

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-222-RWD-004

Reception No. : 2201000217

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. : ZNFTONEFP7

Model Name : TONE-FP7

Multiple Model Name : TONE-TFP7, TONE-TFP7W, TONE-FP7PW, TONE-FP7C, TONE-FP7WC

Serial number : N/A

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

Date of Incoming : May 17, 2021

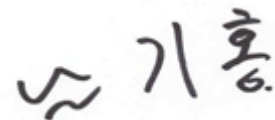
Date of issue : February 07, 2022

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
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CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE	7
2. TEST SUMMARY	8
2.1 TEST ITEMS AND RESULTS	8
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....	8
2.3 RELATED SUBMITTAL(S) / GRANT(S)	8
2.4 PURPOSE OF THE TEST	8
2.5 TEST METHODOLOGY.....	8
2.6 TEST FACILITY.....	8
3. GENERAL INFORMATION.....	9
3.1 PRODUCT DESCRIPTION.....	9
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....	10
4. EUT MODIFICATIONS.....	10
5. SYSTEM TEST CONFIGURATION	11
5.1 JUSTIFICATION.....	11
5.2 PERIPHERAL EQUIPMENT	11
5.3 MODE OF OPERATION DURING THE TEST	11
5.4 CONFIGURATION OF TEST SYSTEM.....	16
5.5 ANTENNA REQUIREMENT	16
6. PRELIMINARY TEST	16
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....	16
6.2 GENERAL RADIATED EMISSIONS TESTS	16
7. MINIMUM 20 DB BANDWIDTH.....	17
7.1 OPERATING ENVIRONMENT	17
7.2 TEST SET-UP	17
7.3 TEST DATE	17
7.4 TEST DATA FOR LEFT EARBUD	18
7.4.1 Test data for 1 Mbps	18
7.4.2 Test data for 2 Mbps	20
7.4.3 Test data for 3 Mbps	22
7.5 TEST DATA FOR RIGHT EARBUD.....	24
7.5.1 Test data for 1 Mbps	24
7.5.2 Test data for 2 Mbps	26

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7.5.3 Test data for 3 Mbps	28
8. HOPPING FREQUENCY SEPARATION.....	30
8.1 OPERATING ENVIRONMENT	30
8.2 TEST SET-UP	30
8.3 TEST DATE	30
8.4 TEST DATA FOR LEFT EARBUD	31
8.4.1 Test data for 1 Mbps	31
8.4.2 Test data for 2 Mbps	32
8.4.3 Test data for 3 Mbps	33
8.5 TEST DATA FOR RIGHT EARBUD.....	34
8.5.1 Test data for 1 Mbps	34
8.5.2 Test data for 2 Mbps	35
8.5.3 Test data for 3 Mbps	36
9. NUMBER OF HOPPING CHANNELS	37
9.1 OPERATING ENVIRONMENT	37
9.2 TEST SET-UP	37
9.3 TEST DATE	37
9.4 TEST DATA FOR LEFT EARBUD	38
9.4.1 Test data for 1 Mbps	38
9.4.2 Test data for 2 Mbps	41
9.4.3 Test data for 3 Mbps	44
9.5 TEST DATA FOR RIGHT EARBUD.....	47
9.5.1 Test data for 1 Mbps	47
9.5.2 Test data for 2 Mbps	50
9.5.3 Test data for 3 Mbps	53
10. TIME OF OCCUPANCY	56
10.1 OPERATING ENVIRONMENT	56
10.2 TEST SET-UP	56
10.3 TEST DATE	56
10.4 TEST DATA FOR LEFT EARBUD	57
10.4.1 Test data for 1 Mbps	57
10.4.2 Test data for 2 Mbps	59
10.4.3 Test data for 3 Mbps	61
10.5 TEST DATA FOR RIGHT EARBUD.....	63
10.5.1 Test data for 1 Mbps	63
10.5.2 Test data for 2 Mbps	65

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OTC-TRF-RF-001(0)

10.5.3 Test data for 3 Mbps	67
11. MAXIMUM PEAK OUTPUT POWER	69
11.1 OPERATING ENVIRONMENT	69
11.2 TEST SET-UP	69
11.3 TEST DATE	69
11.4 TEST DATA FOR LEFT EARBUD	70
11.4.1 Test data for 1 Mbps	70
11.4.2 Test data for 2 Mbps	72
11.4.3 Test data for 3 Mbps	74
11.5 TEST DATA FOR RIGHT EARBUD.....	76
11.5.1 Test data for 1 Mbps	76
11.5.2 Test data for 2 Mbps	78
11.5.3 Test data for 3 Mbps	80
12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND.....	82
12.1 OPERATING ENVIRONMENT	82
12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	82
12.3 TEST SET-UP FOR RADIATED MEASUREMENT.....	82
12.4 TEST DATE	82
12.5 TEST DATA FOR CONDUCTED EMISSION (LEFT EARBUD)	83
12.5.1 Test data for 1 Mbps	83
12.5.2 Test data for 2 Mbps	89
12.5.3 Test data for 3 Mbps	95
12.6 TEST DATA FOR CONDUCTED EMISSION (RIGHT EARBUD).....	101
12.6.1 Test data for 1 Mbps	101
12.6.2 Test data for 2 Mbps	107
12.6.3 Test data for 3 Mbps	113
12.6 TEST DATA FOR TRANSMITTING MODE RADIATED EMISSION	119
12.6.1 Radiated Emission which fall in the Restricted Band (Left Earbud)	119
12.6.2 Radiated Emission which fall in the Restricted Band (Right Earbud).....	122
12.6.3 Spurious & Harmonic Radiated Emission above 1 GHz (Left Earbud)	125
12.6.4 Spurious & Harmonic Radiated Emission above 1 GHz (Right Earbud).....	128
13. RADIATED EMISSION TEST	131
13.1 OPERATING ENVIRONMENT	131
13.2 TEST SET-UP	131
13.3 TEST DATE	131
13.4 TEST DATA FOR LEFT EARBUD	132

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OTC-TRF-RF-001(0)

13.4.1 Test data for 30 MHz ~ 1000 MHz.....	132
13.4.2 Test data for Below 30 MHz	133
13.4.3 Test data for above 1 GHz	133
13.5 TEST DATA FOR RIGHT EARBUD.....	134
13.5.1 Test data for 30 MHz ~ 1000 MHz.....	134
13.5.2 Test data for Below 30 MHz	135
13.5.3 Test data for above 1 GHz	135
14. LIST OF TEST EQUIPMENT	136

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-222-RWD-004	February 07, 2022	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 : ZNFTONEFP7
 Model Name : TONE-FP7
 Multiple Model Name : TONE-TFP7, TONE-TFP7W, TONE-FP7PW, TONE-FP7C, TONE-FP7WC
 Brand Name : LG
 Serial Number : N/A
 Date : February 07, 2022

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-FP7 (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	11.48 dBm
			2 Mbps	11.14 dBm
			3 Mbps	11.70 dBm
		Bluetooth LE	1 Mbps	6.05 dBm
			2 Mbps	6.12 dBm
			Right Earbud	Bluetooth
	2 Mbps	11.47 dBm		
	3 Mbps	12.01 dBm		
	Bluetooth LE	1 Mbps		6.00 dBm
		2 Mbps	6.06 dBm	
Number of Channel		Bluetooth	79 Channels	
		Bluetooth LE	40 Channels	
Modulation Type		Bluetooth	GFSK for 1 Mbps, $\pi/4$ -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-FP7	Basic Model (Global)	☒
TONE-TFP7	This model is identical to the basic model except for the Marketing area (Korea)	☐
TONE-TFP7W	This model is identical to the basic model except for the Marketing area (Korea) and Color (White).	☐
TONE-FP7W	This model is identical to the basic model except for the Color (White).	☐
TONE-FP7C	This model is identical to the basic model except for the Marketing purpose (Customer only).	☐
TONE-FP7WC	This model is identical to the basic model except for the Marketing purpose (Customer only) and Color (White).	☐

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

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-FP7	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

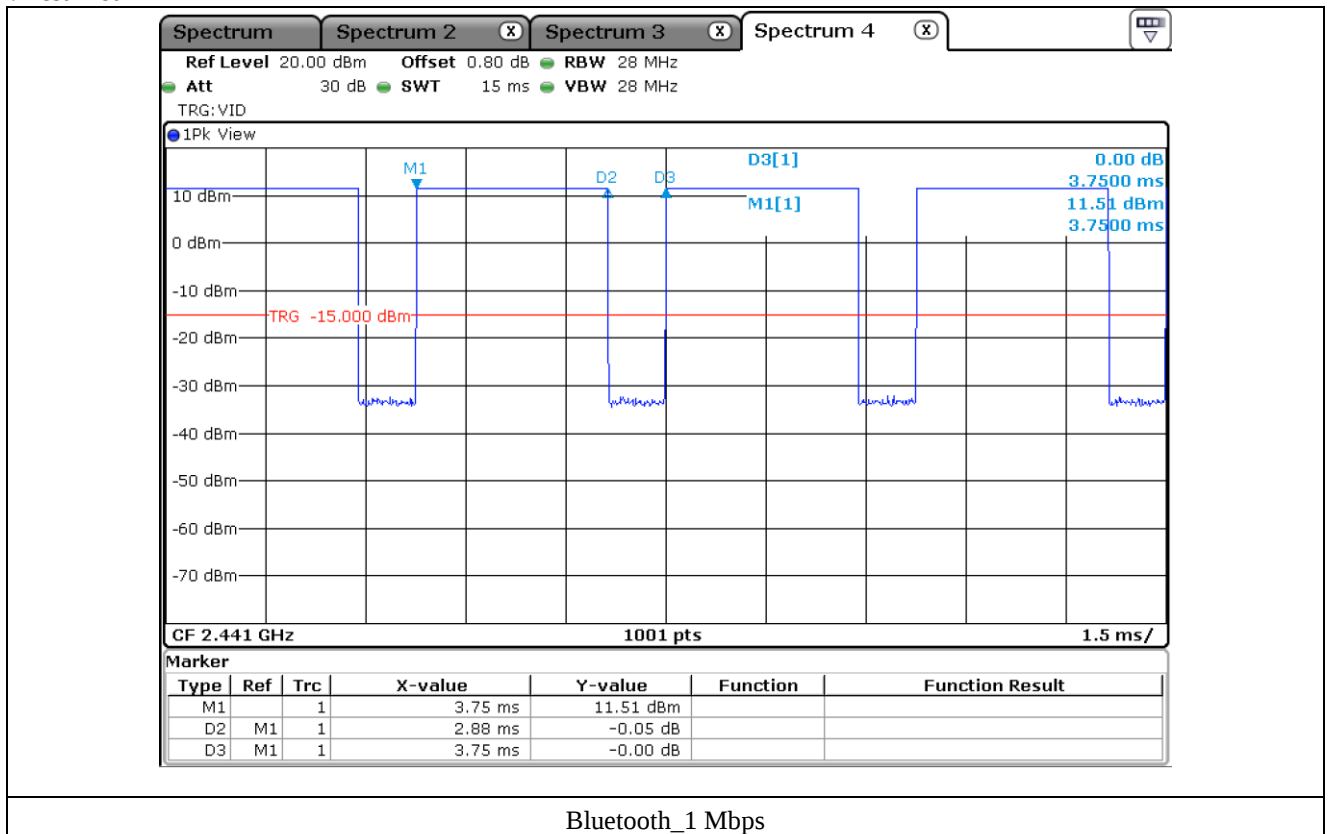
-. Duty Cycle (Left Earbud)

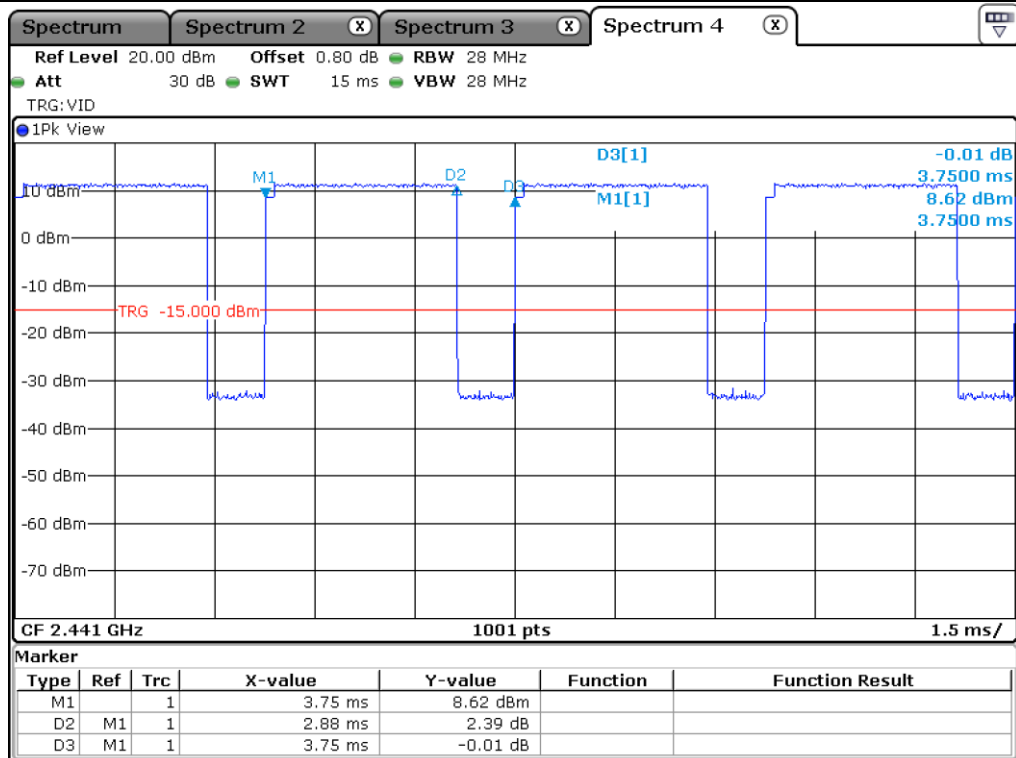
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [2 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [3 Mbps]	2.88	0.87	76.80	1.15

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

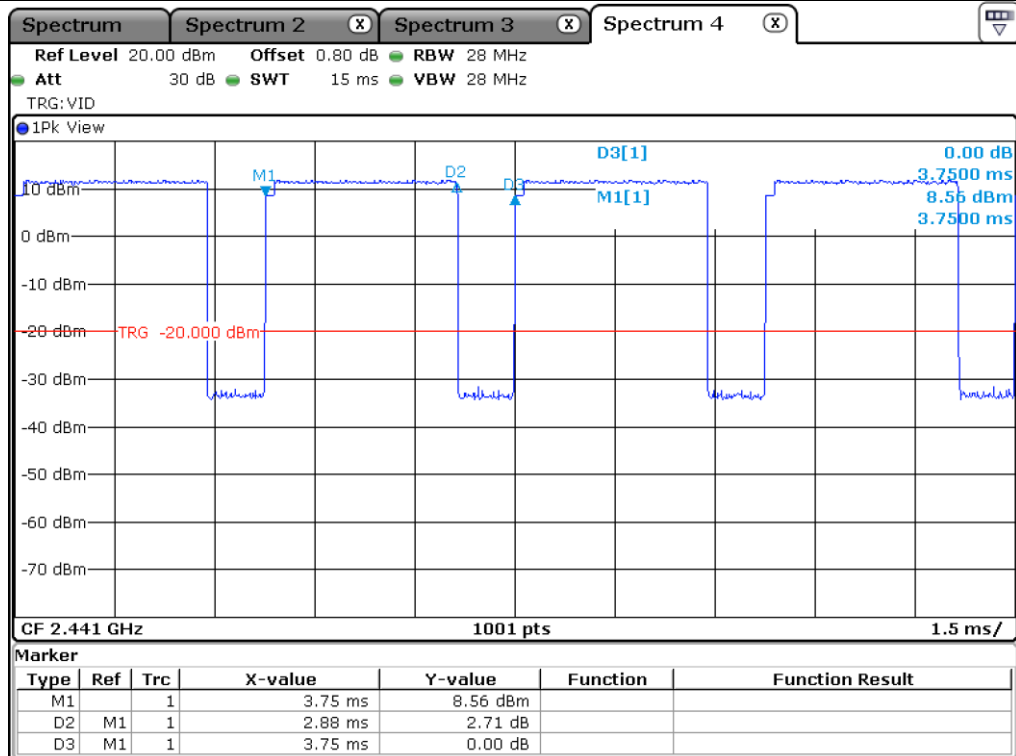
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 Mbps

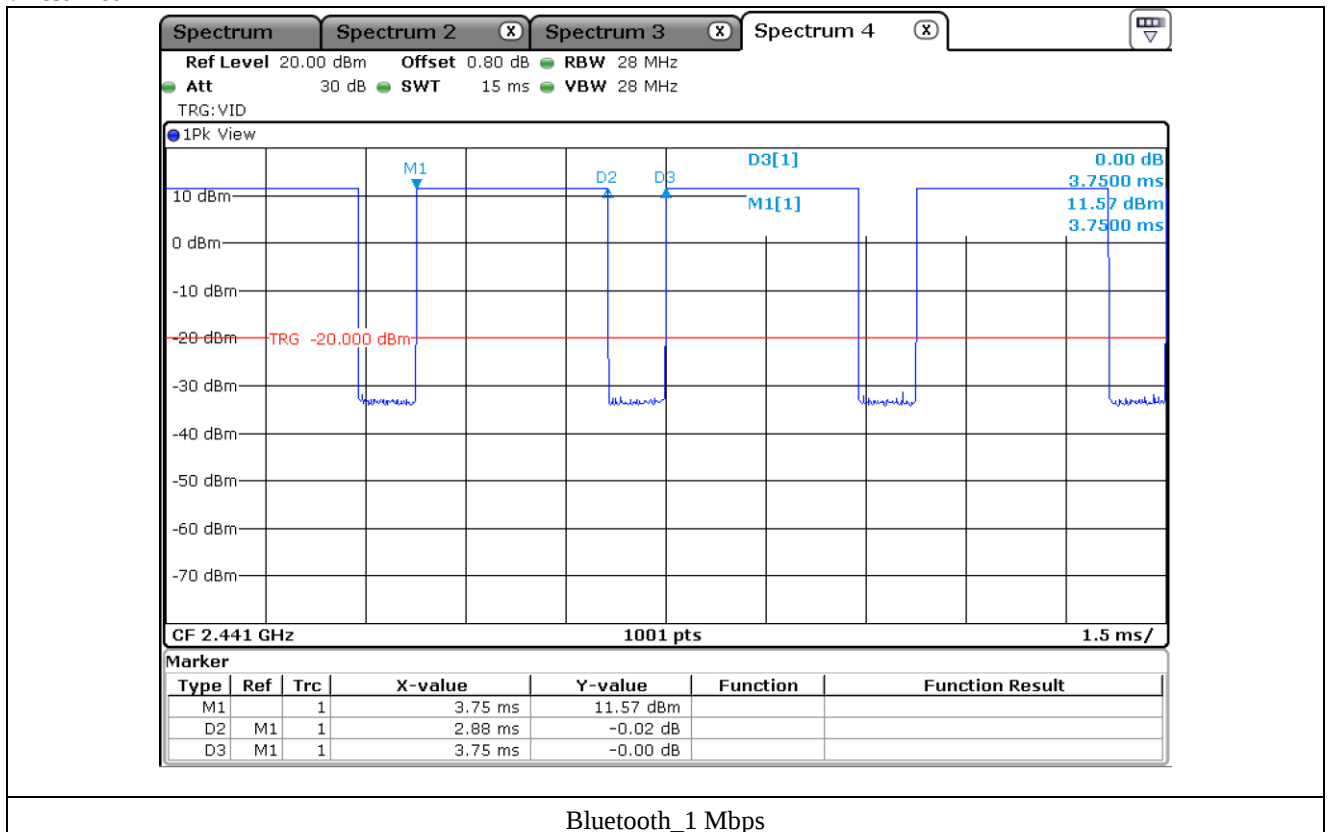
-. Duty Cycle (Right Earbud)

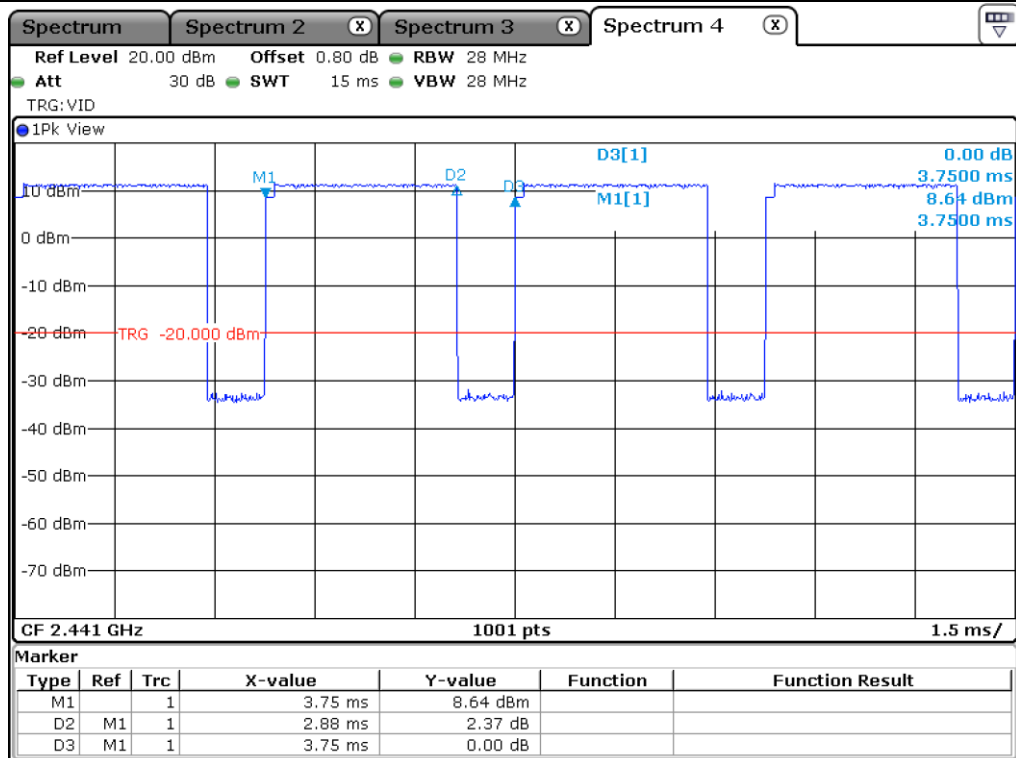
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [2 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [3 Mbps]	2.88	0.87	76.80	1.15

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

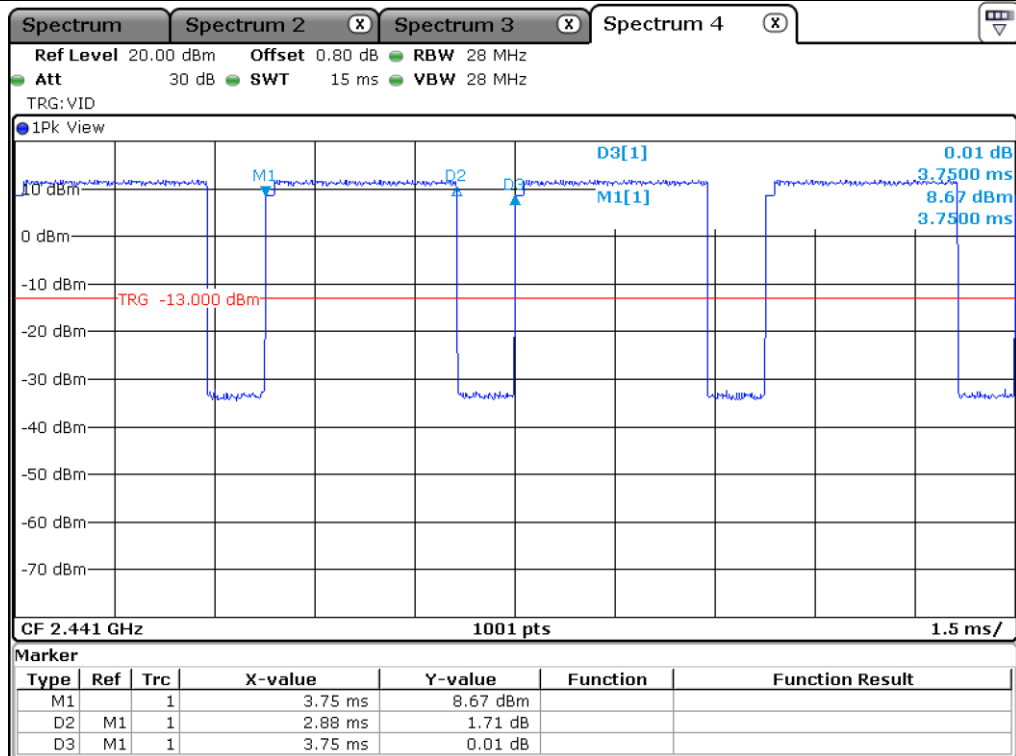
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 Mbps

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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: 2013 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

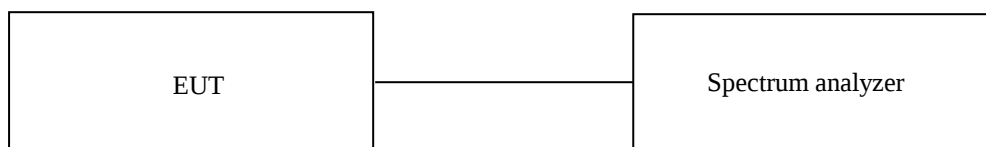
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 22 °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.



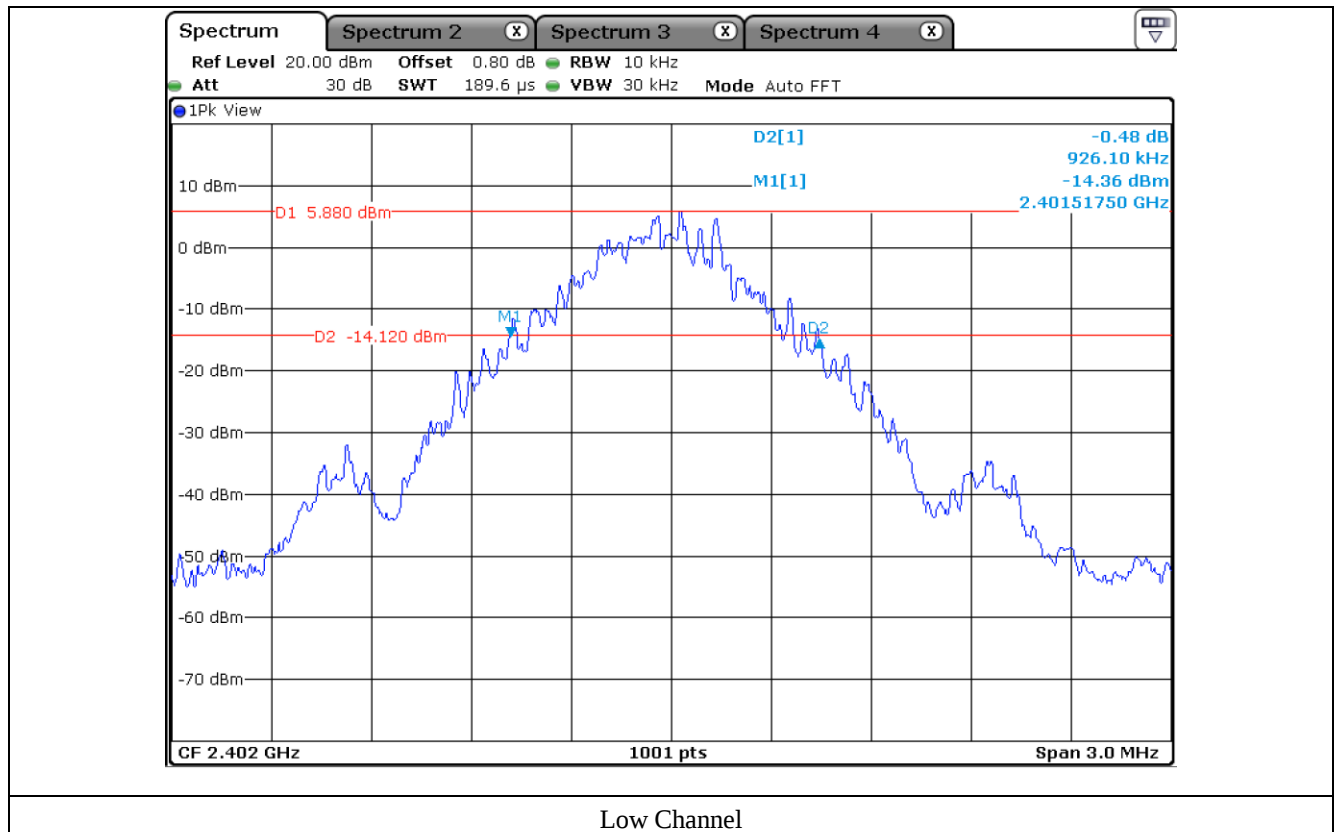
7.3 Test Date

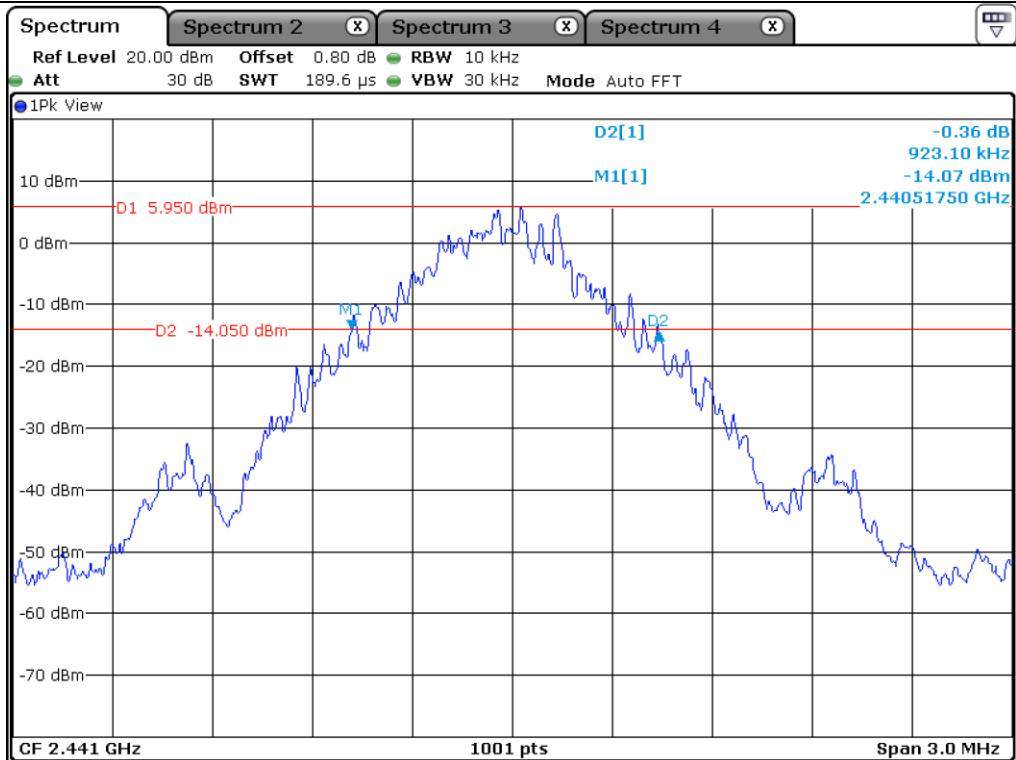
May 17, 2021 ~ May 31, 2021

7.4 Test data for Left Earbud

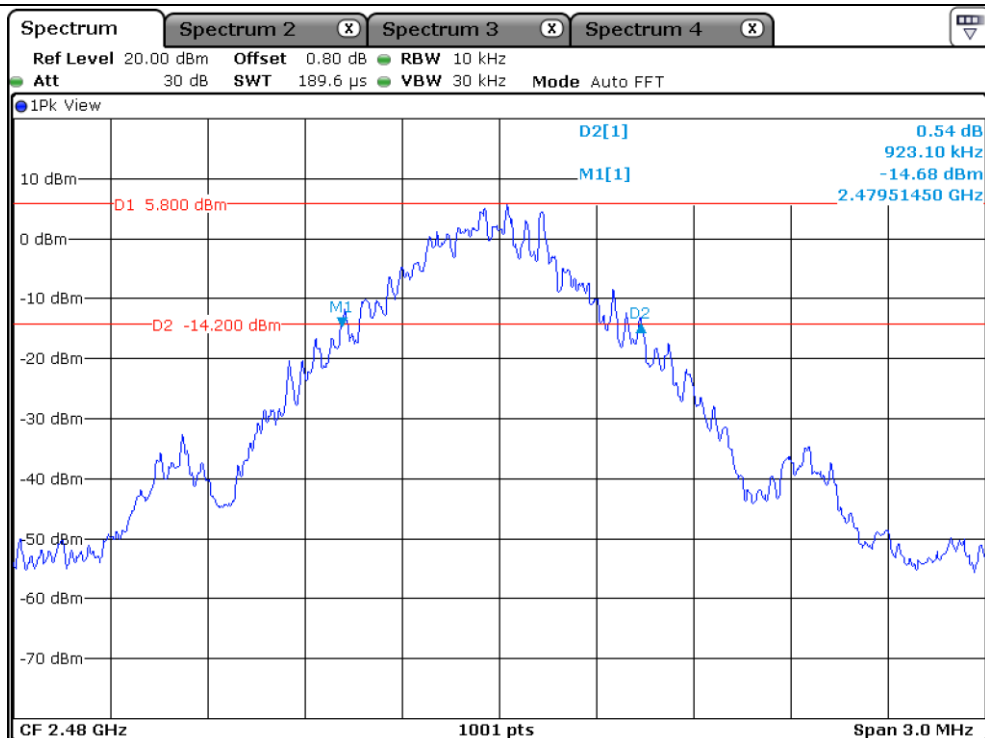
7.4.1 Test data for 1 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	926.10
Middle	2 441.00	923.10
High	2 480.00	923.10





Middle Channel



High Channel

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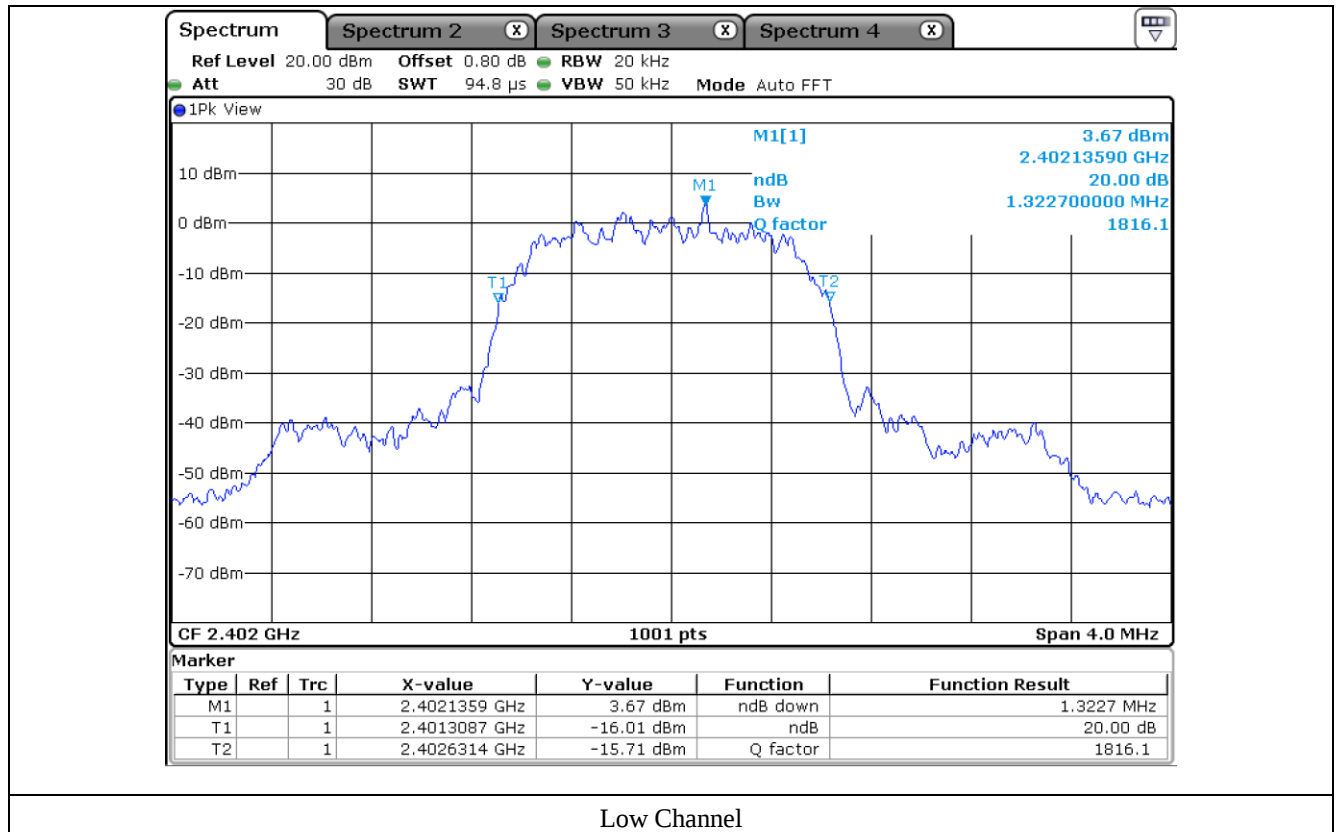
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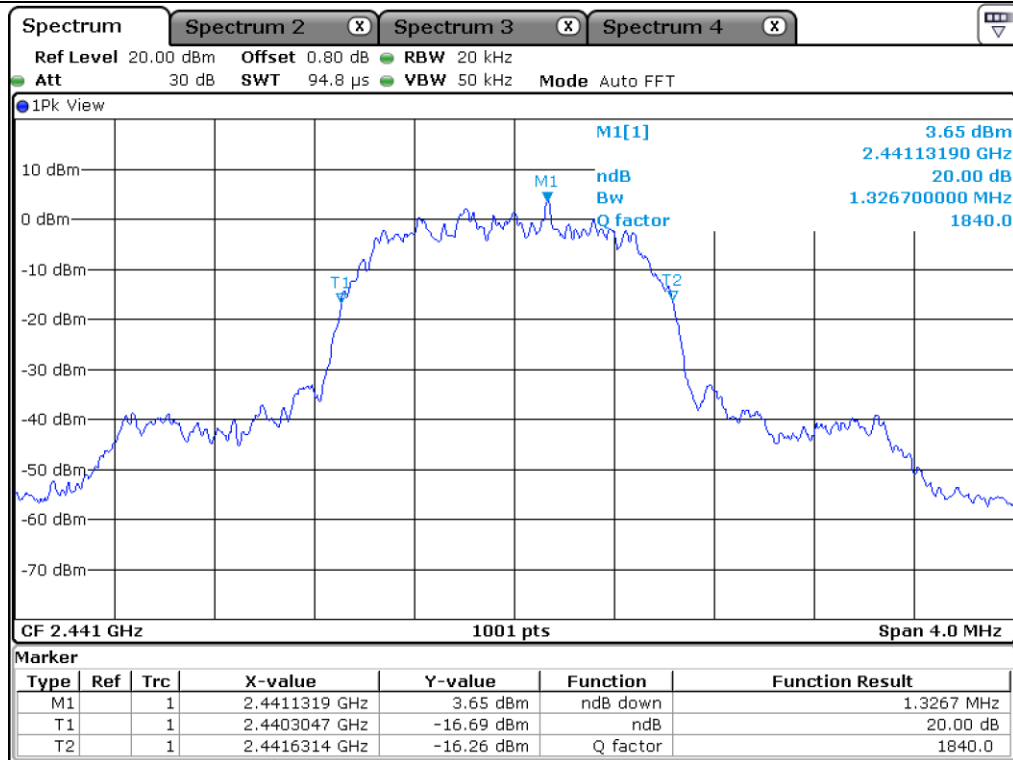
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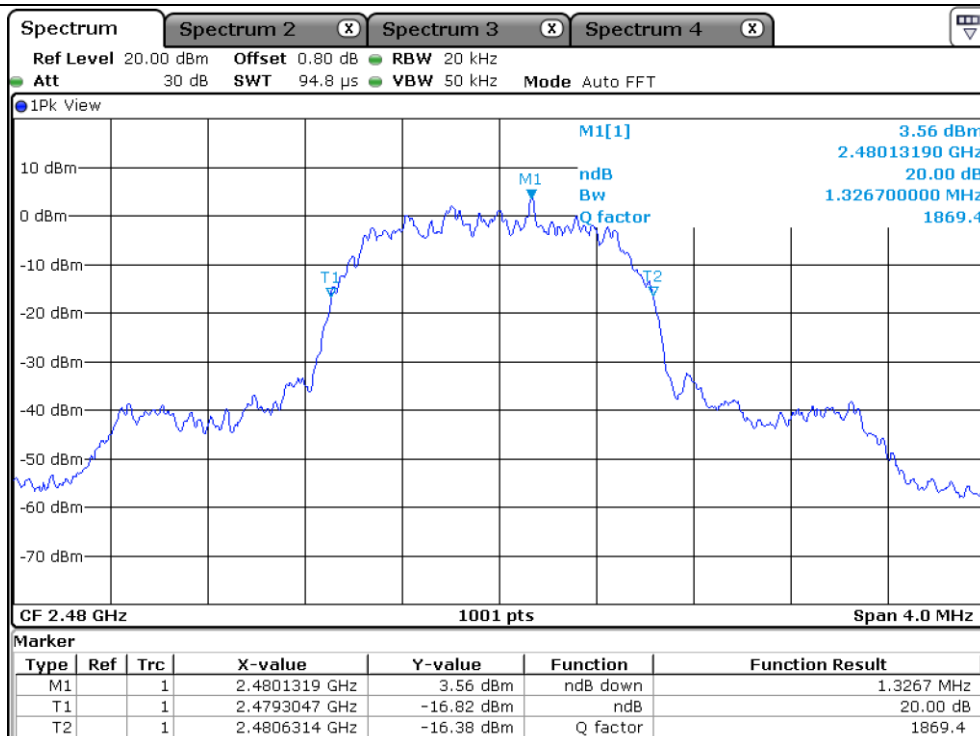
7.4.2 Test data for 2 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 322.70
Middle	2 441.00	1 326.70
High	2 480.00	1 326.70





Middle Channel



High Channel

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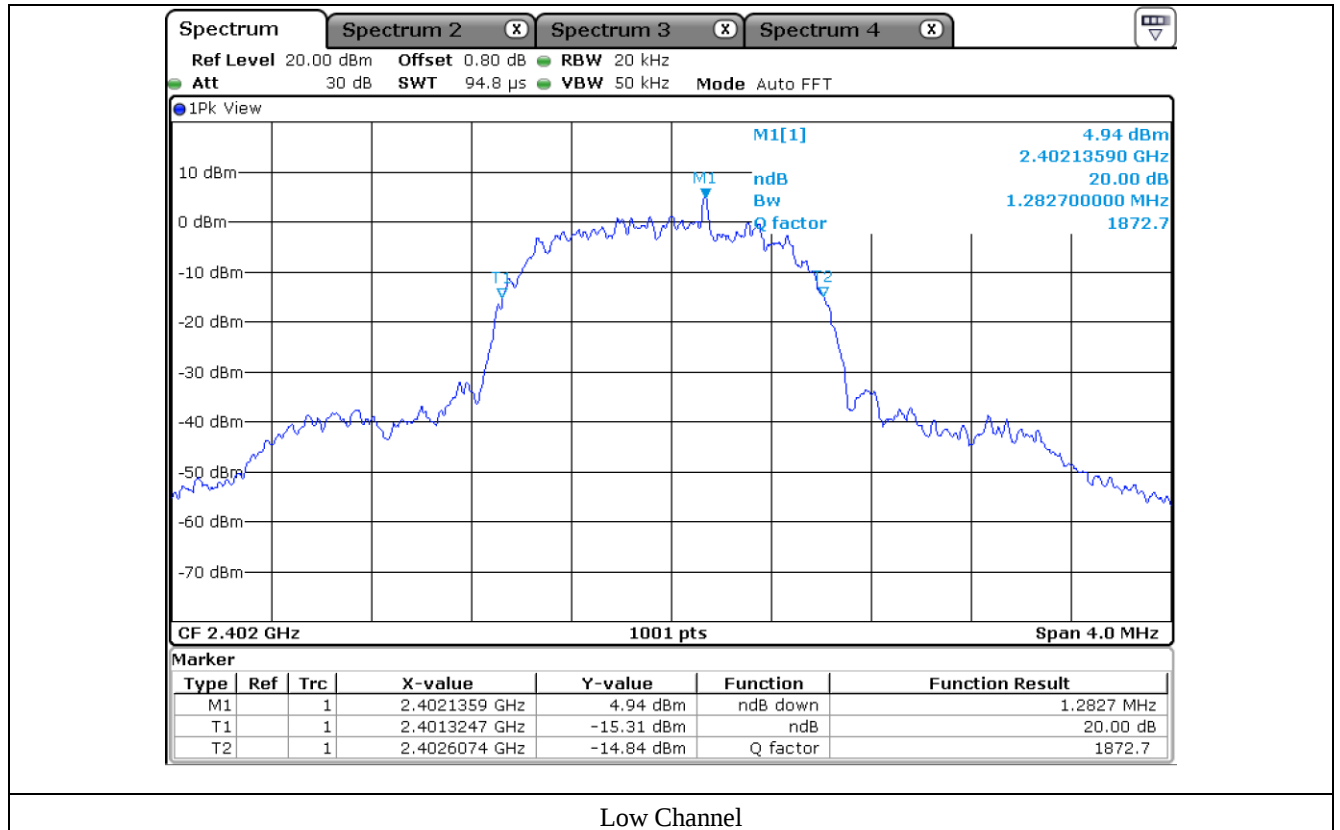
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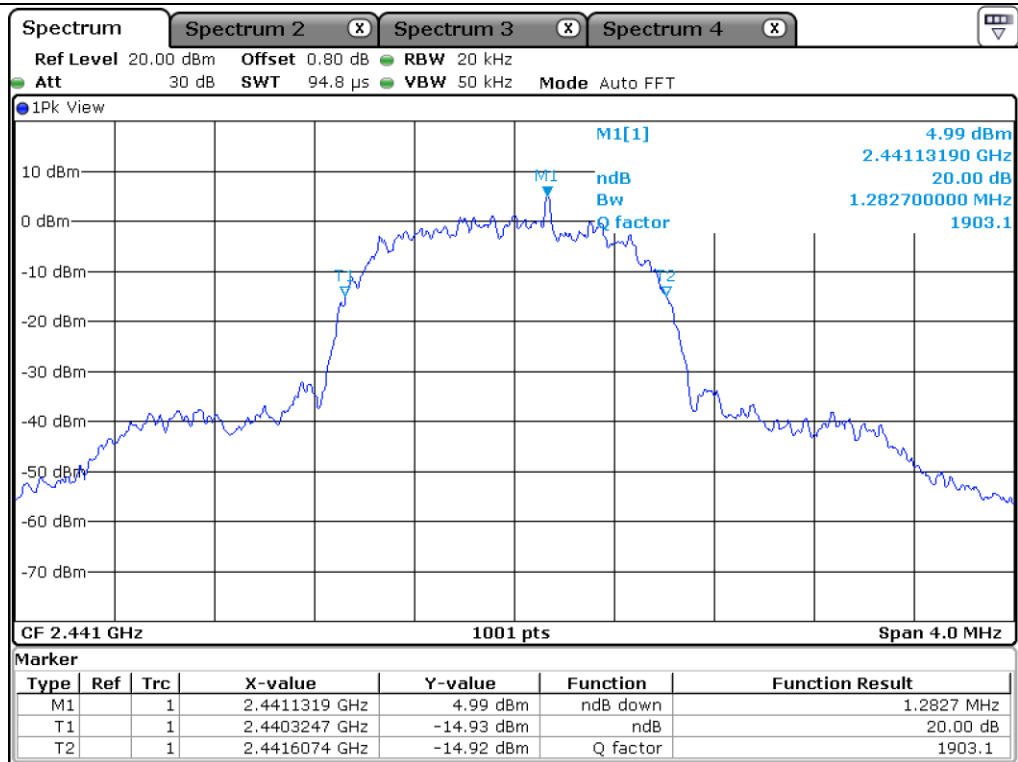
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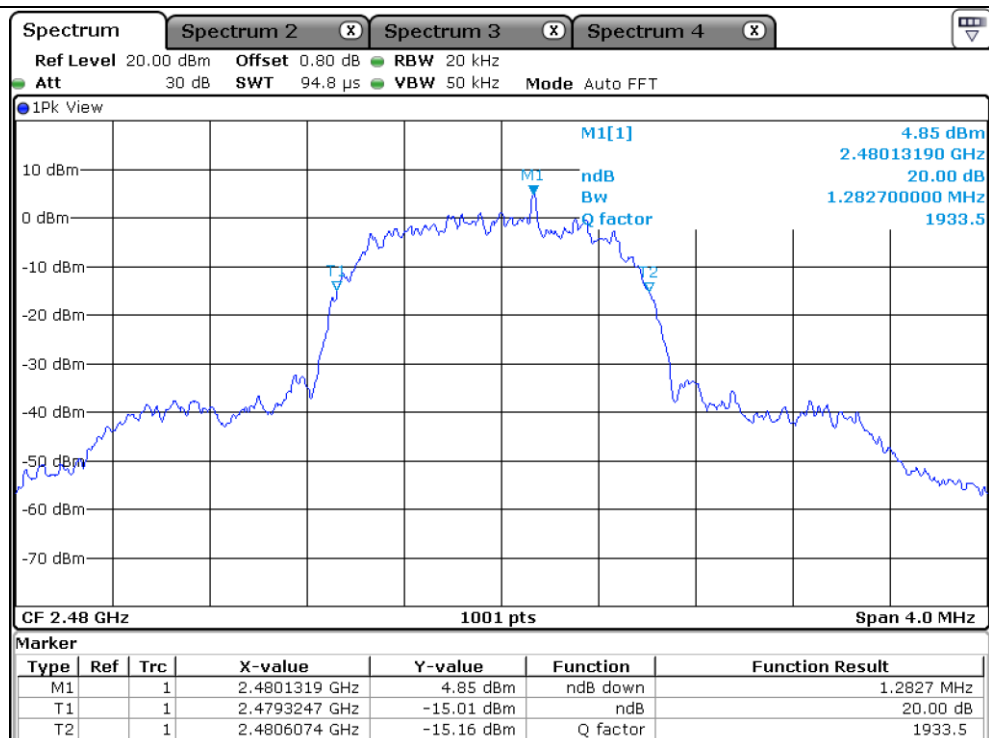
7.4.3 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 282.70
Middle	2 441.00	1 282.70
High	2 480.00	1 282.70





Middle Channel



High Channel

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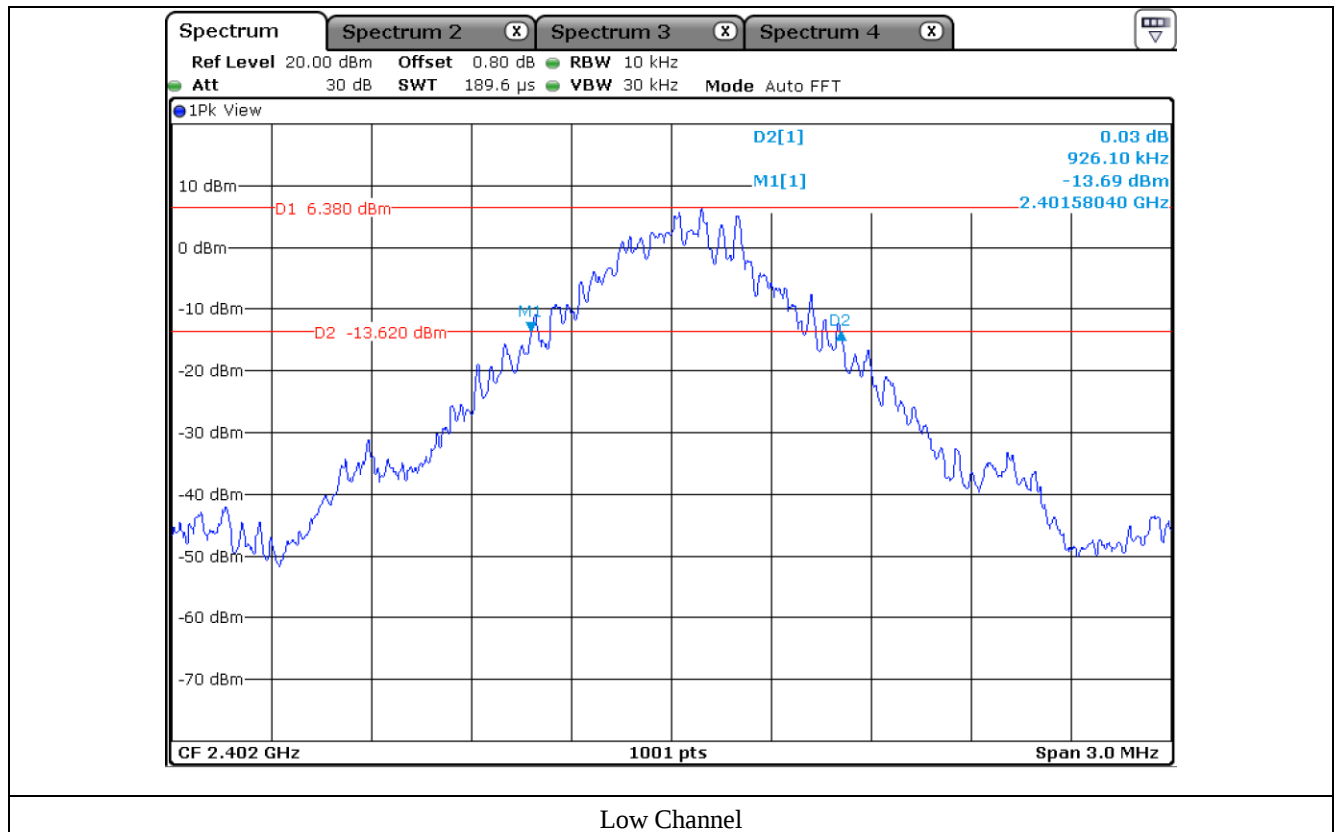
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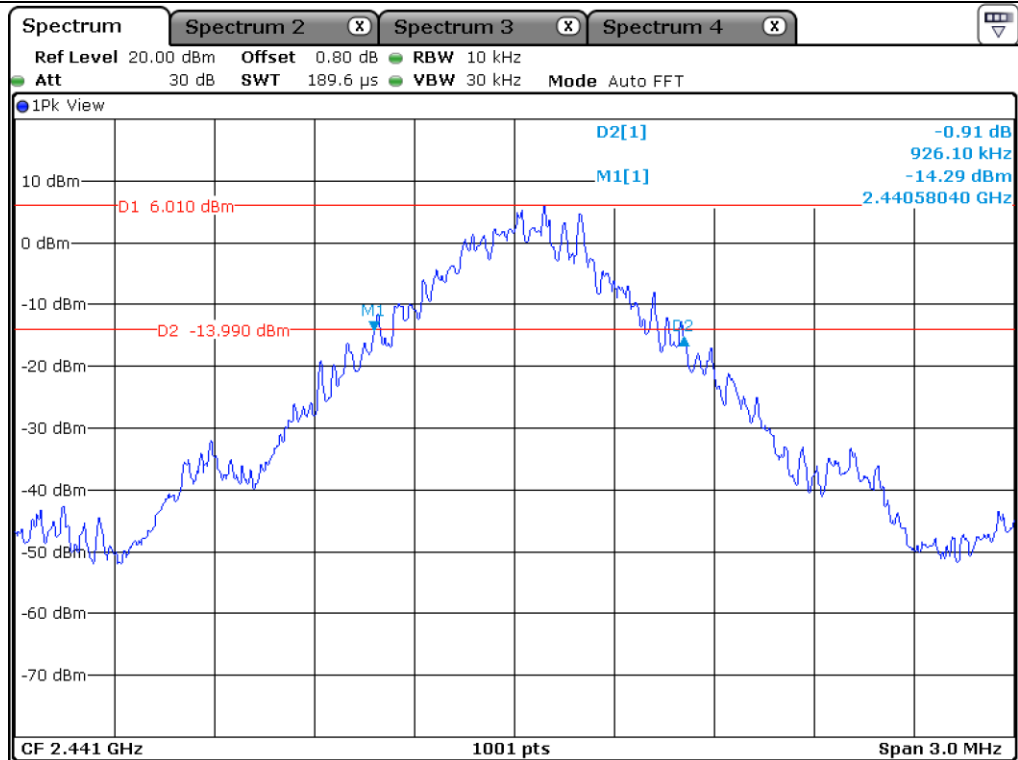
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7.5 Test data for Right Earbud

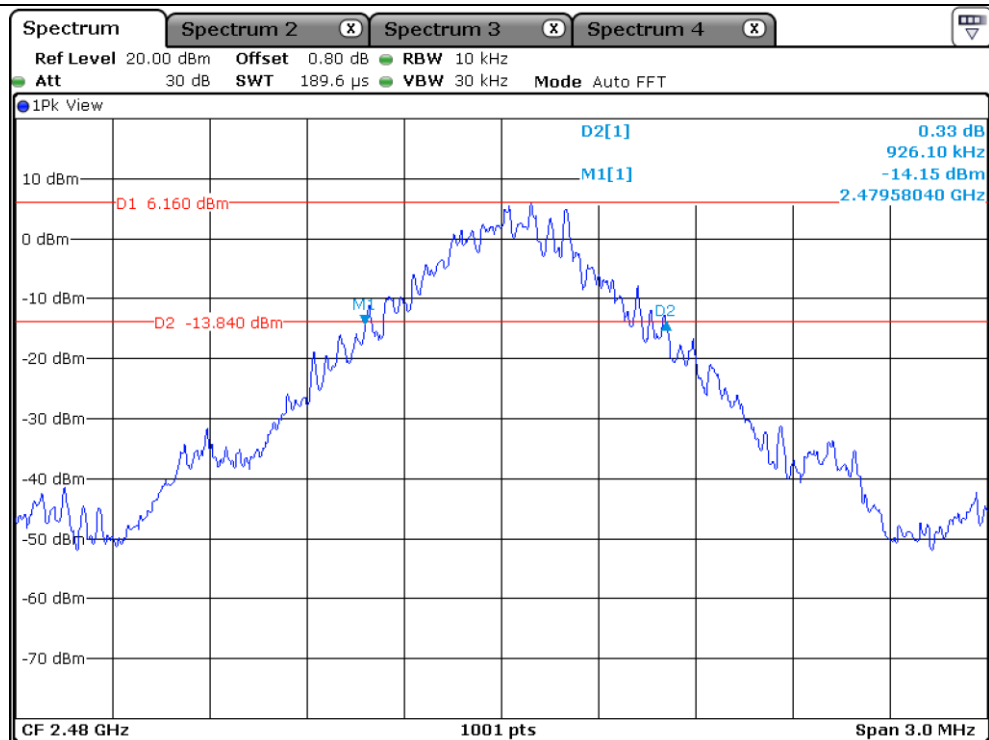
7.5.1 Test data for 1 Mbps

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





Middle Channel



High Channel

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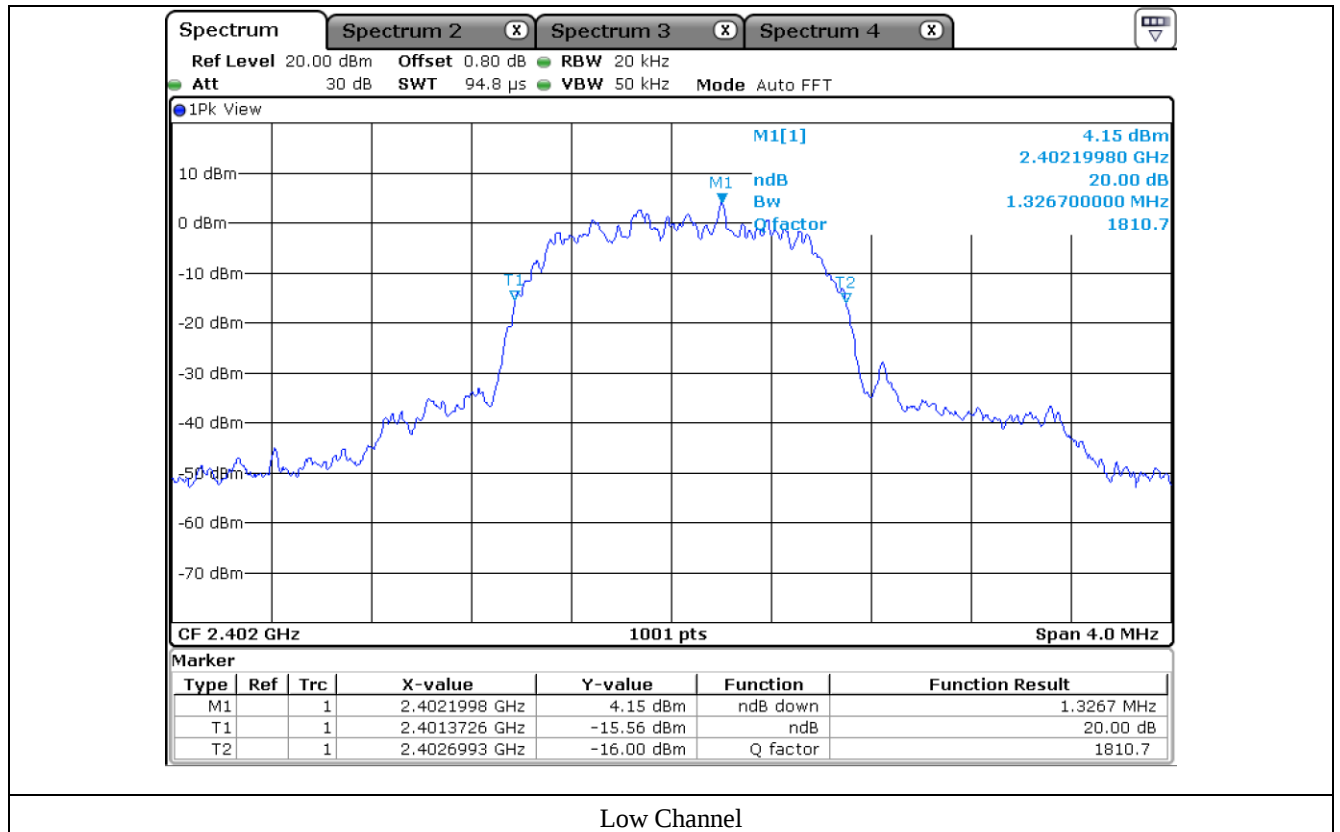
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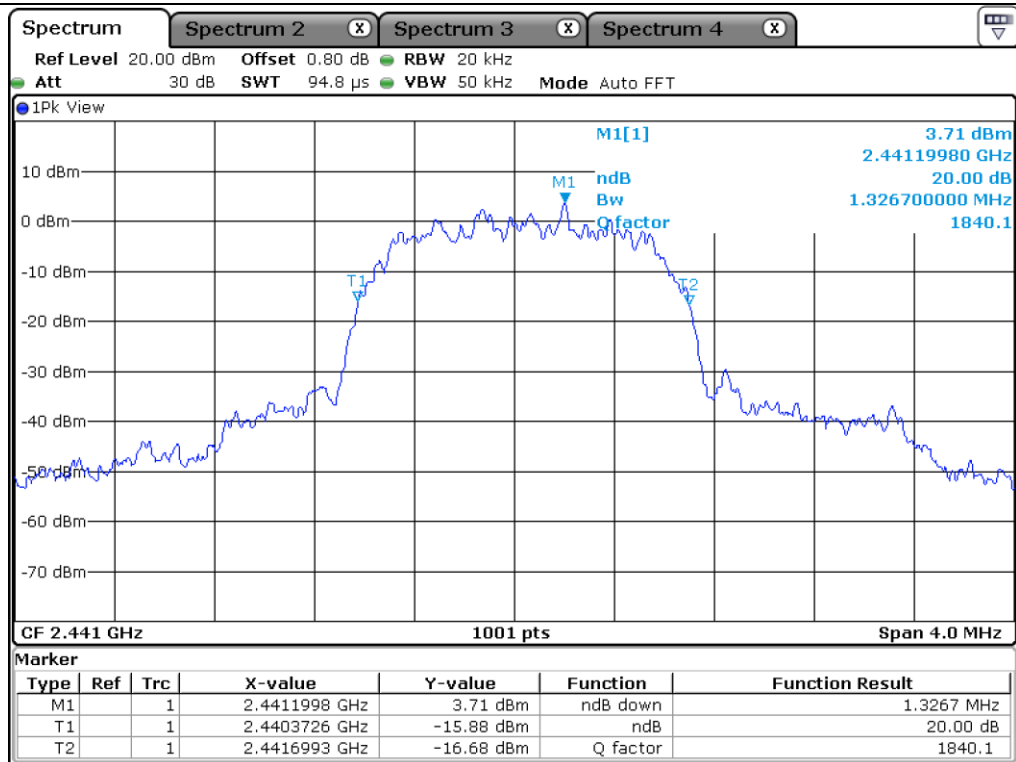
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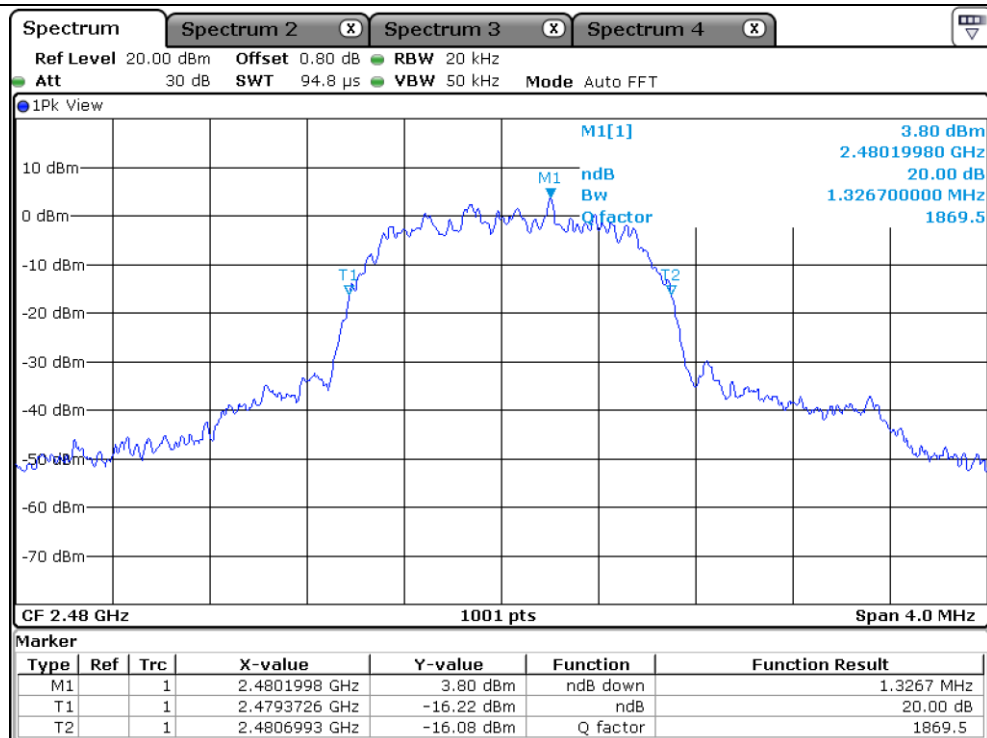
7.5.2 Test data for 2 Mbps

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





Middle Channel



High Channel

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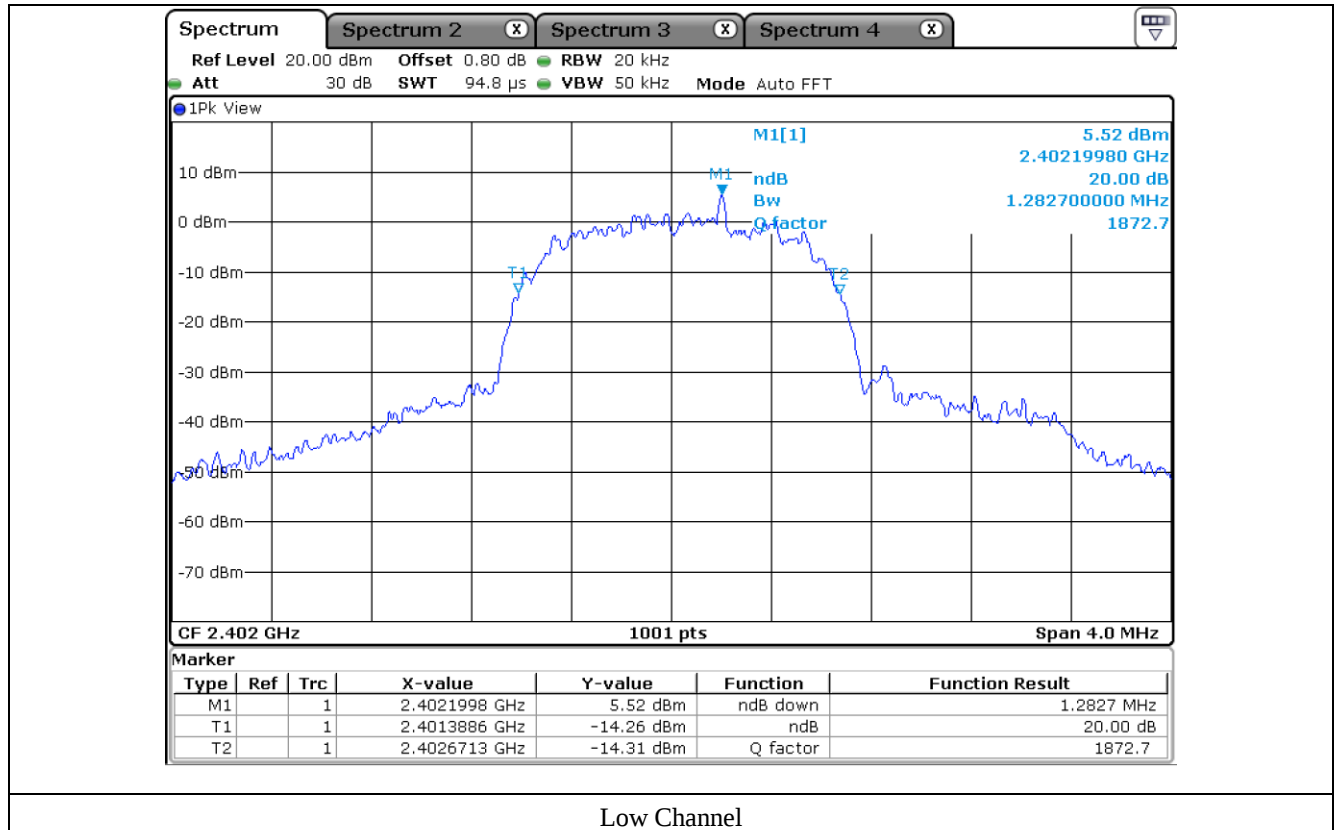
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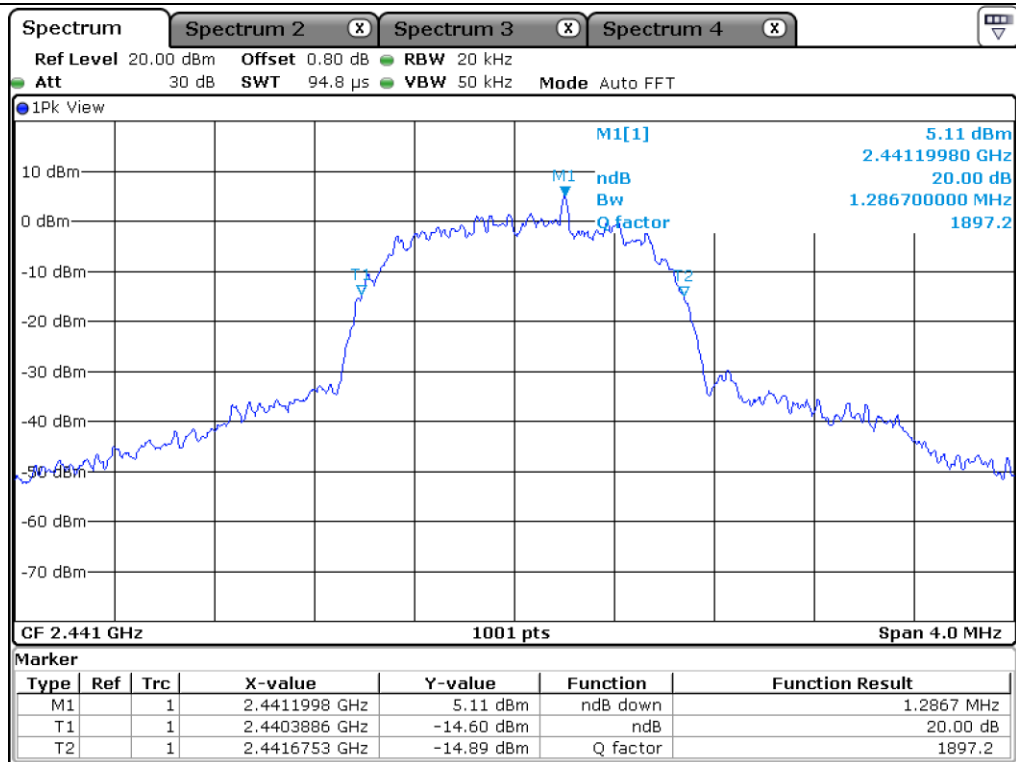
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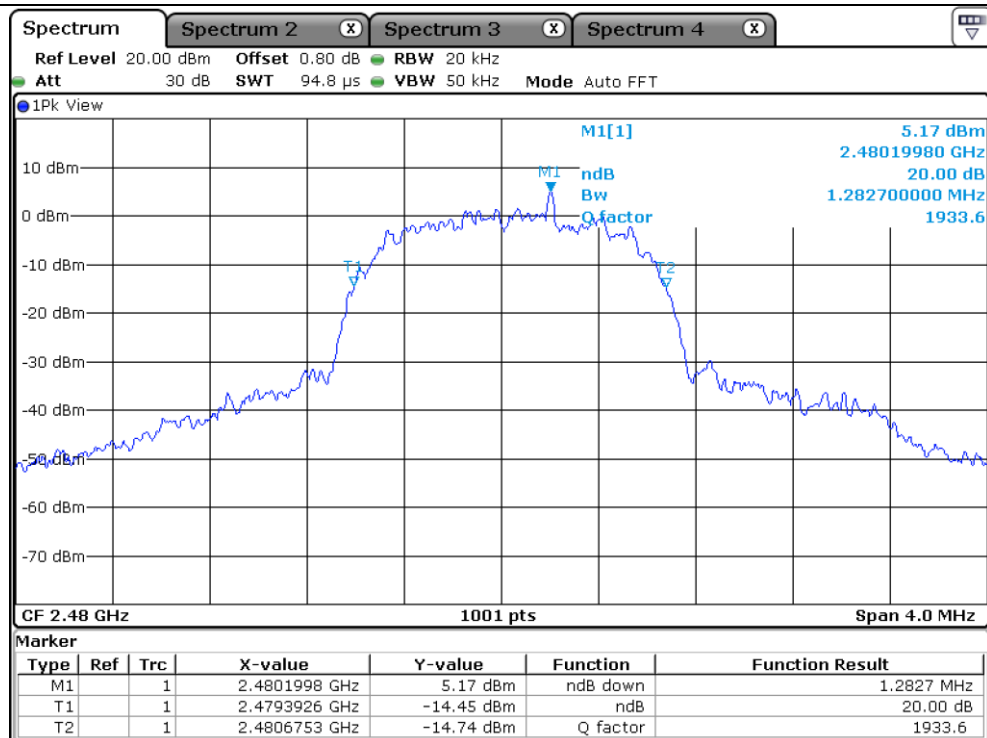
7.5.3 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 282.70
Middle	2 441.00	1 286.70
High	2 480.00	1 282.70





Middle Channel



High Channel

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8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 22 °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 10 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

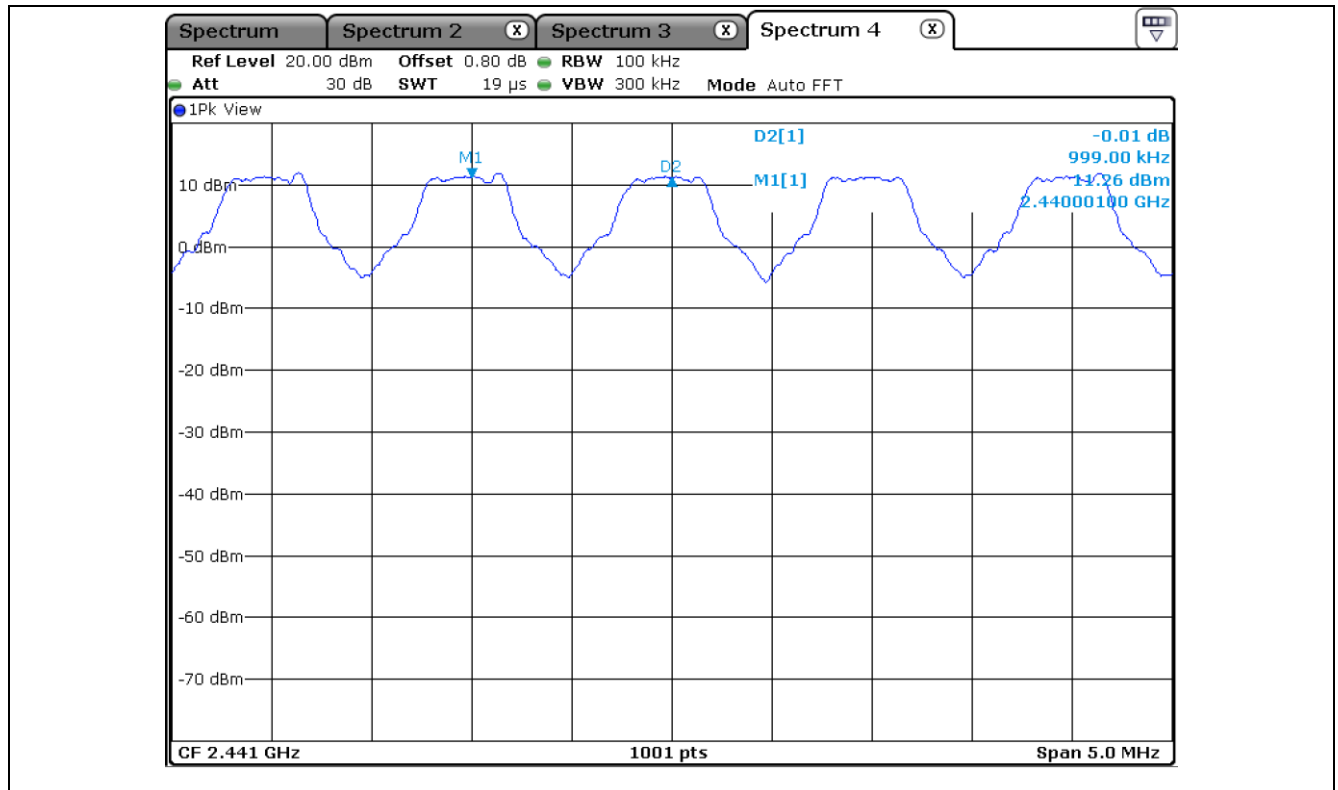
May 17, 2021 ~ May 31, 2021

8.4 Test data for Left Earbud

8.4.1 Test data for 1 Mbps

-. Test Result : Pass

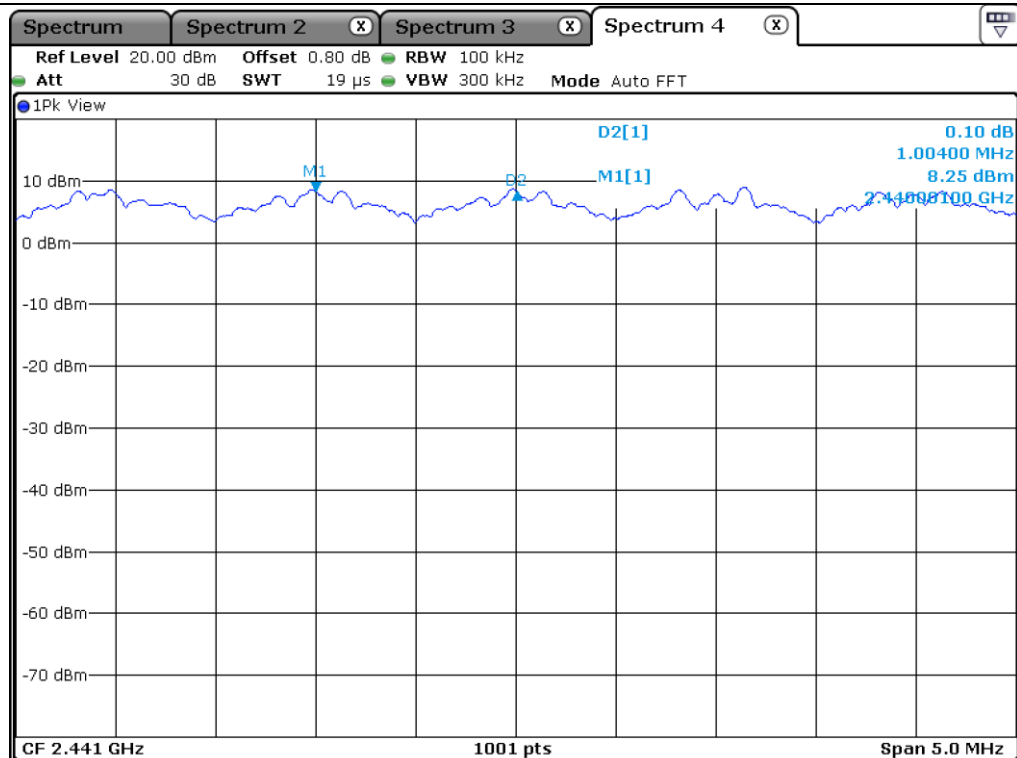
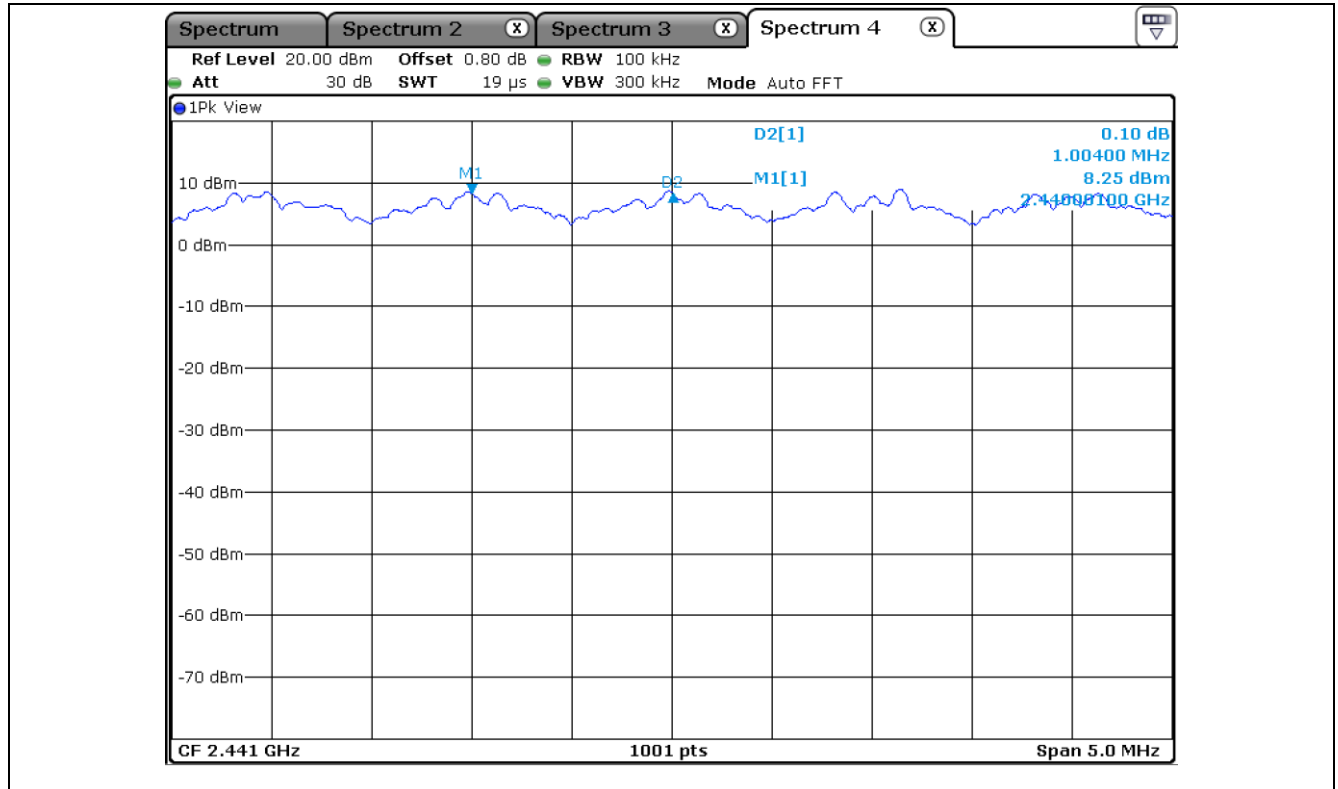
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	615.40	Separated by a minimum of 615.40 kHz



8.4.2 Test data for 2 Mbps

-. Test Result : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.00	884.47	Separated by a minimum of 884.47 kHz



This Report is not

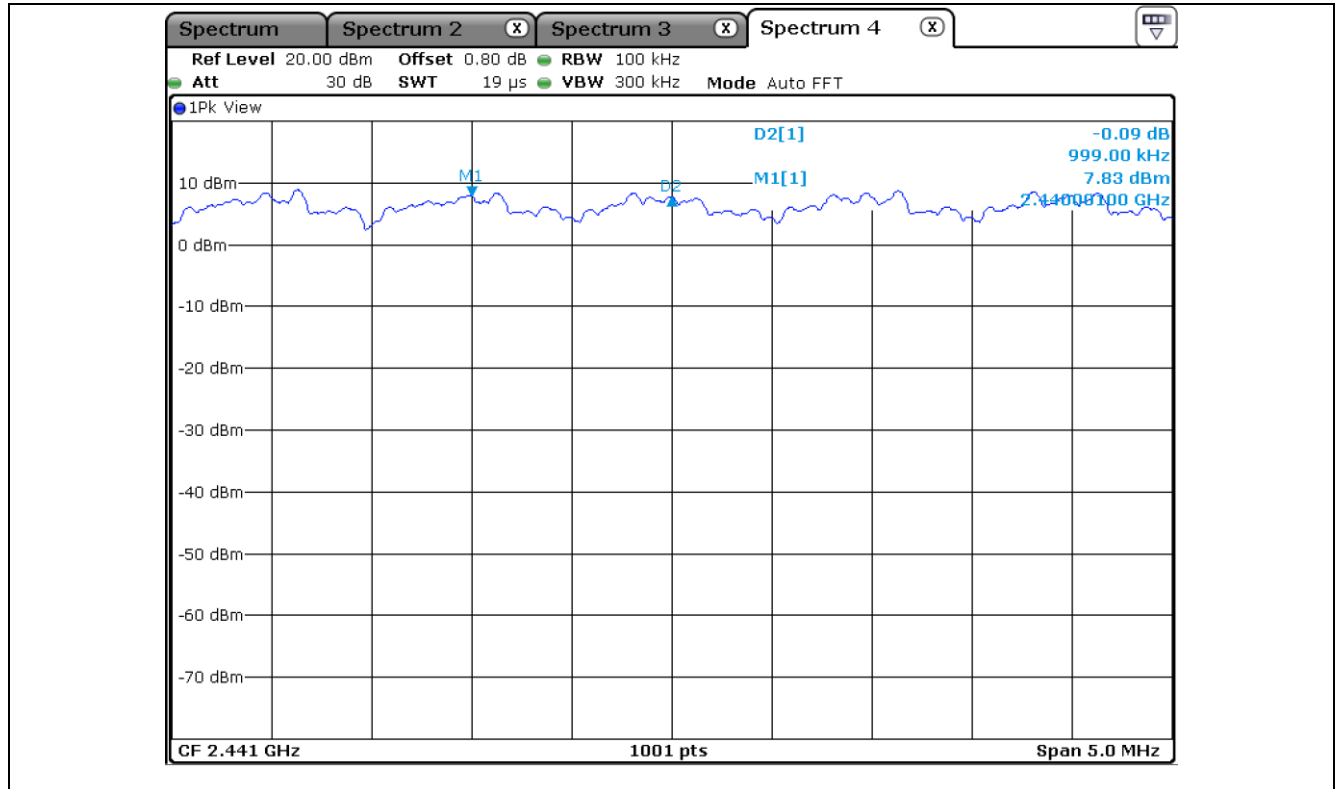
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8.4.3 Test data for 3 Mbps

-. Test Result : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	855.13	Separated by a minimum of 855.13 kHz



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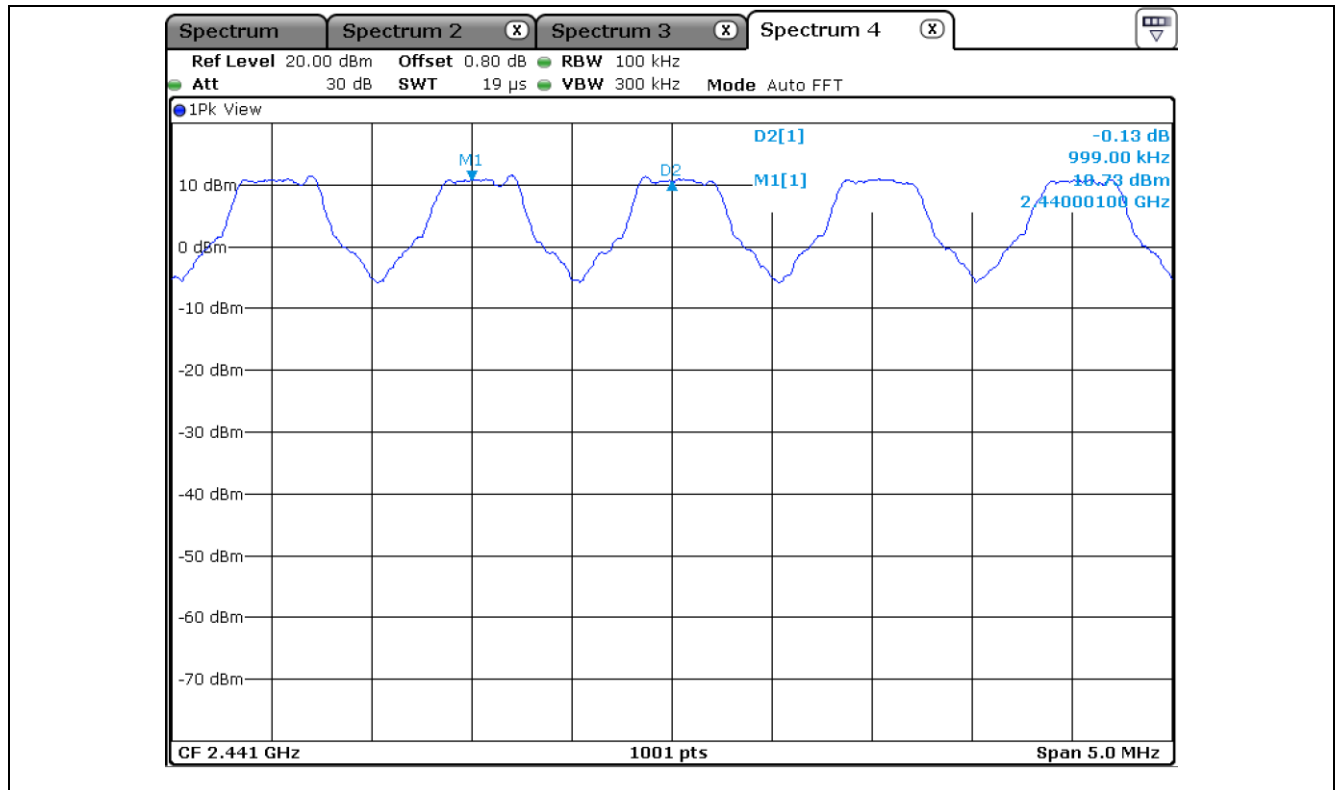
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8.5 Test data for Right Earbud

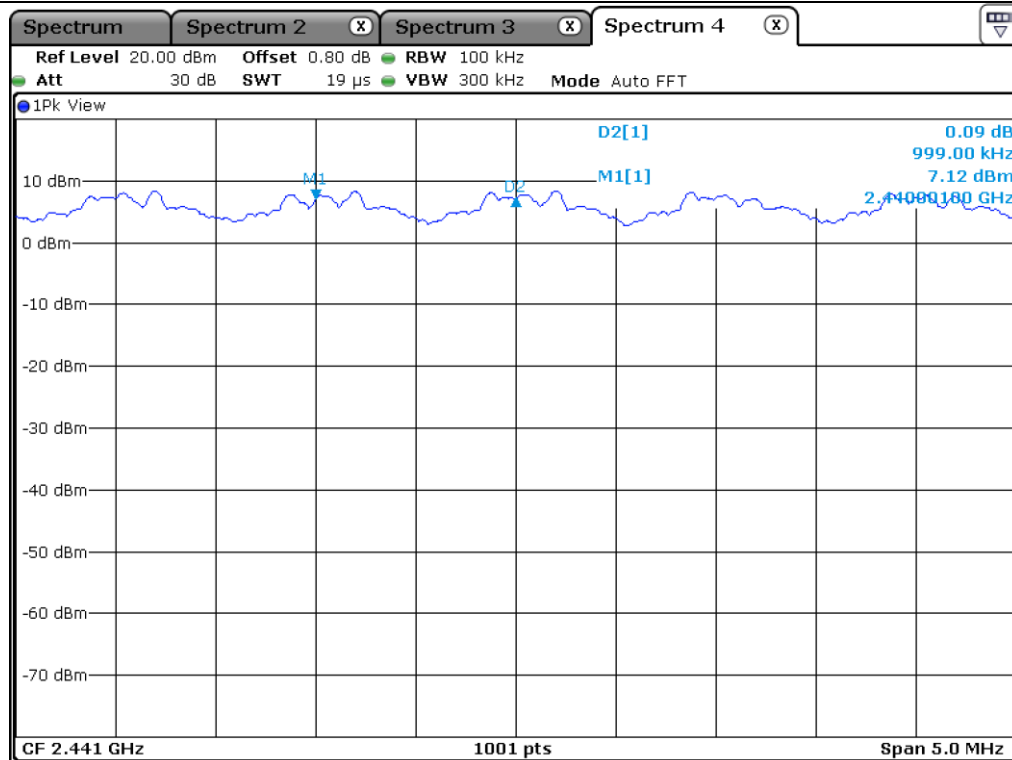
8.5.1 Test data for 1 Mbps

-. 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



-. Test Result : Pass

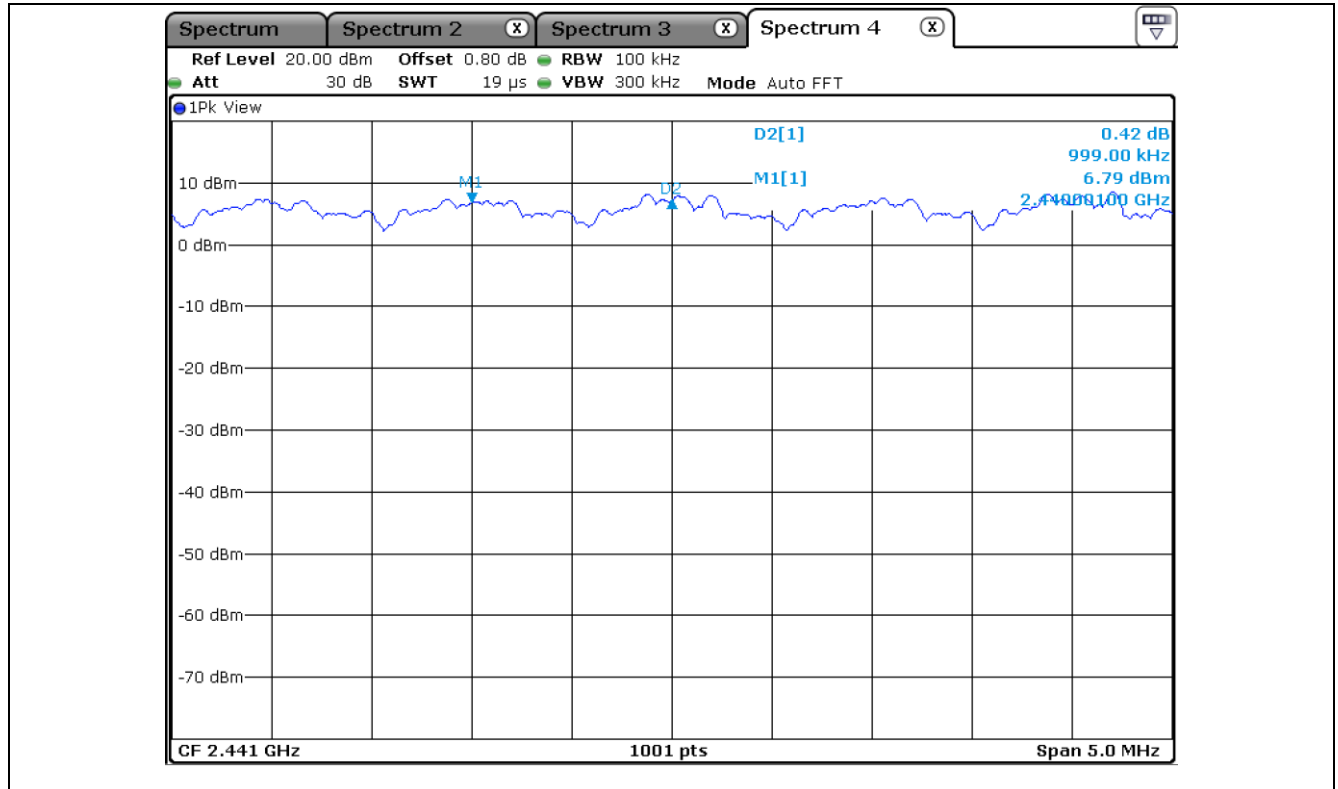


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8.5.3 Test data for 3 Mbps

-. 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



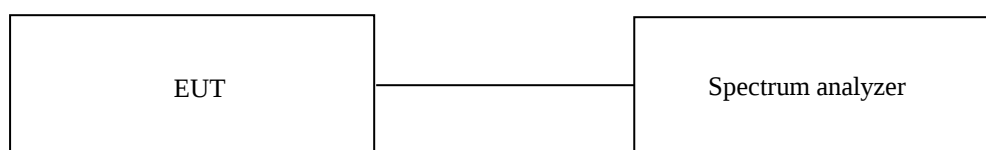
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 22 °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

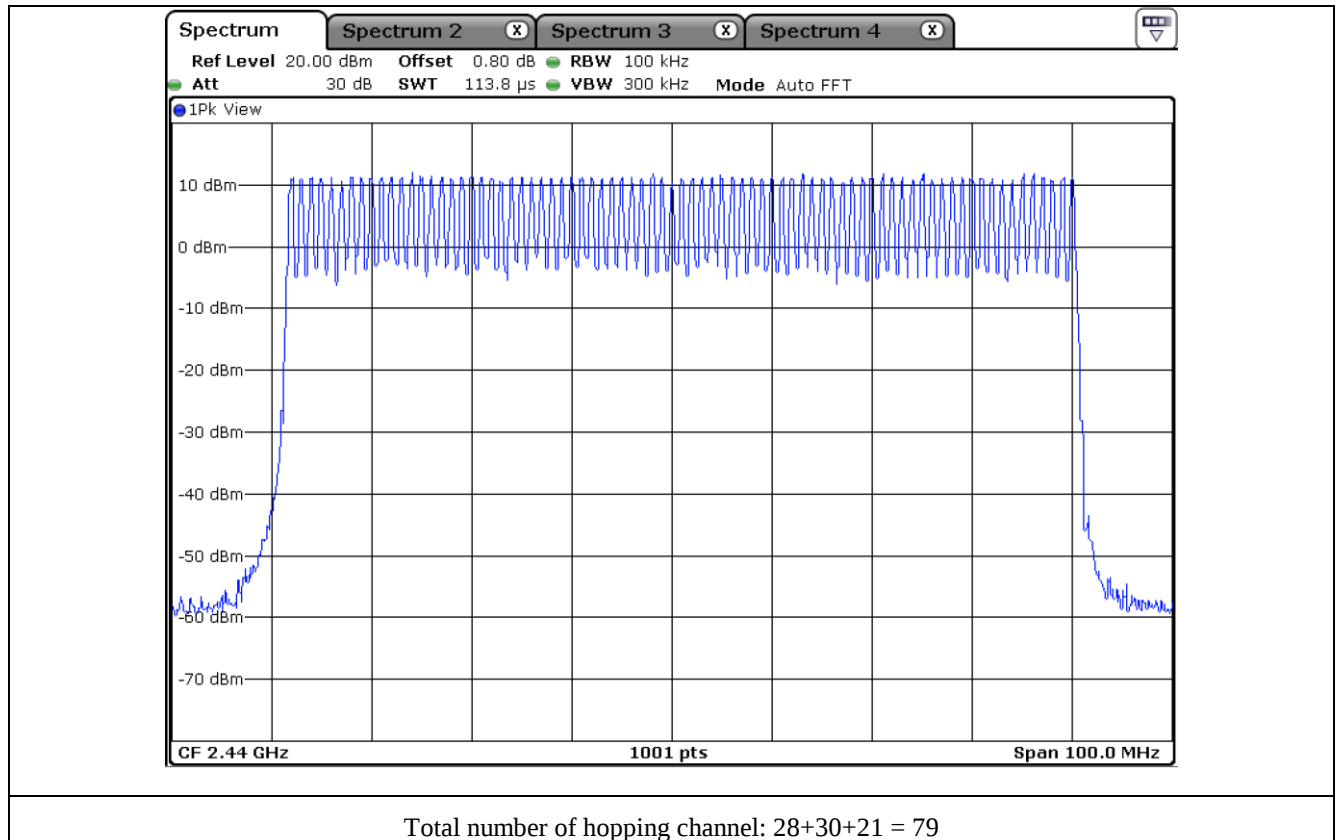
May 17, 2021 ~ May 31, 2021

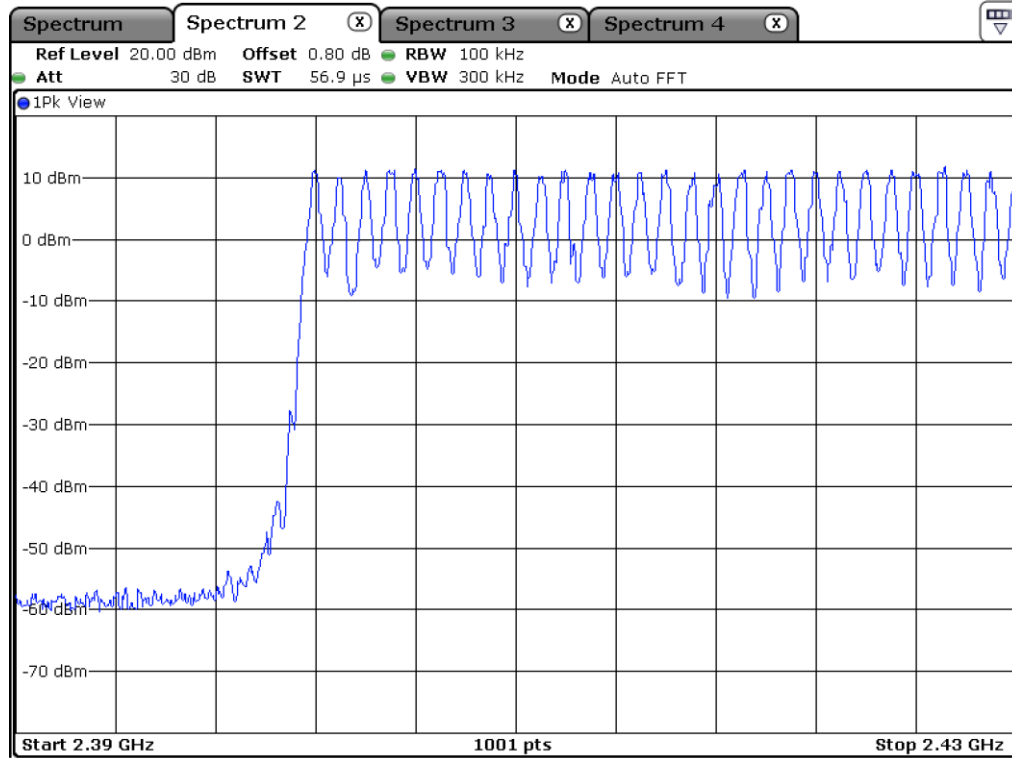
9.4 Test data for Left Earbud

9.4.1 Test data for 1 Mbps

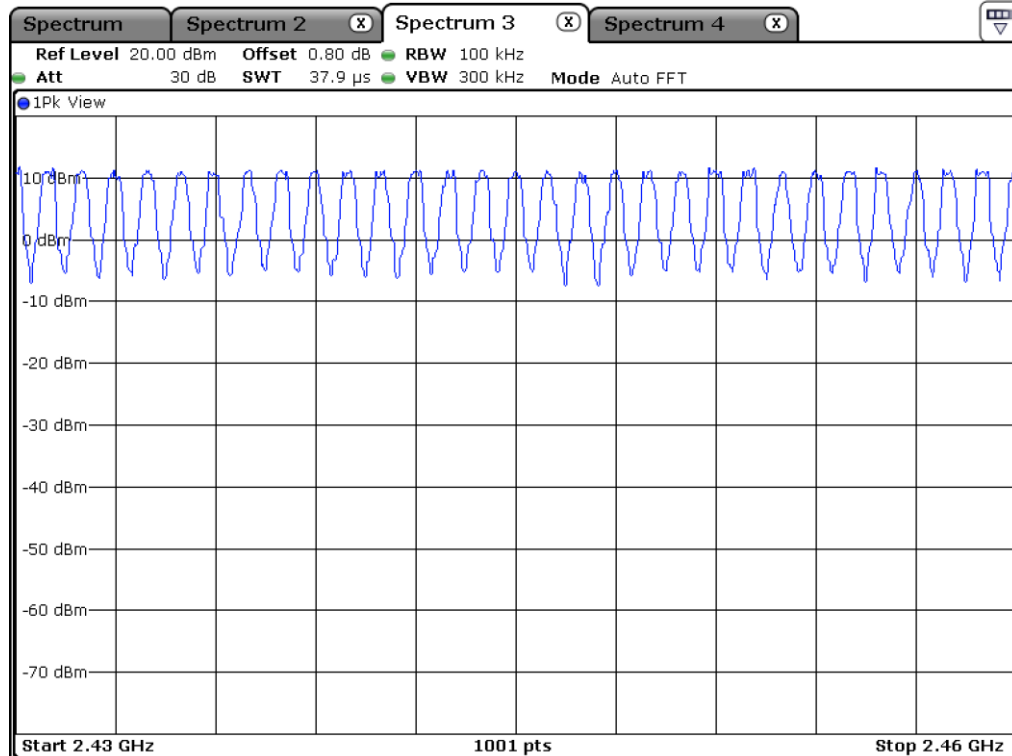
-. Test Result : Pass

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

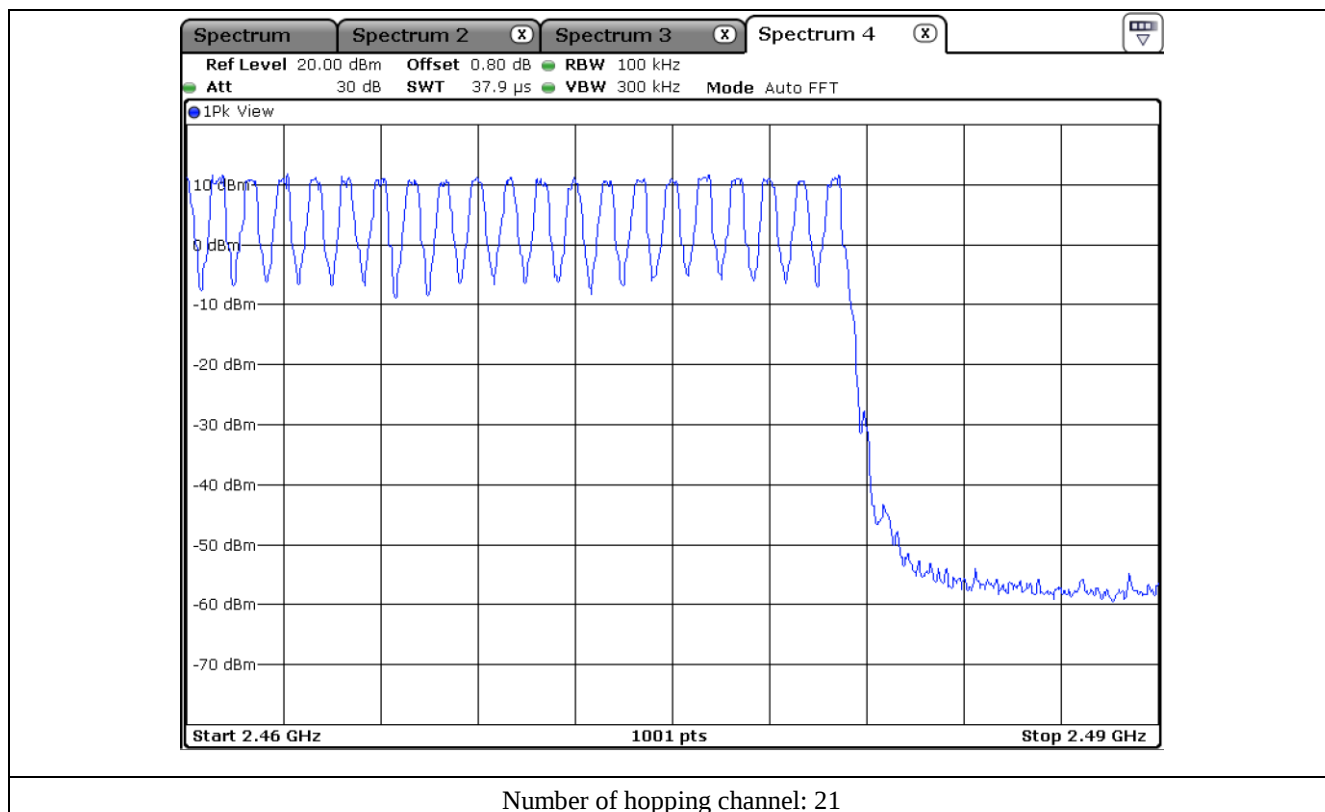




Number of hopping channel: 28



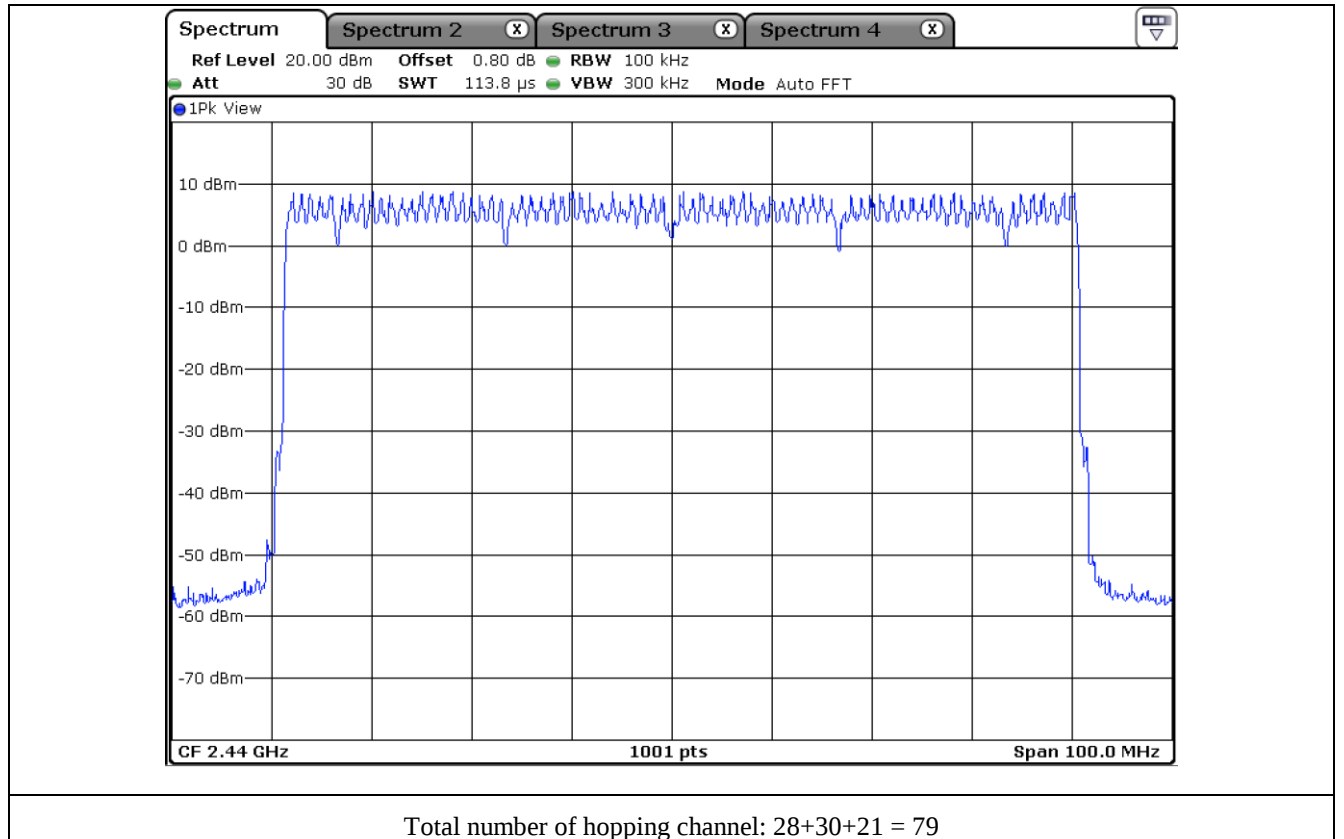
Number of hopping channel: 30

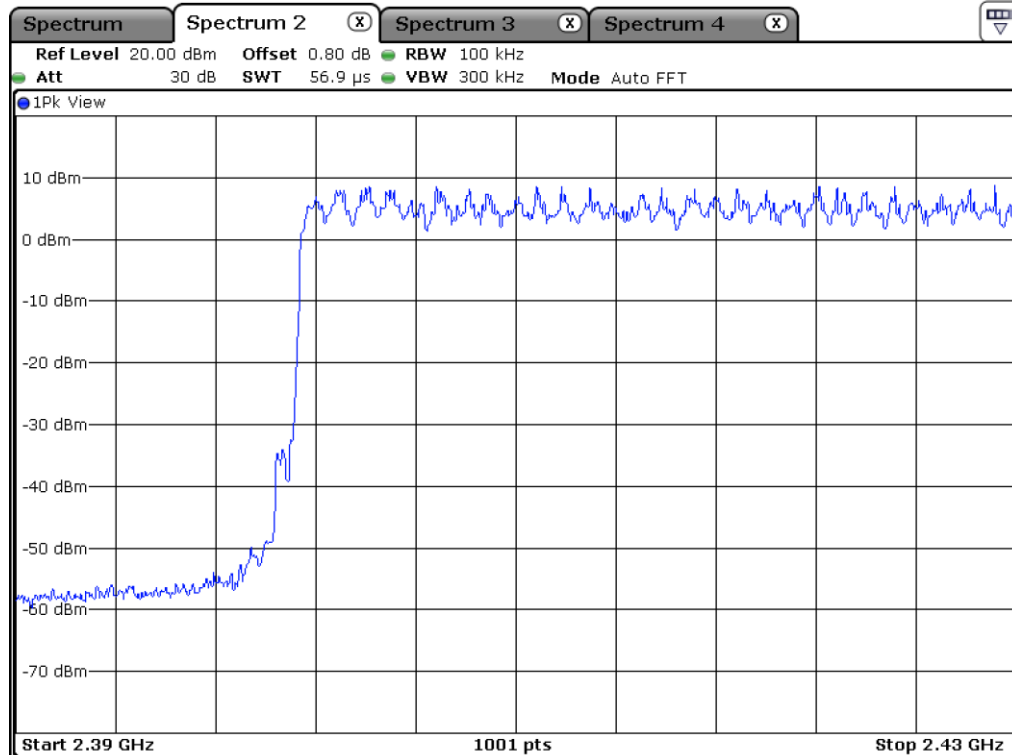


9.4.2 Test data for 2 Mbps

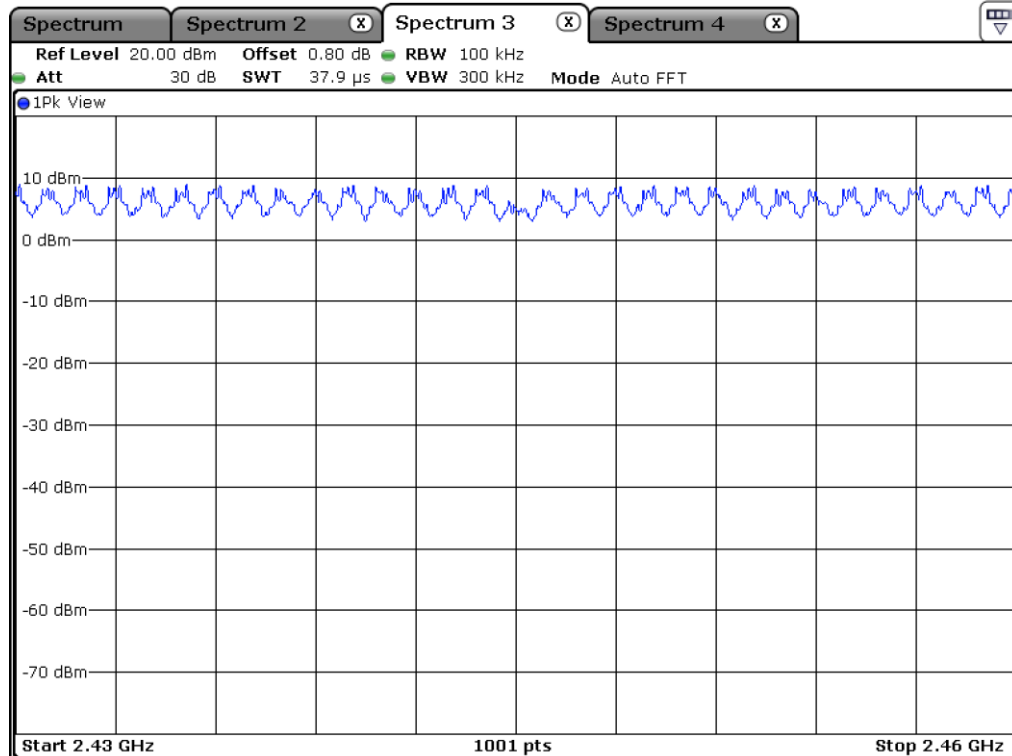
-. Test Result : Pass

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

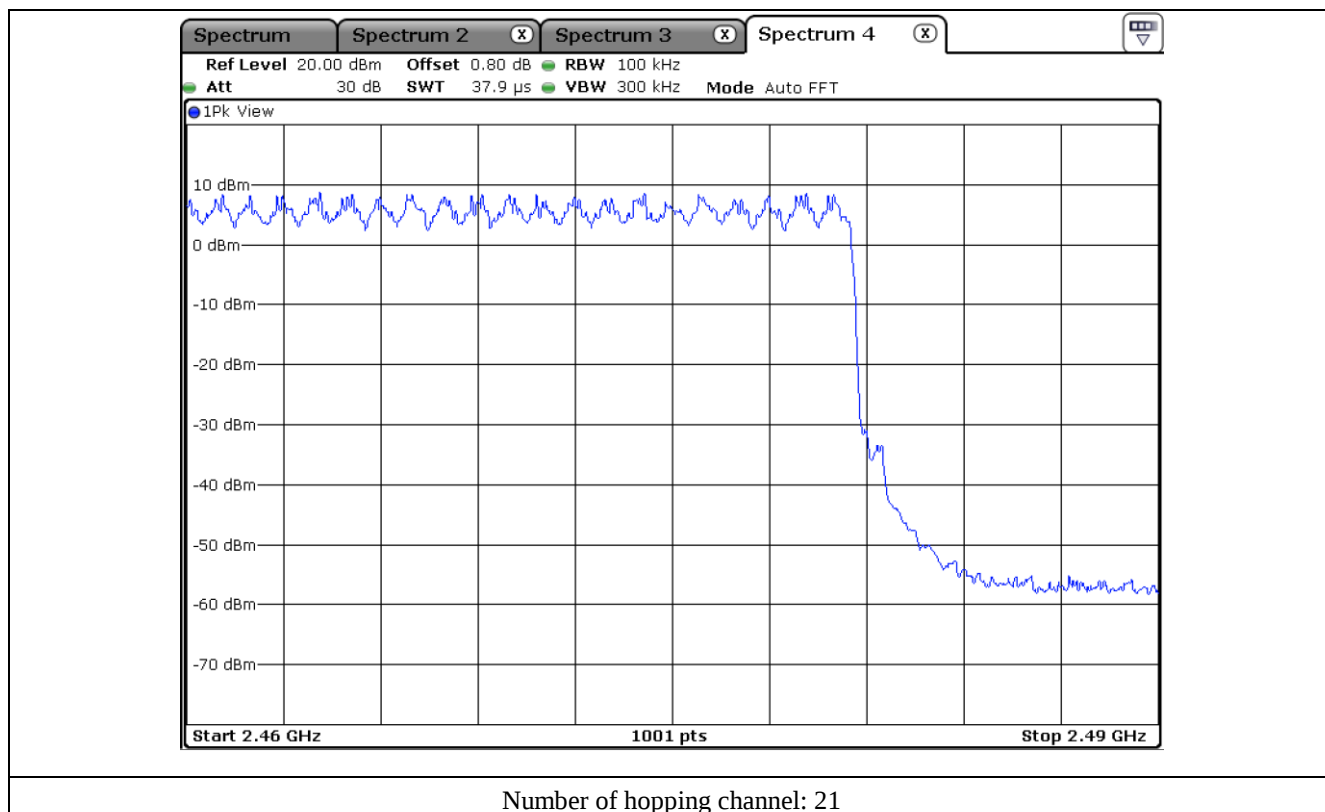




Number of hopping channel: 28



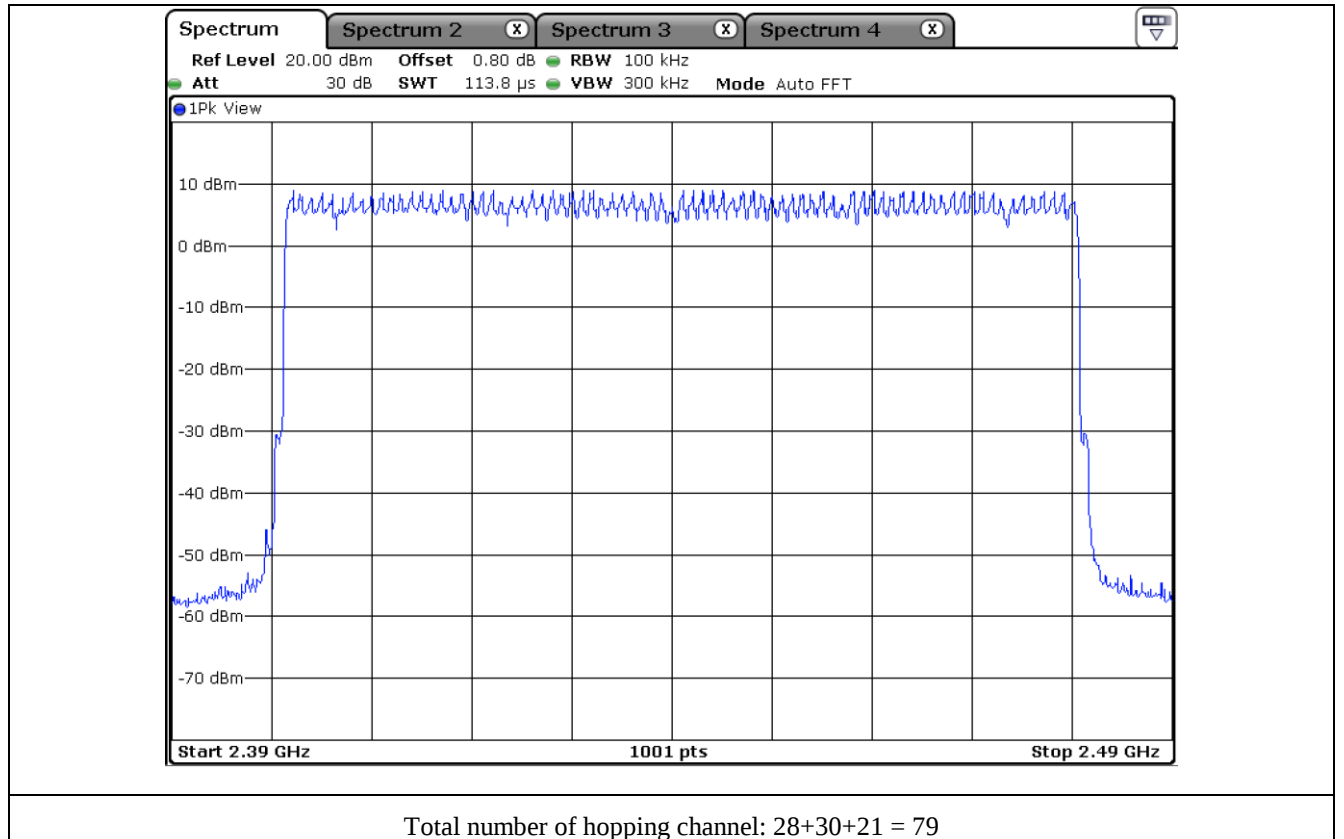
Number of hopping channel: 30

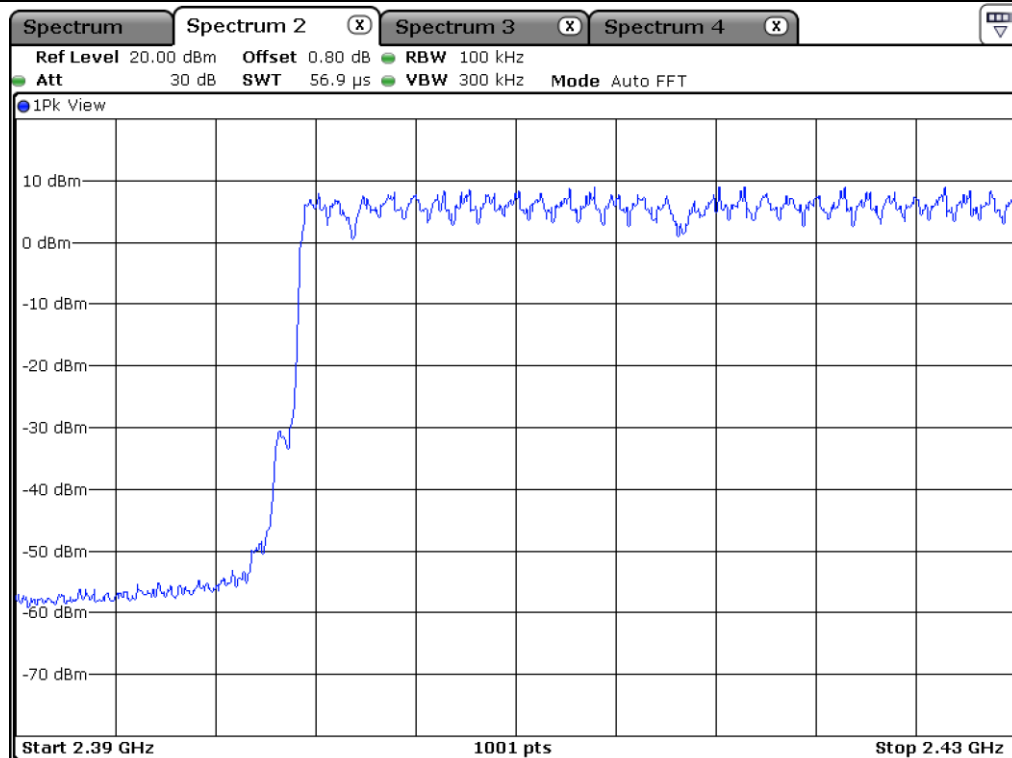


9.4.3 Test data for 3 Mbps

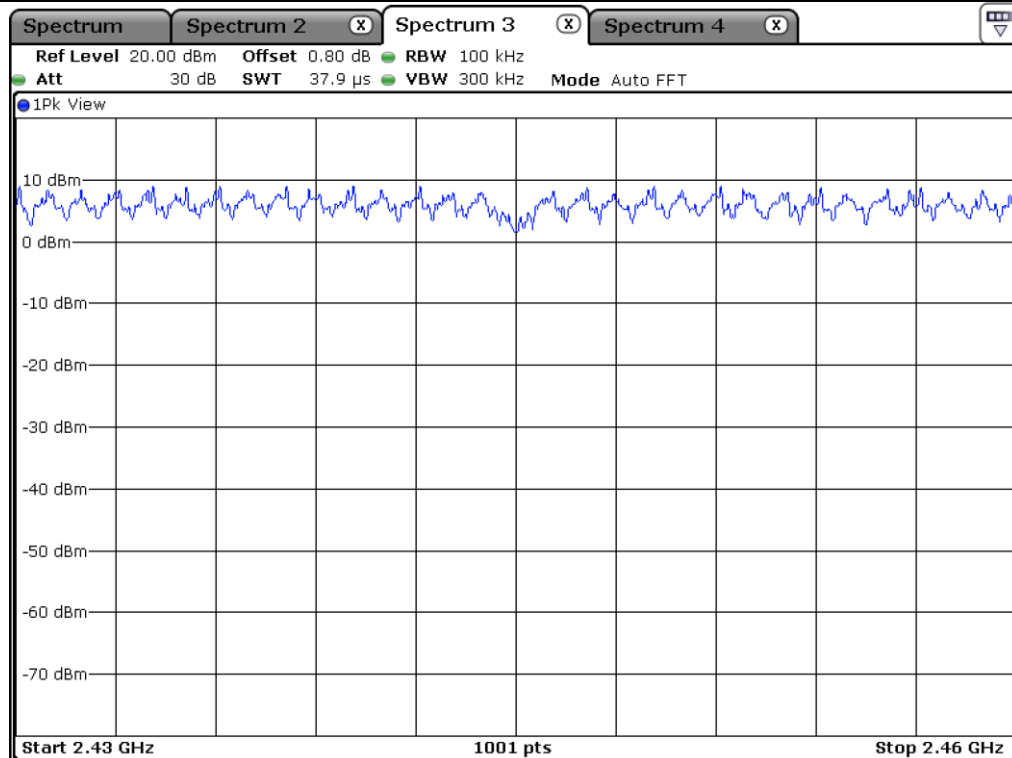
-. Test Result : Pass

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

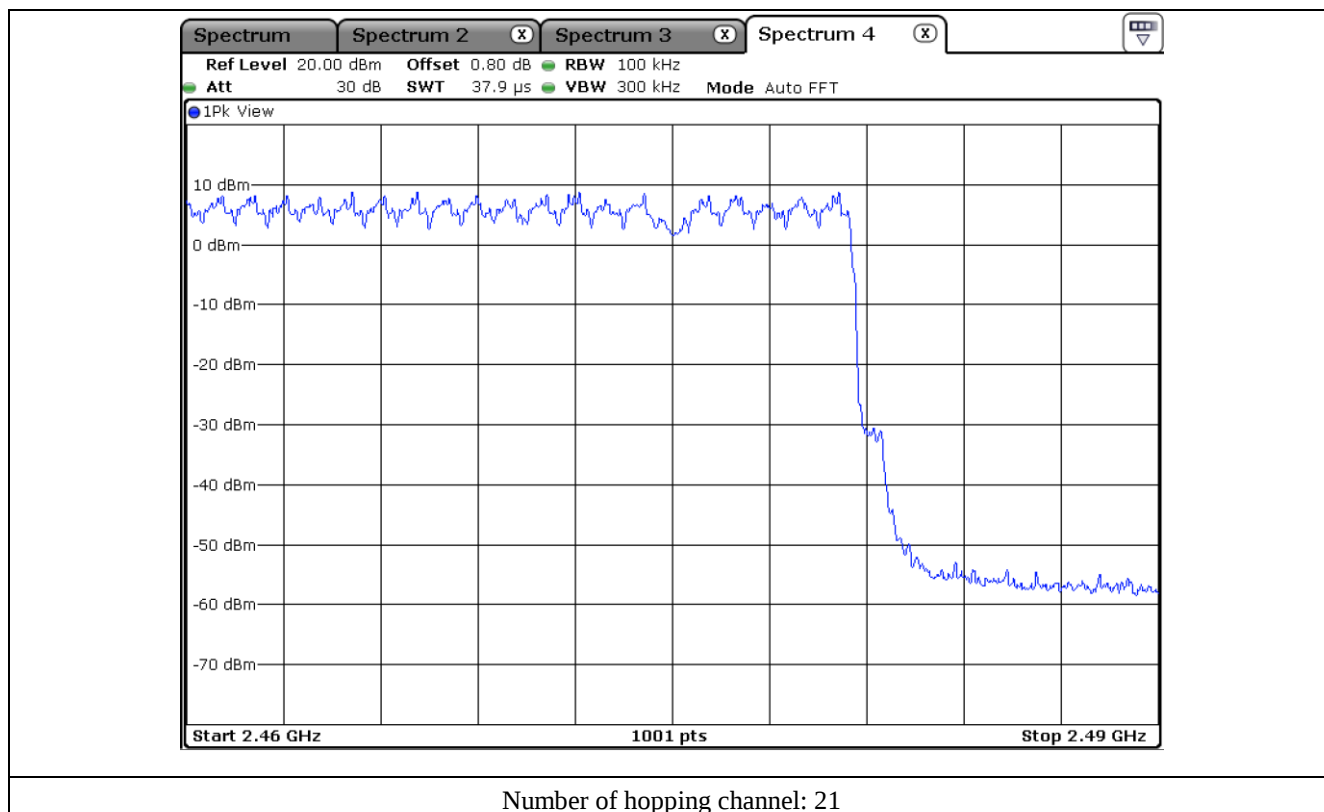




Number of hopping channel: 28



Number of hopping channel: 30

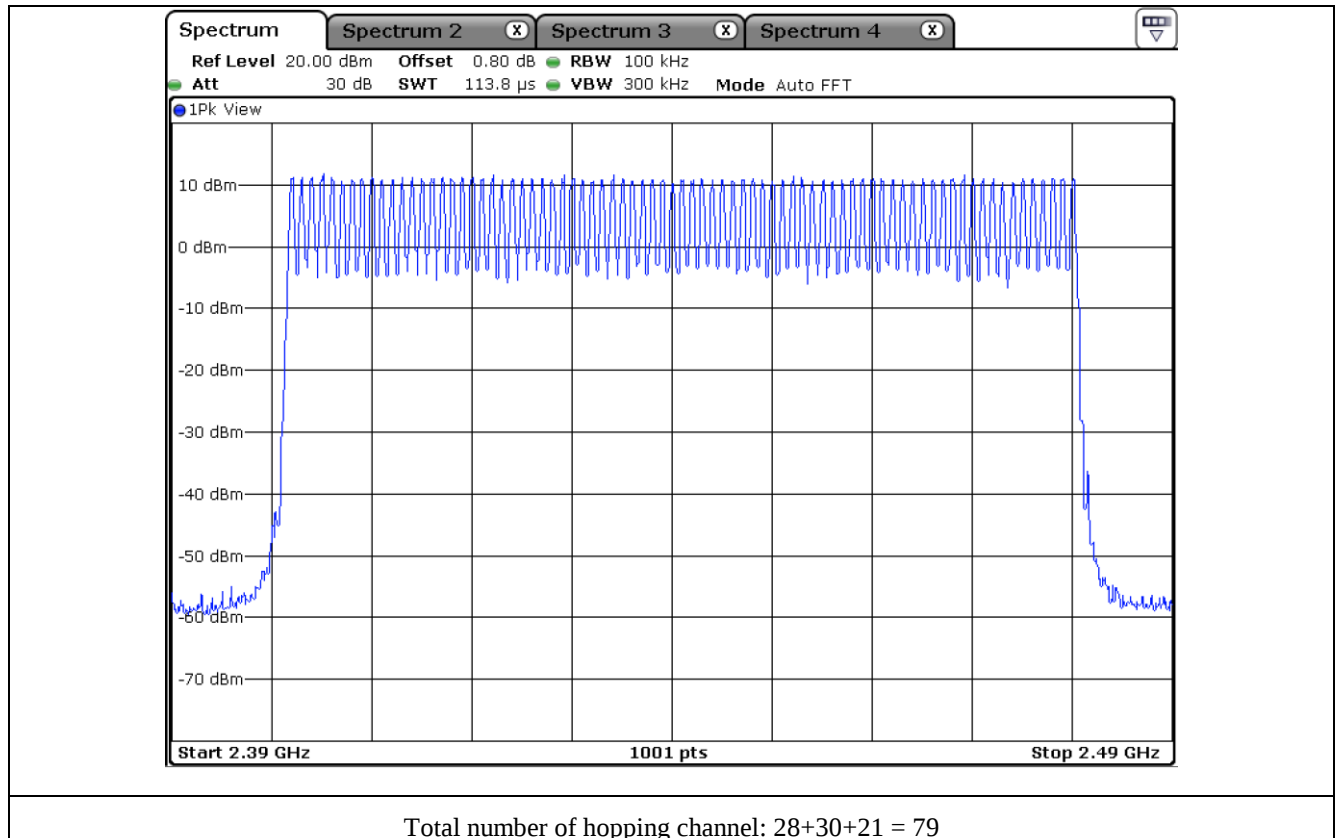


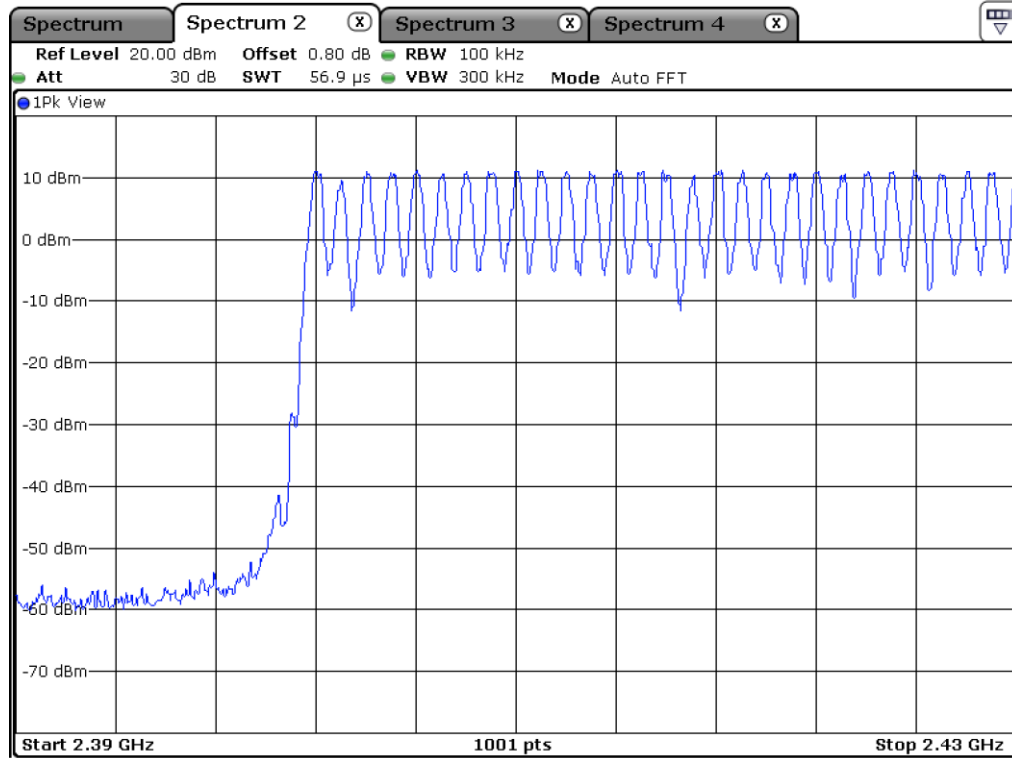
9.5 Test data for Right Earbud

9.5.1 Test data for 1 Mbps

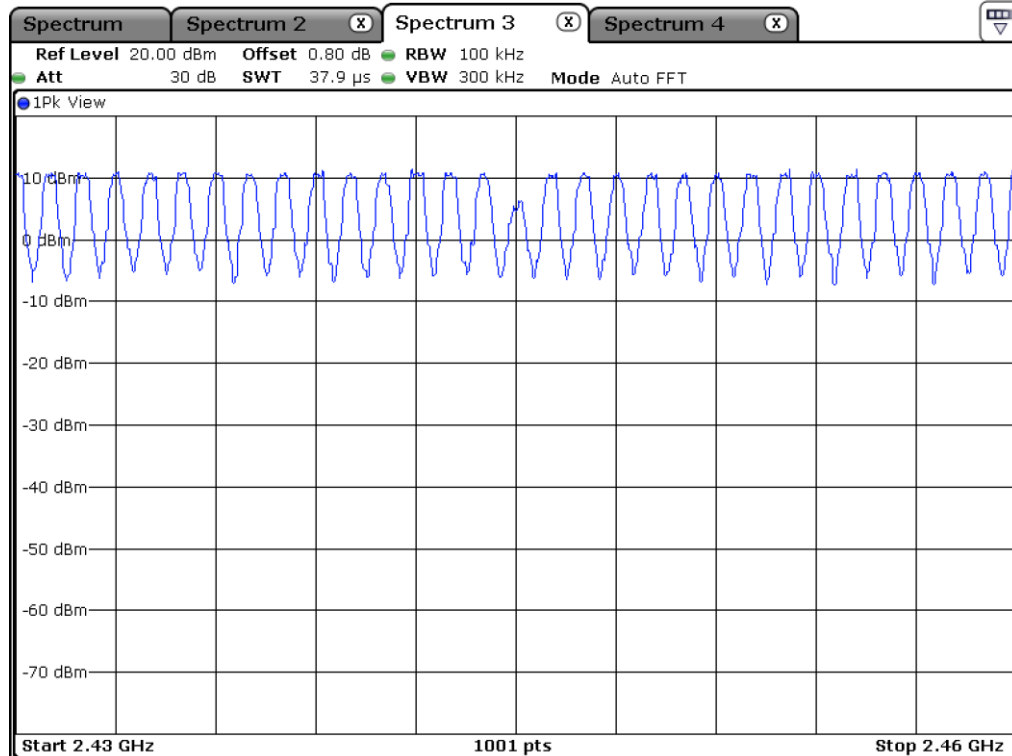
-. Test Result : Pass

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

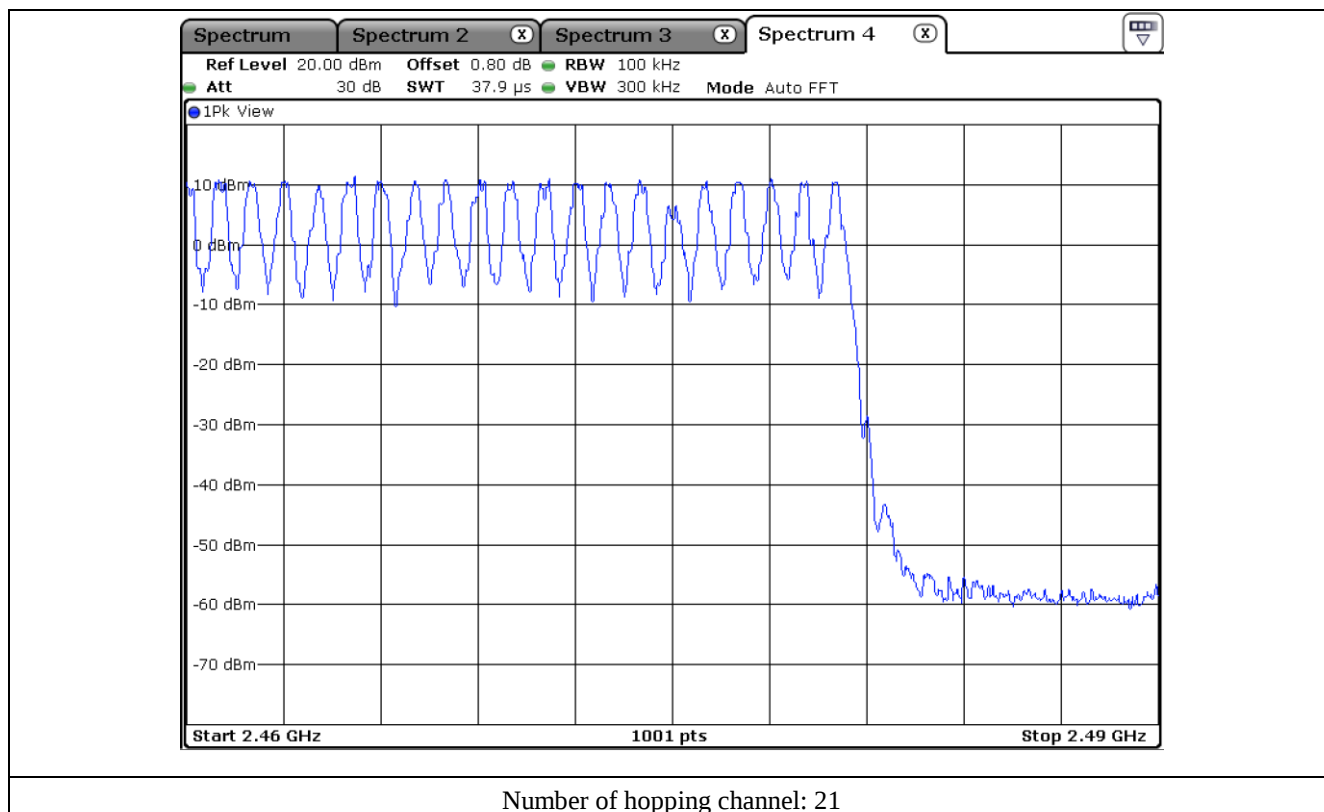




Number of hopping channel: 28



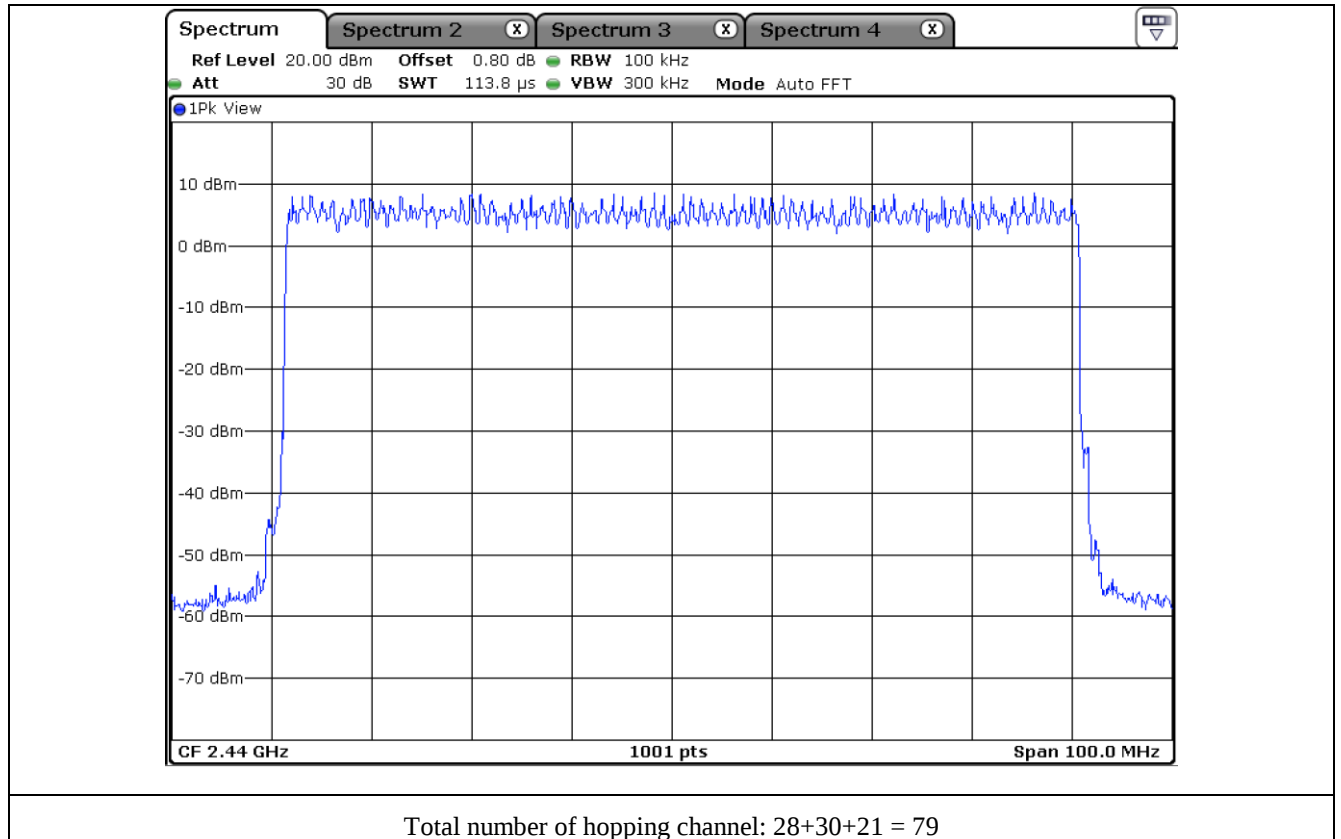
Number of hopping channel: 30

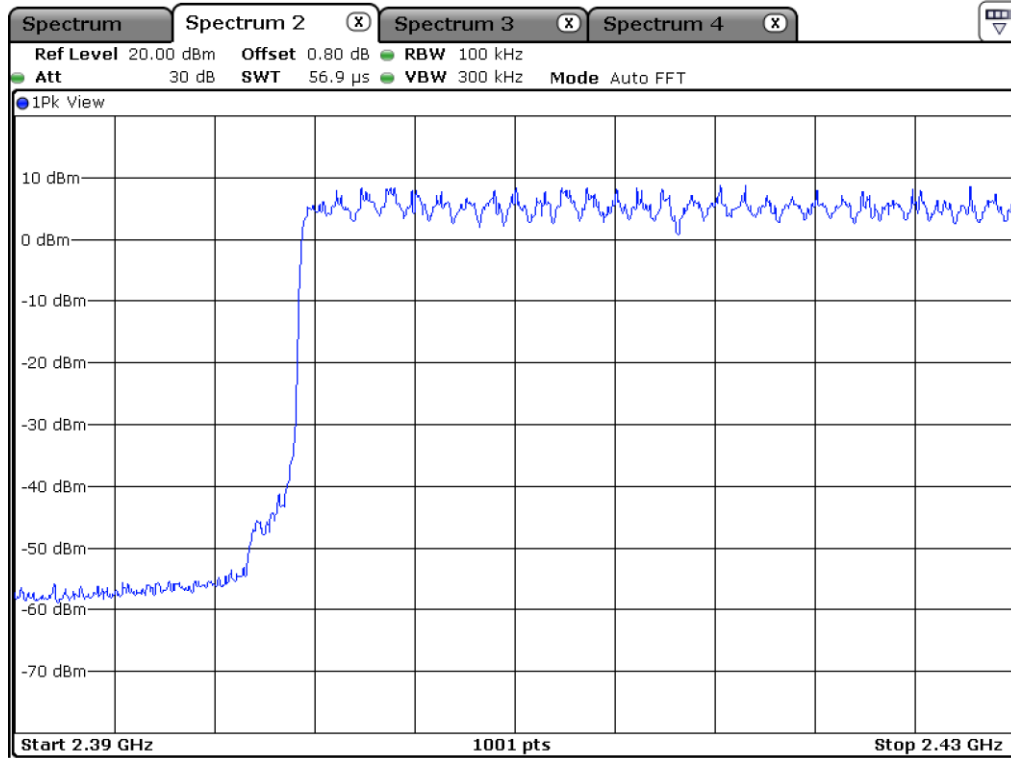


9.5.2 Test data for 2 Mbps

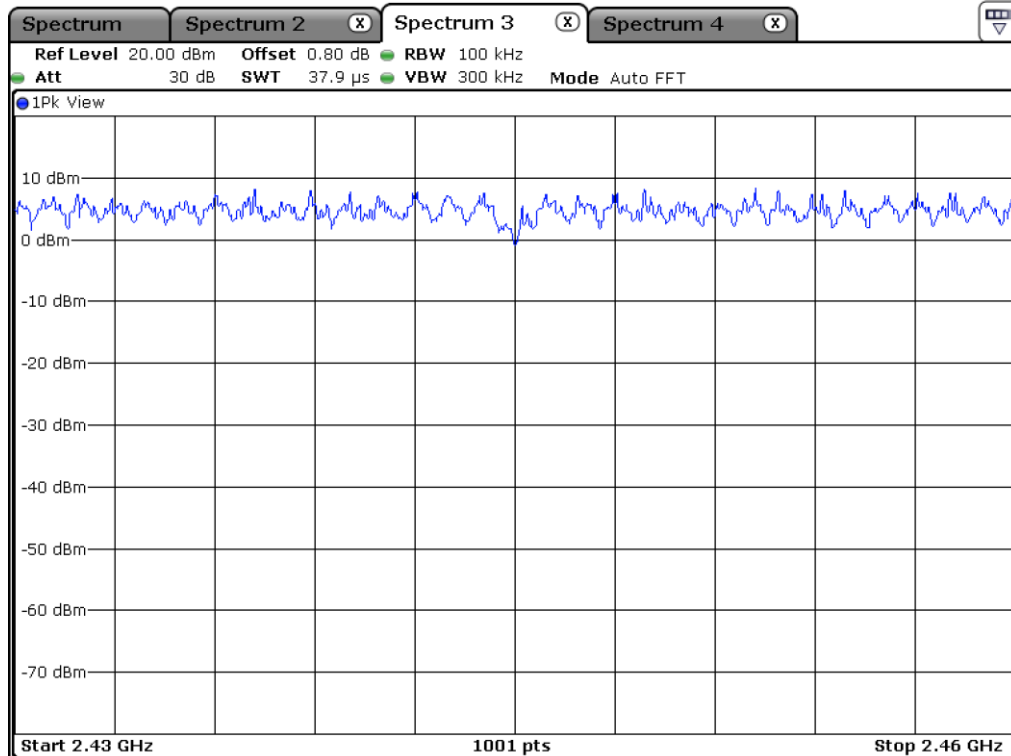
-. Test Result : Pass

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

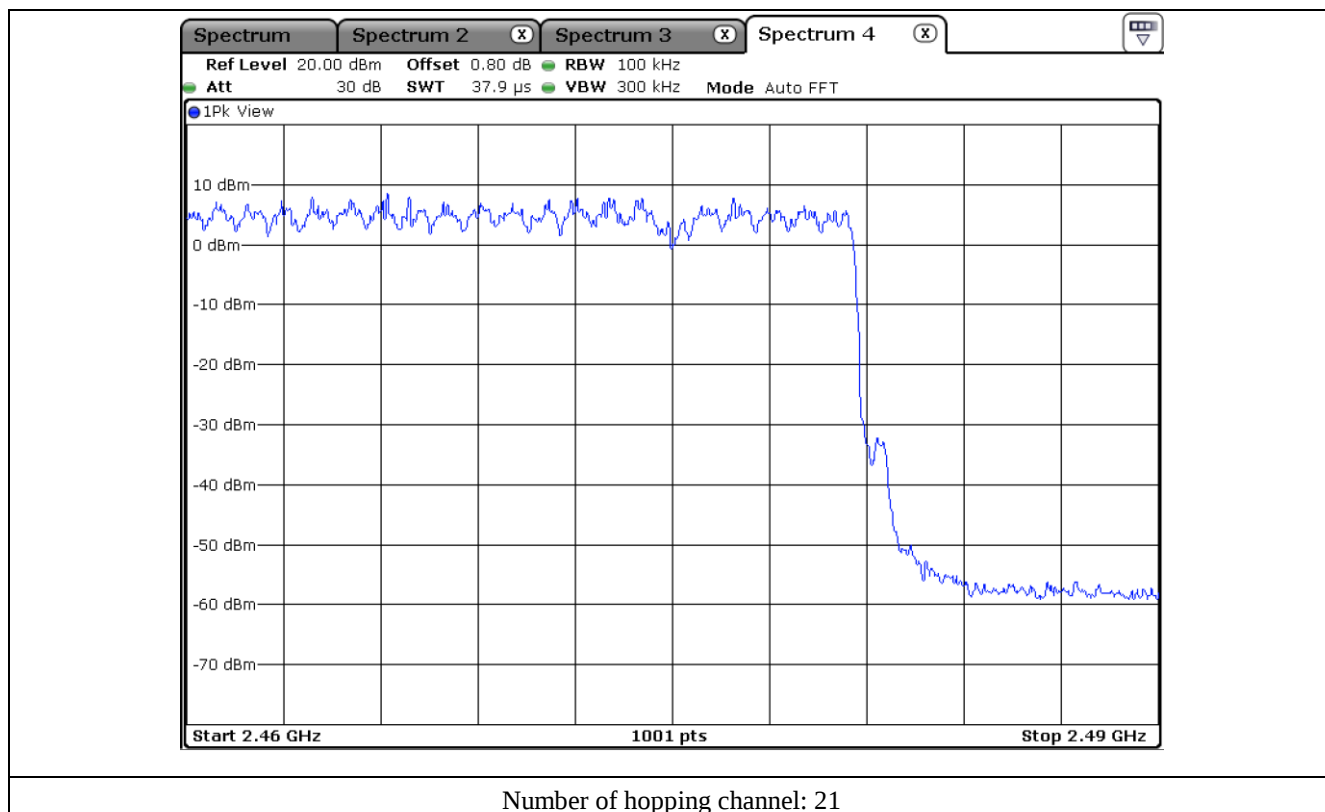




Number of hopping channel: 28



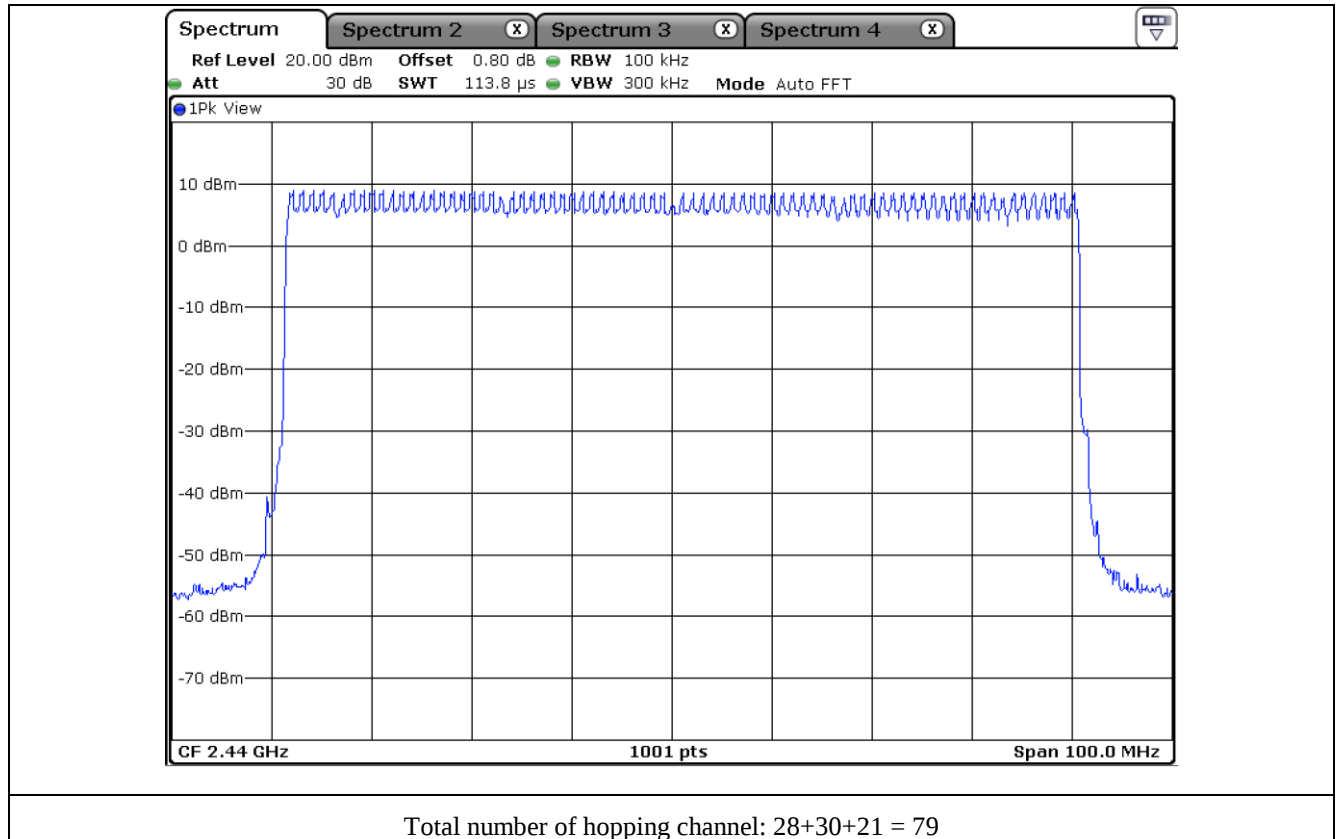
Number of hopping channel: 30

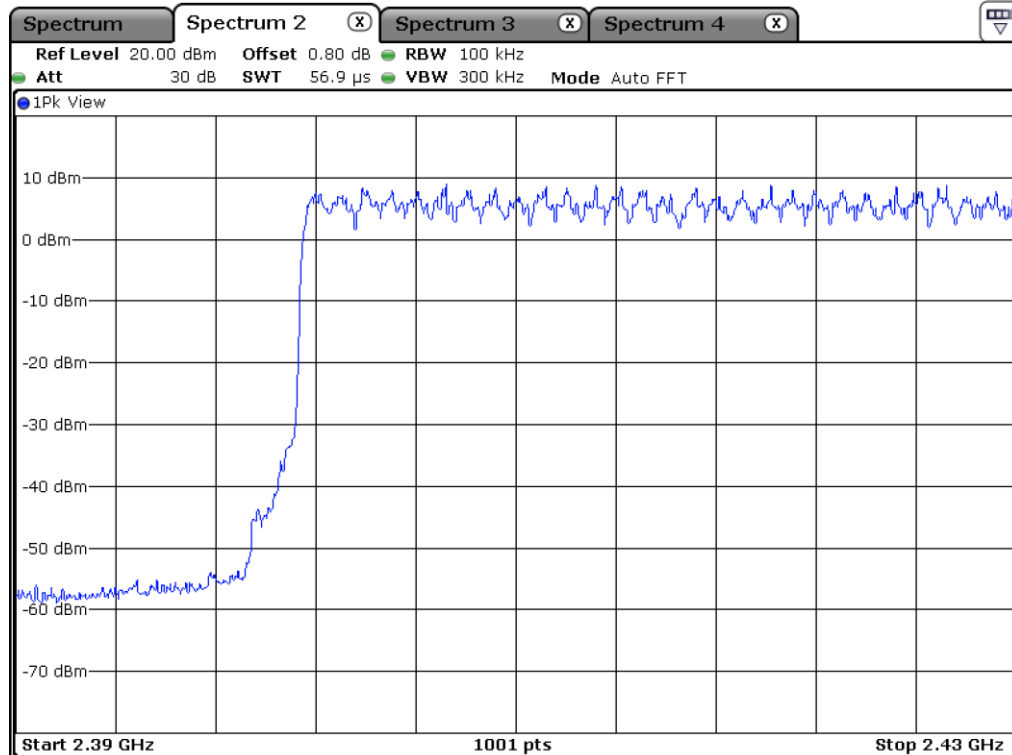


9.5.3 Test data for 3 Mbps

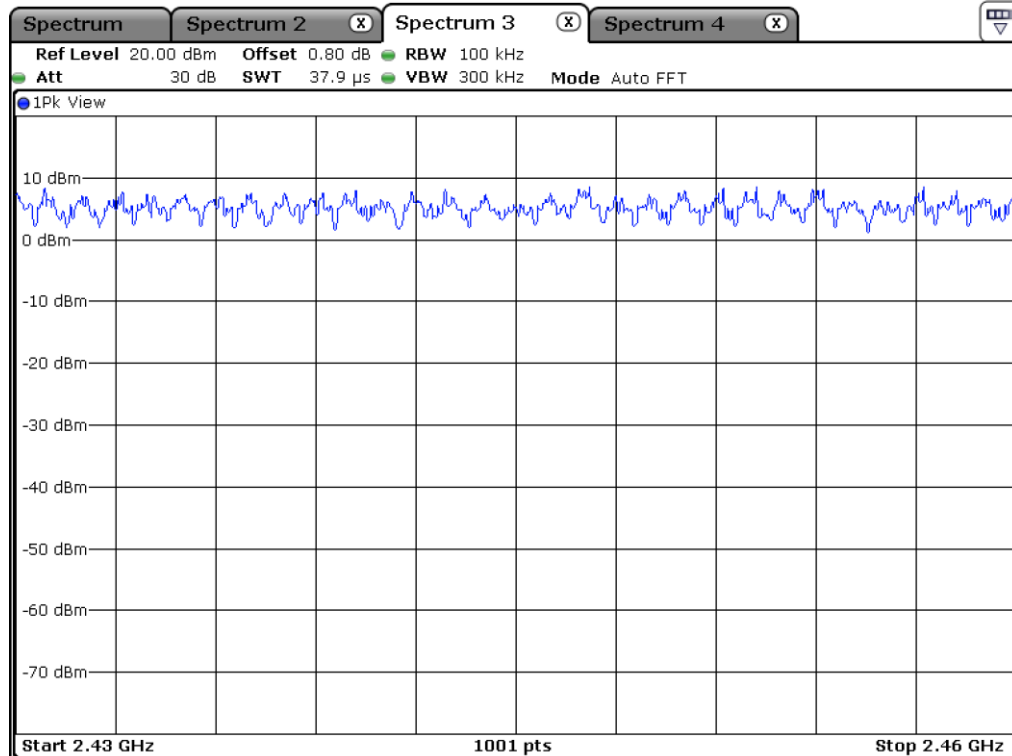
-. Test Result : Pass

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

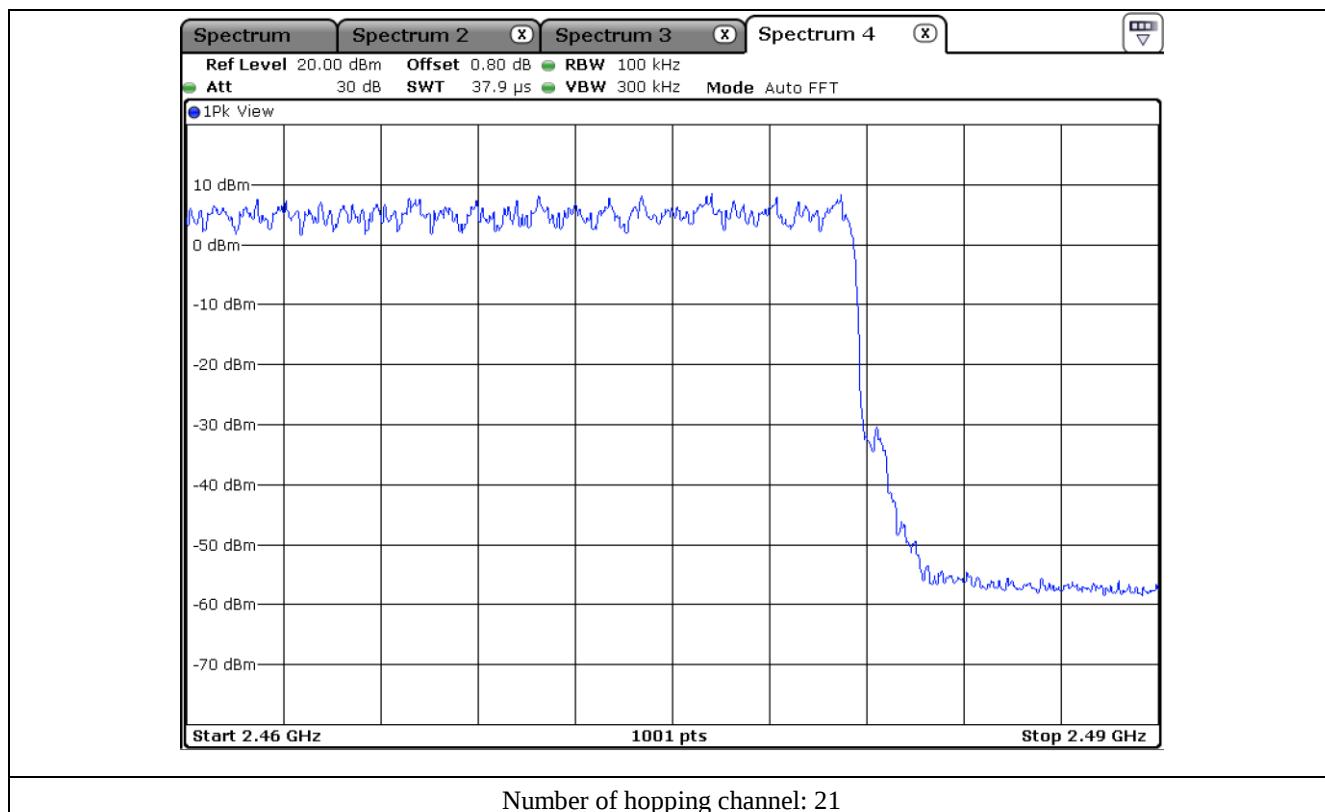




Number of hopping channel: 28



Number of hopping channel: 30



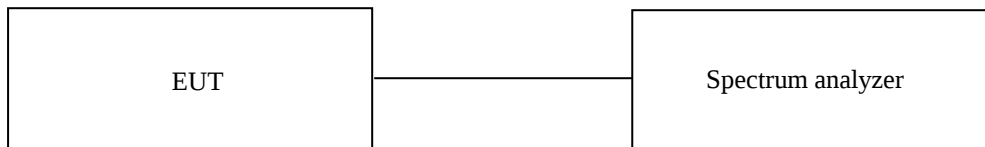
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 22 °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 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.



10.3 Test Date

May 17, 2021 ~ May 31, 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 μ s with 79 channels.

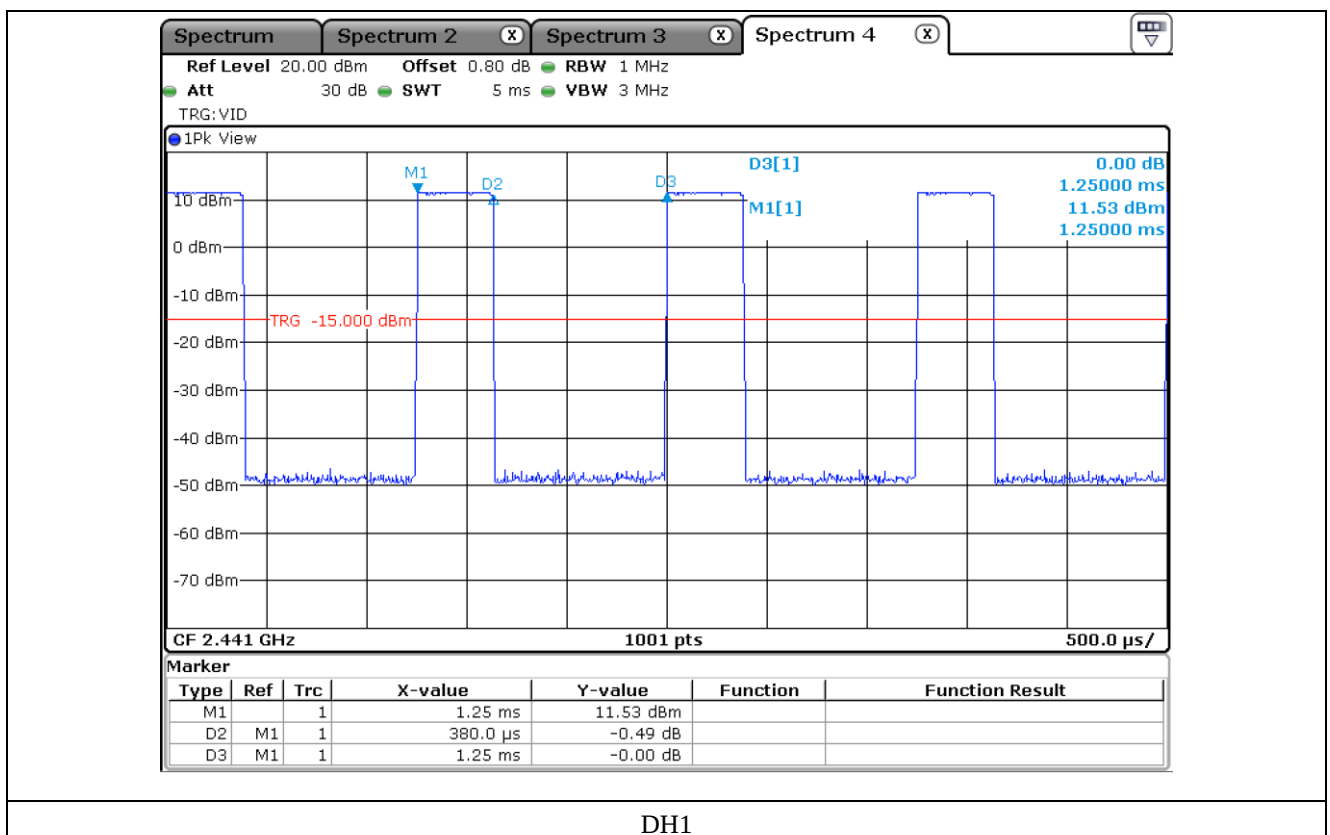
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel 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.

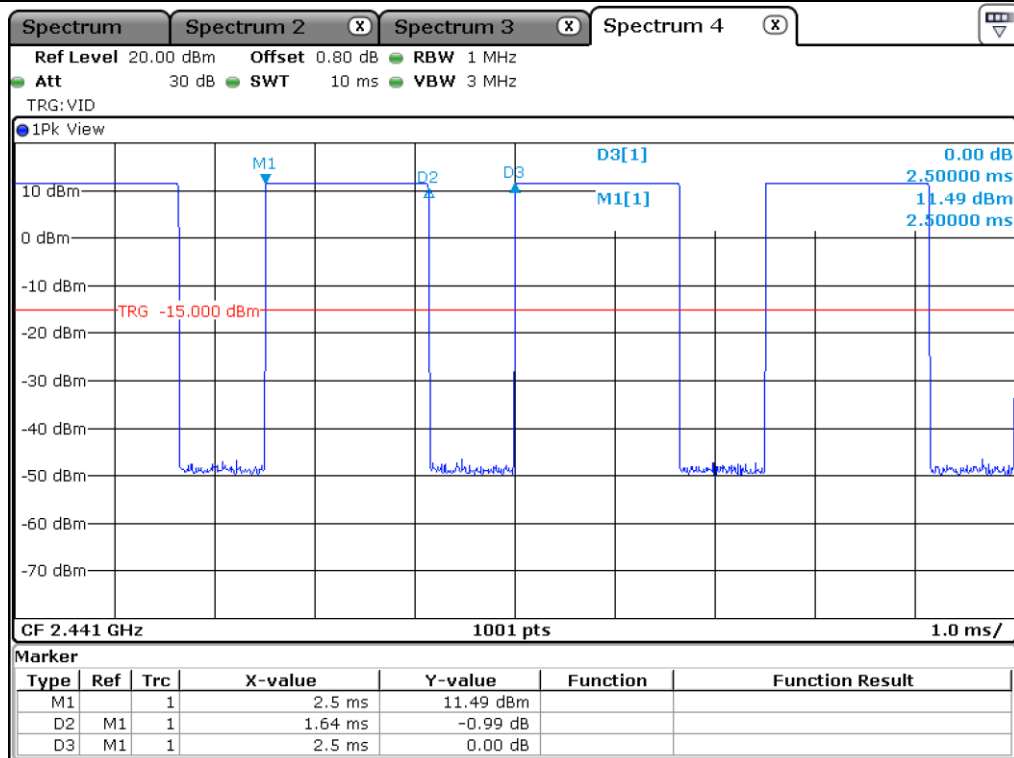
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

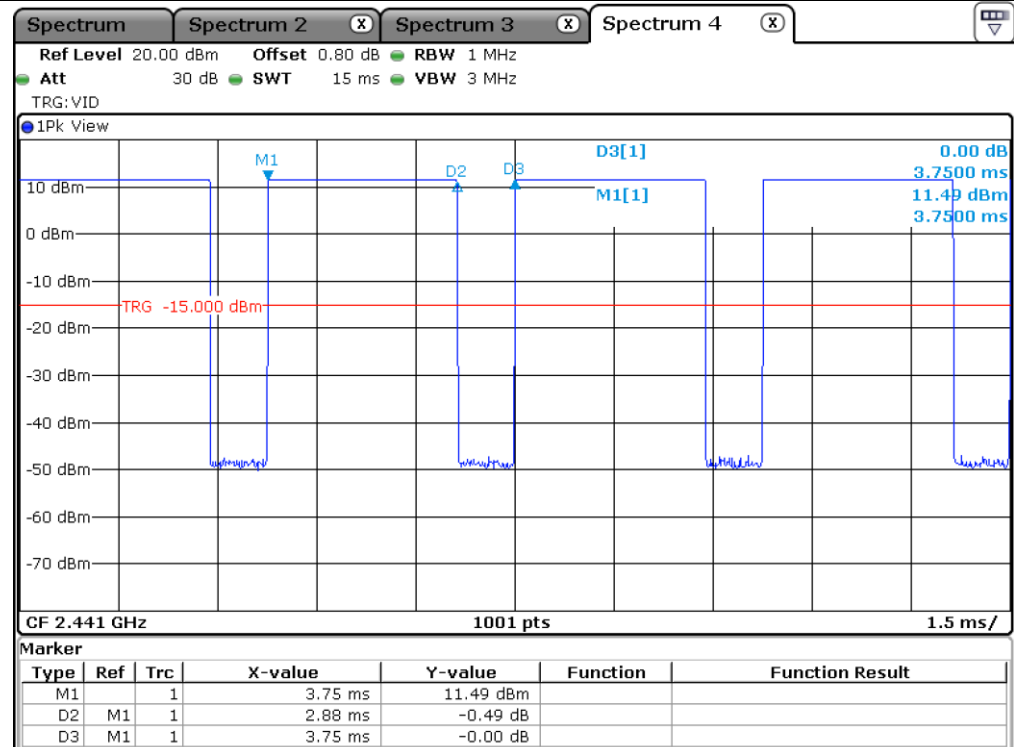
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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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 μ s with 79 channels.

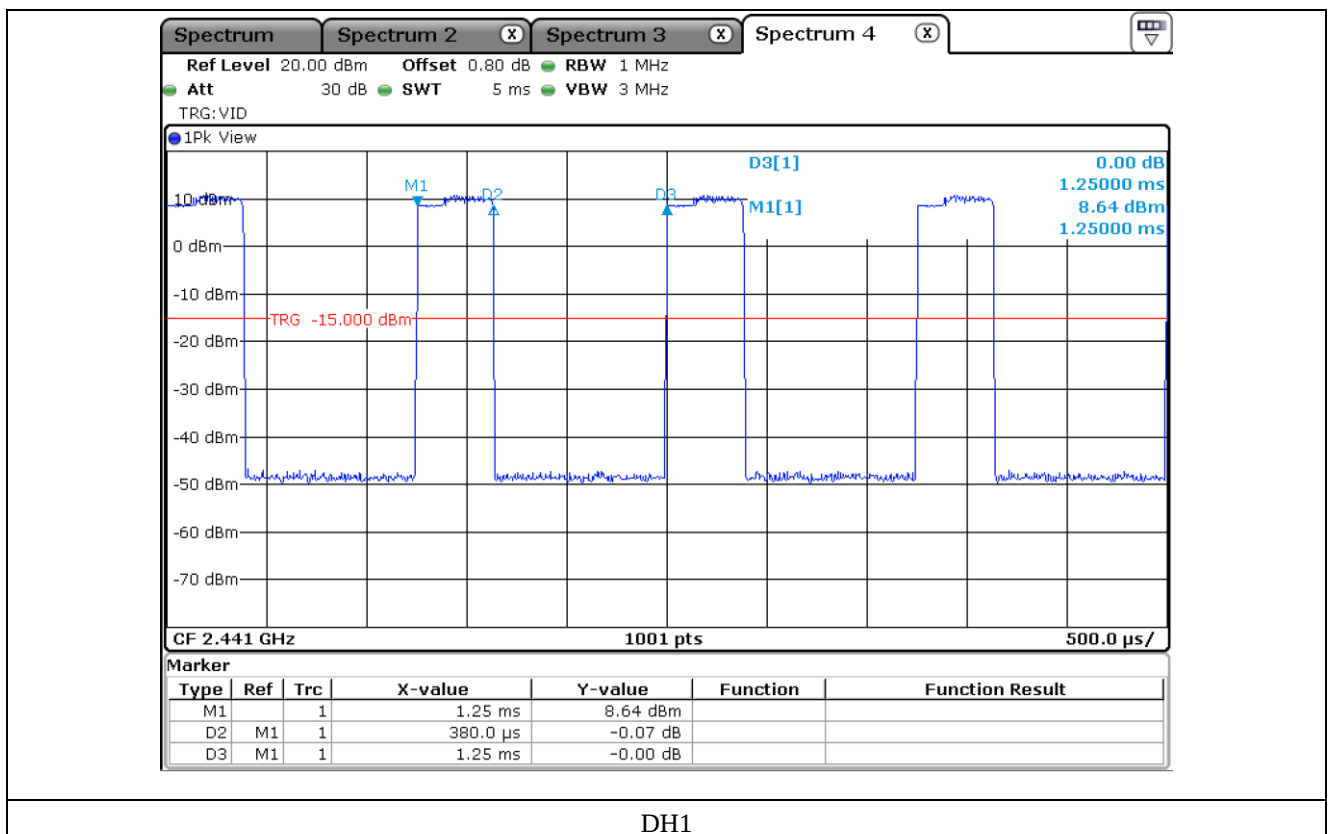
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel 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.

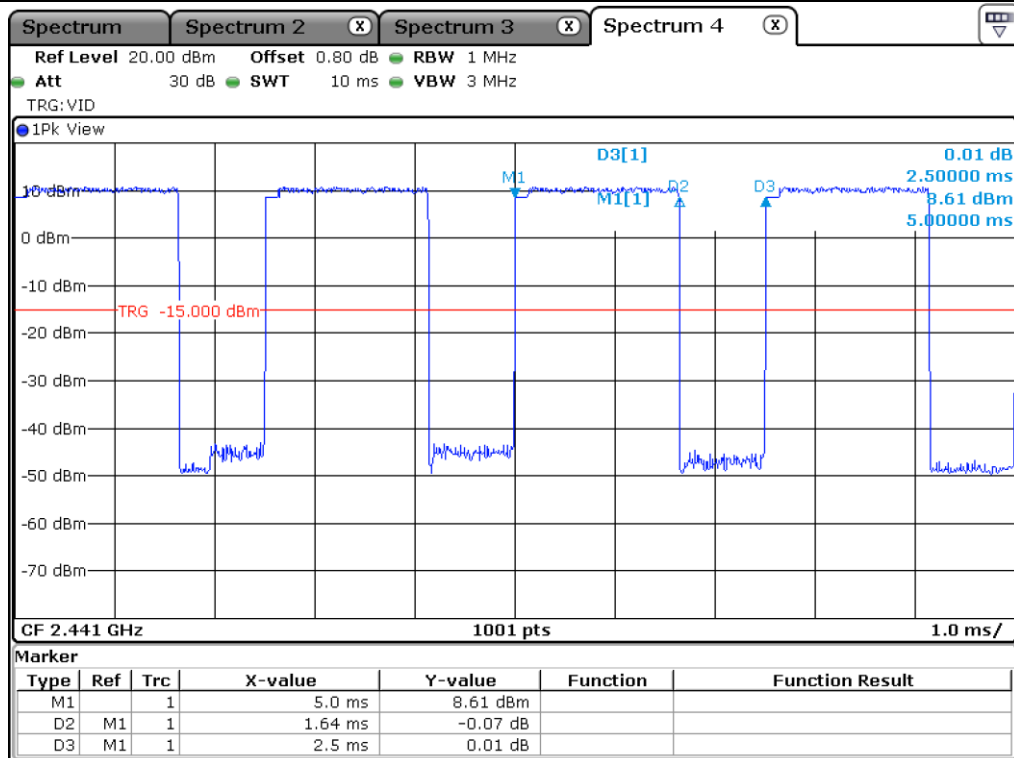
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

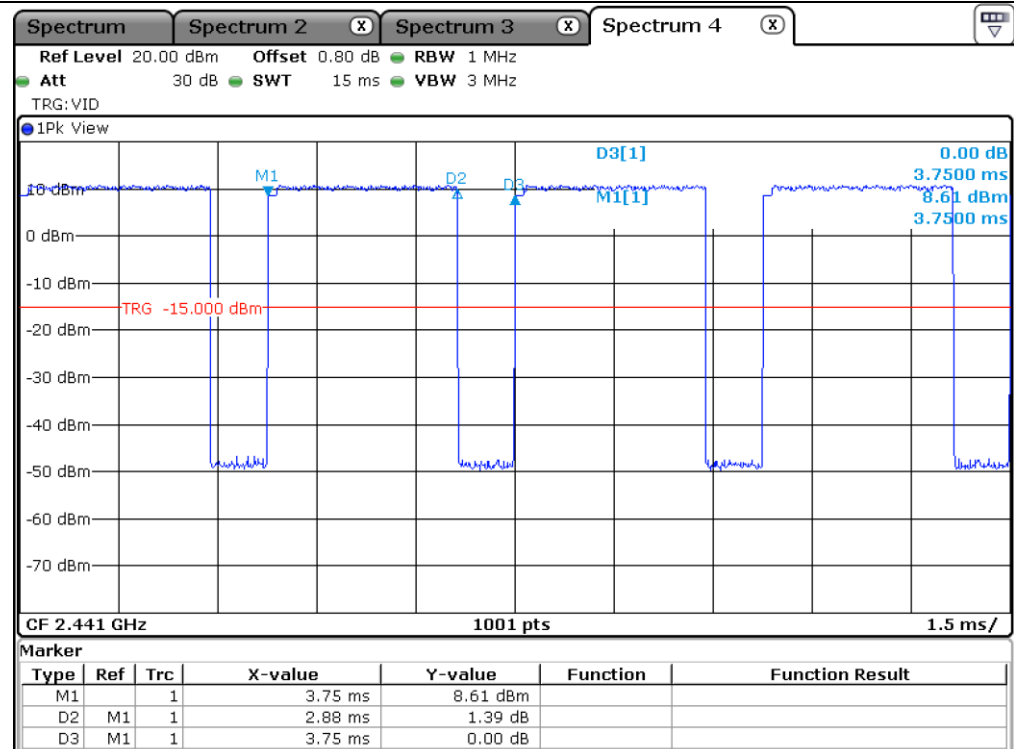
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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