# ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER
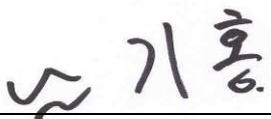
| | |
|---|---|
| **Test Report No.** | : OT-205-RWD-019 |
| **AGR No.** | : A203A-350 |
| **Applicant** | : LG Electronics USA, Inc. |
| **Address** | : 1000 Sylvan Ave. Englewood Cliffs, New Jersey, 07632, United States |
| **Manufacturer** | : LG Electronics Inc. |
| **Address** | : 222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, Korea |
| **Type of Equipment** | : Bluetooth Earbud |
| **FCC ID.** | : ZNFHBSFN6 |
| **Model Name** | : HBS-FN6 |
| **Multiple Model Name** | : HBS-FN5W, HBS-FN5U, HBS-FN4 |
| **Serial number** | : N/A |
| **Total page of Report** | : 102 pages (including this page) |
| **Date of Incoming** | : March 25, 2020 |
| **Date of issue** | : May 11, 2020 |

## SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247*

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: _____
Tae-Ho, Kim / Senior Manager
ONETECH Corp.

Approved by: _____
Ki-Hong, Nam / General Manager
ONETECH Corp.

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**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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## Revision History

| Rev. No. | Issue Report No. | Issued Date | Revisions | Section Affected |
|----------|------------------|-------------|-----------|------------------|
| 0 | OT-205-RWD-019 | May 11, 2020 | Initial Release | All |
| | | | | |
| | | | | |

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# 1. VERIFICATION OF COMPLIANCE

Applicant        : LG Electronics USA, Inc.

Address          : 1000 Sylvan Ave. Englewood Cliffs, New Jersey, 07632, United States

Contact Person   : Kyung-Su, Han / Director, Standards & Compliance

Telephone No.    : 201-266-2215

FCC ID           : ZNFHBSFN6

Model Name       : HBS-FN6

Brand Name       : -

Serial Number    : N/A

Date             : May 11, 2020

| | |
|---|---|
| EQUIPMENT CLASS | DSS – PART 15 SPREAD SPECTRUM TRANSMITTER |
| E.U.T. DESCRIPTION | Bluetooth Earbud |
| THIS REPORT CONCERNS | Original Grant |
| MEASUREMENT PROCEDURES | ANSI C63.10: 2013 |
| TYPE OF EQUIPMENT TESTED | Pre-Production |
| KIND OF EQUIPMENT AUTHORIZATION REQUESTED | Certification |
| EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S) | FCC PART 15 SUBPART C Section 15.247<br>KDB 558074 D01 15.247 Meas Guidance v05r02 |
| Modifications on the Equipment to Achieve Compliance | None |
| Final Test was Conducted On | 10 m, Semi Anechoic Chamber |

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

## 2. TEST SUMMARY

### 2.1 Test items and results

| SECTION | TEST ITEMS | RESULTS |
|---|---|---|
| 15.247 (a) (1) | Carrier Frequency Separation | Met the Limit / PASS |
| 15.247 (a) (1) (iii) | Minimum Number of Hopping Channels | Met the Limit / PASS |
| 15.247 (a) (1) (iii) | Average Time of Occupancy | Met the Limit / PASS |
| 15.247 (b) (1) | Maximum Peak Conducted Output Power | Met the Limit / PASS |
| 15.247 (d) | 100 kHz Bandwidth Outside the Frequency Band | Met the Limit / PASS |
| 15.247 (d) | Radiated Emission which fall in the Restricted Band | Met the Limit / PASS |
| 15.209 | Radiated Emission Limits, General Requirement | Met the Limit / PASS |
| 15.207 | Conducted Limits | N/A (See Note) |
| 15.203 | Antenna Requirement | Met requirement / PASS |

Note: This test is not performed because the EUT is wireless function does not work while charging mode.

### 2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

### 2.3 Related Submittal(s) / Grant(s)

Original submittal only

### 2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

### 2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

### 2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666/ T-1842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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## 3. GENERAL INFORMATION

### 3.1 Product Description

The LG Electronics USA, Inc., Model HBS-FN6 (referred to as the EUT in this report) is a Bluetooth Earbud. The product specification described herein was obtained from product data sheet or user's manual.

| DEVICE TYPE | Bluetooth Earbud | | |
|---|---|---|---|
| Temperature Range | 0 ℃ ~ 35 ℃ | | |
| OPERATING FREQUENCY | Bluetooth LE | 2 402 MHz ~ 2 480 MHz | |
| | Bluetooth | 2 402 MHz ~ 2 480 MHz | |
| MODULATION TYPE | Bluetooth LE | 1 Mbps | GFSK |
| | | Coded_125 kbps | GFSK |
| | Bluetooth | 1 Mbps | GFSK |
| | | 2 Mbps | π/4-DQPSK |
| RF OUTPUT POWER | Bluetooth LE | 1 Mbps | 5.78 dBm(Bluetooth Earbud LEFT) |
| | | | 6.15 dBm(Bluetooth Earbud RIGHT) |
| | | Coded_125 kbps | 5.95 dBm(Bluetooth Earbud LEFT) |
| | | | 6.05 dBm(Bluetooth Earbud RIGHT) |
| | Bluetooth | 1 Mbps | 5.38 dBm(Bluetooth Earbud LEFT) |
| | | | 5.03 dBm(Bluetooth Earbud RIGHT) |
| | | 2 Mbps | 7.55 dBm(Bluetooth Earbud LEFT) |
| | | | 7.24 dBm(Bluetooth Earbud RIGHT) |
| ANTENNA TYPE | FPCB Antenna | | |
| ANTENNA GAIN | 1.23 dBi | | |
| List of each Osc. or crystal Freq.(Freq. >= 1 MHz) | 40 MHz | | |

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**3.2 Alternative type(s)/model(s); also covered by this test report.**

-. The following lists consist of the added model and their differences.

| Model Name | Differences | Tested |
|---|---|---|
| HBS-FN6 | Basic Model (Wireless Charging: O / UV-C LED: O) | ☑ |
| HBS-FN5W | The models are identical to basic model but the use function is different.<br>(Wireless Charging: O / UV-C LED: X) | ☐ |
| HBS-FN5U | The models are identical to basic model but the use function is different.<br>(Wireless Charging: X / UV-C LED: O) | ☐ |
| HBS-FN4 | The models are identical to basic model but the use function is different.<br>(Wireless Charging: X / UV-C LED: X) | ☐ |

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacturer is responsible for the compliance of all variants.

## 4. EUT MODIFICATIONS

-. None

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## 5. SYSTEM TEST CONFIGURATION

### 5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

-. Charging case

| DEVICE TYPE | MANUFACTURER | MODEL/PART NUMBER | FCC ID |
|---|---|---|---|
| Main Board | LG Electronics Inc. | HBS-FN6 CRADLE MAIN | N/A |
| Battery | Spring power technology(ShenZhen)Co., Ltd | N/A | N/A |

-. Bluetooth Earbud

| DEVICE TYPE | MANUFACTURER | MODEL/PART NUMBER | FCC ID |
|---|---|---|---|
| Main Board | LG Electronics Inc. | HBS-FN6 Main L | N/A |
| Sub Board | N/A | N/A | N/A |
| Touch Sensor | N/A | N/A | N/A |
| Speaker | N/A | HBS-FN6 RCV L | N/A |
| MIC | N/A | HBS-FN6_FPCB_TERMINAL | N/A |
| Battery | N/A | N/A | N/A |
| Antenna Board | N/A | HBS-FN6 | N/A |

### 5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

| Model | Manufacturer | Description | Connected to |
|---|---|---|---|
| HBS-FN6 | LG Electronics Inc. | Bluetooth Earbud (EUT) | - |
| HP ProtectSmart | HP | Notebook PC | Jig Board |
| PPP009C | LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD. | AC Adaptor | Notebook PC |
| UMFT234XD | FTDI Chip | Jig Board | EUT |

### 5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 441 MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is "XZ" axis, but the worst data was recorded in this report.

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**-. Duty Cycle(Bluetooth Earbud LEFT)**

| Mode | Tx On Time [ ms ] | Tx Off Time [ ms ] | Duty Cycle [ % ] | Correction Factor [ dB ] |
|---|---|---|---|---|
| Bluetooth [ 1 Mbps ] | - | - | 100.00 | - |
| Bluetooth [ 2 Mbps ] | - | - | 100.00 | - |

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

      Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

**-. Duty Cycle(Bluetooth Earbud RIGHT)**

| Mode | Tx On Time [ ms ] | Tx Off Time [ ms ] | Duty Cycle [ % ] | Correction Factor [ dB ] |
|---|---|---|---|---|
| Bluetooth [ 1 Mbps ] | - | - | 100.00 | - |
| Bluetooth [ 2 Mbps ] | - | - | 100.00 | - |

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

      Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

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**-. Test Plot(Bluetooth Earbud LEFT)**
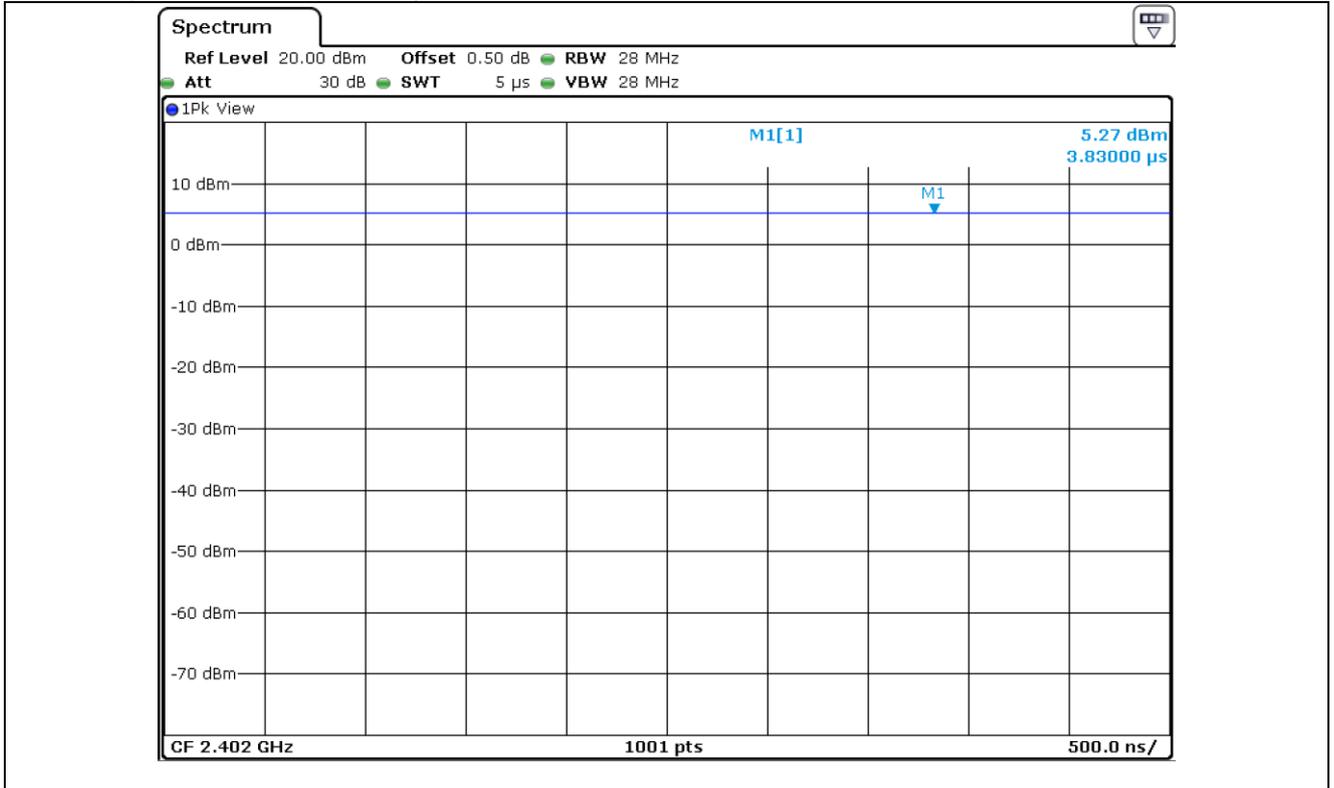


Bluetooth_1 Mbps



Bluetooth_2 Mbps

**-. Test Plot(Bluetooth Earbud RIGHT)**



| Spectrum | | | |
|---|---|---|---|
| Ref Level 20.00 dBm | Offset 0.50 dB | ● RBW 28 MHz | |
| ● Att 30 dB | ● SWT 5 μs | ● VBW 28 MHz | |

● 1Pk View

M1[1]    3.24 dBm
1.84000 μs

CF 2.402 GHz    1001 pts    500.0 ns/

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Bluetooth_1 Mbps



| Spectrum | | | |
|---|---|---|---|
| Ref Level 20.00 dBm | Offset 0.50 dB | ● RBW 28 MHz | |
| ● Att 30 dB | ● SWT 10 ms | ● VBW 28 MHz | |

● 1Pk View

M1[1]    5.56 dBm
4.99000 ms

CF 2.402 GHz    1001 pts    1.0 ms/

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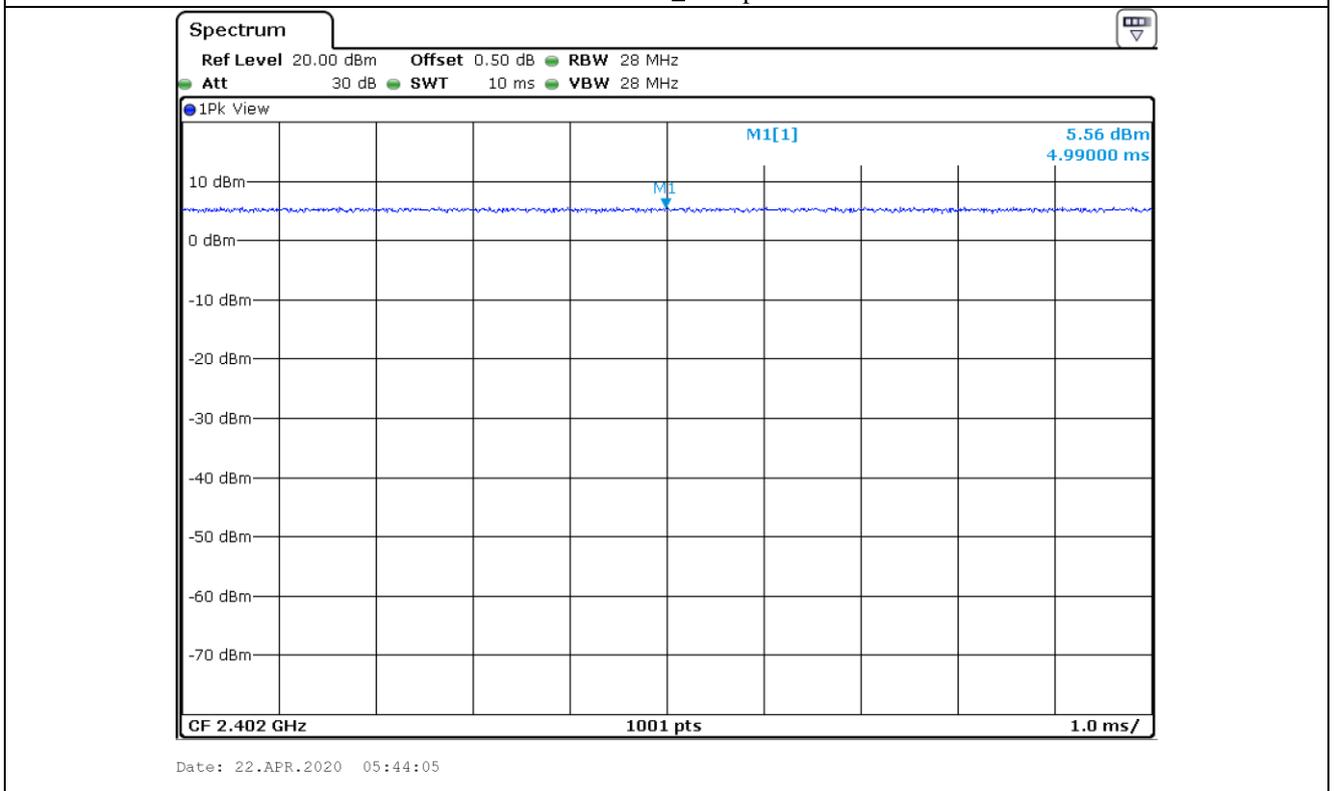
Bluetooth_2 Mbps

## 5.4 Configuration of Test System

**Line Conducted Test**:　　This test is not performed because the EUT is wireless function does not work while charging mode.

**Radiated Emission Test**:　　Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 10 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

## 5.5 Antenna Requirement

For intentional device, according to section 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.

**Antenna Construction:**

The antenna of the EUT is a FPCB Antenna on the main board in the EUT, so no consideration of replacement by the user.

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# 6. PRELIMINARY TEST

## 6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

| Operation Mode | The Worse operating condition (Please check one only) |
|---|---|
| This test is not performed because the EUT is wireless function does not work while charging mode. | |

## 6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

| Operation Mode | The Worse operating condition (Please check one only) |
|---|---|
| Transmitting Mode | X |

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# 7. MINIMUM 20 dB BANDWIDTH

## 7.1 Operating environment

Temperature                  :      23 °C

Relative humidity          :      45 % R.H.

## 7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 10 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.
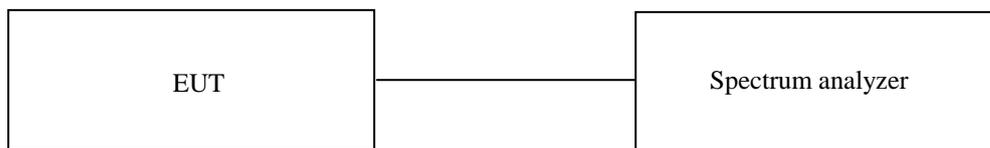
| EUT | Spectrum analyzer |
|-----|-------------------|

## 7.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|--------------|--------------|-------------|---------------|-----------|
| ■ - FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Feb. 21, 2020 (1Y) |

All test equipment used is calibrated on a regular basis.

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## 7.4 Test data for 1 Mbps

### 7.4.1 Test data for Bluetooth Earbud LEFT

-. Test Date            : April 16, 2020 ~ April 23, 2020

| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|------------------------|
| Low | 2 402.00 | 764.20 |
| Middle | 2 441.00 | 764.20 |
| High | 2 480.00 | 764.20 |

Tested by: Hyung-Kwon, Oh / Manager



Low Channel

Spectrum

Ref Level 20.00 dBm    Offset   0.50 dB    RBW  10 kHz
Att          30 dB     SWT    379.3 µs    VBW  30 kHz    Mode  Auto FFT

1Pk View

M1[1]                -1.07 dBm
2.44105990 GHz
ndB                   20.00 dB
Bw         764.200000000 kHz
Q factor                3194.1

CF 2.441 GHz                    1001 pts                    Span 5.0 MHz

Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4410599 GHz | -1.07 dBm | ndB down | 764.2 kHz |
| T1 | | 1 | 2.4406004 GHz | -20.20 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4413646 GHz | -21.46 dBm | Q factor | 3194.1 |

Middle Channel

Spectrum

Ref Level 20.00 dBm    Offset   0.50 dB    RBW  10 kHz
Att          30 dB     SWT    379.3 µs    VBW  30 kHz    Mode  Auto FFT

1Pk View

M1[1]                -0.44 dBm
2.48005490 GHz
ndB                   20.00 dB
Bw         764.200000000 kHz
Q factor                3245.1

CF 2.48 GHz                    1001 pts                    Span 5.0 MHz

Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4800549 GHz | -0.44 dBm | ndB down | 764.2 kHz |
| T1 | | 1 | 2.4796004 GHz | -19.42 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4803646 GHz | -20.96 dBm | Q factor | 3245.1 |

High Channel

## 7.4.2 Test data for Bluetooth Earbud RIGHT

-. Test Date          : April 16, 2020 ~ April 23, 2020

| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---|---|---|
| Low | 2 402.00 | 764.20 |
| Middle | 2 441.00 | 764.20 |
| High | 2 480.00 | 764.20 |

Tested by: Hyung-Kwon, Oh / Manager



Low Channel

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## Spectrum

**Ref Level** 20.00 dBm　**Offset** 0.50 dB　● **RBW** 10 kHz
● **Att** 30 dB　**SWT** 379.3 µs　● **VBW** 30 kHz　**Mode** Auto FFT

● 1Pk View

| | M1[1] | -2.81 dBm |
| | | 2.44106490 GHz |
| | ndB | 20.00 dB |
| | Bw | 764.200000000 kHz |
| | Q factor | 3194.1 |

CF 2.441 GHz　　　　1001 pts　　　　Span 5.0 MHz

### Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4410649 GHz | -2.81 dBm | ndB down | 764.2 kHz |
| T1 | | 1 | 2.4406054 GHz | -23.20 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4413696 GHz | -23.35 dBm | Q factor | 3194.1 |

Date: 22.APR.2020　06:58:03

**Middle Channel**

## Spectrum

**Ref Level** 20.00 dBm　**Offset** 0.50 dB　● **RBW** 10 kHz
● **Att** 30 dB　**SWT** 379.3 µs　● **VBW** 30 kHz　**Mode** Auto FFT

● 1Pk View

| | M1[1] | -2.31 dBm |
| | | 2.48006490 GHz |
| | ndB | 20.00 dB |
| | Bw | 764.200000000 kHz |
| | Q factor | 3245.2 |

CF 2.48 GHz　　　　1001 pts　　　　Span 5.0 MHz

### Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4800649 GHz | -2.31 dBm | ndB down | 764.2 kHz |
| T1 | | 1 | 2.4796054 GHz | -22.73 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4803696 GHz | -22.68 dBm | Q factor | 3245.2 |

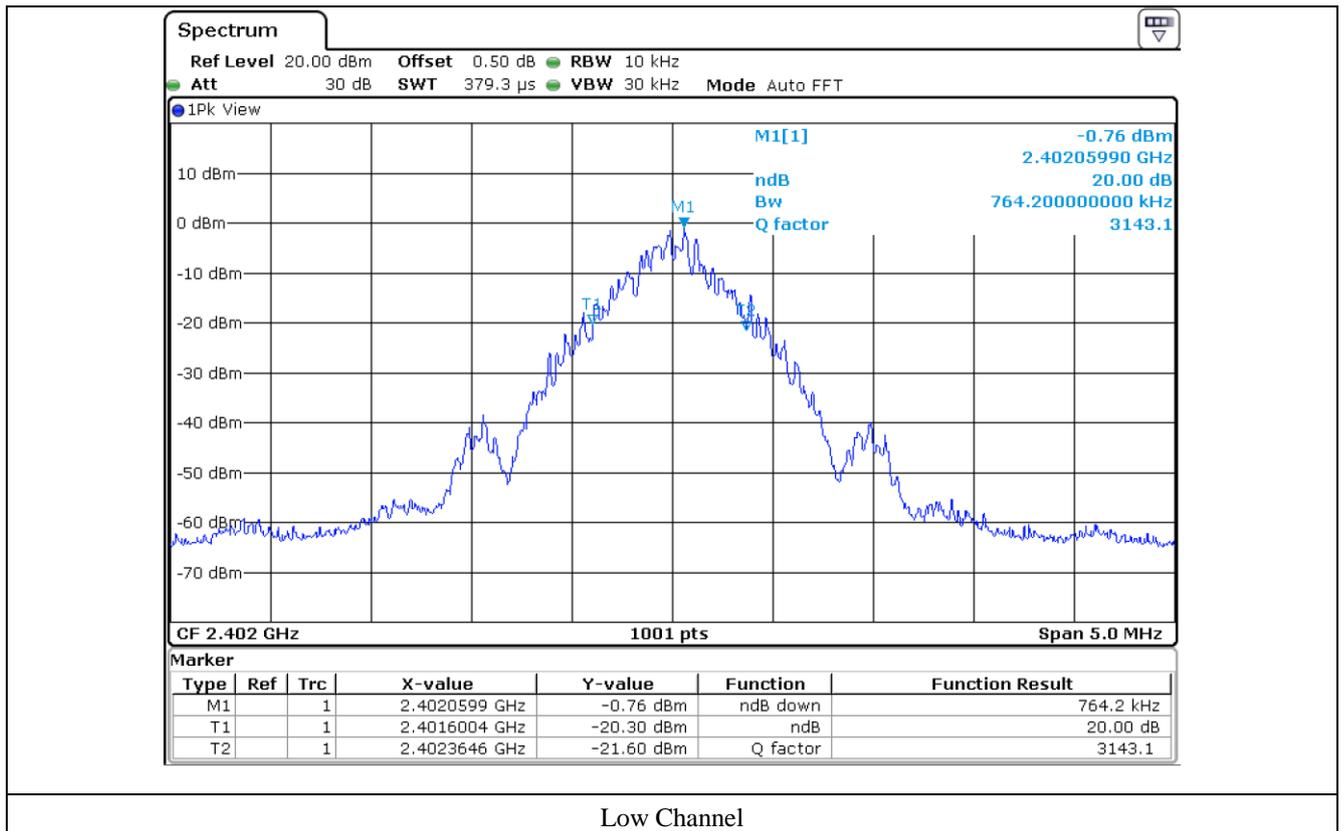Date: 22.APR.2020　06:58:57

**High Channel**
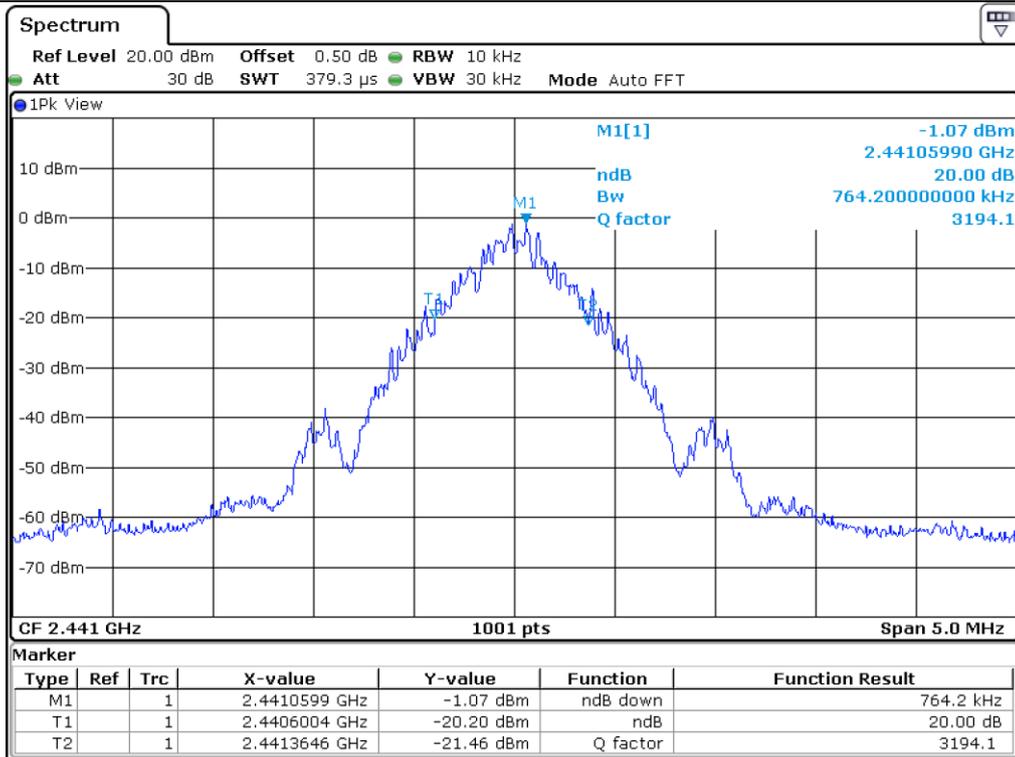
## 7.5 Test data for 2 Mbps

### 7.5.1 Test data for Bluetooth Earbud LEFT

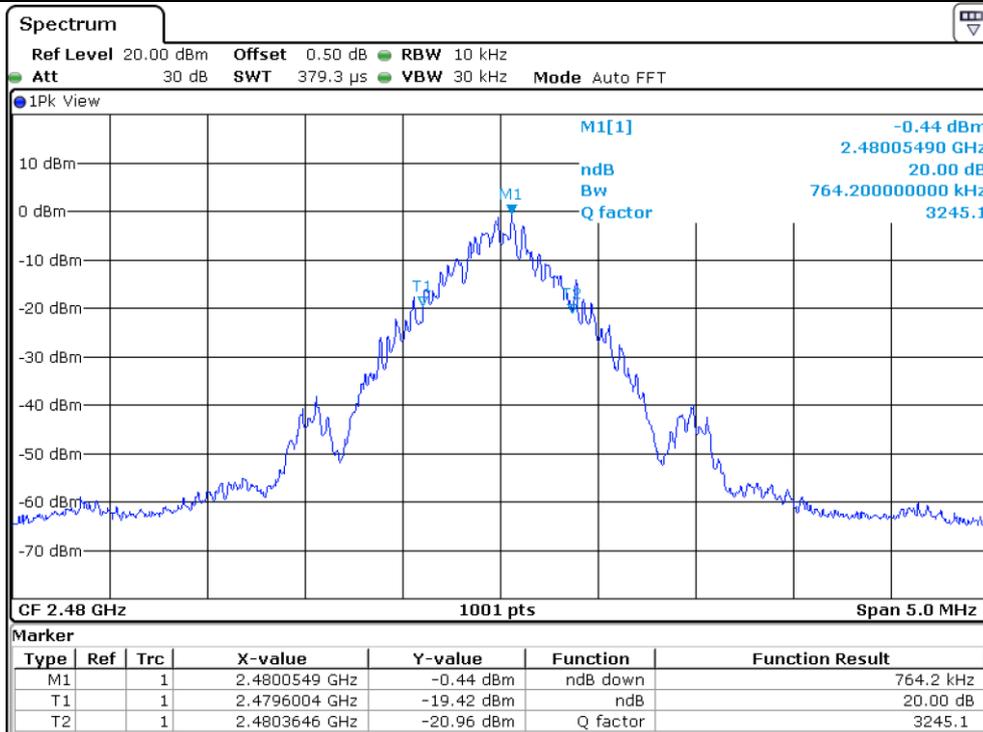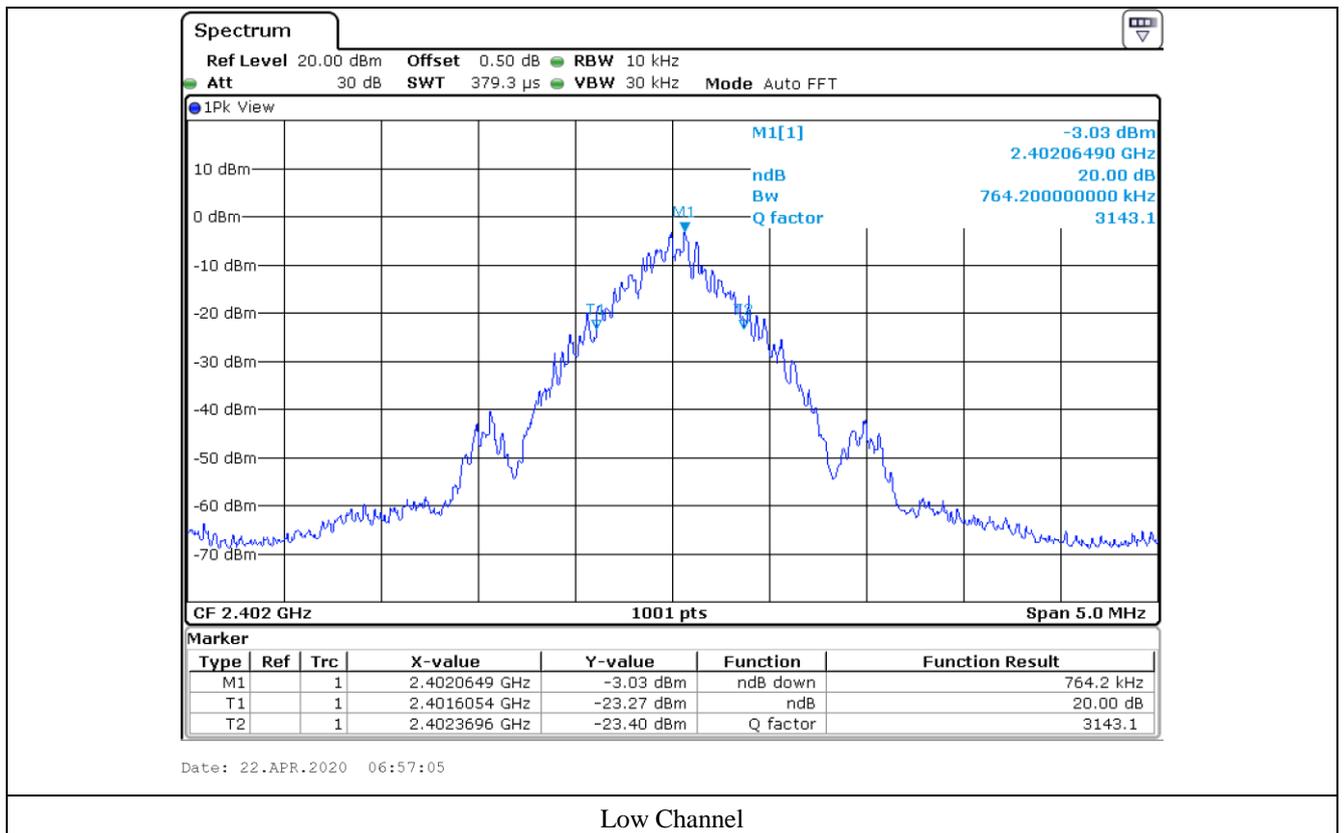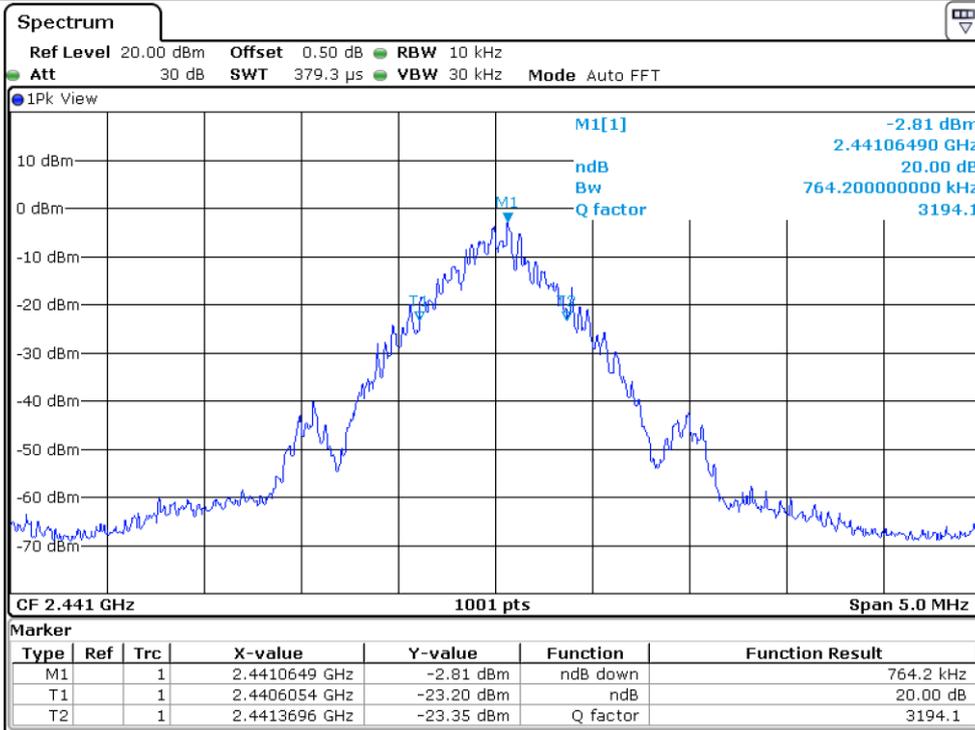-. Test Date              : April 16, 2020 ~ April 23, 2020

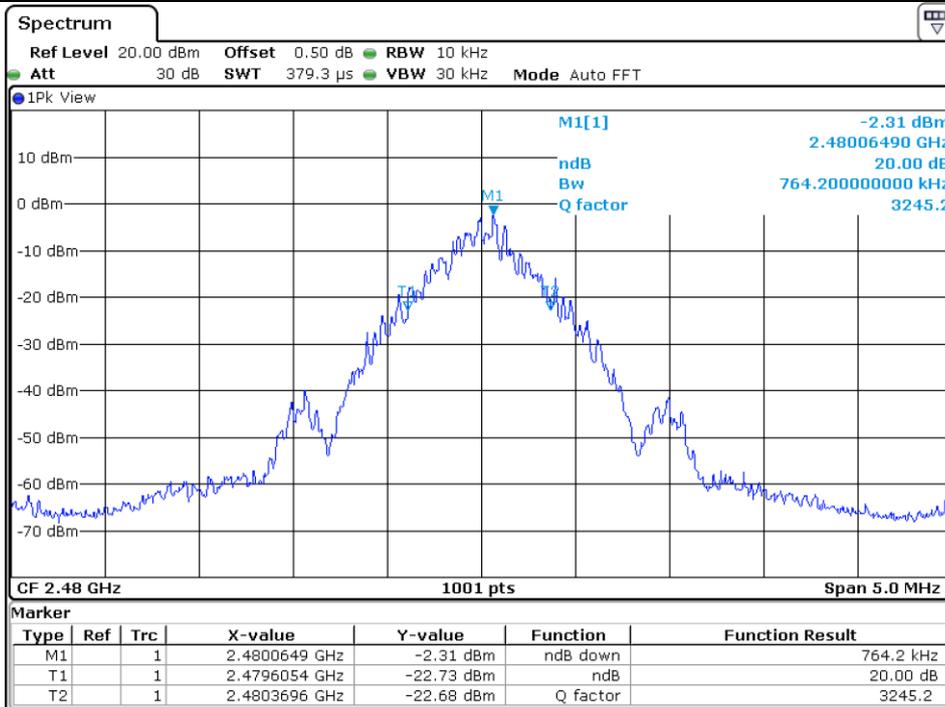| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|------------------------|
| Low | 2 402.00 | 1 348.70 |
| Middle | 2 441.00 | 1 348.70 |
| High | 2 480.00 | 1 348.70 |

Tested by: Hyung-Kwon, Oh / Manager



Low Channel

## Spectrum

Ref Level 10.00 dBm   Offset  0.50 dB   RBW 20 kHz
Att        20 dB   SWT   189.6 µs   VBW 50 kHz   Mode Auto FFT
1Pk View

M1[1]                 -2.83 dBm
                 2.44081520 GHz
ndB              20.00 dB
Bw               1.348700000 MHz
Q factor         1809.8

CF 2.441 GHz        1001 pts        Span 5.0 MHz

### Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.4408152 GHz | -2.83 dBm | ndB down | 1.3487 MHz |
| T1 | | 1 | 2.4403307 GHz | -21.96 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4416793 GHz | -22.32 dBm | Q factor | 1809.8 |

Middle Channel

## Spectrum

Ref Level 10.00 dBm   Offset  0.50 dB   RBW 20 kHz
Att        20 dB   SWT   189.6 µs   VBW 50 kHz   Mode Auto FFT
1Pk View

M1[1]                 -2.77 dBm
                 2.47981520 GHz
ndB              20.00 dB
Bw               1.348700000 MHz
Q factor         1838.7

CF 2.48 GHz        1001 pts        Span 5.0 MHz

### Marker

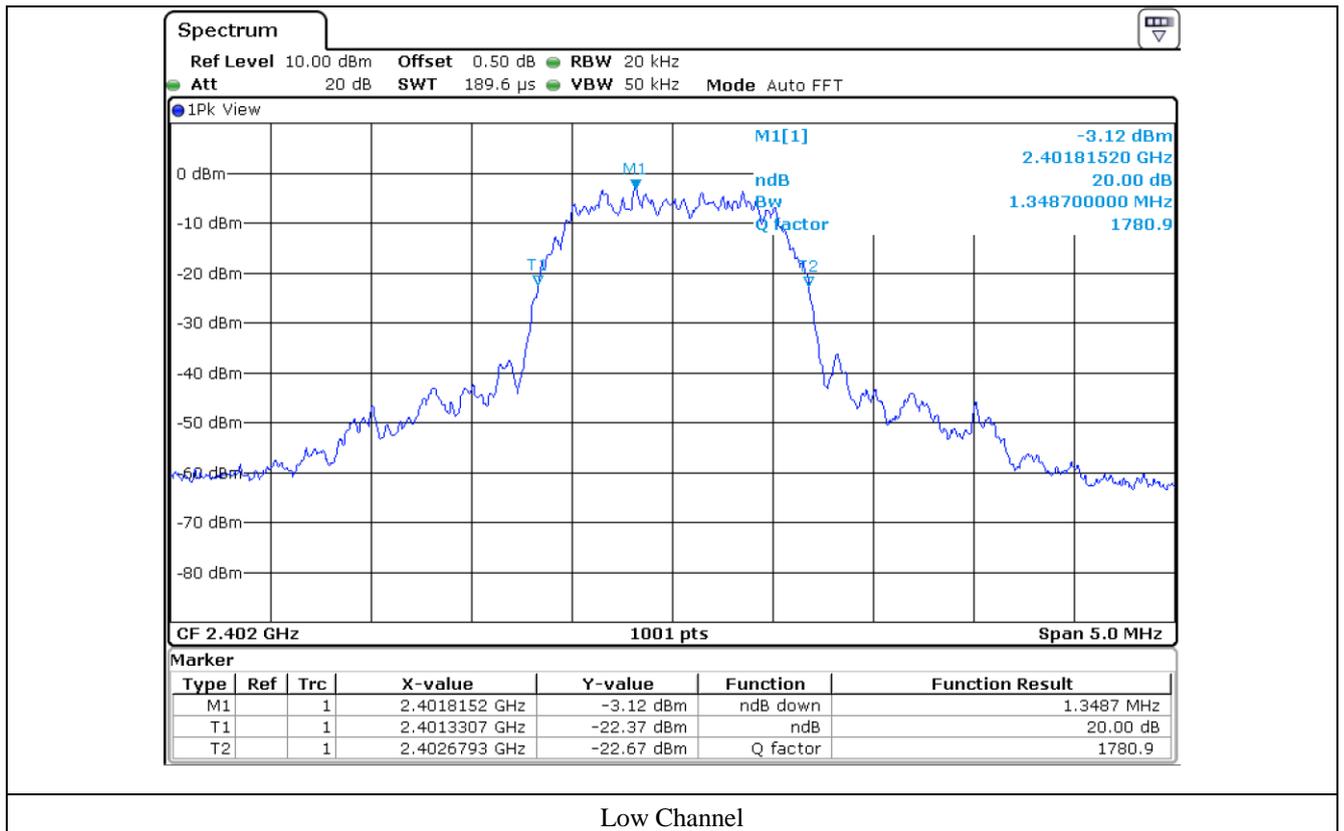| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.4798152 GHz | -2.77 dBm | ndB down | 1.3487 MHz |
| T1 | | 1 | 2.4793307 GHz | -21.77 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4806793 GHz | -22.30 dBm | Q factor | 1838.7 |

High Channel

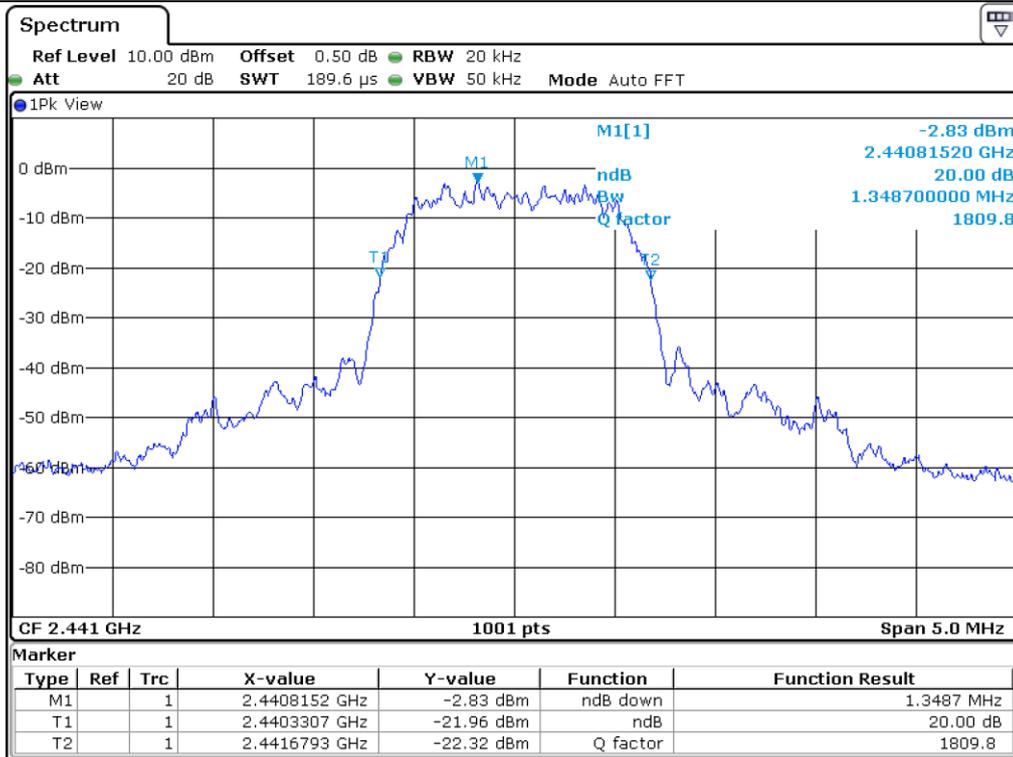## 7.5.2 Test data for Bluetooth Earbud RIGHT

-. Test Date                : April 16, 2020 ~ April 23, 2020

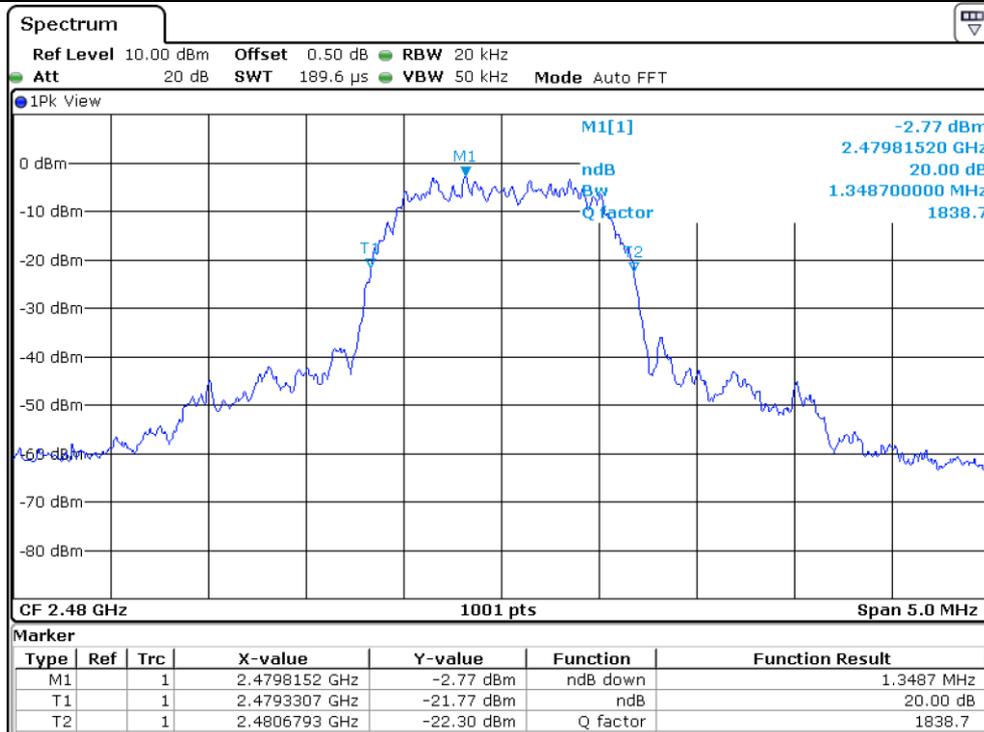| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|-----------------------|
| Low | 2 402.00 | 1 353.60 |
| Middle | 2 441.00 | 1 353.60 |
| High | 2 480.00 | 1 353.60 |

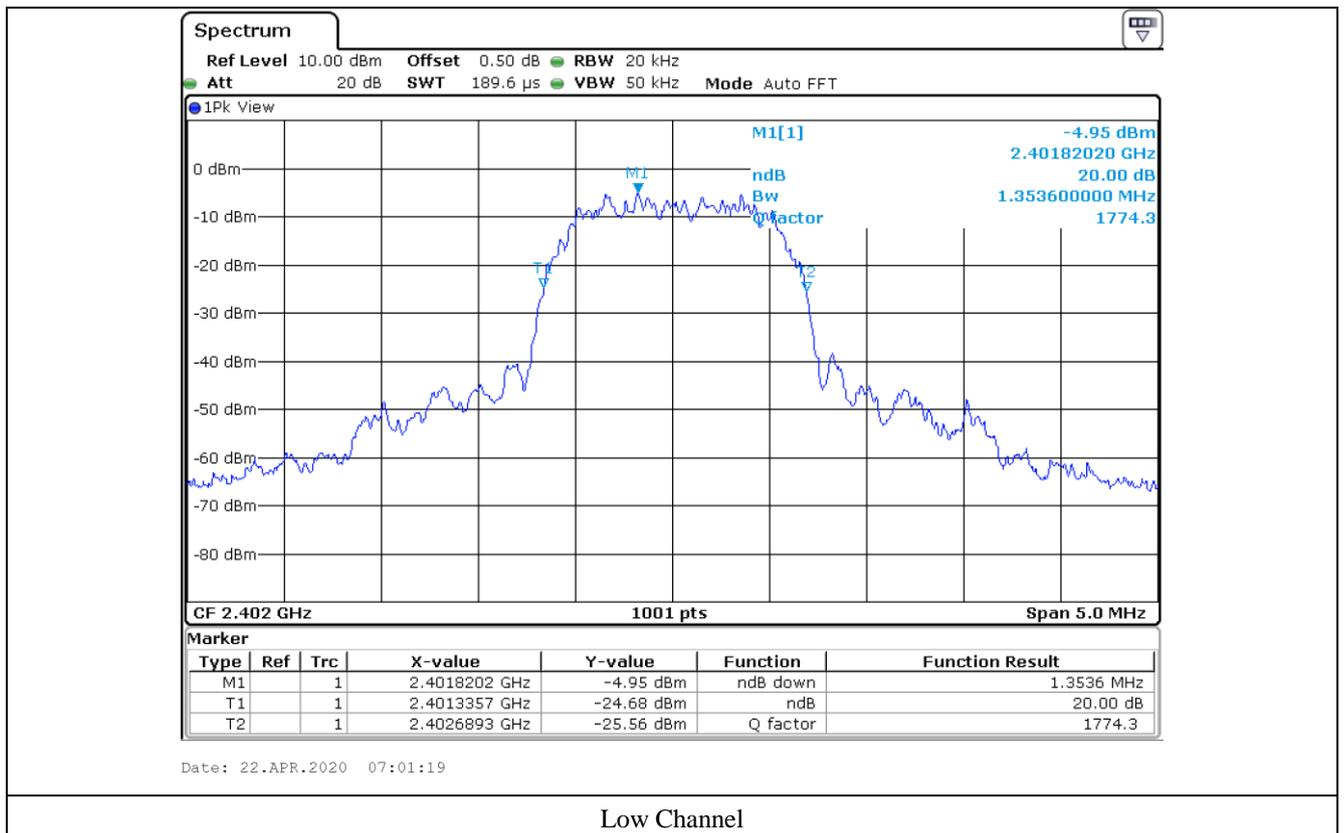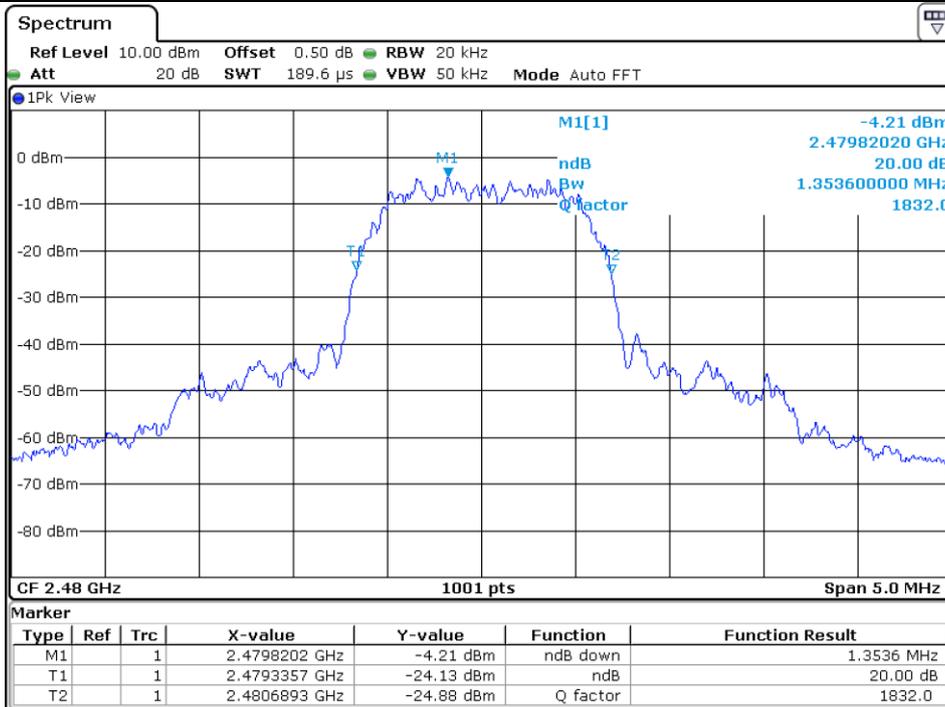**Tested by: Hyung-Kwon, Oh / Manager**



Low Channel

**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

**Spectrum**

Ref Level 10.00 dBm　Offset　0.50 dB ● RBW 20 kHz
● Att　　　20 dB　SWT　189.6 μs ● VBW 50 kHz　Mode Auto FFT
● 1Pk View

M1[1]　　　　　-4.85 dBm
　　　　　　2.44082020 GHz
　　　ndB　　　　20.00 dB
　　　Bw　1.353600000 MHz
　　　Qfactor　　　1803.1

CF 2.441 GHz　　　　1001 pts　　　　Span 5.0 MHz

Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4408202 GHz | -4.85 dBm | ndB down | 1.3536 MHz |
| T1 | | 1 | 2.4403357 GHz | -24.70 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4416893 GHz | -25.32 dBm | Q factor | 1803.1 |

Date: 22.APR.2020　07:02:06

**Middle Channel**



**Spectrum**

Ref Level 10.00 dBm　Offset　0.50 dB ● RBW 20 kHz
● Att　　　20 dB　SWT　189.6 μs ● VBW 50 kHz　Mode Auto FFT
● 1Pk View

M1[1]　　　　　-4.21 dBm
　　　　　　2.47982020 GHz
　　　ndB　　　　20.00 dB
　　　Bw　1.353600000 MHz
　　　Qfactor　　　1832.0

CF 2.48 GHz　　　　1001 pts　　　　Span 5.0 MHz

Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4798202 GHz | -4.21 dBm | ndB down | 1.3536 MHz |
| T1 | | 1 | 2.4793357 GHz | -24.13 dBm | ndB | 20.00 dB |
| T2 | | 1 | 2.4806893 GHz | -24.88 dBm | Q factor | 1832.0 |

Date: 22.APR.2020　07:02:47

**High Channel**

# 8. HOPPING FREQUENCY SEPARATION

## 8.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

## 8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 5 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.
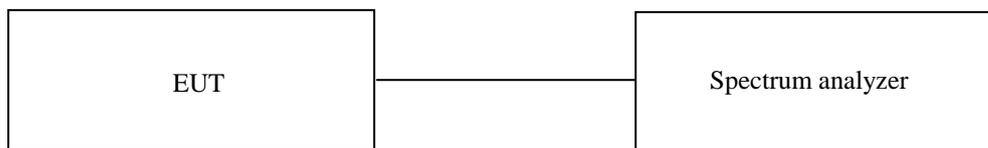


## 8.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|---|---|---|---|---|---|
| ■ - | FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Feb. 21, 2020 (1Y) |

All test equipment used is calibrated on a regular basis.

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## 8.4 Test data for 1 Mbps

### 8.4.1 Test data for Bluetooth Earbud LEFT
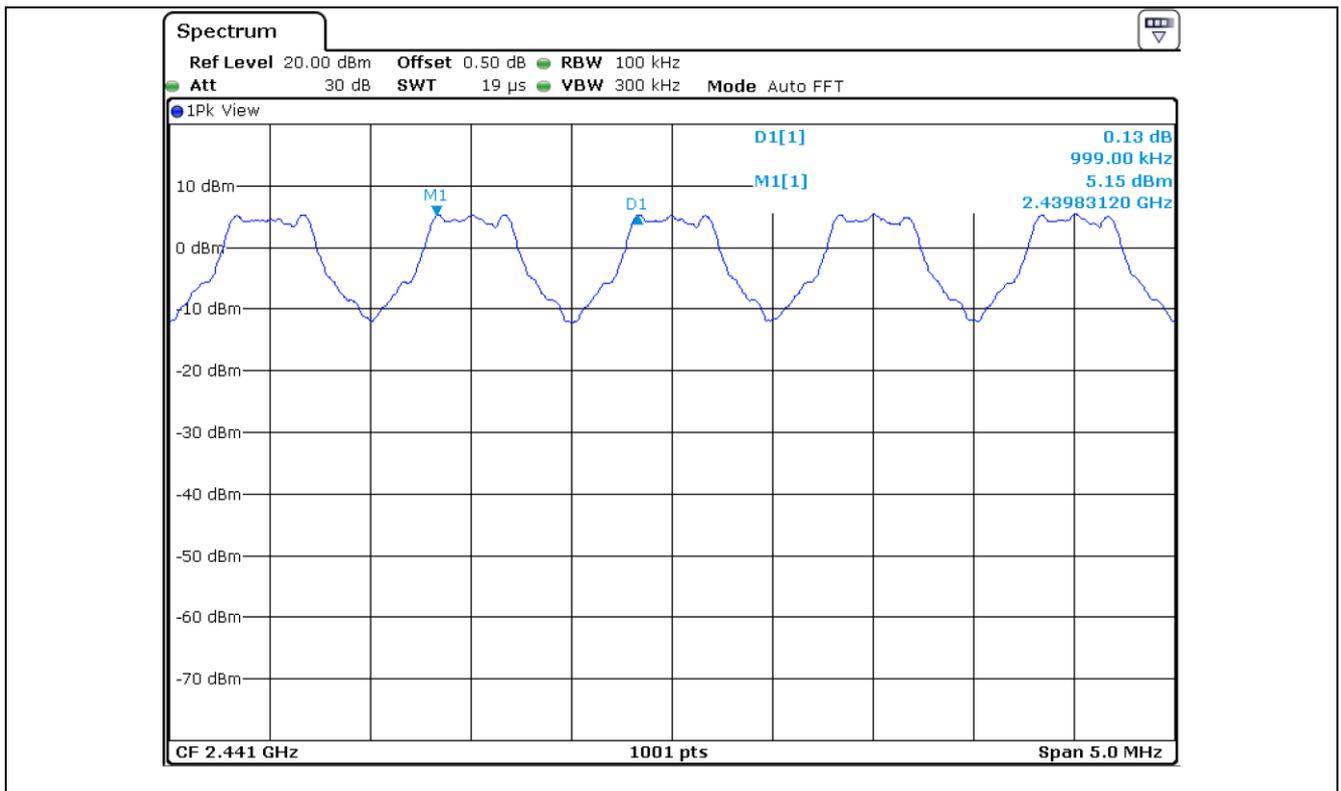
-. Test Date                : April 16, 2020 ~ April 23, 2020

-. Test Result              : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwitdth (kHz) | LIMIT |
|---|---|---|
| 999.00 | 509.47 | Separated by a minimum of 509.47 kHz |

Tested by: Hyung-Kwon, Oh / Manager

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## 8.4.2 Test data for Bluetooth Earbud RIGHT
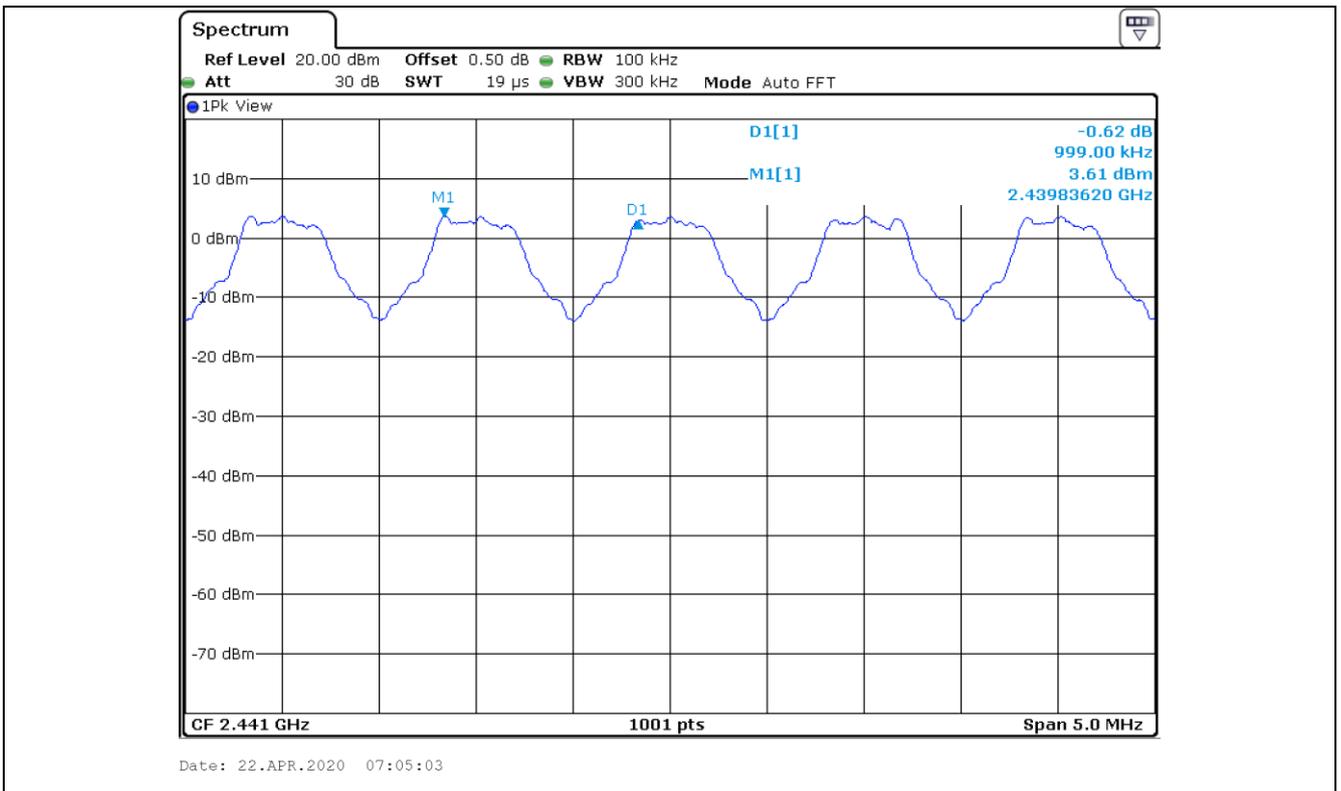
-. Test Date               : April 16, 2020 ~ April 23, 2020

-. Test Result             : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwitdth (kHz) | LIMIT |
|---|---|---|
| 999.00 | 509.47 | Separated by a minimum of 509.47 kHz |

Tested by: Hyung-Kwon, Oh / Manager

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## 8.5 Test data for 2 Mbps

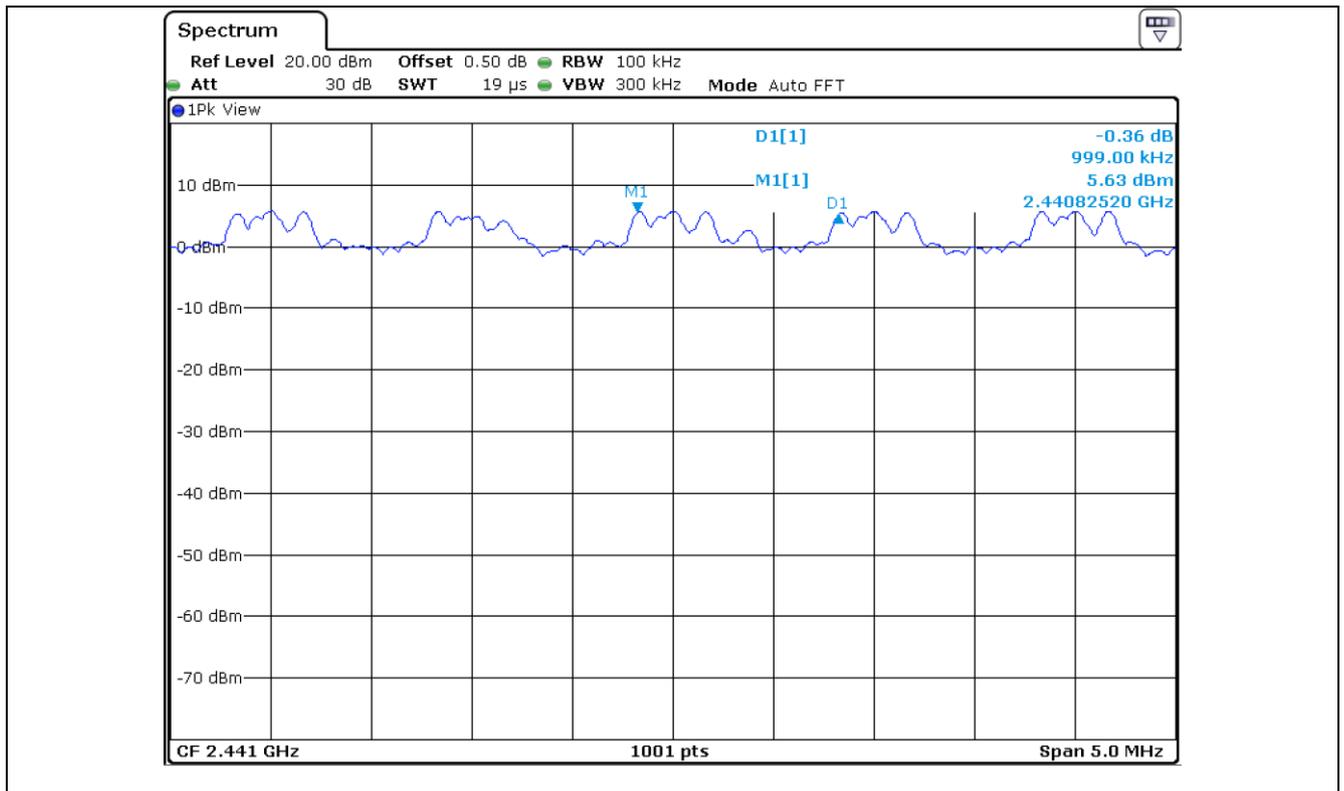### 8.5.1 Test data for Bluetooth Earbud LEFT

-. Test Date          : April 16, 2020 ~ April 23, 2020

-. Test Result        : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwitdth (kHz) | LIMIT |
|---|---|---|
| 999.00 | 899.13 | Separated by a minimum of 899.13 kHz |

**Tested by: Hyung-Kwon, Oh / Manager**

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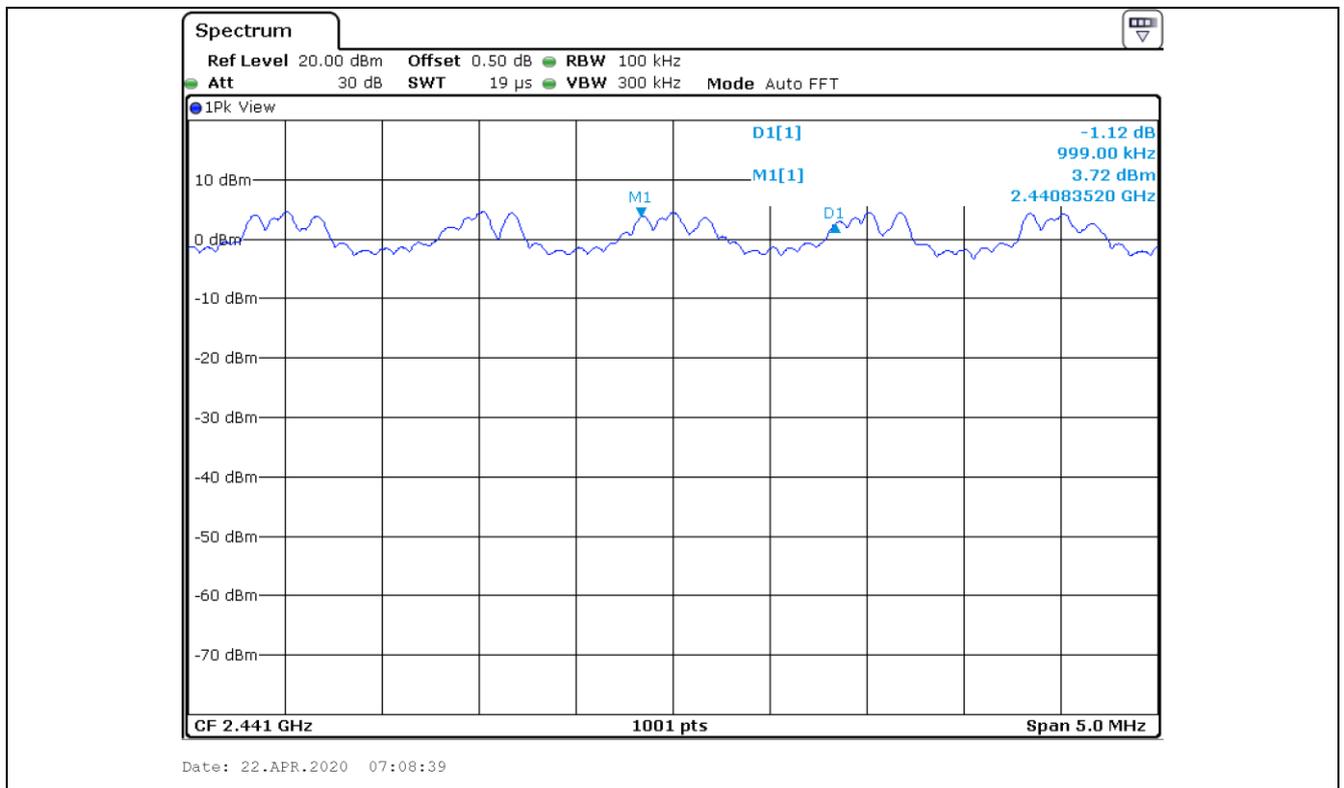
## 8.5.2 Test data for Bluetooth Earbud RIGHT

-. Test Date                    : April 16, 2020 ~ April 23, 2020

-. Test Result                  : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwitdth (kHz) | LIMIT |
|---|---|---|
| 999.00 | 902.40 | Separated by a minimum of 902.4 kHz |

**Tested by: Hyung-Kwon, Oh / Manager**



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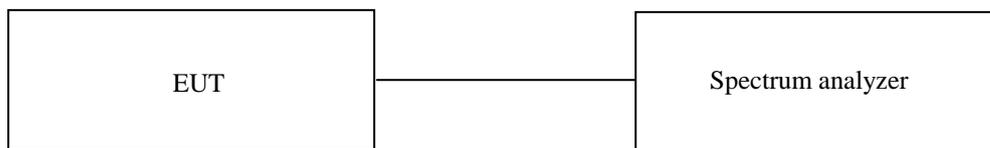
# 9. NUMBER OF HOPPING CHANNELS

## 9.1 Operating environment

Temperature            :     23 °C

Relative humidity      :     45 % R.H.

## 9.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 MHz and the resolution bandwidth is set to 100 kHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.

```
┌──────────────────┐          ┌──────────────────┐
│                  │          │                  │
│       EUT        │──────────│ Spectrum analyzer │
│                  │          │                  │
└──────────────────┘          └──────────────────┘
```

## 9.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|---|---|---|---|---|
| ■ -  FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Feb. 21, 2020 (1Y) |

All test equipment used is calibrated on a regular basis.

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**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

## 9.4 Test data for 1 Mbps

### 9.4.1 Test data for Bluetooth Earbud LEFT
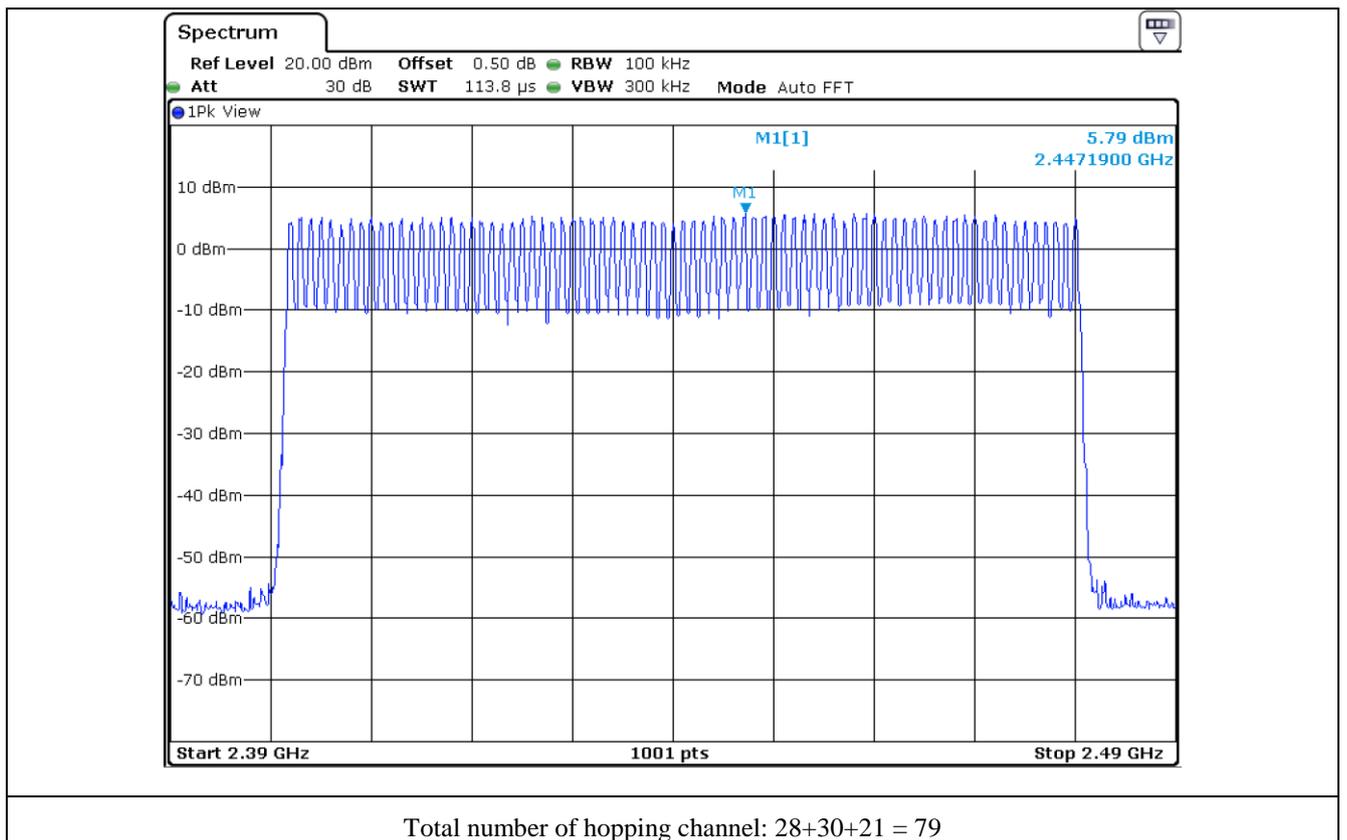
-. Test Date                    : April 16, 2020 ~ April 23, 2020
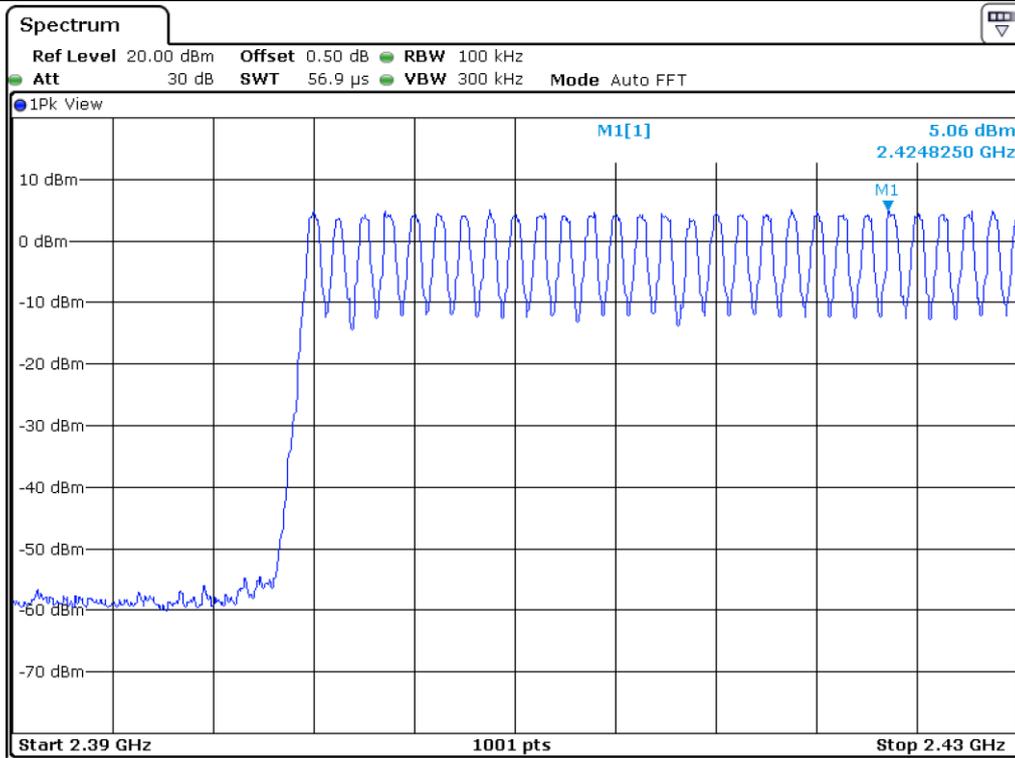
-. Test Result                  : Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|---|---|---|---|
| 1 Mbps | 79 | Minimum of 15 | 64 |

Tested by: Hyung-Kwon, Oh / Manager



Total number of hopping channel: 28+30+21 = 79

Number of hopping channel: 28



Number of hopping channel: 30

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Number of hopping channel: 21

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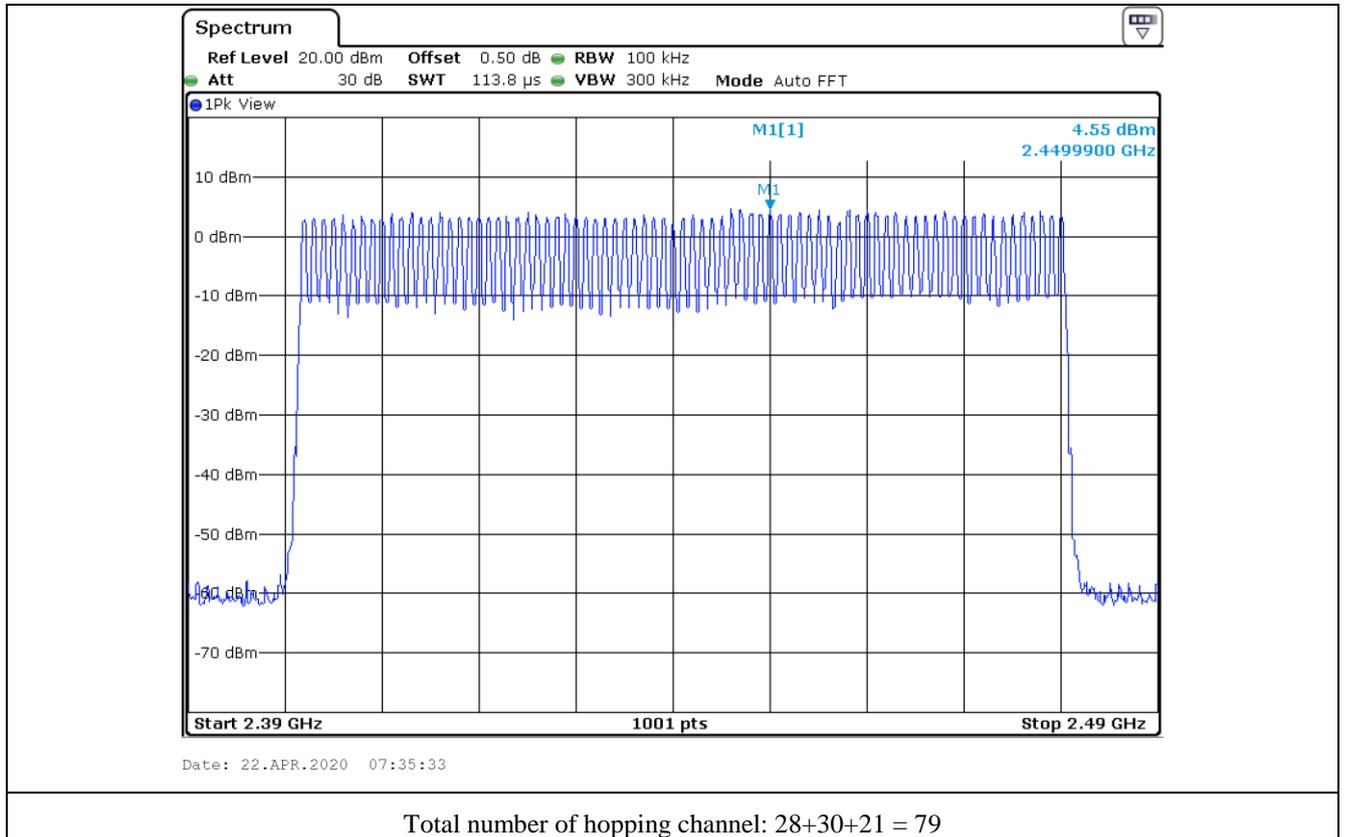
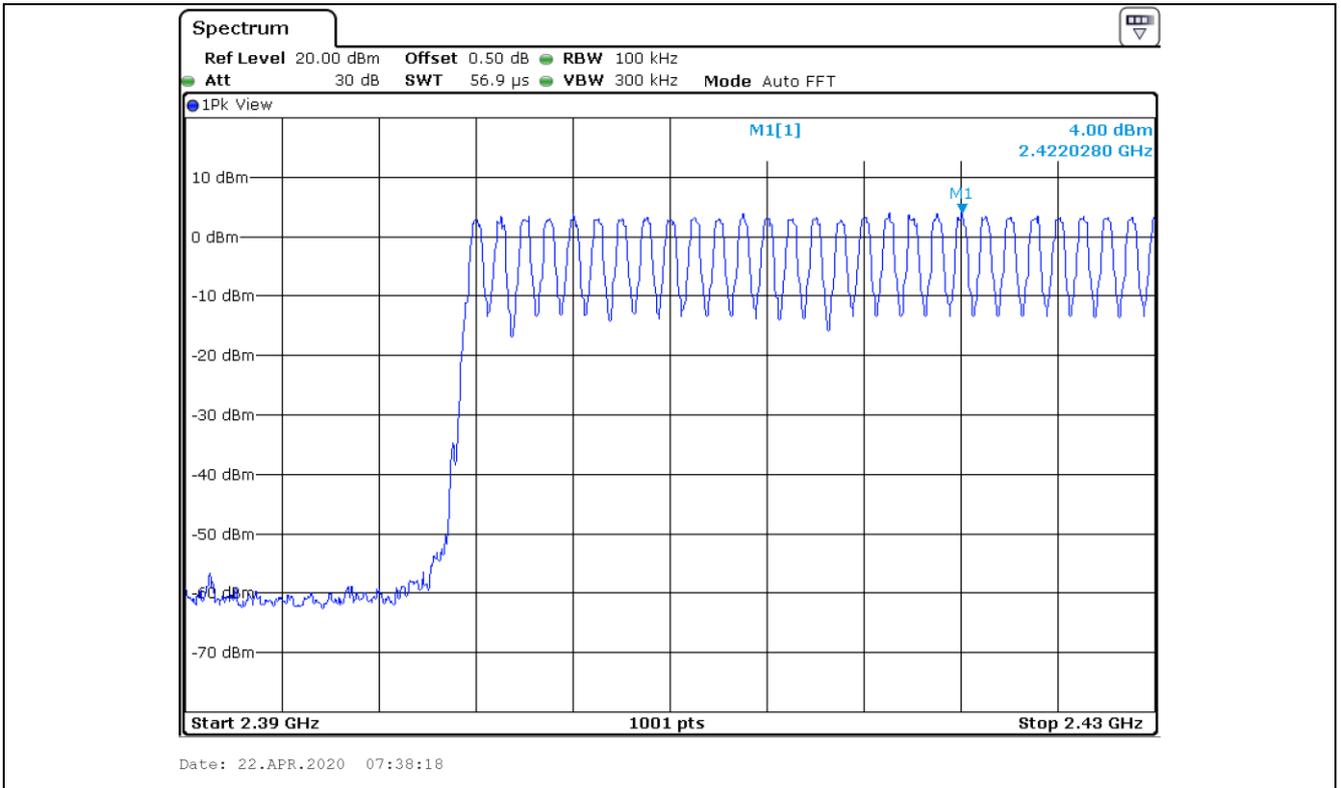## 9.4.2 Test data for Bluetooth Earbud RIGHT

-. Test Date　　　　　: April 16, 2020 ~ April 23, 2020

-. Test Result　　　　: Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|---|---|---|---|
| 1 Mbps | 79 | Minimum of 15 | 64 |

**Tested by: Hyung-Kwon, Oh / Manager**



Total number of hopping channel: 28+30+21 = 79

Number of hopping channel: 28



Number of hopping channel: 30

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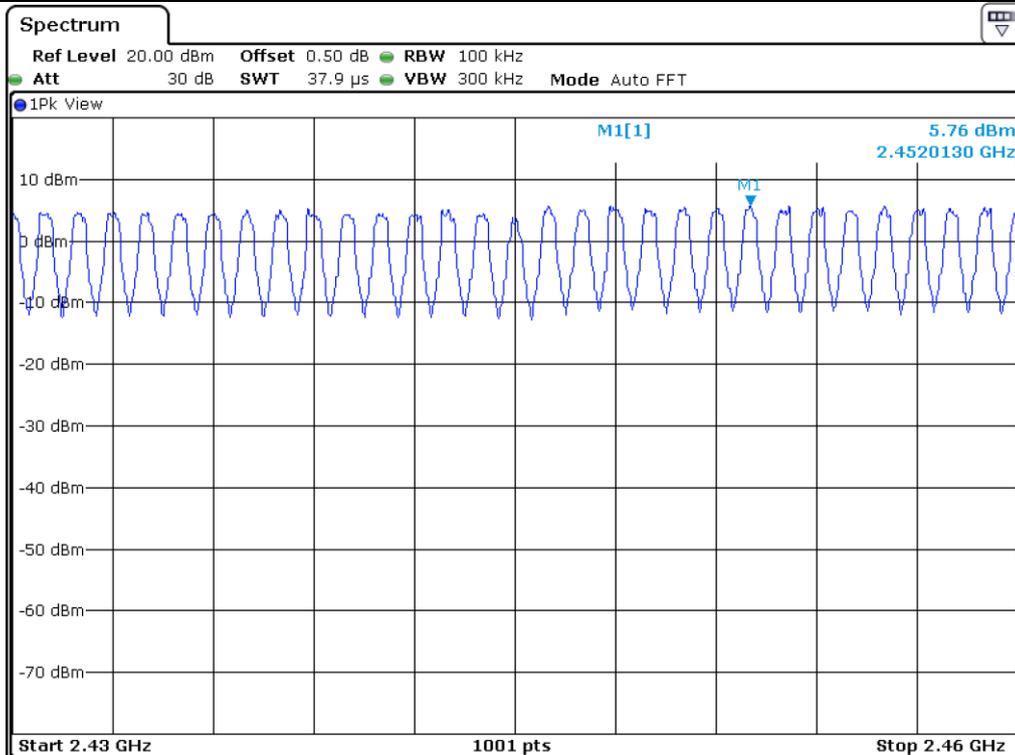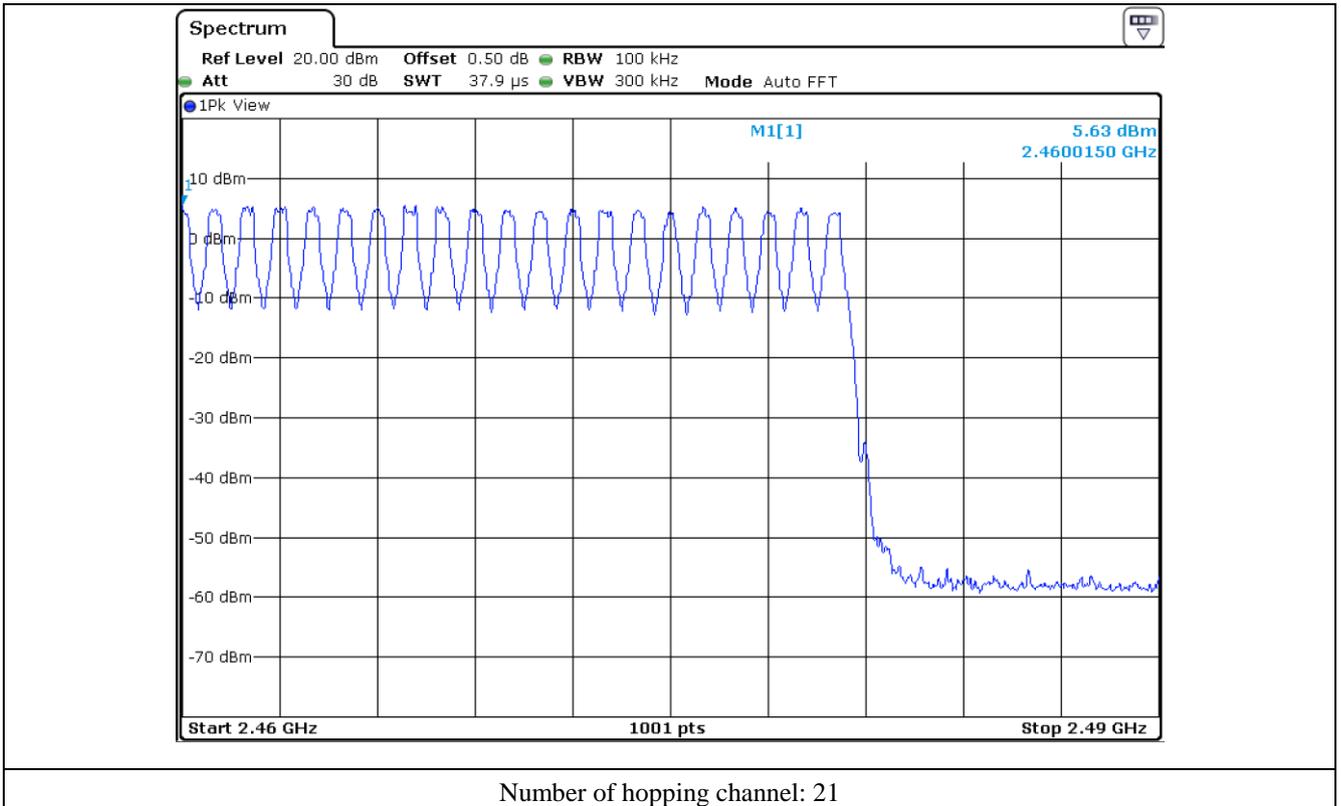
Number of hopping channel: 21

## 9.5 Test data for 2 Mbps

### 9.5.1 Test data for Bluetooth Earbud LEFT

-. Test Date                    : April 16, 2020 ~ April 23, 2020

-. Test Result                  : Pass

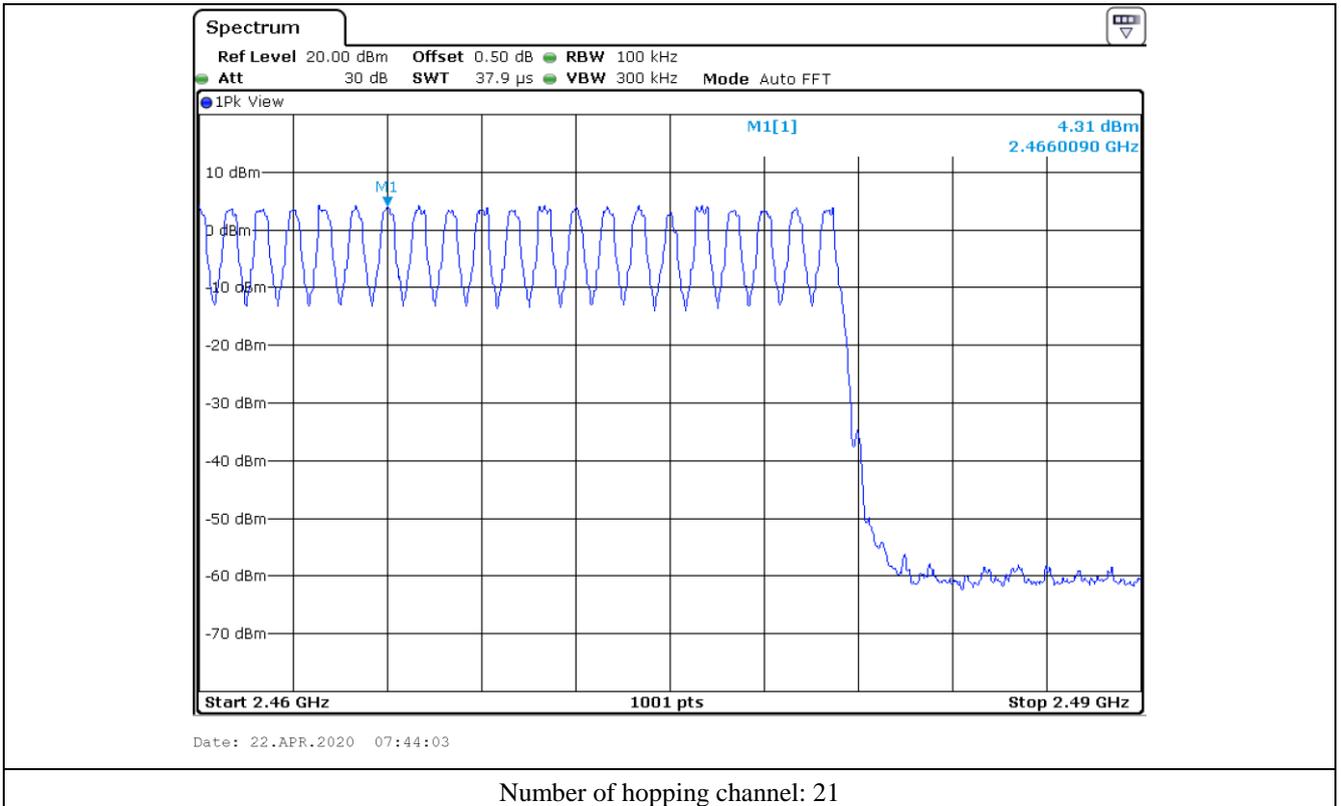| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|---|---|---|---|
| 2 Mbps | 79 | Minimum of 15 | 64 |

Tested by: Hyung-Kwon, Oh / Manager



Total number of hopping channel: 28+30+21 = 79

Number of hopping channel: 28



Number of hopping channel: 30

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Number of hopping channel: 21

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**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
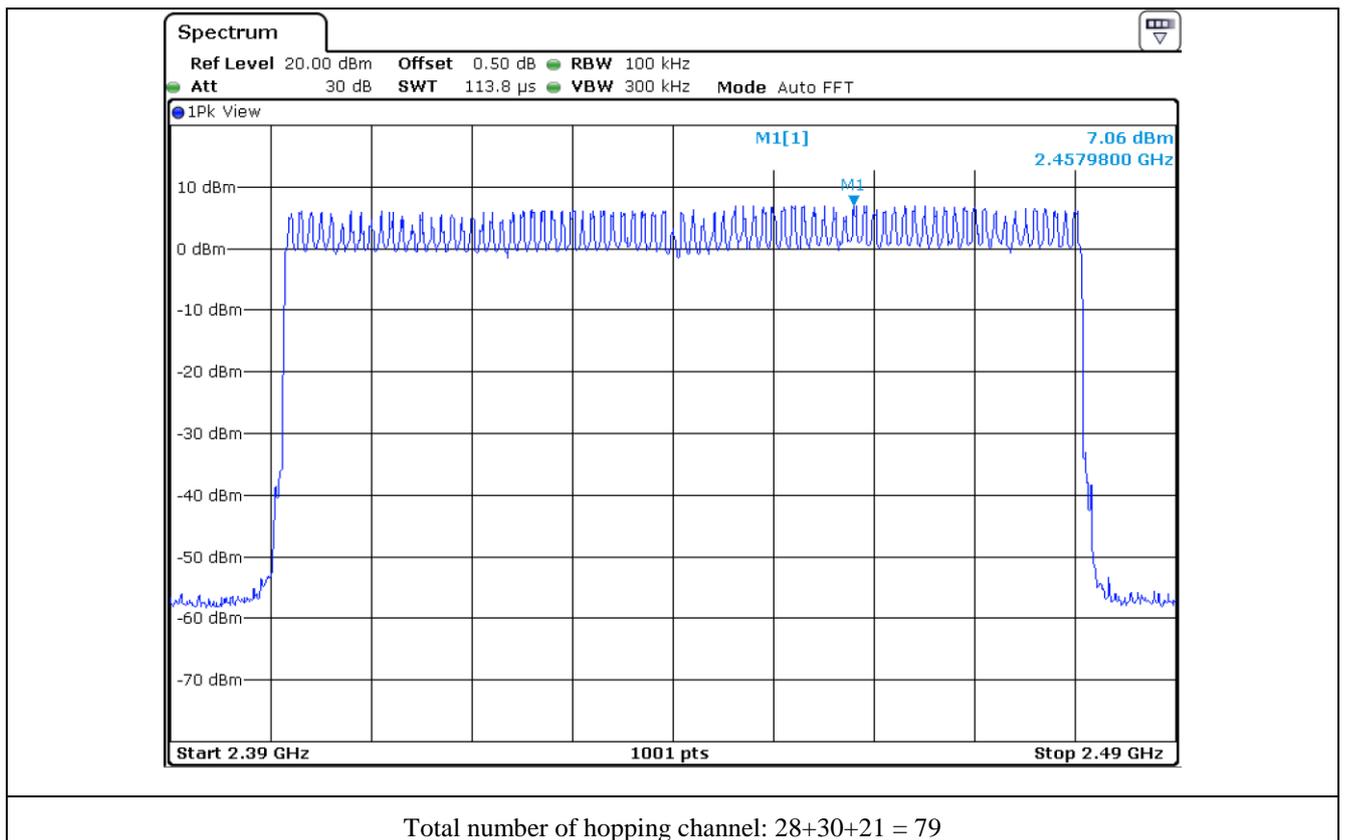
## 9.5.2 Test data for Bluetooth Earbud RIGHT

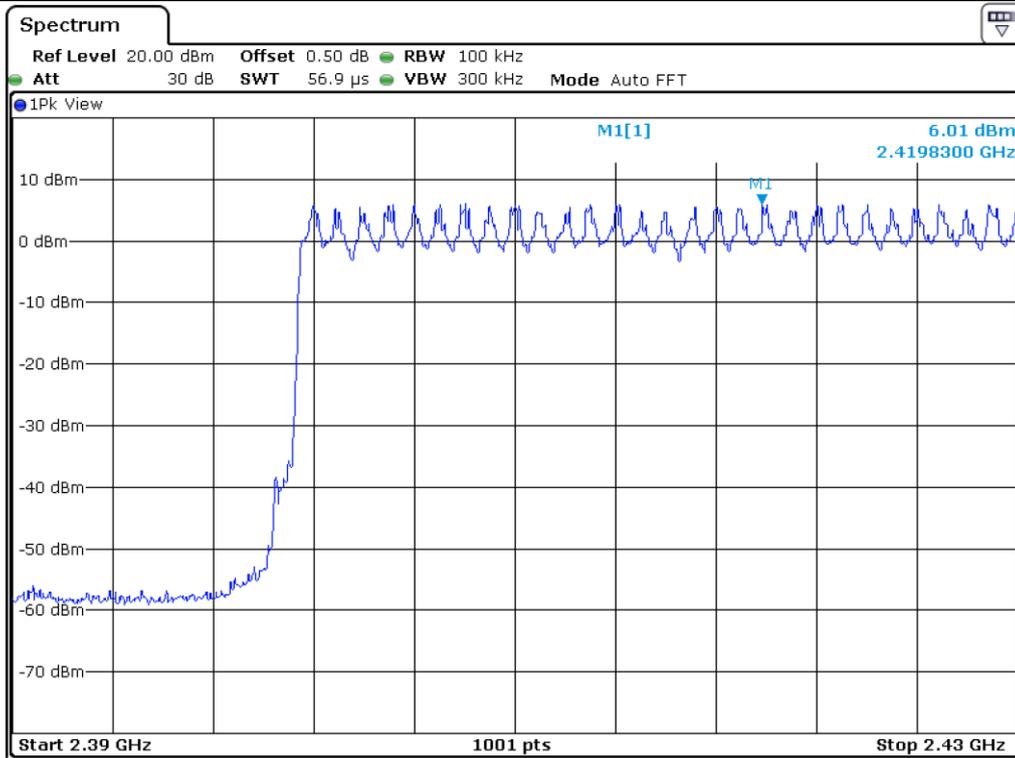-. Test Date                : April 16, 2020 ~ April 23, 2020

-. Test Result             : Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|---|---|---|---|
| 2 Mbps | 79 | Minimum of 15 | 64 |

**Tested by: Hyung-Kwon, Oh / Manager**



Total number of hopping channel: 28+30+21 = 79

Number of hopping channel: 28



Number of hopping channel: 30

Spectrum

Ref Level 20.00 dBm    Offset 0.50 dB    RBW 100 kHz
Att          30 dB    SWT    37.9 µs    VBW 300 kHz    Mode Auto FFT

1Pk View

M1[1]                    5.21 dBm
                         2.4610040 GHz

Start 2.46 GHz          1001 pts          Stop 2.49 GHz
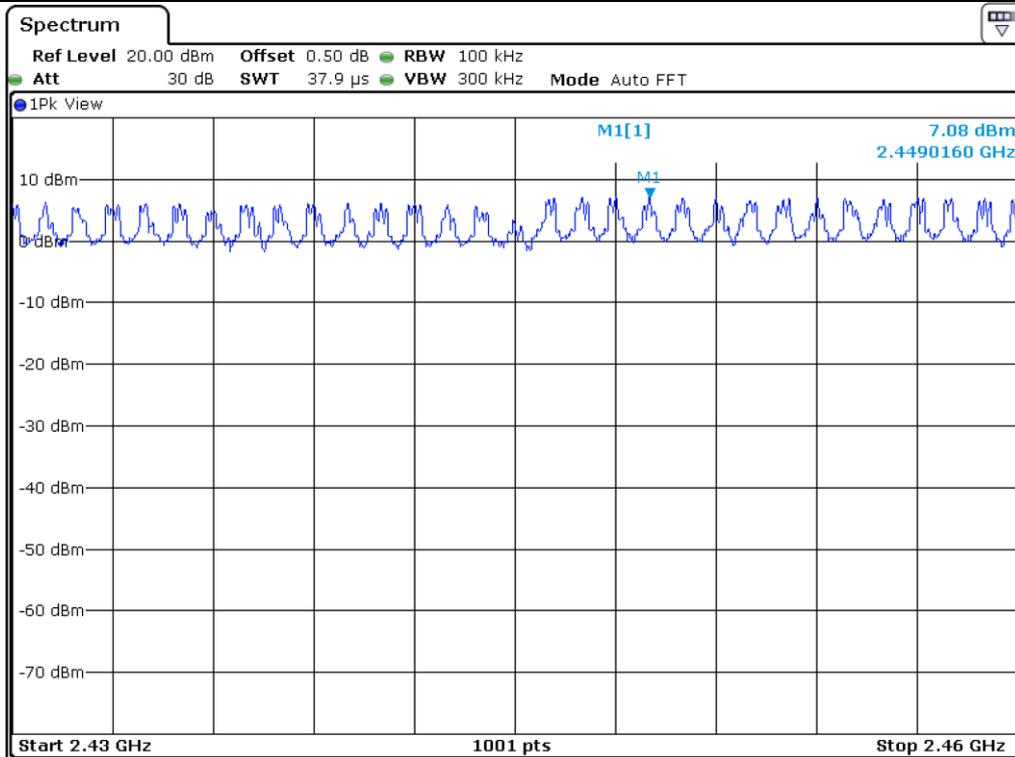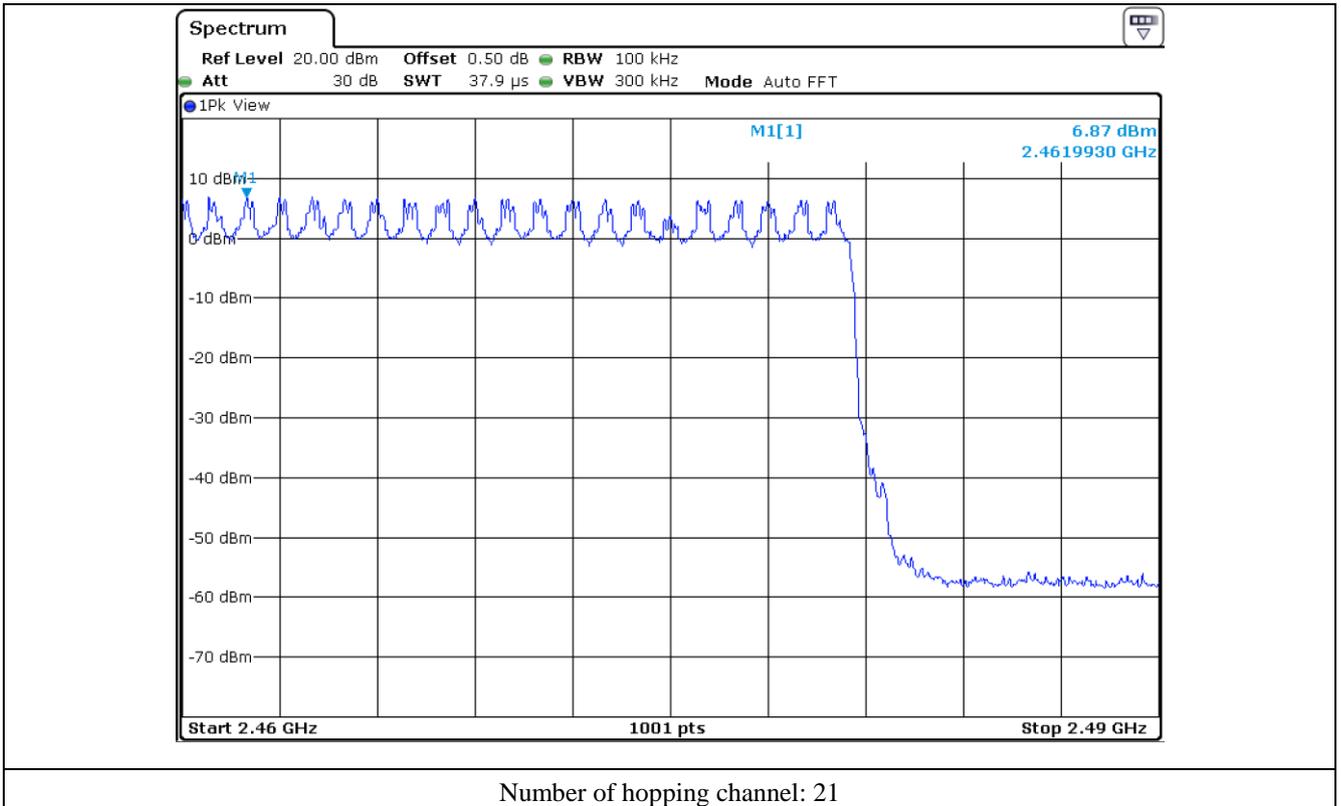
Date: 22.APR.2020  08:18:58

Number of hopping channel: 21

## 10. TIME OF OCCUPANCY

### 10.1 Operating environment

Temperature　　　　　　　:　23 ℃

Relative humidity　　　　　:　45 % R.H.

### 10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.

```
┌─────────────────┐                    ┌─────────────────┐
│                 │                    │                 │
│      EUT        │────────────────────│ Spectrum analyzer│
│                 │                    │                 │
└─────────────────┘                    └─────────────────┘
```

### 10.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|---|---|---|---|---|---|
| ■ - | FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Feb. 21, 2020 (1Y) |

All test equipment used is calibrated on a regular basis.

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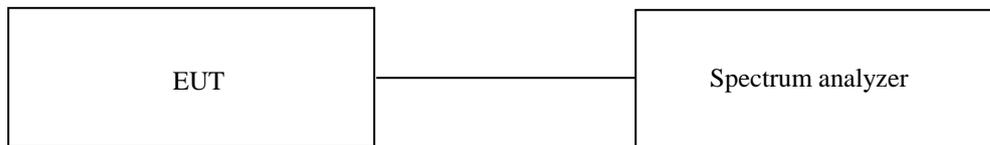
## 10.4 Test data for 1 Mbps

### 10.4.1 Test data for Bluetooth Earbud LEFT

-. Test Date                 : April 16, 2020 ~ April 23, 2020

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (ms) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|---|---|---|---|---|---|---|
| DH1 | 0.380 | 10.13 | 31.60 | 121.64 | 400 | |
| DH3 | 1.620 | 5.06 | 31.60 | 259.03 | 400 | PASS |
| DH5 | 2.900 | 3.38 | 31.60 | 309.74 | 400 | |

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

**Tested by: Hyung-Kwon, Oh / Manager**

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**Spectrum**

Ref Level 20.00 dBm    Offset 0.50 dB ● RBW 1 MHz
● Att        30 dB ● SWT    5 ms ● VBW 3 MHz
TRG:VID

● 1Pk View

|  | D2[1] | -0.73 dB |
| | | 1.28000 ms |
| 10 dBm | M1[1] | 5.28 dBm |
| | | 1.28000 ms |

TRG -17.000 dBm

CF 2.441 GHz                1001 pts              500.0 µs/

**Marker**

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 1.28 ms | 5.28 dBm | | |
| D1 | M1 | 1 | 380.0 µs | 0.01 dB | | |
| D2 | M1 | 1 | 1.28 ms | -0.73 dB | | |

DH1

**Spectrum**

Ref Level 20.00 dBm    Offset 0.50 dB ● RBW 1 MHz
● Att        30 dB ● SWT    20 ms ● VBW 3 MHz
TRG:VID

● 1Pk View

|  | D2[1] | 0.00 dB |
| | | 2.5400 ms |
| 10 dBm | M1[1] | 5.21 dBm |
| | | 5.0800 ms |

TRG -16.000 dBm

CF 2.441 GHz                1001 pts              2.0 ms/

**Marker**

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 5.08 ms | 5.21 dBm | | |
| D1 | M1 | 1 | 1.62 ms | -0.03 dB | | |
| D2 | M1 | 1 | 2.54 ms | -0.00 dB | | |

DH3

**Spectrum**

Ref Level 20.00 dBm   Offset 0.50 dB ● RBW 1 MHz
● Att        30 dB ● SWT   20 ms ● VBW 3 MHz
TRG: VID

● 1Pk View

D2[1]                    0.03 dB
                          3.8000 ms
10 dBm          M1          D1  D2 M1[1]    5.28 dBm
0 dBm                                      7.5600 ms
-10 dBm
TRG -16.000 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm

CF 2.441 GHz              1001 pts              2.0 ms/

**Marker**

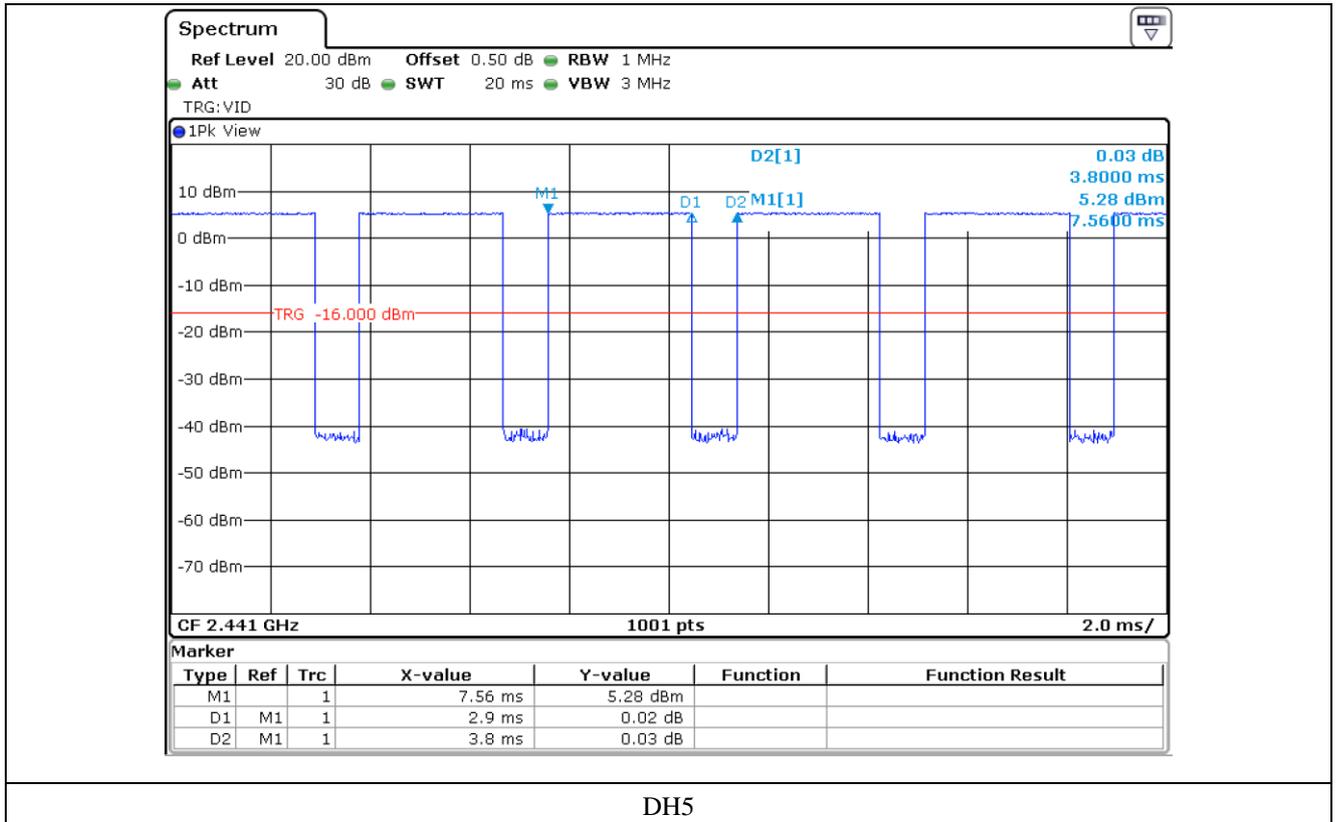| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 7.56 ms | 5.28 dBm | | |
| D1 | M1 | 1 | 2.9 ms | 0.02 dB | | |
| D2 | M1 | 1 | 3.8 ms | 0.03 dB | | |

DH5

## 10.4.2 Test data for Bluetooth Earbud RIGHT

-. Test Date          : April 16, 2020 ~ April 23, 2020

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

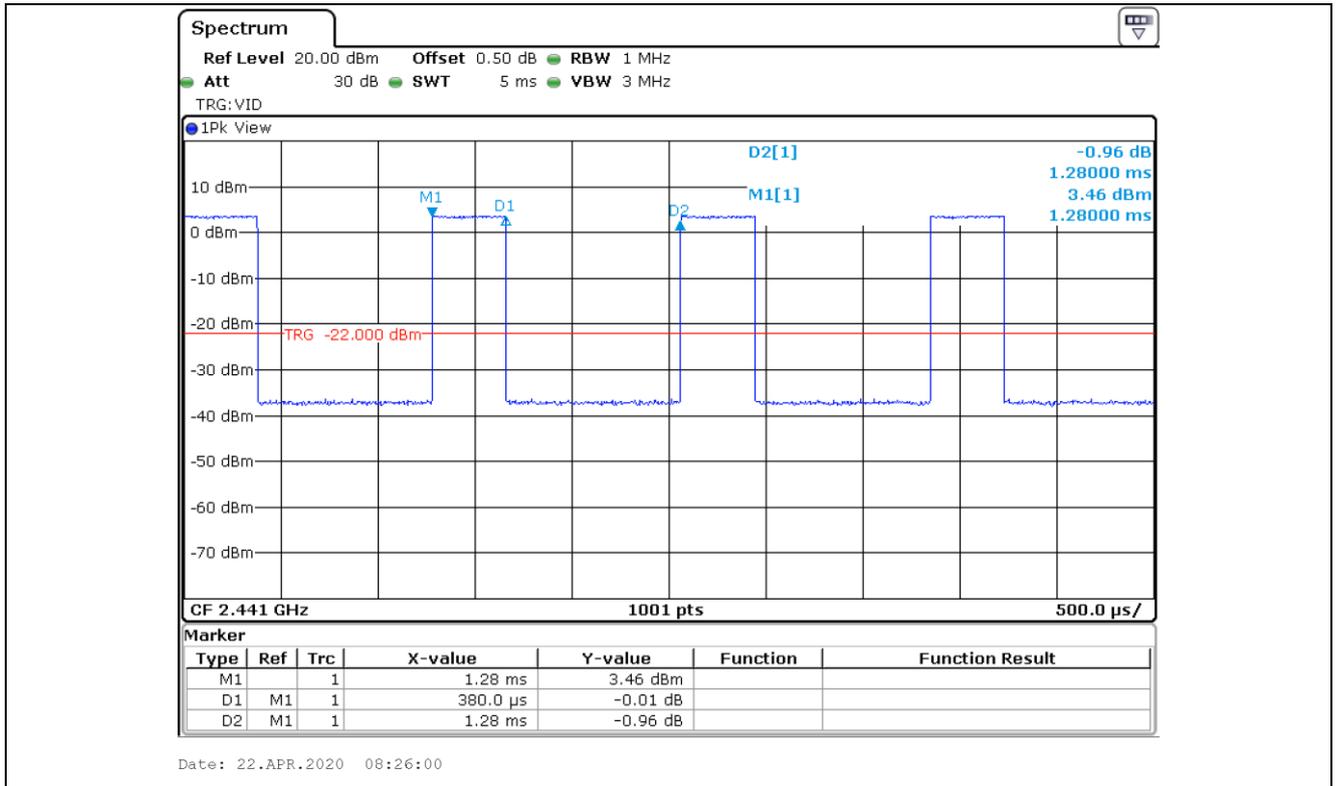| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (ms) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|---|---|---|---|---|---|---|
| DH1 | 0.380 | 10.13 | 31.60 | 121.64 | 400 | |
| DH3 | 1.620 | 5.06 | 31.60 | 259.03 | 400 | PASS |
| DH5 | 2.880 | 3.38 | 31.60 | 307.61 | 400 | |

Total dwell time is calculated as following.

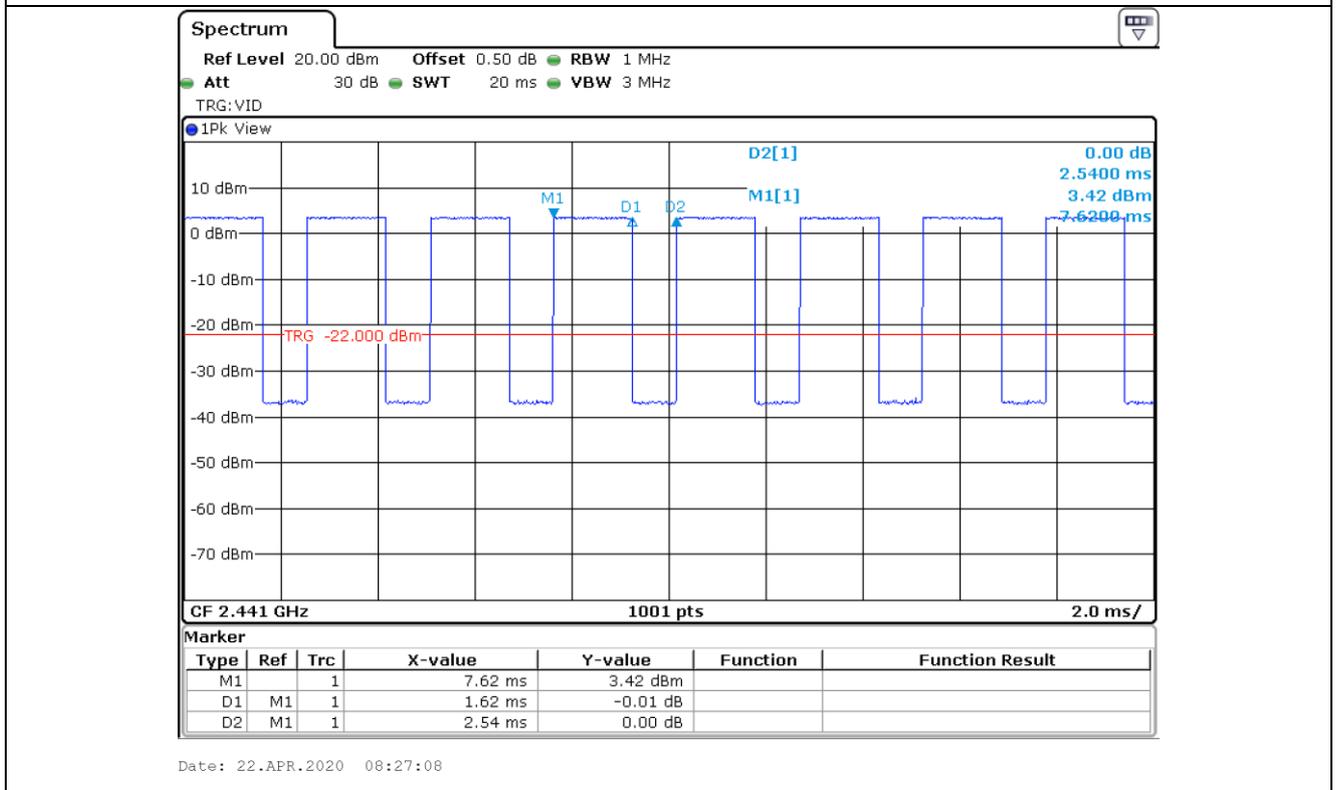Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

**Tested by: Hyung-Kwon, Oh / Manager**

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DH1



DH3

DH5

## 10.5 Test data for 2 Mbps

### 10.5.1 Test data for Bluetooth Earbud LEFT

-. Test Date                    : April 16, 2020 ~ April 23, 2020

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

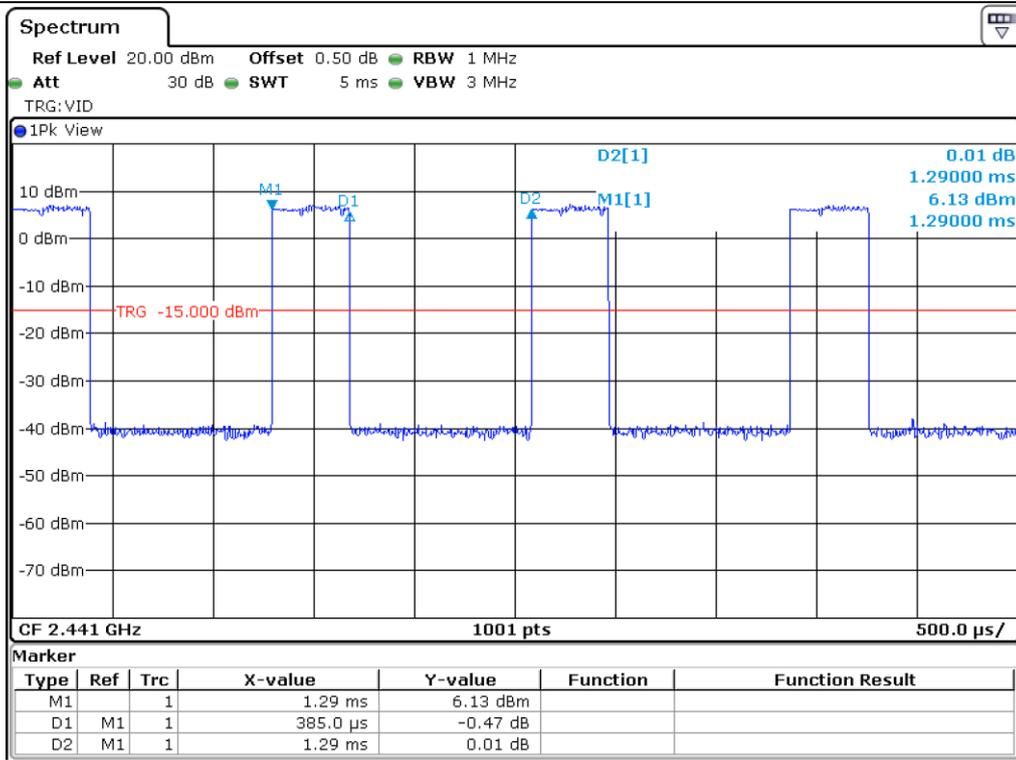| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (ms) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|---|---|---|---|---|---|---|
| DH1 | 0.385 | 10.13 | 31.60 | 123.24 | 400 | |
| DH3 | 1.640 | 5.06 | 31.60 | 262.23 | 400 | PASS |
| DH5 | 2.880 | 3.38 | 31.60 | 307.61 | 400 | |

Total dwell time is calculated as following.

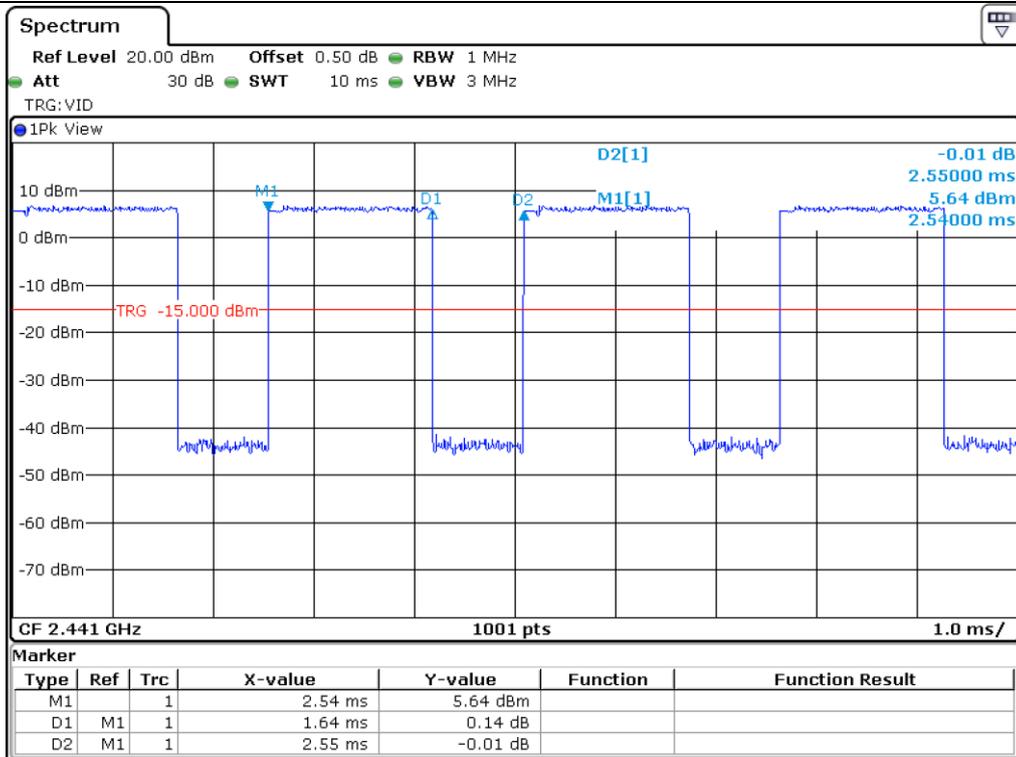Total Dwell Time = Pulse time * Hops per second with channels * period time

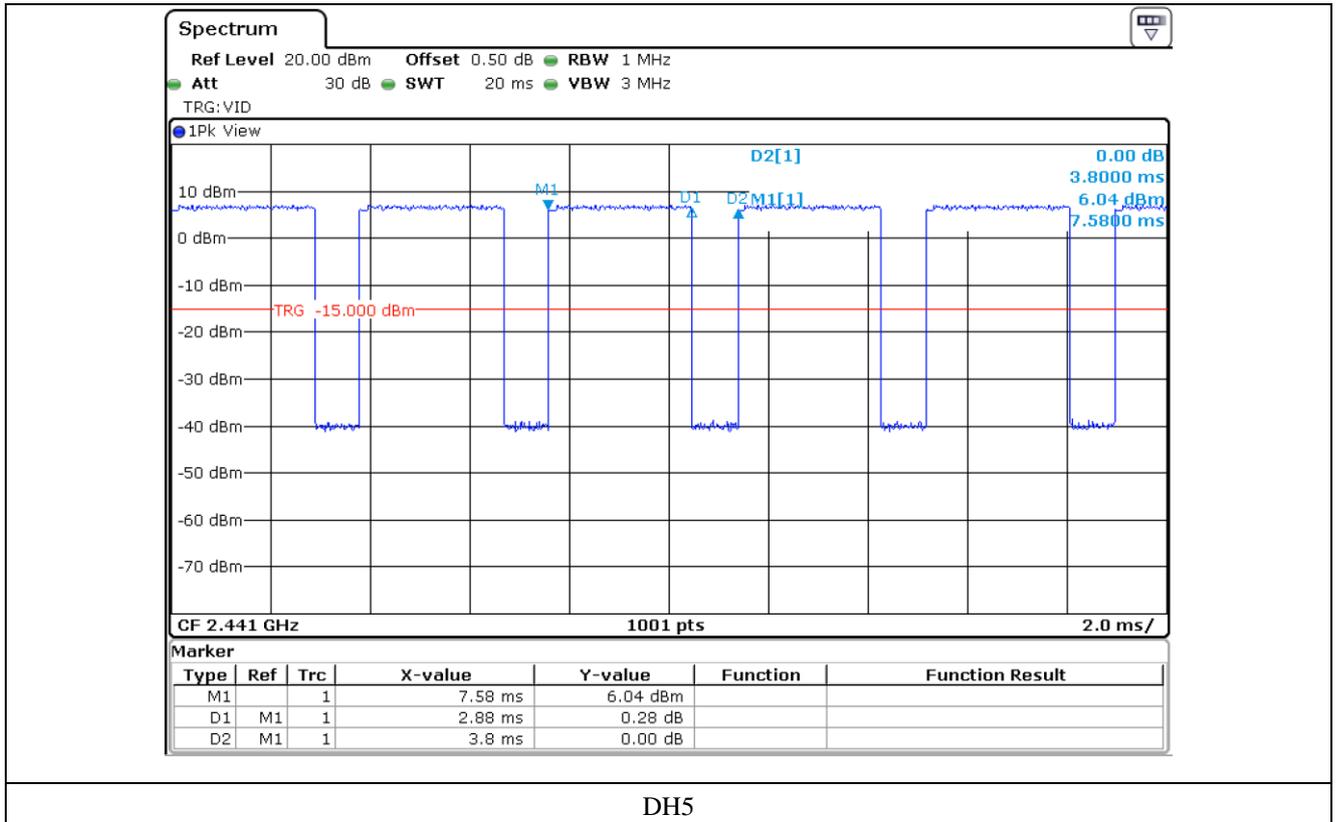Remark: See next page for an overview sweep performed with peak detector.

**Tested by: Hyung-Kwon, Oh / Manager**

DH1



DH3

Spectrum

Ref Level 20.00 dBm    Offset 0.50 dB ● RBW 1 MHz
● Att          30 dB ● SWT    20 ms ● VBW 3 MHz
TRG:VID
● 1Pk View

D2[1]                    0.00 dB
                         3.8000 ms
                         6.04 dBm
                         7.5800 ms

10 dBm
M1
0 dBm
D1  D2 M1[1]
-10 dBm
TRG  -15.000 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm

CF 2.441 GHz                    1001 pts                    2.0 ms/

Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1   |     | 1   | 7.58 ms | 6.04 dBm |          |                 |
| D1   | M1  | 1   | 2.88 ms | 0.28 dB  |          |                 |
| D2   | M1  | 1   | 3.8 ms  | 0.00 dB  |          |                 |

DH5

**10.5.2 Test data for Bluetooth Earbud RIGHT**

-. Test Date                 : April 16, 2020 ~ April 23, 2020

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

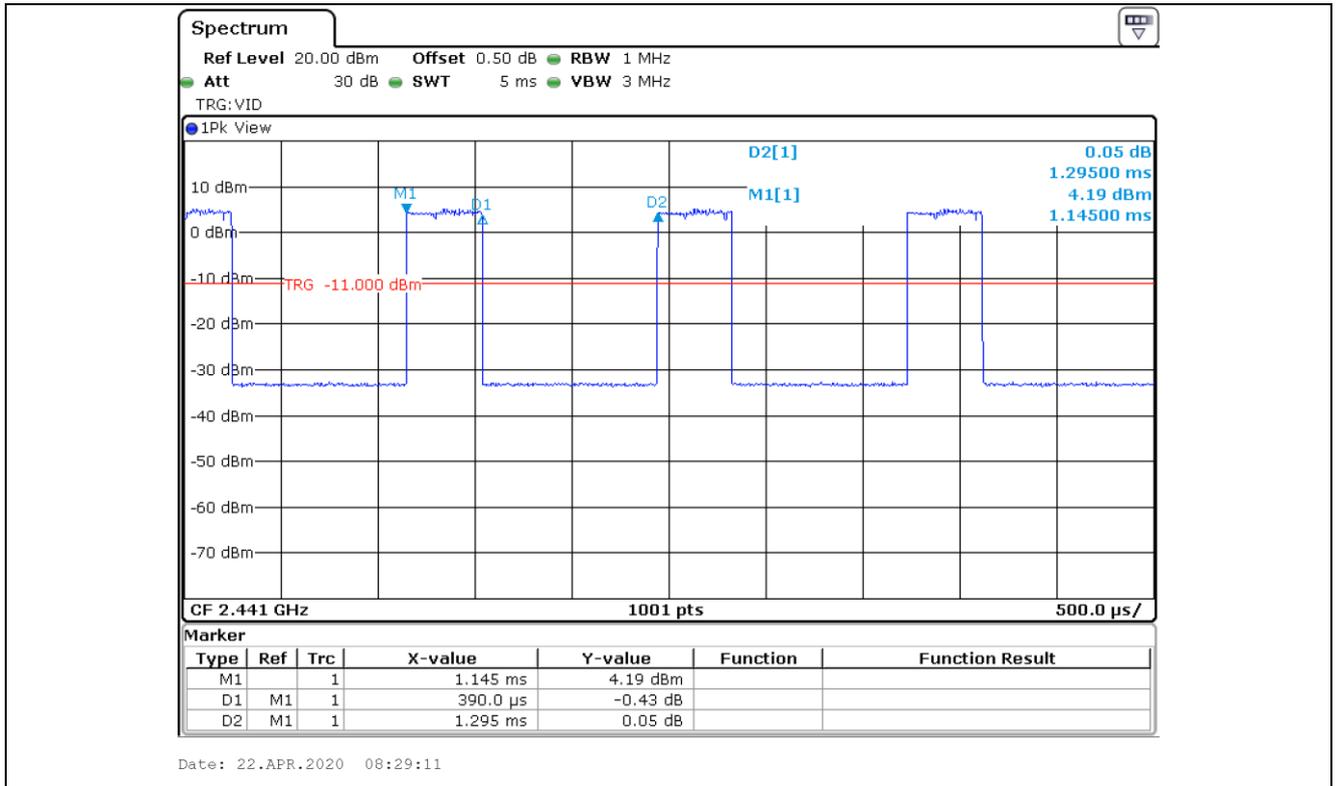| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (ms) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|---|---|---|---|---|---|---|
| DH1 | 0.390 | 10.13 | 31.60 | 124.84 | 400 | |
| DH3 | 1.640 | 5.06 | 31.60 | 262.23 | 400 | PASS |
| DH5 | 2.900 | 3.38 | 31.60 | 309.74 | 400 | |

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

**Tested by: Hyung-Kwon, Oh / Manager**

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## Spectrum

Ref Level 20.00 dBm    Offset 0.50 dB ● RBW 1 MHz
● Att          30 dB ● SWT    5 ms ● VBW 3 MHz
TRG:VID
● 1Pk View

| D2[1] | 0.05 dB |
| | 1.29500 ms |
| M1[1] | 4.19 dBm |
| | 1.14500 ms |

TRG -11.000 dBm

CF 2.441 GHz          1001 pts          500.0 µs/

### Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 1.145 ms | 4.19 dBm | | |
| D1 | M1 | 1 | 390.0 µs | −0.43 dB | | |
| D2 | M1 | 1 | 1.295 ms | 0.05 dB | | |

Date: 22.APR.2020  08:29:11

**DH1**

## Spectrum

Ref Level 20.00 dBm    Offset 0.50 dB ● RBW 1 MHz
● Att          30 dB ● SWT   10 ms ● VBW 3 MHz
TRG:VID
● 1Pk View

| D2[1] | −0.03 dB |
| | 2.54000 ms |
| M1[1] | 4.26 dBm |
| | 2.40000 ms |

TRG -11.000 dBm

CF 2.441 GHz          1001 pts          1.0 ms/

### Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|------|-----|-----|---------|---------|----------|-----------------|
| M1 | | 1 | 2.4 ms | 4.26 dBm | | |
| D1 | M1 | 1 | 1.64 ms | −0.01 dB | | |
| D2 | M1 | 1 | 2.54 ms | −0.03 dB | | |

Date: 22.APR.2020  08:30:21

**DH3**

DH5

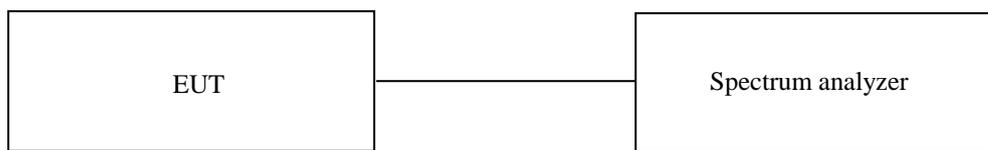## 11. MAXIMUM PEAK OUTPUT POWER

### 11.1 Operating environment

Temperature　　　　　　　：　23 °C

Relative humidity　　　　　：　45 % R.H.

### 11.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to ≥ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



### 11.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|---|---|---|---|---|---|
| ■ - | FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Feb. 21, 2020 (1Y) |

All test equipment used is calibrated on a regular basis.

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**11.4 Test data for 1 Mbps**

**11.4.1 Test data for Bluetooth Earbud LEFT**
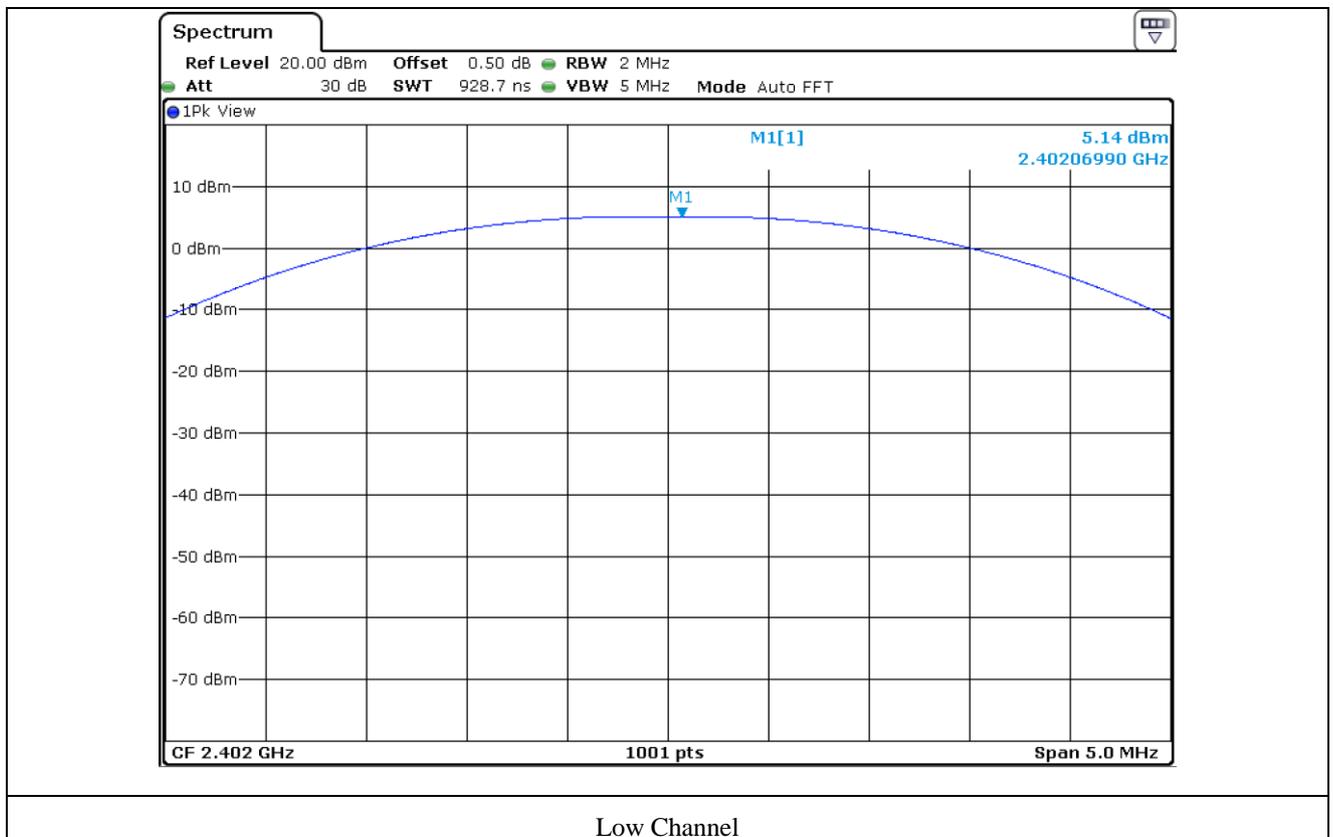
-. Test Date                 : April 16, 2020 ~ April 23, 2020
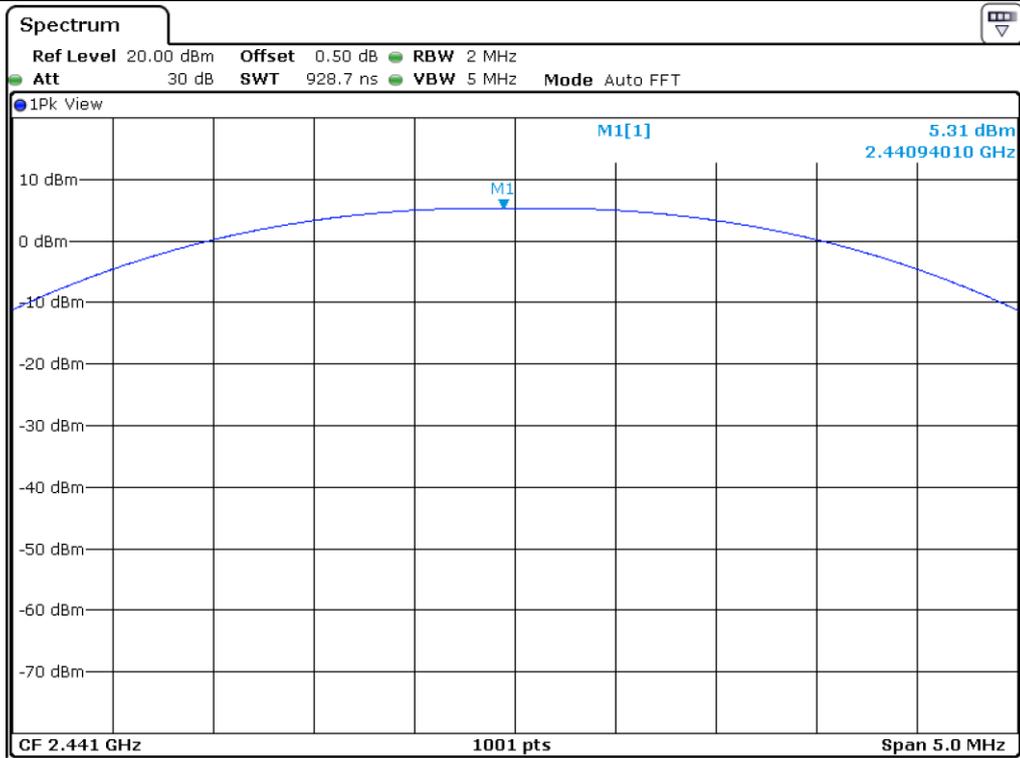
-. Test Result               : Pass

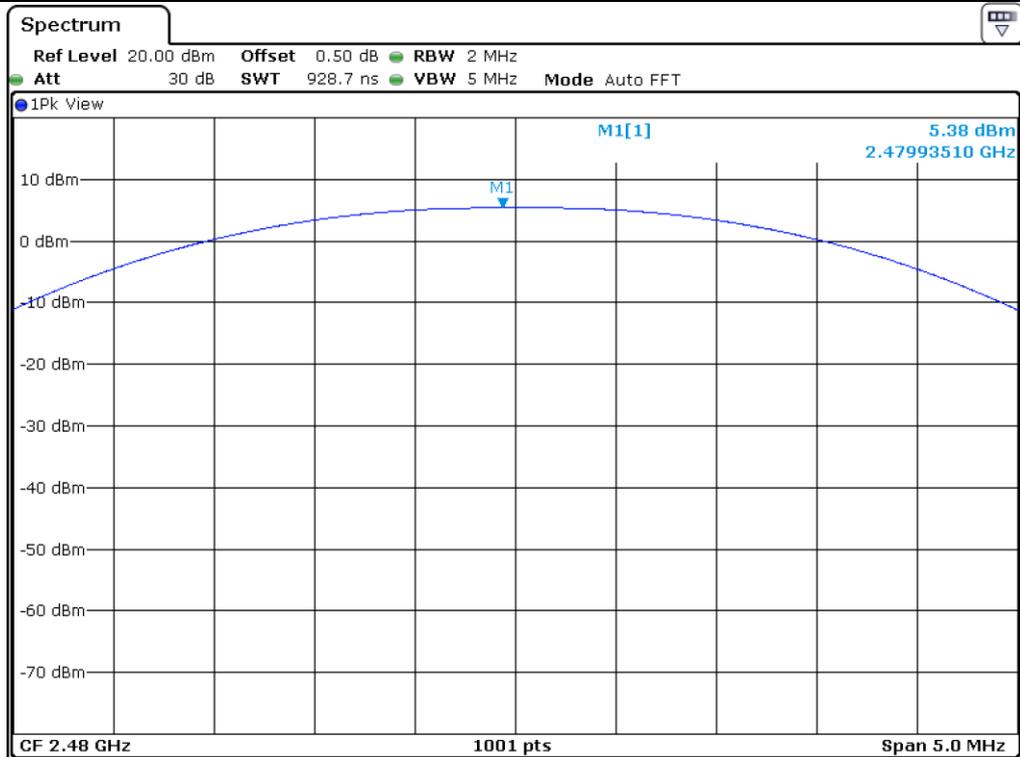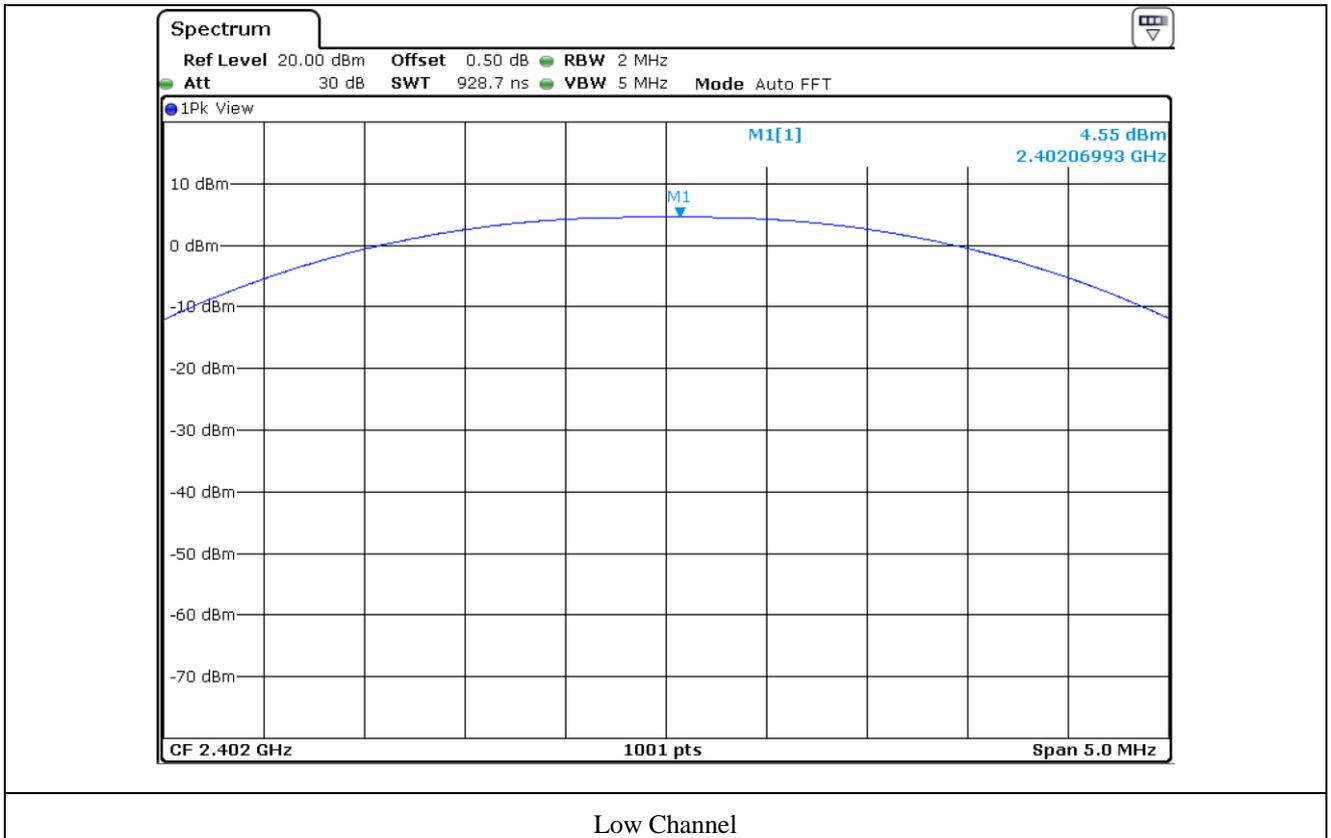| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|-----------------|----------------------|-------------|-------------|
| LOW     | 2 402.00        | 5.14                 | 21.00       | 15.86       |
| MIDDLE  | 2 441.00        | 5.31                 | 21.00       | 15.69       |
| HIGH    | 2 480.00        | 5.38                 | 21.00       | 15.62       |

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

**Tested by: Hyung-Kwon, Oh / Manager**



Low Channel

**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

Middle Channel



High Channel

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## 11.4.2 Test data for Bluetooth Earbud RIGHT

-. Test Date                    : April 16, 2020 ~ April 23, 2020
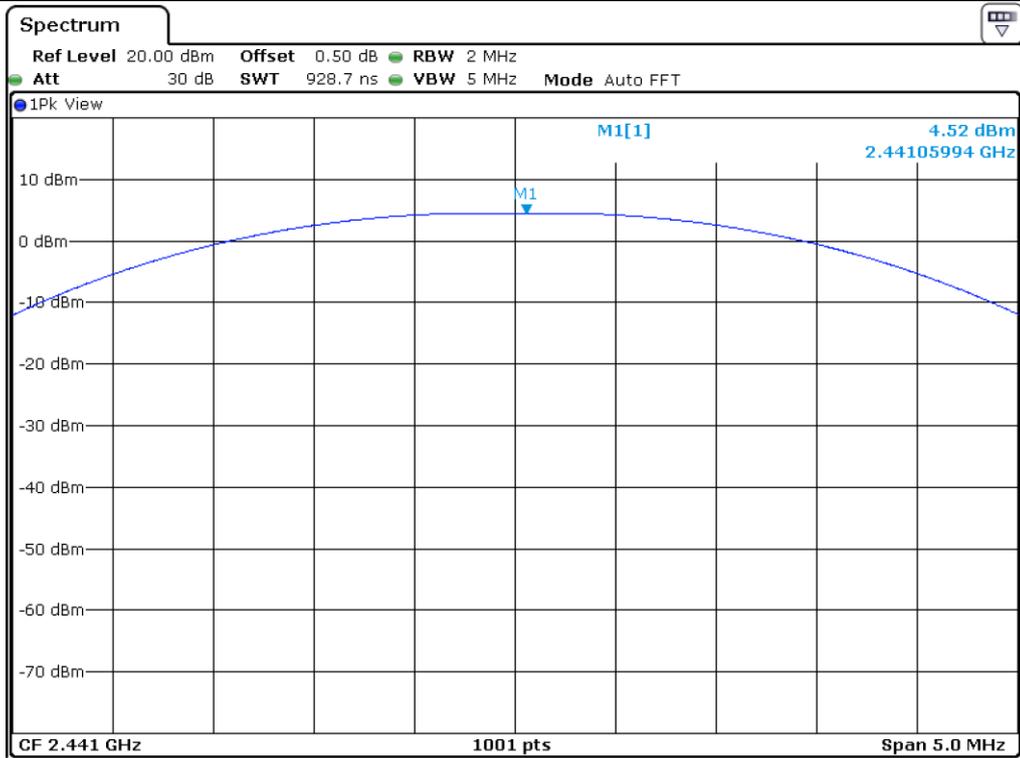
-. Test Result                 : Pass

| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|-----------------|----------------------|-------------|-------------|
| LOW | 2 402.00 | 4.55 | 21.00 | 16.45 |
| MIDDLE | 2 441.00 | 4.52 | 21.00 | 16.48 |
| HIGH | 2 480.00 | 5.03 | 21.00 | 15.97 |

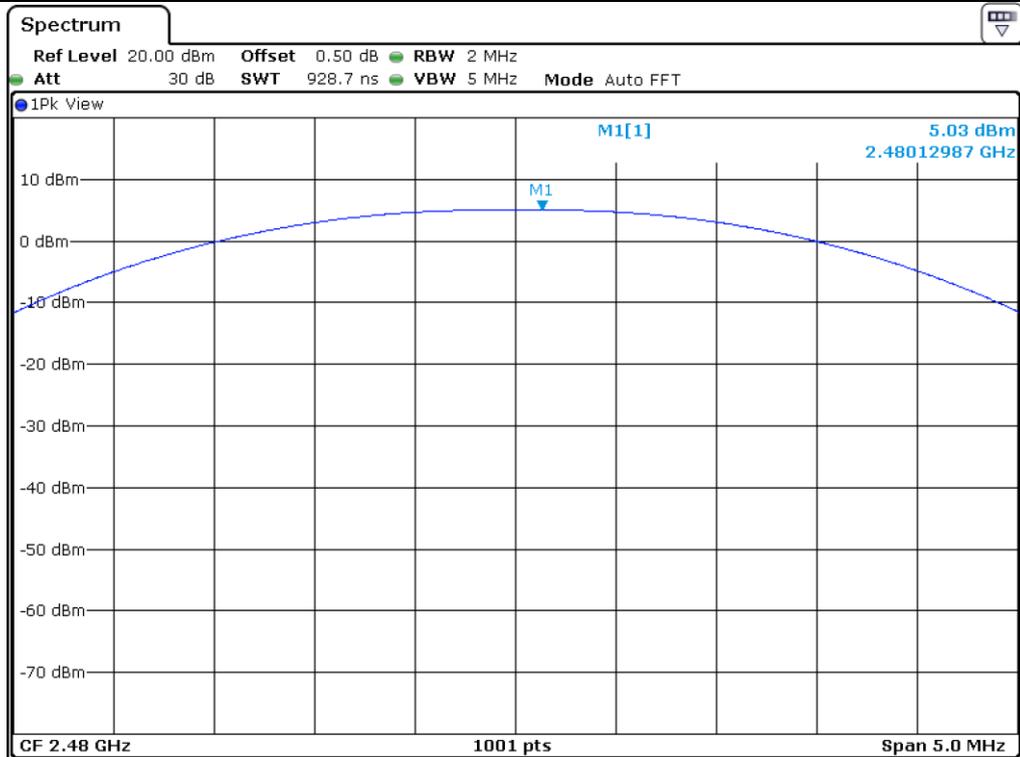Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

**Tested by: Hyung-Kwon, Oh / Manager**



Low Channel

Spectrum

| Ref Level | 20.00 dBm | Offset | 0.50 dB | RBW | 2 MHz | |
| Att | 30 dB | SWT | 928.7 ns | VBW | 5 MHz | Mode Auto FFT |

1Pk View

M1[1]          4.52 dBm
2.44105994 GHz

M1

10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm

CF 2.441 GHz          1001 pts          Span 5.0 MHz

Middle Channel

Spectrum

| Ref Level | 20.00 dBm | Offset | 0.50 dB | RBW | 2 MHz | |
| Att | 30 dB | SWT | 928.7 ns | VBW | 5 MHz | Mode Auto FFT |

1Pk View

M1[1]          5.03 dBm
2.48012987 GHz

M1

10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm

CF 2.48 GHz          1001 pts          Span 5.0 MHz

High Channel

## 11.5 Test data for 2 Mbps

### 11.5.1 Test data for Bluetooth Earbud LEFT
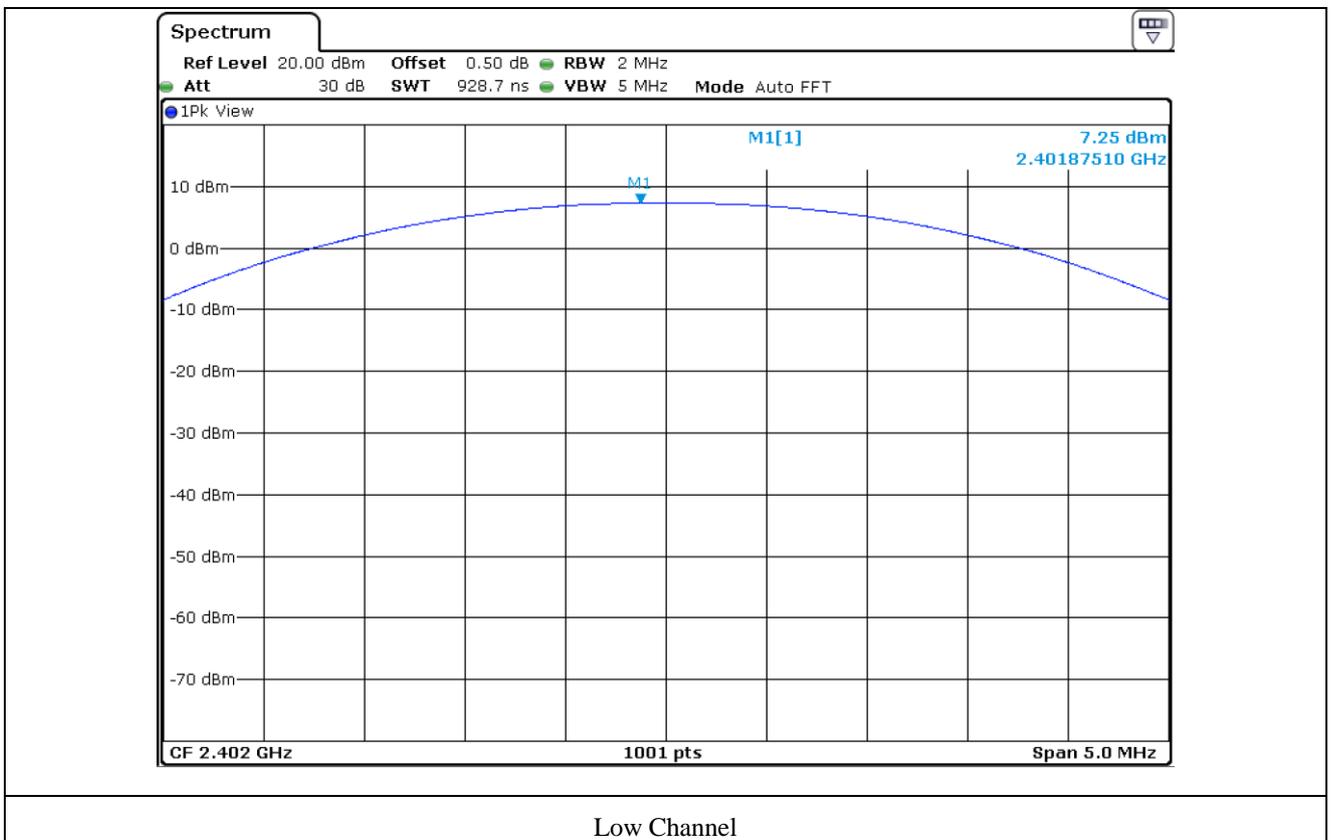
-. Test Date　　　　　　: April 16, 2020 ~ April 23, 2020
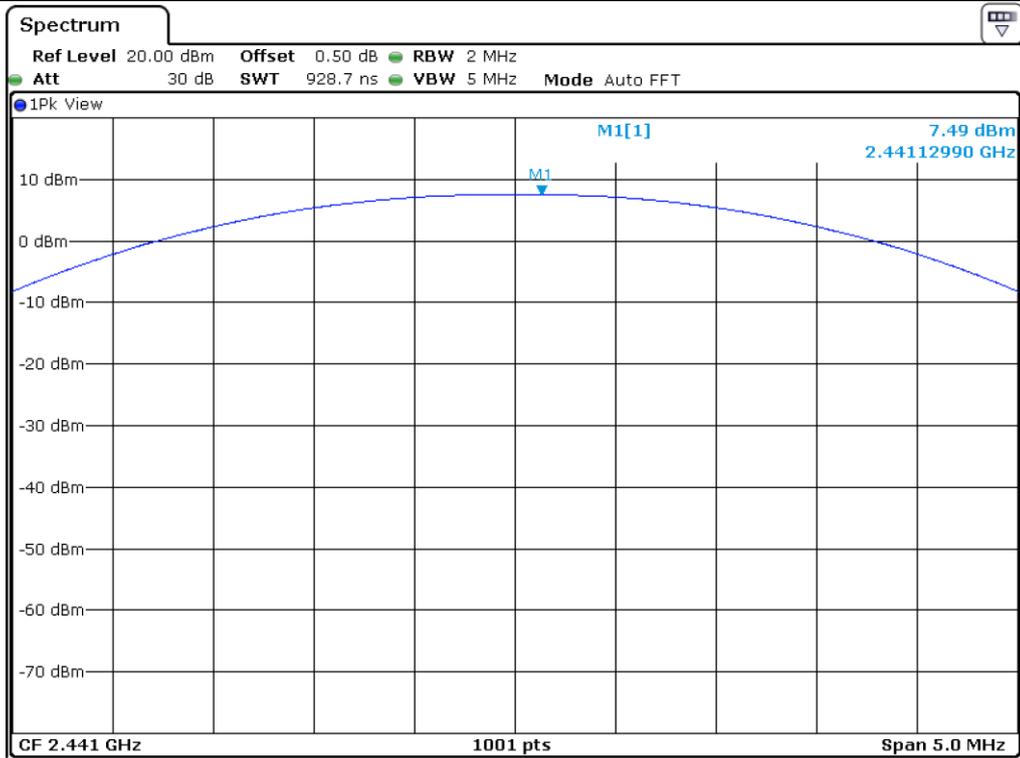
-. Test Result　　　　　: Pass

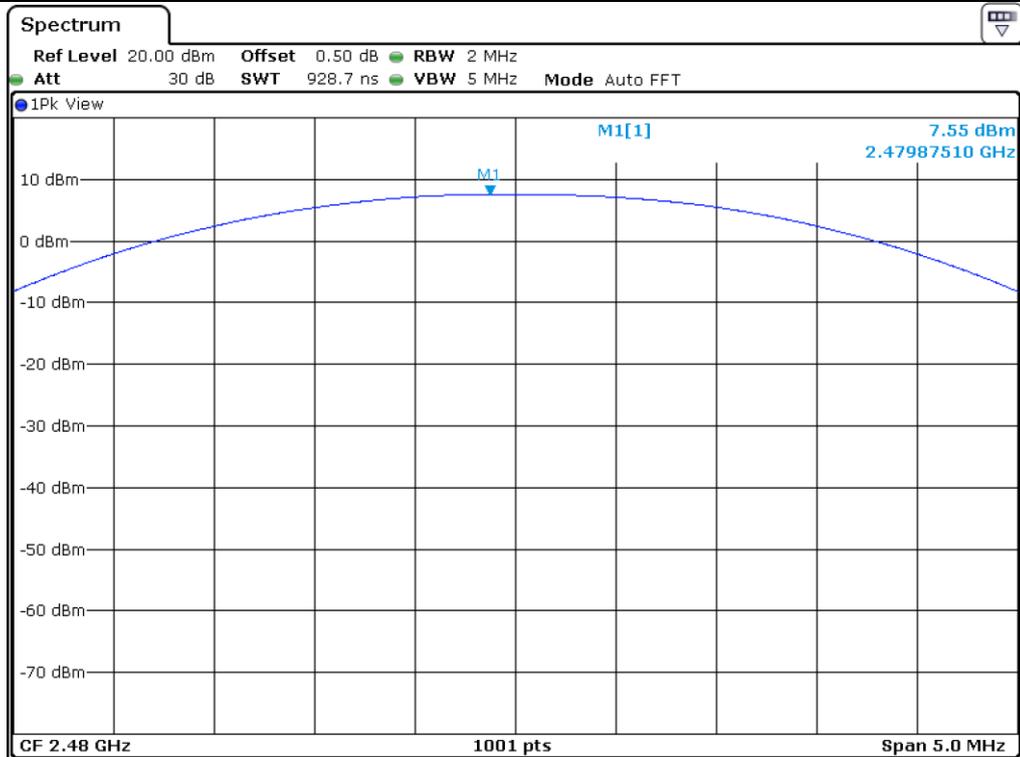| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---|---|---|---|---|
| LOW | 2 402.00 | 7.25 | 21.00 | 13.75 |
| MIDDLE | 2 441.00 | 7.49 | 21.00 | 13.51 |
| HIGH | 2 480.00 | 7.55 | 21.00 | 13.45 |

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

**Tested by: Hyung-Kwon, Oh / Manager**



Low Channel

Middle Channel



High Channel

**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

## 11.5.2 Test data for Bluetooth Earbud RIGHT

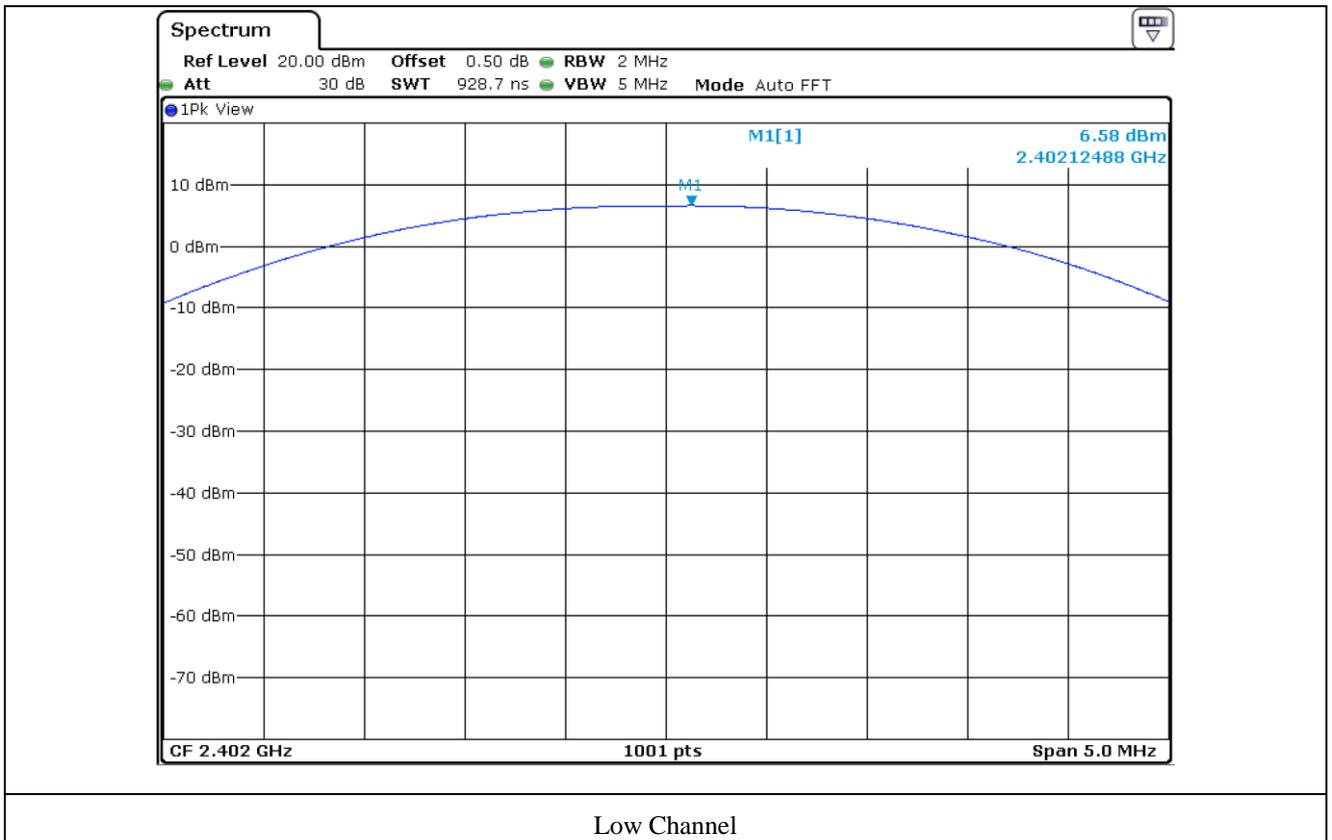-. Test Date                : April 16, 2020 ~ April 23, 2020

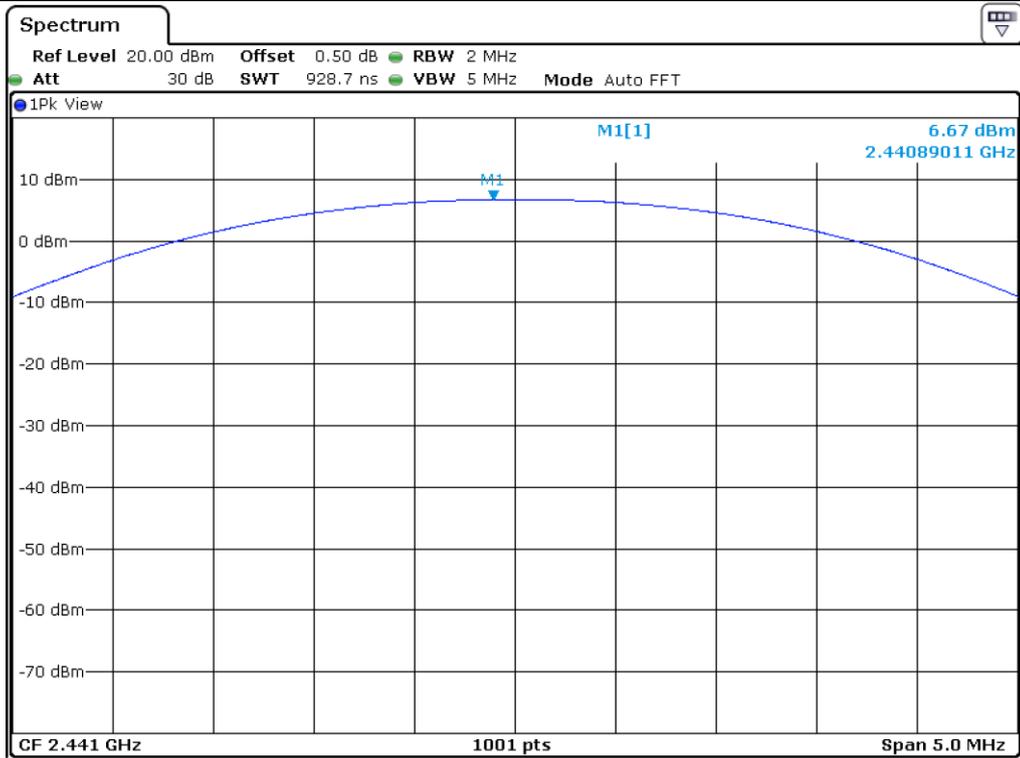-. Test Result             : Pass

| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|-----------------|----------------------|-------------|-------------|
| LOW     | 2 402.00        | 6.58                 | 21.00       | 14.42       |
| MIDDLE  | 2 441.00        | 6.67                 | 21.00       | 14.33       |
| HIGH    | 2 480.00        | 7.24                 | 21.00       | 13.76       |

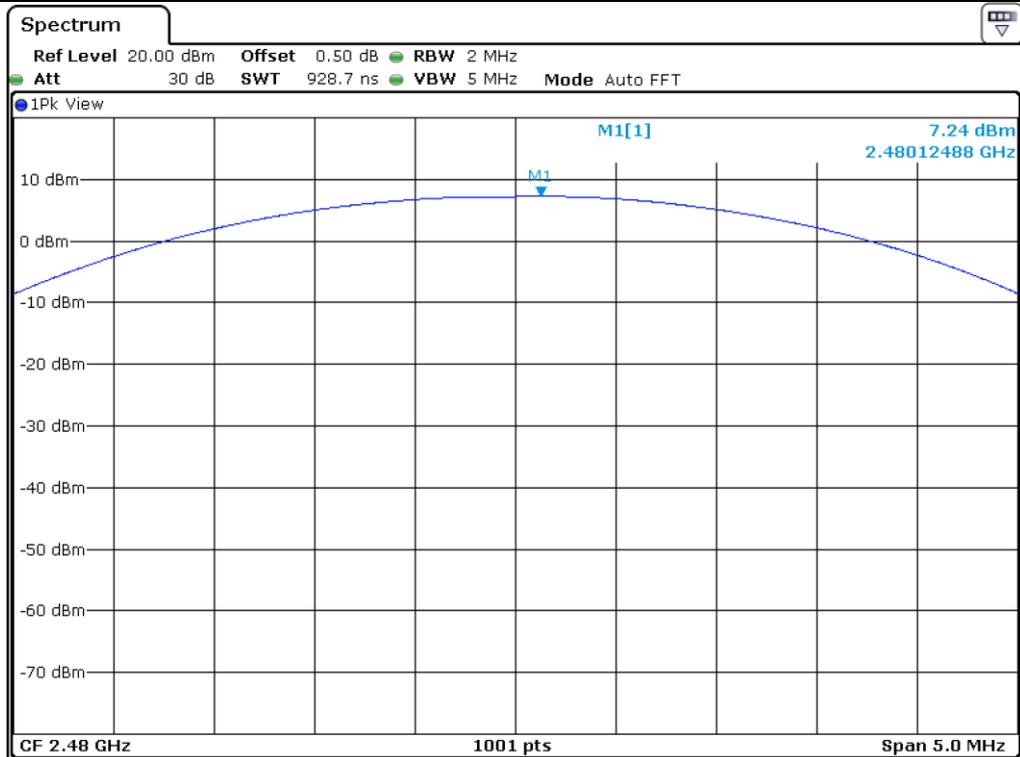Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

**Tested by: Hyung-Kwon, Oh / Manager**



Low Channel

Spectrum

Ref Level 20.00 dBm   Offset   0.50 dB   RBW   2 MHz
Att          30 dB   SWT   928.7 ns   VBW   5 MHz   Mode  Auto FFT
1Pk View

M1[1]                     6.67 dBm
                    2.44089011 GHz
M1

CF 2.441 GHz                    1001 pts                    Span 5.0 MHz

Middle Channel

Spectrum

Ref Level 20.00 dBm   Offset   0.50 dB   RBW   2 MHz
Att          30 dB   SWT   928.7 ns   VBW   5 MHz   Mode  Auto FFT
1Pk View

M1[1]                     7.24 dBm
                    2.48012488 GHz
M1

CF 2.48 GHz                    1001 pts                    Span 5.0 MHz

High Channel