

# Test Report

|                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Product</b>                                                                                                                                                                                                                                                                                                                                                                                                           | Telematics unit for mounting on forklifts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Name and address of the applicant</b>                                                                                                                                                                                                                                                                                                                                                                                 | Toyota Material Handling, Inc.<br>5559 Inwood Drive, Columbus<br>IN 47201, USA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Name and address of the manufacturer</b>                                                                                                                                                                                                                                                                                                                                                                              | Toyota Material Handling, Inc.<br>5559 Inwood Drive, Columbus<br>IN 47201, USA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Model</b>                                                                                                                                                                                                                                                                                                                                                                                                             | DHUnx                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Rating</b>                                                                                                                                                                                                                                                                                                                                                                                                            | External DC supply (12-48 V <sub>DC</sub> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Trademark</b>                                                                                                                                                                                                                                                                                                                                                                                                         | TOYOTA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Additional information</b>                                                                                                                                                                                                                                                                                                                                                                                            | WiFi, BT Classic, BLE, WCDMA, LTE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Tested according to</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>Parts of FCC Part 15.247</b><br>Digital Transmission Systems<br><b>Parts of ISED Canada RSS-247, Issue 3</b><br>Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and<br>Licence-Exempt Local Area Network (LE-LAN) Devices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Order number</b>                                                                                                                                                                                                                                                                                                                                                                                                      | PRJ0033045                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Tested in period</b>                                                                                                                                                                                                                                                                                                                                                                                                  | 2023-08-23 to 2023-08-29                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Issue date</b>                                                                                                                                                                                                                                                                                                                                                                                                        | 2023-11-20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Name and address of the testing laboratory</b>                                                                                                                                                                                                                                                                                                                                                                        | <div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> <br/> Nemko Scandinavia AS<br/> Instituttveien 6<br/> 2007 Kjeller, Norway<br/> www.nemko.com </div> <div style="text-align: center;"> CAB Number:<br/> FCC: NO0001<br/> ISED: NO0470<br/> ISED No: 2040D-1 </div> <div style="text-align: center;"> <br/>  </div> </div> <p style="text-align: center; color: red; font-weight: bold;">An accredited technical test executed under the Norwegian accreditation scheme</p> |
| <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;"> <br/> Prepared by [Frode Sveinsen] </div> <div style="text-align: center;"> <br/> Approved by [Jan G Eriksen] </div> </div> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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## Revision history

| Revision | Date       | Comment       | Sign |
|----------|------------|---------------|------|
| A        | 2023-11-20 | 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                             | Toyota                                                                                                                                                                                                                                                                                          |
| Model/version                    | DHUnx                                                                                                                                                                                                                                                                                           |
| FCC ID                           | 2A226-TELETMH02                                                                                                                                                                                                                                                                                 |
| ISED ID                          | 27732-TELETMH02                                                                                                                                                                                                                                                                                 |
| Serial number                    | 202308REVC161150                                                                                                                                                                                                                                                                                |
| Hardware identity and/or version | Rev. C                                                                                                                                                                                                                                                                                          |
| Software identity and/or version | 1.3.0-Engdrop3-Gerrit7902_3-b253bde                                                                                                                                                                                                                                                             |
| Frequency Range                  | 2412 – 2462 MHz                                                                                                                                                                                                                                                                                 |
| Number of Channels               | 11 (7 channels for HT40)                                                                                                                                                                                                                                                                        |
| Operating Modes                  | 802.11 b/g/n (only 20 MHz Mode)                                                                                                                                                                                                                                                                 |
| Type of Modulation               | DSSS / OFDM                                                                                                                                                                                                                                                                                     |
| Conducted Output Power           | 802.11b: 0.0582 W<br>802.11g: 0.0337 W<br>802.11n HT20: 0.0348 W<br>802.11n HT40: 0.0359 W                                                                                                                                                                                                      |
| Antenna Connector                | Quad MiniFakra                                                                                                                                                                                                                                                                                  |
| Antenna Type                     | Molex Antenna, P/N: 2144500750<br>(P/N is for version with 750mm cable length, longer cables may also be used)<br><br>Antenna element LTE1: Rx/Tx<br>Antenna element LTE2: Rx Only<br>Antenna element WiFi/BT: Rx/Tx 2.4GHz WiFi/BT/BLE and 5GHz WiFi<br>Antenna element GNSS: Rx Only GNSS/GPS |
| Antenna Diversity Supported      | Not for WiFi                                                                                                                                                                                                                                                                                    |
| Smart Antennas Supported         | No                                                                                                                                                                                                                                                                                              |
| Power Source                     | External DC Supply (12-48V <sub>DC</sub> , supplied through MX23 connector)                                                                                                                                                                                                                     |
| Interfaces                       | MX23 Connector<br>HSD Connector (100TX Ethernet)                                                                                                                                                                                                                                                |

### Description of Test Item

The EUT is a telematics unit with radio modules for BT/BLE/WiFi and Mobile (WCDMA/LTE). Both radio modules are certified radio modules. The EUT also contains a GPS receiver.

This test report covers only additional radiated tests for the new antennas.

## 1.2 Normal test conditions

|                      |                                                    |
|----------------------|----------------------------------------------------|
| Temperature:         | 20 - 24 °C                                         |
| Relative humidity:   | 20 - 50 %                                          |
| Normal test voltage: | 24V DC (2x 12V lead acid batteries, Fiamm FG20451) |

The EUT was powered from two fully charged batteries during all tests.

The values are the limit registered during the test period.

## 1.3 Test Engineer

Frode Sveinsen

## 1.4 Antenna Requirement

|                                                          |                                         |                             |
|----------------------------------------------------------|-----------------------------------------|-----------------------------|
| Does the EUT have detachable antenna(s)?                 | <input checked="" type="checkbox"/> YES | <input type="checkbox"/> NO |
| If detachable, is the antenna connector(s) non-standard? | <input checked="" type="checkbox"/> YES | <input type="checkbox"/> NO |
| Antenna Connector: Quad MiniFakra                        |                                         |                             |

Requirement: FCC 15.203, 15.204

## 1.5 EUT Operating Modes

|                                |                                                                                                                                                                        |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description of 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. |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 1.6 Radio Modules

| Data for radio modules |          |                                                  |                                        |               |
|------------------------|----------|--------------------------------------------------|----------------------------------------|---------------|
| Manufacturer           | Model No | Identification                                   | Original Test Report                   | Technology    |
| Quectel                | AF20     | FCC ID: XMR202303AF20<br>IC: 10224A-202306AF20   | TA R2212A1318-R2V1                     | BT Classic    |
|                        |          |                                                  | TA R2212A1318-R1V1                     | BT Low Energy |
|                        |          |                                                  | TA R2212A1318-R1V1                     | WLAN          |
|                        |          |                                                  | TA R2212A1318-R3V1                     | UNII 2TX      |
|                        |          |                                                  | TA R2212A1318-R4V1                     | DFS           |
| Quectel                | AG35-NA  | FCC ID: XMR201905AG35NA<br>IC: 10224A-2019AG35NA | Sporton FG912203A<br>Sporton FG180602A | WCDMA         |
|                        |          |                                                  | Sporton FG912203B<br>Sporton FG180602B | LTE           |

GSM850/GSM1900 (2G) is disabled in this product.

## 1.7 Power Levels

|              | Bitrate      | Channels | Power Setting |
|--------------|--------------|----------|---------------|
| 802.11b      | 1M to 11M    | 1 to 11  | 16            |
| 802.11g      | 6M to 54M    | 1 to 11  | 15            |
| 802.11n HT20 | MCS0 to MCS7 | 1 to 10  | 15            |
|              | MCS0 to MCS7 | 11       | 14            |
| 802.11n HT40 | MCS0 to MCS7 | 3 to 8   | 15            |
|              | MCS0 to MCS7 | 9        | 11            |

Power levels were as shown above.

Levels with red text were reduced, all other levels are the default values from the module manufacturer.

## 1.8 Comments

All ports were populated during spurious emission measurements.

This test report covers only selected tests for new antennas, all other tests are covered by the original Test Report.

## 2 TEST REPORT SUMMARY

### 2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and ISSED RSS-247 Issue 3 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.

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

|                                                     |                                                     |
|-----------------------------------------------------|-----------------------------------------------------|
| <input checked="" type="checkbox"/> New Submission  | <input checked="" type="checkbox"/> Production Unit |
| <input type="checkbox"/> Class II Permissive Change | <input type="checkbox"/> Pre-production Unit        |
| DTS      Equipment Code                             | <input type="checkbox"/> Family Listing             |

### 2.2 Test Summary

| Name of test                           | FCC Part 15 reference               | RSS-247 Issue 3, 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                                     | N/T      |
| DTS Bandwidth                          | 15.247(a)(2)                        | 5.2 (1) (RSS-247)                               | 11.8 Option 2                             | N/T      |
| 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)                       | N/T      |
| Spurious Emissions (Antenna Conducted) | 15.247(c)                           | 5.5 (RSS-247)                                   | 6.7<br>11.11 (DTS)                        | N/T      |
| Spurious Emissions (Radiated)          | 15.247(c)<br>15.109(a)<br>15.209(a) | 3.3 (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 Output Power

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 3, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

| Carrier Frequency | Field Strength, dBμV/m @3m |         |            |         |           |           |           |           |
|-------------------|----------------------------|---------|------------|---------|-----------|-----------|-----------|-----------|
|                   | 802.11b 1M                 | 802.11b | 802.11g 6M | 802.11g | 802.11n   | 802.11n   | 802.11n   | 802.11n   |
|                   | 1M                         | 11M     | 6M         | 54M     | HT20 MCS0 | HT20 MCS7 | HT40 MCS0 | HT40 MCS7 |
| 2412 MHz          | 109.7                      | 109.5   | 108.3      | 107.2   | 108.1     | 105.3     |           |           |
| 2422 MHz          |                            |         |            |         |           |           | 104.7     | 102.4     |
| 2437 MHz          | 111.4                      | 111.2   | 109.2      | 108.0   |           |           | 108.4     | 106.2     |
| 2452 MHz          |                            |         |            |         |           |           | 107.6     | 104.5     |
| 2462 MHz          | 111.7                      | 111.6   | 109.9      | 108.7   | 109.7     | 107.4     |           |           |
| Carrier Frequency | Peak EIRP, dBm             |         |            |         |           |           |           |           |
|                   | 802.11b 1M                 | 802.11b | 802.11g 6M | 802.11g | 802.11n   | 802.11n   | 802.11n   | 802.11n   |
|                   | 1M                         | 11M     | 6M         | 54M     | HT20 MCS0 | HT20 MCS7 | HT40 MCS0 | HT40 MCS7 |
| 2412 MHz          | 14.4                       | 14.3    | 13.1       | 11.9    | 12.9      | 10.0      |           |           |
| 2422 MHz          |                            |         |            |         |           |           | 9.4       | 7.2       |
| 2437 MHz          | 16.2                       | 16.0    | 14.0       | 12.8    |           |           | 13.2      | 11.0      |
| 2452 MHz          |                            |         |            |         |           |           | 12.4      | 9.2       |
| 2462 MHz          | 16.4                       | 16.3    | 14.7       | 13.5    | 14.5      | 12.2      |           |           |

Output Power reported is Maximum Average Power measured radiated.

The Integrated Band Power Method with RMS detector and Trace Averaging (SA1) was used, Ref ANSI C63.10-2013.

Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

Conducted Power = Radiated Power – Declared Antenna Gain

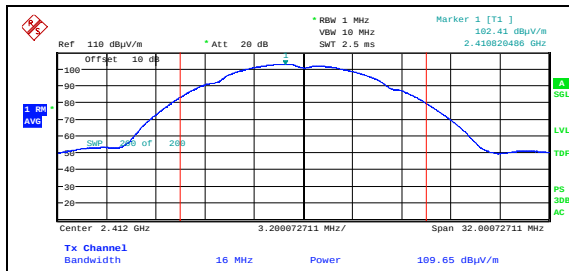
See attached plots.

#### Requirements:

The maximum peak output power shall not exceed the following limits:

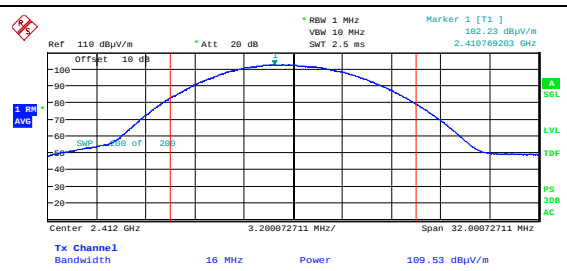
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt (30 dBm)

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.



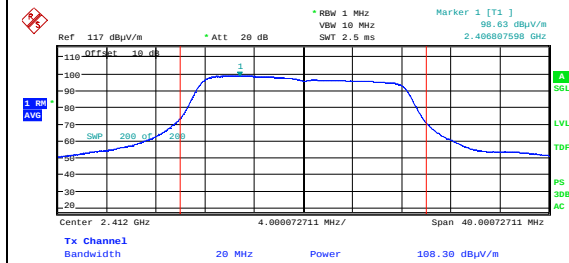
Date: 23.AUG.2023 14:58:45

Maximum Field Strength, 2412 MHz, 802.11b 1M



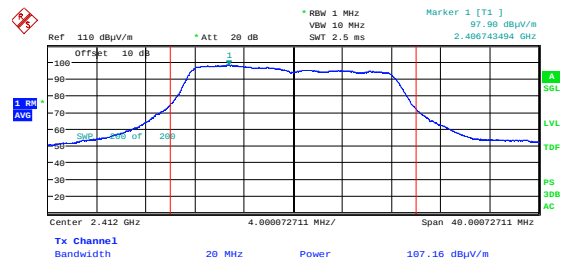
Date: 23.AUG.2023 14:53:55

Maximum Field Strength, 2412 MHz, 802.11b 11M



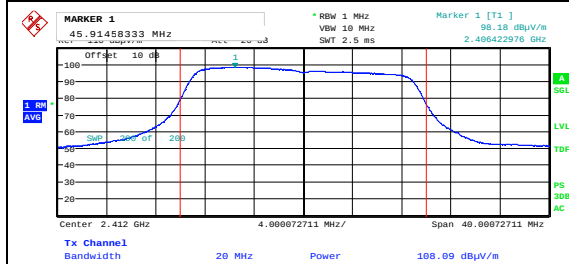
Date: 23.AUG.2023 14:09:17

Maximum Field Strength, 2412 MHz, 802.11g 6M



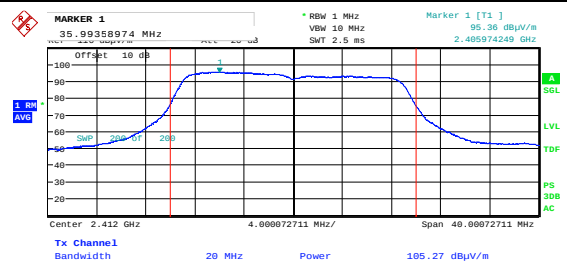
Date: 23.AUG.2023 14:27:48

Maximum Field Strength, 2412 MHz, 802.11g 54M



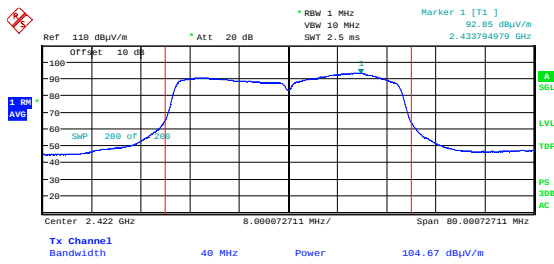
Date: 23.AUG.2023 15:29:34

Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS0



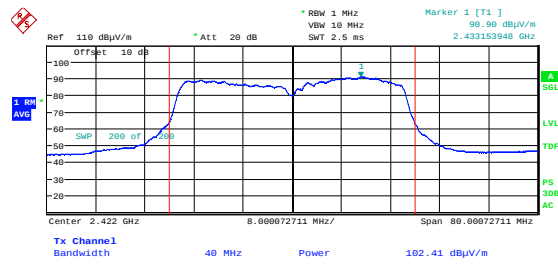
Date: 23.AUG.2023 15:21:23

Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS7



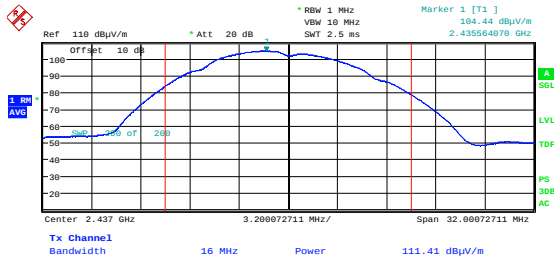
Date: 23.AUG.2023 15:58:58

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS0



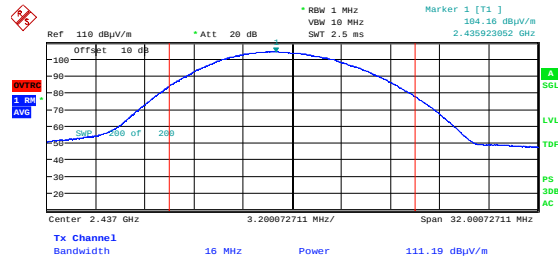
Date: 23.AUG.2023 16:01:35

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS7



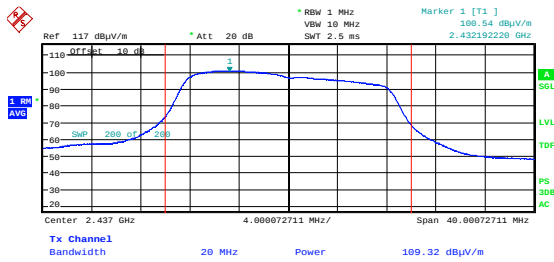
Date: 23.AUG.2023 14:34:32

Maximum Field Strength, 2437 MHz, 802.11b 1M



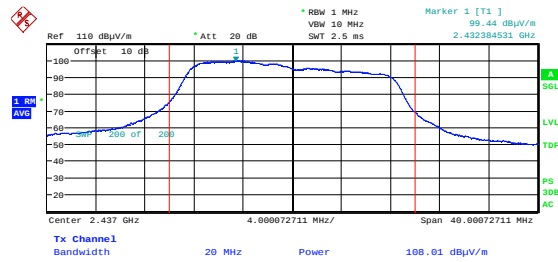
Date: 23.AUG.2023 14:36:19

Maximum Field Strength, 2437 MHz, 802.11b 11M



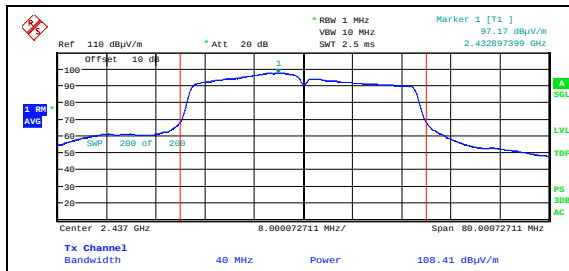
Date: 23.AUG.2023 14:03:16

Maximum Field Strength, 2437 MHz, 802.11g 6M



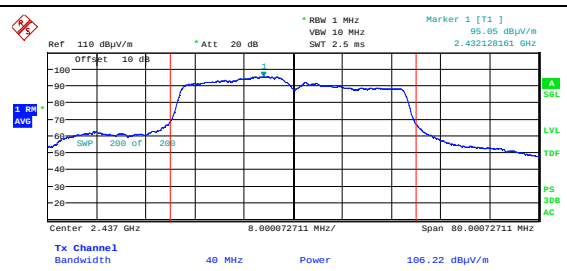
Date: 23.AUG.2023 14:25:49

Maximum Field Strength, 2437 MHz, 802.11g 54M



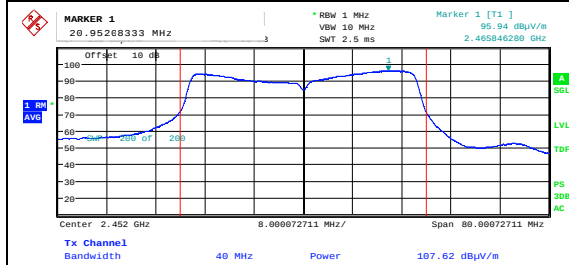
Date: 23.AUG.2023 16:14:01

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS0



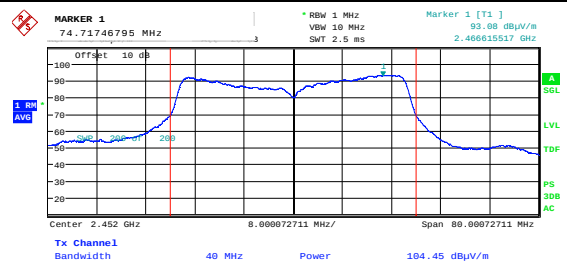
Date: 23.AUG.2023 16:06:55

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS7



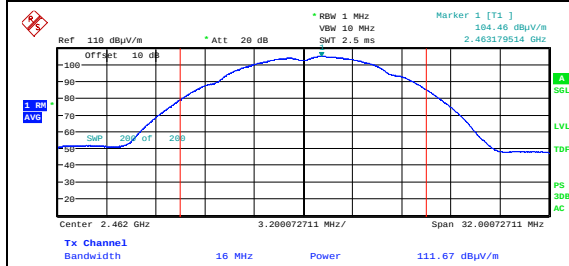
Date: 23.AUG.2023 15:58:36

Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS0



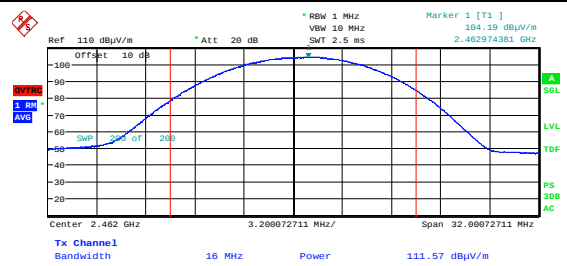
Date: 23.AUG.2023 15:44:06

Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS7



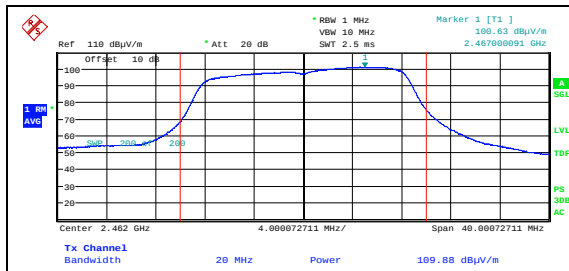
Date: 23.AUG.2023 14:45:06

Maximum Field Strength, 2462 MHz, 802.11b 1M



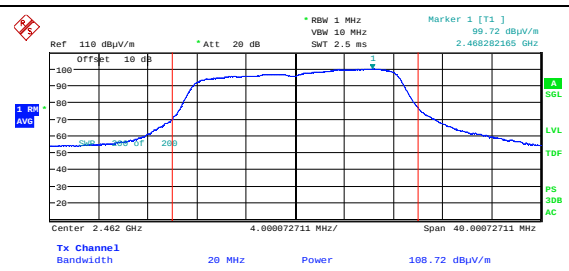
Date: 23.AUG.2023 14:41:14

Maximum Field Strength, 2462 MHz, 802.11b 11M



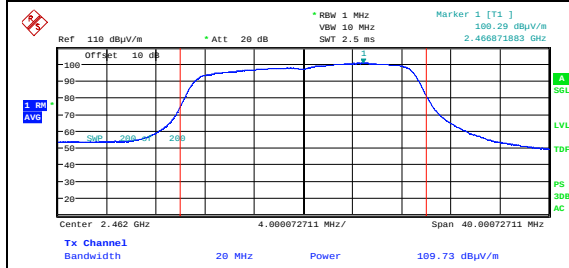
Date: 23.AUG.2023 14:20:45

Maximum Field Strength, 2462 MHz, 802.11g 6M



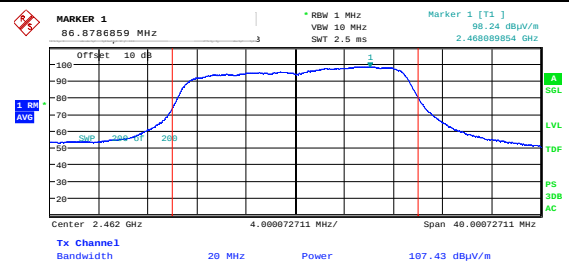
Date: 23.AUG.2023 14:23:47

Maximum Field Strength, 2462 MHz, 802.11g 54M



Date: 23.AUG.2023 15:03:56

Maximum Field Strength, 2462 MHz, 802.11n HT20 MCS0



Date: 23.AUG.2023 15:18:24

Maximum Field Strength, 2462 MHz, 802.11n HT20 MCS7

### 3.2 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED Canada 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)                           | ISSED (MHz)        | FCC (GHz)                            | ISSED (GHz)       |
|-------------------------------------|--------------------|--------------------------------------|-------------------|
| 0.090-0.110                         |                    | <b>0.96-1.24</b><br><b>1.3-1.427</b> | <b>0.96-1.427</b> |
| 0.495-0.505                         |                    | 1.435-1.6265                         |                   |
| 2.1735-2.1905                       |                    | 1.6455-1.6465                        |                   |
|                                     | <b>3.020-3.026</b> | 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                            |                   |
|                                     | <b>5.677-5.683</b> | 2.4835-2.5                           |                   |
| 6.215-6.218                         |                    | <b>2.69-2.9</b>                      | <b>2.655-2.9</b>  |
| 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                         |                    | <b>3.6-4.4</b>                       | <b>3.5-4.4</b>    |
| 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                            |                   |
| <b>108-121.94</b><br><b>123-138</b> | <b>108-138</b>     | 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 ISSED, all other frequencies are common.

### 3.3 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

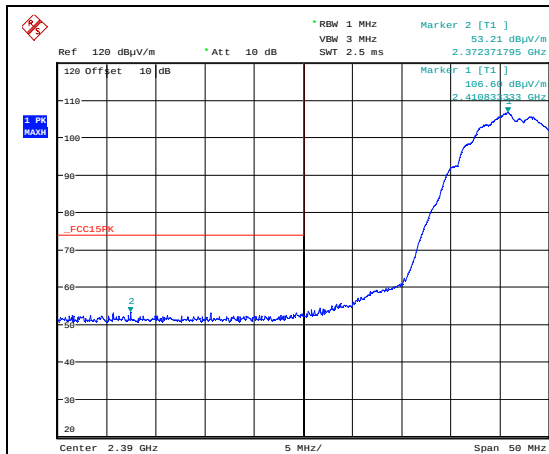
Test Results: Complies

#### Measurement Data:

| Carrier Freq.<br>(MHz) | Modulation and Bitrate | Measured field strength (dBμV/m) |         | Limit (dB) |    | Margin (dB) |      |
|------------------------|------------------------|----------------------------------|---------|------------|----|-------------|------|
|                        |                        | Peak                             | Average | Pk         | Av | Pk          | Av   |
| 2412                   | 11b 1M                 | 53.2                             | 41.4    | 74         | 54 | 20.8        | 12.6 |
|                        | 11b 11M                | 53.3                             | 41.5    | 74         | 54 | 20.7        | 12.5 |
|                        | 11g 6M                 | 57.5                             | 45.3    | 74         | 54 | 16.5        | 8.7  |
|                        | 11g 54M                | 65.2                             | 45.6    | 74         | 54 | 8.8         | 8.4  |
|                        | 11n HT20 MCS0          | 59.1                             | 46.0    | 74         | 54 | 14.9        | 8.0  |
|                        | 11n HT20 MCS7          | 62.6                             | 46.1    | 74         | 54 | 11.4        | 7.9  |
| 2422                   | 11n HT40 MCS0          | 57.6                             | 43.9    | 74         | 54 | 16.4        | 10.1 |
|                        | 11n HT40 MCS7          | 57.4                             | 44.0    | 74         | 54 | 16.6        | 10.0 |
| 2452                   | 11n HT40 MCS0          | 69.1                             | 52.0    | 74         | 54 | 4.9         | 2.0  |
|                        | 11n HT40 MCS7          | 66.5                             | 50.8    | 74         | 54 | 7.5         | 3.2  |
| 2462                   | 11b 1M                 | 55.5                             | 43.3    | 74         | 54 | 18.5        | 10.7 |
|                        | 11b 11M                | 54.9                             | 43.9    | 74         | 54 | 19.1        | 10.1 |
|                        | 11g 6M                 | 59.9                             | 46.4    | 74         | 54 | 14.1        | 7.6  |
|                        | 11g 54M                | 71.4                             | 51.6    | 74         | 54 | 2.6         | 2.4  |
|                        | 11n HT20 MCS0          | 60.5                             | 46.9    | 74         | 54 | 13.5        | 7.1  |
|                        | 11n HT20 MCS7          | 69.7                             | 49.2    | 74         | 54 | 4.3         | 4.8  |

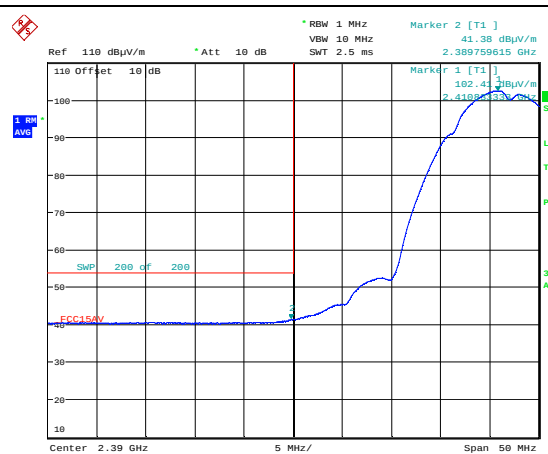
Average values were measured using trace averaging (SA1), Ref. ANSI C63.10-2013 (Duty Cycle ≈100%).

See attached plots.



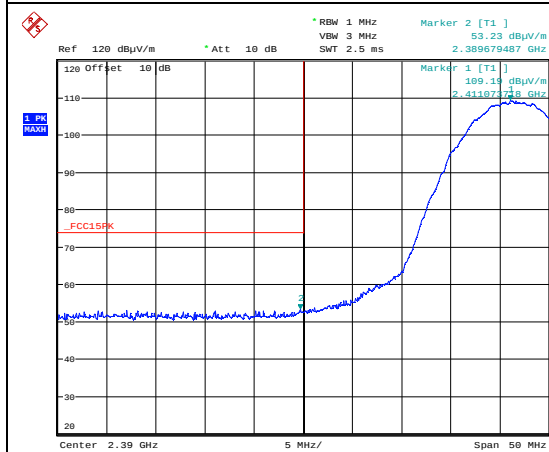
Date: 23.AUG.2023 14:59:31

Lower Band Edge, 2412 MHz, 802.11b 1M, Peak



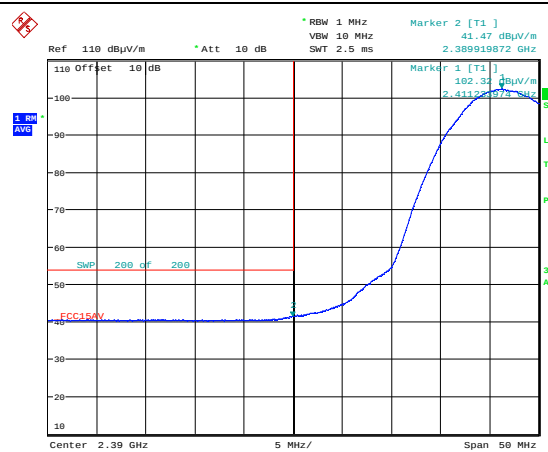
Date: 23.AUG.2023 14:59:52

Lower Band Edge, 2412 MHz, 802.11b 1M, Average



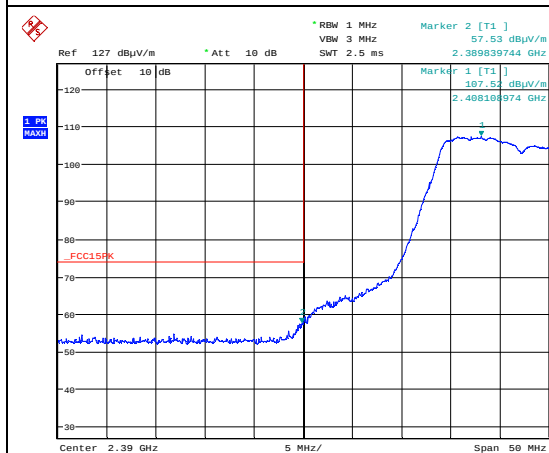
Date: 23.AUG.2023 14:54:41

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



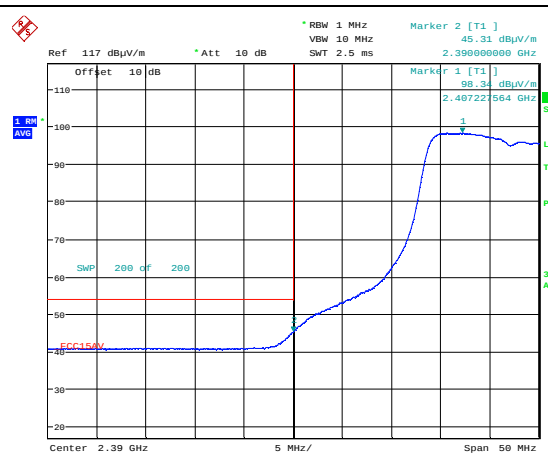
Date: 23.AUG.2023 14:55:03

Lower Band Edge, 2412 MHz, 802.11b 11M, Average



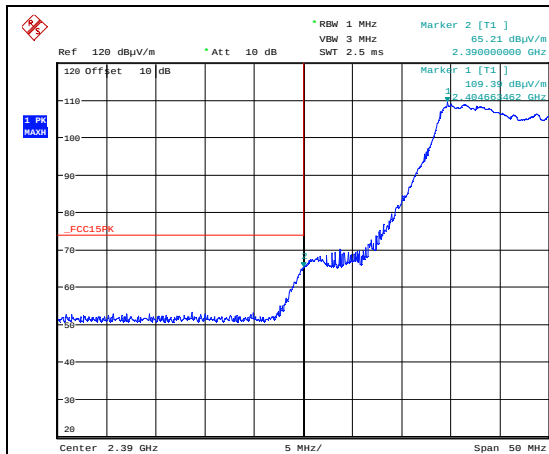
Date: 23.AUG.2023 14:12:38

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



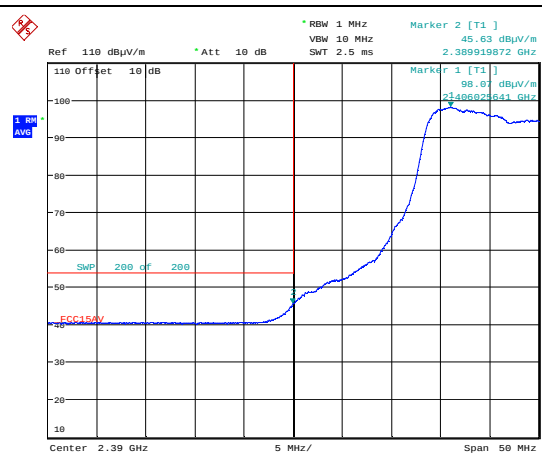
Date: 23.AUG.2023 14:13:23

Lower Band Edge, 2412 MHz, 802.11g 6M, Average



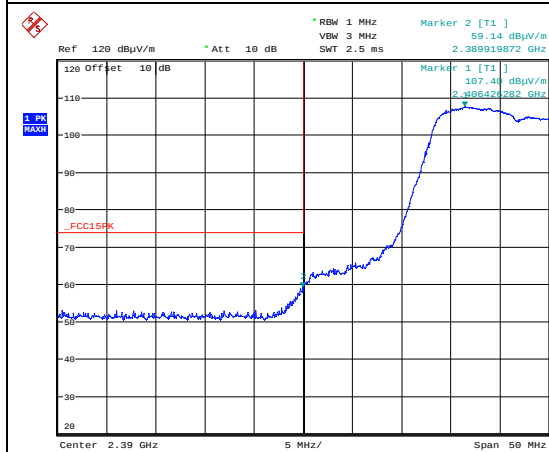
Date: 23.AUG.2023 14:29:51

Lower Band Edge, 2412 MHz, 802.11g 54M, Peak



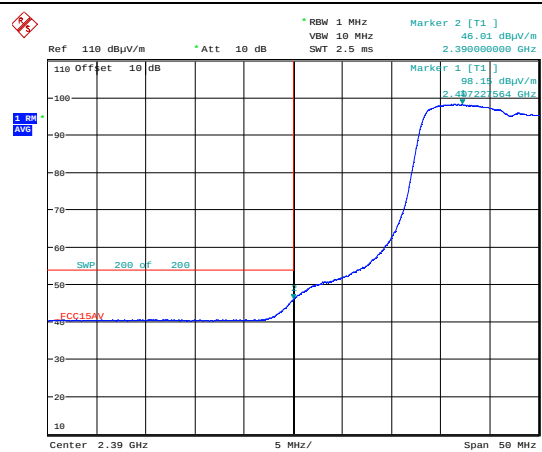
Date: 23.AUG.2023 14:30:33

Lower Band Edge, 2412 MHz, 802.11g 54M, Average



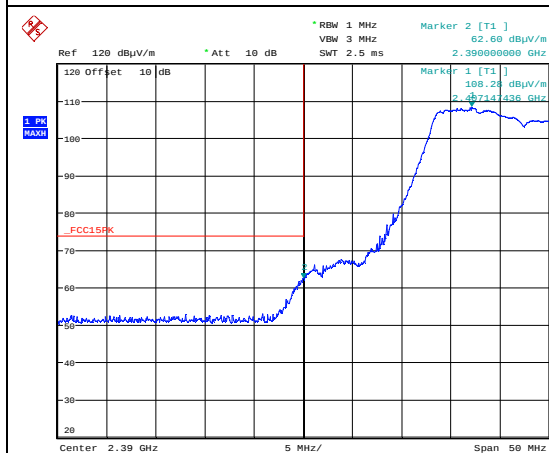
Date: 23.AUG.2023 15:30:22

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS0, Peak



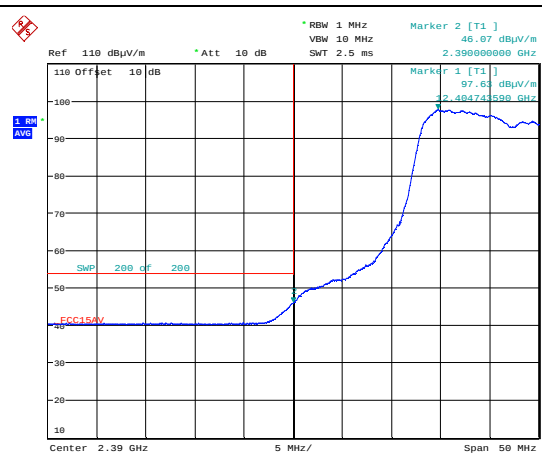
Date: 23.AUG.2023 15:30:45

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS0, Average



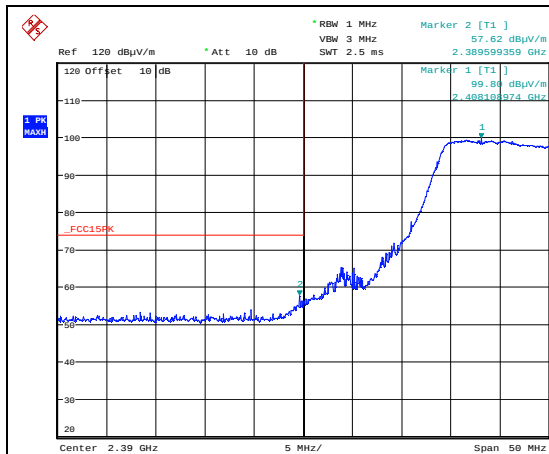
Date: 23.AUG.2023 15:26:11

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS7, Peak



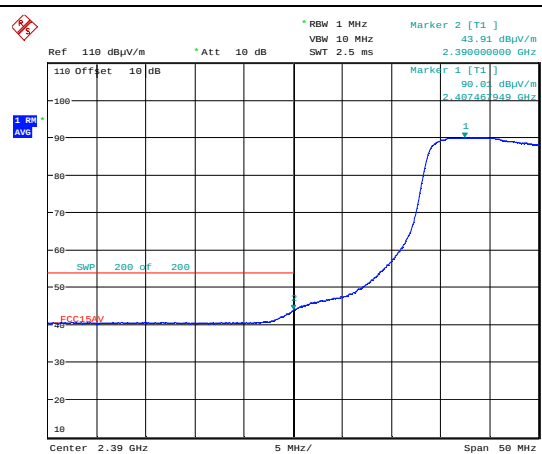
Date: 23.AUG.2023 15:27:07

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS7, Average



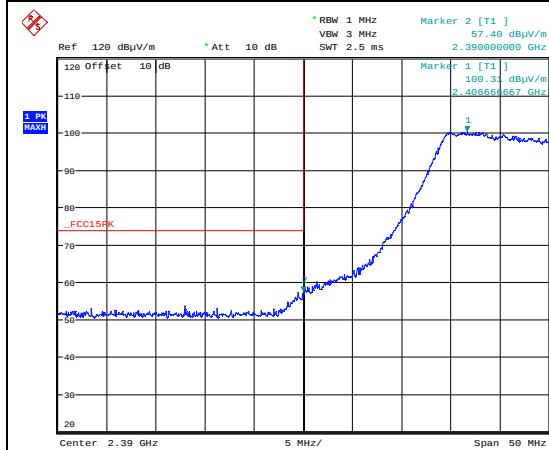
Date: 23.AUG.2023 15:59:47

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Peak



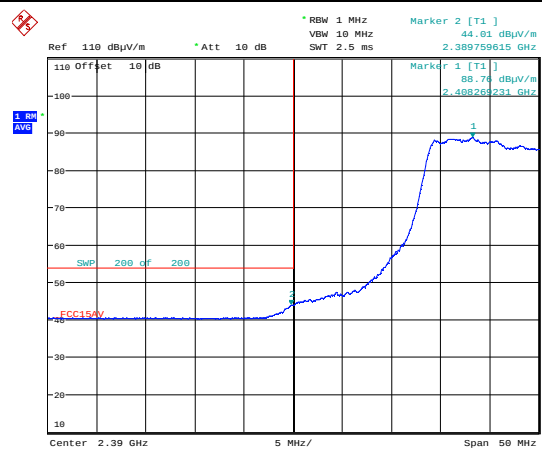
Date: 23.AUG.2023 16:00:09

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Average



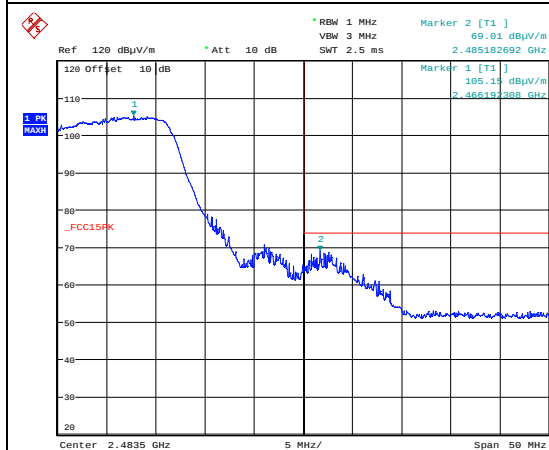
Date: 23.AUG.2023 16:02:21

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Peak



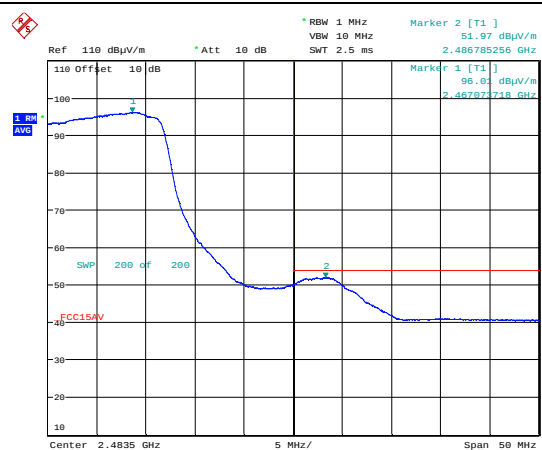
Date: 23.AUG.2023 16:02:43

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Average



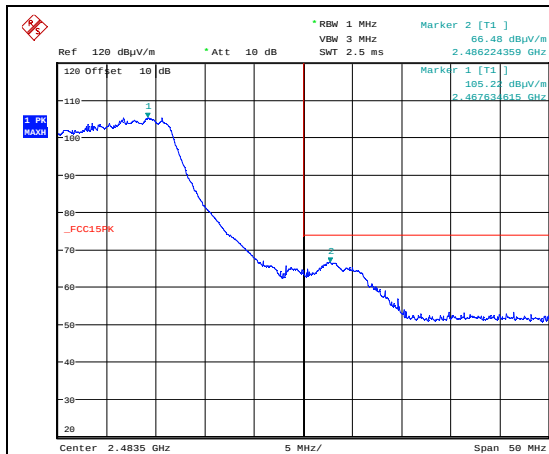
Date: 23.AUG.2023 15:49:37

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Peak PL12



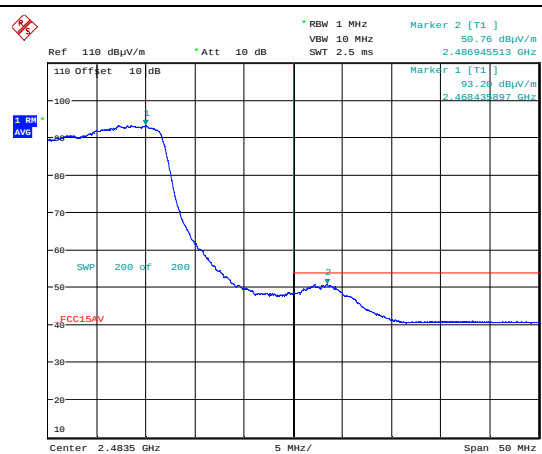
Date: 23.AUG.2023 15:46:59

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Average PL12



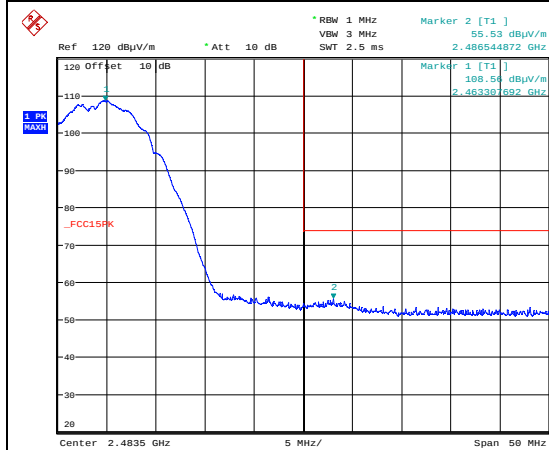
Date: 23.AUG.2023 15:43:05

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Peak PL11



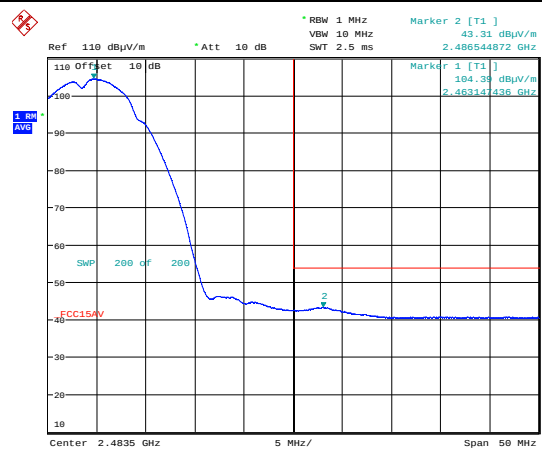
Date: 23.AUG.2023 15:42:15

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Average PL11



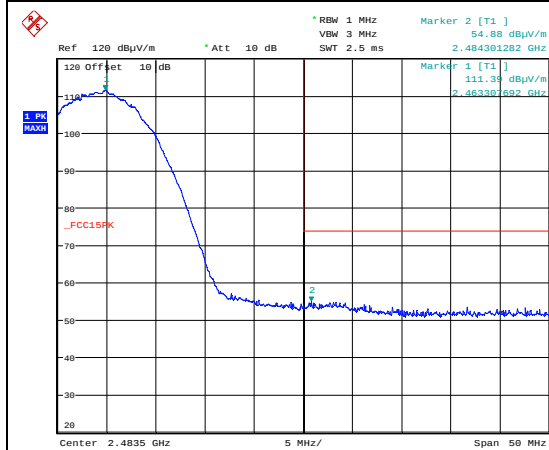
Date: 23.AUG.2023 14:46:33

Upper Band Edge, 2462 MHz, 802.11b 1M, Peak



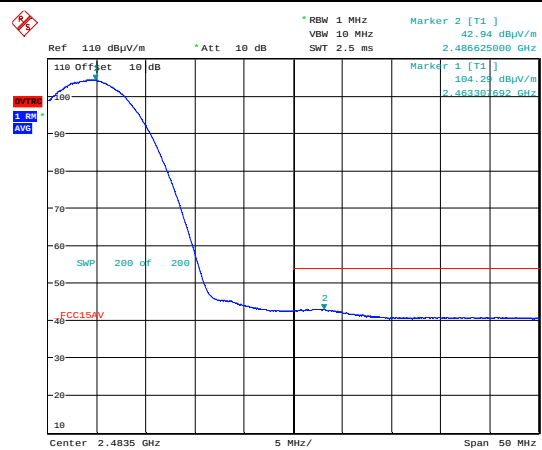
Date: 23.AUG.2023 14:48:15

Upper Band Edge, 2462 MHz, 802.11b 1M, Average



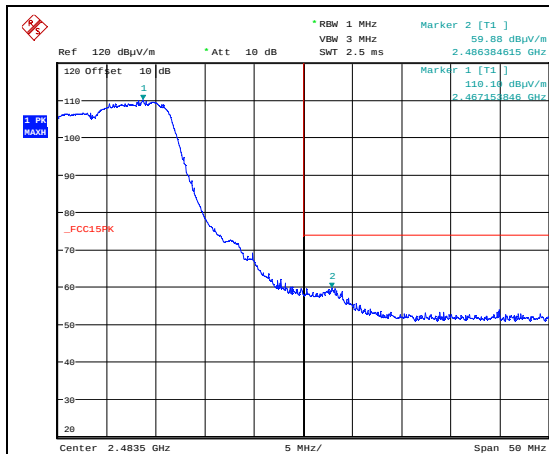
Date: 23.AUG.2023 14:42:12

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



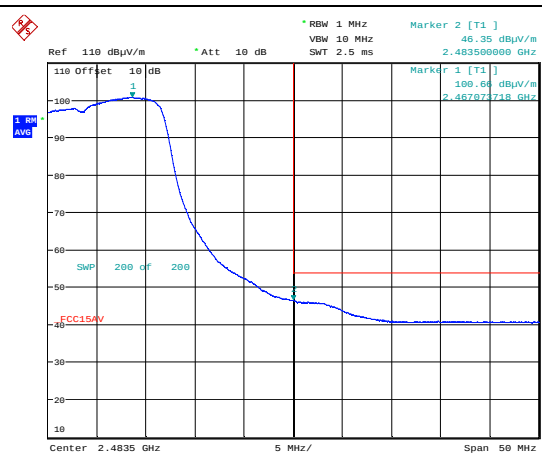
Date: 23.AUG.2023 14:42:44

Upper Band Edge, 2462 MHz, 802.11b 11M, Average



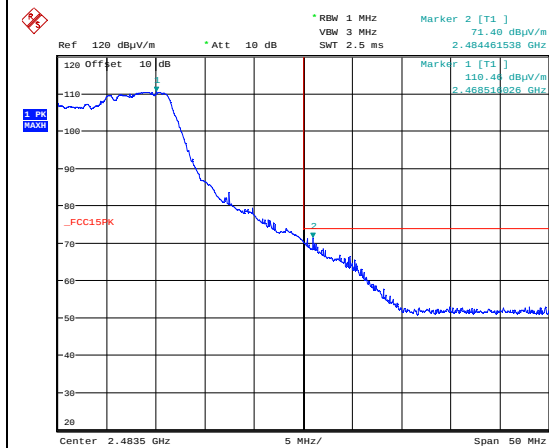
Date: 23.AUG.2023 14:19:52

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



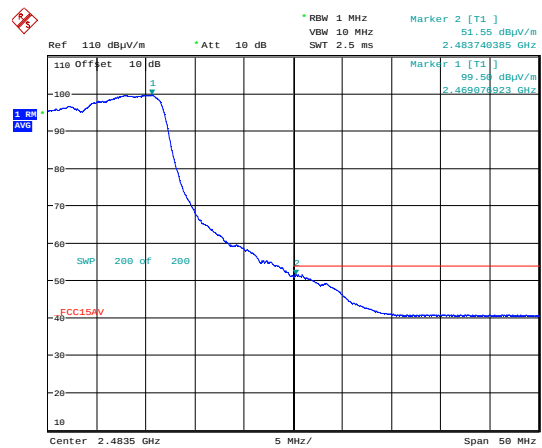
Date: 23.AUG.2023 14:19:04

Upper Band Edge, 2462 MHz, 802.11g 6M, Average



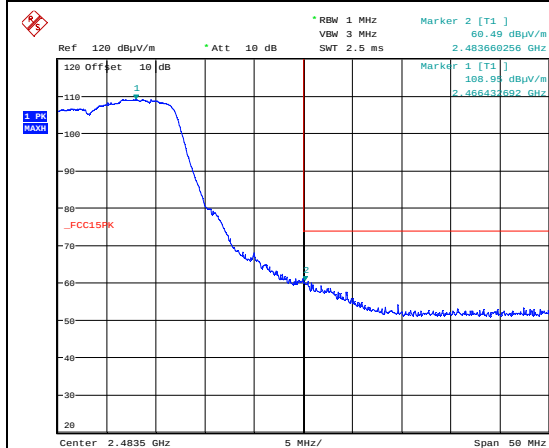
Date: 23.AUG.2023 14:22:50

Upper Band Edge, 2462 MHz, 802.11g 54M, Peak



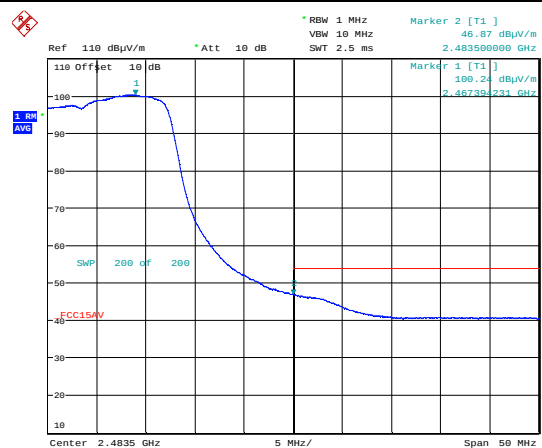
Date: 23.AUG.2023 14:22:00

Upper Band Edge, 2462 MHz, 802.11g 54M, Average



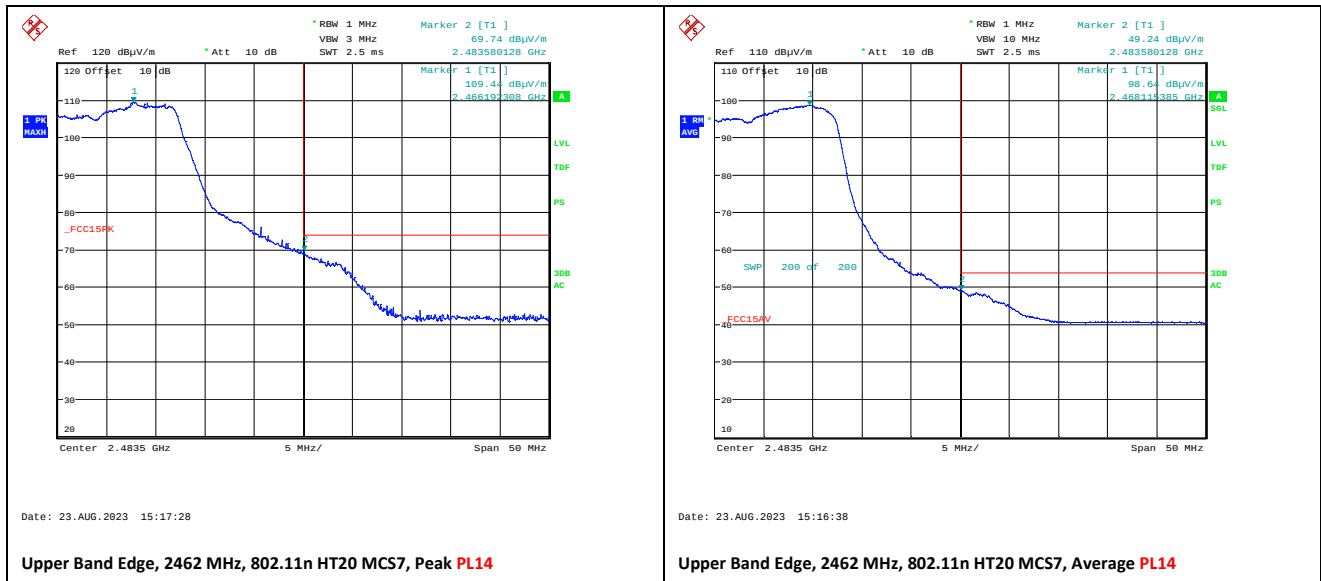
Date: 23.AUG.2023 15:04:42

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS0, Peak



Date: 23.AUG.2023 15:05:02

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS0, Average



### 3.4 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: Peak Detector for Pre-scan (Measurements with Quasi-Peak Detector)

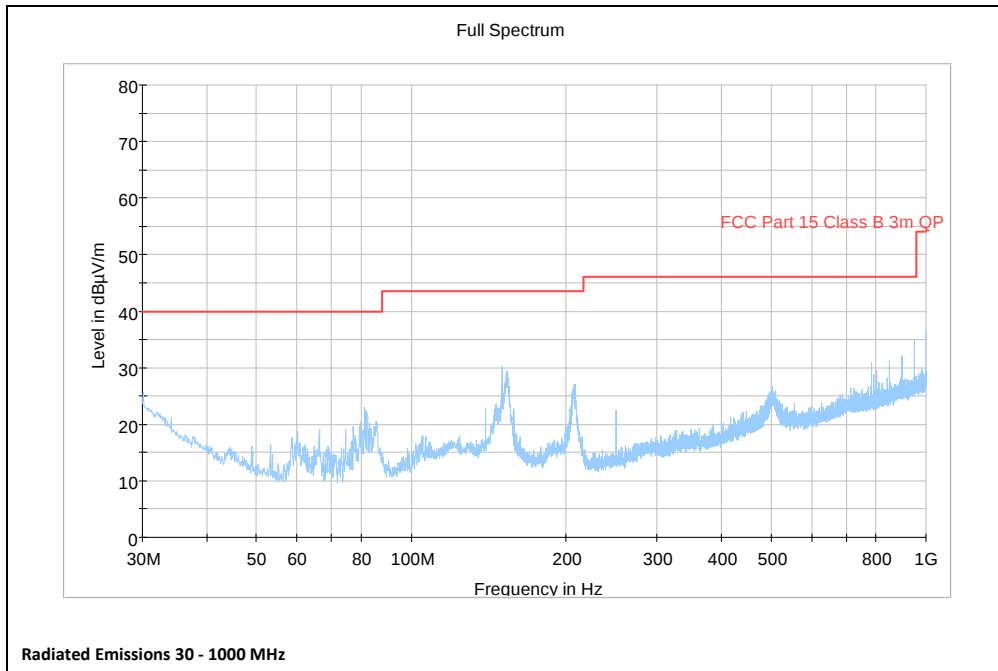
Measuring distance 3m

| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| ---             | ---                | ---            | ---         | ---             | ---             | ---         |     | ---           | ---          |

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                        |             |



### 3.5 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)  
1m (18 – 26 GHz)

RBW/VBW = 1MHz/3MHz

| Carrier Frequency (MHz) | Measured Frequency (GHz) | Modulation and Bitrate | Measured Emissions (dBμV/m) |         | Limit (dBμV/m) |         | Margin (dB) |         |
|-------------------------|--------------------------|------------------------|-----------------------------|---------|----------------|---------|-------------|---------|
|                         |                          |                        | Peak                        | Average | Peak           | Average | Peak        | Average |
| Any                     | Any                      | Any                    | < 56                        | < 46    | 74             | 54      | >18         | >8      |

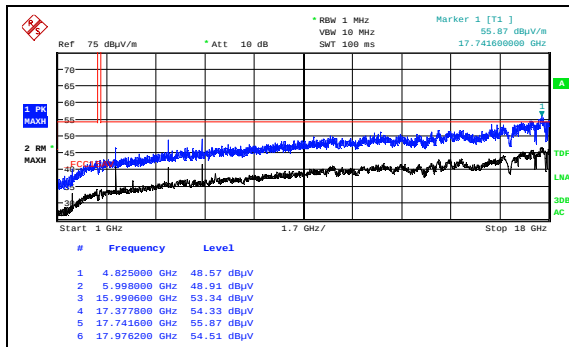
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz.

Antenna factor, PreAmp Gain and Cable Loss are included in spectrum analyzer "Transducer factor".

See plots.

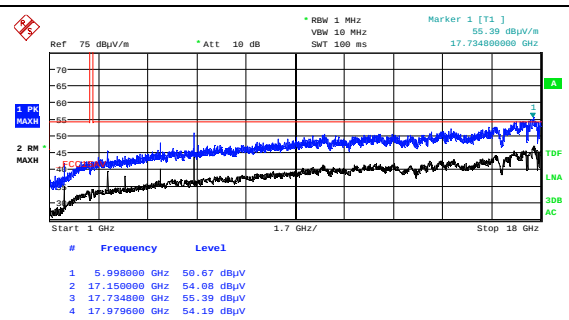
#### Requirements/Limit

|            |                                                                  |               |
|------------|------------------------------------------------------------------|---------------|
| 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   |



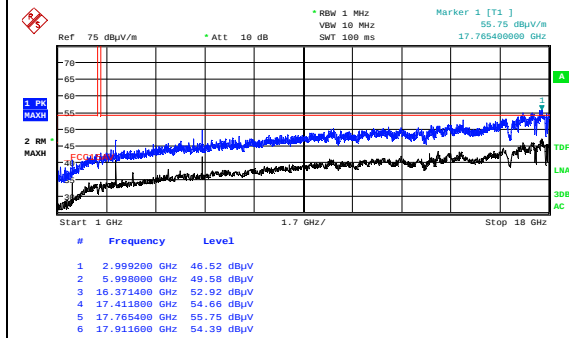
Date: 25.AUG.2023 14:45:25

#### Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11b 11M, VP



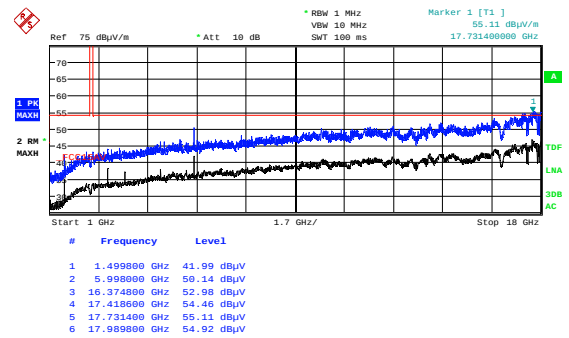
Date: 25.AUG.2023 14:47:22

#### HP



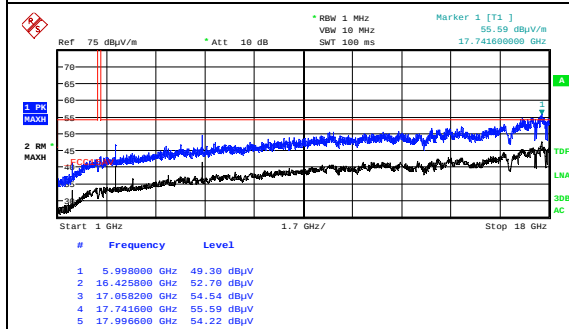
Date: 25.AUG.2023 14:20:02

#### Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11g 54M, VP



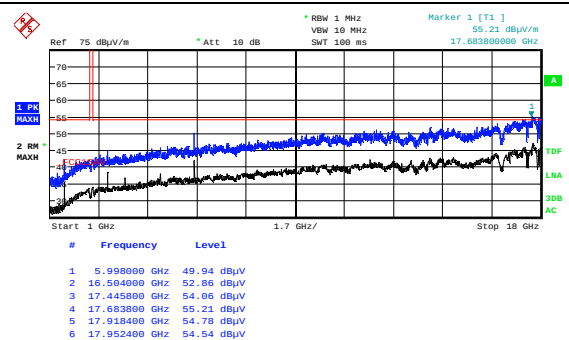
Date: 25.AUG.2023 14:21:59

#### HP



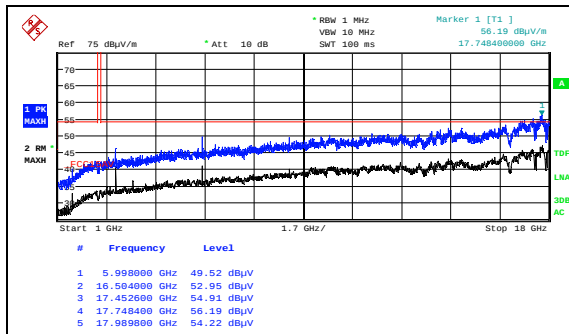
Date: 25.AUG.2023 15:05:45

#### Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11n HT20 MCS7, VP



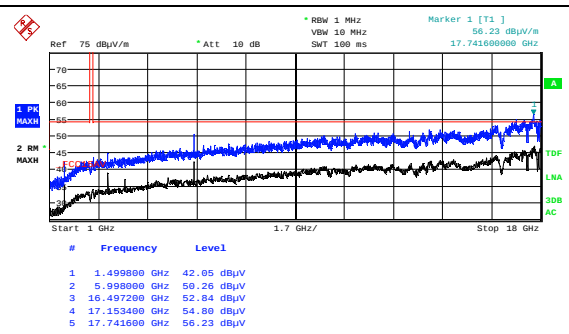
Date: 25.AUG.2023 15:07:42

#### HP



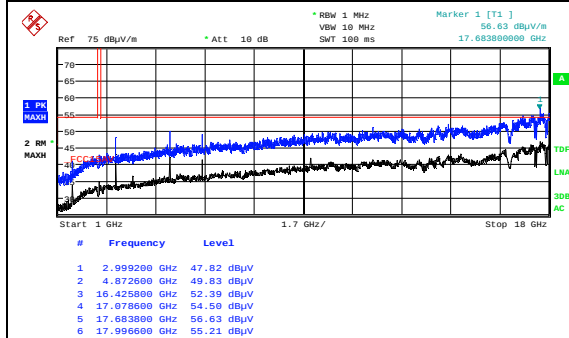
Date: 25.AUG.2023 15:28:24

#### Radiated Emissions 1 - 18 GHz, 2422 MHz, 802.11n HT40 MCS7, VP



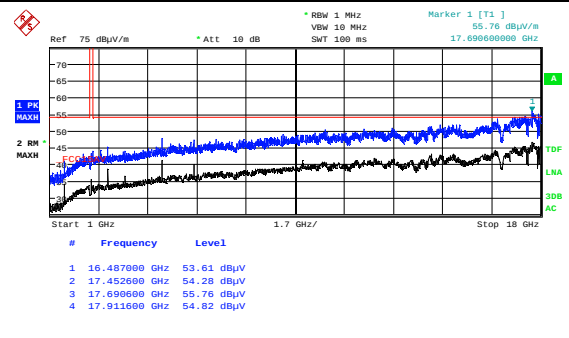
Date: 25.AUG.2023 15:30:21

#### HP



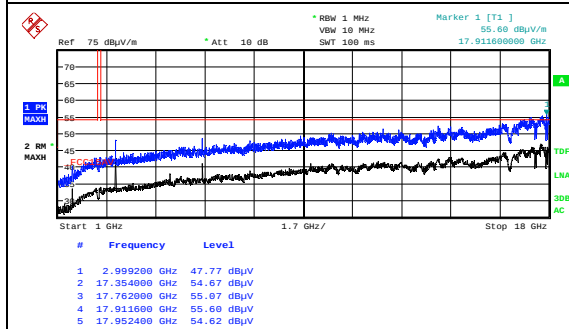
Date: 25.AUG.2023 14:38:54

#### Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11b 11M, VP



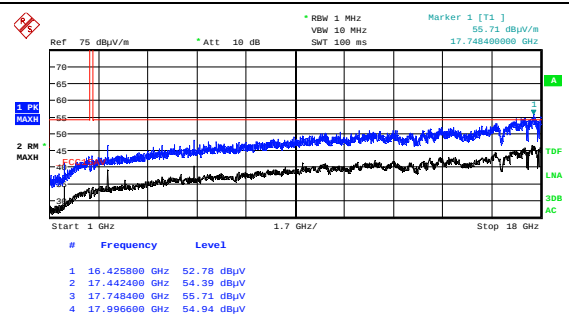
Date: 25.AUG.2023 14:41:07

#### HP



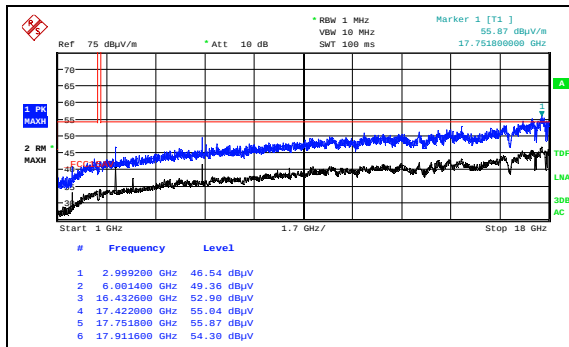
Date: 25.AUG.2023 14:06:42

#### Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11g 54M, VP



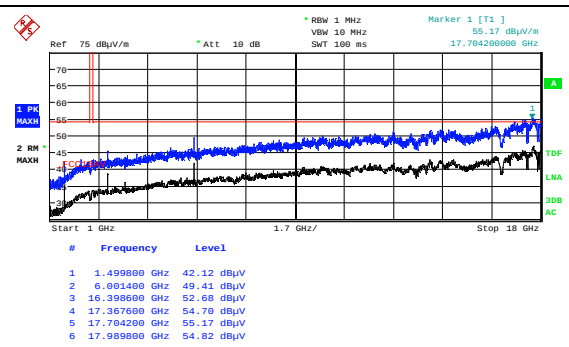
Date: 25.AUG.2023 14:12:36

#### HP



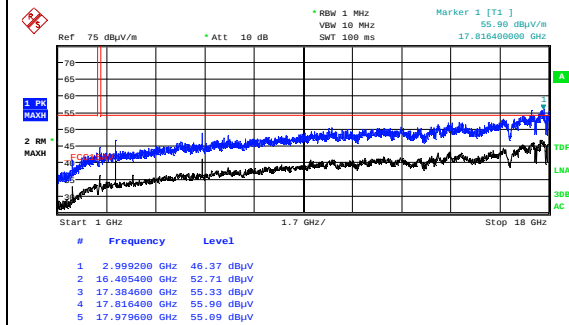
Date: 25.AUG.2023 14:58:19

#### Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT20 MCS7, VP



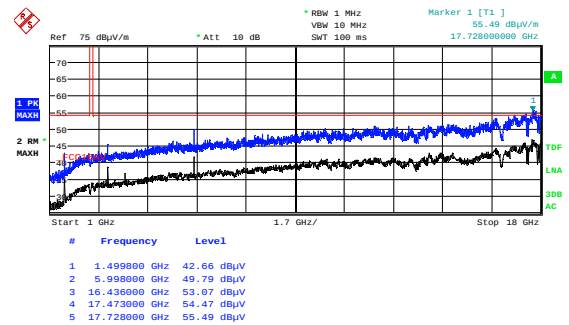
Date: 25.AUG.2023 15:00:16

#### HP



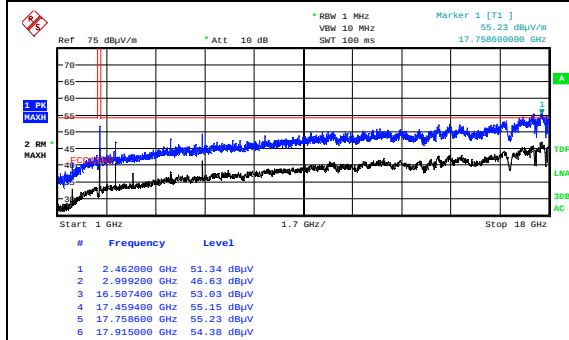
Date: 25.AUG.2023 15:20:53

#### Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT40 MCS7, VP



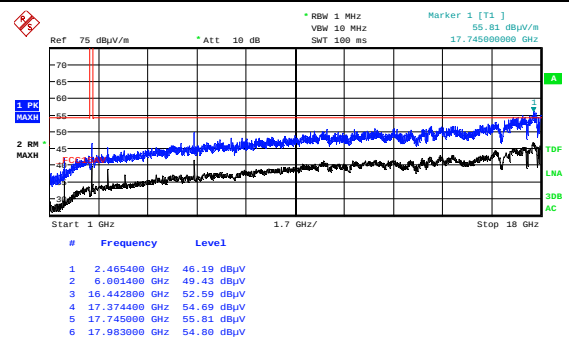
Date: 25.AUG.2023 15:22:49

#### HP



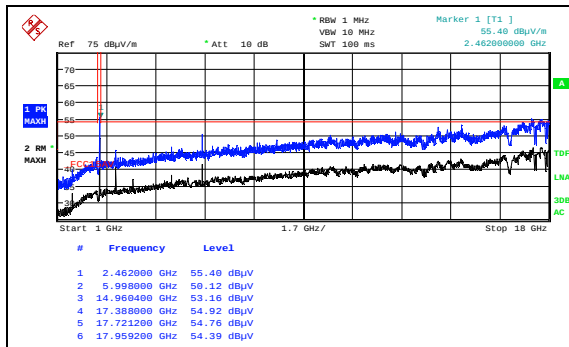
Date: 25.AUG.2023 15:33:42

#### Radiated Emissions 1 - 18 GHz, 2452 MHz, 802.11n HT40 MCS7, VP



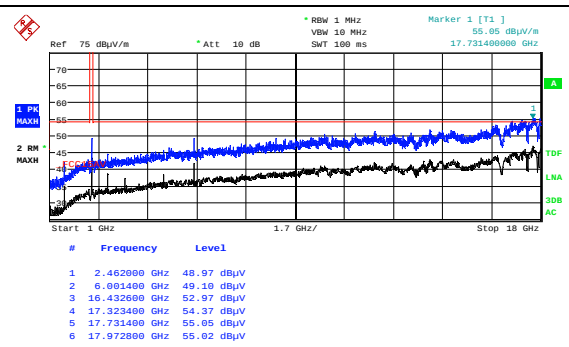
Date: 25.AUG.2023 15:35:39

#### HP



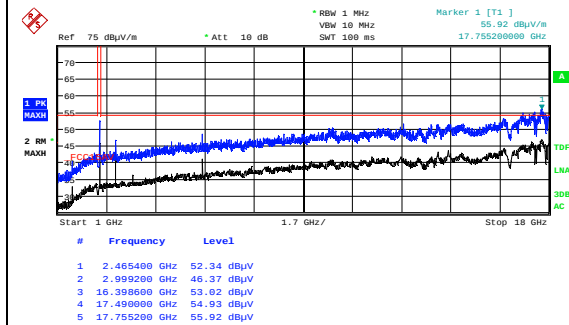
Date: 25.AUG.2023 14:52:41

#### Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11b 11M, VP



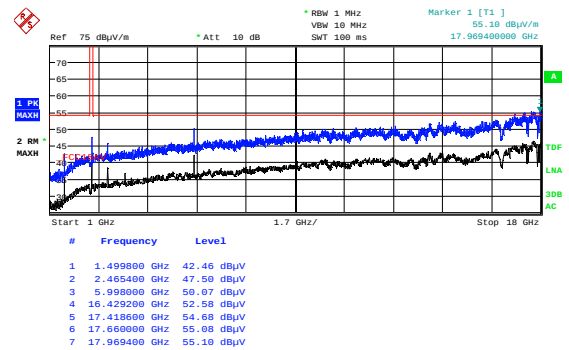
Date: 25.AUG.2023 14:54:38

#### HP



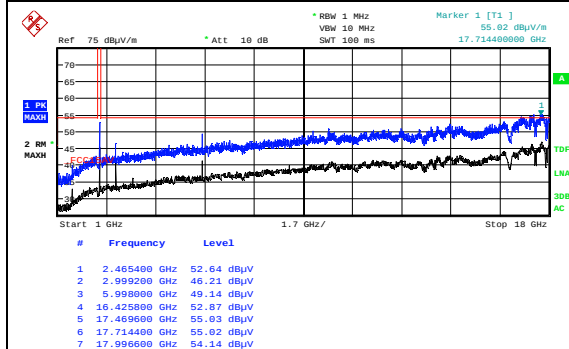
Date: 25.AUG.2023 14:25:45

#### Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11g 54M, VP



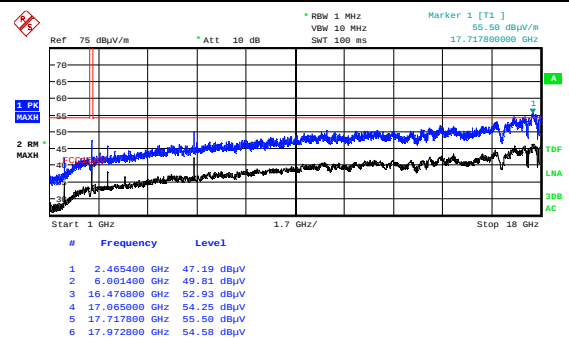
Date: 25.AUG.2023 14:27:41

#### HP



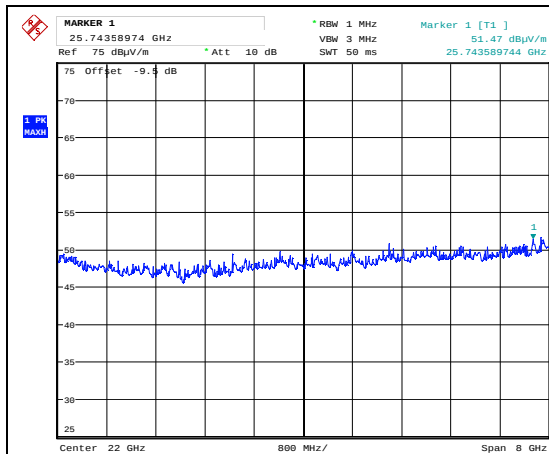
Date: 25.AUG.2023 15:11:37

#### Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11n HT20 MCS7, VP



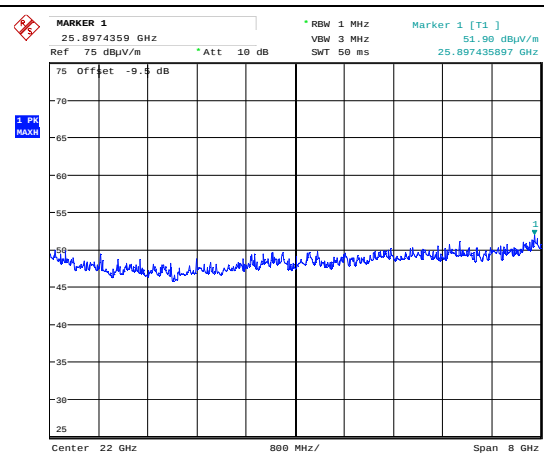
Date: 25.AUG.2023 15:13:34

#### HP



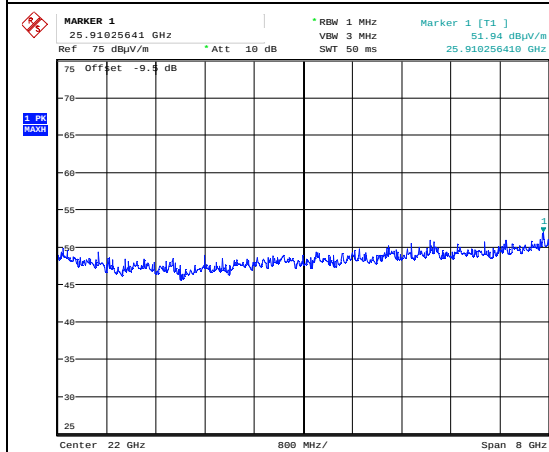
Date: 28.AUG.2023 15:43:29

Emissions 18 - 26 GHz, 2412 MHz, 802.11g 54M, VP, @1m



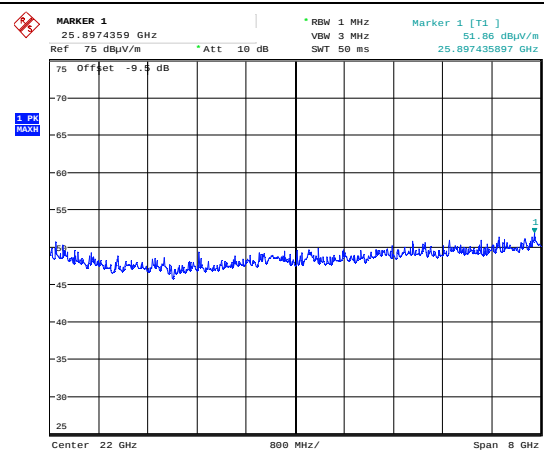
Date: 28.AUG.2023 15:41:15

HP



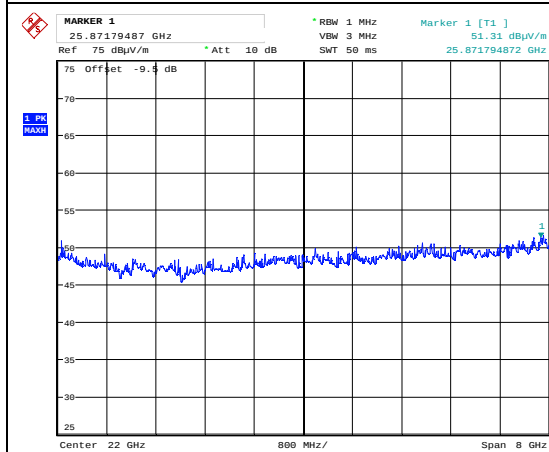
Date: 28.AUG.2023 15:19:49

Emissions 18 - 26 GHz, 2437 MHz, 802.11b 11M, VP, @1m



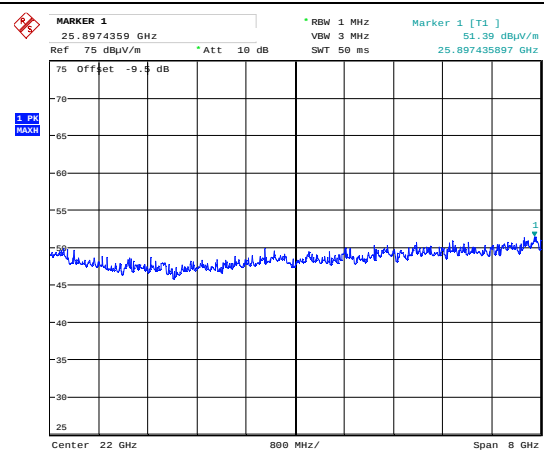
Date: 28.AUG.2023 15:17:44

HP



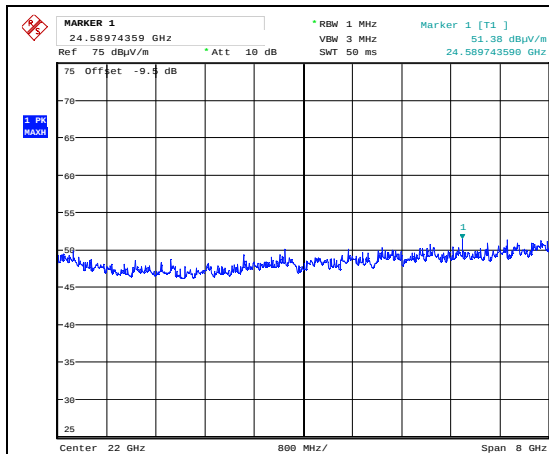
Date: 28.AUG.2023 15:23:05

Emissions 18 - 26 GHz, 2437 MHz, 802.11g 54M, VP, @1m



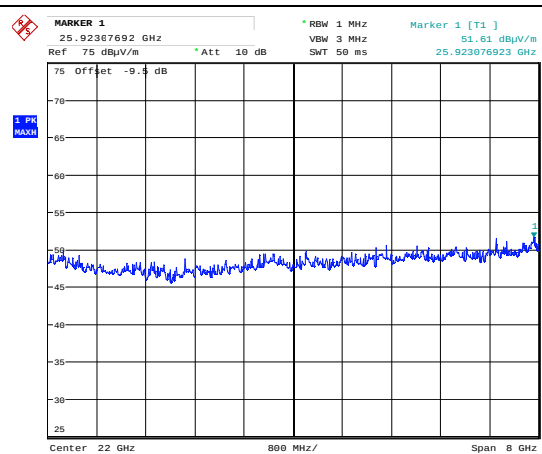
Date: 28.AUG.2023 15:26:26

HP



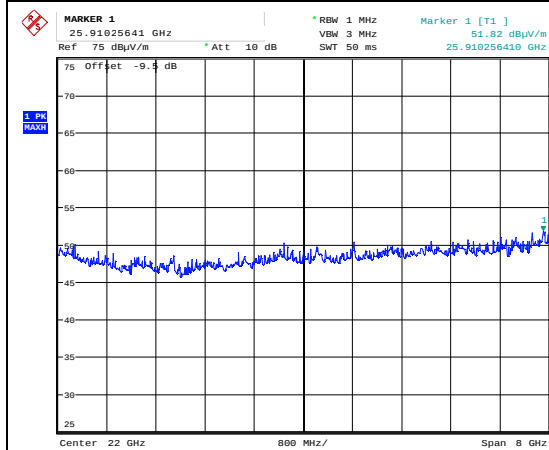
Date: 28.AUG.2023 15:31:19

Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT20 MCS0, VP, @1m



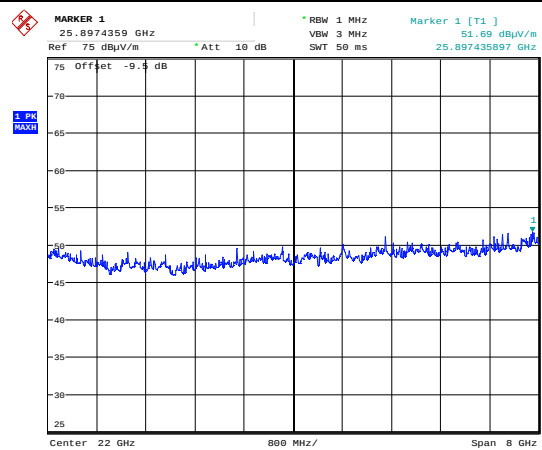
Date: 28.AUG.2023 15:29:15

HP



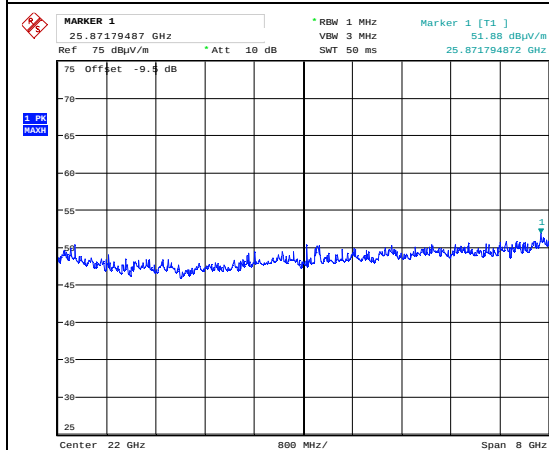
Date: 28.AUG.2023 15:34:40

Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT40 MCS0, VP, @1m



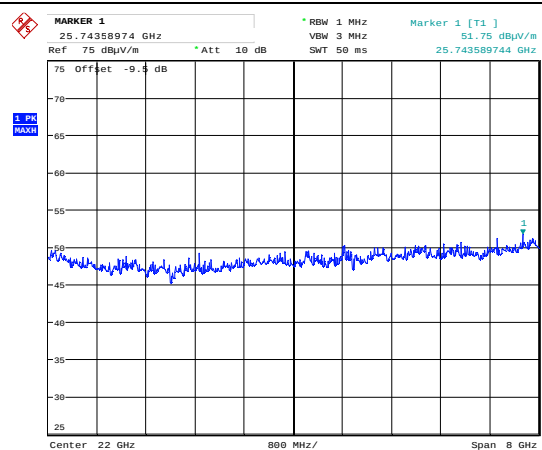
Date: 28.AUG.2023 15:36:55

HP



Date: 28.AUG.2023 15:47:02

Emissions 18 - 26 GHz, 2462 MHz, 802.11g 54M, VP, @1m



Date: 28.AUG.2023 15:49:18

HP

## 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   | ESU40                    | Measuring Receiver        | Rohde & Schwarz    | LR 1639  | 2023-01   | 2024-01  |
| 2   | N0324415                 | BandStop Filter (2.4GHz)  | Microwave Circuits | LR 1760  | COU       |          |
| 3   | WLK5-1100-1485-7000-40SS | Low Pass Filter (1.0 GHz) | Wainwright Inst.   | LR 1761  | COU       |          |
| 4   | 310                      | Preamplifier              | Sonoma Inst.       | LR 1686  | 2023-08   | 2024-08  |
| 5   | 8449A                    | Pre-amplifier             | Hewlett Packard    | LR 1322  | 2023-08   | 2024-08  |
| 6   | 3115                     | Horn Antenna              | EMCO               | LR 1330  | 2022-12   | 2027-12  |
| 7   | 3117-PA                  | Horn Antenna +PreAmp      | EMCO               | LR 1717  | 2023-08   | 2024-08  |
| 8   | JB3                      | BiLog Antenna             | Sunol              | N-4525   | 2023-04   | 2026-04  |
| 9   | Model 638                | Antenna Horn              | Narda              | LR 1480  | N/A       |          |

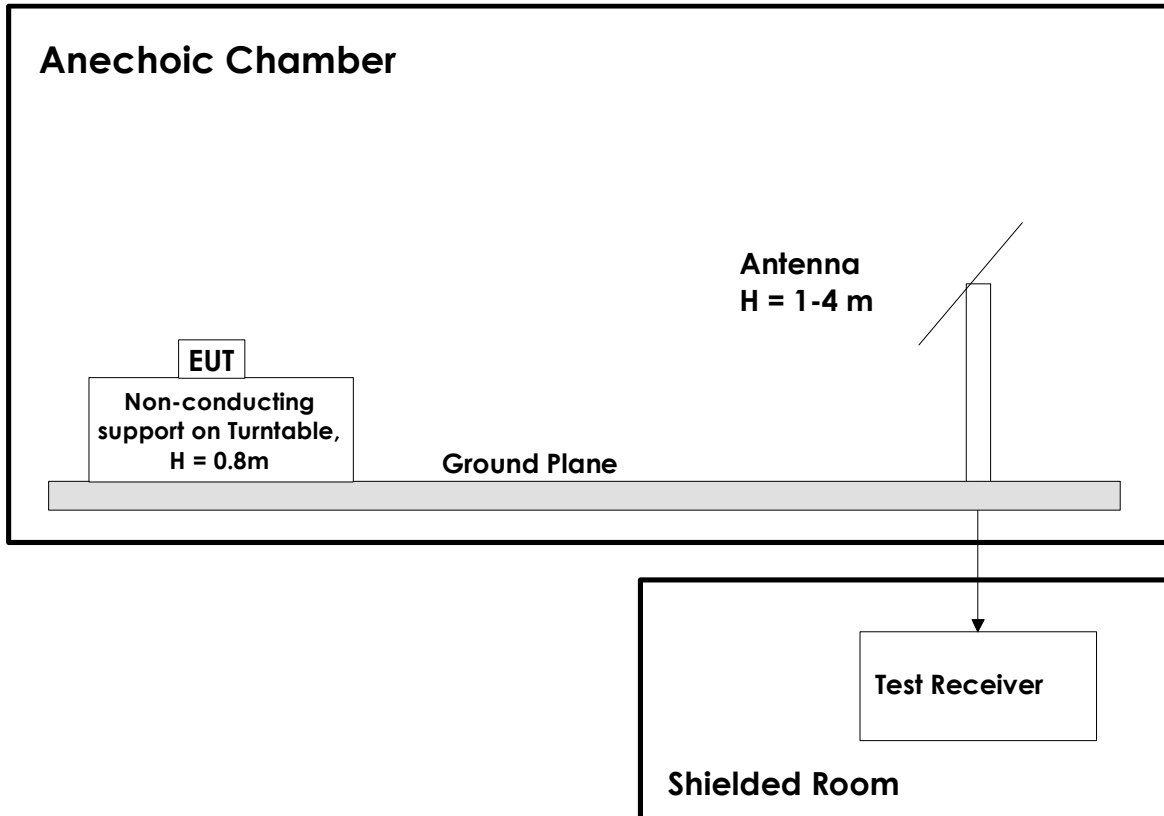
Note: COU – calibrate on use; N/A – Not Applicable

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

| No. | Manufacturer    | Name   | Version  | Comment                                 |
|-----|-----------------|--------|----------|-----------------------------------------|
| 1   | Rohde & Schwarz | EMC32  | 10.50.10 | EMC test software                       |
| 2   | Nemko AS        | RSPlot | 1.0.8.0  | Screenshots from R&S Spectrum Analyzers |
|     |                 |        |          |                                         |

## 6 BLOCK DIAGRAM

### 6.1 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.