RADIO PERFORMANCE
TEST REPORT

Test Report No. : OT-219-RWD-042

Reception No. : 2109004067

Applicant : LG Electronics USA, Inc.

Address : 111 Sylvan Ave, North Building, Englewood Cliffs, New Jersey, United States

Manufacturer : LG Electronics Inc.

Address : 222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, Korea

Type of Equipment : Bluetooth Earbud

FCC ID. : ZNFTONEFP6

Model Name : TONE-FP6

Multiple Model Name : TONE-FP6W, TONE-TFP6, TONE-TFP6W

Serial number : N/A

Total page of Report : 136 pages (including this page)

Date of Incoming : September 09, 2021

Date of issue : September 27, 2021

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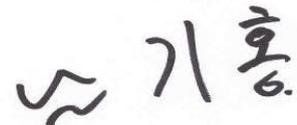
It is not a generally valid assessment of the features of the respective products of the mass-production.

Tested by	Reviewed by	Approved by
Myeong-Hwa, Jang / Manager	Tae-Ho, Kim / Senior Manager	Ki-Hong, Nam / General Manager
ONETECH Corp.	ONETECH Corp.	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-219-RWD-042	September 27, 2021	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant   : LG Electronics USA, Inc.

Address   : 111 Sylvan Ave, North Building, Englewood Cliffs, New Jersey, United States

Contact Person : Sung Soo Kim / Director, Regulatory and Environmental Affairs

Telephone No. : 201-266-2215

FCC ID   : ZNFTONEFP6

Model Name   : TONE-FP6

Brand Name   : LG

Serial Number : N/A

Date   : September 27, 2021

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 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 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)	Minimum 20 dB Bandwidth	Met the Limit / PASS
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 operated by DC battery.

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-20122/ C-14617/ G-10666/ T-11842

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 TONE-FP6 (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	
Operating Frequency		Bluetooth	2 402 MHz ~ 2 480 MHz	
		Bluetooth LE		
RF Output Power	Left Earbud	Bluetooth	1 Mbps	11.10 dBm
			2 Mbps	10.64 dBm
			3 Mbps	11.27 dBm
		Bluetooth LE	1 Mbps	5.34 dBm
			2 Mbps	5.38 dBm
	Right Earbud	Bluetooth	1 Mbps	11.86 dBm
			2 Mbps	11.39 dBm
			3 Mbps	11.85 dBm
		Bluetooth LE	1 Mbps	5.38 dBm
			2 Mbps	5.42 dBm
Number of Channel		Bluetooth	79 Channels	
		Bluetooth LE	40 Channels	
Modulation Type		Bluetooth	GFSK for 1 Mbps, π/4-DQPSK for 2 Mbps, 8-DPSK for 3 Mbps	
		Bluetooth LE	GFSK	
Antenna Type	Left Earbud	FPCB Antenna		
	Right Earbud			
Antenna Gain	Left Earbud	0.05 dBi		
	Right Earbud	1.09 dBi		
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		32 MHz		
Rated Supply Voltage		DC 3.7 V		

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
TONE-FP6	Basic Model (Color: Black).	☑
TONE-FP6W	This model is different from the basic model in color and country of sale. (Color: White / Country of sale: Global)	☐
TONE-TFP6	This model is different from the basic model in color and country of sale. (Color: Black / Country of sale: Korea)	☐
TONE-TFP6W	This model is different from the basic model in color and country of sale. (Color: White / Country of sale: Korea)	☐

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

2. The multiple model name was written at the request of the applicant / manufacturer.

4. EUT MODIFICATIONS

-. None

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.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	LG Electronics Inc.	N/A	N/A
Battery	LG Electronics Inc.	N/A	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
TONE-FP6	LG Electronics Inc.	Bluetooth Earbud (EUT)	-
Ideapad 330-15IKB	Lenovo	Notebook PC	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 "XY" axis, but the worst data was recorded in this report.

-. Frequency / Channel Operations

Channel	Frequency
0	2 402
39	2 441
78	2 480

-. Duty Cycle (Left Earbud)

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.888	0.867	76.91	1.14
Bluetooth [2 Mbps]	2.888	0.867	76.91	1.14
Bluetooth [3 Mbps]	2.888	0.867	76.91	1.14

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

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

-. Test Plot
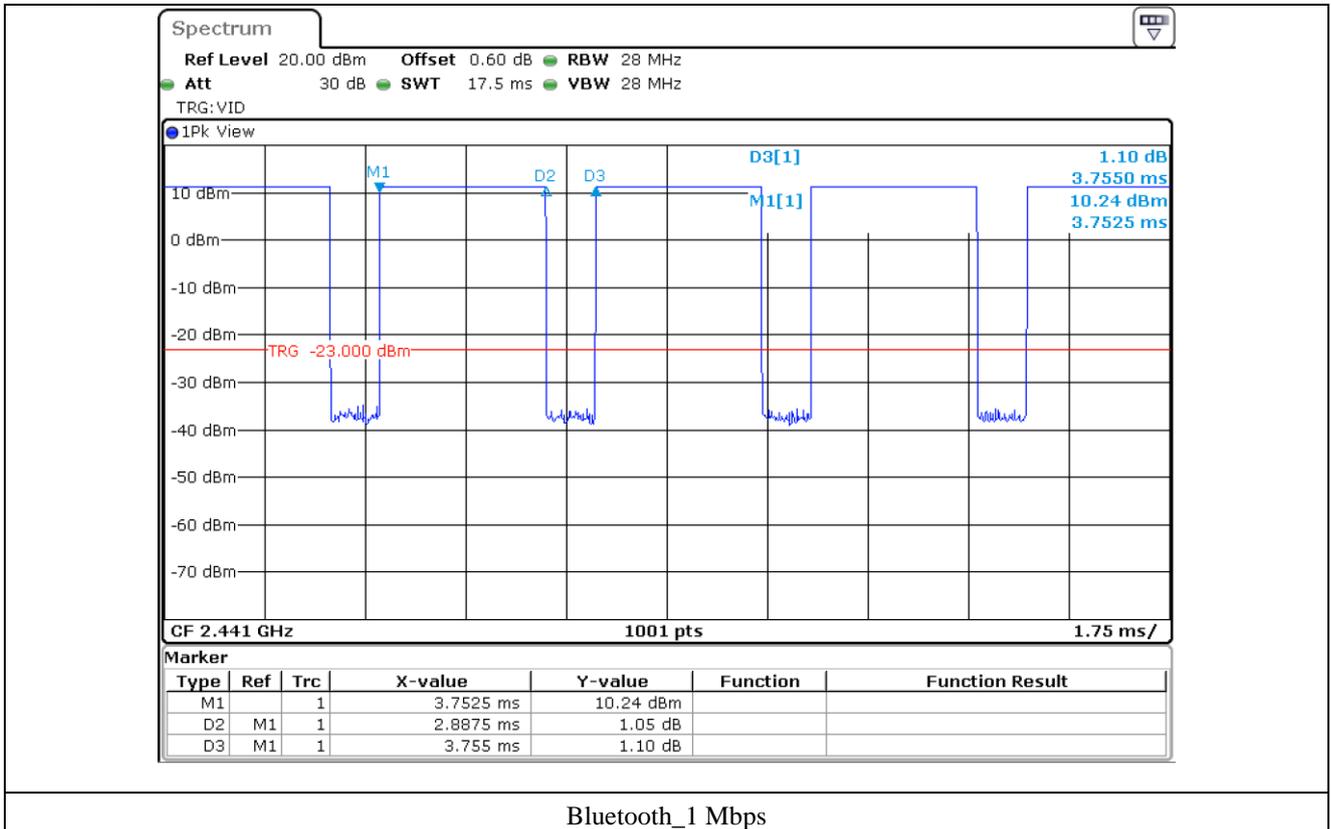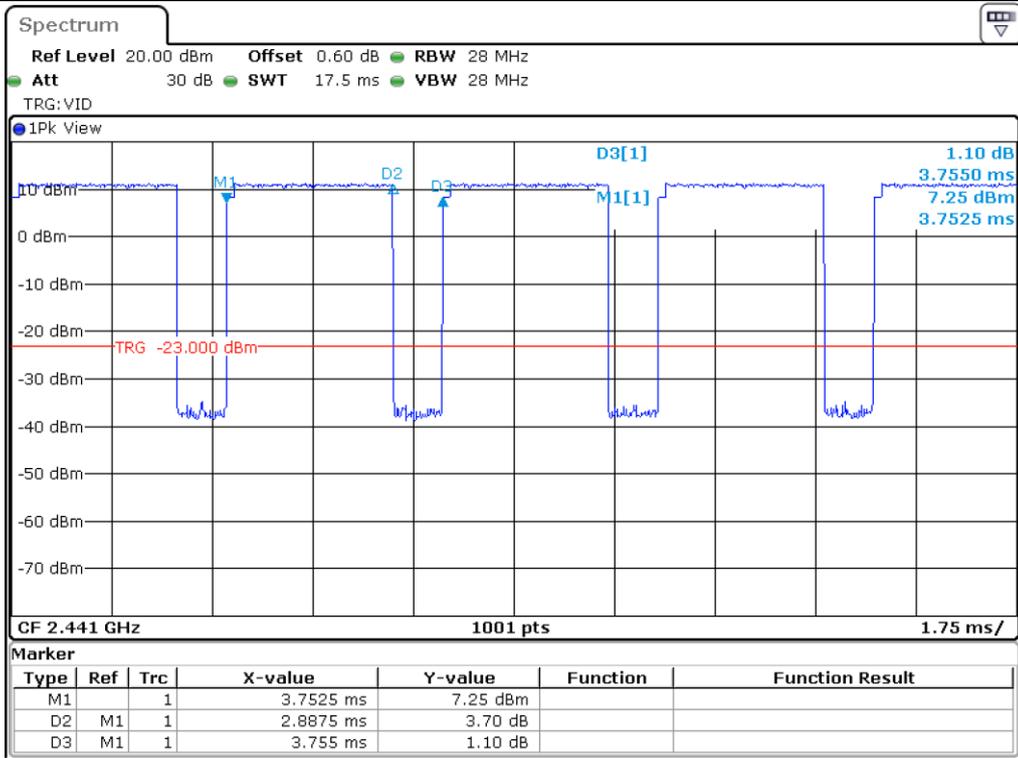
Bluetooth_1 Mbps
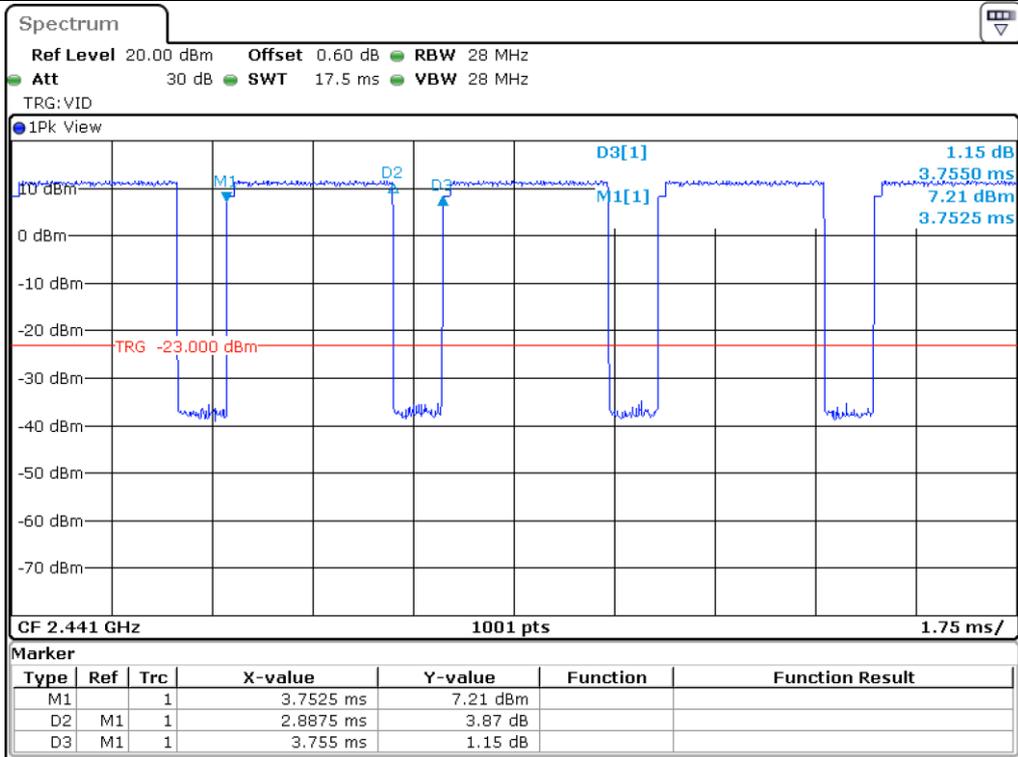
Bluetooth_2 Mbps

Bluetooth_3 Mbps

-. Duty Cycle (Right Earbud)

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.884	0.875	76.72	1.15
Bluetooth [2 Mbps]	2.884	0.875	76.72	1.15
Bluetooth [3 Mbps]	2.884	0.875	76.72	1.15

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

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

-. Test Plot
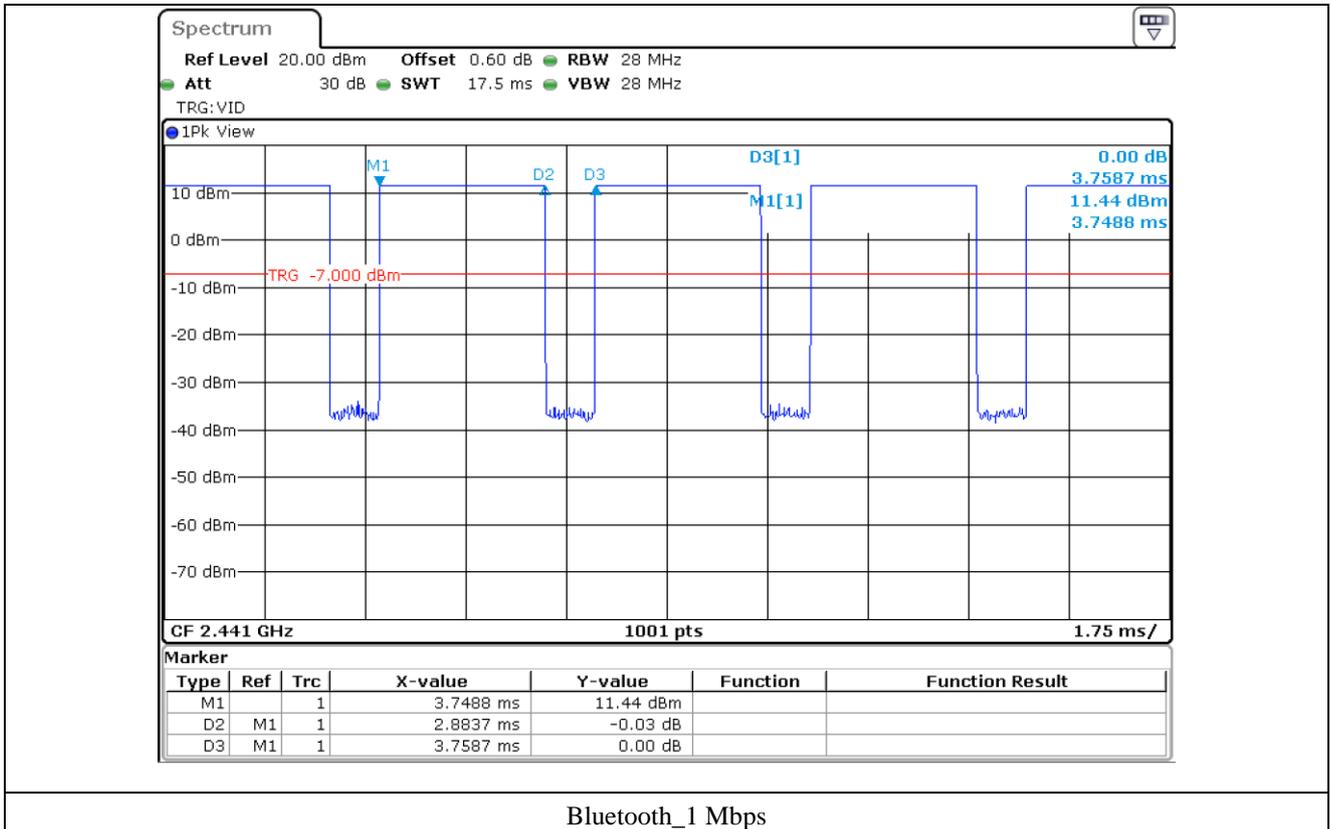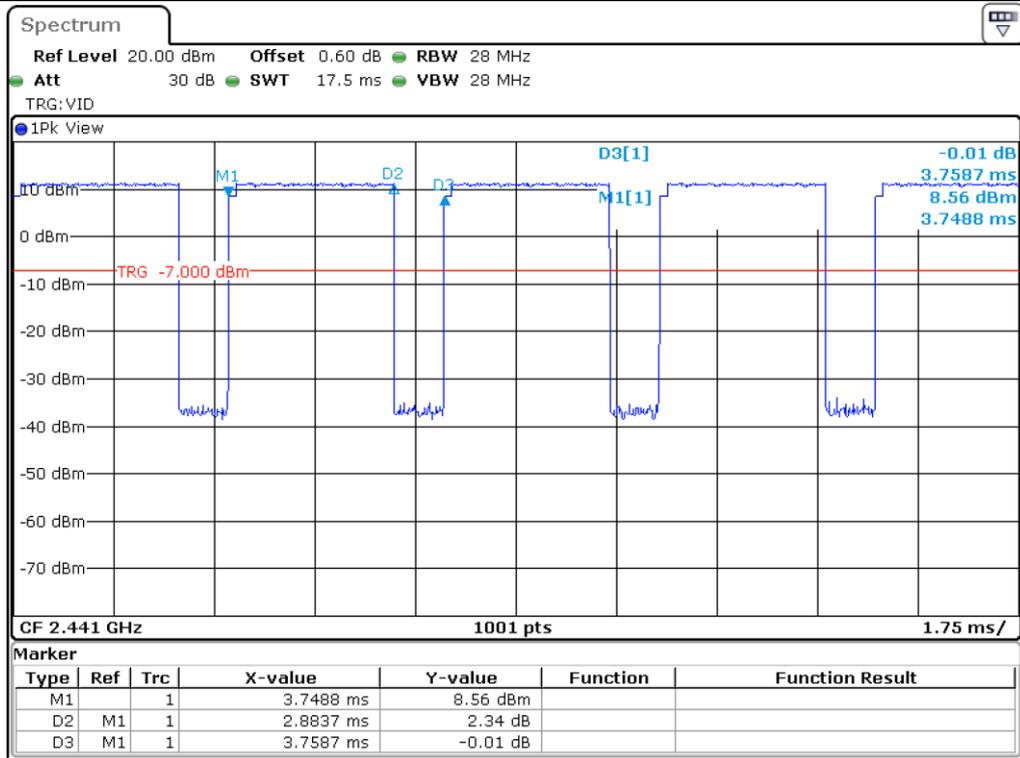
Bluetooth_1 Mbps
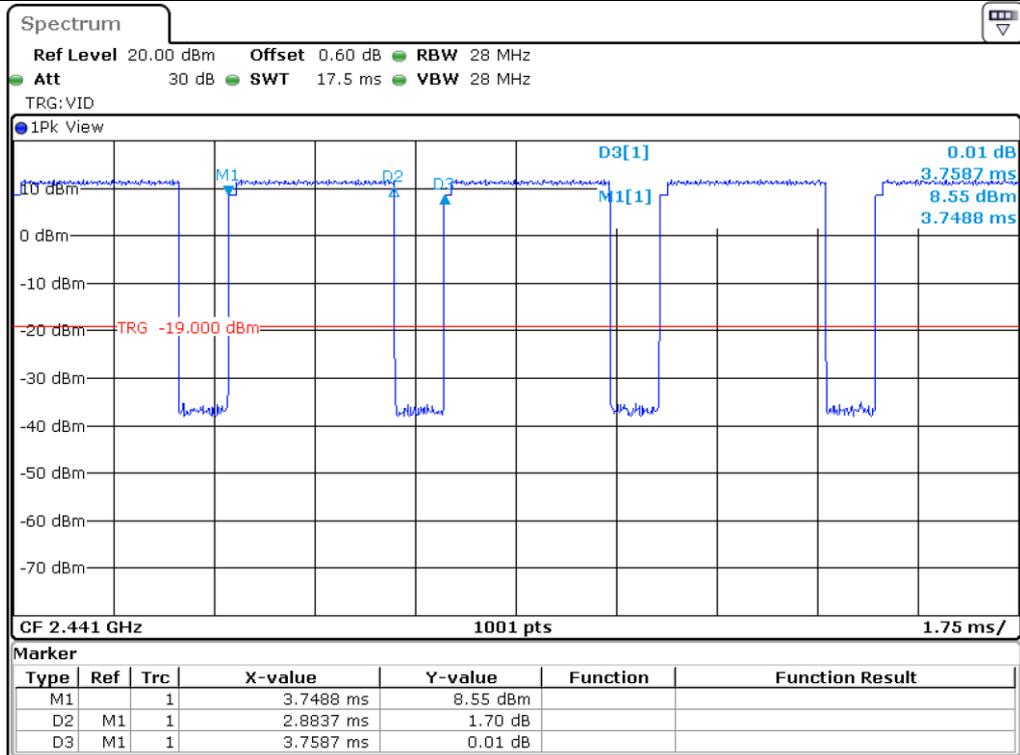
Bluetooth_2 Mbps

Bluetooth_3 Mbps

5.4 Configuration of Test System

Line Conducted Test: As the EUT is operated by DC battery, this test item is not requirement to be performed.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 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.

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   :   46 % 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 20 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 Date

September 09, 2021 ~ September 17, 2021

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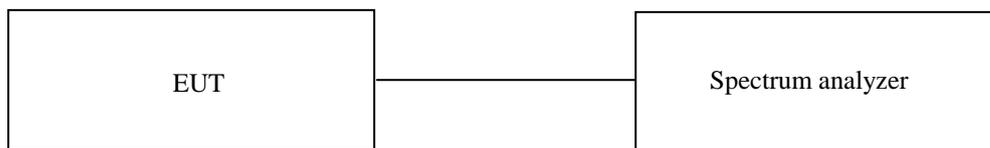
7.4 Test data for Left Earbud

7.4.1 Test data for 1 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	926.10
Middle	2 441.00	926.10
High	2 480.00	926.10

Low Channel

Spectrum

Ref Level 20.00 dBm   Offset   0.60 dB   RBW 10 kHz
Att   30 dB   SWT   189.6 µs   VBW 30 kHz   Mode Auto FFT
1Pk View

D2[1]   -0.95 dB
                             926.10 kHz
M1[1]   -14.86 dBm
                          2.44050850 GHz

D1 5.560 dBm
D2 -14.440 dBm

CF 2.441 GHz   1001 pts   Span 3.0 MHz

Middle Channel

Spectrum

Ref Level 20.00 dBm   Offset   0.60 dB   RBW 10 kHz
Att   30 dB   SWT   189.6 µs   VBW 30 kHz   Mode Auto FFT
1Pk View

D2[1]   -0.92 dB
                             926.10 kHz
M1[1]   -15.11 dBm
                          2.47950850 GHz

D1 5.460 dBm
D2 -14.540 dBm

CF 2.48 GHz   1001 pts   Span 3.0 MHz
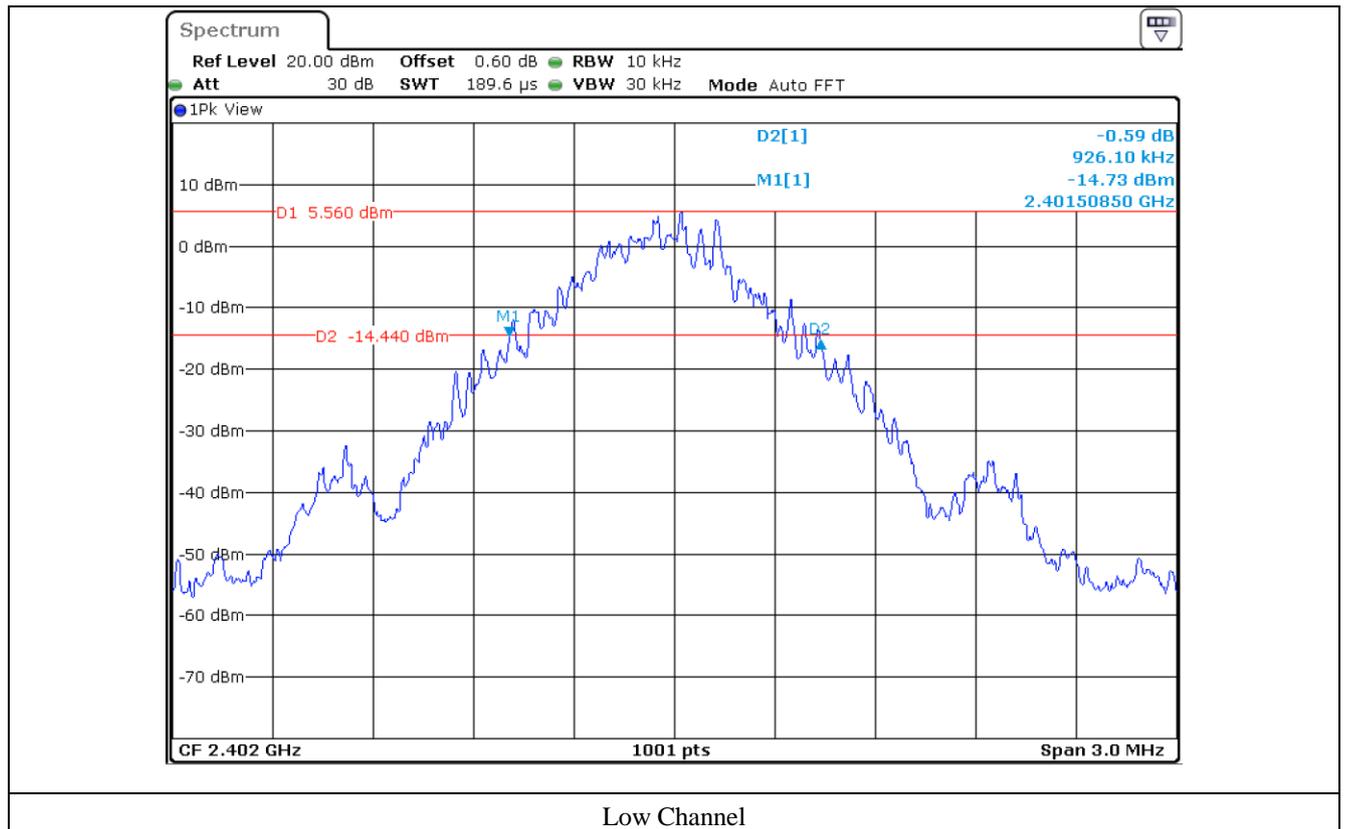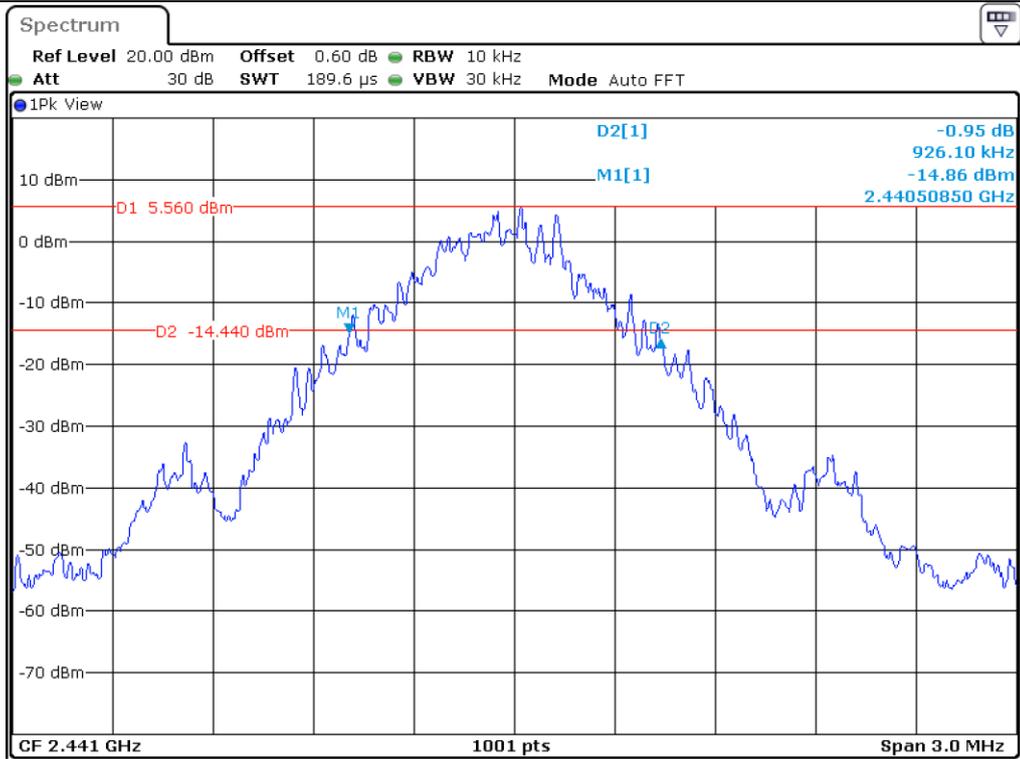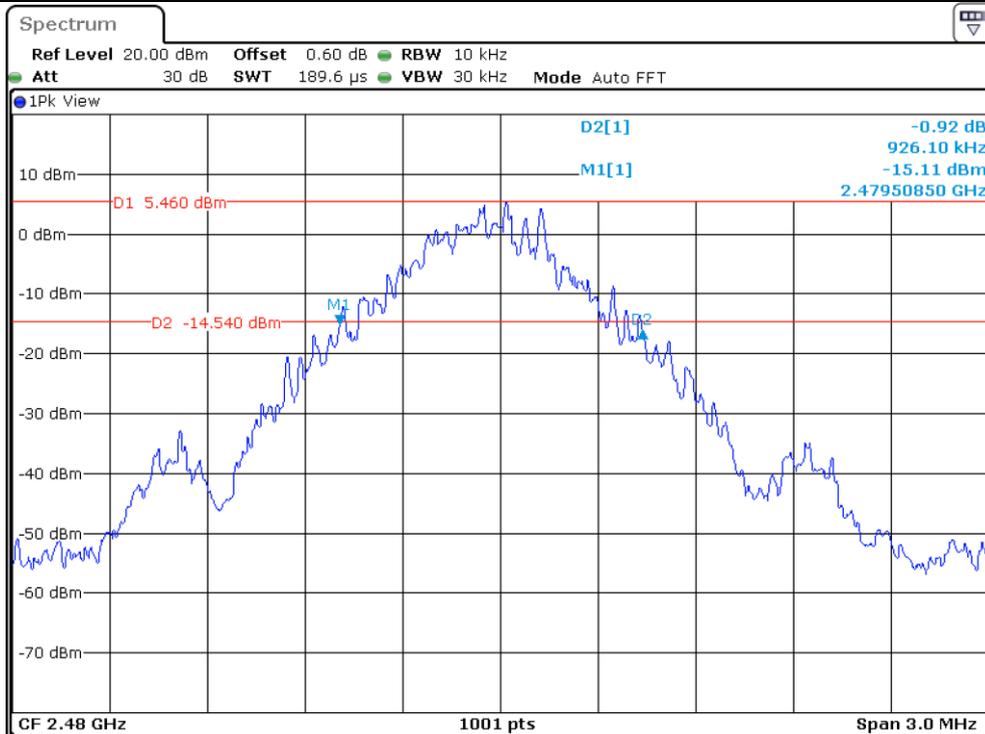
High Channel

7.4.2 Test data for 2 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 326.70
Middle	2 441.00	1 330.70
High	2 480.00	1 329.70
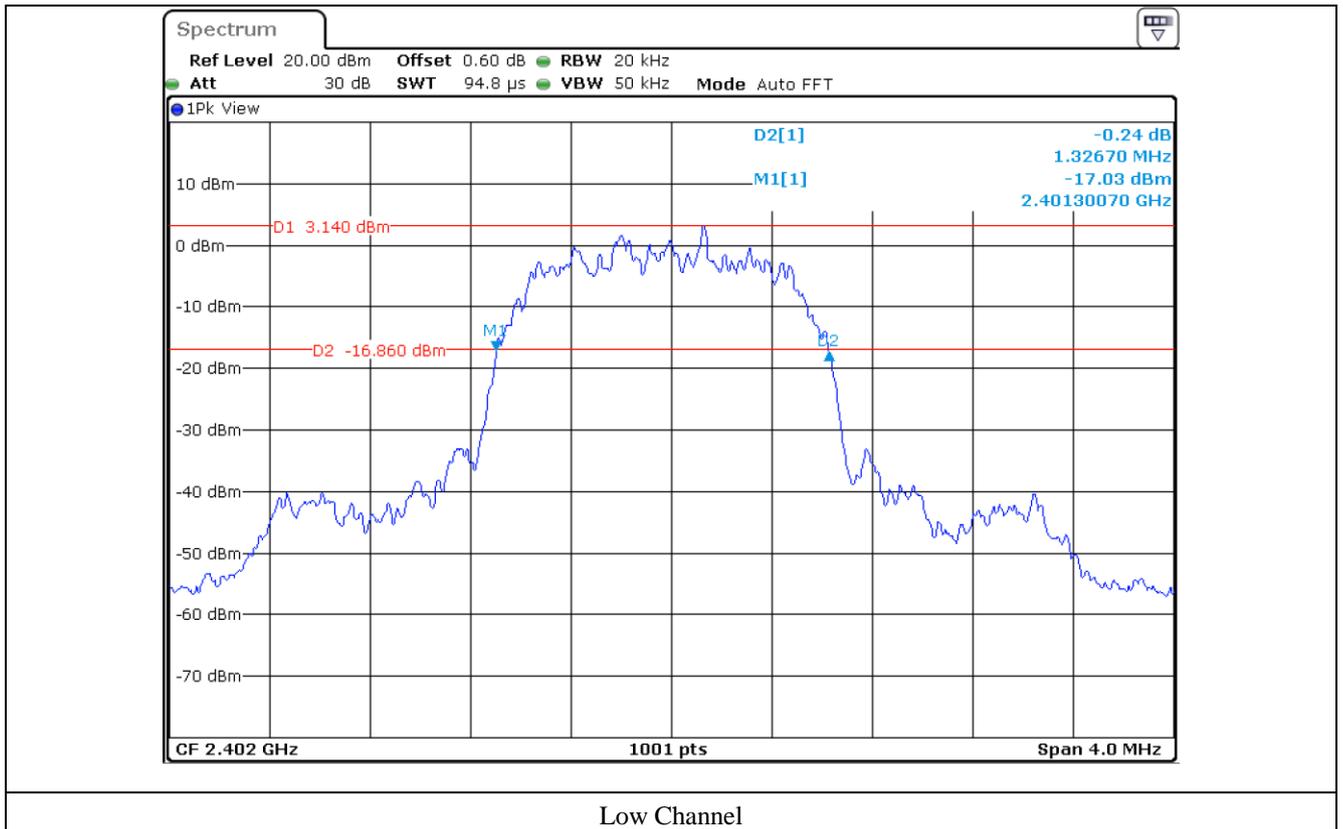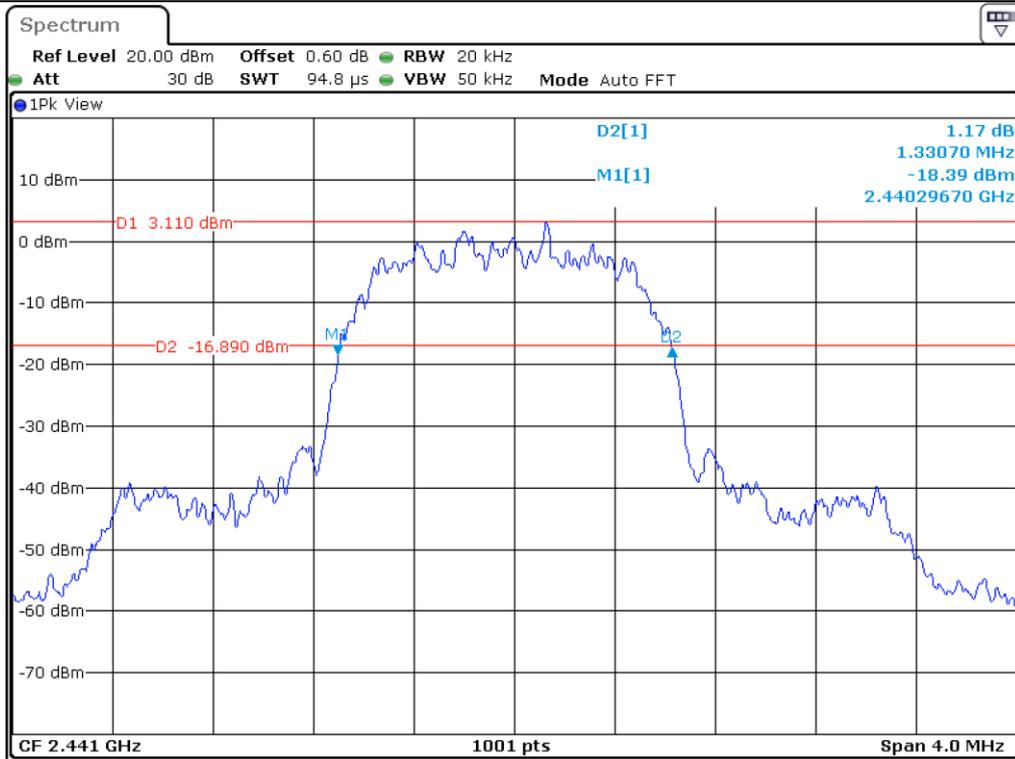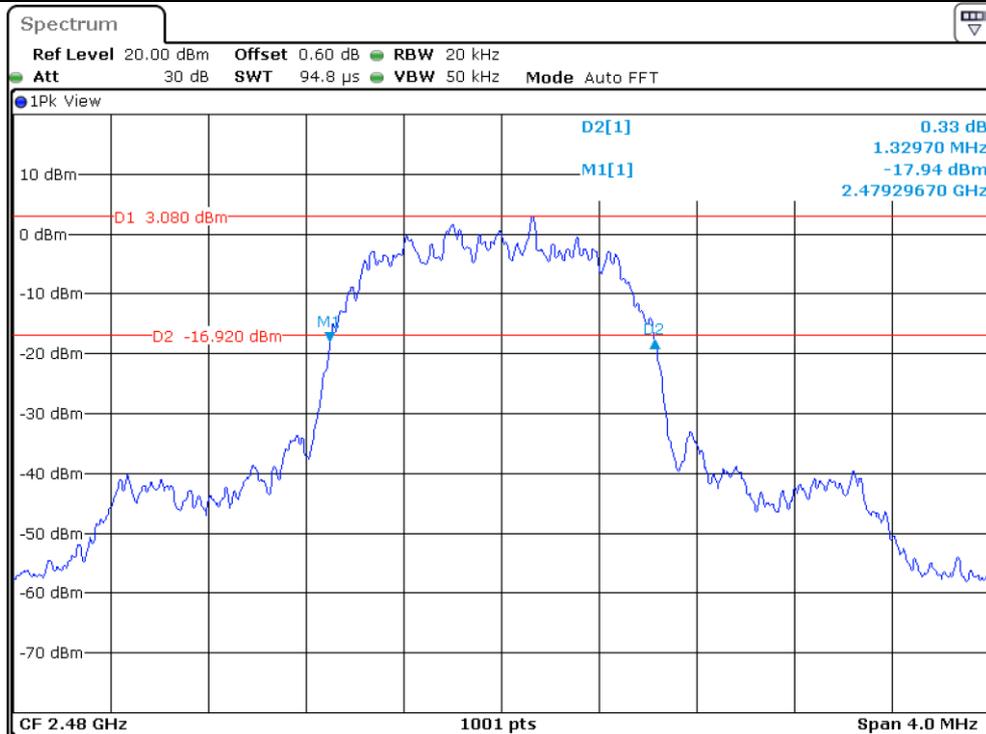
Low Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 20 kHz
● Att   30 dB   SWT   94.8 µs ● VBW 50 kHz   Mode Auto FFT
● 1Pk View

D2[1]   1.17 dB
                         1.33070 MHz
M1[1]   -18.39 dBm
                        2.44029670 GHz

D1 3.110 dBm

D2 -16.890 dBm

CF 2.441 GHz   1001 pts   Span 4.0 MHz

Middle Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 20 kHz
● Att   30 dB   SWT   94.8 µs ● VBW 50 kHz   Mode Auto FFT
● 1Pk View

D2[1]   0.33 dB
                         1.32970 MHz
M1[1]   -17.94 dBm
                        2.47929670 GHz

D1 3.080 dBm

D2 -16.920 dBm

CF 2.48 GHz   1001 pts   Span 4.0 MHz

High Channel

7.4.3 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 286.70
Middle	2 441.00	1 286.70
High	2 480.00	1 286.70
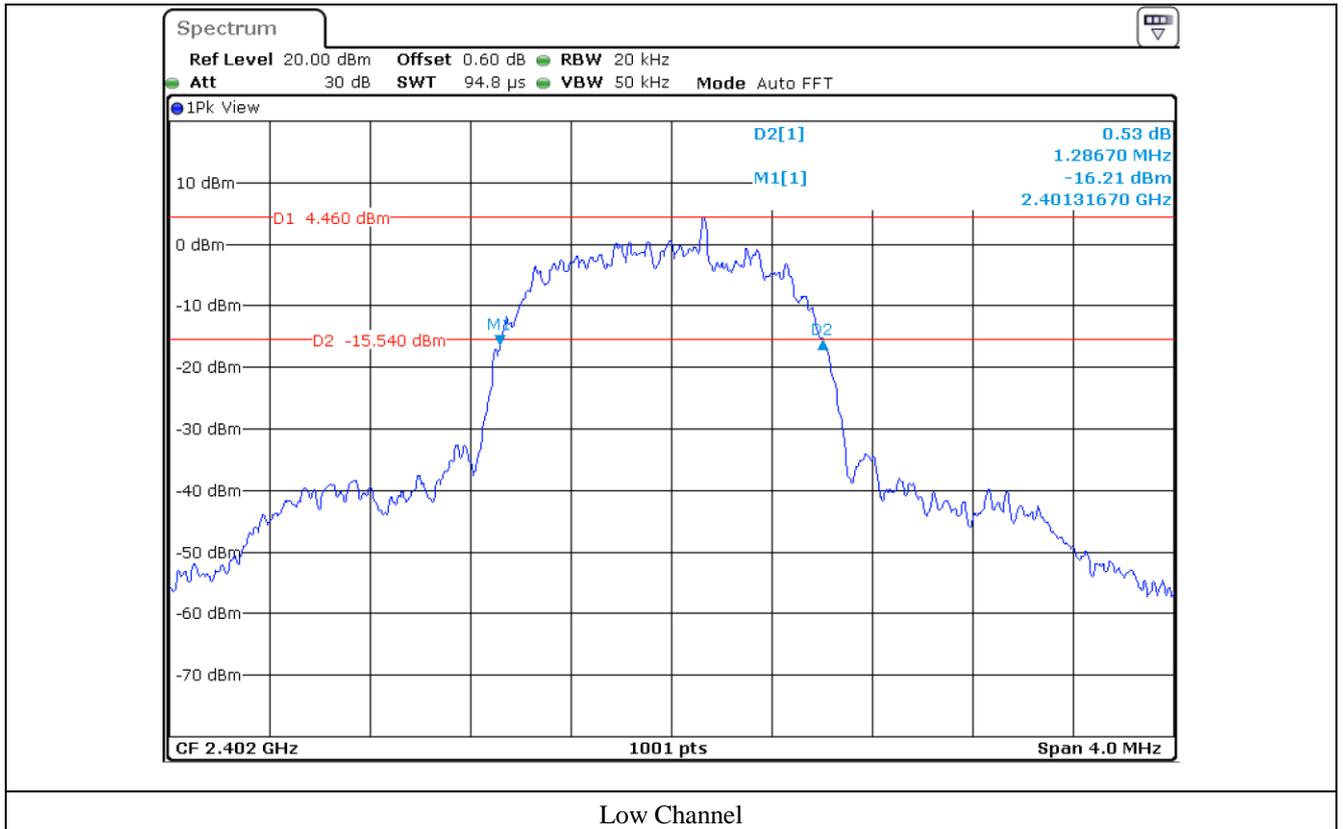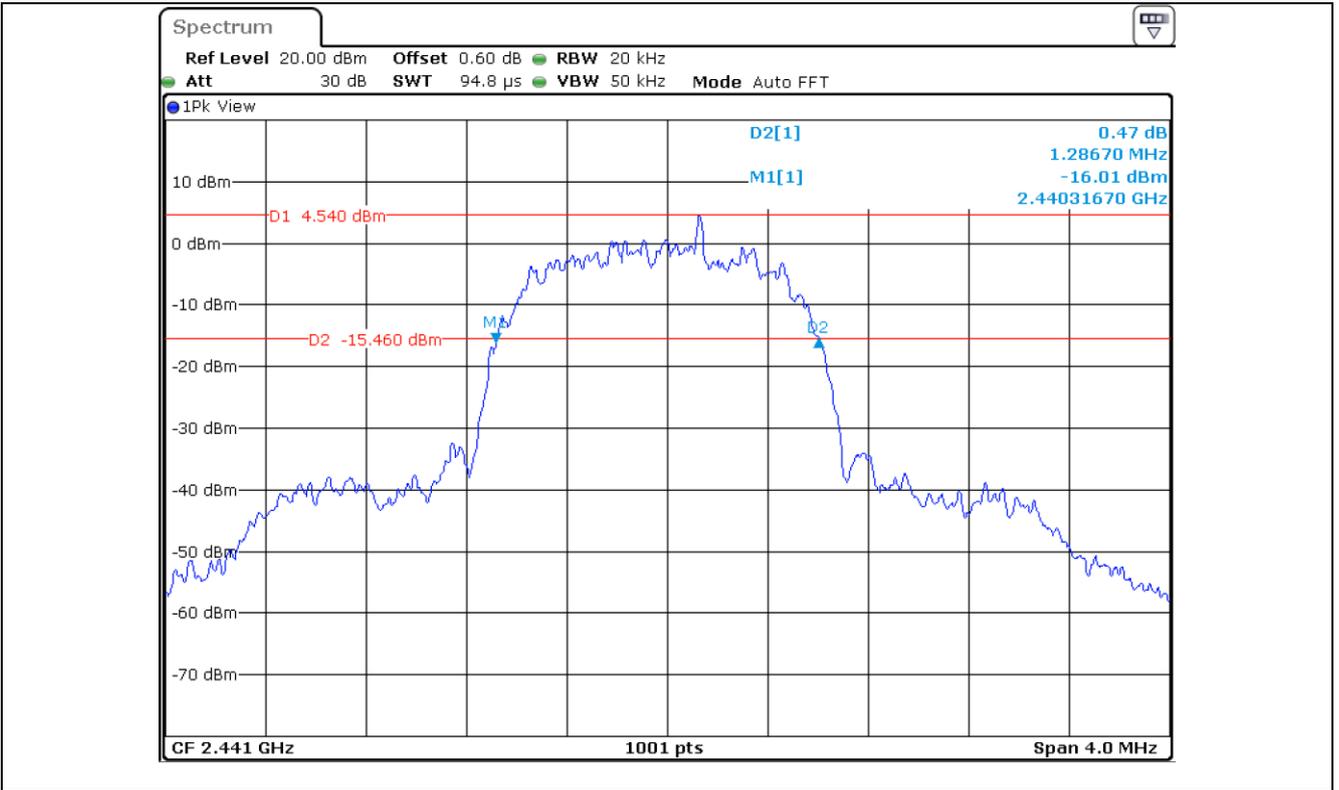
Low Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB   RBW 20 kHz
● Att   30 dB   SWT   94.8 μs   VBW 50 kHz   Mode Auto FFT
● 1Pk View

D2[1]   0.47 dB
1.28670 MHz
M1[1]   -16.01 dBm
2.44031670 GHz

D1 4.540 dBm

D2 -15.460 dBm

CF 2.441 GHz   1001 pts   Span 4.0 MHz

Middle Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB   RBW 20 kHz
● Att   30 dB   SWT   94.8 μs   VBW 50 kHz   Mode Auto FFT
● 1Pk View

D2[1]   0.00 dB
1.28670 MHz
M1[1]   -15.92 dBm
2.47931670 GHz

D1 4.370 dBm

D2 -15.630 dBm

CF 2.48 GHz   1001 pts   Span 4.0 MHz

High Channel

7.5 Test data for Right Earbud

7.5.1 Test data for 1 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	926.10
Middle	2 441.00	926.10
High	2 480.00	926.10

Low Channel
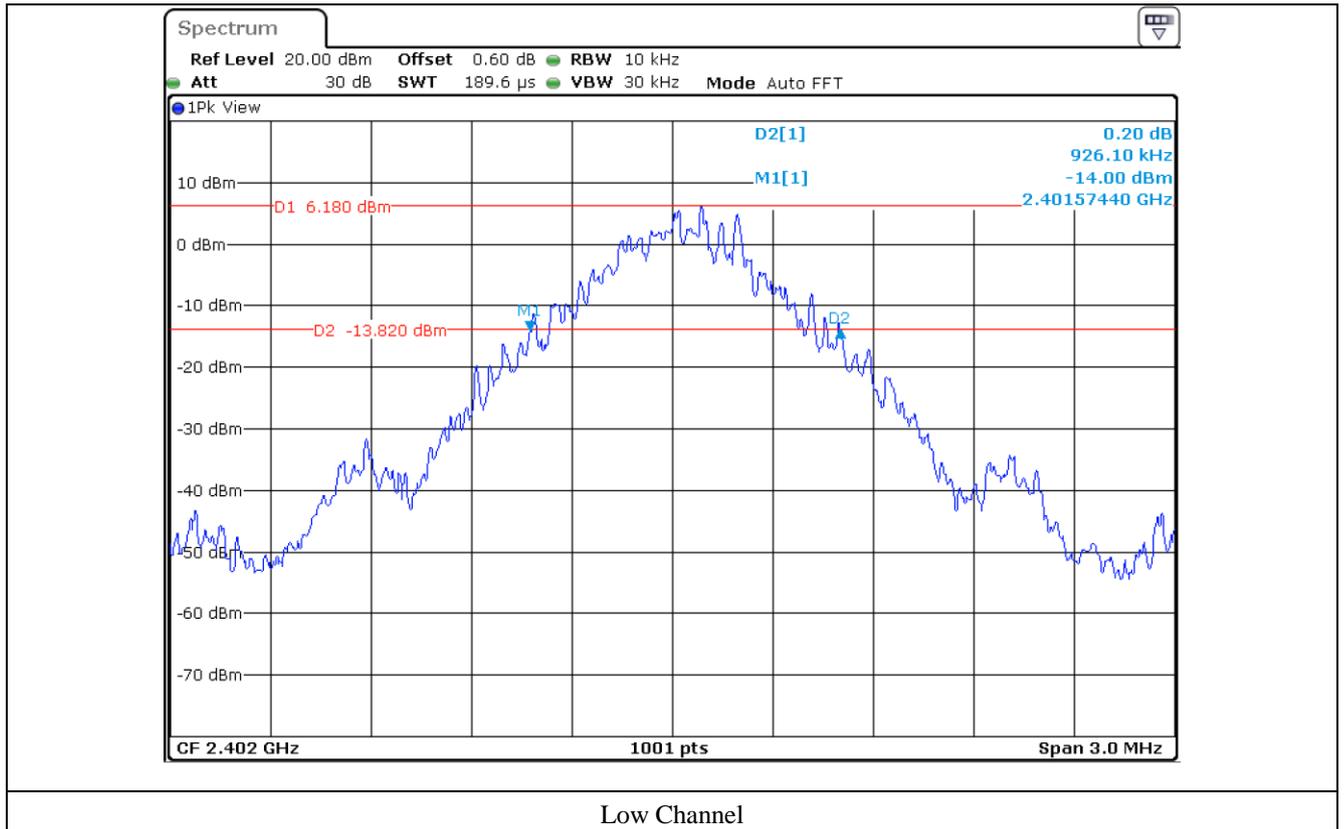
Middle Channel

High Channel

7.5.2 Test data for 2 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 331.70
Middle	2 441.00	1 326.70
High	2 480.00	1 330.70

Low Channel

Middle Channel

High Channel

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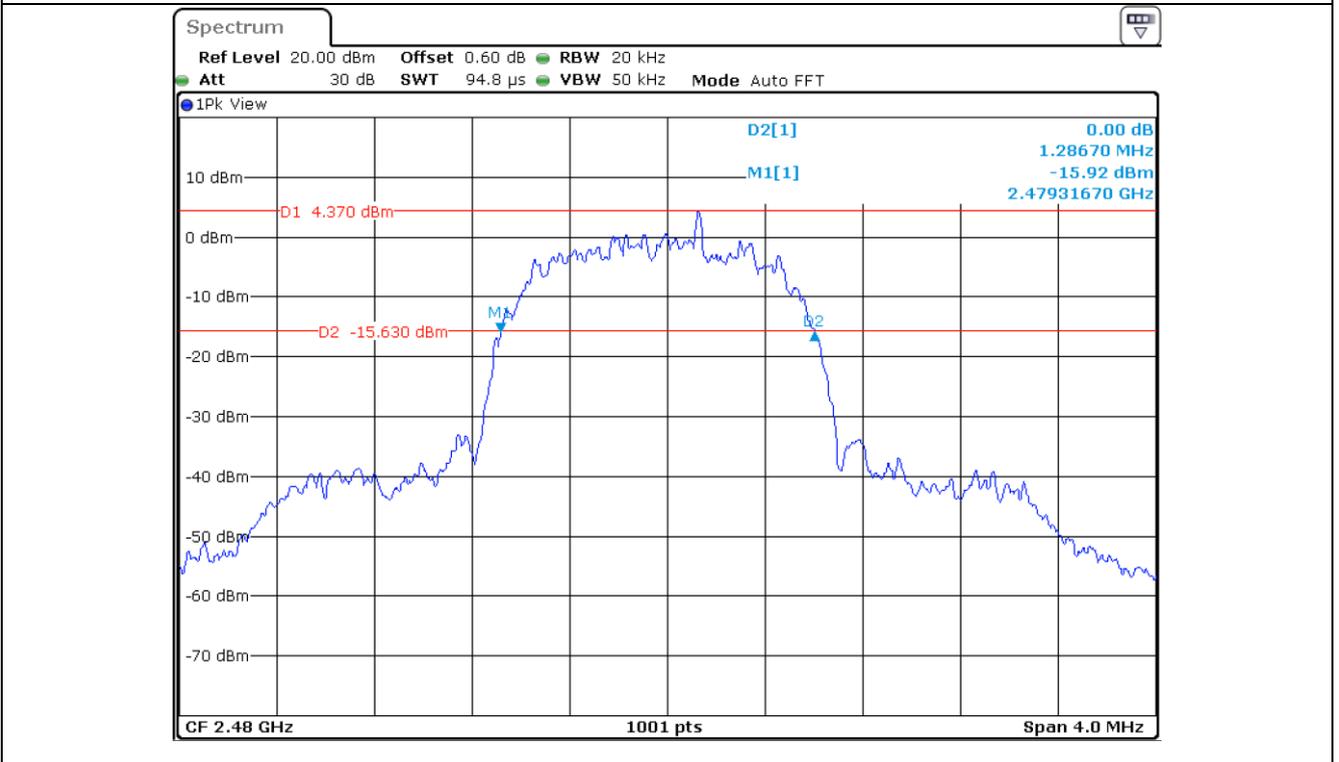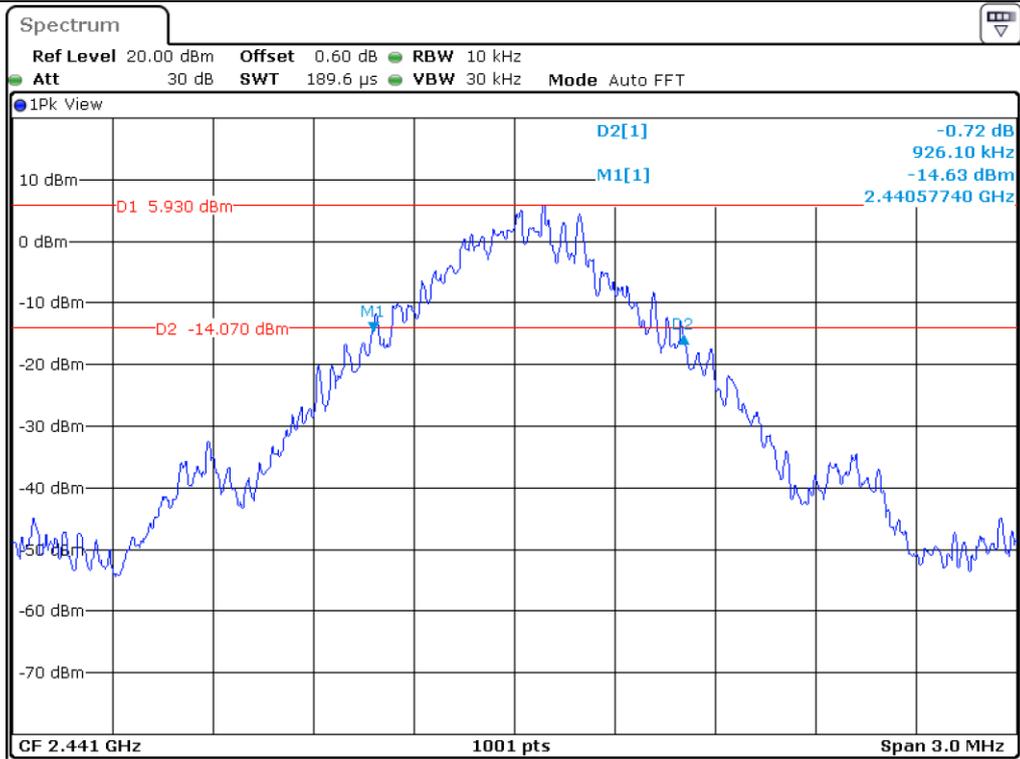It should not be reproduced except in full, without the written approval of ONETECH Corp.   OTC-TRF-RF-001(0)
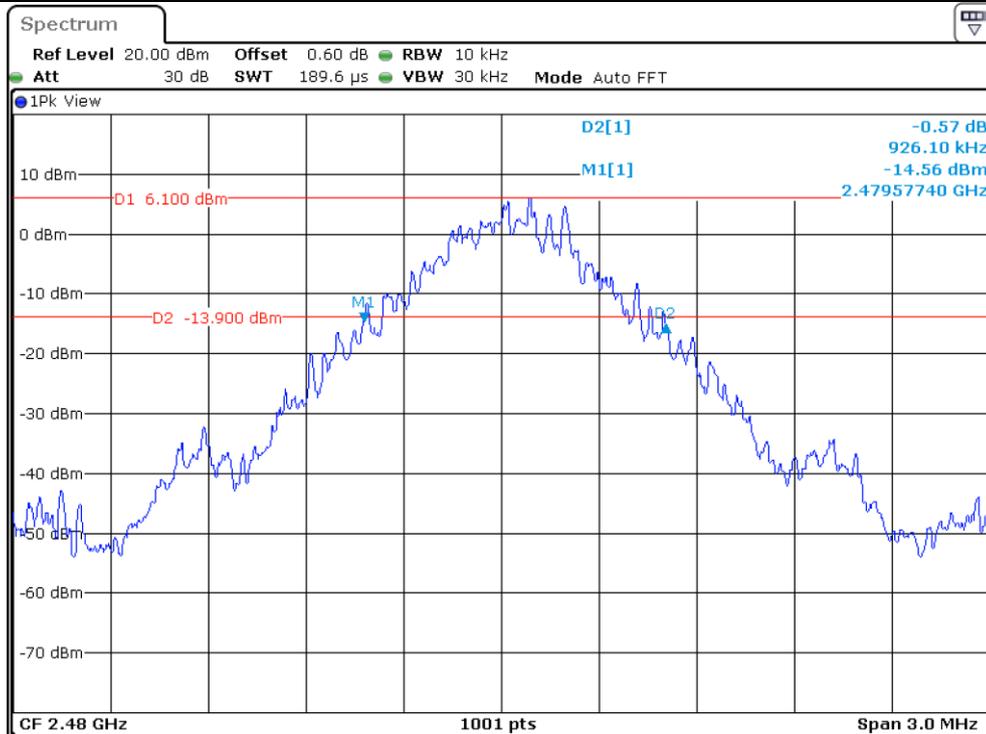
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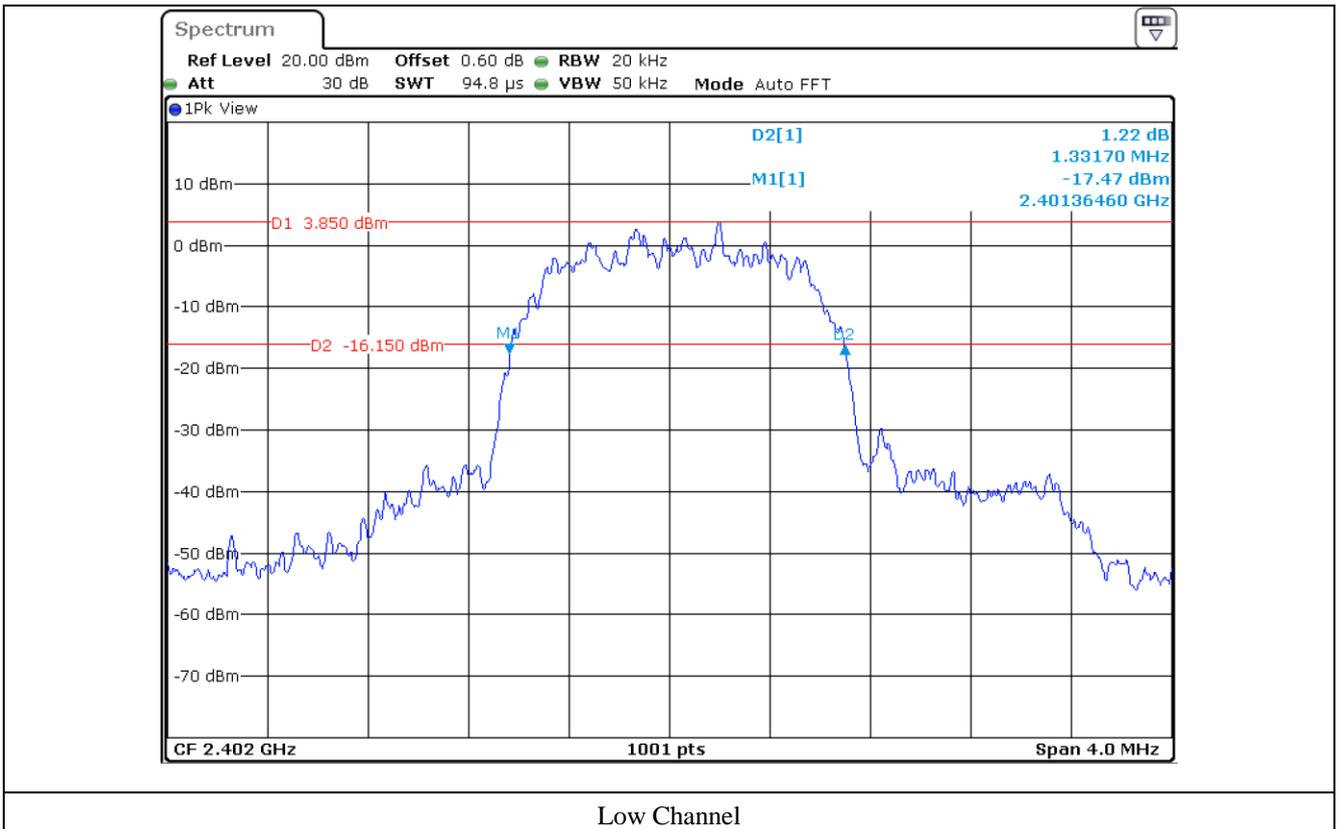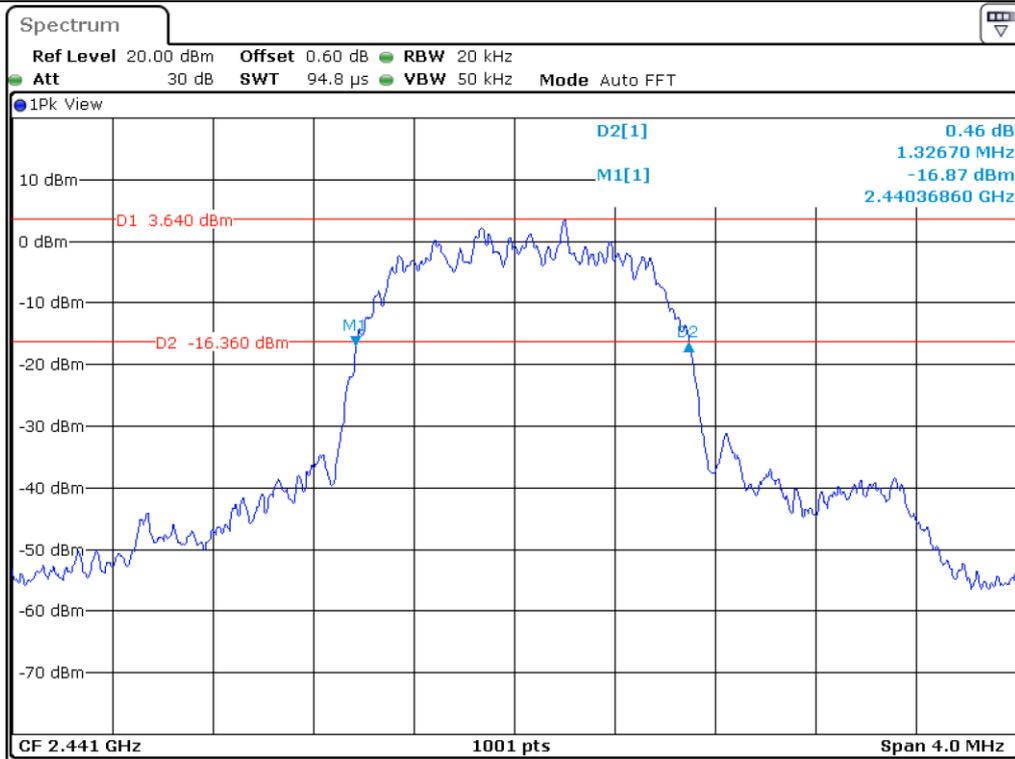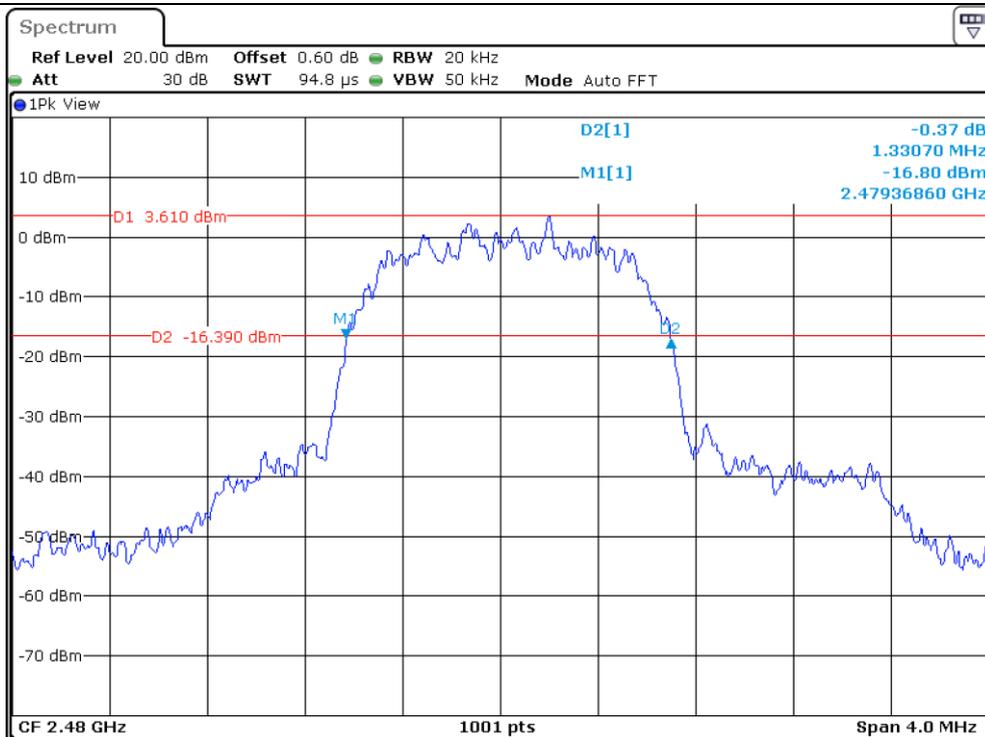
7.5.3 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 294.70
Middle	2 441.00	1 286.70
High	2 480.00	1 290.70
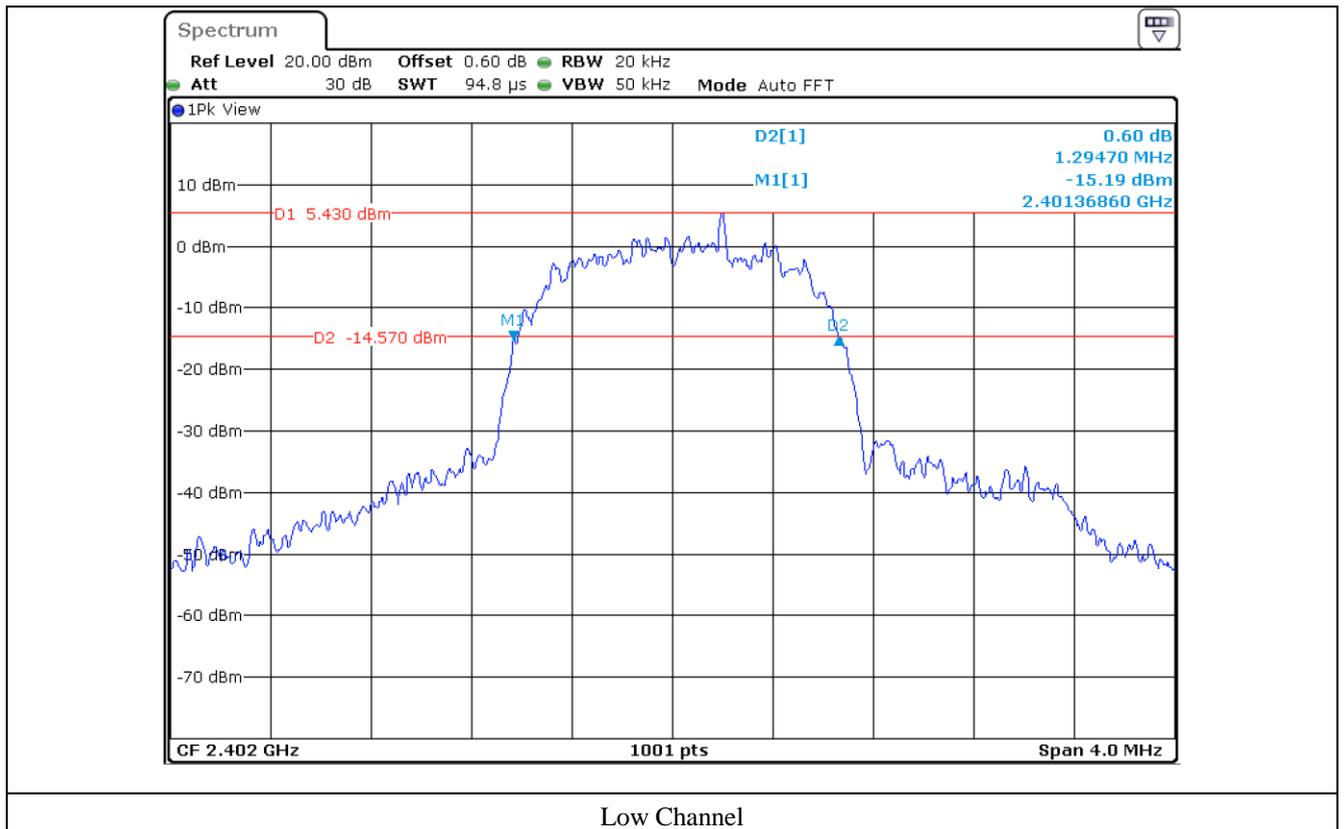
Low Channel
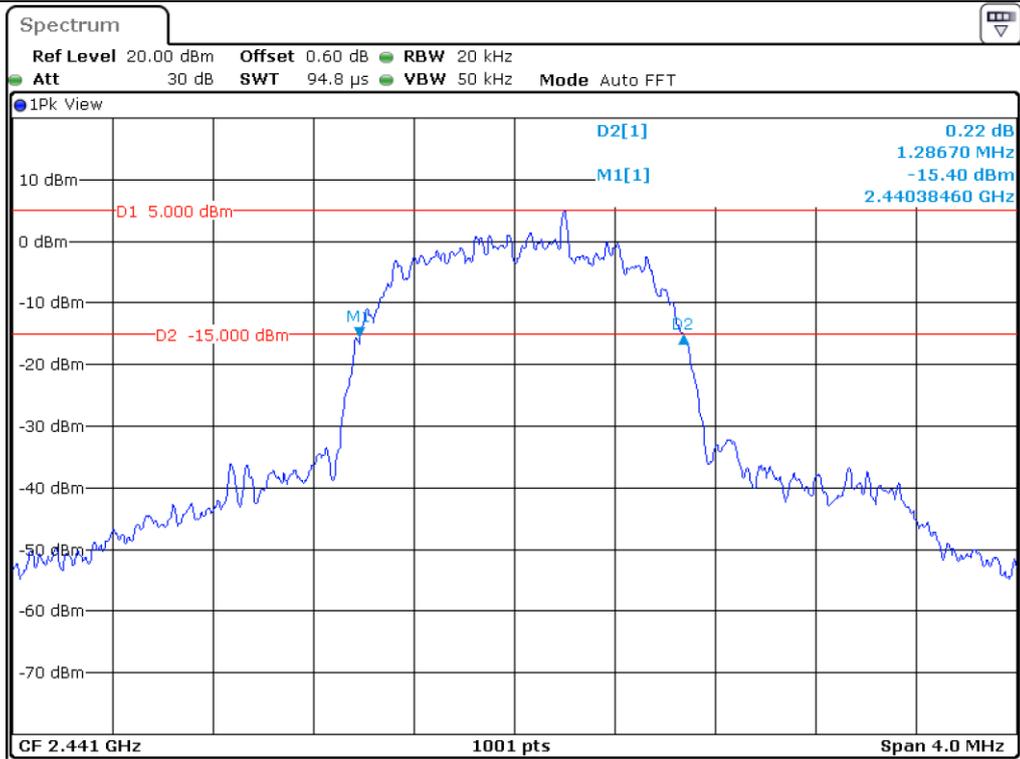
Middle Channel
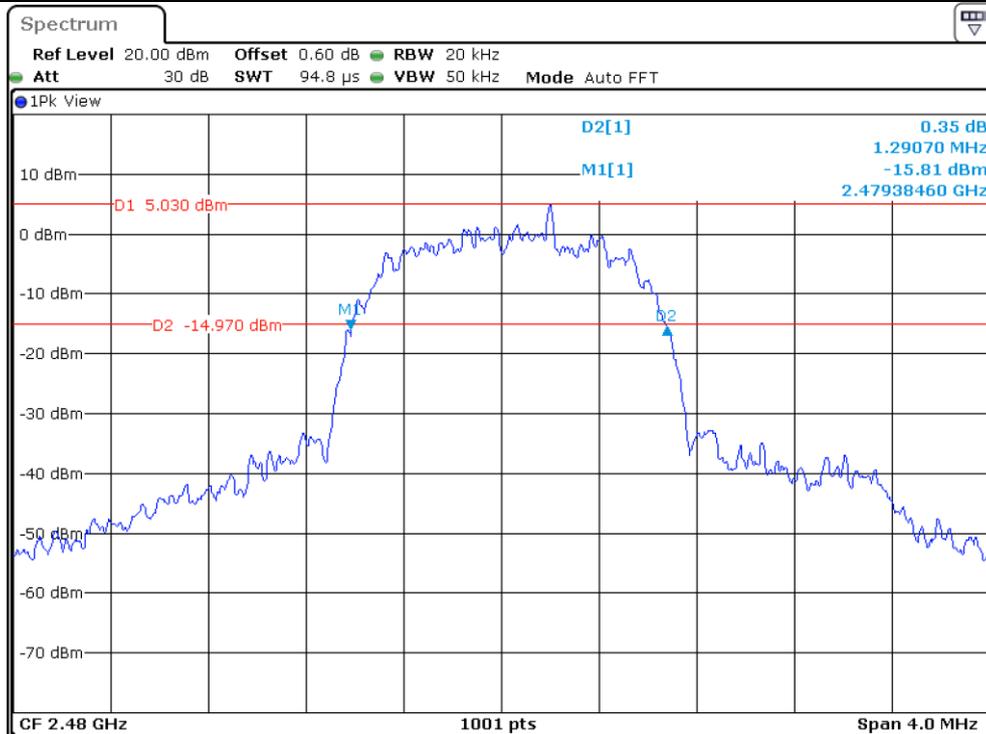
High Channel

8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature   :   23 °C

Relative humidity   :   46 % 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 Date

September 09, 2021 ~ September 17, 2021

8.4 Test data for Left Earbud

8.4.1 Test data for 1 Mbps

-. Test Result   : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	617.40	Separated by a minimum of 617.40 kHz
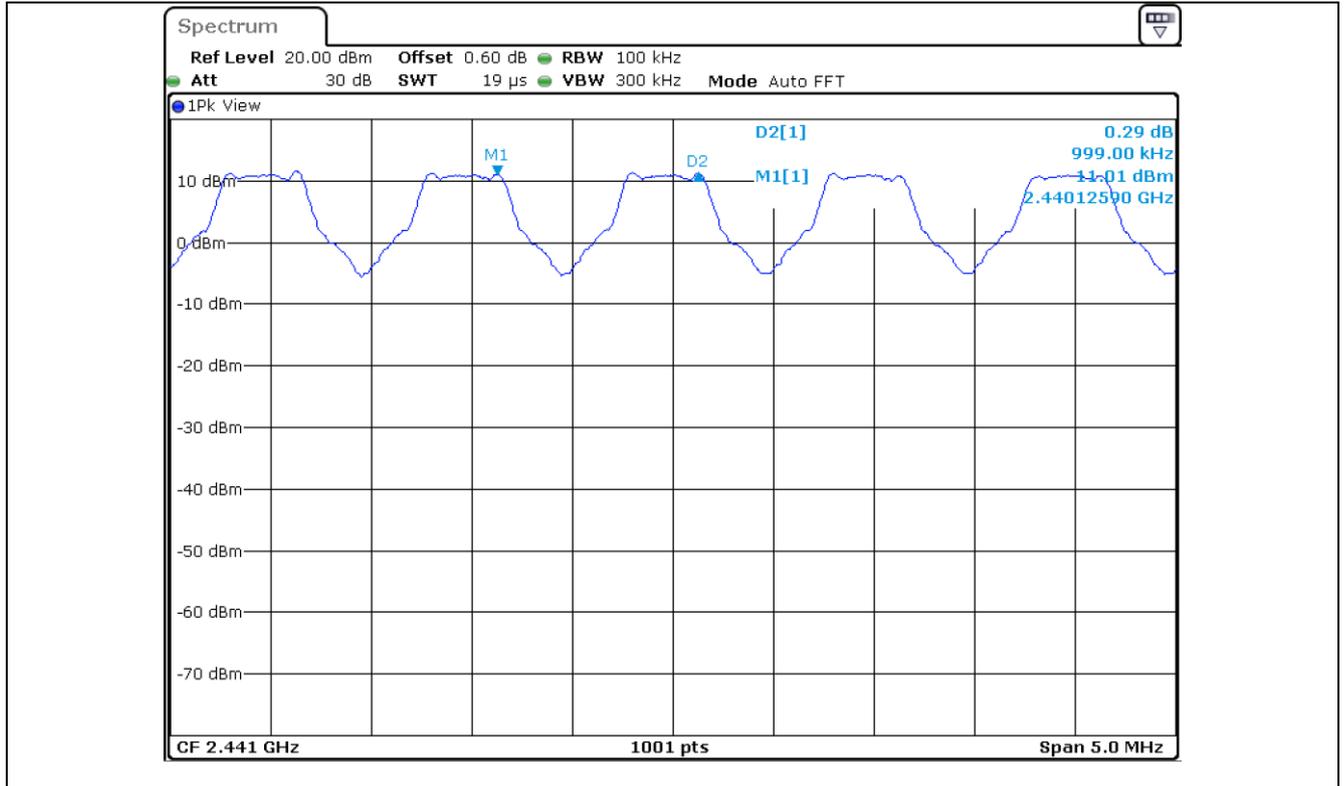
8.4.2 Test data for 2 Mbps

-. Test Result   : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	887.13	Separated by a minimum of 887.13 kHz

8.4.3 Test data for 3 Mbps

-. Test Result   : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	857.80	Separated by a minimum of 857.80 kHz
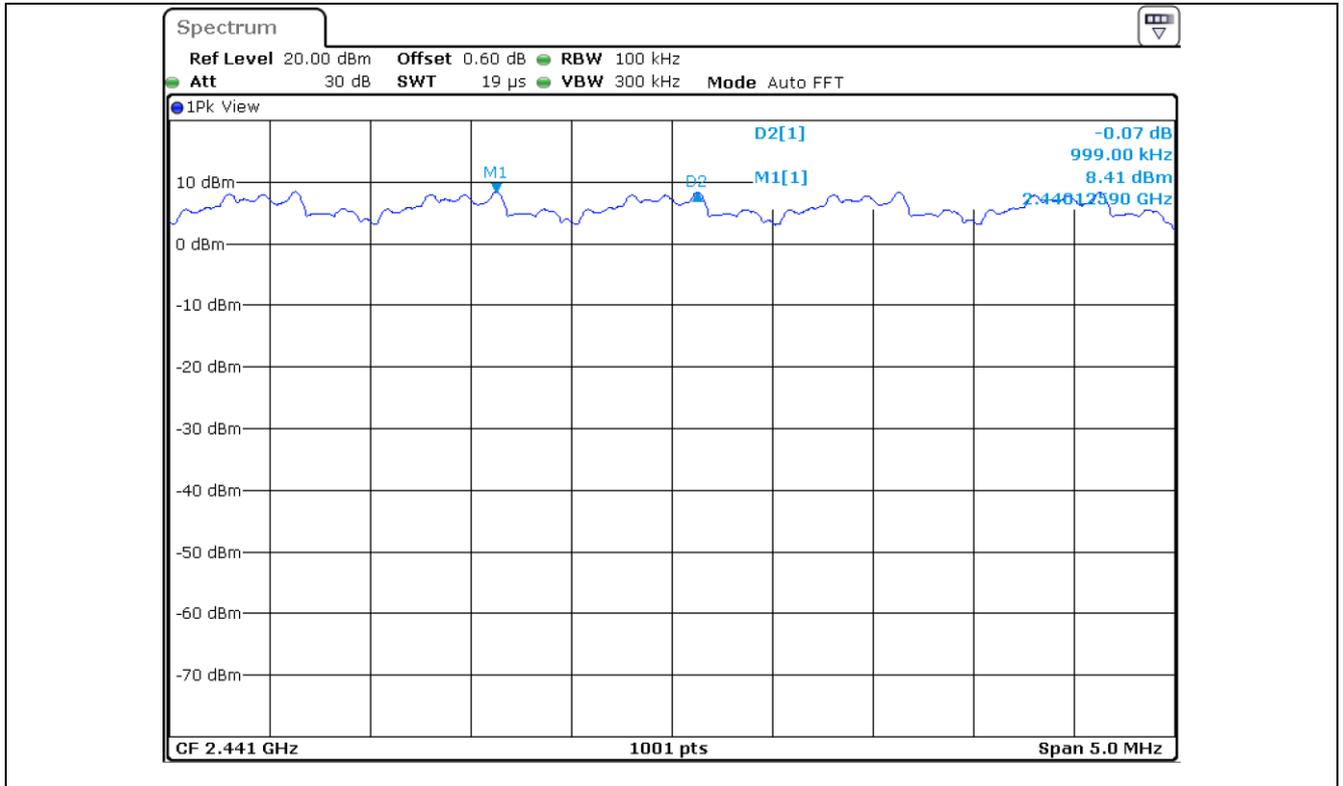
8.5 Test data for Right Earbud

8.5.1 Test data for 1 Mbps

-. Test Result   : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	617.40	Separated by a minimum of 617.40 kHz
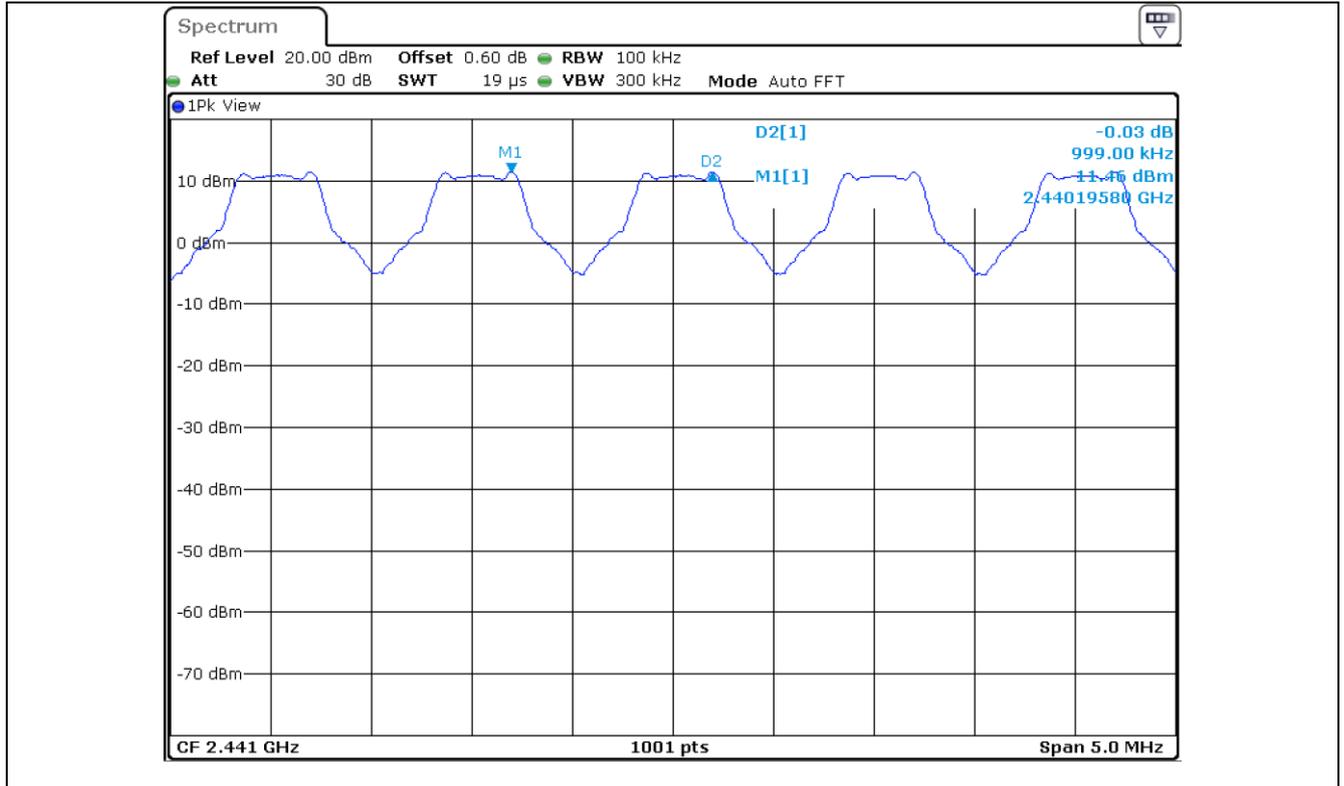
8.5.2 Test data for 2 Mbps

-. Test Result　　　　　: Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	884.47	Separated by a minimum of 884.47 kHz
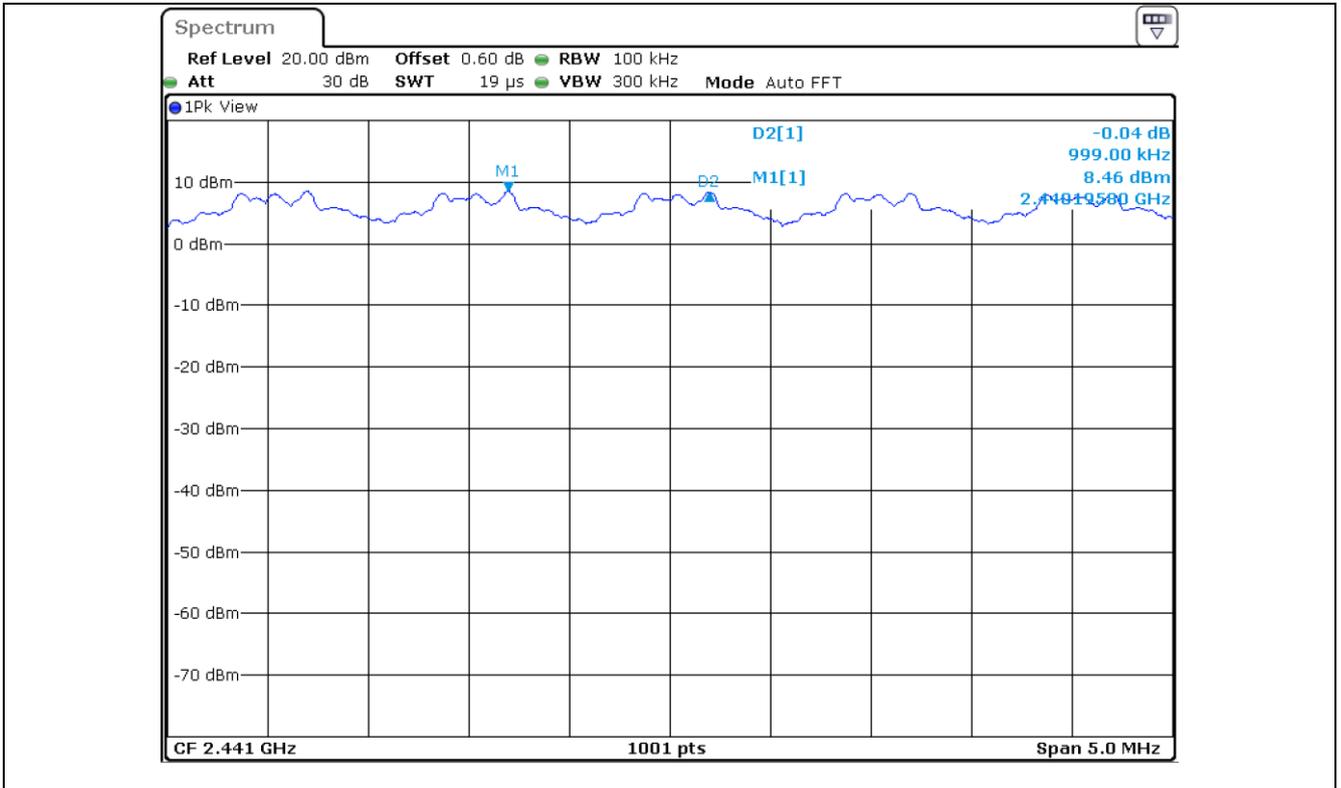
8.5.3 Test data for 3 Mbps

-. Test Result   : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	857.80	Separated by a minimum of 857.80 kHz
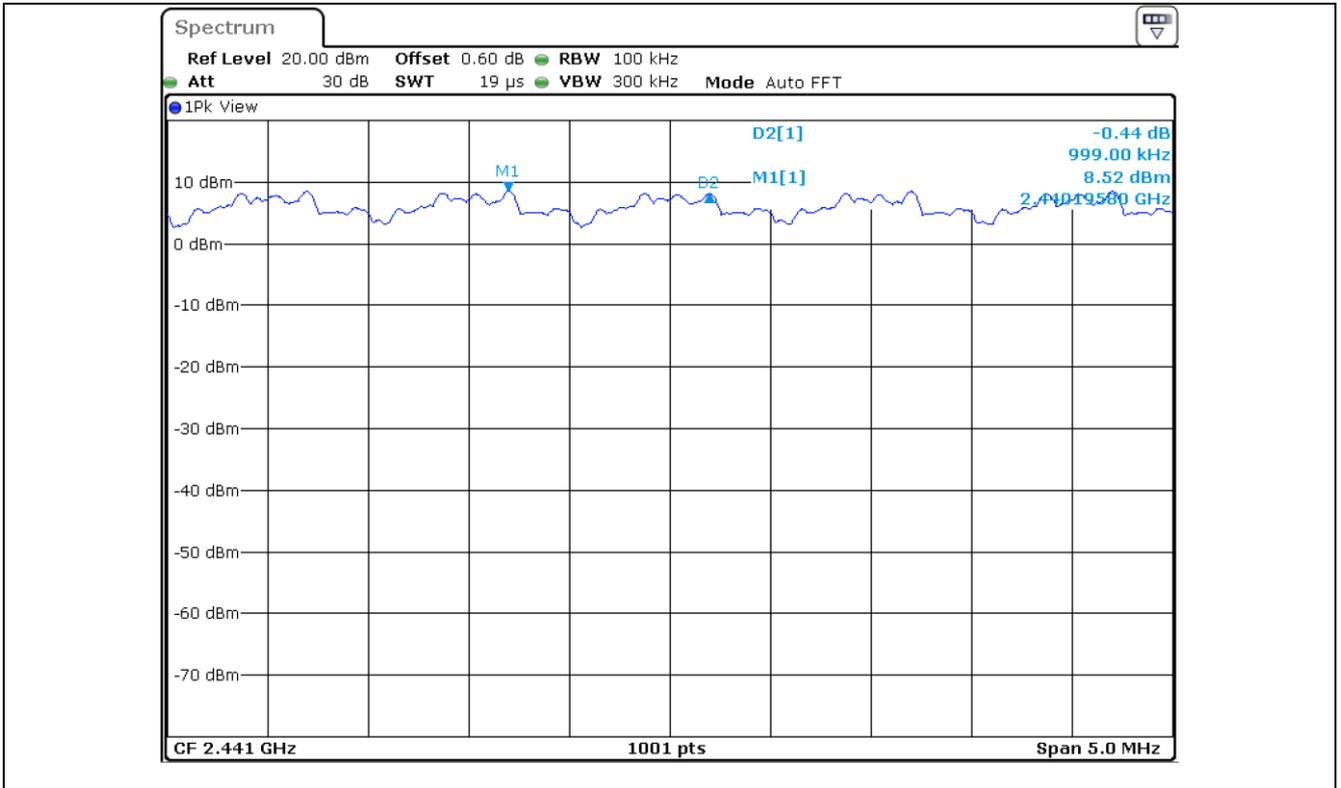
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature   :   23 °C

Relative humidity   :   46 % 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.

9.3 Test Date

September 09, 2021 ~ September 17, 2021

9.4 Test data for Left Earbud

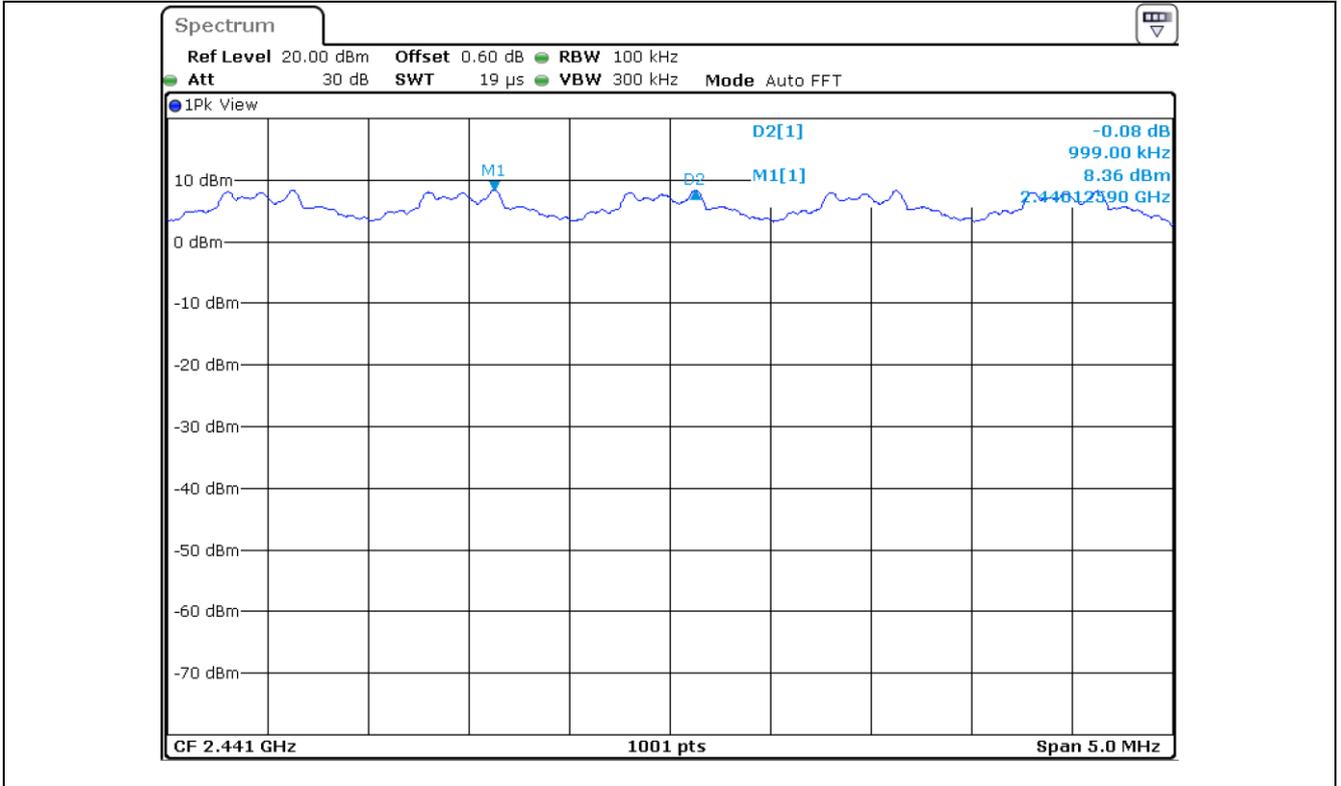### 9.4.1 Test data for 1 Mbps

-. Test Result   : Pass

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

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

Number of hopping channel: 28

Number of hopping channel: 30

Spectrum	Spectrum 2	Spectrum 3	Spectrum 4	

Ref Level 20.00 dBm   Offset 0.60 dB   RBW 100 kHz
Att   30 dB   SWT 37.9 μs   VBW 300 kHz   Mode Auto FFT

1Pk View

Start 2.46 GHz   1001 pts   Stop 2.49 GHz
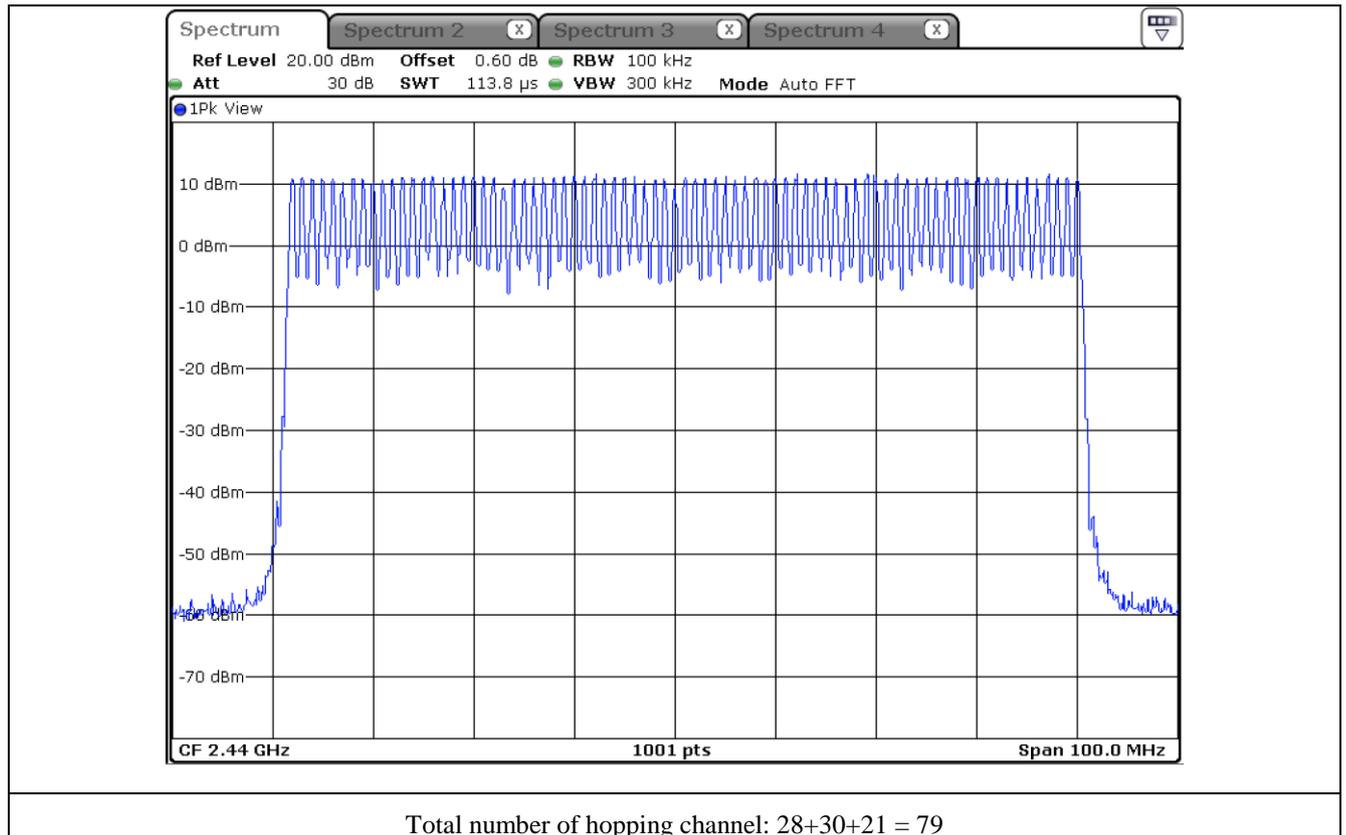
Number of hopping channel: 21

9.4.2 Test data for 2 Mbps

-. Test Result   : Pass

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

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

Spectrum | Spectrum 2 [X] | Spectrum 3 [X] | Spectrum 4 [X]

Ref Level 20.00 dBm   Offset 0.60 dB   RBW 100 kHz
Att   30 dB   SWT   56.9 µs   VBW 300 kHz   Mode Auto FFT
1Pk View

Start 2.39 GHz   1001 pts   Stop 2.43 GHz

Number of hopping channel: 28

Spectrum | Spectrum 2 [X] | Spectrum 3 [X] | Spectrum 4 [X]

Ref Level 20.00 dBm   Offset 0.60 dB   RBW 100 kHz
Att   30 dB   SWT   37.9 µs   VBW 300 kHz   Mode Auto FFT
1Pk View

Start 2.43 GHz   1001 pts   Stop 2.46 GHz

Number of hopping channel: 30

Spectrum	Spectrum 2	Spectrum 3	Spectrum 4	

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB   SWT   37.9 µs ● VBW 300 kHz   Mode Auto FFT

● 1Pk View

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

Start 2.46 GHz   1001 pts   Stop 2.49 GHz

Number of hopping channel: 21

9.4.3 Test data for 3 Mbps

-. Test Result   : Pass

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

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

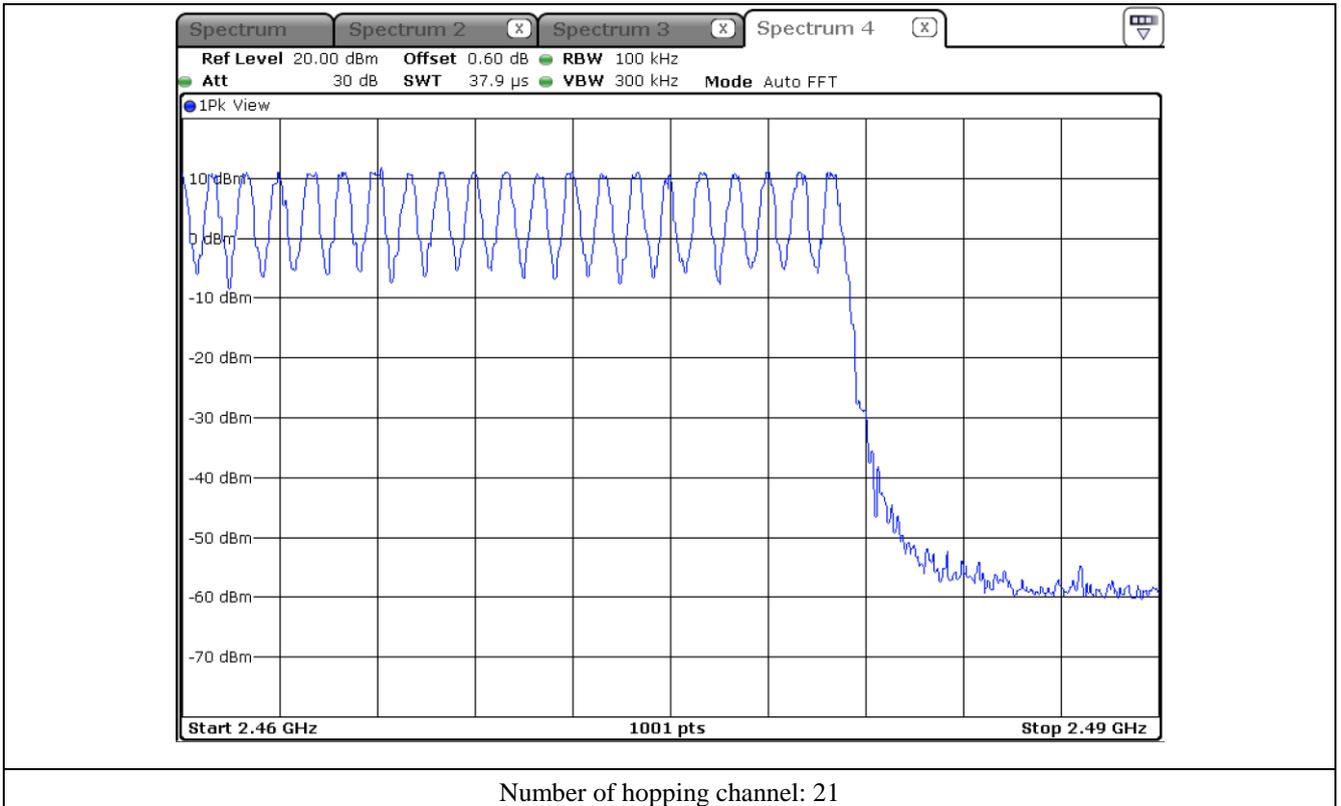Number of hopping channel: 28

Number of hopping channel: 30

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Spectrum	Spectrum 2	Spectrum 3	Spectrum 4	

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB   SWT 37.9 µs ● VBW 300 kHz   Mode Auto FFT

● 1Pk View

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

Start 2.46 GHz   1001 pts   Stop 2.49 GHz
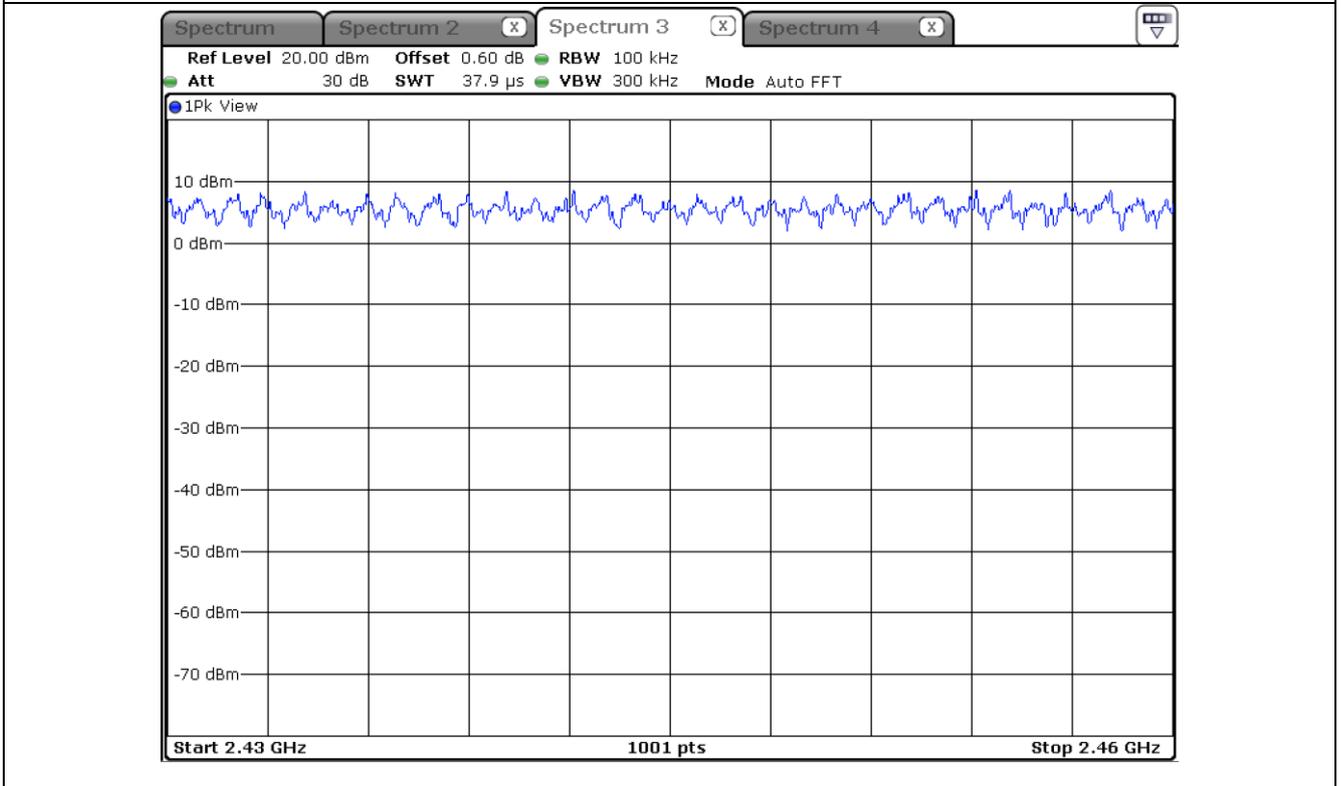
Number of hopping channel: 21

9.5 Test data for Right Earbud

9.5.1 Test data for 1 Mbps

-. Test Result   : Pass

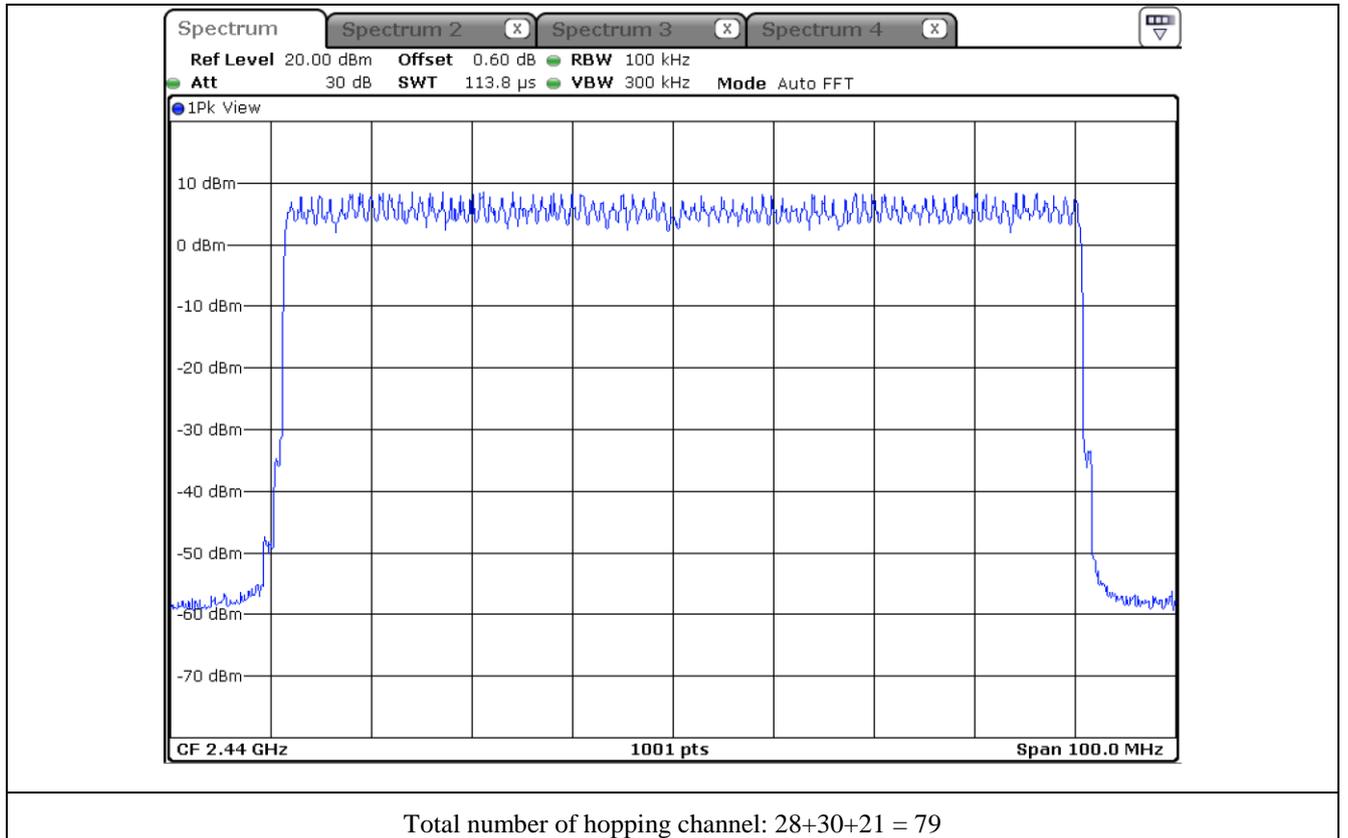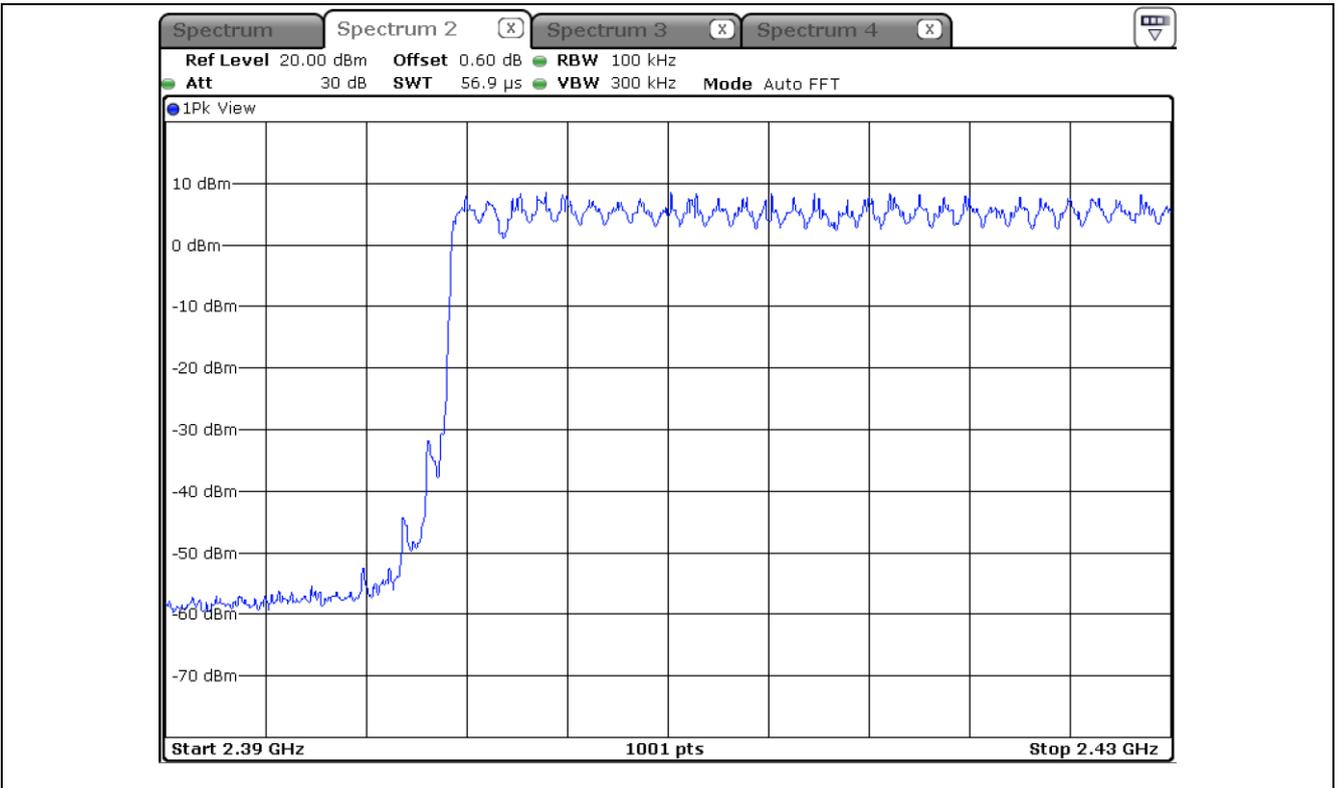| Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64

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

Spectrum Spectrum 2 (X)
Ref Level 20.00 dBm Offset 0.60 dB RBW 100 kHz
Att 30 dB SWT 56.9 µs VBW 300 kHz Mode Auto FFT
1Pk View
Start 2.39 GHz 1001 pts Stop 2.43 GHz

Number of hopping channel: 28

Spectrum Spectrum 2 (X) Spectrum 3 (X)
Ref Level 20.00 dBm Offset 0.60 dB RBW 100 kHz
Att 30 dB SWT 37.9 µs VBW 300 kHz Mode Auto FFT
1Pk View
Start 2.43 GHz 1001 pts Stop 2.46 GHz

Number of hopping channel: 30

Spectrum	Spectrum 2	Spectrum 3	Spectrum 4	

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 100 kHz
Att   30 dB   SWT   37.9 µs ● VBW 300 kHz   Mode Auto FFT
● 1Pk View

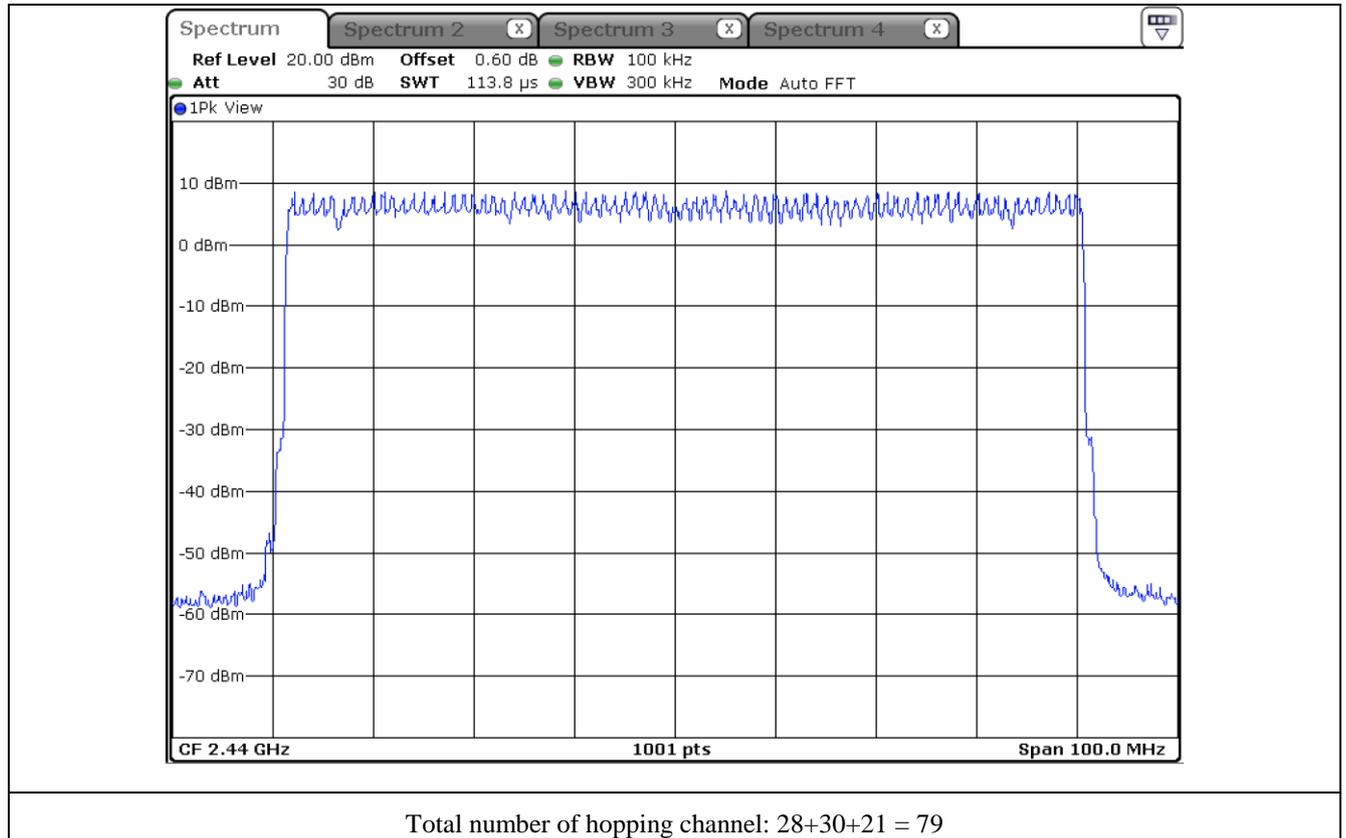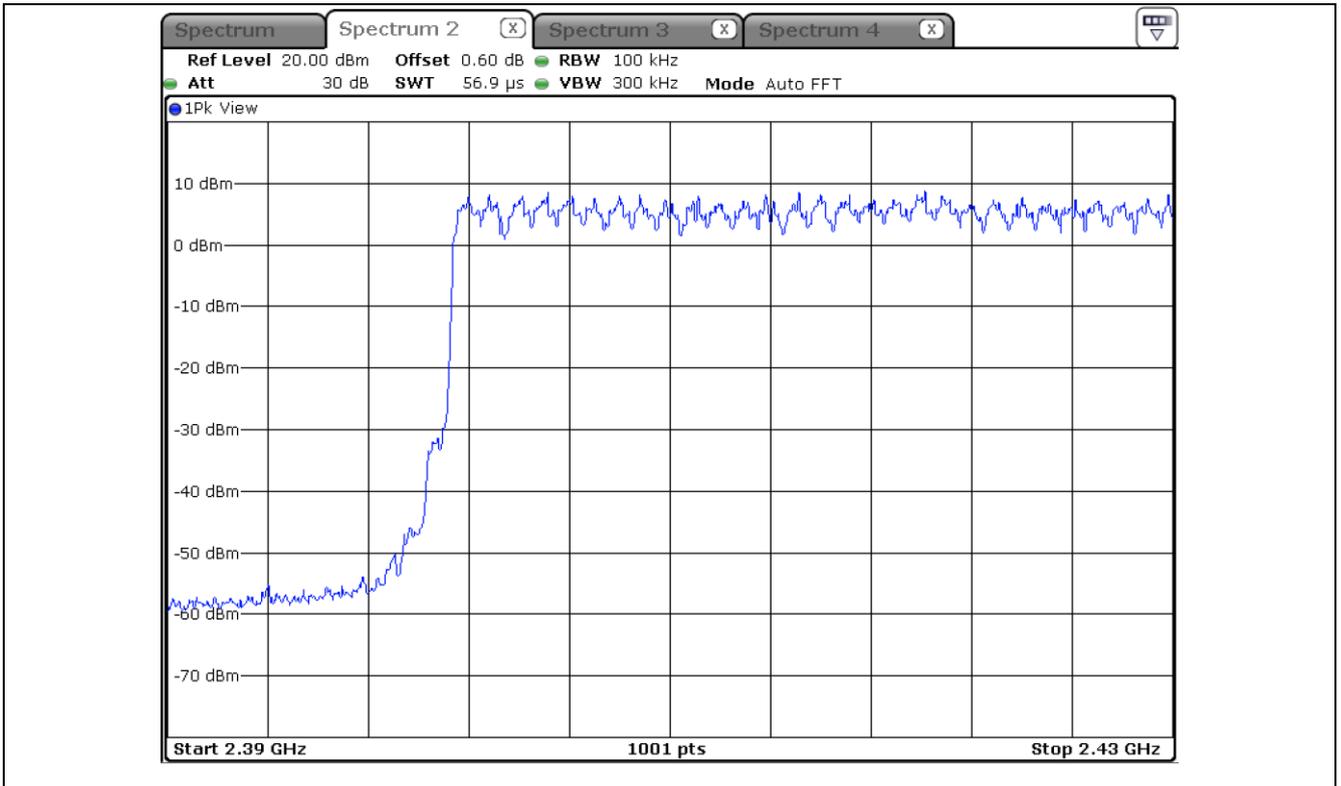Start 2.46 GHz   1001 pts   Stop 2.49 GHz

Number of hopping channel: 21

9.5.2 Test data for 2 Mbps

-. Test Result   : Pass

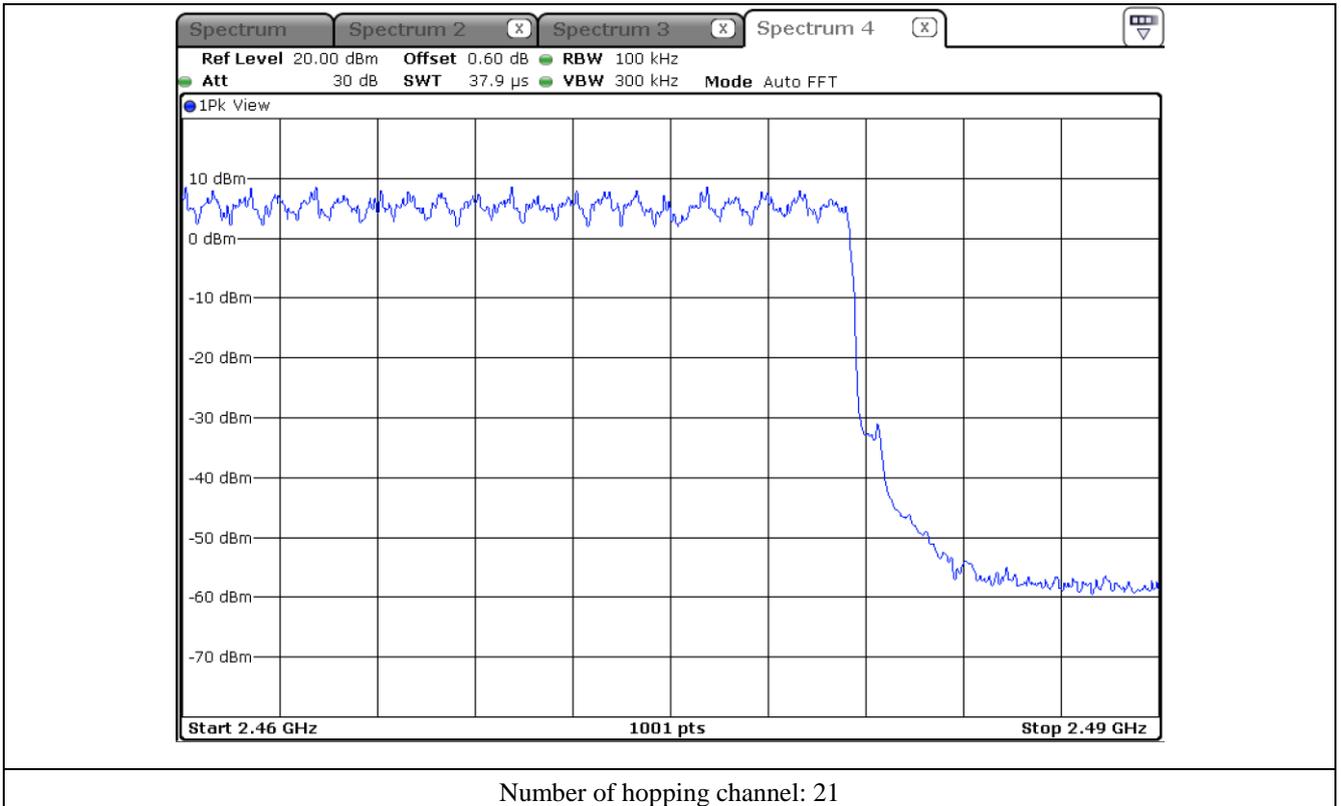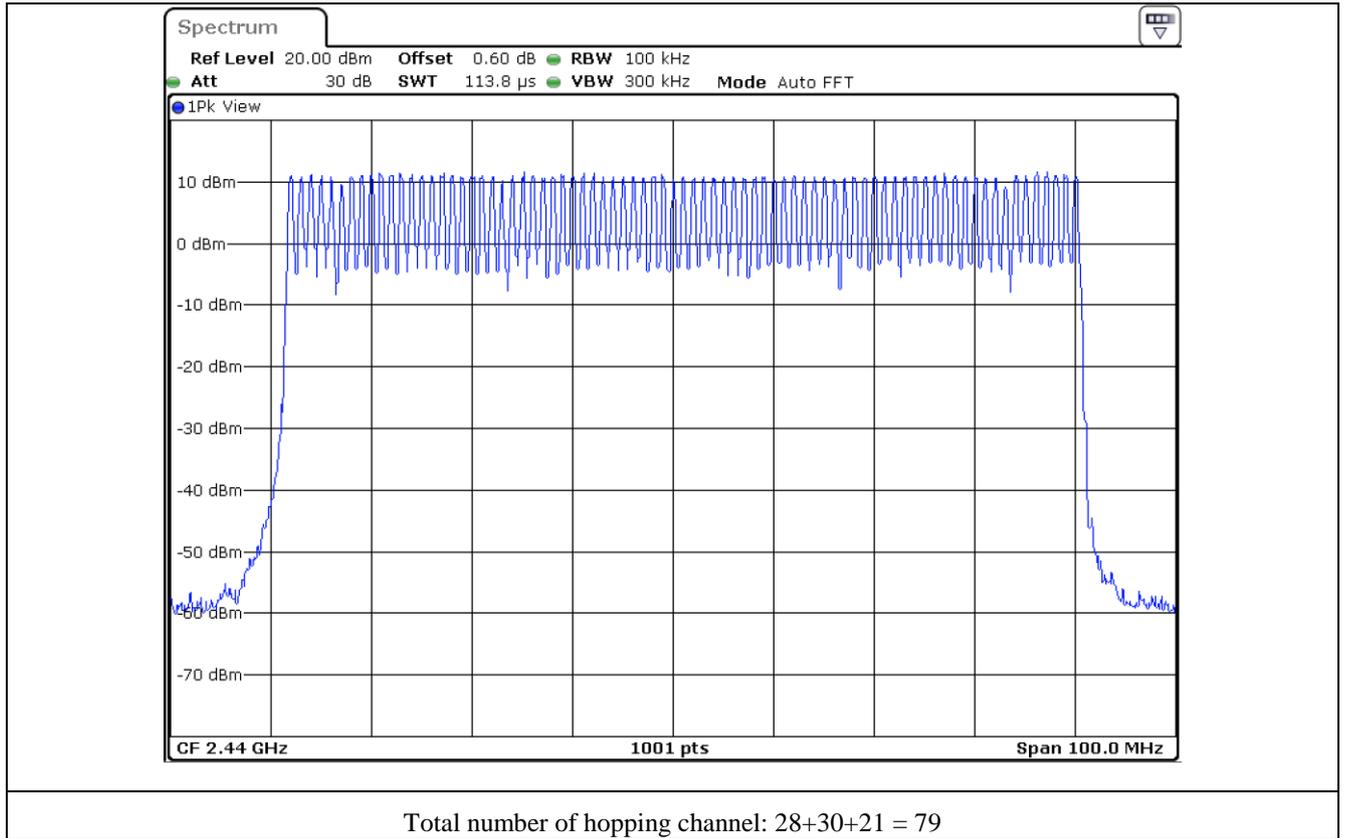| Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64

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

Spectrum	Spectrum 2 [x]	Spectrum 3 [x]	Spectrum 4 [x]	

Ref Level 20.00 dBm Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB SWT   56.9 μs ● VBW 300 kHz Mode Auto FFT
●1Pk View

Start 2.39 GHz   1001 pts   Stop 2.43 GHz

Number of hopping channel: 28

Spectrum	Spectrum 2 [x]	Spectrum 3 [x]	Spectrum 4 [x]	

Ref Level 20.00 dBm Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB SWT   37.9 μs ● VBW 300 kHz Mode Auto FFT
●1Pk View

Start 2.43 GHz   1001 pts   Stop 2.46 GHz

Number of hopping channel: 30

Spectrum	Spectrum 2 [x]	Spectrum 3 [x]	Spectrum 4 [x]	

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB   SWT 37.9 µs ● VBW 300 kHz   Mode Auto FFT

● 1Pk View

10 dBm

0 dBm

-10 dBm

-20 dBm

-30 dBm

-40 dBm

-50 dBm

-60 dBm

-70 dBm

Start 2.46 GHz   1001 pts   Stop 2.49 GHz
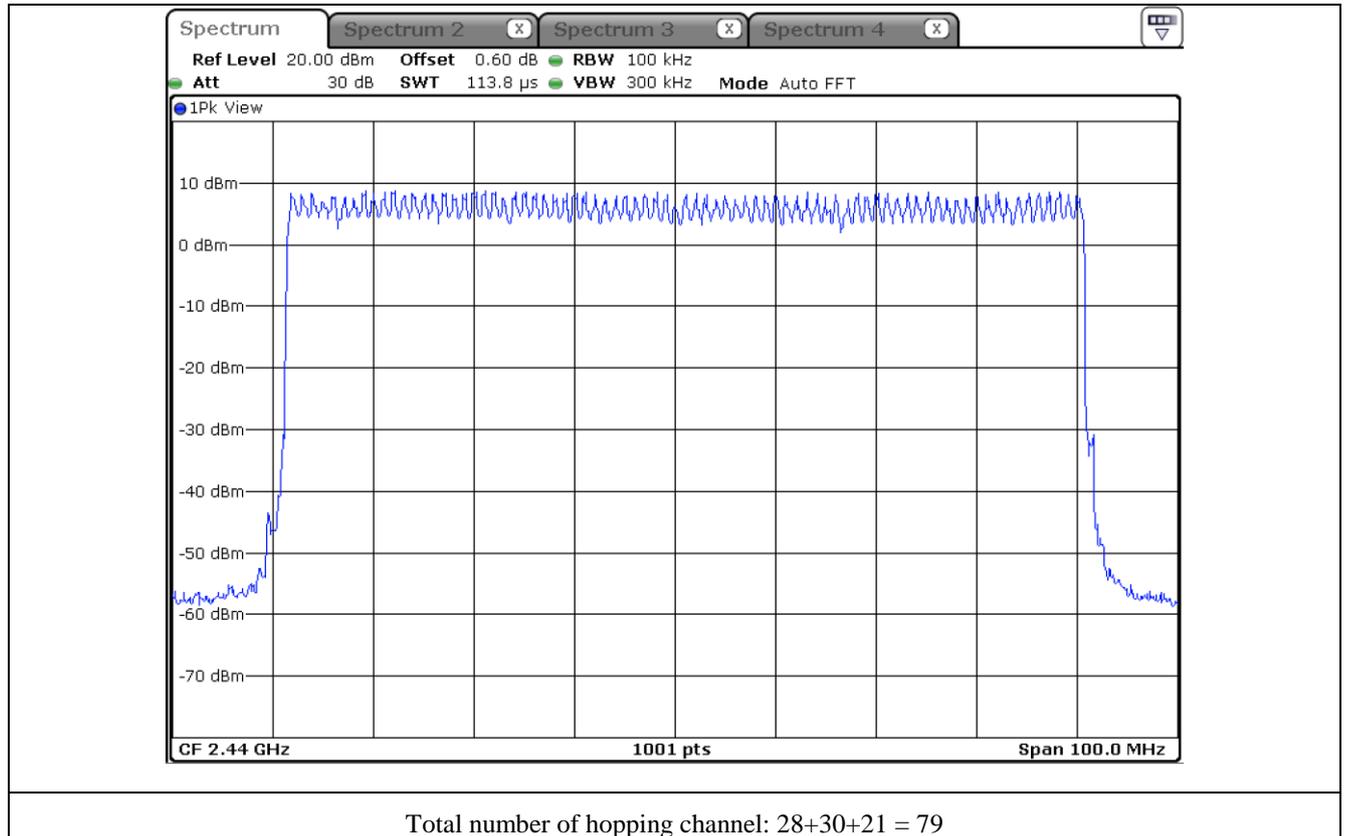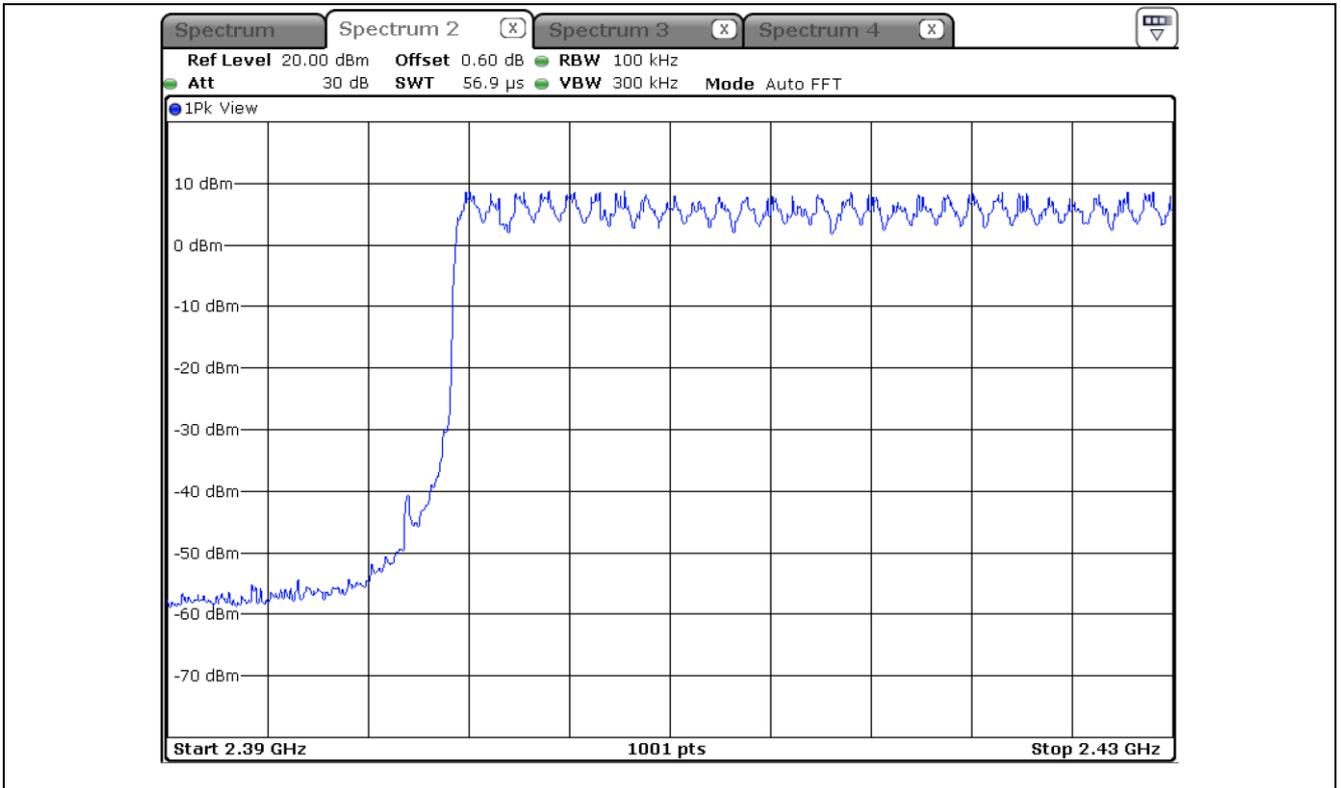
Number of hopping channel: 21

9.5.3 Test data for 3 Mbps

-. Test Result   : Pass

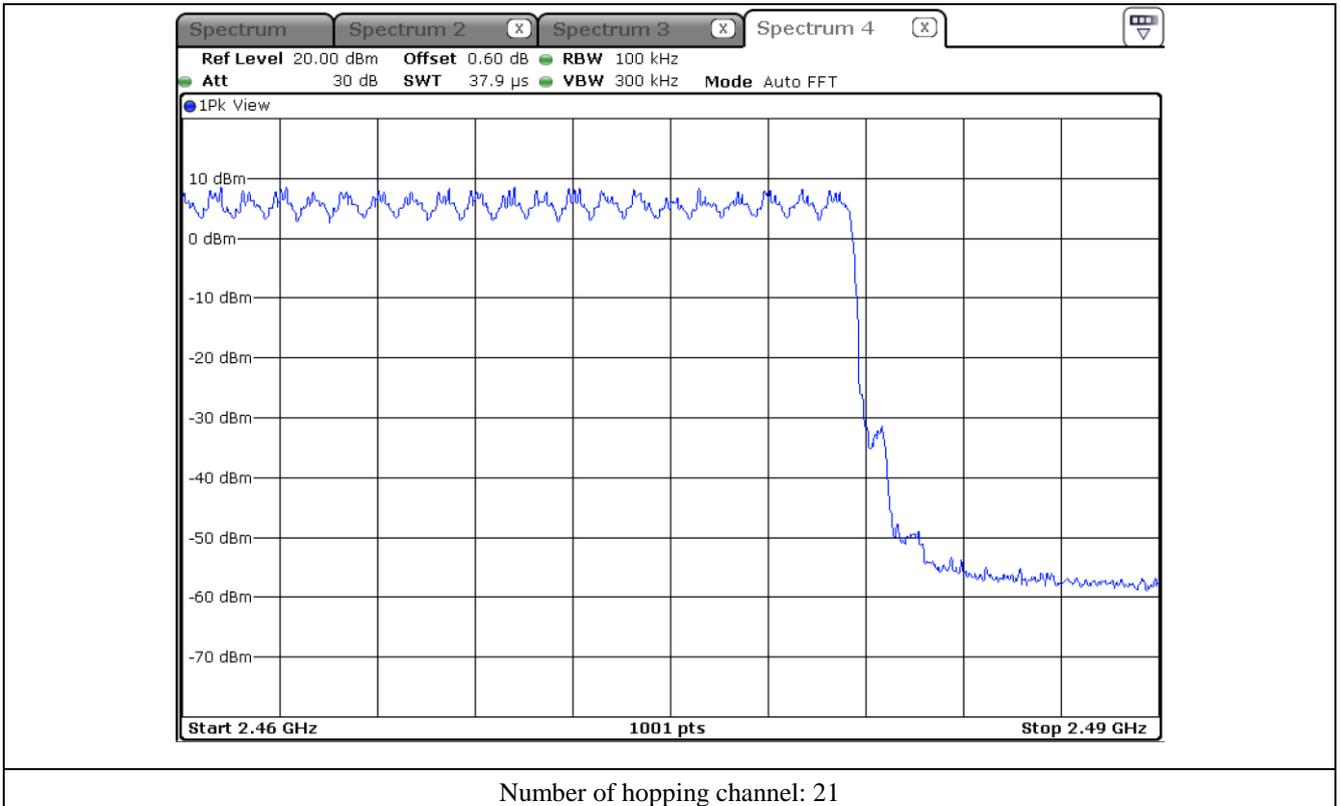| Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
3 Mbps	79	Minimum of 15	64

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

Number of hopping channel: 28

Number of hopping channel: 30

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Spectrum	Spectrum 2 ⓧ	Spectrum 3 ⓧ	Spectrum 4 ⓧ	

Ref Level 20.00 dBm Offset 0.60 dB ● RBW 100 kHz
● Att   30 dB SWT 37.9 μs ● VBW 300 kHz Mode Auto FFT
● 1Pk View

10 dBm

0 dBm

-10 dBm

-20 dBm

-30 dBm

-40 dBm

-50 dBm

-60 dBm

-70 dBm

Start 2.46 GHz   1001 pts   Stop 2.49 GHz

Number of hopping channel: 21

10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature   :   23 °C

Relative humidity   :   46 % 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 ne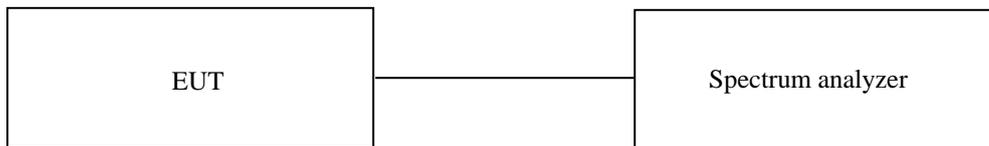ar the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.

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

10.3 Test Date

September 09, 2021 ~ September 17, 2021

10.4 Test data for Left Earbud

10.4.1 Test data for 1 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.
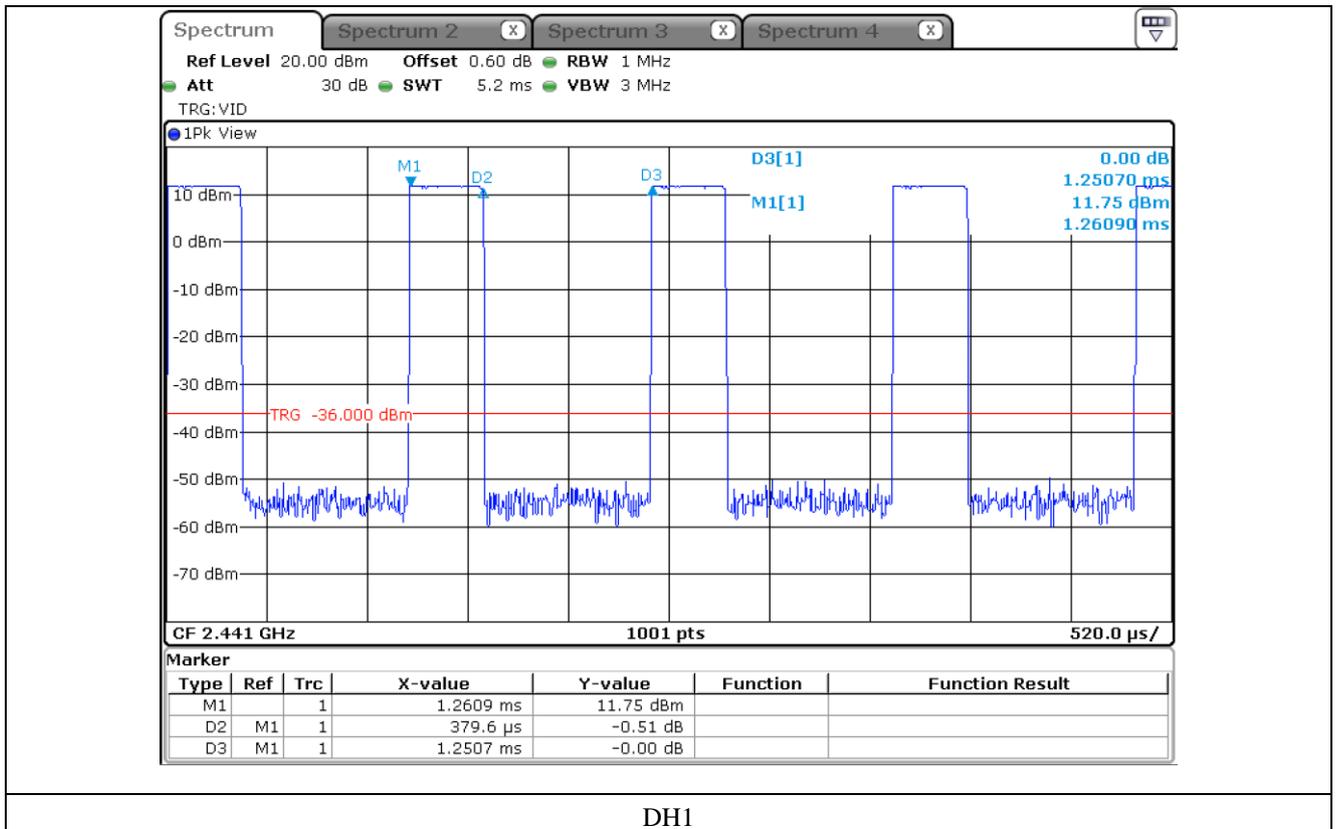
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel 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	0.38	10.13	31.60	121.64	400.00	
DH3	1.64	5.06	31.60	262.23	400.00	PASS
DH5	2.89	3.38	31.60	308.68	400.00	

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.

DH1

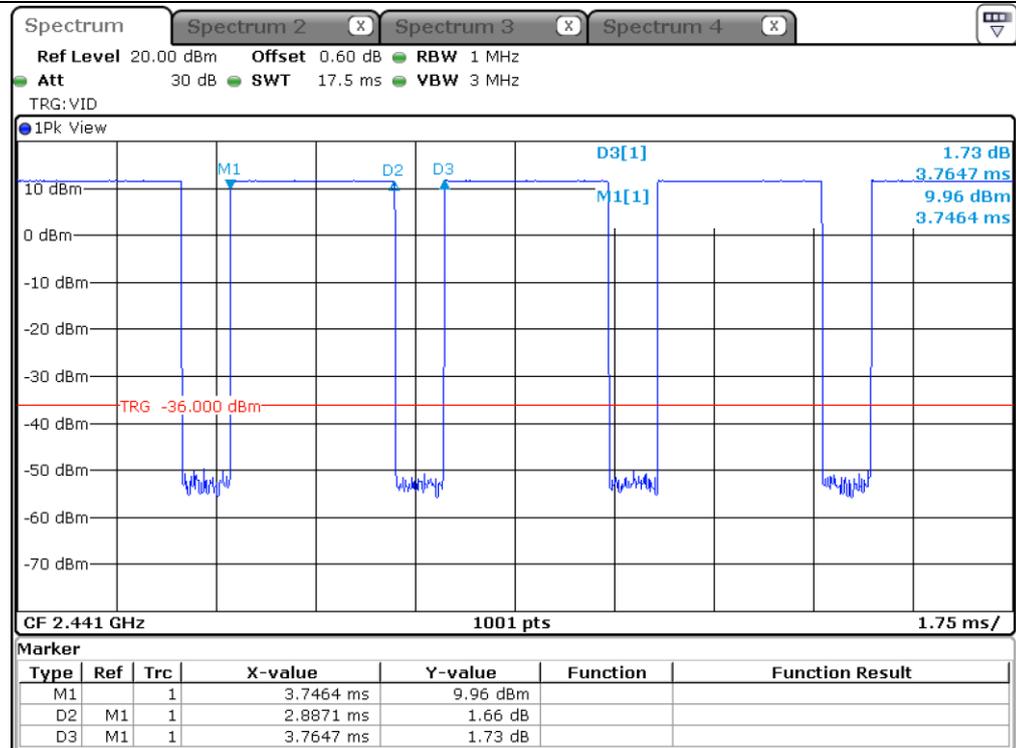**Spectrum** | Spectrum 2 | Spectrum 3 | Spectrum 4

Ref Level 20.00 dBm　Offset 0.60 dB　RBW 1 MHz
Att　30 dB　SWT　11 ms　VBW 3 MHz
TRG:VID
1Pk View

D3[1]　0.00 dB　2.5047 ms
M1[1]　11.73 dBm　2.5039 ms

TRG -36.000 dBm

CF 2.441 GHz　　1001 pts　　1.1 ms/

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.5039 ms	11.73 dBm		
D2	M1	1	1.6446 ms	-0.51 dB		
D3	M1	1	2.5047 ms	0.00 dB		

DH3

Spectrum | Spectrum 2 | Spectrum 3 | Spectrum 4

Ref Level 20.00 dBm　Offset 0.60 dB　RBW 1 MHz
Att　30 dB　SWT　17.5 ms　VBW 3 MHz
TRG:VID
1Pk View

D3[1]　1.73 dB　3.7647 ms
M1[1]　9.96 dBm　3.7464 ms

TRG -36.000 dBm

CF 2.441 GHz　　1001 pts　　1.75 ms/

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	3.7464 ms	9.96 dBm		
D2	M1	1	2.8871 ms	1.66 dB		
D3	M1	1	3.7647 ms	1.73 dB		

DH5

10.4.2 Test data for 2 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs with 79 channels.
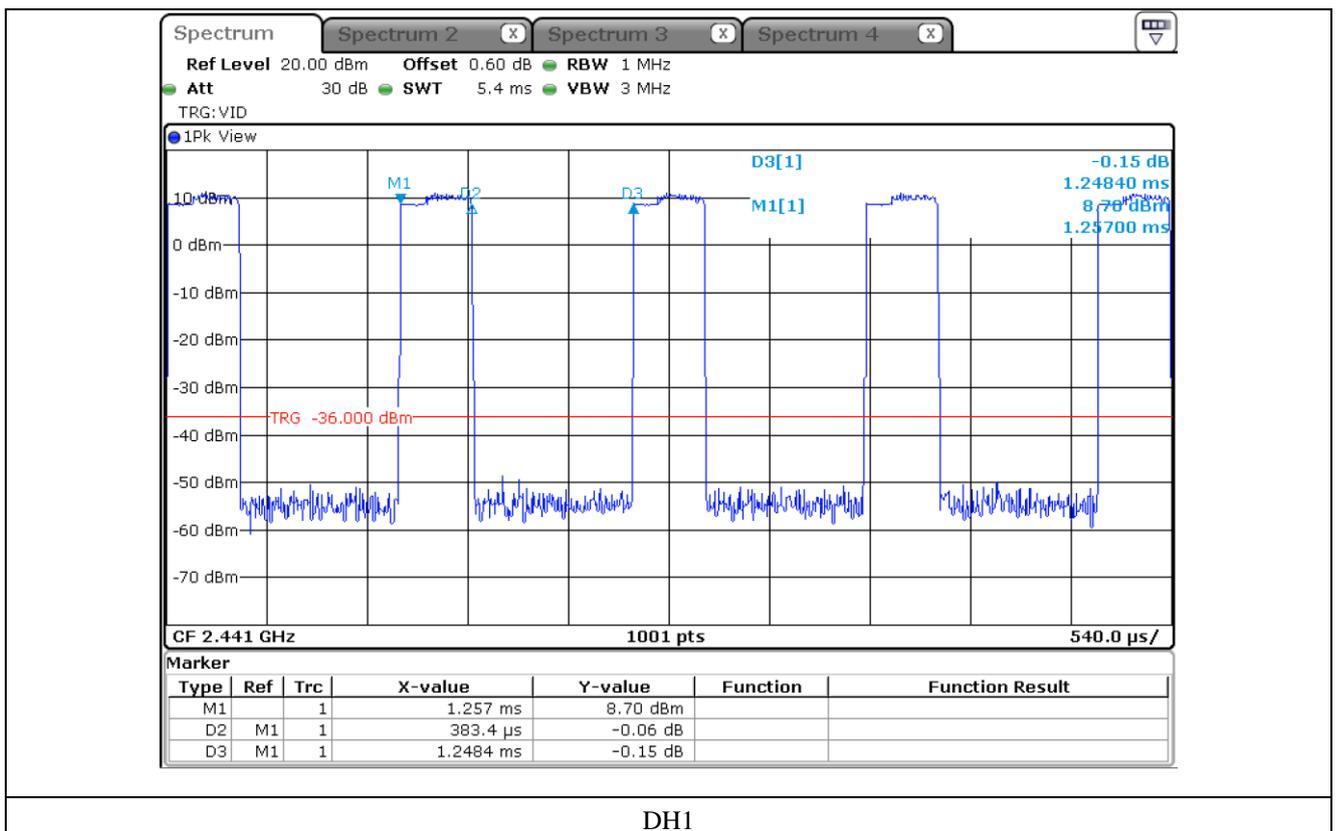
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel 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.

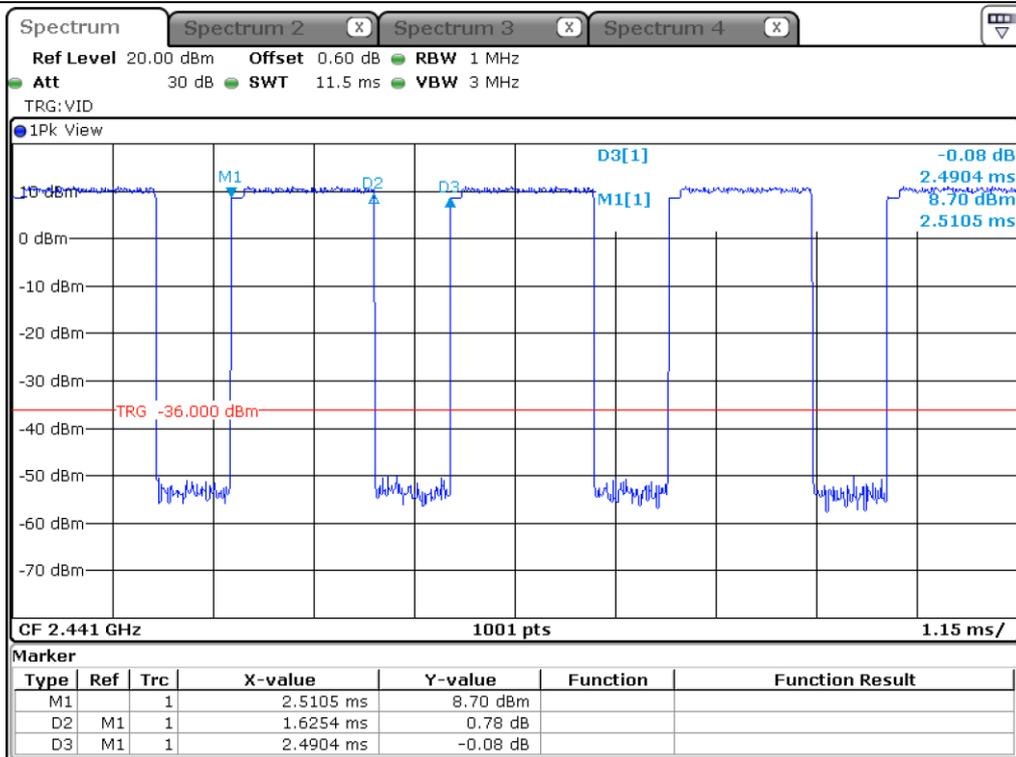| Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	
DH3	1.63	5.06	31.60	260.63	400.00	PASS
DH5	2.89	3.38	31.60	308.68	400.00	

Total dwell time is calculated as following.

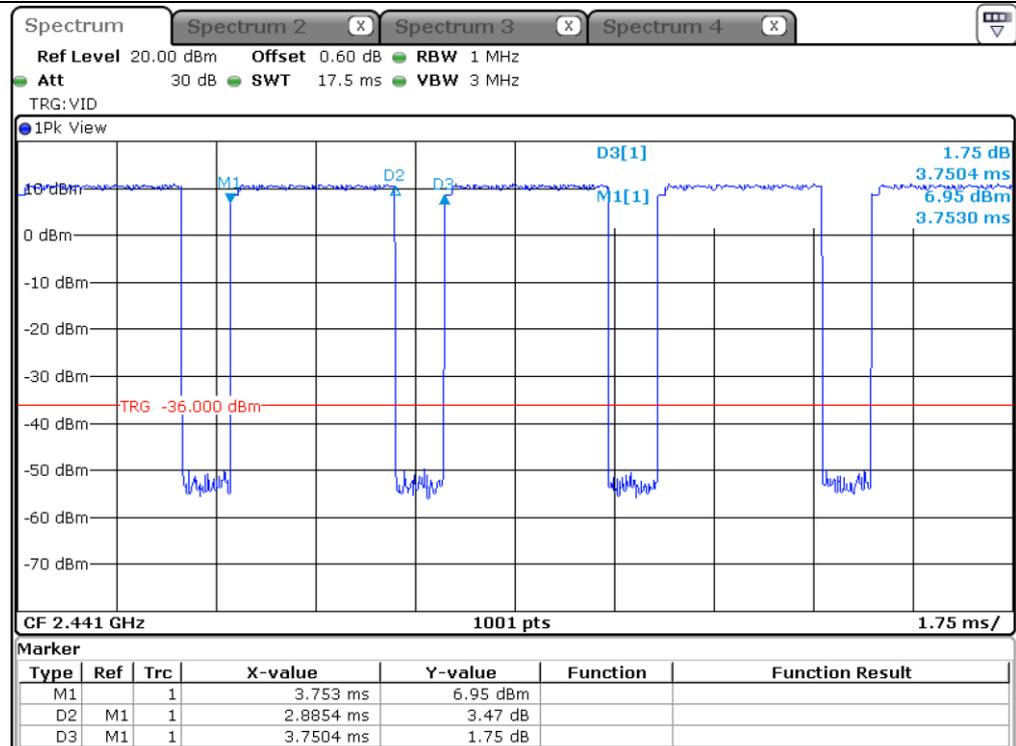Total Dwell Time = Pulse time * Hops per second with channels * period time

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

DH1

DH3

DH5

10.4.3 Test data for 3 Mbps

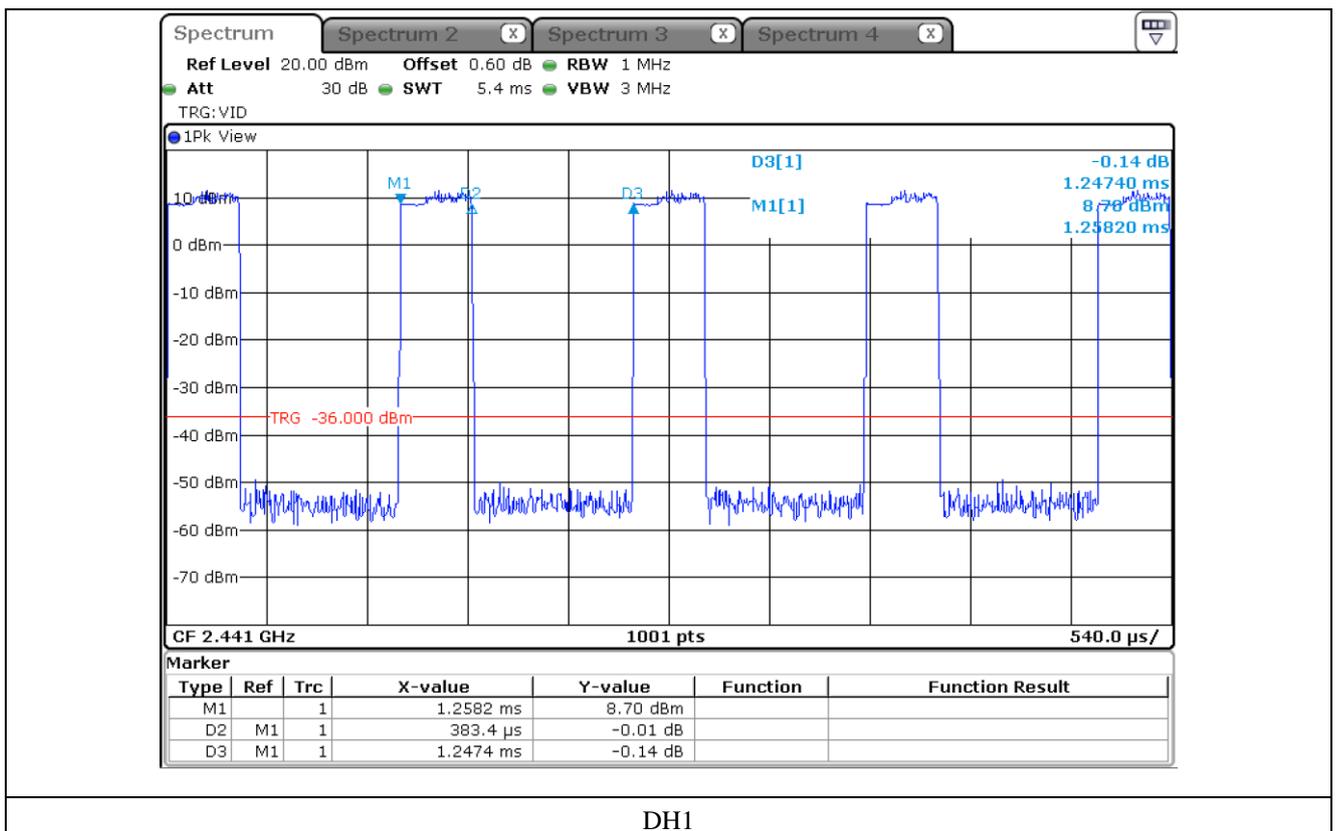The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs with 79 channels.

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.

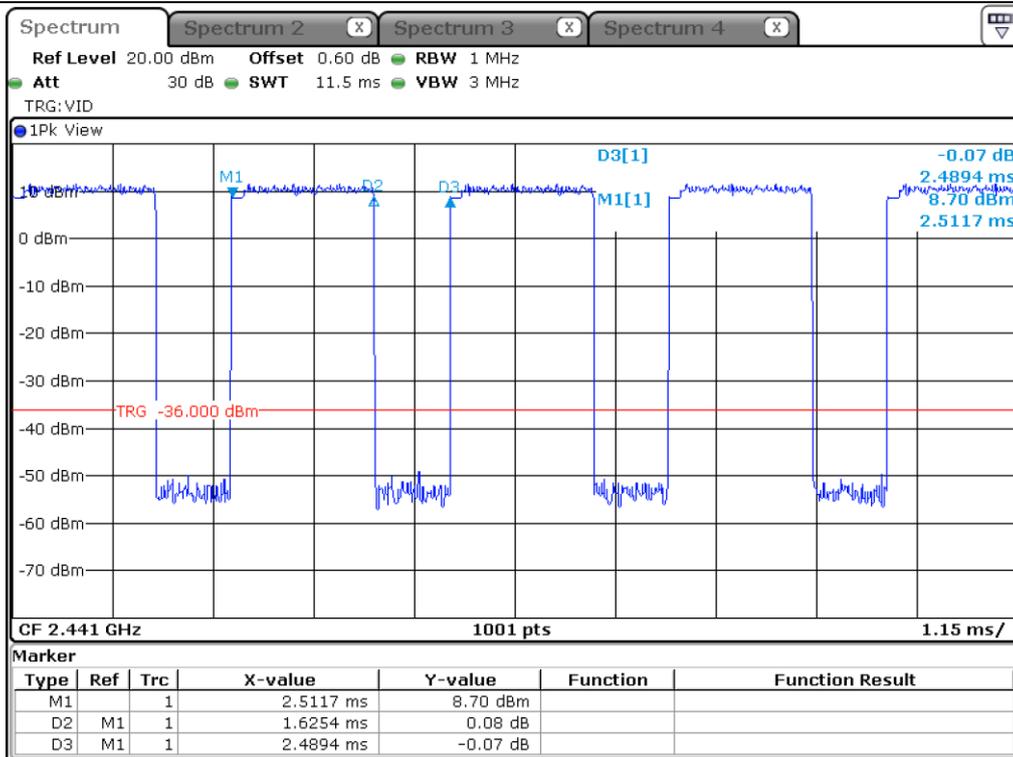| Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	
DH3	1.63	5.06	31.60	260.63	400.00	PASS
DH5	2.90	3.38	31.60	309.74	400.00	

Total dwell time is calculated as following.

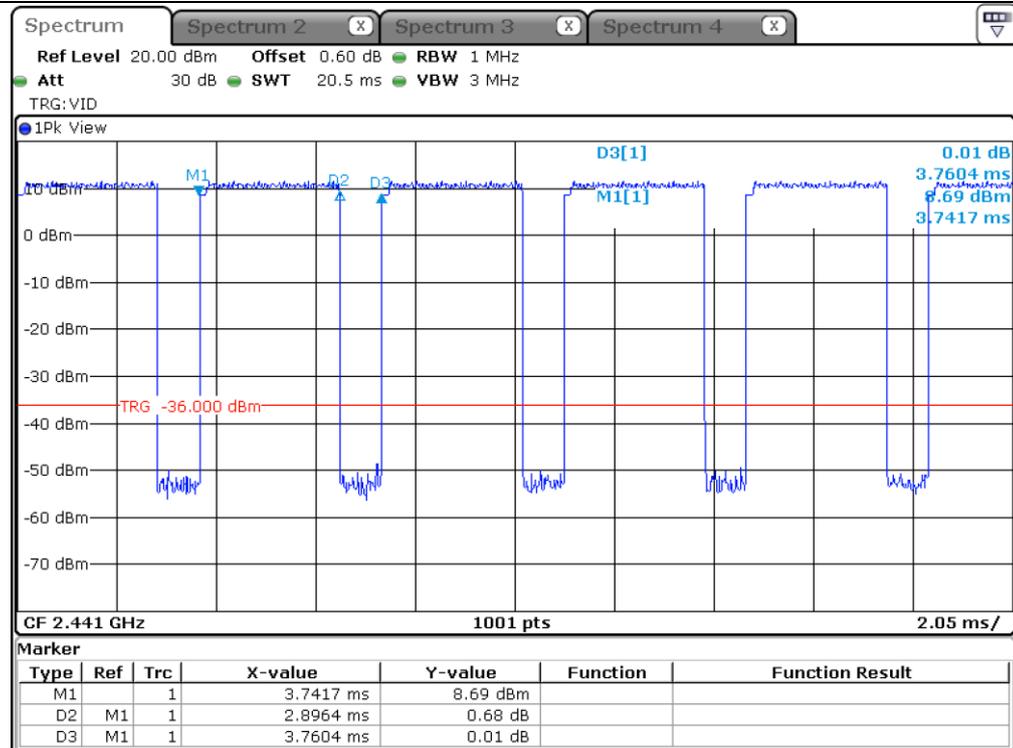Total Dwell Time = Pulse time * Hops per second with channels * period time

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

DH1

DH3

Marker						
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.5117 ms	8.70 dBm		
D2	M1	1	1.6254 ms	0.08 dB		
D3	M1	1	2.4894 ms	-0.07 dB		

DH5

Marker						
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	3.7417 ms	8.69 dBm		
D2	M1	1	2.8964 ms	0.68 dB		
D3	M1	1	3.7604 ms	0.01 dB		

10.5 Test data for Right Earbud

10.5.1 Test data for 1 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.
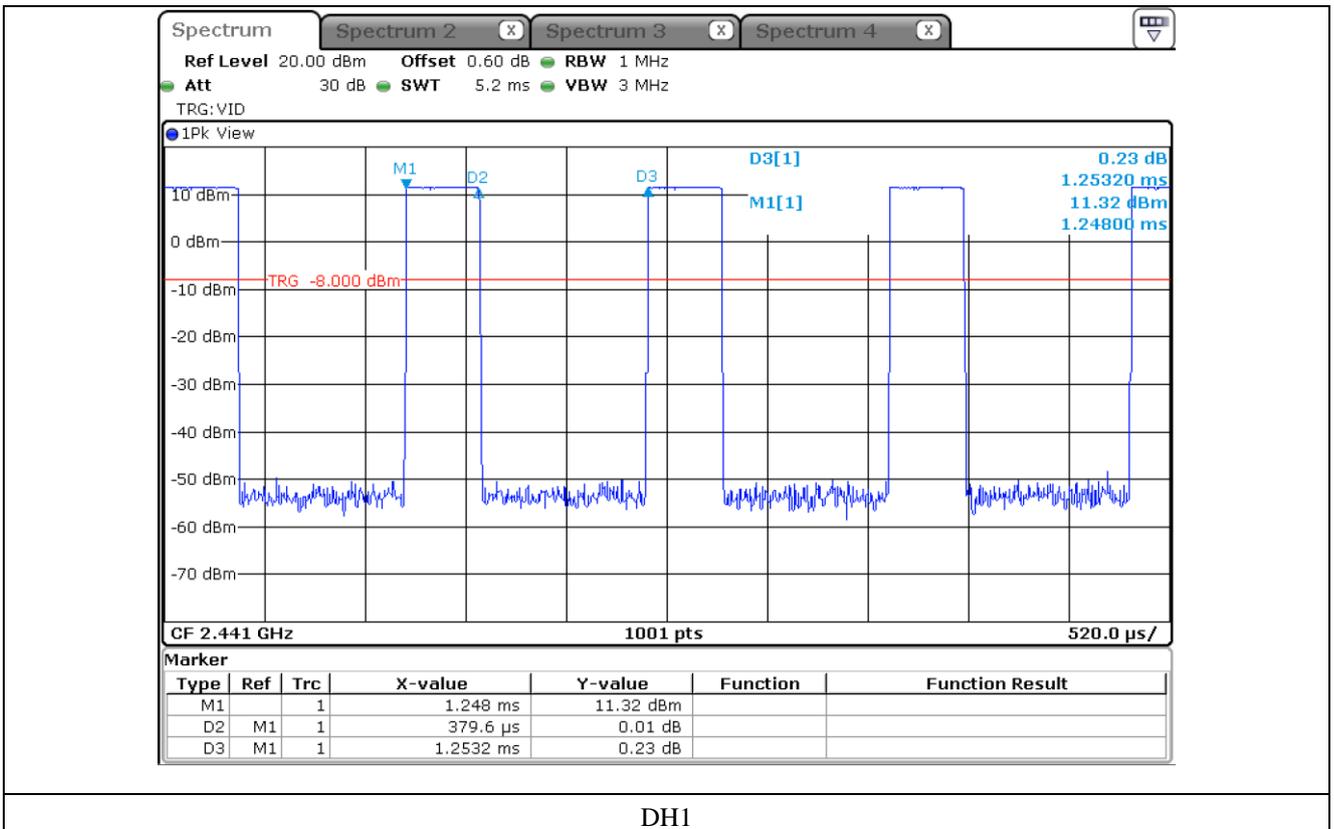
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel 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.
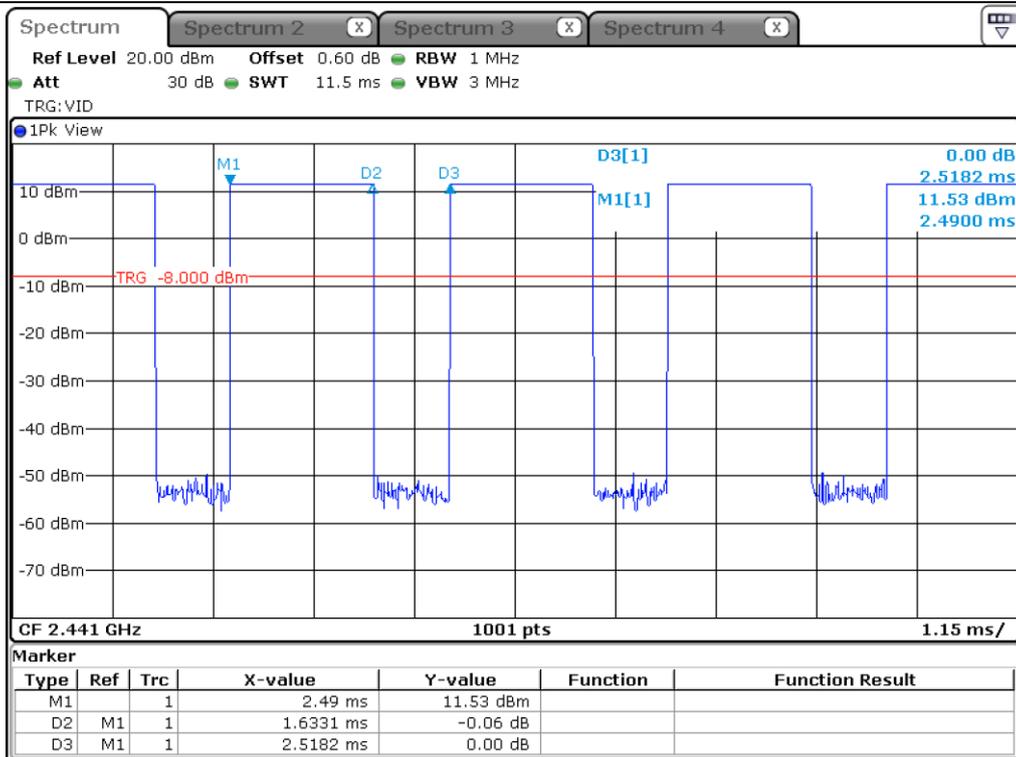
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	
DH3	1.63	5.06	31.60	260.63	400.00	PASS
DH5	2.88	3.38	31.60	307.61	400.00	

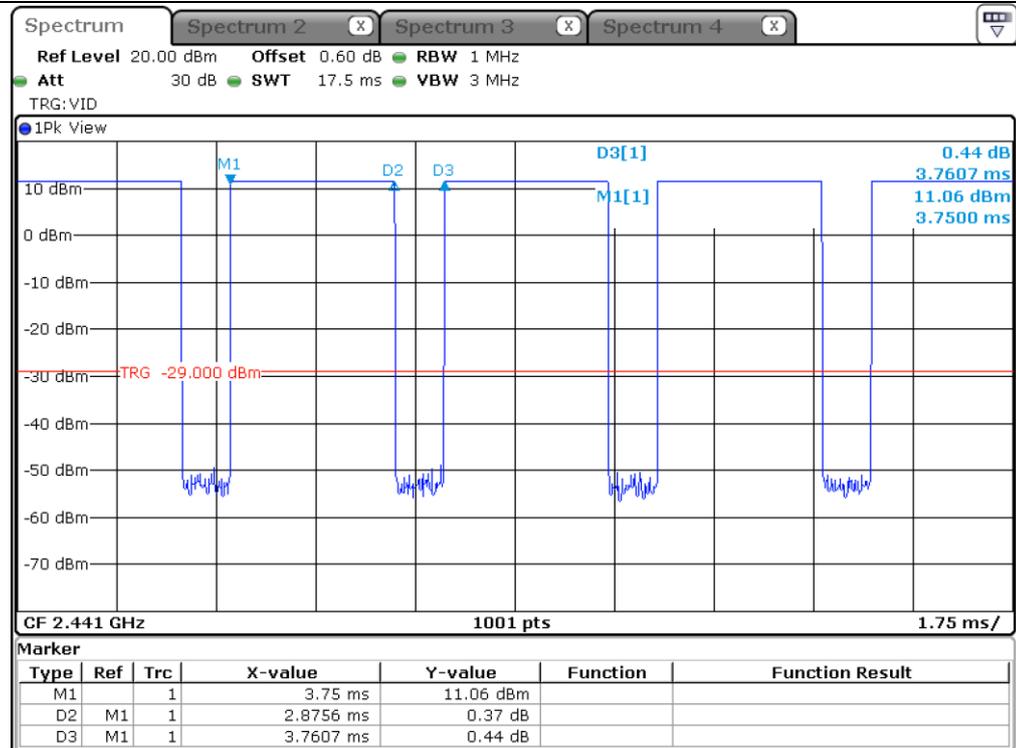Total dwell time is calculated as following.

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

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

DH1

DH3

DH5

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

10.5.2 Test data for 2 Mbps

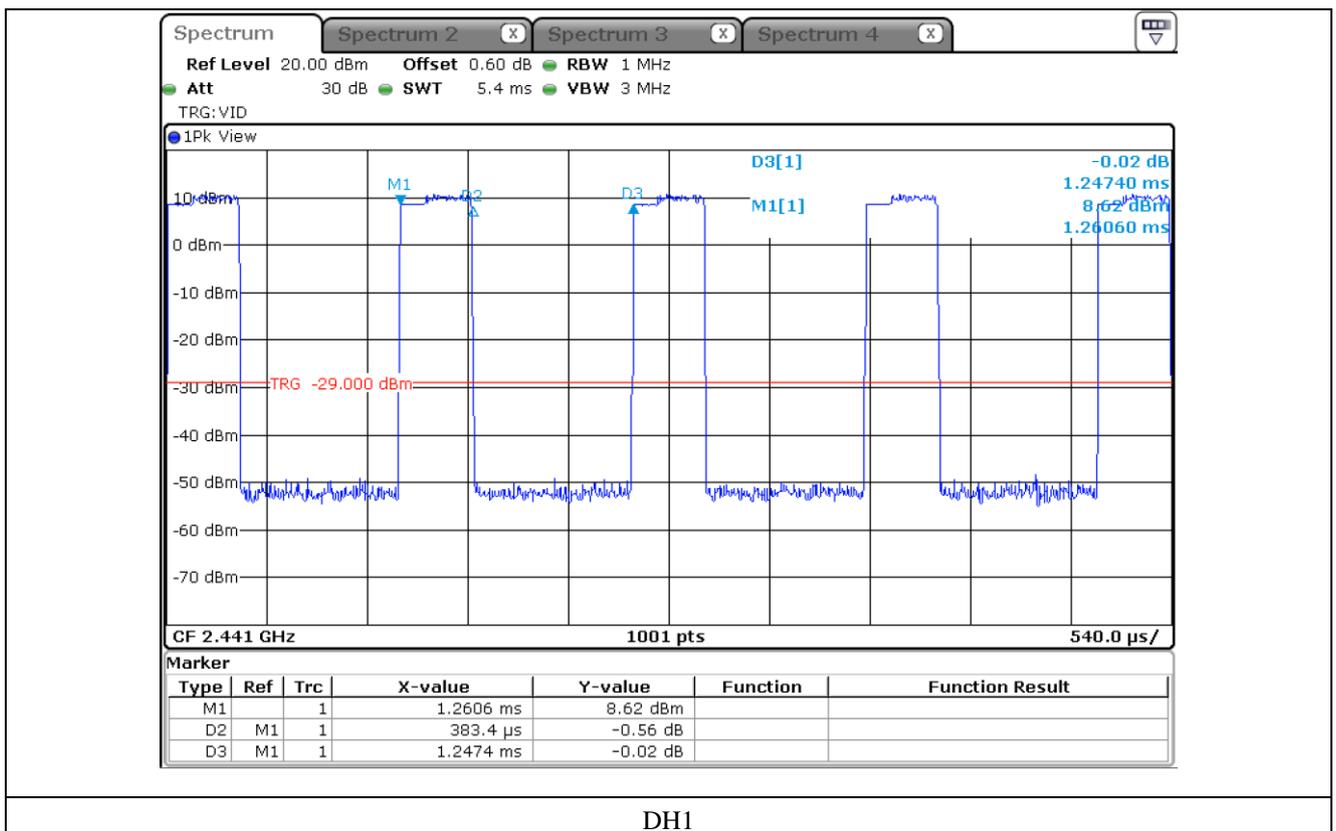The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

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.

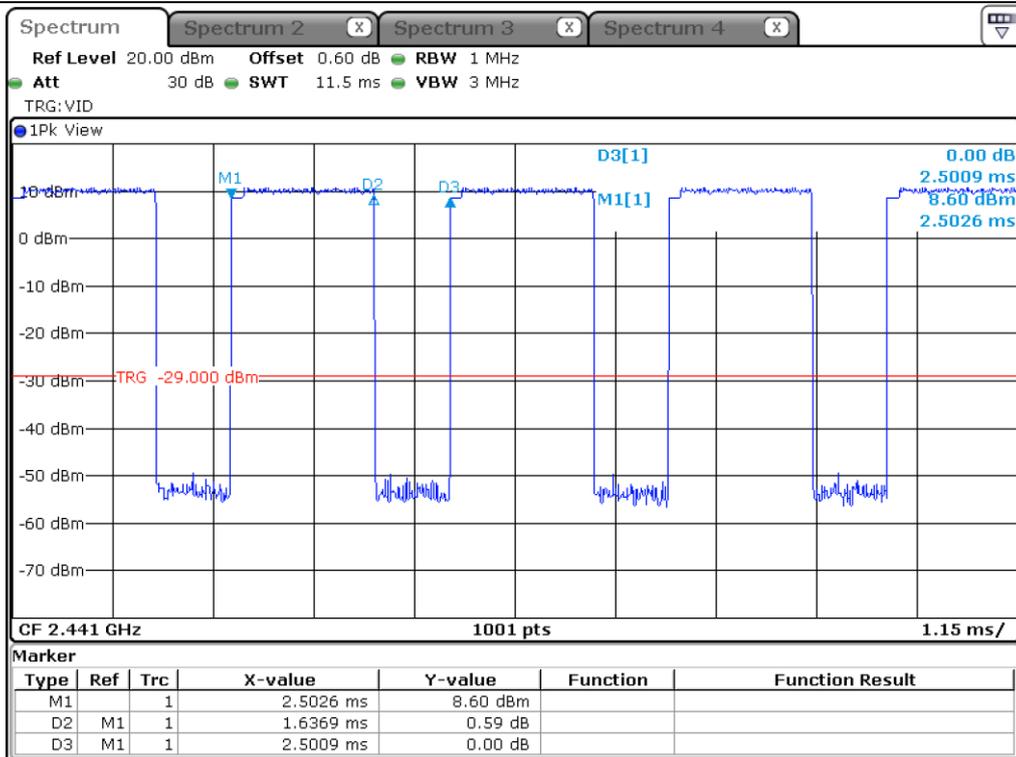| Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	
DH3	1.64	5.06	31.60	262.23	400.00	PASS
DH5	2.88	3.38	31.60	307.61	400.00	

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.

DH1

DH3

DH5

10.5.3 Test data for 3 Mbps

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	0.38	10.13	31.60	121.64	400.00	
DH3	1.63	5.06	31.60	260.63	400.00	PASS
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

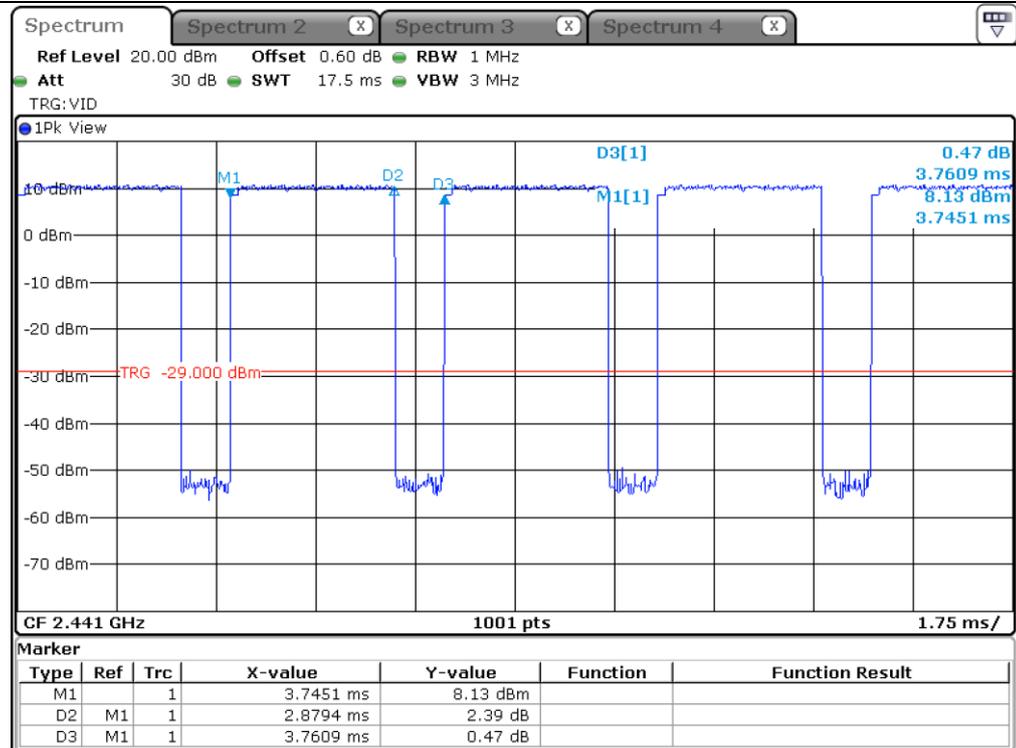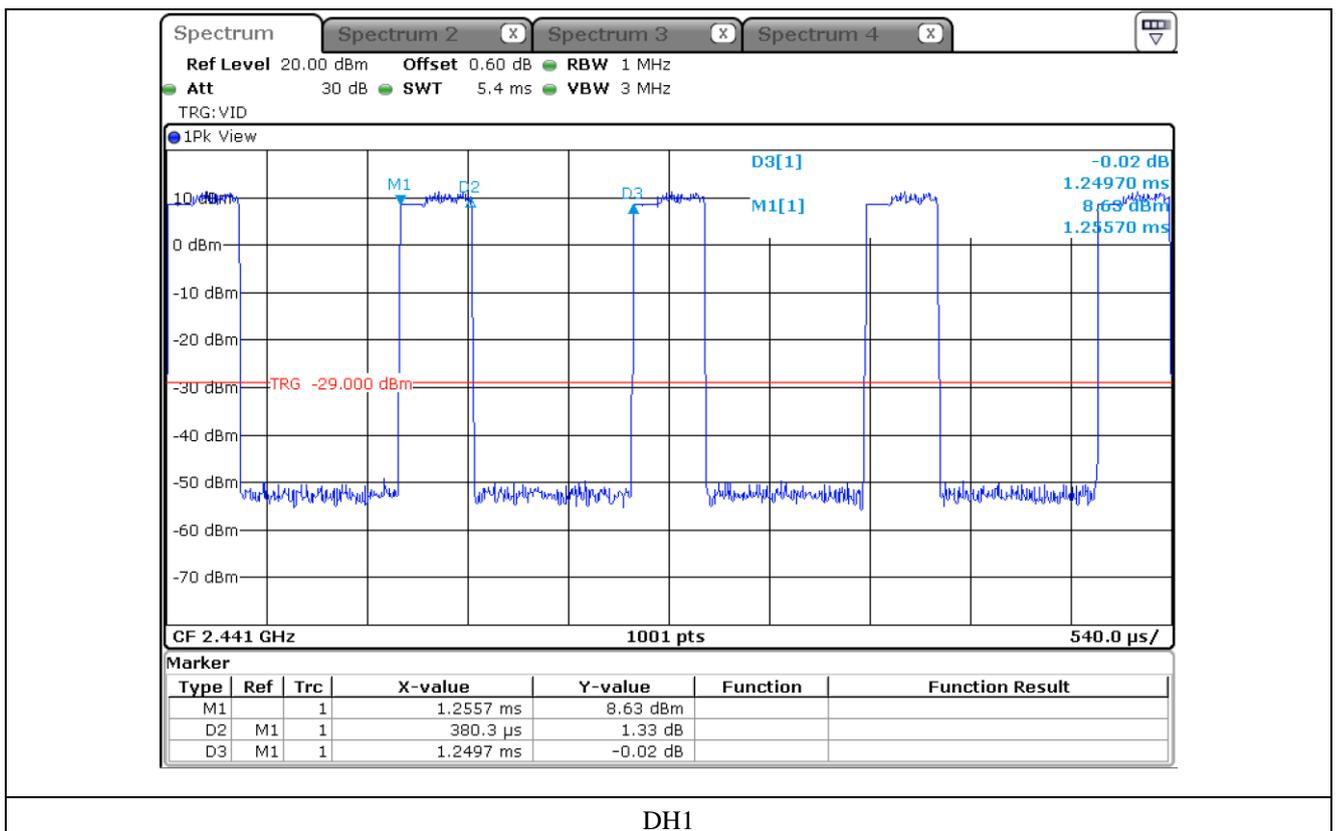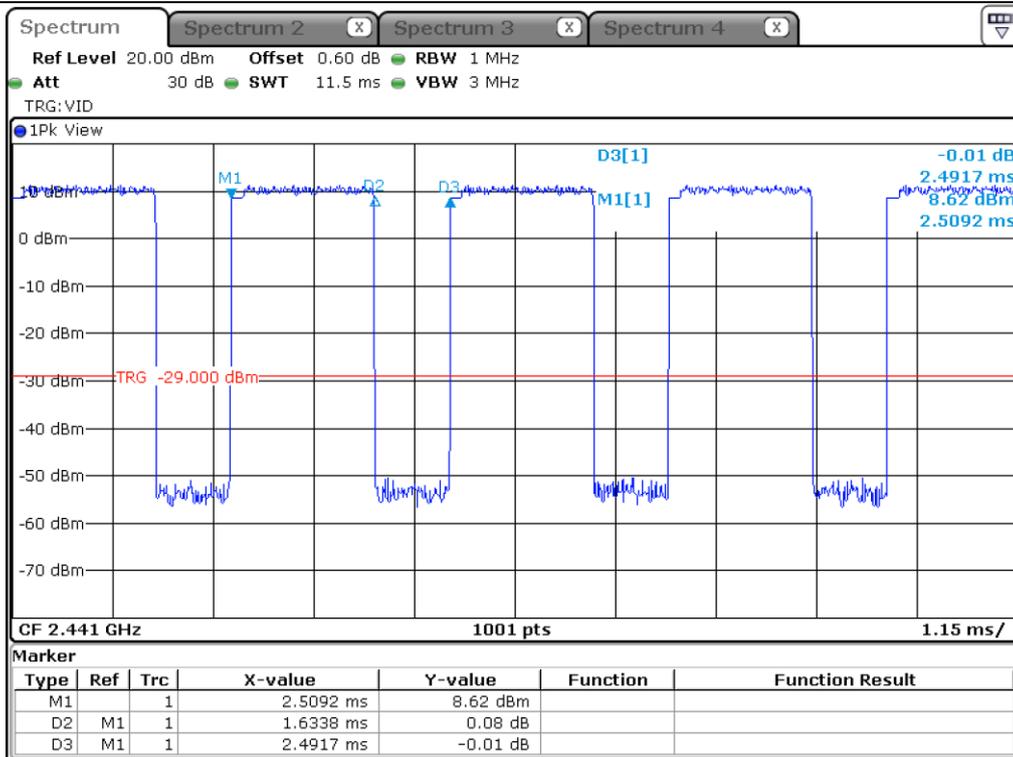Total Dwell Time = Pulse time * Hops per second with channels * period time

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

DH1

DH3

DH5

11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	46 % 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 $\geq$ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.

```
┌──────────────┐                 ┌──────────────────┐
│              │                 │                  │
│     EUT      │─────────────────│ Signal Analyzer  │
│              │                 │                  │
└──────────────┘                 └──────────────────┘
```
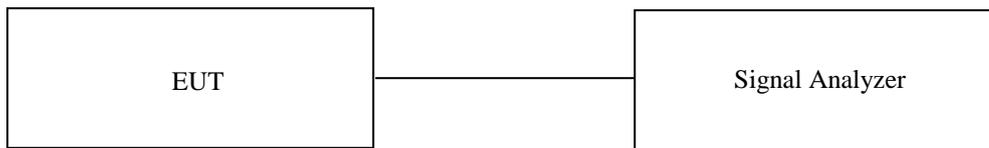
11.3 Test Date

September 09, 2021 ~ September 17, 2021

11.4 Test data for Left Earbud

11.4.1 Test data for 1 Mbps

-. Test Result   : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.09	21.00	9.91
MIDDLE	2 441.00	11.10	21.00	9.90
HIGH	2 480.00	11.04	21.00	9.96

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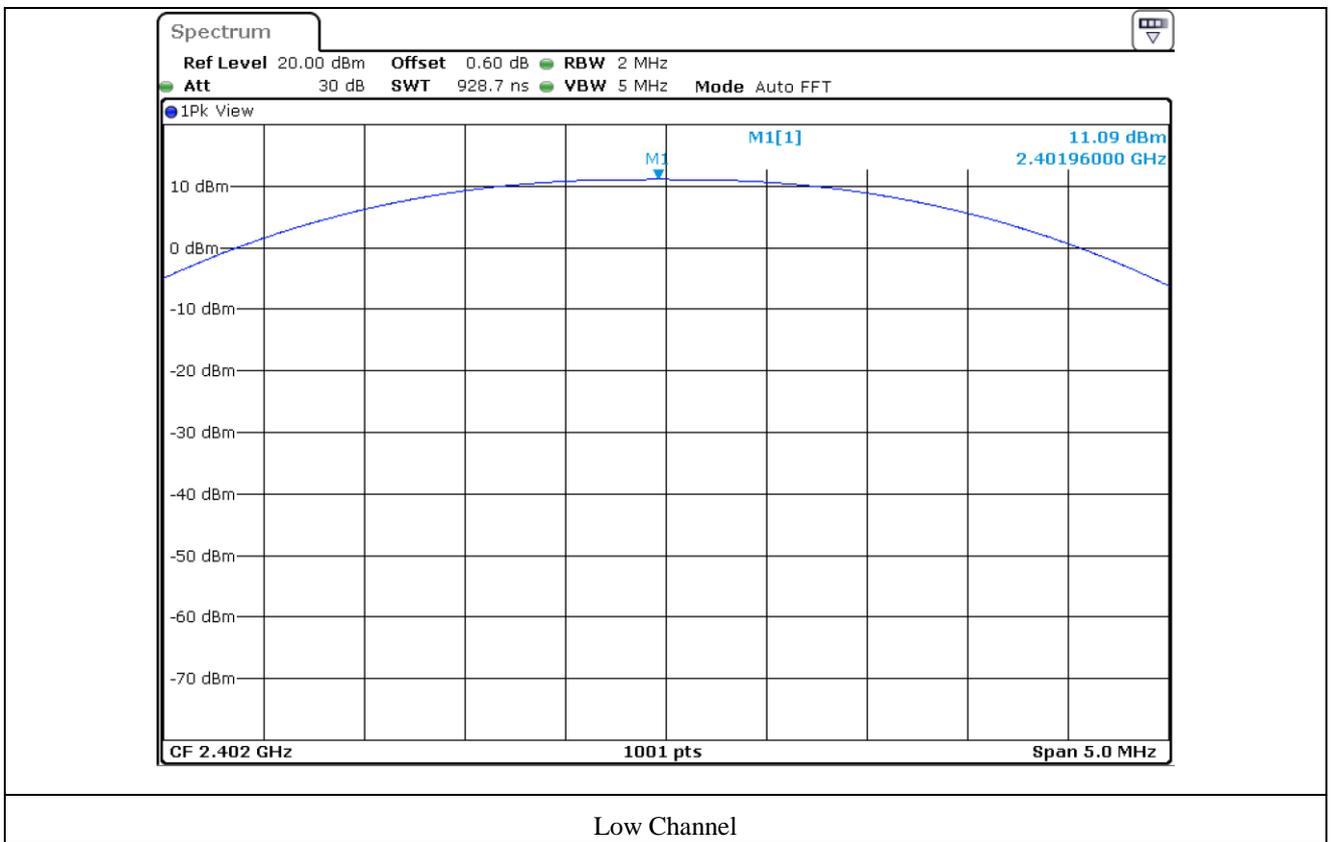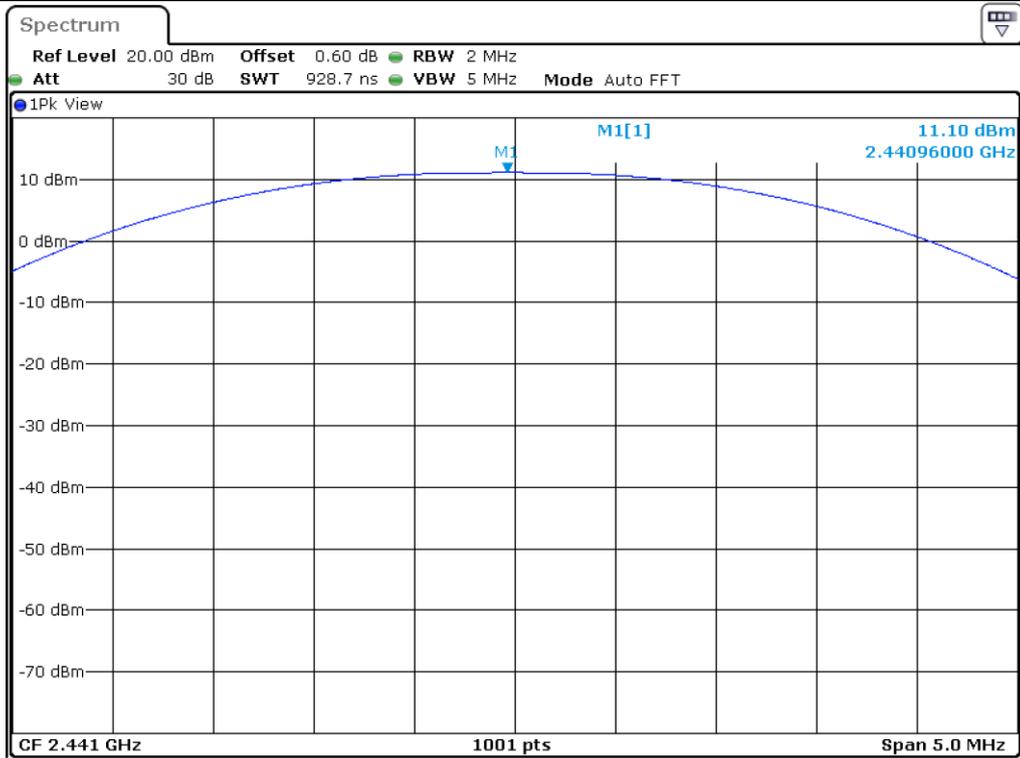
Low Channel

Spectrum

Ref Level 20.00 dBm   Offset   0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   11.10 dBm
M1   2.44096000 GHz

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   0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   11.04 dBm
M1   2.47996000 GHz

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
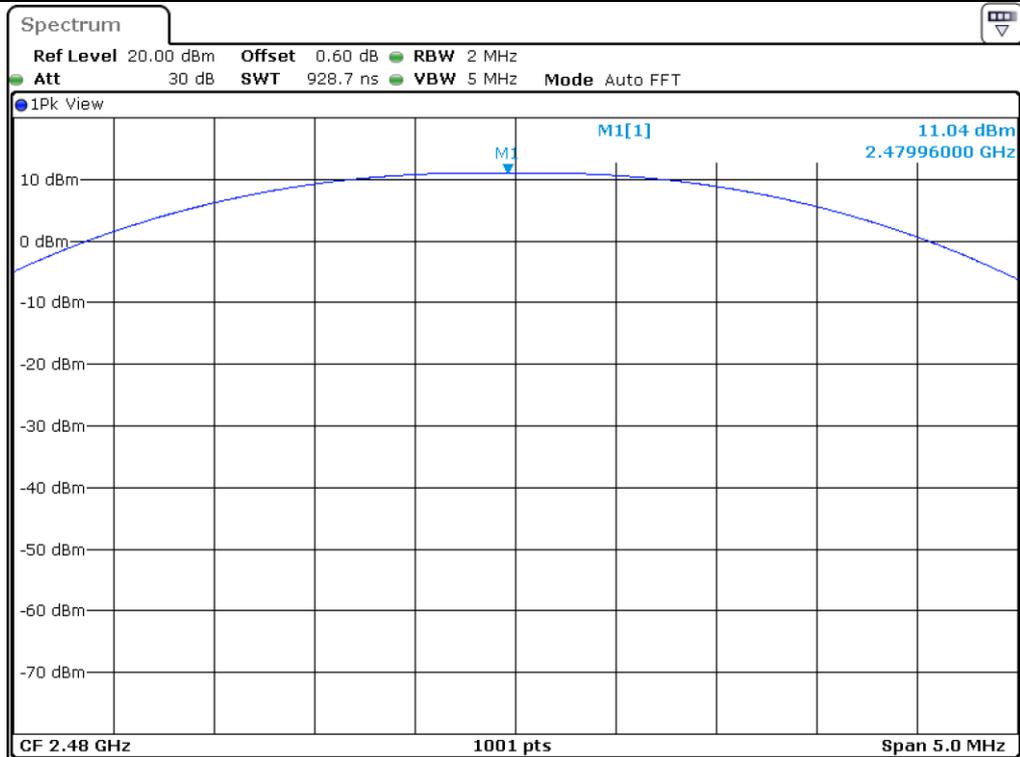
High Channel

11.4.2 Test data for 2 Mbps

-. Test Result   : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	10.64	21.00	10.36
MIDDLE	2 441.00	10.64	21.00	10.36
HIGH	2 480.00	10.59	21.00	10.41

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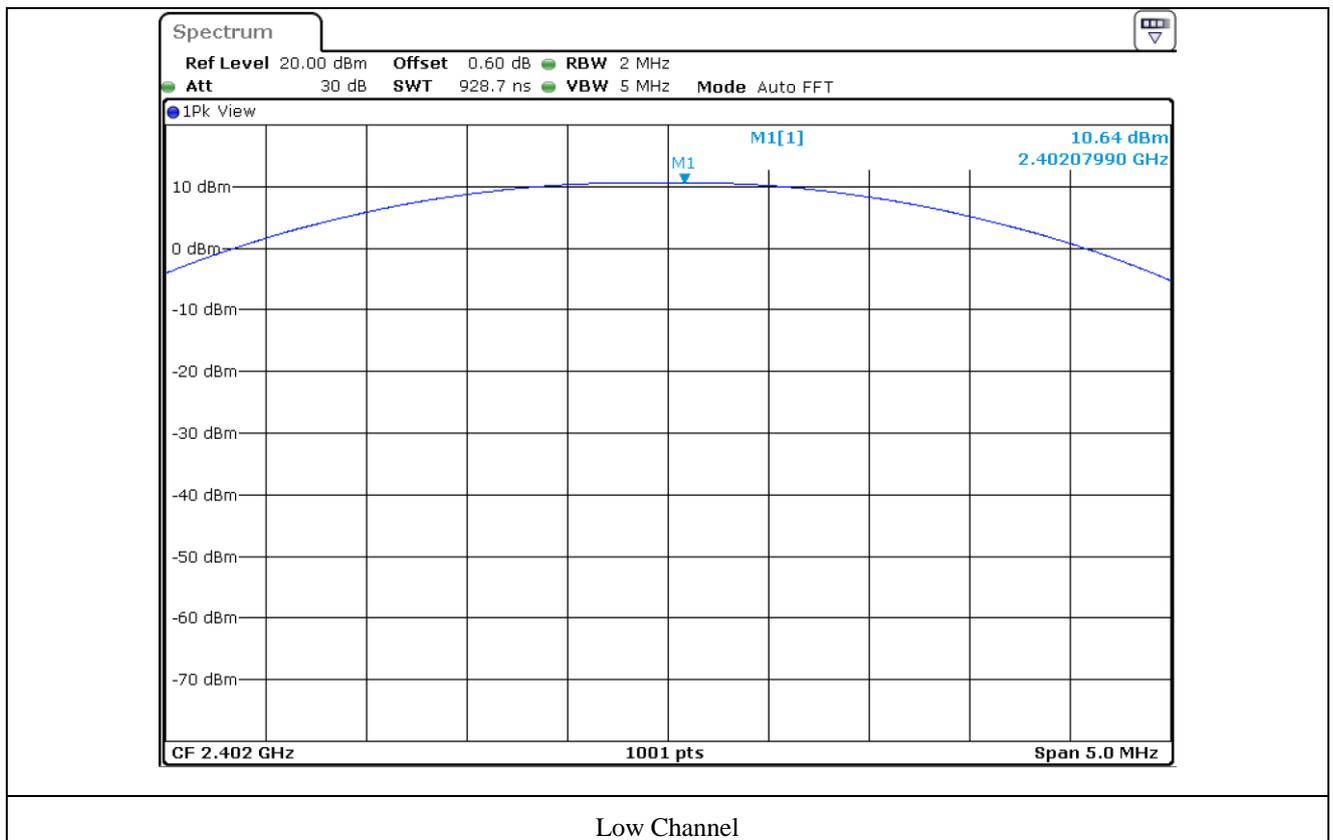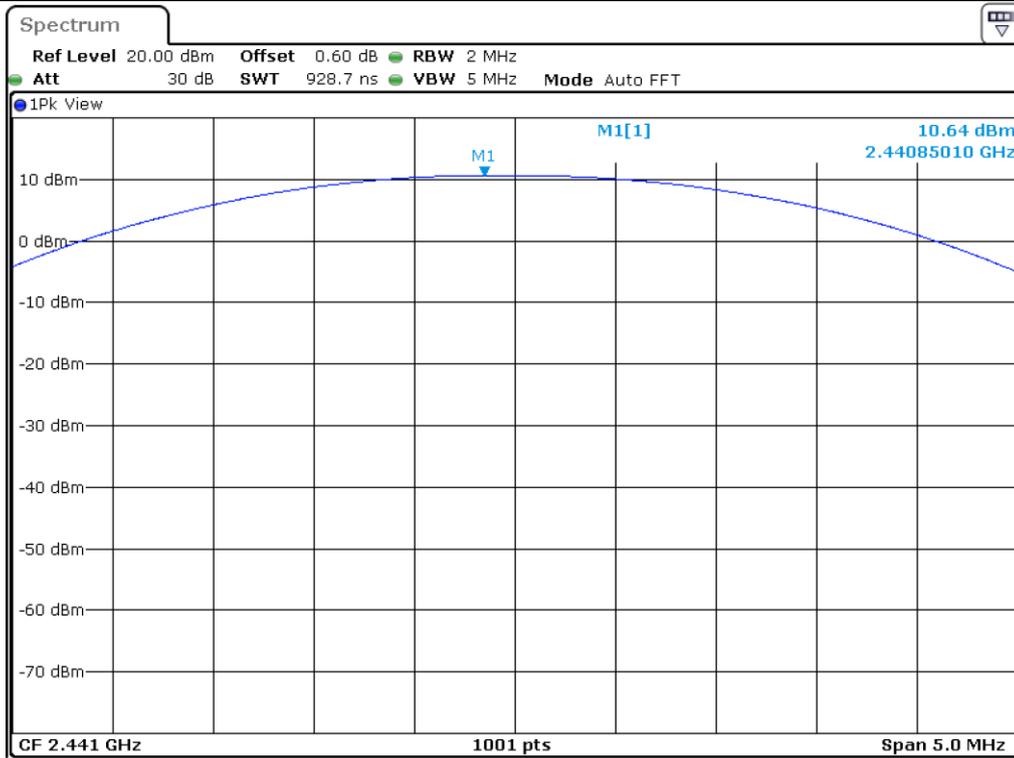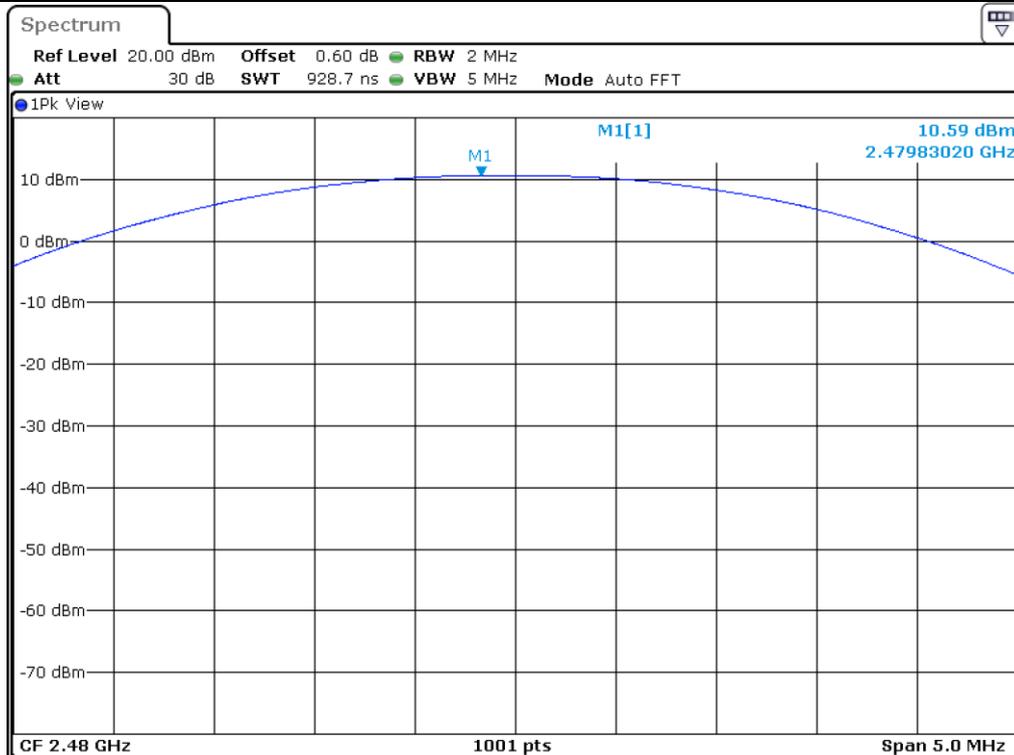
Low Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   10.64 dBm
                         2.44085010 GHz

CF 2.441 GHz   1001 pts   Span 5.0 MHz

Middle Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   10.59 dBm
                         2.47983020 GHz

CF 2.48 GHz   1001 pts   Span 5.0 MHz

High Channel

11.4.3 Test data for 3 Mbps

-. Test Result   : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.26	21.00	9.74
MIDDLE	2 441.00	11.27	21.00	9.73
HIGH	2 480.00	11.23	21.00	9.77

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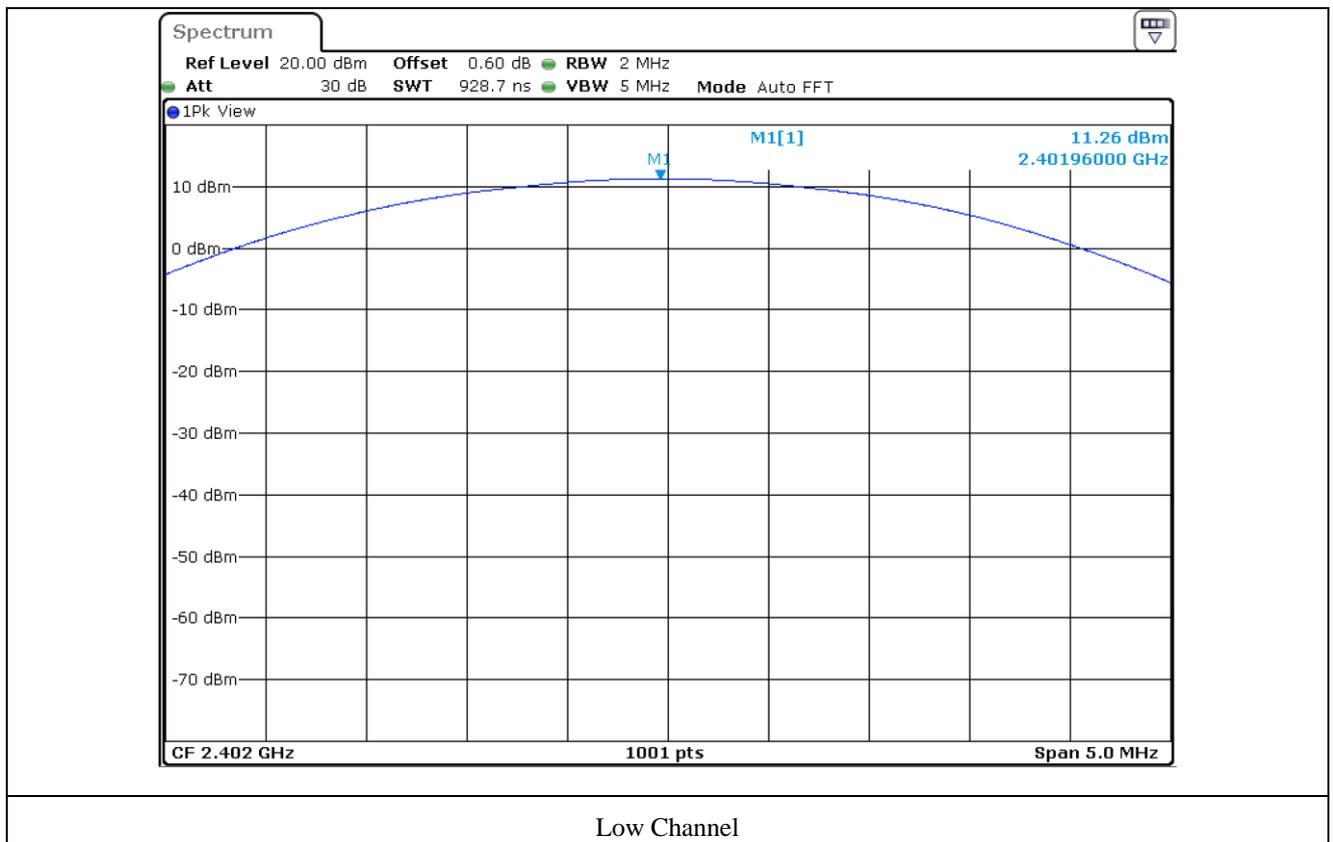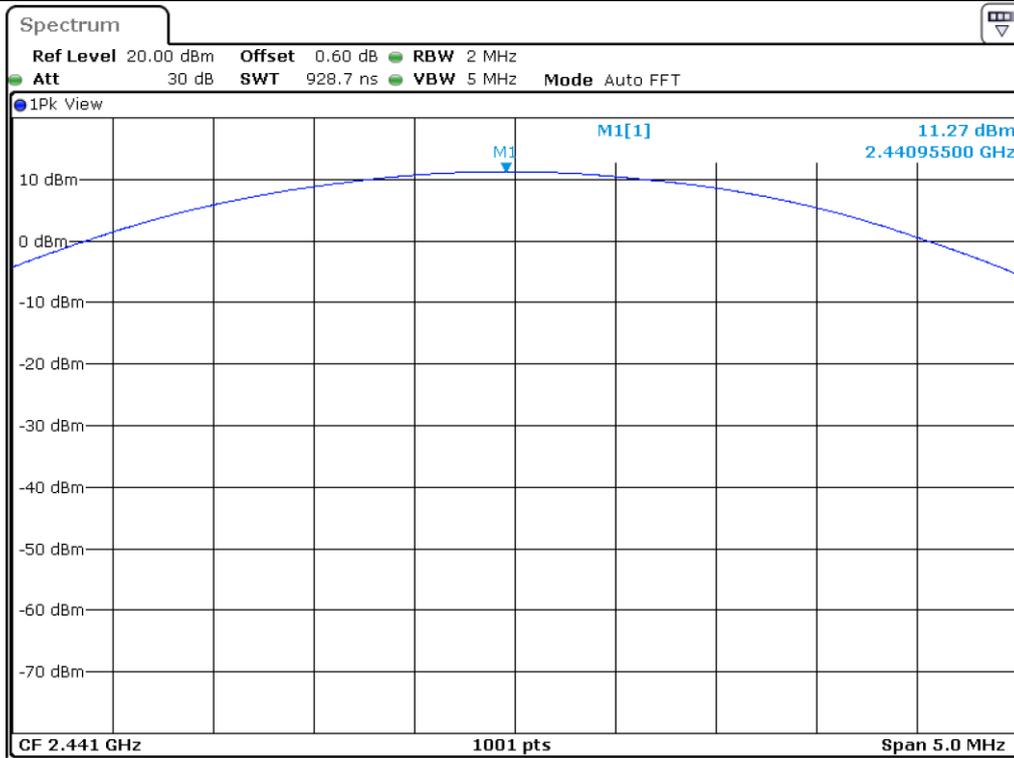
Low Channel

Spectrum

Ref Level 20.00 dBm   Offset 0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   11.27 dBm
M1   2.44095500 GHz

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 0.60 dB ● RBW 2 MHz
● Att   30 dB   SWT   928.7 ns ● VBW 5 MHz   Mode Auto FFT
● 1Pk View

M1[1]   11.23 dBm
M1   2.47995500 GHz

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 Right Earbud

11.5.1 Test data for 1 Mbps

-. Test Result   : Pass

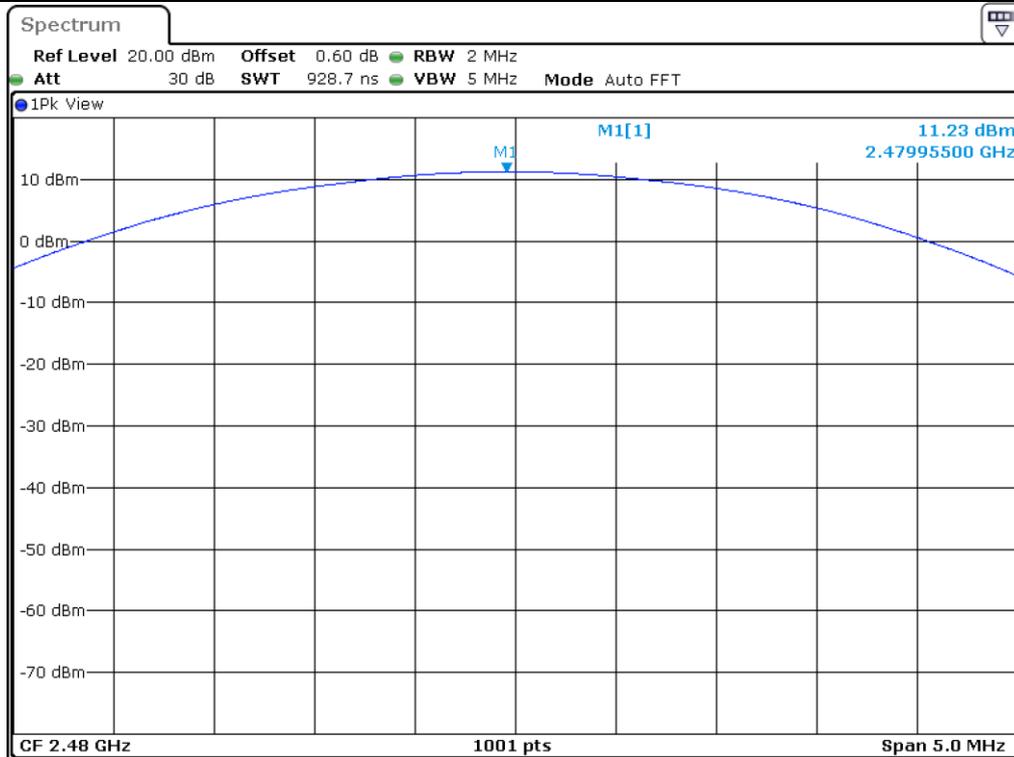| CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.86	21.00	9.14
MIDDLE	2 441.00	11.44	21.00	9.56
HIGH	2 480.00	11.56	21.00	9.44

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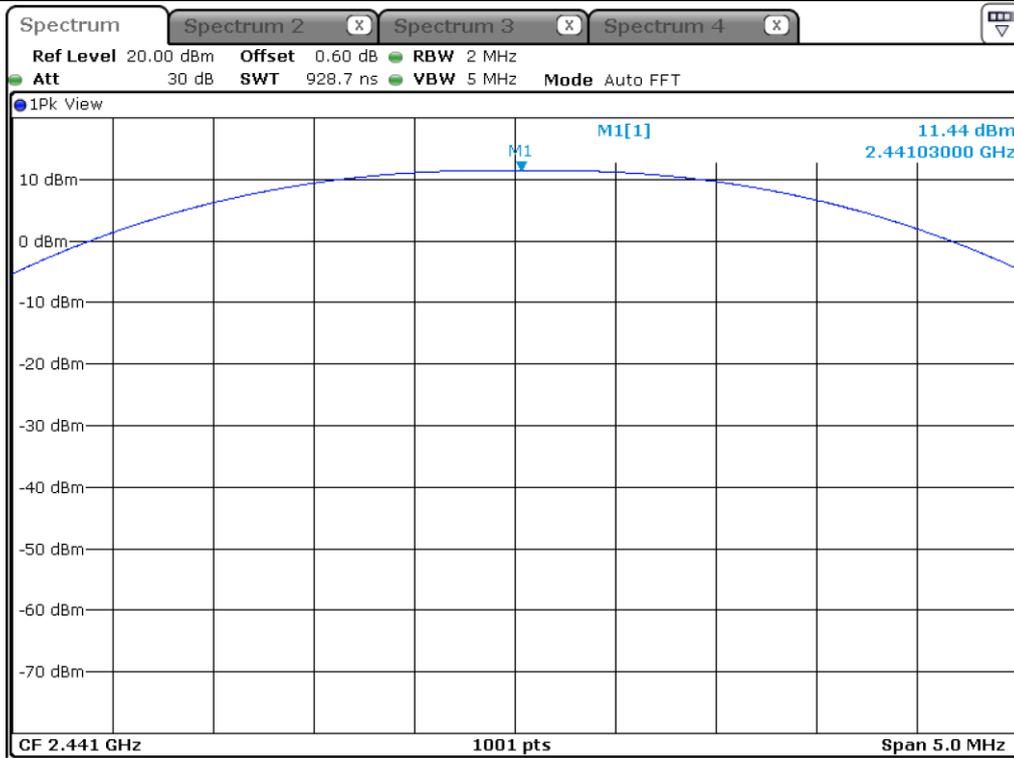
Low Channel

Middle Channel

High Channel

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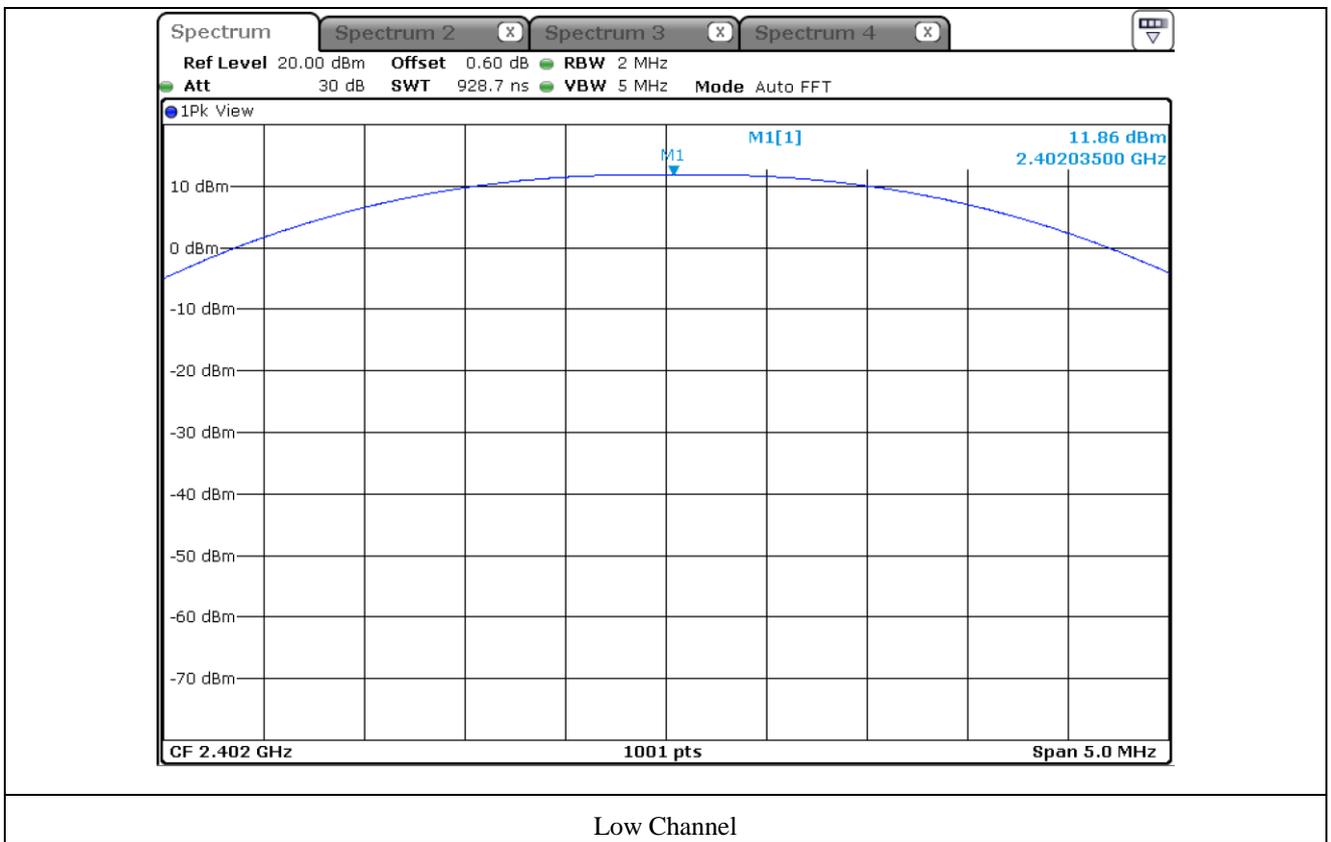
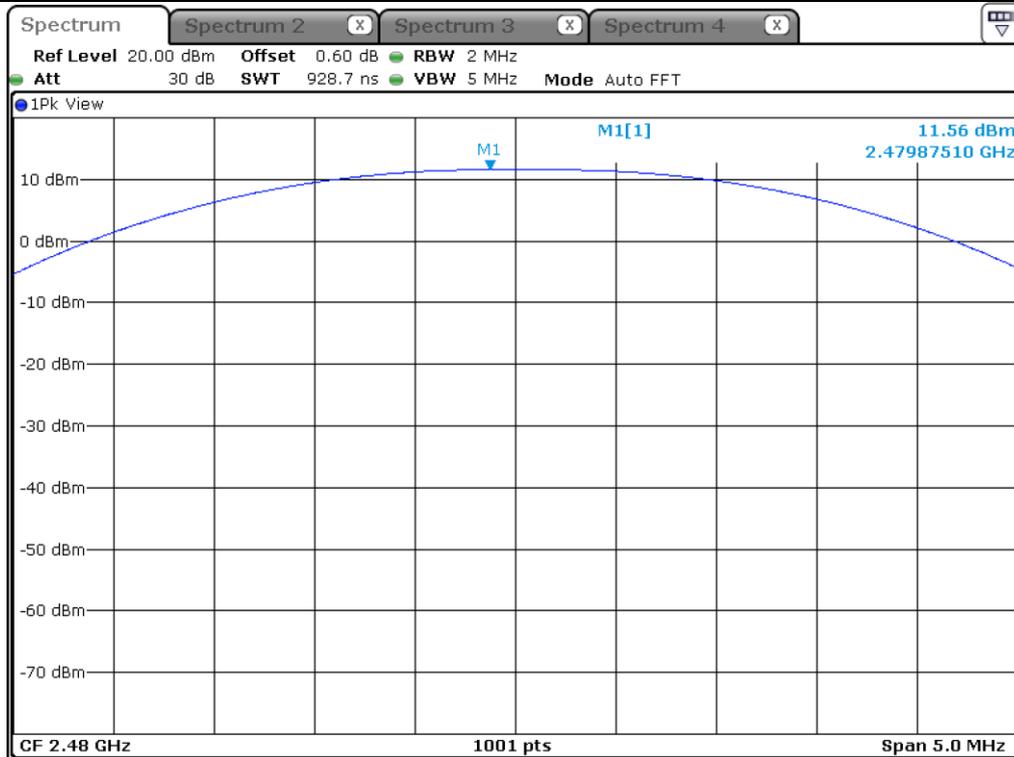**ONETECH Corp.**: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

11.5.2 Test data for 2 Mbps

-. Test Result   : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.39	21.00	9.61
MIDDLE	2 441.00	10.96	21.00	10.04
HIGH	2 480.00	11.13	21.00	9.87

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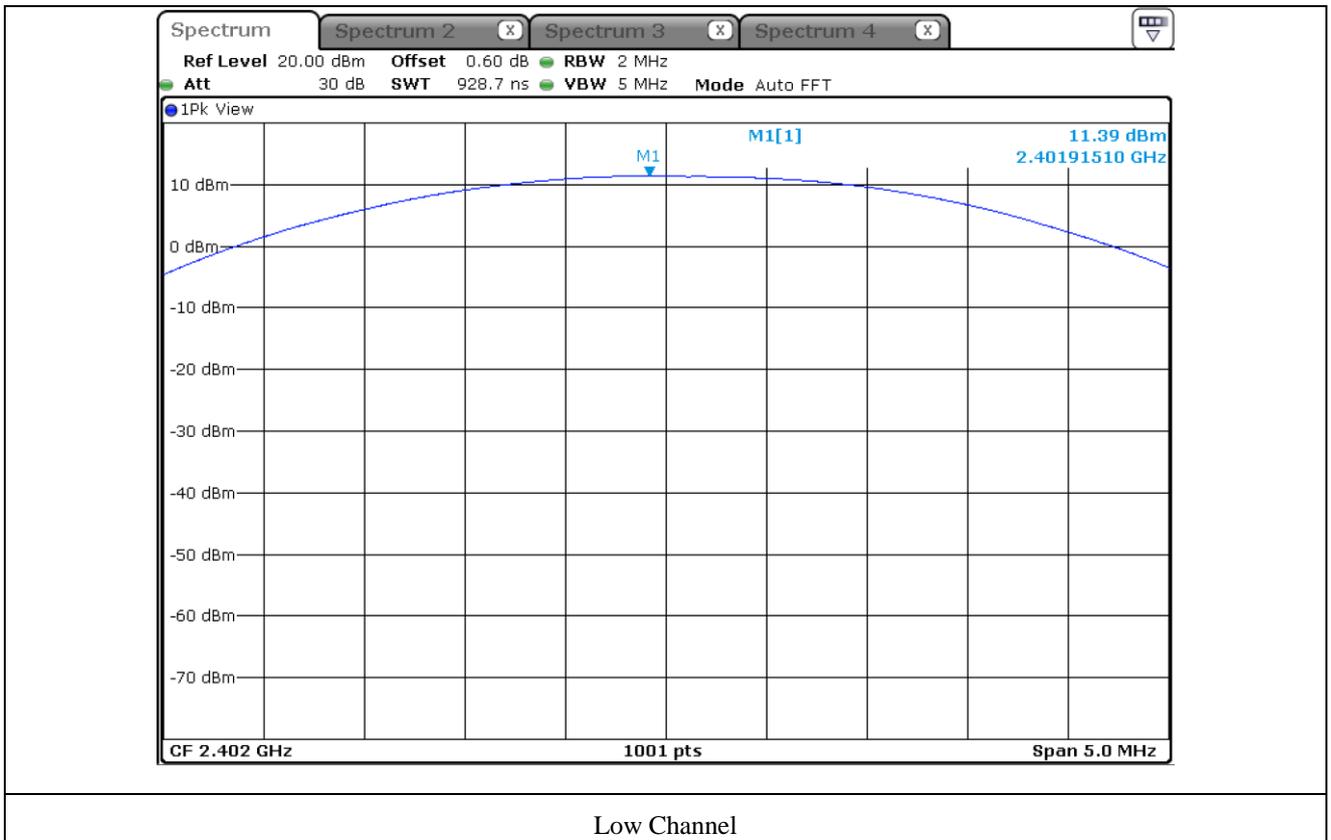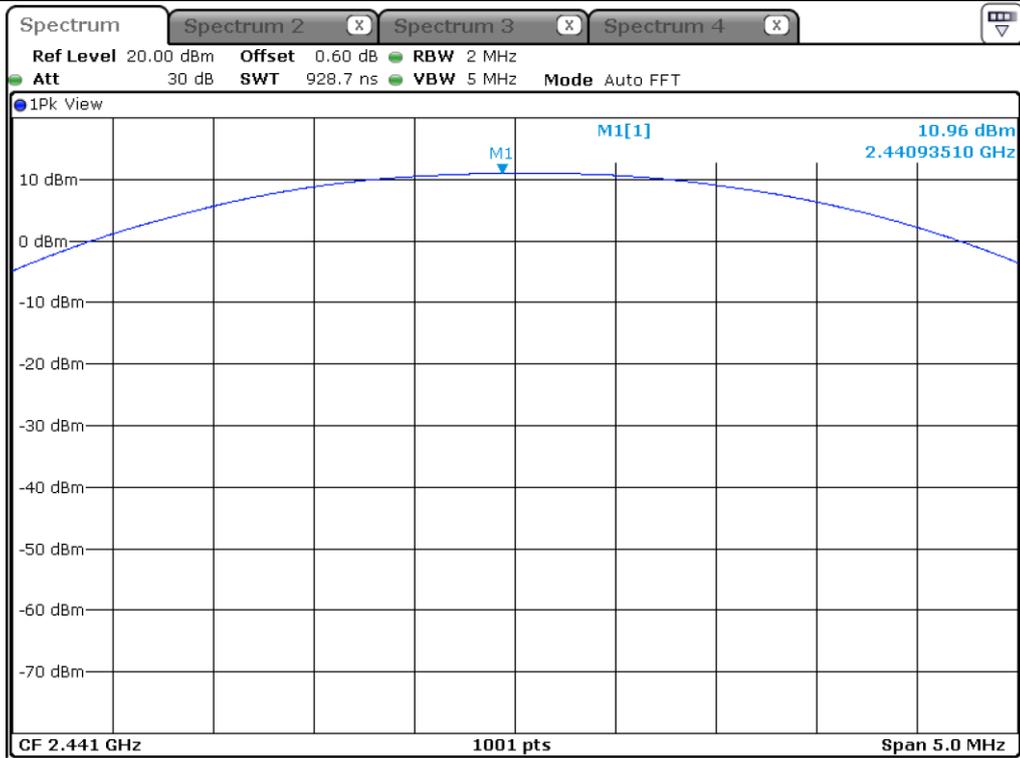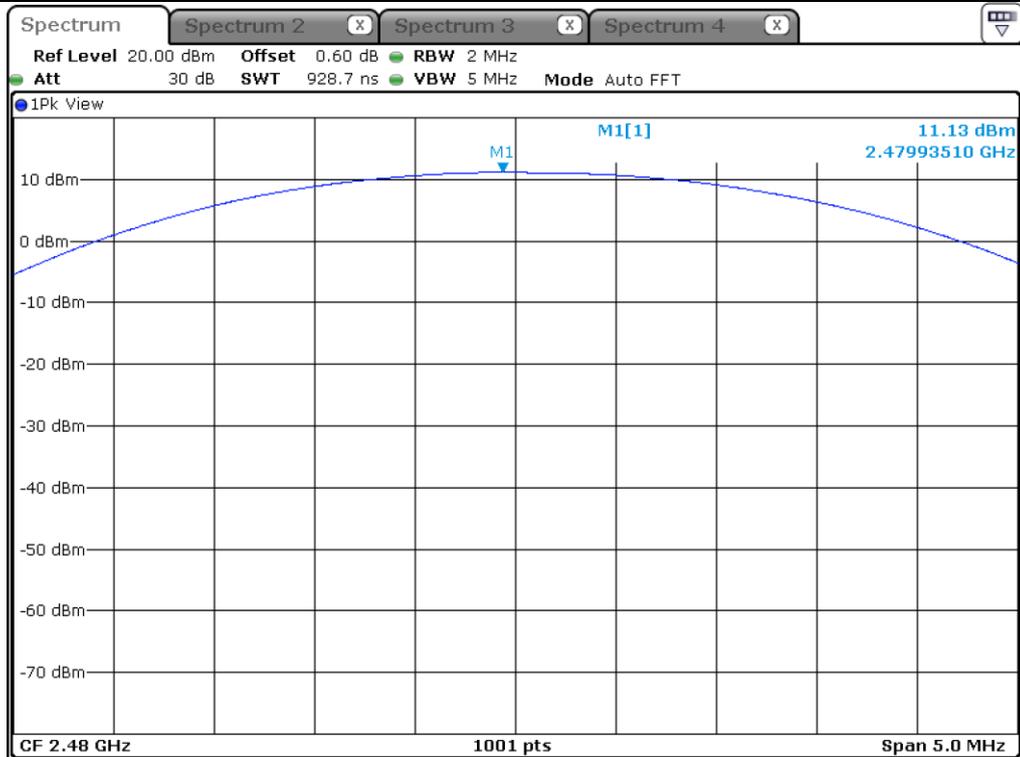
Low Channel

Spectrum   Spectrum 2   x   Spectrum 3   x   Spectrum 4   x

Ref Level 20.00 dBm   **Offset** 0.60 dB ● **RBW** 2 MHz
● **Att**   30 dB   **SWT** 928.7 ns ● **VBW** 5 MHz   **Mode** Auto FFT

● 1Pk View

M1[1]   10.96 dBm
                         2.44093510 GHz

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   Spectrum 2   x   Spectrum 3   x   Spectrum 4   x

Ref Level 20.00 dBm   **Offset** 0.60 dB ● **RBW** 2 MHz
● **Att**   30 dB   **SWT** 928.7 ns ● **VBW** 5 MHz   **Mode** Auto FFT

● 1Pk View

M1[1]   11.13 dBm
                         2.47993510 GHz

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

11.5.3 Test data for 3 Mbps

-. Test Result   : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.85	21.00	9.15
MIDDLE	2 441.00	11.54	21.00	9.46
HIGH	2 480.00	11.51	21.00	9.49

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

Low Channel