

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-216-RWD-020
Reception No. : 2104002367
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. : ZNFTONEFP9
Model Name : TONE-FP9
Multiple Model Name : Refer to the Clause 3.2
Serial number : N/A
Total page of Report : 136 pages (including this page)
Date of Incoming : May 17, 2021
Date of issue : June 16, 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.

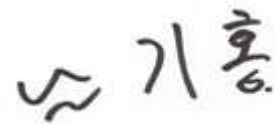
It is not a generally valid assessment of the features of the respective products of the mass-production.



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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-216-RWD-020	June 16, 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 : Dae Woong Kim / Director, Regulatory and Environmental Affairs

Telephone No. : 201-266-2215

FCC ID : ZNFTONEFP9

Model Name : TONE-FP9

Brand Name : LG

Serial Number : N/A

Date : June 16, 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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OTC-TRF-RF-001(0)

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

3. GENERAL INFORMATION

3.1 Product Description

The LG Electronics USA, Inc., Model TONE-FP9 (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	11.52 dBm
			2 Mbps	11.26 dBm
			3 Mbps	11.87 dBm
		Bluetooth LE	1 Mbps	5.95 dBm
			2 Mbps	6.10 dBm
			Right Earbud	Bluetooth
	2 Mbps	11.39 dBm		
	3 Mbps	11.95 dBm		
	Bluetooth LE	1 Mbps		6.31 dBm
		2 Mbps	6.35 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. $\geq$ 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-FP9	Basic Model	☒
TONE-FP9W	This model is identical to the basic model except for the Color (White) and model name.	☐
TONE-FP9E	This model is identical to the basic model except for the Color (Beige) and model name.	☐
TONE-TFP9	This model is identical to the basic model except for the Marketing area (KOREA) and model name.	☐
TONE-TFP9W	This model is identical to the basic model except for the Color(White), Marketing area (KOREA) and model name.	☐
TONE-TFP9E	This model is identical to the basic model except for the Color(Beige), Marketing area (KOREA) and model name.	☐
TONE-UFP9	This model is identical to the basic model except for the Marketing area (United Kingdom) and model name.	☐
TONE-UFP9W	This model is identical to the basic model except for the Color(White), Marketing area (United Kingdom) and model name.	☐
TONE-UFP9E	This model is identical to the basic model except for the Color(Beige), Marketing area (United Kingdom) and model name.	☐
TONE-DFP9	This model is identical to the basic model except for the Marketing area (Germany) and model name.	☐
TONE-DFP9W	This model is identical to the basic model except for the Color(White), Marketing area (Germany) and model name.	☐
TONE-DFP9E	This model is identical to the basic model except for the Color(Beige), Marketing area (Germany) and model name.	☐
TONE-FP9A	This model is identical to the basic model except for the Marketing area (Australia) and model name.	☐
TONE-FP9WA	This model is identical to the basic model except for the Color(White), Marketing area (Australia) and model name.	☐
TONE-FP9EA	This model is identical to the basic model except for the Color(Beige), Marketing area (Australia) and model name.	☐

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-FP9	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

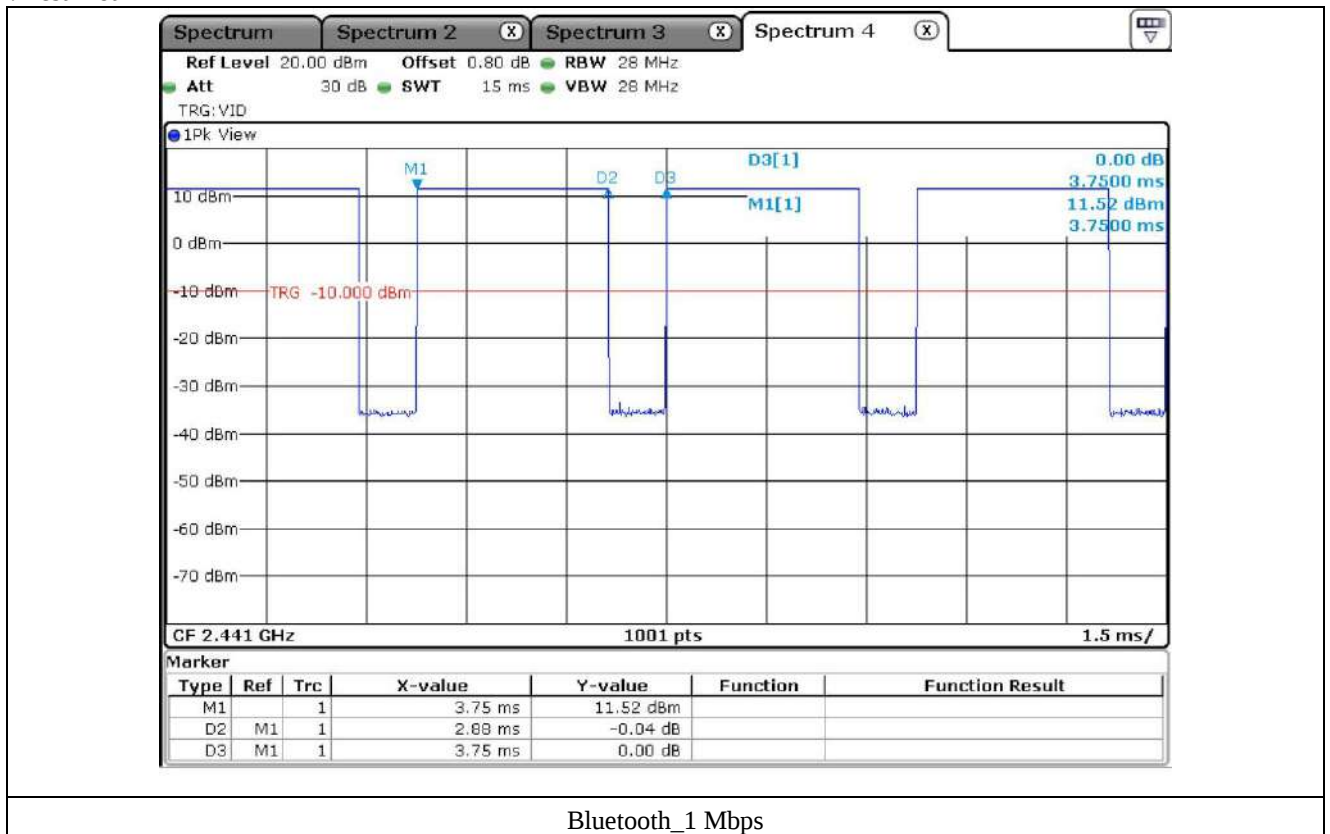
-. Duty Cycle (Left Earbud)

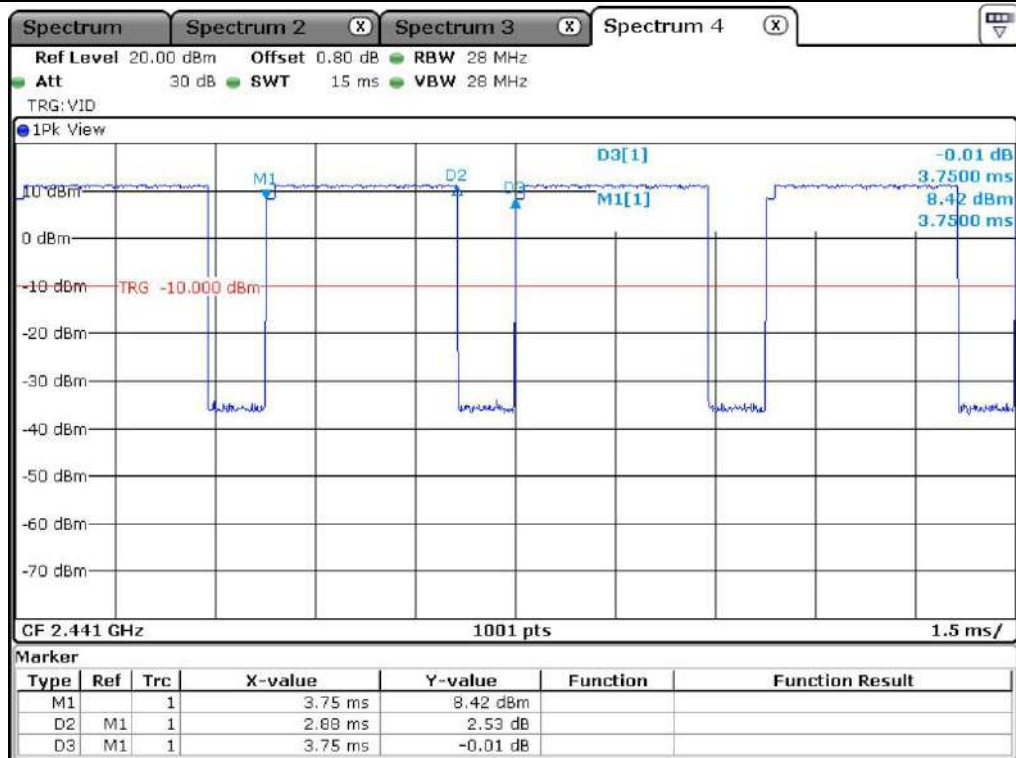
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [2 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [3 Mbps]	2.88	0.87	76.80	1.15

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

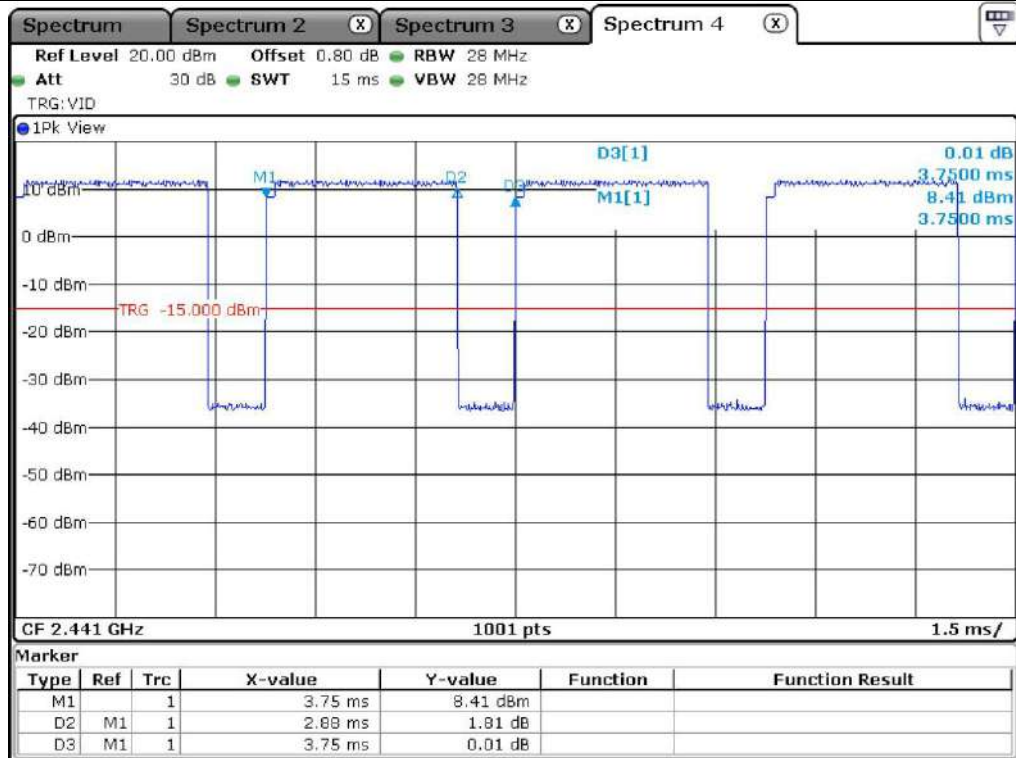
Correction Factor : $10 * \log(1 / (\text{Duty Cycle} / 100))$

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 Mbps

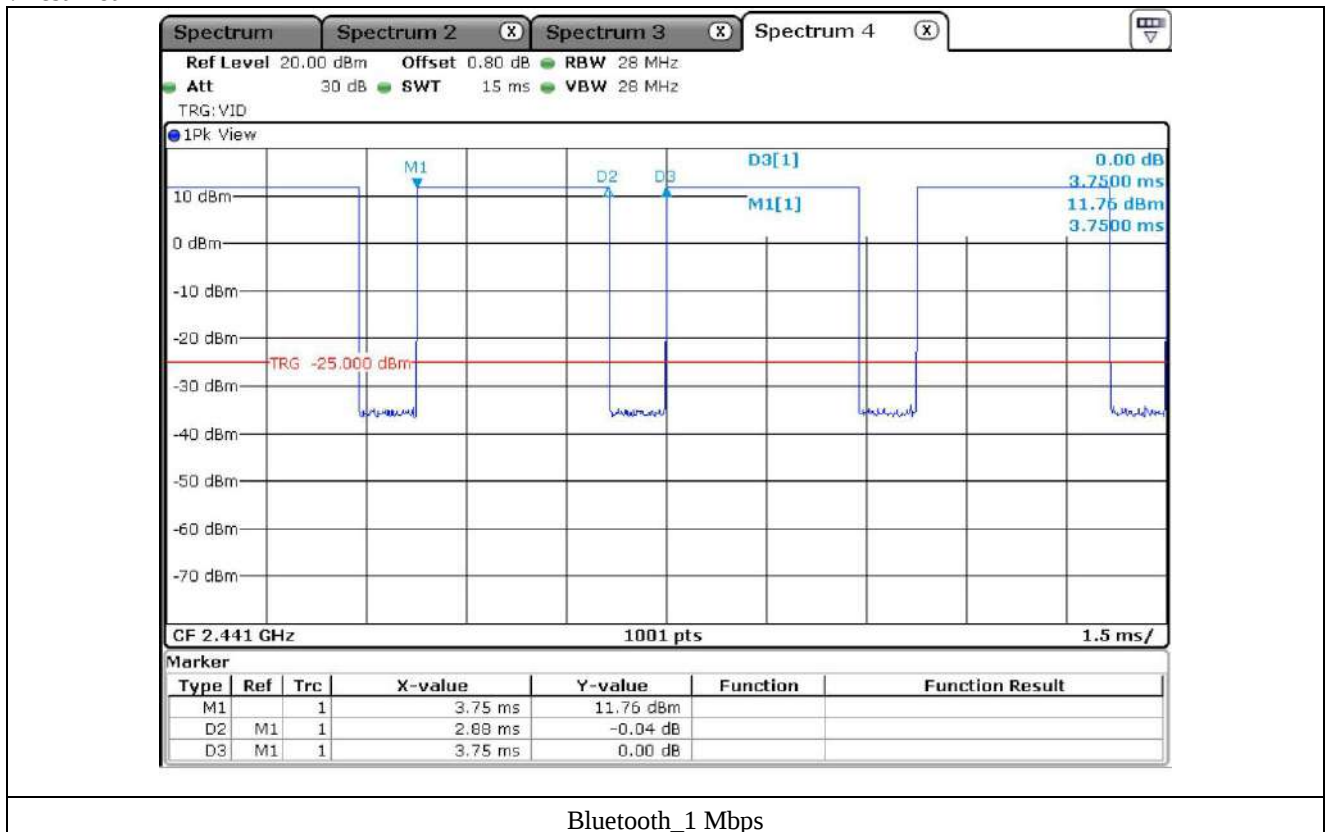
-. Duty Cycle (Right Earbud)

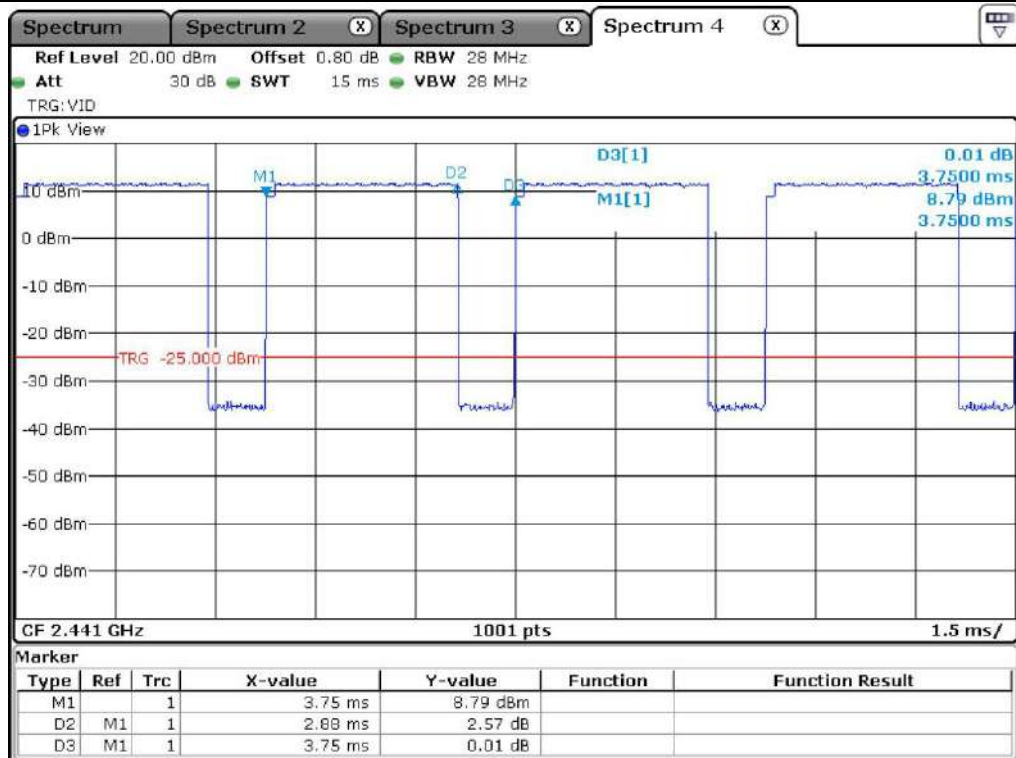
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [2 Mbps]	2.88	0.87	76.80	1.15
Bluetooth [3 Mbps]	2.88	0.87	76.80	1.15

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

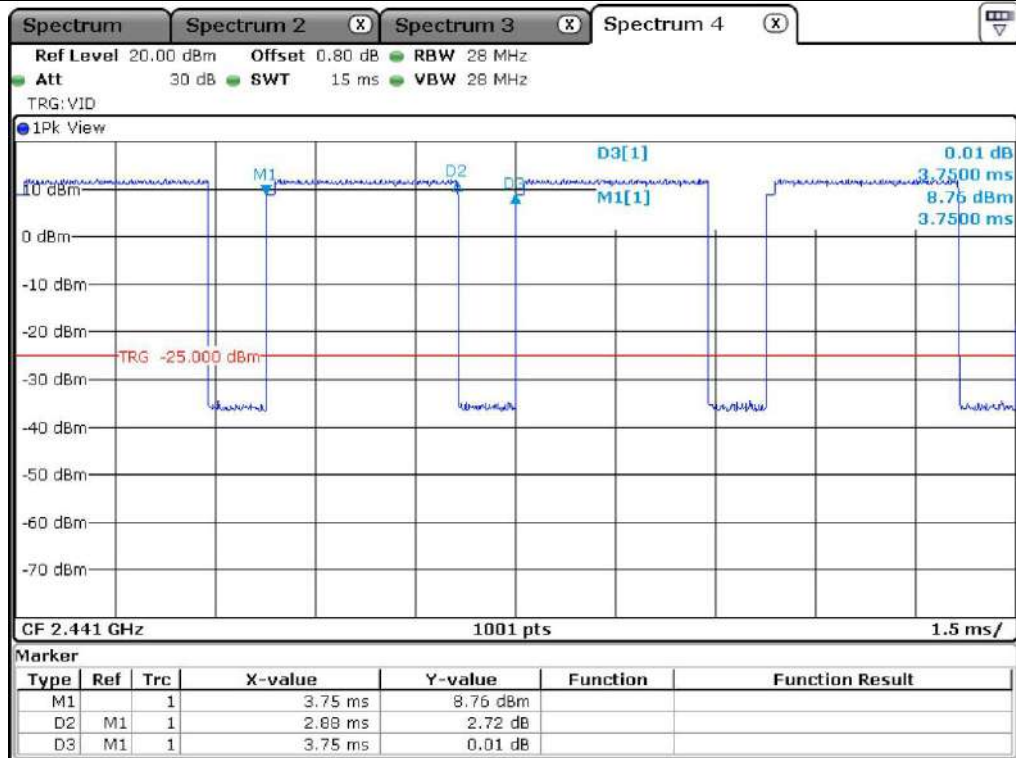
Correction Factor : $10 * \log(1 / (\text{Duty Cycle} / 100))$

-. Test Plot





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: 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

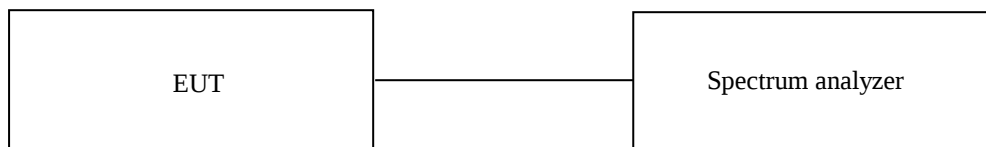
7. MINIMUM 20 dB BANDWIDTH

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.



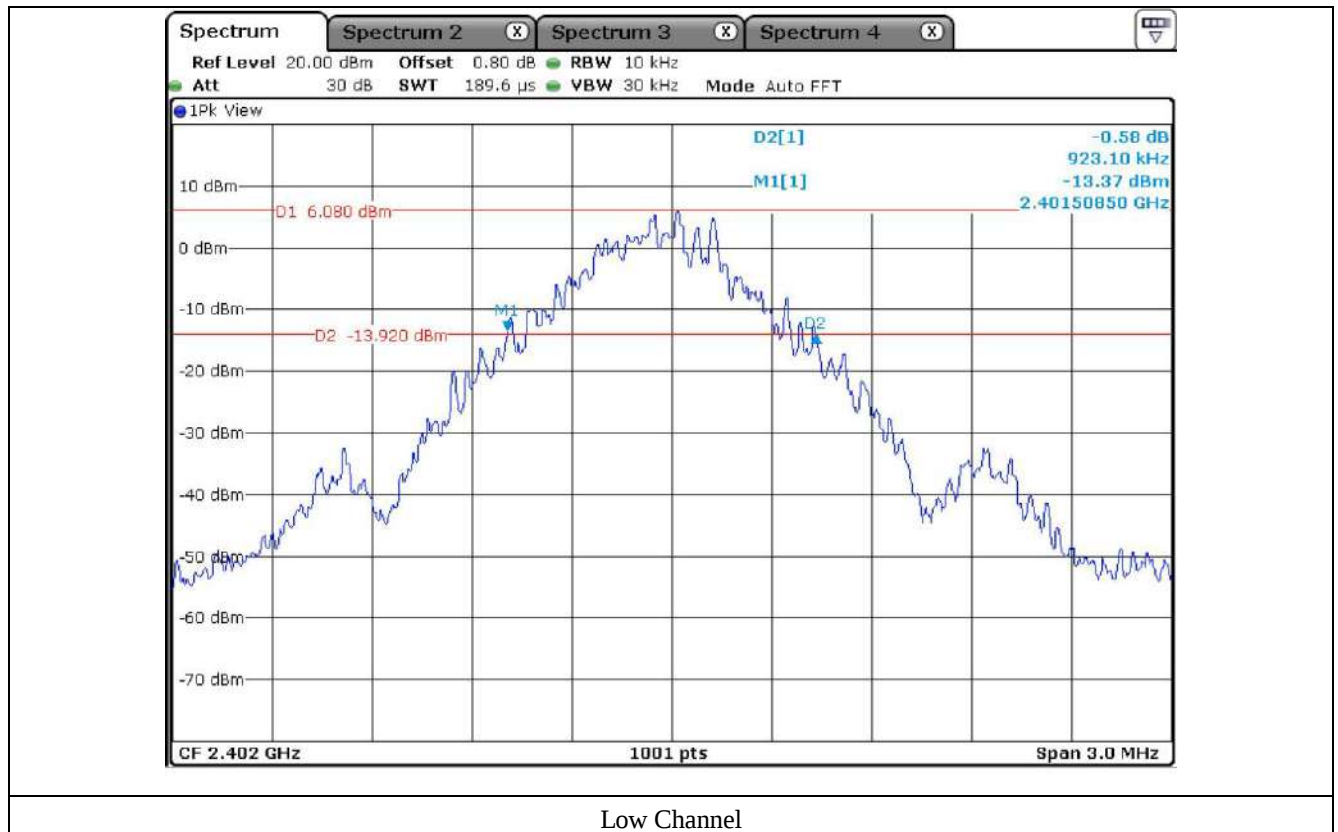
7.3 Test Date

May 17, 2021 ~ May 31, 2021

7.4 Test data for Left Earbud

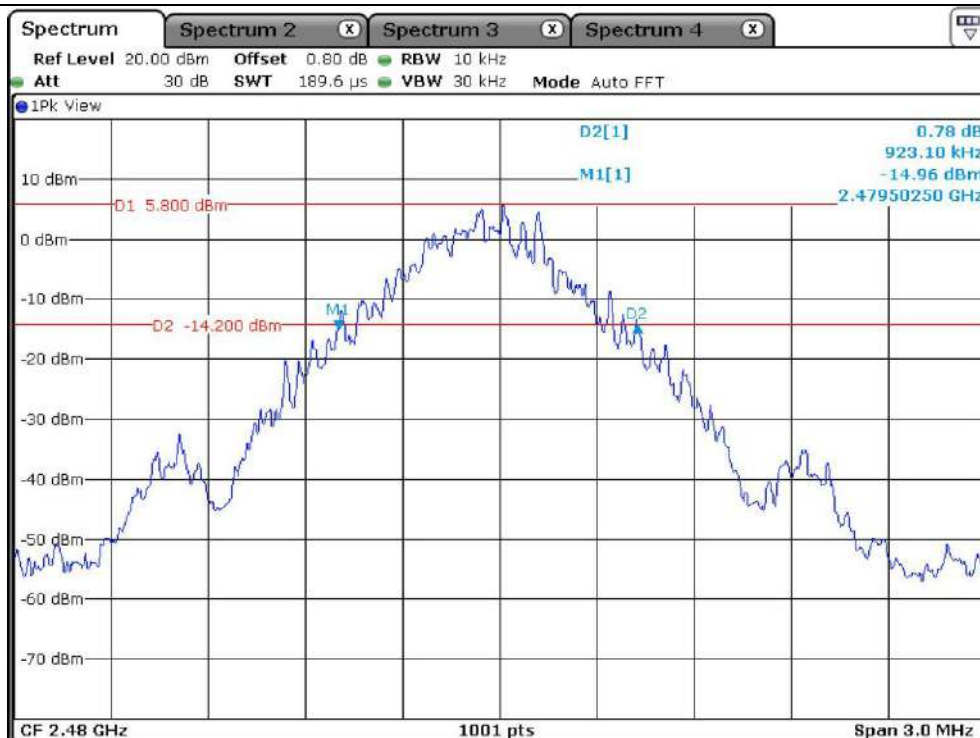
7.4.1 Test data for 1 Mbps

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





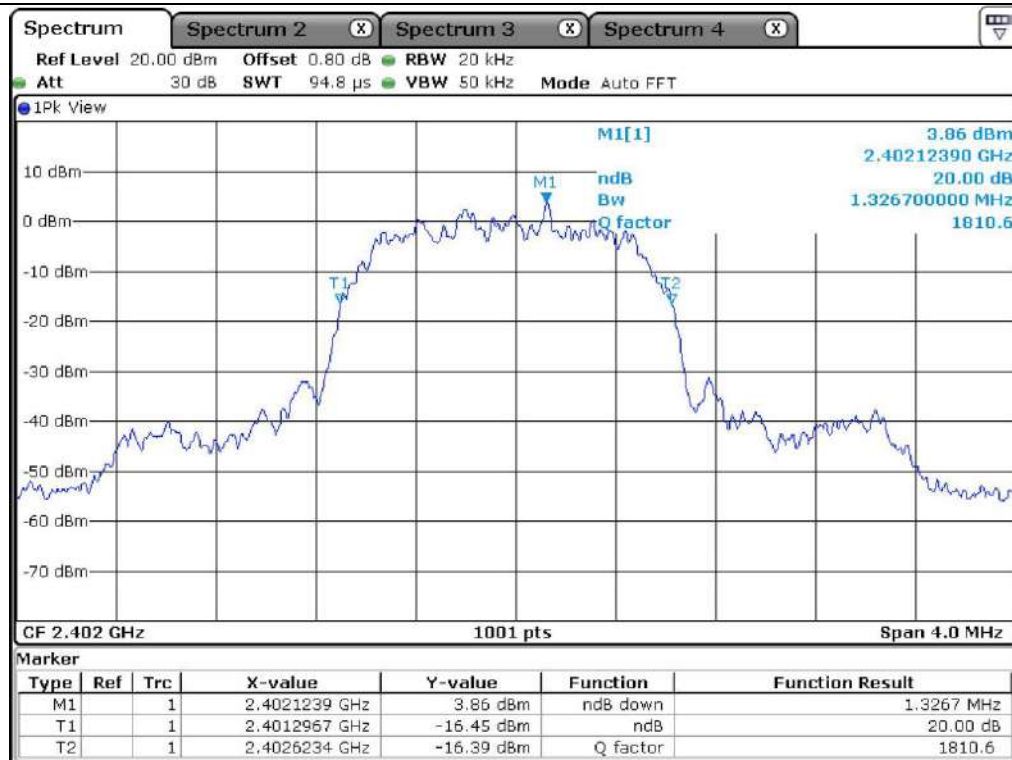
Middle Channel



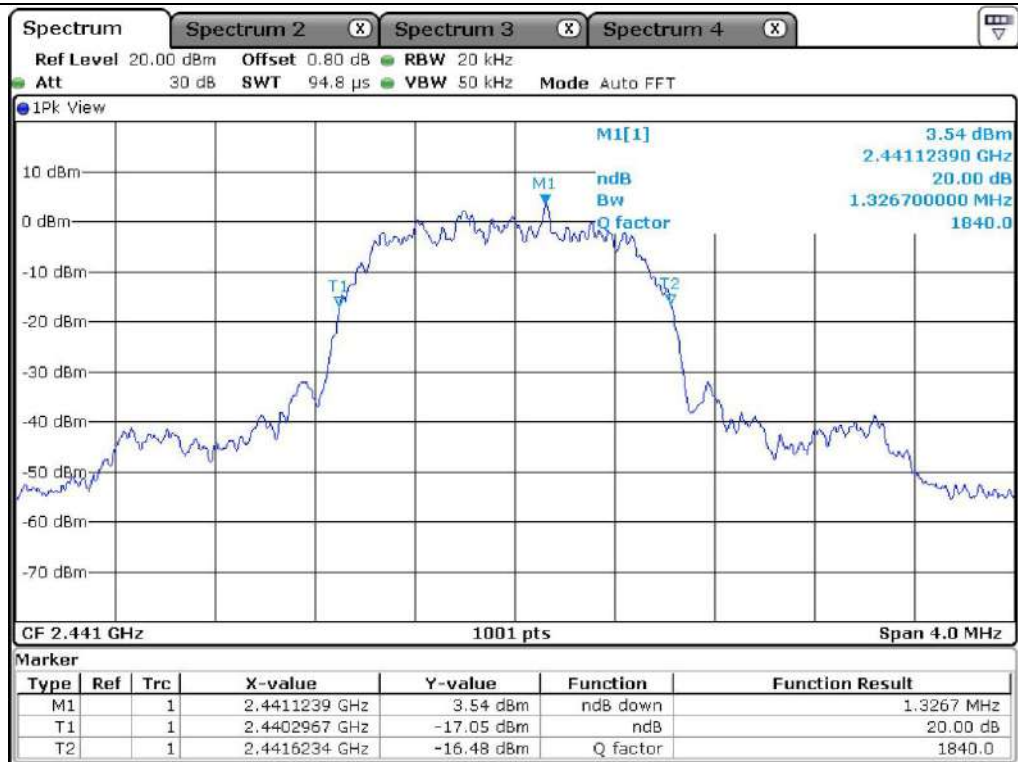
High Channel

7.4.2 Test data for 2 Mbps

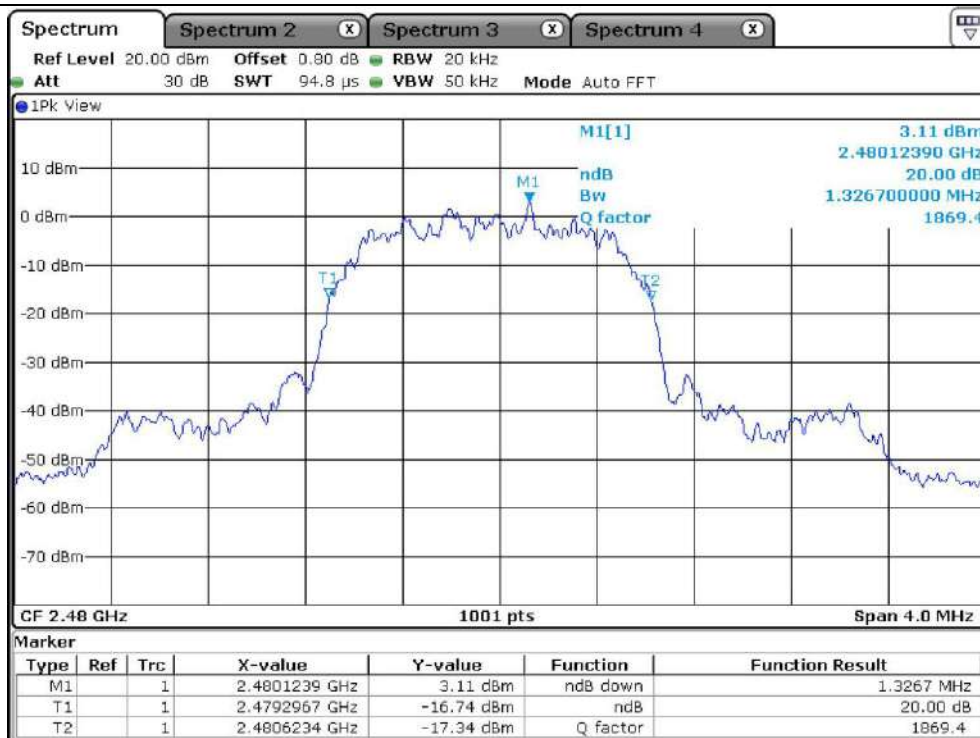
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 326.70
Middle	2 441.00	1 326.70
High	2 480.00	1 326.70



Low Channel



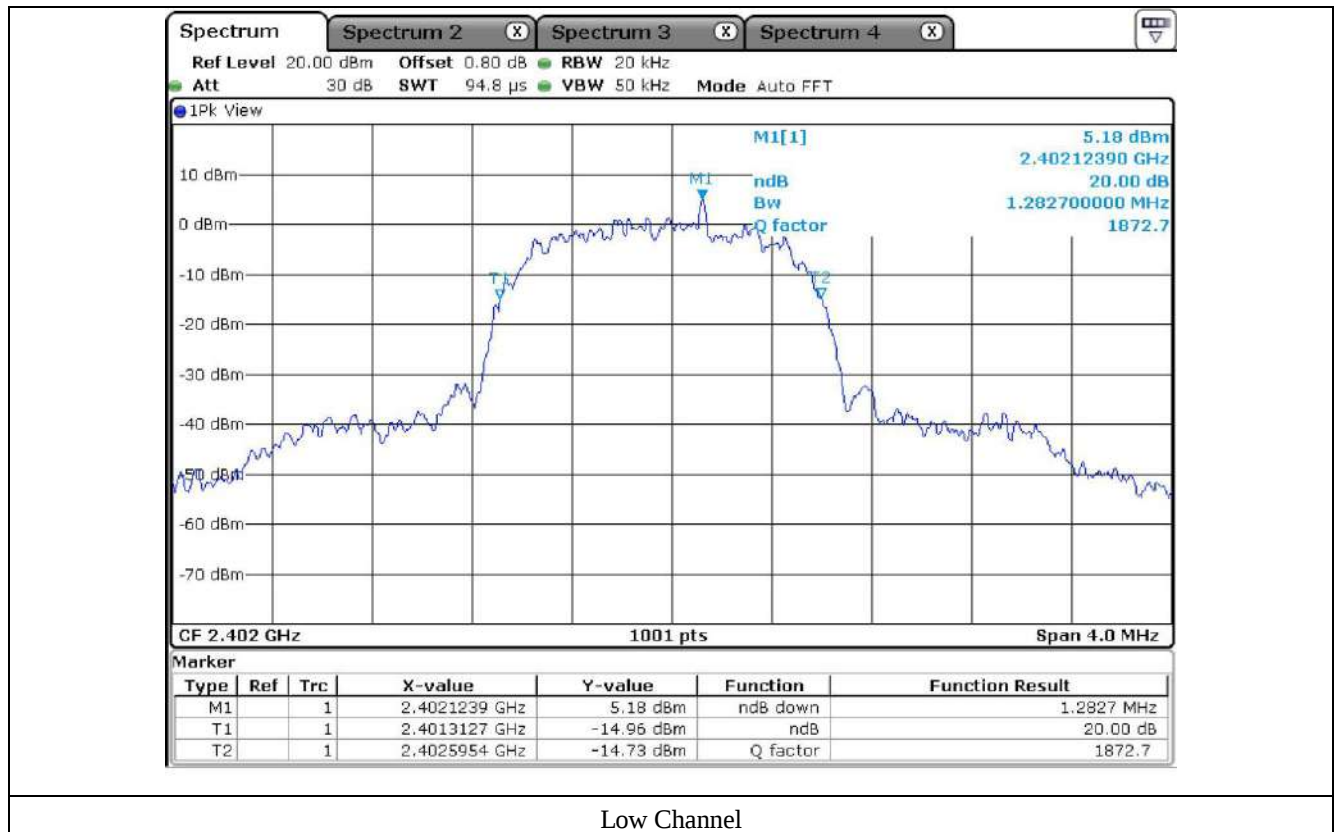
Middle Channel

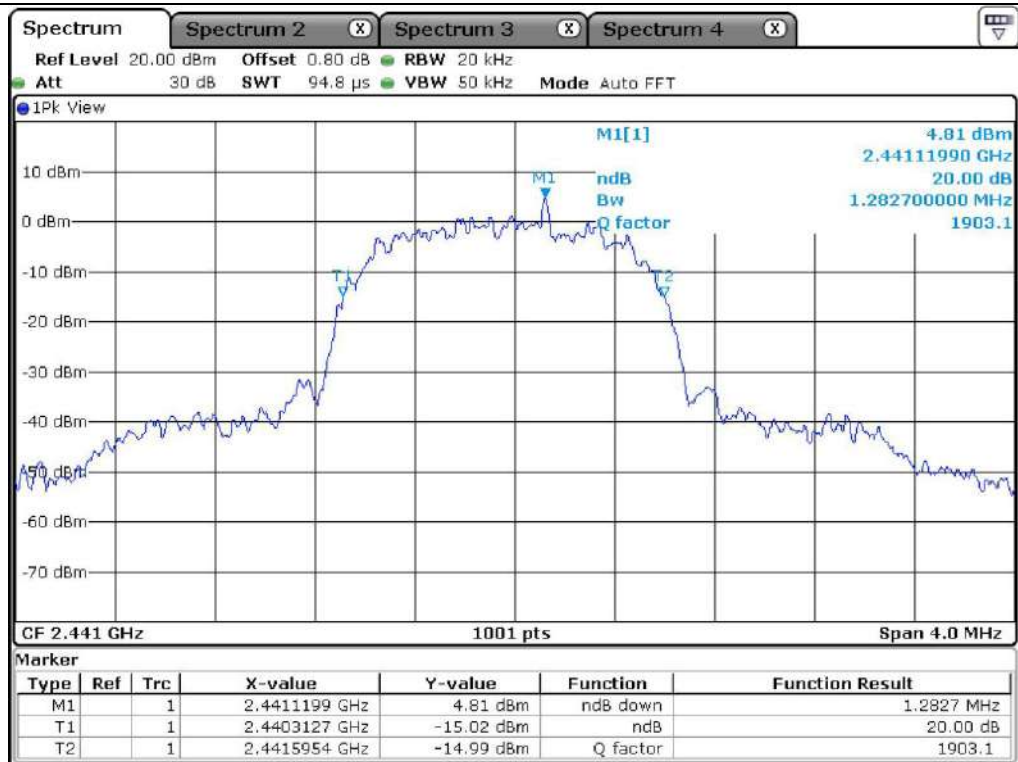


High Channel

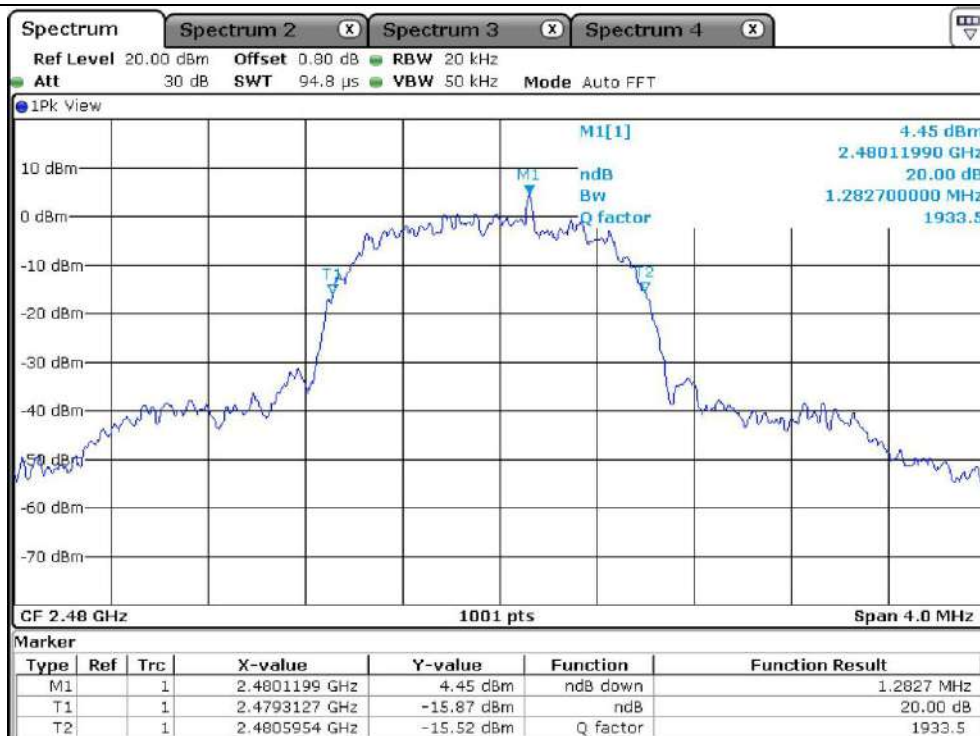
7.4.3 Test data for 3 Mbps

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

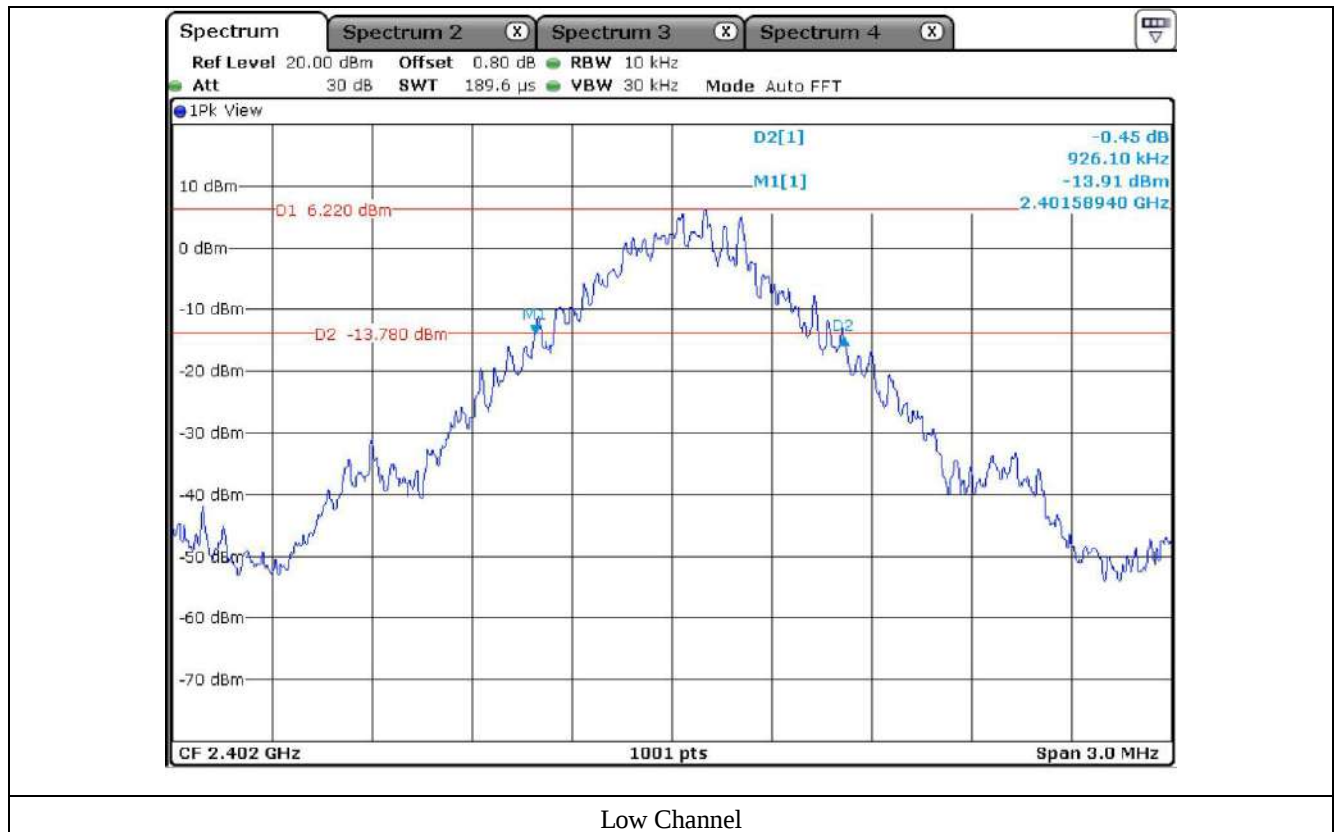


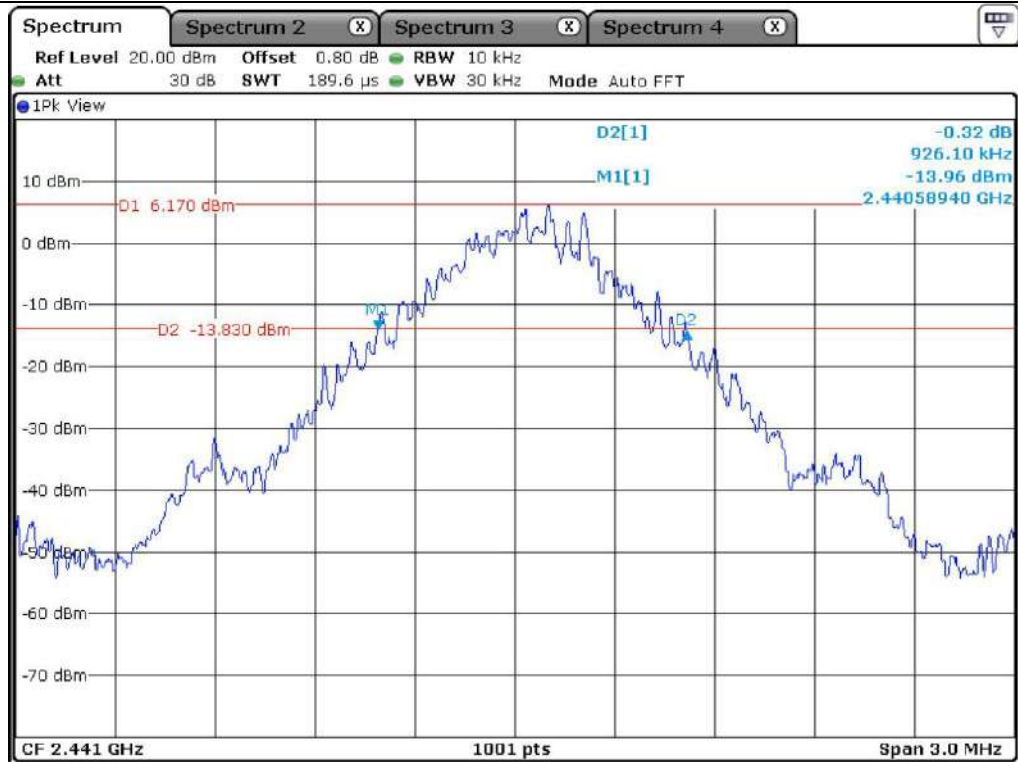
High Channel

7.5 Test data for Right Earbud

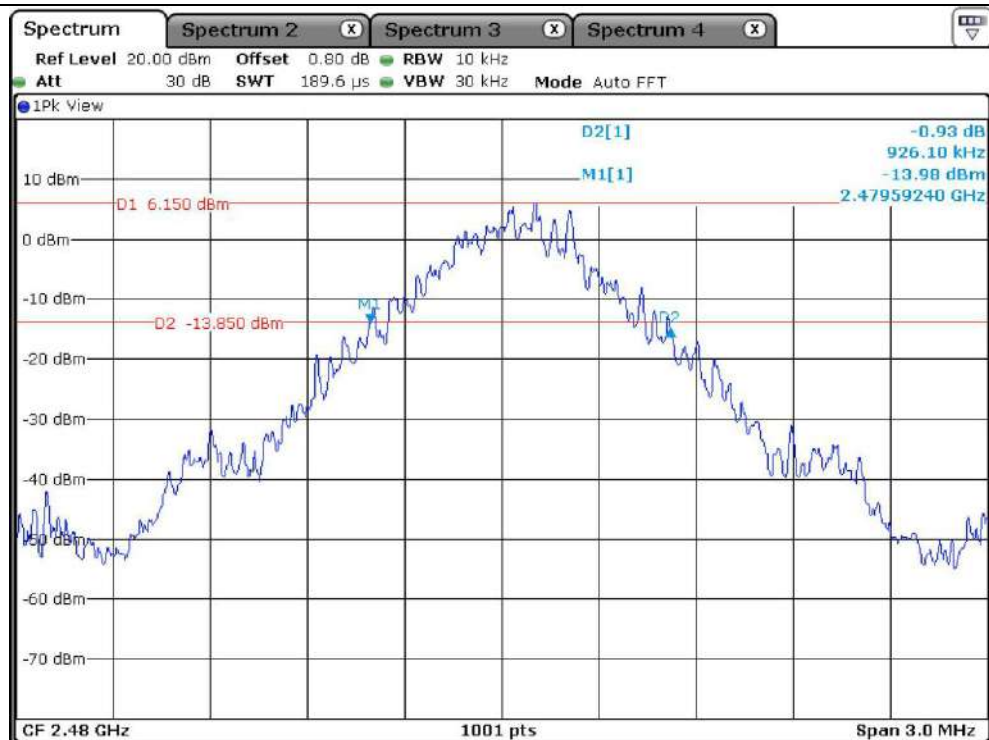
7.5.1 Test data for 1 Mbps

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





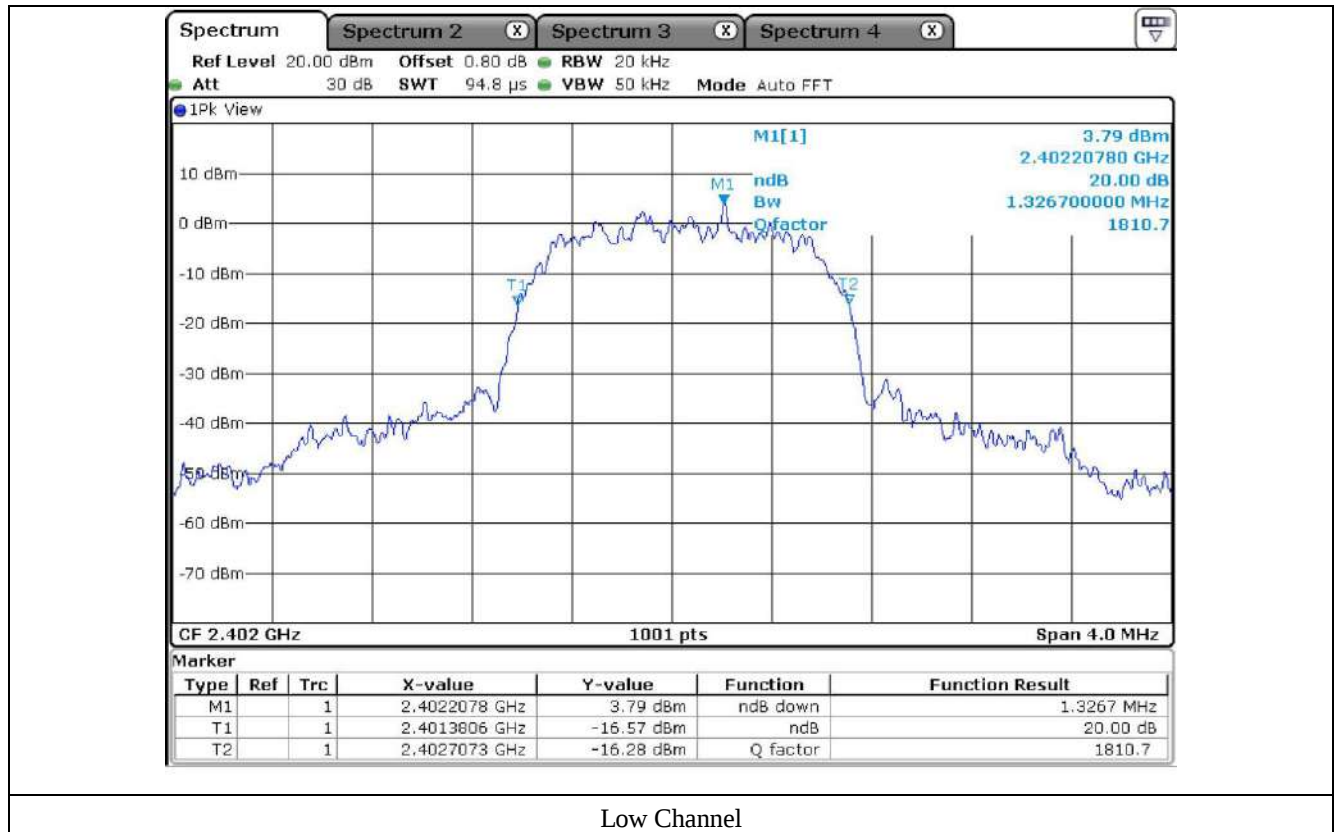
Middle Channel

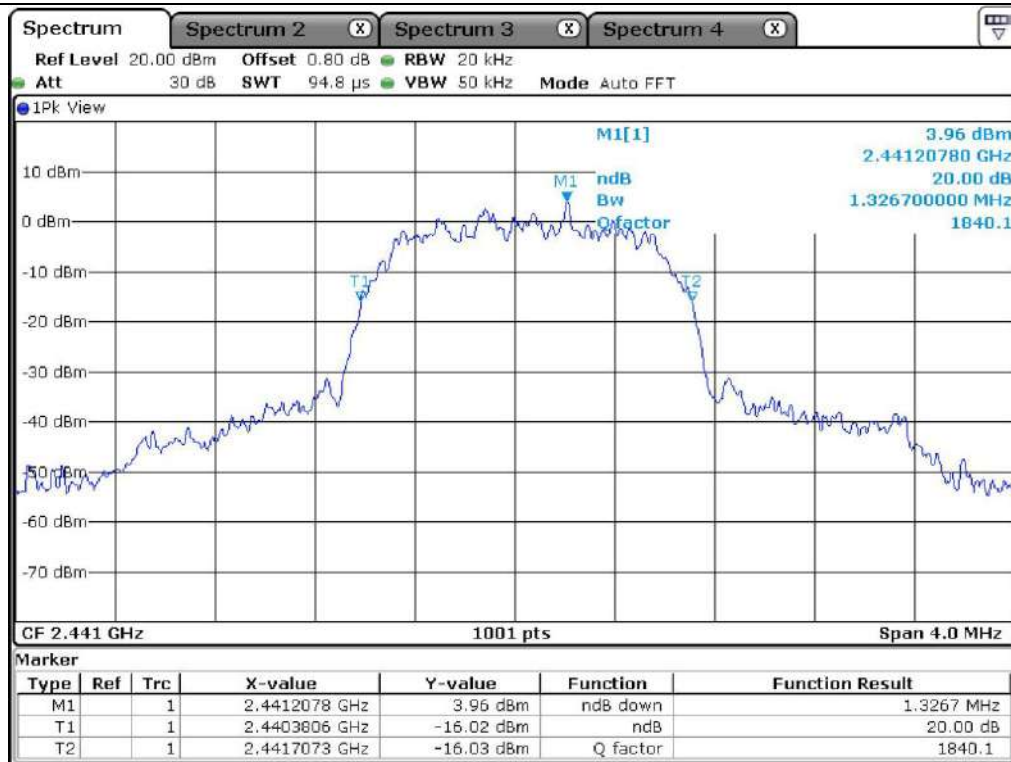


High Channel

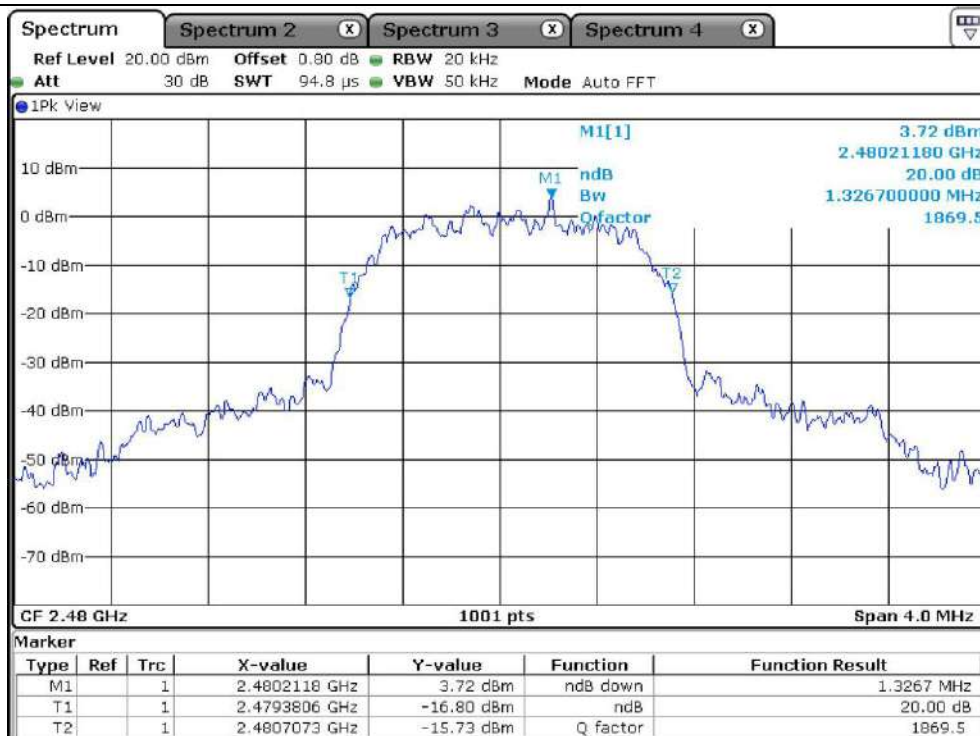
7.5.2 Test data for 2 Mbps

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





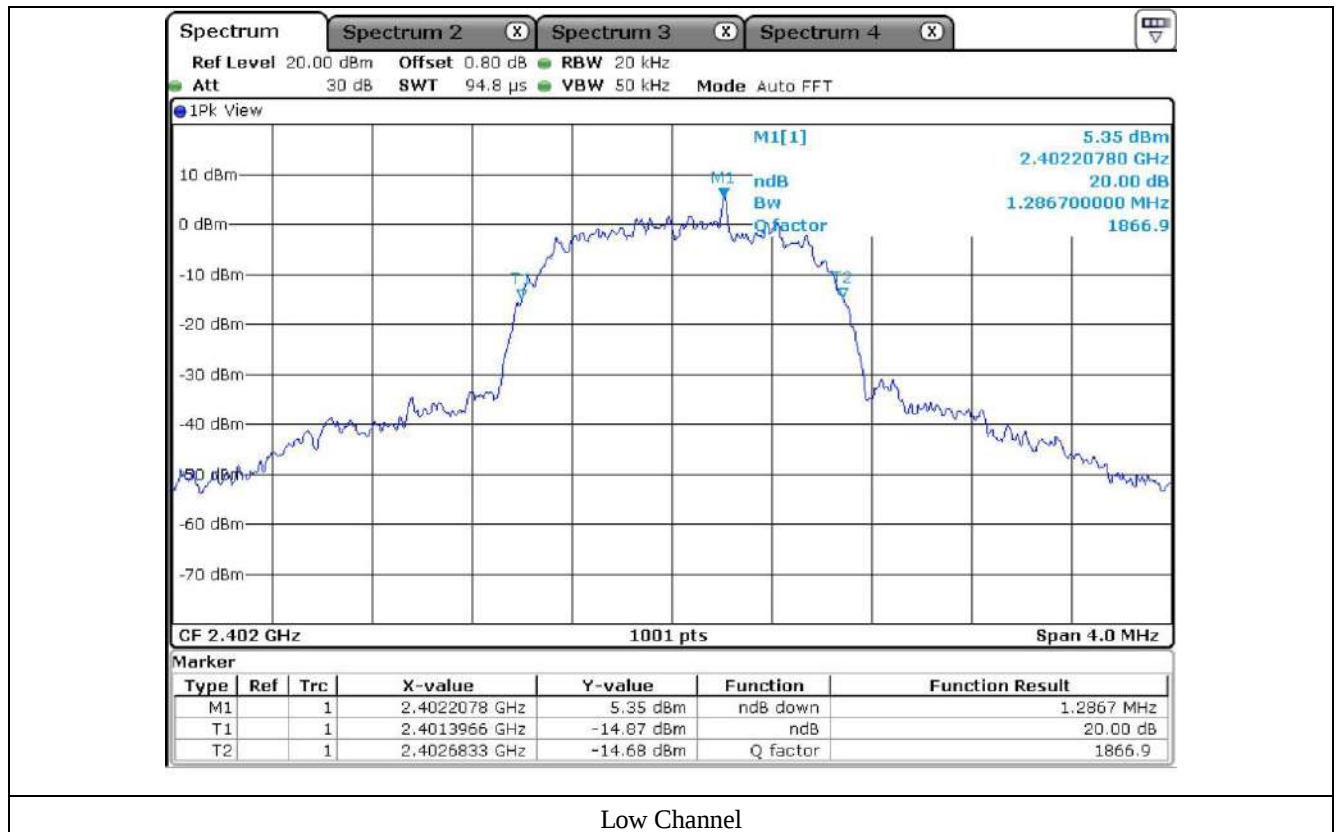
Middle Channel

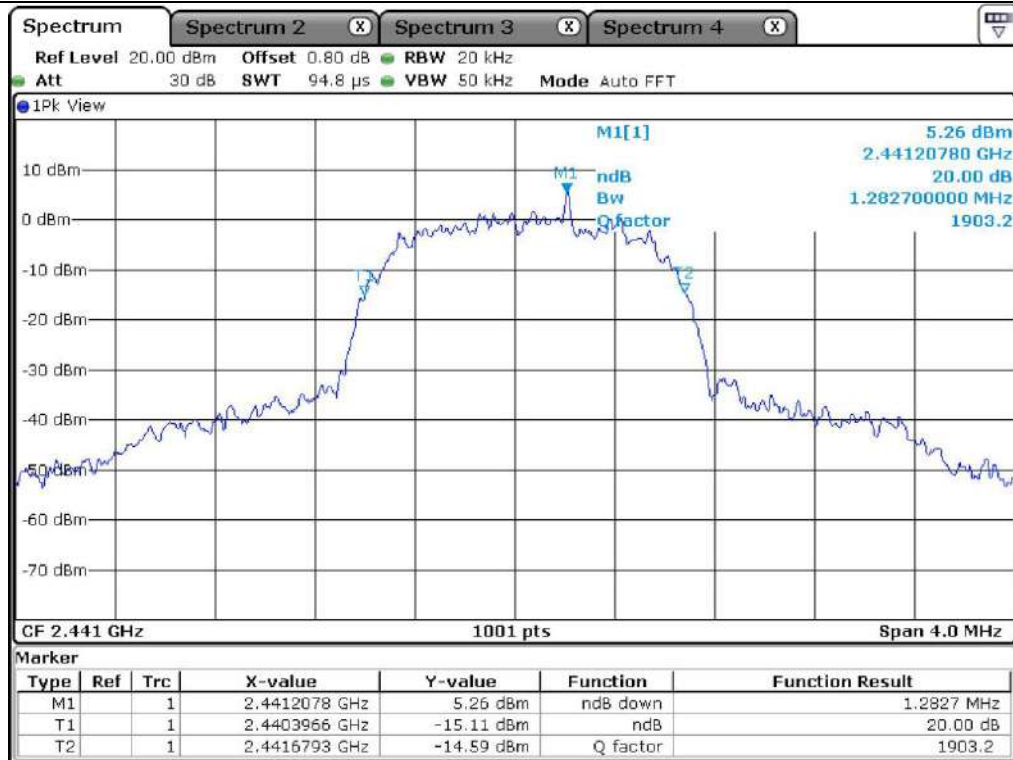


High Channel

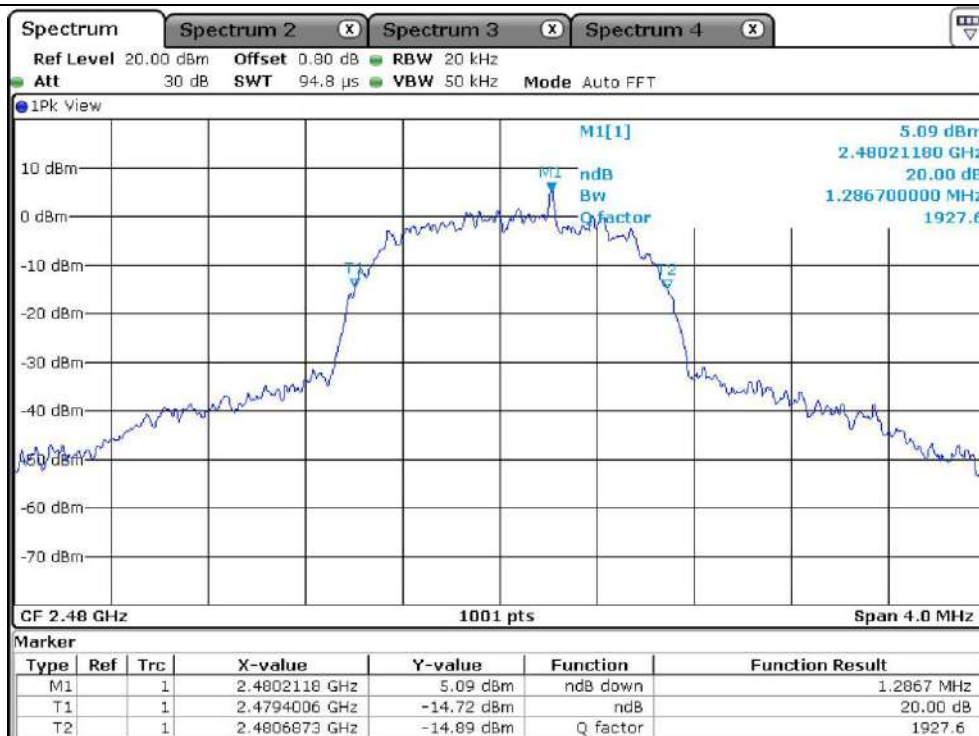
7.5.3 Test data for 3 Mbps

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





Middle Channel



High Channel

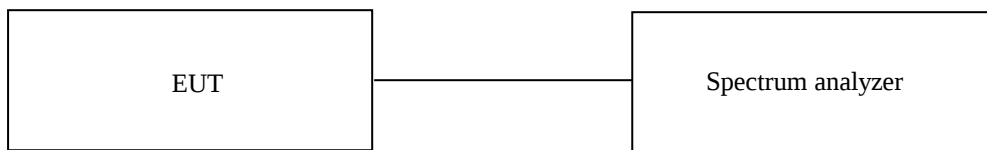
8. HOPPING FREQUENCY SEPARATION

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.



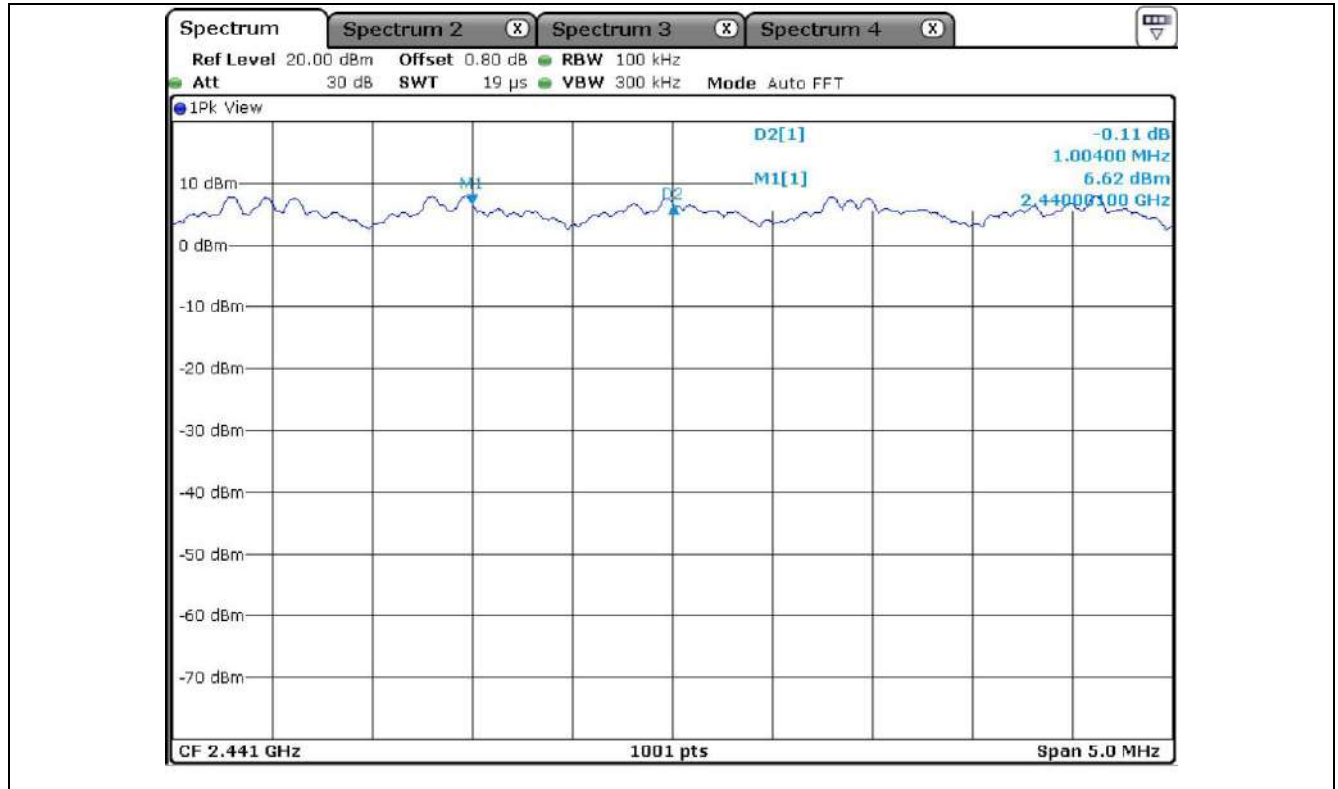
8.3 Test Date

May 17, 2021 ~ May 31, 2021

8.4.2 Test data for 2 Mbps

-. Test Result : Pass

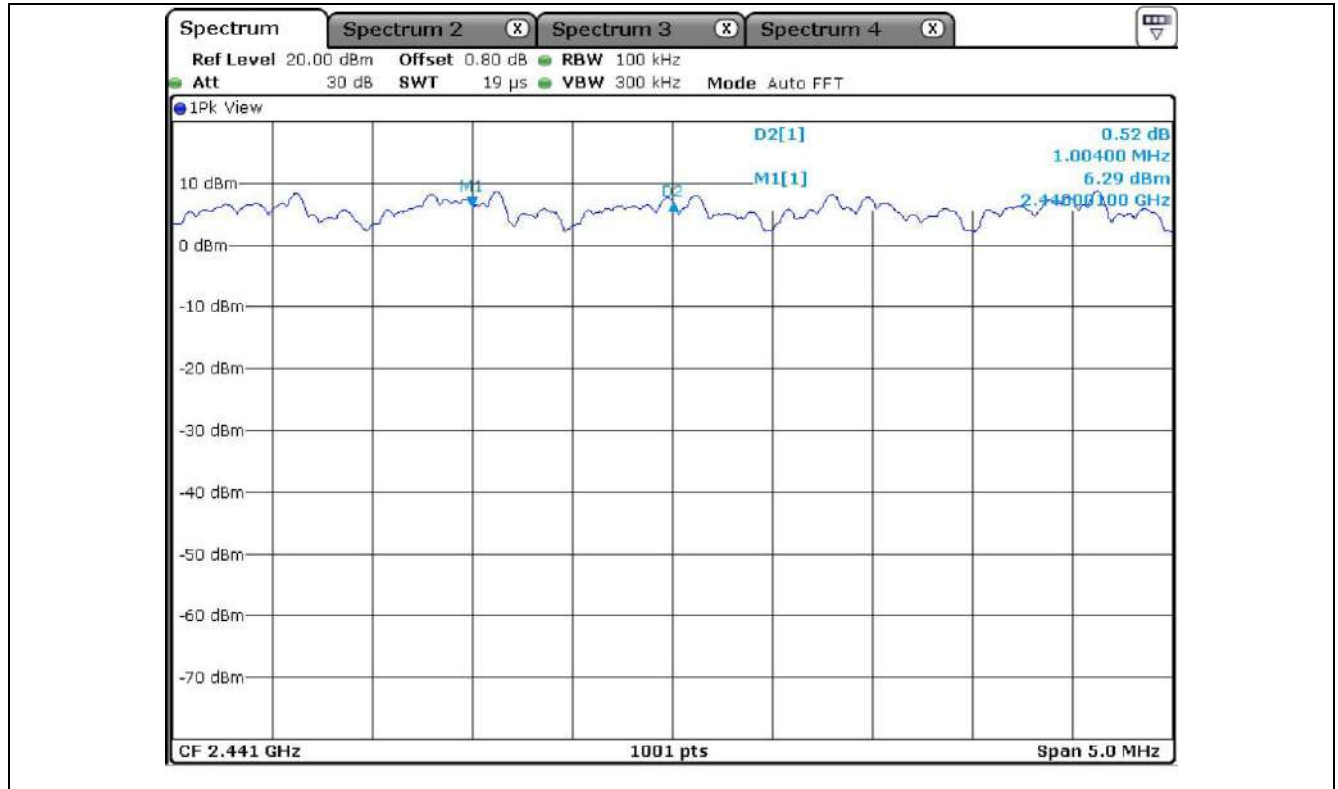
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.0	884.47	Separated by a minimum of 884.47 kHz



8.4.3 Test data for 3 Mbps

-. Test Result : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.00	855.13	Separated by a minimum of 855.13 kHz

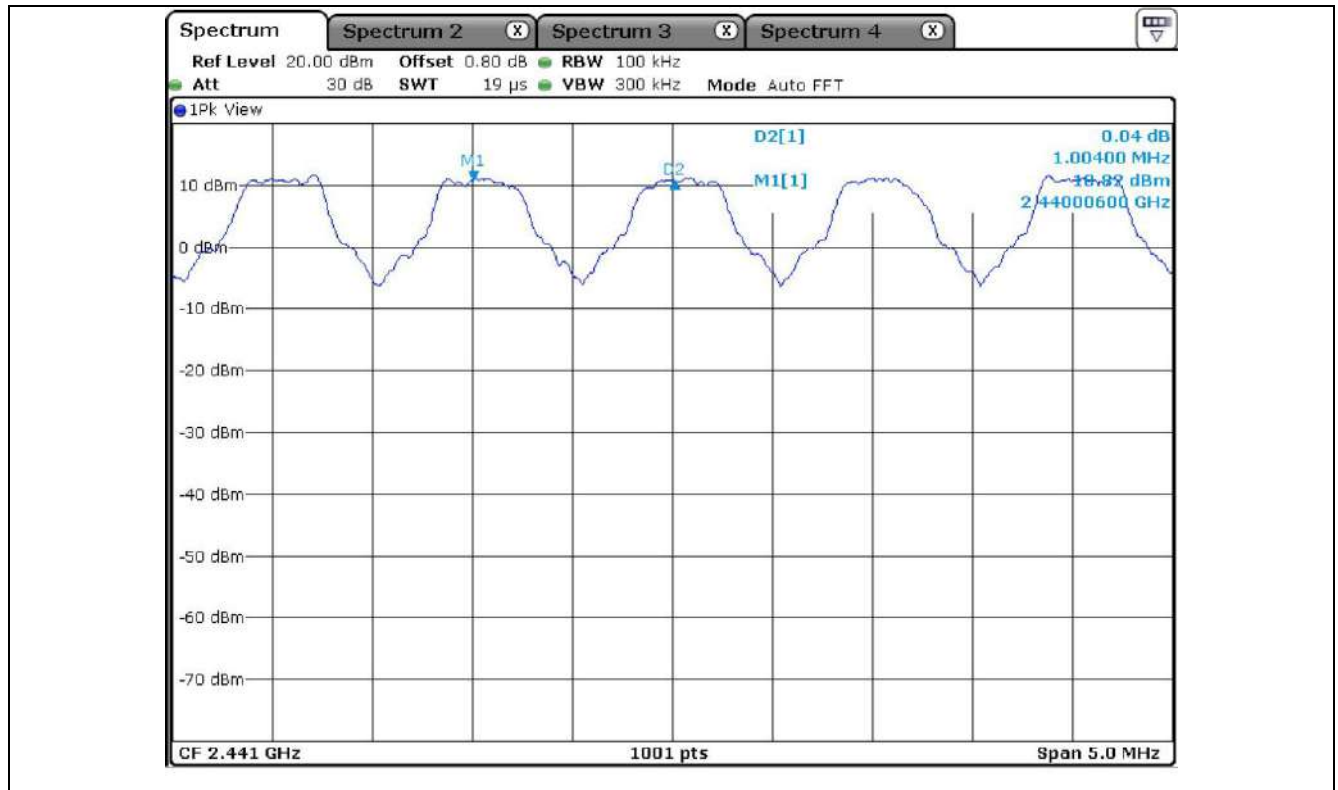


8.5 Test data for Right Earbud

8.5.1 Test data for 1 Mbps

-. Test Result : Pass

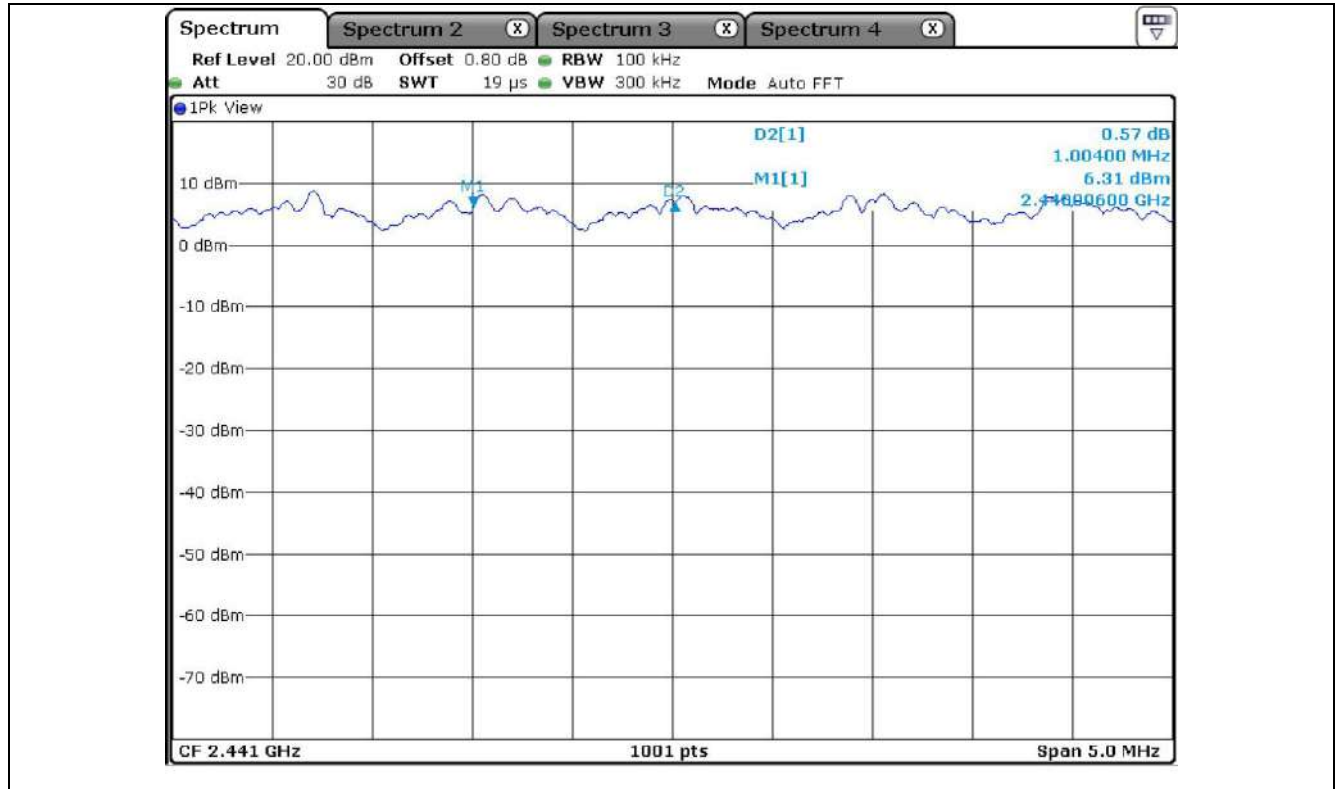
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.00	617.40	Separated by a minimum of 617.40 kHz



8.5.2 Test data for 2 Mbps

-. Test Result : Pass

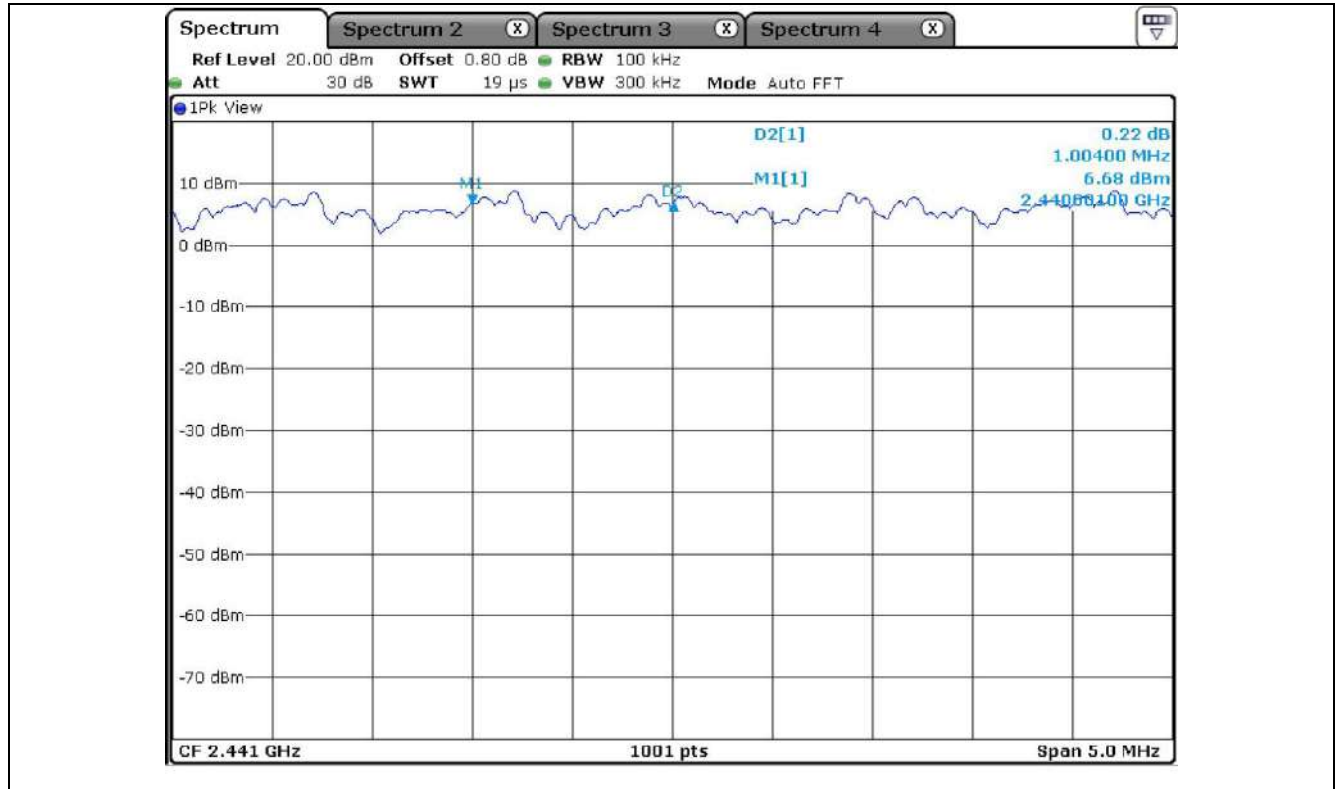
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.00	884.47	Separated by a minimum of 884.47 kHz



8.5.3 Test data for 3 Mbps

-. Test Result : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 004.00	855.13	Separated by a minimum of 855.13 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

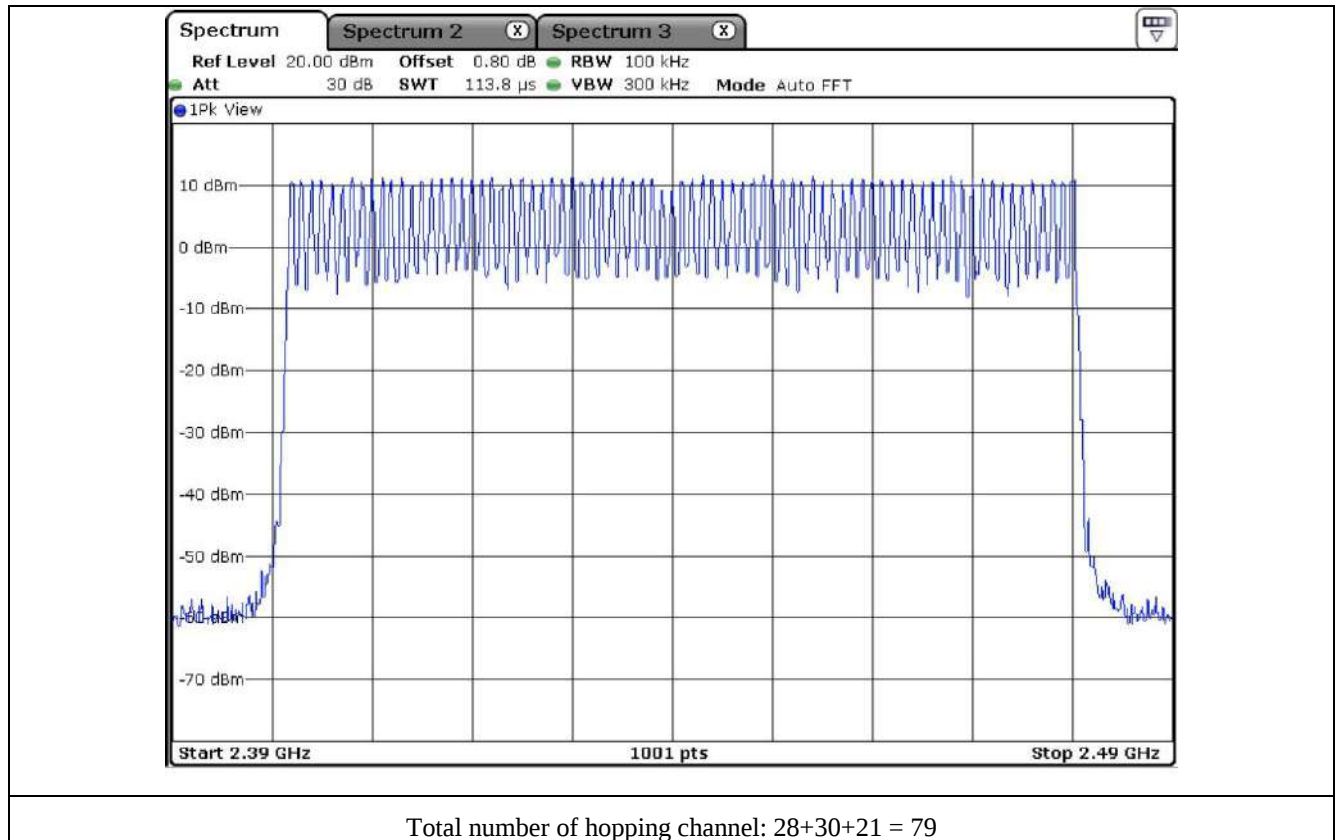
May 17, 2021 ~ May 31, 2021

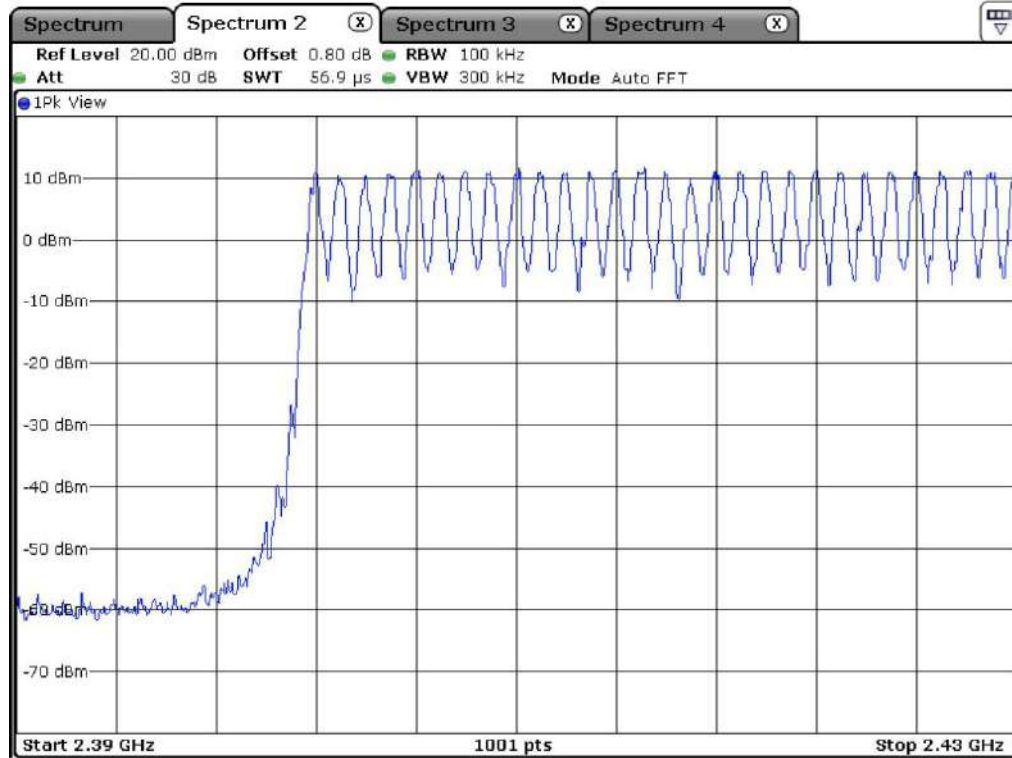
9.4 Test data for Left Earbud

9.4.1 Test data for 1 Mbps

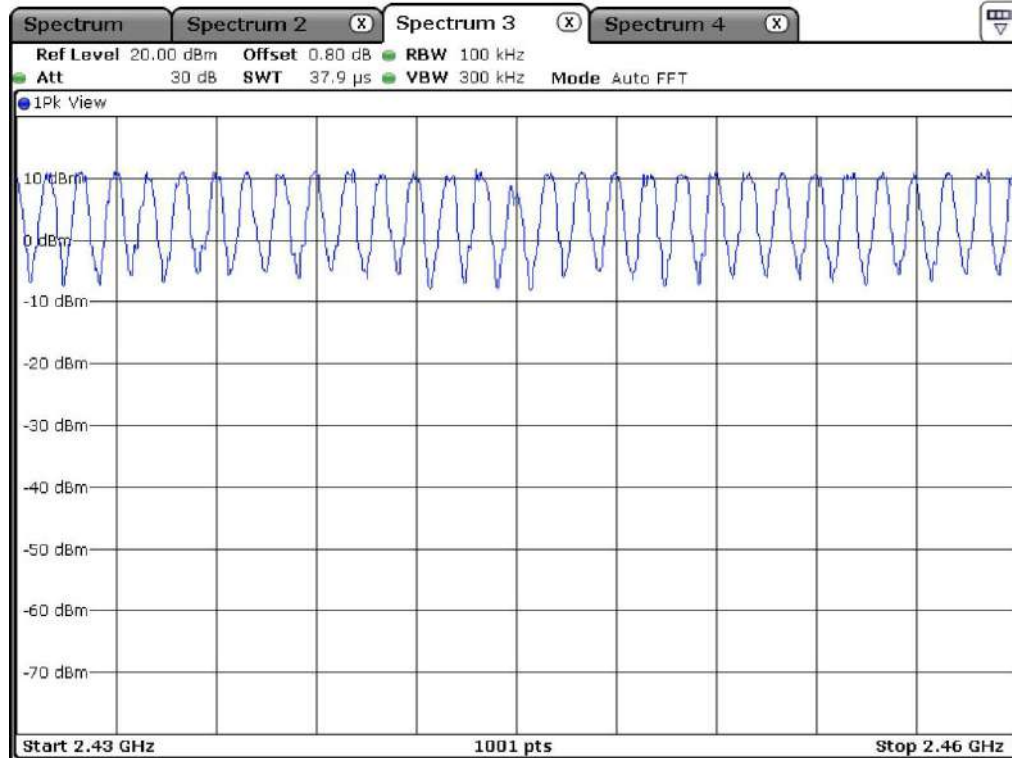
-. Test Result : Pass

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

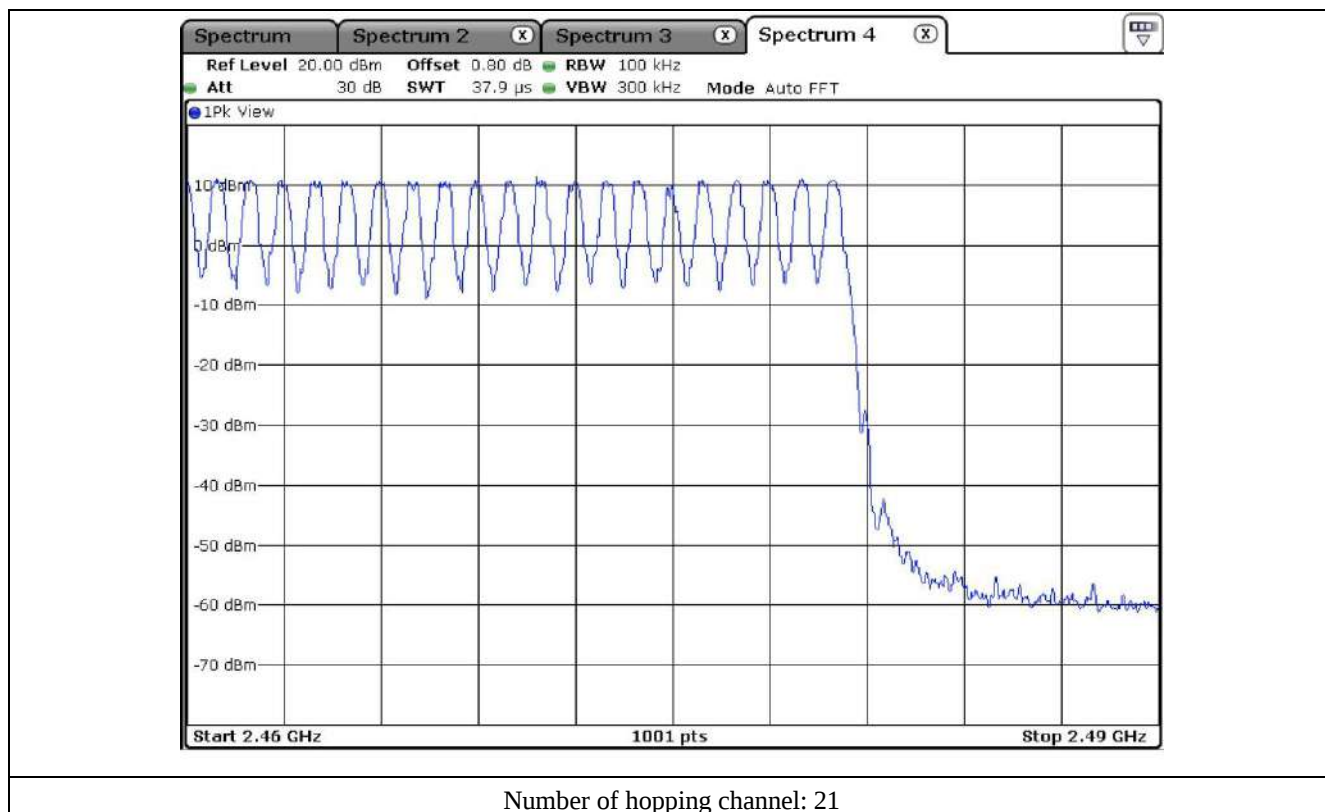




Number of hopping channel: 28



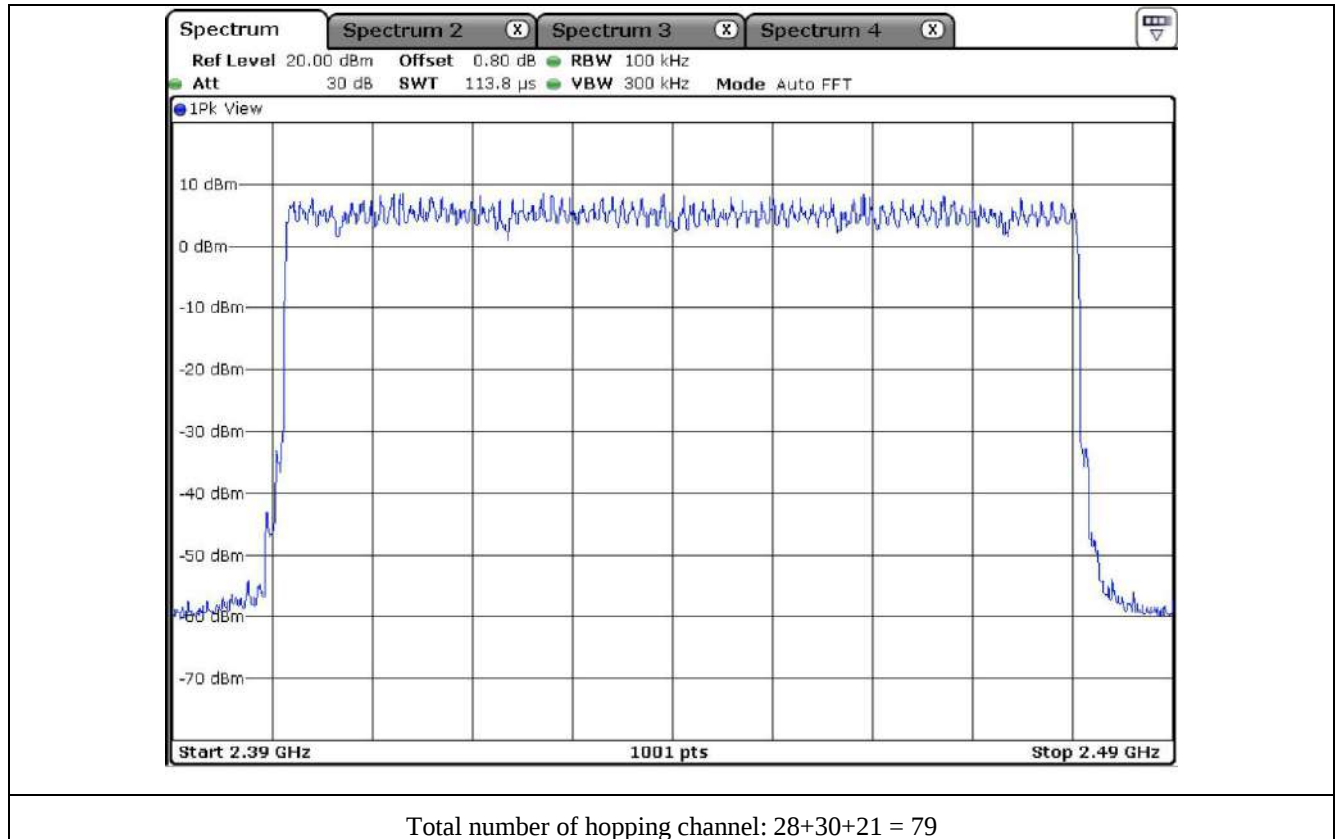
Number of hopping channel: 30

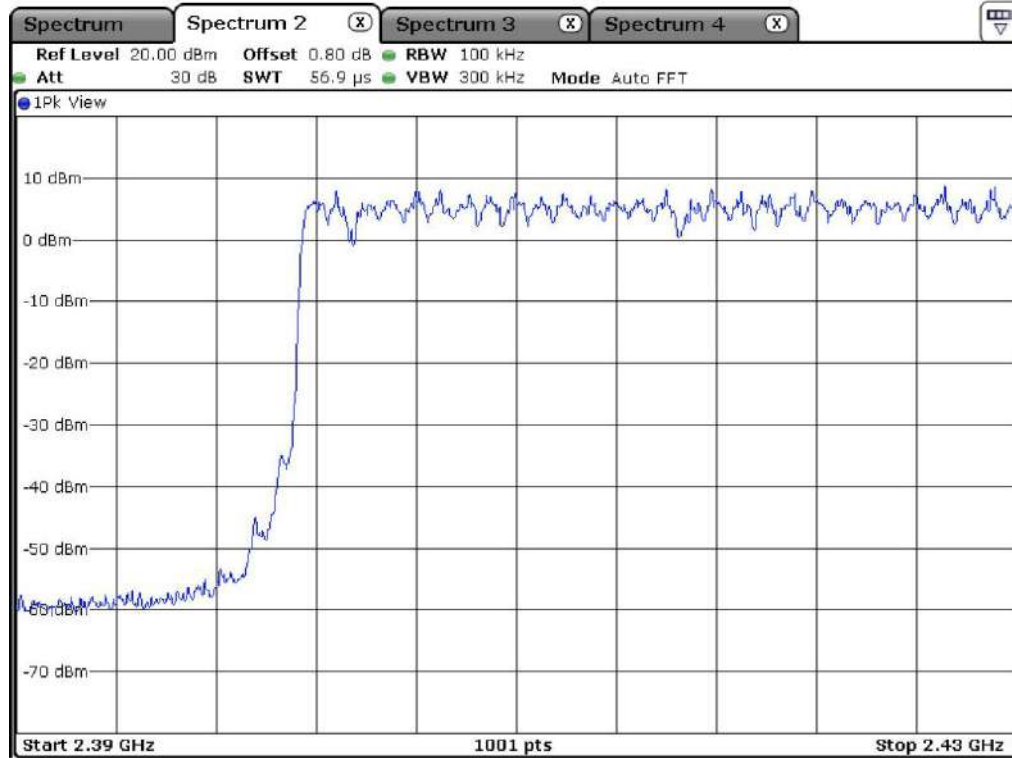


9.4.2 Test data for 2 Mbps

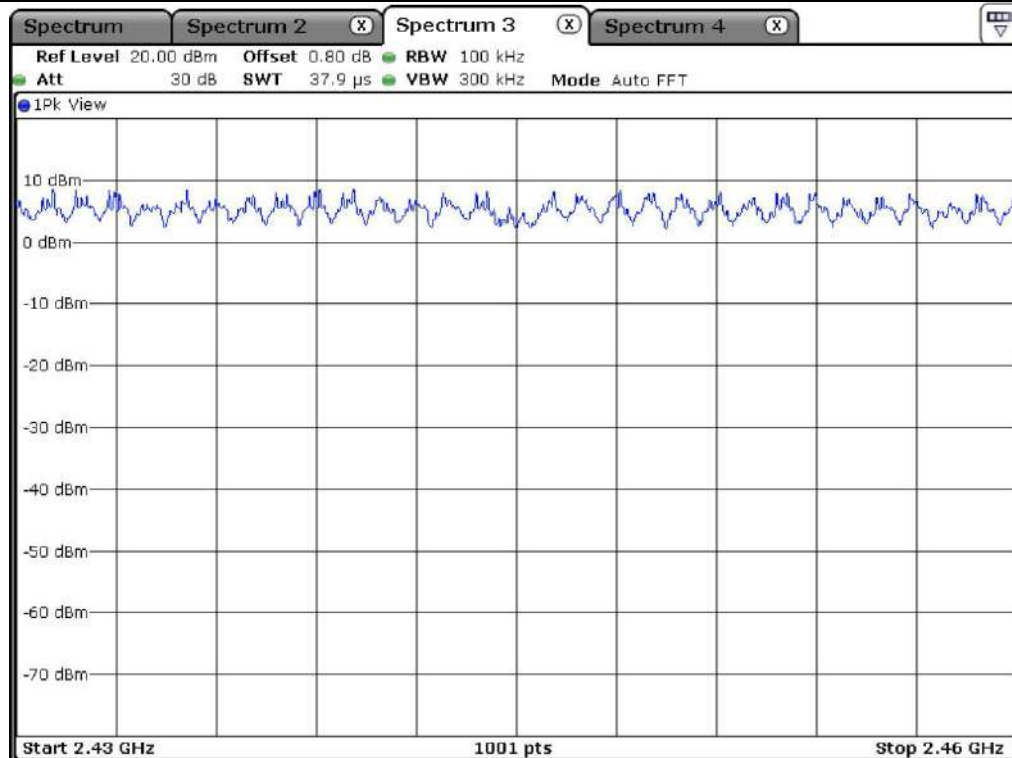
-. Test Result : Pass

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

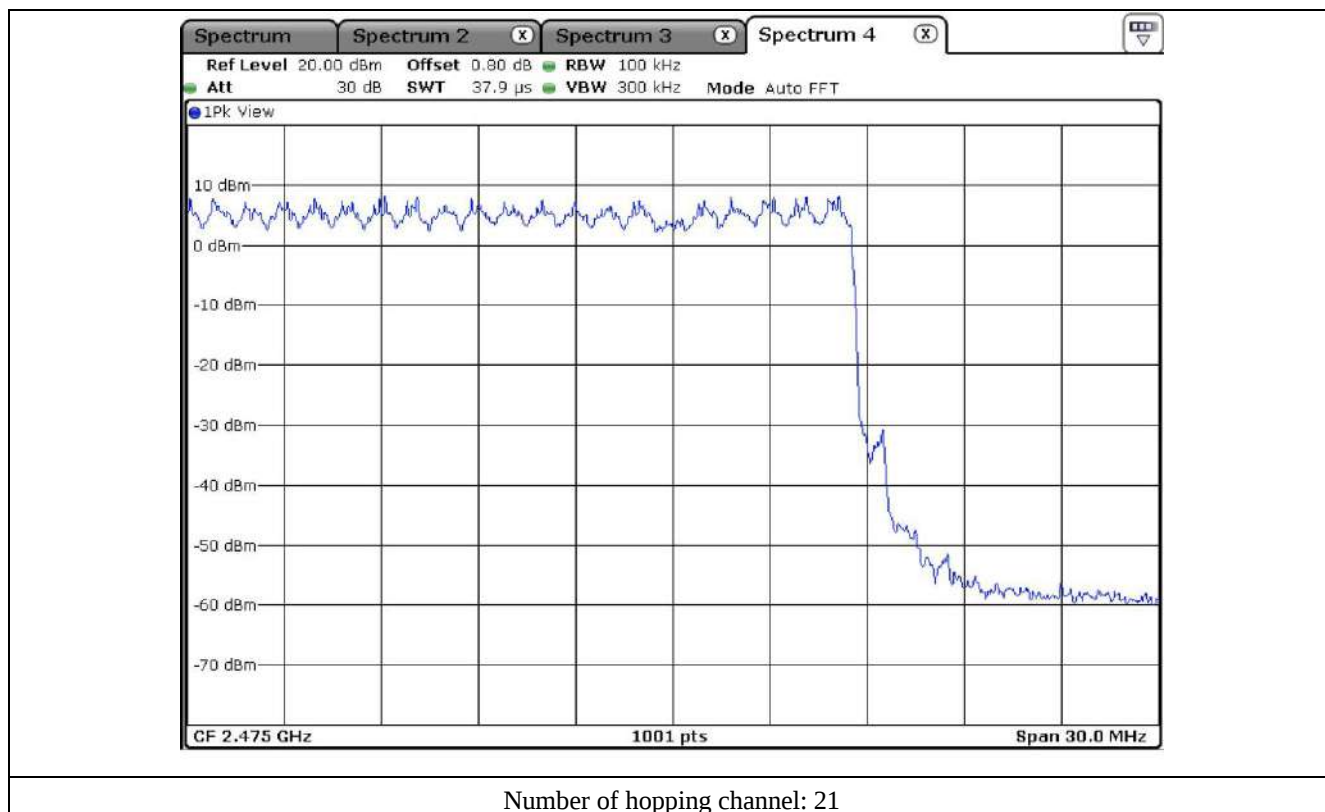




Number of hopping channel: 28



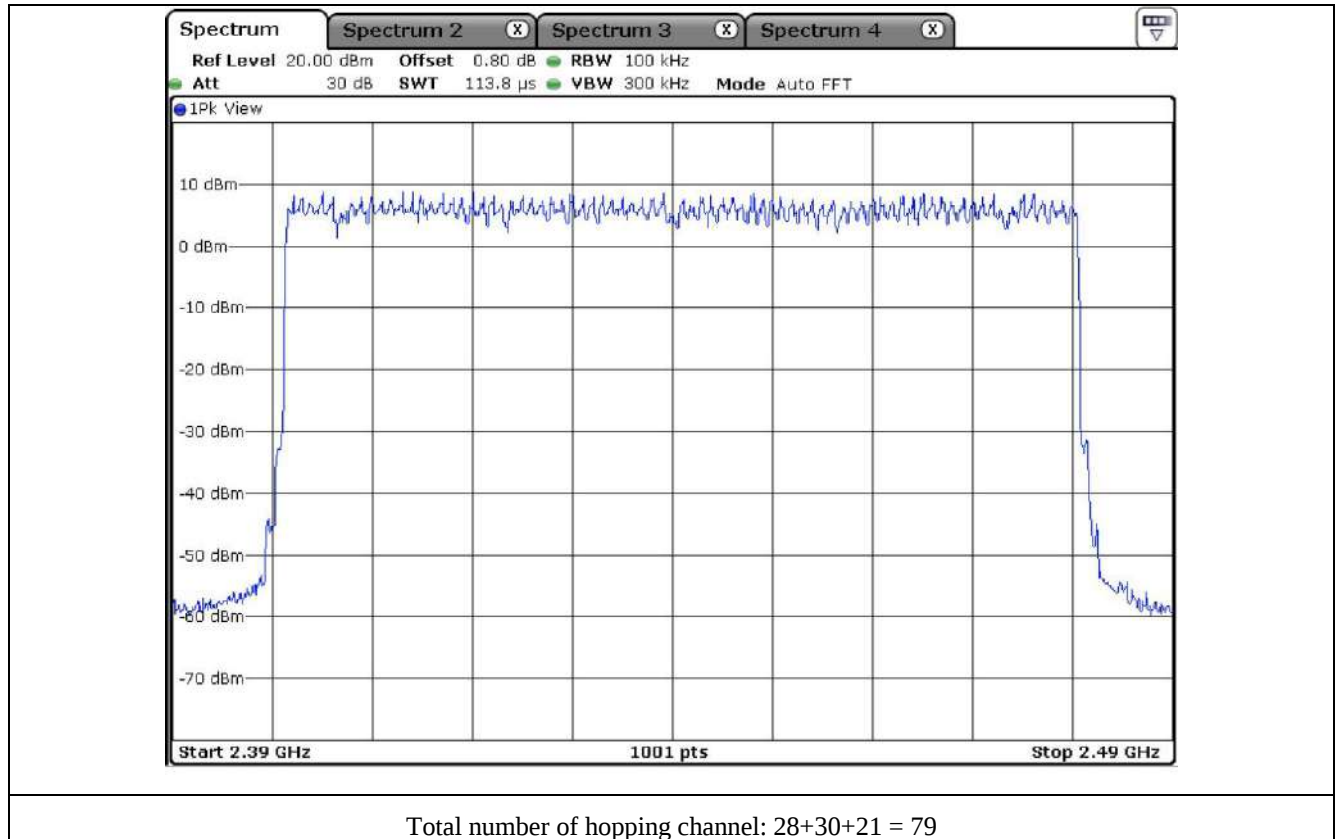
Number of hopping channel: 30

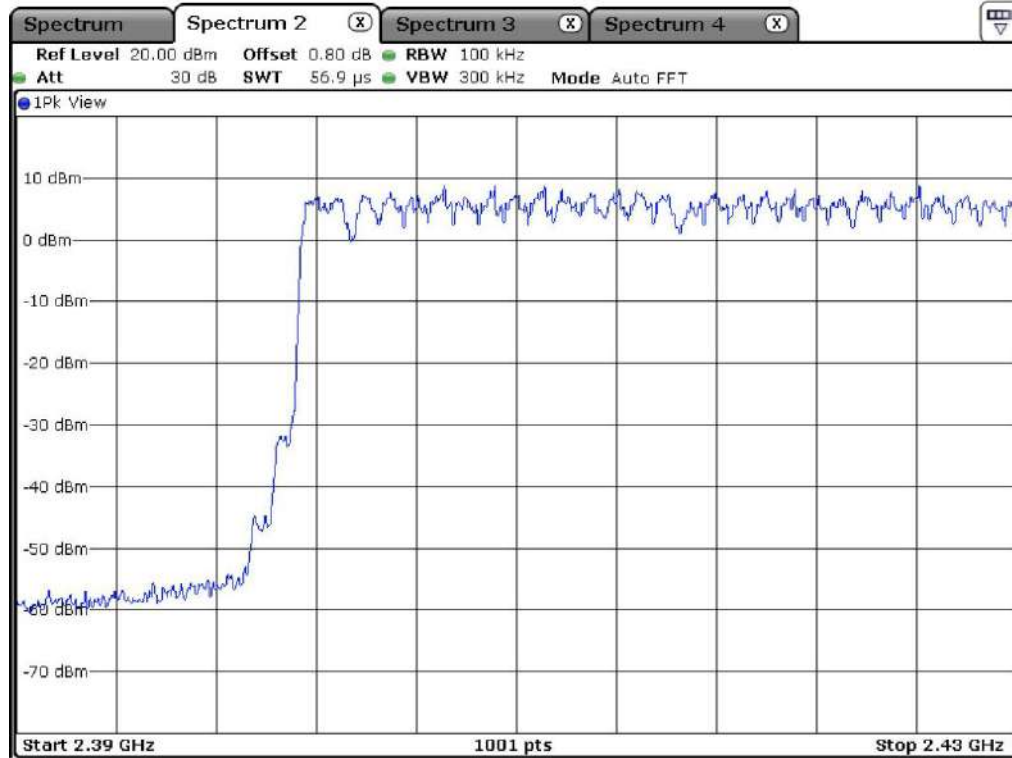


9.4.3 Test data for 3 Mbps

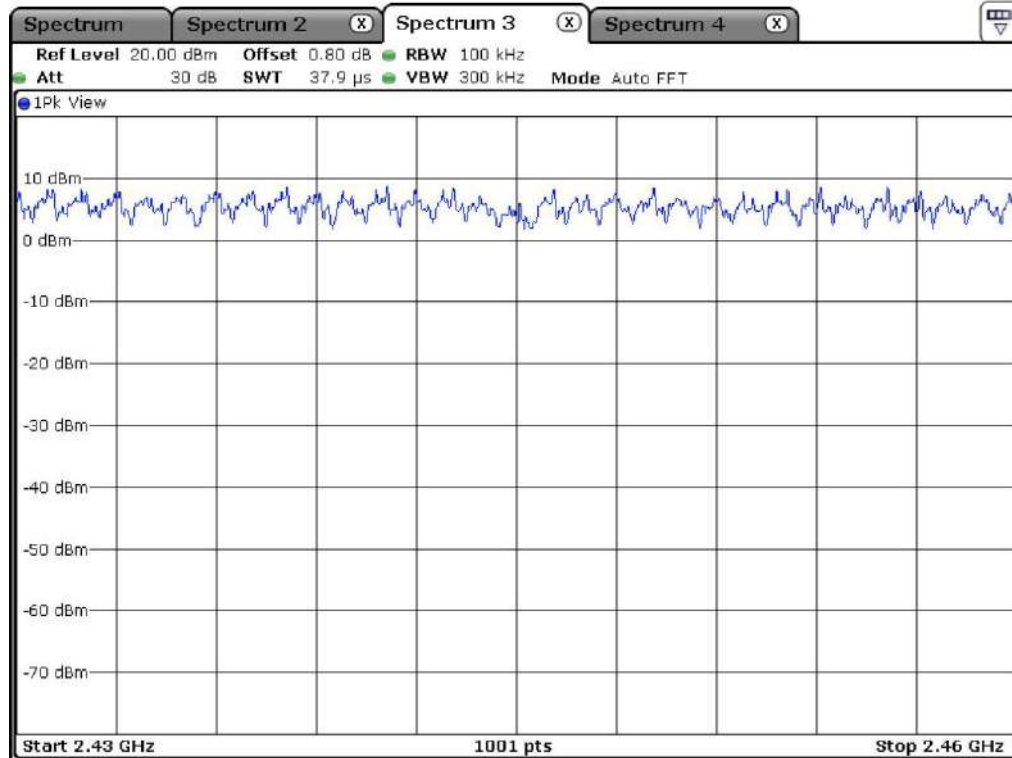
-. Test Result : Pass

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

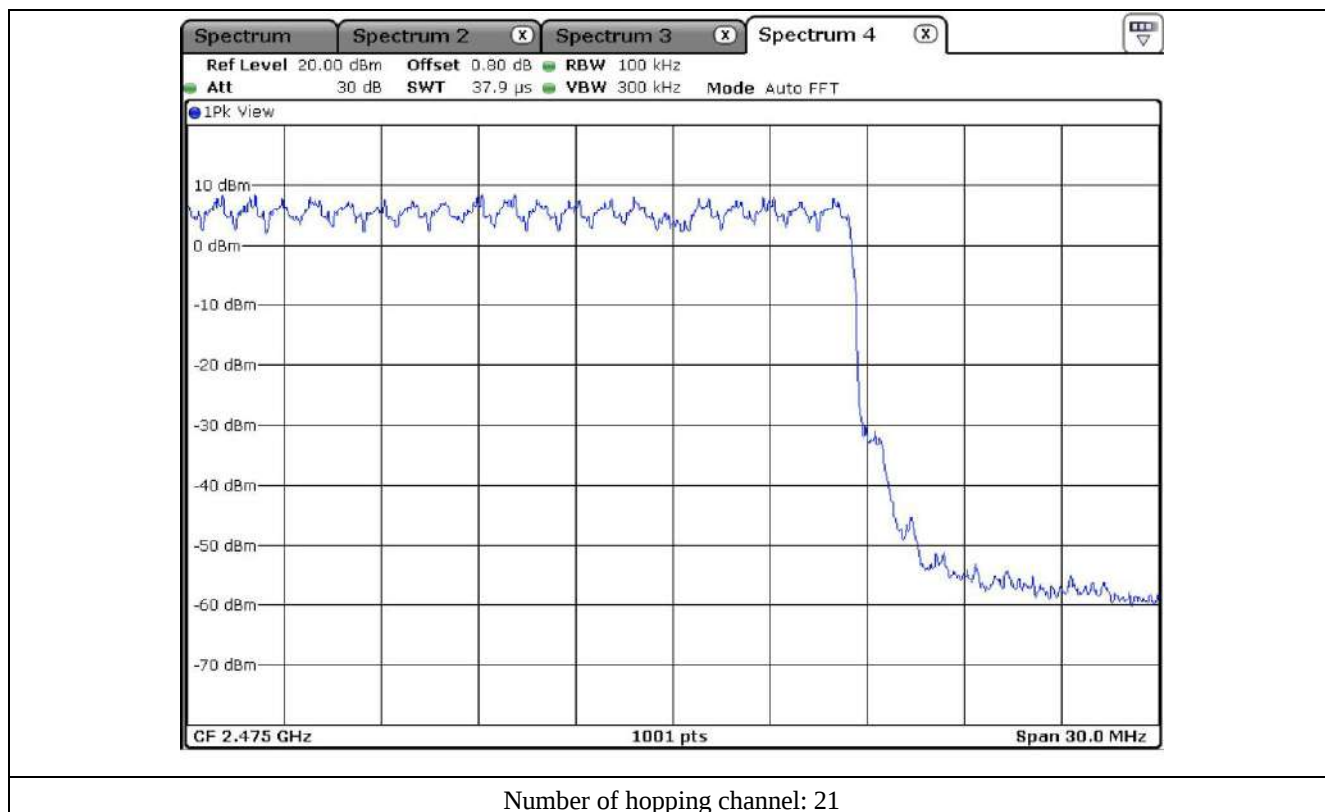




Number of hopping channel: 28



Number of hopping channel: 30

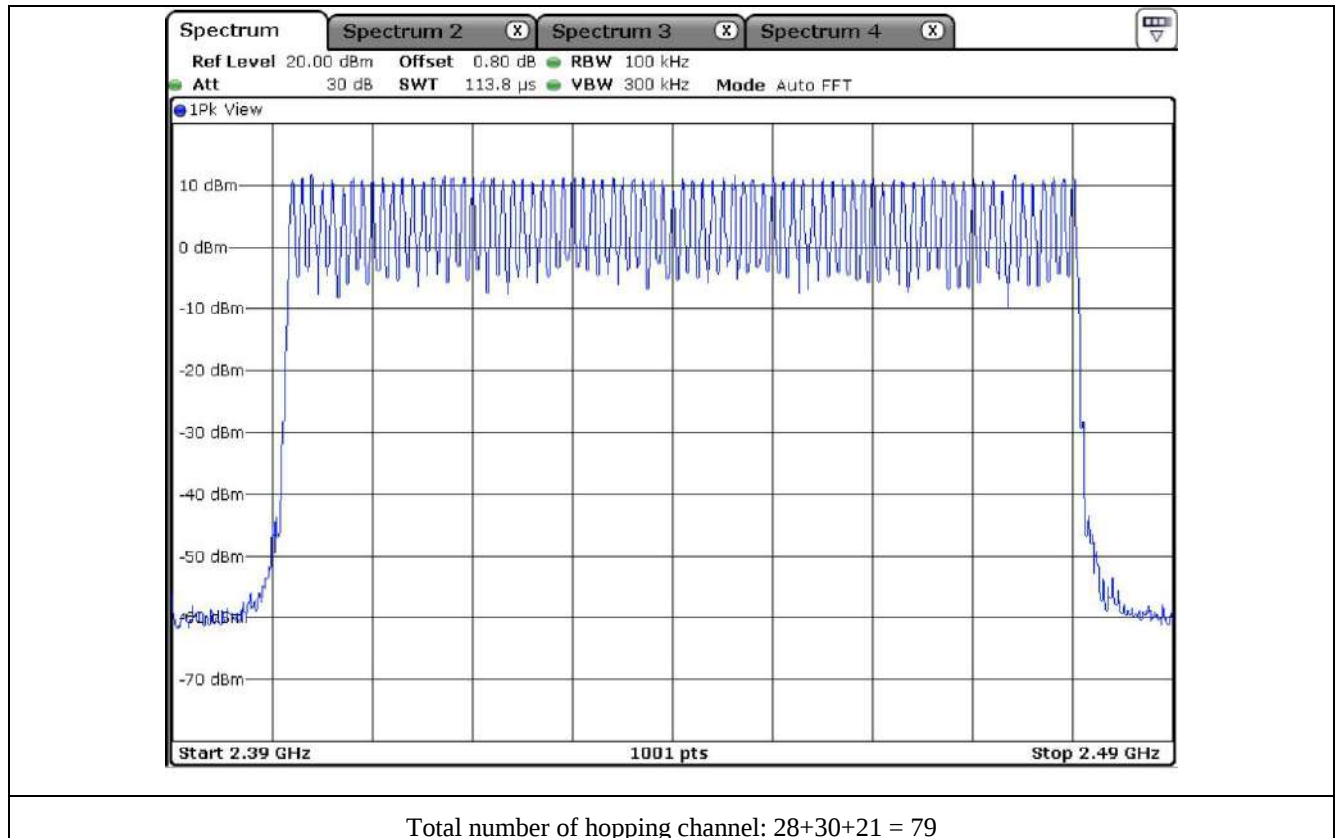


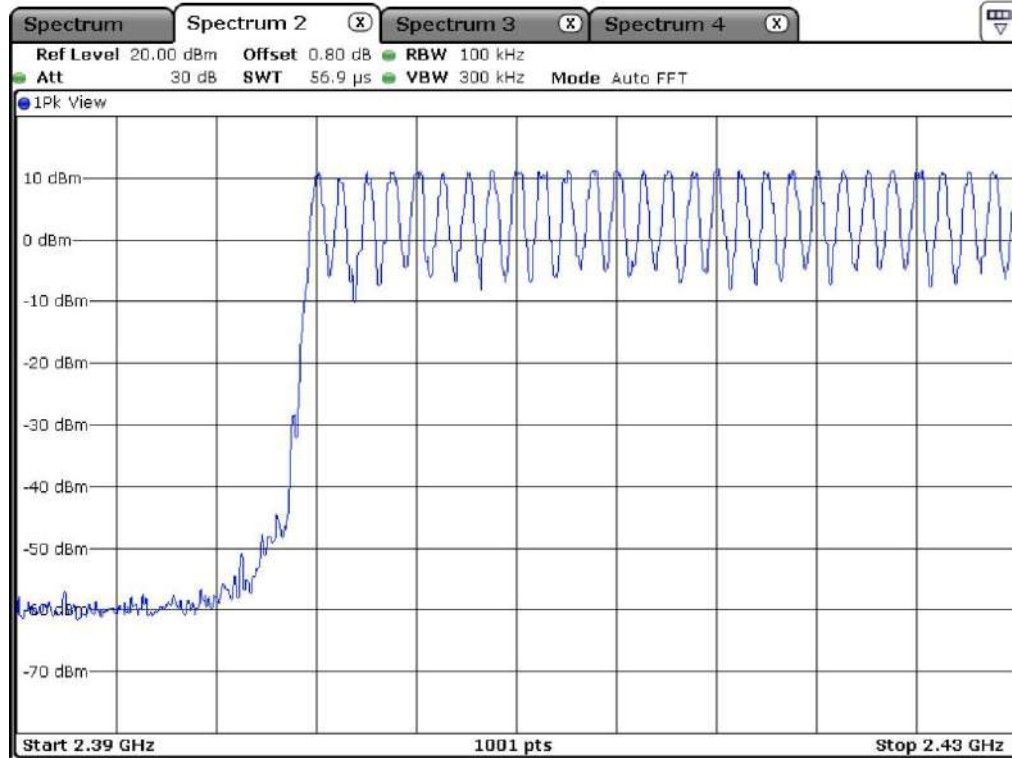
9.5 Test data for Right Earbud

9.5.1 Test data for 1 Mbps

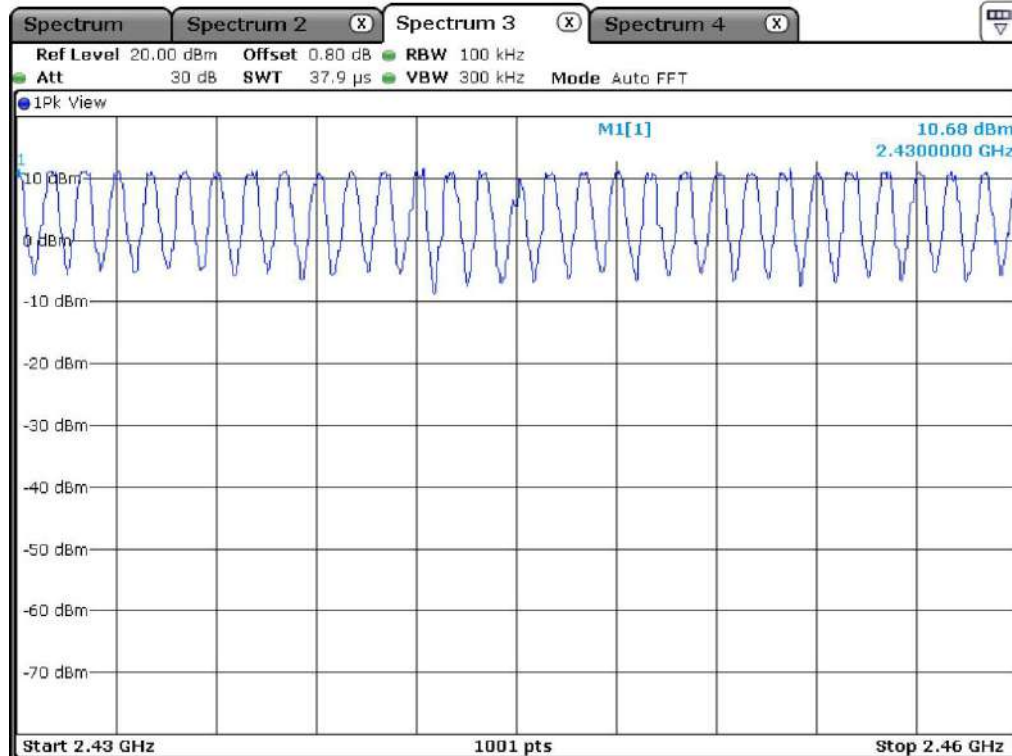
-. Test Result : Pass

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

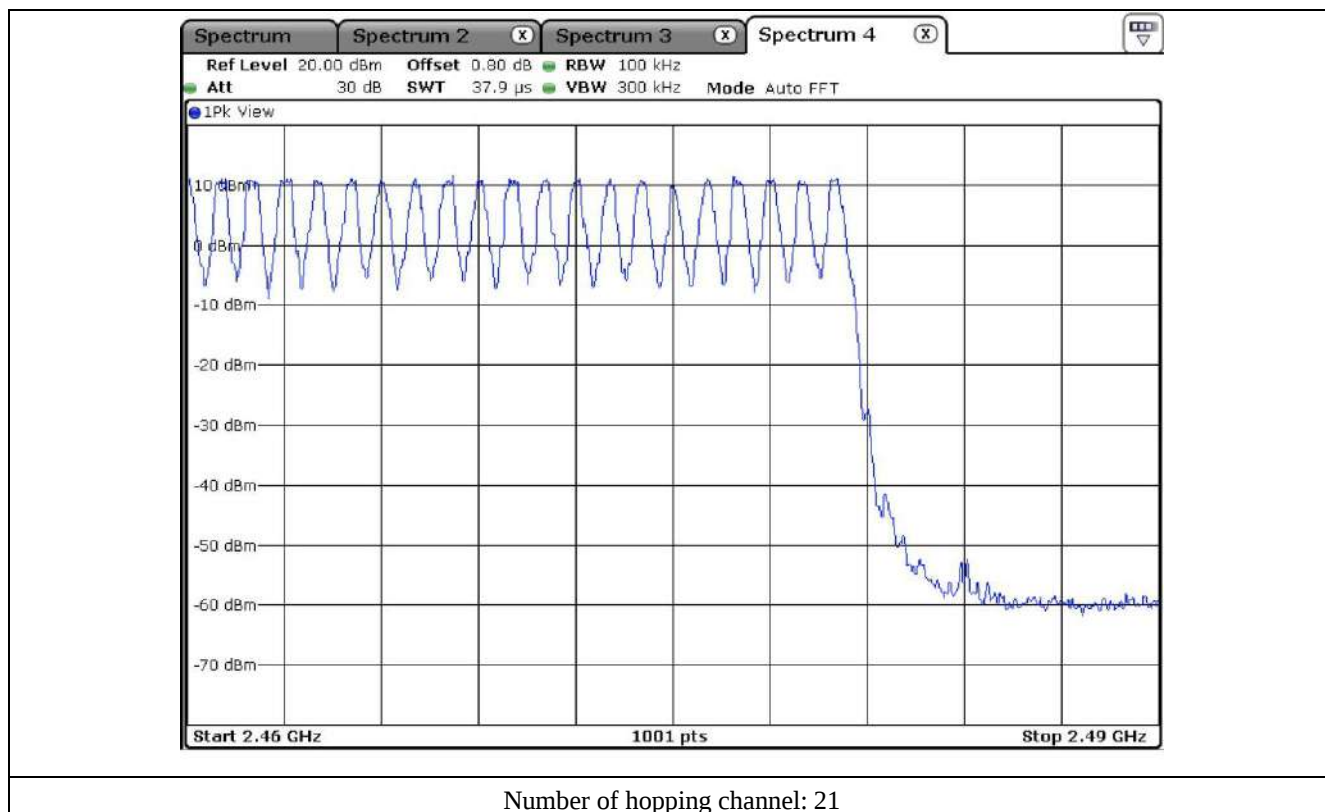




Number of hopping channel: 28



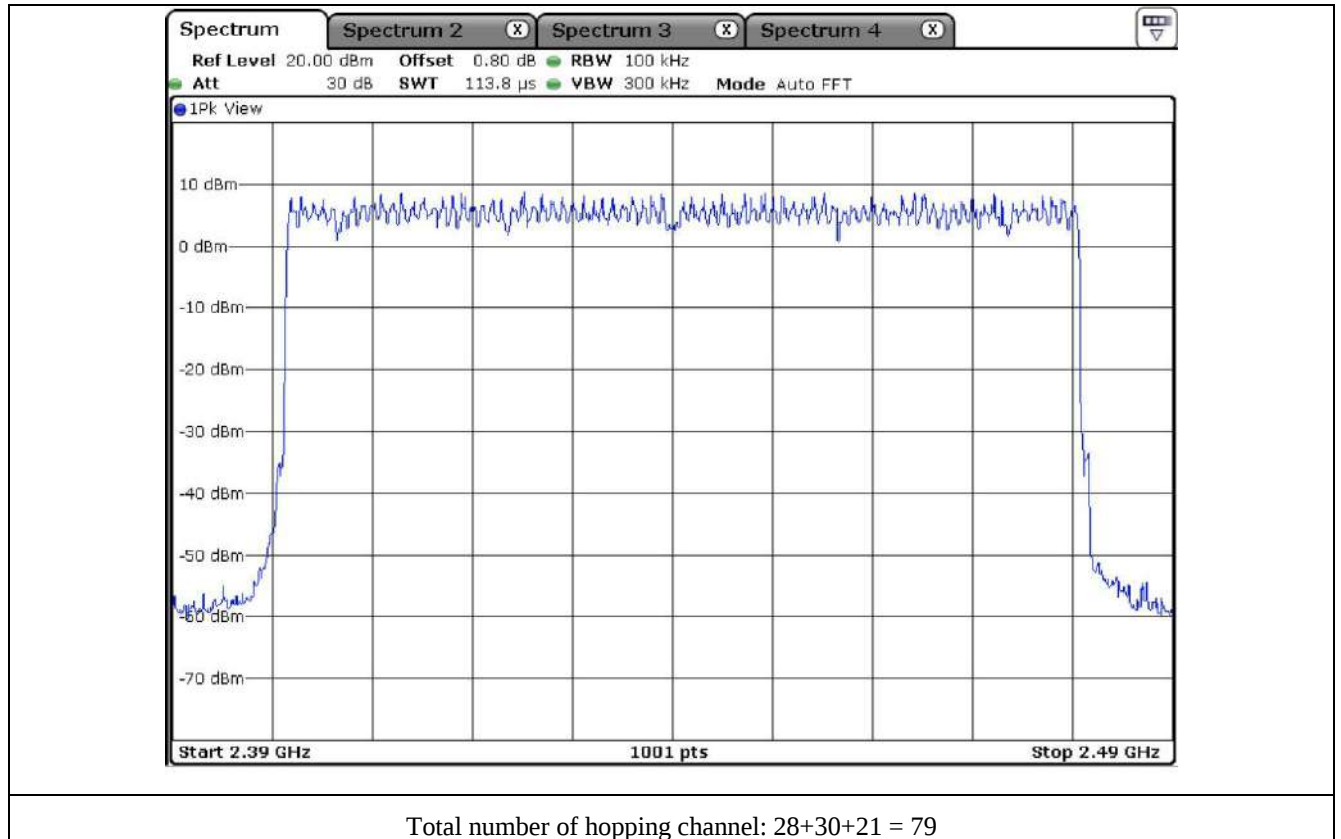
Number of hopping channel: 30

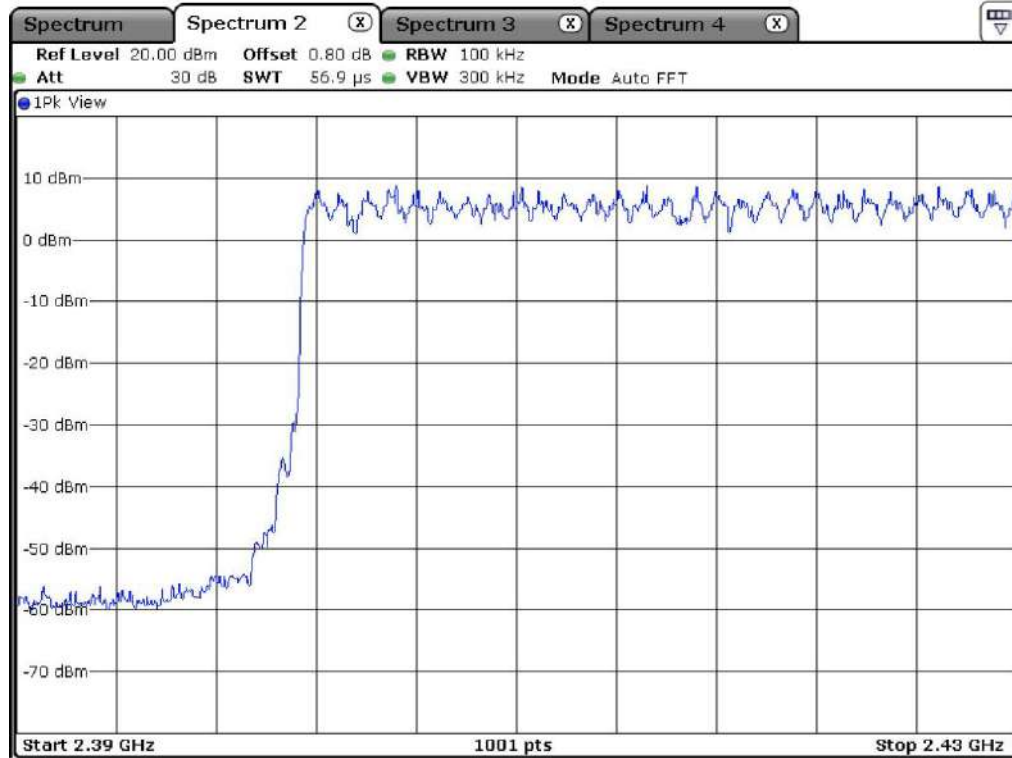


9.5.2 Test data for 2 Mbps

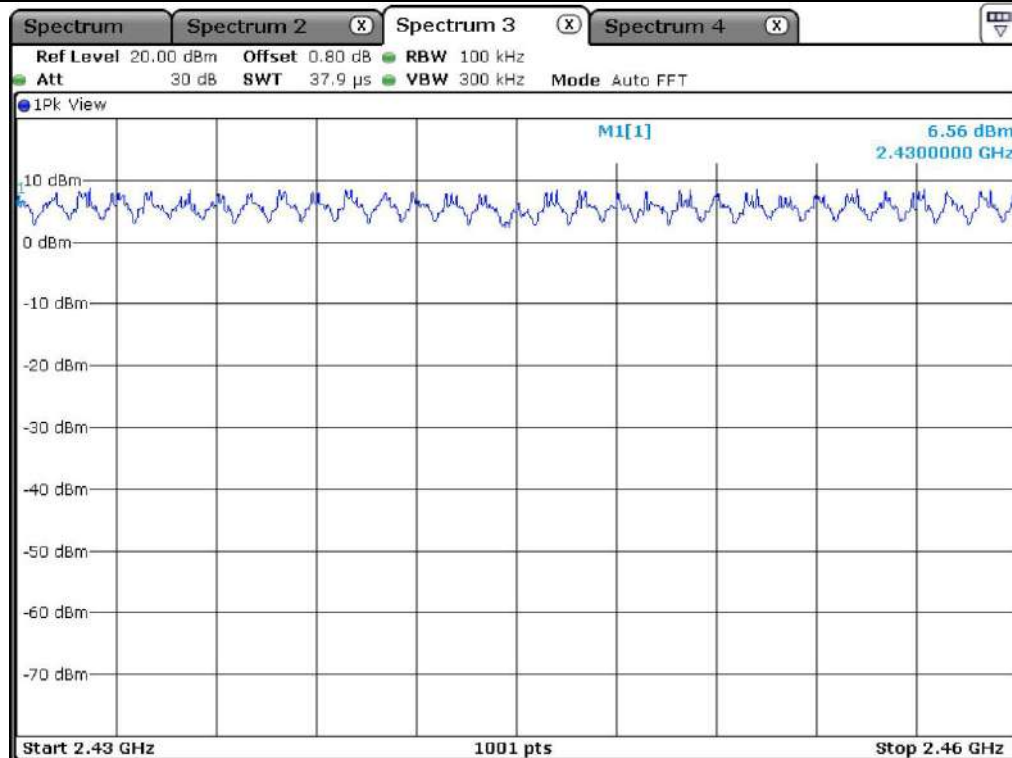
-. Test Result : Pass

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

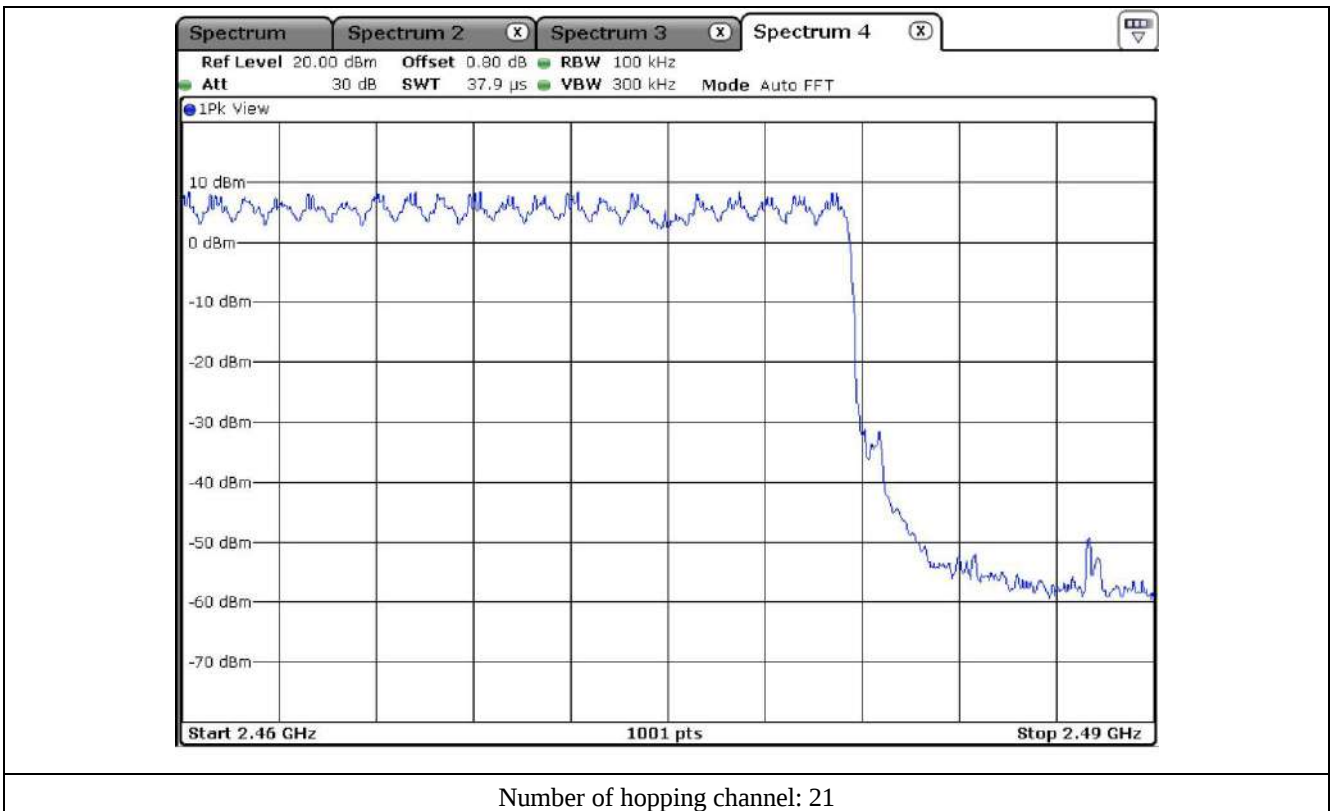




Number of hopping channel: 28



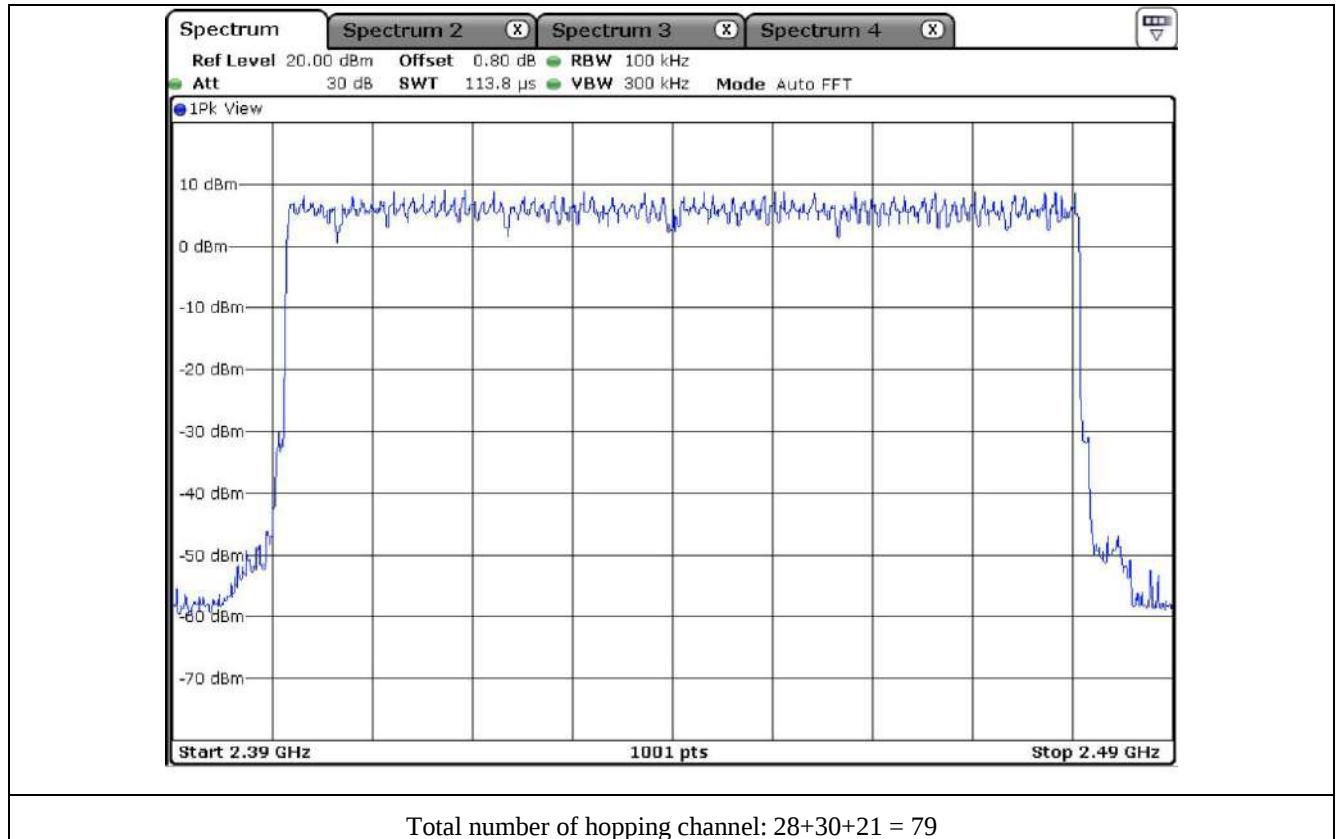
Number of hopping channel: 30

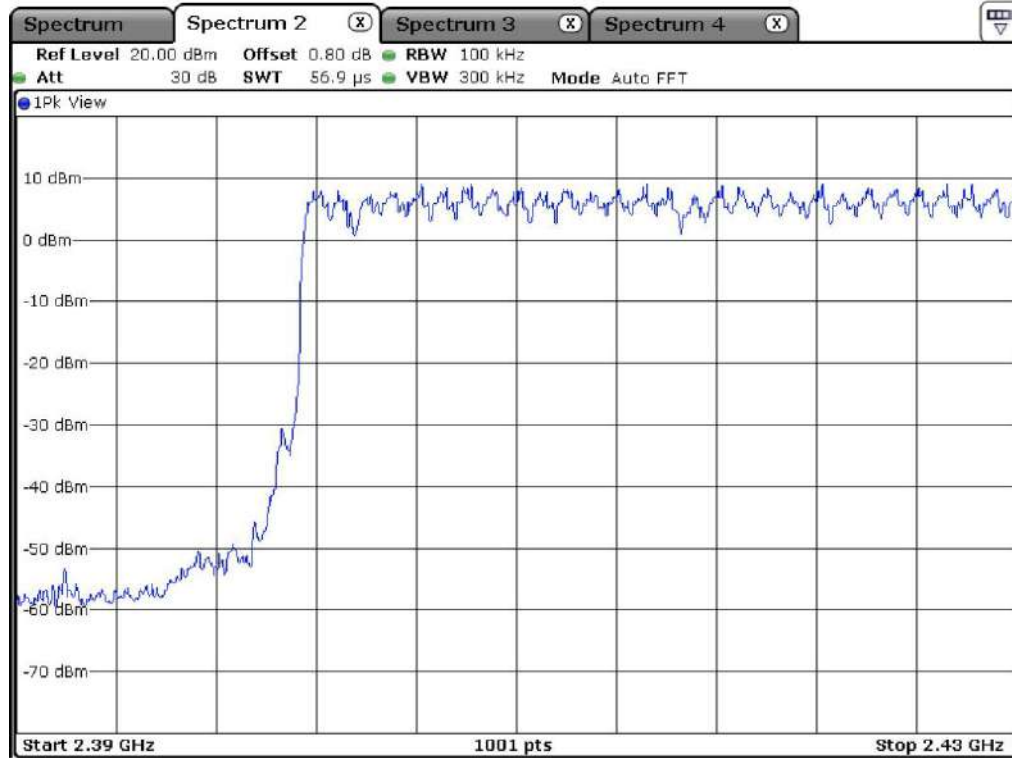


9.5.3 Test data for 3 Mbps

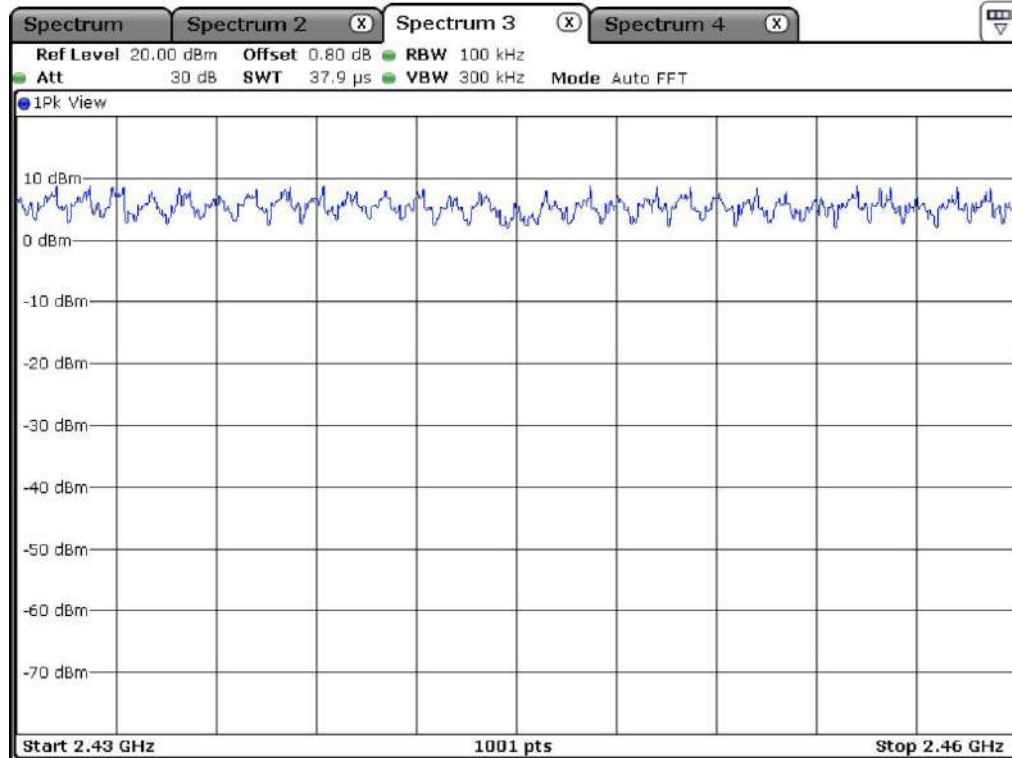
-. Test Result : Pass

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

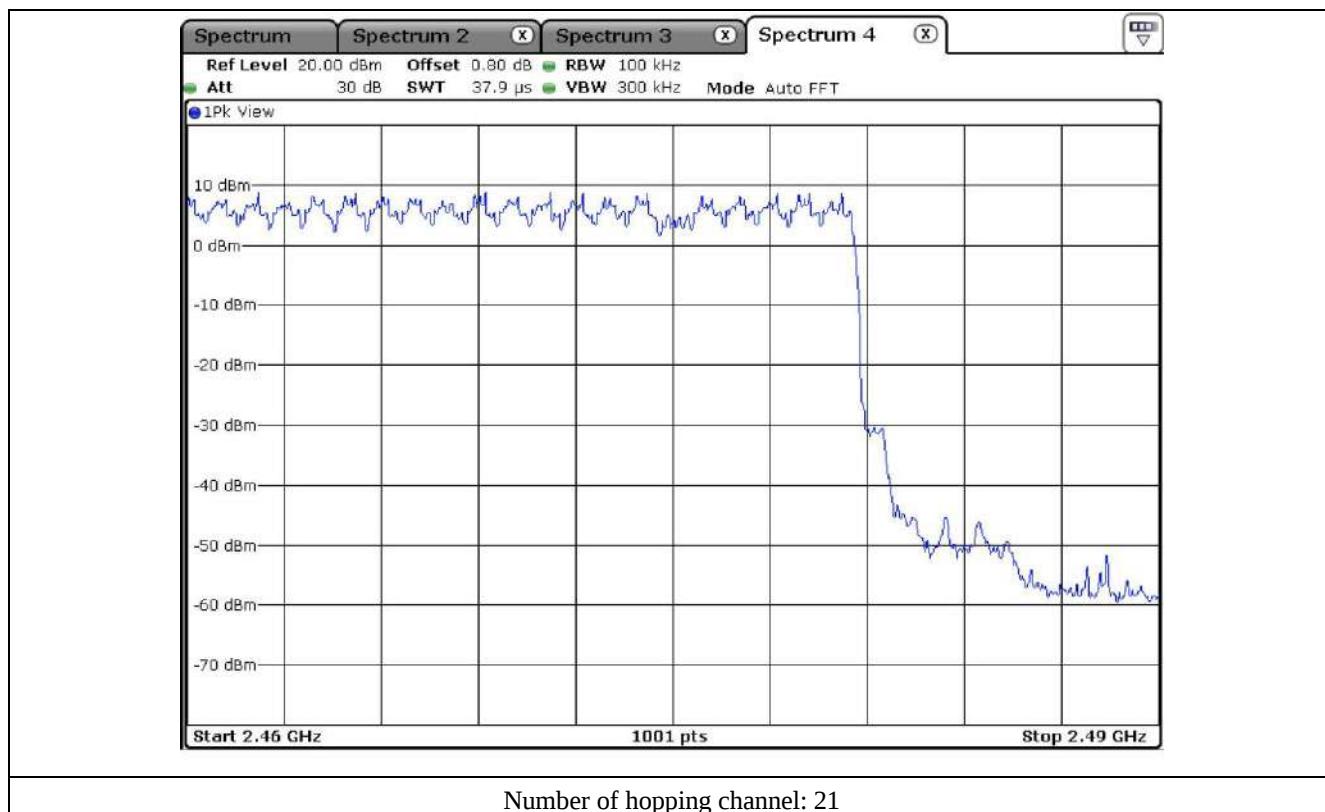




Number of hopping channel: 28



Number of hopping channel: 30



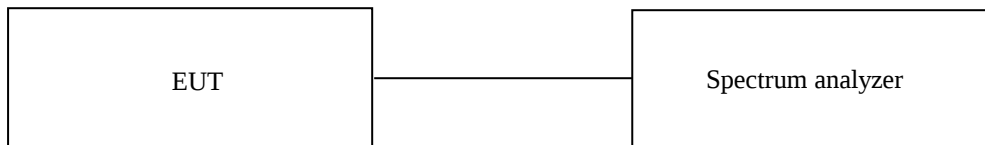
10. TIME OF OCCUPANCY

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.

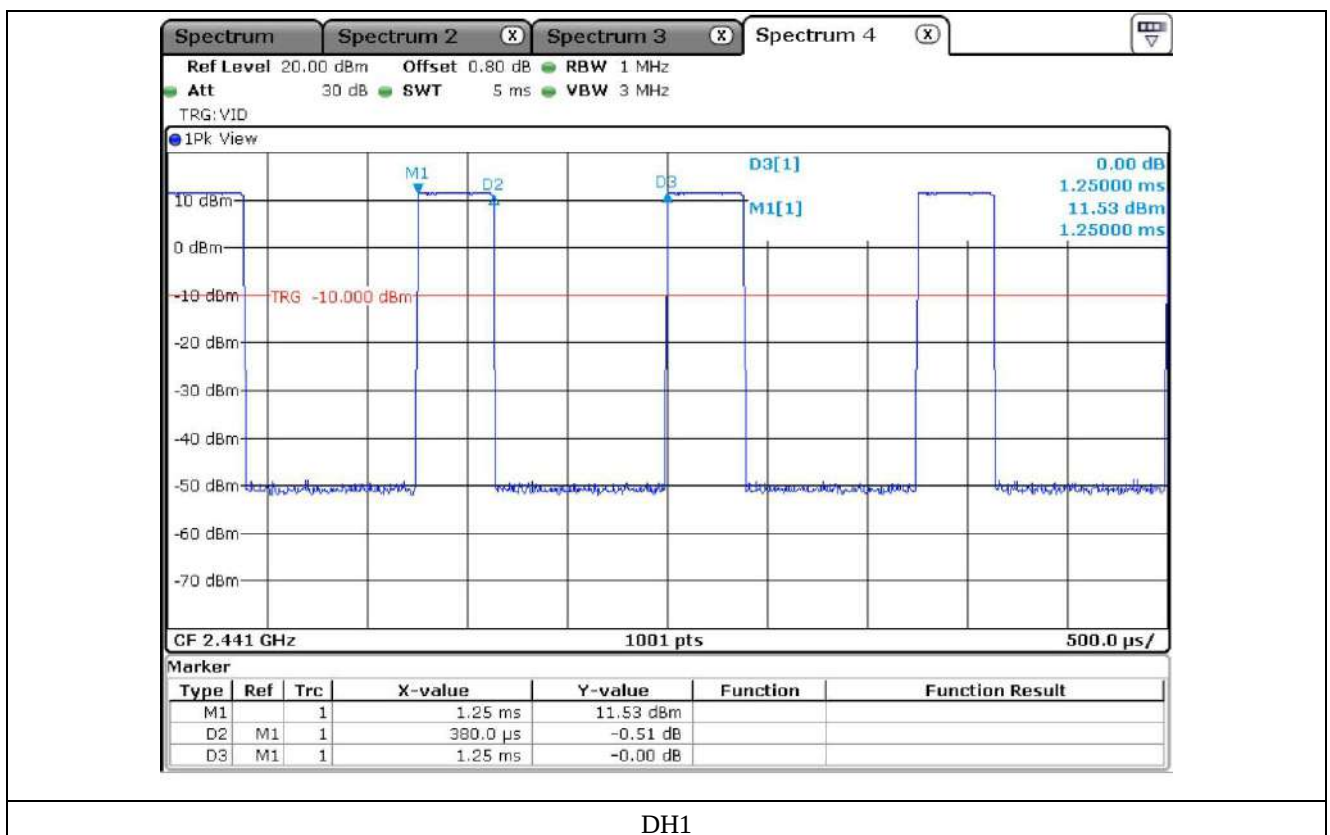
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

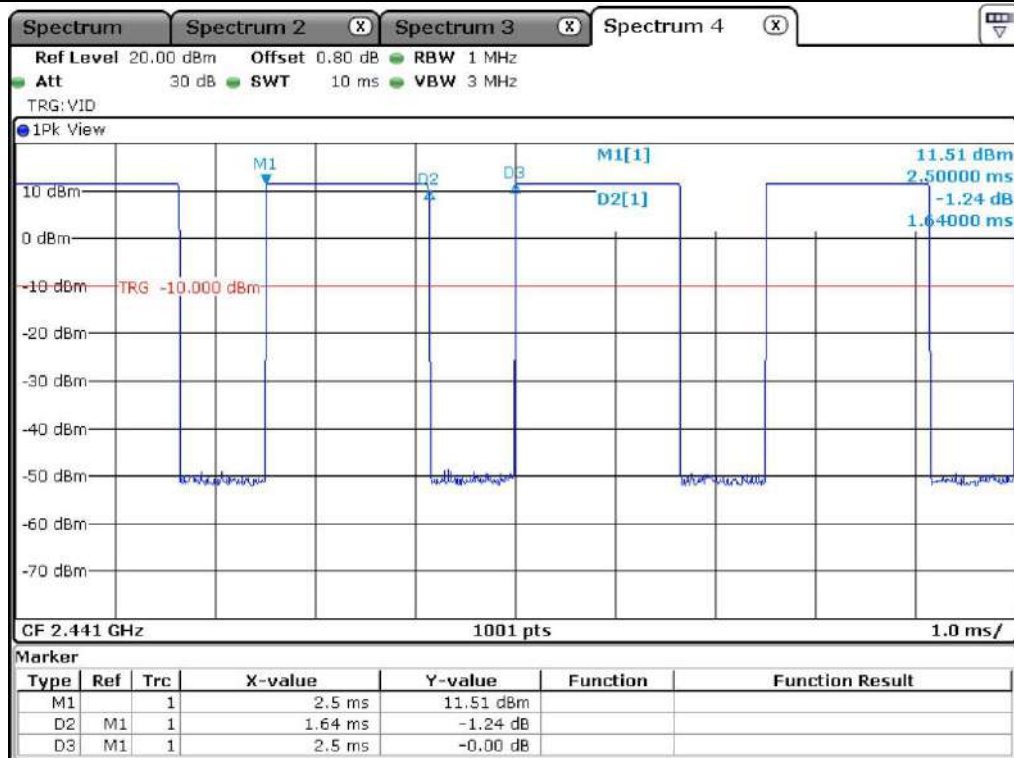
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

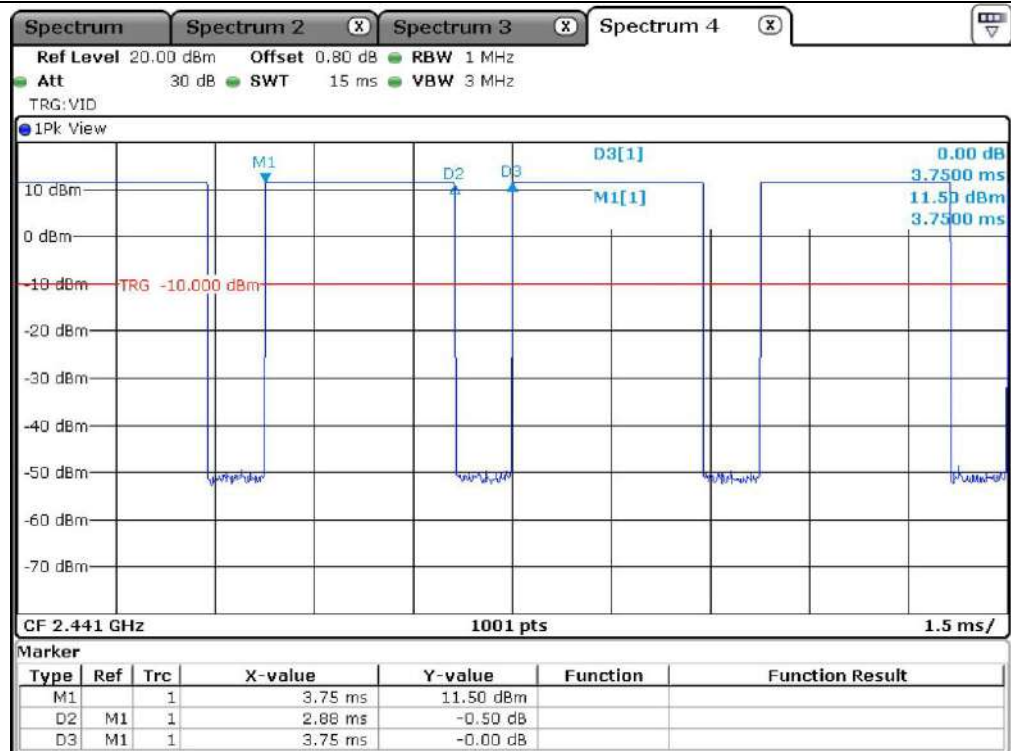
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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.

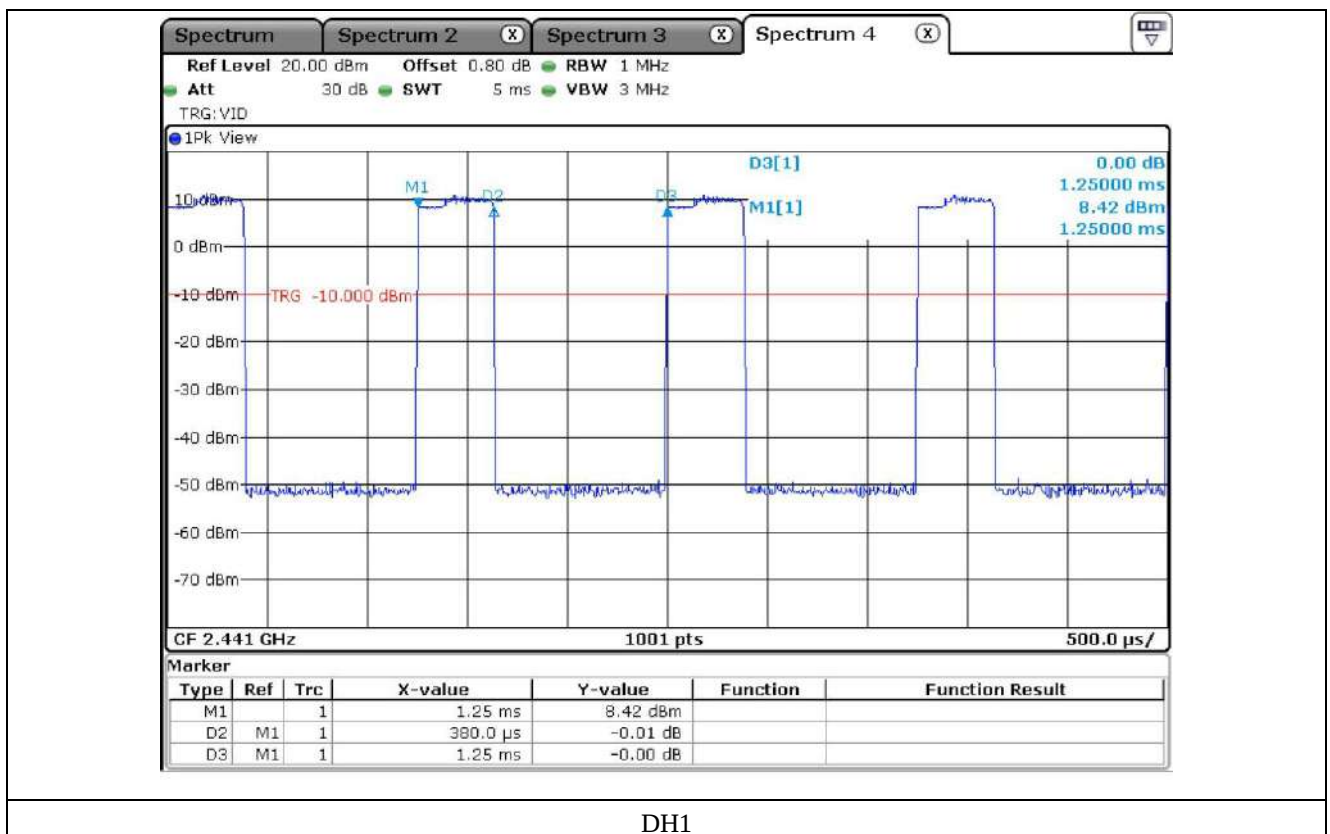
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

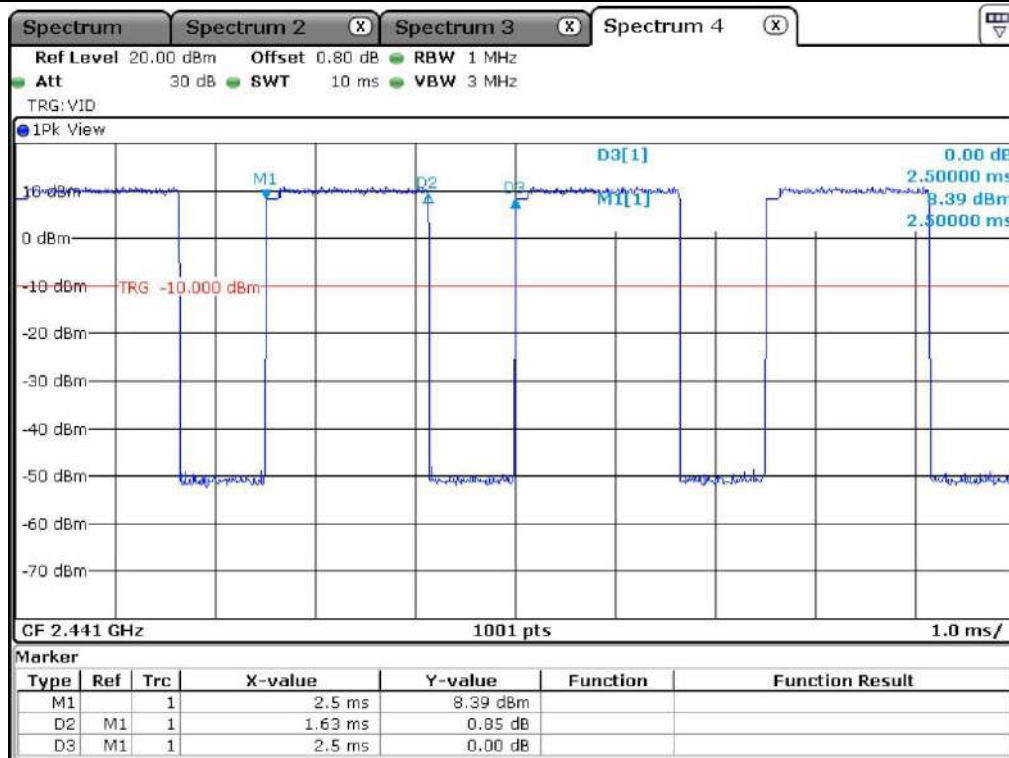
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.63	5.06	31.60	260.63	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

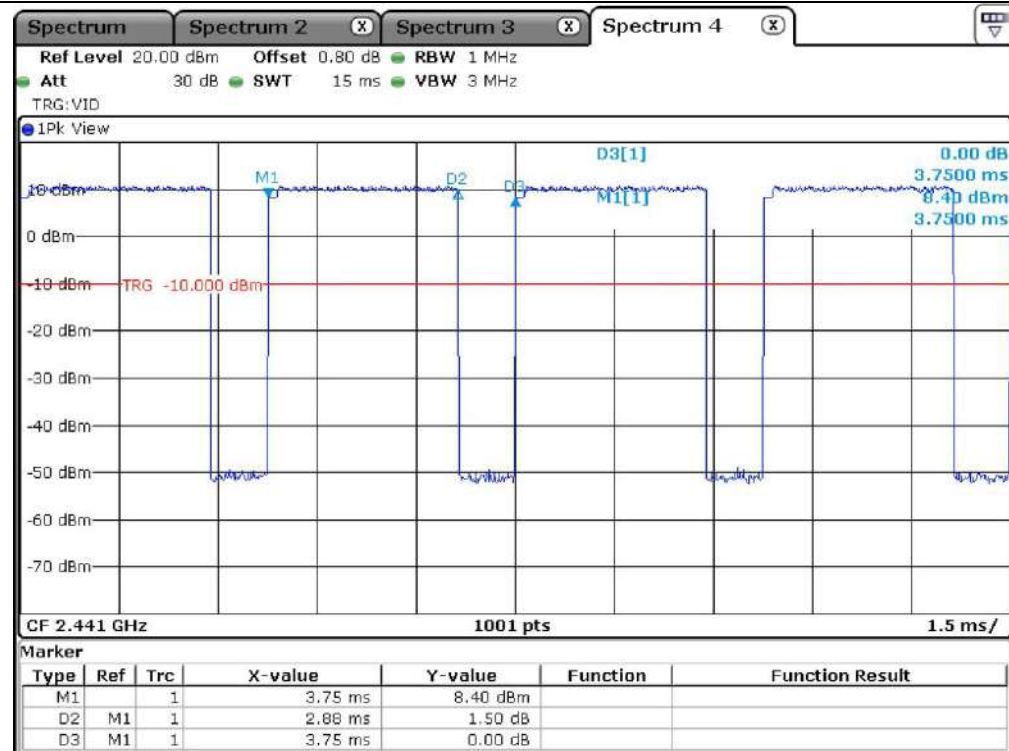
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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 μ s with 79 channels.

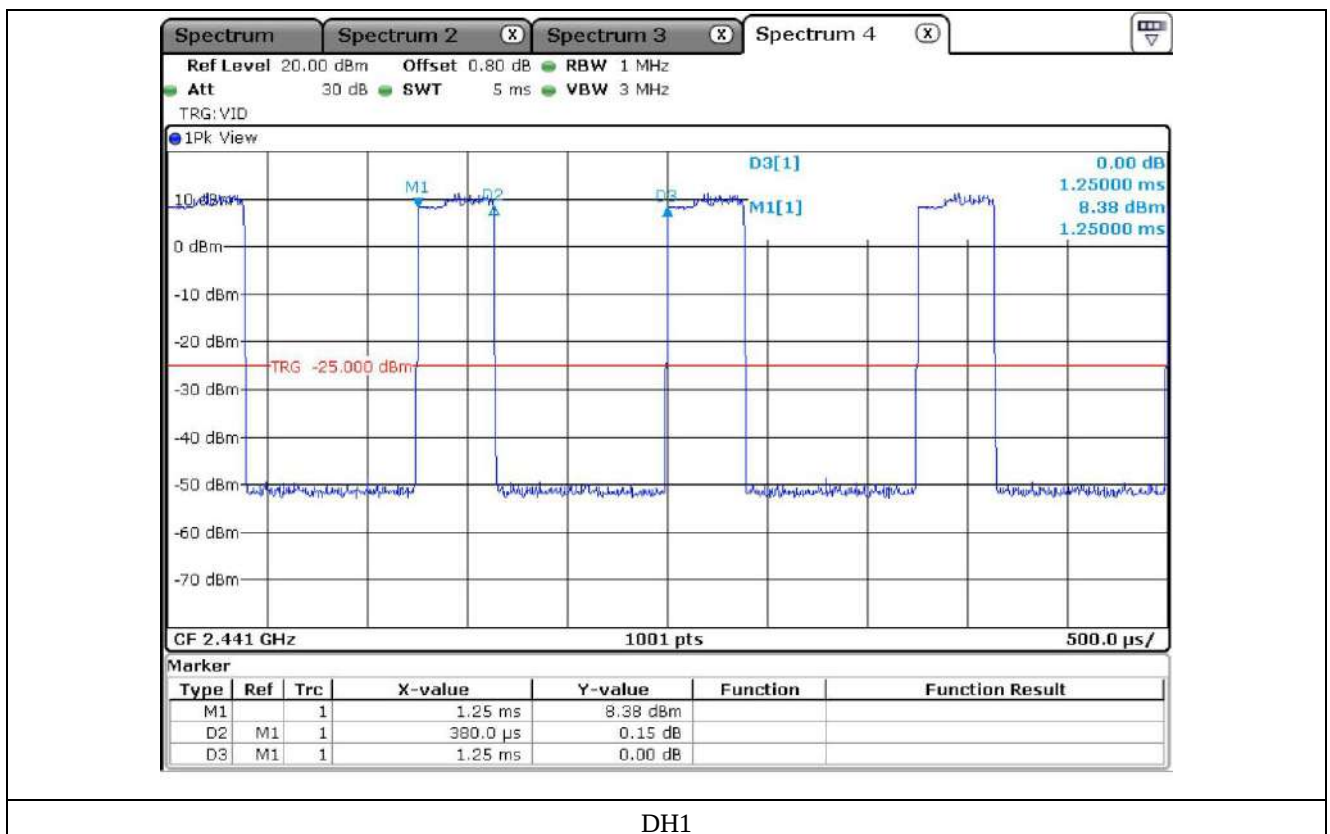
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

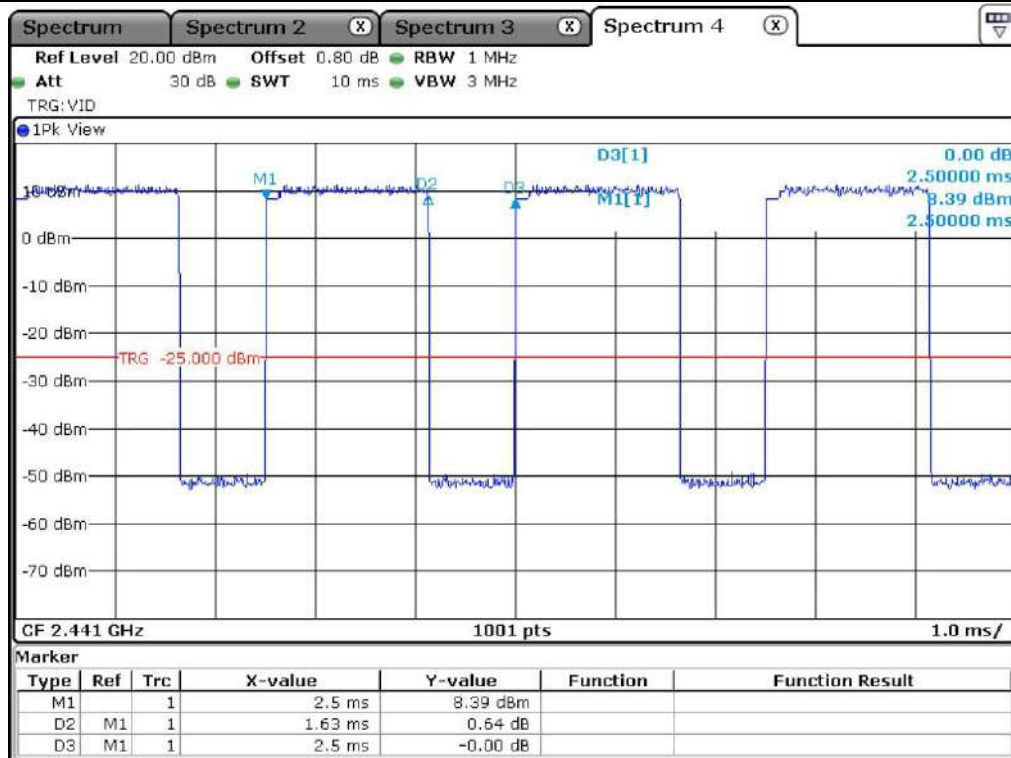
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.63	5.06	31.60	260.63	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

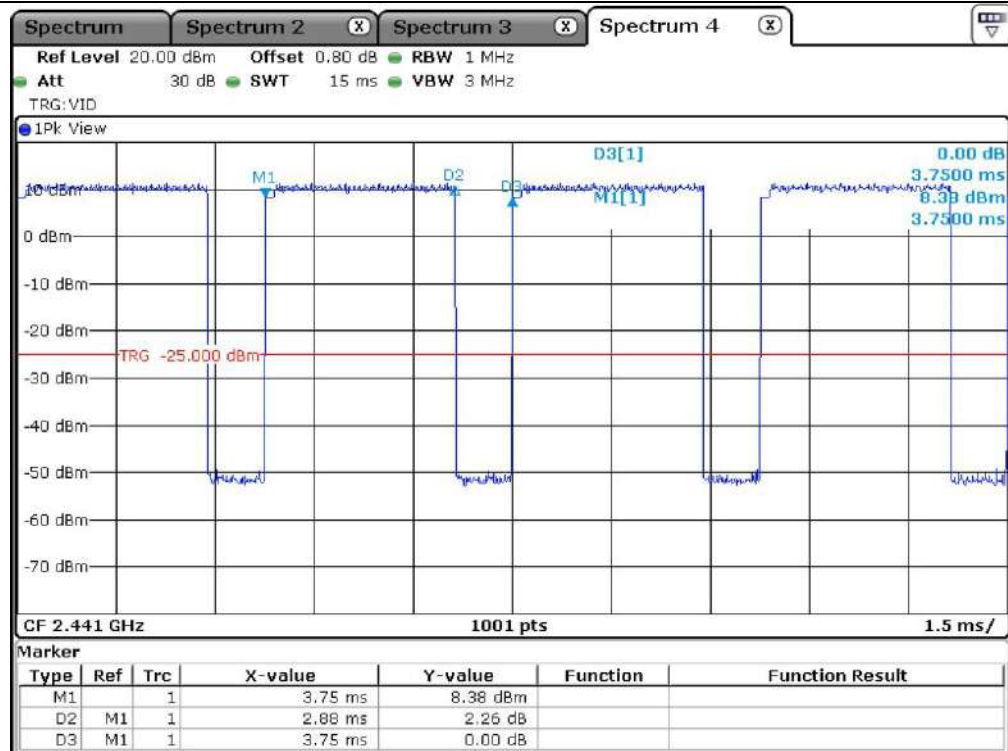
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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 μ s with 79 channels.

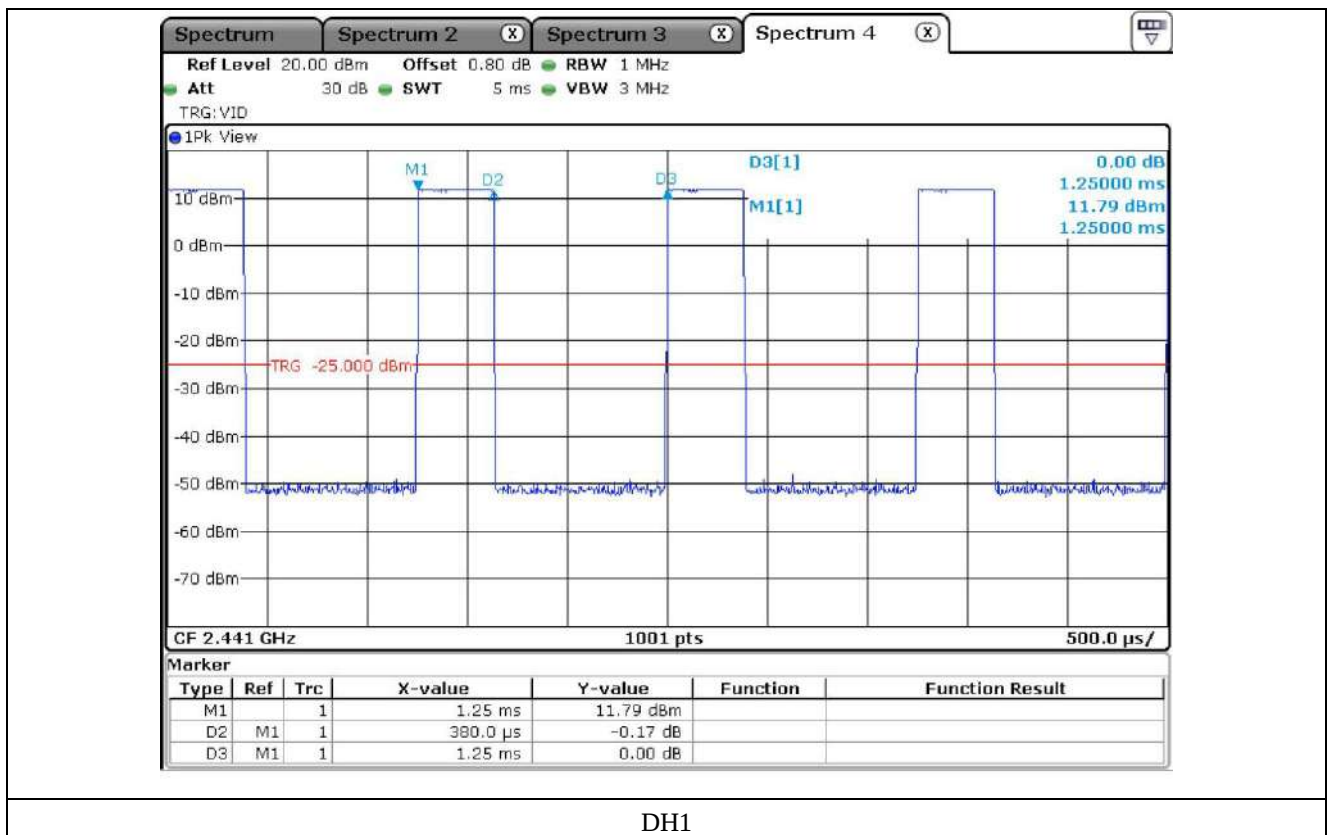
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

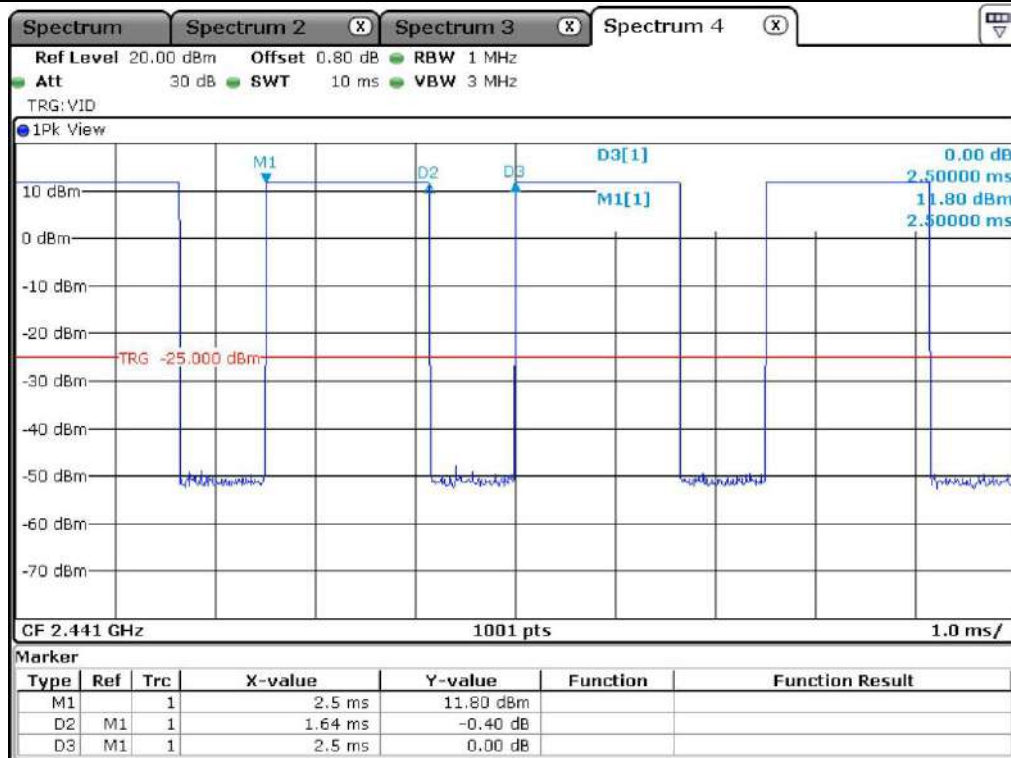
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

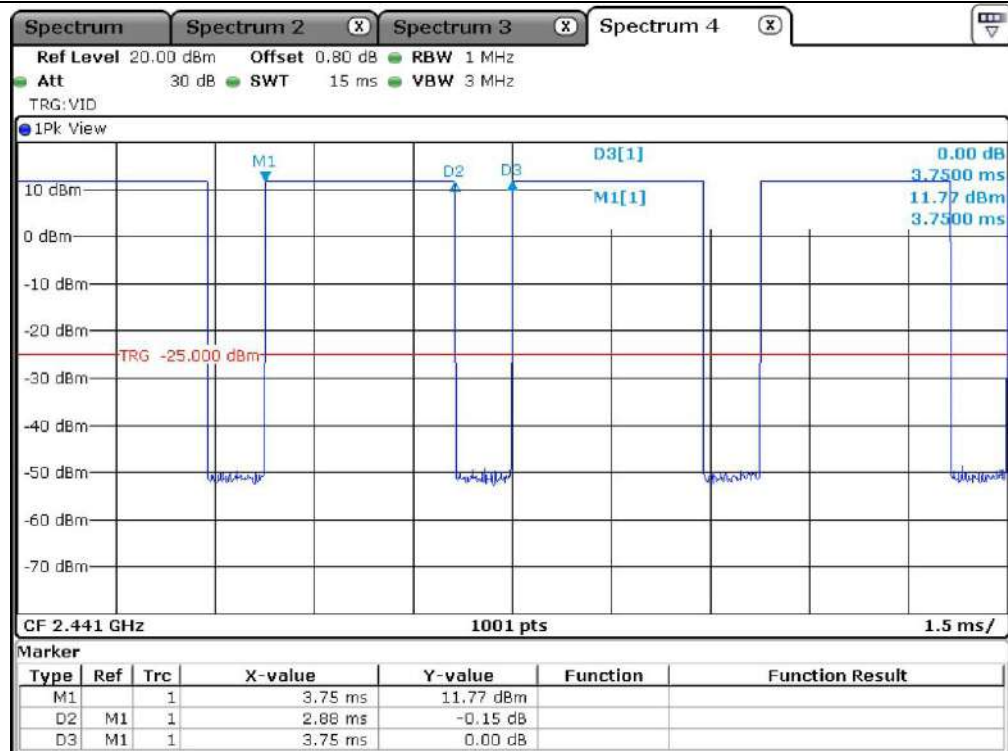
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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 μ s with 79 channels.

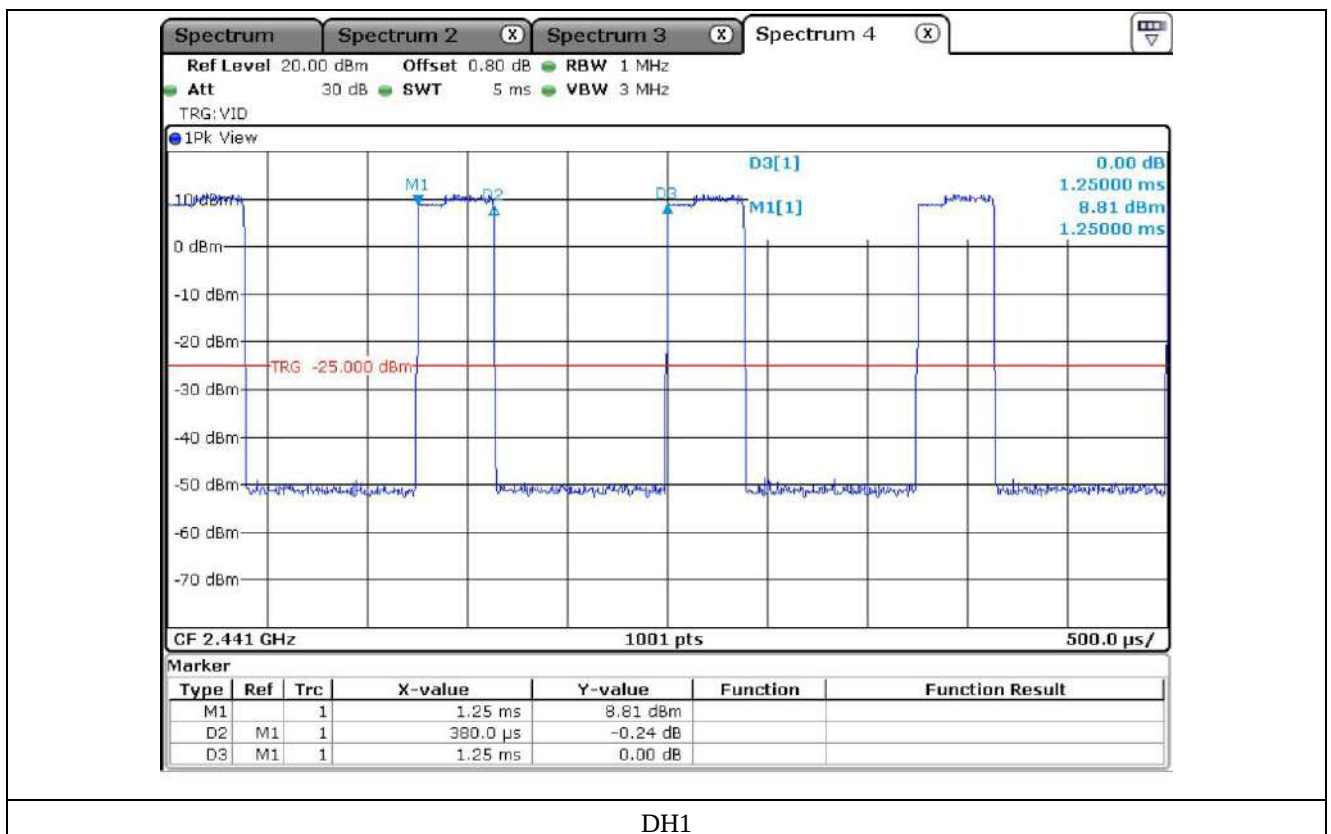
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

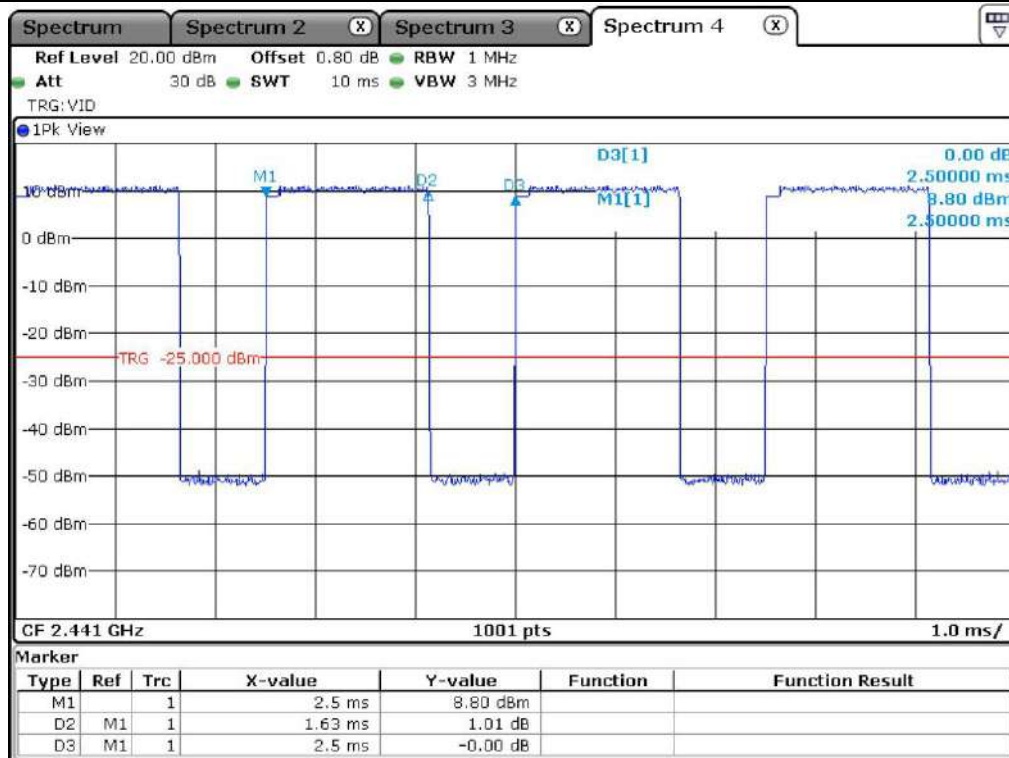
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.63	5.06	31.60	260.63	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

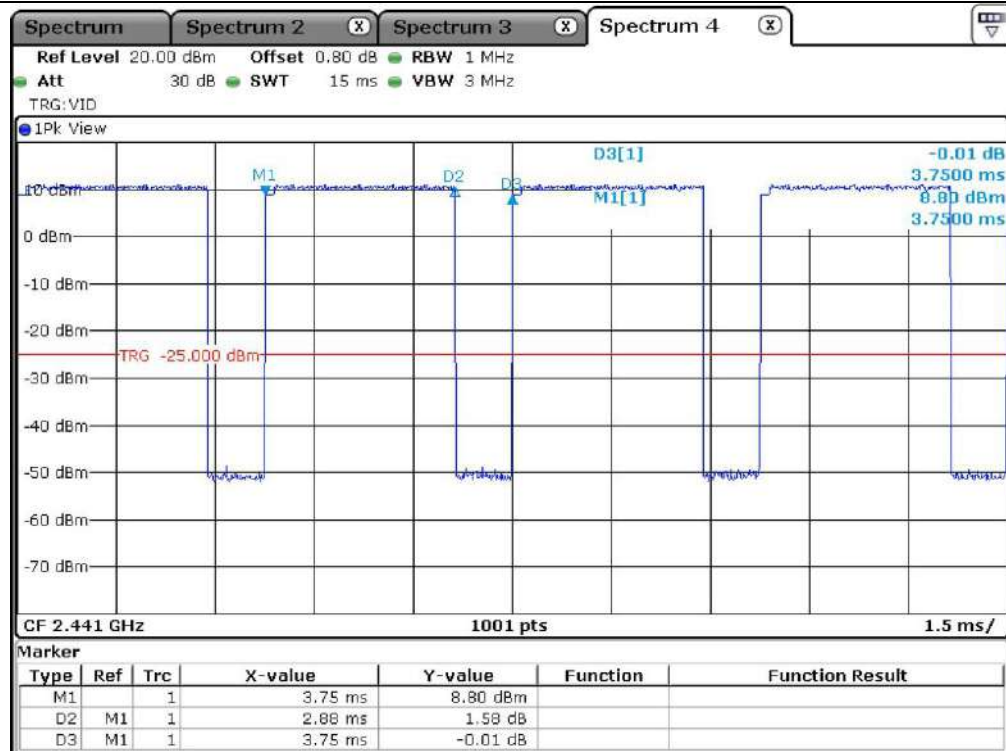
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

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 μ s with 79 channels.

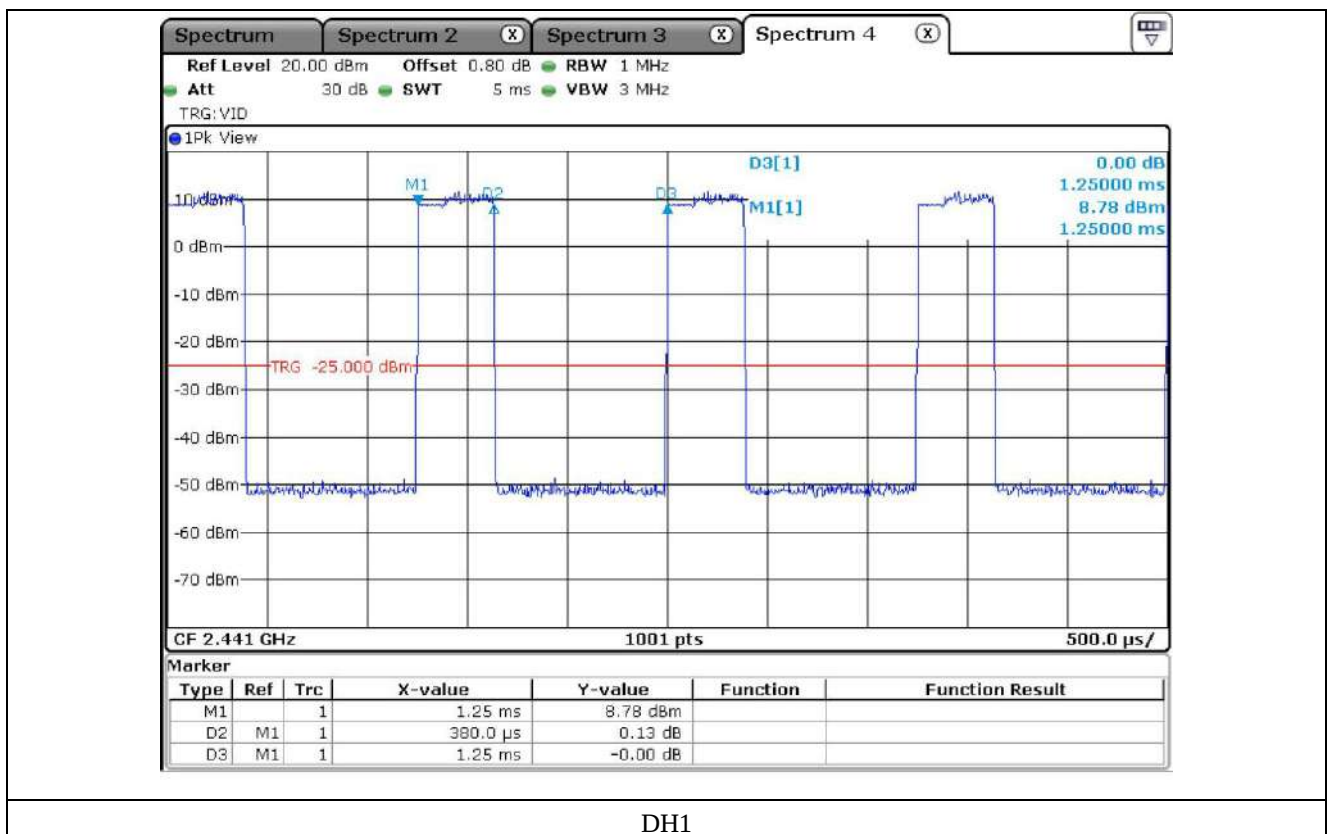
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

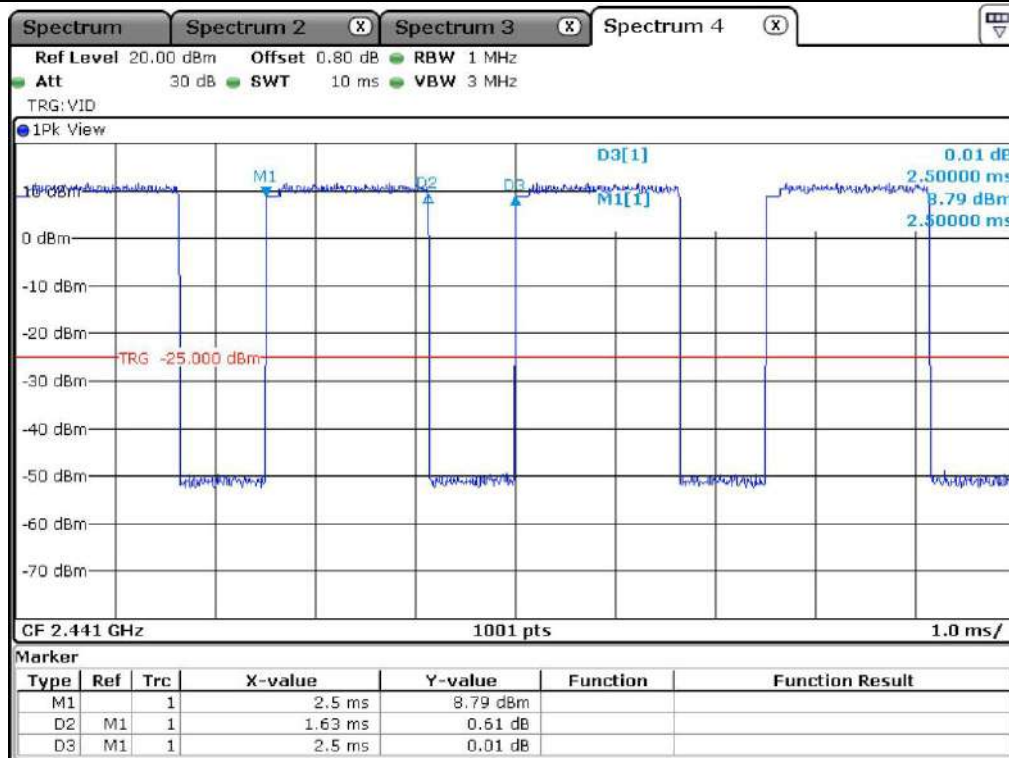
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.63	5.06	31.60	260.63	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

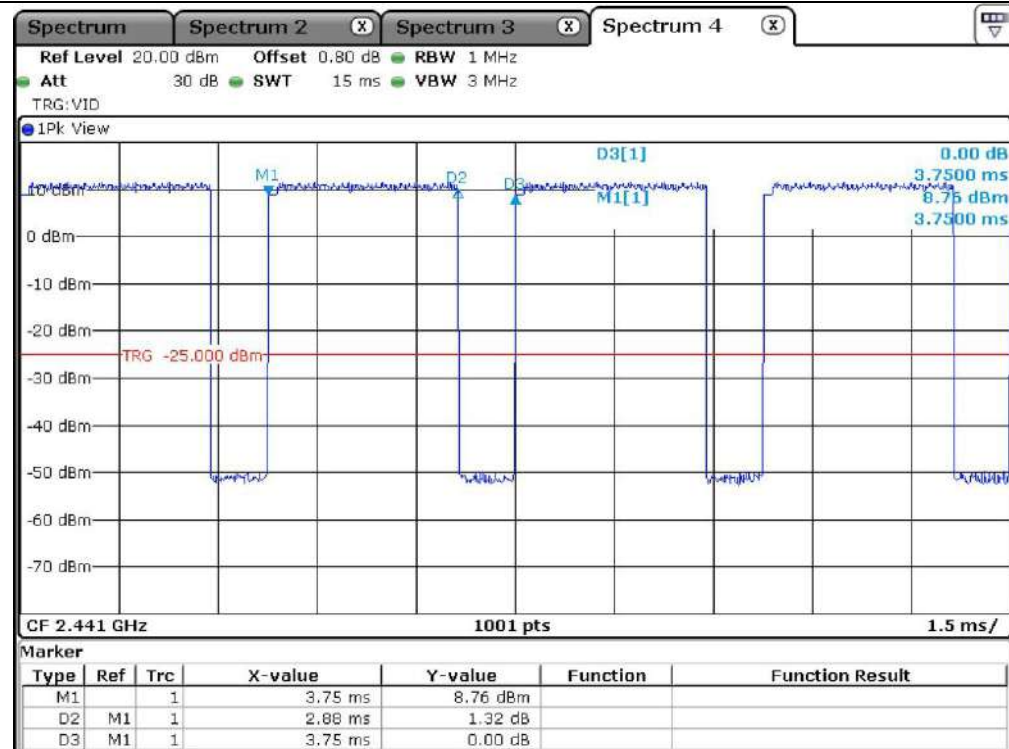
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

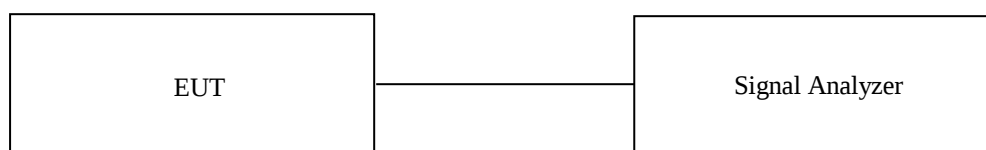
Temperature : 22 °C

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.



11.3 Test Date

May 17, 2021 ~ May 31, 2021

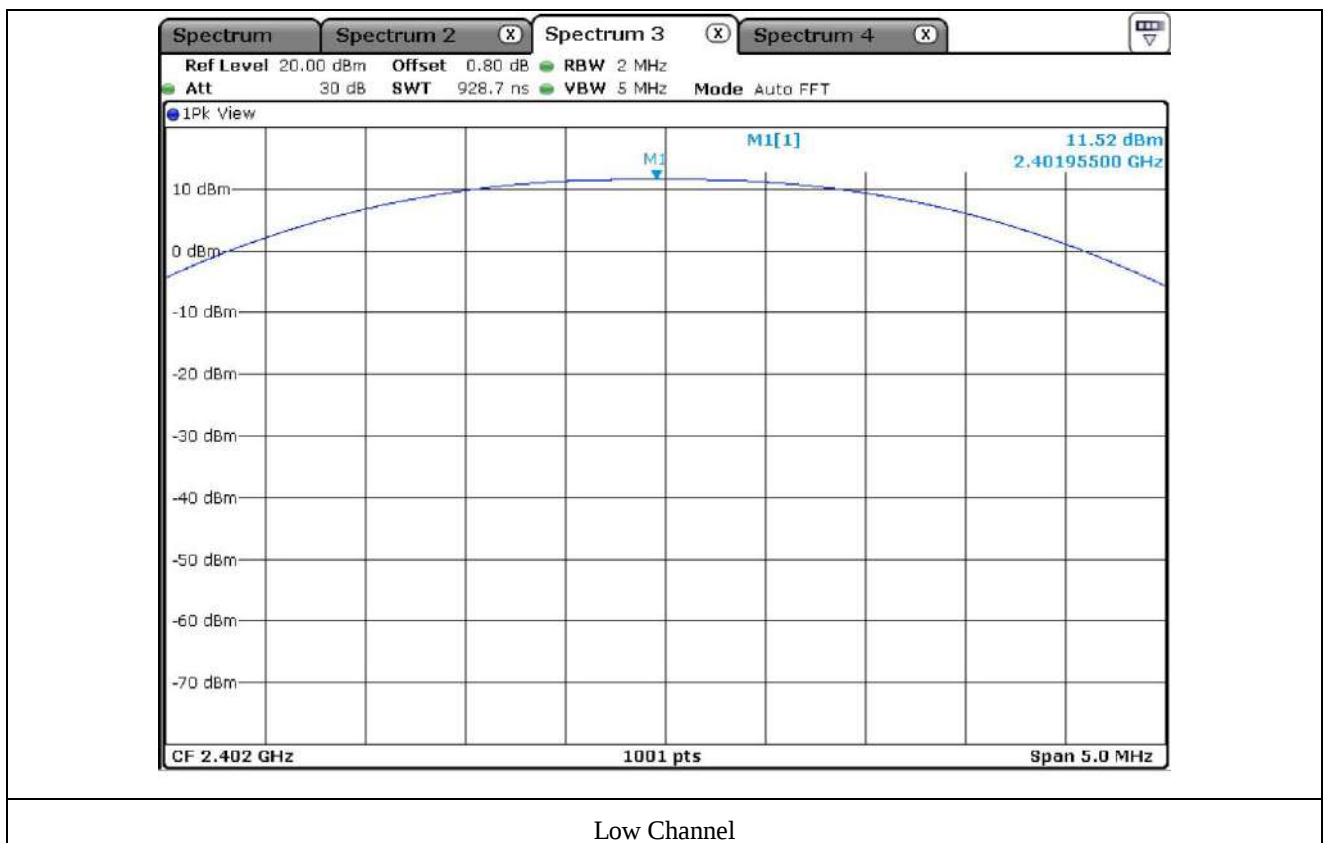
11.4 Test data for Left Earbud

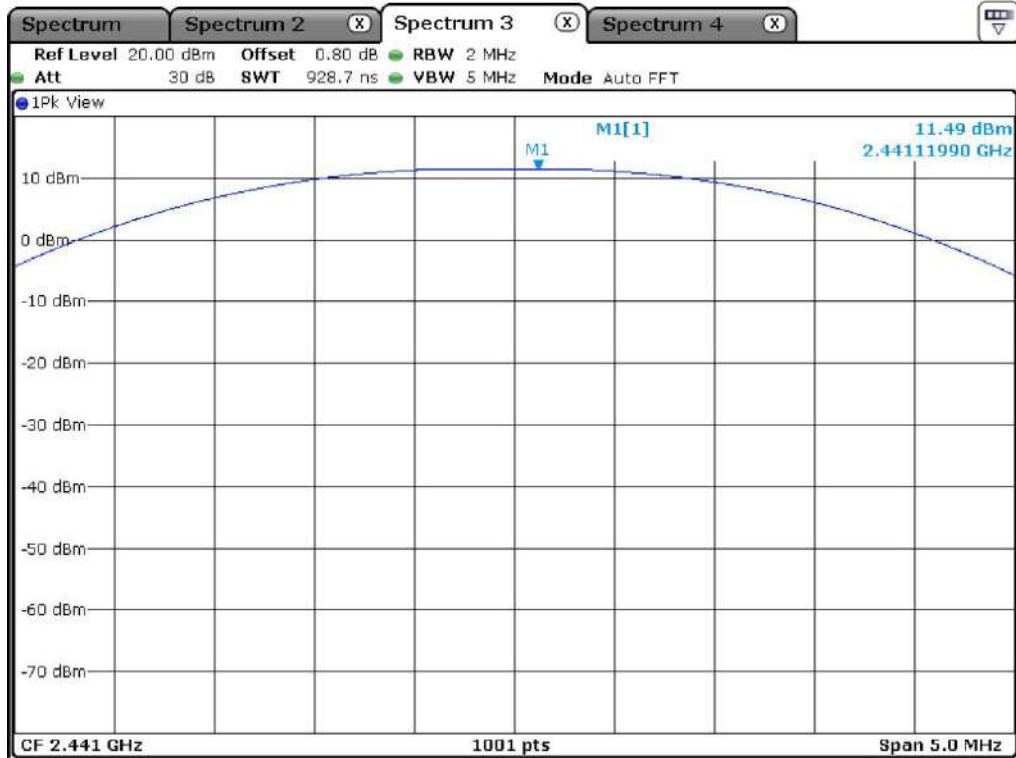
11.4.1 Test data for 1 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.52	21.00	9.48
MIDDLE	2 441.00	11.49	21.00	9.51
HIGH	2 480.00	11.29	21.00	9.71

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





Middle Channel



High Channel

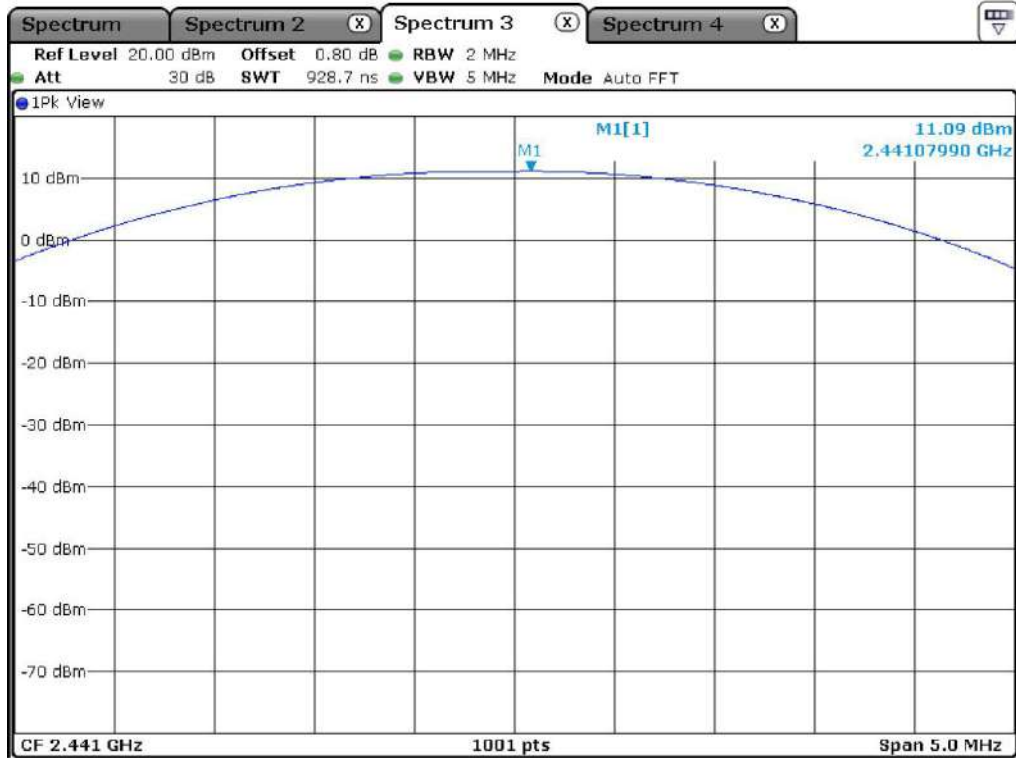
11.4.2 Test data for 2 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.26	21.00	9.74
MIDDLE	2 441.00	11.09	21.00	9.91
HIGH	2 480.00	10.77	21.00	10.23

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





Middle Channel



High Channel

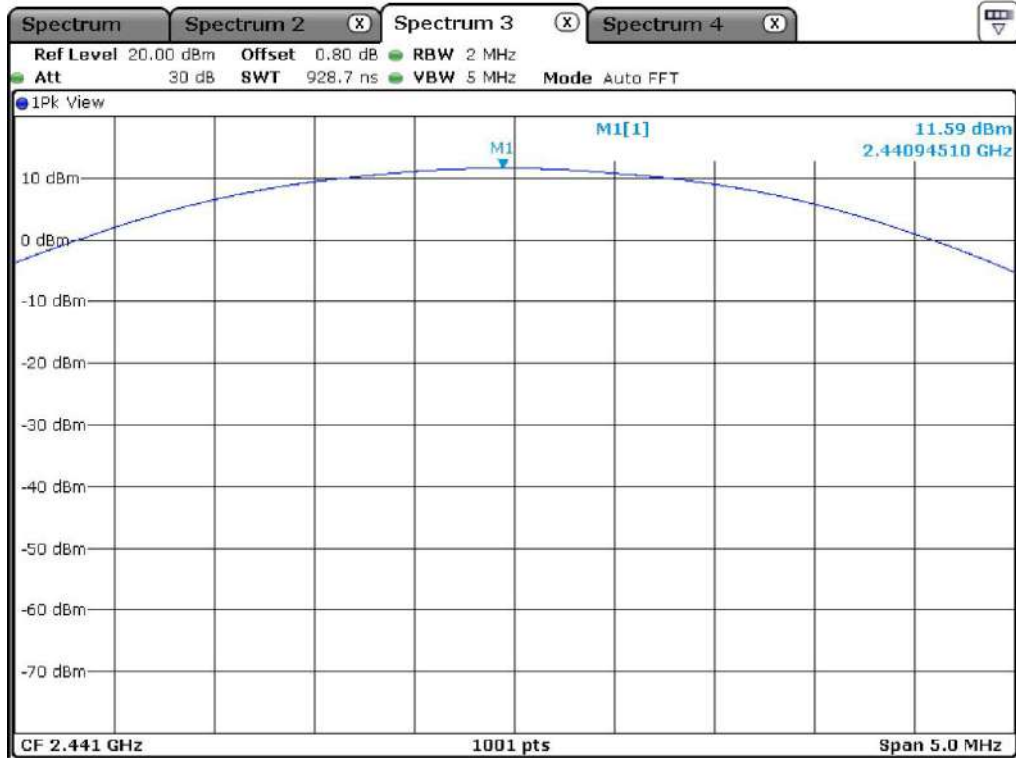
11.4.3 Test data for 3 Mbps

-. Test Result : Pass

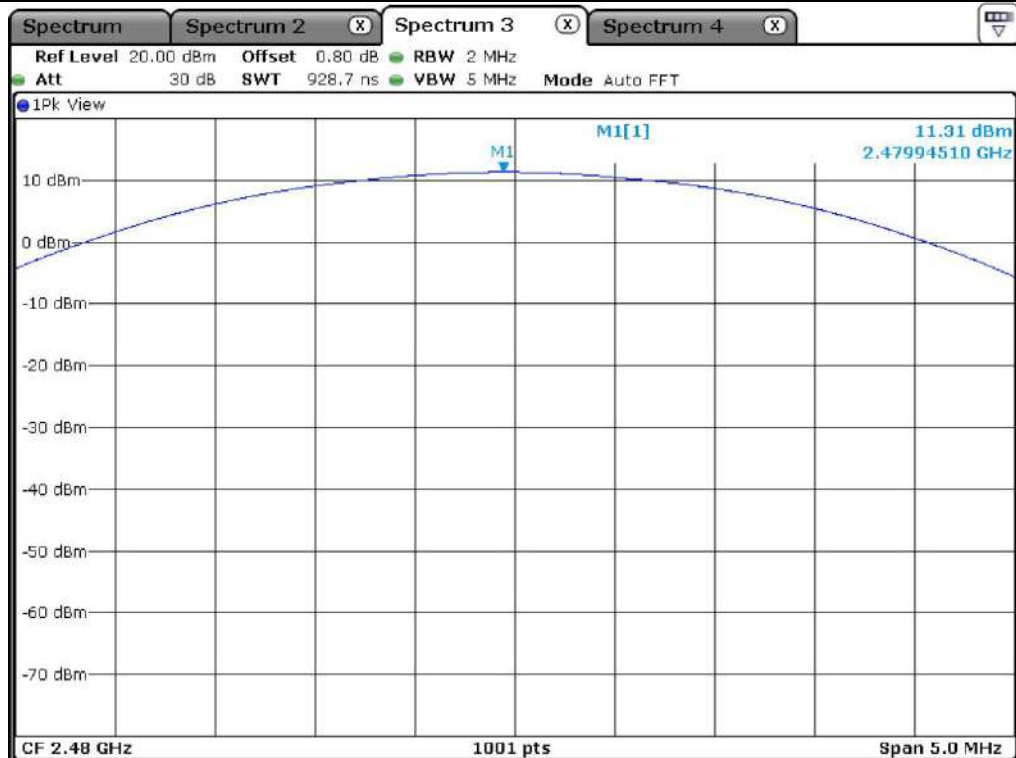
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.87	21.00	9.13
MIDDLE	2 441.00	11.59	21.00	9.41
HIGH	2 480.00	11.31	21.00	9.69

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





Middle Channel



High Channel

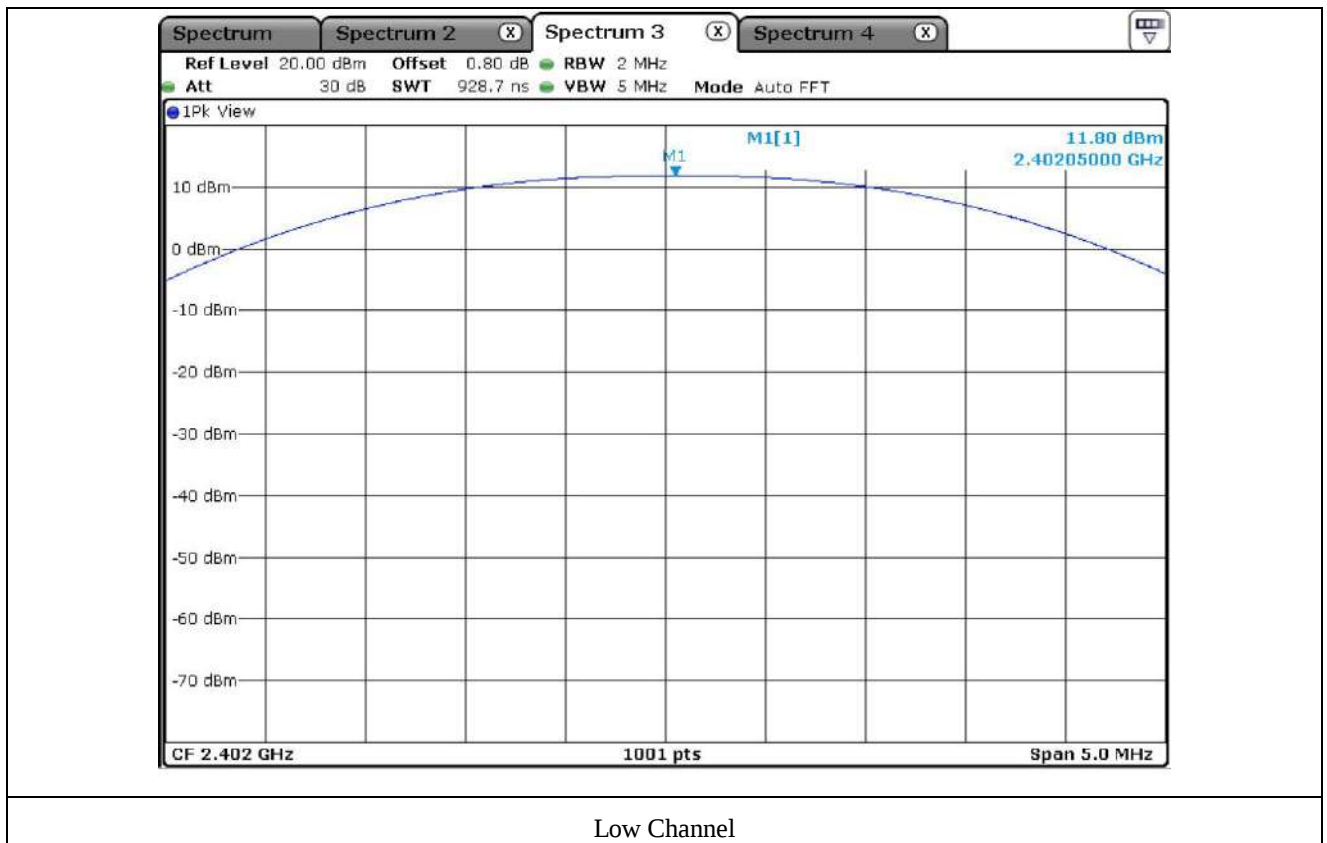
11.5 Test data for Right Earbud

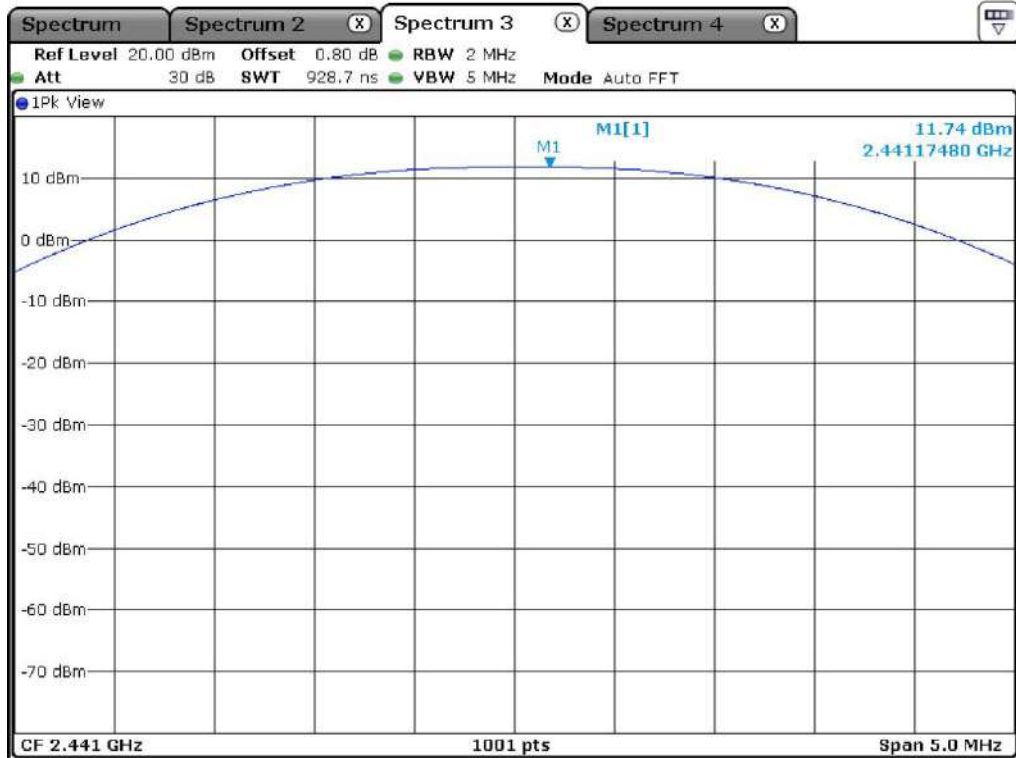
11.5.1 Test data for 1 Mbps

-. Test Result : Pass

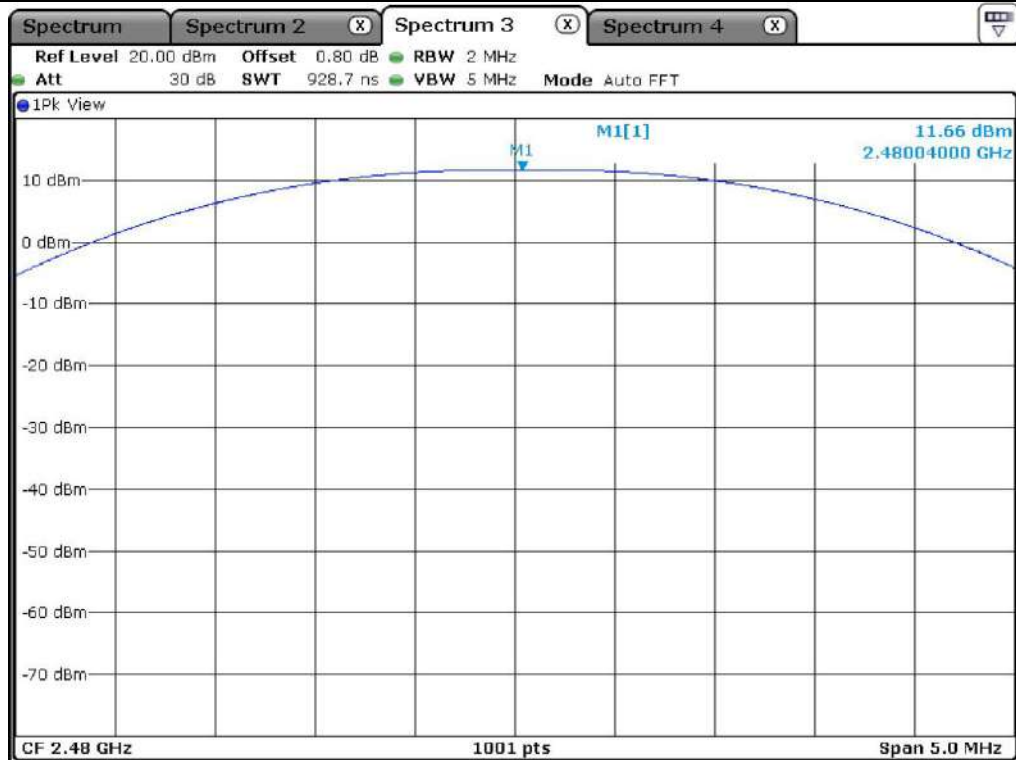
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.80	21.00	9.20
MIDDLE	2 441.00	11.74	21.00	9.26
HIGH	2 480.00	11.66	21.00	9.34

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





Middle Channel



High Channel

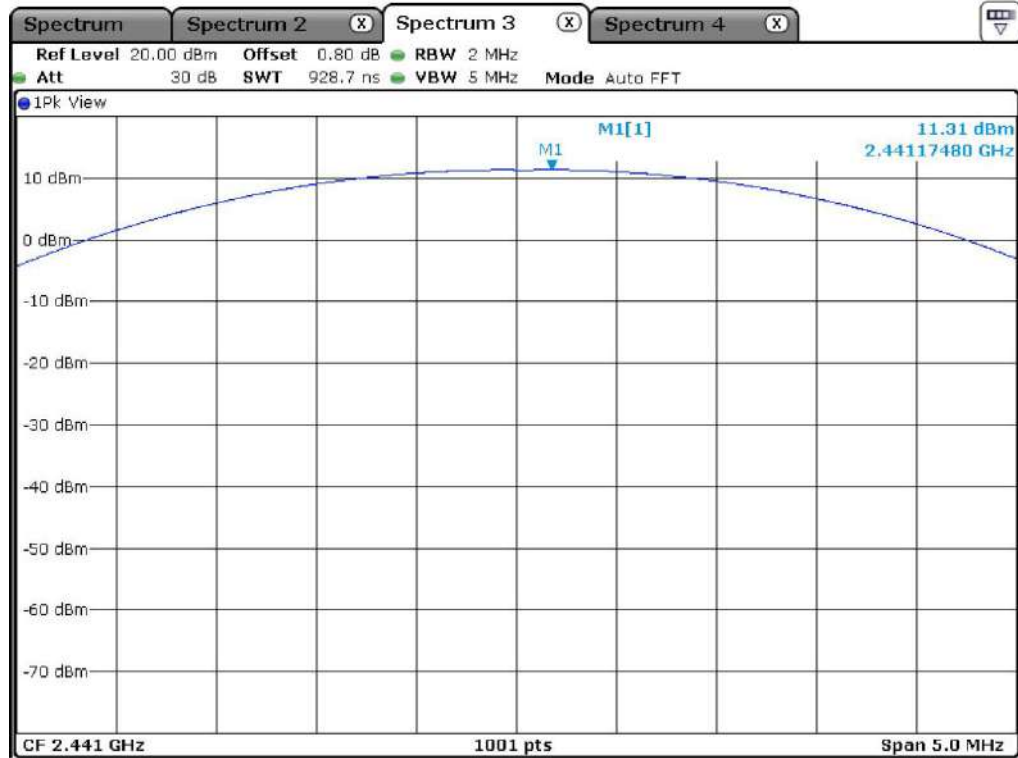
11.5.2 Test data for 2 Mbps

-. 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	11.31	21.00	9.69
HIGH	2 480.00	11.19	21.00	9.81

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





Middle Channel



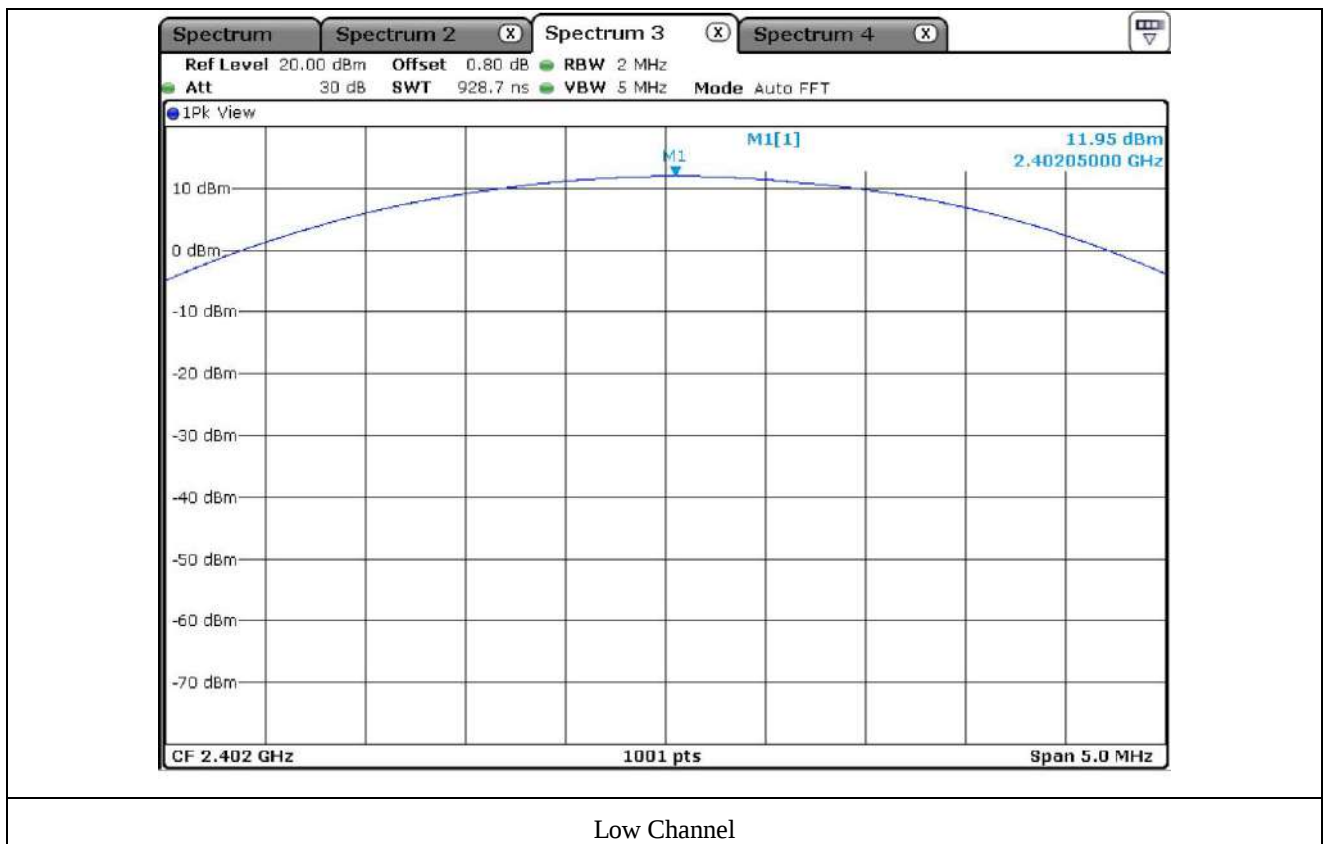
High Channel

11.5.3 Test data for 3 Mbps

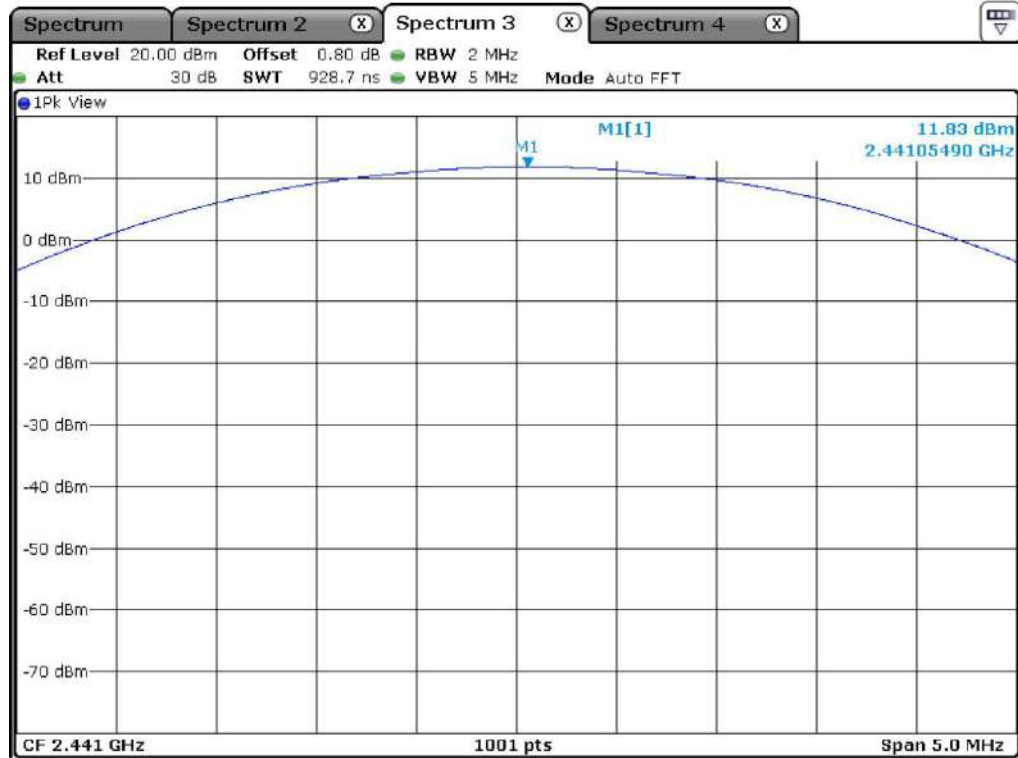
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.95	21.00	9.05
MIDDLE	2 441.00	11.83	21.00	9.17
HIGH	2 480.00	11.77	21.00	9.23

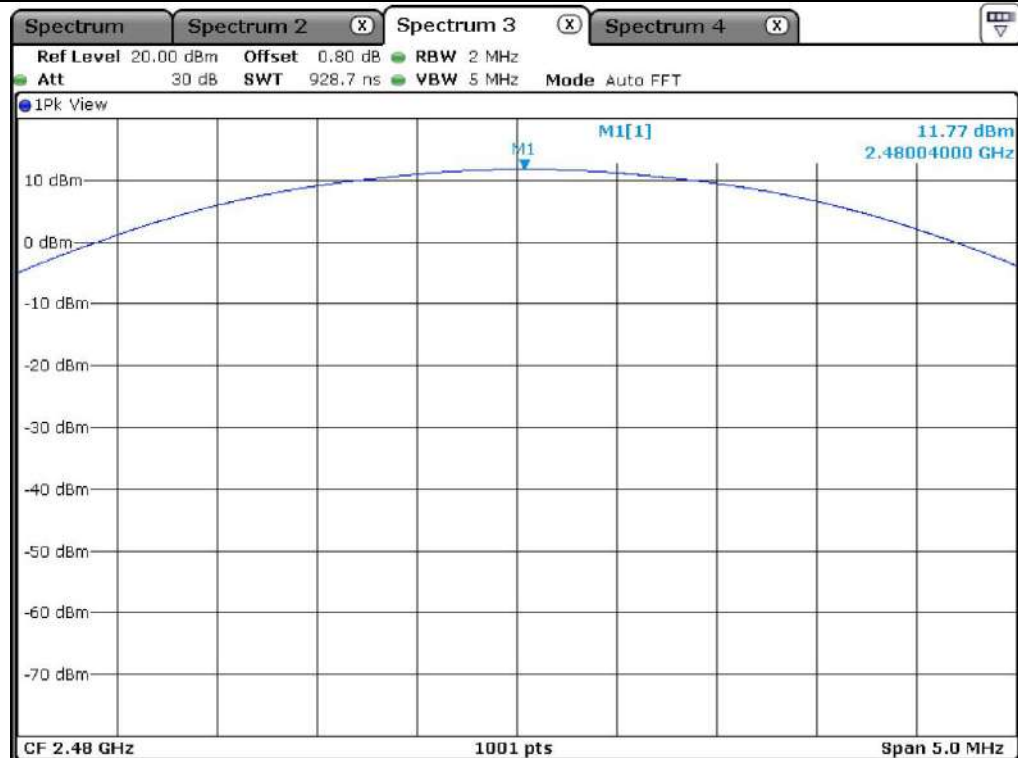
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



Low Channel



Middle Channel



High Channel

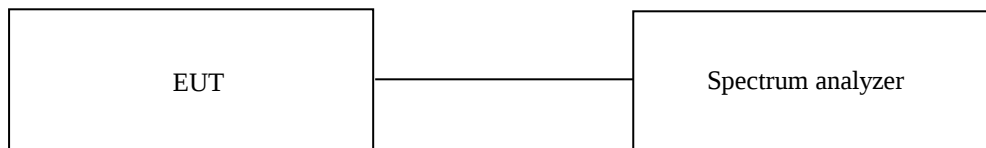
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 22 °C
Relative humidity : 46 % R.H.

12.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 kHz, and peak detection was used.



12.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

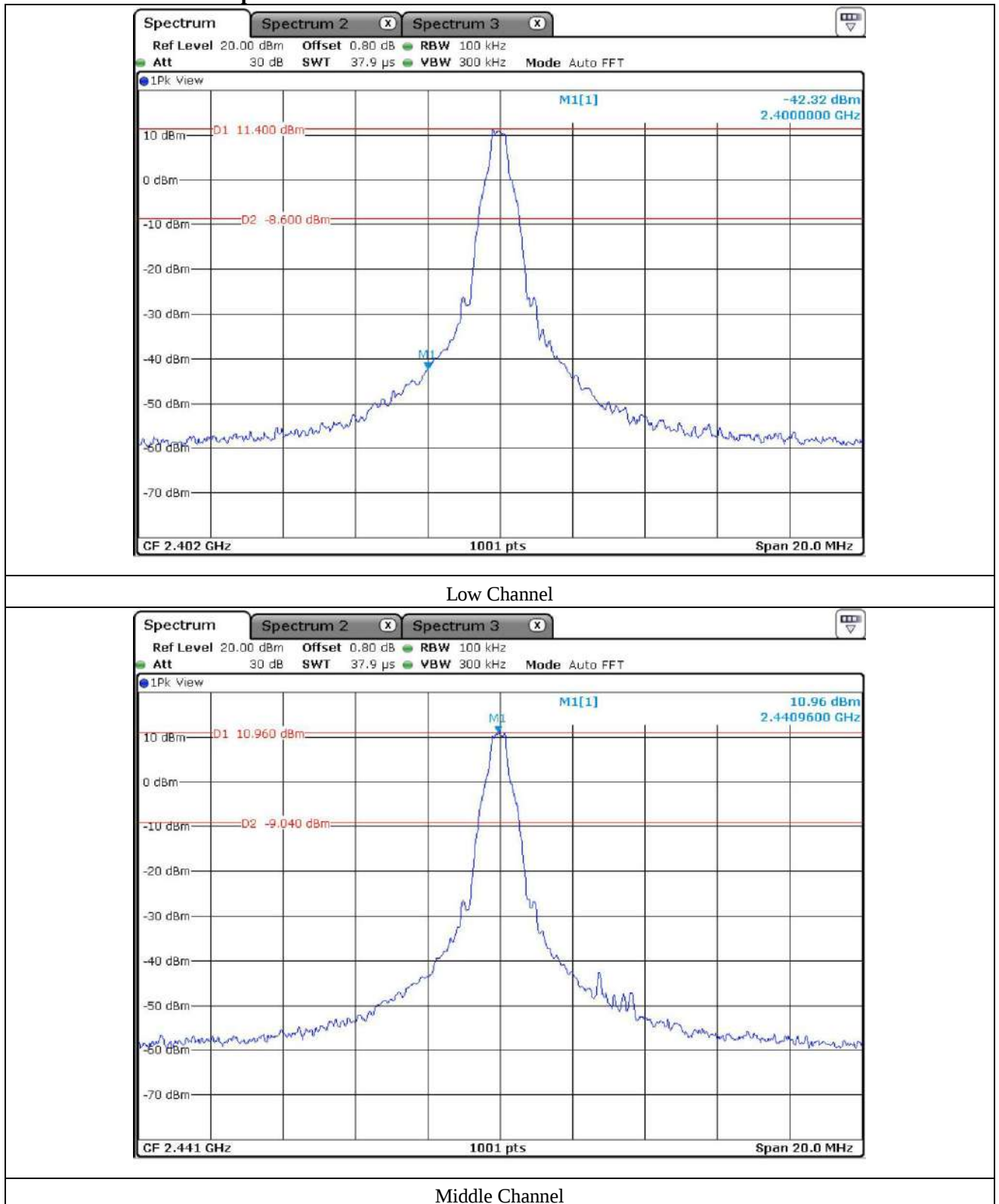
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

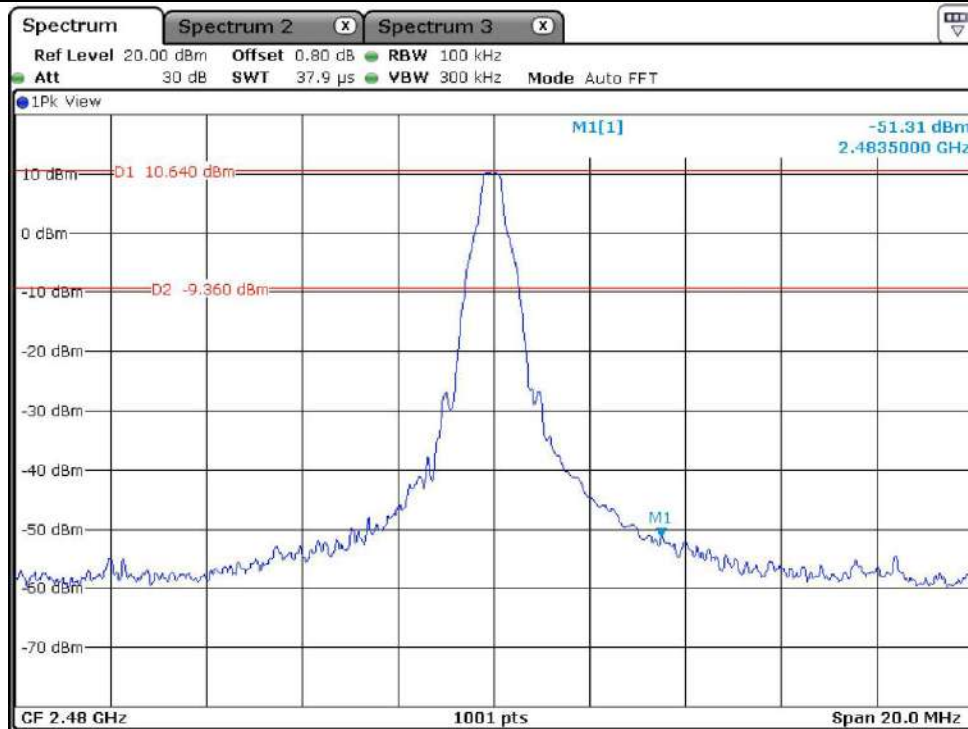
12.4 Test Date

May 17, 2021 ~ May 31, 2021

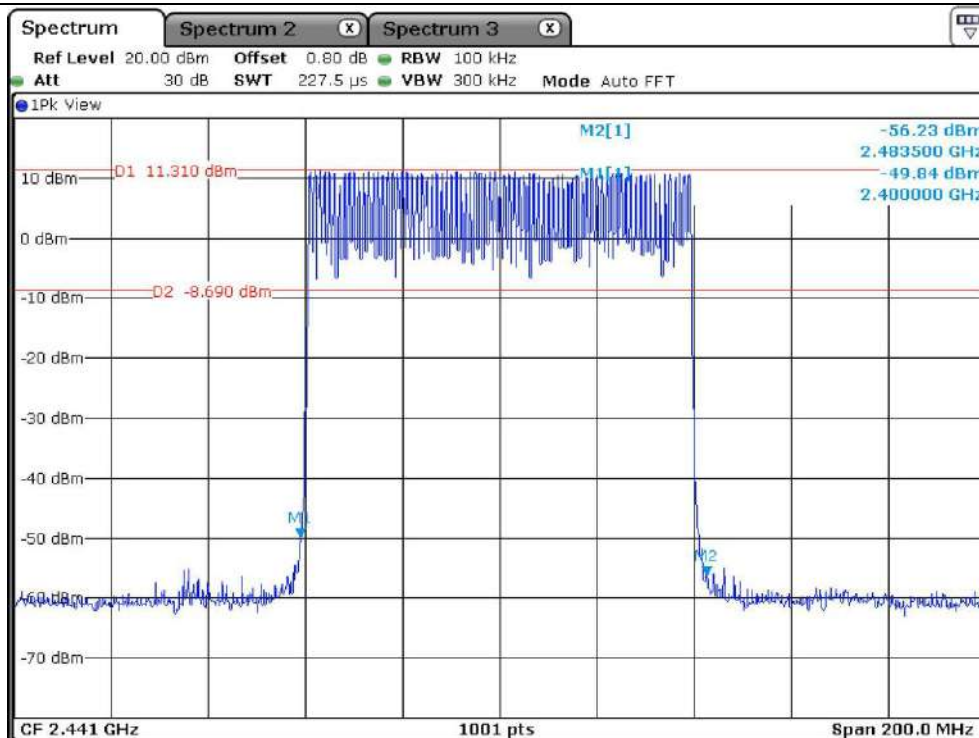
12.5 Test data for conducted emission (Left Earbud)

12.5.1 Test data for 1 Mbps

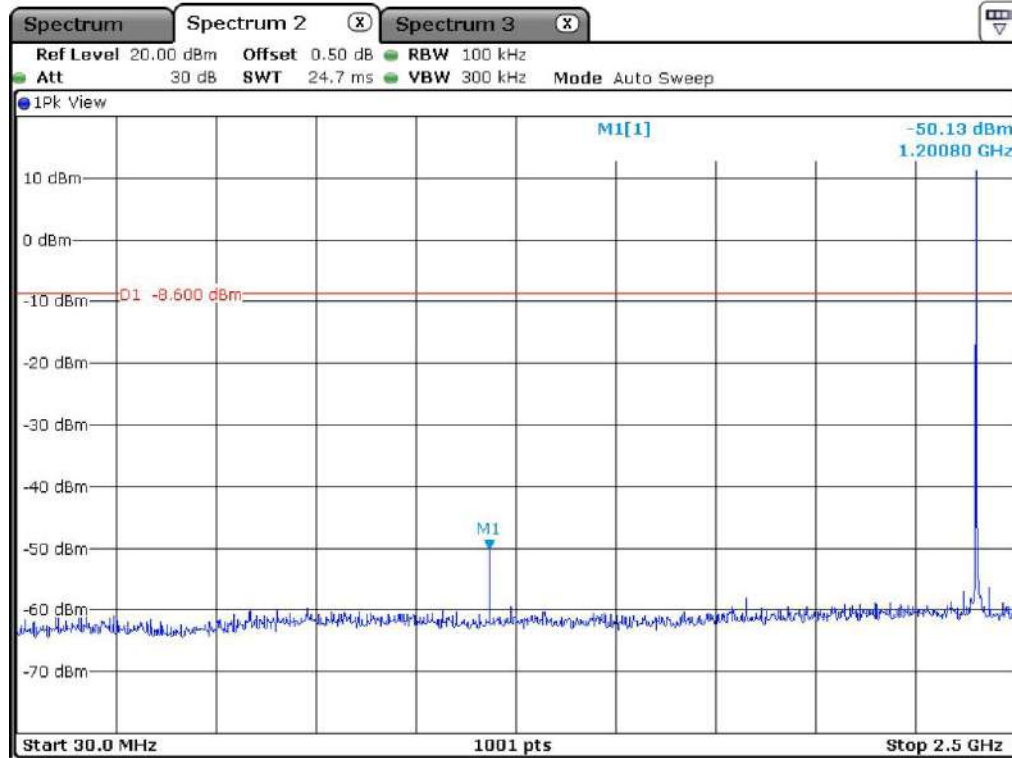




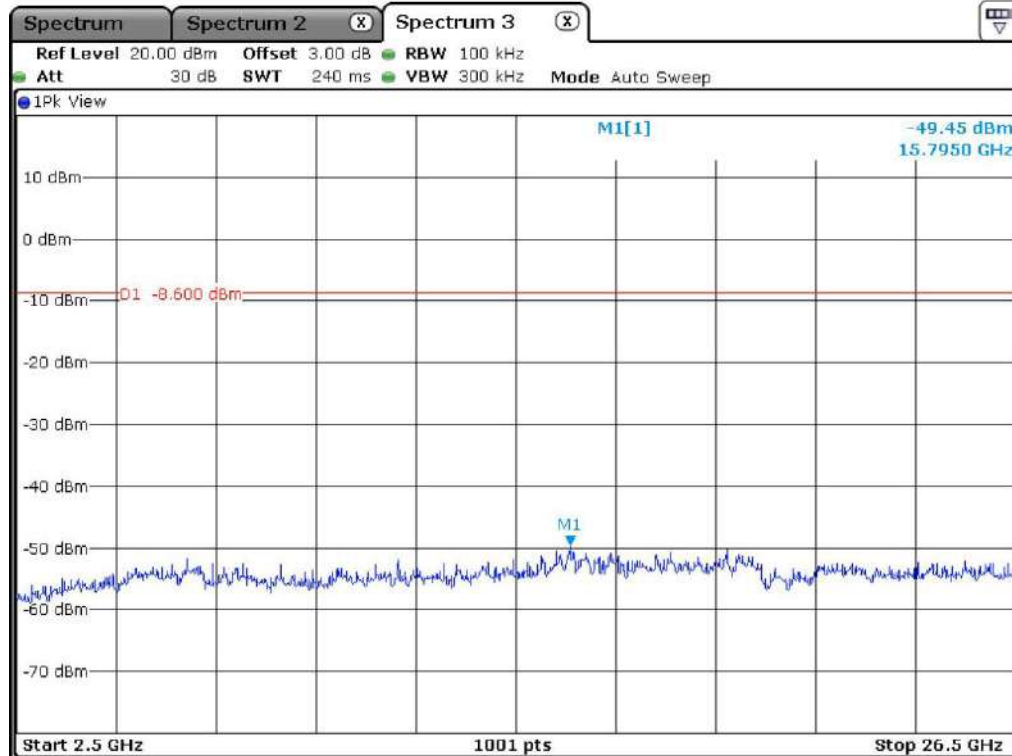
High Channel



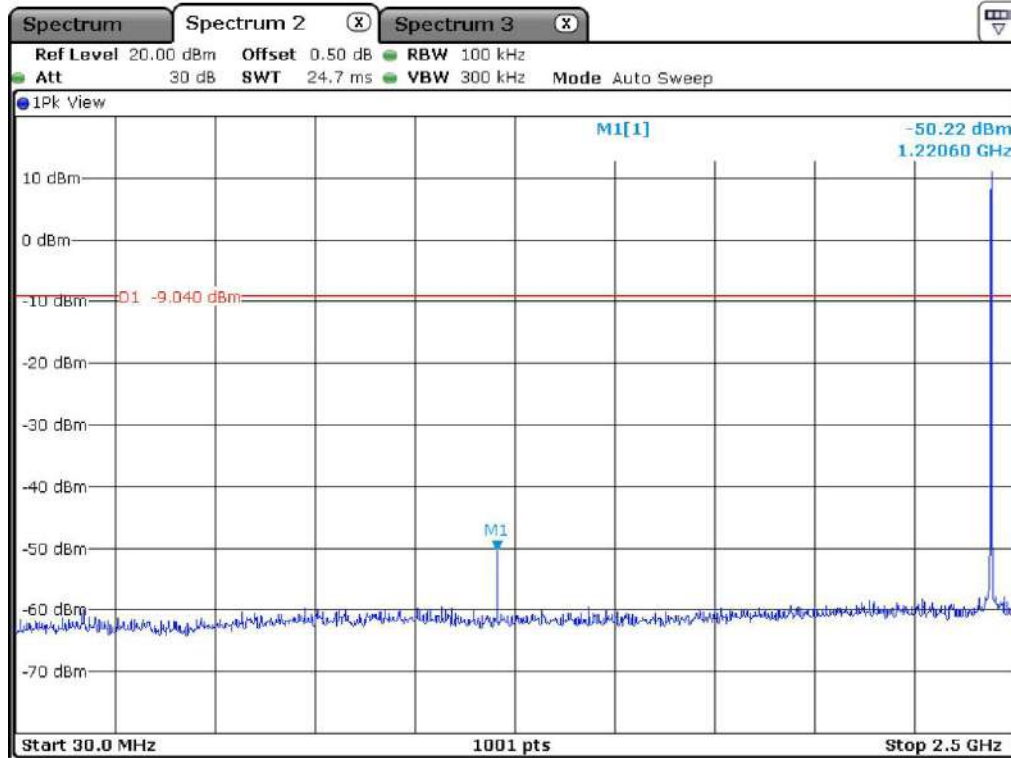
Hopping Mode



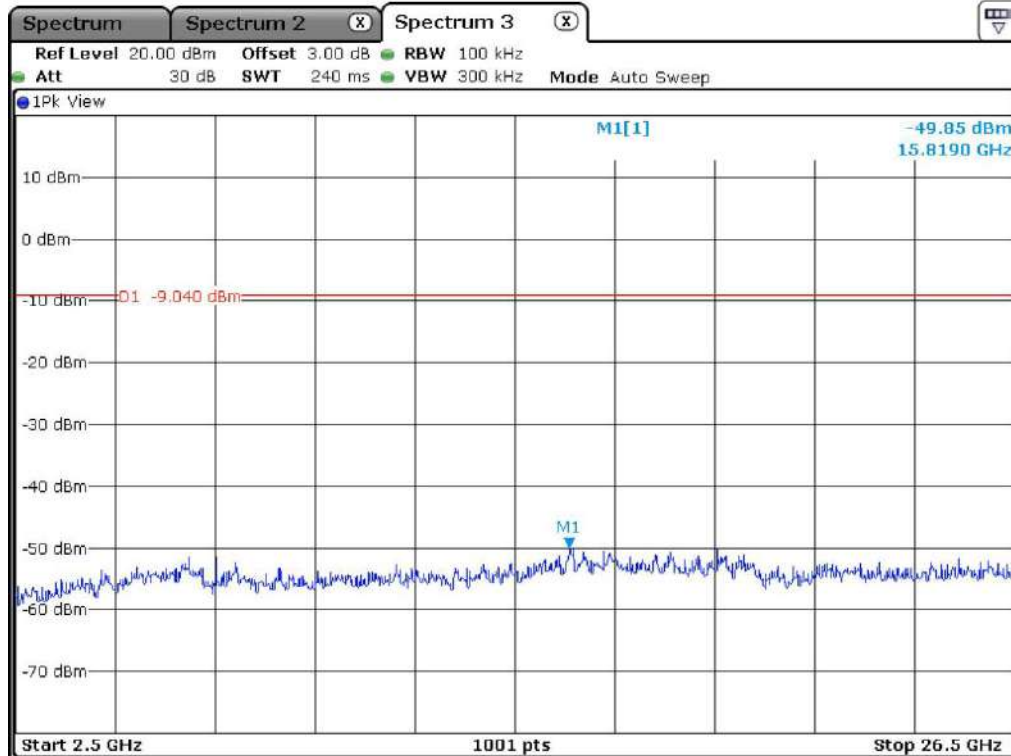
Low Channel



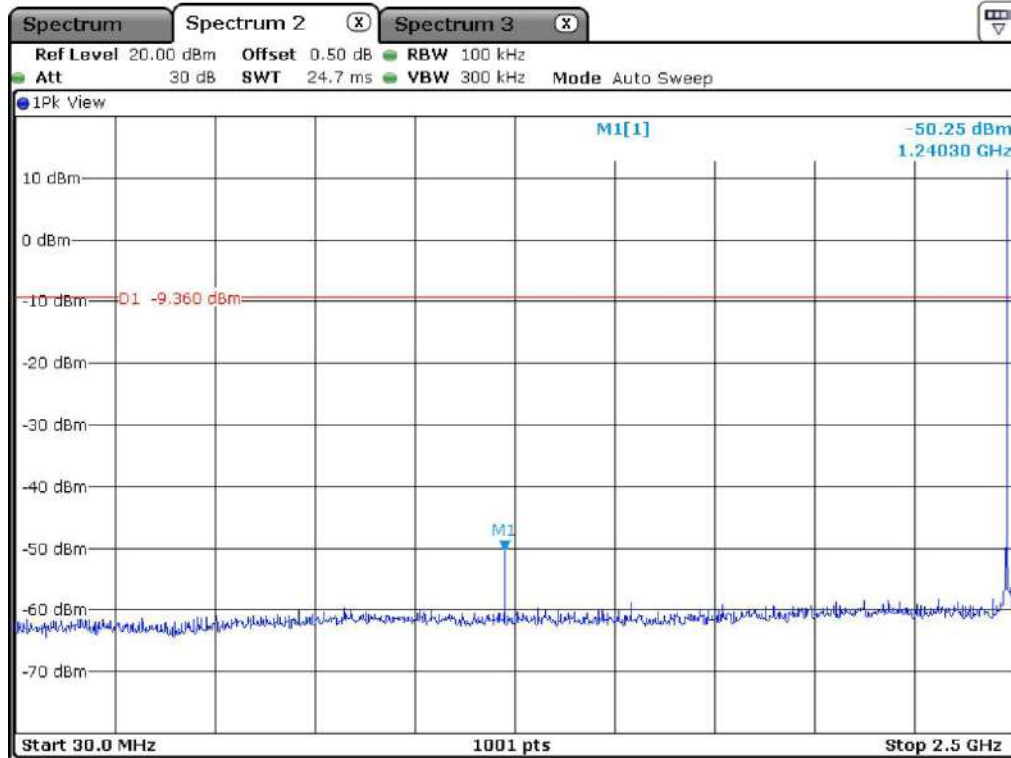
Low Channel



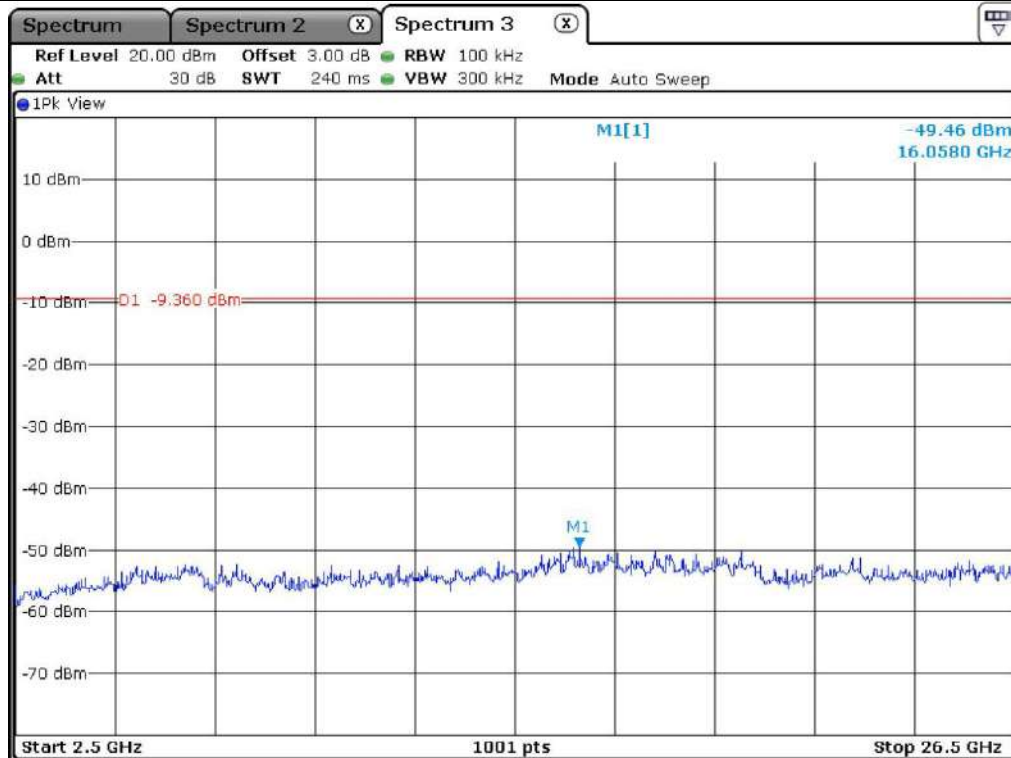
Middle Channel



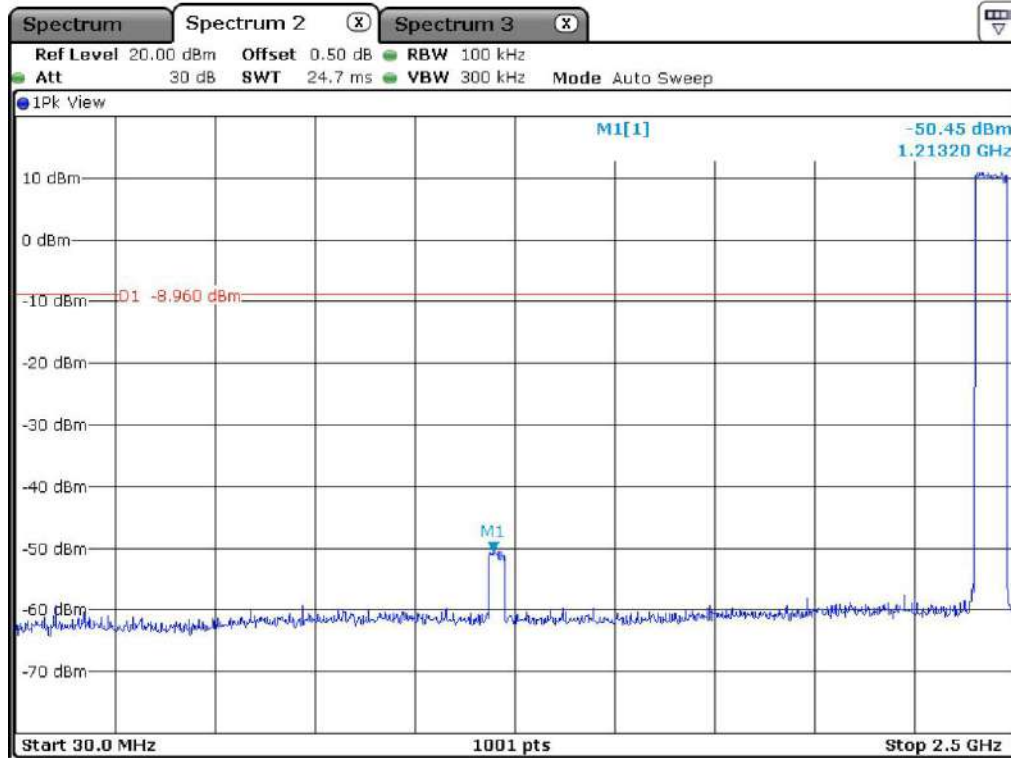
Middle Channel



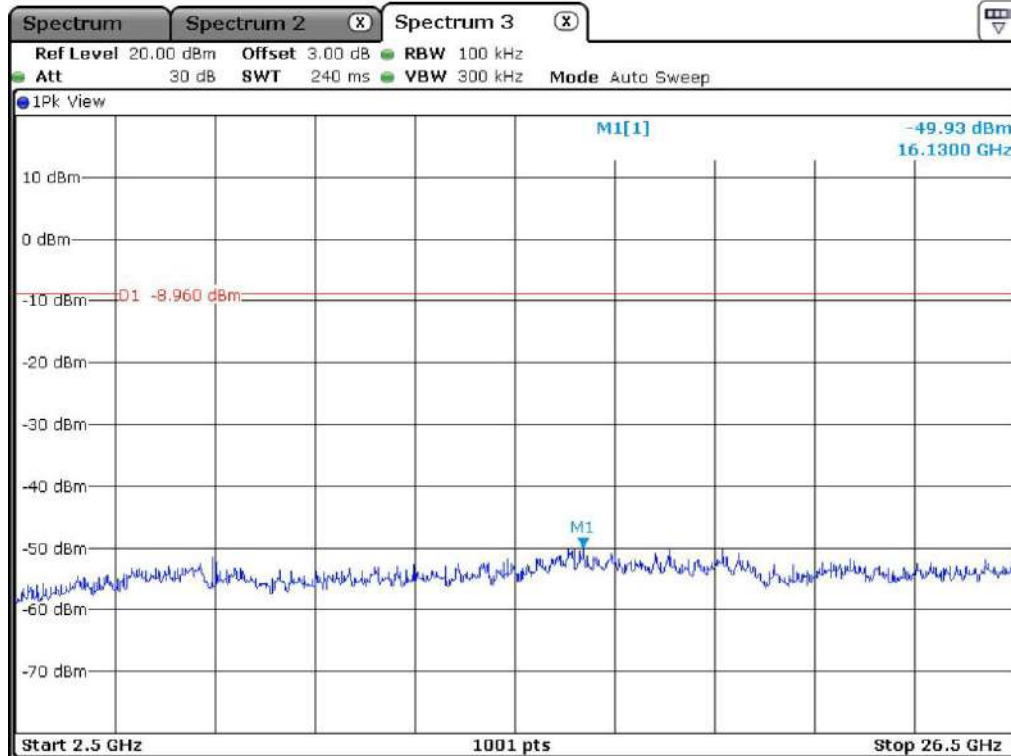
High Channel



High Channel

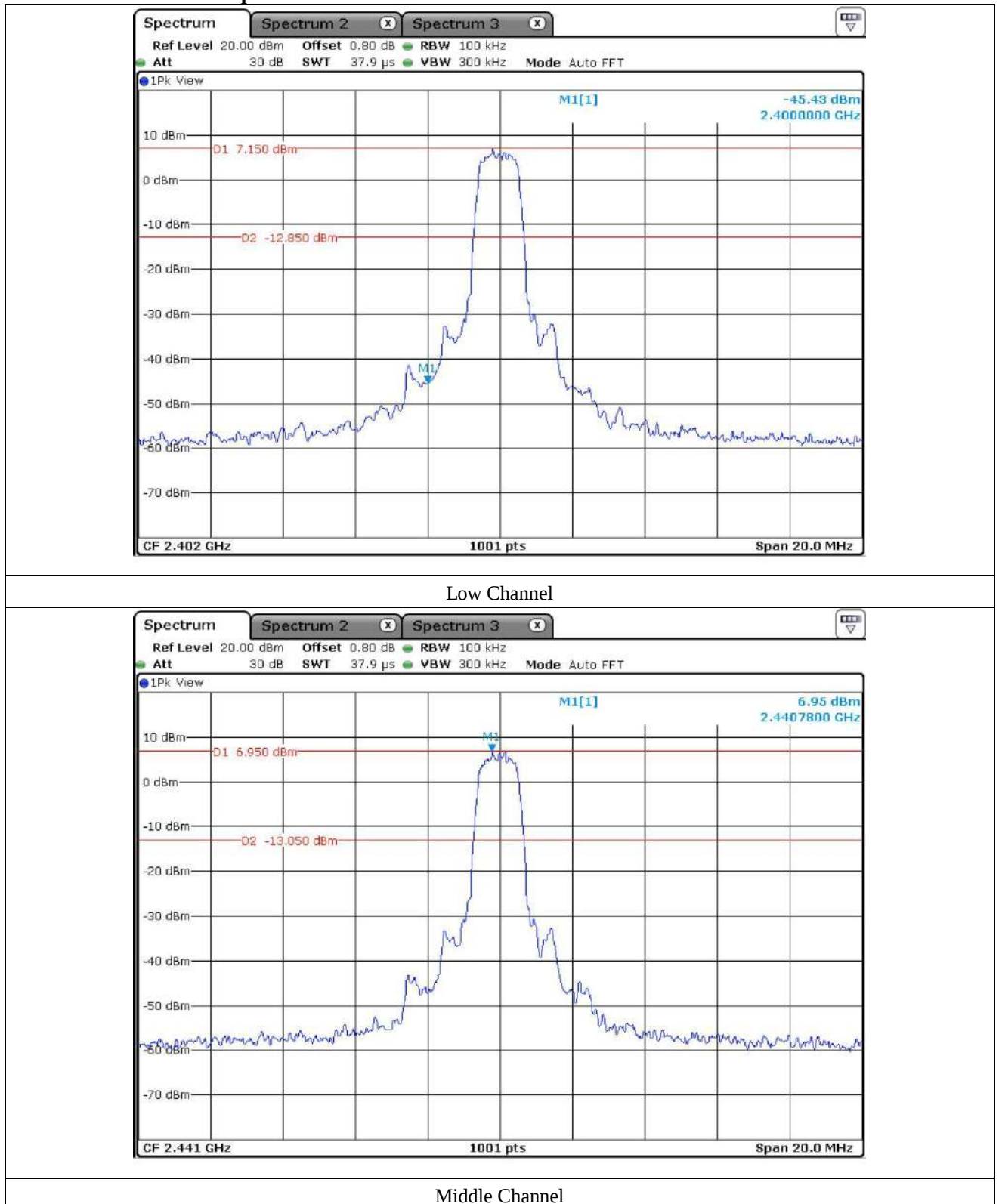


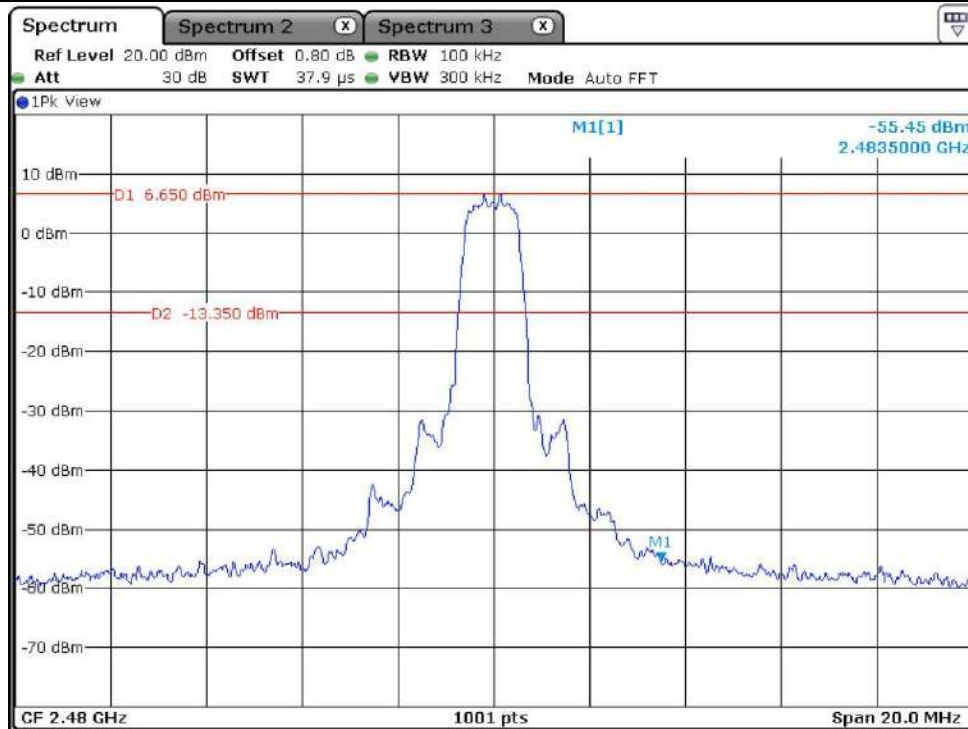
Hopping Mode



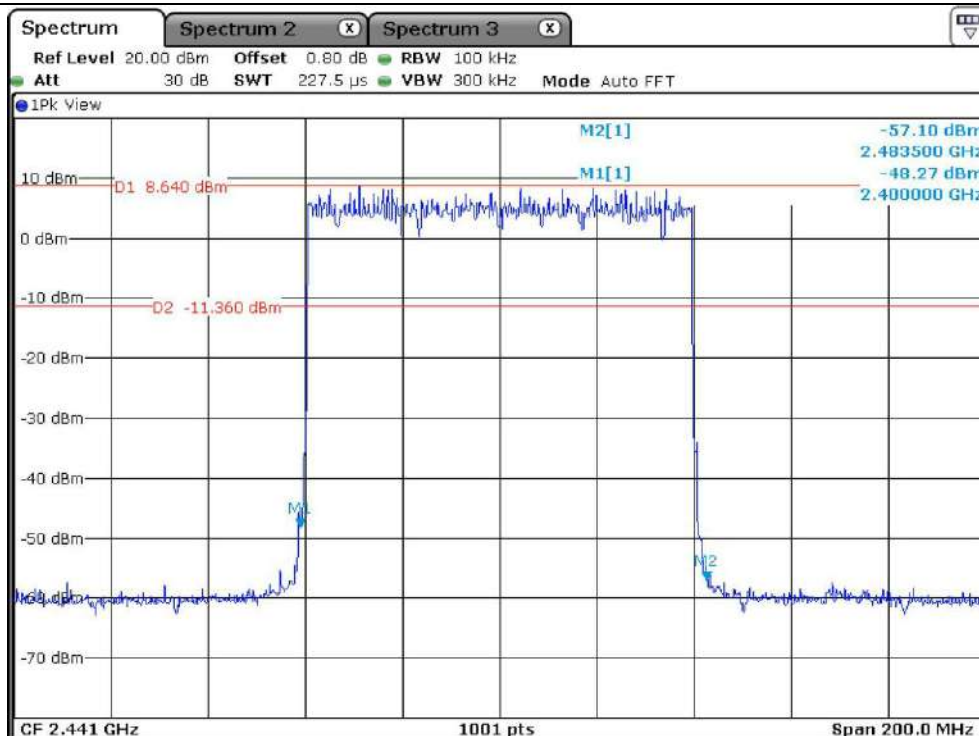
Hopping Mode

12.5.2 Test data for 2 Mbps

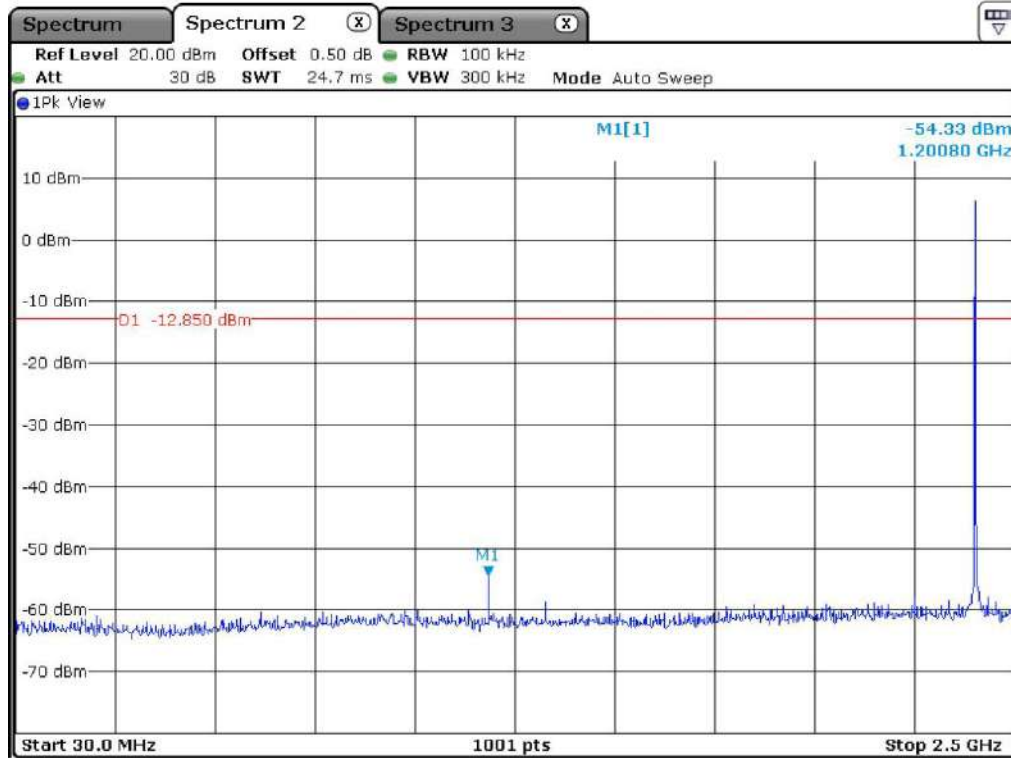




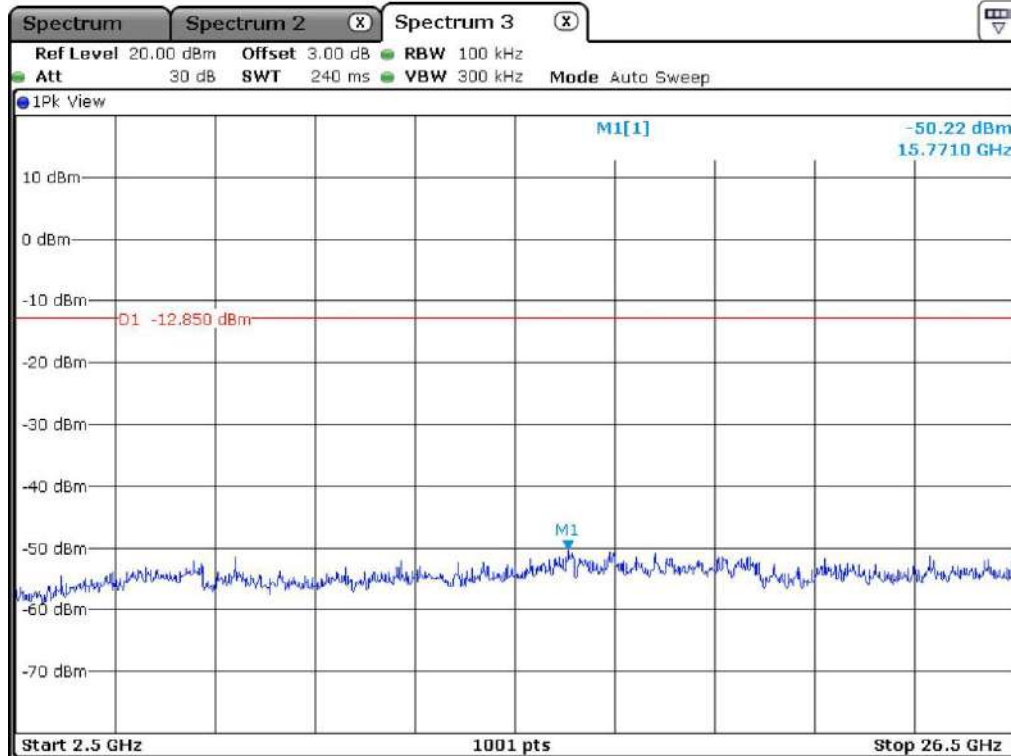
High Channel



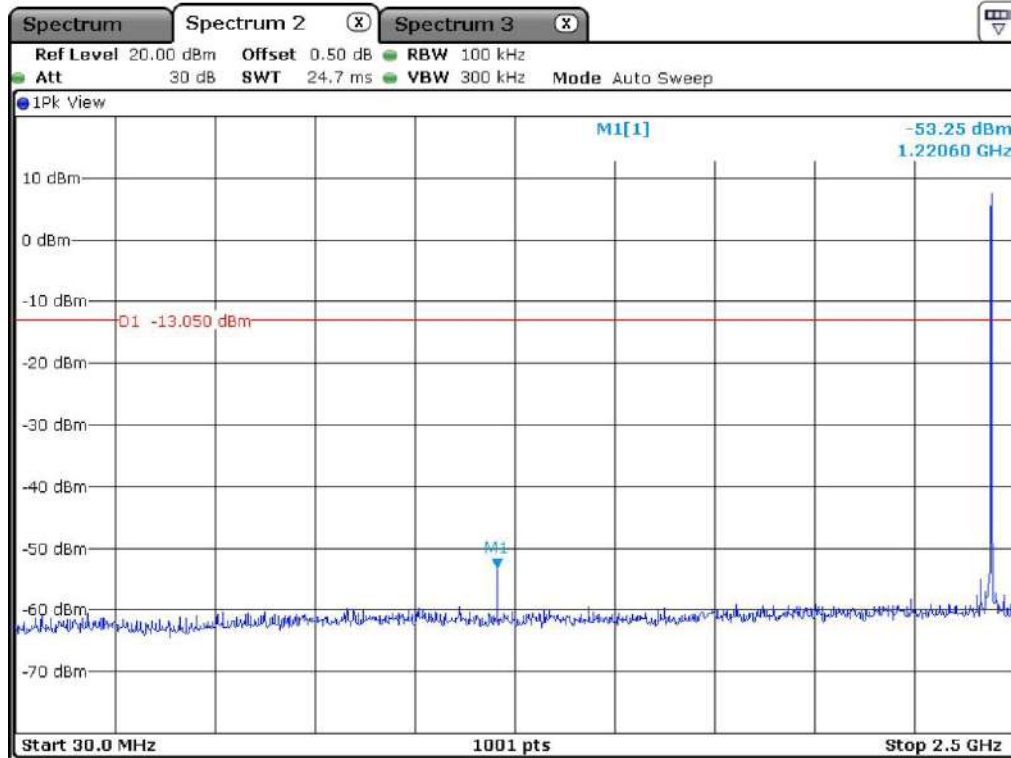
Hopping Mode



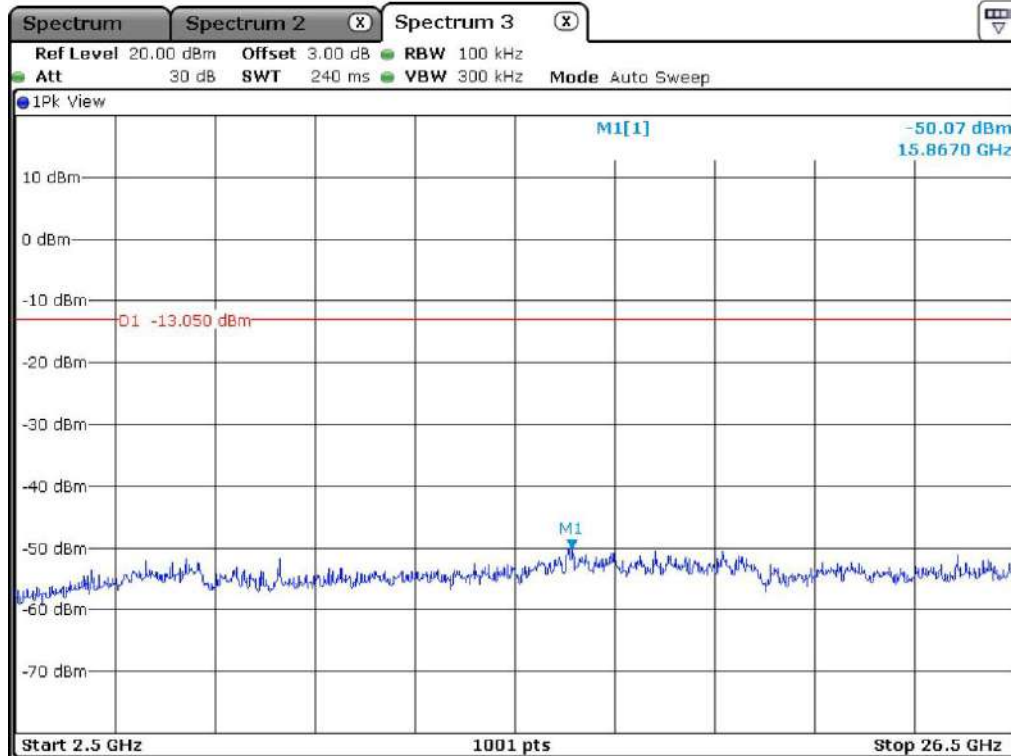
Low Channel



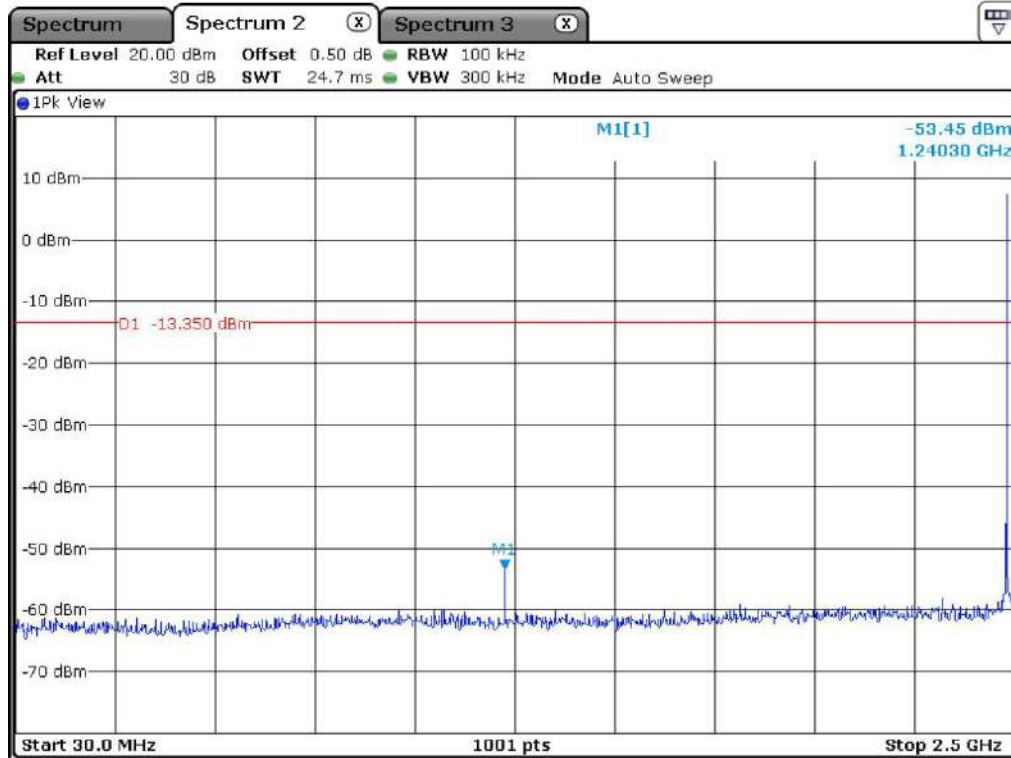
Low Channel



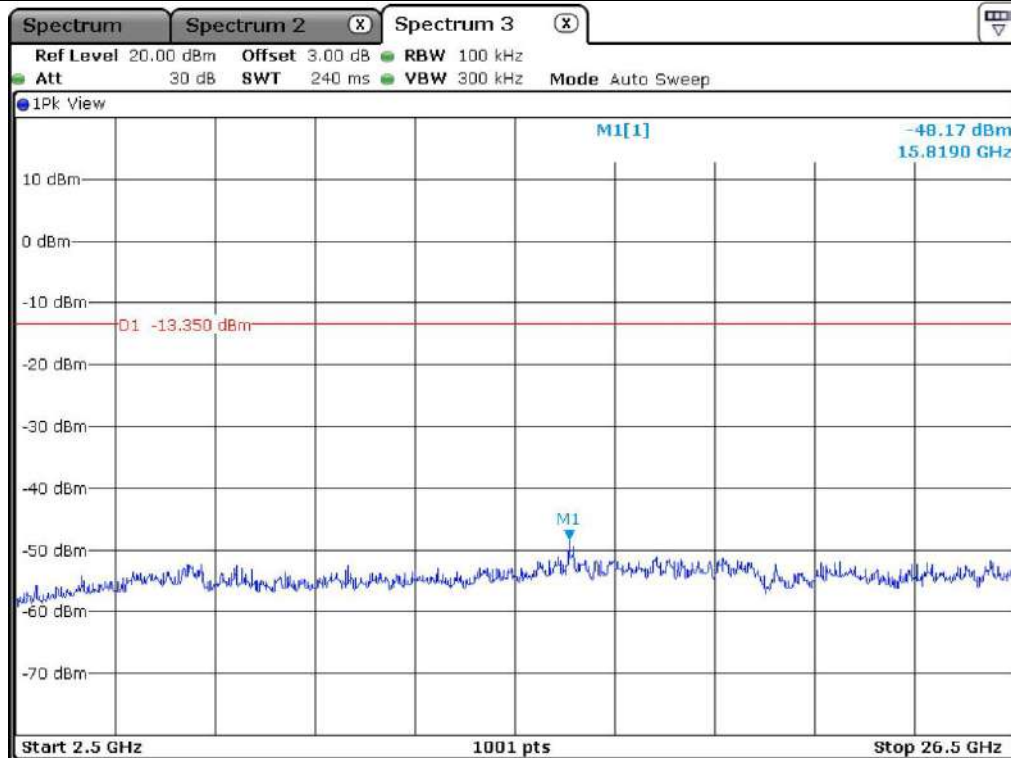
Middle Channel



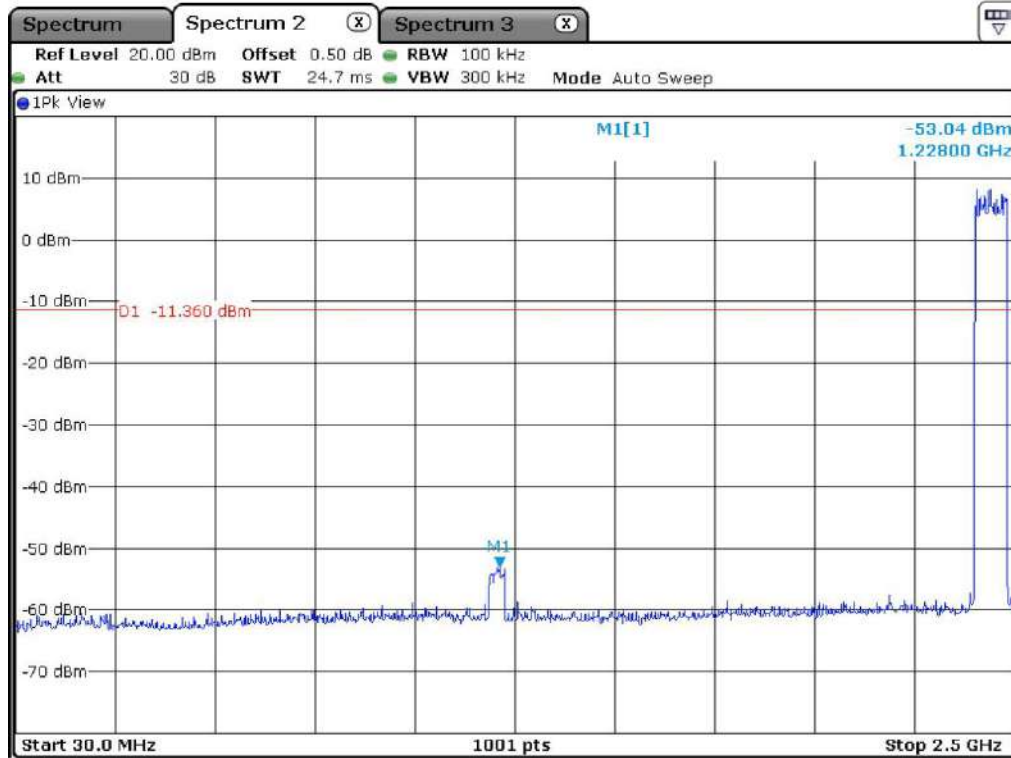
Middle Channel



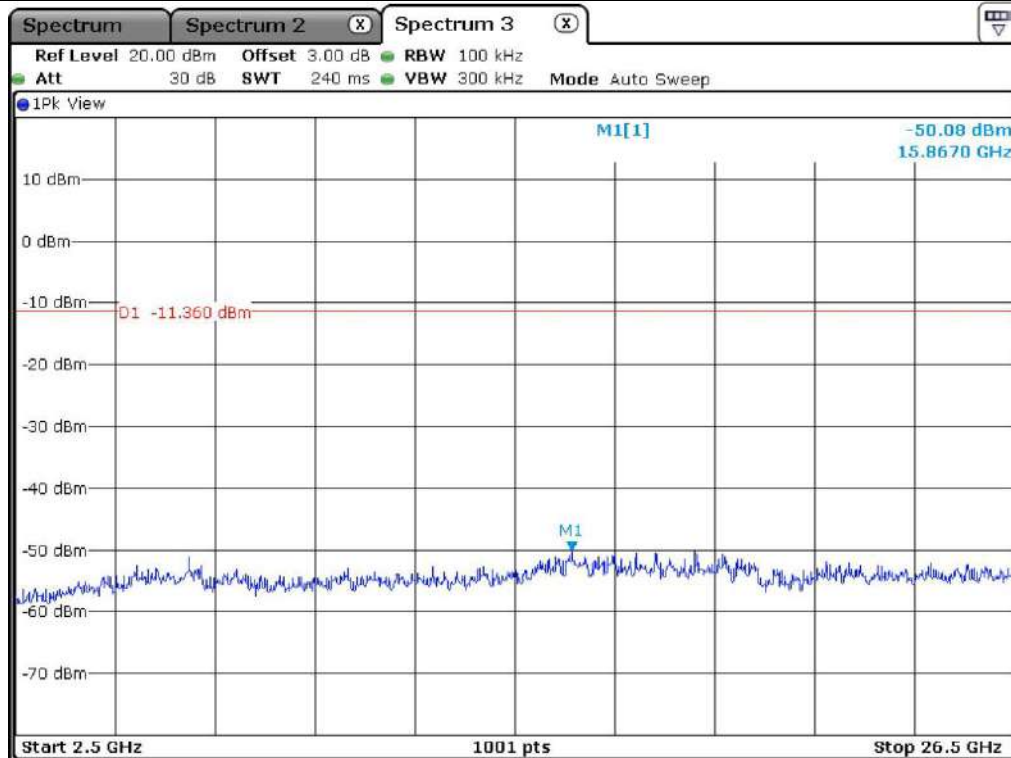
High Channel



High Channel

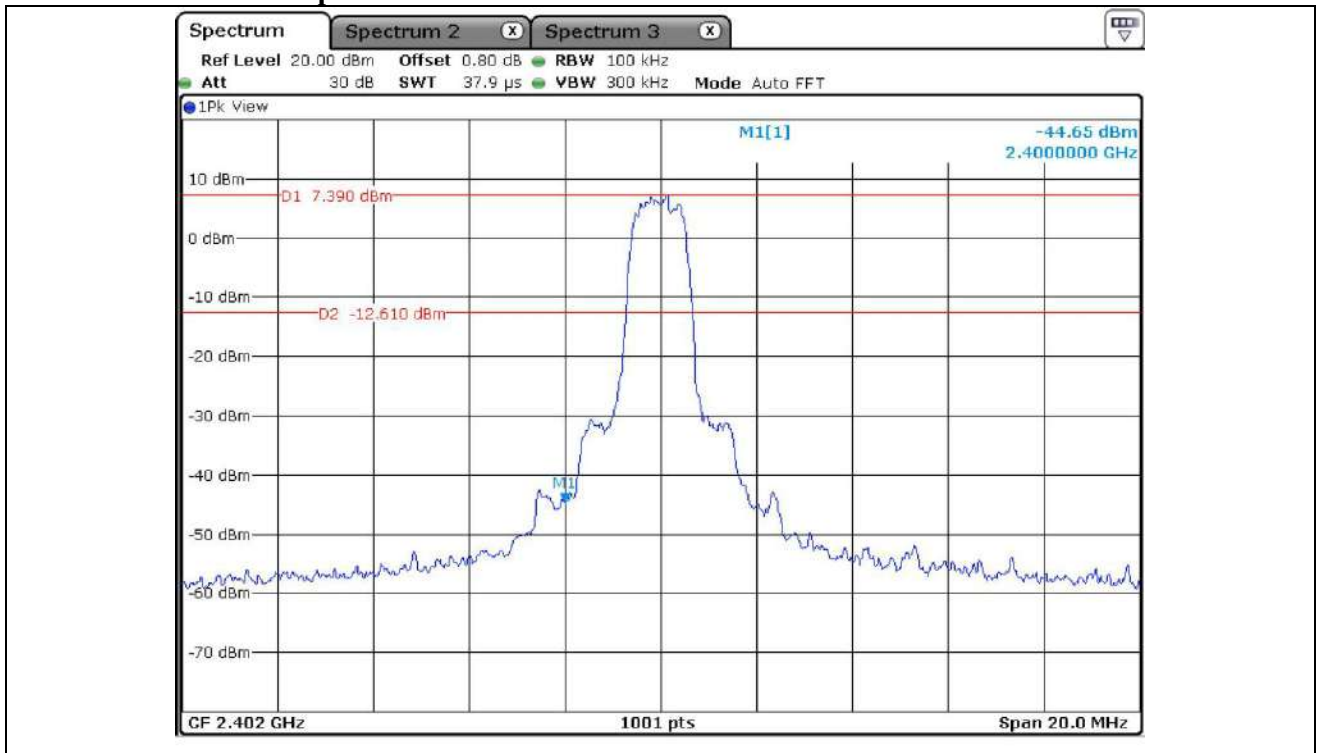


Hopping Mode

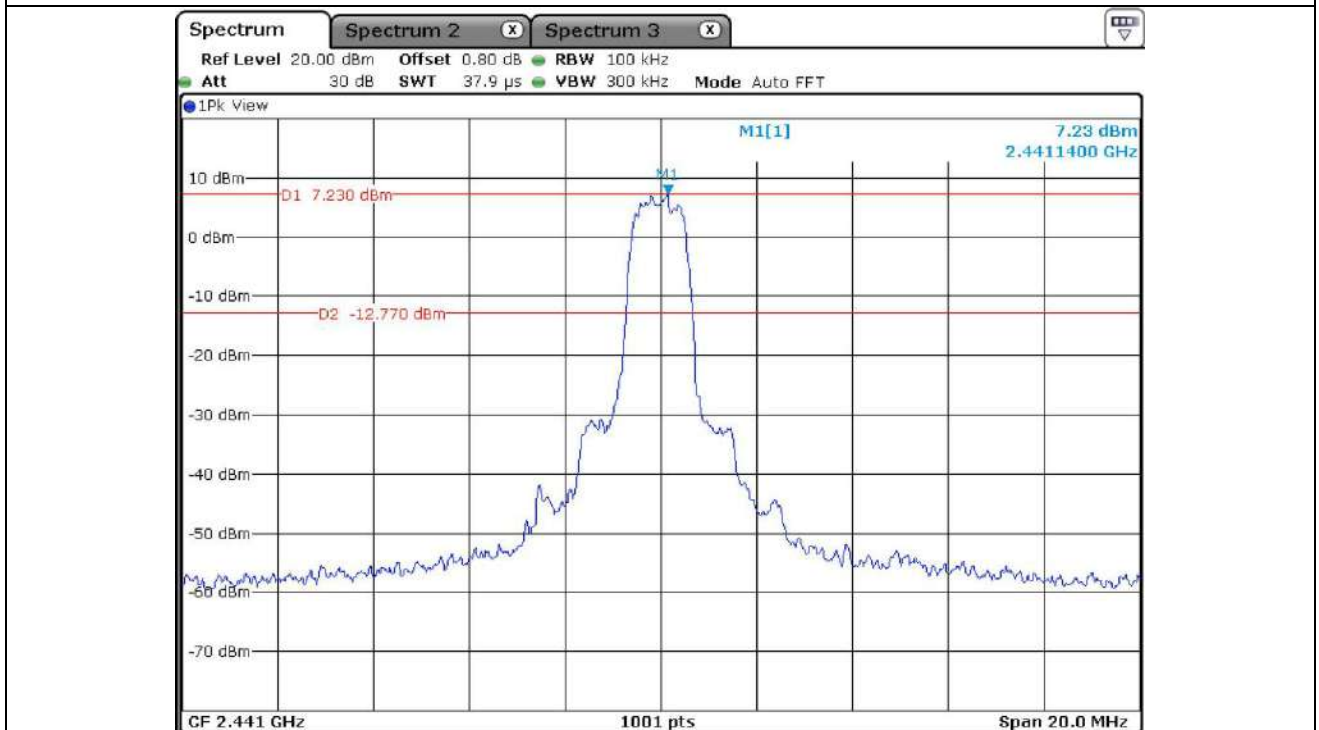


Hopping Mode

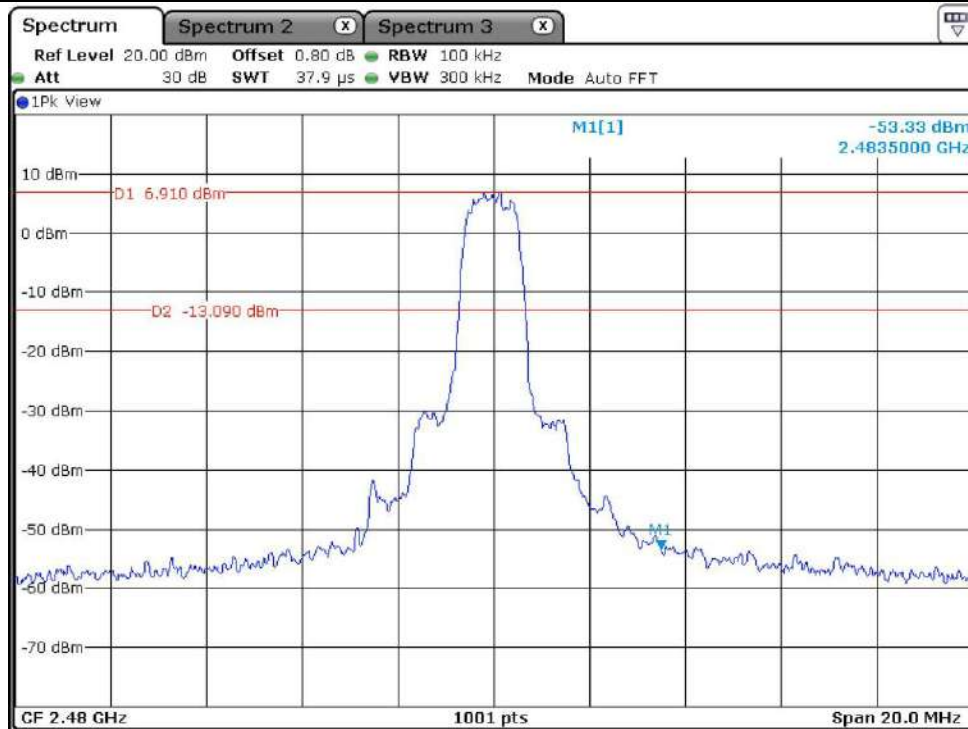
12.5.3 Test data for 3 Mbps



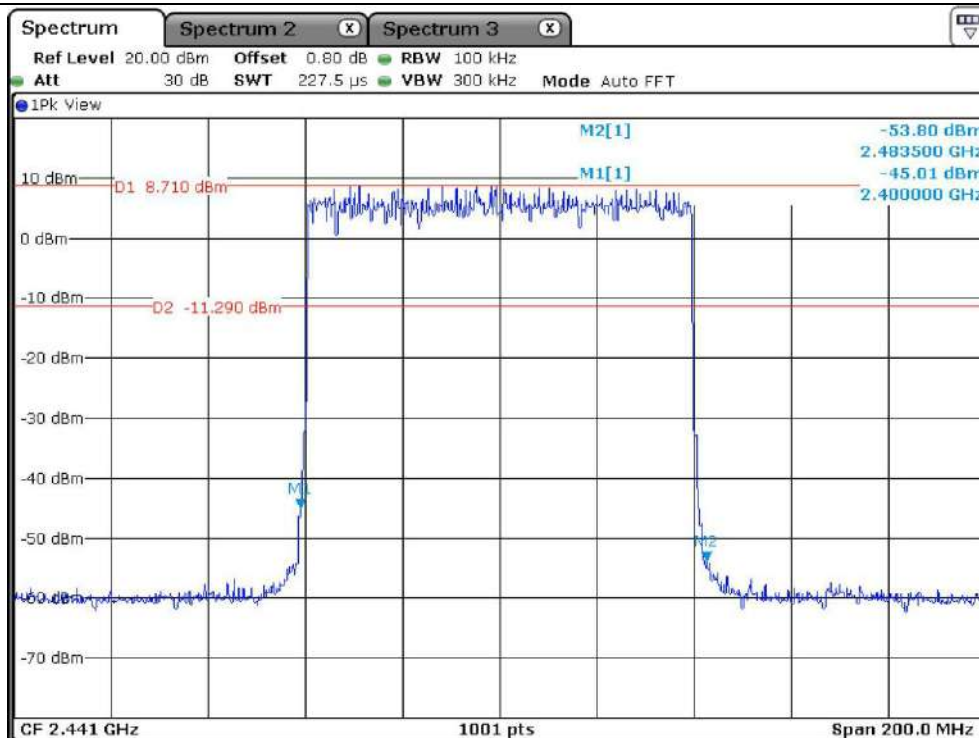
Low Channel



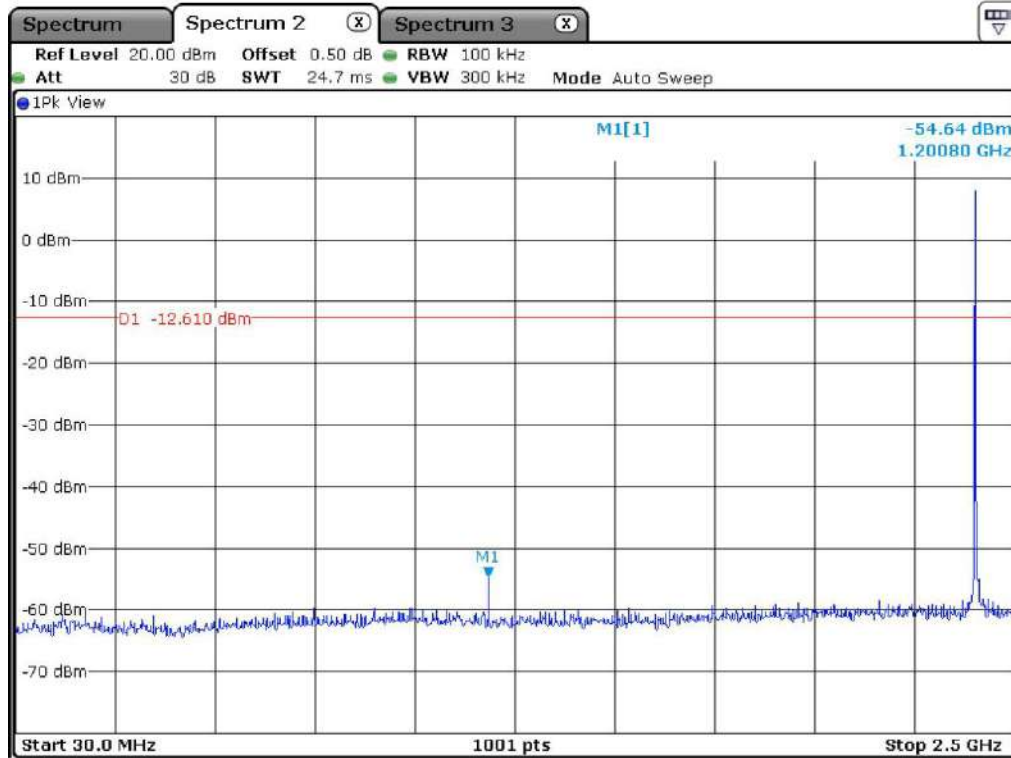
Middle Channel



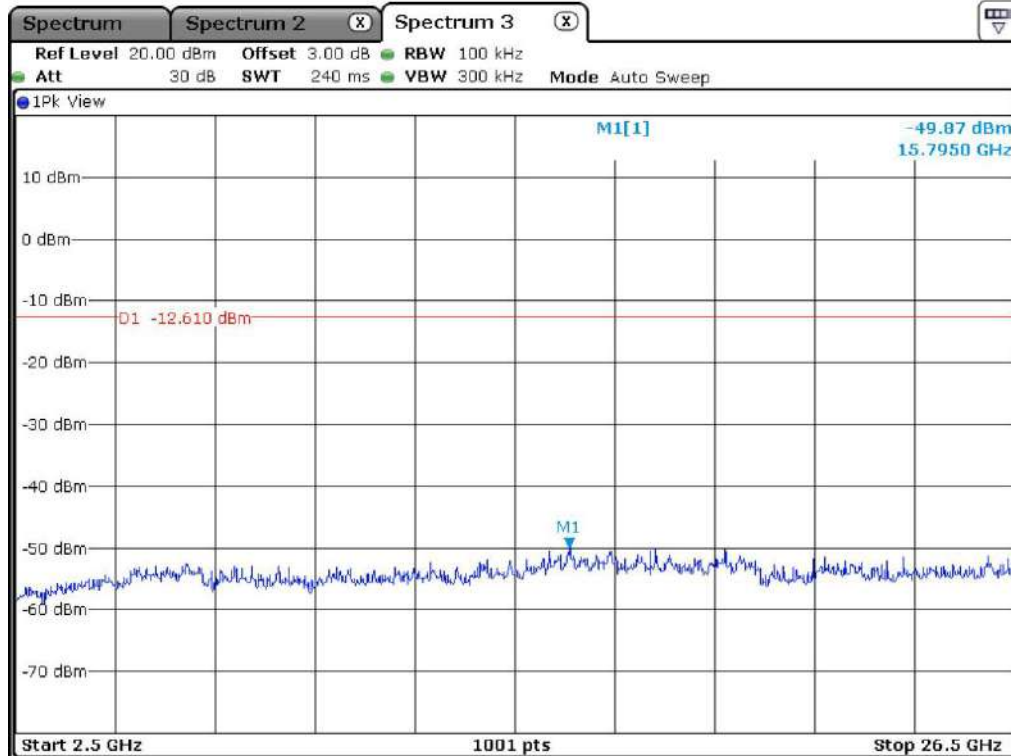
High Channel



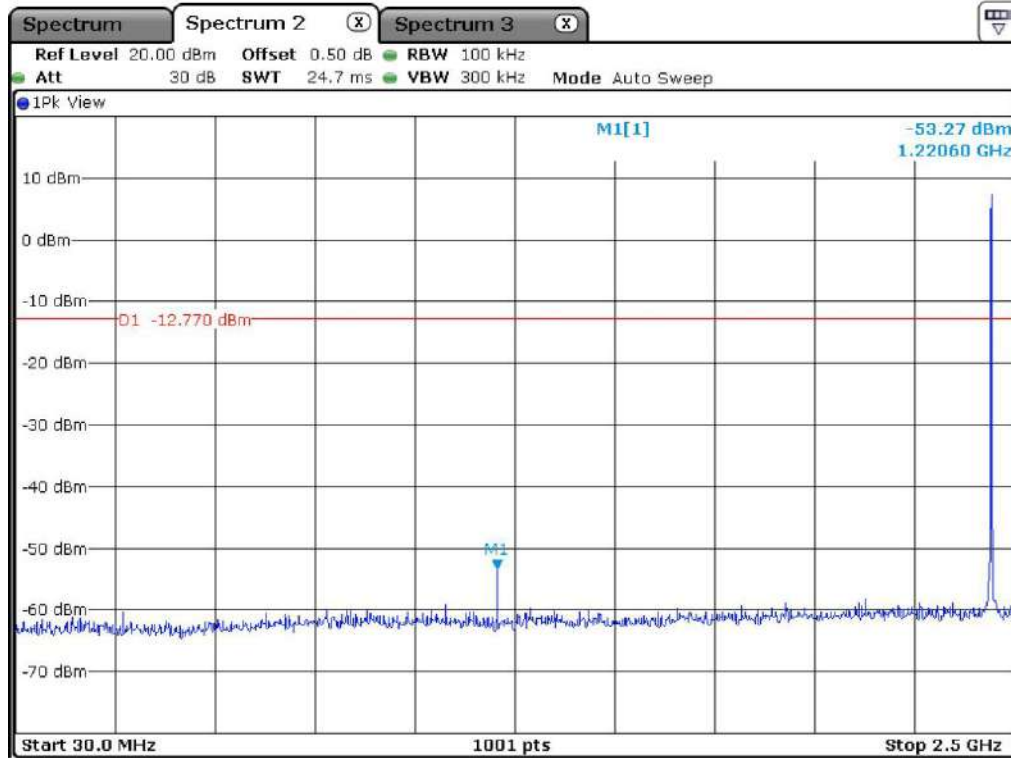
Hopping Mode



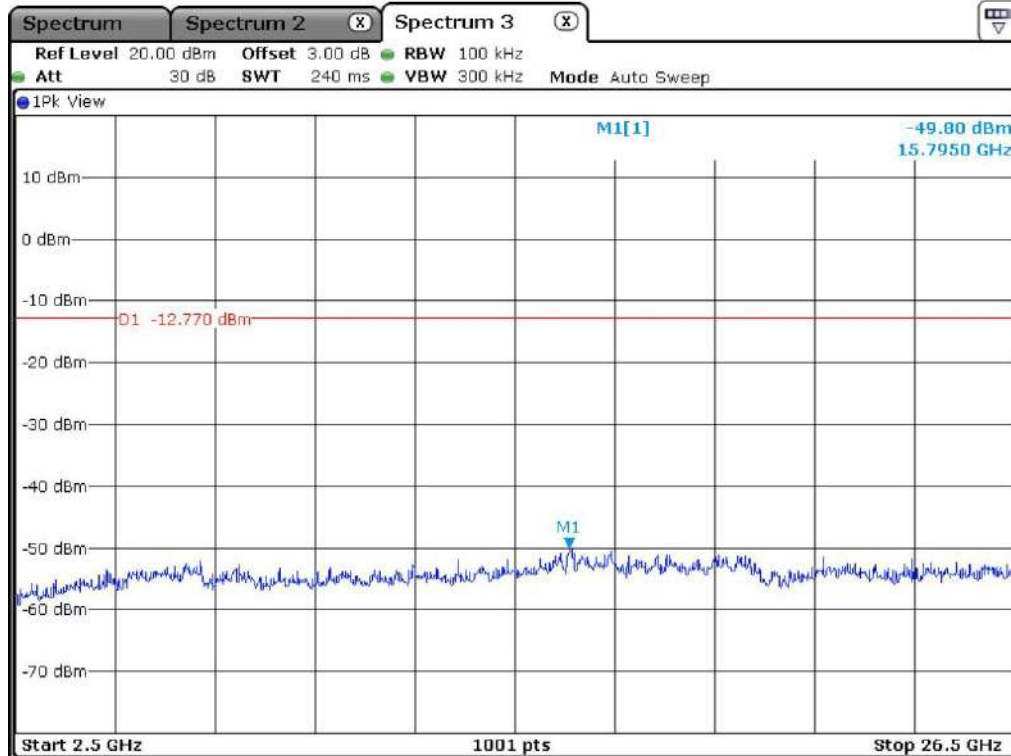
Low Channel



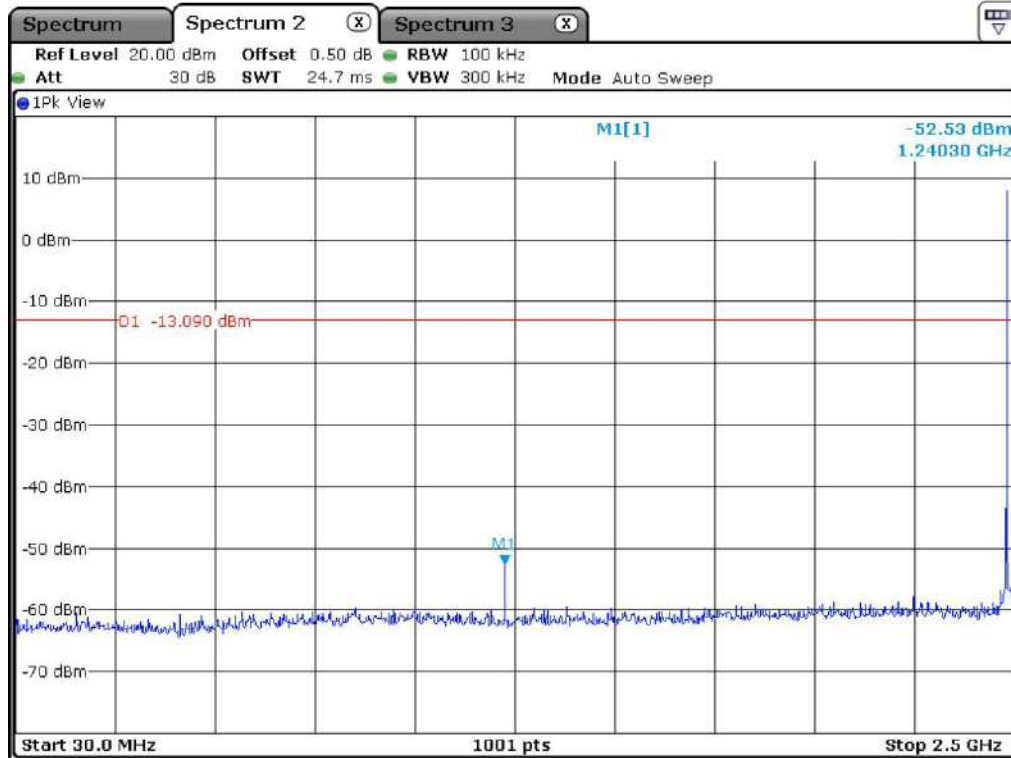
Low Channel



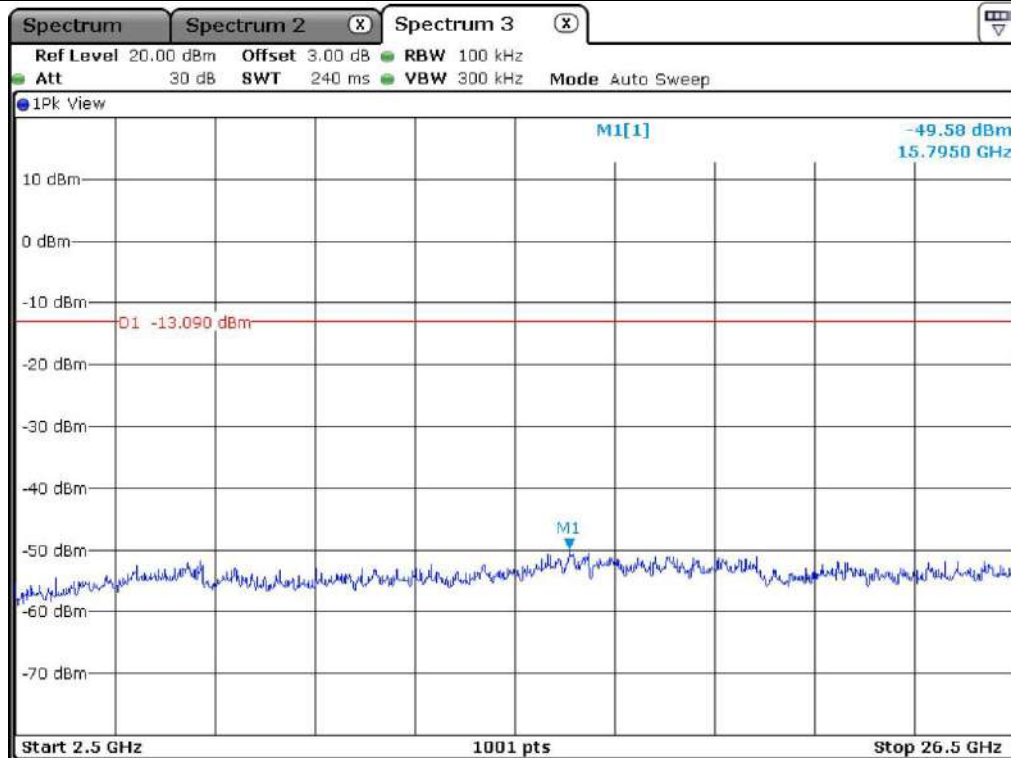
Middle Channel



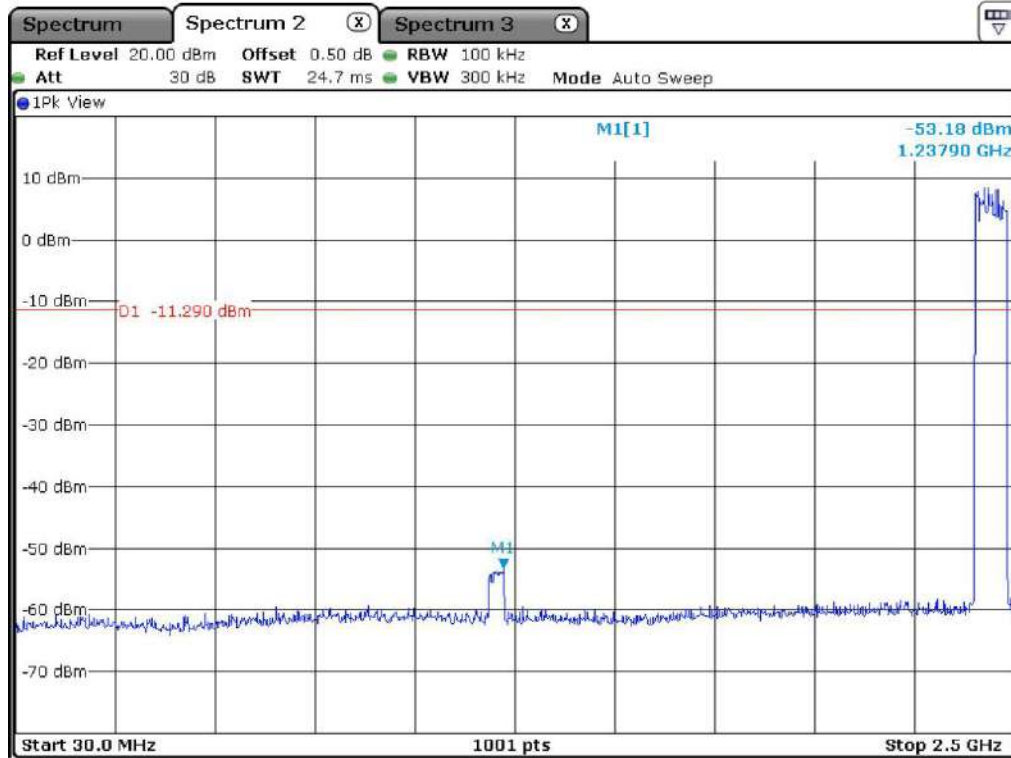
Middle Channel



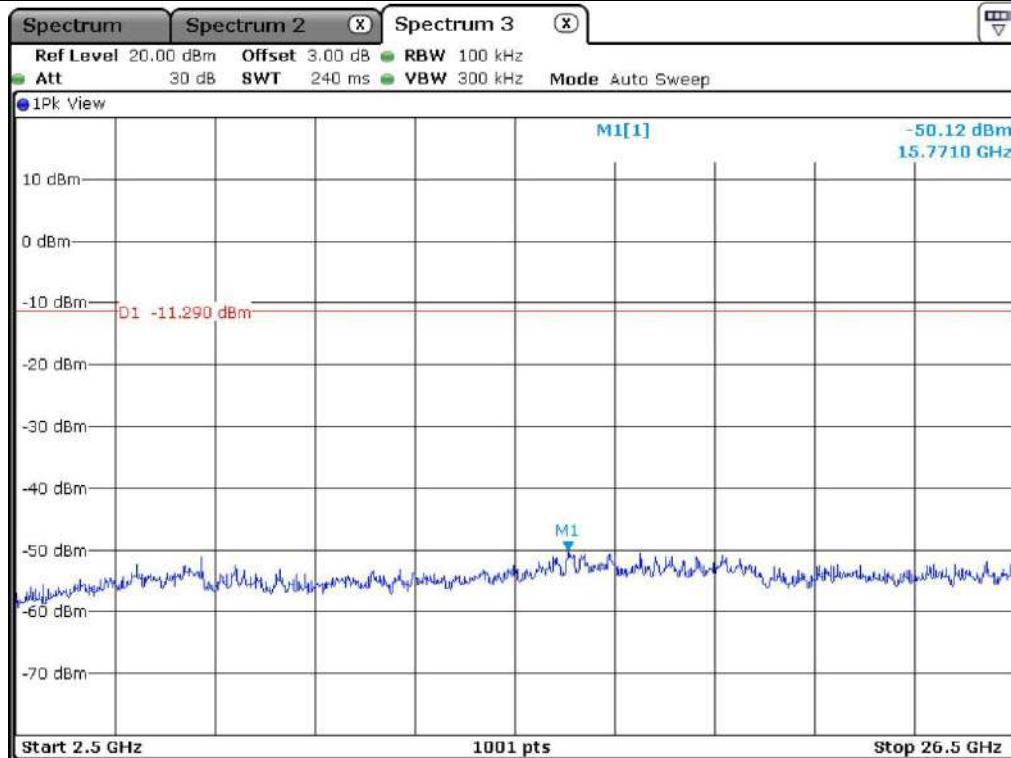
High Channel



High Channel



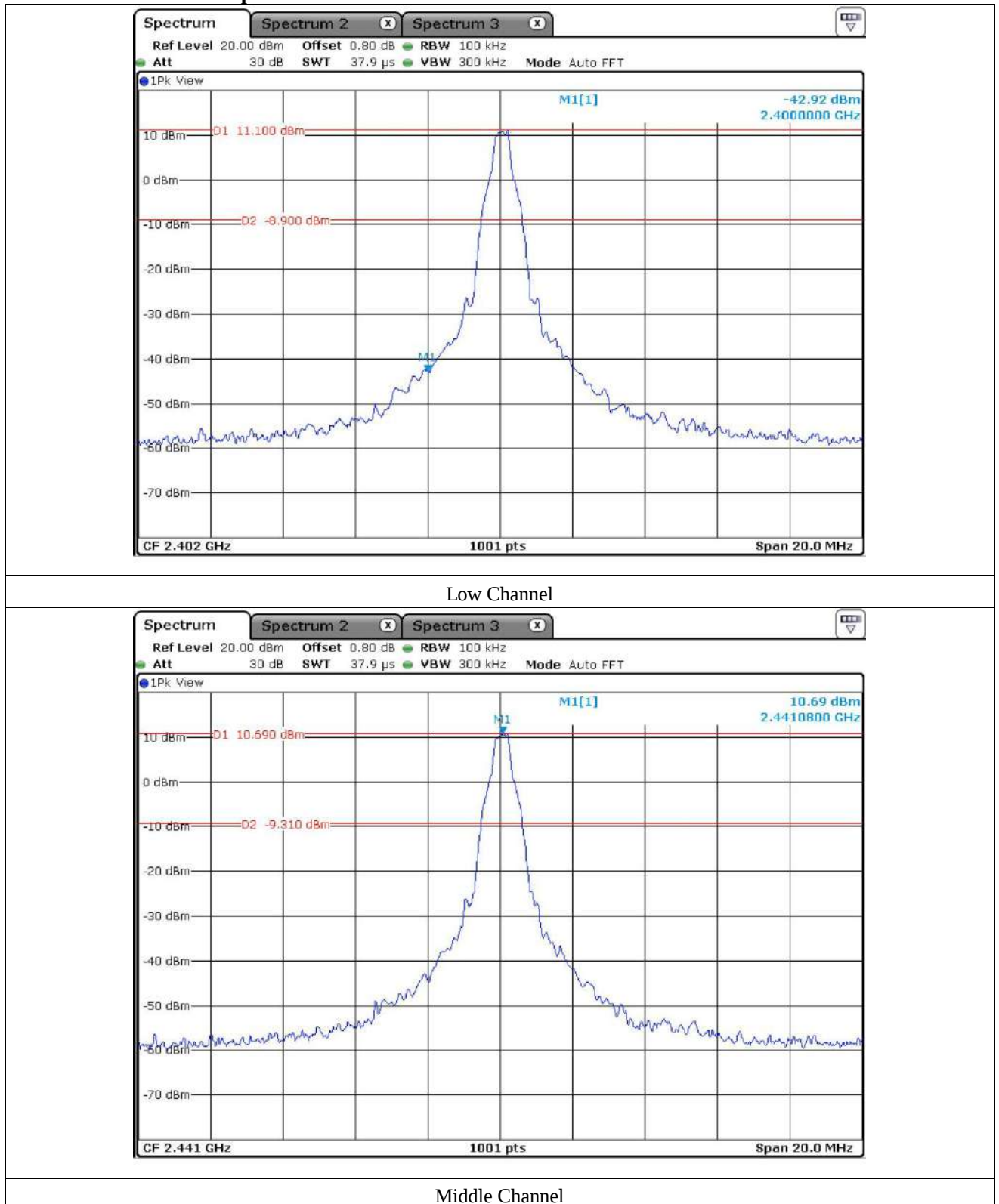
Hopping Mode

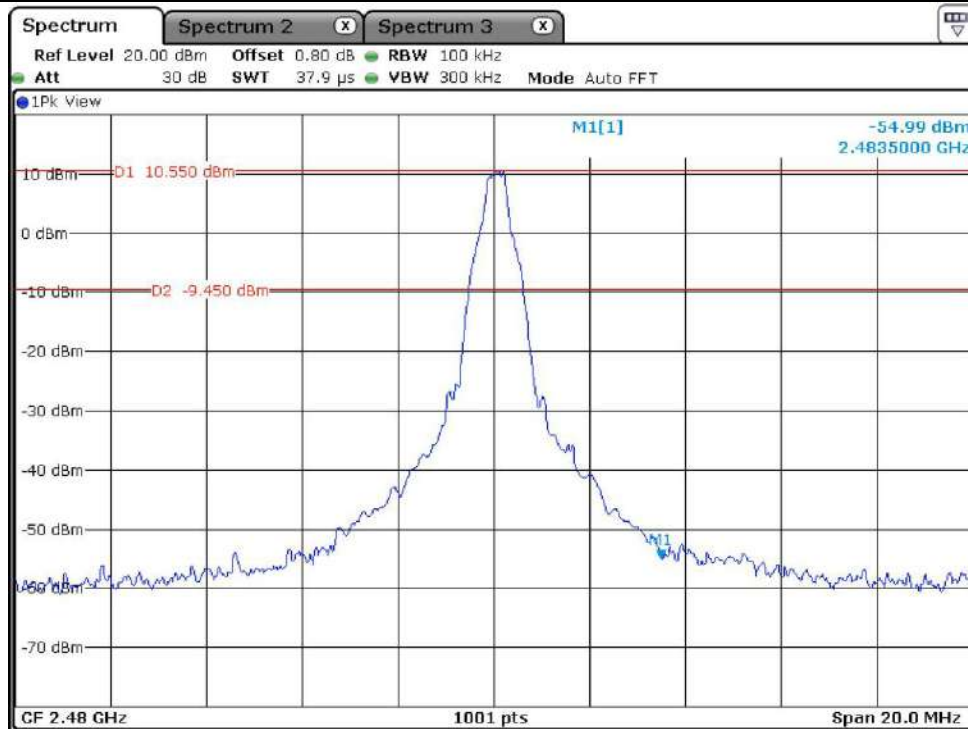


Hopping Mode

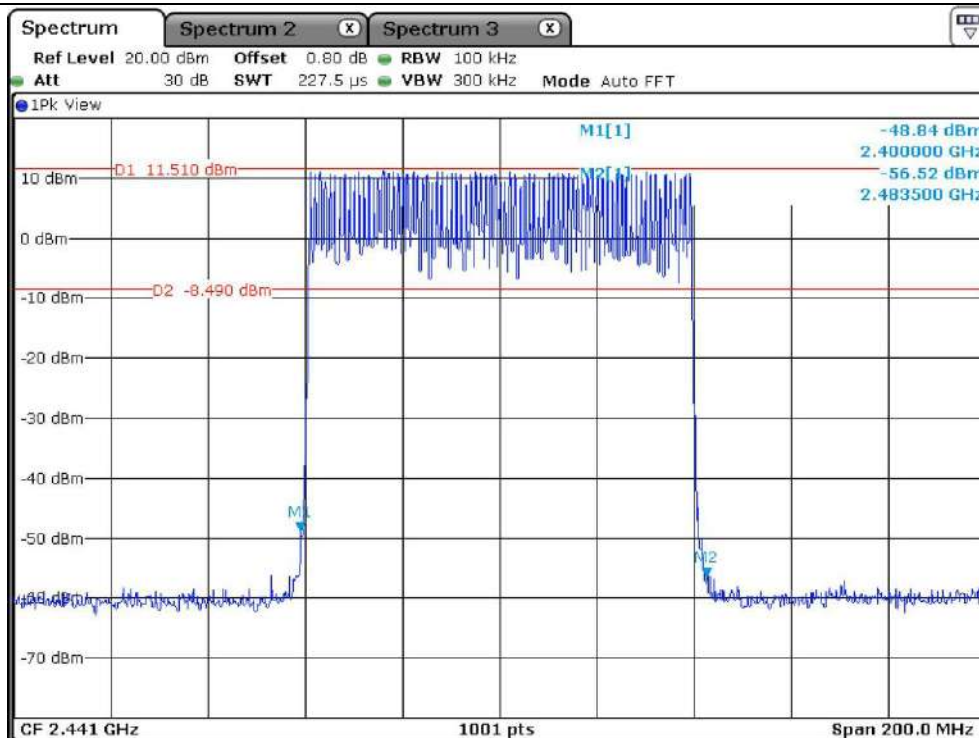
12.6 Test data for conducted emission (Right Earbud)

12.6.1 Test data for 1 Mbps

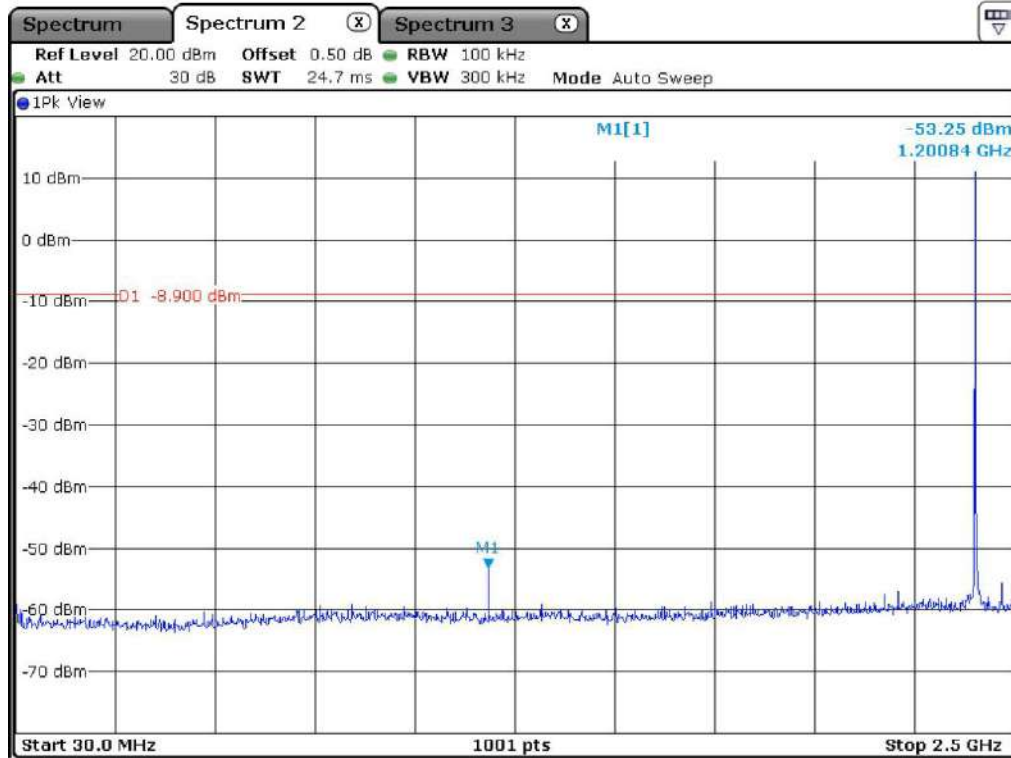




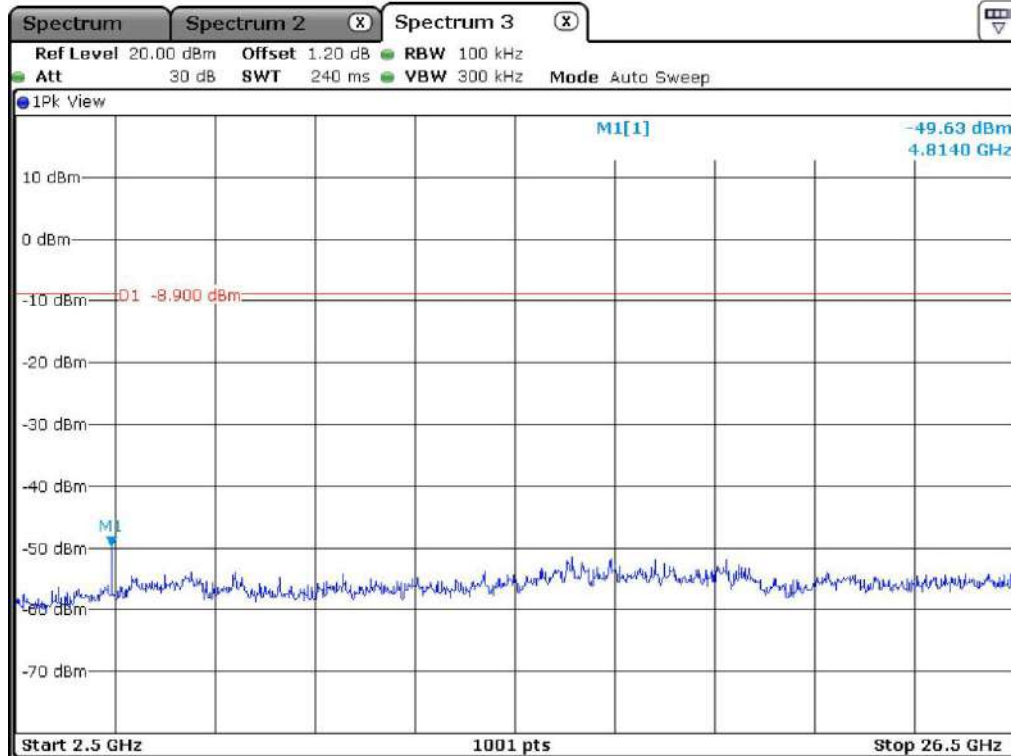
High Channel



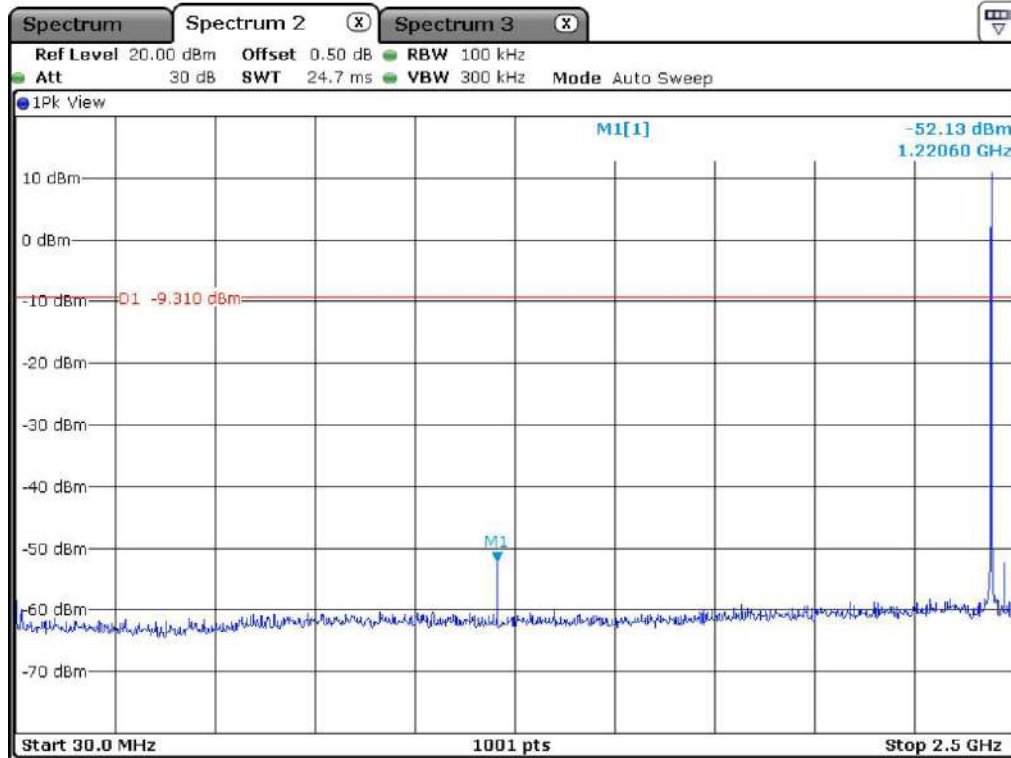
Hopping Mode



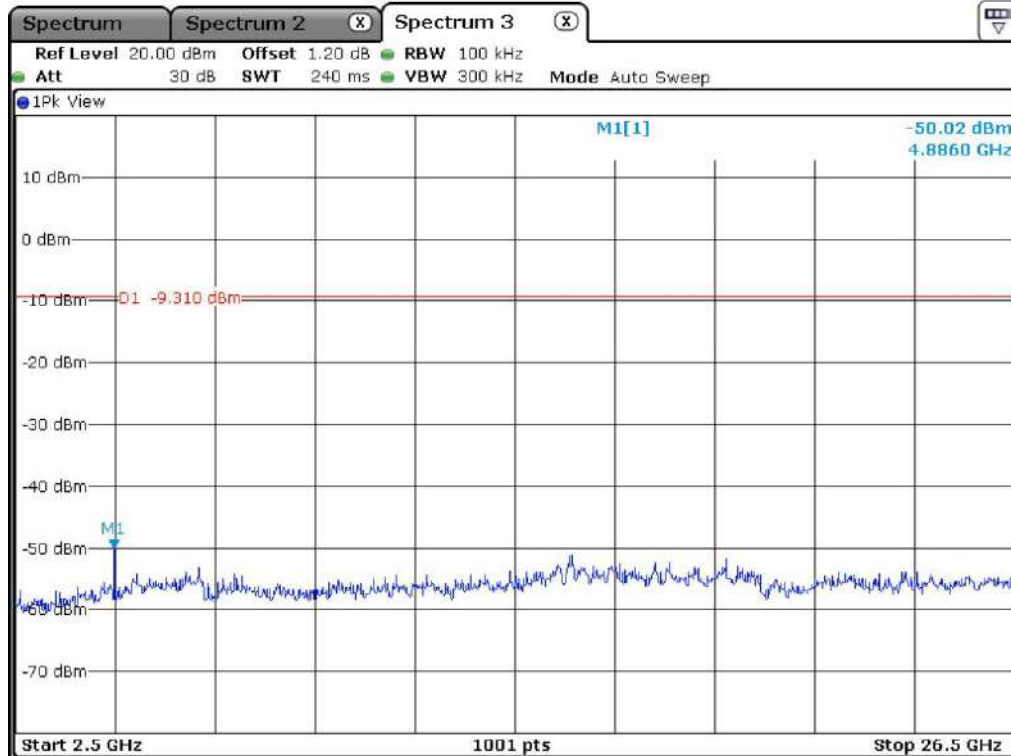
Low Channel



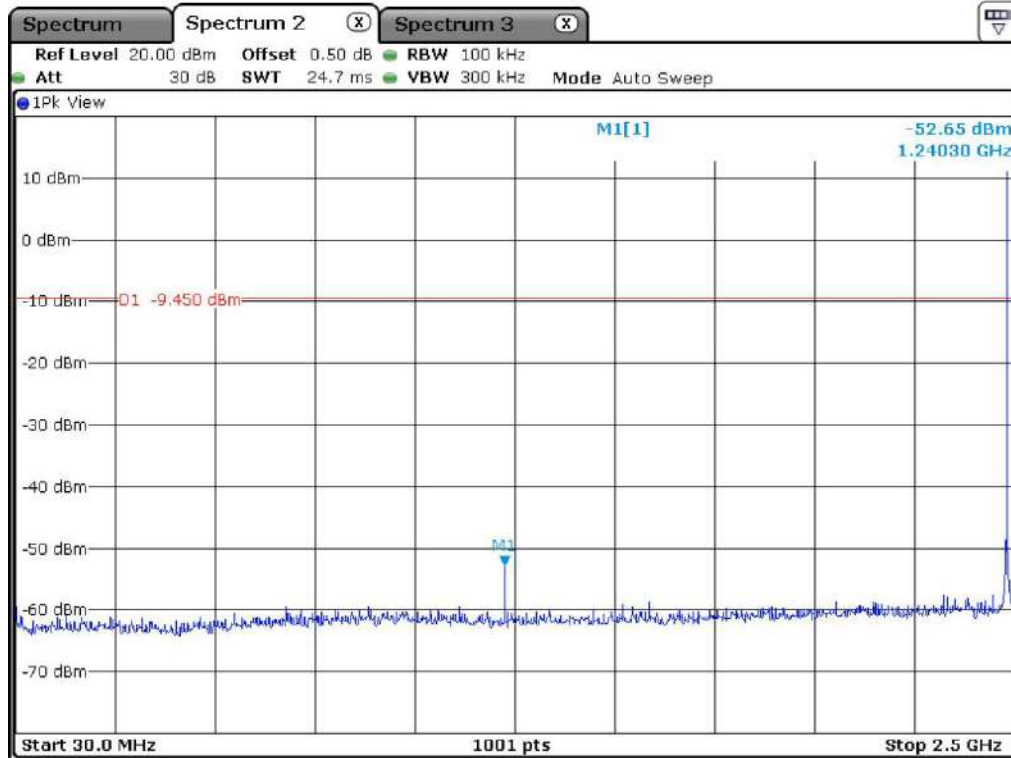
Low Channel



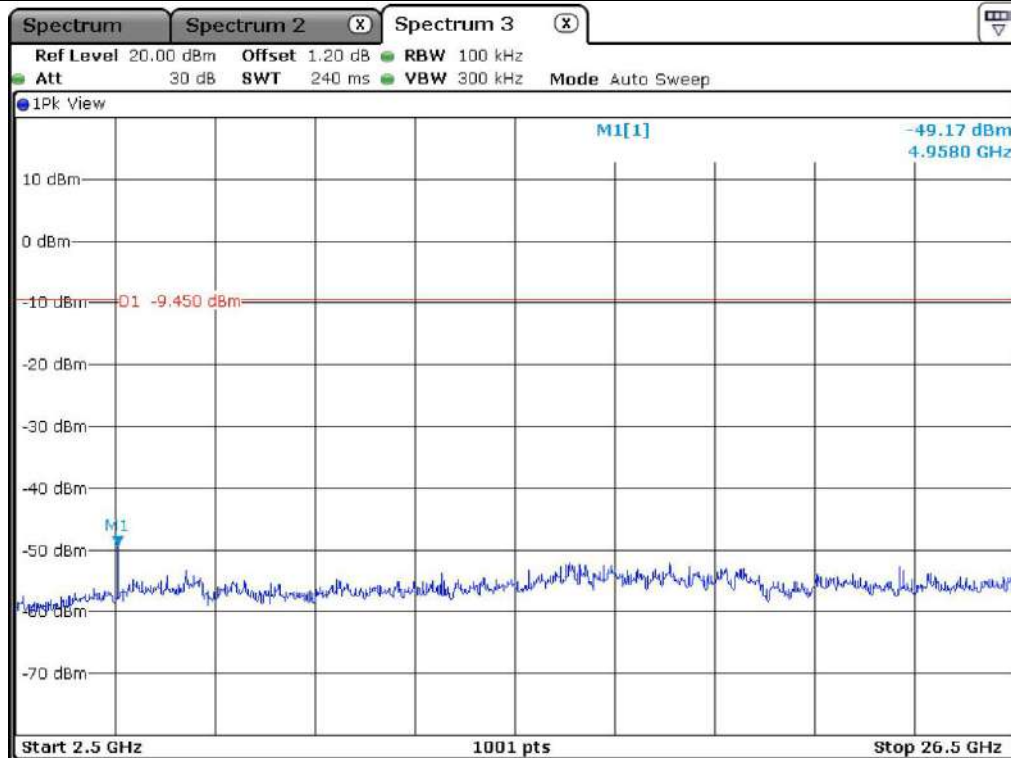
Middle Channel



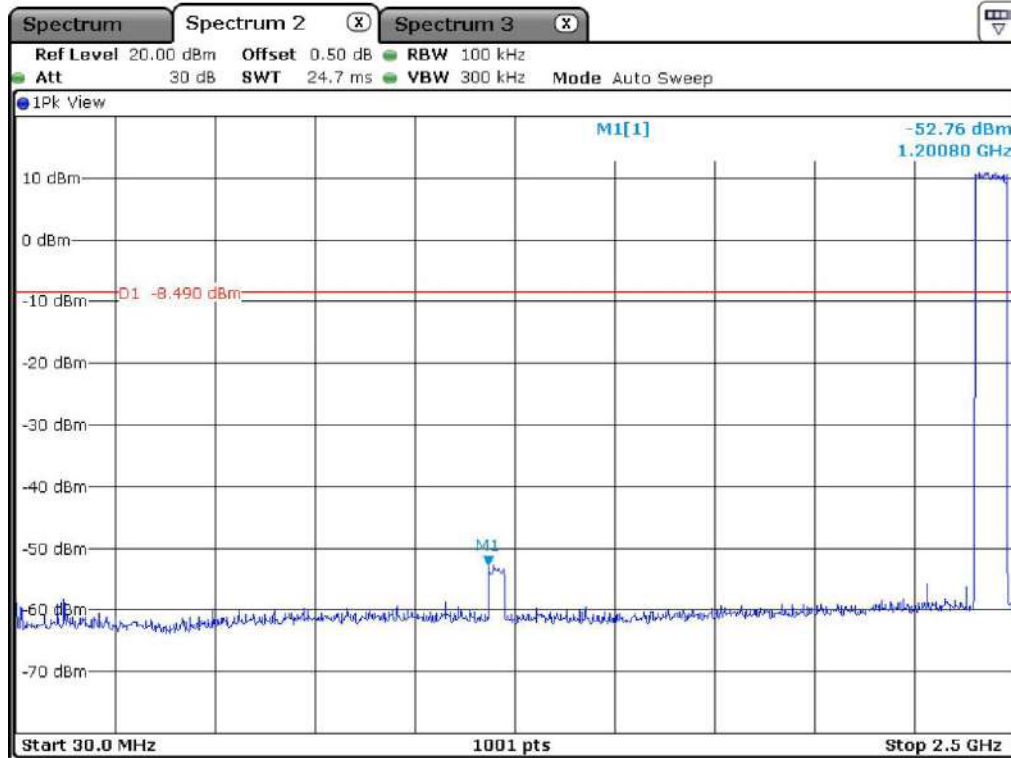
Middle Channel



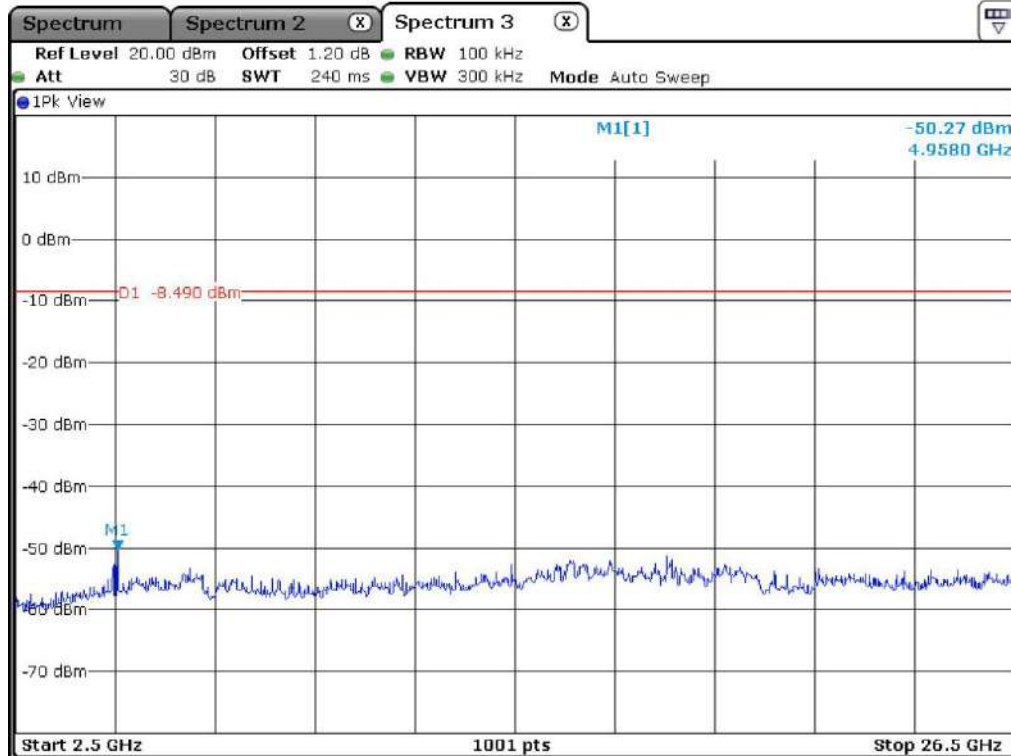
High Channel



High Channel

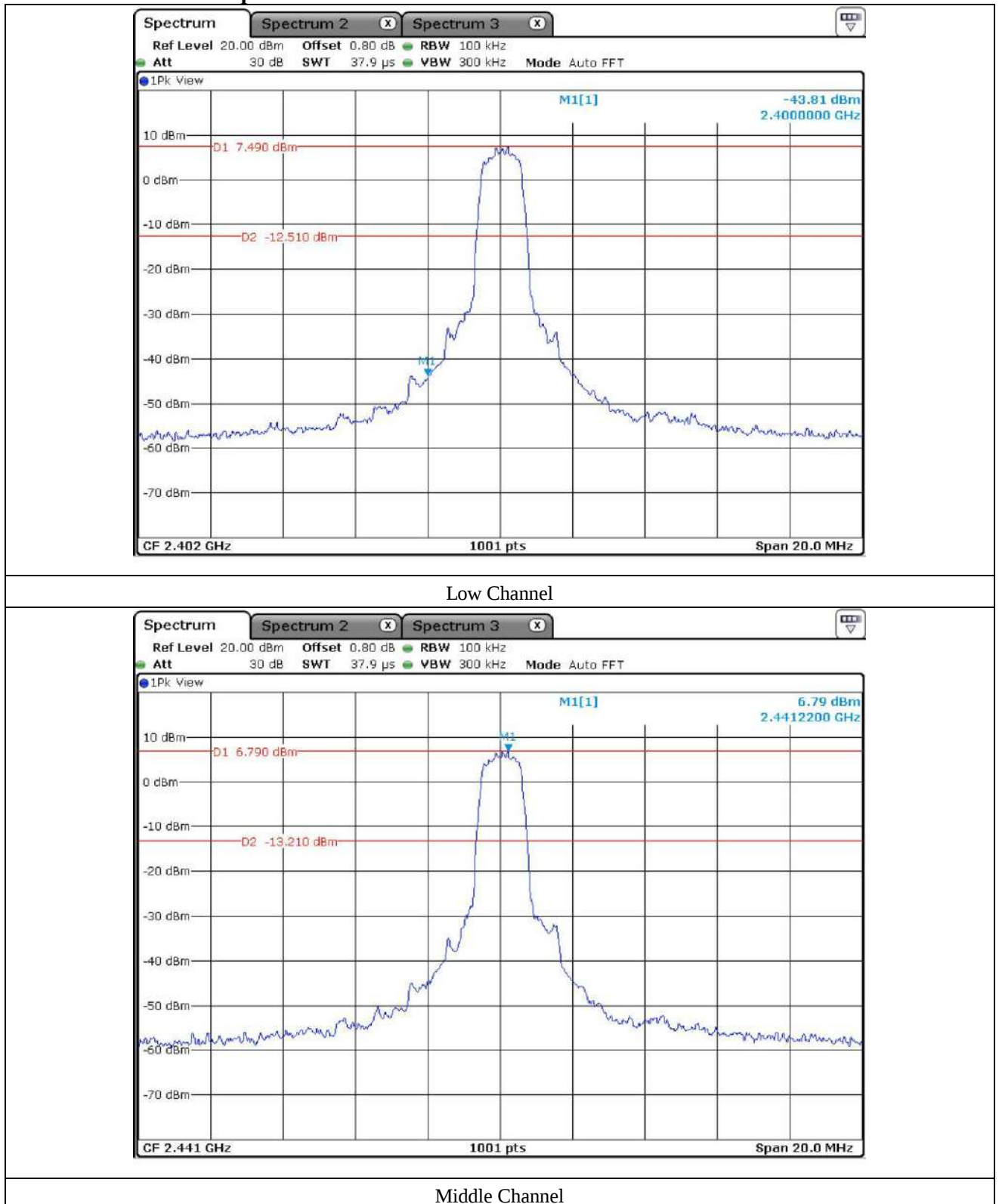


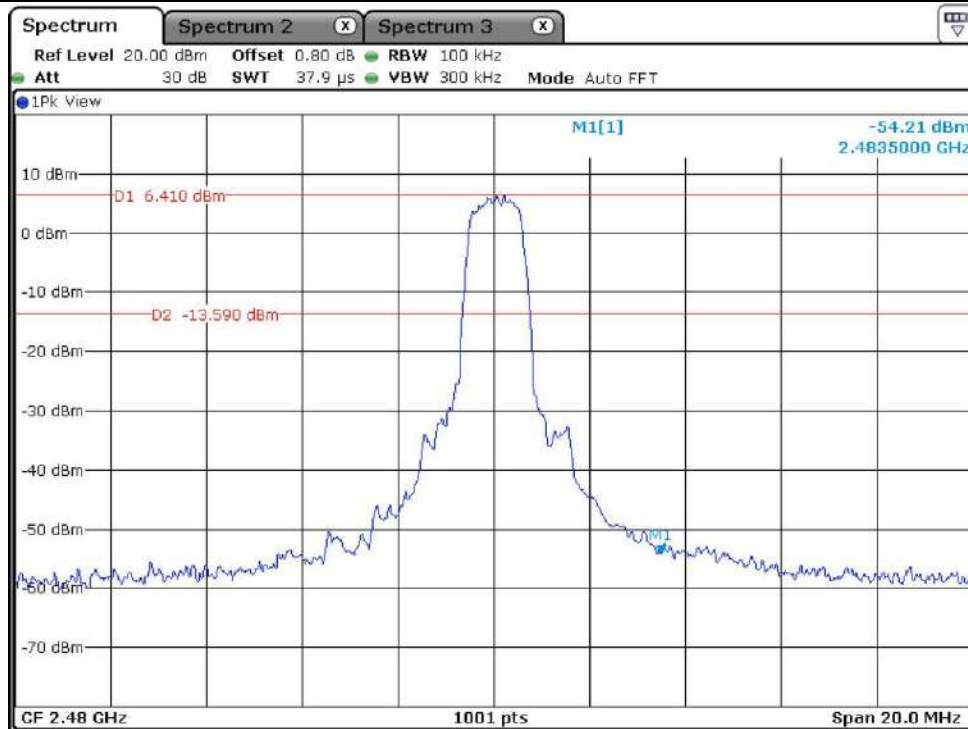
Hopping Mode



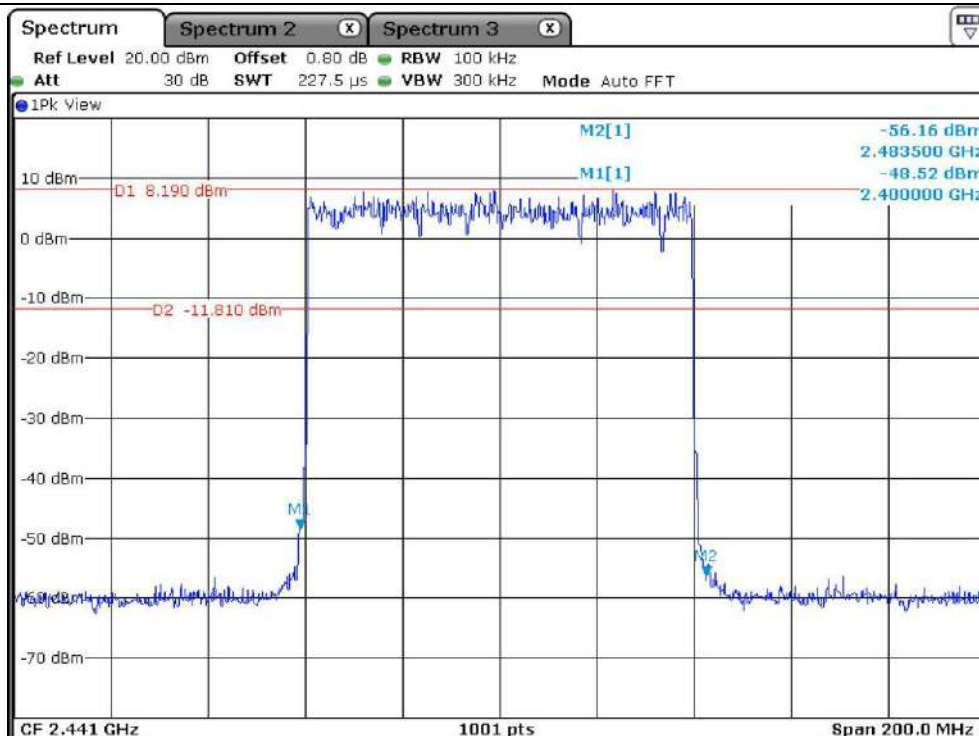
Hopping Mode

12.6.2 Test data for 2 Mbps

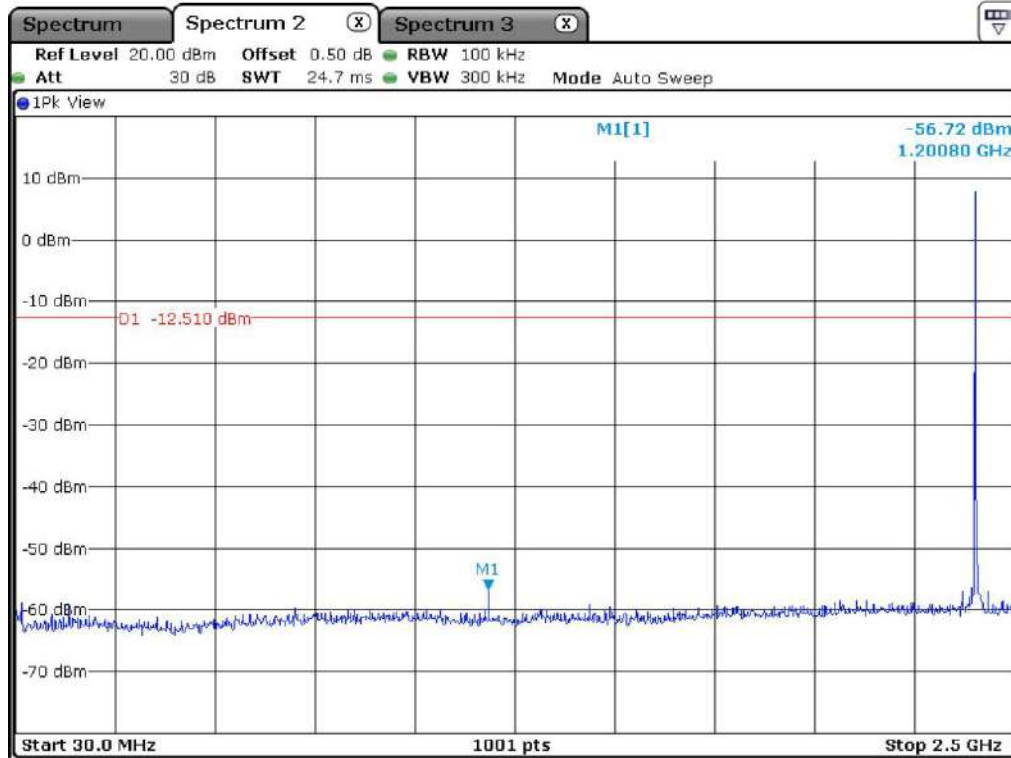




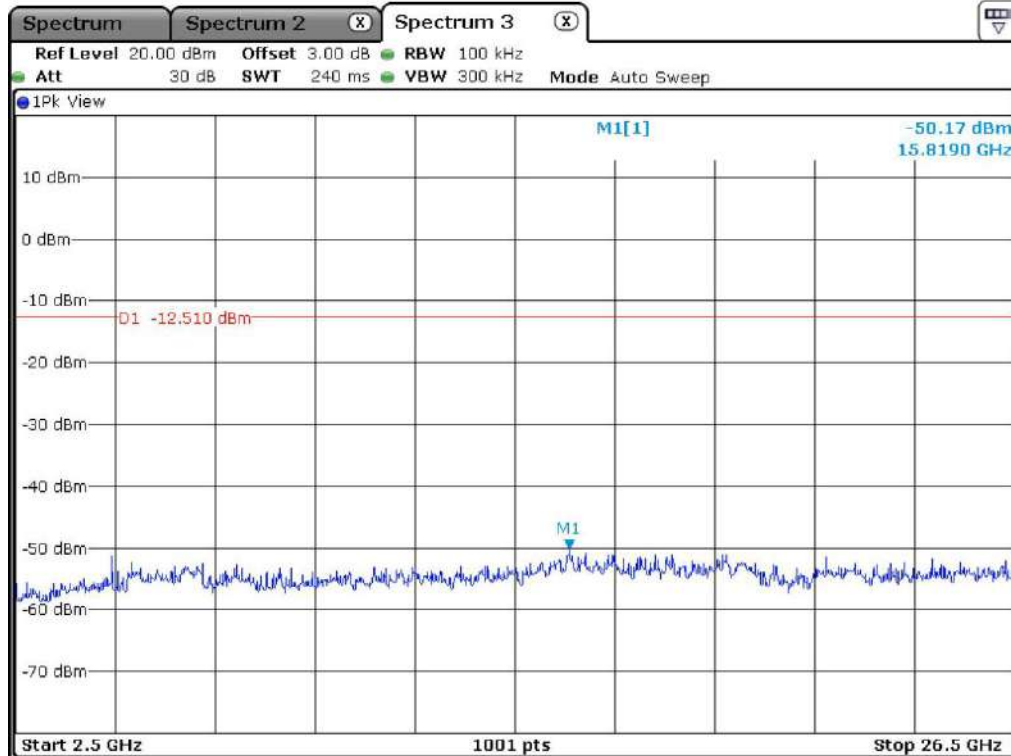
High Channel



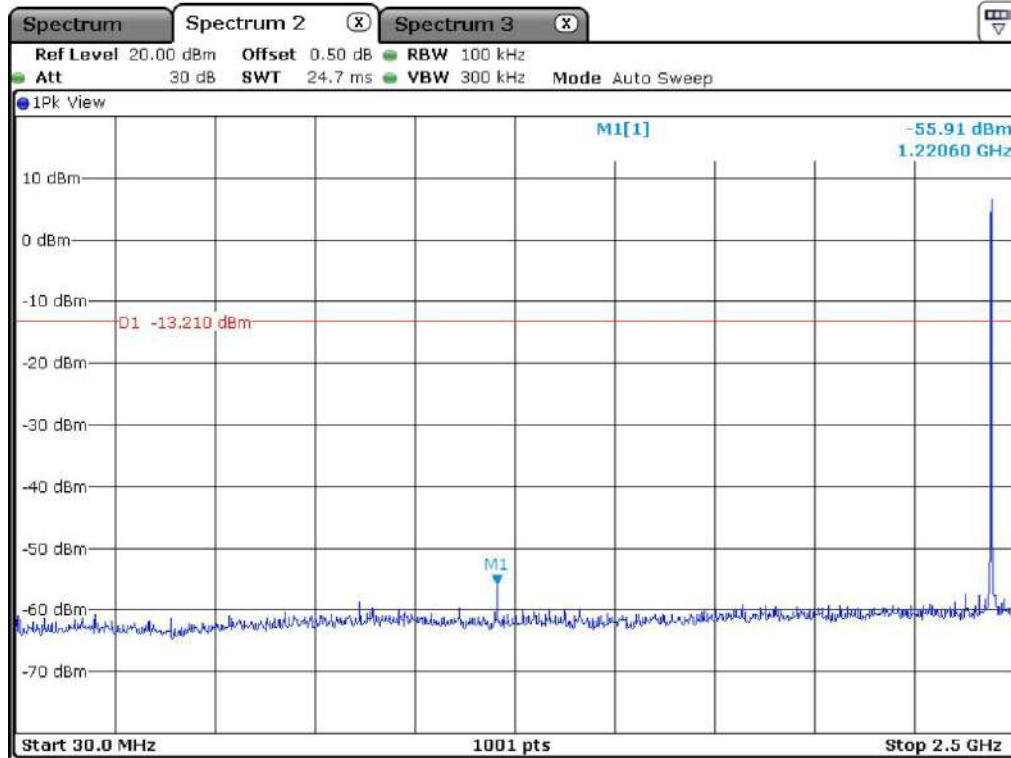
Hopping Mode



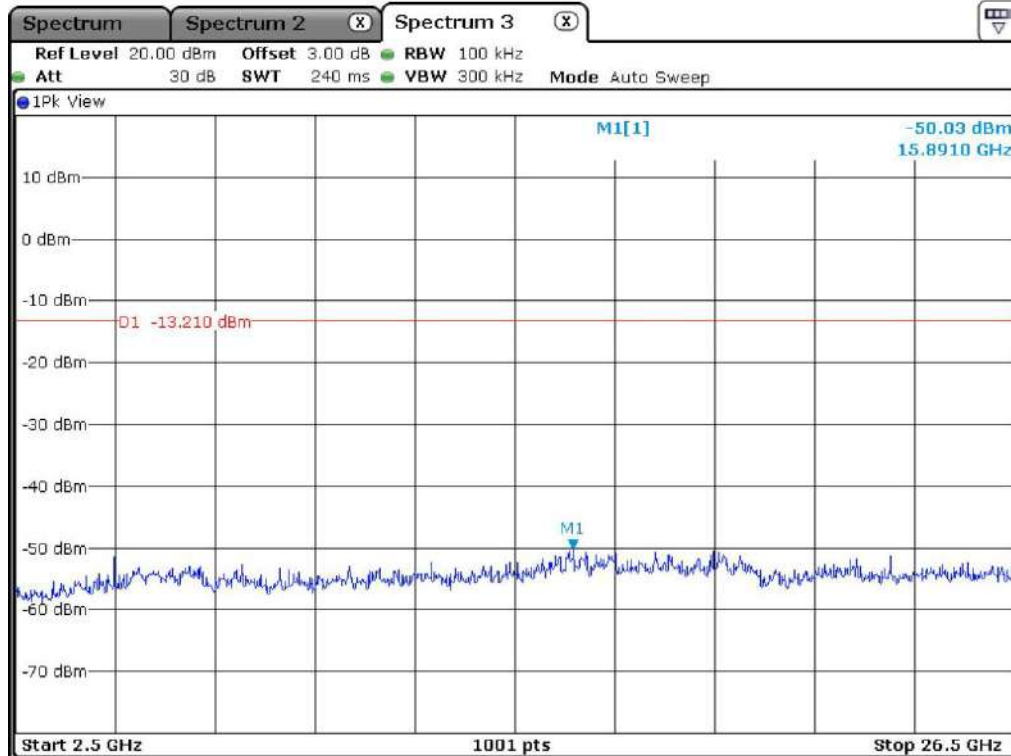
Low Channel



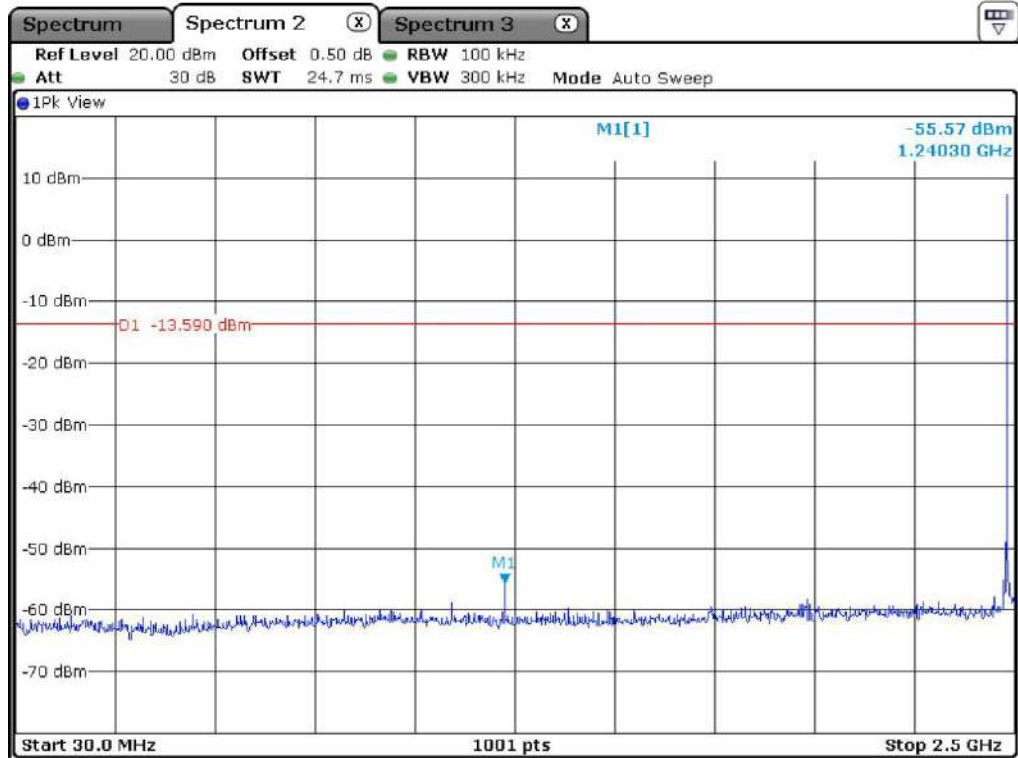
Low Channel



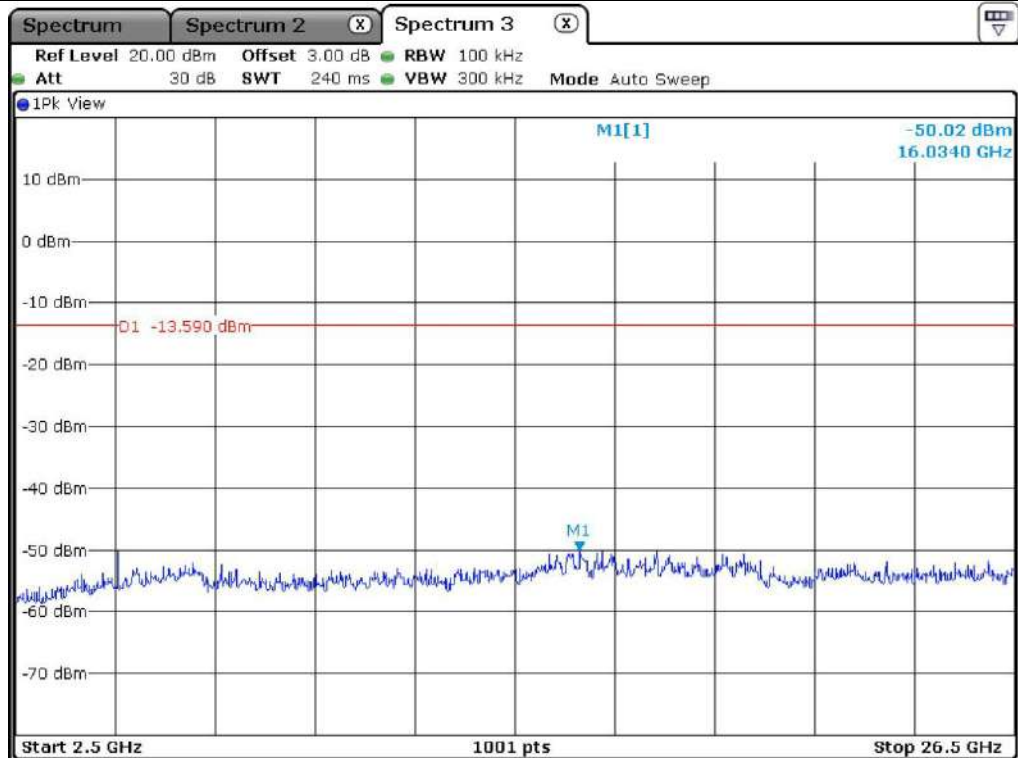
Middle Channel



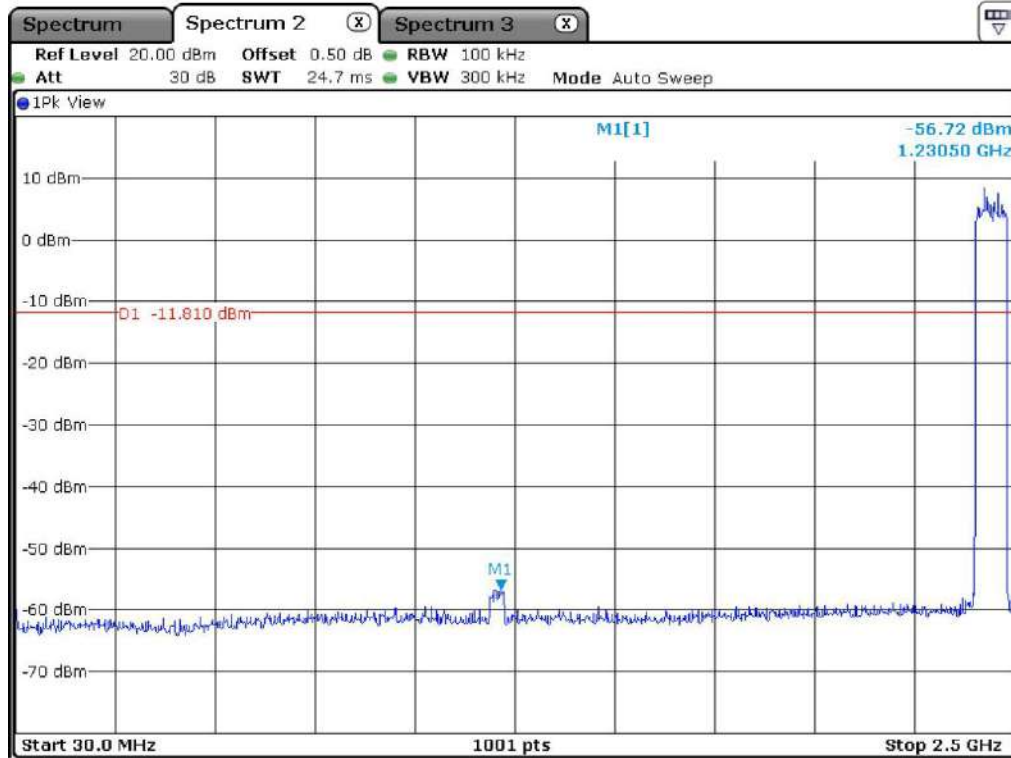
Middle Channel



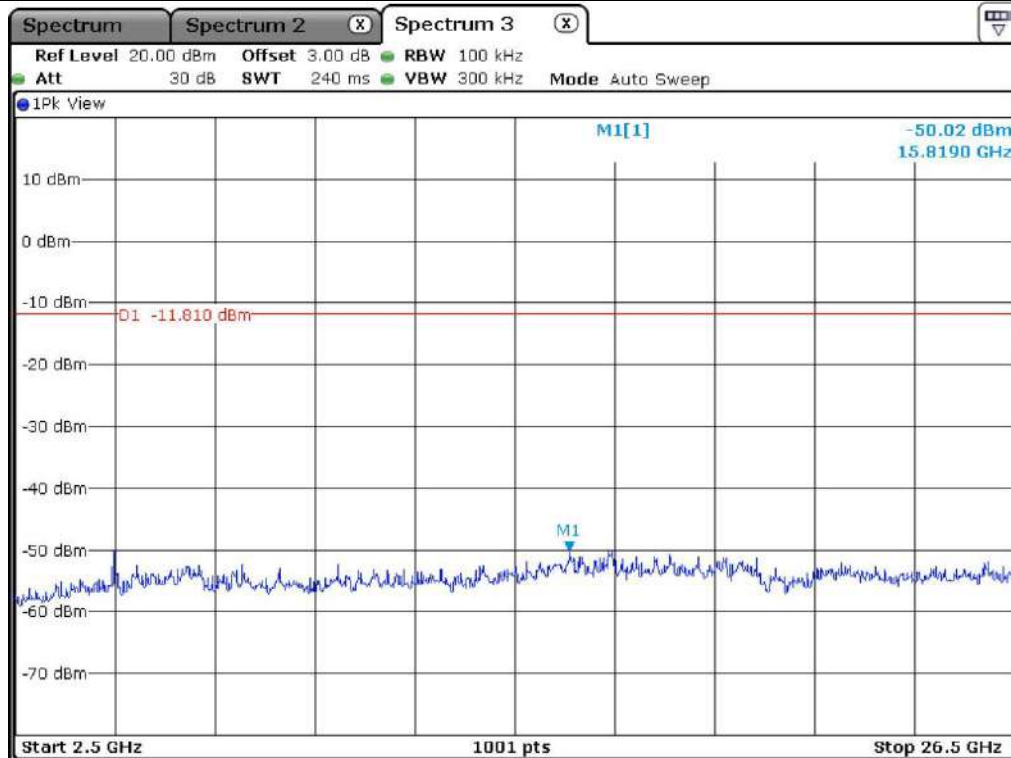
High Channel



High Channel

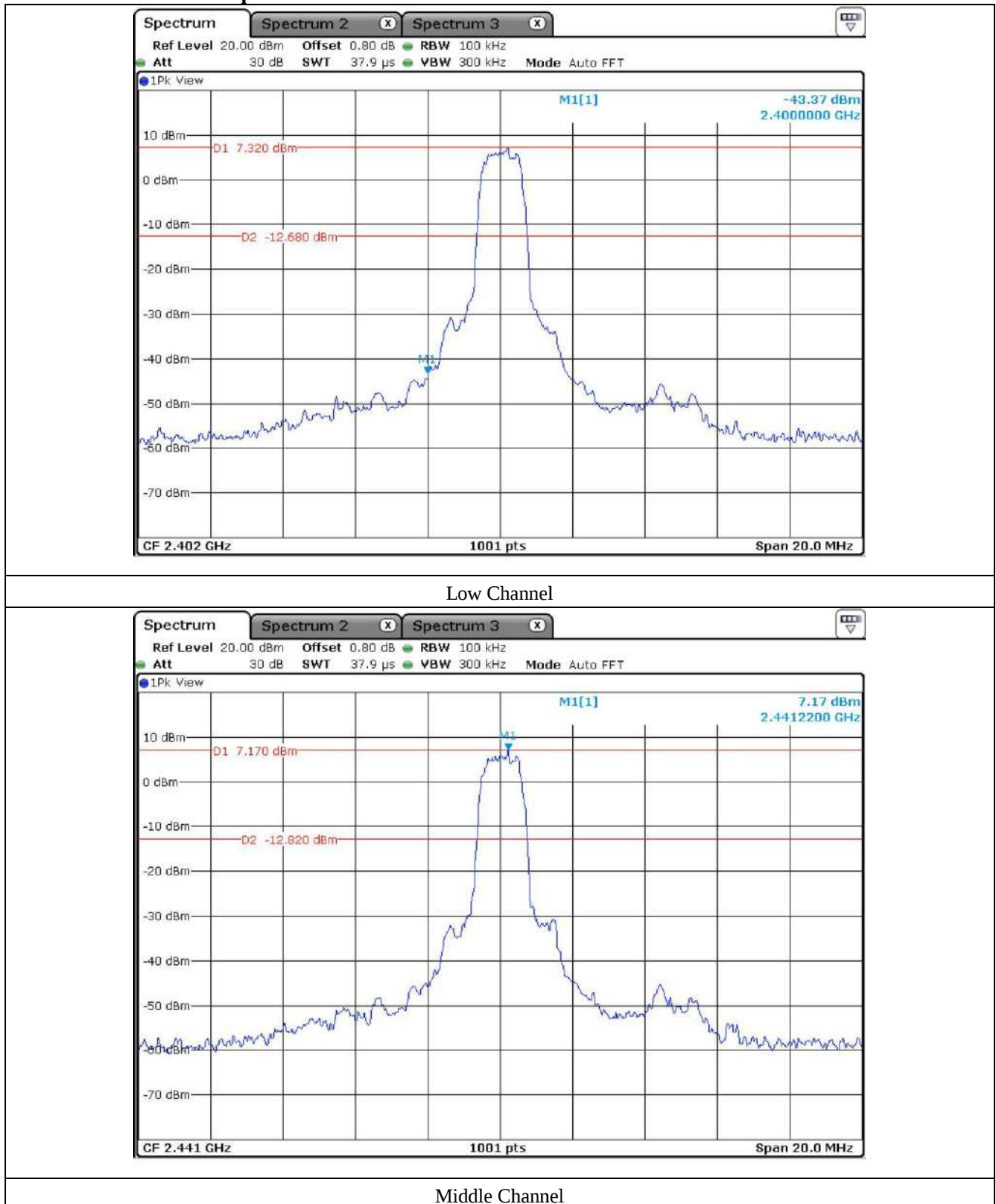


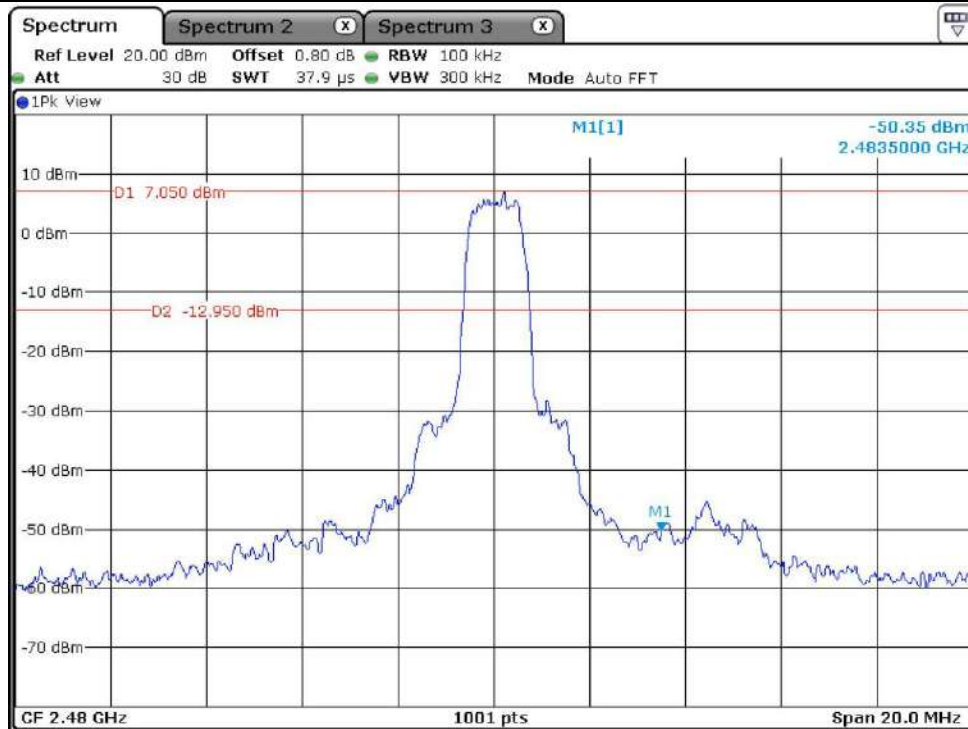
Hopping Mode



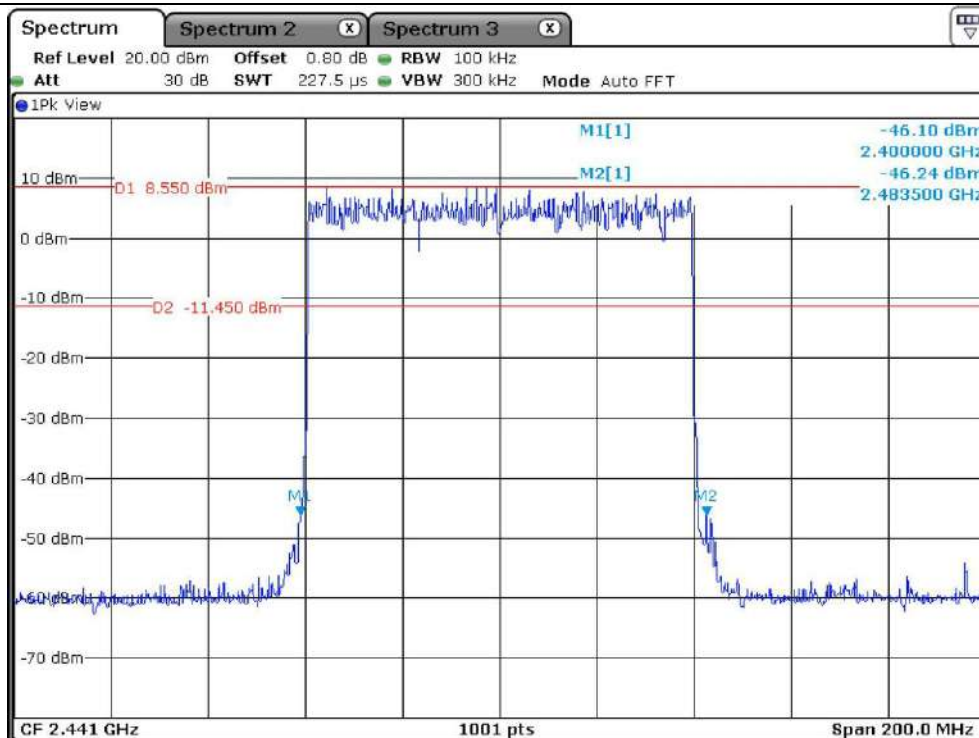
Hopping Mode

12.6.3 Test data for 3 Mbps

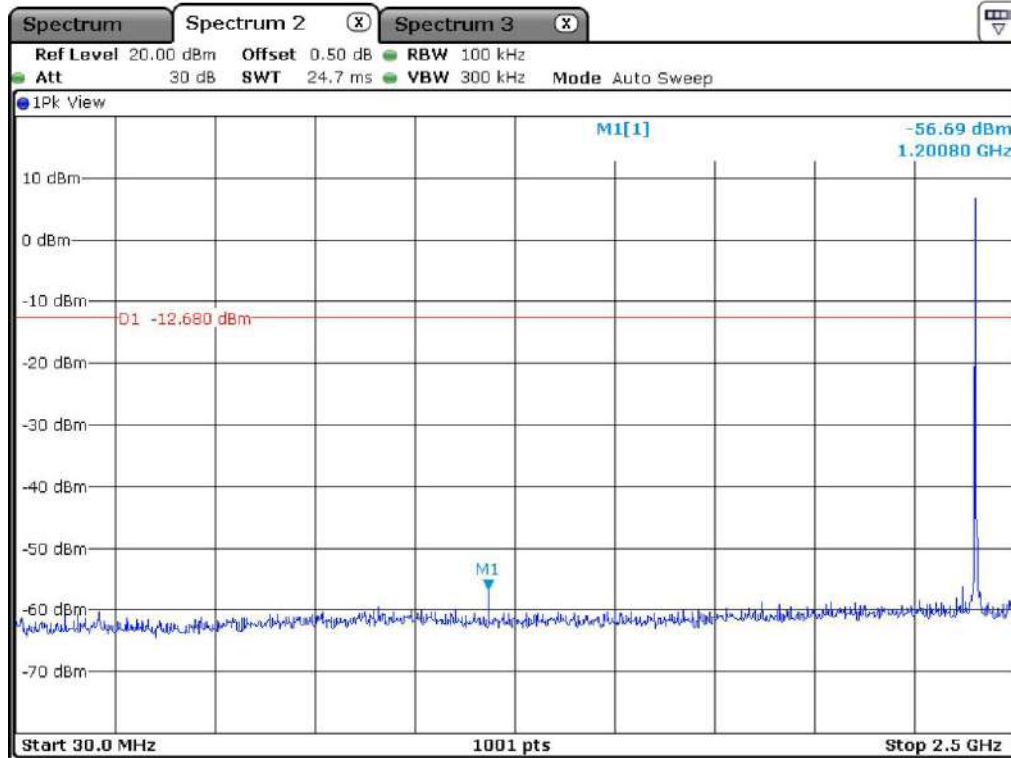




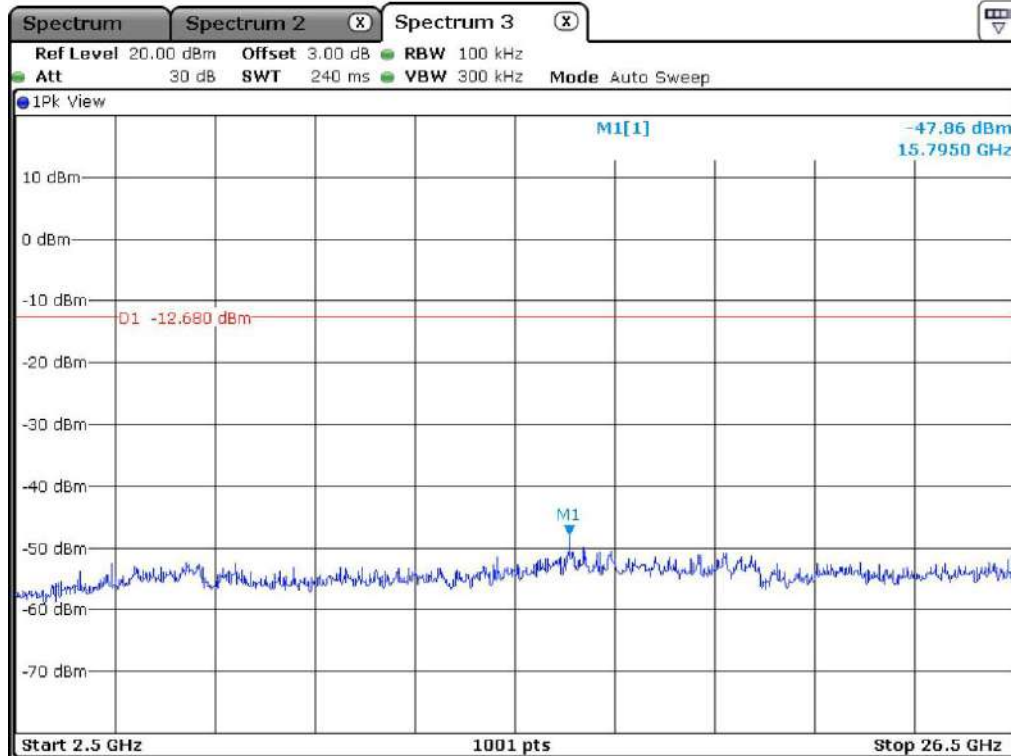
High Channel



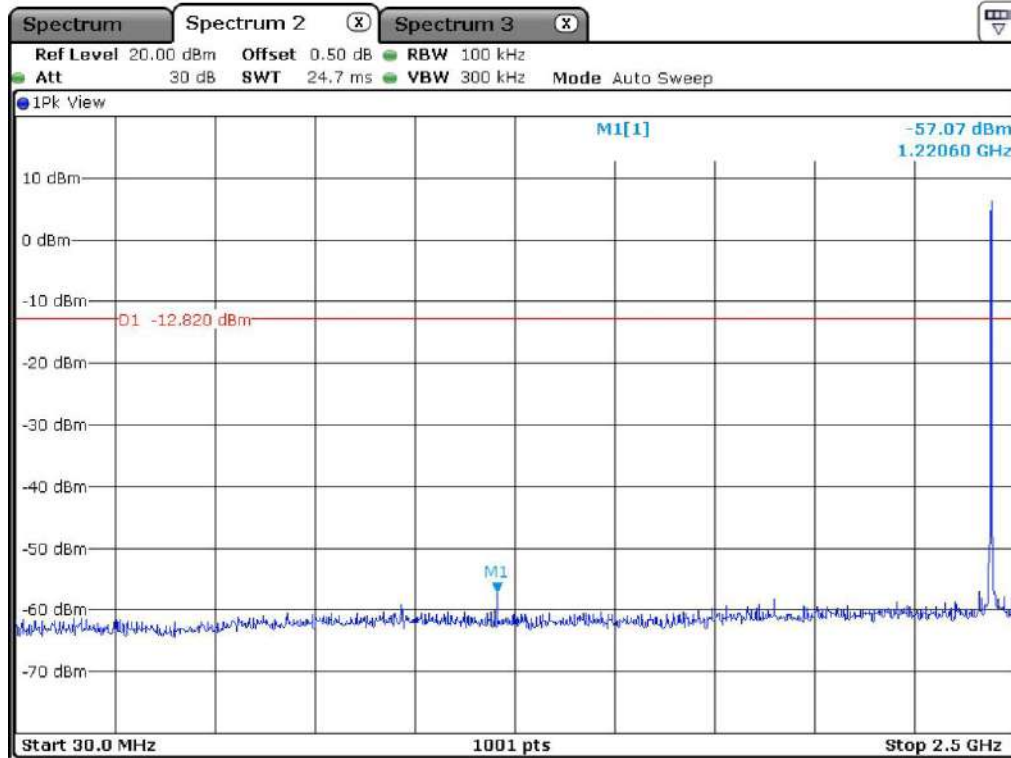
Hopping Mode



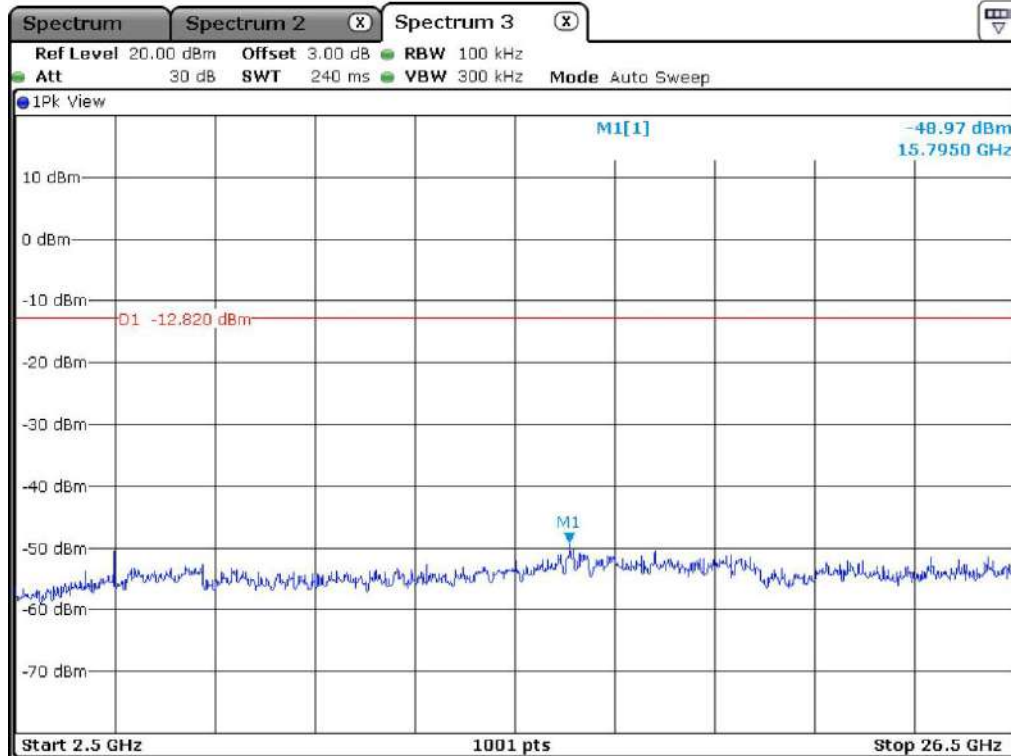
Low Channel



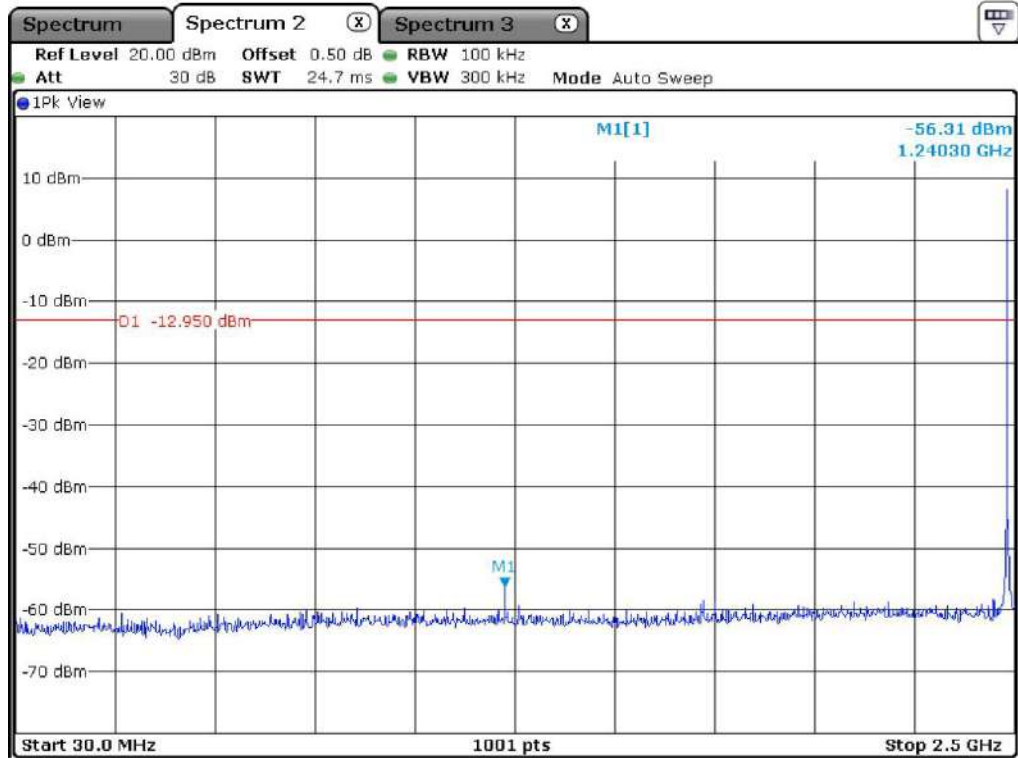
Low Channel



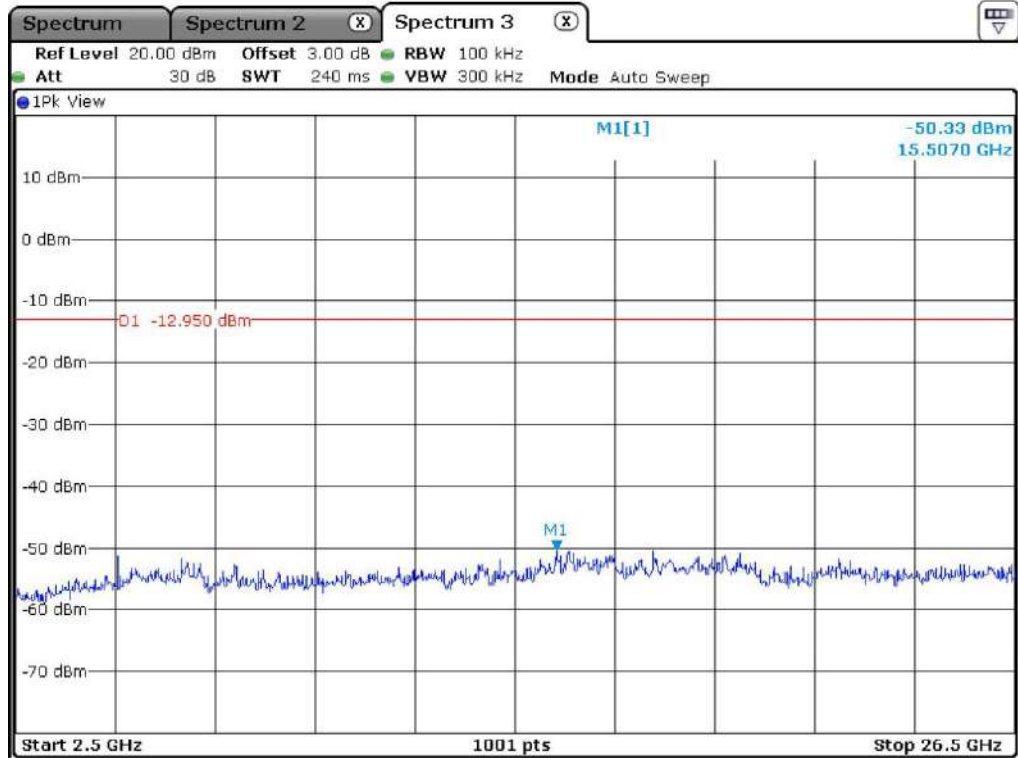
Middle Channel



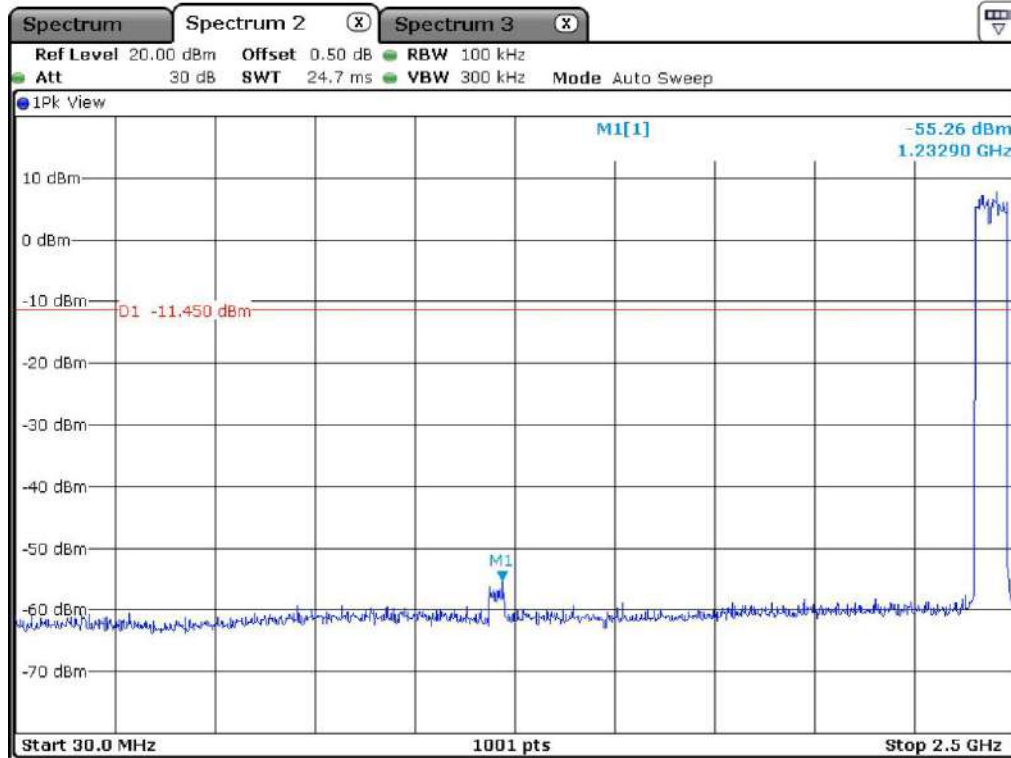
Middle Channel



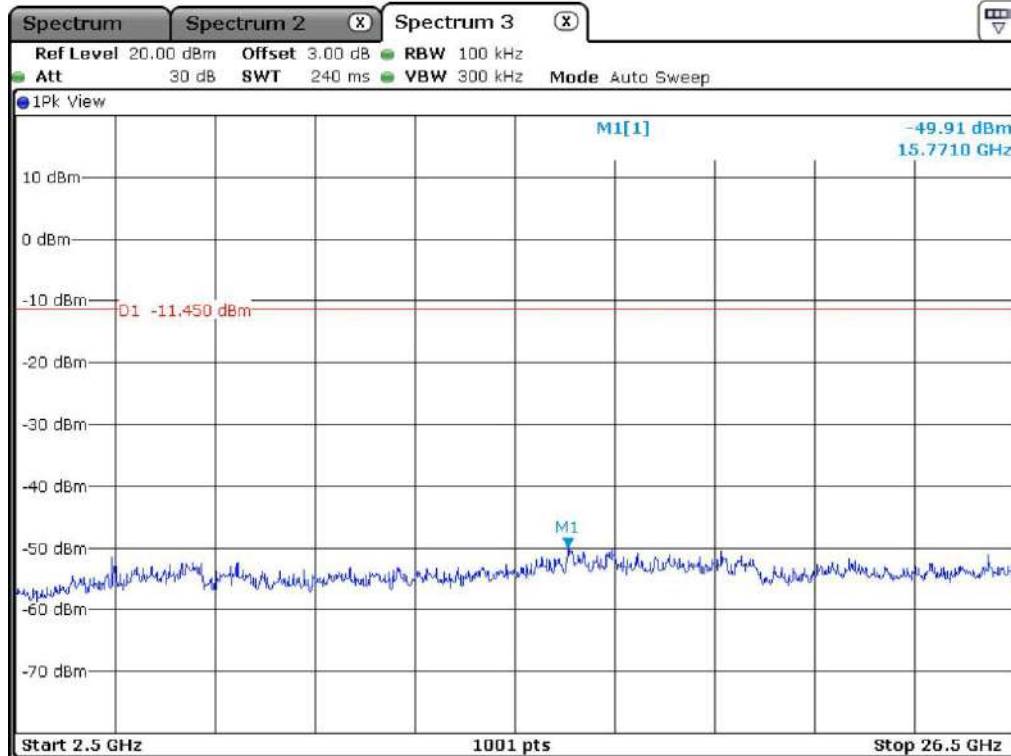
High Channel



High Channel



Hopping Mode



Hopping Mode

12.6 Test data for Transmitting mode radiated emission

12.6.1 Radiated Emission which fall in the Restricted Band (Left Earbud)

12.6.1.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 390.00	53.23	Peak	H	28.30	8.20	46.15	-	43.58	74.00	30.42
2 389.64	44.00	Average	H	28.30	8.20	46.15	1.15	35.50	54.00	18.50
2.389.74	53.02	Peak	V	28.30	8.20	46.15	-	43.37	74.00	30.63
2 390.00	43.85	Average	V	28.30	8.20	46.15	1.15	35.35	54.00	18.65
Test Data for High Channel										
2 484.49	58.03	Peak	H	28.70	8.33	46.06	-	49.00	74.00	25.00
2 483.50	46.97	Average	H	28.70	8.33	46.06	1.15	39.09	54.00	14.91
2 483.50	57.91	Peak	V	28.70	8.33	46.06	-	48.88	74.00	25.12
2 486.55	46.64	Average	V	28.70	8.33	46.06	1.15	38.76	54.00	15.24

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dBμV/m)} - \text{Total Level (dBμV/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.1.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 390.00	53.42	Peak	H	28.30	8.20	46.15	-	43.77	74.00	30.23
2 371.18	44.13	Average	H	28.30	8.20	46.15	1.15	35.63	54.00	18.37
2 390.00	53.44	Peak	V	28.30	8.20	46.15	-	43.79	74.00	30.21
2 390.00	44.00	Average	V	28.30	8.20	46.15	1.15	35.50	54.00	18.50
Test Data for High Channel										
2 483.50	58.77	Peak	H	28.70	8.33	46.06	-	49.74	74.00	24.26
2 483.50	47.67	Average	H	28.70	8.33	46.06	1.15	39.79	54.00	14.21
2 483.50	58.34	Peak	V	28.70	8.33	46.06	-	49.31	74.00	24.69
2 483.50	47.42	Average	V	28.70	8.33	46.06	1.15	39.54	54.00	14.46

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.1.3 Test data for 3 Mbps

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Measurement distance : 3 m
- . Duty Cycle : 76.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 329.68	53.67	Peak	H	28.30	8.20	46.15	-	44.02	74.00	29.98
2 390.00	44.16	Average	H	28.30	8.20	46.15	1.15	35.66	54.00	18.34
2 387.99	53.24	Peak	V	28.30	8.20	46.15	-	43.59	74.00	30.41
2 390.00	43.97	Average	V	28.30	8.20	46.15	1.15	35.47	54.00	18.53
Test Data for High Channel										
2 483.50	58.57	Peak	H	28.70	8.33	46.06	-	49.54	74.00	24.46
2 483.50	47.77	Average	H	28.70	8.33	46.06	1.15	39.89	54.00	14.11
2 483.50	58.12	Peak	V	28.70	8.33	46.06	-	49.09	74.00	24.91
2 483.50	47.27	Average	V	28.70	8.33	46.06	1.15	39.39	54.00	14.61

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.2 Radiated Emission which fall in the Restricted Band (Right Earbud)

12.6.2.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 390.00	52.90	Peak	H	28.30	8.20	46.15	-	43.25	74.00	30.75
2 384.46	43.56	Average	H	28.30	8.20	46.15	1.15	35.06	54.00	18.94
2 372.94	52.65	Peak	V	28.30	8.20	46.15	-	43.00	74.00	31.00
2 390.00	43.36	Average	V	28.30	8.20	46.15	1.15	34.86	54.00	19.14
Test Data for High Channel										
2 483.50	62.94	Peak	H	28.70	8.33	46.06	-	53.91	74.00	20.09
2 483.50	50.80	Average	H	28.70	8.33	46.06	1.15	42.92	54.00	11.08
2 483.50	62.05	Peak	V	28.70	8.33	46.06	-	53.02	74.00	20.98
2 483.50	50.39	Average	V	28.70	8.33	46.06	1.15	42.51	54.00	11.49

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.2.2 Test data for 2 Mbps

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Measurement distance : 3 m
- . Duty Cycle : 76.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 390.00	53.22	Peak	H	28.30	8.20	46.15	-	43.57	74.00	30.43
2 390.00	43.99	Average	H	28.30	8.20	46.15	1.15	35.49	54.00	18.51
2 390.00	52.74	Peak	V	28.30	8.20	46.15	-	43.09	74.00	30.91
2 390.00	43.66	Average	V	28.30	8.20	46.15	1.15	35.16	54.00	18.84
Test Data for High Channel										
2 483.50	60.69	Peak	H	28.70	8.33	46.06	-	51.66	74.00	22.34
2 483.50	50.31	Average	H	28.70	8.33	46.06	1.15	42.43	54.00	11.57
2 483.50	59.61	Peak	V	28.70	8.33	46.06	-	50.58	74.00	23.42
2 483.50	49.70	Average	V	28.70	8.33	46.06	1.15	41.82	54.00	12.18

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.2.3 Test data for 3 Mbps

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Measurement distance : 3 m
- . Duty Cycle : 76.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 359.67	53.28	Peak	H	28.30	8.20	46.15	-	43.63	74.00	30.37
2 377.41	43.95	Average	H	28.30	8.20	46.15	1.15	35.45	54.00	18.55
2 390.00	53.03	Peak	V	28.30	8.20	46.15	-	43.38	74.00	30.62
2 390.00	43.75	Average	V	28.30	8.20	46.15	1.15	35.25	54.00	18.75
Test Data for High Channel										
2 483.50	61.01	Peak	H	28.70	8.33	46.06	-	51.98	74.00	22.02
2 483.50	51.01	Average	H	28.70	8.33	46.06	1.15	43.13	54.00	10.87
2 483.50	60.76	Peak	V	28.70	8.33	46.06	-	51.73	74.00	22.27
2 483.50	50.41	Average	V	28.70	8.33	46.06	1.15	42.53	54.00	11.47

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.3 Spurious & Harmonic Radiated Emission above 1 GHz (Left Earbud)

12.6.3.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	53.68	Peak	H	33.40	11.21	45.73	-	52.56	74.00	21.44
4 804.00	44.88	Average	H	33.40	11.21	45.73	1.15	44.91	54.00	9.09
4 804.00	53.33	Peak	V	33.40	11.21	45.73	-	52.21	74.00	21.79
4 804.00	44.47	Average	V	33.40	11.21	45.73	1.15	44.50	54.00	9.50
Test Data for Middle Channel										
4 882.00	53.44	Peak	H	33.50	11.23	45.80	-	52.37	74.00	21.63
4 882.00	44.74	Average	H	33.50	11.23	45.80	1.15	44.82	54.00	9.18
4 882.00	53.28	Peak	V	33.50	11.23	45.80	-	52.21	74.00	21.79
4 882.00	44.50	Average	V	33.50	11.23	45.80	1.15	44.58	54.00	9.42
Test Data for High Channel										
4 960.00	52.70	Peak	H	33.40	11.31	45.89	-	51.52	74.00	22.48
4 960.00	44.06	Average	H	33.40	11.31	45.89	1.15	44.03	54.00	9.97
4 960.00	52.43	Peak	V	33.40	11.31	45.89	-	51.25	74.00	22.75
4 960.00	43.75	Average	V	33.40	11.31	45.89	1.15	43.72	54.00	10.28

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.3.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	52.64	Peak	H	33.40	11.21	45.73	-	51.52	74.00	22.48
4 804.00	43.87	Average	H	33.40	11.21	45.73	1.15	43.90	54.00	10.10
4 804.00	52.16	Peak	V	33.40	11.21	45.73	-	51.04	74.00	22.96
4 804.00	43.51	Average	V	33.40	11.21	45.73	1.15	43.54	54.00	10.46
Test Data for Middle Channel										
4 882.00	52.44	Peak	H	33.50	11.23	45.80	-	51.37	74.00	22.63
4 882.00	43.80	Average	H	33.50	11.23	45.80	1.15	43.88	54.00	10.12
4 882.00	52.13	Peak	V	33.50	11.23	45.80	-	51.06	74.00	22.94
4 882.00	43.57	Average	V	33.50	11.23	45.80	1.15	43.65	54.00	10.35
Test Data for High Channel										
4 960.00	52.33	Peak	H	33.40	11.31	45.89	-	51.15	74.00	22.85
4 960.00	43.69	Average	H	33.40	11.31	45.89	1.15	43.66	54.00	10.34
4 960.00	52.00	Peak	V	33.40	11.31	45.89	-	50.82	74.00	23.18
4 960.00	43.54	Average	V	33.40	11.31	45.89	1.15	43.51	54.00	10.49

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Duty Factor

12.6.3.3 Test data for 3 Mbps

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Duty Cycle : 76.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	52.53	Peak	H	33.40	11.21	45.73	-	51.41	74.00	22.59
4 804.00	43.99	Average	H	33.40	11.21	45.73	1.15	44.02	54.00	9.98
4 804.00	52.30	Peak	V	33.40	11.21	45.73	-	51.18	74.00	22.82
4 804.00	43.61	Average	V	33.40	11.21	45.73	1.15	43.64	54.00	10.36
Test Data for Middle Channel										
4 882.00	52.52	Peak	H	33.50	11.23	45.80	-	51.45	74.00	22.55
4 882.00	44.01	Average	H	33.50	11.23	45.80	1.15	44.09	54.00	9.91
4 882.00	52.43	Peak	V	33.50	11.23	45.80	-	51.36	74.00	22.64
4 882.00	43.66	Average	V	33.50	11.23	45.80	1.15	43.74	54.00	10.26
Test Data for High Channel										
4 960.00	52.14	Peak	H	33.40	11.31	45.89	-	50.96	74.00	23.04
4 960.00	43.54	Average	H	33.40	11.31	45.89	1.15	43.51	54.00	10.49
4 960.00	52.15	Peak	V	33.40	11.31	45.89	-	50.97	74.00	23.03
4 960.00	43.48	Average	V	33.40	11.31	45.89	1.15	43.45	54.00	10.55

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dBμV/m)} - \text{Total Level (dBμV/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.4 Spurious & Harmonic Radiated Emission above 1 GHz (Right Earbud)

12.6.4.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	55.61	Peak	H	33.40	11.21	45.73	-	54.49	74.00	19.51
4 804.00	50.25	Average	H	33.40	11.21	45.73	1.15	50.28	54.00	3.72
4 804.00	54.26	Peak	V	33.40	11.21	45.73	-	53.14	74.00	20.86
4 804.00	48.39	Average	V	33.40	11.21	45.73	1.15	48.42	54.00	5.58
Test Data for Middle Channel										
4 882.00	53.92	Peak	H	33.50	11.23	45.80	-	52.85	74.00	21.15
4 882.00	48.21	Average	H	33.50	11.23	45.80	1.15	48.29	54.00	5.71
4 882.00	52.69	Peak	V	33.50	11.23	45.80	-	51.62	74.00	22.38
4 882.00	46.86	Average	V	33.50	11.23	45.80	1.15	46.94	54.00	7.06
Test Data for High Channel										
4 960.00	53.36	Peak	H	33.40	11.31	45.89	-	52.18	74.00	21.82
4 960.00	47.65	Average	H	33.40	11.31	45.89	1.15	47.62	54.00	6.38
4 960.00	52.49	Peak	V	33.40	11.31	45.89	-	51.31	74.00	22.69
4 960.00	46.32	Average	V	33.40	11.31	45.89	1.15	46.29	54.00	7.71

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

12.6.4.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	53.96	Peak	H	33.40	11.21	45.73	-	52.84	74.00	21.16
4 804.00	48.56	Average	H	33.40	11.21	45.73	1.15	48.59	54.00	5.41
4 804.00	52.86	Peak	V	33.40	11.21	45.73	-	51.74	74.00	22.26
4 804.00	46.89	Average	V	33.40	11.21	45.73	1.15	46.92	54.00	7.08
Test Data for Middle Channel										
4 882.00	52.87	Peak	H	33.50	11.23	45.80	-	51.80	74.00	22.20
4 882.00	47.25	Average	H	33.50	11.23	45.80	1.15	47.33	54.00	6.67
4 882.00	52.17	Peak	V	33.50	11.23	45.80	-	51.10	74.00	22.90
4 882.00	45.99	Average	V	33.50	11.23	45.80	1.15	46.07	54.00	7.93
Test Data for High Channel										
4 960.00	52.54	Peak	H	33.40	11.31	45.89	-	51.36	74.00	22.64
4 960.00	46.68	Average	H	33.40	11.31	45.89	1.15	46.65	54.00	7.35
4 960.00	51.11	Peak	V	33.40	11.31	45.89	-	49.93	74.00	24.07
4 960.00	45.33	Average	V	33.40	11.31	45.89	1.15	45.30	54.00	8.70

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Duty Factor

12.6.4.3 Test data for 3 Mbps

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Duty Cycle : 76.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	54.25	Peak	H	33.40	11.21	45.73	-	53.13	74.00	20.87
4 804.00	48.53	Average	H	33.40	11.21	45.73	1.15	48.56	54.00	5.44
4 804.00	52.71	Peak	V	33.40	11.21	45.73	-	51.59	74.00	22.41
4 804.00	46.97	Average	V	33.40	11.21	45.73	1.15	47.00	54.00	7.00
Test Data for Middle Channel										
4 882.00	52.81	Peak	H	33.50	11.23	45.80	-	51.74	74.00	22.26
4 882.00	47.23	Average	H	33.50	11.23	45.80	1.15	47.31	54.00	6.69
4 882.00	51.96	Peak	V	33.50	11.23	45.80	-	50.89	74.00	23.11
4 882.00	45.71	Average	V	33.50	11.23	45.80	1.15	45.79	54.00	8.21
Test Data for High Channel										
4 960.00	52.55	Peak	H	33.40	11.31	45.89	-	51.37	74.00	22.63
4 960.00	46.47	Average	H	33.40	11.31	45.89	1.15	46.44	54.00	7.56
4 960.00	51.12	Peak	V	33.40	11.31	45.89	-	49.94	74.00	24.06
4 960.00	45.29	Average	V	33.40	11.31	45.89	1.15	45.26	54.00	8.74

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

13. RADIATED EMISSION TEST

13.1 Operating environment

Temperature : 22 °C
Relative humidity : 46 % R.H.

13.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

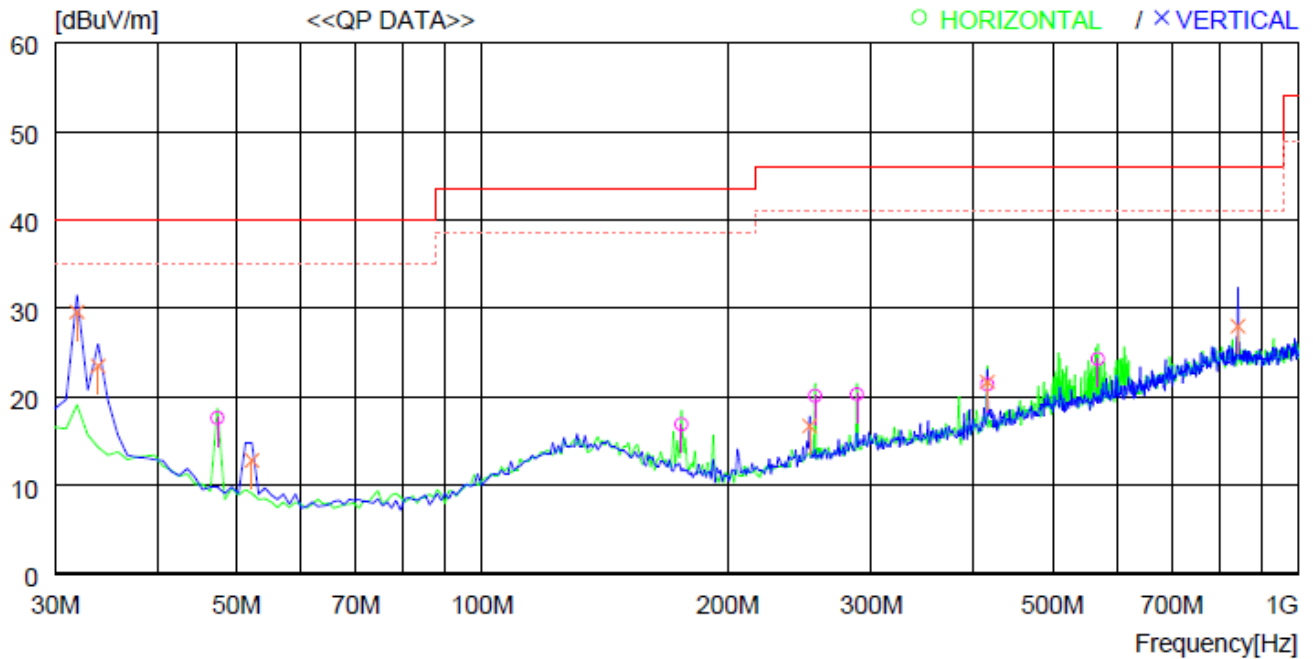
13.3 Test Date

May 17, 2021 ~ May 31, 2021

13.4 Test data for Left Earbud

13.4.1 Test data for 30 MHz ~ 1000 MHz

- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	47.460	34.9	14.1	0.7	32.1	17.6	40.0	22.4	400	359
2	175.500	30.6	16.8	1.5	32.0	16.9	43.5	26.6	200	359
3	256.010	32.4	17.8	1.9	32.0	20.1	46.0	25.9	100	306
4	288.020	31.6	18.7	2.0	32.0	20.3	46.0	25.7	200	231
5	416.061	30.1	20.9	2.5	32.1	21.4	46.0	24.6	100	290
6	568.349	29.9	23.9	2.9	32.4	24.3	46.0	21.7	200	240
----- Vertical -----										
7	31.940	40.7	20.3	0.6	32.0	29.6	40.0	10.4	100	303
8	33.880	35.4	19.5	0.6	32.0	23.5	40.0	16.5	100	312
9	52.310	31.2	12.9	0.8	32.1	12.8	40.0	27.2	100	229
10	252.130	29.1	17.7	1.9	32.0	16.7	46.0	29.3	200	237
11	416.061	30.4	20.9	2.5	32.1	21.7	46.0	24.3	100	312
12	843.821	28.7	27.2	4.0	31.9	28.0	46.0	18.0	100	322

13.4.2 Test data for Below 30 MHz

- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

13.4.3 Test data for above 1 GHz

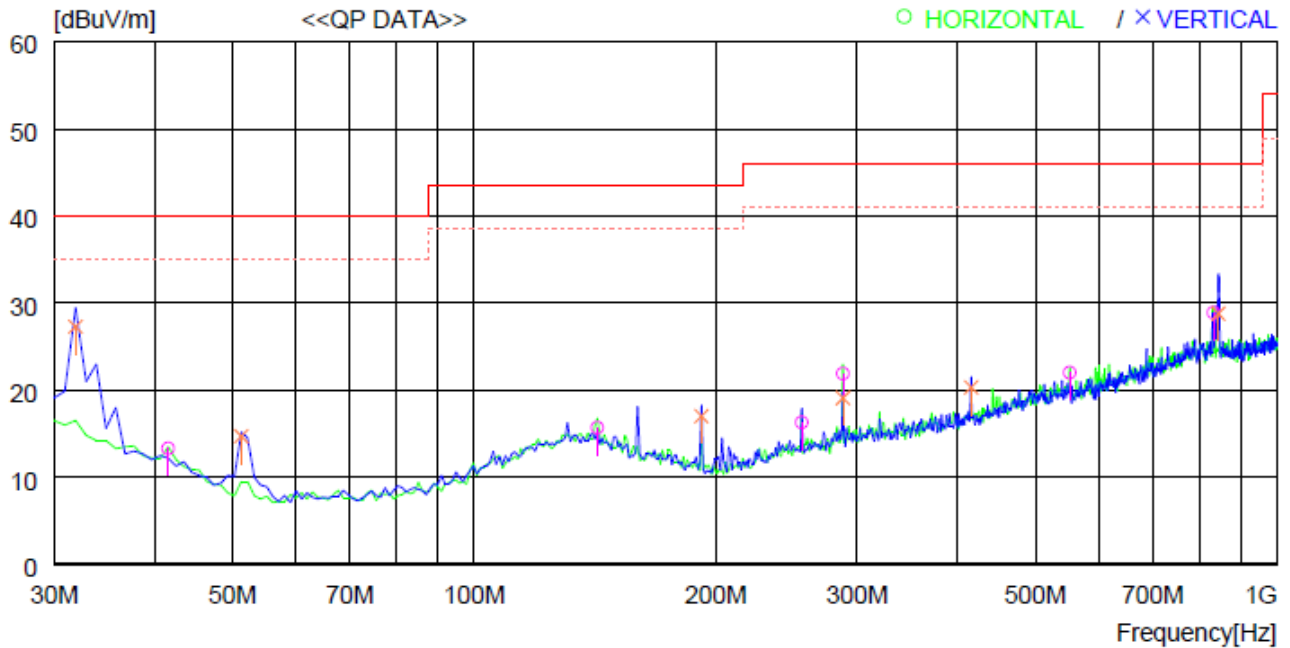
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

13.5 Test data for Right Earbud

13.5.1 Test data for 30 MHz ~ 1000 MHz

- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	41.640	28.1	16.5	0.7	32.0	13.3	40.0	26.7	400	335
2	142.520	27.1	19.2	1.4	32.0	15.7	43.5	27.8	200	359
3	256.010	28.6	17.8	1.9	32.0	16.3	46.0	29.7	200	194
4	288.020	33.2	18.7	2.0	32.0	21.9	46.0	24.1	200	359
5	551.859	27.9	23.7	2.8	32.4	22.0	46.0	24.0	200	210
6	833.151	29.5	27.2	4.1	31.9	28.9	46.0	17.1	400	284
----- Vertical -----										
7	31.940	38.4	20.3	0.6	32.0	27.3	40.0	12.7	100	100
8	51.340	33.0	13.0	0.8	32.1	14.7	40.0	25.3	100	276
9	191.990	31.5	15.9	1.6	32.0	17.0	43.5	26.5	100	359
10	288.020	30.4	18.7	2.0	32.0	19.1	46.0	26.9	100	359
11	416.061	29.0	20.9	2.5	32.1	20.3	46.0	25.7	300	359
12	844.791	29.5	27.2	4.0	31.9	28.8	46.0	17.2	400	39

13.5.2 Test data for Below 30 MHz

- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

13.5.3 Test data for above 1 GHz

- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

14. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	101457	Apr. 16, 2021 (1Y)
ESR7	Rohde & Schwarz	EMI Test Receiver	102190	Oct. 14, 2020 (1Y)
310N	Sonoma Instrument	AMPLIFIER	392756	Oct. 16, 2020 (1Y)
PAM-840A	Com-Power	Pre-Amplifier	461339	Oct. 16, 2020 (1Y)
PAM-118A	Com-Power	Pre-Amplifier	18040081	Oct. 12, 2020 (1Y)
DT2000-2t	Innco Systems GmbH	Turn Table	N/A	N/A
CO3000	Innco Systems GmbH	Controller	1026/40960617/P	N/A
MA-4640-XPET	Innco Systems GmbH	Antenna Master	MA4640/652/43100318/P	N/A
HLP-2008	TDK RF Solutions	Hybrid Antenna	131316	Feb. 27, 2020 (2Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2021(1Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2020 (1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2020(2Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter (1-3 GHz)	N/A	Feb. 08, 2021 (1Y)
GP-4303D	LG Precision Co.,Ltd	DC POWER SUPPLY	5071069	Jan. 06, 2021 (1Y)