

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-21N-RWD-031

Reception No. : 2110004435

Applicant : Union Community

Address : 12F, Munjeong Daemyeong Valeon bldg, 127 Beobwon-ro Songpa-gu, Seoul, South Korea

Manufacturer : Union Community

Address : 12F, Munjeong Daemyeong Valeon bldg, 127 Beobwon-ro Songpa-gu, Seoul, South Korea

Type of Equipment : Bluetooth Module

FCC ID. : XX2-F1DC2706-A

Model Name : F1DC2706-A

Multiple Model Name : N/A

Serial number : N/A

Total page of Report : 80 pages (including this page)

Date of Incoming : October 11, 2021

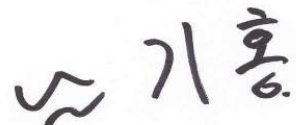
Date of issue : November 15, 2021

SUMMARY

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

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

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



Tested by
Young-Yong, Kim / Assistant Manager
ONETECH Corp.

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

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

CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE	6
2. TEST SUMMARY	7
2.1 TEST ITEMS AND RESULTS	7
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS	7
2.3 RELATED SUBMITTAL(S) / GRANT(S)	7
2.4 PURPOSE OF THE TEST	7
2.5 TEST METHODOLOGY	7
2.6 TEST FACILITY	7
3. GENERAL INFORMATION	8
3.1 PRODUCT DESCRIPTION	8
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT	8
4. EUT MODIFICATIONS	8
5. SYSTEM TEST CONFIGURATION	9
5.1 JUSTIFICATION	9
5.2 PERIPHERAL EQUIPMENT	9
5.3 MODE OF OPERATION DURING THE TEST	9
5.4 CONFIGURATION OF TEST SYSTEM	12
5.5 ANTENNA REQUIREMENT	12
6. PRELIMINARY TEST	12
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS	12
6.2 GENERAL RADIATED EMISSIONS TESTS	12
7. MINIMUM 20 DB BANDWIDTH	13
7.1 OPERATING ENVIRONMENT	13
7.2 TEST SET-UP	13
7.3 TEST DATE	13
7.4 TEST DATA FOR 1 MBPS	14
7.5 TEST DATA FOR 2 MBPS	16
7.6 TEST DATA FOR 3 MBPS	18
8. HOPPING FREQUENCY SEPARATION	20
8.1 OPERATING ENVIRONMENT	20
8.2 TEST SET-UP	20
8.3 TEST DATE	20

8.4 TEST DATA FOR 1 MBPS	21
8.5 TEST DATA FOR 2 MBPS	22
8.6 TEST DATA FOR 3 MBPS	23
9. NUMBER OF HOPPING CHANNELS	24
9.1 OPERATING ENVIRONMENT	24
9.2 TEST SET-UP	24
9.3 TEST DATE	24
9.4 TEST DATA FOR 1 MBPS	25
9.5 TEST DATA FOR 2 MBPS	28
9.6 TEST DATA FOR 3 MBPS	31
10. TIME OF OCCUPANCY	34
10.1 OPERATING ENVIRONMENT	34
10.2 TEST SET-UP	34
10.3 TEST DATE	34
10.4 TEST DATA FOR 1 MBPS	35
10.5 TEST DATA FOR 2 MBPS	37
10.6 TEST DATA FOR 3 MBPS	39
11. MAXIMUM PEAK OUTPUT POWER	41
11.1 OPERATING ENVIRONMENT	41
11.2 TEST SET-UP	41
11.3 TEST DATE	41
11.4 TEST DATA FOR 1 MBPS	42
11.5 TEST DATA FOR 2 MBPS	44
11.6 TEST DATA FOR 3 MBPS	46
12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND	48
12.1 OPERATING ENVIRONMENT	48
12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	48
12.3 TEST SET-UP FOR RADIATED MEASUREMENT	48
12.4 TEST DATE	48
12.5 TEST DATA FOR CONDUCTED EMISSION	49
12.5.1 Test data for 1 Mbps	49
12.5.2 Test data for 2 Mbps	55
12.5.3 Test data for 3 Mbps	61
12.6 TEST DATA FOR TRANSMITTING MODE RADIATED EMISSION	67
12.6.1 Radiated Emission which fall in the Restricted Band	67
12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz	70

13. RADIATED EMISSION TEST	73
13.1 OPERATING ENVIRONMENT	73
13.2 TEST SET-UP	73
13.3 TEST DATE	74
13.4 TEST DATA FOR 30 MHz ~ 1 000 MHz	75
13.5 TEST DATA FOR BELOW 30 MHz	76
13.6 TEST DATA FOR ABOVE 1 GHz	76
14. CONDUCTED EMISSION TEST.....	77
14.1 OPERATING ENVIRONMENT	77
14.2 TEST SET-UP	77
14.3 TEST DATE	77
14.4 TEST DATA.....	78
15. LIST OF TEST EQUIPMENT	80

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-21N-RWD-031	November 15, 2021	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Union Community

Address : 12F, Munjeong Daemyeong Valeon bldg, 127 Beobwon-ro Songpa-gu, Seoul, South Korea

Contact Person : Dong Ho Lee

Telephone No. : +82-2-6488-3054

FCC ID : XX2-F1DC2706-A

Model Name : F1DC2706-A

Brand Name : -

Serial Number : N/A

Date : November 15, 2021

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	Bluetooth Module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2020
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)	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	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

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: 2020. 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

3. GENERAL INFORMATION

3.1 Product Description

The Union Community, Model F1DC2706-A (referred to as the EUT in this report) is a Bluetooth Module. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Bluetooth Module		
Temperature Range	-30 °C ~ 85 °C		
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz	
	Bluetooth	2 402 MHz ~ 2 480 MHz	
MODULATION TYPE	Bluetooth LE	GFSK for 1 Mbps	
	Bluetooth	GFSK for 1Mbps, $\pi/4$ -DQPSK for 2Mbps, 8-DPSK for 3Mbps	
RF OUTPUT POWER	Bluetooth LE	-1.95 dBm	
	Bluetooth	1 Mbps	-11.17 dBm
		2 Mbps	-11.34 dBm
		3 Mbps	-10.78 dBm
ANTENNA TYPE	Chip Antenna		
ANTENNA GAIN	0.8 dBi		
List of each Osc. or crystal Freq. (Freq. $\geq$ 1 MHz)	24 MHz		

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

-. None

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	N/A	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
F1DC2706-A	Union Community	Bluetooth Module (EUT)	
Evaluation Board_REV 1.1	F1media	Jig Board	EUT
LG15N53	LG Electronics Inc.	Notebook PC	
ADL45WCE	Lenovo	AC Adapter	

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 441MHz, 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

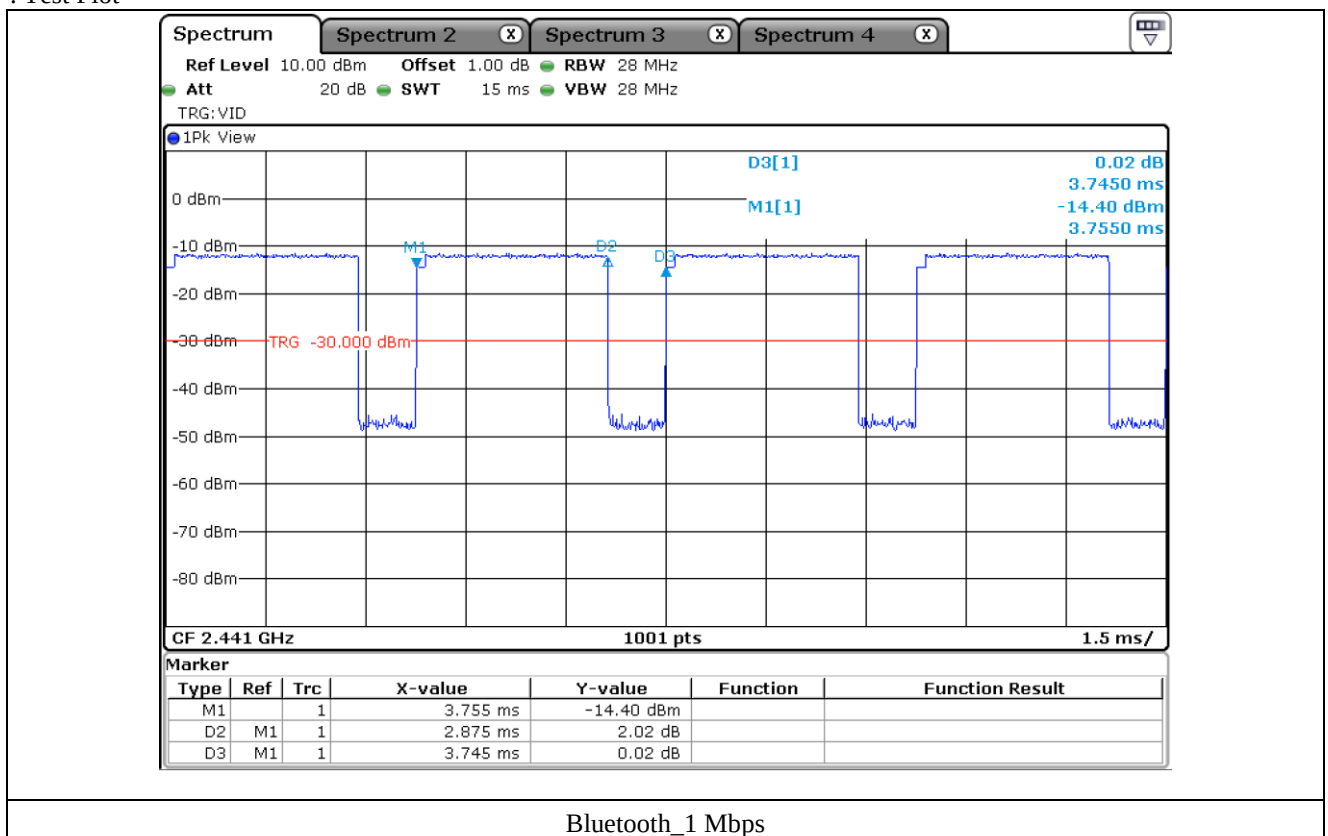
-. Duty Cycle

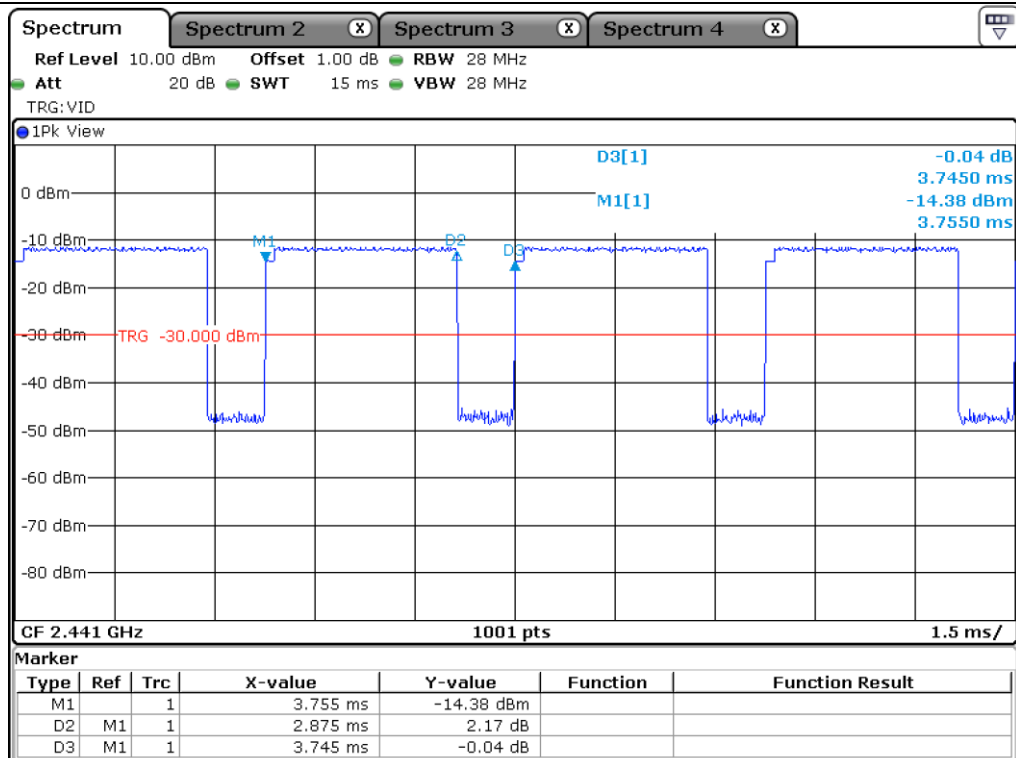
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.875	0.870	76.77	1.15
Bluetooth [2 Mbps]	2.875	0.870	76.77	1.15
Bluetooth [3 Mbps]	2.875	0.870	76.77	1.15

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

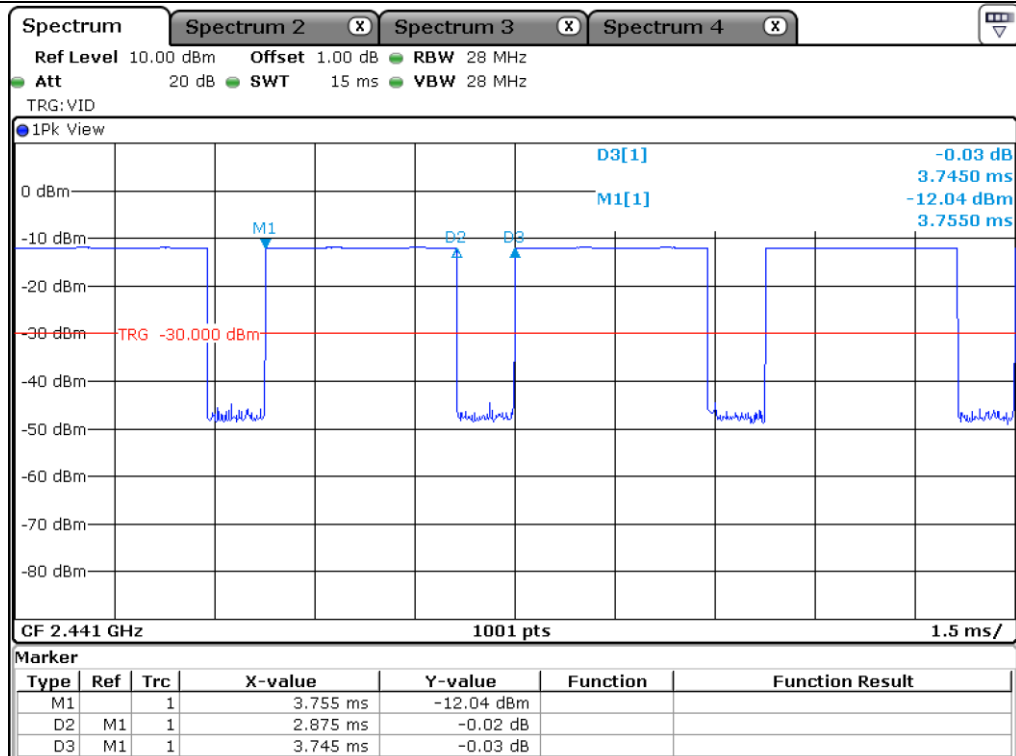
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 Mbps

5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to Jig Board and the power of USB was connected to Notebook PC. All supporting equipment were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions

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

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

5.5 Antenna Requirement

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

Antenna Construction:

The antenna of the EUT is a Chip 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)
Transmitting Mode	X

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

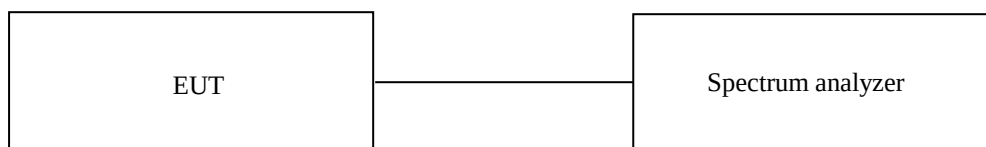
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 10 kHz or 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.

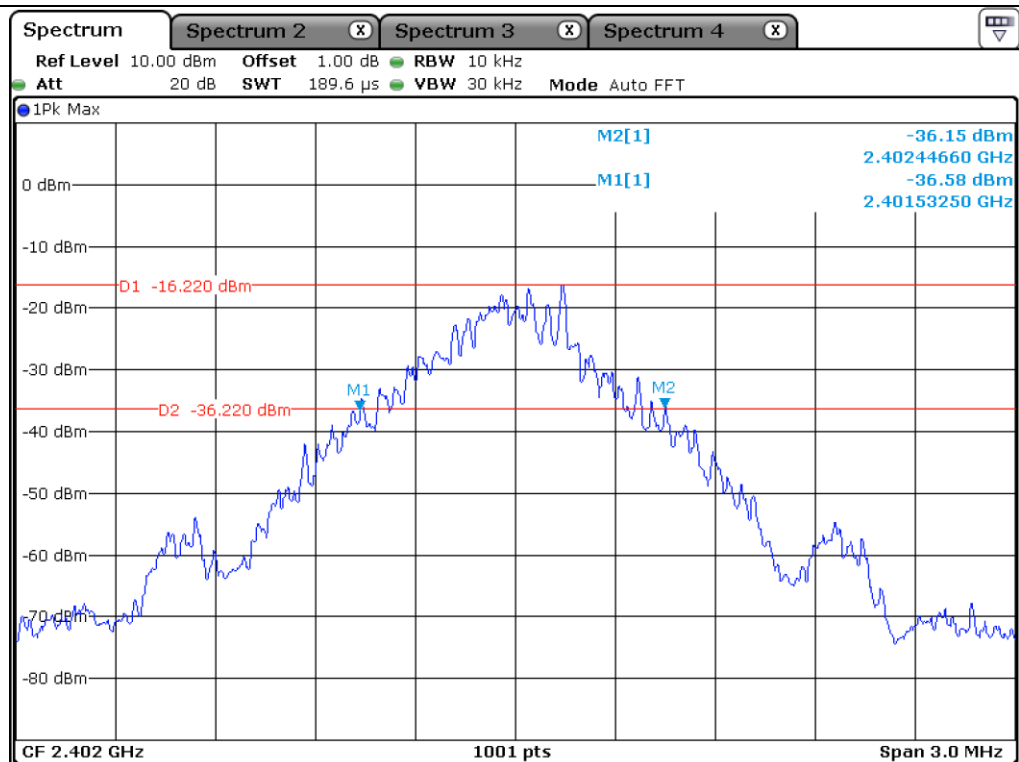


7.3 Test Date

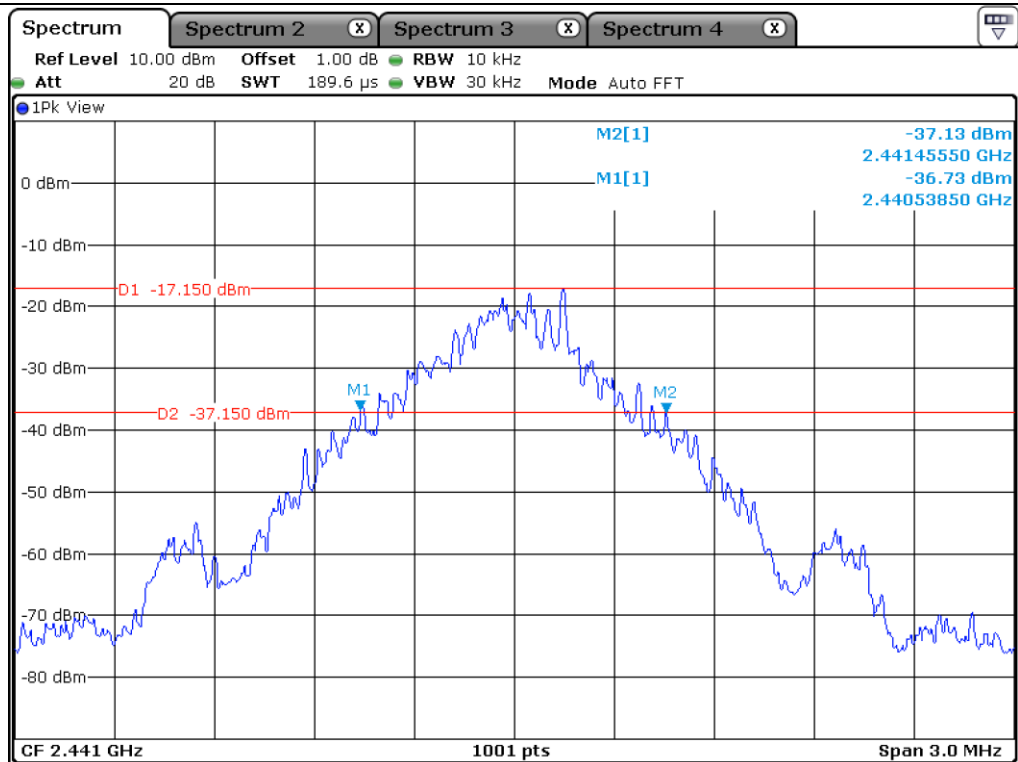
October 13, 2021 ~ October 14, 2021

7.4 Test data for 1 Mbps

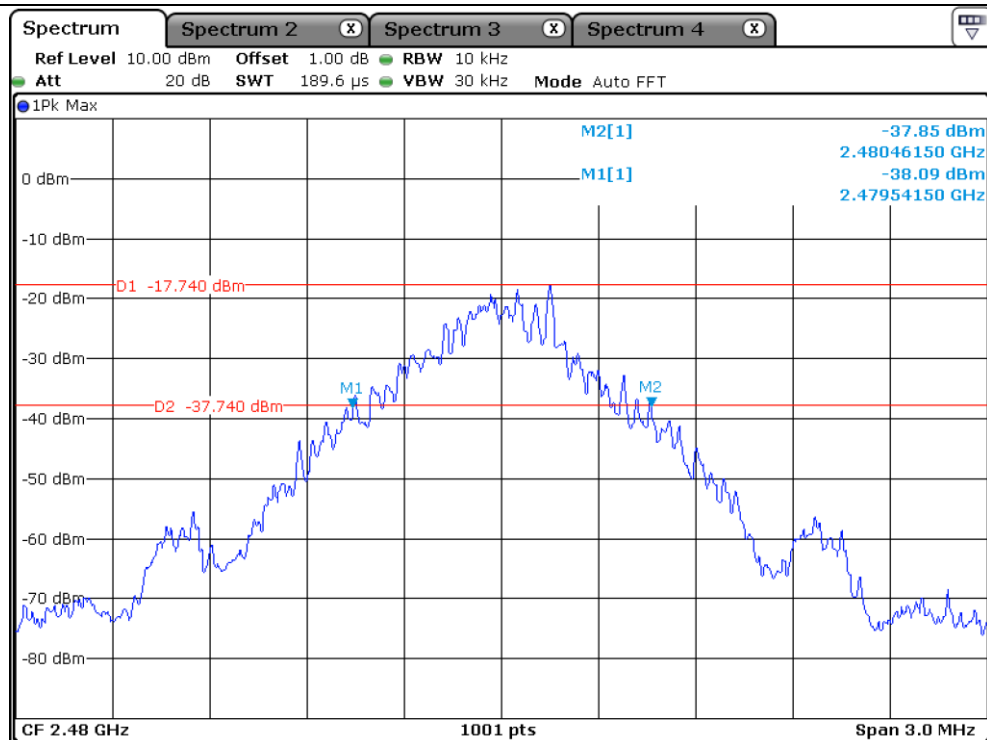
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	914.10
Middle	2 441.00	917.00
High	2 480.00	920.00



Low Channel



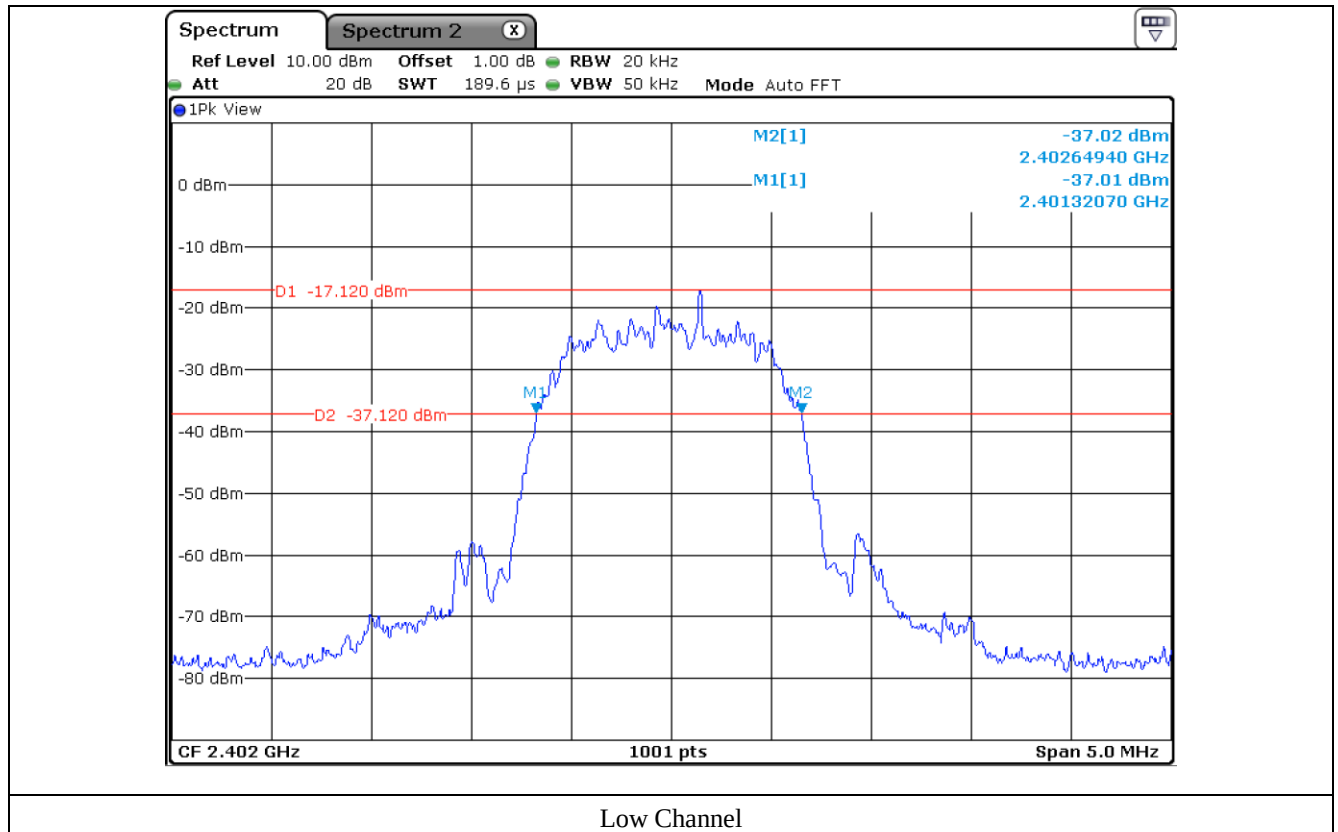
Middle Channel

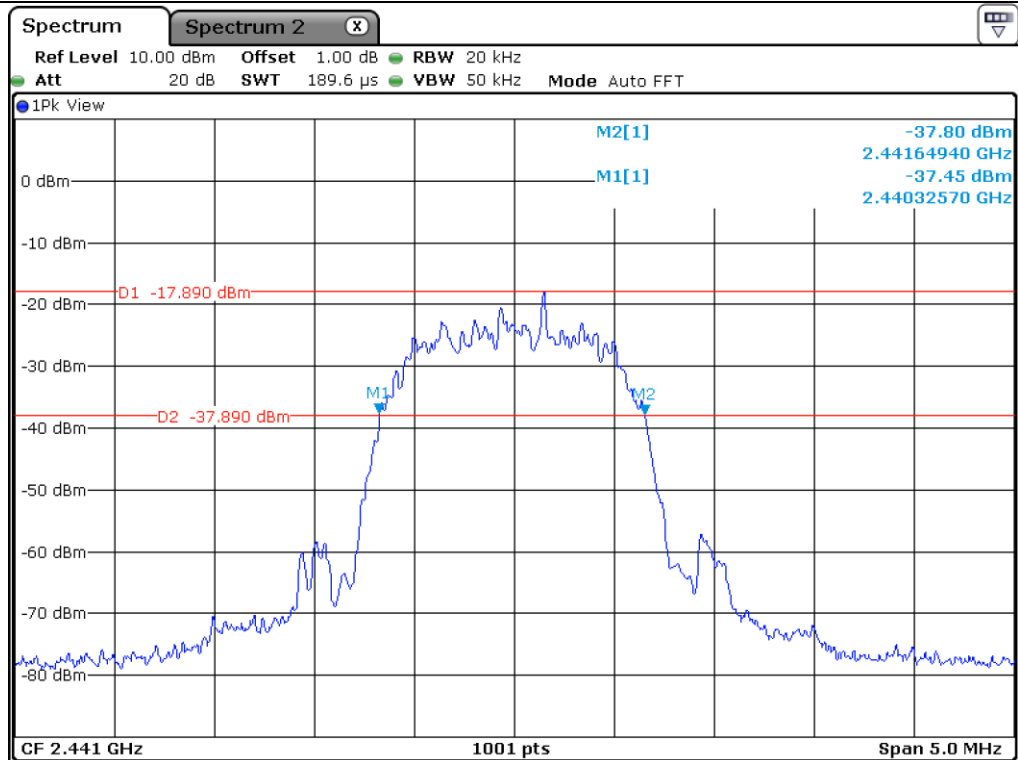


High Channel

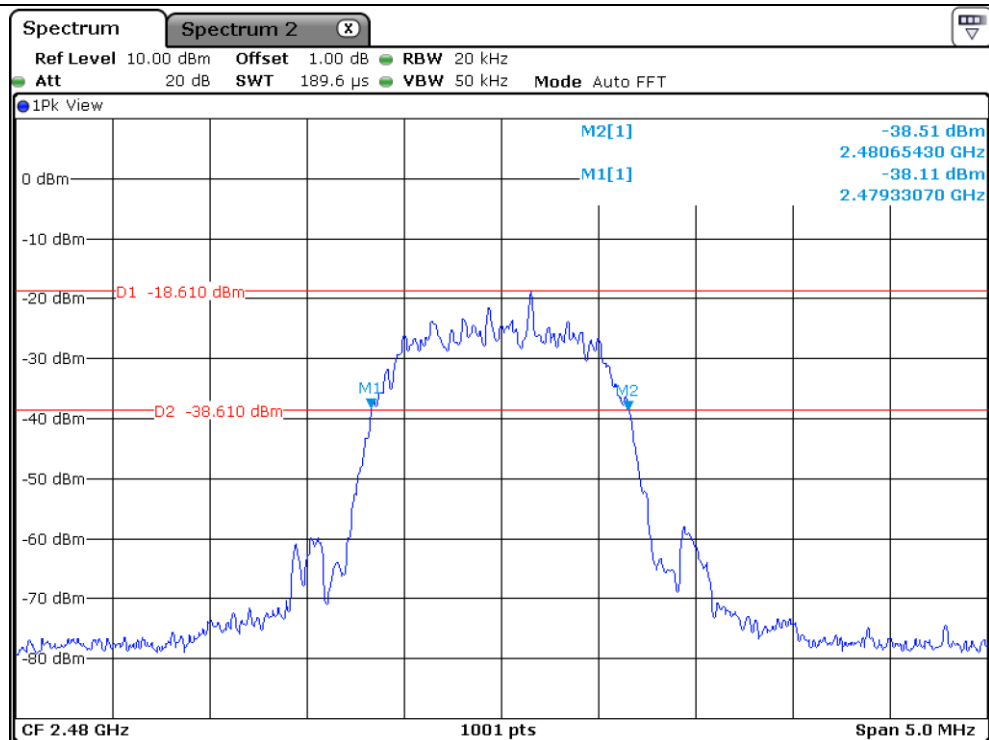
7.5 Test data for 2 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 328.70
Middle	2 441.00	1 323.70
High	2 480.00	1 323.60





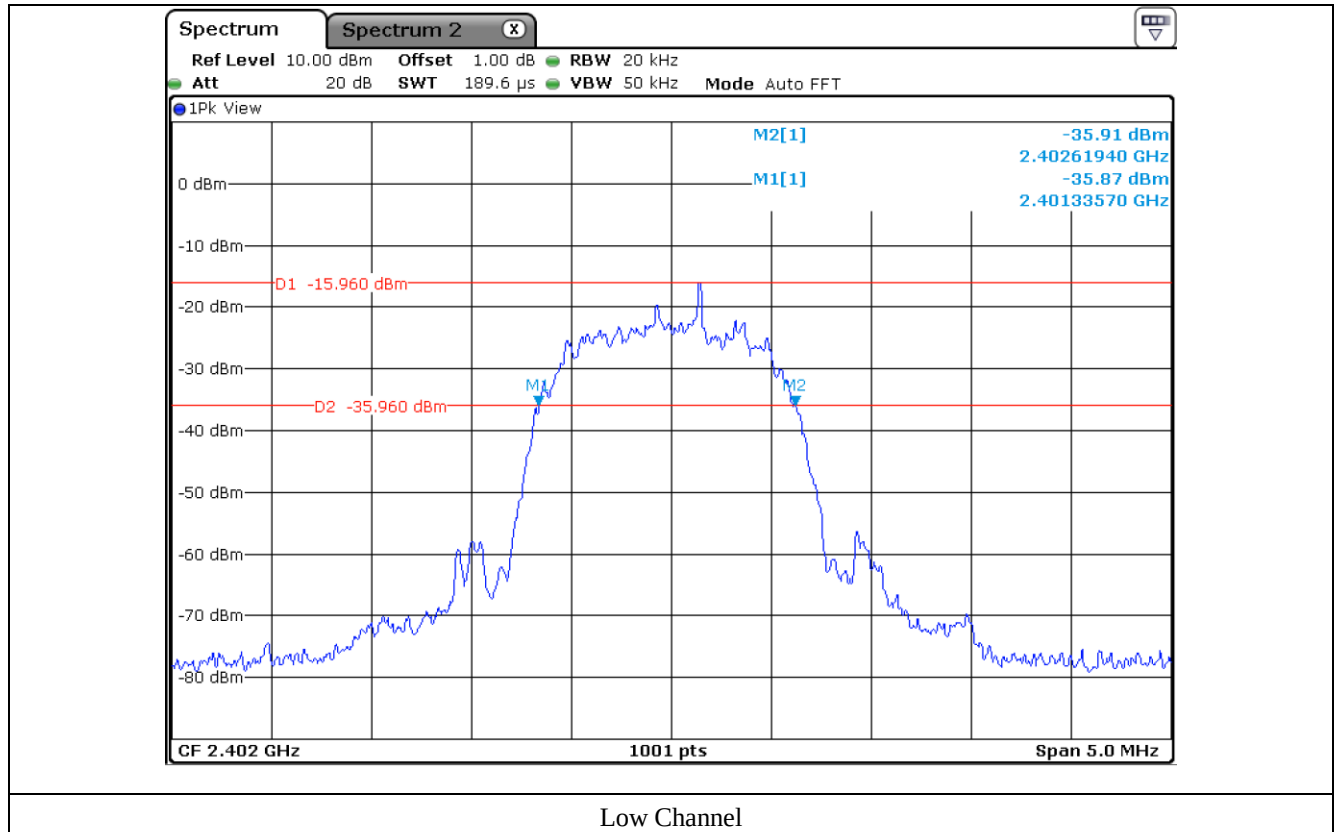
Middle Channel

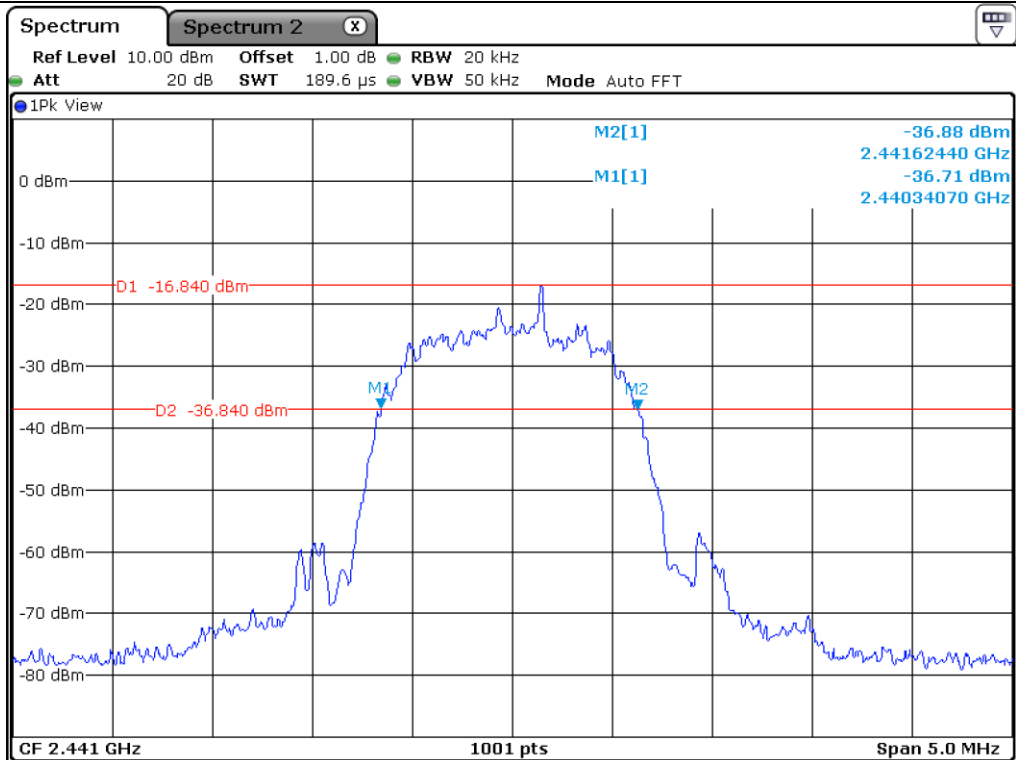


High Channel

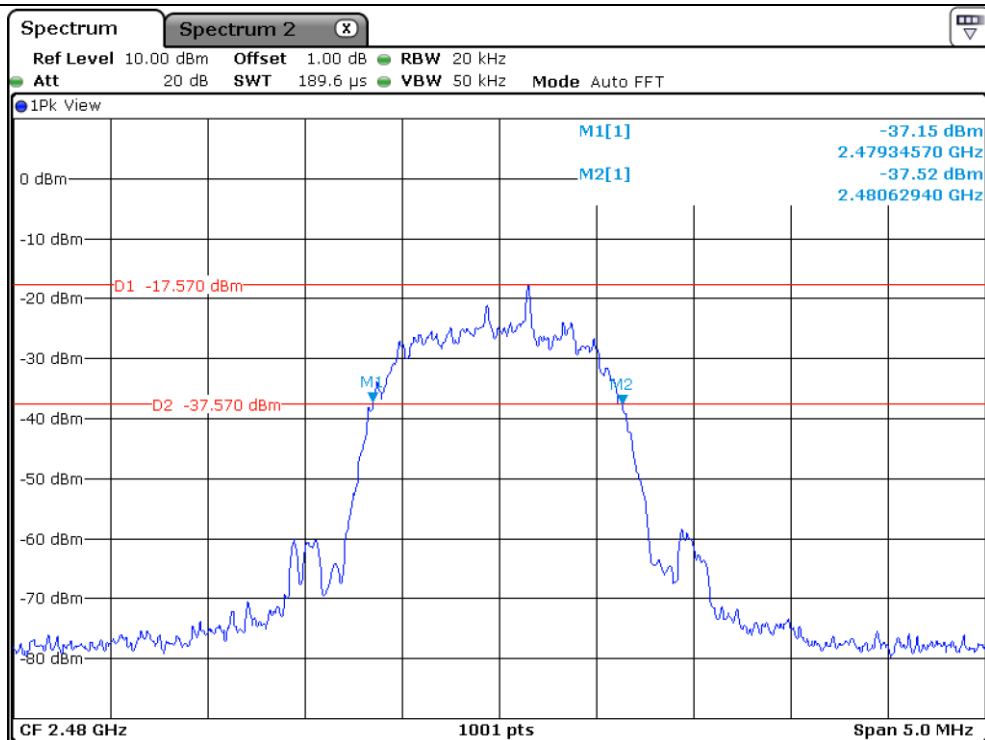
7.6 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 283.70
Middle	2 441.00	1 283.70
High	2 480.00	1 283.70





Middle Channel



High Channel

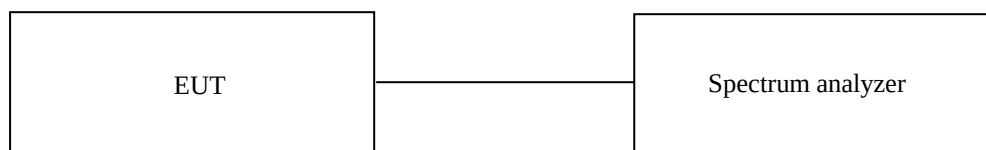
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % R.H.

8.2 Test set-up

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



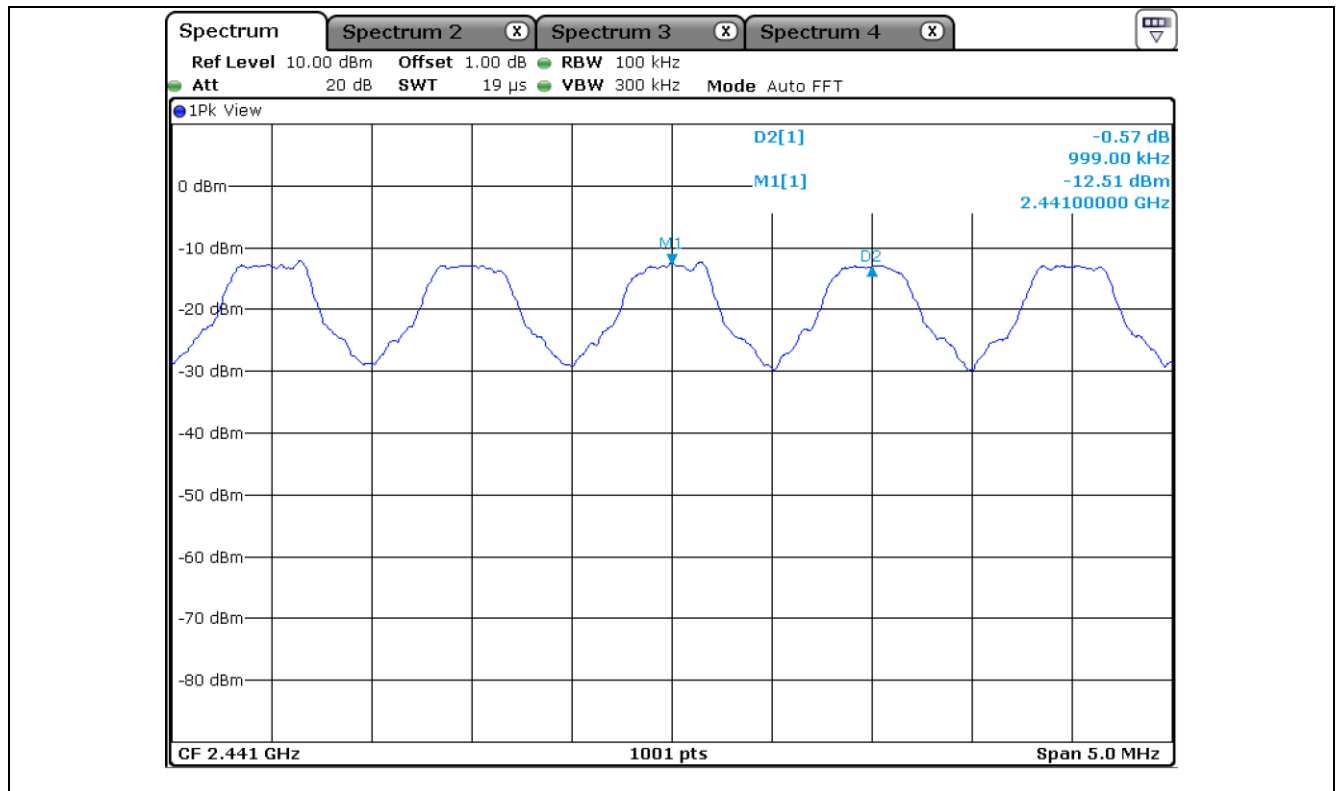
8.3 Test Date

October 13, 2021 ~ October 14, 2021

8.4 Test data for 1 Mbps

-. Test Result : Pass

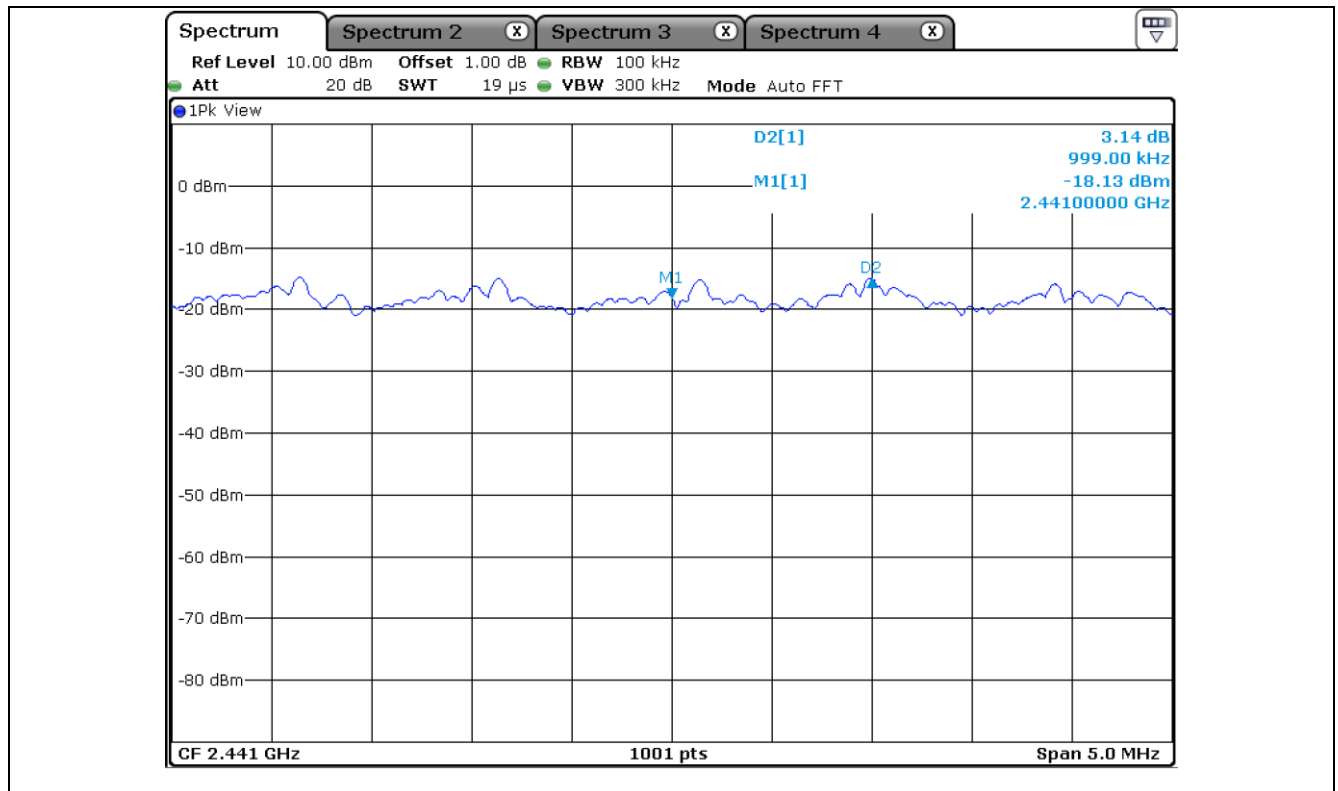
MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	611.33	Separated by a minimum of 611.33 kHz



8.5 Test data for 2 Mbps

-. Test Result : Pass

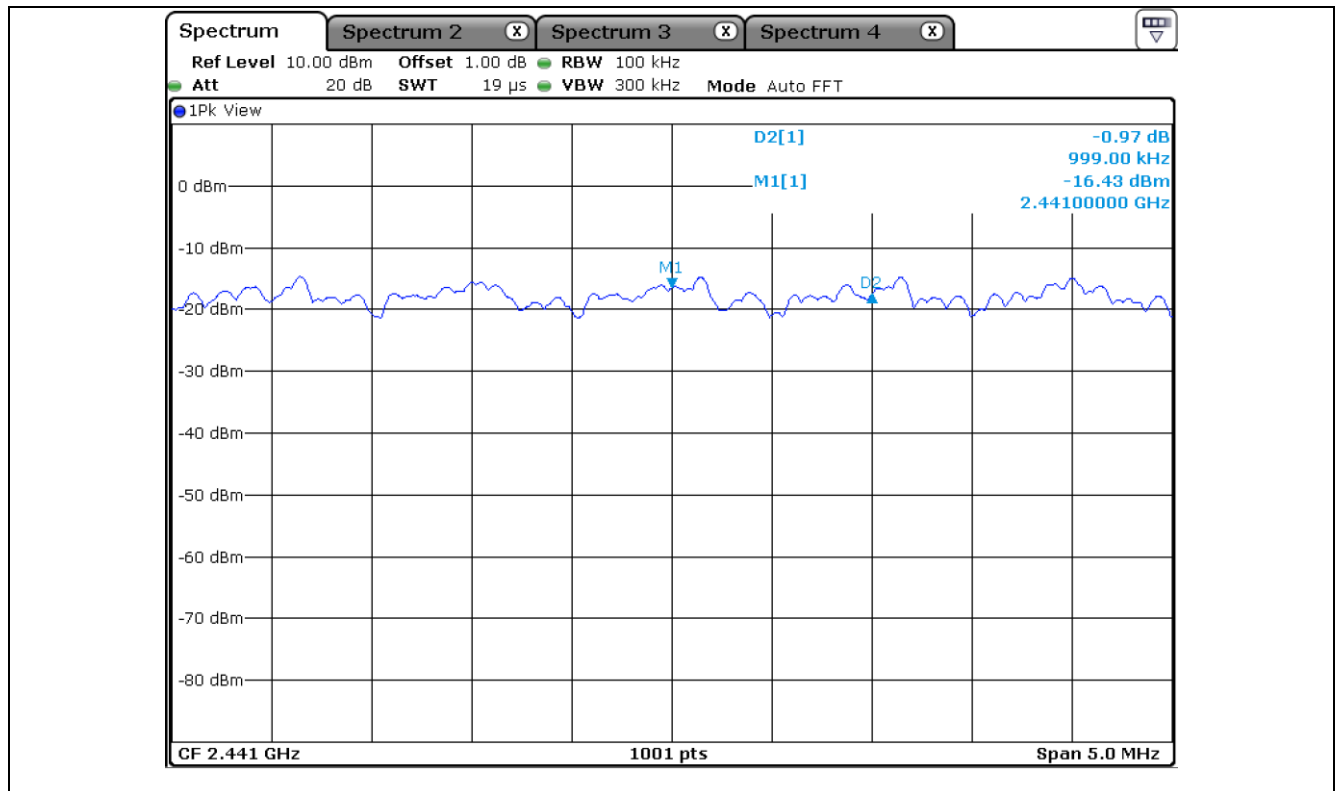
MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	882.47	Separated by a minimum of 882.47 kHz



8.6 Test data for 3 Mbps

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	855.80	Separated by a minimum of 855.80 kHz



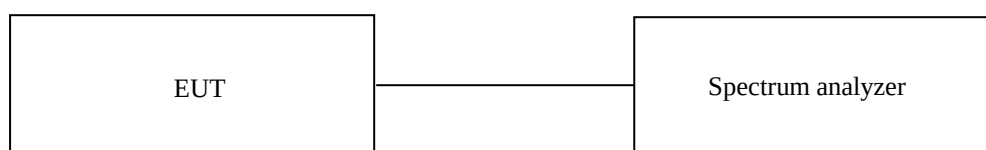
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % R.H.

9.2 Test set-up

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



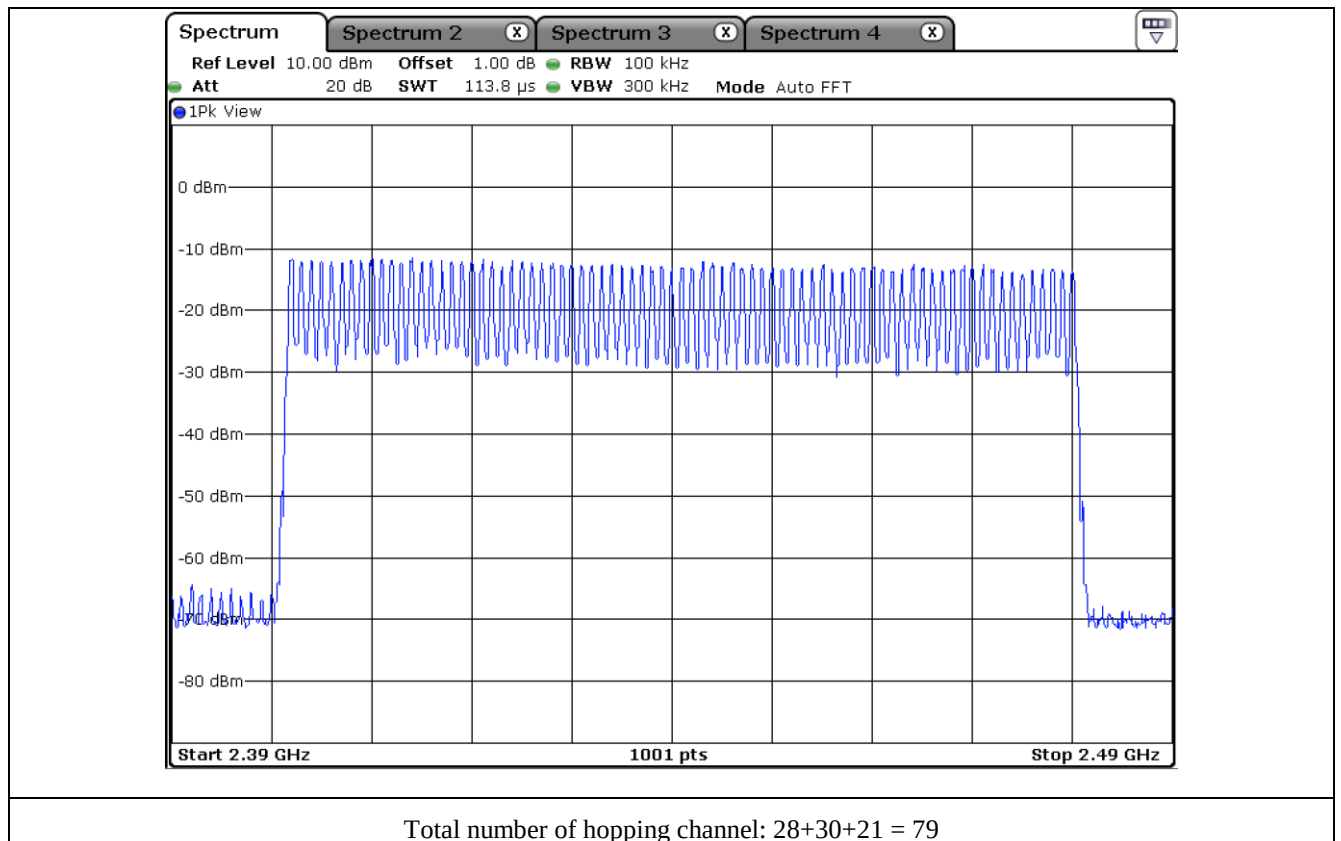
9.3 Test Date

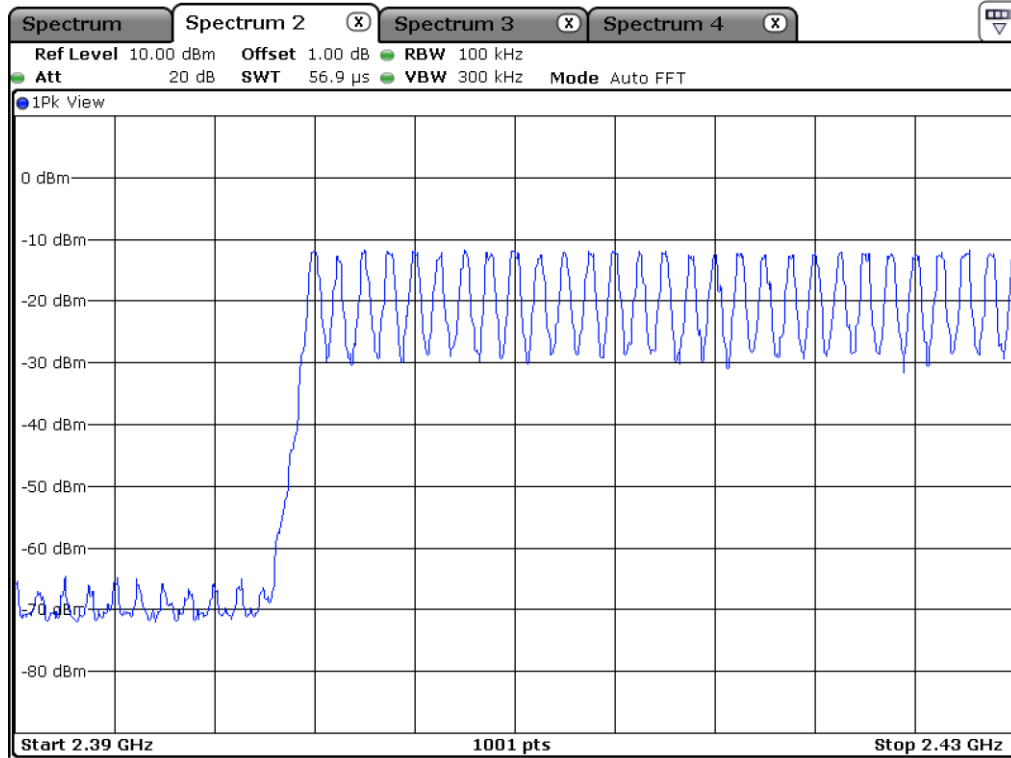
October 13, 2021 ~ October 14, 2021

9.4 Test data for 1 Mbps

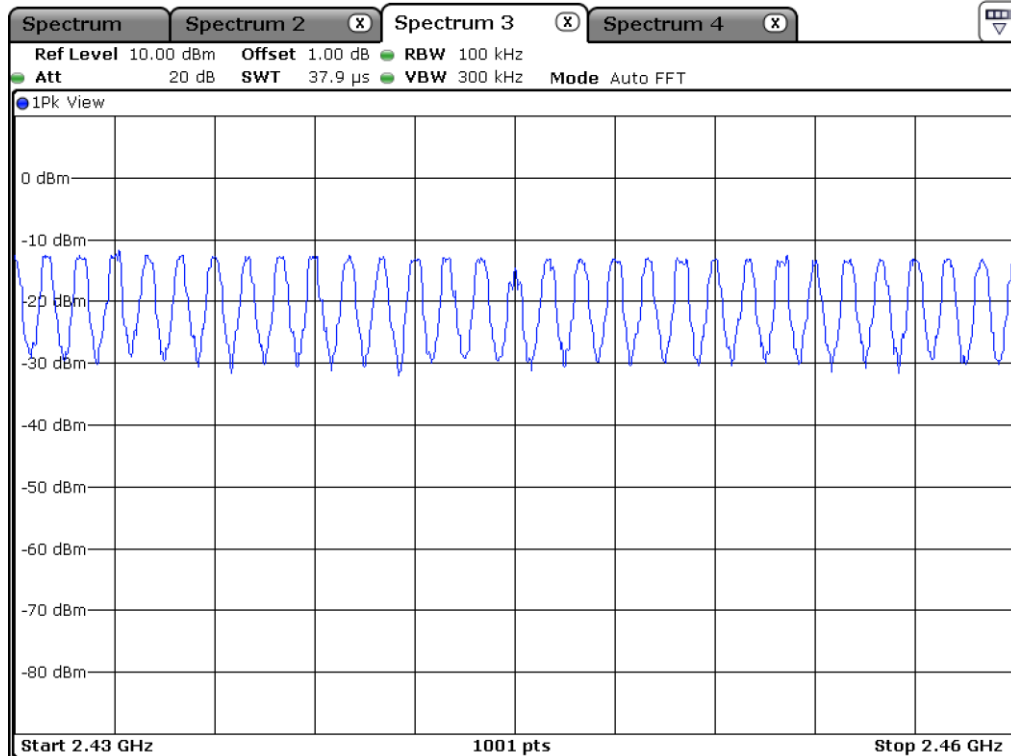
-. Test Result : Pass

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

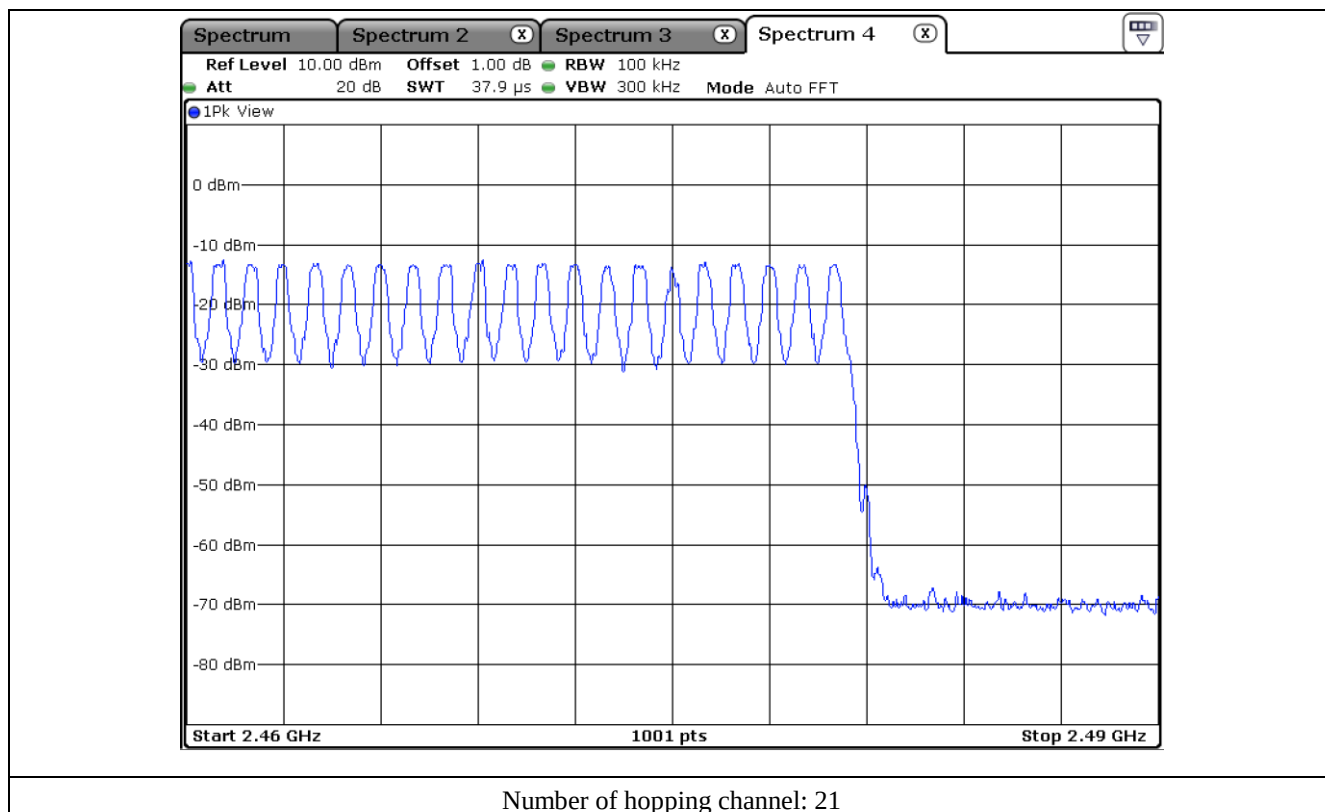




Number of hopping channel: 28



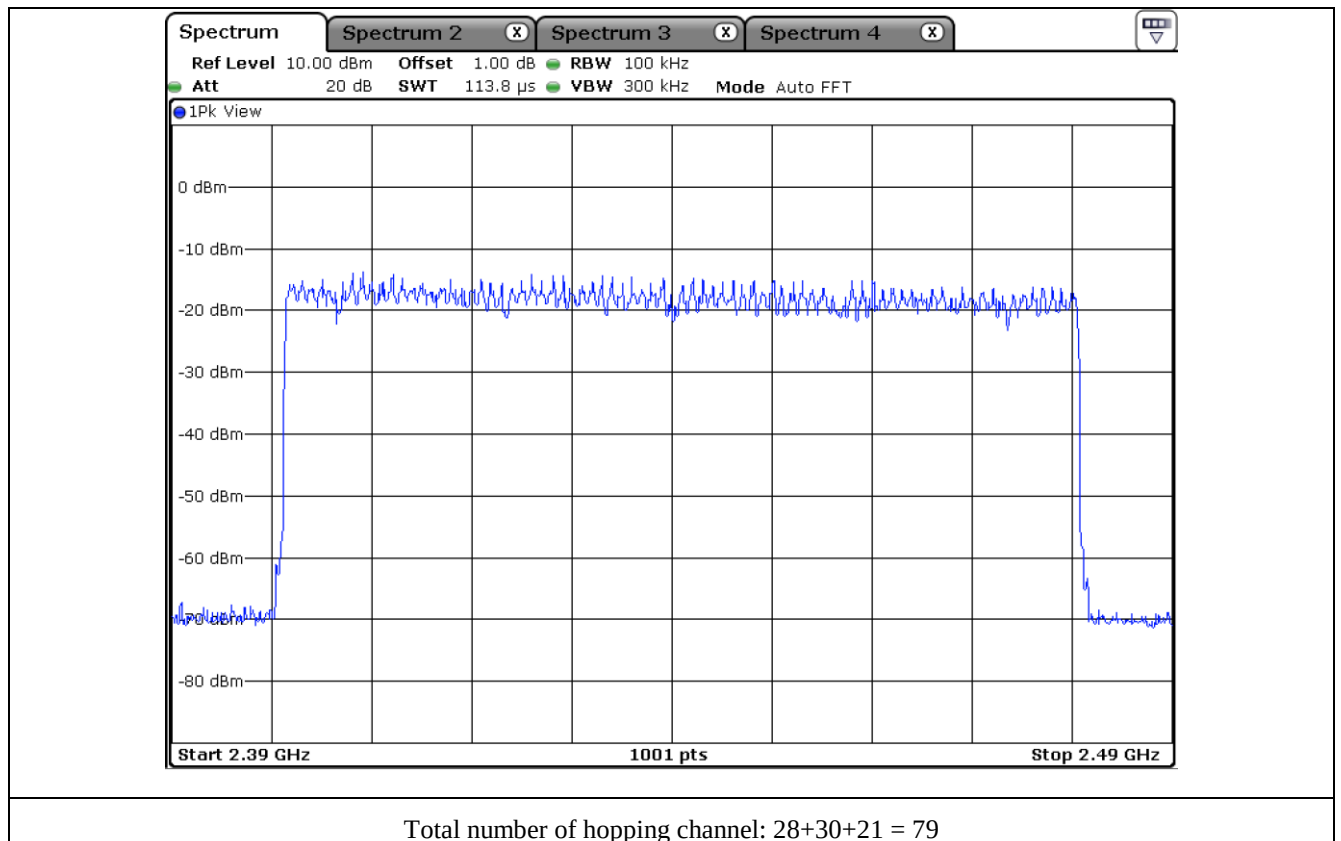
Number of hopping channel: 30

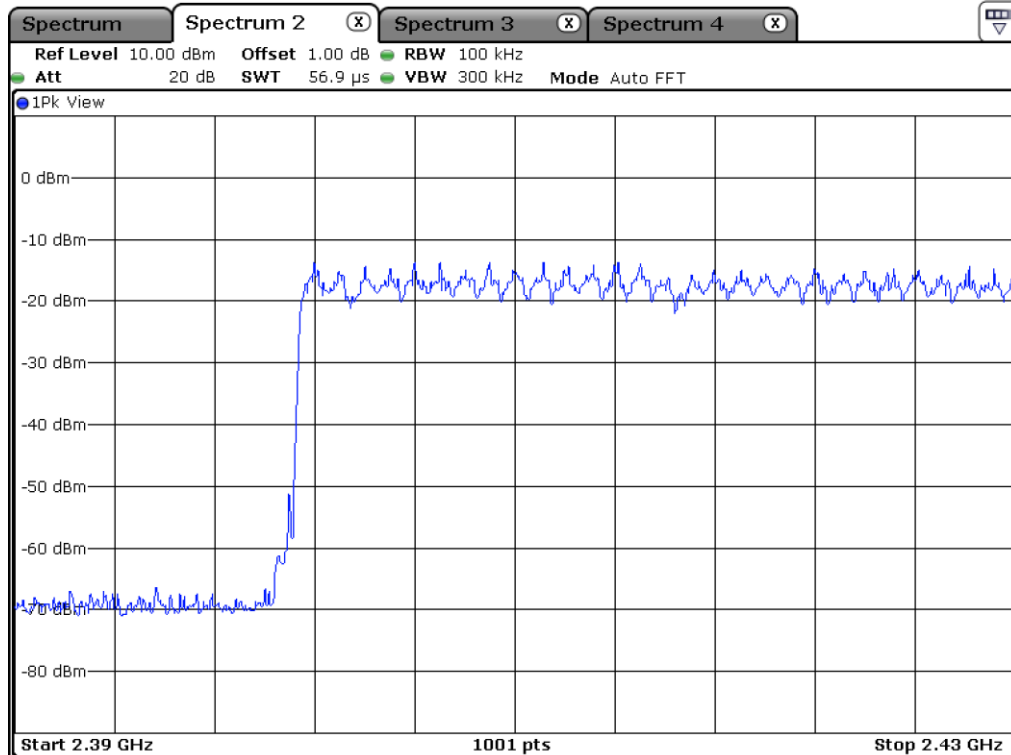


9.5 Test data for 2 Mbps

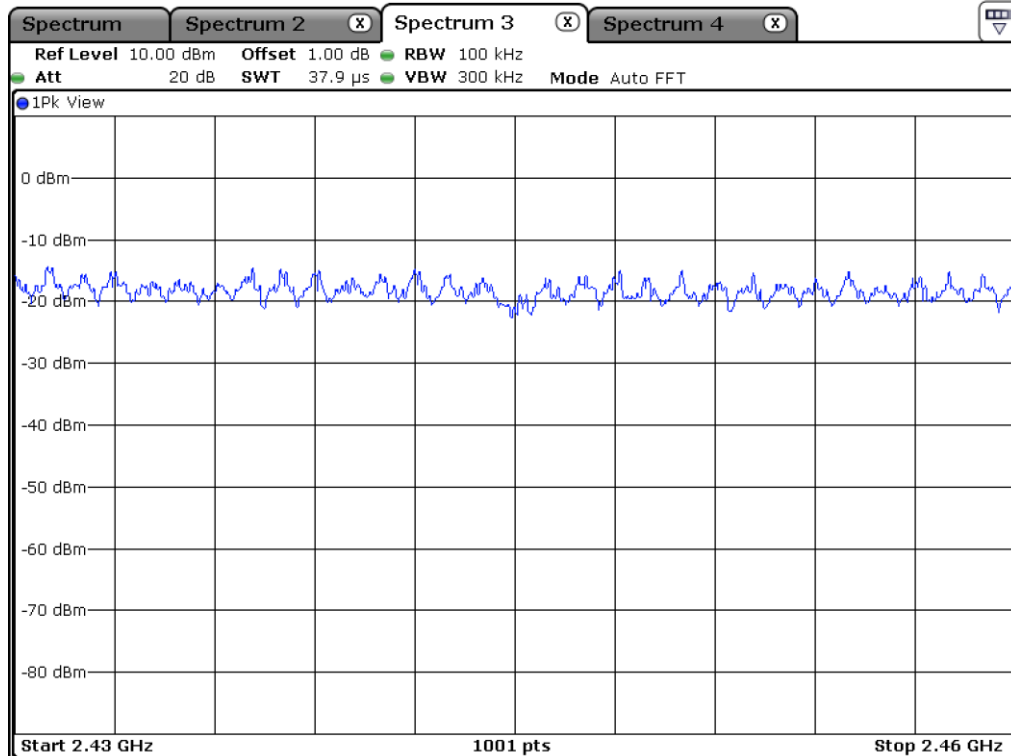
-. Test Result : Pass

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

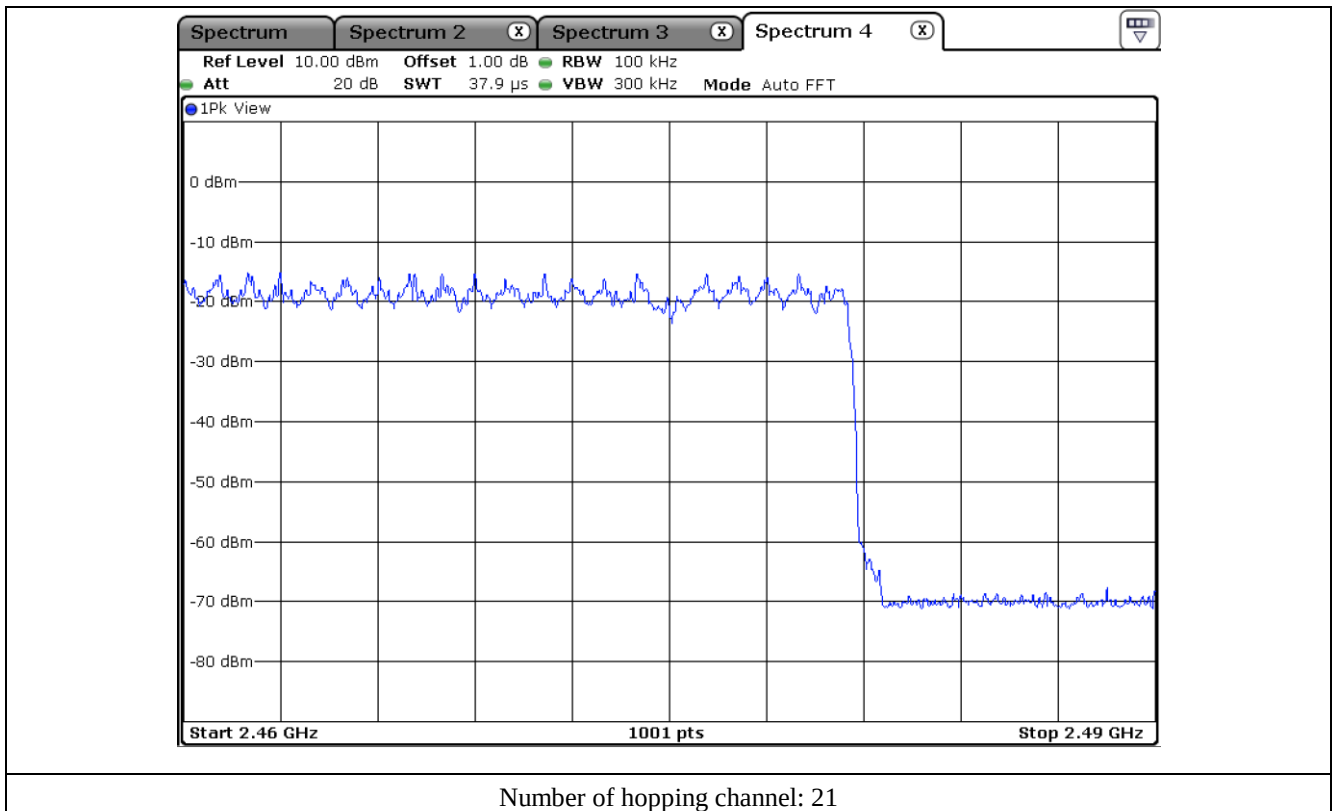




Number of hopping channel: 28



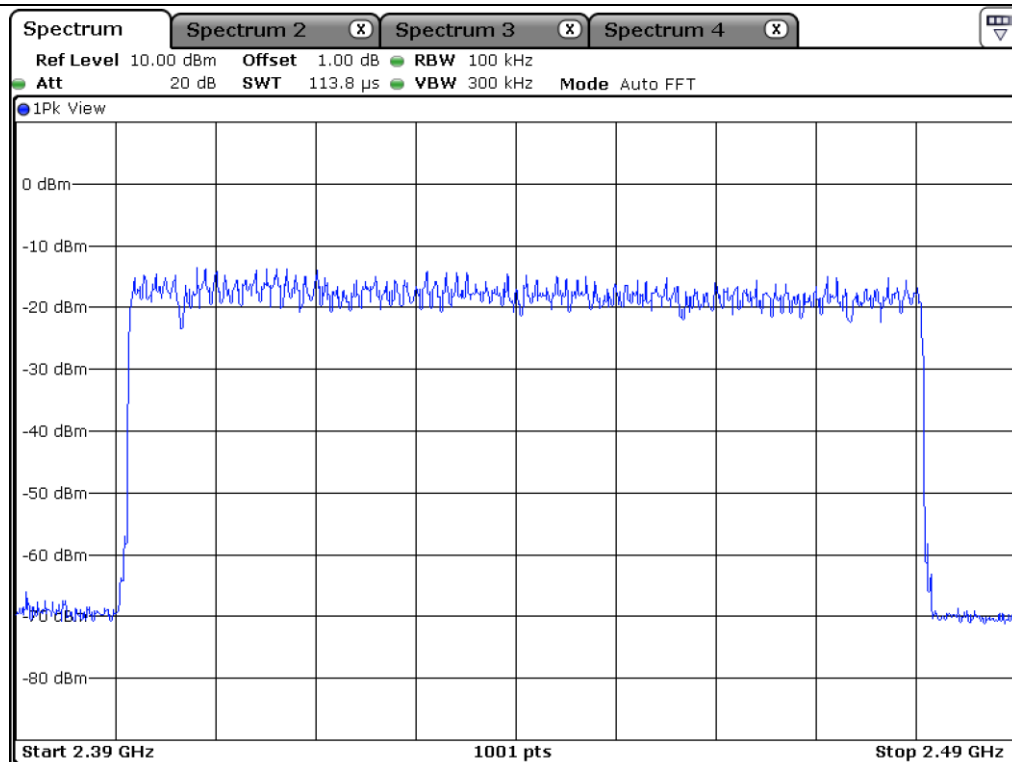
Number of hopping channel: 30



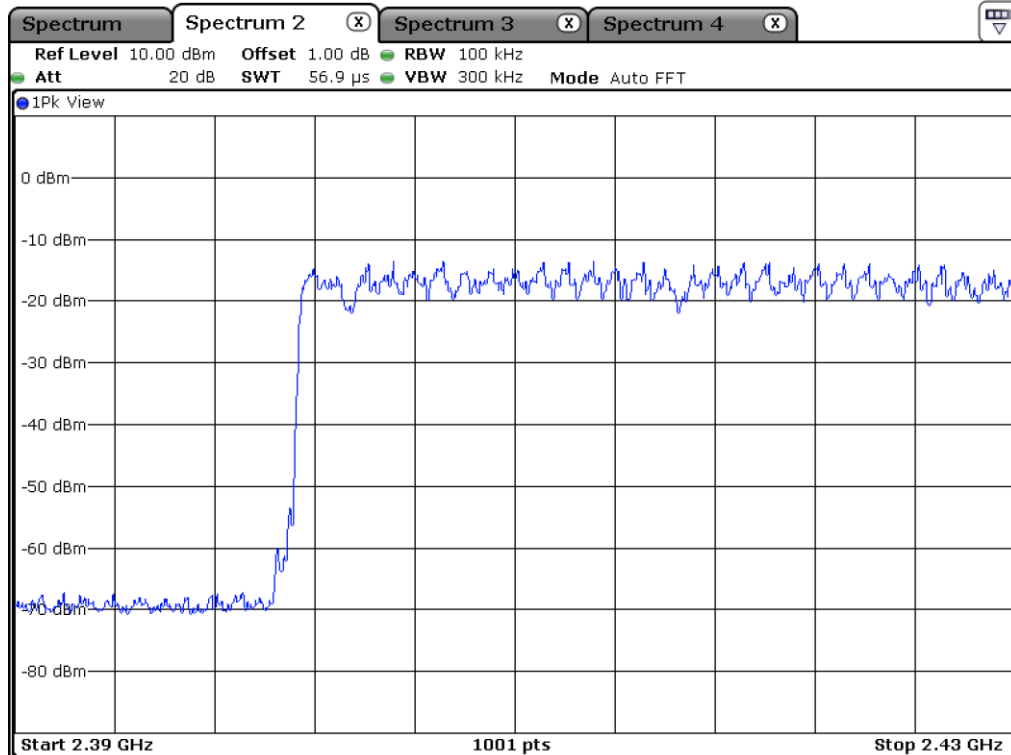
9.6 Test data for 3 Mbps

-. Test Result : Pass

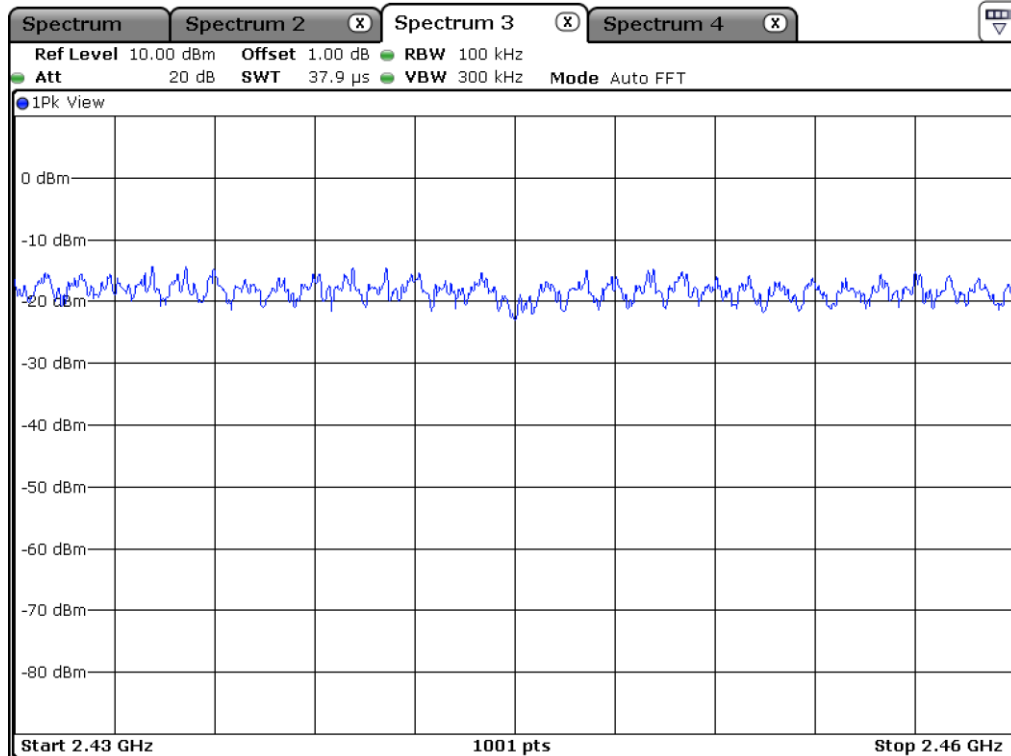
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
3 Mbps	79	Minimum of 15	64



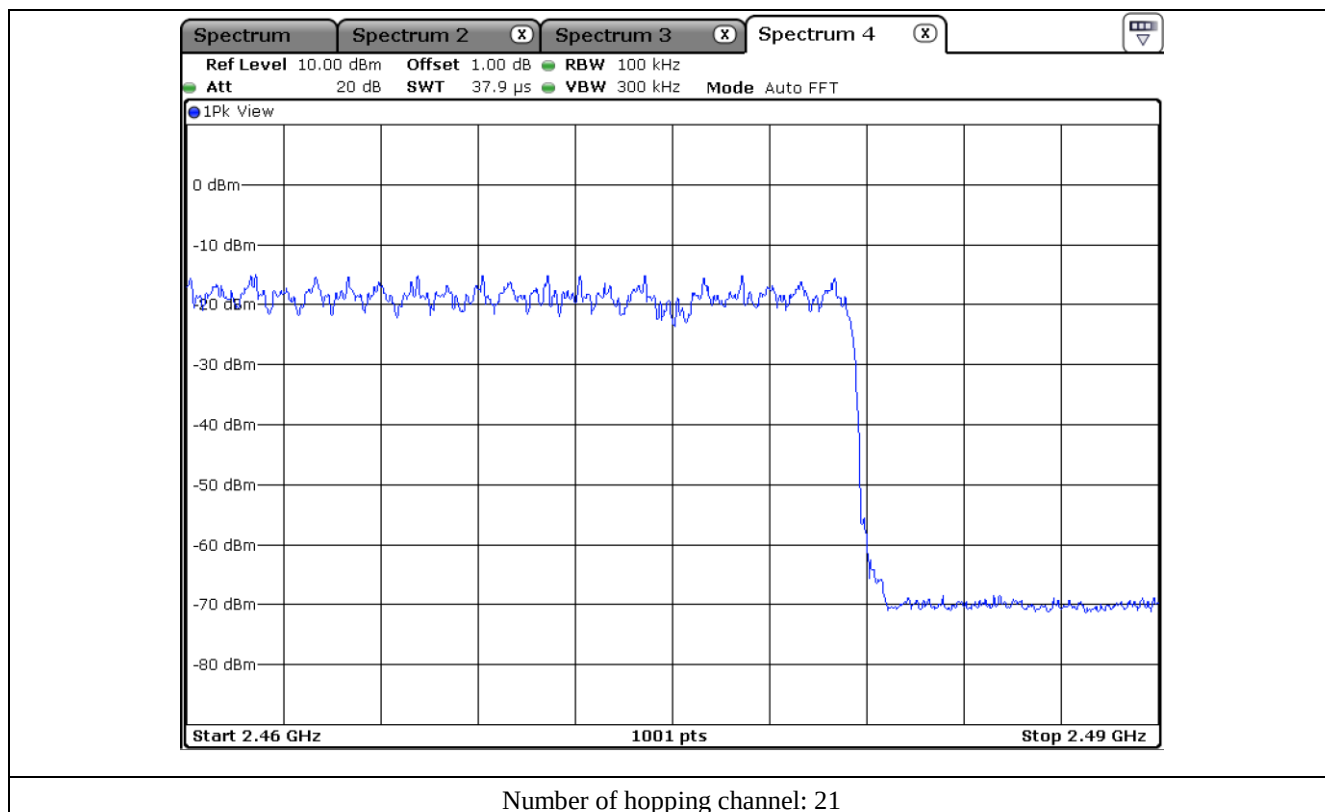
Total number of hopping channel: 28+30+21 = 79



Number of hopping channel: 28



Number of hopping channel: 30



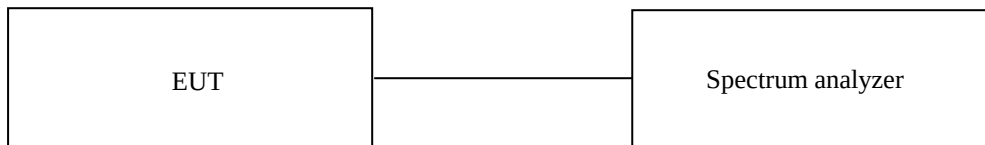
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % R.H.

10.2 Test set-up

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



10.3 Test Date

October 13, 2021 ~ October 14, 2021

10.4 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.

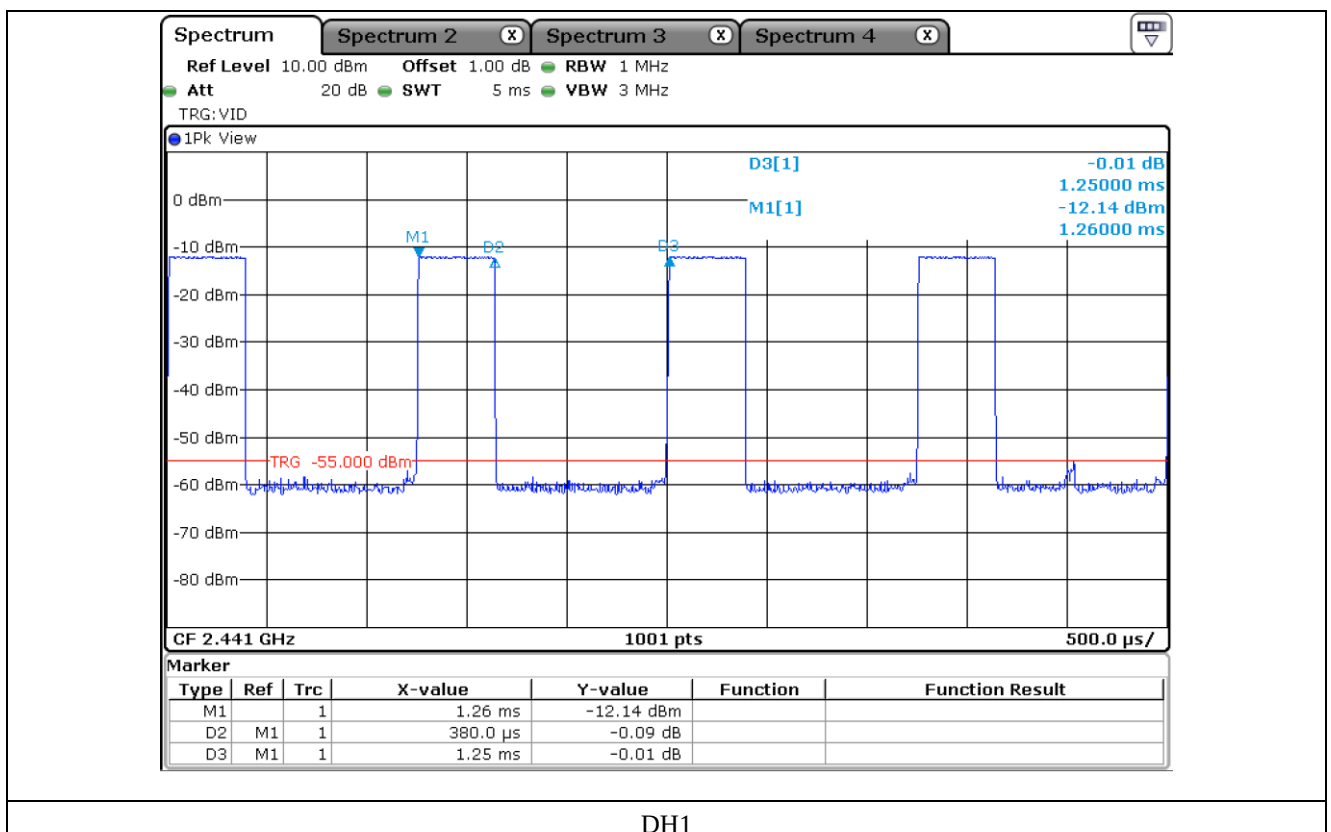
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

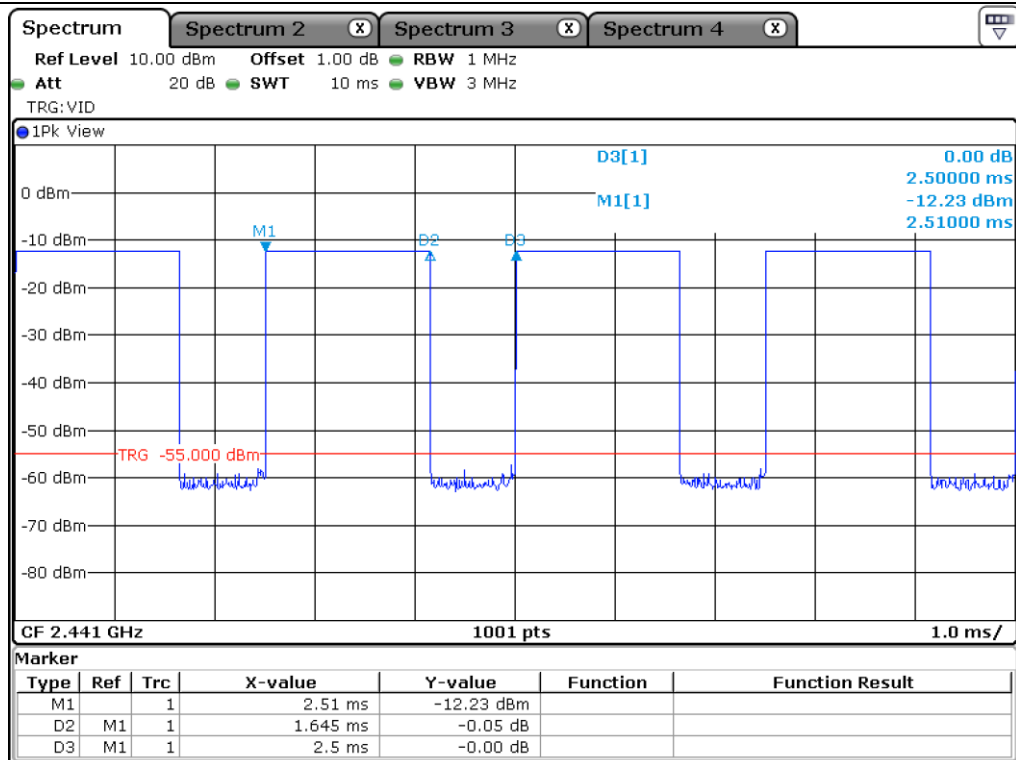
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.380	10.13	31.60	121.64	400.00	PASS
DH3	1.645	5.06	31.60	263.03	400.00	
DH5	2.890	3.38	31.60	308.68	400.00	

Total dwell time is calculated as following.

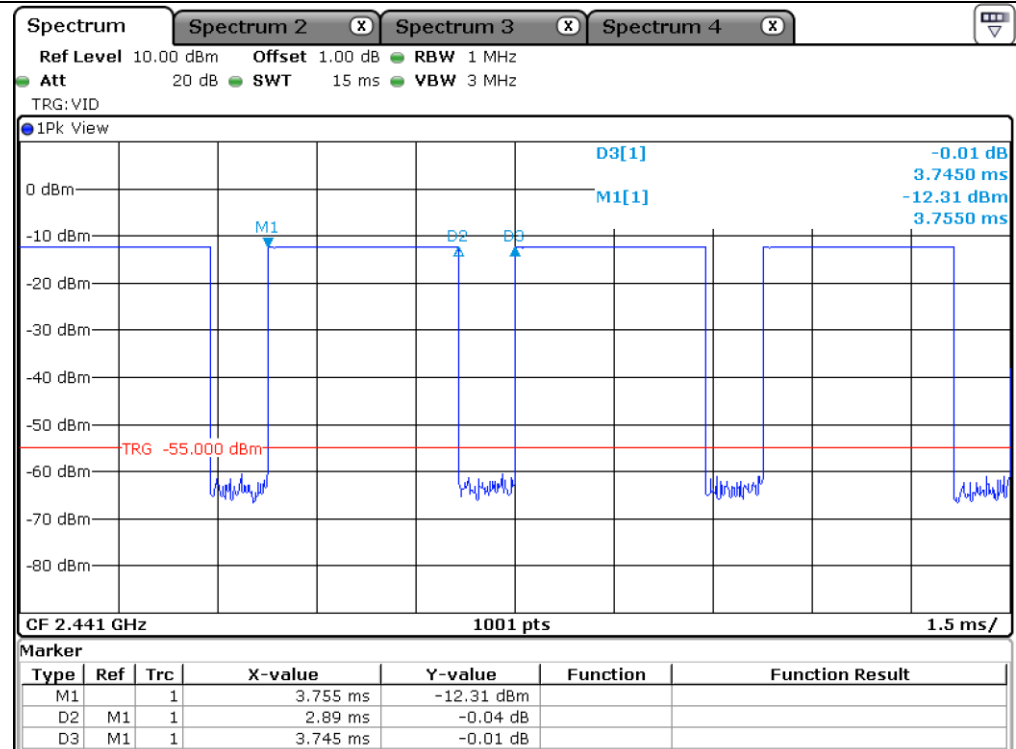
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

10.5 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.

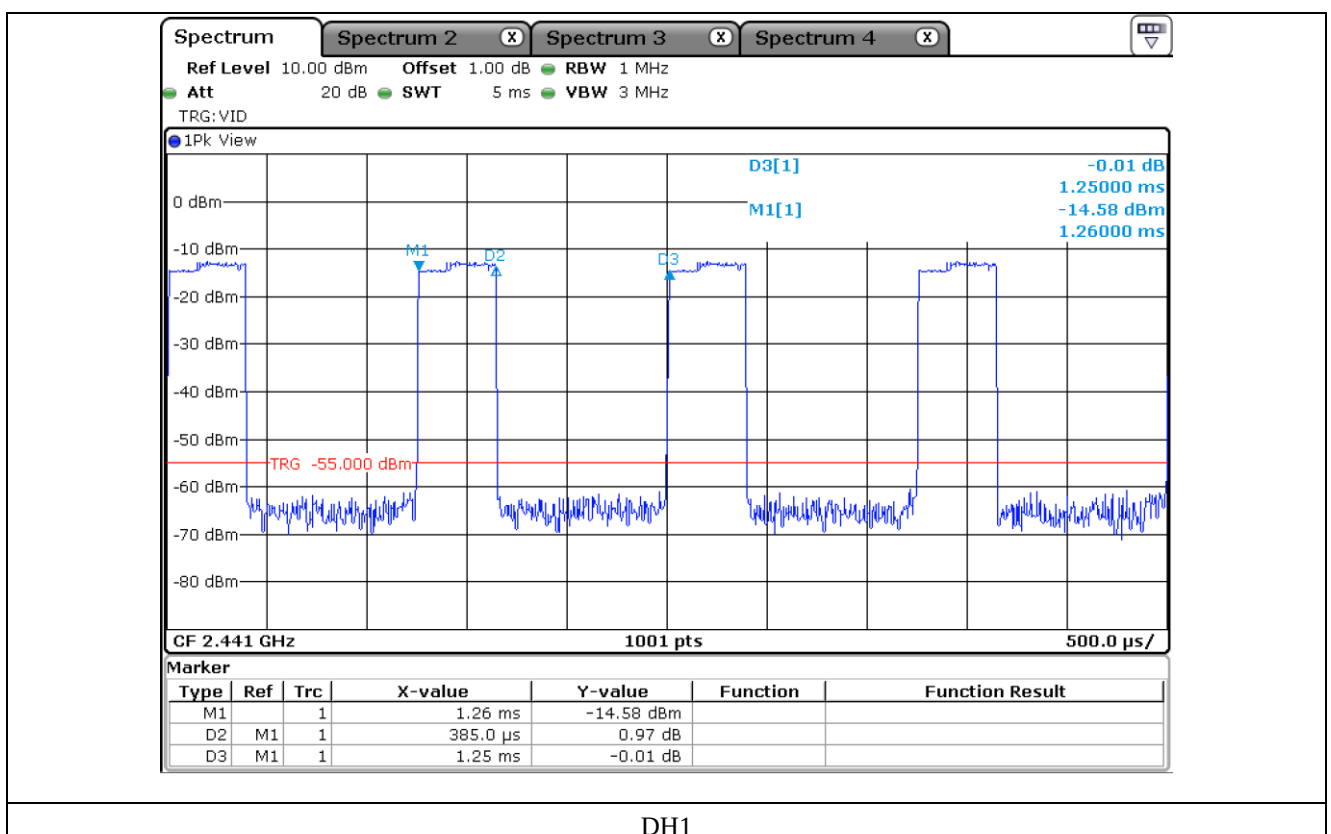
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

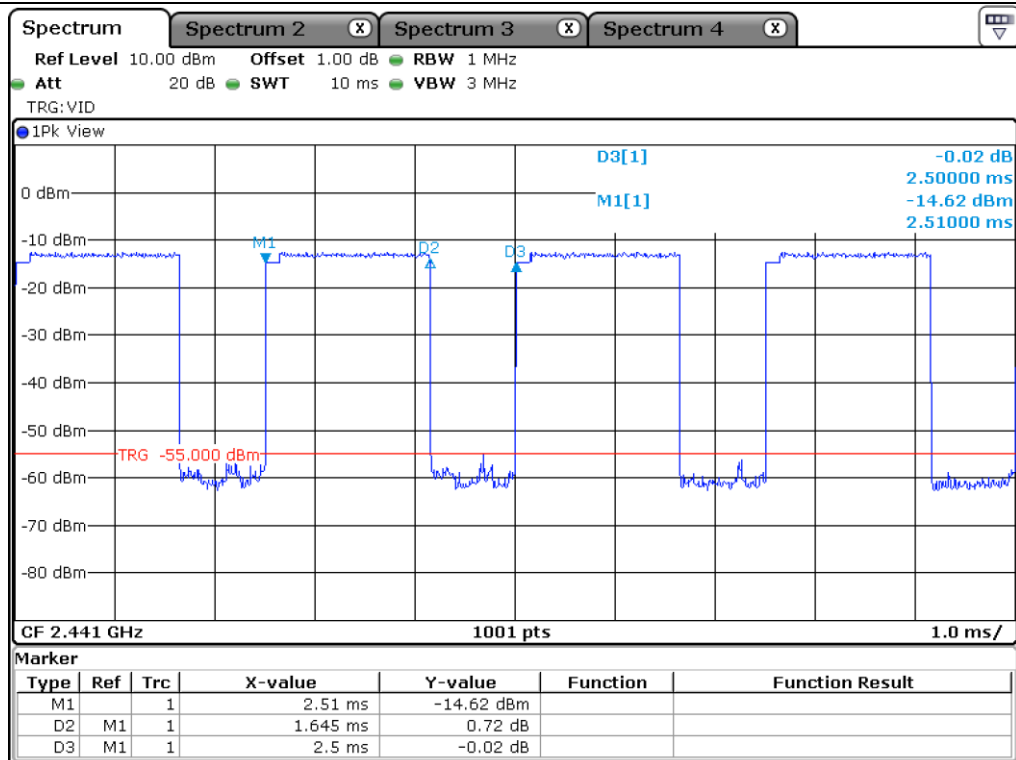
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.385	10.13	31.60	123.24	400.00	PASS
DH3	1.645	5.06	31.60	263.03	400.00	
DH5	2.890	3.38	31.60	308.68	400.00	

Total dwell time is calculated as following.

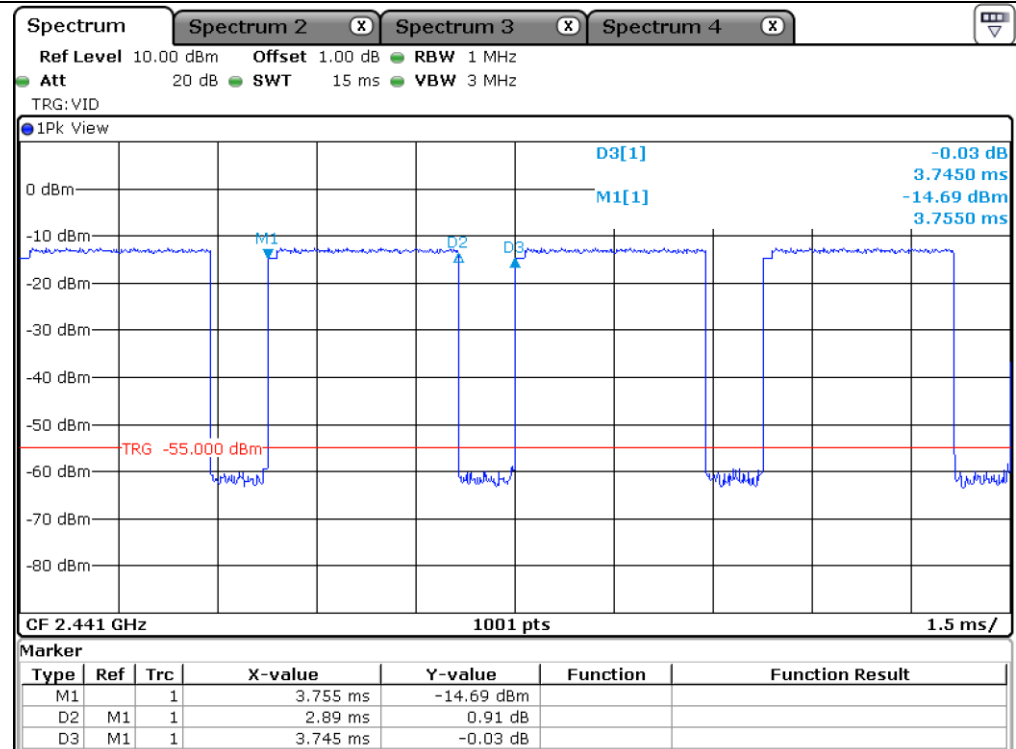
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

10.6 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.

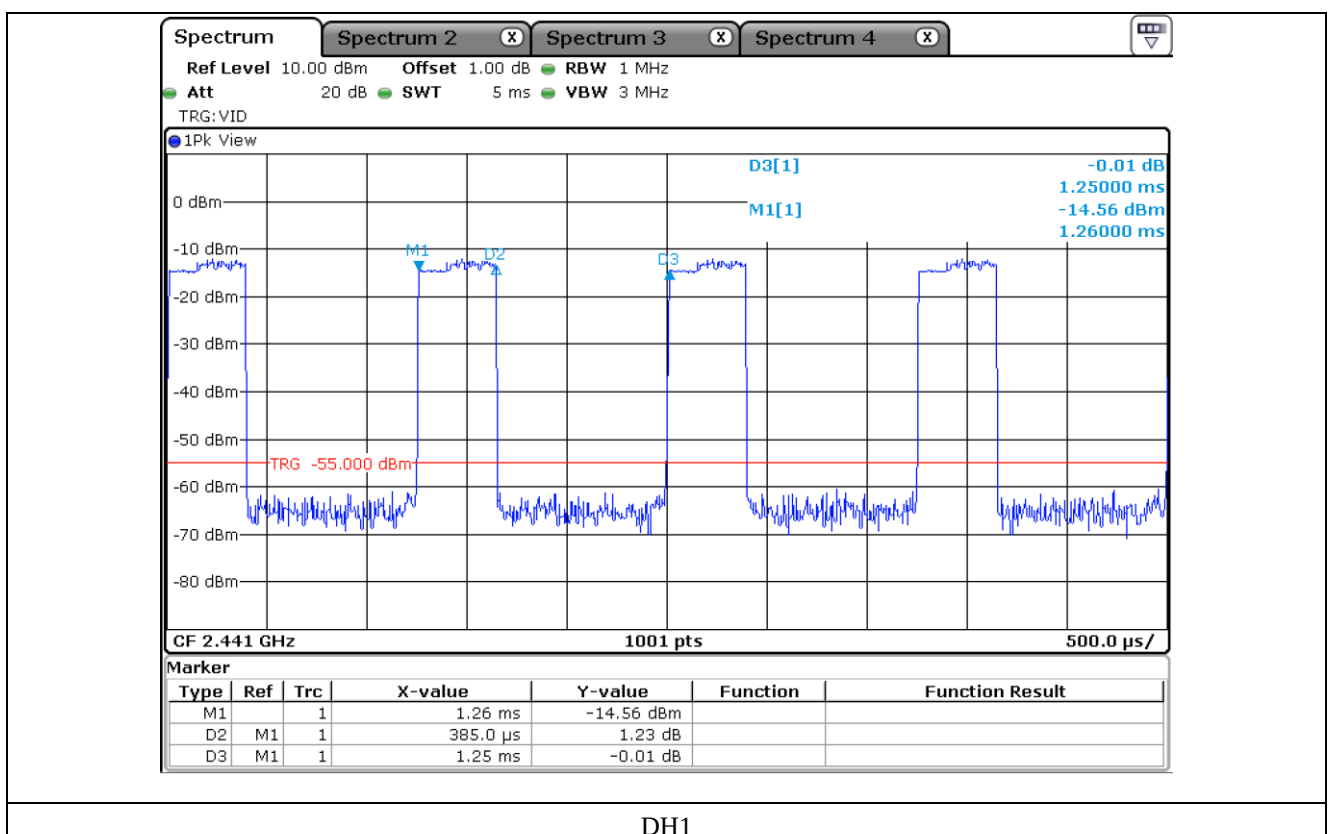
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

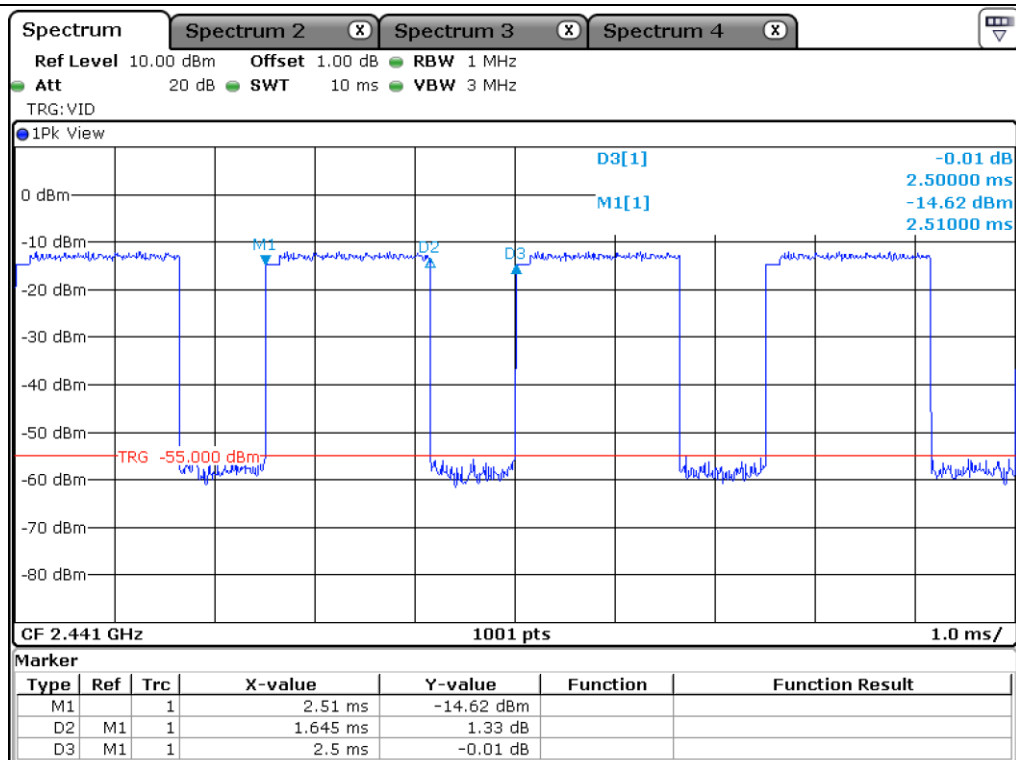
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.385	10.13	31.60	123.24	400.00	PASS
DH3	1.645	5.06	31.60	263.03	400.00	
DH5	2.890	3.38	31.60	308.68	400.00	

Total dwell time is calculated as following.

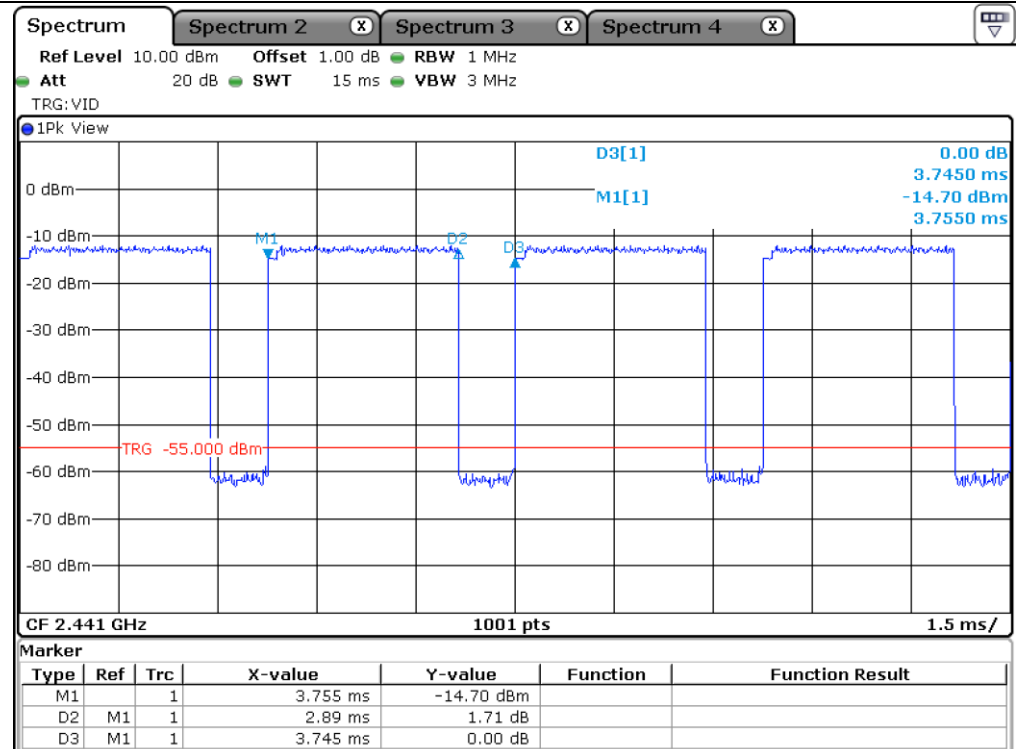
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5