FCC Part 15 EMI TEST REPORT

of

E.U.T. : Bluetooth Earphone

Model : HL220

FCC ID : 2ABTAHNL220

for

APPLICANT: Health & Life Corporation

ADDRESS : 9F., No.186, Jian 1st Rd., Zhonghe Dist.,

New Taipei City 235, Taiwan (R.O.C.)

Test Performed by

ELECTRONICS TESTING CENTER, TAIWAN

NO. 34. LIN 5, DINGFU VIL., LINKOU DIST., NEW TAIPEI CITY, TAIWAN, 24442, R.O.C.

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Report Number: 17-02-RBF-033

TEST REPORT CERTIFICATION

Applicant : Health & Life Corporation

9F., No.186, Jian 1st Rd., Zhonghe Dist., New Taipei City 235,

Taiwan (R.O.C.)

Manufacture : HEALTH&LIFE(SUZHOU) CO.,LTD

No.1428, Xiangjiang Rd, Suzhou New District, Suzhou City, Jiangsu,

P.R.China.

Description of Device :

a) Type of EUT : Bluetooth Earphone

b) Trade Name : ---

c) Model No. : HL220

d) Power Supply : Battery DC 3.7V

Regulation Applied : FCC Rules and Regulations Part 15 Subpart C

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.10-2013, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Note: 1. The result of the testing report relate only to the item tested.

2. The testing report shall not be reproduced expect in full, without the written approval of ETC.

Summary of Tests

| Test | Results |
|---|---------|
| Radiated Emission | Pass |
| Conducted Emission | N/A |
| Hopping Channel Separation | Pass |
| Number of Hopping frequencies used | Pass |
| Hopping Channel Bandwidth | Pass |
| Dwell Time of each frequency | Pass |
| Output Power Requirement | Pass |
| 100 kHz Bandwidth of Frequency Band Edges Requirement | Pass |
| Out-of-Band Conducted Emission Requirement | Pass |
| Duty Cycle | N/A |

NG DEP

Date Test Item Received : Feb. 25, 2017

Date Test Campaign Completed : Apr. 19, 2017

Date of Issue : Jul. 31, 2017

Test Engineer

(Brian Huang, Engineer)

Approve & Authorized

S. S. Liou, Section Manager EMC Dept. II of ELECTRONICS TESTING CENTER, TAIWAN

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1 GENERAL INFORMATION

1.1 Product Description

a) Type of EUT : Bluetooth Earphone

b) Trade Name : ---

c) Model No. : HL220

d) Power Supply : Battery DC 3.7V

1.2 Test Methodology

Both conducted and radiated emissions were performed according to the procedures illustrated in ANSI C63.10-2013. Other required measurements were illustrated in separate sections of this test report for details.

Measurement Software

| Software | Version | Note |
|----------|-------------------|-------------------------|
| e3 | Version 6.100618f | Radiated Emission Test |
| e3 | Version 6.100421 | Conducted Emission Test |

1.3 Test Facility

Location of the Test site: No.34, Lin 5, Dingfu Vil., Linkou Dist., New Taipei City, Taiwan

24442, R.O.C.

Designation Number: TW2628.

2 PROVISIONS APPLICABLE

2.1 Definition

Unintentional radiator:

A device that intentionally generates and radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

Class A Digital Device:

A digital device which is marketed for use in commercial or business environment; exclusive of a device which is market for use by the general public, or which is intended to be used in the home.

Class B Digital Device:

A digital device which is marketed for use in a residential environment notwithstanding use in a commercial, business of industrial environment. Example of such devices that are marketed for the general public.

Note: A manufacturer may also qualify a device intended to be marketed in a commercial, business, or industrial environment as a Class B digital device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B Digital Device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B Digital Device, Regardless of its intended use.

Intentional radiator:

A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Requirement for Compliance

(1) Conducted Emission Requirement

Except as shown in paragraphs (b) and (c) of this section, 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 150kHz to 30 MHz shall not exceed the limits in the following table, as measured using a $50\mu\text{H}/50$ ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency MHz | Quasi Peak dB μ V | Average dB μ V |
|------------------|----------------------|-------------------|
| 0.15 - 0.5 | 66-56* | 56-46* |
| 0.5 - 5.0 | 56 | 46 |
| 5.0 - 30.0 | 60 | 50 |

^{*} Decreases with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limits is same as above table.

(2) Radiated Emission Requirement

For unintentional device, according to §15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

| Frequency MHz | Distance Meters | Radiated dB μ V/m | Radiated μV/m |
|------------------|--------------------|----------------------|------------------|
| 30 - 88 | 3 | 40.0 | 100 |
| 88 - 216 | 3 | 43.5 | 150 |
| 216 - 960 | 3 | 46.0 | 200 |
| Above 960 | 3 | 54.0 | 500 |

For intentional device, according to §15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

(3) Antenna Requirement

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

(4) Hopping Channel Separation

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

(5) Number of Hopping frequencies used

According to 15.247(a)(1)(iii), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

(6) Hopping Channel Bandwidth

For frequency hopping system operating in the 2400–2483.5 MHz band, there is no requirement for the maximum 20dB bandwidth of the hopping channel. The measurement of the hopping channel bandwidth is for the reference of the hopping channel separation requirement.

(7) Dwell Time of each frequency

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 band, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

(8) Output Power Requirement

According to 15.247(b)(1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

(9) 100 kHz Bandwidth of Frequency Band Edges Requirement

According to 15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the

transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

(10) Out-of-Band Conducted Emission Requirement

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

2.3 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|-------------------|-----------------------|---------------|-------------|
| 0.090 - 0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| 0.495 - 0.505 ** | 16.69475 - 16.69525 | 608-614 | 5.35-5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475 - 156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2655-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3360-4400 | Above 38.6 |
| 13.36-13.41 | | | |

^{** :} Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz

2.4 Labeling Requirement

The device shall bear the following statement in a conspicuous location on the device:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.5 User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- -- Reorient or relocate the receiving antenna.
- -- Increase the separation between the equipment and receiver.
- -- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- -- Consult the dealer or an experienced radio / TV technician for help.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

For both radiated and conducted emissions below 1 GHz, the system was configured for testing in a typical fashion as a customer would normally use it. The peripherals other than EUT were connected in normally standing by situation. Measurement was performed under the condition that a computer program was exercised to simulate data communication of EUT, and the transmission rate was set to maximum allowed by EUT. Three highest emissions were verified with varying placement of the transmitting antenna connected to EUT (if applicable) to maximize the emission from EUT.

For conducted and radiated emissions, whichever RF channel is operated, the digital circuits' function identically. As the reason, measurement of emissions from digital circuits is performed with the highest, middle and the lowest channel by transmitting mode.

The following modes were invastegated and the worst cases (mode 1 and 3) were chosen for final test.

- 1. Basic Rate (BR) 1 Mbps uses GFSK modulation
- 2. Enhanced Data Rate (EDR) 2Mbps uses pi/4-DQPSK modulation
- 3. Enhanced Data Rate (EDR) 3Mbps uses 8DPSK modulation

3.2 Devices for Tested System

| Device | Manufacture | Model / FCC ID. | Description |
|----------------------|---------------------|-----------------|-------------|
| Bluetooth Earphone * | HEALTH&LIFE(SUZHOU) | HL220 / | |
| | CO.,LTD | 2ABTAHNL220 | |

Remark "*" means equipment under test.

4 RADIATED EMISSION MEASUREMENT

4.1 Applicable Standard

For unintentional radiator, the radiated emission shall comply with §15.109(a).

For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (d)

4.2 Measurement Procedure

- 1. Setup the configuration per figure 1 and 2 for frequencies measured below and above 1 GHz respectively.
- 2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.
- 3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.
- 4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0° to 360° with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading. A RF test receiver is also used to confirm emissions measured.
- 5. Repeat step 4 until all frequencies need to be measured were complete.
- 6. Repeat step 5 with search antenna in vertical polarized orientations.
- 7. Check the three frequencies of highest emission with varying the placement of cables associated with EUT to obtain the worse case and record the result.

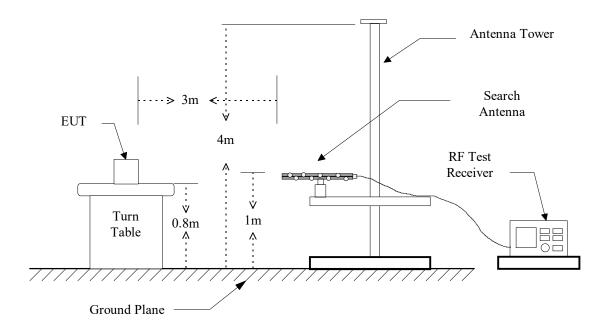
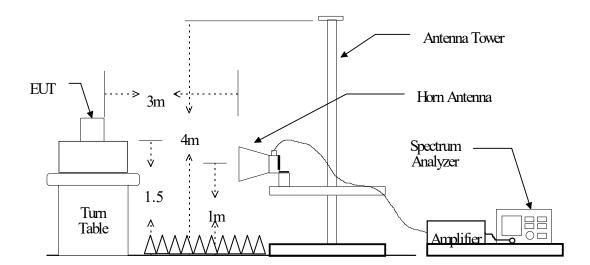


Figure 1: Frequencies measured below 1 GHz configuration

Figure 2: Frequencies measured above 1 GHz configuration



4.3 Measuring Instrument

The following instrument are used for radiated emissions measurement:

| Equipment | Manufacturer | Model No. | Calibration | Next Cal. Date |
|-------------------|-----------------|-----------|-------------|----------------|
| | | | Date | |
| EMI Test Receiver | Rohde & Schwarz | ESU 40 | 2016/11/10 | 2017/11/09 |
| Bi-Log Antenna | ETC | MCTD 2786 | 2016/07/15 | 2017/07/14 |
| Horn Antenna | EMCO | 3115 | 2016/10/05 | 2017/10/04 |
| Horn Antenna | EMCO | 3116 | 2016/10/05 | 2017/10/04 |
| Amplifier | НР | 8447D | 2016/12/28 | 2017/12/27 |
| Amplifier | НР | 83051A | 2016/07/18 | 2017/07/17 |
| LOOP Antenna | EMCO | 6512 | 2016/10/12 | 2017/10/11 |

Measuring instrument setup in measured frequency band when specified detector function is used:

| Frequency Band | Instrument | Function | Resolution | Video |
|-------------------|------------------------------|-----------------|------------|-------------------|
| (MHz) | | 1 3/110 3/10 11 | bandwidth | Bandwidth |
| 30 to 1000 | RF Test Receiver | | 120 kHz | N/A |
| 30 to 1000 | Spectrum Analyzer | Peak | 100 kHz | 100 kHz |
| Above 1000 | Above 1000 Spectrum Analyzer | | 1 MHz | 1 MHz |
| Spectrum Analyzer | | Average | 1 MHz | 10 Hz or ≥ 1/T |
| | | | | (Note 1) |

Note 1:

VBW = 10 Hz, when the duty cycle is no less than 98%.

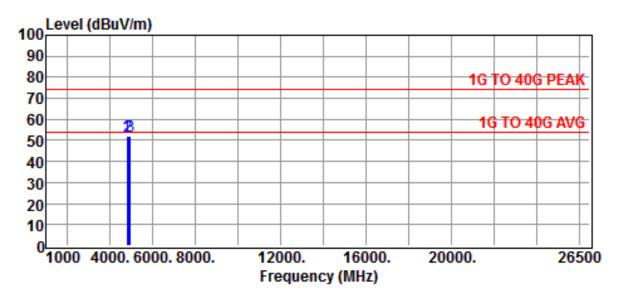
 $VBW \ge 1/T$, when duty cycle is less than 98% where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

4.4 Radiated Emission Data

4.4.1 Tx Portion

A. Bluetooth BR

Test Date : Apr. 19, 2017 Temperature : 24 °C Humidity : 53 %



Site :Chamber #2 Date :2017-04-19

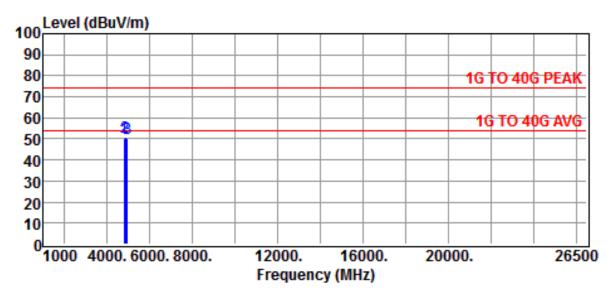
Limit :1G TO 40G PEAK Ant. Pol. :HORIZONTAL

EUT :Bluetooth Earphone Model :HL220
Power Rating :BATTERY 3.7V Temp. :24 °C
Engineer :Brian Huang Humi. :53 %

Test Mode :BR

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 4804.0000 | 50.84 | 1.25 | 52.09 | 74.00 | -21.91 | Peak |
| 4882.0000 | 50.75 | 1.47 | 52.22 | 74.00 | -21.78 | Peak |
| 4960.0000 | 50.06 | 1.74 | 51.80 | 74.00 | -22.20 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.



Site :Chamber #2 Date :2017-04-19 :1G TO 40G PEAK Limit Ant. Pol. :VERTICAL EUT :Bluetooth Earphone Model :HL220 :BATTERY 3.7V :24°C **Power Rating** Temp. Engineer Humi. :53 % :Brian Huang

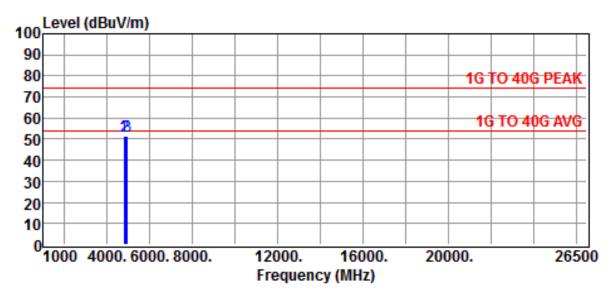
Test Mode :BR

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 4804.0000 | 49.24 | 1.25 | 50.49 | 74.00 | -23.51 | Peak |
| 4882.0000 | 49.35 | 1.47 | 50.82 | 74.00 | -23.18 | Peak |
| 4960.0000 | 48.47 | 1.74 | 50.21 | 74.00 | -23.79 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.

B. Bluetooth EDR

Test Date : Apr. 19, 2017 Temperature : 24 °C Humidity : 53 %



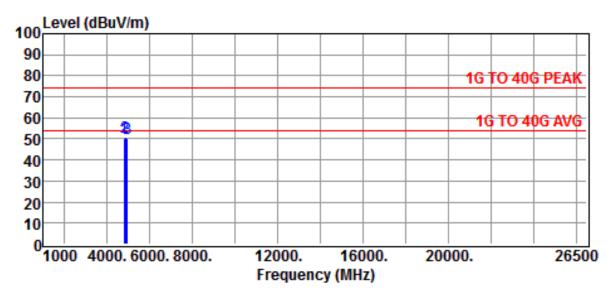
Site :Chamber #2 Date :2017-04-19 Limit :1G TO 40G PEAK Ant. Pol. :HORIZONTAL

EUT :Bluetooth Earphone Model :HL220 Power Rating :BATTERY 3.7V Temp. :24 °C Engineer :Brian Huang Humi. :53 %

Test Mode :EDR

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 4804.0000 | 50.23 | 1.25 | 51.48 | 74.00 | -22.52 | Peak |
| 4882.0000 | 50.15 | 1.47 | 51.62 | 74.00 | -22.38 | Peak |
| 4960.0000 | 49.48 | 1.74 | 51.22 | 74.00 | -22.78 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.



Site :Chamber #2 Date :2017-04-19 :1G TO 40G PEAK Limit Ant. Pol. :VERTICAL EUT :Bluetooth Earphone Model :HL220 :BATTERY 3.7V :24°C **Power Rating** Temp. Engineer Humi. :53 % :Brian Huang

Test Mode :EDR

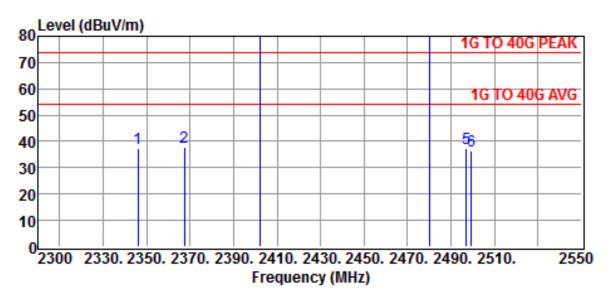
| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 4804.0000 | 49.34 | 1.25 | 50.59 | 74.00 | -23.41 | Peak |
| 4882.0000 | 49.46 | 1.47 | 50.93 | 74.00 | -23.07 | Peak |
| 4960.0000 | 48.43 | 1.74 | 50.17 | 74.00 | -23.83 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.

4.4.2 Radiated Emissions in Restricted Bands

A. Bluetooth BR

Test Date : Apr. 19, 2017 Temperature : 24 °C Humidity : 53 %



Site :Chamber #2 Date :2017-04-19

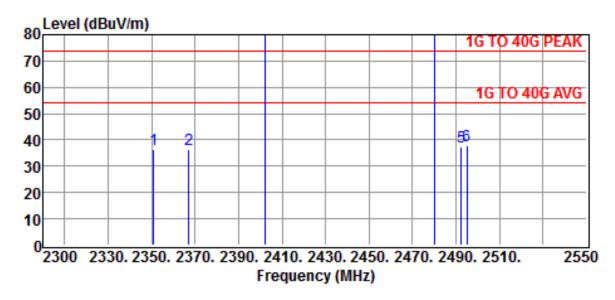
Limit :1G TO 40G PEAK Ant. Pol. :HORIZONTAL

EUT :Bluetooth Earphone Model :HL220 Power Rating :BATTERY 3.7V Temp. :24 °C Engineer :Brian Huang Humi. :53 %

Test Mode :BR

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 2346.0000 | 42.86 | -5.71 | 37.15 | 74.00 | -36.85 | Peak |
| 2367.5000 | 43.51 | -5.67 | 37.84 | 74.00 | -36.16 | Peak |
| 2402.0000 | 104.26 | -5.61 | 98.65 | | | Peak |
| 2480.0000 | 104.42 | -5.40 | 99.02 | | | Peak |
| 2497.0000 | 42.56 | -5.36 | 37.20 | 74.00 | -36.80 | Peak |
| 2499.2500 | 41.74 | -5.36 | 36.38 | 74.00 | -37.62 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.



Site :Chamber #2 Date :2017-04-19 :1G TO 40G PEAK :VERTICAL Limit Ant. Pol. **EUT** :Bluetooth Earphone Model :HL220 :BATTERY 3.7V :24°C **Power Rating** Temp.

Test Mode :BR

:Brian Huang

Engineer

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 2351.0000 | 42.19 | -5.71 | 36.48 | 74.00 | -37.52 | Peak |
| 2367.0000 | 42.04 | -5.67 | 36.37 | 74.00 | -37.63 | Peak |
| 2402.0000 | 101.82 | -5.61 | 96.21 | | | Peak |
| 2480.0000 | 101.95 | -5.40 | 96.55 | | | Peak |
| 2492.5000 | 42.83 | -5.36 | 37.47 | 74.00 | -36.53 | Peak |
| 2495.0000 | 43.03 | -5.36 | 37.67 | 74.00 | -36.33 | Peak |

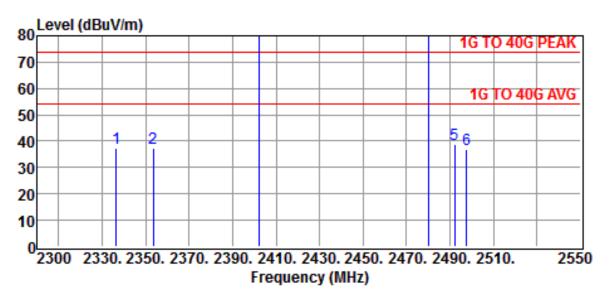
Humi.

:53 %

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.

B. Bluetooth EDR

Test Date : Apr. 19, 2017 Temperature : 24 °C Humidity : 53 %



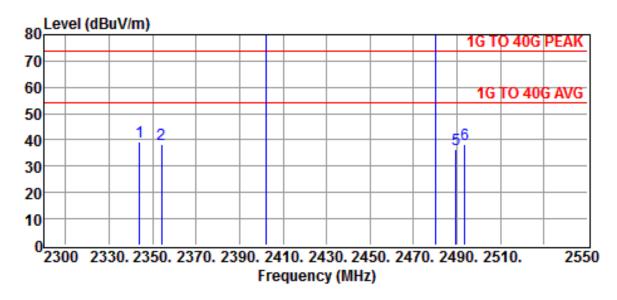
Site :Chamber #2 Date :2017-04-19
Limit :1G TO 40G PEAK Ant. Pol. :HORIZONTAL

EUT :Bluetooth Earphone Model :HL220 Power Rating :BATTERY 3.7V Temp. :24 °C Engineer :Brian Huang Humi. :53 %

Test Mode :EDR

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 2336.5000 | 43.22 | -5.71 | 37.51 | 74.00 | -36.49 | Peak |
| 2353.5000 | 43.24 | -5.67 | 37.57 | 74.00 | -36.43 | Peak |
| 2402.0000 | 103.56 | -5.61 | 97.95 | | | Peak |
| 2480.0000 | 103.65 | -5.40 | 98.25 | | | Peak |
| 2492.0000 | 44.01 | -5.36 | 38.65 | 74.00 | -35.35 | Peak |
| 2497.5000 | 42.32 | -5.36 | 36.96 | 74.00 | -37.04 | Peak |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.



Site :Chamber #2 Date :2017-04-19 :1G TO 40G PEAK :VERTICAL Limit Ant. Pol. **EUT** :Bluetooth Earphone Model :HL220 :BATTERY 3.7V :24°C **Power Rating** Temp.

Test Mode :EDR

:Brian Huang

Engineer

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|-----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 2344.0000 | 44.91 | -5.71 | 39.20 | 74.00 | -34.80 | Peak |
| 2354.0000 | 44.22 | -5.67 | 38.55 | 74.00 | -35.45 | Peak |
| 2402.0000 | 101.94 | -5.61 | 96.33 | | | Peak |
| 2480.0000 | 101.85 | -5.40 | 96.45 | | | Peak |
| 2489.5000 | 41.92 | -5.36 | 36.56 | 74.00 | -37.44 | Peak |
| 2493.5000 | 43.49 | -5.36 | 38.13 | 74.00 | -35.87 | Peak |

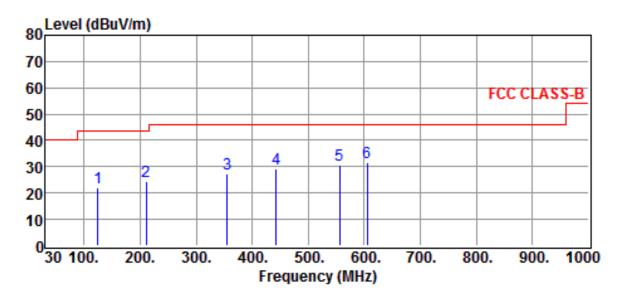
Humi.

:53 %

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss Amplifier Gain (if any)
- 3. The margin value=Limit Result
- 4. Peak measurements are compared to the average limit as peak measurements are below the average limit, they also comply with the peak limit.

4.4.3 Other Emissions

a) Emission frequencies below 1 GHz



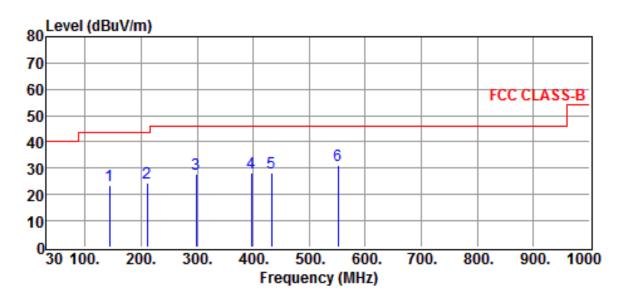
Site :Chamber #2 Date :2017-04-18 Limit :FCC CLASS-B Ant. Pol. :HORIZONTAL

EUT :Bluetooth Earphone Model :HL220 Power Rating :BATTERY 3.7V Temp. :24 °C Engineer :Brian Huang Humi. :53 %

Test Mode :Operation Mode

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 125.0600 | 29.88 | -7.83 | 22.05 | 43.50 | -21.45 | QP |
| 210.4200 | 31.00 | -6.66 | 24.34 | 43.50 | -19.16 | QP |
| 354.9500 | 29.78 | -2.44 | 27.34 | 46.00 | -18.66 | QP |
| 442.2500 | 30.31 | -1.14 | 29.17 | 46.00 | -16.83 | QP |
| 555.7400 | 30.23 | 0.52 | 30.75 | 46.00 | -15.25 | QP |
| 605.2100 | 30.28 | 1.25 | 31.53 | 46.00 | -14.47 | QP |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss
- 3. The margin value=Limit Result



Site :Chamber #2 Date :2017-04-18
Limit :FCC CLASS-B Ant. Pol. :VERTICAL
EUT :Bluetooth Earphone Model :HL220

Power Rating :BATTERY Temp. :24 °C Engineer :Brian Huang Humi. :53 %

Test Mode :Operation Mode

| Freq | Reading | Correction | Result | Limits | Over limit | Detector |
|----------|---------|------------|--------|--------|------------|----------|
| | | Factor | | | | |
| MHz | dΒμV | dB | dBμV/m | dBμV/m | dB | |
| 143.4900 | 30.47 | -7.20 | 23.27 | 43.50 | -20.23 | QP |
| 210.4200 | 31.00 | -6.66 | 24.34 | 43.50 | -19.16 | QP |
| 297.7200 | 31.40 | -3.52 | 27.88 | 46.00 | -18.12 | QP |
| 396.6600 | 29.99 | -1.50 | 28.49 | 46.00 | -17.51 | QP |
| 432.5500 | 29.66 | -1.20 | 28.46 | 46.00 | -17.54 | QP |
| 551.8600 | 30.84 | 0.48 | 31.32 | 46.00 | -14.68 | QP |

- 1. Result = Reading + Corrected Factor
- 2. Corrected Factor = Antenna Factor + Cable Loss
- 3. The margin value=Limit Result

b) Emission frequencies above 1 GHz

Radiated emission frequencies above 1 GHz to 25 GHz were too low to be measured with a pre-amplifier of 35 dB.

c) Emission frequencies below 30MHz (9kHz - 30MHz)

According to exploratory test no any obvious emission were detected from 9kHz to 30MHz. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are 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.

4.5 Field Strength Calculation

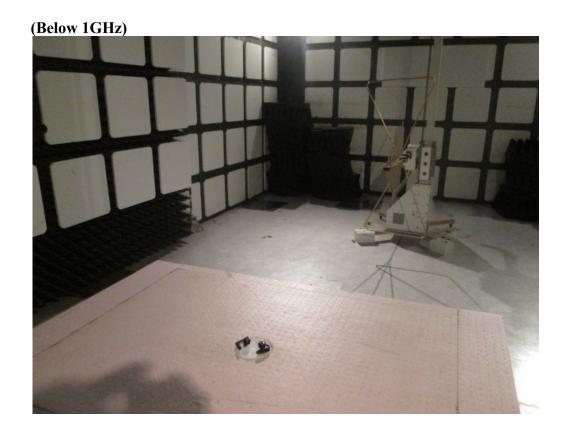
The field strength is calculated by adding the Antenna Factor, High Pass Filter Loss (if used) and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation calculation is as follows:

Result = Reading + Corrected Factor

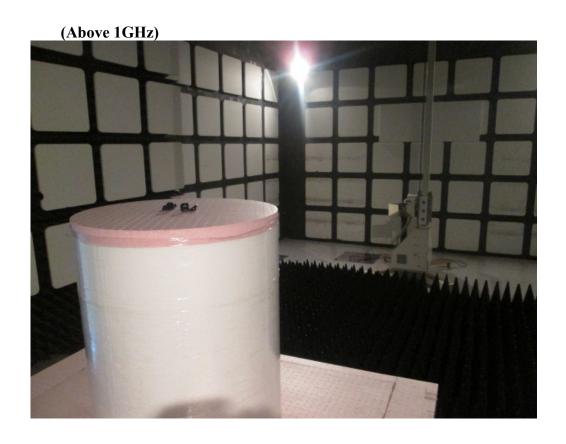
where Corrected Factor

= Antenna FACTOR + Cable Loss + High Pass Filter Loss - Amplifier Gain

4.6 Photos of Radiation Measuring Setup









5 CONDUCTED EMISSION MEASUREMENT

5.1 Description

This EUT is excused from investigation of conducted emission, for it is powered by DC battery only. According to §15.207 (d), measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.

6 ANTENNA REQUIREMENT

6.1 Standard Applicable

For intentional device, according to 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

6.2 Antenna Construction

The antenna is integrated on the main PCB and installed inside the houseing, no consideration of replacement.

Please refer to the construction Photo for details.

7 HOPPING CHANNEL SEPARATION

7.1 Standard Applicable

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

7.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled. Then set it to any one convenient frequency within its operating range.
- 3. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) $\geq 1\%$ of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

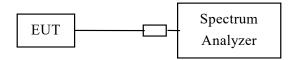
Sweep = auto

Detector function = peak

Trace = max hold

- 4. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all frequencies measured were complete.

Figure 4: Measurement configuration.



ETC Report No.: 17-02-RBF-033

7.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

7.4 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Mode: Bluetooth BR

a) Channel Low : Adjacent Hopping Channel Separation is
 b) Channel Middle : Adjacent Hopping Channel Separation is
 c) Channel High : Adjacent Hopping Channel Separation is
 d) 1.000 MHz
 1.000 MHz

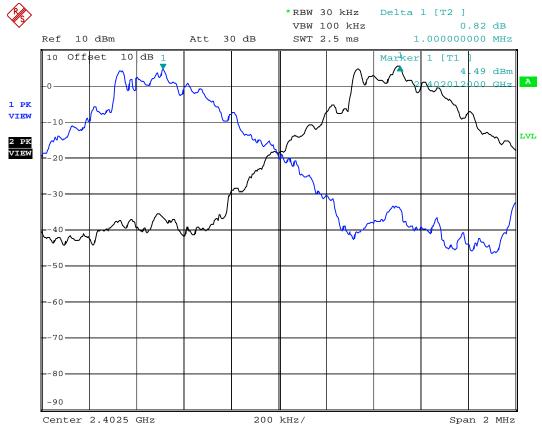
Mode: Bluetooth EDR

a) Channel Low
 b) Channel Middle
 c) Channel High
 djacent Hopping Channel Separation is
 djacent Hopping Channel Separation is
 1.002 MHz
 1.002 MHz
 1.002 MHz

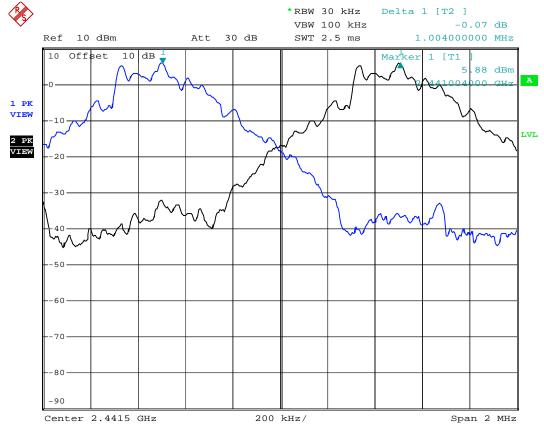
Note: The expanded uncertainty: frequency $\times 1.65 \times 10^{-6}$ (1 GHz $< f \le 18$ GHz).

Mode: Bluetooth BR

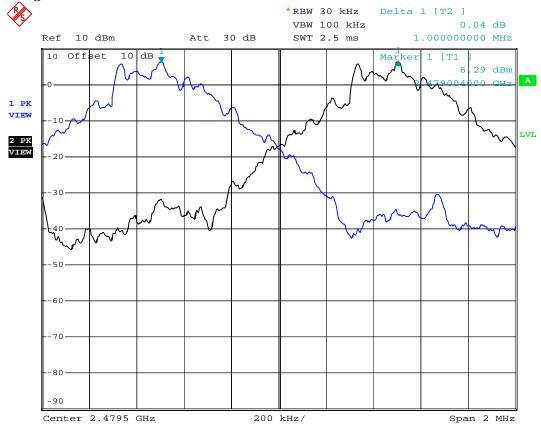
Channel Low



Channel Middle

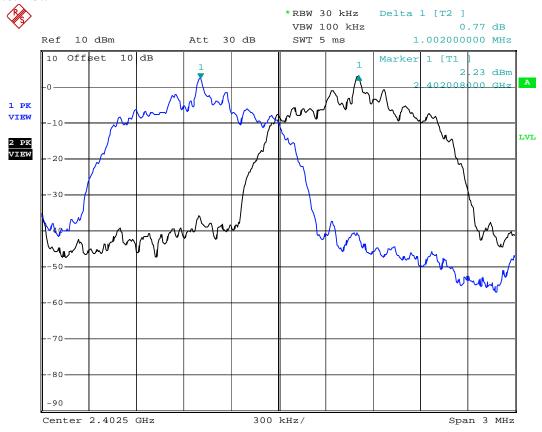


Channel High

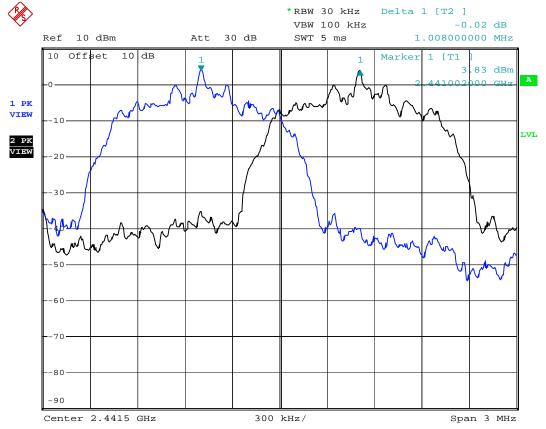


Mode: Bluetooth EDR

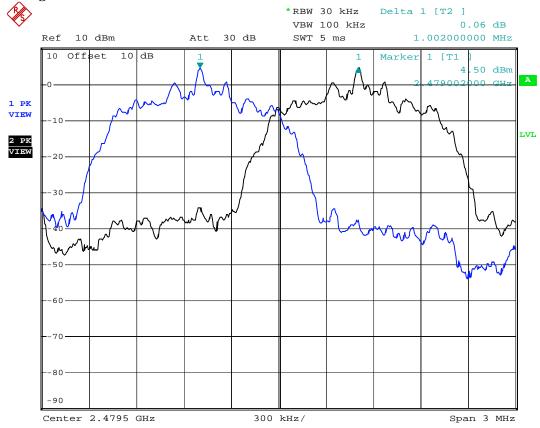
Channel Low



Channel Middle



Channel High



8 NUMBER OF HOPPING FREQUENCY USED

8.1 Standard Applicable

According to 15.247(a)(1)(iii), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

8.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled.
- 3. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW \geq 1% of the span

 $VBW \ge RBW$

Sweep = auto

Detector function = peak

Trace = max hold

- 4. Allow the trace to stabilize. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all frequencies measured were complete.

8.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

8.4 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

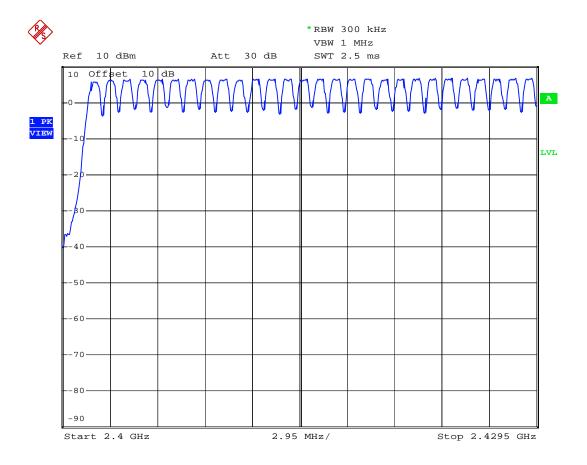
There are 79 hopping frequencies used.

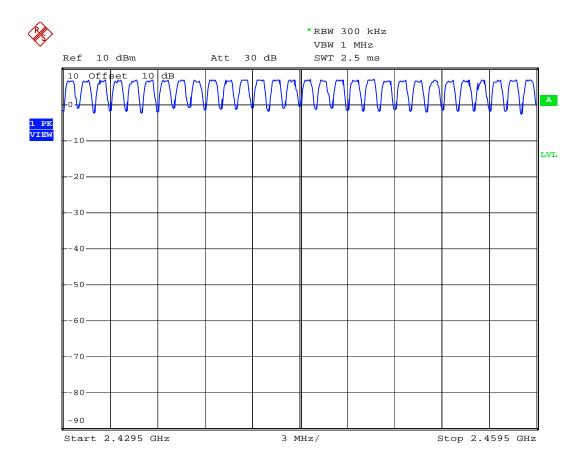
Justification on AFH mode:

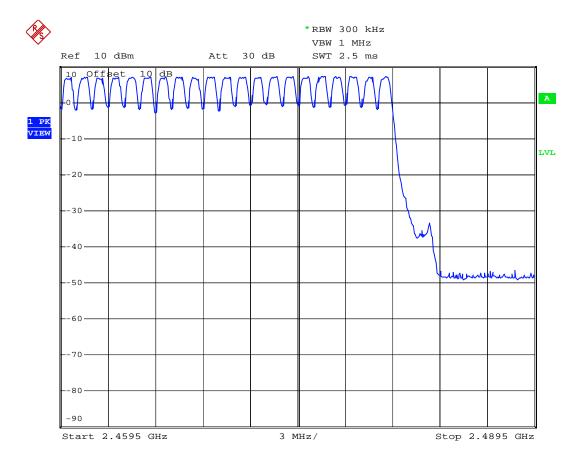
Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used, normally AFH mode has 20 channels.

Note: The expanded uncertainty: frequency $\times 1.65 \times 10^{-6}$ (1 GHz $< f \le 18$ GHz).

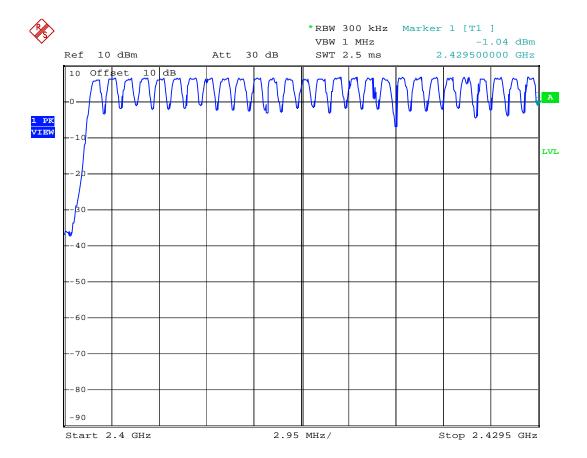
Mode: Bluetooth BR

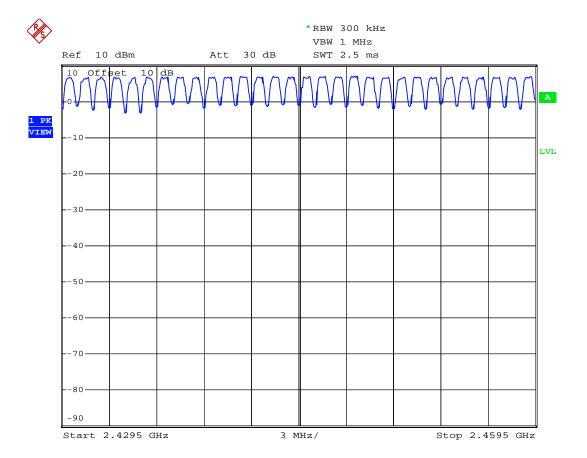


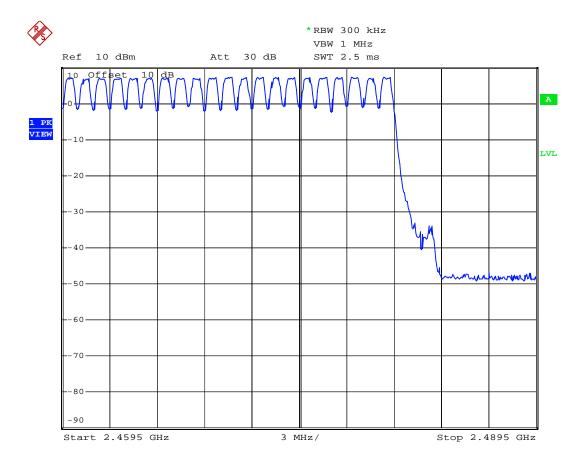




Mode: Bluetooth EDR







9 CHANNEL BANDWIDTH

9.1 Standard Applicable

For frequency hopping system operating in the 2400–2483.5 MHz band, there is no requirement for the maximum 20dB bandwidth of the hopping channel. The measurement of the hopping channel bandwidth is for the reference of the hopping channel separation requirement.

9.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
- 3. Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW \geq 1% of the 20 dB bandwidth

 $VBW \ge RBW$

Sweep = auto

Detector function = peak

Trace = max hold

- 4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all frequencies measured were complete.

9.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

9.4 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Mode: Bluetooth BR

a) Channel Low : Channel Bandwidth is 0.924 MHz
 b) Channel Middle : Channel Bandwidth is 0.860 MHz
 c) Channel High : Channel Bandwidth is 0.852 MHz

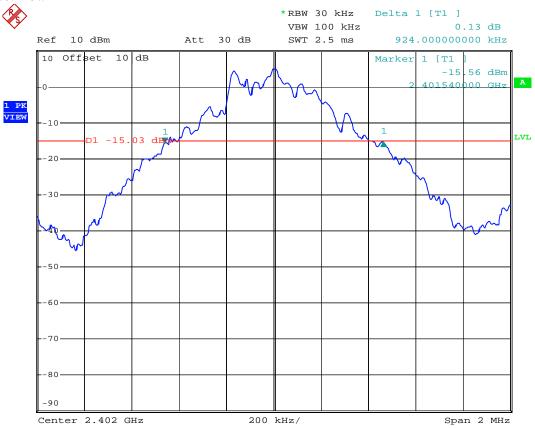
Mode: Bluetooth EDR

a) Channel Low : Channel Bandwidth is 1.220 MHz
b) Channel Middle : Channel Bandwidth is 1.208 MHz
c) Channel High : Channel Bandwidth is 1.212 MHz

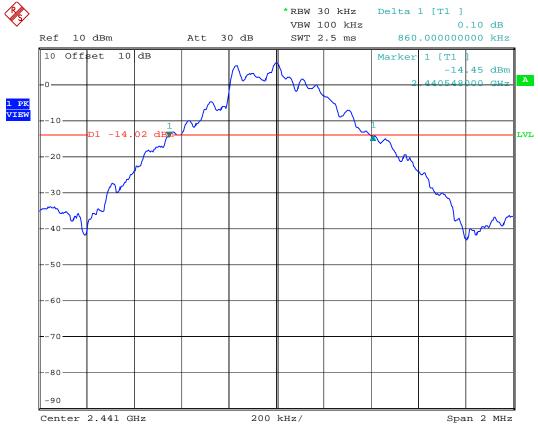
Note: The expanded uncertainty: frequency $\times 1.65 \times 10^{-6}$ (1 GHz $< f \le 18$ GHz).

Mode:Bluetooth BR

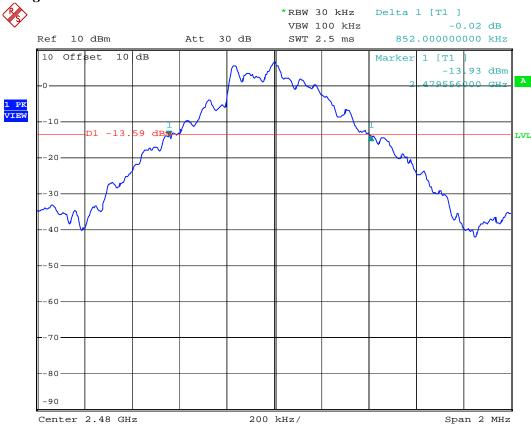
Channel Low



Channel Middle

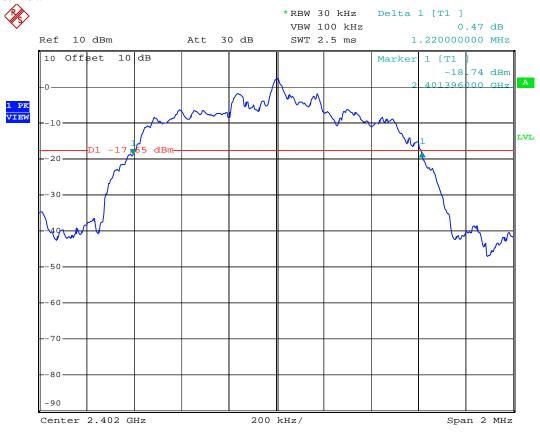


Channel High

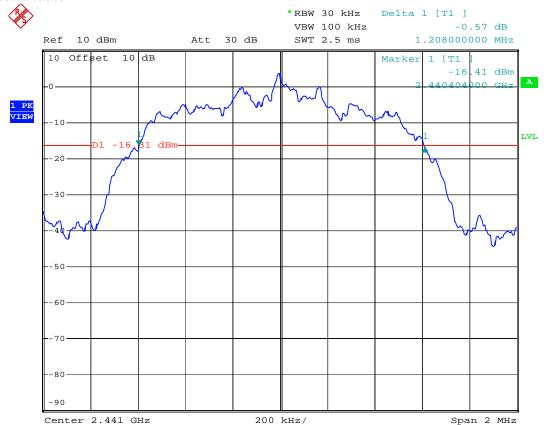


Mode: Bluetooth EDR

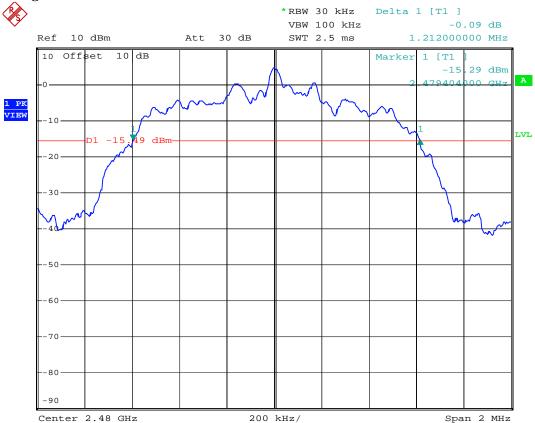
Channel Low



Channel Middle



Channel High



10 DWELL TIME ON EACH CHANNEL

10.1 Standard Applicable

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 band, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

10.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. The EUT must have its hopping function enabled.
- 3. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel

RBW = 1 MHz

 $VBW \ge RBW$

Sweep = as necessary to capture the entire dwell time per hopping channel

Detector function = peak

Trace = max hold

- 4. Use the marker-delta function to determine the dwell time. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all frequencies measured were complete.

Justification on AFH mode:

Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used, normally AFH mode has 20 channels.

10.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

10.4 Measurement Data

Test Mode: Bluetooth BR

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Period = 0.4(seconds) x 79(channels) = 31.6 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 1600/(1+1) = 800 transmissions per second. In one period for each particular channel there are $10.13 \times 31.6 = 320.1$ times of transmissions.

a) Channel Low : the dwell time is $ms \times 320.1 =$ 0.46 147.246 ms b) Channel Middle: the dwell time is $ms \times 320.1 =$ 0.45 144.045 ms c) Channel High : the dwell time is $ms \times 320.1 =$ 0.45 144.045 ms

The maximum time of occupancy for a particular channel is 147.246ms in any 31.6 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 1600/(3+1) = 400 transmissions per second. In one period for each particular channel there are $5.06 \times 31.6 = 159.9$ times of transmissions.

a) Channel Low: the dwell time is 1.74 ms x 159.9 = 278.226 ms b) Channel Middle: the dwell time is 1.76 ms x 159.9 = 281.424 ms c) Channel High: the dwell time is 1.78 ms x 159.9 = 284.622 ms

The maximum time of occupancy for a particular channel is 284.622ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 1600/(5+1) = 266.7 transmissions per second. In one period for each particular channel there are $3.38 \times 31.6 = 106.81$ times of transmissions.

a) Channel Low : the dwell time is ms x 106.81 =2.98 318.293 ms b) Channel Middle: the dwell time is ms x 106.81 =3.00 320.430 ms c) Channel High : the dwell time is 3.02 ms x 106.81 =322.566 ms

The maximum time of occupancy for a particular channel is 322.566ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Test Mode: Bluetooth BR (AFH mode)

Test Date : <u>Apr. 18, 2017</u> Temperature : <u>24</u> °C Humidity : <u>53</u> %

Period = 0.4(seconds) x 20(channels) = 8 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 800/(1+1) = 400 transmissions per second. In one period for each particular channel there are $20 \times 8 = 160$ times of transmissions.

```
a) Channel Low: the dwell time is 0.46ms x 160 = 73.6 ms
b) Channel Middle: the dwell time is 0.45ms x 160 = 72.0 ms
c) Channel Hi: the dwell time is 0.45ms x 160 = 72.0 ms
```

The maximum time of occupancy for a particular channel is 73.6ms in any 8 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 800/(3+1) = 200 transmissions per second. In one period for each particular channel there are $10 \times 8 = 80$ times of transmissions.

```
a) Channel Low: the dwell time is 1.74ms x 80 = 139.2 ms
b) Channel Middle: the dwell time is 1.76ms x 80 = 140.8 ms
c) Channel Hi: the dwell time is 1.78ms x 80 = 142.4 ms
```

The maximum time of occupancy for a particular channel is 142.4ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 800/(5+1) = 133.3 transmissions per second. In one period for each particular channel there are $6.665 \times 8 = 53.32$ times of transmissions.

```
a) Channel Low: the dwell time is 2.98ms x 53.32 = 158.893 ms
b) Channel Middle: the dwell time is 3.00ms x 53.32 = 159.960 ms
c) Channel Hi: the dwell time is 3.02ms x 53.32 = 161.026 ms
```

The maximum time of occupancy for a particular channel is 161.026ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Test Mode:Bluetooth EDR

Test Date : <u>Apr. 18, 2017</u> Temperature : <u>24</u> °C Humidity : <u>53</u> %

Period = 0.4(seconds) x 79(channels) = 31.6 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 1600/(1+1) = 800 transmissions per second. In one period for each particular channel there are $10.13 \times 31.6 = 320.1$ times of transmissions.

```
a) Channel Low: the dwell time is 0.46 \text{ ms x } 320.1 = 147.246 \text{ ms}
b) Channel Middle: the dwell time is 0.44 \text{ ms x } 320.1 = 140.844 \text{ ms}
c) Channel High: the dwell time is 0.44 \text{ ms x } 320.1 = 140.844 \text{ ms}
```

The maximum time of occupancy for a particular channel is 147.246ms in any 31.6 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 1600/(3+1) = 400 transmissions per second. In one period for each particular channel there are $5.06 \times 31.6 = 159.9$ times of transmissions.

```
a) Channel Low: the dwell time is 1.78 \text{ ms x } 159.9 = 284.622 \text{ ms}
b) Channel Middle: the dwell time is 1.78 \text{ ms x } 159.9 = 284.622 \text{ ms}
c) Channel High: the dwell time is 1.80 \text{ ms x } 159.9 = 287.820 \text{ ms}
```

The maximum time of occupancy for a particular channel is 284.820ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

The Bluetooth system hops at a rate of 1600 times per second. This means there are 1600 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 1600/(5+1) = 266.7 transmissions per second. In one period for each particular channel there are $3.38 \times 31.6 = 106.81$ times of transmissions.

```
a) Channel Low: the dwell time is 3.02 ms x106.81 = 322.566 ms
b) Channel Middle: the dwell time is 3.00 ms x106.81 = 320.430 ms
c) Channel High: the dwell time is 2.98 ms x106.81 = 318.293 ms
```

The maximum time of occupancy for a particular channel is 332.566ms in any 31.6 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Test Mode:Bluetooth EDR(AFH mode)

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Period = 0.4(seconds) x 20(channels) = 8 seconds

A. DH1 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH1 data rate operates on a one-slot transmission and one-slot receiving basis. Thus there are 800/(1+1) = 400 transmissions per second. In one period for each particular channel there are $20 \times 8 = 160$ times of transmissions.

```
a) Channel Low: the dwell time is 0.46ms x 160 = 73.6 ms
b) Channel Middle: the dwell time is 0.44ms x 160 = 70.4 ms
c) Channel Hi: the dwell time is 0.44ms x 160 = 70.4 ms
```

The maximum time of occupancy for a particular channel is 73.6ms in any 8 second period, which is less than the 400ms allowed by the rules; therefore, it meets the requirements of this section.

B. DH3 Mode

The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH3 data rate operates on a three-slot transmission and one-slot receiving basis. Thus there are 800/(3+1) = 200 transmissions per second. In one period for each particular channel there are $10 \times 8 = 80$ times of transmissions.

```
a) Channel Low: the dwell time is 1.78ms x 80 = 142.400 ms
b) Channel Middle: the dwell time is 1.78ms x 80 = 142.400 ms
c) Channel Hi: the dwell time is 1.80ms x 80 = 144.000 ms
```

The maximum time of occupancy for a particular channel is 144.000ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

C. DH5 Mode

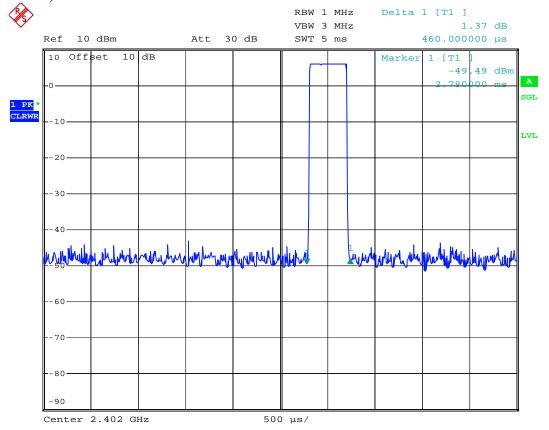
The Bluetooth system hops at a rate of 800 times per second. This means there are 800 timeslots in one second. The DH5 data rate operates on a five-slot transmission and one-slot receiving basis. Thus there are 800/(5+1) = 133.3 transmissions per second. In one period for each particular channel there are $6.665 \times 8 = 53.32$ times of transmissions.

```
a) Channel Low: the dwell time is 3.02ms x 53.32 = 161.026 ms
b) Channel Middle: the dwell time is 3.00ms x 53.32 = 159.960 ms
c) Channel Hi: the dwell time is 2.98ms x 53.32 = 158.893 ms
```

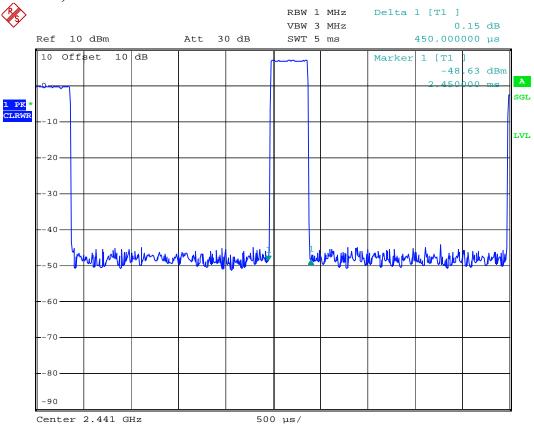
The maximum time of occupancy for a particular channel is 161.026ms in any 8 second period, which is less than the 400 ms allowed by the rules; therefore, it meets the requirements of this section.

Mode: Bluetooth BR

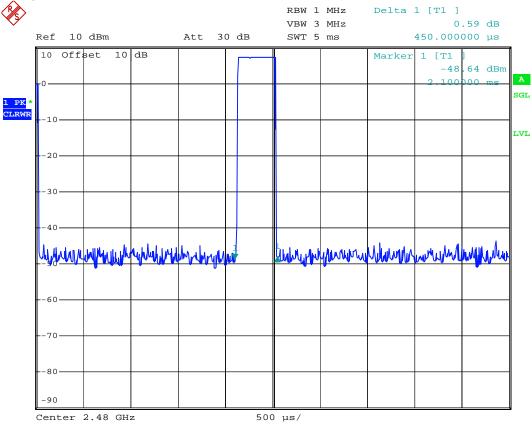
Channel Low; DH1



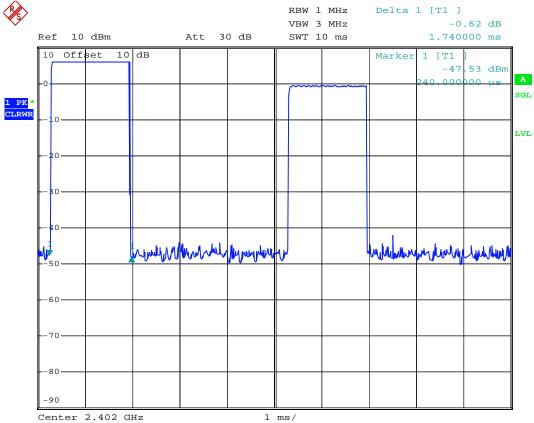
Channel Middle; DH1



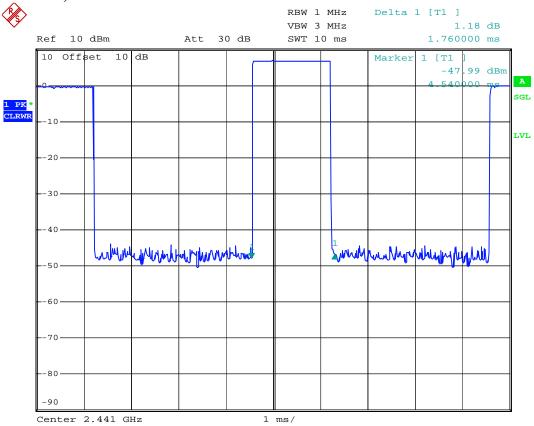
Channel High; DH1



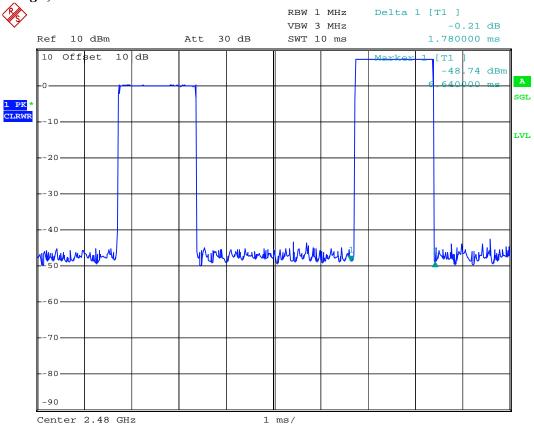
Channel Low; DH3



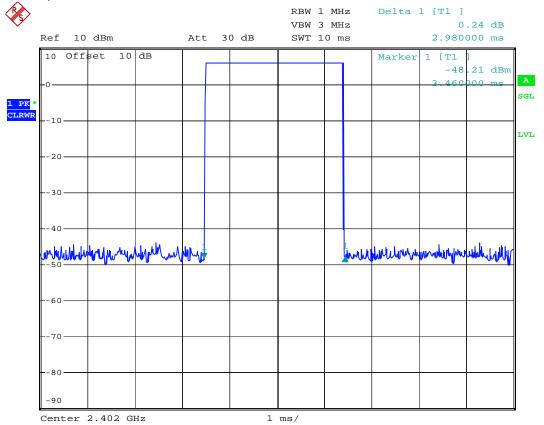
Channel Middle; DH3



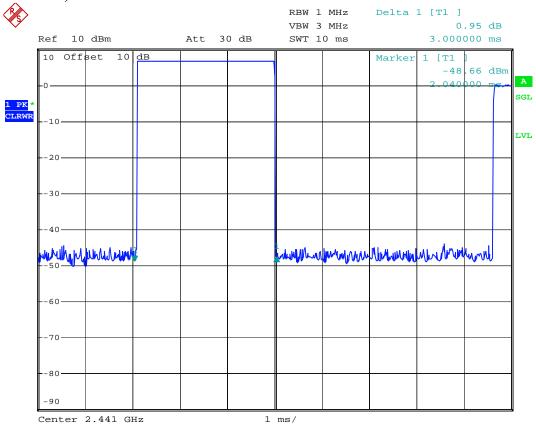
Channel High; DH3



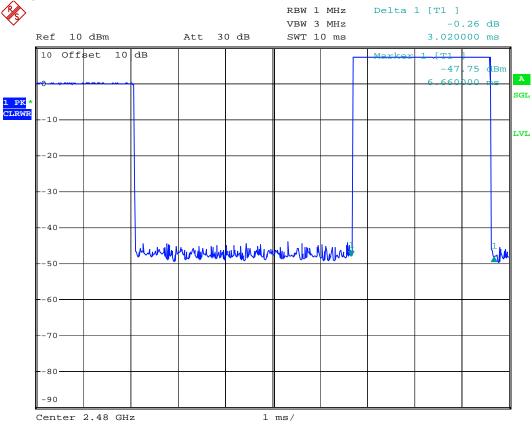
Channel Low; DH5



Channel Middle; DH5

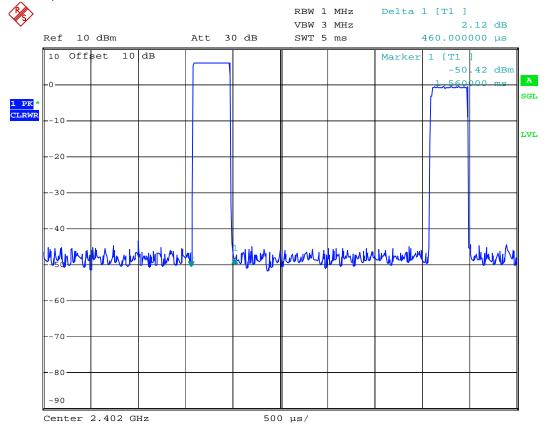


Channel High; DH5

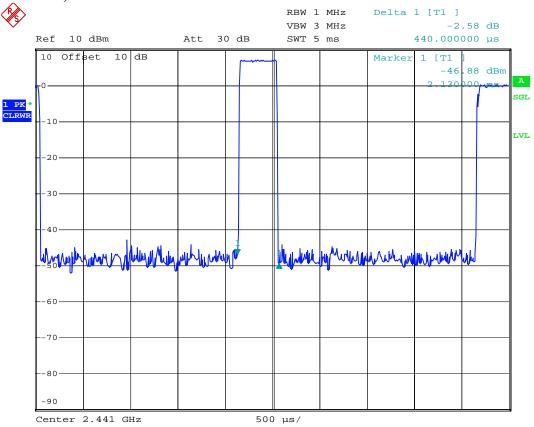


Mode: Bluetooth EDR

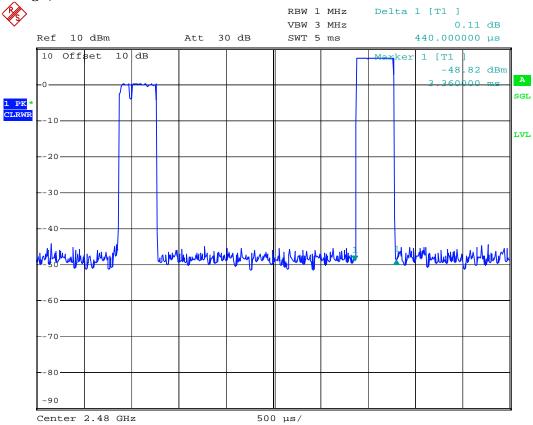
Channel Low; DH1



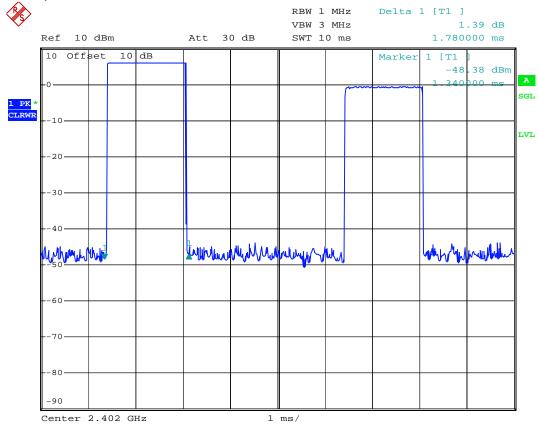
Channel Middle; DH1



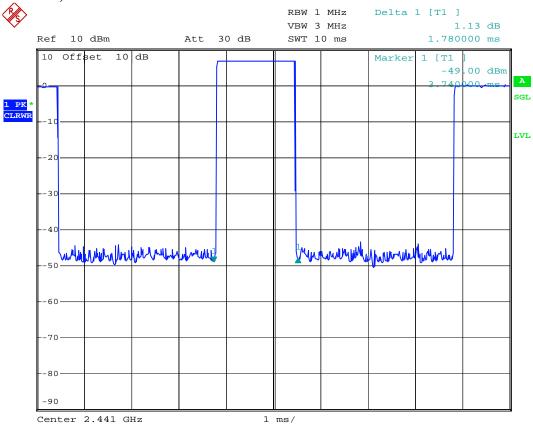
Channel High; DH1



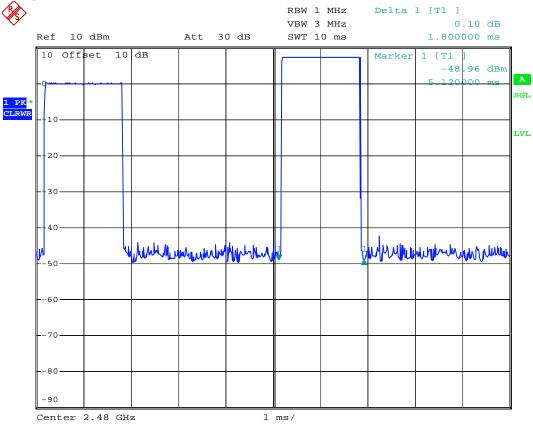
Channel Low; DH3



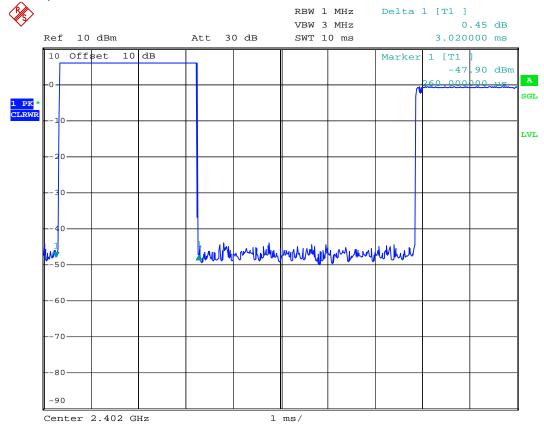
Channel Middle; DH3



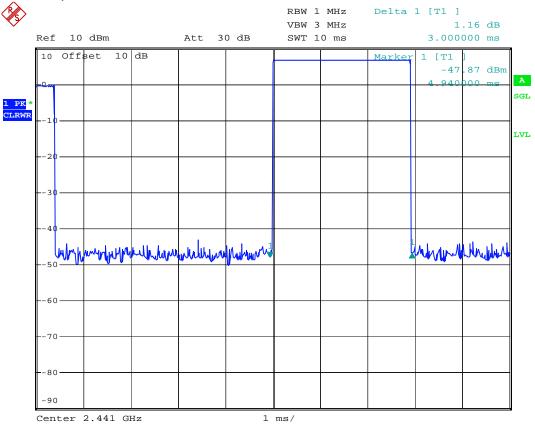
Channel High; DH3



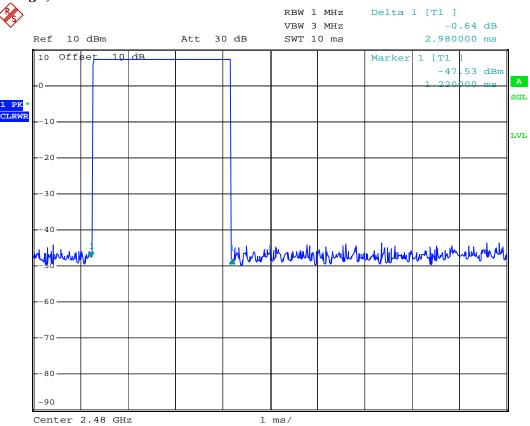
Channel Low; DH5



Channel Middle; DH5



Channel High; DH5



11 OUTPUT POWER MEASUREMENT

11.1 Standard Applicable

According to 15.247(b)(1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

11.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- 3. Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

 $VBW \ge RBW$

Sweep = auto

Detector function = peak

Trace = max hold

- 4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all frequencies measured were complete.

11.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|-------------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

11.4 Measurement Data

| Test | Date : <u>Apr. 18,</u> | <u>20</u> | Temperature | : <u>24</u> ° | °C Humid | lity : <u>53</u> | <u> </u> |
|------|------------------------|-----------|----------------------|---------------|----------|------------------|------------|
| Mo | ode: Bluetooth BI | ₹ | | | | | |
| a) | Channel Low | : | Output Peak Power is | 6.06 | dBm or | 4.036 | $mW\circ$ |
| b) | Channel Middle | : | Output Peak Power is | 6.89 | dBm or | 4.887 | $mW\circ$ |
| c) | Channel High | : | Output Peak Power is | 7.27 | dBm or | 5.333 | $mW \circ$ |
| Mo | ode: Bluetooth EI |)R | | | | | |
| a) | Channel Low | : | Output Peak Power is | 4.98 | dBm or | 3.148 | $mW\circ$ |
| b) | Channel Middle | : | Output Peak Power is | 7.17 | dBm or | 5.212 | $mW\circ$ |
| c) | Channel High | : | Output Peak Power is | 6.68 | dBm or | 4.656 | $mW\circ$ |

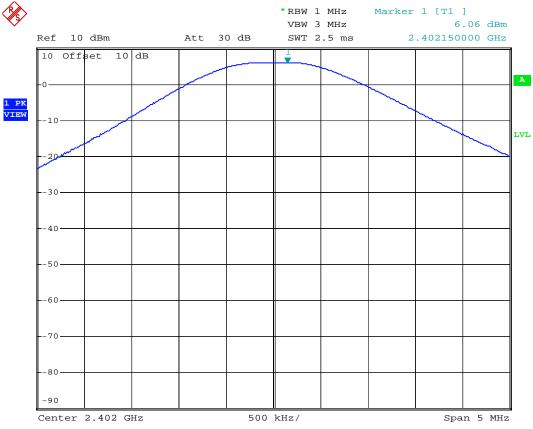
Justification on AFH mode:

Adaptive Frequency Hopping (AFH) means that a device can hop over a reduced set of frequencies. The frequencies hopped may reduced in AFH mode but at least 15 channels will be used. Hence the output power limit is 125mW.

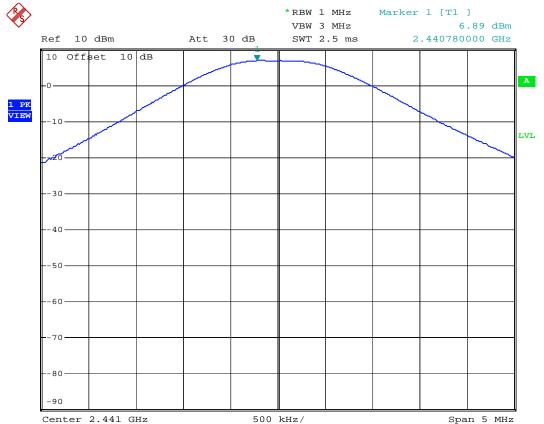
Note: The expanded uncertainty: 2dB.

Mode: Bluetooth BR

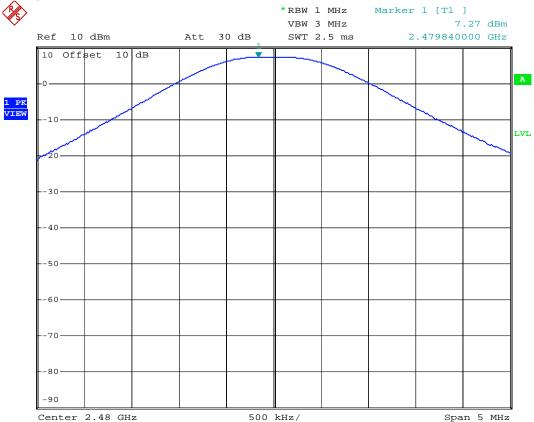




Channel Middle

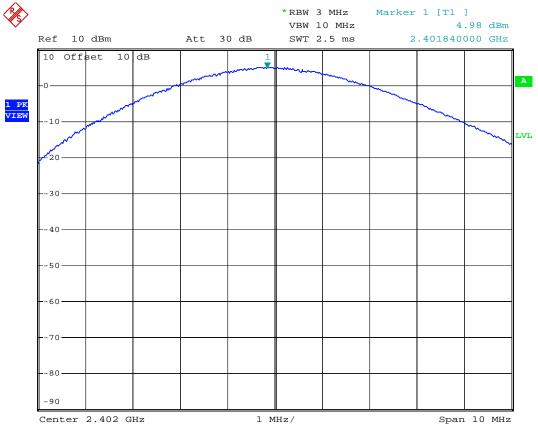




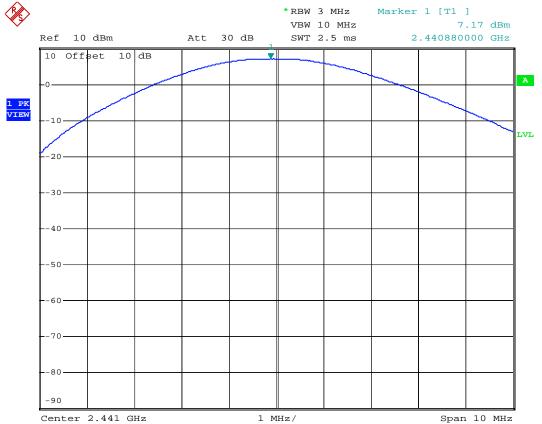


Mode: Bluetooth EDR

Channel Low



Channel Middle



Channel High



12 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

12.1 Standard Applicable

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

12.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- 3. Use the following spectrum analyzer settings:
 - Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation

 $RBW \ge 1\%$ of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

- 4. Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all measured frequencies were complete.

12.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

12.4 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Mode: Bluetooth BR

- a) Lower Band Edge: All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
- b) Upper Band Edge: All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

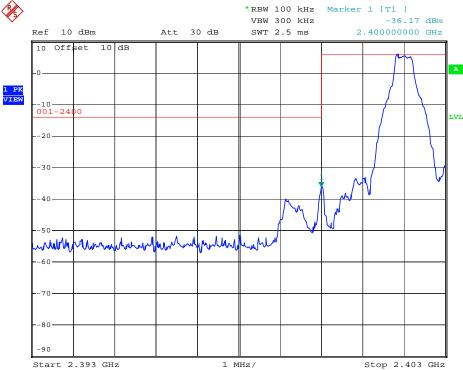
Mode: Bluetooth EDR

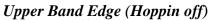
- a) Lower Band Edge: All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
- b) Upper Band Edge: All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

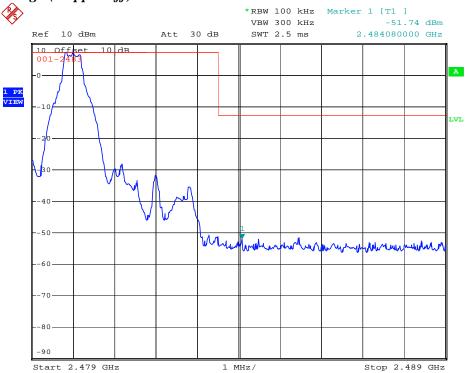
Note: The expanded uncertainty: 2dB.

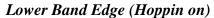
Mode: Bluetooth BR

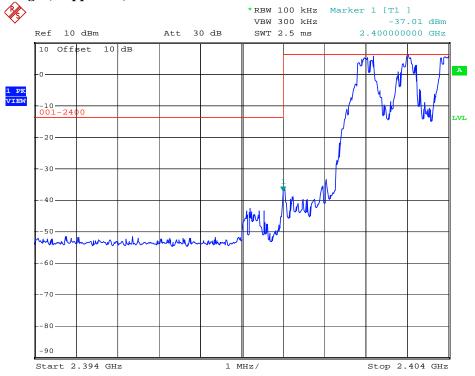




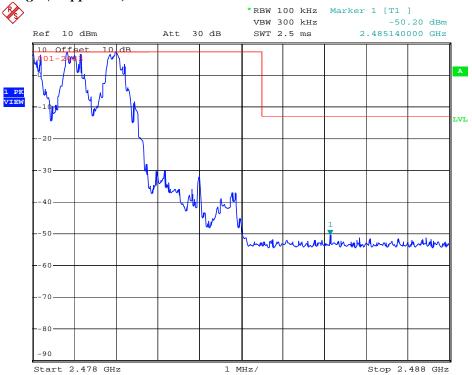






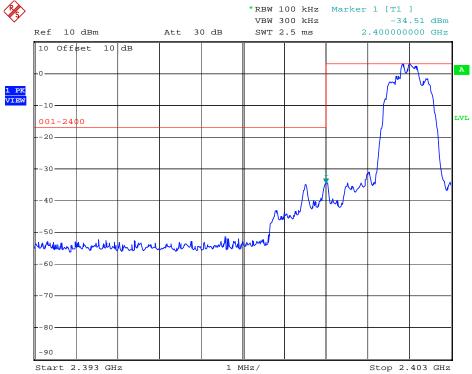


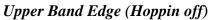


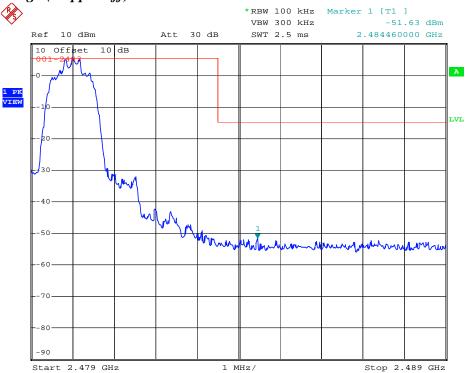


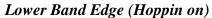
Mode: Bluetooth EDR

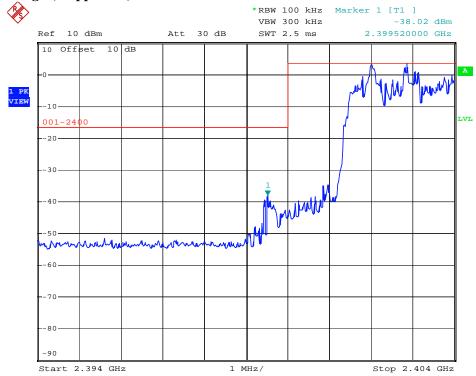


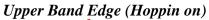


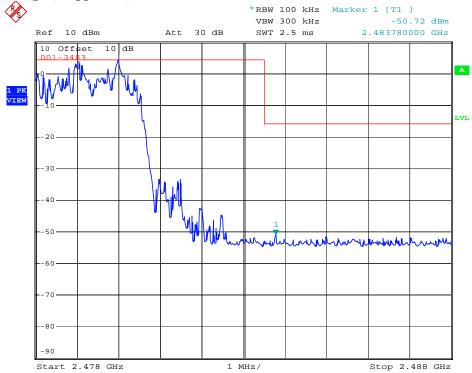












13 CONDUCTED SPURIOUS EMISSION MEASUREMENT

13.1 Standard Applicable

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

13.2 Measurement Procedure

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- 3. Use the following spectrum analyzer settings:
 - 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. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

 $VBW \ge RBW$

Sweep = auto

Detector function = peak

Trace = max hold.

- 4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. Plot the result on the screen of spectrum analyzer.
- 5. Repeat above procedures until all measured frequencies were complete.

13.3 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|-------------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

13.4 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Mode: Bluetooth BR

Mode: Low Channel/ Mid Channel/ Hi Channel

a) 1 GHz to 25 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

Mode: Bluetooth EDR

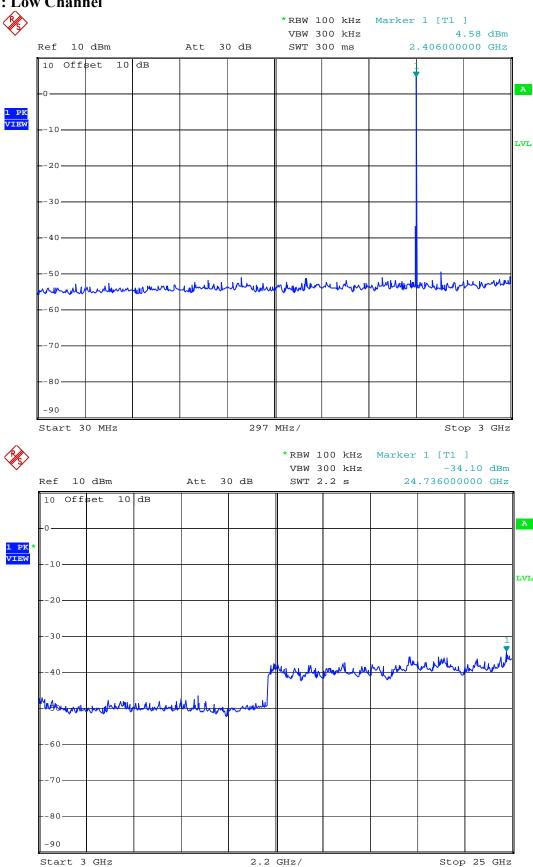
Mode: Low Channel/ Mid Channel/ Hi Channel

a) 1 GHz to 25 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

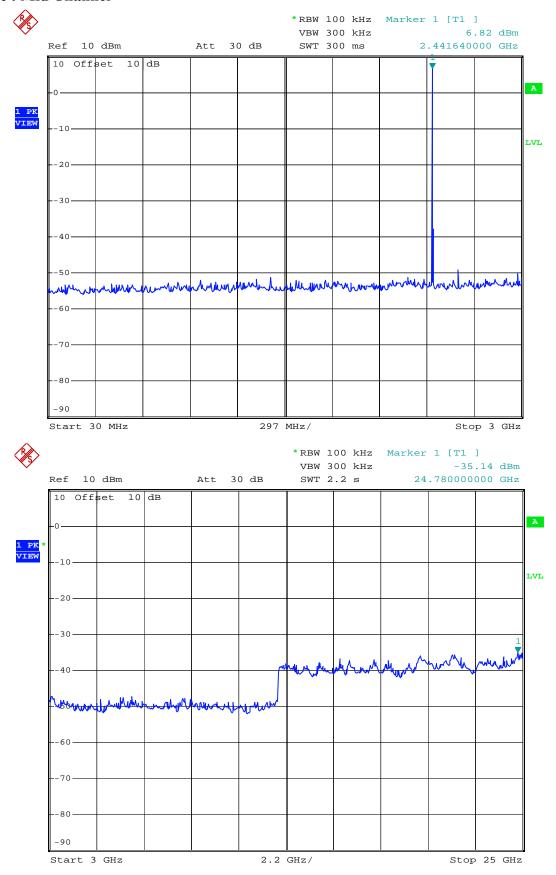
Note: The expanded uncertainty: 2dB.

Mode: Bluetooth BR

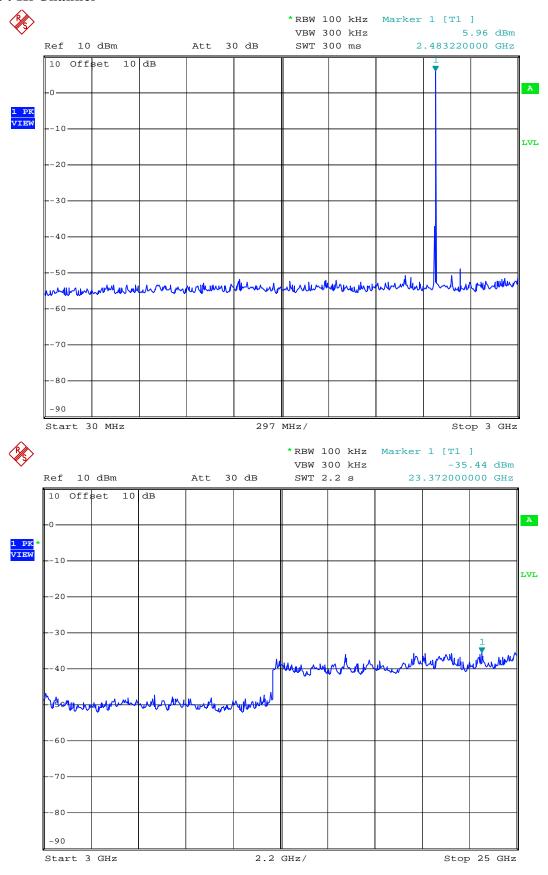




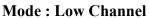
Mode: Mid Channel

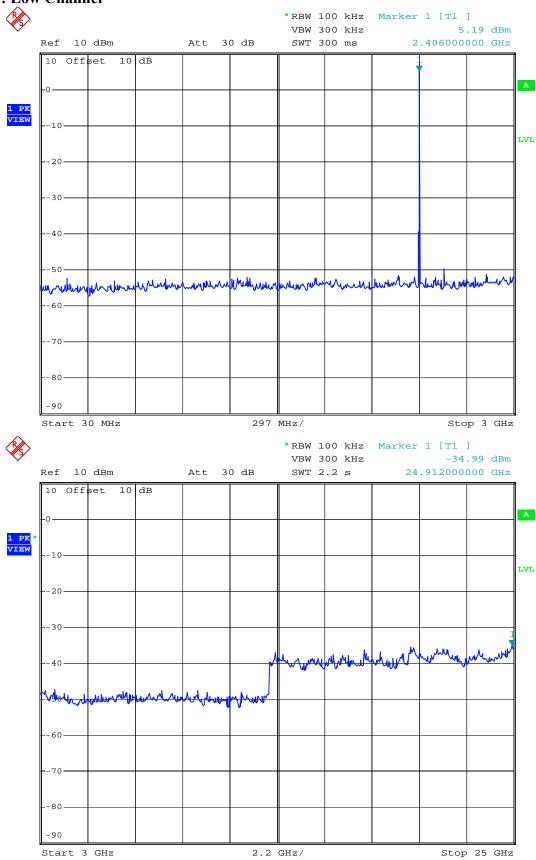


Mode: Hi Channel

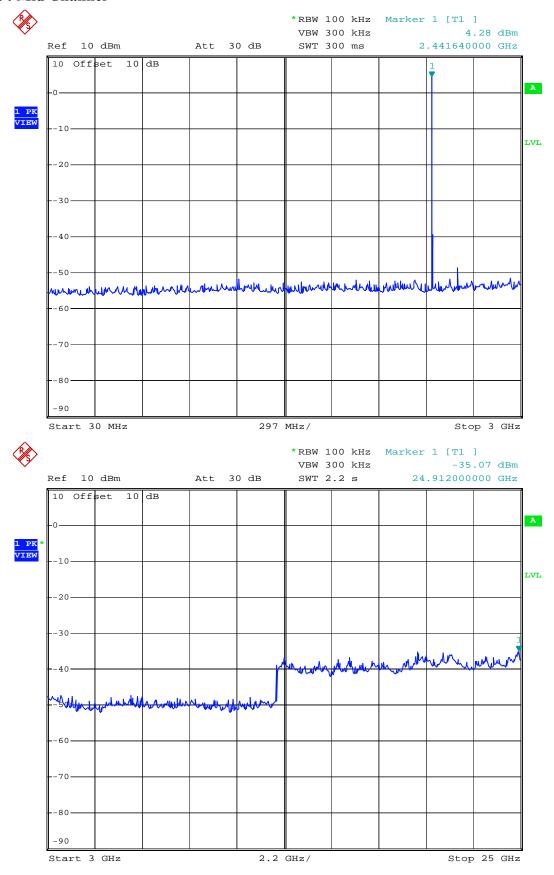


Mode: Bluetooth EDR

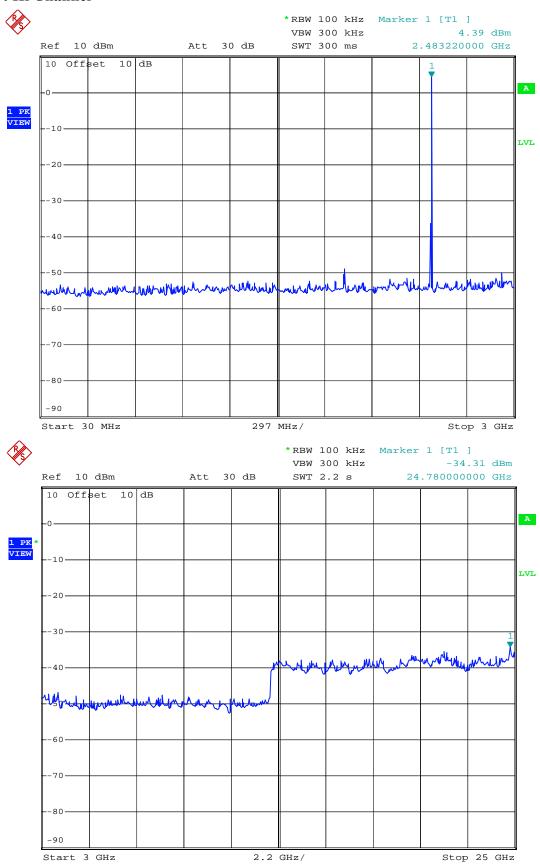




Mode: Mid Channel



Mode: Hi Channel



14. DYTY CYCLE

14.1 Standard Applicable

None. Refereency only.

14.2 Measurement Equipment

| Equipment | Manufacturer | Model No. | Calibration Date | Next Cal. Date |
|-------------------|-----------------|-----------|------------------|----------------|
| Spectrum Analyzer | Rohde & Schwarz | FSP40 | 2016/10/03 | 2017/10/02 |
| Attenuator | MINI-CIRCUITS | BW-S10W2+ | 2016/09/30 | 2017/09/29 |

14.3 Measurement Data

Test Date: Apr. 18, 2017 Temperature: 24 °C Humidity: 53 %

Duty Cycle Calculation

| Mode | Period (ms) | Transmission duration (T) (ms) | Duty Cycle (%) | 1/T (kHz) | VBW setting (kHz) |
|-----------|----------------|--------------------------------|----------------|--------------|-------------------------|
| BR / DH5 | 3.76 | 2.98 | 79.2 | 0.335 | 1 |
| EDR / DH5 | 3.76 | 3.00 | 79.7 | 0.333 | 1 |

Note:

- 1. DH5 has the highest duty cycle worst case and is reported.
- 2. When the duty cycle is less than 98%, for the average measurement of the radiated emission test, the VBW setting is >1/T where the T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

Refer to the following page for data plots.



