



FCC Test Report

| | |
|-------------------------|---|
| Equipment | : Access Control System |
| Model No | : ASP-2000 |
| FCC ID | : 2AXQD-ASP-2000 |
| Applicant | : AHA INC CO.,LTD 67, Hwanggeum-ro, 109 beon-gil, Yangchon-eup, Gimpo-si, Gyeonggi-do, 10048, korea |
| Date of test | : September 11, 2020 to September 30, 2020 |
| FCC Rule Part(s) | : FCC Part 15 Subpart C §15.247 |
| Report Type | : Original Report |

The product was received on September 11, 2020 and testing was completed on September 30, 2020. We, BWS TECH Inc. would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of BWS TECH Inc. the test report shall not be reproduced except in full.

(Date) 07/10/2020

Tested by Hyeong-Bae Lee

(Date) 07/10/2020

Reviewed by Yong-Ki Cho

BWS TECH INC.

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<http://www.bws.co.kr>

*This test report is not related to KS Q ISO/IEC 17025 and KOLAS accreditation.

*The authenticity of this test report can be confirmed in the Android app "DOCUQR" or www.docuqr.com

Report Revision

| TEST REPORT NO. | DATE | DESCRIPTION |
|-------------------|--------------------|--|
| BWS-20-RF-0006 | September 29, 2020 | - First Approval Report |
| BWS-20-RF-0006-R1 | September 30, 2020 | - Added Measurement Uncertatinty and revised 6 dB Bandwidth. |
| BWS-20-RF-0006-R2 | October 7, 2020 | - Update the Model name. |

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1. General Information

Scope – Measurement and determination of electromagnetic emission(EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)

1.1 Applicant

| | |
|--------------------------|---|
| ● Company Name | : AHA INC CO.,LTD |
| ● Company Address | : 67, Hwanggeum-ro, 109 beon-gil, Yangchon-eup, Gimpo-si, Gyeonggi-do, 10048, korea |
| ● Phone/Fax | : Tel No. : +82-31-8048-7232 Fax No. : +82-31-997-0911 |

1.2 Manufacturer

| | |
|--------------------------|---|
| ● Company Name | : AHA INC CO.,LTD |
| ● Company Address | : 67, Hwanggeum-ro, 109 beon-gil, Yangchon-eup, Gimpo-si, Gyeonggi-do, 10048, korea |
| ● Phone/Fax | : Tel No. : +82-31-8048-7232 Fax No. : +82-31-997-0911 |

1.3 EUT Description

| | |
|------------------------------|---|
| ● Equipment | : Access Control System |
| ● Model(s) | : ASP-2000 |
| ● Derived Model(s) | : ASP-19, AIC-1000, SZ-1082D, SZ-1081D, SW-1081-D, SW-1080-D, SW-1082D, SW-1081D, SV-1082D, SV-1081D, FPS-1000R, CRS-100, ASP-1000, ASP-19F, ASP-19E, ASP-19D |
| ● Operation Frequency | : 802.11 b/g/n(HT20): 2412MHz-2462MHz |
| ● Number of Channels | : 802.11 b/g/n(HT20): 11 |
| ● Modulation Method | : 802.11 b : DSSS 802.11 g/n(HT20) : OFDM |
| ● Power Tolerance | : +/- 2dB |
| ● Input Voltage | : DC 12 V |
| ● Antenna Peak Gain | : 802.11b/g/n(HT20/40) :-1 dBi |

1.4 Other Information

| | |
|---------------------------|---|
| ● FCC Rule Part(s) | : Part 15 Subpart C §15.247 |
| ● FCC ID | : 2AXQD-ASP-2000 |
| ● Test Procedure | : ANSI C63.10-2013 KDB 558074 D01 DTS Meas Guidance v05r02 |
| ● Date of Test | : September 11, 2020 to September 29, 2020 |
| ● Place of Test | : BWS TECH Inc. (FCC Registration Number : 287786) #23, Gokhyeon-ro 480 Beon-gil, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17031, South Korea TEL: +82 31 333 5997 FAX: +82 31 333 0017 |

2. Description of Test Facility

Site Description

| | | |
|----------------------|---|--|
| Test Lab. | : |  NRRA Designation Number is KR0017. |
| | |  The Certificate Designation Number is KR0017. |
| | |  The Certificate Accreditation Number is KT174. |
| Name of Firm | : | BWS TECH Inc. |
| Site Location | : | #23, Gokhyeon-ro 480 Beon-gil, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17031, South Korea |

3. Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.10: 2013 and the requirements of FCC Rules Part 15.207, 15.209 and 15.247.

Radio testing was performed according to KDB 558074 D01 DTS Meas Guidance v05r02.

3.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and is operated in a manner that intends to maximize its emission characteristics in a continuous normal application.

3.2 EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

3.3 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|--------------------------|---------------------|---------------|------------------|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| ¹ 0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 38675 | 156.7-156.9 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | (²) |
| 13.36-13.41 | | | |

1 Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

2 Above 38.6

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

3.4 Description of Test Modes

The EUT has been tested under operating condition.

After output power verification, all tests were carried out with the worst case test modes as shown below.

The worst-case of data rates and antenna configurations are shown as follows.

- Data rates

| Band | Data Rate |
|--|-----------|
| 802.11b | 1 Mbps |
| 802.11g | 6 Mbps |
| 802.11n HT20 | MCS 0 |
| This device supports non-beamforming in 802.11n. | |

4. Summary of Test Result

| Clause | TEST Description | Standard Section | Requirements | Result |
|--------|---|--------------------------------------|------------------------|--------|
| 6.1 | AC Power Line Conducted Emission | §15.207 | §15.207(a) | Pass |
| 6.2 | Peak Output Power Measurement | §15.247(b)(3) | ≤ 30 dBm | Pass |
| 6.3 | Power Spectral Density | §15.247(e) | ≤ 8 dBm/3 kHz | Pass |
| 6.4 | 6 dB Bandwidth | §15.247(a)(2) | ≥ 500 kHz | Pass |
| 6.5 | Conducted Spurious Emission | §15.247(d) | ≥ 20 dBc/100 kHz | Pass |
| 6.6 | Band Edges Measurement | §15.247(d) | §15.205(a) | Pass |
| 6.7 | Radiated Spurious Emission | §15.247(d), §15.209(a), §15.35(b) | §15.209(a), §15.247(d) | Pass |
| 6.8 | Antenna Application | §15.247(b), §15.203 | §15.247(b), §15.203 | Pass |

5. Test Equipment

| Equipment | Model | Manufacturer | Serial number | Calibration Due date (year/month/date) |
|-----------------------------------|--------------|-----------------------|----------------|--|
| POWER SUPPLY | MEC 1705 | Mecha solution | 277 | 2021/06/18 |
| USB RF POWER SENSOR | RPR3006W | D.A.R.E!! Instruments | 14I000048SNO09 | 2021/04/07 |
| ATTENUATOR | F04-B1820-01 | SRT | 17060803 | 2021/06/04 |
| SYNTHESIZED SIGNAL GENERATOR | 68367C | ANRITSU | #004908 | 2021/05/15 |
| Signal Analyzer | FSP | Rohde & Schwarz | 100631 | 2020/12/24 |
| EMC ANALYZER | E7405A | Agilent | MY45104194 | 2021/02/13 |
| Boresight Antenna mast controller | AM-BS-4500E | AUDIX | 060908-BS | N/A |
| Antenna Turntable Controller | JAC-2 | Daeli EMC | N/A | N/A |
| Loop Antenna | FMZB1519 | SCHWARZBECK | 00025 | 2022/01/06 |
| TRILOG Broadband Antenna | VULB 9163 | SCHWARZBECK | 01063 | 2021/04/30 |
| Active Horn Antenna | AHA-118 | COM-POWER CORP. | 701064 | 2021/04/30 |
| Horn Antenna | BBHA9170 | Schwartzbek | 157 | 2021/04/27 |
| RF Amplifier | MPA-10-40 | RF Bay, Inc. | 191246 | 2021/06/04 |
| Band reject filter | BRM50701 | Micro-Tronics | G236 | 2021/08/28 |

6. Test Data

6.1 AC Power Line Conducted Emission

6.1.1 Test Limit

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

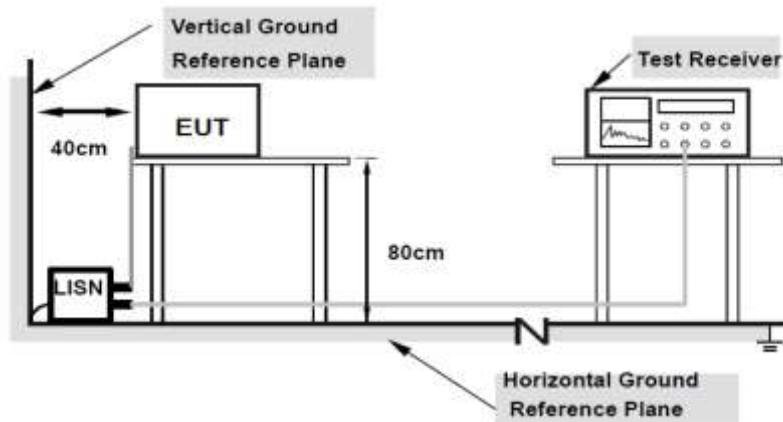
| Frequency of emission(MHz) | Conducted limit(dB μ V) | |
|----------------------------|-----------------------------|-----------|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

*Decreases with the logarithm of the frequency.

6.1.2 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room and was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network(LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 uH LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9 kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

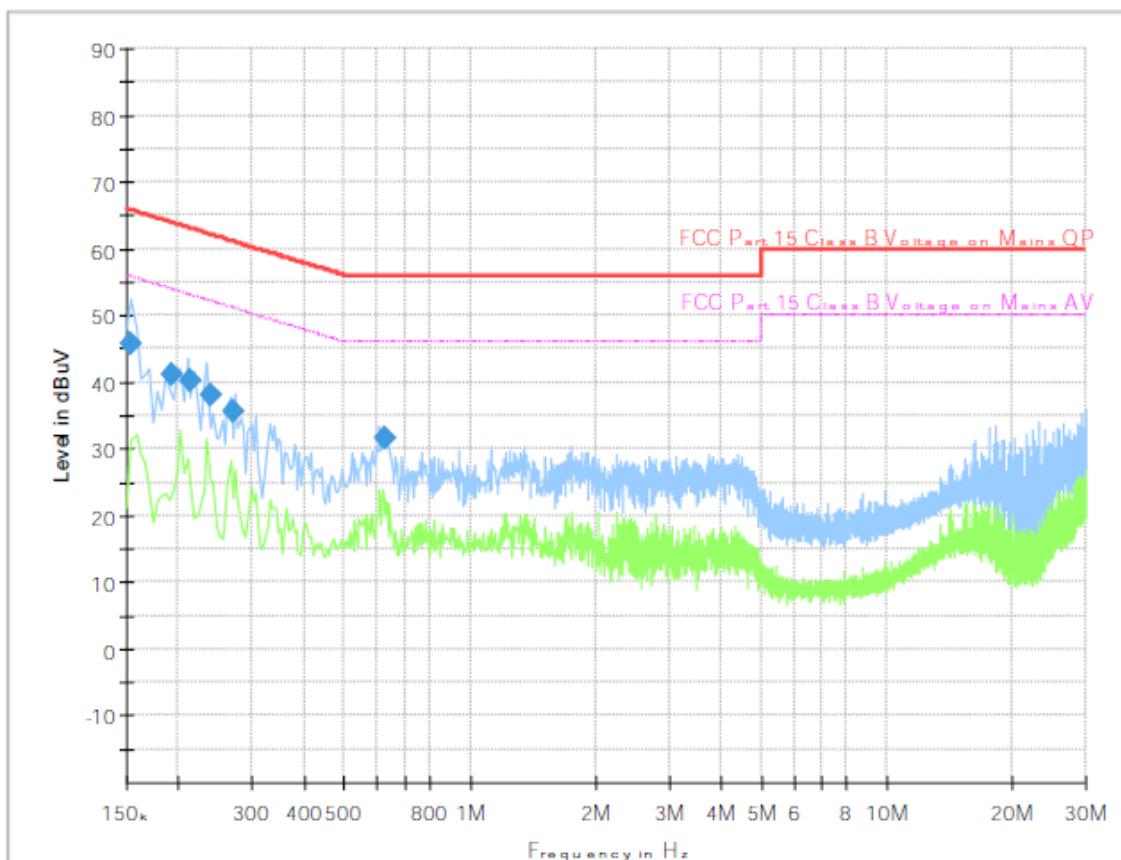
6.1.3 Test SET-UP (Block Diagram of Configuration)



6.1.4 Test Results

Common Information

Test Line: L1
 Comment: 802.11b



Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.154000 | 45.67 | --- | 65.78 | 20.11 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.193500 | 41.21 | --- | 63.89 | 22.68 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.213500 | 40.18 | --- | 63.07 | 22.88 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.237500 | 38.22 | --- | 62.18 | 23.96 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.269500 | 35.68 | --- | 61.13 | 25.45 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.625499 | 31.75 | --- | 56.00 | 24.25 | 3000.0 | 9.000 | L1 | GND | 7.6 |

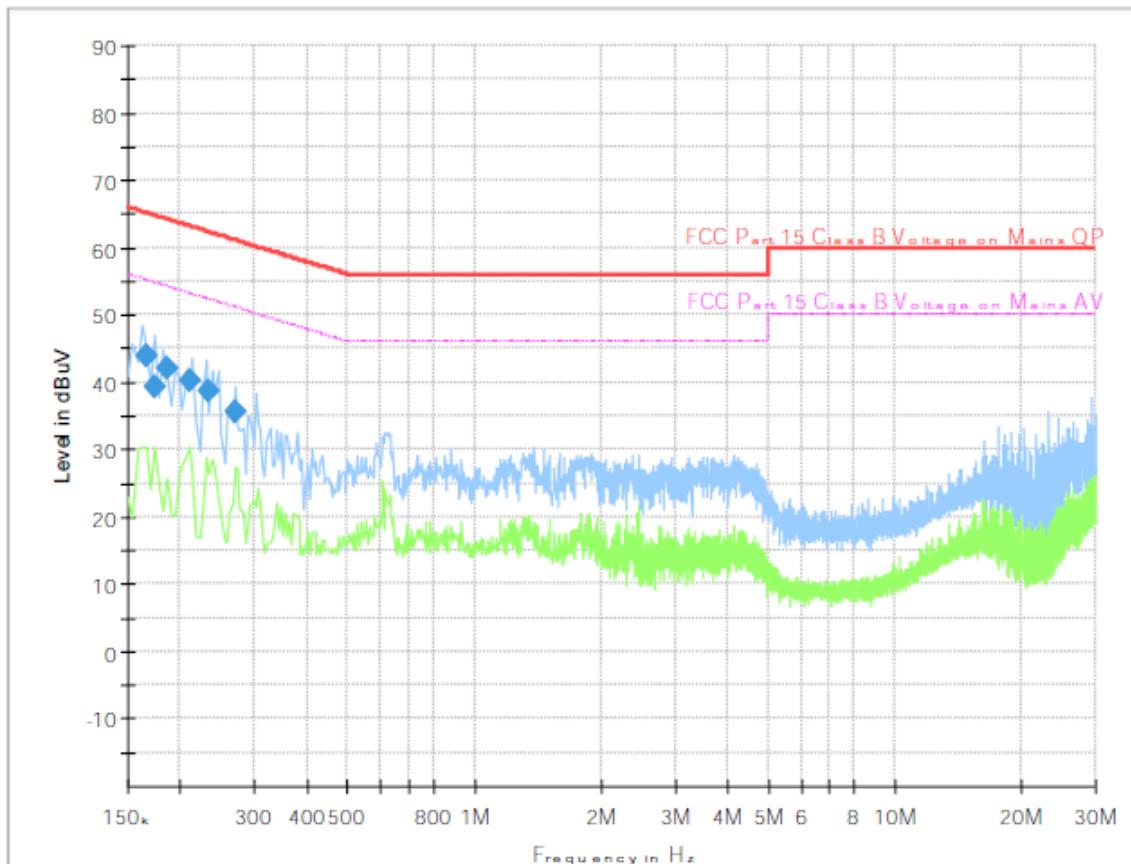
Common Information

Test Line:

N

Comment:

802.11b



Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.165500 | 43.90 | --- | 65.18 | 21.28 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.173500 | 39.19 | --- | 64.79 | 25.60 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.186500 | 42.22 | --- | 64.19 | 21.97 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.209500 | 40.18 | --- | 63.23 | 23.05 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.233500 | 38.60 | --- | 62.32 | 23.72 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.269500 | 35.54 | --- | 61.13 | 25.59 | 3000.0 | 9.000 | N | GND | 7.7 |

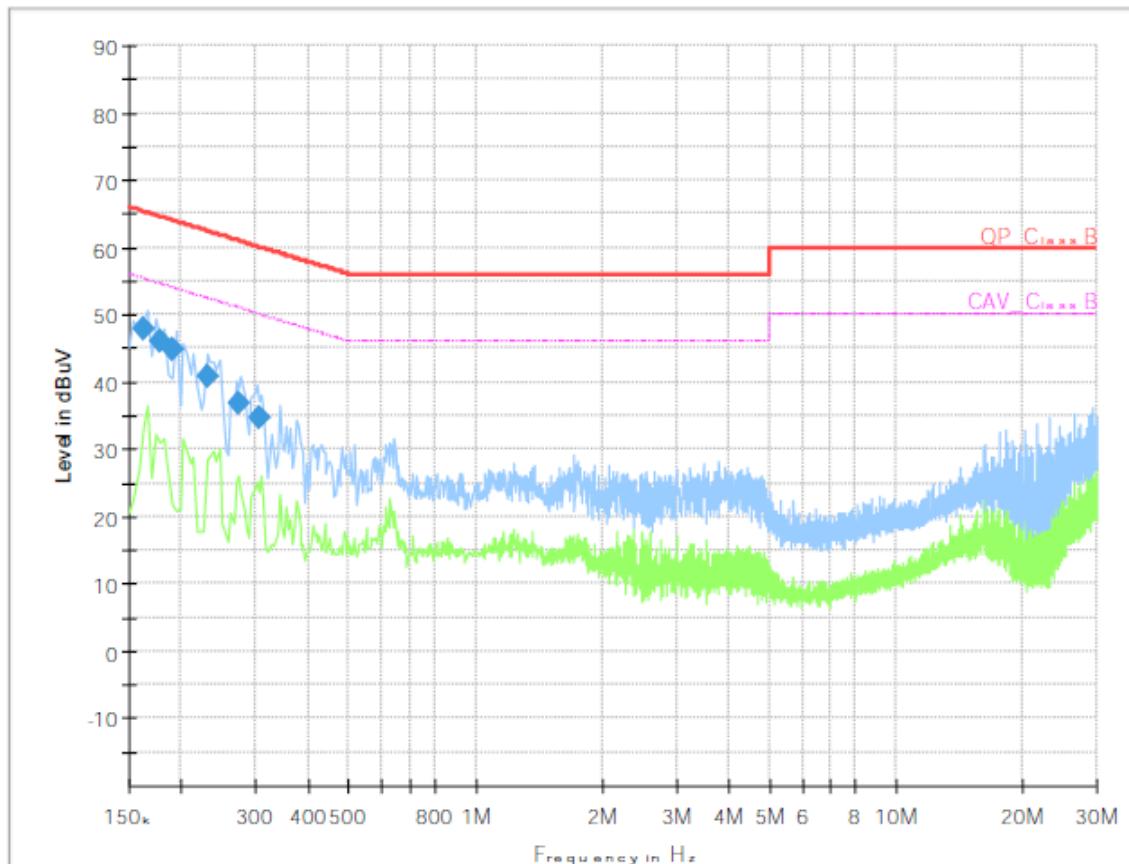
Common Information

Test Line:

L1

Comment:

802.11g



Final_Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.161500 | 47.95 | --- | 65.39 | 17.44 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.177500 | 46.07 | --- | 64.60 | 18.53 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.189500 | 44.84 | --- | 64.06 | 19.21 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.229500 | 40.88 | --- | 62.47 | 21.59 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.273500 | 37.00 | --- | 61.01 | 24.01 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.306500 | 34.66 | --- | 60.07 | 25.40 | 3000.0 | 9.000 | L1 | GND | 7.7 |

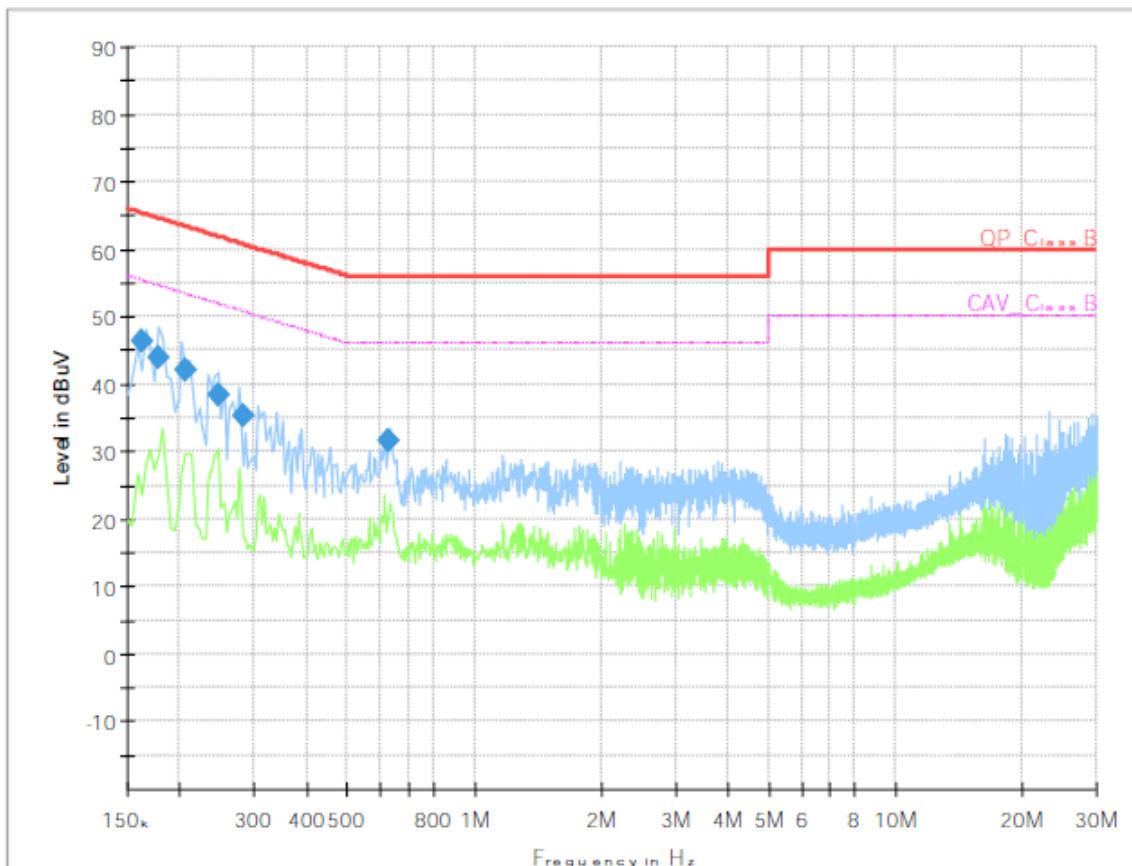
Common Information

Test Line:

N

Comment:

802.11g



Final_Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.161500 | 46.38 | --- | 65.39 | 19.00 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.177500 | 44.05 | --- | 64.60 | 20.55 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.206500 | 41.92 | --- | 63.35 | 21.43 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.246500 | 38.48 | --- | 61.87 | 23.40 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.282500 | 35.16 | --- | 60.74 | 25.58 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.625498 | 31.47 | --- | 56.00 | 24.53 | 3000.0 | 9.000 | N | GND | 7.7 |

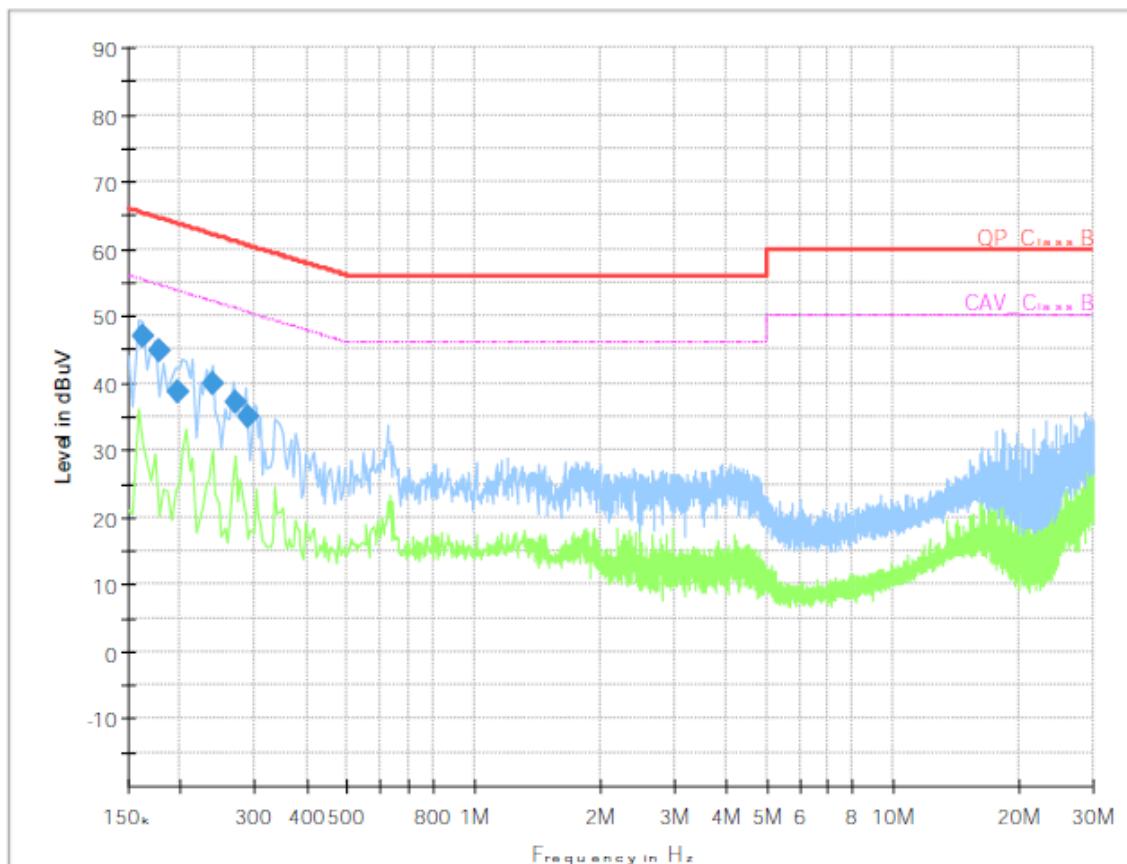
Common Information

Test Line:

L1

Comment:

802.11n HT20



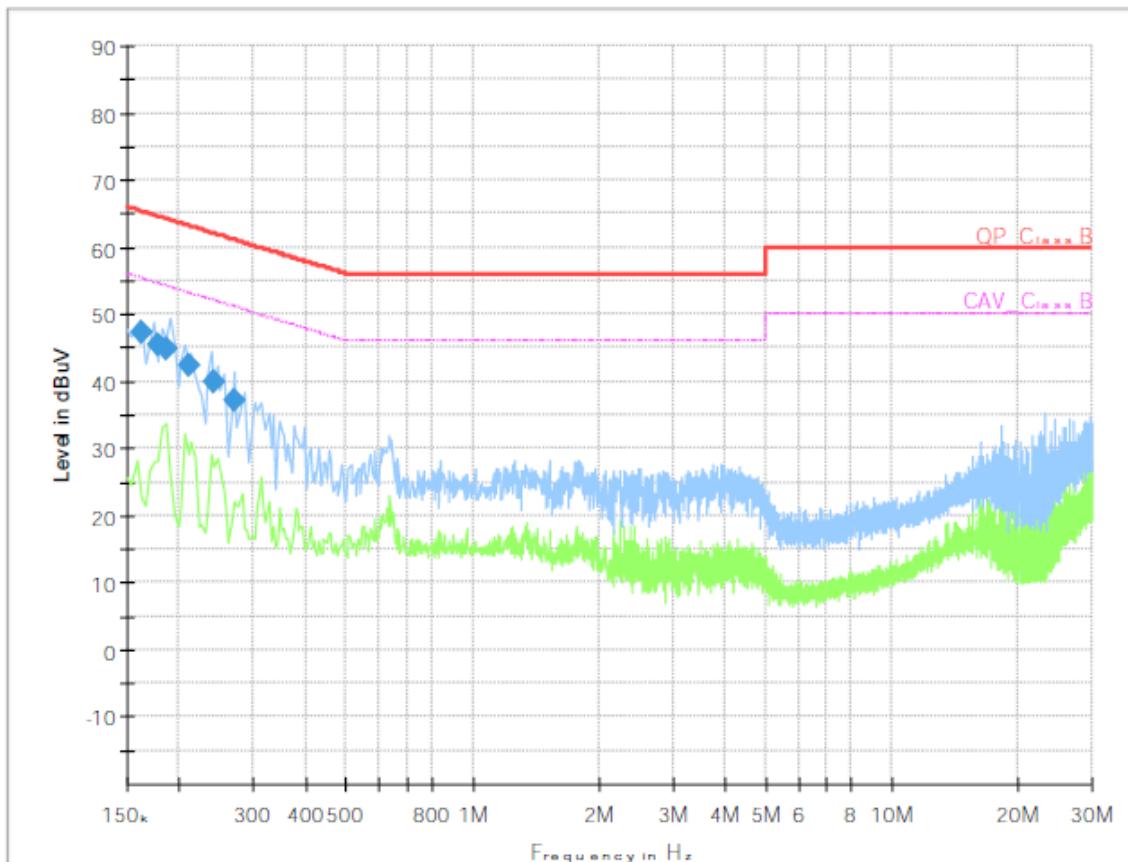
Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.161500 | 47.00 | --- | 65.39 | 18.39 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.178500 | 44.78 | --- | 64.56 | 19.78 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.197500 | 38.66 | --- | 63.72 | 25.06 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.237500 | 39.91 | --- | 62.18 | 22.27 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.269500 | 37.05 | --- | 61.13 | 24.08 | 3000.0 | 9.000 | L1 | GND | 7.7 |
| 0.289500 | 35.07 | --- | 60.54 | 25.47 | 3000.0 | 9.000 | L1 | GND | 7.7 |

Common Information

Test Line:
Comment:

N
802.11n HT20



Final_Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.161500 | 47.27 | --- | 65.39 | 18.12 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.178500 | 45.33 | --- | 64.56 | 19.22 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.185500 | 44.79 | --- | 64.24 | 19.45 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.210500 | 42.43 | --- | 63.19 | 20.76 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.241500 | 39.92 | --- | 62.04 | 22.12 | 3000.0 | 9.000 | N | GND | 7.7 |
| 0.269500 | 37.25 | --- | 61.13 | 23.88 | 3000.0 | 9.000 | N | GND | 7.7 |

6.2 Peak Output Power Measurement

6.2.1 Test Limit

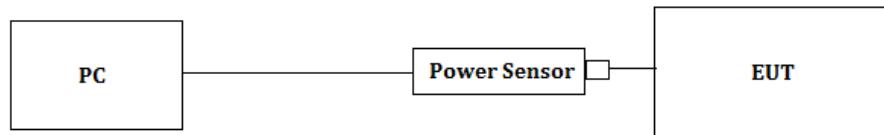
The maximum peak power shall be less than 1 Watt (30 dBm).

Note: If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the direction gain of the antenna exceeds 6dBi, In case of point-to-point operation, the limit has to be reduced by 1dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

6.2.2 Measurement Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 15.247 Meas. Guidance v05.
2. The RF output of EUT was connected to the power meter. The path loss was compensated to the results for each measurement.
3. Set to the maximum output power setting and enable the EUT transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.

6.2.3 Test SET-UP (Block Diagram of Configuration)



6.2.4 Test Results

[Duty Cycle]

[802.11b]

| Channel | Frequency (MHz) | Duty Cycle | Duty Cycle Factor (dB) |
|---------|-----------------|------------|------------------------|
| 1 | 2412 | 0.996 | 0.017 |
| 6 | 2437 | 0.996 | 0.017 |
| 11 | 2462 | 0.996 | 0.017 |

[802.11g]

| Channel | Frequency (MHz) | Duty Cycle | Duty Cycle Factor (dB) |
|---------|-----------------|------------|------------------------|
| 1 | 2412 | 0.972 | 0.123 |
| 6 | 2437 | 0.973 | 0.119 |
| 11 | 2462 | 0.972 | 0.123 |

[802.11n HT20]

| Channel | Frequency (MHz) | Duty Cycle | Duty Cycle Factor (dB) |
|---------|-----------------|------------|------------------------|
| 1 | 2412 | 0.970 | 0.132 |
| 6 | 2437 | 0.970 | 0.132 |
| 11 | 2462 | 0.970 | 0.132 |

Notes : 1. Duty Cycle = T_{on} / T_{total} 2. Duty Cycle Factor = $10 * \log(1/\text{Duty Cycle})$.

[Peak Output Power Measurement]

[802.11b]

| Channel | Frequency (MHz) | Peak Output Power (dBm) | Antenna Gain (dBi) | Peak Output Power (EIRP) (dBm) | Duty Cycle Factor + Peak Output Power (EIRP) (dBm) | Max. Limit (dBm) | Result |
|---------|-----------------|-------------------------|--------------------|--------------------------------|--|------------------|--------|
| 1 | 2412 | 12.0 | -1.00 | 11.00 | 11.02 | ≤ 30 | Pass |
| 6 | 2437 | 12.0 | -1.00 | 11.00 | 11.02 | ≤ 30 | Pass |
| 11 | 2462 | 12.0 | -1.00 | 11.00 | 11.02 | ≤ 30 | Pass |

[802.11g]

| Channel | Frequency (MHz) | Peak Output Power (dBm) | Antenna Gain (dBi) | Peak Output Power (EIRP) (dBm) | Duty Cycle Factor + Peak Output Power (EIRP) (dBm) | Max. Limit (dBm) | Result |
|---------|-----------------|-------------------------|--------------------|--------------------------------|--|------------------|--------|
| 1 | 2412 | 11.8 | -1.00 | 10.80 | 10.92 | ≤ 30 | Pass |
| 6 | 2437 | 11.8 | -1.00 | 10.80 | 10.92 | ≤ 30 | Pass |
| 11 | 2462 | 11.7 | -1.00 | 10.70 | 10.82 | ≤ 30 | Pass |

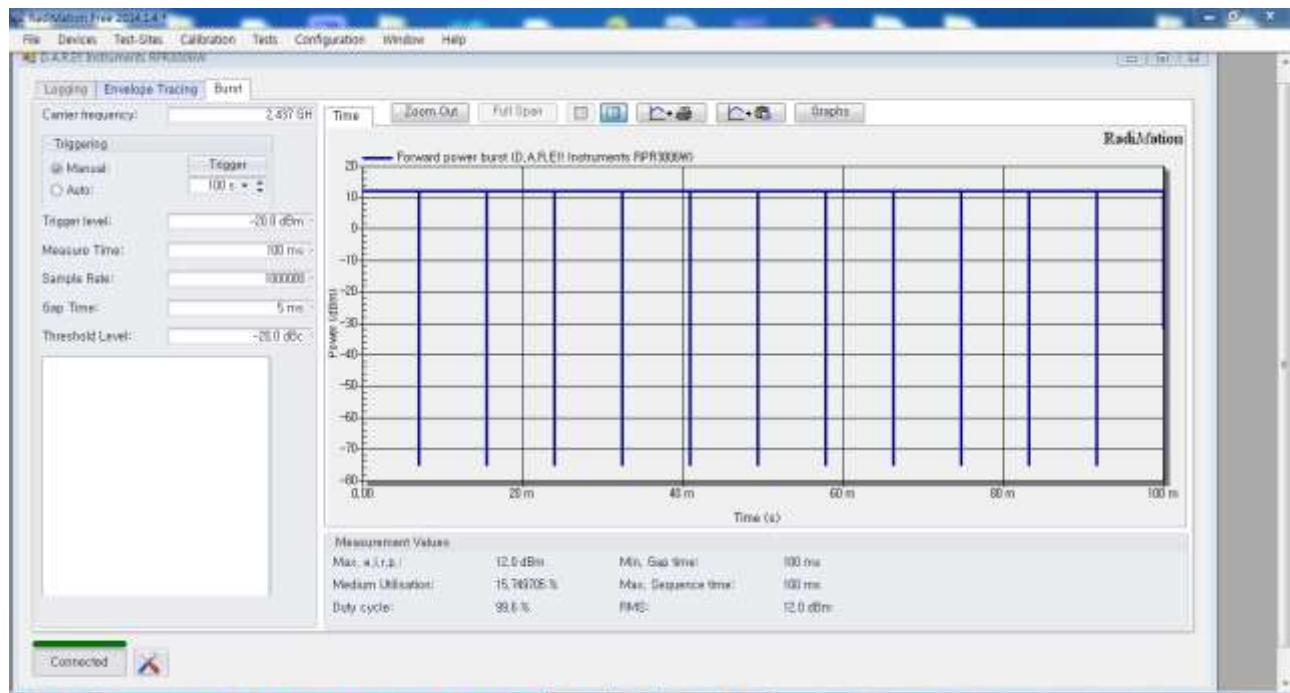
[802.11n HT20]

| Channel | Frequency (MHz) | Peak Output Power (dBm) | Antenna Gain (dBi) | Peak Output Power (EIRP) (dBm) | Duty Cycle Factor + Peak Output Power (EIRP) (dBm) | Max. Limit (dBm) | Result |
|---------|-----------------|-------------------------|--------------------|--------------------------------|--|------------------|--------|
| 1 | 2412 | 11.7 | -1.00 | 10.70 | 10.83 | ≤ 30 | Pass |
| 6 | 2437 | 11.6 | -1.00 | 10.60 | 10.73 | ≤ 30 | Pass |
| 11 | 2462 | 11.5 | -1.00 | 10.50 | 10.63 | ≤ 30 | Pass |

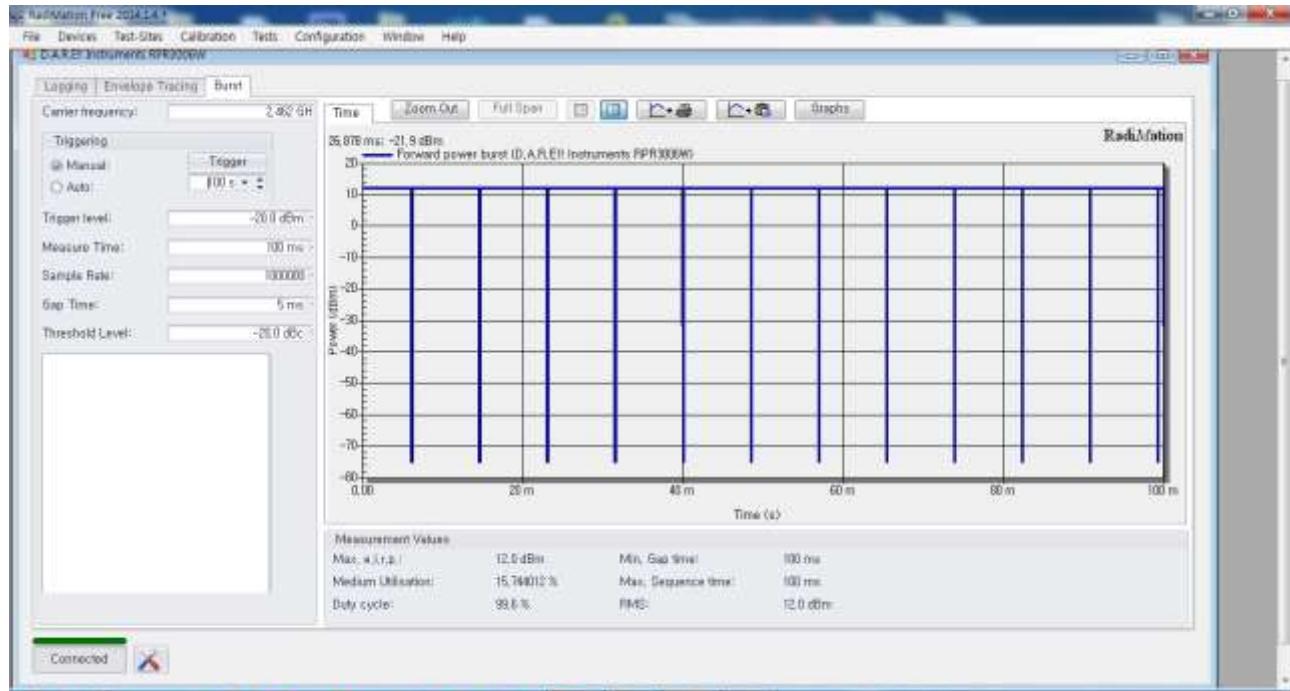
Test Mode : 802.11b 2412MHz



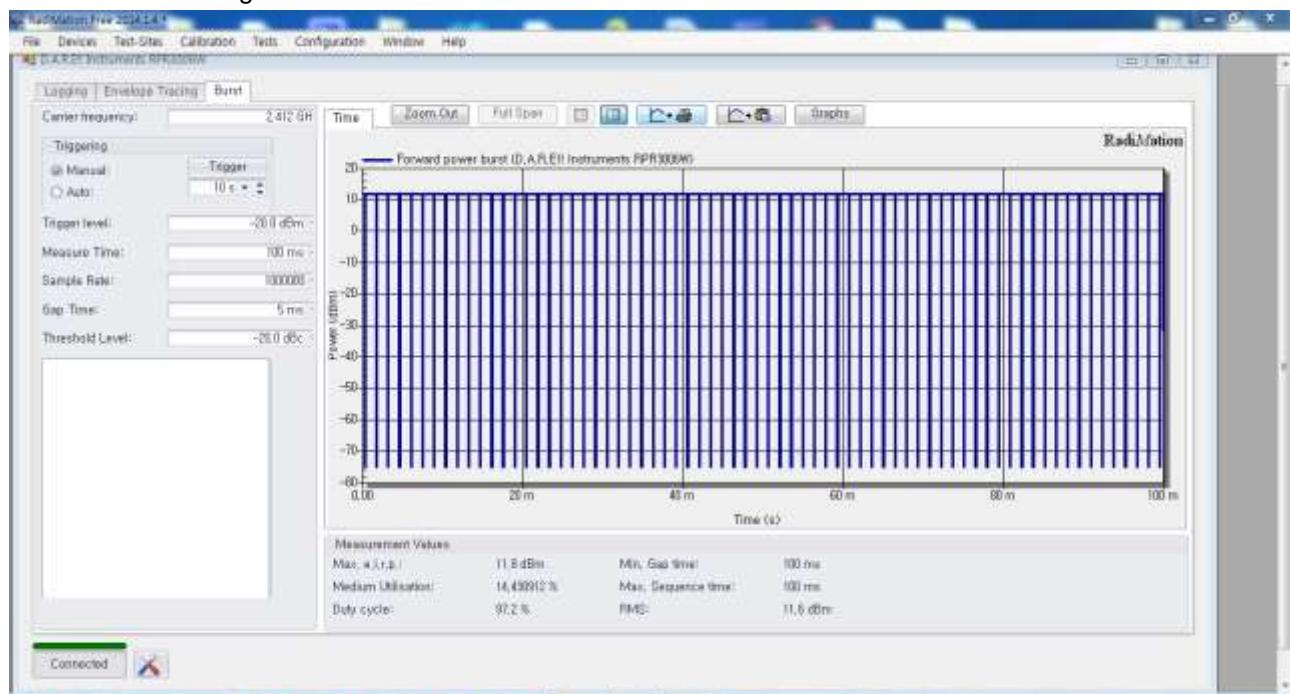
Test Mode : 802.11b 2437MHz



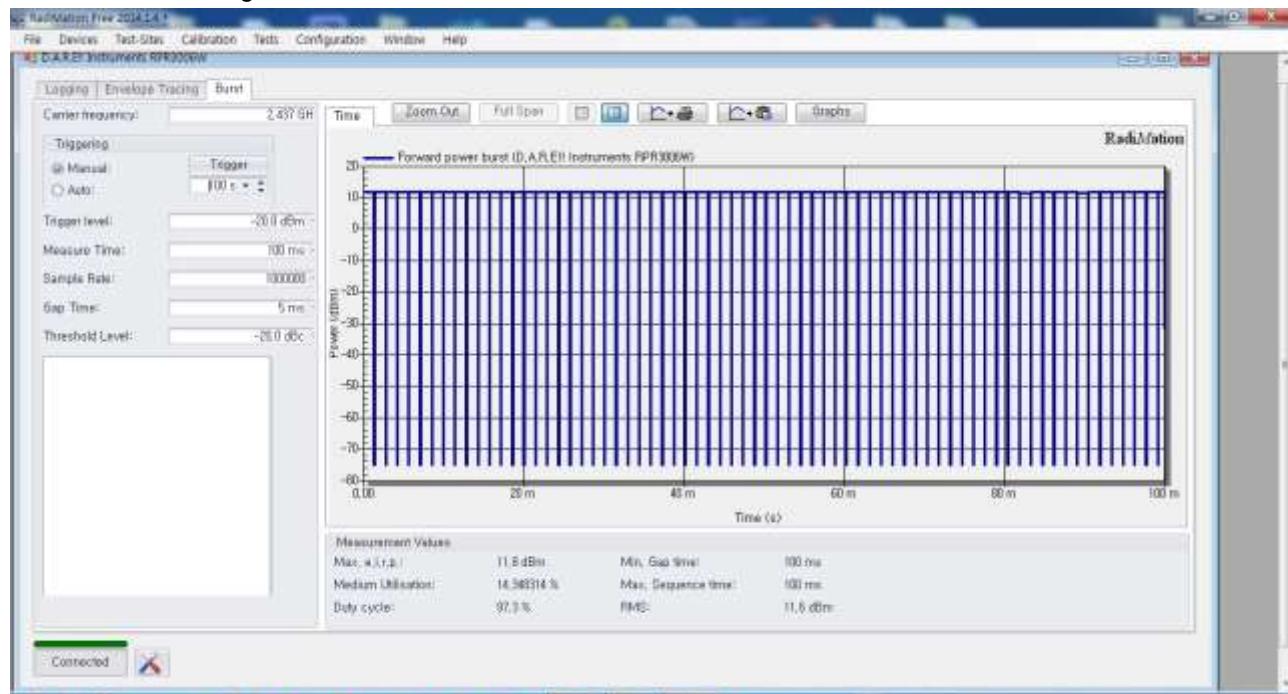
Test Mode : 802.11b 2462MHz



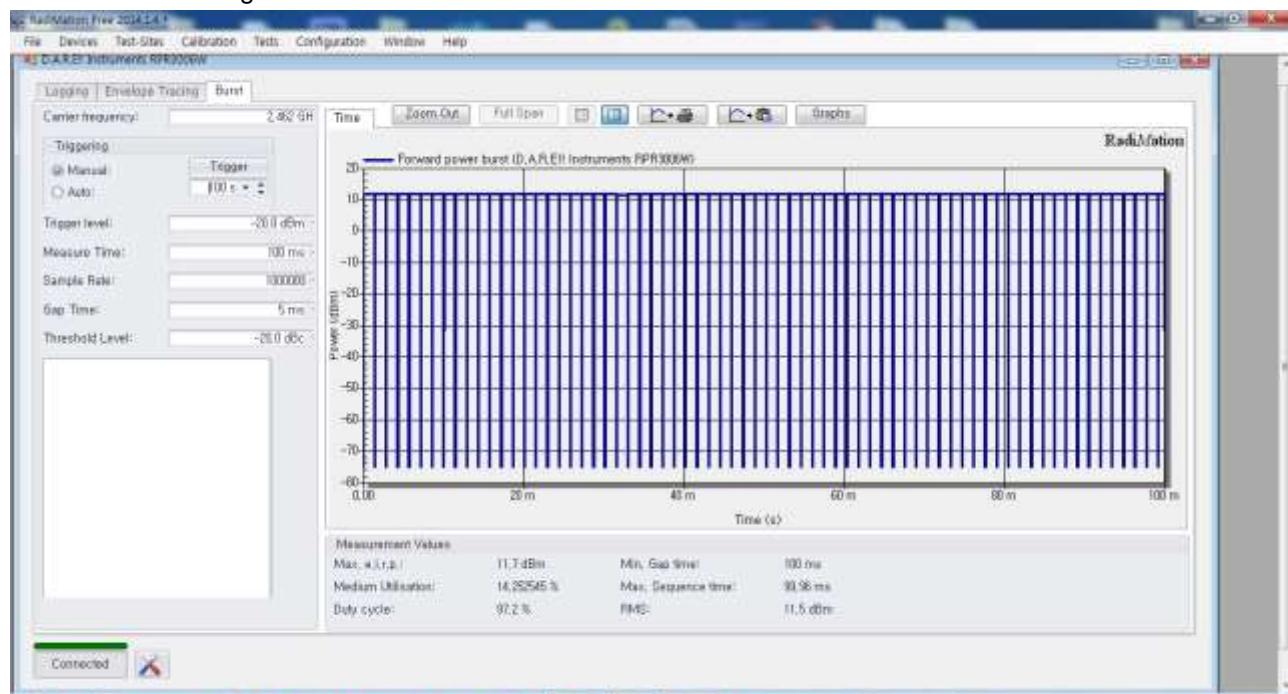
Test Mode : 802.11g 2412MHz



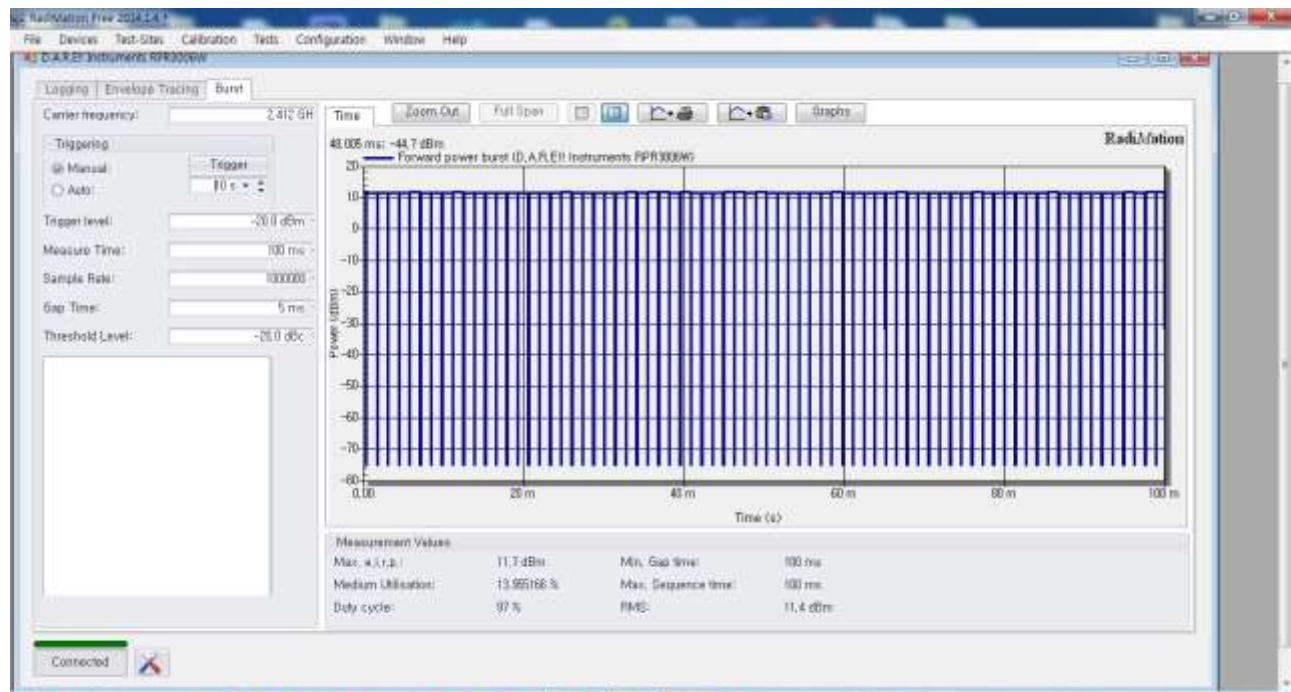
Test Mode : 802.11g 2437MHz



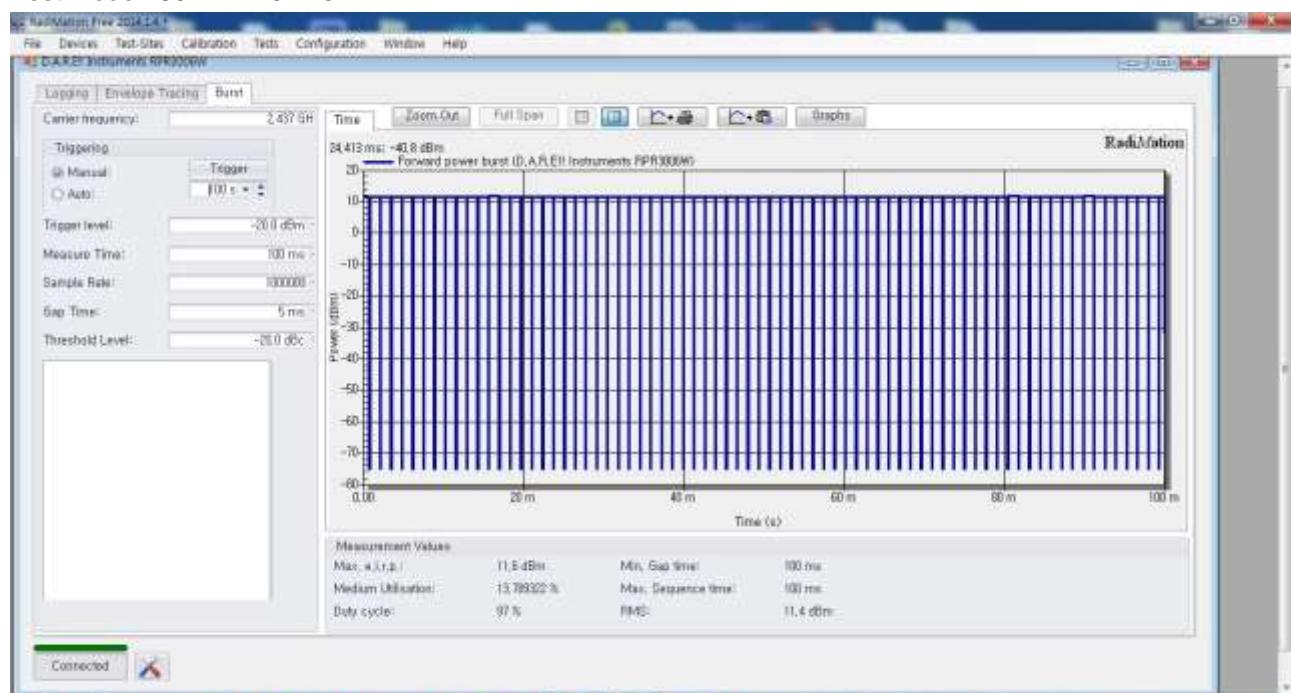
Test Mode : 802.11g 2462MHz



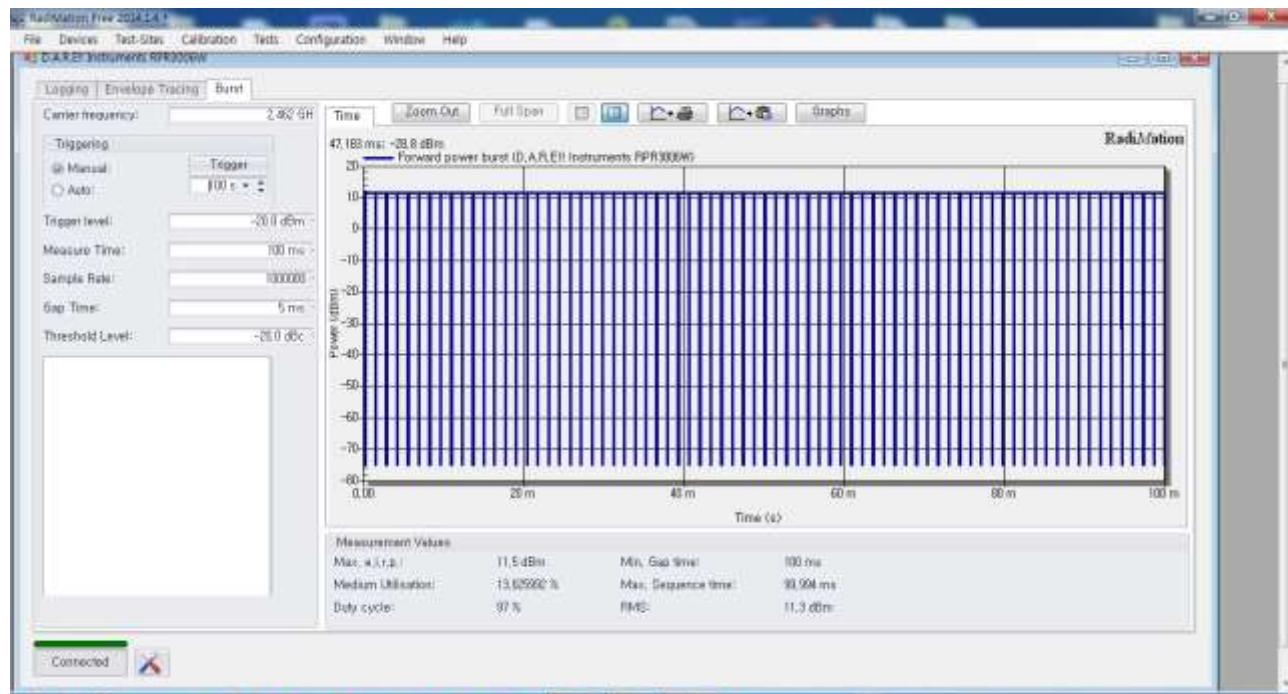
Test Mode : 802.11n20 2412MHz



Test Mode : 802.11n20 2437MHz



Test Mode : 802.11n20 2462MHz



6.2.5 Measurement Uncertainty

→ Uncertainty = ± 1.2 dB (k = 2, 95.45 %)

6.3 Power Spectral Density

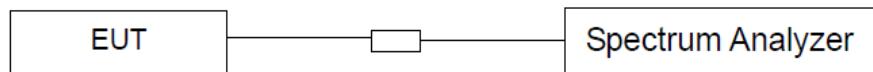
6.3.1 Test Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiated to the Antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

6.3.2 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 15.247 Meas. Guidance v05.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 3 kHz, VBW = 10 kHz, Detector = Peak, Span = 1.5 times DTS Channel Bandwidth, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

6.3.3 Test SET-UP (Block Diagram of Configuration)



6.3.4 Test Results

[802.11b]

| Channel | Frequency (MHz) | Power Spectral Density (dBm) | Limit (dBm) | Result |
|---------|-----------------|------------------------------|-------------|--------|
| 1 | 2412 | -6.61 | ≤ 8.00 | Pass |
| 6 | 2437 | -5.93 | ≤ 8.00 | Pass |
| 11 | 2462 | -6.22 | ≤ 8.00 | Pass |

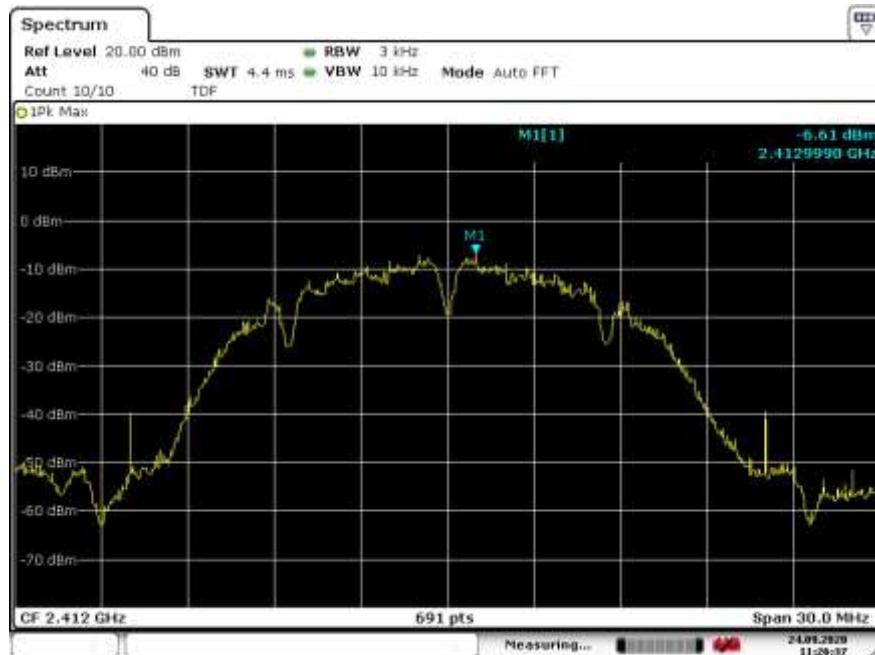
[802.11g]

| Channel | Frequency (MHz) | Power Spectral Density (dBm) | Limit (dBm) | Result |
|---------|-----------------|------------------------------|-------------|--------|
| 1 | 2412 | -10.29 | ≤ 8.00 | Pass |
| 6 | 2437 | -11.18 | ≤ 8.00 | Pass |
| 11 | 2462 | -10.25 | ≤ 8.00 | Pass |

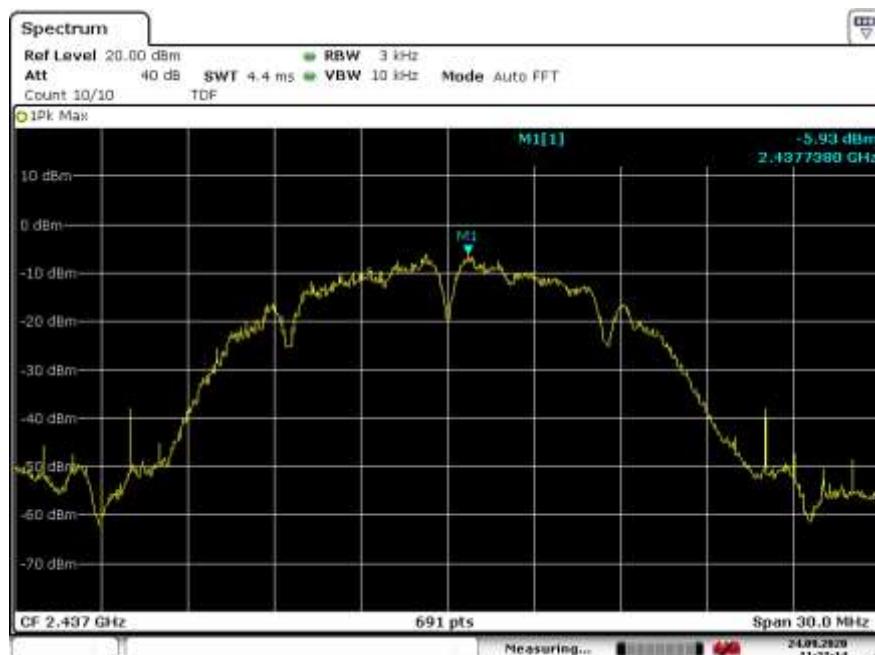
[802.11n HT20]

| Channel | Frequency (MHz) | Power Spectral Density (dBm) | Limit (dBm) | Result |
|---------|-----------------|------------------------------|-------------|--------|
| 1 | 2412 | -11.33 | ≤ 8.00 | Pass |
| 6 | 2437 | -11.37 | ≤ 8.00 | Pass |
| 11 | 2462 | -11.95 | ≤ 8.00 | Pass |

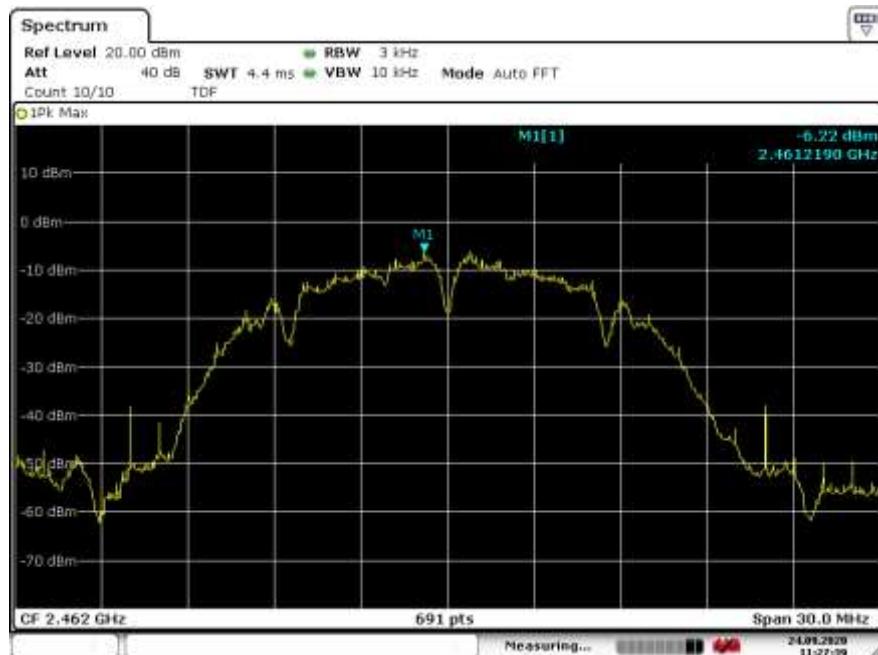
Test Mode : 802.11b 2412MHz



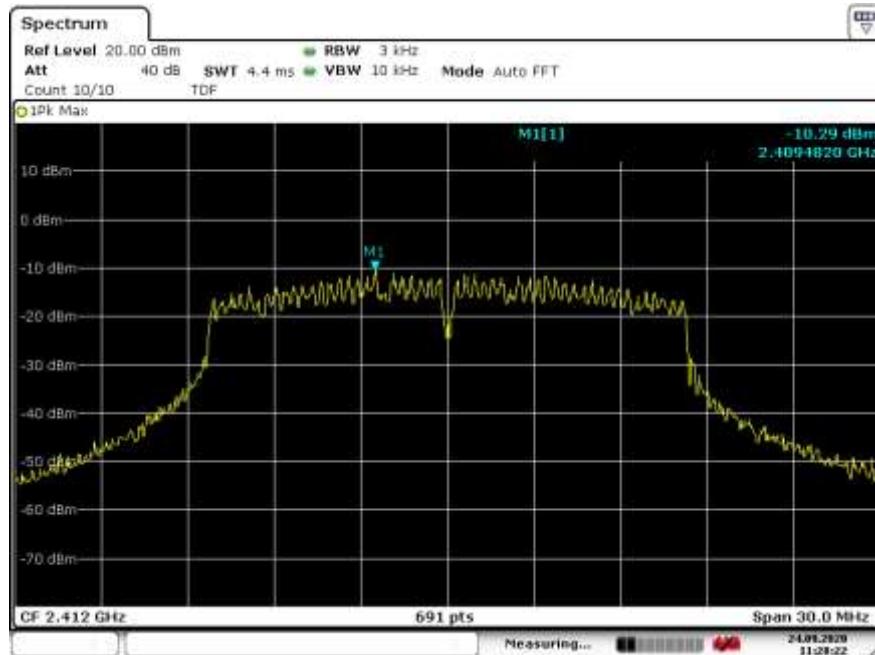
Test Mode : 802.11b 2437MHz



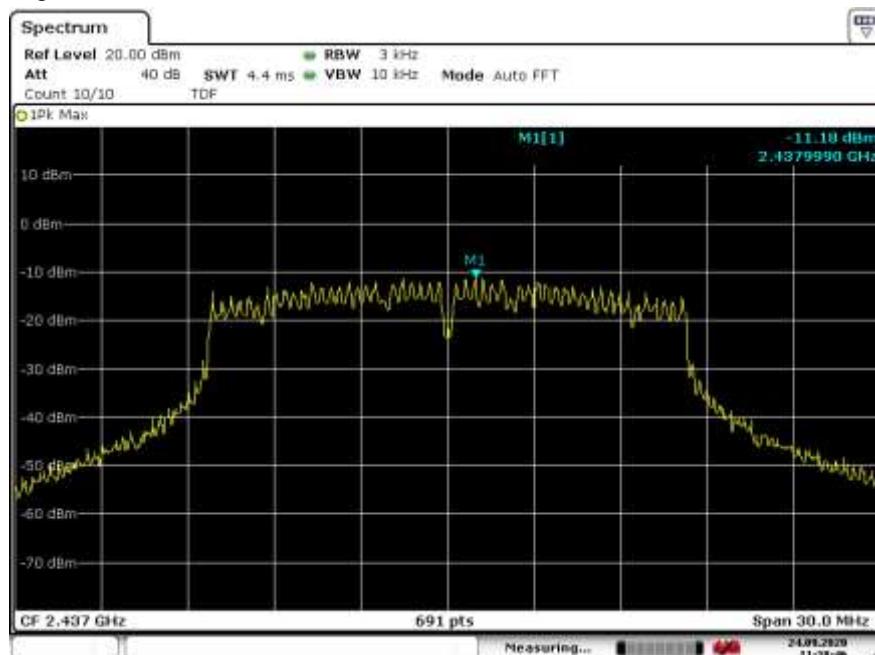
Test Mode : 802.11b 2462MHz



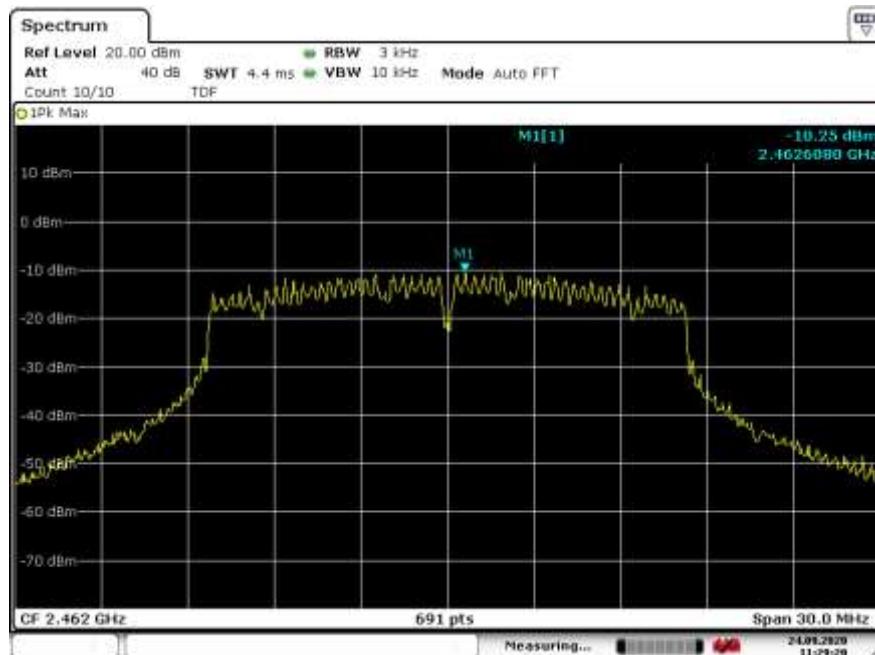
Test Mode : 802.11g 2412MHz



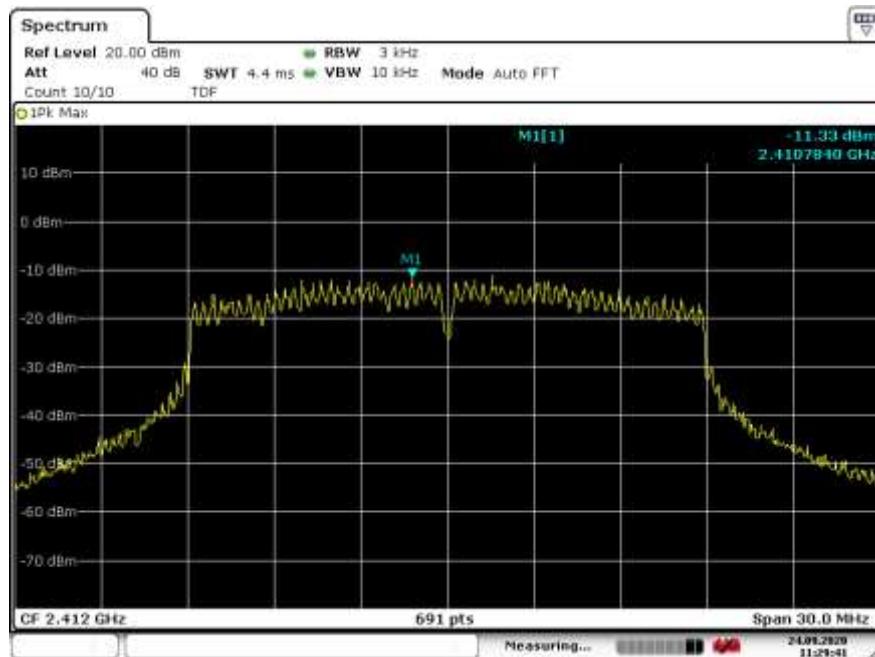
Test Mode : 802.11g 2437MHz



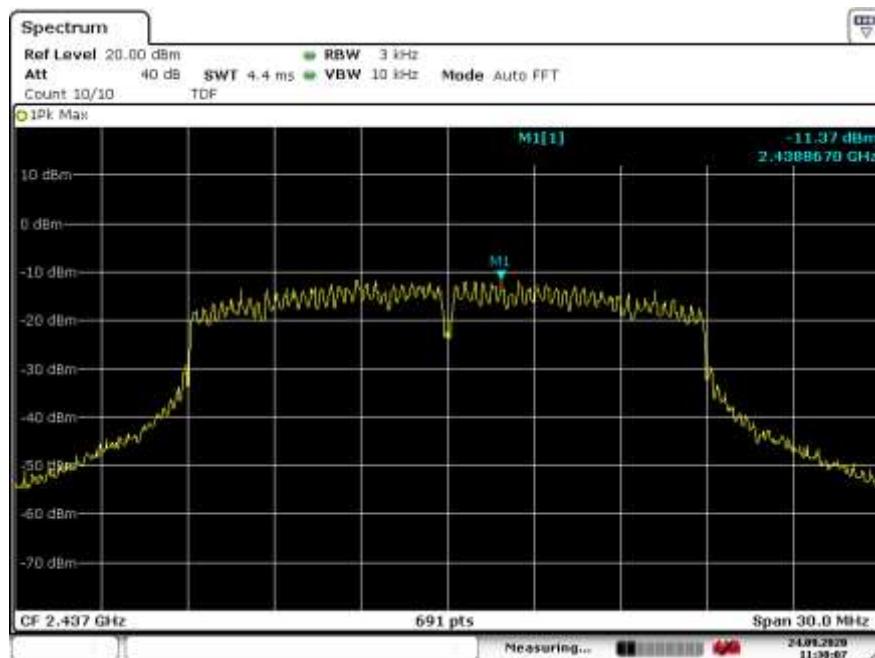
Test Mode : 802.11g 2462MHz



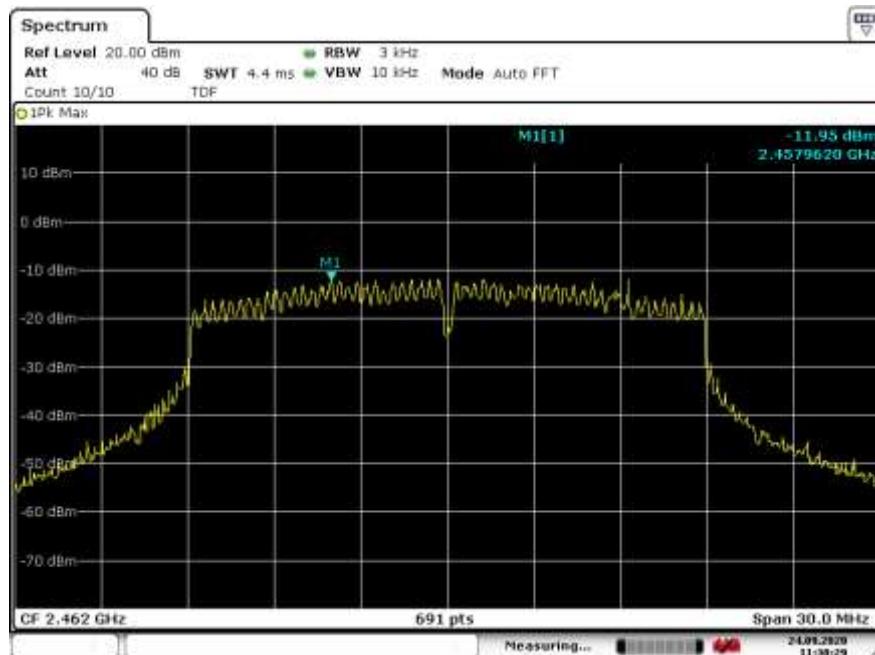
Test Mode : 802.11n HT20 2412MHz



Test Mode : 802.11n HT20 2437MHz



Test Mode : 802.11n HT20 2462MHz



6.3.5 Measurement Uncertainty

→ Uncertainty = ± 1.2 dB (k = 2, 95.45 %)

6.4 6 dB Bandwidth

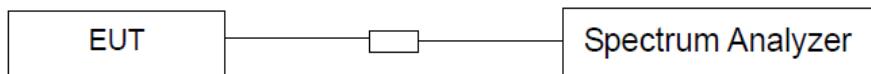
6.4.1 Test Limit

The minimum 6 dB bandwidth shall be at least 500 kHz.

6.4.2 Measurement Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 15.247 Meas. Guidance v05.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 100 kHz, VBW = 300 kHz, Detector = Peak, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

6.4.3 Test SET-UP (Block Diagram of Configuration)



6.4.4 Test Results

[802.11b]

| Channel | Frequency (MHz) | 6dB Bandwidth (MHz) | Limit (MHz) | Result |
|---------|-----------------|---------------------|-------------|--------|
| 1 | 2412 | 3.82 | ≥ 0.5 | Pass |
| 6 | 2437 | 2.03 | ≥ 0.5 | Pass |
| 11 | 2462 | 1.80 | ≥ 0.5 | Pass |

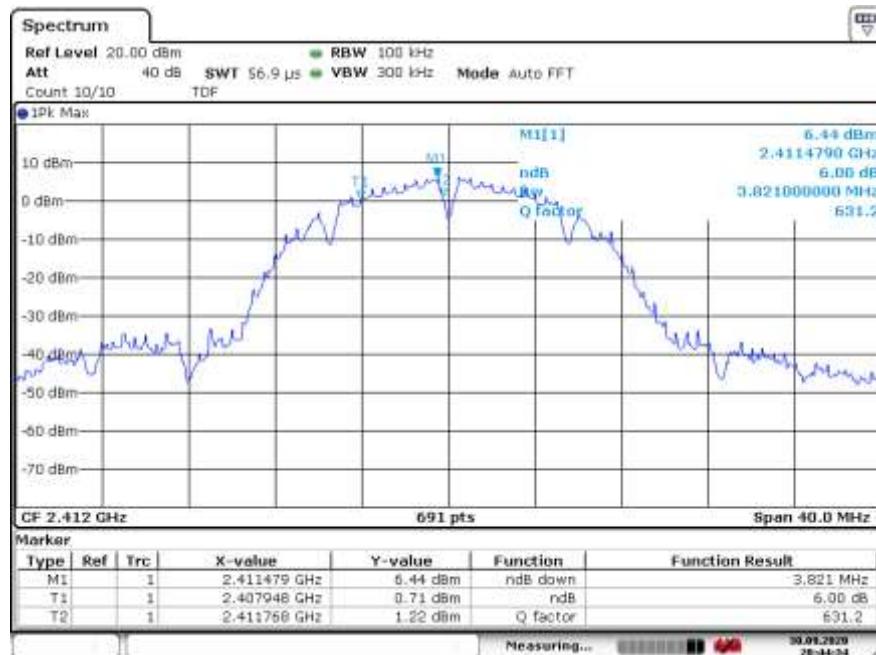
[802.11g]

| Channel | Frequency (MHz) | 6dB Bandwidth (MHz) | Limit (MHz) | Result |
|---------|-----------------|---------------------|-------------|--------|
| 1 | 2412 | 4.69 | ≥ 0.5 | Pass |
| 6 | 2437 | 3.71 | ≥ 0.5 | Pass |
| 11 | 2462 | 5.33 | ≥ 0.5 | Pass |

[802.11n HT20]

| Channel | Frequency (MHz) | 6dB Bandwidth (MHz) | Limit (MHz) | Result |
|---------|-----------------|---------------------|-------------|--------|
| 1 | 2412 | 6.19 | ≥ 0.5 | Pass |
| 6 | 2437 | 5.33 | ≥ 0.5 | Pass |
| 11 | 2462 | 4.98 | ≥ 0.5 | Pass |

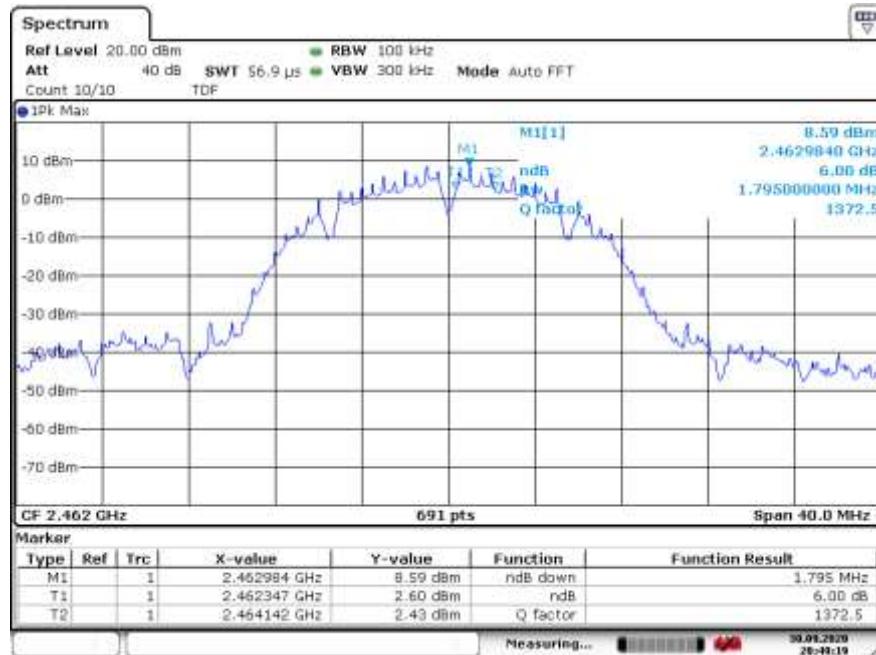
Test Mode : 802.11b 2412MHz



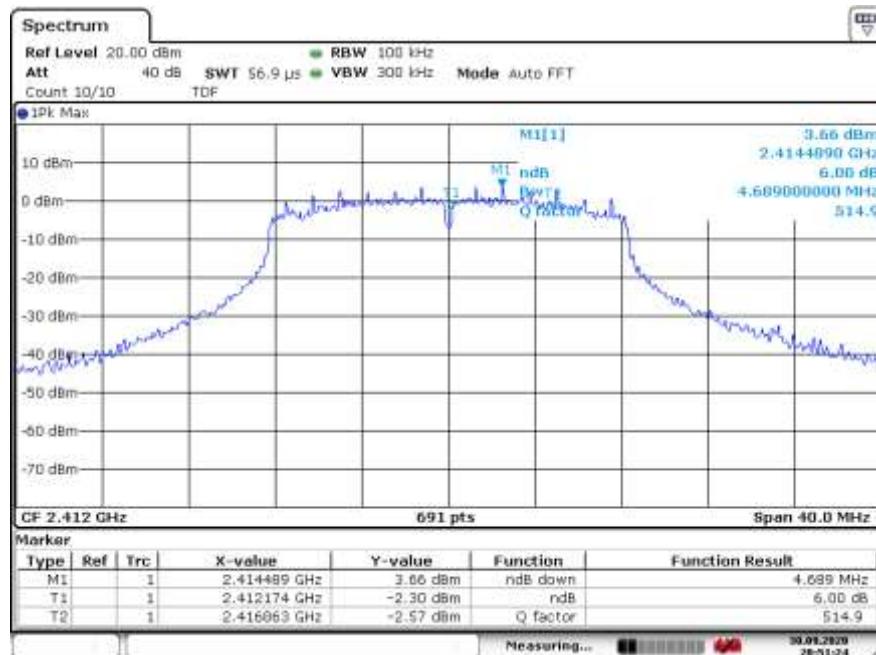
Test Mode : 802.11b 2437MHz



Test Mode : 802.11b 2462MHz



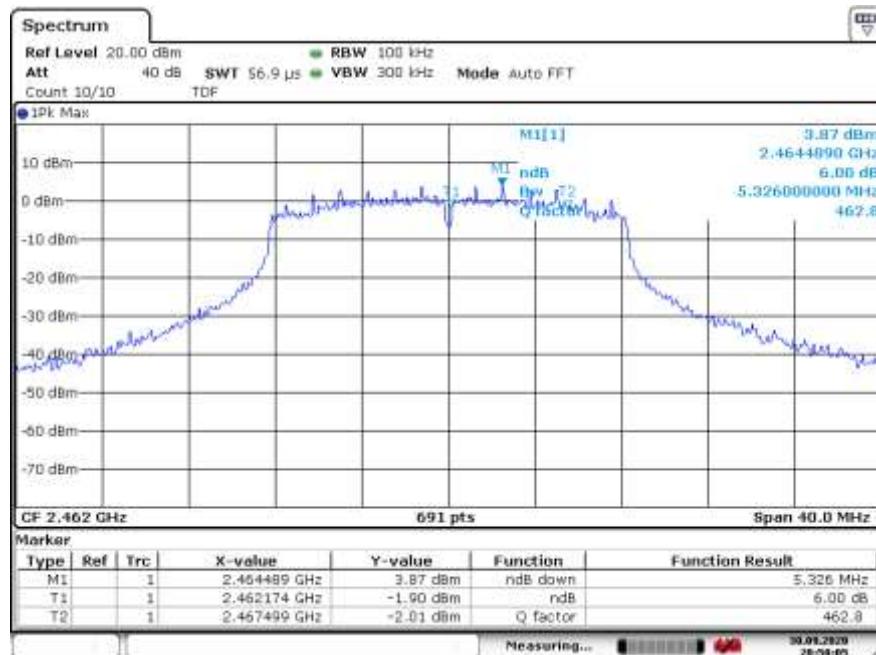
Test Mode : 802.11g 2412MHz



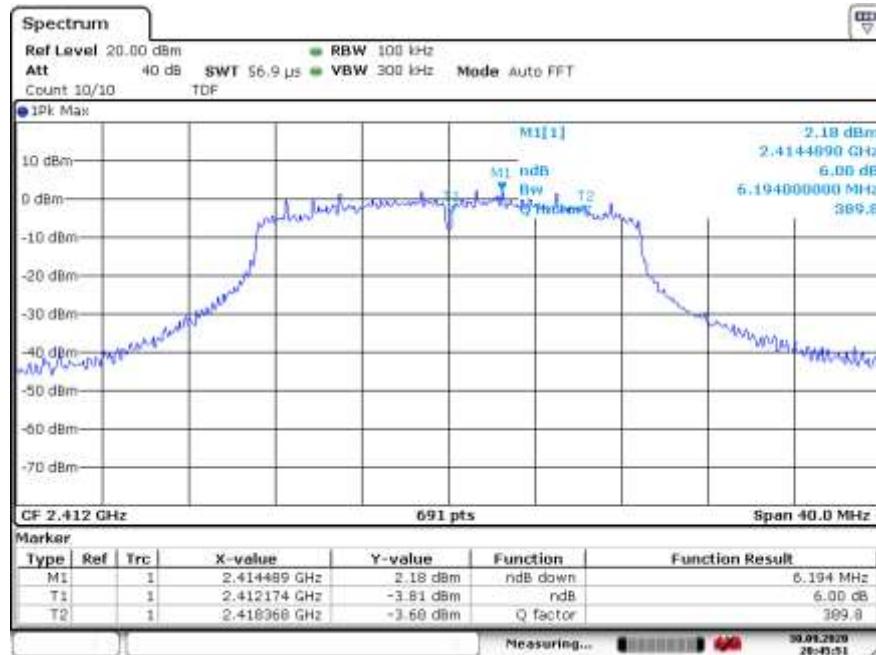
Test Mode : 802.11g 2437MHz



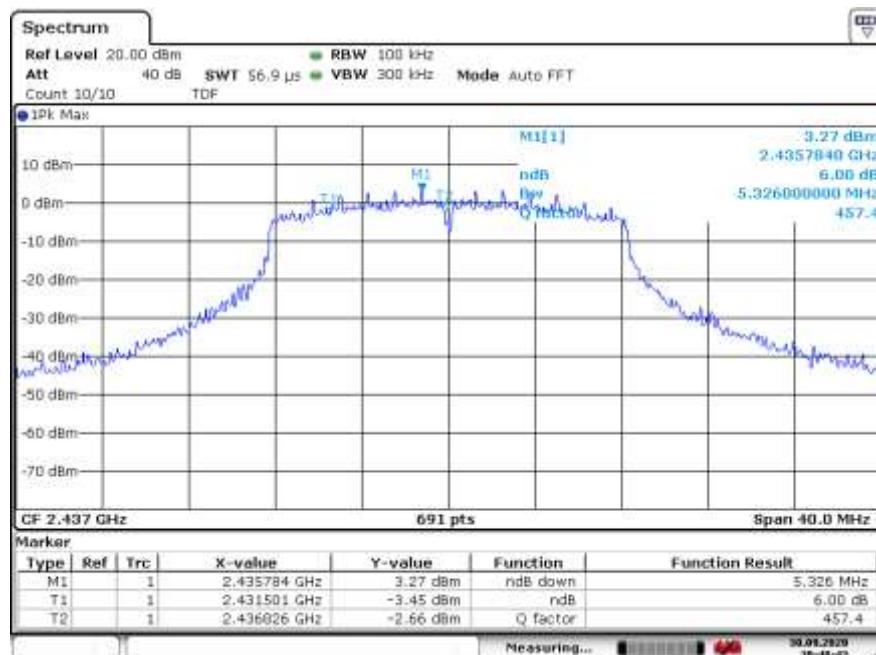
Test Mode : 802.11g 2462MHz



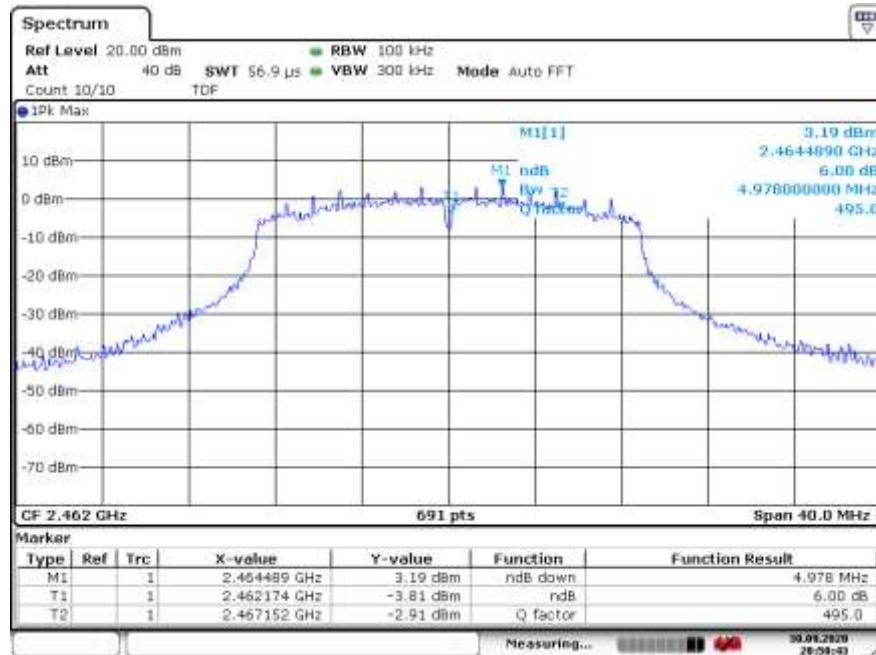
Test Mode : 802.11n HT20 2412MHz



Test Mode : 802.11n HT20 2437MHz



Test Mode : 802.11n HT20 2462MHz



6.4.5 Measurement Uncertainty

→ Uncertainty = $\pm 3.4\%$

6.5 Conducted Spurious Emission

6.5.1 Test Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a).

6.5.2 Test Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 15.247 Meas. Guidance v05.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 100 kHz, VBW = 300 kHz, Detector = Peak, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

6.5.3 Test SET-UP (Block Diagram of Configuration)

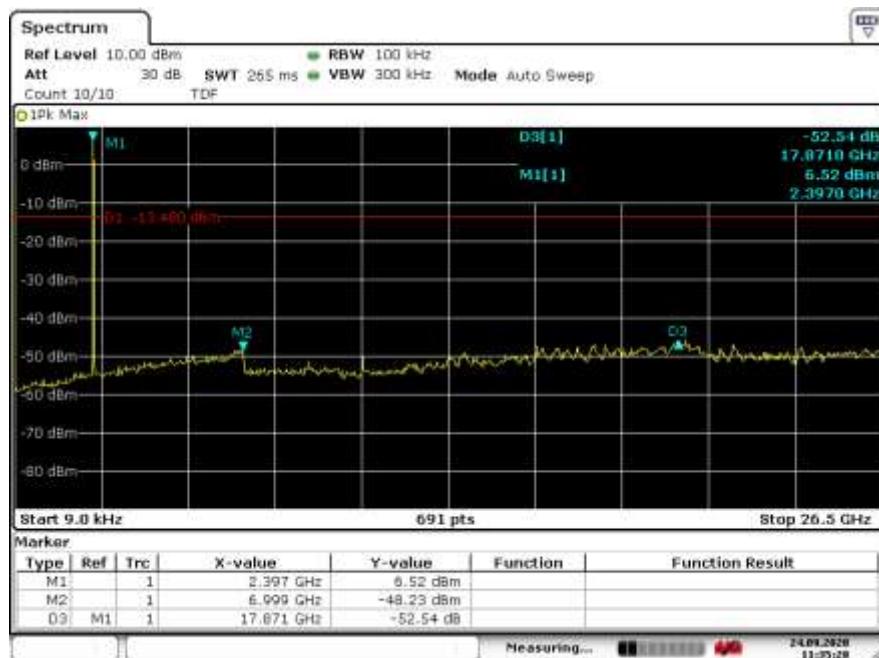
Conducted Emission Test Set-Up, Frequency above 1000 MHz



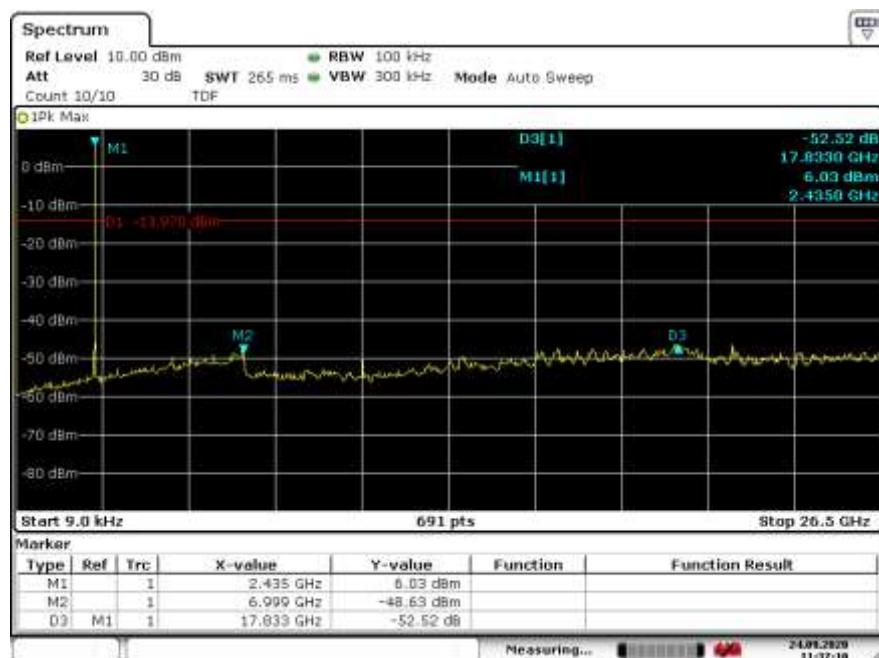
6.5.4 Test Result

[Conducted Spurious Emission Test]

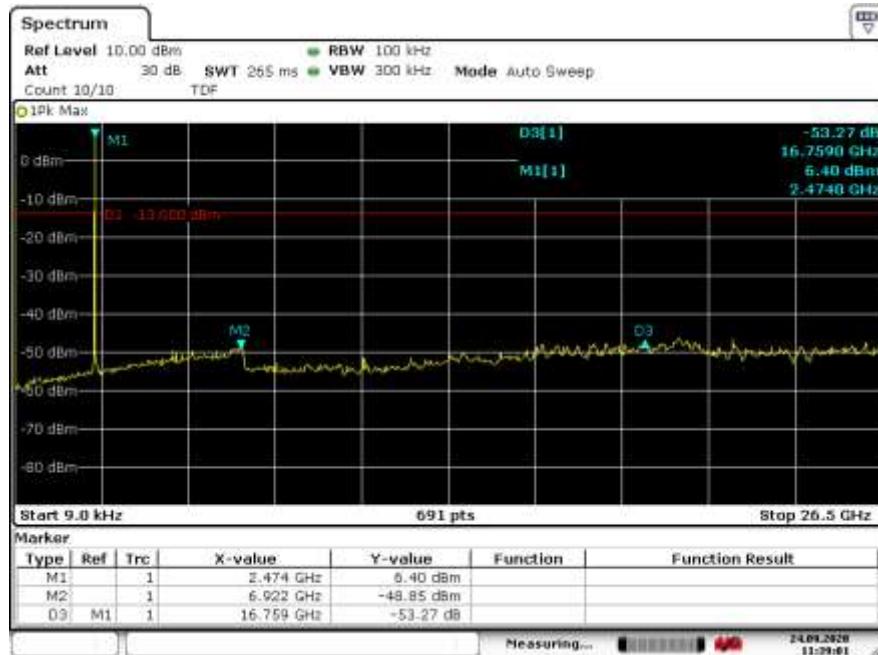
Test Mode : 802.11b 2412MHz



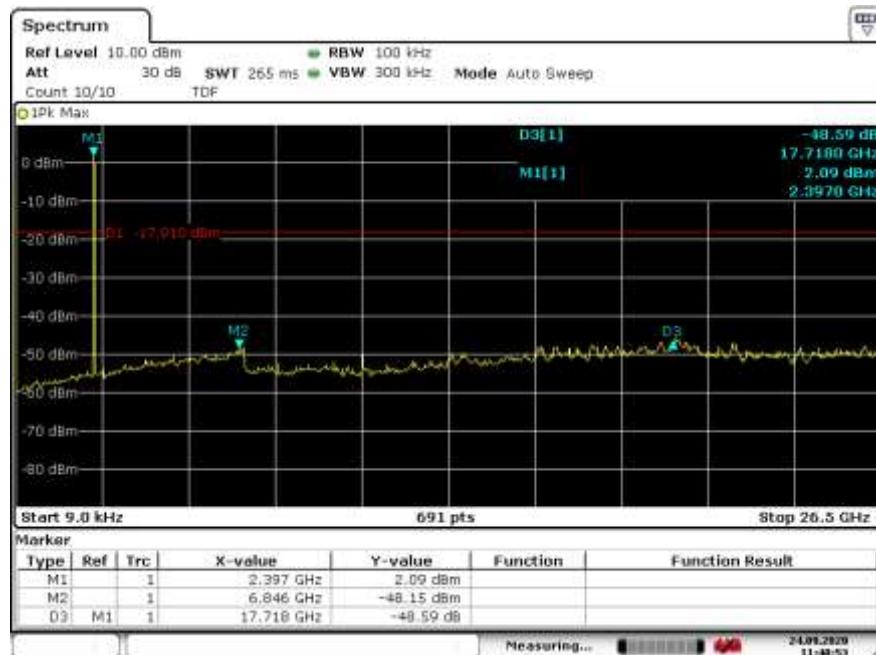
Test Mode : 802.11b 2437MHz



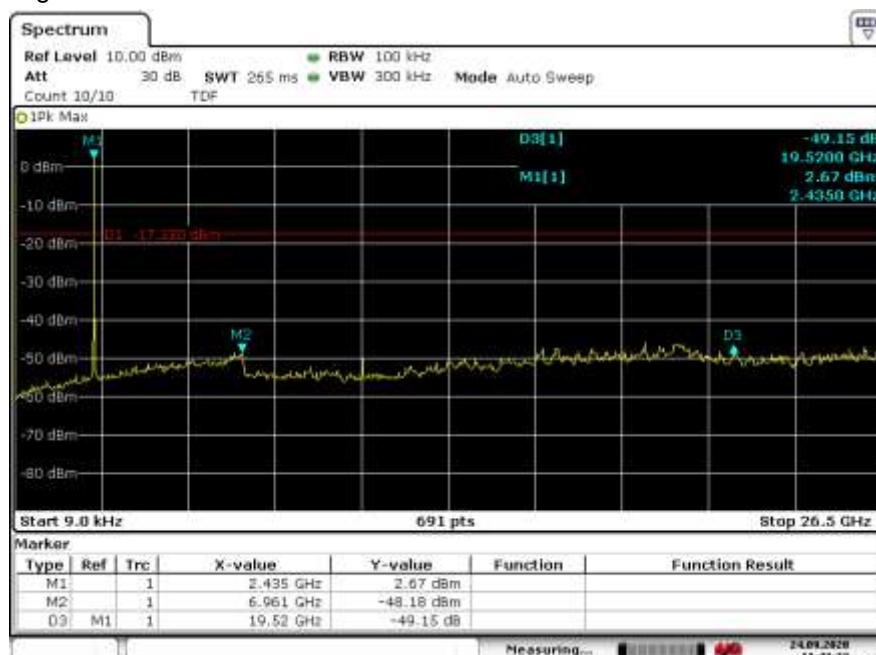
Test Mode : 802.11b 2462MHz



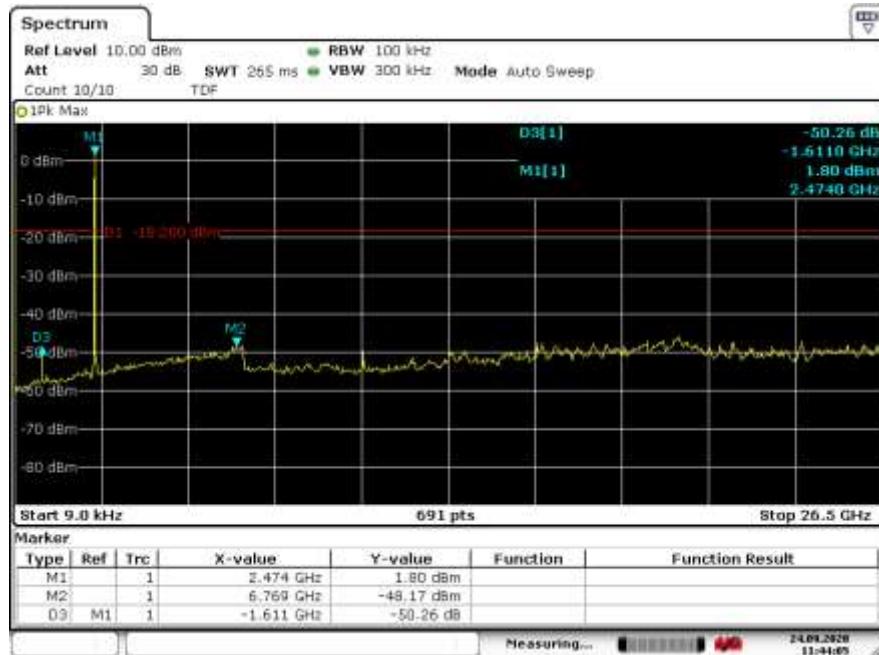
Test Mode : 802.11g 2412MHz



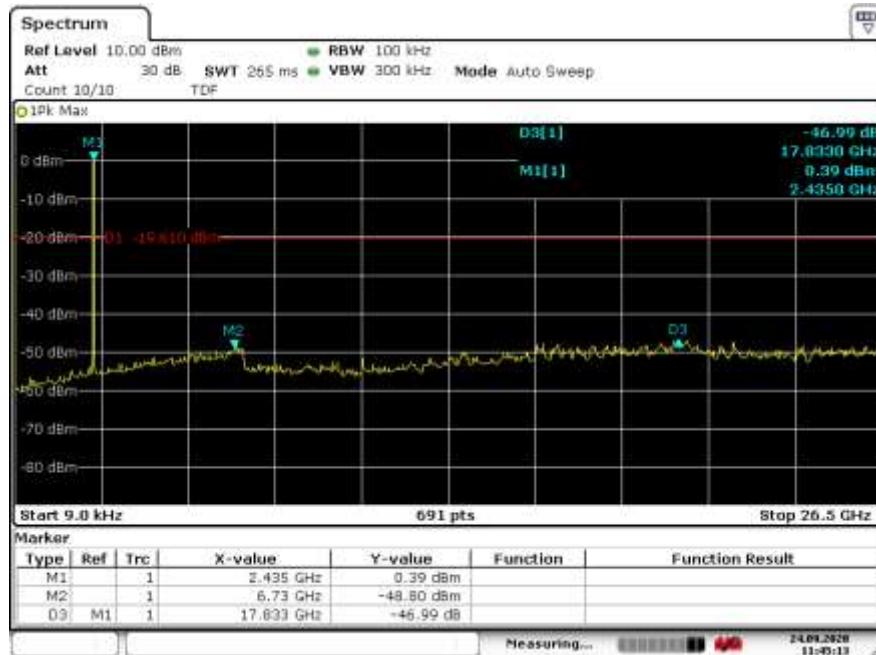
Test Mode : 802.11g 2437MHz



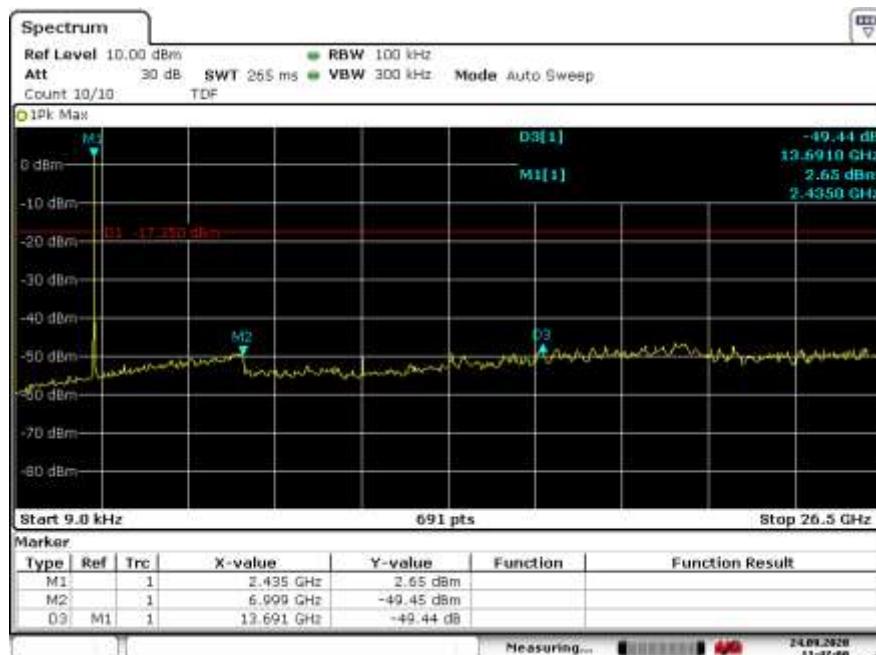
Test Mode : 802.11g 2462MHz



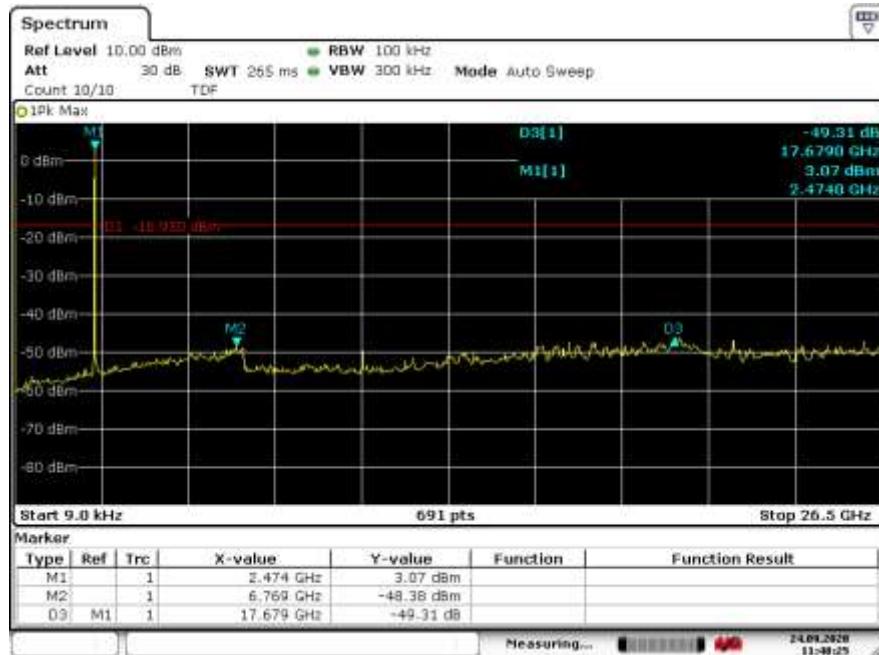
Test Mode : 802.11n HT20 2412MHz



Test Mode : 802.11n HT20 2437MHz



Test Mode : 802.11n HT20 2462MHz



6.5.5 Measurement Uncertainty

→ Uncertainty = ± 1.2 dB ($k = 2$, 95.45 %)

6.6 Band Edges Measurement

6.6.1 Test Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a).

6.6.2 Test Procedure

The EUT is placed on a turntable with 1.5 meter above ground.

The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.

Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:

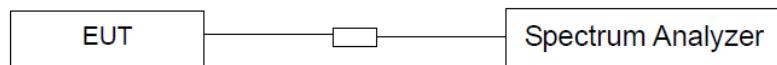
PEAK: RBW=VBW=100 kHz / Sweep=AUTO

AVERAGE: RBW=100 kHz / VBW=10Hz / Sweep=AUTO

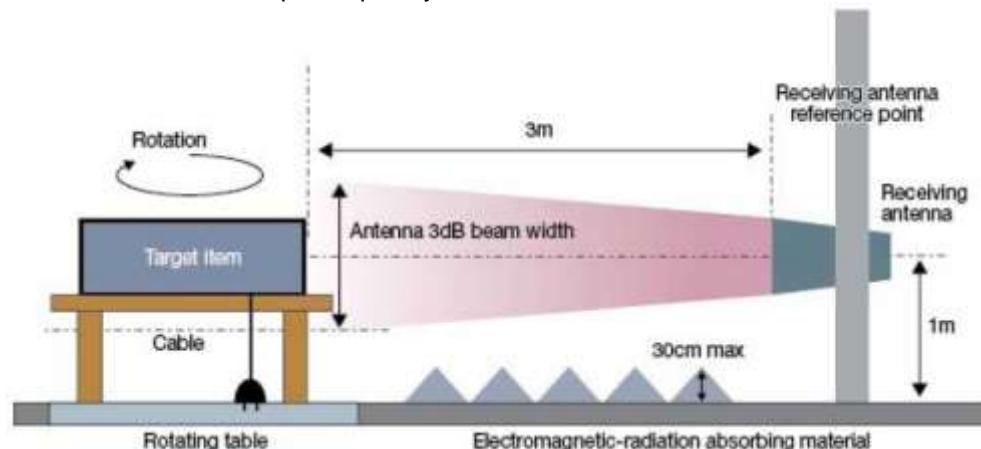
Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

6.6.3 Test SET-UP (Block Diagram of Configuration)

(a) Conducted Emission Test Set-Up, Frequency above 1000 MHz



(b) Radiated Emission Test Set-Up, Frequency above 1000 MHz



6.6.4 Test Result

[Conducted Band Edges]

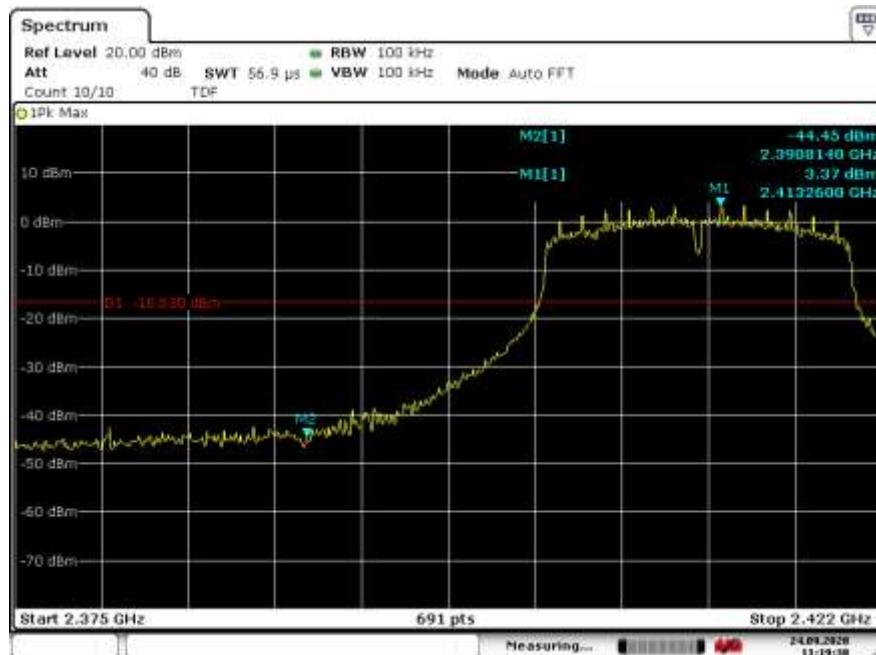
Test Mode : 802.11b 2412MHz Band Edge



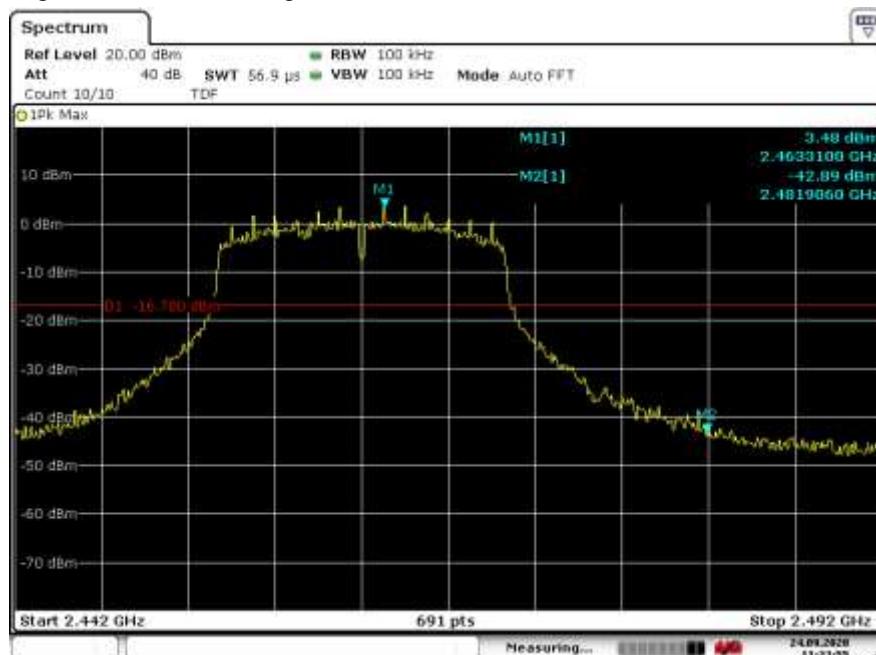
Test Mode : 802.11b 2462MHz Band Edge



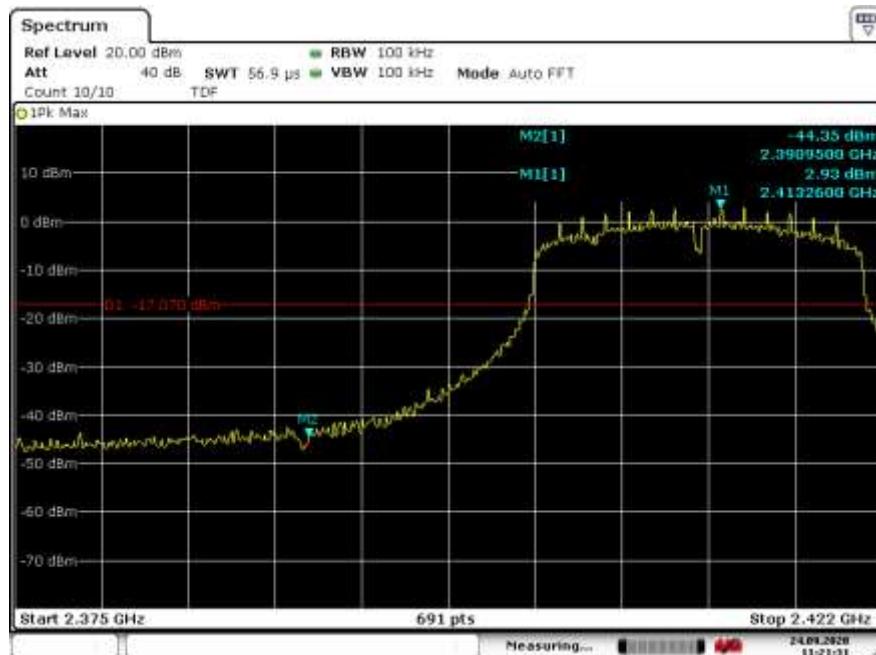
Test Mode : 802.11g 2412MHz Band Edge



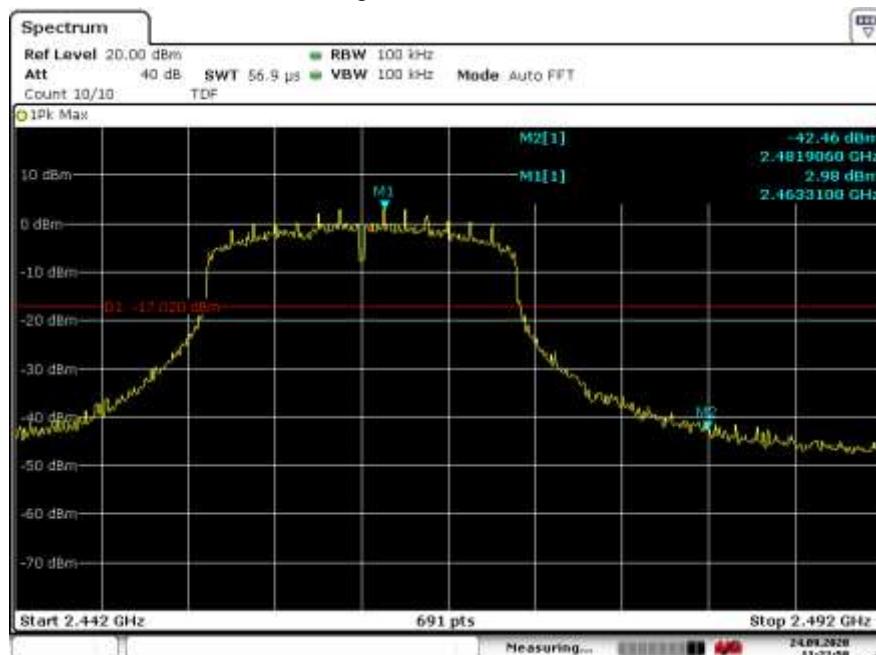
Test Mode : 802.11g 2462MHz Band Edge



Test Mode : 802.11n HT20 2412MHz Band Edge



Test Mode : 802.11n HT20 2462MHz Band Edge



[Radiated Band Edges Test]

[802.11b]

| Frequency [MHz] | Reading [dB μ V] | Detector Mode | Factor [dB] | Level [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Pol/Phase |
|-----------------|----------------------|---------------|-------------|----------------|----------------|-------------|-----------|
| 2390.04 | 42.98 | Peak | -7.14 | 35.84 | 73.98 | 38.14 | Hor |
| 2390.04 | 47.33 | Peak | -7.14 | 40.19 | 73.98 | 33.79 | Ver |
| 2483.50 | 66.72 | Peak | -6.94 | 59.78 | 73.98 | 14.20 | Hor |
| 2483.50 | 61.99 | Peak | -6.94 | 55.05 | 73.98 | 18.93 | Ver |

[802.11g]

| Frequency [MHz] | Reading [dB μ V] | Detector Mode | Factor [dB] | Level [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Pol/Phase |
|-----------------|----------------------|---------------|-------------|----------------|----------------|-------------|-----------|
| 2390.04 | 63.11 | Peak | -7.14 | 55.97 | 73.98 | 18.01 | Hor |
| 2390.04 | 62.01 | Peak | -7.14 | 54.87 | 73.98 | 19.11 | Ver |
| 2483.48 | 76.37 | Peak | -6.94 | 69.43 | 73.98 | 4.55 | Hor |
| 2483.48 | 74.59 | Peak | -6.94 | 67.65 | 73.98 | 6.33 | Ver |

[802.11n HT20]

| Frequency [MHz] | Reading [dB μ V] | Detector Mode | Factor [dB] | Level [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Pol/Phase |
|-----------------|----------------------|---------------|-------------|----------------|----------------|-------------|-----------|
| 2390.04 | 59.15 | Peak | -7.14 | 52.01 | 73.98 | 21.97 | Hor |
| 2390.04 | 58.43 | Peak | -7.14 | 51.29 | 73.98 | 22.69 | Ver |
| 2483.50 | 75.35 | Peak | -6.94 | 68.41 | 73.98 | 5.57 | Hor |
| 2483.50 | 73.13 | Peak | -6.94 | 66.19 | 73.98 | 7.79 | Ver |

Note : Factor = Antenna Gain + Cable loss – Amplifier Gain.

6.6.5 Measurement Uncertainty

- Conducted Uncertainty = ± 1.2 dB (k = 2, 95.45 %)
- Radiated Uncertainty = ± 2.50 dB (k = 2, 95.45 %)

6.7 Radiated Spurious Emission

6.7.1 Test Limit

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

Note: Bluetooth module configuration was evaluated.

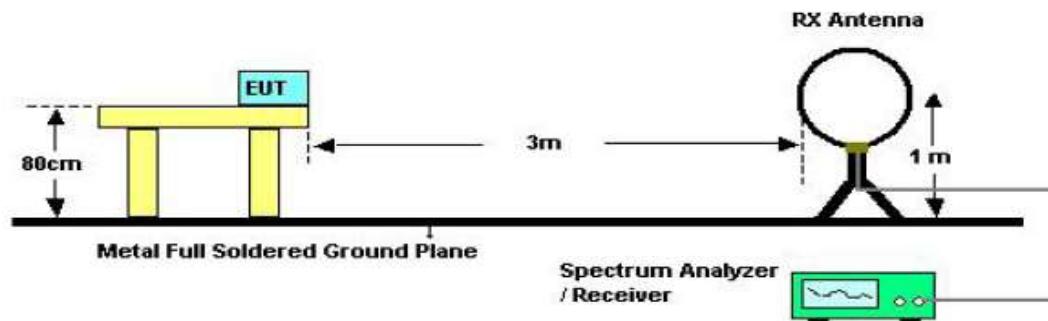
| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement distance (meters) |
|-----------------|-----------------------------------|-------------------------------|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

6.7.2 Test Procedure

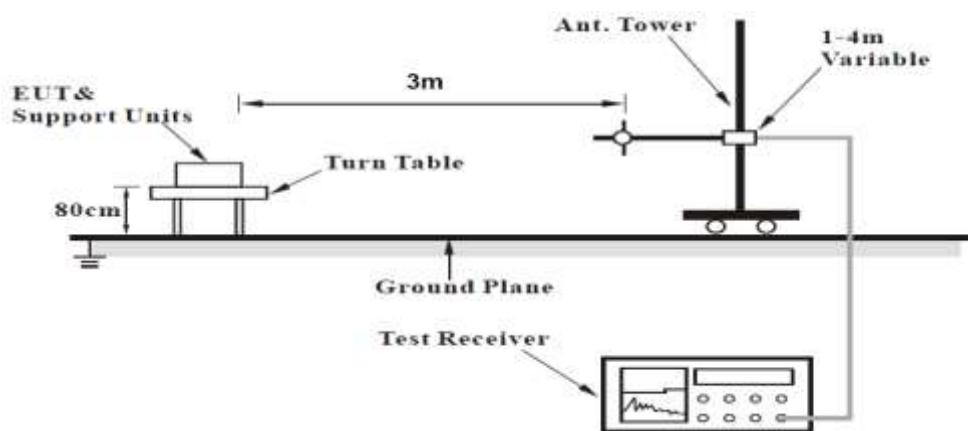
1. The testing follows FCC KDB Publication No. 558074 D01 15.247 Meas. Guidance v05.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable. For emissions testing at or below 1 GHz, the table height was 80cm above the reference ground plane. For emission measurements above 1 GHz, the table height was 1.5m.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1 GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings and peak emission levels are measured :
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW (9-150 kHz: 200 Hz, 0.15-30MHz: 9kHz, 30-1000 MHz: 120 kHz, above 1GHz: 1 MHz).
 - (3) VBW \geq 3 x RBW ; Sweep = auto; Detector function = peak; Trace = max hold
 For average measurement:
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW \geq 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
8. Measure and record the results in the test report.

6.7.3 Test SET-UP (Block Diagram of Configuration)

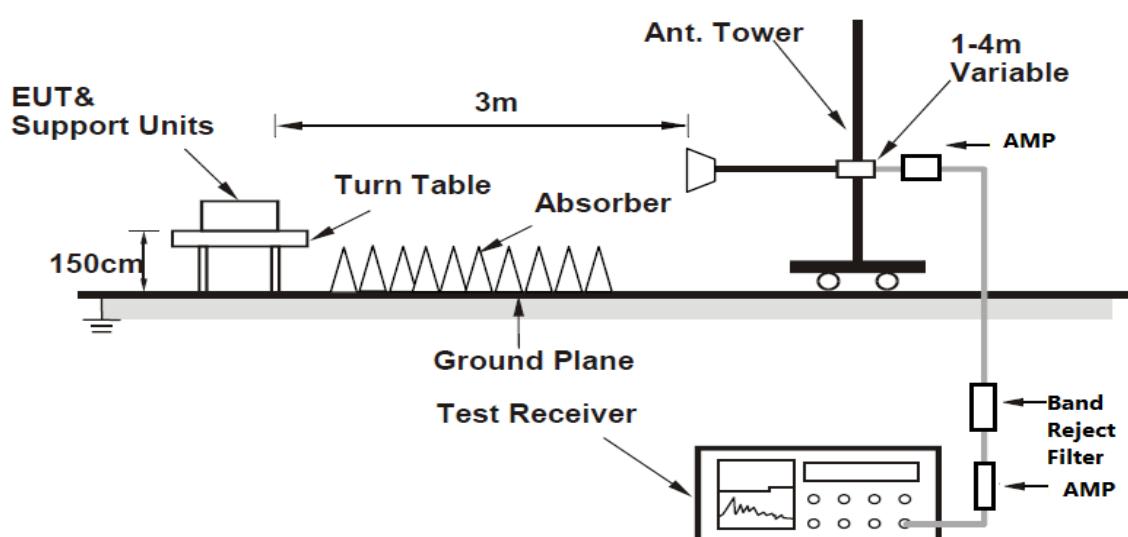
1. Radiated Emission Test Set-Up, Frequency Below 30 MHz



2. Radiated Emission Test Set-Up, Frequency Below 1000 MHz



3. Radiated Emission Test Set-Up, Frequency Above 1000 MHz.



6.7.4 Test Results

[Below 30MHz]

| Frequency [MHz] | Reading [dB μ V] | Antenna Factor [dB] | Cable Loss [dB] | Preamp Factor [dB] | Level [dBuV/m] | Pol/Phase |
|---|-------------------------|---------------------------|--------------------|--------------------------|-------------------|-----------|
| No other emissions were detected at a level greater than 20 dB below limit. | | | | | | |

Remark: §15.31(o)_The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

[Below 1 GHz – 30 MHz ~ 1 GHz]

Test Mode : 802.11b (Worst case : X-H)

BWS

Testing
Laboratory

BWS TECH

tel:031-333-5997

fax:031-333-0017

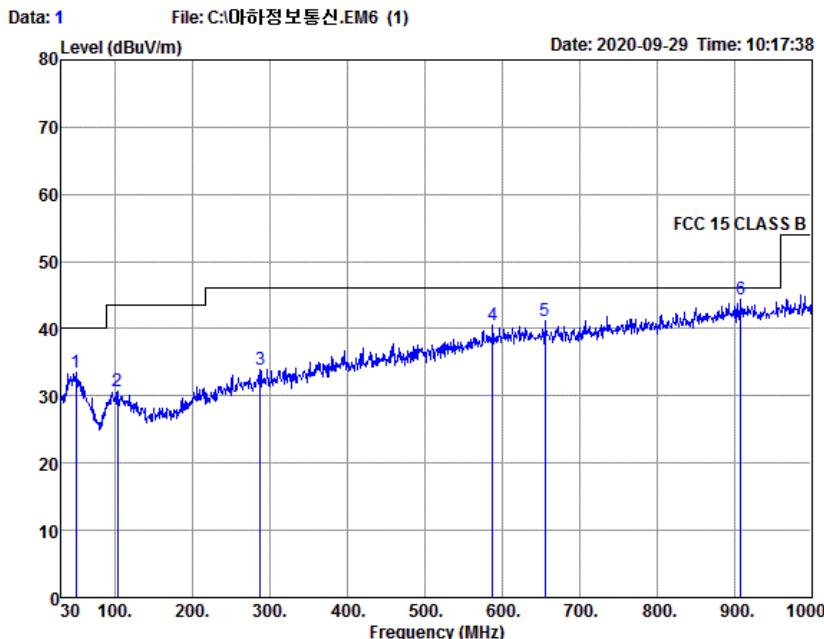
www.bws.co.kr

Radiated Emission TEST..test

EUT:

Manufacturer: H

Operating Condition:



| Freq. MHz | AntFac (dB/m) | CabLoss (dB) | Reading (dBuV) | Measured (dBuV/m) | Over (dBuV/m) | Limit (dBuV/m) | Pol/Phase | Remark |
|--------------|------------------|-----------------|-------------------|----------------------|------------------|-------------------|------------|--------|
| 49.400 | 19.86 | 0.36 | 13.25 | 33.47 | -6.53 | 40.00 | HORIZONTAL | Peak |
| 102.750 | 17.35 | 0.54 | 12.83 | 30.72 | -12.78 | 43.50 | HORIZONTAL | Peak |
| 287.050 | 19.36 | 0.90 | 13.73 | 33.99 | -12.01 | 46.00 | HORIZONTAL | Peak |
| 587.750 | 25.31 | 1.34 | 13.79 | 40.44 | -5.56 | 46.00 | HORIZONTAL | Peak |
| 655.650 | 25.70 | 1.40 | 14.08 | 41.18 | -4.82 | 46.00 | HORIZONTAL | Peak |
| 908.820 | 28.52 | 1.66 | 14.28 | 44.46 | -1.54 | 46.00 | HORIZONTAL | Peak |

Note: 1. Measured Level = Antenna Factor + Cable Loss - Preamp + Reading

Review: _____

Note : Only the worst case plots for Radiated Spurious Emissions.

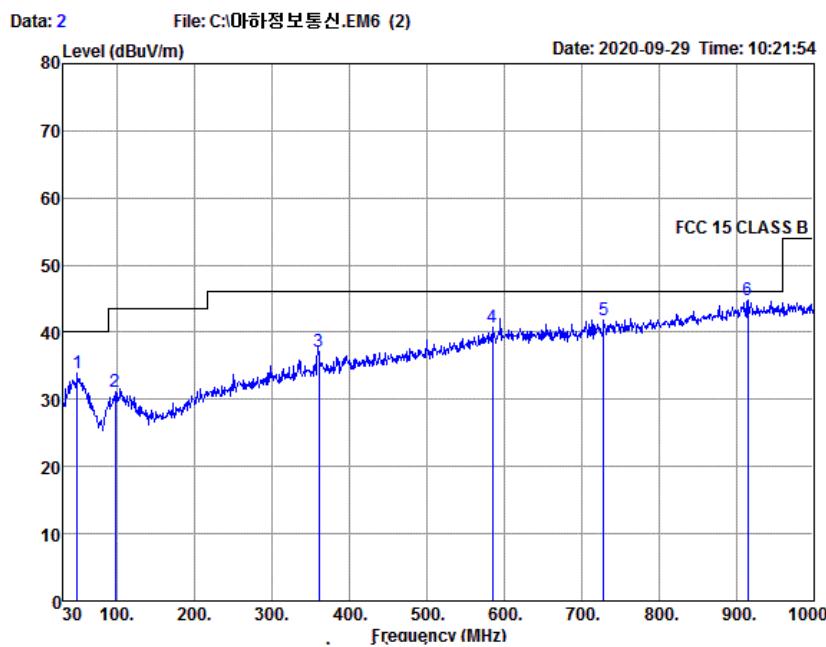
Test Mode : 802.11g (Worst case : X-H)



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fax:031-333-0017
www.bws.co.kr

Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



| Freq. MHz | AntFac (dB/m) | CabLoss (dB) | Reading (dBuV) | Measured (dBuV/m) | Over (dBuV/m) | Limit (dBuV/m) | Pol/Phase | Remark |
|--------------|------------------|-----------------|-------------------|----------------------|------------------|-------------------|------------|--------|
| 48.430 | 19.84 | 0.35 | 13.83 | 34.02 | -5.98 | 40.00 | HORIZONTAL | Peak |
| 96.930 | 17.13 | 0.59 | 13.48 | 31.20 | -12.30 | 43.50 | HORIZONTAL | Peak |
| 360.770 | 20.94 | 1.03 | 15.15 | 37.12 | -8.88 | 46.00 | HORIZONTAL | Peak |
| 584.840 | 25.24 | 1.34 | 14.17 | 40.75 | -5.25 | 46.00 | HORIZONTAL | Peak |
| 728.400 | 26.15 | 1.47 | 14.15 | 41.77 | -4.23 | 46.00 | HORIZONTAL | Peak |
| 915.610 | 28.54 | 1.68 | 14.68 | 44.90 | -1.10 | 46.00 | HORIZONTAL | Peak |

Note: 1. Measured Level = Antenna Factor + Cable Loss - FreeSpace + Reading

Review:

Note : Only the worst case plots for Radiated Spurious Emissions.

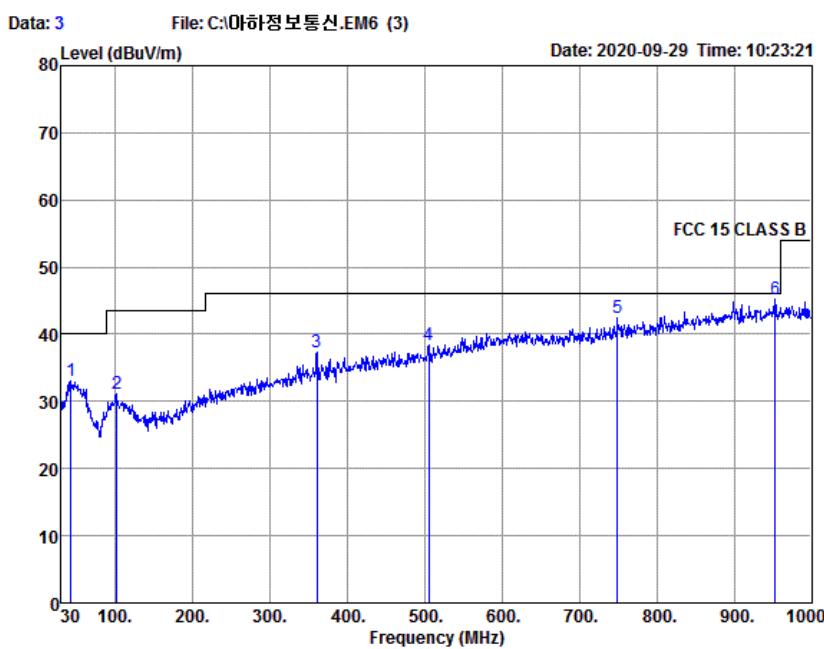
Test Mode : 802.11n(HT20) (Worst case : X-H)



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Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



| Freq. MHz | AntFac (dB/m) | CabLoss (dB) | Reading (dBuV) | Measured (dBuV/m) | Over (dBuV/m) | Limit (dBuV/m) | Pol/Phase | Remark |
|--------------|------------------|-----------------|-------------------|----------------------|------------------|-------------------|------------|--------|
| 42.610 | 19.40 | 0.32 | 13.27 | 32.99 | -7.01 | 40.00 | HORIZONTAL | Peak |
| 101.780 | 17.42 | 0.53 | 13.12 | 31.07 | -12.43 | 43.50 | HORIZONTAL | Peak |
| 360.770 | 20.94 | 1.03 | 15.35 | 37.32 | -8.68 | 46.00 | HORIZONTAL | Peak |
| 505.300 | 23.40 | 1.27 | 13.74 | 38.41 | -7.59 | 46.00 | HORIZONTAL | Peak |
| 748.770 | 26.41 | 1.49 | 14.57 | 42.47 | -3.53 | 46.00 | HORIZONTAL | Peak |
| 953.440 | 28.62 | 1.76 | 14.84 | 45.22 | -0.78 | 46.00 | HORIZONTAL | Peak |

Note: 1. Measured Level = Antenna Factor + Cable Loss - Preamp + Reading

Review:

Note : Only the worst case plots for Radiated Spurious Emissions.

[Above 1 GHz – 1 GHz ~ 18 GHz]

Test Mode : 802.11b (Worst case : X-H)



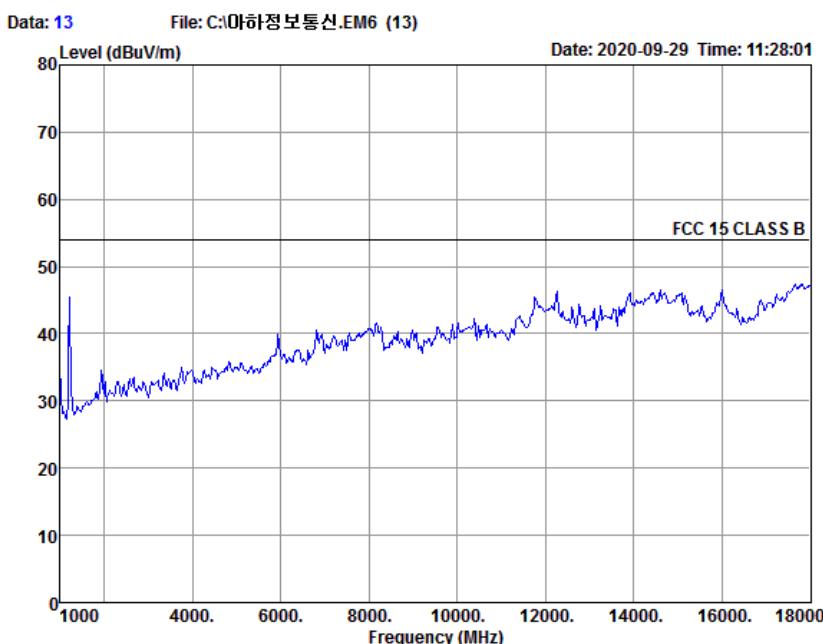
BWS TECH
tel:031-333-5997
fax:031-333-0017
www.bws.co.kr

Radiated Emission TEST ..test

EUT:

Manufacturer: H

Operating Condition:



Review:

Note : 1) Only the worst case plots for Radiated Spurious Emissions.
2) A filter was used for this test.

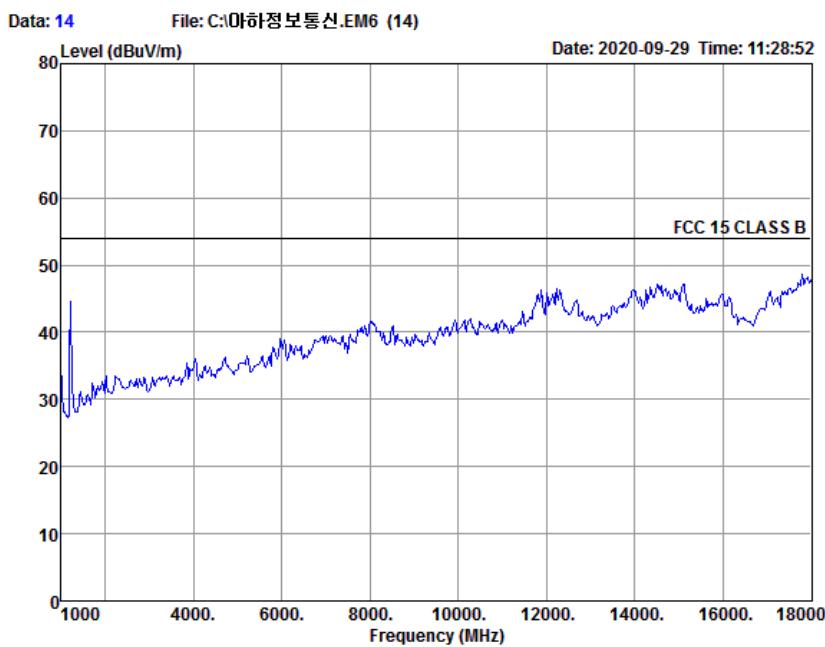
Test Mode : 802.11g (Worst case : X-H)



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Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



Review: _____

Note : 1) Only the worst case plots for Radiated Spurious Emissions.
2) A filter was used for this test.

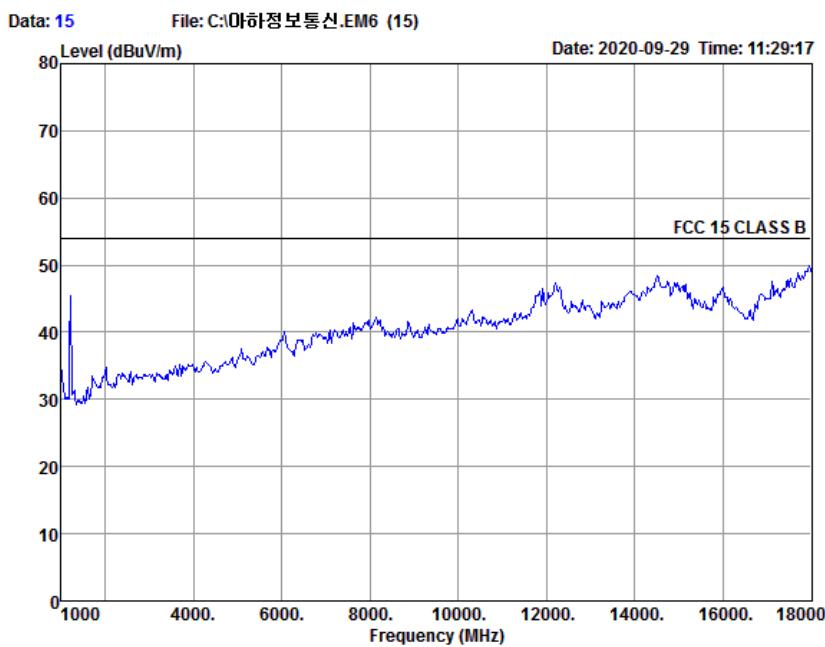
Test Mode : 802.11n(HT20) (Worst case : X-H)



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Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



Review: _____

Note : 1) Only the worst case plots for Radiated Spurious Emissions.
2) A filter was used for this test.

[Above 18 GHz – 18 GHz ~ 30 GHz]

Test Mode : 802.11b (Worst case : X-H)

BWS

Testing
Laboratory

BWS TECH

tel:031-333-5997

fax:031-333-0017

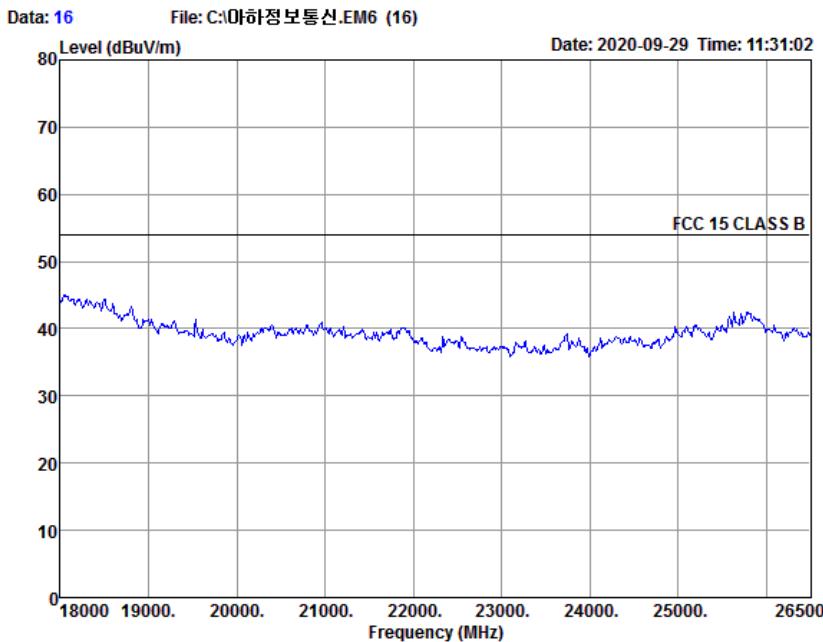
www.bws.co.kr

Radiated Emission TEST ..test

EUT:

Manufacturer: H

Operating Condition:



Review:

Note : Only the worst case plots for Radiated Spurious Emissions.

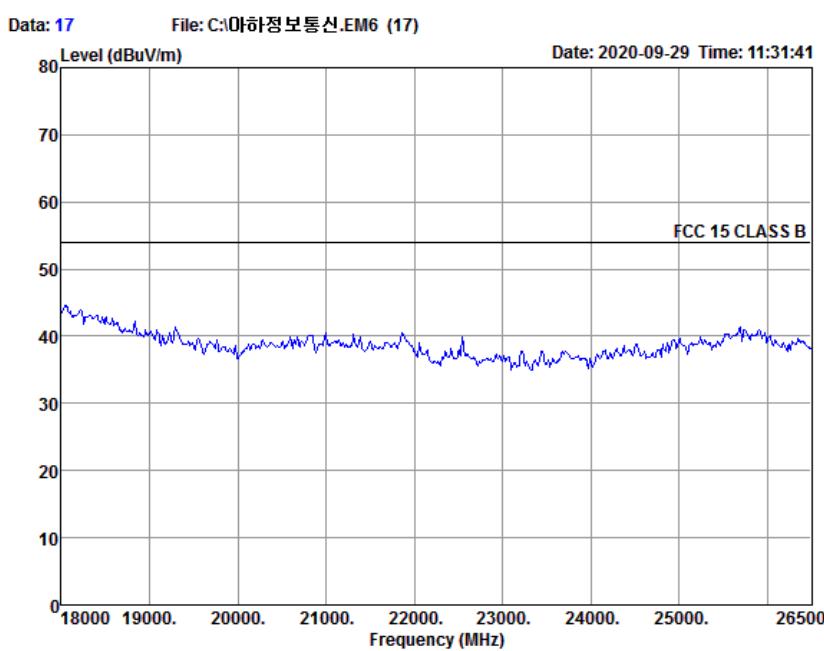
Test Mode : 802.11g (Worst case : X-H)



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Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



Review: _____

Note : Only the worst case plots for Radiated Spurious Emissions.

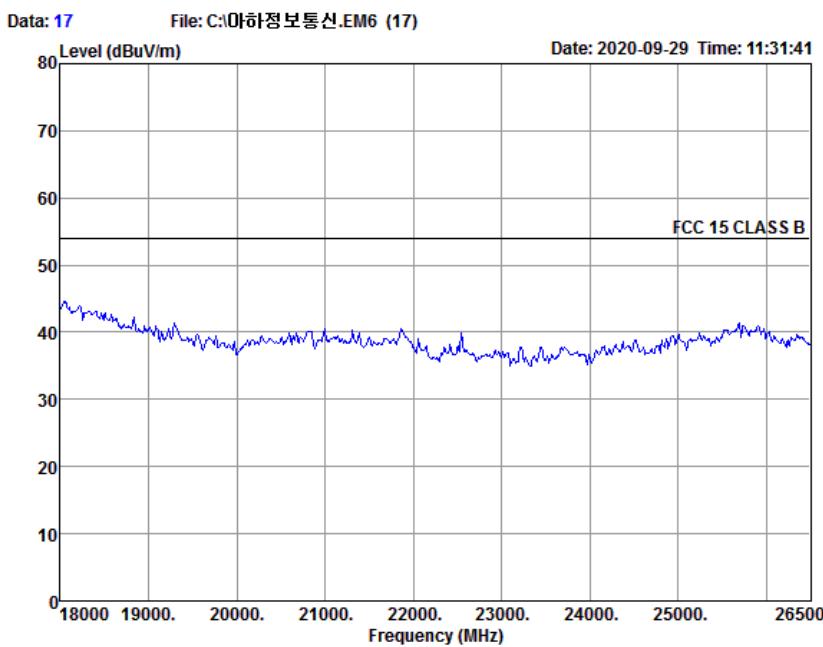
Test Mode : 802.11n(HT20) (Worst case : X-H)



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Radiated Emission TEST ..test

EUT:
Manufacturer: H
Operating Condition:



Review: _____

Note : Only the worst case plots for Radiated Spurious Emissions.

6.7.5 Measurement Uncertainty

→ Uncertainty = ± 2.50 dB ($k = 2, 95.45\%$)

6.8 Antenna Application

6.8.1 Antenna Requirement

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

6.8.2 Test Results

| Antenna Type | Frequency | Antenna Gain | Limit | Result |
|--------------|-----------|--------------|---------|--------|
| PCB Antenna | 2.400 GHz | -1.0 dBi | ≤ 6 dBi | Pass |

<End>