# TEST REPORT

# Part 15 Subpart E 15.407

**Equipment under test** BLACK BOX

**Model name** F790

**FCC ID** 2ADTG-F790

**Applicant** THINKWARE CORPORATION

**Manufacturer** THINKWARE CORPORATION

**Date of test(s)** 2020.09.21 ~ 2020.09.25

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**Issued to**
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## Revision history

| Revision | Date of issue | Test report No. | Description |
|---|---|---|---|
| - | 2020.10.23 | KES-RF1-20T0205 | Initial |
| | | | |

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## 1. General information

| | |
|---|---|
| Applicant: | THINKWARE CORPORATION |
| Applicant address: | A, 9FL, Samwhan Hipex, 240, Pangyoyeok-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea |
| Test site: | KES Co., Ltd. |
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| Test Facility | FCC Accreditation Designation No.: KR0100, Registration No.: 444148 |
| FCC rule part(s): | 15.247 |
| FCC ID: | 2ADTG- F790 |
| Test device serial No.: | ☒ Production ☐ Pre-production ☐ Engineering |

### 1.1. EUT description

| | |
|---|---|
| Equipment under test | BLACK BOX |
| Frequency range | 2 412 ㎒ ~ 2 462 ㎒ (11b/g/n_HT20)<br>5 180 ㎒ ~ 5 240 ㎒ (11n_HT20, 11ac_VHT20)<br>5 190 ㎒ ~ 5 230 ㎒ (11n_HT40, 11ac_VHT40) |
| Model: | F790 |
| Modulation technique | DSSS, OFDM |
| Number of channels | 2 412 ㎒ ~ 2 462 ㎒ (11b/g/n_HT20) : 11ch<br>5 180 ㎒ ~ 5 240 ㎒ (11n_HT20, 11ac_VHT20) : 4ch<br>5 190 ㎒ ~ 5 230 ㎒ (11n_HT40, 11ac_VHT40) : 2ch |
| Antenna specification | Antenna type(2.4㎓ WIFI) : Chip antenna, Peak gain : 0.80 ㏈i<br>Antenna type( 5㎓ WIFI) : Chip antenna, Peak gain : 1.95 ㏈i |
| Power source | DC 12 V / DC 24V |
| H/W version | V 3.1 PP2 |
| S/W version | V 1.00.00 |

### 1.2. Test configuration

The **THINKWARE CORPORATION // F790 // FCC ID: 2ADTG-F790** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
KDB 558074 D01 v05 r02
ANSI C63.10-2013

### 1.3. Device modifications

N/A

### 1.4. Accessory information

N/A

## 1.5. Measurement results explanation example

For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 1.40 + 10.00 = 11.40 (dB)

## 1.6. Measurement Uncertainty

| Test Item | | Uncertainty |
|---|---|---|
| Uncertainty for Conduction emission test | | 2.46 dB |
| Uncertainty for Radiation emission test (include Fundamental emission) | Below 1 GHz | 4.40 dB |
| | Above 1GHz | 5.94 dB |
| Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. | | |

## 1.7. Frequency/channel operations

**UNII-1 802.11a/n/ac_HT20/VHT20**

| Ch. | Frequency (MHz) | Mode |
|---|---|---|
| 36 | 5 180 | 802.11a/n/ac_HT20/VHT20 |
| . | | . |
| 44 | 5 220 | 802.11a/n/ac_HT20/VHT20 |
| . | | . |
| 48 | 5 240 | 802.11a/n/ac_HT20/VHT20 |

**UNII-1 802.11n/ac_HT40/VHT40**

| Ch. | Frequency (MHz) | Mode |
|---|---|---|
| 38 | 5 190 | 802.11n/ac_HT40/VHT40 |
| . | | . |
| 46 | 5 230 | 802.11n/ac_HT40/VHT40 |

## 1.8. Worst case data rate

1. Radiated emission was performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.
2. Worst-case data rates were:

802.11a: **54 Mbps**
802.11n_HT20/HT40: **MCS7**
802.11ac_VHT20: **MCS8**
802.11ac_VHT40: **MCS9**

## 2. Summary of tests

| Reference | Parameter | Test results |
|---|---|---|
| 15.407(a) | 26 dB bandwidth & 99 % Occupied Bandwidth | N/A[1)] |
| 15.407(a) | Maximum conducted output power | Pass |
| 15.407(a) | Power spectral density | N/A[1)] |
| 15.407(g) | Frequency stability | N/A[1)] |
| 15.205 15.209 | Radiated restricted band and emission | Pass |
| 15.407(d) | General field strength limit<br>(Restricted bands and radiated emission limit) | N/A[1)] |
| 15.207 | AC power line conducted emissions | N/A[1)] |

Note 1) Please Refer to the approved Module Report (Report No.: EC1905007RI03, EC1905007RI04) for these parameters.

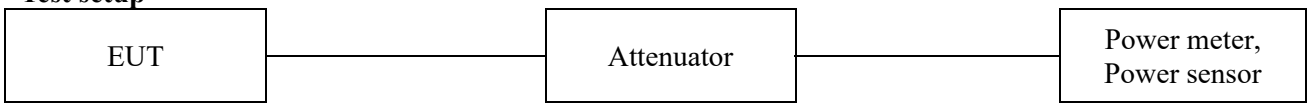
# 3. Test results

## 3.1. Output power

**Test procedure**

ANSI C63.10-2013 - Section 11.9.1.3 and 11.9.2.3.2

**Test setup**




**ANSI C63.10-2013 - Section 11.9.1.3**

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS ba ndwidth and shall use a fast-responding diode detector.

**ANSI C63.10-2013 - Section 11.9.2.3.2**

Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

**Limit**

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

**FCC**

| Band | EUT Category | | Limit |
|---|---|---|---|
| UNII-1 | | Outdoor access point | 1 W (30 dBm) |
| | | Indoor access point | |
| | | Fixed point-to-point access point | |
| | ✓ | Mobile and portable client device | 250 mW(24 dBm) |
| UNII-2A | | | 250 mW or 11 dBm + 10logB* |
| UNII-2C | | | 250 mW or 11 dBm + 10logB* |
| UNII-3 | | | 1 W (30 dBm) |

**Note.**

1. FCC Limit B is the 26 dB emission bandwidth.

**Test results**

| Band | Frequency (㎒) | Mode | Peak Output Power (dBm) | Average Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| | | | | | FCC |
| UNII-1 | 5 180 | 802.11a | 16.89 | 10.93 | 24.00 |
| | 5 220 | | 16.59 | 10.95 | |
| | 5 240 | | 16.43 | 10.90 | |

| Band | Frequency (㎒) | Mode | Peak Output Power (dBm) | Average Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| | | | | | FCC |
| UNII-1 | 5 180 | 802.11n_ HT20 | 15.50 | 10.74 | 24.00 |
| | 5 220 | | 15.43 | 10.50 | |
| | 5 240 | | 15.27 | 10.43 | |

| Band | Frequency (㎒) | Mode | Peak Output Power (dBm) | Average Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| | | | | | FCC |
| UNII-1 | 5 180 | 802.11n_ HT40 | 15.48 | 10.30 | 24.00 |
| | 5 220 | | 15.85 | 10.31 | |

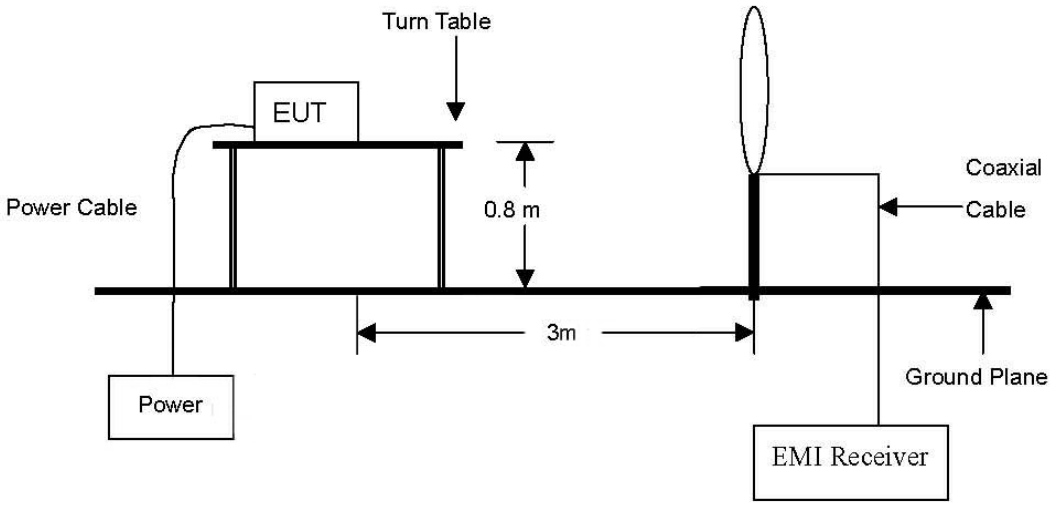
| Band | Frequency (㎒) | Mode | Peak Output Power (dBm) | Average Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| | | | | | FCC |
| UNII-1 | 5 180 | 802.11ac _VHT20 | 15.26 | 10.56 | 24.00 |
| | 5 220 | | 15.41 | 10.31 | |
| | 5 240 | | 15.22 | 10.45 | |

| Band | Frequency (㎒) | Mode | Peak Output Power (dBm) | Average Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| | | | | | FCC |
| UNII-1 | 5 180 | 802.11ac _VHT40 | 15.09 | 10.23 | 24.00 |
| | 5 220 | | 15.11 | 10.40 | |

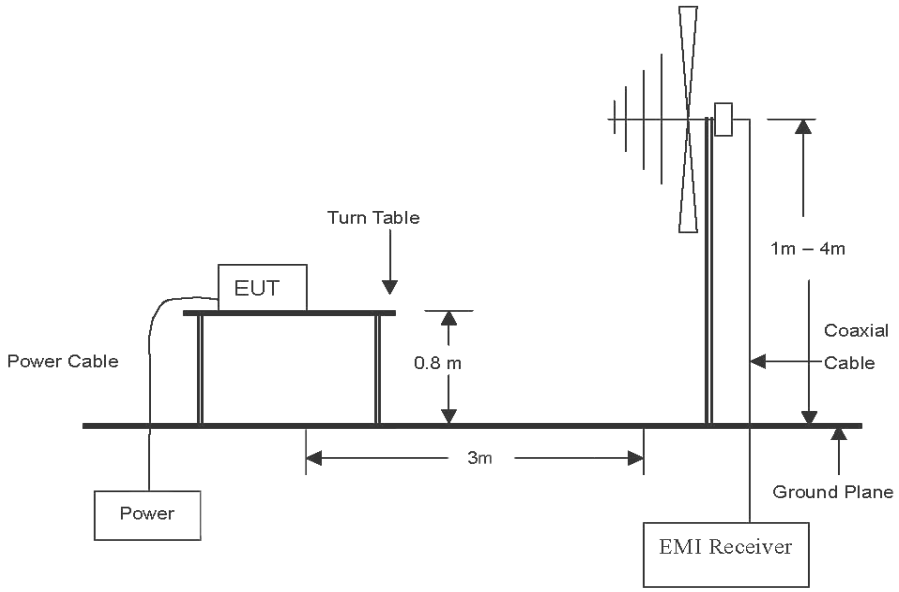
## 3.2. Radiated restricted band and emissions

**Test setup**

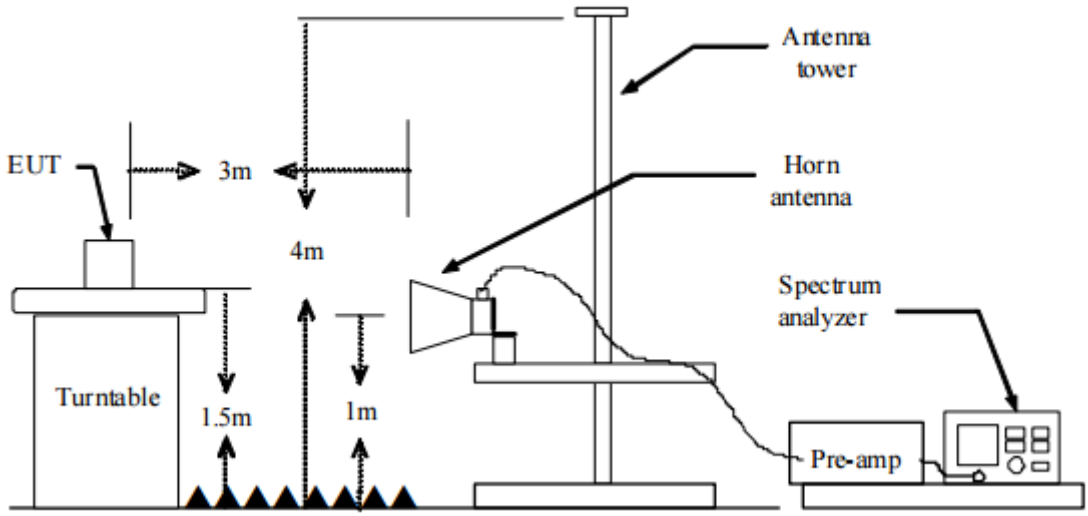
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.




The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.




**Test procedure below 30 ㎒**

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
4. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

**Test procedure above 30 ㎒**

1. Spectrum analyzer settings for $f < 1$ ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 100 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
2. Spectrum analyzer settings for $f \geq 1$ ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 ㎒
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

3. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × RBW
   ④ Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
   ⑤ Averaging type = power(i.e., RMS)
      1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
      2) Some instruments require linear display mode in order to use linear voltage averaging. Log or ㏈ averaging shall not be used.
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Perform a trace average of at least 100 traces.
   ⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
      1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
      2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
      3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

**Note.**

1. The loop antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case.
2. $f$ <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   $f$ ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   $F_d$ = Distance factor in ㏈
   $D_m$ = Measurement distance in meters
   $D_s$ = Specification distance in meters
3. CF(Correction factors(㏈)) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or $F_d$(㏈)
4. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
5. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
6. Emissions below 18 ㎓ were measured at a 3 meter test distance while emissions above 18 ㎓ were measured at a 1 meter test distance with the application of a distance correction factor.
5. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation.**
6. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
7. According to exploratory test no any obvious emission were detected from 9㎑ to 30㎒. Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

**Limit**

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

| Frequency (㎒) | Distance (Meters) | Radiated (㎶/m) |
|---|---|---|
| 0.009 ~ 0.490 | 300 | 2400/F(㎑) |
| 0.490 ~ 1.705 | 30 | 24000/F(㎑) |
| 1.705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 3 | 100** |
| 88 ~ 216 | 3 | 150** |
| 216 ~ 960 | 3 | 200** |
| Above 960 | 3 | 500 |

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

**Duty cycle**

Regarding to KDB 558074 D01_v05 r02, 6. Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

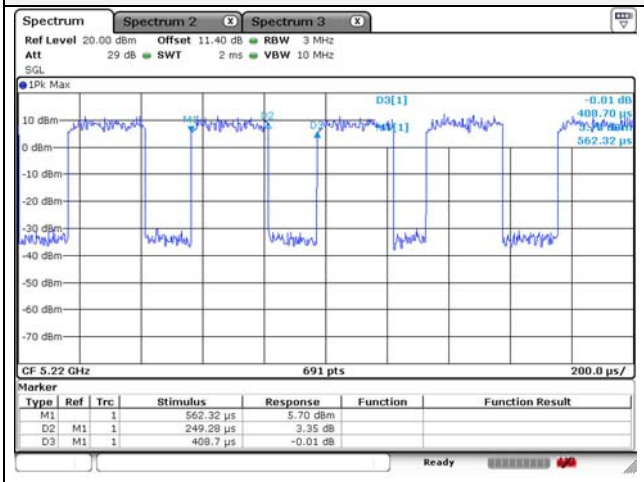
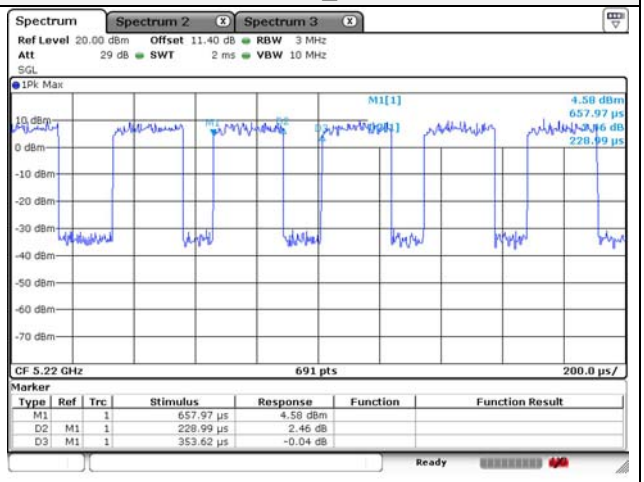
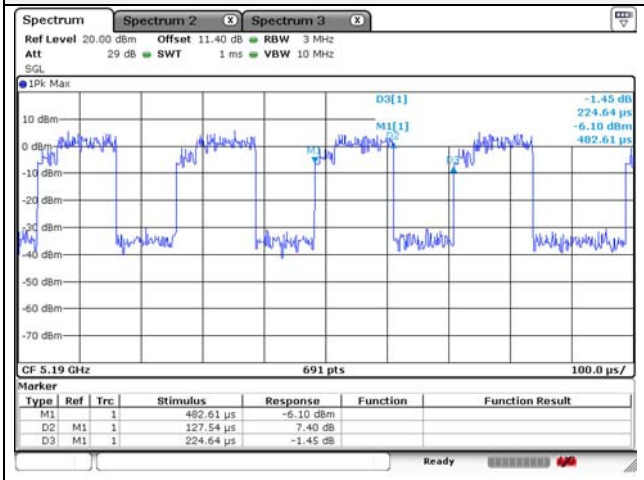
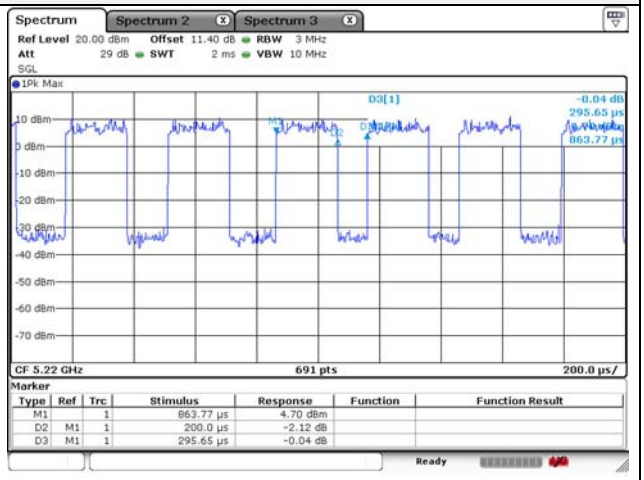
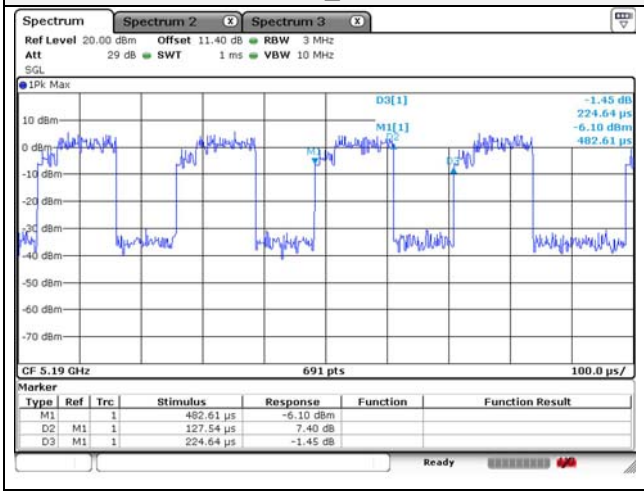
a) A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on- and off-times of the transmitted signal.

b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on- and off-times of the transmitted signal.

| Test mode | $T_{on}$ time (㎳) | Period (㎳) | Duty cycle (Linear) | Duty cycle (%) | Duty cycle correction factor (㏈) |
|---|---|---|---|---|---|
| 802.11a | 0.249 | 0.409 | 0.609 | 60.880 | 2.16 |
| 802.11n_HT20 | 0.229 | 0.354 | 0.647 | 64.689 | 1.89 |
| 802.11n_HT40 | 0.128 | 0.225 | 0.569 | 56.889 | 2.45 |
| 802.11ac_VHT20 | 0.2 | 0.296 | 0.676 | 67.568 | 1.70 |
| 802.11ac_VHT40 | 0.128 | 0.225 | 0.569 | 56.889 | 2.45 |

Duty cycle (Linear) = $T_{on}$ time/Period

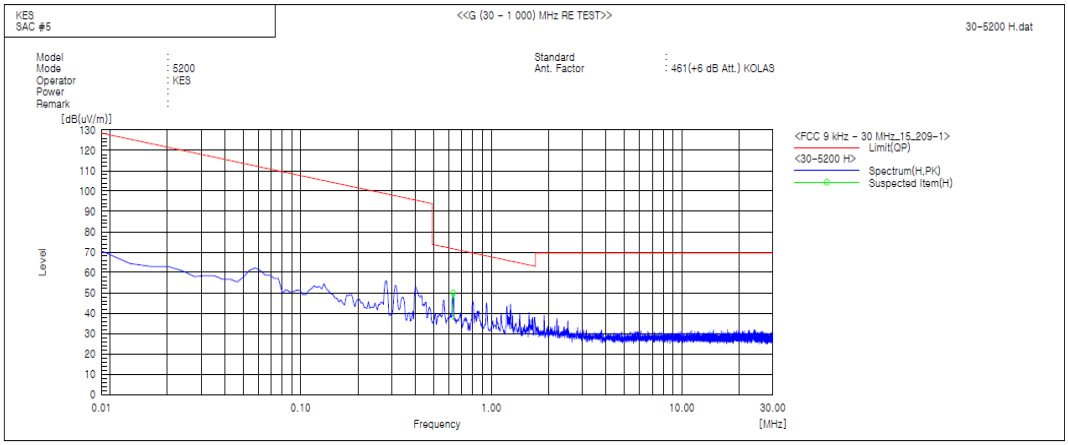
DCF(Duty cycle correction factor (㏈)) = 10log(1/duty cycle)

| 802.11a | 802.11n_HT20 |
|---|---|
|  |  |
| **802.11n_HT40** | **802.11ac_VHT20** |
|  |  |
| **802.11ac_VHT40** | **N/A** |
|  | N/A |

**Test results (Below 30 ㎒)**

| | |
|---|---|
| Mode: | 802.11a |
| Distance of measurement: | 3 meter |
| Channel: | 36 (Worst case) |

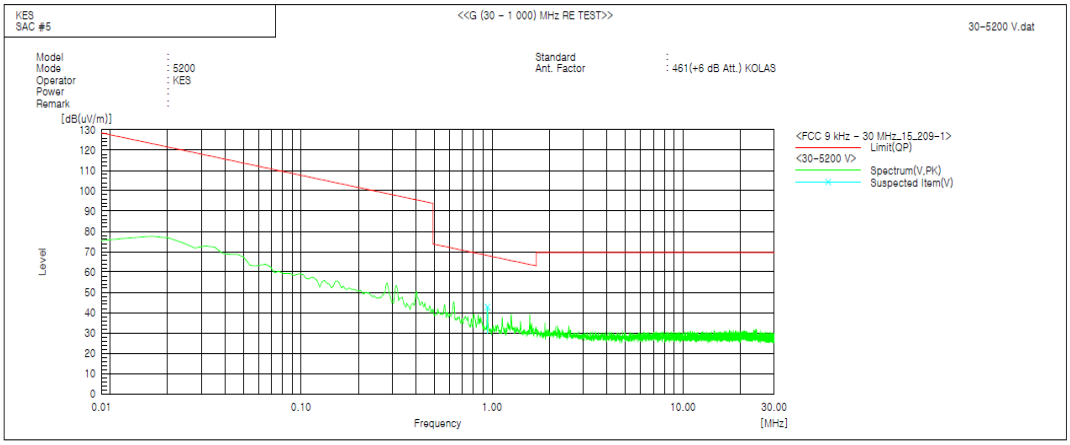
## Horizontal




Spectrum Selection

| No. | Frequency | (P) | Reading | c.f | Result PK | Limit QP | Margin QP | Height | Angle | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| | [MHz] | | [dB(uV)] | [dB(1/m)] | [dB(uV/m)] | [dB(uV/m)] | [dB] | [cm] | [deg] | |
| 1 | 0.631 | H | 29.4 | 20.4 | 49.8 | 71.6 | 21.8 | 99.8 | 51.9 | |

## Vertical



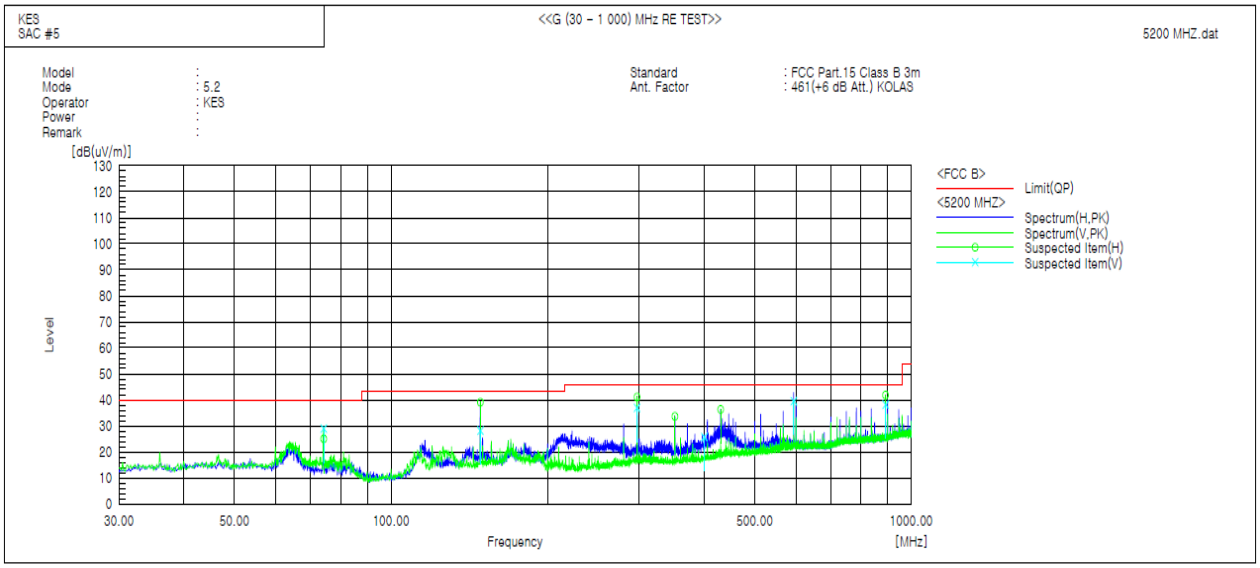

Spectrum Selection

| No. | Frequency | (P) | Reading | c.f | Result PK | Limit QP | Margin QP | Height | Angle | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| | [MHz] | | [dB(uV)] | [dB(1/m)] | [dB(uV/m)] | [dB(uV/m)] | [dB] | [cm] | [deg] | |
| 1 | 0.946 | V | 22.1 | 20.7 | 42.8 | 68.1 | 25.3 | 99.8 | 48.3 | |

**Test results (Below 1 000 ㎒)**

| | |
|---|---|
| Mode: | 802.11a |
| Distance of measurement: | 3 meter |
| Channel: | 36 (Worst case) |

**Horizontal // Vertical**




| No. | Frequency [MHz] | (P) | Reading [dB(uV)] | c.f [dB(1/m)] | Result PK [dB(uV/m)] | Limit QP [dB(uV/m)] | Margin QP [dB] | Height [cm] | Angle [deg] | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 74.256 | H | 41.2 | -16.2 | 25.0 | 40.0 | 15.0 | 400.1 | 249.7 | |
| 2 | 148.461 | H | 51.8 | -12.7 | 39.1 | 43.5 | 4.4 | 200.3 | 205.6 | |
| 3 | 296.993 | H | 53.3 | -12.2 | 41.1 | 46.0 | 4.9 | 99.8 | 286.4 | |
| 4 | 351.313 | H | 44.9 | -11.3 | 33.6 | 46.0 | 12.4 | 99.8 | 281.9 | |
| 5 | 430.004 | H | 45.3 | -9.0 | 36.3 | 46.0 | 9.7 | 99.8 | 143.4 | |
| 6 | 891.845 | H | 42.5 | -0.7 | 41.8 | 46.0 | 4.2 | 99.8 | 204.7 | |
| 7 | 74.256 | V | 45.1 | -16.2 | 28.9 | 40.0 | 11.1 | 99.9 | 241.3 | |
| 8 | 148.461 | V | 40.8 | -12.7 | 28.1 | 43.5 | 15.4 | 400.1 | 278.6 | |
| 9 | 296.993 | V | 49.2 | -12.2 | 37.0 | 46.0 | 9.0 | 99.9 | 155.5 | |
| 10 | 399.934 | V | 35.8 | -10.1 | 25.7 | 46.0 | 20.3 | 99.9 | 255.1 | |
| 11 | 594.055 | V | 45.2 | -5.6 | 39.6 | 46.0 | 6.4 | 149.7 | 213.4 | |
| 12 | 891.845 | V | 38.8 | -0.7 | 38.1 | 46.0 | 7.9 | 149.7 | 88.8 | |

**Test results (Above 1 000 ㎒)**

Mode: UNII-1_802.11a

Distance of measurement: 3 meter

Channel: 36

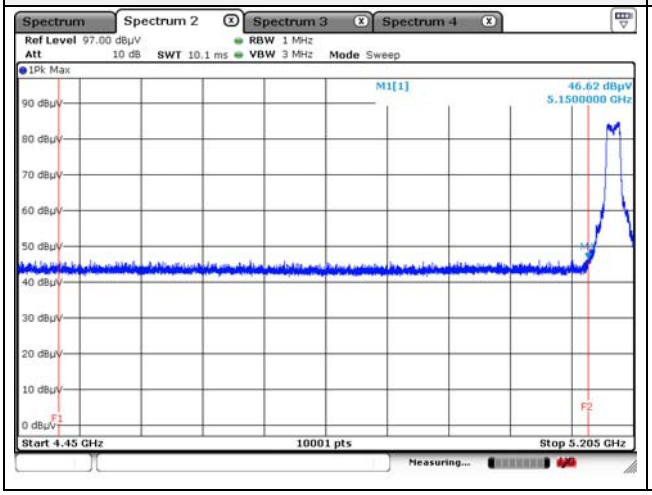
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1088.69 | 54.10 | Peak | H | -9.19 | - | 44.91 | 74.00 | 29.09 |
| 1585.14 | 49.90 | Peak | V | -7.44 | - | 42.46 | 74.00 | 31.54 |

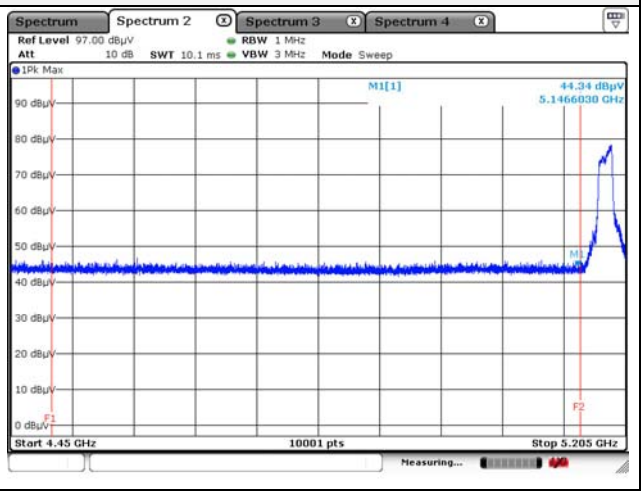
- **Band edge**

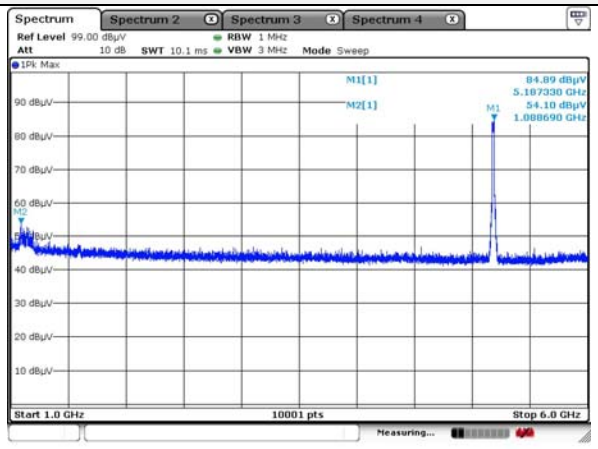
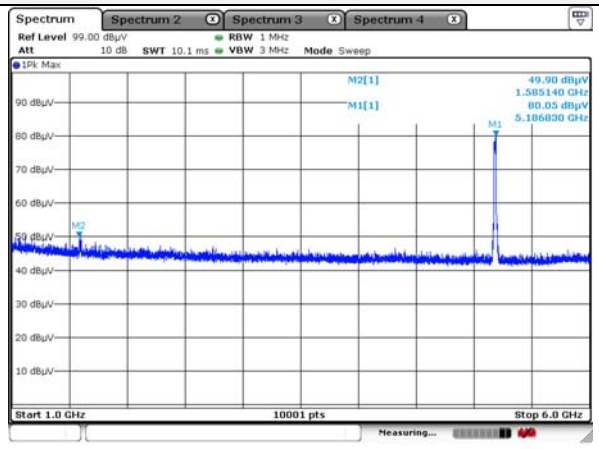
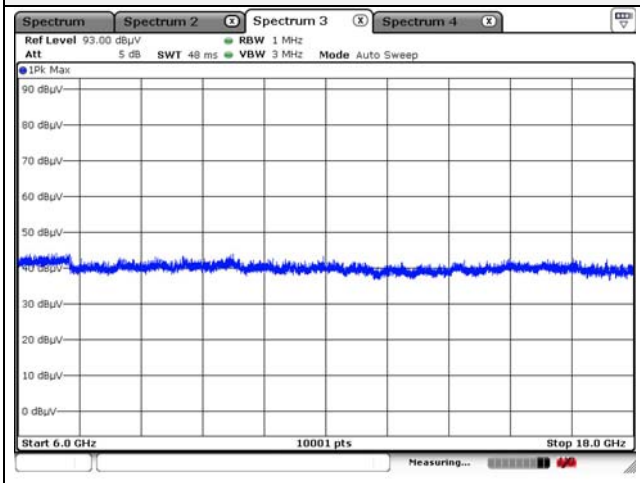
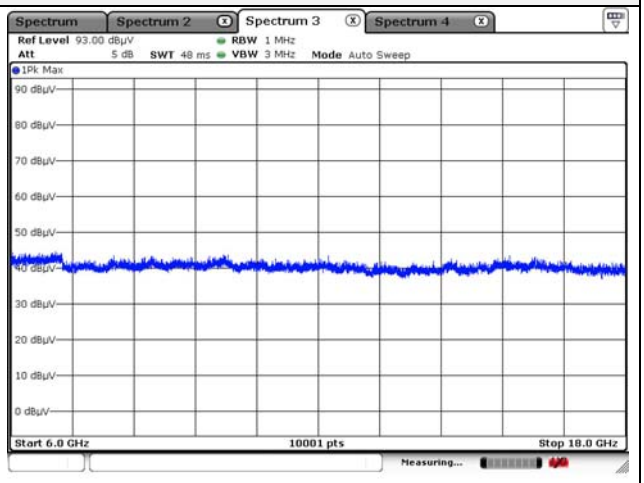
| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5150.00 | 46.62 | Peak | H | 3.26 | - | 49.88 | 74.00 | 24.12 |
| 5146.60 | 44.34 | Peak | V | 3.26 | - | 47.60 | 74.00 | 26.40 |

**Restricted band // Horizontal // Peak**




**Restricted band // Vertical // Peak**



| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11a

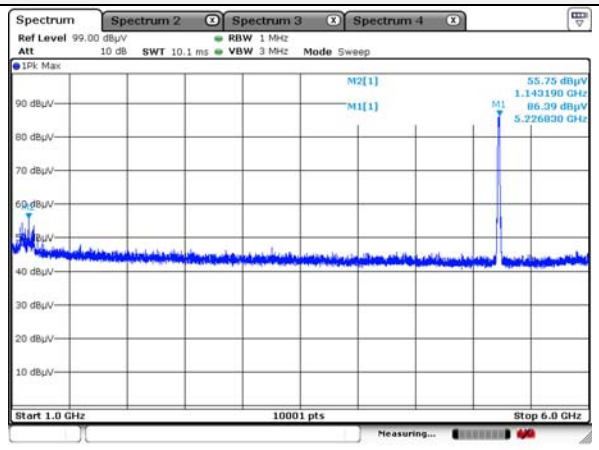
Distance of measurement: 3 meter

Channel: 44

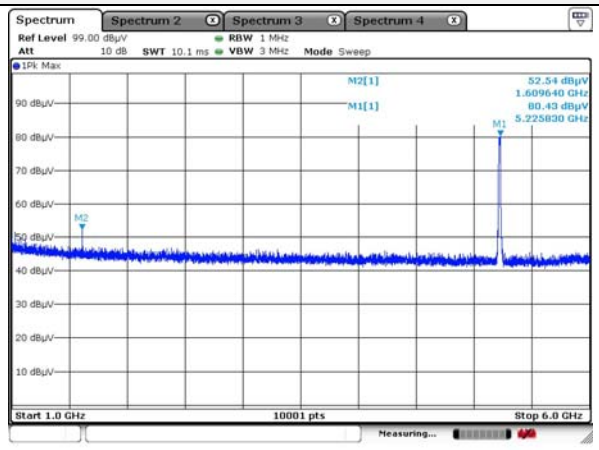
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1143.19 | 55.75 | Peak | H | -9.03 | - | 46.72 | 74.00 | 27.28 |
| 1609.64 | 52.54 | Peak | V | -7.25 | - | 45.29 | 74.00 | 28.71 |

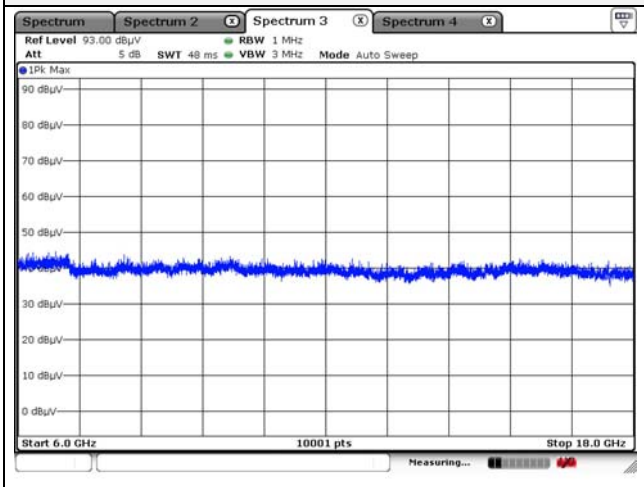
**Horizontal // Peak for 1 ㎓ to 6 ㎓**



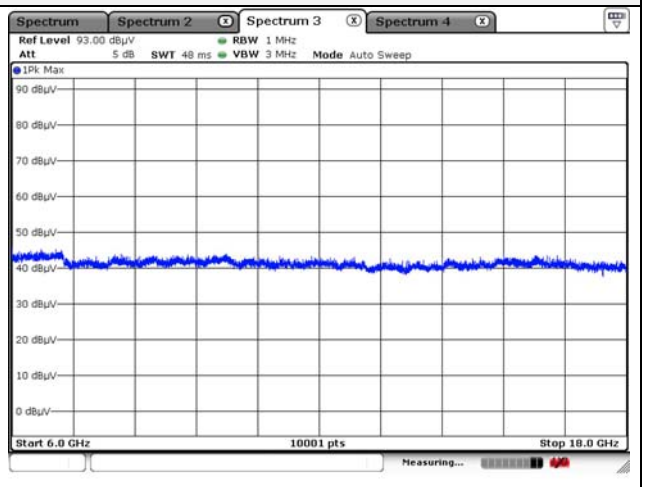

**Vertical // Peak for 1 ㎓ to 6 ㎓**




**Horizontal // Peak for 6 ㎓ to 18 ㎓**




**Vertical // Peak for 6 ㎓ to 18 ㎓**




Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11a

Distance of measurement: 3 meter

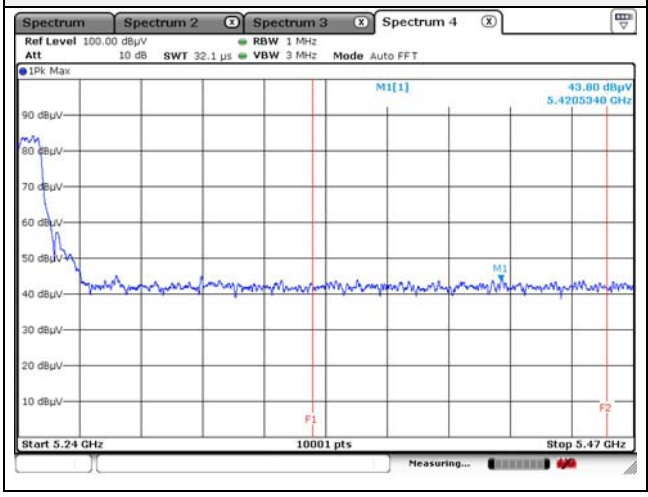
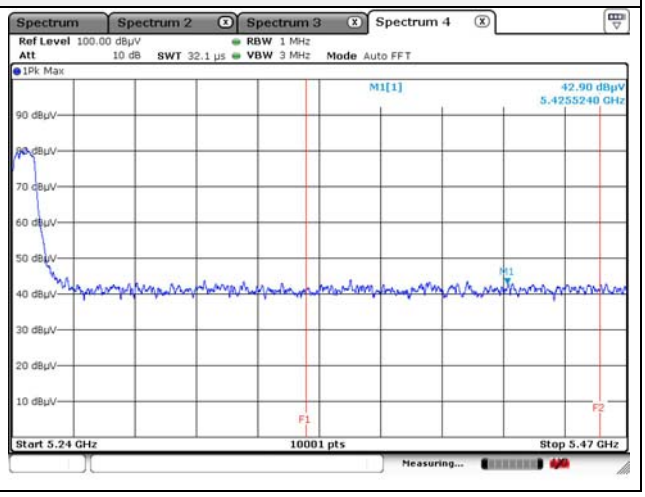
Channel: 48

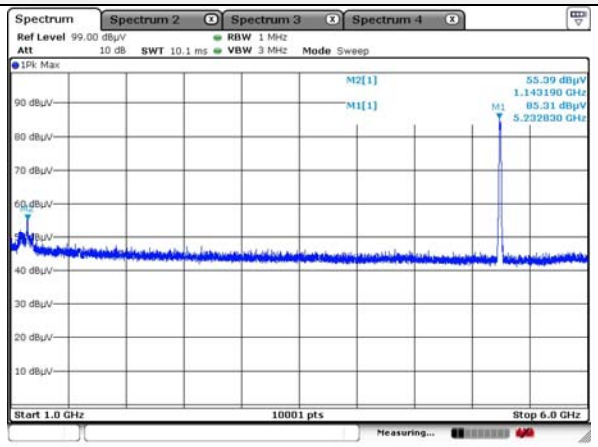
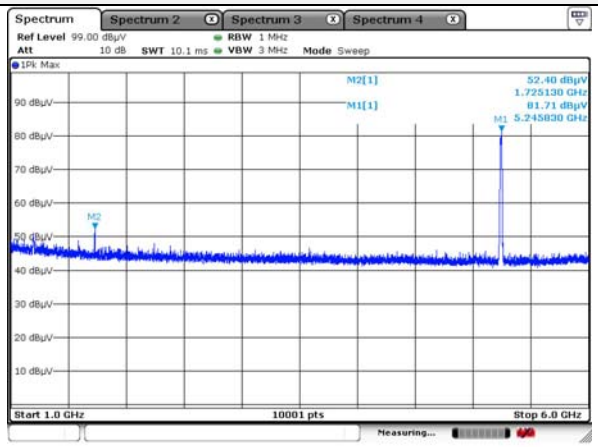
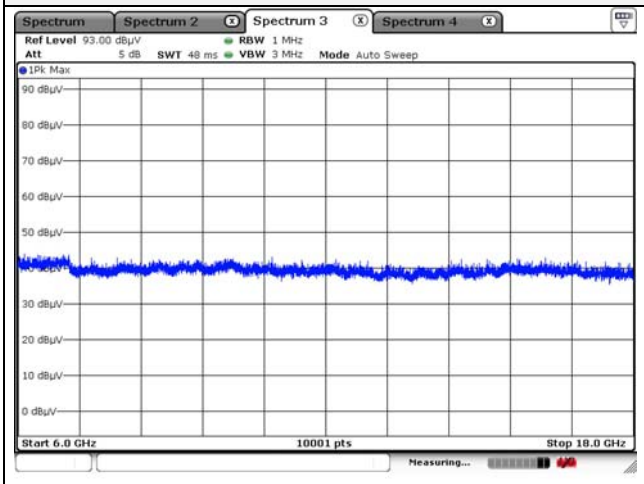
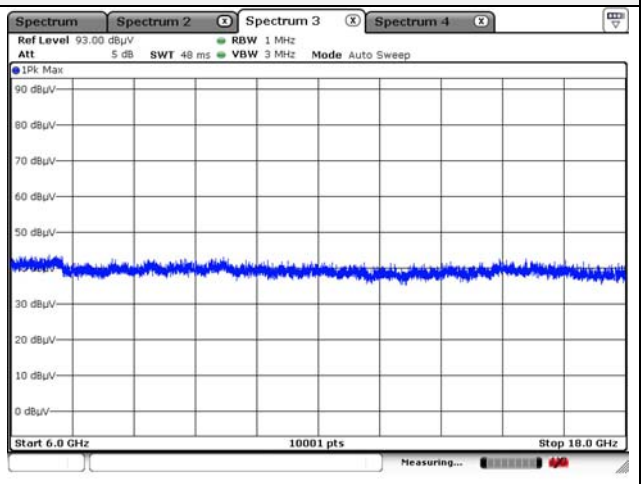
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1143.19 | 55.39 | Peak | H | -9.03 | - | 46.36 | 74.00 | 27.64 |
| 1725.13 | 52.40 | Peak | V | -6.36 | - | 46.04 | 74.00 | 27.96 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5420.53 | 43.80 | Peak | H | 3.39 | - | 47.19 | 74.00 | 26.81 |
| 5425.52 | 42.90 | Peak | V | 3.37 | - | 46.27 | 74.00 | 27.73 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11n(HT20)

Distance of measurement: 3 meter

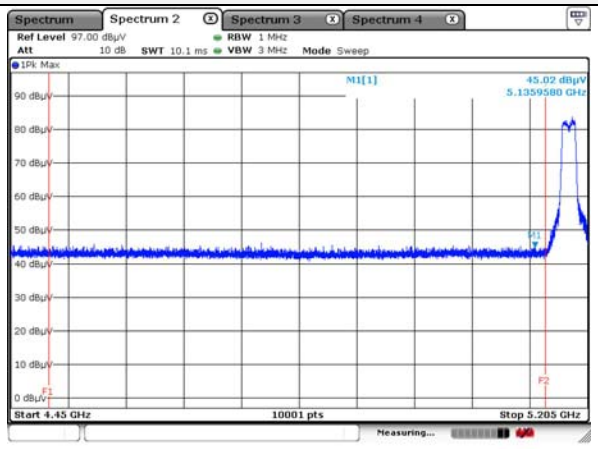
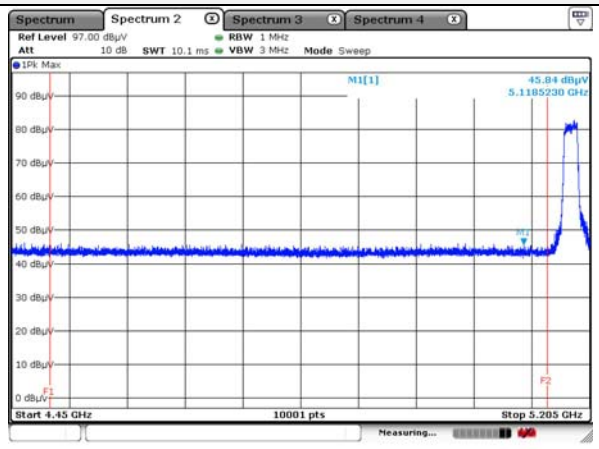
Channel: 36

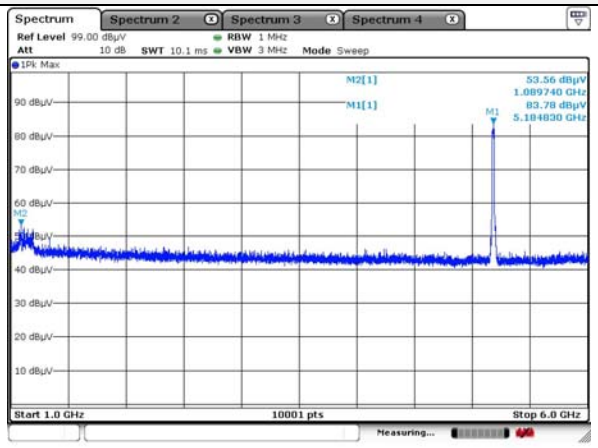
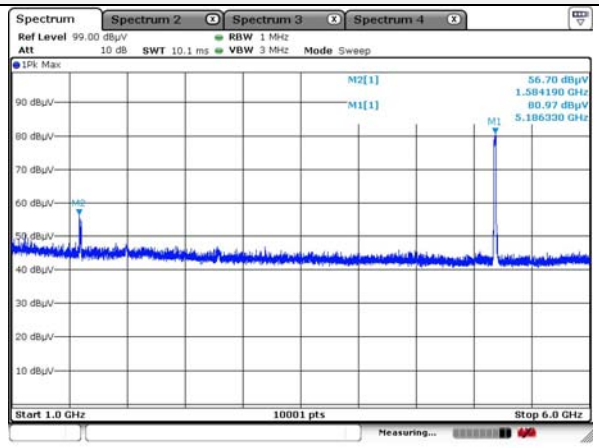
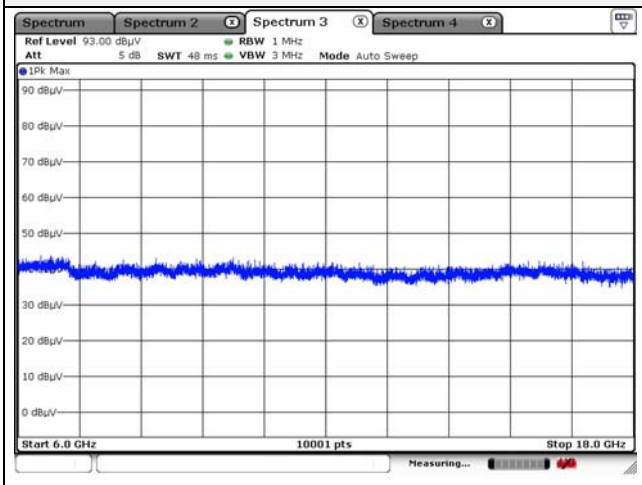
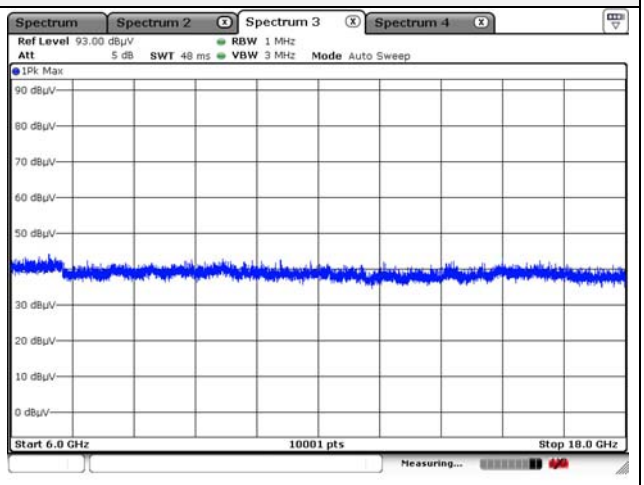
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1089.74 | 53.56 | Peak | H | -9.19 | - | 44.37 | 74.00 | 29.63 |
| 1584.19 | 56.70 | Peak | V | -7.45 | - | 49.25 | 74.00 | 24.75 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5135.96 | 45.02 | Peak | H | 3.26 | - | 48.28 | 74.00 | 25.72 |
| 5118.52 | 45.84 | Peak | V | 3.25 | - | 49.09 | 74.00 | 24.91 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.
1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11n(HT20)

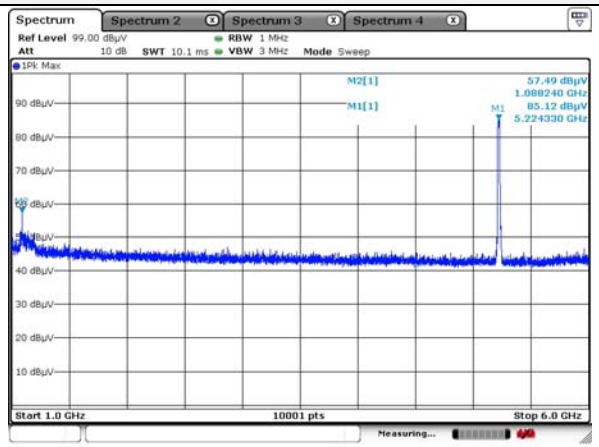
Distance of measurement: 3 meter

Channel: 44

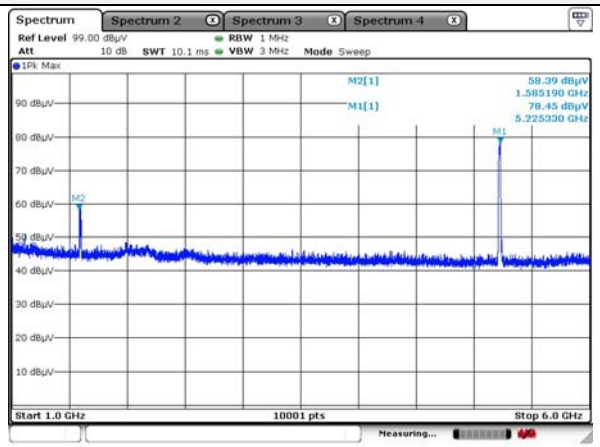
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1088.24 | 57.49 | Peak | H | -9.19 | - | 48.30 | 74.00 | 25.70 |
| 1585.19 | 58.39 | Peak | V | -7.44 | - | 50.95 | 74.00 | 23.05 |

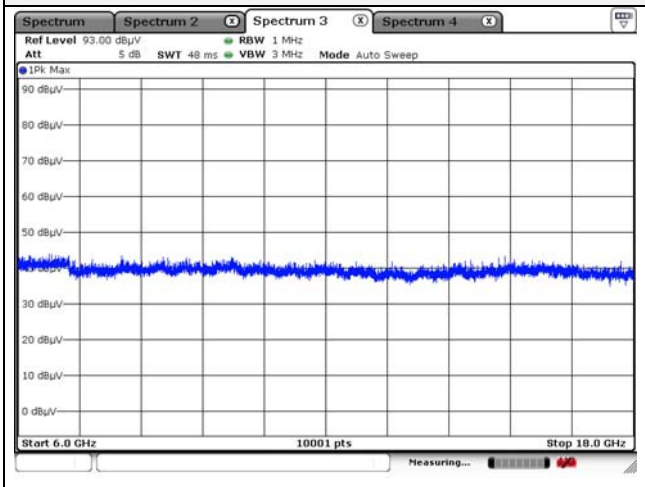
**Horizontal // Peak for 1 ㎓ to 6 ㎓**



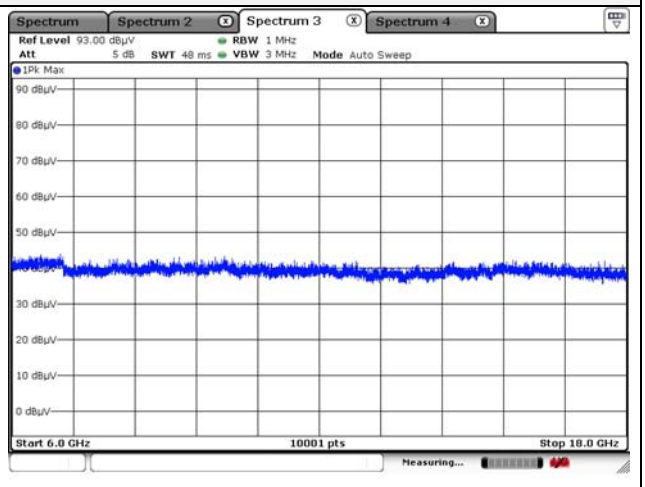

**Vertical // Peak for 1 ㎓ to 6 ㎓**




**Horizontal // Peak for 6 ㎓ to 18 ㎓**




**Vertical // Peak for 6 ㎓ to 18 ㎓**




Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11n(HT20)

Distance of measurement: 3 meter

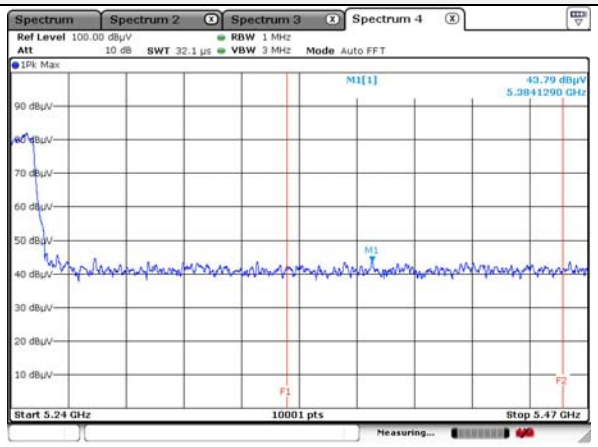
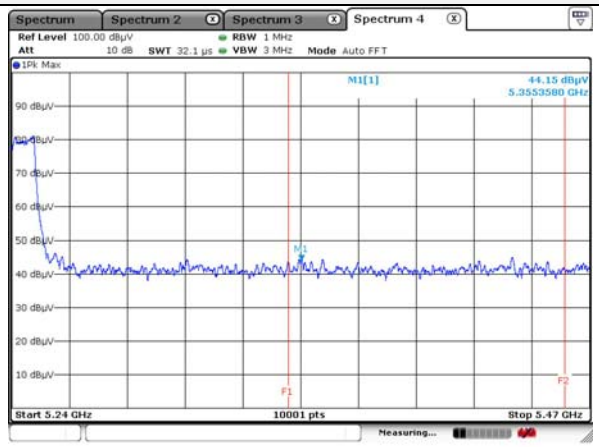
Channel: 48

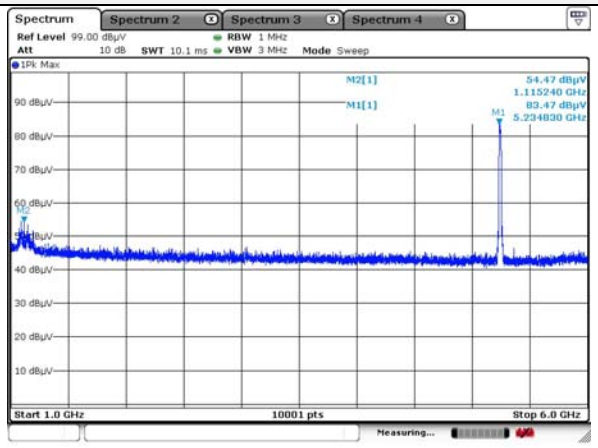
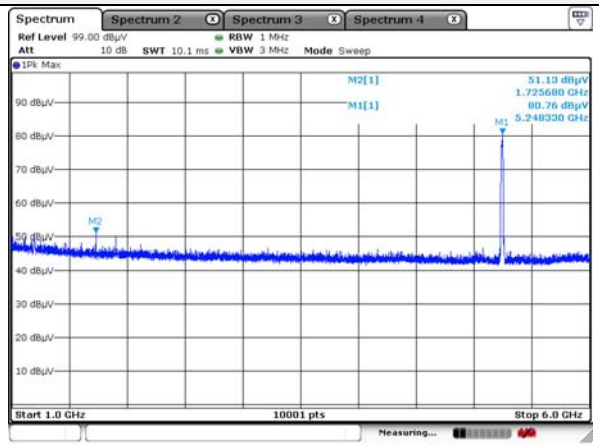
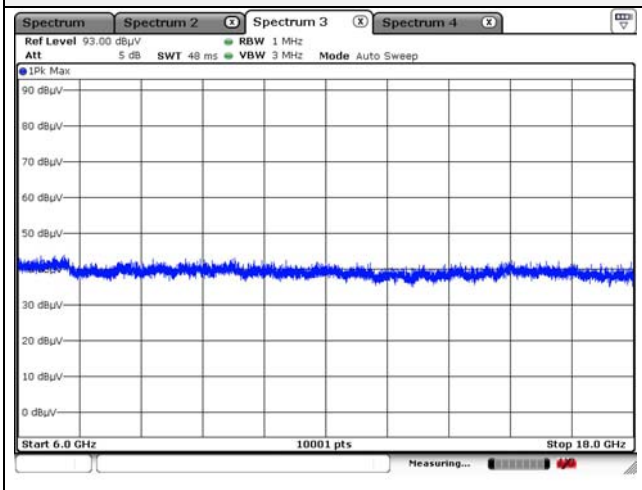
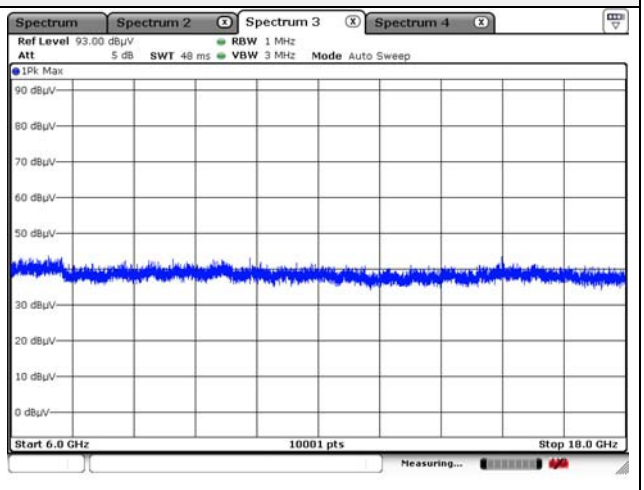
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1115.24 | 54.47 | Peak | H | -9.11 | - | 45.36 | 74.00 | 28.64 |
| 1725.68 | 51.13 | Peak | V | -6.36 | - | 44.77 | 74.00 | 29.23 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5384.13 | 43.79 | Peak | H | 3.46 | - | 47.25 | 74.00 | 26.75 |
| 5355.36 | 44.15 | Peak | V | 3.43 | - | 47.58 | 74.00 | 26.42 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11n(HT40)

Distance of measurement: 3 meter

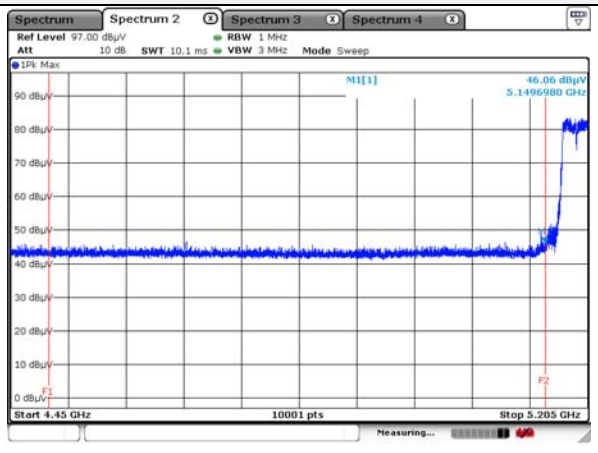
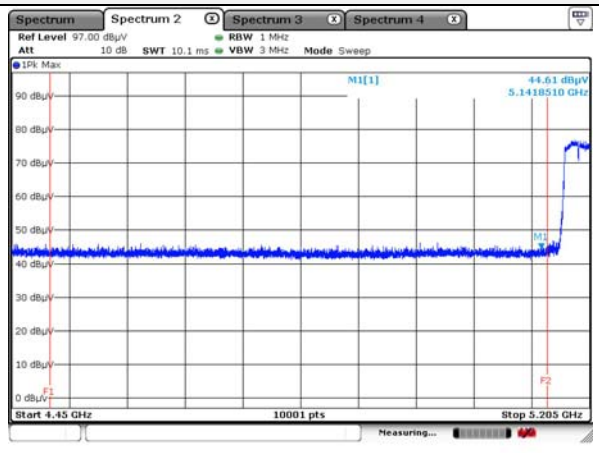
Channel: 38

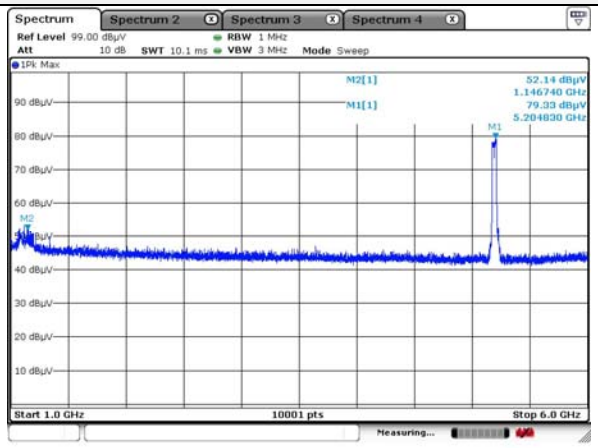
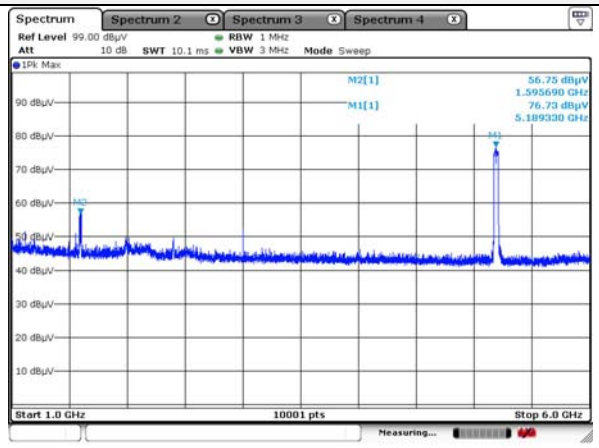
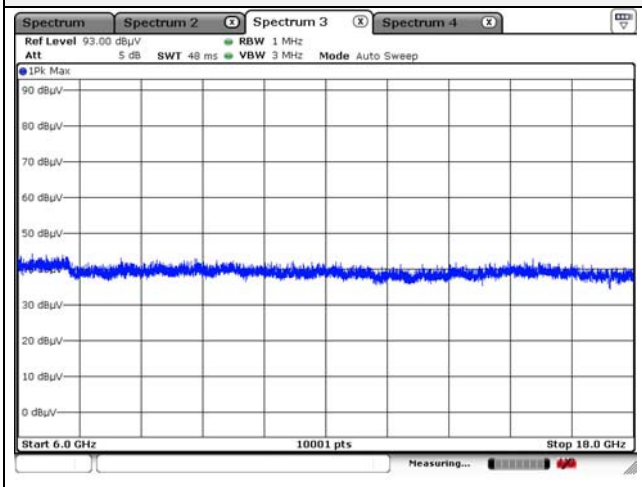
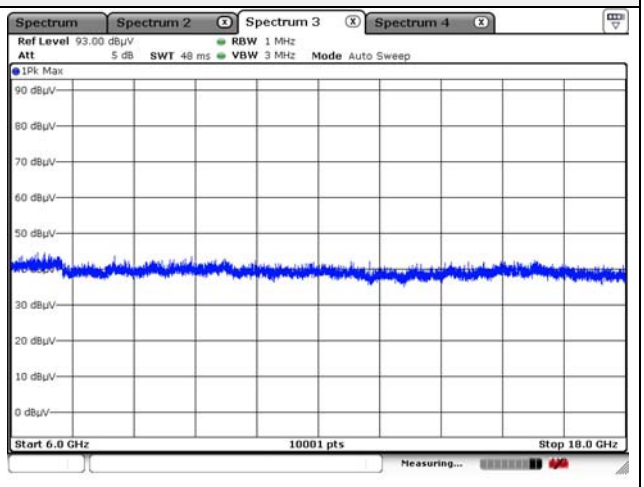
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1146.74 | 52.14 | Peak | H | -9.02 | - | 43.12 | 74.00 | 30.88 |
| 1595.69 | 56.75 | Peak | V | -7.36 | - | 49.39 | 74.00 | 24.61 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5149.70 | 46.06 | Peak | H | 3.26 | - | 49.32 | 74.00 | 24.68 |
| 5141.85 | 44.61 | Peak | V | 3.26 | - | 47.87 | 74.00 | 26.13 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11n(HT40)

Distance of measurement: 3 meter

Channel: 46

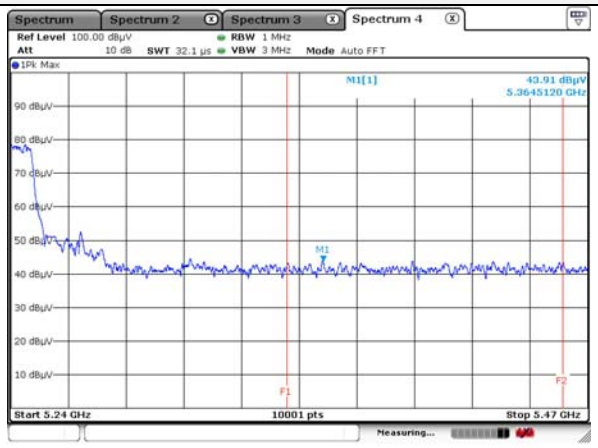
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1113.24 | 53.83 | Peak | H | -9.12 | - | 44.71 | 74.00 | 29.29 |
| 1592.19 | 48.93 | Peak | V | -7.39 | - | 41.54 | 74.00 | 32.46 |

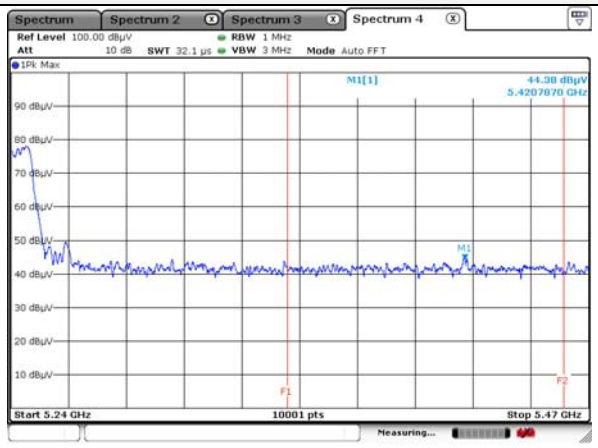
- **Band edge**

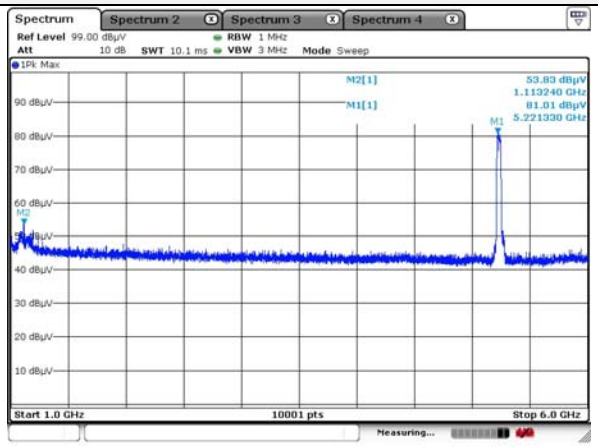
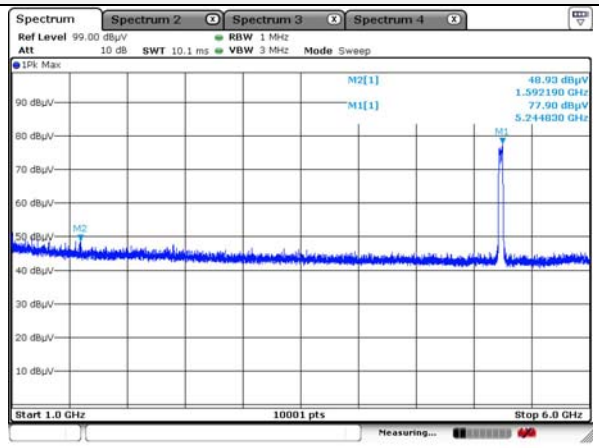
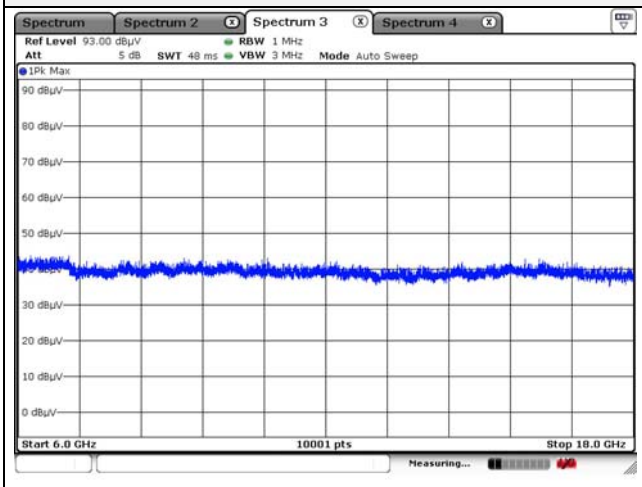
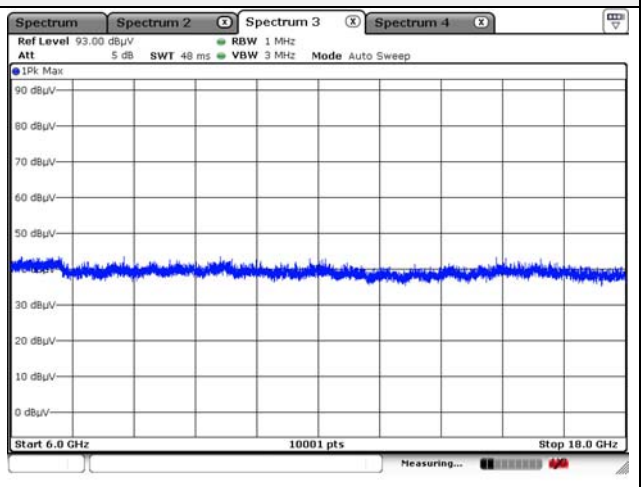
| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5364.51 | 43.91 | Peak | H | 3.44 | - | 47.35 | 74.00 | 26.65 |
| 5420.08 | 44.38 | Peak | V | 3.39 | - | 47.77 | 74.00 | 26.23 |

**Restricted band // Horizontal // Peak**




**Restricted band // Vertical // Peak**



| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |



Note.
1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11ac(VHT20)

Distance of measurement: 3 meter

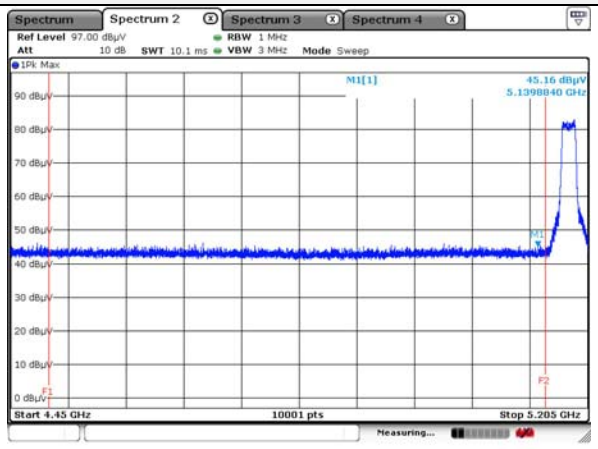
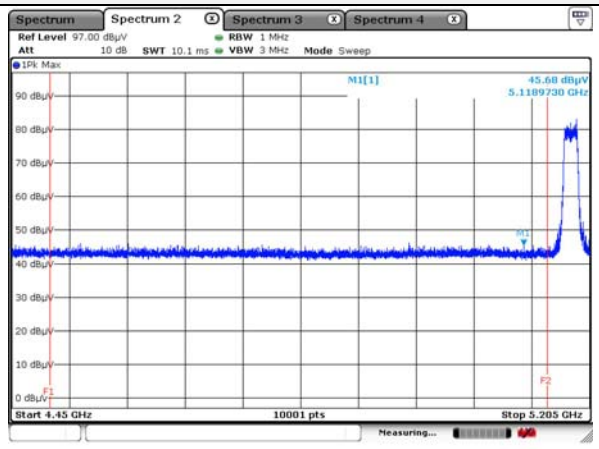
Channel: 36

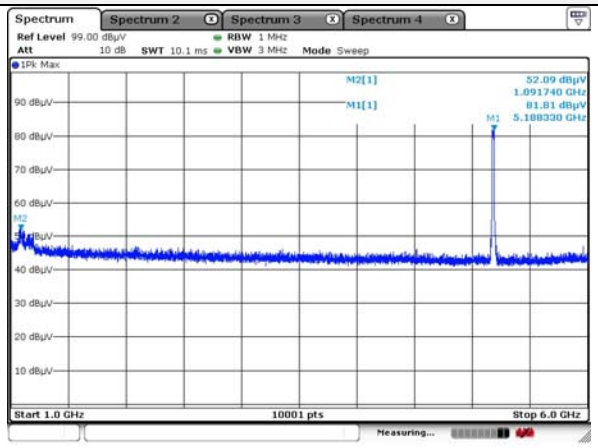
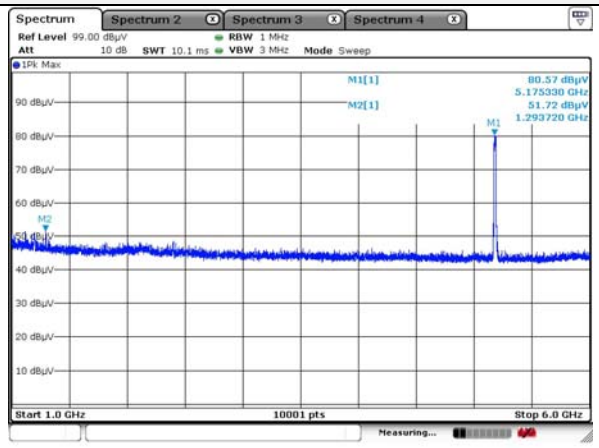
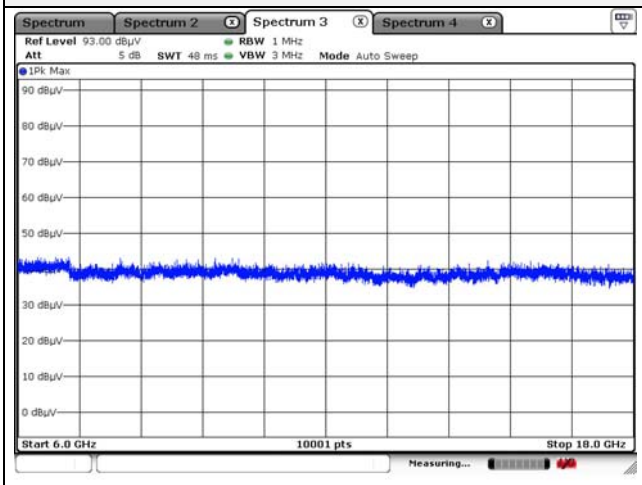
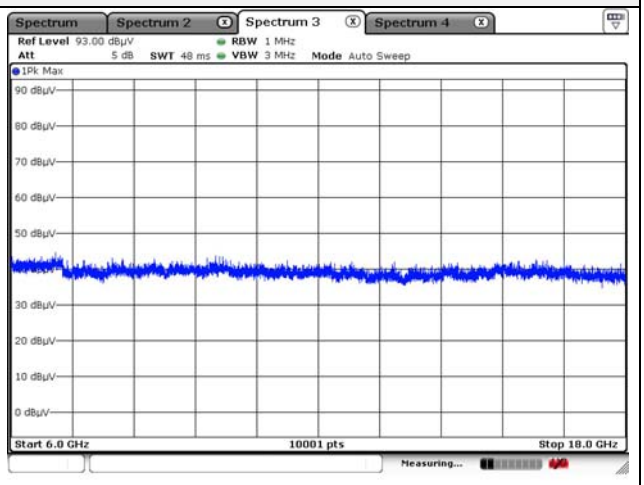
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1091.74 | 52.09 | Peak | H | -9.18 | - | 42.91 | 74.00 | 31.09 |
| 1293.72 | 51.72 | Peak | V | -8.64 | - | 43.08 | 74.00 | 30.92 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5139.88 | 45.16 | Peak | H | 3.26 | - | 48.42 | 74.00 | 25.58 |
| 5118.97 | 45.68 | Peak | V | 3.25 | - | 48.93 | 74.00 | 25.07 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.
1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11ac(VHT20)

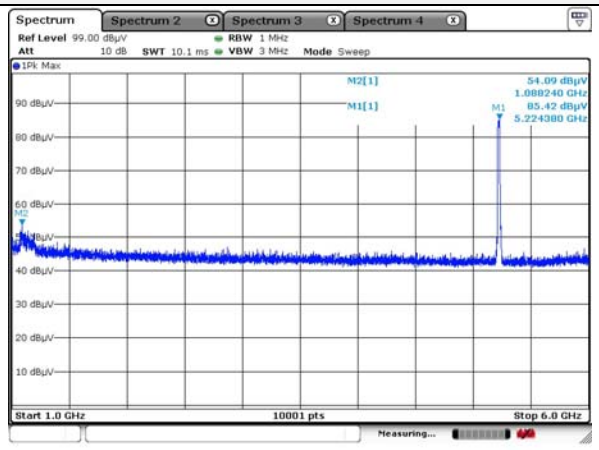
Distance of measurement: 3 meter

Channel: 44

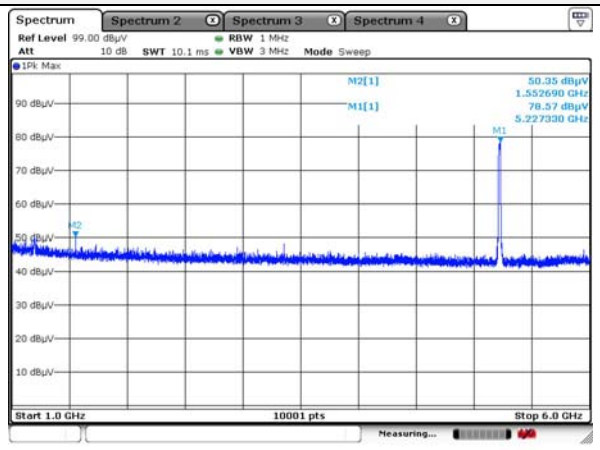
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1088.24 | 54.09 | Peak | H | -9.19 | - | 44.90 | 74.00 | 29.10 |
| 1552.69 | 50.35 | Peak | V | -7.71 | - | 42.64 | 74.00 | 31.36 |

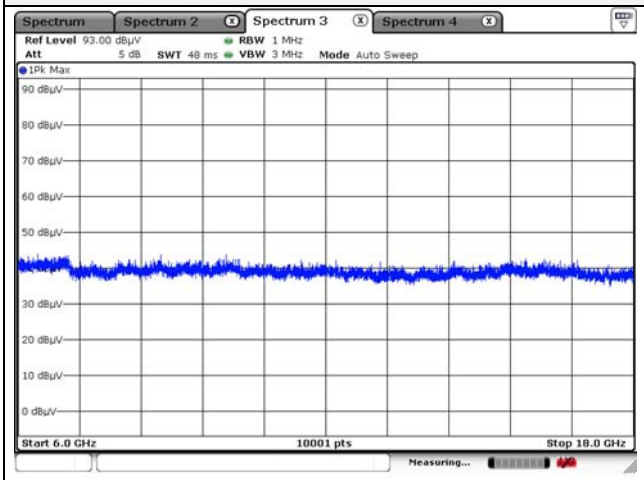
**Horizontal // Peak for 1 ㎓ to 6 ㎓**



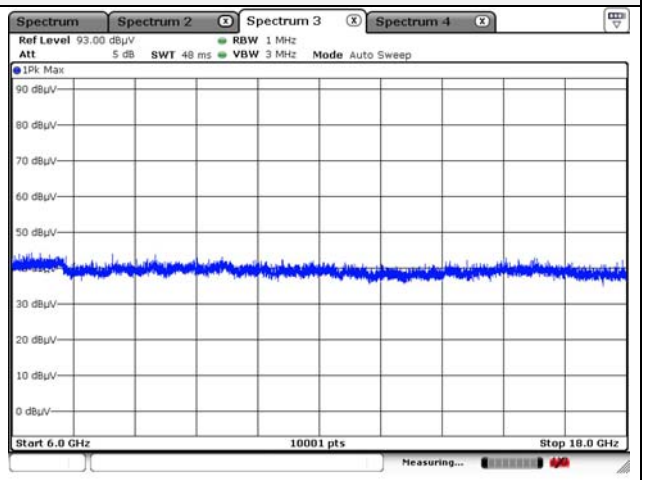

**Vertical // Peak for 1 ㎓ to 6 ㎓**




**Horizontal // Peak for 6 ㎓ to 18 ㎓**




**Vertical // Peak for 6 ㎓ to 18 ㎓**




Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11ac(VHT20)

Distance of measurement: 3 meter

Channel: 48

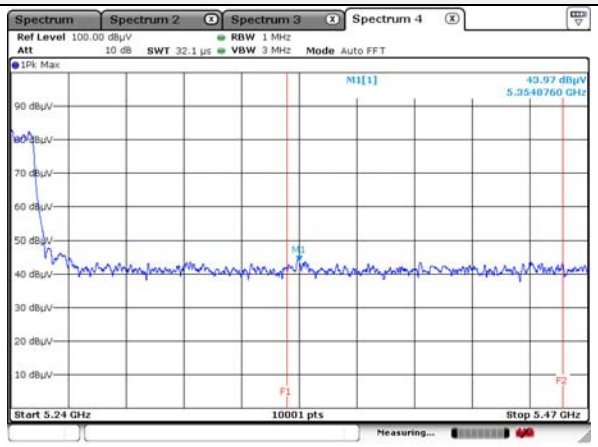
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1089.74 | 54.70 | Peak | H | -9.19 | - | 45.51 | 74.00 | 28.49 |
| 1190.23 | 50.11 | Peak | V | -8.90 | - | 41.21 | 74.00 | 32.79 |

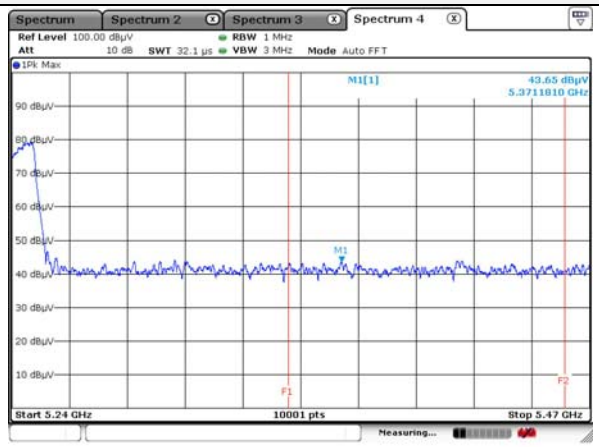
- **Band edge**

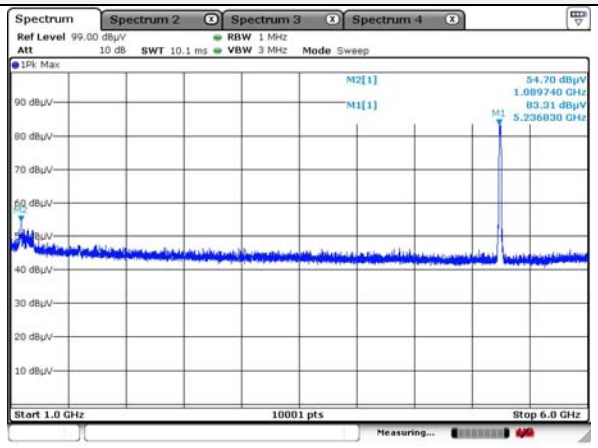
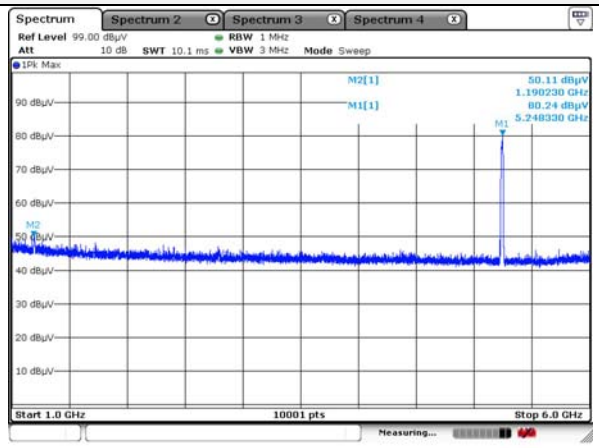
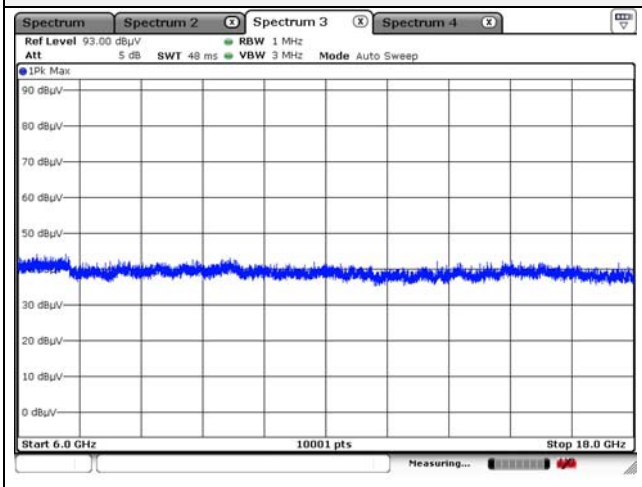
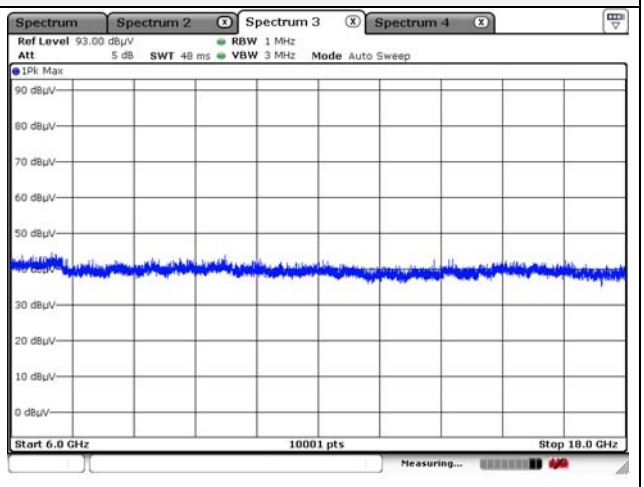
| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5354.88 | 43.97 | Peak | H | 3.43 | - | 47.40 | 74.00 | 26.60 |
| 5371.18 | 43.65 | Peak | V | 3.45 | - | 47.10 | 74.00 | 26.90 |

**Restricted band // Horizontal // Peak**




**Restricted band // Vertical // Peak**



| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11ac(VHT40)

Distance of measurement: 3 meter

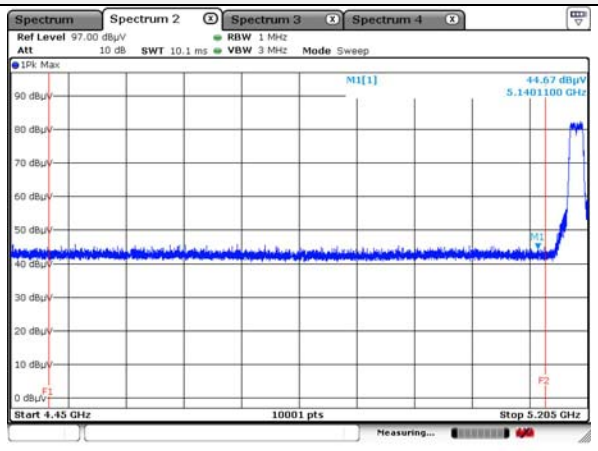
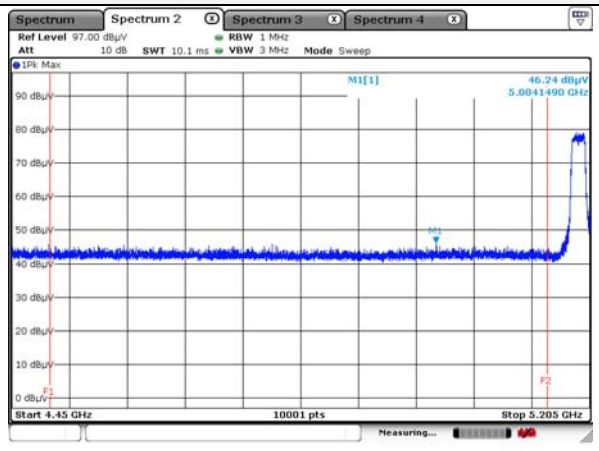
Channel: 38

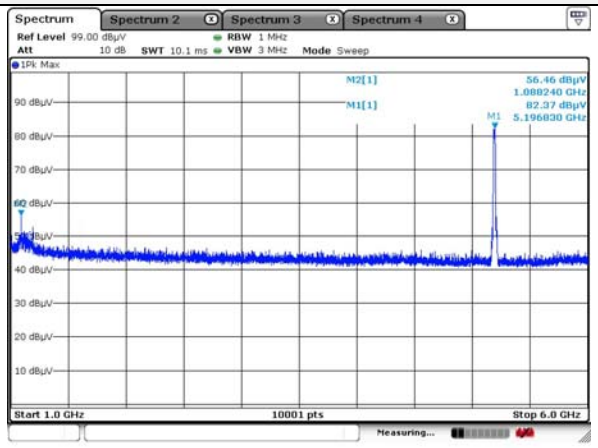
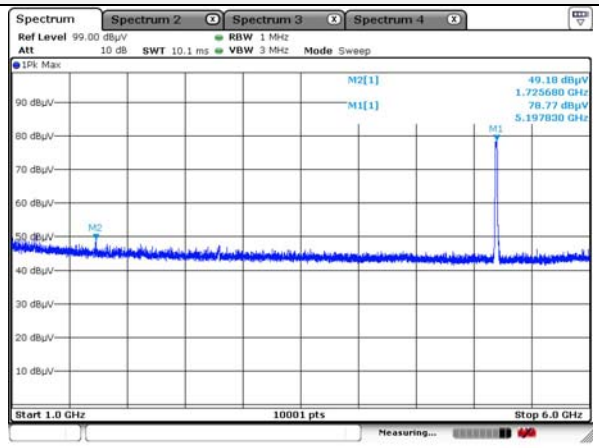
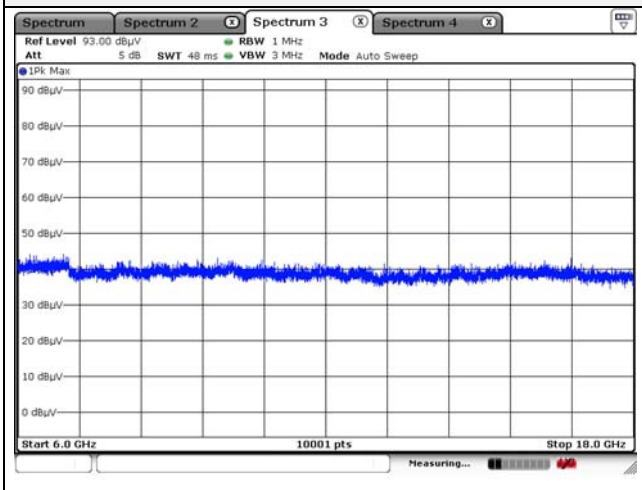
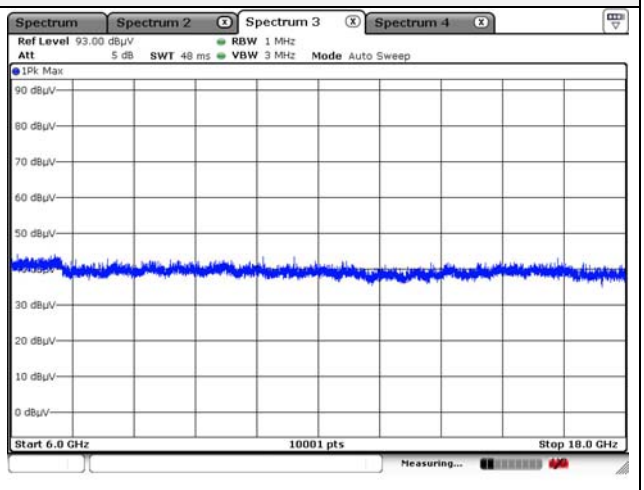
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1088.24 | 56.46 | Peak | H | -9.19 | - | 47.27 | 74.00 | 26.73 |
| 1725.68 | 49.18 | Peak | V | -6.36 | - | 42.82 | 74.00 | 31.18 |

- **Band edge**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5140.11 | 44.67 | Peak | H | 3.26 | - | 47.93 | 74.00 | 26.07 |
| 5004.15 | 46.24 | Peak | V | 3.22 | - | 49.46 | 74.00 | 24.54 |

| Restricted band // Horizontal // Peak | Restricted band // Vertical // Peak |
|---|---|
|  |  |

| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |









Note.
1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: UNII-1_802.11ac(VHT40)

Distance of measurement: 3 meter

Channel: 46

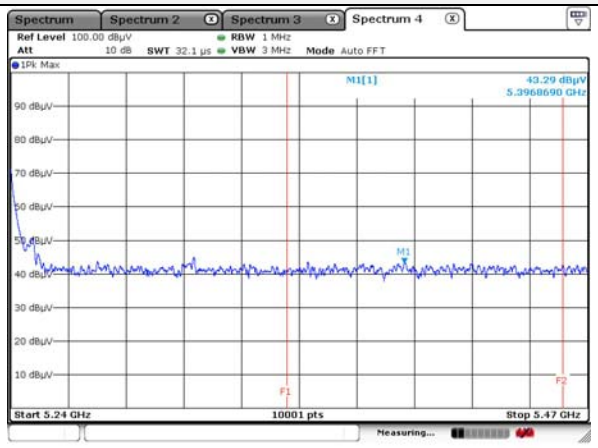
- **Spurious**

| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1088.74 | 54.54 | Peak | H | -9.19 | - | 45.35 | 74.00 | 28.65 |
| 1897.66 | 48.03 | Peak | V | -5.04 | - | 42.99 | 74.00 | 31.01 |

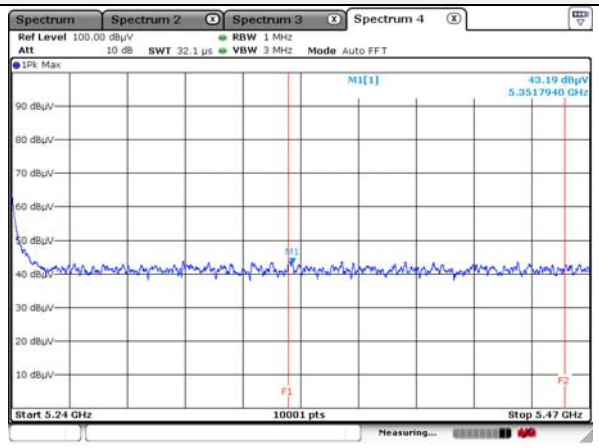
- **Band edge**

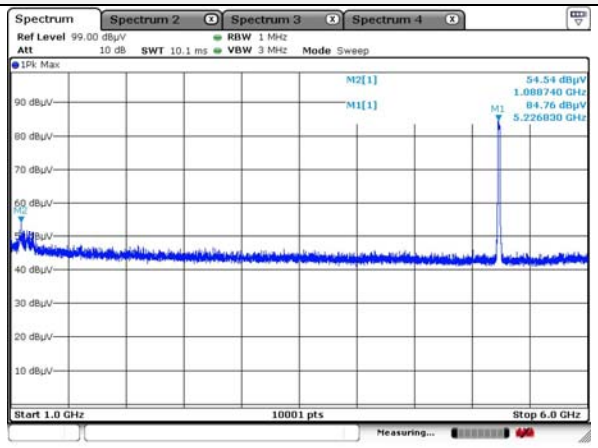
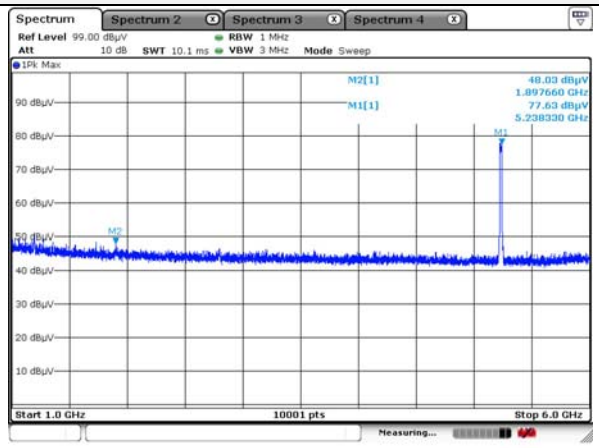
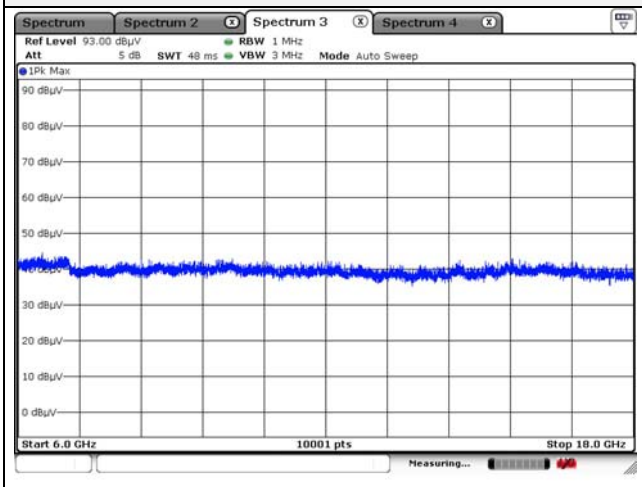
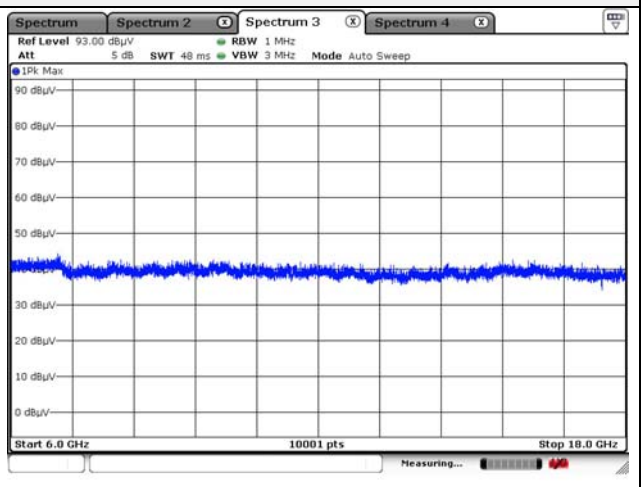
| Frequency (㎒) | Level (dBμV) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 5396.87 | 43.29 | Peak | H | 3.47 | - | 46.76 | 74.00 | 27.24 |
| 5351.79 | 43.19 | Peak | V | 3.43 | - | 46.62 | 74.00 | 27.38 |

**Restricted band // Horizontal // Peak**




**Restricted band // Vertical // Peak**



| Horizontal // Peak for 1 ㎓ to 6 ㎓ | Vertical // Peak for 1 ㎓ to 6 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 6 ㎓ to 18 ㎓** | **Vertical // Peak for 6 ㎓ to 18 ㎓** |
|  |  |





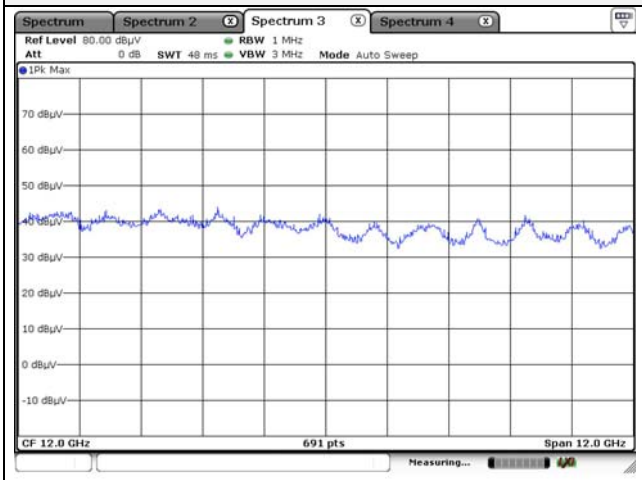
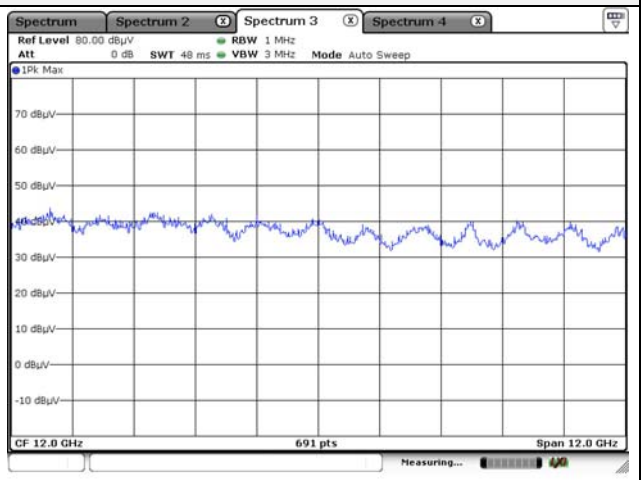




Note.
1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

**Test results (18 ㎓ to 40 ㎓) – Worst case**

| | |
|---|---|
| Mode: | 802.11a |
| Distance of measurement: | 3 meter |
| Channel: | 36 (Worst case) |

| Horizontal | Vertical |
|---|---|
|  |  |



Note.
No spurious emission were detected above 18 ㎓.

## Appendix A. Measurement equipment

| Equipment | Manufacturer | Model | Serial No. | Calibration interval | Calibration due. |
|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSV30 | 101389 | 1 year | 2021.01.15 |
| 8360B Series Swept Signal Generator | HP | 83630B | 3844A00786 | 1 year | 2021.01.15 |
| DC Power Supply | Agilent | 6632B | US36351824 | 1 year | 2021.01.14 |
| Power Meter | Anritsu | ML2495A | 1438001 | 1 year | 2021.01.14 |
| Pulse Power Sensor | Anritsu | MA2411B | 1339205 | 1 year | 2021.01.14 |
| Attenuator | KEYSIGHT | 8493C | 82506 | 1 year | 2021.01.14 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 225 | 2 years | 2021.02.15 |
| Trilog-broadband antenna | SCHWARZBECK | VULB 9163 | 715 | 2 years | 2020.11.29 |
| Horn Antenna | A.H | SAS-571 | 414 | 2 years | 2021.02.11 |
| Horn Antenna | SCHWARZBECK | BBHA9170 | BBHA 9170550 | 2 years | 2021.02.19 |
| Preamplifier | R&S | SCU01 | 100603 | 1 year | 2020.11.25 |
| Preamplifier | AGILENT | 8449B | 3008A01742 | 1 year | 2021.01.02 |
| EMI Test Receiver | R&S | ESU26 | 100551 | 1 year | 2021.04.01 |
| EMI TEST RECEIVER | R & S | ESR3 | 101781 | 1 year | 2021.01.10 |
| PULSE LIMITER | R & S | ESH3-Z2 | 101915 | 1 year | 2021.01.02 |

**Peripheral devices**

| Device | Manufacturer | Model No. | Serial No. |
|---|---|---|---|
| Notebook computer | LG Electronics Inc., | LGS53 | 306QCZP560949 |