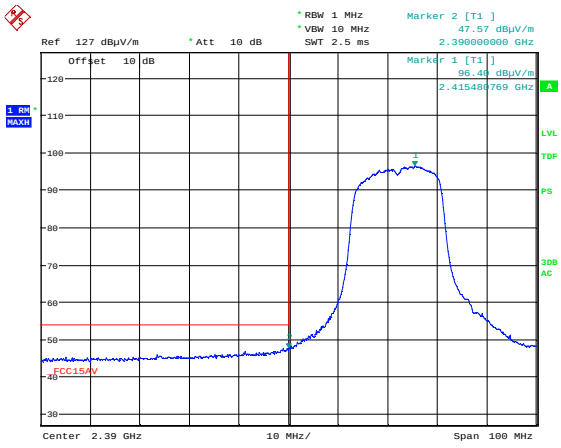
**Average PL11**

## Whip Antenna +Patch Antenna for Ant 1 and MIMO



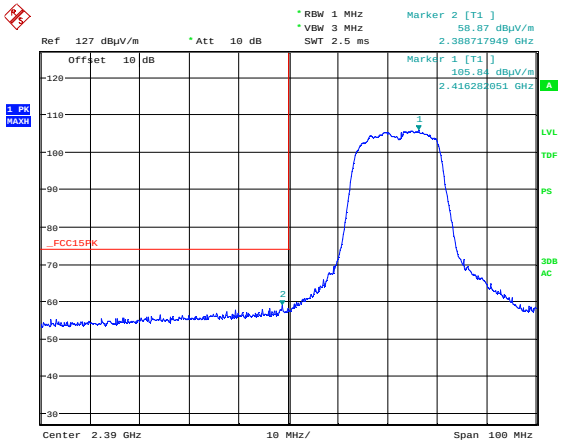

Date: 6.MAR.2023 13:09:33

**Band Edge, 2412 MHz, 802.11n MCS0, SISO, Peak**



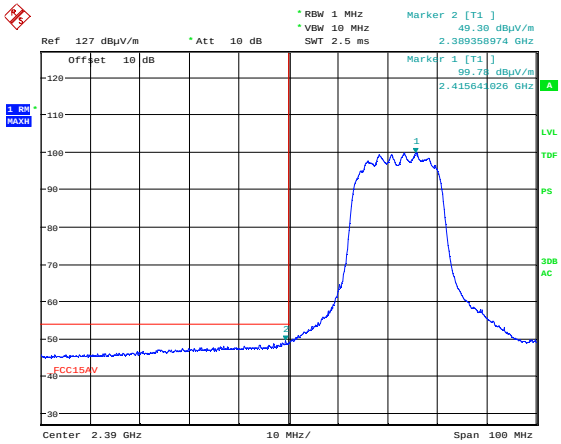

Date: 6.MAR.2023 13:10:19

**Average**



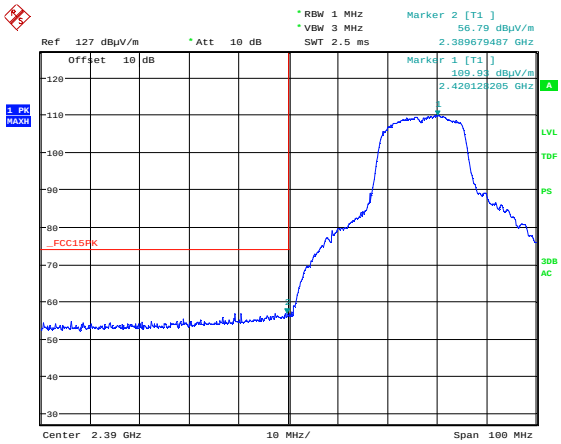

Date: 6.MAR.2023 13:45:42

**Band Edge, 2412 MHz, 802.11n MCS8, MIMO, Peak**



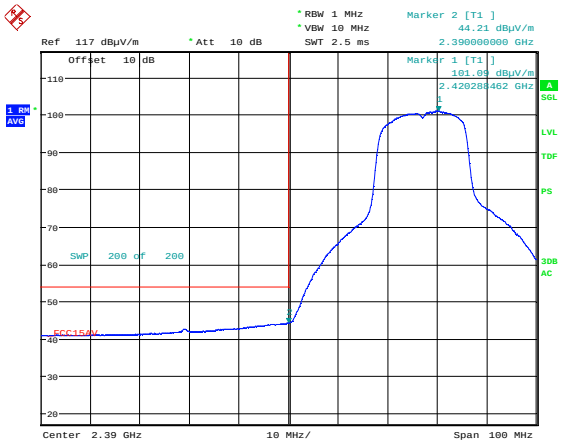

Date: 6.MAR.2023 13:46:28

**Average**



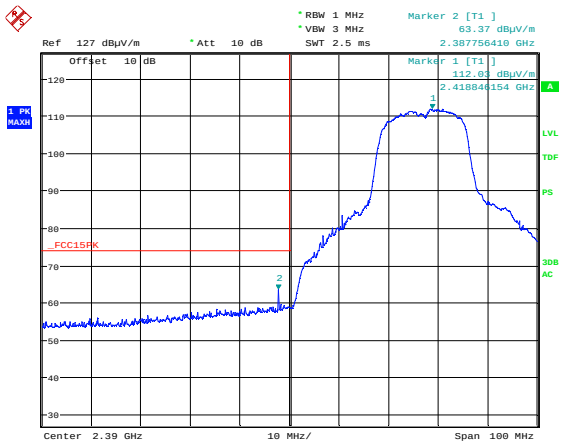

Date: 6.MAR.2023 13:03:04

**Band Edge, 2417 MHz, 802.11n MCS0, SISO, Peak**

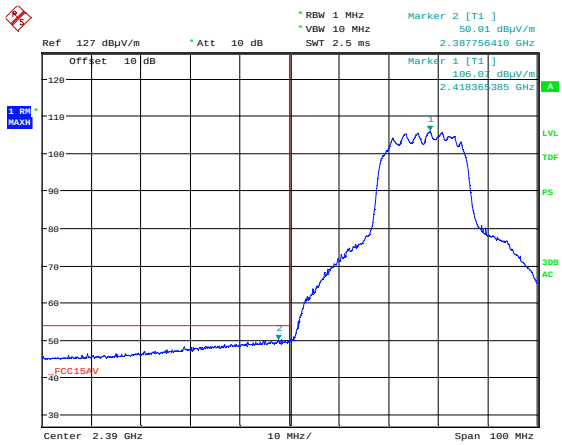



Date: 6.MAR.2023 13:05:40

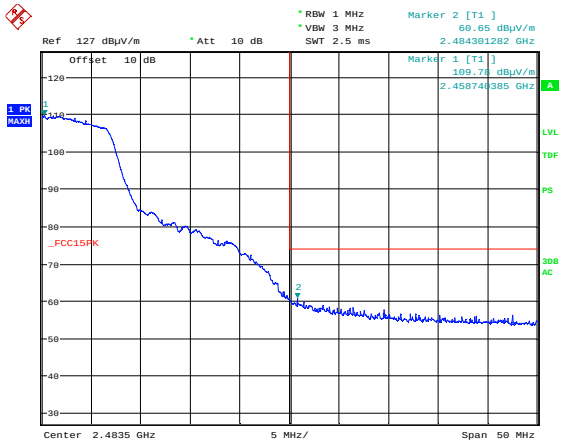
**Average**



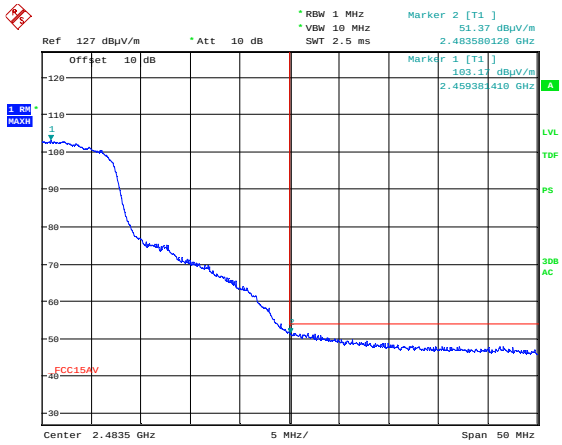

**Band Edge, 2417 MHz, 802.11n MCS8, MIMO, Peak**



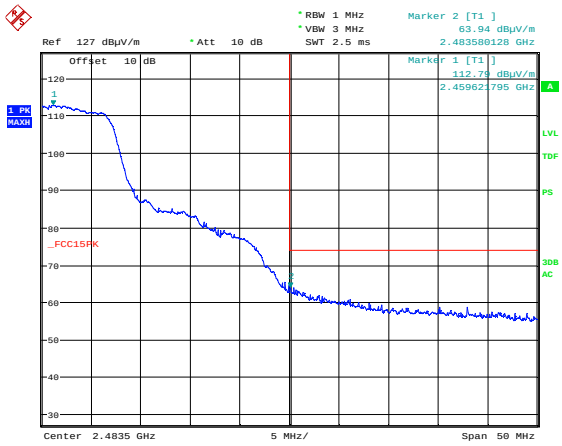

**Average**



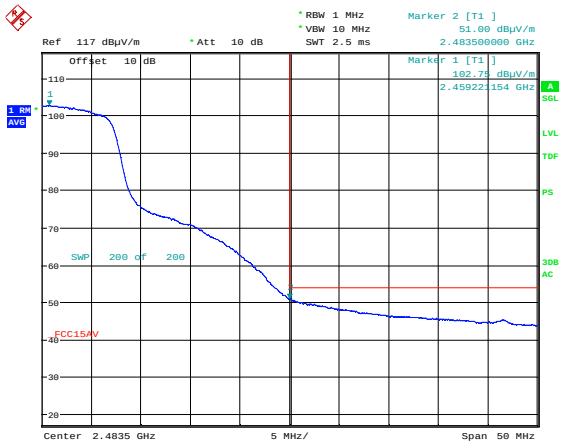

**Band Edge, 2457 MHz, 802.11n MCS0, SISO, Peak**



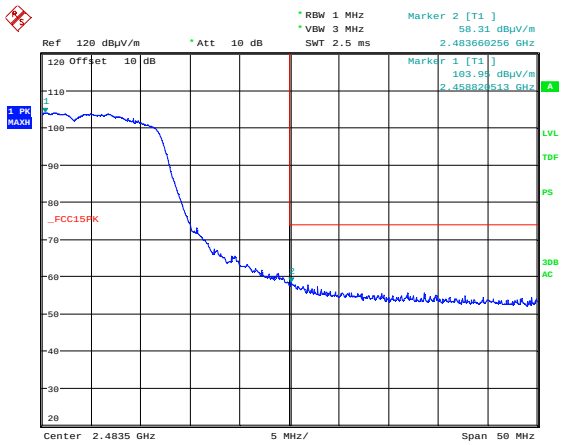

**Average**



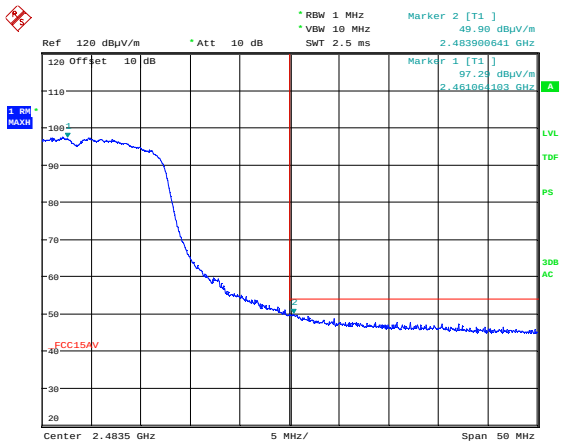

**Band Edge, 2457 MHz, 802.11n MCS8, MIMO, Peak**



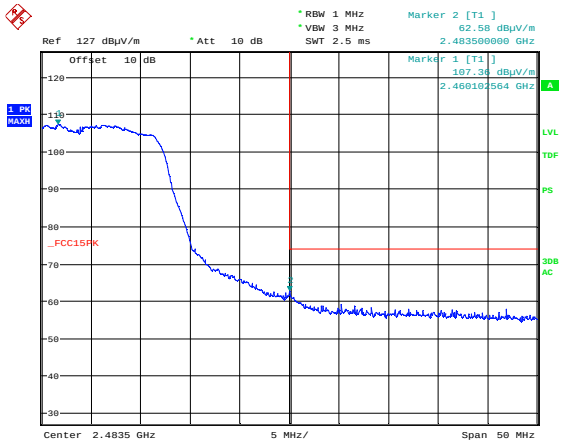

**Average**



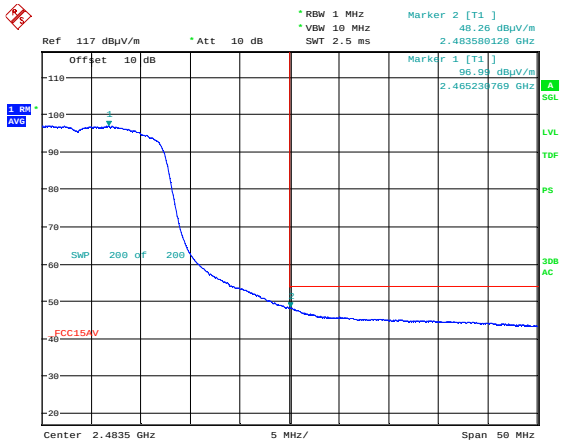

**Band Edge, 2462 MHz, 802.11n MCS0, SISO, Peak**




**Average**




**Band Edge, 2462 MHz, 802.11n MCS8, MIMO, Peak**




**Average**

## 3.7 Radiated Emissions, 30 – 1000 MHz

**FCC Part 15.209 (a)**

**ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9**

**Measurement procedure: ANSI C63.10-2013 Clause 11.12**

**Test Results: Complies**

**Measurement Data:**

Detector: Quasi-Peak

Measuring distance 3 m

Tested in test mode with EUT transmitting on ch06.

| Measured Frequency (MHz) | Carrier Frequency (MHz) | Modulation | Measured Emission (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 30 – 88 | 2440 | GFSK | < 30 | 40.0 | > 10 |
| 88 – 216 | 2440 | GFSK | 40.0 | 43.5 | 3.5 |
| 216 – 960 | 2440 | GFSK | < 36 | 46.0 | > 10 |
| 960 – 1000 | 2440 | GFSK | < 35 | 54.0 | > 19 |
| 120.010 | 2440 | GFSK | 40.0 | 43.5 | 3.5 |

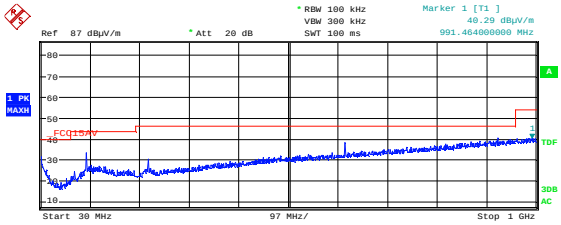
The spurious at 120.010 MHz is independent of RF signal or antenna type.

See attached plots.

**Requirements/Limit**

| FCC | Part 15.209 @ frequencies defined in §15.205 | |
|---|---|---|
| ISED | RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10 | |
| Frequency | Radiated emission limit @3 meters | |
| 30 – 88 MHz | 100 µV/m | 40.0 dBµV/m |
| 88 – 216 MHz | 150 µV/m | 43.5 dBµV/m |
| 216 – 960 MHz | 200 µV/m | 46.0 dBµV/m |
| 960 – 1000 MHz | 500 µV/m | 54.0 dBµV/m |
| | Limits above are with Quasi Peak Detector | |

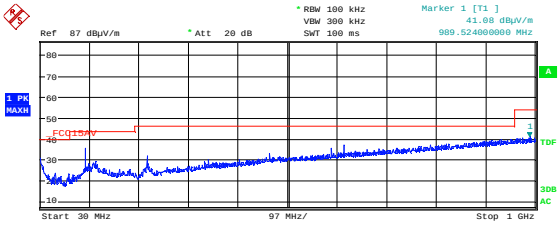
**Combi Antenna**




| # | Frequency | Level |
|---|---|---|
| 1 | 31.552000 MHz | 31.13 dBµV |
| 2 | 120.016000 MHz | 33.29 dBµV |
| 3 | 239.908000 MHz | 30.01 dBµV |
| 4 | 625.192000 MHz | 38.15 dBµV |
| 5 | 991.464000 MHz | 40.29 dBµV |

Date: 10.MAR.2023 13:30:29

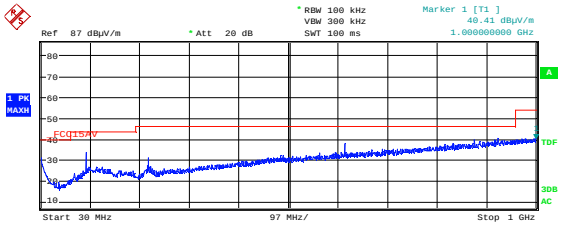
**Radiated Emissions 30 - 1000 MHz, 802.11b 11M, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.388000 MHz | 30.51 dBµV |
| 2 | 120.016000 MHz | 35.23 dBµV |
| 3 | 239.908000 MHz | 31.49 dBµV |
| 4 | 989.524000 MHz | 41.08 dBµV |

Date: 10.MAR.2023 13:28:33

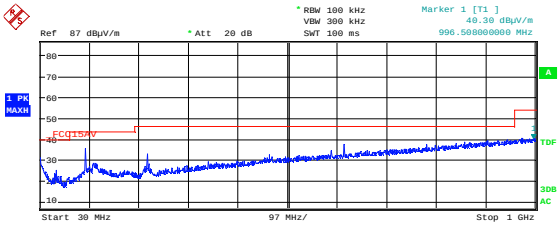
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.000000 MHz | 30.93 dBµV |
| 2 | 120.016000 MHz | 33.31 dBµV |
| 3 | 239.908000 MHz | 30.76 dBµV |
| 4 | 625.192000 MHz | 37.74 dBµV |
| 5 | 1.000000 GHz | 40.41 dBµV |

Date: 10.MAR.2023 13:21:50

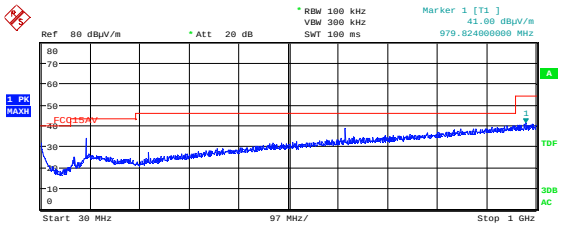
**Radiated Emissions 30 - 1000 MHz, 802.11g 6M, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 31.164000 MHz | 30.95 dBµV |
| 2 | 61.428000 MHz | 24.79 dBµV |
| 3 | 120.016000 MHz | 35.31 dBµV |
| 4 | 239.908000 MHz | 32.63 dBµV |
| 5 | 625.192000 MHz | 37.21 dBµV |
| 6 | 996.508000 MHz | 40.30 dBµV |

Date: 10.MAR.2023 13:19:54

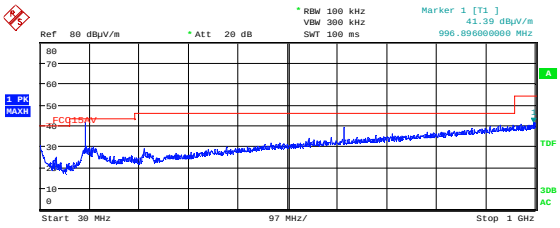
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.000000 MHz | 31.47 dBµV |
| 2 | 120.016000 MHz | 33.79 dBµV |
| 3 | 625.192000 MHz | 38.35 dBµV |
| 4 | 979.824000 MHz | 41.00 dBµV |

Date: 10.MAR.2023 14:37:09

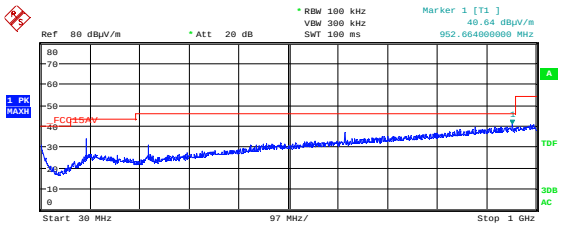
**Radiated Emissions 30 - 1000 MHz, 802.11n MCS0, Ant 1, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.388000 MHz | 30.09 dBµV |
| 2 | 61.428000 MHz | 24.50 dBµV |
| 3 | 120.016000 MHz | 41.16 dBµV |
| 4 | 234.864000 MHz | 28.71 dBµV |
| 5 | 625.192000 MHz | 38.94 dBµV |
| 6 | 996.896000 MHz | 41.39 dBµV |

Date: 10.MAR.2023 14:34:47

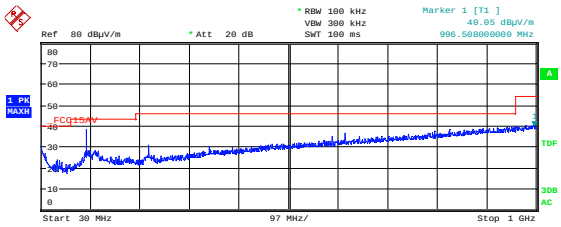
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 31.552000 MHz | 30.47 dBµV |
| 2 | 120.016000 MHz | 33.46 dBµV |
| 3 | 239.908000 MHz | 30.79 dBµV |
| 4 | 625.192000 MHz | 36.63 dBµV |
| 5 | 952.664000 MHz | 40.64 dBµV |

Date: 10.MAR.2023 14:27:12

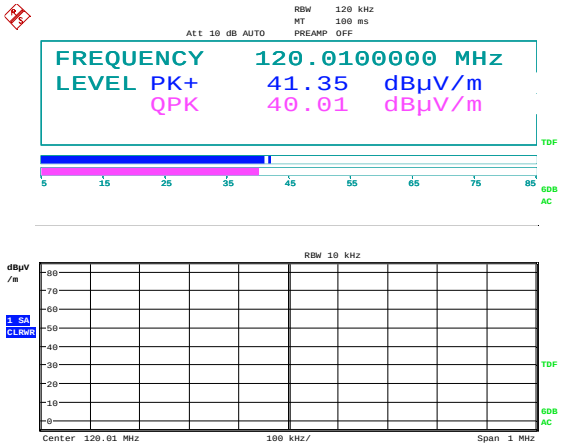
**Radiated Emissions 30 - 1000 MHz, 802.11n MCS0, MIMO, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.000000 MHz | 30.00 dBµV |
| 2 | 120.016000 MHz | 38.29 dBµV |
| 3 | 239.908000 MHz | 30.68 dBµV |
| 4 | 996.508000 MHz | 40.05 dBµV |

Date: 10.MAR.2023 14:25:16

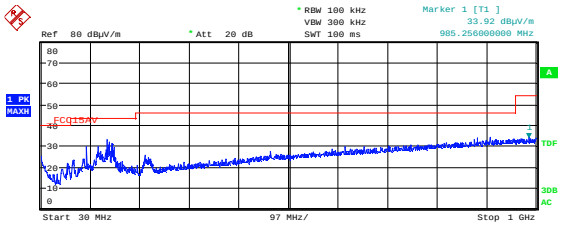
**VP**




Date: 10.MAR.2023 16:05:41

**Radiated Emissions 120 MHz, Max: VP**

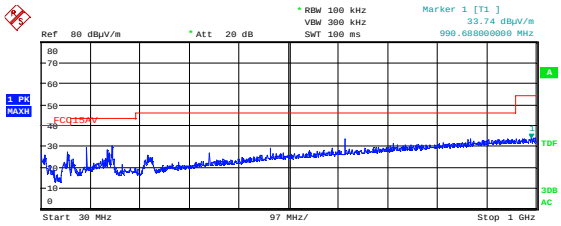
## Whip Antenna (+Patch Antenna for Ant 1 and MIMO)




| # | Frequency | Level |
|---|---|---|
| 1 | 31.164000 MHz | 24.94 dBµV |
| 2 | 82.380000 MHz | 21.63 dBµV |
| 3 | 94.020000 MHz | 23.20 dBµV |
| 4 | 120.016000 MHz | 29.35 dBµV |
| 5 | 142.132000 MHz | 29.33 dBµV |
| 6 | 160.368000 MHz | 33.04 dBµV |
| 7 | 164.636000 MHz | 31.89 dBµV |
| 8 | 168.904000 MHz | 31.08 dBµV |
| 9 | 233.700000 MHz | 25.25 dBµV |
| 10 | 985.256000 MHz | 33.92 dBµV |

Date: 13.MAR.2023 10:41:29

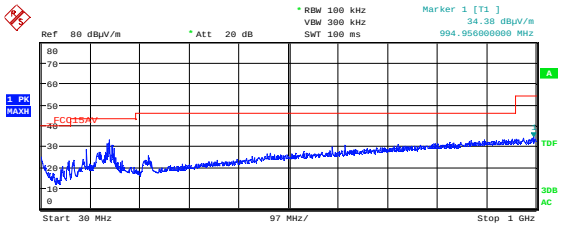
**Radiated Emissions 30 - 1000 MHz, 802.11g 6M, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 31.164000 MHz | 25.59 dBµV |
| 2 | 81.992000 MHz | 26.83 dBµV |
| 3 | 92.856000 MHz | 23.43 dBµV |
| 4 | 120.016000 MHz | 29.02 dBµV |
| 5 | 160.368000 MHz | 27.96 dBµV |
| 6 | 168.904000 MHz | 29.86 dBµV |
| 7 | 238.744000 MHz | 25.52 dBµV |
| 8 | 359.800000 MHz | 26.54 dBµV |
| 9 | 625.192000 MHz | 33.07 dBµV |
| 10 | 990.688000 MHz | 33.74 dBµV |

Date: 13.MAR.2023 10:39:32

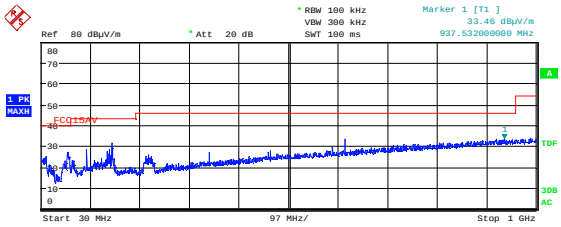
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.388000 MHz | 24.77 dBµV |
| 2 | 85.484000 MHz | 22.61 dBµV |
| 3 | 94.020000 MHz | 23.08 dBµV |
| 4 | 120.016000 MHz | 28.50 dBµV |
| 5 | 162.696000 MHz | 31.54 dBµV |
| 6 | 164.636000 MHz | 32.87 dBµV |
| 7 | 168.904000 MHz | 30.35 dBµV |
| 8 | 170.844000 MHz | 30.15 dBµV |
| 9 | 239.908000 MHz | 25.19 dBµV |
| 10 | 994.956000 MHz | 34.38 dBµV |

Date: 13.MAR.2023 10:51:26

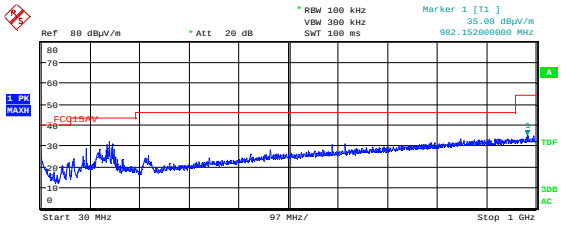
**Radiated Emissions 30 - 1000 MHz, 802.11g 6M, Ant 1, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 31.552000 MHz | 24.84 dBµV |
| 2 | 83.544000 MHz | 26.94 dBµV |
| 3 | 92.080000 MHz | 23.18 dBµV |
| 4 | 120.016000 MHz | 28.42 dBµV |
| 5 | 164.636000 MHz | 28.31 dBµV |
| 6 | 168.904000 MHz | 31.24 dBµV |
| 7 | 239.908000 MHz | 25.63 dBµV |
| 8 | 359.800000 MHz | 26.87 dBµV |
| 9 | 625.192000 MHz | 33.16 dBµV |
| 10 | 987.972000 MHz | 33.61 dBµV |

Date: 13.MAR.2023 10:49:29

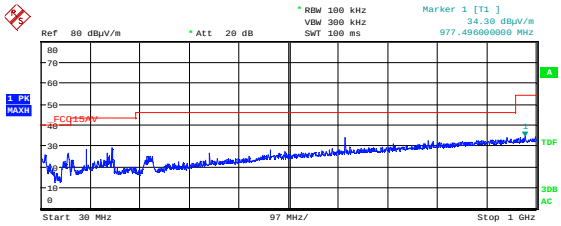
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 30.776000 MHz | 25.74 dBµV |
| 2 | 94.020000 MHz | 23.64 dBµV |
| 3 | 120.016000 MHz | 28.21 dBµV |
| 4 | 145.236000 MHz | 28.06 dBµV |
| 5 | 160.368000 MHz | 30.37 dBµV |
| 6 | 164.636000 MHz | 31.86 dBµV |
| 7 | 170.844000 MHz | 30.43 dBµV |
| 8 | 190.244000 MHz | 23.17 dBµV |
| 9 | 239.908000 MHz | 24.79 dBµV |
| 10 | 982.152000 MHz | 35.08 dBµV |

Date: 13.MAR.2023 11:00:17

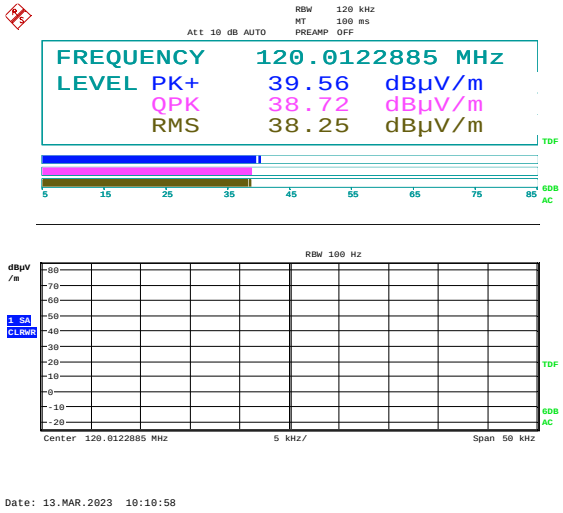
**Radiated Emissions 30 - 1000 MHz, 802.11n MCS0, MIMO, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 39.312000 MHz | 25.20 dBµV |
| 2 | 83.156000 MHz | 26.07 dBµV |
| 3 | 93.632000 MHz | 22.90 dBµV |
| 4 | 120.016000 MHz | 27.89 dBµV |
| 5 | 160.368000 MHz | 26.18 dBµV |
| 6 | 168.904000 MHz | 28.90 dBµV |
| 7 | 239.908000 MHz | 24.73 dBµV |
| 8 | 625.192000 MHz | 33.52 dBµV |
| 9 | 977.496000 MHz | 34.30 dBµV |

Date: 13.MAR.2023 10:58:20

**VP**




Date: 13.MAR.2023 10:10:58

**Radiated Emissions 30 - 1000 MHz, Max: VP**

## 3.8 Radiated Emissions, 1 – 26 GHz

**FCC Part 15.209 (a)**

**ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9**

**Measurement procedure:** **ANSI C63.10-2013 Clause 11.12**

**Test Results: Complies**

**Measurement Data:**

Measuring distance: 3m (1 – 18 GHz)

A pre-scan was performed above 18 GHz and no spurious emissions were detected.

A Band Reject Filter was used for measurements from 1 GHz to 18 GHz

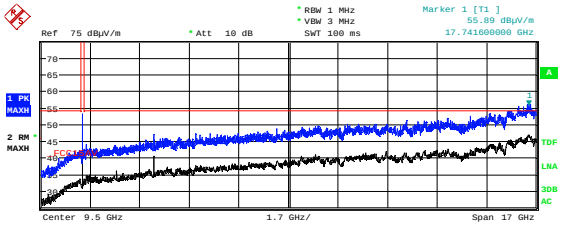
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.

See plots.

**Requirements/Limit**

| FCC | Part 15.209 @ frequencies defined in §15.205 | |
|---|---|---|
| ISED | RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10 | |
| | Radiated emission limit @3 meters | |
| Frequency | Average Detector | Peak Detector |
| 1 – 26 GHz | 54.0 dBµV/m | 74.0 dBµV/m |

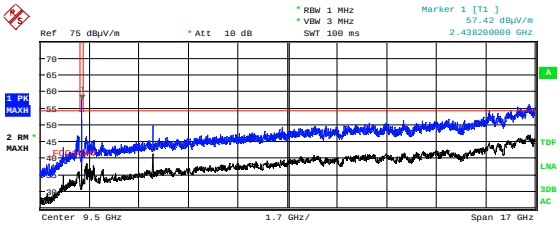
## Combi Antenna




| # | Frequency | Level |
|---|---|---|
| 1 | 2.434800 GHz | 52.98 dBµV |
| 2 | 17.741600 GHz | 55.89 dBµV |

Date: 28.FEB.2023 12:02:58

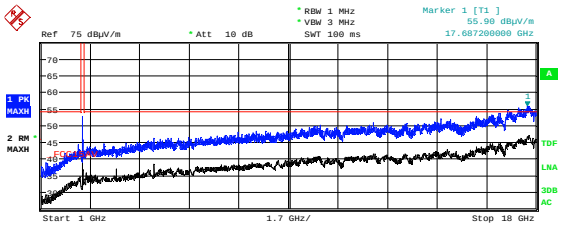
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11b 11M, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.288600 GHz | 46.48 dBµV |
| 2 | 2.438200 GHz | 57.42 dBµV |
| 3 | 2.598000 GHz | 46.33 dBµV |
| 4 | 4.872600 GHz | 49.51 dBµV |
| 5 | 17.765400 GHz | 55.85 dBµV |

Date: 28.FEB.2023 12:00:35

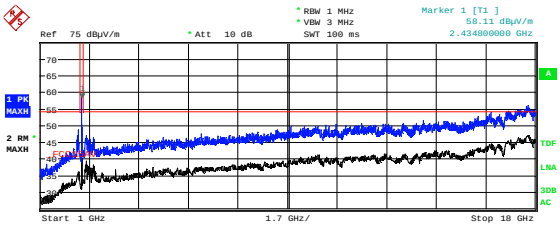
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.431400 GHz | 52.54 dBµV |
| 2 | 17.687200 GHz | 55.90 dBµV |

Date: 28.FEB.2023 11:07:46

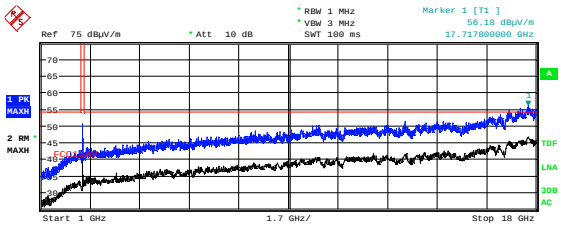
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11g 6M, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.319200 GHz | 48.50 dBµV |
| 2 | 2.434800 GHz | 58.11 dBµV |
| 3 | 2.591200 GHz | 47.01 dBµV |
| 4 | 17.731400 GHz | 55.80 dBµV |

Date: 28.FEB.2023 11:05:48

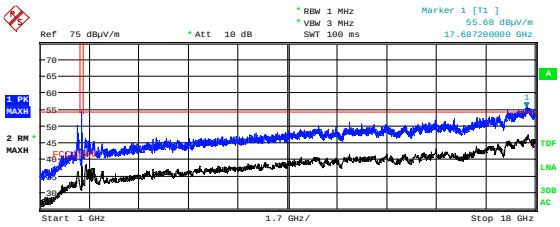
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.431400 GHz | 50.56 dBµV |
| 2 | 17.717800 GHz | 56.18 dBµV |

Date: 28.FEB.2023 12:31:21

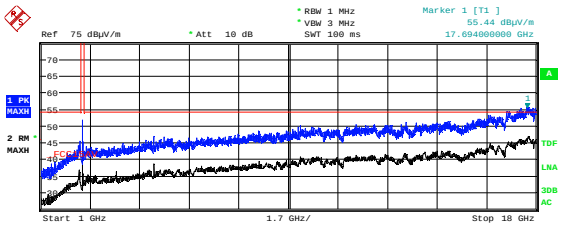
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n MCS0, Ant 0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.298800 GHz | 49.93 dBµV |
| 2 | 2.431400 GHz | 54.14 dBµV |
| 3 | 17.687200 GHz | 55.68 dBµV |

Date: 28.FEB.2023 12:28:57

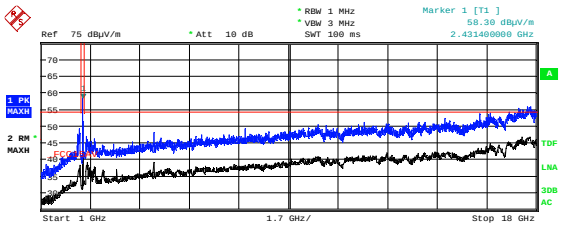
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.336200 GHz | 45.25 dBµV |
| 2 | 2.431400 GHz | 51.63 dBµV |
| 3 | 17.694000 GHz | 55.44 dBµV |

Date: 28.FEB.2023 11:19:10

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n MCS0, MIMO, HP**

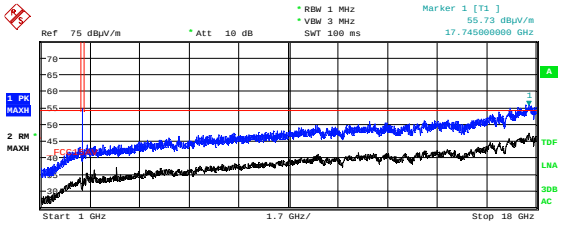



| # | Frequency | Level |
|---|---|---|
| 1 | 2.332800 GHz | 49.09 dBµV |
| 2 | 2.431400 GHz | 58.30 dBµV |
| 3 | 2.577600 GHz | 46.64 dBµV |
| 4 | 4.872600 GHz | 47.97 dBµV |
| 5 | 17.785800 GHz | 55.71 dBµV |

Date: 28.FEB.2023 11:16:47

**VP**

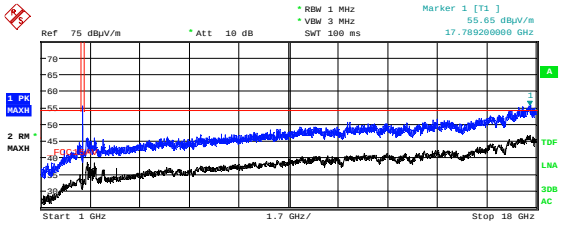
**Whip Antenna**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.434800 GHz | 54.41 dBµV |
| 2 | 17.745000 GHz | 55.73 dBµV |

Date: 2.MAR.2023 15:07:14

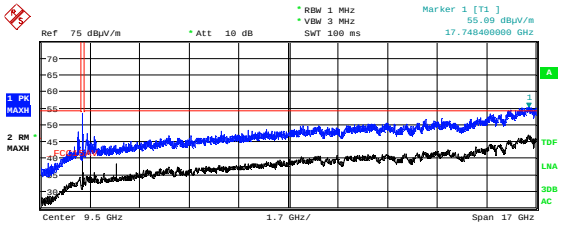
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11b 11M, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.434800 GHz | 55.36 dBµV |
| 2 | 17.789200 GHz | 55.65 dBµV |

Date: 2.MAR.2023 15:04:50

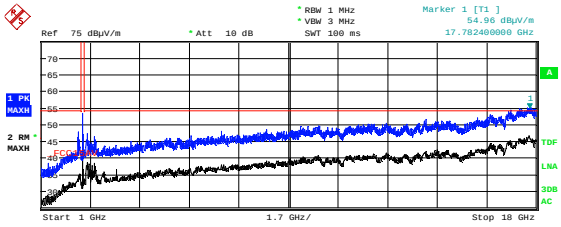
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.298800 GHz | 47.73 dBµV |
| 2 | 2.431400 GHz | 53.25 dBµV |
| 3 | 2.594600 GHz | 47.10 dBµV |
| 4 | 17.748400 GHz | 55.09 dBµV |

Date: 2.MAR.2023 15:39:43

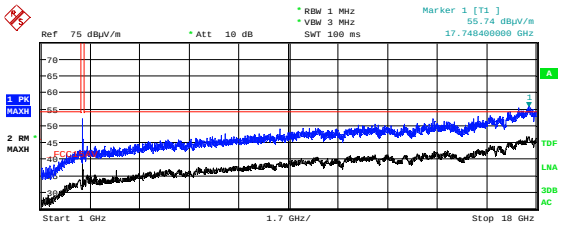
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11g 6M, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.298800 GHz | 47.73 dBµV |
| 2 | 2.431400 GHz | 53.25 dBµV |
| 3 | 2.594600 GHz | 47.10 dBµV |
| 4 | 17.782400 GHz | 54.96 dBµV |

Date: 2.MAR.2023 15:37:45

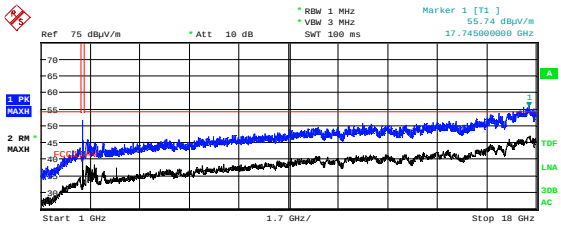
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.434800 GHz | 51.83 dBµV |
| 2 | 17.748400 GHz | 55.74 dBµV |

Date: 2.MAR.2023 15:50:08

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n MCS0, HP**

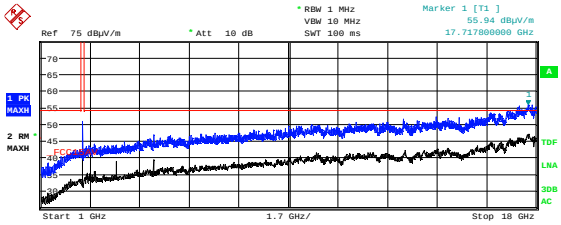



| # | Frequency | Level |
|---|---|---|
| 1 | 2.431400 GHz | 51.49 dBµV |
| 2 | 17.745000 GHz | 55.74 dBµV |

Date: 2.MAR.2023 15:47:44

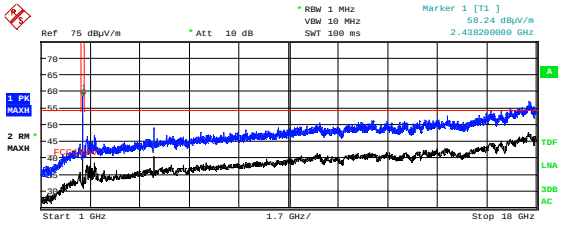
**VP**

**Patch Antenna**



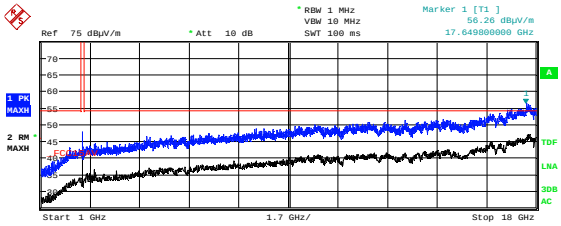

Date: 7.MAR.2023 15:57:08

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11b 11M, HP**



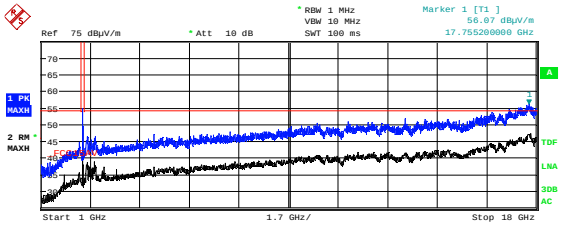

Date: 7.MAR.2023 15:55:10

**VP**




Date: 7.MAR.2023 15:42:26

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11g 6M, HP**




Date: 7.MAR.2023 15:40:27

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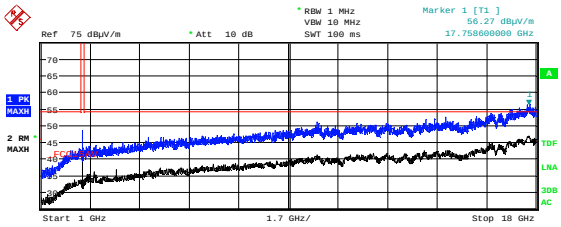
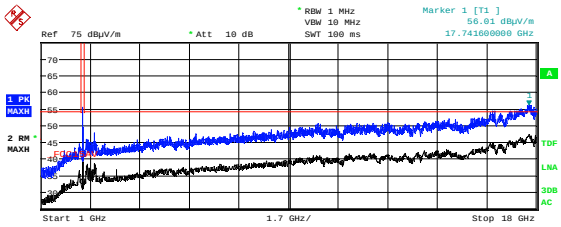


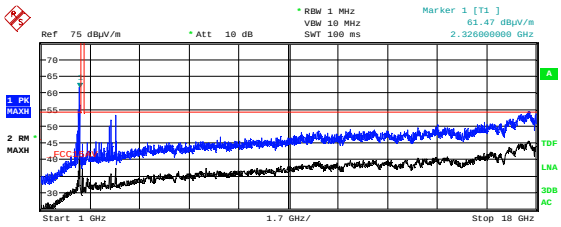

Date: 7.MAR.2023 15:49:25

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n MCS0, HP**




Date: 7.MAR.2023 15:47:28

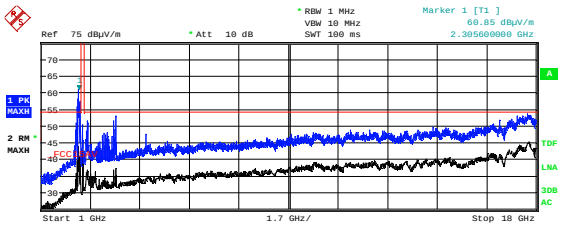
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.285200 GHz | 54.76 dBµV |
| 2 | 2.309000 GHz | 54.24 dBµV |
| 3 | 2.326000 GHz | 61.47 dBµV |
| 4 | 2.332800 GHz | 60.03 dBµV |
| 5 | 2.356600 GHz | 55.19 dBµV |
| 6 | 3.342600 GHz | 49.64 dBµV |
| 7 | 3.352800 GHz | 49.66 dBµV |
| 8 | 3.400400 GHz | 51.58 dBµV |
| 9 | 3.573800 GHz | 52.94 dBµV |
| 10 | 17.724600 GHz | 54.23 dBµV |

Date: 6.JUN.2023 13:55:15

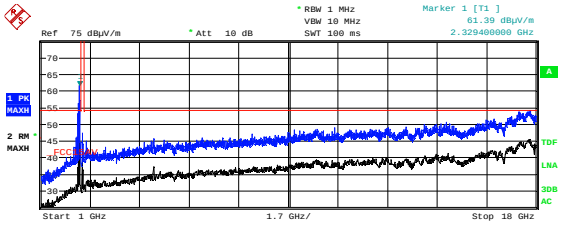
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n HT40, Ant0, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.227400 GHz | 52.31 dBµV |
| 2 | 2.254600 GHz | 56.57 dBµV |
| 3 | 2.305600 GHz | 60.85 dBµV |
| 4 | 2.336200 GHz | 57.34 dBµV |
| 5 | 2.431400 GHz | 50.13 dBµV |
| 6 | 2.594600 GHz | 49.04 dBµV |
| 7 | 2.601400 GHz | 51.35 dBµV |
| 8 | 3.495600 GHz | 51.32 dBµV |
| 9 | 3.570400 GHz | 52.90 dBµV |
| 10 | 17.694000 GHz | 53.59 dBµV |

Date: 6.JUN.2023 13:53:19

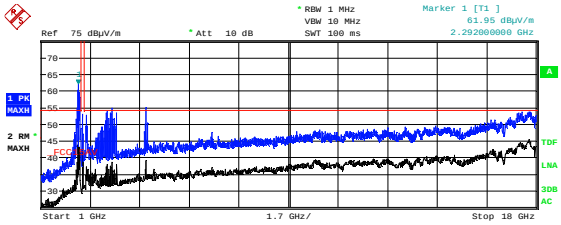
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.258000 GHz | 50.29 dBµV |
| 2 | 2.264800 GHz | 53.01 dBµV |
| 3 | 2.278400 GHz | 48.53 dBµV |
| 4 | 2.292000 GHz | 52.77 dBµV |
| 5 | 2.302200 GHz | 56.00 dBµV |
| 6 | 2.312400 GHz | 52.75 dBµV |
| 7 | 2.329400 GHz | 61.39 dBµV |
| 8 | 2.343000 GHz | 53.63 dBµV |
| 9 | 2.434800 GHz | 47.20 dBµV |
| 10 | 17.779000 GHz | 54.09 dBµV |

Date: 6.JUN.2023 14:00:39

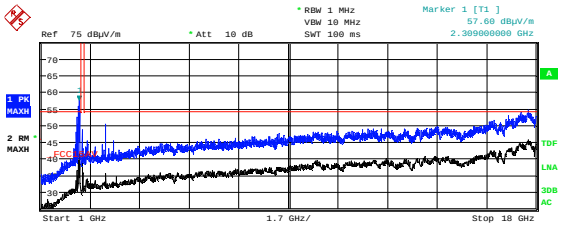
**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n HT40, Ant1, HP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.247800 GHz | 54.59 dBµV |
| 2 | 2.271600 GHz | 60.08 dBµV |
| 3 | 2.292000 GHz | 61.95 dBµV |
| 4 | 2.309000 GHz | 58.49 dBµV |
| 5 | 2.322600 GHz | 59.49 dBµV |
| 6 | 3.261000 GHz | 53.82 dBµV |
| 7 | 3.444600 GHz | 54.77 dBµV |
| 8 | 3.587400 GHz | 53.31 dBµV |
| 9 | 4.600600 GHz | 54.91 dBµV |
| 10 | 17.734800 GHz | 53.63 dBµV |

Date: 6.JUN.2023 14:03:59

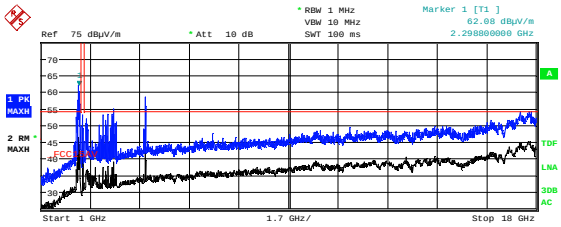
**VP**




| # | Frequency | Level |
|---|---|---|
| 1 | 2.237600 GHz | 48.78 dBµV |
| 2 | 2.251200 GHz | 52.43 dBµV |
| 3 | 2.264800 GHz | 49.61 dBµV |
| 4 | 2.281800 GHz | 55.74 dBµV |
| 5 | 2.292000 GHz | 53.61 dBµV |
| 6 | 2.309000 GHz | 57.60 dBµV |
| 7 | 2.339600 GHz | 53.93 dBµV |
| 8 | 2.431400 GHz | 48.61 dBµV |
| 9 | 3.227000 GHz | 50.29 dBµV |
| 10 | 17.717800 GHz | 54.43 dBµV |

Date: 6.JUN.2023 14:09:21

**Radiated Emissions 1 - 18 GHz, Ch06, 802.11n HT40, MIMO, HP**

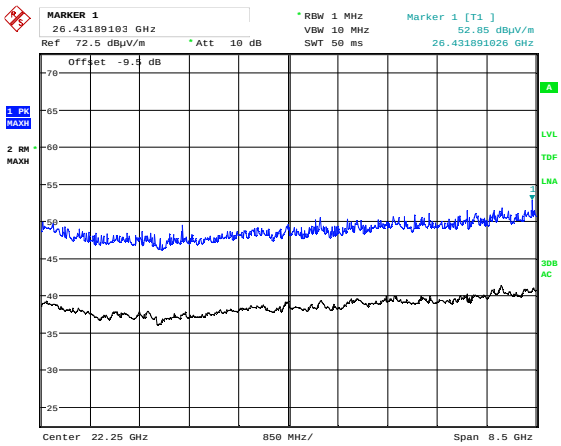



| # | Frequency | Level |
|---|---|---|
| 1 | 2.230800 GHz | 54.77 dBµV |
| 2 | 2.258000 GHz | 57.54 dBµV |
| 3 | 2.281800 GHz | 59.16 dBµV |
| 4 | 2.298800 GHz | 62.08 dBµV |
| 5 | 2.312400 GHz | 60.06 dBµV |
| 6 | 2.346400 GHz | 56.39 dBµV |
| 7 | 2.353200 GHz | 55.17 dBµV |
| 8 | 3.492200 GHz | 54.83 dBµV |
| 9 | 4.573400 GHz | 58.35 dBµV |
| 10 | 4.610800 GHz | 55.68 dBµV |

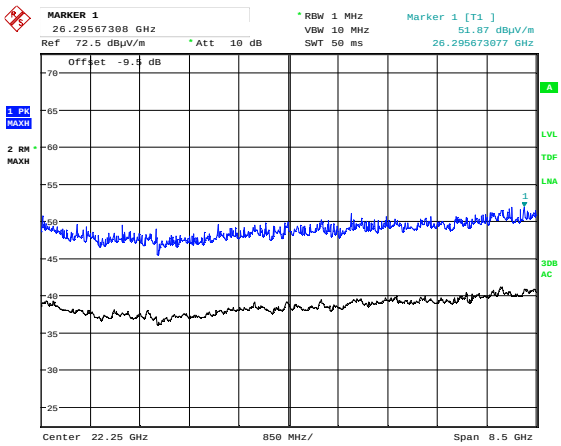
Date: 6.JUN.2023 14:07:24

**VP**

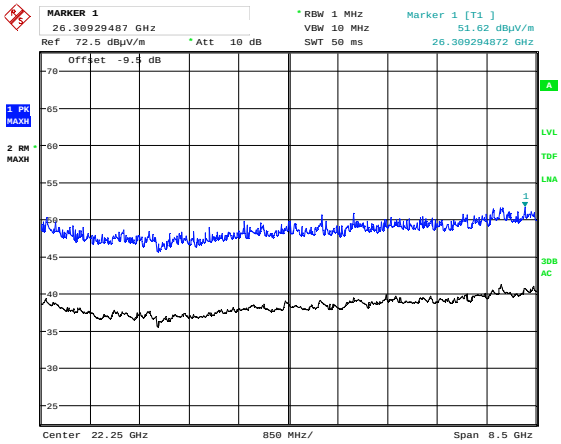
**COMBI Antenna**



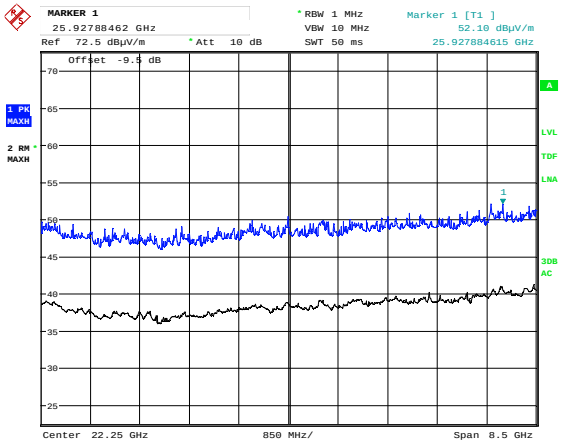

**Emissions 18 - 26 GHz, Ch06, 802.11b 11M Ant1, HP**



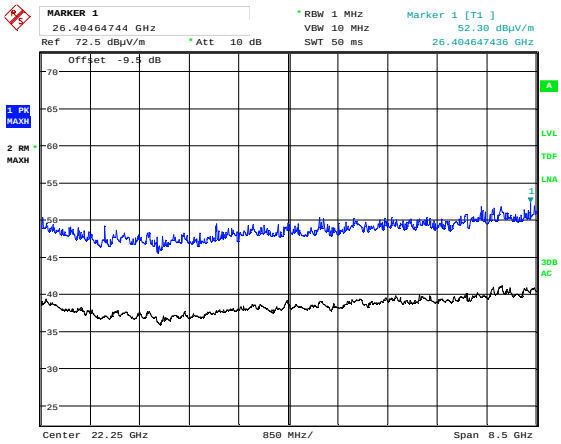

**VP**



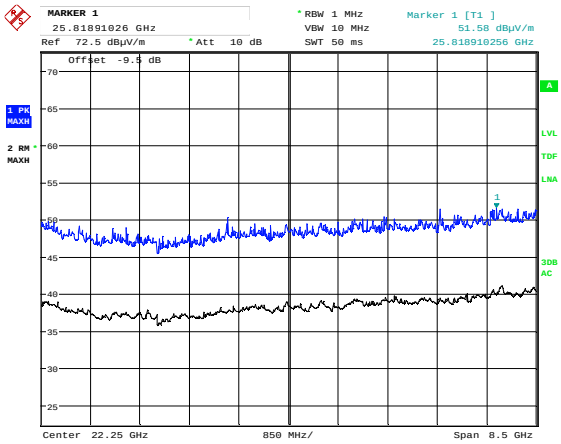

**Emissions 18 - 26 GHz, Ch06, 802.11g 6M Ant0, HP**




**VP**




**Emissions 18 - 26 GHz, Ch06, 802.11g 6M Ant1, HP**

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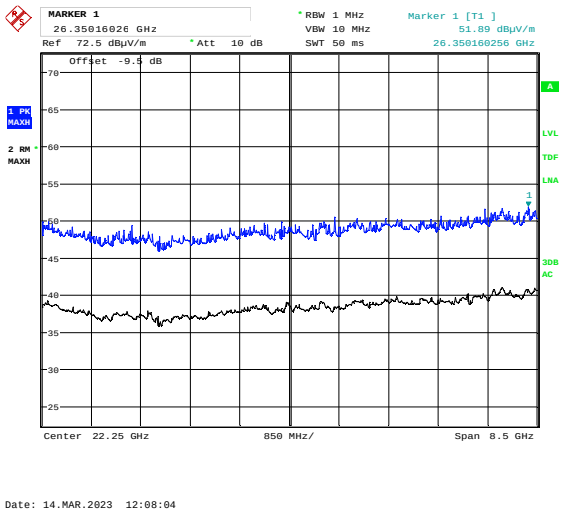
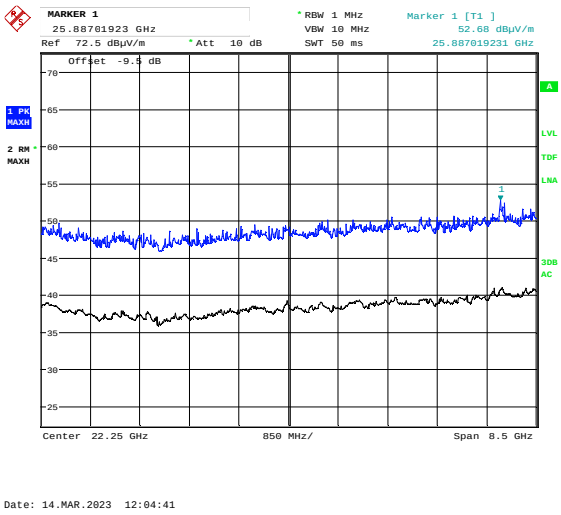
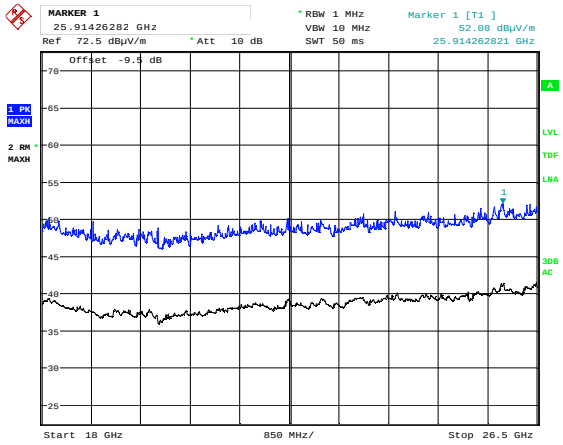



**Emissions 18 - 26 GHz, Ch06, 802.11n MCS0 MIMO, HP**

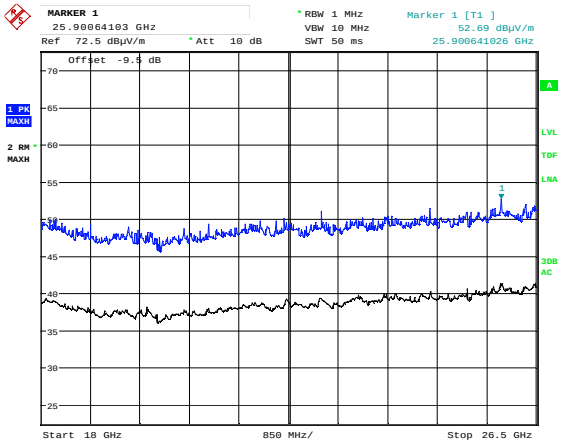



**VP**

**WHIP + Patch Antenna**




**Emissions 18 - 26 GHz, Ch06, 802.11b 11M Ant0, HP**

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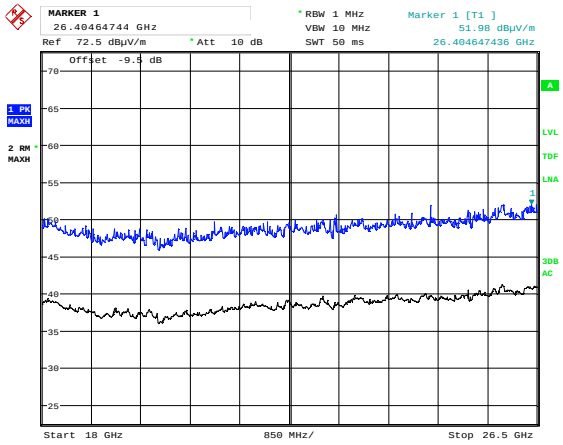
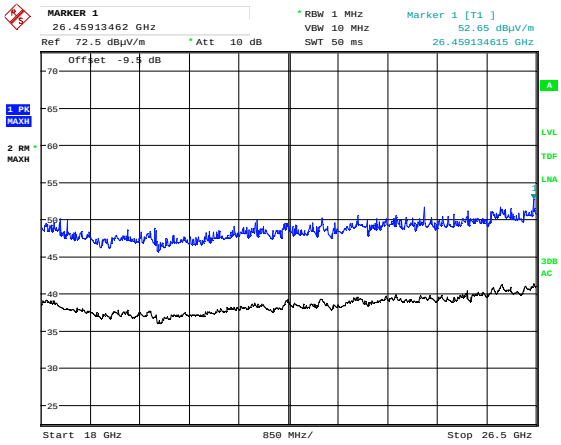



**Emissions 18 - 26 GHz, Ch06, 802.11b 11M Ant1, HP**

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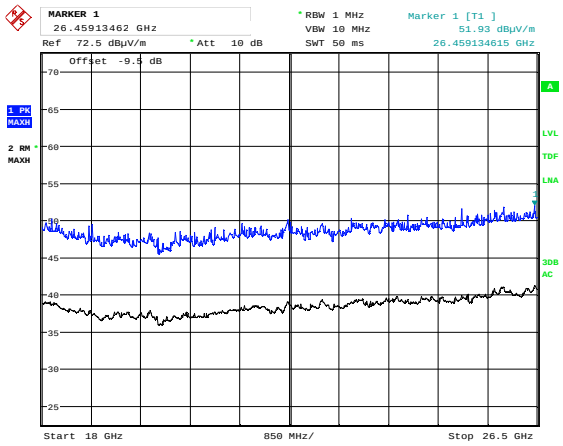
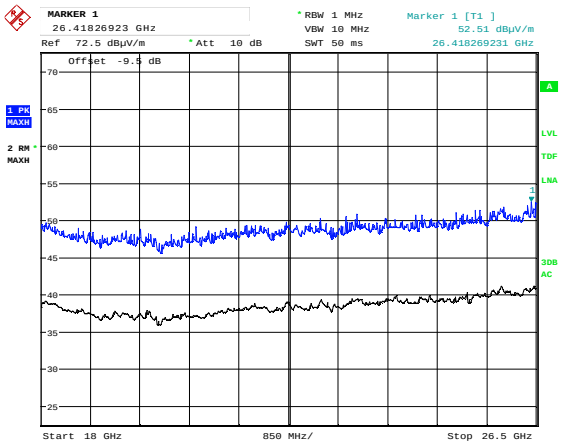



**Emissions 18 - 26 GHz, Ch06, 802.11g 6M Ant0, HP**

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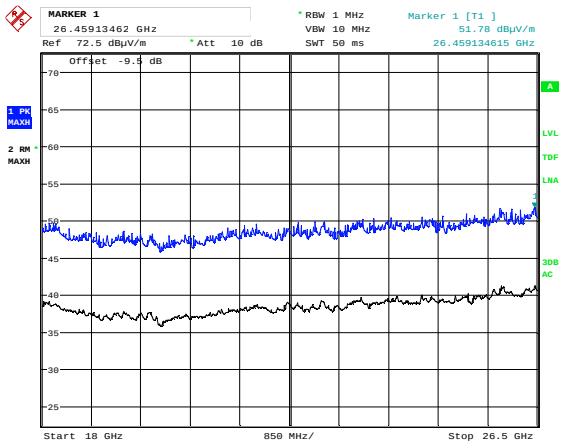
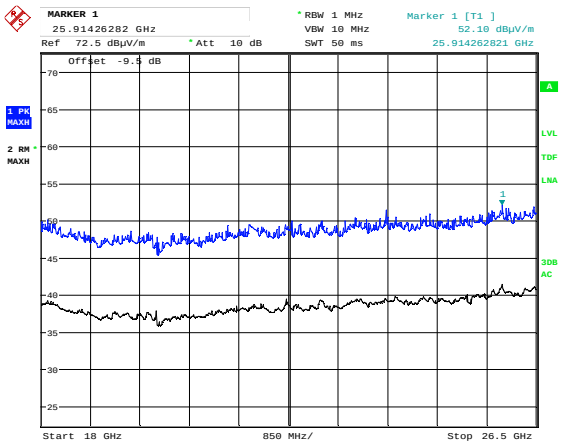
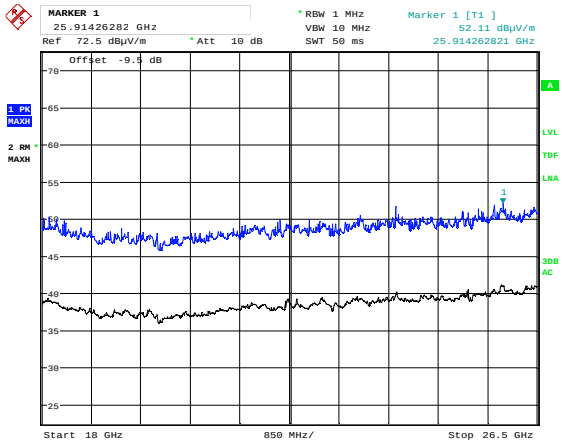


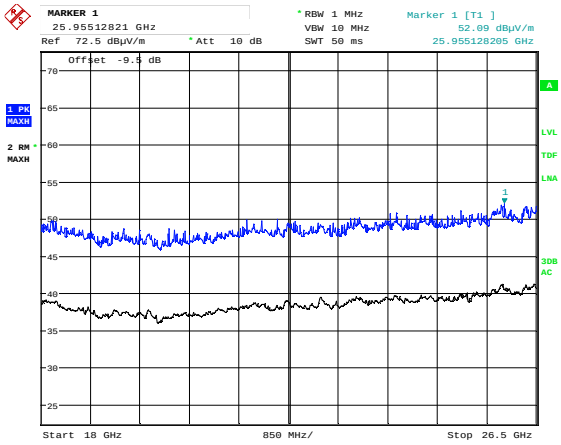

**Emissions 18 - 26 GHz, Ch06, 802.11g 6M Ant1, HP**




**VP**




**Emissions 18 - 26 GHz, Ch06, 802.11m MCS0 MIMO, HP**




**VP**

## 3.9 Power Spectral Density (PSD)

**FCC part 15.247(d)**

**ISED Canada RSS-247 Issue 2, Clause 5.2 (2)**

**Measurement procedure: ANSI C63.10-2013 Clause 11.10**

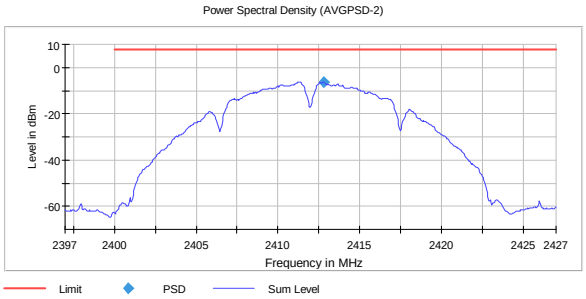
**Test Results: Complies**

**Measurement Data:**

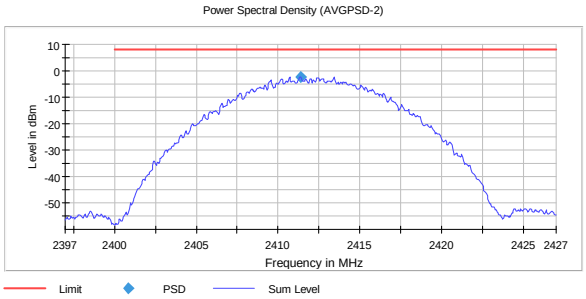
The measurement procedure AVG-PSD2 described in ANSI C63.10-2013 was used.

| Modulation Type | Measured Power Spectral Density (dBm/3kHz) | | | | |
|---|---|---|---|---|---|
| | 2412 MHz | 2417 MHz | 2437 MHz | 2457 MHz | 2462 MHz |
| 802.11b | -2.3 | 1.7 | 1.6 | 1.6 | -1.5 |
| 802.11g | -9.3 | -3.5 | -3.0 | -2.7 | -7.8 |
| 802.11n SISO | -9.3 | -3.6 | -3.3 | -2.7 | -8.6 |
| 802.11n MIMO | -9.2 | -3.5 | -3.2 | -3.3 | -8.7 |
| | 2422 MHz | 2427 MHz | 2437 MHz | 2447 MHz | 2452 MHz |
| 802.11n HT40 SISO | -11.4 | -5.9 | -5.6 | -6.0 | -11.5 |
| 802.11n HT40 MIMO | -11.5 | -6.1 | -5.9 | -6.1 | -11.5 |

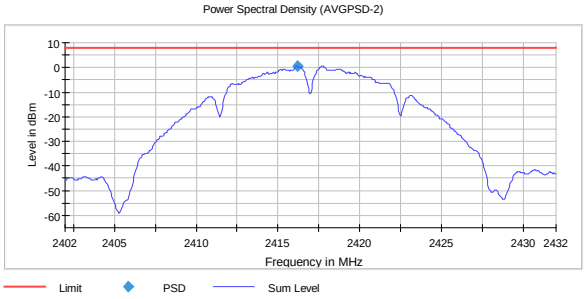
| Requirement for systems using Digital Modulation |
|---|
| The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. |



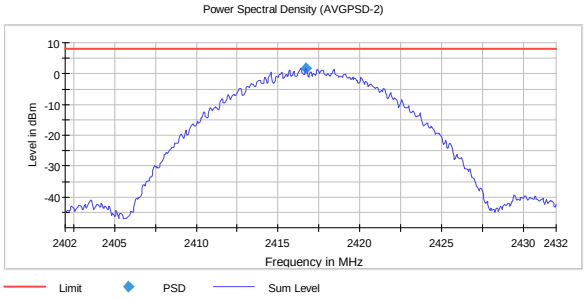

**PSD, 2412 MHz, 802.11b 1M -6.20**



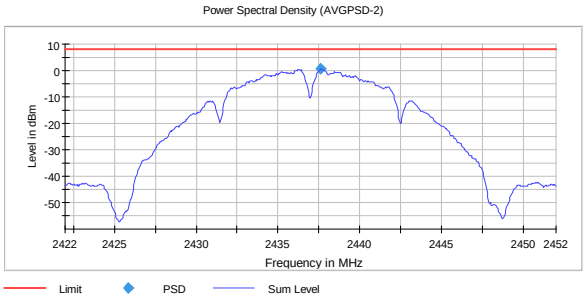

**PSD, 2412 MHz, 802.11b 11M -2.27**



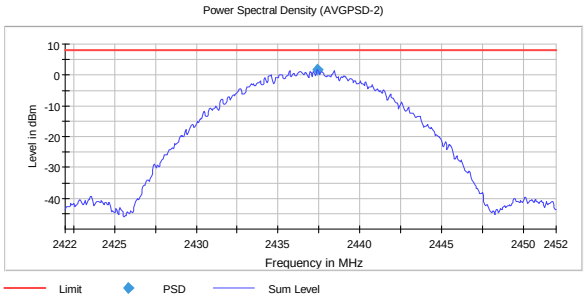

**PSD, 2417 MHz, 802.11b 1M 0.45**



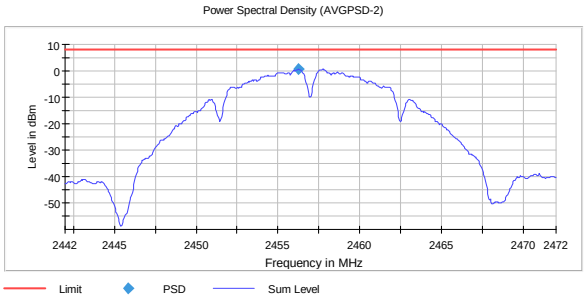

**PSD, 2417 MHz, 802.11b 11M 1.73**



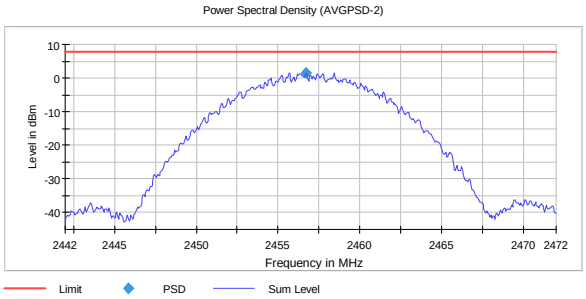

**PSD, 2437 MHz, 802.11b 1M 0.64**



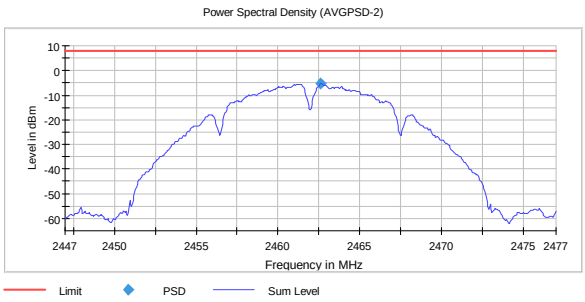

**PSD, 2437 MHz, 802.11b 11M 1.63**

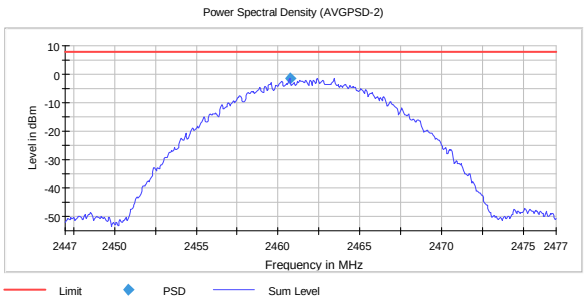



**PSD, 2457 MHz, 802.11b 1M 0.66**

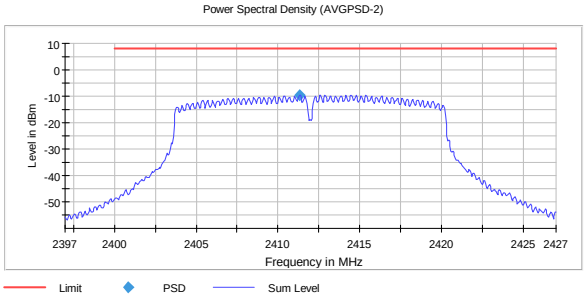



**PSD, 2457 MHz, 802.11b 11M 1.58**

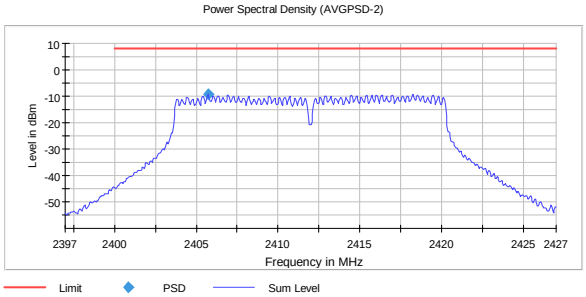


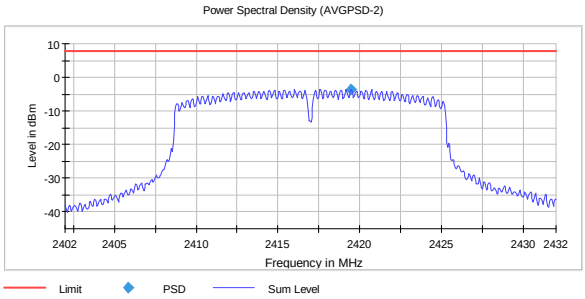
**PSD, 2462 MHz, 802.11b 1M -5.18**



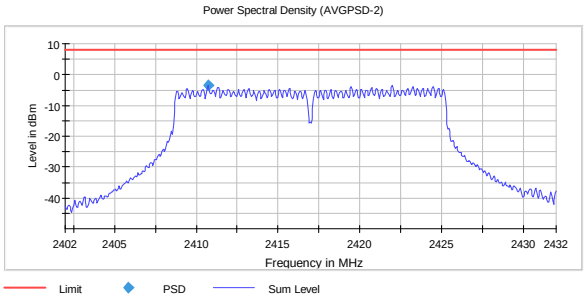

**PSD, 2462 MHz, 802.11b 11M -1.49**



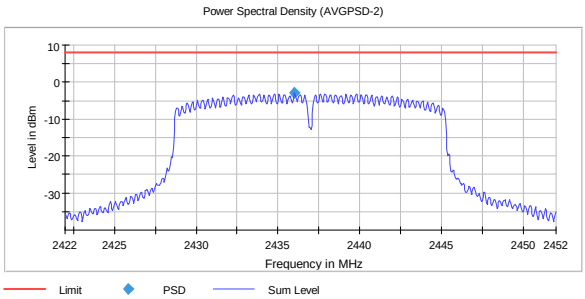

**PSD, 2412 MHz, 802.11g 6M -9.50**



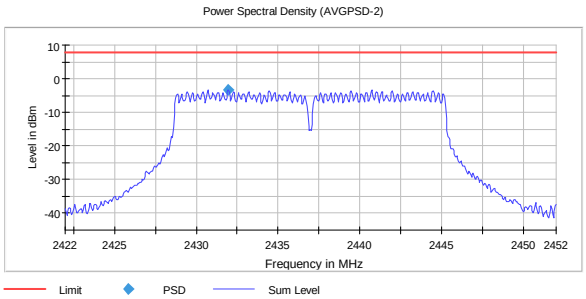

**PSD, 2412 MHz, 802.11g 54M -9.33**



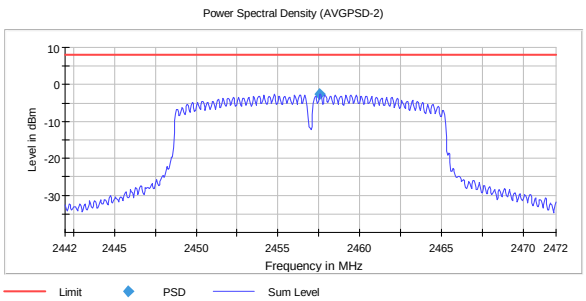

**PSD, 2417 MHz, 802.11g 6M -3.56**



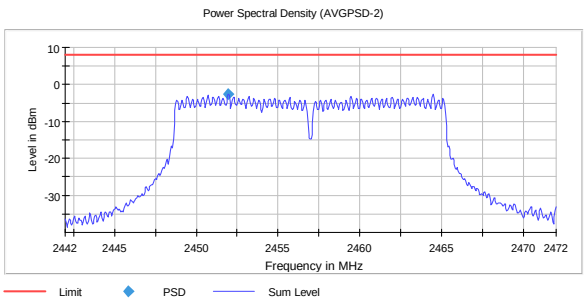

**PSD, 2417 MHz, 802.11g 54M -3.52**



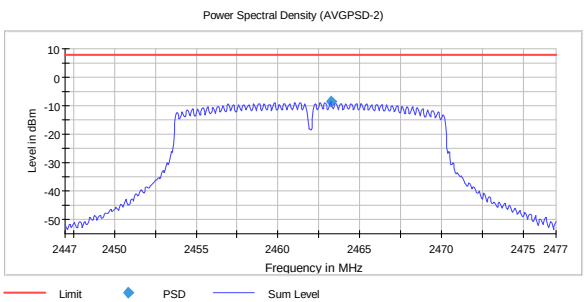

**PSD, 2437 MHz, 802.11g 6M -3.05**



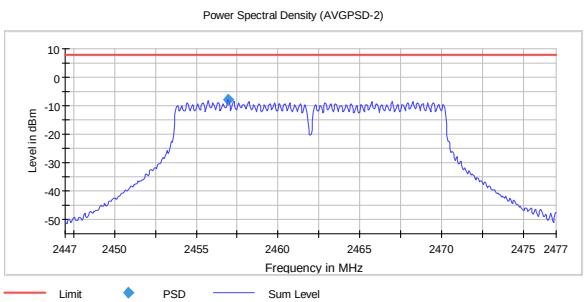

**PSD, 2437 MHz, 802.11g 54M -3.31**




**PSD, 2457 MHz, 802.11g 6M -2.73**




**PSD, 2457 MHz, 802.11g 54M -2.66**

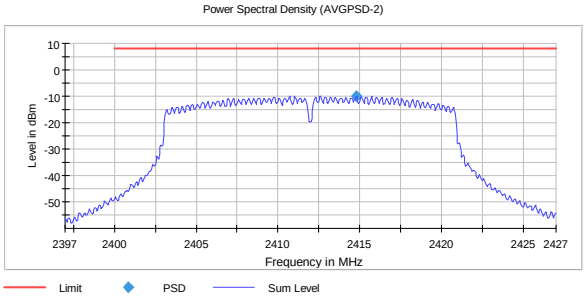



**PSD, 2462 MHz, 802.11b 1M -5.18**

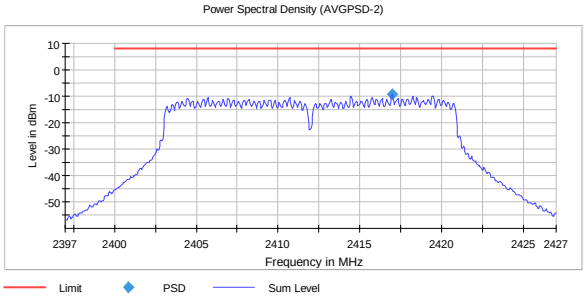



**PSD, 2462 MHz, 802.11b 11M -1.49**

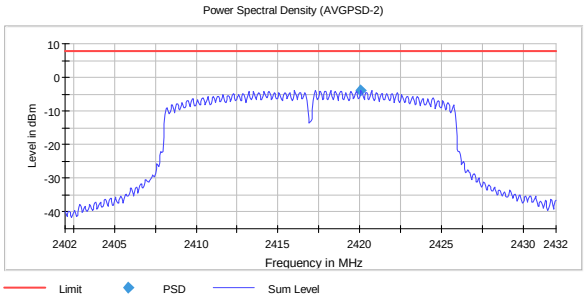
**PSD, 2462 MHz, 802.11g 6M -8.69**



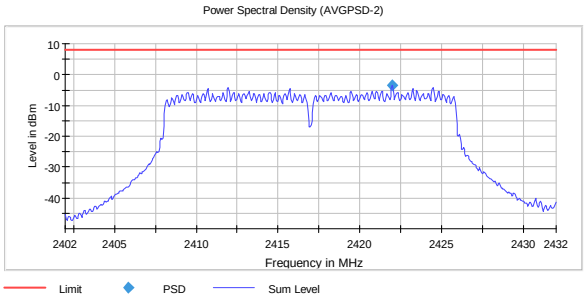

**PSD, 2462 MHz, 802.11g 54M -7.83**



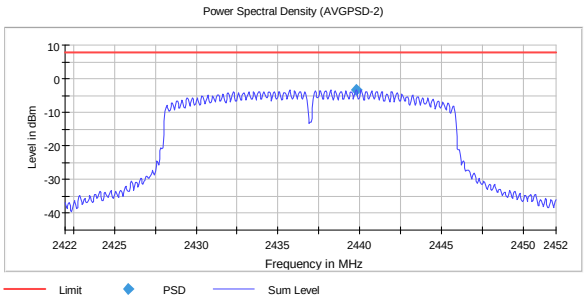

**PSD, 2412 MHz, 802.11n SISO MCS0 -9.96**



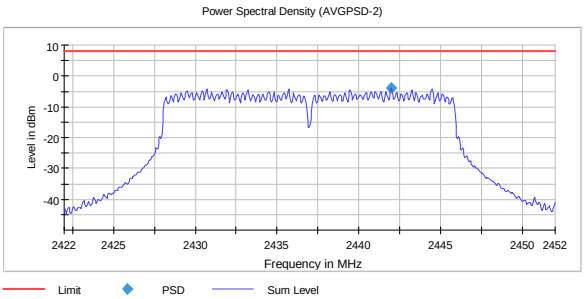

**PSD, 2412 MHz, 802.11n SISO MCS7 -9.3**



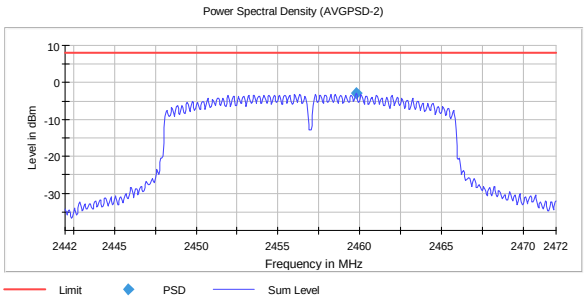

**PSD, 2417 MHz, 802.11n SISO MCS0 -3.93**



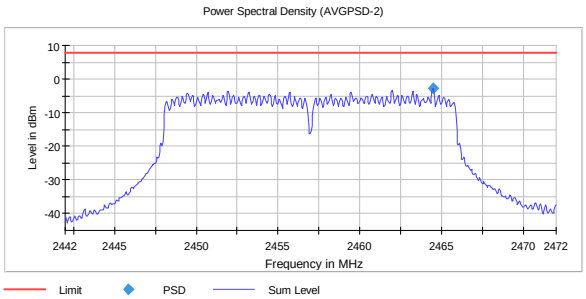

**PSD, 2417 MHz, 802.11n SISO MCS7 -3.64**



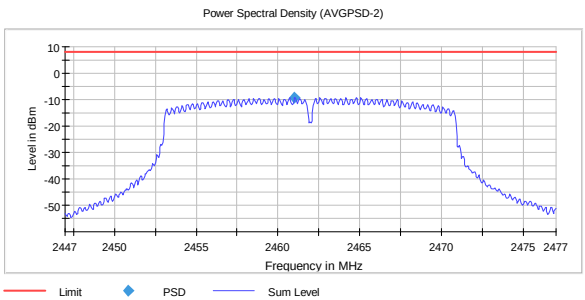

**PSD, 2437 MHz, 802.11n SISO MCS0 -3.30**



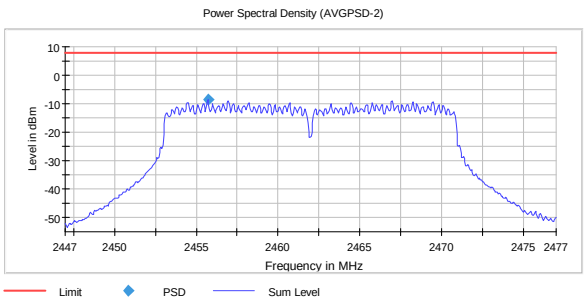

**PSD, 2437 MHz, 802.11n SISO MCS7 -3.77**




**PSD, 2457 MHz, 802.11n SISO MCS0 -2.86**




**PSD, 2457 MHz, 802.11n SISO MCS7 -2.72**

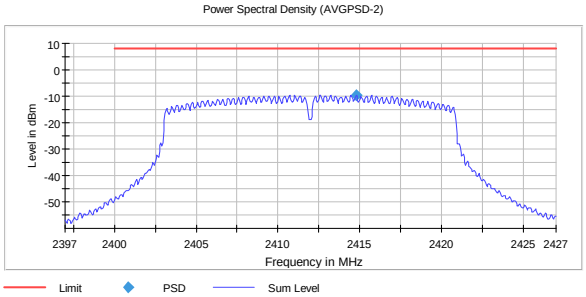



**PSD, 2462 MHz, 802.11n SISO MCS0 -9.96**

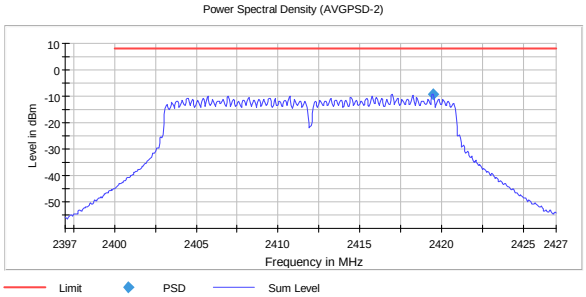



**PSD, 2462 MHz, 802.11n SISO MCS7 -9.3**

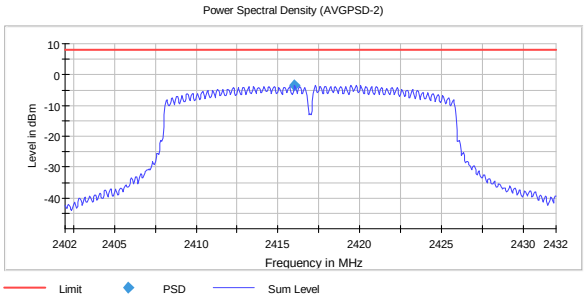
**PSD, 2462 MHz, 802.11n SISO MCS0 -9.345**



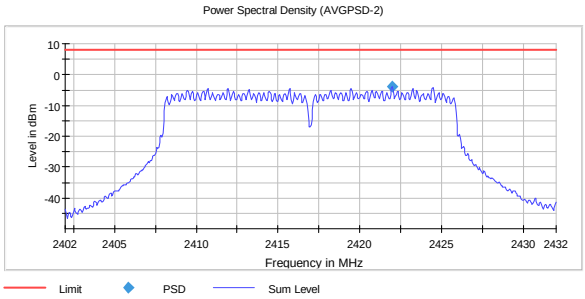

**PSD, 2462 MHz, 802.11n SISO MCS7 -8.62**



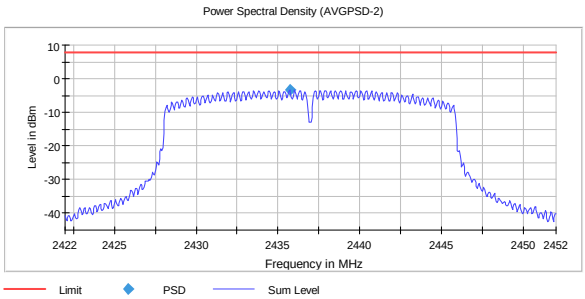

**PSD, 2412 MHz, 802.11n MIMO MCS8 -9.63**



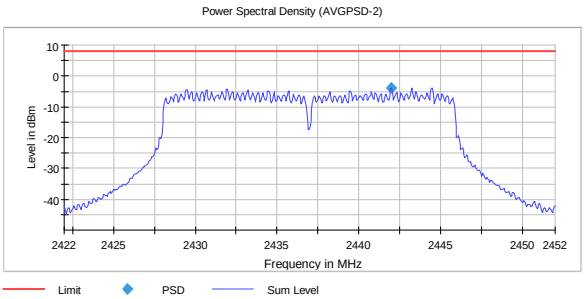

**PSD, 2412 MHz, 802.11n MIMO MCS15 -9.17**



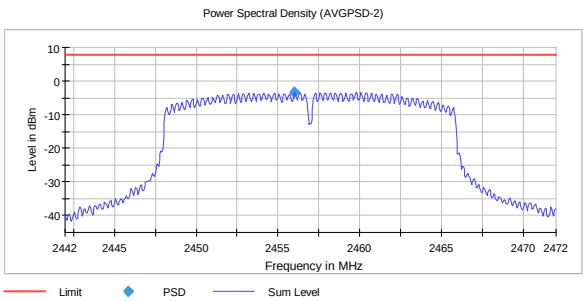

**PSD, 2417 MHz, 802.11n MIMO MCS8 -3.55**



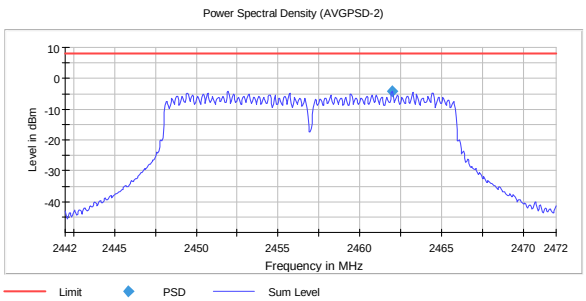

**PSD, 2417 MHz, 802.11n MIMO MCS15 -3.78**



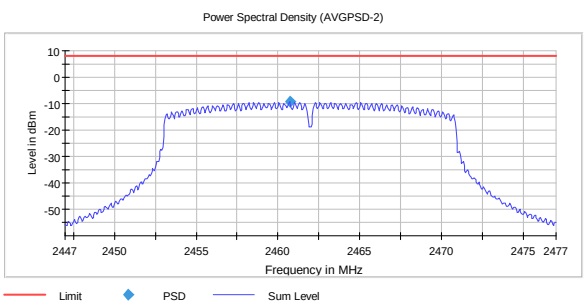

**PSD, 2437 MHz, 802.11n MIMO MCS8 -3.24**



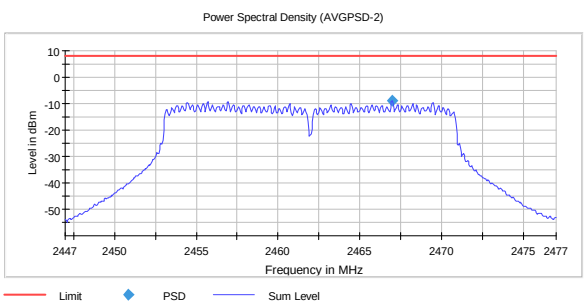

**PSD, 2437 MHz, 802.11n MIMO MCS15 -3.69**



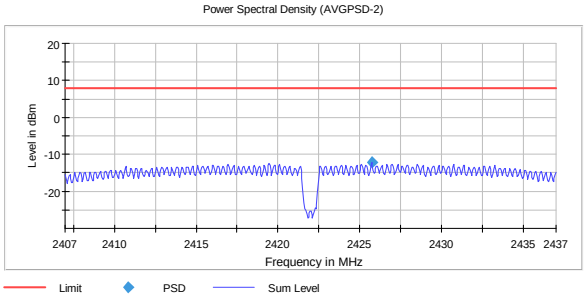

**PSD, 2457 MHz, 802.11n MIMO MCS8 -3.29**



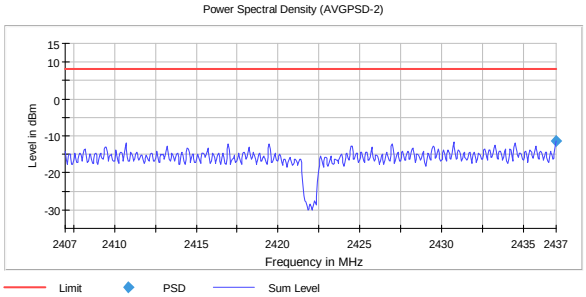

**PSD, 2457 MHz, 802.11n MIMO MCS15 -4.13**



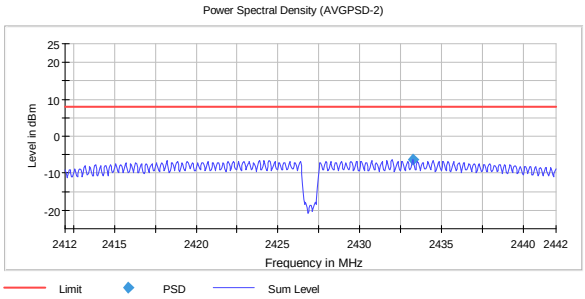
**PSD, 2462 MHz, 802.11n MIMO MCS8 -9.38**



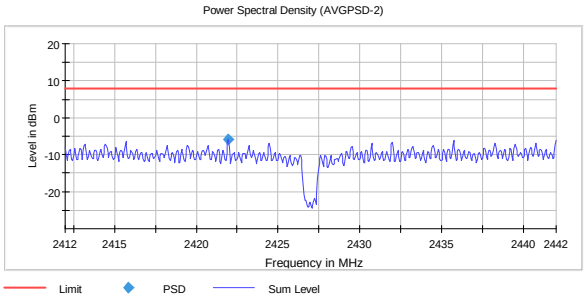

**PSD, 2462 MHz, 802.11n MIMO MCS15 -8.74**



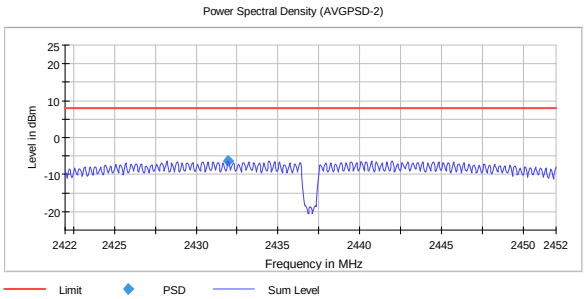

**PSD, 2422 MHz, 802.11n HT40 SISO MCS0 -12.2**



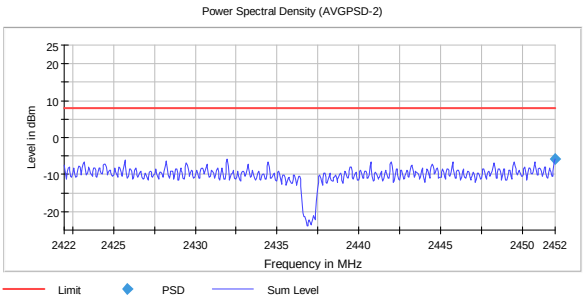

**PSD, 2422 MHz, 802.11n HT40 SISO MCS7 -11.4**




**PSD, 2427 MHz, 802.11n HT40 SISO MCS0 -6.3**




**PSD, 2427 MHz, 802.11n HT40 SISO MCS7 -5.9**



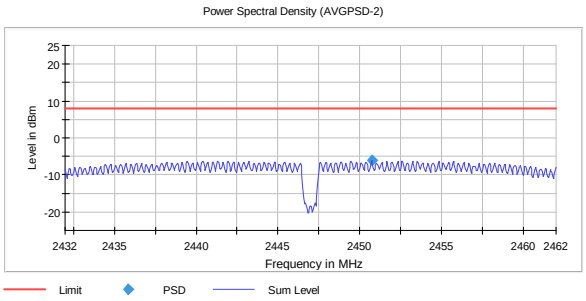

**PSD, 2437 MHz, 802.11n HT40 SISO MCS0 -6.2**



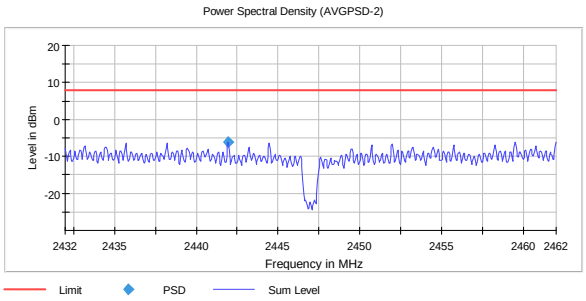

**PSD, 2437 MHz, 802.11n HT40 SISO MCS7 -5.6**

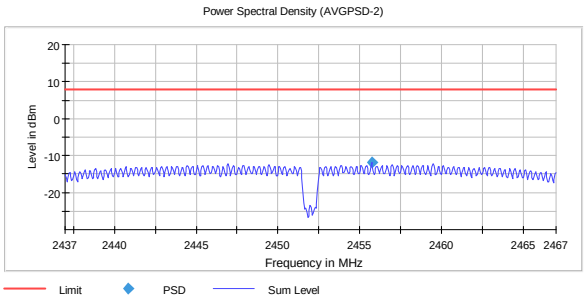



**PSD, 2447 MHz, 802.11n HT40 SISO MCS0 -6.1**

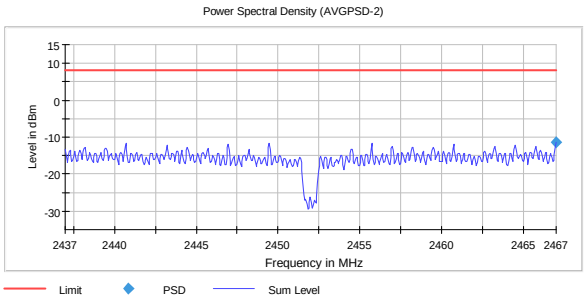



**PSD, 2447 MHz, 802.11n HT40 SISO MCS7 -6.0**

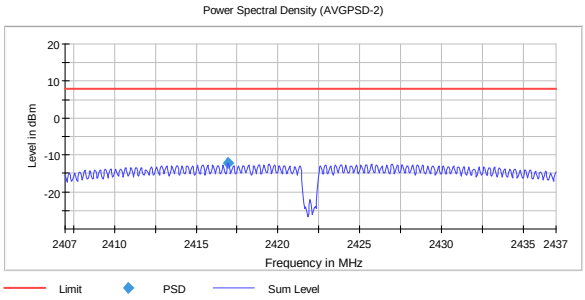




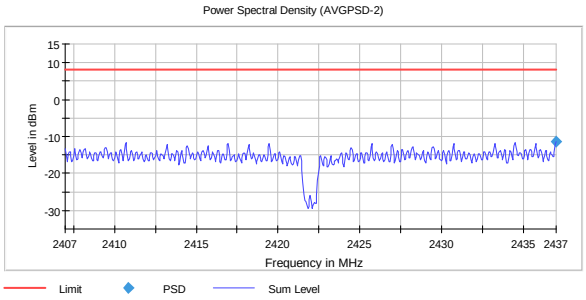

**PSD, 2452 MHz, 802.11n HT40 SISO MCS0 -11.9**



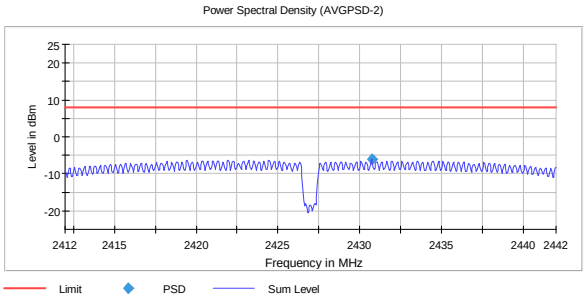

**PSD, 2452 MHz, 802.11n HT40 SISO MCS7 -11.5**



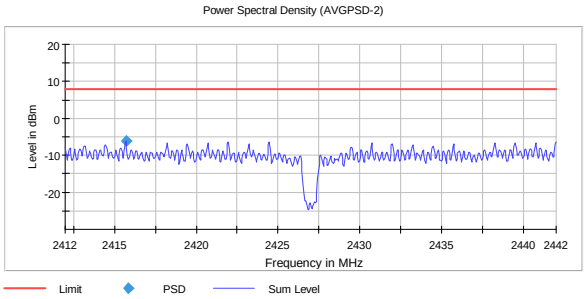

**PSD, 2422 MHz, 802.11n HT40 MIMO MCS8 -12.1**



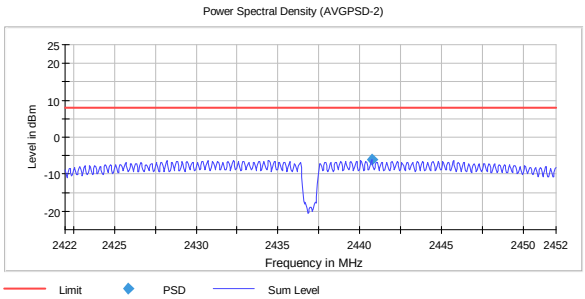

**PSD, 2422 MHz, 802.11n HT40 MIMO MCS15 -11.5**



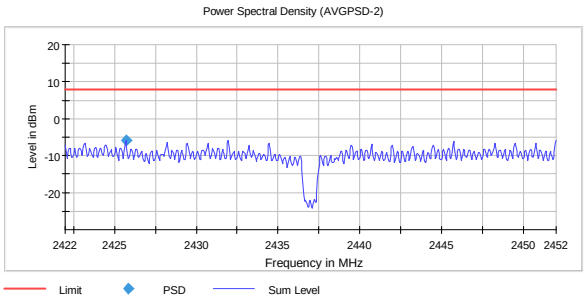

**PSD, 2427 MHz, 802.11n HT40 MIMO MCS8 -6.1**



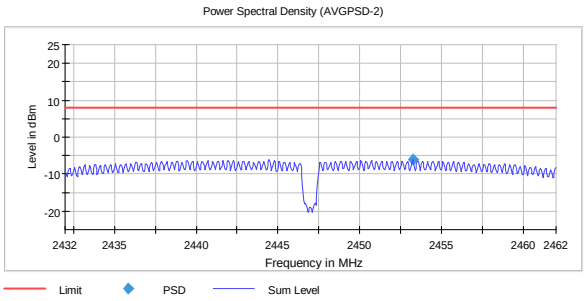

**PSD, 2427 MHz, 802.11n HT40 MIMO MCS15 -6.1**



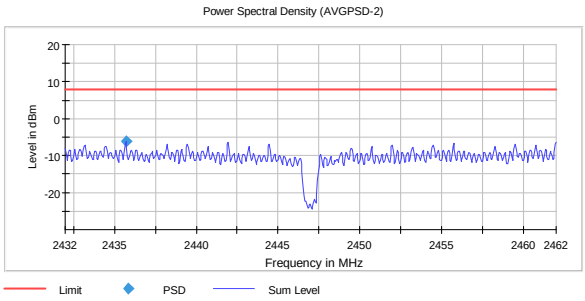

**PSD, 2437 MHz, 802.11n HT40 MIMO MCS8 -6.1**



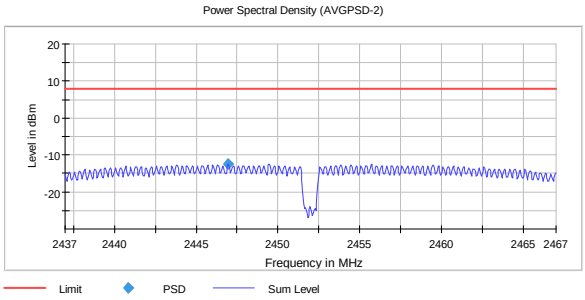

**PSD, 2437 MHz, 802.11n HT40 MIMO MCS15 -5.9**



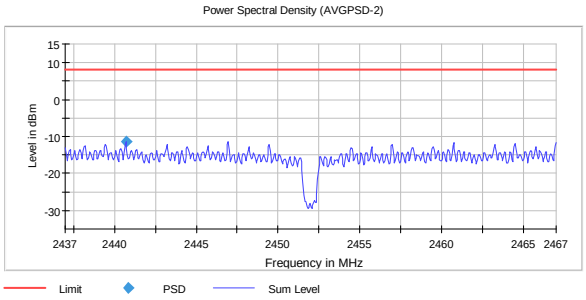

**PSD, 2447 MHz, 802.11n HT40 MIMO MCS8 -6.1**




**PSD, 2447 MHz, 802.11n HT40 MIMO MCS15 -6.1**




**PSD, 2452 MHz, 802.11n HT40 MIMO MCS8 -12.4**




**PSD, 2452 MHz, 802.11n HT40 MIMO MCS15 -11.5**

# 4 Measurement Uncertainty

| Measurement Uncertainty Values | | |
|---|---|---|
| **Test Item** | | **Uncertainty** |
| **Output Power** | | ±0.5 dB |
| **Power Spectral Density** | | ±0.5 dB |
| **Out of Band Emissions, Conducted** | **< 3.6 GHz** | ±0.6 dB |
| | **> 3.6 GHz** | ±0.9 dB |
| **Spurious Emissions, Radiated** | **< 1 GHz** | ±2.5 dB |
| | **> 1 GHz** | ±2.2 dB |
| **Emission Bandwidth** | | ±4 % |
| **Power Line Conducted Emissions** | | +2.9 / -4.1 dB |
| **Spectrum Mask Measurements** | **Frequency** | ±5 % |
| | **Amplitude** | ±1.0 dB |
| **Frequency Error** | | ±0.6 ppm |
| **Temperature Uncertainty** | | ±1 °C |

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

# 5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

| No. | Model number | Description | Manufacturer | Ref. no. | Cal. date | Cal. Due |
|---|---|---|---|---|---|---|
| 1 | FSW43 | Spectrum Analyzer | Rohde & Schwarz | LR 1690 | 2023-01 | 2024-01 |
| 2 | ESU40 | Measuring Receiver | Rohde & Schwarz | LR 1639 | 2023-01 | 2024-01 |
| 3 | 6810.17B | Attenuator | Suhner | LR 1669 | 2022-08 | 2023-08 |
| 4 | NO324415 | Band Reject Filter (2.4GHz) | Microwave Circuits | LR 1760 | COU | |
| 5 | JB3 | BiLog Antenna | Sunol | N-4525 | 2022-09 | 2025-09 |
| 6 | 317 | Preamplifier | Sonoma Inst. | LR 1687 | 2022-08 | 2023-08 |
| 7 | 3117-PA | Horn Antenna +PreAmp | EMCO | LR 1717 | 2022-08 | 2023-08 |
| 8 | 3115 | Horn Antenna | EMCO | LR 1226 | 2022-12 | 2027-12 |
| 9 | 8449A | Pre-amplifier | Hewlett Packard | LR 1322 | 2022-08 | 2023-08 |
| 10 | WLK5-1100-1485-7000-40SS | Low Pass Filter | Wainwright Inst. | LR 1761 | COU | |
| 11 | 638 | Antenna Horn | Narda | LR 1480 | N/A | |
| 12 | 6032A | System Power Supply | Hewlett Packard | LR 1062 | COU | |
| 13 | Model 87V | Multimeter | Fluke | LR 1600 | 2022-03 | 2024-03 |
| 14 | ST18/SMA/N/36 | RF Cable | Suhner | LR 1627 | COU | |

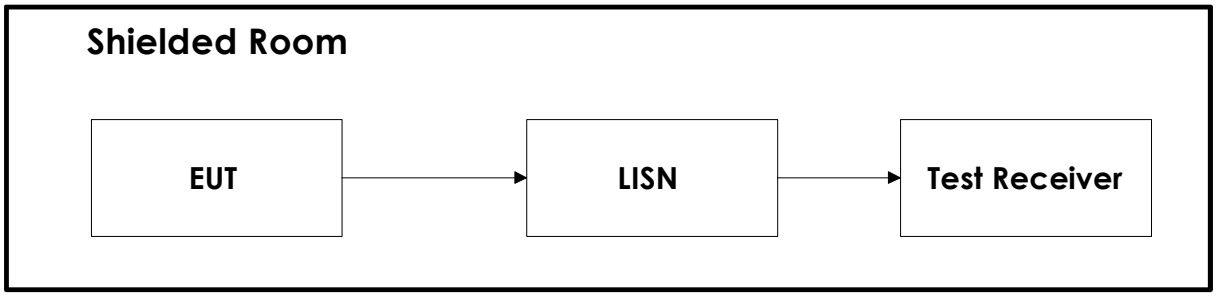
COU = Calibrate on Use

The software listed below has been used for one or more tests.

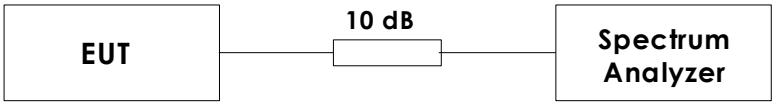
| No. | Manufacturer | Name | Version | Comment |
|---|---|---|---|---|
| 1 | Rohde & Schwarz | EMC32 | 10.50.40 | EMC test software |
| 2 | Rohde & Schwarz | GPIBShot | 2.7 | Screenshots from R&S Spectrum Analyzers |
| | | | | |

# 6 BLOCK DIAGRAM

## 6.1 Power Line Conducted Emission

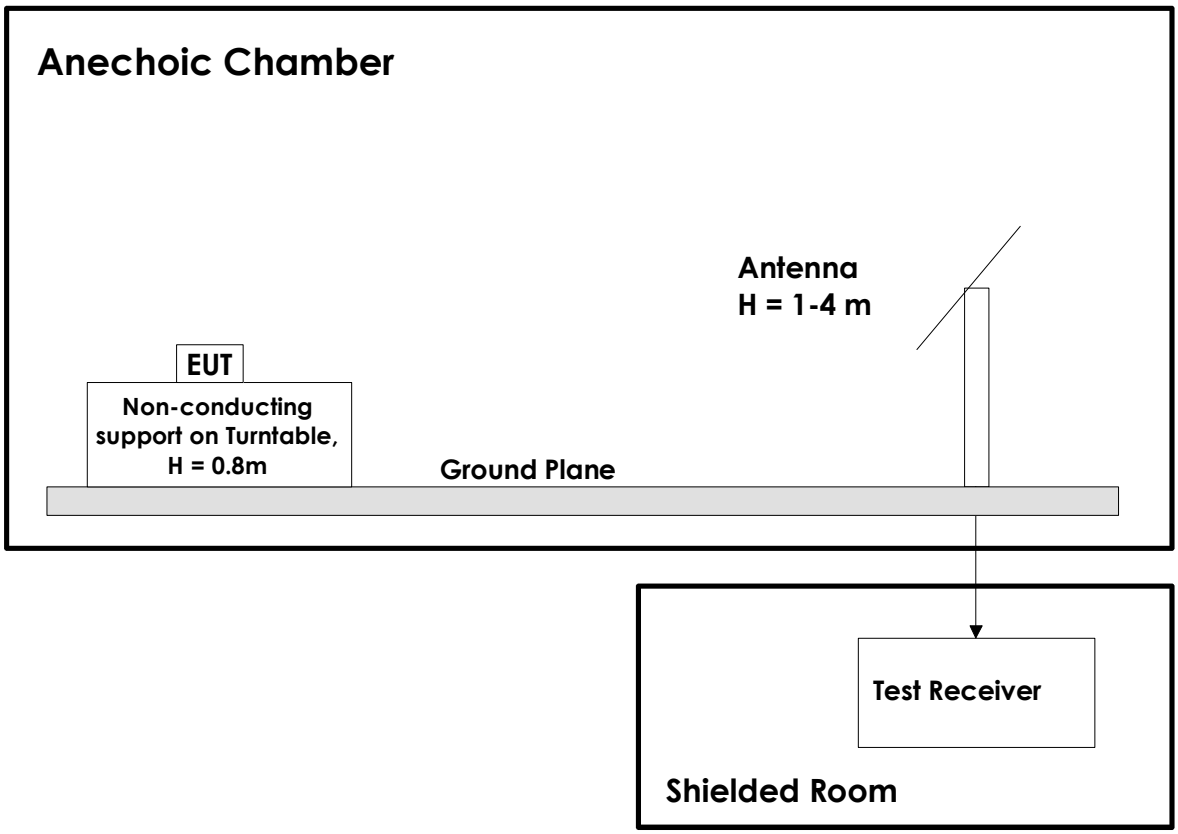



## 6.2 Conducted Tests




This test set-up is used for all Conducted tests.
For Frequency Stability test the EUT was placed in a climatic chamber.

## 6.3 Test Site Radiated Emission




This test setup is used for all radiated emissions tests. For frequencies below 30 MHz the measuring distance is 10m, for all other frequencies it is 3m or 1m. Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna. For measurements above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss. All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers. A pre-amplifier is used for all measurements above 30 MHz, and High-Pass or Band-Pass filter is used for all harmonics.