

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-231-RWD-022
Reception No. : 2212004158
Applicant : BLUECOM Co., Ltd.
Address : 116, Venture-ro, Yeonsu-gu, Incheon, Korea
Manufacturer : BLUECOM Co., Ltd.
Address : 116, Venture-ro, Yeonsu-gu, Incheon, Korea
Type of Equipment : Bluetooth Stereo Headset
FCC ID. : U3WBCS700PRO
Model Name : BCS-700 Pro
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 79 pages (including this page)
Date of Incoming : December 27, 2022
Date of issue : January 19, 2023

SUMMARY

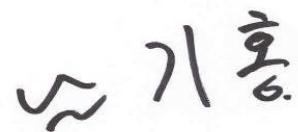
The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247*

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.

This report is not correlated with the "KS Q ISO/IEC 17025 and KOLAS accreditation" of Korean Laboratory Accreditation Scheme.





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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-231-RWD-022	January 19, 2023	Initial Release	All

* Please contact us (e-mail: info@onetech.co.kr) for verification of this test report.

1. VERIFICATION OF COMPLIANCE

Applicant : BLUECOM Co., Ltd.
 Address : 116, Venture-ro, Yeonsu-gu, Incheon, Korea
 Contact Person : Ki-eok Park / Principal Engineer
 Telephone No. : 82-32-8100-582
 FCC ID : U3WBCS700PRO
 Model Name : BCS-700 Pro
 Brand Name : N/A
 Serial Number : N/A
 Date : January 19, 2023

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	Bluetooth Stereo Headset
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	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: 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

3. GENERAL INFORMATION

3.1 Product Description

The BLUECOM Co., Ltd., Model BCS-700 Pro (referred to as the EUT in this report) is a Bluetooth Stereo Headset. The product specification described herein was obtained from product data sheet or user’s manual.

Device Type	Bluetooth Stereo Headset		
Operating Frequency	Bluetooth	2 402 MHz ~ 2 480 MHz	
	Bluetooth LE		
RF Output Power	Bluetooth	1 Mbps	8.57 dBm
		2 Mbps	8.37 dBm
		3 Mbps	7.56 dBm
	Bluetooth LE	1 Mbps	4.05 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	FPCB Antenna		
Antenna Gain	-0.47 dBi		
List of each Osc. or crystal Freq.(Freq. \geq 1 MHz)	40 MHz		
Rated Supply Voltage	DC 3.7 V		

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	BLUECOM Co., Ltd.	N/A	N/A
Sub Board	BLUECOM Co., Ltd.	N/A	N/A
Battery	BLUECOM Co., Ltd.	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
BCS-700 Pro	BLUECOM Co., Ltd.	Bluetooth Stereo Headset (EUT)	-
Probook	HP	Notebook Computer	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

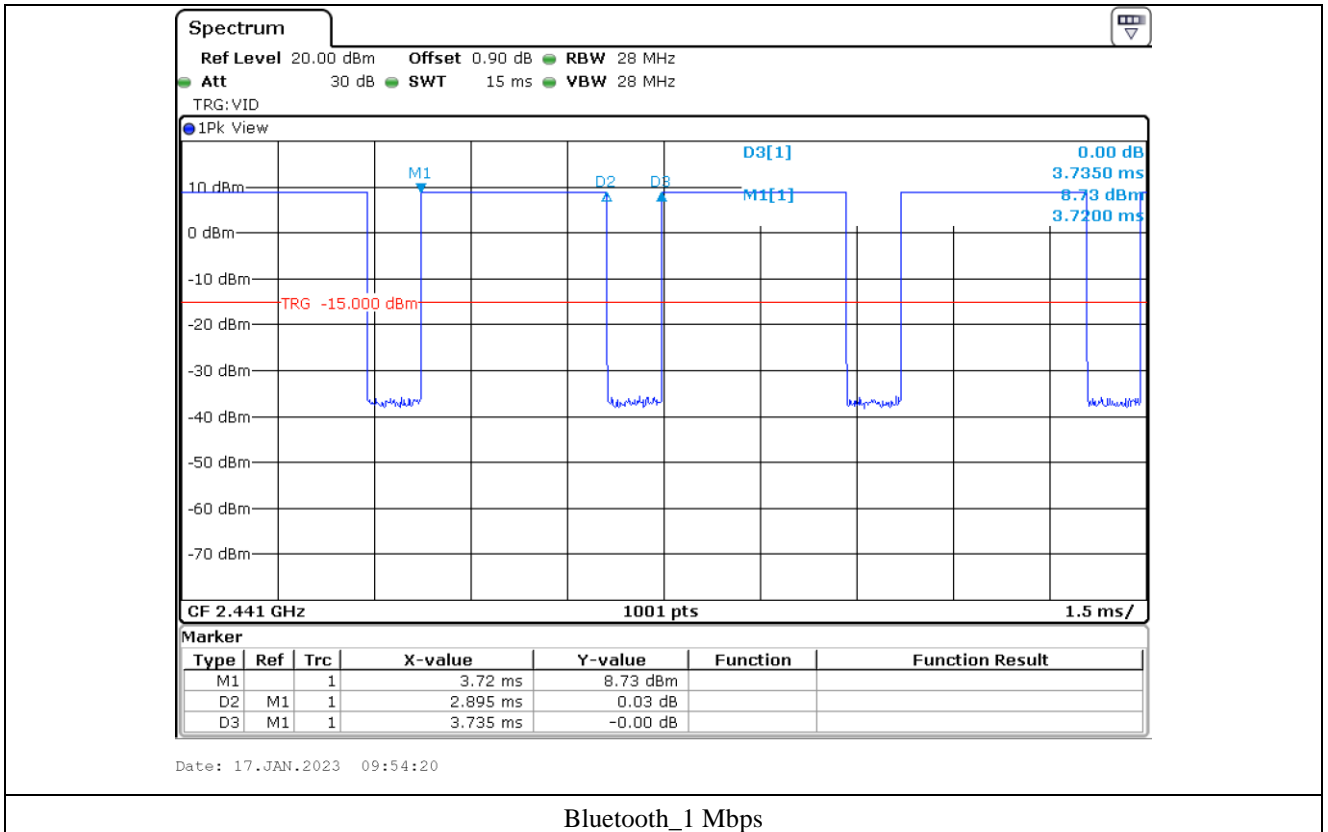
- Duty Cycle

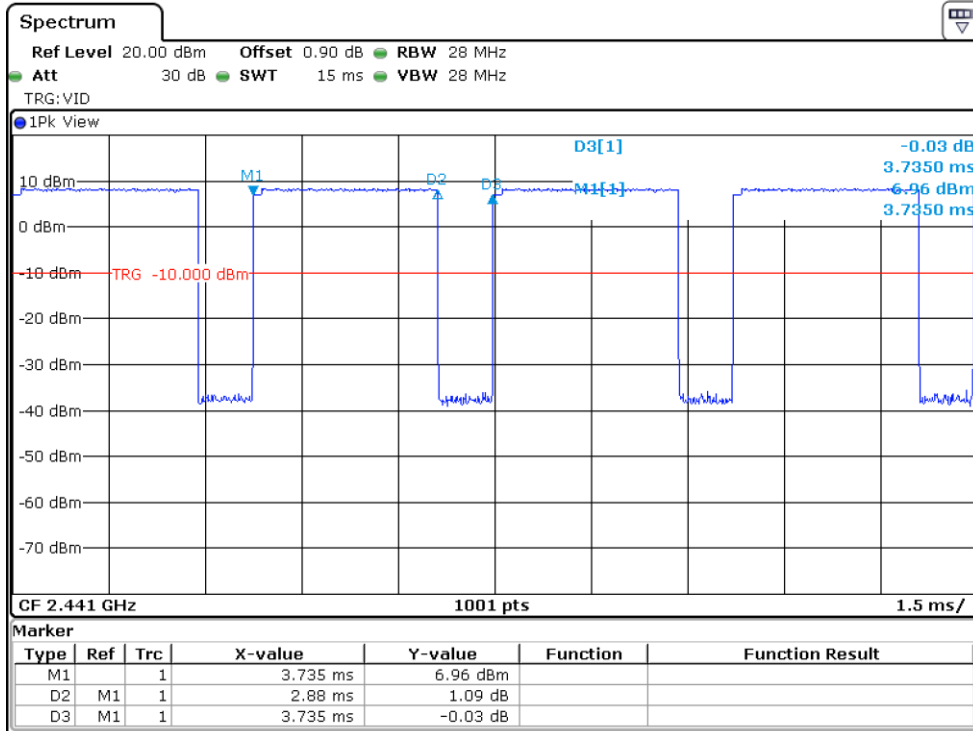
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.895	0.840	77.51	1.11
Bluetooth [2 Mbps]	2.880	0.855	77.11	1.13
Bluetooth [3 Mbps]	2.880	0.855	77.11	1.13

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

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

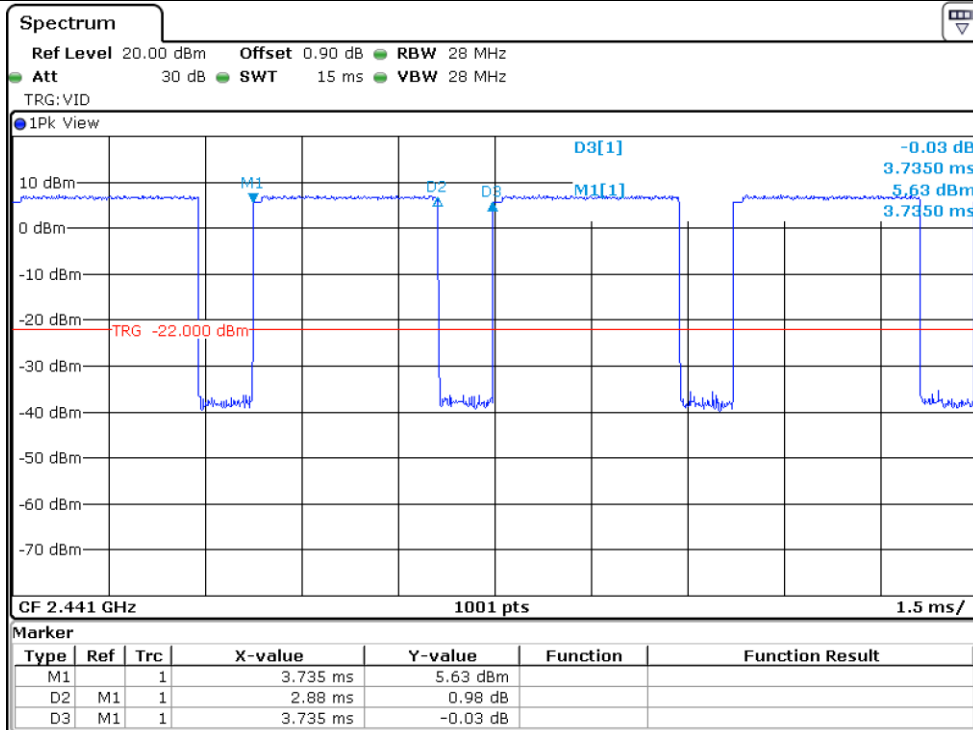
- Test Plot





Date: 17.JAN.2023 09:56:03

Bluetooth_2 Mbps



Date: 17.JAN.2023 09:57:02

Bluetooth_3 Mbps

5.4 Configuration of Test System

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)
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

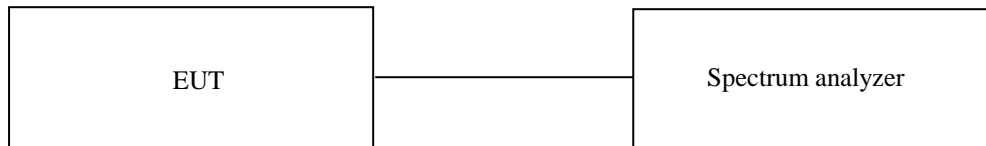
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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.



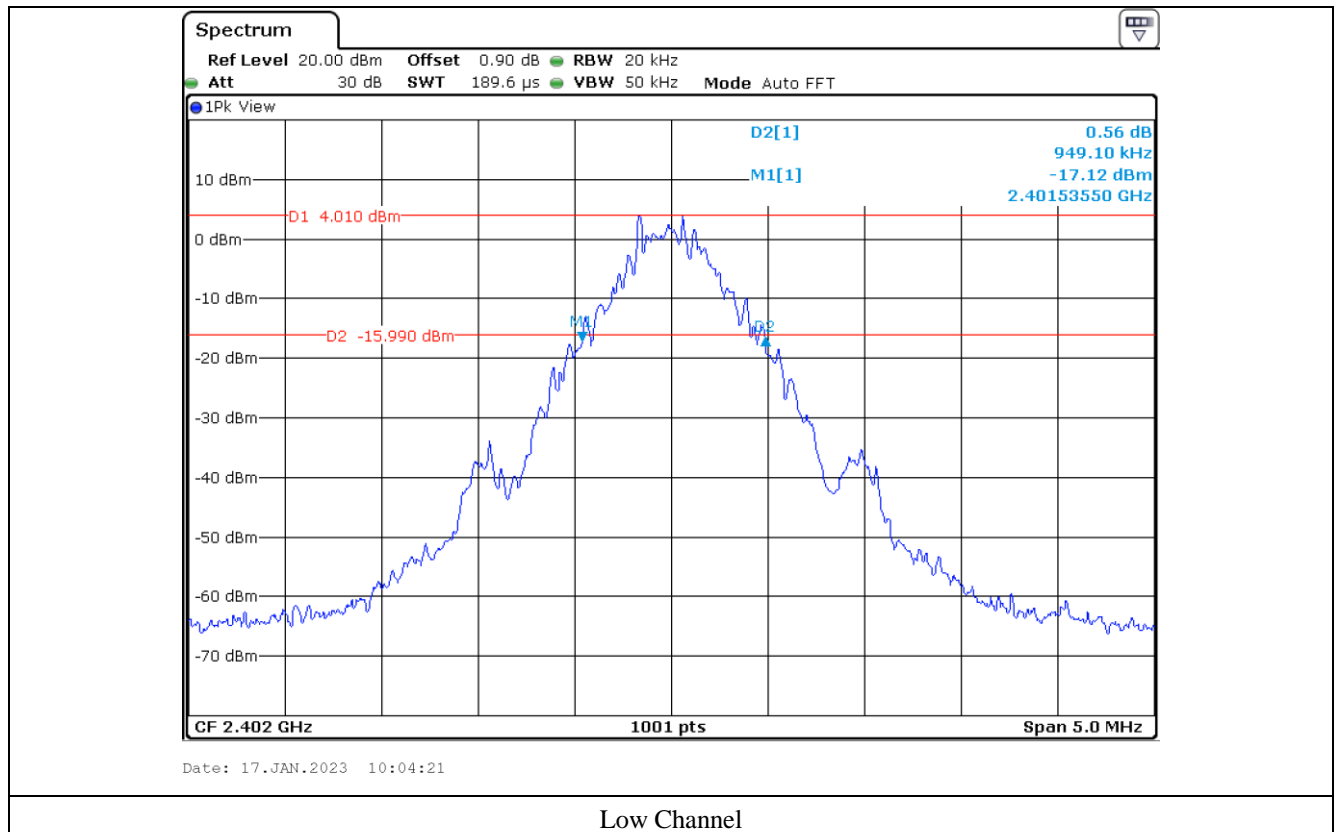
7.3 Test Date

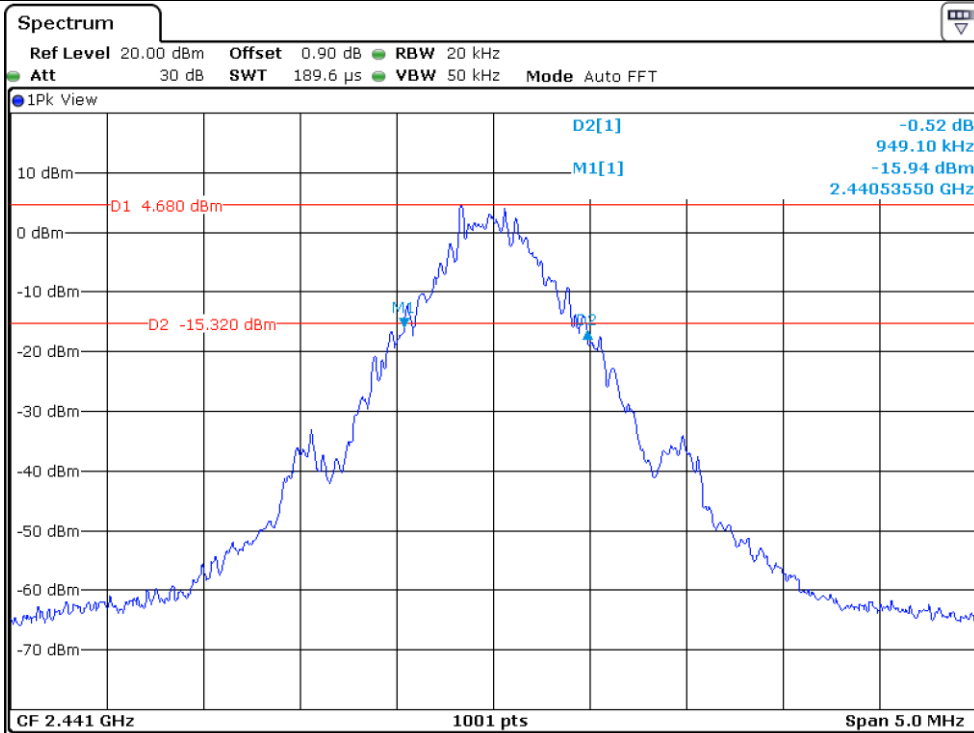
December 27, 2022 ~ January 19, 2023

7.4 Test data

7.4.1 Test data for 1 Mbps

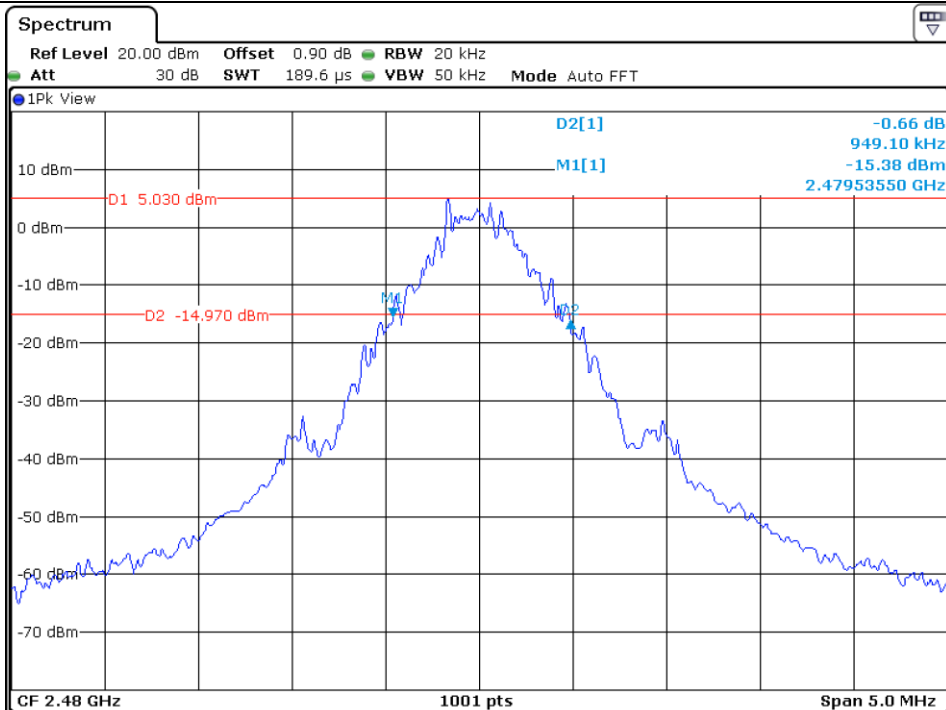
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	949.10
Middle	2 441.00	949.10
High	2 480.00	949.10





Date: 17.JAN.2023 10:05:29

Middle Channel

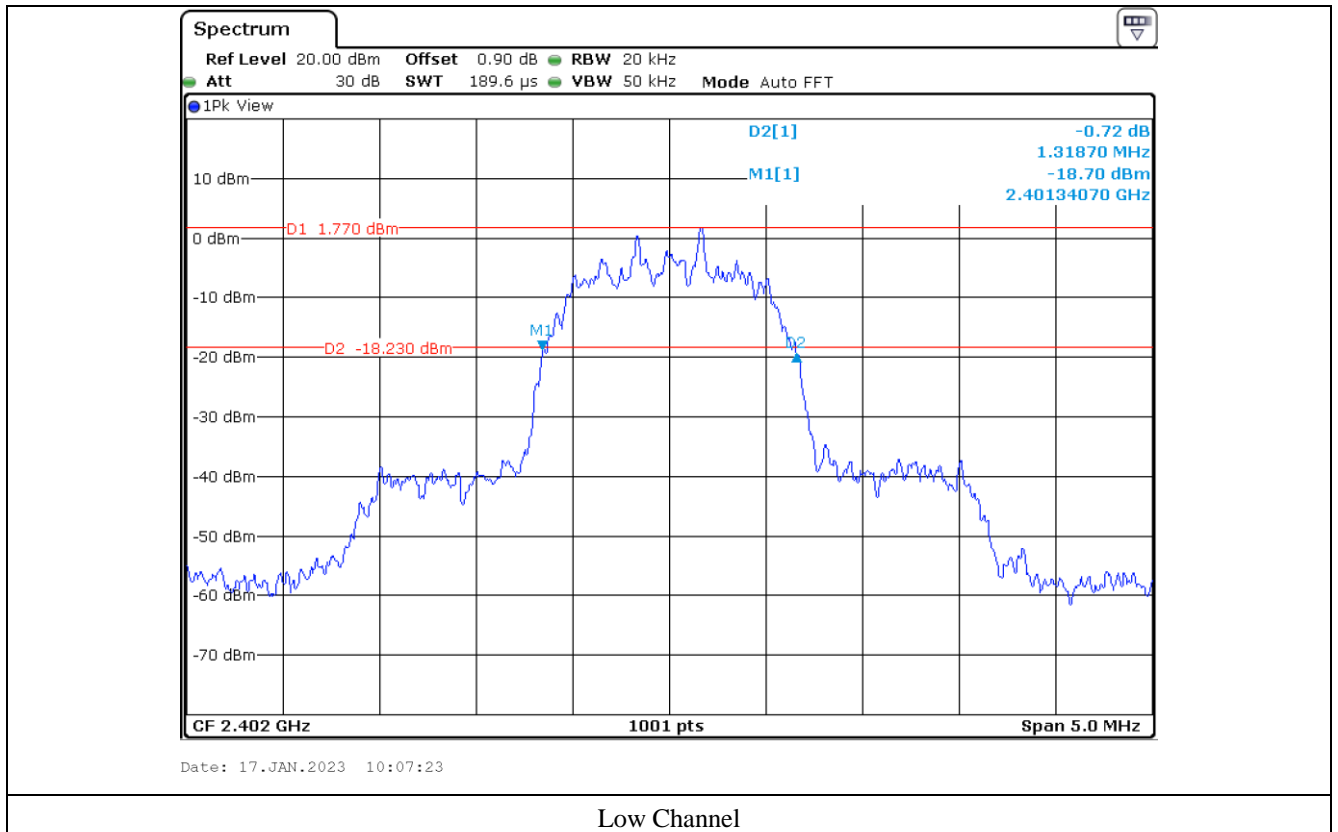


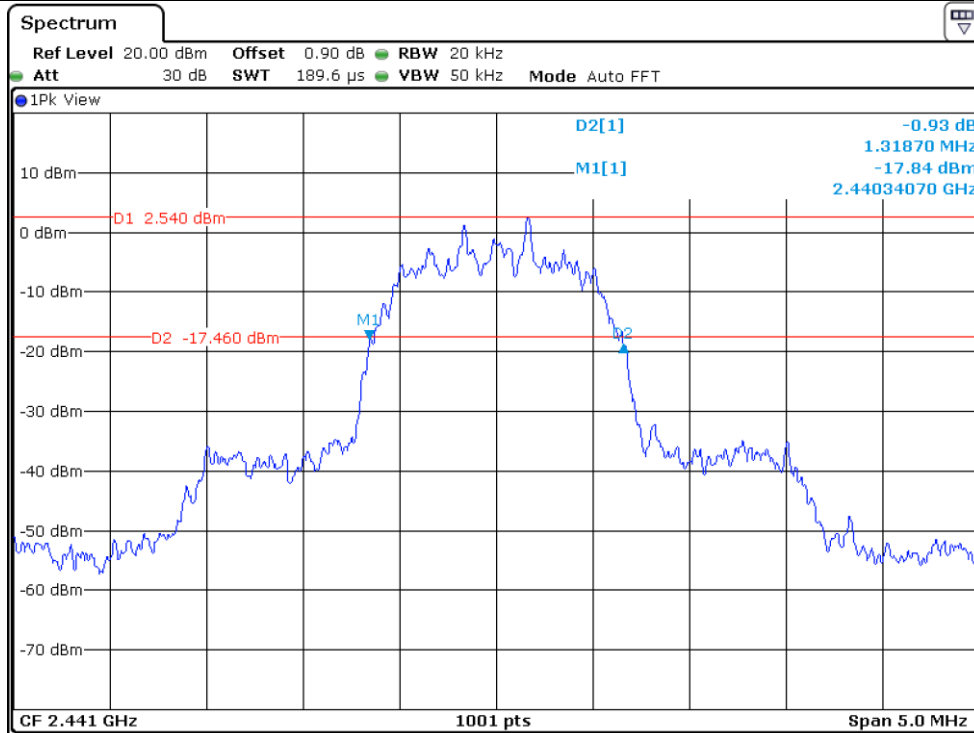
Date: 17.JAN.2023 10:06:25

High Channel

7.4.2 Test data for 2 Mbps

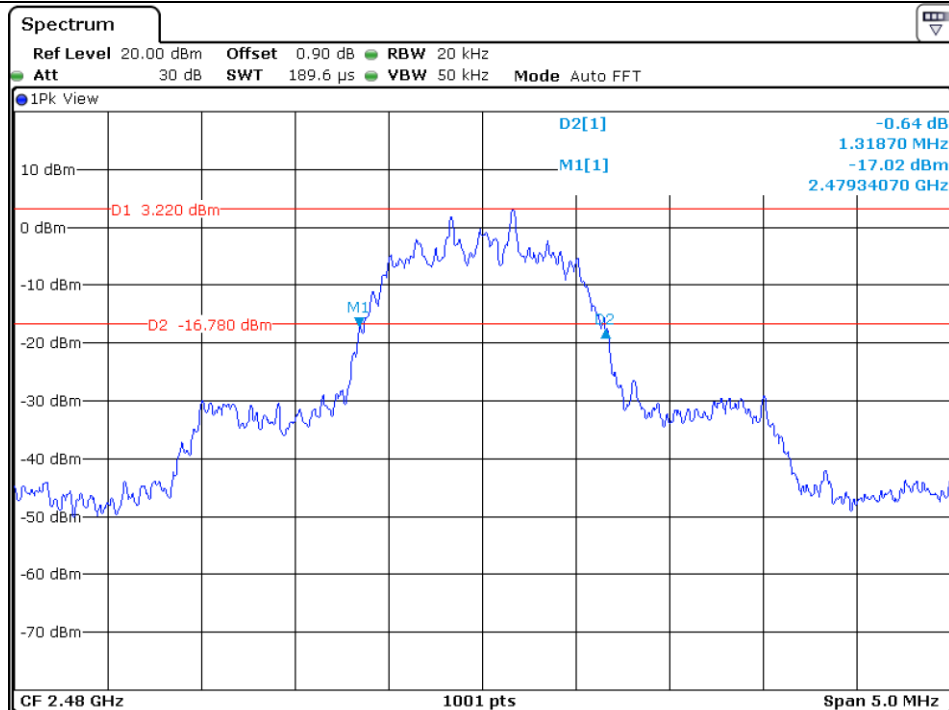
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 318.70
Middle	2 441.00	1 318.70
High	2 480.00	1 318.70





Date: 17.JAN.2023 10:08:27

Middle Channel

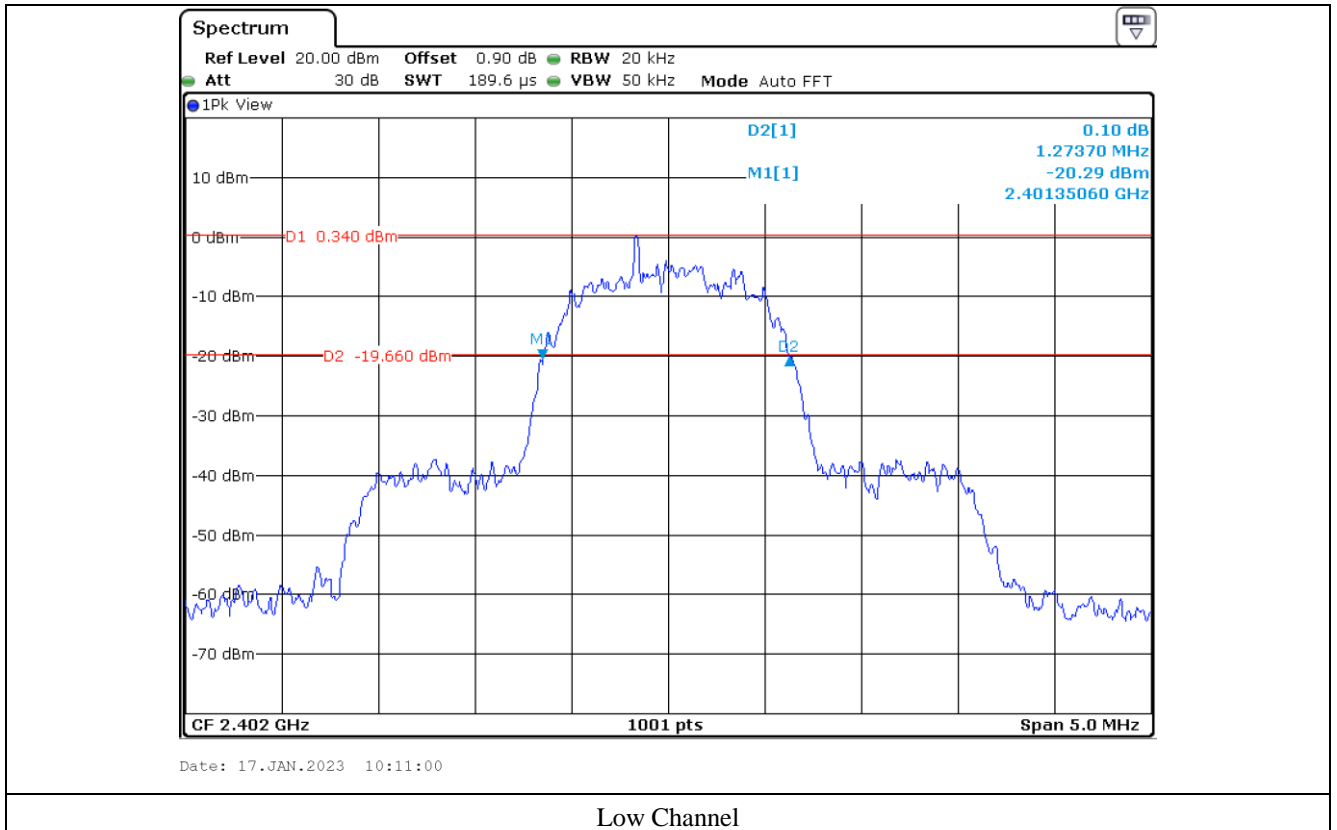


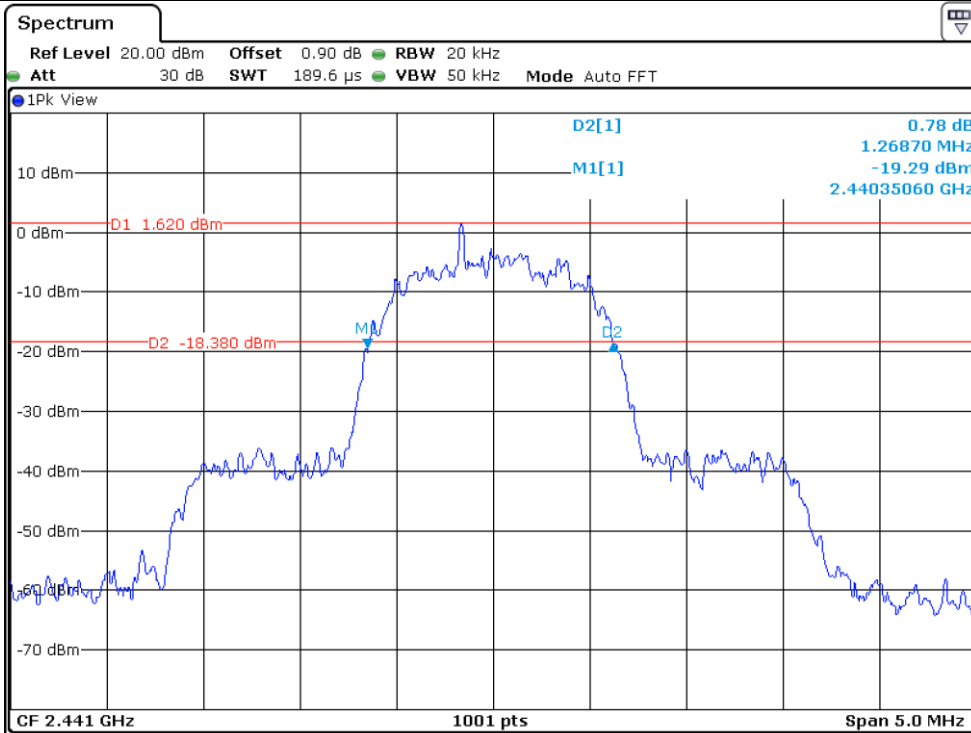
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High Channel

7.4.3 Test data for 3 Mbps

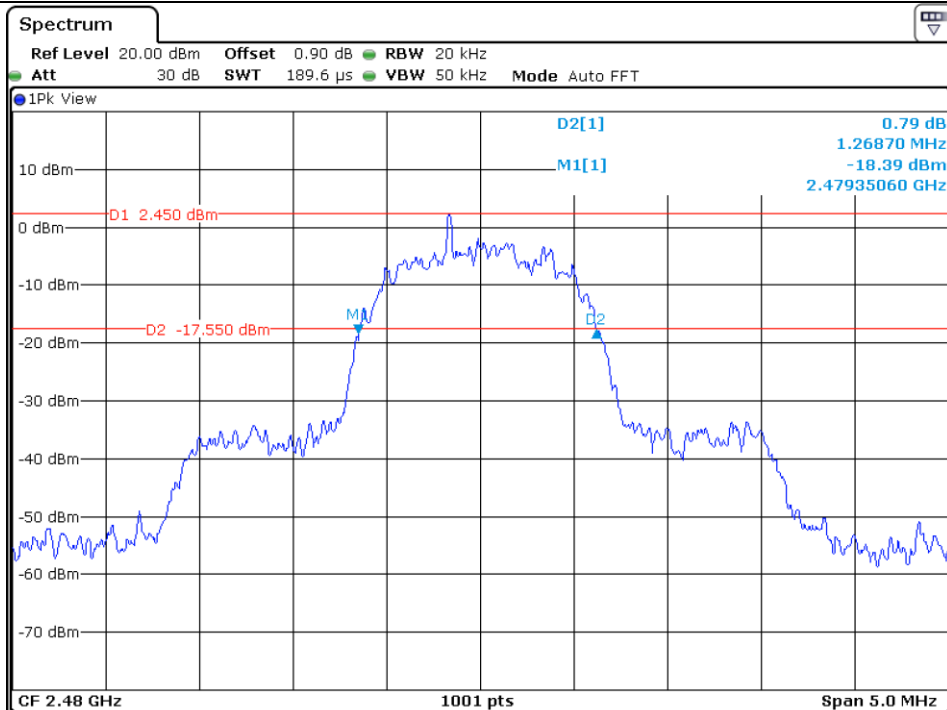
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 273.70
Middle	2 441.00	1 268.70
High	2 480.00	1 268.70





Date: 17.JAN.2023 10:12:06

Middle Channel



Date: 17.JAN.2023 10:13:01

High Channel

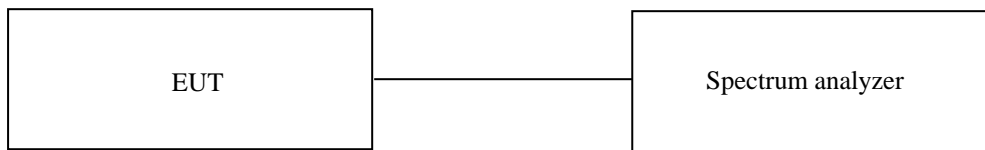
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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

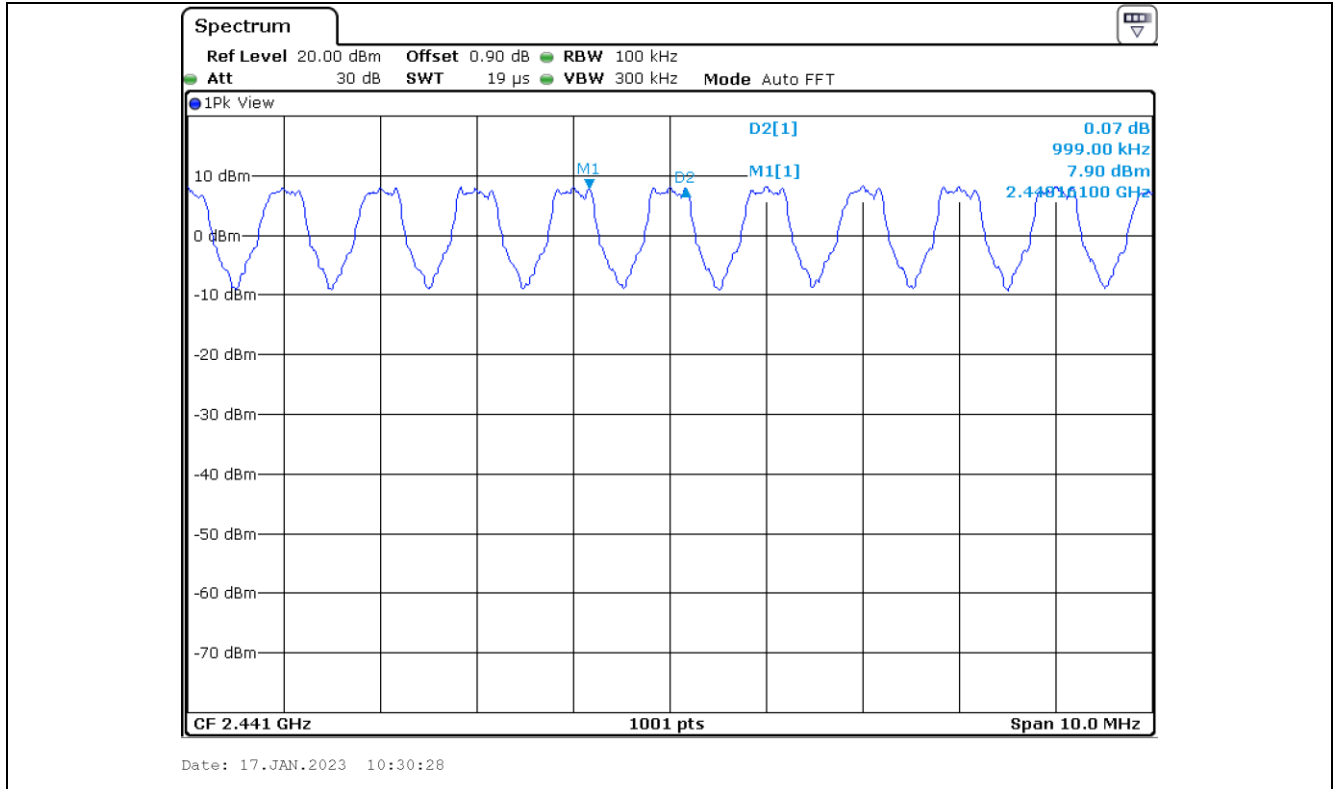
December 27, 2022 ~ January 19, 2023

8.4 Test data

8.4.1 Test data for 1 Mbps

-. Test Result : Pass

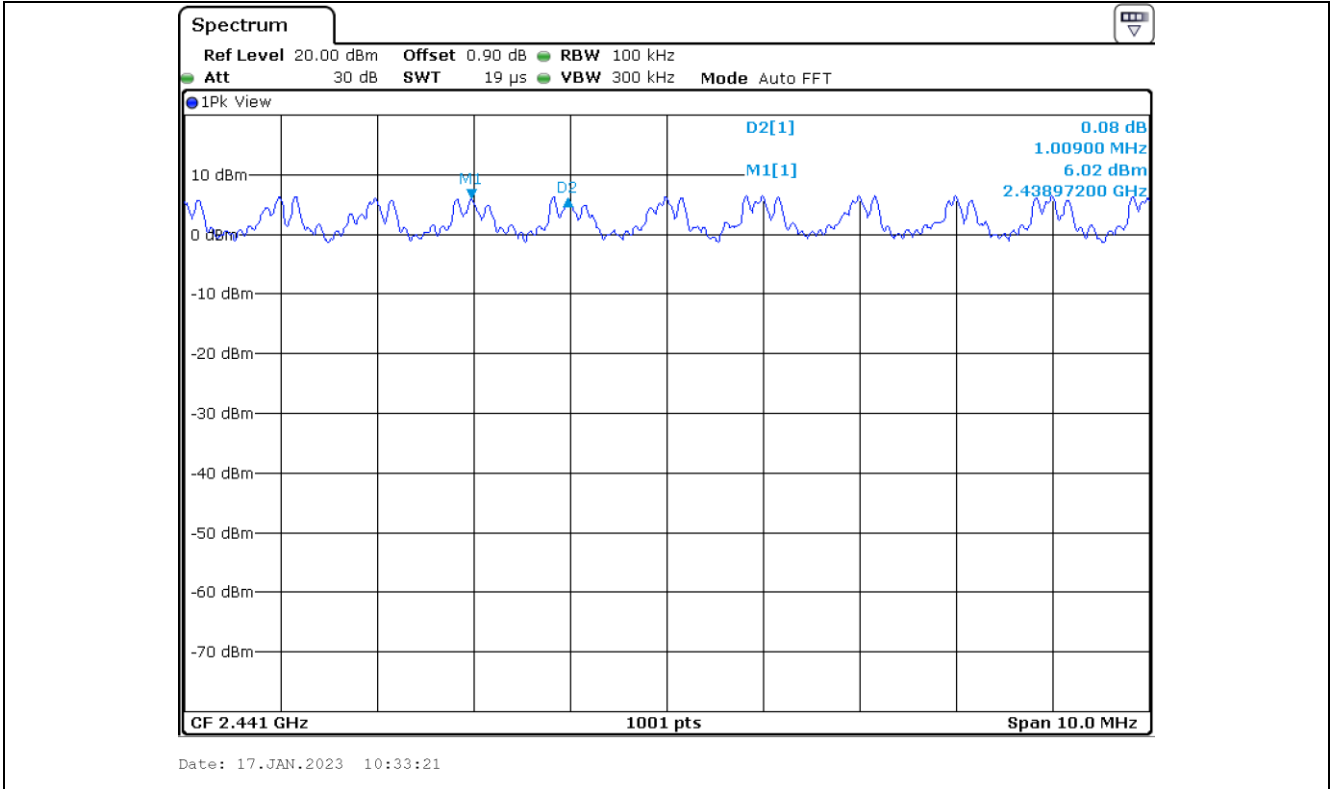
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	632.73	Separated by a minimum of 632.73 kHz



8.4.2 Test data for 2 Mbps

-. Test Result : Pass

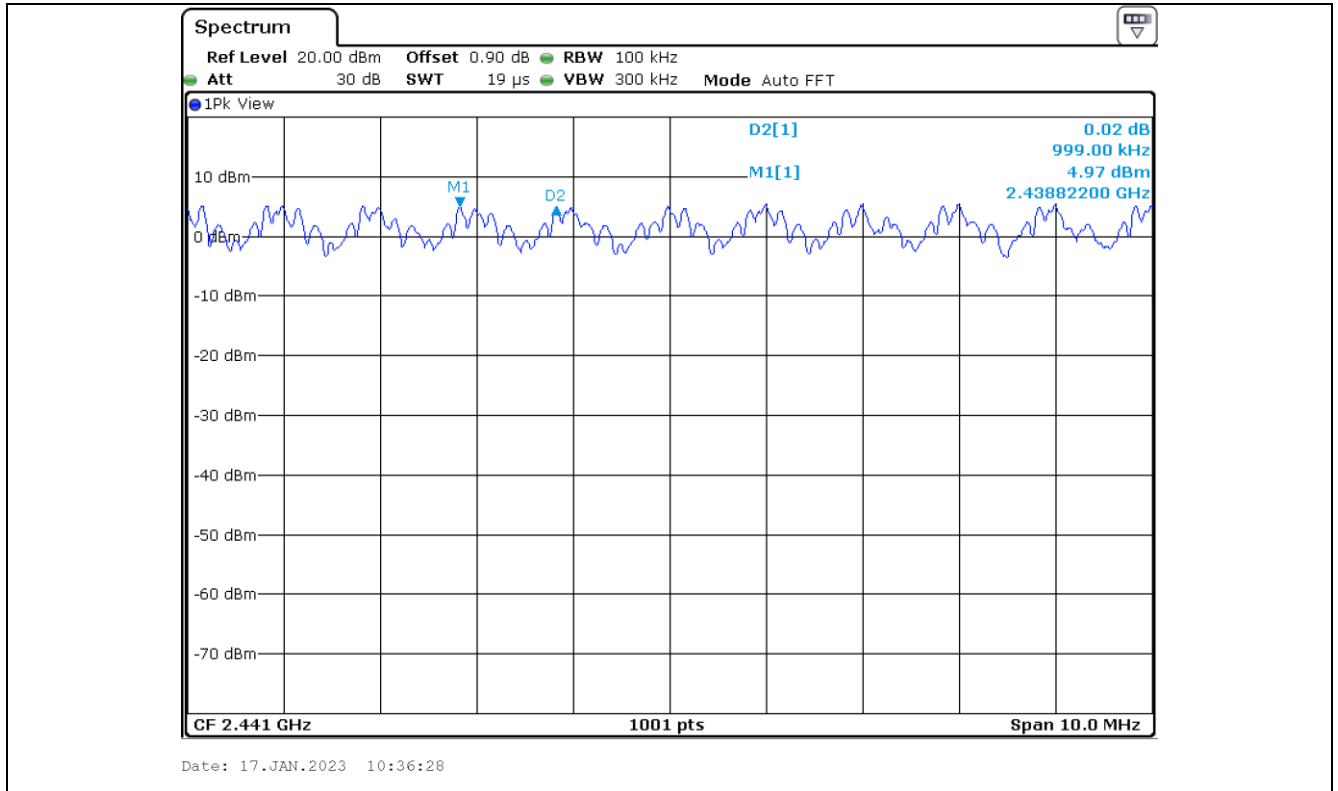
Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
1 009.00	879.13	Separated by a minimum of 879.13 kHz



8.4.3 Test data for 3 Mbps

-. Test Result : Pass

Measured Value (kHz)	Two-third of 20 dB Bandwidth (kHz)	Limit
999.00	845.80	Separated by a minimum of 845.80 kHz



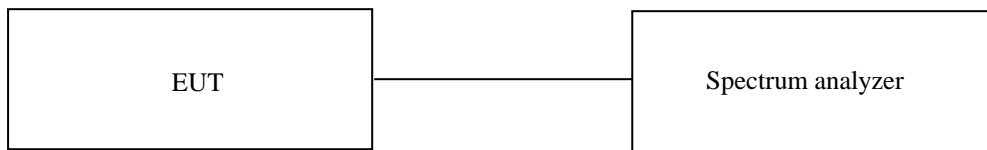
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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

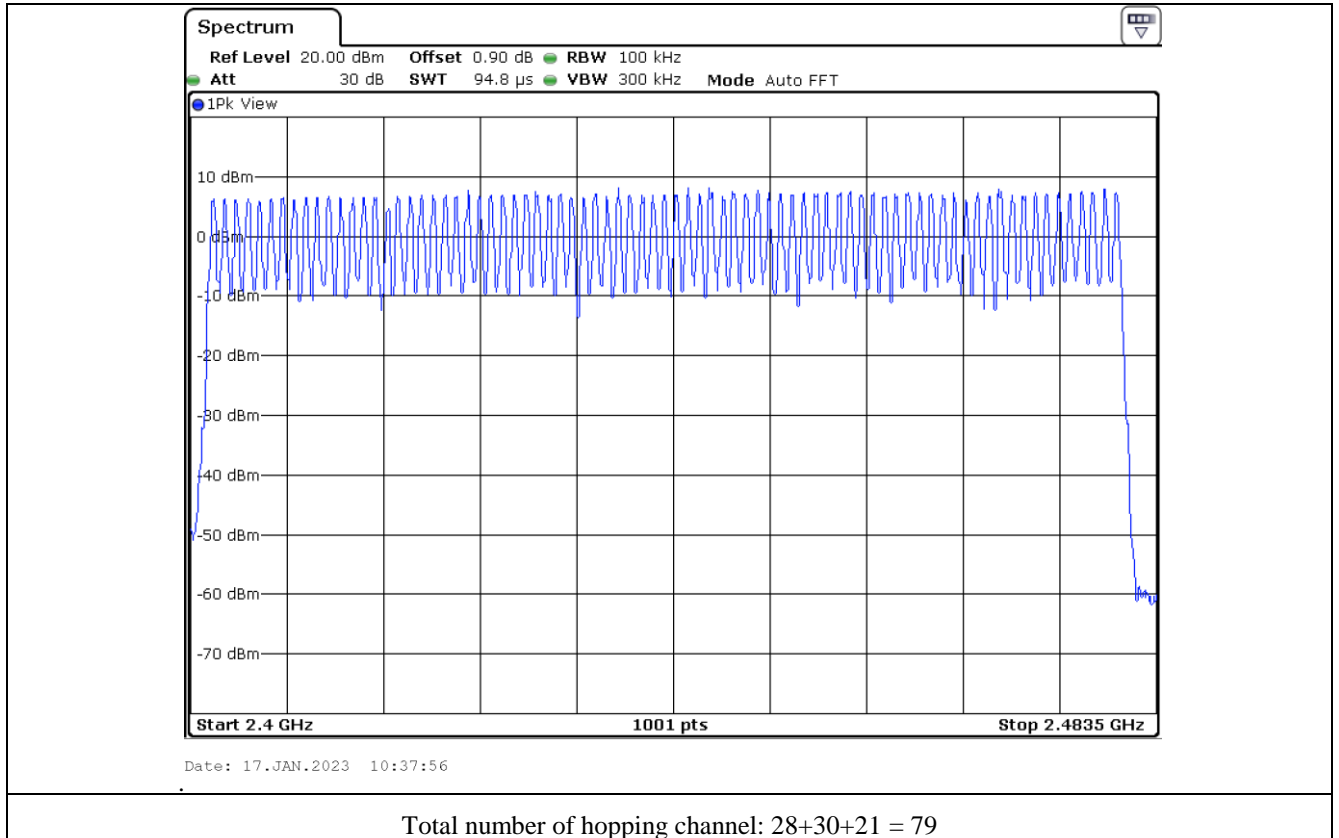
December 27, 2022 ~ January 19, 2023

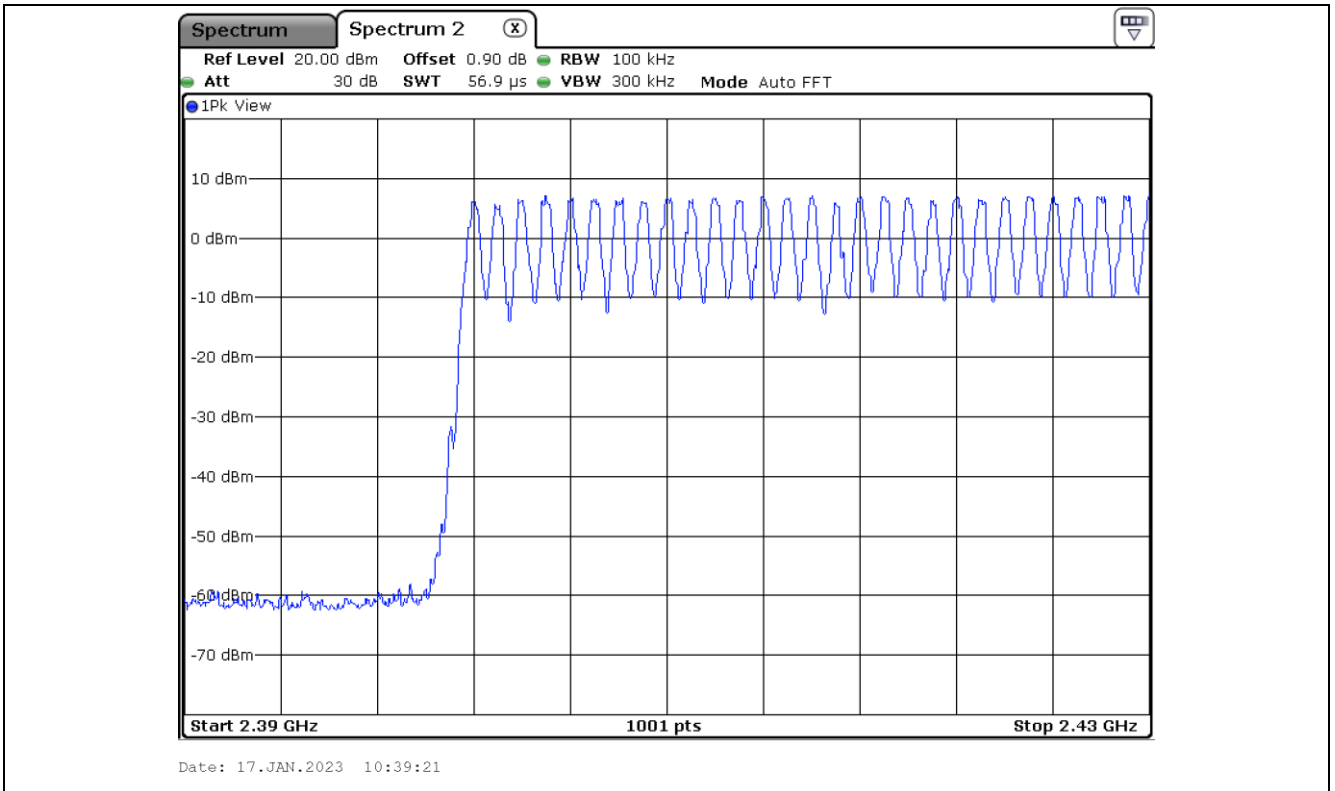
9.4 Test data

9.4.1 Test data for 1 Mbps

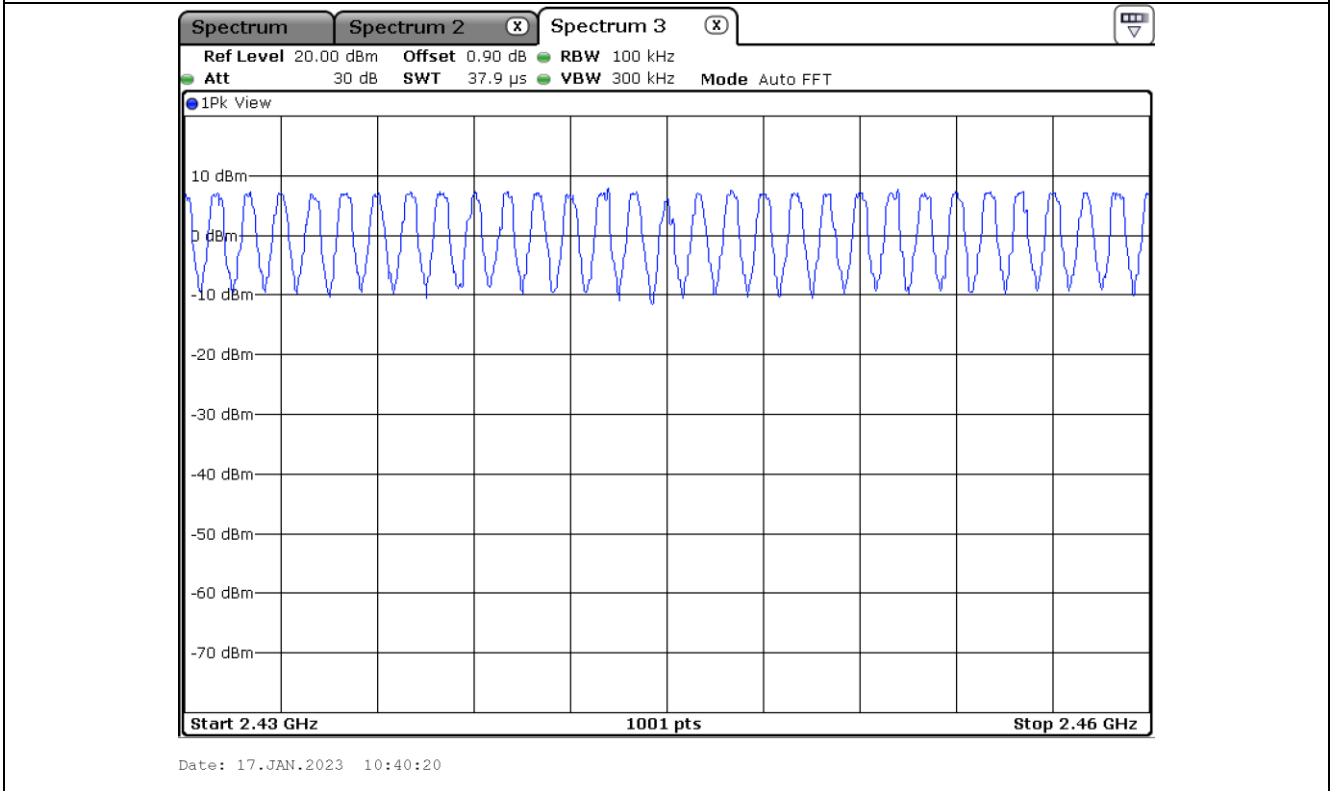
-. Test Result : Pass

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

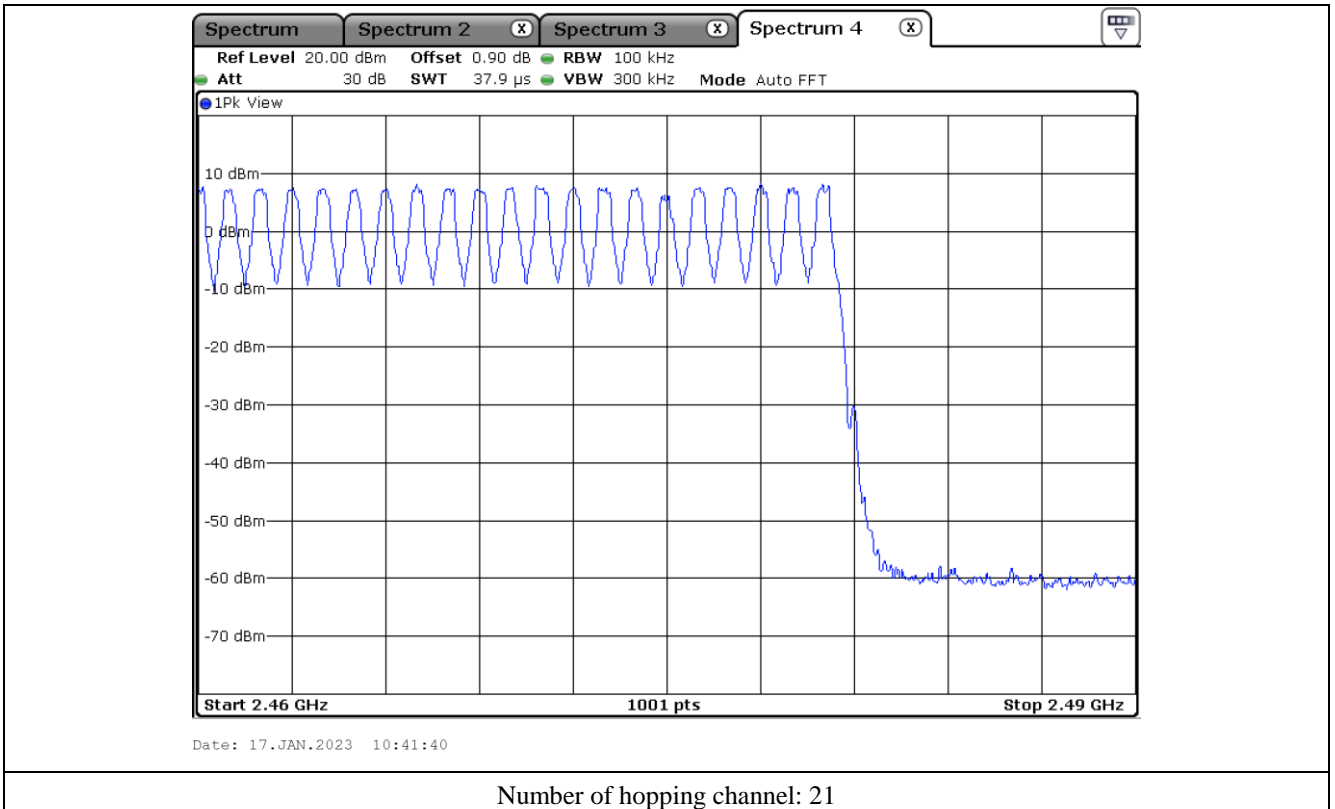




Number of hopping channel: 28



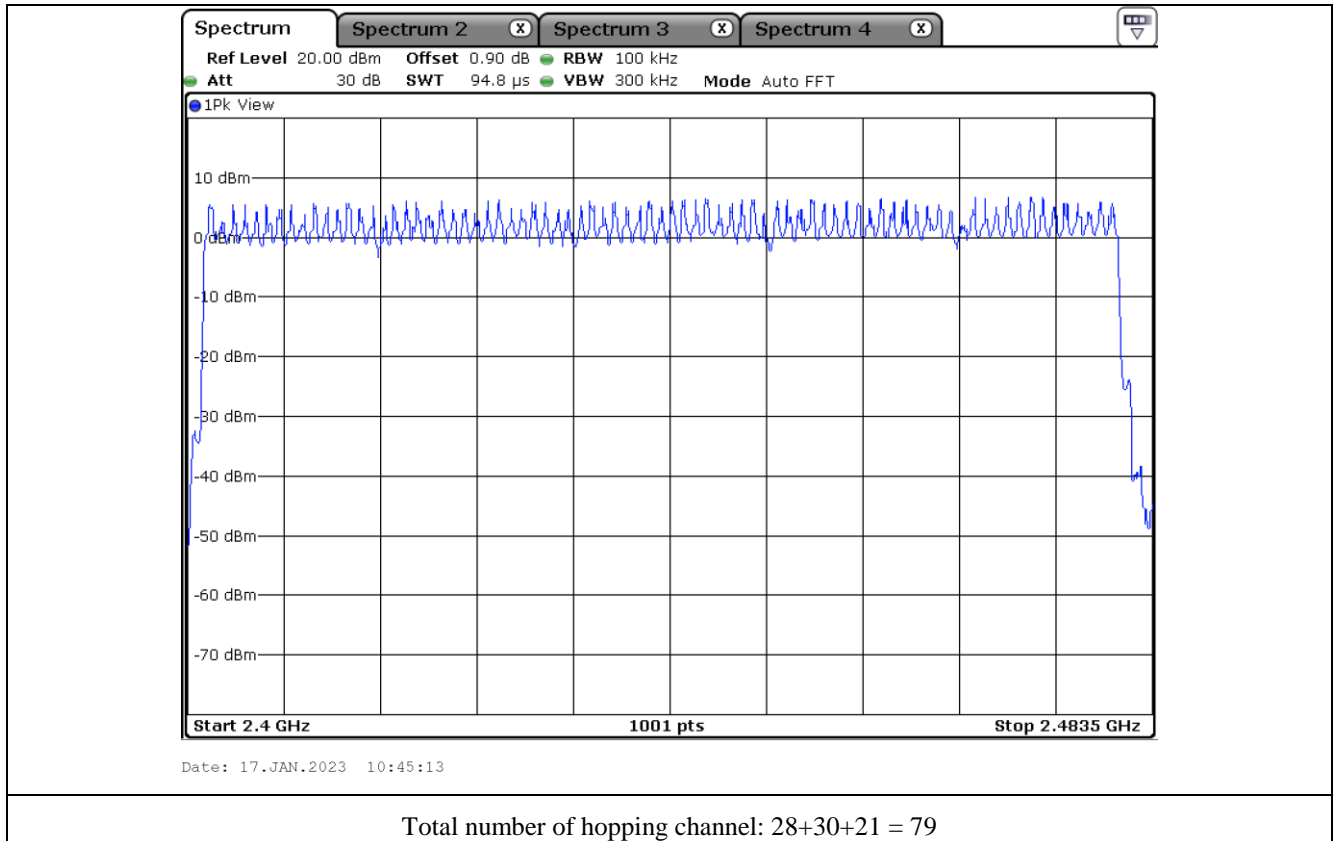
Number of hopping channel: 30

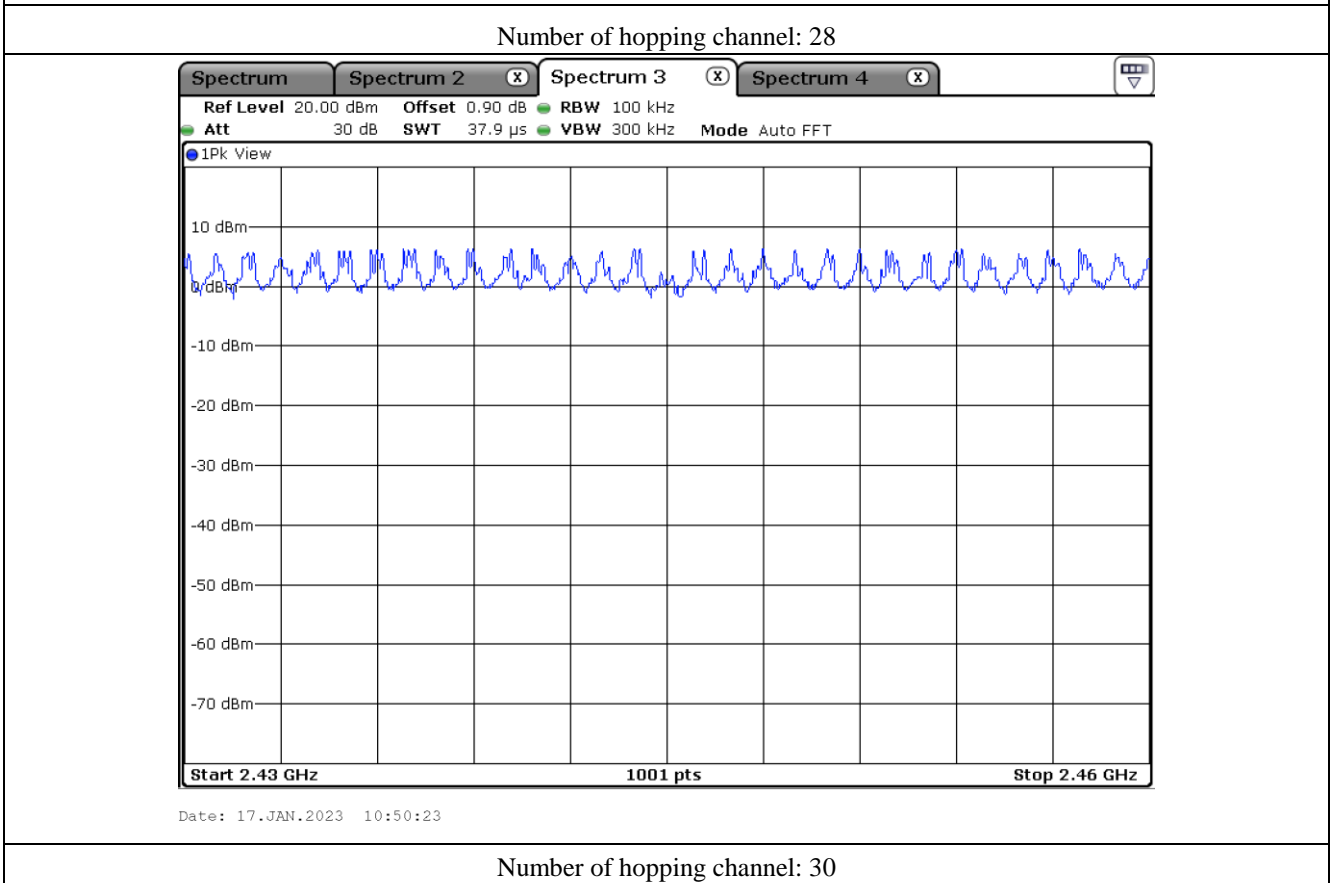
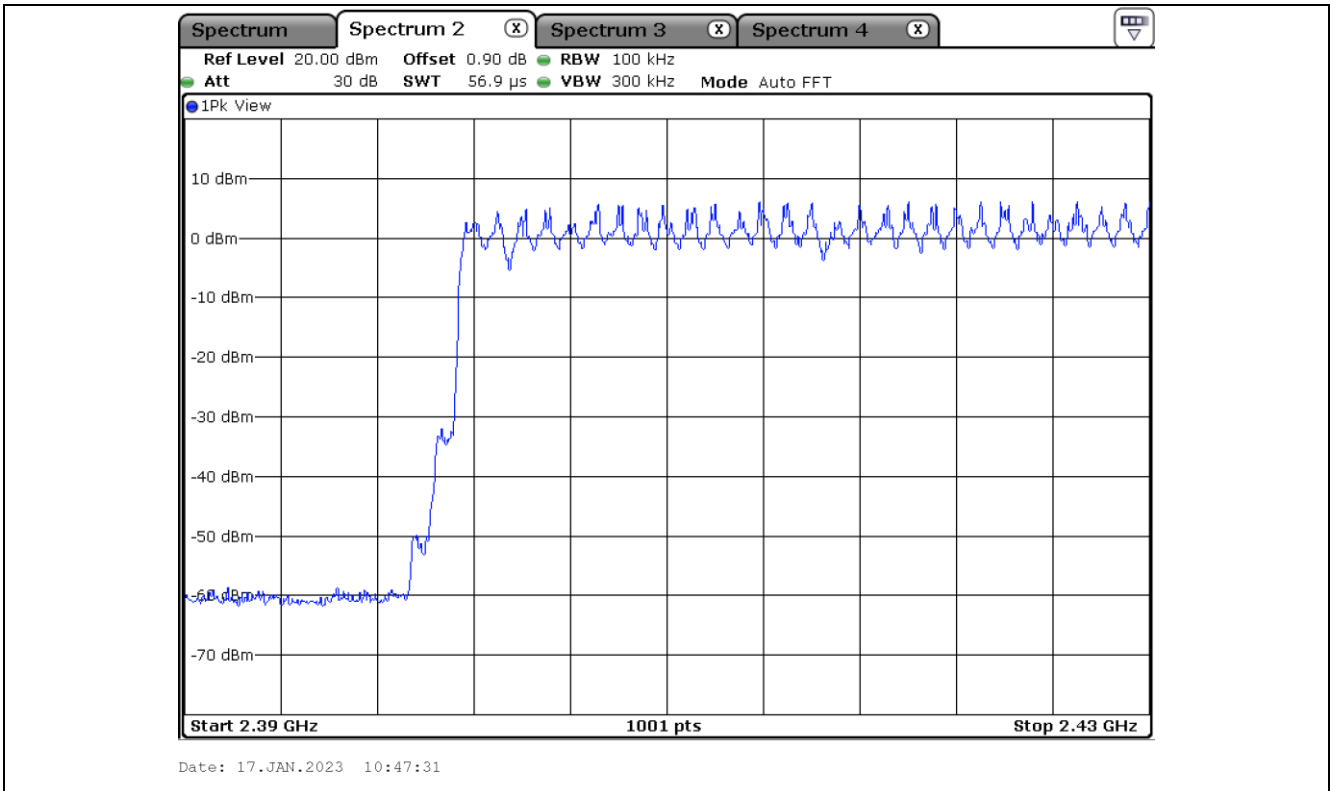


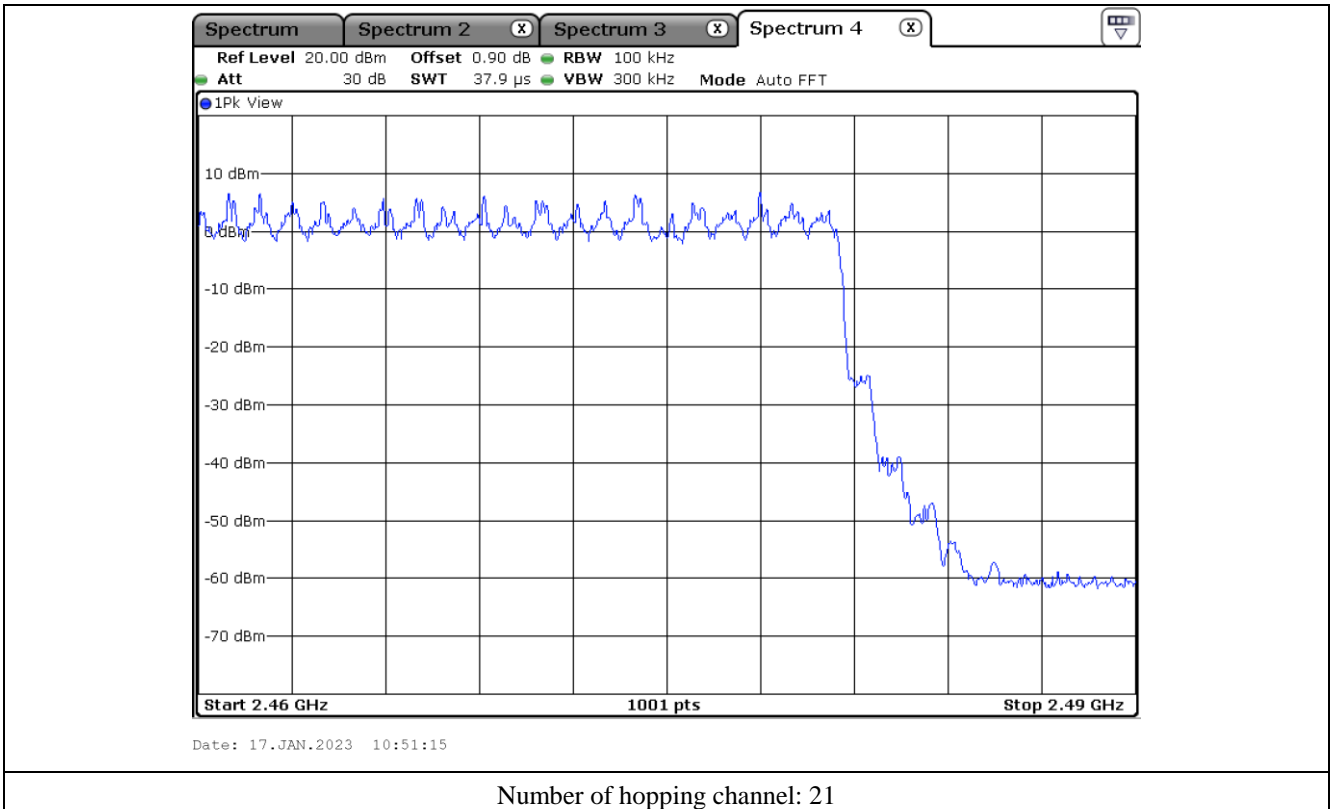
9.4.2 Test data for 2 Mbps

-. Test Result : Pass

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



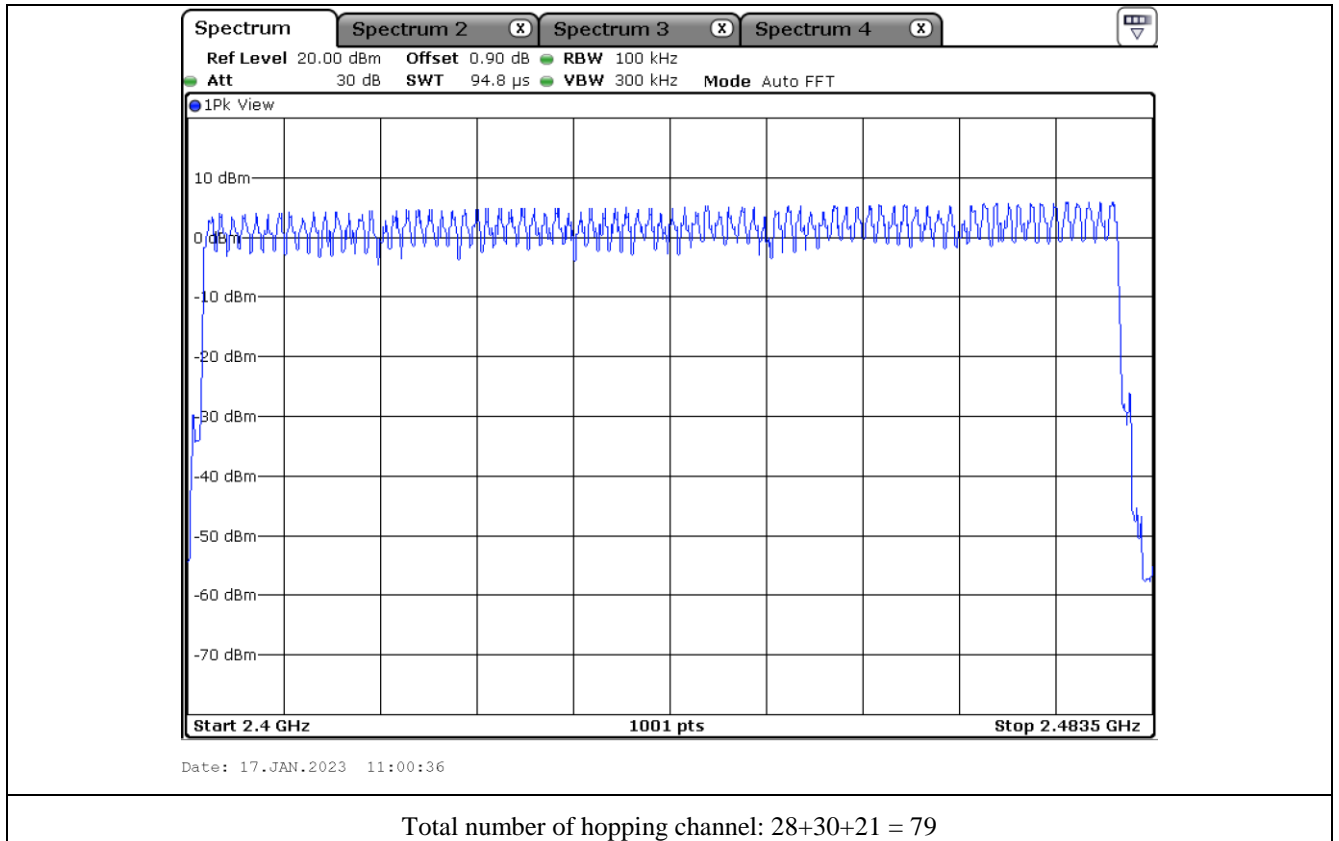


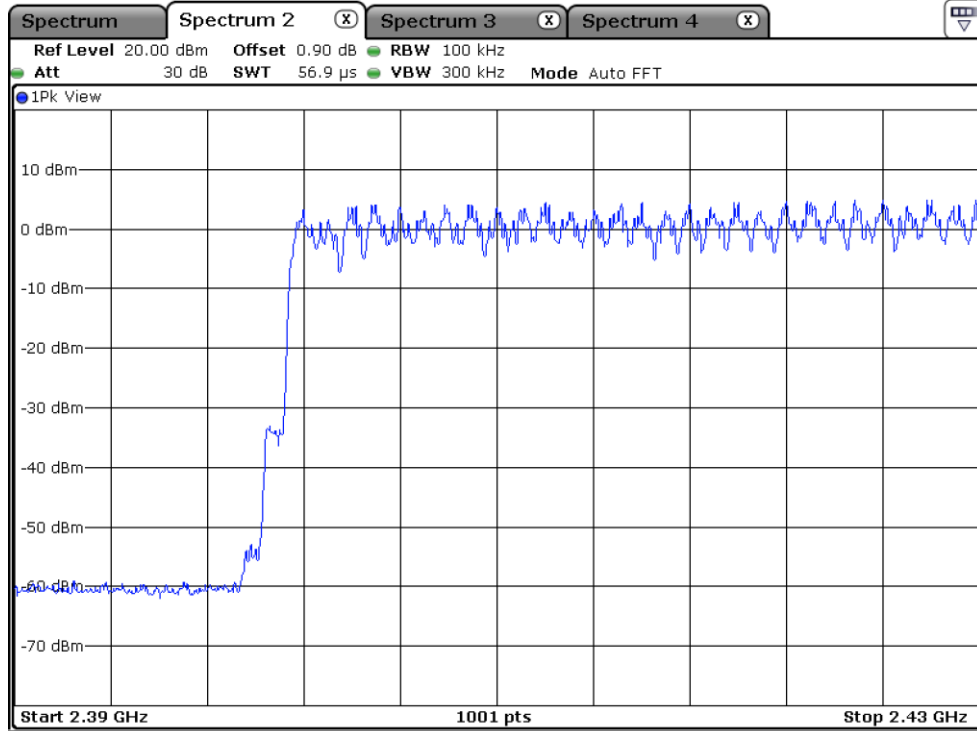


9.4.3 Test data for 3 Mbps

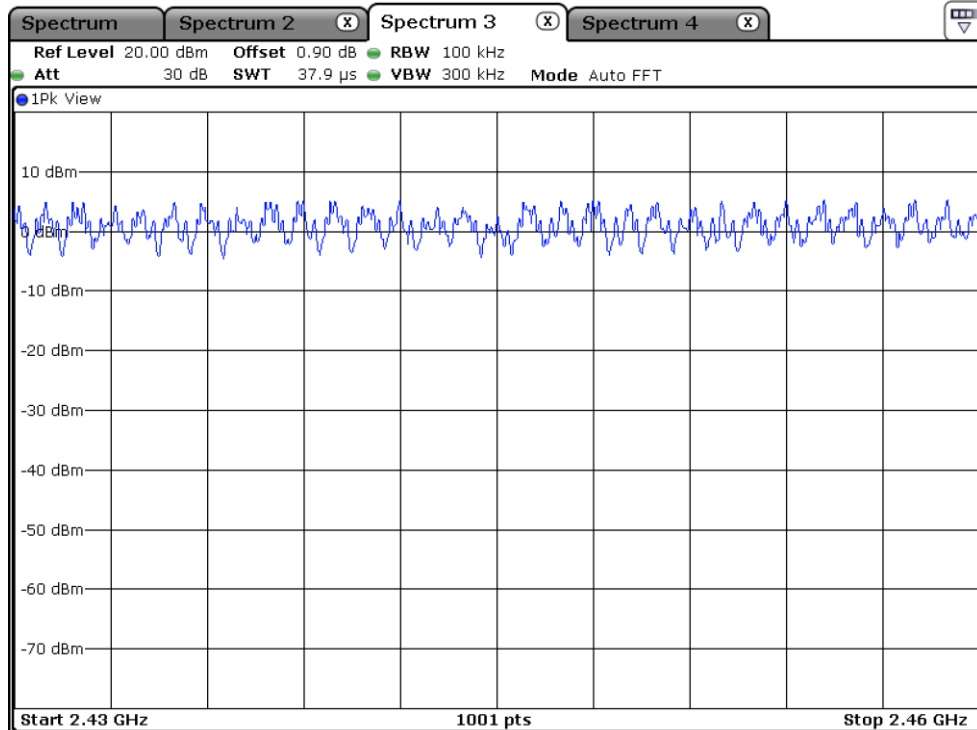
-. Test Result : Pass

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

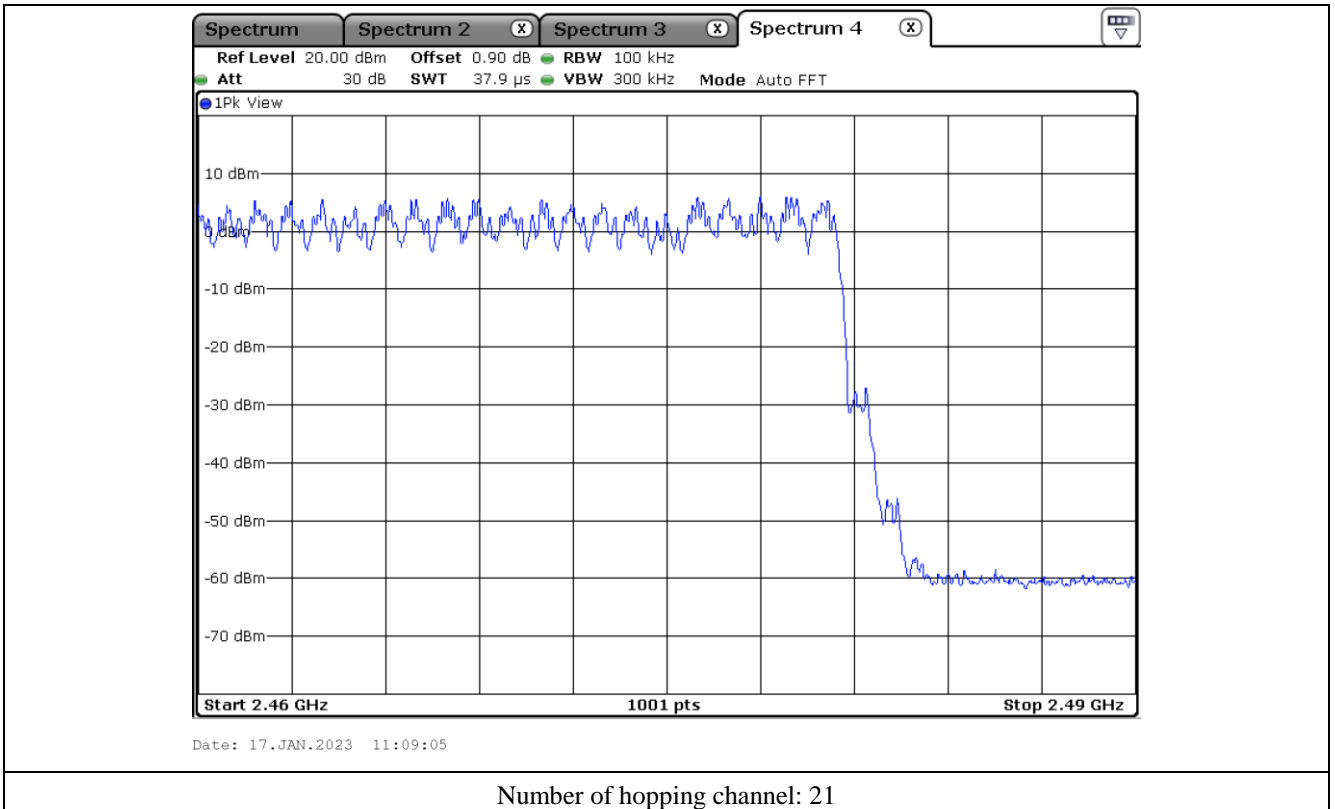




Number of hopping channel: 28



Number of hopping channel: 30



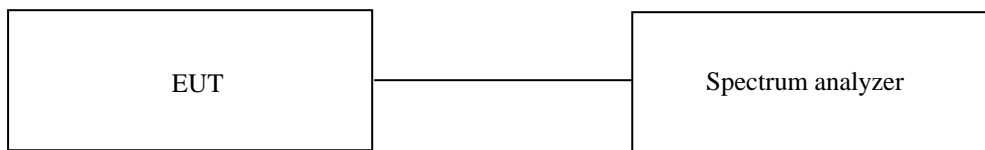
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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

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10.4 Test data

10.4.1 Test data for 1 Mbps

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

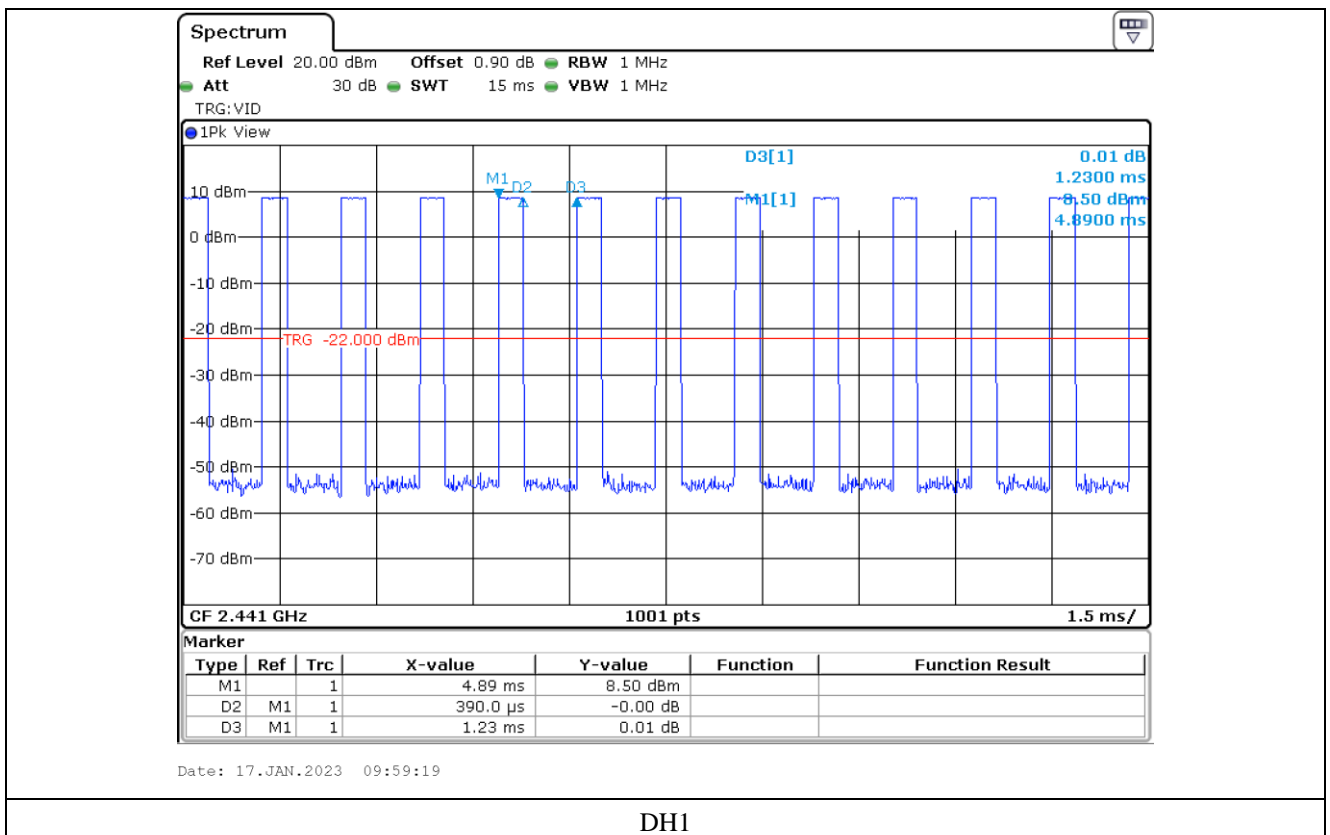
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

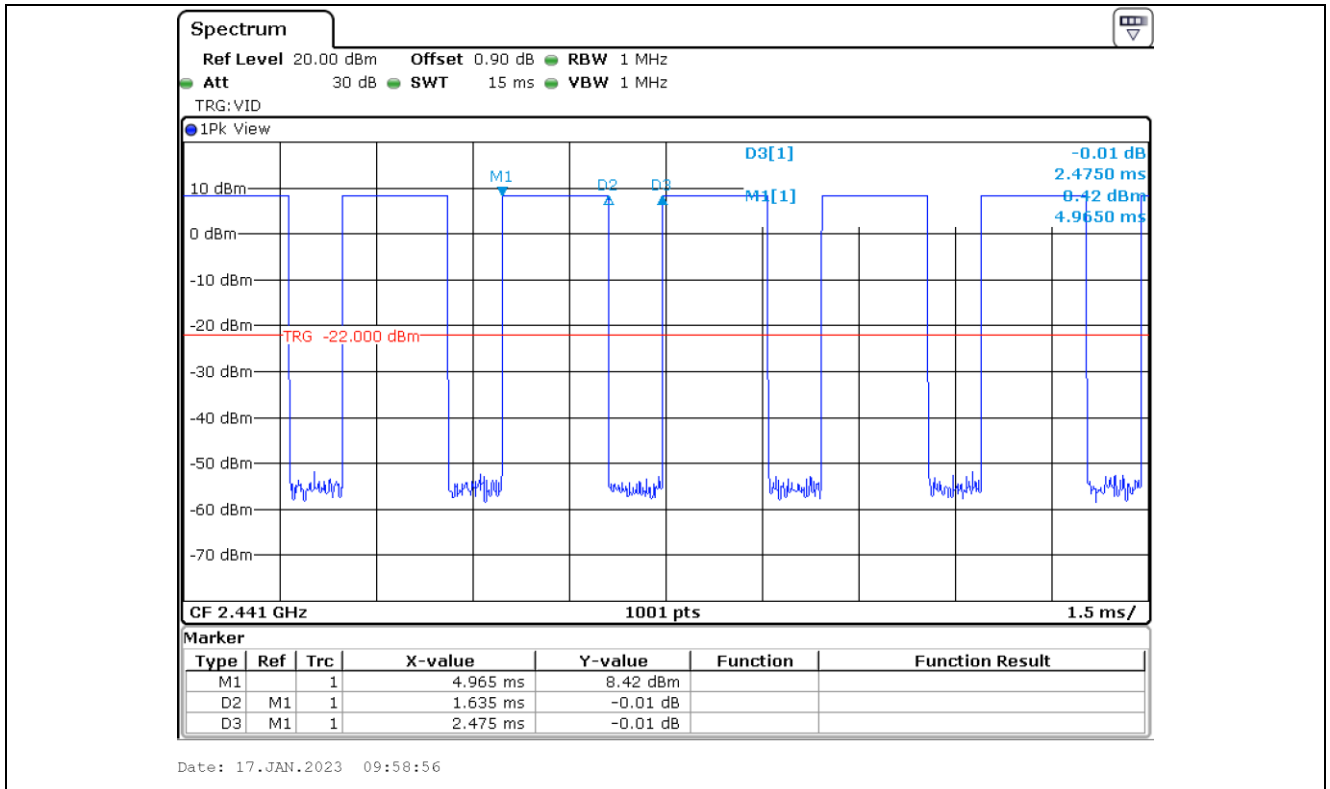
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.390	10.13	31.60	124.84	400.00	PASS
DH3	1.635	5.06	31.60	261.43	400.00	
DH5	2.895	3.38	31.60	309.21	400.00	

Total dwell time is calculated as following.

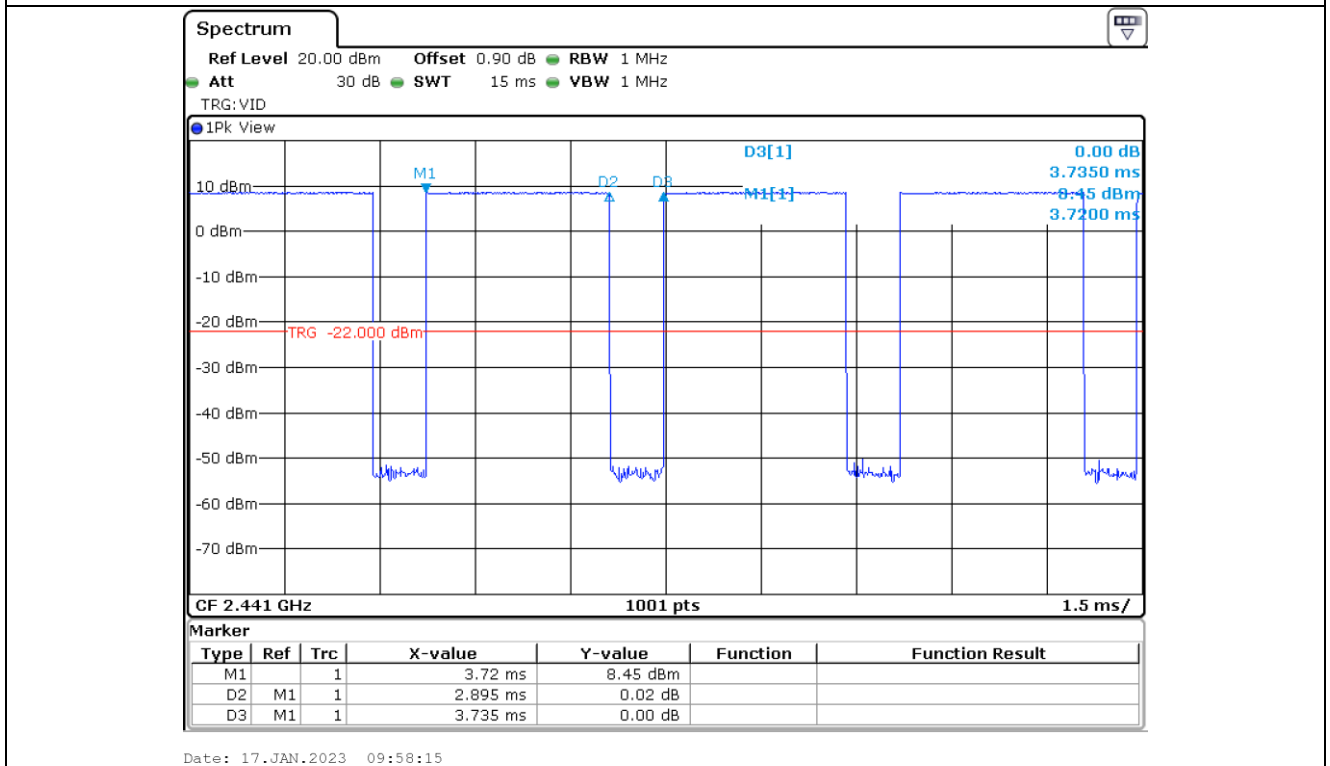
Total Dwell Time = Pulse time * Hops per second with channels * period time

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 μs with 79 channels.

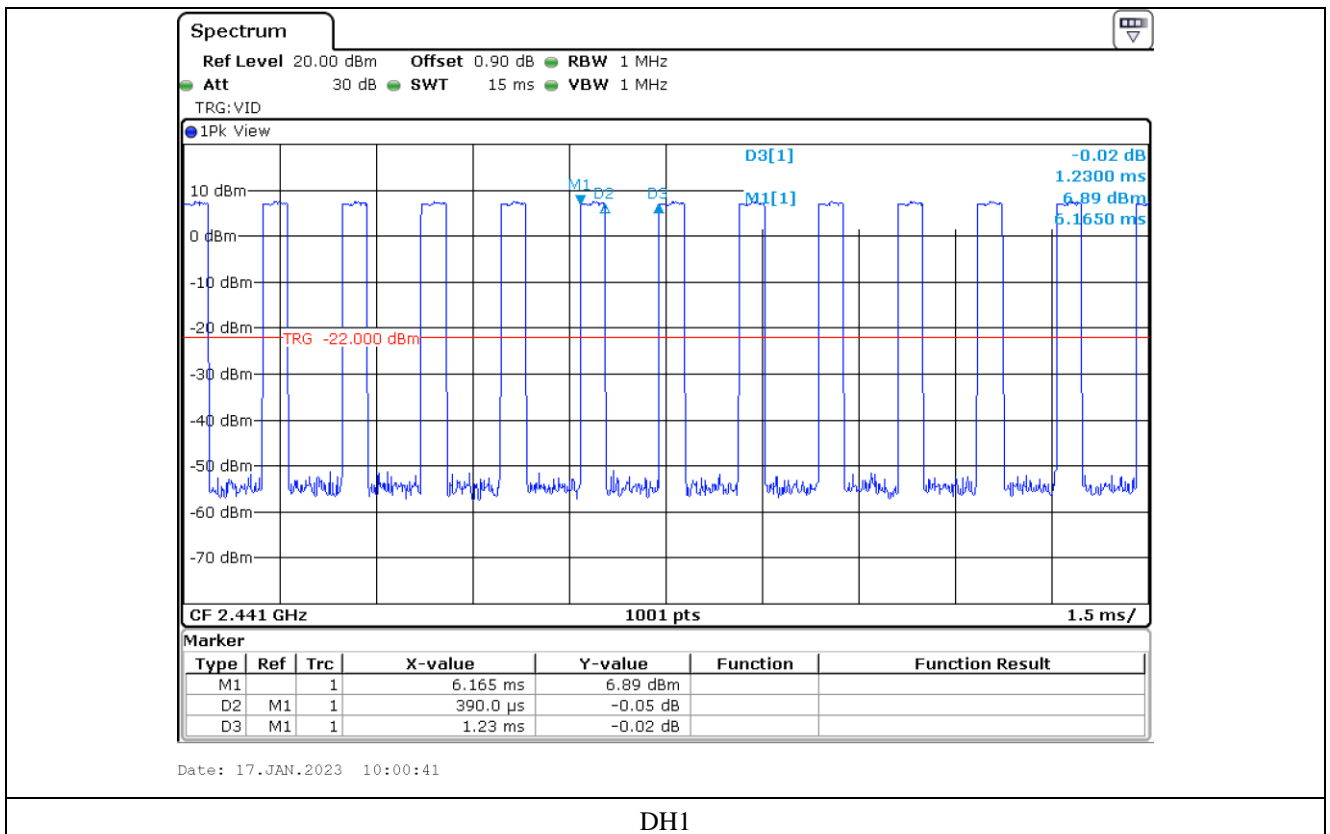
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

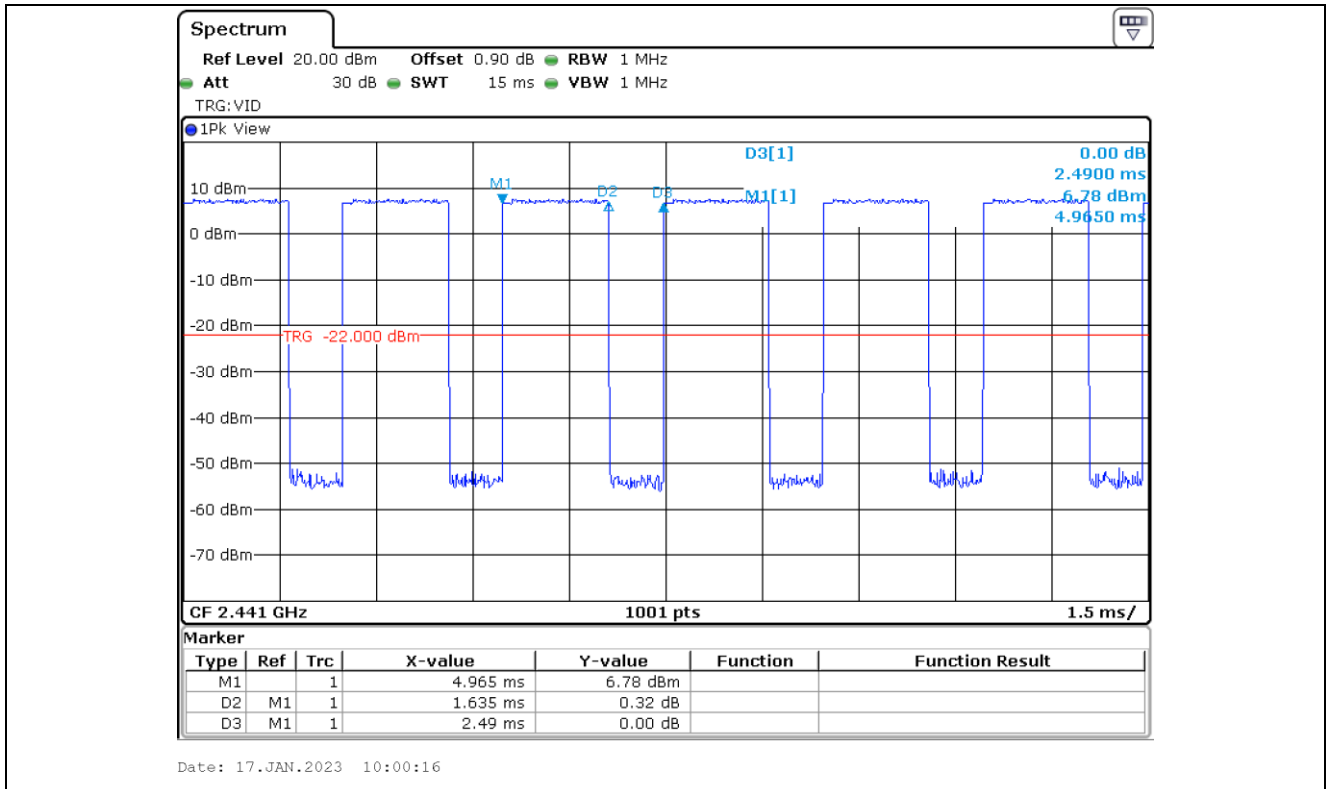
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.390	10.13	31.60	124.84	400.00	PASS
DH3	1.635	5.06	31.60	261.43	400.00	
DH5	2.880	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

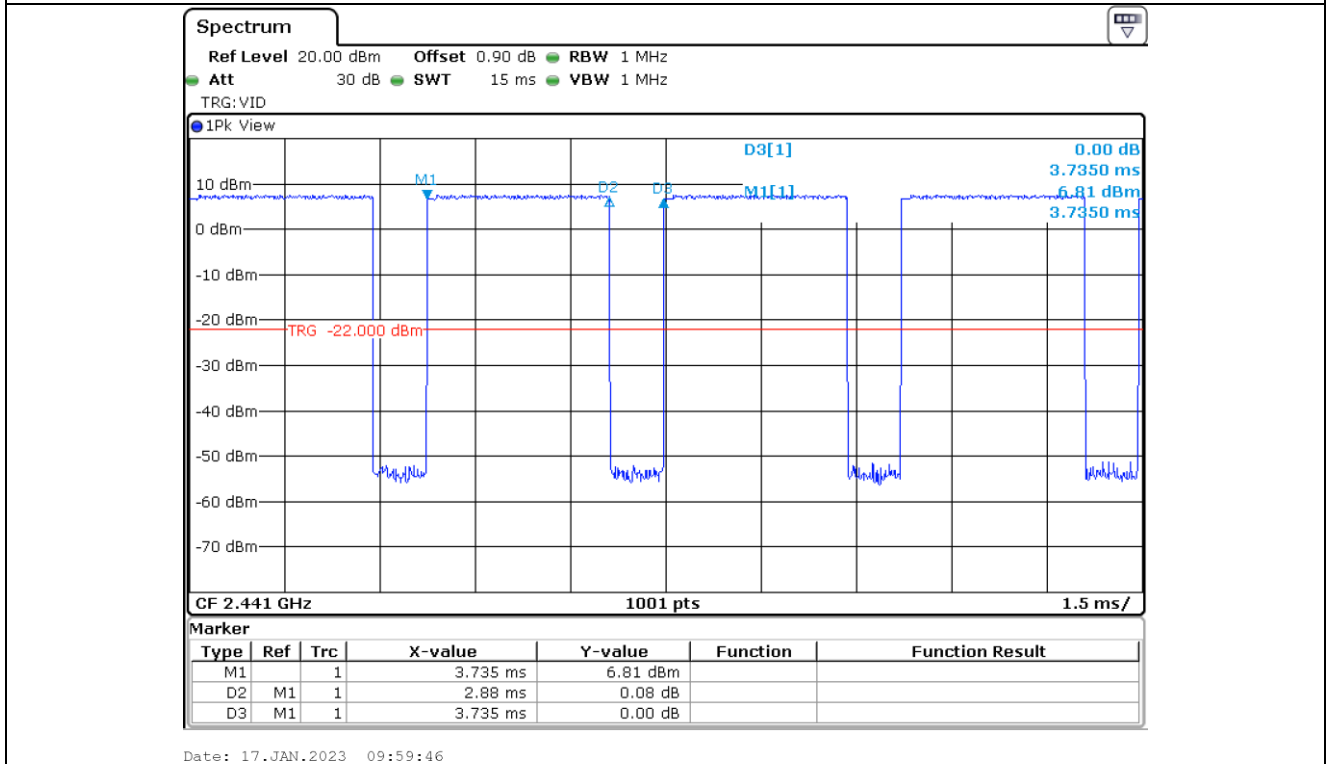
Total Dwell Time = Pulse time * Hops per second with channels * period time

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 μs with 79 channels.

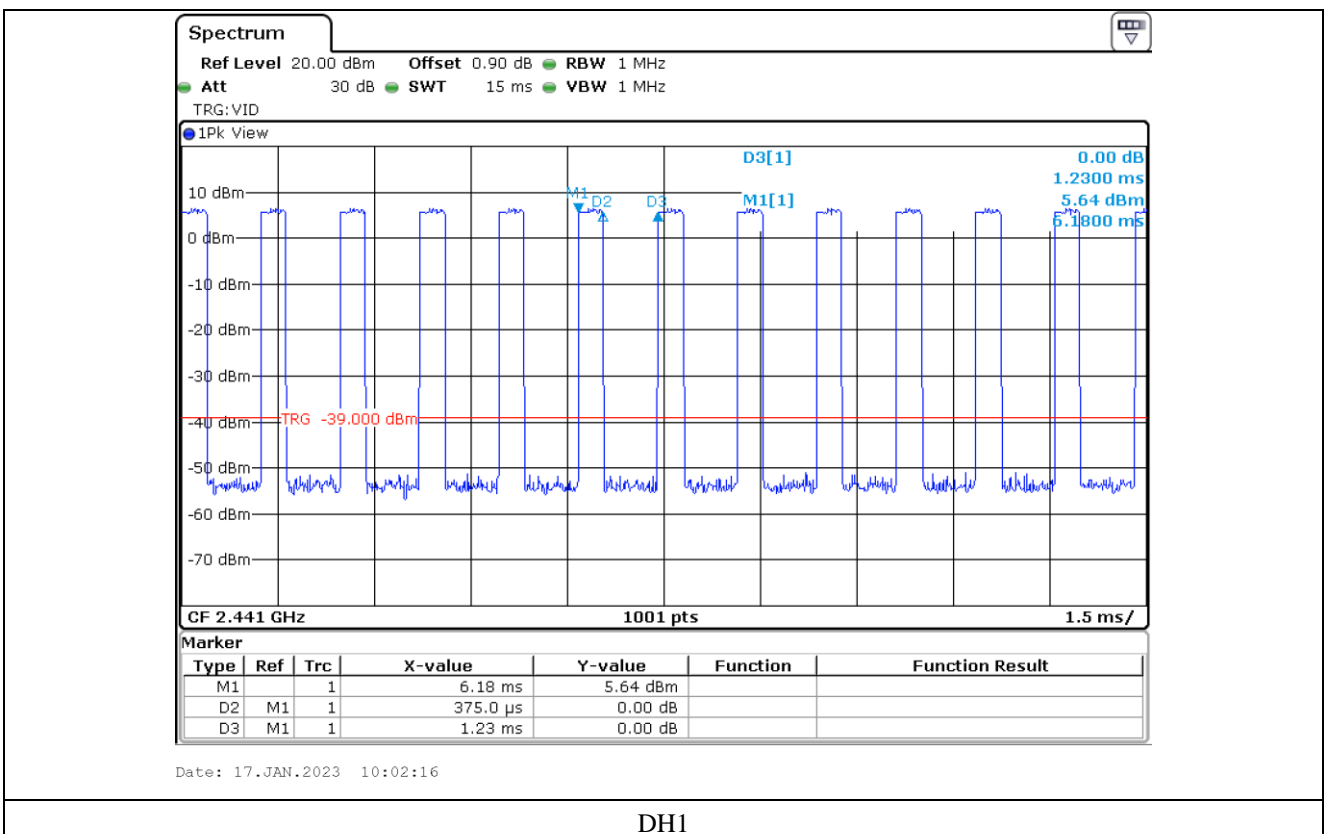
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So, The EUT has each channel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

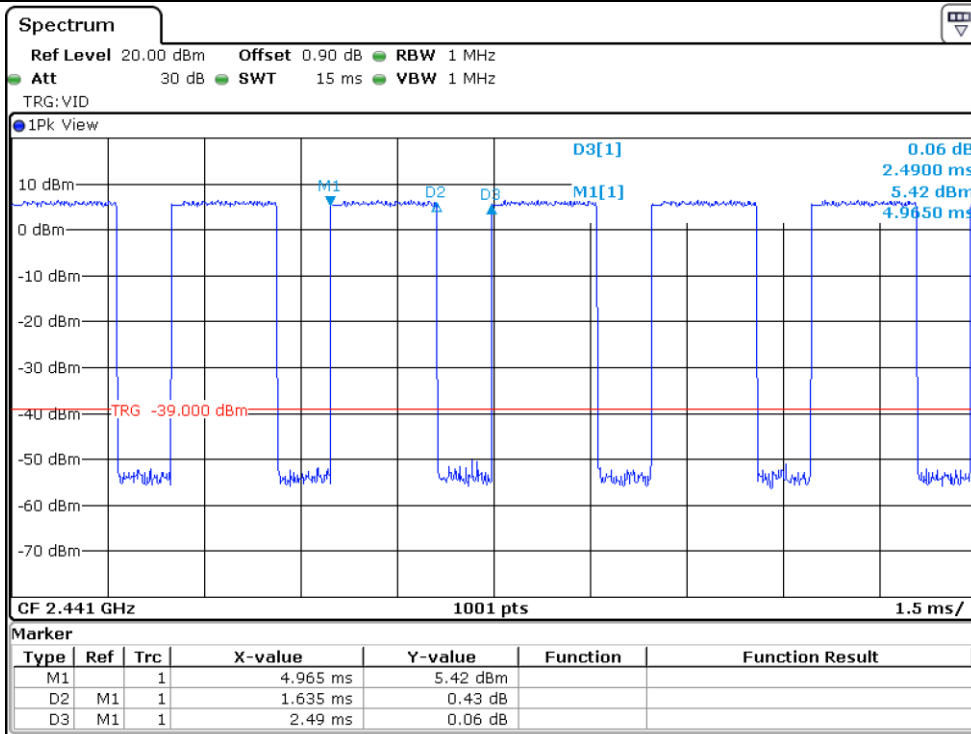
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.375	10.13	31.60	120.04	400.00	PASS
DH3	1.635	5.06	31.60	261.43	400.00	
DH5	2.880	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

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

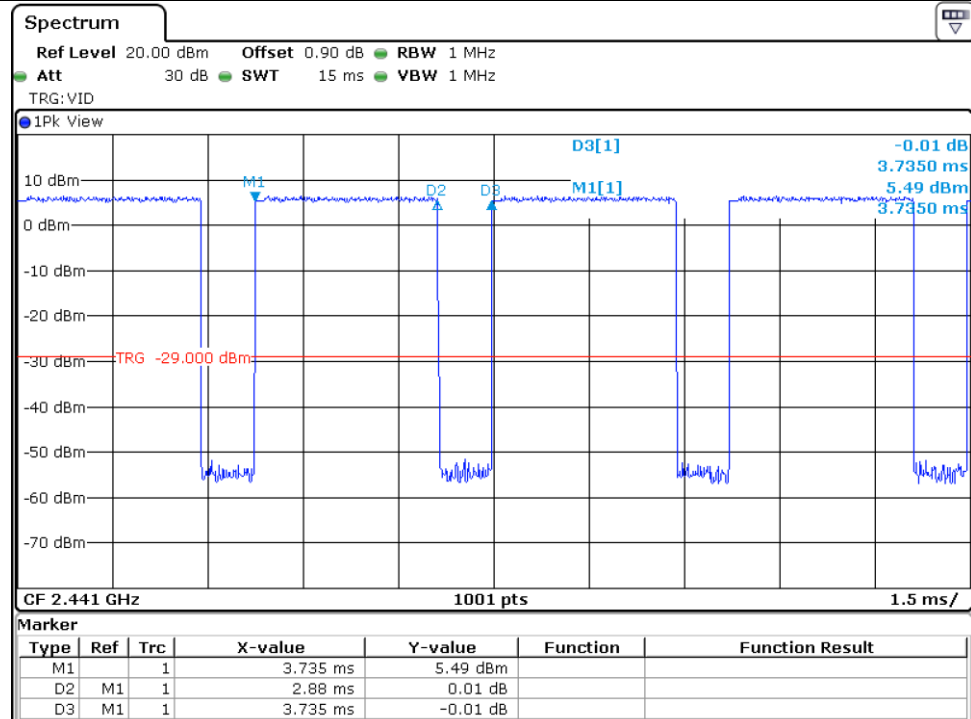
Remark: See next page for an overview sweep performed with peak detector.





Date: 17.JAN.2023 10:01:51

DH3



Date: 17.JAN.2023 10:01:14

DH5

11. MAXIMUM PEAK OUTPUT POWER

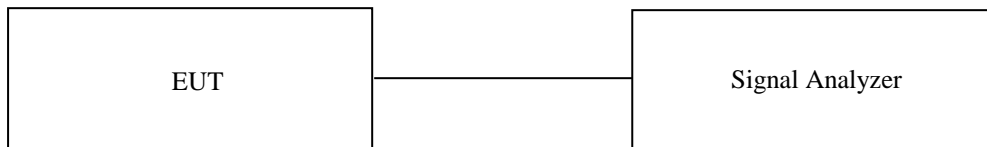
11.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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

December 27, 2022 ~ January 19, 2023

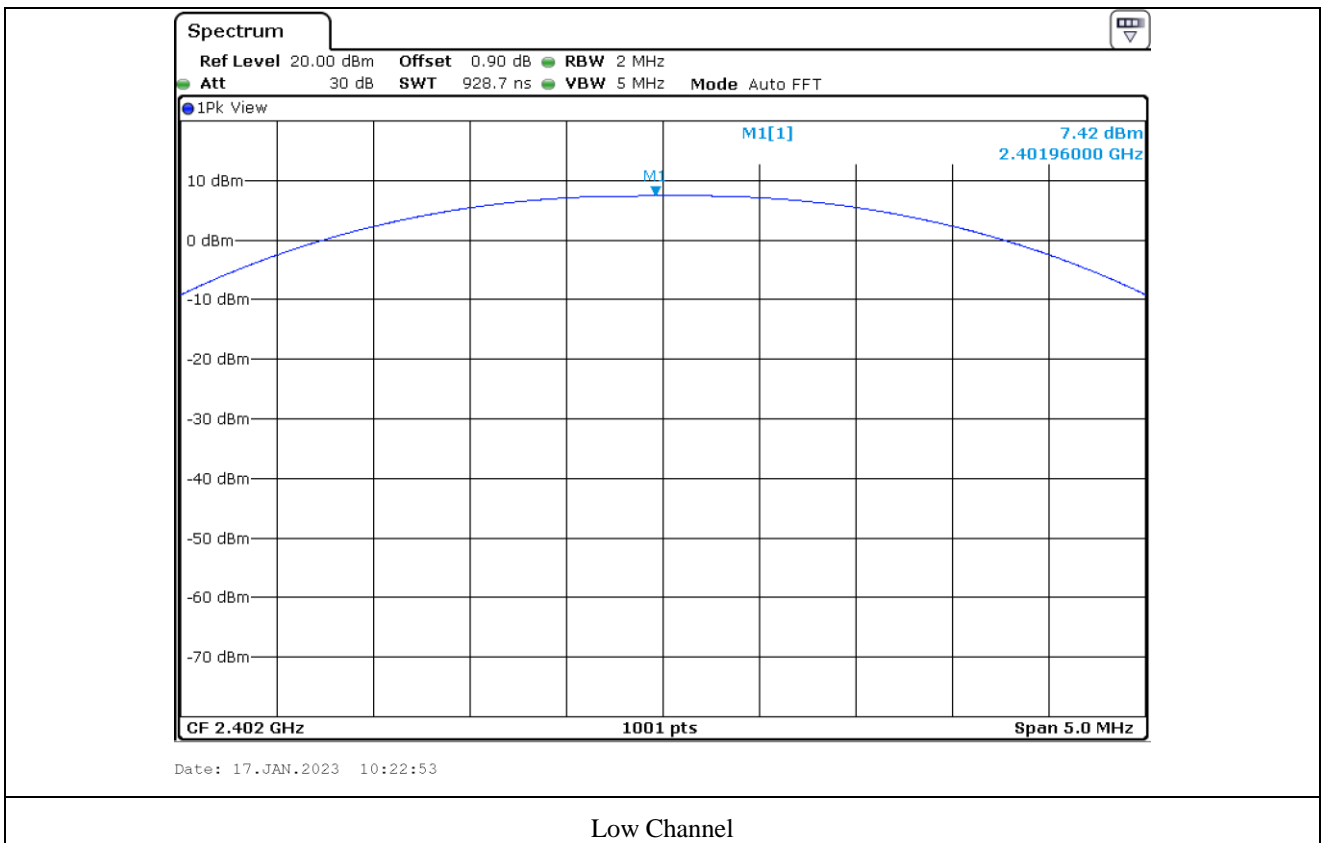
11.4 Test data

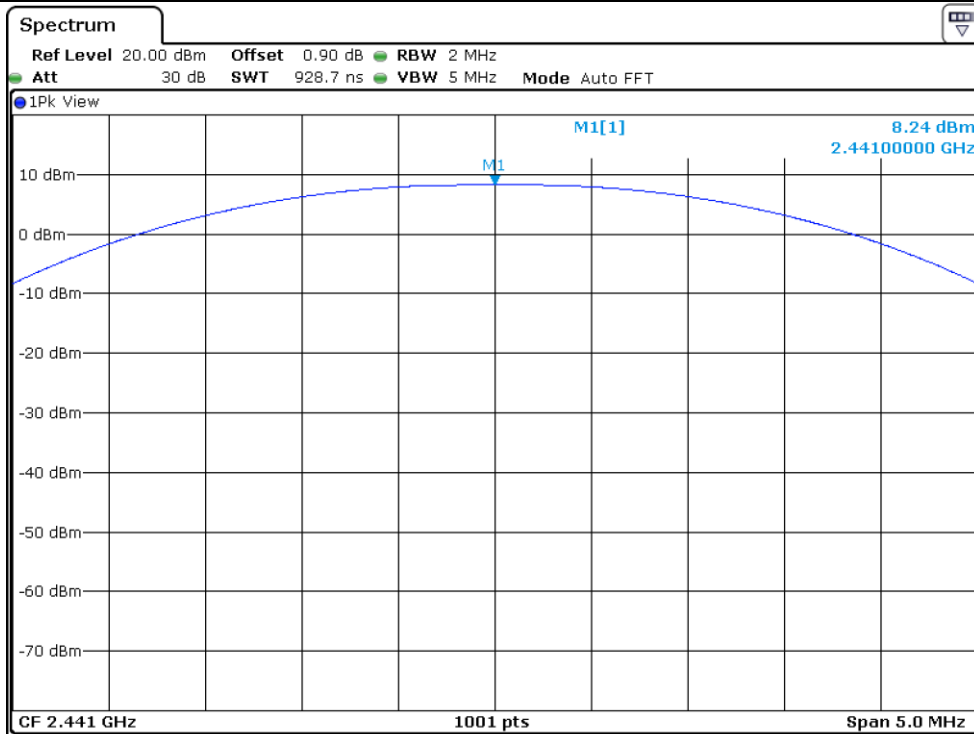
11.4.1 Test data for 1 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	7.42	21.00	13.58
MIDDLE	2 441.00	8.24	21.00	12.76
HIGH	2 480.00	8.57	21.00	12.43

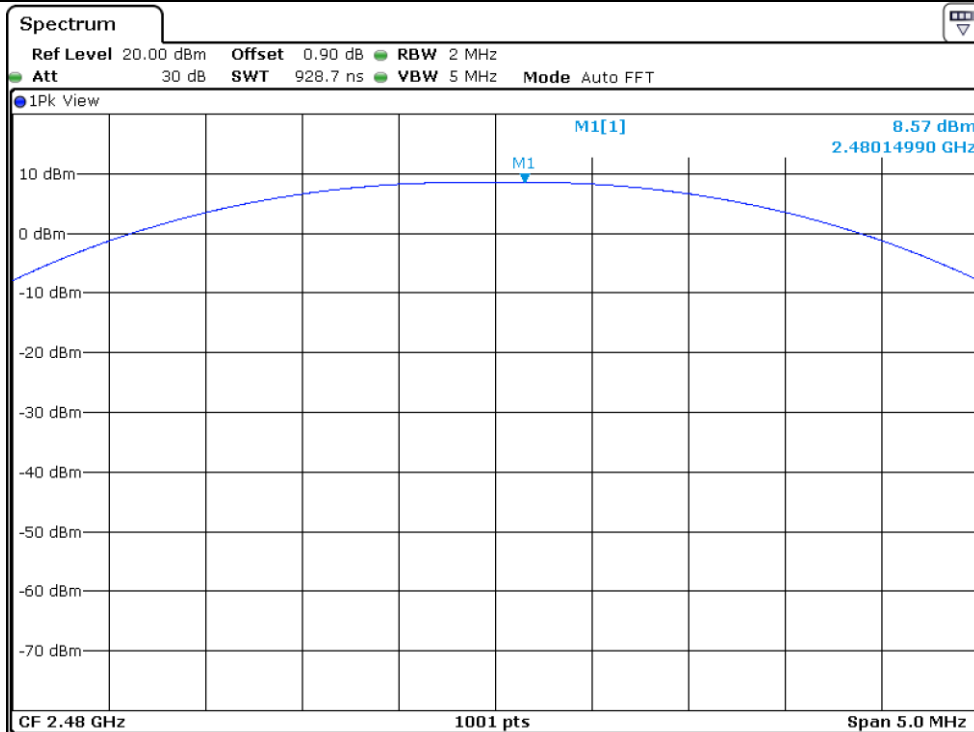
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)





Date: 17.JAN.2023 10:23:29

Middle Channel



Date: 17.JAN.2023 10:23:50

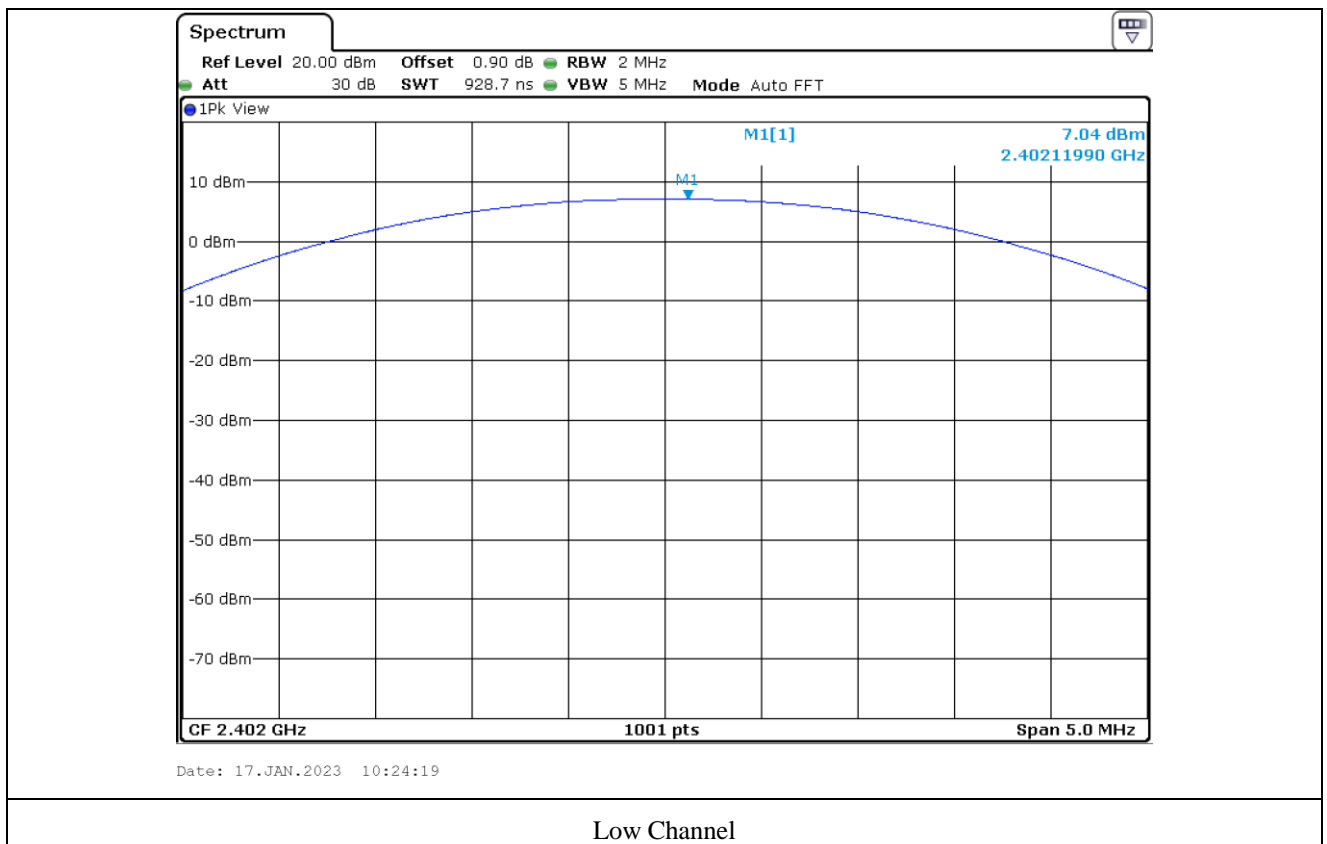
High Channel

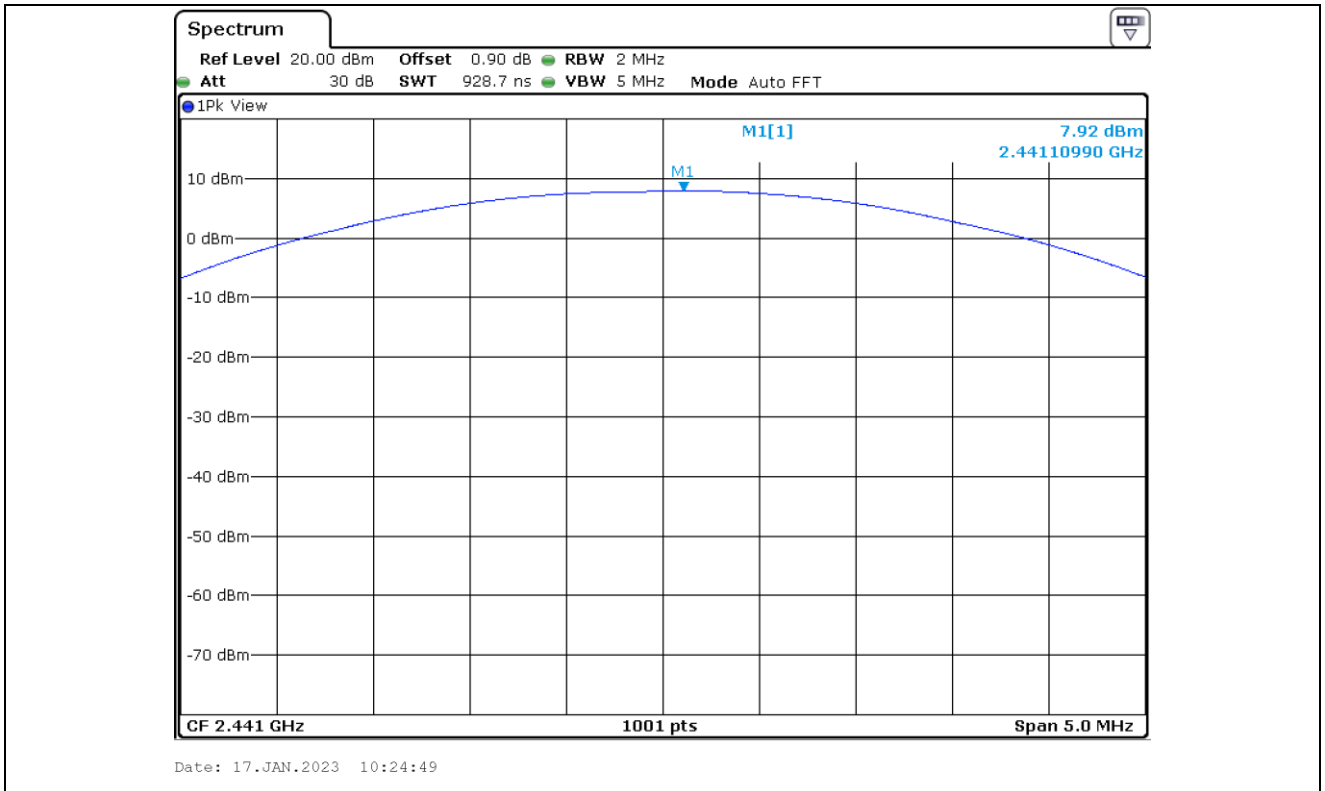
11.4.2 Test data for 2 Mbps

-. Test Result : Pass

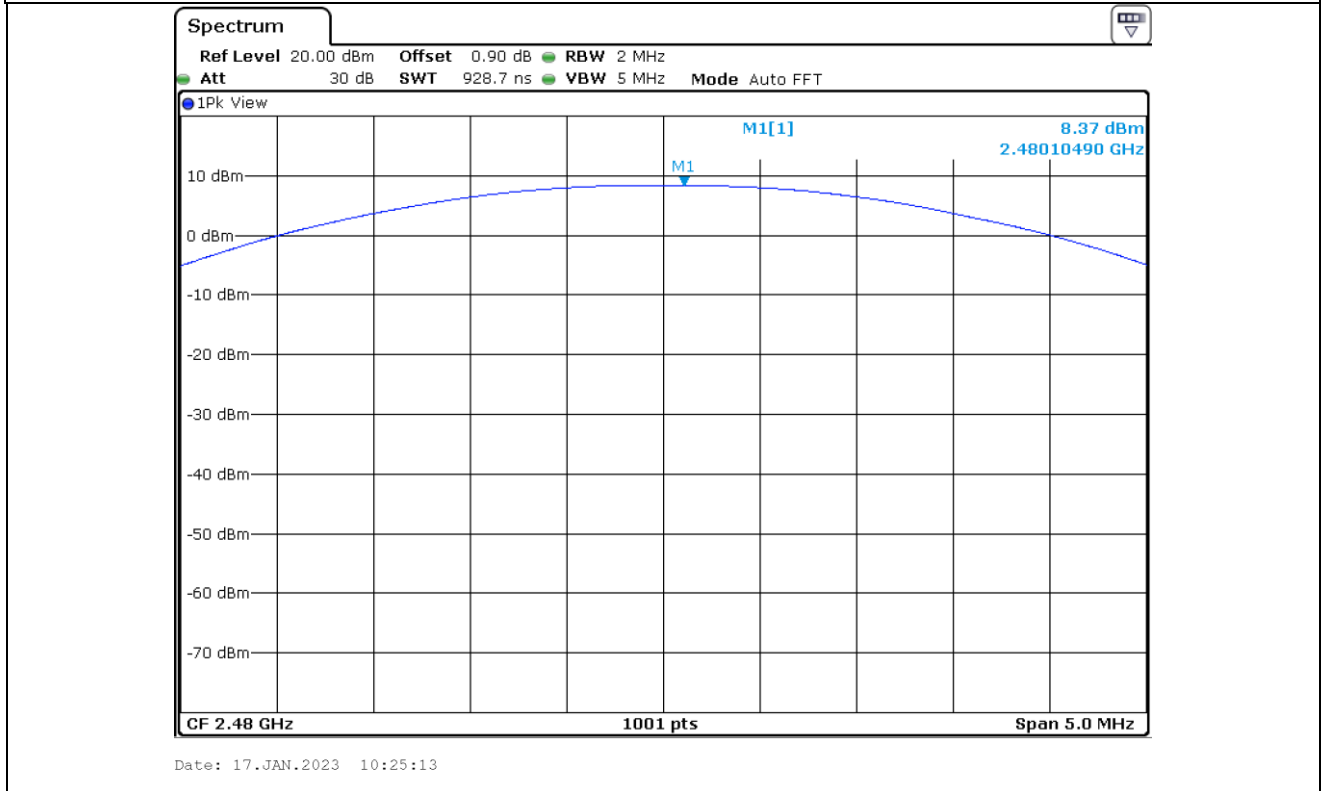
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	7.04	21.00	13.96
MIDDLE	2 441.00	7.92	21.00	13.08
HIGH	2 480.00	8.37	21.00	12.63

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





Middle Channel



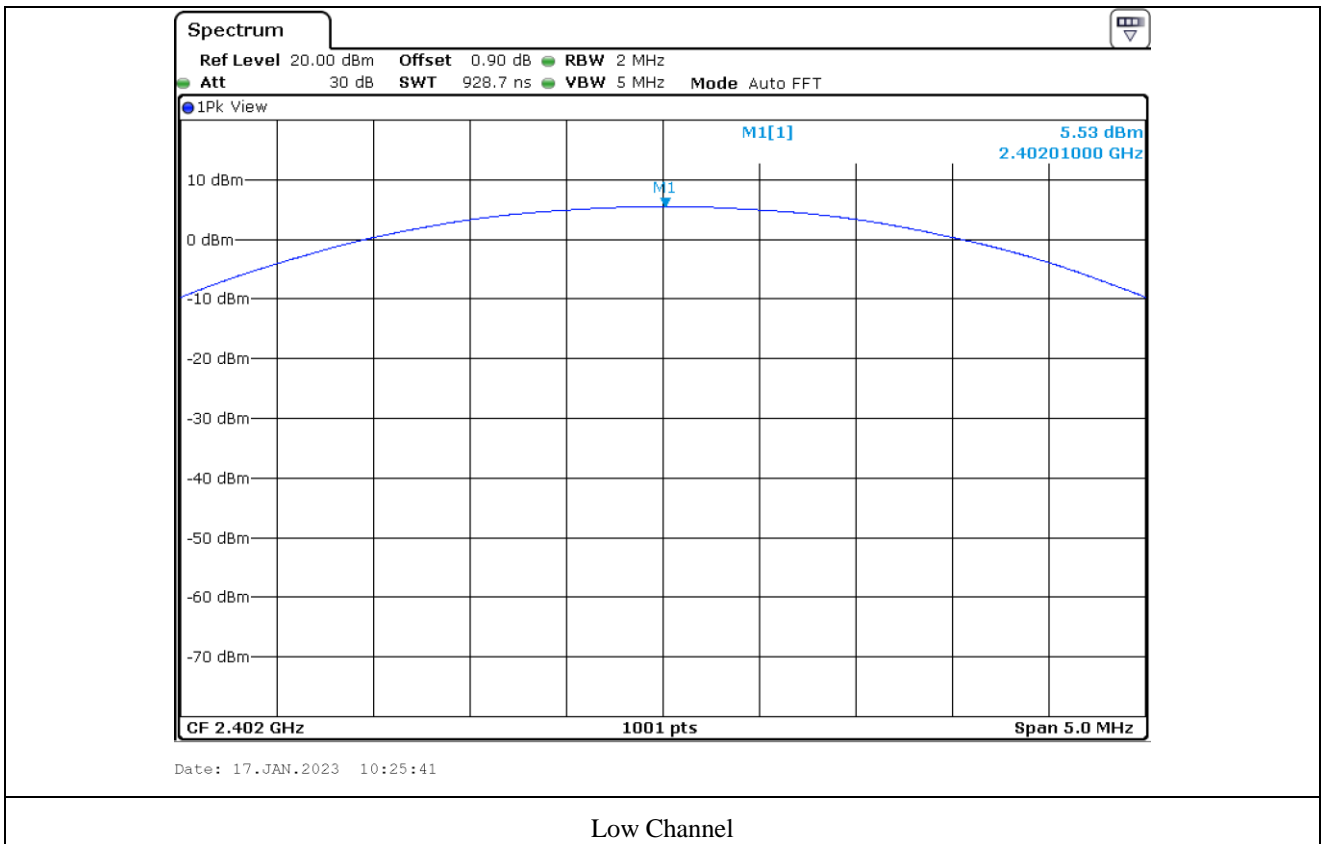
High Channel

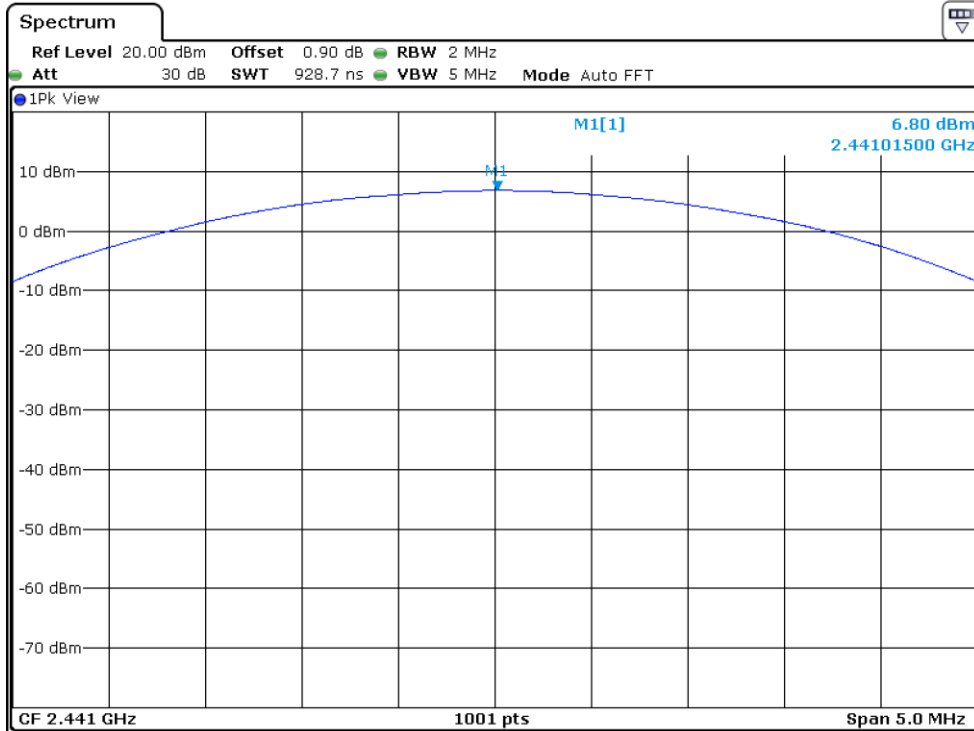
11.4.3 Test data for 3 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	5.53	21.00	15.47
MIDDLE	2 441.00	6.80	21.00	14.20
HIGH	2 480.00	7.56	21.00	13.44

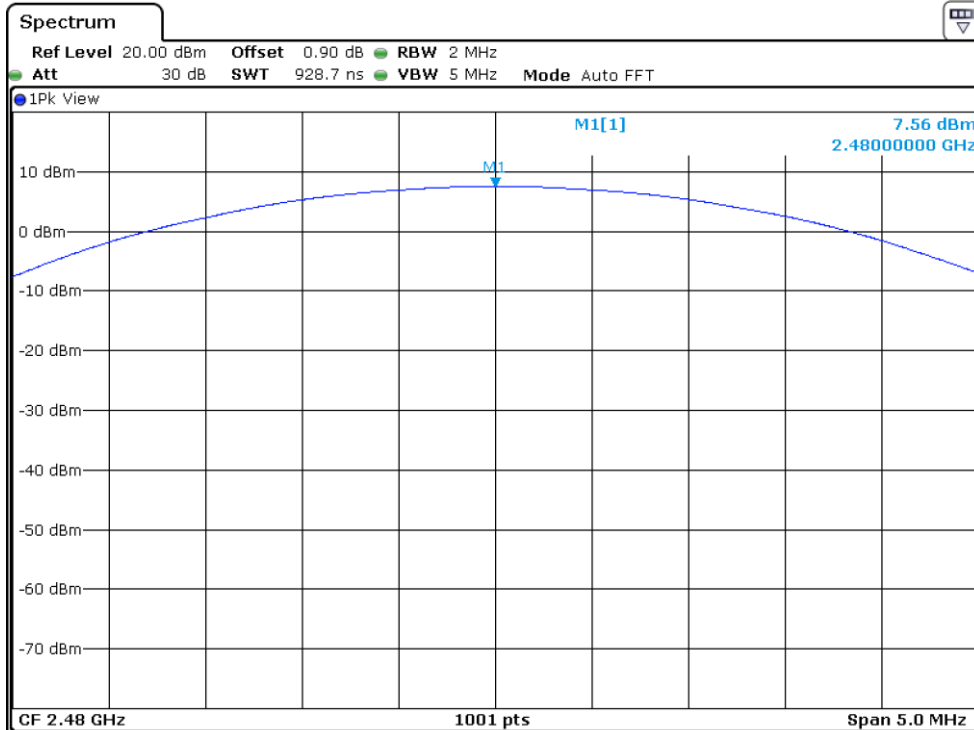
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)





Date: 17.JAN.2023 10:26:11

Middle Channel



Date: 17.JAN.2023 10:26:35

High Channel

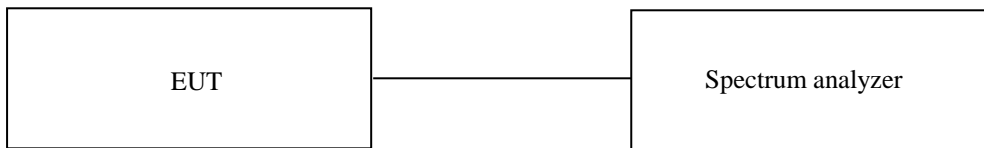
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 23 °C
 Relative humidity : 50 % 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.

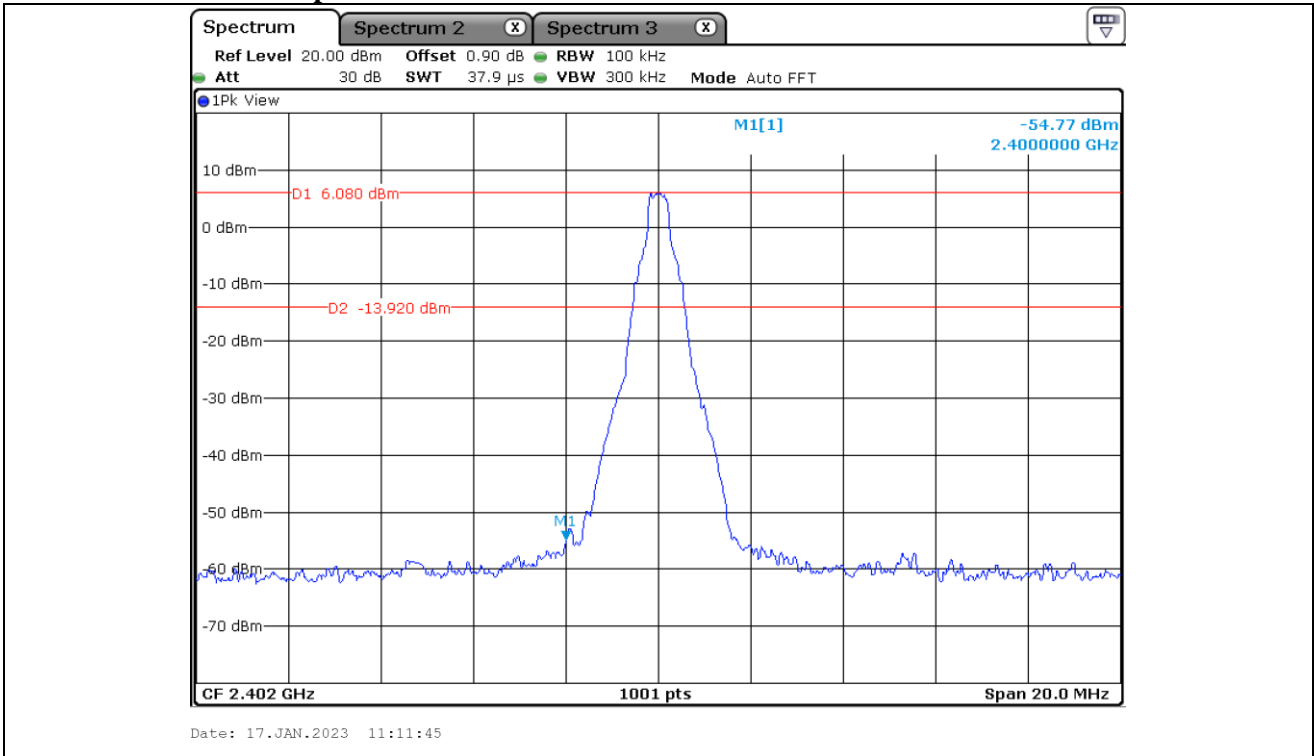
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal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

12.4 Test Date

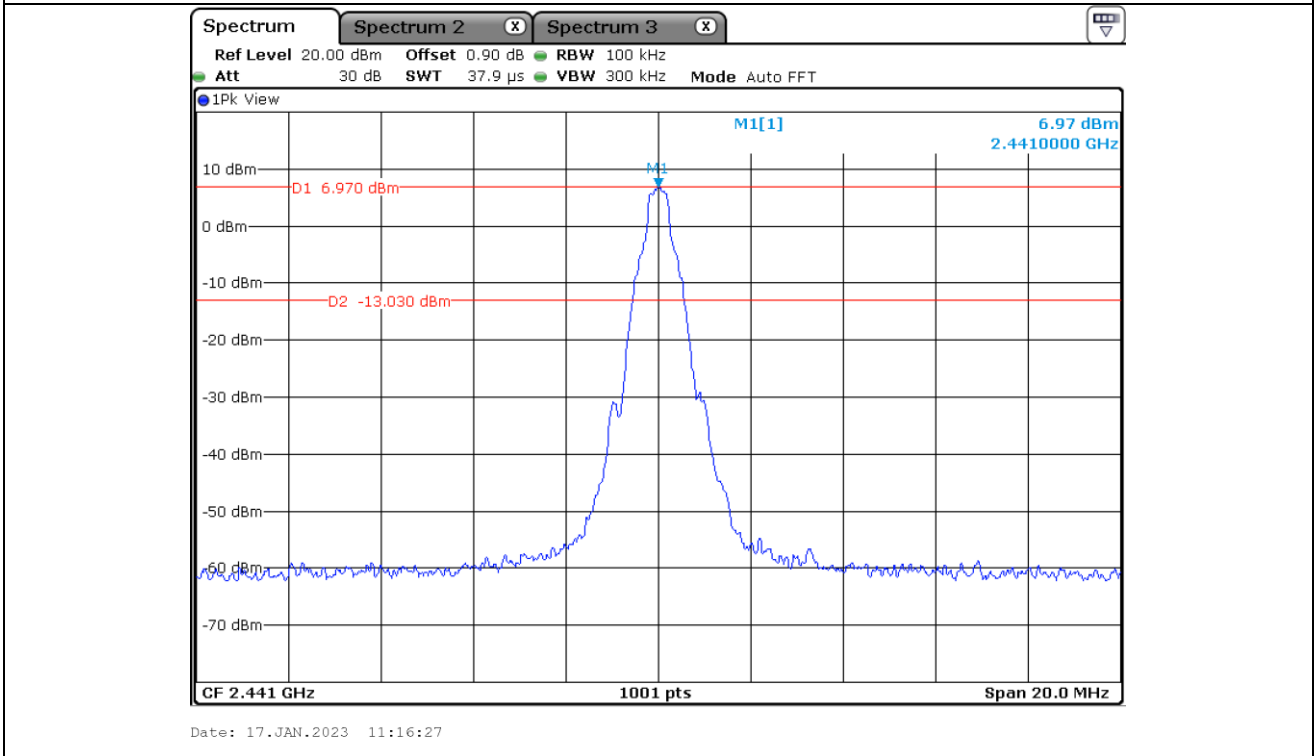
December 27, 2022 ~ January 19, 2023

12.5 Test data for conducted emission

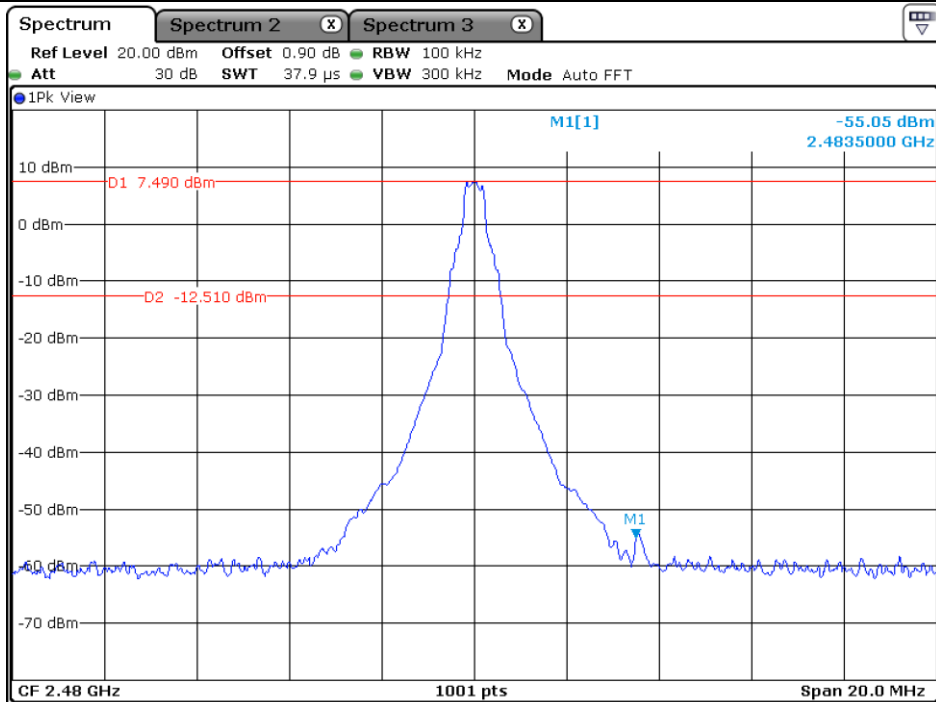
12.5.1 Test data for 1 Mbps



Low Channel

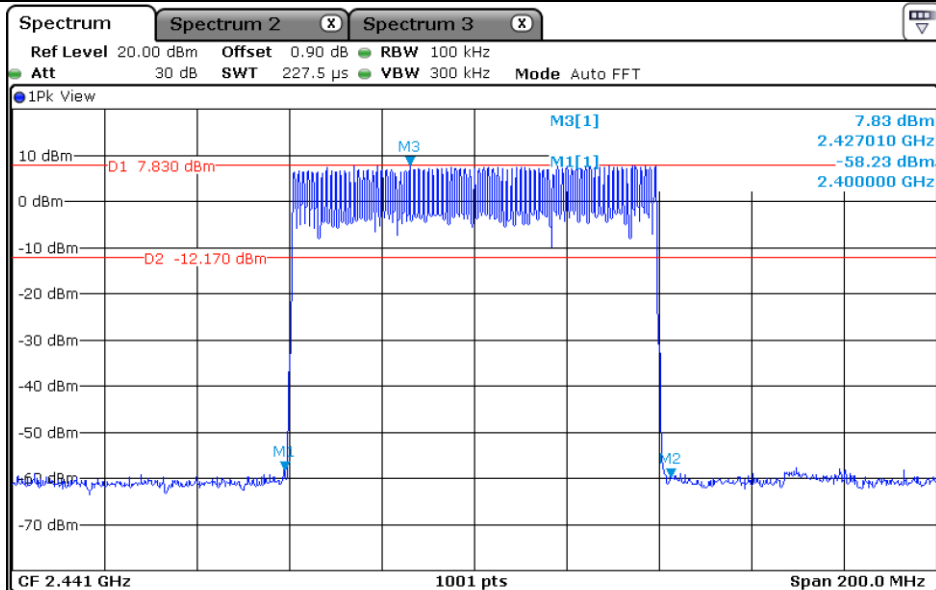


Middle Channel



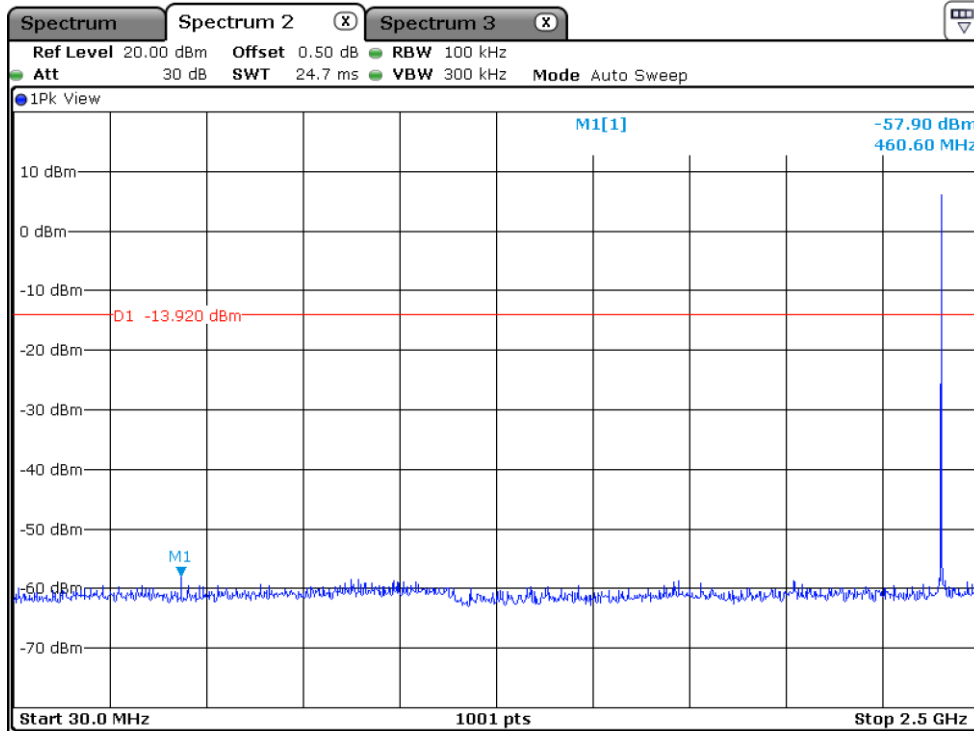
Date: 17.JAN.2023 11:18:43

High Channel



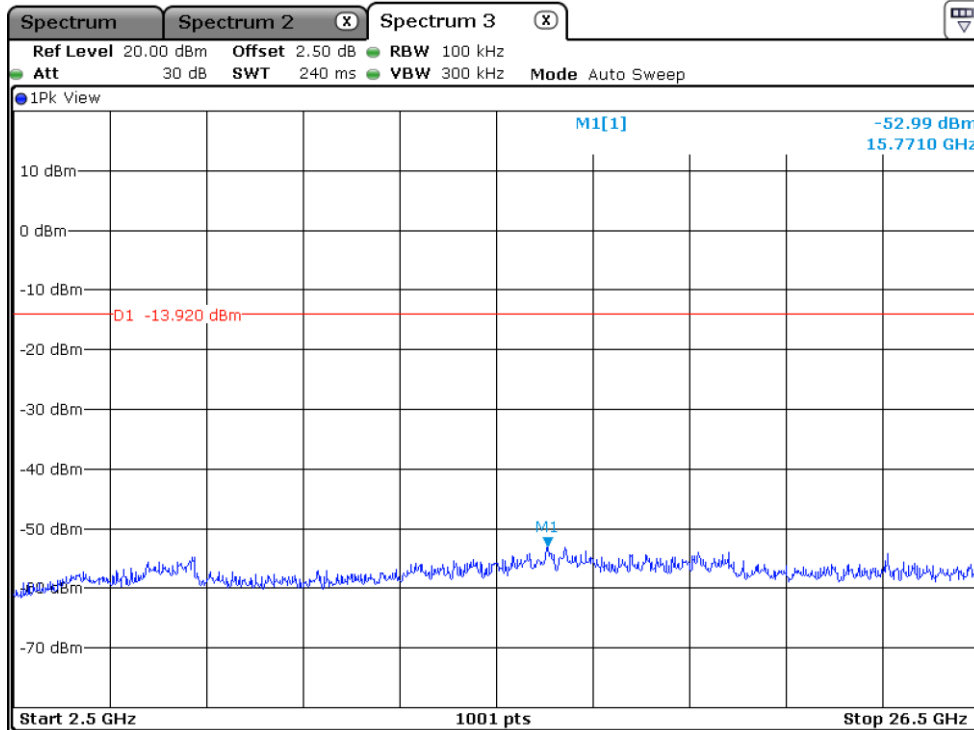
Date: 17.JAN.2023 11:39:32

Hopping Channel



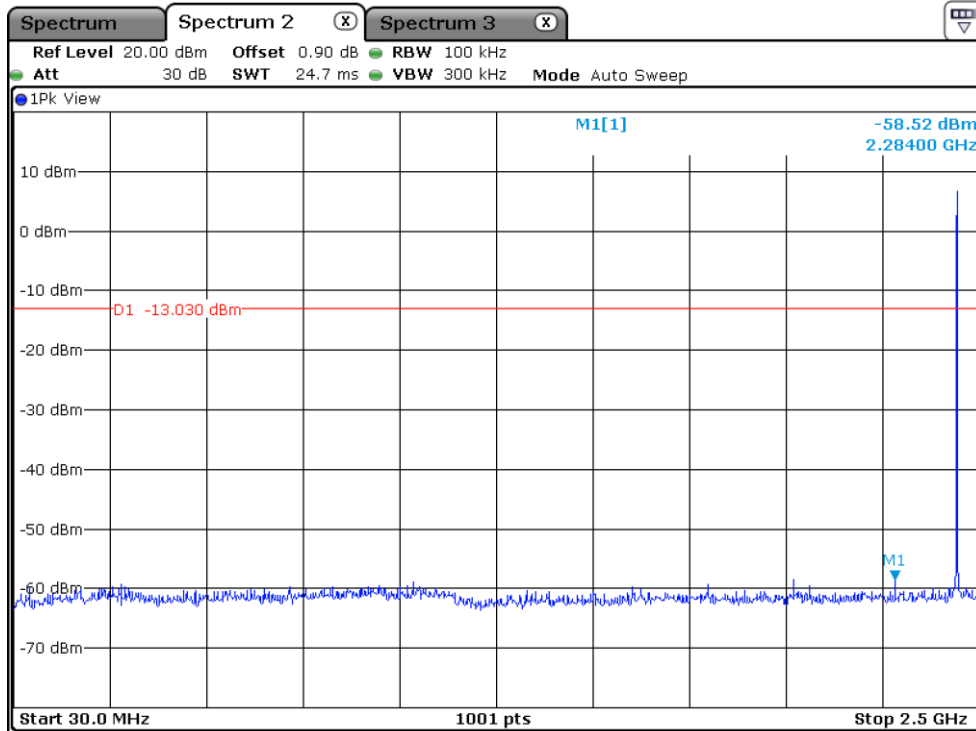
Date: 17.JAN.2023 11:14:24

Low Channel



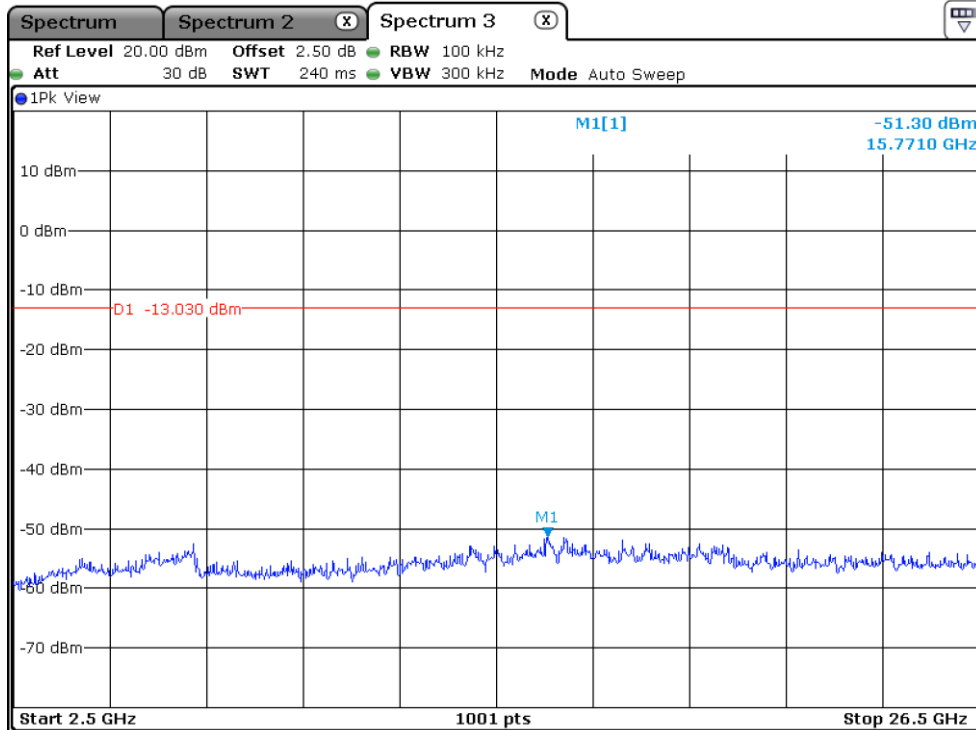
Date: 17.JAN.2023 11:15:40

Low Channel



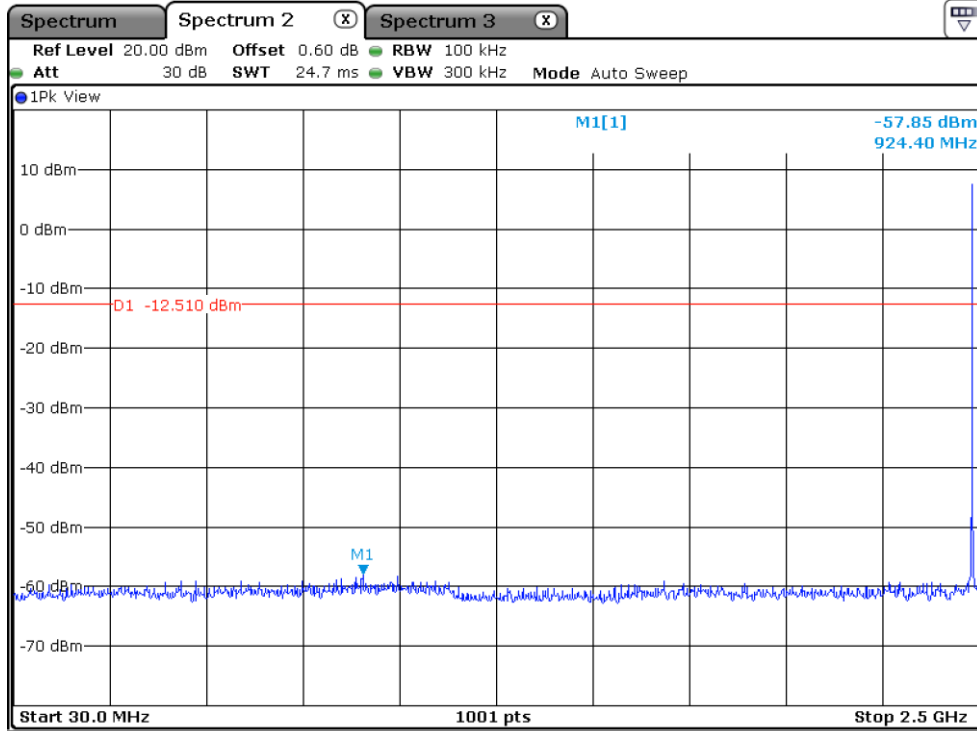
Date: 17.JAN.2023 11:17:26

Middle Channel



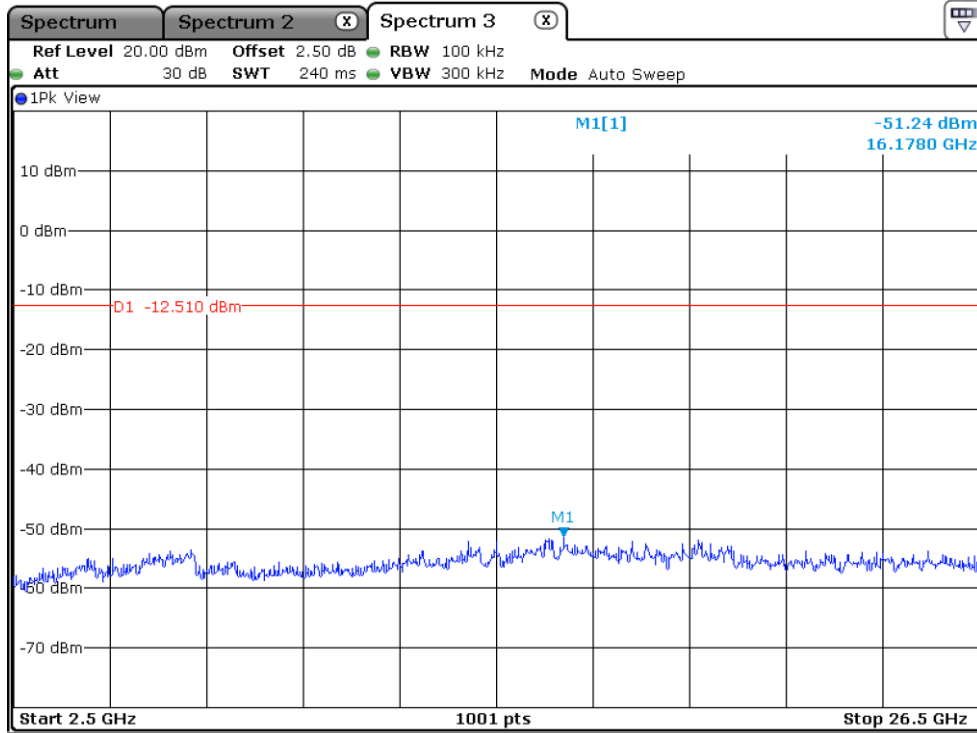
Date: 17.JAN.2023 11:17:53

Middle Channel



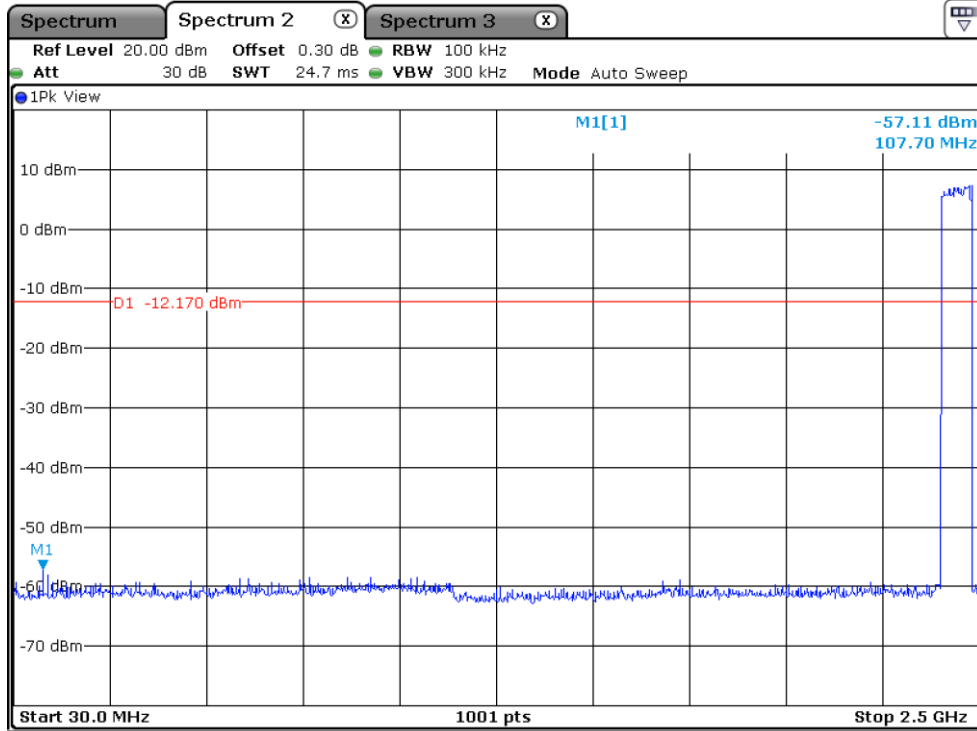
Date: 17.JAN.2023 11:19:33

High Channel



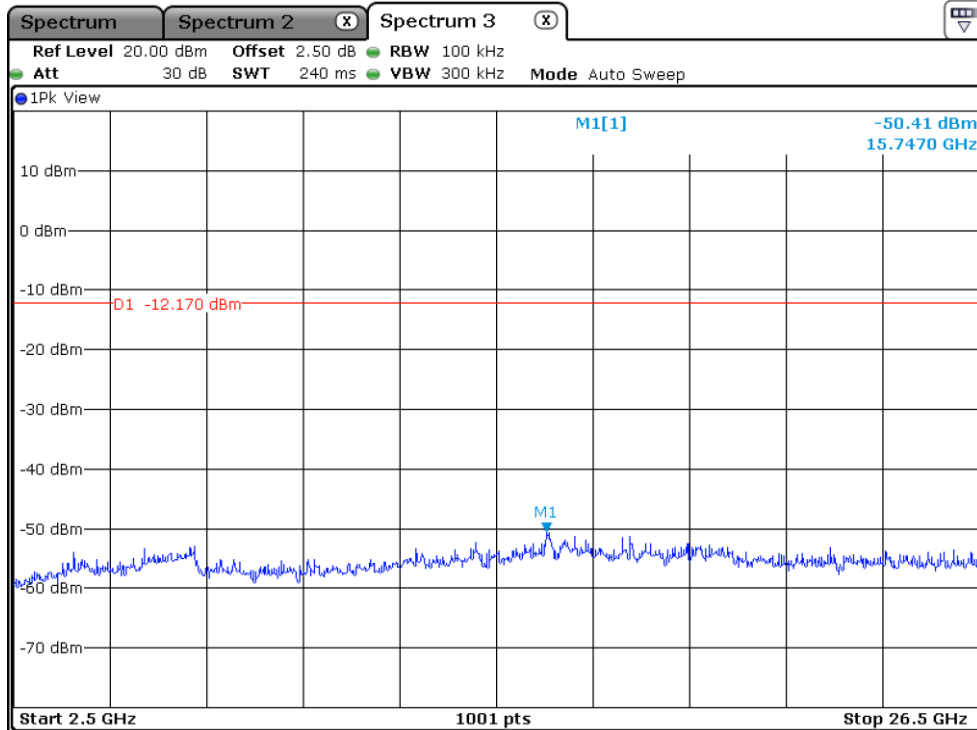
Date: 17.JAN.2023 11:20:12

High Channel



Date: 17.JAN.2023 11:40:44

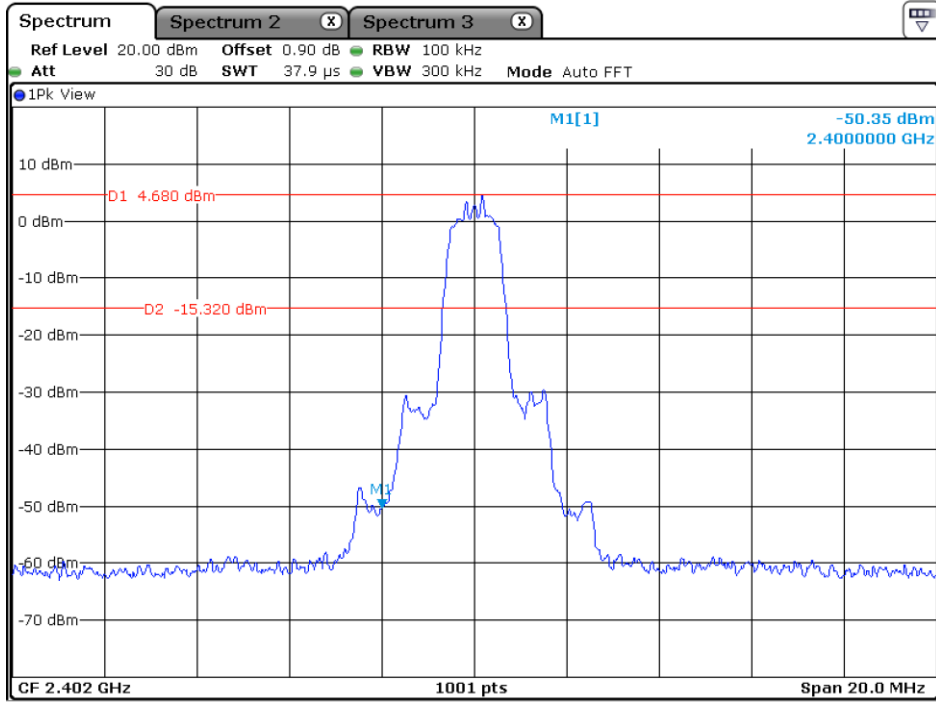
Hopping Channel



Date: 17.JAN.2023 11:41:20

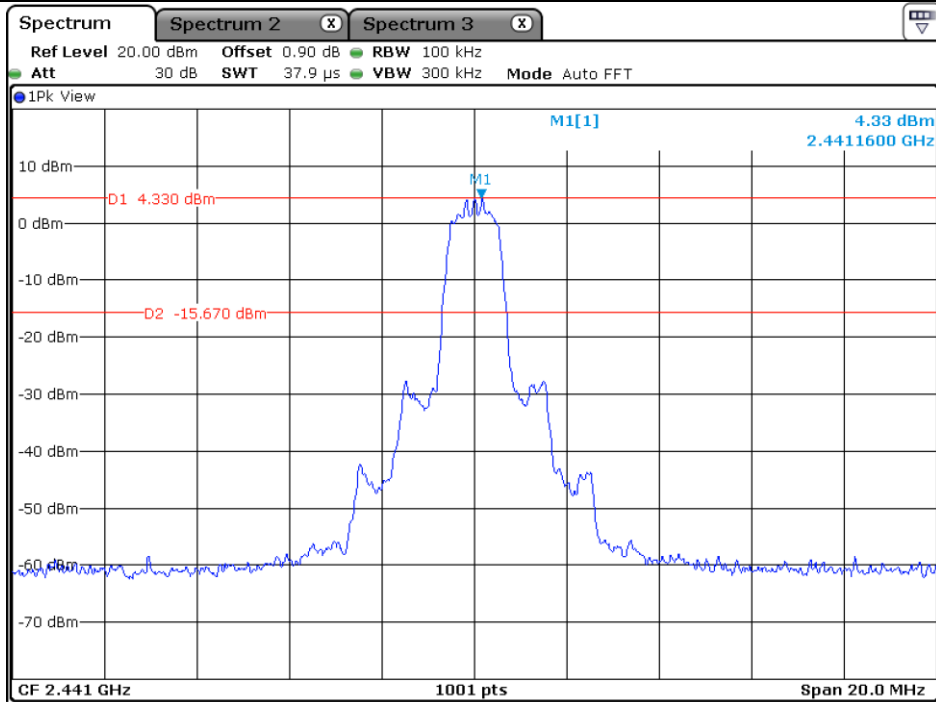
Hopping Channel

12.5.2 Test data for 2 Mbps



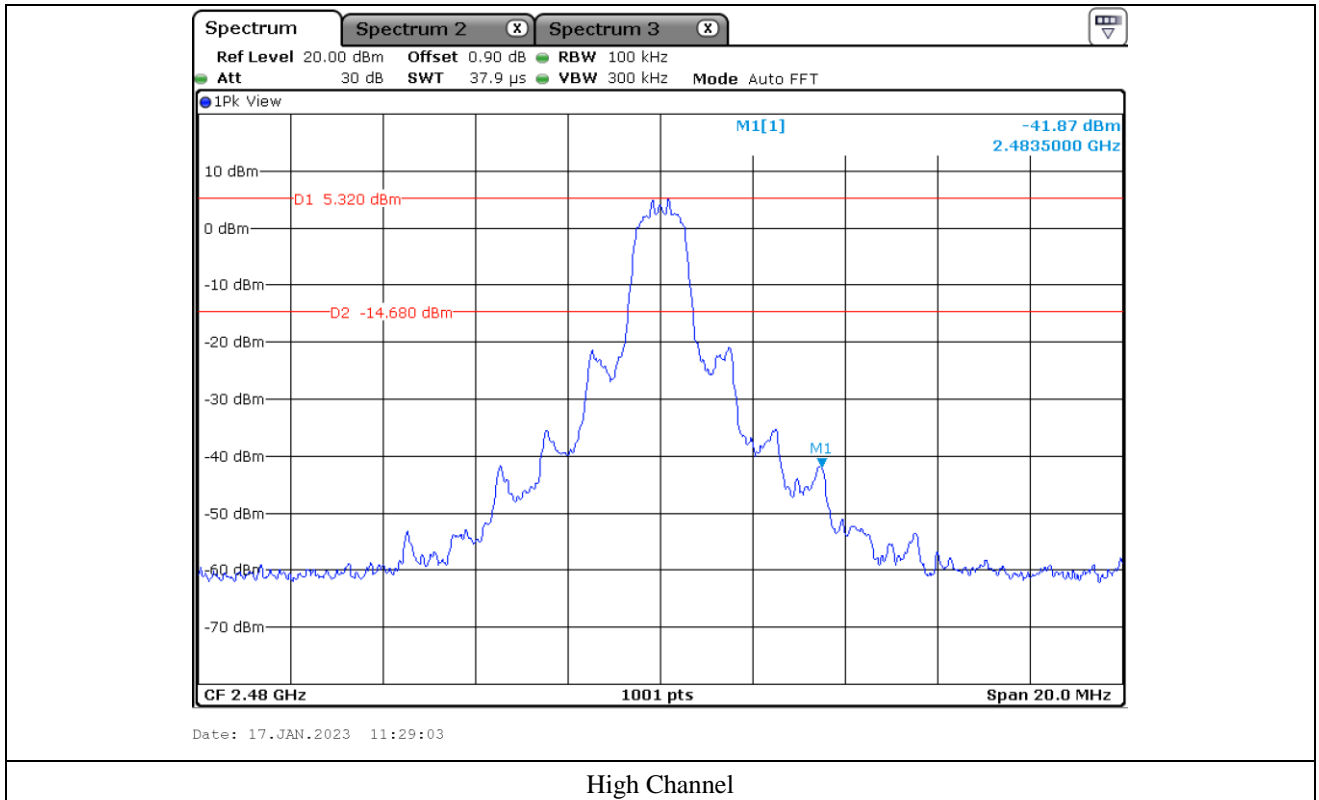
Date: 17.JAN.2023 11:20:56

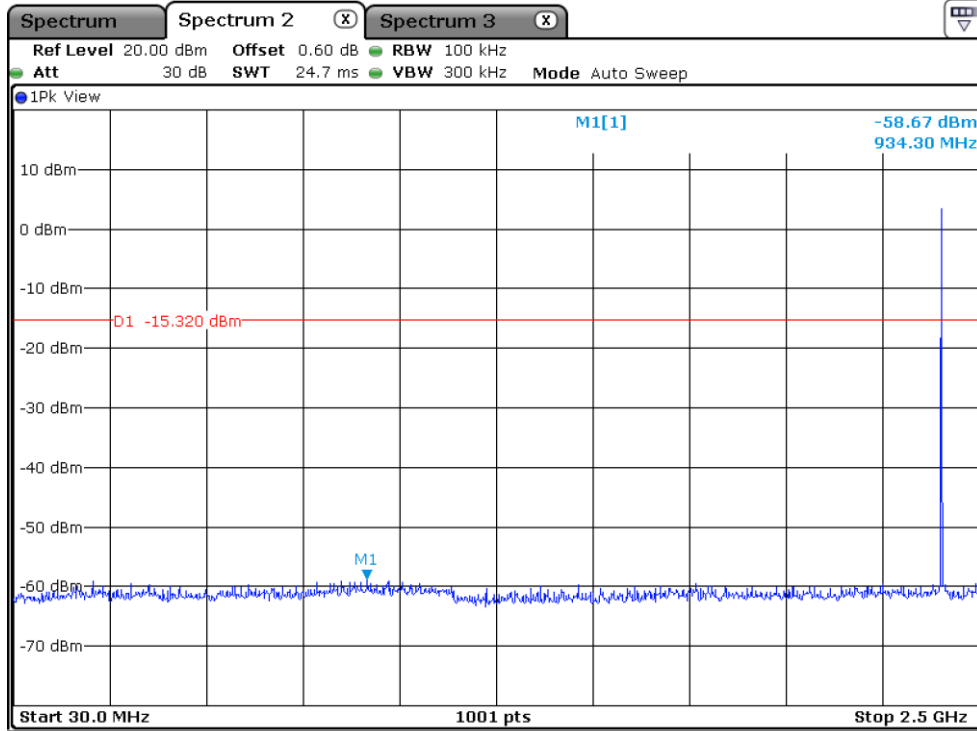
Low Channel



Date: 17.JAN.2023 11:23:01

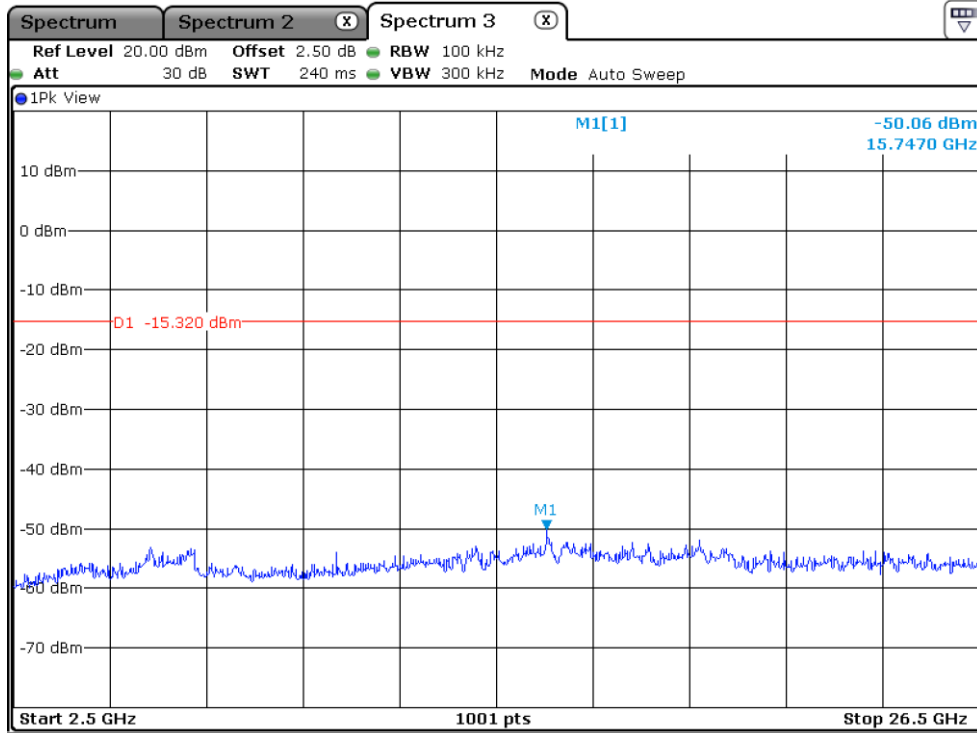
Middle Channel





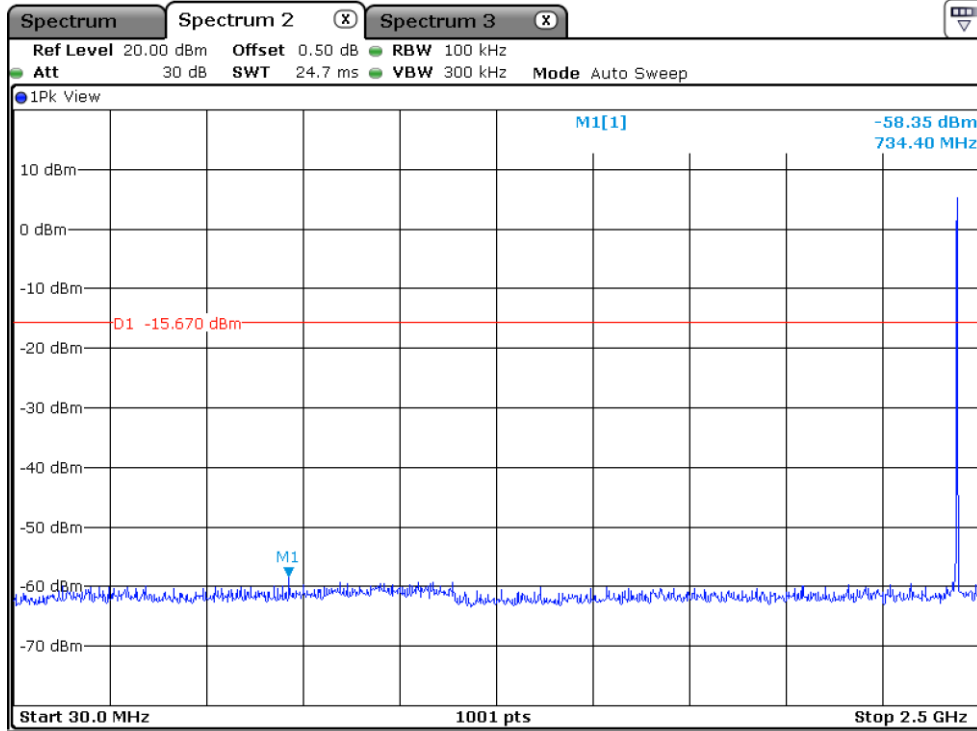
Date: 17.JAN.2023 11:21:44

Low Channel



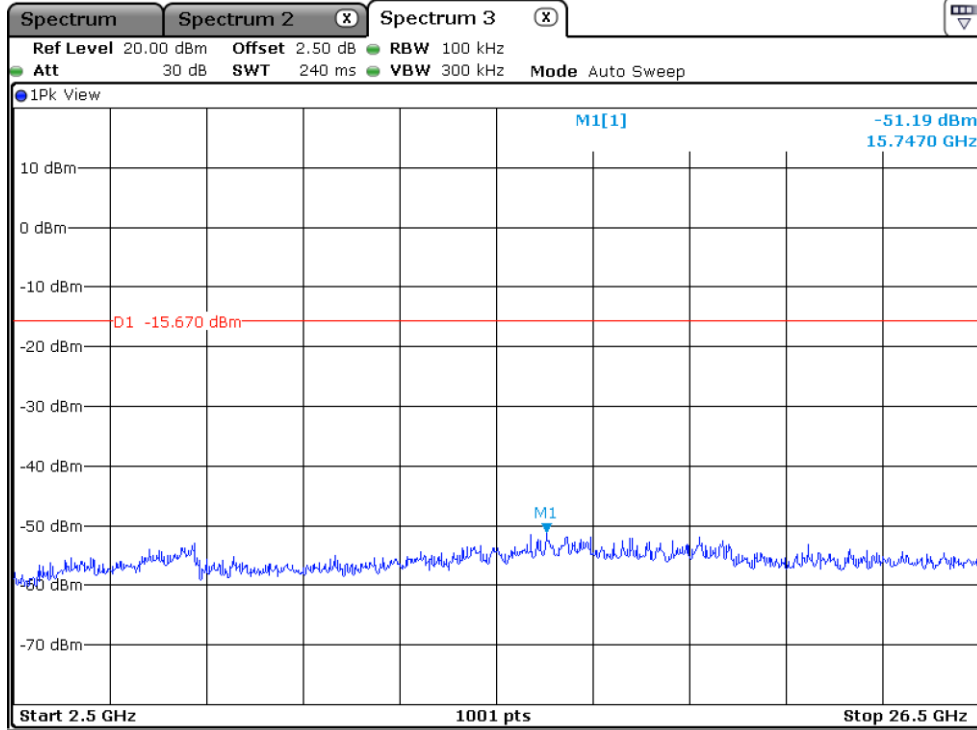
Date: 17.JAN.2023 11:22:11

Low Channel



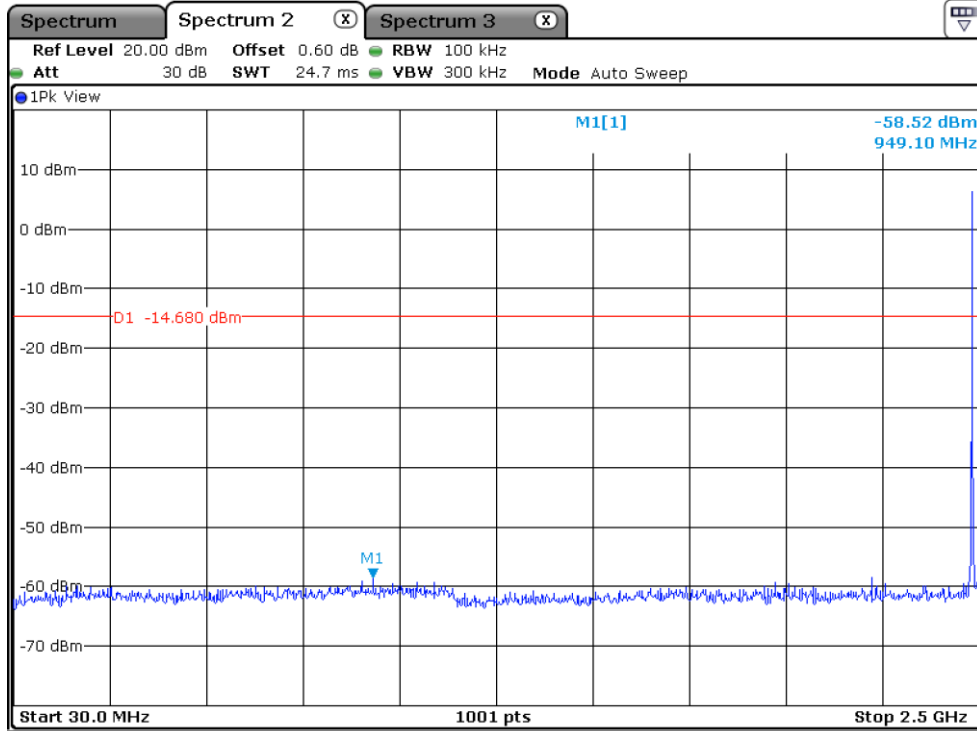
Date: 17.JAN.2023 11:26:47

Middle Channel



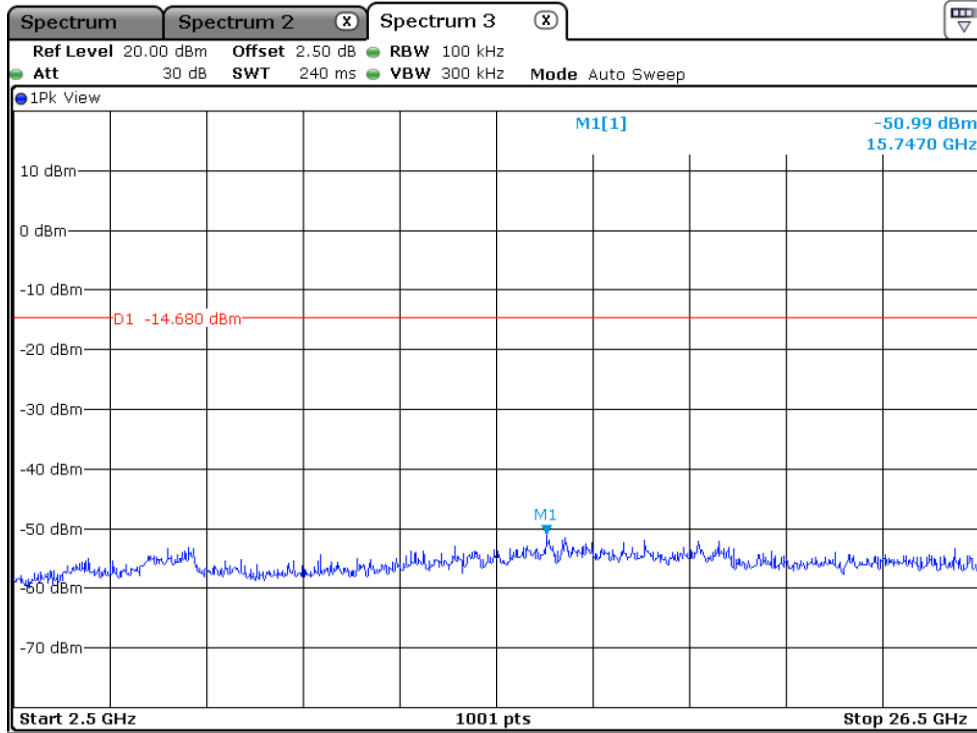
Date: 17.JAN.2023 11:27:22

Middle Channel



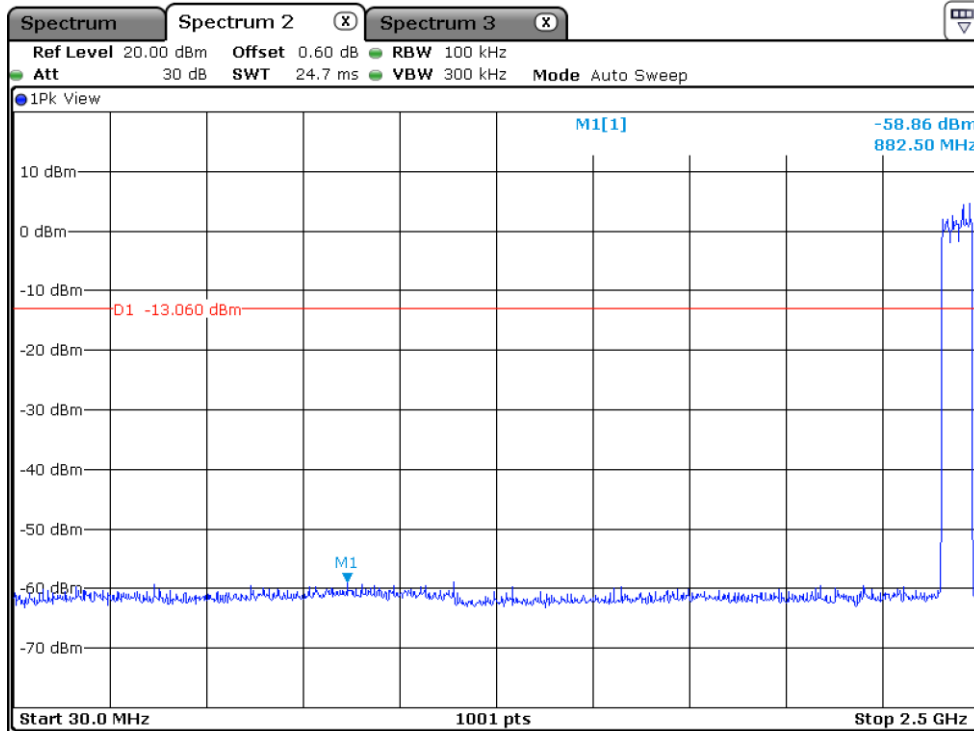
Date: 17.JAN.2023 11:29:46

High Channel



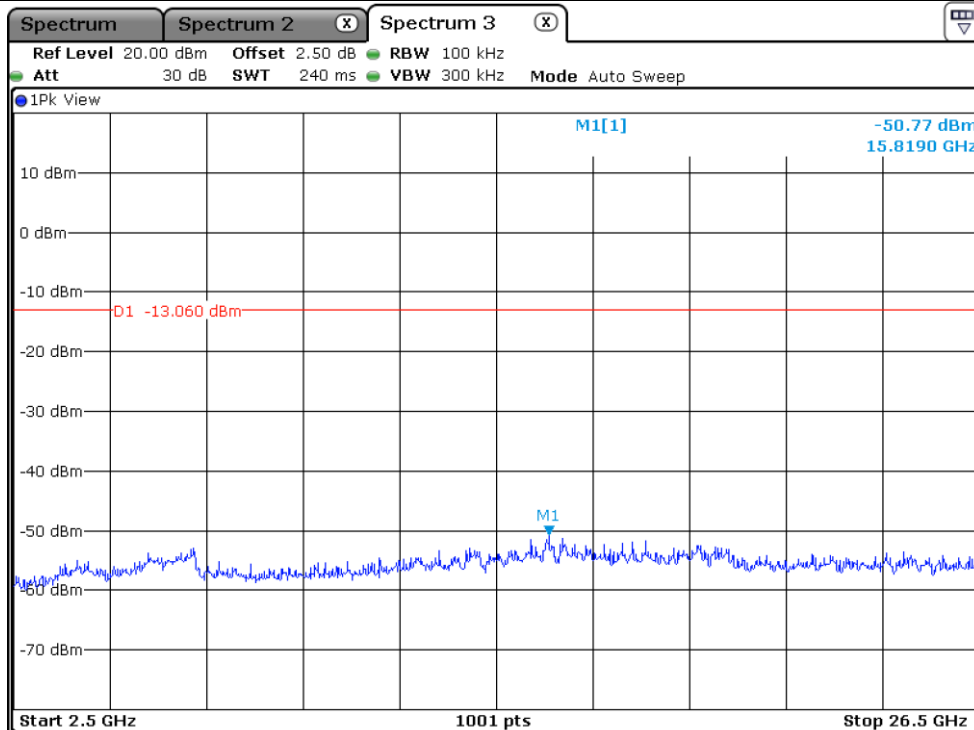
Date: 17.JAN.2023 11:30:25

High Channel



Date: 17.JAN.2023 11:44:30

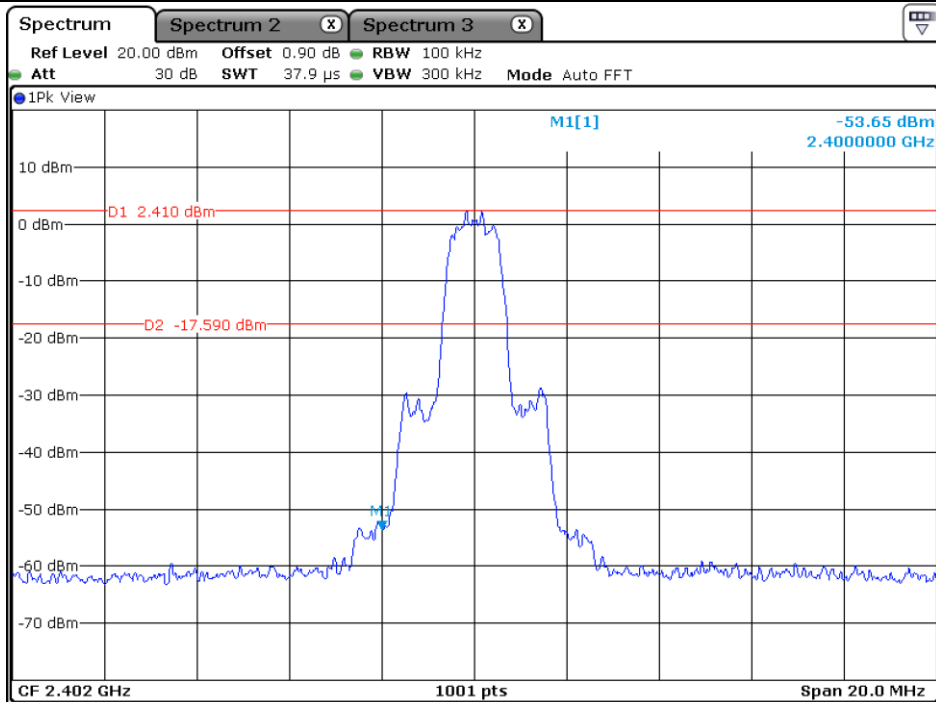
Hopping Channel



Date: 17.JAN.2023 11:45:44

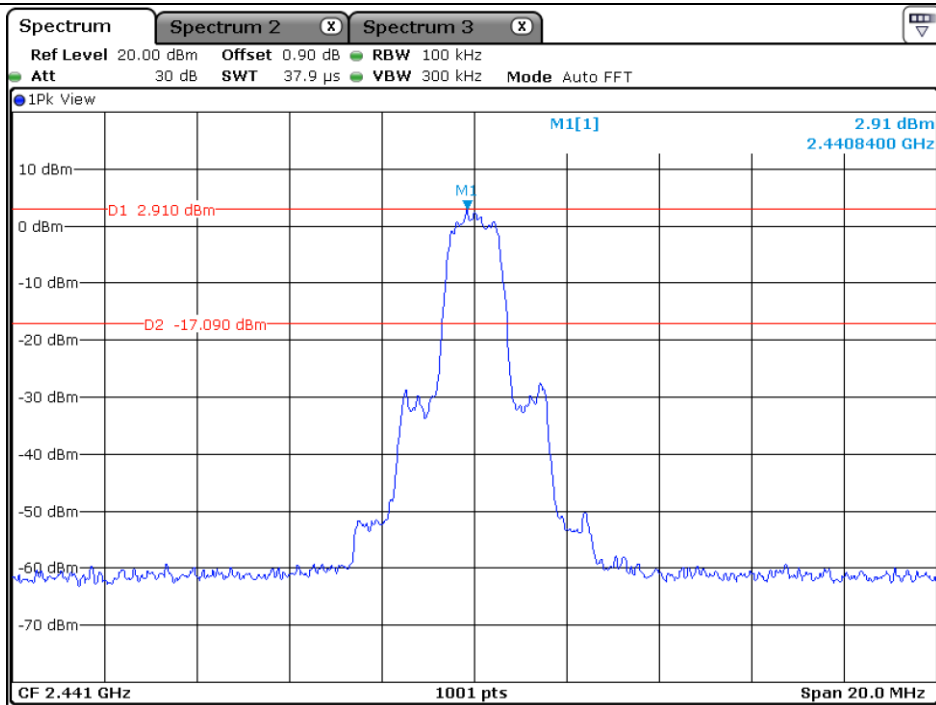
Hopping Channel

12.5.3 Test data for 3 Mbps



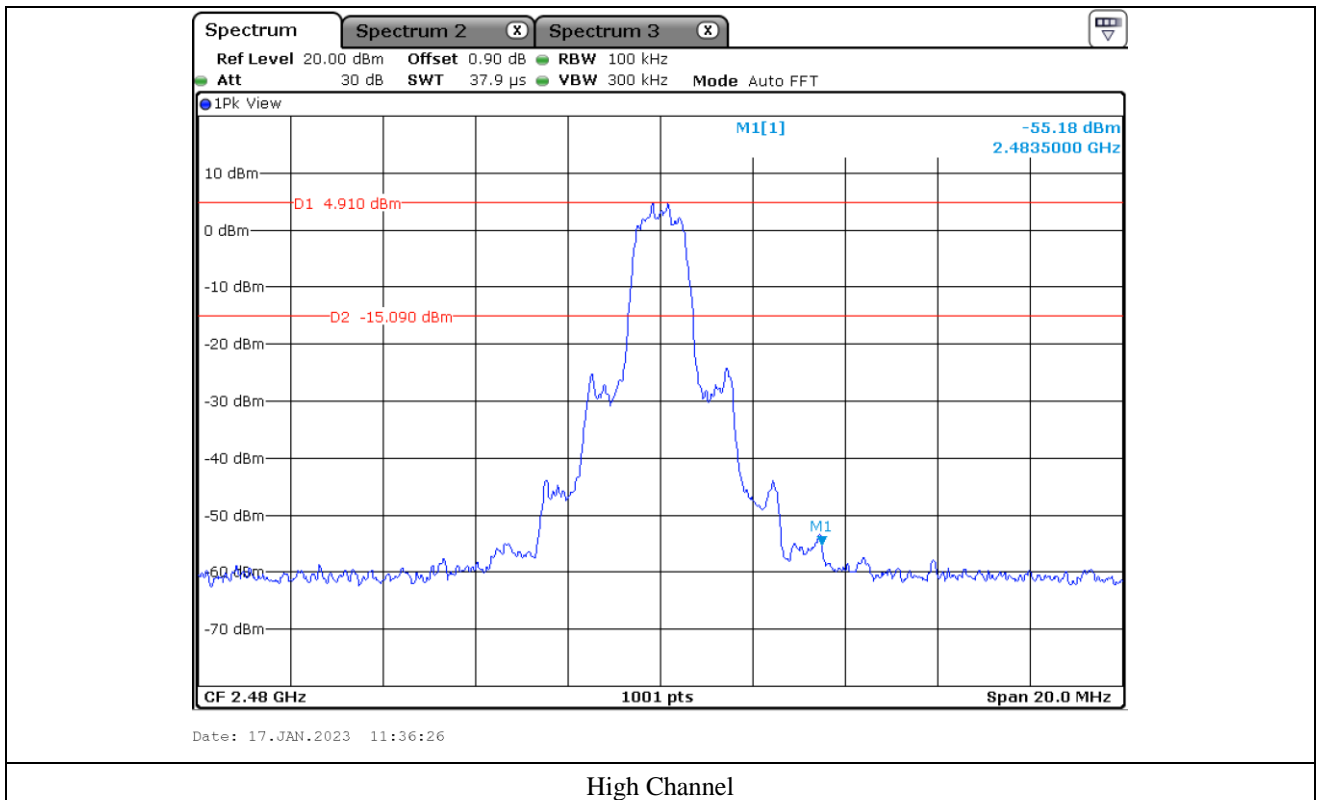
Date: 17.JAN.2023 11:31:26

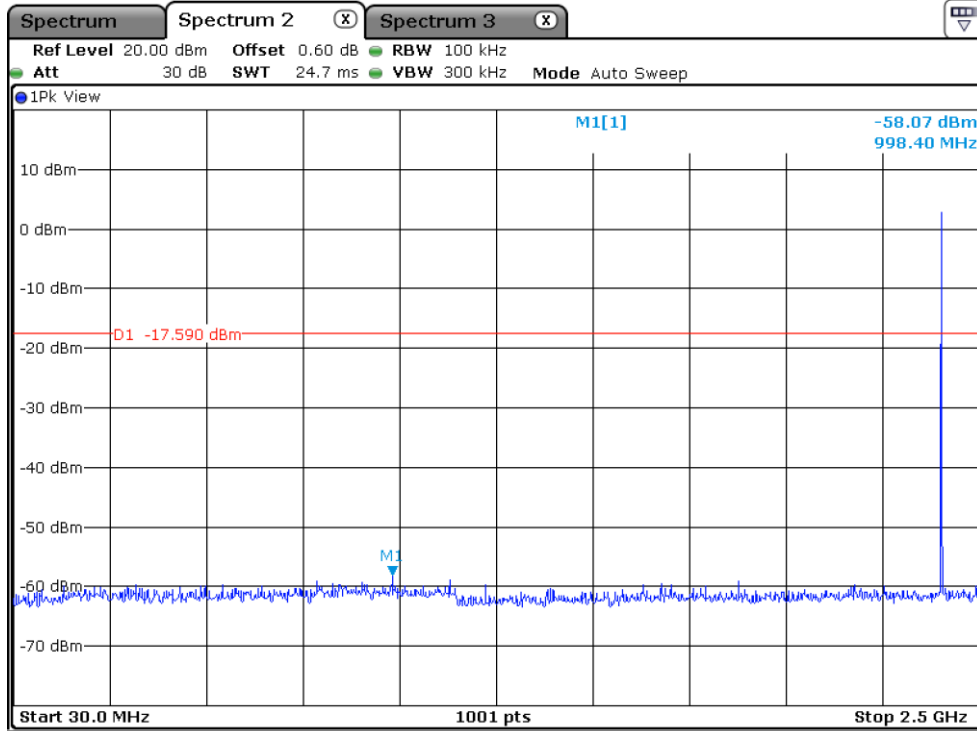
Low Channel



Date: 17.JAN.2023 11:34:00

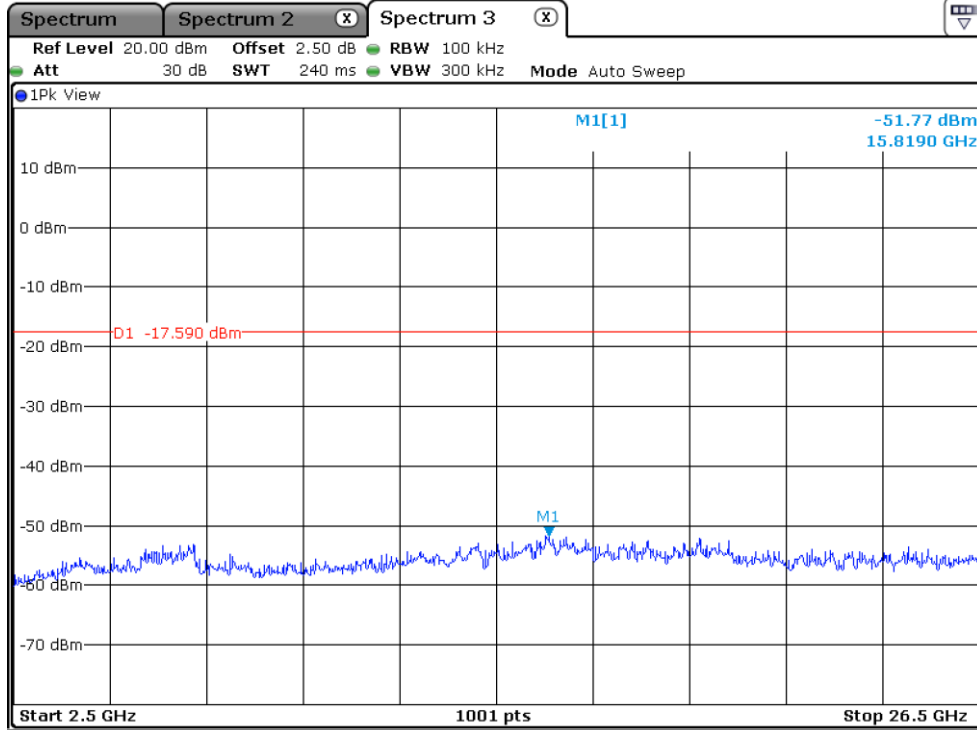
Middle Channel





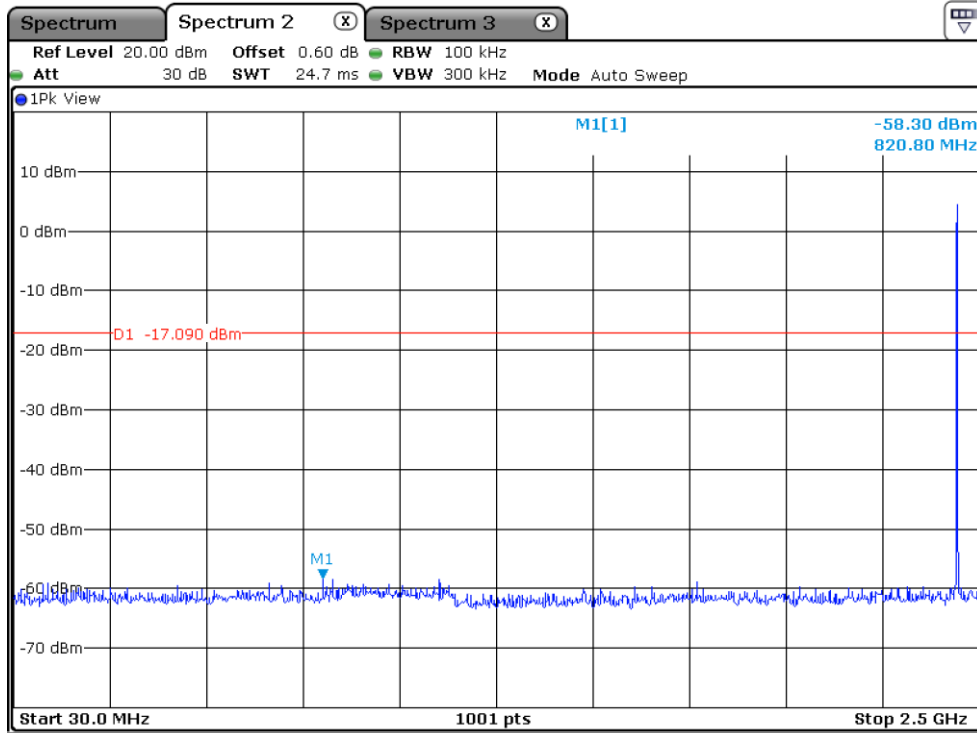
Date: 17.JAN.2023 11:32:48

Low Channel



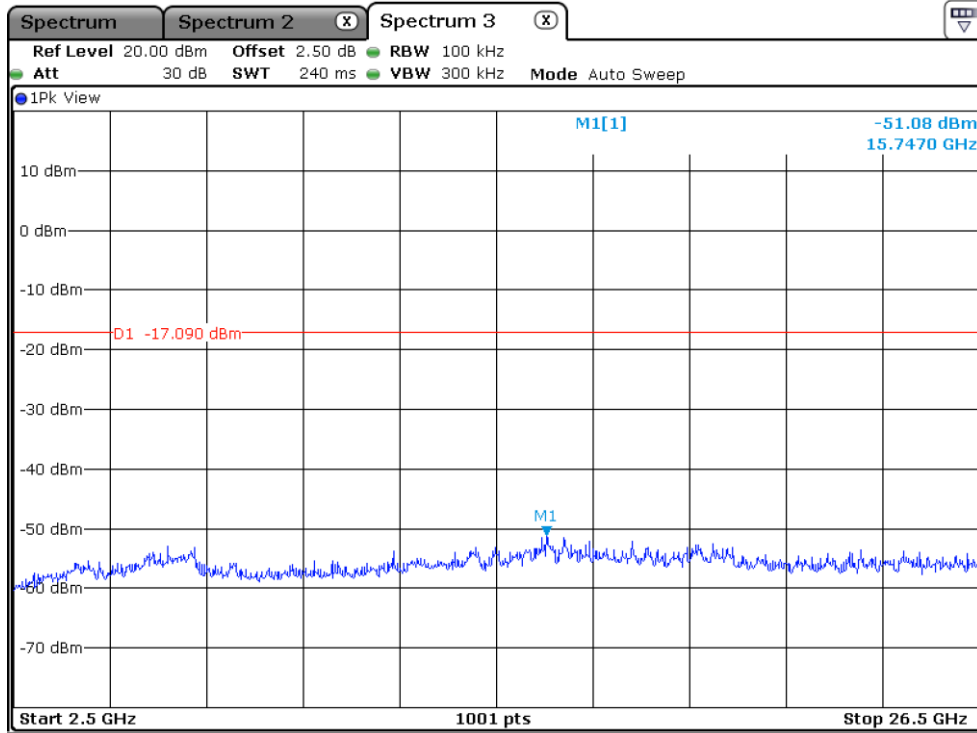
Date: 17.JAN.2023 11:33:16

Low Channel



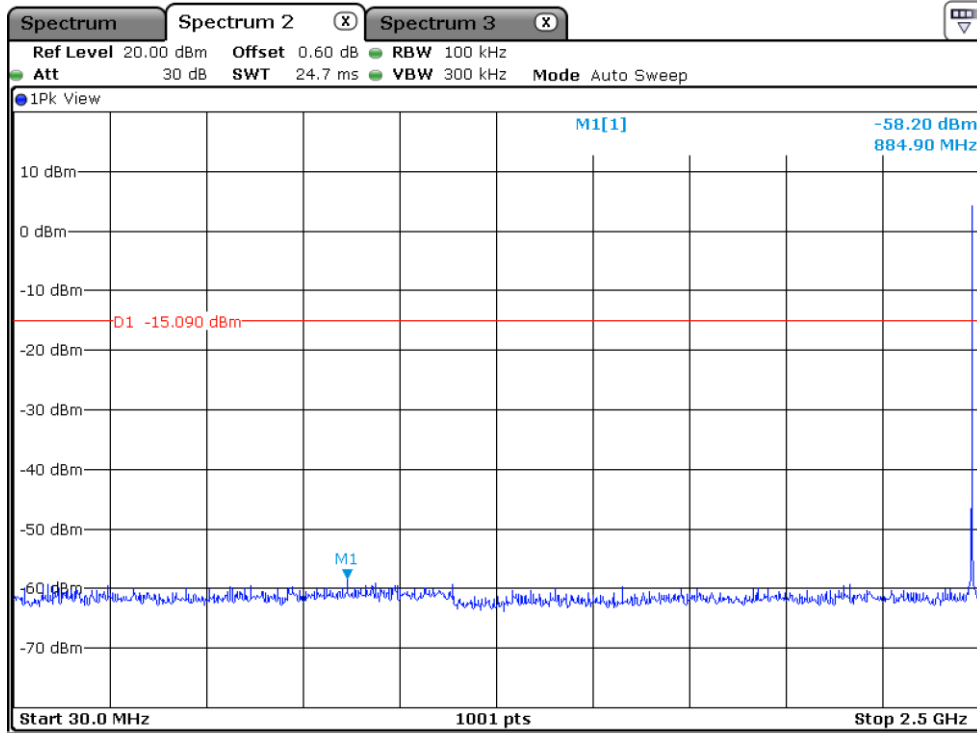
Date: 17.JAN.2023 11:35:09

Middle Channel



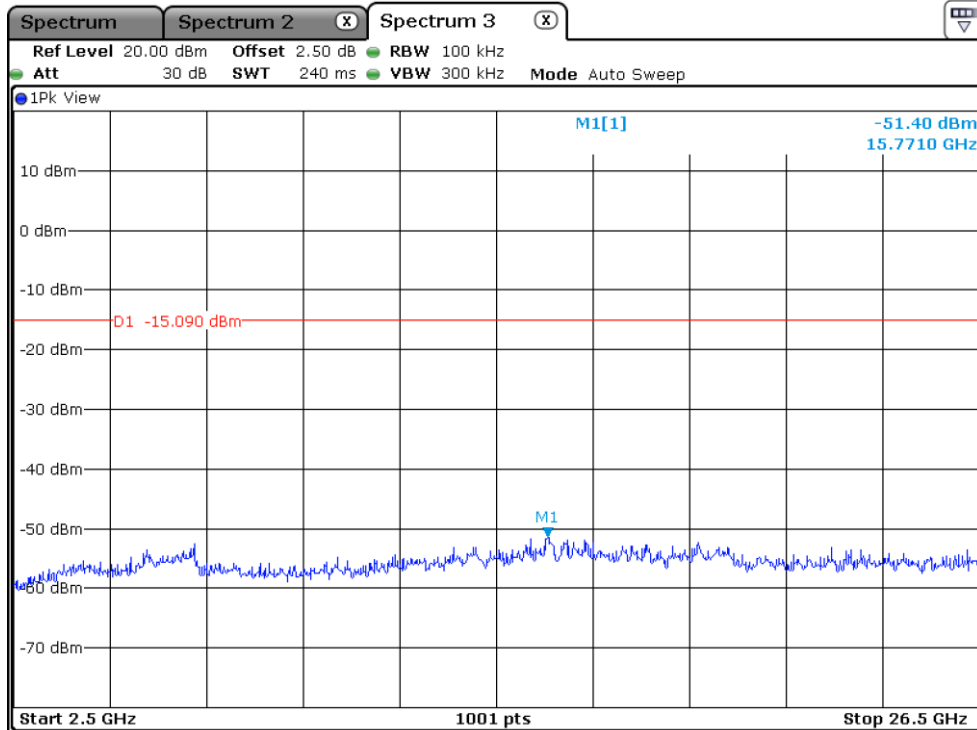
Date: 17.JAN.2023 11:35:39

Middle Channel



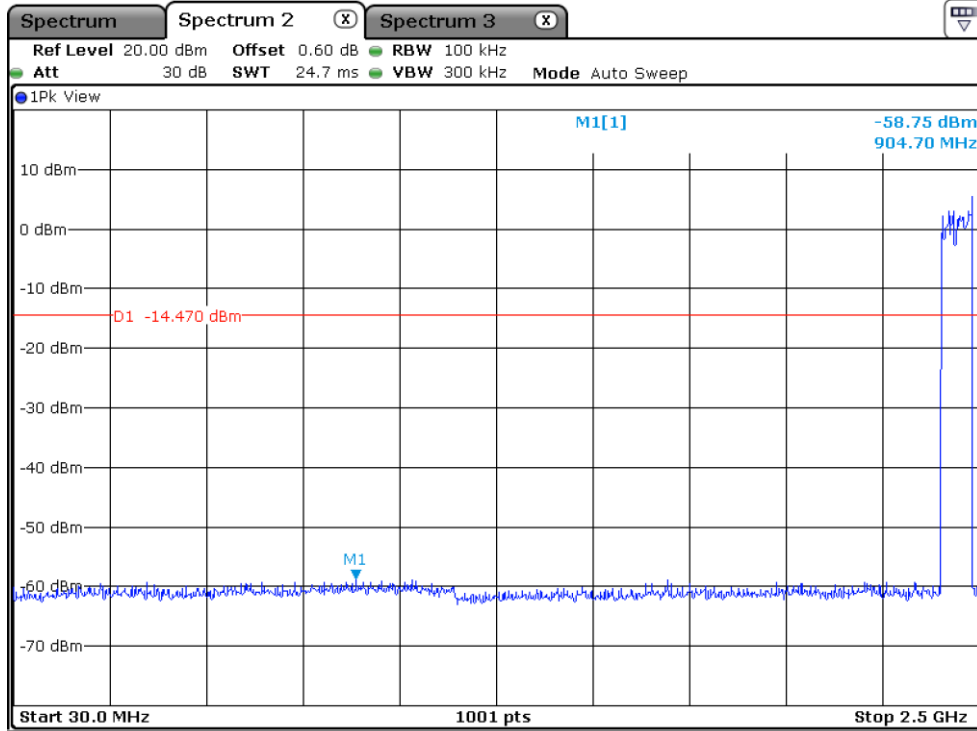
Date: 17.JAN.2023 11:36:55

High Channel



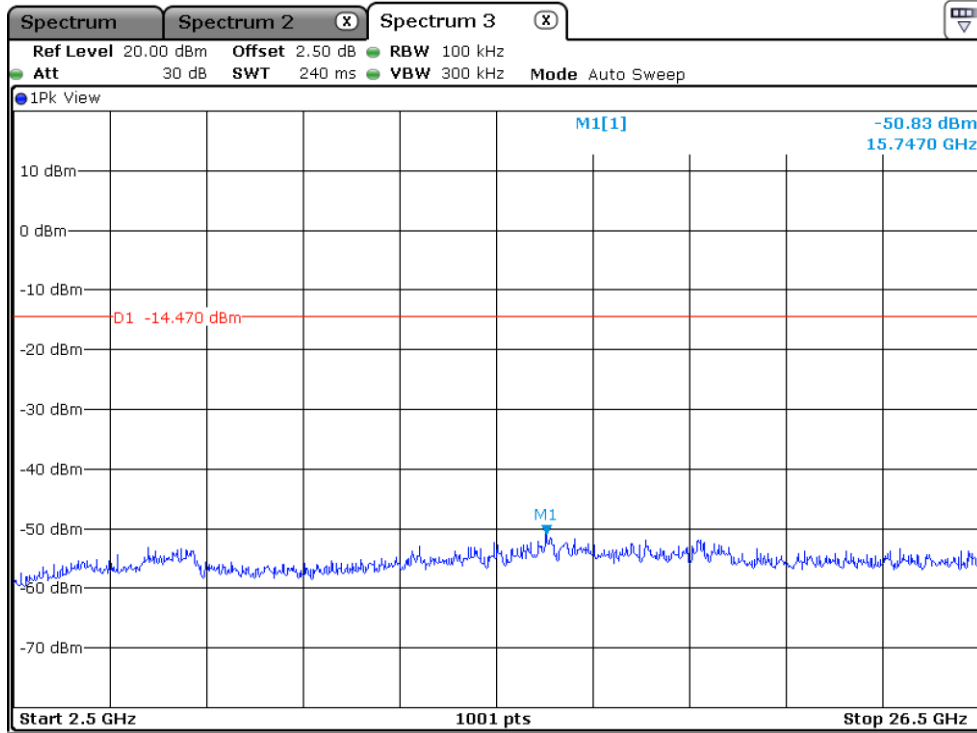
Date: 17.JAN.2023 11:37:23

High Channel



Date: 17.JAN.2023 11:49:14

Hopping Channel



Date: 17.JAN.2023 11:49:52

Hopping Channel

12.7 Test data for Transmitting mode radiated emission

12.7.1 Radiated Emission which fall in the Restricted Band

12.7.1.1 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 : 77.51 %
- 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										
2 316.38	54.88	Peak	H	28.03	7.27	44.96	-	45.22	74.00	28.78
2 389.36	43.57	Average	H	28.40	7.44	44.94	1.11	35.58	54.00	18.42
2 318.41	55.24	Peak	V	28.00	7.19	44.97	-	45.46	74.00	28.54
2 389.54	43.77	Average	V	28.00	7.19	44.98	1.11	35.09	54.00	18.91
Test Data for High Channel										
2 487.36	55.63	Peak	H	28.83	7.62	44.91	-	47.17	74.00	26.83
2 483.88	44.27	Average	H	28.82	7.62	44.90	1.11	36.92	54.00	17.08
2 483.72	55.49	Peak	V	28.81	7.53	44.90	-	46.93	74.00	27.07
2 483.86	44.05	Average	V	28.83	7.62	44.91	1.11	36.70	54.00	17.30

Tabulated test data for Restricted Band

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

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

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

12.7.1.2 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 : 77.11 %
- 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										
2 352.78	54.94	Peak	H	28.03	7.27	44.96	-	45.28	74.00	28.72
2 389.55	43.72	Average	H	28.40	7.44	44.94	1.13	35.75	54.00	18.25
2 315.28	55.05	Peak	V	28.00	7.19	44.97	-	45.27	74.00	28.73
2 331.00	43.25	Average	V	28.00	7.19	44.98	1.13	34.59	54.00	19.41
Test Data for High Channel										
2 483.56	56.54	Peak	H	28.83	7.62	44.91	-	48.08	74.00	25.92
2 483.52	44.27	Average	H	28.82	7.62	44.90	1.13	36.94	54.00	17.06
2 497.37	55.93	Peak	V	28.81	7.53	44.90	-	47.37	74.00	26.63
2 484.23	43.65	Average	V	28.83	7.62	44.91	1.13	36.32	54.00	17.68

Tabulated test data for Restricted Band

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

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

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

12.7.1.3 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 : 77.11 %
- . 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										
2 317.49	55.02	Peak	H	28.00	7.19	44.97	-	45.24	74.00	28.76
2 388.90	43.58	Average	H	28.39	7.44	44.94	1.13	35.60	54.00	18.40
2 332.75	55.15	Peak	V	28.00	7.27	44.97	-	45.45	74.00	28.55
2 316.57	43.43	Average	V	28.00	7.19	44.97	1.13	34.78	54.00	19.22
Test Data for High Channel										
2 486.46	56.41	Peak	H	28.83	7.62	44.91	-	47.95	74.00	26.05
2 484.05	43.82	Average	H	28.83	7.62	44.91	1.13	36.49	54.00	17.51
2 494.66	55.54	Peak	V	28.81	7.53	44.90	-	46.98	74.00	27.02
2 485.88	43.65	Average	V	28.83	7.62	44.91	1.13	36.32	54.00	17.68

Tabulated test data for Restricted Band

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

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

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

12.7.3 Spurious & Harmonic Radiated Emission above 1 GHz

12.7.3.1 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 : 77.51 %
- 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										
4 803.75	51.36	Peak	H	33.49	12.02	44.66	-	52.21	74.00	21.79
4 804.15	40.26	Average	H	33.49	12.02	44.66	1.11	42.22	54.00	11.78
4 804.36	50.65	Peak	V	33.49	12.02	44.66	-	51.50	74.00	22.50
4 803.89	39.88	Average	V	33.49	12.02	44.66	1.11	41.84	54.00	12.16
Test Data for Middle Channel										
4 881.28	50.53	Peak	H	33.46	12.02	44.68	-	51.33	74.00	22.67
4 881.87	40.62	Average	H	33.46	12.02	44.68	1.11	42.53	54.00	11.47
4 881.10	50.54	Peak	V	33.46	12.02	44.68	-	51.34	74.00	22.66
4 881.85	40.44	Average	V	33.46	12.02	44.68	1.11	42.35	54.00	11.65
Test Data for High Channel										
4 959.75	50.90	Peak	H	33.63	12.02	44.69	-	51.86	74.00	22.14
4 959.89	40.85	Average	H	33.63	12.02	44.69	1.11	42.92	54.00	11.08
4 959.95	50.30	Peak	V	33.62	12.02	44.69	-	51.25	74.00	22.75
4 960.05	40.54	Average	V	33.62	12.02	44.69	1.11	42.60	54.00	11.40

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

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

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

12.7.3.2 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 : 77.11 %
- 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										
4 803.75	52.37	Peak	H	33.49	12.02	44.66	-	53.22	74.00	20.78
4 803.91	42.44	Average	H	33.49	12.02	44.66	1.13	44.42	54.00	9.58
4 803.03	50.64	Peak	V	33.49	12.02	44.66	-	51.49	74.00	22.51
4 805.28	38.44	Average	V	33.49	12.02	44.66	1.13	40.42	54.00	13.58
Test Data for Middle Channel										
4 881.90	50.73	Peak	H	33.46	12.02	44.68	-	51.53	74.00	22.47
4 882.06	40.33	Average	H	33.46	12.02	44.68	1.13	42.26	54.00	11.74
4 881.60	50.26	Peak	V	33.46	12.02	44.68	-	51.06	74.00	22.94
4 882.17	38.43	Average	V	33.46	12.02	44.68	1.13	40.36	54.00	13.64
Test Data for High Channel										
4 963.28	50.88	Peak	H	33.63	12.02	44.69	-	51.84	74.00	22.16
4 964.98	38.15	Average	H	33.63	12.02	44.69	1.13	40.24	54.00	13.76
4 958.73	50.43	Peak	V	33.62	12.02	44.69	-	51.38	74.00	22.62
4 960.04	38.51	Average	V	33.62	12.02	44.69	1.13	40.59	54.00	13.41

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

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

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

12.7.3.3 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 : 77.11 %
- 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										
4 800.23	50.54	Peak	H	33.50	12.02	44.66	-	51.40	74.00	22.60
4 806.37	38.54	Average	H	33.49	12.02	44.66	1.13	40.52	54.00	13.48
4 804.69	50.60	Peak	V	33.49	12.02	44.66	-	51.45	74.00	22.55
4 804.12	38.52	Average	V	33.49	12.02	44.66	1.13	40.50	54.00	13.50
Test Data for Middle Channel										
4 884.00	50.20	Peak	H	33.47	12.02	44.68	-	51.01	74.00	22.99
4 881.76	38.26	Average	H	33.46	12.02	44.68	1.13	40.19	54.00	13.81
4 885.46	50.11	Peak	V	33.47	12.02	44.68	-	50.92	74.00	23.08
4 882.03	38.21	Average	V	33.46	12.02	44.68	1.13	40.14	54.00	13.86
Test Data for High Channel										
4 964.28	50.29	Peak	H	33.63	12.02	44.69	-	51.25	74.00	22.75
4 955.96	38.32	Average	H	33.61	12.02	44.69	1.13	40.39	54.00	13.61
4 964.90	50.16	Peak	V	33.63	12.02	44.69	-	51.12	74.00	22.88
4 960.29	38.44	Average	V	33.62	12.02	44.69	1.13	40.52	54.00	13.48

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 : 23 °C
Relative humidity : 50 % 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.

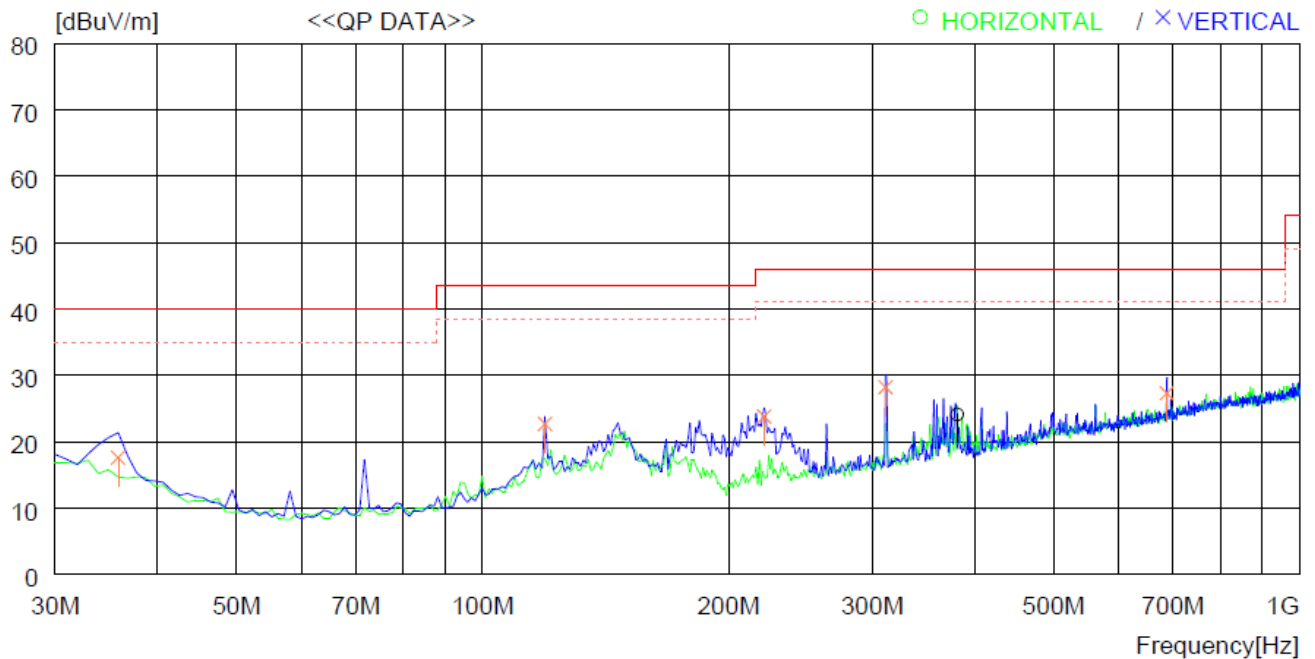
13.3 Test Date

December 27, 2022 ~ January 19, 2023

13.4 Test data

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 [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	381.140	33.3	20.3	2.5	32.0	24.1	46.0	21.9	300	293
----- Vertical -----										
2	35.820	30.2	18.8	0.8	32.2	17.6	40.0	22.4	100	0
3	119.240	34.8	18.5	1.4	32.0	22.7	43.5	20.8	100	355
4	221.090	37.6	16.3	1.9	32.0	23.8	46.0	22.2	100	0
5	311.300	38.5	19.4	2.3	32.0	28.2	46.0	17.8	100	100
6	687.655	31.0	25.2	3.4	32.3	27.3	46.0	18.7	100	190

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

14. CONDUCTED EMISSION TEST

14.1 Operating environment

Temperature : 23 °C
Relative humidity : 50 % R.H.

14.2 Test set-up

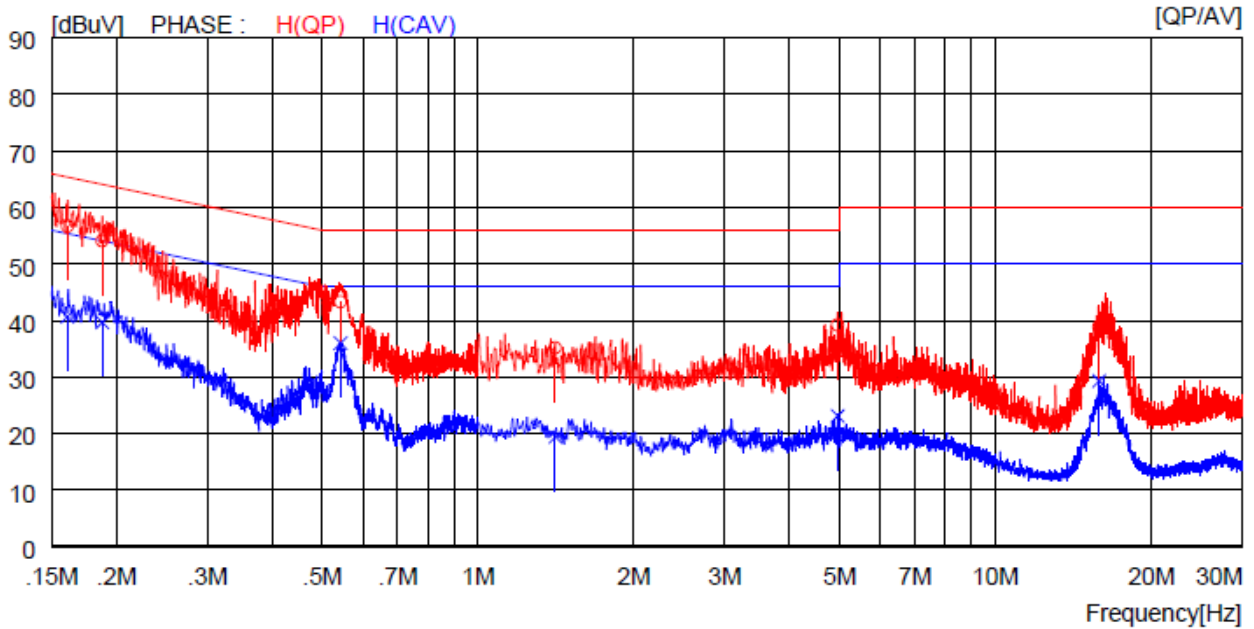
The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

14.3 Test Date

December 27, 2022 ~ January 19, 2023

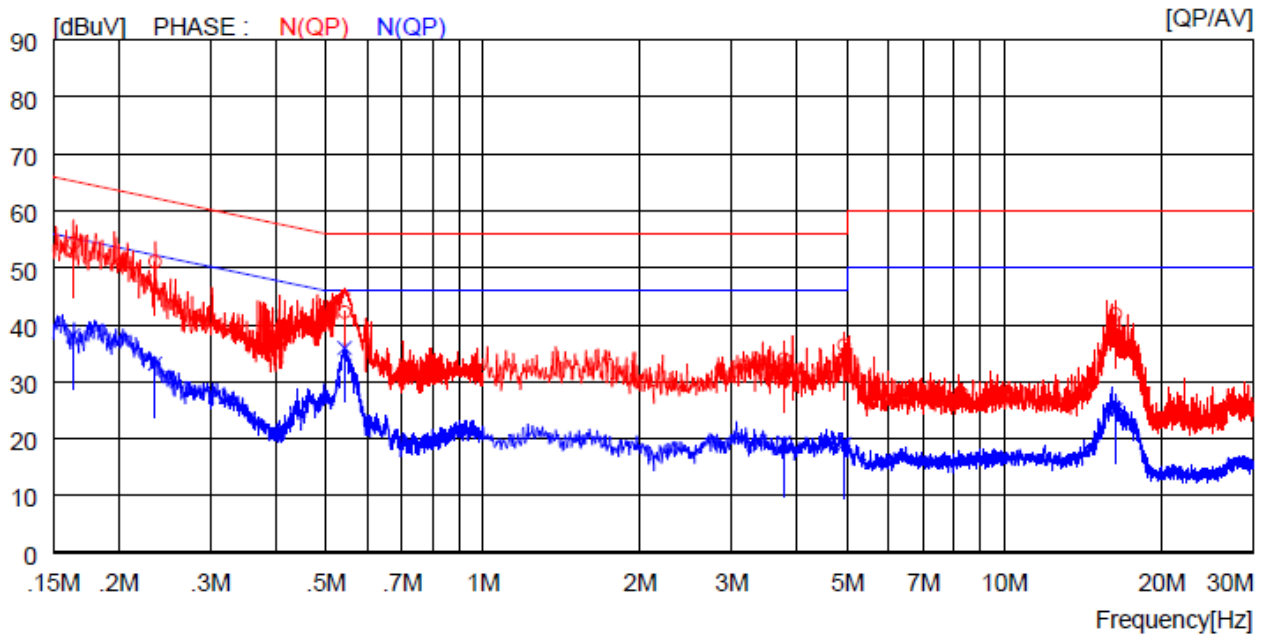
14.4 Test data

- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.16100	46.5	----	10.2	56.7	----	65.4	----	8.7	----	H(QP)
2	0.18800	44.0	----	10.1	54.1	----	64.1	----	10.0	----	H(QP)
3	0.54300	33.3	----	10.0	43.3	----	56.0	----	12.7	----	H(QP)
4	1.41200	25.1	----	10.1	35.2	----	56.0	----	20.8	----	H(QP)
5	4.96000	29.1	----	10.1	39.2	----	56.0	----	16.8	----	H(QP)
6	15.88000	28.7	----	10.2	38.9	----	60.0	----	21.1	----	H(QP)
7	0.16100	----	30.5	10.2	----	40.7	----	55.4	----	14.7	H(CAV)
8	0.18800	----	29.6	10.1	----	39.7	----	54.1	----	14.4	H(CAV)
9	0.54300	----	26.0	10.0	----	36.0	----	46.0	----	10.0	H(CAV)
10	1.41200	----	9.3	10.1	----	19.4	----	46.0	----	26.6	H(CAV)
11	4.96000	----	13.0	10.1	----	23.1	----	46.0	----	22.9	H(CAV)
12	15.88000	----	19.1	10.2	----	29.3	----	50.0	----	20.7	H(CAV)

- Test Line : NEUTRAL LINE



NO	FREQ [MHz]	READING		C. FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.16400	44.1	----	10.2	54.3	----	65.3	----	11.0	----	N(QP)
2	0.23500	41.0	----	10.1	51.1	----	62.3	----	11.2	----	N(QP)
3	0.54300	32.2	----	10.0	42.2	----	56.0	----	13.8	----	N(QP)
4	3.78000	23.9	----	10.1	34.0	----	56.0	----	22.0	----	N(QP)
5	4.92800	26.3	----	10.1	36.4	----	56.0	----	19.6	----	N(QP)
6	16.34000	31.7	----	10.2	41.9	----	60.0	----	18.1	----	N(QP)
7	0.16400	----	28.0	10.2	----	38.2	----	55.3	----	17.1	N(CAV)
8	0.23500	----	23.1	10.1	----	33.2	----	52.3	----	19.1	N(CAV)
9	0.54300	----	25.9	10.0	----	35.9	----	46.0	----	10.1	N(CAV)
10	3.78000	----	9.2	10.1	----	19.3	----	46.0	----	26.7	N(CAV)
11	4.92800	----	9.0	10.1	----	19.1	----	46.0	----	26.9	N(CAV)
12	16.34000	----	14.9	10.2	----	25.1	----	50.0	----	24.9	N(CAV)

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

15. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	101457	Apr. 11, 2022 (1Y)
ESR	Rohde & Schwarz	EMI TEST RECEIVER	101470	Oct. 18, 2022 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 15, 2022 (1Y)
DT3000-3t- Tragplatten	Innco System	Turn Table	930611	N/A
MA-4000XPET	Innco System	Antenna Master	MA4000/509/37211215/L	N/A
BBHA9120D	Schwarzbeck	Horn Antenna	295	Mar. 02, 2022(1Y)
SCU18	Rohde & Schwarz	Amplifier	102209	Oct. 14, 2022(1Y)
HLP-2008	TDK RF Solutions	Hybrid Antenna	131314	Mar. 02, 2022 (2Y)
Cavity Band Rejection Filter	Microwave	Filter (2.4 ~ 2.4835)GHz	WT22040502-1	Jun. 21, 2022 (1Y)
ZUP36-6	TDK-Lambda	DC POWER SUPPLY	6MJ-850Z16-0014	Apr. 11, 2022 (1Y)
ESR7	Rohde & Schwarz	EMI Test Receiver	102190	Oct. 12, 2022 (1Y)
ESH3-Z2	Rohde & Schwarz	Pulse Limiter	100655	Mar. 14, 2022 (1Y)
NSLK8128	Schwarzbeck Mess-ELE	Artificial Main Networks	8128216	Mar. 14, 2022 (1Y)