# TEST REPORT

# Part 15 Subpart C 15.247

| | |
|---|---|
| **Equipment under test** | Wearable Translator |
| **Model name** | TalkBox |
| **FCC ID** | 2AG88-TALKBOX |
| **Applicant** | Soundbridge Co., Ltd. |
| **Manufacturer** | Soundbridge Co., Ltd. |
| **Date of test(s)** | 2019.09.27 ~ 2019.10.04 |
| **Date of issue** | 2019.10.10 |

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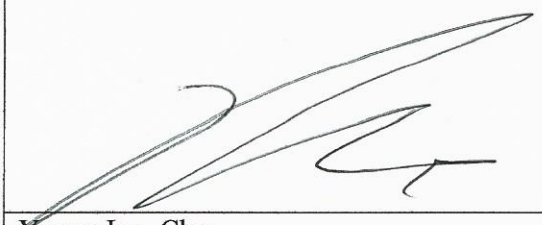
| **Test and report completed by :** | **Report approval by :** |
|---|---|
|  |  |
| Yeong-Jun, Cho<br>Test engineer | Hyeon-Su, Jang<br>Technical manager |

## Revision history

| Revision | Date of issue | Test report No. | Description |
|---|---|---|---|
| - | 2019.10.10 | KES-RF-19T0145 | Initial |
| | | | |

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## 1. General information

| | |
|---|---|
| Applicant: | Soundbridge Co., Ltd. |
| Applicant address: | 4th Fl., Daegu CCEI, 51, Hoam-ro, Buk-gu, Deagu-si, South Korea |
| Test site: | KES Co., Ltd. |
| Test site address: | 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea<br>473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea |
| Test Facility | FCC Accreditation Designation No.: KR0100, Registration No.: 444148 |
| FCC rule part(s): | 15.247 |
| FCC ID: | 2AG88-TALKBOX |
| Test device serial No.: | ☒ Production ☐ Pre-production ☐ Engineering |

### 1.1. EUT description

| | |
|---|---|
| Equipment under test | Wearable Translator |
| Frequency range | 2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR / BLE) |
| Model: | TalkBox |
| Modulation technique | GFSK, π/4DQPSK, 8DPSK |
| Number of channels | 2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR) : 79ch<br>2 402 ㎒ ~ 2 480 ㎒ (BLE) : 40ch |
| Antenna specification | Antenna type : Chip Antenna // Peak gain: 3.40 dBi |
| Power source | DC 3.7 V (Internal Rechargeable Battery) |
| H/W version | V 0.91 |
| S/W version | V 0.9 |

## 1.2. Requirements for Bluetooth transmitter

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted signals.

**Pseudorandom frequency hopping sequence**
The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

**Equal hopping frequency use**
The channels of this system will be used equally over the long-term distribution of the hopsets.

**Example of a 79 hopping sequence in data mode:**
02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

**System receiver input bandwidth**
Each channel bandwidth is 1 ㎒.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

## 1.3. Test configuration

The **Soundbridge Co., Ltd. // Wearable Translator // TalkBox // FCC ID: 2AG88-TALKBOX** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Subpart C 15.247
KDB 558074 D01 V05r02
ANSI C63.10-2013

## 1.4. Device modifications

N/A

## 1.5. Accessory information

| Equipment | Manufacturer | Model | Serial No. | Power source |
|---|---|---|---|---|
| - | - | - | - | - |

## 1.6. Sample calculation

Where relevant, the following sample calculation is provided

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).
= 1.56 + 10 = 11.56 (dB)

For Radiation test :
Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

## 1.7. Measurement Uncertainty

| Test Item | | Uncertainty |
|---|---|---|
| Uncertainty for Conduction emission test | | 2.62 dB |
| Uncertainty for Radiation emission test (include Fundamental emission) | 9kHz - 30MHz | 4.54 dB |
| | 30MHz - 1GHz | 4.36 dB |
| | Above 1GHz | 5.00 dB |
| Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. | | |

## 1.8. Frequency/channel operations

| Ch. | Frequency (㎒) | Rate(Mbps) |
|---|---|---|
| 00 | 2402 | BDR 1 Mbps,<br>EDR 2 Mbps,<br>EDR 3 Mbps |
| . | . | . |
| 40 | 2442 | BDR 1 Mbps,<br>EDR 2 Mbps,<br>EDR 3 Mbps |
| . | . | . |
| 78 | 2480 | BDR 1 Mbps,<br>EDR 2 Mbps,<br>EDR 3 Mbps |

## 2. Summary of tests

| Reference | Test description | Test results |
|---|---|---|
| 15.247(a)(1)(iii) | 20 dB bandwidth | Pass |
| 15.247(b)(1) | Output power | Pass |
| 15.247(a)(1) | Channel separation | Pass |
| 15.247(a)(1)(iii) | Number of channels | Pass |
| 15.247(a)(1)(iii) | Time of occupancy | Pass |
| 15.205, 15.209 | Radiated restricted band and emission | Pass |
| 15.207(d) | Conducted band edge and out of band emissions | Pass |
| 15.207(a) | AC conducted emissions | Pass |

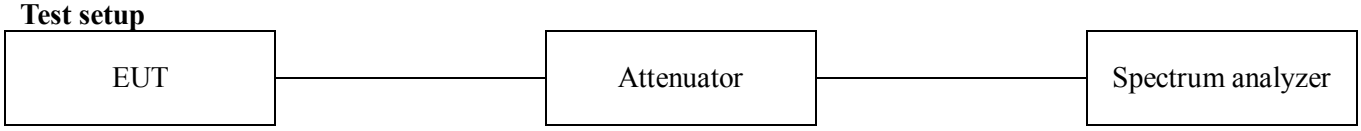
# 3. Test results

## 3.1. 20 dB bandwidth

**Test procedure**

ANSI 63.10-2013

**Test setup**



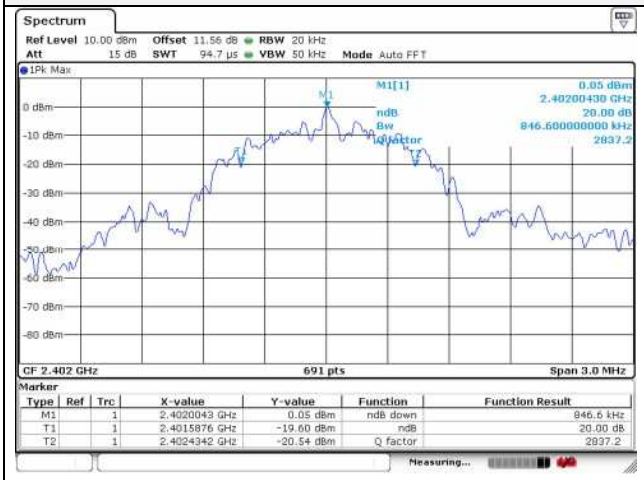
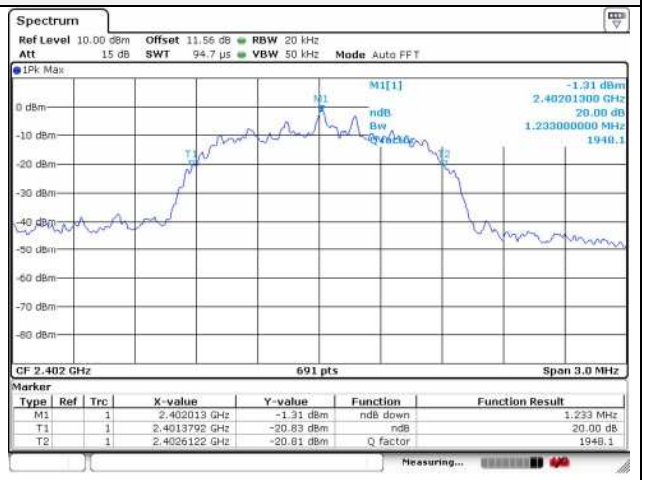
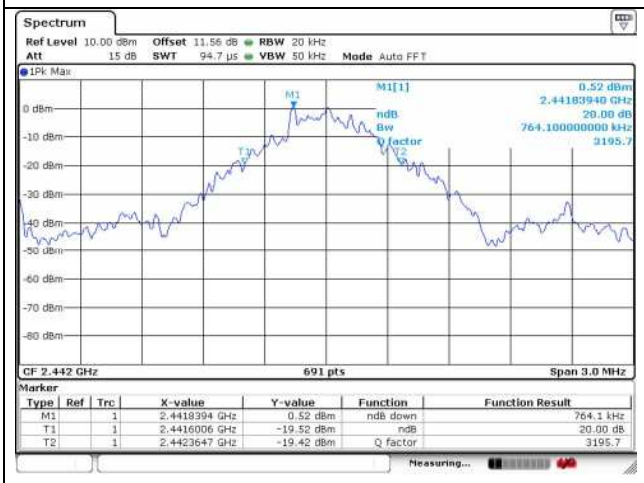
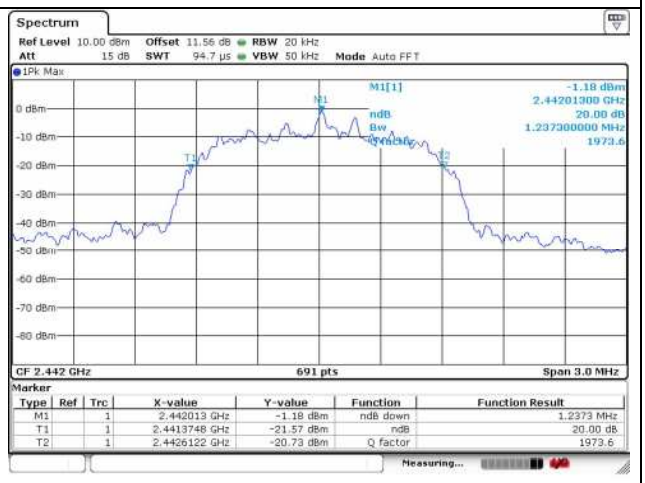
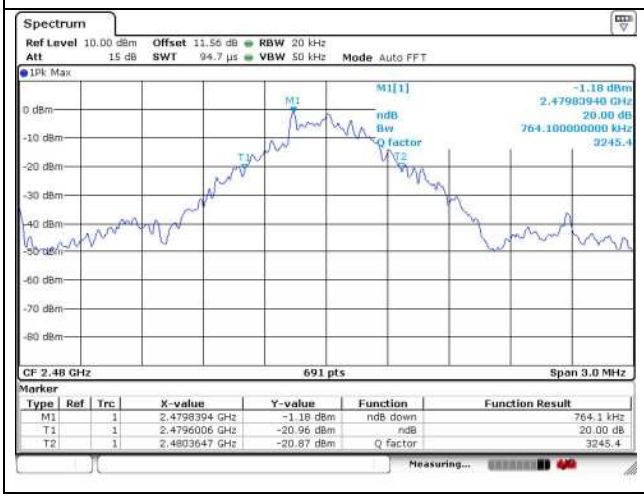
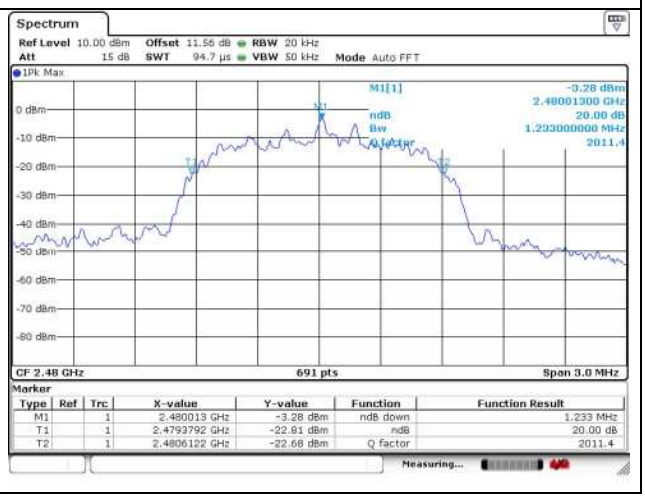

**Test setting**

1. Span = Set between two times and five times the OBW
2. RBW ≥ 1 % to 5 %of the OBW
3. VBW ≥ 3 * RBW
4. Sweep = Auto
5. Detector function = Peak
6. Sweep = Auto couple
7. Trace mode = Max hold
8. All the trace to stabilize

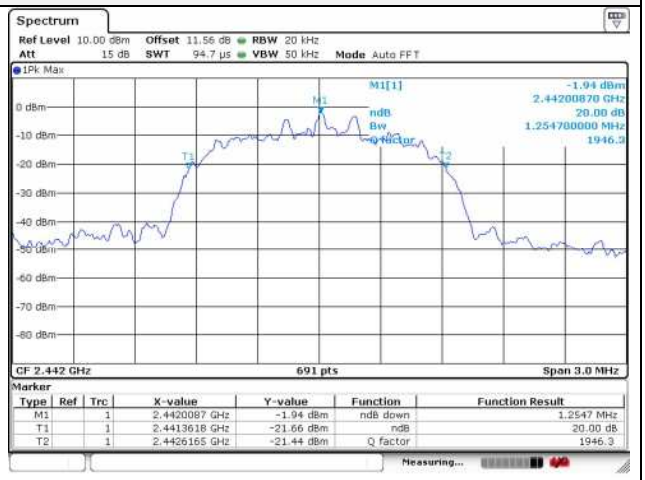
**Limit**

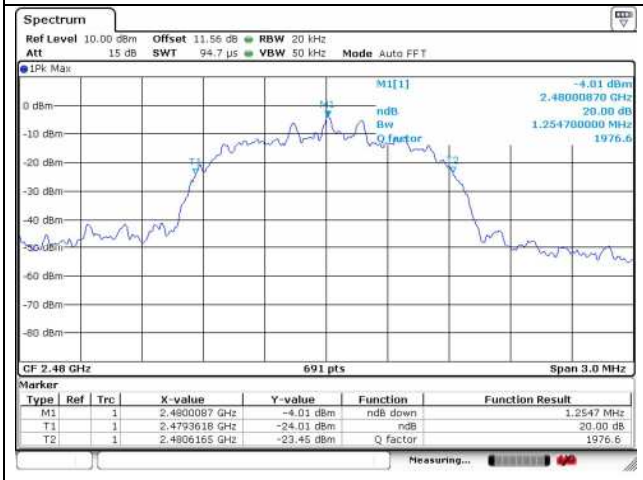
Not applicable

| Frequency(㎒) | Channel no. | Data rate(Mbps) | Measured bandwidth(㎒) |
|---|---|---|---|
| 2 402 | 00 | BDR 1 Mbps | 0.847 |
| 2 442 | 40 | | 0.764 |
| 2 480 | 78 | | 0.764 |
| 2 402 | 00 | EDR 2 Mbps | 1.233 |
| 2 442 | 40 | | 1.237 |
| 2 480 | 78 | | 1.233 |
| 2 402 | 00 | EDR 3 Mbps | 1.255 |
| 2 442 | 40 | | 1.255 |
| 2 480 | 78 | | 1.255 |

| BDR(1Mbps) | EDR(2Mbps) |
|---|---|
|  |  |
|  |  |
|  |  |

**EDR(3Mbps)**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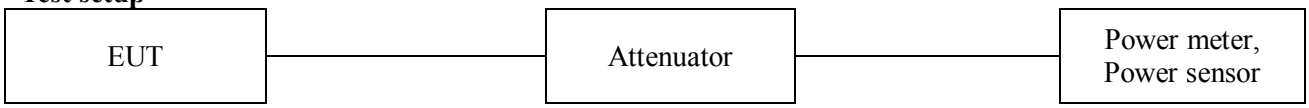
## 3.2. Output power

**Test procedure**

KDB 558074 v05r02 & ANSI 63.10-2013 – Section 11.9.2.1 and 11.9.2.3.2

**Test setup**




**Test setting**

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 factor is required.

**Limit**

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 ㎒ band: 1 Watt.

According to §15.247(a)(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 dBi.

**Test results**

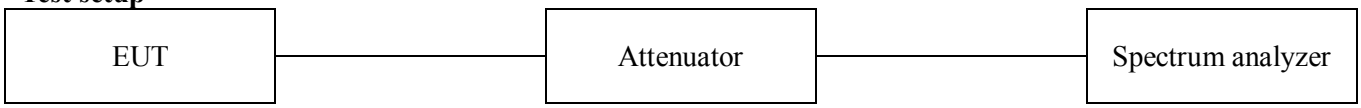
| Frequency(㎒) | Channel no. | Data rate(Mbps) | Average Power (dBm) | Power Limit (dBm) |
|---|---|---|---|---|
| 2 402 | 00 | BDR 1 Mbps | 4.13 | 20.97 |
| 2 442 | 40 | | 4.42 | 20.97 |
| 2 480 | 78 | | 2.74 | 20.97 |
| 2 402 | 00 | EDR 2 Mbps | 0.49 | 20.97 |
| 2 442 | 40 | | 0.68 | 20.97 |
| 2 480 | 78 | | -1.43 | 20.97 |
| 2 402 | 00 | EDR 3 Mbps | 0.53 | 20.97 |
| 2 442 | 40 | | 0.68 | 20.97 |
| 2 480 | 78 | | -1.43 | 20.97 |

## 3.3. Carrier frequency separation

**Test procedure**

KDB 558074 v05r02 & ANSI 63.10-2013

**Test setup**




**Test Setting**

1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
2. Span = wide enough to capture the peaks of two adjacent channels
3. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
4. Video (or Average) Bandwidth (VBW) ≥ RBW
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold
8. Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

**Limit**

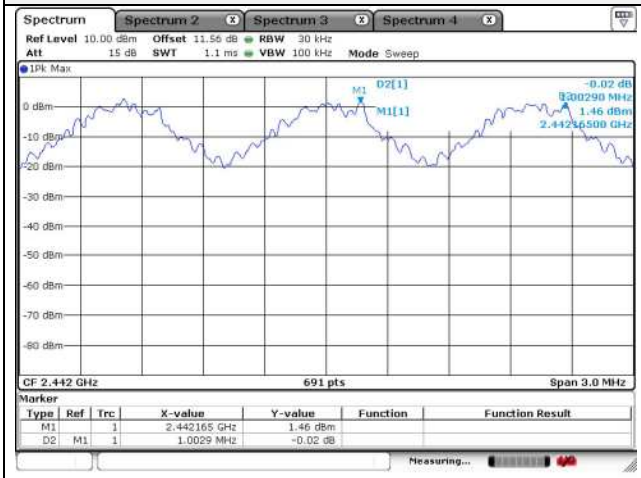
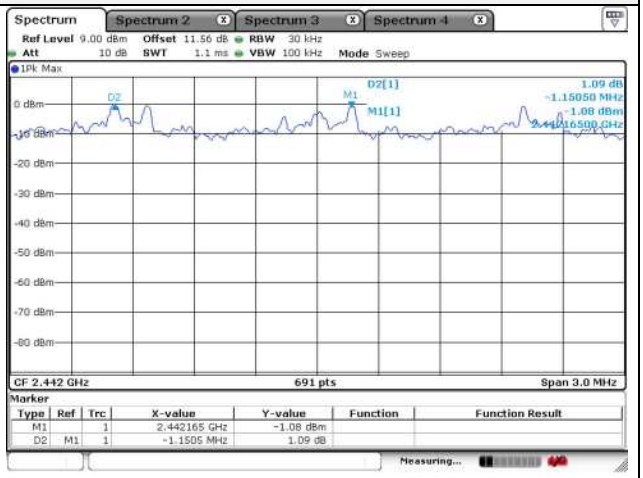
According to 15.247(a)(1), frequency hopping system operating in 2 400 ~ 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

**Note:**

Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

**Test results**

| Frequency(㎒) | Channel no. | Data rate(Mbps) | Channel Separation (㎒) |
|---|---|---|---|
| 2 442 | 40 | BDR 1 Mbps | 1.003 |
| 2 442 | 40 | EDR 3 Mbps | 1.151 |

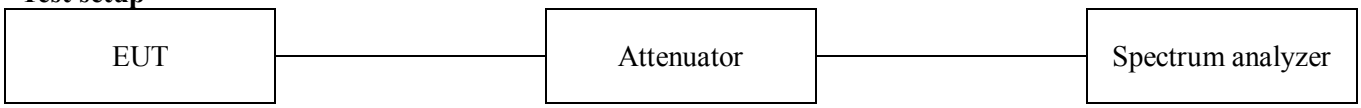
| Hopping mode_BDR(1Mbps) | Hopping mode_EDR(3Mbps) |
|---|---|
|  |  |

## 3.4. Number of hopping frequency

**Test procedure**

KDB 558074 v05r02 & ANSI 63.10-2013

**Test setup**




**Test setting**

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings.

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW ≥ RBW.
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

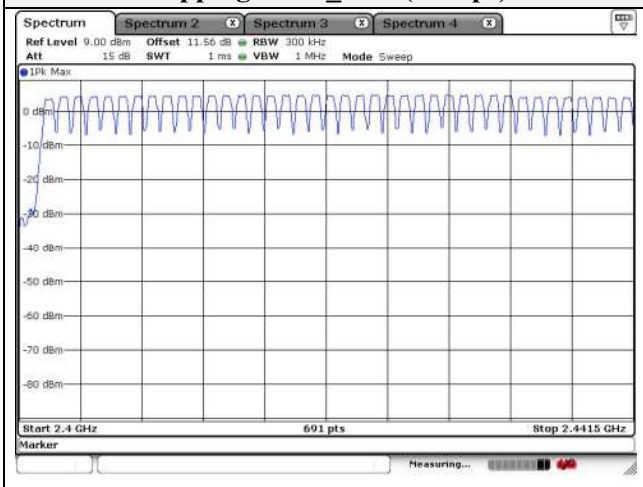
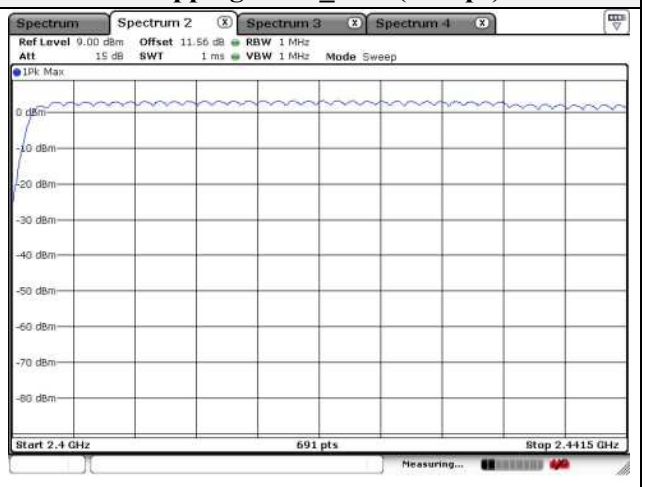
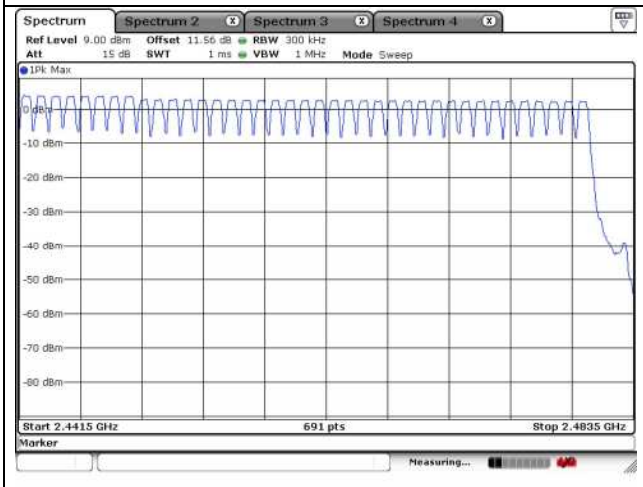
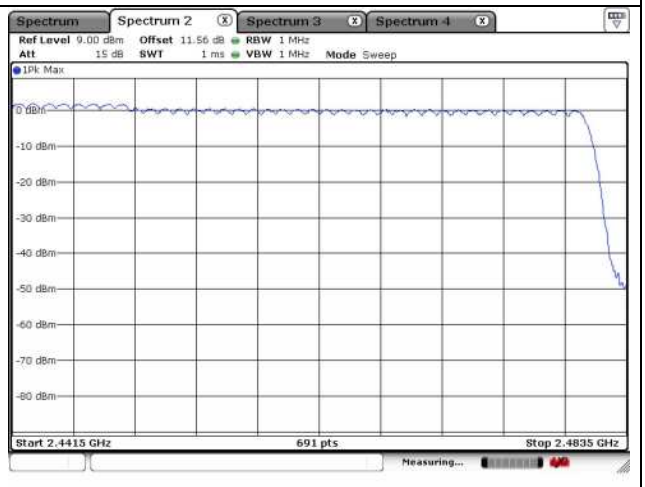
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

**Limit**

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

**Test results**

| Frequency | Data rate(Mbps) | Number of hopping frequency | Limit |
|---|---|---|---|
| 2402 ~ 2480 ㎒ | BDR 1 Mbps | 79 | ≥ 15 |
| 2402 ~ 2480 ㎒ | EDR 3 Mbps | 79 | ≥ 15 |

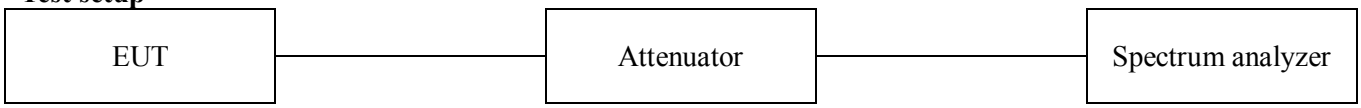
| Hopping mode_BDR(1Mbps) | Hopping mode_EDR(3Mbps) |
|---|---|
|  |  |
|  |  |

## 3.5. Time of occupancy

**Test procedure**

KDB 558074 v05r02 & ANSI 63.10-2013

**Test setup**




**Test setting**

1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
3. RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
4. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
5. Detector function = peak
6. Trace = max hold

**Limit**

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) × 79 = 31.6(s)

Time of occupancy on the TX channel in 31.6 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 31.6

**• Adaptive Frequency Hopping**

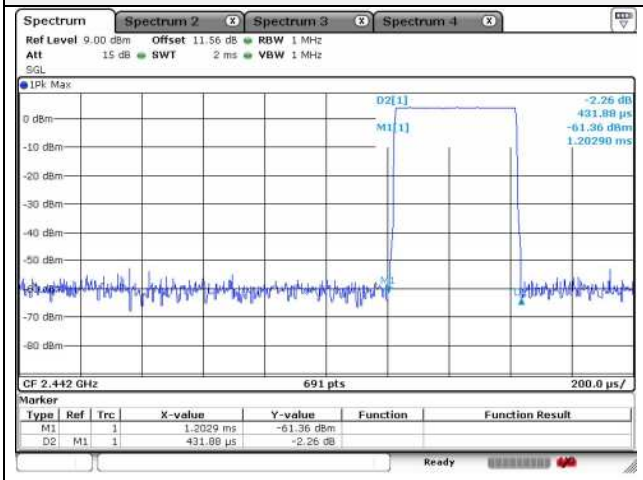
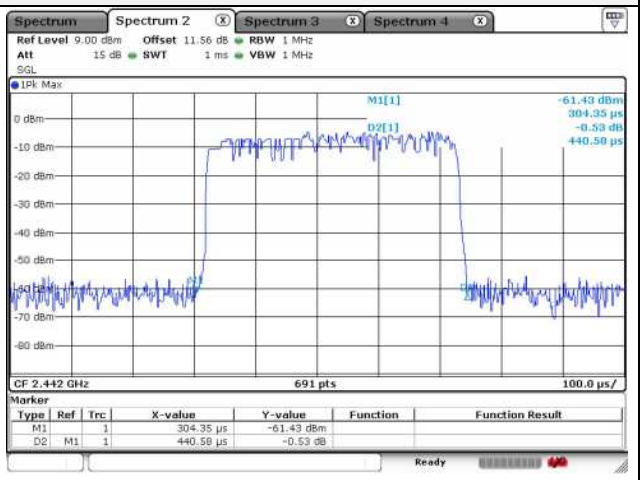
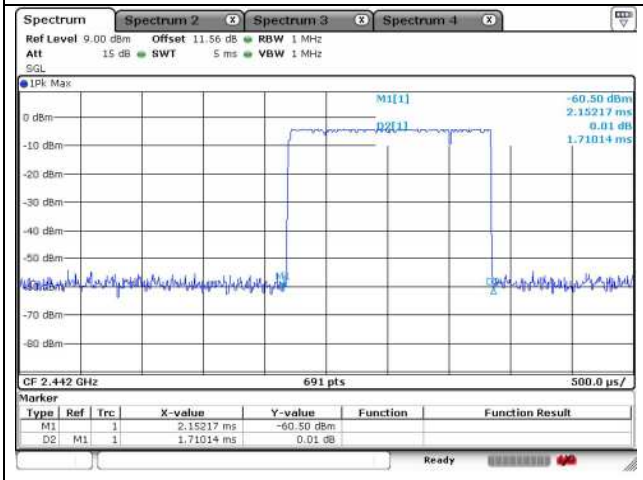
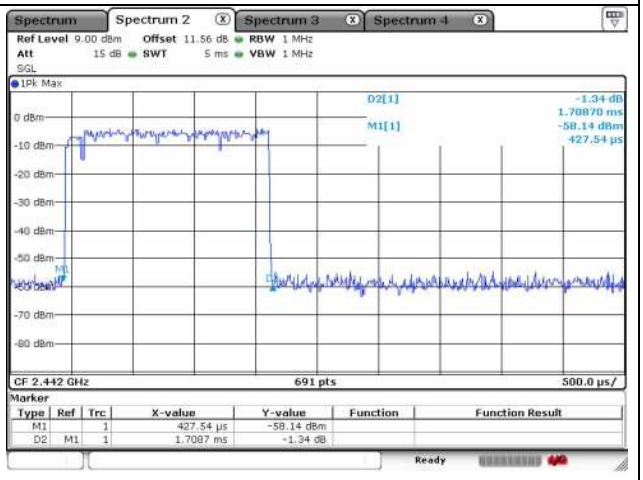
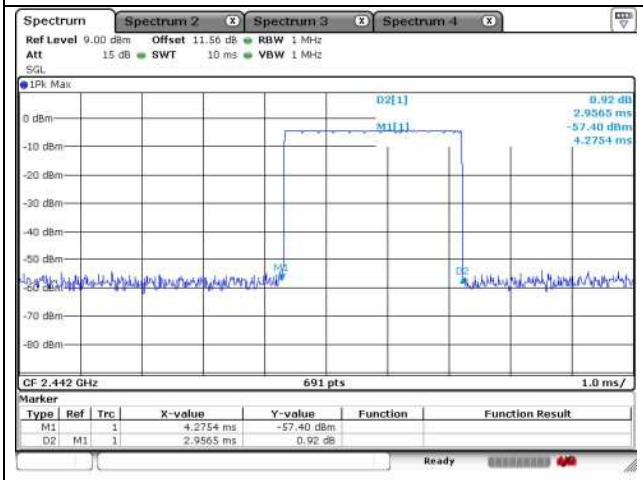
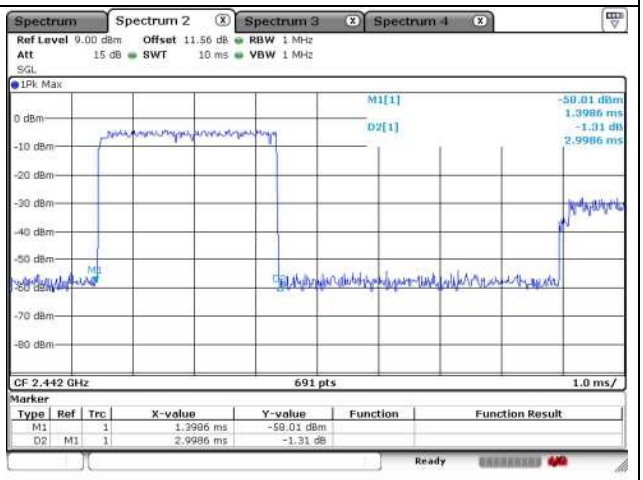
A period time = 0.4(s) × 20 = 8.0(s)

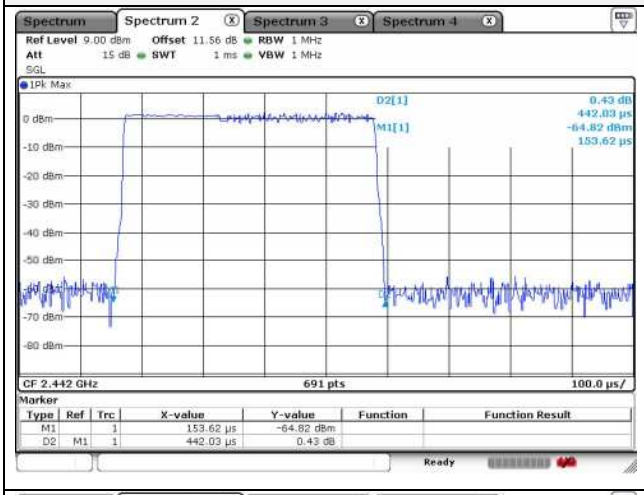
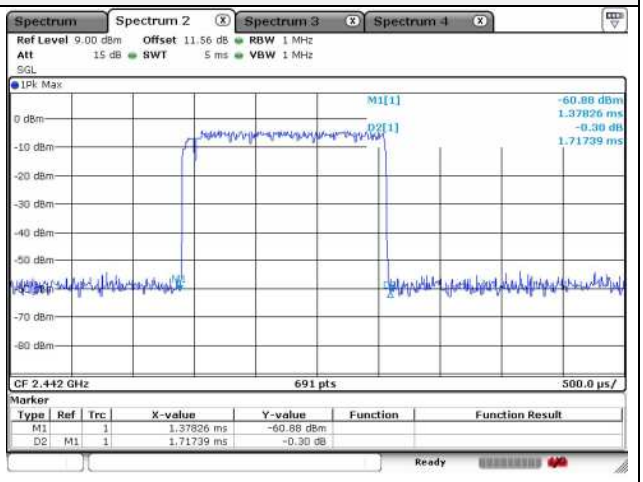
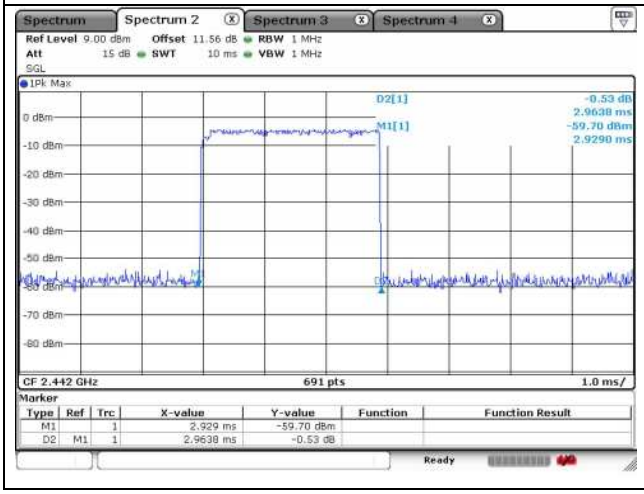
Time of occupancy on the TX channel in 8.0 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 8.0

**Operation mode: GFSK , π/4-DQPSK, 8DPSK**

| Packet type | Frequency (㎒) | Dwell time (ms) | Time of occupancy on the Tx channel in 31.6 sec (ms) | Limit for time of occupancy on the Tx channel in 31.6 sec (ms) |
|---|---|---|---|---|
| DH1 | 2 442 | 0.432 | 138.24 | 400 |
| DH3 | 2 442 | 1.710 | 273.60 | 400 |
| DH5 | 2 442 | 2.957 | 315.41 | 400 |
| 2-DH1 | 2 442 | 0.441 | 141.12 | 400 |
| 2-DH3 | 2 442 | 1.709 | 273.44 | 400 |
| 2-DH5 | 2 442 | 2.999 | 319.89 | 400 |
| 3-DH1 | 2 442 | 0.442 | 141.44 | 400 |
| 3-DH3 | 2 442 | 1.717 | 274.72 | 400 |
| 3-DH5 | 2 442 | 2.964 | 316.16 | 400 |

**Note:**
**Normal Mode**
DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 138.24 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 273.60 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 315.41 (ms)
2-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 141.12 (ms)
2-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 273.44 (ms)
2-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 319.89 (ms)
3-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 141.44 (ms)
3-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 274.72 (ms)
3-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 316.16 (ms)

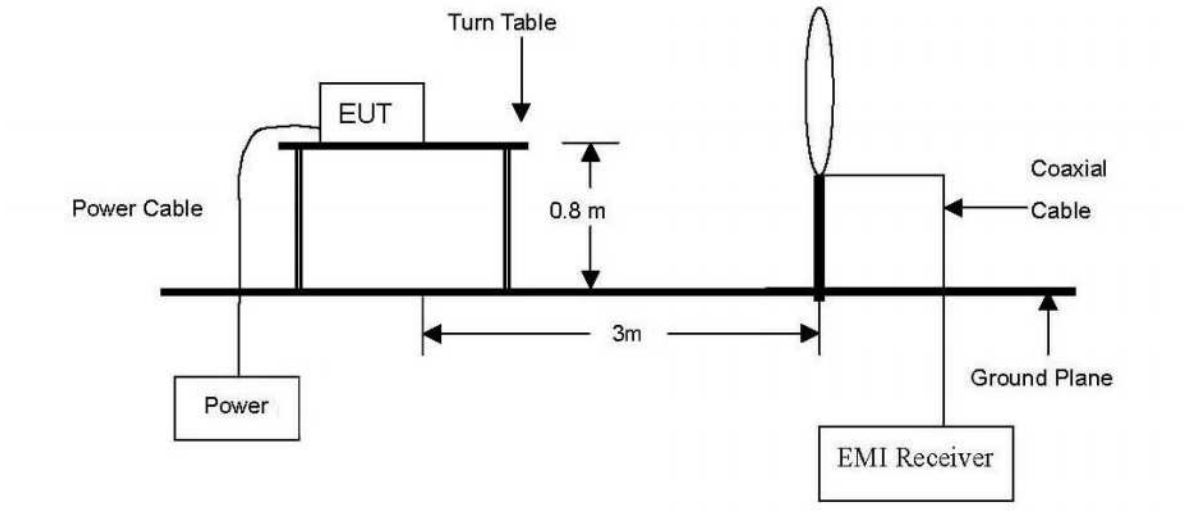
| BDR(1Mbps) | EDR(2Mbps) |
|---|---|
|  |  |
|  |  |
|  |  |

| EDR(3Mbps) | |
|---|---|
|  |  |
|  | Blank |

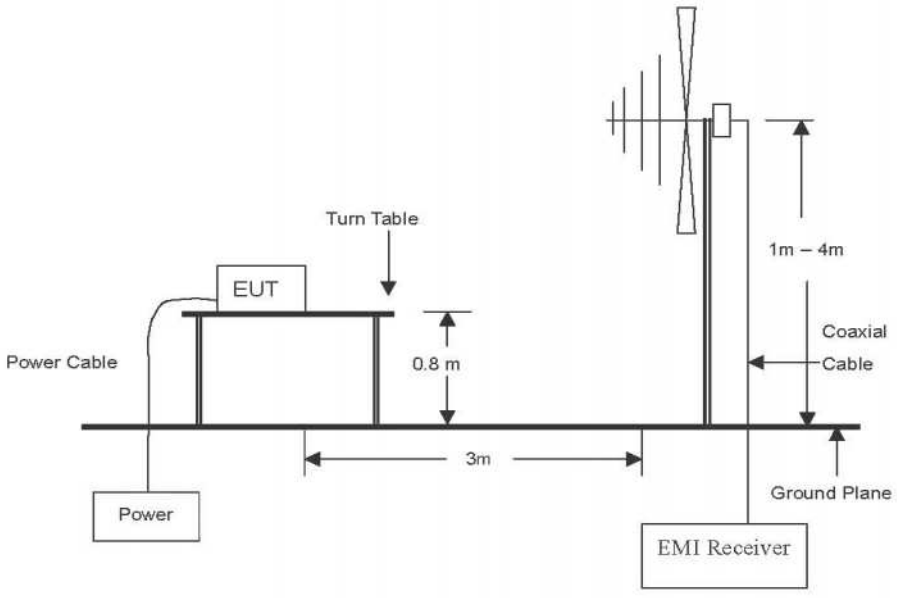
## 3.6. Radiated restricted band and emissions

**Test setup**

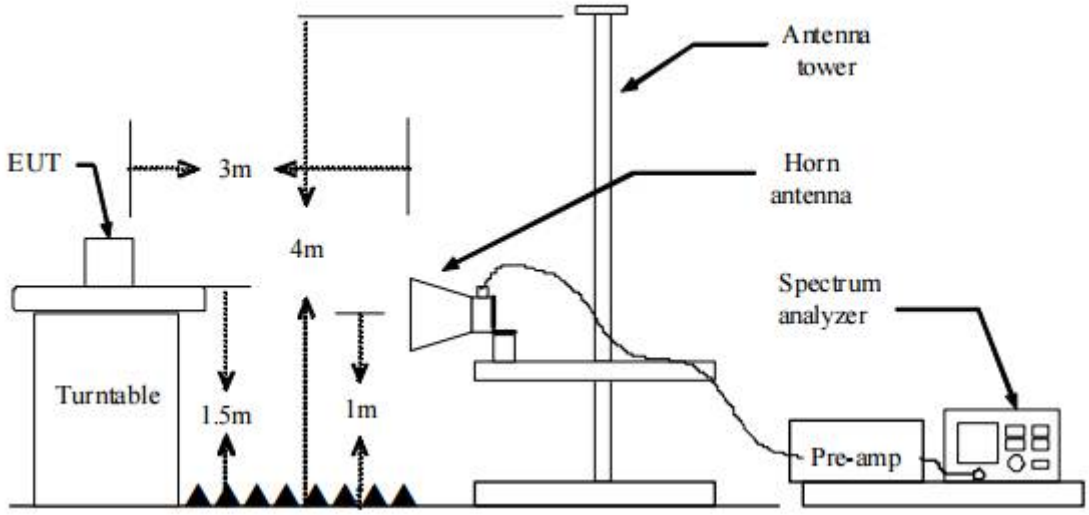
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.




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**

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

**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, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that **parallel** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **parallel.**
3. 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.
4. 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. The EUT was placed on the top of a rotating table 1.5 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. The antenna is a bi-log antenna, a horn antenna ,and its height are varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

5. 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
6. 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

7. 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. $f$<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
2. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
3. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
4. 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.
7. 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.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field 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：

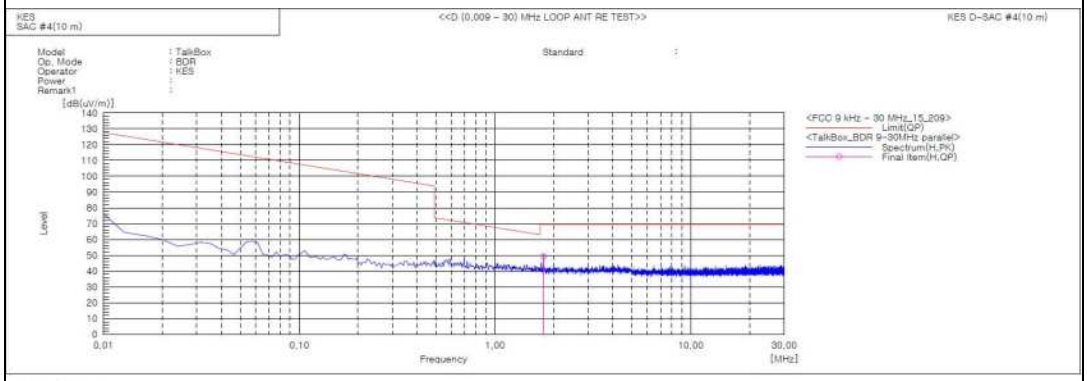
| Frequency (㎒) | Distance (Meters) | Radiated (㎶/m) |
|---|---|---|
| 0.009 ~ 0.490 | 300 | 2400/F(㎑) |
| 0.490 ~ 1.705 | 30 | 24000/F(㎑) |
| 1.705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 3 | 100** |
| 88 ~ 216 | 3 | 150** |
| 216 ~ 960 | 3 | 200** |
| Above 960 | 3 | 500 |

**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.

**Test results (Below 30 ㎒)**

| | |
|---|---|
| Mode: | BDR |
| Distance of measurement: | 3 meter |
| Channel: | 40(Worst case) |

**Parallel**



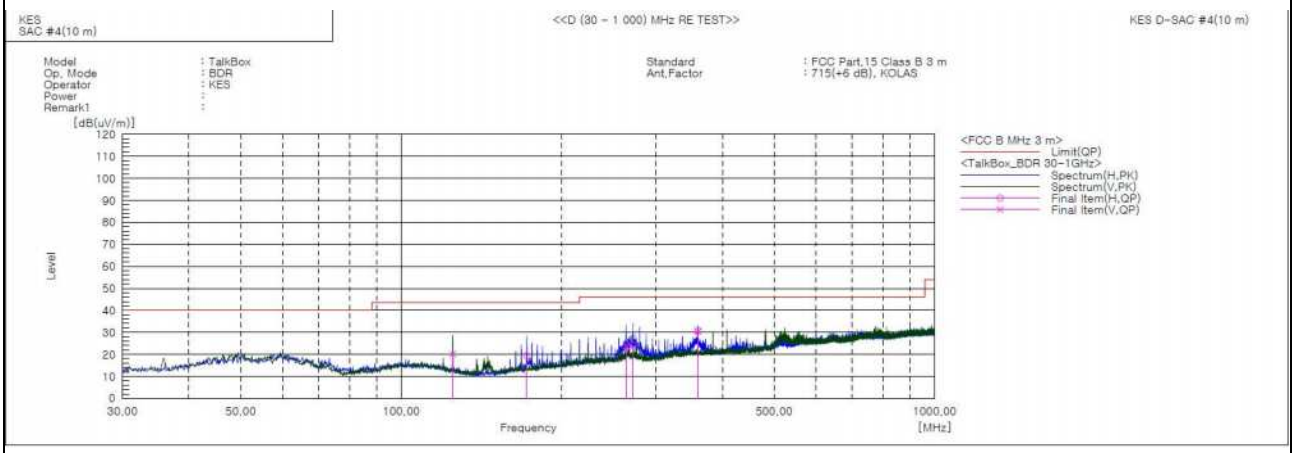

Final Result

| No. | Frequency [MHz] | (P) | Reading QP [dB(uV)] | c.f [dB(1/m)] | Result QP [dB(uV/m)] | Limit QP [dB(uV/m)] | Margin QP [dB] | Height [cm] | Angle [deg] | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.774 | H | 30.0 | 19.3 | 49.3 | 69.5 | 20.2 | 100.0 | 17.0 | |

**Test results (Below 1 000 ㎒) – Worst case**

| | |
|---|---|
| Mode: | BDR |
| Distance of measurement: | 3 meter |
| Channel: | 40(Worst case) |

**Horizontal // Vertical**




Final Result

| No. | Frequency [MHz] | (P) | Reading QP [dB(uV)] | c.f [dB(1/m)] | Result QP [dB(uV/m)] | Limit QP [dB(uV/m)] | Margin QP [dB] | Height [cm] | Angle [deg] | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 124.939 | V | 45.8 | -25.6 | 20.2 | 43.5 | 23.3 | 125.0 | 150.0 | |
| 2 | 171.984 | H | 44.7 | -25.3 | 19.4 | 43.5 | 24.1 | 266.0 | 344.0 | |
| 3 | 264.013 | V | 45.0 | -21.0 | 24.0 | 46.0 | 22.0 | 214.0 | 110.0 | |
| 4 | 272.015 | H | 45.2 | -20.9 | 24.3 | 46.0 | 21.7 | 390.0 | 117.0 | |
| 5 | 360.043 | H | 48.3 | -17.5 | 30.8 | 46.0 | 15.2 | 400.0 | 192.0 | |
| 6 | 360.043 | V | 47.9 | -17.5 | 30.4 | 46.0 | 15.6 | 100.0 | 15.0 | |

**Test results (Above 1 000 ㎒)**

Mode: BDR

Distance of measurement: 3 meter

Channel: 00

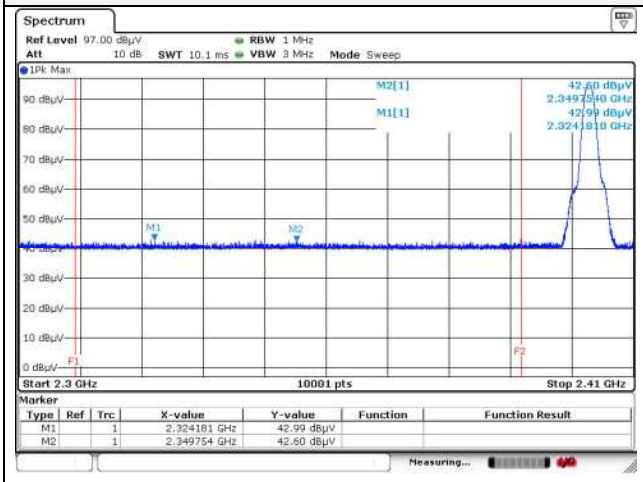
- **Spurious**

| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 044.70 | 45.60 | Peak | H | -10.31 | - | 35.29 | 74.00 | 38.71 |
| 1 375.46 | 44.80 | Peak | H | -10.40 | - | 34.40 | 74.00 | 39.60 |
| 1 039.10 | 45.71 | Peak | V | -10.31 | - | 35.40 | 74.00 | 38.60 |
| 1 947.61 | 45.18 | Peak | V | -1.17 | - | 44.01 | 74.00 | 29.99 |

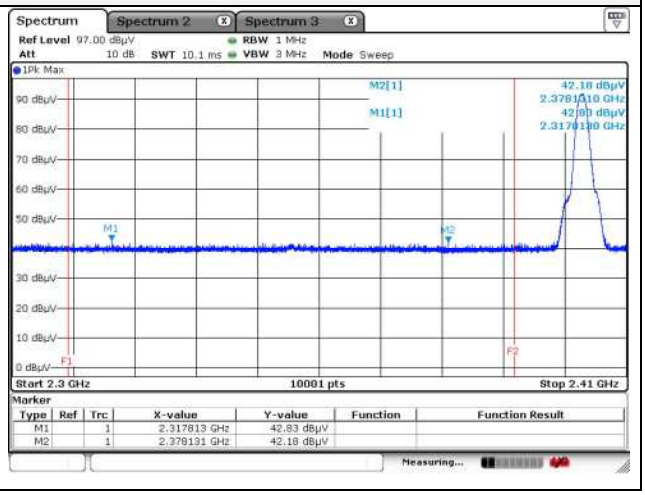
- **Band edge**

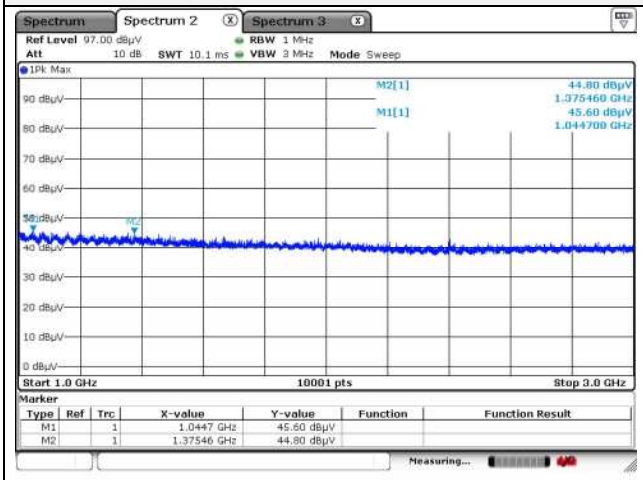
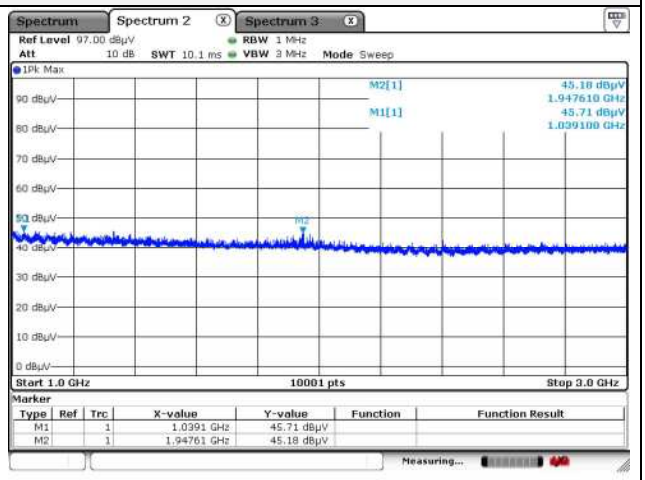
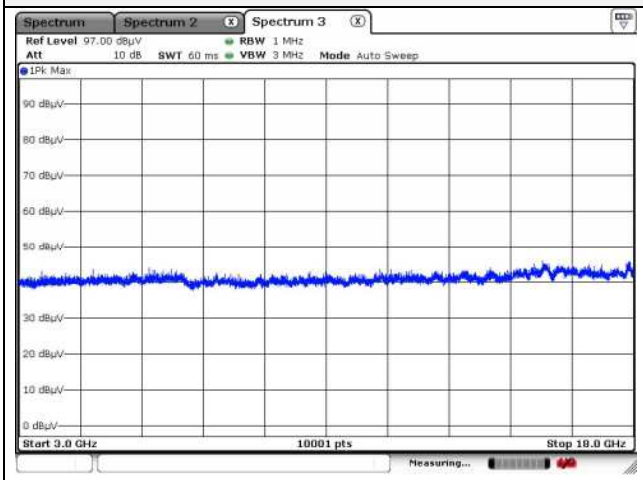
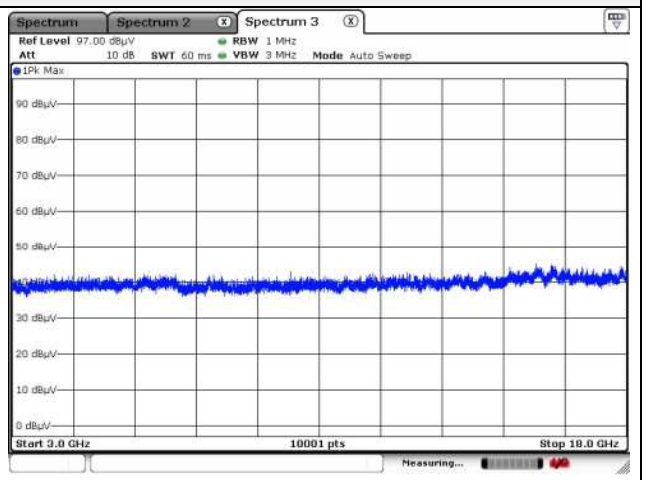
| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 324.18 | 42.99 | Peak | H | -5.84 | - | 37.15 | 74.00 | 36.85 |
| 2 349.75 | 42.60 | Peak | H | -5.98 | - | 36.62 | 74.00 | 37.38 |
| 2 317.81 | 42.83 | Peak | V | -5.80 | - | 37.03 | 74.00 | 36.97 |
| 2 378.13 | 42.18 | Peak | V | -6.14 | - | 36.04 | 74.00 | 37.96 |

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




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



| Horizontal // Peak for 1 ㎓ to 3 ㎓ | Vertical // Peak for 1 ㎓ to 3 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 3 ㎓ to 18 ㎓** | **Vertical // Peak for 3 ㎓ to 18 ㎓** |
|  |  |

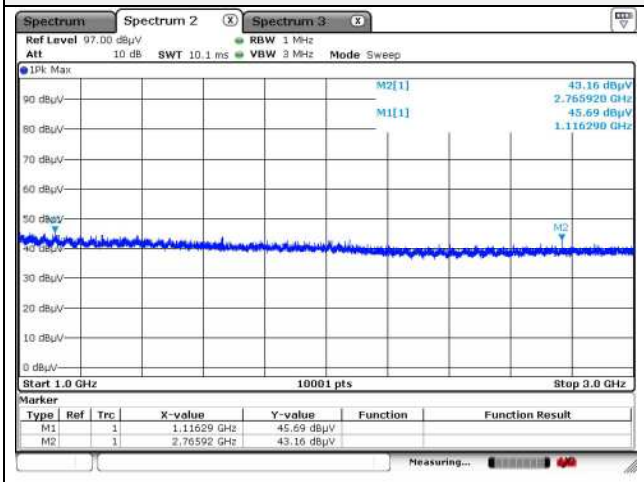


Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

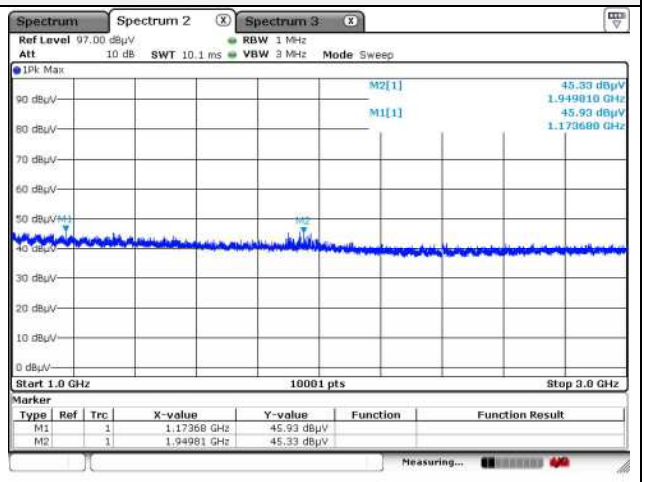
Mode: BDR
Distance of measurement: 3 meter
Channel: 40

| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 116.29 | 45.69 | Peak | H | -10.36 | - | 35.33 | 74.00 | 38.67 |
| 2 765.92 | 43.16 | Peak | H | -2.28 | - | 40.88 | 74.00 | 33.12 |
| 1 173.68 | 45.93 | Peak | V | -10.40 | - | 35.53 | 74.00 | 38.47 |
| 1 949.81 | 45.33 | Peak | V | -1.13 | - | 44.20 | 74.00 | 29.80 |

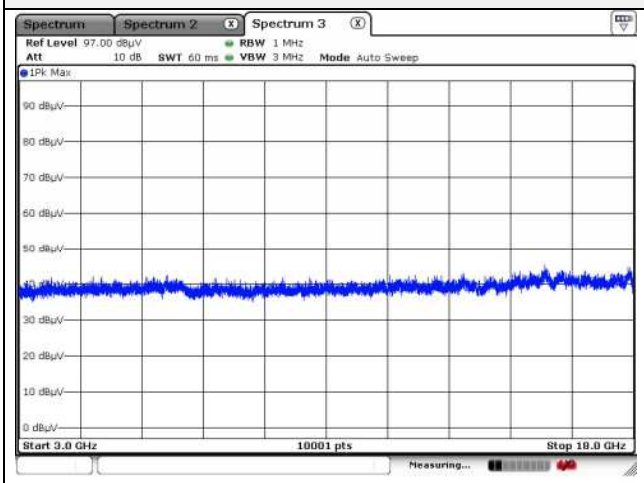
**Horizontal // Peak for 1 ㎓ to 3 ㎓**



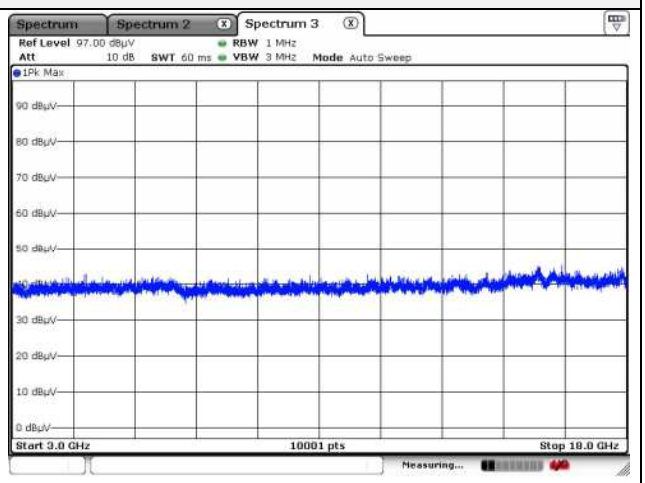

**Vertical // Peak for 1 ㎓ to 3 ㎓**




**Horizontal // Peak for 3 ㎓ to 18 ㎓**




**Vertical // Peak for 3 ㎓ to 18 ㎓**




Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

| | |
|---|---|
| Mode: | BDR |
| Transfer rate: | 1 Mbps |
| Distance of measurement: | 3 meter |
| Channel: | 78 |

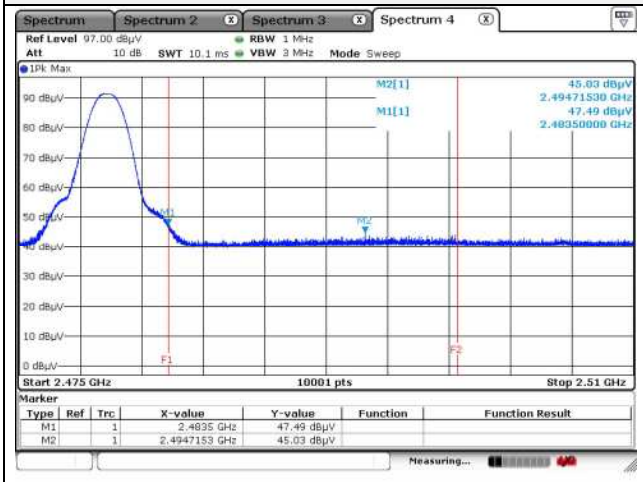
- **Spurious**

| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 045.90 | 45.31 | Peak | H | -10.32 | - | 34.99 | 74.00 | 39.01 |
| 1 385.26 | 44.81 | Peak | H | -10.40 | - | 34.41 | 74.00 | 39.59 |
| 1 125.89 | 45.14 | Peak | V | -10.37 | - | 34.77 | 74.00 | 39.23 |
| 1 782.82 | 43.84 | Peak | V | -3.82 | - | 40.02 | 74.00 | 33.98 |

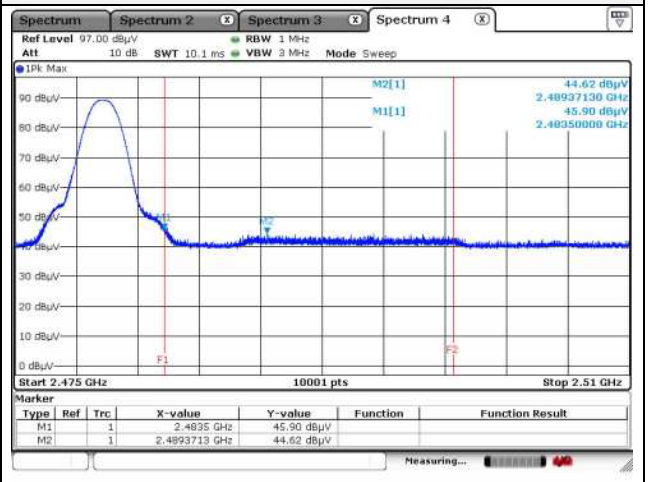
- **Band edge**

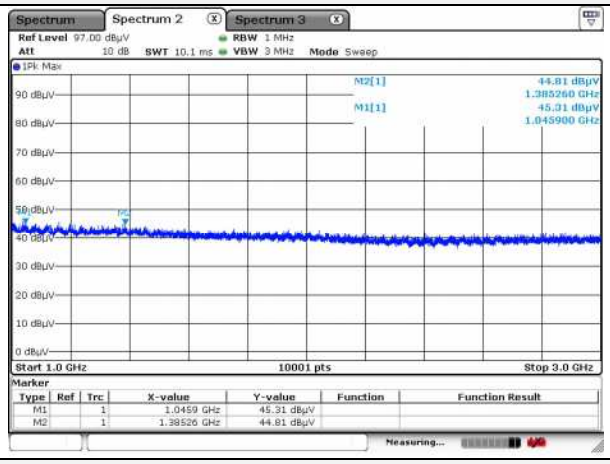
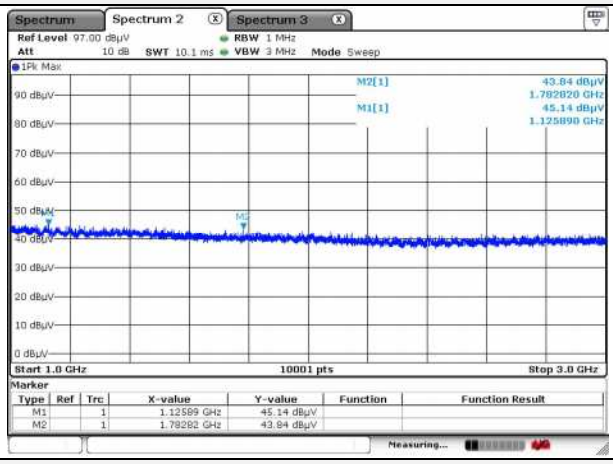
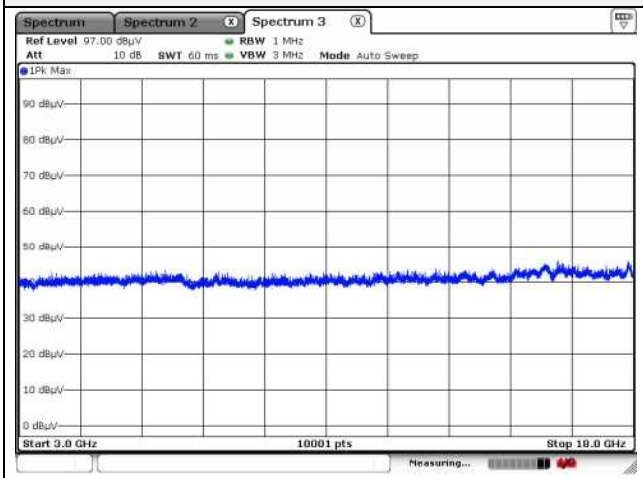
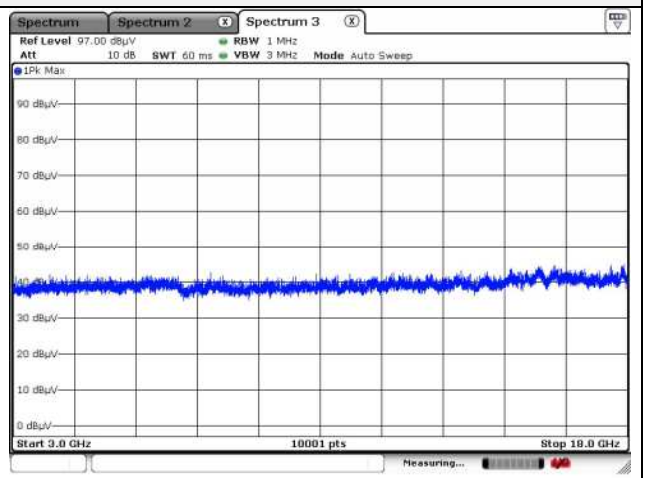
| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 483.50 | 47.49 | Peak | H | -6.69 | - | 40.80 | 74.00 | 33.20 |
| 2 494.72 | 45.03 | Peak | H | -6.74 | - | 38.29 | 74.00 | 35.71 |
| 2 483.50 | 45.90 | Peak | V | -6.69 | - | 39.21 | 74.00 | 34.79 |
| 2 489.37 | 44.62 | Peak | V | -6.71 | - | 37.91 | 74.00 | 36.09 |

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




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



| Horizontal // Peak for 1 ㎓ to 3 ㎓ | Vertical // Peak for 1 ㎓ to 3 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 3 ㎓ to 18 ㎓** | **Vertical // Peak for 3 ㎓ to 18 ㎓** |
|  |  |

Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

| | |
|---|---|
| Mode: | EDR |
| Transfer rate: | 3 Mbps(Worst case) |
| Distance of measurement: | 3 meter |
| Channel: | 00 |

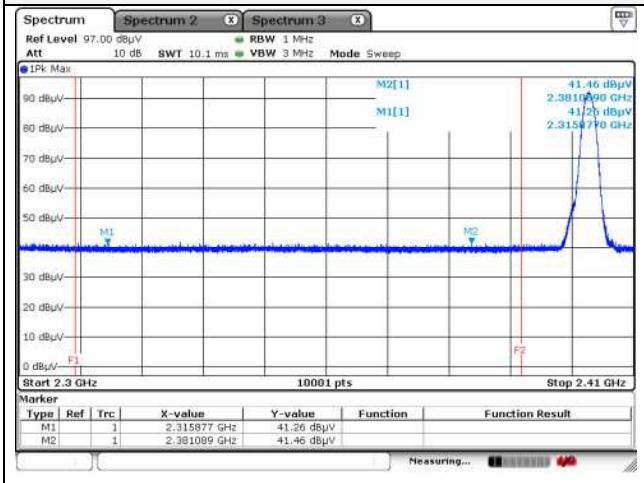
- **Spurious**

| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 013.50 | 45.96 | Peak | H | -10.29 | - | 35.67 | 74.00 | 38.33 |
| 2 730.93 | 42.45 | Peak | H | -2.32 | - | 40.13 | 74.00 | 33.87 |
| 1 330.27 | 45.92 | Peak | V | -10.41 | - | 35.51 | 74.00 | 38.49 |
| 1 934.81 | 45.74 | Peak | V | -1.38 | - | 44.36 | 74.00 | 29.64 |

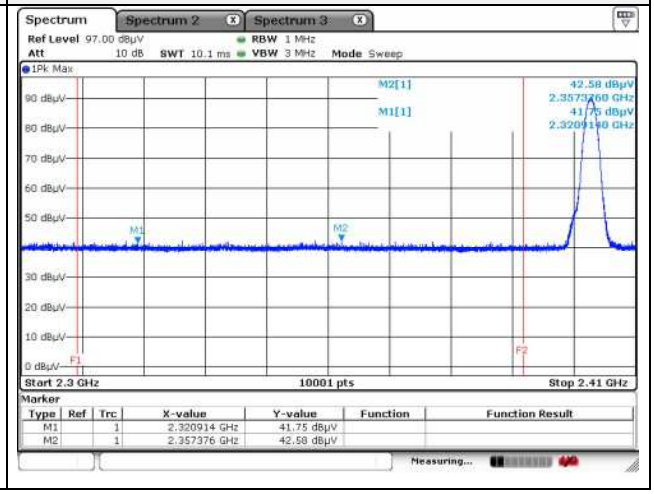
- **Band edge**

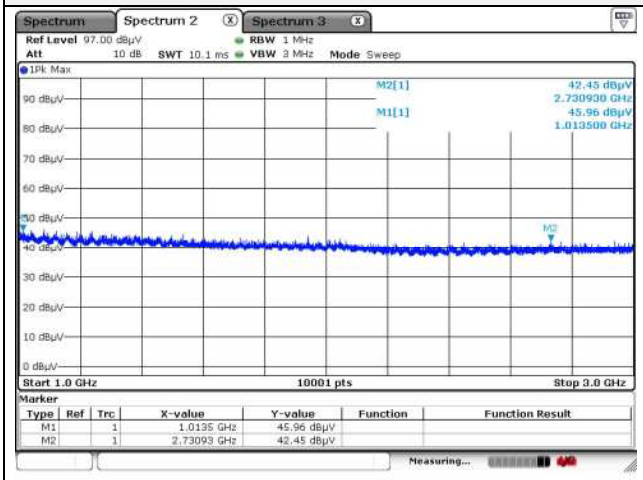
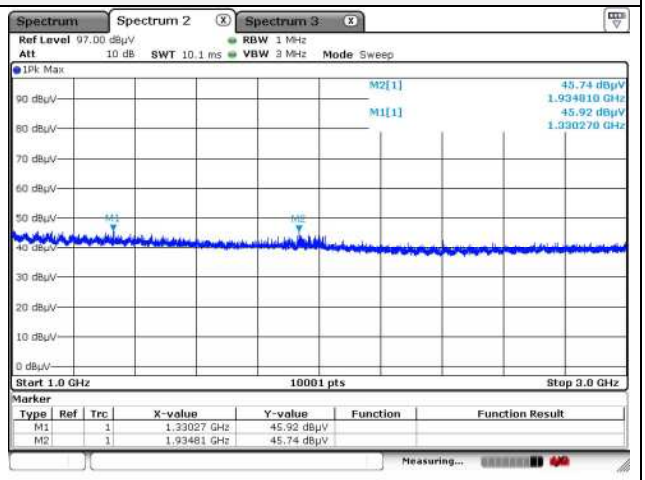
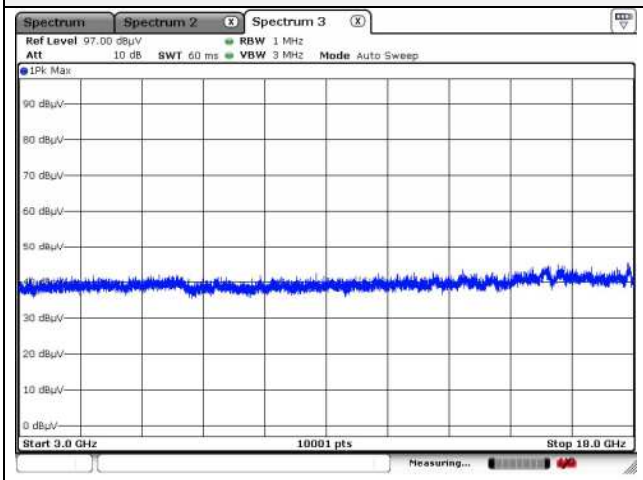
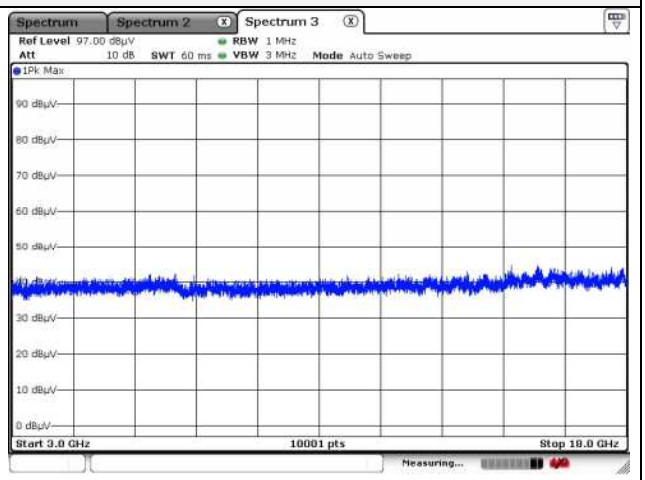
| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 315.88 | 41.26 | Peak | H | -5.80 | - | 35.46 | 74.00 | 38.54 |
| 2 381.09 | 41.46 | Peak | H | -6.15 | - | 35.31 | 74.00 | 38.69 |
| 2 320.91 | 41.75 | Peak | V | -5.82 | - | 35.93 | 74.00 | 38.07 |
| 2 357.38 | 42.58 | Peak | V | -6.02 | - | 36.56 | 74.00 | 37.44 |

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




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



| Horizontal // Peak for 1 ㎓ to 3 ㎓ | Vertical // Peak for 1 ㎓ to 3 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 3 ㎓ to 18 ㎓** | **Vertical // Peak for 3 ㎓ to 18 ㎓** |
|  |  |









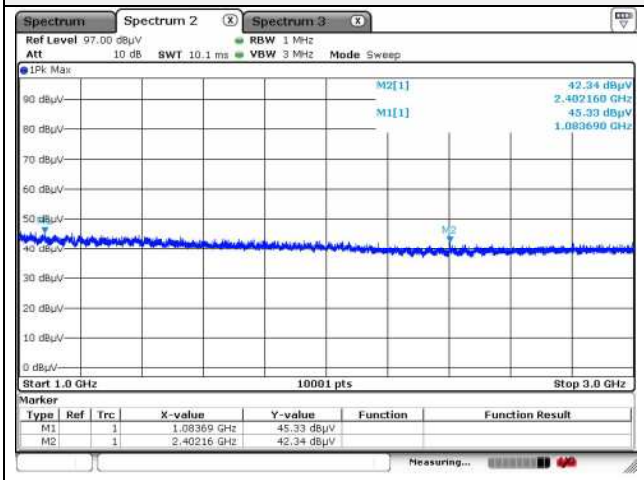
Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

| | |
|---|---|
| Mode: | EDR |
| Transfer rate: | 3 Mbps(Worst case) |
| Distance of measurement: | 3 meter |
| Channel: | 40 |

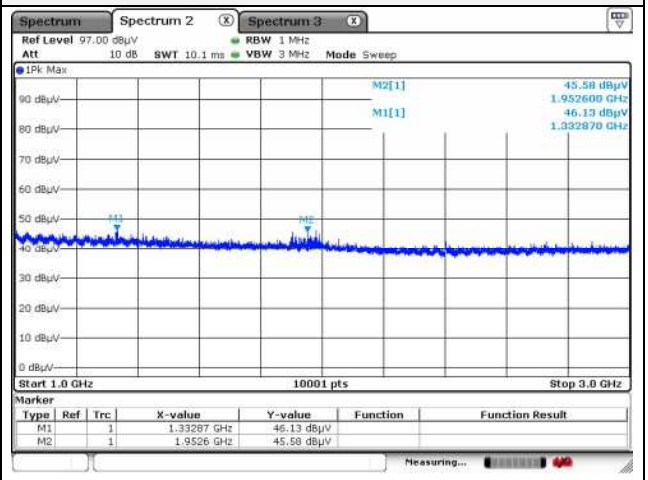
- **Spurious**

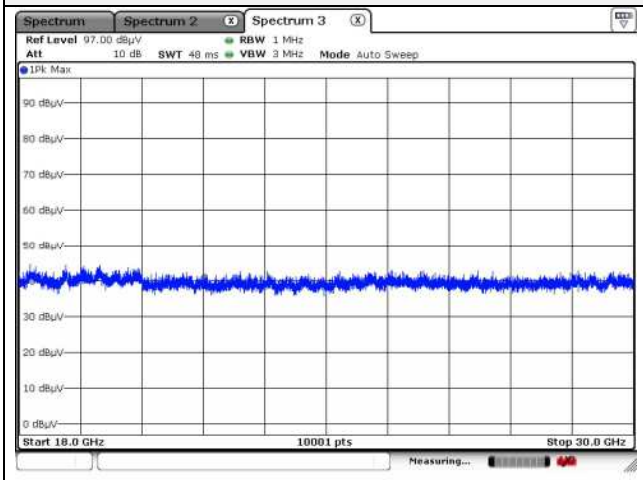
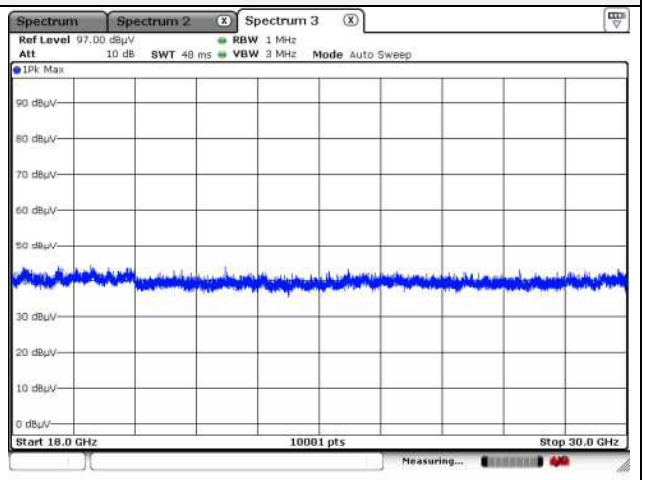
| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 083.69 | 45.33 | Peak | H | -10.34 | - | 34.99 | 74.00 | 39.01 |
| 2 402.16 | 42.34 | Peak | H | -6.27 | - | 36.07 | 74.00 | 37.93 |
| 1 332.87 | 46.13 | Peak | V | -10.41 | - | 35.72 | 74.00 | 38.28 |
| 1 952.60 | 45.58 | Peak | V | -1.09 | - | 44.49 | 74.00 | 29.51 |

**Horizontal // Peak for 1 ㎓ to 3 ㎓**




**Vertical // Peak for 1 ㎓ to 3 ㎓**



| Horizontal // Peak for 3 ㎓ to 18 ㎓ | Vertical // Peak for 3 ㎓ to 18 ㎓ |
|---|---|
|  |  |



Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

| | |
|---|---|
| Mode: | EDR |
| Transfer rate: | 3 Mbps(Worst case) |
| Distance of measurement: | 3 meter |
| Channel: | 78 |

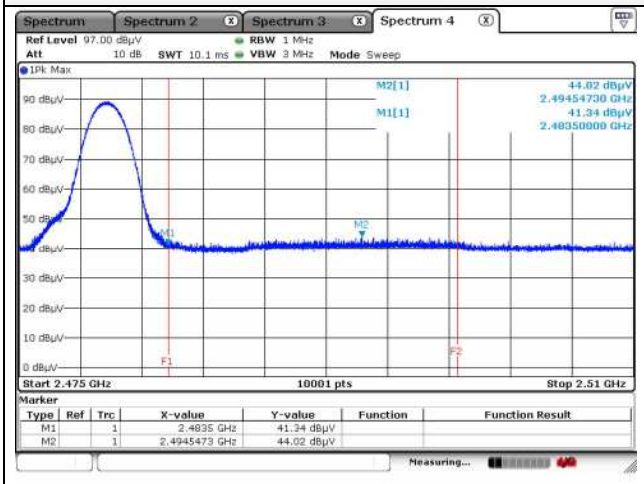
- **Spurious**

| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 117.69 | 46.44 | Peak | H | -10.36 | - | 36.08 | 74.00 | 37.92 |
| 2 036.80 | 43.02 | Peak | H | -4.33 | - | 38.69 | 74.00 | 35.31 |
| 1 412.26 | 46.01 | Peak | V | -10.41 | - | 35.60 | 74.00 | 38.40 |
| 2 074.99 | 42.39 | Peak | V | -4.53 | - | 37.86 | 74.00 | 36.14 |

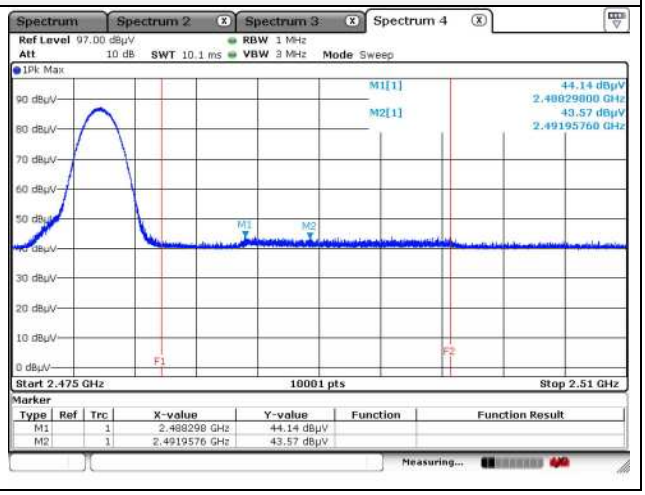
- **Band edge**

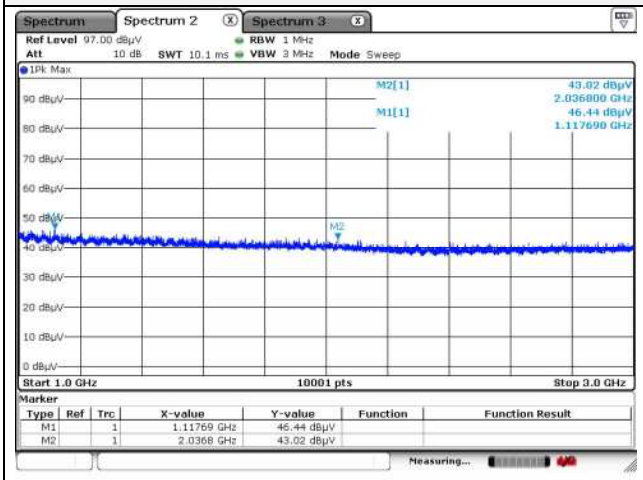
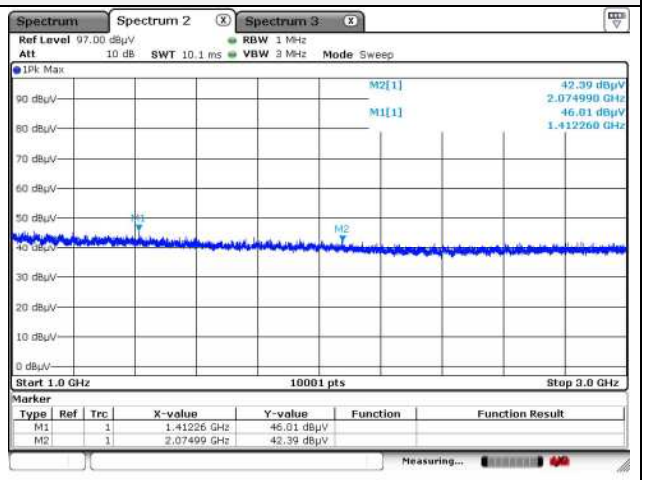
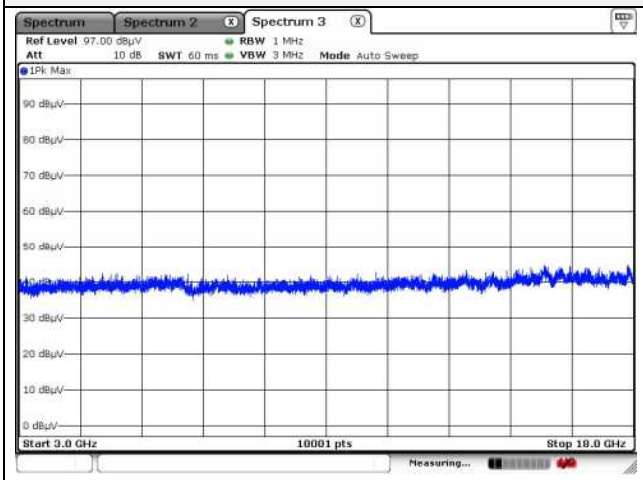
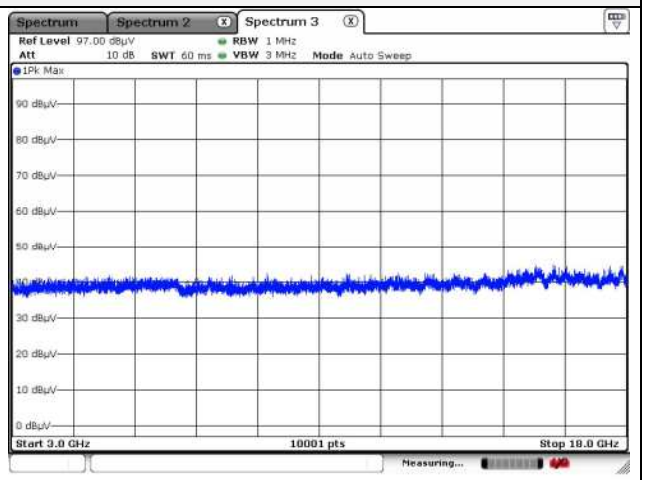
| Frequency (㎒) | Level (dB㎶) | Detect mode | Ant. Pol. (H/V) | CF (dB) | DCF (dB) | Field strength (dB㎶/m) | Limit (dB㎶/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 483.50 | 41.34 | Peak | H | -6.69 | - | 34.65 | 74.00 | 39.35 |
| 2 494.55 | 44.02 | Peak | H | -6.74 | - | 37.28 | 74.00 | 36.72 |
| 2 488.30 | 44.14 | Peak | V | -6.71 | - | 37.43 | 74.00 | 36.57 |
| 2 491.96 | 43.57 | Peak | V | -6.73 | - | 36.84 | 74.00 | 37.16 |

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




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



| Horizontal // Peak for 1 ㎓ to 3 ㎓ | Vertical // Peak for 1 ㎓ to 3 ㎓ |
|---|---|
|  |  |
| **Horizontal // Peak for 3 ㎓ to 18 ㎓** | **Vertical // Peak for 3 ㎓ to 18 ㎓** |
|  |  |





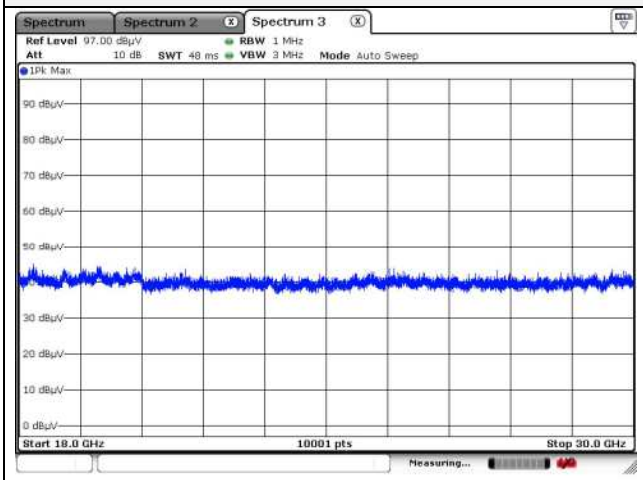
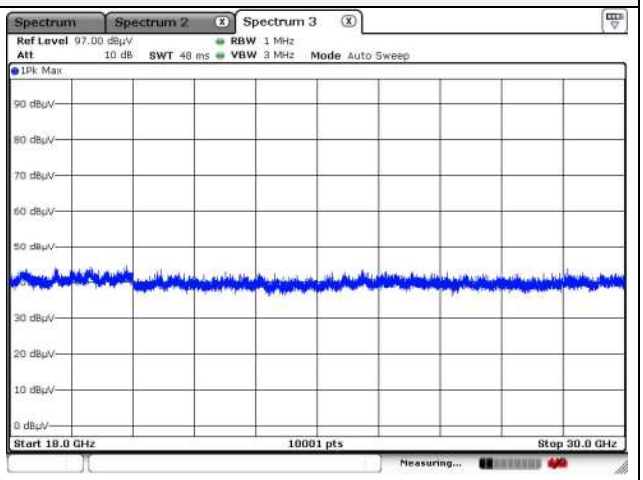




Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

**Test results (18 ㎓ to 30 ㎓) – Worst case**

| | |
|---|---|
| Mode: | BDR |
| Transfer rate: | 1 Mbps |
| Distance of measurement: | 3 meter |
| Channel: | 40(Worst case) |

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



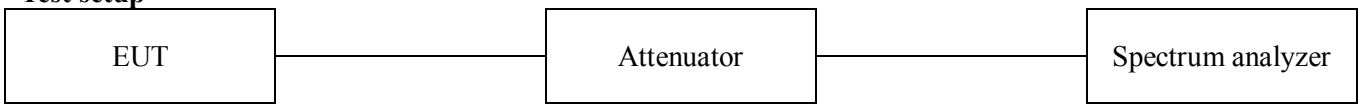
Note.
1. No spurious emission were detected above 18 ㎓.

## 3.7. Conducted band edge and out of band emissions

**Test procedure**

KDB 558074 v05r02 & ANSI 63.10-2013

**Test setup**



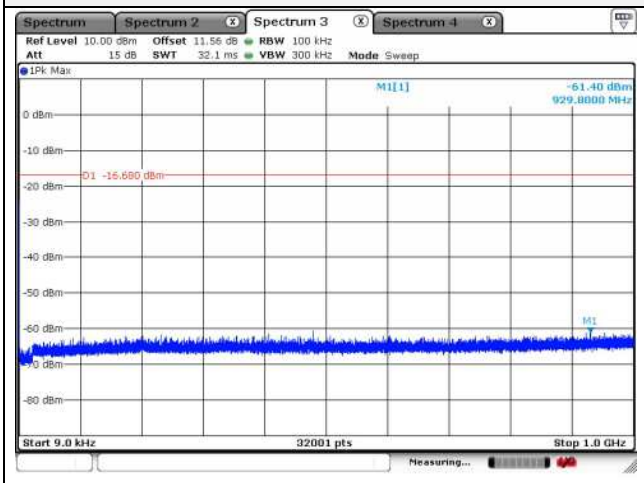
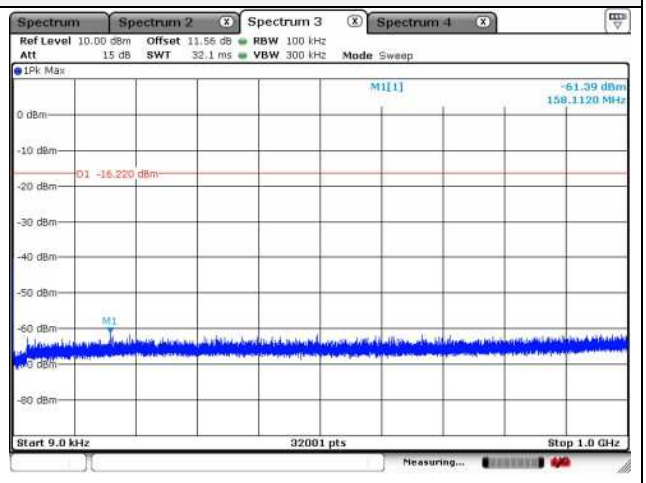
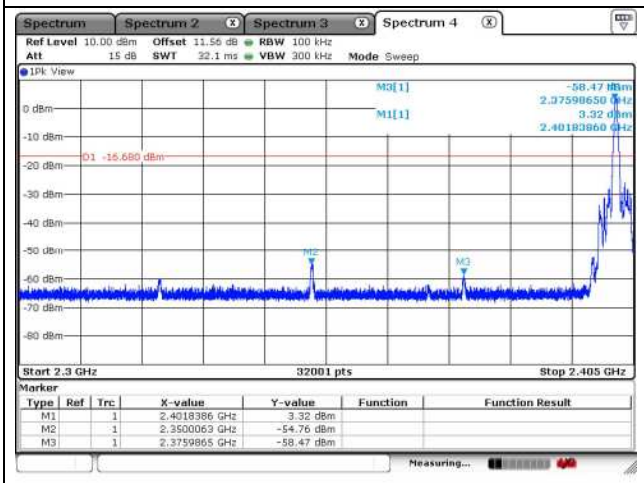
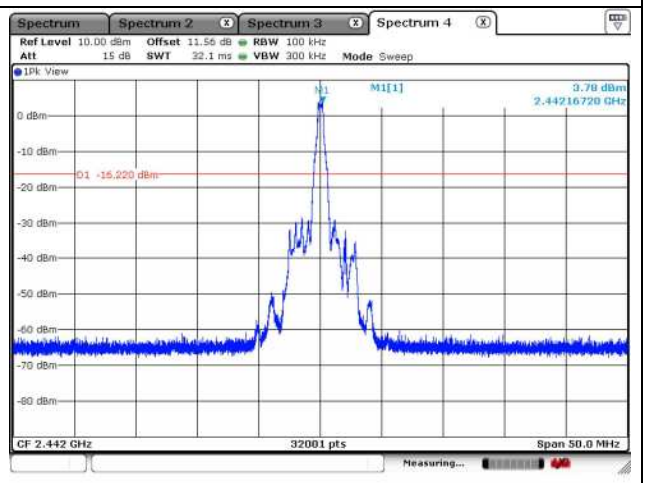
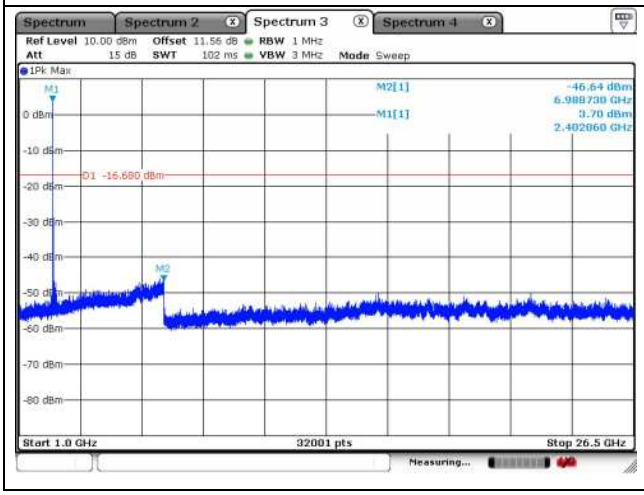
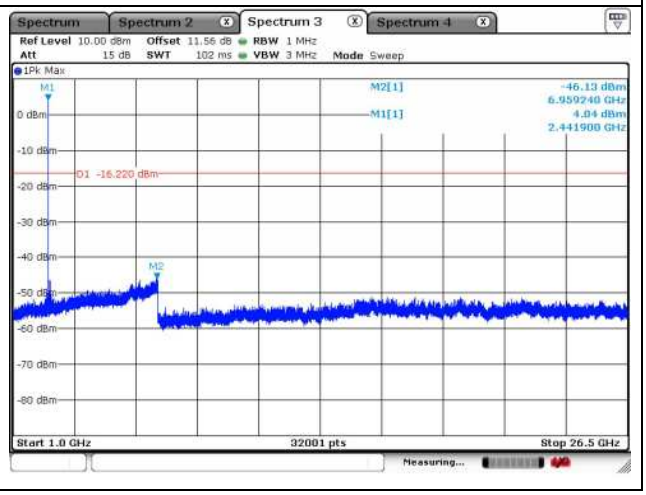

**Test setting**

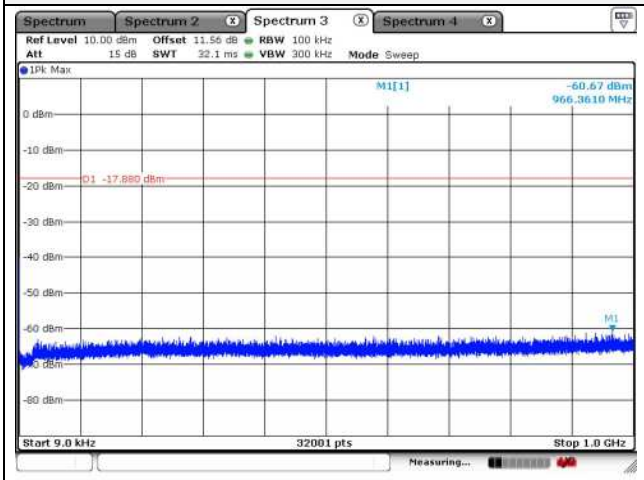
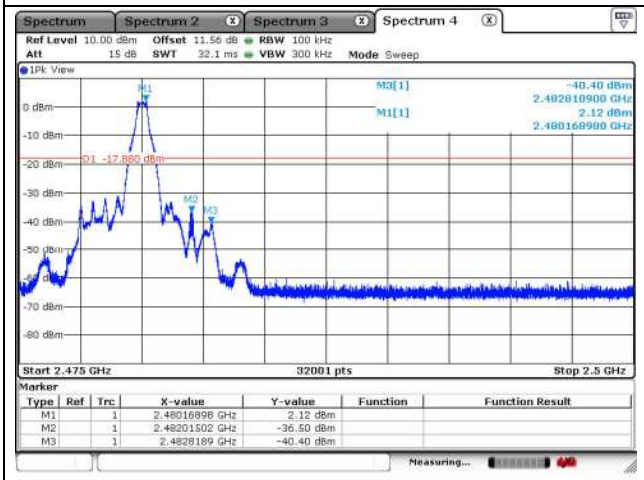
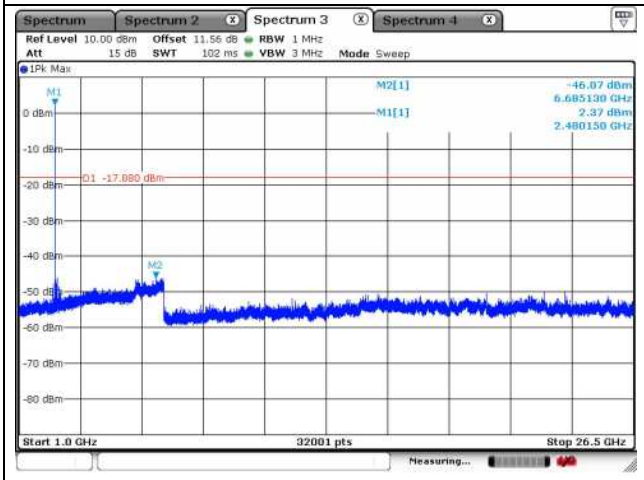
1. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions(e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
2. RBW = 100 ㎑
3. VBW ≥ 300 ㎑
4. Detector = Peak
5. Number of sweep points ≥ 2 × Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

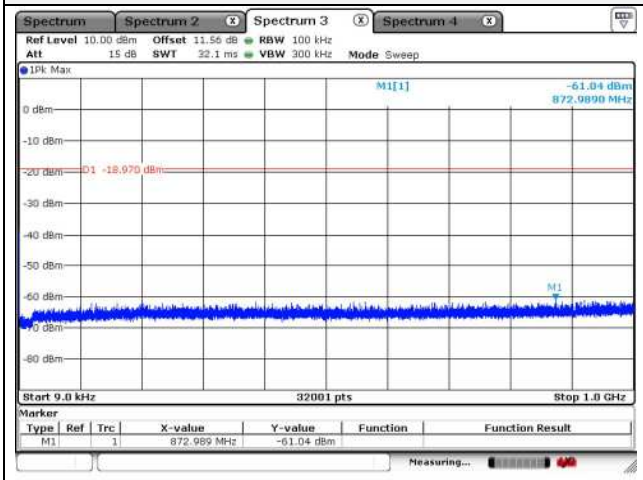
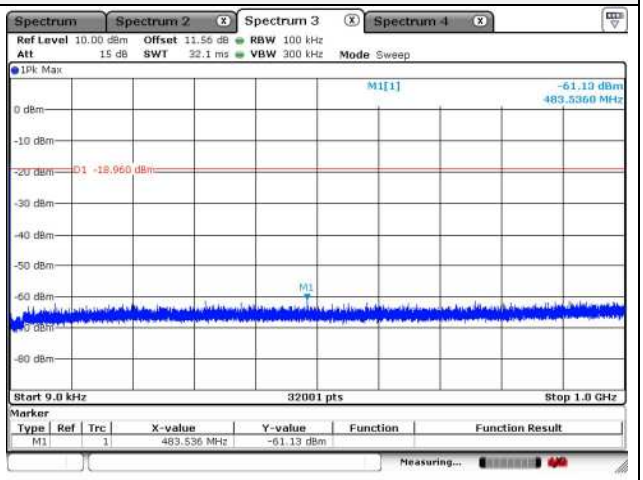
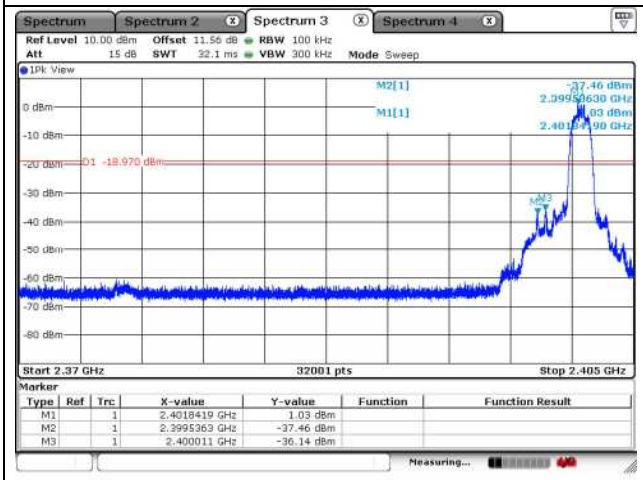
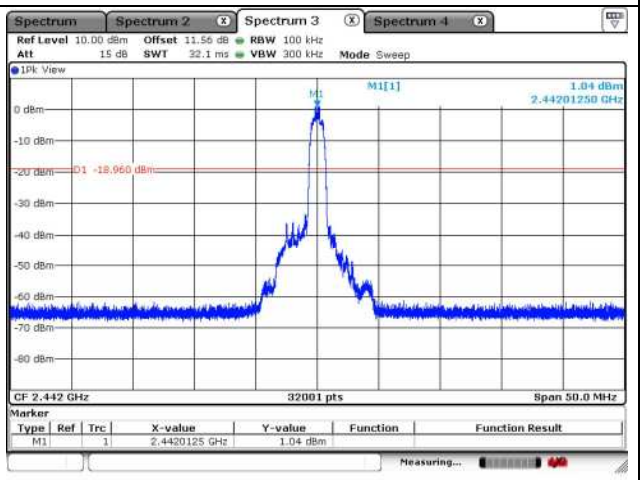
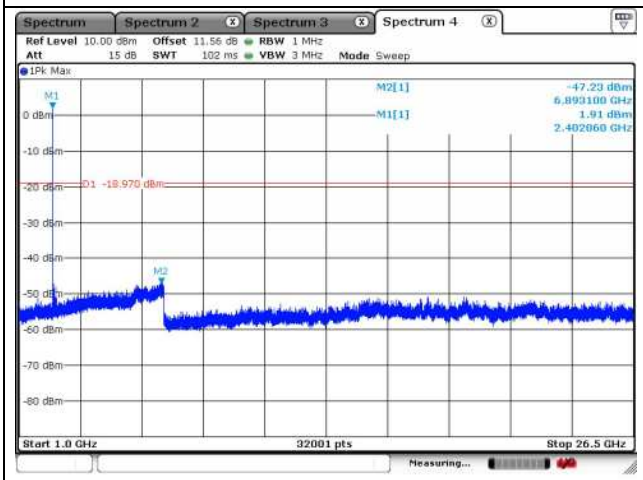
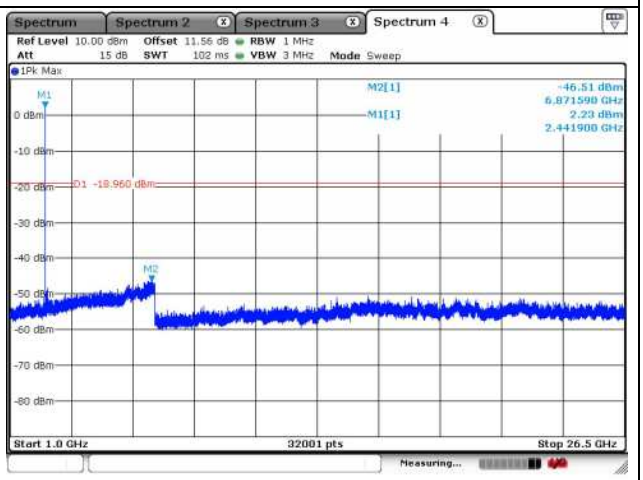
**Limit**

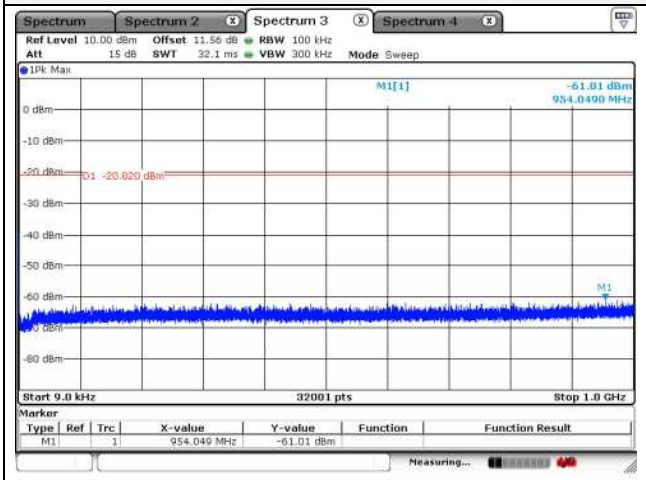
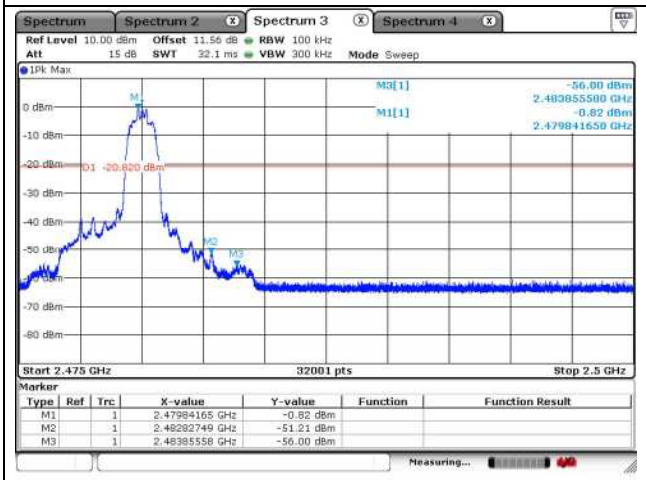
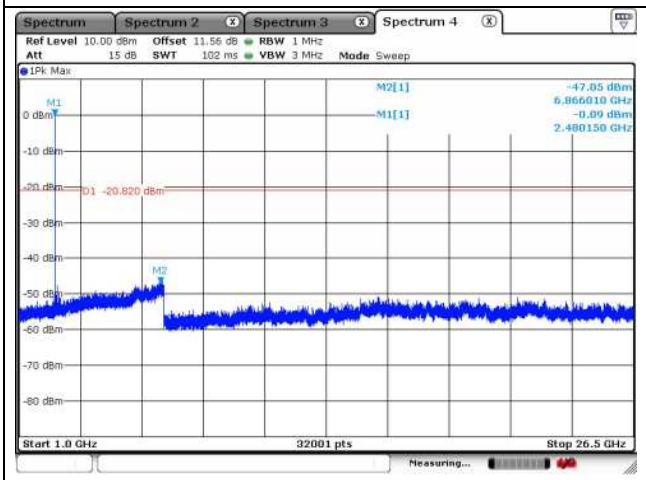
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

## Test results

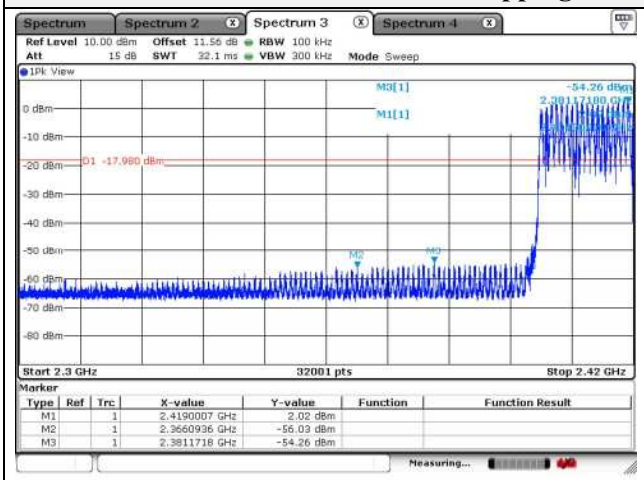
| BDR(1Mbps) | |
|---|---|
| 2402 ㎒ | 2442 ㎒ |
|  |  |
|  |  |
|  |  |

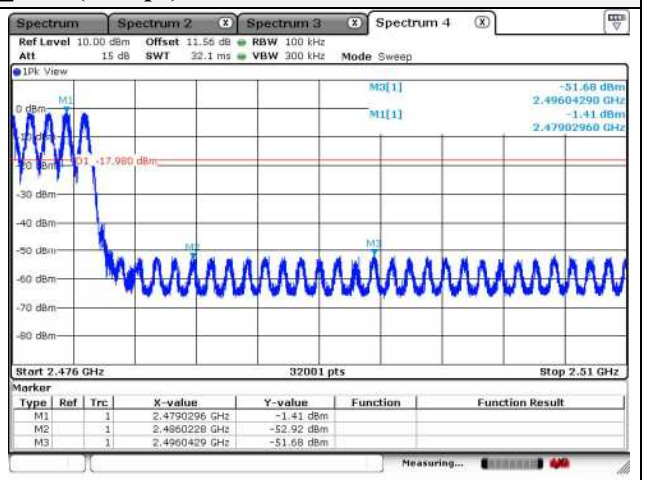
| BDR(1Mbps) | |
|---|---|
| 2480 ㎒ | - |
|  | BLANK |
|  | BLANK |
|  | BLANK |

| EDR(3Mbps) | |
|---|---|
| 2402 ㎒ | 2442 ㎒ |
|  |  |
|  |  |
|  |  |

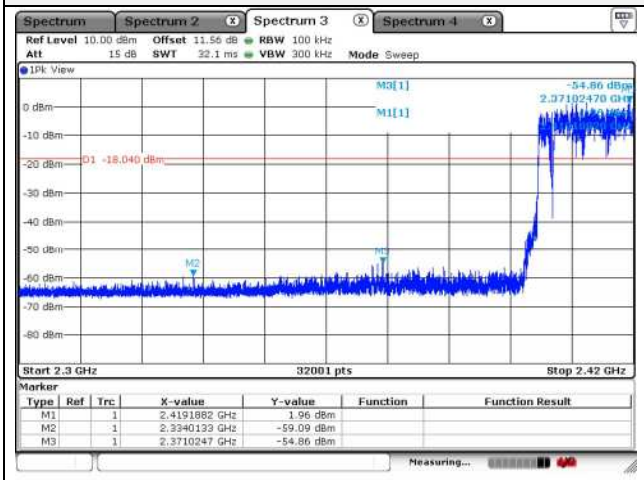
| EDR(3Mbps) | |
|---|---|
| 2480 ㎒ | - |
|  | BLANK |
|  | BLANK |
|  | BLANK |

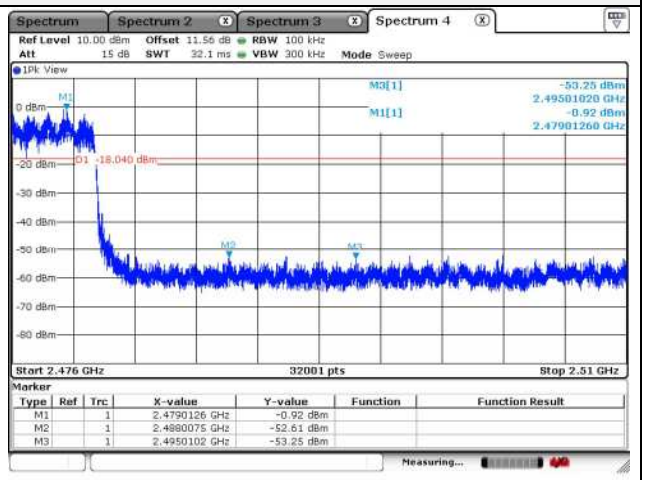
## Hopping mode_BDR(1Mbps)



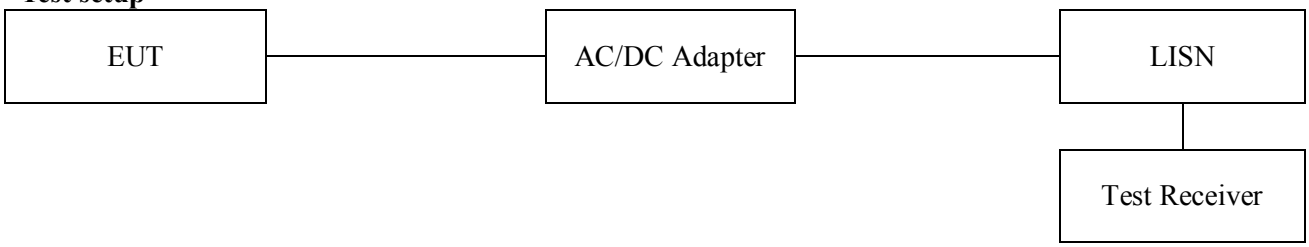

## Hopping mode_EDR(3Mbps)



## 3.8. AC conducted emissions

**Test setup**




**Limit**

According to 15.207(a), for an intentional radiator 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 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

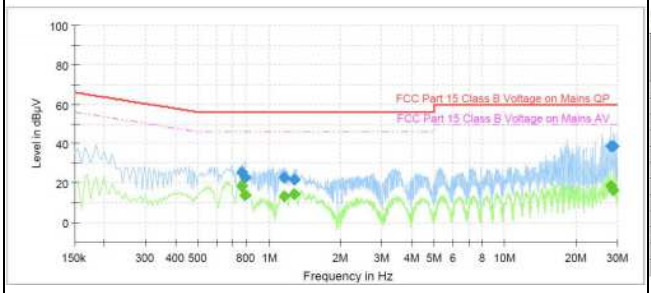
| Frequency of Emission (㎒) | Conducted limit (dB㎶/m) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 – 0.50 | 66 - 56* | 56 - 46* |
| 0.50 – 5.00 | 56 | 46 |
| 5.00 – 30.0 | 60 | 50 |

**Note:**

1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
3. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

## Test results

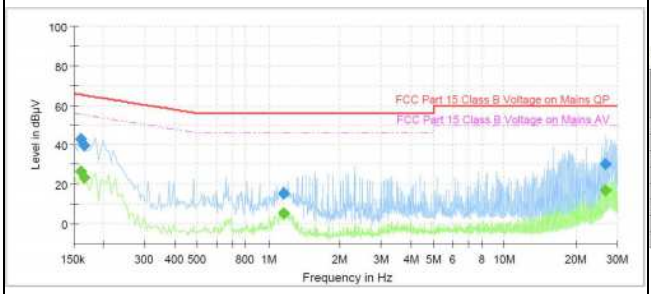
### Hot Line




Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|
| 0.765000 | --- | 18.68 | 46.00 | 27.32 | 1000.0 | 9.000 | L1 | 11.5 |
| 0.765000 | 25.67 | --- | 56.00 | 30.33 | 1000.0 | 9.000 | L1 | 11.5 |
| 0.790000 | --- | 13.79 | 46.00 | 32.21 | 1000.0 | 9.000 | L1 | 11.5 |
| 0.790000 | 22.63 | --- | 56.00 | 33.37 | 1000.0 | 9.000 | L1 | 11.5 |
| 1.155000 | --- | 13.13 | 46.00 | 32.87 | 1000.0 | 9.000 | L1 | 11.1 |
| 1.155000 | 22.76 | --- | 56.00 | 33.24 | 1000.0 | 9.000 | L1 | 11.1 |
| 1.275000 | --- | 14.19 | 46.00 | 31.81 | 1000.0 | 9.000 | L1 | 10.8 |
| 1.275000 | 21.90 | --- | 56.00 | 34.10 | 1000.0 | 9.000 | L1 | 10.8 |
| 28.240000 | --- | 18.80 | 50.00 | 31.20 | 1000.0 | 9.000 | L1 | 11.6 |
| 28.240000 | 38.77 | --- | 60.00 | 21.23 | 1000.0 | 9.000 | L1 | 11.6 |
| 28.680000 | --- | 16.52 | 50.00 | 33.48 | 1000.0 | 9.000 | L1 | 11.7 |
| 28.680000 | 38.72 | --- | 60.00 | 21.28 | 1000.0 | 9.000 | L1 | 11.7 |

### Neutral Line




Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|
| 0.160000 | --- | 26.58 | 55.46 | 28.88 | 1000.0 | 9.000 | N | 10.0 |
| 0.160000 | 43.09 | --- | 65.46 | 22.37 | 1000.0 | 9.000 | N | 10.0 |
| 0.165000 | --- | 23.44 | 55.21 | 31.77 | 1000.0 | 9.000 | N | 10.0 |
| 0.165000 | 39.61 | --- | 65.21 | 25.60 | 1000.0 | 9.000 | N | 10.0 |
| 1.155000 | --- | 5.43 | 46.00 | 40.57 | 1000.0 | 9.000 | N | 11.1 |
| 1.155000 | 15.32 | --- | 56.00 | 40.68 | 1000.0 | 9.000 | N | 11.1 |
| 26.685000 | --- | 17.04 | 50.00 | 32.96 | 1000.0 | 9.000 | N | 11.6 |
| 26.685000 | 30.21 | --- | 60.00 | 29.79 | 1000.0 | 9.000 | N | 11.6 |

## Appendix A. Measurement equipment

| Equipment | Manufacturer | Model | Serial No. | Calibration interval | Calibration due. |
|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSV30 | 101389 | 1 year | 2020.01.09 |
| Spectrum Analyzer | R&S | FSV40 | 101002 | 1 year | 2020.06.24 |
| 8360B Series Swept Signal Generator | HP | 83630B | 3844A00786 | 1 year | 2020.01.15 |
| Vector Signal Generator | R&S | SMBV100A | 1407.6004K02 | 1 year | 2020.06.25 |
| Power Meter | Anritsu | ML2495A | 1438001 | 1 year | 2020.01.15 |
| Pulse Power Sensor | Anritsu | MA2411B | 1339205 | 1 year | 2020.01.15 |
| Attenuator | HP | 8494B | 2630A12857 | 1 year | 2020.01.15 |
| Attenuator | KEYSIGHT | 8493C | 82506 | 1 year | 2020.01.15 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 225 | 2 years | 2021.02.15 |
| Trilog-broadband antenna | SCHWARZBECK | VULB 9163 | 715 | 2 years | 2020.09.20 |
| Horn Antenna | A.H | SAS-571 | 414 | 1 years | 2020.02.11 |
| Horn Antenna | SCHWARZBECK | BBHA9170 | BBHA 9170550 | 2 years | 2021.02.19 |
| High Pass Filter | Wainwright Instrument Gmbh | WHJS3000-10TT | 1 | 1 year | 2020.06.25 |
| Band Reject Filter | MICRO-TRONICS | BRM50702 | G272 | 1 year | 2020.01.16 |
| Low Pass Filter | Wainwright Instrument Gmbh | WLK1.0/18G-10TT | 1 | 1 year | 2020.06.24 |
| Broadband Amplifier | Schwarzbeck | BBV9721 | PS9721-003 | 1 year | 2020.01.16 |
| Preamplifier | AGILENT | 8449B | 3008A01742 | 1 year | 2020.01.08 |
| Amplifier | R&S | SCU 01 | 100603 | 1 year | 2019.11.26 |
| EMI Test Receiver | R&S | ESU26 | 100551 | 1 year | 2020.04.09 |
| EMI Test Receiver | R&S | ESR3 | 101781 | 1 year | 2020.04.22 |
| DC Power supply | Agilent | 6632B | MY43004090 | 1 year | 2020.06.25 |
| LISN | R&S | ENV216 | 101786 | 1 year | 2020.01.25 |
| RF Cable 1 | Woken | - | #3 | 2019.9.27 (Cal. date) | |
| RF Cable 2 | Woken | - | #21 | 2019.9.27 (Cal. date) | |

* The RF cable cal. is measured every time before the test.

### Peripheral devices

| Device | Manufacturer | Model No. | Serial No. |
|---|---|---|---|
| Notebook computer | LG Electronics Inc., | LGS53 | 306QCZP560949 |
| Test Jig Board | N/A | N/A | N/A |